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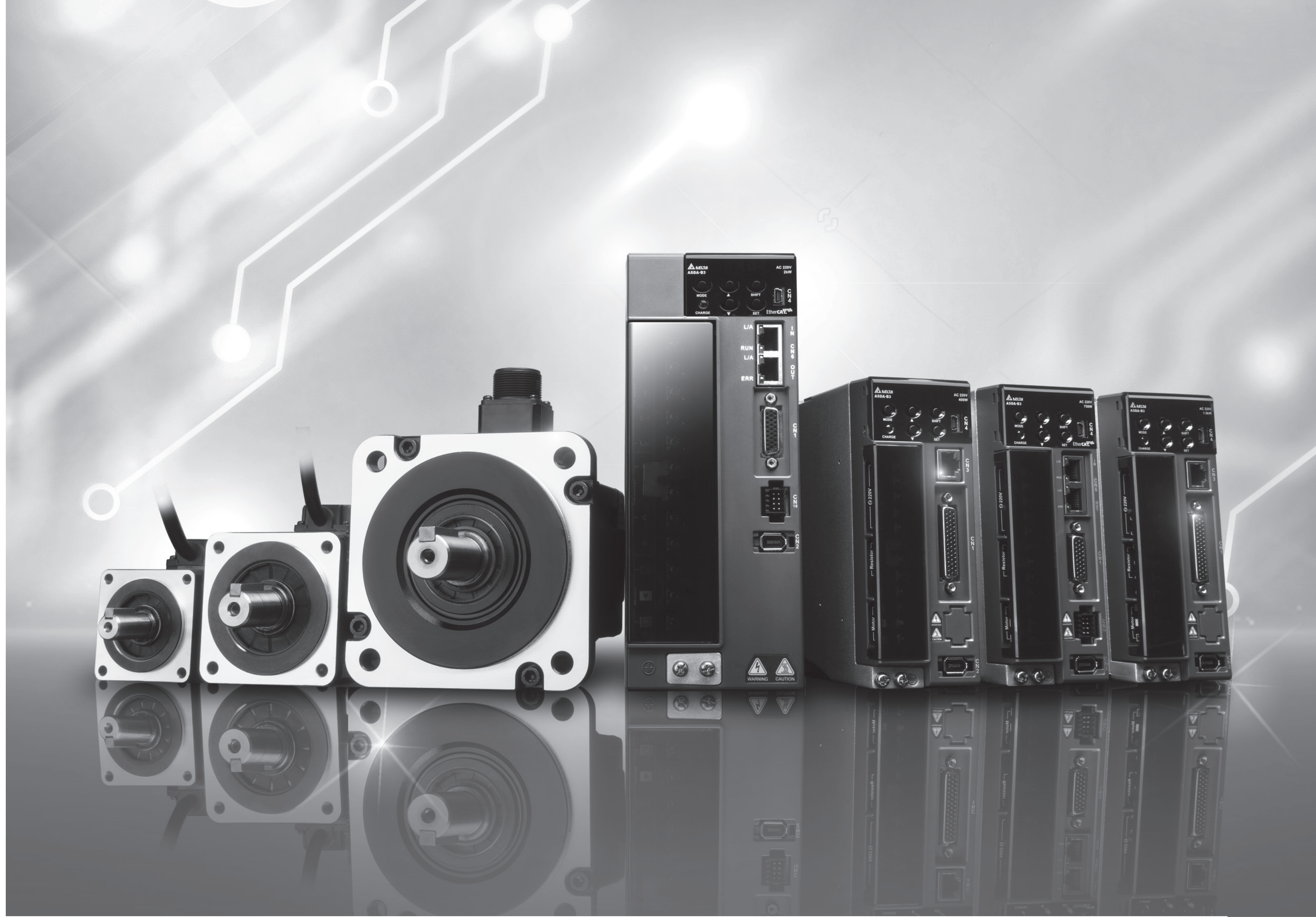
DELTA_IA-ASD_ASDA-B3_UM_EN_20250108

Delta ASDA-B3 Series Servo Drive User Manual



Delta ASDA-B3 Series Servo Drive User Manual

www.deltaww.com

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Preface

Thank you for purchasing this product. This manual provides information about the ASDA-B3 series servo drives (B3) and the ECM-B3 and ECM-A3 series servo motors.

This manual includes:

- Installation and inspection of servo drive and servo motor
- Servo structure and wiring diagram
- Instructions for test operation
- Instructions for servo tuning
- Description of motion control
- Description of parameters
- Description of communication protocol
- Troubleshooting

Product features:

- New control algorithm: overcomes the problems of a lack of stiffness or flexibility in the machine structure.
- Auto tuning function: user-friendly and allows you to complete tuning easily.
- Gain adjustment function: automatically detects changes in the inertia and improves the control precision.
- New generation servo motor: a compact size servo motor meets the need for reducing the size and weight of the equipment structures.

How to use this manual:

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

Delta technical services:

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

Safety precautions

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

This product is used in industrial applications and should be installed in a control cabinet. Servo drives, wires, and motors should all be installed in an environment which complies with the minimum requirement of UL50 Type 1.

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

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

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

Inspection

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

Installation

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

Wiring

DANGER

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

Operation

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

- To avoid accidents, remove all units during the first test run, so that the motor is operating without any load.
- If you fail to operate the servo motor properly after it is connected to the machine, it may damage the machine and lead to personal injury.
- In order to prevent danger, it is strongly recommended that you make sure the servo motor can operate normally without load first. Then, try operating the motor with load.
- Do not touch the heat sink of the servo drive during operation, or it may cause burns.
- There should be at least a 5-minute interval between each operation of the dynamic brake.

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

Maintenance and examination

- 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 wiring terminals until the “CHARGE” indicator is off, since the residual voltage may cause electric shock.
- Do not disassemble the servo motor, or it may cause electric shock or personal injury.
- Do not change the wiring when the power is on, or it may cause electric shock or personal injury.
- Only qualified electricians can install, wire, repair, and maintain the servo drive and servo motor.

Main circuit wiring

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

- Do not put the power cable and signal cable in the same channel or bond them together. Separate the power cable and signal cable by at least 30 centimeters (11.8 inches).
- Use stranded wires and multi-core shielded-pair wires for signal cables and encoder cables. The maximum length of the signal cable is 3 meters (9.84 feet) and the maximum length of the encoder cable is 20 meters (65.62 feet).
- High voltage may remain in the servo drive after the power is turned off. Do not touch the terminals or perform wiring until the “CHARGE” indicator is off.
- When wiring, securely tighten the screws of the terminal block.
- When inserting the wires, do not short-circuit the adjacent wires.
- Before applying power, 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 standard, the wires must comply with one of the following specifications to ensure proper grounding:
  1. Copper wire with a cross-sectional area of at least 10 mm^2.
  2. Aluminum wire with a cross-sectional area of at least 16 mm^2.
- Failure to comply with the specifications may result in personal injury.
- Before applying power, inspect and ensure that the wiring is correct.

Disposal instructions

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

Certification information

Certified products will have the corresponding certification marks printed on the nameplates. Products without a certification mark indicate non-compliance with the relevant specifications.

Download the safety certificate from Delta's Download Center or contact Delta.

The servo drives, servo motors, and their accessories are **not** subject to the China Compulsory Certificate (CCC).

Certification mark	Certification for servo drive		Specification
	CE	EMC Directive	EN IEC 61800-3
		Low Voltage Directive	EN 61800-5-1
	UL	UL Standard	UL 61800-5-1
	TÜV SÜD	Machinery Directive	EN IEC 62061: 2021
			EN 61800-5-2: 2017
			EN ISO 13849-1: 2023
		Functional Safety	IEC / EN 61508: 2010
		EMC for Functional Safety	EN 61326-3-1: 2017
			EN 61000-6-7: 2015
	TÜV Rheinland	Machinery Directive	EN IEC 62061: 2021
			EN 61800-5-2: 2017
			EN ISO 13849-1: 2015
		Functional Safety	IEC / EN 61508: 2010
		EMC for Functional Safety	EN 61326-3-1: 2017
			EN 61000-6-7: 2015

Inspection and maintenance

Operating conditions:

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

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

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

Part replacement

Operating conditions:

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

Product	Part name	Suggested replacement cycle	Note
Servo drive	Electrolytic capacitor	Approx. 5 years	The replacement cycle varies depending on the ambient conditions and usage. Replace the part immediately when any error occurs.
	Cooling fan	2 to 3 years (10,000 to 30,000 hours)	
	Relay	Approx. 100,000 times	
	Soft start resistor	Approx. 20,000 times	
Battery box	Battery	Refer to Section 10.1.1	
Servo motor	Bearing	20,000 hours	
	Oil seal	5,000 hours	

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

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

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Table of Contents

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1 Product Overview

2 Installation

3 Wiring

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5 Tuning

Operation and Motion Control

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Control Mode

9 Modbus Communication

10 Absolute System

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12 EtherCAT Mode

Troubleshooting

Troubleshooting

Appendix

A Specifications

B Accessories

1

Product Overview

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

1

1.1 Items to check after unpacking

When unpacking, check that the corresponding items are included and the number is correct. If anything is missing, contact the distributor for service.

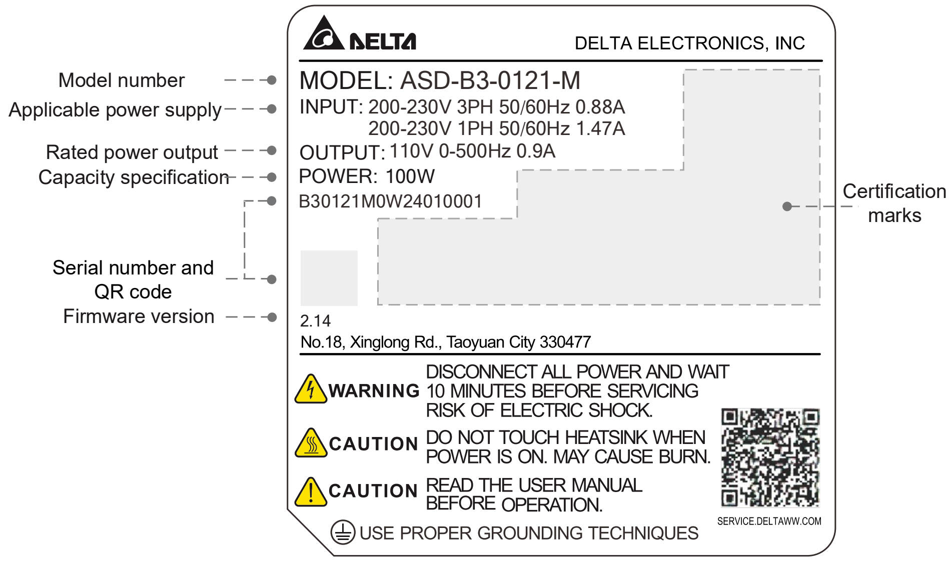
Item \ Model		B3-L	B3-M / B3-E / B3-F	B3A-L	B3A-M / B3A-E / B3A-F / B3A-P
D-Sub connector (for CN1)	26-pin	0	1	0	1
	44-pin	1	0	1	0
STO connector (for CN10)		0	0	1	1
Instruction sheet		1	1	1	1

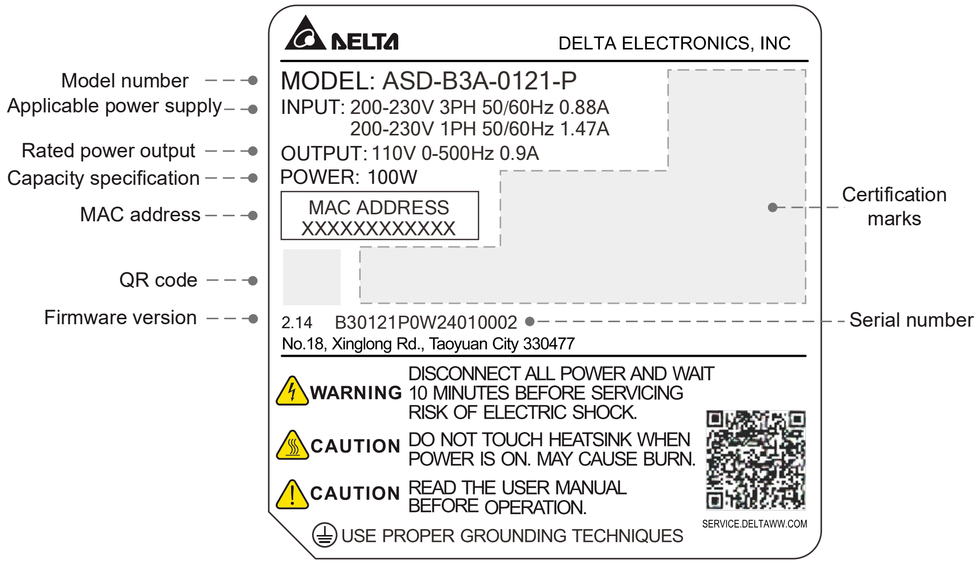
1.2 Model overview

1.2.1 Nameplate information

ASDA-B3 series servo drive

■ **Nameplate information**





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

■ **Serial number**

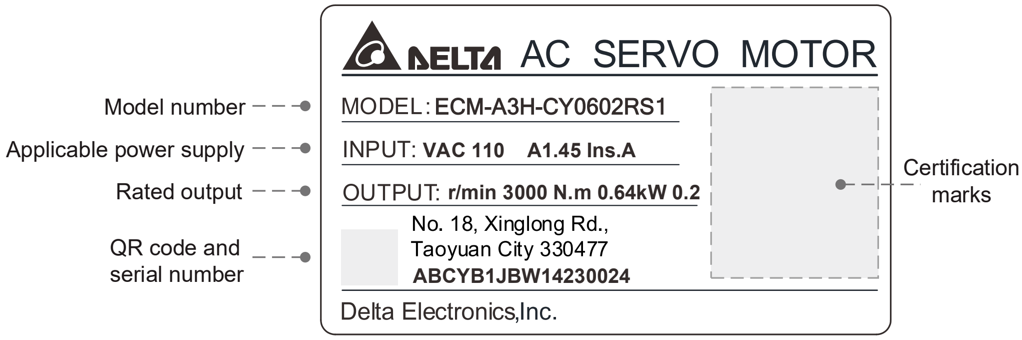
B30121P0	W	24	01	0002
(1)	(2)	(3)	(4)	(5)

(1) Model number
(2) Manufacturing plant (T: Taoyuan; W: Wujiang)
(3) Year of production (24: year 2024)
(4) Week of production (from 1 to 52)
(5) Production sequence in a week (starting from 0001)

1

ECM-A3 / ECM-B3 series servo motor

■ Nameplate information



■ Serial number

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

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

Note: the rated voltage (220V / 400V) written in the servo motor specifications indicates the input voltage for the servo drive. The servo motor uses the certified voltage as the rated input voltage for operation, so the applicable power supply for 220V series servo motor is 110V, and the applicable power supply for 400V series servo motor is 220V.

1.2.2 Model explanation

ASDA-B3 servo drive

ASD – B3 – 04 21 – M

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

(1) Product name
ASD: AC Servo Drive

(2) Series
B3: B3 series
B3A: B3A series

(3) Rated power output

Code	Specification	Code	Specification	Code	Specification
01	100 W	15	1.5 kW	55	5.5 kW
02	200 W	20	2 kW	75	7.5 kW
04	400 W	30	3 kW	80	8 kW
07	750 W	40	4 kW	-	-
10	1 kW	45	4.5 kW	-	-

(4) Input voltage and phase
21: 220V, single- / three-phase
23: 220V, three-phase
43: 400V, three-phase

(5) Model type
B3 series

Connector	Function	L	M	F	E
CN1	Number of DIs / DOs	9 / 6	4 / 2	4 / 2	4 / 2
	Analog voltage input / output	2 / 2	2 / 2	2 / 2	2 / 2
	Pulse input (Pulse / Sign)	✓	-	-	-
	Pulse output (OA / OB / OZ)	✓	✓	✓	✓
	OCZ signal	✓	-	-	-
	High-speed Capture DI (PR)	DI7	DI3	DI3	-
	Touch Probe (EtherCAT)	-	-	-	DI1, DI2
	Number of CN1 pins	44	26	26	26
CN3	Communication function	RS-485	CANopen	-	-
CN4	Communication function (to PC)	Mini USB	Mini USB	Mini USB	Mini USB
CN6	Bus communication	-	-	DMCNET	EtherCAT
-	STO	-	-	-	-
-	Dynamic brake (hardware)*2	-	-	-	-
-	PR mode	✓	✓	✓	✓
-	Absolute function	✓	✓	✓	✓

1

B3A series

Connector	Function	L	M	F	E	P
CN1	Number of DIs / DOs	9 / 6	4 / 2	4 / 2	4 / 2	6 / 3
	Analog voltage input / output	2 / 2	2 / 2	2 / 2	2 / 2	-
	Pulse input (Pulse / Sign)	✓	✓	✓	✓	-
	Pulse output (OA / OB / OZ)	✓	✓	✓	✓	✓
	OCZ signal	✓	-	-	-	-
	High-speed Capture DI (PR)	DI7	DI3	DI3	-	DI3
	Touch Probe (EtherCAT)	-	-	-	DI1, DI2	-
	Number of CN1 pins	44	26	26	26	26
CN3	Communication function	RS-485	CANopen RS-485	-	-	-
CN4	Communication function (to PC)	Mini USB	Mini USB	Mini USB	Mini USB	Mini USB
CN6	Bus communication	-	-	DMCNET	EtherCAT	PROFINET
CN10	STO	✓	✓	✓	✓	✓
-	Dynamic brake (hardware)[*2]	✓	✓	✓	✓	✓
-	PR mode	✓	✓	✓	✓	✓
-	Absolute function	✓	✓	✓	✓	✓

Note:

1. the model codes listed here are only for demonstration of the naming convention; some combinations of the model codes are not available. Contact the distributors for the models available for purchase.
2. The dynamic brake is activated when power to the servo drive is lost.

ECM-B3 series servo motor

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

(1) Product name
ECM: electronically commutated motor

(2) Servo type
B: general type servo motor

(3) Series
3: 3rd series

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

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

(6) Encoder type
A: 24-bit absolute optical encoder
(resolution of single turn: 24-bit; number of revolutions: 16-bit)
2: 24-bit incremental optical encoder (single-turn absolute)
P: 17-bit absolute magnetic encoder
(resolution of single turn: 17-bit; number of revolutions: 16-bit)
M: 17-bit incremental magnetic encoder (single-turn absolute)

Note: number of revolutions means the maximum number of turns the encoder can record.

(7) Motor frame size

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

(8) Rated power output

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

(9) Shaft type and oil seal

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

(10) Shaft diameter and connector type

S: standard shaft diameter and standard connectors

7: special shaft diameter (14 mm)*1 and standard connectors

J: standard shaft diameter and CHOGORI connectors (IP67)

K: special shaft diameter (14 mm)*1 and CHOGORI connectors (IP67)

3: standard shaft diameter (42 mm)*2 and standard connectors

B: standard shaft diameter and bulkhead connectors

Note:

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

(11) Special code

1: standard products

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

ECM-A3 series servo motor

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

(1) Product name
ECM: electronically commutated motor

(2) Servo type
A: high-precision servo motor

(3) Series
3: 3rd 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; number of revolutions: 16-bit)
1: 24-bit incremental optical encoder (single-turn absolute)
A: 24-bit absolute optical encoder
(resolution of single turn: 24-bit; number of revolutions: 16-bit)
2: 24-bit incremental optical encoder (single-turn absolute)
Note: number of revolutions means the maximum number of turns the encoder can record.

1

(7) Motor frame size

Code	Specification	Code	Specification
04	40 mm	08	80 mm
06	60 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, with oil seal	with brake, with oil seal
with keyway with screw hole	R	S

(10) Shaft diameter and connector type

S: standard shaft diameter and standard connectors

7: special shaft diameter (14 mm)* and standard connectors

J: standard shaft diameter and CHOGORI connectors (IP67)

K: special shaft diameter (14 mm)* and CHOGORI connectors (IP67)

Note: special shaft diameter is available for F80 400 W models.

(11) Special code

1: standard products

Z: special code of C☐0807☐S☐. Refer to the note in Section A.3.5.

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

1.3 ASDA-B3 servo drive and applicable motor

1.3.1 220V models

ECM-A3 series servo motor

Servo motor model							Servo drive model		
Model number	Rated / Max. speed (rpm)	Frame size (mm)	Rated power (W)	Inertia ($x10^{-4}kg \cdot m^2$) with brake / without brake	Rated / Max. current (Arms)	Rated / Max. torque (N·m)	Model number	Rated power (W)	Rated / Max. current (Arms)
ECM-A3L-C□040F	3000 / 6000	40	50	0.0229 / 0.0255	0.66 / 2.82	0.159 / 0.557	ASD-B3□-0121-□	100	0.9 / 3.88
ECM-A3L-C□0401	3000 / 6000	40	100	0.04 / 0.0426	0.9 / 3.88	0.32 / 1.12	ASD-B3□-0121-□	100	0.9 / 3.88
ECM-A3L-C□0602	3000 / 6000	60	200	0.09 / 0.12	1.45 / 6.2	0.64 / 2.24	ASD-B3□-0221-□	200	1.55 / 7.07
ECM-A3L-C□0604	3000 / 6000	60	400	0.15 / 0.18	2.65 / 10.1	1.27 / 4.45	ASD-B3□-0421-□	400	2.65 /10.6
ECM-A3L-C□0804	3000 / 6000	80	400	0.352 / 0.408	2.6 / 10.6	1.27 / 4.44	ASD-B3□-0421-□	400	2.65 /10.6
ECM-A3L-C□0807	3000 / 6000	80	750	0.559 / 0.614	5.1 / 20.6	2.39 / 6.45	ASD-B3□-0721-□	750	5.1 / 14.14
						2.39 / 8.36	ASD-B3□-1021-□	1k	7.3 / 21.21
ECM-A3H-C□040F	3000 / 6000	40	50	0.0455 / 0.0517	0.64 / 2.59	0.159 / 0.557	ASD-B3□-0121-□	100	0.9 / 3.88
ECM-A3H-C□0401	3000 / 6000	40	100	0.0754 / 0.0816	0.9 / 3.64	0.32 / 1.12	ASD-B3□-0121-□	100	0.9 / 3.88
ECM-A3H-C□0602	3000 / 6000	60	200	0.25 / 0.28	1.45 / 5.3	0.64 / 2.24	ASD-B3□-0221-□	200	1.55 / 7.07
ECM-A3H-C□0604	3000 / 6000	60	400	0.45 / 0.48	2.65 / 9.8	1.27 / 4.45	ASD-B3□-0421-□	400	2.65 / 10.6
ECM-A3H-C□0804	3000 / 6000	80	400	0.92 / 1.07	2.6 / 9.32	1.27 / 4.44	ASD-B3□-0421-□	400	2.65 / 10.6
ECM-A3H-C□0807	3000 / 6000	80	750	1.51 / 1.66	4.61 / 16.4	2.39 / 7.23	ASD-B3□-0721-□	750	5.1 / 14.14
						2.39 / 8.36	ASD-B3□-1021-□	1k	7.3 / 21.21

ECM-B3 series servo motor

Servo motor model							Servo drive model		
Model number	Rated / Max. speed (rpm)	Frame size (mm)	Rated power (W)	Inertia ($x10^{-4}kg \cdot m^2$) with brake / without brake	Rated / Max. current (Arms)	Rated / Max. torque (N·m)	Model number	Rated power (W)	Rated / Max. current (Arms)
ECM-B3L-C□0401	3000 / 6000	40	100	0.0299 / 0.0315	0.857 / 3.44	0.32 / 1.12	ASD-B3□-0121-□	100	0.9 / 3.88
ECM-B3M-C□0602	3000 / 6000	60	200	0.141 / 0.151	1.42 / 6.62	0.64 / 2.24	ASD-B3□-0221-□	200	1.55 / 7.07
ECM-B3M-C□0604	3000 / 6000	60	400	0.254 / 0.264	2.40 / 9.47	1.27 / 4.45	ASD-B3□-0421-□	400	2.65 /10.6
ECM-B3M-C□0804	3000 / 6000	80	400	0.648 / 0.695	2.53 / 9.42	1.27 / 4.45	ASD-B3□-0421-□	400	2.65 /10.6
ECM-B3M-C□0807	3000 / 6000	80	750	1.07 / 1.13	4.27 / 15.8	2.4 / 7.61	ASD-B3□-0721-□	750	5.1 / 14.14
						2.4 / 8.4	ASD-B3□-1021-□	1k	7.3 / 21.21
ECM-B3M-C□0810	3000 / 6000	80	1k	1.37 / 1.40	5.00 / 18.2	3.18 / 11.13	ASD-B3□-1021-□	1k	7.3 / 21.21
ECM-B3M-C□1010	3000 / 6000	100	1k	2.78 / 3.06	6.05 / 18.4	3.18 / 9.54	ASD-B3□-1021-□	1k	7.3 / 21.21
ECM-B3M-C□1015	3000 / 6000	100	1.5k	3.69 / 3.97	7.48 / 22.8	4.77 / 14.3	ASD-B3□-1521-□	1.5k	8.3 / 24.3
ECM-B3M-C□1020	3000 / 6000	100	2k	4.68 / 4.95	9.96 / 30.7	6.37 / 19.1	ASD-B3□-2023-□	2k	13.4 / 38.3
ECM-B3M-E□1310	2000 / 3000	130	1k	7.79 / 7.94	5.96 / 19.9	4.77 / 14.3	ASD-B3□-1021-□	1k	7.3 / 21.21
ECM-B3M-E□1315	2000 / 3000	130	1.5k	11.22 / 11.37	8.17 / 26.82	7.16 / 19.34	ASD-B3□-1521-□	1.5k	8.3 / 23.7
						7.16 / 21.48	ASD-B3□-2023-□	2k	13.4 / 38.3
ECM-B3M-E□1320	2000 / 3000	130	2k	14.65 / 14.8	10.59 / 34.20	9.55 / 28.65	ASD-B3□-2023-□	2k	13.4 / 38.3
ECM-B3M-E□1820	2000 / 3000	180	2k	29.11 / 30.38	11.43 / 36.21	9.55 / 28.65	ASD-B3□-2023-□	2k	13.4 / 38.3
ECM-B3M-F□1830	1500 / 3000	180	3k	53.63 / 54.9	18.21 / 58.9	19.1 / 52.3	ASD-B3□-3023-□	3k	19.4 / 53.03
						19.1 / 57.29	-	-	-
ECM-B3H-C□0602	3000 / 6700	60	200	0.265 / 0.280	1.51 / 6.12	0.64 / 2.43	ASD-B3□-0221-□	200	1.55 / 7.07
ECM-B3H-C□0604	3000 / 6700	60	400	0.523 / 0.538	2.21 / 8.46	1.27 / 4.83	ASD-B3□-0421-□	400	2.65 /10.6
ECM-B3H-C□0807	3000 / 6700	80	750	1.55 / 1.62	4.19 / 16.3	2.4 / 7.86	ASD-B3□-0721-□	750	5.1 / 14.14
						2.4 / 9.12	ASD-B3□-1021-□	1k	7.3 / 21.21
ECM-B3H-F□1308	1500 / 4000	130	850	12.44 / 12.62	6.65 / 20.0	5.39 / 16.17	ASD-B3□-1021-□	1k	7.3 / 21.21
ECM-B3H-F□1313	1500 / 4000	130	1.3k	18.00 / 18.14	7.70 / 23.9	8.34 / 25.02	ASD-B3□-1521-□	1.5k	8.3 / 24.3
ECM-B3H-F□1318	1500 / 4000	130	1.8k	22.60 / 22.80	11.5 / 36.1	11.5 / 34.5	ASD-B3□-2023-□	2k	13.4 / 38.3

1.3.2 400V models

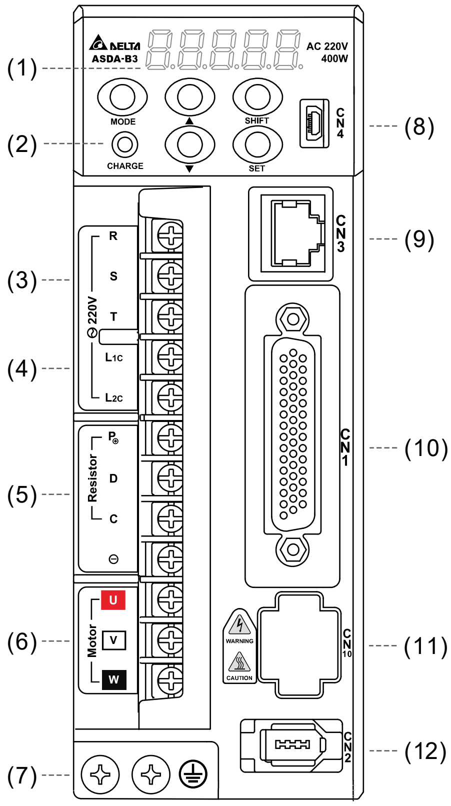
ECM-B3 series servo motor

Servo motor model							Servo drive model		
Model number	Rated / Max. speed (rpm)	Frame size (mm)	Rated power (W)	Inertia ($x10^{-4}kg \cdot m^2$) with brake / without brake	Rated / Max. current (Arms)	Rated / Max. torque (N·m)	Model number	Rated power (W)	Rated / Max. current (Arms)
ECM-B3M-J☐0807	3000 / 6000	80	750	1.07 /1.13	2.15 / 7.90	2.4 / 7.61	ASD-B3☐-1043-☐	1k	3.37 / 7.07
						2.4 / 8.4	ASD-B3☐-1543-☐	1.5k	4.09 / 10.6
ECM-B3M-J☐1010	3000 / 6000	100	1k	2.78 / 3.06	3.03 / 9.21	3.18 / 7.4	ASD-B3☐-1043-☐	1k	3.37 / 7.07
						3.18 / 9.54	ASD-B3☐-1543-☐	1.5k	4.09 / 10.6
ECM-B3M-J☐1015	3000 / 6000	100	1.5k	3.69 / 3.97	3.73 / 11.4	4.77 / 13.08	ASD-B3☐-1543-☐	1.5k	4.09 / 10.6
						4.77 / 14.31	ASD-B3☐-2043-☐	2k	5.96 / 18.98
ECM-B3M-J☐1020	3000 / 6000	100	2k	4.68 / 4.95	5.00 / 15.3	6.37 / 19.11	ASD-B3☐-2043-☐	2k	5.96 / 18.98
ECM-B3M-K☐1310	2000 / 3000	130	1k	7.79 / 7.94	3.00 / 9.95	4.77 / 11.08	ASD-B3☐-1043-☐	1k	3.37 / 7.07
						4.77 / 14.3	ASD-B3☐-1543-☐	1.5k	4.09 / 10.6
ECM-B3M-K☐1315	2000 / 3000	130	1.5k	11.22 / 11.37	4.09 / 13.37	7.16 / 17.78	ASD-B3☐-1543-☐	1.5k	4.09 / 10.6
						7.16 / 21.48	ASD-B3☐-2043-☐	2k	5.96 / 18.98
ECM-B3M-K☐1320	2000 / 3000	130	2k	14.65 / 14.80	5.30 / 17.1	9.55 / 28.65	ASD-B3☐-2043-☐	2k	5.96 / 18.98
ECM-B3H-L☐1308	1500 / 4000	130	850	12.44 / 12.62	3.35 / 10.0	5.39 / 11.55	ASD-B3☐-1043-☐	1k	3.37 / 7.07
						5.39 / 16.17	ASD-B3☐-1543-☐	1.5k	4.09 / 10.6
ECM-B3H-L☐1313	1500 / 4000	130	1.3k	18.00 / 18.14	3.85 / 12.0	8.34 / 22.14	ASD-B3☐-1543-☐	1.5k	4.09 / 10.6
						8.34 / 25.02	ASD-B3☐-2043-☐	2k	5.96 / 18.98
ECM-B3H-L☐1318	1500 / 4000	130	1.8k	22.60 / 22.80	5.75 / 18.1	11.5 / 34.5	ASD-B3☐-2043-☐	2k	5.96 / 18.98
ECM-B3M-K☐1820	2000 / 3000	180	2k	29.11 / 30.38	5.7 / 18.1	9.55 / 28.65	ASD-B3☐-2043-☐	2k	5.96 / 18.98
ECM-B3M-L☐1830	1500 / 3000	180	3k	53.63 / 54.9	9.1 / 29.45	19.1 / 53.9	ASD-B3☐-3043-☐	3k	9.11 / 27.33
						19.1 / 53.9	ASD-B3☐-4043-☐	4k	11 / 27.33
						19.1 / 57.29	ASD-B3☐-4543-☐	4.5k	13.30 / 35.35
ECM-B3M-L☐1845	1500 / 4000	180	4.5k	67.73 / 69.15	13.3 / 35.35	28.62 / 71.6	ASD-B3☐-4543-☐	4.5k	13.30 / 35.35
ECM-B3M-L☐1855	1500 / 4000	180	5.5k	98.88 / 100.1	15.3 / 49.29	35.01 / 105	ASD-B3☐-5543-☐	5.5k	15.34 / 49.29
ECM-B3M-L☐1875	1500 / 4000	180	7.5k	134.95 / 136.24	22.1 / 56.68	47.75 / 110.9	ASD-B3☐-7543-☐	7.5k	22.11 / 53.03
						47.75 / 110.9	ASD-B3☐-8043-☐	8k	22.5 / 53.03
						47.75 / 119	-	-	-

1

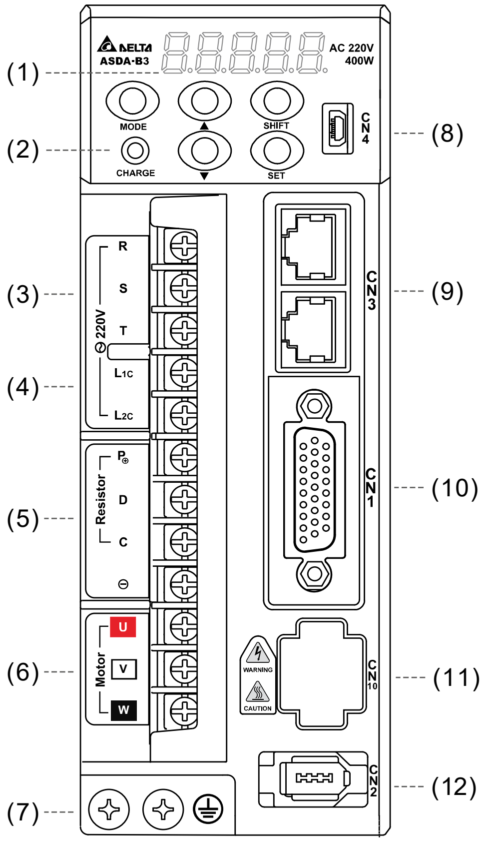
1.4 Description of the drive interface

1.4.1 -L models



No.	Name	Description
(1)	-	7-segment display.
(2)	CHARGE	Power indicator.
(3)	RST	Main circuit power input terminal. 220V models: connects to commercial power supply (200 - 230 V_{AC}, 50/60 Hz); 400V models: connects to commercial power supply (380 - 400 V_{AC}, 50/60 Hz).
(4)	L_{1C}, L_{2C}	Control circuit power input terminal. 220V models: connects to single-phase power supply (200 - 230 V_{AC}, 50/60 Hz); 400V models: connects to single-phase power supply (380 - 400 V_{AC}, 50/60 Hz).
(5)	Regenerative resistor	For using the built-in regenerative resistor, or connecting to an external regenerative resistor or external power regenerative unit.
(6)	UVW	Servo drive current output: connects to the motor power connector (U, V, W). Do not connect to the main circuit power. Incorrect wiring will cause damage to the servo drive.
(7)	Grounding screws	Connects to the ground wires for the power and servo motor.
(8)	CN4	Mini USB connector: connects to PC.
(9)	CN3	Modbus communication port.
(10)	CN1	I/O signal interface: connects to PLC or controls I/O.
(11)	CN10	STO termial: only supported by the B3A series.
(12)	CN2	Encoder connector: connects to the encoder.

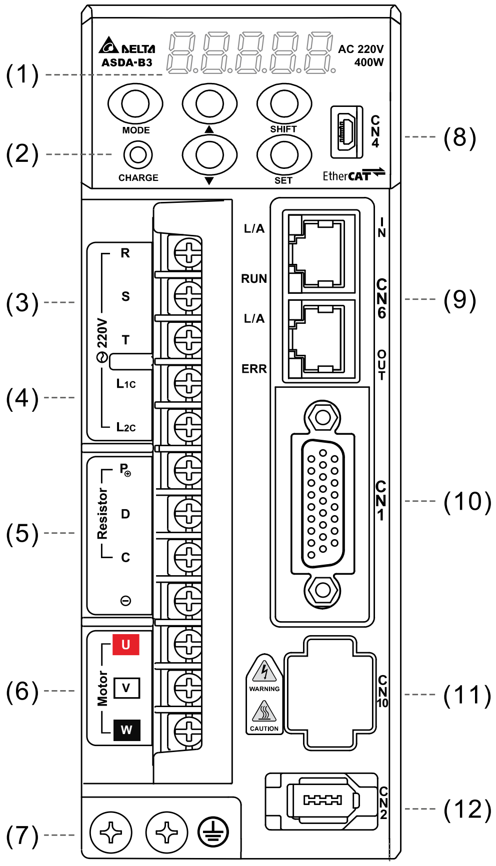
1.4.2 -M / -F models



No.	Name	Description
(1)	-	7-segment display.
(2)	CHARGE	Power indicator.
(3)	RST	Main circuit power input terminal. 220V models: connects to commercial power supply (200 - 230 V_{AC}, 50/60 Hz); 400V models: connects to commercial power supply (380 - 400 V_{AC}, 50/60 Hz).
(4)	L_{1C}, L_{2C}	Control circuit power input terminal. 220V models: connects to single-phase power supply (200 - 230 V_{AC}, 50/60 Hz); 400V models: connects to single-phase power supply (380 - 400 V_{AC}, 50/60 Hz).
(5)	Regenerative resistor	For using the built-in regenerative resistor, or connecting to an external regenerative resistor or external power regenerative unit.
(6)	UVW	Servo drive current output: connects to the motor power connector (U, V, W). Do not connect to the main circuit power. Incorrect wiring will cause damage to the servo drive.
(7)	Grounding screws	Connects to the ground wires for the power and servo motor.
(8)	CN4	Mini USB connector: connects to PC.
(9)	CN3 / CN6	CANopen (CN3) or DMCNET (CN6) high-speed communication ports.
(10)	CN1	I/O signal interface: connects to PLC or controls I/O.
(11)	CN10	STO terminal: only supported by the B3A series.
(12)	CN2	Encoder connector: connects to the encoder.

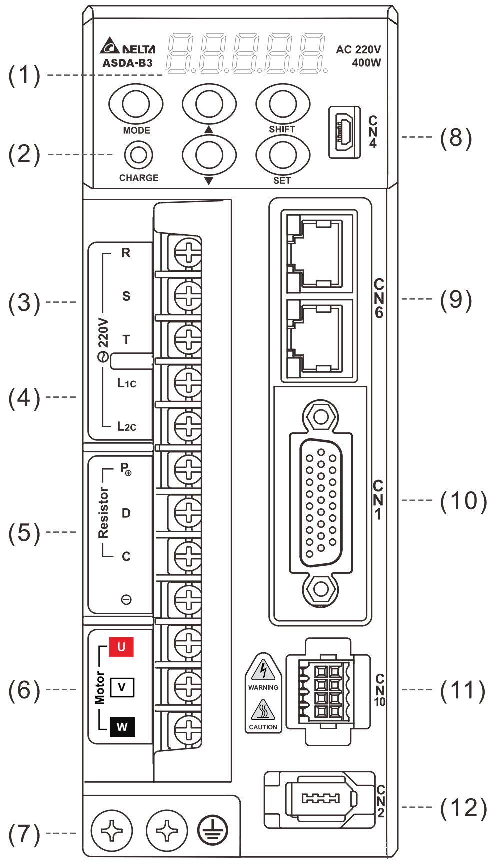
1

1.4.3 -E models



No.	Name	Description
(1)	-	7-segment display.
(2)	CHARGE	Power indicator.
(3)	RST	Main circuit power input terminal. 220V models: connects to commercial power supply (200 - 230 V_{AC}, 50/60 Hz); 400V models: connects to commercial power supply (380 - 400 V_{AC}, 50/60 Hz).
(4)	L_{1C}, L_{2C}	Control circuit power input terminal. 220V models: connects to single-phase power supply (200 - 230 V_{AC}, 50/60 Hz); 400V models: connects to single-phase power supply (380 - 400 V_{AC}, 50/60 Hz).
(5)	Regenerative resistor	For using the built-in regenerative resistor, or connecting to an external regenerative resistor or external power regenerative unit.
(6)	UVW	Servo drive current output: connects to the motor power connector (U, V, W). Do not connect to the main circuit power. Incorrect wiring will cause damage to the servo drive.
(7)	Grounding screws	Connects to the ground wires for the power and servo motor.
(8)	CN4	Mini USB connector: connects to PC.
(9)	CN6	EtherCAT high-speed communication ports.
(10)	CN1	I/O signal interface: connects to PLC or controls I/O.
(11)	CN10	STO terminal: only supported by the B3A series.
(12)	CN2	Encoder connector: connects to the encoder.

1.4.4 B3A-P models



No.	Name	Description
(1)	-	7-segment display.
(2)	CHARGE	Power indicator.
(3)	RST	Main circuit power input terminal. 220V models: connects to commercial power supply (200 - 230 V_{AC}, 50/60 Hz); 400V models: connects to commercial power supply (380 - 400 V_{AC}, 50/60 Hz).
(4)	L_{1C}, L_{2C}	Control circuit power input terminal. 220V models: connects to single-phase power supply (200 - 230 V_{AC}, 50/60 Hz); 400V models: connects to single-phase power supply (380 - 400 V_{AC}, 50/60 Hz).
(5)	Regenerative resistor	For using the built-in regenerative resistor, or connecting to an external regenerative resistor or external power regenerative unit.
(6)	UVW	Servo drive current output: connects to the motor power cable (U, V, W). Do not connect to the main circuit power. Incorrect wiring will cause damage to the servo drive.
(7)	Grounding screws	Connects to the ground wires for the power and servo motor.
(8)	CN4	Mini USB connector: connects to PC.
(9)	CN6	PROFINET high-speed communication ports.
(10)	CN1	I/O signal interface: connects to PLC or controls I/O.
(11)	CN10	STO terminal: only supported by the B3A series.
(12)	CN2	Encoder connector: connects to the encoder.

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Installation 2

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

2

2.1 Ambient storage conditions

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

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

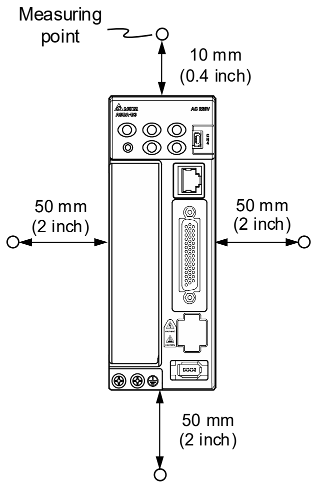
2.2 Ambient installation conditions

WARNING

B3 servo drive: the environment should be free of water, water vapor, dust, oily dust, corrosive and inflammable gas or liquids, airborne dust or metal particles, or devices that generate excessive heat. And the environment should be solid without vibration or interference of electromagnetic noise.

Motor: the ambient temperature for the ECM-A3 and ECMC motors should be between 0°C (32°F) and 40°C (104°F). The ambient temperature for the ECM-B3 motors should be between -20°C (-4°F) and +60°C (+140°F)*. The environment should be free of water, water vapor, dust, oily dust, corrosive and inflammable gas or liquids, airborne dust or metal particles, or devices that generate excessive heat.

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



- The ambient operating temperature for the servo drive should be between 0°C (32°F) and 55°C (131°F). During long-term operation, it is advisable to keep the temperature below 45°C (113°F) to ensure the servo drive's performance.
- For the 220V models, if the ambient temperature is over 45°C (113°F), place the product in a well-ventilated environment.
- For the 400V models, if the ambient temperature is over 45°C (113°F), keep the average load rate at 80% or less, and place the product in a well-ventilated environment.
- Mount the product vertically in the control cabinet (see the illustration of the correct mounting direction in Section 2.3).
- Install a fan at the top of the control cabinet for heat dissipation. Make sure the size of the control cabinet and its ventilation condition can prevent the internal electrical devices from overheating.
- Check if the vibration of the machine affects the electrical devices in the control cabinet. 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.
- For the 400V models, the airflow velocity at the measuring point, which is 10 mm (0.4 inches) above the servo drive, has to be 0.5 m/s or higher.

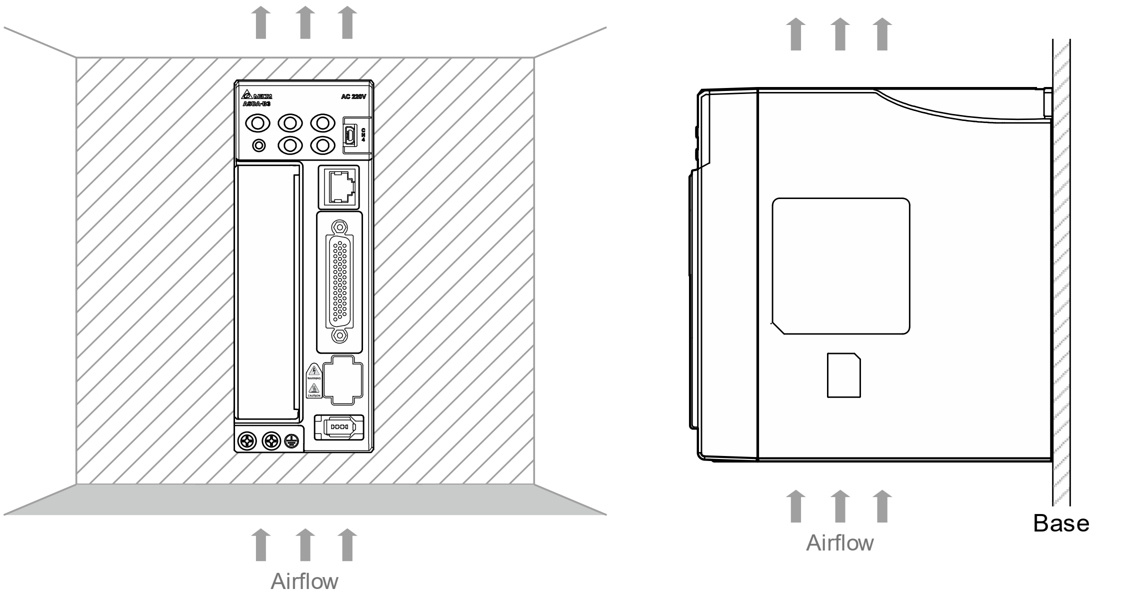
2

2.3 Mounting direction and space

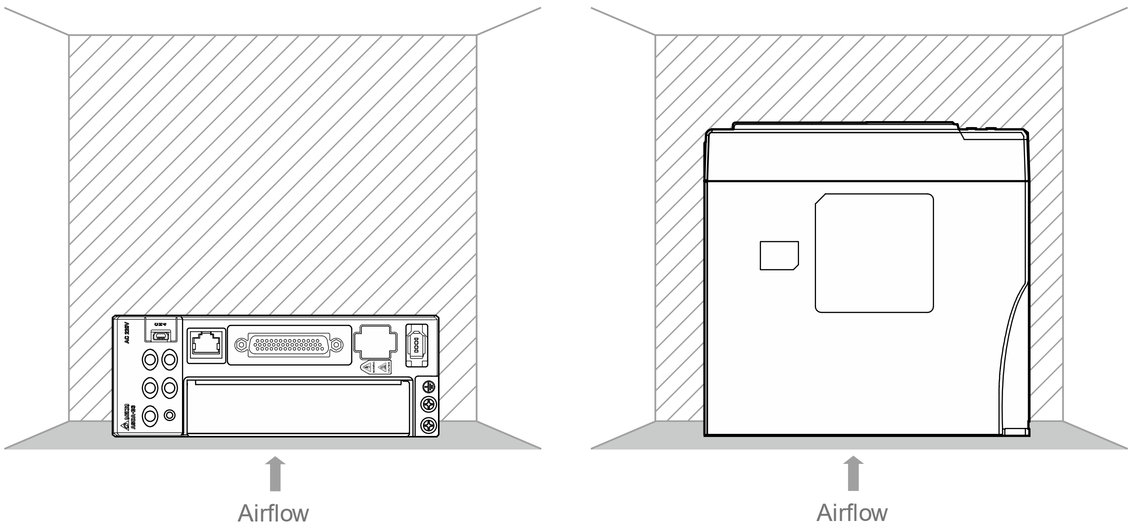
Important:

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

Correct



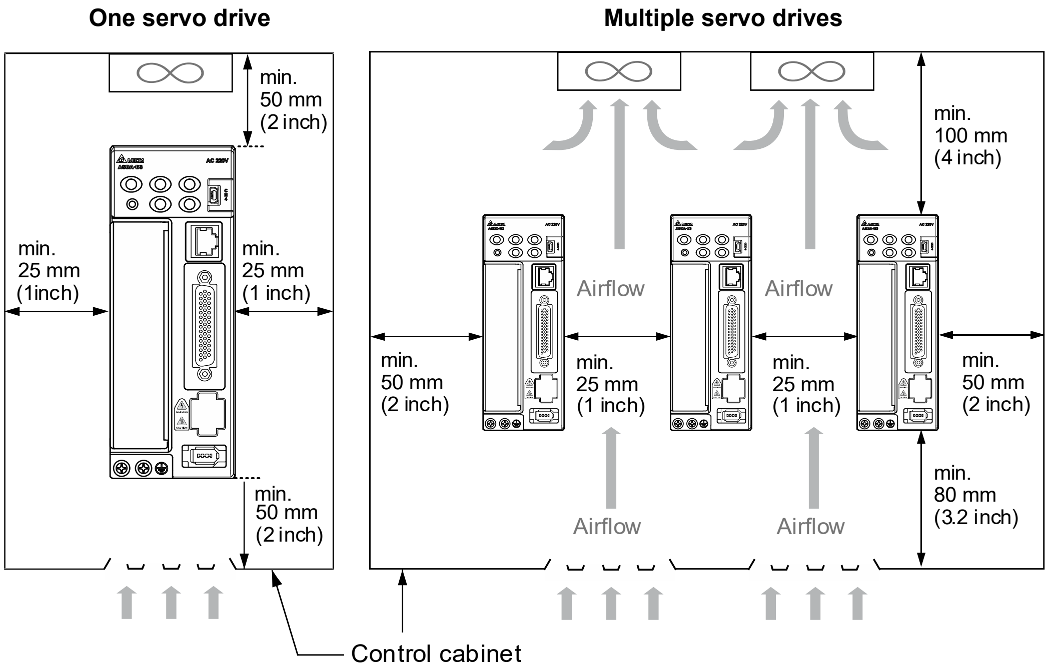
Incorrect



2

Heat dissipation requirements

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



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

2

2.4 Safety precautions for using motors

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

The safety precautions are as follows:

Handling, mounting, and storage

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

Wiring

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

Operation

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

Others

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

2

2.4.1 Troubleshooting for the motor operation and status

When the servo motor makes abnormal noises:

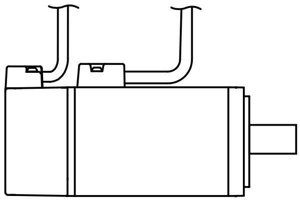
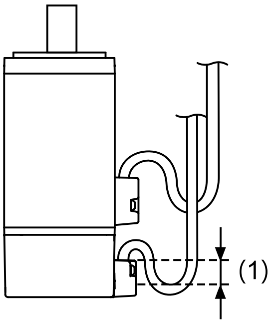
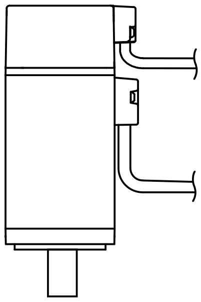
Possible cause	Checking method	Corrective action
There is a source of vibration in the connecting components.	Check if there is any foreign object, damage, or deformation in the movable parts of the connecting component.	Replace the connecting components (such as the coupling) or contact the manufacturer.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

When the servo motor is overheating:

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

2.4.2 Mounting directions and precautions for the servo motor

You can install the servo motor horizontally or vertically.

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

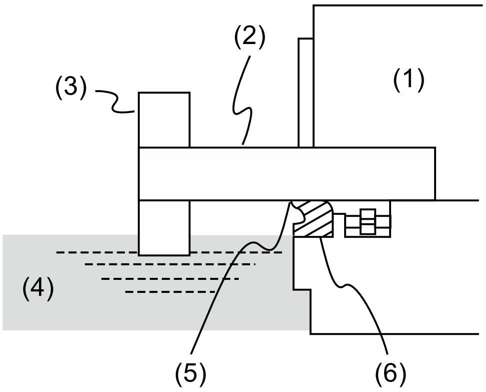
Note: if you desire to install gears on the servo motor, follow the manufacturer's instructions for installation.

2

2.4.3 Precautions for using servo motor with oil seal

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

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



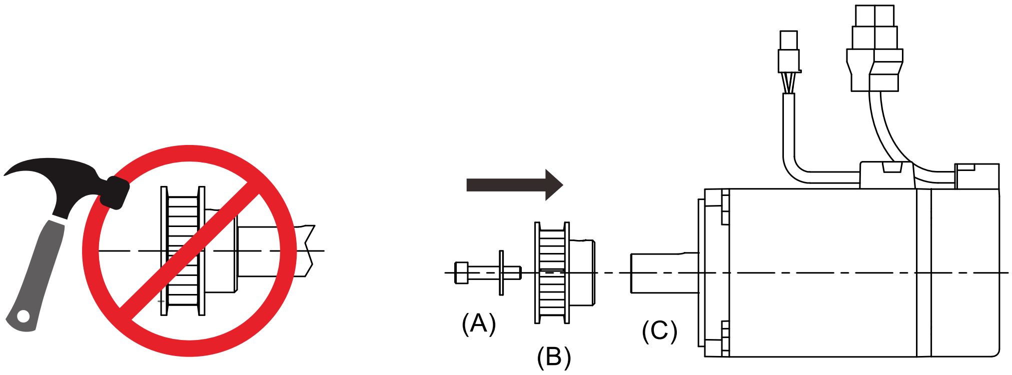
(1) Servo motor; (2) Motor shaft; (3) Gear; (4) Oil; (5) Oil seal lip; (6) Oil seal

- The oil seal cannot be submerged in liquid. It can only withstand splashes of oil.
- The oil seal lip cannot be soaked in oil.

2.4.4 Precautions for installing servo motor accessories

2

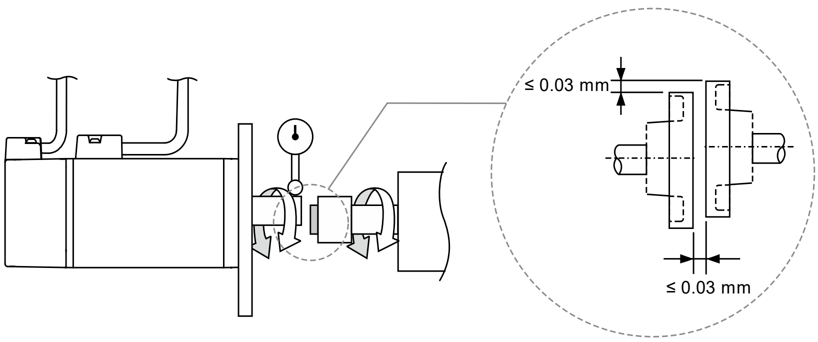
- Wipe off the rustproof coating or oil on the motor shaft.
- If you use a servo motor with a keyway, install the attached key or a key matching the specified dimensions to the motor shaft.
- When installing the key or the motor shaft accessories (such as a belt pulley or gear) to the servo motor, do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



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

Installation safety precautions for coupling applications

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



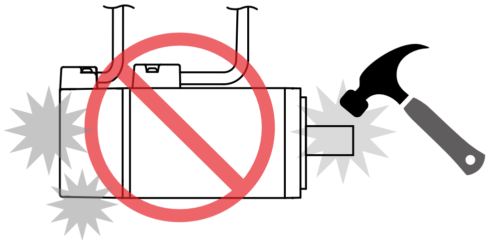
As shown in the previous figure, the distance is measured at four different positions on the circumference for the centering precision. The difference between the maximum and minimum measurements should be 0.03 mm or less. Even within this range, you can make adjustments to increase the centering precision.

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

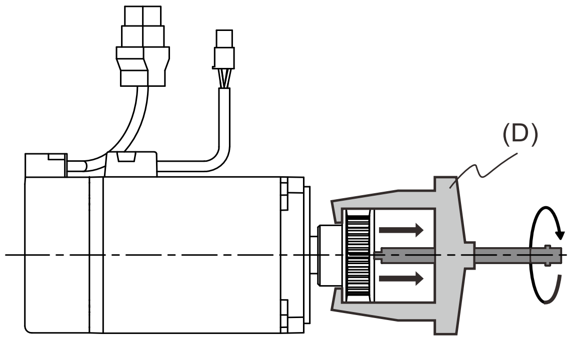
2

Installation / disassembly safety precautions for motor shaft accessories

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



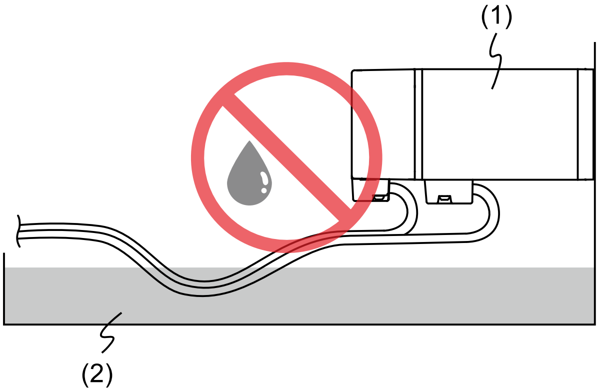
- If the coupling makes any abnormal noise, realign the shafts until the noise disappears.
- Ensure the axial load and radial load are within the specifications. Refer to the specifications for the maximum axial load (N) and maximum radial load (N) for each servo motor.
- Use a bearing puller (D) to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



2.4.5 Oil and water prevention measures for the servo motor

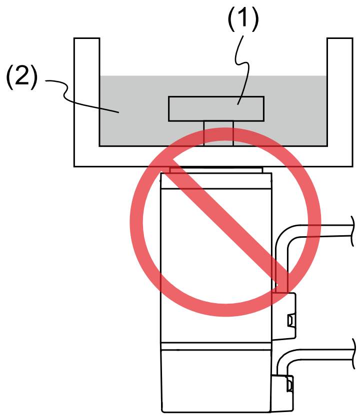
Follow these precautions and do not allow water, oil, or other foreign objects to enter the servo motor.

- Do not submerge the cable in oil or water.



(1) Servo motor; (2) Oil

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



(1) Gear; (2) Oil

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

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

2

2.4.6 Measures to suppress temperature increase of the servo motor

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

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

2.5 Specifications for the circuit breaker, magnetic contactor and fuse

2

220V models

Servo drive model	Control power supply (L_{1C}, L_{2C})			Main circuit power supply (R, S, T)		
	Circuit breaker	Magnetic contactor	Fuse (Class CC)	Circuit breaker	Magnetic contactor	Fuse (Class T)
ASD-B3□-0121-□	2 A	2 A	2 A	5 A	5 A	10 A
ASD-B3□-0221-□	2 A	2 A	2 A	5 A	5 A	10 A
ASD-B3□-0421-□	2 A	2 A	2 A	10 A	10 A	10 A
ASD-B3□-0721-□	2 A	2 A	2 A	10 A	10 A	20 A
ASD-B3□-1021-□	2 A	2 A	2 A	15 A	15 A	30 A
ASD-B3□-1521-□	2 A	2 A	2 A	20 A	20 A	30 A
ASD-B3□-2023-□	2 A	2 A	2 A	30 A	30 A	40 A
ASD-B3□-3023-□	2 A	2 A	2 A	30 A	30 A	40 A

Note:

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

Servo drive model	Maximum fault loop impedance	
	TN system	TT system
ASD-B3□-0121-□	1.6Ω	139Ω
ASD-B3□-0221-□	1.6Ω	139Ω
ASD-B3□-0421-□	1.3Ω	139Ω
ASD-B3□-0721-□	0.85Ω	139Ω
ASD-B3□-1021-□	0.75Ω	139Ω
ASD-B3□-1521-□	0.69Ω	139Ω
ASD-B3□-2023-□	0.69Ω	139Ω
ASD-B3□-3023-□	0.65Ω	139Ω

2

400V models

Servo drive model	Control power supply (L_{1C}, L_{2C})			Main circuit power supply (R, S, T)		
	Circuit breaker	Magnetic contactor	Fuse (Class CC)	Circuit breaker	Magnetic contactor	Fuse (Class T)
ASD-B3□-1043-□	2 A	2 A	2 A	10 A	10 A	10 A
ASD-B3□-1543-□	2 A	2 A	2 A	15 A	15 A	15 A
ASD-B3□-2043-□	2 A	2 A	2 A	20 A	20 A	20 A
ASD-B3□-3043-□	2 A	2 A	2 A	35 A	35 A	35 A
ASD-B3□-4043-□	2 A	2 A	2 A	40 A	40 A	50 A
ASD-B3□-4543-□	2 A	2 A	2 A	40 A	40 A	50 A
ASD-B3□-5543-□	2 A	2 A	2 A	60 A	60 A	60 A
ASD-B3□-7543-□	2 A	2 A	2 A	60 A	60 A	70 A
ASD-B3□-8043-□	2 A	2 A	2 A	60 A	60 A	70 A

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

Servo drive model	Maximum fault loop impedance	
	TN system	TT system
ASD-B3□-1043-□	0.75Ω	220Ω
ASD-B3□-1543-□	0.75Ω	220Ω
ASD-B3□-2043-□	0.75Ω	220Ω
ASD-B3□-3043-□	0.69Ω	220Ω
ASD-B3□-4043-□	0.69Ω	220Ω
ASD-B3□-4543-□	0.69Ω	220Ω
ASD-B3□-5543-□	0.65Ω	220Ω
ASD-B3□-7543-□	0.65Ω	220Ω
ASD-B3□-8043-□	0.65Ω	220Ω

2.6 Ferrite ring

2

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

Ferrite ring model	Applicable servo drive model
ASD-ACFC7K00	ASD-B3□-1043-□, ASD-B3□-1543-□, ASD-B3□-2043-□, ASD-B3□-3043-□, ASD-B3□-4043-□, ASD-B3□-4543-□, ASD-B3□-5543-□, ASD-B3□-7543-□, ASD-B3□-8043-□

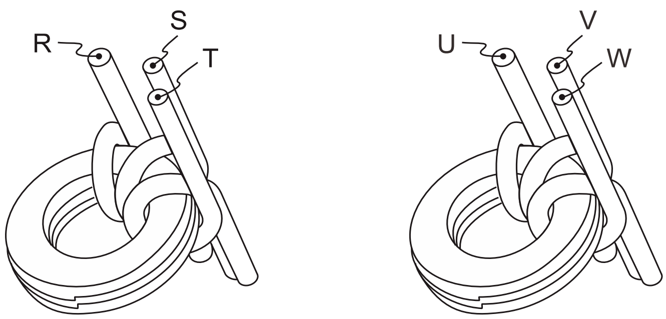
Installation precautions

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

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

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

- For 400V models

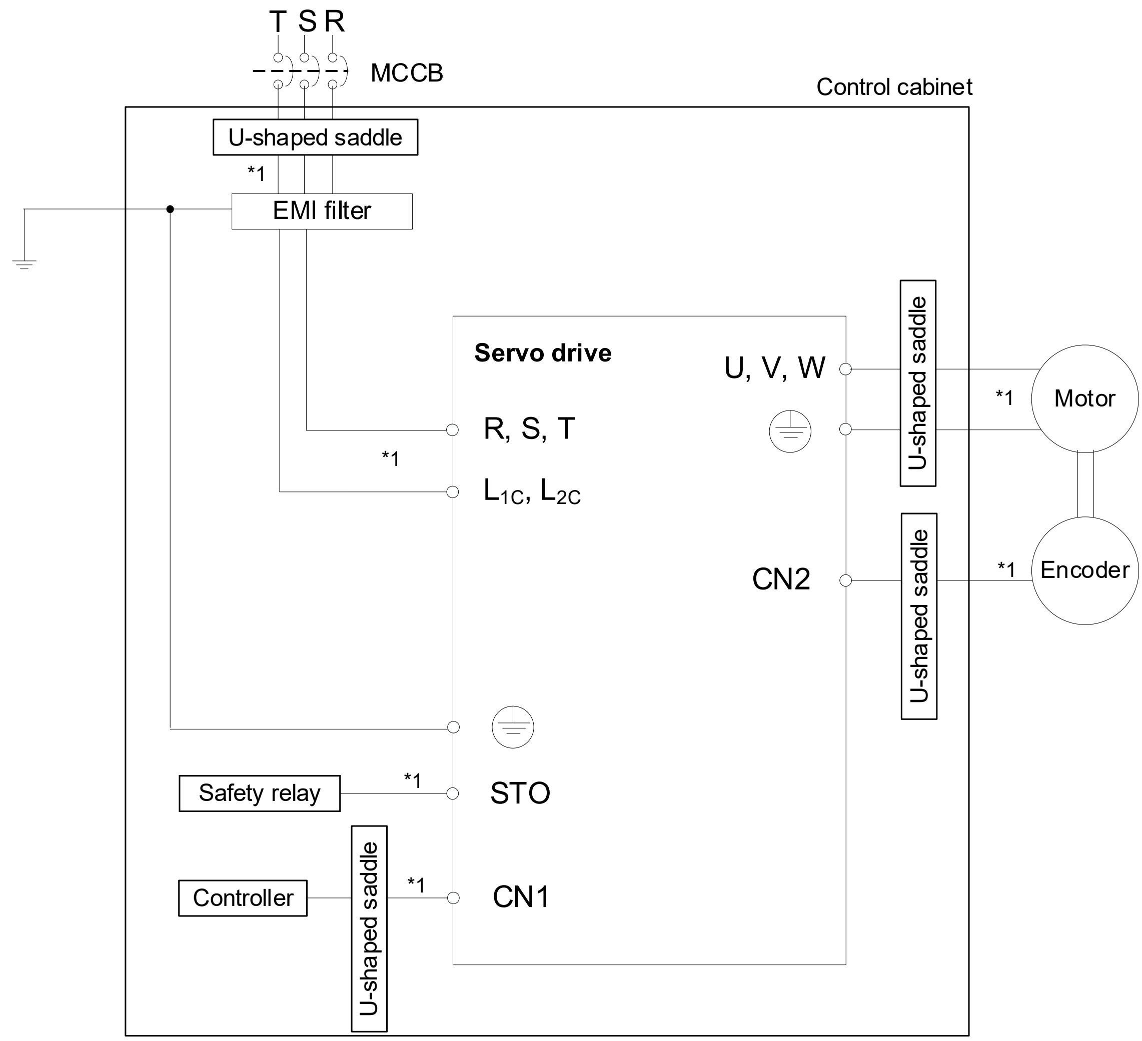


Note:
1. Refer to Chapter 3 for the selection of the motor power cable.
2. Only the motor power cable or servo drive power cable can be led through the ferrite ring. If needed, prepare extra ferrite rings for grounding.
3. An EMI filter for absorbing radiation may be required when a longer motor power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

2

2.7 Installation requirements for EMC

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



Note:
1. Use shielded wires.

2.7.1 EMI filters

2

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

220V models

Power	Servo drive model	Recommended EMI filter	
		1PH	3PH
100 W	ASD-B3□-0121-□	EMF023A21A	EMF10AM23A
200 W	ASD-B3□-0221-□	EMF023A21A	EMF10AM23A
400 W	ASD-B3□-0421-□	EMF023A21A	EMF10AM23A
750 W	ASD-B3□-0721-□	EMF023A21A	EMF10AM23A
1 kW	ASD-B3□-1021-□	EMF023A21A	EMF10AM23A
1.5 kW	ASD-B3□-1521-□	EMF023A21A	EMF10AM23A
2 kW	ASD-B3□-2023-□	-	EMF021A23A
3 kW	ASD-B3□-3023-□	-	EMF021A23A

400V models

Power	Servo drive model	Recommended EMI filter
		3PH
1 kW	ASD-B3□-1043-□	EMF018A43A
1.5 kW	ASD-B3□-1543-□	EMF018A43A
2 kW	ASD-B3□-2043-□	EMF018A43A
3 kW	ASD-B3□-3043-□	EMF018A43A
4 kW	ASD-B3□-4043-□	EMF033A43A
4.5 kW	ASD-B3□-4543-□	EMF033A43A
5.5 kW	ASD-B3□-5543-□	EMF033A43A
7.5 kW	ASD-B3□-7543-□	EMF033A43A
8 kW	ASD-B3□-8043-□	EMF033A43A

2

General precautions for installation

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

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

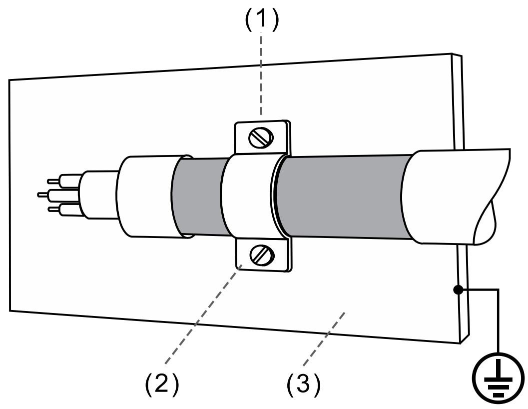
Refer to the following standards for more specifications of EMI filter installation:

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

Motor power cable selection and installation precautions

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

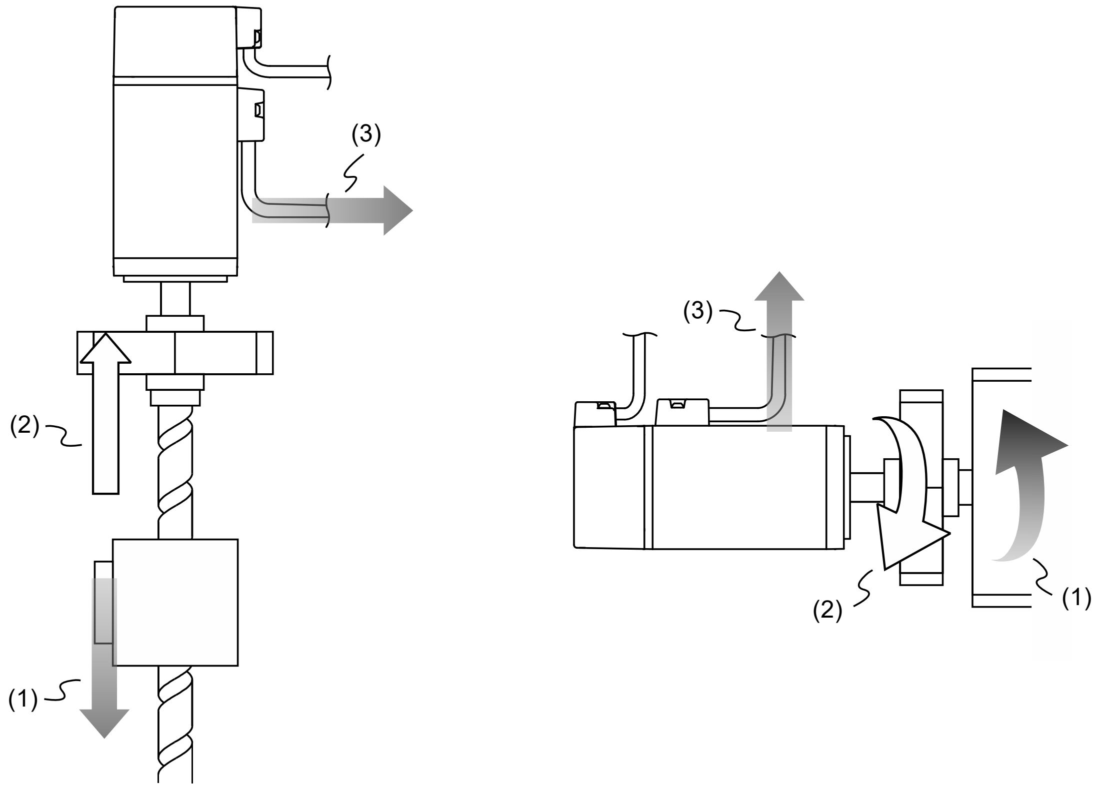
1. Use a cable that has braided shielding (the effect of double shielding is better).
2. The shield on both ends of the motor power cable should be grounded with the shortest distance and the largest contact area.
3. Remove the protective paint on the U-shaped saddle and metal plate to ensure good contact.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



(1) Remove the protective paint on the U-shaped saddle and metal plate to ensure good contact
(2) U-shaped saddle
(3) Well-grounded metal plate

2.8 Selecting the regenerative resistor

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



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

Specifications of the built-in regenerative resistor of the servo drive are as follows:

220V models

Servo drive (kW)	Specifications of the built-in regenerative resistor		Capacity of the built-in regenerative resistor (Watt)	Minimum allowable resistance value (reference for external resistors) (Ohm)
	Resistance (Ohm)	Capacity (Watt)		
0.1	-	-	-	60
0.2	-	-	-	60
0.4	100	40	20	60
0.75	100	40	20	60
1	100	40	20	30
1.5	100	40	20	30
2	20	80	40	15
3	20	80	40	15

400V models

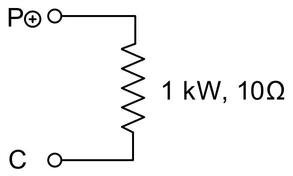
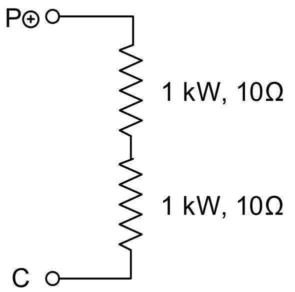
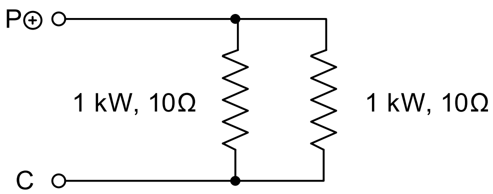
Servo drive (kW)	Specifications of the built-in regenerative resistor		Capacity of the built-in regenerative resistor (Watt)	Minimum allowable resistance value (reference for external resistors) (Ohm)
	Resistance (Ohm)	Capacity (Watt)		
1	100	80	40	80
1.5	100	80	40	60
2	50	80	40	45
3	50	80	40	40
4	35	100	50	35
4.5	35	100	50	35
5.5	35	100	50	25
7.5	35	100	50	25
8	35	100	50	25

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

1. Correctly set the resistance value (P1.052) and capacity (P1.053) for the regenerative resistor; otherwise it might affect the performance.
2. When using an external regenerative resistor, ensure the total resistance value is greater than the minimum allowable resistance value of the servo drive.

3. The general application is to connect multiple resistors in series. If the resistance value exceeds the setting range, you can reduce the value by connecting the resistors in parallel. If you want to connect the resistors in parallel to increase the capacity of the regenerative resistors, make sure the resistance value meets the requirements.

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

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

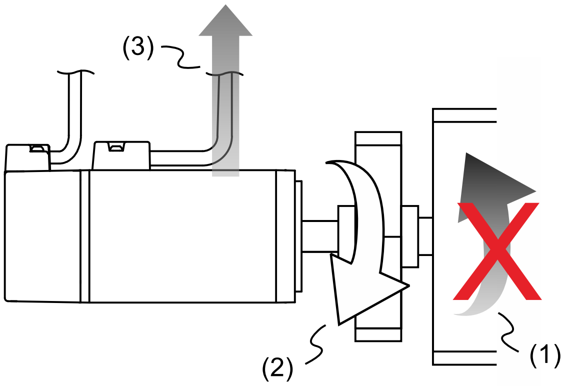
4. Normally, if the average regenerative energy is within the rated capacity of regenerative resistor, the temperature of the resistor can increase to 120°C (248°F) or even higher under the condition that the regenerative energy continues to function. For safety reasons, apply forced cooling to reduce the temperature of the regenerative resistor. Alternatively, you can use the 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 P⊕ and C contacts, and leave the P⊕ and D contacts open. Choose the external regenerative resistors of the resistance values specified in the table on page 24. For easy calculation of the required regenerative resistor capacity, ignore the energy consumed by IGBT and select the capacity of the external regenerative resistor according to the selected 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 table on next page when making calculations and selecting the required regenerative resistor.

220V models

Power	Servo drive model	Maximum regenerative energy that can be absorbed by the capacitor Ec (joule)
100 W	ASD-B3□-0121-□	4.21
200 W	ASD-B3□-0221-□	5.62
400 W	ASD-B3□-0421-□	8.42
750 W	ASD-B3□-0721-□	18.25
1 kW	ASD-B3□-1021-□	26.21
1.5 kW	ASD-B3□-1521-□	34.94
2 kW	ASD-B3□-2023-□	26.21
3 kW	ASD-B3□-3023-□	31.82

400V models

Power	Servo drive model	Maximum regenerative energy that can be absorbed by the capacitor Ec (joule)
1 kW	ASD-B3□-1043-□	14.66
1.5 kW	ASD-B3□-1543-□	17.47
2 kW	ASD-B3□-2043-□	29.33
3 kW	ASD-B3□-3043-□	34.94
4 kW	ASD-B3□-4043-□	42.43
4.5 kW	ASD-B3□-4543-□	42.43
5.5 kW	ASD-B3□-5543-□	51.17
7.5 kW	ASD-B3□-7543-□	62.40
8 kW	ASD-B3□-8043-□	62.40

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

Step	Item	Calculation and setting method
1	Set the capacity of the regenerative resistor to the maximum.	Set P1.053 to the maximum value.
2	Set the reciprocating motion cycle (T).	Manual input.
3	Set the rotation speed (wr).	Manual input or read the of motor operation speed with P0.002 (Drive status).
4	Set the ratio (N) of load inertia to the motor inertia.	Manual input or read the ratio with P0.002.(Drive status)
5	Calculate the maximum regenerative energy (Eo).	Eo = Rotor inertia × (rotation speed (wr))^2 / 182
6	Regenerative energy that can be absorbed by the drive (Ec).	Refer to the table on the preceding page.
7	Calculate the required capacity of the regenerative resistor.	2 × ((N+1) × Eo - Ec) / T
8	Set parameters according to the resistor specification	Set P1.052 and P1.053 correctly.

Example:

For the 400 W motor (ECM-A3L-CY0604RS1), its rotor inertia is 0.15×10^{-4}. When the reciprocating motion cycle (T) is 0.4 sec, the motor operation speed is 3,000 rpm, and the load inertia is 15 times of the motor inertia:

The maximum regenerative energy (Eo) = $(0.15 \times 10^{-4}) \times (3000)^2 / 182 = 0.74$ joules.

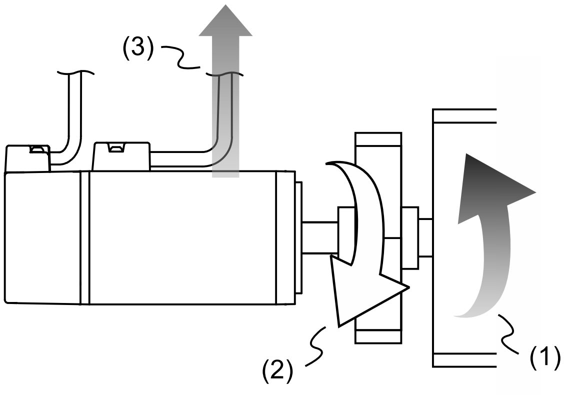
The regenerative energy that can be absorbed by the drive (Ec) = 8.42 joules (listed in the table on the preceding page).

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

From the preceding calculation, the required capacity of the regenerative resistor is 17.1 W, which is smaller than the capacity (20 W) of the built-in regenerative resistor. In this case, the built-in regenerative resistor of 40 W fulfills the need. In general, the built-in regenerative resistor can meet the requirement when the external load is not too great.

2

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



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

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

Example:

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

Therefore, a regenerative resistor of 560 W and 60Ω* is needed.

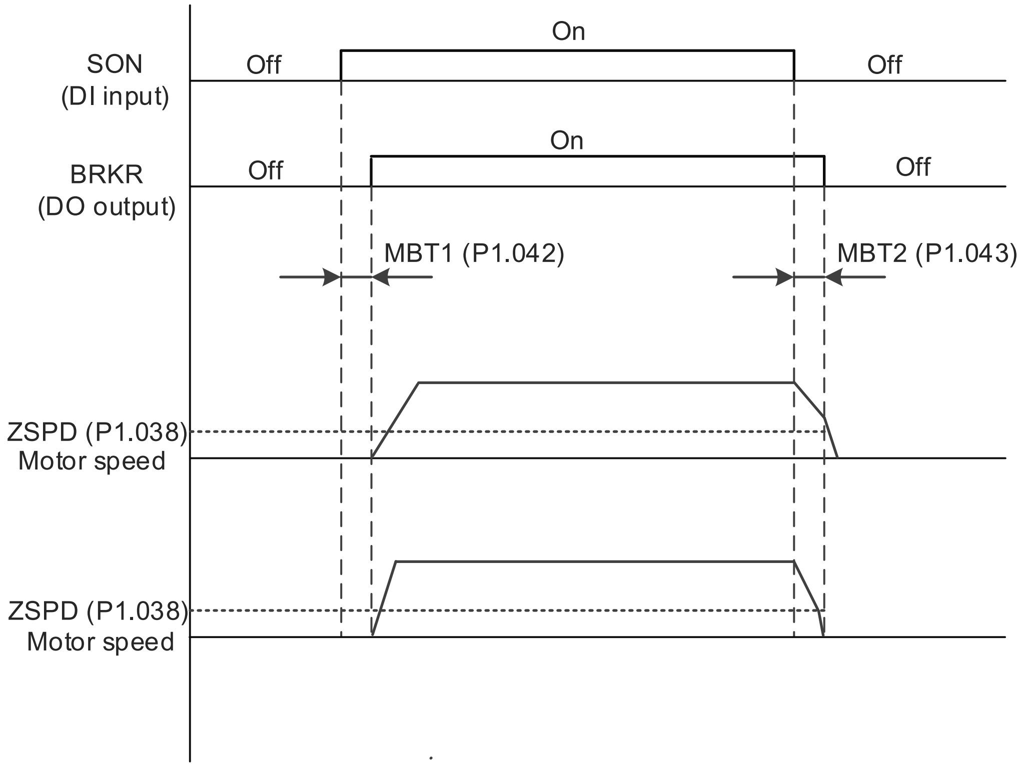
Note: the minimum allowable resistance value is 60Ω for the external resistor of the 400 W servo drives.

2.9 The use of electromagnetic brake

2

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

Timing diagram of electromagnetic brake control:

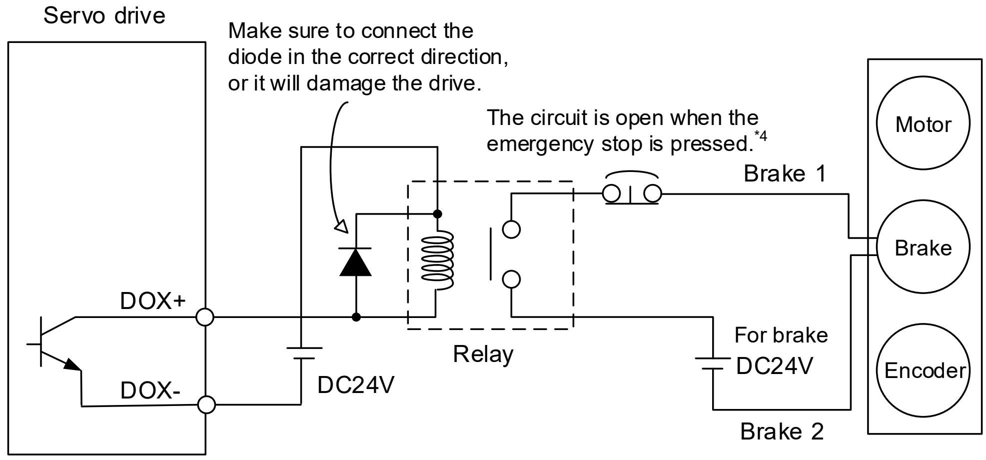


Output timing of the BRKR signal:

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

2

Wiring of the electromagnetic brake:



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

Calculate the brake’s rated current (ECM-B3H-F21308RS1 motor is used as an example).

Brake power consumption (at 20°C (68°F)) = 24 W (refer to Appendix A Specifications), so the brake's rated current = $\frac{24\ W}{24V}$ = 1 A.

2.10 The use of cable

Precautions:

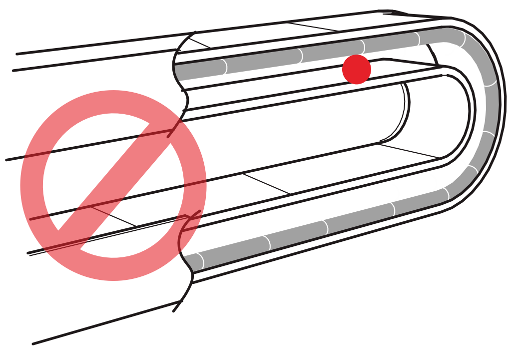
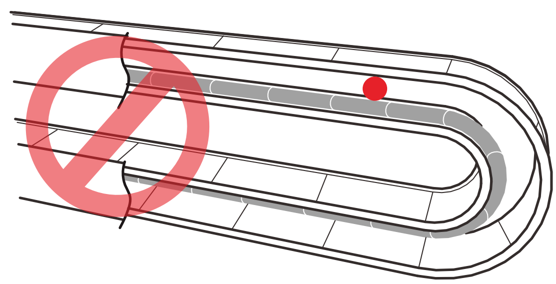
- Prevent the termination point between the connector and the cable from being subject to weight (include that of the attachments) or bending stress.
- If bending the cable is required, start bending it at least 20 mm (0.79 inches) from the termination point between the connector and the cable. The suggested bend radius is no less than 10 times of the cable outer diameter.
- Avoid scraping, crushing, or stepping on the cable. This can damage the inner wires even when the cable seems intact on the outside.
- Do not twist the cable when installing.
- Inappropriate installation and wrong usage shorten the cable lifespan.

Standard cable:

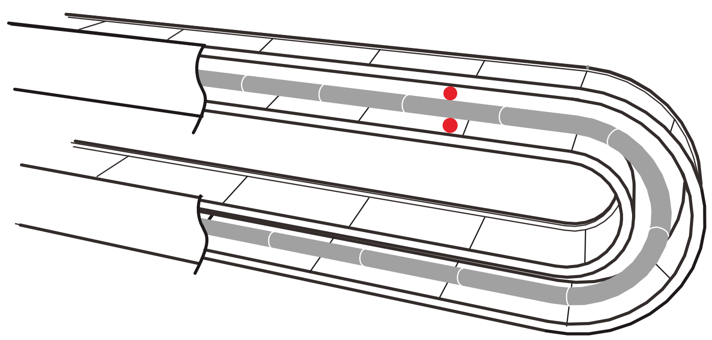
- Do not use a standard cable when the application requires the cable to move or bend. If required, use a flexible cable instead.

Flexible cable:

- Do not fix the cable on or near the bending part, otherwise the cable may break.
- After cable fixation, make sure the cable can be moved with ease, so that it does not create excessive tension on the bending or fixation part.
- Excessive cable length causes unnecessary bending, while insufficient cable length leads to breakage due to the excessive tension on the cable fixation part. Estimate the suitable cable length by dragging the cable carrier to the longest and shortest possible.

Cable is too long	Cable is too short
	

Appropriate cable length, with clearance on both sides of cable



- When installing the cable carrier, avoid contact between the cables. Do not stack the cables one above the other; use dividers to prevent cable entanglement.
- Do not bend the flexible cable under any normal circumstances. Refer to Section 3.1.6.4 for detailed flexible cable specifications.

Wiring

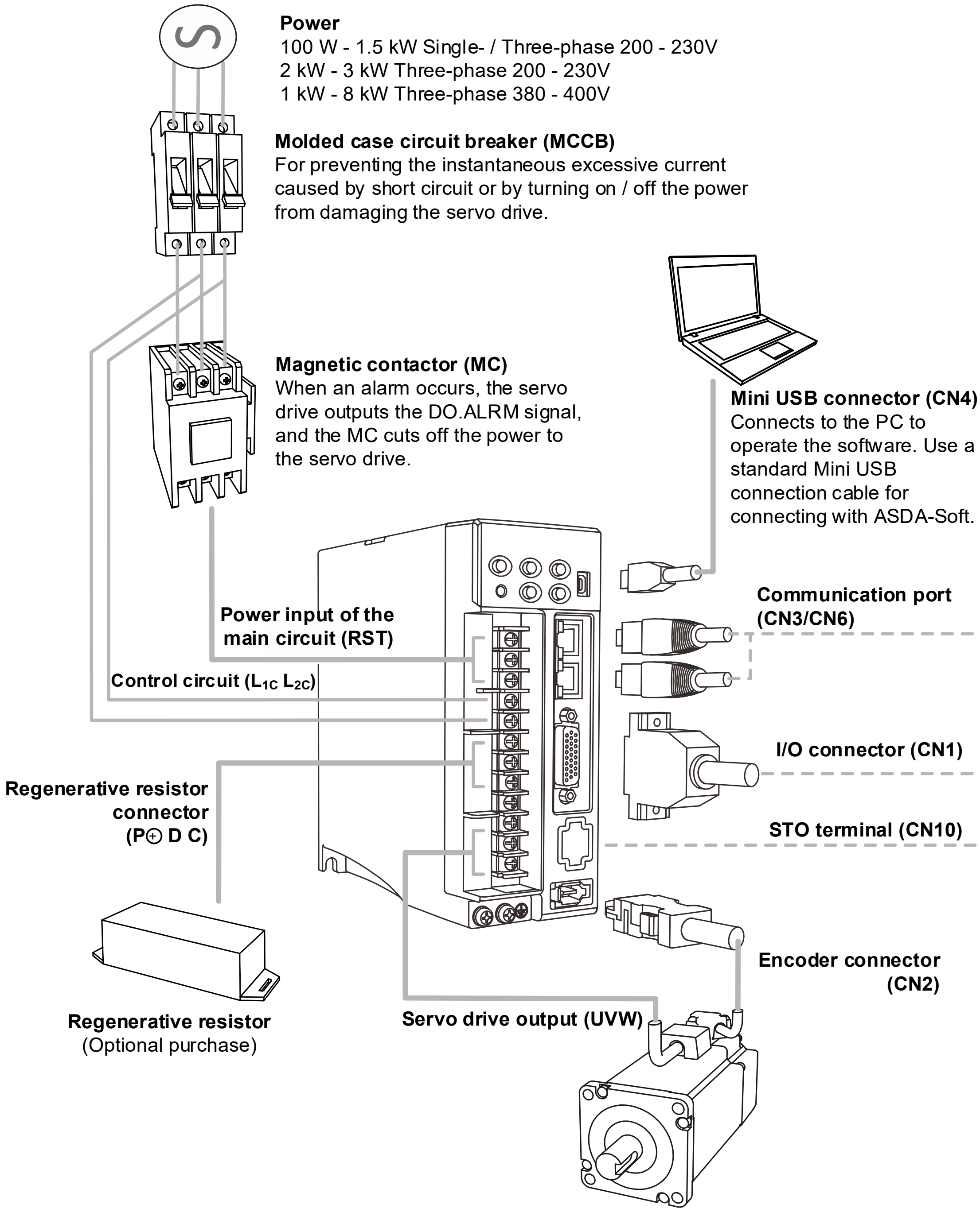
3

This chapter illustrates the power supply circuit, connectors, and wiring for each control mode of the servo drive.

3

3.1 System connection

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



Installation precautions:

1. Make sure the power and wirings of the R, S, T, and L_{1C}, L_{2C} are correct. Refer to the specifications of the servo drives in Appendix A 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 motor operation.
3. When an external regenerative resistor is used, P⊕ and D contacts should be left open, and the external regenerative resistor should connect to P⊕ and C contacts. When the built-in regenerative resistor is used, P⊕ and D contacts should be short-circuited, and P⊕ and C contacts should be left open.
4. When an alarm occurs or the system is under emergency stop status, use DO.ALRM or DO.WARN to switch off the magnetic contactor (MC) to cut off the power to the servo drive.

3.1.2 Connectors and terminals

<table>
<tr><th>Terminal</th><th>Name</th><th colspan="3">Description</th></tr>
<tr><td>L_{1C}, L_{2C}</td><td>Power input for the control circuit</td><td colspan="3">Connect to single-phase AC power.
(Refer to the model specification for the proper input voltage.)</td></tr>
<tr><td>R, S, T</td><td>Power input for the main circuit</td><td colspan="3">Connect to three-phase AC power.
(Refer to the model specification for the proper input voltage.)</td></tr>
<tr><td rowspan="6">U, V, W, FG</td><td rowspan="6">Terminals for motor connection</td><td colspan="3">Connect to the servo motor.</td></tr>
<tr><th>Terminal</th><th>Wire color</th><th>Description</th></tr>
<tr><td>U</td><td>Red</td><td rowspan="3">Connection terminals for the three-phase main power cable to the motor.</td></tr>
<tr><td>V</td><td>White</td></tr>
<tr><td>W</td><td>Black</td></tr>
<tr><td>FG</td><td>Yellow / Green</td><td>Connect to the ground terminal ⏚ on the servo drive.</td></tr>
<tr><td rowspan="3">P⊕, D, C, ⊖</td><td rowspan="3">Terminals for the regenerative resistor terminal or power regenerative unit</td><td colspan="2">Use the built-in resistor</td><td>Short-circuit P⊕ and D contacts, and leave P⊕ and C contacts open.</td></tr>
<tr><td colspan="2">Use an external resistor</td><td>Connect P⊕ and C contacts to the resistor, and leave P⊕ and D contacts open.</td></tr>
<tr><td colspan="2">Use an external power regenerative unit</td><td>Connect the power regenerative unit to P⊕ and⊖ on the servo drive. Leave P⊕ & D contacts and P⊕ & C contacts open.</td></tr>
<tr><td>⏚</td><td>Ground terminals</td><td colspan="3">Connect to the ground wires for the power and servo motor.</td></tr>
<tr><td>CN1</td><td>I/O connector</td><td colspan="3">Connect to the controller. Refer to Section 3.3 for more information.</td></tr>
<tr><td>CN2</td><td>Encoder connector</td><td colspan="3">Connect to the encoder. Refer to Section 3.4 for more information.</td></tr>
<tr><td>CN3</td><td>Communication port</td><td colspan="3">For RS-485 or CANopen communication. Refer to Section 3.5 for more information.</td></tr>
<tr><td>CN4</td><td>Mini USB port</td><td colspan="3">Connect to PC or laptop. Refer to Section 3.6 for more information.</td></tr>
<tr><td>CN6</td><td>Communication port</td><td colspan="3">For DMCNET, EtherCAT, or PROFINET communication. Refer to Section 3.7 for more information.</td></tr>
<tr><td>CN10</td><td>STO terminal</td><td colspan="3">Provides the STO (Safe Torque Off) function. The STO function is supported by the B3A models only. Refer to Sections 3.8 and 3.9 for more information.</td></tr>
</table>

Pay special attention to the following when wiring:

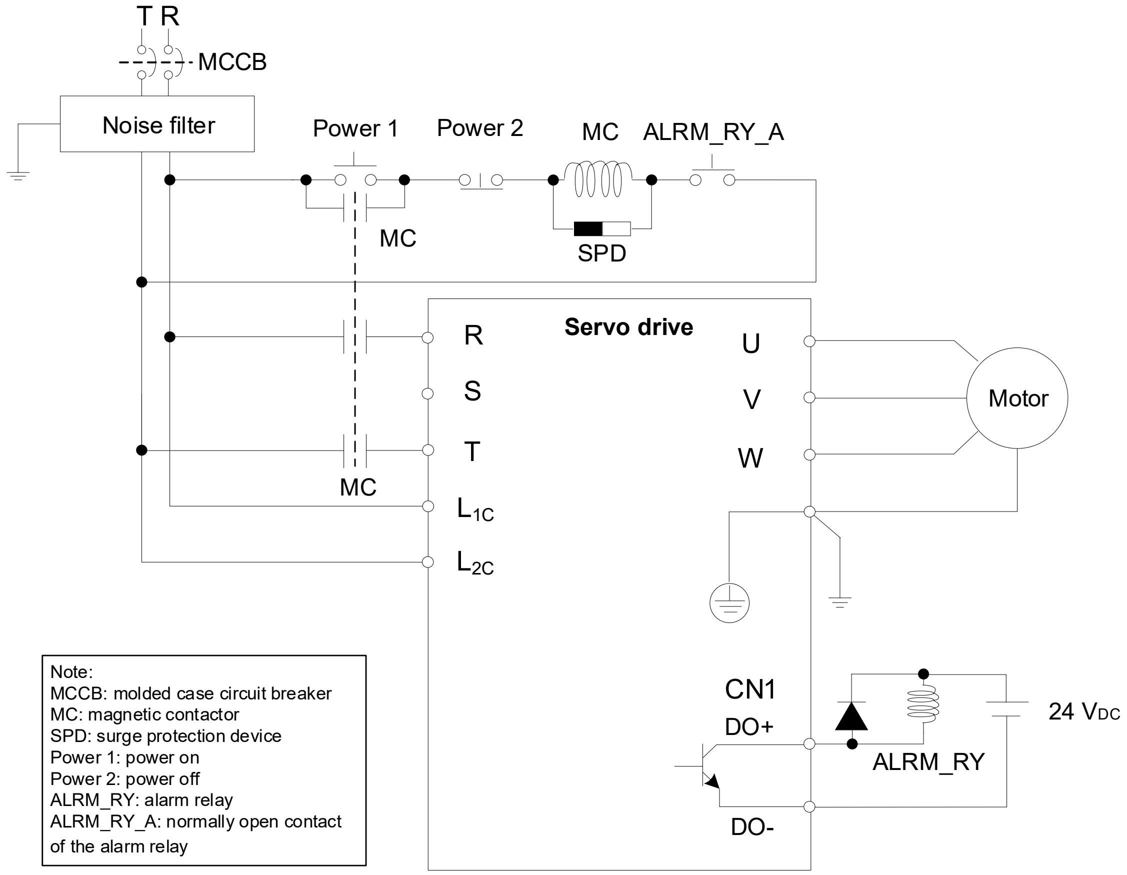
1. Do not touch the RST and UVW cables and P⊕, D, C, ⊖ wires immediately after the power is off since the built-in capacitor of the servo drive can still contain a dangerously large amount of electric charge. Wait until the “CHARGE” indicator is off.
2. Separate the RST power cable and the UVW power cable from other signal cables. The minimum separation distances should be at least 30 cm (11.8 inches).
3. For the encoder cable for CN2, use a metal braided shielded twisted-pair cable that conforms to the UL2464 standard.
4. When using RS-485, CANopen, DMCNET, EtherCAT, or PROFINET, use the shielded twisted-pair communication cable to ensure the communication quality.
5. Do not use any external capacitors, or it may 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.

The single-phase wiring is only applicable to models of 220V 1.5 kW or below. In the following diagram, Power 1 and ALRM_RY_A are normally open contacts, and Power 2 is a normally closed contact. MC (magnetic contactor) is the power relay and the contact for the main power circuit.

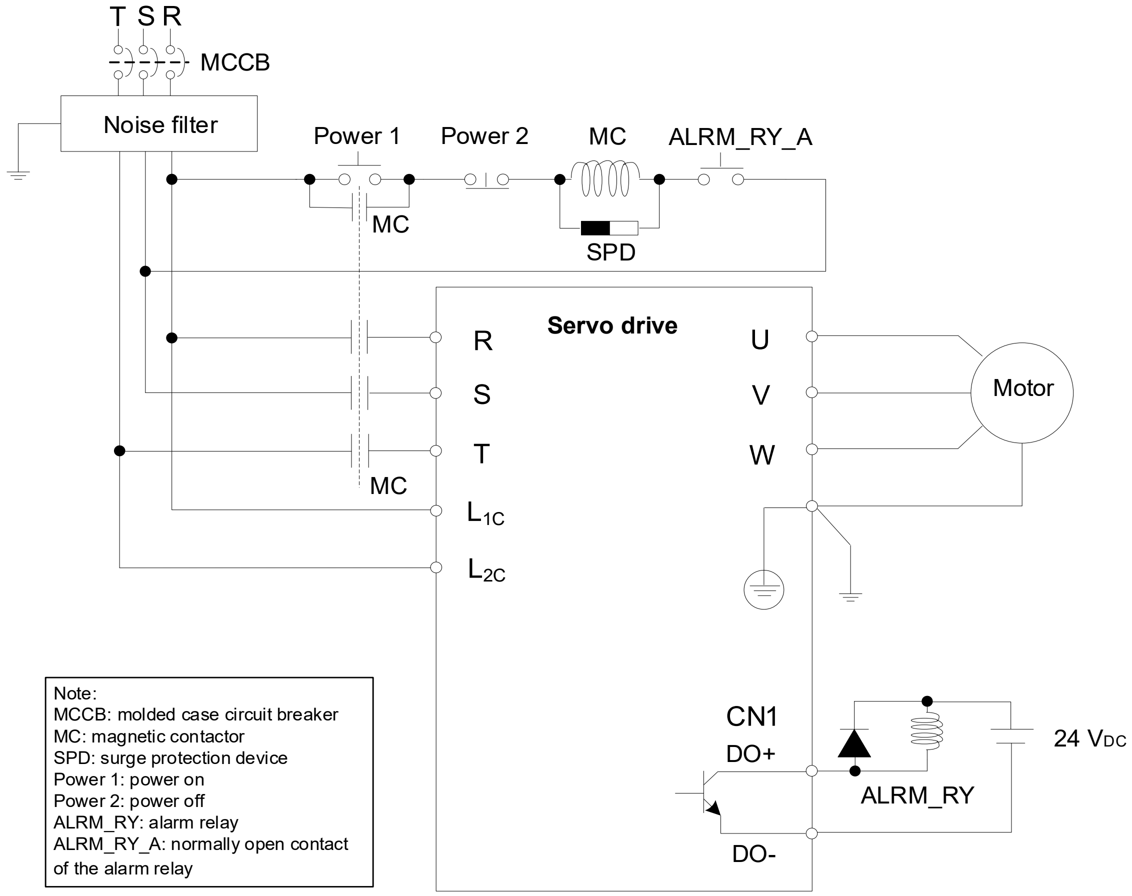
- Wiring method for single-phase power supply (for models of 220V 1.5 kW or below)



Note: perform wiring according to the actual DO parameter configurations of each model.

3

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



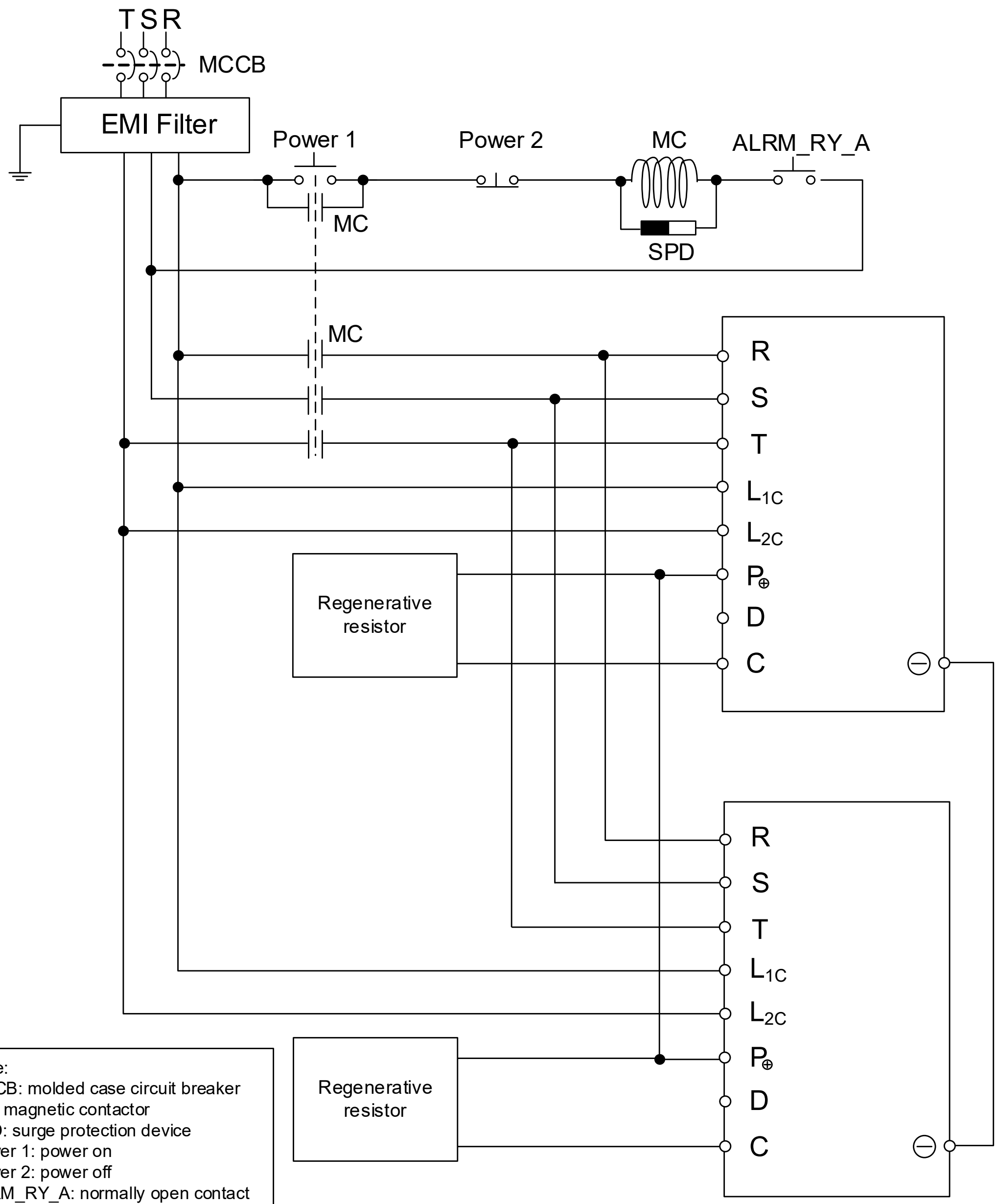
Note: perform wiring according to the actual DO parameter configurations of each model.

3

■ Connecting multiple servo drives (in parallel)

Using a common DC Bus can make efficient use of the regenerative energy. For instance, while one of the axes is decelerating, the regenerative energy can be supplied to the other axes. If you need to connect servo drives of different power levels, only **models of the same power level or the next upper / lower power level** can be connected; moreover, each servo drive should connect to a regenerative resistor (or a power regenerative unit).

Example: if there is a 400 W servo drive in the system, you can add servo drives of the same or different power level which ranges from 200 W to 750 W. This is because one system can only support servo drives of up to two different power levels.

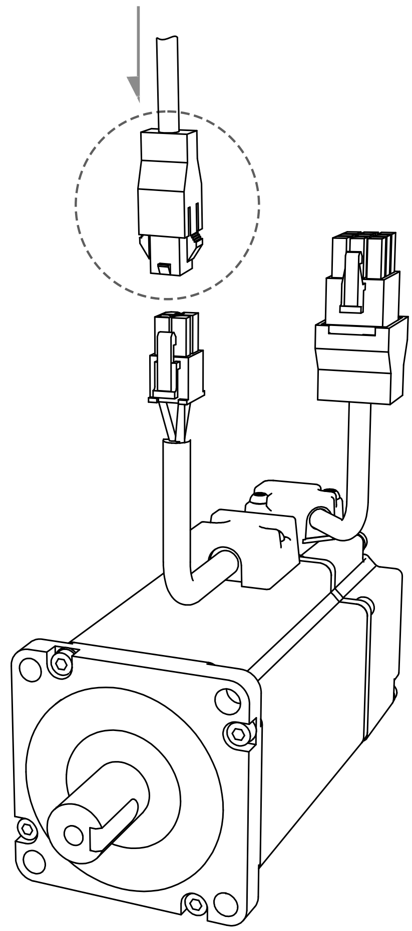


Note:
MCCB: molded case circuit breaker
MC: magnetic contactor
SPD: surge protection device
Power 1: power on
Power 2: power off
ALRM_RY_A: normally open contact of the alarm relay

3.1.4 UVW power connector specifications

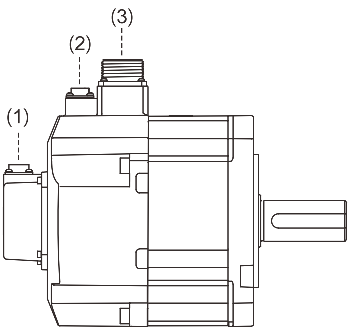
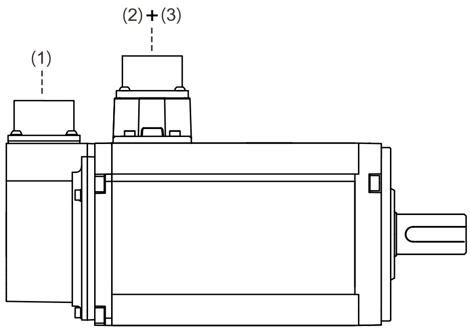
Select the appropriate connector according to the code of **Shaft diameter and connector type** in the motor model number. Refer to Section 1.2.2 for the model explanation of the servo motor.

3



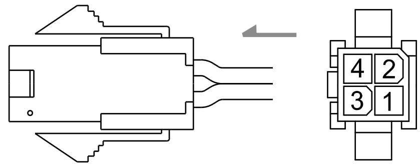
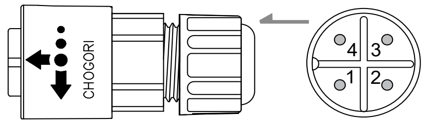
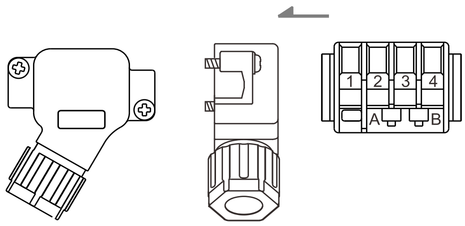
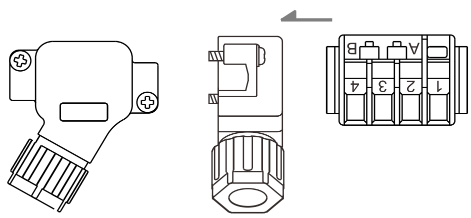
Note: pin assignments of the ECM-B3 and ECM-B2 motor connectors are the same. For easier wiring, ECM-B3's connector illustration (angle of viewing) is changed, which is different from that of ECM-B2.

The (2) and (3) in the following figures show the difference between the military connectors of the ECM-B3 motors and those of the ECMA / ECMC (old series) motors.

ECM-B3 (F100 - F180)	ECMA / ECMC (F100 - F180)
	

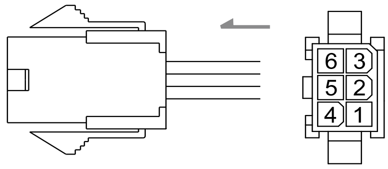
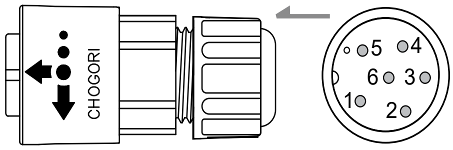
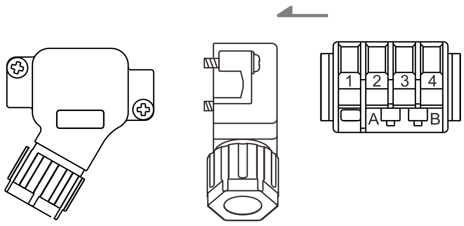
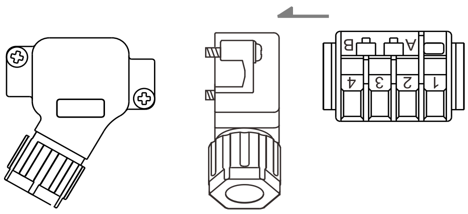
(1) Encoder connector; (2) Brake connector; (3) UVW power connector

3.1.4.1 F40 - F80 motors – Power connectors

Connector type **Model number**	**Applicable model** **Model number**	**UVW power connector - w/o brake**
Standard ACS3-CAPW1000	ECM-B3 & ECM-A3 ECM-B3□-□□△△□□RS□ ECM-B3□-□□△△□□R7□ ECM-A3□-□□△△□□RS□ ECM-A3□-□□△△□□R7□ △△ = 04, 06, 08	
CHOGORI ACS3-CNPW1A00	ECM-B3 & ECM-A3 (220V models only) ECM-B3□-□□△△□□RJ□ ECM-B3□-□□△△□□RK□ ECM-A3□-□□△△□□RJ□ ECM-A3□-□□△△□□RK□ △△ = 04, 06, 08	
Bulkhead - cable exit direction towards motor shaft ACS3-AFPWSS00	ECM-B3 ECM-B3□-□□△△□□RB□ △△ = 04, 06, 08	
Bulkhead - cable exit direction towards encoder ACS3-ABPWSS00	ECM-B3 ECM-B3□-□□△△□□RB□ △△ = 04, 06, 08	

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

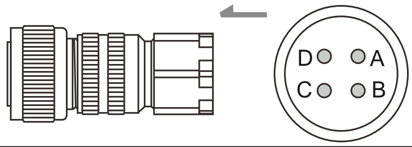
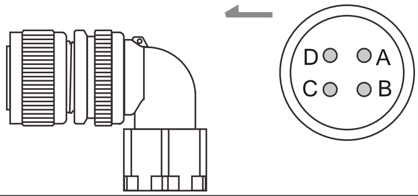
Note: all bulkhead connectors are with brakes. Do not wire Pin A and Pin B when using the motors without brakes.

Connector type Model number	Applicable model **Model number**	UVW power connector - with brake
Standard ACS3-CAPW2000	ECM-B3 & ECM-A3 ECM-B3□-□□△△□□SS□ ECM-B3□-□□△△□□S7□ ECM-A3□-□□△△□□SS□ ECM-A3□-□□△△□□S7□ △△ = 04, 06, 08	
CHOGORI ACS3-CNPW2A00	ECM-B3 & ECM-A3 (220V models only) ECM-B3□-□□△△□□SJ□ ECM-B3□-□□△△□□SK□ ECM-A3□-□□△△□□SJ□ ECM-A3□-□□△△□□SK□ △△ = 04, 06, 08	
Bulkhead - cable exit direction towards motor shaft ACS3-AFPWSS00	ECM-B3 ECM-B3□-□□△△□□SB□ △△ = 04, 06, 08	
Bulkhead - cable exit direction towards encoder ACS3-ABPWSS00	ECM-B3 ECM-B3□-□□△△□□SB□ △△ = 04, 06, 08	

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

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

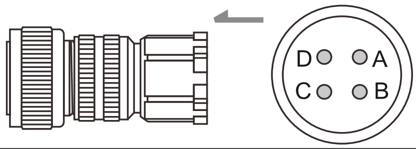
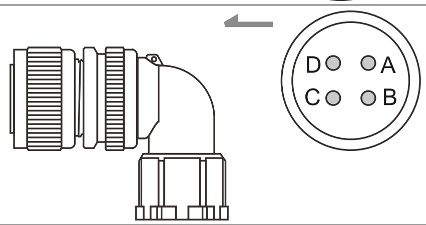
3.1.4.2 F100 - F130 motors – Power connectors

Connector type Model number	Applicable model Model number	UVW power connector – w/o brake
Military - straight 3106A-18-10S ACS3-CAPWA000	ECM-B3 ECM-B3□-□□△△□□□S□ △△ = 10, 13	
Military - right angle 3108A-18-10S ACS3-CRPWA000	ECM-B3 ECM-B3□-□□△△□□□S□ △△ = 10, 13	

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

Note: see Section 3.1.4.5 for the brake connectors.

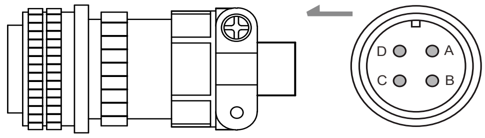
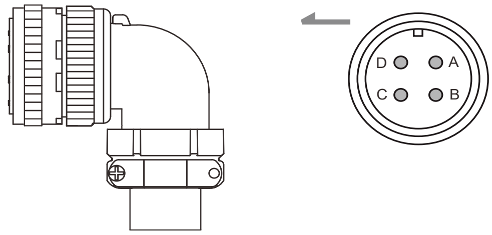
3.1.4.3 F180 4.5 kW (or below) motors – Power connectors

Connector type Model number	Applicable model Model number	UVW power connector – w/o brake
Military - straight 3106A-22-22S ACS3-CAPWC000	ECM-B3 ECM-B3□-□□△△□□□S□ △△ = 18	
Military - right angle 3108A-22-22S ACS3-CRPWC000	ECM-B3 ECM-B3□-□□△△□□□S□ △△ = 18	

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

Note: see Section 3.1.4.5 for the brake connectors.

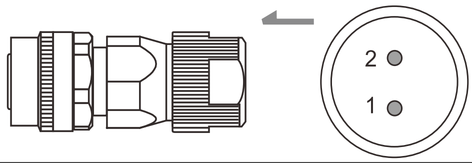
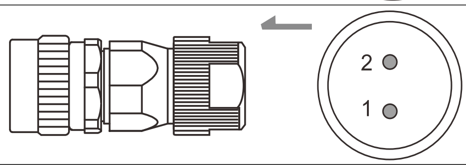
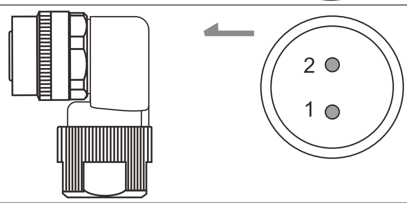
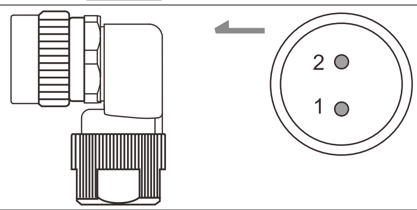
3.1.4.4 F180 5.5 kW (or above) motors – Power connectors

Connector type Model number	Applicable model Model number	UVW power connector - w/o brake
Military - straight 3106A-32-17S ACS3-CAPWE000	ECM-B3 ECM-B3□-□□△△▲▲□3□ △△ = 18; ▲▲ = 55, 75	
Military - right angle 3108A-32-17S ACS3-CRPWE000	ECM-B3 ECM-B3□-□□△△▲▲□3□ △△ = 18; ▲▲ = 55, 75	

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

Note: see Section 3.1.4.5 for the brake connectors.

3.1.4.5 F100 - F180 motors – Brake connectors

Connector type Model number	Applicable model Model number	Brake connector
Military - straight CMV1-SP2S [bayonet] ACS3-CABRA000	ECM-B3 ECM-B3□-□□△△□□S□□ △△ = 10, 13, 18	
Military - straight [threaded, M17.5] ACS3-CABRM000	ECM-B3 ECM-B3□-□□△△□□S□□ △△ = 10, 13, 18	
Military - right angle CMV1-AP2S [bayonet] ACS3-CRBRA000	ECM-B3 ECM-B3□-□□△△□□S□□ △△ = 10, 13, 18	
Military - right angle [threaded, M17.5] ACS3-CRBRM000	ECM-B3 ECM-B3□-□□△△□□S□□ △△ = 10, 13, 18	

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

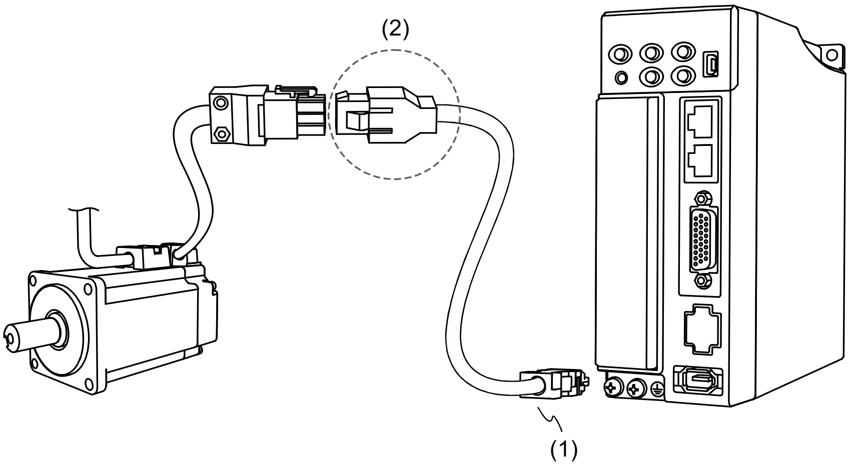
Note:
1. Power supply for the brake is 24 V_{DC}; do not share the same power supply with other signals. The brake coil has no polarity.
2. Motors with bayonet receptacles are not compatible with threaded military connectors. Refer to Section B.13 for details.

3.1.5 Encoder connector specifications

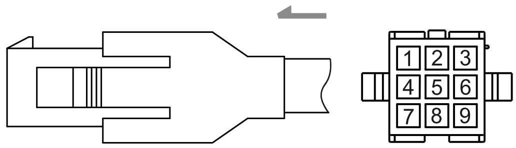
Select the appropriate connector according to the code of **Shaft diameter and connector type** in the motor model number. Refer to Section 1.2.2 for the model explanation of the servo motor.

3.1.5.1 F40 - F80 motors – Encoder connectors

Standard connector

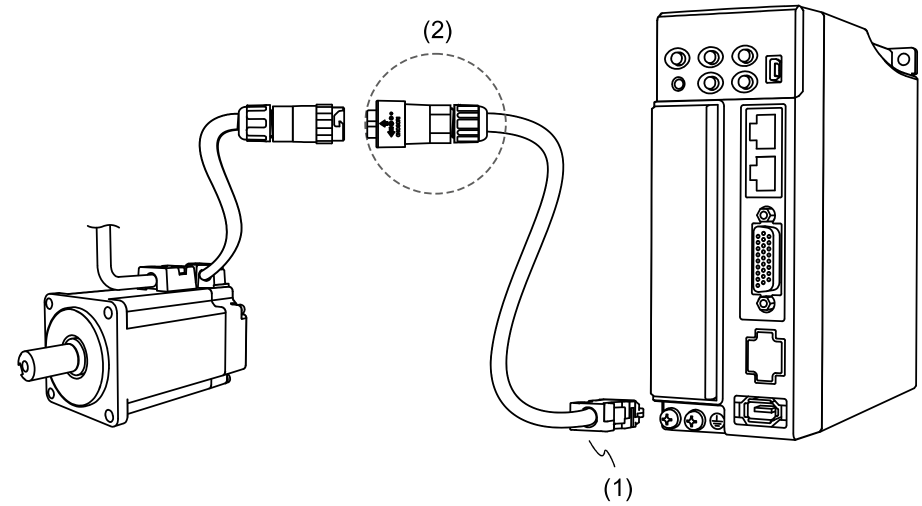


(1) CN2 connector; (2) Standard connector

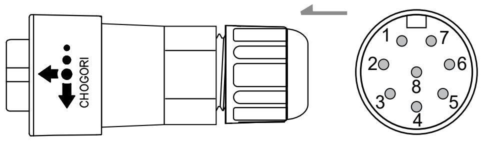
Connector type Model number	Applicable model Model number	Encoder connector
Standard ACS3-CAEN0000	ECM-B3 & ECM-A3 ECM-B3□-□□△△□□□S□ ECM-B3□-□□△△□□□7□ ECM-A3□-□□△△□□□S□ ECM-A3□-□□△△□□□7□ △△ = 04, 06, 08	

Note: see Section 3.4 for the pin assignment of the encoder connectors.

CHOGORI connector

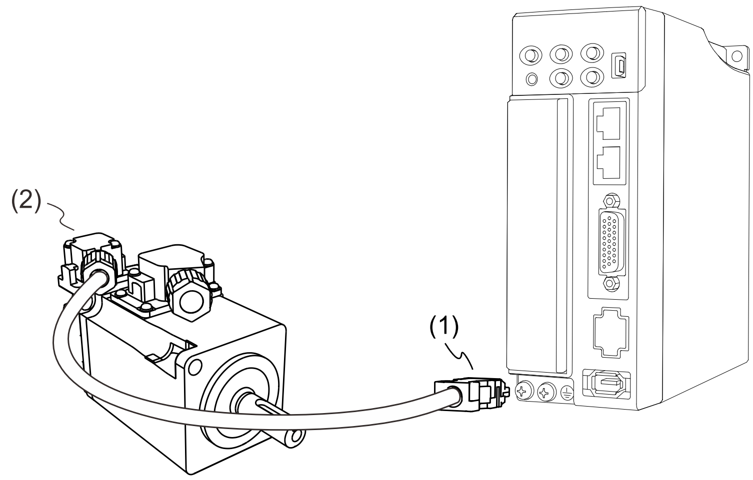


(1) CN2 connector; (2) CHOGORI connector

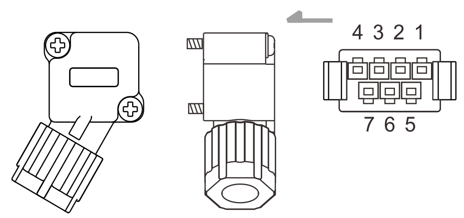
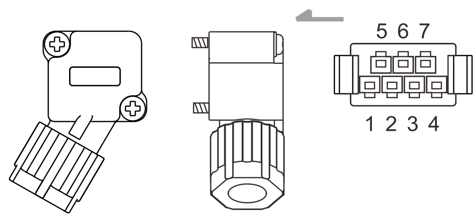
Connector type Model number	Applicable model Model number	Encoder connector
CHOGORI ACS3-CNEN2A00	ECM-B3 & ECM-A3 (220V models only) ECM-B3□-□□△△□□□J□ ECM-B3□-□□△△□□□K□ ECM-A3□-□□△△□□□J□ ECM-A3□-□□△△□□□K□ △△ = 04, 06, 08	

Note: see Sectgion 3.4 for the pin assignment for the encoder connectors.

Bulkhead connector

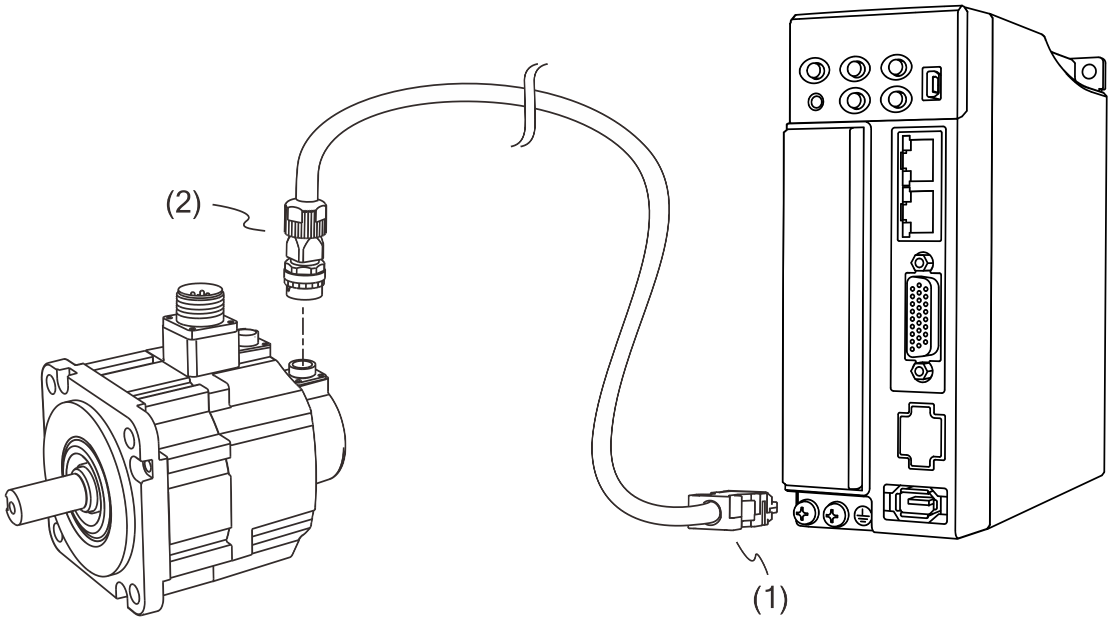


(1) CN2 connector; (2) Bulkhead connector (cable exit direction towards motor shaft)

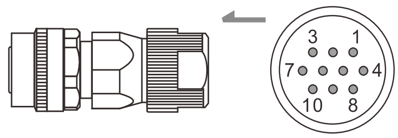
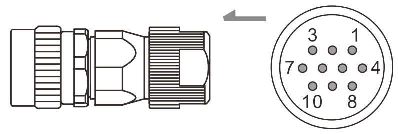
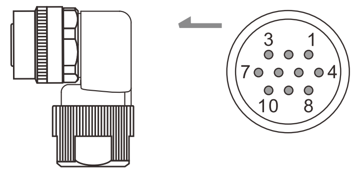
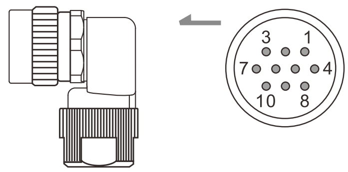
Connector type Model number	Applicable model Model number	Encoder connector
Bulkhead - cable exit direction towards motor shaft ACS3-AFEASA00	ECM-B3 ECM-B3□-□□△△□□□B□ △△ = 04, 06, 08	
Bulkhead - cable exit direction towards encoder ACS3-AFEASA00	ECM-B3 ECM-B3□-□□△△□□□B□ △△ = 04, 06, 08	

Note: see Section 3.4 for the pin assignment of the encoder connectors.

3.1.5.2 F100 - F180 motors – Encoder connectors



(1) CN2 connector; (2) Military connector

Connector type Model number	Applicable model Model number	Encoder connector
Military - straight CMV1-SP10S [bayonet] ACS3-CAENA000	ECM-B3 ECM-B3□-□□△△□□□□□ △△ = 10, 13, 18	
Military - straight [threaded, M17.5] ACS3-CAENM000	ECM-B3 ECM-B3□-□□△△□□□□□ △△ = 10, 13, 18	
Military - right angle CMV1-AP10S [bayonet] ACS3-CRENA000	ECM-B3 ECM-B3□-□□△△□□□□□ △△ = 10, 13, 18	
Military - right angel [threaded, M17.5] ACS3-CRENM000	ECM-B3 ECM-B3□-□□△△□□□□□ △△ = 10, 13, 18	

Note:
1. See Section 3.4 for the pin assignment of the encoder connectors.
2. Motors with bayonet receptacles are not compatible with threaded military connectors. Refer to Section B.13 for details.

3

3.1.6 Wire selection

3.1.6.1 Wire specifications / screw terminal block dimensions / screw and tightening torque specifications

3.1.6.1.1 220V models

The following tables are the suggested specifications for wiring the terminals and signals for the servo drive.

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

Servo drive model	Wire spec.	K.S. Terminals Inc.		Kise Terminal		Kss Terminal	
	U, V, W	Fork terminal	Ring terminal	Fork terminal	Ring terminal	Fork terminal	Ring terminal
ASD-B3□-0121-□	18 AWG 0.82 mm²	SVBL1-3.7	RVBM1-3.7	SVS 1.25-3.5	RVS 1.25-3.5	YF1.25-3	RF1.25-3
ASD-B3□-0221-□							
ASD-B3□-0421-□							
ASD-B3□-0721-□							
ASD-B3□-1021-□	16 AWG 1.3 mm²	SVBL2-3.7	RVBM2-3.7	SV 1.25-3	RV 1.25-3	YF1.25-3	RF1.25-3
ASD-B3□-1521-□							
ASD-B3□-2023-□	12 AWG 3.3 mm²	SVB3-4	RVB3-4	SV 3.5-4	RV 3.5-4	YF3.5-4	RF3.5-4
ASD-B3□-3023-□	10 AWG 5.3 mm²	SVBS5-4	RVBS5-4	SVS 5.5-4	RVS 5.5-4	YF5.5-4	RF5.5-4

Servo drive model	Wire spec.	K.S. Terminals Inc.		Kise Terminal		Kss Terminal	
	P⊕, C	Fork terminal	Ring terminal	Fork terminal	Ring terminal	Fork terminal	Ring terminal
ASD-B3□-0121-□	14 AWG 2.1 mm²	SVBL2-3.7	RVBM2-3.7	SV 3.5-3	RV 2-3	YF3.5-3S	RF2-3
ASD-B3□-0221-□							
ASD-B3□-0421-□							
ASD-B3□-0721-□							
ASD-B3□-1021-□							
ASD-B3□-1521-□							
ASD-B3□-2023-□		SVBL2-4	RVBL2-4	SV 3.5-4	RV 3.5-4	YF2-4	RF2-4
ASD-B3□-3023-□							

Servo drive model	Wire spec.	K.S. Terminals Inc.		Kise Terminal		Kss Terminal	
	L_{1C}, L_{2C}	Fork terminal	Ring terminal	Fork terminal	Ring terminal	Fork terminal	Ring terminal
ASD-B3□-0121-□	16 AWG 1.3 mm²	SVBL2-3.7	RVBM2-3.7	SV 1.25-3	RV 1.25-3	YF1.25-3	RF1.25-3
ASD-B3□-0221-□							
ASD-B3□-0421-□							
ASD-B3□-0721-□							
ASD-B3□-1021-□							
ASD-B3□-1521-□							
ASD-B3□-2023-□		SVBL2-4	RVBL2-4	SV 1.25-4	RVL 1.25-4	YF2-4	RF2-4
ASD-B3□-3023-□							

Servo drive model	Wire spec.	K.S. Terminals Inc.		Kise Terminal		Kss Terminal	
	R, S, T	Fork terminal	Ring terminal	Fork terminal	Ring terminal	Fork terminal	Ring terminal
ASD-B3□-0121-□	22 AWG 0.32 mm^2	SVBL1-3.7	RVBM1-3.7	SV 1.25-3	RV 1.25-3	YF1.25-3	RF1.25-3
ASD-B3□-0221-□							
ASD-B3□-0421-□	20 AWG 0.52 mm^2						
ASD-B3□-0721-□	16 AWG 1.3 mm^2						
ASD-B3□-1021-□	14 AWG 2.1 mm^2	SVBL2-3.7	RVBM2-3.7	SV 3.5-3	RV 2-3	YF3.5-3S	RF2-3
ASD-B3□-1521-□	12 AWG 3.3 mm^2	-	-		-		-
ASD-B3□-2023-□	12 AWG 3.3 mm^2	SVBS5-4	RVBS5-4	SVS 5.5-4	RVS 5.5-4	YF5.5-4	RF5.5-4
ASD-B3□-3023-□	10 AWG 5.3 mm^2						

If you choose terminals of other brands, refer to the following terminal block dimensions.

Servo drive model	Screw terminal block dimensions
ASD-B3□-0121-□	7 mm
ASD-B3□-0221-□	
ASD-B3□-0421-□	
ASD-B3□-0721-□	
ASD-B3□-1021-□	
ASD-B3□-1521-□	
ASD-B3□-2023-□	9.5 mm
ASD-B3□-3023-□	

Note:
1. Choose the suitable terminals that comply with the wiring specifications for the servo drive.
2. Use a crimping tool to properly crimp the terminals and wires.
3. Do not use bare wires for wiring, or the loose wires may cause accidents.
4. Use a 600 V_{AC} PVC cable with the length less than 20 meters (65.62 feet) for the power cable.

Refer to the following screws specifications and ensure the tightening torque does not exceed the following specifications.

Screw specification and tightening torque (kgf-cm)												
Servo drive model	L_{1C}, L_{2C}		R, S, T		U, V, W		P⊕, D, C, ⊖		Ground screw ⏚		CN1	
ASD-B3□-0121-□	M3	6 - 7	M3	6 - 7	M3	6 - 7	M3	6 - 7	M4	12 - 14	-	2 - 2.5
ASD-B3□-0221-□	M3	6 - 7	M3	6 - 7	M3	6 - 7	M3	6 - 7	M4	12 - 14	-	2 - 2.5
ASD-B3□-0421-□	M3	6 - 7	M3	6 - 7	M3	6 - 7	M3	6 - 7	M4	12 - 14	-	2 - 2.5
ASD-B3□-0721-□	M3	6 - 7	M3	6 - 7	M3	6 - 7	M3	6 - 7	M4	12 - 14	-	2 - 2.5
ASD-B3□-1021-□	M3	6 - 7	M3	6 - 7	M3	6 - 7	M3	6 - 7	M4	12 - 14	-	2 - 2.5
ASD-B3□-1521-□	M3	6 - 7	M3	6 - 7	M3	6 - 7	M3	6 - 7	M4	12 - 14	-	2 - 2.5
ASD-B3□-2023-□	M4	10 - 11	M4	10 - 11	M4	10 - 11	M4	10 - 11	M4	12 - 14	-	2 - 2.5
ASD-B3□-3023-□	M4	10 - 11	M4	10 - 11	M4	10 - 11	M4	10 - 11	M4	12 - 14	-	2 - 2.5

3

3.1.6.1.2 400V models

The following table is the suggested specifications for wiring the terminals and signals for the servo drive and the suggested brand of ring terminals is K.S. Terminals Inc.

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

Servo drive model	L_{1C}, L_{2C}		R, S, T		U, V, W		P⊕, D, C, ⊖	
	Wire spec.	Ring terminal	Wire spec.	Ring terminal	Wire spec.	Ring terminal	Wire spec.	Ring terminal
ASD-B3□-1043-□	15 AWG 1.7 mm^2	RVBS2-3.2	14 AWG 2.1 mm^2	RVBS2-3.2	16 AWG 1.3 mm^2	RVBS2-3.7	14 AWG 2.1 mm^2	RVBS2-3.2
ASD-B3□-1543-□	15 AWG 1.7 mm^2	RVBS2-3.2	14 AWG 2.1 mm^2	RVBS2-3.2	16 AWG 1.3 mm^2	RVBS2-3.7	14 AWG 2.1 mm^2	RVBS2-3.2
ASD-B3□-2043-□	15 AWG 1.7 mm^2	RVBS2-3.2	14 AWG 2.1 mm^2	RVBS2-3.2	16 AWG 1.3 mm^2	RVBS2-3.7	14 AWG 2.1 mm^2	RVBS2-3.2
ASD-B3□-3043-□	15 AWG 1.7 mm^2	RVBS2-3.2	12 AWG 3.3 mm^2	-	14 AWG 2.1 mm^2	RVBS2-3.2	14 AWG 2.1 mm^2	RVBS2-3.2
ASD-B3□-4043-□	15 AWG 1.7 mm^2	RVBL2-4	12 AWG 3.3 mm^2	RVBS5-4	12 AWG 3.3 mm^2	RVBS5-4	14 AWG 2.1 mm^2	RVBL2-4
ASD-B3□-4543-□	15 AWG 1.7 mm^2	RVBL2-4	12 AWG 3.3 mm^2	RVBS5-4	12 AWG 3.3 mm^2	RVBS5-4	14 AWG 2.1 mm^2	RVBL2-4
ASD-B3□-5543-□	15 AWG 1.7 mm^2	RVBL2-4	10 AWG 5.3 mm^2	RVBS5-4	8 AWG 8.4 mm^2	RNBS8-4	12 AWG 3.3 mm^2	RVBS5-4
ASD-B3□-7543-□	15 AWG 1.7 mm^2	RVBL2-4	10 AWG 5.3 mm^2	RVBS5-4	8 AWG 8.4 mm^2	RNBS8-4	12 AWG 3.3 mm^2	RVBS5-4
ASD-B3□-8043-□	15 AWG 1.7 mm^2	RVBL2-4	10 AWG 5.3 mm^2	RVBS5-4	8 AWG 8.4 mm^2	RNBS8-4	12 AWG 3.3 mm^2	RVBS5-4

If you choose terminals of other brands, refer to the following terminal block dimensions.

Servo drive model	Screw terminal block dimensions
ASD-B3□-1043-□	7 mm
ASD-B3□-1543-□	
ASD-B3□-2043-□	
ASD-B3□-3043-□	
ASD-B3□-4043-□	9.5 mm
ASD-B3□-4543-□	
ASD-B3□-5543-□	
ASD-B3□-7543-□	
ASD-B3□-8043-□	

3

Refer to the following screw specifications and ensure the tightening torque does not exceed the following specifications.

Screw specifications and tightening torque (kgf-cm)												
Servo drive model	L_{1C}, L_{2C}		R, S, T		U, V, W		P⊕, D, C, ⊖		Ground screw ⏚		CN1	
ASD-B3□-1043-□	M3	8 - 9	M3	8 - 9	M3	8 - 9	M3	8 - 9	M4	12 - 14	-	2 - 2.5
ASD-B3□-1543-□	M3	8 - 9	M3	8 - 9	M3	8 - 9	M3	8 - 9	M4	12 - 14	-	2 - 2.5
ASD-B3□-2043-□	M3	8 - 9	M3	8 - 9	M3	8 - 9	M3	8 - 9	M4	12 - 14	-	2 - 2.5
ASD-B3□-3043-□	M3	8 - 9	M3	8 - 9	M3	8 - 9	M3	8 - 9	M4	12 - 14	-	2 - 2.5
ASD-B3□-4043-□	M4	9 - 10	M4	9 - 10	M4	9 - 10	M4	9 - 10	M4	12 - 14	-	2 - 2.5
ASD-B3□-4543-□	M4	9 - 10	M4	9 - 10	M4	9 - 10	M4	9 - 10	M4	12 - 14	-	2 - 2.5
ASD-B3□-5543-□	M4	9 - 10	M4	9 - 10	M4	9 - 10	M4	9 - 10	M4	12 - 14	-	2 - 2.5
ASD-B3□-7543-□	M4	9 - 10	M4	9 - 10	M4	9 - 10	M4	9 - 10	M4	12 - 14	-	2 - 2.5
ASD-B3□-8043-□	M4	9 - 10	M4	9 - 10	M4	9 - 10	M4	9 - 10	M4	12 - 14	-	2 - 2.5

Note:
1. Choose the suitable ring terminals that comply with the wiring specifications for the servo drive.
2. Use a crimping tool to properly crimp the terminals and wires.
3. Do not use bare wires for wiring, or the loose wires may cause accidents.
4. Use a 600 V_{AC} PVC cable with the length less than 20 meters (65.62 feet) for the power cable.

3

3.1.6.2 Encoder cable specifications

Item	Standard cable	Flexible cable
Model number	ACS3-CAEN01XX ACS3-CAEA01XX ACS3-CAEN11XX ACS3-CAEA11XX ACS3-CAENA1XX ACS3-CAEAA1XX ACS3-CRENA1XX ACS3-CREAA1XX ACS3-CAENM1XX ACS3-CAEAM1XX ACS3-CRENM1XX ACS3-CREAM1XX	ACS3-CAEF01XX ACS3-CAEB01XX ACS3-CAEF11XX ACS3-CAEB11XX ACS3-CAEFA1XX ACS3-CAEBA1XX ACS3-CREFA1XX ACS3-CREBA1XX ACS3-CAEFM1XX ACS3-CAEBM1XX ACS3-CREFM1XX ACS3-CREBM1XX
Cable type	UL2464 (Temp. rating: 80°C / 176°F)	UL2464 (Temp. rating: 80°C / 176°F)
DC+5V, GND	AWG#22-2C (0.32 mm²) Outer diameter of insulated wire: Φ1.3 mm	AWG#22-2C (0.32 mm²) Outer diameter of insulated wire: Φ1.3 mm
T+, T-	AWG#24-2P (0.21 mm²) Outer diameter of insulated wire: Φ1.1 mm	AWG#24-2P (0.21 mm²) Outer diameter of insulated wire: Φ1.1 mm
Cable diameter	Φ7 mm	
Max. allowable wiring length	20 m	
Standard length provided by Delta	L = 3 m, 5 m, 10 m, 20 m	

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

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

3.1.6.3 Power cable specifications

F40 - F80 motors

220V models:

Item	Standard cable	Flexible cable
Model number	ACS3-CAPW11XX ACS3-CAPW51XX ACS3-CAPW61XX	ACS3-CAPF11XX ACS3-CAPF51XX ACS3-CAPF61XX
Cable type	UL2517 (Temp. rating: 105°C / 221°F)	UL2517 (Temp. rating: 105°C / 221°F)
UVW wire	AWG#18-4C (0.82 mm²) Outer diameter of insulated wire: Φ2.1 mm Voltage rating: 300 V_{AC}	AWG#18-4C (0.82 mm²) Outer diameter of insulated wire: Φ2.1 mm Voltage rating: 300 V_{AC}
Brake wire	AWG#22-2C (0.32 mm²) Outer diameter of insulated wire: Φ1.6 mm Voltage rating: 300 V_{AC}	AWG#22-2C (0.32 mm²) Outer diameter of insulated wire: Φ1.6 mm Voltage rating: 300 V_{AC}
Cable diameter	Power cable w/o brake: Φ7.7 mm; power cable with brake: Φ8.6 mm	
Max. allowable wiring length	20 m	
Standard length provided by Delta	L = 3 m, 5 m, 10 m, 20 m	

Item	Standard cable	Flexible cable
Model number	ACS3-AFPWSRXX ACS3-AFPWSSXX ACS3-ABPWSRXX ACS3-ABPWSSXX	ACS3-AFPRSRXX ACS3-AFPRSSXX ACS3-ABPRSRXX ACS3-ABPRSSXX
Cable type	UL2517 (Temp. rating: 105°C / 221°F)	UL2517 (Temp. rating: 105°C / 221°F)
UVW wire	AWG#20-4C (0.52 mm²) Outer diameter of insulated wire: Φ1.55 mm Voltage rating: 300 V_{AC}	AWG#20-4C (0.52 mm²) Outer diameter of insulated wire: Φ1.55 mm Voltage rating: 300 V_{AC}
Brake wire	AWG#24-2C (0.21 mm²) Outer diameter of insulated wire: Φ1.12 mm Voltage rating: 300 V_{AC}	AWG#24-2C (0.21 mm²) Outer diameter of insulated wire: Φ1.12 mm Voltage rating: 300 V_{AC}
Cable diameter	Φ6.0 - Φ6.8 mm	
Max. allowable wiring length	20 m	
Standard length provided by Delta	L = 3 m, 5 m, 10 m, 20 m	

Note:
1. Refer to Section 3.1.6.1 for detailed specifications for wires, screw terminal block dimensions, screws, and tightening torque.
2. Apart from these specifications, refer to Section 2.7.1 for the motor power cable selection and installation precautions.
3. Wire specification of the power adapter cables is the same as that of the power cables. For the cable length, refer to Section B.3.

3

400V models:

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

Item	Standard cable	Flexible cable
Model number	ACS3-AFPWSAXX ACS3-AFPWSBXX ACS3-ABPWSAXX ACS3-ABPWSBXX	ACS3-AFPRSAXX ACS3-AFPRSBXX ACS3-ABPRSAXX ACS3-ABPRSBXX
Cable type	UL2586 (Temp. rating: 105°C / 221°F)	UL2586 (Temp. rating: 105°C / 221°F)
UVW wire	AWG#20-4C (0.52 mm²) Outer diameter of insulated wire: Φ1.7 mm Voltage rating: 600 V_{AC}	AWG#20-4C (0.52 mm²) Outer diameter of insulated wire: Φ1.7 mm Voltage rating: 600 V_{AC}
Brake wire	AWG#24-2C (0.21 mm²) Outer diameter of insulated wire: Φ1.35 mm Voltage rating: 600 V_{AC}	AWG#24-2C (0.21 mm²) Outer diameter of insulated wire: Φ1.35 mm Voltage rating: 600 V_{AC}
Cable diameter	Φ6.0 - 6.8 mm	
Max. allowable wiring length	20 m	
Standard length provided by Delta	L = 3 m, 5 m, 10 m, 20 m	

Note:
1. Refer to Section 3.1.6.1 for detailed specifications for wires, screw terminal block dimensions, screws, and tightening torque.
2. Apart from these specifications, refer to Section 2.7.1 for the motor power cable selection and installation precautions.
3. Wire specification of the power adapter cables is the same as that of the power cables. For the cable length, refer to Section B.3.

F100 - F130 motors

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

Note:
1. Refer to Section 3.1.6.1 for detailed specifications for wires, screw terminal block dimensions, screws, and tightening torque.
2. Apart from these specifications, refer to Section 2.7.1 for the motor power cable selection and installation precautions.

F180 4.5 kW (or below) motors

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

Note:

1. Refer to Section 3.1.6.1 for detailed specifications for wires, screw terminal block dimensions, screws, and tightening torque.
2. Apart from these specifications, refer to Section 2.7.1 for the motor power cable selection and installation precautions.

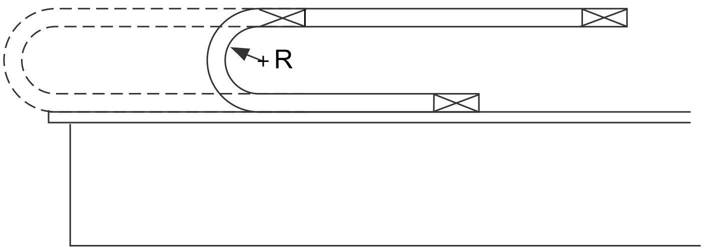
F180 5.5 kW (or above) motors

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

Note:
1. Refer to Section 3.1.6.1 for detailed specifications for wires, screw terminal block dimensions, screws, and tightening torque.
2. Apart from these specifications, refer to Section 2.7.1 for the motor power cable selection and installation precautions.

3.1.6.4 Flexible cable specifications

Delta provides two types of power and encoder cables[*1]: standard cables and flexible cables. Use flexible cable when connecting to a moving machinery. Refer to the following table for flexible cable specifications.



R = bend radius of the cable

Item	Specification
Bend radius	10 times of the cable outer diameter
Number of bending times	10 million times[*2]
Speed	3 m/s
Acceleration	15 m/s^2

Note:
1. Delta provides both standard and flexible power and encoder cables. Refer to Appendix B for more details.
2. Bending the cable into a curve and then straightening it is considered as one time.
3. For precautions relevant to the use of cables, refer to Section 2.10.

3.1.6.5 Wire specifications for the attached terminals of Delta connectors

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

Connector type	Connector model	Applicable wire spec.
Standard	ACS3-CAPW1000	24 - 18 AWG (0.21 mm^2 - 0.82 mm^2)
	ACS3-CAPW2000	24 - 18 AWG (0.21 mm^2 - 0.82 mm^2)
	ACS3-CAEN0000	26 - 22 AWG (0.13 mm^2 - 0.32 mm^2)
Bulkhead - cable exit direction towards motor shaft	ACS3-AFPWSS00	UVW: 20 - 18 AWG (0.52 mm^2 - 0.82 mm^2) Brake: 26 - 22 AWG (0.13 mm^2 - 0.32 mm^2)
Bulkhead - cable exit direction towards encoder	ACS3-ABPWSS00	
Bulkhead - cable exit direction towards encoder / towards encoder	ACS3-AFEASA00	26 - 22 AWG (0.13 mm^2 - 0.32 mm^2)

3.1.7 Connector installation

3.1.7.1 Connector specifications

IP67 waterproof connector

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

Motor frame size	Connector type	Connector model	Rubber ring diameter (mm)	Torque for tightening the connector
F40 - F80	CHOGORI	ACS3-CNPW1A00	Φ6.5 - Φ9.5	1.6 N·m
		ACS3-CNPW2A00	Φ6.5 - Φ9.5	1.6 N·m
		ACS3-CNEN2A00	Φ3.5 - Φ6.8	1.1 N·m
	Bulkhead - cable exit direction towards motor shaft	ACS3-AFPWSS00	Φ6.0 - Φ6.8	0.4 - 0.6 N·m
	Bulkhead - cable exit direction towards encoder	ACS3-ABPWSS00	Φ6.0 - Φ6.8	0.4 - 0.6 N·m
	Bulkhead - cable exit direction towards motor shaft / towards encoder	ACS3-AFEASA00	Φ5.8 - Φ6.2	0.4 - 0.6 N·m
F100 - F130	Military - straight 3106A-18-10S	ACS3-CAPWA000	Two sets of rubber rings attached Φ9 - Φ10 and Φ11 - Φ12	8 - 9 N·m (Φ9 - Φ10) 9 - 10 N·m (Φ11 - Φ12)
	Military - right angle 3108A-18-10S	ACS3-CRPWA000		
F180	Military - straight 3106A-22-22S	ACS3-CAPWC000	Two sets of rubber rings attached Φ11 - Φ12 and Φ15 - Φ16	7.5 ~ 8.5 N·m (Φ11 - Φ12) 7.5 N·m (Φ15 - Φ16)
	Military - right angle 3108A-22-22S	ACS3-CRPWC000		
F100 - F180	Military - straight CMV1-SP2S [bayonet]	ACS3-CABRA000	Φ5.5 - Φ7.5	4 - 5 N·m
	Military - right angle CMV1-AP2S [bayonet]	ACS3-CRBRA000		
	Military - straight [threaded, M17.5]	ACS3-CABRM000	Φ5.5 - Φ7.5	4 - 5 N·m
	Military - right angle [threaded, M17.5]	ACS3-CRBRM000	Φ5.5 - Φ7.5	4 - 5 N·m
	Military - straight CMV1-SP10S [bayonet]	ACS3-CAENA000	Φ5.5 - Φ7.5	4 - 5 N·m
	Military - right angle CMV1-AP10S [bayonet]	ACS3-CRENA000		
	Military - straight [threaded, M17.5]	ACS3-CAENM000	Φ5.5 - Φ7.5	4 - 5 N·m
	Military - right angle [threaded, M17.5]	ACS3-CRENM000	Φ5.5 - Φ7.5	4 - 5 N·m

IP42 connector

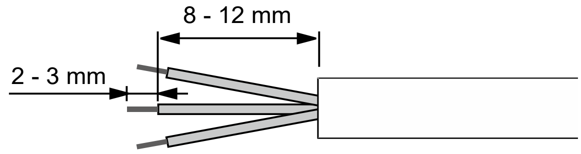
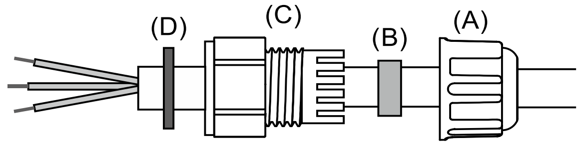
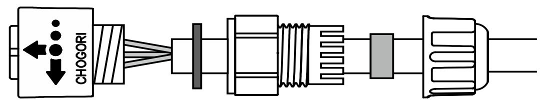
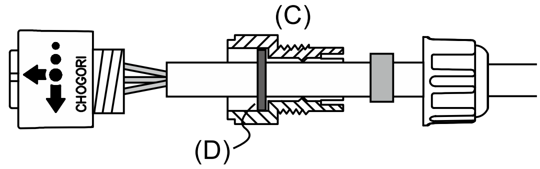
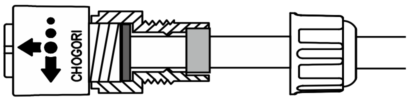
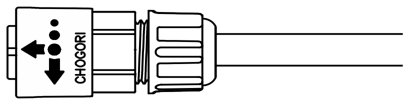
Motor frame size	Connector type	Connector model	Wire gauge (mm)	Torque for tightening the connector
F180	Military - straight 3106A-32-17S	ACS3-CAPWE000	Φ20 (Max.)	Tighten until snug
	Military - right angle 3108A-32-17S	ACS3-CRPWE000		

IP20 connector

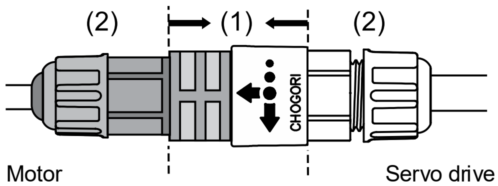
Motor frame size	Connector type	Connector model	Note
F40 - F80	Standard	ACS3-CAPW1000	-
		ACS3-CAPW2000	-
		ACS3-CAEN0000	We recommend using encoder connector with tin-plated terminals since the motor encoder receptacle is also tin-plated.

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

CHOGORI connector

CHOGORI connector		
Step 1		Strip the cable; the exposed wire length should be 8 - 12 mm (0.31 - 0.47 inches) and the tinned conductor length should be 2 - 3 mm (0.08 - 0.12 inches).
Step 2		Place the (A) seals nut, (B) seals ring, (C) clamp ring, and (D) gasket on the cable in sequence. Note: place the flat face of the gasket outwards and the groove face towards the clamp ring to meet the IP67 standard.
Step 3		■ For the power connector, refer to Section 3.1.4 for the pin assignment to connect the pins. ■ For the encoder connector, refer to Section 3.4.1 for the pin assignment to connect the pins.
Step 4		Place the groove face of the (D) gasket towards the clamp ring and fit it into the (C) clamp ring.
Step 5		Use a wrench to lock the clamp ring to the housing and **place** the seals ring **in** the clamp ring.
Step 6		Use a wrench to lock the seals nut to the clamp ring to complete the wiring.

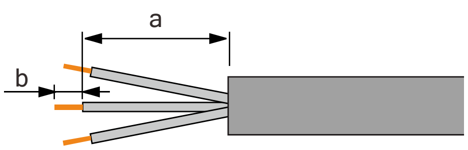
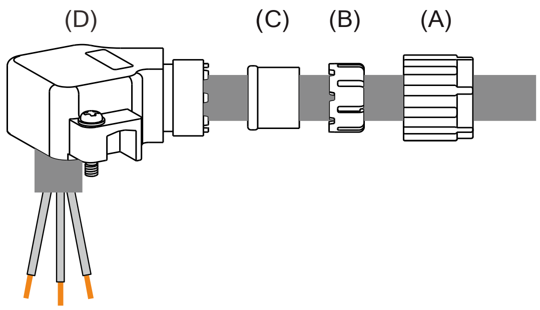
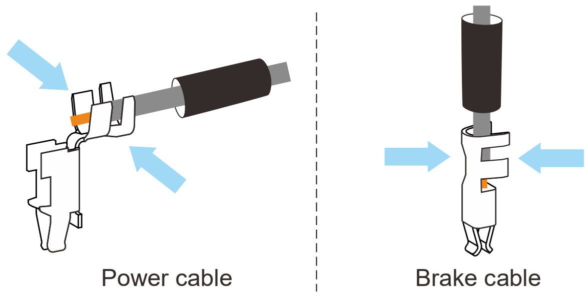
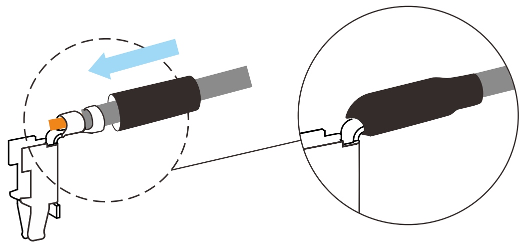
Instruction on mating and unmating the CHOGORI connectors:



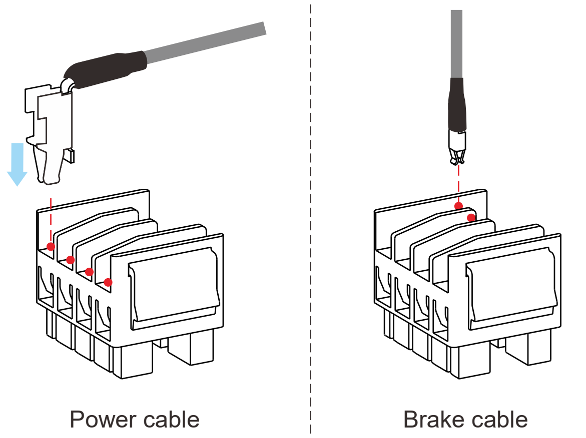
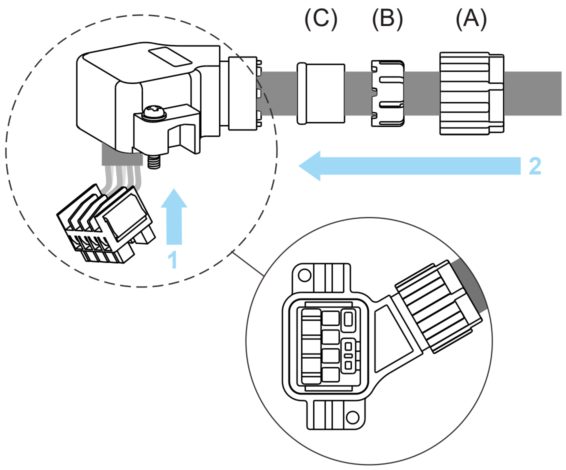
After wiring the CHOGORI connector, mate the part (1) to connect the servo motor and drive. Do not pull or rotate the (2) clamp ring and seals nut to avoid loose connection and thus fail to meet the IP67 standard.

Bulkhead connector

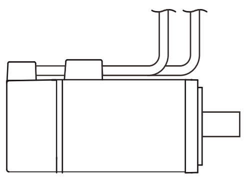
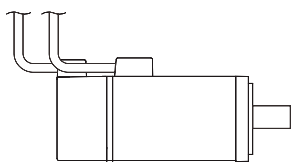
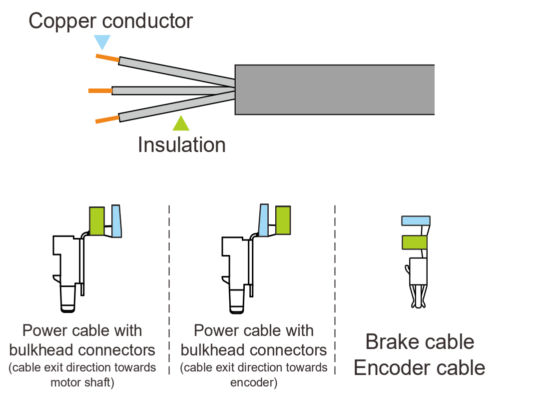
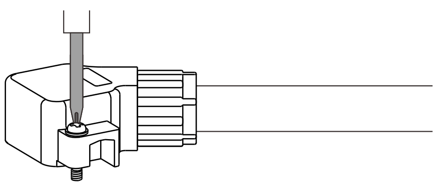
The example here uses the **bulkhead connector - cable exit direction towards motor shaft**:

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

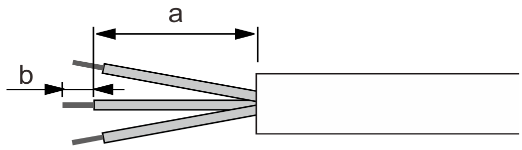
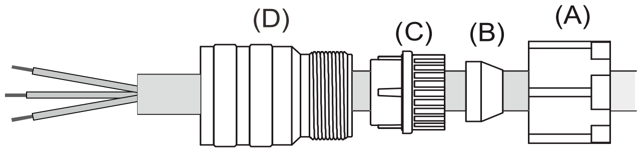
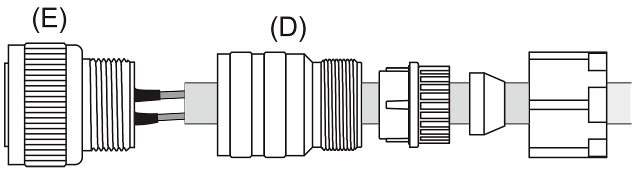
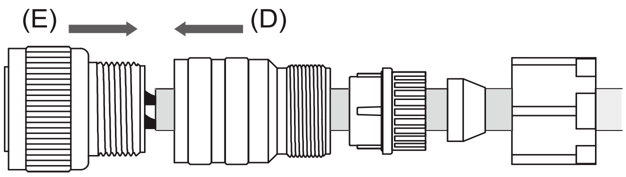
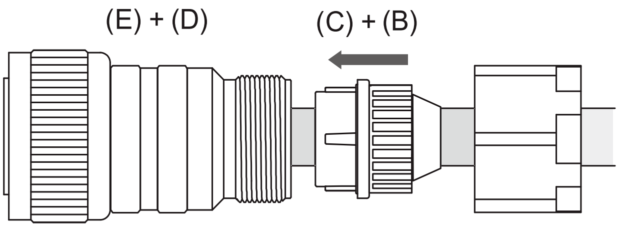
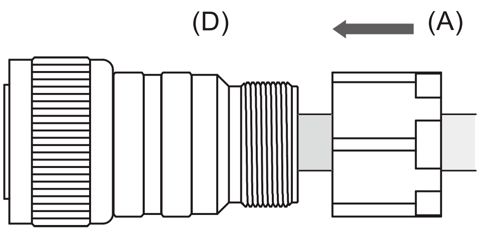
3

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

Note the following:

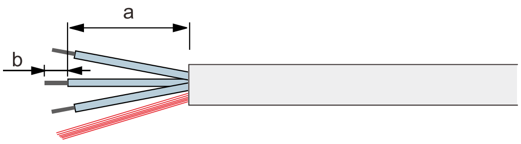
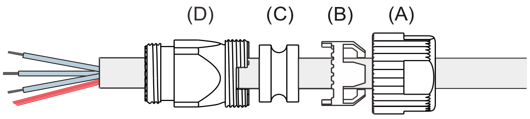
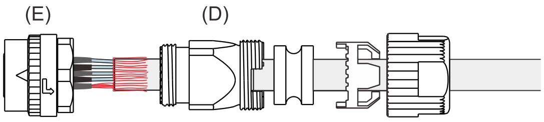
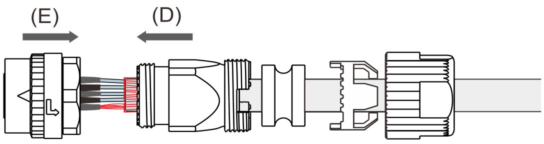
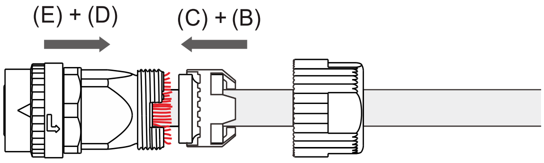
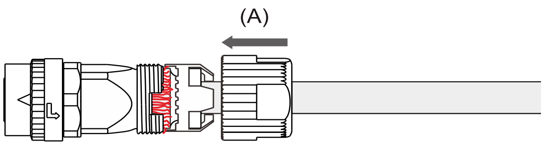
Cable exit direction towards motor shaft	Cable exit direction towards encoder	
		Illustrations for the cable exit direction.
		The green highlighted area on the terminal is where you crimp the copper conductor. The blue highlighted area on the terminal is where you crimp the wire insulation. Refer to Section 3.1.6.1 for the wire specifications of terminals.
		It is advisable to tighten the connector to the motor at the torque of 0.15 ± 0.015 N·m. Use the M2 screw for tightening.

3.1.7.3 F100 - F180 4.5 kW (or below) motor – Power connectors

Military connector		
Step 1		Strip the cable; the exposed wire length (a) should be 23 - 27 mm (0.9 - 1.06”) for straight connectors and 28 - 32 mm (1.1 - 1.26”) for right angle connectors, and the tinned conductor length (b) should be 3 - 5 mm (0.12 - 0.2”).
Step 2		Place the (A) seals nut, (B) rubber ring, (C) black compression ring, and (D) straight or right angle connector on the cable in sequence. Note: use the rubber ring corresponding to the cable in order to meet the IP67 standard.
Step 3		Refer to Section 3.1.4 for the pin assignment of power connectors. Note: it is suggested that you use 20 mm (0.79”) heat shrink for straight connectors, and 25 mm (0.98”) heat shrink for right angle connectors.
Step 4		Tighten (D) and (E) with adequate torque. For the torque value, refer to Section 3.1.7.1.
Step 5		Place (B) in (C), and then place (C) + (B) in (D).
Step 6		Tighten (A) and (D) at the torque of 10 N·m.

3.1.7.4 F100 - F180 motors – Brake / Encoder connectors

The example here uses the **<u>encoder connector.</u>** For brake connectors, disregards the descriptions about metal shield.

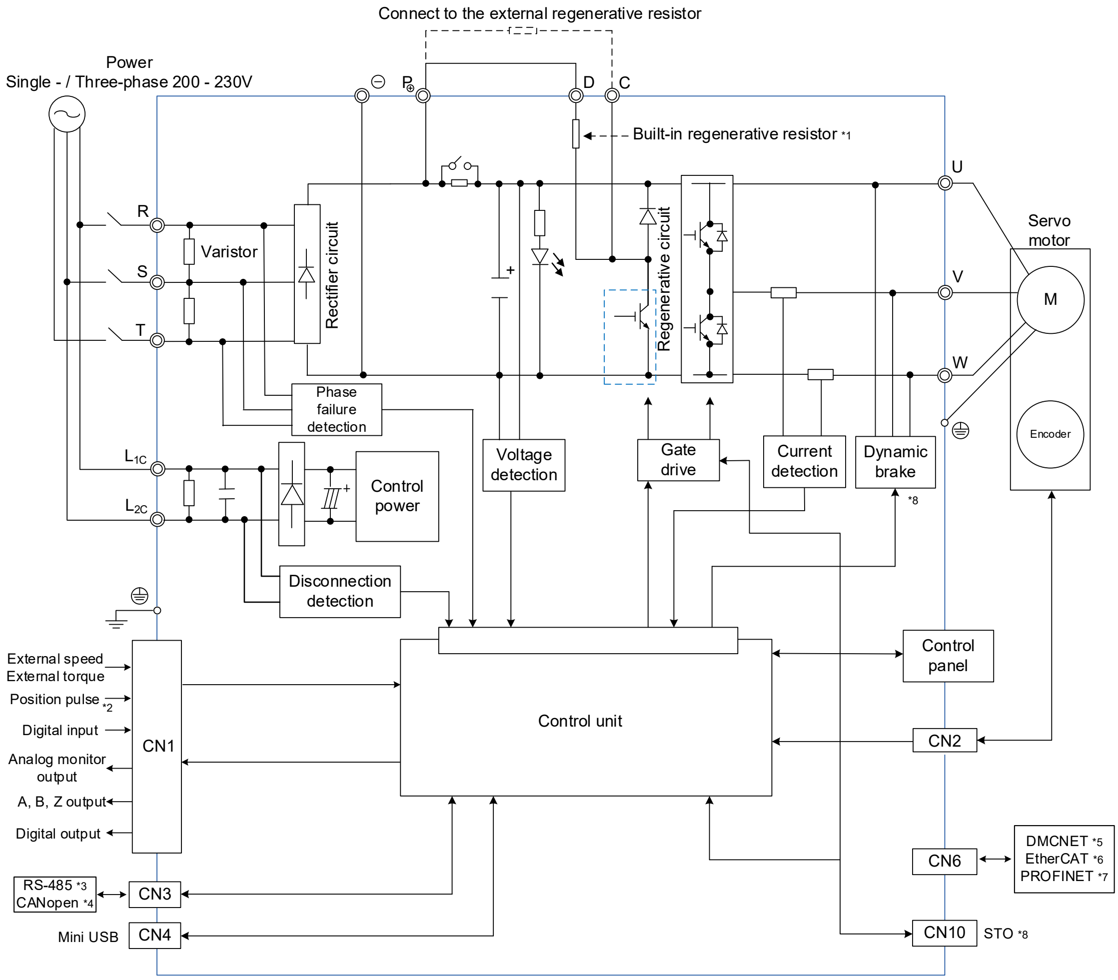
Military connector		
Step 1		Strip the cable and expose the wires covered by the metal shield. The exposed wire ength (a) should be 12 mm (0.47”) for straight connectors and 17 mm (0.67”) for right angle connectors, and the tinned conductor length (b) should be 2 mm (0.08”).
Step 2		Place the (A) seals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

3

3.2 Wiring diagrams for the servo system

3.2.1 220V models

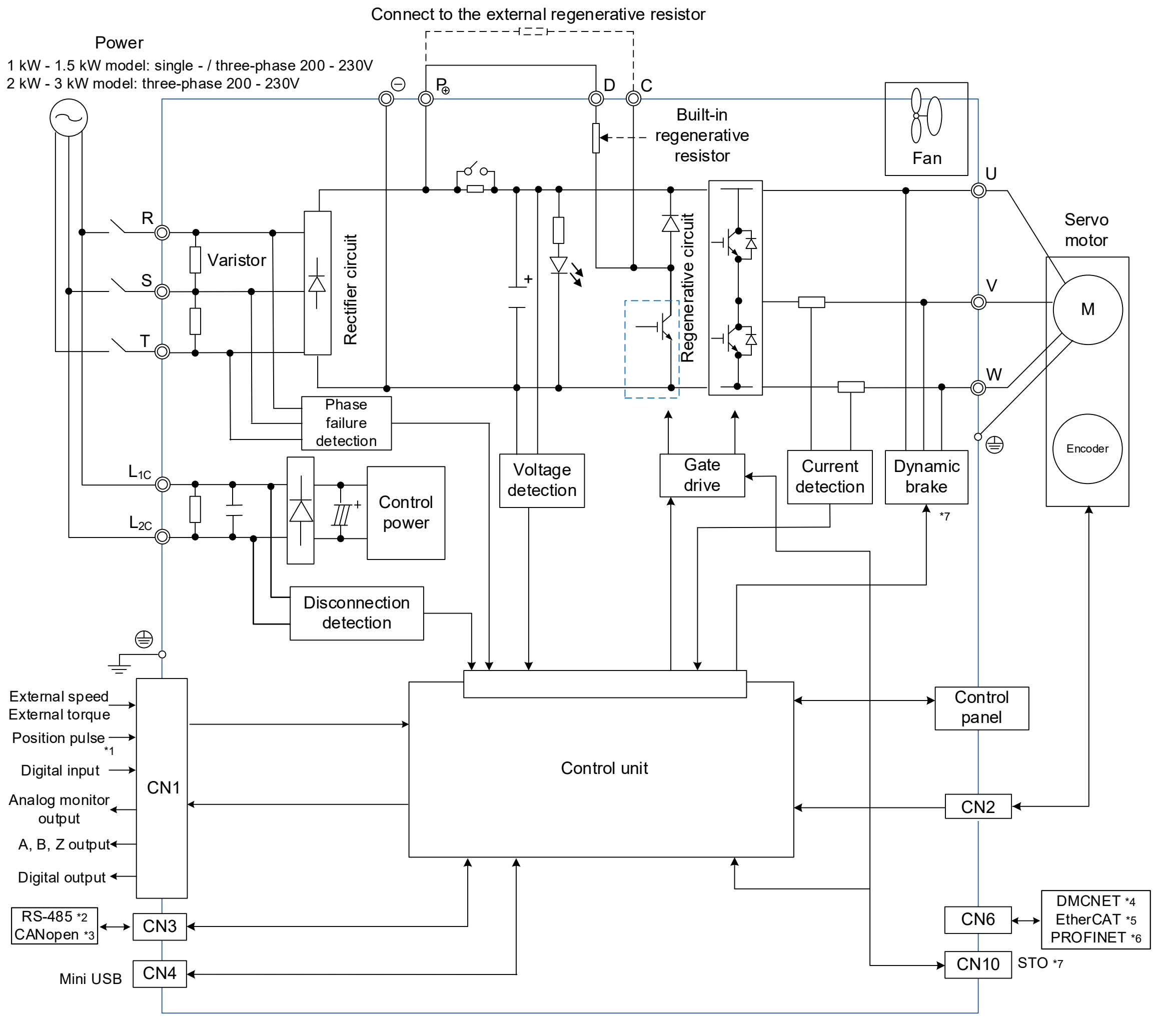
750 W (and below) models



Note:
*1. Models of 200 W and below do not have built-in regenerative resistors; models of 400 W and 750 W have built-in regenerative resistors.
*2. Position pulse is available on B3A-E, B3A-F, and B3A-M models only.
*3. RS-485 is available on -L and B3A-M models only.
*4. CANopen is available on -M models only.
*5. DMCNET is available on -F models only.
*6. EtherCAT is available on -E models only.
*7. PROFINET is available on B3A-P models only.
*8. STO function and dynamic brake are available on B3A series only.

3

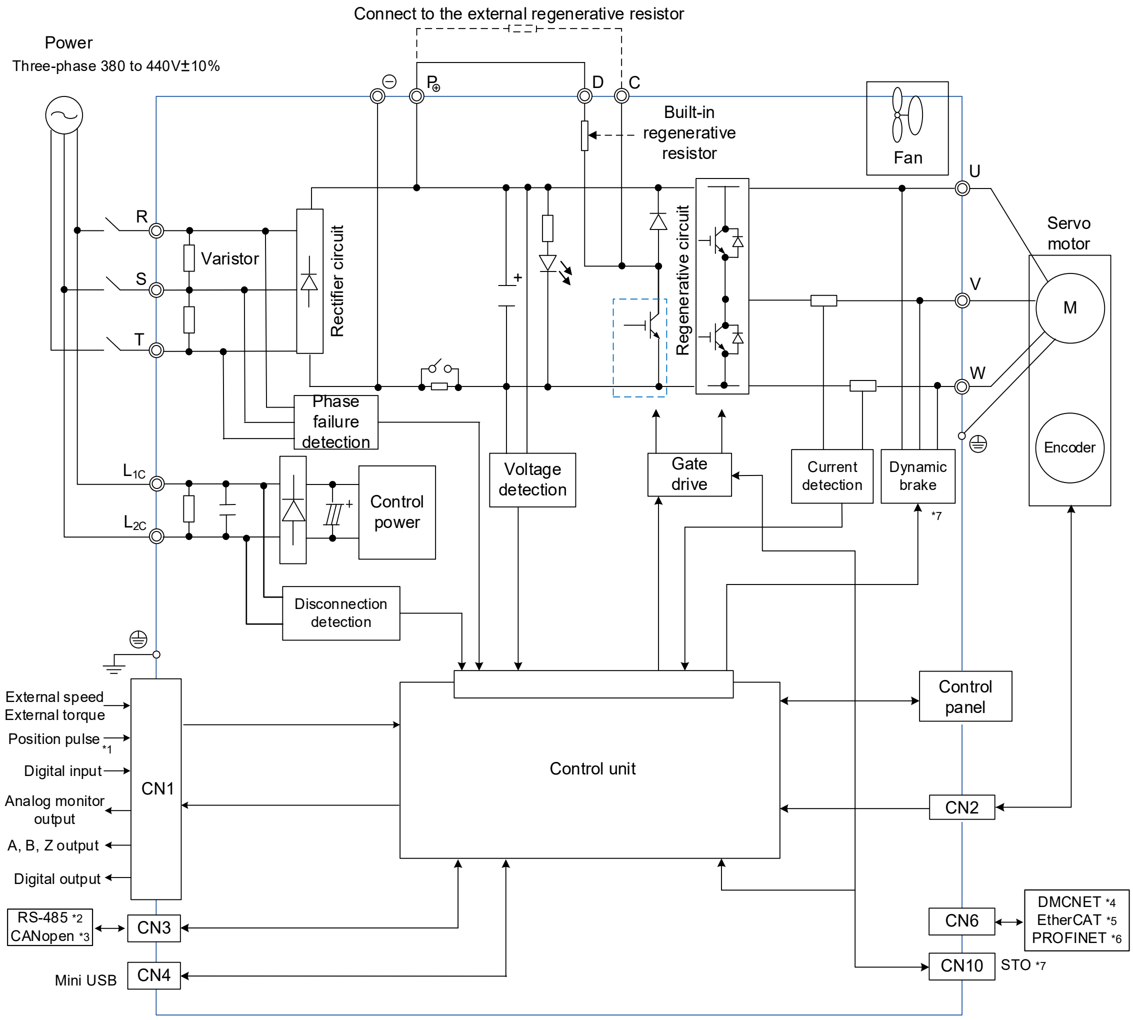
Models of 1 kW - 3 kW (with built-in regenerative resistor and fan)



Note:
*1. Position pulse is available on B3A-E, B3A-F, and B3A-M models only.
*2. RS-485 is available on -L and B3A-M models only.
*3. CANopen is available on -M models only.
*4. DMCNET is available on -F models only.
*5. EtherCAT is available on -E models only.
*6. PROFINET is available on B3A-P models only.
*7. STO function and dynamic brake are available on B3A series only.

3.2.2 400V models

Models of 1 kW - 8 kW (with built-in regenerative resistor and fan)



Note:
*1. Position pulse is available on B3A-E, B3A-F, and B3A-M models only.
*2. RS-485 is available on -L and B3A-M models only.
*3. CANopen is available on -M models only.
*4. DMCNET is available on -F models only.
*5. EtherCAT is available on -E models only.
*6. PROFINET is available on B3A-P models only.
*7. STO function and dynamic brake are available on B3A series only.

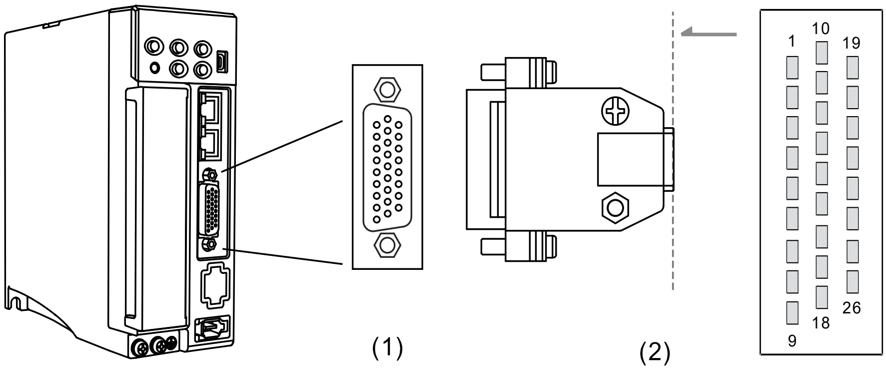
3.3 Wiring for the CN1 I/O connector

Pin assignments of the CN1 terminal differ from model types. Refer to the corresponding wiring information based on the model.

3.3.1 Communication type models (-E, -F, and -M models)

3.3.1.1 Communication type models – CN1 I/O connector pin assignment

On -E, -F, and -M models, the CN1 I/O connector includes 4 inputs and 2 outputs for you to define their functions. The differential output signals (OA, /OA, OB, /OB, OZ, and /OZ) for the encoder are provided. The pin assignments are shown as follows.



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

Note: the tightening torque of the CN1 connector is 2 - 2.5 kgf-cm (1.7 - 2.2 lbf-in).

3

Pin assignment:

Pin	Signal	Description	Pin	Signal	Description
1	OA	Differential output for encoder A pulse	14	PULL HI_P (Pulse) *1	External power input of Sign pulse (24V ± 10%)
2	/OA	Differential output for encoder /A pulse	15	DO1+	Digital output
3	OZ	Differential output for encoder Z pulse	16	DO1-	Digital output
4	/OZ	Differential output for encoder /Z pulse	17	DO2+	Digital output
5	COM+	Power input (24V ± 10%)	18	DO2-	Digital output
6	DI1-	Digital input	19	V_REF	Analog speed / position command input (+)
7	DI2-	Digital input	20	T_REF	Analog torque command input
8	DI3-	Digital input	21	MON1	Analog monitor output 1
9	DI4-	Digital input	22	MON2	Analog monitor output 2
10	GND	Ground for analog / differential output signal	23	SIGN+ *1	Position sign (+)
11	OB	Differential output for encoder B pulse	24	SIGN- *1	Position sign (-)
12	/OB	Differential output for encoder /B pulse	25	PULSE+ *1	Position pulse (+)
13	PULL HI_S (Sign) *1	External power input of Sign pulse (24V ± 10%)	26	PULSE- *1	Position pulse (-)

Note:
1. Only B3A-E, B3A-F, and B3A-M models support the pulse input function.
2. **When the source of the pulse input is open collector NPN or PNP type equipment, you must connect the external power (24V ± 10%) to the PULL HI pins.**
   - **Do not connect the 24V power to the SIGN+ and SIGN- pins at the same time, or the circuit elements will be damaged.**
   - **Do not connect the 24V power to the PULSE+ and PULSE- pins at the same time, or the circuit elements will be damaged.**

3

Caution: only B3A-E, B3A-F, and B3A-M models support the pulse input function.

Signal description:

Signal		Pin No.	Description	Wiring method (refer to Section 3.3.1.3)
Analog command (input)	V_REF	19	(1) When the motor speed command is set to -10V to +10V, it means the rotation speed is -3000 rpm to +3000 rpm (default). You can set the parameter to change the corresponding range. (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	20	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	21 22	The operation status of motor, such as speed and current, can be displayed in analog voltage. 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 (GND).	C2
Position pulse (input)	PULSE+ PULSE-	25 26	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 train + sign, and A phase + B phase.	C3 / C4
	SIGN+ SIGN-	23 24		
	PULL HI_P PULL HI_S	14 13	If using open collector type when sending position pulses, ensure to use an external power supply (24V ± 10%) for pull high.	
Position pulse (output)	OA /OA	1 2	Differential output (line driver) for the encoder signals A, B, and Z.	C9 / C10
	OB /OB	11 12		
	OZ /OZ	3 4		
Power	COM+	5	NPN: COM+ is the positive terminal of the voltage source for DI and requires an external power supply (24V ± 10%). PNP: COM+ is the negative terminal of the voltage source for DI and requires an external power supply (24V ± 10%).	-
	GND	10	The ground for analog signals and differential output signals.	

There are various control modes available (refer to Section 6.1) and the I/O configuration differs for each mode. This servo drive provides user-defined I/O for you to set functions according to the application requirements. Refer to Section 8.2 for Table 8.1 Digital input (DI) descriptions and Table 8.2 Digital output (DO) descriptions. The default DI/DO signal configuration for each control mode includes the most commonly used functions and meets the requirements for general applications. To reset the DI/DO signals to the default values of each corresponding mode, set P1.001.U to 1 and cycle the power to the servo drive.

See the following tables for the default DI signals of each control mode:

DI	Control mode						
	PT	PR	S/Sz	T/Tz	S-PT	T-PT	S-PR
	Default	Default	Default	Default	Default	Default	Default
	Symbol	Symbol	Symbol	Symbol	Symbol	Symbol	Symbol
1	0x01	0x01	0x01	0x01	0x01	0x01	0x01
	SON	SON	SON	SON	SON	SON	SON
2	0x22	0x22	0x22	0x22	0x22	0x22	0x22
	NL	NL	NL	NL	NL	NL	NL
3	0x23	0x23	0x23	0x23	0x23	0x23	0x23
	PL	PL	PL	PL	PL	PL	PL
4	0x21	0x21	0x21	0x21	0x21	0x21	0x21
	EMGS	EMGS	EMGS	EMGS	EMGS	EMGS	EMGS

DI	Control mode					
	T-PR	S-T	Communication	PT-PR	PT-PR-S	PT-PR-T
	Default	Default	Default	Default	Default	Default
	Symbol	Symbol	Symbol	Symbol	Symbol	Symbol
1	0x01	0x01	0x00	0x01	0x01	0x01
	SON	SON	-	SON	SON	SON
2	0x22	0x22	0x22	0x22	0x22	0x22
	NL	NL	NL	NL	NL	NL
3	0x23	0x23	0x23	0x23	0x23	0x23
	PL	PL	PL	PL	PL	PL
4	0x21	0x21	0x21	0x21	0x21	0x21
	EMGS	EMGS	EMGS	EMGS	EMGS	EMGS

Note:

1. Description of each DI signal:

DI name	Description	DI name	Description
SON	Servo On	NL	Negative limit
EMGS	Emergency stop	PL	Positive limit

2. Refer to the C7 and C8 diagrams in Section 3.3.1.3 for wiring.

3

See the following tables for the default DO signals of each control mode:

DO	Control mode						
	PT	PR	S/Sz	T/Tz	S-PT	T-PT	S-PR
	Default	Default	Default	Default	Default	Default	Default
	Symbol	Symbol	Symbol	Symbol	Symbol	Symbol	Symbol
1	0x01	0x01	0x01	0x01	0x01	0x01	0x01
	SRDY	SRDY	SRDY	SRDY	SRDY	SRDY	SRDY
2	0x07	0x07	0x07	0x07	0x07	0x07	0x07
	ALRM	ALRM	ALRM	ALRM	ALRM	ALRM	ALRM

DO	Control mode					
	T-PR-	S-T	Communication	PT-PR	PT-PR-S	PT-PR-T
	Default	Default	Default	Default	Default	Default
	Symbol	Symbol	Symbol	Symbol	Symbol	Symbol
1	0x01	0x01	0x01	0x01	0x01	0x01
	SRDY	SRDY	SRDY	SRDY	SRDY	SRDY
2	0x07	0x07	0x07	0x07	0x07	0x07
	ALRM	ALRM	ALRM	ALRM	ALRM	ALRM

Note:

1. Description of each DO signal:

DO name	Description	DO name	Description
SRDY	Servo ready	ALRM	Servo alarm

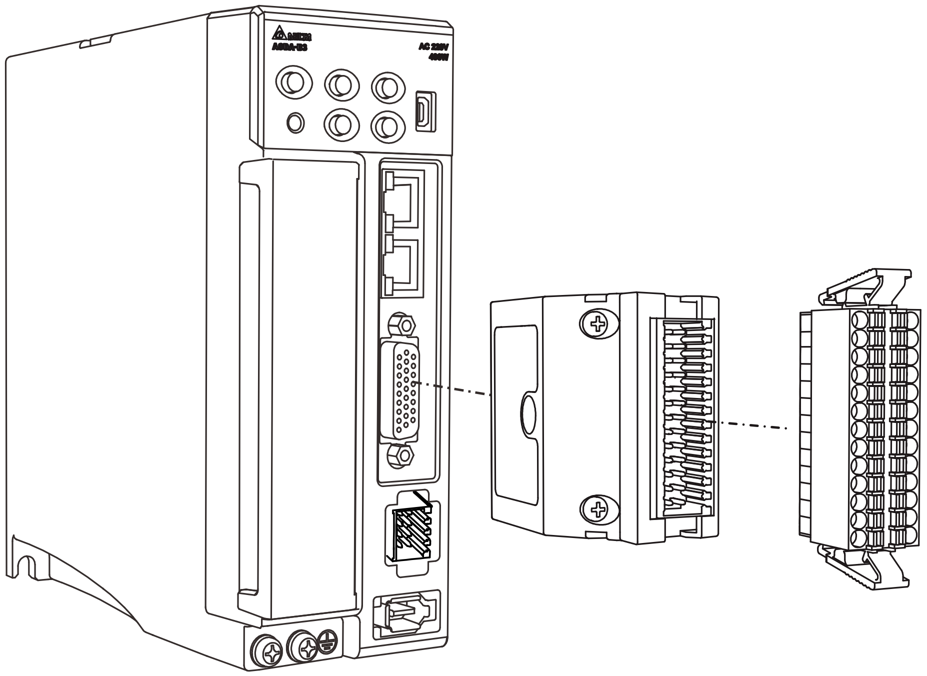
2. Refer to the C5 and C6 diagrams in Section 3.3.1.3 for wiring.

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

Signal		CN1 Pin No.	Corresponding parameter	Signal		CN1 Pin No.	Corresponding parameter
Standard DI	DI1-	6	P2.010	Standard DO	DO1+	15	P2.018
	DI2-	7	P2.011		DO1-	16	
	DI3-	8	P2.012		DO2+	17	P2.019
	DI4-	9	P2.013		DO2-	18	

3.3.1.2 Communication type models – Wire with CN1 quick connector

The CN1 quick connector ACS3-IFSC2626 is applicable to the -E, -F, and -M models. You do not need to solder the wires; the spring-loaded terminals prevent the wires from loosening caused by vibration, which makes it a good choice for wiring.



The pin assignments of the CN1 quick connector (ACS3-IFSC2626) are as follows:

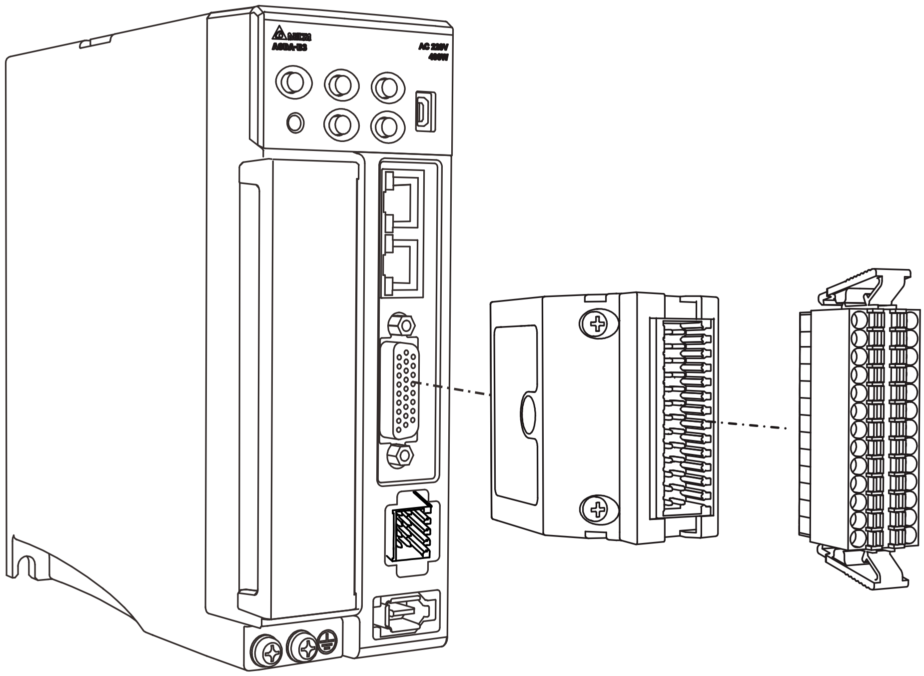
PULSE-	26	25	PULSE+
SIGN-	24	23	SIGN+
MON2	22	21	MON1
T_REF	20	19	V_REF
DO2-	18	17	DO2+
DO1-	16	15	DO1+
PULL HI_P	14	13	PULL HI_S
/OB	12	11	OB
GND	10	9	DI4-
DI3-	8	7	DI2-
DI1-	6	5	COM+
/OZ	4	3	OZ
/OA	2	1	OA

Note: only B3A-E, B3A-F, and B3A-M models support the pulse input function.

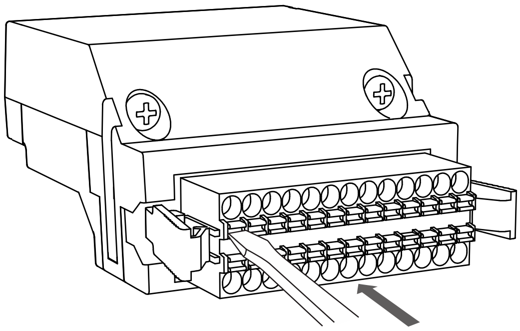
3

Installation and wiring for the CN1 quick connector (ACS3-IFSC2626):

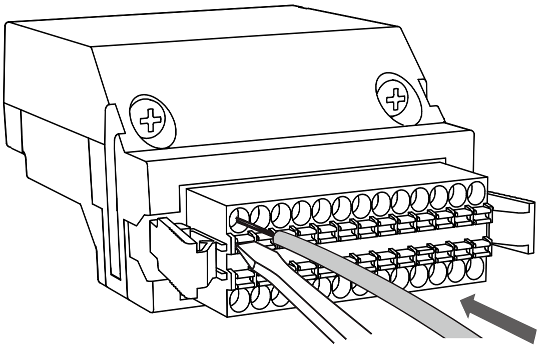
Installation



Wiring



(1) The CN1 quick connector (ACS3-IFSC2626) has multiple spring-loaded terminals. Determine which terminal is to be wired in advance. Use a flathead screwdriver to press the spring down to open the pin.



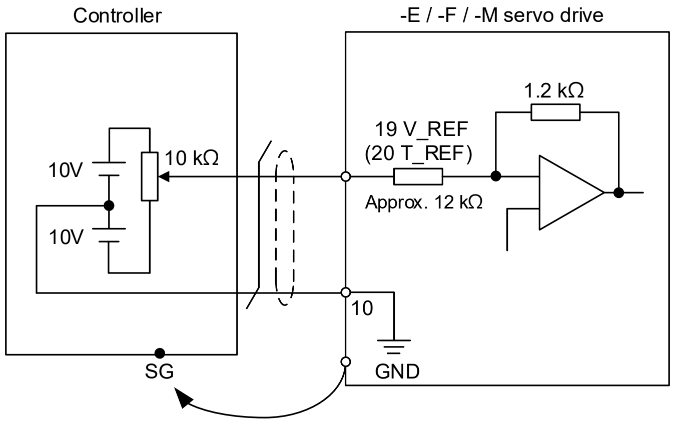
(2) Insert the stripped wire into the pin. Then, withdraw the screwdriver to complete the wiring.

3.3.1.3 Communication type models – CN1 wiring diagrams

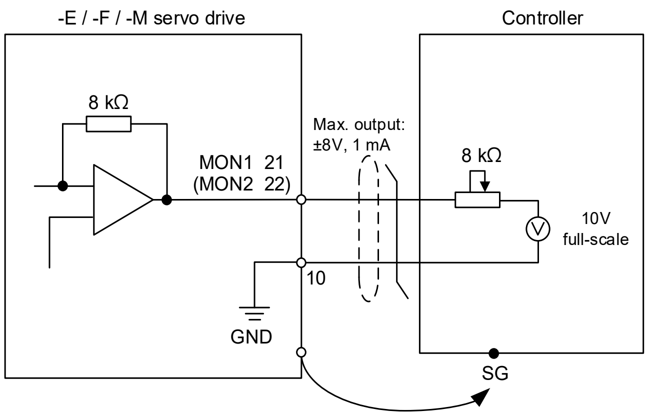
For the analog speed command and the analog torque (thrust) command of the -E, -F, and -M models, the valid voltage is between -10V and +10V. You can set the command value that corresponds to the voltage range with the relevant parameters.

3

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



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



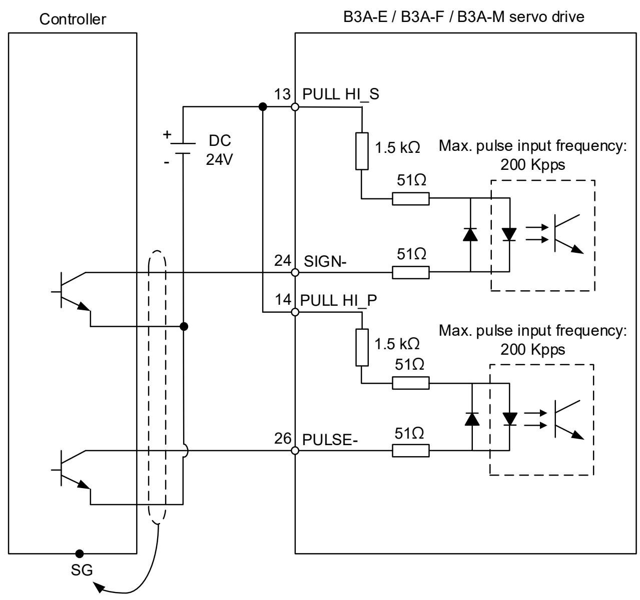
3

The B3A-E, B3A-F, and B3A-M models support the pulse input function. You can input the pulse command with the open collector or differential line driver. The maximum pulse input is 4 Mpps for the differential line driver and 200 Kpps for the open collector.

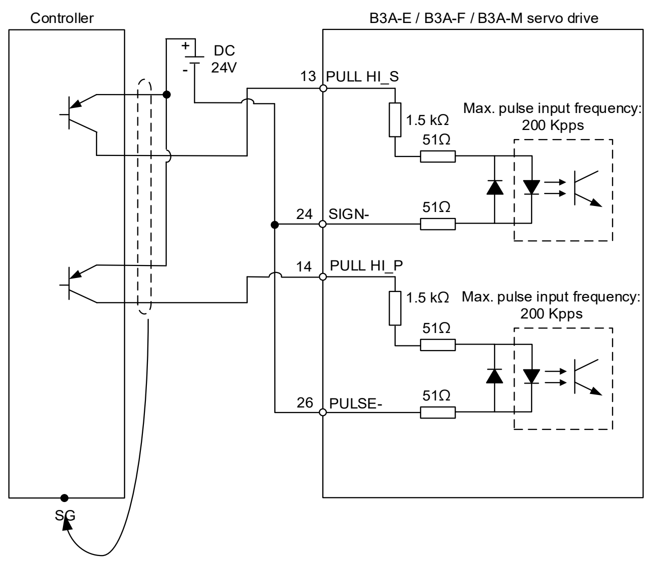
Caution: when the source for the pulse input is open collector NPN type or PNP type equipment, you must connect the external power (24V ± 10%) to the PULL HI pins.

- **Do not connect the 24V power to the SIGN+ and SIGN- pins at the same time, or the circuit elements will be damaged.**
- **Do not connect the 24V power to the PULSE+ and PULSE- pins at the same time, or the circuit elements will be damaged.**

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



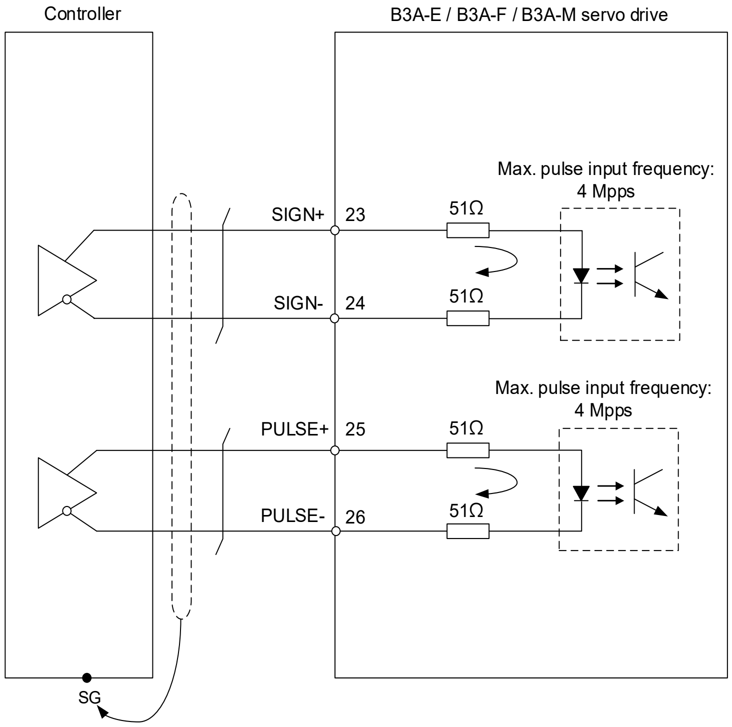
C3-2: the source for the pulse input is open collector PNP type equipment, which uses the external power supply.



C4: pulse input (differential line driver input) can only be used with 2.8V - 3.6V power systems.

Do not use it with 24V power.

Pulse	Type		Maximum input frequency
High speed pulse	Differential signal	Pulse train + sign	4 Mpps
		CW and CCW pulses	
		A phase + B phase	2 Mpps
Low speed pulse	Differential signal		200 Kpps



Note: refer to the description of P1.000 in Chapter 8 for setting details.

3

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

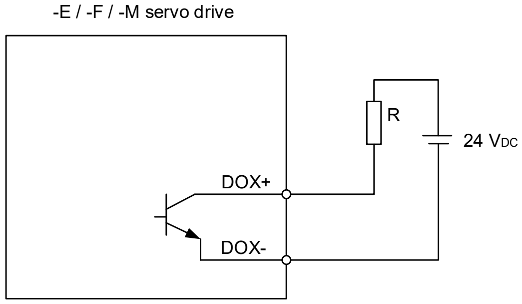
DO specification:

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

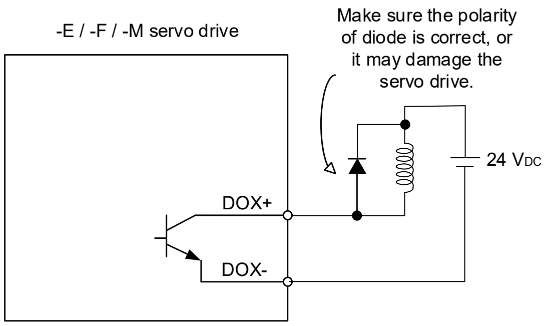
Diode specification:

1A or above, 500V or above (such as the 1N4005 diode).

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.



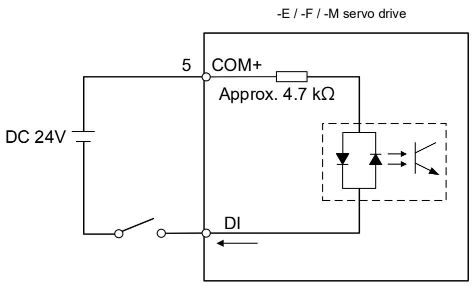
DI wiring - input signals by relay or open collector transistor.

Conditions of DI On / Off:

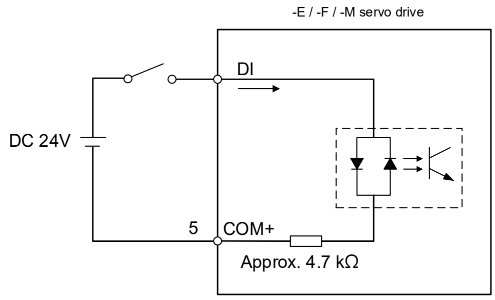
ON: 15V - 24V; input current = 3 mA.

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

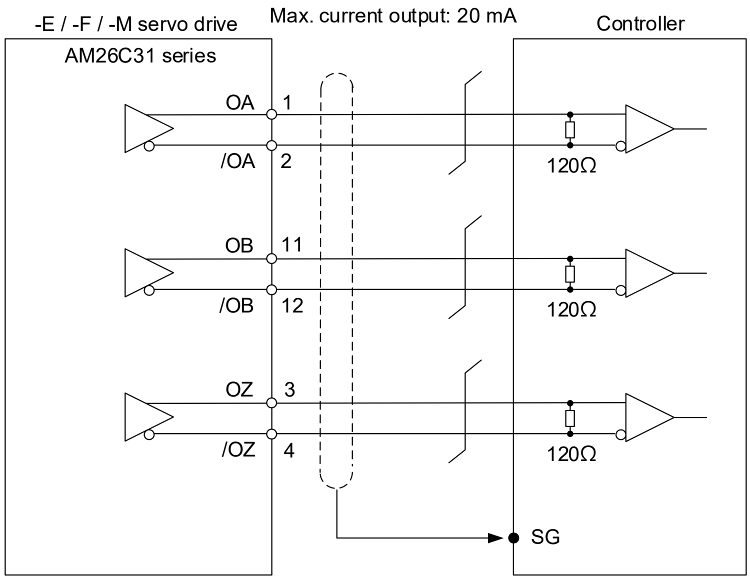
C7: NPN transistor (SINK mode)



C8: PNP transistor (SOURCE mode)

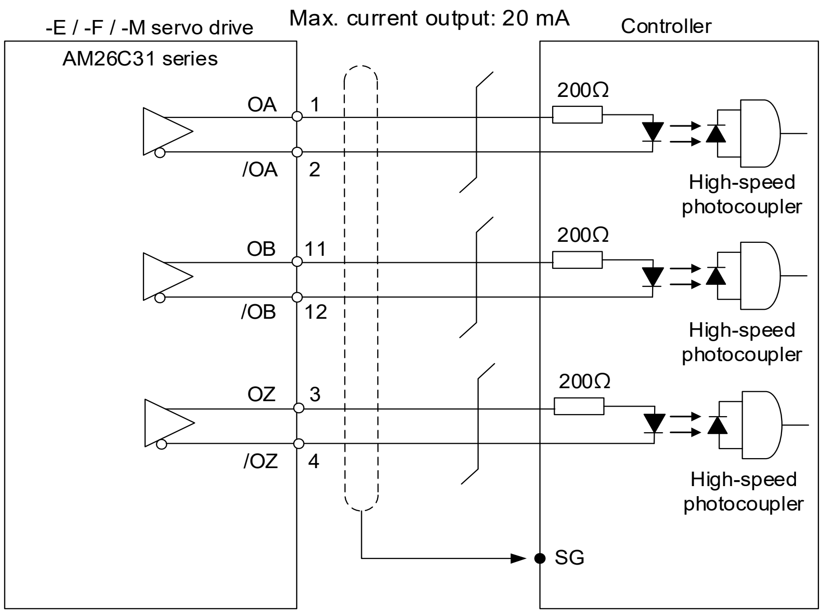


C9: output for encoder position signal (line driver)



Note: it is suggested that you connect the GND of the controller and the GND of the servo drive in parallel when the voltage difference between the two GND terminals is too great.

C10: output for encoder position signal (photocoupler)

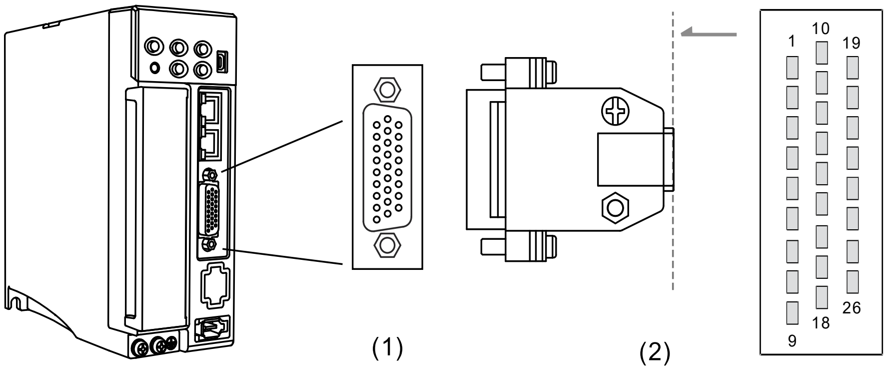


3.3.2 Communication type models (B3A-P model)

3.3.2.1 Communication type models – CN1 I/O connector pin assignment

3

On B3A-P models, the CN1 I/O connector includes 6 inputs and 3 outputs for you to define their functions. The differential output signals (OA, /OA, OB, /OB, OZ, and /OZ) for the encoder are provided. The pin assignments are shown as follows:



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

Note: the tightening torque of the CN1 connector is 2 - 2.5 kgf-cm (1.7 - 2.2 lbf-in).

Pin assignment:

Pin	Signal	Description	Pin	Signal	Description
1	OA	Differential output for encoder A pulse	14	DI6-	Digital input
2	/OA	Differential output for encoder /A pulse	15	DO1+	Digital output
3	OZ	Differential output for encoder Z pulse	16	DO1-	Digital output
4	/OZ	Differential output for encoder /Z pulse	17	DO2+	Digital output
5	COM+	Power input (24V ± 10%)	18	DO2-	Digital output
6	DI1-	Digital input	19	DO3+	Digital output
7	DI2-	Digital input	20	DO3-	Digital output
8	DI3-	Digital input	21	NC	Reserved
9	DI4-	Digital input	22	NC	Reserved
10	GND	Ground for differential output signal	23	NC	Reserved
11	OB	Differential output for encoder B pulse	24	NC	Reserved
12	/OB	Differential output for encoder /B pulse	25	NC	Reserved
13	DI5-	Digital input	26	NC	Reserved

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

Signal description:

<table>
<tr><th colspan="2">Signal</th><th>Pin No.</th><th>Description</th><th>Wiring method (refer to Section 3.3.2.2)</th></tr>
<tr><td rowspan="3">Position pulse (output)</td><td>OA
/OA</td><td>1
2</td><td rowspan="3">Differential output (line driver) for the encoder signals A, B, and Z.</td><td rowspan="3">C9 / C10</td></tr>
<tr><td>OB
/OB</td><td>11
12</td></tr>
<tr><td>OZ
/OZ</td><td>3
4</td></tr>
<tr><td rowspan="2">Power</td><td>COM+</td><td>5</td><td>NPN: COM+ is the positive terminal of the voltage source for DI and requires an external power supply (24V ± 10%).
PNP: COM+ is the negative terminal of the voltage source for DI and requires an external power supply (24V ± 10%).</td><td rowspan="2">-</td></tr>
<tr><td>GND</td><td>10</td><td>The ground for differential output signals.</td></tr>
</table>

3

There are various control modes available (refer to Section 6.1) and the I/O configuration differs for each mode. This servo drive provides user-defined I/O for you to set functions according to the application requirements. Refer to Section 8.2 for Table 8.1 Digital input (DI) descriptions and Table 8.2 Digital output (DO) descriptions. The default DI/DO signal configuration for each control mode includes the most commonly used functions and meets the requirements for general applications. To reset the signals to the default values of each corresponding mode, set P1.001.U to 1 and cycle the power to the servo drive.

See the following tables for the default DI signals of each control mode:

DI	Control mode						
	PR	S/Sz	T/Tz	S-PR	T-PR	S-T	Communi-cation
	Default	Default	Default	Default	Default	Default	Default
	Symbol	Symbol	Symbol	Symbol	Symbol	Symbol	Symbol
1	0x01	0x01	0x01	0x01	0x01	0x01	0x00
	SON	SON	SON	SON	SON	SON	-
2	0x22	0x22	0x22	0x22	0x22	0x22	0x22
	NL	NL	NL	NL	NL	NL	NL
3	0x23	0x23	0x23	0x23	0x23	0x23	0x23
	PL	PL	PL	PL	PL	PL	PL
4	0x21	0x21	0x21	0x21	0x21	0x21	0x21
	EMGS	EMGS	EMGS	EMGS	EMGS	EMGS	EMGS
5	0x00	0x00	0x00	0x00	0x00	0x00	0x00
	-	-	-	-	-	-	-
6	0x00	0x00	0x00	0x00	0x00	0x00	0x00
	-	-	-	-	-	-	-

Note:
1. Description of each DI signal:

DI name	Description	DI name	Description
SON	Servo On	NL	Negative limit
EMGS	Emergency stop	PL	Positive limit

2. Refer to the C7 and C8 diagrams in Section 3.3.2.2 for wiring.

3

See the following tables for the default DO signals of each control mode:

DO	Control mode						
	PR	S/Sz	T/Tz	S-PR	T-PR	S-T	Communi-cation
	Default	Default	Default	Default	Default	Default	Default
	Symbol	Symbol	Symbol	Symbol	Symbol	Symbol	Symbol
1	0x01	0x01	0x01	0x01	0x01	0x01	0x01
	SRDY	SRDY	SRDY	SRDY	SRDY	SRDY	SRDY
2	0x07	0x07	0x07	0x07	0x07	0x07	0x07
	ALRM	ALRM	ALRM	ALRM	ALRM	ALRM	ALRM
3	0x00	0x00	0x00	0x00	0x00	0x00	0x00
	-	-	-	-	-	-	-

Note:
1. Description of each DO signal:

DO name	Description	DO name	Description
SRDY	Servo ready	ALRM	Servo alarm

2. Refer to the C5 and C6 diagrams in Section 3.3.2.2 for wiring.

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

Signal		CN1 Pin No.	Corresponding parameter	Signal		CN1 Pin No.	Corresponding parameter
Standard DI	DI1-	6	P2.010	Standard DO	DO1+	15	P2.018
	DI2-	7	P2.011		DO1-	16	
	DI3-	8	P2.012		DO2+	17	P2.019
	DI4-	9	P2.013		DO2-	18	
	DI5-	13	P2.014		DO3+	19	P2.020
	DI6-	14	P2.015		DO3-	20	

3

3.3.2.2 Communication type models – CN1 wiring diagrams

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

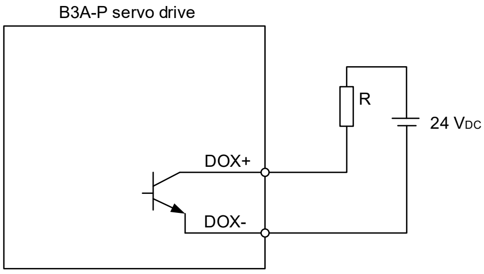
DO specification:

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

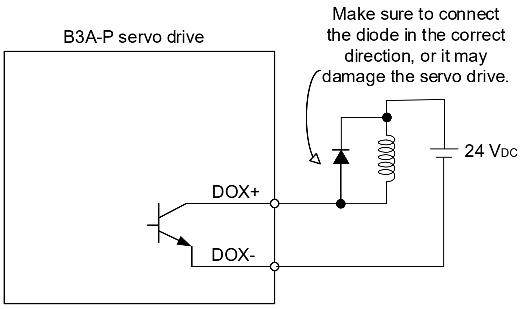
Diode specification:

1A or above, 500V or above (such as the 1N4005 diode).

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.



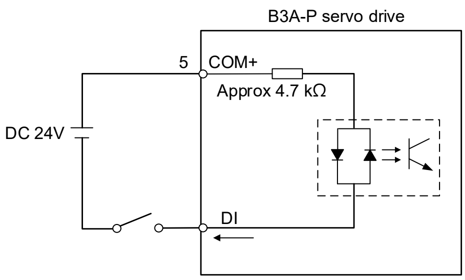
DI wiring - input signals by relay or open collector transistor.

Conditions of DI On / Off:

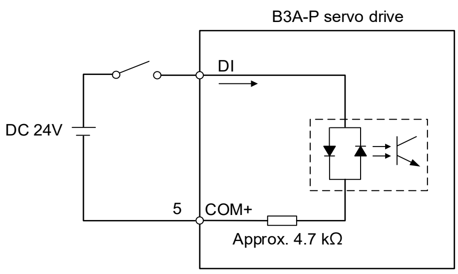
ON: 15V - 24V; input current = 3 mA.

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

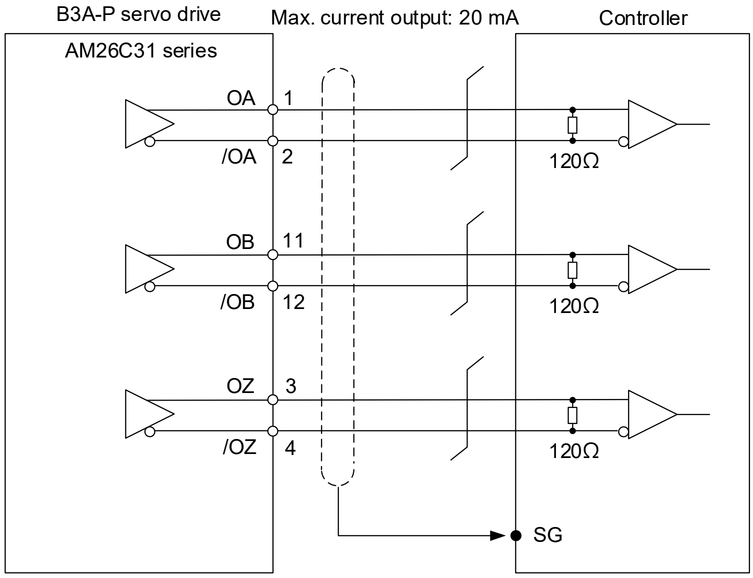
C7: NPN transistor (SINK mode)



C8: PNP transistor (SOURCE mode)

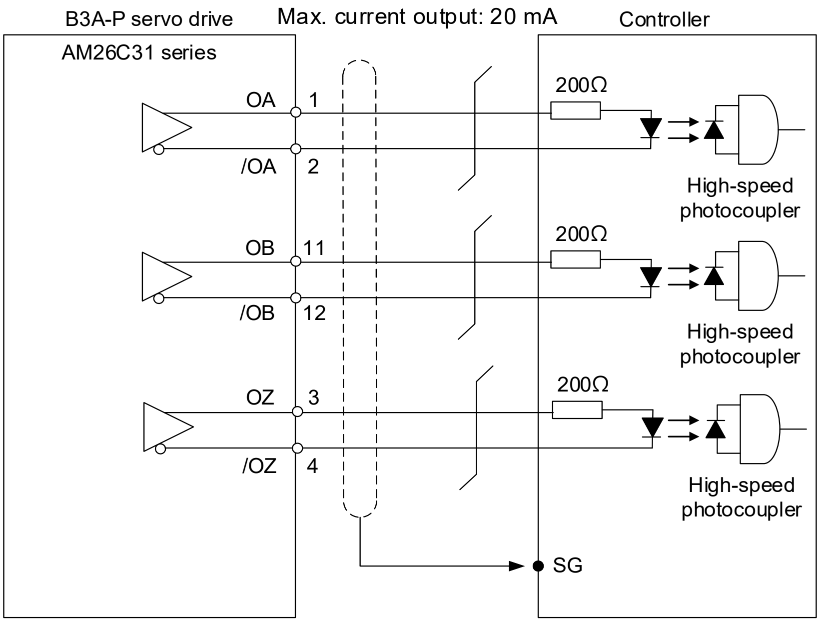


C9: output for encoder position signal (line driver)



Note: it is suggested that you connect the GND of the controller and the GND of the servo drive in parallel when the voltage difference between the two GND terminals is too great.

C10: output for encoder position signal (photocoupler)

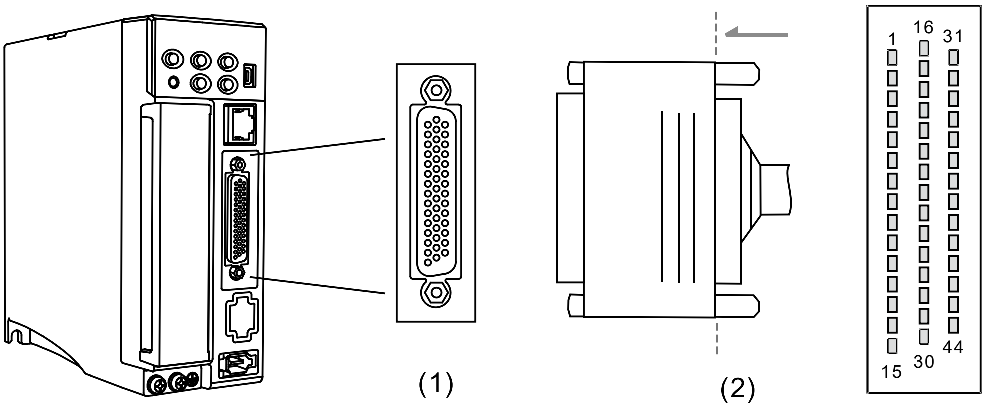


3

3.3.3 Pulse type models (-L models)

3.3.3.1 Pulse type models – CN1 I/O connector pin assignment

On -L models, the CN1 I/O connector includes 9 inputs and 6 outputs for you to define their functions. The differential output signals (OA, /OA, OB, /OB, OZ, and /OZ) for the encoder 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
1	DO4+	Digital output	23	/OB	Differential output for encoder /B pulse
2	DO3-	Digital output	24	/OZ	Differential output for encoder /Z pulse
3	DO3+	Digital output	25	OB	Differential output for encoder B pulse
4	DO2-	Digital output	26	DO4-	Digital output
5	DO2+	Digital output	27	DO5-	Digital output
6	DO1-	Digital output	28	DO5+	Digital output
7	DO1+	Digital output	29	GND	GND for analog signal and differential output signal
8	DI4-	Digital input	30	DI8-	Digital input
9	DI1-	Digital input	31	DI7-	Digital input
10	DI2-	Digital input	32	DI6-	Digital input
11	COM+	Power input (24V ± 10%)	33	DI5-	Digital input
12	DI9-	Digital input	34	DI3-	Digital input
13	OZ	Differential output for encoder Z pulse	35	PULL HI_S (Sign)	External power input of command sign (24V ± 10%)
14	MON2	Analog monitor output 2	36	PULL HI_P (Pulse)	External power input of command pulse (24V ± 10%)
15	DO6-	Digital output	37	SIGN-	Position sign (-)
16	DO6+	Digital output	38	NC	Reserved
17	MON1	Analog monitor output 1	39	SIGN+	Position sign (+)
18	T_REF	Analog torque command input	40	GND	GND for analog signal and differential output signal
19	GND	GND for analog signal and differential output signal	41	PULSE-	Position pulse (-)
20	V_REF	Analog speed / position command input (+)	42	NC	Reserved
21	OA	Differential output for encoder A pulse	43	PULSE+	Position pulse (+)
22	/OA	Differential output for encoder /A pulse	44	OCZ	Open collector output for encoder Z pulse

Note:

1. NC represents “No connection”, which is for internal use only. Do not connect to NC, or it may damage the servo drive.
2. **When the source for the pulse input is open collector NPN or PNP type equipment, you must connect the external power (24V ± 10%) to the PULL HI pins.**
   - **Do not connect the 24V power to the SIGN+ and SIGN- pins at the same time, or the circuit elements will be damaged.**
   - **Do not connect the 24V power to the PULSE+ and PULSE- pins at the same time, or the circuit elements will be damaged.**

Signal description:

Signal		Pin No.	Description	Wiring method (refer to Section 3.3.3.3)
Analog command (input)	V_REF	20	(1) When the motor speed command is set to -10V to +10V, it means the rotation speed is -3000 rpm 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	17 14	The operation status of motor, such as speed and current, can be displayed in analog voltage. 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 (GND).	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 train + sign, and A phase + B phase.	C3 / C4
	SIGN+ SIGN-	39 37		
	PULL HI_P PULL HI_S	36 35	If using open collector type when sending position pulses, ensure to use an external power supply (24V ± 10%) for pull high.	
Position pulse (output)	OA /OA	21 22	Differential output (line driver) for the encoder signals A, B, and Z.	C9 / C10
	OB /OB	25 23		
	OZ /OZ	13 24		
	OCZ	44	Open collector output for the encoder Z pulse.	C11
Power	COM+	11	NPN: COM+ is the positive terminal of the voltage source for DI and requires an external power supply (24V ± 10%). PNP: COM+ is the negative terminal of the voltage source for DI and requires an external power supply (24V ± 10%).	-
	GND	19, 29, 40	The ground for analog signals and differential output signals.	
Others	NC	38, 42	No connection. This is for internal use only. Do not connect to NC, or it may damage the servo drive.	

There are various control modes available (refer to Section 6.1) and the I/O configuration differs for each mode. This servo drive provides user-defined I/O for you to set functions according to the application requirements. Refer to Section 8.2 for Table 8.1 Digital input (DI) descriptions and Table 8.2 Digital output (DO) descriptions. The default DI/DO signal configuration for each control mode includes the most commonly used functions and meets the requirements for general applications. To reset the signals to the default values of each corresponding mode, set P1.001.U to 1 and cycle the power to the servo drive.

See the following tables for the default DI signals of each control mode:

DI	Control mode					
	PT	PR	S/Sz	T/Tz	S-PT	T-PT
	Default	Default	Default	Default	Default	Default
	Symbol	Symbol	Symbol	Symbol	Symbol	Symbol
1	0x01	0x01	0x01	0x01	0x01	0x01
	SON	SON	SON	SON	SON	SON
2	0x04	0x08	0x09	0x10	0x04	0x04
	CCLR	CTRG	TRQLM	SPDLM	CCLR	CCLR
3	0x16	0x11	0x14	0x16	0x14	0x16
	TCM0	POS0	SPD0	TCM0	SPD0	TCM0
4	0x17	0x12	0x15	0x17	0x15	0x17
	TCM1	POS1	SPD1	TCM1	SPD1	TCM1
5	0x02	0x02	0x02	0x02	0x00	0x00
	ARST	ARST	ARST	ARST	-	-
6	0x22	0x22	0x22	0x22	0x00	0x00
	NL	NL	NL	NL	-	-
7	0x23	0x23	0x23	0x23	0x18	0x20
	PL	PL	PL	PL	S-P	T-P
8	0x21	0x21	0x21	0x21	0x21	0x21
	EMGS	EMGS	EMGS	EMGS	EMGS	EMGS
9	0x00	0x00	0x00	0x00	0x00	0x00
	-	-	-	-	-	-

3

DI	Control mode					
	S-PR	T-PR	S-T	PT-PR	PT-PR-S	PT-PR-T
	Default	Default	Default	Default	Default	Default
	Symbol	Symbol	Symbol	Symbol	Symbol	Symbol
1	0x01	0x01	0x01	0x01	0x01	0x01
	SON	SON	SON	SON	SON	SON
2	0x08	0x08	0x00	0x04	0x04	0x04
	CTRG	CTRG	-	CCLR	CCLR	CCLR
3	0x11	0x11	0x14	0x08	0x08	0x08
	POS0	POS0	SPD0	CTRG	CTRG	CTRG
4	0x12	0x12	0x15	0x11	0x11	0x11
	POS1	POS1	SPD1	POS0	POS0	POS0
5	0x14	0x16	0x16	0x12	0x12	0x12
	SPD0	TCM0	TCM0	POS1	POS1	POS1
6	0x15	0x17	0x17	0x13	0x24	0x24
	SPD1	TCM1	TCM1	POS2	ORGP	ORGP
7	0x18	0x20	0x19	0x24	0x18	0x20
	S-P	T-P	S-T	ORGP	S-P	T-P
8	0x21	0x21	0x21	0x2B	0x2B	0x2B
	EMGS	EMGS	EMGS	PT-PR	PT-PR	PT-PR
9	0x00	0x00	0x00	0x02	0x02	0x02
	-	-	-	ARST	ARST	ARST

Note:

1. Description of each DI signal:

DI name	Description	DI name	Description	DI name	Description
SON	Servo On	NL	Negative limit	PL	Positive limit
CCLR	Pulse clear	ARST	Alarm reset	EMGS	Emergency stop
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 between S and P modes (dual / multi-mode)	T-P	Switch between T and P modes (dual / multi-mode)	S-T	Switch between S and T modes (dual / multi-mode)
PT-PR	Switch between PT and PR modes (dual / multi-mode)	POS2	Internal position selection 2	ORGP	ORG signal

2. Refer to the C7 and C8 diagrams in Section 3.3.3.3 for wiring.

3

See the following tables for the default DO signals of each control mode:

DO	Control mode					
	PT	PR	S/Sz	T/Tz	S-PT	T-PT
	Default Symbol	Default Symbol	Default Symbol	Default Symbol	Default Symbol	Default Symbol
1	0x01 SRDY	0x01 SRDY	0x01 SRDY	0x01 SRDY	0x01 SRDY	0x01 SRDY
2	0x03 ZSPD	0x03 ZSPD	0x03 ZSPD	0x03 ZSPD	0x03 ZSPD	0x03 ZSPD
3	0x09 HOME	0x09 HOME	0x04 TSPD	0x04 TSPD	0x04 TSPD	0x04 TSPD
4	0x05 TPOS	0x05 TPOS	0x08 BRKR	0x08 BRKR	0x05 TPOS	0x05 TPOS
5	0x07 ALRM	0x07 ALRM	0x07 ALRM	0x07 ALRM	0x07 ALRM	0x07 ALRM
6	0x00 -	0x00 -	0x00 -	0x00 -	0x00 -	0x00 -

DO	Control mode					
	S-PR	T-PR	S-T	PT-PR	PT-PR-S	PT-PR-T
	Default Symbol	Default Symbol	Default Symbol	Default Symbol	Default Symbol	Default Symbol
1	0x01 SRDY	0x01 SRDY	0x01 SRDY	0x01 SRDY	0x01 SRDY	0x01 SRDY
2	0x03 ZSPD	0x03 ZSPD	0x03 ZSPD	0x03 ZSPD	0x03 ZSPD	0x03 ZSPD
3	0x04 TSPD	0x04 TSPD	0x04 TSPD	0x09 HOME	0x09 HOME	0x09 HOME
4	0x05 TPOS	0x05 TPOS	0x00 -	0x05 TPOS	0x05 TPOS	0x05 TPOS
5	0x07 ALRM	0x07 ALRM	0x07 ALRM	0x07 ALRM	0x07 ALRM	0x07 ALRM
6	0x00 -	0x00 -	0x00 -	0x00 -	0x00 -	0x00 -

Note:
Description of each DO signal:

DO name	Description	DO name	Description	DO name	Description
SRDY	Servo ready	HOME	Homing is complete	TSPD	Target speed reached
ZSPD	Zero motor speed	TPOS	Target position reached	ALRM	Servo alarm
BRKR	Magnetic brake	-	-	-	-

3

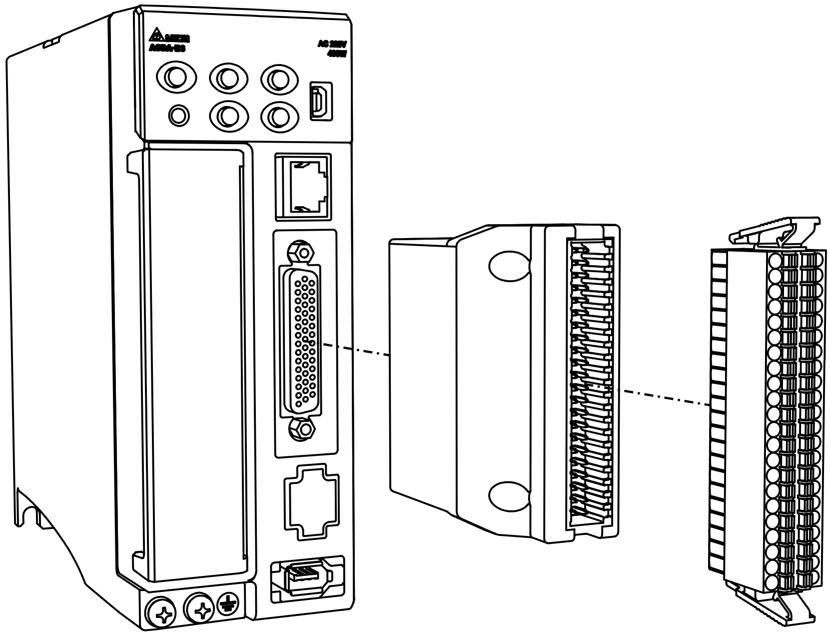
If the default DI/DO functions cannot meet the application requirement, you can refer to the following tables and specify the DI/DO functions by setting the DI and DO codes to the corresponding parameters.

Signal		CN1 Pin No.	Corresponding parameter	Signal		CN1 Pin No.	Corresponding parameter
Standard DI	DI1-	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-	12	P2.036
	DI5-	33	P2.014		-	-	-

Signal		CN1 Pin No.	Corresponding parameter	Signal		CN1 Pin No.	Corresponding parameter
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+	16	P2.041
	DO3-	2			DO6-	15	

3.3.3.2 Pulse type models – Wire with CN1 quick connector

The CN1 quick connector ACS3-IFSC4444 is applicable to the -L models. You do not need to solder the wires; the spring-loaded terminals prevent the wires from loosening caused by vibration, which makes it a good choice for wiring.



The pin assignments for the CN1 quick connector (ACS3-IFSC4444) are as follows:

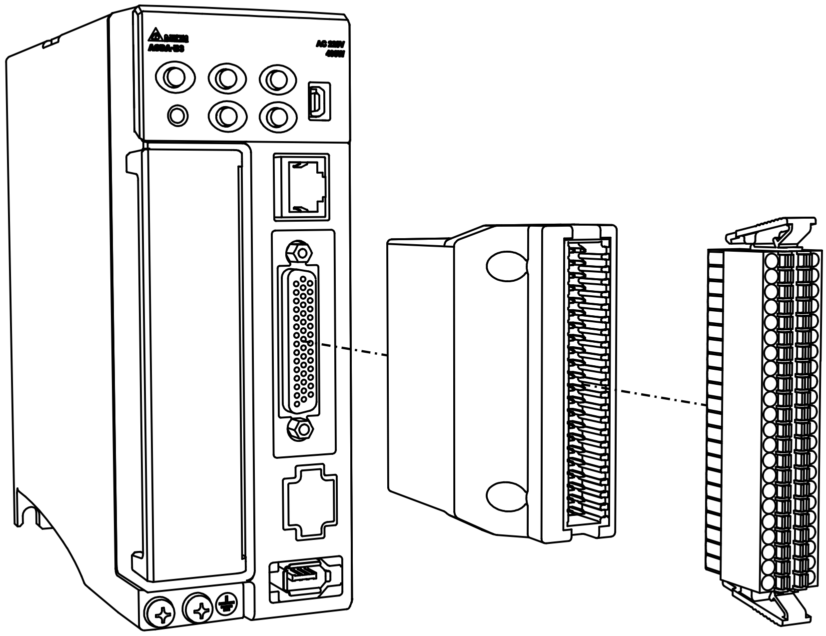
OCZ	44	43	PULSE+
NC	42	41	PULSE-
GND	40	39	SIGN+
NC	38	37	SIGN-
PULL HI_P	36	35	PULL HI_S
DI3-	34	33	DI5-
DI6-	32	31	DI7-
DI8-	30	29	GND
DO5+	28	27	DO5-
DO4-	26	25	OB
/OZ	24	23	/OB
/OA	22	21	OA
V_REF	20	19	GND
T_REF	18	17	MON1
DO6+	16	15	DO6-
MON2	14	13	OZ
DI9-	12	11	COM+
DI2-	10	9	DI1-
DI4-	8	7	DO1+
DO1-	6	5	DO2+
DO2-	4	3	DO3+
DO3-	2	1	DO4+

Note: NC represents “No connection”.

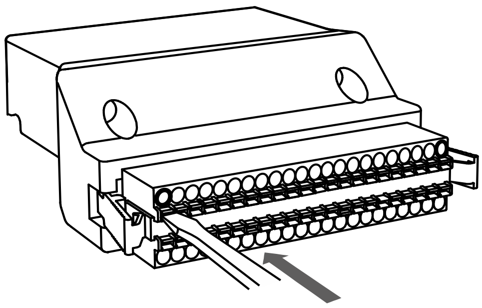
3

Installation and wiring for the CN1 quick connector (ACS3-IFSC4444):

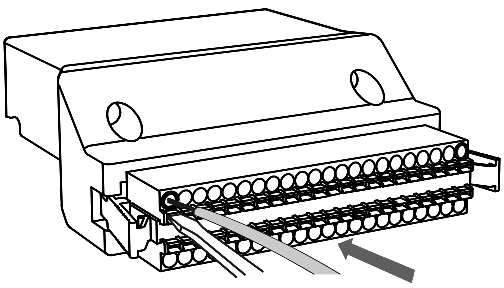
Installation



Wiring



(1) The CN1 quick connector (ACS3-IFSC4444) has multiple spring-loaded terminals. Determine which terminal is to be wired in advance. Use a flathead screwdriver to press the spring down to open the pin.

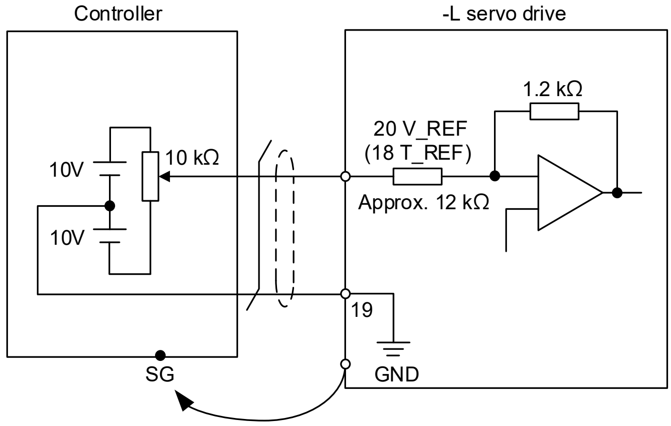


(2) Insert the stripped wire into the pin. Then, withdraw the screwdriver to complete the wiring.

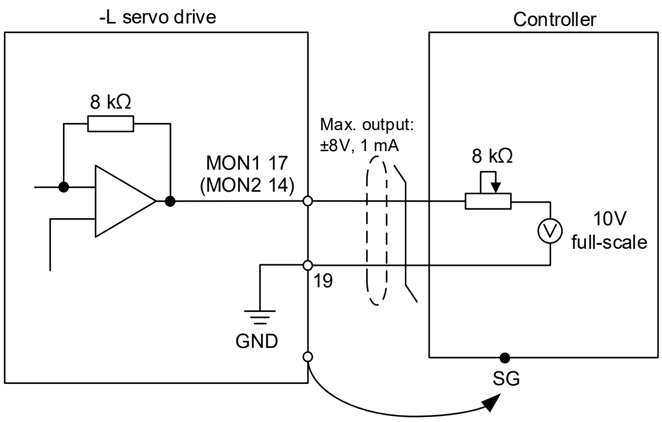
3.3.3.3 Pulse type models – CN1 wiring diagrams

For the analog speed command and the analog torque (thrust) command of the -L models, the valid voltage is between -10V and +10V. You can set the command value that corresponds to the voltage range with the relevant parameters.

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



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



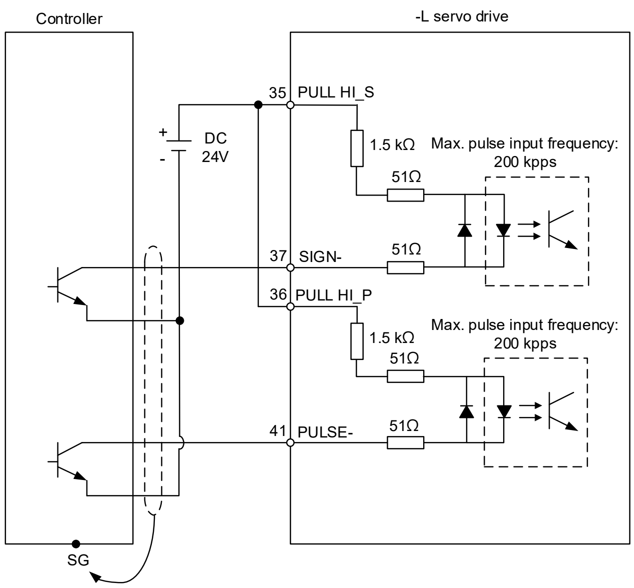
3

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

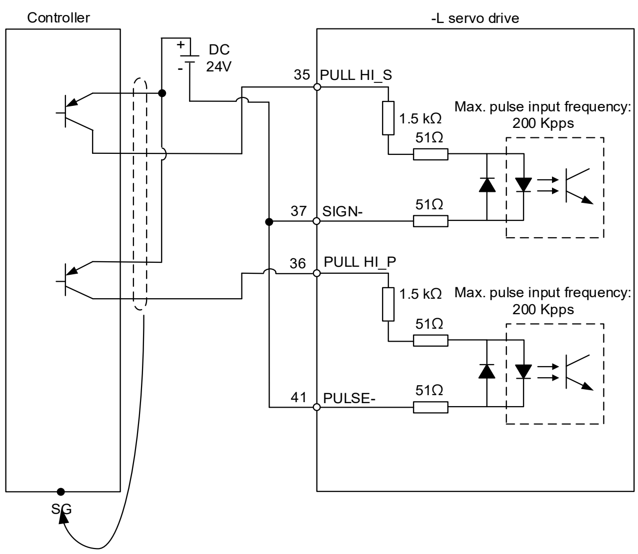
Caution: when the source for the pulse input is open collector NPN type or PNP type equipment, you must connect the external power (24V ± 10%) to the PULL HI pins.

- **Do not connect the 24V power to the SIGN+ and SIGN- pins at the same time, or the circuit elements will be damaged.**
- **Do not connect the 24V power to the PULSE+ and PULSE- pins at the same time, or the circuit elements will be damaged.**

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

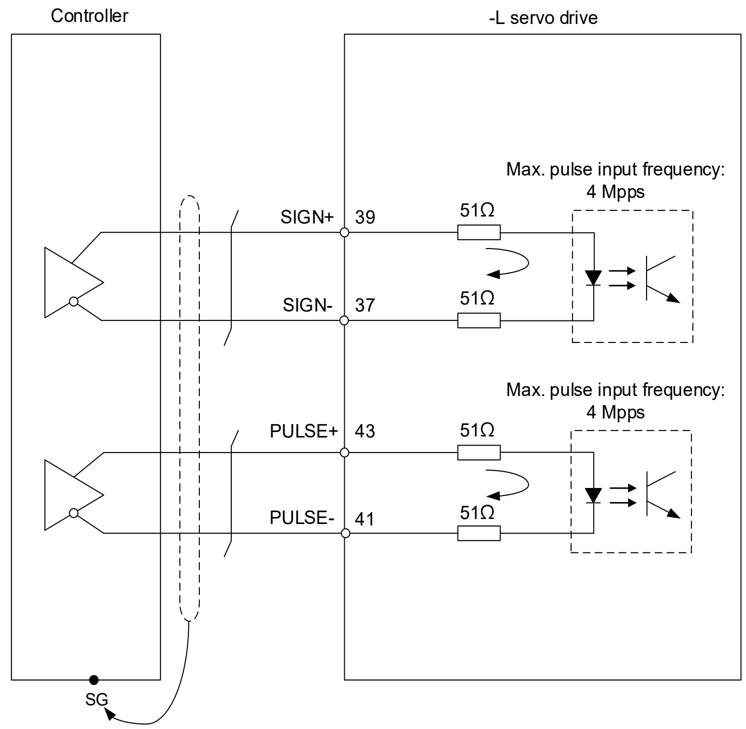


C3-2: the source for the pulse input is open collector PNP type equipment, which uses the external power supply.



C4: pulse input (differential input) can only be used with 2.8V - 3.6V power systems. **Do not use it with 24V power**.

Pulse	Type		Maximum input frequency
High speed pulse	Differential signal	Pulse train + sign	4 Mpps
		CW and CCW pulses	
		A phase + B phase (single phase)	2 Mpps
Low speed pulse	Differential signal		200 Kpps



Note: refer to the description of P1.000 in Chapter 8 for setting details.

3

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

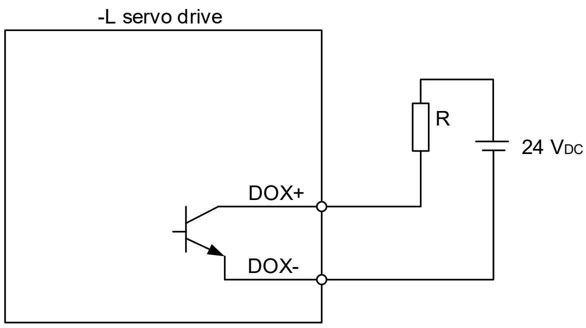
DO specification:

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

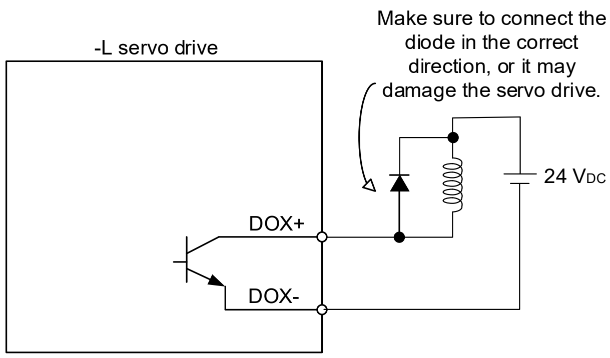
Diode specification:

1A or above, 500V or above (such as the 1N4005 diode).

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.



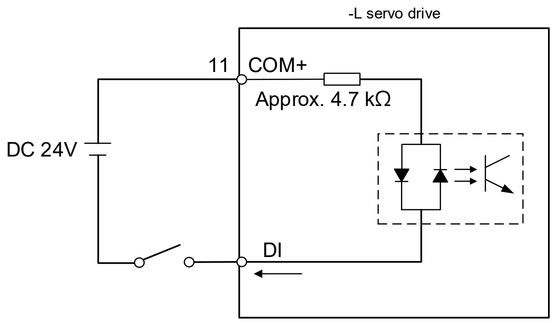
DI wiring - input signals by relay or open collector transistor.

Conditions of DI On / Off:

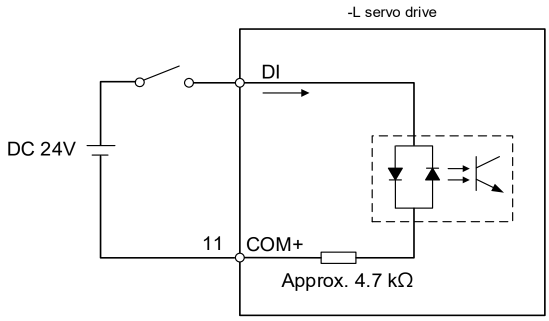
ON: 15V - 24V; input current = 3 mA.

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

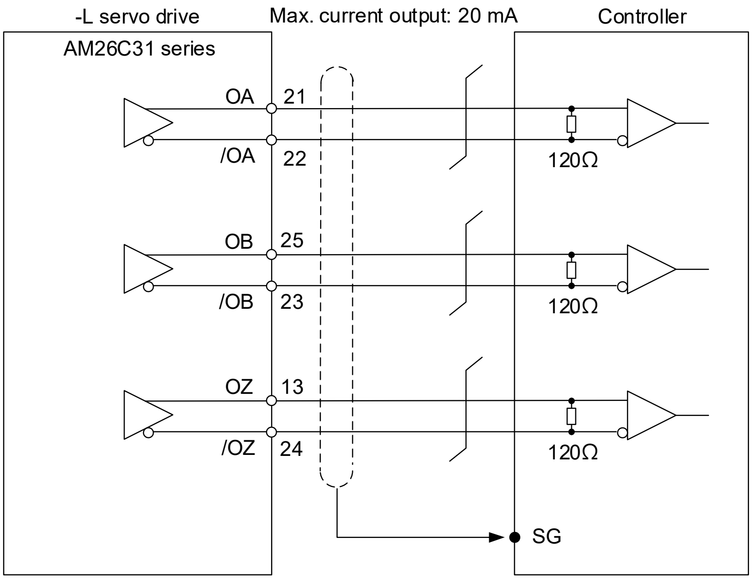
C7: NPN transistor (SINK mode)



C8: PNP transistor (SOURCE mode)



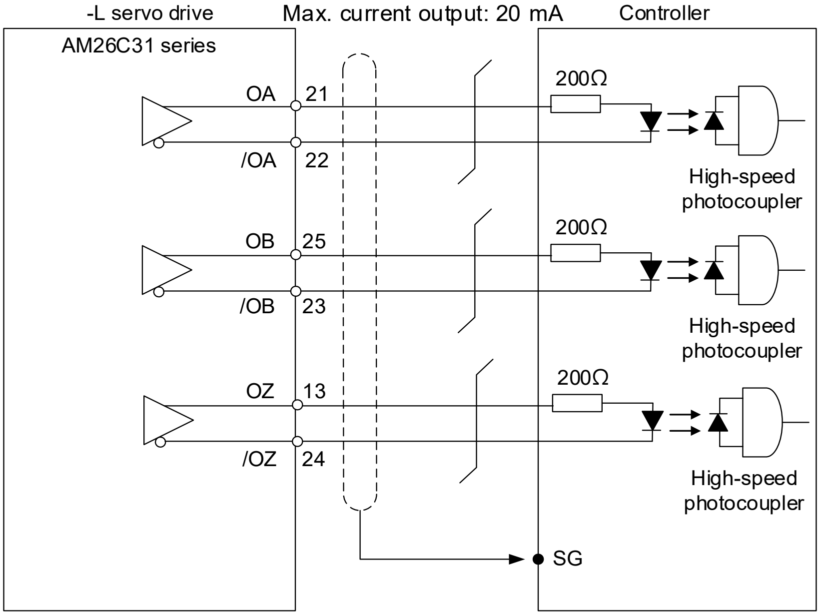
C9: output for encoder position signal (line driver)



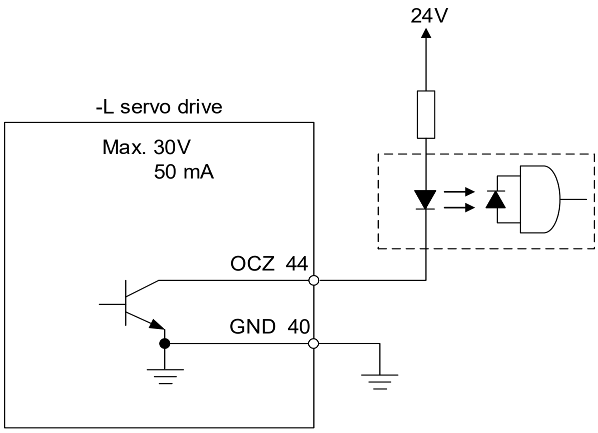
Note: it is suggested that you connect the GND of the controller and the GND of the servo drive in parallel when the voltage difference between the two GND terminals is too great.

3

C10: output for encoder position signal (photocoupler)

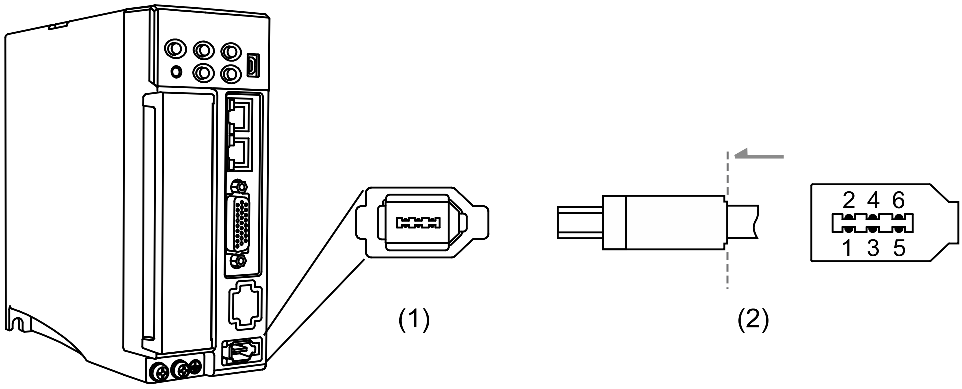


C11: output for encoder OCZ signal (open collector output for Z pulse)



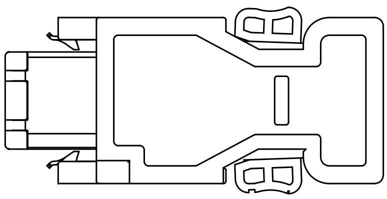
3.4 Wiring for the CN2 encoder connector

The wiring of the CN2 encoder connector is shown as follows:

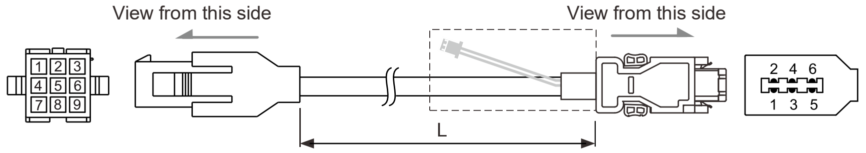
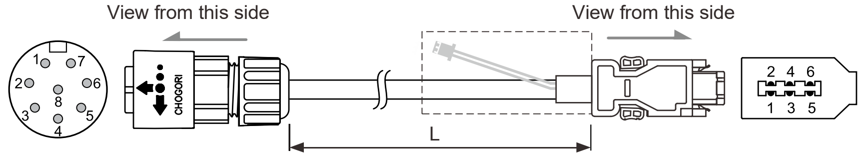
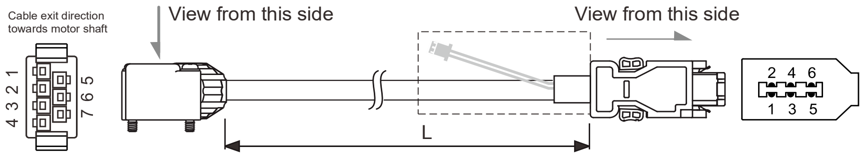
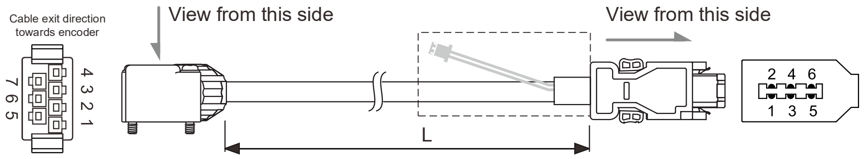


(1) CN2 connector (female); (2) CN2 connector (male)

WARNING	
	■ DO NOT connect to Pin 3 and Pin 4 of the servo drive CN2 connector. These pins are for internal use only. Wiring them will cause damage to the internal circuit. ■ When an absolute encoder is used, the battery supplies power directly to the encoder, so wiring the battery wires to the CN2 connector of the servo drive is not required.

CN2 connector	Connector type Model number
	IEEE 1934 ACS3-CNENC200

3.4.1 F40 - F80 motors – Encoder cables

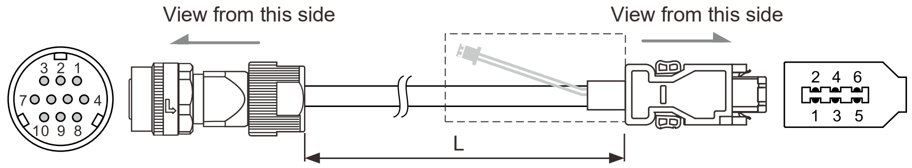
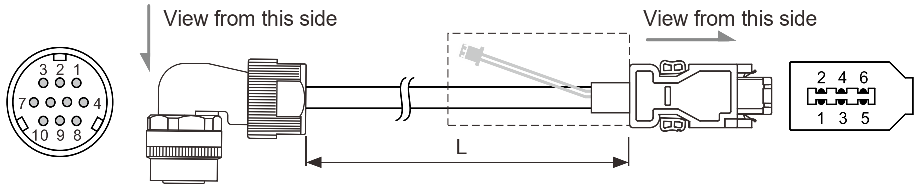
Encoder cable	
Standard connector	
CHOGORI connector	
Bulkhead connector - cable exit direction towards motor shaft	
Bulkhead connector - cable exit direction towards encoder	

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

Pin assignment:

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

3.4.2 F100 – F180 motors – Encoder cables

<table>
<tr><th colspan="2">Encoder cable</th></tr>
<tr><td>Military connector - straight</td><td>
</td></tr>
<tr><td>Military connector - right angle</td><td>
</td></tr>
</table>

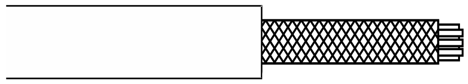
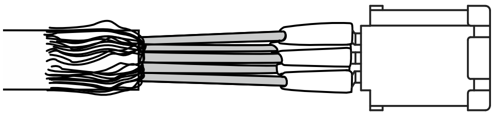
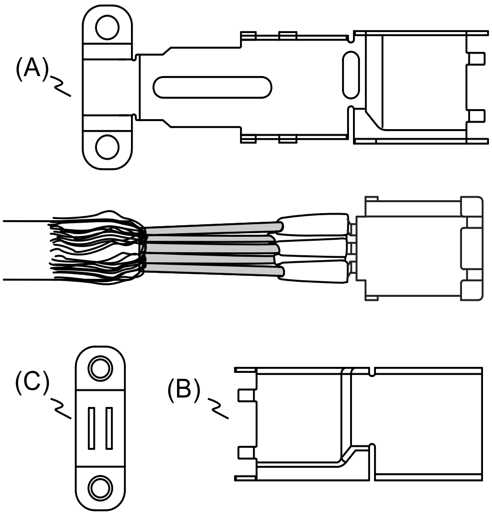
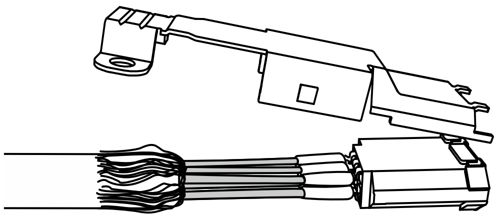
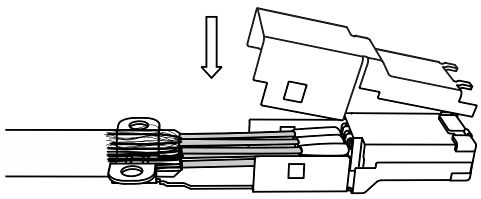
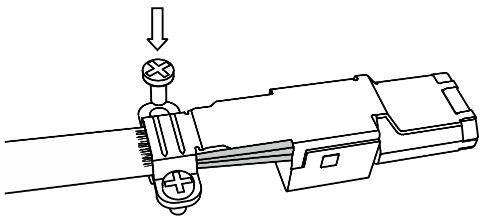
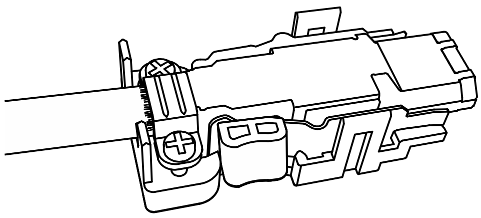
Note: only the absolute encoder cables have the battery box connection wire.

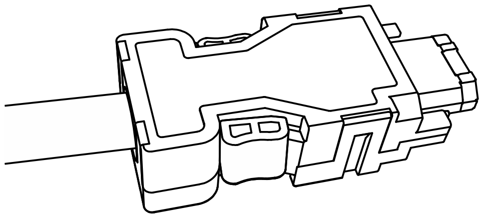
Pin assignment:

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

3

3.4.3 Installing shielded wires for CN2 connector

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

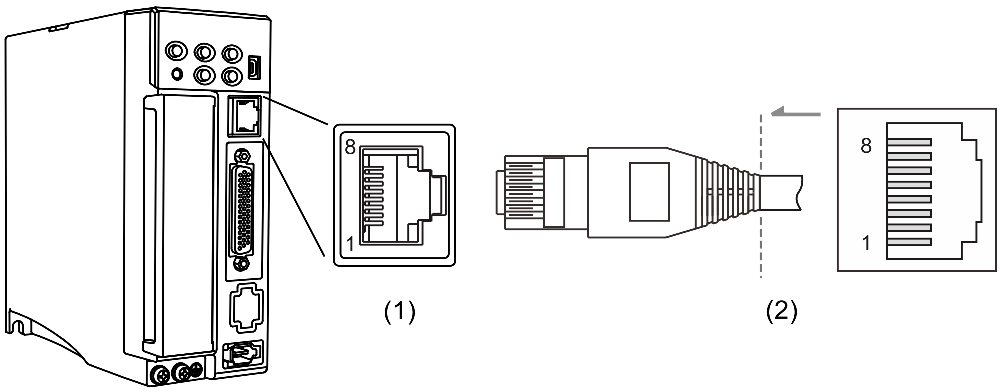
Step 8		Place and fasten the other side of the case to complete assembling the connector.

3.5 Wiring for the CN3 connector

3.5.1 Wiring for the Modbus communication connector

When the servo drive is connected to the PC via the CN3 connector, you can operate the servo drive, PLC, or HMI through Modbus using the assembly language. The CN3 connector supports RS-485 communication interface, allowing you to connect multiple servo drives simultaneously.

Note:
1. -L models have a single port (Pin 1 - Pin 8) which only supports RS-485 communication.
2. B3A-M models have dual ports which support both RS-485 and high-speed communication (CANopen). Refer to Section 3.5.2 for more information.



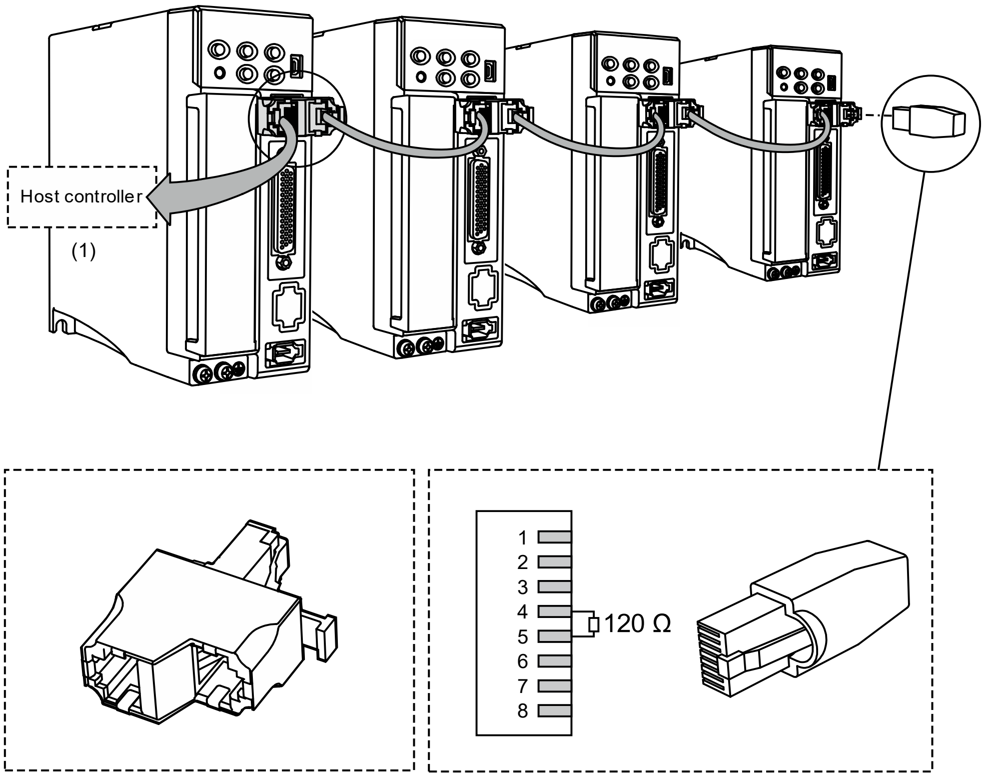
(1) CN3 connector (female); (2) CN3 connector (male)

Pin assignment:

Pin No.	Signal	Description
1	-	Reserved
2	-	Reserved
3, 7	GND_ISO	Signal GND
4	RS-485-	For the servo drive to transmit the data to differential terminal (-).
5	RS-485+	For the servo drive to transmit the data to differential terminal (+).
6, 8	-	Reserved

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

Connecting multiple servo drives:



(2) (3)

(1) Connect to the controller / PLC; (2) Modbus connector;

(3) Wiring for RS-485 terminal resistor

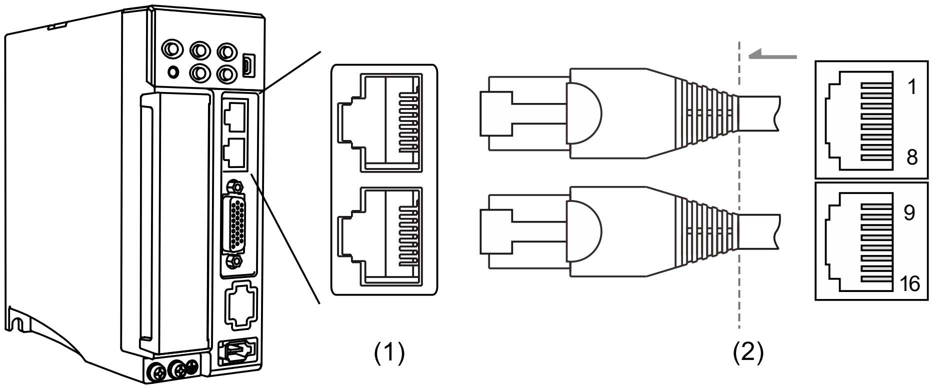
Note:

1. You can connect up to 32 axes through RS-485. The communication quality and the allowable number of connected 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 that you use a terminal resistor of 120Ω (Ohm) and 0.5 W (or more).
3. Connect multiple servo drives in parallel through the Modbus connector and put the terminal resistor in the last servo drive.

3.5.2 Wiring for the CANopen communication connector

Conforming to the CANopen DS301 and DS402 standards, the CN3 connector use the standard CANopen communication interface to control the position, torque, and speed of the motor, and access or monitor the servo status, allowing you to connect multiple servo drives simultaneously.

Note: -M models have dual ports; B3-M models only support high-speed communication (CANopen), and B3A-M models support both RS-485 and high-speed communication (CANopen).



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

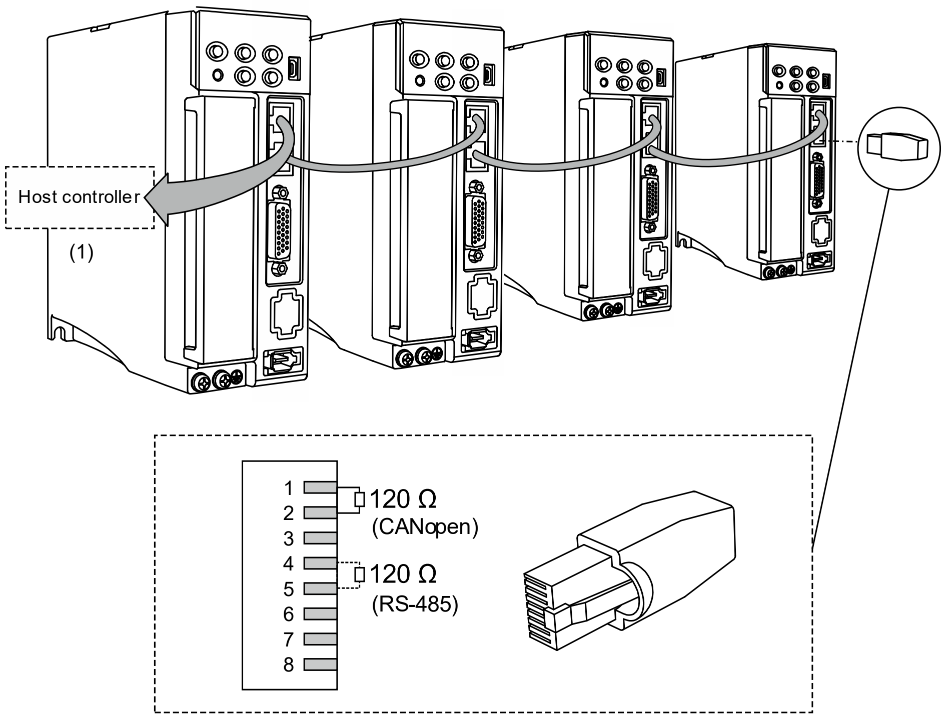
Pin assignment:

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

3

Connecting multiple servo drives:

Configure the terminal resistor according to the communication interface in use.



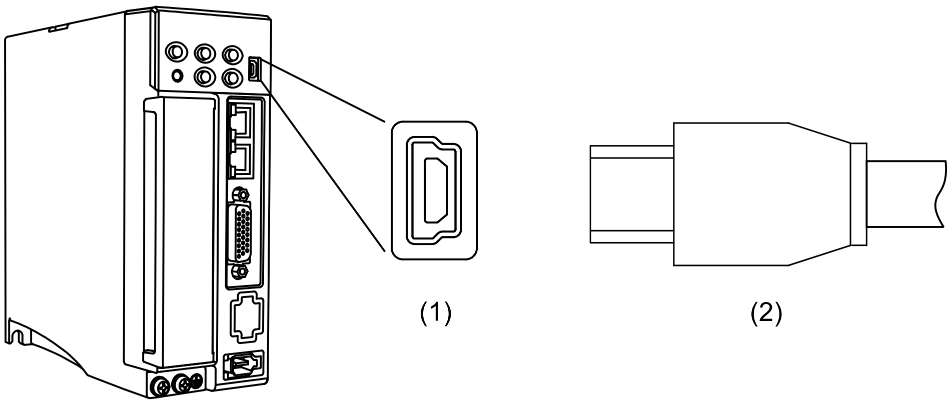
(1) Connect to the controller / PLC; (2) Wiring for CANopen / RS-485 terminal resistor

Note:
1. CANopen cable length can be up to 30 m (98.43 ft). You can connect up to 32 axes through RS-485. The communication quality and the allowable number of connected 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 that you use a terminal resistor of 120Ω (Ohm) and 0.5 W (or more).
3. Connect multiple servo drives in parallel through the two ports and put the terminal resistor in the last servo drive.

3

3.6 CN4 connector (Mini USB)

CN4 is a serial communication port through which you can connect the servo drive to a PC and operate the servo drive with the software.
This is a Type B Mini USB connector that is compatible with the USB 2.0 specification, and installing the USB isolator (Delta model number: UC-ADP01-A) is required.



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

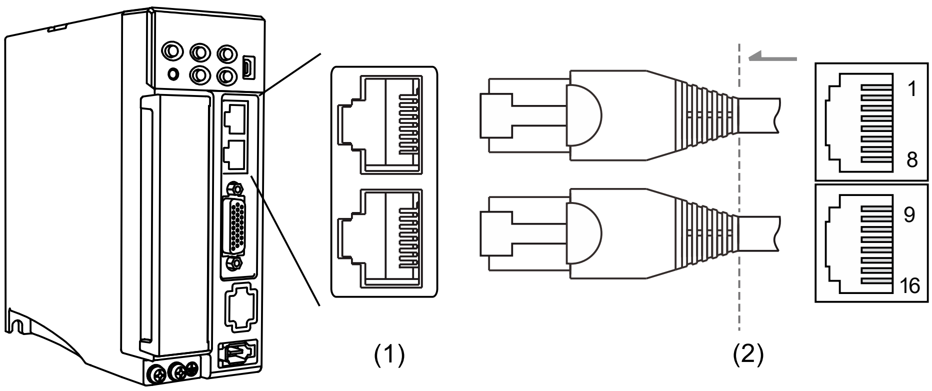
3

3.7 Wiring for the CN6 connector

3.7.1 Wiring for the DMCNET communication connector

The CN6 connector of the -F models allows you to connect the servo drive to the controller or motion control card using a standard RJ45 connector and a shielded network cable, controlling the position, torque, and speed of the motor, and accessing or monitoring the servo status with Delta's DMCNET system.

You can set the address with P3.000 when using DMCNET communication. Its maximum transmission rate is 20 Mbps. The -F models provide two DMCNET ports for connecting multiple servo drives, with one way in and the other way out. Remember to put the terminal resistor that comes with the accessory kit of the controller or motion control card in the last servo drive.

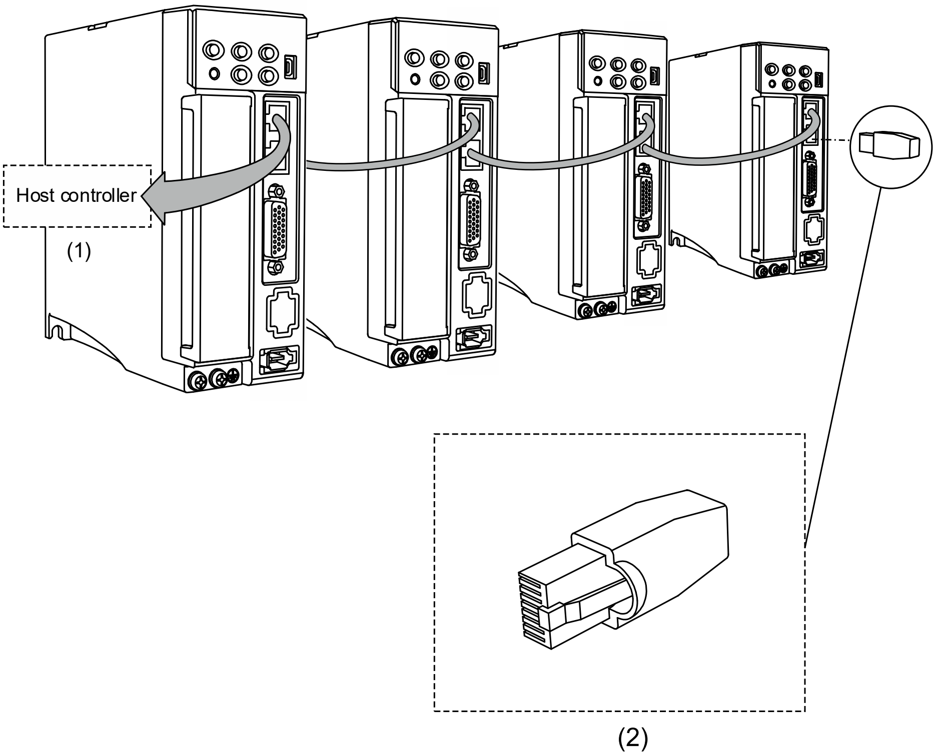


(1) CN6 connector (female); (2) CN6 connector (male)

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	-	Reserved
6, 14	DMCNET_2B	DMCNET Channel 2 bus line (-)
7, 15 8, 16	-	Reserved

Connecting multiple servo drives:

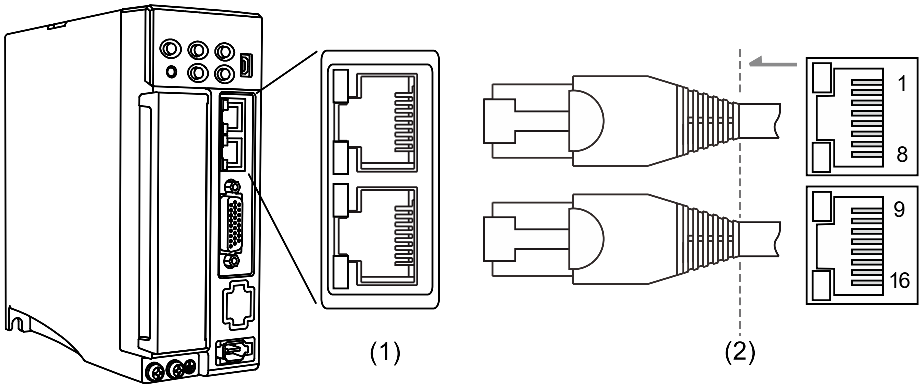


(1) Connect to the controller / motion control card; (2) Illustration of DMCNET terminal resistor

Note:
1. You can connect up to 12 axes through DMCNET communication with the cable length up to 30 m (98.43 ft).
2. To connect multiple servo drives in series, use the two DMCNET ports with one way in and the other way out, and then put the terminal resistor in the last servo drive.
3. The required resistance value of the terminal resistor varies depending on the specification of the controller or motion control card. Contact the Customer Service Center of the controller or motion control card for details.

3.7.2 Wiring for the EtherCAT communication connector

The CN6 connector of the -E models provides two EtherCAT ports for connecting multiple servo drives, with one way in and the other way out.



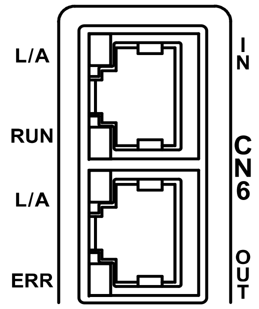
(1) CN6 connector (female); (2) CN6 connector (male)

Pin assignment:

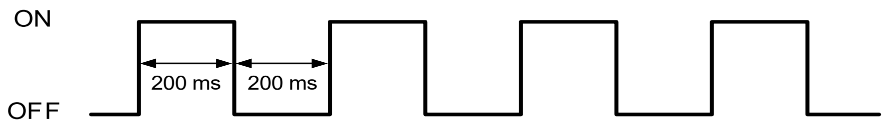
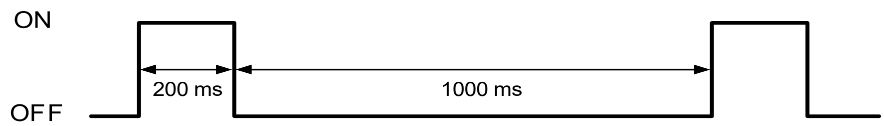
Transmission port	Pin No.	Signal	Function description
IN	1	TX+	Transmit +
	2	TX-	Transmit -
	3	RX+	Receive +
	4	-	Reserved
	5	-	Reserved
	6	RX-	Receive -
	7	-	Reserved
	8	-	Reserved
OUT	9	TX+	Transmit +
	10	TX-	Transmit -
	11	RX+	Receive +
	12	-	Reserved
	13	-	Reserved
	14	RX-	Receive -
	15	-	Reserved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

Note: the IN port is for connecting the controller or the previous servo drive, and the OUT port is for connecting the next servo drive or not connecting to other devices. Incorrect wiring will lead to communication failure.

Description of each indicator for the CN6 connector:



■ LED indicator state description

Indicator	Description
On	
Blinking	
Single flash	
Off	

■ Network state indicator (L/A)

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

■ EtherCAT connection state indicator (RUN)

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

■ EtherCAT error indicator (ERR)

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

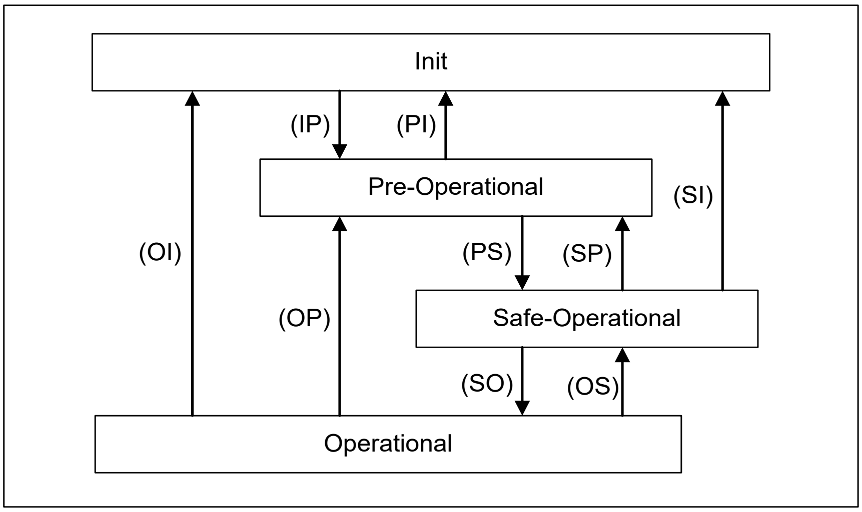
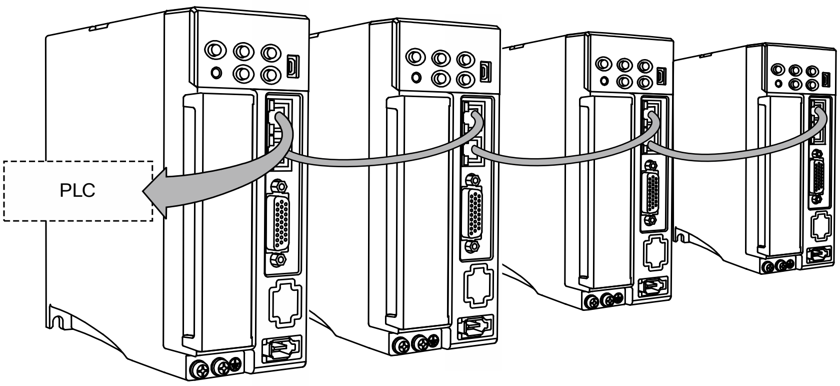


Figure 3.7.2.1 EtherCAT State Machine

Connecting multiple servo drives:

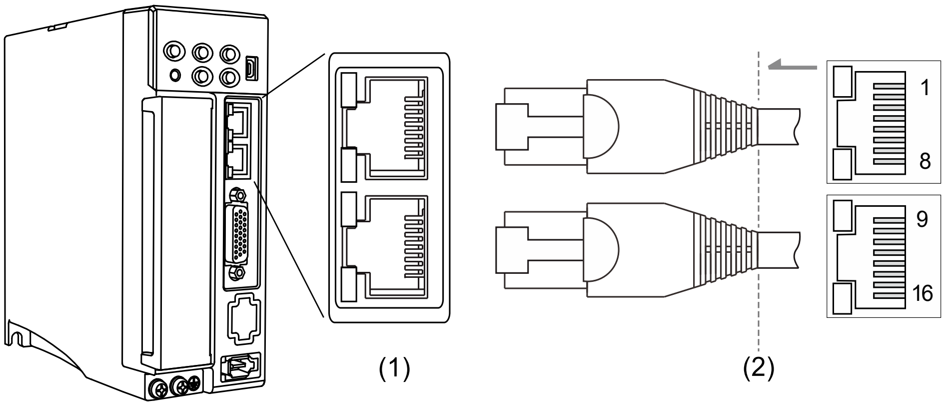


Note:
1. When multiple servo drives are connected, the maximum distance between each drive is 50 m (164.04 inches)
2. Use CAT5e STP cable.
3. It is suggested that you use a Beckhoff cable (model number: ZB9020).
4. Ensure the wiring is correct. The IN port is for connecting the controller or the previous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

3.7.3 Wiring for the PROFINET communication connector

3

The CN6 connector of the B3A-P models allows you to connect the servo drive to the controller using standard RJ45 connectors and shielded network cables, controlling the motor position and speed of the motor, and accessing or monitoring the servo status with Siemens' PROFINET system.

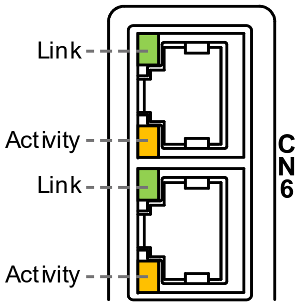


(1) CN6 connector (female); (2) CN6 connector (male)

Pin assignment:

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

Description of each indicator for the CN6 connector:



Name	Color	Indicator	Description
Link	Green	On	Network is connected.
		Off	No connection or connection error.
Activity	Orange	On	Data exchange in progress.
		Off	No data exchange.

3

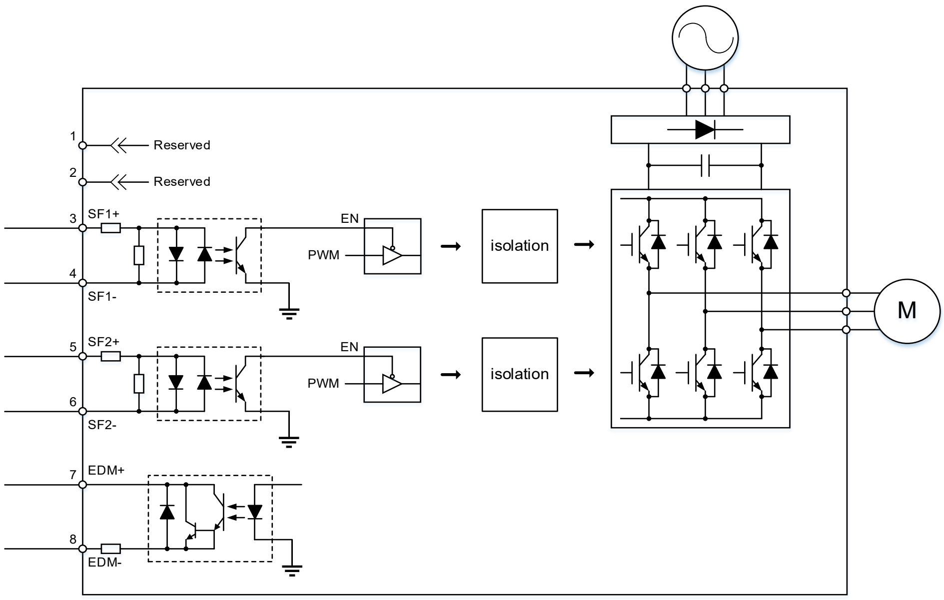
3.8 CN10 STO terminal (SIL3)

The STO function descriptions in this section are applicable to servo drives certified by TÜV SÜD.

Note: the STO function is supported by B3A series only.

3.8.1 Introduction to STO

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



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

3.8.2 Preacautions for using STO function

Read the following safety precautions carefully to ensure system safety.

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

3.8.3 Potential risks of STO

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

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

3.8.4 Safety parameters

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

Standard		Certification body
Functional Safety	IEC / EN 61508: 2010	
Machinery Directive	EN IEC 62061: 2021	
	EN 61800-5-2: 2017	
	EN ISO 13849-1: 2023	
Low Voltage Directive	EN 61800-5-1: 2007/A11:2021	
EMC for Functional Safety	EN 61326-3-1: 2017	
	EN 61000-6-7: 2015	

Note: Functional Safety certification application is in progress.

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

3.8.5 How does the STO function work?

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

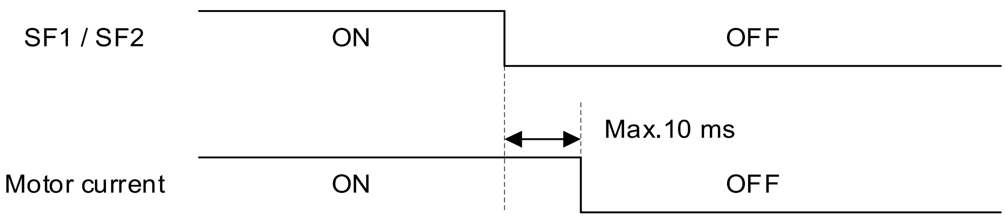
Signal		Status of opto-isolator			
STO	SF1+ SF1-	ON	ON	OFF	OFF
	SF2+ SF2-	ON	OFF	ON	OFF
Servo drive output status		Ready	Torque off (SF2 lost)	Torque off (SF1 lost)	Torque off (STO activated)
Diagnostic output (EDM)		OFF	OFF	OFF	ON
Alarm		N/A	AL502	AL501	AL500

Note:

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

3.8.5.1 Response time

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



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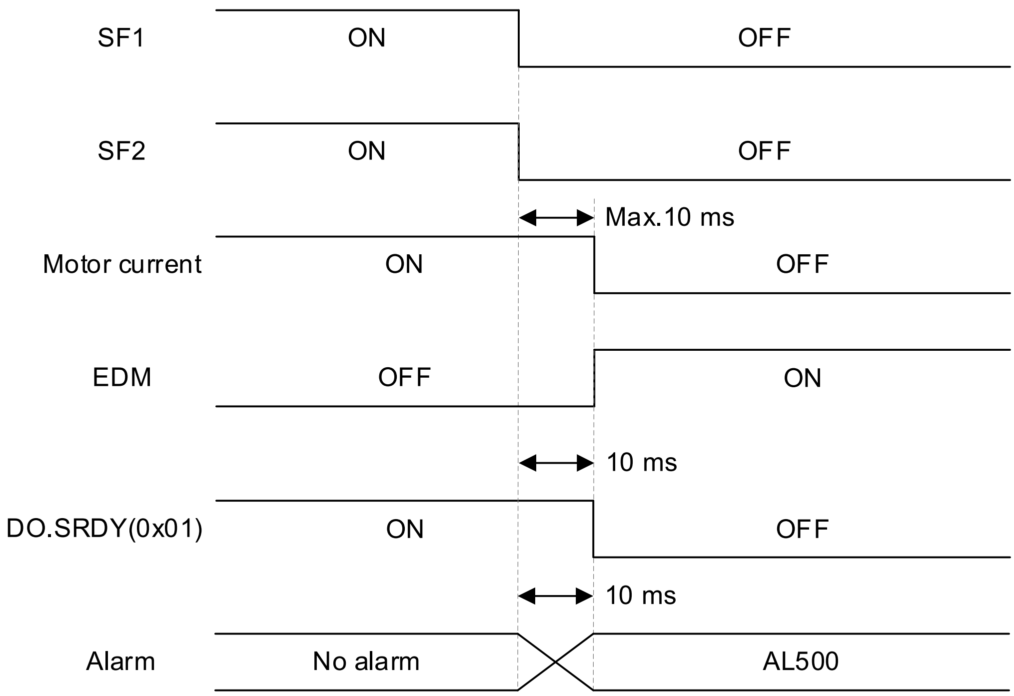
3.8.5.2 Alarm triggering

(1) AL500 (STO function is enabled)

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

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

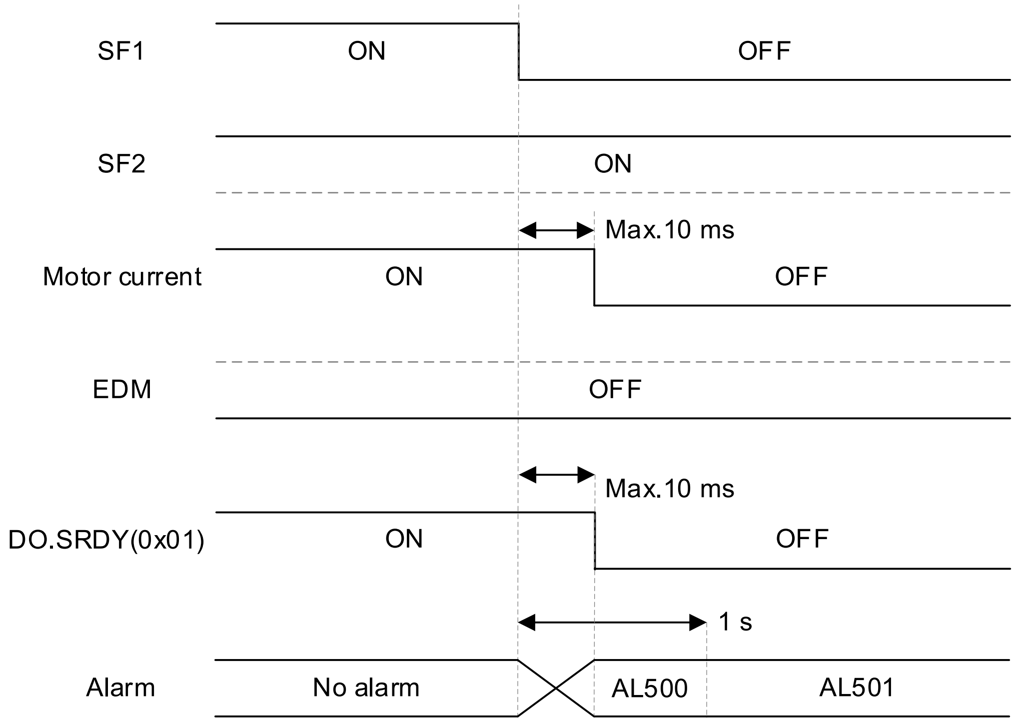


In addition, when either SF1 and SF2 signal becomes OFF, AL500 is also triggered. See the descriptions of AL501 and AL502 for details.

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

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

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



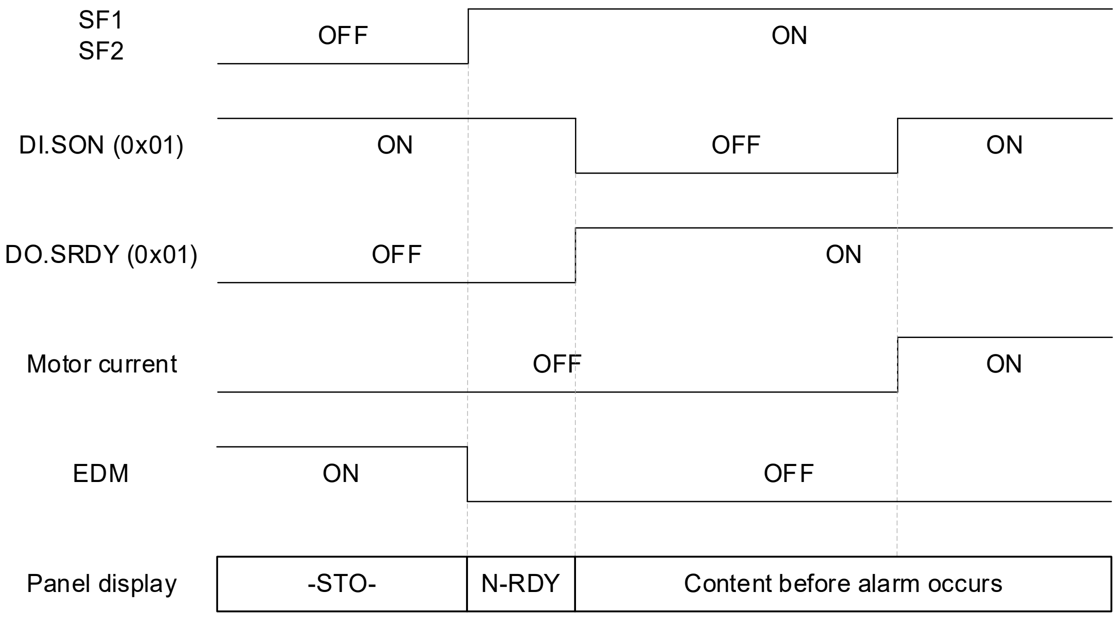
Note: when SF1 becomes OFF, AL501 occurs. When SF2 becomes OFF, AL502 occurs.

3.8.5.3 STO deactivation settings

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

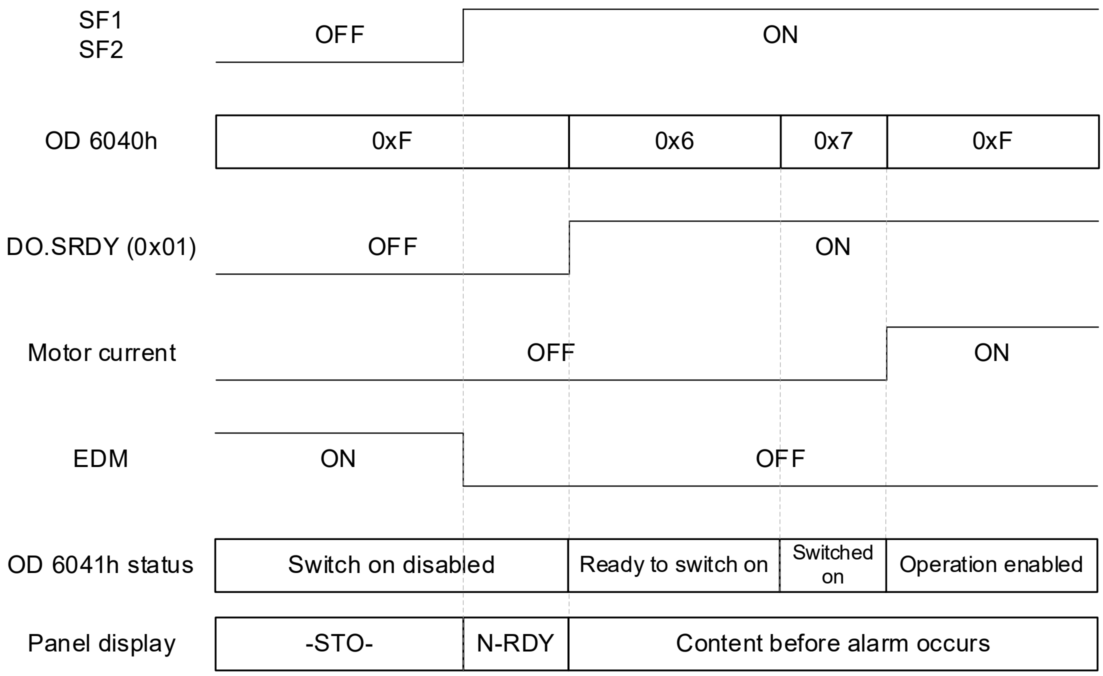
P1.120	Function
0	Switching on the servo drive is invalid / prohibited after the STO function is activated. To deactivate the STO function and restart the servo drive, send the Servo Off command to cancel the state (Servo On invalid / prohibited), and then send the Servo On command. DMCNET communication does not support this setting.
1	AL500 is triggered after the STO function is activated. To deactivate the STO function and restart the servo drive, you have to clear the alarm first, send the Servo Off command to cancel the state (Servo On invalid / prohibited), and then send the Servo On command. DMCNET communication does not support this setting.
2	Switching on the servo drive is invalid / prohibited when the STO function is activated. The servo drive starts to operate again after the STO function is deactivated. DMCNET communication does not support this setting.
3 (Default)	AL500 is triggered after the STO function is activated. To deactivate the STO function and restart the servo drive, you have to clear the alarm.

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

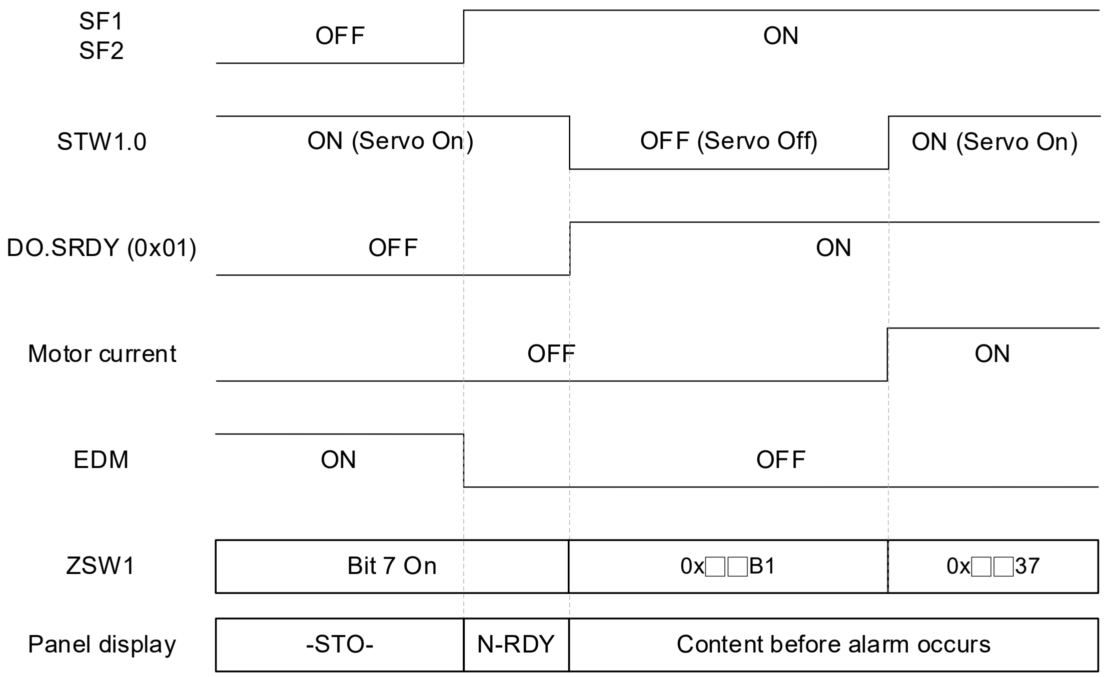


Note: DI.SON is invalid in communication modes, and thus you have to switch the drive to Servo On with the controller.

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



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



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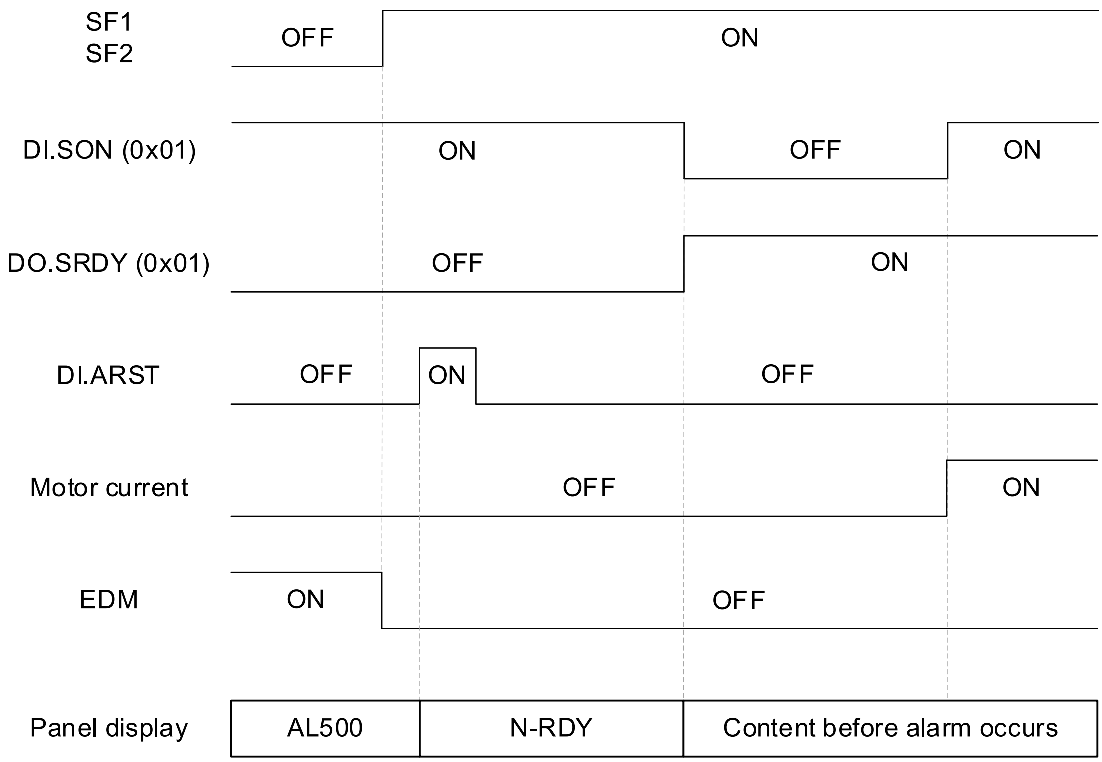
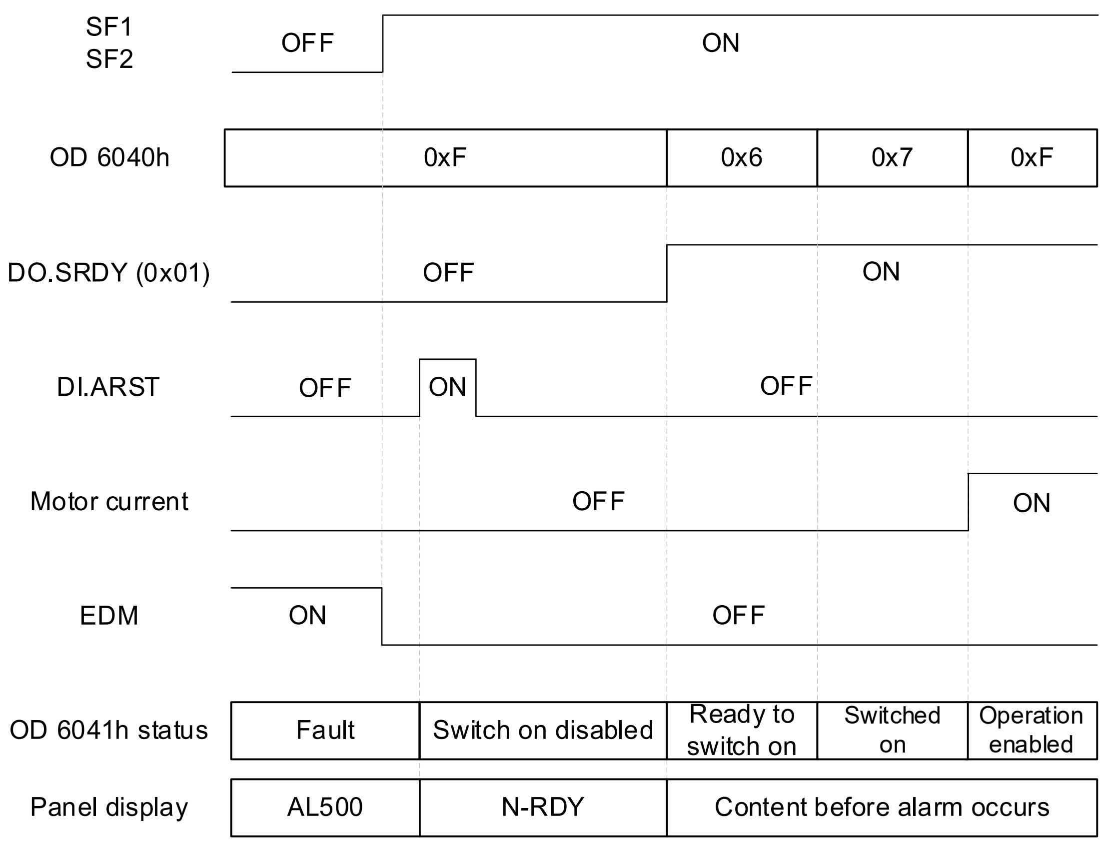
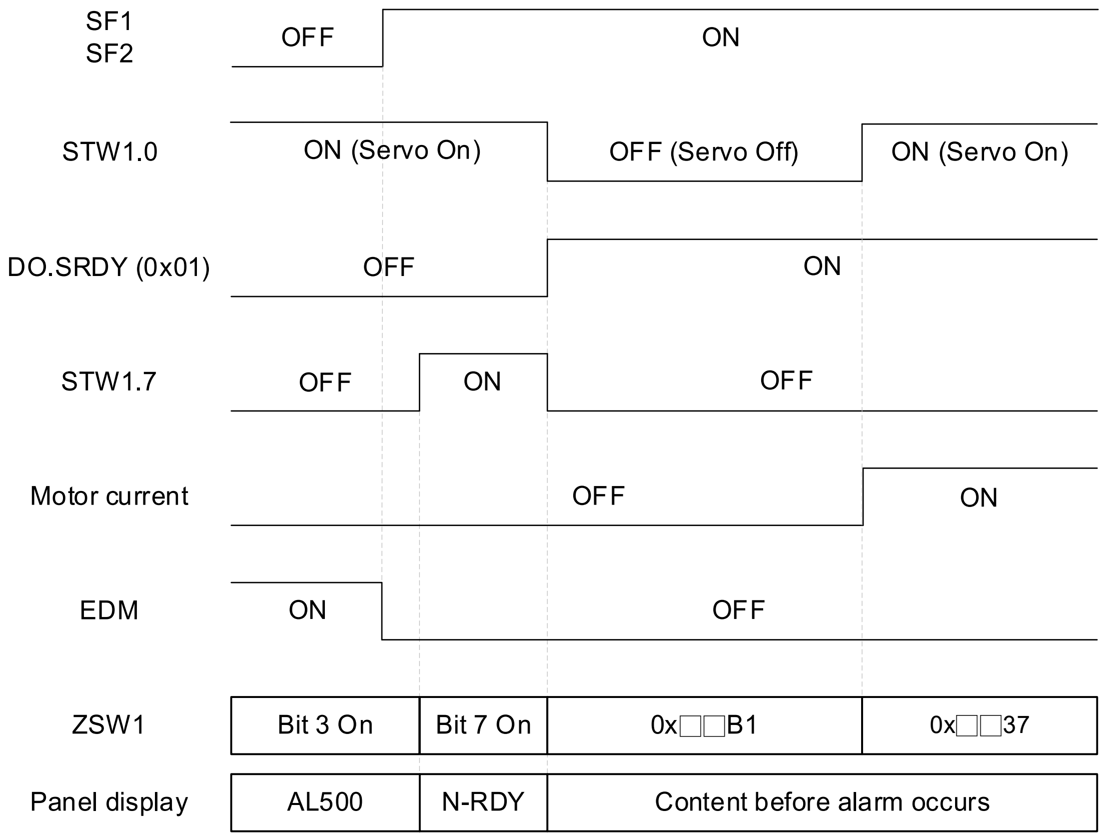
(4) When P1.120 = 1 and the Servo On / Off command is sent with external DI



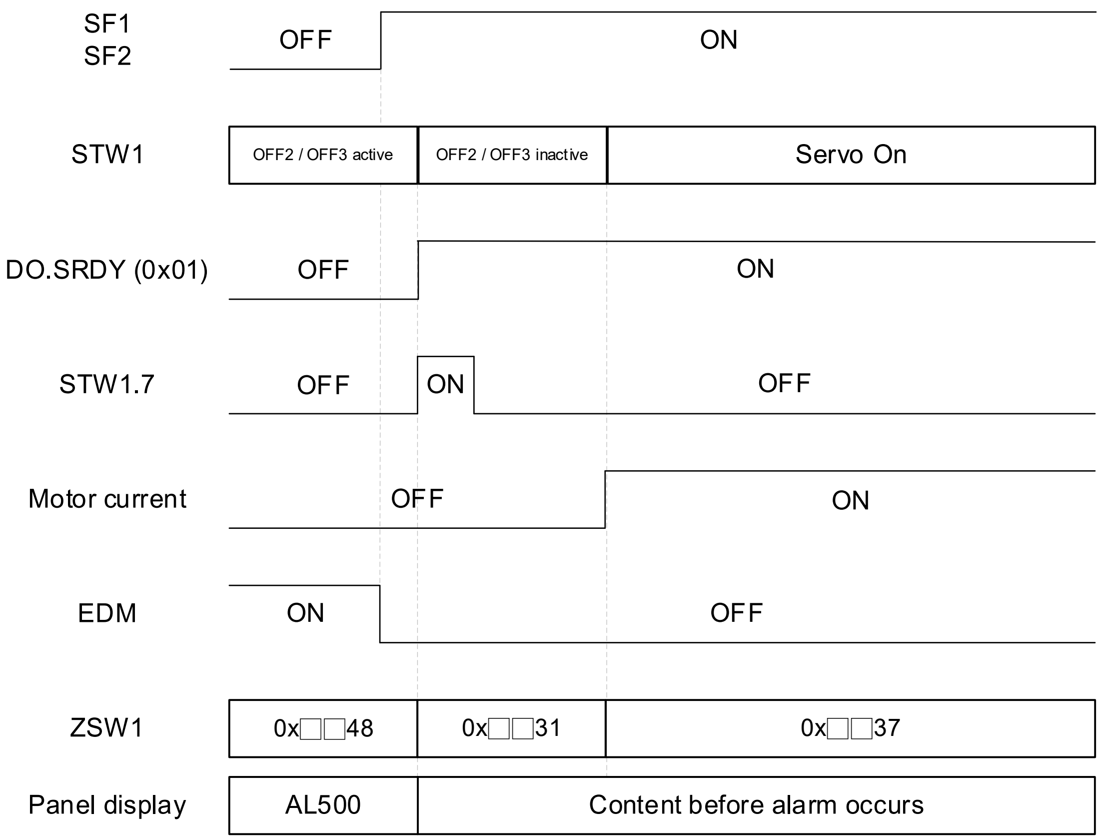
(5) When P1.120 = 1 and the Servo On / Off command is sent through EtherCAT / CANopen communication



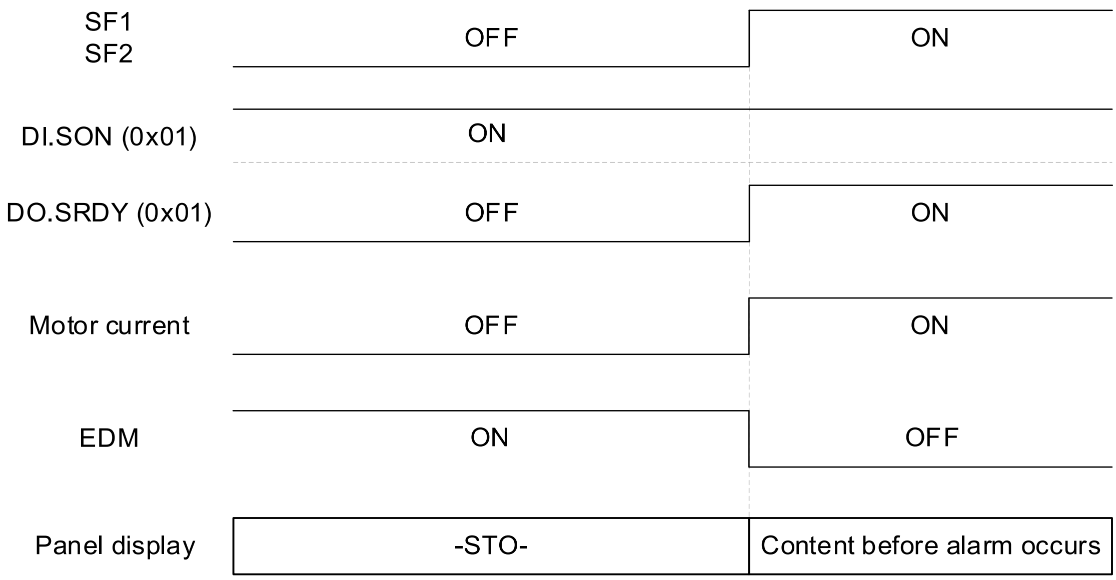
(6) When P1.120 = 1 and the Servo On / Off command is sent through telegram 1 or 111 under PROFINET communication



(7) When P1.120 = 1 and the Servo On / Off command is sent through telegrams 3, 102, or 105 with technology objects under PROFINET communication

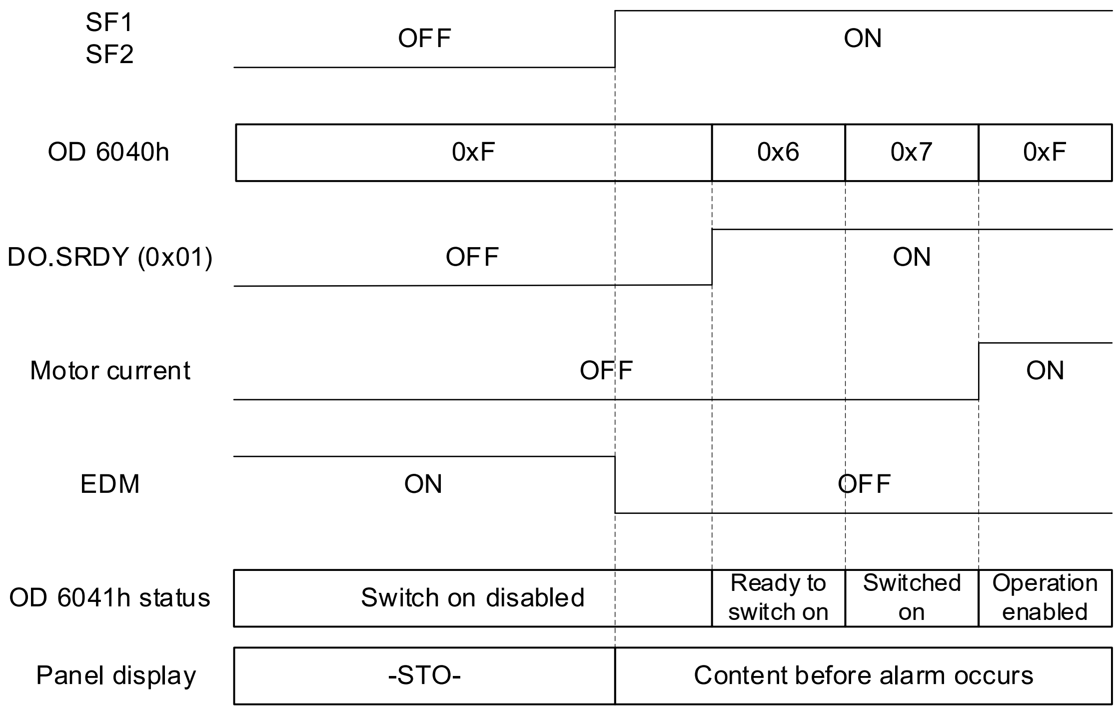


(8) When P1.120 = 2 and the Servo On / Off command is sent with external DI

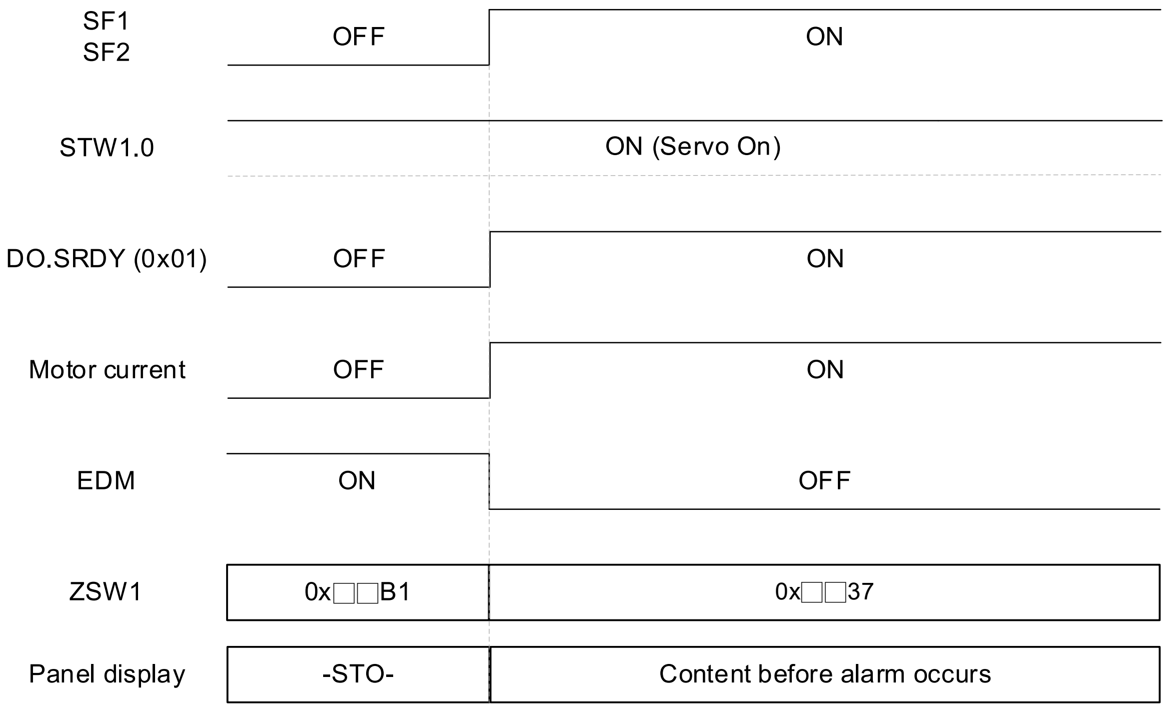


Note: if you switch the STO signal to ON when the servo drive sends the position or speed command to the motor, it may cause drastic motor operation. Before switching the STO signals to ON, check if there is any command input and ensure personal safety.

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

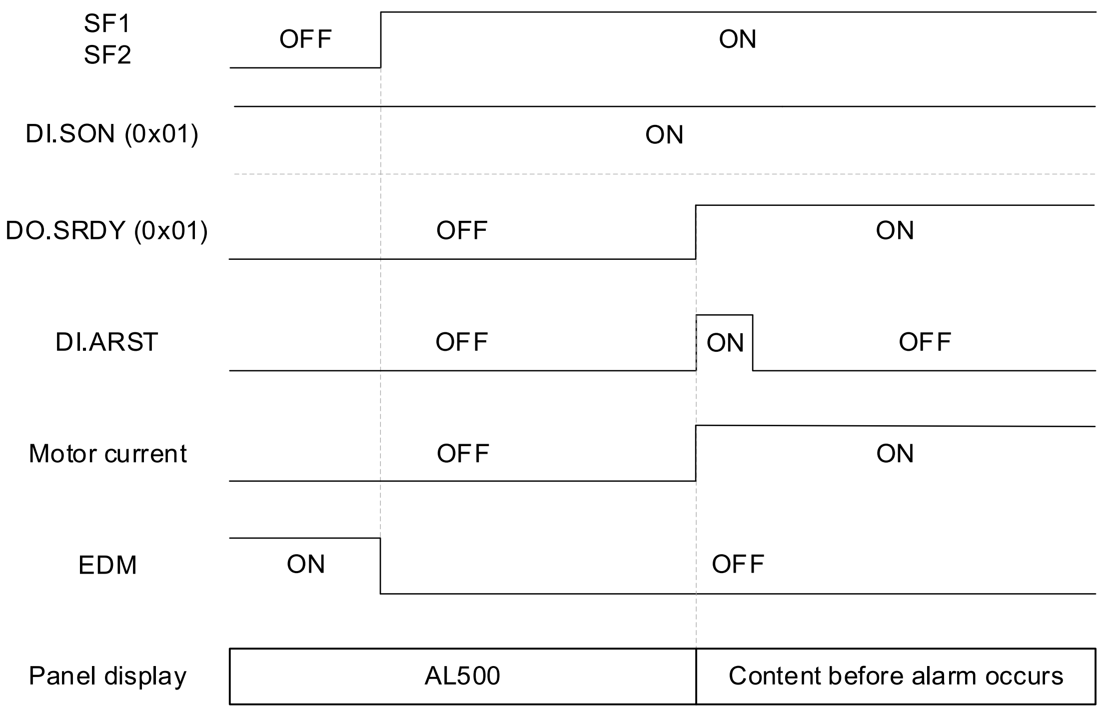


(10) When P1.120 = 2 and the Servo On / Off command is sent through PROFINET communication



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

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



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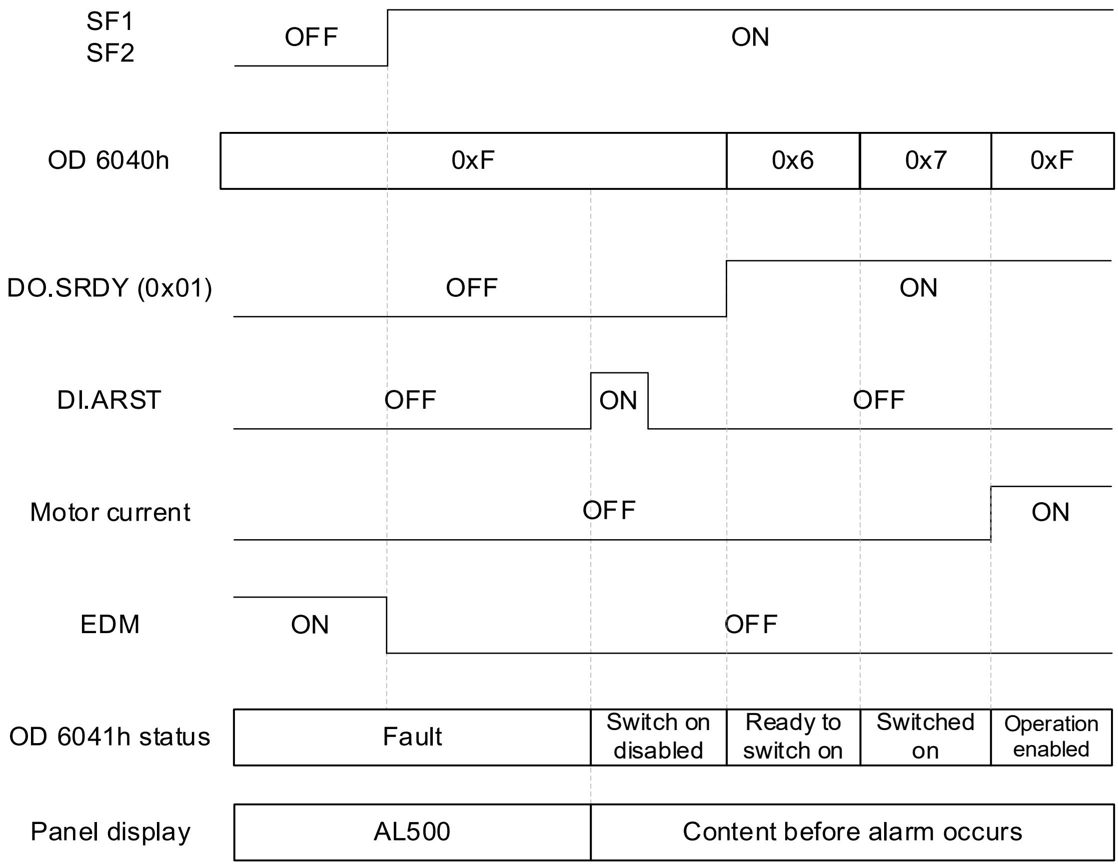
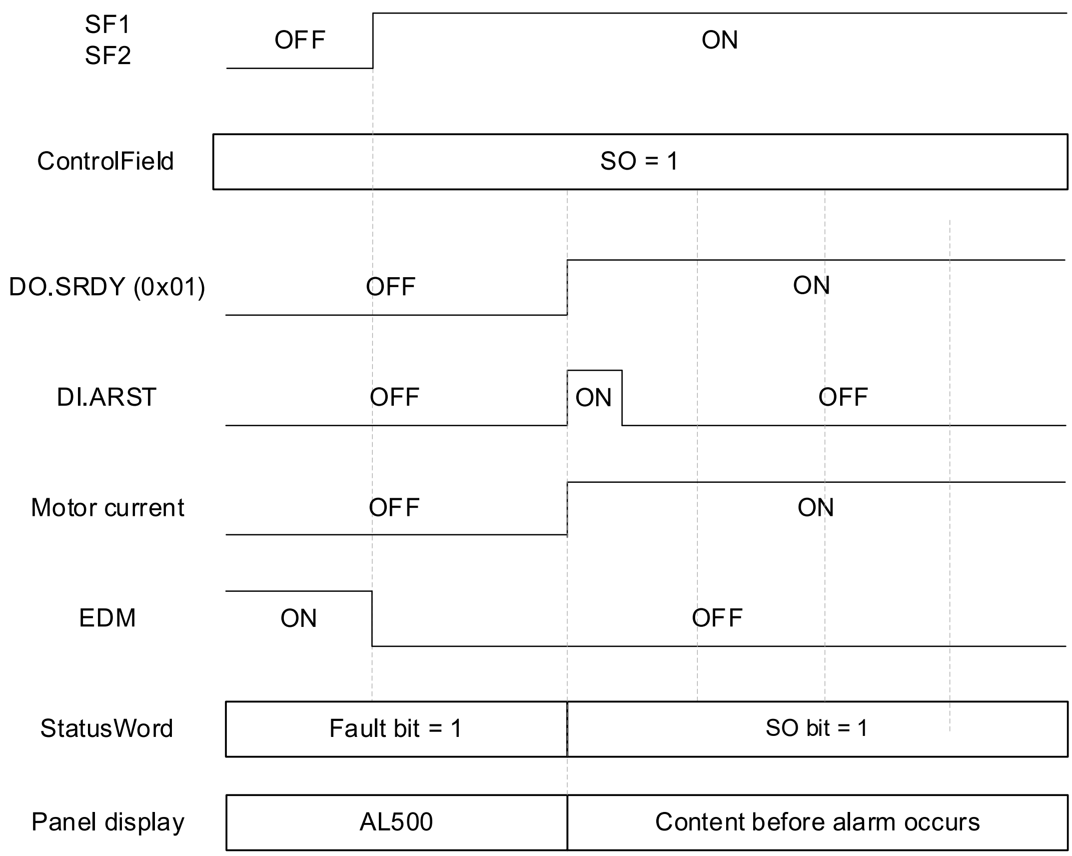
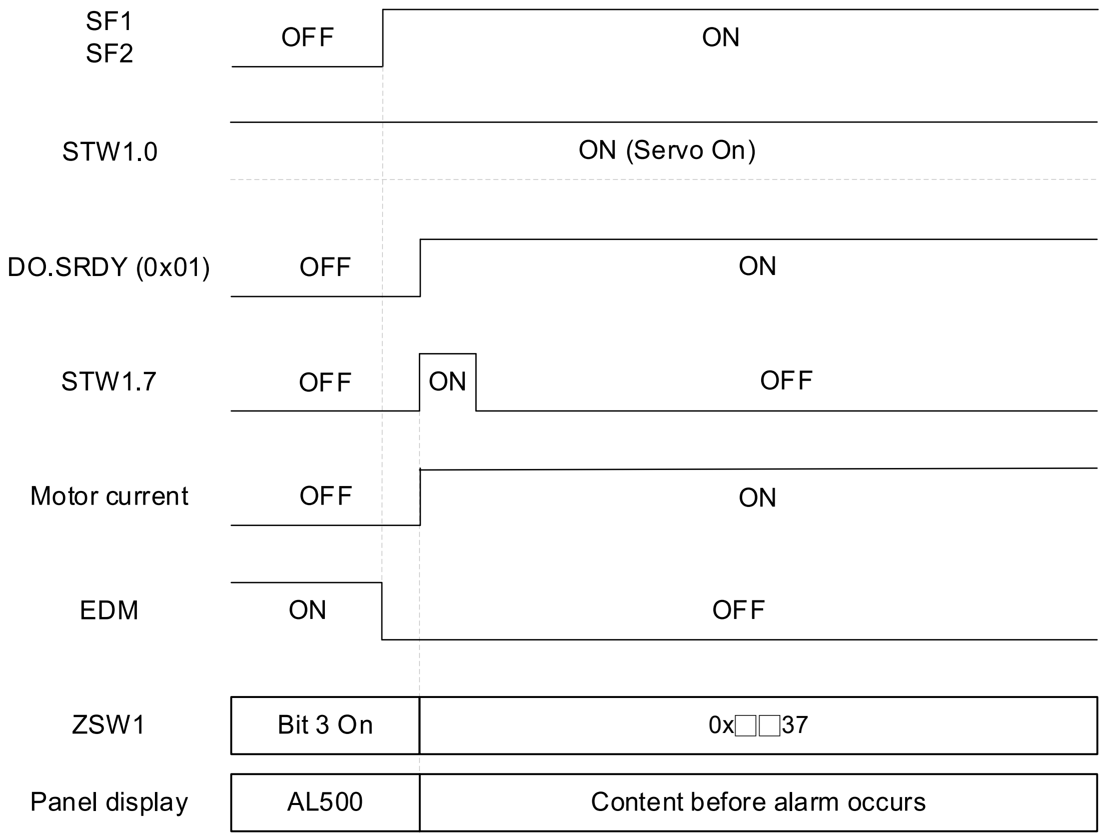
(12) When P1.120 = 3 and the Servo On / Off command is sent through EtherCAT / CANopen communication



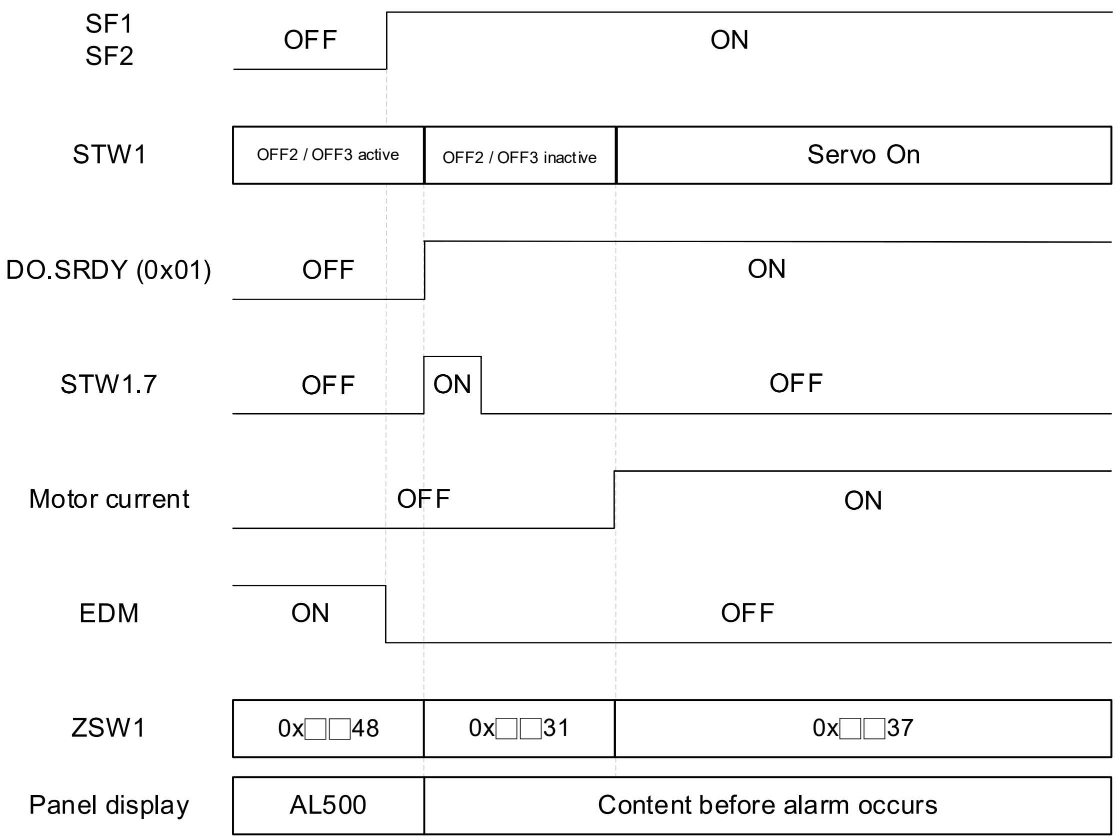
(13) When P1.120 = 3 and the Servo On / Off command is sent through DMCNET communication



(14) When P1.120 = 3 and the Servo On / Off command is sent through telegram 1 or 111 under PROFINET communication



(15) When P1.120 = 3 and the Servo On / Off command is sent through telegram 3, 102, or 105 with technology objects under PROFINET communication



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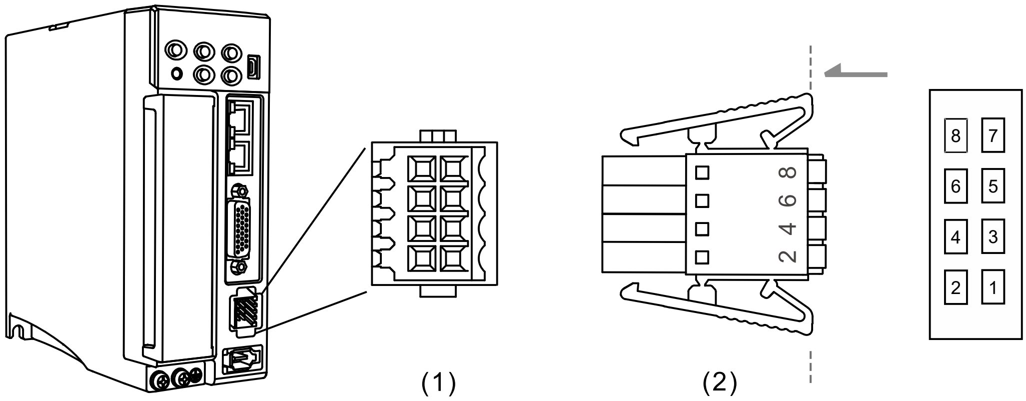
3.8.6 Wiring for STO

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

3.8.6.1 CN10 STO terminal

This terminal provides the STO function.

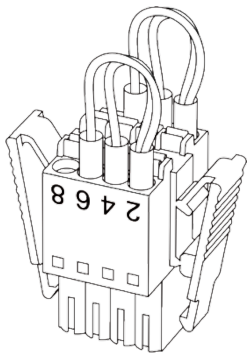


(1) CN10 STO terminal (female); (2) CN10 STO terminal (male)

Pin assignment:

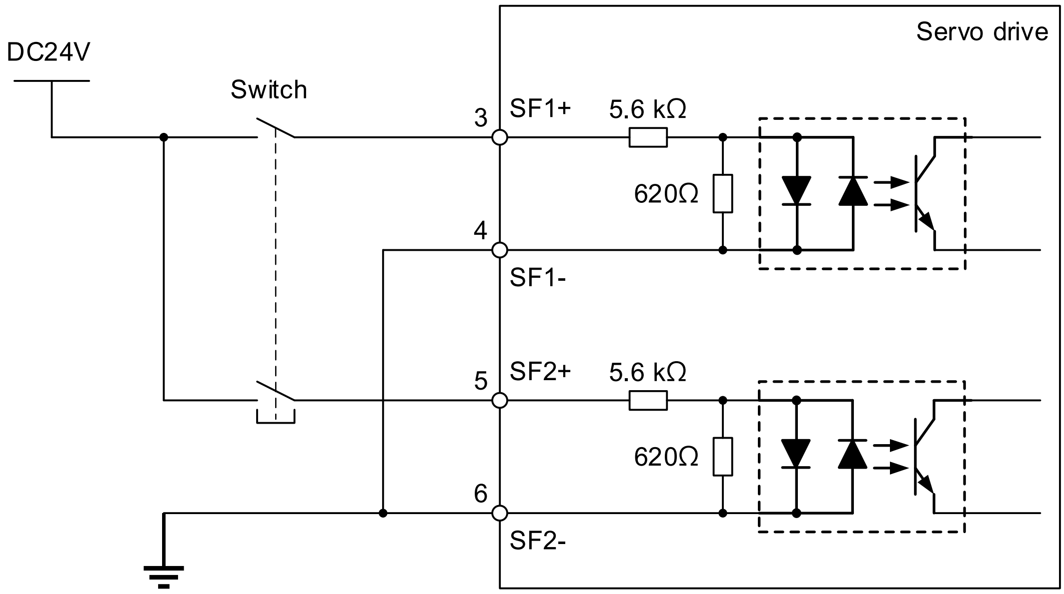
Pin No.	Signal	Description	Function
1	-	Reserved	For deactivating the STO function; refer to Section 3.10.6.3 for the wiring diagram. Do not connect these two pins if using the STO function is required.
2	-	Reserved	
3	SF1+	STO input SF1+	Input signal for the STO function. ON (close): servo drive is in normal operation OFF (open): STO is activated
4	SF1-	STO input SF1-	
5	SF2+	STO input SF2+	
6	SF2-	STO input SF2-	
7	EDM+	Diagnostic output+	Monitoring outputs for STO input status and STO circuit failure.
8	EDM-	Diagnostic output-	

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



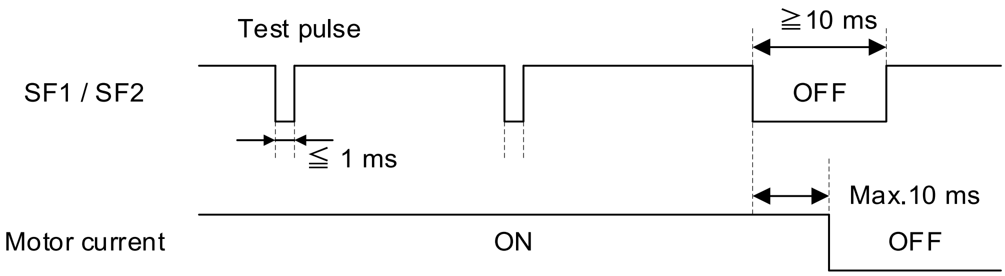
3.8.6.2 Input / output signal specification

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



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

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



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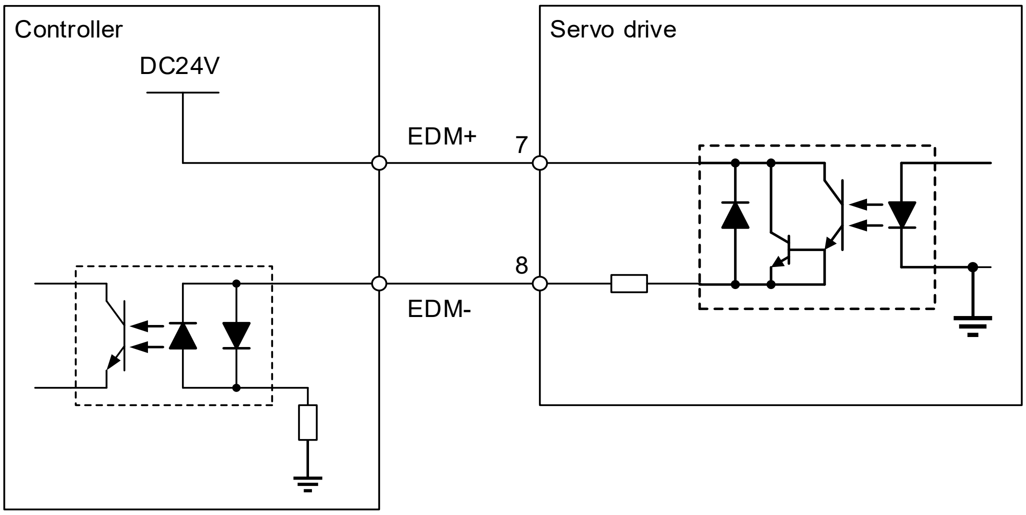
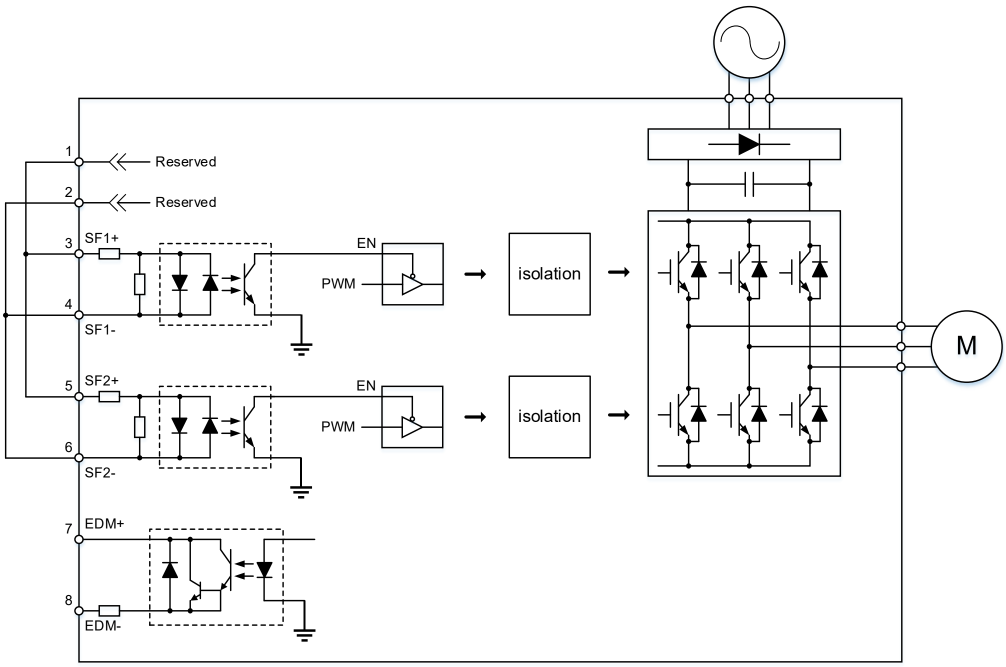
(2) Diagnostic output signal (EDM+, EDM-)



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

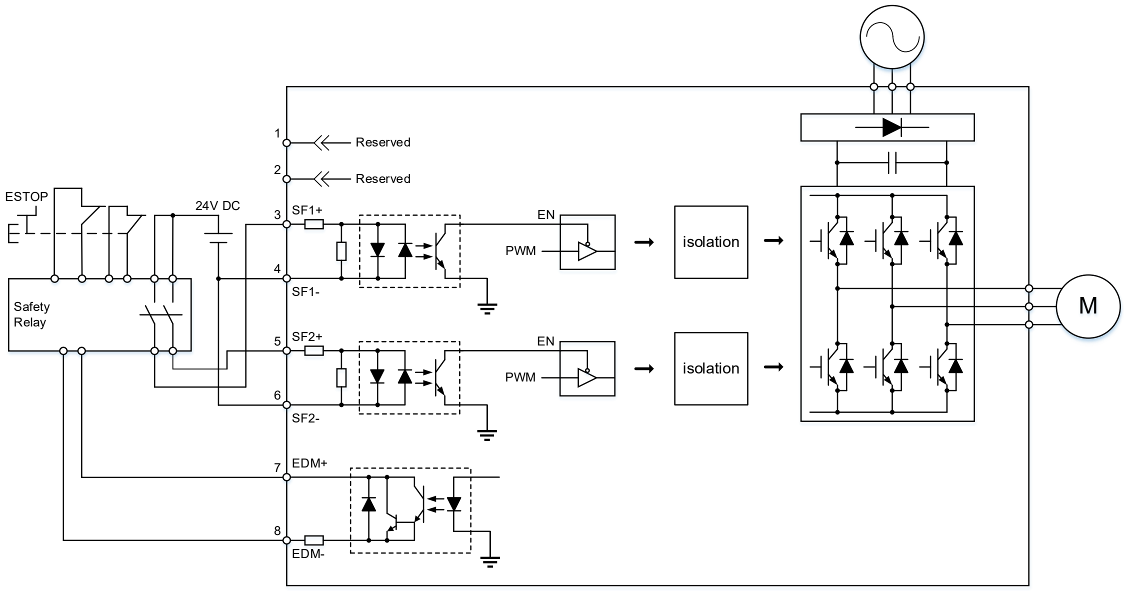
3.8.6.3 Not using the STO function

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



3.8.6.4 Using the STO function for a single drive

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



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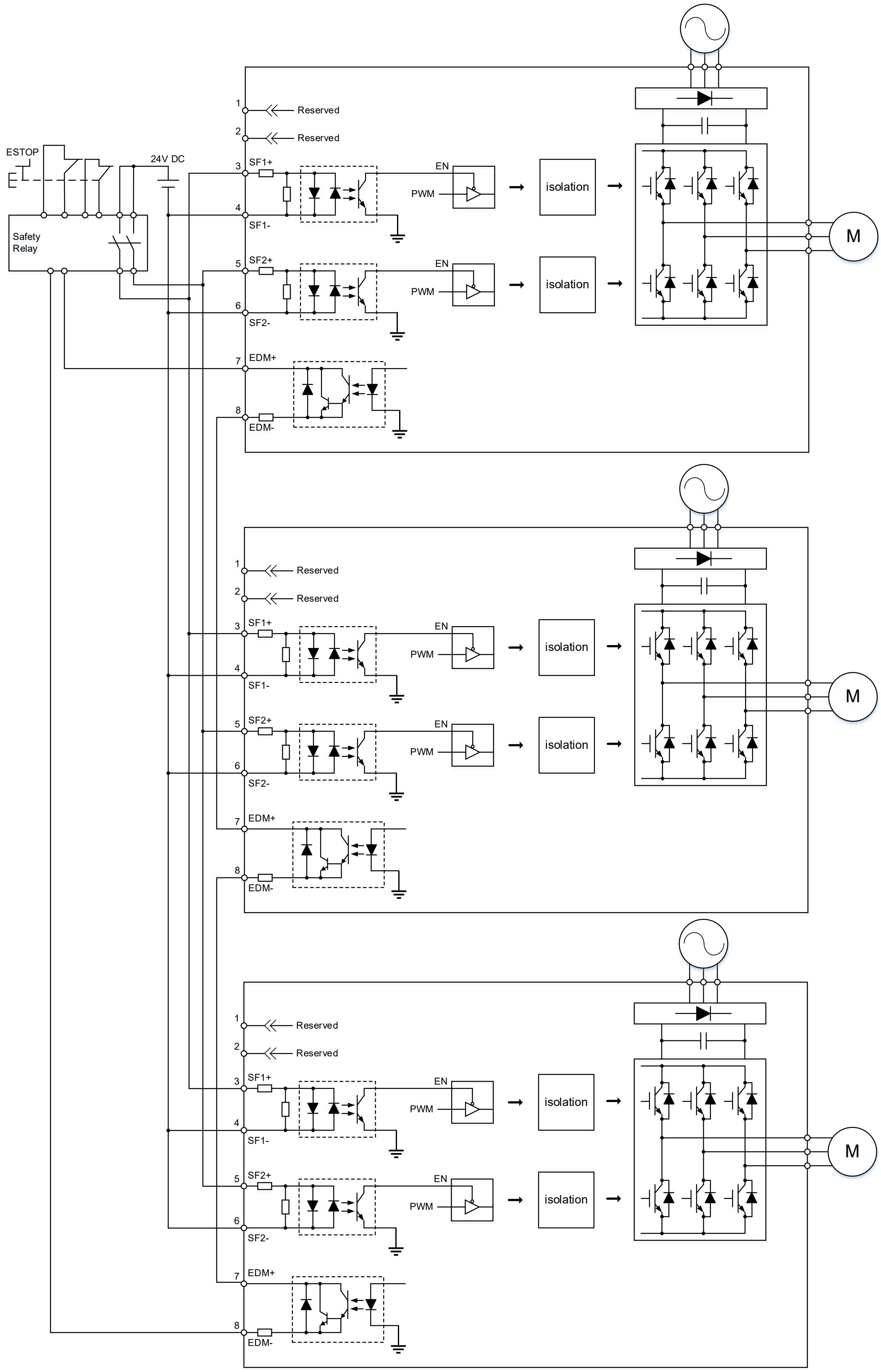
3.8.6.5 Using the STO function for multiple drives

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



3.8.7 Validation test

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

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

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

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

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

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

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

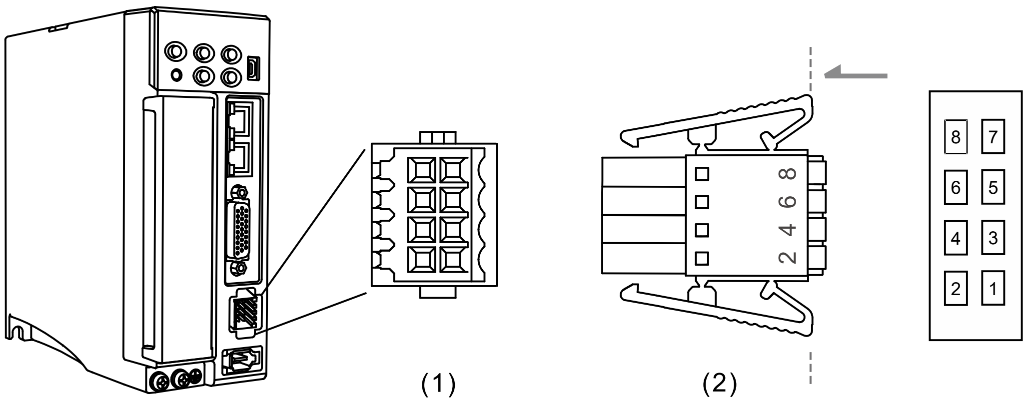
  (2) When SF1 and SF2 signals are both ON or OFF, neither AL501 nor AL502 is triggered.

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

3.9 CN10 STO terminal (SIL2)

The STO function descriptions in this section are applicable to servo drives certified by TÜV Rheinland.

Note: the STO function is supported by B3A series only.



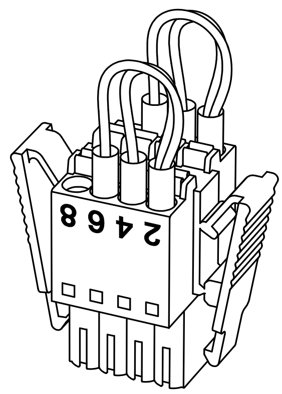
(1) CN10 STO connector (female); (2) CN10 quick connector (male)

Pin assignment:

Pin No.	Signal	Description
1	-	Reserved
2	-	Reserved
3	SF1+	STO input: safety input 1+
4	SF1-	STO input: safety input 1-
5	SF2+	STO input: safety input 2+
6	SF2-	STO input: safety input 2-
7	EDM+	STO output: feedback monitoring Max. rating: 80 V_{DC}, 0.5 A
8	EDM-	STO output: feedback monitoring 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 short-circuit wiring has been done as shown in the figure on the right.

If the wiring is removed, refer to the wiring information in Section 3.9.5.1 Not using the STO function.



3.9.1 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 cannot control the time the motor stops and the motor speed with parameters. (The STO function is not a stop function.)

3.9.2 Precautions for using STO function

After the STO function is activated, the servo drive can no longer control the motor. Hence, take all the potential danger resulted from activating the STO function into consideration. Delta is not liable for mechanical damage and personal 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 and wiring, read the operation manuals of all the peripheral devices carefully.
3. Do not touch the servo drive after activating the STO function. The STO function stops the servo drive from supplying power to the motor but the power supply is not removed from the servo drive. Thus, there is a potential risk of electric shock.
4. When maintaining the servo drive, use the molded-case circuit breaker (MCCB) or magnetic contactor (MC) to cut off the power.
5. When the STO function is activated, the servo drive can no longer control, stop, or decelerate the motor.
6. After the STO function is activated, the servo drive can no longer control the motor, but the motor can still be moved by other external forces.
7. The EDM signals are not safety output signals. The EDM signals are only for inspecting the STO function status.
8. The STO function must be powered by the safety extra-low voltage (SELV) power source with reinforced insulation.
9. Supply power to the STO signals with a single power source, or the leakage current will result in STO misoperation.

3

3.9.3 Specifications of STO

The servo drive conforms to the following safety specifications:

Item	Definition	Standard	Performance
SFF	Safe failure fraction	IEC 61508	Channel 1: 80.08% Channel 2: 68.91%
HFT (Type A subsystem)	Hardware fault tolerance	IEC 61508	1
SIL	Safety integrity level	IEC 61508	SIL2
		IEC 62061	SILCL2
PFH	Probability of dangerous failure per hour [h^{-1}]	IEC 61508	9.56×10^{-10}
PFD_{avg}	Average probability of failure on demand	IEC 61508	4.18×10^{-6}
Category	Category	ISO 13849-1	Category 3
PL	Performance level	ISO 13849-1	d
$MTTF_d$	Mean time to dangerous failure	ISO 13849-1	High
DC	Diagnostic coverage	ISO 13849-1	Low

3.9.4 How does the STO function work?

The STO function controls the motor current by two individual circuits. The two circuits cut off the power supply to the motor when needed, making the motor free from torque force. When an STO alarm occurs, determine which alarm is triggered according to the EDM (External Device Monitoring) status. The following table details how this function works.

Description of STO ON/OFF and EDM status

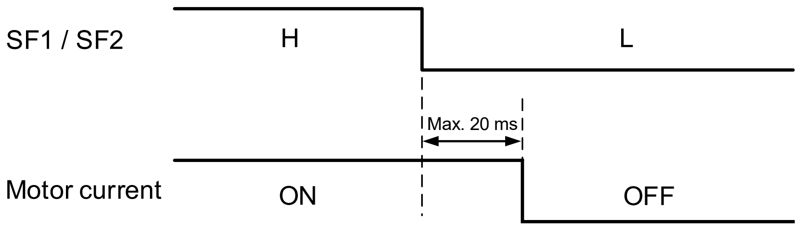
Signal		Status of opto-isolator			
STO	SF1+ SF1-	ON	ON	OFF	OFF
	SF2+ SF2-	ON	OFF	ON	OFF
Servo drive output status		Ready	Torque off (SF2 lost)	Torque off (SF1 lost)	Torque off (STO activated)
Feedback monitoring (EDM status)		Open	Open	Open	Close
Alarm		N/A	AL502	AL501	AL500

Note:
1. ON = 24 V; OFF = 0 V.
2. Open = open circuit; Close = closed circuit.
3. The status of the feedback monitor signal changes at once according to the status of the safety signals (SF1 and SF2 signals).
4. Contact the distributor if AL503 (STO self-diagnostic error) occurs. Refer to Chapter 14 Troubleshooting for more details of the alarms.

3.9.4.1 Activation status

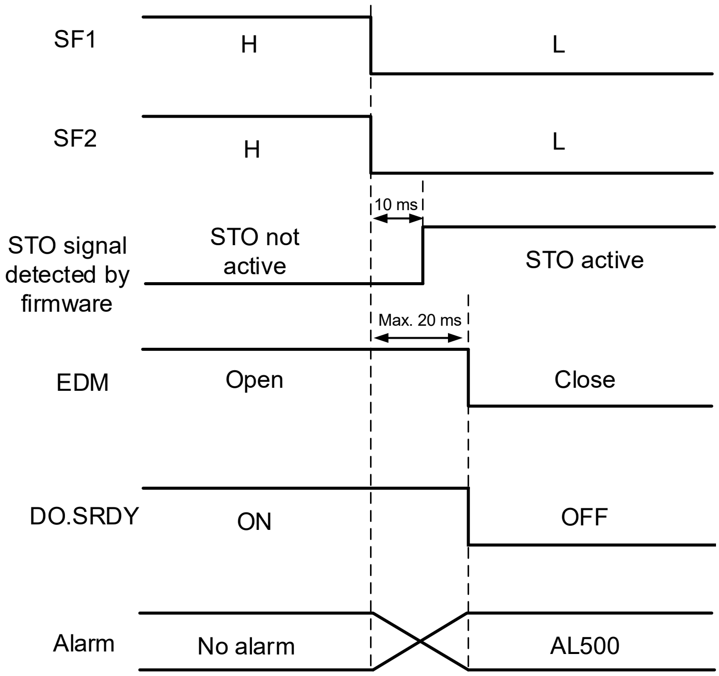
STO response time:

When either SF1 or SF2 signal (safety signal source) is low, the circuit cuts off the motor current within 20 ms.

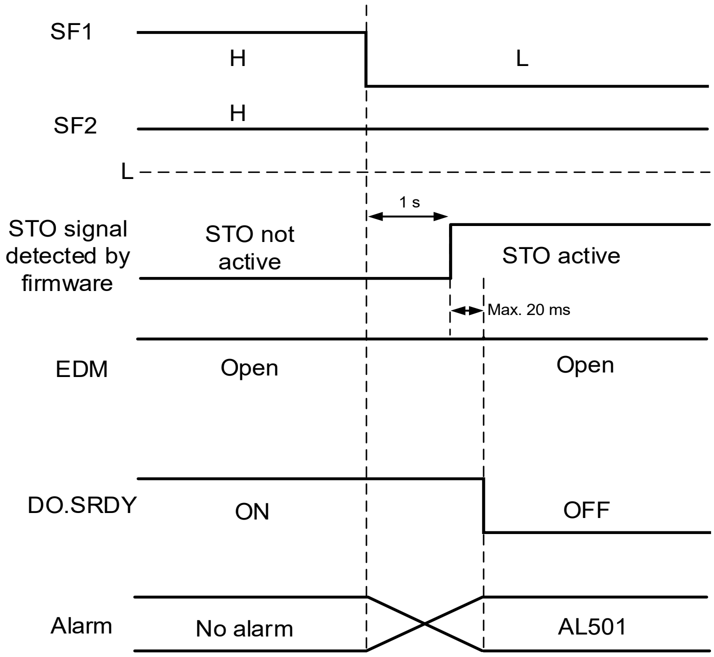


3

AL500 STO function is activated: see the following diagram. When the motor runs normally, but both SF1 and SF2 signals are low for 10 ms **simultaneously**, the “STO signal detected by firmware” flag is on and the servo drive becomes off, triggering AL500.



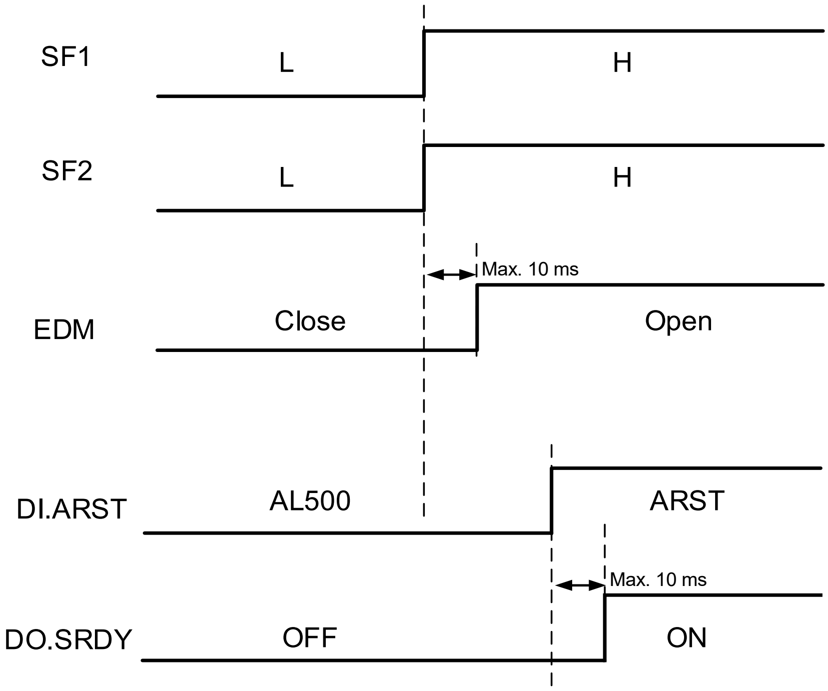
AL501 SF1 lost / AL502 SF2 lost (signal loss or signal error): see the following diagram. When the motor runs normally, but one of the safety signal source is low for 1 second, the “STO signal detected by firmware” flag is on, and the servo drive becomes off, triggering AL501 or AL502. The following diagram illustrates how AL501 occurs.



Note:
1. Contact the distributor if AL503 (STO self-diagnostic error) occurs.
2. Refer to Section 3.9.4 for the EDM signal.

3.9.4.2 Deactivation status

When the safety signal source (SF1 and SF2 signals) switches 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 3.9.4 for the EDM signal.

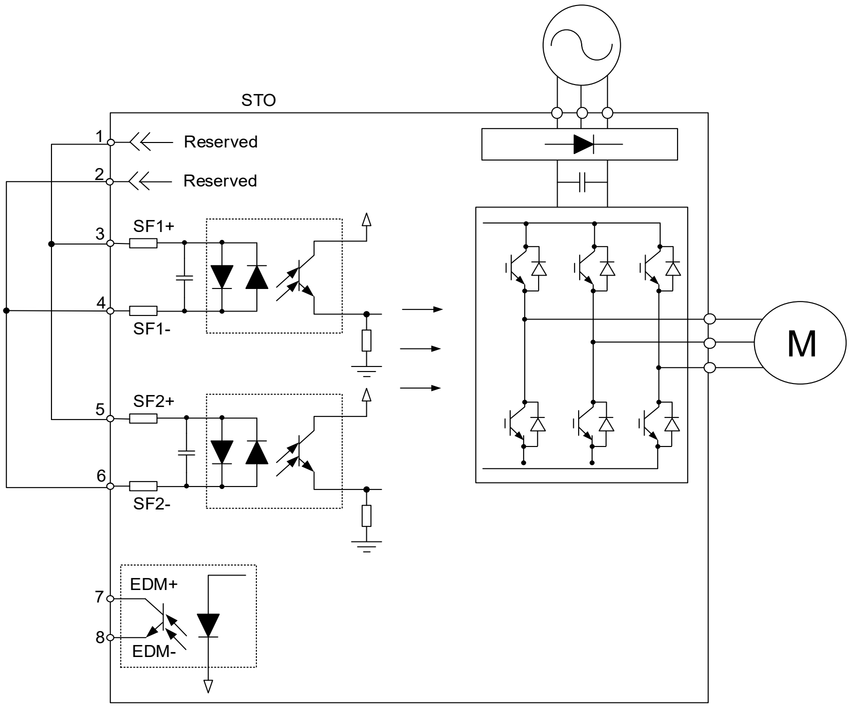
3

3.9.5 Wiring for STO

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

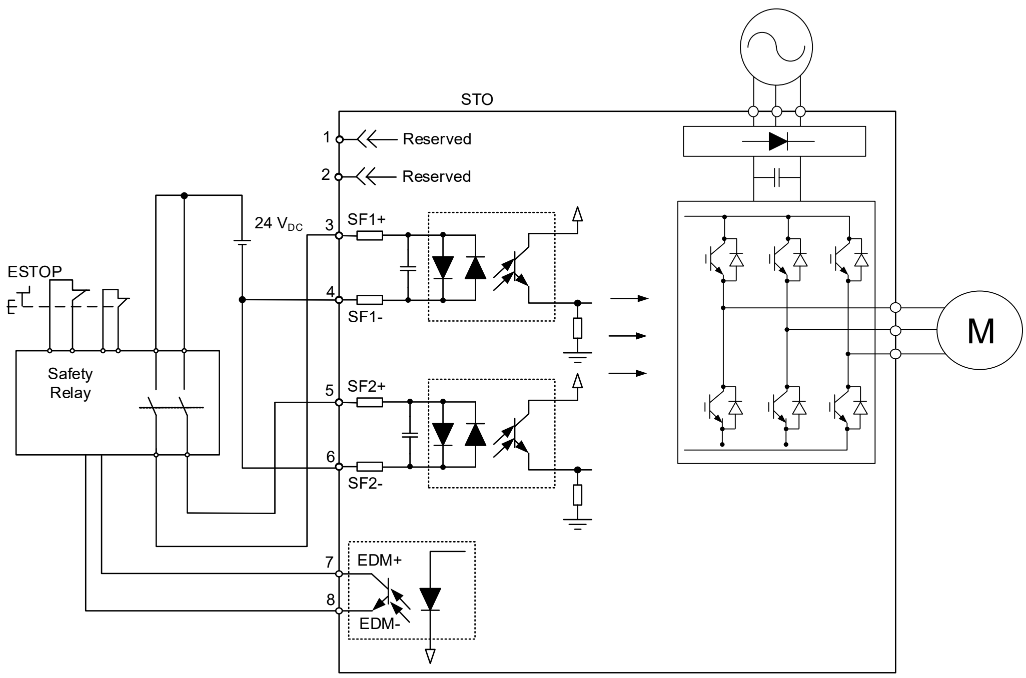
3.9.5.1 Not using the STO function

You can short-circuit the connector or plug in the short-circuit connector that comes with the servo drive. The wiring is as follows.



3.9.5.2 Using the STO function for a single drive

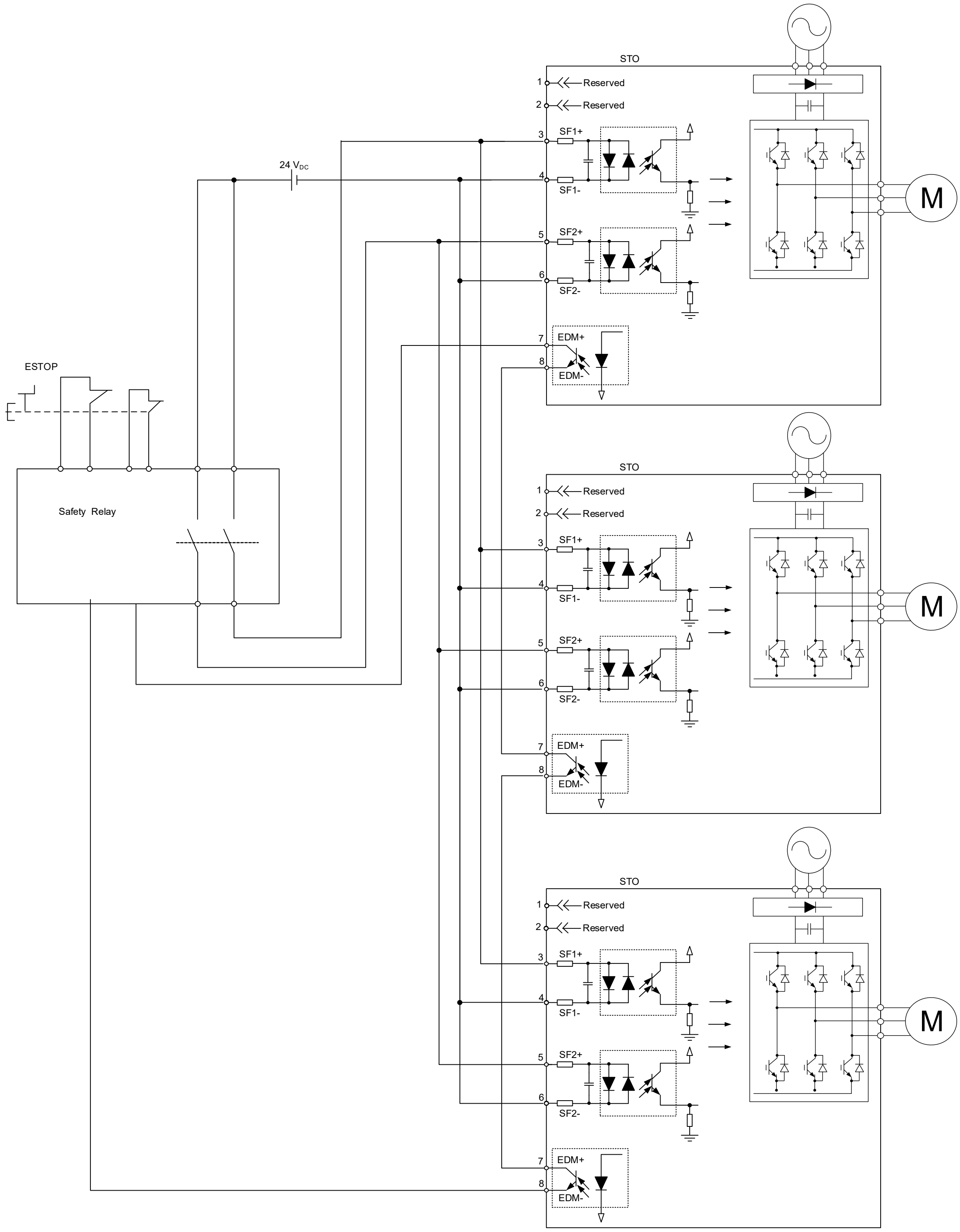
To use a safety relay to trigger the STO function, following the diagram for wiring.



3

3.9.5.3 Using the STO function for multiple drives

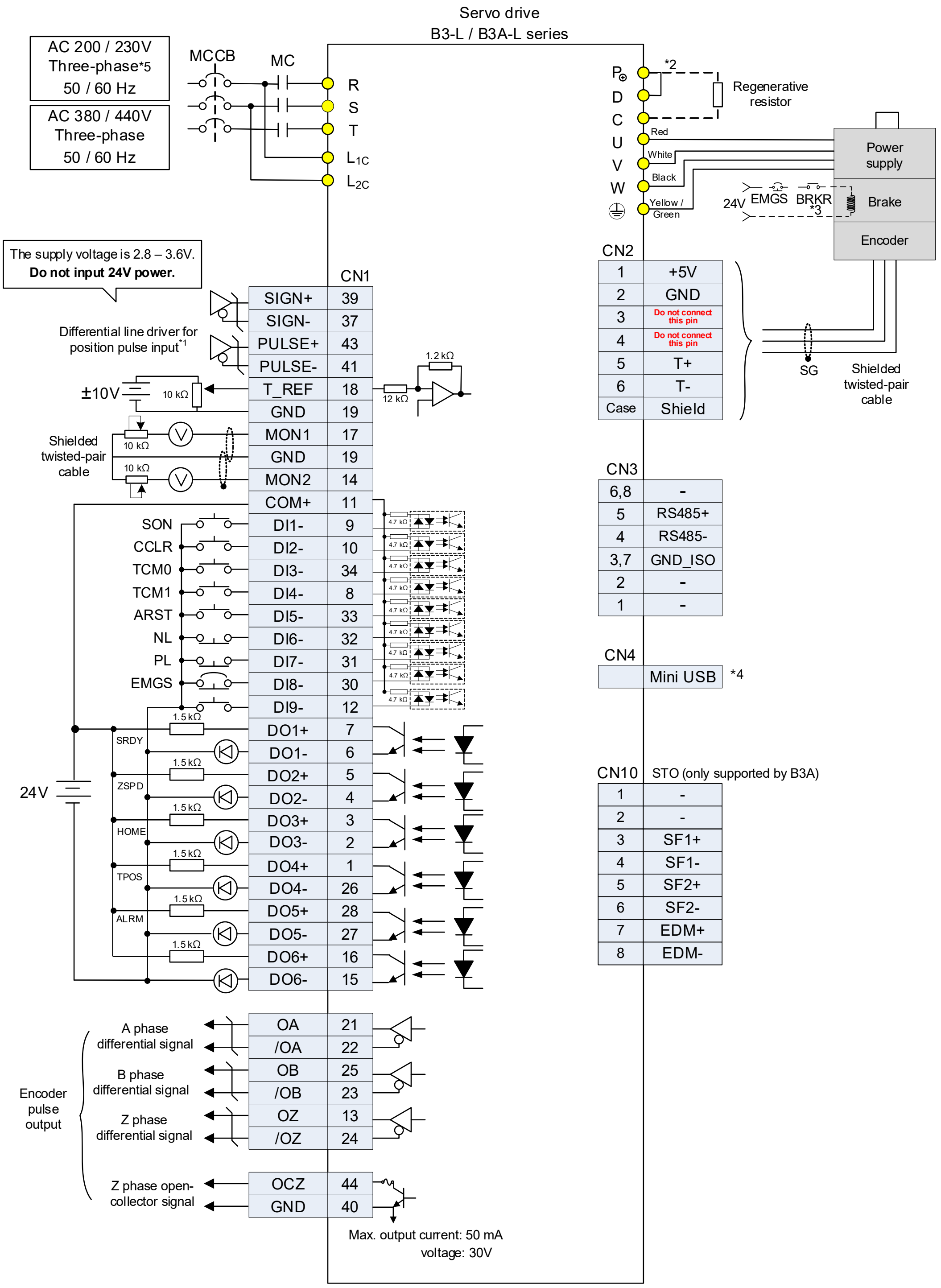
In the multi-drive system, the values of (PFD x number of drives) and (PFH x number of drives) must not exceed the safety values of the device specification.



3

3.10 Standard wiring example

3.10.1 Position (PT) control mode – differential line driver input



Note:

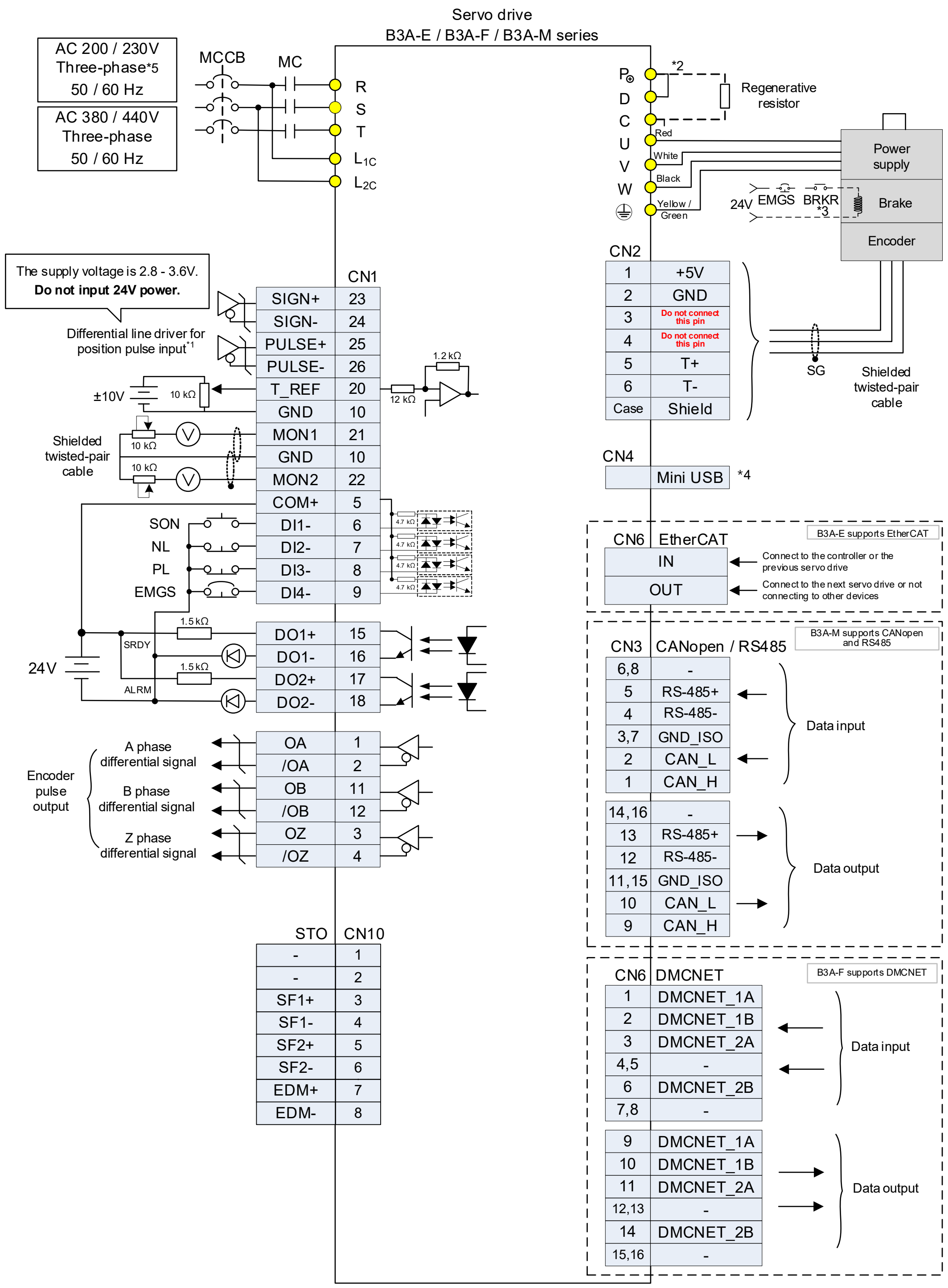
*1. The preceding figure uses the differential line driver for position pulse input. For open collector input, refer to Section 3.10.2.

*2. The 220V 200 W models and below have no built-in regenerative resistor.

*3. The brake coil has no polarity.

*4. The Mini USB connector for connecting to the PC.

*5. The 220V 1.5 kW models and below can use single-phase power supply.



Note:

*1. The preceding figure uses the differential line driver for position pulse input. For open collector input, refer to Section 3.10.2.

*2. The 220V 200 W models and below have no built-in regenerative resistor.

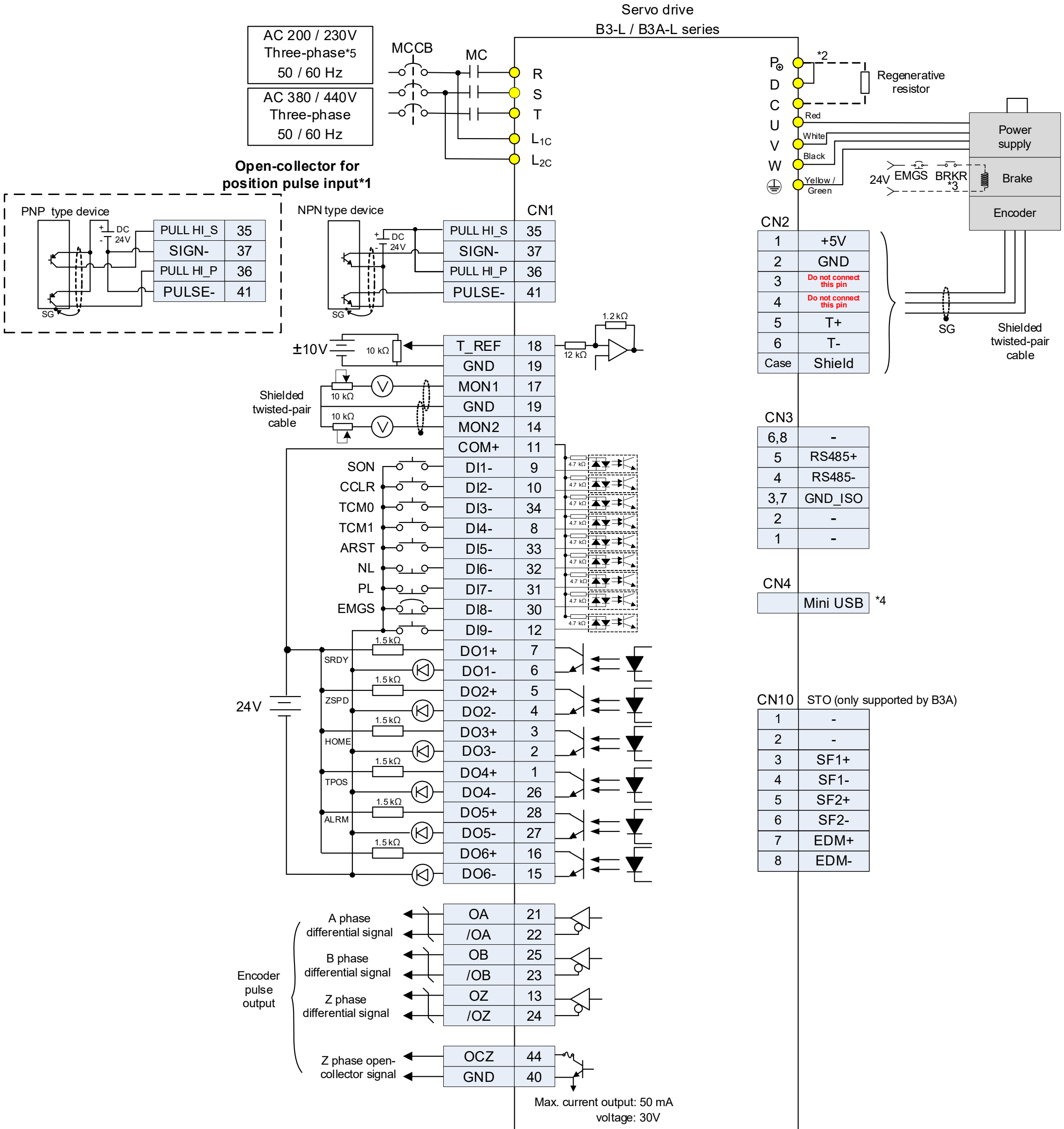
*3. The brake coil has no polarity.

*4. The Mini USB connector for connecting to the PC.

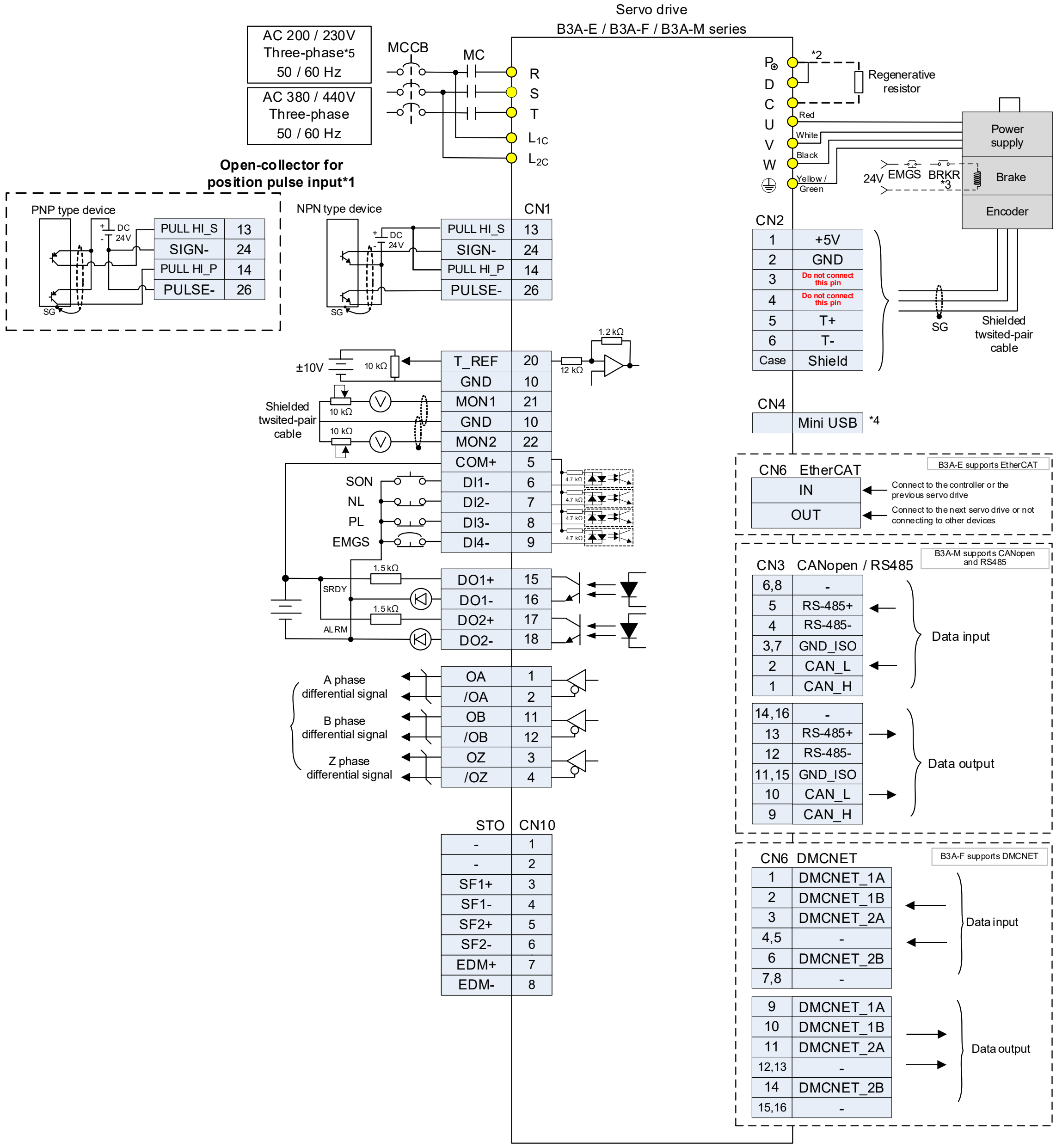
*5. The 220V 1.5 kW models and below can use single-phase power supply.

3

3.10.2 Position (PT) control mode – open collector input



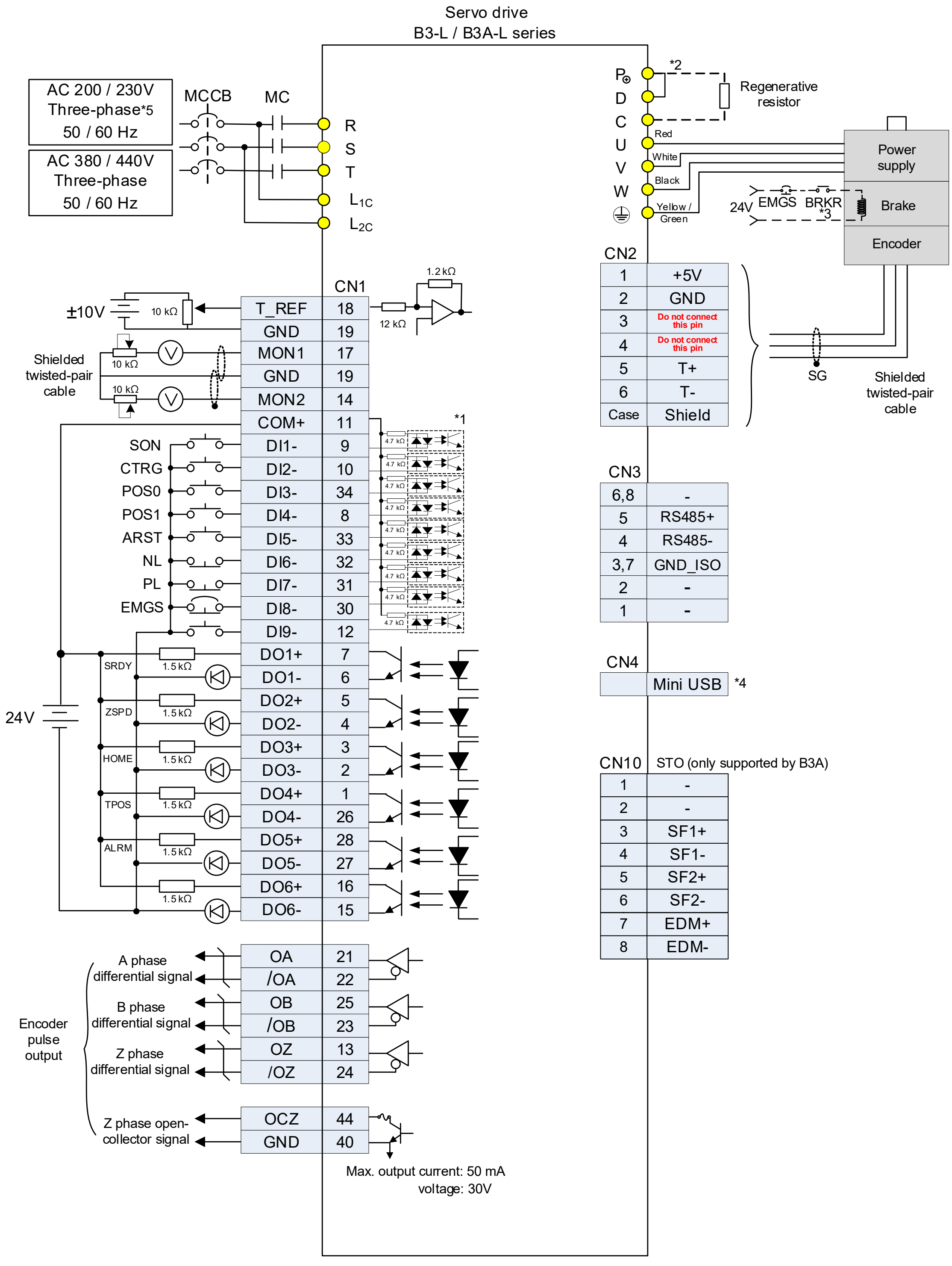
Note:
*1. The preceding figure uses the open collector for position pulse input. For differential line driver input, refer to Section 3.10.1.
*2. The 220V 200 W models and below have no built-in regenerative resistor.
*3. The brake coil has no polarity.
*4. The Mini USB connector for connecting to the PC.
*5. The 220V 1.5 kW models and below can use single-phase power supply.



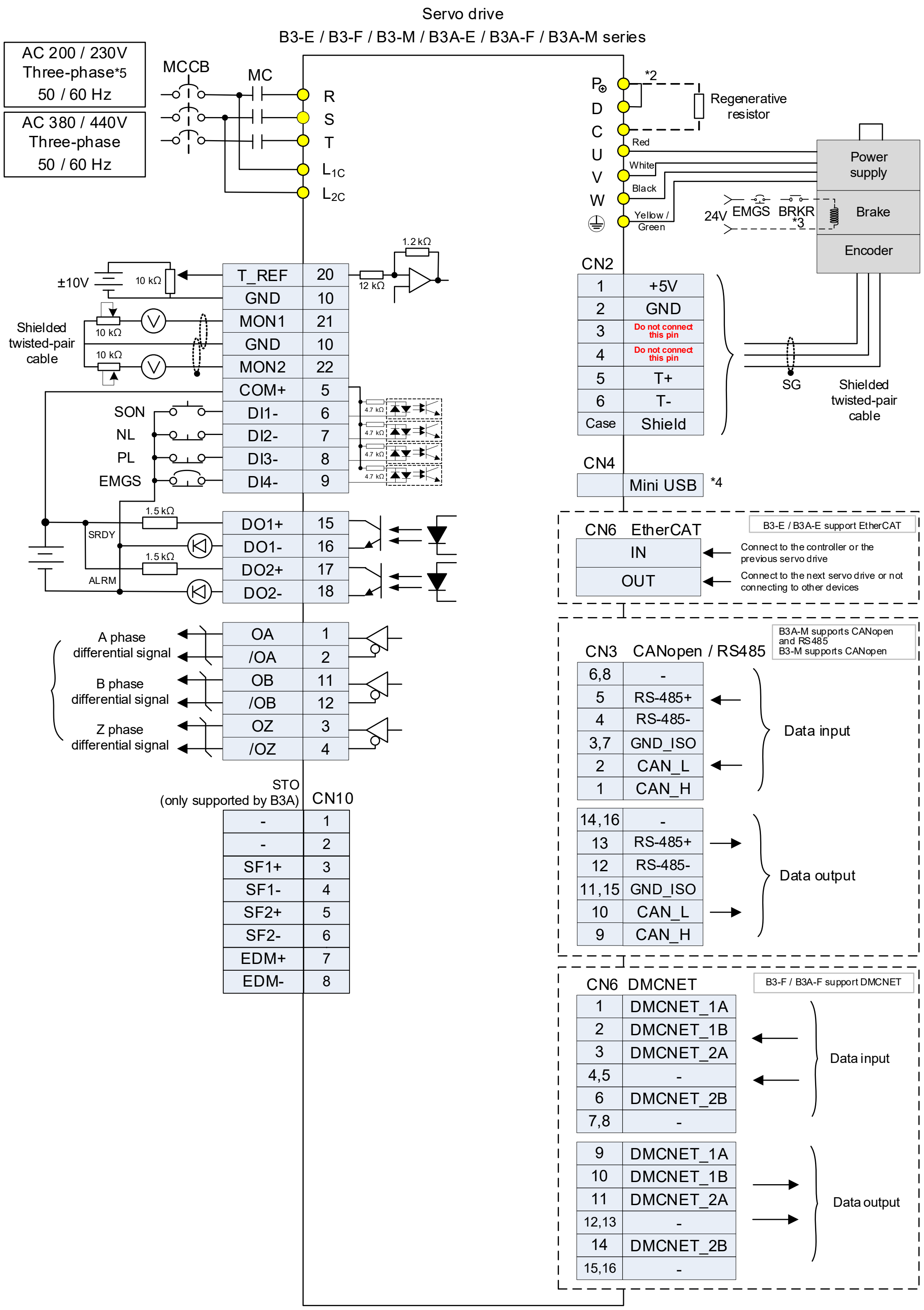
Note:
*1. The preceding figure uses the open collector for position pulse input. For differential line driver input, refer to Section 3.10.1.
*2. The 220V 200 W models and below have no built-in regenerative resistor.
*3. The brake coil has no polarity.
*4. The Mini USB connector for connecting to the PC.
*5. The 220V 1.5 kW models and below can use single-phase power supply.

3

3.10.3 Position (PR) control mode – internal position commands

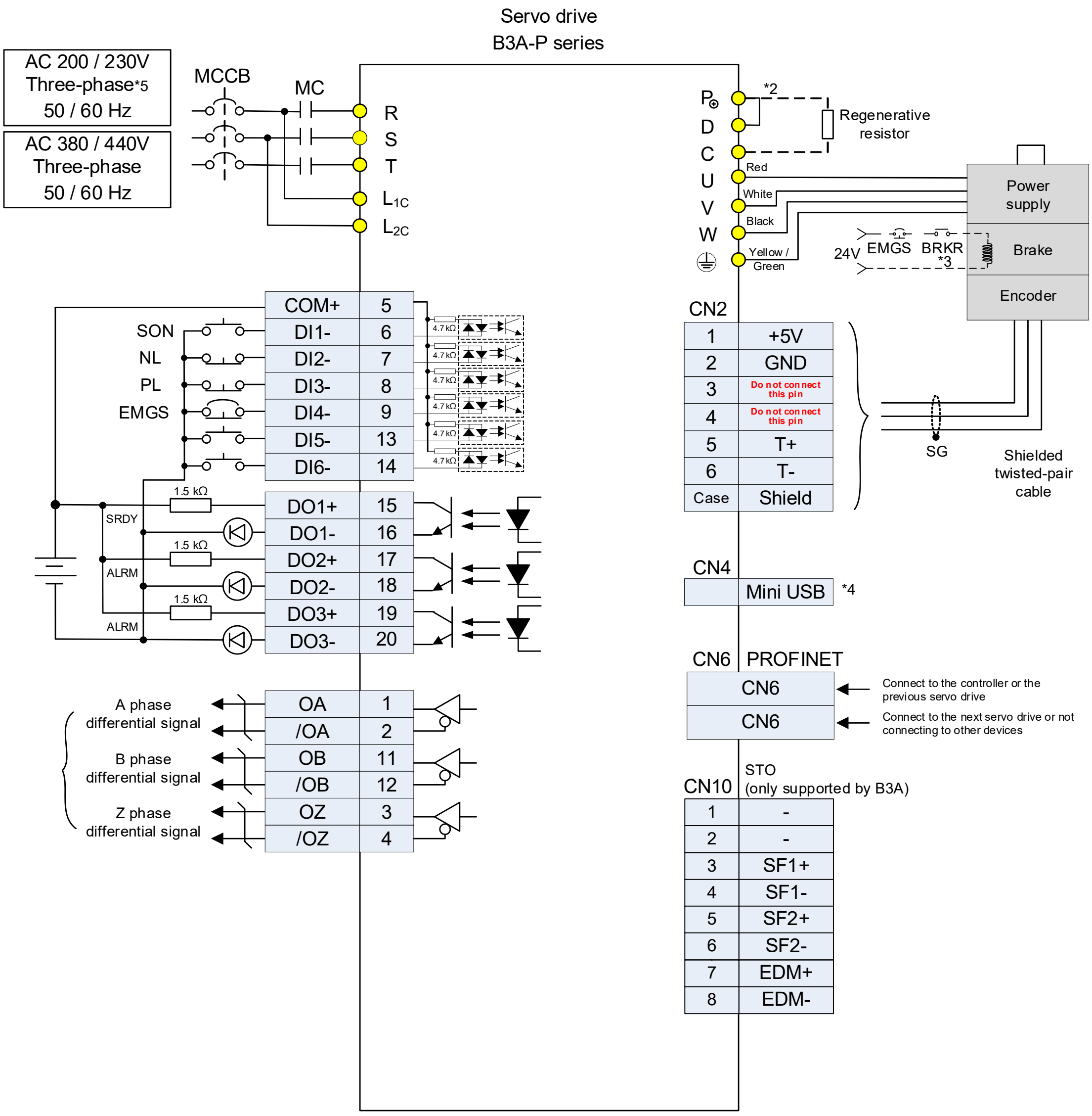


Note:
*1. Refer to Section 3.3 for wiring.
*2. The 220V 200 W models and below have no built-in regenerative resistor.
*3. The brake coil has no polarity.
*4. The Mini USB connector for connecting to the PC.
*5. The 220V 1.5 kW models and below can use single-phase power supply.



Note:
*1. Refer to Section 3.3 for wiring.
*2. The 220V 200 W models and below have no built-in regenerative resistor.
*3. The brake coil has no polarity.
*4. The Mini USB connector for connecting to the PC.
*5. The 220V 1.5 kW models and below can use single-phase power supply.

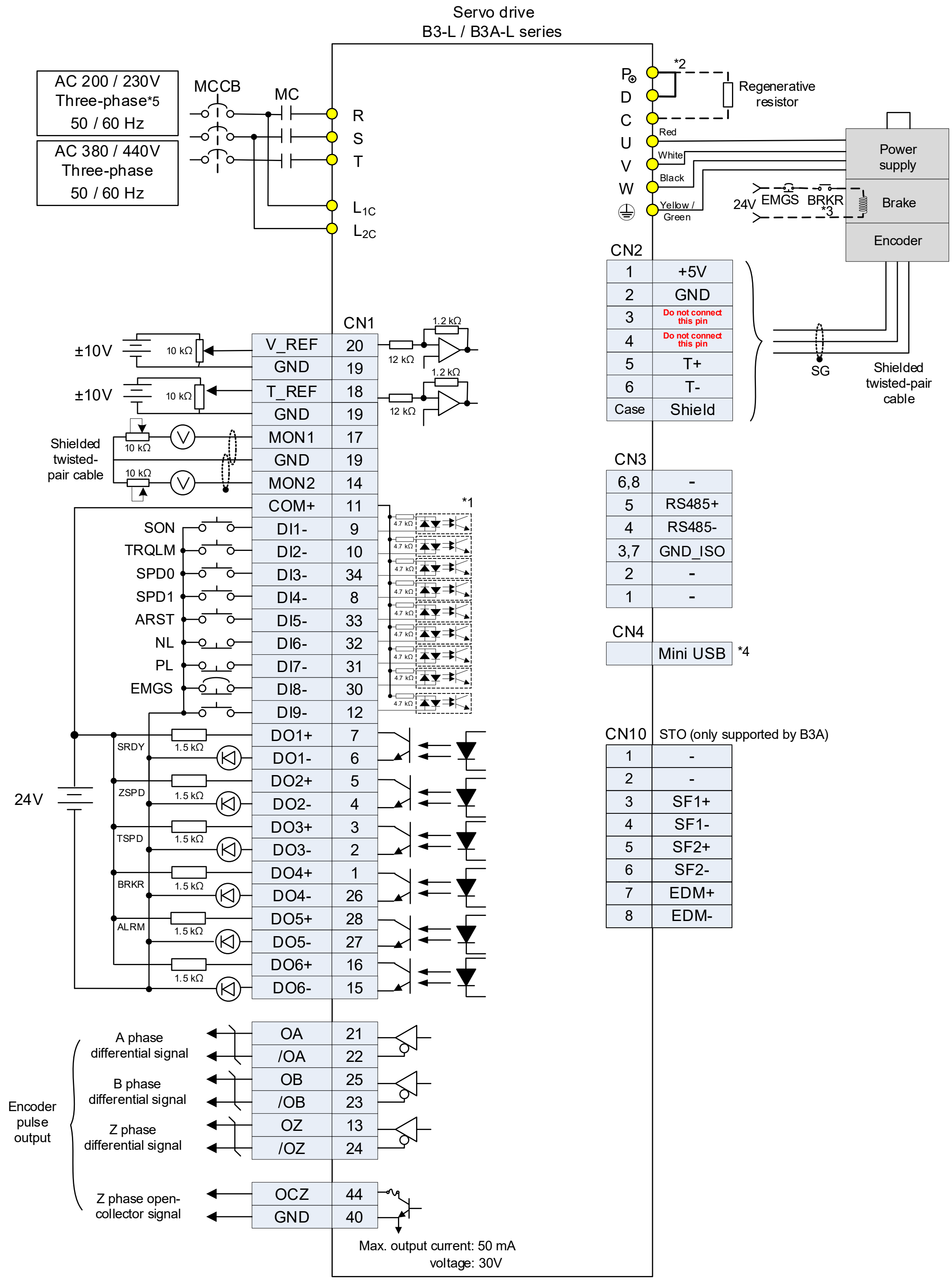
3



Note:
*1. Refer to Section 3.3 for wiring.
*2. The 220V 200 W models and below have no built-in regenerative resistor.
*3. The brake coil has no polarity.
*4. The Mini USB connector for connecting to the PC.
*5. The 220V 1.5 kW models and below can use single-phase power supply.

3

3.10.4 Speed (S) control mode



Note:

*1. Refer to Section 3.3 for wiring.

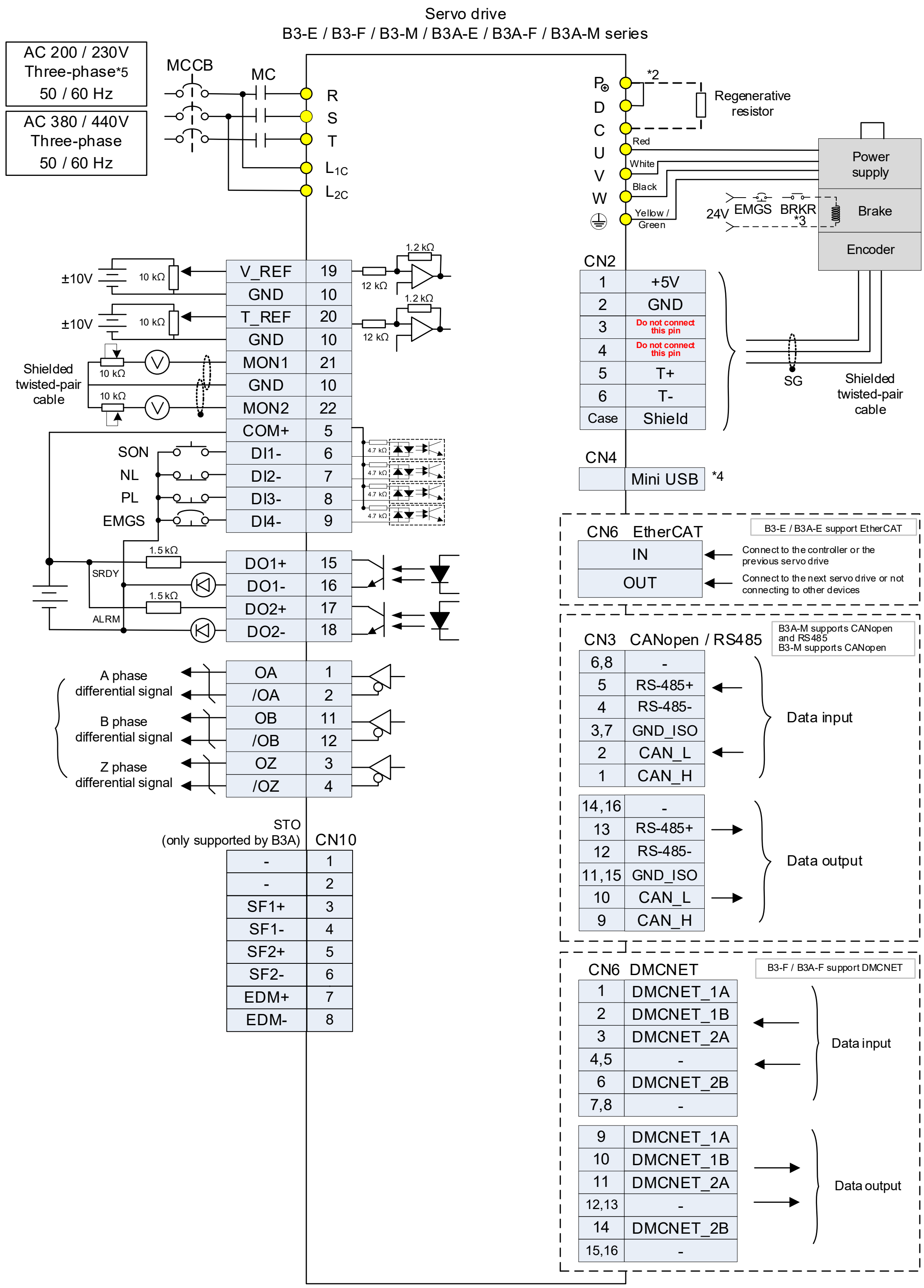
*2. The 220V 200 W models and below have no built-in regenerative resistor.

*3. The brake coil has no polarity.

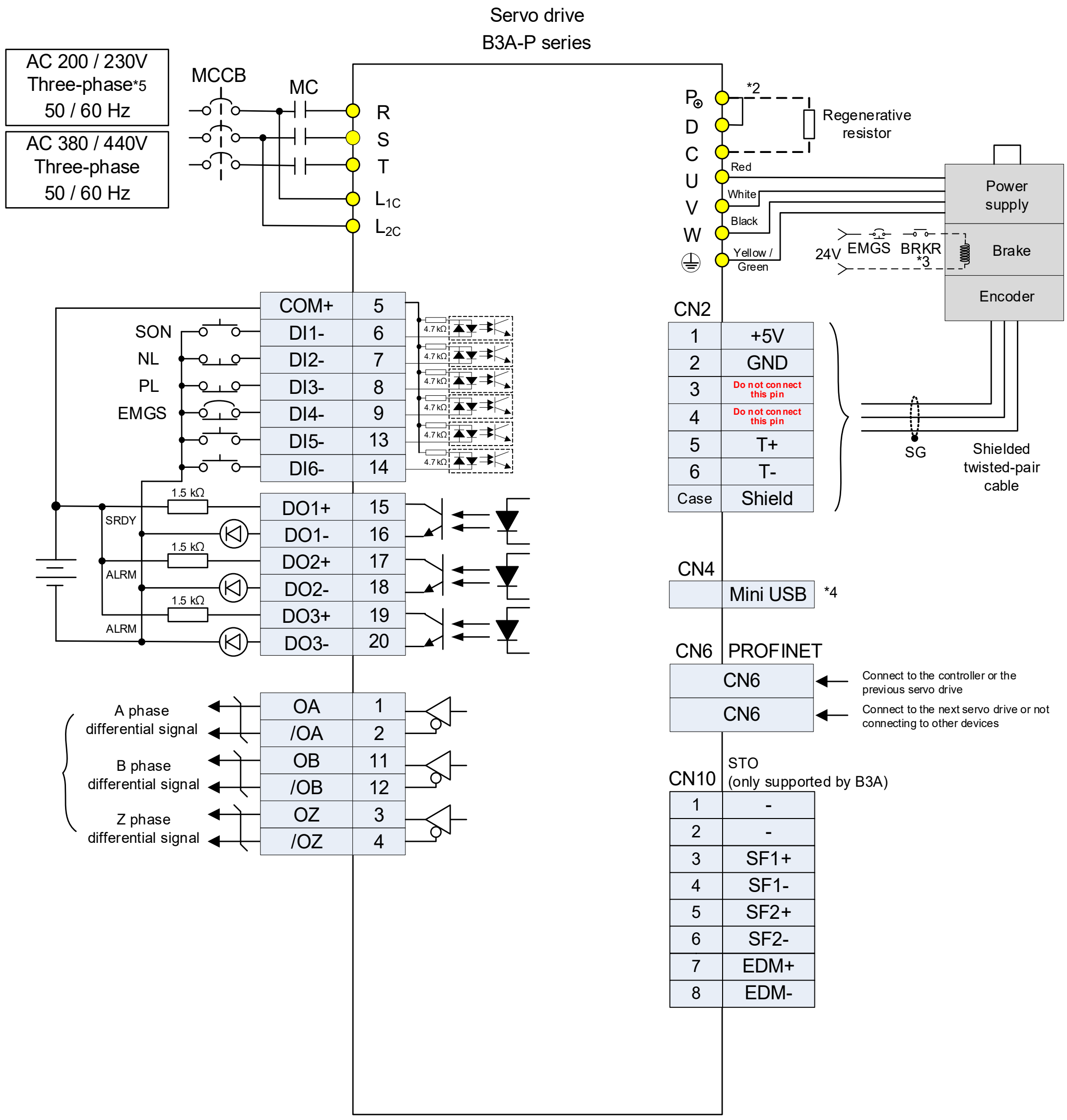
*4. The Mini USB connector for connecting to the PC.

*5. The 220V 1.5 kW models and below can use single-phase power supply.

3



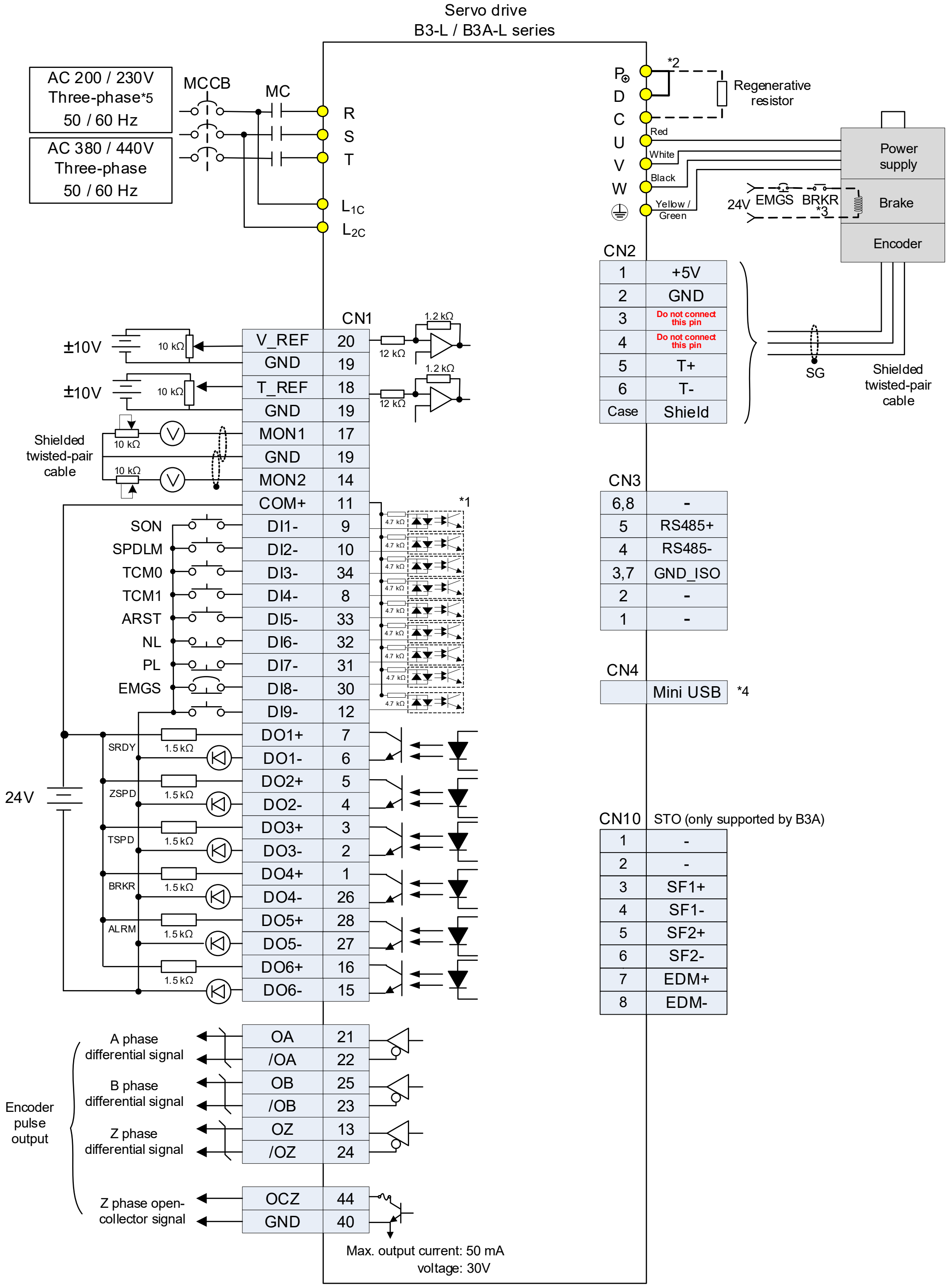
Note:
*1. Refer to Section 3.3 for wiring.
*2. The 220V 200 W models and below have no built-in regenerative resistor.
*3. The brake coil has no polarity.
*4. The Mini USB connector for connecting to the PC.
*5. The 220V 1.5 kW models and below can use single-phase power supply.



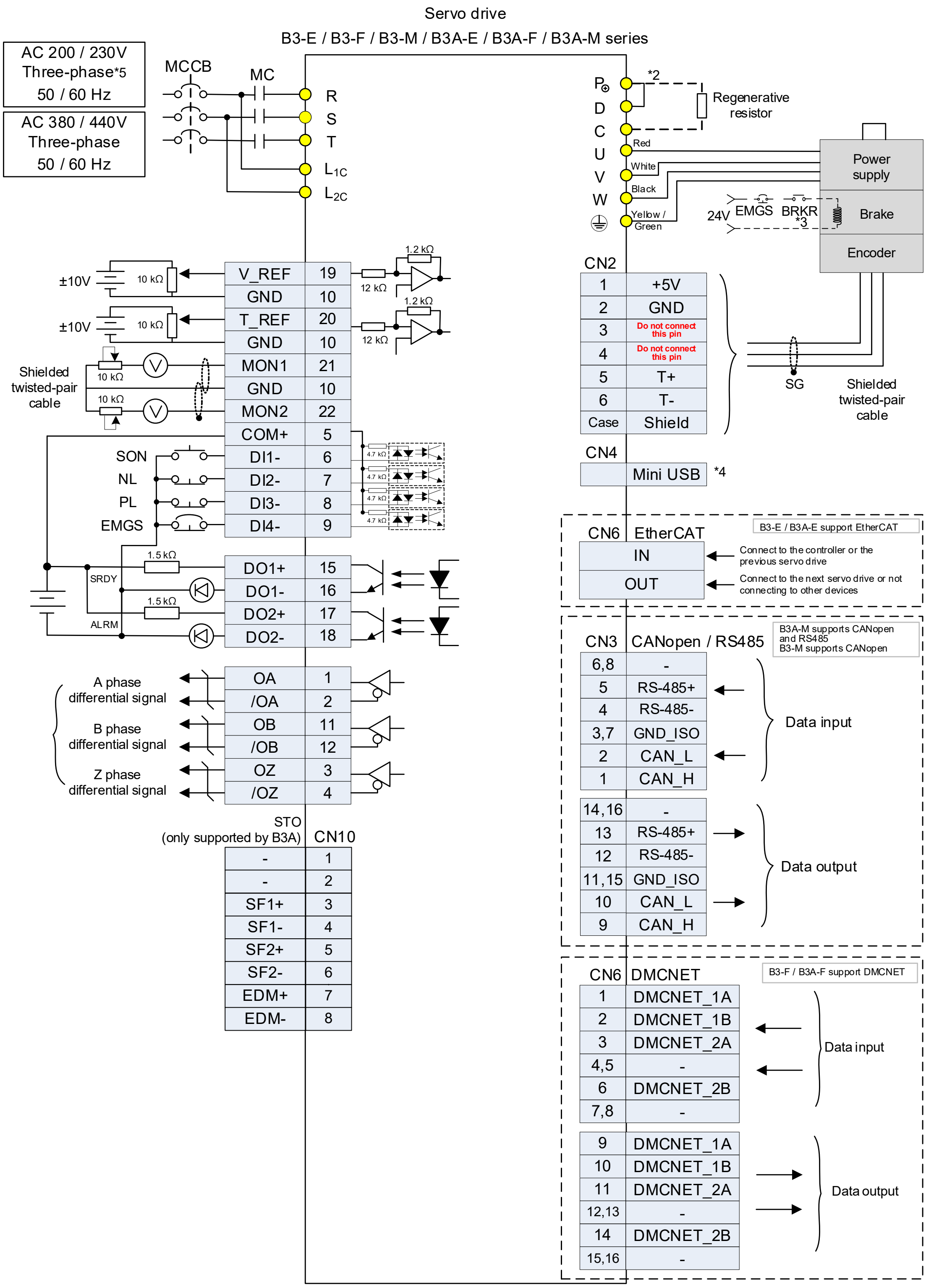
Note:
*1. Refer to Section 3.3 for wiring.
*2. The 220V 200 W models and below have no built-in regenerative resistor.
*3. The brake coil has no polarity.
*4. The Mini USB connector for connecting to the PC.
*5. The 220V 1.5 kW models and below can use single-phase power supply.

3

3.10.5 Torque (T) control mode

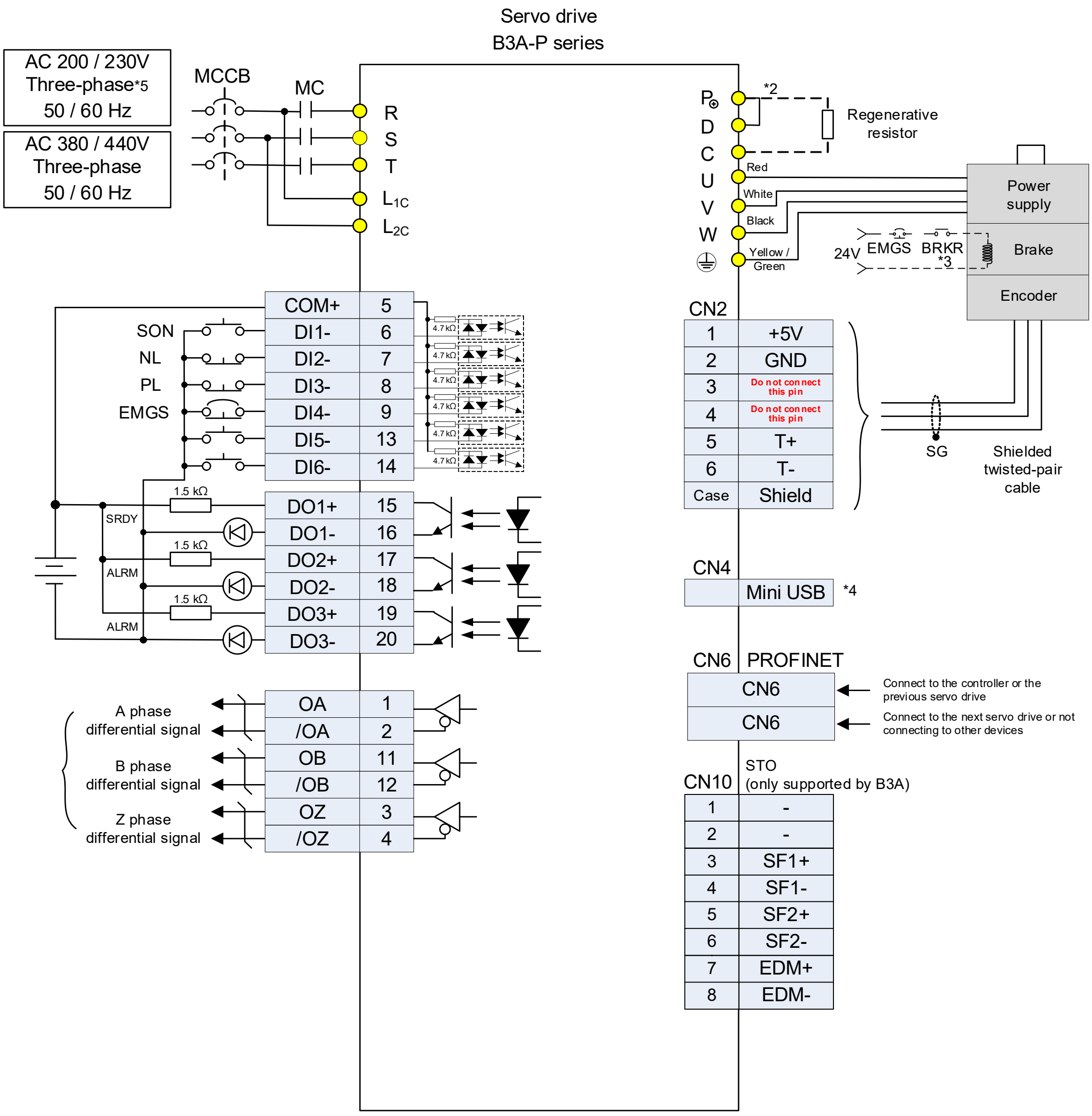


Note:
*1. Refer to Section 3.3 for wiring.
*2. The 220V 200 W models and below have no built-in regenerative resistor.
*3. The brake coil has no polarity.
*4. The Mini USB connector for connecting to the PC.
*5. The 220V 1.5 kW models and below can use single-phase power supply.



Note:
*1. Refer to Section 3.3 for wiring.
*2. The 220V 200 W models and below have no built-in regenerative resistor.
*3. The brake coil has no polarity.
*4. The Mini USB connector for connecting to the PC.
*5. The 220V 1.5 kW models and below can use single-phase power supply.

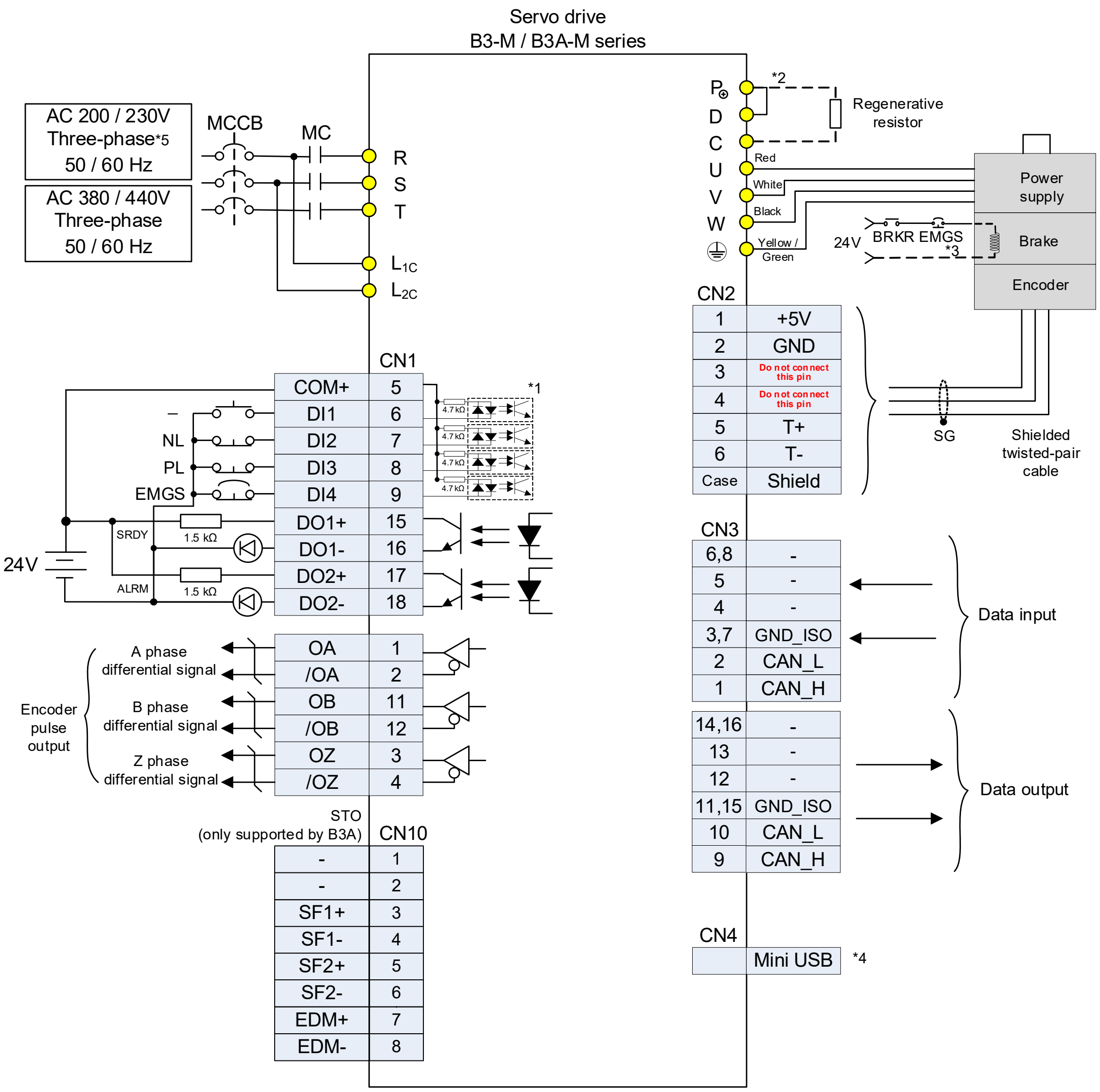
3



Note:
*1. Refer to Section 3.3 for wiring.
*2. The 220V 200 W models and below have no built-in regenerative resistor.
*3. The brake coil has no polarity.
*4. The Mini USB connector for connecting to the PC.
*5. The 220V 1.5 kW models and below can use single-phase power supply.

3

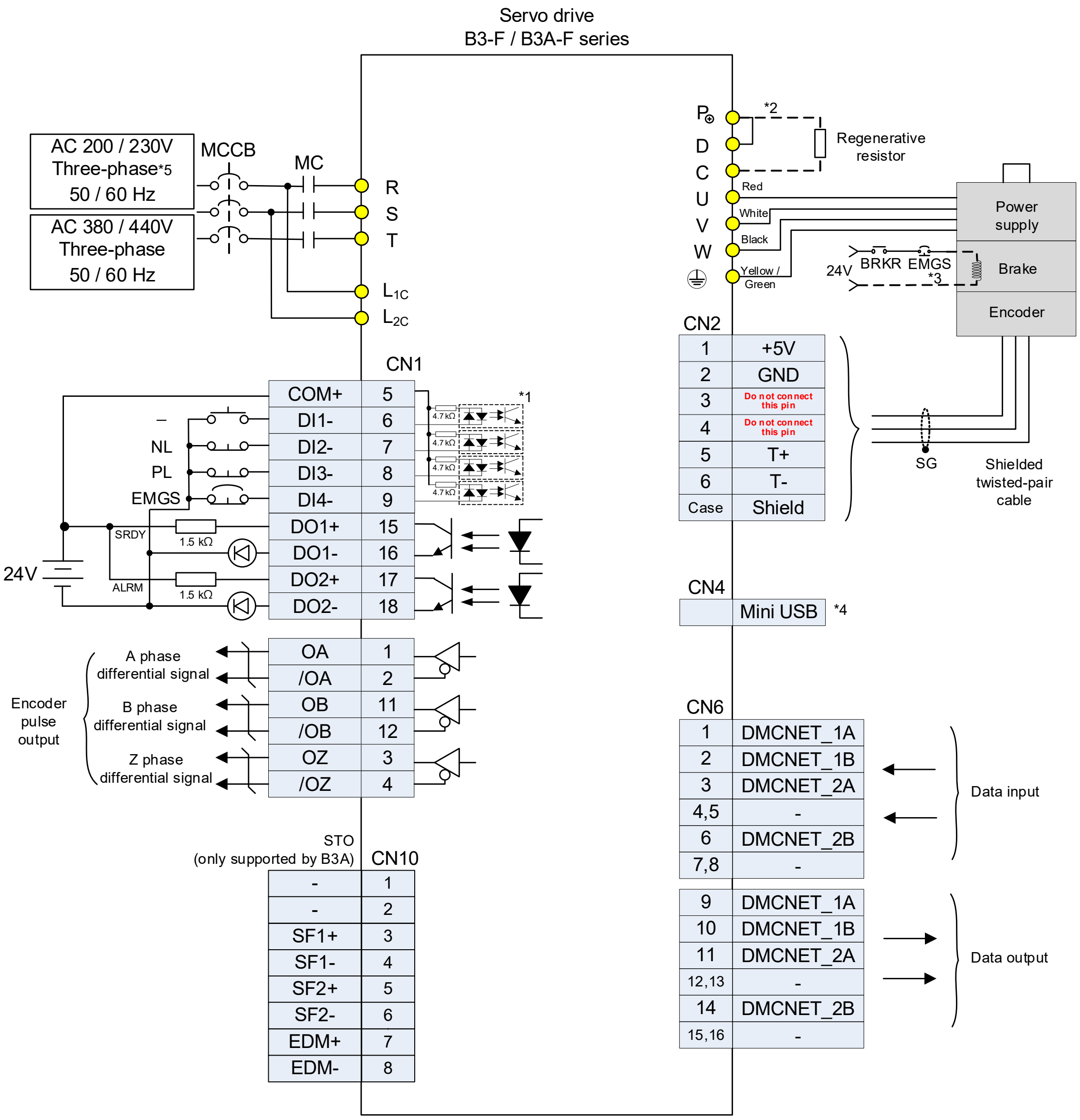
3.10.6 Communication mode – CANopen



Note:
*1. Refer to Section 3.3 for wiring.
*2. The 220V 200 W models and below have no built-in regenerative resistor.
*3. The brake coil has no polarity.
*4. The Mini USB connector for connecting to the PC.
*5. The 220V 1.5 kW models and below can use single-phase power supply.

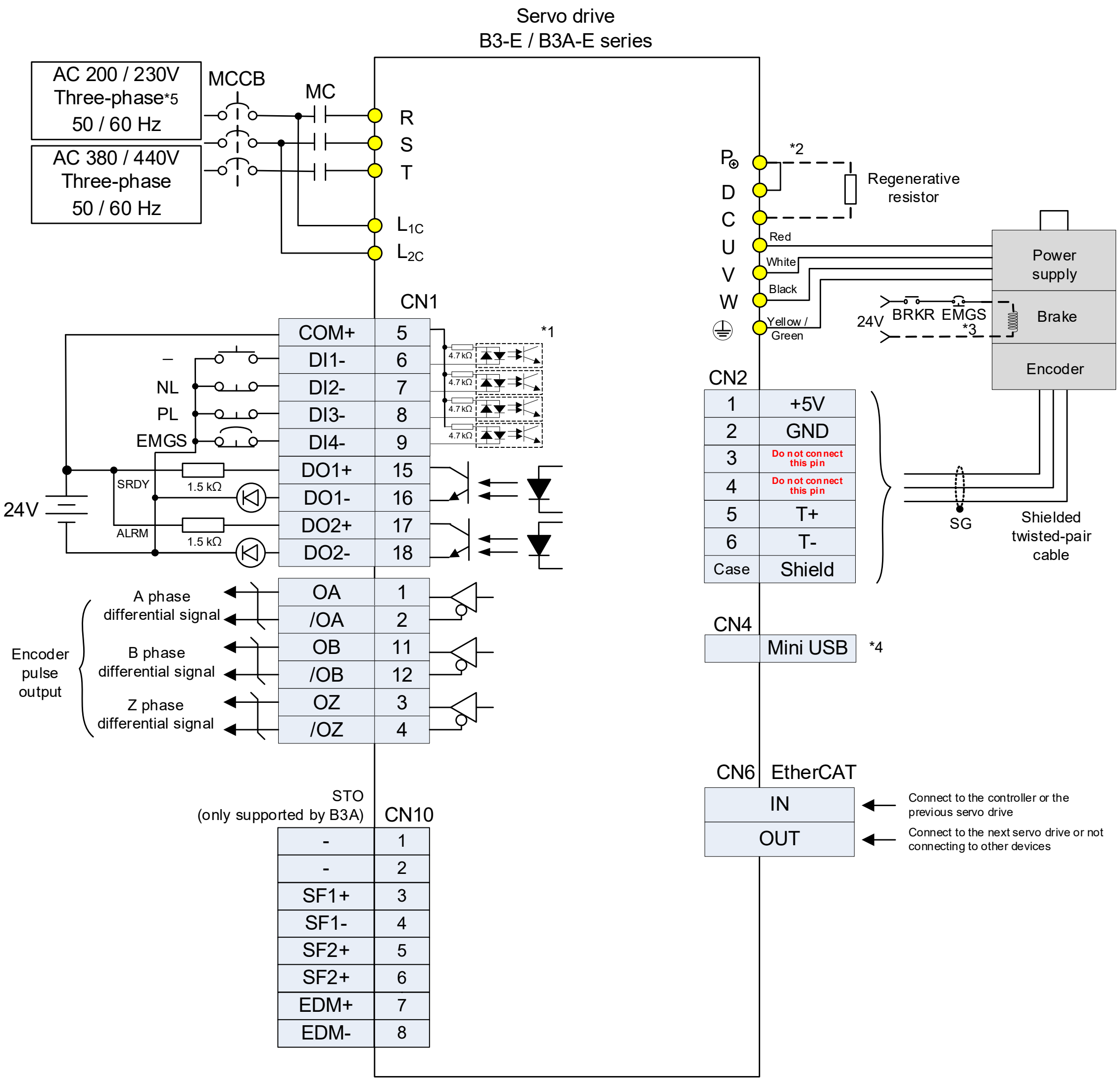
3

3.10.7 Communication mode – DMCNET



Note:
*1. Refer to Section 3.3 for wiring.
*2. The 220V 200 W models and below have no built-in regenerative resistor.
*3. The brake coil has no polarity.
*4. The Mini USB connector for connecting to the PC.
*5. The 220V 1.5 kW models and below can use single-phase power supply.

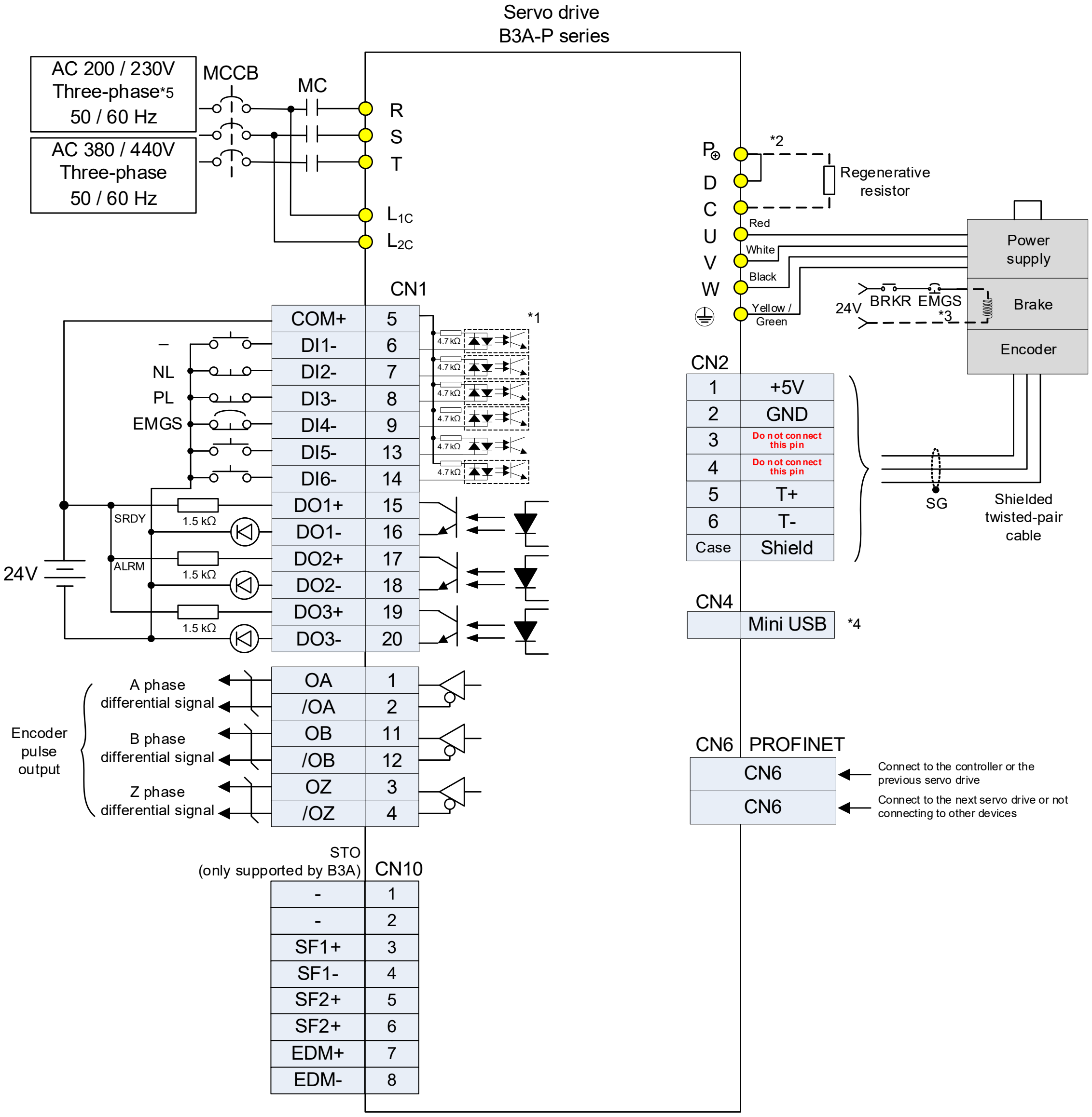
3.10.8 Communication mode – EtherCAT



Note:
*1. Refer to Section 3.3 for wiring.
*2. The 220V 200 W models and below have no built-in regenerative resistor.
*3. The brake coil has no polarity.
*4. The Mini USB connector for connecting to the PC.
*5. The 220V 1.5 kW models and below can use single-phase power supply.

3

3.10.9 Communication mode – PROFINET



Note:
*1. Refer to Section 3.3 for wiring.
*2. The 220V 200 W models and below have no built-in regenerative resistor.
*3. The brake coil has no polarity.
*4. The Mini USB connector for connecting to the PC.
*5. The 220V 1.5 kW models and below can use single-phase power supply.

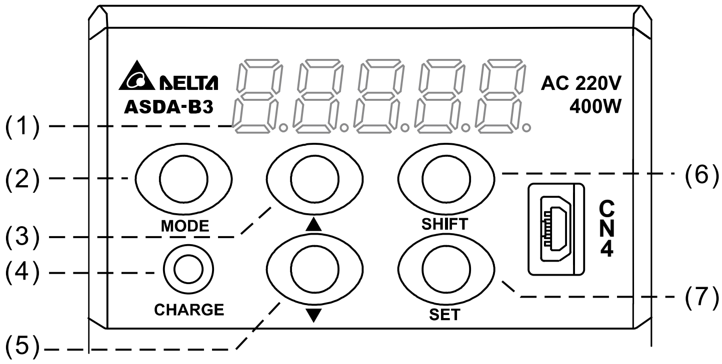
Test Operation and Panel Display

4

This chapter describes the display and operation for the servo drive panel and the testing for the servo drive and motor.

4

4.1 Panel description



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

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

(3) UP (▲) key: changes the monitoring codes, parameter numbers, and setting values.

(4) CHARGE indicator: the LED indicator is on when the power is applied to the main circuit.

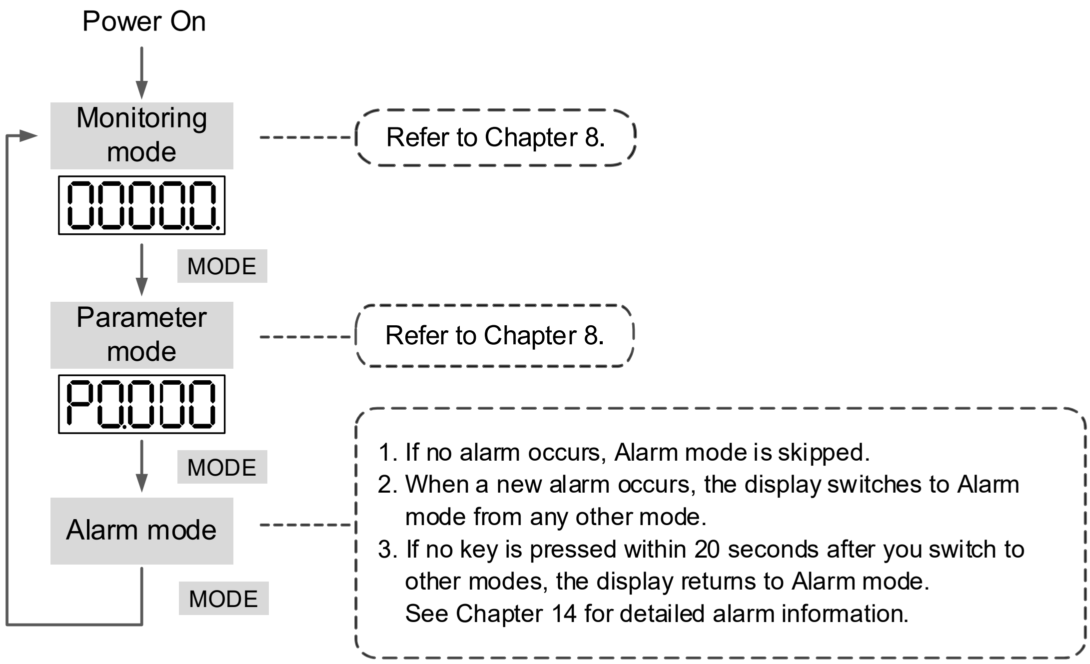
(5) DOWN (▼) key: changes the monitoring codes, parameter numbers, and setting values.

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

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

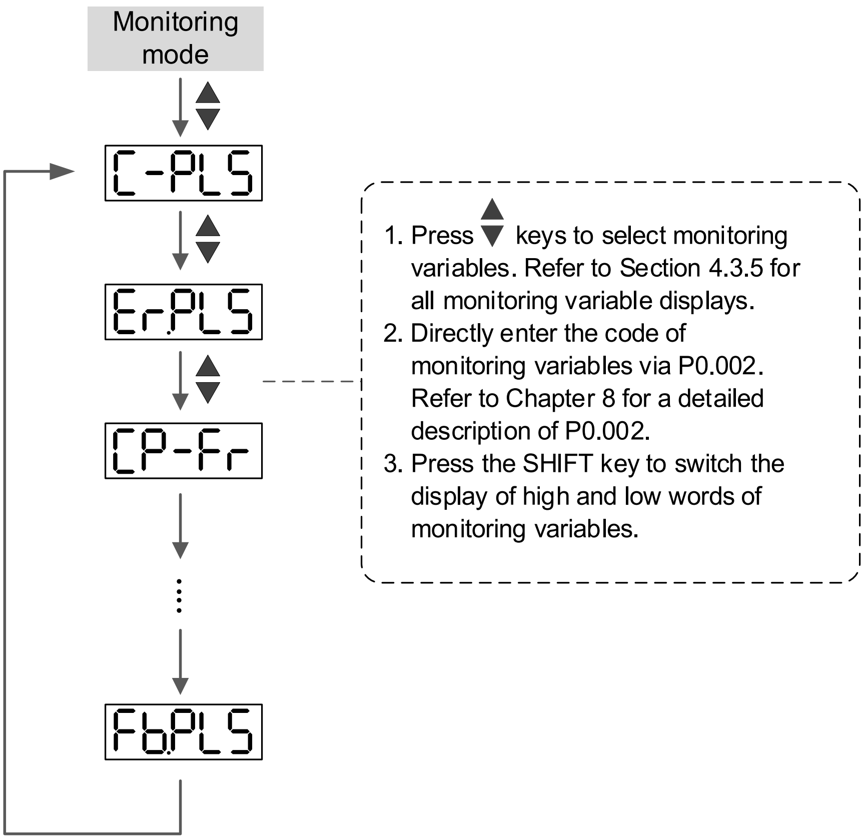
4.2 Parameter setting procedure

Switching modes:



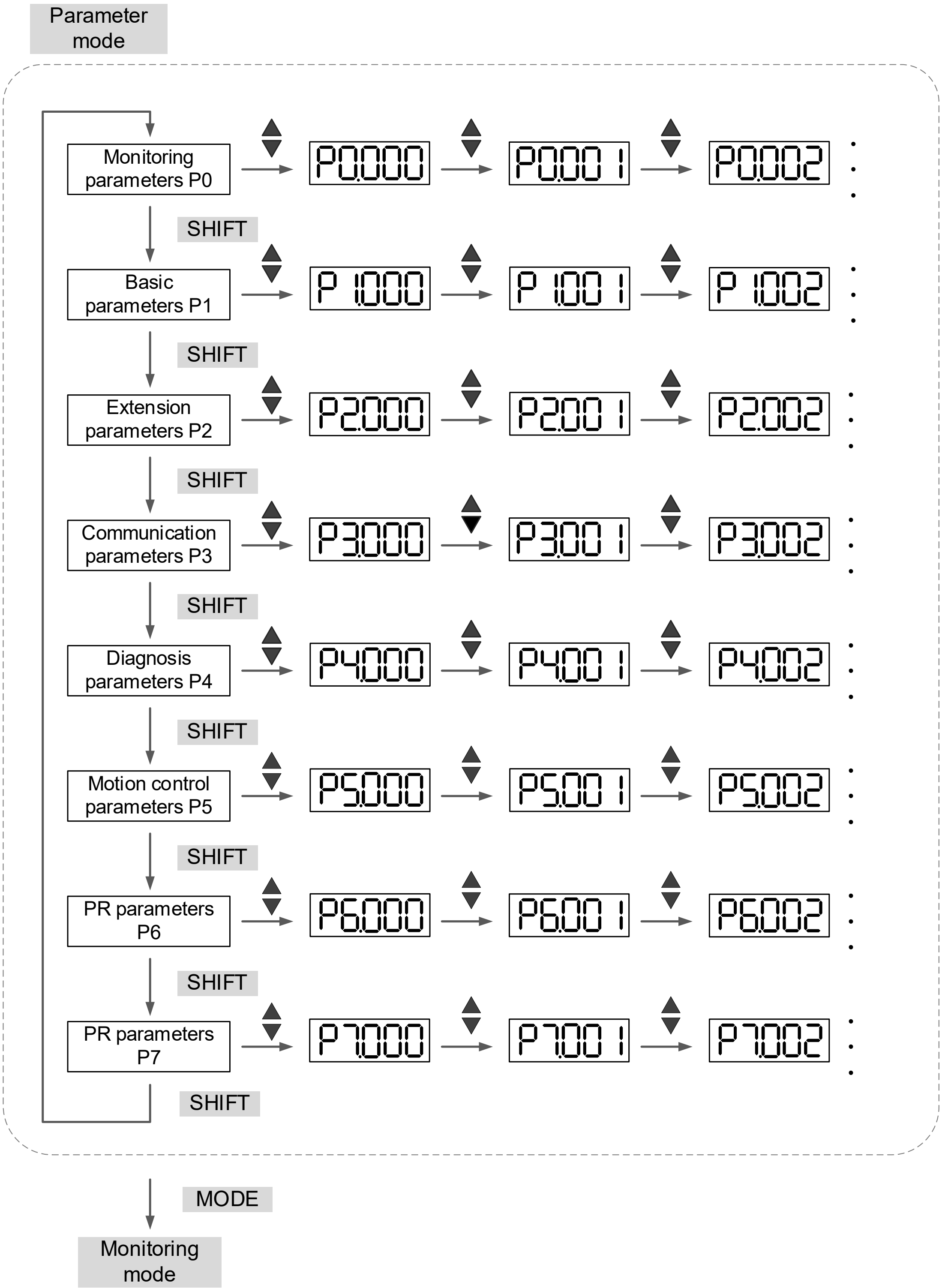
Operating in each mode:

Monitoring mode

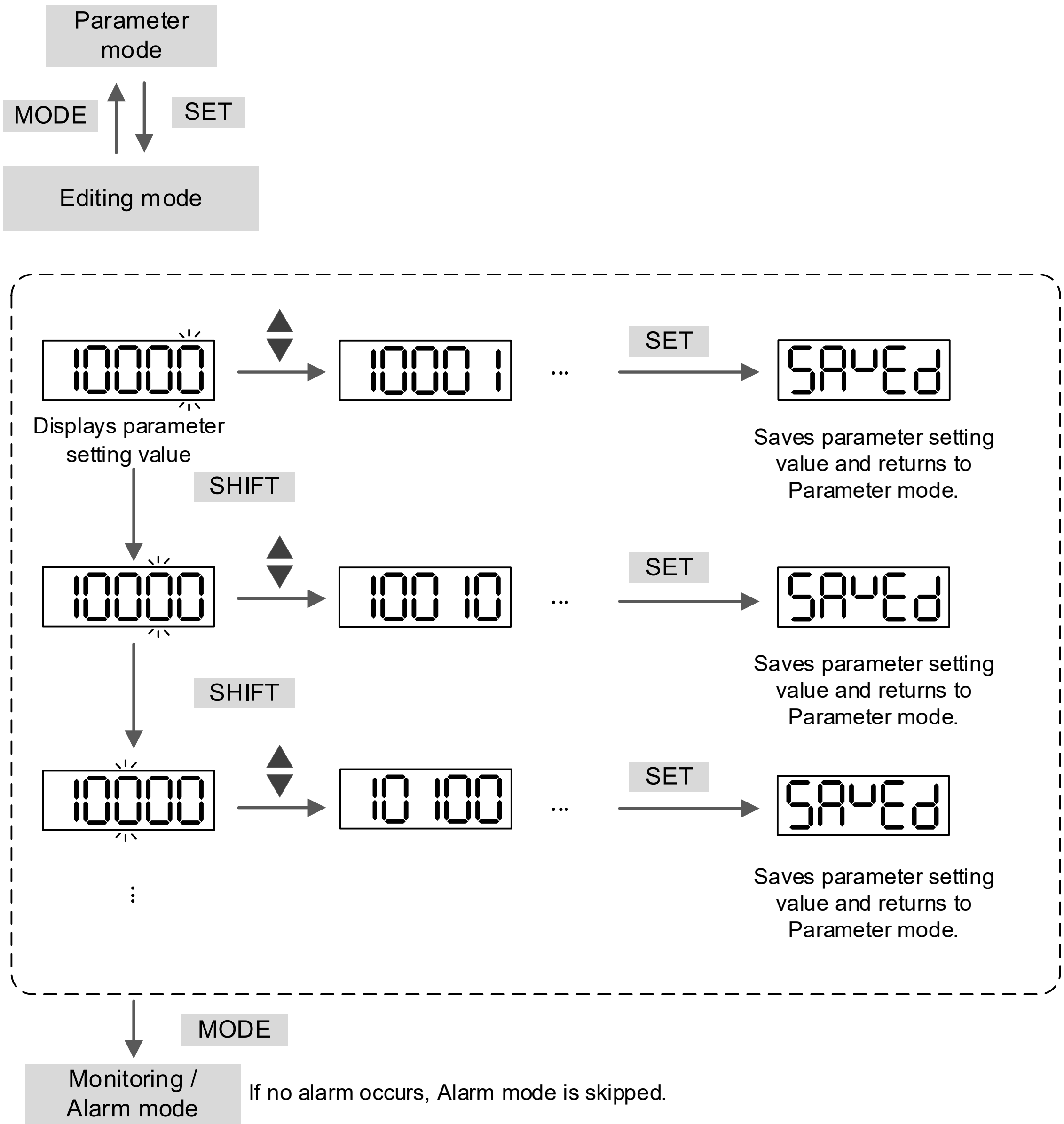


4

Parameter mode



Editing mode

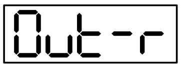
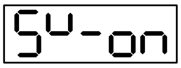


4

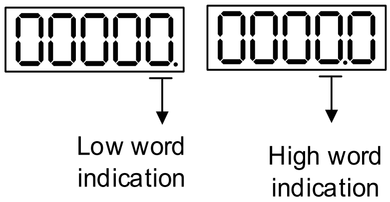
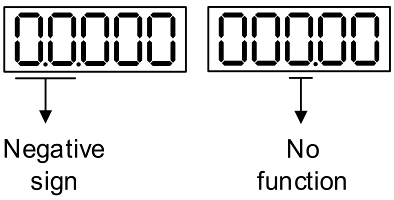
4.3 Status display

4.3.1 Data save status

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

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

4.3.2 Decimal points

Display symbol	Description
	High word / low word indication: indicates the high word or low word when the 32-bit data is displayed in decimal format.
	Negative sign: the two decimal points on the left represent the negative sign when the 16- or 32-bit data is displayed in decimal format. When in hexadecimal format, it only shows positive values.

4.3.3 Alarm messages

Display symbol	Description
	When an error occurs, the servo drive panel displays ‘AL’ as the alarm symbol and ‘nnn’ as the alarm code. Refer to Chapter 14 Troubleshooting for alarm details.

4.3.4 Positive and negative value setting

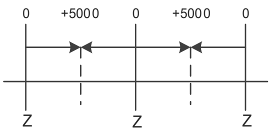
In Editing mode, pressing and holding the SHIFT key for 2 seconds switches between the positive and negative signs. If the value is out of the parameter setting range after switching, then the servo drive automatically resets it to the original value.

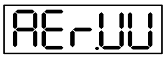
Display example	Description
02468	The positive value has no decimal points.
2.4.680	The negative value has two decimal points on the left.

4.3.5 Monitoring display

When you apply power to the drive, the display shows the monitoring display 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 set P0.002 to specify the monitoring code. When the drive is powered, the default monitoring code is determined by the value of P0.002. For example, if the value of P0.002 is 4, when the drive is powered, the display shows “C-PLS” first and then shows the input number of pulse commands. Refer to the following table for more information. For all monitoring variables, refer to Table 8.3 Monitoring variables descriptions in Section 8.2.

P0.002 setting value	Display symbol	Description	Unit
0	Fb.PUU	Motor feedback pulse number (after the scaling of E-Gear ratio)	PUU
1	C-PUU	Input number of pulse commands (after the scaling of E-Gear ratio)	PUU
2	Er.PUU	The deviation between control command pulse and feedback pulse number	PUU
3	Fb.PLS	Motor feedback pulse number (encoder unit)	pulse
4	C-PLS	Input number of pulse commands (before the scaling of E-Gear ratio) (encoder unit)	pulse
5	Er.PLS	Error pulse number (after the scaling of E-Gear ratio) (encoder unit)	pulse
6	CP-Fr	Position command frequency	Kpps
7	SPEEd	Motor speed	rpm
8	CSPd1	Speed command	Volt
9	CSPd2	Speed command	rpm
10	C-tq1	Torque command	Volt
11	C-tq2	Torque command	%

P0.002 setting value	Display symbol	Description	Unit
12	AUG-L	Average torque	%
13	PE-L	Peak torque	%
14	U buS	Main circuit voltage	Volt
15	J-L	Ratio of load inertia to motor inertiaNote: if the display shows 13.0, it means the load inertia ratio is 13.	1 times
16	IGbt.t	IGBT temperature	°C
17	rSn.Fr	Resonance frequency (low word is the first resonance point and high word is the second resonance point)	Hz
18	d IFF.2 	The absolute pulse number counting from the encoder Z phase (origin). It is -4999 to +5000 pulses when the motor rotates in the forward or reverse direction starting from the origin (0).	-
19	nnAP 1	Mapping parameter #1: shows the content of parameter P0.025 (P0.035 specifies the mapping target)	-
20	nnAP2	Mapping parameter #2: shows the content of parameter P0.026 (P0.036 specifies the mapping target)	-
21	nnAP3	Mapping parameter #3: shows the content of parameter P0.027 (P0.037 specifies the mapping target)	-
22	nnAP4	Mapping parameter #4: shows the content of parameter P0.028 (P0.038 specifies the mapping target)	-
23	UAr- 1	Monitoring variable #1: shows the content of parameter P0.009 (P0.017 specifies the monitoring variable)	-
24	UAr--2	Monitoring variable #2: shows the content of parameter P0.010 (P0.018 specifies the monitoring variable)	-
25	UAr--3	Monitoring variable #3: shows the content of parameter P0.011 (P0.019 specifies the monitoring variable)	-
26	UAr--4	Monitoring variable #4: shows the content of parameter P0.012 (P0.020 specifies the monitoring variable)	-
27	2-d IF.	Offset value between motor position and Z phase. (Only available for Delta CNC controllers.)	PUU
28	ALn-C	The alarm code (in decimal format). The value being converted to the hexadecimal format is identical to the alarm code displayed in P0.001 and the error code of communication models.	-
29	AFb.UU	Position feedback from the auxiliary encoder. Note: B3 drives do not support this monitoring variable.	PUU

P0.002 setting value	Display symbol	Description	Unit
30		Position difference between the position feedback and the command from the auxiliary encoder. Note: B3 drives do not support this monitoring variable.	PUU
31		Feedback position difference between the main encoder and auxiliary encoder. Note: B3 drives do not support this monitoring variable.	PUU

4

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

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

The following table shows the panel display for negative values.

Display example	Description
	If the value is -12345, the panel displays 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 means the value is displayed in hexadecimal format.
2. The display shown in the preceding tables is applicable in both Monitoring mode and Editing mode.
3. All monitoring variables are 32-bit data, and the display can be switched between high / low word or Dec / Hex. The parameter (Px.xxx) data formats are defined in Chapter 8. Each parameter only supports one display method and cannot be switched.

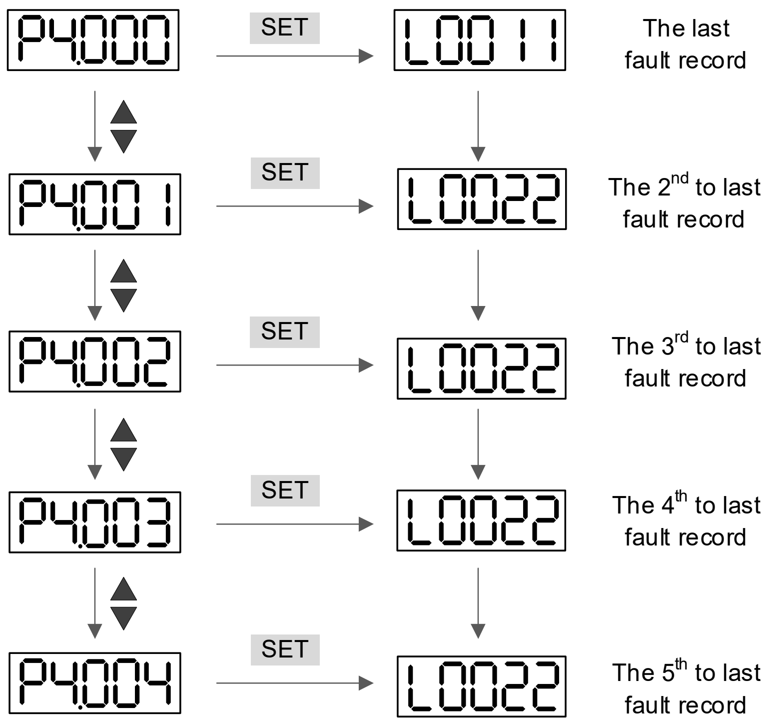
4.3.6 PROFINET Flash LED function

Display symbol	Description
	When the Flash LED function is enabled, the corresponding drive panel flashes this symbol.

4.4 General functions

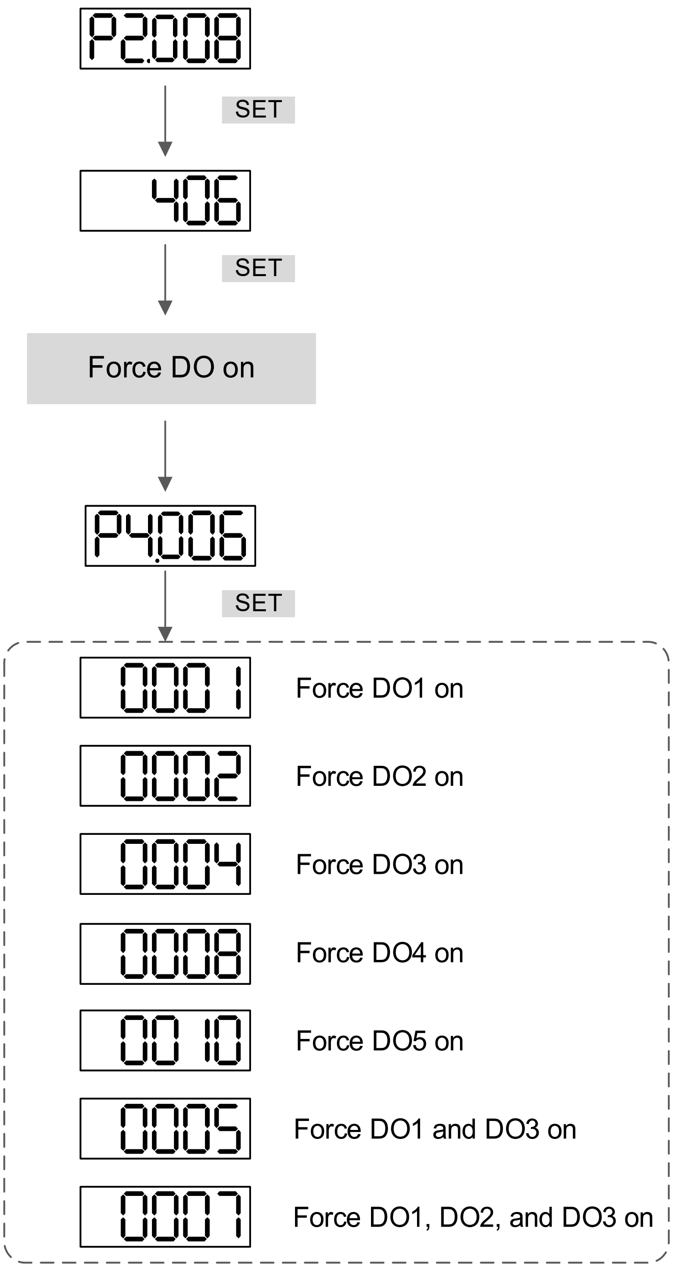
4.4.1 Operation of fault record display

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



4.4.2 Force DO on

You can switch to Diagnosis mode by the following steps. Set P2.008 to 406 to force DO on. Then, set the DO by binary method with P4.006. When the value of P4.006 is 0x0002, it forces DO2 on. When the value is 0x0005, it forces DO1 and DO3 on. The mode is volatile; the drive returns to the normal DO mode after power cycling. You can also set P2.008 to 400 to switch to the normal DO mode.

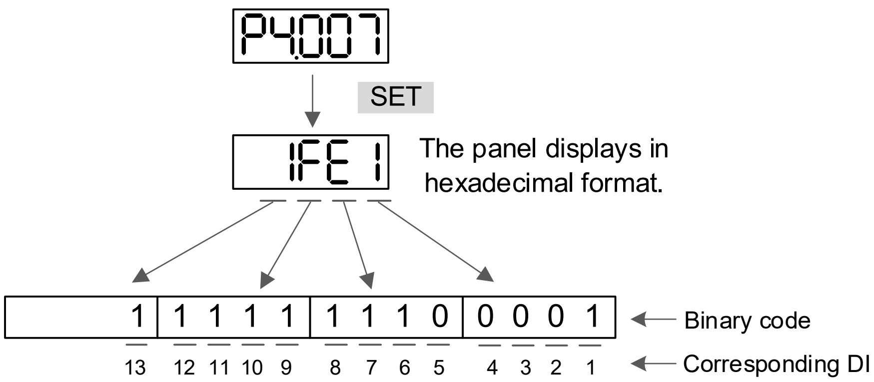


4

4.4.3 Digital input diagnosis

You can switch to Diagnosis mode by the following steps. When DI1 - DI9 are triggered by the external signal, the panel shows the corresponding signal. In binary format, when the bit shows 1, it means the DI is on.

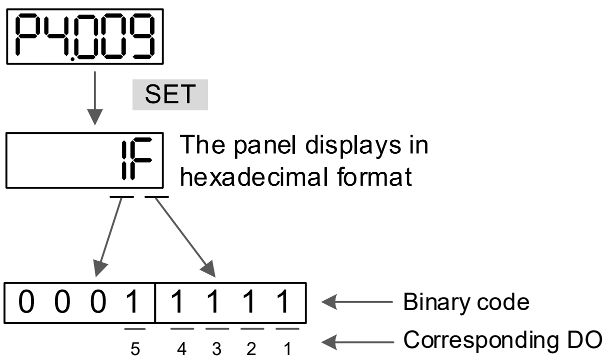
For example, if the panel shows “1FE1”, the hexadecimal E equals 1110 in binary format, indicating that DI6 - DI8 are on.



4.4.4 Digital output diagnosis

You can switch to Diagnosis mode by the following steps. When DO1 - DO6 are triggered by the output signal, the panel shows the corresponding signal. In binary format, when the bit shows 1, it means the DO is on.

For example, if the panel shows “1F”, the hexadecimal F equals 1111 in binary format, indicating that DO1 - DO4 are on.



4.5 Testing

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

4.5.1 Initial testing

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

Caution: to prevent danger, check first if the motor runs normally without load during normal operation. Then, try operating the motor with load.

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

Inspection before operation (without power)	■ Check for any obvious visible damage on the servo drive. ■ The wires at the wiring terminal should be isolated. ■ Make sure the wiring is correct to avoid damage or any abnormal operation. ■ Check for and remove any conductive objects, including sheet metals and screws, or inflammable objects inside or near the servo drive. ■ Check that the control switch is in the “Off” state. ■ Do not place the servo drive or external regenerative resistor on inflammable objects. ■ To ensure the electromagnetic brake works, check if the stop and circuit breaker functions are working normally. ■ Reduce the 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 the relay makes abnormal noise or does not make any contact noise when operating, please contact Delta. ■ Check that the power indicator and LED display work properly.

4.5.2 Applying power to the servo drive

Follow these instructions.

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

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

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

- When the power is on, the servo drive panel shows:

AL013

The default signal settings for DI6 - DI8 are negative limit (NL), positive limit (PL), and emergency stop (EMGS). If not using the default settings for DI6 - DI8, you must set the values of P2.015 - P2.017 to 0 (disable the DI function) or some other values for different functions.

- When P0.002 is set to 07 (motor speed), the servo drive panel shows:

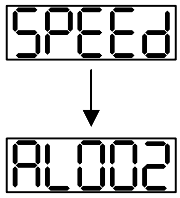
SPEEd

↓

00000

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

- When the panel shows:



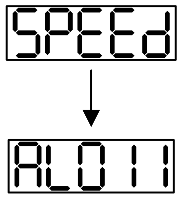
Overvoltage warning:

The input voltage of the main circuit is higher than the allowable rated value or an incorrect power input is applied (incorrect power system).

Corrective action:

1. Use a voltmeter to check if the input voltage of the main circuit is within the allowable rated value.
2. Use a voltmeter to check if the power system complies with the specifications.

- When the panel shows:



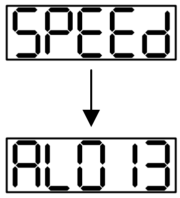
CN2 communication failure warning:

Check if the CN2 connector is securely connected and the wiring is correct.

Corrective action:

1. Make sure the wiring complies with the instructions in the user manual.
2. Check the CN2 connector.
3. Check for loose wiring.
4. Check if the encoder is damaged.

- When the panel shows:



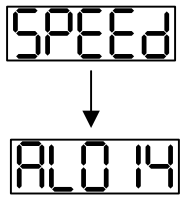
Emergency stop warning:

Check if any of the digital inputs DI1 - DI9 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 - DI9 are set to emergency stop (EMGS) (make sure that none of the parameters, P2.010 - P2.017 and P2.036, are set to 21).
2. If the emergency stop (EMGS) function is needed, make sure the corresponding 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 panel shows:



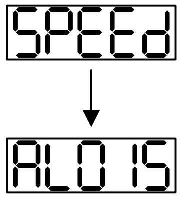
Negative limit error warning:

Check if any of the digital inputs DI1 - DI9 are set to negative limit (NL) and that DI is off.

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 - DI9 are set to negative limit (NL) (make sure that none of the parameters, P2.010 - P2.017 and P2.036, are set to 22).
2. If the negative limit (NL) function is needed, make sure the corresponding 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 panel shows:



Positive limit error warning:

Check if any of the digital inputs DI1 - DI9 are set to positive limit (PL) and that DI is off.

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 - DI9 are set to positive limit (PL) (make sure that none of the parameters, P2.010 - P2.017 and P2.036, are set to 23).
2. If the positive limit (PL) function is needed, make sure the corresponding 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 panel shows:

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 make sure the metal part of the wiring is not exposed.

- When the panel shows:

Undervoltage warning:

Corrective action:

1. Check if the wiring of input voltage for the main circuit is correct.
2. Use a voltmeter to check the main circuit voltage.
3. Use a voltmeter to check if the power system complies with the specifications.

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

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 that you set JOG at low speed. Follow these steps:

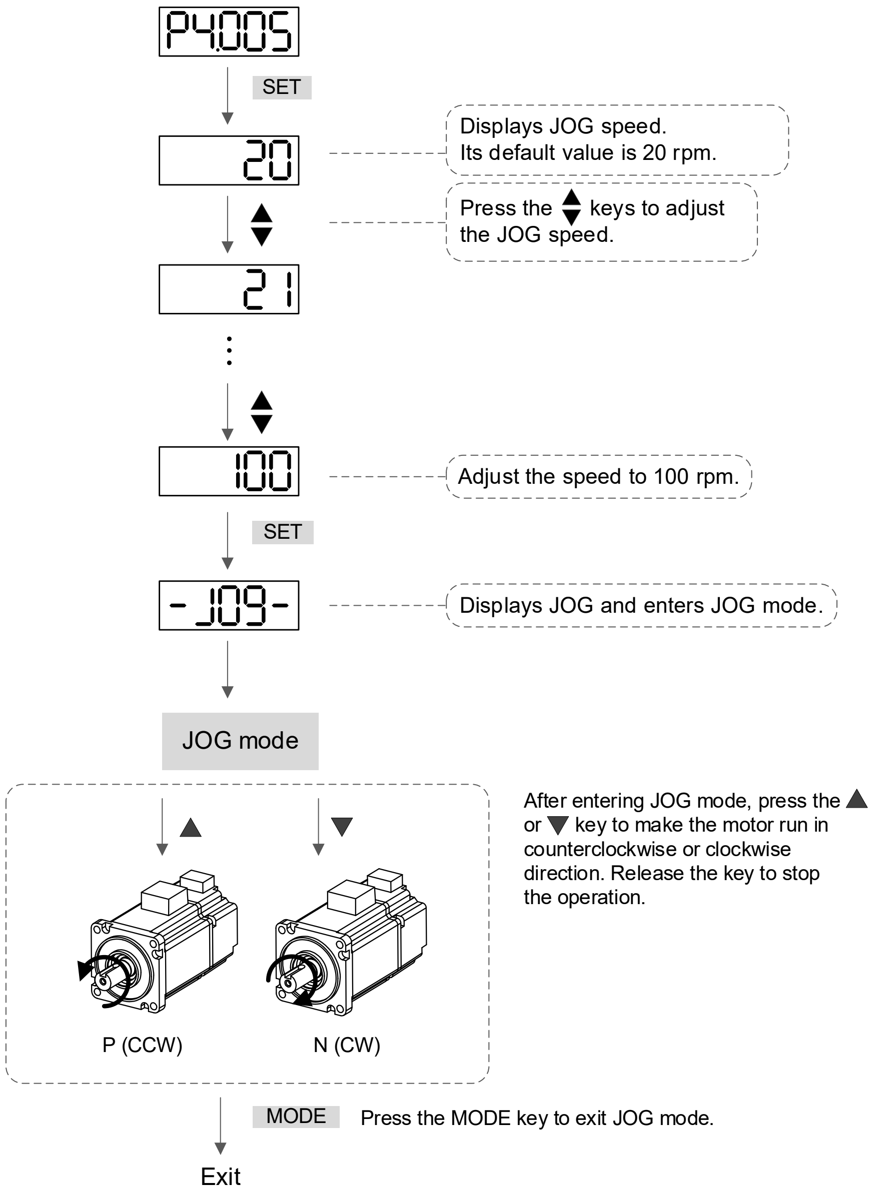
Step 1: JOG trial run is available only when the servo drive is in the Servo On state. The drive can be forced into the Servo On state by setting P2.030 to 1 or with the controller. JOG trial run by panel operation is not available in the communication mode (P1.001.X = B or C).

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

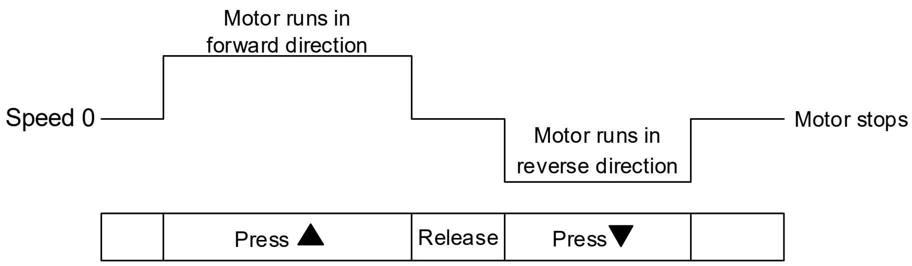
Step 3: press the ▲ or ▼ key to adjust the JOG speed. In the following example, the speed is set to 100 rpm.

Step 4: press the SET key to save the setting value, and then the panel displays “JOG” and enters JOG mode.

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



The following shows the JOG timing diagram:



If the motor does not run, check if the UVW and encoder cables are correctly wired.

If the motor runs abnormally, check if the U, V, W phase sequence is correct.

4

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 counterforce generated during motor rotation.

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

Step 2: in Speed mode, set the digital input settings as shown in the following table for the trial run.

Digital input	Parameter setting value	DI name	Function description	CN1 Pin No.
DI1	P2.010 = 0x0101	SON	Servo On	DI1- = 9
DI2	P2.011 = 0x0109	TRQLM	Torque limit	DI2- = 10
DI3	P2.012 = 0x0114	SPD0	Speed selection 0	DI3- = 34
DI4	P2.013 = 0x0115	SPD1	Speed selection 1	DI4- = 8
DI5	P2.014 = 0x0102	ARST	Alarm reset	DI5- = 33
DI6	P2.015 = 0x0000	-	DI disabled	-
DI7	P2.016 = 0x0000	-	DI disabled	-
DI8	P2.017 = 0x0000	-	DI disabled	-
DI9	P2.036 = 0x0000	-	DI disabled	-
DI10	P2.037 = 0x0000	-	DI disabled	-
DI11	P2.038 = 0x0000	-	DI disabled	-
DI12	P2.039 = 0x0000	-	DI disabled	-
DI13	P2.040 = 0x0000	-	DI disabled	-

The preceding settings take the -L model for example. 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 0x0000 (disabled). You can program the digital inputs of Delta's servo drive by referring to Table 8.1 Digital input (DI) descriptions in Chapter 8.

The default setting includes the negative limit, positive limit, and emergency stop functions. Therefore, if any alarm occurs after you complete the preceding settings, cycle power on the servo drive or set DI5 to On to clear the alarm. Refer to Section 4.5.2.

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

Speed command number	DI signal of CN1		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	Internal register parameter			P1.009	-75000 to +75000
S3	1	0				P1.010	-75000 to +75000
S4	1	1				P1.011	-75000 to +75000

0: means that DI is off (the circuit is open).

1: means that DI is on (the circuit is closed).

The parameter setting range of the internal register is from -75000 to +75000.

Rotation speed = setting value x unit (0.1 rpm).

For example, P1.009 = +30000, and the rotation speed = +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 rotation direction:

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

Step 3:

(a) Switch on DI1 to have the drive be in the Servo On state.

(b) When both DI3 (SPD0) and DI4 (SPD1) are off, that means the drive executes the S1 command. The motor rotates according to the analog voltage command.

(c) When DI3 (SPD0) is on, that means the drive executes the S2 command. The rotation speed is +3000 rpm.

(d) When DI4 (SPD1) is on, that means the drive executes the S3 command. The rotation speed is +100 rpm.

(e) When both DI3 (SPD0) and DI4 (SPD1) are on, that means the drive executes the S4 command. The rotation speed is -3000 rpm.

(f) You can repeatedly execute steps (c), (d), and (e).

(g) If you want to stop the motor, switch off DI1 (Servo Off).

4

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 counterforce generated during motor rotation.

Step 1: set P1.001 to 1 to set the control mode of the servo drive to Position (PR) mode. Then cycle power on the servo drive.

Step 2: in Position (PR) mode, set the digital input settings as shown in the following table for the trial run.

Digital input	Parameter setting value	DI name	Function description	CN1 Pin No.
DI1	P2.010 = 0x0101	SON	Servo On	DI1- = 9
DI2	P2.011 = 0x0108	CTRG	Command triggered	DI2- = 10
DI3	P2.012 = 0x0111	POS0	Position selection 0	DI3- = 34
DI4	P2.013 = 0x0112	POS1	Position selection 1	DI4- = 8
DI5	P2.014 = 0x0102	ARST	Alarm reset	DI5- = 33
DI6	P2.015 = 0x0000	-	DI disabled	-
DI7	P2.016 = 0x0000	-	DI disabled	-
DI8	P2.017 = 0x0000	-	DI disabled	-
DI9	P2.036 = 0x0000	-	DI disabled	-
DI10	P2.037 = 0x0000	-	DI disabled	-
DI11	P2.038 = 0x0000	-	DI disabled	-
DI12	P2.039 = 0x0000	-	DI disabled	-
DI13	P2.040 = 0x0000	-	DI disabled	-

The preceding settings take the -L model for example. 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 0x0000 (disabled). You can program the digital inputs of Delta’s servo drive by referring to Table 8.1 Digital input (DI) descriptions in Chapter 8.

The default setting includes the negative limit, positive limit, and emergency stop functions. Therefore, if any alarm occurs after you complete the preceding settings, cycle power on the servo drive or set DI5 to On to clear the alarm. Refer to Section 4.5.2.

Refer to Section 3.10.3 for the wiring for Position (PR) control mode. See the following table for the 100 sets of PR and the corresponding Position commands (POS0 - POS6) and parameters.

Position command	POS6	POS5	POS4	POS3	POS2	POS1	POS0	CTRG	Corresponding parameter
Homing	0	0	0	0	0	0	0	↑	P6.000 P6.001
PR#01	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

0: means that DI is off (the circuit is open).

1: means that DI is on (the circuit is closed).

You can set the 100 sets of PR (P6.000 - P7.099), which you can also set for absolute position commands.

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Tuning 5

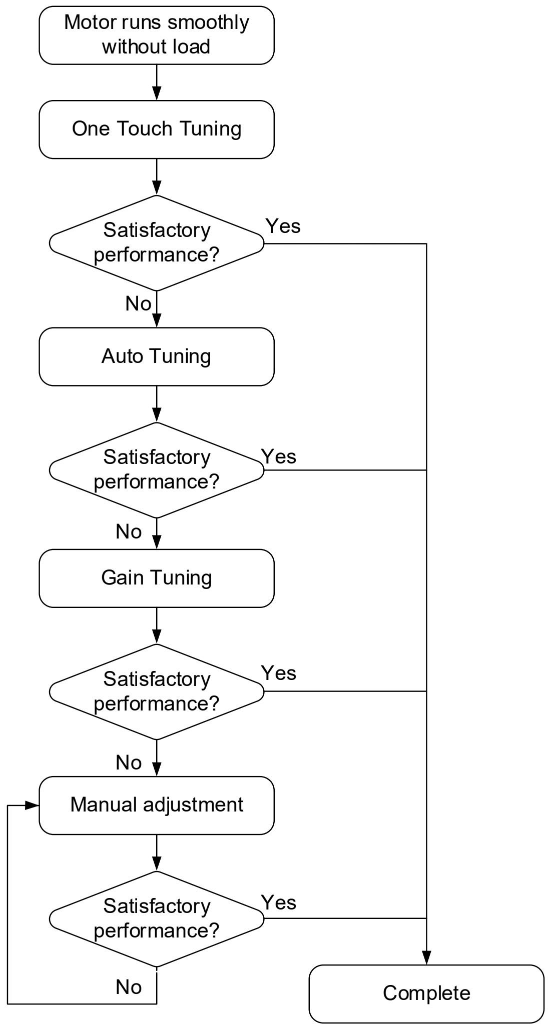
This chapter contains information about One Touch tuning, Auto tuning, and gain adjustment modes. Advanced users can also tune the servo system in Manual mode. In addition, this chapter also describes how to deal with the mechanical resonance and noise and the adjustments for application functions.

5

5

5.1 Tuning procedure

You can tune the servo drive by following this flowchart. First, start from **One Touch Tuning**. If you are not satisfied with the tuning results, then use **Auto Tuning**, **Gain Tuning**, and Manual mode in sequence to meet the requirements.



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

5.2 Inertia estimation

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

The estimation of load inertia can be done without the controller's command. During the estimation process, the motor runs back-and-forth in the forward and reverse directions. If the inertia estimation cannot be done or the inertia cannot be correctly estimated in the systems described in the following section, estimate the load inertia ratio by yourself and set P1.037 with the estimated value.

5.2.1 Precautions for inertia estimation

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

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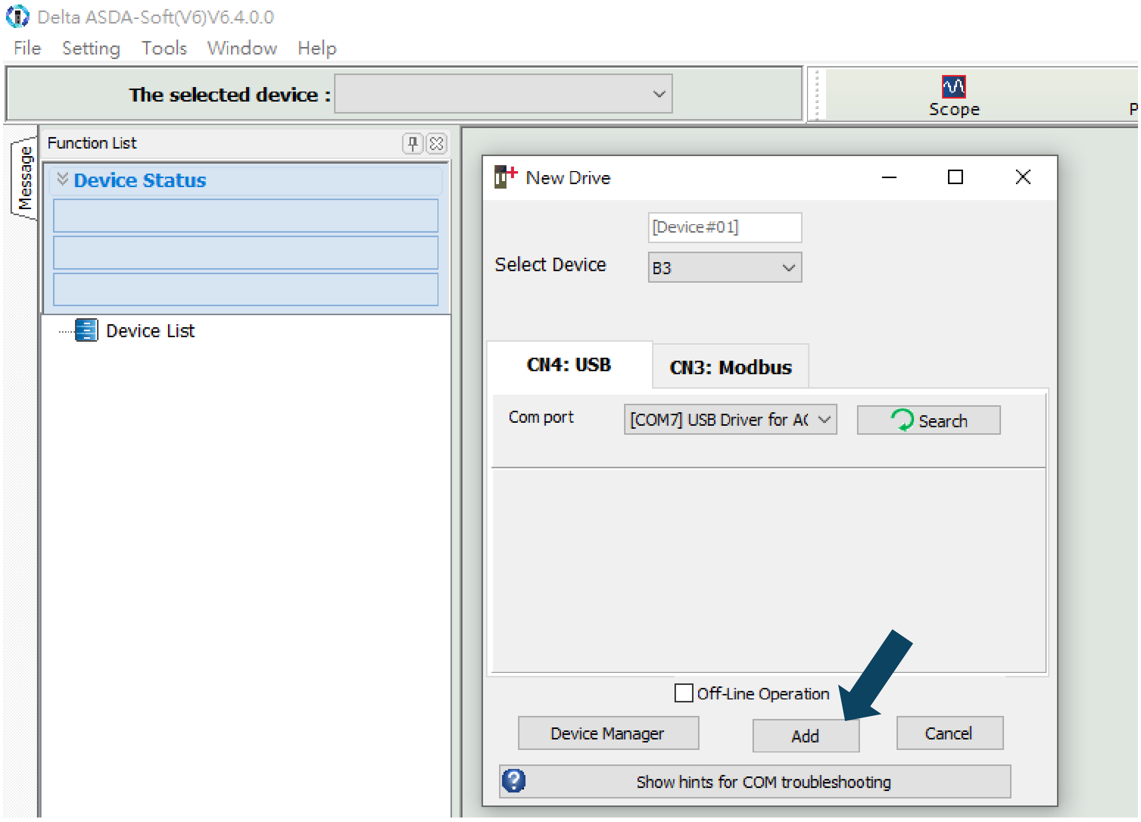
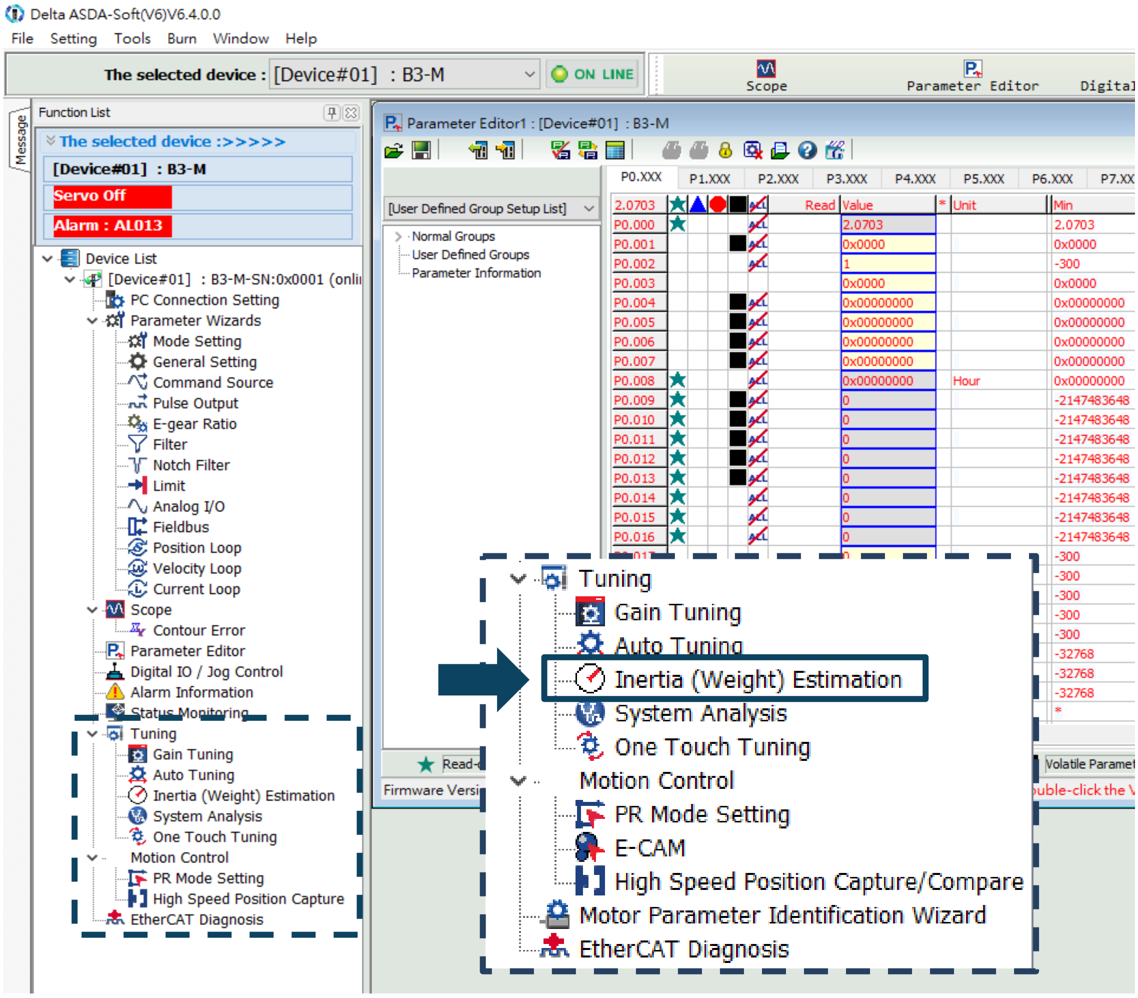
5.2.2 Inertia estimation with ASDA-Soft

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



Make sure your servo drive, servo motor, and power are all properly connected. Click **Search**, and the software automatically selects the corresponding communication port (USB Driver for Delta AC Servo Drive). Then, click **Add** for the ASDA-Soft to be in online mode.

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



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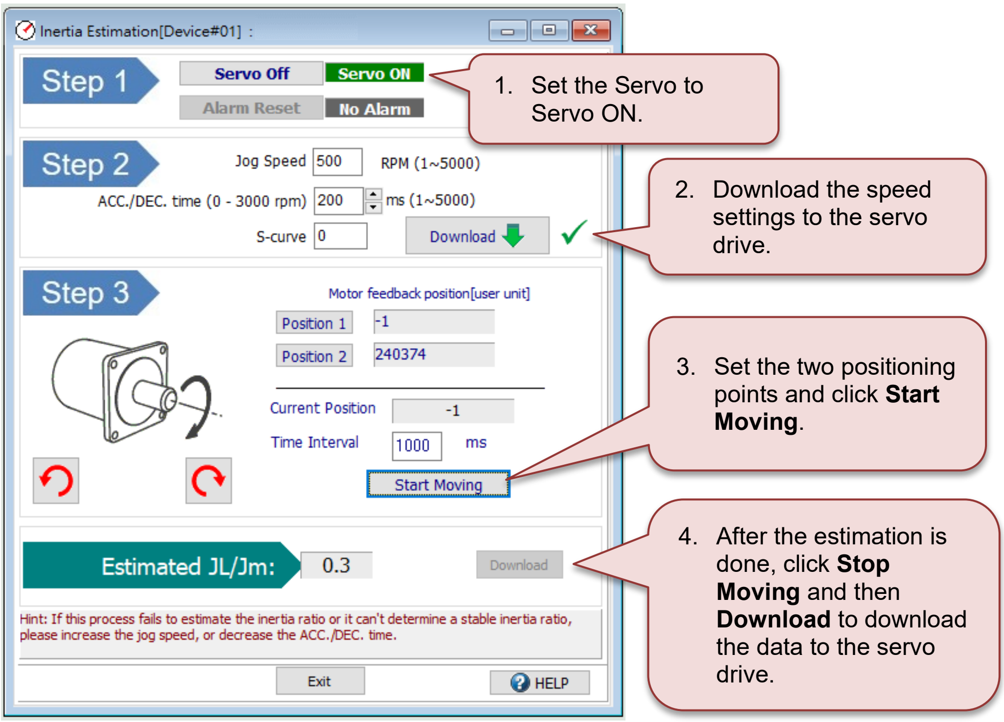
Perform the inertia estimation according to the following descriptions.

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



5.3 One Touch Tuning

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

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

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

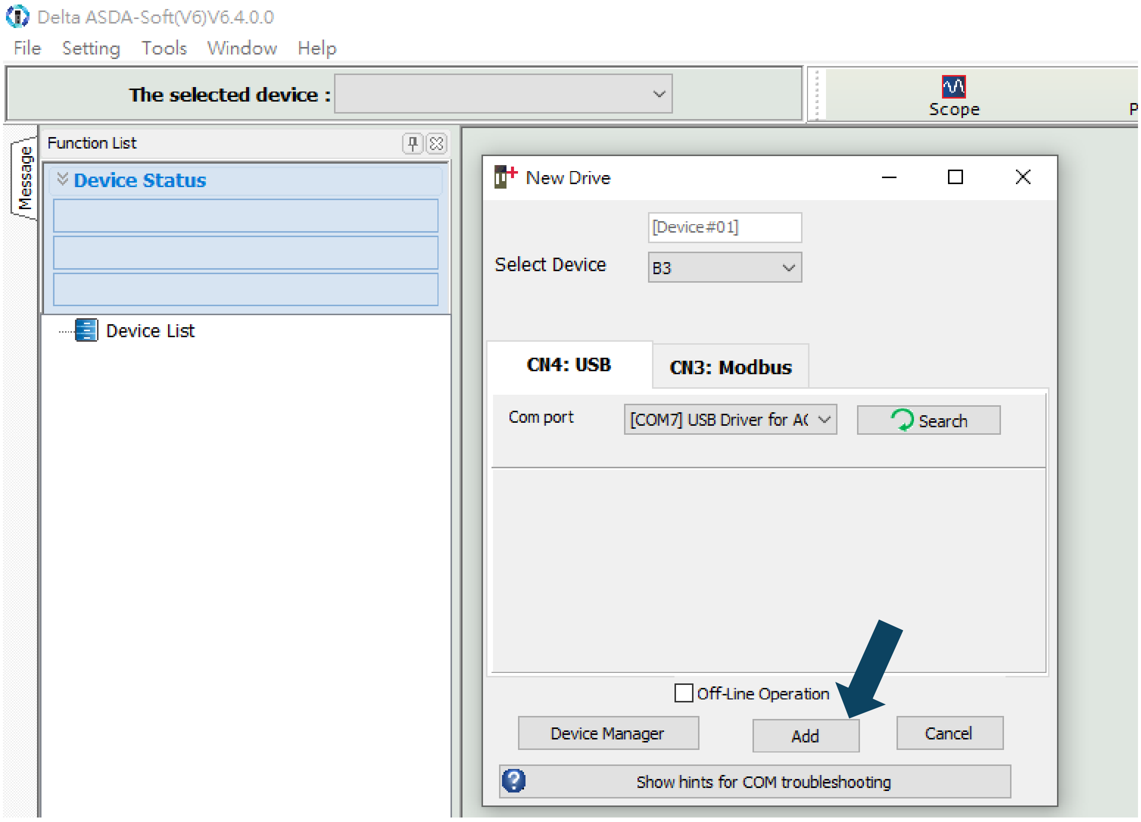
5

5.3.1 Precautions for one touch tuning

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

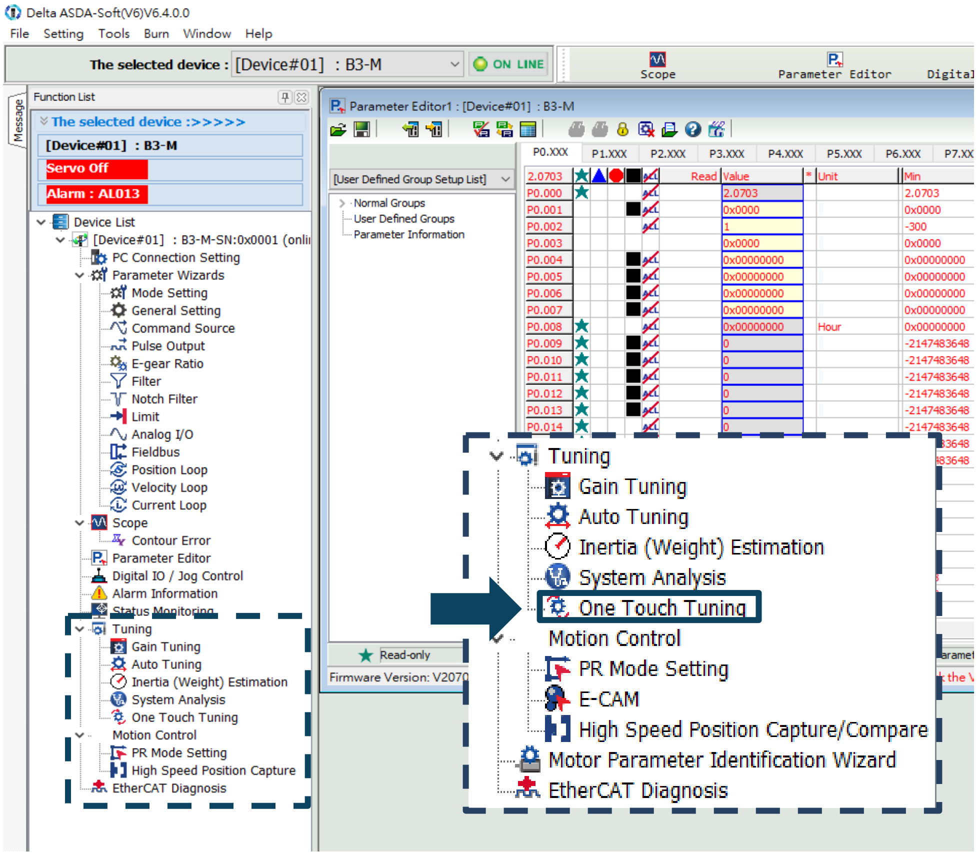
5.3.2 One touch tuning with ASDA-Soft

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

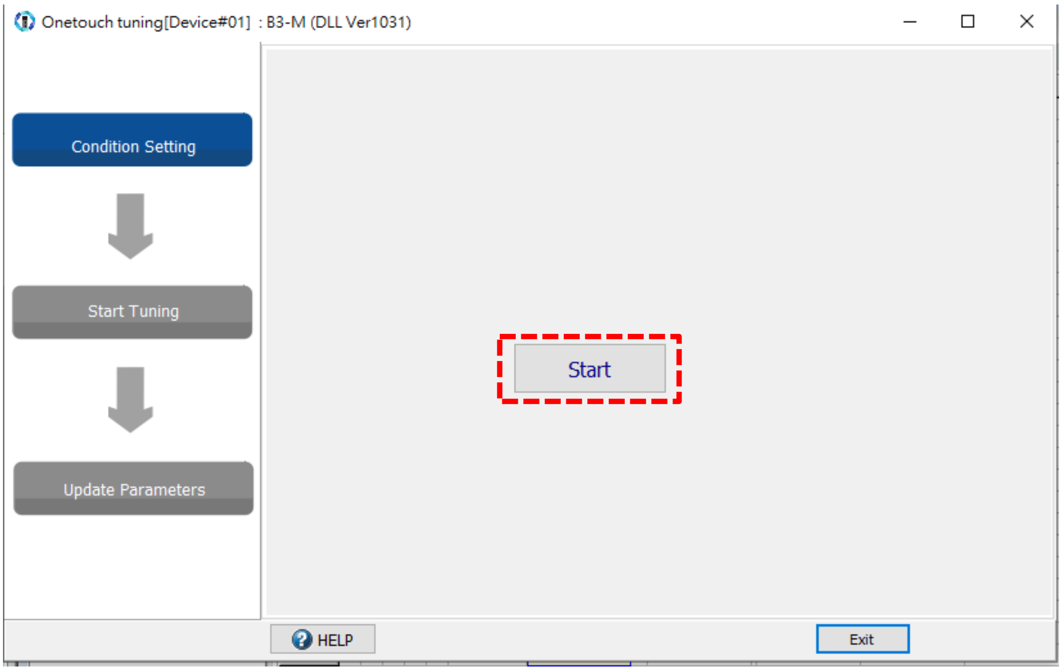


Make sure your servo drive, servo motor, and power are all properly connected. Click **Search**, and the software automatically selects the corresponding communication port (USB Driver for Delta AC Servo Drive). Then, click **Add** for the ASDA-Soft to be in online mode.

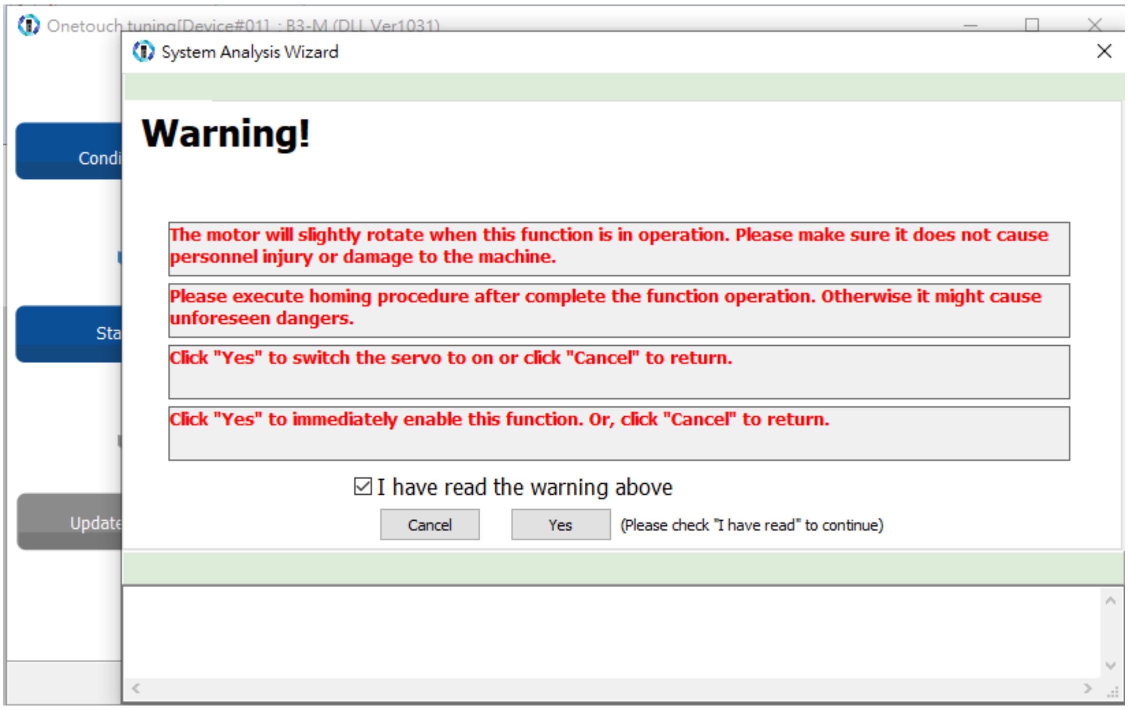
When ASDA-Soft is in online mode, the program window appears as follows. Click **One Touch Tuning** in the Function List tree view.



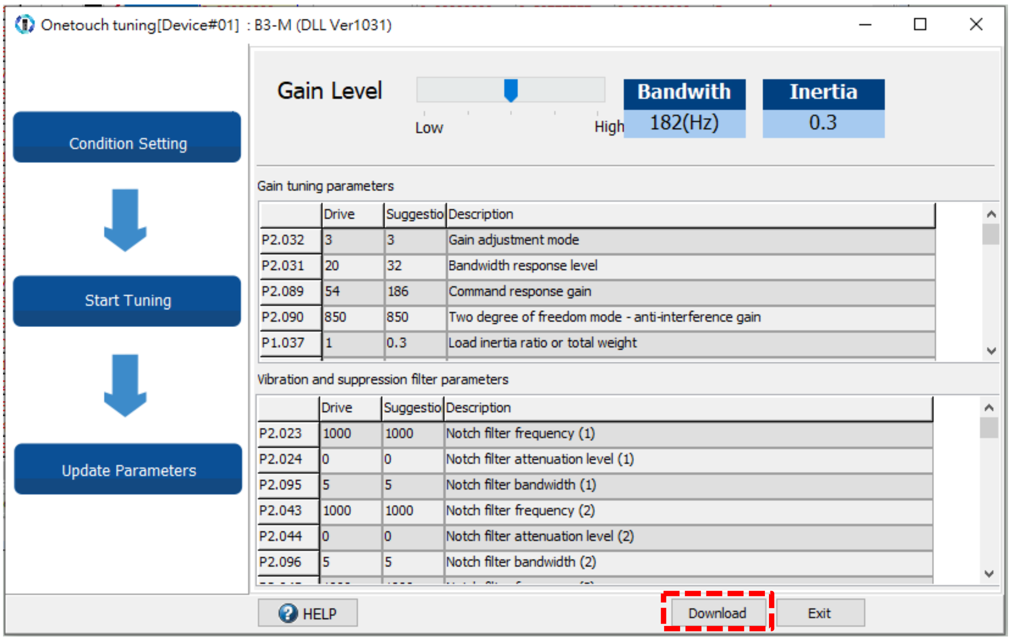
Click **Start**.



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



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



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

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

5

5.4 Auto tuning

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

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

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

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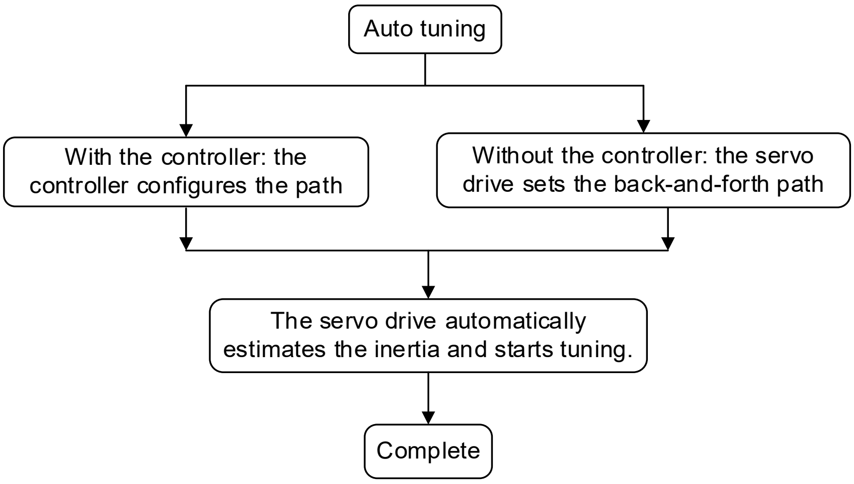
5.4.1 Precautions for auto tuning

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

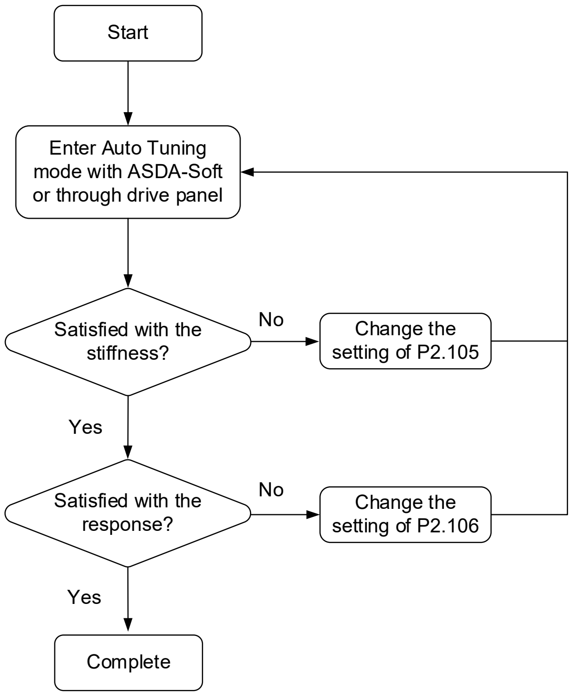
5.4.2 Flowchart of auto tuning

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



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

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



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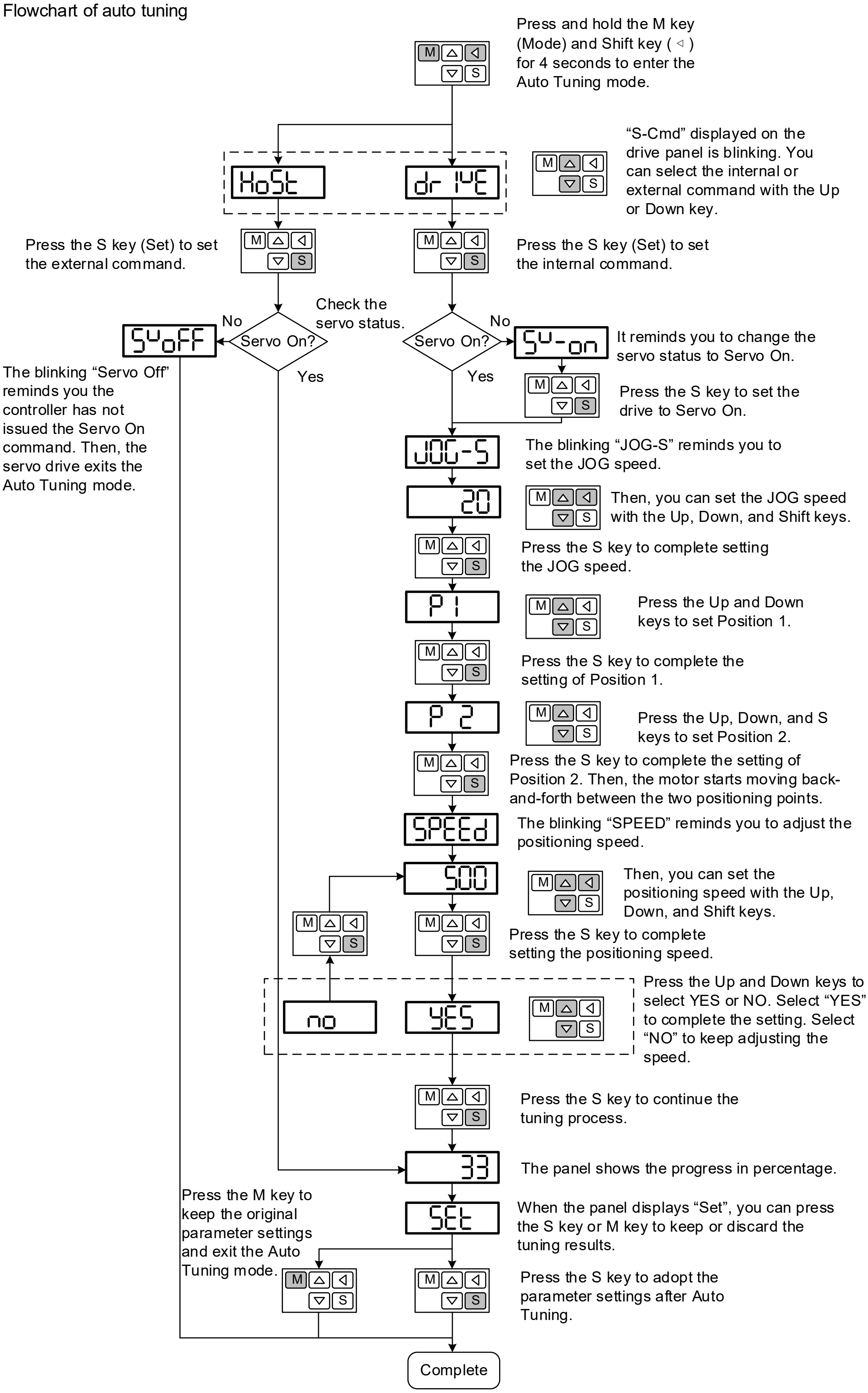
5.4.3 Auto tuning through the drive panel

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

Flowchart of auto tuning



5.4.4 Auto tuning with ASDA-Soft

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

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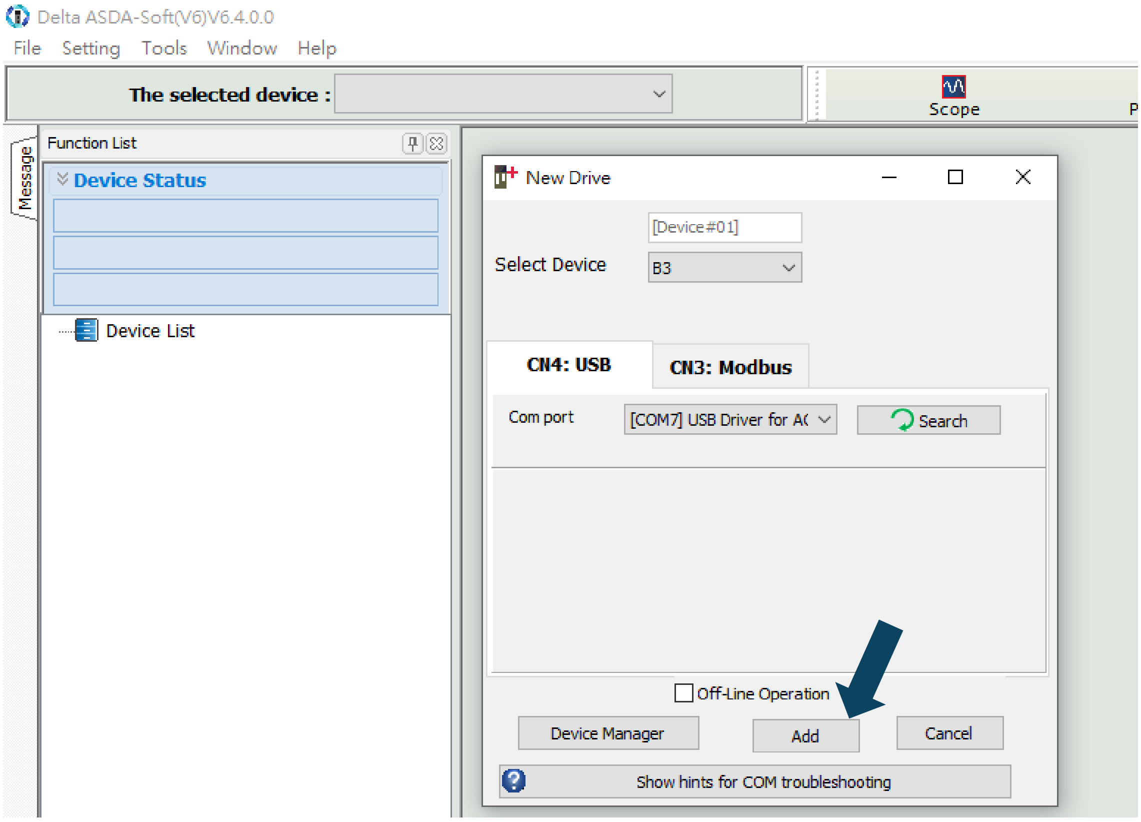

Make sure your servo drive, servo motor, and power are all properly connected. Then click **Add** for the ASDA-Soft to be in online mode.

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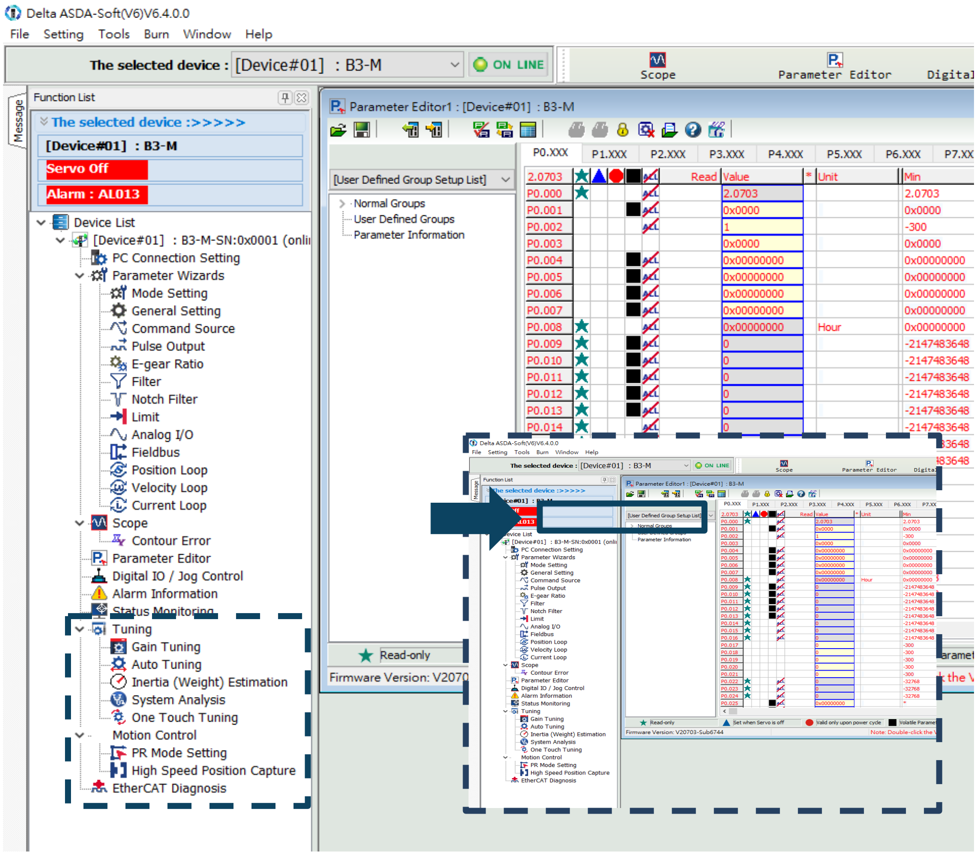
When ASDA-Soft is in online mode, start auto tuning according to the following steps. The following describes two auto tuning procedures, one using the controller and the other using the servo drive.

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

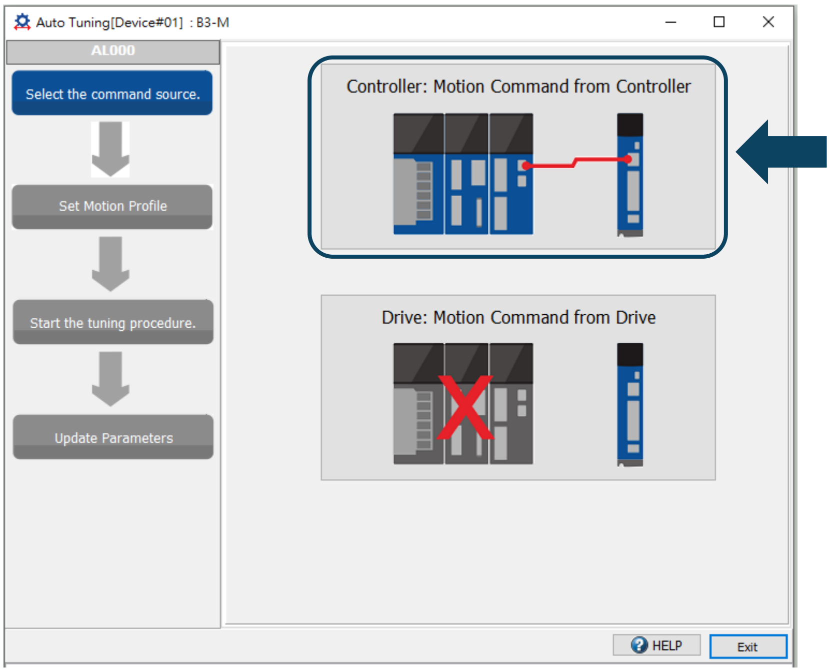
Step 1:

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



Step 2:

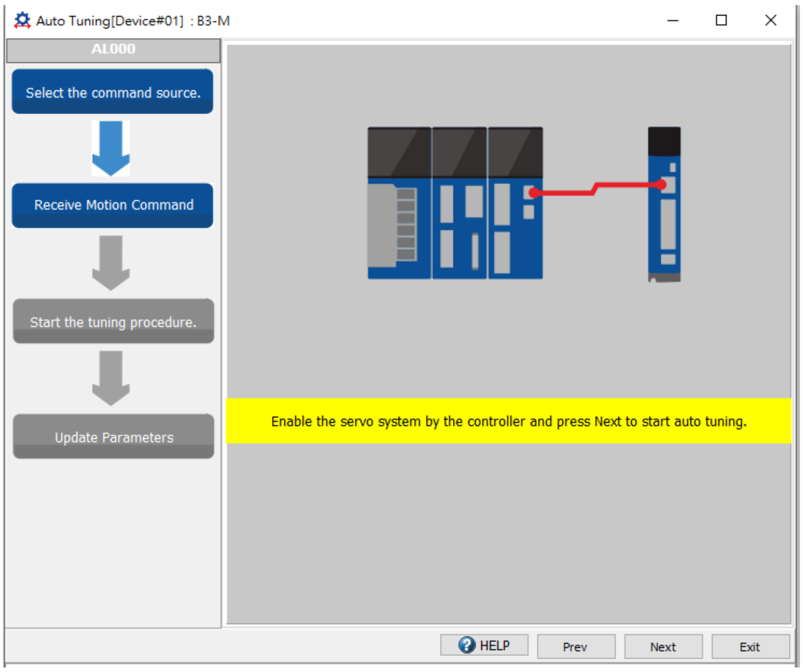
Click **Controller: Motion Command from Controller** and check for the motion / machining path.



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

Step 3:

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



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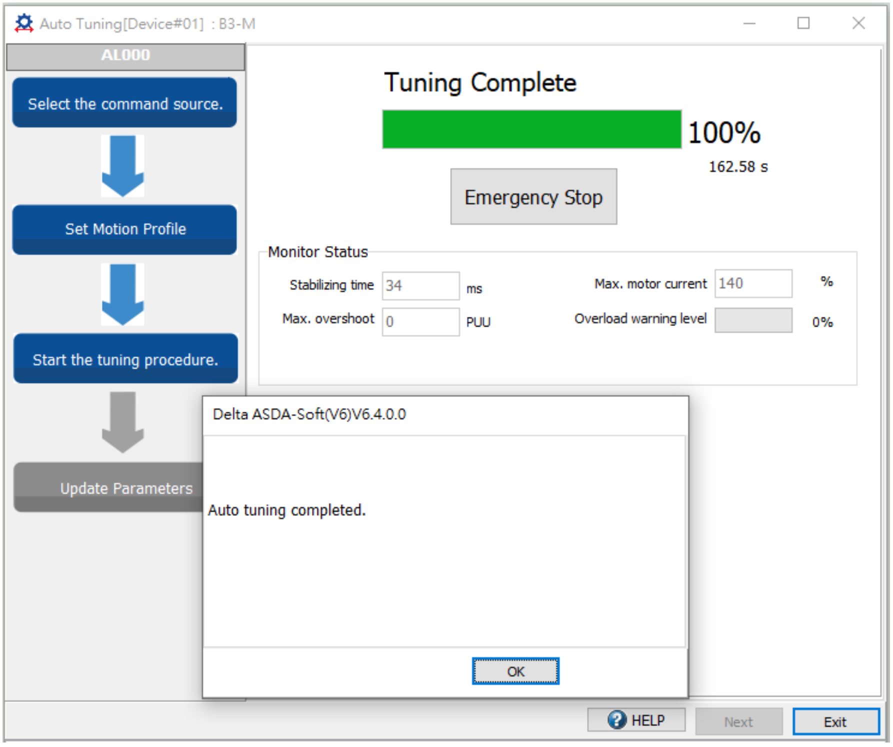
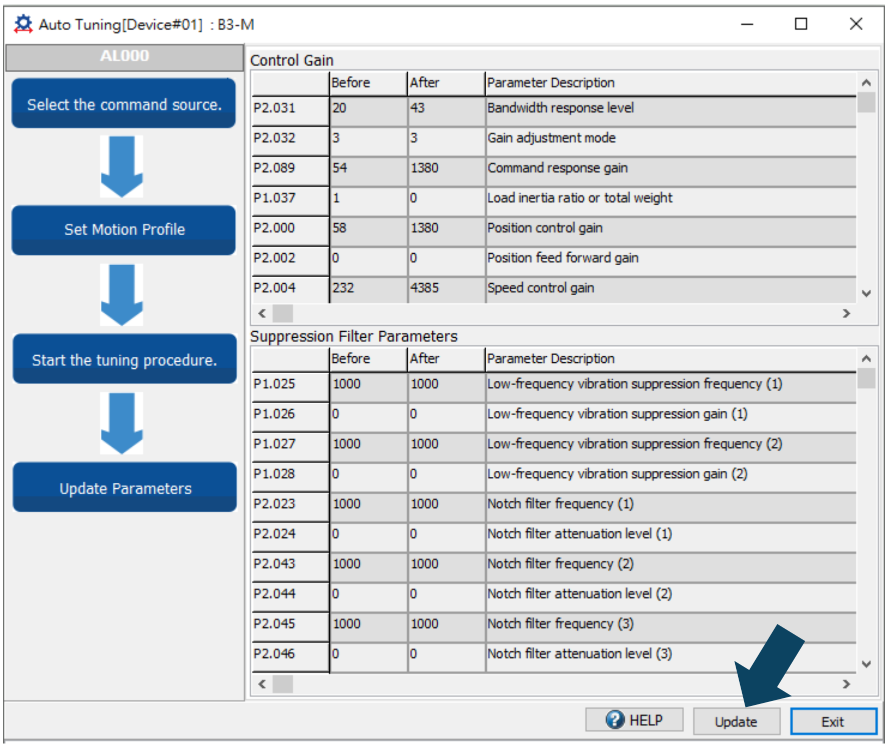
Wait until the tuning progress bar reaches 100%, and a window with “Auto tuning completed.” appears as follows. Then click **OK**.



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

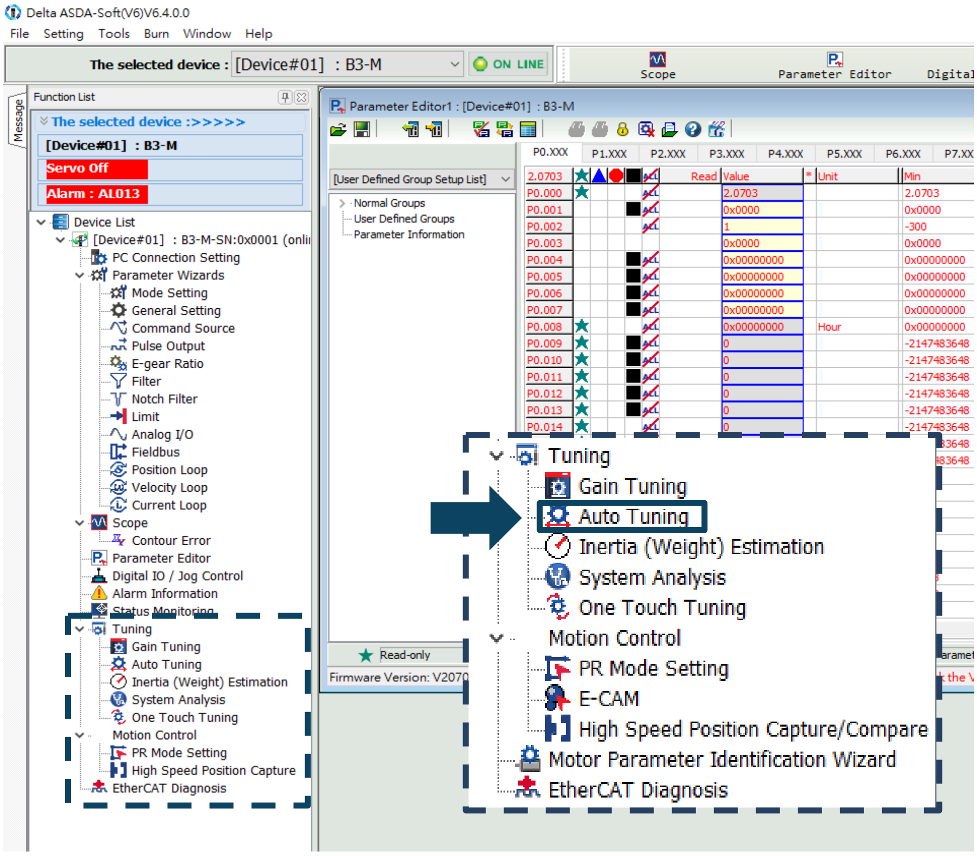


Click **Update** to complete auto tuning.

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

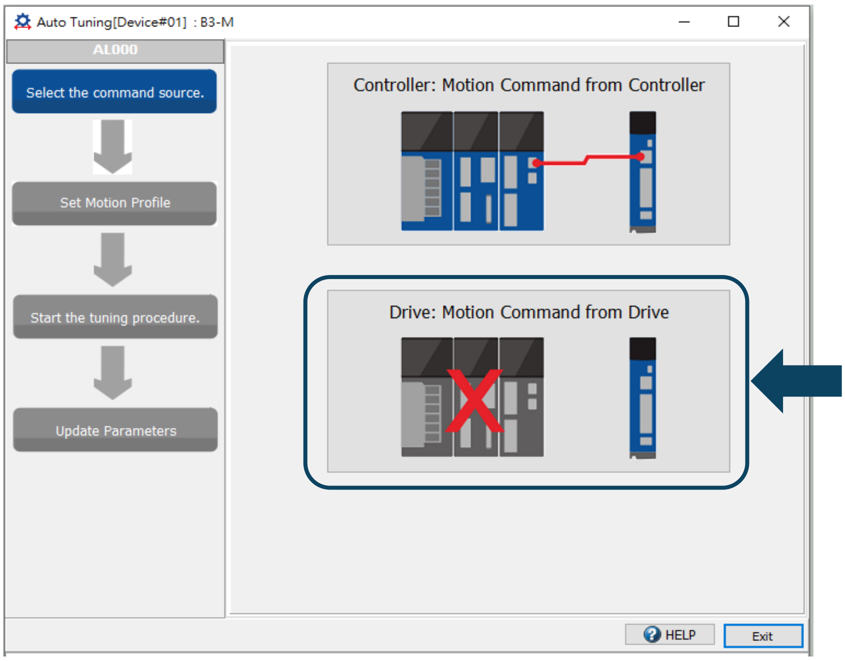
Step 1:

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



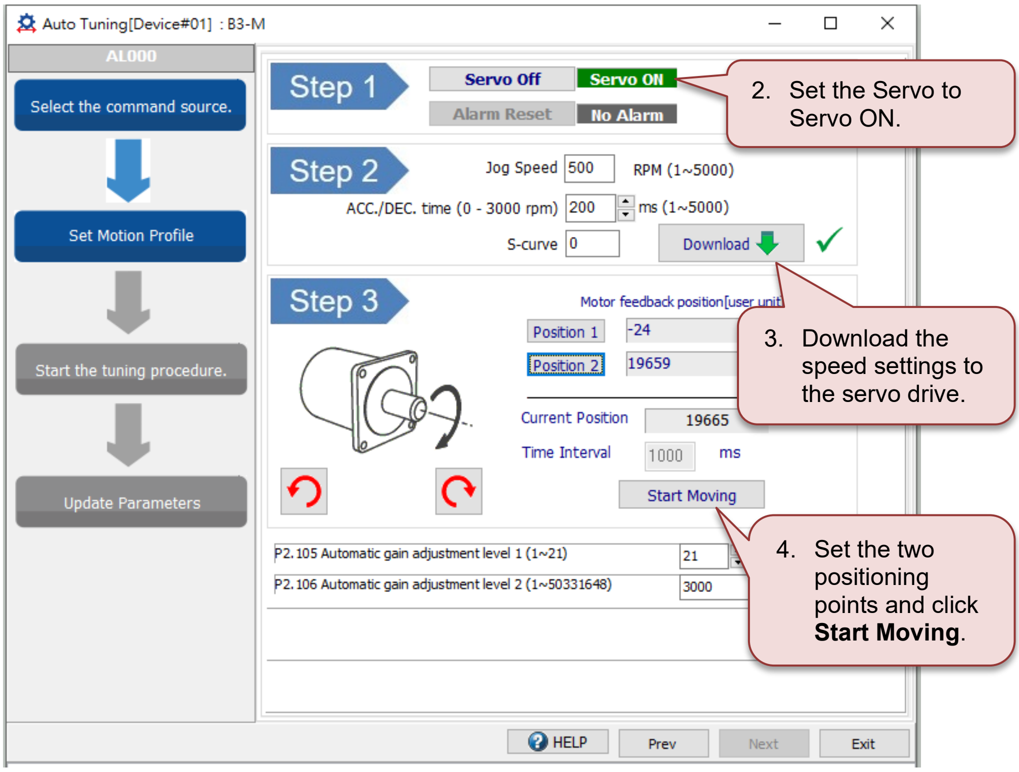
Step 2:

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



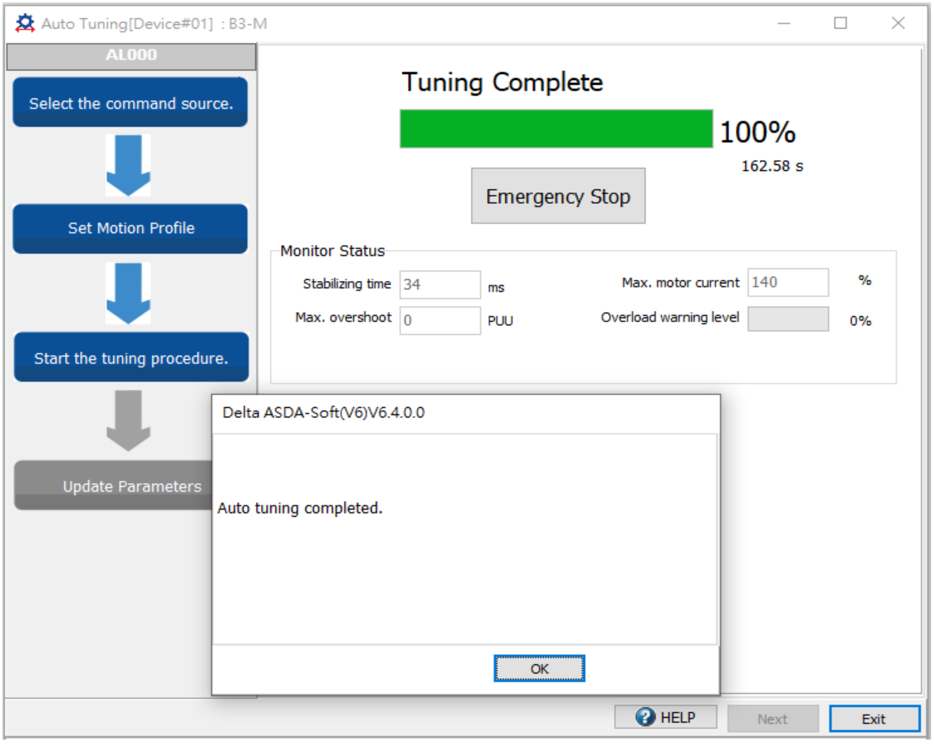
Follow these steps to set the motor running path:

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

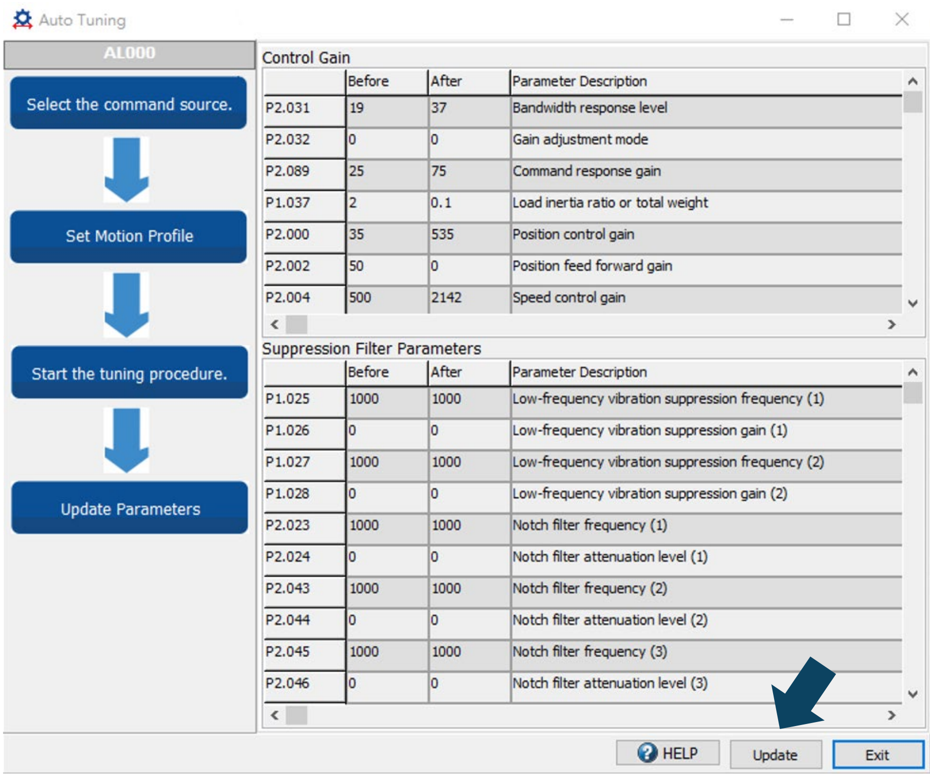


Step 3:

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



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

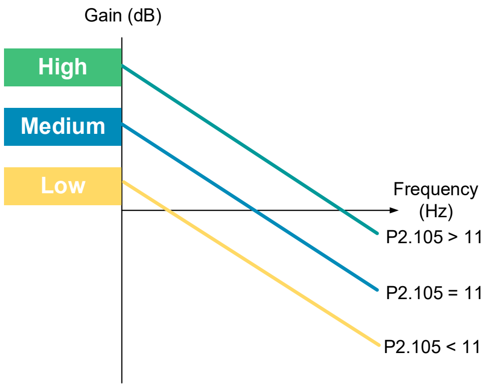


Click **Update** to complete auto tuning.

5.4.5 Parameters related to auto tuning

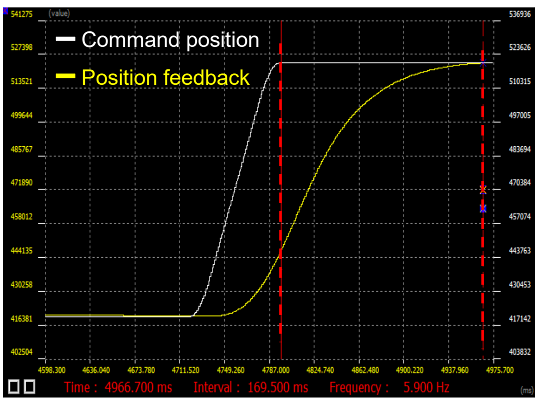
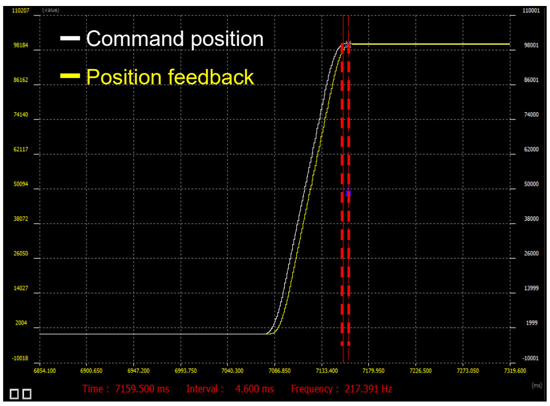
Before the auto gain adjustment starts, first set the automatic gain adjustment level 1 (P2.105) and automatic gain adjustment level 2 (P2.106), which are only available for **Auto Tuning**.

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



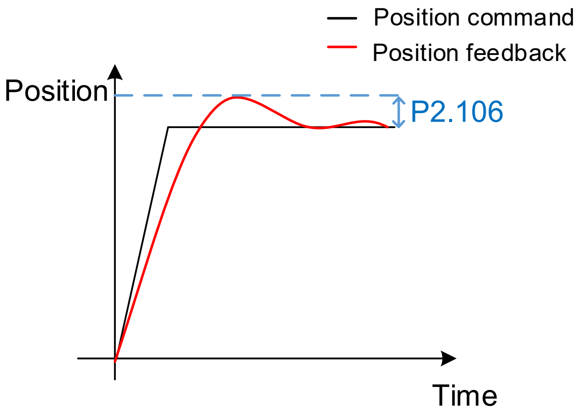
P2.105 defines the servo stiffness after auto tuning. The higher the setting value, the greater the bandwidth after auto tuning. On the other hand, the system margin becomes smaller, which means resonance is more likely to occur when the system is degrading. You can first use P2.105's default setting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

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

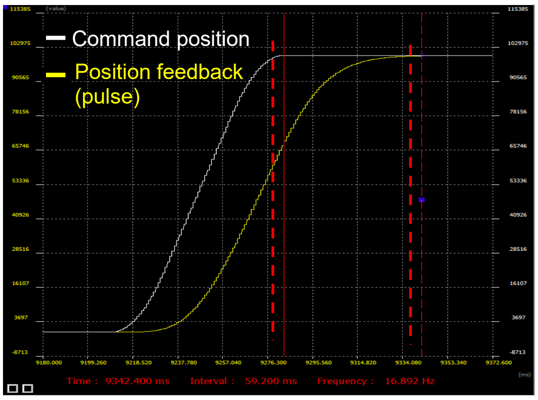
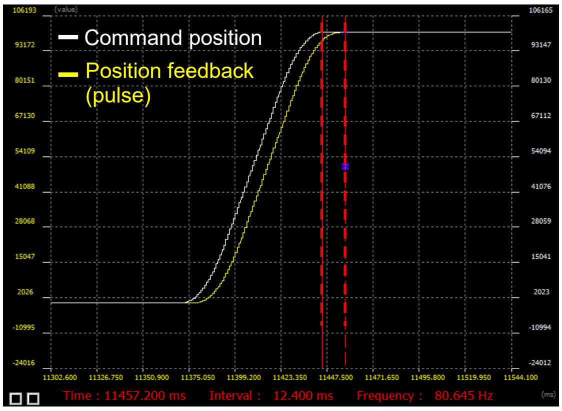
P2.105 = 1	P2.105 = 11
	

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

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



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

P2.106 = 1	P2.106 = 30000
	
Allowable amount of overshoot ≤ 1 pulse Settling time: 59.2 ms	Allowable amount of overshoot ≤ 30000 pulses Settling time: 12.4 ms

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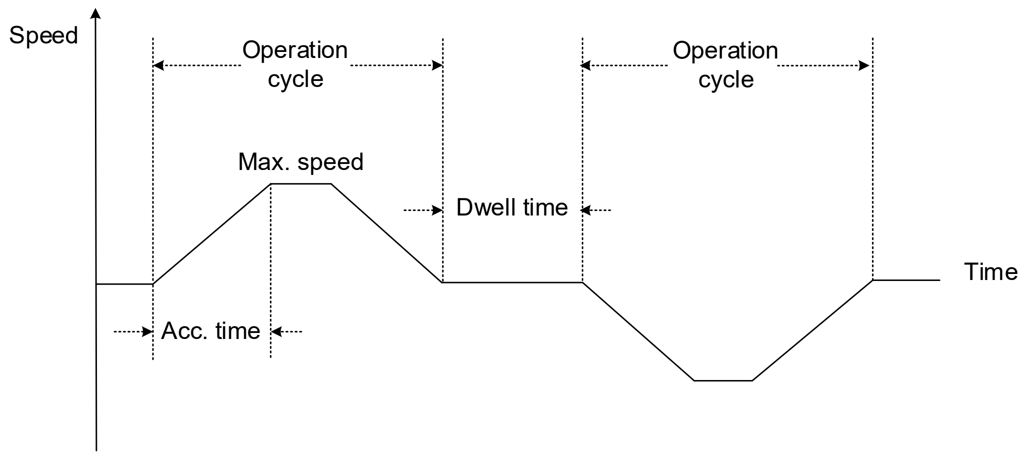
5.4.6 Alarms related to auto tuning

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



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

5

5.5 Gain adjustment modes

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

5.5.1 Differences between gain adjustment modes

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

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

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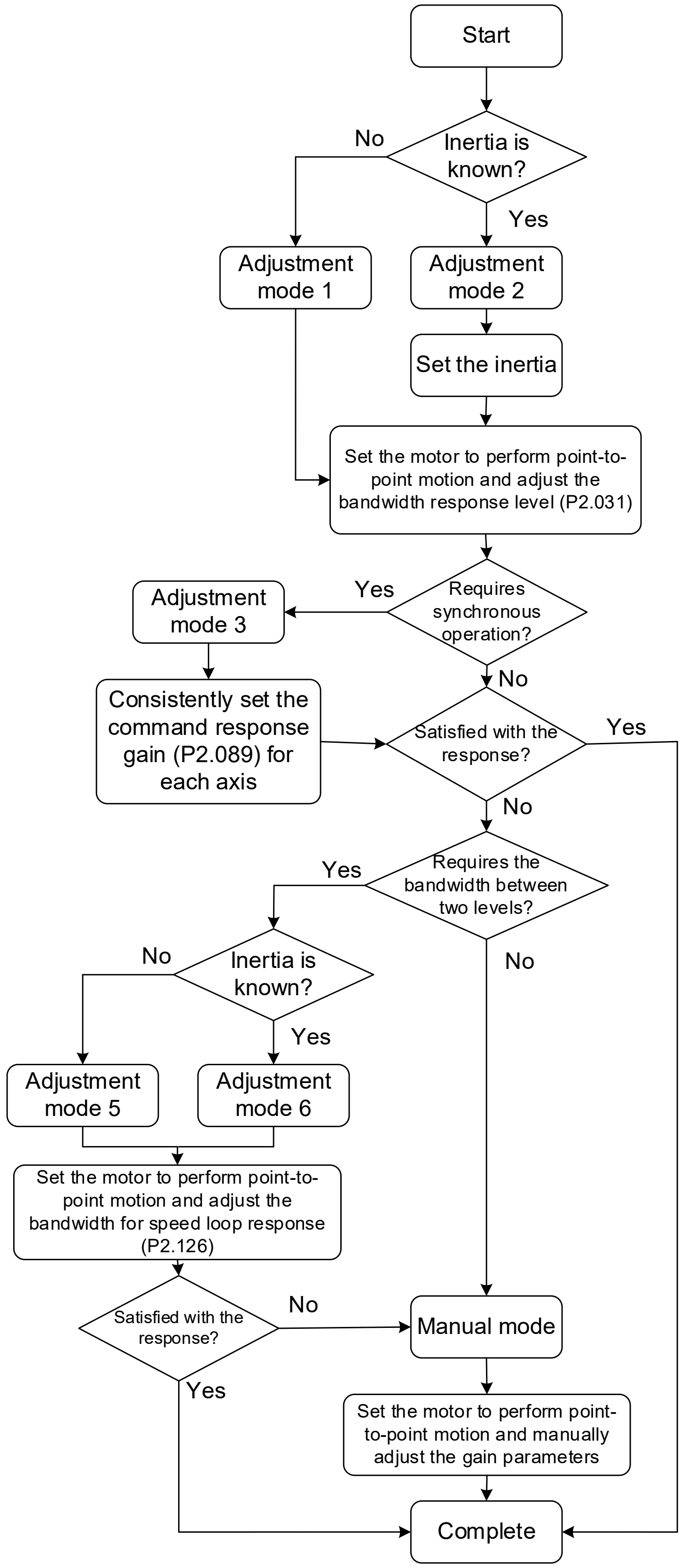
P2.032 value	Adjustment mode	Mode name	Inertia estimation	Parameter	
				Manual	Auto
5	Gain adjustment mode 5 (Same as setting P2-32 = 1 for the A2 series)	**Bandwidth adjustment** - Auto	Real-time estimation	P2.126	P1.037, P2.000, P2.004, P2.006, P2.023, P2.024, P2.025, P2.043, P2.044, P2.045, P2.046,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

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

5.5.2 Flowchart of gain adjustment mode



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

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5.5.3 Gain adjustment mode 1

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

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

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

5.5.4 Gain adjustment mode 2

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

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

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

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

5.5.5 Gain adjustment mode 3

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

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

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5.5.6 Gain adjustment mode 4

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

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

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

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

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

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

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5.5.7 Gain adjustment mode 5

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

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

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

5.5.8 Gain adjustment mode 6

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

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

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

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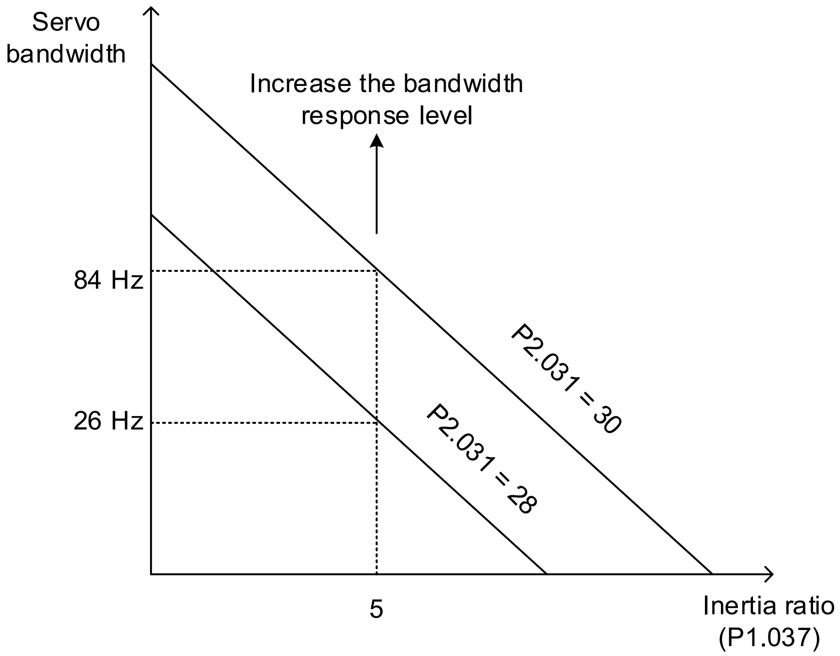
5.5.9 Parameters related to gain adjustment modes

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

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

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



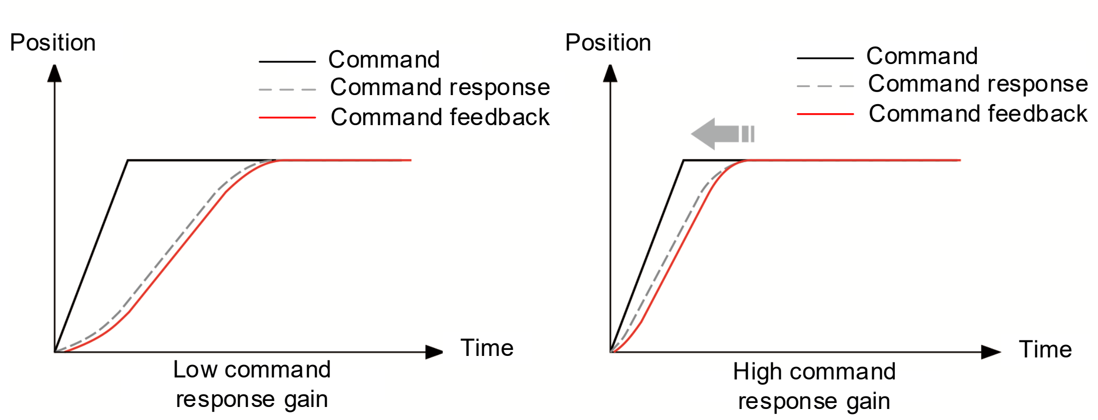
Bandwidth response level reversion (P2.125 [Bit 3])

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

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

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

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



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

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

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

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

5.6 Manual tuning of gain parameters

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

- P2.000 Position control gain (KPP)

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

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

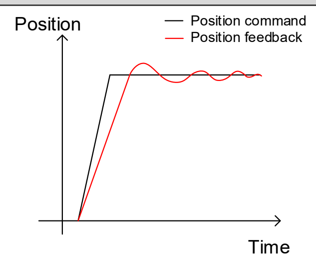
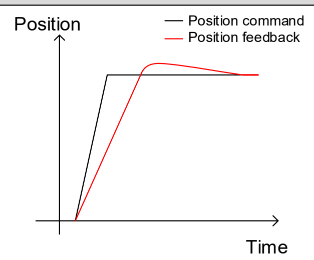
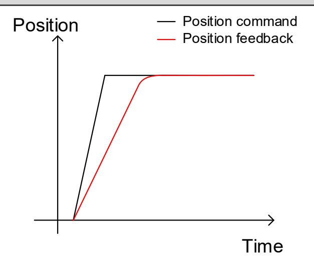
- P2.004 Speed control gain (KVP)

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

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

  JM: motor inertia; JL: load inertia

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

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

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

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

- P2.006 Speed integral compensation (KVI)

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

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

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

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

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

- P2.026 Anti-interference gain (DST)

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

  Note: p2.026 is invalid when the two degree of freedom control function is enabled (P2.094 [Bit 12] = 1).

- P2.002 Position feed forward gain (PFG)

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

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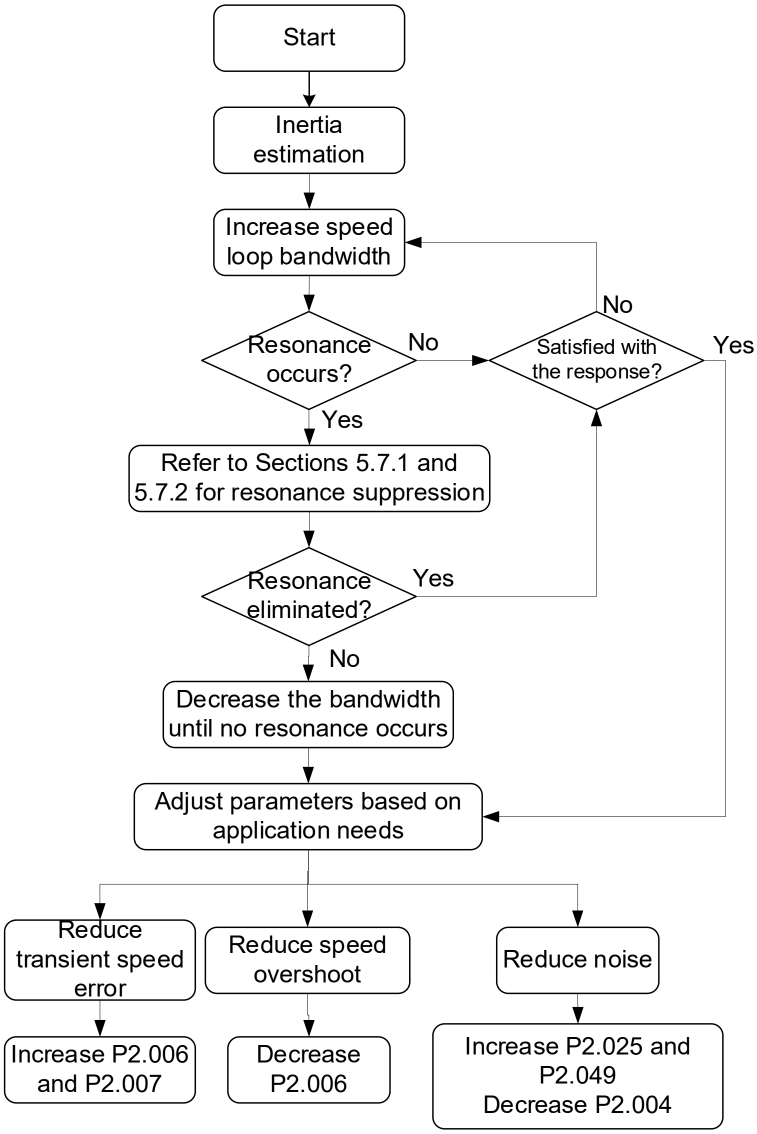
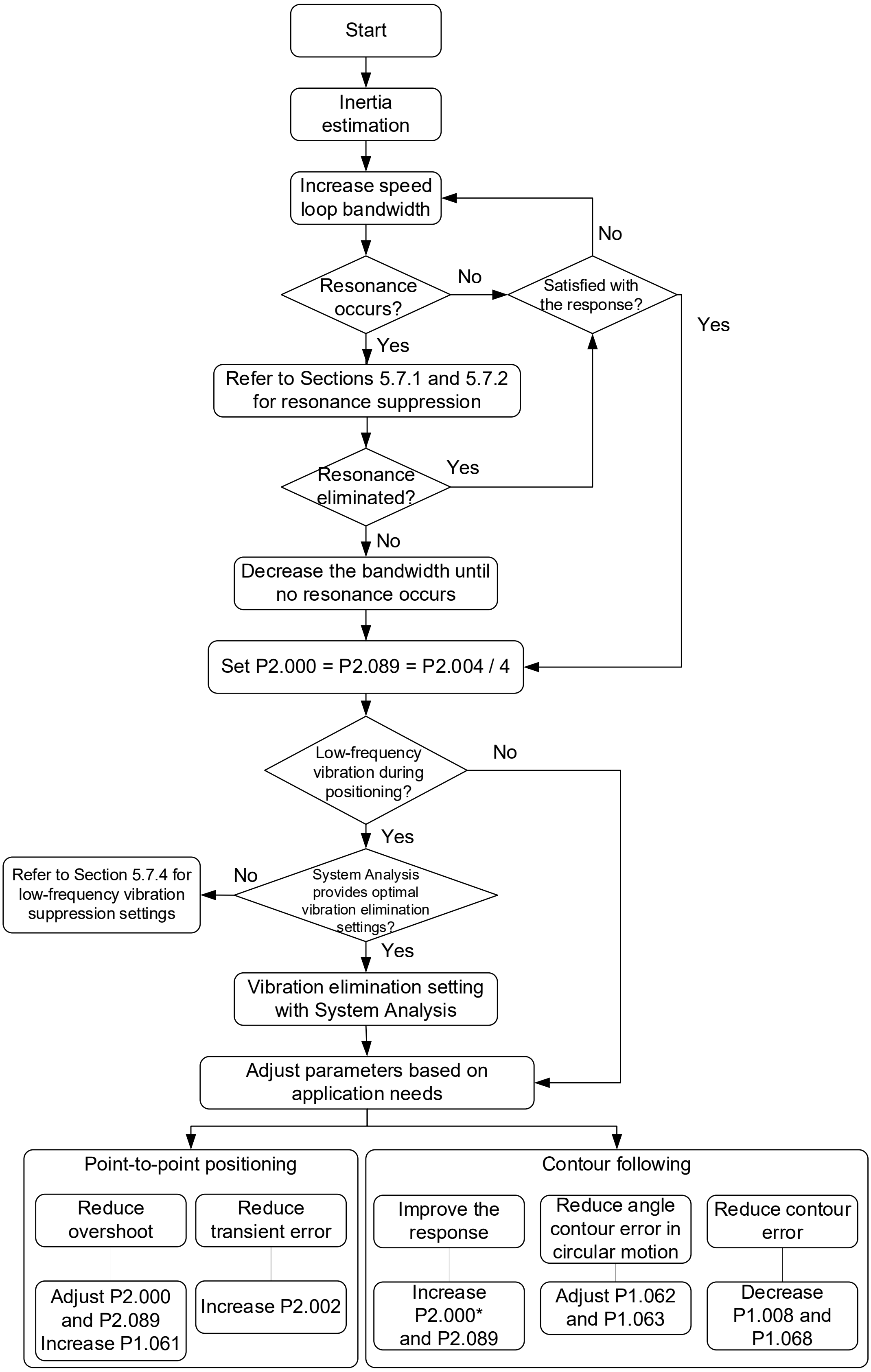
5.6.1 Flowchart of manual tuning in Speed mode



5.6.2 Flowchart of manual tuning in Position mode



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

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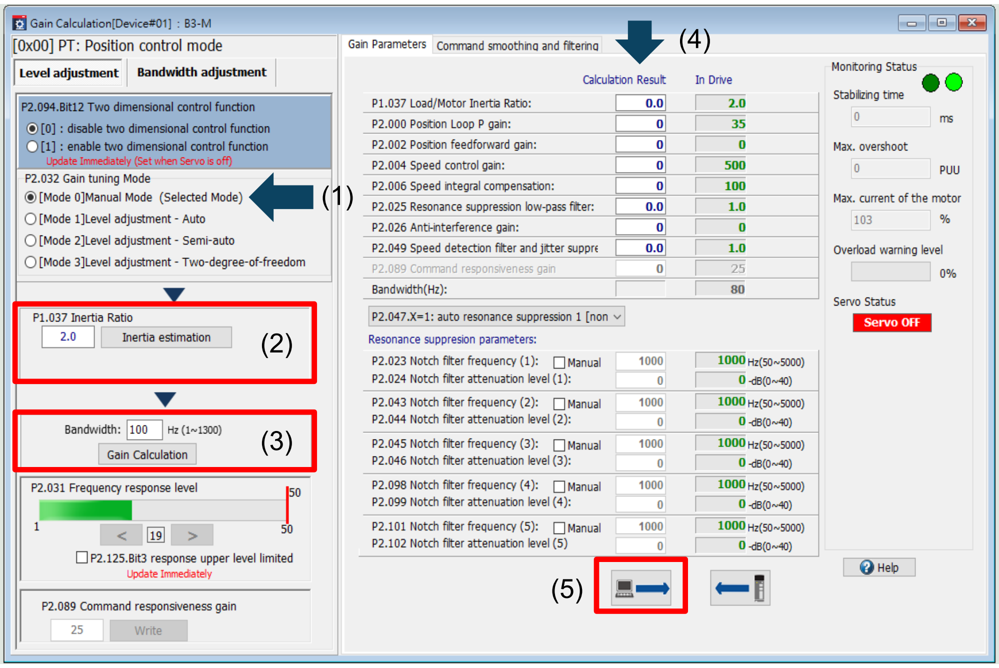
5.6.3 Manual tuning with ASDA-Soft

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

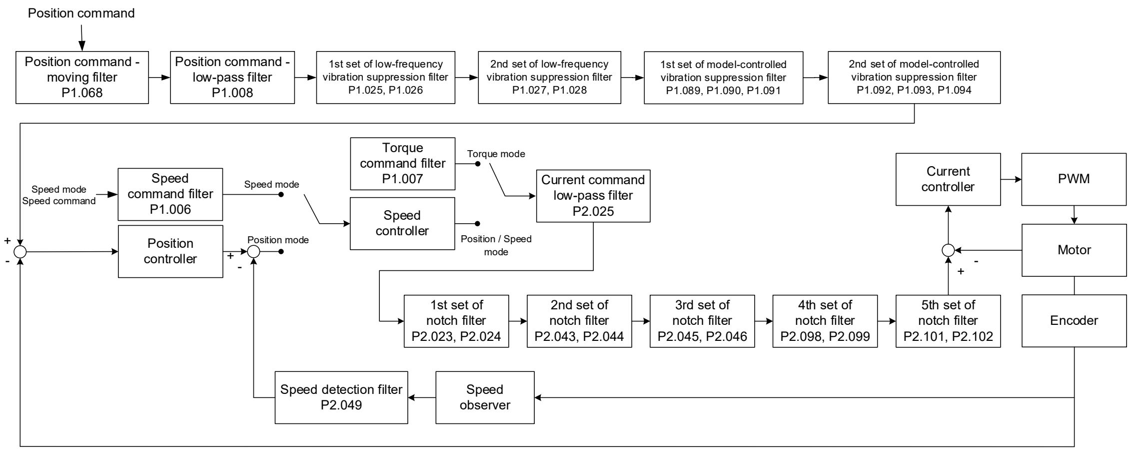
Note: for parameter settings of the two degree of freedom control function in Manual mode (P2.032 = 0), refer to Section 5.7.5.3.



5.7 Mechanical resonance suppression and noise elimination

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

Block diagram of filter setting



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5.7.1 Notch filter

5.7.1.1 Function restriction

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

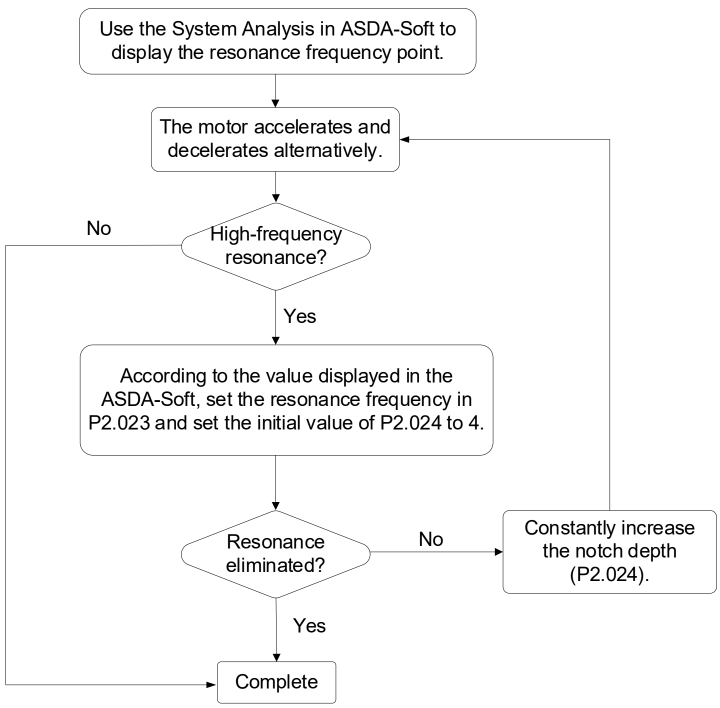
Note: it is recommended that you set the Analysis Type to **Speed Open-loop** in the System Analysis of ASDA-Soft; the zero-crossing frequency is the speed loop bandwidth.

5.7.1.2 Function description

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

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

Flowchart of manual resonance suppression:



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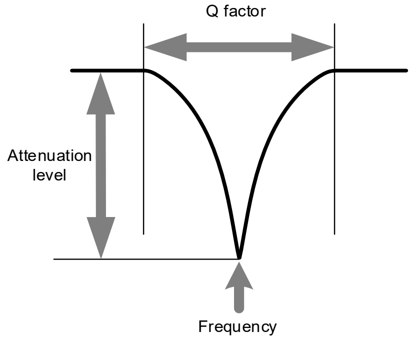
5.7.1.3 Parameter descriptions

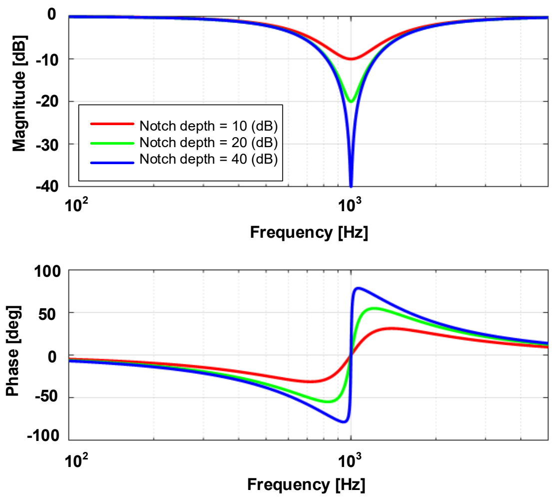
A notch filter is used to remove frequencies within a specific range. You can set the three parameters, including frequency, attenuation level, and Q factor, for each set of notch filter. The following describes the parameters of attenuation level (notch depth) and Q factor.



Attenuation level of notch filter

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

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



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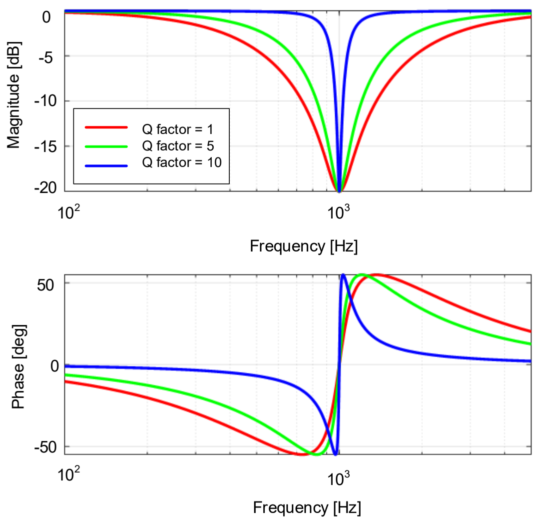
Q factor of notch filter

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

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



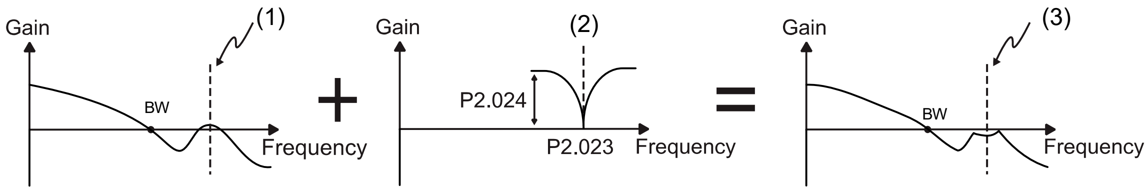
5.7.1.4 Application example

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

Frequency-domain analysis

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

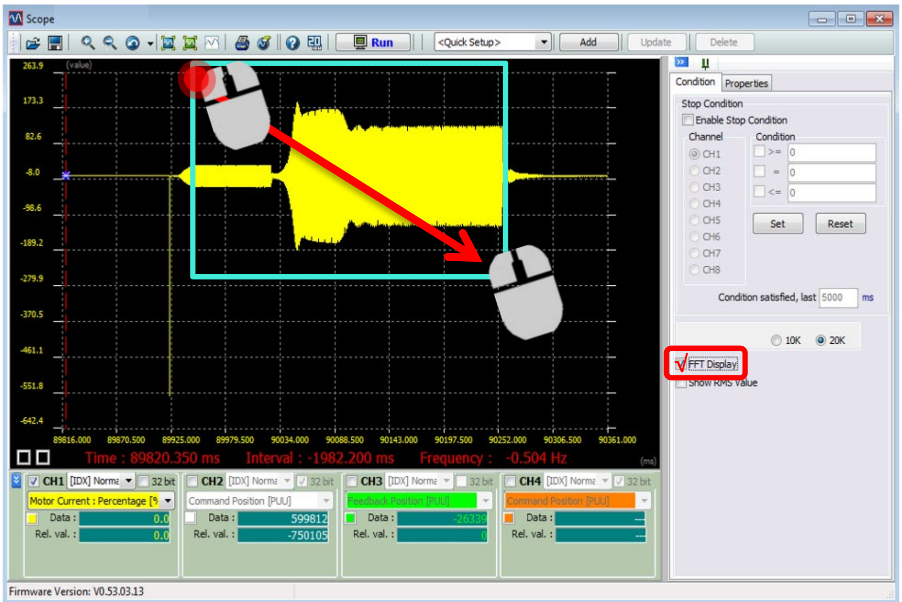
Note: when the frequency setting is lower than 100 Hz, it is advisable to select the check box for **Enable Low Frequency Analysis** in the System Analysis of ASDA-Soft. If the check box is not selected, the zero-crossing frequency might not be correctly detected or the low-frequency resonance point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



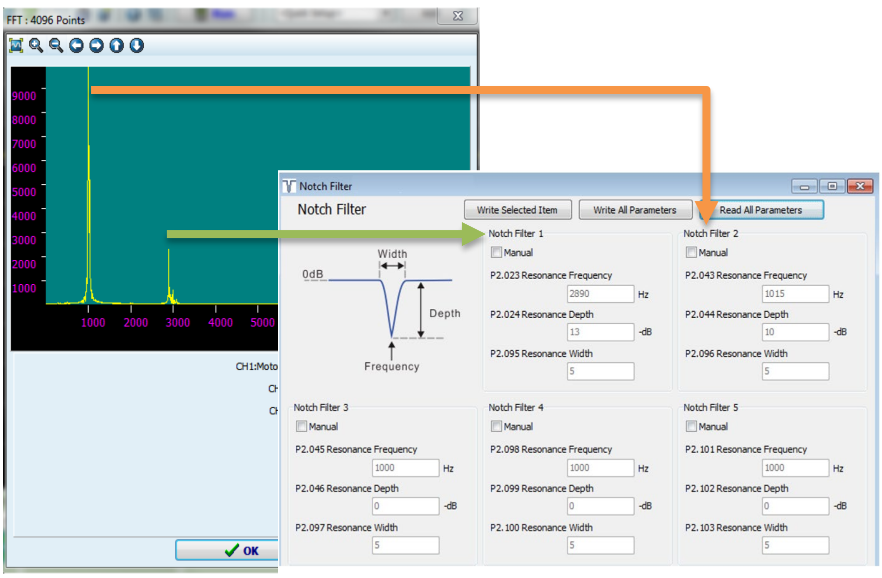
(1) Resonance point; (2) Notch filter; (3) Resonance point after resonance suppression

Time-domain analysis

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



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



Relevant parameter

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

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

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5.7.2 Resonance suppression low-pass filter

5.7.2.1 Function restriction

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

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

5.7.2.2 Function description

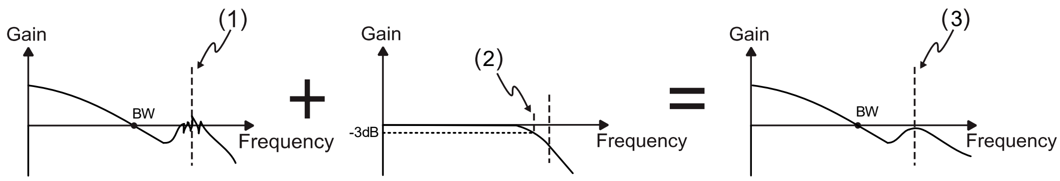
The current command generated in the speed loop is filtered by the resonance suppression low-pass filter, which reduces the interference of high-frequency resonance or noise to current control. Since the filter causes a delay in the current command, when increasing the servo response bandwidth, you must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

5.7.2.3 Application example

Draw Bode plots by setting the Analysis Type to **Speed Open-loop** in the System Analysis of ASDA-Soft. When there is more than one resonance point and the distribution of the resonance points is not wide, it is advisable to use the resonance suppression low-pass filter to suppress the resonance occurring at the resonance points within a specified range.

If the resonance frequency is known, the Notch filter works better than the resonance suppression low-pass filter for resonance suppression. If the spectrum displays multiple resonance points which are densely distributed, or the resonance frequency drifts significantly with time or due to other causes, use the resonance suppression low-pass filter instead.

When P2.025 is gradually increased, the filter bandwidth becomes smaller. Although resonance does not occur in this condition, the servo response is slower and the phase margin is reduced. If the ratio between the filter bandwidth (1000 / P2.025) and speed loop bandwidth (P2.004 / 2π) is too small, the system becomes unstable.



(1) Resonance point;

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

(3) Resonance point after resonance suppression

Relevant parameter

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

Parameter	Function
P2.025	Resonance suppression low-pass filter

5.7.3 Speed detection filter

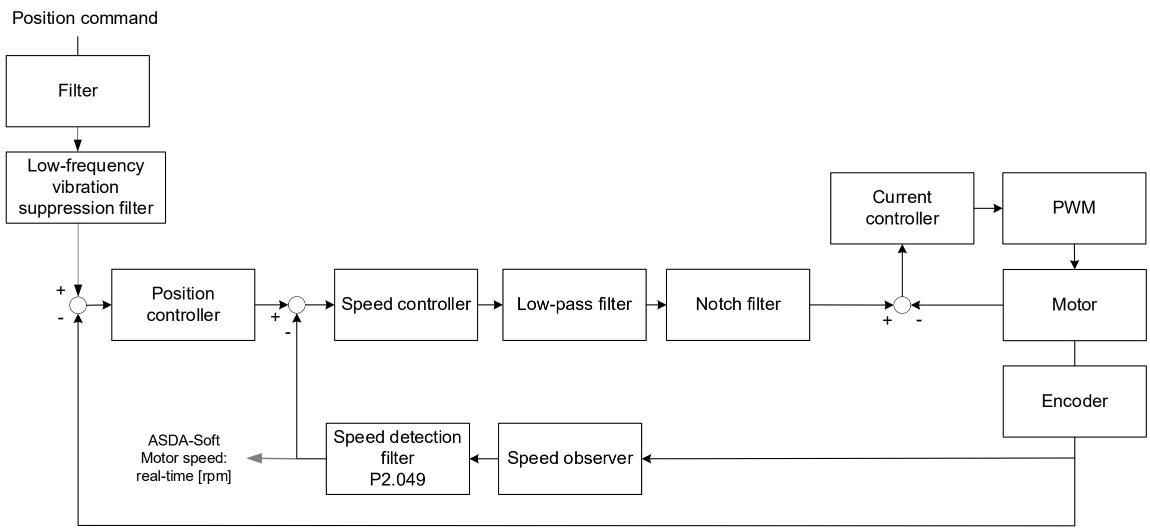
5.7.3.1 Function restriction

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

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

5.7.3.2 Function description

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



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

P2.084.U	Speed observer	Filter bandwidth	Applicable range
0	Speed observer 1	1000 / P2.049	Available for high resolution encoders.
1	Speed observer 2	The bandwidth cannot be adjusted.	Available for encoders or linear scales with low resolution, such as rotary encoders with the single-turn resolution smaller than 40000 pulse/rev used in low speed (< 100 rpm) applications, or linear encoders with the resolution greater than 5 μm/pulse.
2	Speed observer 3	1000 / P2.049	

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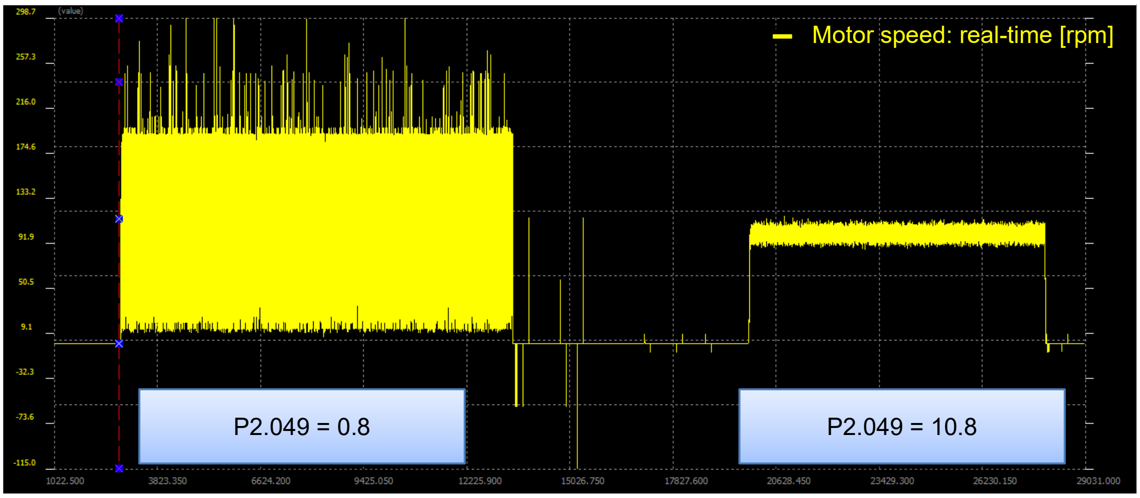
5.7.3.3 Application example

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



Relevant parameter

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

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

5.7.4 Low-frequency vibration suppression filter

5.7.4.1 Function restriction

5

1. Set the control mode (P1.001.YX) to Position mode (PT or PR).
2. Frequency range: 1.0 Hz to 100.0 Hz.
3. If the low-frequency vibration suppression function and the vibration elimination function are enabled simultaneously, the system response becomes slower.

5.7.4.2 Function description

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

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

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

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

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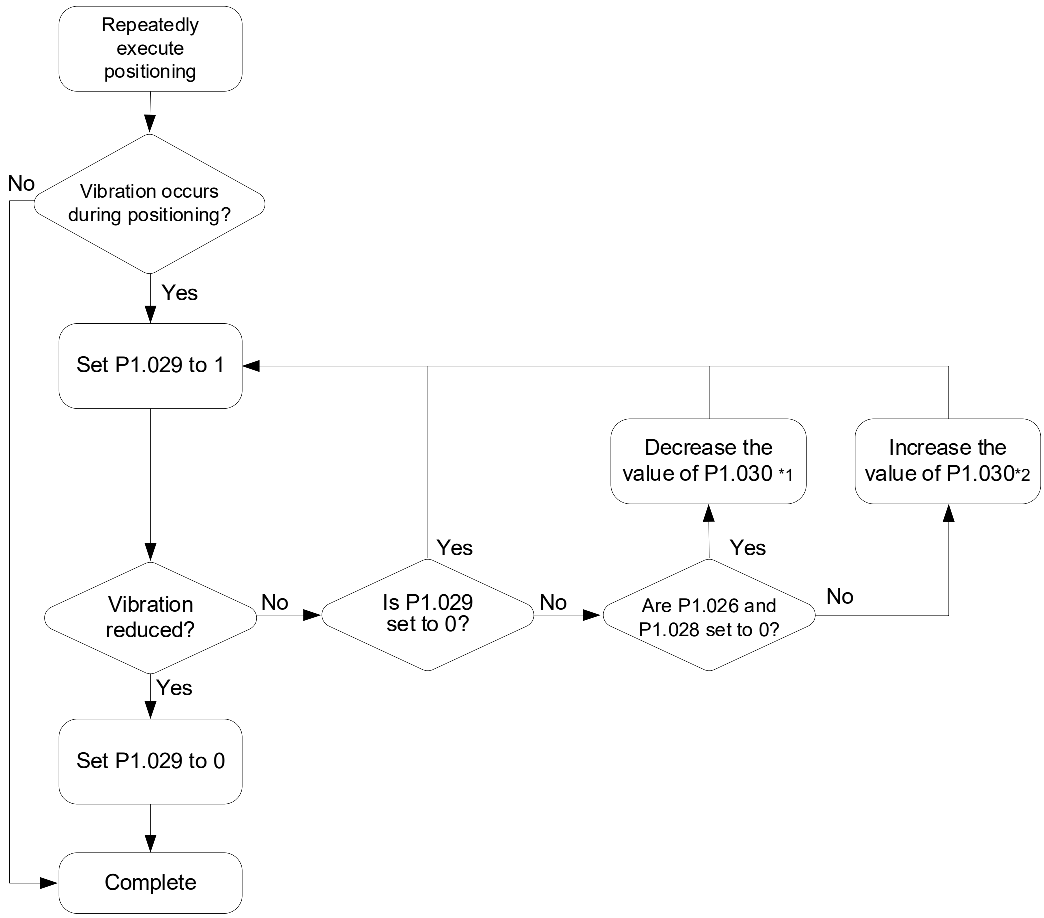
Flowchart of auto low-frequency vibration suppression:



Note:

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

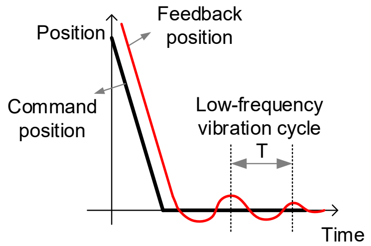
Manual setting:

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

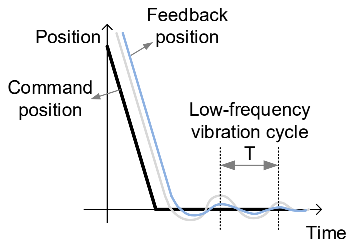
5.7.4.3 Application example

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

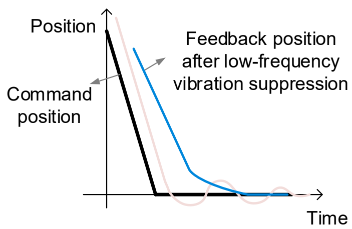
If the frequency of the low-frequency vibration in the system varies during operation, such as in a long-distance belt drive system, the vibration frequency may be different at two positioning points. In this case, set the two sets of low-frequency vibration suppression filters individually.



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



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



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

Relevant parameter

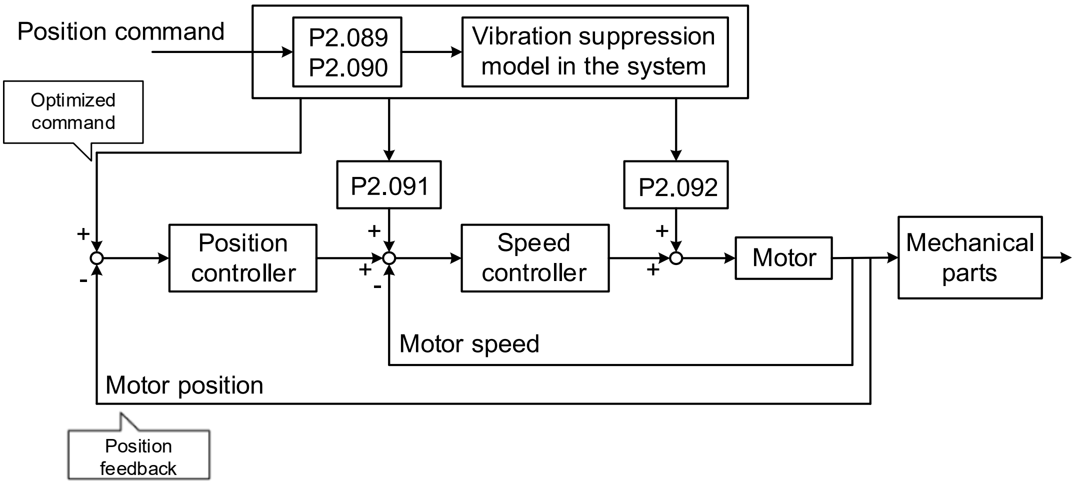
Refer to Chapter 8 for detailed descriptions of the relevant parameters.

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

5

5.7.5 Model-controlled vibration suppression filter

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



5.7.5.1 Restrictions of the two degree of freedom control function

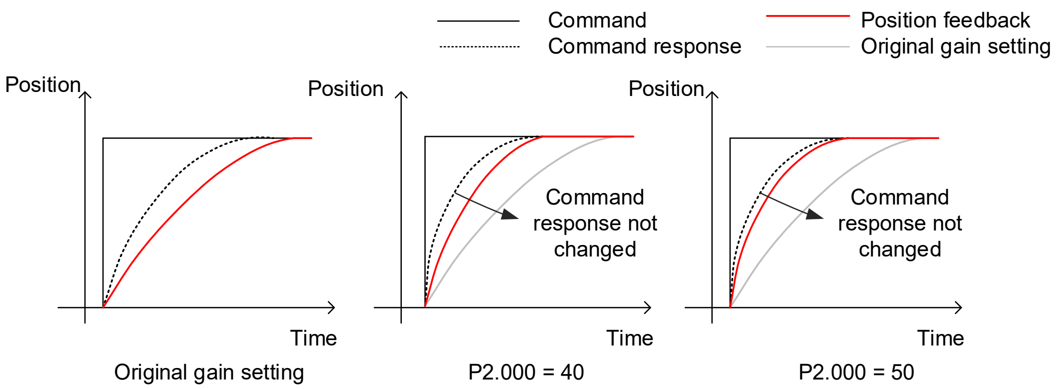
Setting P2.094 [Bit 12] to 1 enables the two degree of freedom control mode, but you need to pay attention to the following restrictions.

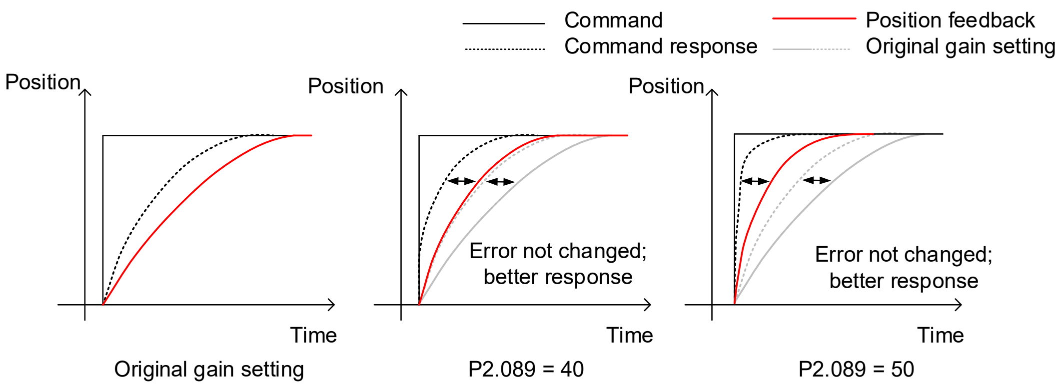
1. Set the control mode (P1.001.YX) to Position mode (PT or PR).
2. Set the inertia ratio (P1.037) correctly when using this function.
3. The setting of anti-interference gain (P2.026) is invalid when this function is used.

5.7.5.2 Function description of two degree of freedom control function

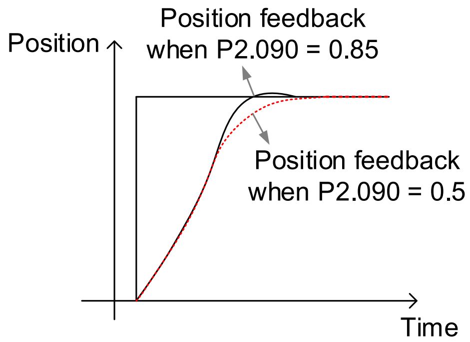
When the two degree of freedom control function is enabled (P2.094 [Bit 12] = 1), set P2.000 and P2.089 for better position response.

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



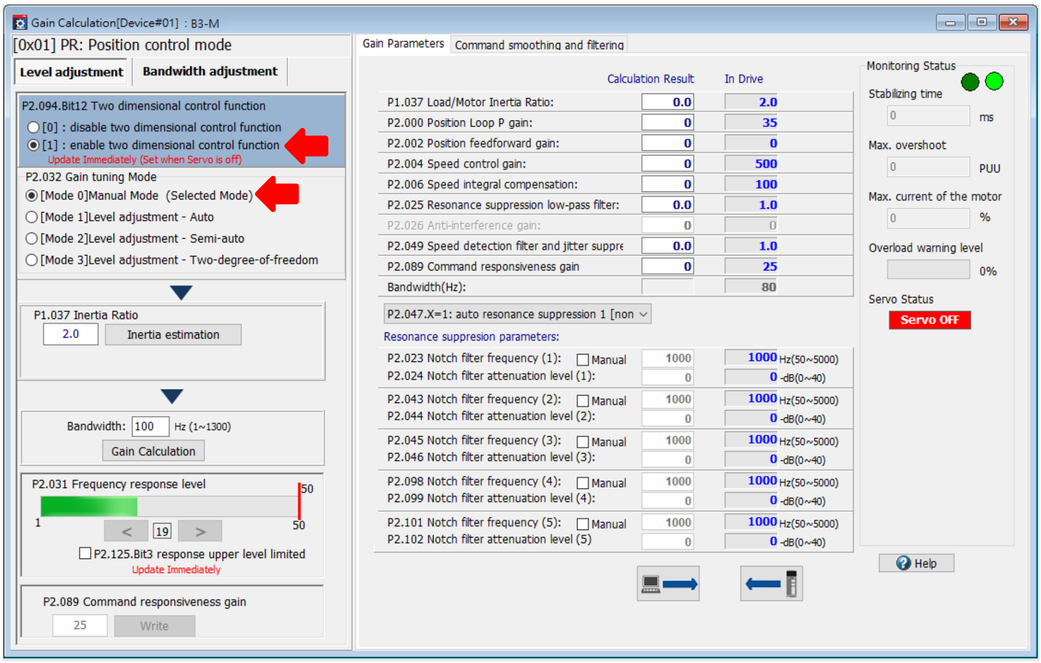


Setting P2.090 (Two degree of freedom mode - anti-interference gain) can adjust the position settling waveform but does not change the command response time. Setting P2.090 to a smaller value lowers the response after the command is complete but reduces the position feedback overshoot.



5.7.5.3 Application example of two degree of freedom control function

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



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

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

Relevant parameter

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

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

5.7.5.4 Restrictions of vibration elimination

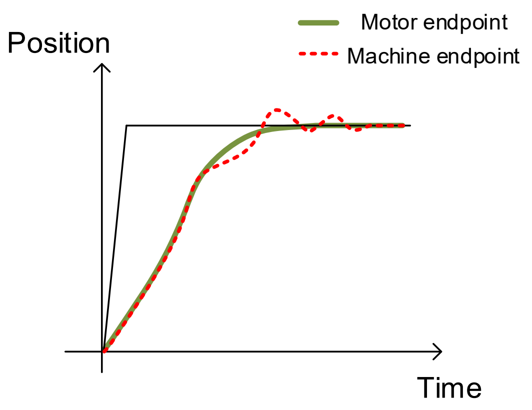
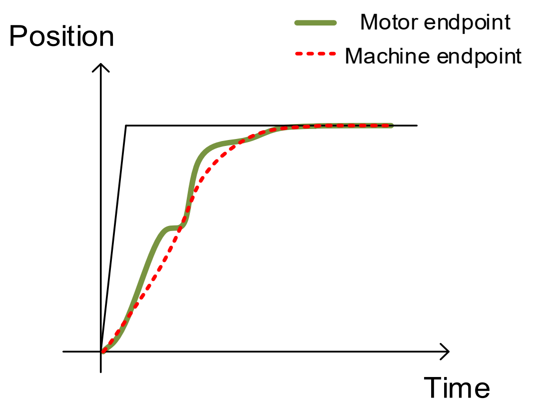
1. The two degree of freedom control function must be enabled (P2.094 [Bit 12] = 1).
2. Frequency range: 1.0 Hz to 400.0 Hz.
3. You can enable two sets of vibration elimination functions simultaneously for -E and -F models, while you can enable only one set of vibration elimination function for -M and -L models.

5.7.5.5 Function description of vibration elimination

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

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

After the vibration elimination function is enabled, the servo adjusts the motor command according to the internal model. When you monitor the motor position feedback in the scope, there might be a jitter, but the machine endpoint is stable when settling.

Vibration elimination not enabled	Vibration elimination enabled
	

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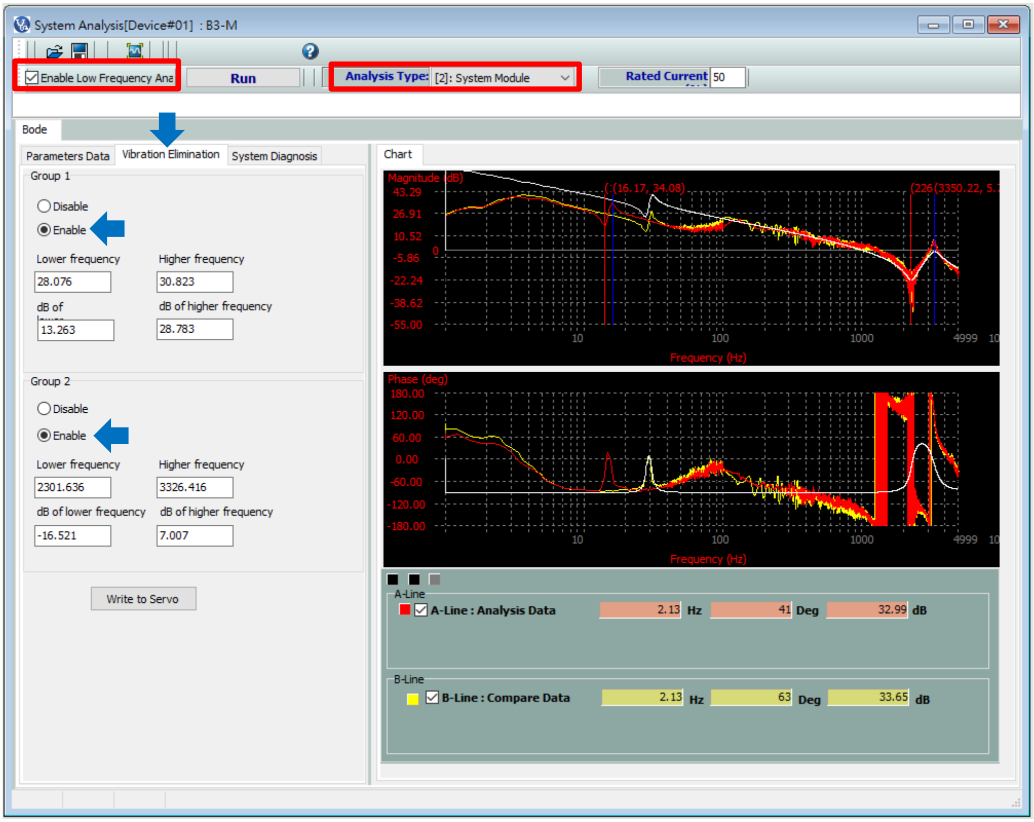
5.7.5.6 Application example of vibration elimination

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



Relevant parameter

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

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

5

5.7.6 Position command filter

5.7.6.1 Function restriction

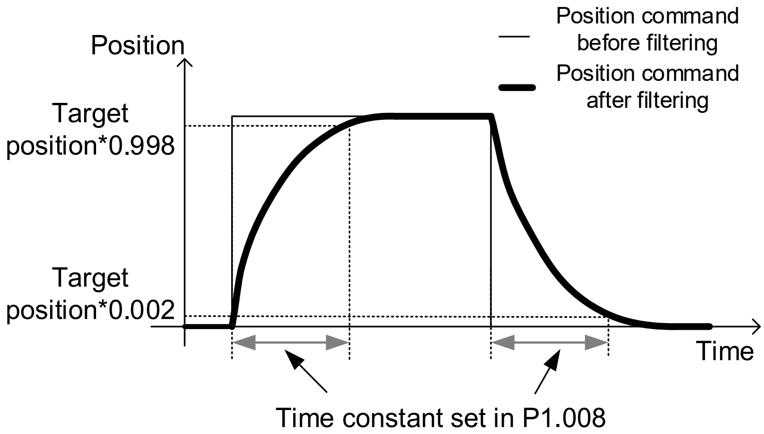
Set the control mode (P1.001.YX) to Position mode (PT or PR).

5.7.6.2 Function description

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

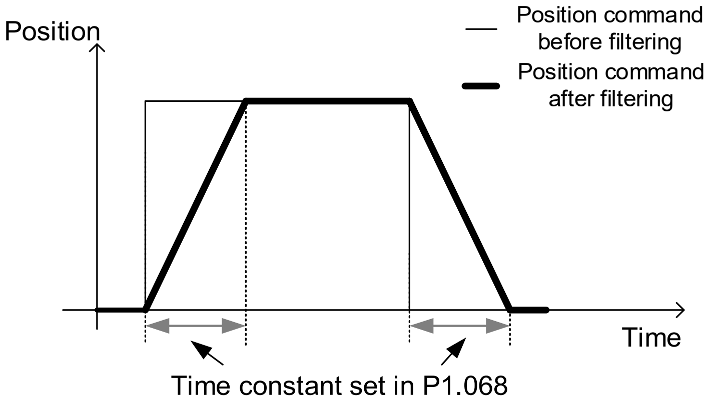
Position command - smoothing constant (low-pass filter) (P1.008)

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



Position command - moving filter (P1.068)

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



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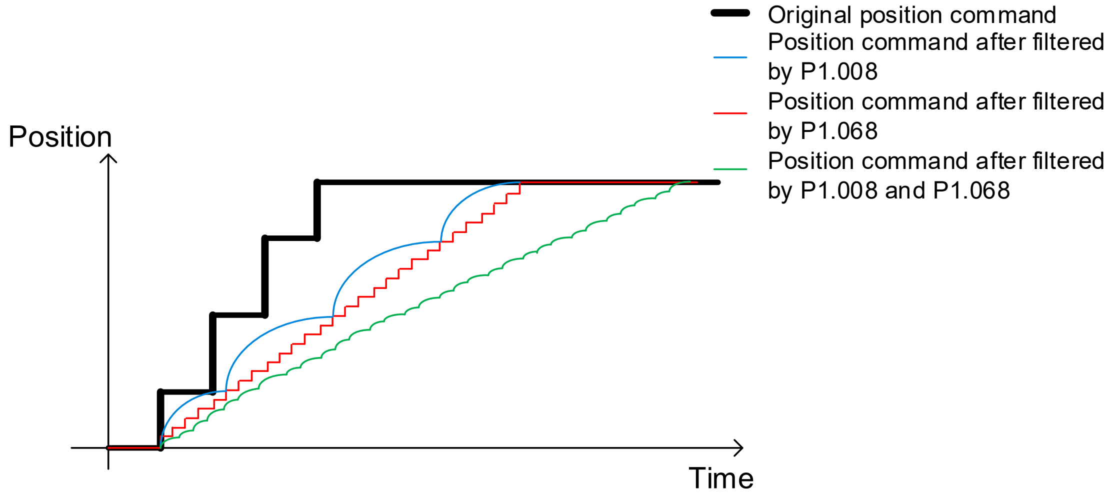
5.7.6.3 Application example

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



Relevant parameter

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

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

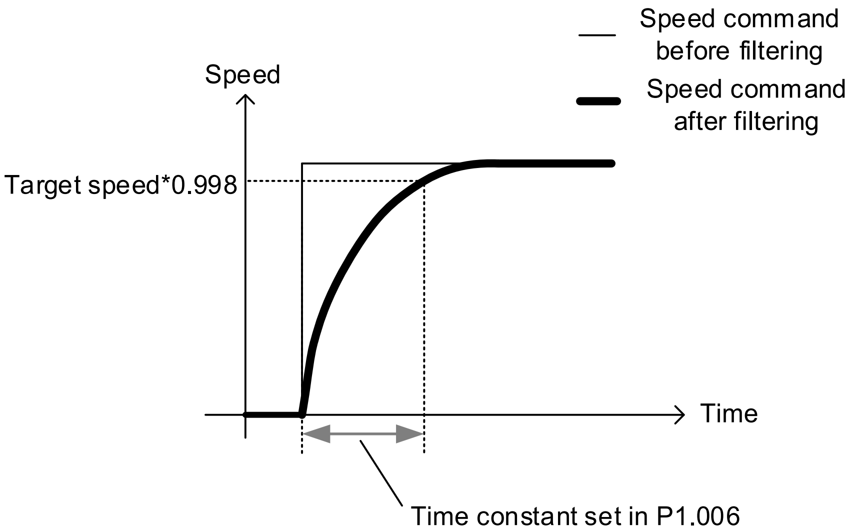
5.7.7 Speed command filter

5.7.7.1 Function restriction

Set the control mode (P1.001.YX) to Speed mode (S or Sz).

5.7.7.2 Function description

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



5.7.7.3 Application example

When the position control circuit of the machine is built in the controller, the servo is in analog Speed mode (S) and receives the external analog voltage speed command issued by the controller. To reduce the analog voltage noise, which can be detected by setting the channel to **Speed command: Voltage [Volt]** in the Scope function of ASDA-Soft, increase the setting value of P1.006. However, if the filter time is set too long, the position control response of the controller becomes slower. If desiring to keep the position control response stable, set the filter bandwidth 8 times (or more) the position bandwidth of the controller.

Relevant parameter

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

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

5

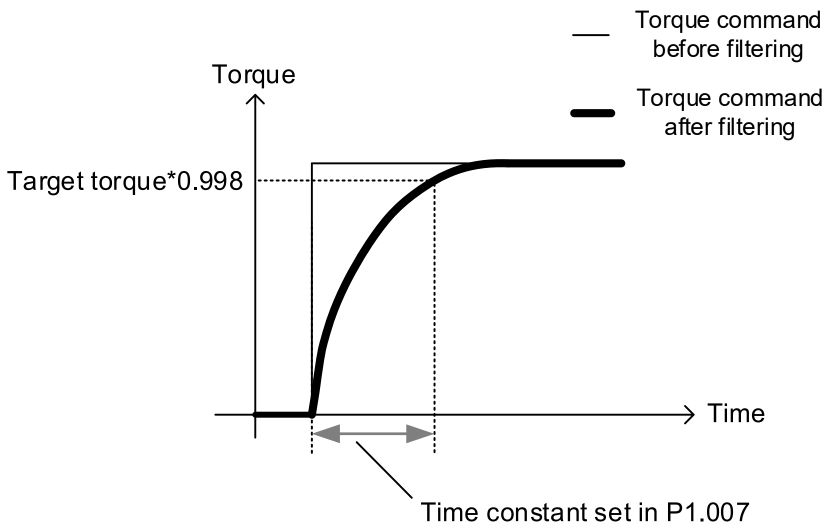
5.7.8 Torque command filter

5.7.8.1 Function restriction

Set the control mode (P1.001.YX) to Torque mode (T or Tz).

5.7.8.2 Function description

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



5.7.8.3 Application example

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

Relevant parameter

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

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

5

5.8 Application function adjustment

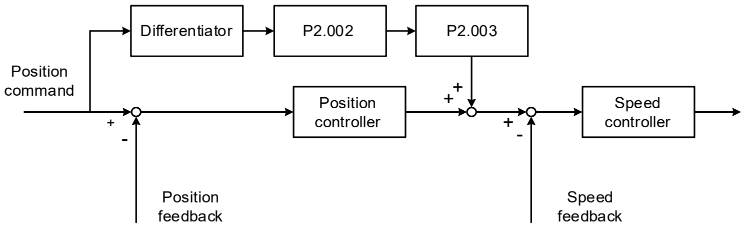
5.8.1 Adjusting position error in constant speed zone

5.8.1.1 Function restriction

1. When using P2.002 and P2.003, set the control mode (P1.001.YX) to Position mode (PT, PR).
2. When using P2.007, set the control mode (P1.001.YX) to Position or Speed mode (PT, PR, S, Sz).

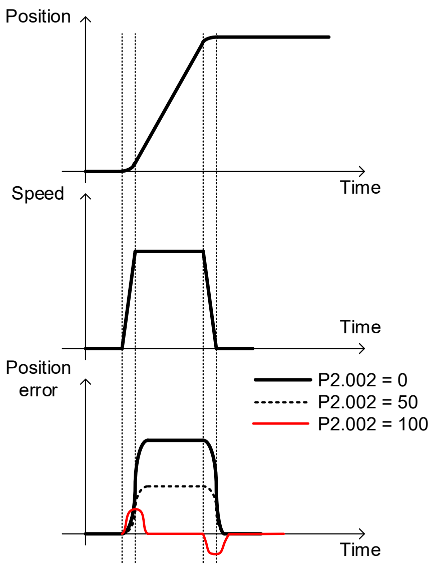
5.8.1.2 Function description

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



P2.002 Position feed forward gain

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



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P2.003 Position feed forward gain smoothing constant

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

P2.007 Speed feed forward gain

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

5.8.1.3 Application example

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

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

Relevant parameter

Refer to Chapter 8 for detailed descriptions.

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

5

5.8.2 Position overshoot adjustment

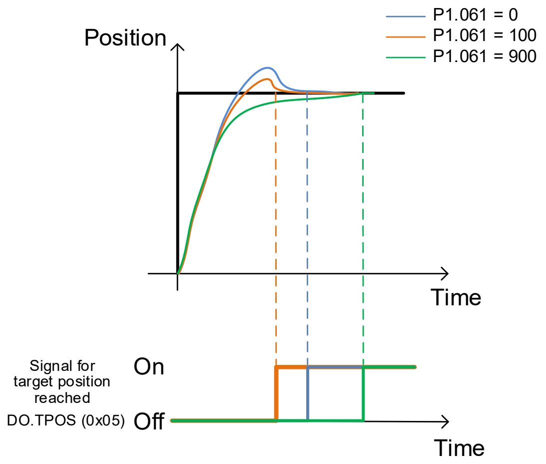
5.8.2.1 Function restriction

When using this function, set the control mode (P1.001.YX) to Position or Speed mode (PT, PR, S, or Sz).

5.8.2.2 Function description

The position overshoot occurred during positioning may be caused by the high value of P2.002 or a great change in the system friction. Lowering the setting of P2.002 or properly setting the viscous friction compensation can reduce the position overshoot.

When using P1.061 (Viscous friction compensation), set P1.062 (Percentage of friction compensation) to a non-zero value. P1.061 is the torque compensation amount based on the speed change, which unit is 0.1%/1000 rpm. It is recommended that you first set this parameter to 100, then 200, and then gradually increase the setting value. Setting the value too high may cause an increased overshoot or a longer settling time with an unchanged overshoot.



5.8.2.3 Application example

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

Relevant parameter

Refer to Chapter 8 for detailed descriptions.

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

5

5.8.3 Multi-axis contour control

5.8.3.1 Function restriction

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

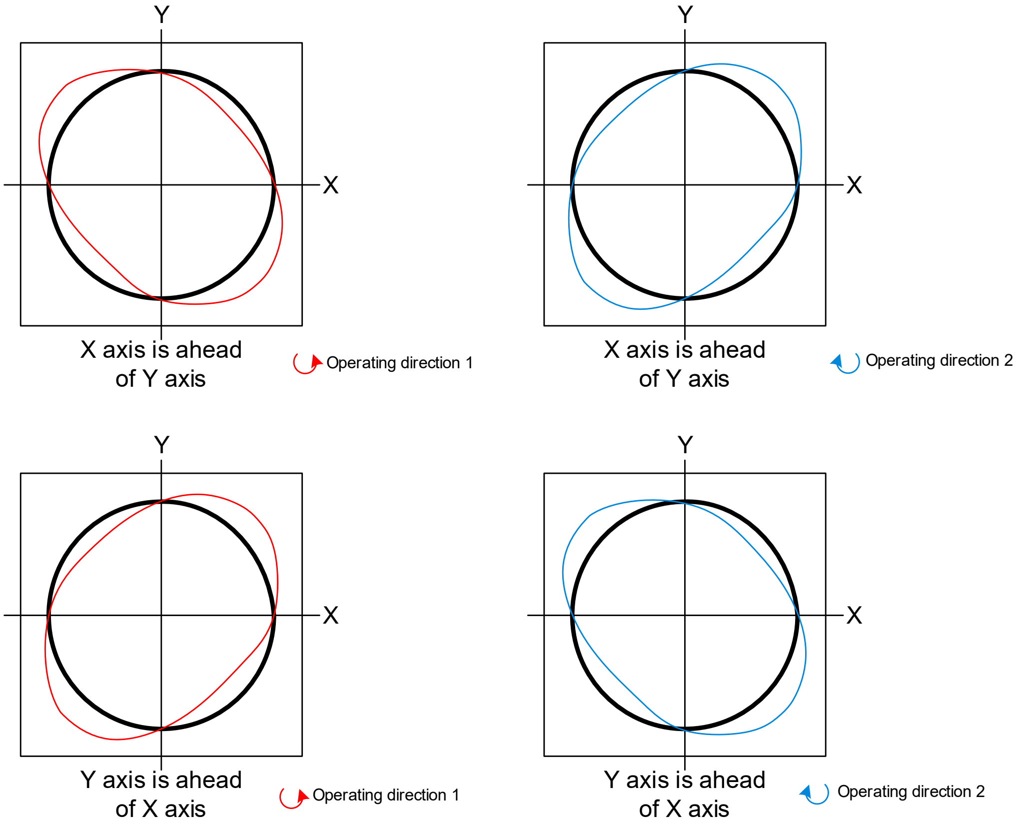
5.8.3.2 Function description

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

1. When the filter parameter settings (P1.008, P1.068) of each axis are inconsistent, the response of the axis with a lower filter parameter setting goes ahead of the other axes.
2. When the position gain parameter settings (P2.000, P2.002, P2.089) of each axis are inconsistent, the response of the axis set with a higher position gain goes ahead of the other axes.
3. After all axes are tuned, if their speed loop bandwidth settings (P2.004 / 2π) are inconsistent but the contours remain undistorted, you can apply the position gain parameter settings of the axis with the lowest bandwidth to the other axes.

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

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



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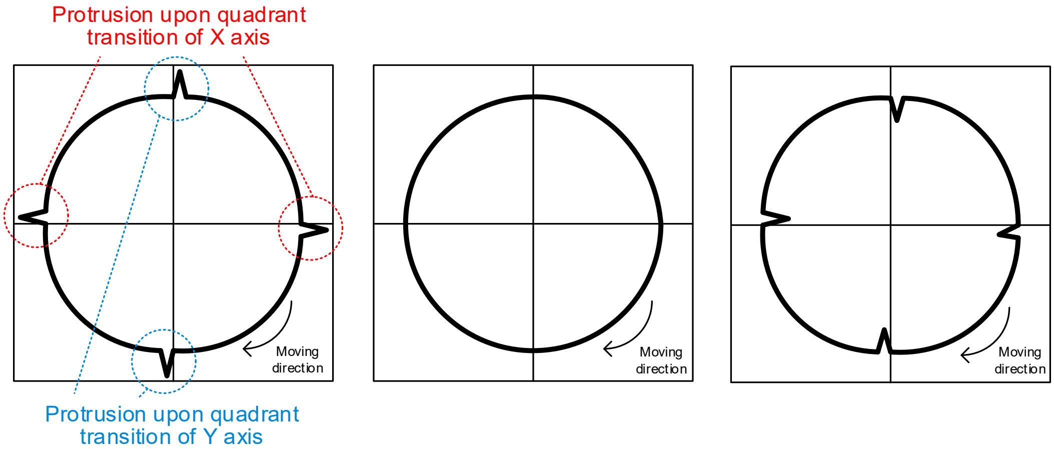
5.8.3.3 Application example

Adjusting the contour errors:

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

Manual adjustment:

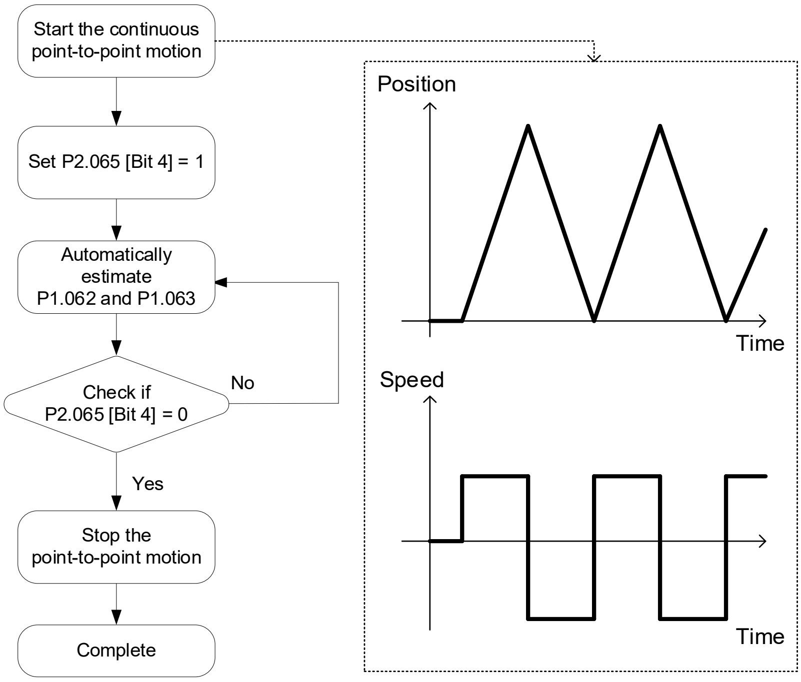
Take the circular motion for example; you can gradually increase the value of P1.062 until the quadrant protrusion disappears and the quadrant becomes concave, and then start adjusting P1.063. On the basis of the default 100% of P1.063, the lower the value of P1.063, the sooner the system reaches the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



Undercompensation of friction | Proper compensation of friction | Overcompensation of friction

Auto adjustment:

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



Relevant parameter

Refer to Chapter 8 for detailed descriptions.

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

5

5.8.4 Gain switching

5.8.4.1 Function restriction

1. When P2.027.X is set to 0, 1, 2, 4, 5, 6, or 8, P1.078 (Gain switching delay time) is not supported.
2. When P2.027.X is set to 3 or 7, P1.078 (Gain switching delay time) is supported.

5.8.4.2 Function description

Increasing the gain during operation can achieve a better command following and shorter settling time. Reducing the gain when the servo motor is in a stop state can reduce the high frequency noise and vibration.
During the gain switching process, if the servo motor operation is not smooth, increasing the gain switching time constant (P2.028) can smooth the gain switching process.
The servo automatically switches the relevant control parameters based on the value set for P2.027.X (Gain switching condition); however, you need to additionally set the change rate of the parameter (refer to the “After switching” columns in the following page).

5.8.4.3 Application example

The control mode and whether P1.078 is supported are determined by the gain switching conditions. Refer to the following descriptions.

P2.027.X: gain switching condition

X	Condition	Control mode	P1.078 Gain switching delay time
0	Disable gain switching function.	-	-
1	Signal of gain switching (DI.GAINUP: 0x03) is on.	All	-
2	In Position control mode, position error (P0.002 = 33) is larger than P2.029.	PT / PR	-
3	Position command frequency (P0.002 = 6) is larger than P2.029.	PT / PR	Supported
4	Motor speed (P0.002 = 51) is faster than P2.029.	All	-
5	Signal of gain switching (DI.GAINUP: 0x03) is off.	All	-
6	In Position control mode, position error (P0.002 = 33) is smaller than P2.029.	PT / PR	-
7	Position command frequency is smaller than P2.029.	PT / PR	Supported
8	Motor speed is slower than P2.029.	All	-

P2.027.Y: gain switching method

0: gain rate switching

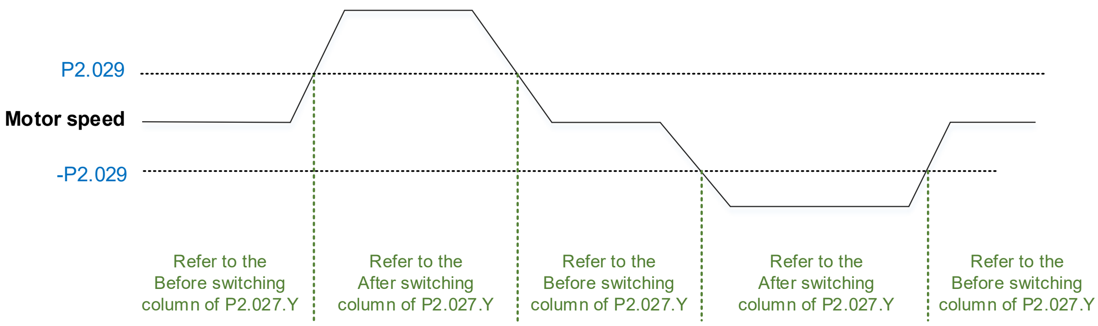
1: integrator switching (switch from P controller to PI controller)

PT / PR			
Y = 0		Y = 1	
Before switching	After switching	Before switching	After switching
P2.000 x 100%	P2.000 x P2.001	P2.000 x 100%	P2.000 x P2.001
P2.004 x 100%	P2.004 x P2.005	P2.004 x 100%	P2.004 x 100%
P2.025 x 100%	P2.025 x P2.107	P2.025 x 100%	P2.025 x P2.107
P2.026 x 100%	P2.026 x 100%	P2.026 x 0%	P2.026 x 100%
P2.049 x 100%	P2.049 x P1.080	P2.049 x 100%	P2.049 x P1.080

S / Sz			
Y = 0		Y = 1	
Before switching	After switching	Before switching	After switching
P2.004 x 100%	P2.004 x P2.005	P2.004 x 100%	P2.004 x 100%
P2.025 x 100%	P2.025 x P2.107	P2.025 x 100%	P2.025 x P2.107
P2.026 x 100%	P2.026 x 100%	P2.026 x 0%	P2.026 x 100%
P2.049 x 100%	P2.049 x P1.080	P2.049 x 100%	P2.049 x P1.080

When **P2.027.X is set to 0, 1, 2, 4, 5, 6, or 8**, P1.078 (Gain switching delay time) is not supported. P2.027.X = 4 is taken as the example in the following figure.

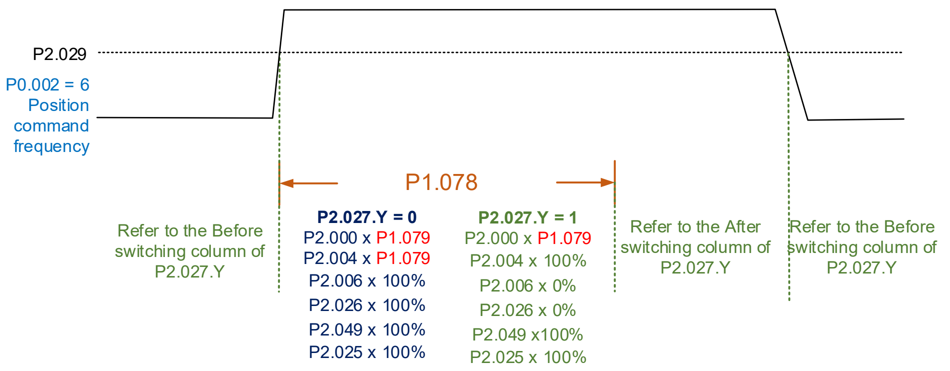
P2.027.X = 4



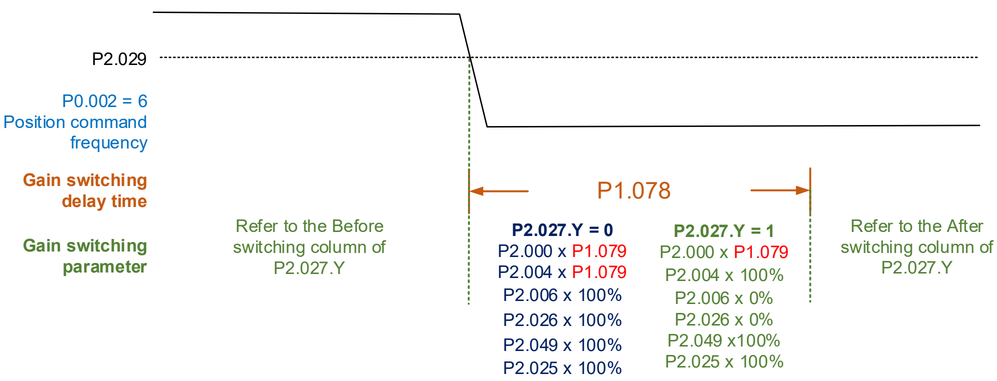
5

When P2.027.X is set to 3 or 7 and P1.078 (Gain switching delay time) is set, the gain parameter during the delay time is adjusted as follows.

P2.027.X = 3



P2.027.X = 7



Relevant parameter

Refer to Chapter 8 for detailed descriptions.

Parameter	Function
P1.078	Gain switching delay time
P2.027	Gain switching condition and method selection
P2.028	Gain switching time constant
P2.029	Gain switching condition

Control Mode 6

This chapter describes the control structure of each mode, including the usage of gain adjustment and filters. For Position mode, you can 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 external analog voltage input. In addition to the single modes, users can also use dual modes and multi-modes according to their needs.

6.1 Selecting the control mode

This servo drive provides three basic control modes, Position, Speed, and Torque, and communication modes. For the basic control mode, you can choose from the single modes, dual modes, and multi-modes. The following table lists all the available modes and corresponding descriptions.

Mode		Short name	Code	Description
Single mode	Position mode (Terminal block input)	PT	00	The servo drive receives the Position command and controls the motor to move to the target position. The Position commands are input from the external terminal block and the signal type is pulse.
	Position mode (Internal register)	PR	01	The servo drive receives the Position command and controls the motor to move to the target position. The Position commands are issued from the internal registers (100 sets in total). Select the register number with DI signals or through communication.
	Speed mode	S	02	The servo drive receives the Speed command and controls the motor to reach the target speed. The Speed commands are issued from the internal registers (3 sets in total) or by analog voltage (-10V to +10V) input from the external terminal block. Select the command with DI signals.
	Speed mode (No analog input)	Sz	04	The servo drive receives the Speed command and controls the motor to reach the target speed. The Speed command can only be issued from the internal registers (3 sets in total) instead of from the external terminal block. Select the command with DI signals.
	Torque mode	T	03	The servo drive receives the Torque command and controls the motor to reach the target torque. The Torque commands are issued from the internal registers (3 sets in total) or by analog voltage (-10V to +10V) which is input from the external terminal block. Select the command with DI signals.
	Torque mode (No analog input)	Tz	05	The servo drive receives the Torque command and controls the motor to reach the target torque. The Torque command can only be issued from the internal registers (3 sets in total) instead of from the external terminal block. Select the command with DI signals.
Dual mode		S-PT	06	Switch S and PT modes with DI signals.
		T-PT	07	Switch T and PT modes with DI signals.
		S-PR	08	Switch S and PR modes with DI signals.
		T-PR	09	Switch T and PR modes with DI signals.
		S-T	0A	Switch S and T modes with DI signals.
		PT-PR	0D	Switch PT and PR modes with DI signals.
Communication mode		CANopen	0B	The dedicated communication mode for Delta's DVP-15MC PLC controller.
		DMCNET		DMCNET mode.
		CANopen	0C	CANopen mode.
		EtherCAT		EtherCAT mode.
		PROFINET		PROFINET mode.
Multi-mode		PT-PR-S	0E	Switch PT, PR, and S modes with DI signals.
		PT-PR-T	0F	Switch PT, PR, and T modes with DI signals.

Here are the steps to switch the control modes:

1. Switch the servo drive to the Servo Off state. You can do this by setting DI.SON to Off.
2. Set P1.001 by referring to the codes listed in the preceding table to set the control mode.
3. After setting P1.001, cycle power on the servo drive.

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

6.2 Position mode

The servo drive can receive two types of position control commands: external pulse (PT mode) and internal register (PR mode).

In PT mode, the servo drive receives the pulse command for the moving direction (motor runs forward or reverse). The input pulse controls the rotation angle of the motor. The servo drive can receive pulse commands of up to 4 Mpps.

In PR mode, the internal registers allow users to accomplish position control without the external pulse command. The servo drive provides 100 sets of command registers. Set the required registers first before switching the drive to the Servo On state. There are two ways to select the commands. One is setting DI.POS0 - DI.POS6 of CN1, and the other is directly setting the register values through communication.

6.2.1 Position command in PT mode

The PT position command source 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 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

6

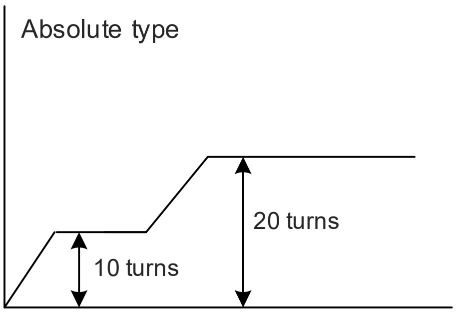
The PR position command source is the 100 sets of internal command registers (P6.000 - P7.099). Use DI.POS0 - POS6 of CN1 (0x11, 0x12, 0x13, 0x1A, 0x1B, 0x1C, 0x1E) to select one of the 100 sets as the Position command and then trigger the command with DI.CTRG (0x08). See the following table for more details.

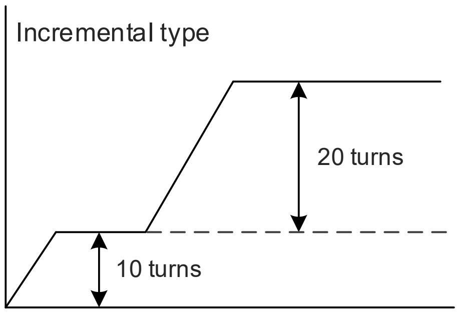
Position command	POS6	POS5	POS4	POS3	POS2	POS1	POS0	CTRG	Corresponding parameter
Homing	0	0	0	0	0	0	0	↑	P6.000
									P6.001
PR#01	0	0	0	0	0	0	1	↑	P6.002
									P6.003
…									…
PR#50	0	1	1	0	0	1	0	↑	P6.098
									P6.099
PR#51	0	1	1	0	0	1	1	↑	P7.000
									P7.001
…									…
PR#99	1	1	0	0	0	1	1	↑	P7.098
									P7.099

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 the DI is switched from Off to On.

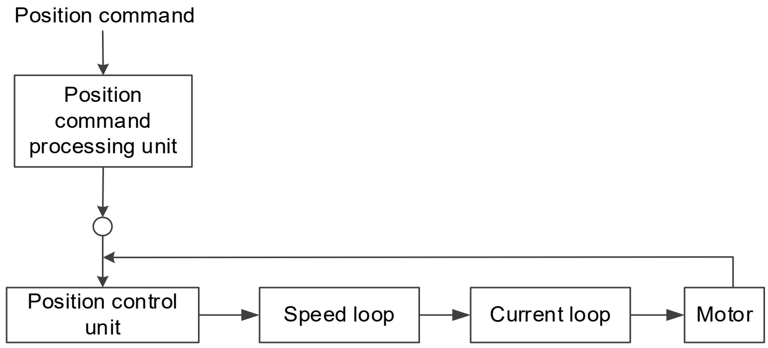
The absolute type and incremental type position registers are used to control the operation process. You can easily complete a periodic motor operation according to the preceding table. For example, if the Position command PR#01 is 10 turns and PR#02 is 20 turns, when PR#01 is issued first and PR#02 comes second, the difference between absolute and incremental positioning is shown in the following diagrams.



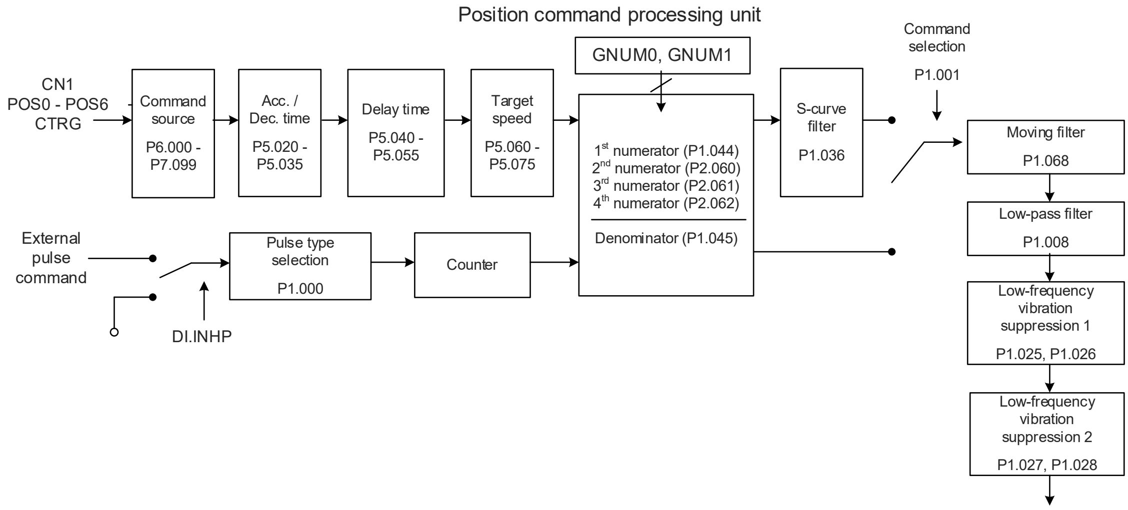


6.2.3 Control structure of Position mode

The following diagram shows the basic control structure of Position mode.



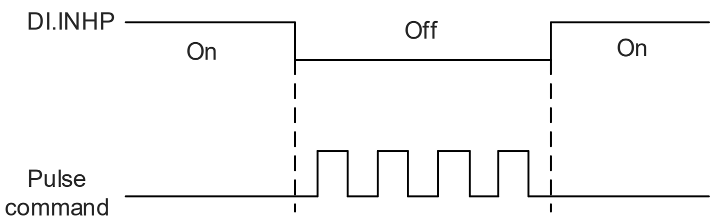
For better control, the pulse signals are processed by the Position command processing unit first. The structure is shown in the following diagram.



In the diagram, the upper path is the PR mode and the lower one is the PT mode, which you can select with P1.001. You can set the E-Gear ratio in both modes to adjust the positioning resolution. In addition, you can use either a moving filter or a low-pass filter to smooth the command. Refer to the following sections for more details.

The Pulse Command Input Inhibit (INHP) function

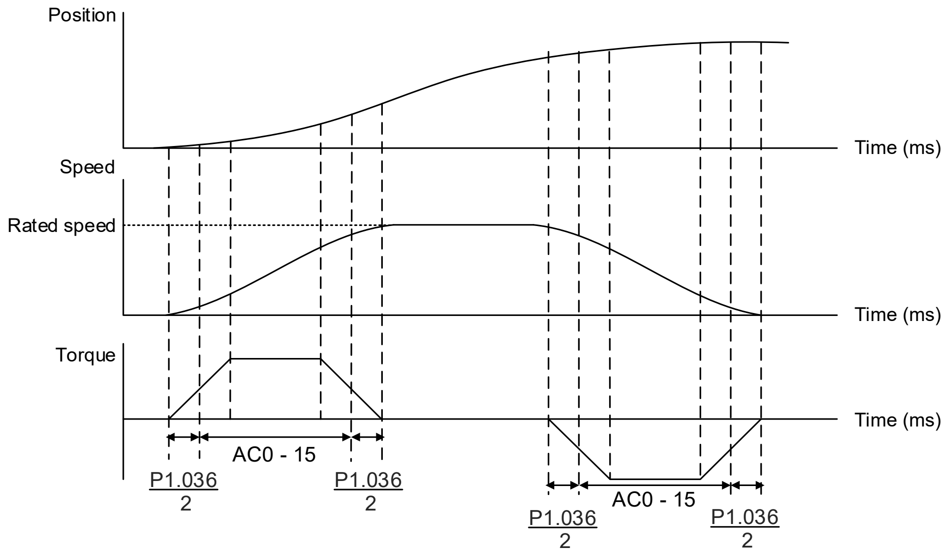
In PT mode, when DI.INHP is On, the servo drive stops receiving external pulse commands and the motor stops running. As this function is only supported by P2.013 (DI4 functional planning), setting P2.013 to 0x45 (DI.INHP) is required.



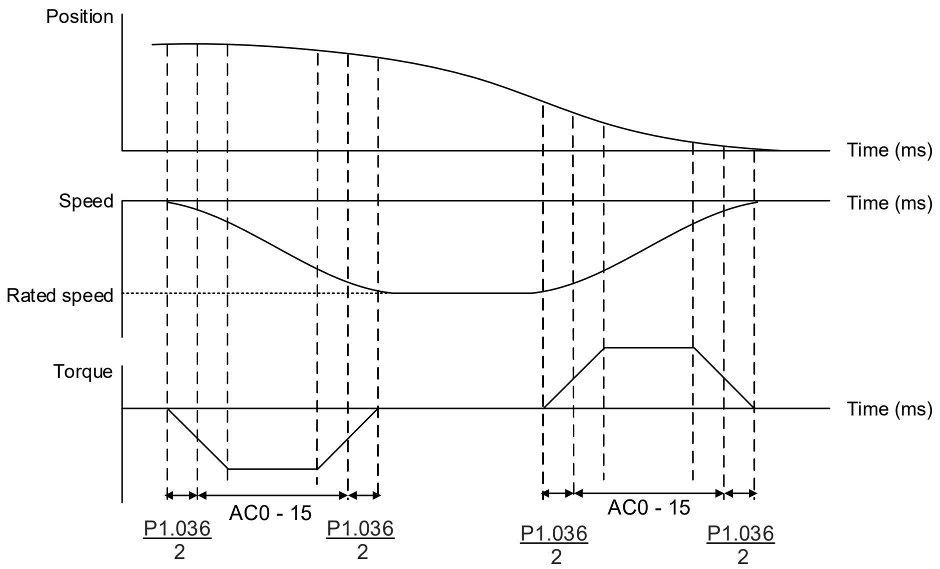
6

6.2.4 S-curve filter for Position commands

The S-curve filter for Position commands smooths the motion command in PR mode. The filter makes the speed and acceleration continuous and reduces jerks, resulting in a smoother mechanical operation. If the load inertia increases, the motor operation is affected by friction and inertia when the motor starts or stops rotating. Setting higher values for the S-curve acceleration / deceleration constant (P1.036) and the acceleration / deceleration time (P5.020 - P5.035) can increase the smoothness of operation. When the Position command source is the pulse input, the speed and angular acceleration are continuous, so the S-curve command filter is not necessary.



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



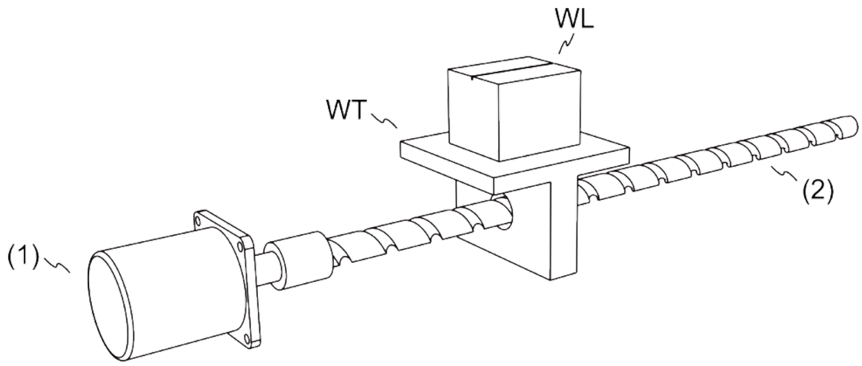
S-curve speed profile of Position command and time setting (decremental position command)

6.2.5 Electronic gear ratio (E-Gear ratio)

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

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

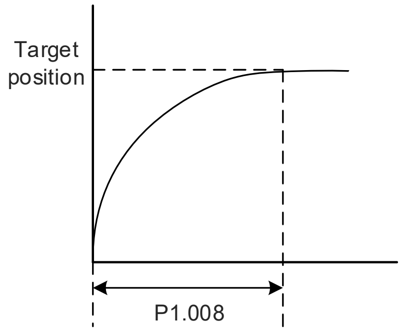
For example, if a workpiece is moved at the speed of 1 μm/pulse after you set a proper E-Gear ratio, then it means the workpiece moves 1 μm per pulse.



(1) Motor; (2) Ball screw pitch: 3 mm (equals 3,000 μm); WL: workpiece; WT: platform

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

6.2.6 Low-pass filter

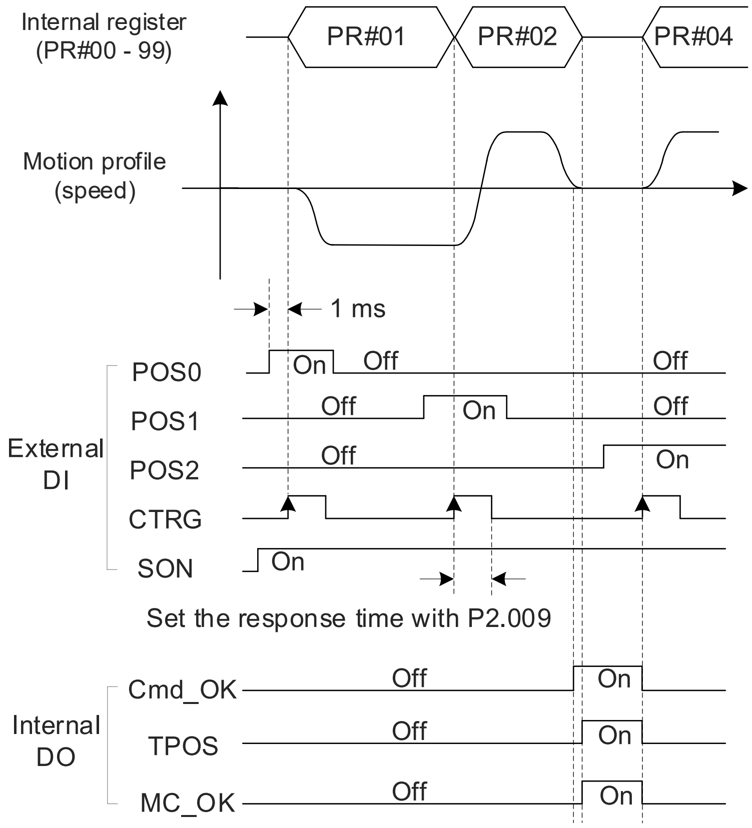


Refer to Chapter 8 for detailed descriptions of the relevant parameter.

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 selected by the DI signals (POS0 - POS6 and CTRG) of CN1. Refer to Section 6.2.2 for information about the DI signals and the selected register. The timing diagrams are shown as follows.



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

6

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

Manual adjustment

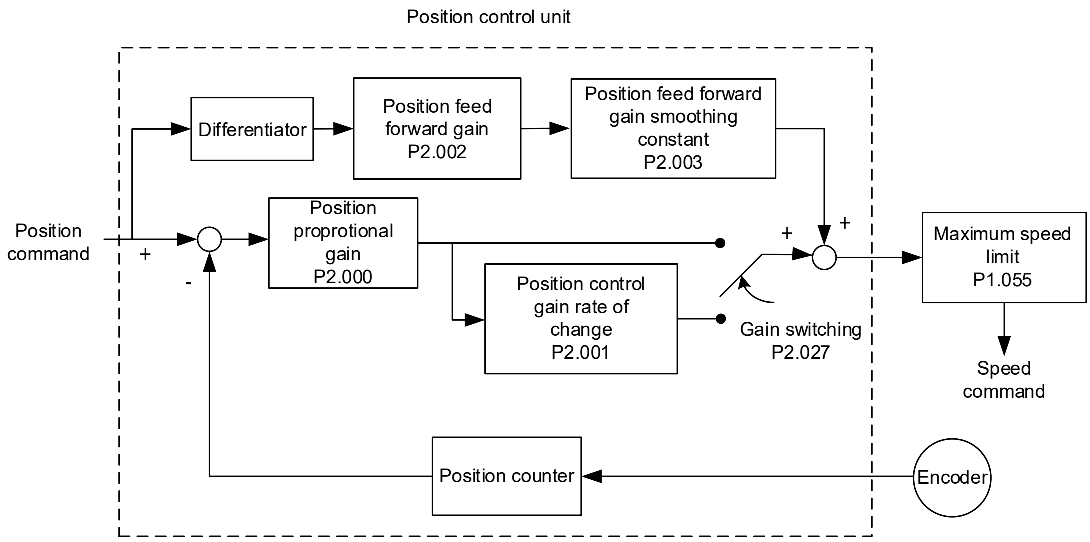
Before setting the position control unit, users have to manually set the speed control unit with P2.004 and P2.006 since a speed loop is included in the position loop. Then, set the position proportional gain (P2.000) and position feed forward gain (P2.002). The parameter descriptions are as follows.

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

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

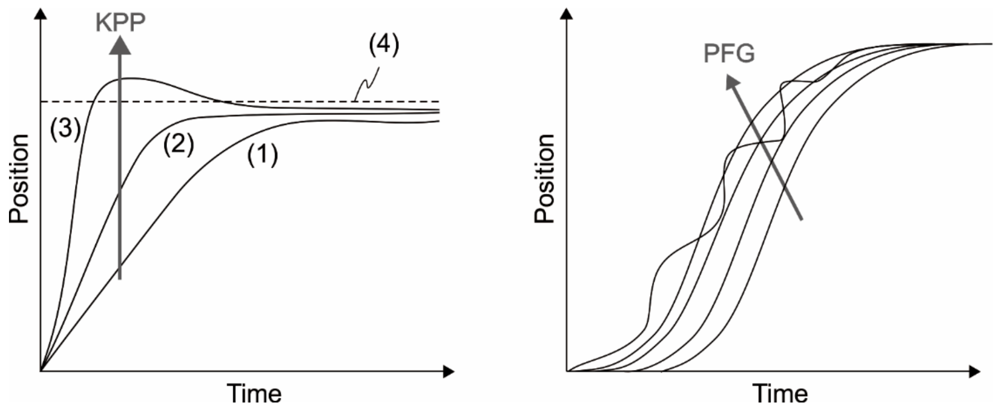
Calculation: KPP = 2 × π × fp

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



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

6



The actual position profile 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 the positioning command is complete. The low-frequency vibration suppression function can reduce the machine vibration. The suppression range is between 1.0 Hz and 100.0 Hz. You can use this function with either auto or manual setting. Refer to Section 5.7.4 for details.

6

6.3 Speed mode

The servo drive can receive two types of speed control command: analog input and internal register (parameters).

The analog command controls the motor speed by external voltage input. The internal register controls the motor speed in two ways. Before operation, respectively set the speed values in the three registers. Then, you can switch among the three sets of speed settings either by using DI.SPD0 and DI.SPD1 of CN1 or by communication. In order to deal with the problem of non-continuous speed when switching registers, you can use the S-curve acceleration and deceleration filter.

6.3.1 Selecting the Speed command source

There are two types of Speed command sources: external analog voltage and internal register (parameters). Select the command source with DI signals of CN1. See the following table for more details.

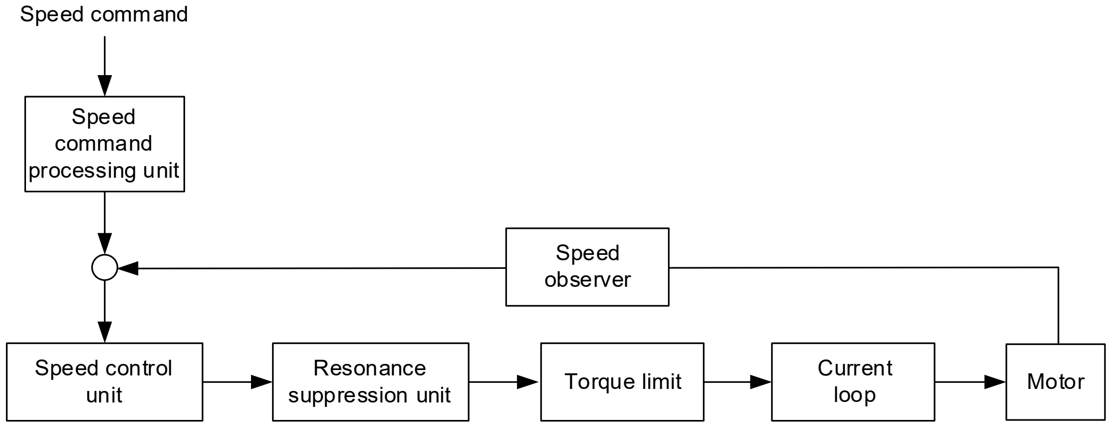
<table>
<tr><th rowspan="2">Speed command number</th><th colspan="2">CN1 DI signal</th><th rowspan="2" colspan="3">Command source</th><th rowspan="2">Content</th></tr>
<tr><th>SPD1</th><th>SPD0</th></tr>
<tr><td rowspan="2">S1</td><td rowspan="2">0</td><td rowspan="2">0</td><td rowspan="2">Mode</td><td>S</td><td>External analog signal</td><td>Voltage difference between V_REF and GND</td></tr>
<tr><td>Sz</td><td>N/A</td><td>Speed command is 0</td></tr>
<tr><td>S2</td><td>0</td><td>1</td><td rowspan="3" colspan="3">Internal register (parameter)</td><td>P1.009</td></tr>
<tr><td>S3</td><td>1</td><td>0</td><td>P1.010</td></tr>
<tr><td>S4</td><td>1</td><td>1</td><td>P1.011</td></tr>
</table>

- Status of SPD0 and 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 the drive is in Sz mode, the command is 0. Thus, if there is no need to use the analog voltage for the Speed command, you can use Sz mode to avoid the problem of zero drift in the voltage. If the drive is in S mode, then 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 with P1.040.
- When either one of SPD0 and SPD1 is not 0, the internal parameters become the source for the Speed command. The command is activated once the status of SPD0 and SPD1 are switched. There is no need to use DI.CTRG for triggering.
- 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

The Speed command can be used to control the speed in Speed mode (S or Sz) or limit the speed in Torque mode (T or Tz).

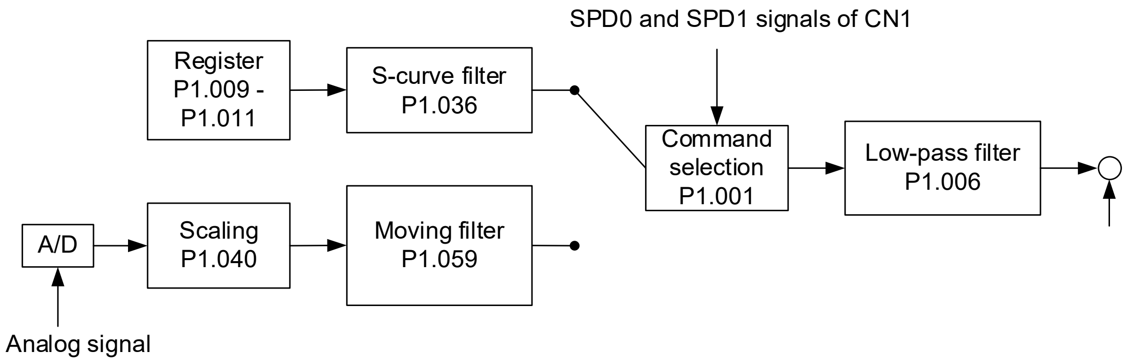
6.3.2 Control structure of Speed mode

The following diagram shows the basic control structure of Speed mode.



The Speed command processing unit selects the command source (see Section 6.3.1), including the scaling parameter (P1.040) for rotation speed corresponding to the analog voltage and the S-curve parameter (P1.036) for smoothing the Speed command. 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 as follows.



The upper path is the command from the internal register and the lower one is the command from the external analog voltage, which 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 Smoothing the 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 profile. Using the S-curve filter avoids jerks (rapid change of acceleration), resonance, and noise caused by abrupt changes in the speed input. You can use the following parameters for adjustment.

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

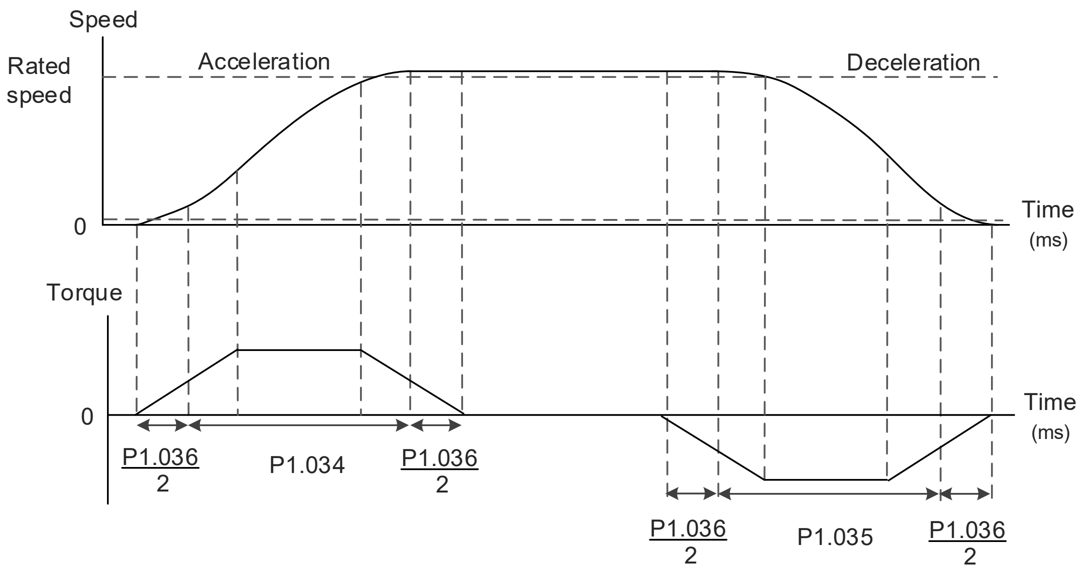
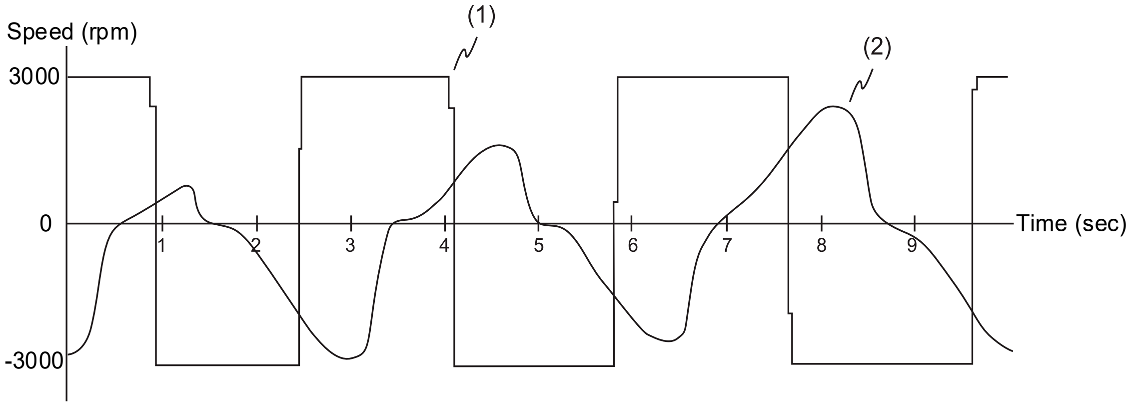


Figure 6.3.3.1 S-curve speed profile of Speed command and time setting

6

Analog Speed command filter

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

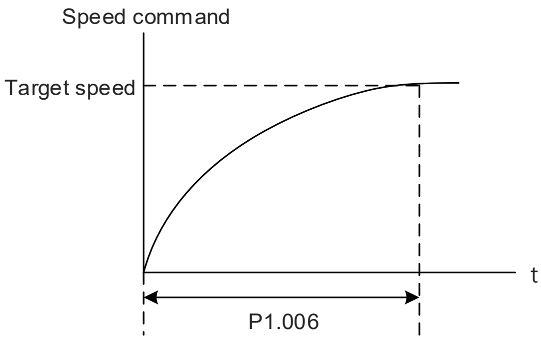


(1) Analog Speed command; (2) Motor speed

The time planning for smoothing analog input commands is the same as that of a general speed S-curve filter, and the speed and acceleration curves are continuous. In the preceding diagram, the slopes of the Speed command in acceleration and deceleration are different. It shows a poor performance in command following. Adjust the time settings (P1.034, P1.035, and P1.036) according to the actual application to improve the performance.

Low-pass filter for Speed commands

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

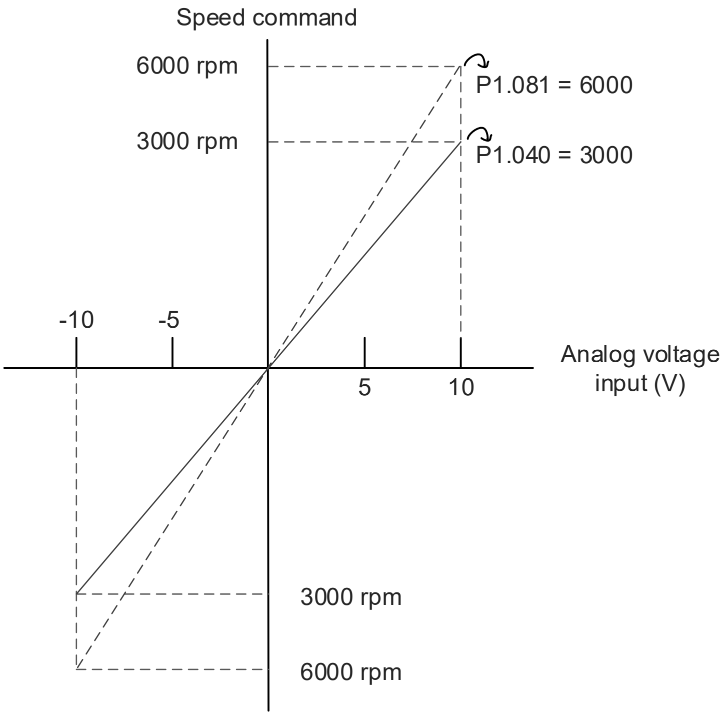


Refer to Chapter 8 for detailed descriptions of the relevant parameter.

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

6.3.4 Scaling of the analog command

The Speed command is controlled by the analog voltage difference between V_REF and GND. Use P1.040 and P1.081 to adjust the slope of the speed change and its range. Moreover, you can use P1.082 to change the time constant for switching between P1.040 and P1.081.

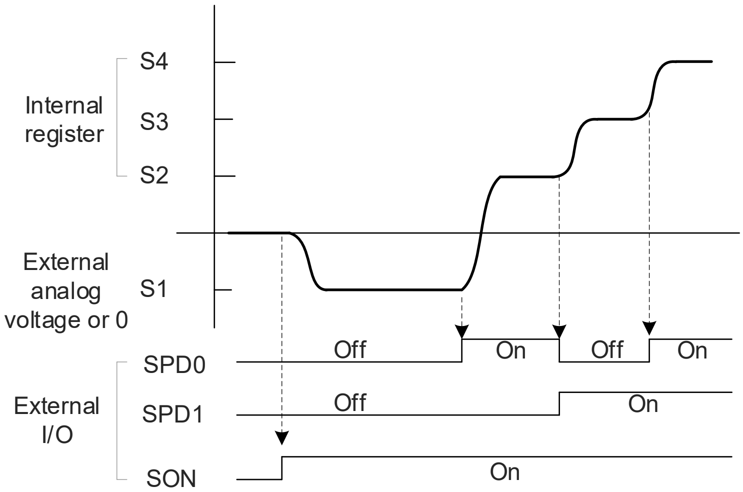


Refer to Chapter 8 for detailed descriptions of the relevant parameters.

Parameter	Function
P1.040	Maximum motor speed for analog Speed command 1
P1.081	Maximum motor speed for analog Speed command 2
P1.082	Time constant for switching between P1.040 and P1.081

6

6.3.5 Timing diagram of Speed mode



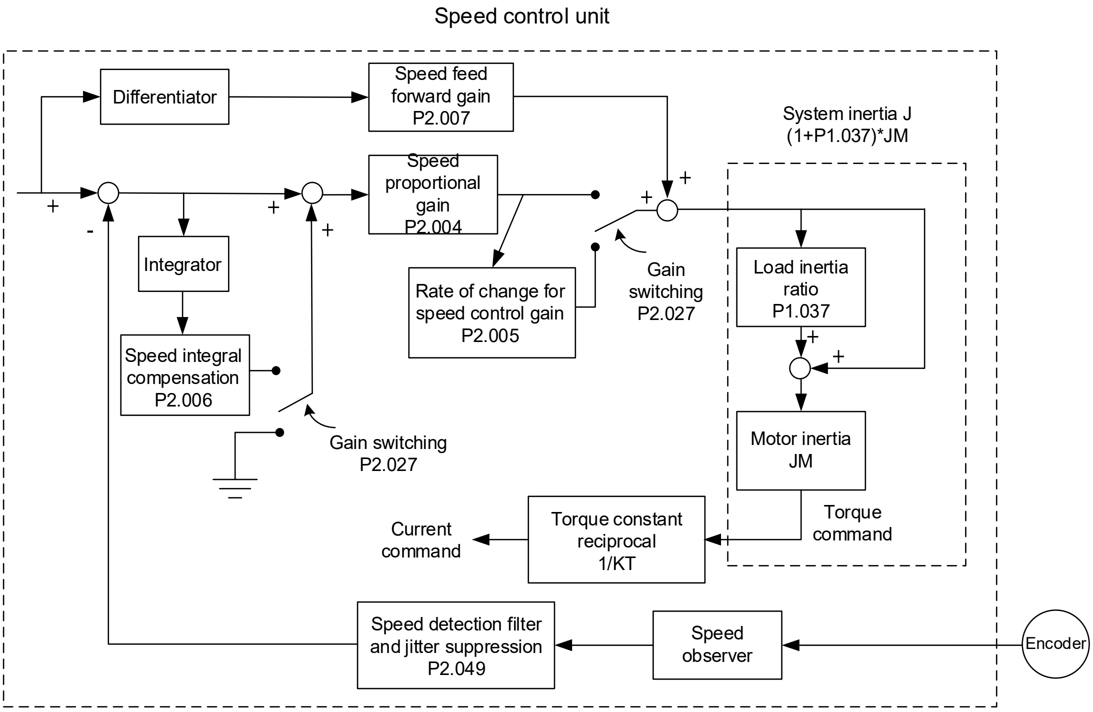
Note:

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

6

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 manually or by using the multiple gain adjustment modes.

Manual mode: manually set the parameters with all auto or auxiliary functions disabled.

Gain adjustment mode: refer to the Auto Tuning section in Chapter 5.

Manual mode

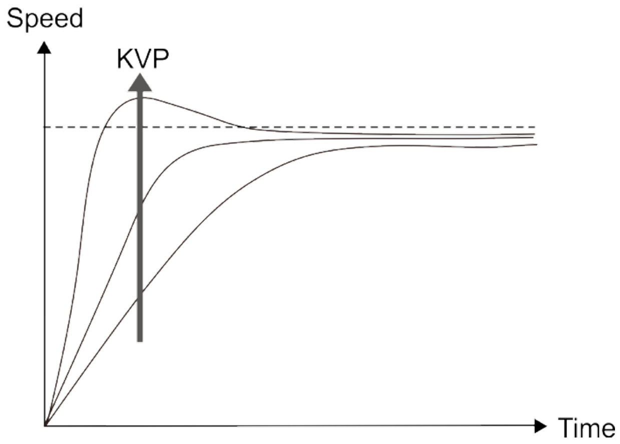
When you set P2.032 to 0, set the speed proportional gain (P2.004), speed integral compensation (P2.006), and speed feed forward gain (P2.007) as well. The parameter descriptions are as follows.

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

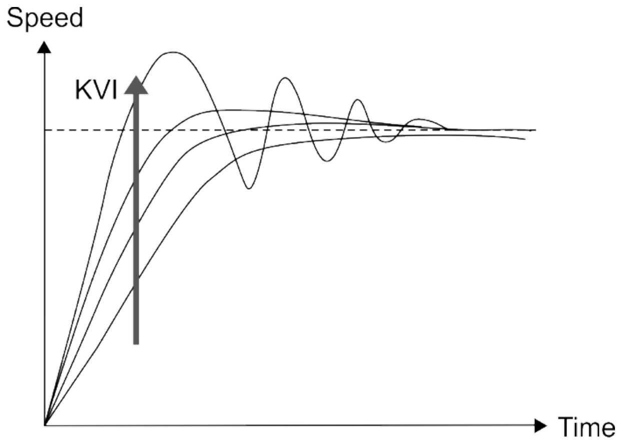
Here, the step response is used to illustrate the basic principles for speed proportional gain (KVP), speed integral compensation (KVI), and speed feed forward gain (KVF). Refer to the following examples.

Time domain

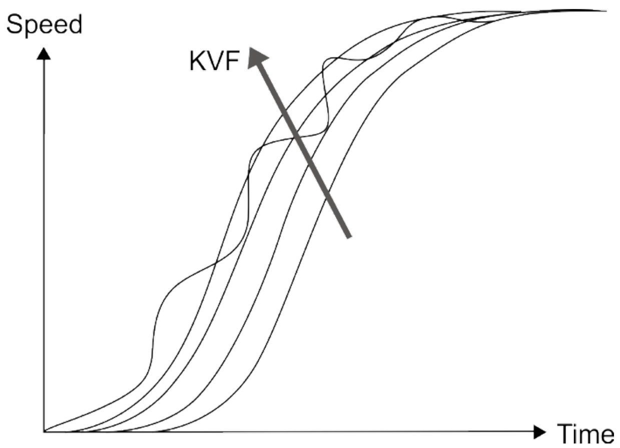
6



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



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



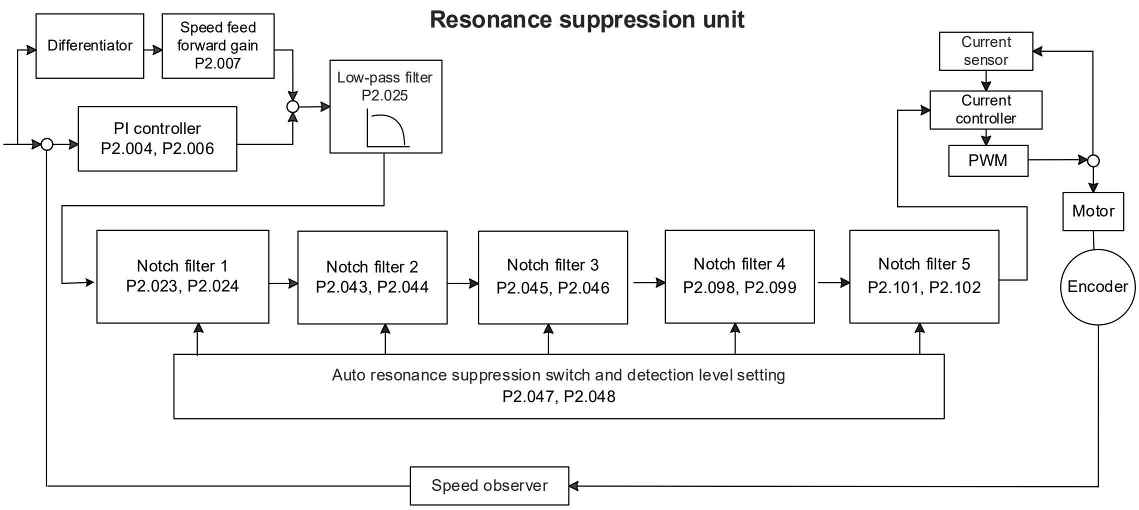
The closer the KVF value is to 1, the more complete the forward compensation.
The following error becomes very small.
However, setting the KVF value too high causes vibration.

6.3.7 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. You can use the low-pass filter (P2.025) and Notch filters (P2.023, P2.024, P2.043 - P2.046, and P2.095 - P2.103) to suppress the resonance with the control parameters remain unchanged.

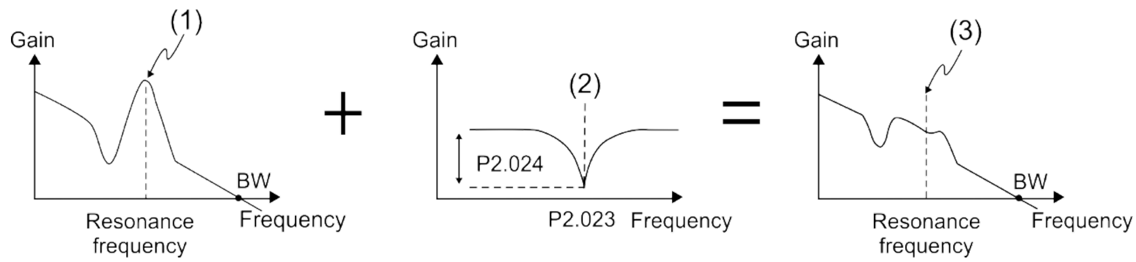
Refer to Chapter 8 for detailed descriptions of the relevant parameters.

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



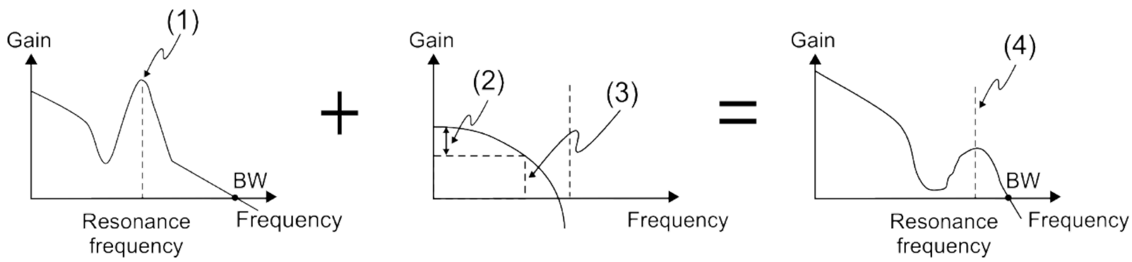
The servo drive provides two filters, the Notch filter and the low-pass filter, for suppressing the resonance. See the following diagrams for the effects of these filters. System open-loop gain with resonance:

■ Notch filter



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

■ Low-pass filter



(1) Resonance point; (2) Attenuation 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, making the system unstable.

If knowing 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. The setting range for the frequency of the Notch filter is 50 - 5000 Hz and the attenuation level is 0 - 40 dB. If the resonance frequency drifts significantly with time or due to other causes, using the low-pass filter to reduce the resonance is suggested.

6.4 Torque mode

The Torque control mode (T or Tz) is suitable for torque control applications, such as printing machines and winding machines. The servo drive can receive two types of torque control commands: analog input and internal register (parameters). The analog command input uses scaled external voltage to control the torque of the motor while the internal registers use the internal parameters (P1.012 - P1.014) for the Torque command.

6.4.1 Selecting the Torque command source

There are two types of Torque command sources: external analog voltage and internal parameters.
Select the command source with DI signals of CN1. See the following table for more details.

<table>
<tr><th rowspan="2">Torque command number</th><th colspan="2">CN1 DI signal</th><th rowspan="2" colspan="3">Command source</th><th rowspan="2">Content</th></tr>
<tr><th>TCM1</th><th>TCM0</th></tr>
<tr><td rowspan="2">T1</td><td rowspan="2">0</td><td rowspan="2">0</td><td rowspan="2">Mode</td><td>T</td><td>External analog signal</td><td>Voltage difference between T_REF and GND</td></tr>
<tr><td>Tz</td><td>N/A</td><td>Torque command is 0</td></tr>
<tr><td>T2</td><td>0</td><td>1</td><td rowspan="3" colspan="3">Internal register (parameter)</td><td>P1.012</td></tr>
<tr><td>T3</td><td>1</td><td>0</td><td>P1.013</td></tr>
<tr><td>T4</td><td>1</td><td>1</td><td>P1.014</td></tr>
</table>

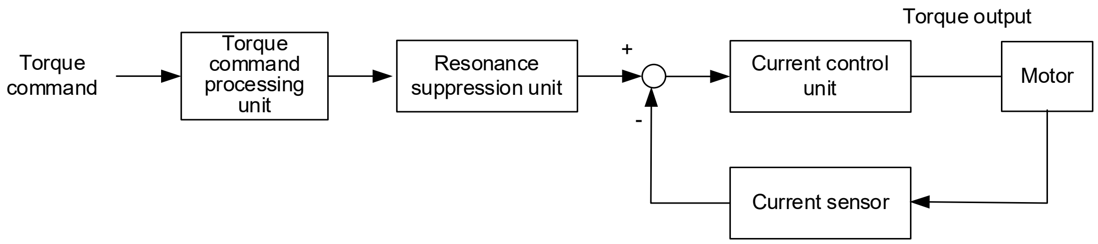
- Status of TCM0 and TCM1: 0 means that DI is off (the circuit is open); 1 means that DI is on (the circuit is closed).
- When both TCM0 and TCM1 are 0, if the drive is in Tz mode, the command is 0. Thus, if there is no need to use the analog voltage for the Torque command, you can use Tz mode to avoid the problem of zero drift in the voltage. If the drive is in T mode, then the command is the voltage difference between T_REF and GND. The range of the input voltage is between -10V and +10V, and you can adjust the corresponding torque with 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 activated once the status of TCM0 and TCM1 are switched. There is no need to use DI.CTRG for triggering.

The Torque command can be used to control the torque in Torque mode (T or Tz) or limit the torque in Speed mode (S or Sz).

6

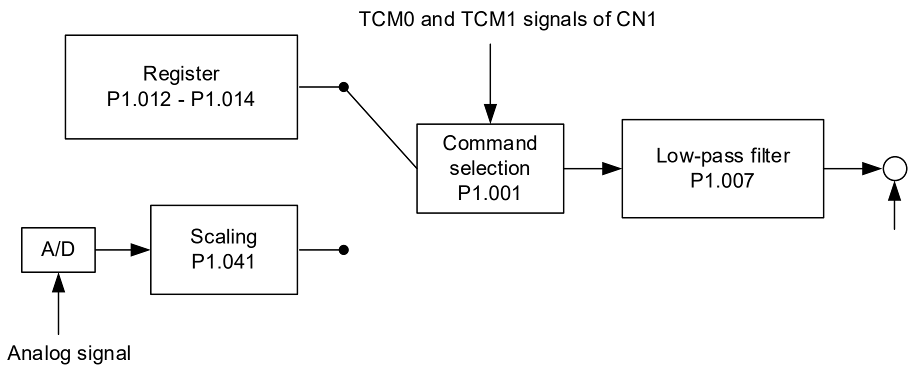
6.4.2 Control structure of Torque mode

The following diagram shows the basic control structure of Torque mode.



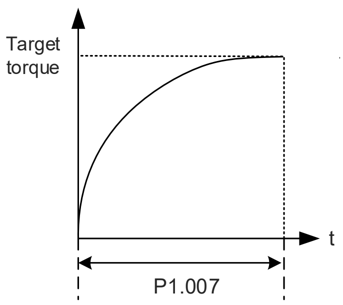
The Torque command processing unit selects the command source (see Section 6.4.1), including the scaling parameter (P1.041) for the torque corresponding to the analog voltage and the low-pass filter (P1.007) for smoothing the torque. The current control unit manages the gain parameters for the servo drive and calculates the current for servo motor in real-time.

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, which you can select with the status of TCM0 and TCM1, and P1.001 (T or Tz). Adjust the torque with the analog voltage scaling (P1.041) and smooth the response with the low-pass filter (P1.007).

6.4.3 Smoothing the Torque command



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

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

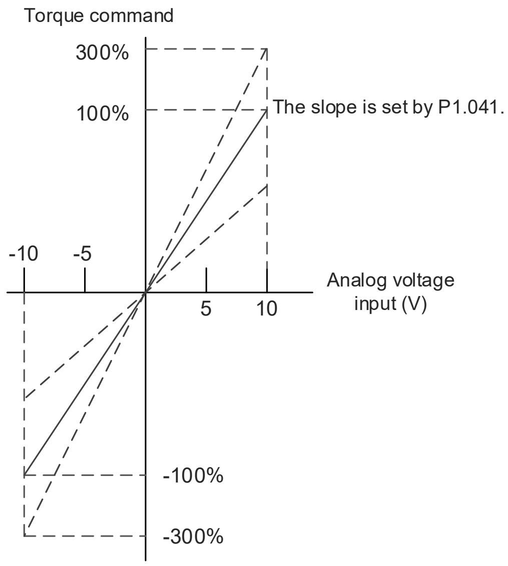
6.4.4 Scaling of the analog command

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

6

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.

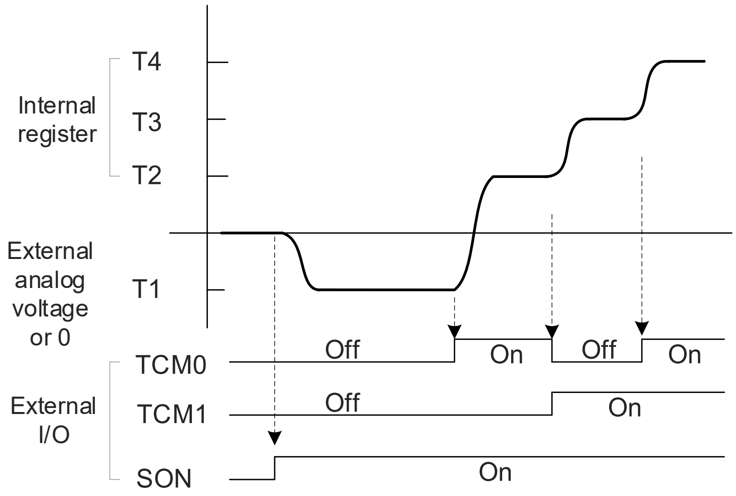


Refer to Chapter 8 for detailed descriptions of the relevant parameter.

Parameter	Function
P1.041	Maximum output for analog Torque command

6

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 on (the circuit is closed).
2. When the drive is in Tz mode, the Torque command T1 = 0; when the drive is in T mode, the Torque command T1 refers to the external analog voltage input.
3. In the Servo On state, the command is selected according to the status of TCM0 and TCM1.

6.5 Dual and multi-modes

Apart from the single modes for controlling the position, speed, and torque of the motor, there are also dual modes and multi-modes available for operation (see Section 6.1).

Mode	Short name	Code	Description
Dual mode	S-PT	06	Switch S and PT modes with DI.S-P.
	T-PT	07	Switch T and PT modes with DI.T-P.
	S-PR	08	Switch S and PR modes with DI.S-P.
	T-PR	09	Switch T and PR modes with DI.T-P.
	S-T	0A	Switch S and T modes with DI.S-T.
	PT-PR	0D	Switch PT and PR modes with DI.PT-PR.
Multi-mode	PT-PR-S	0E	Switch PT, PR, and S modes with DI.S-P and DI.PT-PR.
	PT-PR-T	0F	Switch PT, PR, and T modes with DI.T-P and DI.PT-PR.

The dual mode for Sz and Tz is not supported. To avoid occupying too many digital inputs in the dual or multi-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); the PT position mode can use pulse input as the command source to reduce the use of DI points (POS0 - POS6).

To refer to the table of default DI / DO functions or to change the settings of DI / DO functions, see Section 3.3 for more information.

6

6.5.1 Speed / Position dual mode

Speed / Position dual modes include S-PT and S-PR. The command source for S-PT is the external pulse while the source for S-PR is the internal parameters (P6.000 - P7.099). You can select the source for the Speed command as the external analog voltage or the internal parameters (P1.009 - P1.011). The switch between Speed and Position modes is controlled by DI.S-P (0x18). The switch between PT and PR for Position mode is controlled by DI.PT-PR (0x2B). The following timing diagram illustrates the S-PR mode. The switch between Position and Speed commands in S-PR mode is controlled by DI signals.

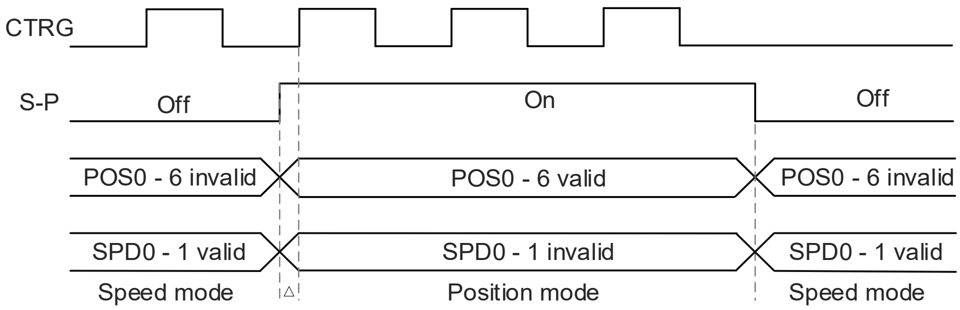


Figure 6.5.1.1 Speed / Position dual mode

In Speed mode (DI.S-P is Off), you select the Speed command with DI.SPD0 and DI.SPD1, and DI.CTRG is not applicable. When the drive switches to Position mode (DI.S-P is On), since the Position command has not been issued (it waits for the rising edge of DI.CTRG), the motor stops (indicated by △ in the preceding figure). The Position command is selected with DI.POS0 - DI.POS6 when the rising edge of DI.CTRG is triggered, and then the motor moves to the specified position. When DI.S-P is Off, the drive returns to the Speed mode. Refer to the introduction of single modes for the DI signals and the selected commands.

6.5.2 Speed / Torque dual mode

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

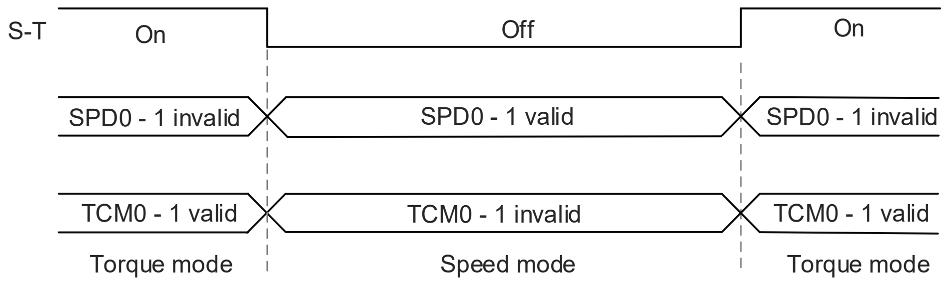


Figure 6.5.2.1 Speed / Torque dual mode

In Torque mode (DI.S-T is On), you select the Torque command with DI.TCM0 and DI.TCM1. When the drive switches to Speed mode (DI.S-T is Off), you select the Speed command with DI.SPD0 and DI.SPD1. Then the motor operates according to the Speed command. When DI.S-T is On, the drive returns to the Torque mode. Refer to the introduction of single modes for the DI signals and the selected commands.

6

6.5.3 Torque / Position dual mode

Torque / Position dual modes include T-PT and T-PR. The command source for T-PT is the external pulse while the source for T-PR is the internal parameters (P6.000 - P7.099). You can select the source for the Torque command as the external analog voltage or the internal parameters (P1.012 - P1.014). The switch between Torque and Position modes is controlled by DI.T-P (0x20). The switch between PT and PR for Position mode is controlled by DI.PT-PR (0x2B). The following timing diagram illustrates the T-PR mode. The switch between Position and Torque commands in T-PR mode is controlled by DI signals.

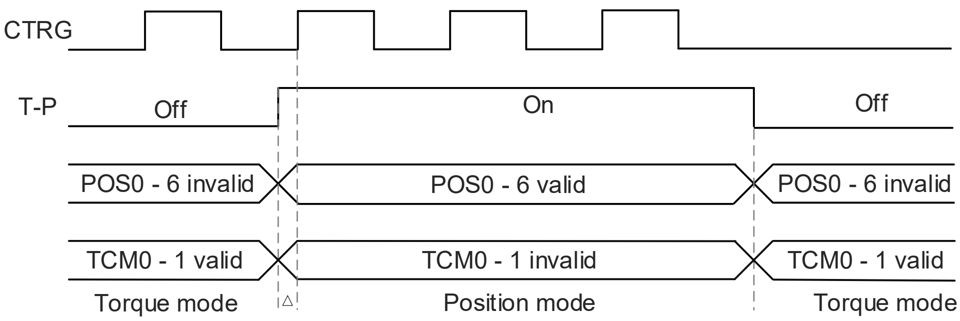


Figure 6.5.3.1 Torque / Position dual mode

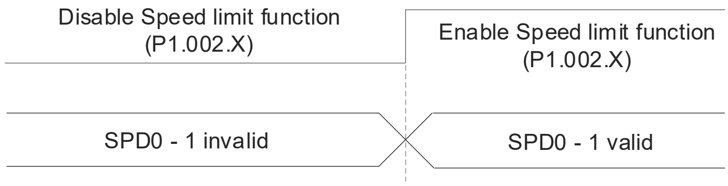
In Torque mode (DI.T-P is Off), you select the Torque command with DI.TCM0 and DI.TCM1, and DI.CTRG is not applicable. When the drive switches to Position mode (DI.T-P is On), since the Position command has not been issued (it waits for the rising edge of DI.CTRG), the motor stops (indicated by △ in the preceding figure). The Position command is selected with DI.POS0 - DI.POS6 when the rising edge of DI.CTRG is triggered, and then the motor operates to the specified position. When DI.T-P is Off, the drive returns to the Torque mode. Refer to the introduction of single mode for the DI signals and the selected commands.

6.6 Others

6.6.1 Applying the speed limit

The maximum motor speed in each mode (Position, Speed, and Torque) is determined by the internal parameter P1.055. The methods for using the Speed limit command and Speed command are the same. You can use either the external analog voltage or the internal parameters (P1.009 - P1.011). Refer to Section 6.3.1 for more details.

The speed limit is applicable only in Torque mode (T or Tz) for controlling the motor’s maximum speed. If you are using the external analog voltage in Torque mode, you can use the available DI signals to set SPD0 and SPD1 for the motor speed limit value (internal parameters). If there are no DI signals available, use the analog voltage input for the Speed limit command. When you set P1.002.X (disable / enable Speed limit function) to 1, the Speed limit function is enabled. The timing diagram is shown as follows.

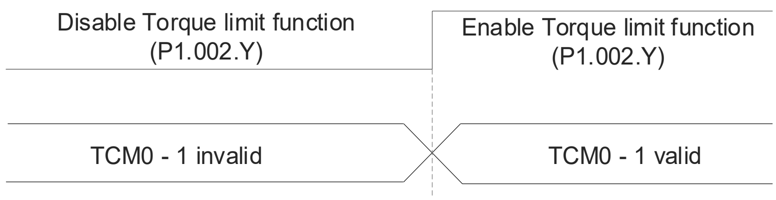


Source selection for Speed limit command

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 more details.

The torque limit is applicable in Position mode (PT or PR) or Speed mode (S) for limiting the motor torque output. If you are using the external pulse in Position mode or using the external analog voltage in Speed mode, you can use the available DI signals to set TCM0 and TCM1 for the torque limit command (internal parameters). If there are no DI signals available, use the analog voltage input for the Torque limit command. When you set P1.002.Y (disable / enable Torque limit function) to 1, the Torque limit function is enabled. The timing diagram is shown as follows.



Source selection for Torque limit command

6.6.3 Analog monitoring

You can find the required voltage signal with analog monitoring. The servo drive provides two analog channels. Refer to Chapter 3 for more information about wiring.

6

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	Analog monitor output (Ch1) - offset compensation value
P4.021	Analog monitor output (Ch2) - offset compensation value

Example:
If the analog voltage output is 8V when the motor speed is 1,000 rpm and the maximum speed of the motor is 5,000 rpm, the setting of P1.004 is as follows.

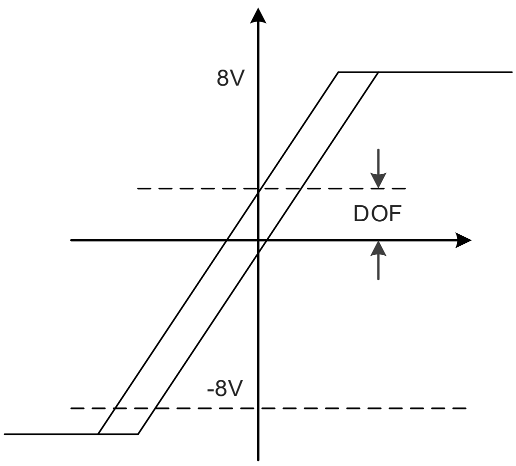
$$P1.004 = \frac{\text{Required speed}}{\text{Max. speed}} \text{ x } 100\% = \frac{1000 \text{ rpm}}{5000 \text{ rpm}} \times 100\% = 20\%$$

You can calculate the voltage output corresponding to the current motor speed with the following formula.

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

Voltage drift

When voltage drift occurs, the voltage level defined as zero voltage is different from the set zero point. To fix this problem, 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 10 bits, which is equivalent to 13 mV/LSB.



Motion Control 7

This chapter introduces internal motion commands of the servo drive in PR mode. In this mode, motion control commands are generated based on the internal command of the servo drive. Various motion commands are available, including Homing, Speed, Position, Jump, Write, and high-speed position capture (Capture). This chapter contains detailed description of each command type.

7.1 PR mode description

In PR mode, the servo drive automatically generates the motion commands and saves all parameter settings in the servo drive parameter file. Thus changing parameter values simultaneously changes the PR commands. The servo drive provides 100 sets of path settings, which include the homing method, Speed command, Position command, Jump command, Write command, and Rotary Axis Position command.

The property and corresponding data for each PR path are set by parameters. You can find information of all PR parameters in the descriptions of parameter groups 6 and 7 in Chapter 8. For example, PR#01 is defined by two parameters, P6.002 and P6.003. P6.002 is for specifying the property of PR#01, 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 property set in P6.002. If P6.002 is set to a Speed command, then P6.003 specifies the target speed; if P6.002 is set to a Jump command, then P6.003 specifies the target PR. The parameters for defining PR#02 are P6.004 and P6.005, and they work the same way as P6.002 and P6.003. The same is true for the rest of PR paths. See Figure 7.1.1.

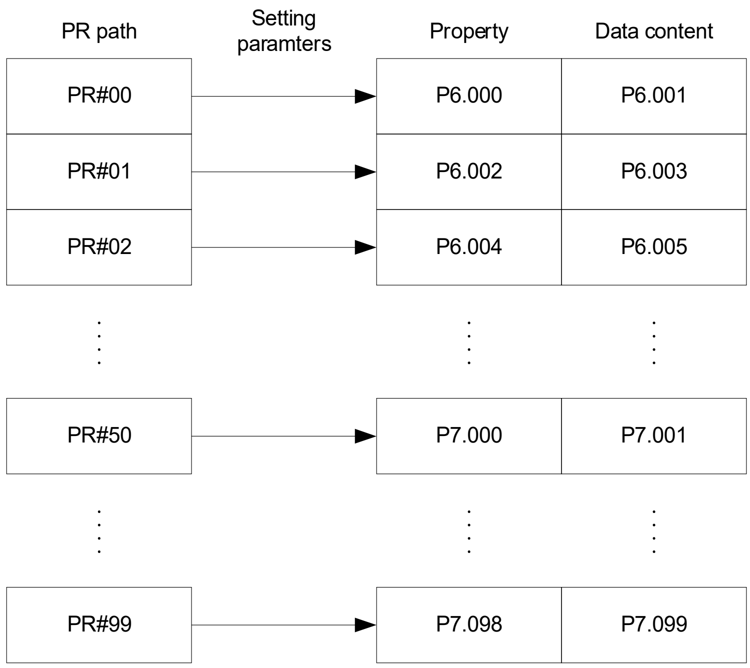


Figure 7.1.1 Setting parameters for each PR path

In the ASDA-Soft software, when you select the PR path 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#01, the settings of P6.002 and P6.003 appear at the top in the editing section. Table 7.1.1 shows that the path property and data content differ based on the motion command type with P6.002 and P6.003 as the example. For more information about Motion Control mode, refer to Section 7.1.3.

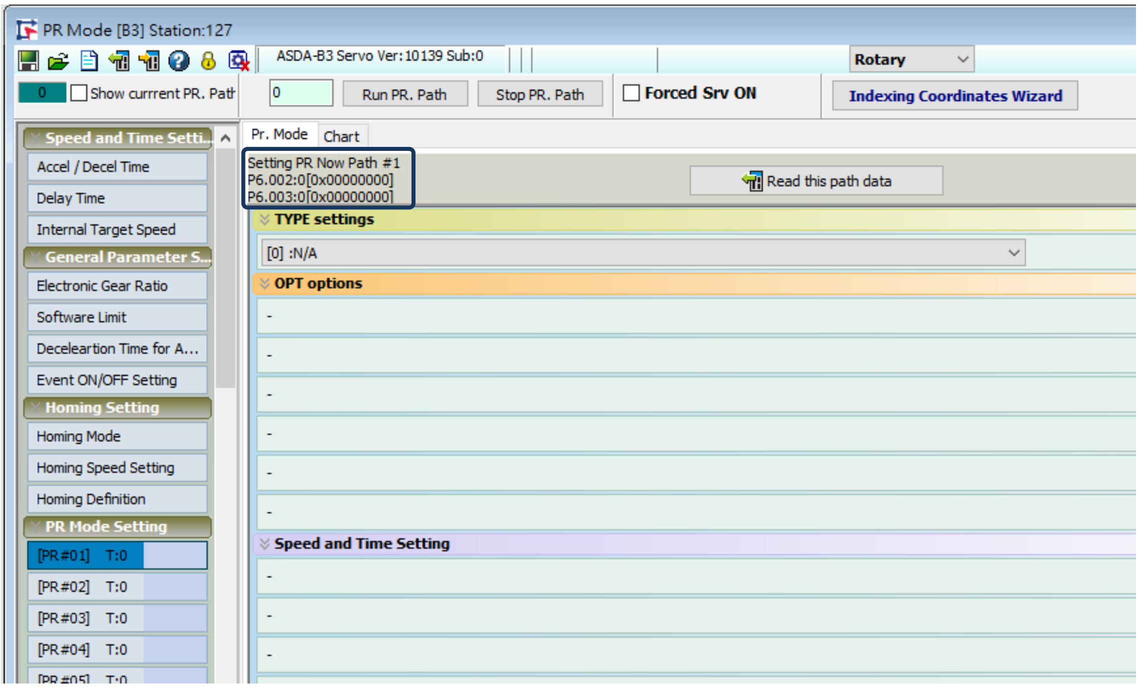


Figure 7.1.2 PR Mode interface in ASDA-Soft

Table 7.1.1 Example of PR#01 property and data content

Bit / PR#01	31 - 28	27 - 24	23 - 20	19 - 16	15 - 12	11 - 8	7 - 4	3 - 0
P6.002	-	AUTO	DLY	SPD	DEC	ACC	OPT	TYPE
P6.003	Data content (32-bit)							

Note:
TYPE: path type

TYPE settings	Path type
1	SPEED, constant speed control
2	SINGLE, positioning control. The execution stops once the positioning is complete.
3	AUTO, positioning control. The next PR path is automatically loaded once the positioning is complete.
7	JUMP, jump to the specified path.
8	WRITE, write specified parameters to specified path.
A	INDEX, rotary axis position control (index position control)

7

ASDA-Soft provides a graphical interface for editing PR paths.

It is easier to set PR paths, including the options of command triggering, command types, and other properties.

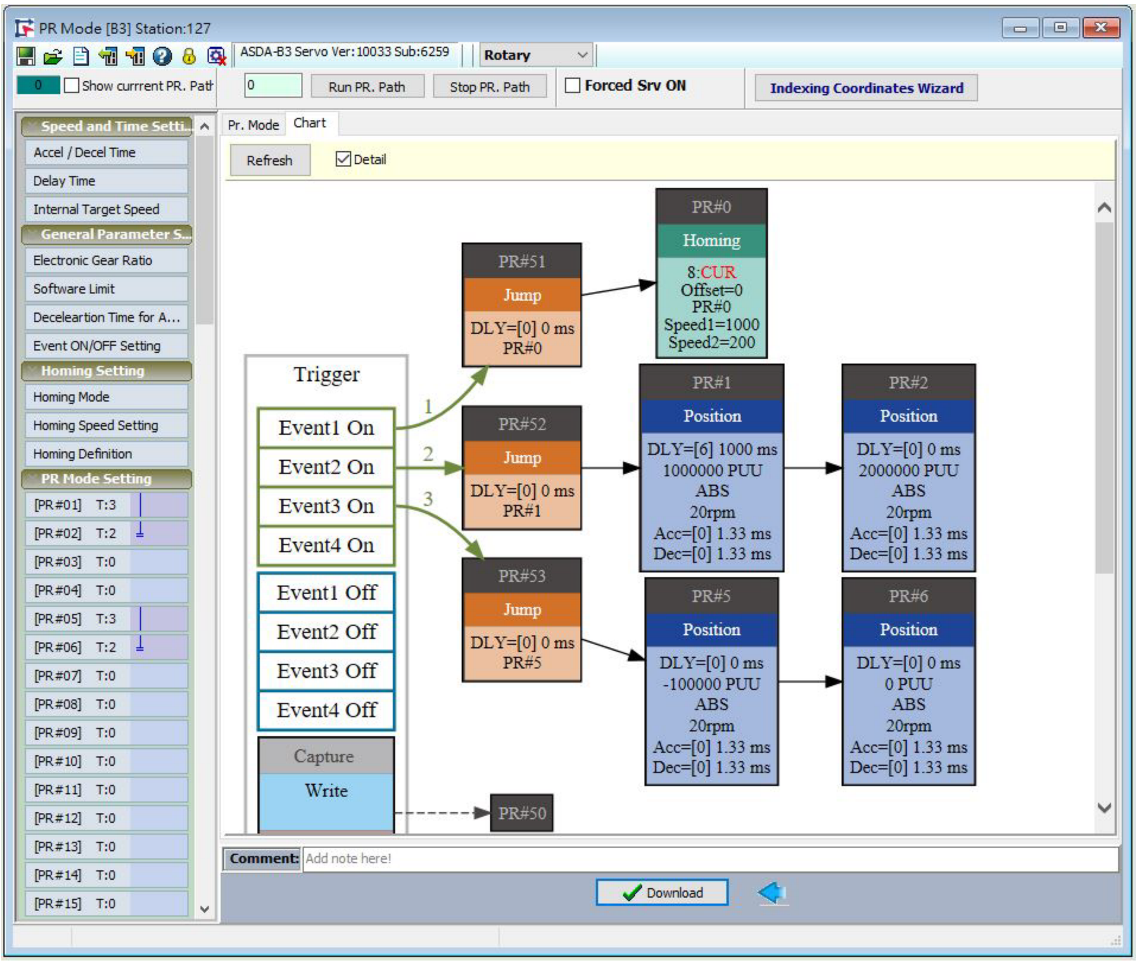


Figure 7.1.3 Graphical interface for PR paths in ASDA-Soft

7.1.1 Shared PR parameters

The servo drive provides 16 sets of acceleration or deceleration time settings (P5.020 - P5.035), 16 sets of delay time settings (P5.040 - P5.055), and 16 sets of 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. 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 settings are changed as well. Be aware of this when setting PR paths so as to avoid any danger or damage to the machine.

ASDA-Soft provides a user-friendly interface for setting the shared PR parameters (see Figure 7.1.1.2). Among the data, the acceleration or deceleration time is set based on the time duration required for the motor to accelerate from 0 to 3000 rpm or to decelerate from 3000 rpm to 0. For instance, if the acceleration time is set to 50 ms, when the target speed for the motion command is 3000 rpm, then the required duration is 50 ms. If the target speed for the motion command is 1500 rpm, then the acceleration time is 25 ms. Setting the acceleration or deceleration time is like setting a fixed slope for acceleration or deceleration, and the slope does not change when you change the target speed settings.

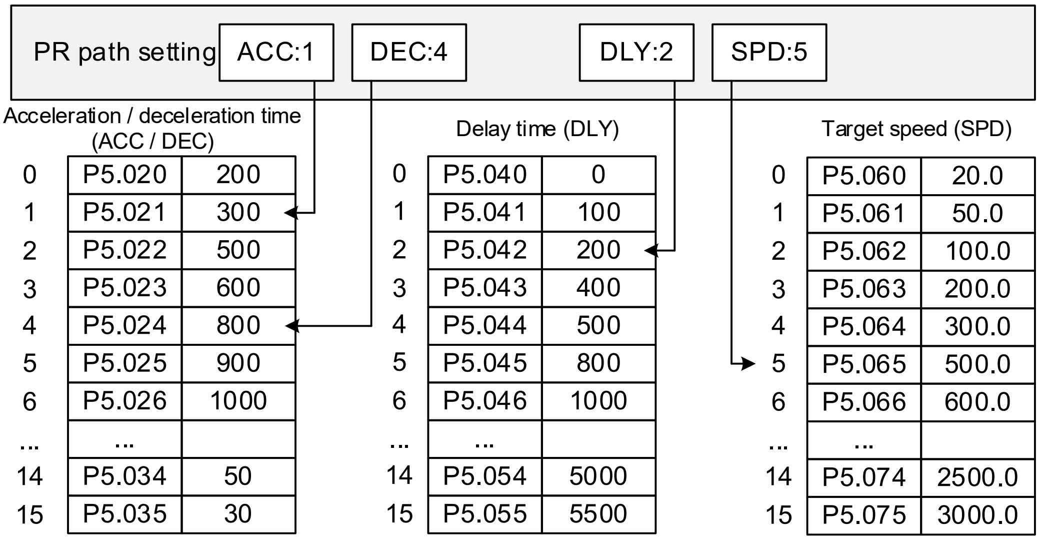


Figure 7.1.1.1 Shared parameter data for PR paths

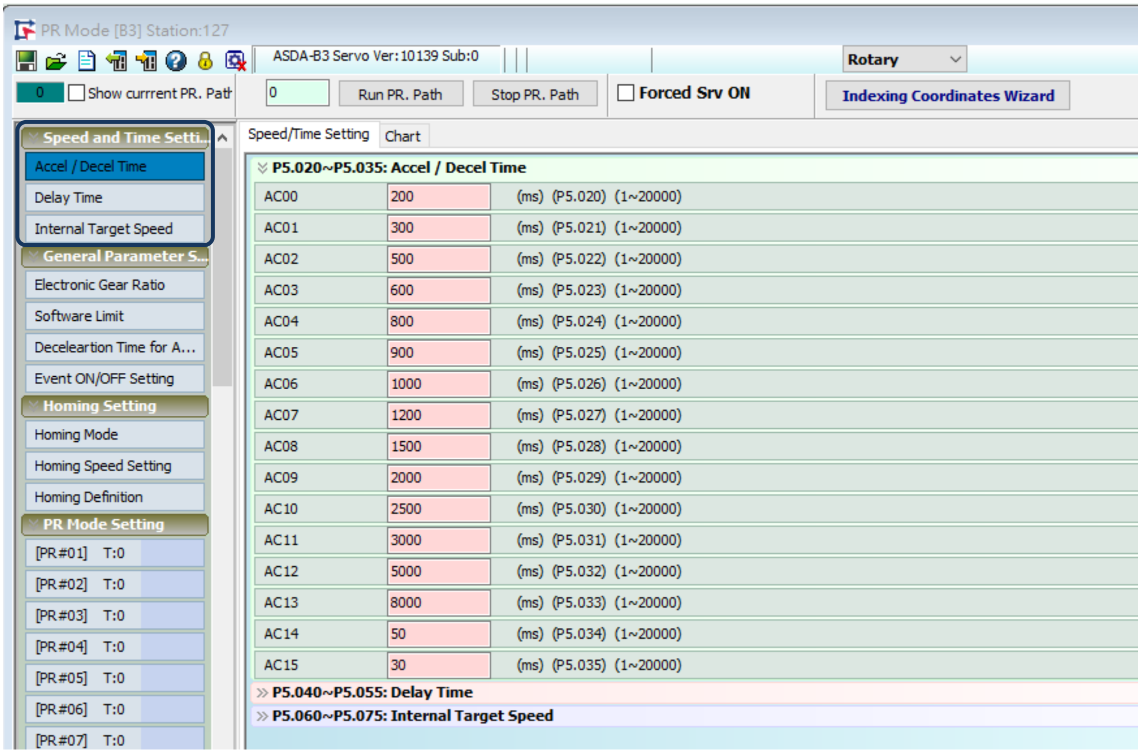


Figure 7.1.1.2 ASDA-Soft interface for shared PR parameter data

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7

7.1.2 Monitoring variables for PR mode

In PR mode, you can use four monitoring variables for checking the servo commands and feedback status: position command (PUU), register of PR command endpoint, feedback position (PUU), and following error (PUU). These are described as follows:

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

How these four monitoring variables work is shown in Figure 7.1.2.1. After issuing 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 difference in each fixed cycle and sends it to the servo drive, where it is treated as a dynamic command. Fb_PUU is motor encoder position feedback and Err_PUU is the difference of subtracting Fb_PUU from Cmd_O.

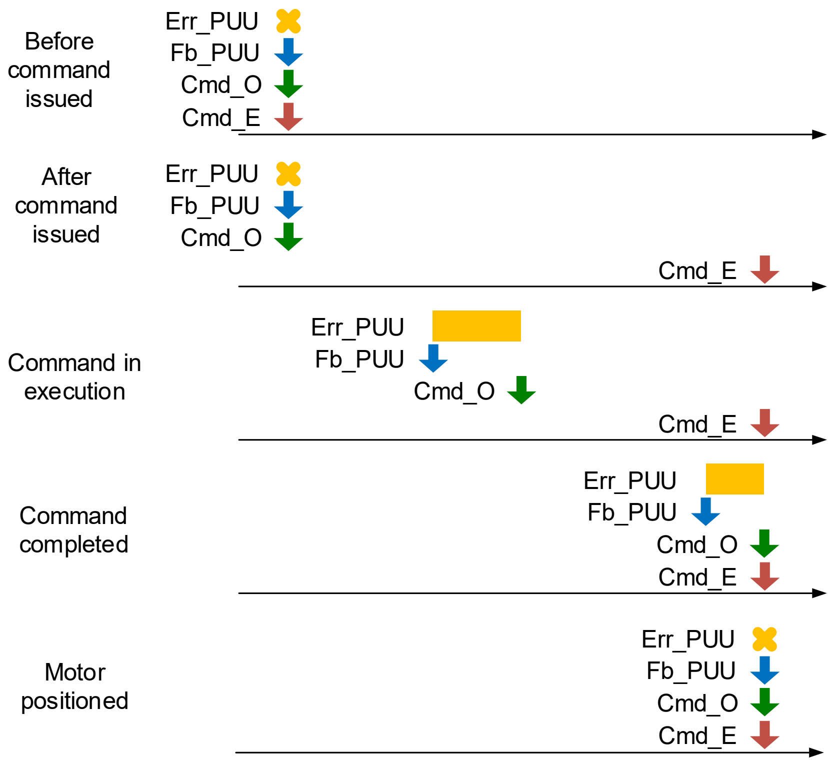

Figure 7.1.2.1 Timing diagram for PR mode monitoring variables

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

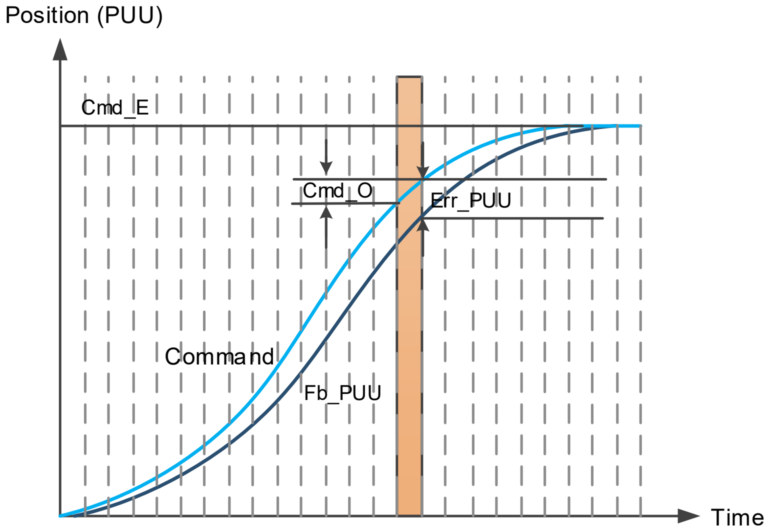

Figure 7.1.2.2 Monitoring variable status when a command is executed in PR mode

You can use digital input (DI) to call PR paths and digital output (DO) to monitor PR paths (refer to Tables 8.1 and 8.2 for the DI/O function descriptions in Chapter 8). 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) is set to On. When the motor reaches its target position, DO.TPOS (0x05) is set to On. When both DO.Cmd_OK (0x15) and DO.TPOS (0x05) are On, the servo outputs the DO.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, when the motor reaches the target position, DO.TPOS (0x05) is set to On. When the delay time is over, DO.Cmd_OK (0x15) is set to On. After these two DO signals are both On, the servo outputs the DO.MC_OK (0x17) signal to signify that it has completed this PR path. The operation is as shown in Figure 7.1.2.4.

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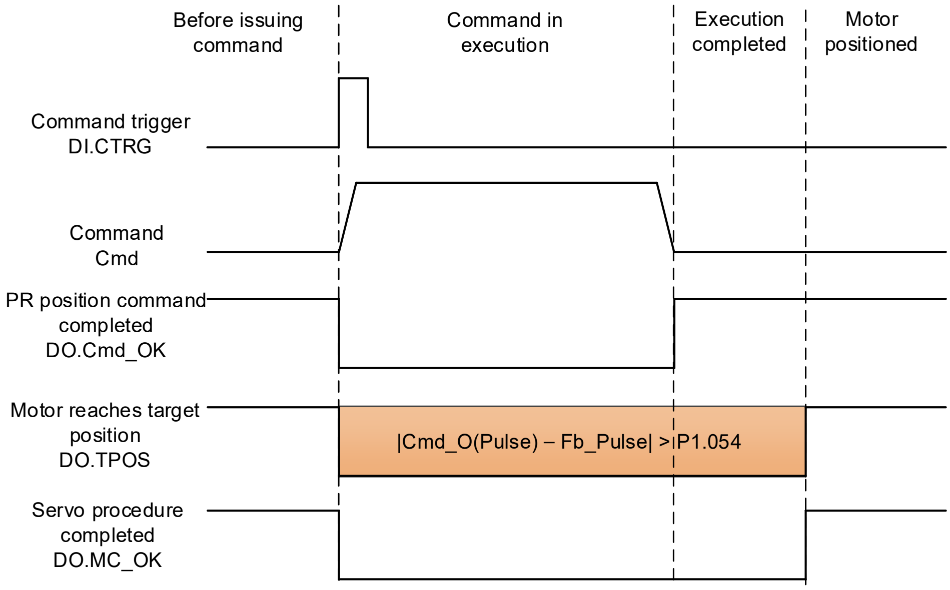

Figure 7.1.2.3 Operation of DI/DO signals in PR mode

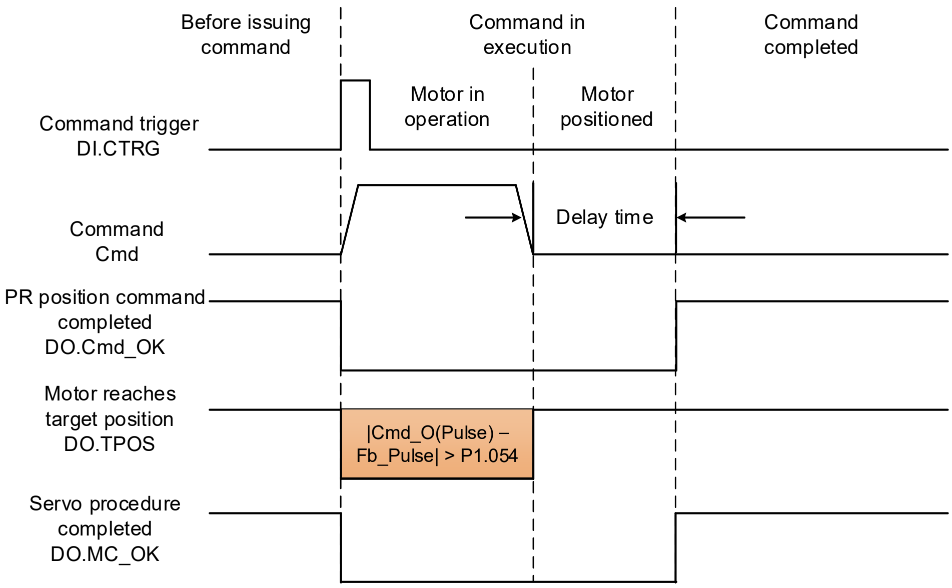

Figure 7.1.2.4 Operation of DI/DO signals in PR mode (including delay time)

7.1.3 Motion Control commands

The servo drive provides 100 sets of path settings, which include the Homing methods, Speed command, Position command, Jump command, Write command, and Rotary Axis Position command (Index Position). The following sections detail each command type.

7.1.3.1 Homing methods

The servo drive provides 11 homing methods in the PR mode, including using the 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 following lists the function of each bit.

P5.004	**Homing methods**		**Address: 0508H 0509H**
Default:	0x0000	Control mode:	PR
Unit:	-	Setting range:	0x0000 - 0x012A
Format:	HEX	Data size:	16-bit

Settings:

0000

U Z Y X

Definition of each setting value:

<table>
<tr><td>U</td><td>Z</td><td>Y</td><td>X</td></tr>
<tr><td>Reserved</td><td>Limit setting</td><td>Z pulse setting</td><td>Homing method</td></tr>
<tr><td rowspan="12">-</td><td>0 - 1</td><td>0 - 2</td><td>0 - A</td></tr>
<tr><td rowspan="2">-</td><td rowspan="4">Y = 0: reverse 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="6">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: reverse 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 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: reverse 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>

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

Settings:

High word

D C B A

Low word

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	Reserved	U	DEC1: deceleration time selection for first homing
D	BOOT: whether to execute homing automatically when the drive is powered on	-	-

- YX: PATH: path type

  0x00: Stop: the servo stops after homing is complete

  0x01 - 0x63: Auto: the servo executes the specified path (PR#01 - PR#99) after homing is complete

- 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: whether to execute homing automatically when the drive is powered on

  0: do not execute homing

  1: execute homing automatically (servo switches to On for the first time after power is applied)

The PR Homing mode includes the function for setting the origin offset. You can define any point in the position system as the reference origin, which does not have to be 0. Once you define the reference origin, the position system of the motion axis can be established.

See Figure 7.1.3.1.1. The position of the reference origin is 2000 (P6.001 = 2000). The motor passes by the reference origin and then stops at the position of 1477. From the position system that it established, the system automatically calculates the position of the 0 point. As soon as the PR motion command is issued, the motor moves to the specified position.

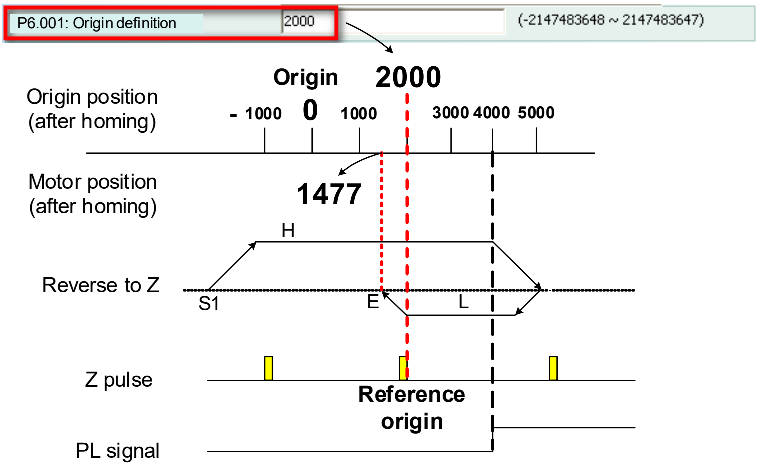

Figure 7.1.3.1.1 Origin definition

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. The servo starts the homing procedure at high speed to seek the reference point (such as the limit switch and ORG signal), which takes shorter time. 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.

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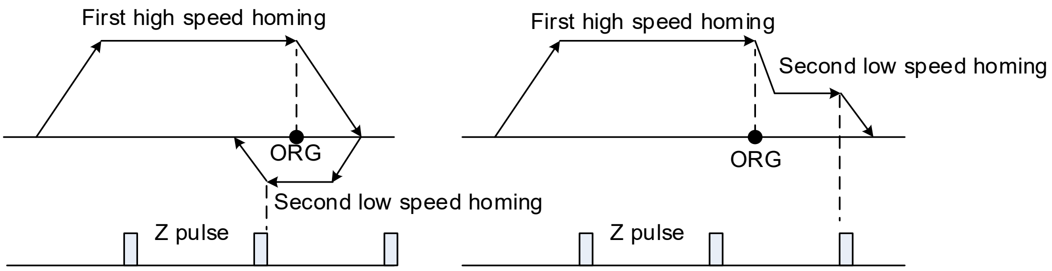
P5.005	High speed homing (first speed setting)			Address: 050AH 050BH
Operation interface:	Panel / software	Communication	Control mode:	PR (set with P5.004)
Default:	100.0	1000	Data size:	32-bit
Unit:	1 rpm	0.1 rpm	-	-
Setting range:	0.1 - 2000.0	1 - 20000	-	-
Format:	DEC	DEC	-	-
Example:	1.5 = 1.5 rpm	15 = 1.5 rpm	-	-

Settings:

The first speed setting for high speed homing.



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	0.1 rpm	-	-
Setting range:	0.1 - 500.0	1 - 5000	-	-
Format:	DEC	DEC	-	-
Example:	1.5 = 1.5 rpm	15 = 1.5 rpm	-	-

Settings:

The second speed setting for low speed homing.

7

You can set the homing parameters in the PR mode Homing Setting screen in ASDA-Soft, including the Homing Mode, Homing Speed Setting, and Homing Definition (see Figure 7.1.3.1.2).

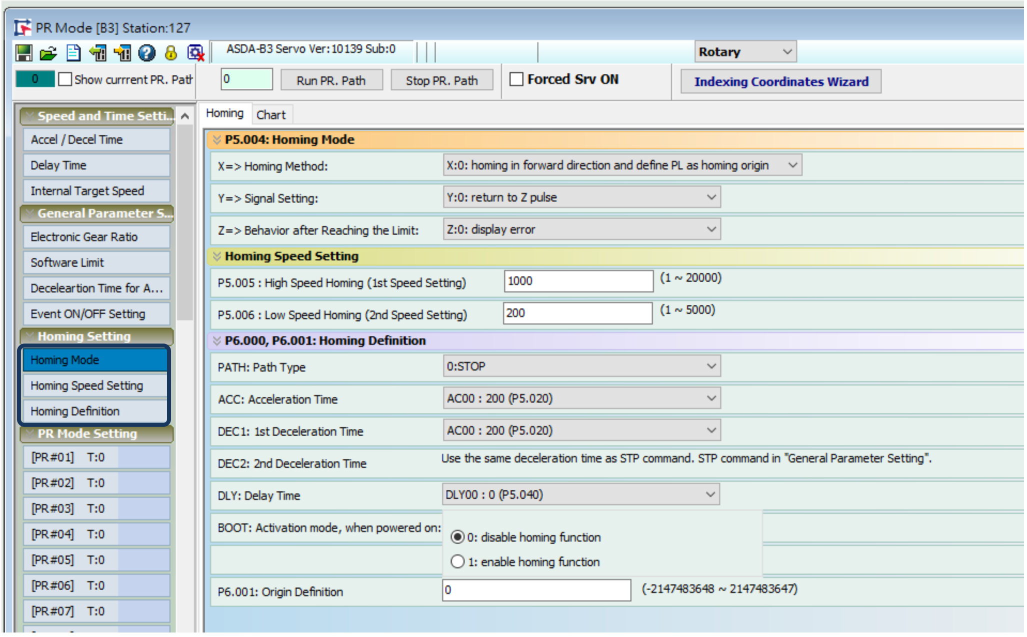
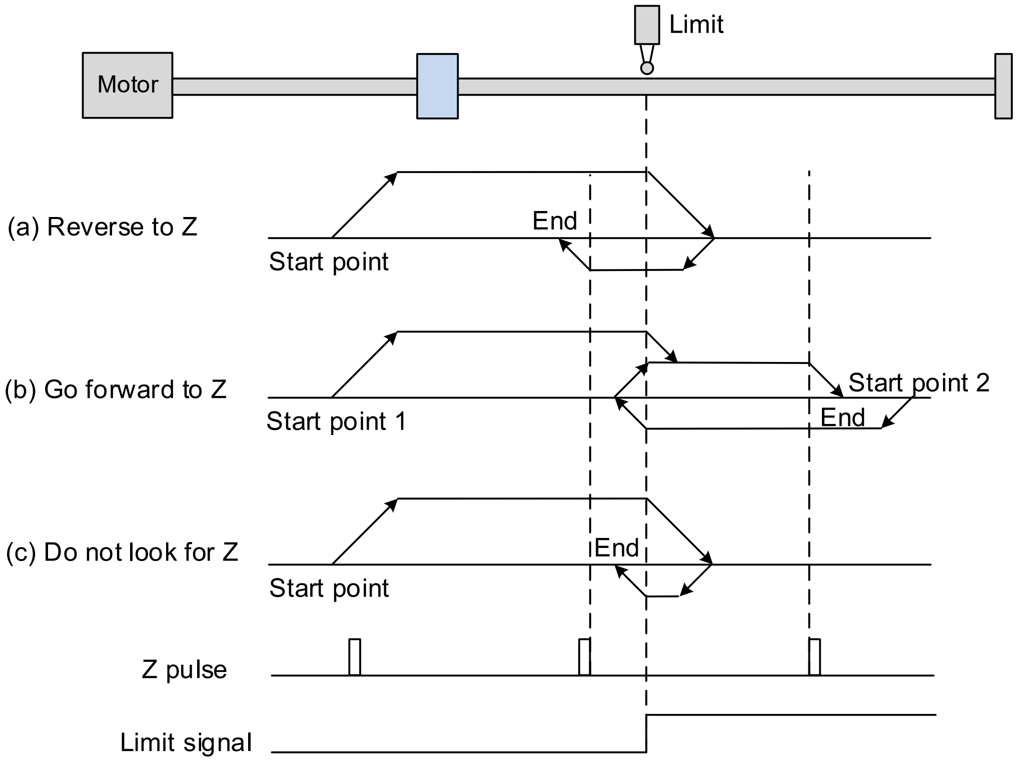


Figure 7.1.3.1.2 Homing screen in ASDA-Soft

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

1. Referencing the limit.

This method uses the positive or negative limit as the reference point. When the limit is detected, you can choose whether or not to look for the Z pulse and use it as the reference origin. The searching result is the same regardless of where the start point is. The servo drive always looks for the set reference point to reset the motor position.



(a) If you set the servo to look for the Z pulse in the reverse direction, the servo operates at high speed (first speed setting) then decelerates once reaching the limit (rising-edge triggered). Then the servo switches to low speed (second speed setting) to look for the Z pulse in the reverse direction. When the servo finds the Z pulse, it decelerates to a stop, completing the homing procedure.

(b) If you set the servo to look for the Z pulse in the forward direction and the limit signal at the start position is un-triggered (low, Start point 1), the servo operates at high speed (first speed setting) then decelerates once reaching the limit (rising-edge triggered). Then the servo switches to low speed (second speed setting) to look for the Z pulse in the forward direction. When the servo finds the Z pulse, it decelerates to a stop, completing the homing procedure.

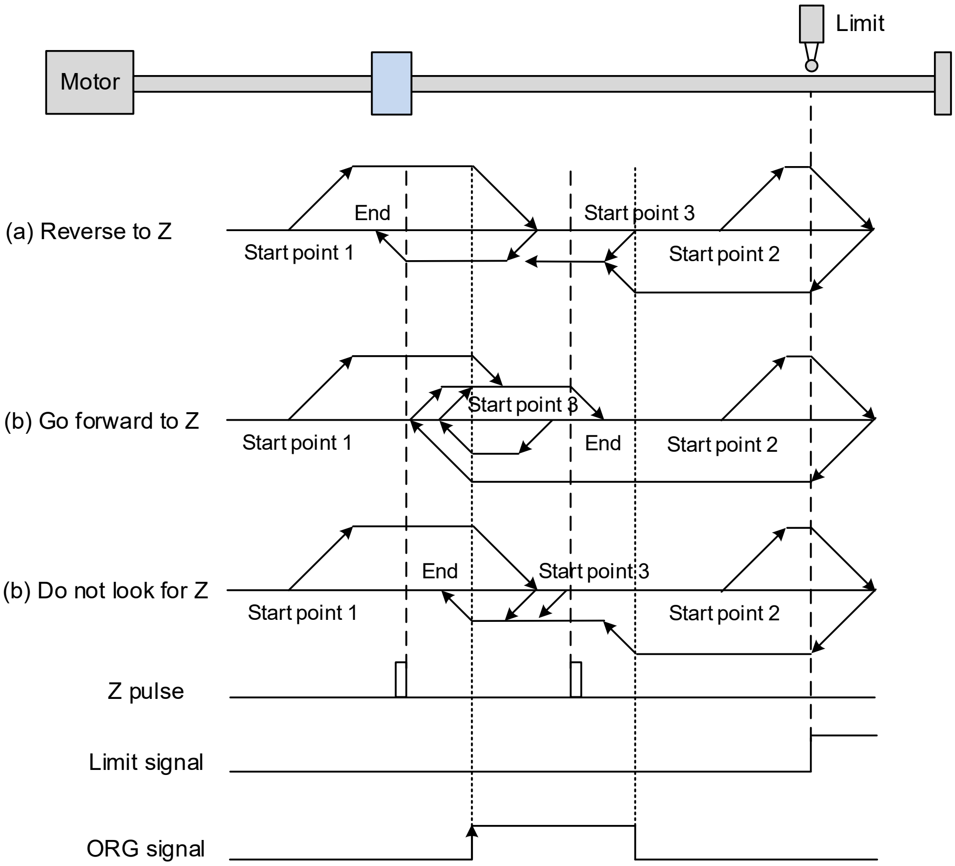
If you set the servo to look for the Z pulse in the forward direction and the limit signal at the start position is triggered (high, Start point 2), the servo operates at low speed (second speed setting) in the reverse direction to look for the rising-edge limit signal. Then the servo starts to look for the Z pulse in the forward direction once reaching the limit (rising-edge triggered). When the servo finds the Z pulse, it decelerates to a stop, completing the homing procedure.

From the examples, regardless of the start positions, the origin position after homing is the same under the same setting condition.

(c) If you set the servo to not look for the Z pulse, the servo operates at high speed (first speed setting) then decelerates once reaching the limit (rising-edge triggered). Then the servo switches to low speed (second speed setting) in the reverse direction to look for the rising-edge limit signal. When the servo finds the rising-edge signal, it decelerates to a stop, completing the homing procedure.

2. Referencing the rising edge of the home sensor (ORG) signal.

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



(a) If you set the servo to look for the Z pulse in the reverse direction, when the ORG signal at the start point is un-triggered (low, Start point 1), the servo operates at high speed (first speed setting) then decelerates once reaching the ORG signal (rising-edge triggered). Then it reverses and switches to low speed (second speed setting) until the ORG signal switches to low. Next, the servo starts to look for the Z pulse in the reverse direction. When the servo finds the Z pulse, it decelerates to a stop, completing the homing procedure.

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

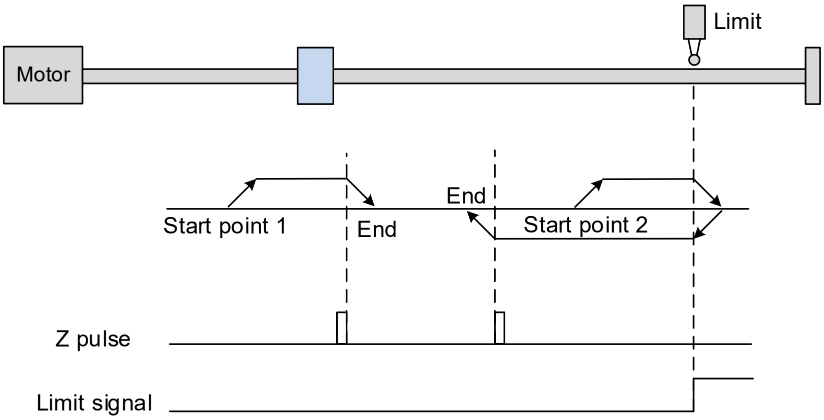
If the ORG signal at the start point is triggered (high, Start point 3), the servo reverses with low speed (second speed setting) until the ORG signal switches to low. Next, the servo continues to look for the Z pulse. When the servo finds the Z pulse, it decelerates to a stop, completing the homing procedure.

(b) If you set the servo to look for the Z pulse in the forward direction or not to look for the Z pulse (this is similar to method (a) reversing to look for the Z pulse), refer to the preceding timing diagram.

7

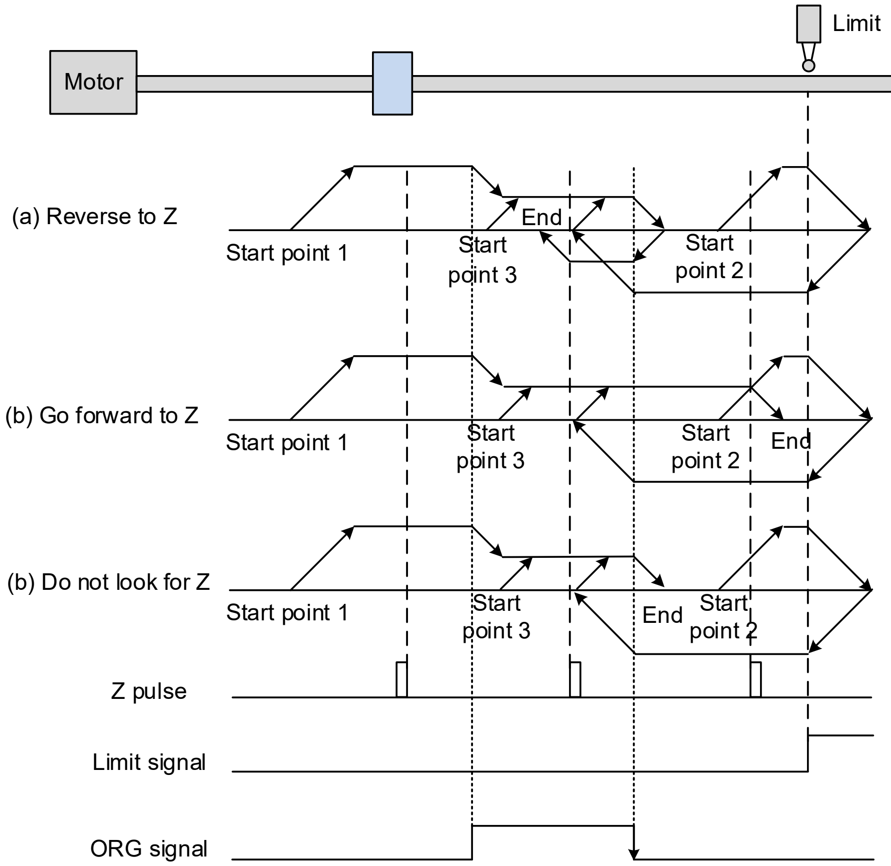
3. Referencing the Z pulse.

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



4. Referencing the falling edge of the home sensor (ORG) signal.

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



(a) If you set the servo to look for the Z pulse in the reverse direction, when the ORG signal at the start point is un-triggered (low, Start point 1), the servo operates 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 switches to low. Next, the servo reverses to look for the Z pulse. When the servo finds the Z pulse, it decelerates to a stop, completing the homing procedure.

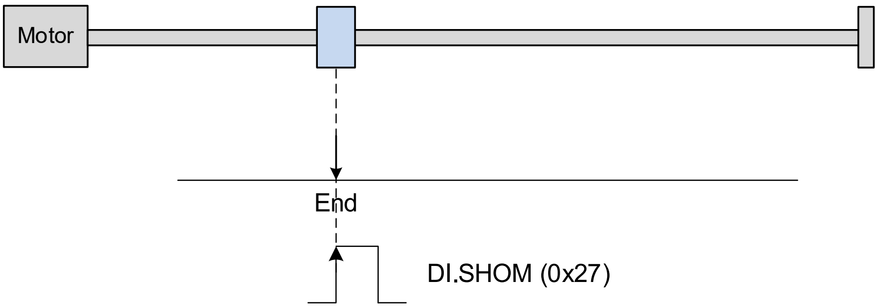
    If the ORG signal at the start point is un-triggered (low, Start point 2) and the start point is relatively closer to the limit switch, the servo operates at high speed (first speed setting) until reaching the limit switch. You can set whether to show an error or reverse the direction when the servo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

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

(b) If you set the servo to look for the Z pulse in the forward direction or not to look for the Z pulse (this is similar to method (a) reversing to look for the Z pulse), refer to the preceding timing diagram.

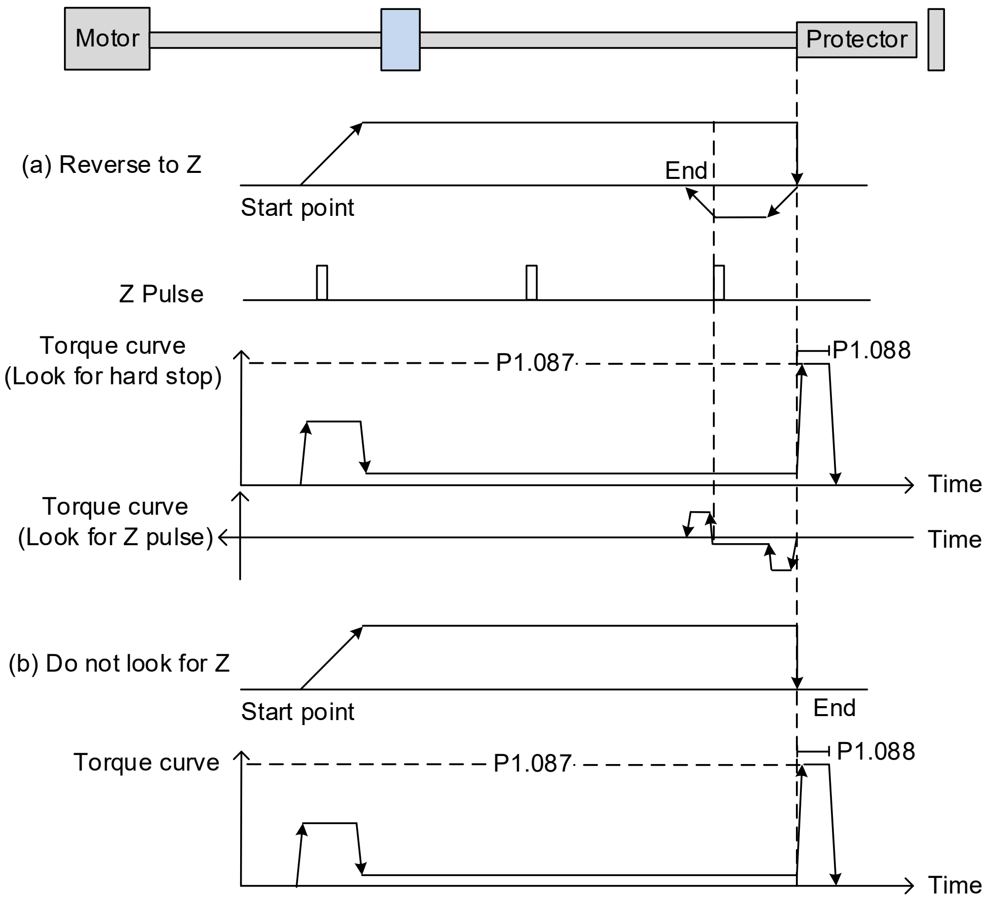
7

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 motor positioning is complete.



6. Referencing the torque limit.

   This method uses the motor's stop position as the origin by referring to: the limit on the mechanical parts, the torque level detection (P1.087), and the level reached timer (P1.088). You can also choose whether or not to use the Z pulse as the reference origin.



(a) If you set the servo to look for the Z pulse in the reverse direction, the servo operates at high speed (first speed setting) and outputs a greater current to counter the external force once it touches the protector. When the motor torque reaches the torque level detection (P1.087) and the output duration is longer than the level reached timer setting (P1.088), the servo operates in the reverse direction to look for the Z pulse at low speed (second speed setting). When the servo finds the Z pulse, it decelerates to a stop, completing the homing procedure.

(b) If you set the servo not to look for the Z pulse, the servo operates at high speed (first speed setting) and outputs a greater current to counter the external force once it touches the protector. When the motor torque reaches the torque level detection (P1.087) and the output duration is longer than the level reached timer setting (P1.088), the servo stops, completing the homing procedure.

Pay special attention when executing the Torque homing procedure. The motor's actual maximum torque output is 10% greater than the torque level detection setting (P1.087); excessive impact may cause damage to the machine.

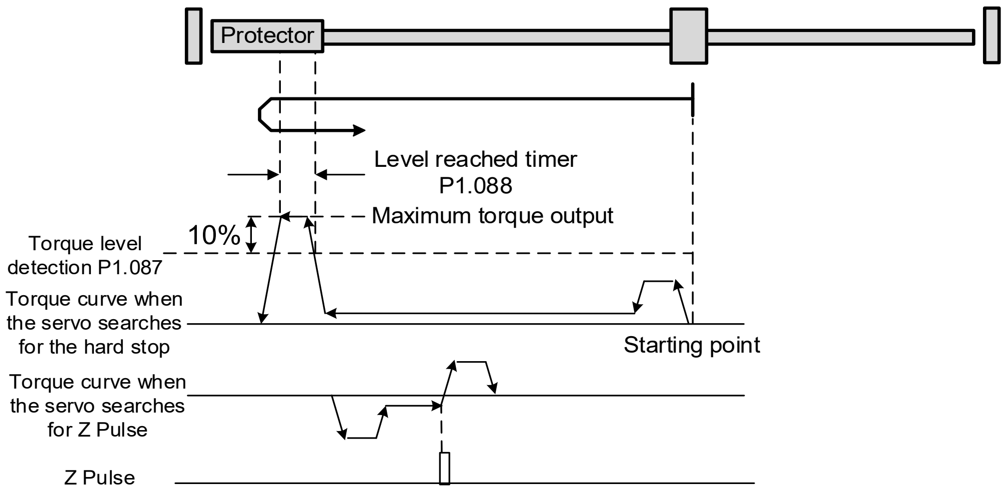
7

The following tables describe the settings for the torque level detection (P1.087) and the level reached timer (P1.088).

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 the mechanical part reaches the protector. The servo drive then outputs a larger motor current in order to counter the external force. The servo drive uses P1.087 and P1.088 as the conditions for homing. Since the hard stops are not always the same, it is recommended that you have the servo reverse to find the Z pulse as the origin.



Note: the actual maximum torque output of the motor is 10% greater than the detected torque level (P1.087).
For example: set P1.087 to 50%, 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.

7

As mentioned in Section 7.1.2, in PR mode, you can use four monitoring variables for checking the servo commands and feedback status. These variables are position command (PUU) (Cmd_O), register of PR command register (Cmd_E), feedback position (PUU) (Fb_PUU), and following error (PUU) (Err_PUU). Before homing completes, Cmd_E cannot be calculated because the position system can only be established after homing is complete, and the target position remains unknown after the Homing command is issued. This is why the changes of the monitoring variables in Homing mode (Figure 7.1.3.1.3) are different from that when the servo issues the PR position command (Figure 7.1.2.1). In Homing command's default setting, the contents of Cmd_E and Cmd_O are identical. After the servo finds the reference origin and establishes the position system, it sets the content of Cmd_E to the position of the reference origin. However, once the servo finds the reference origin, it still requires some distance for the motor to decelerate to a stop. Meanwhile, Cmd_O continues to issue commands. If no other PR commands are issued after the Homing command, unlike the condition where the servo issues the PR position command, the final contents of Cmd_O and Cmd_E in Homing mode will be different. See Figure 7.1.3.1.3.

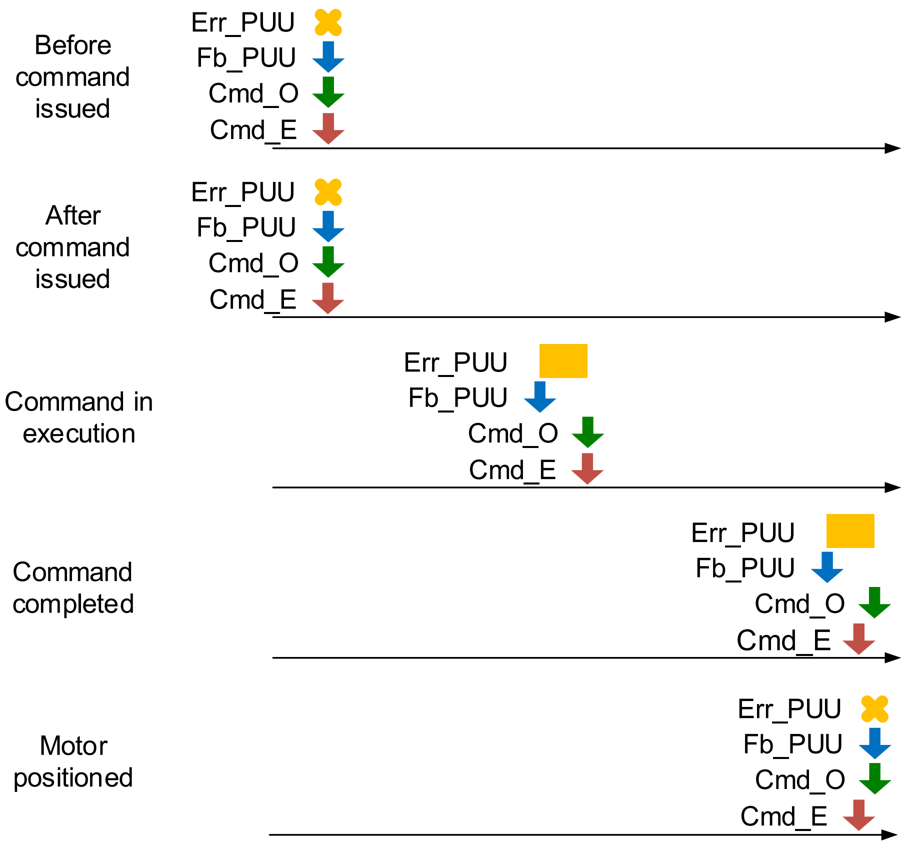


Figure 7.1.3.1.3 Timing diagram for Homing mode monitoring variables

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 by selecting **[1]: Constant speed control** for the TYPE settings 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.
- UNIT is the target speed unit with two options, 0.1 rpm and 1 PPS, and the setting range is -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 the motor to accelerate from 0 to the target speed or to decelerate from the target speed to 0.
- DLY is the delay time determined by the shared PR parameters. It is defined by the command from the controller; in other words, once the target speed is reached, the servo drive starts counting the delay time.

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 functions when speed control is in operation.

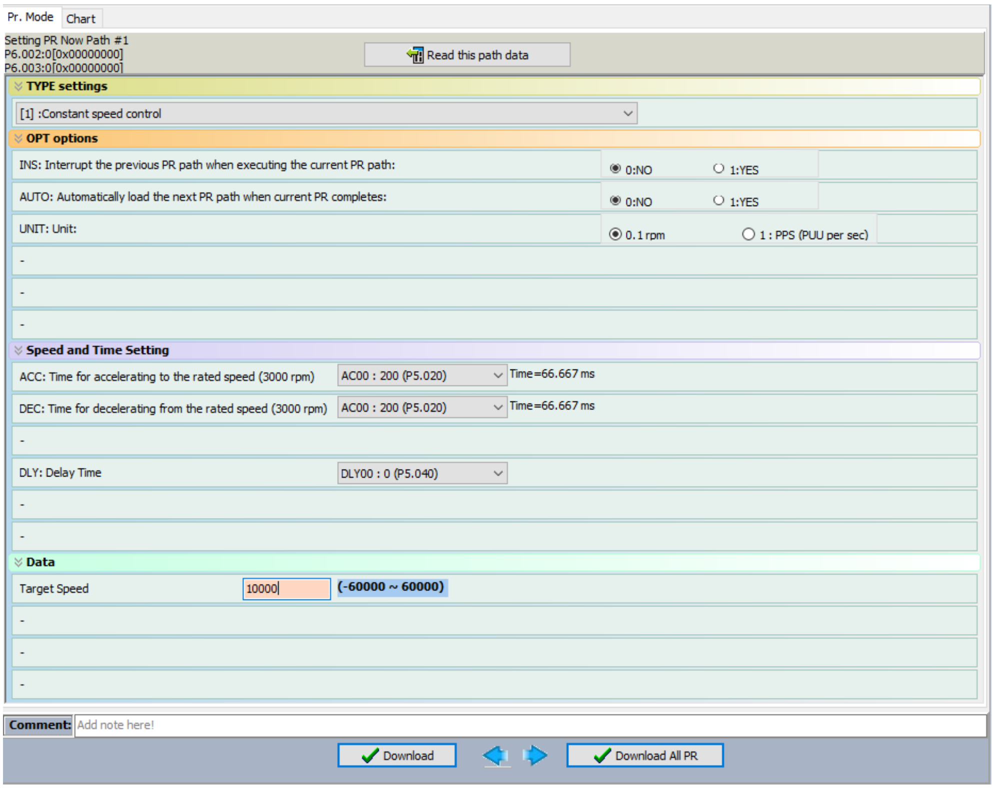


Figure 7.1.3.2.1 PR mode Speed control screen in ASDA-Soft

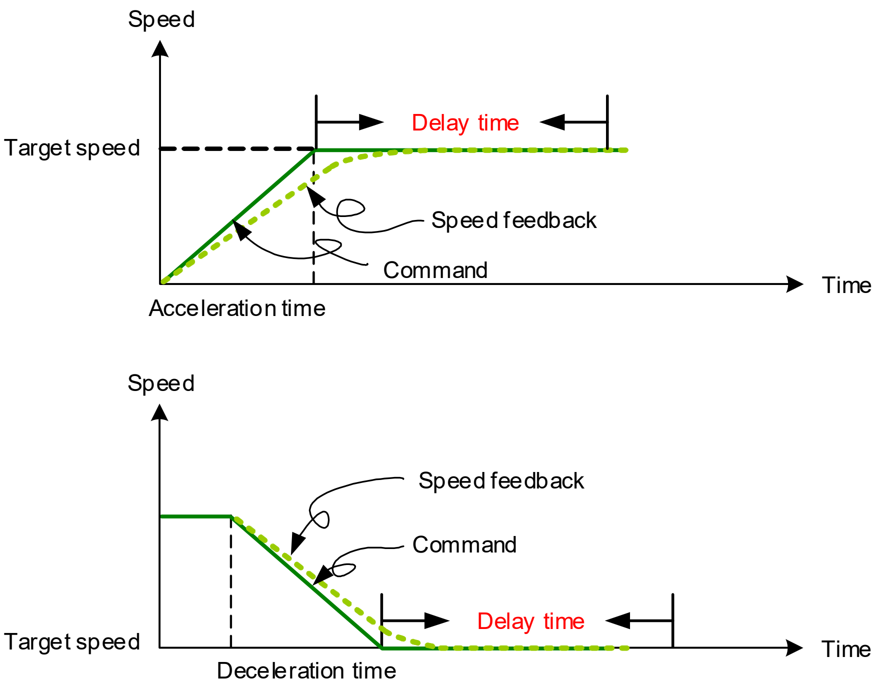


Figure 7.1.3.2.2 Parameters for PR mode speed control

Table 7.1.3.2.1 Bit functions of PR speed control

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

Note:
1. X: 1: SPEED, constant speed control
2. Y: OPT, option

Bit	3	2	1	0
Property	-	UNIT	AUTO	INS

INS: interrupts the previous path when the current path is executed.
AUTO: once current PR path is finished, automatically loads the next path.
UNIT: speed unit selection; 0 = 0.1 rpm and 1 = PPS.
3. Z, U: ACC / DEC, acceleration / deceleration time, set by P5.020 - P5.035.
4. 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 types: Type 2 (The execution stops once the positioning is complete) and Type 3 (The next PR path is automatically loaded once the positioning is complete). The way to set these types of commands is the same. See Figure 7.1.3.3.1 for setting these commands in ASDA-Soft.

- INS is an interrupt command that interrupts the previous motion command. Refer to Section 7.1.6 for more details.
- OVLP is an overlap command that allows the next PR command to overlap the command currently being executed during deceleration. If you use this function, setting the delay time to 0 is suggested. Refer to Section 7.1.6 for more details.
- ACC / DEC is the acceleration / deceleration time determined by the shared PR parameters. The software calculates and displays the required duration for the motor to accelerate from 0 to the target speed or to decelerate from the target speed to 0.
- SPD is the target speed determined by the shared PR parameters. You can choose whether it is multiplied by 0.1.
- DLY is the delay time determined by the shared PR parameters. 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 in units of 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 functions when position control is in operation.

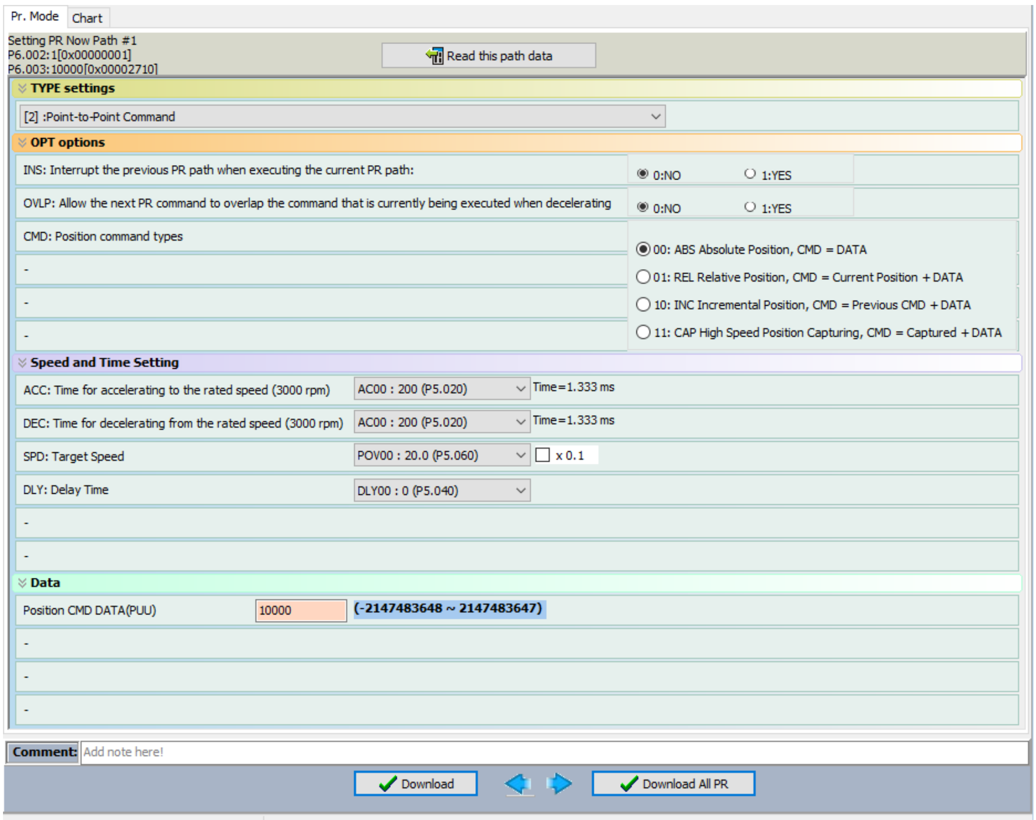


Figure 7.1.3.3.1 PR mode Position control screen in ASDA-Soft

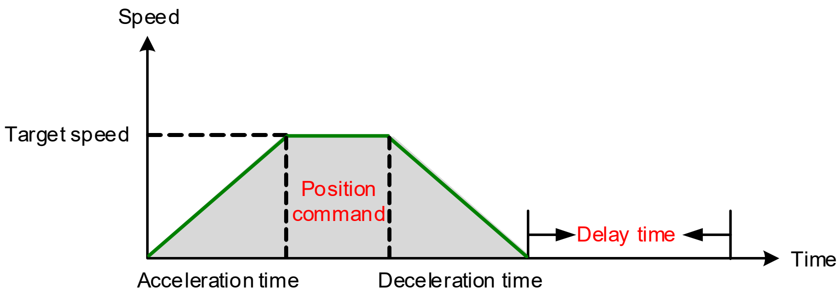


Figure 7.1.3.3.2 Parameters for PR mode position control

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 the definition of each command and how the position commands are combined, refer to Figure 7.1.3.3.3.

1. Absolute position command (ABS): when an absolute command is inserted, 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, so the target position is 60000 PUU in the position system.
2. Relative position command (REL): when a relative command is inserted, 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 in the position system. The target position specified by the original command is omitted.
3. Incremental position command (INC): when an incremental command is inserted, 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 in the position system. The target position specified by the previous command is combined to define the new one.
4. High-speed position capturing command (CAP): when a high-speed capturing command is inserted, 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 capture 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 position command (60000 PUU), which equals 70000 PUU in the position system. The target position specified by the original command is omitted.

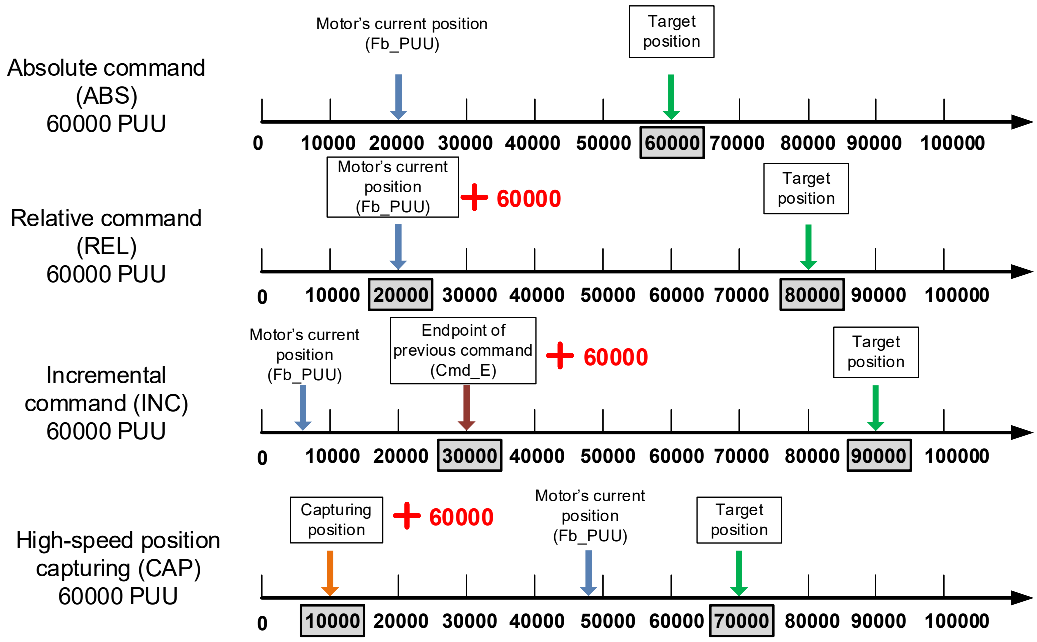


Figure 7.1.3.3.3 Four types of Position command

Table 7.1.3.3.1 Bit functions of PR position control

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

Note:

1. X:
   2: SINGLE, positioning control. It stops once positioning is complete.
   3: AUTO, positioning control. It automatically loads the next path once positioning is complete.
2. Y: OPT, option

Bit	3	2	1	0	Description
Property	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: interrupts the previous path when the current path is executed.
OVLP: allow overlapping of the next command.
CMD: Position command selection.

3. Z, U: ACC / DEC, acceleration / deceleration time, set by P5.020 - P5.035.
4. A: SPD, target speed, set by P5.060 - P5.075.
5. 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 target PR number 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 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.

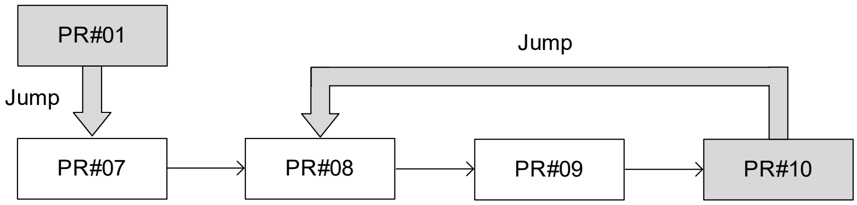


Figure 7.1.3.4.1 Jump command in PR mode

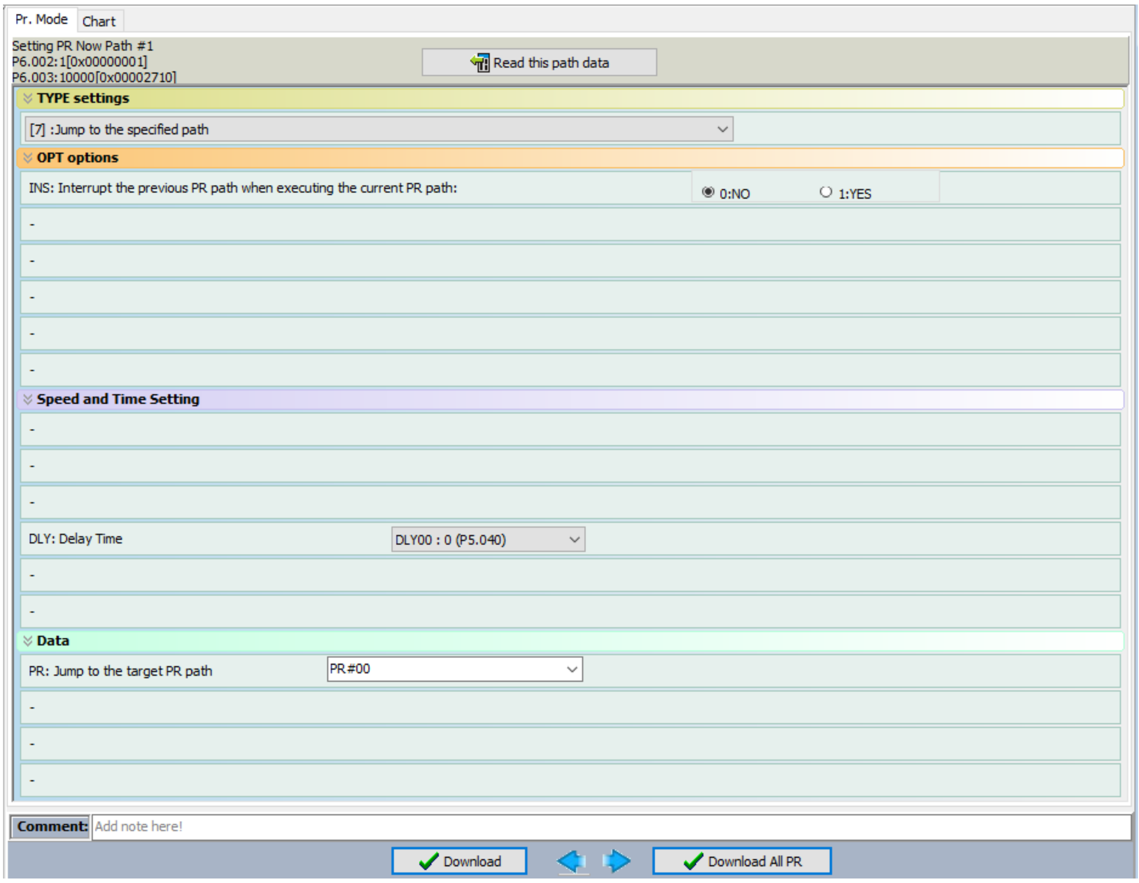


Figure 7.1.3.4.2 PR mode Jump command screen in ASDA-Soft

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Table 7.1.3.4.1 shows the bit functions when Jump command is in operation.

Table 7.1.3.4.1 Bit functions of PR Jump command

PR parameters	D	C	B	A	U	Z	Y	X
Property	-	-	DLY	-	-	-	OPT	7
Data content	Jump to target PR path (0 - 99)							

Note:

1. X: 7: JUMP, jump to the specified path.
2. Y: OPT, option

Bit	3	2	1	0
Property	-	-	-	INS

INS: interrupts the previous path when the current path is executed.

3. 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 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. The function of writing to non-volatile memory is also available; however, frequent usage shortens the lifetime of the EEPROM.
- DLY is the delay time determined by the shared PR parameters. Once a Write command is issued, the servo drive starts counting the delay time.

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

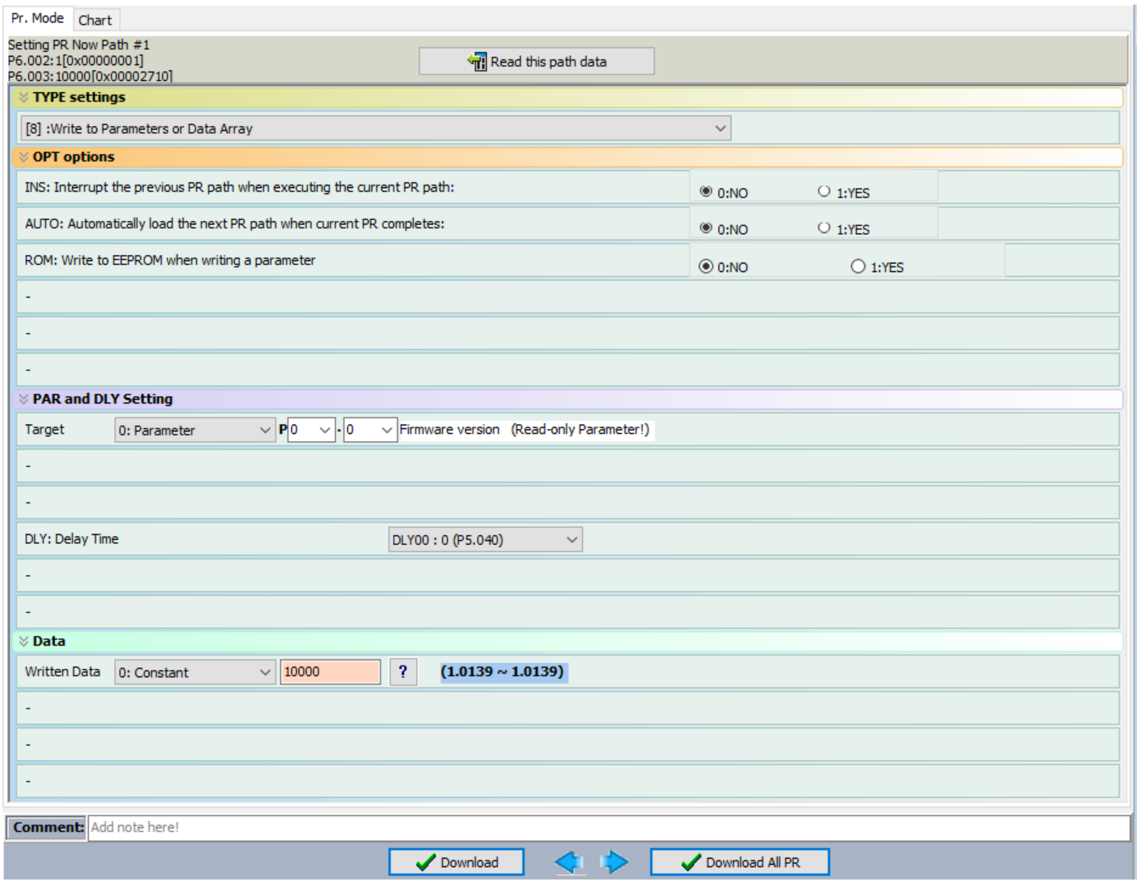

Figure 7.1.3.5.1 PR mode Write command screen in ASDA-Soft

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Table 7.1.3.5.1 shows the bit functions when a Write command is in operation.

Table 7.1.3.5.1 Bit functions of PR Write command

PR parameters	D	C	B	A	U	Z	Y	X
Property	0	SOUR_DEST	DLY	DESTINATION			OPT	8
Data content	SOURCE							

Note:

1. X: 8: WRITE, write specified parameters to the specified path.
2. Y: OPT, option

Bit	3	2	1	0
Property	-	ROM	AUTO	INS

INS: interrupts the previous path when the current path is executed.
AUTO: once current PR path is finished, automatically loads the next path.
ROM: write data to RAM and EEPROM at the same time. This function can only write parameters.

3. B: DLY, delay time, set by P5.040 - P5.055.
4. C: SOUR_DEST, data source and data format to be written.

Bit	3	2	1	0	Description	
Property	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

5. Z, U, A: DESTINATION, destination

	A	U	Z
Writing target: parameter	Parameter group	Parameter number	
Writing target: data array	Data array number		

6. 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 Rotary Axis Position command (Index Position)

The PR mode includes a Rotary Axis Position command, which creates a rotary axis position system. This command positions the motor within the rotary axis position system, unlike the position feedback in a global coordinate system. The Rotary Axis Position command is able to divide the rotary axis position scale into the number of paths required by the application (see Figure 7.1.3.6.1). When the Rotary Axis Position command is used for motor operation in single direction (or mostly in the same direction), 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 rotary axis positioning with the Rotary Axis Position Setting Wizard (Index Coordinates Setting Wizard) in the PR mode screen in ASDA-Soft (see Figure 7.1.3.6.2).
As shown in the example, the starting PR path is set to 1, the number of paths (path size) is set to 8, and the total moving distance (P2.052) 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 rotary axis position reaches 80000 PUU, it automatically returns to 0 PUU.

In addition, you can modify the rotary axis position in each PR path as needed, as shown in Figure 7.1.3.6.3.

- INS is an interrupt command that interrupts the previous motion command. Refer to Section 7.1.6 for more details.
- OVLP is an overlap command that allows the next PR command to overlap the command currently being executed during deceleration. If you use this function, setting the delay time to 0 is suggested. Refer to Section 7.1.6 for more details.
- 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 determined by the shared PR parameters.
- DLY is the delay time determined by the shared PR parameters. It is defined by a command from the controller; in other words, once the target position is reached, the servo drive starts counting the delay time.
- Position command is the target position of each rotary axis traveling segment. Note that the setting range must be smaller than the rotary axis position scale (P2.052).

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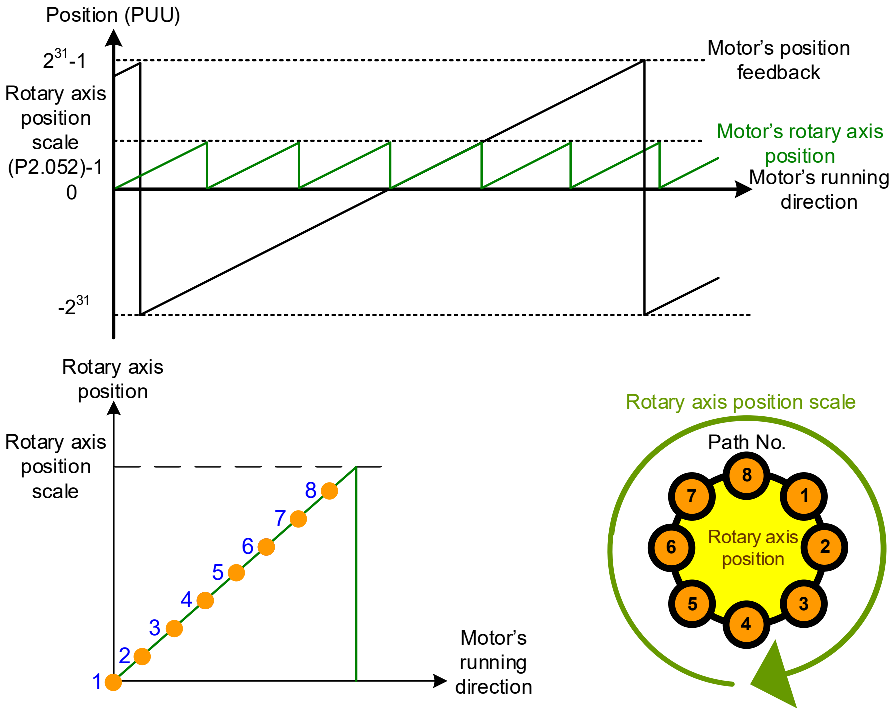

Figure 7.1.3.6.1 Rotary axis position in PR mode

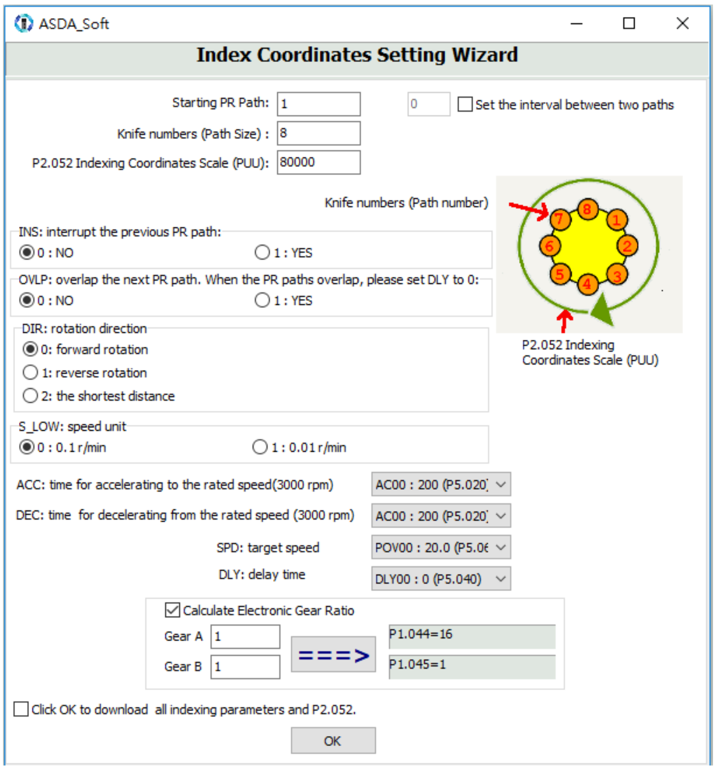

Figure 7.1.3.6.2 Rotary Axis Position Setting Wizard (Index Coordinates Setting Wizard) in PR mode

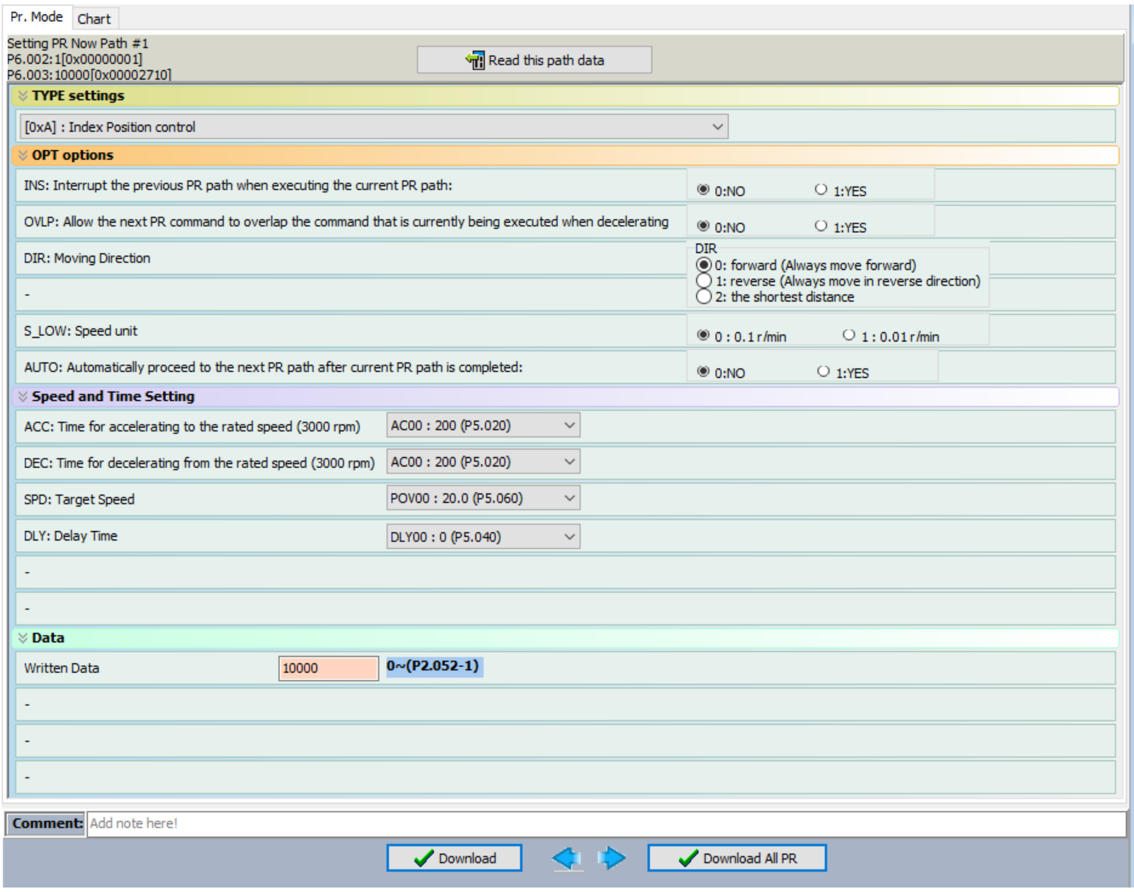

Figure 7.1.3.6.3 PR mode Rotary Axis Position control (Index Position control) screen in ASDA-Soft

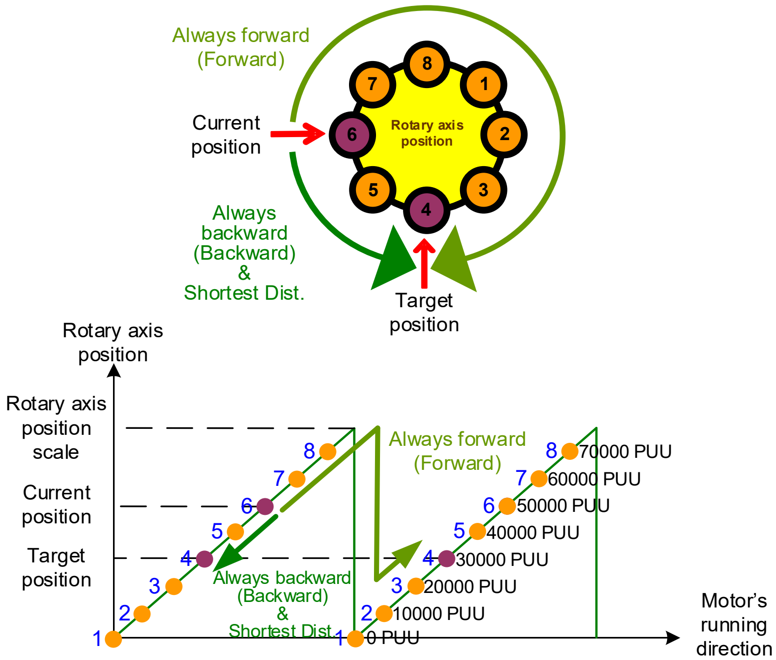

Figure 7.1.3.6.4 Motor's operation direction and rotary axis position

Table 7.1.3.6.1 shows the bit functions when a Rotary Axis Position command is in operation. If you use the rotary axis position function, execute homing first in order to create the position system so that the origin of the motor's position feedback and that of the motor's rotary axis position can be identical. If you do not execute homing, AL237 occurs.

Table 7.1.3.6.1 Bit functions of the PR Rotary Axis Position command

PR parameters \ Bit	D	C	B	A	U	Z	Y	X
Property	-	OPT2	DLY	SPD	DEC	ACC	OPT	A
Data content	Rotary Axis Position command [PUU] (0 to P2.052 minus 1)							

Note:

1. X: A: INDEX, rotary axis position control (index position control)
2. Y: OPT, option

Bit	3	2	1	0	Description
Property	DIR		OVLP	INS	-
Data content	0	0	-	-	Always goes forward (Forward)
	0	1			Always goes backward (Backward)
	1	0			Shortest distance
	1	1			-

INS: interrupts the previous path when the current path is executed.
OVLP: allow overlapping of the next command.
DIR: rotation direction.

3. C: OPT2, option 2

Bit	3	2	1	0
Property	-	AUTO	-	S_LOW

S_LOW: speed unit options, 0 = 0.1 r/min and 1 = 0.01 r/min.
AUTO: once current PR path is finished, automatically loads the next path.

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

7.1.4 Overview of the PR procedure

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

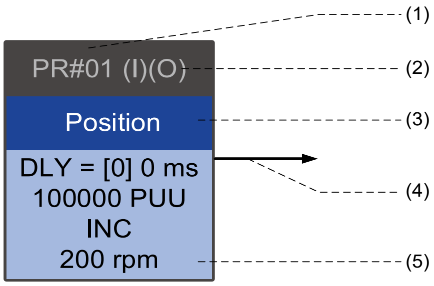

Figure 7.1.4.1 Overview of the PR procedure

(1) Number: the PR path number, ranging from PR#00 to PR#99 (100 sets of PR paths).

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

(3) Command type: there are six types of PR procedure commands: Homing, Speed, Position, Jump, Write, and Rotary Axis Position (Index Position). The color displayed in this section depends on the command type.

(4) Next procedure command: if the current path is followed by a PR command, there would be an arrow pointing to the specified PR path.

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

The following sections illustrate each command type and its representation.

Homing methods

In the display of homing methods, PR#00 always signifies the homing procedure, which is marked as “Homing”. See Figure 7.1.4.2.

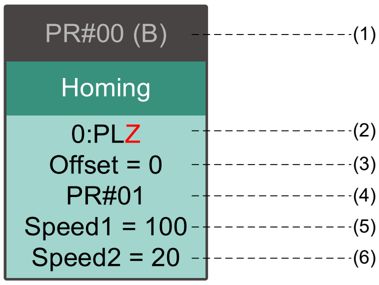

Figure 7.1.4.2 Homing methods display

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

(2) Method selection: including the homing methods and Z pulse setting shown as follows. When the mode name ends with a “Z”, it means the servo looks for the Z pulse in the forward or reverse direction; when the mode name ends with a non-Z character, it means the servo does not look for the Z pulse. F signifies running forward; R signifies running in reverse; ORG signifies the origin (home sensor); CUR signifies the current position; and BUMP signifies the hard stop.

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 and define the positive limit (PL) as the homing origin	0: PLZ	0: PL
X = 1: homing in reverse direction and define the negative limit (NL) as the homing origin	1: NLZ	1: NL
X = 2: homing in forward direction, ORG: OFF→ON as the homing origin	2: F_ORGZ	2: F_ORG
X = 3: homing in reverse direction, ORG: OFF→ON as the homing origin	3: R_ORGZ	3: R_ORG
X = 4: look for Z pulse in forward direction and define it as the homing origin	4: F_Z	
X = 5: look for Z pulse in reverse direction and define it as the homing origin	5: R_Z	
X = 6: homing in forward direction, ORG: ON→OFF as the homing origin	6: F_ORGZ	6: F_ORG
X = 7: homing in reverse direction, ORG: ON→OFF as the homing origin	7: R_ORGZ	7: R_ORG
X = 8: define the current position 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: the next PR path to be executed after homing.

(5) Homing at high speed (Speed1): first homing speed (P5.005).

(6) Homing at low speed (Speed2): second homing speed (P5.006).

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Speed command

You can use the Speed command in any of the PR paths, PR#01 - PR#99. It is marked as "Speed". See Figure 7.1.4.3.

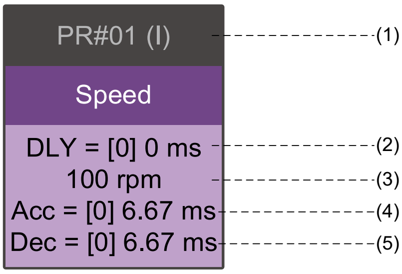

Figure 7.1.4.3 Speed command display

(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 the shared PR parameters. It is defined by the command from the controller; in other words, once the target speed is reached, the servo drive starts counting the delay time.

(3) Target speed: the set target speed.

(4) Acceleration time (Acc): determined by the shared PR parameters; the required time to accelerate from stopped to target speed.

(5) Deceleration time (Dec): determined by the shared PR parameters; the required time to decelerate from target speed to stopped.

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Position command

You can use the Position command in any of the PR paths, PR#01 - PR#99. It is marked as “Position”, and includes the options of “Stop once position control completed” and “Load the next path once position control completed”. The only difference is that the latter one shows an arrow pointing to the next PR. See Figure 7.1.4.4.

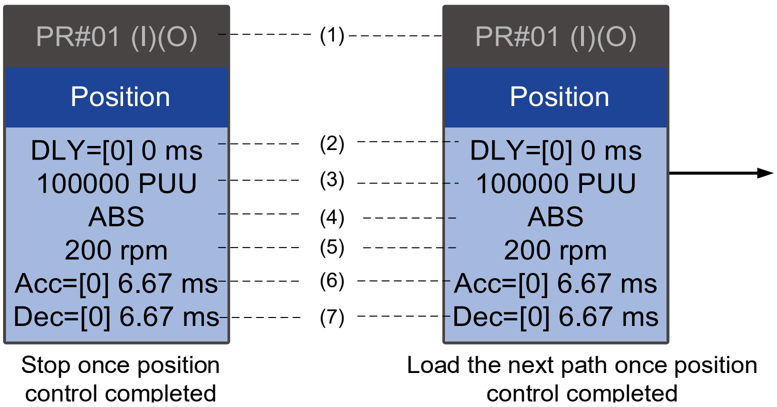

Figure 7.1.4.4 Position command display

(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. You can also set an Overlap (OVLP) function in the Position command and set the delay time (DLY) to 0, so that the next PR path can overlap the current one. If the Overlap function is enabled, it displays (O); if not, no information is displayed.

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

(3) Target position: the set target position.

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

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

(6) Acceleration time (Acc): determined by the shared PR parameters; the required time to accelerate from stopped to target speed.

(7) Deceleration time (Dec): determined by the shared PR parameters; the required time to decelerate from target speed to stopped.

Jump command

You can use the Jump command in any of the PR paths, PR#01 - PR#99. It is marked as "Jump" and followed by an arrow pointing to the next PR path. See Figure 7.1.4.5.

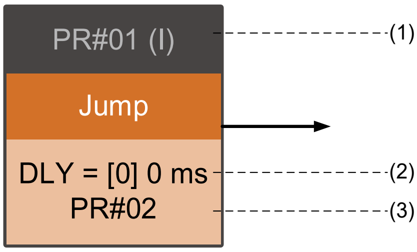

Figure 7.1.4.5 Jump command display

(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 the shared PR parameters.

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

Write command

You can use the Write command in any of the PR paths, PR#01 - PR#99. It is marked as "Write". See Figure 7.1.4.6.

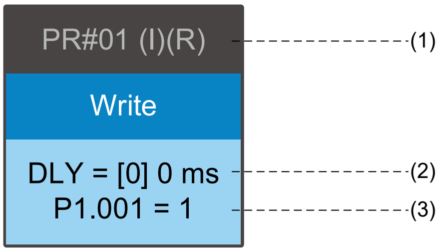

Figure 7.1.4.6 Write command display

(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 the 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[#])

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Rotary Axis Position command (Index Position)

You can use the Rotary Axis Position command in any of the PR paths, PR#01 - PR#99. The number of PR paths is determined by the number of Rotary Axis commands. It is marked as "Index Position". See Figure 7.1.4.7.

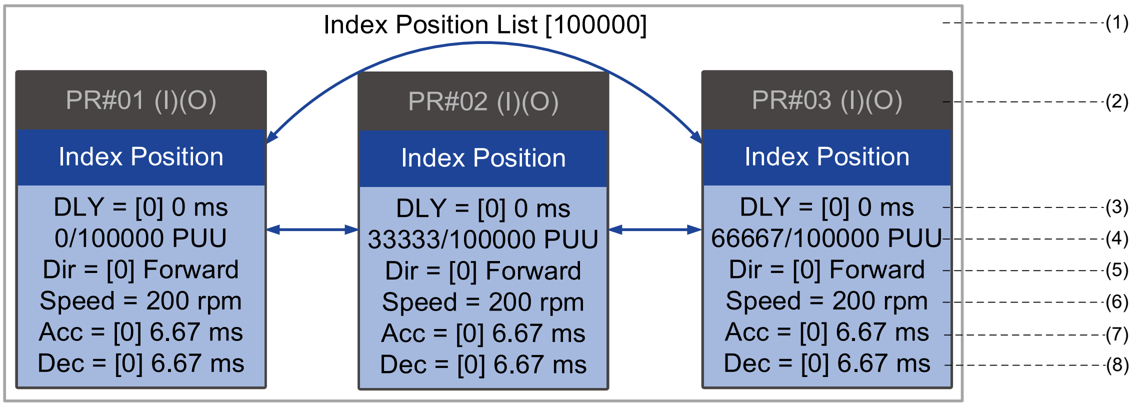


Figure 7.1.4.7 Rotary Axis Position command (Index Position) display

(1) Rotary Axis Position command section: a set of Rotary Axis Position commands. 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 Rotary Axis Position 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 also set an Overlap (OVLP) function in the Rotary Axis Position command and set the delay time (DLY) to 0, so that the next PR path can overlap the current one. If the Overlap function is enabled, it displays (O); if not, no information is displayed.

(3) Delay time (DLY): determined by the shared PR parameters. It is defined by the command from the controller; in other words, once the target position is reached, the servo starts counting the delay time.

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

(5) Rotation direction (Dir): available options are "Always move forward (Forward)", "Always move in reverse direction (Reverse)", and "The shortest distance (Shortest)".

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

(7) Acceleration time (Acc): determined by the shared PR parameters; the required time to accelerate from stopped to target speed.

(8) Deceleration time (Dec): determined by the shared PR parameters; the required time to decelerate from target speed to stopped.

7.1.5 Trigger methods for the PR command

There are four types of PR trigger methods. They are Digital input (DI) triggering, Event triggering, PR command trigger register (P5.007), and High-speed position capture (Capture) triggering. Choose the most suitable trigger method based on the applications and requirements.

Digital input (DI) triggering

You can choose the PR path to be executed by using the internal command registers (POS0 - POS6) and use the CTRG command to trigger the selected PR path. Before triggering the PR command with the digital inputs (DIs), you must define the functions of the 8 sets of DIs, which are DI.POS0 (0x11), DI.POS1 (0x12), DI.POS2 (0x13), DI.POS3 (0x1A), DI.POS4 (0x1B), DI.POS5 (0x1C), DI.POS6 (0x1E), and DI.CTRG (0x08) (refer to Table 8.1 in Chapter 8). You can set these DIs in the Digital IO setting screen in ASDA-Soft, as shown in Figure 7.1.5.1.

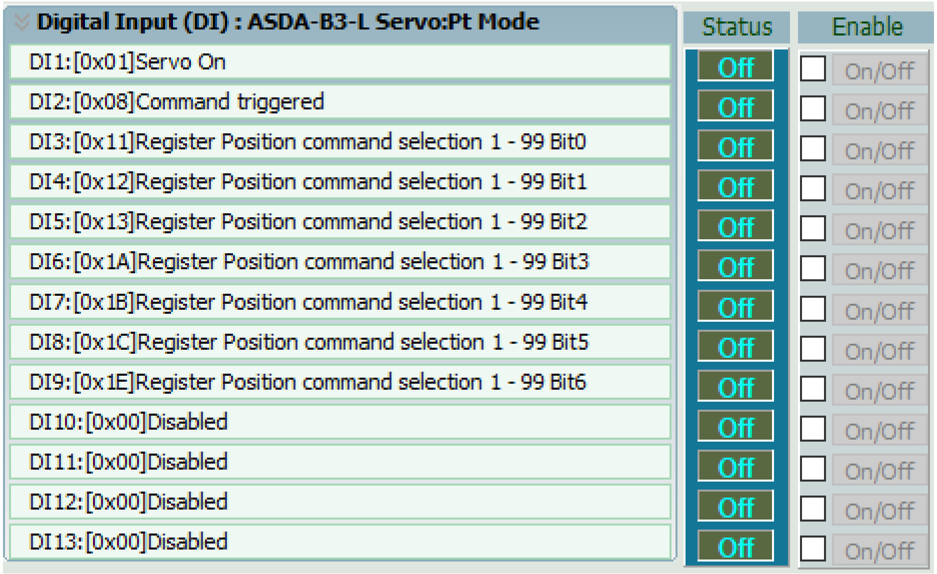


Figure 7.1.5.1 Digital IO setting screen in ASDA-Soft

Select the PR number to be executed based on the On/Off status of DI.POS0 - POS6 and use DI.CTRG to trigger the specified PR path. See the following table for an example.

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#01	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 DIs for special functions: DI.SHOM (0x27) and DI.STP (0x46). 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 Digital IO setting screen in ASDA-Soft to set these functions, as shown in Figure 7.1.5.2.

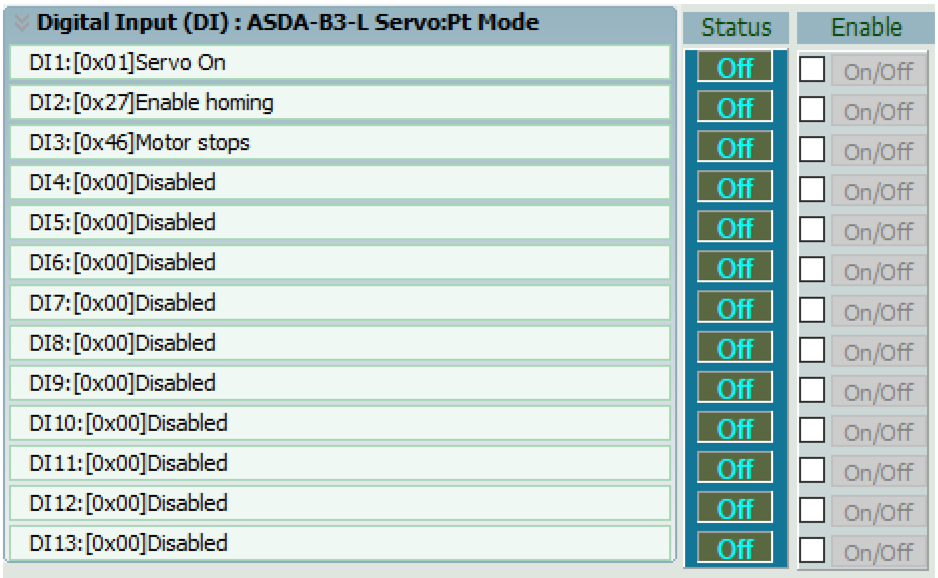


Figure 7.1.5.2 Digital IO setting screen in ASDA-Soft

Event triggering

You can use Event trigger commands 1 - 4 to execute the specified PR path. There are two types of Event triggering: rising-edge trigger and falling-edge trigger. The PR path numbers that you can specify are PR#51 - 63 (see the example in Figure 7.1.5.3). Before using the event triggering for PR commands, you must define the functions of these DIs, which are DI.EV1 (0x39), DI.EV2 (0x3A), DI.EV3 (0x3B), and DI.EV4 (0x3C) (see Table 8.1 in Chapter 8). You can use the Digital IO setting screen in ASDA-Soft to set these functions, as shown in Figure 7.1.5.4.

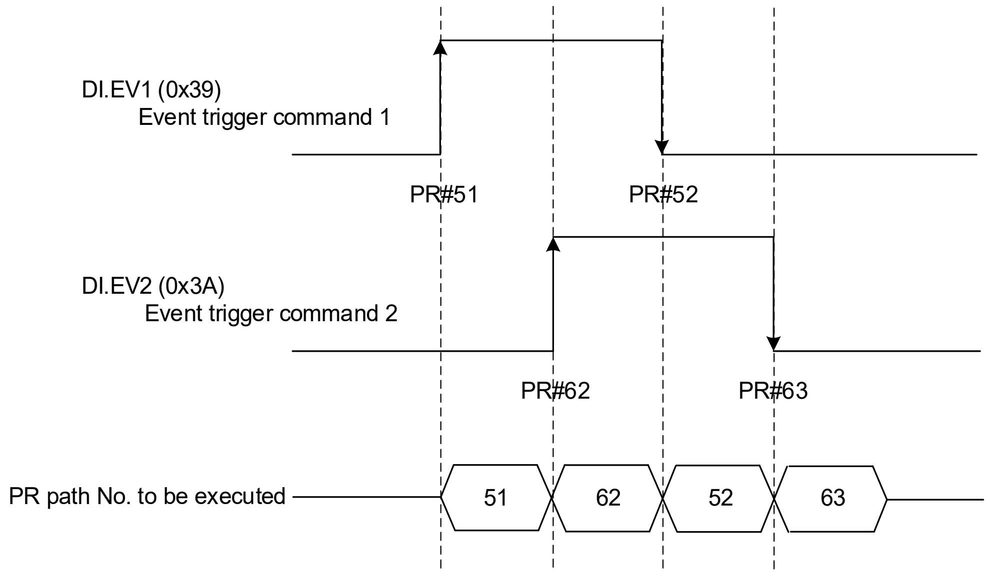


Figure 7.1.5.3 Example of event triggering timing diagram

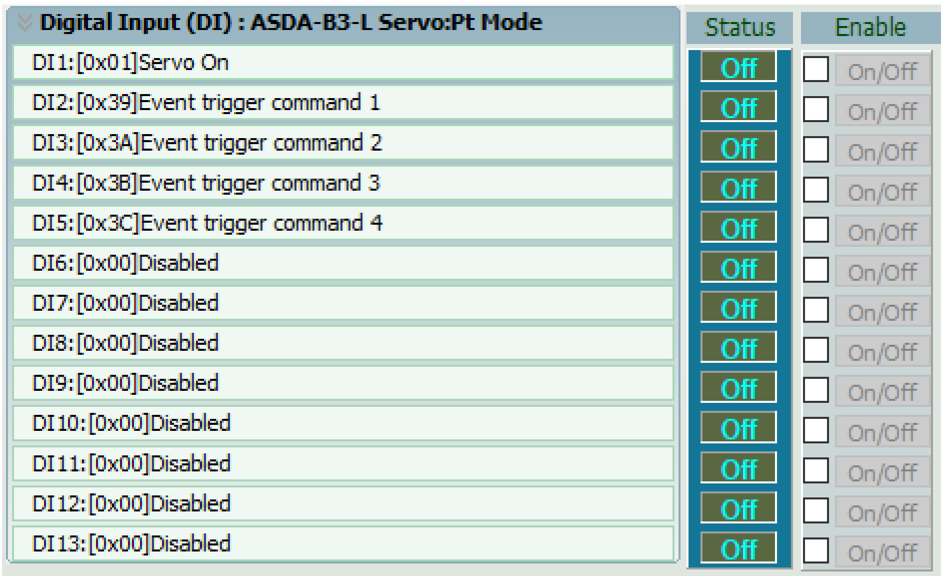


Figure 7.1.5.4 Digital IO setting screen in ASDA-Soft

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

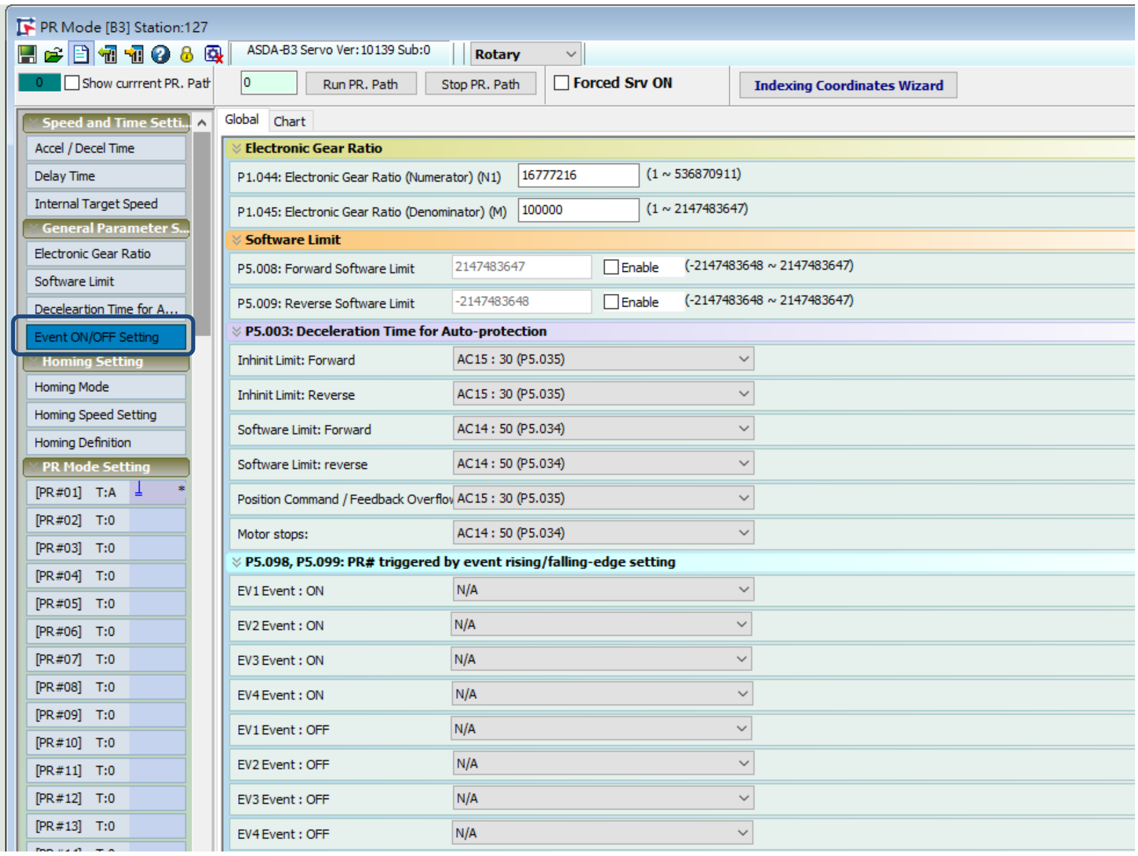


Figure 7.1.5.5 Event ON/OFF Setting screen in ASDA-Soft

PR command trigger register (P5.007)

You can write the PR number to be executed in P5.007 to have the servo drive execute the specified PR path. If you set P5.007 to 0, the servo drive executes homing. If you set P5.007 to 1 - 99, the servo drive executes the specified PR path. If you set P5.007 to 1000, the servo drive stops executing PR commands. Refer to the setting descriptions of P5.007 in Chapter 8.

High-speed position capture (Capture) triggering

You can trigger the specified PR path with the high-speed position capture function. When the capturing completes, you can set whether to trigger PR#50 with P5.039.X [Bit 3]. For detailed settings, refer to Section 7.2.2.

7.1.6 PR procedure execution flow

The servo drive updates the command status every millisecond. Figure 7.1.6.1 illustrates how the servo drive deals with the PR commands. Once a PR procedure is triggered, it goes through three processing units, which are PR queue, PR executor, and motion command generator.

Priority High ⇐ CAP | DI.CTRG | P5.007 | Event (↑) | Event (↓) ⇒ Low

PR queue

- Issues the waiting lead PR to PR executor in every millisecond no matter whether the executor has completed the commands or not.
- The issued lead PR replaces the PR in the executor.

PR executor

- Sends the PR paths set with motion commands (Speed and Position commands) to the generator.
- Completes Jump and Write commands.
- Within 1 ms, the executor completes at least 20 consecutive PR paths with Interrupt functions and without delay.

Motion command generator

- Integrates multiple commands (Sequence, Interrupt, or Overlap commands).
- Outputs the integrated motion commands.

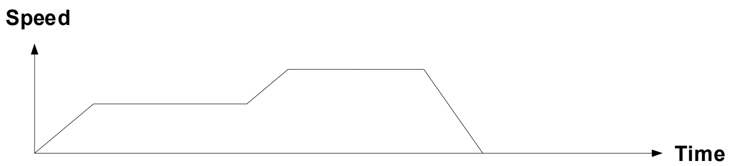


Figure 7.1.6.1 PR execution flow in the servo drive

■ **Trigger mechanism**

As mentioned in Section 7.1.5, the servo drive provides multiple trigger methods. A PR procedure is executed as long as a trigger signal is output. When two different trigger commands are generated within the same millisecond, the priority is as follows: High-speed position capture triggering (CAP) > DI triggering (DI.CTRG) > PR command trigger register (P5.007) > Rising-edge event triggering (Event ↑) > Falling-edge event triggering (Event ↓). Within this millisecond, commands with higher priority are executed first and then the lower priority commands are sent in the next millisecond. If three trigger commands are generated in the same millisecond, 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 millisecond, 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 the received PR group includes motion commands (Speed 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 PR executor can consecutively complete at least 20 PR paths with Interrupt functions (INS) without delay (DLY) within 1 millisecond. If there are PR paths that have not been completed within 1 millisecond, and a new PR group is sent to the executor by the PR 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. If there are PR paths that have not been completed within 1 millisecond but no new PR group is sent to the executor, the executor continues to execute the unfinished PR paths.

- **Motion command generator**

The PR executor sends the motion commands (Speed and Position 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 long as they enter the generator. If another motion command with the Interrupt setting also enters the generator, it is integrated with the current command in the generator. The settings of the integrated command, including whether multiple motion commands are Sequence commands and whether they are set with the Interrupt (INS) or Overlap (OVLP) function, are determined by the setting of each PR path.

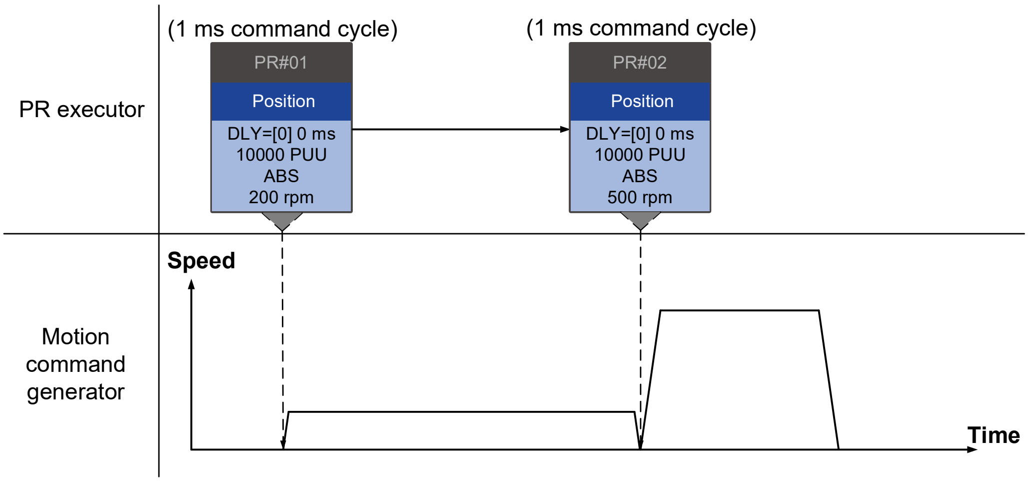
Sequence command

The configurable motion commands for PR paths are the Position and Speed commands. A Sequence command is a series of motion commands without the Overlap (OVLP) or Interrupt (INS) function, and the following command is executed only after the delay time (DLY) set in the previous command elapses. For Position commands, the delay time starts to count after the target position is reached. For Speed commands, the delay time starts to count after the target speed is reached.

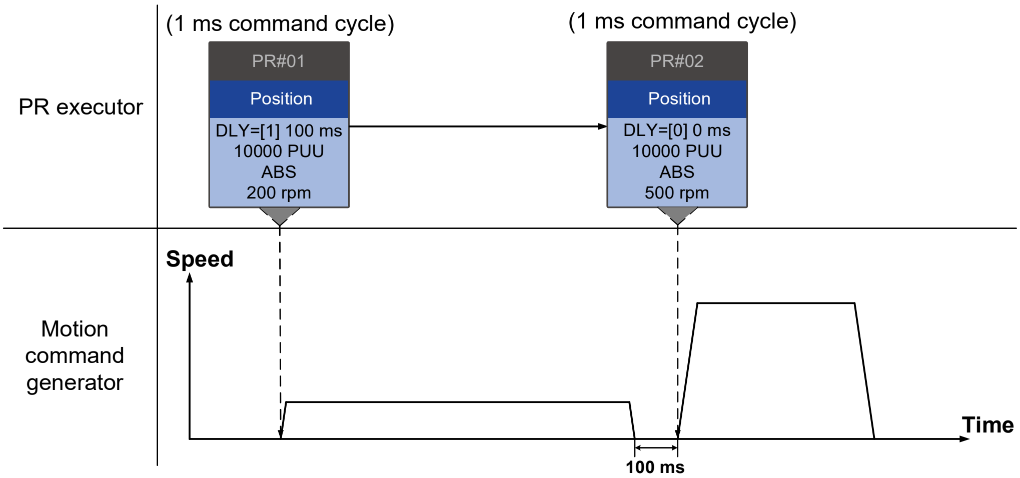
7

■ Position command ▶ Position command

When the PR executor receives two consecutive Position commands without the Interrupt or Overlap functions, the PR executor sends 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 sends 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 sends 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



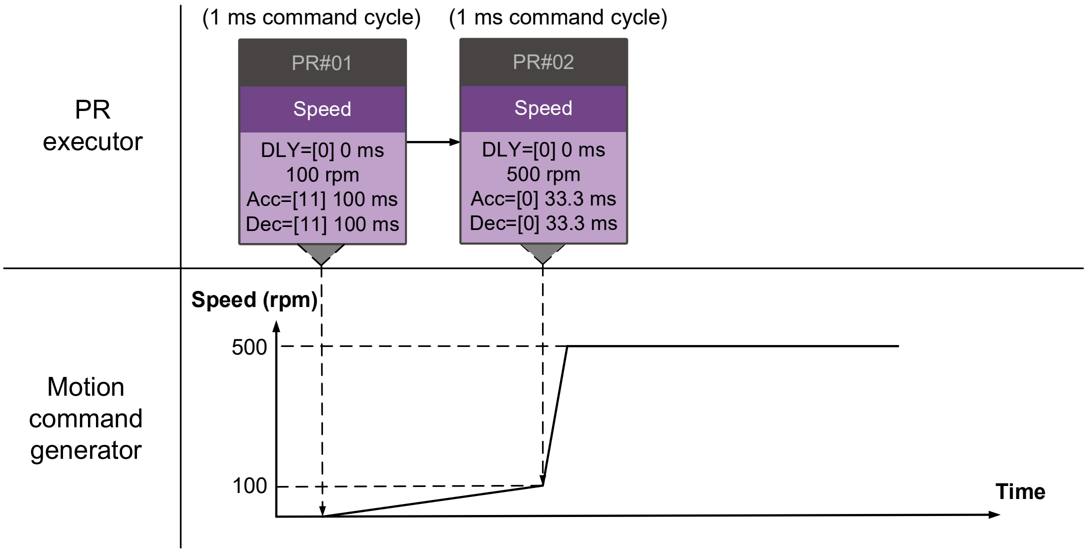
(b) Position command with delay

Figure 7.1.6.2 Position Sequence command

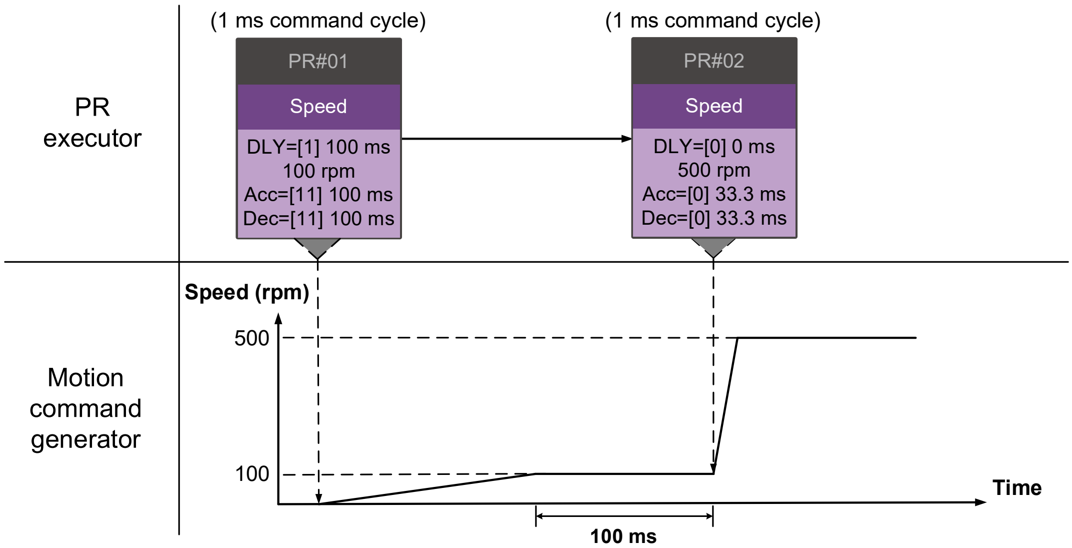
■ Speed command ▶ Speed command

When the PR executor receives two consecutive Speed commands without the Interrupt or Overlap functions, the PR executor sends 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 sends 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 sends 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 millisecond. 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 by the PR executor immediately. As shown in Figure 7.1.6.4, in the first millisecond, the PR queue receives a Position command and the PR executor sends this command to the motion command generator, having the generator to execute the command. In the second millisecond, the PR queue receives a Write command and the PR executor executes it immediately. In the third millisecond, the PR queue receives a Jump command and the PR executor executes it immediately as well. These two commands (Write and Jump commands) are not sent to the motion command generator since the PR executor and the generator execute commands independently. In the fourth millisecond, the PR queue receives a Position command and the PR executor sends this Position command to the generator for execution.

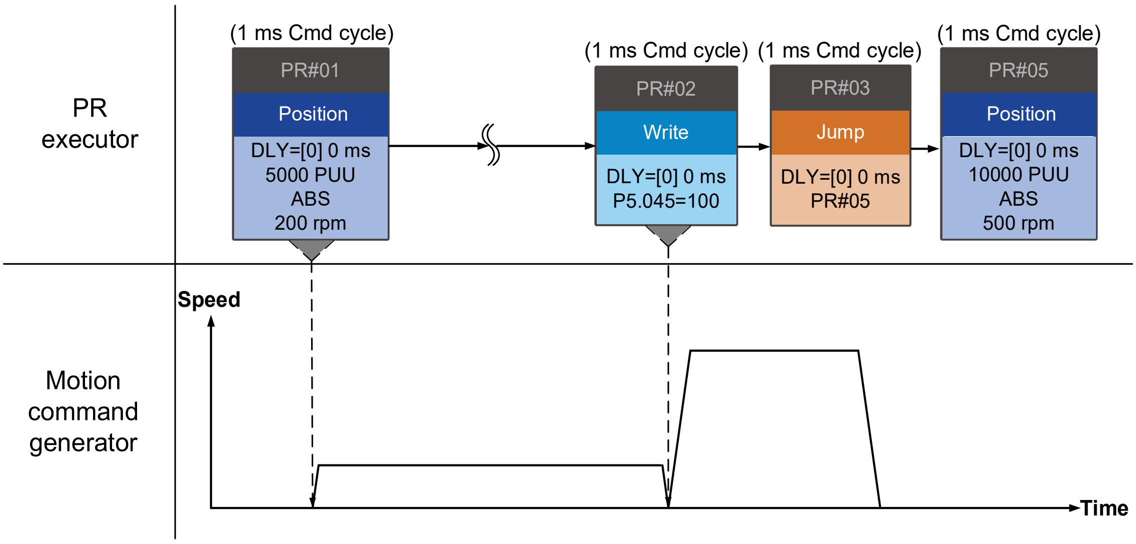


Figure 7.1.6.4 Multiple Sequence commands

7

Command interruption

Interruption (INS) causes a command in execution to be replaced or integrated by the next command. The results of the interruption differ based on the command types. There are two types of interruption: internal and external, as shown in Figure 7.1.6.5.

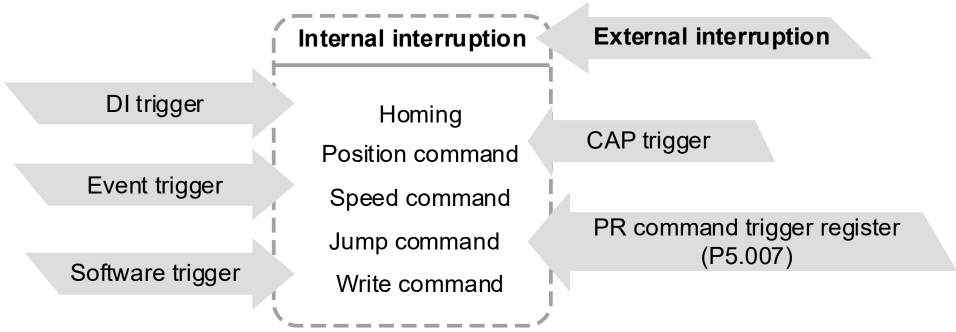


Figure 7.1.6.5 Internal and external interruption

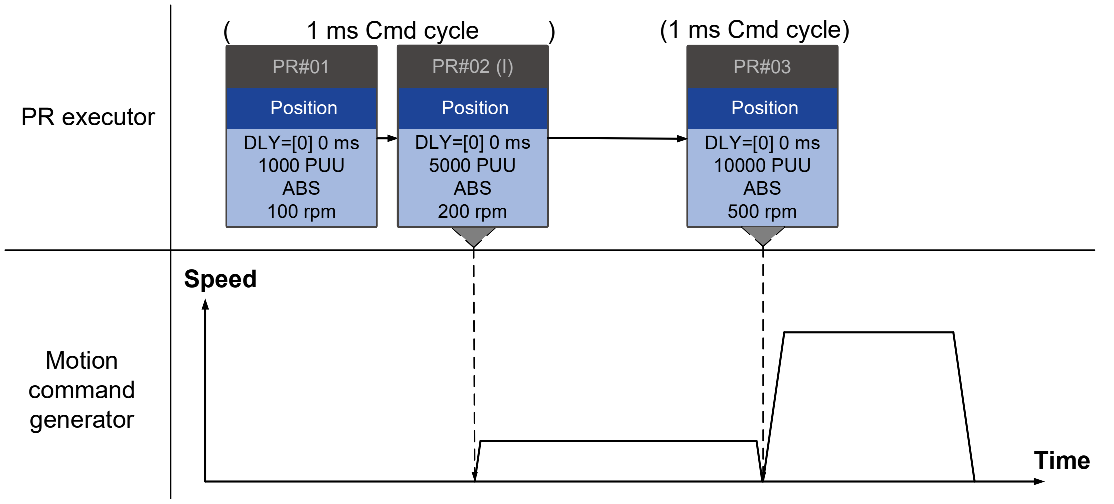
1. Internal interruption

For a series of PR paths, if one PR path includes an AUTO function (auto-execute the next path), the system continues to read the next path right after reading the current path instead of reading the next path after the current path is complete. If the current path includes a delay, the next path is read after the 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 by replacing the un-executed commands in the previous path with the next path or integrating the commands of the previous path which are in execution with the next path.

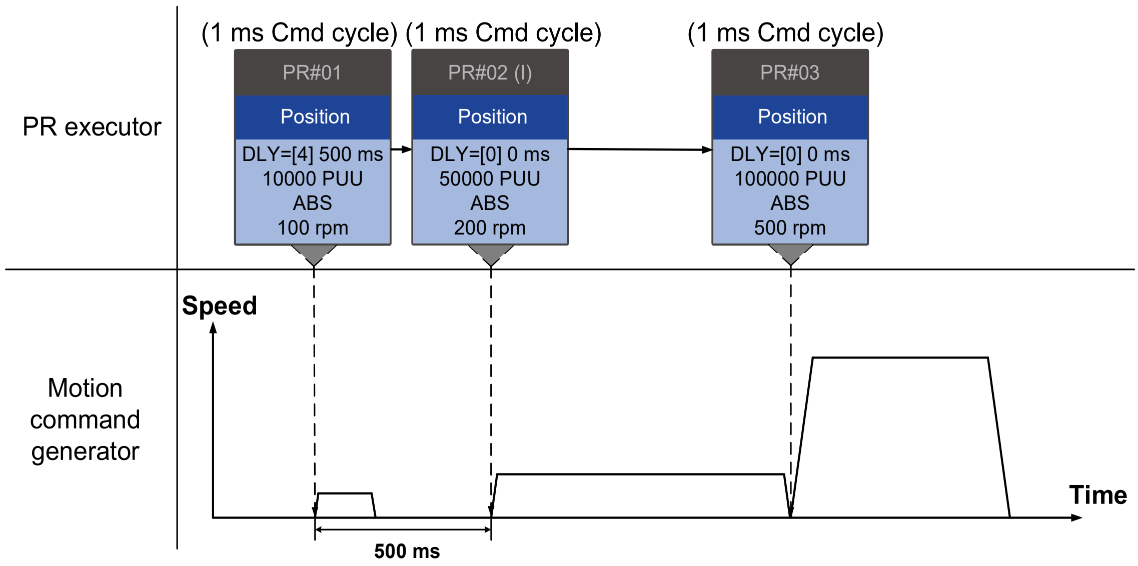
■ Position command ▶ Position command (I) ▶ Position command

When the PR executor receives three consecutive Position commands with the second command set with an Interrupt function, the executor treats the first and the second Position commands as one PR group. Since the first Position command is not executed by the executor, the executor replaces the first command with the second command and 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, the PR executor sends the first command to the generator and then starts counting the delay time. After the delay is over, the executor 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. Since this integration differs from that described in Section 7.1.3, refer to the following note for descriptions. Once the integrated 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

Note: the way to integrate the position commands of internal interruption is slightly different from what is described in Section 7.1.3.3.
In general, the relative position command (REL)'s target position = motor's current position + command value. However, for internal interruption, the relative position command (REL) works the same as the incremental position command (INC), with the target position = previous target position + command value. See the following example.
The rest of the integration method is the same as that mentioned in Section 7.1.3.3.

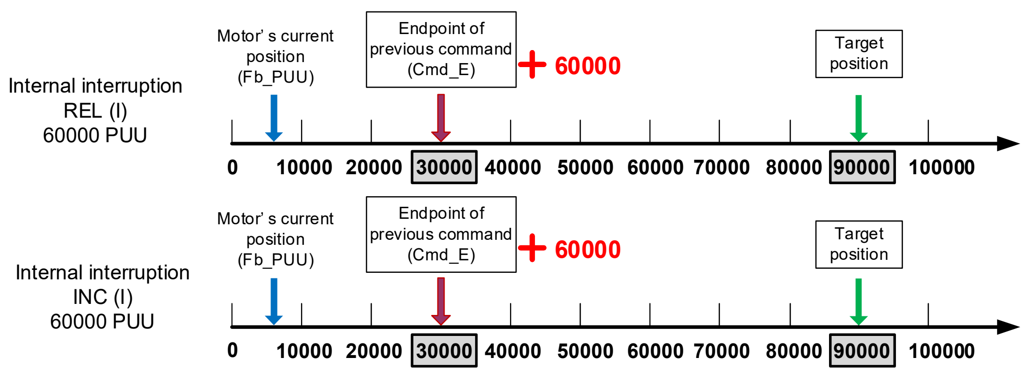


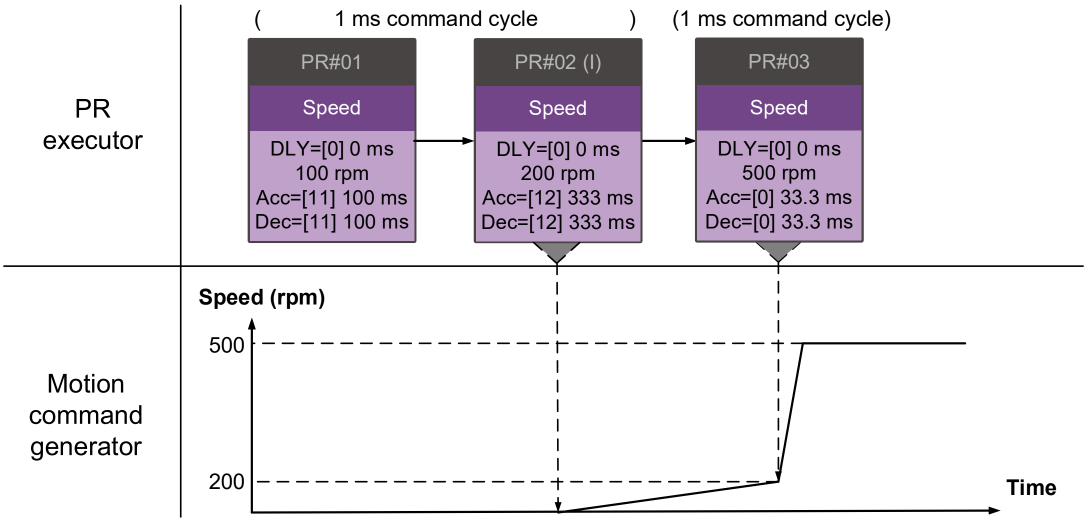
Figure 7.1.6.7 Example of relative and incremental position commands for internal interruption

7

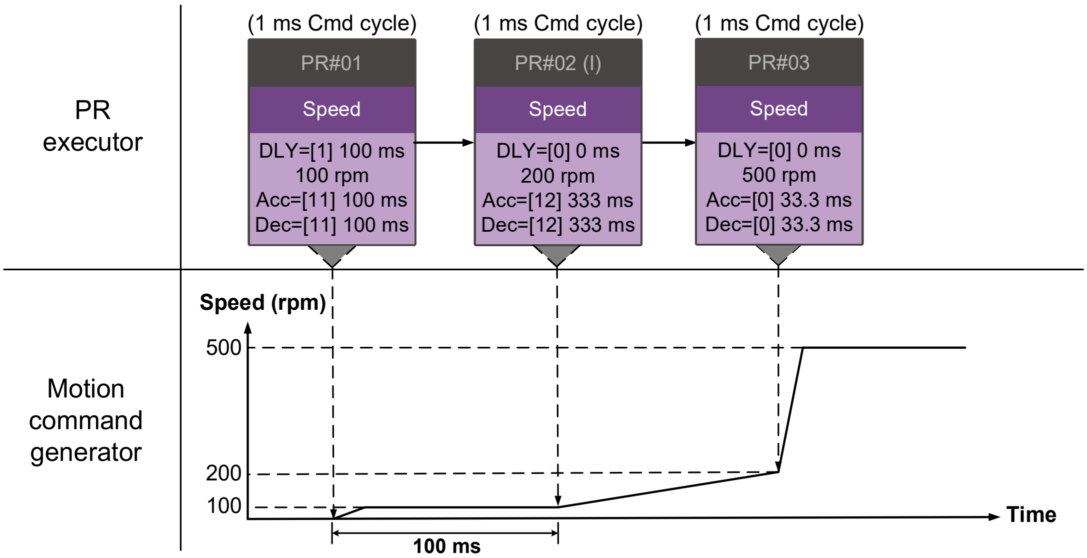
■ Speed command ▶ Speed command (I) ▶ Speed command

When the PR executor receives three consecutive Speed commands with the second command set with an Interrupt function, the executor treats the first and the second as one PR group. Since the first Speed command is not executed by the executor, the executor replaces the first command with the second command and 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, the PR executor sends the first command to the generator and then starts counting the delay time. After the delay is over, the executor 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



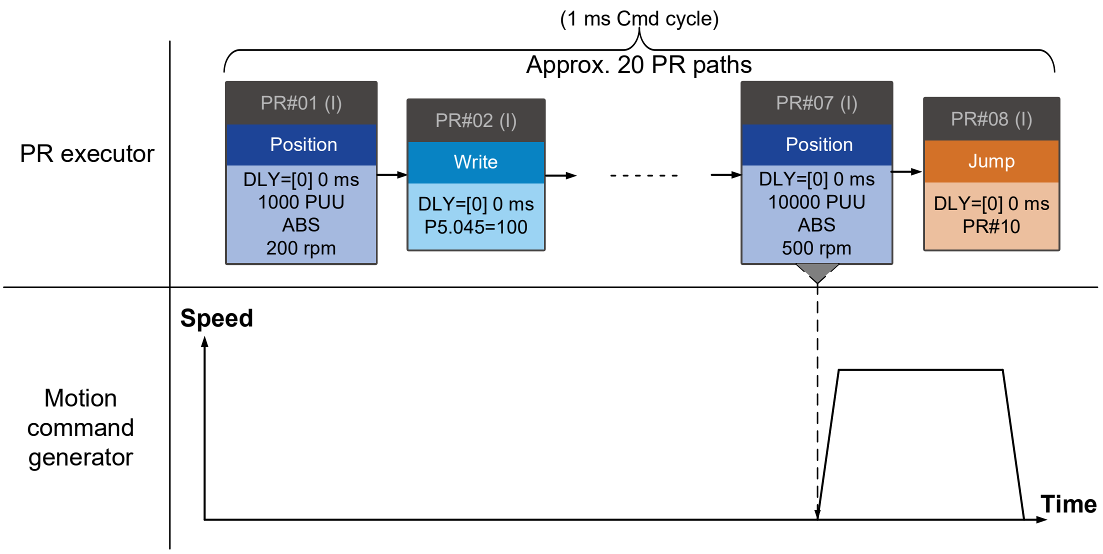
(b) Speed command with delay

Figure 7.1.6.8 Internal interruption - Speed command

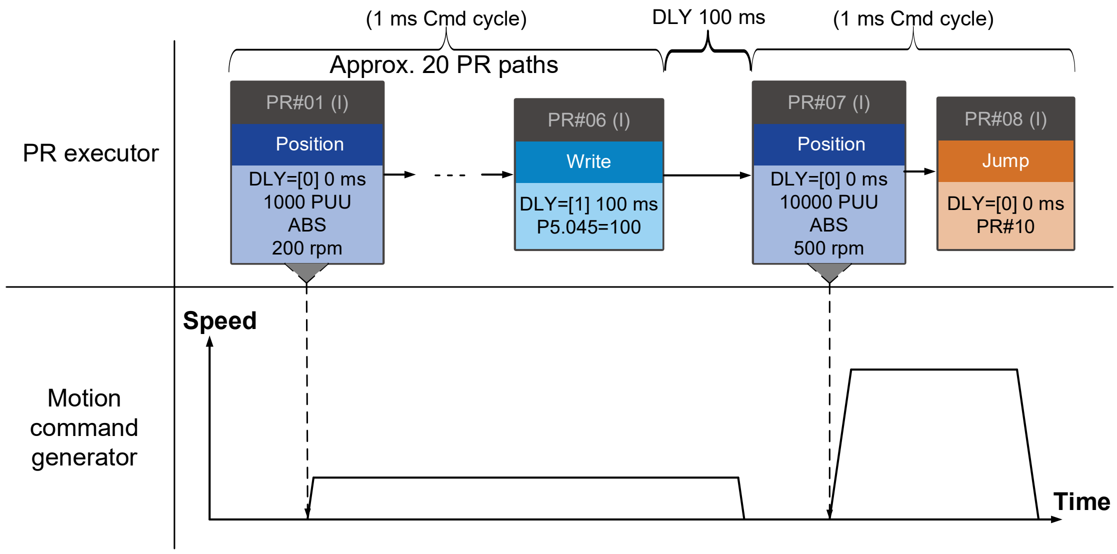
■ Multiple interrupt commands

The PR queue updates commands every millisecond. If all PR paths are consecutive with Interrupt functions and without delay, the queue can read at least 20 PR paths in 1 millisecond, and these paths are regarded as a PR group. If this PR group includes 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 by the executor 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 regards this PR path and the prior path(s) as the first PR group, and what follows is the second PR group. In this case, 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

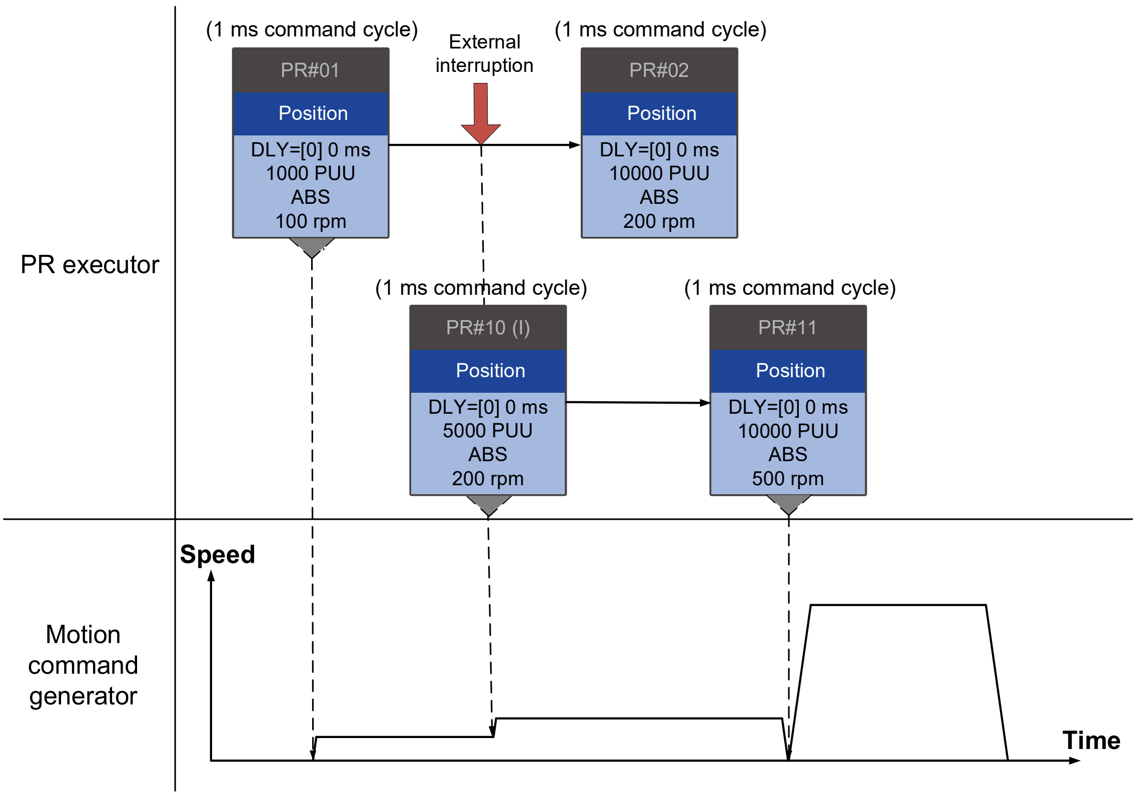
Figure 7.1.6.9 Internal interruption - Multiple commands

7

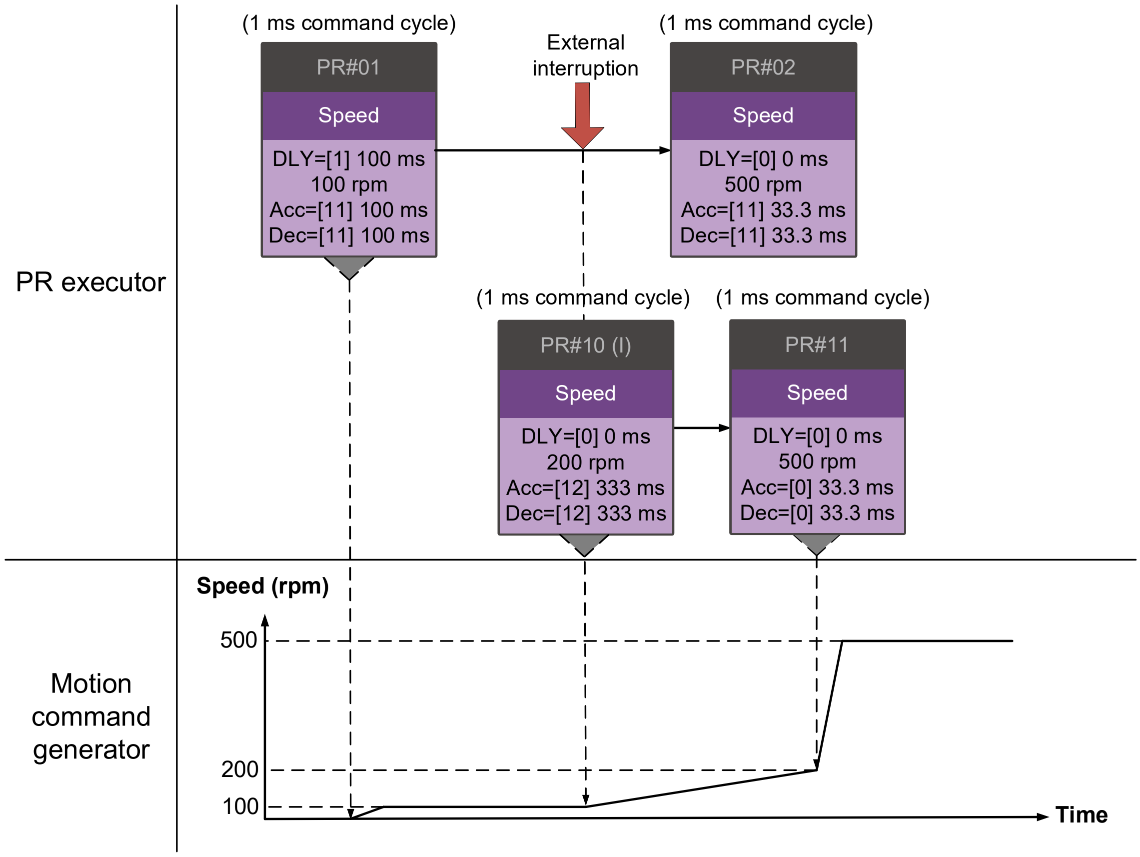
2. External interruption

When a PR path is being executed, if another PR path is forced to execute with any of the trigger methods for the PR command (refer to Section 7.1.5 for PR trigger methods), the PR queue receives a PR path with an Interrupt function and sends this path to the motion command generator immediately, and then 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 command.

The external interruption of the Position command is as shown in Figure 7.1.6.10 (a). If a PR path with an Interrupt function enters the PR executor by external interruption, 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 command when running. The methods of integration are described in Section 7.1.3.3. The external interruption of the Speed commands is the same as that of the Position commands (see Figure 7.1.6.10 (b)), and the same is true for multiple commands.



(a) External interruption - Position command



(b) External interruption - Speed command

Figure 7.1.6.10 External interruption

Overlap command

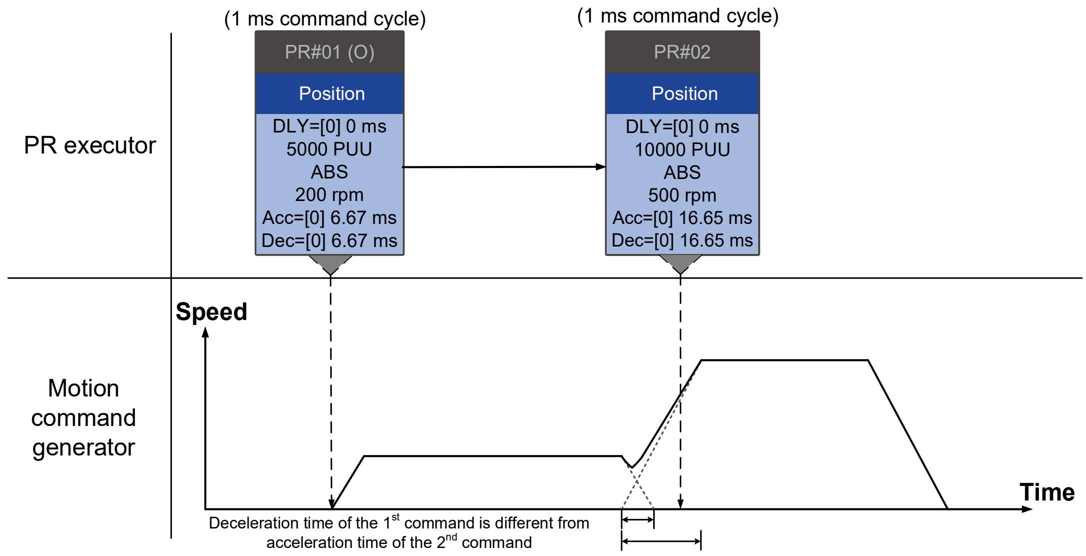
If the previous position command includes an Overlap (OVLP) function, it allows the next command to be executed while the previous motion is decelerating, thus achieving a continuous motion. When you use an Overlap command, the delay time is still effective. The delay time starts to count from the start point of the command with the delay time setting; however, in order to have a smooth command transition, setting the delay time to 0 is suggested. In addition, if the deceleration time of the previous command is identical to the acceleration time of the next command, the discontinuous speed during transition can be avoided, smoothing the transition between commands (see Figure 7.1.6.11).

The relationship between the 1st target speed and its deceleration time and the relationship between the 2nd target speed and its acceleration time are as follows.

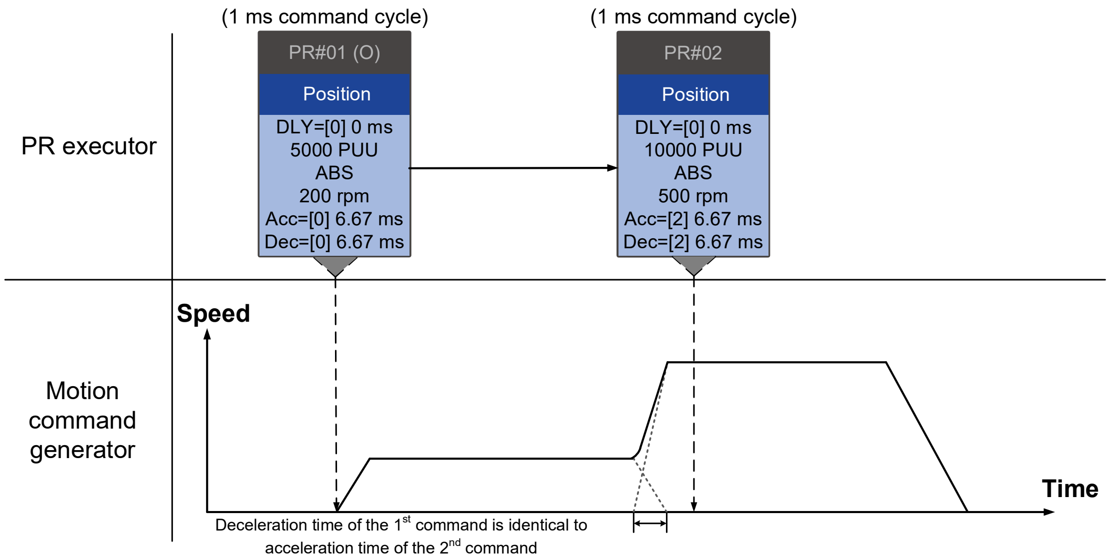
$$\frac{\text{1st target speed (Spd1)}}{3000} \times \text{Deceleration time (Dec)} = \frac{\text{2nd target speed (Spd2)}}{3000} \times \text{Acceleration time (Acc)}$$

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.

7



(a) Overlap command - Acceleration and deceleration times are different



(b) Overlap command - Acceleration and deceleration times are identical

Figure 7.1.6.11 Overlap command

Interpret PR path flow

The PR paths mentioned earlier include commands such as Sequence, Interrupt, and Overlap. The replacement, integration, and overlapping for commands lead to different behavior depending on the settings. The suggested steps to interpret a series of PR paths are as follows.

1. Check the command sequence. Check whether there are delay time (DLY) and interrupt (INS) settings because these two types change the command execution sequence.
2. Find the lead PR and identify the PR groups of each millisecond.
3. In each PR group of 1 millisecond, 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.

7.2 Application of motion control

The servo drive motion control includes the high-speed position capture (Capture) function. The Capture function uses the digital input DI3 (-F, -M, B3A-P models) or DI7 (-L models) to instantly capture the motor's position feedback and store this position in the data array. See the following sections for more details about the setting and how it works.

Note: -E models do not support the Capture function.

7

7.2.1 Data array

The data array can store up to 128 sets (0 - 127) of 32-bit data captured by the high-speed capture function. Set P2.008 to 30 and then 35 or use ASDA-Soft to write the data to EEPROM; otherwise, the data in RAM is volatile. ASDA-Soft provides a user-friendly screen for reading and writing the data array.

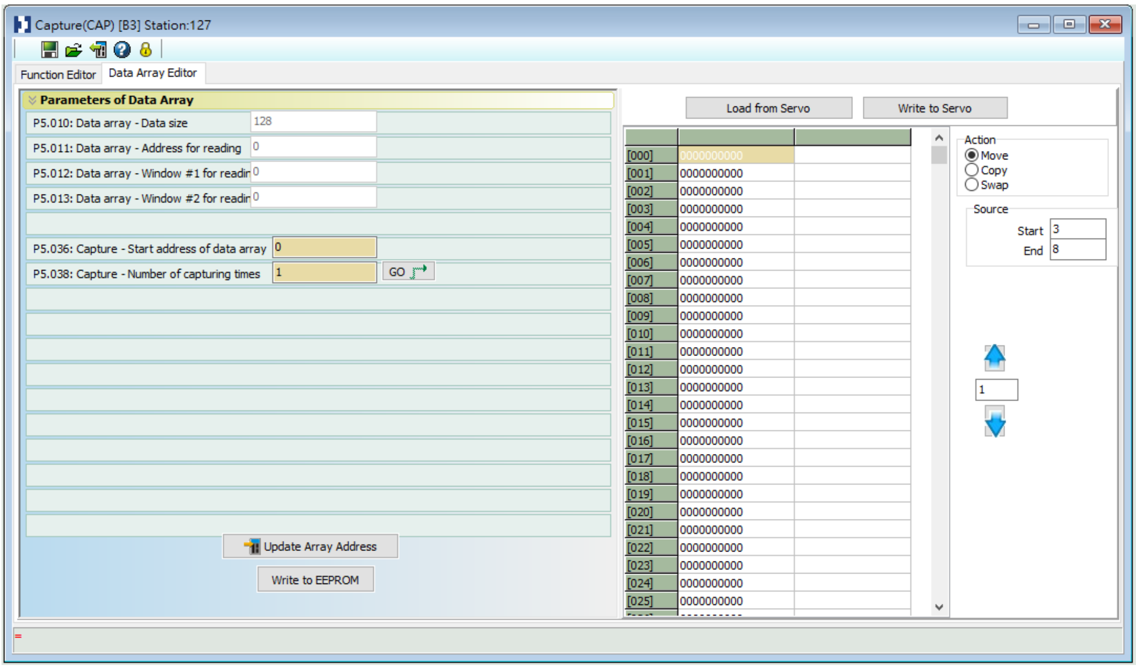


Figure 7.2.1.1 Data Array Editor screen in ASDA-Soft

You can use the drive panel, communication, or ASDA-Soft to read data from or write data to the data array with parameter settings.

The first group of parameters for reading and writing the data array are P5.011 - P5.013. P5.011 specifies the address of data array to be read and written. P5.012 and P5.013 read data from or write data to the data array address set by P5.011. The behaviors after reading and writing is different between P5.012 and P5.013. Refer to Table 7.2.1.1 for more information.

The second group of parameters for reading and writing the data array are P5.011 and P5.100 - P5.103. P5.011 specifies the address of data array to be read and written. 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 value, the return content of the address is 0. Refer to Table 7.2.1.2 for descriptions and examples.

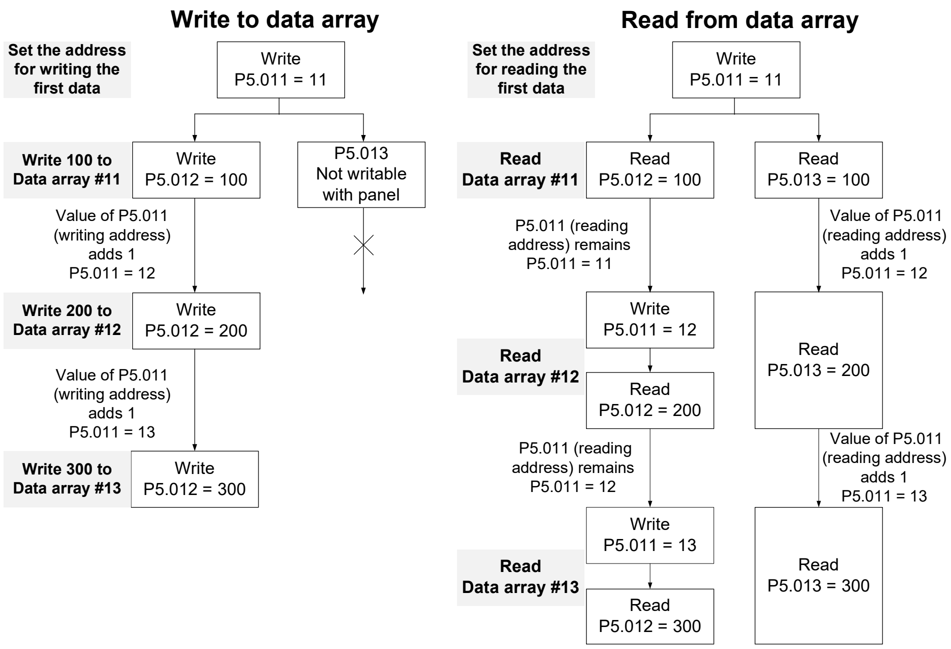
Table 7.2.1.1 Group 1 parameters for reading and writing the data array

Parameter	Description		
P5.011 Address for reading and writing	Specifies the data array address for reading and writing		
Window for reading and writing	**Read / write with**	**Behavior after reading**	**Behavior after writing**
P5.012 Window #1 for reading and writing	Drive 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 and writing	Drive panel	Value of P5.011 adds 1	**Not writable with the drive panel**
	Communication / ASDA-Soft	Value of P5.011 adds 1	Value of P5.011 adds 1

Example: reading and writing the data array through the drive panel or communication.

Write values to the data array address in the following sequence: Data array #11 = 100, Data array #12 = 200, Data array #13 = 300. Then, read the data in the same sequence.

1. Read / write with drive panel:



2. Read / write with 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 the consecutive writing command to write 100 to Data array #11, 200 to Data array #12, and 300 to Data array #13. When reading, use the single data writing command to set the start address as Data array #11, and then use the consecutive reading command to read P5.011 - P5.013 (Data array #11 and #12). Since P5.011 has been read twice, its value is incremented by 2, and you can continue to read from Data array #13.

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Writing to the data array									
Packet	Communication command	Start address	Data length	P5.011		P5.012		P5.013	
				Low byte	High byte	Low word	High word	Low word	High word
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 from the data array									
Packet	Communication command	Start address	Data length	P5.011		P5.012		P5.013	
				Low byte	High byte	Low word	High word	Low word	High word
3	0x06	P5.011	-	11	0	-	-	-	-
4	0x03	P5.011	6 words	11	0	100	0	200	0
5	0x03	P5.011	6 words	13	0	300	0	0	0

Table 7.2.1.2 Group 2 parameters for reading and writing the data array

Parameter	Description	Example 1		Example 2	
P5.011 Address for reading and writing	Specifies the data array address for reading and writing	5		125	
Window for reading and writing	Description	Example 1		Example 2	
		Address	Content	Address	Content
P5.100 Window #3 for reading and writing	Reads from or writes to the address specified by P5.011.	5	1234	125	5678
P5.101 Window #4 for reading and writing	Reads from or writes to the first address following the address specified by P5.011.	6	2345	126	6789
P5.102 Window #5 for reading and writing	Reads from or writes to the second address following the address specified by P5.011.	7	3456	127	7890
P5.103 Window #6 for reading and writing	Reads from or writes to the third address following the address specified by P5.011.	8	4567	x	0

7.2.2 High-speed position capture (Capture) function

The high-speed position capture (Capture) function, abbreviated as CAP, uses the external signal to trigger the high-speed digital input DI3 (-F, -M, B3A-P models) or DI7 (-L models) (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 defines the function of DI3 or DI7 (based on the models) as data capturing, which means the DI is not user-defined.

The flowchart for high-speed position capturing is shown in Figure 7.2.2.1. You can set the Capture function in ASDA-Soft, as shown in Figure 7.2.2.2. The relevant parameters are as follows.

- P5.036 sets the start address of the data array for storing the captured data; if it is not set, the default start address is #0.
- P5.038 sets the number of capturing times, which has to be greater than 0 for the Capture function to be executed.
- P1.019.X enables the cycle mode. When the last data is captured, the number of capturing times is reset to 0 (P5.038 = 0), and the next cycle starts automatically to capture the previously set number of capturing times. However, the start address for storing the captured position data is still determined by P5.036; that is, the data captured in the previous cycle is overwritten by the data captured in the next cycle.
- When the Capture function is set to capture multiple points (P5.038 > 1), use P1.020 to set the masking range for capturing. This prevents the same position data from being captured repeatedly by setting the masked area within which only one capturing is allowed.
- P5.039 enables or disables the Capture function and other settings. See the following table for more information.

P5.039	Bit	Function	Description
X	0	Activate Capture	1: when P5.038 > 0, the capturing starts and DO.CAP_OK (0x16) is off. Each time one data is captured, the value of P5.038 is decremented by 1.When P5.038 = 0, it means the capturing is finished, DO.CAP_OK (0x16) is On, and Bit 0 is reset to 0. If Bit 0 is already 1, the written value must not be 1; you can only write 0 to deactivate the Capture function.
	1	Reset position	1: after capturing the first data, reset the position of the first data to the value of P5.076.
	2	Reserved	-
	3	Execute PR	1: execute PR#50 automatically after all data are captured.
Y	-	Axis source of Capture	0: the Capture function is disabled 1: reserved 2: CN1 (pulse command) 3: CN2 (motor encoder)
Z	-	Trigger logic	0: NO (normally open) 1: NC (normally closed)
U	-	Minimum interval between each trigger	0 - F: 0 - 15 ms

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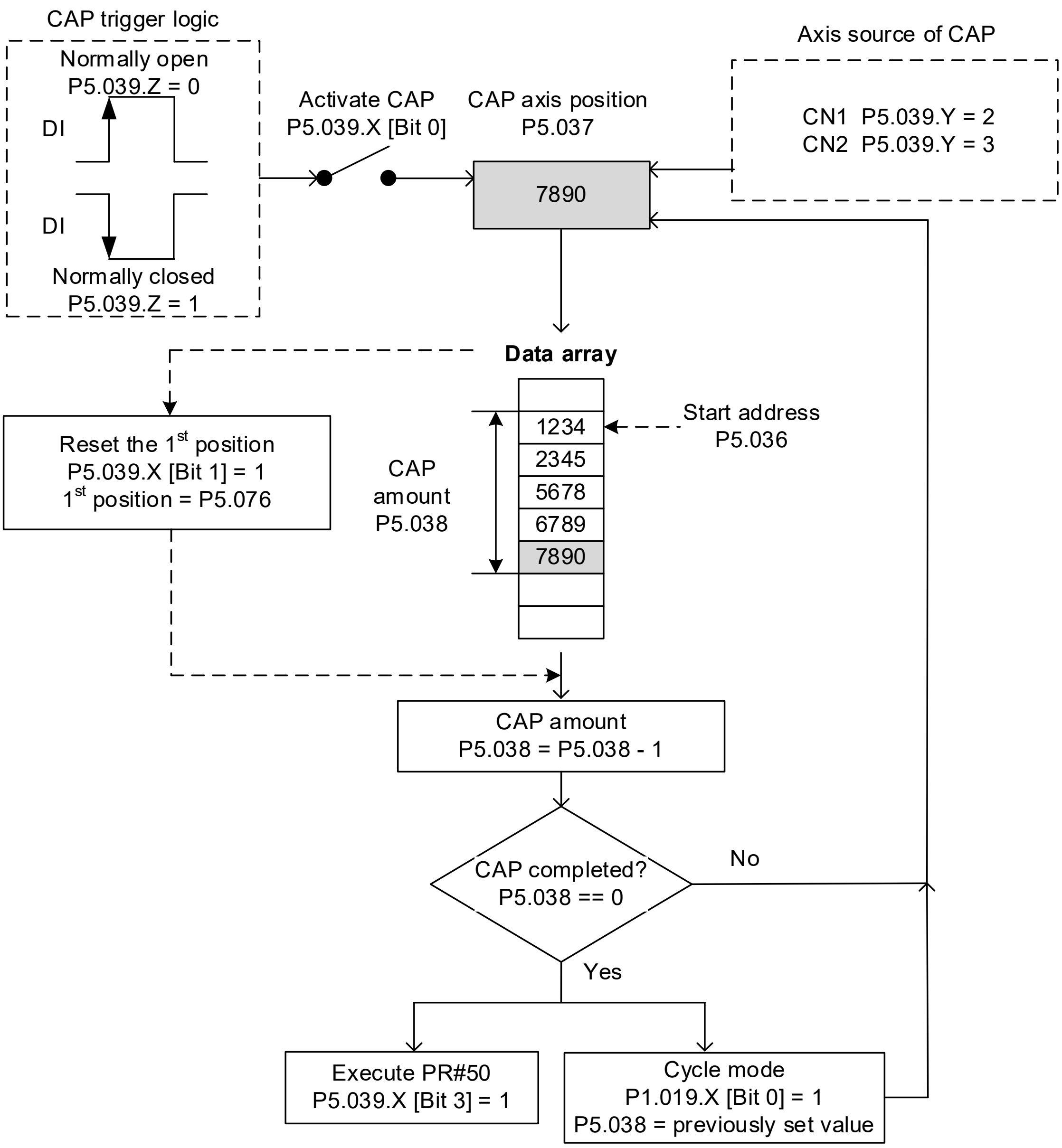

Figure 7.2.2.1 Flowchart for high-speed position capturing

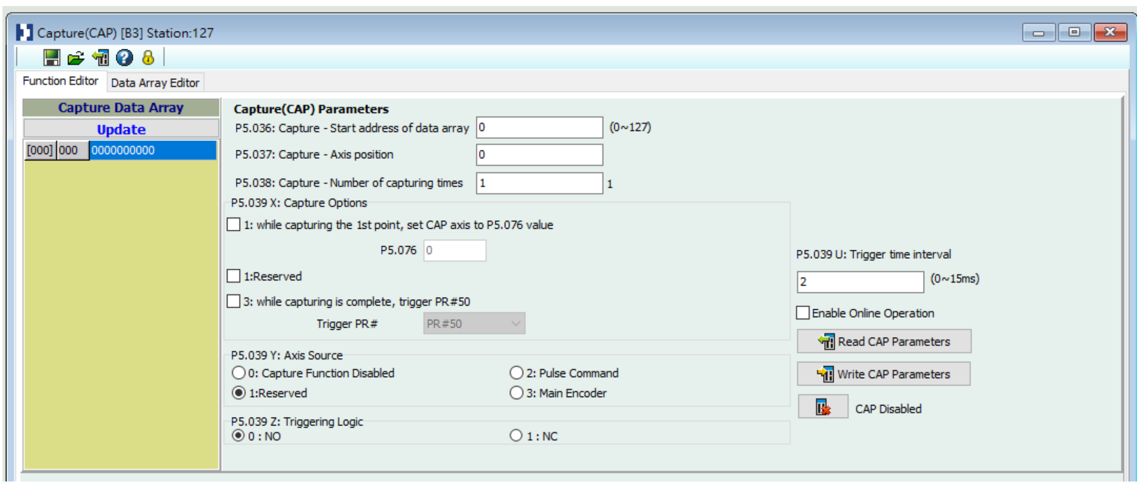

Figure 7.2.2.2 Capture function screen in ASDA-Soft

It is suggested that you program the PR paths to execute the Capture function with the motion commands. By doing so, 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#01 deactivates the Capture function (P5.039.X [Bit 0] = 0). PR#02 sets the start address of data array to #1. PR#03 sets the number of capturing times to 3. PR#04 sets the capturing axis' position to 0 for the first capture point. PR#05 enables the Capture cycle mode and sets a delay of 1 ms to ensure that the next PR path for activating the Capture function can be executed. PR#06 activates the Capture function, resets the position of the first point, executes PR#50 after capturing is complete, selects the motor encoder as the axis source of Capture, sets the trigger logic as "normally open", and sets the trigger interval as 2 ms. PR#07 sets the Speed command to 50 rpm. PR#50 is set to 50000 PUU as the capture Position command. Once the command is complete, the servo continues to execute PR#51 with the Speed command setting remaining at 50 rpm.

In Figure 7.2.2.4, you can see that after the CAP DI is first triggered, the capturing axis's position is reset to 0 and the position data is stored in data array #1 because the Reset function for the first point is enabled and P5.076 is set to 0. At the moment the CAP DI is triggered the second and third time, the position data is written to data array #2 and #3. Once the first capture cycle is complete, DO.CAP_OK (0x16) 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_OK (0x16) is set to Off and the number of capturing times is set to 3 again. When the CAP DI is triggered for the fourth time, the capture axis' position is not reset; instead, the current position of the capturing axis is written to data array #1 again, which means the data written in the previous cycle is overwritten. At the moment the CAP DI is triggered the fifth and sixth time, the current position of the capturing axis is written to data array #2 and #3. Once the second capture cycle is complete, DO.CAP_OK (0x16) is set to On, and then PR#50 (high-speed position capture command) and PR#51 (motion with fixed speed) are executed again.

When the Capture cycle mode is enabled (P1.019.X [Bit 0] = 1), the Reset function for the first point is only valid for the first cycle. Meanwhile, the Execute PR function is valid for every cycle; in other words, PR#50 is executed every time a cycle ends. The first position data captured in every cycle is written to the data array address set by P5.036, and then other data of the same cycle is written in sequence. So, the position data written in the previous cycle is always overwritten by the position data of the next cycle.

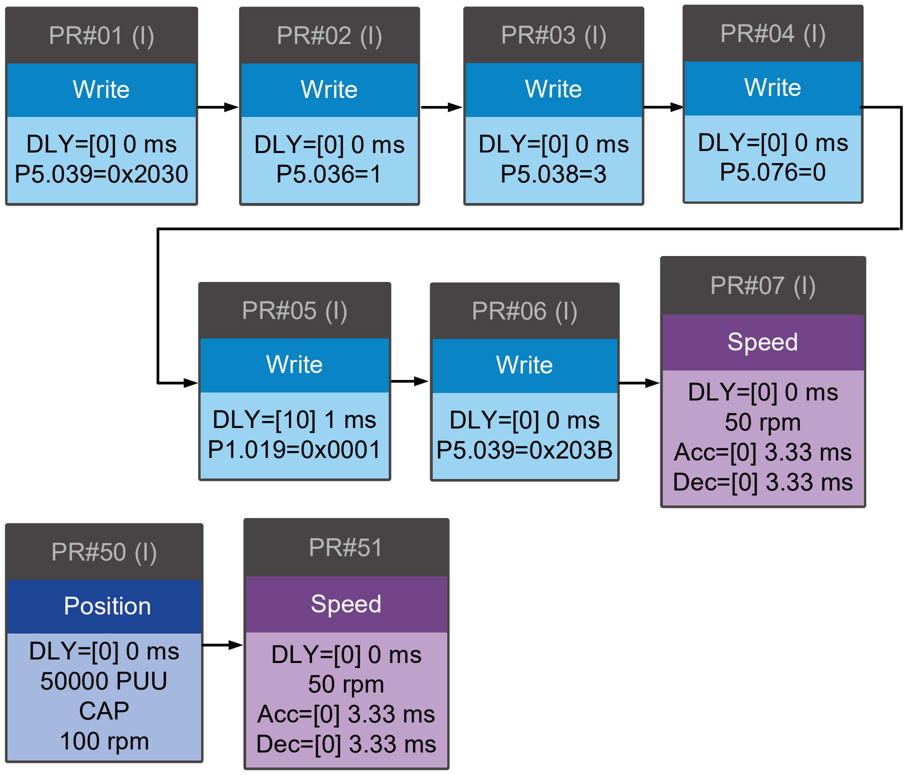

Figure 7.2.2.3 PR path with application of high-speed capture function

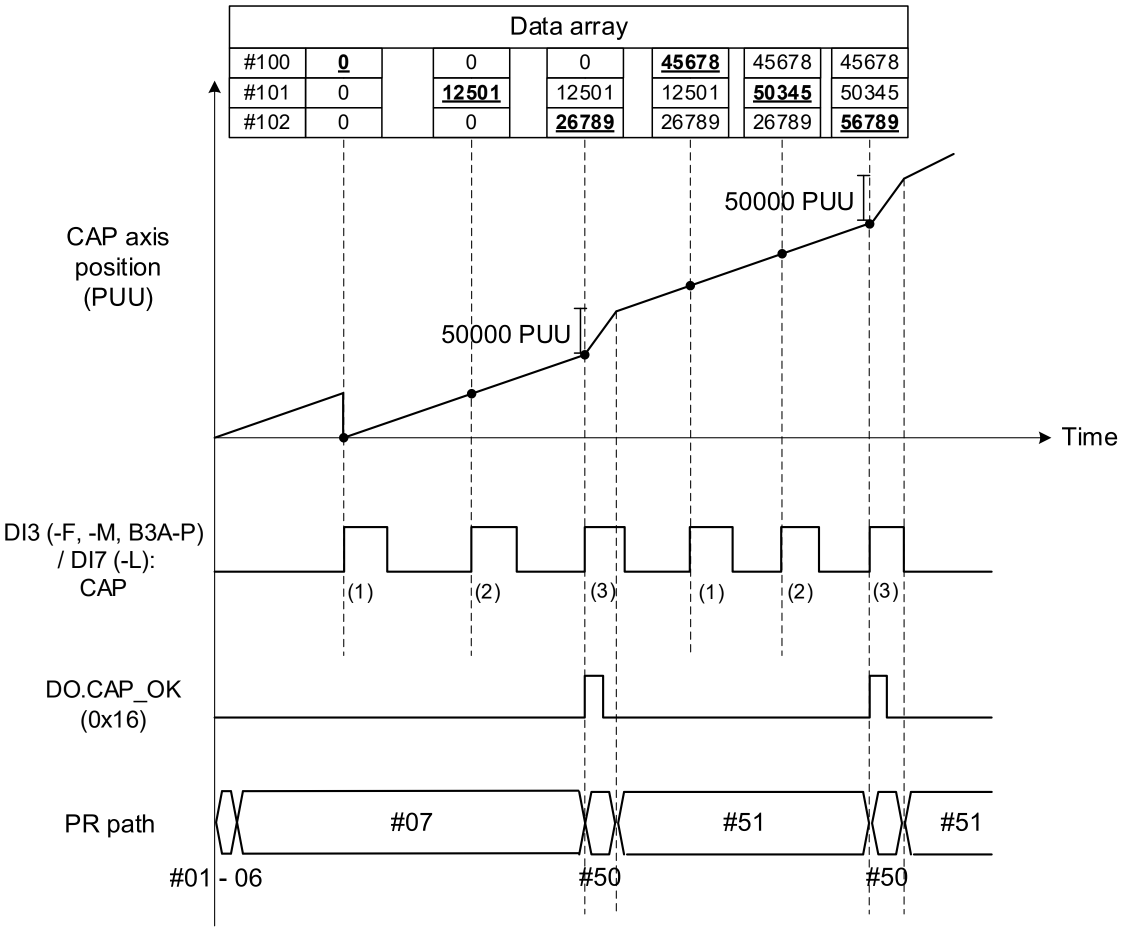

Figure 7.2.2.4 Application example for high-speed capture function

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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), digital output (DO), and monitoring variables. You can control the drive functions with these parameters and DI/O.

8

8.1 Parameter definitions

The servo drive parameters are divided into eight 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)

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

CANopen, DMCNET, EtherCAT, and PROFINET: Communication control

Special symbol description:

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

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8.2 Parameter descriptions

P0.xxx Monitoring parameters

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

Settings:

Displays the firmware version of the servo drive.

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

Settings:

For the list of alarms, refer to Section 14.1 Alarm list.

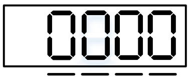
P0.002	Drive status		Address: 0004H 0005H
Default:	1	Control mode:	All
Unit:	-	Setting range:	-4096 to +4095
Format:	DEC	Data size:	16-bit

Settings:

Input the monitoring code to P0.002 to view changes to the variable on the panel. For the list of monitoring variables, refer to Table 8.3 Monitoring variables descriptions.

P0.003	Analog output monitoring		Address: 0006H 0007H
Default:	0x0000	Control mode:	All
Unit:	-	Setting range:	0x0000 to 0x0077
Format:	HEX	Data size:	16-bit

Settings:



U Z Y X

X	MON2 value	Z	Reserved
Y	MON1 value	U	Reserved

MON1 and MON2 set value	Description	MON1 and MON2 set 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 0x0001 (MON1 is the analog output of motor speed; MON2 is the analog output of motor torque):

$$\text{MON1 output voltage} = 8 \times \frac{\text{Motor speed}}{(\text{Maximum speed} \times \frac{\text{P1.004}}{100})} \ \text{(Unit: volts)}$$

$$\text{MON2 output voltage} = 8 \times \frac{\text{Motor speed}}{(\text{Maximum speed} \times \frac{\text{P1.005}}{100})} \ \text{(Unit: volts)}$$

P0.004 - P0.007	Reserved

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

Settings:

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

High word

D C B A

Low word

U Z Y X

DCBA	Total Servo On time	UZYX	Total power-on time

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

Settings:

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

For example, when you set P0.017 to 7, reading P0.009 can access the motor speed (rpm). To access the data through Modbus communication, have the servo drive read the two 16-bit values (0012H and 0013H) as a single 32-bit value. (0013H : 0012H) = (High word : Low word). To monitor the data from the panel, set P0.002 to 23 and the panel displays "VAR-1" and then the value of P0.009.

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

Settings:

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

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

Settings:

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

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

Settings:

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

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

Settings:

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

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:	-4096 to +4095
Format:	DEC	Data size:	16-bit

Settings:

Refer to Table 8.3 for the available values.

For example, if you set P0.017 to 7, 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:	-4096 to +4095
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:	-4096 to +4095
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:	-4096 to +4095
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:	-4096 to +4095
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:	-
Format:	HEX	Data size:	32-bit

Settings:

You can continuously read and write two different parameters faster with mapping paramemters. Use P0.035 to specify the parameter numbers to be read or written with the mapping parameter through 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.

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

Settings:

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

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

Settings:

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

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

Settings:

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

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

Settings:

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

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

Settings:

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

8

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

Settings:

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

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

Settings:

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

P0.033 - P0.034	Reserved

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

Settings:

The formats of the parameter high word (PH) and parameter low word (PL) are:

High word

D C BA

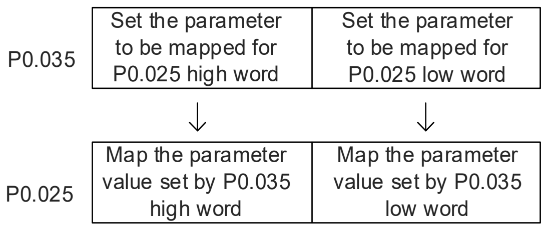
Low word

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	Reserved	U	Reserved

Select the corresponding parameter(s) for the data block access register 1 (P0.035). The mapping value is 32 bits and can map to two 16-bit parameters or one 32-bit parameter.

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



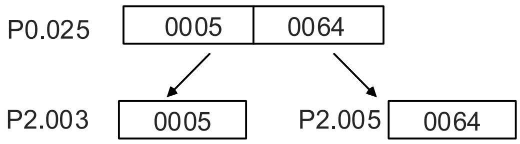
1. When PH ≠ PL, it indicates that the content of P0.025 includes two 16-bit parameters.

   Example: Target: set P2.003 to 5 and P2.005 to 100 through the mapping parameter.

   Setting: set the P0.035 high word to 0203 (P2.003) and low word to 0205 (P2.005).

   Thus, P0.035 = 0x02030205.

   Write: set 0x00050064 to the mapping parameter P0.025, 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 through the mapping parameter.

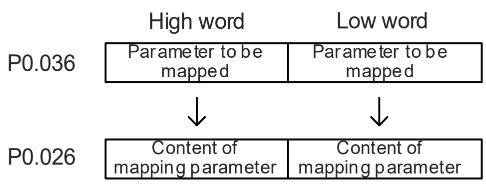
   Setting: set both the high word and low word of P0.035 to 060A (P6.010).

   Thus, P0.035 = 0x060A060A.

   Write: set 0x00050064 to the mapping parameter P0.025, and P6.010 changes immediately.

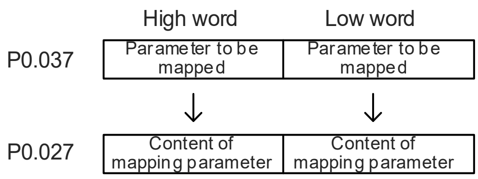
P0.036	**Target setting for mapping parameter P0.026**		**Address: 0048H 0049H**
Default:	-	Control mode:	All
Unit:	-	Setting range:	-
Format:	HEX	Data size:	32-bit

Settings:



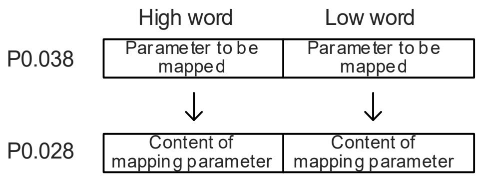
P0.037	Target setting for mapping parameter P0.027		Address: 004AH 004BH
Default:	-	Control mode:	All
Unit:	-	Setting range:	-
Format:	HEX	Data size:	32-bit

Settings:



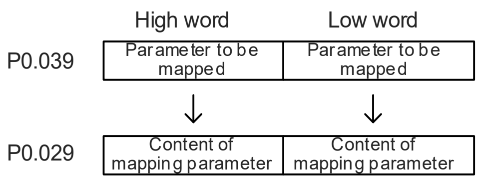
P0.038	Target setting for mapping parameter P0.028		Address: 004CH 004DH
Default:	-	Control mode:	All
Unit:	-	Setting range:	-
Format:	HEX	Data size:	32-bit

Settings:



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

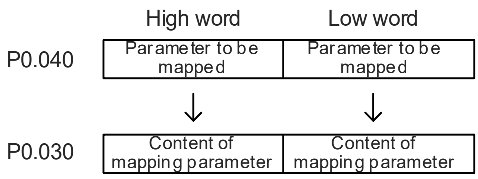
Settings:



8

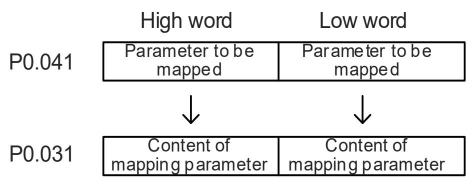
P0.040	**Target setting for mapping parameter P0.030**		**Address: 0050H 0051H**
Default:	-	Control mode:	All
Unit:	-	Setting range:	-
Format:	HEX	Data size:	32-bit

Settings:



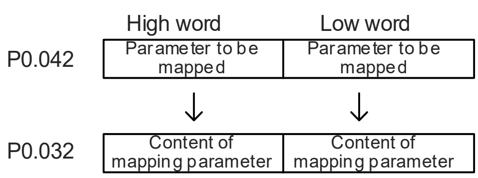
P0.041	**Target setting for mapping parameter P0.031**		**Address: 0052H 0053H**
Default:	-	Control mode:	All
Unit:	-	Setting range:	-
Format:	HEX	Data size:	32-bit

Settings:



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

Settings:



P0.043	**Reserved**

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

Settings:

This setting is the same as P0.009.

P0.045■	Status monitoring register content selection (for PC software)		Address: 005AH 005BH
Default:	0	Control mode:	All
Unit:	-	Setting range:	-4096 to +4095
Format:	DEC	Data size:	16-bit

Settings:

This setting is the same as P0.017.

P0.046★■	Servo drive digital output (DO) status		Address: 005CH 005DH
Default:	0x0000	Control mode:	All
Unit:	-	Setting range:	0x0000 to 0x00FF
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	Bit	Function
0	SRDY (servo ready)	8	HOME (homing complete)
1	SON (Servo On)	9	OLW (early warning for motor overload)
2	ZSPD (zero speed detection)	10	WARN (Servo warning, CW, CCW, EMGS, undervoltage, or communication error)
3	TSPD (target speed reached)	11	Reserved
4	TPOS (target position reached)	12	Reserved
5	TQL (torque limit activated)	13	Reserved
6	ALRM (servo alarm)	14	Reserved
7	BRKR (electromagnetic brake control output)	15	Reserved

P0.047 - P0.048	Reserved

P0.049■	Update encoder absolute position		Address: 0062H 0063H
Default:	0x0000	Control mode:	All
Unit:	-	Setting range:	0x0000 to 0x0002
Format:	HEX	Data size:	16-bit

Settings:

0002
U Z Y X

X	Command processing	Z	Reserved
Y	Reserved	U	Reserved

■ X: command processing

0: N/A

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

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

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

Settings:

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

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

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

Settings:

When you set P2.070 [Bit 1] to 1 for reading the pulse number, this parameter displays the encoder's absolute position in the form of number of revolutions. When you set P2.070 [Bit 1] to 0 for reading the PUU number, this parameter becomes invalid and the panel displays 0.

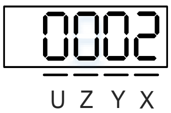
P0.052★■	Encoder absolute position - pulse number within single turn or PUU		Address: 0068H 0069H
Default:	0	Control mode:	All
Unit:	pulse or PUU	Setting range:	0 to 16777216-1 (pulse) -2147483648 to +2147483647 (PUU)
Format:	DEC	Data size:	32-bit

Settings:

When you set P2.070 [Bit 1] to 1 for reading the pulse number, this parameter displays the encoder's absolute position in the form of pulse number within a single turn. When you set P2.070 [Bit 1] to 0 for reading the PUU number, this parameter displays the motor's absolute position in PUU.

P0.053	General range compare digital output - filter time		Address: 006AH 006BH
Default:	0x0000	Control mode:	All
Unit:	-	Setting range:	0x0000 to 0xFFFF
Format:	HEX	Data size:	16-bit

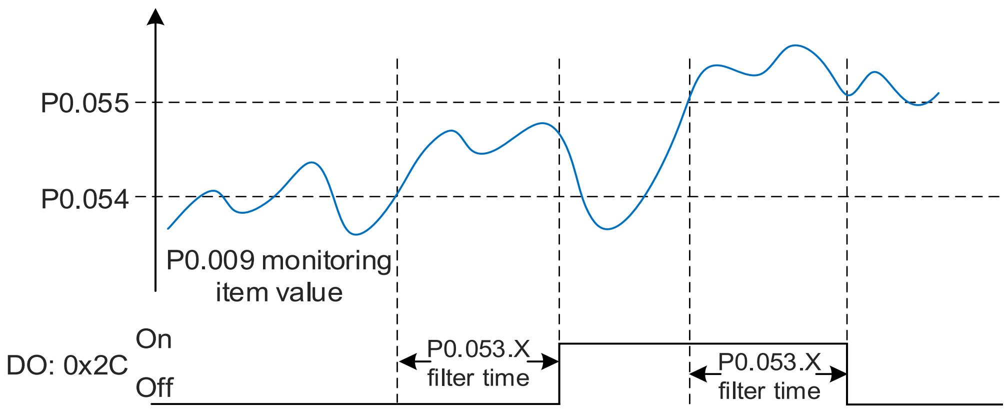
Settings:



X	First filter time	Z	Third filter time
Y	Second 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:



8

P0.054	General range compare digital output 1 - 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 item of P0.017. When the monitoring item value of P0.009 is within the range set in P0.054 and P0.055, and after the filter time set in P0.053.X has elapsed, this digital output is on.

P0.055	General range compare digital output 1 - 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 2 - lower limit		Address: 0070H 0071H
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 item of P0.018. When the monitoring item value of P0.010 is within the range set in P0.056 and P0.057, and after the filter time set in P0.053.Y has elapsed, this digital output is on.

P0.057	General range compare digital output 2 - upper limit		Address: 0072H 0073H
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 3 - lower limit		Address: 0074H 0075H
Default:	0	Control mode:	All
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

8

Settings:

Before using this function, set the digital output function to 0x2E (third set of general range comparison) and the monitoring item of P0.019. When the monitoring item value of P0.011 is within the range set in P0.058 and P0.059, and after the filter time set in P0.053.Z has elapsed, this digital output is on.

P0.059	General range compare digital output 3 - upper limit		Address: 0076H 0077H
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 4 - lower limit		Address: 0078H 0079H
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 item of P0.020. When the monitoring item value of P0.012 is within the range set in P0.060 and P0.061, and after the filter time set in P0.053.U has elapsed, this digital output is on.

P0.061	General range compare digital output 4 - upper limit		Address: 007AH 007BH
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

8

P0.063★	Total duration of DC Bus voltage exceeding 400V		Address: 007EH 007FH
Default:	0	Control mode:	All
Unit:	ms	Setting range:	0 to 2147483647
Format:	DEC	Data size:	32-bit

Settings:

Records the total time during which the voltage of the DC Bus exceeded 400V.

P0.064 - P0.078	Reserved

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

Settings:

Records the highest IGBT temperature.

P0.080 - P0.100	Reserved

P1.xxx Basic parameters

P1.000▲	External pulse input type		Address: 0100H 0101H
Default:	0x1042	Control mode:	PT
Unit:	-	Setting range:	0x0000 to 0x31F2
Format:	HEX	Data size:	16-bit

Settings:

U Z Y X

X	Pulse type	Z	Logic type
Y	Filter width	U	Filter width

- X: pulse type

  0: AB phase pulse (4x)

  1: clockwise and counterclockwise pulses

  2: pulse train + sign

- Z: logic type

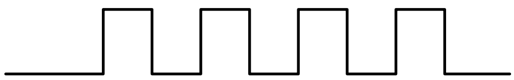
  0: positive logic

  1: negative logic

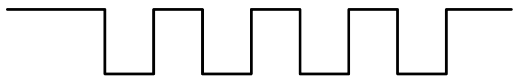
  Digital circuits use 0 and 1 to represent the high and low voltage levels. In positive logic, 1 represents high voltage and 0 represents low voltage; in negative logic, 1 represents low voltage and 0 represents high voltage.

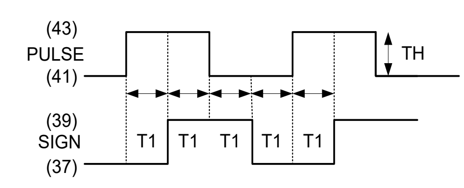
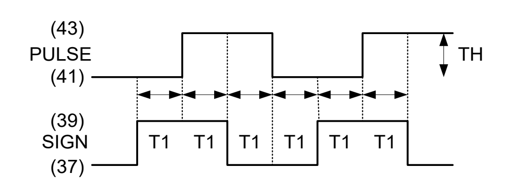
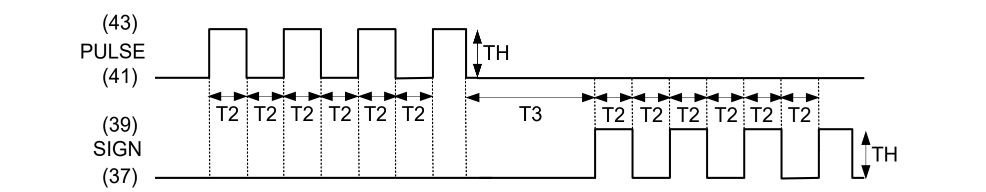
  Example:

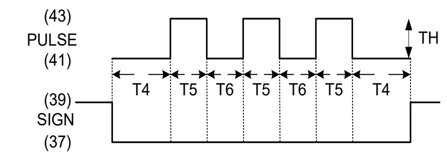
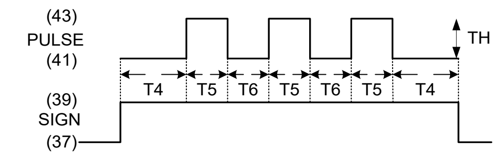
Positive logic



Negative logic



<table>
<tr><th rowspan="2">Logic type</th><th rowspan="2">Pulse type</th><th colspan="2">Pulse input</th></tr>
<tr><th>Forward</th><th>Reverse</th></tr>
<tr><td rowspan="3">Z = 0</td><td></td><td>Pulse phase lead</td><td>Pulse phase lag</td></tr>
<tr><td>X = 0</td><td>
</td><td>
</td></tr>
<tr><td>X = 1</td><td colspan="2">
</td></tr>
</table>

Logic type	Pulse type	Pulse input	
		Forward	Reverse
		Sign = low	Sign = high
Z = 0	X = 2		

Note: the preceding diagrams are based on the -L model.
Communication type model pins: SIGN+ (23), SIGN- (24), PULSE+ (25), and PULSE- (26).

Pulse type		Maximum input frequency	Minimum allowed time width					
			T1	T2	T3	T4	T5	T6
Differential signal	Pulse train + sign	4 Mpps	62.5 ns	125 ns	250 ns	200 ns	125 ns	125 ns
	CW and CCW pulses							
	A phase + B phase (single-phase)	2 Mpps	125 ns	250 ns	250 ns	200 ns	250 ns	250 ns
Open-collector		200 Kpps	1.25 μs	2.5 μs	5 μs	5 μs	2.5 μs	2.5 μs

Pulse	Parameter settings	Type		Maximum input frequency	Voltage	Forward current
High speed pulse	Refer to the U & Y settings in the following table	Differential signal	Pulse train + sign	4 Mpps	5V	< 25 mA
			CW and CCW pulses			
			A phase + B phase (single-phase)	2 Mpps		
		Open-collector		200 Kpps	24V (max.)	< 25 mA
Low speed pulse[Note]	U = 2 and Y = 0	Differential signal		200 Kpps	5V	< 25 mA
		Open-collector		200 Kpps	24V (max.)	< 25 mA

Note:
1. When the low speed pulse is used (U = 2), parameter Y has to be 0 (no filter function).
2. It is suggested that you use the low speed pulse function when there is high frequency interference.
3. Contact Delta for the week for introducing the low speed pulse function to the servo drive.

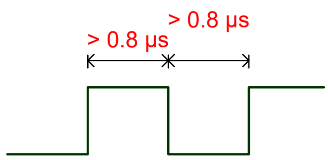
■ U, Y: filter width

If the pulse frequency is suddenly too high, causing a pulse width smaller than the set 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.

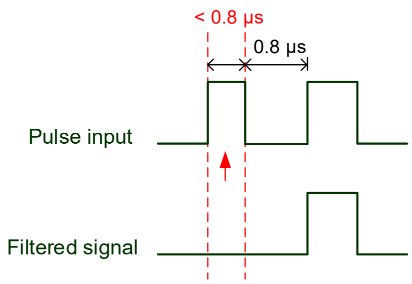
U and Y values	Filter width Unit: µs (kHz)	U and Y values	Filter width Unit: µs (kHz)
0, 0	No filter function	1, 0	No filter function
0, 1	2 (250)	1, 1	0.2 (2500)
0, 2	3 (166)	1, 2	0.3 (1666)
0, 3	4 (125)	1, 3	0.4 (1250)
0, 4	5 (100)	1, 4	0.5 (1000)
0, 5	6 (83)	1, 5	0.6 (833)
0, 6	7 (71)	1, 6	0.7 (714)
0, 7	8 (62)	1, 7	0.8 (625)
0, 8	9 (55)	1, 8	0.9 (555)
0, 9	10 (50)	1, 9	1 (500)
0, A	11 (45)	1, A	1.1 (454)
0, B	12 (41)	1, B	1.2 (416)
0, C	13 (38)	1, C	1.3 (384)
0, D	14 (35)	1, D	1.4 (357)
0, E	15 (33)	1, E	1.5 (333)

Example:

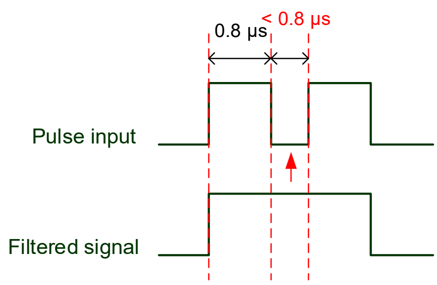
When you set U and Y both to 1 (filter width = 0.2 µs), and when the widths of the command pulse at high and low levels are both larger than 0.8 µs (four times the filter width 0.2 µs), then the pulse command is not filtered out.



When the width of the pulse at high or low level is smaller than the filter width, then the pulse is filtered out.



If the first pulse width is smaller than 0.8 µs, the pulse may be filtered out, and thus two input pulses will be regarded as one pulse. If the pulse width is smaller than 0.2 µs, the pulse will be filtered out.



If the low level pulse width is smaller than 0.8 µs, the pulse may be filtered out, and thus two input pulses will be regarded as one pulse. If the low level pulse width is smaller than 0.2 µs, the pulse will be filtered out.

If you use a 125 ns (4 Mpps) input pulse, set the filter width value Y to 0 to disable the filter function.

Note: when the signal is a high-speed pulse (4 Mpps) and the value of the filter width is 0, then the pulse is not filtered out.

P1.001●	Input for control mode and control command		Address: 0102H 0103H
Default:	0x0000 (-M, -L) 0x000B (-F) 0x000C (-E, -P)	Control mode:	All
Unit:	-	Setting range:	0x0000 to 0x112F
Format:	HEX	Data size:	16-bit

Settings:

0002

U Z YX

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

■ 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	CANopen mode (for Delta's DVP-15MC PLC controller) DMCNET mode					
0C	CANopen mode EtherCAT mode PROFINET mode					
0D	▲	▲				
Multi-mode						
0E	▲	▲	▲			
0F	▲	▲		▲		

PT: Position control mode; the command source is from the external pulse and the external analog voltage.

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 registers 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 registers which you can select with DI.TCM0 and DI.TCM1.

Sz: Speed control mode; the speed command is zero or the command source is from the internal speed registers which you can select with DI.SPD0 and DI.SPD1.

Tz: Torque control mode; the torque command is zero or the command source is from the internal torque registers which you can select with DI.TCM0 and DI.TCM1.

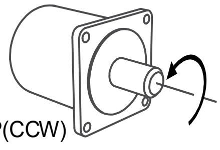
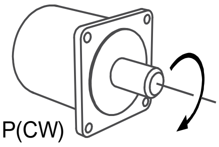
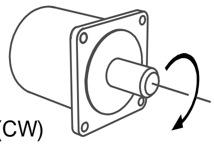
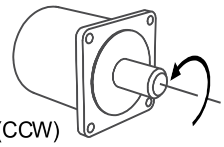
Dual mode: you can switch between two modes with the external DI. For example, you can use DI.S-P to switch the dual mode of PT-S (control mode setting: 06). Refer to Table 8.1 for further information.

Multi-mode: you can switch between three modes with the 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: 0E). Refer to Table 8.1 for further information.

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

Note: if the command source is the external analog voltage, make sure to connect the voltage source properly to avoid floating connection causing misoperation.

- Z: direction control

	Z = 0	Z = 1
Positive direction	 P(CCW)	 P(CW)
Negative direction	 N(CW)	 N(CCW)

- U: DIO value control (volatile)
  0: when modes are switched, DIO settings remain the same.
  1: when modes are switched, DIO settings are reset to the default for each mode.

  Note: for the default settings of -M, -F, and -E models, refer to Section 3.3.1. For the default settings of -P models, refer to Section 3.3.2. For the default settings of -L models, refer to Section 3.3.3.

8

P1.002▲	Speed and torque limits		Address: 0104H 0105H
Default:	0x0000	Control mode:	All
Unit:	-	Setting range:	0x0000 to 0x0011
Format:	HEX	Data size:	16-bit

Settings:

0002

U Z Y X

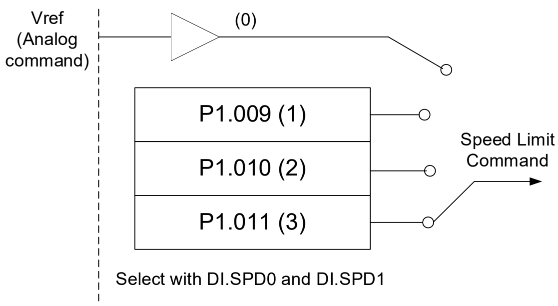
X	Disable / enable Speed Limit function	Z	Reserved
Y	Disable / enable Torque Limit function	U	Reserved

- 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:

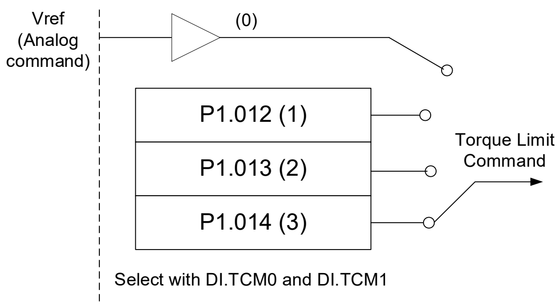


- Y: disable / enable Torque Limit function

  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 P1.002.Y to 1 to enable the Torque Limit function permanently without occupying a DI setting. Alternatively, you can enable or disable the Torque 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.

P1.003	Encoder pulse output polarity		Address: 0106H 0107H
Default:	0x0000	Control mode:	All
Unit:	-	Setting range:	0x0000 to 0x0013
Format:	HEX	Data size:	16-bit

Settings:

0002

U Z Y X

X	Polarity of monitor analog output	Z	Reserved
Y	Direction of encoder pulse output	U	Reserved

- X: polarity of monitor analog output

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

Bit	Fucnction	Description
Bit 0	MON2 polarity	0: MON2(+) 1: MON2(-)
Bit 1	MON1 polarity	0: MON1(+) 1: MON1(-)
Bit 2, Bit 3	Reserved	-

- Y: direction of encoder pulse output

  0: forward

  1: reverse

P1.004	MON1 analog monitor output proportion		Address: 0108H 0109H
Default:	100	Control mode:	All
Unit:	% (full scale)	Setting range:	0 to 100
Format:	DEC	Data size:	16-bit

Settings:

Refer to P0.003 for the analog output setting.

Example:

If the analog voltage output is 8V when the motor speed is 1,000 rpm and the maximum speed of the motor is 5,000 rpm, the setting is as follows.

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

You can calculate the voltage output corresponding to the current motor speed with the following formula.

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

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P1.005	MON2 analog monitor output proportion		Address: 010AH 010BH
Default:	100	Control mode:	All
Unit:	% (full scale)	Setting range:	0 to 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 to 1000
Format:	DEC	Data size:	16-bit

Settings:

0: disable this function.

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

Settings:

0: disable this function.

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

Settings:

0: disable this function.

P1.009	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	Setting range:	-75000 to +75000
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			

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	Setting range:	-75000 to +75000
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			

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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	Setting range:	-75000 to +75000
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			

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:	-5000 to +5000
Format:	DEC	Data size:	16-bit

Settings:

Internal Torque command 1: first internal Torque command.

Internal torque limit 1: first internal torque limit.

1. When P2.112 [Bit 14] = 0

Internal Torque command: 35 = 35%

Internal torque limit: positive and negative values are identical. Refer to the following descriptions.

Example of internal torque limit:

Torque limit value of P1.012	Valid torque range	Torque limit in forward direction	Torque limit in reverse direction
35	-35% to +35%	35%	-35%
-35			

2. When P2.112 [Bit 14] = 1

Internal Torque command: 35 = 3.5%

Internal torque limit: positive and negative values are identical. Refer to the following descriptions.

Example of internal torque limit:

Torque limit value of P1.012	Valid torque range	Torque limit in forward direction	Torque limit in reverse direction
35	-3.5% to +3.5%	3.5%	-3.5%
-35			

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:	-5000 to +5000
Format:	DEC	Data size:	16-bit

Settings:

Internal Torque command 2: second internal Torque command.

Internal torque limit 2: second internal torque limit.

1. When P2.112 [Bit 14] = 0

Internal Torque command: 35 = 35%

Internal torque limit: positive and negative values are identical. Refer to the following descriptions.

Example of internal torque limit:

Torque limit value of P1.013	Valid torque range	Torque limit in forward direction	Torque limit in reverse direction
35	-35% to +35%	35%	-35%
-35			

2. When P2.112 [Bit 14] = 1

Internal Torque command: 35 = 3.5%

Internal torque limit: positive and negative values are identical. Refer to the following descriptions.

Example of internal torque limit:

Torque limit value of P1.013	Valid torque range	Torque limit in forward direction	Torque limit in reverse direction
35	-3.5% to +3.5%	3.5%	-3.5%
-35			

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:	-5000 to +5000
Format:	DEC	Data size:	16-bit

Settings:

Internal Torque command 3: third internal Torque command.

Internal torque limit 3: third internal torque limit.

1. When P2.112 [Bit 14] = 0

Internal Torque command: 35 = 35%

Internal torque limit: positive and negative values are identical. Refer to the following descriptions.

Example of internal torque limit:

Torque limit value of P1.014	Valid torque range	Torque limit in forward direction	Torque limit in reverse direction
35	-35% to +35%	35%	-35%
-35			

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2. When P2.112 [Bit 14] = 1

Internal Torque command: 35 = 3.5%

Internal torque limit: positive and negative values are identical. Refer to the following descriptions.

Example of internal torque limit:

Torque limit value of P1.014	Valid torque range	Torque limit in forward direction	Torque limit in reverse direction
35	-3.5% to +3.5%	3.5%	-3.5%
-35			

P1.015 - P1.018	Reserved

P1.019	Capture: additional function settings		Address: 0126H 0127H
Default:	0x0000	Control mode:	All
Unit:	-	Setting range:	0x0000 to 0x0101
Format:	HEX	Data size:	16-bit

Settings:

0000

U Z Y X

X	Additional function for Capture	Z	Reserved
Y	Reserved	U	Reserved

■ X: additional function for Capture

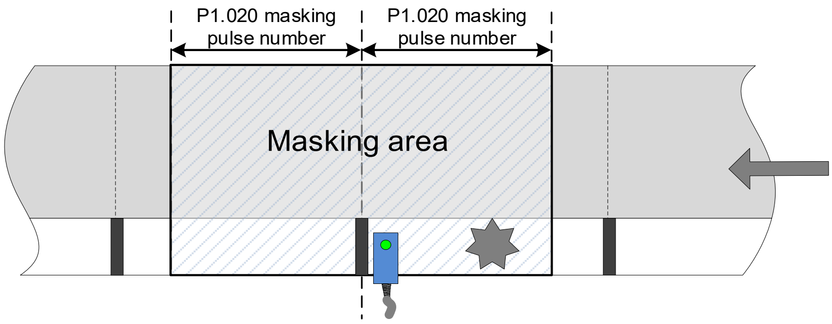
Bit	3	2	1	0

Bit	Function	Description
Bit 0	Cycle mode	0: disable this function. When the number of capturing times (P5.038) is 0, capturing is complete. 1: enable this function. When the number of capturing times (P5.038) is 0, the servo drive automatically resets the number of capturing times to the default setting.
Bit 1 - Bit 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), use this parameter to set the range within which the system stops receiving the DI captured signal once the data is captured. The DI captured signal received within this range is not recognized as valid. Use this function to prevent the system from seeing noise as effective signals within the non-capture range.



The system activates the masking area after capturing this mark.

P1.021	Reserved

P1.022	PR command special filter		Address: 012CH 012DH
Default:	0x0000	Control mode:	PR
Unit:	-	Setting range:	0x0000 to 0x107F
Format:	HEX	Data size:	16-bit

Settings:

0000

U Z YX

YX	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 or to decelerate from 3,000 rpm to 0) 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.

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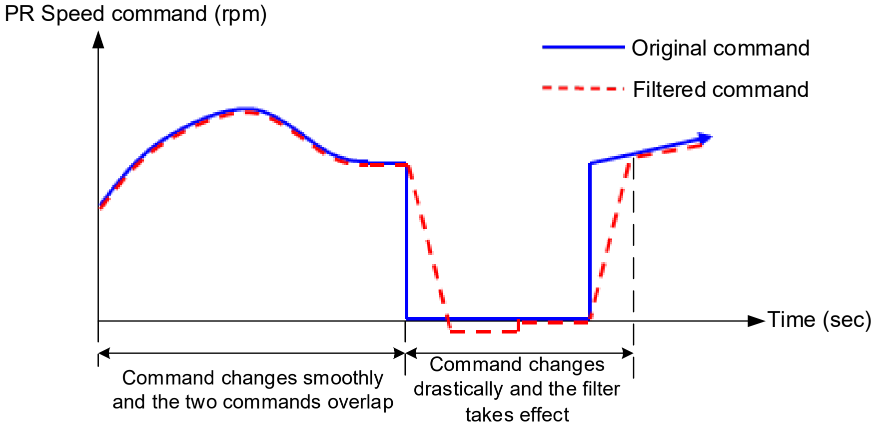
Example:

Set YX to 12 (data format is HEX and unit is 10 ms) and thus the acceleration / deceleration time limit is 180 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.

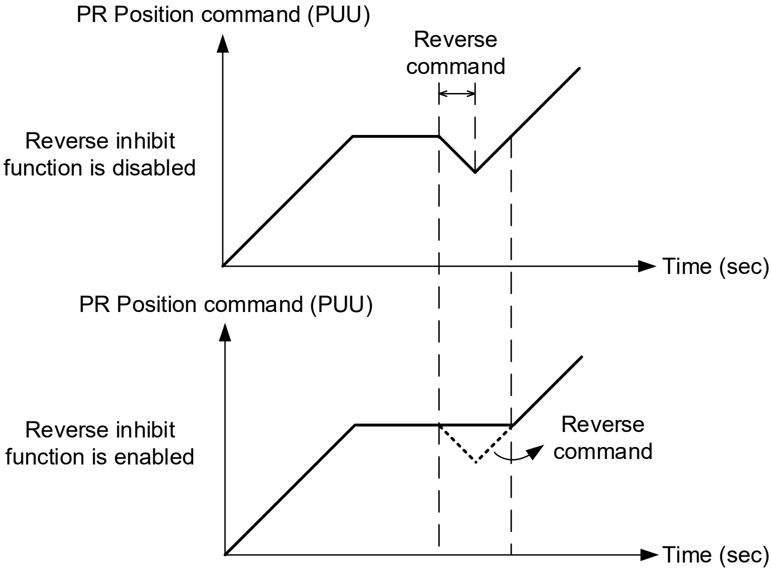


Note: if the command keeps changing drastically, the following error of the internal position exceeds the allowable range and then triggers AL404.

- U: reverse inhibit

  0: disable this function

  1: enable this function. When the value of the current position command is lower than that of the previous position command, the motor does not move.



P1.023 - P1.024	**Reserved**

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

Settings:

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

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

Settings:

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

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

Settings:

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

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

Settings:

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

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

Settings:

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

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

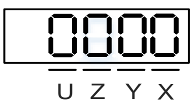
Settings:

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

P1.031	Reserved

P1.032	Motor stop mode		Address: 0140H 0141H
Default:	0x0000	Control mode:	All
Unit:	-	Setting range:	0x0000 to 0x0020
Format:	HEX	Data size:	16-bit

Settings:



X	Reserved	Z	Reserved
Y	Motor stop mode	U	Reserved

■ Y: motor stop mode

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

Bit	Function	Description
Bit 5, Bit 4	Dynamic brake operation options	Options for stopping the motor when the servo is in the Servo Off state or an alarm (including EMGS) occurs Bit 5 = 0 and Bit 4 = 0: use dynamic brake Bit 5 = 0 and Bit 4 = 1: motor runs freely Bit 5 = 1 and Bit 4 = 0: use dynamic brake first, and then let the motor run freely once the speed is slower than the value of P1.038
Bit 6	Trigger stop command when RST power error (AL022) occurs[Note]	0: disable this function 1: when P1.043 is a negative value and RST power error (AL022) occurs, the servo drive commands the motor to decelerate to 0 in the Servo On state
Bit 7	Reserved	-

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

Note: this function is only available in Position and Speed (PT, PR, S, and Sz) modes and is effective only when P1.043 (Delay time for disabling the magnetic brake) is a negative value.

P1.033	**Reserved**

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

Settings:

Sets the time for the Speed command to accelerate the motor from 0 to 3000 rpm. You can set P1.034, P1.035, and P1.036 individually. When an internal command is used, even if you set P1.036 to 0, the acceleration and deceleration follow a trapezoidal curve; when an analog command is used, you must set P1.036 larger than 0 so that the acceleration and deceleration follow a trapezoidal curve.

Note: when an analog Speed command is used, the setting range is limited to 1 - 20000.

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:

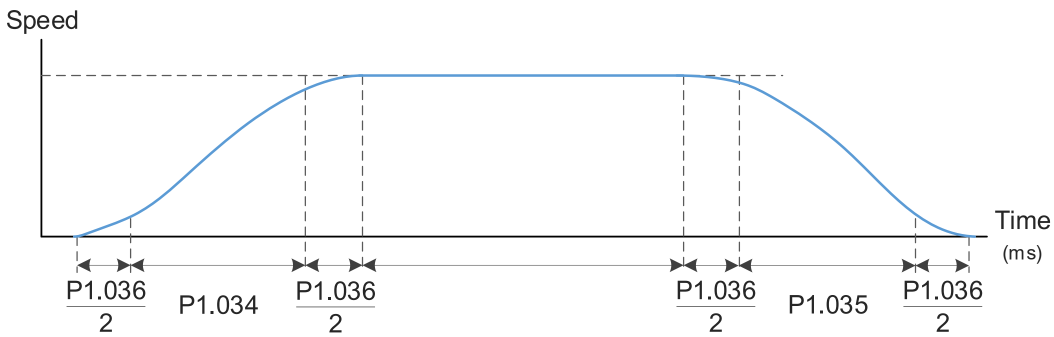
Sets the time for the Speed command to decelerate the motor from 3000 rpm to 0. You can set P1.034, P1.035, and P1.036 individually. When an internal command is used, even if you set P1.036 to 0, the acceleration and deceleration follow a trapezoidal curve; when an analog command is used, you must set P1.036 larger than 0 so that the acceleration and deceleration follow a trapezoidal curve.

Note: when an analog Speed command is used, the setting range is limited to 1 - 20000.

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

Settings:

0: disable this function



P1.034: sets the acceleration time for the trapezoidal curve.

P1.035: sets the deceleration time for the trapezoidal curve.

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

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

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

Note: when an analog Speed command is used, the setting range is limited to 1 - 10000.

P1.037	Load inertia ratio or total weight			Address: 014AH 014BH
Operation interface:	Panel / software	Communication	Control mode:	All
Default:	2.0 0.0 (-F)	20 0 (-F)	Data size:	16-bit
Unit:	1 times	0.1 times	-	-
Setting range:	0.0 to 200.0	0 to 2000	-	-
Format:	One decimal	DEC	-	-
Example:	1.5 = 1.5 times	15 = 1.5 times	-	-

Settings:

Load inertia ratio of servo motor (rotary motor): (J_load / J_motor)

J_motor: rotational inertia of the servo motor

J_load: total equivalent inertia of external mechanical load

P1.038	Zero speed detection level			Address: 014CH 014DH
Operation interface:	Panel / software	Communication	Control mode:	All
Default:	10.0	100	Data size:	16-bit
Unit:	1 rpm	0.1 rpm	-	-
Setting range:	0.0 to 200.0	0 to 2000	-	-
Format:	One decimal	DEC	-	-
Example:	1.5 = 1.5 rpm	15 = 1.5 rpm	-	-

Settings:

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

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

Settings:

Sets the motor target speed. When the absolute value of the motor speed is higher than this value, the condition for triggering the target speed reached signal is met and DO.TSPD is on.

P1.040	Maximum motor speed for analog Speed command 1		Address: 0150H 0151H
Default:	Rated speed	Control mode:	S / T
Unit:	rpm	Setting range:	0 to 50000
Format:	DEC	Data size:	32-bit

Settings:

In Speed mode:

Sets the motor speed corresponding to 10V (maximum voltage) for the analog Speed command.

$$\text{Speed control command} = \frac{\text{Input voltage} \times \text{P1.040}}{10}$$

If the value is 2000 and the external voltage input is 5V, then the speed control command = $\frac{5\text{V} \times 2000\text{ rpm}}{10}$ = 1000 rpm

In Torque mode:

Sets the motor speed limit corresponding to 10V (maximum voltage) for the analog speed limit.

$$\text{Speed limit command} = \frac{\text{Input voltage} \times \text{P1.040}}{10}$$

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

Settings:

In Torque mode:

Sets the torque corresponding to 10V (maximum voltage) for the analog Torque command.

$$\text{Torque control command} = \frac{\text{Input voltage} \times \text{P1.041}}{10} \text{ (Unit: \%)}$$

In Speed, PT, and PR modes:

Sets the torque limit corresponding to 10V (maximum voltage) for the analog torque limit.

$$\text{Torque limit command} = \frac{\text{Input voltage} \times \text{P1.041}}{10} \text{ (Unit: \%)}$$

Example:

If P1.041 = 10,

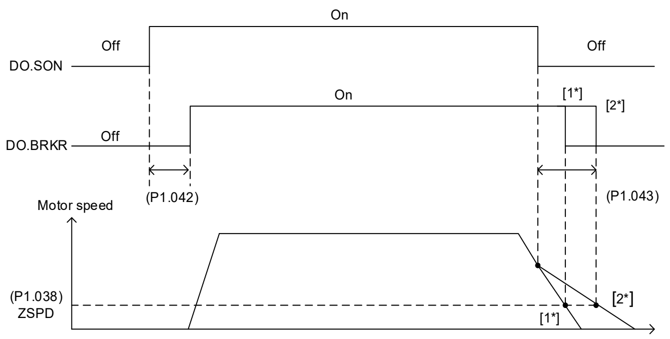
(a) when the external analog voltage input is 10V, the torque control (limit) command = $\frac{10V \times 10}{10}$ = 10%

(b) when the external analog voltage input is 5V, the torque control (limit) command = $\frac{5V \times 10}{10}$ = 5%

P1.042	Delay time for enabling the magnetic brake		Address: 0154H 0155H
Default:	0	Control mode:	All
Unit:	ms	Setting range:	0 to 1000
Format:	DEC	Data size:	16-bit

Settings:

Sets the delay time from Servo On state to the activation of electromagnetic brake signal (DO: 0x08, BRKR).



Note:

1. If the delay time specified in P1.042 has not passed yet and the motor speed is slower than the value of P1.038, the electromagnetic brake signal (DO.BRKR) is disabled.
2. If the delay time specified in P1.042 has passed and the motor speed is faster than the value of P1.038, the electromagnetic brake signal (DO.BRKR) is disabled.

P1.043	Delay time for disabling the 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). Refer to P1.042 for the detailed diagram.

Note: if P1.043 is a negative value and the servo is off due to an alarm (except for AL022) or emergency stop, the setting of P1.043 is invalid. This is equivalent to setting the delay time to 0.

P1.044▲	E-Gear ratio - numerator N1		Address: 0158H 0159H
Default:	16777216	Control mode:	All
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. For multiple E-Gear ratio (numerator) settings, refer to P2.060 - P2.062.

Note:
1. Do not change the setting in the Servo On state.
2. In DMCNET / CANopen / EtherCAT / PROFINET communication mode, 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 position 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:	All
Unit:	pulse	Setting range:	1 to (2^{31}-1)
Format:	DEC	Data size:	32-bit

Settings:

If the setting is incorrect, the servo motor is prone to sudden unintended acceleration. Follow these instructions.

E-Gear ratio setting: $f2=f1\times\frac{N}{M}$

Pulse of User Unit (PUU) (f1) $\rightarrow \boxed{\frac{N}{M}} \rightarrow$ Resolution determined by servo drive (pulse) (f2)

Range of E-gear ratio: 1 ≤ 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 DMCNET / CANopen / EtherCAT / PROFINET communication mode, 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 position 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.

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P1.046▲	Encoder pulse number output (OA, OB)		Address: 015CH 015DH
Default:	2500	Control mode:	All
Unit:	pulse	Setting range:	1 to 536870912
Format:	DEC	Data size:	32-bit

Settings:

The number of single-phase pulse outputs per revolution. The maximum output frequency of the hardware is 19.8 MHz.

Note:
In the following circumstances, pulse output of the encoder may exceed the maximum allowable output pulse frequency of the drive, causing AL018 or AL048:

1. Encoder error.
2. The motor speed is faster than the setting of P1.076.
3. If P1.074.Y = 0 and P1.097 = 0, motor speed (rpm)/60 x P1.046 x 4 > 19.8 x 10^6

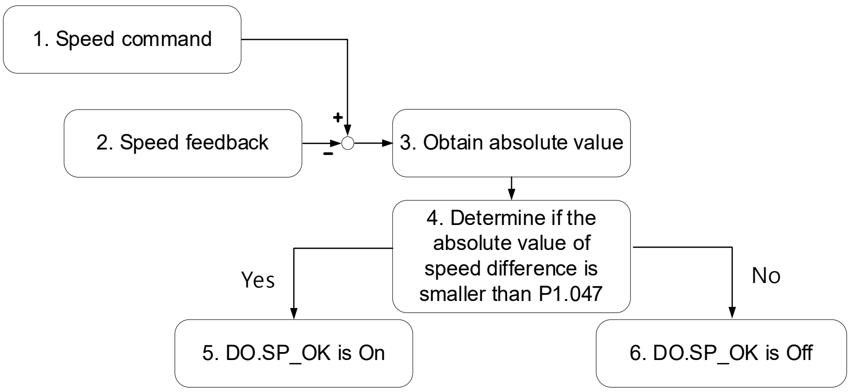
P1.047	Speed reached (DO.SP_OK) range		Address: 015EH 015FH
Default:	10	Control mode:	S / Sz
Unit:	rpm	Setting range:	0 to 300
Format:	DEC	Data size:	16-bit

Settings:

In Speed mode, when the absolute value of the difference between the Speed command and the motor speed feedback is less than this parameter and this status is kept for the time duration set in P1.049, the digital output DO.SP_OK (0x19) is on.

Note: when the difference between the Speed command and the motor speed feedback exceeds the range set in P1.047, the system recalculates the duration.

Diagram:

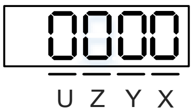


1. Speed command: the command that you input without acceleration or deceleration, rather than the command from the front end speed circuit. Its source is from the register.
2. Speed feedback: the actual speed of the motor which has been filtered.
3. Obtain the absolute value.
4. Determine whether the absolute value of the speed difference is smaller than the parameter value. If you set the parameter to 0, DO.SP_OK is always off. If the absolute value is smaller than the parameter, the digital output is on, otherwise it is off.

P1.048	Motion reached (DO.MC_OK) operation selection		Address: 0160H 0161H
Default:	0x0000	Control mode:	PR
Unit:	-	Setting range:	0x0000 to 0x0011
Format:	HEX	Data size:	16-bit

Settings:

Options for controlling the behavior of the digital output DO.MC_OK (0x17).



X	DO output retaining option	Z	Reserved
Y	Position deviation alarm (AL380) option	U	Reserved

- X: DO output retaining option

  0: output status is not retained

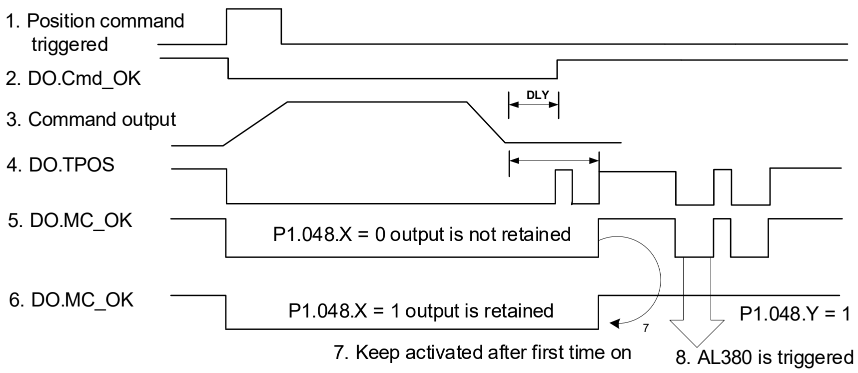
  1: output status is retained

- 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 signals 2, 4, 5, and 6 are cleared simultaneously. Command triggering source: DI.CTRG, DI.EV1/EV2, and P5.007 (triggered through software).
2. DO.Cmd_OK: indicates whether command 3 is complete, and can be set with a delay time (DLY) with parameters.
3. Command output: output the profile of the Position command based on the setting for acceleration or deceleration.
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 indicates 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 retained regardless of the signal 4 status.

8

7. Either signal 5 or signal 6 can be output, and this is determined by P1.048.X.
8. Position deviation: when event 7 occurs, if signal 4 or 5 is off, it means the position has deviated and AL380 can be triggered.
9. Set whether to enable AL380 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 to 65535
Format:	DEC	Data size:	16-bit

Settings:

In Speed mode, when the absolute value of the difference between the Speed command and the motor speed feedback is less than the range set in P1.047 and this status is kept for the time duration set in P1.049, the digital output DO.SP_OK (0x19) is on. If the difference exceeds the range set in P1.047, no matter how long it lasts, the system recalculates the duration.

P1.050 - P1.051	**Reserved**

P1.052	**Regenerative resistor value**		**Address: 0168H 0169H**
Default:	Determined by the model. Refer to the following table.	Control mode:	All
Unit:	Ohm	Setting range:	Refer to the following table.
Format:	DEC	Data size:	16-bit

Settings:

Model		Default (Ω)	Setting range (Ω)
220V	750 W or below	100	60 to 750
	1 to 1.5 kW	100	30 to 750
	2 to 3 kW	20	15 to 750
400V	1 kW	100	80 to 750
	1.5 kW	100	60 to 750
	2 kW	50	45 to 750
	3 kW	50	40 to 750
	4 kW to 4.5 kW	35	35 to 750
	5.5 kW to 8 kW	35	25 to 750

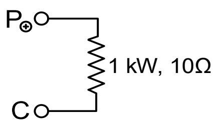
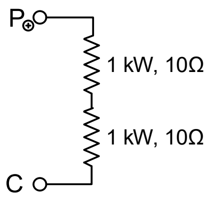
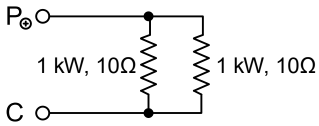
Refer to the description of P1.053 for the parameter values when connecting the regenerative resistor with different methods.

P1.053	Regenerative resistor capacity		Address: 016AH 016BH
Default:	Determined by the model. Refer to the following table.	Control mode:	All
Unit:	Watt	Setting range:	0 to 15000
Format:	DEC	Data size:	16-bit

Settings:

Model		Default (Watt)
220V	200 W or below	0
	400 W to 1.5 kW	40
	2 kW to 3 kW	80
400V	3 kW or below	80
	4 kW to 8 kW	100

Setting the parameter values when connecting the regenerative resistor with different methods:

External regenerative resistor	Setting
Single 	Setting: P1.052 = 10 (Ω) P1.053 = 1000 (W)
In series 	Setting: P1.052 = 20 (Ω) P1.053 = 2000 (W)
In parallel 	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 to 16777216
Format:	DEC	Data size:	32-bit

Settings:

In Position (PT) mode, when the pulse number error is smaller than the range set by P1.054, DO.TPOS is on.

In Position Register (PR) mode, when the difference between the target position and the actual motor position is less than this parameter, DO.TPOS is On.

Example:

If P1.054 = 167772 and the error is less than 167772 pulses, which equals 0.01 turns (167772 / 16777216 = 0.01), then DO.TPOS is on.

8

P1.055	Maximum speed limit		Address: 016EH 016FH
Default:	Rated speed	Control mode:	All
Unit:	rpm	Setting range:	0 to maximum speed
Format:	DEC	Data size:	16-bit

Settings:

Sets the maximum speed of the servo motor.

P1.056	Motor output overload warning level		Address: 0170H 0171H
Default:	120	Control mode:	All
Unit:	%	Setting range:	0 to 120
Format:	DEC	Data size:	16-bit

Settings:

When the value is 0 - 100 and the servo motor continuously outputs load that is higher than the setting of P1.056, the pre-warning signal for overload (DO: 0x10, OLW) is on. If the value is over 100, the pre-warning function is disabled.

P1.057	Motor hard stop 1 - torque percentage		Address: 0172H 0173H
Default:	0	Control mode:	All
Unit:	%	Setting range:	0 to 300
Format:	DEC	Data size:	16-bit

Settings:

Sets the protection level which is the percentage of rated torque. Set the value to 0 to disable the function and set the value to 1 or above to enable the function.

When there is no external force, the setting value = (motor current in percentage when the motor runs at constant speed in the forward direction + motor current in percentage when the motor runs at constant speed in the reverse direction) / 2 + protection torque value. When there is external force, set P1.060 additionally.

P1.058	Motor hard stop - protection time		Address: 0174H 0175H
Default:	1	Control mode:	All
Unit:	ms	Setting range:	1 to 1000
Format:	DEC	Data size:	16-bit

Settings:

Sets the protection time: when the motor torque reaches the protection level and the protection time is exceeded, AL030 occurs.

Note: this function is only suitable for non-contactable uses, such as electrical discharge machines (make sure P1.037 is correctly set).

8

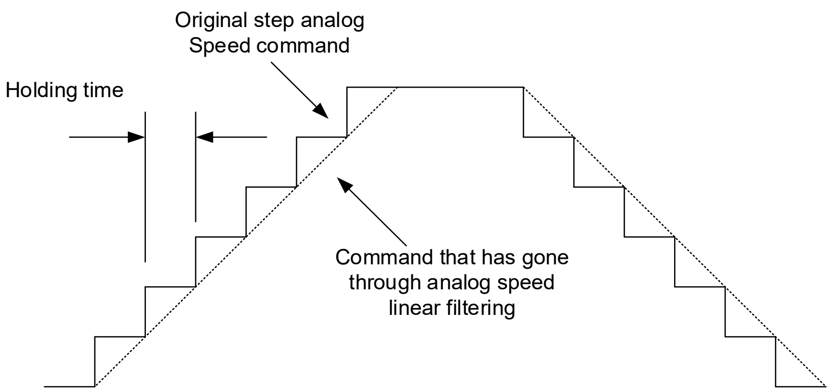
P1.059	Speed command - moving filter			Address: 0176H 0177H
Operation interface:	Panel / software	Communication	Control mode:	S
Default:	0.0	0	Data size:	16-bit
Unit:	1 ms	0.1 ms	-	-
Format:	One decimal	DEC	-	-
Setting range:	0.0 to 4.0	0 to 40	-	-
Example:	1.5 = 1.5 ms	15 = 1.5 ms	-	-

Settings:

0: disable this function.

P1.006 is the low-pass filter and P1.059 is the moving filter. The difference between them is that 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	Motor hard stop 1 - level offset		Address: 0178H 0179H
Default:	0	Control mode:	All
Unit:	%	Setting range:	-300 to +300
Format:	DEC	Data size:	16-bit

Settings:

When using P1.057 (Motor hard stop 1 - torque percentage) and the average torque level deviates because of an external force, such as Z-axis gravity, you can use this parameter to set the corresponding compensation.

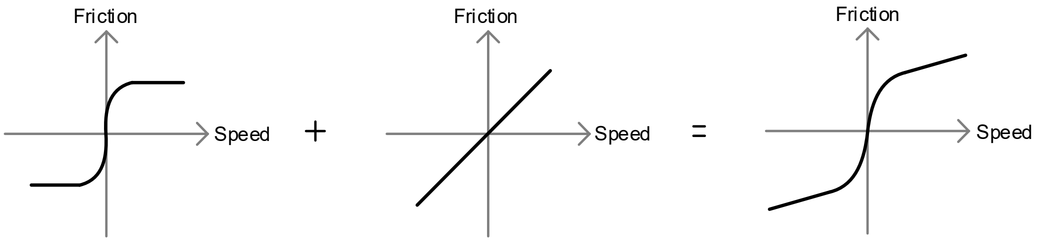
Suggested setting value = (Average torque at constant speed in positive direction + Average torque at constant speed in negative direction) / 2

Note: refer to P0.002 = 54 (Torque feedback) for the average torque at constant speed.

P1.061	Viscous friction compensation		Address: 017AH 017BH
Default:	0	Control mode:	PT / PR / S / Sz
Unit:	0.1%/1000 rpm	Setting range:	0 to 1000
Format:	DEC	Data size:	16-bit

Settings:

Because kinetic friction corresponds with the speed, you can use this parameter to compensate the motor torque according to the speed to improve the position error during acceleration and deceleration. When P1.062 = 0, this parameter is invalid.



P1.062 Percentage of friction compensation
P1.063 Constant of friction compensation

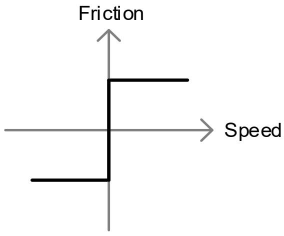
P1.061 Viscous friction compensation

P1.062 Percentage of friction compensation
P1.063 Constant of friction compensation
P1.061 Viscous friction compensation

P1.062	Percentage of friction compensation		Address: 017CH 017DH
Default:	0	Control mode:	PT / PR / S / Sz
Unit:	%	Setting range:	0 to 100
Format:	DEC	Data size:	16-bit

Settings:

Sets the level of friction compensation, which is the percentage of the rated torque. Set the value to 0 to disable the friction compensation function. Set the value to 1 or above to enable the function to reduce the position error at the moment the motion starts.



P1.062 Percentage of friction compensation

P1.063	Constant of friction compensation		Address: 017EH 017FH
Default:	100	Control mode:	PT / PR / S / Sz
Unit:	%	Setting range:	1 to 1000
Format:	DEC	Data size:	16-bit

Settings:

Sets the speed for the friction compensation value to reach the setting value of P1.062. Based on the default setting of 100%, the smaller the setting value of P1.063, the faster the setting value of P1.062 is reached; the bigger the setting value of P1.063, the slower the setting value of P1.062 is reached.

8

P1.064	Analog position command - activation control		Address: 0180H 0181H
Default:	0x0000	Control mode:	PT
Unit:	-	Setting range:	0x0000 to 0x0011
Format:	HEX	Data size:	16-bit

Settings:

0000

U Z Y X

X	Setting for position command issued by the analog signal	Z	Reserved
Y	Initial position setting	U	Reserved

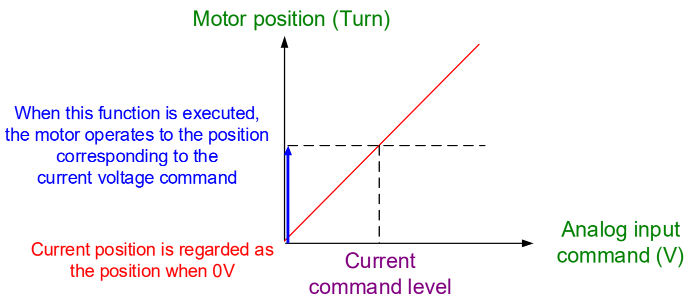
- X: setting for position command issued by the analog signal

  0: disable

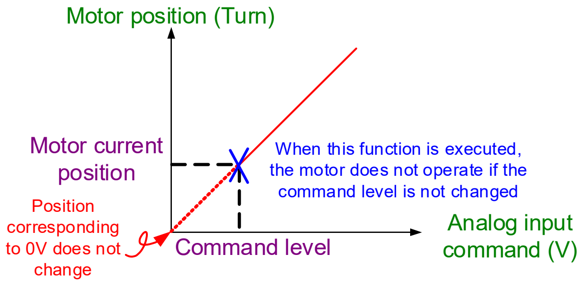
  1: enable

- 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	Analog Position command - smoothing constant		Address: 0182H 0183H
Default:	1	Control mode:	PT
Unit:	10 ms	Setting range:	1 to 1000
Format:	DEC	Data size:	16-bit

Settings:

The smooth constant of analog Position command is only effective to analog Position command.

P1.066	Analog Position command - maximum cycle number			Address: 0184H 0185H
Operation interface:	Panel / software	Communication	Control mode:	PT
Default:	0.0	0	Data size:	16-bit
Unit:	1 cycle	0.1 cycle	-	-
Format:	One decimal	DEC	-	-
Setting range:	0.0 to 200.0	0 to 2000	-	-
Example:	1.5 = 1.5 cycles	15 = 1.5 cycles	-	-

Settings:

Rotation number setting when the maximum voltage (10V) is input 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 P1.066 setting value / 10

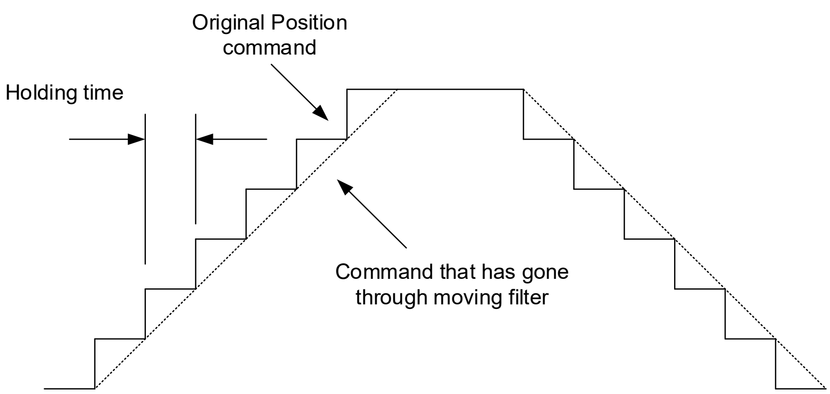
P1.067	Reserved

P1.068	Position command - moving filter		Address: 0188H 0189H
Default:	4	Control mode:	PT / PR
Unit:	ms	Setting range:	0 to 100
Format:	DEC	Data size:	16-bit

Settings:

0: disable this function.

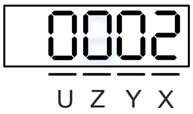
The moving filter smooths the beginning and end of the step command, but it also delays the command.



P1.069 - P1.073	Reserved

P1.074	Output source of OA / OB / OZ		Address: 0194H 0195H
Default:	0x0000	Control mode:	PT
Unit:	-	Setting range:	0x0000 to 0x0030
Format:	HEX	Data size:	16-bit

Settings:



X	Reserved	Z	Reserved
Y	Selection of OA / OB / OZ output source	U	Reserved

- Y: selection of OA / OB / OZ output source

  0: CN2 encoder is the output source

  1: reserved

  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.)

P1.075	Reserved

P1.076▲	Maximum speed for encoder output (OA, OB)		Address: 0198H 0199H
Default:	5500	Control mode:	All
Unit:	rpm	Setting range:	0 - 6000 (0: disable this function)
Format:	DEC	Data size:	16-bit

Settings:

Set a value which is slightly higher than the required maximum speed of motor.

P1.077	Reserved

P1.078	Gain switching delay time		Address: 019CH 019DH
Default:	0	Control mode:	P / S
Unit:	ms	Setting range:	0 to 32767
Format:	DEC	Data size:	16-bit

Settings:

When using the gain switching function (P2.027.X = 3 or 7), you can use this parameter to set the delay time after the switching condition is met. Refer to the description of P2.027 for more details.

8

P1.079	Rate of change for gain values during gain switching delay		Address: 019EH 019FH
Default:	100	Control mode:	P / S
Unit:	%	Setting range:	0 to 500
Format:	DEC	Data size:	16-bit

Settings:

Sets the rate of change for the gain values during gain switching delay. If P1.078 is 0, this function is disabled.

Within the delay time set by P1.078, the settings of P2.000 (Position proportional gain) and P2.004 (Speed proportional gain) will be affected by the setting of P1.079. Refer to the description of P2.027 for more details.

P1.080	Rate of change for speed detection filter and jitter suppression		Address: 01A0H 01A1H
Default:	100	Control mode:	P / S
Unit:	%	Setting range:	0 to 100
Format:	DEC	Data size:	16-bit

Settings:

Adjusts the rate of change for speed detection filter and jitter suppression (P2.049) according to the gain switching condition. (This parameter is inversely proportional to the value of P2.049. The smaller the setting value, the stronger the filtering effect.)

P1.081	Maximum motor speed for analog Speed command 2		Address: 01A2H 01A3H
Default:	Rated speed	Control mode:	S / T
Unit:	rpm	Setting range:	0 to 50000
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P1.040.

P1.082	Time constant for switching between P1.040 and P1.081		Address: 01A4H 01A5H
Default:	0	Control mode:	S / T
Unit:	ms	Setting range:	0 to 1000 (0: disable this function)
Format:	DEC	Data size:	16-bit

Settings:

0: disable this function.

P1.083	Abnormal analog input voltage level		Address: 01A6H 01A7H
Default:	0	Control mode:	S
Unit:	mV	Setting range:	0 to 12000 (0: disable this function)
Format:	DEC	Data size:	16-bit

8

Settings:

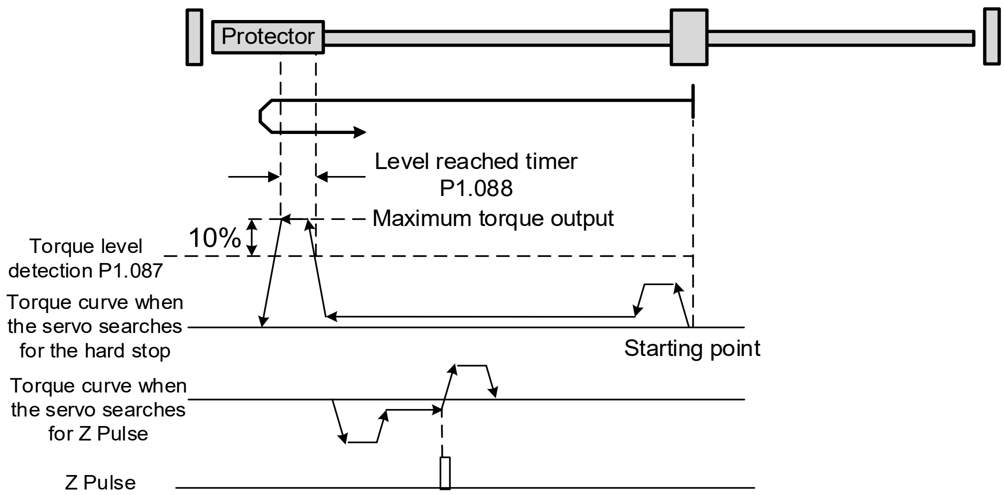
When the absolute value of the analog input voltage is higher than the set value of this parameter for more than 50 ms, AL042 occurs. The comparison value for this parameter is the original analog input voltage which has not been changed by an offset value through P4.022 (Analog speed input - offset compensation value).

P1.084 - P1.086	Reserved

P1.087	Torque homing - torque level detection		Address: 01AEH 01AFH
Default:	1	Control mode:	PR
Unit:	%	Setting range:	1 to 300
Format:	DEC	Data size:	16-bit

Settings:

This setting is only for the torque homing mode. As shown in the following figure, after homing is triggered, the motor runs in one direction and the mechanical part reaches the protector. The servo drive then outputs a larger motor current in order to counter the external force. The servo drive uses P1.087 and P1.088 as the conditions for homing. Since the hard stops are not always the same, it is recommended that you have the servo reverse to find the Z pulse as the origin.



Note: the actual maximum torque output of the motor is 10% greater than the detected torque level (P1.087). For example, when you set P1.087 to 50%, 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.

P1.089	Vibration elimination 1 - 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.

The servo drive provides two sets of vibration elimination. The first set is P1.089 - P1.091 and the second set is P1.092 - P1.094. The vibration elimination setting must be obtained through the **System Module** function in **System Analysis** of ASDA-Soft with the check box for **Low Frequency Analysis** selected.

Vibration elimination takes effect only when the two degree of freedom control function is enabled (P2.094 [Bit 12] = 1). After enabling the two degree of freedom control function, enable the first set of vibration elimination with P2.094 [Bit 8] and the second set with P2.094 [Bit 9].

Example:

1. Set P2.094 = 0x11☐☐ to enable the first set.
2. Set P2.094 = 0x12☐☐ to enable the second set.
3. Set P2.094 = 0x13☐☐ to enable the first and second sets simultaneously.

P1.090	Vibration elimination 1 - resonance frequency		Address: 01B4H 01B5H
Default:	4000	Control mode:	PT / PR
Unit:	0.1 Hz	Setting range:	10 to 4000
Format:	DEC	Data size:	16-bit

Settings:

Resonance frequency for the first set of low frequency vibration elimination.

8

P1.091	Vibration elimination 1 - resonance difference		Address: 01B6H 01B7H
Default:	10	Control mode:	PT / PR
Unit:	0.1 dB	Setting range:	10 to 4000
Format:	DEC	Data size:	16-bit

Settings:

Attenuation rate for the first set of low frequency vibration elimination.

P1.092	Vibration elimination 2 - anti-resonance frequency		Address: 01B8H 01B9H
Default:	4000	Control mode:	PT / PR
Unit:	0.1 Hz	Setting range:	10 to 4000
Format:	DEC	Data size:	16-bit

Settings:

Anti-resonance frequency for the second set of low frequency vibration elimination. The setting method is the same as the first set of vibration elimination (P1.089).

P1.093	Vibration elimination 2 - resonance frequency		Address: 01BAH 01BBH
Default:	4000	Control mode:	PT / PR
Unit:	0.1 Hz	Setting range:	10 to 4000
Format:	DEC	Data size:	16-bit

Settings:

Resonance frequency for the second set of low frequency vibration elimination.

P1.094	Vibration elimination 2 - resonance difference		Address: 01BCH 01BDH
Default:	10	Control mode:	PT / PR
Unit:	0.1 dB	Setting range:	10 to 4000
Format:	DEC	Data size:	16-bit

Settings:

Attenuation rate for the second set of low frequency vibration elimination.

P1.095 - P1.096	Reserved

8

P1.097▲	Encoder output denominator (OA, OB)		Address: 01C2H 01C3H
Default:	0	Control mode:	All
Unit:	-	Setting range:	0 to 160000
Format:	DEC	Data size:	32-bit

Settings:

1. When P1.074.Y = 0 (output source is from the encoder connected to CN2):
   - When P1.097 = 0, OA / OB pulse output refers to the setting of P1.046. (Refer to Example 1.)
   - When P1.097 ≠ 0, OA / OB pulse output refers to the settings of P1.046 and P1.097. (Refer to Example 2.)
2. When P1.074.Y = 2 (output source is the pulse command from CN1):
   - When P1.097 = 0, OA / OB pulse output does not refer to the setting of P1.046, but outputs according to the ratio of 1:1 instead.
   - When P1.097 ≠ 0, OA / OB pulse output refers to the settings 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, indicating OA / OB outputs P1.046 * 4 = 10,000 pulses when the motor rotates 1 cycle.

Example 2 (the calculated value does not need to be multiplied by 4 times the frequency):

When P1.097 = 7 and P1.046 = 2500, indicating OA / OB outputs 2,500 pulses when the motor rotates 7 cycles.

P1.098	Disconnection detection protection (UVW) response time		Address: 01C4H 01C5H
Default:	0	Control mode:	All
Unit:	ms	Setting range:	0, 100 to 800
Format:	DEC	Data size:	16-bit

Settings:

When the switch for motor power cable disconnection detection (ALC31) is enabled (P2.065 [Bit 9] = 1), set the detection response time with this parameter.

Set P1.098 to 0 to use the servo's default response time (800 ms).

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

8

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 P0.003 (Analog output monitoring) to 0x0006, then the analog monitor output voltage refers to the voltage value of P1.101.

Note: the valid setting range of P1.101 is -8V to +8V.

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 P0.003 (Analog output monitoring) to 0x0007, then the analog monitor output voltage refers to the voltage value of P1.102.

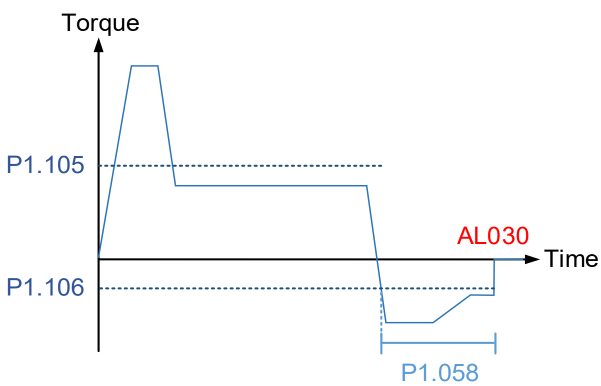
Note: the valid setting range of P1.102 is -8V to +8V.

P1.103 - P1.104	Reserved

P1.105	Motor hard stop 2 - torque upper limit		Address: 01D2H 01D3H
Default:	0	Control mode:	All
Unit:	%	Setting range:	-300 to +300
Format:	DEC	Data size:	16-bit

Settings:

When Motor hard stop 2 is enabled (P2.112 [Bit [8]]= 1), the settings of torque percentage (P1.057) and level offset (P1.060) for Motor hard stop 1 are invalid. During motor operation, if the motor torque is higher than this protection setting value and the duration of this condition exceeds the protection time (P1.058), AL030 will be triggered.



8

P1.106	Motor hard stop 2 - torque lower limit		Address: 01D4H 01D5H
Default:	0	Control mode:	All
Unit:	%	Setting range:	-300 to +300
Format:	DEC	Data size:	16-bit

Settings:

When Motor hard stop 2 is enabled (P2.112 [Bit [8]]= 1), the settings of torque percentage (P1.057) and level offset (P1.060) for Motor hard stop 1 are invalid. During motor operation, if the motor torque is lower than this protection setting value and the duration of this condition exceeds the protection time (P1.058), AL030 will be triggered.

P1.107 - P1.110	Reserved

P1.111	Overspeed protection level		Address: 01DEH 01DFH
Default:	Maximum motor speed x 1.1	Control mode:	All
Unit:	1 rpm	Setting range:	0 to 66000
Format:	DEC	Data size:	32-bit

Settings:

This function is to protect the motor from overspeeding, which can be applied to all control modes. When the filtered motor speed exceeds this set speed, AL056 occurs.

P1.112■	Single-direction torque limit		Address: 01E0H 01E1H
Default:	500	Control mode:	All
Unit:	%	Setting range:	-500 to +500
Format:	DEC	Data size:	16-bit

Settings:

Refer to the description of P4.044 for more details.

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P2.xxx Extension parameters

P2.000	Position proportional gain		Address: 0200H 0201H
Default:	35	Control mode:	PT / PR
Unit:	rad/s	Setting range:	0 to 2047
Format:	DEC	Data size:	16-bit

Settings:

Increasing the position proportional 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	Rate of change for position control gain		Address: 0202H 0203H
Default:	100	Control mode:	PT / PR
Unit:	%	Setting range:	10 to 500
Format:	DEC	Data size:	16-bit

Settings:

Adjust the rate of change for the position proportional gain (P2.000) 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 to 100
Format:	DEC	Data size:	16-bit

Settings:

If the position control command changes smoothly, increasing the gain value can reduce the position following errors. If the position control command does not change smoothly, decreasing the gain value can reduce the mechanical vibration.

P2.003	Position feed forward gain smoothing constant		Address: 0206H 0207H
Default:	5	Control mode:	PT / PR
Unit:	ms	Setting range:	2 to 100
Format:	DEC	Data size:	16-bit

Settings:

If the position control command changes smoothly, decreasing the smoothing constant value can reduce the position following errors. If the position control command does not change smoothly, increasing the smoothing constant value can reduce the mechanical vibration.

P2.004	Speed proportional gain		Address: 0208H 0209H
Default:	500	Control mode:	All
Unit:	rad/s	Setting range:	0 to 8191
Format:	DEC	Data size:	16-bit

Settings:

Increasing the speed proportional gain can enhance the speed response. If you set the value too high, it may cause vibration and noise.

P2.005	Rate of change for speed control gain		Address: 020AH 020BH
Default:	100	Control mode:	All
Unit:	%	Setting range:	10 to 500
Format:	DEC	Data size:	16-bit

Settings:

Adjust the rate of change for the speed proportional gain (P2.004) 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 to 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 to 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 the speed control command does not change smoothly, decreasing the gain value can reduce the mechanical vibration.

P2.008■	Special parameter write-in function		Address: 0210H 0211H
Default:	0	Control mode:	All
Unit:	-	Setting range:	0 to 501
Format:	DEC	Data size:	16-bit

Settings:

Code	Function
10	Reset parameter groups P0 - P7 (cycle the power after reset).
20	P4.010 is writable.
22	P4.011 - P4.021 are writable.
30, 35	Save Capture data.
271	First set P2.069.X to 1 and cycle power on the servo drive to enable the absolute function. Then, set P2.008 to 271 and P2.071 to 0x0001 to establish the absolute origin.
406	Enable forced DO mode.
400	When forced DO mode is enabled, switch back to the normal DO mode.

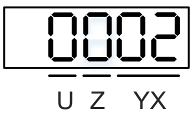
P2.009	DI response filter time		Address: 0212H 0213H
Default:	2	Control mode:	All
Unit:	ms	Setting range:	0 to 100
Format:	DEC	Data size:	16-bit

Settings:

When environmental interference is high, increasing this value can enhance the control stability. If you set the value too high, it affects the response time.

P2.010	DI1 functional planning		Address: 0214H 0215H
Default:	0x0101 (-L) 0x0100 (-F, -E, -M, -P)	Control mode:	All
Unit:	-	Setting range:	0x0000 to 0x015F (last two codes are DI codes)
Format:	HEX	Data size:	16-bit

Settings:



YX	Input function selection	Z	Input contact: A or B contact
-	-	U	Reserved

- ■ YX: input function selection

  Refer to Table 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)

When these parameters are modified, cycle power on the servo drive to ensure they function normally. Use P3.006 to change the source for the digital input signal, which can be either an external terminal block or the parameter P4.007.

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P2.011	DI2 functional planning		Address: 0216H 0217H
Default:	0x0104 (-L) 0x0022 (-F, -E, -M, -P)	Control mode:	All
Unit:	-	Setting range:	0x0000 to 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 (-L) 0x0023 (-F, -E, -M, -P)	Control mode:	All
Unit:	-	Setting range:	0x0000 to 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 (-L) 0x0021 (-F, -E, -M, -P)	Control mode:	All
Unit:	-	Setting range:	0x0000 to 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 (-L) 0x0100 (-F, -E, -M, -P)	Control mode:	All
Unit:	-	Setting range:	0x0000 to 0x015F (last two codes are DI codes)
Format:	HEX	Data size:	16-bit

Settings:

Refer to the description of P2.010. There is no physical pin for DI5 on -F, -E, and -M models. DI5 is a virtual digital input which you can use when the number of physical DI points is insufficient and trigger through communication. You can set the DI to be used as soon as the servo power is on (e.g. DI.SON) to be a virtual DI and normally closed.

P2.015	DI6 functional planning		Address: 021EH 021FH
Default:	0x0022 (-L) 0x0100 (-F, -E, -M, -P)	Control mode:	All
Unit:	-	Setting range:	0x0000 to 0x015F (last two codes are DI codes)
Format:	HEX	Data size:	16-bit

Settings:

Refer to the description of P2.010. There is no physical pin for DI6 on -F, -E, and -M models. DI6 is a virtual digital input which you can use when the number of physical DI points is insufficient and trigger through communication. You can set the DI to be used as soon as the servo power is on (e.g. DI.SON) to be a virtual DI and normally closed.

P2.016	DI7 functional planning		Address: 0220H 0221H
Default:	0x0023 (-L) 0x0100 (-F, -E, -M, -P)	Control mode:	All
Unit:	-	Setting range:	0x0000 to 0x015F (last two codes are DI codes)
Format:	HEX	Data size:	16-bit

Settings:

Refer to the description of P2.010. There is no physical pin for DI7 on -F, -E, -M, and -P models. DI7 is a virtual digital input which you can use when the number of physical DI points is insufficient and trigger through communication. You can set the DI to be used as soon as the servo power is on (e.g. DI.SON) to be a virtual DI and normally closed.

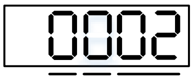
P2.017	DI8 functional planning		Address: 0222H 0223H
Default:	0x0021 (-L) 0x0100 (-F, -E, -M, -P)	Control mode:	All
Unit:	-	Setting range:	0x0000 to 0x015F (last two codes are DI codes)
Format:	HEX	Data size:	16-bit

Settings:

Refer to the description of P2.010. There is no physical pin for DI8 on -F, -E, -M, and -P models. DI8 is a virtual digital input which you can use when the number of physical DI points is insufficient and trigger through communication. You can set the DI to be used as soon as the servo power is on (e.g. DI.SON) to be a virtual DI and normally closed.

P2.018	DO1 functional planning		Address: 0224H 0225H
Default:	0x0101	Control mode:	All
Unit:	-	Setting range:	0x0000 to 0x014F (last two codes are DO codes)
Format:	HEX	Data size:	16-bit

Settings:



U Z YX

YX	Output function selection	Z	Output contact: A or B contact
-	-	U	Reserved

- 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).

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 (-L) 0x0100 (-F, -E, -M, -P)	Control mode:	All
Unit:	-	Setting range:	0x0000 to 0x014F (last two codes are DO codes)
Format:	HEX	Data size:	16-bit

Settings:

Refer to the description of P2.018.

P2.020	DO3 functional planning		Address: 0228H 0229H
Default:	0x0109 (-L) 0x0100 (-F, -E, -M, -P)	Control mode:	All
Unit:	-	Setting range:	0x0000 to 0x014F (last two codes are DO codes)
Format:	HEX	Data size:	16-bit

Settings:

Refer to the description of P2.018.

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P2.021	DO4 functional planning		Address: 022AH 022BH
Default:	0x0105 (-L) 0x0100 (-F, -E, -M, -P)	Control mode:	All
Unit:	-	Setting range:	0x0000 to 0x014F (last two codes are DO codes)
Format:	HEX	Data size:	16-bit

Settings:

Refer to the description of P2.018.

P2.022	DO5 functional planning		Address: 022CH 022DH
Default:	0x0007 (-L) 0x0100 (-F, -E, -M, -P)	Control mode:	All
Unit:	-	Setting range:	0x0000 to 0x014F (last two codes are DO codes)
Format:	HEX	Data size:	16-bit

Settings:

Refer to the description of P2.018.

P2.023	Notch filter 1 - frequency		Address: 022EH 022FH
Default:	5000	Control mode:	All
Unit:	Hz	Setting range:	50 to 5000
Format:	DEC	Data size:	16-bit

Settings:

The resonance frequency of the first notch filter. This function is disabled if P2.024 is 0. P2.023, P2.024, and P2.095 are the first set of notch filter parameters.

P2.024	Notch filter 1 - attenuation level		Address: 0230H 0231H
Default:	0	Control mode:	All
Unit:	-dB	Setting range:	0 to 40
Format:	DEC	Data size:	16-bit

Settings:

The attenuation level of the first notch filter. For example, a value of 5 indicates -5 dB. Set this parameter to 0 to disable the first notch filter.

P2.025	Resonance suppression low-pass filter			Address: 0232H 0233H
Operation interface:	Panel / software	Communication	Control mode:	All
Default:	1.0	10	Data size:	16-bit
Unit:	1 ms	0.1 ms	-	-
Setting range:	0.0 to 100.0	0 to 1000	-	-
Format:	One decimal	DEC	-	-
Example:	1.5 = 1.5 ms	15 = 1.5 ms	-	-

Settings:

Sets 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 to 1023
Format:	DEC	Data size:	16-bit

Settings:

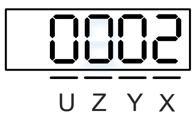
Increasing this parameter can increase the damping of the speed loop and reduce the speed loop response. Setting the value of P2.026 to the same value of P2.006 is recommended. See the following for setting P2.026:

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: the setting of this gain parameter is invalid when the two degree of freedom 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 to 0x0018
Format:	HEX	Data size:	16-bit

Settings:



X	Gain switching condition	Z	Reserved
Y	Gain switching method	U	Reserved

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- X: gain switching condition

X	Condition	Control mode	P1.078 (Gain switching delay time)
0	Disable gain switching function.	-	-
1	Signal of gain switching (DI.GAINUP: 0x03) is on.	All	-
2	In Position control mode, position error (P0.002 = 33) is larger than P2.029.	PT/ PR	-
3	Position command frequency (P0.002 = 6) is larger than P2.029.	PT/ PR	Supported
4	Motor speed (P0.002 = 51) is faster than P2.029.	All	-
5	Signal of gain switching (DI.GAINUP: 0x03) is off.	All	-
6	In Position control mode, position error (P0.002 = 33) is smaller than P2.029.	PT/ PR	-
7	Position command frequency (P0.002 = 6) is smaller than P2.029.	PT/ PR	Supported
8	Motor speed (P0.002 = 51) is slower than P2.029.	All	-

- Y: gain switching method

  0: gain rate switching

  1: integrator switching (switch from P controller to PI controller)

Setting value	Control mode P	Control mode S	Gain switching
0	P2.000 x 100%	-	Before switching
	P2.004 x 100%	P2.004 x 100%	
	P2.006 x 100%	P2.006 x 100%	
	P2.025 x 100%	P2.025 x 100%	
	P2.026 x 100%	P2.026 x 100%	
	P2.049 x 100%	P2.049 x 100%	
	P2.000 x P2.001	-	After switching
	P2.004 x P2.005	P2.004 x P2.005	
	P2.006 x 100%	P2.006 x 100%	
	P2.025 x P2.107	P2.025 x P2.107	
	P2.026 x 100%	P2.026 x 100%	
	P2.049 x P1.080	P2.049 x P1.080	
1	P2.000 x 100%	-	Before switching
	P2.004 x 100%	P2.004 x 100%	
	P2.006 x 0%	P2.006 x 0%	
	P2.025 x 100%	P2.025 x 100%	
	P2.026 x 0%	P2.026 x 0%	
	P2.049 x100%	P2.049 x100%	
	P2.000 x P2.001	-	After switching
	P2.004 x 100%	P2.004 x 100%	
	P2.006 x 100%	P2.006 x 100%	
	P2.025 x P2.107	P2.025 x P2.107	
	P2.026 x 100%	P2.026 x 100%	
	P2.049 x P1.080	P2.049 x P1.080	

Note: the parameters marked with different colors in the preceding table are the differences between Y = 0 and Y = 1.

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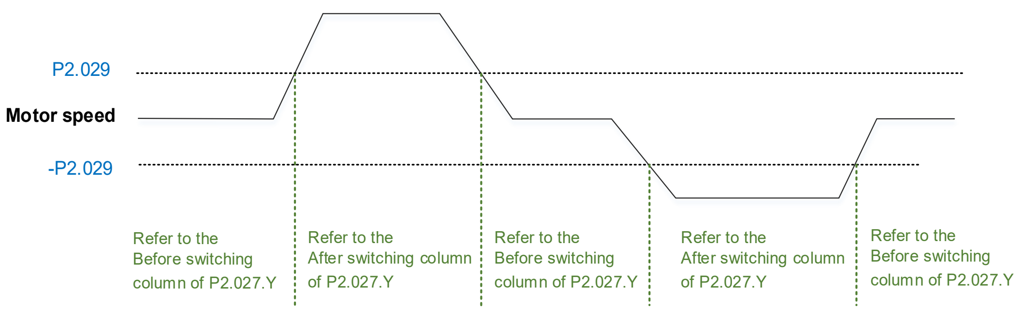
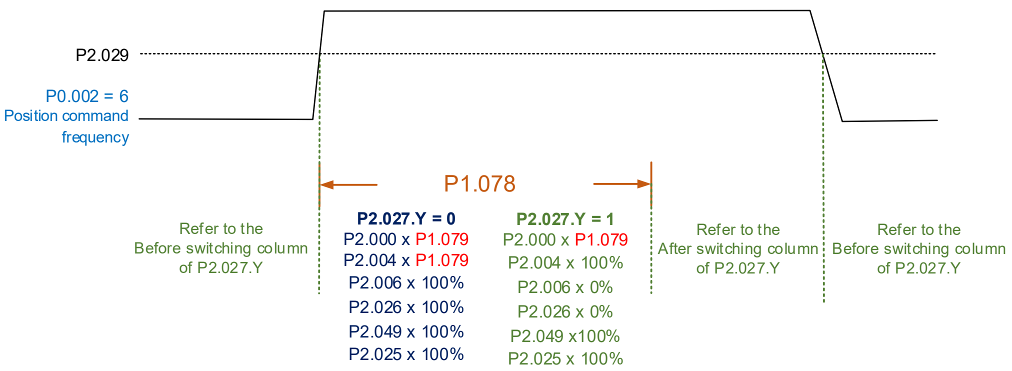
When P2.027.X is set to 0, 1, 2, 4, 5, 6, or 8, P1.078 (Gain switching delay time) is not supported. P2.027.X = 4 is taken as the example in the following figure.

P2.027.X = 4

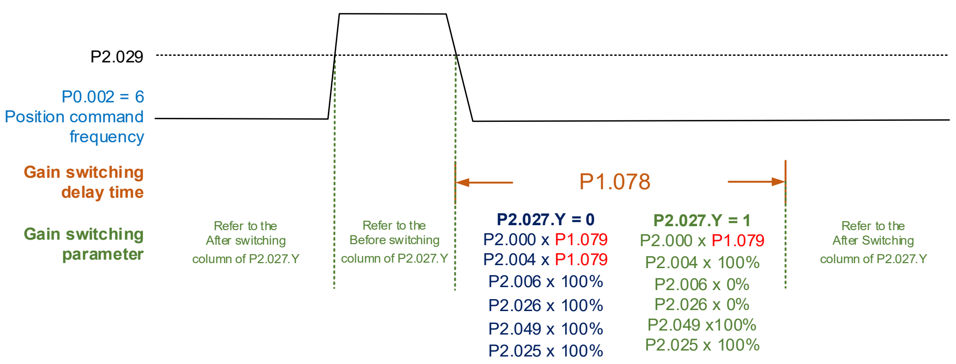


When P2.027.X is set to 3 or 7 and P1.078 (Gain switching delay time) is set, the gain parameter during the delay time is adjusted as follows.

P2.027.X = 3



P2.027.X = 7



P2.028	Gain switching time constant		Address: 0238H 0239H
Default:	10	Control mode:	Refer to P2.027.X: gain switching condition
Unit:	ms	Setting range:	0 to 1000
Format:	DEC	Data size:	16-bit

Settings:

Smoothes the speed of gain switching (P2.027). Set this parameter to 0 to disable this function.

P2.029	Gain switching condition		Address: 023AH 023BH
Default:	16777216	Control mode:	Refer to P2.027.X: gain switching condition
Unit:	pulse; Kpps; rpm	Setting range:	0 to 50331648
Format:	DEC	Data size:	32-bit

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Settings:

The unit of this setting value is determined by the selection of gain switching condition (P2.027.X).

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 to 4	Reserved.
5	This setting makes all parameter settings volatile. When there is no need to permanently save the data continually written through the panel or communication, this setting can avoid shortening the lifetime of the EEPROM from continuous writing. You must use this function when using communication control.
6	This setting enables command simulation mode. In this mode, use the **Digital IO** function in ASDA-Soft to switch the servo to the Servo On state as both the external Servo On signal and the force Servo On of the PR mode in ASDA-Soft cannot work, the error code of the servo drive (monitoring variable 0x6F) is read as 0, and P0.001 only shows part of the error codes (such as positive / negative limit, emergency stop). When DO.SRDY is on, commands are accepted in each mode. You can use the **Scope** function in ASDA-Soft to observe these commands to examine their accuracy, but the motor does not operate.
7	Reserved.
8	Back up all current parameter values to EEPROM, so that the values are retained after power cycling. The panel displays ‘to.rom’ during execution. This feature can also be executed when servo is in the Servo On state.
-1, -5, -6	Respectively disable the functions of setting values 1, 5, and 6.
-2 to -4, -7, -8	Reserved.

Note: set this parameter to 0 during normal operation. The value returns to 0 automatically after power cycling of the servo drive.

P2.031	Bandwidth response level		Address: 023EH 023FH
Default:	19	Control mode:	All
Unit:	-	Setting range:	1 to 50
Format:	DEC	Data size:	16-bit

Settings:

In gain adjustment mode (P2.032), adjust the servo bandwidth with the bandwidth response level parameter (P2.031). When you increase the bandwidth response level (P2.031), the servo bandwidth increases as well. Refer to Chapter 5 for adjustment details.

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P2.032	**Gain adjustment mode**		**Address: 0240H 0241H**
Default:	0x0000	Control mode:	All
Unit:	-	Setting range:	0x0000 to 0x0006
Format:	HEX	Data size:	16-bit

Settings:

The servo drive provides the following gain adjustment modes for fine tuning. You can then easily complete tuning by increasing or decreasing the bandwidth response level (P2.031).

Recommendations for tuning the machine are in Section 5.1.

Value	Adjustment mode	Inertia estimation	Parameter	
			Manual	Auto
0	Manual	Fixed set value of P1.037	P1.037, P2.000, P2.004, P2.006, P2.023, P2.024, P2.025, P2.043, P2.044, P2.045, P2.046, P2.049, P2.089, P2.098, P2.099, P2.101, P2.102	N/A
1	Gain adjustment mode 1	Real-time estimation	P2.031	P1.037, P2.000, P2.004, P2.006, P2.023, P2.024, P2.025, P2.043, P2.044, P2.045, P2.046, P2.049, P2.089, P2.098, P2.099, P2.101, P2.102
2	Gain adjustment mode 2	Fixed set value of P1.037	P1.037 P2.031	P2.000, P2.004, P2.006, P2.023, P2.024, P2.025, P2.043, P2.044, P2.045, P2.046, P2.049, P2.089, P2.098, P2.099, P2.101, P2.102
3	Gain adjustment mode 3 (only when the two degree of freedom control function is enabled)	Fixed set value of P1.037	P1.037 P2.031 P2.089	P2.000, P2.004, P2.006, P2.023, P2.024, P2.025, P2.043, P2.044, P2.045, P2.046, P2.049, P2.098, P2.099, P2.101, P2.102
4	Gain adjustment mode 4	Reset to gain default value		
5	Gain adjustment mode 5 (same as setting P2-32 to 1 for B2 series)	Real-time estimation, the value is updated to P1.037 every 30 minutes	P2.126	P1.037, P2.000, P2.004, P2.006, P2.023, P2.024, P2.025, P2.043, P2.044, P2.045, P2.046, P2.049, P2.089, P2.094, P2.098, P2.099, P2.101, P2.102
6	Gain adjustment mode 6 (same as setting P2-32 to 2 for B2 series)	Fixed set value of P1.037	P1.037 P2.126	P2.000, P2.004, P2.006, P2.023, P2.024, P2.025, P2.043, P2.044, P2.045, P2.046, P2.049, P2.089, P2.094, P2.098, P2.099, P2.101, P2.102

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

P2.033	**Reserved**

P2.034	Excessive deviation warning condition of Speed command		Address: 0244H 0245H
Default:	5000	Control mode:	S / Sz
Unit:	rpm	Setting range:	1 to 30000
Format:	DEC	Data size:	16-bit

Settings:

In Speed mode, this parameter sets the acceptable difference between the command speed and the speed feedback. If the difference is greater than this value, AL007 occurs.

Note: when P2.094 [Bit 6] = 1, this parameter is available in both Position mode (PT, PR) and Speed mode (S, Sz).

P2.035	Excessive deviation warning condition of Position command		Address: 0246H 0247H
Default:	50331648	Control mode:	PT / PR
Unit:	pulse	Setting range:	1 to 1677721600
Format:	DEC	Data size:	32-bit

Settings:

In Position mode, this parameter sets the acceptable difference between the command position and the position feedback. If the difference is greater than this value, AL009 occurs.

P2.036	DI9 functional planning		Address: 0248H 0249H
Default:	0x0100	Control mode:	All
Unit:	-	Setting range:	0x0000 to 0x015F (last two codes are DI codes)
Format:	HEX	Data size:	16-bit

Settings:

Refer to the description of P2.010. If there is no physical pin for DI9 on the model, use DI9 as a virtual digital input when the number of physical DI points is insufficient or a trigger through communication. You can set the DI to be used as soon as the servo power is on (e.g. Servo On) to be a virtual DI and normally closed.

P2.037	DI10 functional planning		Address: 024AH 024BH
Default:	0x0100	Control mode:	All
Unit:	-	Setting range:	0x0000 to 0x015F (last two codes are DI codes)
Format:	HEX	Data size:	16-bit

Settings:

Refer to the description of P2.010. If there is no physical pin for DI10 on the model, use DI10 as a virtual digital input when the number of physical DI points is insufficient or a trigger through communication. You can set the DI to be used as soon as the servo power is on (e.g. Servo On) to be a virtual DI and normally closed.

8

P2.038	DI11 functional planning		Address: 024CH 024DH
Default:	0x0100	Control mode:	All
Unit:	-	Setting range:	0x0000 to 0x015F (last two codes are DI codes)
Format:	HEX	Data size:	16-bit

Settings:

Refer to the description of P2.010. If there is no physical pin for DI11 on the model, use DI11 as a virtual digital input when the number of physical DI points is insufficient or a trigger through communication. You can set the DI to be used as soon as the servo power is on (e.g. Servo On) to be a virtual DI and normally closed.

P2.039	DI12 functional planning		Address: 024EH 024FH
Default:	0x0100	Control mode:	All
Unit:	-	Setting range:	0x0000 to 0x015F (last two codes are DI codes)
Format:	HEX	Data size:	16-bit

Settings:

Refer to the description of P2.010. If there is no physical pin for DI12 on the model, use DI12 as a virtual digital input when the number of physical DI points is insufficient or a trigger through communication. You can set the DI to be used as soon as the servo power is on (e.g. Servo On) to be a virtual DI and normally closed.

P2.040	DI13 functional planning		Address: 0250H 0251H
Default:	0x0100	Control mode:	All
Unit:	-	Setting range:	0x0000 to 0x015F (last two codes are DI codes)
Format:	HEX	Data size:	16-bit

Settings:

Refer to the description of P2.010. If there is no physical pin for DI13 on the model, use DI13 as a virtual digital input when the number of physical DI points is insufficient or a trigger through communication. You can set the DI to be used as soon as the servo power is on (e.g. Servo On) to be a virtual DI and normally closed.

P2.041	DO6 functional planning		Address: 0252H 0253H
Default:	0x0100	Control mode:	All
Unit:	-	Setting range:	0x0000 to 0x014F (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 2 - frequency		Address: 0256H 0257H
Default:	5000	Control mode:	All
Unit:	Hz	Setting range:	50 to 5000
Format:	DEC	Data size:	16-bit

Settings:

The resonance frequency of the second notch filter. This function is disabled if P2.044 is 0.

P2.043, P2.044, and P2.096 are the second set of notch filter parameters.

P2.044	Notch filter 2 - attenuation level		Address: 0258H 0259H
Default:	0	Control mode:	All
Unit:	-dB	Setting range:	0 to 40
Format:	DEC	Data size:	16-bit

Settings:

The attenuation level of the second notch filter. A value of 5 indicates -5 dB. Set this parameter to 0 to disable the second notch filter.

P2.045	Notch filter 3 - frequency		Address: 025AH 025BH
Default:	5000	Control mode:	All
Unit:	Hz	Setting range:	50 to 5000
Format:	DEC	Data size:	16-bit

Settings:

The resonance frequency of the third notch filter. This function is disabled if P2.046 is 0.

P2.045, P2.046, and P2.097 are the third set of notch filter parameters.

P2.046	Notch filter 3 - attenuation level		Address: 025CH 025DH
Default:	0	Control mode:	All
Unit:	-dB	Setting range:	0 to 40
Format:	DEC	Data size:	16-bit

Settings:

The attenuation level of the third notch filter. A value of 5 indicates -5 dB. Set this parameter to 0 to disable the third notch filter.

P2.047	Auto resonance suppression mode		Address: 025EH 025FH
Default:	0x0001	Control mode:	All
Unit:	-	Setting range:	0x0000 to 0x21F2
Format:	HEX	Data size:	16-bit

Settings:

0000

U Z Y X

X	Auto resonance suppression function	Z	Fixed resonance suppression parameter
Y	Fixed resonance suppression parameter	U	Auto resonance suppression method selection

- 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 to EEPROM (non-volatile memory for parameters) and disables the auto resonance suppression function (X = 0). Before the servo is stable,

  (1) If you cycle power on the servo drive, the found resonance suppression points are lost and will not be saved. The servo searches for the resonance suppression points again.

  (2) If you switch the setting of X from 1 to 0, the known resonance suppression points will be stored to EEPROM.

  (3) If you keep the setting of X as 1, the known resonance suppression points will not be cleared, but they are not written to EEPROM yet. They are written to EEPROM when the servo determines it is stable.

  2: auto resonance suppression mode 2; when the servo determines it is stable*[2], the servo stores the known resonance suppression points to EEPROM (non-volatile memory for parameters). In this mode, the searching cycle continues until the 5 sets of resonance suppression parameters are set, and then the auto resonance suppression function is disabled (X = 0). Before the servo is stable,

  (1) If you cycle power on the servo drive, the resonance suppression points that are not yet stored in EEPROM are lost and will not be saved. The resonance suppression points that have been stored to EEPROM will not be affected.

  (2) If you switch the setting of X from 2 to 0, the known resonance suppression points will be stored to EEPROM.

  (3) If you keep the setting of X as 2, the known resonance suppression points will not be cleared, but they are not written to EEPROM yet. They are written to EEPROM when the servo determines it is stable.

Note:

1. If you switch the setting of X from 0 to 1 or 2, the unfixed notch filter is automatically cleared, the frequency is set to 1,000 Hz, and the suppression level is set to 0 dB.
2. The servo determines it is stable when the following conditions are met: resonances have been suppressed, no other interference that affects the operation is found, and the motor speed is maintained at above 10 rpm for 3 minutes.

8

- Y: fixed resonance suppression parameter

  In auto resonance suppression mode, you can set the resonance suppression parameters manually by setting P2.047.Y.

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

Bit	Function	Description
4	Notch 1 auto / manual setting	0: auto resonance suppression 1: manually set the first set of resonance suppression parameters
5	Notch 2 auto / manual setting	0: auto resonance suppression 1: manually set the second set of resonance suppression parameters
6	Notch 3 auto / manual setting	0: auto resonance suppression 1: manually set the third set of resonance suppression parameters
7	Notch 4 auto / manual setting	0: auto resonance suppression 1: manually set the fourth set of resonance suppression parameters

- Z: fixed resonance suppression parameter

  In auto resonance suppression mode, you can set the resonance suppression parameters manually by setting P2.047.Z.

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

Bit	Function	Description
8	Notch 5 auto / manual setting	0: auto resonance suppression 1: manually set the fifth set of resonance suppression parameters
9 - 11	Reserved	-

Example: if P2.047 = 0x0021, the auto resonance suppression function is enabled, and the servo searches for the point of resonance and suppresses it. When you set Y to 2, you manually set the second set of resonance suppression parameters. Then, if the servo finds 2 resonance points, it writes the data of the 1st point to the 1st set of resonance suppression parameters and the data of the 2nd point to the 3rd set of resonance suppression parameters. That is, it skips the 2nd set of parameters.

- U: auto resonance suppression method selection

  0: quick auto resonance suppression; up to 5 sets of notch filters are available.

  2: slow but stable auto resonance suppression; up to 2 sets of notch filters are available (same setting as A2 / B2 series)

  Note: when U = 2, P2.047.ZY is automatically set to 1C, which force disables the auto resonance function of notch filters 3 - 5. In this case, you can manually set the resonance point.

P2.048	Auto resonance detection level		Address: 0260H 0261H
Default:	100	Control mode:	All
Unit:	-	Setting range:	0 to 1000
Format:	DEC	Data size:	16-bit

Settings:

If P2.048 is larger, the resonance sensitivity is lower; on the other hand, if P2.048 is smaller, the resonance sensitivity is higher.

8

P2.049	Speed detection filter and jitter suppression			Address: 0262H 0263H
Operation interface:	Panel / software	Communication	Control mode:	All
Default:	1.0	10	Data size:	16-bit
Unit:	1 ms	0.1 ms	-	-
Setting range:	0.0 to 100.0	0 to 1000	-	-
Format:	One decimal	DEC	-	-
Example:	1.5 = 1.5 ms	15 = 1.5 ms	-	-

Settings:

Sets the filter for speed detection. 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, and thus makes the system unstable.

P2.050	Position error clear setting		Address: 0264H 0265H
Default:	0x0000	Control mode:	PT, PR
Unit:	-	Setting range:	0x0000 to 0x0001
Format:	HEX	Data size:	16-bit

Settings:

Refer to Table 8.1 for digital input descriptions. Set the digital input as CCLR (DI: 0x04) to enable this function. When DI.CCLR is on, the position error in the servo drive is reset to 0.

When P2.050 = 0, DI.CCLR is rising-edge triggered.

When P2.050 = 1, DI.CCLR is level triggered.

P2.051	Reserved

P2.052▲	Rotary axis position scale		Address: 0268H 0269H
Default:	1073741824	Control mode:	All
Unit:	PUU	Setting range:	32 to 1073741824
Format:	DEC	Data size:	32-bit

Settings:

Sets the scale of the rotary axis position, rotary axis command position, and rotary axis position feedback. If the value is too small, it may cause errors in the rotary axis position system.

The input range of P2.052 is:

$$\text{P2.052} > 1.05 \times \text{Maximum motor speed (rpm)} \times \frac{16777216}{60000} \times \frac{\text{P1.045}}{\text{P1.044}}$$

P2.053	Position integral compensation		Address: 026AH 026BH
Default:	0	Control mode:	All
Unit:	rad/s	Setting range:	0 to 1023
Format:	DEC	Data size:	16-bit

8

Settings:

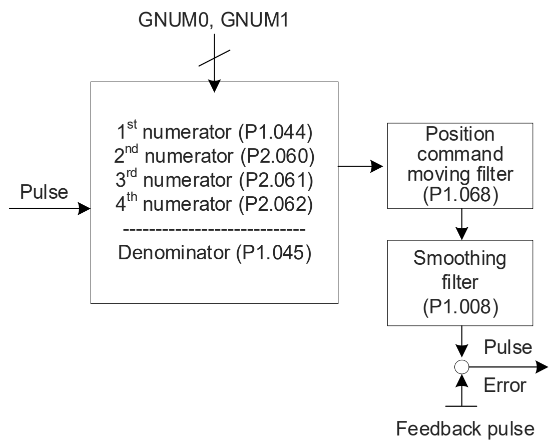
Increase the position control integral compensation to reduce the position steady-state errors. If the value is too high, it may cause position overshoot and noise.

P2.054 - P2.059	Reserved

P2.060	E-Gear ratio - numerator N2		Address: 0278H 0279H
Default:	16777216	Control mode:	All
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 the numerator 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:	All
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:	All
Unit:	pulse	Setting range:	1 to (2^{29}-1)
Format:	DEC	Data size:	32-bit

Settings:

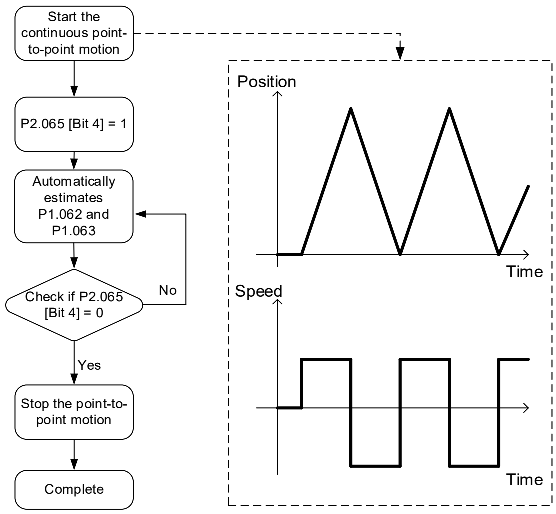
Refer to the description of P2.060.

P2.063 - P2.064	Reserved

P2.065	Special bit register 1		Address: 0282H 0283H
Default:	0x0300	Control mode:	PT / PR / S / Sz
Unit:	-	Setting range:	0x0000 to 0xFFFF
Format:	HEX	Data size:	-

Settings:

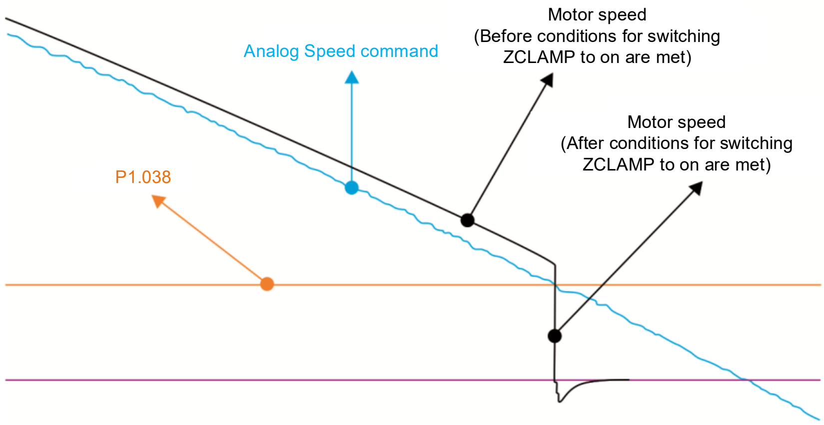
Bit	7	6	5	4	3	2	1	0
Bit	15	14	13	12	11	10	9	8

<table>
<tr><th>Bit</th><th>Function</th><th>Description</th></tr>
<tr><td>Bit 0 - Bit 3</td><td>Reserved</td><td>-</td></tr>
<tr><td>Bit 4</td><td>Automatic friction estimation</td><td>After enabling this function, you must conduct the continuous point-to-point motion to automatically write the estimated values to P1.062 and P1.063.
0: disable the function.
1: enable the function.

</td></tr>
<tr><td>Bit 5</td><td>Switch for AL003 (Undervoltage) and AL022 (RST power error) in Servo Off status</td><td>0: when the servo is off, disable the detection for AL003 (Undervoltage) and AL022 (RST power error).
1: when the servo is off, enable the detection for AL003 (Undervoltage) and AL022 (RST power error).</td></tr>
<tr><td>Bit 6</td><td>Pulse error (pulse frequency is too high) protection function in PT mode</td><td>0: enable the function.
1: disable the function.</td></tr>
<tr><td>Bit 7</td><td>Reserved</td><td>-</td></tr>
<tr><td>Bit 8</td><td>Switch for motor power cable wiring error detection (AL031)</td><td>0: disable the detection.
1: enable the detection.</td></tr>
</table>

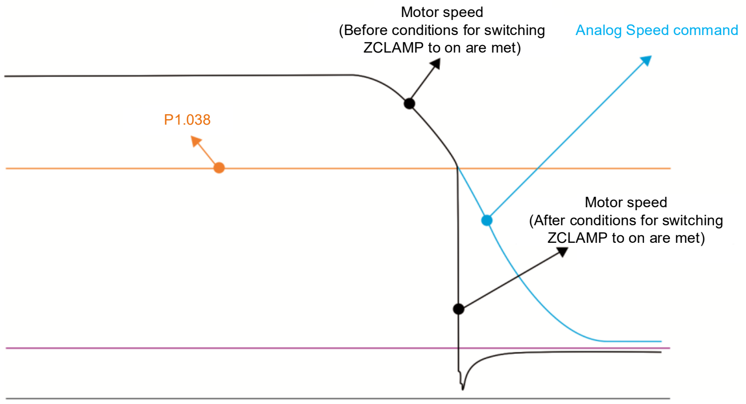
Bit	Function	Description
Bit 9	Switch for motor power cable disconnection detection (ALC31)	0: disable the detection. 1: enable the detection.
Bit 10	ZCLAMP function selection	The ZCLAMP function is enabled when all the following conditions are met. Condition 1: Speed mode Condition 2: DI.ZCLAMP is on Condition 3: motor speed is slower than the value of P1.038

8

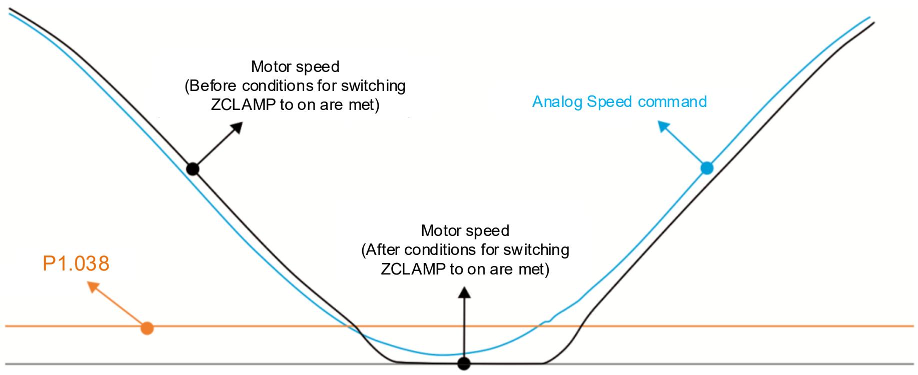
Bit 10 description
Bit 10 = 0 and command source is the analog voltage. The ZCLAMP function uses the analog Speed command without acceleration or deceleration to determine if this function should be enabled. The motor is clamped at the position where ZCLAMP conditions are met.



Bit 10 = 0 and command source is the internal register. The ZCLAMP function uses the register Speed command with acceleration or deceleration to determine if this function should be enabled. The motor is clamped at the position where ZCLAMP conditions are met.

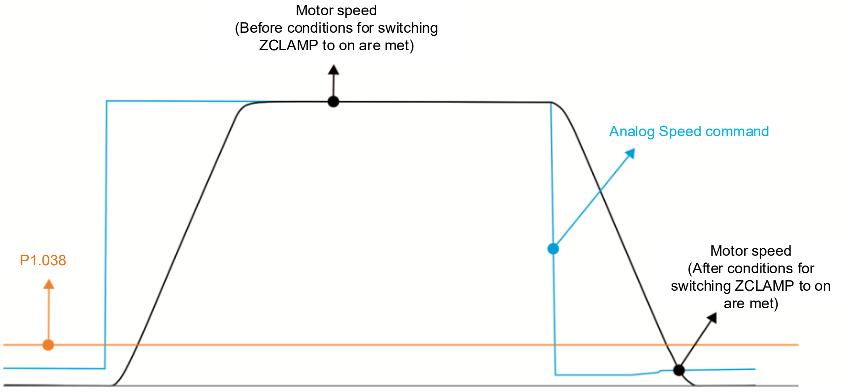


Bit 10 = 1 and command source is the analog voltage. The ZCLAMP function uses the analog Speed command without acceleration or deceleration to determine if this function should be enabled. When ZCLAMP conditions are met, the motor speed decelerates to 0 rpm by S-curve deceleration. If ZCLAMP conditions are not met, the motor follows the analog Speed command through the S-curve.

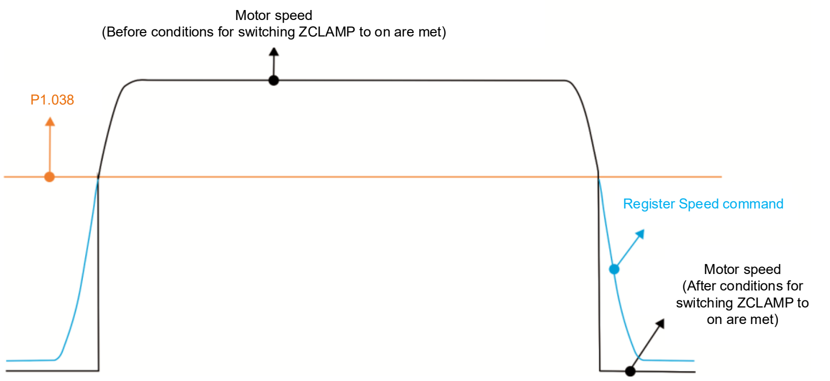


8

Bit 10 description



Bit 10 = 1 and command source is the internal register. The ZCLAMP function uses the register Speed command with acceleration or deceleration to determine if this function should be enabled. When ZCLAMP conditions are met, the motor speed is set to 0 rpm.



Bit	Function	Description
Bit 11	Pulse inhibit function in PT mode	0: disable PL / NL pulse inhibit function. In PT mode, the servo drive receives pulse position commands for both positive- and negative-direction operations whether the motor reaches the PL or NL. 1: enable PL / NL pulse inhibit function. In PT mode, if the motor reaches the PL, the servo drive receives pulse position commands for negative-direction operation and stops receiving pulse position commands for positive-direction operation. In PT mode, if the motor reaches the NL, the servo drive receives pulse position commands for positive-direction operation and stops receiving pulse position commands for negative-direction operation.
Bit 12	RST power error (AL022) detection function	0: enable the RST power error (AL022) detection function. 1: disable the RST power error (AL022) detection function.
Bit 13	OA and OB output error (AL018 / AL048) detection	0: enable OA and OB output error (AL018 / AL048) detection. 1: disable OA and OB output error (AL018 / AL048) detection.
Bit 14 ~ Bit 15	Reserved	-

P2.066	Special bit register 2		Address: 0284H 0285H
Default:	0x0020	Control mode:	PT / PR / S / Sz
Unit:	-	Setting range:	0x0000 to 0x187F
Format:	HEX	Data size:	16-bit

8

Settings:

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

Bit	Function	Description
Bit 0 - Bit 1	Reserved	-
Bit 2	Disable the AL003 (Undervoltage error) latch	0: latch enabled; the undervoltage error is not cleared automatically. 1: latch disabled; the undervoltage error is cleared automatically.
Bit 3	Reserved	-
Bit 4	Disable the detection for AL044 (Servo function overload warning)	0: enable the detection. 1: disable the detection.
Bit 5	Reserved	-
Bit 6	RST power error (AL022) latch	0: disable the latch; RST power error (AL022) is cleared automatically. 1: enable the latch; RST power error (AL022) is not cleared automatically.
Bit 7 - Bit 8	Reserved	-
Bit 9	Set AL003 (Undervoltage) as ALM or WARN	0: WARN 1: ALM
Bit 10 - Bit 11	Reserved	-
Bit 12	Set AL022 (RST power error) as ALM or WARN	0: WARN 1: ALM
Bit 13 - Bit 15	Reserved	-

P2.067	Reserved

P2.068	Special function switch		Address: 0288H 0289H
Default:	0x00000000	Control mode:	All
Unit:	-	Setting range:	0x00000000 - 0x10002101
Format:	HEX	Data size:	32-bit

Settings:

High word: h0000 (D C B A)

Low word: L0020 (U Z Y X)

A	Reserved	X	Following error compensation switch
B	Reserved	Y	Reserved
C	Reserved	Z	DI.STP triggering method
D	[EtherCAT] / [CANopen] Power off movement function	U	[CANopen] Unit selection for PV mode [PROFINET] Unit selection for telegrams 1, 3, 102, and 105

- X: following error compensation switch (functions under the condition of P1.036 > 1)

  0: disable following error compensation

  1: enable following error compensation

- Z: DI.STP triggering method

  0: rising-edge triggered

  1: level triggered

- U: [CANopen] Unit selection for PV mode / [PROFINET] Unit selection for telegrams 1, 3, 102, and 105

  0: 0.1 rpm

  1: 0.01 rpm

  Note: when you change the setting of P2.068.U in CANopen mode, the units of OD 606Bh, OD 606Ch, OD 60FFh, and P5.003 (Deceleration time for auto-protection) change as well. Make sure the setting values are correct.

- D: [EtherCAT] / [CANopen] Power off movement function

  0: disable

  1: enable

  When the servo drive detects RST power off, it can move according to PR#63 (which specifies the moving distance, speed, and acceleration / decceleration) that you have set beforehand.

  Note the following when using this function:

  1. Set P0.001.YX (control mode) = 0C.
  2. Set P2.065 [Bit 12] = 0 (enable the AL022 detection function).
  3. Set P2.065 [Bit 5] = 1 (when the servo is off, enable the detection for AL022).
  4. The logest moving distance is based on the capacitor's capacitance at present in the servo drive.

  Applications for the power off movement function:

  1. When the machine tool is forced power off due to errors, prevents the continuous contact between workpiece and cutting tool.
  2. Although you can set P1.042 and P1.043 (enable Servo On delay time and DO.BRKR) to prevent Z-axis from falling, during Z-axis power off, the Z-axis falls by a small amount due to machine backlash. In this case, you can use this function to compensate the fall and avoid machine damage.

P2.069●	Absolute encoder		Address: 028AH 028BH
Default:	0x0000	Control mode:	All
Unit:	-	Setting range:	0x0000 to 0x1211
Format:	HEX	Data size:	16-bit

Settings:

0000

U Z Y X

X	Operation mode setting	Z	Function of preventing rotary axis position offset when overflow occurs
Y	Pulse command setting when absolute position is lost	U	Single-turn absolute function

- X: operation mode setting

  0: incremental mode. An absolute type motor can be operated as an incremental type motor.

  1: absolute mode. This setting is only applicable to an absolute type motor. If it is used for an incremental type motor, AL069 occurs.

- Y: pulse command setting when absolute position is lost

  0: when AL060 or AL06A occurs, the system cannot receive a pulse command.

  1: when AL060 or AL06A occurs, the system can receive a pulse command.

- Z: function of preventing rotary axis position offset when overflow occurs

  0: when the number of revolutions of the encoder overflows, the absolute position and rotary axis position are offset after power is off.

  1: during power-on initialization and the establishment of origin position, the position feedback remains unchanged as the servo drive position feedback. The rotary axis position is not affected by overflow, but the absolute position is offset (AL062, AL066, and AL289 do not function).

  2: during power-on initialization and the establishment of origin position, the position feedback is set as the current rotary axis position. The rotary axis position is not affected by overflow, but the absolute position is offset (AL062, AL066, and AL289 do not function). This setting is applicable when the Delta AX series or DVP50MC series controller is used; optional when other controllers are used.

- U: single-turn absolute function

  0: disable the single-turn absolute function.

  1: enable the single-turn absolute function and automatically set both P2.069.X and P2.069.Z to 1.

Note: changes to this setting are effective only after power is cycled to the servo drive.

8

P2.070	Read data selection		Address: 028CH 028DH
Default:	0x0000	Control mode:	All
Unit:	-	Setting range:	0x0000 to 0x0007
Format:	HEX	Data size:	16-bit

Settings:

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

Bit	Function	Description
Bit 0	DI/DO data unit setting	0: PUU 1: pulse
Bit 1	Unit setting for P0.051 and P0.052	0: P0.051 is invalid; P0.052 is units of PUU. 1: P0.051 is in units of number of turns; P0.052 is in units of pulse.
Bit 2	Overflow warning setting	0: the servo drive issues the overflow warnings AL289 (PUU) and AL062 (pulse). 1: no overflow warning.
Bit 3 - Bit 15	Reserved	-

P2.071■	Absolute position homing		Address: 028EH 028FH
Default:	0x0000	Control mode:	All
Unit:	-	Setting range:	0x0000 to 0x0001
Format:	HEX	Data size:	16-bit

Settings:

Setting P2.071 to 0x0001 resets the current absolute position of the encoder. The clear function is enabled by setting P2.008 to 271 and P2.069.X to 1.

P2.072 - P2.088	Reserved

P2.089	Command response gain		Address: 02B2H 02B3H
Default:	25	Control mode:	PT / PR
Unit:	rad/s	Setting range:	1 to 2000
Format:	DEC	Data size:	16-bit

Settings:

Increasing this gain speeds up the responsiveness of the Position command and shortens the settling time, but when the gain is too large, it causes position overshoot which leads to machine jitter.

Note: enable the two degree of freedom control function (P2.094 [Bit 12] = 1) before adjusting this parameter.

P2.090	Two degree of freedom mode - anti-interference gain		Address: 02B4H 02B5H
Default:	850	Control mode:	PT / PR
Unit:	0.001	Setting range:	500 to 1999
Format:	DEC	Data size:	16-bit

Settings:

This parameter improves the command response and fine tunes the overshoot when the command is settling. Set this parameter to a smaller value to reduce the occurrence of command overshoot. This parameter is only valid when the two degree of freedom control function is enabled (P2.094 [Bit 12] = 1) and its function is similar to that of P2.026.

P2.091	Two degree of freedom mode - position feed forward gain		Address: 02B6H 02B7H
Default:	1000	Control mode:	PT / PR
Unit:	0.1%	Setting range:	0 to 3000
Format:	DEC	Data size:	16-bit

Settings:

This parameter reduces the following error of the motor. If the value is set too high, it may cause overshoot during positioning. It is suggested that you set this parameter to the default value or only make small adjustments. This parameter is only valid when the two degree of freedom control function is enabled (P2.094 [Bit 12] = 1) and its function is similar to that of P2.002.

P2.092	Two degree of freedom mode - speed feed forward gain		Address: 02B8H 02B9H
Default:	1000	Control mode:	PT / PR
Unit:	0.1%	Setting range:	0 to 3000
Format:	DEC	Data size:	16-bit

Settings:

This parameter reduces the following error when the motor starts and stops. Use this parameter to roughly adjust the overshoot during positioning. Set this parameter to a larger value to reduce overshoot. This parameter is only valid when the two degree of freedom control function is enabled (P2.094 [Bit 12] = 1) and its function is similar to that of P2.007.

P2.093	Reserved

8

P2.094▲	Special bit register 3		Address: 02BCH 02BDH
Default:	0x0090	Control mode:	PT / PR / S / Sz
Unit:	-	Setting range:	0x0000 to 0xF3F6
Format:	HEX	Data size:	16-bit

Settings:

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

Bit	Function	Description
Bit 0 - Bit 3	Reserved	-
Bit 4	Dynamic brake options	0: disable new dynamic brake. 1: enable new dynamic brake.
Bit 5	Switch for AL016 (Abnormal IGBT temperature)	0: enable AL016 (Abnormal IGBT temperature). 1: disable AL016 (Abnormal IGBT temperature).
Bit 6	Switch for AL007 detection in Position mode	Switch for AL007 detection in Position mode (PT and PR) 0: disable AL007 detection (default). 1: enable AL007 detection.
Bit 7	Switch for AL086	Switch for the regenerative resistor temperature protection when the input voltage is too high 0: disable 1: enable
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 degree of freedom control function is enabled (P2.094 [Bit 12] = 1).
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 degree of freedom control function is enabled (P2.094 [Bit 12] = 1).
Bit 10 - Bit 11	Reserved	-
Bit 12	Two degree of freedom control function	0: disable two degree of freedom control function (A2 and B2 models do not have this function.) 1: enable two degree of freedom control function
Bit 13 - Bit 15	Reserved	-

P2.095	Notch filter 1 - Q factor		Address: 02BEH 02BFH
Default:	5	Control mode:	All
Unit:	-	Setting range:	1 to 10
Format:	DEC	Data size:	16-bit

Settings:

The resonance Q factor of the first notch filter. This function is disabled if P2.024 is 0. P2.023, P2.024, and P2.095 are the first set of notch filter parameters.

P2.096	Notch filter 2 - Q factor		Address: 02C0H 02C1H
Default:	5	Control mode:	All
Unit:	-	Setting range:	1 to 10
Format:	DEC	Data size:	16-bit

Settings:

The resonance Q factor of the second notch filter. This function is disabled if P2.044 is 0. P2.043, P2.044, and P2.096 are the second set of notch filter parameters.

P2.097	Notch filter 3 - Q factor		Address: 02C2H 02C3H
Default:	5	Control mode:	All
Unit:	-	Setting range:	1 to 10
Format:	DEC	Data size:	16-bit

Settings:

The resonance Q factor of the third notch filter. This function is disabled if P2.046 is 0. P2.045, P2.046, and P2.097 are the third set of notch filter parameters.

P2.098	Notch filter 4 - frequency		Address: 02C4H 02C5H
Default:	5000	Control mode:	All
Unit:	Hz	Setting range:	50 to 5000
Format:	DEC	Data size:	16-bit

Settings:

The resonance frequency of the fourth notch filter. This function is disabled if P2.099 is 0. P2.098, P2.099, and P2.100 are the fourth set of notch filter parameters.

P2.099	Notch filter 4 - attenuation level		Address: 02C6H 02C7H
Default:	0	Control mode:	All
Unit:	-dB	Setting range:	0 to 40
Format:	DEC	Data size:	16-bit

Settings:

The attenuation level of the fourth notch filter. A value of 5 indicates -5 dB. Set this parameter to 0 to disable the fourth notch filter.

P2.100	Notch filter 4 - Q factor		Address: 02C8H 02C9H
Default:	5	Control mode:	All
Unit:	-	Setting range:	1 to 10
Format:	DEC	Data size:	16-bit

Settings:

The resonance Q factor of the fourth notch filter. This function is disabled if P2.099 is 0. P2.098, P2.099, and P2.100 are the fourth set of notch filter parameters.

8

P2.101	Notch filter 5 - frequency		Address: 02CAH 02CBH
Default:	5000	Control mode:	All
Unit:	Hz	Setting range:	50 to 5000
Format:	DEC	Data size:	16-bit

Settings:

The resonance frequency of the fifth notch filter. This function is disabled if P2.102 is 0. P2.101, P2.102, and P2.103 are the fifth set of notch filter parameters.

P2.102	Notch filter 5 - attenuation level		Address: 02CCH 02CDH
Default:	0	Control mode:	All
Unit:	-dB	Setting range:	0 to 40
Format:	DEC	Data size:	16-bit

Settings:

The attenuation level of the fifth notch filter. A value of 5 indicates -5 dB. Set this parameter to 0 to disable the fifth notch filter.

P2.103	Notch filter 5 - Q factor		Address: 02CEH 02CFH
Default:	5	Control mode:	All
Unit:	-	Setting range:	1 to 10
Format:	DEC	Data size:	16-bit

Settings:

The resonance Q factor of the fifth notch filter. This function is disabled if P2.102 is 0. P2.101, P2.102, and P2.103 are the fifth set of notch filter parameters.

P2.104	Torque command condition for P/PI switching		Address: 02D0H 02D1H
Default:	800	Control mode:	PT / PR
Unit:	%	Setting range:	1 to 800
Format:	DEC	Data size:	16-bit

Settings:

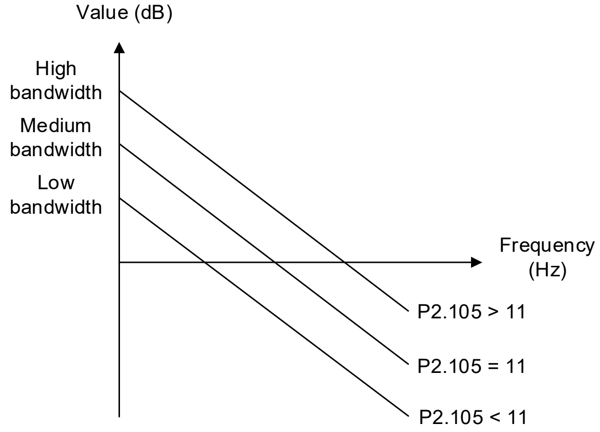
When the Torque command exceeds P2.104, the speed controller gain is switched from PI to P in order to reduce response overshoot.

P2.105	Automatic gain adjustment level 1		Address: 02D2H 02D3H
Default:	11	Control mode:	PT / PR
Unit:	-	Setting range:	1 to 21
Format:	DEC	Data size:	16-bit

Settings:

Use this parameter to adjust the bandwidth when auto tuning. Setting P2.105 higher increases the bandwidth after auto tuning but reduces the system margin, causing machine jitter. Setting P2.105 lower decreases the bandwidth after auto tuning but slows downs the response.

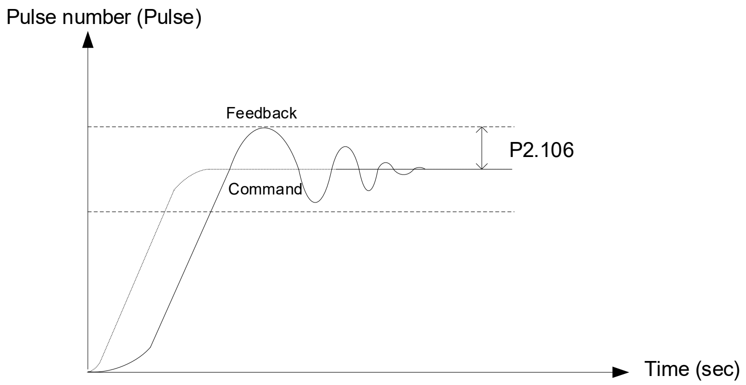
P2.105 setting value	Stiffness and response	Applicable mechanical parts
1 - 7	Low stiffness and low response	Belt, gear rack, reducer, cam
8 - 14	Medium stiffness and medium response	Screw
15 - 21	High stiffness and high response	Direct-coupled mechanical parts



P2.106	Automatic gain adjustment level 2		Address: 02D4H 02D5H
Default:	2000	Control mode:	PT / PR
Unit:	pulse	Setting range:	1 to 50331648
Format:	DEC	Data size:	32-bit

Settings:

Use this parameter to adjust the maximum allowable overshoot when auto tuning. The overshoot range is set according to either the user's requirement or the machine characteristics. Setting P2.106 higher increases the maximum overshoot allowed by auto-tuning and speeds up the response. Setting P2.106 lower reduces the maximum overshoot allowed by auto-tuning but slows down the response.



8

P2.107	Rate of change for resonance suppression low-pass filter		Address: 02D6H 02D7H
Default:	100	Control mode:	P / S
Unit:	%	Setting range:	0 to 100
Format:	DEC	Data size:	16-bit

Settings:

Adjusts the rate of change for **the resonance suppression low-pass filter** (P2.025) according to the gain switching condition.

(This parameter is inversely proportional to the value of P2.025. The smaller the setting value of P2.107, the stronger the filtering effect.)

P2.108 - P2.111	Reserved

P2.112▲	Special bit register 4		Address: 02E0H 02E1H
Default:	0x2018	Control mode:	PT / PR / S / Sz
Unit:	-	Setting range:	0x0000 to 0x75BF
Format:	HEX	Data size:	16-bit

Settings:

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

Bit	Function	Description
Bit 0	Reserved	-
Bit 1	Enable or disable AL089	0: disable AL089 1: enable AL089
Bit 2	Reserved	-
Bit 3	Auto gain adjustment mode	0: reserved 1: cycle adjustment
Bit 4 - Bit 7	Reserved	-
Bit 8	Motor hard stop function selection	Motor hard stop 2 currently supports absolute motors. 0: Motor hard stop 1 (refer to the settings of P1.057, P1.058, and P1.060.) 1: Motor hard stop 2 (refer to the settings of P1.105, P1.106, and P1.058.)
Bit 9 - Bit 12	Reserved	-
Bit 13	Regenerative braking method	0: method 1 1: method 2, which releases the capacitor voltage faster and reduces the load voltage of the capacitor.
Bit 14	Unit selection for internal Torque command / internal torque limit (P1.012 - P1.014).	0: 1% 1: 0.1%
Bit 15	Reserved	-

P2.113	Bandwidth of disturbance attenuation		Address: 02E2H 02E3H
Default:	50	Control mode:	T
Unit:	Hz	Setting range:	0 to 3000
Format:	DEC	Data size:	16-bit

8

Settings:

The disturbance attenuation function is disabled when P2.114 is 0. It is recommended that you set P2.113 to the default of 50. The higher you set P2.113, the more likely the high-frequency resonance is to occur; the lower you set P2.113, the less the low-frequency vibration is suppressed.

P2.114	Level of disturbance attenuation		Address: 02E4H 02E5H
Default:	0	Control mode:	T
Unit:	-	Setting range:	0 to 500
Format:	DEC	Data size:	16-bit

Settings:

The disturbance attenuation function is disabled when P2.114 is 0. Increasing this parameter can better attenuate the disturbance. However, if you set the value too high, it may cause slower response and system divergence.

P2.115 - P2.120	Reserved

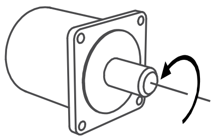
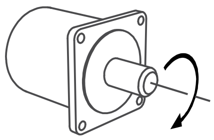
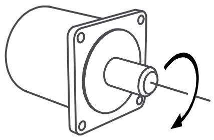
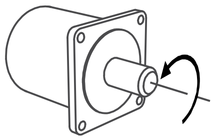
8

P2.121	Special bit register 6		Address: 02F2H 02F3H
Default:	0x00000000	Control mode:	All
Unit:	-	Setting range:	0x00000000 - 0x000001FF
Format:	HEX	Data size:	32-bit

Settings:

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

Bit	Function	Description
Bit 0	Reserved	-
Bit 1	[CANopen] / [EtherCAT] / [DMCNET] Behavior after homing in communication mode	0: after homing, execute absolute positioning to the position with the offset distance set in OD 607Ch. 1: decelerate to a stop after homing.
	[PROFINET] Behavior after homing in communication mode	0: after homing, execute absolute positioning to the position with the offset distance set in PNU11. 1: decelerate to a stop after homing.
Bit 2	[CANopen] / [EtherCAT] / [DMCNET] Definition of the settings for Origin definition (P6.001) and Home offset (OD 607Ch) in communication mode	0: origin definition (P6.001) = - (setting of OD 607Ch) 1: origin definition (P6.001) = OD 607Ch
	[PROFINET] Definition of the settings for Origin definition (P6.001) and Home offset (PNU11) in communication mode	0: origin definition (P6.001) = - (setting of PNU11) 1: origin definition (P6.001) = PNU11
Bit 3	[CANopen] / [EtherCAT] / [DMCNET] Unit of Homing speeds (OD 6099h) in communication mode	0: 0.1 rpm 1: 1 rpm
	[PROFINET] Unit of Homing speeds (PNU12, PNU13) in communication mode	
Bit 4	Reserved	-
Bit 5	[CANopen] / [EtherCAT] / [DMCNET] Unit selection for Homing speeds (OD 6099h), Homing acceleration (OD 609Ah), Profile acceleration (OD 6083h), and Profile deceleration (OD 6084h) in communication mode	0: the unit of OD 6099h is determined by the setting of P2.121 [Bit 3]. The unit of OD 609Ah, OD 6083h, and OD 6084h is ms (0 - 3000 rpm). When P2.121 [Bit 3] = 0, the unit of OD 6099h is 0.1 rpm. When P2.121 [Bit 3] = 1, the unit of OD 6099h is 1 rpm. 1: the unit of OD 6099h is PUU/sec. The unit of OD 609Ah, OD 6083h, and OD 6084h is PUU/sec^2.
	[PROFINET] Reserved	PROFINET communication does not support this function.
Bit 6	Reserved	-

<table>
<tr><th>Bit</th><th>Function</th><th>Description</th></tr>
<tr><td>Bit 7</td><td>Definition of positive / negative direction when P4.005 (Servo motor JOG control) controls the motor through USB / RS-485 communication</td><td>0: the same as the direction originally defined.
1: in reverse to the direction originally defined.
<table>
<tr><th>P2.121</th><th>Bit 7 = 0</th><th>Bit 7 = 1</th></tr>
<tr><td>P4.005 = 4999</td><td></td><td></td></tr>
<tr><td>P4.005 = 4998</td><td></td><td></td></tr>
</table></td></tr>
<tr><td>Bit 8</td><td>[EtherCAT]
Auto clearing of AL180 and AL185 after the state machine re-enters the Operational state in communication mode</td><td>0: no; you need to manually clear the alarms
1: yes</td></tr>
<tr><td>Bit 9 - Bit 15</td><td>Reserved</td><td>-</td></tr>
</table>

P2.122	Reserved

P2.123	Delay time before alarm reset		Address: 02F6H 02F7H
Default:	3000	Control mode:	All
Unit:	ms	Setting range:	0 - 20000
Format:	DEC	Data size:	16-bit

Settings:

When an alarm occurs, performing “Alarm reset” is not allowed until this delay time has elapsed. You can monitor the remaining time with the monitoring variable -248 (Alarm reset delay time).

This parameter setting affects the alarms: AL001, AL005, AL006, AL016, AL085, AL086, AL02C, and AL02F.

Important: setting P2.123 lower than 3000 may cause component overheating.

P2.124	Reserved

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P2.125	Special bit register 7		Address: 02FAH 02FBH
Default:	0x0000	Control mode:	All
Unit:	-	Setting range:	0x0000 to 0xFFFF
Format:	HEX	Data size:	16-bit

Settings:

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

Bit	Function	Description
Bit 0	Frequency setting of the filter processing the speed feedback (monitoring variable of P0.002 = 7)	0: 15 Hz 1: 1 Hz
Bit 1 - Bit 2	Reserved	-
Bit 3	Bandwidth response level reversion	Before using this function, set the gain adjustment mode to mode 1, mode 2, or mode 3. When the system limit is reached and the resonance cannot be suppressed, the servo automatically reverts to the response level where the resonance does not occur. 0: disable 1: enable
Bit 4 - Bit 6	Reserved	-
Bit 7	[EtherCAT] Smoothing function for Velocity offset (OD 60B1h) and Torque offset (OD 60B2h) in communication mode	0: disable 1: enable
Bit 8 - Bit 15	Reserved	-

P2.126	Bandwidth for speed loop response		Address: 02FCH 02FDH
Default:	40	Control mode:	PT / PR / S / Sz
Unit:	Hz	Setting range:	1 to 1000
Format:	DEC	Data size:	16-bit

Settings:

The setting of P2.126 is effective only when you set P2.032 to 5 or 6.

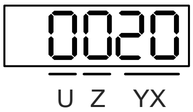
Bandwidth	Stiffness and response	Applicable mechanical parts
1 - 100 Hz	Low stiffness and low response	Belt, gear rack, reducer, cam
101 - 250 Hz	Medium stiffness and medium response	Screw
251 Hz and above	High stiffness and high response	Direct-coupled mechanical parts

Note: the servo drive automatically sets the response of the position loop according to the setting of P2.126.
The function of P2.126 is the same as that of P2-31 for the A2 series models.

P3.xxx Communication parameters

P3.000●	Address		Address: 0300H 0301H
Default:	0x007F	Control mode:	All
Unit:	-	Setting range:	0x0001 - 0x007F (-L, -M, -F, -P) 0x0001 - 0xFFFF (-E)
Format:	HEX	Data size:	16-bit

Settings:



UZ	Reserved	YX	Communication address setting

The address setting required for using RS-485, CANopen, and DMCNET communication. Make sure there are no duplicate addresses in the same communication circuit, or it may cause communication failure.

■ RS-485

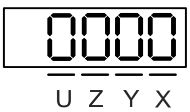
When the master station sets the communication address to 0xFF, the address is always 0xFF in the response message.

■ EtherCAT

When P3.018.A = 1, the address refers to the setting of P3.000; when P3.018.A = 0, the address must be set by the controller.

P3.001●	Transmission speed		Address: 0302H 0303H
Default:	0x0203 (-L, -M, -E) 0x3203 (-F, -P)	Control mode:	All
Unit:	-	Setting range:	0x0000 - 0x0405 (-L, -M, -E) 0x0000 - 0xF405 (-F, -P)
Format:	HEX	Data size:	16-bit

Settings:



X	RS-485 transmission speed	Z	CANopen / DMCNET transmission speed
Y	Reserved	U	DMCNET motion card

■ X: RS-485 transmission speed

0: 4800 bps	1: 9600 bps	2: 19200 bps
3: 38400 bps	4: 57600 bps	5: 115200 bps

8

■ Z: CANopen / DMCNET transmission speed

0: 125 Kbps	1: 250 Kbps	2: 500 Kbps
3: 800 Kbps	4: 1.0 Mbps	-

■ U: DMCNET motion card

0: when using Delta's controller, such as PLC or HMI
3: when using Delta's motion card

Note:
1. The transmission speed of USB is set at 1.0 Mbps and cannot be changed.
2. If this parameter is set through CANopen, only Z can be set and the others remain unchanged.
3. After the Z value is set, cycle the power to take effect.

P3.002	Modbus communication protocol		Address: 0304H 0305H
Default:	0x0006	Control mode:	All
Unit:	-	Setting range:	0x0000 to 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	Modbus communication error handling		Address: 0306H 0307H
Default:	0x0000	Control mode:	All
Unit:	-	Setting range:	0x0000 to 0x0001
Format:	HEX	Data size:	16-bit

Settings:

0: display AL020 and let the motor continue operating.

1: display AL020 and let the motor decelerate to a stop. Deceleration time is set in P5.003.B.

P3.004	Modbus communication timeout		Address: 0308H 0309H
Default:	0	Control mode:	All
Unit:	sec	Setting range:	0 to 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	Modbus communication		Address: 030AH 030BH
Default:	0x0000	Control mode:	All
Unit:	-	Setting range:	0x0000 to 0x0112
Format:	HEX	Data size:	16-bit

Settings:

0000

U Z Y X

X	Reserved	Z	During Modbus communication, when the function code is 03H or 10H (read or write multiple words), the system gives priority to read or write high word data.
Y	Sets the servo drive as the master or slave of Modbus	U	Reserved

- Y: sets the servo drive as the master or slave of Modbus.

  0: slave of Modbus

  1: master of Modbus

- Z: during Modbus communication, when the function code is 03H or 10H (read or write multiple words), the system gives priority to read or write high word data. Use this function for controllers with different priority for transmitting high word and low word of the packets.

  0: transmit low word first

  1: transmit high word first

P3.006■	Digital input (DI) control switch		Address: 030CH 030DH
Default:	0x0000	Control mode:	All
Unit:	-	Setting range:	0x0000 to 0x1FFF
Format:	HEX	Data size:	16-bit

Settings:

Control switch for the source of DI. Each bit of this parameter determines the input source of one DI signal: Bit 0 - Bit 12 correspond to DI1 - DI13.

The setting for each bit is as follows:

0: DI status is controlled by the external terminal block.

1: DI status is controlled by P4.007.

For more information on DI functional planning, refer to the following:

DI1 - DI8: P2.010 - P2.017

DI9 - DI13: P2.036 - P2.040

P3.007	**Modbus communication response delay time**		**Address: 030EH 030FH**
Default:	1	Control mode:	All
Unit:	0.5 ms	Setting range:	0 to 1000
Format:	DEC	Data size:	16-bit

Settings:

Delays the time of communication response from servo drive to controller.

P3.008	**Reserved**

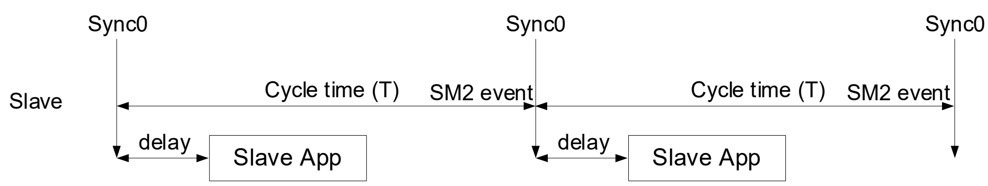
P3.009	**Communication synchronization**		**Address: 0312H 0313H**
Default:	0x5055	Control mode:	CANopen / EtherCAT
Unit:	-	Setting range:	0x1001 - 0x9FFF (-L, -M, -F, -P) 0x1001 - 0x9AFF (-E)
Format:	HEX	Data size:	16-bit

Settings:

Digit	U	Z	Y	X
Function	[CANopen] Range of synchronous error	[CANopen] / [EtherCAT] Target value	[CANopen] Deadband	Reserved
Range	1 to 9	-M, -F, -L, -P models: 0 to F -E models: 0 to A	0 to F	-

The slave synchronizes with the master via SYNC. The definition is as follows:

- Y: sets the size of deadband (unit: µsec). If the deviation between the SYNC arrival time and the target value does not exceed the deadband, a correction is not needed.
- Z: adjusts the timing of the servo accessing the packets to ensure this timing is not in conflict with the timing of the controller sending the packets.
  The delay time shown in the following figure is (T/10) x Z (µs).



- U: 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:	0x1011	Control mode:	CANopen / DMCNET
Unit:	-	Setting range:	0x0000 to 0xFFFF
Format:	HEX	Data size:	16-bit

Settings:

0000
U Z Y X

X	Reserved	Z	Source of torque limit
Y	Motor status when communication error occurs	U	Auto clearing of PDO alarm

- Y: motor status when the communication error occurs

  0: when the communication error occurs (AL170), the motor continues to operate (only applicable to DMCNET mode and CANopen B mode).

  1: when the communication error occurs (AL180), the motor is switched to Servo Off state (only applicable to CANopen C mode).

- Z: source of torque limit (only applicable to DMCNET mode)

  0: communication commands.

  1: DI commands.

- U: auto clearing of PDO alarm

  0: when the PDO error (AL112, AL113, AL121 - AL132) occurs, the servo alarm has to be cleared by DI.ARST, NMT reset, or OD 6040h [Bit 7] Fault reset.

  1: if the PDO error (AL112, AL113, AL121 - AL132) disappears, the servo alarm is automatically cleared.

P3.011	CANopen / DMCNET / PROFINET options		Address: 0316H 0317H
Default:	0x0000	Control mode:	CANopen / DMCNET / PROFINET
Unit:	-	Setting range:	Shown as follows
Format:	HEX	Data size:	16-bit

Settings:

0000
U Z Y X

X	Store parameters in EEPROM or not	Z	Reserved
Y	Reserved	U	Reserved

- X: store parameters in EEPROM or not

  0: not to store parameters in EEPROM.

  1: when writing parameters with packets through cyclic synchronous communication, store parameters in EEPROM.

  Note: if you set X to 1 and continuously write parameters with packets through cyclic synchronous communication, it shortens the lifetime of the EEPROM.

P3.012	Communication support setting		Address: 0318H 0319H
Default:	0x0000	Control mode:	CANopen / DMCNET / EtherCAT / PROFINET
Unit:	-	Setting range:	0x0000 to 0x1111
Format:	HEX	Data size:	16-bit

Settings:

0000

U Z Y X

X	Reserved	Z	Load in the CANopen / DMCNET / EtherCAT / PROFINET parameter values
Y	Reserved	U	Error clearing when the limit alarm occurs

- Z: load in the CANopen / DMCNET / EtherCAT / PROFINET parameter values

  0: when the servo drive is power cycled or the communication is reset, parameters in the following table load the values of the CANopen / DMCNET / EtherCAT / PROFINET parameters.

  1: when the servo drive is power cycled or the communication is reset, parameters in the following table retain the same settings and do not load the values of the CANopen / DMCNET / EtherCAT / PROFINET parameters.

Relevant parameters for CANopen / DMCNET / EtherCAT communication mode:

CANopen / DMCNET / EtherCAT				
Parameter	P3.012 = 0x0100 (Z = 1)		P3.012 = 0x0000 (Z = 0)	
	Servo parameter	Default	OD address	Default
Motor stop mode	P1.032	0x0000	605Bh	0
S-curve acceleration constant	P1.034	200	6087h	200
Zero speed detection level	P1.038	100 (0.1 rpm)	606Fh	100 (0.1 rpm)
E-Gear ratio - numerator N1	P1.044	16777216	6093h sub1	1
E-Gear ratio - denominator M	P1.045	100000	6093h sub2	1
Speed reached (DO.SP_OK) range	P1.047	10 (1 rpm)	606Dh	100 (0.1 rpm)
Accumulated time to reach desired speed	P1.049	0	606Eh	0
Maximum speed limit	P1.055	Depending on the motor (rpm)	607Fh	Depending on the motor (0.1 rpm)
			6080h	Depending on the motor (rpm)
Excessive deviation warning condition of Position command	P2.035	50331648	6065h	50331648
Positive software limit (PP / CSP / CSV / CST mode)	P5.008	2147483647	607Dh sub2	2147483647
Negative software limit (PP / CSP / CSV / CST mode)	P5.009	-2147483648	607Dh sub1	-2147483648
Origin definition (HM mode)	P6.001	0	607Ch	0

Methods to write parameters to EEPROM (non-volatile):

SDO: parameters are stored in EEPROM when written.

PDO: refer to the setting of P3.011.X.

P3.011.X = 1 indicates when written through PDOs, parameters are stored in EEPROM.

P3.011.X = 0 indicates when written through PDOs, parameters are not stored in EEPROM.

Note: when the function of OD 1010h (Store parameter) is enabled, the CANopen OD value is stored in non-volatile memory. When P3.012.Z = 0, the non-volatile value of CANopen OD is loaded as the initial content. Refer to the descriptions in CANopen Standard. When P3.012.Z = 1, the initial content refers to the preceding table.

Relevant parameters for PROFINET communication:

PROFINET				
Parameter	P3.012 = 0x0100 (Z = 1)		P3.012 = 0x0000 (Z = 0)	
	Servo parameter	Default	PNU parameter	Default
Motor stop mode	P1.032	0x0000	PNU30	0x0000
Zero speed detection level	P1.038	100 (0.1 rpm)	PNU32	100 (0.1 rpm)
E-Gear ratio - numerator N1	P1.044	16777216	PNU33	1
E-Gear ratio - denominator M	P1.045	100000	PNU34	1
Speed reached (DO.SP_OK) range	P1.047	10 (1 rpm)	PNU35	100 (0.1 rpm)
Accumulated time to reach desired speed	P1.049	0	PNU36	0
Maximum speed limit	P1.055	Depending on the motor (1 rpm)	PNU37	Depending on the motor (0.1 rpm)
			PNU38	Depending on the motor (1 rpm)
Excessive deviation warning condition of Position command	P2.035	50331648 (pulse)	PNU39	50331648 (PUU)
Positive software limit	P5.008	2147483647 (PUU)	PNU40	2147483647 (PUU)
Negative software limit	P5.009	-2147483648 (PUU)	PNU41	-2147483648 (PUU)
Origin definition	P6.001	0	PNU11	0

■ U: error clearing when the limit alarm occurs

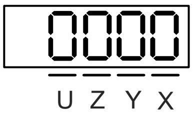
0: when the limit alarm (AL014 or AL015) occurs, it needs to be cleared before the servo reverses to move away from the limit.

1: when the limit alarm (AL014 or AL015) occurs, it does not need to be cleared before the servo reverses to move away from the limit.

Note: determine whether the servo has reached the limit with the bit status of OD 6041h Statusword and OD 60FDh Digital inputs.
Positive limit: OD 6041h [Bit 14] is On & OD 60FDh [Bit 1] is On
Negative limit: OD 6041h [Bit 15] is On & OD 60FDh [Bit 0] is On
The status of other bits of OD 6041h (Fault / Warning / Quick stop) remains unchanged when the servo reaches the limit.

P3.013	OD 6064h feedback source		Address: 031AH 031BH
Default:	0x0000	Control mode:	All
Unit:	-	Setting range:	0x0000 ~ 0x0003
Format:	HEX	Data size:	16-bit

Settings:



X	Feedback source of OD 6064h and Feedback position (PUU)	Z	Reserved
Y	Reserved	U	Reserved

- X: feedback source of OD 6064h and Feedback position (PUU)

  0: motor encoder feedback

  3: rotary axis position feedback

  Note: the Feedback position (PUU) is P0.002 = 0.

P3.014 - P3.016	Reserved

P3.017	CANopen B mode disconnection delay time		Address: 0322H 0323H
Default:	1000	Control mode:	CANopen
Unit:	ms	Setting range:	1 to 1000
Format:	DEC	Data size:	16-bit

Settings:

If the communication disconnection time exceeds this set value when in the PV (Profile Velocity), PT (Profile Torque), or HM (Homing Mode) mode of CANopen B mode, the system issues AL303.

P3.018	EtherCAT special function switch		Address: 0324H 0325H
Default:	0x00002000	Control mode:	EtherCAT
Unit:	-	Setting range:	0x00000000 - 0x01112211
Format:	HEX	Data size:	32-bit

Settings:

A	Source setting for the content loaded to the EtherCAT Station Alias Register 0x0012 after the servo drive is powered on	X	Unit selection for Target velocity (OD 60FFh) and Velocity actual value (OD 606Ch) when in the PV (Profile Velocity) mode or CSV (Cyclic Synchronous Velocity) mode
B	Reserved	Y	Reserved
C	Unit selection for the maximum speed of OD 607Fh and OD 6080h	Z	AL185 communication disconnection detection setting
D	Reserved	U	Reserved

- A: source setting for the content loaded to the EtherCAT Station Alias Register 0x0012 after the servo drive is powered on.

  0: determined by the EtherCAT EEPROM station number field (ADR 0x0004) setting, which needs to be set via the controller interface.

  1: determined by the address set with servo parameter P3.000.

- X: unit selection for Target velocity (OD 60FFh) and Velocity actual value (OD 606Ch) when in the PV (Profile Velocity) mode or CSV (Cyclic Synchronous Velocity) mode.

  0: 0.1 rpm

  1: pulse/sec

- Z: AL185 communication disconnection detection setting

  0: disconnection detection starts after EtherCAT communication enters OP state.

  1: disconnection detection starts after EtherCAT communication enters Init state.

  2: disable disconnection detection.

  Note: when using the ring topology connection, set P3.018.Z to 2 to disable the disconnection detection.

- C: unit selection for the maximum speed of OD 607Fh and OD 6080h

  0: 0.1 rpm for OD 607Fh and rpm for OD 6080h.

  1: pulse/sec for OD 607Fh and OD 6080h.

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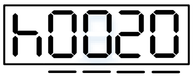
P3.019	Statusword display content		Address: 0326H 0327H
Default:	0x00000021	Control mode:	CANopen / EtherCAT
Unit:	-	Setting range:	0x00000000 - 0x0001FFFF
Format:	HEX	Data size:	32-bit

Settings:

High word



D C B A

Low word

U Z Y X

A	OD 6041h [Bit 3] display status when servo alarm AL014, AL015, AL283, or AL285 is triggered	X	Reserved
B	Reserved	Y	Reserved
C	Reserved	Z	Display content of OD 6041h [Bit 14]
D	Reserved	U	Reserved

■ Z: display content of OD 6041h [Bit 14]

0: display the positive limit status.

1: display the current synchronization status between the servo drive and controller. When the status displays On, it indicates that the synchronization is complete (SYNC_OK).

■ A: OD 6041h [Bit 3] display status when servo alarm AL014, AL015, AL283, or AL285 is triggered

0: OD 6041 [Bit 3] is Off.

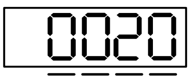
1: OD 6041 [Bit 3] is On (must set to 1 when the Delta AX series controller is used).

P3.020 - P3.021	Reserved

P3.022	EtherCAT PDO timeout setting		Address: 032CH 032DH
Default:	0xFF04	Control mode:	EtherCAT
Unit:	-	Setting range:	0x0002 to 0xFF14
Format:	HEX	Data size:	16-bit

Settings:

When using the PDO to transmit data periodically, use this parameter to set the allowable timeout. The following two sets of digits specify the trigger conditions for AL180 and AL3E3 respectively to ensure that the servo drive receives the PDO. When one of the alarms occurs, it means the packet loss period has exceeded the allowable range.



U Z Y X

Digit	UZ	YX
Function	AL180 trigger condition	AL3E3 trigger condition
Range	0x00 (disabled) - 0xFF (default)	0x02 - 0x14

■ YX: AL3E3 alarm condition (allowable cycle for elapsed time); applicable to CSP / CSV / CST mode.

AL3E3 occurs when the servo drive does not receive the PDO within the set cycle.
When the communication cycle is 4 ms and you set this parameter to 0x02 (allow two cycles), it means if the servo drive does not receive any PDO within 8 ms, AL3E3 occurs.

- UZ: AL180 trigger condition (allowable duration for elapsed time); applicable to all operation modes.

  AL180 occurs when the servo drive does not receive the PDO within the set duration (unit: ms). For example, when you set P3.022.UZ to 0x01, the duration is 1 ms; when you set P3.022.UZ to 0x02, the duration is 2 ms; and when you set P3.022.UZ to 0xFF, the duration is 255 ms.

P3.023 - P3.038	Reserved

8

P4.xxx Diagnosis parameters

P4.000	Fault record (last)		Address: 0400H 0401H
Default:	0x00000000	Control mode:	All
Unit:	-	Setting range:	-
Format:	HEX	Data size:	32-bit

Settings:

The last fault record.

Low word (LXXXX): the alarm number.

High word (hYYYY): the error code corresponding to CANopen / DMCNET / EtherCAT.

For example, when the low word displays ALF21, the high word displays the error code of ALF21.

P4.001★	Fault record (second to last)		Address: 0402H 0403H
Default:	0x00000000	Control mode:	All
Unit:	-	Setting range:	-
Format:	HEX	Data size:	32-bit

Settings:

The second to last fault record.

Refer to the description of high / low word in P4.000.

P4.002★	Fault record (third to last)		Address: 0404H 0405H
Default:	0x00000000	Control mode:	All
Unit:	-	Setting range:	-
Format:	HEX	Data size:	32-bit

Settings:

The third to last fault record.

Refer to the description of high / low word in P4.000.

P4.003★	Fault record (fourth to last)		Address: 0406H 0407H
Default:	0x00000000	Control mode:	All
Unit:	-	Setting range:	-
Format:	HEX	Data size:	32-bit

Settings:

The fourth to last fault record.

Refer to the description of high / low word in P4.000.

P4.004★	Fault record (fifth to last)		Address: 0408H 0409H
Default:	0x00000000	Control mode:	All
Unit:	-	Setting range:	-
Format:	HEX	Data size:	32-bit

Settings:

The fifth to last fault record.

Refer to the description of high / low word in P4.000.

P4.005	Servo motor JOG control		Address: 040AH 040BH
Default:	20	Control mode:	All
Unit:	rpm	Setting range:	0 - 5000
Format:	DEC	Data size:	16-bit

Settings:

The control methods are as follows:

1. Panel control:

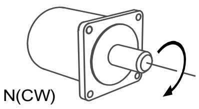
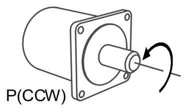
   Set the P4.005 JOG speed with the panel and it displays the JOG symbol. Pressing the UP key controls the JOG operation in the positive direction; pressing the DOWN key controls the JOG operation in the negative direction. Stop pressing to stop the JOG operation. If there is any error in this setting, then the motor cannot operate.

2. DI control:

   If you set the DI to 0x37 (JOGU) and 0x38 (JOGD) (refer to Table 8.1), then the JOG operation in the positive or negative direction is controlled with this DI.

3. USB / RS-485 communication control:

   Set the JOG speed (1 - 4997, 5000) for operation to P4.005, and then set P4.005 to 4999 or 4998 for positive or negative direction. To stop the motor operation, set P4.005 to 0.

0: stop operation	1 – 4997, 5000: JOG speed
4998*2: JOG operation in negative direction  	4999*2: JOG operation in positive direction 

Note:
1. When using communication to write values frequently, set P2.030 to 5.
2. When you control the JOG operation with the panel, the operation direction (positive / negative) varies depending on the value of P1.001.Z. When you control the JOG speed with USB communication, the operation direction (positive / negative) can be modified with P2.121 [Bit 7].
3. This function supports the S-curve acceleration / deceleration settings in P1.034 - P1.036.
4. When P1.001.X = B or C, JOG operation test is not supported.

8

P4.006■	Software digital output register (readable and writable)		Address: 040CH 040DH
Default:	0x0000	Control mode:	All
Unit:	-	Setting range:	0x0000 to 0xFFFF
Format:	HEX	Data size:	16-bit

Settings:

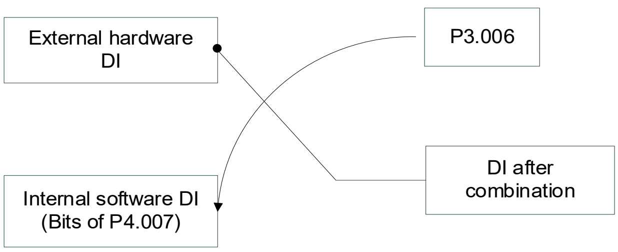
bit 00: corresponds to DO code = 0x30	bit 08: corresponds to DO code = 0x38
bit 01: corresponds to DO code = 0x31	bit 09: corresponds to DO code = 0x39
bit 02: corresponds to DO code = 0x32	bit 10: corresponds to DO code = 0x3A
bit 03: corresponds to DO code = 0x33	bit 11: corresponds to DO code = 0x3B
bit 04: corresponds to DO code = 0x34	bit 12: corresponds to DO code = 0x3C
bit 05: corresponds to DO code = 0x35	bit 13: corresponds to DO code = 0x3D
bit 06: corresponds to DO code = 0x36	bit 14: corresponds to DO code = 0x3E
bit 07: corresponds to DO code = 0x37	bit 15: corresponds to DO code = 0x3F

If you set P2.018 to 0x0130, then the output of DO1 is the bit 00 status of P4.006, and so forth. Set the DO codes (0x30 - 0x3F) through communication DO, and then write to P4.006.

P4.007■	Multi-function for digital input		Address: 040EH 040FH
Default:	0x0000	Control mode:	All
Unit:	-	Setting range:	0x0000 to 0x3FFF
Format:	HEX	Data size:	16-bit

Settings:

The source of the DI input signal can be the external hardware terminal or the internal software DI (P4.007), which is determined by P3.006. If the corresponding bit of P3.006 is 1, it means the source is the software DI (P4.007); if the corresponding bit is 0, then the source is the hardware DI. See the following figure:



Read parameter: shows the DI status after combining external DI and software DI.

Write parameter: writes the software DI status. This function is the same whether you use the panel or communication to set the parameter.

For example: if the read value of P4.007 is 0x0011, it means DI1 and DI5 are on after combination; if the value written to P4.007 is 0x0011, it means the software DI1 and DI5 are on. Refer to P2.010 - P2.017 and P2.036 - P2.040 for more information on DI functional planning.

P4.008★	Input status of servo drive panel (read-only)		Address: 0410H 0411H
Default:	-	Control mode:	All
Unit:	-	Setting range:	Read-only
Format:	HEX	Data size:	16-bit

Settings:

Read this parameter through communication and check if the five keys (MODE, UP, DOWN, SHIFT, and SET) can function normally.

P4.009★	Digital output status (read-only)		Address: 0412H 0413H
Default:	-	Control mode:	All
Unit:	-	Setting range:	0x0000 to 0x003F
Format:	HEX	Data size:	16-bit

Settings:

There is no difference either reading by panel or through communication.

P4.010▲■	Hardware calibration options		Address: 0414H 0415H
Default:	0	Control mode:	All
Unit:	-	Setting range:	0 to 14
Format:	DEC	Data size:	16-bit

Settings:

0: reserved	4: calibrate the hardware offset of the current detector (W phase)
1: calibrate the hardware offset of the analog speed input	5: calibrate the hardware offset of options 1 - 4
2: calibrate the hardware offset of the analog torque input	6 - 14: reserved
3: calibrate the hardware offset of the current detector (V phase)	-

Note: the calibration function must be enabled by setting P2.008. When calibration, remove all external wirings for torque input and make sure the servo is in the Off state.

P4.011	Analog speed input 1 - hardware offset calibration		Address: 0416H 0417H
Default:	Factory setting	Control mode:	All
Unit:	-	Setting range:	13926 to 18842
Format:	DEC	Data size:	16-bit

Settings:

Manually calibrate the hardware offset. The function must be enabled by setting P2.008. Do not change the auxiliary calibration as this parameter cannot be reset.

8

P4.012	Analog speed input 2 - hardware offset calibration		Address: 0418H 0419H
Default:	Factory setting	Control mode:	All
Unit:	-	Setting range:	13926 to 18842
Format:	DEC	Data size:	16-bit

Settings:

Refer to the description of P4.011.

P4.013	Analog torque input 1 - hardware offset calibration		Address: 041AH 041BH
Default:	Factory setting	Control mode:	All
Unit:	-	Setting range:	13926 to 18842
Format:	DEC	Data size:	16-bit

Settings:

Refer to the description of P4.011.

P4.014	Analog torque input 2 - hardware offset calibration		Address: 041CH 041DH
Default:	Factory setting	Control mode:	All
Unit:	-	Setting range:	13926 to 18842
Format:	DEC	Data size:	16-bit

Settings:

Refer to the description of P4.011.

P4.015	Current detector (V1 phase) - hardware offset calibration		Address: 041EH 041FH
Default:	Factory setting	Control mode:	All
Unit:	-	Setting range:	13926 to 18842
Format:	DEC	Data size:	16-bit

Settings:

Refer to the description of P4.011.

P4.016	Current detector (V2 phase) - hardware offset calibration		Address: 0420H 0421H
Default:	Factory setting	Control mode:	All
Unit:	-	Setting range:	13926 to 18842
Format:	DEC	Data size:	16-bit

Settings:

Refer to the description of P4.011.

P4.017	Current detector (W1 phase) - hardware offset calibration		Address: 0422H 0423H
Default:	Factory setting	Control mode:	All
Unit:	-	Setting range:	13926 to 18842
Format:	DEC	Data size:	16-bit

Settings:

Refer to the description of P4.011.

P4.018	Current detector (W2 phase) - hardware offset calibration		Address: 0424H 0425H
Default:	Factory setting	Control mode:	All
Unit:	-	Setting range:	13926 to 18842
Format:	DEC	Data size:	16-bit

Settings:

Refer to the description of P4.011.

P4.019	IGBT NTC calibration level (cannot reset)		Address: 0426H 0427H
Default:	Factory setting	Control mode:	All
Unit:	-	Setting range:	1 to 4
Format:	DEC	Data size:	16-bit

Settings:

Cool down the drive to 25°C (77°F) before calibration. The function must be enabled by setting P2.008.

P4.020	Analog monitor output (Ch1) - offset compensation value		Address: 0428H 0429H
Default:	0	Control mode:	All
Unit:	mV	Setting range:	-800 to +800
Format:	DEC	Data size:	16-bit

Settings:

Manually adjust the compensation value for the offset (cannot reset). The function must be enabled by setting P2.008.

P4.021	Analog monitor output (Ch2) - offset compensation value		Address: 042AH 042BH
Default:	0	Control mode:	All
Unit:	mV	Setting range:	-800 to +800
Format:	DEC	Data size:	16-bit

Settings:

Manually adjust the compensation value for the offset (cannot reset). The function must be enabled by setting P2.008.

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P4.022	Analog speed input - offset compensation value		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 compensation value for the offset.

P4.023	Analog torque input - offset compensation value		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 compensation value for the offset.

P4.024	Level of undervoltage error		Address: 0430H 0431H
Default:	160 (220V models) 282 (400V models)	Control mode:	All
Unit:	V (rms)	Setting range:	140 to 380
Format:	DEC	Data size:	16-bit

Settings:

When the voltage of the DC Bus is lower than P4.024 x $\sqrt{2}$, the undervoltage alarm (AL003) occurs.

P4.025 - P4.026	Reserved

P4.027	AL503 diagnosis time		Address: 0436H 0437H
Default:	200	Control mode:	All
Unit:	ms	Setting range:	1 to 500
Format:	DEC	Data size:	16-bit

Settings:

This parameter is used to adjust the time duration before the STO internal circuit diagnosis is performed to avoid misdetection and triggering AL503.

Note: this parameter is available only for SIL2 models certified by TÜV Rheinland.

P4.028 - P4.043	Reserved

8

P4.044	Special bit register 5		Address: 0458H 0459H
Default:	0x0000	Control mode:	All
Unit:	-	Setting range:	0x0000 to 0x0063
Format:	HEX	Data size:	16-bit

Settings:

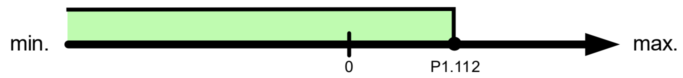
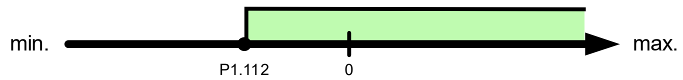
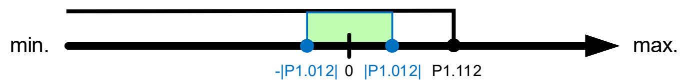
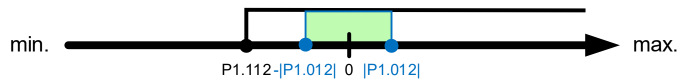
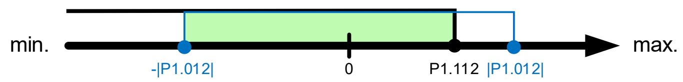
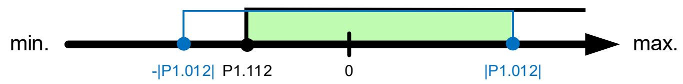
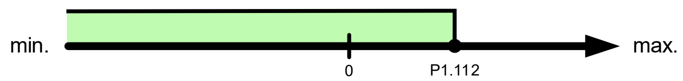
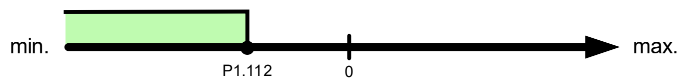
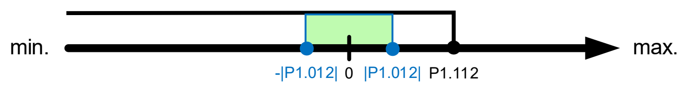
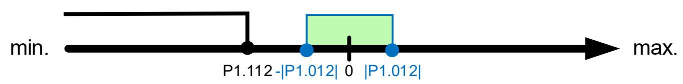
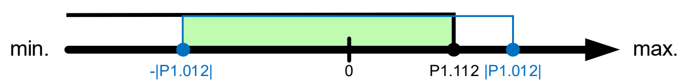
0000

U Z Y X

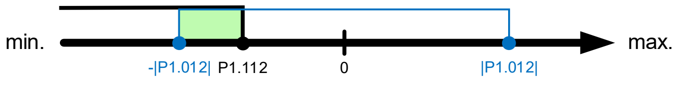
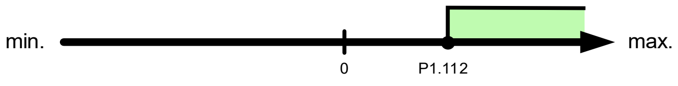
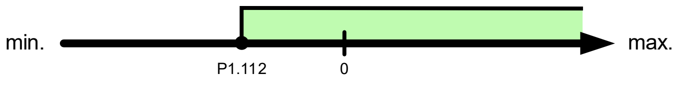
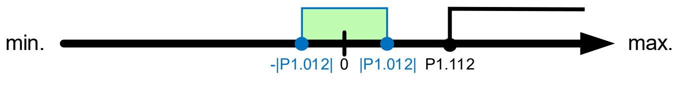
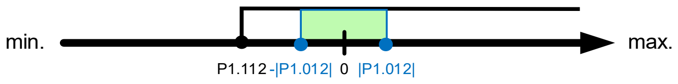
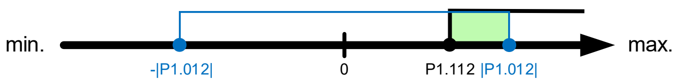
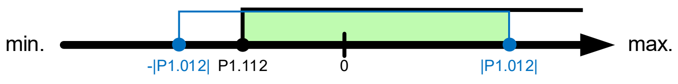
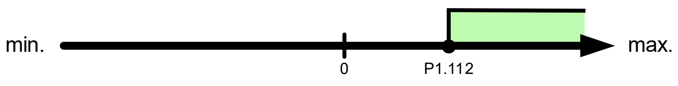
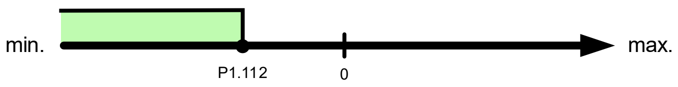
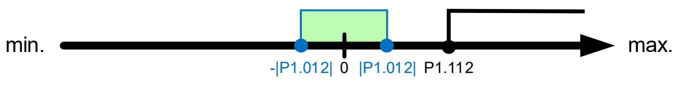
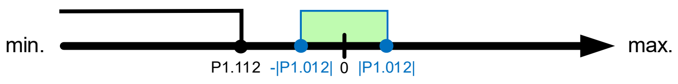
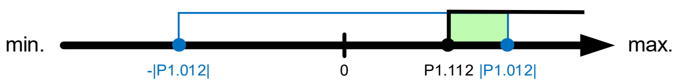
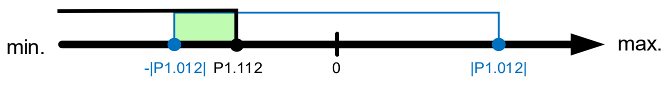
X	Single-direction torque limit setting	Z	Reserved
Y	Special function switch	U	Reserved

X: single-direction torque limit setting

This setting limits the torque of the motor, and is applicable to external analog commands and internal torque limits (P1.012 - P1.014). The following diagrams are illustrated based on P1.012; you can set parameters P1.012 - P1.014 according to the requirements. The light green highlighted area is the torque limit area.

P4.044.X	P1.012	P1.112	Operating range
0	Disable P1.012 (P1.002.Y = 0)	≥ 0	
		< 0	
	≤ |P1.112|	≥ 0	
		< 0	
	≥ |P1.112|	≥ 0	
		< 0	
1	Disable P1.012 (P1.002.Y = 0)	≥ 0	
		< 0	
	< |P1.112|	≥ 0	
		< 0	
	> |P1.112|	≥ 0	

8

P4.044.X	P1.012	P1.112	Operating range
1	> |P1.112|	< 0	
2	Disable P1.012 (P1.002.Y = 0)	≥ 0	
		< 0	
	< |P1.112|	≥ 0	
		< 0	
	> |P1.112|	≥ 0	
		< 0	
3	Disable P1.012 (P1.002.Y = 0)	≥ 0	
		< 0	
	< |P1.112|	≥ 0	
		< 0	
	> |P1.112|	≥ 0	
		< 0	

Y: special function switch

Bit	7	6	5	4	3	2	1	0

Y

Bit	15	14	13	12	11	10	9	8

Bit	Function	Description
Bit 4	Reserved	-
Bit 5	Function of Velocity offset (OD 60B1h) in EtherCAT mode	0: enable 1: disable
Bit 6	Function of Torque offset (OD 60B2h) in EtherCAT mode	0: enable 1: disable
Bit 7	Reserved	-

8

P5.xxx Motion control parameters

P5.000★■	Firmware subversion		Address: 0500H 0501H
Default:	Factory setting	Control mode:	All
Unit:	-	Setting range:	-
Format:	DEC	Data size:	32-bit

Settings:

The low word is the subversion of the firmware.

P5.001 - P5.002	Reserved

P5.003	Deceleration time for auto-protection		Address: 0506H 0507H
Default:	0xEEEFEEFF	Control mode:	Except PT
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Digit	D	C	B	A	U	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

1. OVF (DO: 0x12, Position command / feedback overflows), CTO (AL020 Serial communication timeout), SPL, SNL, PL, and NL are auto-protection functions.
2. STP is the stop function.
3. Use 0 - F to index the deceleration time of P5.020 - P5.035. For example: if you set P5.003.X to A, then the deceleration time of PL is determined by P5.030.

8

P5.004	Homing methods		Address: 0508H 0509H
Default:	0x0000	Control mode:	PR
Unit:	-	Setting range:	0x0000 to 0x012A
Format:	HEX	Data size:	16-bit

Settings:

0000

U Z Y X

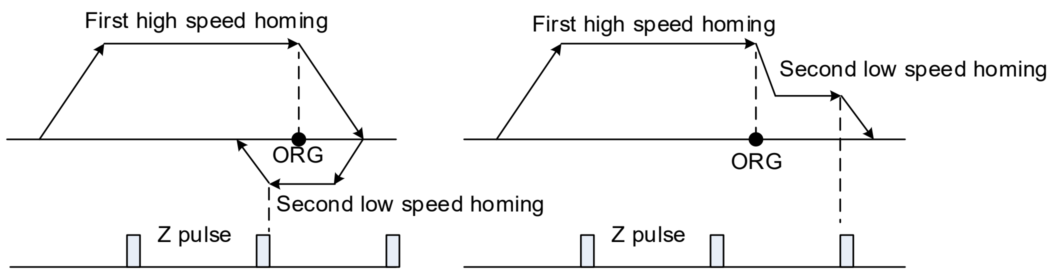
Definition of each setting value:

<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="12">-</td><td>0 to 1</td><td>0 to 2</td><td>0 to A</td></tr>
<tr><td rowspan="2">-</td><td rowspan="4">Y = 0: reverse 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="6">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 homing origin</td></tr>
<tr><td>X = 5: look for the Z pulse in reverse direction and define it as the homing origin</td></tr>
<tr><td rowspan="2">Y = 0: reverse 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 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: reverse 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	0.1 rpm	-	-
Setting range:	0.1 to 2000.0	1 to 20000	-	-
Format:	DEC	DEC	-	-
Example:	1.5 = 1.5 rpm	15 = 1.5 rpm	-	-

Settings:

The first speed setting for high speed homing.



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	0.1 rpm	-	-
Setting range:	0.1 to 500.0	1 to 5000	-	-
Format:	DEC	DEC	-	-
Example:	1.5 = 1.5 rpm	15 = 1.5 rpm	-	-

Settings:

The second speed setting for low speed homing.

P5.007■	Trigger Position command (PR mode only)		Address: 050EH 050FH
Default:	0	Control mode:	PR
Unit:	-	Setting range:	0 to 1000
Format:	DEC	Data size:	16-bit

Settings:

1. Set P5.007 to 0 to start homing.
2. 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 - 99 Bit 1 (DI: 0x12) + Command triggered (DI: 0x08)
Method 2	Trigger by P5.007: Set P5.007 to 2 to start executing PR#2

3. Set P5.007 to 1000 to execute the stop command which is the same as DI.STP.

8

8

4. When reading P5.007, if the command is incomplete and DO.TPOS is off (the motor does not reach the target position), 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 and DO.TPOS is on (the motor reaches the target position), 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 being executed and not yet complete.
   If the value read is 10003, it means PR#3 is complete, but the motor has not reached the target position yet.
   If the value read is 20003, it means PR#3 is complete and the motor reached the target position.

P5.008	**Positive 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 moves in the positive direction and its position feedback exceeds the value of P5.008, AL283 occurs.

P5.009	**Negative software limit**		**Address: 0512H 0513H**
Default:	-2147483648	Control mode:	PR
Unit:	PUU	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

In PR mode, if the motor moves in the negative direction and its position feedback 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:

The total data size is N x 32 bits, where N indicates the number of data sets returned to the 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 to read or write the data array. 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 read with the panel, the value set by P5.011 does not add 1, but when read or written by other methods, it 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 read with the panel or read and written through communication, the value set by P5.011 adds 1, but this parameter is not writable with the panel. 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 to 0x0011
Format:	HEX	Data size:	16-bit

Settings:

This parameter allows you to write data to the target continuously through communication.

0000

U Z Y X

X	PATH 1 volatile setting	Z	Reserved
Y	PATH 2 volatile setting	U	Reserved

- X: PATH 1 volatile setting

  0: non-volatile

  1: volatile

- Y: PATH 2 volatile setting

  0: non-volatile

  1: volatile

P5.016■	Axis position - main encoder		Address: 0520H 0521H
Default:	0	Control mode:	All
Unit:	PUU	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Read: main encoder position feedback, which is the monitoring variable 000 (00h) + offset value (value written in P5.016).

Write: writing any value to the parameter neither changes the monitoring variable 000 (00h) nor affects the positioning system. It adjusts the offset value only for easier observation.

P5.017	Reserved

P5.018	Axis position - pulse command		Address: 0524H 0525H
Default:	0	Control mode:	All
Unit:	pulse	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Pulse count from the pulse command.

P5.019	Reserved

P5.020	Acceleration / deceleration time #0		Address: 0528H 0529H
Default:	200	Control mode:	PR
Unit:	ms	Setting range:	1 to 65500
Format:	DEC	Data size:	16-bit

Settings:

The time setting for acceleration or deceleration in PR mode, which is the time duration required for the motor to accelerate from 0 to 3,000 rpm or decelerate from 3,000 rpm to 0.

P5.021	Acceleration / deceleration time #1		Address: 052AH 052BH
Default:	300	Control mode:	PR
Unit:	ms	Setting range:	1 to 65500
Format:	DEC	Data size:	16-bit

Settings:

The time setting for acceleration or deceleration in PR mode. Refer to P5.020 for details.

P5.022	Acceleration / deceleration time #2		Address: 052CH 052DH
Default:	500	Control mode:	PR
Unit:	ms	Setting range:	1 to 65500
Format:	DEC	Data size:	16-bit

Settings:

The time setting for acceleration or deceleration in PR mode. Refer to P5.020 for details.

P5.023	Acceleration / deceleration time #3		Address: 052EH 052FH
Default:	600	Control mode:	PR
Unit:	ms	Setting range:	1 to 65500
Format:	DEC	Data size:	16-bit

Settings:

The time setting for acceleration or deceleration in PR mode. Refer to P5.020 for details.

P5.024	Acceleration / deceleration time #4		Address: 0530H 0531H
Default:	800	Control mode:	PR
Unit:	ms	Setting range:	1 to 65500
Format:	DEC	Data size:	16-bit

Settings:

The time setting for acceleration or deceleration in PR mode. Refer to P5.020 for details.

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P5.025	Acceleration / deceleration time #5		Address: 0532H 0533H
Default:	900	Control mode:	PR
Unit:	ms	Setting range:	1 to 65500
Format:	DEC	Data size:	16-bit

Settings:

The time setting for acceleration or deceleration in PR mode. Refer to P5.020 for details.

P5.026	Acceleration / deceleration time #6		Address: 0534H 0535H
Default:	1000	Control mode:	PR
Unit:	ms	Setting range:	1 to 65500
Format:	DEC	Data size:	16-bit

Settings:

The time setting for acceleration or deceleration in PR mode. Refer to P5.020 for details.

P5.027	Acceleration / deceleration time #7		Address: 0536H 0537H
Default:	1200	Control mode:	PR
Unit:	ms	Setting range:	1 to 65500
Format:	DEC	Data size:	16-bit

Settings:

The time setting for acceleration or deceleration in PR mode. Refer to P5.020 for details.

P5.028	Acceleration / deceleration time #8		Address: 0538H 0539H
Default:	1500	Control mode:	PR
Unit:	ms	Setting range:	1 to 65500
Format:	DEC	Data size:	16-bit

Settings:

The time setting for acceleration or deceleration in PR mode. Refer to P5.020 for details.

P5.029	Acceleration / deceleration time #9		Address: 053AH 053BH
Default:	2000	Control mode:	PR
Unit:	ms	Setting range:	1 to 65500
Format:	DEC	Data size:	16-bit

Settings:

The time setting for acceleration or deceleration in PR mode. Refer to P5.020 for details.

8

P5.030	Acceleration / deceleration time #10		Address: 053CH 053DH
Default:	2500	Control mode:	PR
Unit:	ms	Setting range:	1 to 65500
Format:	DEC	Data size:	16-bit

Settings:

The time setting for acceleration or deceleration in PR mode. Refer to P5.020 for details.

P5.031	Acceleration / deceleration time #11		Address: 053EH 053FH
Default:	3000	Control mode:	PR
Unit:	ms	Setting range:	1 to 65500
Format:	DEC	Data size:	16-bit

Settings:

The time setting for acceleration or deceleration in PR mode. Refer to P5.020 for details.

P5.032	Acceleration / deceleration time #12		Address: 0540H 0541H
Default:	5000	Control mode:	PR
Unit:	ms	Setting range:	1 to 65500
Format:	DEC	Data size:	16-bit

Settings:

The time setting for acceleration or deceleration in PR mode. Refer to P5.020 for details.

P5.033	Acceleration / deceleration time #13		Address: 0542H 0543H
Default:	8000	Control mode:	PR
Unit:	ms	Setting range:	1 to 65500
Format:	DEC	Data size:	16-bit

Settings:

The time setting for acceleration or deceleration in PR mode. Refer to P5.020 for details.

P5.034	Acceleration / deceleration time #14		Address: 0544H 0545H
Default:	50	Control mode:	PR
Unit:	ms	Setting range:	1 to 1500
Format:	DEC	Data size:	16-bit

Settings:

The deceleration time setting for auto-protection. The default value is small for faster deceleration.

8

P5.035	Acceleration / deceleration time #15		Address: 0546H 0547H
Default:	30	Control mode:	PR
Unit:	ms	Setting range:	1 to 1200
Format:	DEC	Data size:	16-bit

Settings:

The deceleration time setting for auto-protection. The default value is small for faster deceleration.

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:

Specifies the address of the data array to save the first data to be captured. 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 the Capture pulse source. Note that this parameter is only writable when Capture stops (refer to P5.039). If the pulsesource of Capture is the main encoder, this parameter is write-protected and the axis position is the motor position feedback (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

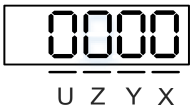
Settings:

When Capture is not in operation, this parameter indicates the number of data sets expected to be captured (readable and writable). When Capture is in operation, this parameter indicates the remaining number of data to be captured (read-only). Each time one data is captured, the value of P5.038 decrements by 1 until the value is 0, indicating that capturing is complete.

Note: the total number of data sets from Capture cannot exceed 100.

P5.039■	Capture: activate CAP control		Address: 054EH 054FH
Default:	0x2020	Control mode:	All
Unit:	-	Setting range:	0x0000 to 0xF23F
Format:	HEX	Data size:	16-bit

Settings:



X	Capture setting	Z	Trigger logic
Y	Axis source of Capture	U	Minimum interval between each trigger

■ X: Capture setting

Bit	Function	Description
0	Activate Capture	Start capturing; after capturing is complete, set this bit to 0 automatically (Capture disabled).
1	Reset position	After capturing the first data, reset the position of the first data. The position of the reset point is set by P5.076.
2	Reserved	-
3	Execute PR	Execute PR#50 automatically after capturing is complete.

■ Y: axis source of Capture

0: the Capture function is disabled

1: reserved

2: CN1 (pulse command)

3: CN2 (motor encoder)

■ Z: trigger logic

0: NO (normally open)

1: NC (normally closed)

■ U: minimum interval between each trigger

0 - F: 0 - 15 ms

Note: refer to Chapter 7 for detailed instructions for Capture.

P5.040	Delay time #0 after position reached		Address: 0550H 0551H
Default:	0	Control mode:	PR
Unit:	ms	Setting range:	0 to 32767
Format:	DEC	Data size:	16-bit

Settings:

There are 16 sets of delay time (# 0 - 15) in PR mode. This parameter is the delay time #0 in PR mode.

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P5.041	Delay time #1 after position reached		Address: 0552H 0553H
Default:	100	Control mode:	PR
Unit:	ms	Setting range:	0 to 32767
Format:	DEC	Data size:	16-bit

Settings:

Delay time #1 in PR mode.

P5.042	Delay time #2 after position reached		Address: 0554H 0555H
Default:	200	Control mode:	PR
Unit:	ms	Setting range:	0 to 32767
Format:	DEC	Data size:	16-bit

Settings:

Delay time #2 in PR mode.

P5.043	Delay time #3 after position reached		Address: 0556H 0557H
Default:	400	Control mode:	PR
Unit:	ms	Setting range:	0 to 32767
Format:	DEC	Data size:	16-bit

Settings:

Delay time #3 in PR mode.

P5.044	Delay time #4 after position reached		Address: 0558H 0559H
Default:	500	Control mode:	PR
Unit:	ms	Setting range:	0 to 32767
Format:	DEC	Data size:	16-bit

Settings:

Delay time #4 in PR mode.

P5.045	Delay time #5 after position reached		Address: 055AH 055BH
Default:	800	Control mode:	PR
Unit:	ms	Setting range:	0 to 32767
Format:	DEC	Data size:	16-bit

Settings:

Delay time #5 in PR mode.

P5.046	Delay time #6 after position reached		Address: 055CH 055DH
Default:	1000	Control mode:	PR
Unit:	ms	Setting range:	0 to 32767
Format:	DEC	Data size:	16-bit

Settings:

Delay time #6 in PR mode.

P5.047	Delay time #7 after position reached		Address: 055EH 055FH
Default:	1500	Control mode:	PR
Unit:	ms	Setting range:	0 to 32767
Format:	DEC	Data size:	16-bit

Settings:

Delay time #7 in PR mode.

P5.048	Delay time #8 after position reached		Address: 0560H 0561H
Default:	2000	Control mode:	PR
Unit:	ms	Setting range:	0 to 32767
Format:	DEC	Data size:	16-bit

Settings:

Delay time #8 in PR mode.

P5.049	Delay time #9 after position reached		Address: 0562H 0563H
Default:	2500	Control mode:	PR
Unit:	ms	Setting range:	0 to 32767
Format:	DEC	Data size:	16-bit

Settings:

Delay time #9 in PR mode.

P5.050	Delay time #10 after position reached		Address: 0564H 0565H
Default:	3000	Control mode:	PR
Unit:	ms	Setting range:	0 to 32767
Format:	DEC	Data size:	16-bit

Settings:

Delay time #10 in PR mode.

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P5.051	Delay time #11 after position reached		Address: 0566H 0567H
Default:	3500	Control mode:	PR
Unit:	ms	Setting range:	0 to 32767
Format:	DEC	Data size:	16-bit

Settings:

Delay time #11 in PR mode.

P5.052	Delay time #12 after position reached		Address: 0568H 0569H
Default:	4000	Control mode:	PR
Unit:	ms	Setting range:	0 to 32767
Format:	DEC	Data size:	16-bit

Settings:

Delay time #12 in PR mode.

P5.053	Delay time #13 after position reached		Address: 056AH 056BH
Default:	4500	Control mode:	PR
Unit:	ms	Setting range:	0 to 32767
Format:	DEC	Data size:	16-bit

Settings:

Delay time #13 in PR mode.

P5.054	Delay time #14 after position reached		Address: 056CH 056DH
Default:	5000	Control mode:	PR
Unit:	ms	Setting range:	0 to 32767
Format:	DEC	Data size:	16-bit

Settings:

Delay time #14 in PR mode.

P5.055	Delay time #15 after position reached		Address: 056EH 056FH
Default:	5500	Control mode:	PR
Unit:	ms	Setting range:	0 to 32767
Format:	DEC	Data size:	16-bit

Settings:

Delay time #15 in PR mode.

P5.056 - P5.059	Reserved

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	0.1 rpm	-	-
Setting range:	0.0 to 7500.0	0 to 75000	-	-
Format:	DEC	DEC	-	-
Example:	15 = 15 rpm	150 = 15 rpm	-	-

Settings:

Target speed #0 of PR mode.

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	0.1 rpm	-	-
Setting range:	0.0 to 7500.0	0 to 75000	-	-
Format:	DEC	DEC	-	-
Example:	15 = 15 rpm	150 = 15 rpm	-	-

Settings:

Target speed #1 of PR mode.

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	0.1 rpm	-	-
Setting range:	0.0 to 7500.0	0 to 75000	-	-
Format:	DEC	DEC	-	-
Example:	15 = 15 rpm	150 = 15 rpm	-	-

Settings:

Target speed #2 of PR mode.

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	0.1 rpm	-	-
Setting range:	0.0 to 7500.0	0 to 75000	-	-
Format:	DEC	DEC	-	-
Example:	15 = 15 rpm	150 = 15 rpm	-	-

Settings:

Target speed #3 of PR mode.

8

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	0.1 rpm	-	-
Setting range:	0.0 to 7500.0	0 to 75000	-	-
Format:	DEC	DEC	-	-
Example:	15 = 15 rpm	150 = 15 rpm	-	-

Settings:

Target speed #4 of PR mode.

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	0.1 rpm	-	-
Setting range:	0.0 to 7500.0	0 to 75000	-	-
Format:	DEC	DEC	-	-
Example:	15 = 15 rpm	150 = 15 rpm	-	-

Settings:

Target speed #5 of PR mode.

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	0.1 rpm	-	-
Setting range:	0.0 to 7500.0	0 to 75000	-	-
Format:	DEC	DEC	-	-
Example:	15 = 15 rpm	150 = 15 rpm	-	-

Settings:

Target speed #6 of PR mode.

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	0.1 rpm	-	-
Setting range:	0.0 to 7500.0	0 to 75000	-	-
Format:	DEC	DEC	-	-
Example:	15 = 15 rpm	150 = 15 rpm	-	-

Settings:

Target speed #7 of PR mode.

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	0.1 rpm	-	-
Setting range:	0.0 to 7500.0	0 to 75000	-	-
Format:	DEC	DEC	-	-
Example:	15 = 15 rpm	150 = 15 rpm	-	-

Settings:

Target speed #8 of PR mode.

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	0.1 rpm	-	-
Setting range:	0.0 to 7500.0	0 to 75000	-	-
Format:	DEC	DEC	-	-
Example:	15 = 15 rpm	150 = 15 rpm	-	-

Settings:

Target speed #9 of PR mode.

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	0.1 rpm	-	-
Setting range:	0.0 to 7500.0	0 to 75000	-	-
Format:	DEC	DEC	-	-
Example:	15 = 15 rpm	150 = 15 rpm	-	-

Settings:

Target speed #10 of PR mode.

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	0.1 rpm	-	-
Setting range:	0.0 to 7500.0	0 to 75000	-	-
Format:	DEC	DEC	-	-
Example:	15 = 15 rpm	150 = 15 rpm	-	-

Settings:

Target speed #11 of PR mode.

8

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	0.1 rpm	-	-
Setting range:	0.0 to 7500.0	0 to 75000	-	-
Format:	DEC	DEC	-	-
Example:	15 = 15 rpm	150 = 15 rpm	-	-

Settings:

Target speed #12 of PR mode.

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	0.1 rpm	-	-
Setting range:	0.0 to 7500.0	0 to 75000	-	-
Format:	DEC	DEC	-	-
Example:	15 = 15 rpm	150 = 15 rpm	-	-

Settings:

Target speed #13 of PR mode.

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	0.1 rpm	-	-
Setting range:	0.0 to 7500.0	0 to 75000	-	-
Format:	DEC	DEC	-	-
Example:	15 = 15 rpm	150 = 15 rpm	-	-

Settings:

Target speed #14 of PR mode.

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	0.1 rpm	-	-
Setting range:	0.0 to 7500.0	0 to 75000	-	-
Format:	DEC	DEC	-	-
Example:	15 = 15 rpm	150 = 15 rpm	-	-

Settings:

Target speed #15 of PR mode.

P5.076	Capture: reset position after first data captured		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 position of the first point, and the position of the reset point is defined by this parameter.

P5.077 - P5.092	Reserved

P5.093	Motion control macro command: command parameter #4		Address: 05BAH 05BBH
Default:	0x00000000	Control mode:	All
Unit:	-	Setting range:	0x00000000 to 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Before issuing 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:

Refer to P5.093 for details.

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:

Refer to P5.093 for details.

8

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:

Refer to P5.093 for details.

P5.097■	Motion control macro command: issue command / read execution result		Address: 05C2H 05C3H
Default:	0x0000	Control mode:	All
Unit:	-	Setting range:	0x0000 to 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.

When you write the command code 0x0003 to this parameter, 0x1003 is returned if successful; and 0xF03X if unsuccessful (depending on the command description). If you issue 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 write protection 0: disabled 1: enabled P5.094 = read protection range of parameter and data array (-1 to 8) -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 8: all parameter groups (P0 - P7) are unreadable 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 8)
	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 parameter	P5.096 = enter password (1 - 16777215)
Read the return value of P5.097 after executing the macro	Success code
	0x1004
	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, the function is disabled and does not allow further attempts.

P5.098	**PR number triggered by event rising-edge**		**Address: 05C4H 05C5H**
Default:	0x0000	Control mode:	PR
Unit:	-	Setting range:	0x0000 to 0xDDDD
Format:	HEX	Data size:	16-bit

Settings:

0000
U Z Y X

X	The action when PR is EV1 rising-edge triggered	Z	The action when PR is EV3 rising-edge triggered
Y	The action when PR is EV2 rising-edge triggered	U	The action when PR is EV4 rising-edge triggered

- X: the action when EV1 is on

  0: no action

  1 - D: execute PR#51 - 63

- Y: the action when EV2 is on

  0: no action

  1 - D: execute PR#51 - 63

- Z: the action when EV3 is on

  0: no action

  1 - D: execute PR#51 - 63

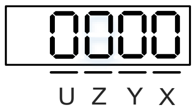
- U: the action when EV4 is on

  0: no action

  1 - D: execute PR#51 - 63

P5.099	**PR number triggered by event falling-edge**		**Address: 05C6H 05C7H**
Default:	0x0000	Control mode:	PR
Unit:	-	Setting range:	0x0000 to 0xDDDD
Format:	HEX	Data size:	16-bit

Settings:



X	The action when PR is EV1 falling-edge triggered	Z	The action when PR is EV3 falling-edge triggered
Y	The action when PR is EV2 falling-edge triggered	U	The action when PR is EV4 falling-edge triggered

■ X: the action when EV1 is off

0: no action

1 - D: execute PR#51 - 63

■ Y: the action when EV2 is off

0: no action

1 - D: execute PR#51 - 63

■ Z: the action when EV3 is off

0: no action

1 - D: execute PR#51 - 63

■ U: the action when EV4 is off

0: no action

1 - D: execute PR#51 - 63

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 read or written 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 read or written by any method, the value set by P5.011 does not add 1.

Refer to Section 7.2.1 Data array for detailed instructions.

P5.102■	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 read or written by any method, the value set by P5.011 does not add 1.

Refer to Section 7.2.1 Data array for detailed instructions.

P5.103■	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 read or written by any method, the value set by P5.011 does not add 1.

Refer to Section 7.2.1 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:

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	Reserved	U	DEC1: deceleration time selection for first homing
D	BOOT: whether to execute homing automatically when the drive is powered on	-	-

- YX: PATH: path type

  0x00: Stop: the servo stops after homing is complete

  0x01 - 0x63: Auto: the servo executes the specified path (PR#1 - PR#99) after homing is complete

- 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: whether to execute homing automatically when the drive is powered on

  0: do not execute homing

  1: execute homing automatically (servo switches to on for the first time after power is applied)

Apart from the preceding definitions, the related settings for homing also include:

1. P5.004: homing methods.
2. P5.005 - P5.006: speed settings for homing.
3. P6.001: the origin definition (ORG_DEF) is the position of the origin and may not be 0. This function is used as a traversal of the position system.

Note:

1. After finding the origin (sensor or Z), the servo 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 0x00.
   If returning to the origin is needed, set PATH to 0x01 to 0x63 and set the route as PABS = 0.
   Example:
   When P6.000 = 0x0001, the servo automatically executes PR#1 after homing is complete.
   Set the route of PR#1 (setting P6.002 & P6.003) as moving to the absolute position of 0.
2. If the origin is found (sensor or Z) and you want the servo to move an offset S and define the position after moving as P, then set 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

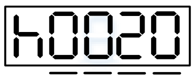
Settings:

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:

High word



D C B A

Low word

U Z Y X

A	SPD, Target speed[Note]	X	TYPE, Path type
B	DLY, Delay time	Y	OPT, Option
C	AUTO[Note]	Z	ACC, Acceleration time[Note]
D	Reserved	U	DEC, Deceleration time[Note]

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.
-	-	-	INS	7: JUMP, jump to the specified path.
-	ROM	AUTO	INS	8: WRITE, write specified parameter to specified path.
DIR		OVLP	INS	A: INDEX, rotary axis position control.

TYPE (path type): when 1, 2, or 3 is executed, the motor operation can be interrupted and stopped by DI.STP and software limits.

INS: interrupts the previous path when the current path is executed.

OVLP: allow overlapping of the next path. Overlapping is not allowed in Speed mode.

AUTO: once current PR path is finished, automatically load the next path.

CMD, DIR, ROM, and UNIT: refer to Section 7.1.3 Motion Control commands.

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■ 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

A	Corresponding parameter	Default value (rpm)
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
11	P5.071	1800
12	P5.072	2000
13	P5.073	2300
14	P5.074	2500
15	P5.075	3000

- B: DLY, delay time

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 enabled only when P6.002.X = A (rotary axis position control).

  Description of each bit:

Bit	Function	Description
Bit 0 - Bit 1	Reserved	-
Bit 2	AUTO	0: disable auto function 1: once current PR path is finished, automatically load the next path

Note: the parameter format definition [C, A, U, Z] is different from the preceding table when P6.002.X = 8 (write specified parameter to specified path). 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 and 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.

8

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.

8

P6.015	PATH 7 data		Address: 061EH 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.

8

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.

8

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.

8

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.

8

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.

8

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.

8

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 068DH
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.

8

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.

8

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.

8

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.

8

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: 06C6H 06C7H
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.

8

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.

8

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.

8

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.

8

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.

8

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.

8

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.

8

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.

8

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.

8

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.

8

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.

8

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.

8

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.

8

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: 07C2H 07C3H
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.

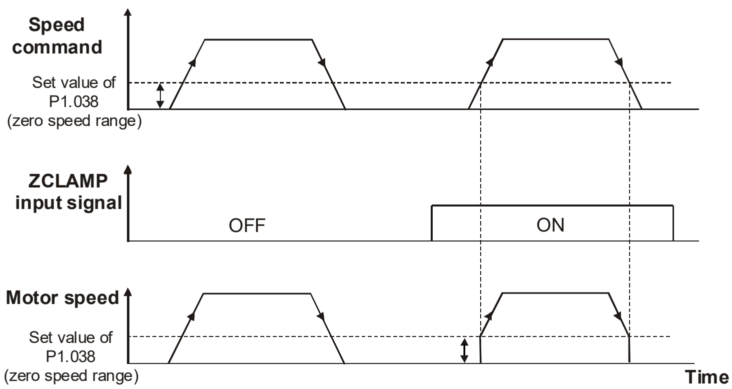
Table 8.1 Digital input (DI) descriptions

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 you troubleshoot the alarm, this DI is on and the error signal displayed by the servo drive is cleared.	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 0x0001), the gain value switches to the value which is the original gain multiplied by the rate of change.	Level triggered	PT, PR, S

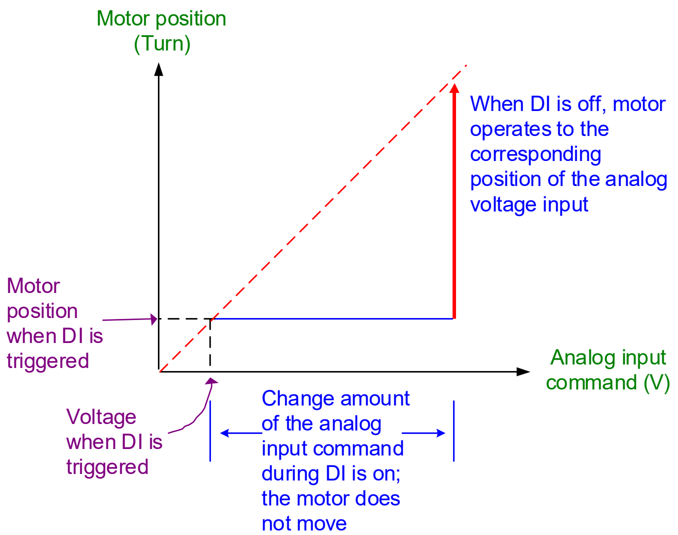
Value: 0x04			
DI name	Description	Triggering method	Control mode
CCLR	Clear the pulse counter. Refer to P2.050 for the methods to clear the pulses. When this DI is on, the accumulative position pulse deviation of the drive (P0.002 = 33) is cleared to 0.	Rising-edge triggered, level triggered	PT, PR

Value: 0x05			
DI name	Description	Triggering method	Control mode
ZCLAMP	When the speed is slower than the setting of P1.038 Zzero speed detection level), the motor stops operating when this DI is on.  	Level triggered	S

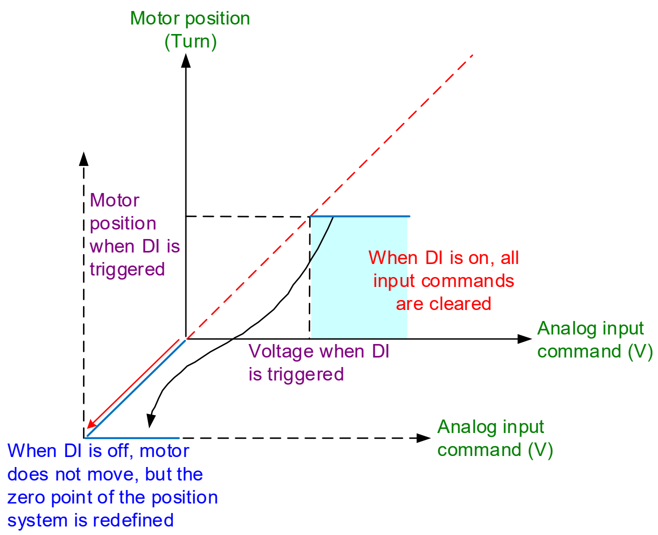
Value: 0x06			
DI name	Description	Triggering method	Control mode
CMDINV	In Speed and Torque modes, the input command is reversed when this DI is on.	Level triggered	S, Sz, T, Tz

Value: 0x08			
DI name	Description	Triggering method	Control mode
CTRG	In PR mode, after the PR command (POS0 - 6) is selected, 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 Torque limit command is the internal register or analog voltage.	Level triggered	PT, PR, S

<table>
<tr><th colspan="4">Value: 0x0C</th></tr>
<tr><th>DI name</th><th>Description</th><th>Triggering method</th><th>Control mode</th></tr>
<tr><td>VPL</td><td>Latch function of analog Position command. When this DI is on, the 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.

</td><td>Level triggered</td><td>PT</td></tr>
</table>

8

Value: 0x0D			
DI name	Description	Triggering method	Control mode
VPRS	Clear function of analog Position command. When 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 position system of the motor. 	Level triggered	PT

Value: 0x0F			
DI name	Description	Triggering method	Control mode
SPDKVC	Switch between P1.040 (Maximum motor speed for analog Speed command 1) and P1.081 (Maximum motor speed for analog Speed command 2).	Level triggered	S

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 Speed limit command is the internal register or analog voltage.	Level triggered	T

<table>
<tr><th colspan="13">Value: 0x11, 0x12, 0x13, 0x1A, 0x1B, 0x1C, 0x1E</th></tr>
<tr><th>DI name</th><th colspan="10">Description</th><th>Triggering method</th><th>Control mode</th></tr>
<tr><td rowspan="15">POS0
POS1
POS2
POS3
POS4
POS5
POS6</td><td colspan="10">PR command selection (0 - 99)</td><td rowspan="15">Level triggered</td><td rowspan="15">PR</td></tr>
<tr><td>Position command</td><td>POS6</td><td>POS5</td><td>POS4</td><td>POS3</td><td>POS2</td><td>POS1</td><td>POS0</td><td>CTRG</td><td>Corresponding parameter</td></tr>
<tr><td rowspan="2">Homing</td><td rowspan="2">0</td><td rowspan="2">0</td><td rowspan="2">0</td><td rowspan="2">0</td><td rowspan="2">0</td><td rowspan="2">0</td><td rowspan="2">0</td><td rowspan="2">↑</td><td>P6.000</td></tr>
<tr><td>P6.001</td></tr>
<tr><td rowspan="2">PR#01</td><td rowspan="2">0</td><td rowspan="2">0</td><td rowspan="2">0</td><td rowspan="2">0</td><td rowspan="2">0</td><td rowspan="2">0</td><td rowspan="2">1</td><td rowspan="2">↑</td><td>P6.002</td></tr>
<tr><td>P6.003</td></tr>
<tr><td>...</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>...</td></tr>
<tr><td rowspan="2">PR#50</td><td rowspan="2">0</td><td rowspan="2">1</td><td rowspan="2">1</td><td rowspan="2">0</td><td rowspan="2">0</td><td rowspan="2">1</td><td rowspan="2">0</td><td rowspan="2">↑</td><td>P6.098</td></tr>
<tr><td>P6.099</td></tr>
<tr><td rowspan="2">PR#51</td><td rowspan="2">0</td><td rowspan="2">1</td><td rowspan="2">1</td><td rowspan="2">0</td><td rowspan="2">0</td><td rowspan="2">1</td><td rowspan="2">1</td><td rowspan="2">↑</td><td>P7.000</td></tr>
<tr><td>P7.001</td></tr>
<tr><td>...</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>...</td></tr>
<tr><td rowspan="2">PR#99</td><td rowspan="2">1</td><td rowspan="2">1</td><td rowspan="2">0</td><td rowspan="2">0</td><td rowspan="2">0</td><td rowspan="2">1</td><td rowspan="2">1</td><td rowspan="2">↑</td><td>P7.098</td></tr>
<tr><td>P7.099</td></tr>
</table>

Value: 0x1D			
DI name	Description	Triggering method	Control mode
ABSE	When DI.ABSE is on, the servo is in absolute mode and can enable the functions of DI.ABSQ, DI.ABSC, DO.ABSR, and DO.ABSD 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.ABSQ, DO2 will be DO.ABSR, and DO3 will be DO.ABSD. In addition, the DI point of DI.ABSC can be assigned by the parameter.	Level triggered	All

Value: 0x1F			
DI name	Description	Triggering method	Control mode
ABSC	When DI.ABSC is on, the current absolute position of the encoder is set as the origin definition (P6.001), but this DI is only valid when DI.ABSE is on. Note: in CANopen / EtherCAT / DMCNET mode, the origin definition is the setting value of OD 607Ch multiplied by a negative sign; in PROFINET mode, the origin definition is the setting value of PNU11 multiplied by a negative sign.	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 10.3.5.1.1 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)	Level triggered	S, Sz

Speed command number	DI signal of CN1: SPD1	DI signal of CN1: SPD0	Command source		Content
S1	0	0	S	External analog signal	Voltage difference between V_REF and GND
			Sz	N/A	Speed command is 0
S2	0	1	Internal register parameter		P1.009
S3	1	0			P1.010
S4	1	1			P1.011

Value: 0x16, 0x17

DI name	Description	Triggering method	Control mode
TCM0 TCM1	Register Torque command selection (1 - 4)	Level triggered	T, Tz

Torque command number	DI signal of CN1: TCM1	DI signal of CN1: TCM0	Command source		Content
T1	0	0	T	External analog signal	Voltage difference between T_REF and GND
			Tz	N/A	Torque command is 0
T2	0	1	Internal register parameter		P1.012
T3	1	0			P1.013
T4	1	1			P1.014

Value: 0x18

DI name	Description	Triggering method	Control mode
S-P	In S-P dual / multi-mode, when this DI is off, the drive is in Speed mode; when this DI is on, the drive is in Position mode. Select PT or PR with DI.PT-PR (0x2B).	Level triggered	Dual / multi-mode

Value: 0x19

DI name	Description	Triggering method	Control mode
S-T	In S-T dual mode, when this DI is off, the drive is in Speed mode; when this DI is on, the drive is in Torque mode.	Level triggered	Dual mode

Value: 0x20

DI name	Description	Triggering method	Control mode
T-P	In T-P dual / multi-mode, when this DI is off, the drive is in Torque mode; when this DI is on, the drive is in Position mode. Select PT or PR with DI.PT-PR (0x2B).	Level triggered	Dual / multi-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)	Negative inhibit limit (normally closed contact).	Level triggered	All

Value: 0x23			
DI name	Description	Triggering method	Control mode
PL (CCWL)	Positive inhibit limit (normally closed contact).	Level triggered	All

Value: 0x24			
DI name	Description	Triggering method	Control mode
ORGP	During homing, when this DI is on, the servo regards this position as the homing origin. 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, the servo starts 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 multi-mode. When this DI is off, the drive is in PT mode; when this DI is on, the drive is in PR mode.	Level triggered	Dual / multi-mode

Value: 0x37			
DI name	Description	Triggering method	Control mode
JOGU	When this DI is on, the motor jogs in the positive direction.	Level triggered	All

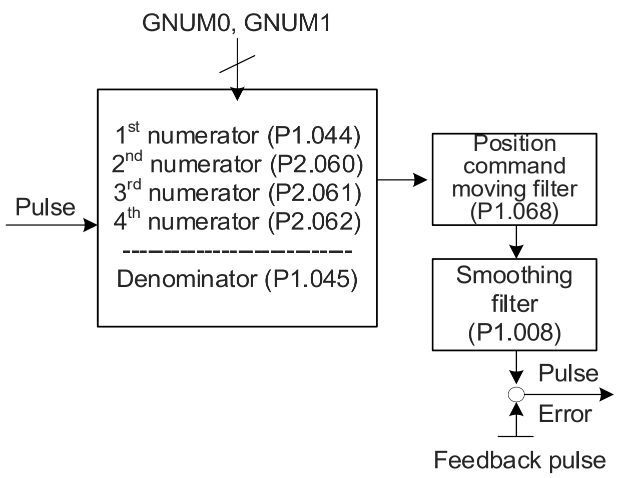
Value: 0x38			
DI name	Description	Triggering method	Control mode
JOGD	When this DI is on, the motor jogs in the negative direction.	Level triggered	All

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

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

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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. Important: this function has to be set to DI4 to ensure immediate pulse inhibition.	Level triggered	PT

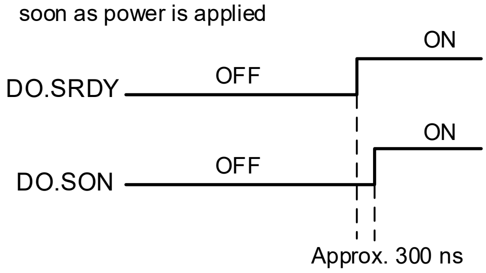
Value: 0x46			
DI name	Description	Triggering method	Control mode
STP	Motor stops.	Rising-edge triggered	PR

Value: 0x47			
DI name	Description	Triggering method	Control mode
PFQS	Use this DI to set the emergency stop for P5.003 (deceleration time for auto-protection). When this DI is on, AL35F occurs and the motor starts decelerating. When the speed reaches 0, AL3CF occurs and servo is switched to Servo Off.	Rising-edge triggered	PT, PR, T, S

Note: the digital input function is disabled when P2.010 - P2.017 and P2.036 - P2.040 are set to 0x0100.

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 being on when the servo is on as soon as power is applied 	Level triggered	All

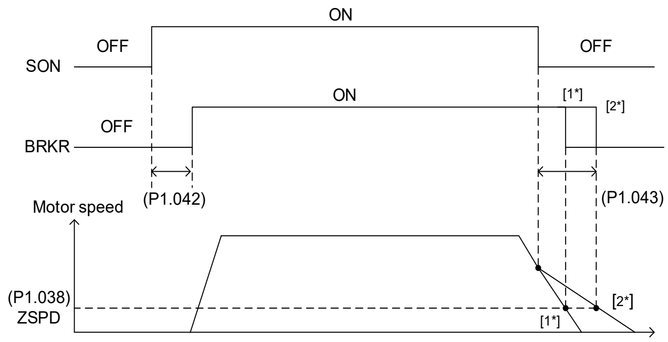
Value: 0x03			
DO name	Description	Triggering method	Control mode
ZSPD	When the motor speed is slower than the zero speed detection level (P1.038), this DO is on.	Level triggered	All

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 pulse number error is smaller than the position range setting (P1.054), this DO is on.	Level triggered	PT, PR

Value: 0x06			
DO name	Description	Triggering method	Control mode
TQL	When the torque limit is activated, this DO is on.	Level triggered	All (except for T and Tz)

Value: 0x07			
DO name	Description	Triggering method	Control mode
ALRM	When a servo alarm occurs, this DO is on. (Except for positive / negative limit, communication error, and undervoltage.)	Level triggered	All

Value: 0x08			
DO name	Description	Triggering method	Control mode
BRKR	Output signal of the magnetic brake control. Set P1.042 and P1.043 to adjust the delay time before and after the magnetic brake control function is activated and deactivated.  Note: refer to the note in P1.042.	Level triggered	All

Value: 0x09			
DO name	Description	Triggering method	Control mode
HOME	When homing is complete, it means the position system and position counter are defined and this DO is on. When power is applied for the first time, this DO is off; when homing is complete, this DO is on. During operation, this DO is on until the position counter overflows (including commands or feedback). Then, this DO turns off. When the homing command is triggered, this DO is off; after homing is complete, this DO is on.	Level triggered	PR

Value: 0x0D			
DO name	Description	Triggering method	Control mode
ABSW	When an absolute encoder alarm occurs, this DO is on.	-	All

Value: 0x0E			
DO name	Description	Triggering method	Control mode
IDXD	When this DI is on, it means the rotary axis position is defined. When homing is complete, the rotary axis position is defined as well.	-	PR

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Value: 0x10			
DO name	Description	Triggering method	Control mode
OLW	This DO is on when the overload accumulative time exceeds t_{OL}. However, if the overload accumulative time exceeds the overload allowable time of the servo, the servo sends the overload alarms AL006 and AL023. t_{OL}= Overload allowable time of the servo x setting value of P1.056 (Motor output overload warning level) For example: P1.056 = 60 (unit: %). When the output average load of the servo drive is 200% and the output time exceeds 8 seconds, the overload alarms (AL006 and AL023) occur. t_{OL} = 8 sec x 60% = 4.8 sec That is, when the output average load of the servo drive is 200% for over t_{OL} = 4.8 seconds, DO.OLW (DO code: 0x10) is on. If the duration exceeds 8 seconds, the servo drive sends AL006 (overload) and AL023 (early overload warning).	Level triggered	All

Value: 0x11			
DO name	Description	Triggering method	Control mode
WARN	Warning outputs (positive / negative limit, communication error, and undervoltage).	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 (negative limit).	Level triggered	PR

Value: 0x14			
DO name	Description	Triggering method	Control mode
SPL (SCCWL)	Software limit (positive limit).	Level triggered	PR

Value: 0x15			
DO name	Description	Triggering method	Control mode
Cmd_OK	When the Position command is complete and the drive enters Position mode, this DO is on. When the Position command is executing, this DO is off; after the command is complete, 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

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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; otherwise, it is off. Refer to P1.048.	Level triggered	PR

Value: 0x19			
DO name	Description	Triggering method	Control mode
SP_OK	Motor speed reaches the target speed: in Speed mode, when the error between the speed feedback and the command is smaller than the value of P1.047, this DO is on.	Level triggered	S, Sz

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

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Value: 0x3A			
DO name	Description	Triggering method	Control mode
SPO_A	Output bit 10 of P4.006.	Level triggered	All

Value: 0x3B			
DO name	Description	Triggering method	Control mode
SPO_B	Output bit 11 of P4.006.	Level triggered	All

Value: 0x3C			
DO name	Description	Triggering method	Control mode
SPO_C	Output bit 12 of P4.006.	Level triggered	All

Value: 0x3D			
DO name	Description	Triggering method	Control mode
SPO_D	Output bit 13 of P4.006.	Level triggered	All

Value: 0x3E			
DO name	Description	Triggering method	Control mode
SPO_E	Output bit 14 of P4.006.	Level triggered	All

Value: 0x3F			
DO name	Description	Triggering method	Control mode
SPO_F	Output bit 15 of P4.006.	Level triggered	All

Value: when DI.ABSE is on, DO.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 the servo drive can receive request issued by DI.ABSQ; when DO.ABSR is on, it indicates after the request is received, the data has been prepared and the ABSD data is valid for the controller to access. This DO is only valid when DI.ABSE is on. Refer to Figure 10.3.5.1.1 for a detailed description.	Level triggered	All

Value: when DI.ABSE is on, DO.ABSD triggered by DO3 will replace the DO3 assigned by P2.020			
DO name	Description	Triggering method	Control mode
ABSD (always output by DO3)	The DO for ABS data. This DO is only valid when DI.ABSE and DO.ABSR are both on. Refer to Figure 10.3.5.1.1 for a detailed description.	Level triggered	All

Note: the digital output function is disabled when P2.018 - P2.022 and P2.041 are set to 0x0100.

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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 for monitoring the variable.
Format	Each monitoring variable is stored in the 32-bit format (long integer) in the servo drive.
Category	Basic variables / extension variables: 1. Basic variables: the variables (P0.002 = 0 to 28) within the loop of pressing the UP / DOWN keys; in Monitoring mode, use the UP / DOWN keys on the panel to display the variables. 2. Extension variables: the variables other than basic variables.
Monitoring method	Panel display / mapping: 1. Panel display: monitor with the panel 2. Mapping: monitor the variables or parameters by mapping parameters
Panel display	1. Use the MODE key to switch to the Monitoring mode and press the UP / DOWN keys to select the variable to monitor. 2. Input the code of the variable to be monitored into P0.002 and start monitoring. Press the SHIFT key on the panel to switch between high and low word display; press the SET key on the panel to switch between decimal and hexadecimal display.
Mapping	1. Parameters that support monitoring variable mapping: P0.009 - P0.013. Refer to Section 8.2 Parameter descriptions. 2. Read the monitoring variables through communication using mapping parameters. 3. The values of the mapping parameters (P0.009 - P0.013) are the content of the basic variables (17h, 18h, 19h, and 1Ah). To monitor P0.009, set P0.017 to the value to read (refer to P0.002). When reading the data through communication, you can directly read the data specified by P0.017; when monitoring the data with the panel (set P0.002 to 23), the panel displays “VAR-1” and then 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 and D2 indicates 2 decimal places.
Dec	Only decimal display is available on the panel, and you cannot switch to hexadecimal display by pressing the SET key.
Hex	Only hexadecimal display is available on the panel, and you cannot switch to decimal display by pressing the SET key.

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The monitoring variables are described in the following table by the code sequence:

Code	Variable name / property	Description
000 (00h)	Feedback position (PUU) B	Current position feedback of the motor encoder. Unit: Pulse of User Unit (PUU).
001 (01h)	Position command (PUU) B	Current position of the Position command. Unit: Pulse of User Unit (PUU). PT mode: number of pulse commands received by the servo drive. PR mode: absolute position of the Position command.
002 (02h)	Following error (PUU) B	Difference between the Position command before filtered and the position feedback. Unit: Pulse of User Unit (PUU).
003 (03h)	Feedback position (pulse) B	Current position feedback of the motor encoder. Unit: encoder unit (pulse).
004 (04h)	Position command (pulse) B	Current position of the Position command. Unit: encoder unit (pulse).
005 (05h)	Following error (pulse) B	Difference between the Position command before filtered and the position feedback. Unit: encoder unit (pulse).
006 (06h)	Position command frequency B	Frequency of the position command received by the drive. Unit: Kpps. Applicable to PT and PR modes.
007 (07h)	Speed feedback B D1 Dec	Current motor speed. Unit: 0.1 rpm. This is the speed processed by the low-pass filter, which makes it more stable.
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.

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Code	Variable name / property	Description
017 (11h)	Resonance frequency B Dec	Resonance frequency of the system, consisting of two sets of frequencies: F1 and F2 When monitoring from the panel, press the SHIFT key to switch between F1 and F2: F2 displays zero decimal places; F1 displays 1 decimal place. When reading by communication (mapping parameter): Low word returns frequency F2. High word returns frequency F1.
018 (12h)	Z phase offset B Dec	Offset value between motor position and Z phase; range: -4999 to +5000. When the motor position overlaps with Z phase, the value is 0; the greater the absolute value of this variable, the greater the offset.
019 (13h)	Mapping parameter content #1 B	Returns the value of P0.025 which is mapped by P0.035.
020 (14h)	Mapping parameter content #2 B	Returns the value of P0.026 which is mapped by P0.036.
021 (15h)	Mapping parameter content #3 B	Returns the value of P0.027 which is mapped by P0.037.
022 (16h)	Mapping parameter content #4 B	Returns the value of P0.028 which is mapped by P0.038.
023 (17h)	Mapping monitoring variable #1 B	Returns the value of P0.009 which is mapped by P0.017.
024 (18h)	Mapping monitoring variable #2 B	Returns the value of P0.010 which is mapped by P0.018.
025 (19h)	Mapping monitoring variable #3 B	Returns the value of P0.011 which is mapped by P0.019.
026 (1Ah)	Mapping monitoring variable #4 B	Returns the value of P0.012 which is mapped by P0.020.
027 (1Bh)	Z phase offset B	Offset value between motor position and Z phase. (Only available for Delta CNC controllers.)
028 (1Ch)	Alarm code Dec B	The alarm code (in decimal). The value being converted to the hexadecimal notation is identical to the alarm code displayed in P0.001 and the error code of communication models.
032 (20h)	Position error (PUU)	Difference between the Position command after filtered and the position feedback. Unit: Pulse of User Unit (PUU).
033 (21h)	Position error (pulse)	Difference between the Position command after filtered and the position feedback. Unit: encoder unit (pulse).
035 (23h)	Rotary axis position command	Rotary axis position command at present. Unit: Pulse of User Unit (PUU).
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).

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Code	Variable name / property	Description
039 (27h)	DI status (integrated) Hex	Integrated DI status of the drive. Each bit corresponds to one DI channel. Source includes hardware channel or P4.007, which is determined by P3.006.
040 (28h)	DO status (hardware) Hex	Actual status from the DO hardware. Each bit corresponds to one DO channel.
041 (29h)	Status of the drive	Returns the value of P0.046. Refer to the description of P0.046.
042 (2Ah)	PR number in execution	Displays the number of the PR command being executed.
043 (2Bh)	Captured data of CAP	The latest data captured by CAP. Note: CAP can continuously capture multiple points.
049 (31h)	Pulse command CNT	Pulse counts from the pulse command (CN1).
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	Actual motor current at present. Unit: 0.01 ampere (Amp).
056 (38h)	DC Bus voltage D1 Dec	Rectified capacitor voltage. Unit: 0.1 Volt.
064 (40h)	Register of PR command endpoint	In PR mode, the endpoint of the Position command (Cmd_E).
065 (41h)	Register of PR command output	In PR mode, the accumulative output of the Position command after filtered.
067 (43h)	PR target speed	Target speed specified in the PR path. Unit: PPS (pulse per second).
072 (48h)	Speed command (analog) B D1 Dec	Speed command from the analog channel. Unit: 0.1 rpm.
081 (51h)	Incremental pulse input of synchronous Capture axis	When the synchronous Capture axis is enabled, the actual distance between two marks can be measured by the received pulse number between two captures.
082 (52h)	PR number in execution	Provides the number of the PR command currently executed by the servo drive to the HMC. (Available for -F models)
084 (54h)	Pulse number deviation of synchronous Capture axis	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.
091 (5Bh)	Rotary axis position feedback	Immediate feedback of the rotary axis position. Unit: Pulse of User Unit (PUU).
096 (60h)	Drive firmware version Dec	Includes 2 versions: DSP and CPLD. When monitoring from the panel, press the SHIFT key to switch between DSP and CPLD: DSP displays zero decimal places; CPLD displays 1 decimal place. When reading by communication (mapping parameter): Low word returns the DSP version number. High word returns the CPLD version number.

Code	Variable name / property	Description
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 (time stamp) the servo drive receives the SYNC signal. Unit: μsec.
113 (71h)	CANopen SYNC TS (filtered)	The time (time stamp) the servo drive receives the SYNC signal that has been processed the low-pass filter. Unit: μsec.
119 (77h)	EtherCAT state machine	1: Init 2: Pre-Operational (Pre-OP) 4: Safe-Operational (Safe-OP) 8: Operational (OP)
120 (78h)	Communication error rate	When this value continues to increase, it indicates that there is communication interference. In an interference-free environment, this value should not increase. (Available on all models except -L)
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 change.
-91	Overload (AL006) protection counter	Displays the motor load during operation. When the value reaches 100%, AL006 occurs.
-111	Regeneration error (AL005) protection counter	When the value of the regeneration counter reaches 100%, AL005 occurs.
-124	Encoder temperature	Monitor the encoder temperature.
-169	Regenerative resistance overload (AL086) protection counter	This variable monitors the average power consumed by the regenerative resistor (unit: %) when the capacitor energy of the servo drive is released to the regenerative resistor. When the value reaches 100%, AL086 occurs.
-202	Motor electrical angle	The current electrical angle multiplied by 4.
-207	Regenerative resistor power consumption	The power consumption (unit: %) of the regenerative resistor at the time when the energy of the servo drive capacitor is released to the regenerative resistor.
-248	Alarm reset delay time	When an alarm occurs, this value counts down from the time (unit: ms) set in P2.123 to 0. The alarm can be reset only when this value reaches 0. Affected alarms: AL001, AL005, AL006, AL016, AL085, AL086, AL02C, and AL02F.

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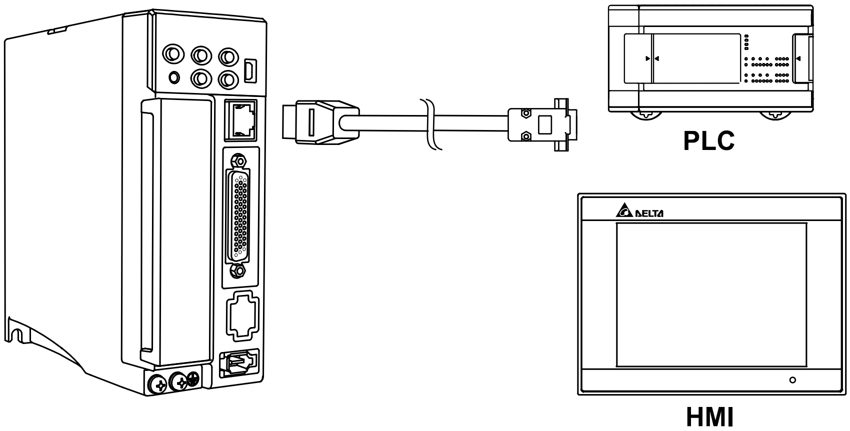
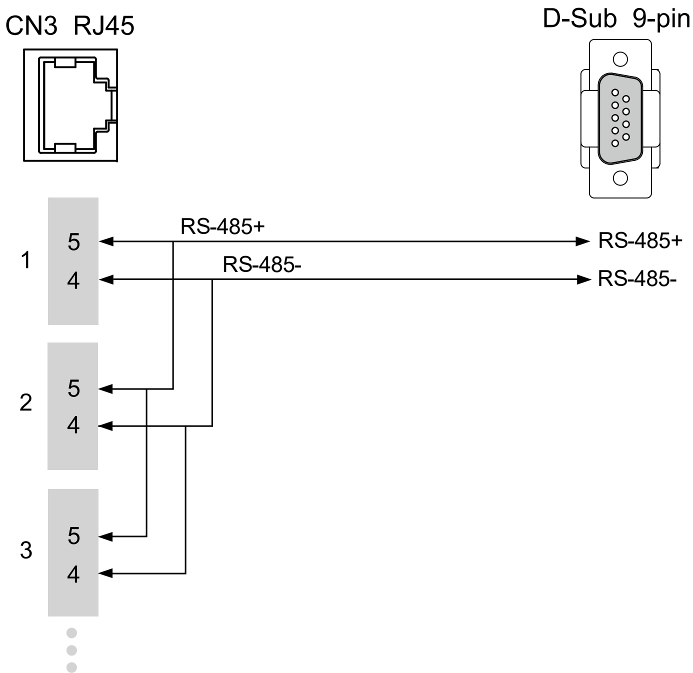
Modbus Communication 9

This chapter describes the Modbus communication which you use for reading and writing general parameters. For fieldbus control, refer to the related DMCNET, CANopen, EtherCAT, and PROFINET documentation. The details of ASCII and RTU modes are also provided in this chapter.

9.1 RS-485 communication interface (hardware)

The servo drive supports RS-485 serial communication that you can use to access and change the parameters of the servo system. See the following wiring description:





Note:

1. 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 cable with the length of 15 meters or less is recommended to ensure data transmission accuracy.
2. The gray-shaded numbers 4 and 5 in the preceding figure represent the pin numbers of the connectors.
3. The power supply unit should supply 12 V_{DC} (or higher) power for the controller.
4. When using RS-485, you may connect up to 32 servo drives. Install a repeater to connect more servo drives (the maximum is 127 stations).
5. Refer to Wiring for the CN3 connector in Chapter 3.

9.2 RS-485 communication parameters

The servo drive requires setting these parameters for using Modbus communication: P3.000 (Address), P3.001 (Transmission speed), and P3.002 (Modbus communication protocol). On the other hand, P3.003 (Modbus communication error handling), P3.004 (Modbus communication timeout), P3.005 (Modbus communication), P3.006 (Digital input (DI) control switch), and P3.007 (Modbus communication response delay time) are optional parameters. Refer to Chapter 8 for detailed descriptions of the relevant parameters.

9.3 Modbus communication protocol

There are two modes of Modbus network communication: ASCII (American Standard Code for Information Interchange) and RTU (Remote Terminal Unit). You can set the communication protocol (ASCII or RTU) with P3.002 according to your requirements. The servo drive also supports these functions: reading multiple words (03H), writing a single word (06H), and writing multiple words (10H). Refer to the following descriptions.

Note: the servo drive does not support the broadcast mode.

Code description

ASCII mode:

In ASCII mode, data is transmitted in ASCII (American Standard Code for Information Interchange) format. For instance, to transmit “64H” between the master and slave, the ASCII codes “36H” and “34H” are sent to represent “6” and “4” respectively.

The corresponding ASCII codes for the numbers 0 to 9 and the characters A to F are as follows:

Symbol	‘0’	‘1’	‘2’	‘3’	‘4’	‘5’	‘6’	‘7’
ASCII code	30H	31H	32H	33H	34H	35H	36H	37H
Symbol	‘8’	‘9’	‘A’	‘B’	‘C’	‘D’	‘E’	‘F’
ASCII code	38H	39H	41H	42H	43H	44H	45H	46H

RTU mode:

In RTU mode, each data frame consists of an 8-bit character (hexadecimal), which is more efficient than ASCII mode for data transmission because it can be done without code interchange. For instance, when transmitting “64H” between the master and slave, simply send “64H”.

Characters are encoded into the following frames and transmitted in series. The methods for checking each type of frame are as follows.

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ASCII mode:

10-bit data frame (for 7-bit character)

	L									H
7N2	Start bit	0	1	2	3	4	5	6	Stop bit	Stop bit

7 data bits

10-bit data frame

	L									H
7E1	Start bit	0	1	2	3	4	5	6	Even Parity	Stop bit

7 data bits

10-bit data frame

	L									H
7O1	Start bit	0	1	2	3	4	5	6	Odd Parity	Stop bit

7 data bits

10-bit data frame

RTU mode:

11-bit data frame (for 8-bit character)

	L										H
8N2	Start bit	0	1	2	3	4	5	6	7	Stop bit	Stop bit

8 data bits

11-bit data frame

	L										H
8E1	Start bit	0	1	2	3	4	5	6	7	Even parity	Stop bit

8 data bits

11-bit data frame

	L										H
8O1	Start bit	0	1	2	3	4	5	6	7	Odd parity	Stop bit

8 data bits

11-bit data frame

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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, consisting of 2 ASCII codes (ADR)
Function	Function code: 1 byte, consisting of 2 ASCII codes (CMD)
Data (n-1)	Data content: n word(s) = 2n bytes (consists of 4n ASCII codes), n ≤ 10
…….	
Data (0)	
LRC	Error checking: 1 byte, consisting of 2 ASCII codes
End 1	End code 1: (0DH)(CR)
End 0	End code 0: (0AH)(LF)

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(s) = 2n bytes, n ≤ 10
…….	
Data (0)	
CRC	Error checking: 2 bytes
End 1	A silent interval of more than 10 ms

Example 1: function code 03H, reading multiple words

In the following example, the master issues a read command to the first slave.

The slave 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 number of data for one single read action is 10 words, which equals 5 continuous parameter data.

ASCII mode:

Command Message (Master):

Start	‘:’
Slave Address	‘0’
	‘1’
Function	‘0’
	‘3’
Start Data Address	‘0’
	‘2’
	‘0’
	‘0’
Data Quantity (in words)	‘0’
	‘0’
	‘0’
	‘2’
LRC	‘F’
	‘8’
End 1	(0DH)(CR)
End 0	(0AH)(LF)

Response Message (Slave):

Start	‘:’
Slave Address	‘0’
	‘1’
Function	‘0’
	‘3’
Data Quantity (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	‘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 Quantity (in words)	00H
	02H
CRC (Check Low)	C5H (Low)
CRC (Check High)	B3H (High)

Response Message (Slave):

Slave Address	01H
Function	03H
Data Quantity (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.

Example 2: function code 06H, writing a single word

In the following example, the master issues a write command to the first slave.

The slave writes data 0064H to the start data address 0200H and sends a response message to the master after the writing is complete.

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	‘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	‘9’
	‘3’
End 1	(0DH)(CR)
End 0	(0AH)(LF)

RTU mode:

Command Message (Master):

Slave Address	01H
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):

Slave Address	01H
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.

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Example 3: function code 10H, writing multiple words

In the following example, the master issues a write command to the first slave.
The slave writes two words 0BB8H and 0000H starting from the start data address 0112H. In other words, 0BB8H is written into 0112H and 0000H is written into 0113H. The maximum allowable number of data for one single write action is 8 words, which equals 4 continuous parameter data. The slave sends a response message to the master after the writing is complete.

ASCII mode:

Command Message (Master):

Start	‘:’
Slave Address	‘0’
	‘1’
Function	‘1’
	‘0’
Start Data Address	‘0’
	‘1’
	‘1’
	‘2’
Data Quantity (in words)	‘0’
	‘0’
	‘0’
	‘2’
Data Quantity (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	‘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 Quantity (in words)	‘0’
	‘0’
	‘0’
	‘2’
LRC	‘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 Quantity (in words)	00H (High)	
	02H (Low)	
Data Quantity (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 Quantity (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.

9

LRC and CRC transmission error checking

In ASCII mode, the error checking method is LRC (Longitudinal Redundancy Check). In RTU mode, the error checking method is CRC (Cyclic 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 Quantity (in words)	‘0’
	‘0’
	‘0’
	‘1’
LRC	‘B’
	‘4’
End 1	(0DH)(CR)
End 0	(0AH)(LF)

The LRC value is calculated by adding all the bytes, rounding down the carry, and taking the two’s complement.

In the preceding 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: perform (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 perform (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 byte of the CRC value in the command message, and then the high byte. For example, if the result of CRC calculation is 3794H, put 94H in the message and then 37H as shown in the following table.

ADR	01H
CMD	03H
Start Data Address	01H (High)
	01H (Low)
Data Quantity (in words)	00H (High)
	02H (Low)
CRC (Check Low)	94H (Low)
CRC (Check High)	37H (High)

CRC example code:

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 in 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;
}
```

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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);          /*  Interruption enable  */
outportb(PORT+IER,0x01);               /* Interruption 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 protocol
                                       <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, data is read  */
          rdat[I++] = inportb(PORT+RDR); /*   read data from RDR  */
     }
}
}
```

9.4 Writing and reading communication parameters

Refer to Chapter 8 for the descriptions of all the servo drive parameters. The following describes the parameters that you can write or read through communication.

The servo drive parameters are divided into eight 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), and Group 6 and Group 7 (PR parameters). Except for the read-only parameters, all parameters can be set through communication. And you can read the values of all Group 0 to Group 7 parameters through communication.

Note the following additional details:

P3.001: when a new transmission speed is set, the next data is written at the new transmission speed.

P3.002: when a new communication protocol is set, the next data is written with the new communication protocol.

P4.005: servo motor JOG control. Refer to Chapter 8 for detailed descriptions.

P4.006: force digital output (DO) contact control. You can use this parameter to test the DO contacts. First set P2.008 to 406, and then set P4.006 to 0x0001, 0x0002, 0x0004, 0x0008, 0x0010, and 0x0020 to test DO1, DO2, DO3, DO4, DO5, and DO6 respectively. Afterwards, set P4.006 to 0x0000 to complete the test.

P4.010: hardware calibration options. First set P2.008 to 20 (14H in hexadecimal format) to enable this function.

P4.011 - P4.021: hardware offset calibration. The parameters were adjusted before delivery, so changing the parameter settings is not recommended. If you need to modify these parameters, first set P2.008 to 22 (16H in hexadecimal format) to enable this function.

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9.5 RS-485 communication specification

Compared with RS-232, RS-485 communication can carry out one-to-many transmission and has better anti-interference ability. RS-485 uses a balanced transmission line for signal reception and transmission. The transmitter converts the TTL signal into a differential signal and then sends it to the receiver. 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 the use of RS-485 communication, so note the following when wiring.

- Number of stations
  CN3 supports up to 32 servo drives. 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 speed. 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 cable with the length of 15 meters or less 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 that you use a shielded twisted-pair cable as it has metal shield and a grounding wire, which ensures better anti-interference ability.

- Topology
  For topology, the closer to the master station, the more stable the transmitted signal.
  RS-485 supports 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 transmission line, 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 measures

  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 ferrite ring at the power input. For its usage, refer to Section 2.6.
  6. Add IEC 60384-14 certified X capacitor and Y capacitor at the power input.

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Absolute System 10

This chapter introduces the absolute servo system, including the installation of the battery box, and the steps and procedures for initializing and operating the system for the first time.

Important

A complete absolute servo system includes a servo drive, an absolute servo motor, and a battery box. The battery supplies power to the system so that the encoder continues operating when the main power to the servo drive is off. In addition, the absolute encoder can continuously record the motor's actual position at any time, even when the motor shaft is rotated after power off. The absolute servo system must be used with an absolute motor; if it is used with an incremental motor and the absolute function is enabled (P2.069.X = 1), AL069 occurs.

When using an absolute motor, make sure the motor speed is lower than 250 rpm at the moment when power is on. When the encoder is operating with the battery, make sure the maximum speed of the motor does not exceed 200 rpm.

To determine whether an absolute motor is used, check the model number as follows:

ECM-A3 series servo motor

ECM－A3□－□□□□□□□□□

A / Y: absolute motor

ECM-B3 series servo motor

ECM－B3□－□□□□□□□□□

A / P: absolute motor

ECMC series servo motor

ECMC - □W□□□□□□

W / V: absolute motor

Correctly connect the battery box to the encoder. One servo drive uses one single battery box; two servo drives can share one dual battery box. Use the specified Delta encoder cable to connect to the battery box.

10.1 Battery specifications

Precautions

Carefully read the following precautions. Only use batteries in accordance with the specifications as follows to avoid damage or danger.

WARNING

- Make sure the installation location is free of water vapor, corrosive gas, and inflammable gas.
- Properly store the batteries to avoid short-circuiting.
- Do not short-circuit the positive and negative electrodes of the battery, and or install the batteries in reverse direction.
- Do not use new and used batteries together to avoid losing power or shortening the life of the new batteries. Replacing all batteries with new ones is recommended.
- The battery box J1 port connects to the battery and J2 port connects to the battery box connection wire on the encoder cable.
- The current consumption is nearly 0 when the absolute origin position is not established. Once the absolute origin position is established, the battery drains. To avoid battery power consumption when the machine is in transport, it is recommended that you disconnect the battery or do not establish the absolute origin position.
- When installing and wiring the battery box, follow the instructions in this manual to avoid danger.
- Use the battery provided by Delta, or the absolute function may not work normally.

STOP

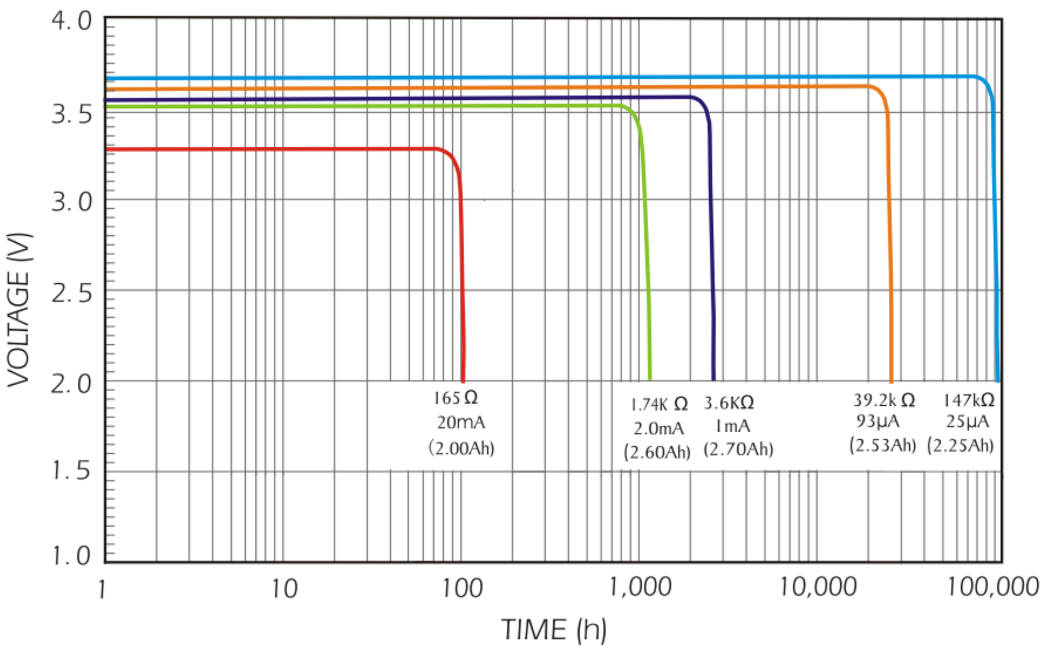
- Do not place the battery in fire or an environment over 100°C (212°F), or this may cause a fire or an explosion.
- The batteries are non-rechargeable. Do not charge the batteries as this may cause an explosion.
- Do not directly weld on the surface of the battery.

Battery specifications

Item	Li/SOCl2 Cylindrical Battery
Delta model number	ASD-CLBT0100
International standard size	AA
Nominal voltage	3.6V
Nominal 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 (-40°F to +185°F)

10

Battery life



Source: *EVE Energy Co. ER14505 Discharge Characteristics*

(1) The preceding figure illustrates the discharge current curves measured in the constant current test. According to the five curves shown in the preceding figure, if the battery voltage keeps at 3V or higher, the battery life expectancy is as shown in the following table. Therefore, the lowest battery voltage for an absolute encoder is defined as 3.1V.

Motor	Current consumption*2 (μA) when the encoder operates with the battery	Battery life expectancy (month)
ECM-A3□-□A□□□□□□□ ECM-B3□-□A□□□□□□□ ECM-B3□-□P□□□□□□□	30	87.5
ECMC-□W□□□□□□□ ECM-A3□-□Y□□□□□□□	45	58.33
ECMC-□V□□□□□□□	35	75

(2) When the battery is stored in a cool dry place, the battery voltage can be kept at 3.6V or above for up to 5 years.

Note: the battery life expectancy is measured with a test using a servo drive, a motor, and a single battery.

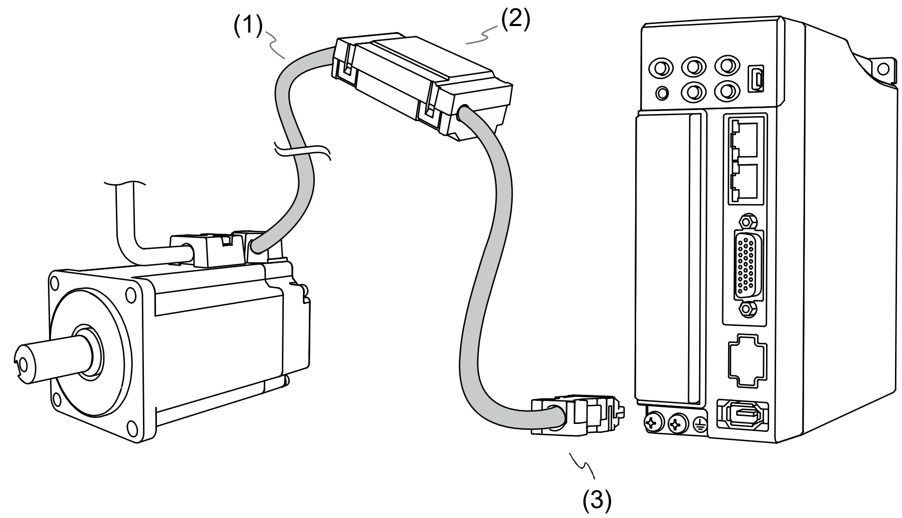
10.2 Installation

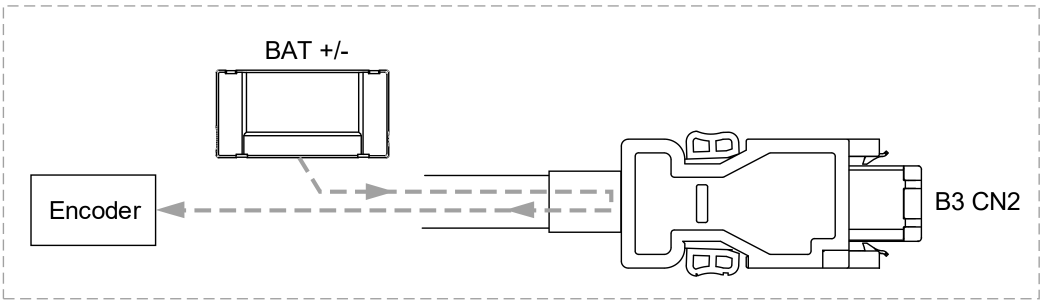
- For the pin assignments of the absolute encoder cables, refer to Section 3.4.
- When selecting the battery box and the absolute encoder cables, refer to Appendix B.

10.2.1 Installing the battery box in the servo system

When an absolute encoder is used, the battery supplies power directly to the encoder, so wiring the battery wires to the CN2 connector of the servo drive is not required.
Do not wire Pin 3 and Pin 4 of the servo drive CN2 connector, or it will cause damage to the internal circuit.

Example: single battery box (standard wiring)





(4)

(1) Absolute encoder cable; (2) Single battery box;

(3) CN2 connector; (4) Battery box wiring

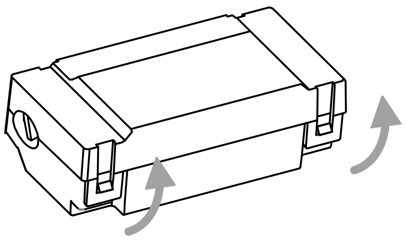
10.2.2 Installing and replacing a battery

When the servo drive displays the alarm AL061, it means the voltage of the absolute encoder is too low. In this case, you can set P0.002 to 38 to read the voltage level of the battery. If the displayed value is lower than 31 (indicating that the voltage is under 3.1V), replace the battery immediately to avoid data loss.

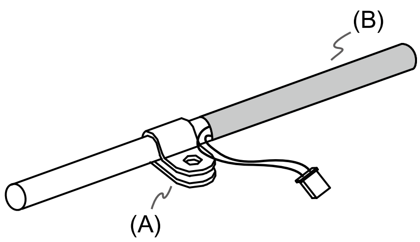
When the battery voltage is under 2.9V, the motor's position record may be lost. If the servo drive displays the alarm AL060, it will then display AL06A after the battery is replaced. In this case, you need to re-establish the absolute origin position.

Caution: replace the battery only when the main power to the servo drive is on to avoid absolute position data loss.

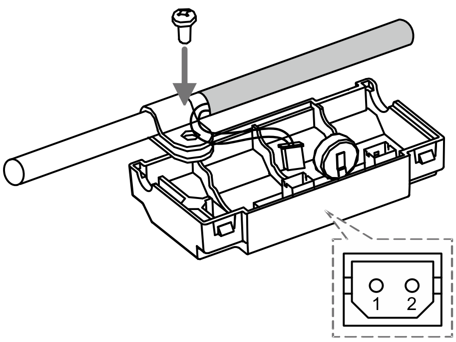
Single battery box



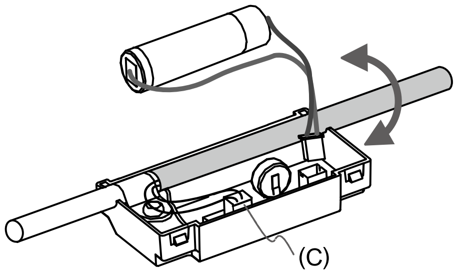
Step 1:
Release the snap-fit tabs on both sides and remove the battery box cover.



Step 2:
Attach the cable clamp to the encoder cable. Note that the cable clamp should be placed as close as possible to the heat shrink.
(A) Cable clamp; (B) Heat shrink



Step 3:
Tighten a cable clamp screw to secure the clamp to the battery box, and then connect the battery box connection wire to the J2 port on the battery box.

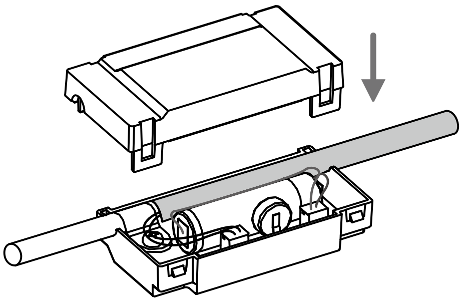


Step 4:

Install a new battery, and then connect the battery wire to the J1 port on the battery box.

Replace the battery only when the main power to the servo drive is on. Do not remove the battery box connection wire which connects to the servo drive, or the system data may be lost.

(C) Battery box connection wire



Step 5:

Place the wires into the box and fit the cover, and then the battery replacement and battery box installation is complete.

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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 through 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 position system has not been established. Clear the alarm by setting up the position system.
- AL060 occurs when position data is lost due to low battery voltage or an interruption in the battery power.
- In the absolute system, the position data has to be within a specific range. AL062 occurs when the number of motor revolutions exceeds the range of -32,768 to +32,767. AL289 occurs when the PUU number exceeds the range of -2,147,483,648 to +2,147,483,647.
- In addition to the preceding alarms (which are enabled by default), you can use P2.070 [Bit 2] to set whether to show AL062 and AL289 when the absolute position system overflows (the number of revolutions or the PUU number exceeds the preceding ranges). This function is for systems which use incremental commands to operate in a single direction.

Steps for system initialization:

1. Establish the absolute origin position with DI/DO, parameter settings, PR homing function, or the Homing methods of P1.001.X = C. When the position is established, AL06A or AL060 is automatically cleared. The controller can establish the absolute origin position in pulse or PUU.
2. When the system is power cycled, the controller can access the motor's absolute position with either DI/DO or communication. Based on the setting of P2.070 [Bit 1], the controller can read the number of revolutions plus the pulse number within single turn (refer to Section 10.3.2) or the PUU number (refer to Section 10.3.3).

10.3.2 Pulse number

When the motor rotates clockwise, the number of revolutions is defined as a negative value. When the motor rotates counterclockwise, the number of revolutions is defined as a positive value. The countable number of revolutions is between -32768 and +32767. AL062 occurs once the number of revolutions overflows (i.e. the number exceeds the range). To clear the alarm, re-establish the absolute origin position. If P2.070 [Bit 2] has been set to not show any alarm, then the system ignores the overflow of number of revolutions.

If the motor rotates counterclockwise and the number of revolutions reaches +32,767, the value jumps to -32,768 in the next turn, and keeps increasing from -32,768 to +32,767.If the motor rotates clockwise and the number of revolutions reaches -32,768, the value jumps to +32,767 in the next turn, and keeps decreasing form +32767 to -32768.

In addition, there are 16,777,216 pulses (0 to 16,777,215) in one motor revolution. Pay attention to the motor's rotation direction. You can read the number of revolutions and the pulse number within a single turn with either communication or DI/DO.

Total pulse number = m (number of revolutions) x 16,777,216 + pulse number within a single turn (0 to 16,777,215).

The conversions between pulse number and PUU are as follows:

When P1.001.Z = 0: the PUU number when power on = pulse number x $\frac{P1.045}{P1.044}$ + P6.001.

When P1.001.Z = 1: the PUU number when power on = (-1) x pulse number x $\frac{P1.045}{P1.044}$ + P6.001.

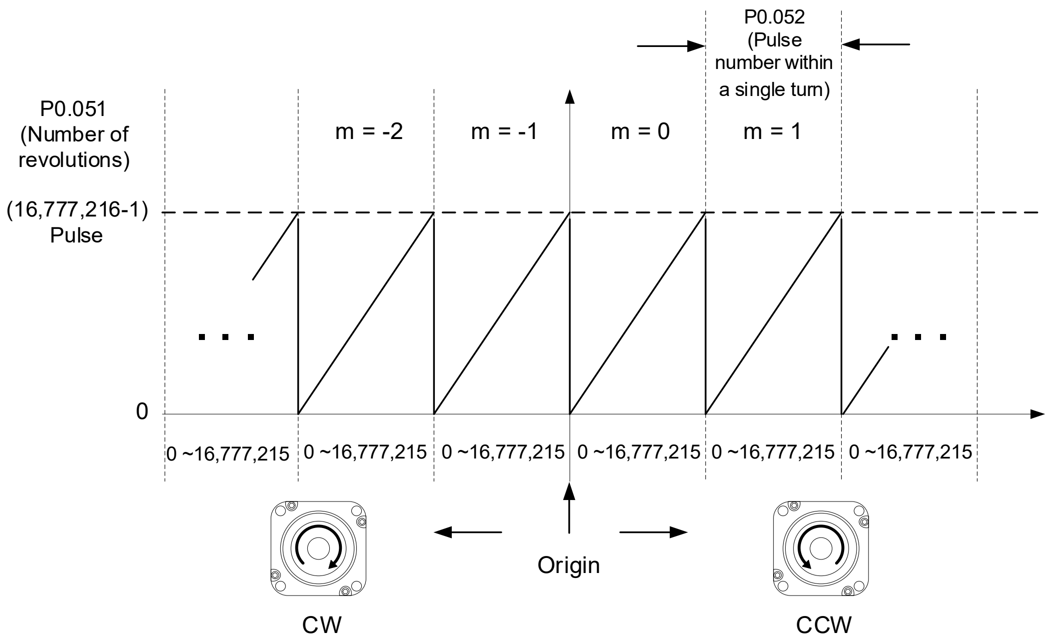

Figure 10.3.2.1 Absolute position in pulses

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10.3.3 PUU number

The PUU number is a 32-bit absolute position data with a positive or negative sign. When the motor rotates in the positive direction, the PUU number increases; when the motor rotates in the negative direction, the PUU number decreases. The motor rotation direction (positive / negative) is defined by P1.001.Z; operation in the positive direction does not necessarily mean the motor is operating clockwise.

If the motor keeps rotating in the same direction and the number of revolutions exceeds the range of -32768 to +32767, the servo drive generates AL062. If the motor's PUU number exceeds the range of -2147483648 to +2147483647, the servo drive generates AL289. When an overflow issue occurs to the absolute encoder, re-establish the absolute origin position to clear the alarm. You can set P2.070 to determine whether the servo drive generates AL062 and AL289 when an overflow occurs. If the motor rotates in the positive direction and the absolute position data reaches +2147483647 PUU, the value jumps to -2147483648 in the next turn, and keeps increasing from -2147483648 to 2147483647. The value changes the other way when the motor is rotating in the negative direction.

See the following examples.

Example 1:

When P1.044 = 16777216 and P1.045 = 100000, the motor needs 100,000 PUU to run one revolution. 2,147,483,647 ÷ 100,000 ≒ 21,474.8, so once the motor runs over 21,474.8 (< 32,767) revolutions in the positive direction, AL289 occurs.

Example 2:

When P1.044 = 16,777,216 and P1.045 = 10,000, the motor needs 10,000 PUU to run one revolution. 2,147,483,647 ÷ 10,000 ≒ 214,748.3, so once the motor runs over 32,767 (< 214,748.3) revolutions in the positive direction, AL062 occurs.

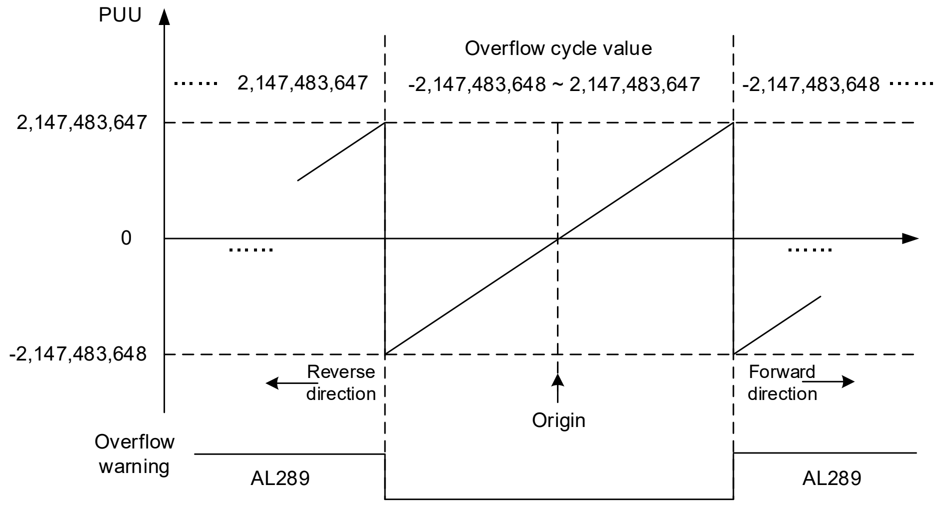


Figure 10.3.3.1 Absolute position in PUU

Note: after the absolute origin position is established, any modification of P1.001.Z or the E-Gear ratio (P1.044 and P1.045) changes the original setting of the absolute origin position. If one of these parameters is changed, re-establish the absolute origin position.

10.3.4 Establish the absolute origin position

When the absolute position is lost, the servo drive provides the following methods to establish the absolute origin position. See the following sections for more details of each method.

10.3.4.1 Establishing the absolute origin position with DI/DO

When the servo system is controlled by the controller, you can establish the absolute origin position with DI/DO. Once the absolute position is established, the pulse number is reset to 0 and the PUU number is reset to the setting 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 the T_S delay time before proceeding to the next step.
2. After reaching T_S, the controller starts to establish the absolute origin position. When DI.ABSC is triggered and remains on for the T_Q delay time, the pulse number is reset to 0 and the PUU number is reset to the setting value of P6.001.

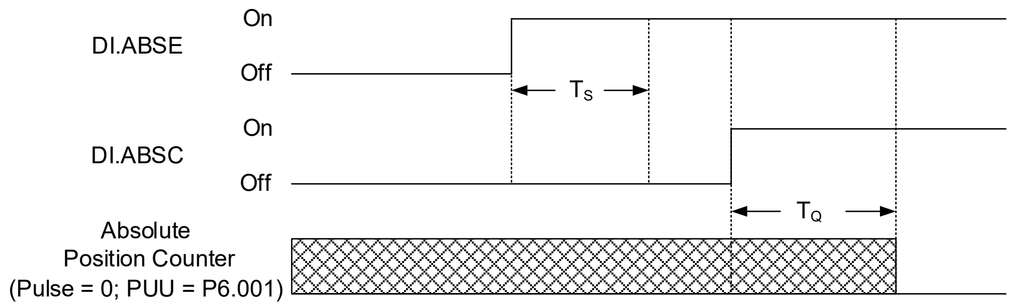


Figure 10.3.4.1.1 Timing diagram for establishing the absolute origin position with DI/DO

The following table describes the T_S and T_Q delay time after DI.ABSE and DI.ABSC are switched to On.

	T_S (ms)	T_Q (ms)
Min.	P2.009 + 2	
Max.	P2.009 + 10	

10.3.4.2 Establishing the absolute origin position with parameters

Set P2.071 to 0x0001 through the panel or communication to establish the absolute origin position. Since P2.071 is write-protected by P2.008, you must set P2.008 to 271 first, and then set P2.071 to 0x0001. Then, the absolute position system immediately resets.

10

10.3.4.3 Establishing the absolute origin position with the PR homing function

You can use the 11 homing modes in the PR mode to establish the absolute origin position. For more details, refer to Section 7.1.3.1 Homing methods.

10.3.4.4 Establishing the absolute origin position with Homing methods of P1.001.X = C

EtherCAT / CANopen: establish the absolute origin position according to the homing modes defined in the CiA 402 profile. See Chapter 11 or 12 for details of the homing methods.
PROFINET: see Chapter 13 for details of the homing methods.

10.3.5 Read the absolute position

10.3.5.1 Reading the absolute origin 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.

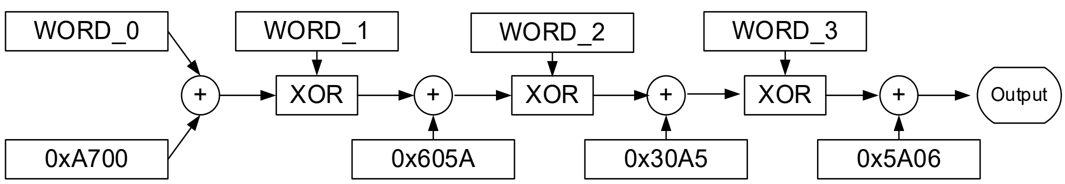
Bit 79 - Bit 64	Bit 63 - Bit 32	Bit 31 - Bit 16	Bit 15 - Bit 0
-	WORD_3	WORD_2	WORD_1
Check Sum	Encoder PUU -2147483648 to +2147483647	0	Encoder status (P0.050)

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
-	WORD_3	WORD_2	WORD_1
Check Sum	Encoder pulse number within a single turn 0 to 16,777,215 (= 16,777,216 - 1)	Number of encoder revolution -32768 to +32767	Encoder status (P0.050)

Example: reading the pulse number with DI/DO:

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.

You can set P2.070 [Bit 0] to read the position value in units of pulse or PUU with DI/DO. See the following timing diagram.

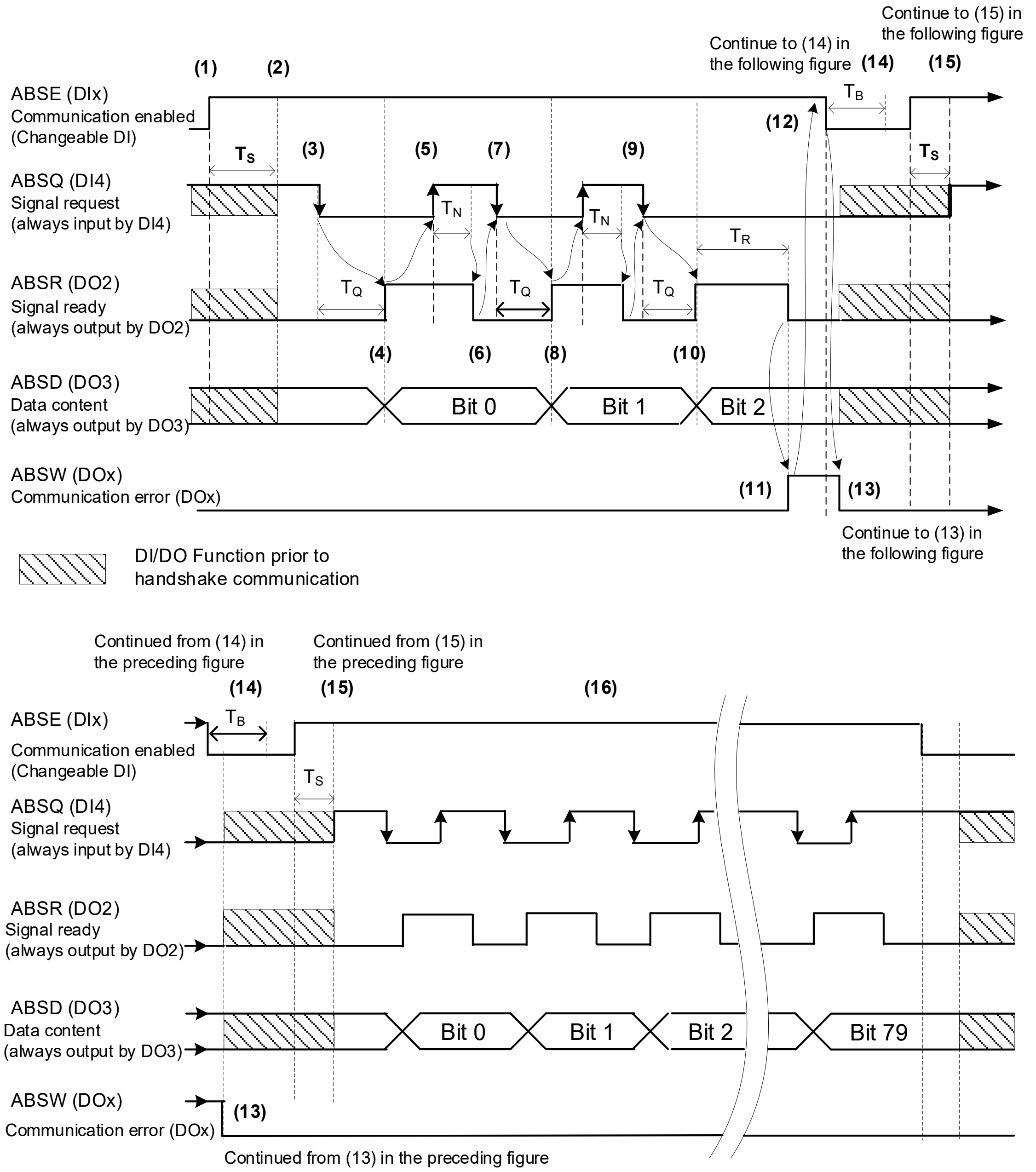


Figure 10.3.5.1.1 Timing diagram for reading the absolute position with DI/DO

The following table describes the delay time when you read the absolute position with DI/DO.

	T_R (ms)	T_S (ms)	T_Q (ms)	T_N (ms)	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 (to make sure the ABSE signal is On), the functions of DI4, DO2, and DO3 are switched to ABSQ, ABSR, and ABSD, respectively. If DI4 was in the high-level state before switching, it remains in the high-level state when switched to ABSQ (logic high-level signal). DI4, DO2, and DO3 are dual-function DI/DOs, which means the original functions of DI4, DO2, and DO3 share the same DI/DOs with ABSQ, ABSR, and ABSD. Pay special attention when switching their functions before, during, and after the signal handshake. To set these three DI/DOs as single function, set them to 0 before switching the functions.

(3) If DI4 was in the high-level state and its function was 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 request for data access.

(4) After the T_Q delay time, the handshake data is ready and sent to ABSD. Now the servo drive triggers the ABSR signal and the controller can access the data. If the controller cannot detect that the ABSR state has changed to high level after the maximum T_Q time, there may be a communication error such as communication cable disconnection.

(5) Once detecting the ABSR signal state as high level, the controller accesses the data, and sets the ABSQ signal to high level to notify the servo drive that the data was read.

(6) When ABSQ is at high level for the T_N time, ABSR is set to low level in order to send the data for the next bit communication.

(7) When detecting the ABSR signal state as low level, the controller sets ABSQ to low level and sends a request to the servo drive 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 reads the data and notifies the servo drive that it 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 triggered the ABSQ signal, the servo drive sends the ABSW signal (communication error) and stops the handshake communication.

(12) When the controller receives the ABSW signal, it sets ABSE to low level and prepares to restart the handshake communication.

(13) ABSW resumes to low level after the controller sets the ABSE signal to low level.

(14) The controller restarts the communication after the T_B time.

(15) Repeat step 1.

(16) If no error occurs, the controller completes 80 bits (Bit 0 - 79) of the handshake communication with the servo drive. DI4, DO2, and DO3 then restore to the original functions.

Note: if ABSE is set to low level first and then changed to high level, but ABSW does not return to low level and the communication remains in the error state, it means some other errors have also occurred, such as AL060 (absolute position is lost), AL061 (encoder undervoltage), or AL062 (number of revolutions of the absolute encoder overflows (issued by encoder)). The communication cycle can only be restarted after the errors have been cleared.

10.3.5.2 Reading the absolute position with communication

You can access the data of the absolute encoder through the following two communication methods.

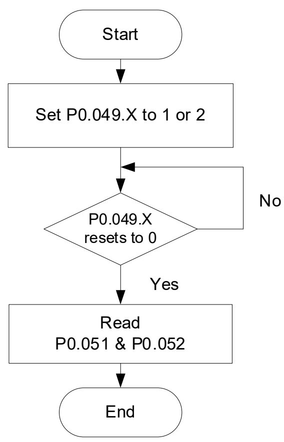
Instant access

The servo drive reads the motor's position feedback once the power is supplied. Setting P0.017 = 0 means to access the motor's position feedback through P0.009 (Status monitoring register 1).

Register access

The motor's position is stored in the drive's register and the read value does not change with the motor's movement. Once you set P0.049.X through communication, the encoder absolute position is stored in P0.051, and P0.052, which data unit can be set with P2.070 [Bit 1].

- When P0.049.X = 1, the drive does not clear the position error while reading the position value.
- When P0.049.X = 2, the drive clears the error while reading the position value. After the motor is enabled, it moves slightly forward and backward to correct its position even when stopped. To avoid the difference between the actual and read positions, set P0.049.X to 2 to update the motor's actual position to the drive, which clears the position error.
  For example, the motor's current position is 20000, but the actual position is between 19999 and 20001 under normal circumstances. If you issue a command to read the position when the motor is at 20001, the read value is 20001 and updated to the drive as the motor position, which clears the position error. If the read position is not updated, a command error occurs.
- When the position data is updated to P0.051 and P0.052, P0.049.X automatically resets to 0, meaning the controller can access the values of P0.051 and P0.052.
- P0.050 shows the status of the absolute encoder. When "absolute position lost" or "absolute number of revolutions overflows" is shown, the read absolute position is invalid. In this case, you must re-establish the absolute origin position.



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CANopen Mode 11

This chapter provides details for the required parameter settings when the servo communicates with the controller through the CANopen communication function.

11.1 Basic configuration

11.1.1 Supported functions

CANopen functions supported by Delta servo drives:

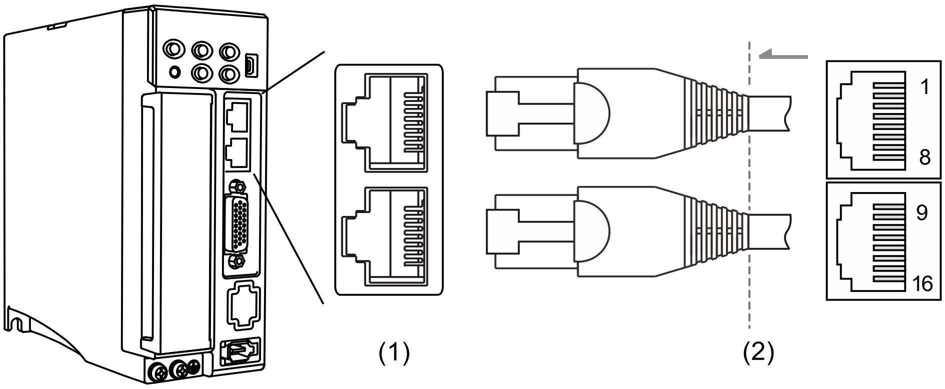
- CANopen communication objects: NMT, SYNC, SDO, PDO, and EMCY.
- SDO transmission: acyclic data exchange for reading / writing parameters and communication related settings.
- PDO transmission / reception: time-triggered, event-triggered, synchronous transmission (cyclic), and asynchronous transmission (acyclic).
- Node guarding.
- Heartbeat.

CANopen function not supported by Delta servo drives:

- Time stamp.

11.1.2 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, 9	CAN_H	CAN_H bus line (dominant high)
2, 10	CAN_L	CAN_L bus line (dominant low)
3, 11	GND_ISO	Signal GND
4, 12	RS-485-	For the servo drive to transmit the data to differential terminal (-).
5, 13	RS-485+	For the servo drive to transmit the data to differential terminal (+).
6, 14	-	Reserved
7, 15	GND_ISO	Signal GND
8, 16	-	Reserved

- Baud rate setting

Baud rate and bus length

Baud rate	Maximum bus length
1 Mbps	25 m (82 ft)
800 Kbps	50 m (164 ft)
500 Kbps (default)	100 m (328 ft)
250 Kbps	250 m (820 ft)
125 Kbps	500 m (1640 ft)

11.1.3 Parameter settings in CANopen mode

Follow these instructions to connect the CANopen controller and the servo drive:

1. Set to CANopen mode: set P1.001.YX to 0C.
2. Set the node ID: set P3.000 to 0x0001 - 0x007F.
3. Set the transmission rate (baud rate): set P3.001.Z to 4
   (Z = 0: 125 Kbps; 1: 250 Kbps; 2: 500 Kbps; 3: 800 Kbps; 4: 1 Mbps).
4. It is suggested that you change the setting value of P3.012.Z from 0 (default) to 1 to enable the non-volatile setting for the parameter. Note that the default E-Gear ratio varies with the set value of P3.012.Z.

Function	P3.012 = 0x0100 (Z = 1)		P3.012 = 0x0000 (Z = 0)	
	Servo parameter	Default	OD address	Default
Motor stop mode	P1.032	0x0000	605Bh	0
S-curve acceleration constant	P1.034	200	6087h	200
Zero speed range	P1.038	100 (0.1 rpm)	606Fh	100 (0.1 rpm)
E-Gear ratio - numerator N1	P1.044	16777216	6093h sub1	1
E-Gear ratio - denominator M	P1.045	100000	6093h sub2	1
Speed reached (DO.SP_OK) range	P1.047	10 (rpm)	606Dh	100 (0.1 rpm)
Accumulated time to reach desired speed	P1.049	0	606Eh	0
Maximum speed limit	P1.055	Depending on the motor (rpm)	607Fh	Depending on the motor (0.1 rpm)
			6080h	Depending on the motor (rpm)
Excessive deviation warning condition of Position command	P2.035	50331648	6065h	50331648
Positive software limit (PP / CSP / CSV / CST mode)	P5.008	2147483647	607Dh sub2	2147483647
Negative software limit (PP / CSP / CSV / CST mode)	P5.009	-2147483648	607Dh sub1	-2147483648
Origin definition (HM mode)	P6.001	0	607Ch	0

5. It is suggested that you enable the dynamic brake function (P1.032 = 0x0000).

11.2 Communication specification

11.2.1 Servo communication architecture

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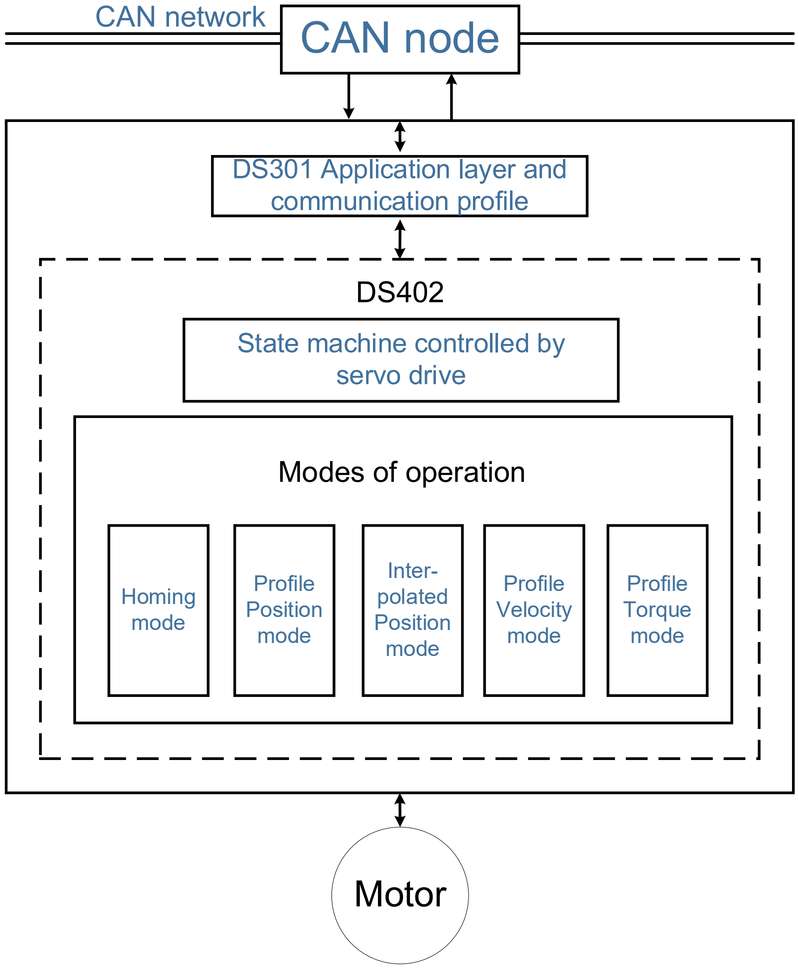
The CANopen architecture of the servo drive is as follows:



- 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. It defines the behavior of each operation mode and the required object index settings for execution.

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11.2.2 Communication objects

The default values of the Delta servo drive object dictionary comply 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 0 - Bit 6	Node-ID	The data size is 7-bit and the setting range is 1 - 127.
Bit 7 - Bit 10	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 index
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, 1006h
EMCY object	0 0 0 1	X X X X X X X	128 (80h) + Node-ID	1014h
TxPDO1	0 0 1 1	X X X X X X X	384 (180h) + Node-ID	1800h
RxPDO1	0 1 0 0	X X X X X X X	512 (200h) + Node-ID	1400h
TxPDO2	0 1 0 1	X X X X X X X	640 (280h) + Node-ID	1801h
RxPDO2	0 1 1 0	X X X X X X X	768 (300h) + Node-ID	1401h
TxPDO3	0 1 1 1	X X X X X X X	896 (380h) + Node-ID	1802h
RxPDO3	1 0 0 0	X X X X X X X	1024 (400h) + Node-ID	1402h
TxPDO4	1 0 0 1	X X X X X X X	1152 (480h) + Node-ID	1803h
RxPDO4	1 0 1 0	X X X X X X X	1280 (500h) + Node-ID	1403h
TxSDO	1 0 1 1	X X X X X X X	1408 (580h) + Node-ID	1200h
RxSDO	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, and X indicates the bit is set according to the requirement.

Communication object dictionary:

Communication object index	Object area
1000h - 1FFFh	Communication Profile Area
2000h - 2FFFh	Manufacturer Specific Profile Area
6000h - 9FFFh	Standardized Device Profile Area

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11.2.2.1 Process data object (PDO)

Real-time data transmission can be achieved with Process data objects (PDOs). There are two types of PDOs: transmit PDOs (TxPDOs) and receive PDOs (RxPDOs). This definition is from the perspective of the servo drive, for example, the 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.

RxPDOs

Communi-cation object	Communication object index	Mapping object index
RxPDO1	1400h	1600h
RxPDO2	1401h	1601h
RxPDO3	1402h	1602h
RxPDO4	1403h	1603h

TxPDOs

Communi-cation object	Communication object index	Mapping object index
TxPDO1	1800h	1A00h
TxPDO2	1801h	1A01h
TxPDO3	1802h	1A02h
TxPDO4	1803h	1A03h

The format of PDO mapping parameter is:

Bit	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

Bit	Function
Bit 0 - Bit 7	Object data length
Bit 8 - Bit 15	Object sub-index
Bit 16 - Bit 31	Object index

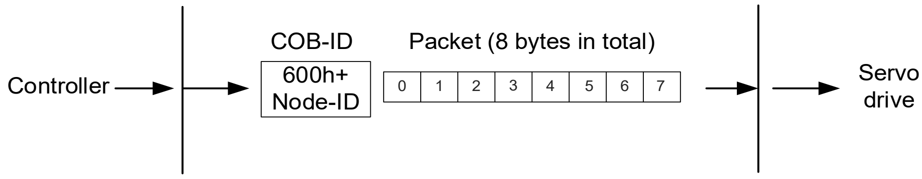
Example:

To set the three PDOs, OD 6040h, OD 607Ah, and OD 6060h, in the first group of PDOs, the setting is as follows:

Mapping parameter setting for RxPDO	Data			Description
OD 1600h sub0	3			Set 3 PDO mappings.
OD 1600h sub1	6040h	00h	10h	Mapping the Controlword (OD 6040h); data length is 16-bit.
OD 1600h sub2	607Ah	00h	20h	Mapping the target position (OD 607Ah); data length is 32-bit.
OD 1600h sub3	6060h	00h	08h	Mapping the operation mode (OD 6060h); data length is 8-bit.
Note	The total length is 38h (56-bit) which meets the specification of less than 64-bit.			

11.2.2.2 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 packets. SDO packets can transmit up to 4 bytes.

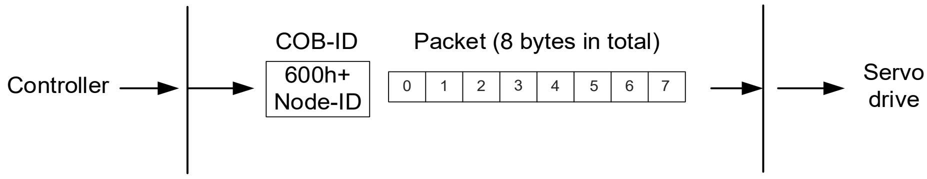


Byte	Function
Byte 0	Command code
Byte 1 - Byte 2	Object index
Byte 3	Object sub-index
Byte 4 - Byte 7	Data

■ Write data with SDO

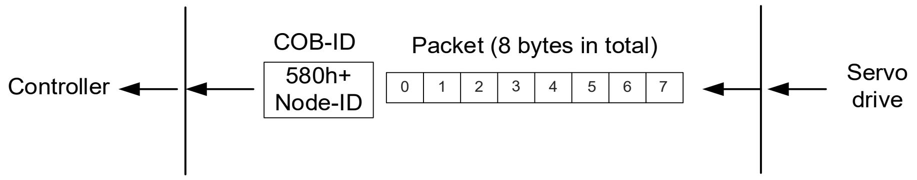
To use an SDO to write data with the controller, you need to write the command code, indexes, and data according to the SDO format. The servo drive then returns the corresponding message based on the written data.

The following figure shows the packet format when the controller sends the SDO for writing data:



Command 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:



Command 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 11.2.2.3.

Example:

Write the value of 300,000 (493E0h) to the servo parameter P7.001 (OD 2701h).

The write-in format is as follows:

Command 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.

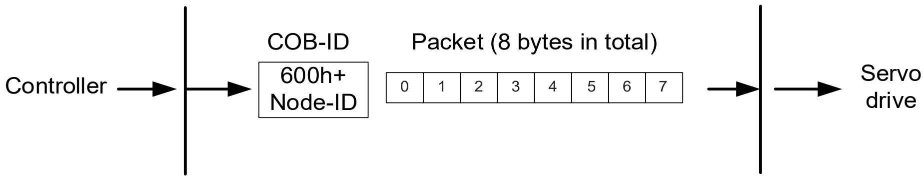
The returned packet is as follows:

Command 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.

■ Read data with SDO

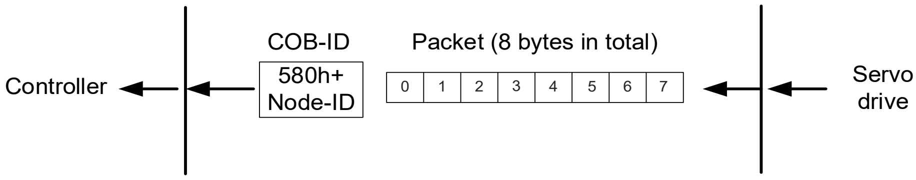
To use an SDO to read data with the controller, you need to write the command code and indexes according to the SDO format. The servo drive then returns the object's data based on the object to be read.

The following figure shows the packet format when the controller sends the SDO for reading data:



Command 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:



Command 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 11.2.2.3.

11.2.2.3 SDO abort codes

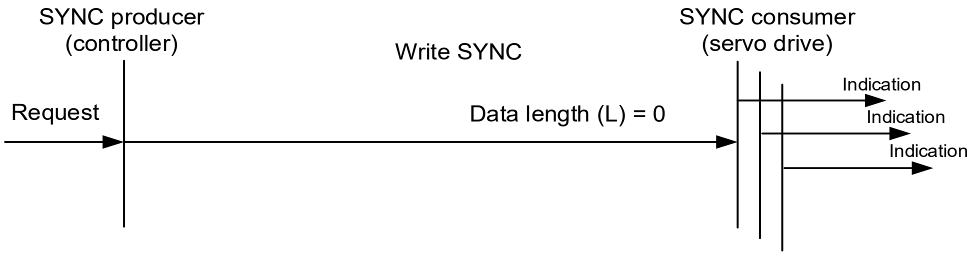
The abort codes are as follows:

SDO 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 an object is read from EEPROM.
080000a2h	An error occurred when an object is written to EEPROM.
080000a3h	Invalid range when accessing EEPROM.
080000a4h	EEPROM data content error occurred when EEPROM is accessed.
080000a5h	The entered password is incorrect when data is written 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.

11.2.2.4 Synchronization object (SYNC)

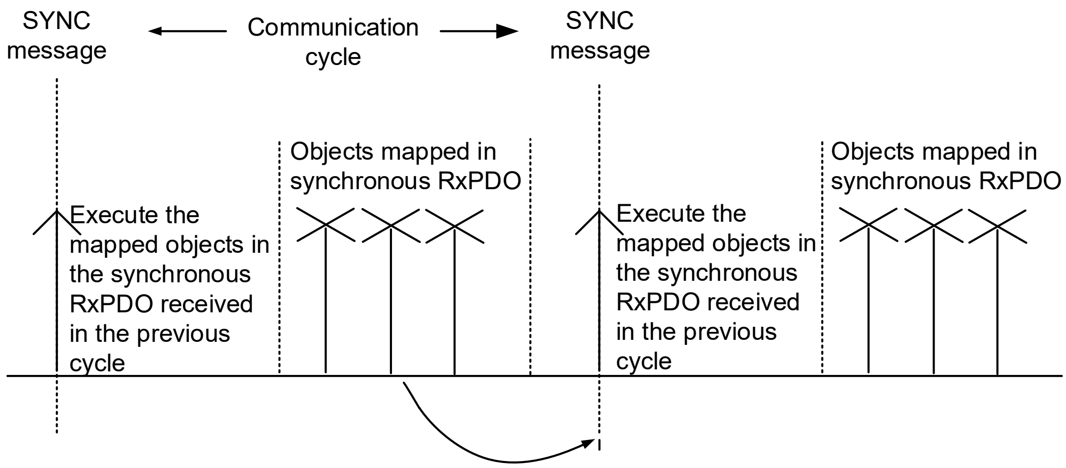
The Synchronization objects (SYNCs) are periodically broadcast by the SYNC producer. There is no data in the SYNC packet (L = 0).

The SYNC protocol is as follows:

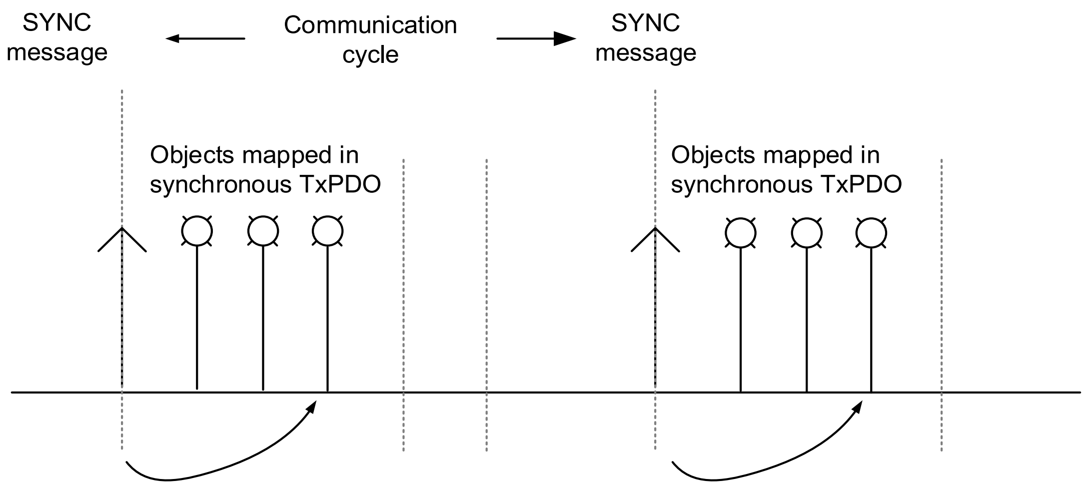


The SYNC object is used to achieve the synchronization of PDO transmission and reception between the controller and servo drive. The SYNC object transmission cycle is set by the object OD 1006h (see Section 11.4 Object dictionary for detailed settings).

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.

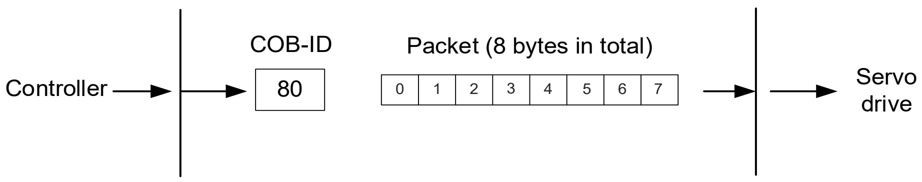


The following figure shows the timing sequence between the servo drive TxPDO transmission and the controller SYNC transmission. The servo drive transmits the TxPDO data to the controller as soon as it receives the SYNC.



11.2.2.5 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 transmit only 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 is transmitted to 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
Refer to Section 12.5.2 Alarm list for details.		OD 1001h	Refer to Chapter 14 Troubleshooting for details.	

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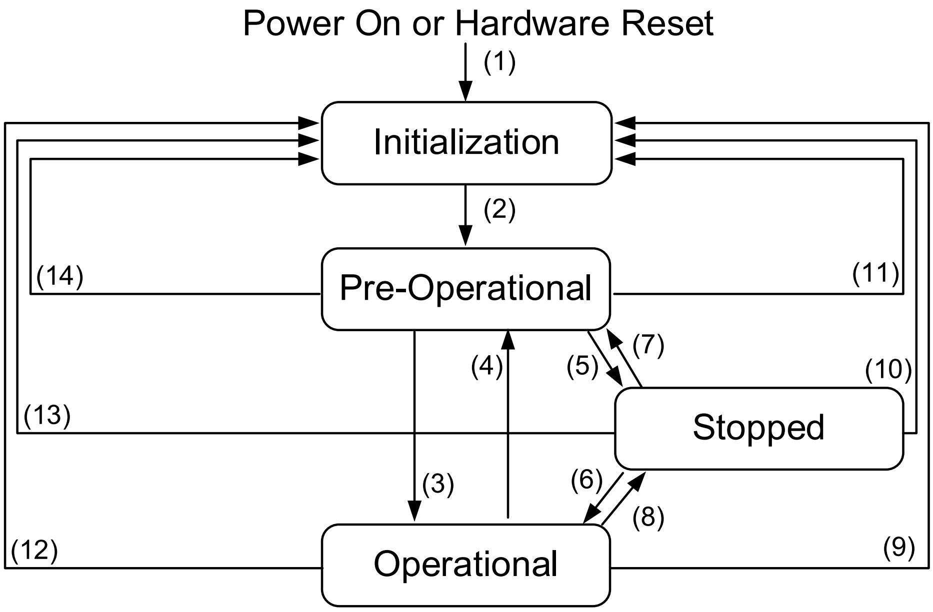
11.2.2.6 NMT services

■ State machine

The NMT state machine is shown as follows. After the servo drive completes the initialization, it enters the Pre-Operational state. The NMT state machine determines the behavior of the communication objects, such as PDO functions only in the Operational state.



Status	Description
Initialization	The servo drive successfully completes initialization after being powered on without errors occurring. The packets cannot yet be transmitted in this state.
Pre-Operational	Data can be exchanged with SDOs. If an alarm occurs in the servo drive, an emergency message is sent to notify the controller.
Stopped	The servo drive can use SDO and TxPDO data packets to exchange data with the controller.
Operational	All data exchanges, including SDOs and PDOs (TxPDOs and RxPDOs), are allowed.

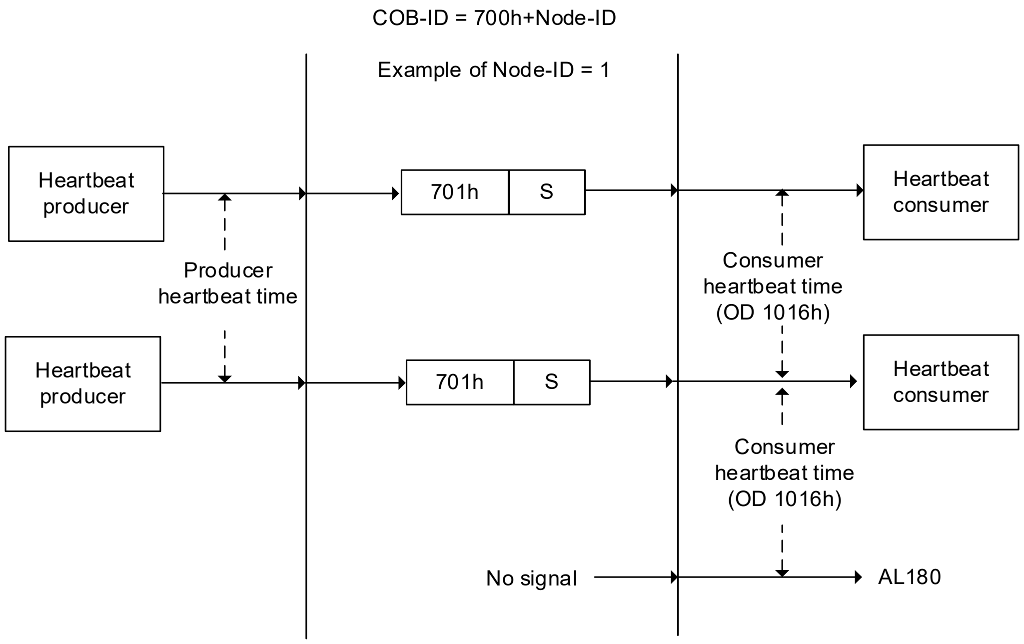
The following table shows the available communication objects in each communication state:

Communication object	Initialization	Pre-Operational	Operational	Stopped
PDO	-	-	V	TxPDO
SDO	-	V	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 send packets to the consumer periodically. 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 controller to send the heartbeat and the servo drive as the consumer, you need to set the consumer heartbeat time (OD 1016h) for the servo drive. When the servo drive does not receive the heartbeat signal within the receiving time, it triggers the heartbeat event, meaning AL180 is triggered. Consumer heartbeat time (OD 1016h) is defined as the time the servo drive expects to receive a heartbeat. To start the Heartbeat mechanism, set the consumer heartbeat time (OD 1016h) and then have the controller send the heartbeat signal. The consumer heartbeat time (OD 1016h) must be greater than the producer heartbeat time which is set by the controller. Since there are delays and other uncontrollable external factors in transmitting the heartbeat message, you must retain a tolerance time for the transmission.



The S code is described as follows:

S	State
0	Bootup
4	Stopped
5	Operational
127	Pre-Operational

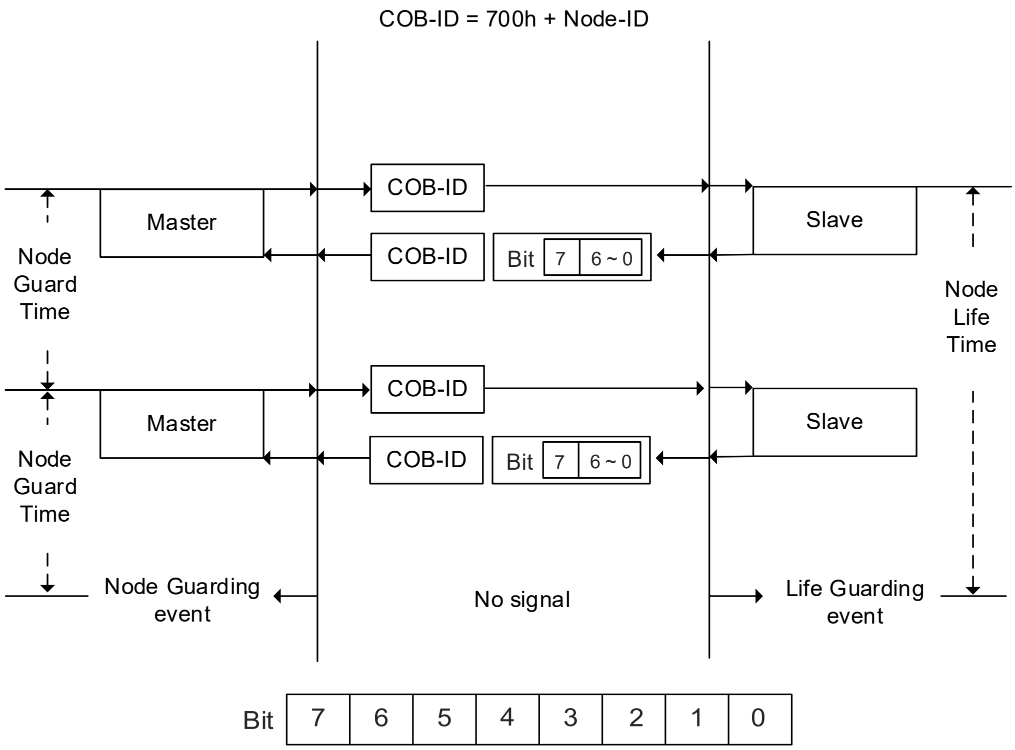
If you want to use the servo drive as the producer, then the heartbeat is sent by the drive. When the controller does not receive the heartbeat signal within the receiving time, it triggers the heartbeat event which corresponds to the alarm defined by the controller.

The servo drive can be the consumer and the producer simultaneously. In that case, you need to set OD 1016h and OD 1017h at the same time, and the controller must be set as the producer and the consumer as well.

■ Node/Life guarding

The Node/Life guarding mechanism is similar to the Heartbeat mechanism. The main difference between the two is that Heartbeat only uses the consumer but not the producer to judge whether there are packets or not. The mechanism of Node/Life guarding is mainly based on the two-way relationship between the master and slave. The master periodically sends packets to the slave, and the slave must return the packets to the master within the set guard time (OD 100Ch), otherwise an error occurs. You must set the life time for the slave and the master must send the packets within the guard time. If the slave 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 0 - Bit 6	State of the NMT slave	4: Stopped 5: Operational 127: Pre-Operational
Bit 7	Reserved	-

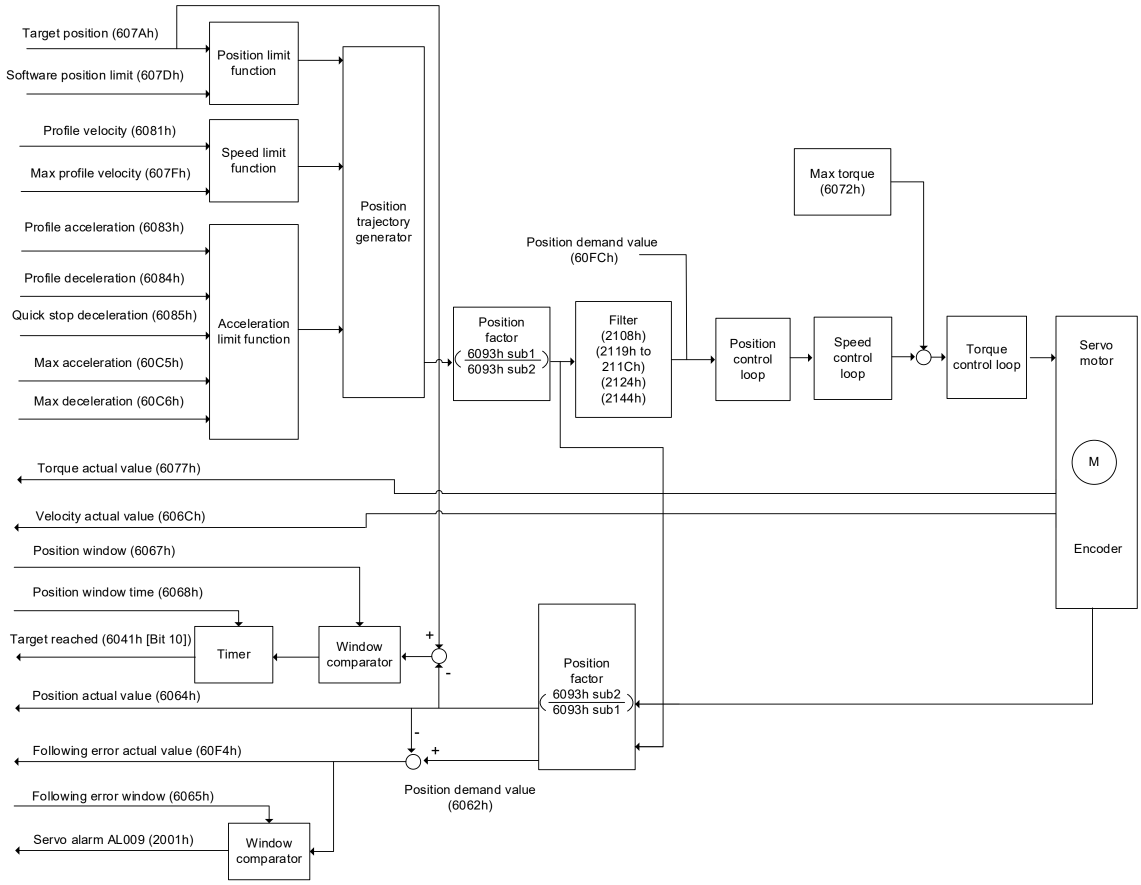
11.3 CANopen operation modes

This section describes the modes of operation specified by CiA DS402 when the servo is in the CANopen mode. The content includes basic operation settings and related object descriptions.

11.3.1 Profile Position mode

After receiving the position command transmitted from the controller, the servo drive controls the servo motor to reach the target position. In Profile Position (PP) mode, the controller only informs the servo drive of the target position, speed command, and acceleration / deceleration settings at the beginning. The motion planning from command triggering to the arrival of the target position is performed by the trajectory generator in the servo drive.

The following figure shows the Profile Position mode architecture of the servo drive:



Operation steps:

1. Set OD 6060h to 01h to set the mode as Profile Position mode.
2. Set OD 607Ah for the target position (unit: PUU).
3. Set OD 6081h for the profile velocity (unit: PUU/sec).
4. Set OD 6083h for the profile acceleration (unit: ms).
5. Set OD 6084h for the profile deceleration (unit: ms).
6. Set the Controlword (OD 6040h). Follow these steps for operation. 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 11.4.3.3.

Step	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Description
6.1	0	0	1	1	0	Shutdown.
6.2	0	0	1	1	1	Switch on (ready for Servo On).
6.3	0	1	1	1	1	Enable operation (Servo On).
6.4	1	1	1	1	1	Command triggering (rising-edge triggered)

7. After the servo completes the first motion command, the servo sets the target position, speed, and other conditions to execute the next motion command.
8. Set the Controlword (OD 6040h). Since the command is rising-edge triggered, switch Bit 4 to Off first and then to On.

Step	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Description
8.1	0	1	1	1	1	Enable operation (Servo On).
8.2	1	1	1	1	1	Command triggering (rising-edge triggered)

Read the servo drive information:

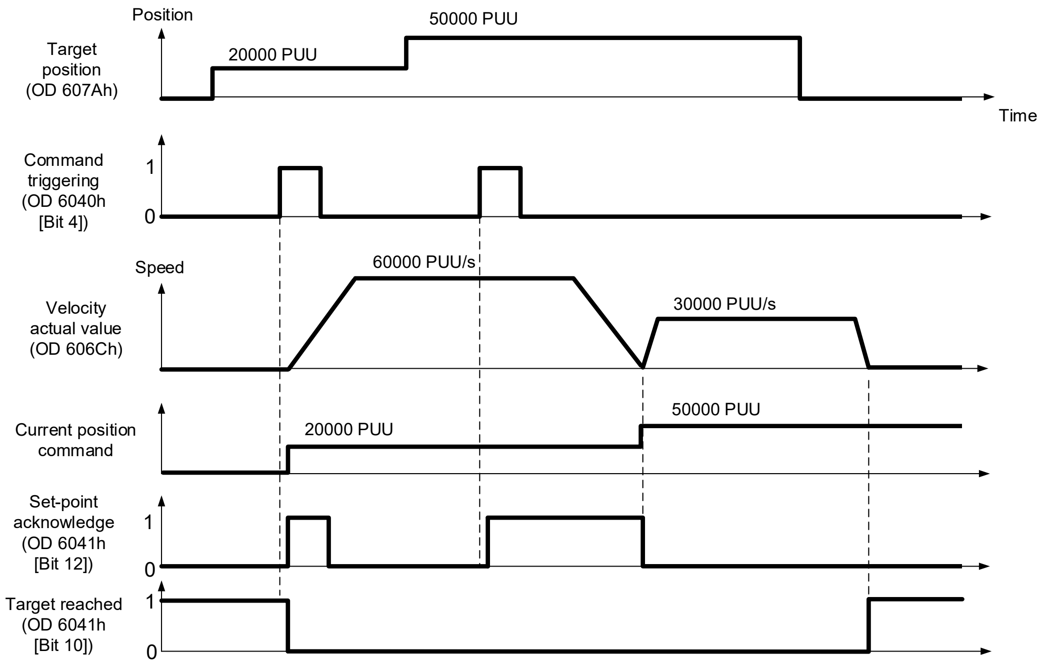
1. Read OD 6064h to obtain the actual value of the motor position at present.
2. Read OD 6041h to obtain the servo drive status, including the following error and notifications for set-point acknowledge and target reached.

Function for the command to take immediate effect

In Profile Position mode, set the command to take effect immediately or not with OD 6040h [Bit 5].

- Set OD 6040h [Bit 5] to 0 to disable the command from taking immediate effect

If the command is not enabled to take immediate effect, when the current motion command is in execution (not yet complete), the servo continues to execute the current motion command even if a new command is triggered. The new command is acknowledged and executed only after the current command is complete.



- Set OD 6040h [Bit 5] to 1 to enable the command to take immediate effect (only valid in Profile Position mode)

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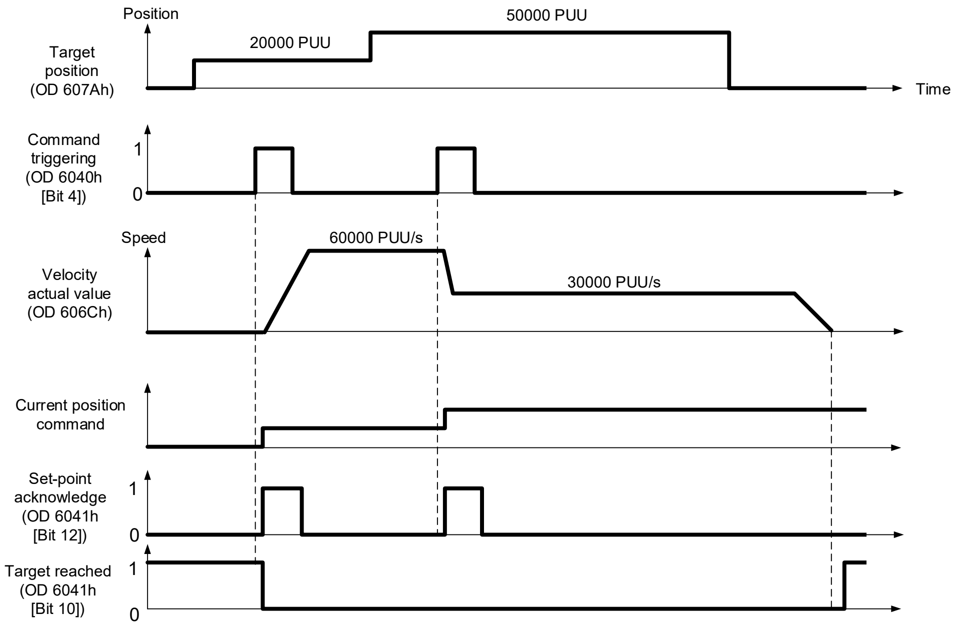
If the command is enabled to take immediate effect, when the current motion command is in execution (not yet complete), the servo immediately interrupts the current command and executes the new command once receiving the new triggered command.



Relevant object list

Index	Name	Data type	Access
6040h	Controlword	UNSIGNED16	RW
6041h	Statusword	UNSIGNED16	RO
6060h	Modes of operation	INTEGER8	RW
6061h	Modes of operation display	INTEGER8	RO
6062h	Position demand value [PUU]	INTEGER32	RO
6063h	Position actual internal value [Pulse]	INTEGER32	RO
6064h	Position actual value [PUU]	INTEGER32	RO
6065h	Following error window	UNSIGNED32	RW
6067h	Position window	UNSIGNED32	RW
6068h	Position window time	UNSIGNED16	RW
606Ch	Velocity actual value	INTEGER32	RO
6072h	Max torque	UNSIGNED16	RW
6077h	Torque actual value	INTEGER16	RO
607Ah	Target position	INTEGER32	RW
607Dh	Software position limit	INTEGER32	RW
607Fh	Max profile velocity	UNSIGNED32	RW
6081h	Profile velocity	UNSIGNED32	RW
6083h	Profile acceleration	UNSIGNED32	RW
6084h	Profile deceleration	UNSIGNED32	RW
6085h	Quick stop deceleration	UNSIGNED32	RW
6093h	Position factor	UNSIGNED32	RW
60C5h	Max acceleration	UNSIGNED32	RW

Index	Name	Data type	Access
60C6h	Max deceleration	UNSIGNED32	RW
60F4h	Following error actual value	INTEGER32	RO
60FCh	Position demand value	INTEGER32	RO

Note: for more details, refer to Section 11.4.3 Details of objects.

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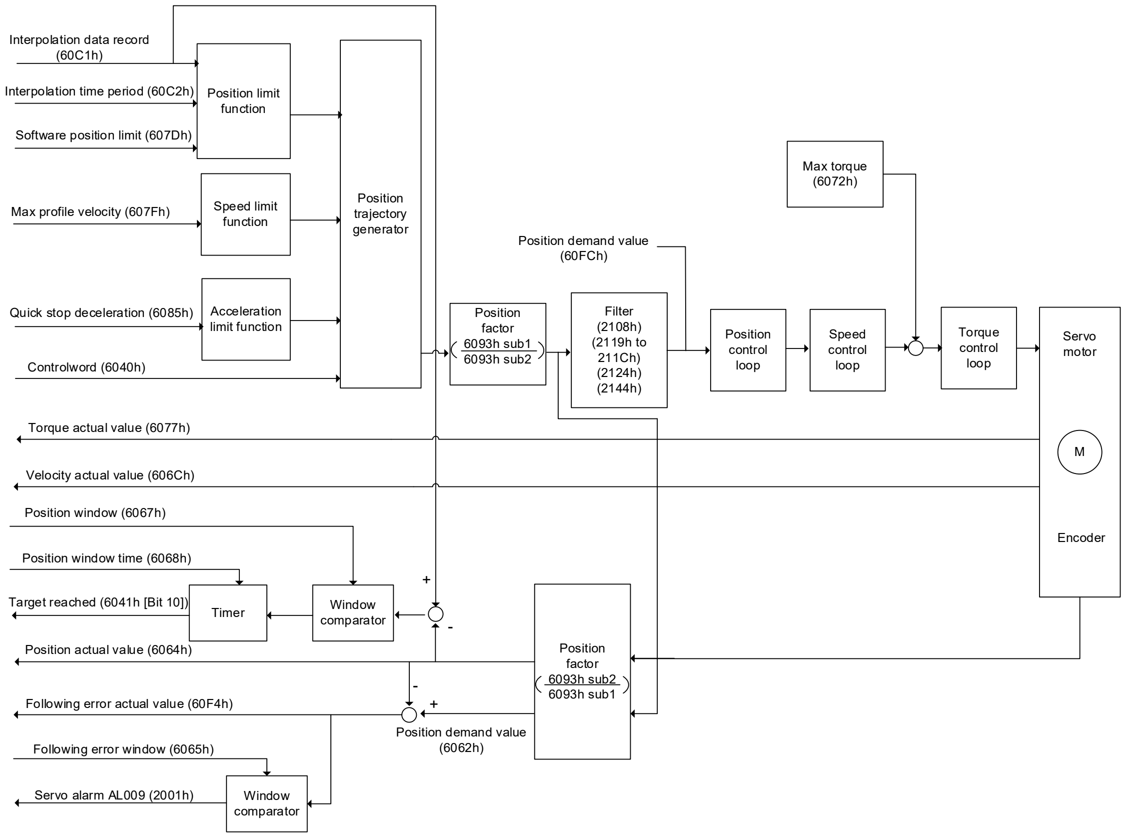
11.3.2 Interpolated Position mode

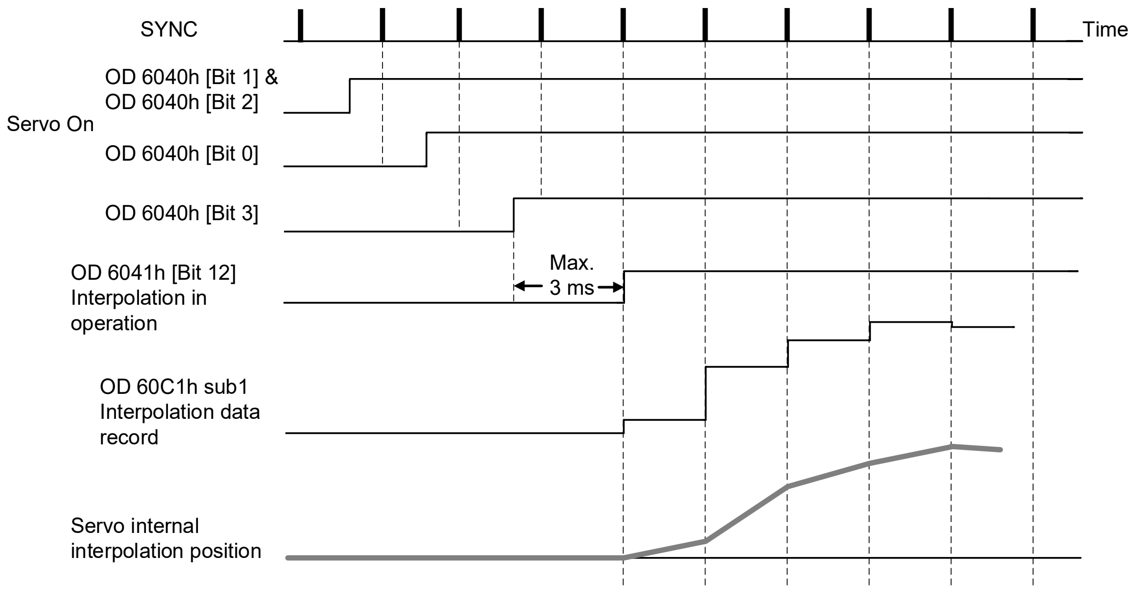
Interpolated Position (IP) mode requires a series of position data to complete the interpolation for positioning. Different from PP (Profile Position) mode, all the motion command paths in IP mode are issued by the controller. The servo drive only follows each position that the controller issues and finally completes a motion command. Delta servo drives only support synchronous operation in which the controller periodically sends the SYNC object (COB-ID = 0x80). The interpolation time period can be set with OD 60C2h. And the controller issues the position command to the interpolation position of OD 60C1h.



Operation steps:

1. Set OD 6060h to 07h to set the mode as Interpolated Position mode.
2. Set OD 60C2h for the interpolation time period. The setting must be the same as the communication cycle period (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 position actual value (OD 6064h).
5. Set the Controlword (OD 6040h). Follow these steps for operation. Steps 5.1 and 5.2 are to bring the servo drive's state machine into the ready state. For more details of the state machine, refer to the OD 6040h description in Section 11.4.3.3.

Step	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Description
5.1	0	0	1	1	0	Shutdown.
5.2	0	0	1	1	1	Switch on (ready for Servo On).
5.3	0	1	1	1	1	Enable operation (Servo On).



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Adjustment method:

It is suggested that you set the SYNC communication cycle period (OD 1006h) between 1 ms and 10 ms. If the cycle period is too long, the interval between cycles also increases. If the position change is big, it causes speed fluctuations. In this case, use P1.036 (S-curve acceleration / deceleration smoothing constant) or P1.068 (Position command - moving filter) to smooth the position difference. Since the jitter of each controller is different, the time the servo receives the SYNC differs from the SYNC communication cycle time. When this happens, adjust the value of P3.009.U to increase the error range and have the servo drive automatically correct the internal timer so it is consistent with the communication cycle of the controller.

Relevant object list

Index	Name	Data type	Access
6040h	Controlword	UNSIGNED16	RW
6041h	Statusword	UNSIGNED16	RO
6060h	Modes of operation	INTEGER8	RW
6061h	Modes of operation display	INTEGER8	RO
6093h	Position factor	UNSIGNED32	RW
60C0h	Interpolation sub mode select	INTEGER16	RW
60C1h	Interpolation data record	INTEGER32	RW

Note: for more details, refer to Section 11.4.3 Details of objects.

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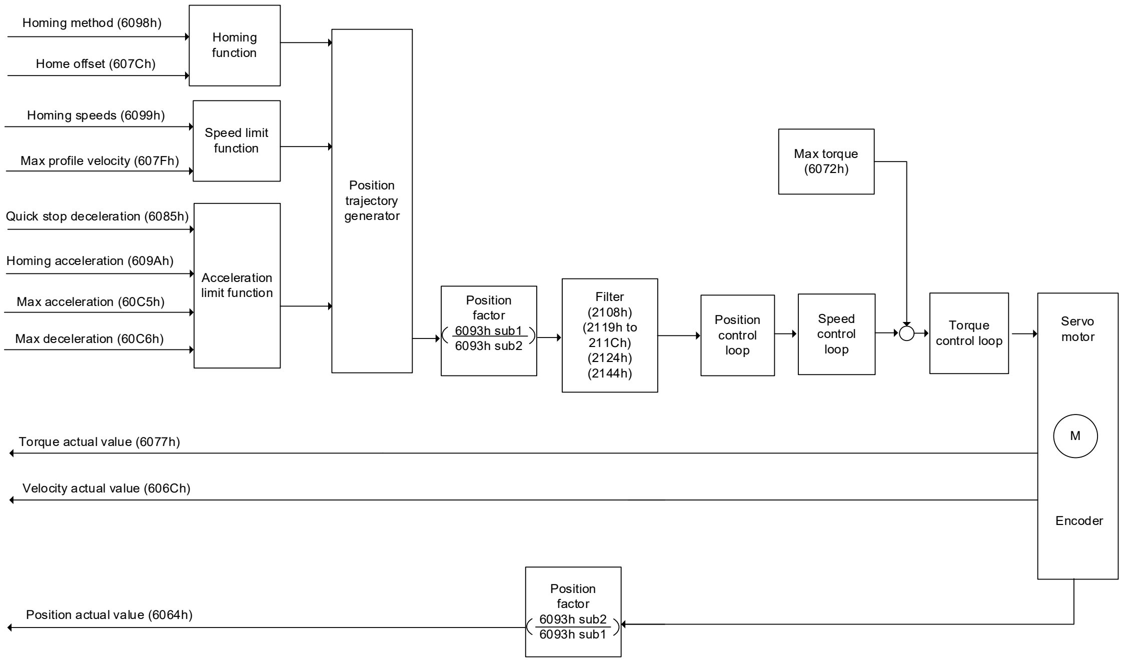
11.3.3 Homing mode

After homing is complete, the position system of the servo drive is established and the drive can start executing the position command issued by the controller. The Delta servo drive offers 39 homing methods, including homing on the home switch, positive or negative limit, motor Z pulse, and hard stop.



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 homing method.
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.
7. Set the Controlword (OD 6040h). Follow these steps for operation. Steps 7.1 and 7.2 are to bring the servo drive's state machine into the ready state. For more details of the state machine, refer to the OD 6040h description in Section 11.4.3.3.

Step	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Description
7.1	0	0	1	1	0	Shutdown.
7.2	0	0	1	1	1	Switch on (ready for Servo On).
7.3	0	1	1	1	1	Enable operation (Servo On).
7.4	1	1	1	1	1	Homing (rising-edge triggered).

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Read the servo drive information:

1. Read OD 6041h to obtain the servo drive status.
2. Read OD 6064h to obtain the actual value of the motor position at present.

Relevant object list

Index	Name	Data type	Access
6040h	Controlword	UNSIGNED16	RW
6041h	Statusword	UNSIGNED16	RO
6060h	Modes of operation	INTEGER8	RW
6061h	Modes of operation display	INTEGER8	RO
6064h	Position actual value [PUU]	INTEGER32	RO
606Ch	Velocity actual value	INTEGER32	RO
6072h	Max torque	UNSIGNED16	RW
607Ch	Home offset	INTEGER32	RW
607Fh	Max profile velocity	UNSIGNED32	RW
6085h	Quick stop deceleration	UNSIGNED32	RW
6093h	Position factor	UNSIGNED32	RW
6098h	Homing method	INTEGER8	RW
6099h	Homing speeds	UNSIGNED32	RW
609Ah	Homing acceleration	UNSIGNED32	RW
60C5h	Max acceleration	UNSIGNED32	RW
60C6h	Max deceleration	UNSIGNED32	RW

Note: for more details, refer to Section 11.4.3 Details of objects.

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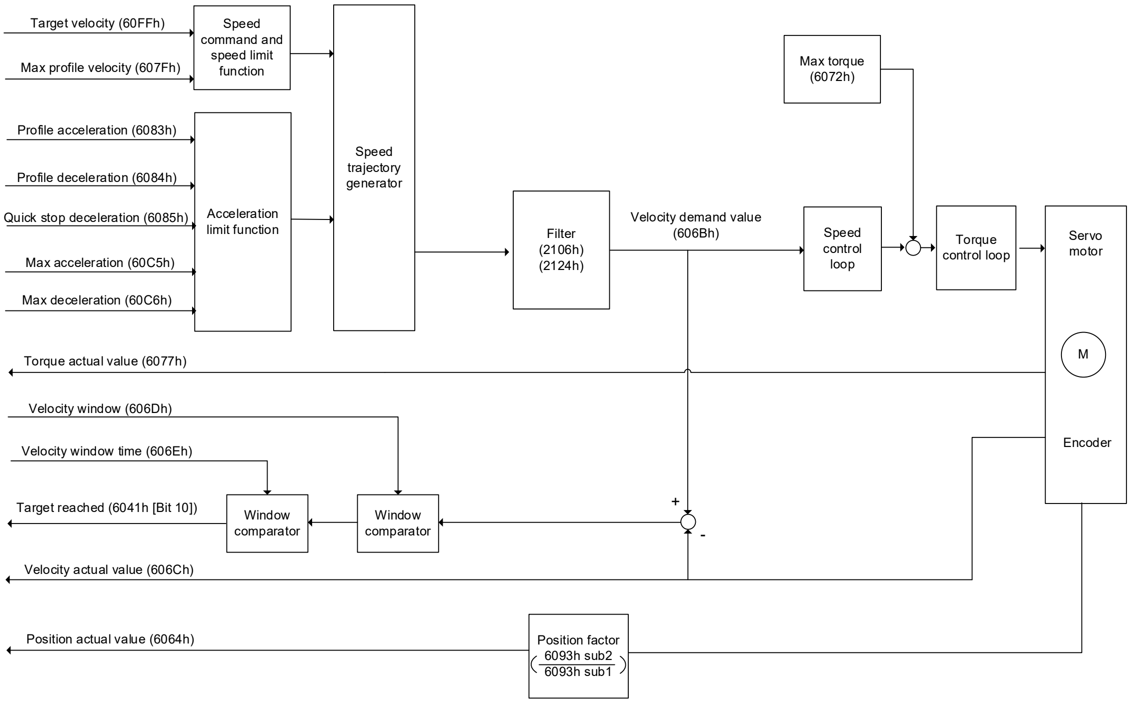
11.3.4 Profile Velocity mode

In Profile Velocity (PV) mode, the controller specifies the speed command and acceleration / deceleration settings, and then the trajectory 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 Profile Velocity mode.
2. Set OD 6083h for the profile acceleration.
3. Set OD 6084h for the profile deceleration.
4. Set the target velocity (OD 60FFh) to 0. In Profile Velocity mode, the servo motor starts operating once the servo drive is switched to Servo On (Step 5). Therefore, setting the target velocity (OD 60FFh) to 0 is to ensure that the motor maintains at 0 rpm at the moment of Servo On.
5. Set the Controlword (OD 6040h). Follow these steps for operation. Steps 5.1 and 5.2 are to bring the servo drive's state machine into the ready state. For more details of the state machine, refer to the OD 6040h description in Section 11.4.3.3.

Step	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Description
5.1	0	0	1	1	0	Shutdown.
5.2	0	0	1	1	1	Switch on (ready for Servo On).
5.3	0	1	1	1	1	Enable operation (Servo On).

6. Set OD 60FFh for the target velocity.

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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	Data type	Access
6040h	Controlword	UNSIGNED16	RW
6041h	Statusword	UNSIGNED16	RO
6060h	Modes of operation	INTEGER8	RW
6061h	Modes of operation display	INTEGER8	RO
6064h	Position actual value [PUU]	INTEGER32	RO
606Bh	Velocity demand value	INTEGER32	RO
606Ch	Velocity actual value	INTEGER32	RO
606Dh	Velocity window	UNSIGNED16	RW
606Eh	Velocity window time	UNSIGNED16	RW
606Fh	Velocity threshold	UNSIGNED16	RW
6072h	Max torque	UNSIGNED16	RW
6077h	Torque actual value	INTEGER16	RO
607Fh	Max profile velocity	UNSIGNED32	RW
6083h	Profile acceleration	UNSIGNED32	RW
6084h	Profile deceleration	UNSIGNED32	RW
6085h	Quick stop deceleration	UNSIGNED32	RW
6093h	Position factor	UNSIGNED32	RW
60C5h	Max acceleration	UNSIGNED32	RW
60C6h	Max deceleration	UNSIGNED32	RW
60FFh	Target velocity	INTEGER32	RW

Note: for more details, refer to Section 11.4.3 Details of objects.

11.3.5 Profile Torque mode

In Profile Torque (PT) mode, the controller specifies the torque command and filtering conditions, and then the trajectory generator of the servo drive plans the torque slope according to these conditions.

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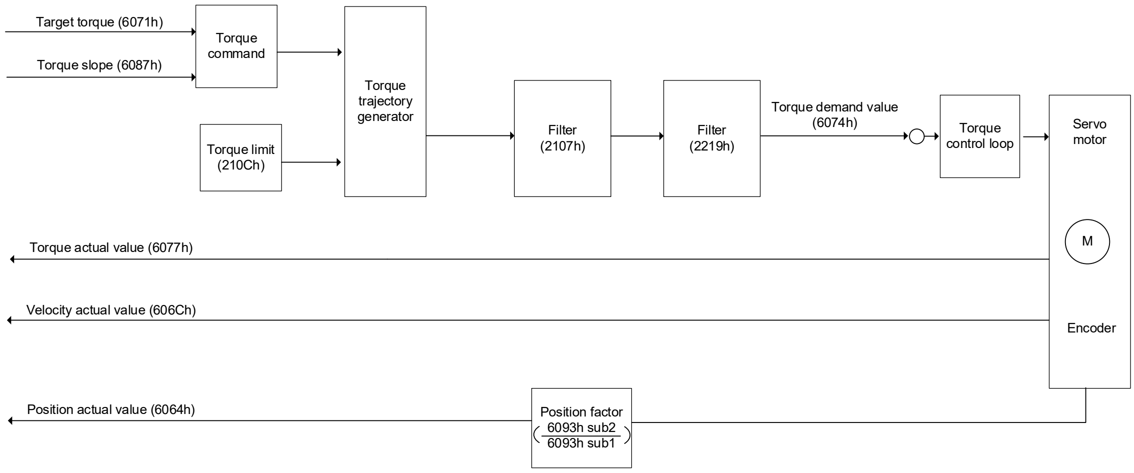

Operation steps:

1. Set OD 6060h to 04h to set the mode as Profile Torque mode.
2. Set OD 6087h for the torque slope.
3. Set the target torque (OD 6071h) to 0. In Profile Torque mode, the servo target torque takes effect once the servo drive is switched to Servo On (Step 4). Therefore, set the target torque (OD 6071h) to 0 for safety reasons.
4. Set the Controlword (OD 6040h). Follow these steps for operation. Steps 4.1 and 4.2 are to bring the servo drive's state machine into the ready state. For more details of the state machine, refer to the OD 6040h description in Section 11.4.3.3.

Step	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Description
4.1	0	0	1	1	0	Shutdown.
4.2	0	0	1	1	1	Switch on (ready for Servo On).
4.3	0	1	1	1	1	Enable operation (Servo On).

5. Set OD 6071h for the target torque.

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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	Access
6040h	Controlword	UNSIGNED16	RW
6041h	Statusword	UNSIGNED16	RO
6060h	Modes of operation	INTEGER8	RW
6061h	Modes of operation display	INTEGER8	RO
6064h	Position actual value [PUU]	INTEGER32	RO
606Ch	Velocity actual value	INTEGER32	RO
6071h	Target torque	INTEGER16	RW
6074h	Torque demand value	INTEGER16	RO
6075h	Motor rated current	UNSIGNED32	RO
6077h	Torque actual value	INTEGER16	RO
6078h	Current actual value	INTEGER16	RO
6087h	Torque slope	UNSIGNED32	RW
6093h	Position factor	UNSIGNED32	RW

Note: for more details, refer to Section 11.4.3 Details of objects.

11.4 Object dictionary

This section details the CANopen objects supported by the servo. The contents include object index, name, data type, data length, and read / write permissions (access).

11.4.1 Specifications for objects

Object code

Object code	Description
VAR	A single value, such as an UNSIGNED8, Boolean, float, and INTEGER16.
ARRAY	An object of multiple data fields consisting of multiple variables of the same data type, such as an UNSIGNED16 array. The sub-index 0h 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 0h data type is UNSIGNED8, so it is not a RECORD data.

Data type

Refer to CANopen DS301.

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11.4.2 List of objects

OD 1XXXh communication object group

Index	Object code	Name	Data type	Access
1000h	VAR	Device type	UNSIGNED32	RO
1001h	VAR	Error register	UNSIGNED8	RO
1003h	ARRAY	Pre-defined error field	UNSIGNED32	RW
1005h	VAR	COB-ID SYNC message	UNSIGNED32	RO
1006h	VAR	Communication cycle period	UNSIGNED32	RW
100Ch	VAR	Guard time	UNSIGNED16	RW
100Dh	VAR	Life time factor	UNSIGNED8	RW
1010h	ARRAY	Store parameters	UNSIGNED32	RW
1011h	ARRAY	Restore parameters	UNSIGNED32	RW
1014h	VAR	COB-ID emergency message	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	Server SDO parameter	SDO parameter	RO
1400h - 1403h	RECORD	Receive PDO communication parameter	UNSIGNED16/32	RW
1600h - 1603h	RECORD	Receive PDO mapping parameter	UNSIGNED32	RW
1800h - 1803h	RECORD	Transmit PDO communication parameter	UNSIGNED16/32	RW
1A00h - 1A03h	RECORD	Transmit PDO mapping parameter	UNSIGNED32	RW

Note: only 1001h can be mapped to PDO.

OD 2XXXh servo parameter group

Index	Object code	Name	Data type	Access	Mappable
2XXXh	VAR	Parameter mapping	INTEGER16/32	RW	Y

OD 6XXXh communication object group

Index	Object code	Name	Data type	Access	Mappable
603Fh	VAR	Error code	UNSIGNED16	RO	Y
6040h	VAR	Controlword	UNSIGNED16	RW	Y
6041h	VAR	Statusword	UNSIGNED16	RO	Y
605Bh	VAR	Shutdown option code	INTEGER16	RW	Y
6060h	VAR	Modes of operation	INTEGER8	RW	Y
6061h	VAR	Modes of operation display	INTEGER8	RO	Y
6062h	VAR	Position demand value [PUU]	INTEGER32	RO	Y
6063h	VAR	Position actual internal value [Pulse]	INTEGER32	RO	Y
6064h	VAR	Position actual value [PUU]	INTEGER32	RO	Y
6065h	VAR	Following error window	UNSIGNED32	RW	Y
6067h	VAR	Position window	UNSIGNED32	RW	Y
6068h	VAR	Position window time	UNSIGNED16	RW	Y
606Bh	VAR	Velocity demand value	INTEGER32	RO	Y
606Ch	VAR	Velocity actual value	INTEGER32	RO	Y
606Dh	VAR	Velocity window	UNSIGNED16	RW	Y
606Eh	VAR	Velocity window time	UNSIGNED16	RW	Y

Index	Object code	Name	Data type	Access	Mappable
606Fh	VAR	Velocity threshold	UNSIGNED16	RW	Y
6071h	VAR	Target torque	INTEGER16	RW	Y
6072h	VAR	Max torque	UNSIGNED16	RW	Y
6074h	VAR	Torque demand value	INTEGER16	RO	Y
6075h	VAR	Motor rated current	UNSIGNED32	RO	Y
6076h	VAR	Motor rated torque	UNSIGNED32	RO	Y
6077h	VAR	Torque actual value	INTEGER16	RO	Y
6078h	VAR	Current actual value	INTEGER16	RO	Y
607Ah	VAR	Target position	INTEGER32	RW	Y
607Ch	VAR	Home offset	INTEGER32	RW	Y
607Dh	ARRAY	Software position limit	INTEGER32	RW	Y
607Fh	VAR	Max profile velocity	UNSIGNED32	RW	Y
6080h	VAR	Max motor speed	UNSIGNED32	RW	Y
6081h	VAR	Profile velocity	UNSIGNED32	RW	Y
6083h	VAR	Profile acceleration	UNSIGNED32	RW	Y
6084h	VAR	Profile deceleration	UNSIGNED32	RW	Y
6085h	VAR	Quick stop deceleration	UNSIGNED32	RW	Y
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	INTEGER32	RW	Y
60C2h	RECORD	Interpolation time period	UNSIGNED8	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
60FEh	ARRAY	Digital outputs	UNSIGNED32	RW	Y
60FFh	VAR	Target velocity	INTEGER32	RW	Y
6502h	VAR	Supported drive modes	UNSIGNED32	RO	Y

11.4.3 Details of objects

11.4.3.1 OD 1XXXh communication object group

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Object 1000h: Device type

Index	1000h
Name	Device type
Object code	VAR
Data type	UNSIGNED32
Access	RO
PDO mapping	No
Setting range	UNSIGNED32

Format of this object: (High word h) DCBA; (Low word L) UZYX

A	Bit 16 - Bit 31 Model type	X	Bit 0 - Bit 15 Device profile number
B		Y	
C		Z	
D		U	

Definitions are as follows:

- UZYX: device profile number (servo drive: 0192)
- DCBA: model type

DCBA	Model type
0402	A2
0602	M
0702	A3
0B02	B3

Object 1001h: Error register

Index	1001h
Name	Error register
Object code	VAR
Data type	UNSIGNED8
Access	RO
PDO mapping	Yes
Setting range	UNSIGNED8
Default	0

Object function:

The bits and corresponding functions are as follows:

Bit	7	6	5	4	3	2	1	0

Bit	Function
Bit 0	Generic error
Bit 1	Current
Bit 2	Voltage
Bit 3	Temperature
Bit 4	Communication error
Bit 5 - Bit 7	Reserved

Object 1003h: Pre-defined error field

Index	1003h
Name	Pre-defined error field
Object code	ARRAY
Data type	UNSIGNED32
Access	RW
PDO mapping	No

Sub-index	0h
Description	Number of errors
Data type	UNSIGNED8
Access	RW
PDO mapping	No
Setting range	0 - 5
Default	0

Sub-index	1h – 5h
Description	Standard error field
Data type	UNSIGNED32
Access	RO
PDO mapping	No
Setting range	UNSIGNED32
Default	0

Format of this object: (High word h) DCBA; (Low word L) UZYX

A	Bit 16 - Bit 31 Delta servo alarm	X	Bit 0 - Bit 15 Error code
B		Y	
C		Z	
D		U	

Definitions are as follows:

- UZYX: error code. Refer to the error code definition in DS402.
- DCBA: Delta servo alarm. Refer to Chapter 14 Troubleshooting.

Example:

When you operate the servo, if the encoder cable is not correctly connected, the servo drive panel displays AL011 and the error code is stored in the OD 1003h array. The display is as follows:

Byte:	High word	Low word
	Delta servo alarm (UINT16)	Error code (UINT16)
	0x0011	0x7305

AL011 is defined as “CN2 communication failed” according to the Delta servo alarm.

Error code: 0x7305 is defined as “Incremental sensor 1 fault” according to DS402.

Object 1005h: COB-ID SYNC message

Index	1005h
Name	COB-ID SYNC message
Object code	VAR
Data type	UNSIGNED32
Access	RO
PDO mapping	No
Setting range	UNSIGNED32
Default	80h

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 0 - Bit 10	SYNC-COB-ID = 0x80	-
Bit 11 - Bit 31	Reserved	-

Object 1006h: Communication cycle period

Index	1006h
Name	Communication cycle period
Object code	VAR
Data type	UNSIGNED32
Access	RW
PDO mapping	No
Setting range	UNSIGNED32
Default	0
Unit	μs

Object function:

This object is to set the communication cycle, which 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 type	UNSIGNED16
Access	RW
PDO mapping	No
Setting range	UNSIGNED16
Default	0
Unit	ms

Object function:

OD 100Ch (guard time) multiplied by OD 100Dh (multiplying factor) gives the life time for the Life Guarding Protocol. If the guard time (OD 100Ch) is set to 0, then the Life Guarding Protocol is invalid.

Example: if OD 100Ch = 5 ms and OD 100Dh = 10, then the life time is 50 ms.

Object 100Dh: Life time factor

Index	100Dh
Name	Life time factor
Object code	VAR
Data type	UNSIGNED8
Access	RW
PDO mapping	No
Setting range	UNSIGNED8
Default	0

Object function:

OD 100Ch (guard time) multiplied by OD 100Dh (multiplying factor) gives the life time for the Life Guarding Protocol. If the guard time (OD 100Ch) is set to 0, then the Life Guarding Protocol is invalid.

Example: if OD 100Ch = 5 ms and OD 100Dh = 10, then the life time is 50 ms.

Object 1010h: Store parameters

Index	1010h
Name	Store parameters
Object code	ARRAY
Data type	UNSIGNED32
Access	RW
PDO mapping	No

Sub-index	0h
Description	Number of sub-index
Data type	UNSIGNED8
Access	RO
PDO mapping	No
Setting range	UNSIGNED8
Default	1

Sub-index	1h
Description	Store communication parameters
Data type	UNSIGNED32
Access	RW
PDO mapping	No
Setting range	0x65766173 (save)
Default	1

Object function:

You can only write 0x65766173 (save) to OD 1010h sub1, writing all current OD setting values to the EEPROM.

Object 1011h: Restore parameters

Index	1011h
Name	Restore parameters
Object code	ARRAY
Data type	UNSIGNED32
Access	RW
PDO mapping	No

Sub-index	0h
Description	Number of sub-index
Data type	UNSIGNED8
Access	RO
PDO mapping	No
Setting range	UNSIGNED8
Default	1

Sub-index	1h
Description	Restore communication parameters
Data type	UNSIGNED32
Access	RW
PDO mapping	No
Setting range	0x64616F6C (load)
Default	1

Object function:

You can only write 0x64616F6C (load) to OD 1011h sub1, resetting all ODs to their default values.

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Object 1014h: COB-ID emergency message

Index	1014h
Name	COB-ID emergency message
Object code	VAR
Data type	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 0 - Bit 10	COB-ID	80h + Node-ID. The data size is 11-bit.
Bit 11 - Bit 30	Reserved	-
Bit 31	Emergency (EMCY) function	0: enabled (servo drive sends the EMCY command). 1: disabled (servo drive does not send the EMCY command).

The COB-ID setting format is as follows:

Communication object	Function code Bit 10 9 8 7	Node ID Bit 6 5 4 3 2 1 0	COB-ID DEC (HEX)
EMCY object	0001	1	129 (81h)
		2	130 (82h)
		…	…
		127	255 (FFh)

Object 1016h: Consumer heartbeat time

Index	1016h
Name	Consumer heartbeat time
Object code	ARRAY
Data type	UNSIGNED32
Access	RW
PDO mapping	No

Sub-index	0h
Description	Number of sub-index
Data type	UNSIGNED8
Access	RO
PDO mapping	No
Setting range	1
Default	1

Sub-index	1h
Description	Consumer heartbeat time
Data type	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 0 - Bit 15	Heartbeat time	UNSIGNED8; unit: ms
Bit 16 - Bit 23	Node-ID	UNSIGNED8
Bit 24 - Bit 31	Reserved	-

Consumer heartbeat time is defined as the time the servo drive expects to receive a heartbeat. When the servo drive does not receive the heartbeat signal within the receiving time, it triggers the heartbeat event, meaning AL180 is triggered. The consumer heartbeat time must be greater than the producer heartbeat time. Since there are delays and other uncontrollable external factors in transmitting the heartbeat message, you must retain a tolerance time for the transmission.

Object 1017h: Producer heartbeat time

Index	1017h
Name	Producer heartbeat time
Object code	VAR
Data type	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 type	Identity
Access	RO
PDO mapping	No

Sub-index	0h
Description	Number of sub-index
Data type	UNSIGNED8
Access	RO
PDO mapping	No
Setting range	3
Default	3

Sub-index	1h
Description	Vendor ID
Data type	UNSIGNED32
Access	RO
PDO mapping	No
Setting range	UNSIGNED32
Default	1DDh

Sub-index	2h
Description	Product code
Data type	UNSIGNED32
Access	RO
PDO mapping	No
Setting range	UNSIGNED32
Default	6000h: A2 series 6010h: A3 series 6030h: M series 6080h: B3 series

Sub-index	3h
Description	Version
Data type	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 type	UNSIGNED8
Access	RW
PDO mapping	No

Sub-index	0h
Description	Number of error types
Data type	UNSIGNED8
Access	RO
PDO mapping	No
Setting range	1
Default	1

Sub-index	1h
Description	Communication error
Data type	UNSIGNED8
Access	RW
PDO mapping	No
Setting range	UNSIGNED8
Default	0

Object function:

Generally, when a serious fault is detected in the Operational state, the servo drive automatically switches to the Pre-Operational state. Use this object setting to switch the state to the Pre-Operational state, keep the original state, or switch to the Stopped state.

OD 1029h sub1 setting	Switch the state to
0	Pre-Operational (only when the servo is currently in the Operational state)
1	Keep the original state
2	Stopped

Object 1200h: Server SDO parameter

Index	1200h
Name	Server SDO parameter
Object code	RECORD
Data type	SDO parameter
Access	RO
PDO mapping	No

Sub-index	0h
Description	Number of sub-index
Data type	UNSIGNED8
Access	RO
PDO mapping	No
Setting range	2
Default	2

Sub-index	1h
Description	Controller sends to servo drive COB-ID Client->Server (rx)
Data type	UNSIGNED32
Access	RO
PDO mapping	No
Setting range	UNSIGNED32
Default	Index 1200h: 600h + Node-ID

Sub-index	2h
Description	Servo drive returns to controller COB-ID Server->Client (tx)
Data type	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 = 600h + Ah = 60Ah
OD 1200h sub1 reads 60Ah.

If the servo drive station number for transmitting is 10:
580h + Node-ID: Ah = 580h + Ah = 58Ah
OD 1200h sub2 reads 58Ah.

Objects 1400h - 1403h: Receive PDO communication parameter

Index	1400h, 1401h, 1402h, 1403h
Name	Receive PDO communication parameter
Object code	RECORD
Data type	PDO CommPar
Access	RW

Sub-index	0h
Description	Number of sub-index
Data type	UNSIGNED8
Access	RO
PDO mapping	No
Setting range	5
Default	5

Sub-index	1h
Description	COB-ID used by PDO
Data type	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 0 - Bit 10	COB-ID	The data size is 11-bit.
Bit 11 - Bit 30	Reserved	-
Bit 31	PDO function switch	0: enable 1: disable Enable / disable the PDO function to determine if the PDO is used in the Operational state.

The COB-ID setting format is as follows:

Communication object	Object index	COB-ID DEC (HEX)
RxPDO1	1400h	512 (200h) + Node-ID
RxPDO2	1401h	768 (300h) + Node-ID
RxPDO3	1402h	1024 (400h) + Node-ID
RxPDO4	1403h	1280 (500h) + Node-ID

Sub-index	2h
Description	Transmission type
Data type	UNSIGNED8
Access	RW
PDO mapping	No
Setting range	UNSIGNED8
Default	0

Object function:

The transmission 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	3h
Description	Inhibit time (not used for RxPDO)
Data type	UNSIGNED16
Access	RW
PDO mapping	No
Setting range	UNSIGNED16
Default	0

Sub-index	4h
Description	Compatibility entry
Data type	UNSIGNED8
Access	RW
PDO mapping	No
Setting range	UNSIGNED8
Default	0

Sub-index	5h
Description	Event timer (not used for RxPDO)
Data type	UNSIGNED16
Access	RW
PDO mapping	No
Setting range	UNSIGNED16
Default	0

Objects 1600h - 1603h: Receive PDO mapping parameter

Index	1600h, 1601h, 1602h, 1603h
Name	Receive PDO mapping parameter
Object code	RECORD
Data type	PDO mapping
Access	RW
Note	The total length of objects in a group of PDO cannot exceed 64 bits.

Sub-index	0h
Description	Number of PDO mappings
Data type	UNSIGNED8
Access	RW
PDO mapping	No
Setting range	0: disable 1 - 8: set the number of PDO mapping and enable the function
Default	0

Sub-index	1h – 8h
Description	Specify the 1st (to 8th) object and its content to be mapped
Data type	UNSIGNED32
Access	RW
PDO mapping	No
Setting range	UNSIGNED32
Default	0

The format of this object is as follows:

Bit	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

Bit	Function
Bit 0 - Bit 7	Object data length
Bit 8 - Bit 15	Object sub-index
Bit 16 - Bit 31	Object index

Example:

To set the three PDOs, OD 6040h, OD 607Ah, and OD 6060h, in the first group of PDO, the setting is as follows:

Mapping parameter setting for RxPDO	Data			Description
OD 1600h sub0	3			Set 3 PDO mappings.
OD 1600h sub1	6040h	00h	10h	Mapping the Controlword (OD 6040h); data length is 16-bit.
OD 1600h sub2	607Ah	00h	20h	Mapping the target position (OD 607Ah); data length is 32-bit.
OD 1600h sub3	6060h	00h	08h	Mapping the operation mode (OD 6060h); data length is 8-bit.
Note	The total length is 38h (56-bit) which meets the specification of less than 64-bit.			

Objects 1800h - 1803h: Transmit PDO communication parameter

Index	1800h, 1801h, 1802h, 1803h
Name	Transmit PDO communication parameter
Object code	RECORD
Data type	PDO CommPar
Access	RW

Sub-index	0h
Description	Largest sub-index supported
Data type	UNSIGNED8
Access	RO
PDO mapping	No
Setting range	5
Default	5

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Sub-index	1h
Description	COB-ID used by PDO
Data type	UNSIGNED32
Access	RW
PDO mapping	No
Setting range	UNSIGNED32
Default	Default Node-ID: 0 OD 1800h: 180h + Node-ID OD 1801h: 280h + Node-ID OD 1802h: 380h + Node-ID OD 1803h: 480h + 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 0 - Bit 10	COB-ID	The data size is 11-bit.
Bit 11 - Bit 30	Reserved	-
Bit 31	PDO function switch	0: enable 1: disable Enable / disable the PDO function to determine if the PDO is used in the Operational state.

Sub-index	2h
Description	Transmission type
Data type	UNSIGNED8
Access	RW
PDO mapping	No
Setting range	UNSIGNED8
Default	0

Object function:

The transmission 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	3h
Description	Inhibit time
Data type	UNSIGNED16
Access	RW
PDO mapping	No
Setting range	UNSIGNED16
Default	0

Sub-index	4h
Description	Reserved
Data type	UNSIGNED8
Access	RW
PDO mapping	No
Setting range	UNSIGNED8
Default	0

Sub-index	5h
Description	Event timer
Data type	UNSIGNED16
Access	RW
PDO mapping	No
Setting range	0: not in use UNSIGNED16
Default	0

Objects 1A00h - 1A03h: Transmit PDO mapping parameter

Index	1A00h, 1A01h, 1A02h, 1A03h
Name	Transmit PDO mapping parameter
Object code	RECORD
Data type	PDO mapping
Access	RW
Note	The total length of objects in a group of PDO cannot exceed 64 bits.

Sub-index	0h
Description	Number of PDO mappings
Data type	UNSIGNED8
Access	RW
PDO mapping	No
Setting range	0: disable 1 - 8: set the number of PDO mapping and enable the function
Default	0

Sub-index	1h – 8h
Description	Specify the 1st (to 8th) object and its content to be mapped
Data type	UNSIGNED32
Access	RW
PDO mapping	No
Setting range	UNSIGNED32
Default	0

Format of this object: (High word h) DCBA; (Low word L) UZYX

DCBA	Bit 16 - Bit 31 Object index	YX	Bit 0 - Bit 7 Object data length
		UZ	Bit 8 - Bit 15 Object sub-index

11.4.3.2 OD 2XXXh servo parameter group

Object 2XXXh: Parameter mapping

Index	2XXXh
Name	Parameter mapping
Object code	VAR
Data type	INTEGER16 / INTEGER32
Access	RW
PDO mapping	Yes
Setting range	INTEGER16 / INTEGER32
Default	N/A

Object function:

Access the corresponding servo parameters with the OD 2XXXh group. The conversion between the parameter number and object index is as follows:

Object index	Servo parameter	Description
2**aBC**h	P**a**.**bcd**	“**BC**” is the hexadecimal format of “**bcd**”.

You can read the object index first to get the information of the parameter length, and then use the SDO or PDO to change the data.

Example 1:

Object 2300h: Node-ID [P3.000]

Index	2300h
Name	Node-ID
Object code	VAR
Data type	INTEGER16
Access	RW
PDO mapping	Yes
Setting range	INTEGER16
Default	7F

Example 2:

Object 212Ch: Electronic gear [P1.044]

Index	212Ch
Name	Electronic gear
Object code	VAR
Data type	INTEGER32
Access	RW
PDO mapping	Yes
Setting range	INTEGER32
Default	1

11.4.3.3 OD 6XXXh communication object group

Object 603Fh: Error code (CANopen-defined)

Index	603Fh
Name	Error code
Object code	VAR
Data type	UNSIGNED16
Access	RO
PDO mapping	Yes
Setting range	UNSIGNED16
Default	0

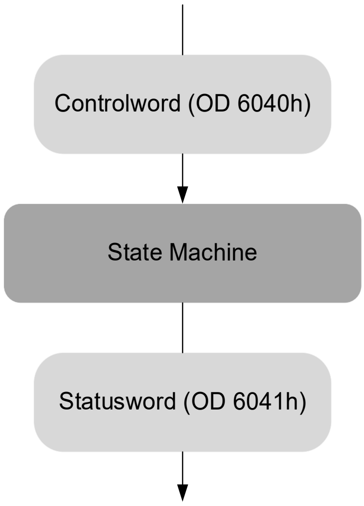
Object 6040h: Controlword

Index	6040h
Name	Controlword
Object code	VAR
Data type	UNSIGNED16
Access	RW
PDO mapping	Yes
Setting range	UNSIGNED16
Default	0x0004

Object function:

The Controlword contains many functions, such as Servo On, command triggering, fault reset, and quick stop.

The state machine architecture is as follows:



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

Bit	Function	Description
Bit 0	Switch on	Ready for Servo On.
Bit 1	Enable voltage	-
Bit 2	Quick stop (B contact (NC))	-
Bit 3	Enable operation	Servo On.
Bit 4 - Bit 6	Defined in each operation mode	These bits are individually defined according to the operation mode, as shown in the following table.
Bit 7	Fault reset	-
Bit 8	Halt	-
Bit 9 - Bit 15	Reserved	-

Bits 4 - 6 are individually defined according to the operation mode, as shown in the following table:

Bit	Definition in each operation mode		
	Profile Position mode	Homing mode	Profile Velocity mode Profile Torque mode Interpolated Position mode
Bit 4	Command triggering (rising-edge triggered)	Homing (rising-edge triggered)	-
Bit 5	Function for the command to take immediate effect	-	-
Bit 6	0: absolute position command 1: relative position command	-	-

Note: - indicates the bit is invalid.

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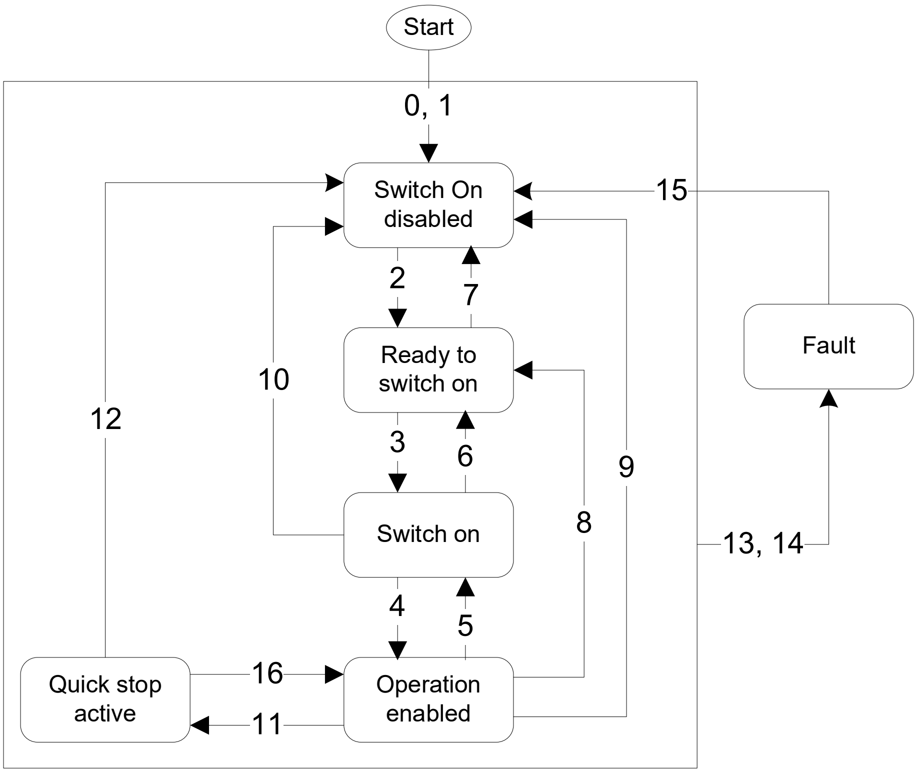
Finite state machine (as shown in the following diagram) defines the behavior of a servo drive system. Each state represents an internal or external behavior. For example, the servo drive can execute point-to-point motion only in the Operation enabled state.



The state transition is defined as follows:

Transition	Event	Action
0, 1	Automatic transition after power-on	Device boot and initialization
2	Shutdown command	N/A
3	Switch on command	Servo is ready for Servo On
4	Enable operation command	Servo switches to Servo On and enters the mode in which the controller is allowed to issue a motion command.
5	Disable operation command	Servo switches to Servo Off
6	Shutdown command	N/A
7	Disable voltage or quick stop command	N/A
8	Shutdown command	Servo switches to Servo Off
9	Disable voltage command	Servo switches to Servo Off
10	Disable voltage or quick stop command	N/A
11	Quick stop command The following two errors belong to this quick stop type: 1. Positive / negative limit switch triggered 2. Quick stop triggered by the Controlword (OD 6040h [Bit 2] = 0)	Quick stop function is enabled. The time setting for deceleration to a stop is different for the two errors. 1. OD 2503h (P5.003) 2. OD 6085h
12	Disable voltage command (OD 6040h = 0000 0110 or OD 6040h [Bit 1] = 0)	Servo switches to Servo Off
13, 14	Alarm occurs	Servo switches to Servo Off
15	Fault reset	N/A
16	Enable operation command; no alarm	Motion operation restart. The restart action is mode-dependent.

State transition can be achieved by issuing commands with the Controlword (OD 6040h). The settings of OD 6040h for different commands are as follows:

OD 6040h					Command	Transition
Bit 7	Bit 3	Bit 2	Bit 1	Bit 0		
0	X	1	1	0	Shutdown	2, 6, 8
0	0	1	1	1	Switch on	3
0	1	1	1	1	Switch on + Enable operation	3 + 4
0	X	X	0	X	Disable voltage	7, 9, 10, 12
0	X	0	1	X	Quick stop	7, 10, 11
0	0	1	1	1	Disable operation	5
0	1	1	1	1	Enable operation	4, 16
	X	X	X	X	Fault reset	15

Object 6041h: Statusword

Index	6041h
Name	Statusword
Object code	VAR
Data type	UNSIGNED16
Access	RO
PDO mapping	Yes
Setting range	UNSIGNED16
Default	0

Object function:

The Statusword contains many statuses, such as Servo On, command statuses, fault signal, and quick stop. The state machine architecture is as follows:

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

Bit	Status		Description
Bit 0	Ready to switch on	Ready to be activated	Current status of the servo drive (see the following table for details).
Bit 1	Switched on	Servo ready	
Bit 2	Operation enabled	Servo On	
Bit 3	Fault	Fault signal	
Bit 4	Voltage enabled	Servo is powered on	
Bit 5	Quick stop	Quick stop	
Bit 6	Switch on disabled	Servo disabled	
Bit 7	Warning	Warning signal	When outputting the warning signal, the servo keeps outputting the Servo On signal.
Bit 8	Reserved	-	-
Bit 9	Remote	Remote control	-
Bit 10	Target reached	Target reached	-
Bit 11	Reserved	-	-

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Bit	Status		Description
Bit 12 - Bit 13	-	-	These bits are individually defined according to the operation mode, as shown in the following table.
Bit 14	Positive limit	Positive limit	-
Bit 15	Negative limit	Negative limit	-

Bit 0 - Bit 6: current status of the servo drive.

Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Description
0	-	-	0	0	0	0	Not ready to switch on.
1	-	-	0	0	0	0	Switch on disabled.
0	1	-	0	0	0	1	Ready to switch on.
0	1	-	0	0	1	1	Switched on.
0	1	-	0	1	1	1	Operation enabled (Servo On).
0	0	-	0	1	1	1	Quick stop active.
0	-	-	1	1	1	1	Fault reaction active.
0	-	-	1	0	0	0	Servo fault (servo switches to Servo Off).

Note: 0 indicates the bit is off, 1 indicates the bit is on, and - indicates the bit is invalid.

Bit 12 - Bit 13: current status of the servo drive.

Bit	Definition in each operation mode				
	Profile Position mode	Homing mode	Interpolated Position mode	Profile Velocity mode	Profile Torque mode
Bit 12	Set-point acknowledge (servo received the command signal)	Homing is complete	Interpolation in operation	Zero speed	-
Bit 13	Following error	Homing error	-	-	-

Note: - indicates the bit is invalid.

Object 605Bh: Shutdown option code

Index	605Bh
Name	Shutdown option code
Object code	VAR
Data type	INTEGER16
Access	RW
PDO mapping	Yes
Setting range	INTEGER16
Default	0

Object function:

OD 605Bh = 0: when Servo Off, the dynamic brake has no effect, so the motor runs freely and the machine stops only by friction.

OD 605Bh = -1: when Servo Off, the servo stops with the operation of the dynamic brake.

Note: when P3.012.Z is set to 1, the non-volatile setting for this object is enabled.

Object 6060h: Modes of operation

Index	6060h
Name	Modes of operation
Object code	VAR
Data type	INTEGER8
Access	RW
PDO mapping	Yes
Setting range	INTEGER8
Default	0

Object function:

This object sets the mode for operation.

Setting value	Mode
0	Reserved
1	Profile Position mode
2	Reserved
3	Profile Velocity mode
4	Profile Torque mode
5	Reserved
6	Homing mode
7	Interpolated Position mode

Object 6061h: Modes of operation display

Index	6061h
Name	Modes of operation display
Object code	VAR
Data type	INTEGER8
Access	RO
PDO mapping	Yes
Setting range	INTEGER8
Default	0

Object function:

This object displays the current operation mode. Refer to the table in OD 6060h.

Object 6062h: Position demand value (PUU)

Index	6062h
Name	Position demand value
Object code	VAR
Data type	INTEGER32
Access	RO
PDO mapping	Yes
Setting range	INTEGER32
Default	0
Unit	PUU

Object function:

This position demand value is the interpolation command calculated by the servo internal interpolator. This command passes through the servo internal filter. For its detailed location, refer to the servo architecture diagram of each mode.

Object 6063h: Position actual internal value (Pulse)

Index	6063h
Name	Position actual internal value
Object code	VAR
Data type	INTEGER32
Access	RO
PDO mapping	Yes
Setting range	INTEGER32
Default	0
Unit	Pulse (unit for encoder pulse resolution) The ASDA-A2 servo drive generates 1,280,000 pulses per motor revolution. The ASDA-A3 / ASDA-B3 servo drive generates 16,777,216 pulses per motor revolution.

Object 6064h: Position actual value (PUU)

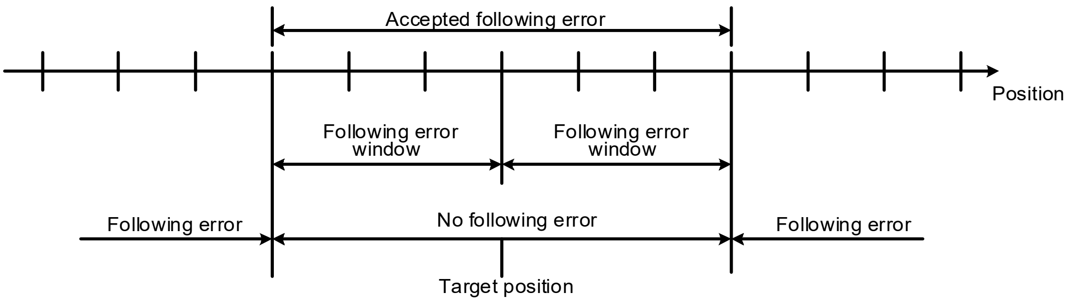
Index	6064h
Name	Position actual value
Object code	VAR
Data type	INTEGER32
Access	RO
PDO mapping	Yes
Setting range	INTEGER32
Default	0
Unit	PUU

Object 6065h: Following error window

Index	6065h
Name	Following error window
Object code	VAR
Data type	UNSIGNED32
Access	RW
PDO mapping	Yes
Setting range	UNSIGNED32
Default	50331648
Unit	PUU

Object function:

When the following error actual value (OD 60F4h) exceeds this setting range, AL009 (Excessive deviation of Position command) is triggered.



Note: when P3.012.Z is set to 1, the non-volatile setting for this object is enabled.

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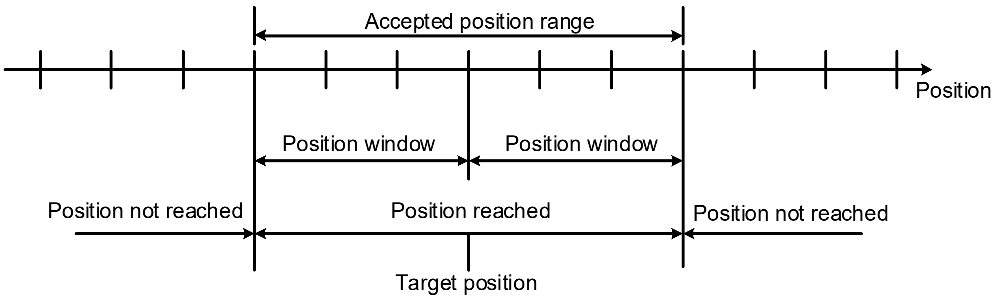
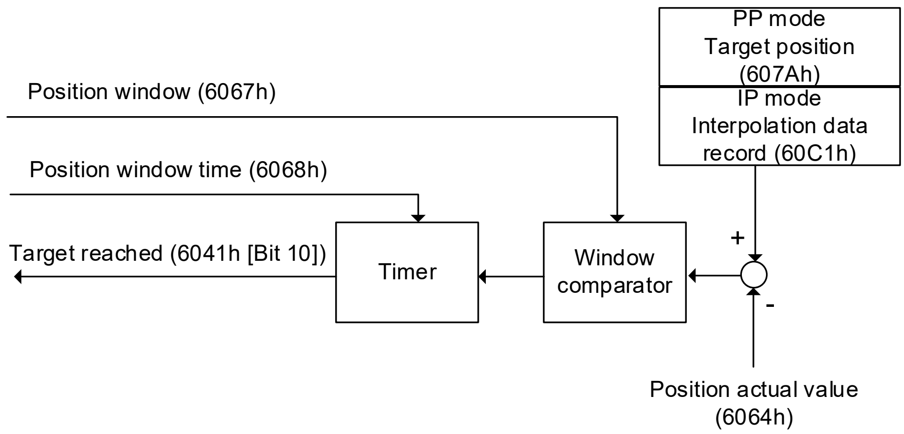
Object 6067h: Position window

Index	6067h
Name	Position window
Object code	VAR
Data type	UNSIGNED32
Access	RW
PDO mapping	Yes
Setting range	UNSIGNED32
Default	100
Unit	PUU

Object function:

When the difference (absolute value) between the position command (PP mode: OD 607Ah; IP mode: OD 60C1h) and the position actual value (OD 6064h) is within the range set in OD 6067h (Position window), and the duration of this condition is longer than the time set in OD 6068h (Position window time), OD 6041h [Bit 10] (Target reached) is output.



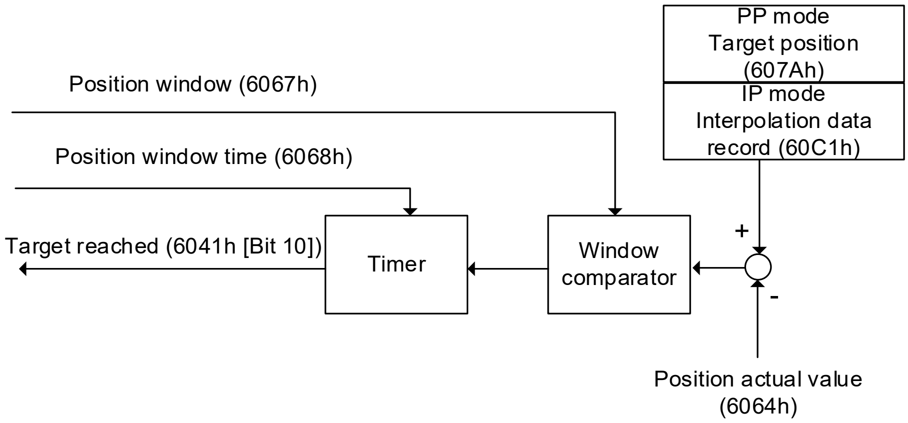


Object 6068h: Position window time

Index	6068h
Name	Position window time
Object code	VAR
Data type	UNSIGNED16
Access	RW
PDO mapping	Yes
Setting range	UNSIGNED16
Default	0
Unit	ms

Object function:

When the difference (absolute value) between the position command (PP mode: OD 607Ah; IP mode: OD 60C1h) and the position actual value (OD 6064h) is within the range set in OD 6067h (Position window), and the duration of this condition is longer than the time set in OD 6068h (Position window time), OD 6041h [Bit 10] (Target reached) is output.



Object 606Bh: Velocity demand value

Index	606Bh
Name	Velocity demand value
Object code	VAR
Data type	INTEGER32
Access	RO
PDO mapping	Yes
Setting range	INTEGER32
Default	0.1 rpm

Object function:

The velocity demand value is the command generated by the speed trajectory generator and filtered by the 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 type	INTEGER32
Access	RO
PDO mapping	Yes
Setting range	INTEGER32
Default	0.1 rpm

Object function:

Returns the motor speed at present for monitoring.

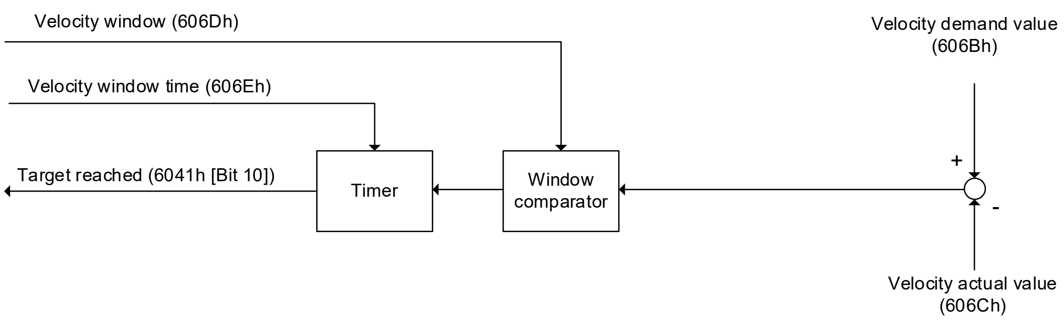
Object 606Dh: Velocity window

Index	606Dh
Name	Velocity window
Object code	VAR
Data type	UNSIGNED16
Access	RW
PDO mapping	Yes
Setting range	0 - 3000
Default	100
Unit	0.1 rpm

Object function:

The window comparator compares the speed difference with the velocity window (OD 606Dh). When the difference (absolute value) is within the range set in the velocity window and the duration of this condition is longer than the time set in the velocity window time (OD 606Eh), OD 6041h [Bit 10] (Target reached) is output. This object only works in Profile Velocity mode.

Note: when P3.012.Z is set to 1, the non-volatile setting for this object is enabled.



Object 606Eh: Velocity window time

Index	606Eh
Name	Velocity window time
Object code	VAR
Data type	UNSIGNED16
Access	RW
PDO mapping	Yes
Setting range	UNSIGNED16
Default	0
Unit	ms

Object function:

Refer to OD 606Dh for the description of the object.

Note: when P3.012.Z is set to 1, the non-volatile setting for this object is enabled.

Object 606Fh: Velocity threshold

Index	606Fh
Name	Velocity threshold
Object code	VAR
Data type	UNSIGNED16
Access	RW
PDO mapping	Yes
Setting range	0 - 2000
Default	100
Unit	0.1 rpm

Object function:

This object sets the range for the zero-speed signal output. When the forward or reverse speed (absolute value) of the motor is lower than the setting value of OD 606Fh, OD 6041h [Bit 12] (zero-speed signal) outputs 1.

Note: when P3.012.Z is set to1, the non-volatile setting for this object is enabled.

Object 6071h: Target torque

Index	6071h
Name	Target torque
Object code	VAR
Data type	INTEGER16
Access	RW
PDO mapping	Yes
Setting range	-3500 to +3500
Default	0
Unit	0.1%

Object function:

This object sets the target torque in Profile Torque mode. If OD 6071h = 1000 (100.0%), it corresponds to the motor rated torque.

Object 6072h: Max torque

Index	6072h
Name	Max torque
Object code	VAR
Data type	UNSIGNED16
Access	RW
PDO mapping	Yes
Setting range	0 - 3500
Default	3500
Unit	0.1%

Object function:

This object sets the maximum torque in Profile Torque mode.

Object 6074h: Torque demand value

Index	6074h
Name	Torque demand value
Object code	VAR
Data type	INTEGER16
Access	RO
PDO mapping	Yes
Setting range	INTEGER16
Default	0
Unit	0.1%

Object function:

The torque demand value is the command generated by the speed trajectory generator and filtered by the 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 type	UNSIGNED32
Access	RO
PDO mapping	Yes
Setting range	UNSIGNED32
Default	0
Unit	mA

Object function:

This object displays the rated current specified on the motor nameplate.

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Object 6076h: Motor rated torque

Index	6076h
Name	Motor rated torque
Object code	VAR
Data type	UNSIGNED32
Access	RO
PDO mapping	Yes
Setting range	UNSIGNED32
Default	0
Unit	0.001 N-m

Object function:

This object displays the rated torque specified on the motor nameplate.

Object 6077h: Torque actual value

Index	6077h
Name	Torque actual value
Object code	VAR
Data type	INTEGER16
Access	RO
PDO mapping	Yes
Setting range	INTEGER16
Default	0
Unit	0.1%

Object function:

This object is the motor torque feedback in percentage at present.

Object 6078h: Current actual value

Index	6078h
Name	Current actual value
Object code	VAR
Data type	INTEGER16
Access	RO
PDO mapping	Yes
Setting range	INTEGER16
Default	0
Unit	0.1%

Object function:

This object is the motor current feedback in percentage at present.

Object 607Ah: Target position

Index	607Ah
Name	Target position
Object code	VAR
Data type	INTEGER32
Access	RW
PDO mapping	Yes
Setting range	INTEGER32
Default	0
Unit	PUU

Object function:

This object only works in Profile Position mode. For more details, refer to Section 11.3.1.

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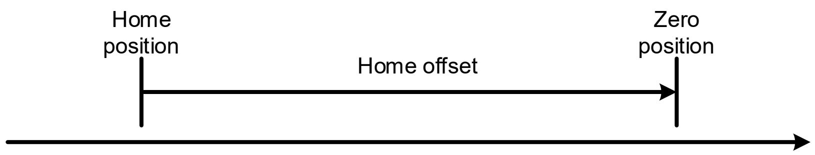
Object 607Ch: Home offset

Index	607Ch
Name	Home offset
Object code	VAR
Data type	INTEGER32
Access	RW
PDO mapping	Yes
Setting range	INTEGER32
Default	0
Unit	PUU

Object function:

The origin reference point which the system looks for during the homing procedure is Home position, 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 (Zero position), and the offset value is Home offset.

Note: when P3.012.Z is set to 1, the non-volatile setting for this object is enabled.



Object 607Dh: Software position limit

Index	607Dh
Name	Software position limit
Object code	ARRAY
Data type	INTEGER32
Access	RW

Sub-index	0h
Description	Number of entries
Data type	UNSIGNED8
Access	RO
PDO mapping	Yes
Setting range	2
Default	2

Sub-index	1h
Description	Min position limit
Data type	INTEGER32
Access	RW
PDO mapping	Yes
Setting range	-2147483648 to +2147483647
Default	-2147483648
Unit	PUU

Sub-index	2h
Description	Max position limit
Data type	INTEGER32
Access	RW
PDO mapping	Yes
Setting range	-2147483648 to +2147483647
Default	+2147483647
Unit	PUU

Note: when P3.012.Z is set to 1, the non-volatile setting for this object is enabled.

Object 607Fh: Max profile velocity

Index	607Fh
Name	Max profile velocity
Object code	VAR
Data type	UNSIGNED32
Access	RW
PDO mapping	Yes
Setting range	UNSIGNED32
Default	Varies depending on the motor model
Corresponding servo parameter	P1.055 (rpm) / 10
Unit	0.1 rpm

Object function:

The unit of this object is 0.1 rpm, so dividing this object by 10 is equivalent to P1.055 (Maximum speed limit in units of 1 rpm).

Note: when P3.012.Z is set to 1, the non-volatile setting for this object is enabled.

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Object 6080h: Max motor speed

Index	6080h
Name	Max motor speed
Object code	VAR
Data type	UNSIGNED32
Access	RW
PDO mapping	Yes
Setting range	UNSIGNED32
Default	Varies depending on the motor model
Corresponding servo parameter	P1.055
Unit	rpm

Object function:

OD 6080h is equivalent to P1.055 (Maximum speed limit).

Note: when P3.012.Z is set to 1, the non-volatile setting for this object is enabled.

Object 6081h: Profile velocity

Index	6081h
Name	Profile velocity
Object code	VAR
Data type	UNSIGNED32
Access	RW
PDO mapping	Yes
Setting range	UNSIGNED32
Default	10000
Unit	PUU/s

Object function:

This object only works in Profile Position mode. For more details, refer to Section 11.3.1.

Object 6083h: Profile acceleration

Index	6083h
Name	Profile acceleration
Object code	VAR
Data type	UNSIGNED32
Access	RW
PDO mapping	Yes
Setting range	1 - 65500
Default	200
Unit	ms

Object function:

The time slope set by this object is the time required for the motor to accelerate from 0 rpm to 3,000 rpm. This object only works in Profile Position mode and Profile Velocity mode.

Object 6084h: Profile deceleration

Index	6084h
Name	Profile deceleration
Object code	VAR
Data type	UNSIGNED32
Access	RW
PDO mapping	Yes
Setting range	1 - 65500
Default	200
Unit	ms

Object function:

The time slope set by this object is the time required for the motor to decelerate from 3,000 rpm to 0 rpm. This object only works in Profile Position mode and Profile Velocity mode.

Object 6085h: Quick stop deceleration

Index	6085h
Name	Quick stop deceleration
Object code	VAR
Data type	UNSIGNED32
Access	RW
PDO mapping	Yes
Setting range	1 - 65500
Default	200
Unit	ms

Object function:

The time slope set by this object is the time required for the motor to decelerate from 3,000 rpm to 0 rpm using the quick stop function.

Object 6087h: Torque slope

Index	6087h
Name	Torque slope
Object code	VAR
Data type	UNSIGNED32
Access	RW
PDO mapping	Yes
Setting range	0 - 65500
Default	200
Unit	ms

Object function:

The time slope set by this object is the time required for the motor to change from 0% to 100% of the rated torque.

Note: when P3.012.Z is set to 1, the non-volatile setting for this object is enabled.

Object 6093h: Position factor

Index	6093h
Name	Position factor
Object code	ARRAY
Data type	UNSIGNED32
Access	RW
PDO mapping	Yes
Corresponding servo parameter	P1.044 and P1.045
Note	Position factor = Numerator / Feed_constant

Sub-index	0h
Description	Number of sub-index
Data type	UNSIGNED8
Access	RO
PDO mapping	No
Setting range	2
Default	2

Sub-index	1h
Description	E-Gear ratio numerator
Data type	UNSIGNED32
Access	RW
PDO mapping	Yes
Default	1
Corresponding servo parameter	P1.044
Note	For the E-Gear ratio setting, refer to Section 6.2.5.

Sub-index	2h
Description	E-Gear ratio denominator
Data type	UNSIGNED32
Access	RW
PDO mapping	Yes
Default	1
Corresponding servo parameter	P1.045
Note	For the E-Gear ratio setting, refer to Section 6.2.5.

Note: when P3.012.Z is set to 1, the non-volatile setting for this object is enabled.

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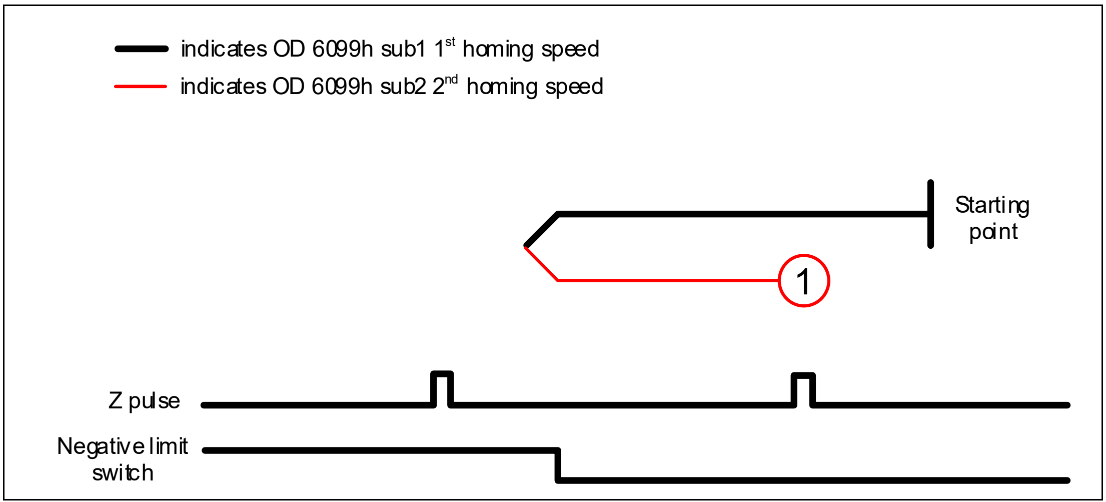
Object 6098h: Homing method

Index	6098h
Name	Homing method
Object code	VAR
Data type	INTEGER8
Access	RW
PDO mapping	Yes
Setting range	-4 to 35
Default	0

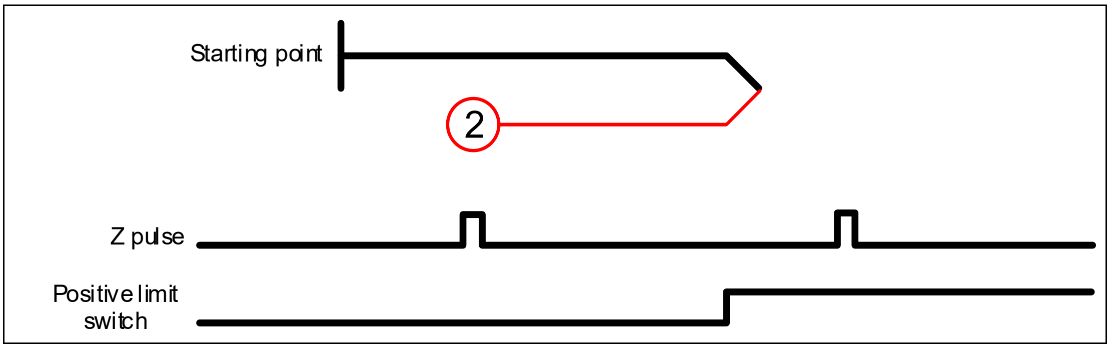
Object function:

The homing methods include looking for the Z pulse (Methods 1 - 14, 33, 34, 36, 37), not looking for the Z pulse (Methods 17 - 30), defining the current position as the origin (Method 35), and looking for the hard stop (Methods 36 - 39). Methods 15, 16, 31, and 32 are reserved. To use Methods 1 to 35, set OD 6098h to 1 to 35. To use Methods 36 to 39, set OD 6098h to -1 to -4.

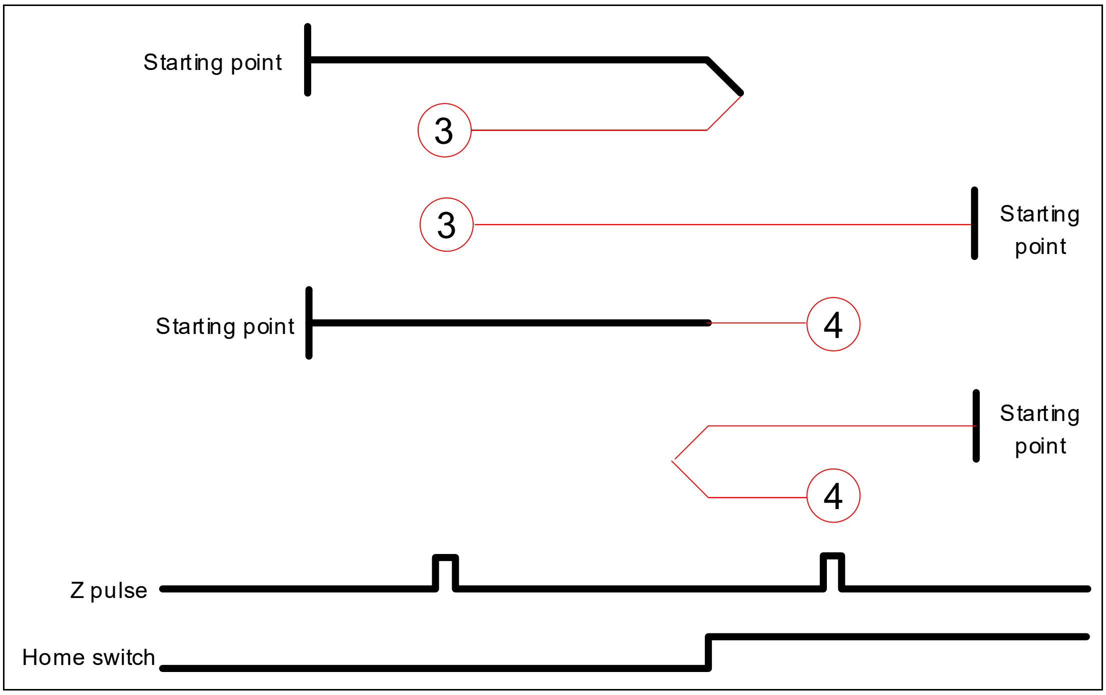
Method 1: homing on the negative limit switch and Z pulse



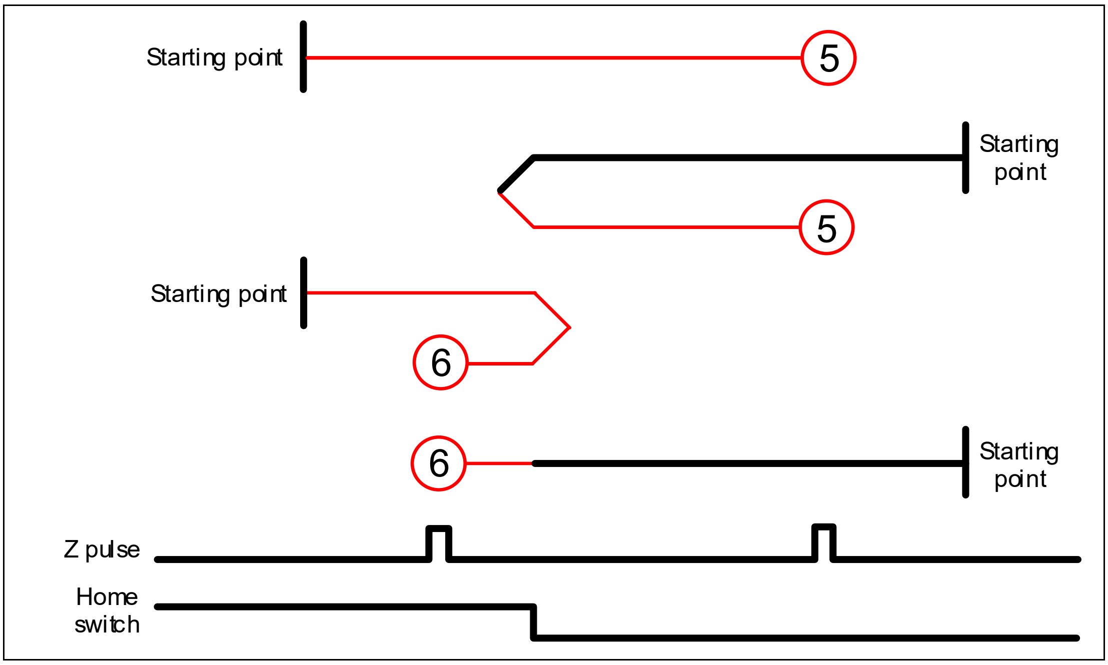
Method 2: homing on the positive limit switch and Z pulse



Methods 3 and 4: homing on the home switch and Z pulse



Methods 5 and 6: homing on the home switch and Z pulse



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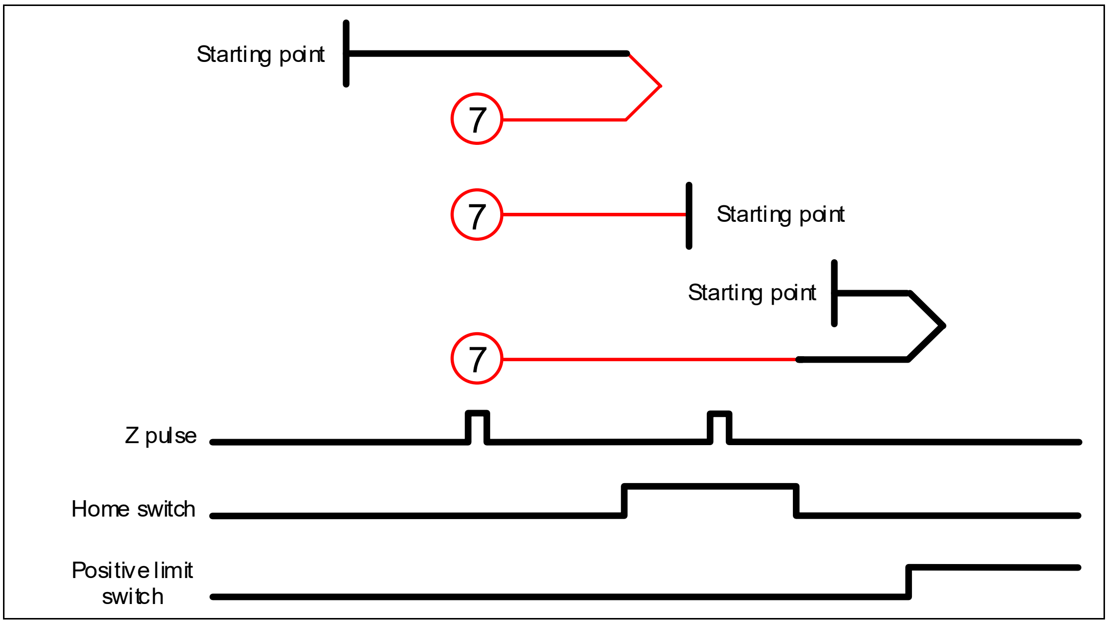
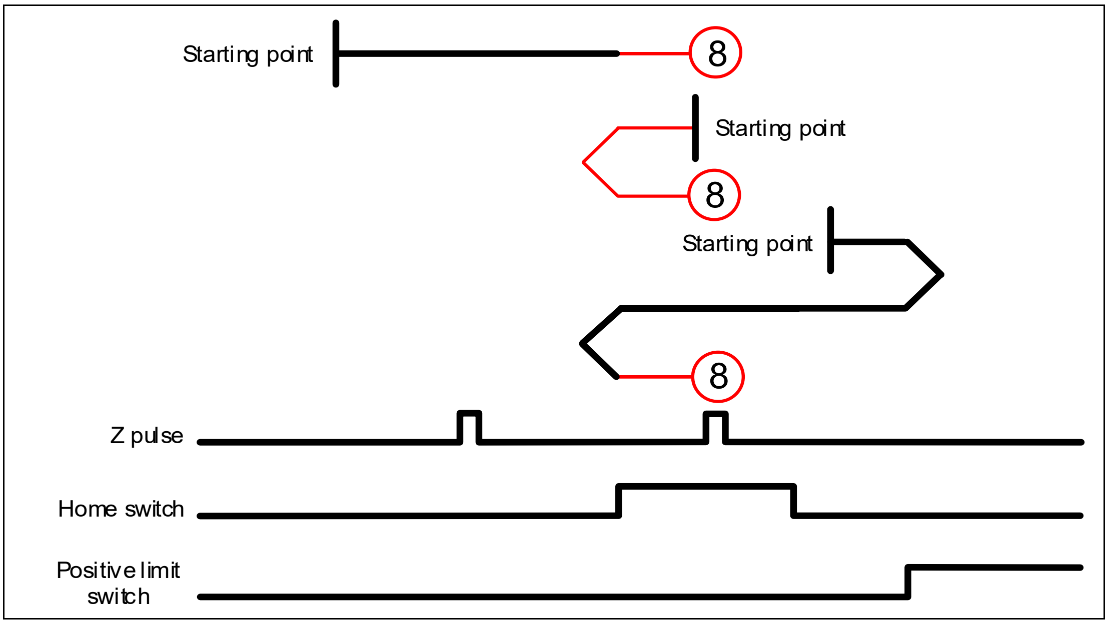
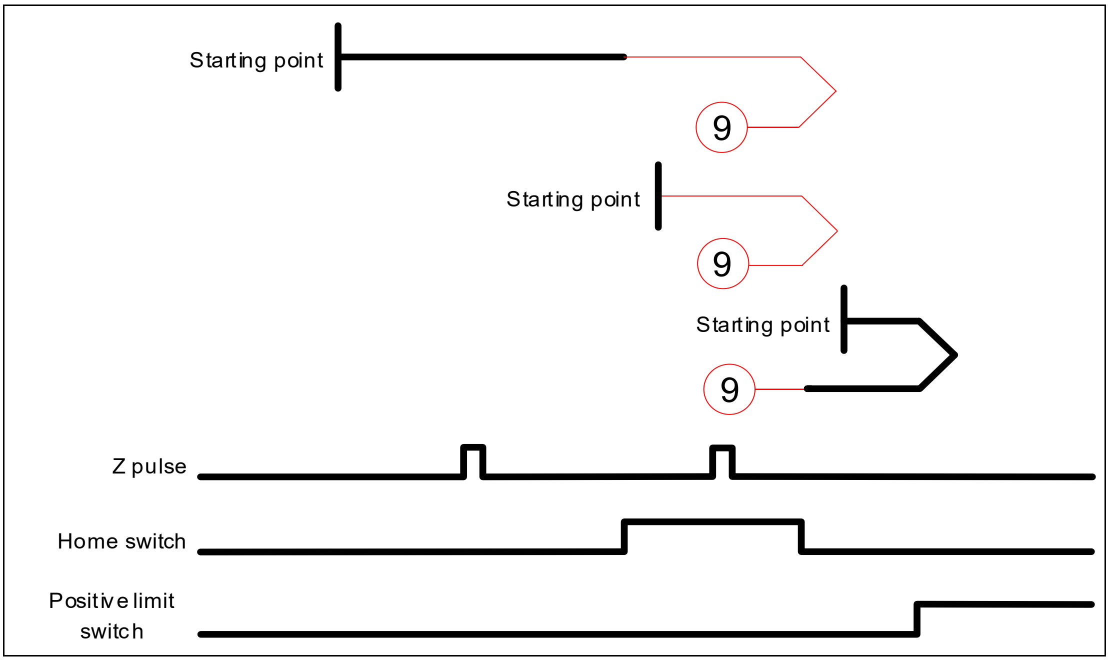
Method 7: homing on the positive limit switch, home switch, and Z pulse



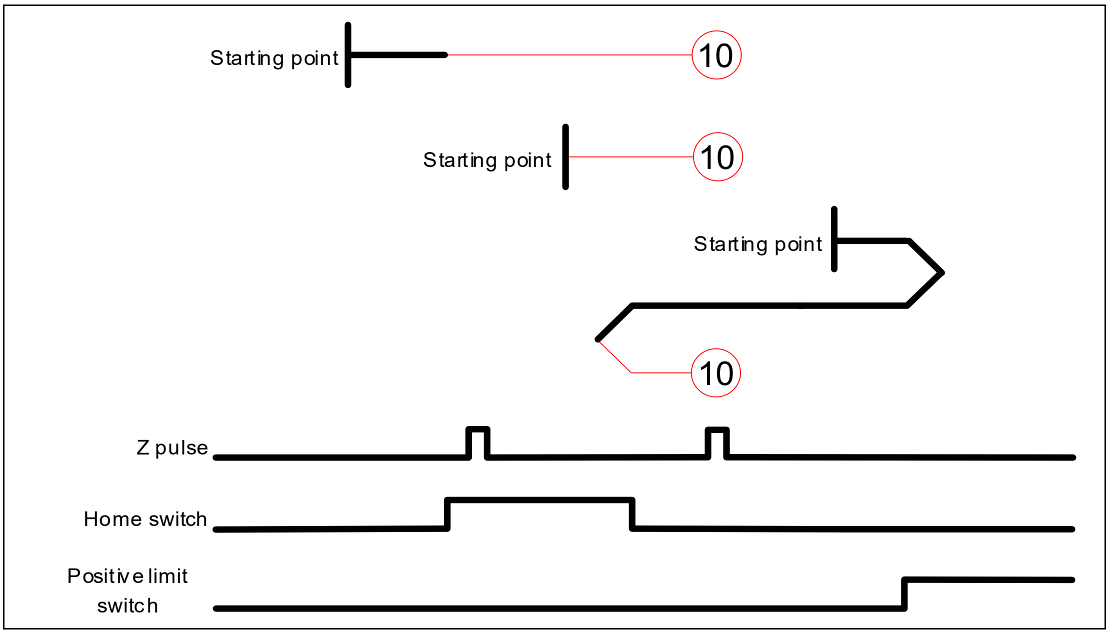
Method 8: homing on the positive limit switch, home switch, and Z pulse



Method 9: homing on the positive limit switch, home switch, and Z pulse



Method 10: homing on the positive limit switch, home switch, and Z pulse



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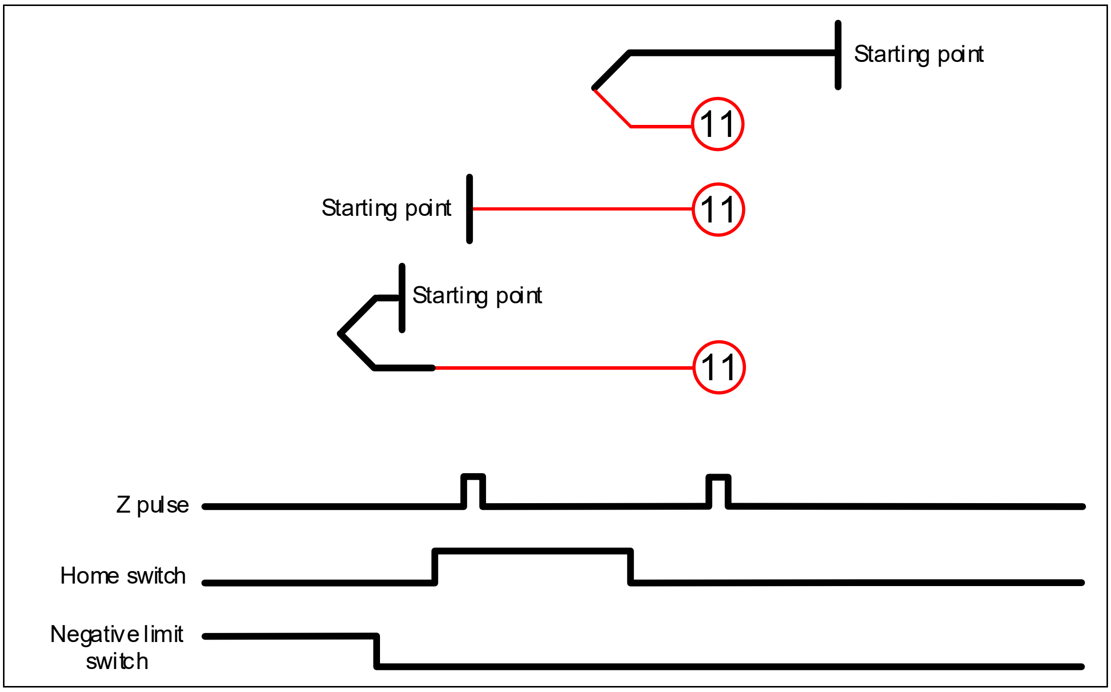
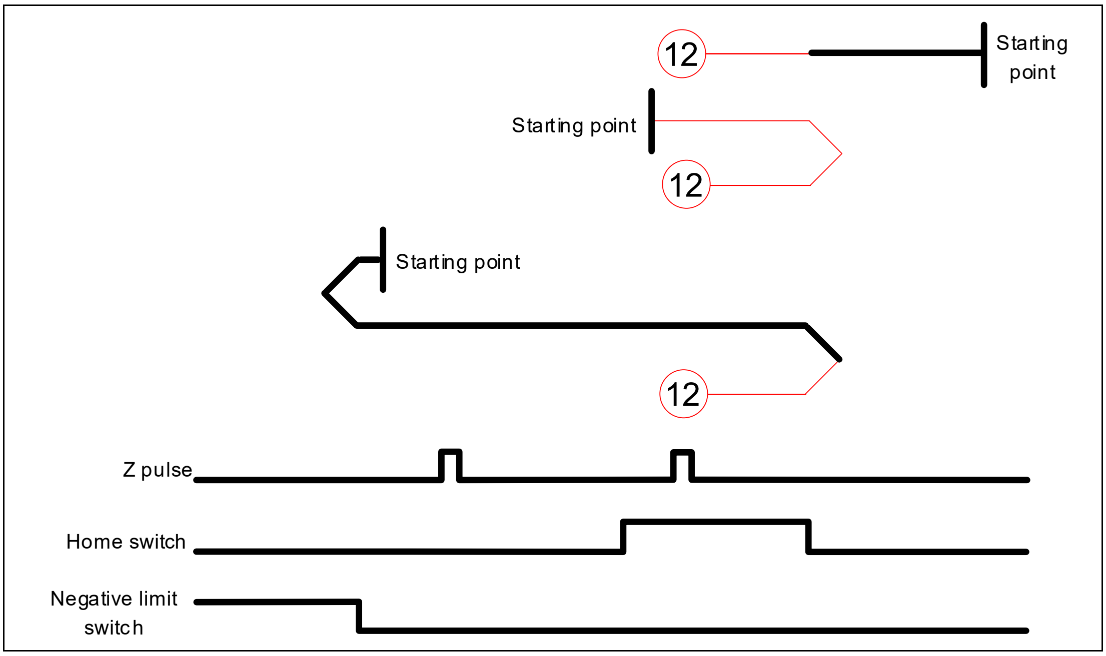
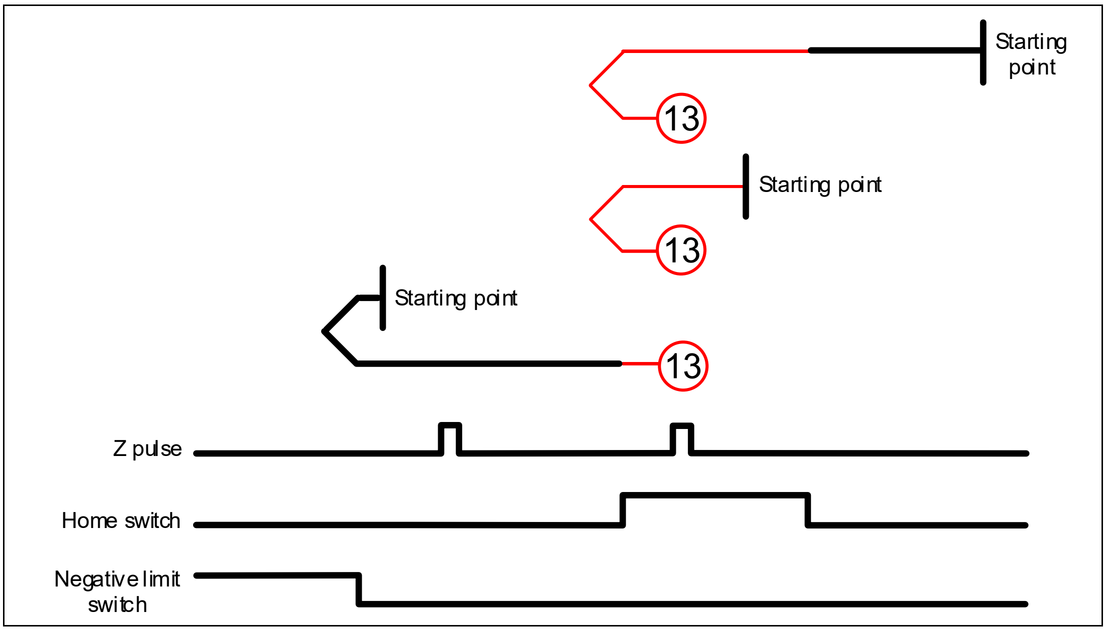
Method 11: homing on the negative limit switch, home switch, and Z pulse



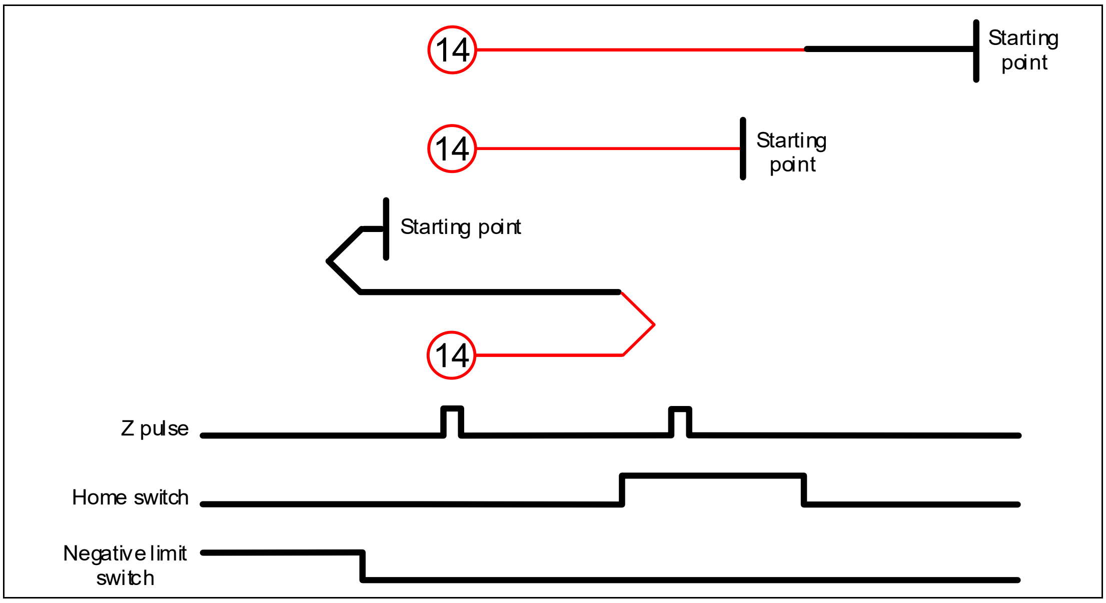
Method 12: homing on the negative limit switch, home switch, and Z pulse



Method 13: homing on the negative limit switch, home switch, and Z pulse



Method 14: homing on the negative limit switch, home switch, and Z pulse



Methods 15 and 16: reserved

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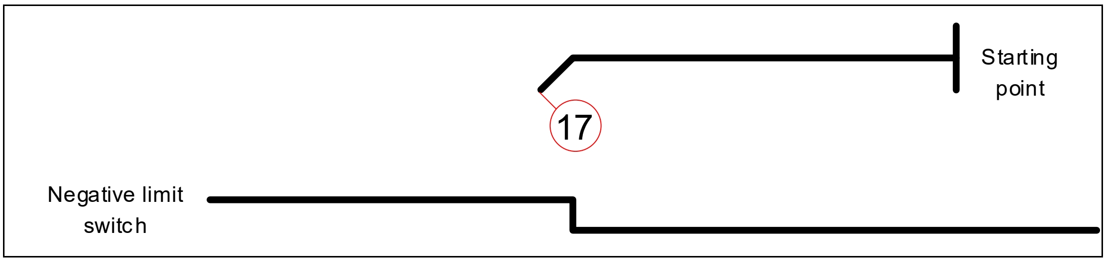
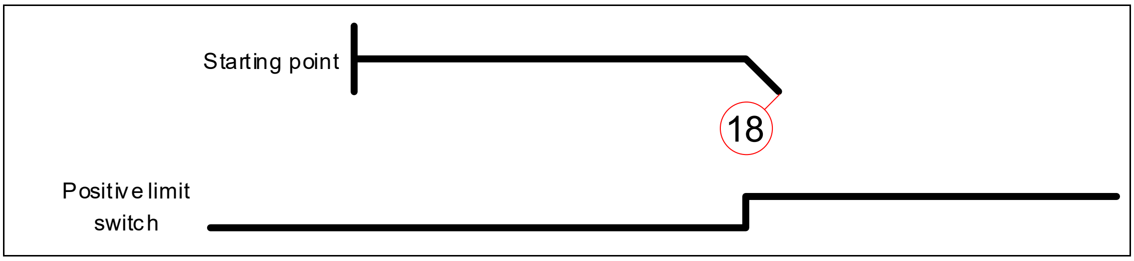
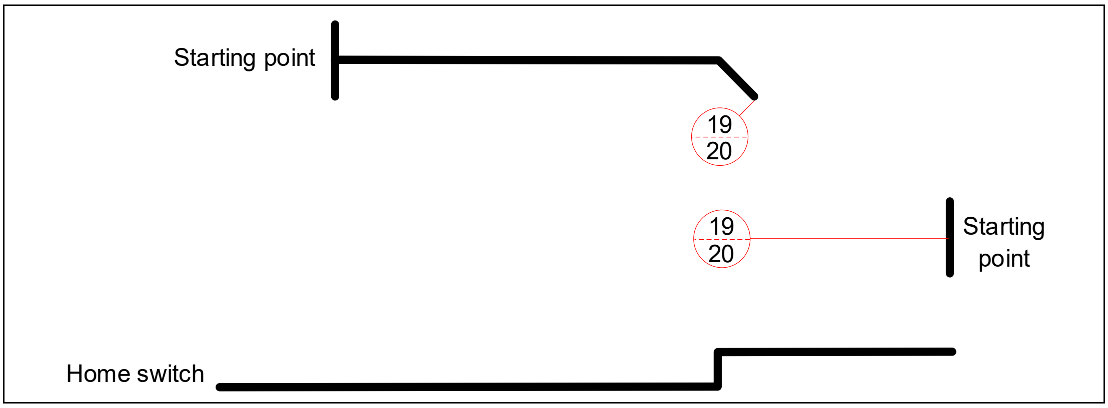
Method 17: homing on the negative limit switch



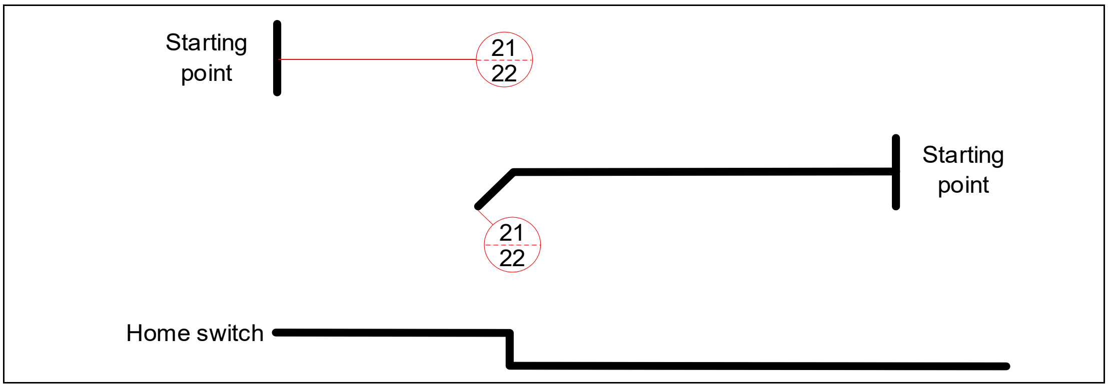
Method 18: homing on the positive limit switch



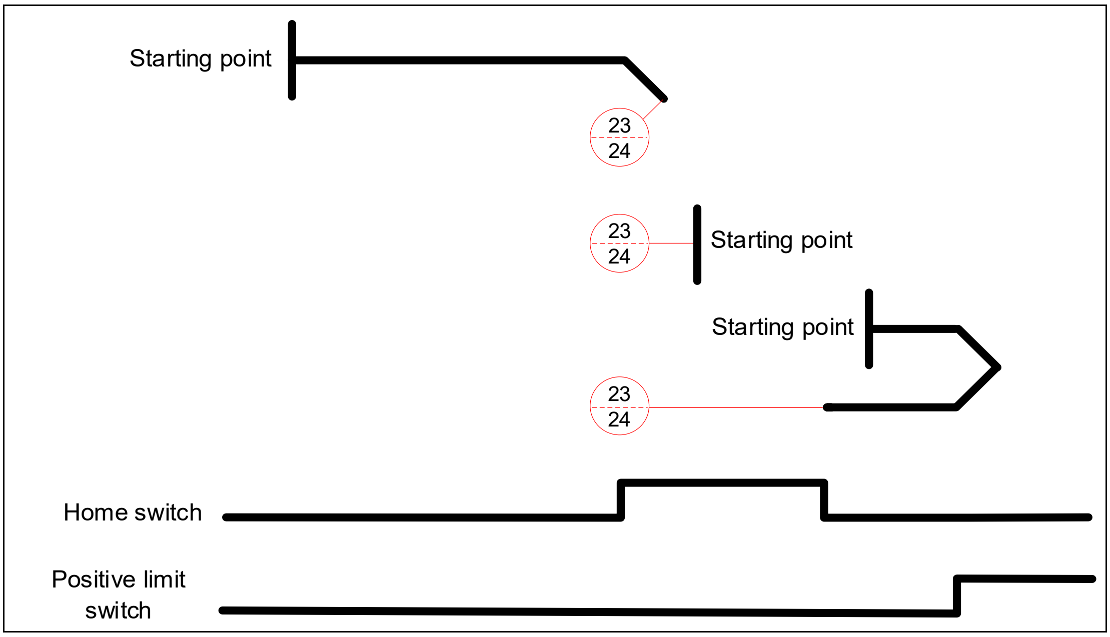
Methods 19 and 20: homing on the home switch



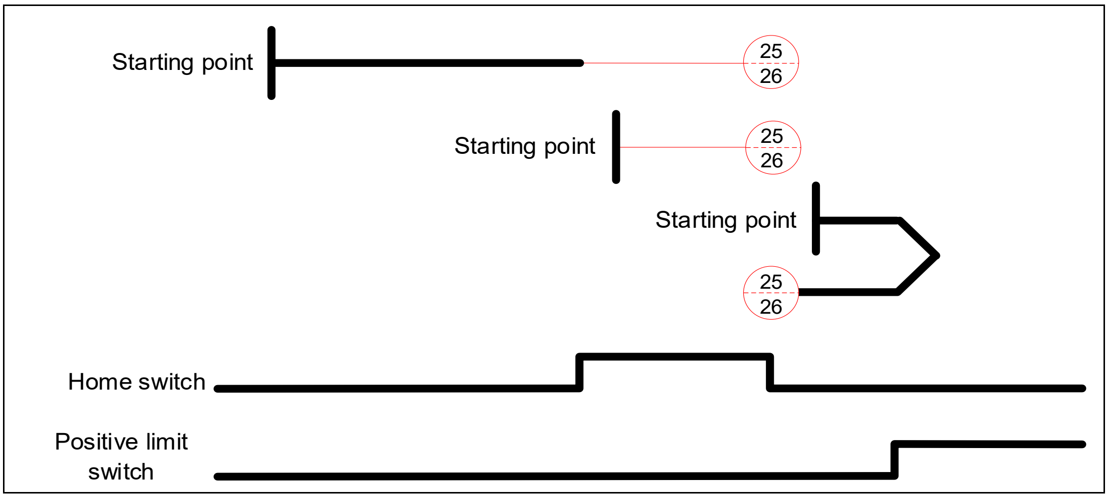
Methods 21 and 22: homing on the home switch



Methods 23 and 24: homing on the positive limit switch and home switch



Methods 25 and 26: homing on the positive limit switch and home switch



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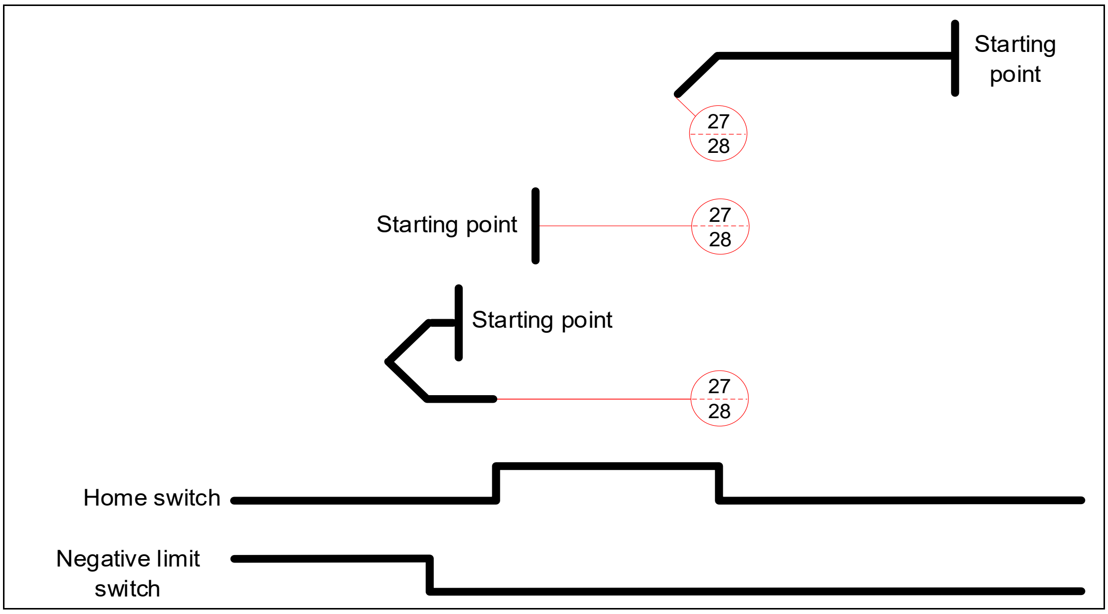
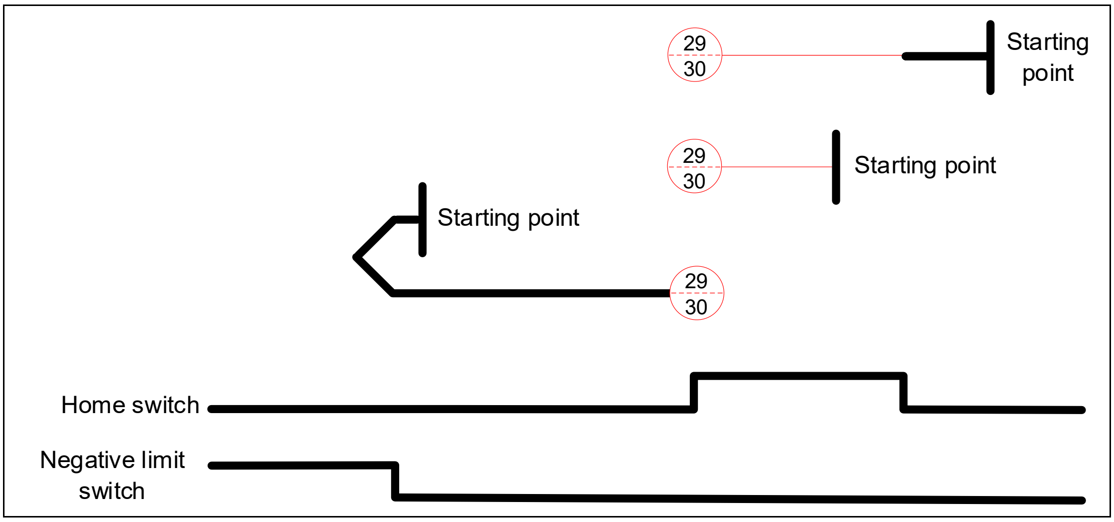
Methods 27 and 28: homing on the negative limit switch and home switch

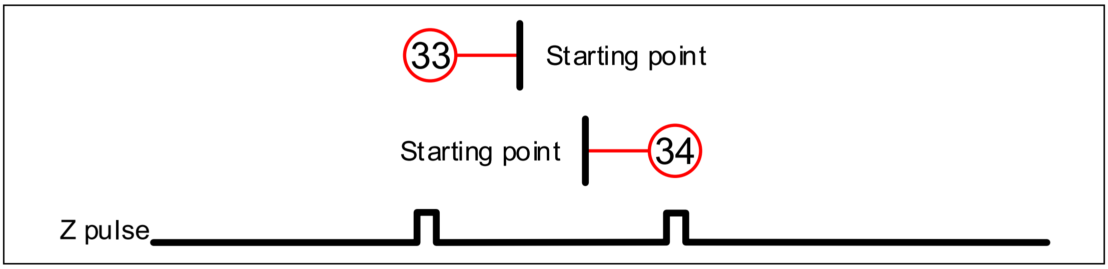


Methods 29 and 30: homing on the negative limit switch and home switch



Methods 31 and 32: reserved

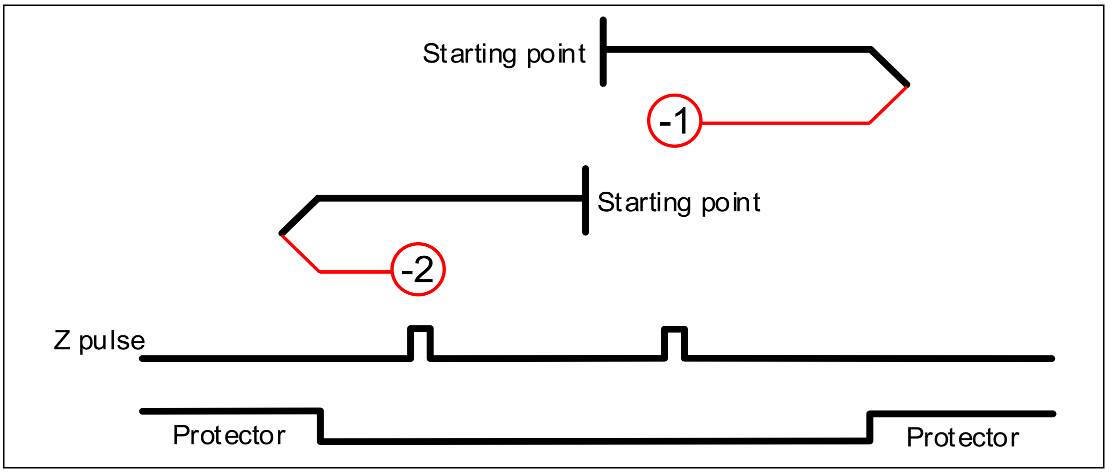
Methods 33 and 34: homing on the Z pulse



Method 35: defines the current feedback position as the origin

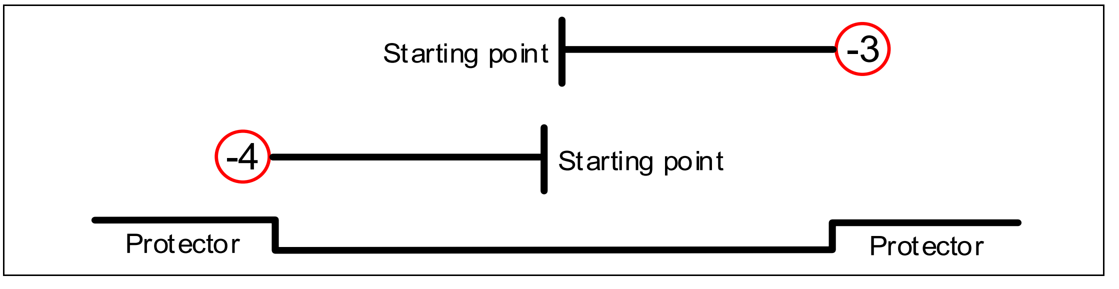
Methods 36 and 37:

When OD 6098h is set to -1 or -2: homing on the hard stop and Z pulse. Set the servo parameters P1.087 (torque level detection) and P1.088 (level reached timer) when using these homing methods.



Methods 38 and 39:

When OD 6098h is set to -3 or -4: homing on the hard stop. Set the servo parameters P1.087 (torque level detection) and P1.088 (level reached timer) when using these homing methods.



11

Object 6099h: Homing speeds

Index	6099h
Name	Homing speeds
Object code	ARRAY
Data type	UNSIGNED32
Access	RW
PDO mapping	Yes

Sub-index	0h
Description	Number of sub-index
Data type	UNSIGNED8
Access	RO
PDO mapping	Yes
Setting range	2
Default	2

Sub-index	1h
Description	Speed during search for switch
Data type	UNSIGNED32
Access	RW
PDO mapping	Yes
Setting range	1 - 20000
Default	100
Unit	0.1 rpm

Sub-index	2h
Description	Speed during search for zero
Data type	UNSIGNED32
Access	RW
PDO mapping	Yes
Setting range	1 - 5000
Default	20
Unit	0.1 rpm

Object 609Ah: Homing acceleration

Index	609Ah
Name	Homing acceleration
Object code	VAR
Data type	UNSIGNED32
Access	RW
PDO mapping	Yes
Setting range	UNSIGNED32
Default	100
Unit	ms

Object function:

The time slope set by this object is the time required for the motor to accelerate from 0 rpm to 3,000 rpm and decelerate from 3,000 rpm to 0 rpm. This object only works 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
Setting range	INTEGER16
Default	0

Object function:

No need to set this object.

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Object 60C1h: Interpolation data record

Index	60C1h
Name	Interpolation data record
Object code	ARRAY
Data type	INTEGER32
Access	RW
PDO mapping	Yes

Sub-index	0h
Description	Number of sub-index
Data type	UNSIGNED8
Access	RO
PDO mapping	No
Setting range	2
Default	2

Sub-index	1h
Description	Command position Pos_Cmd
Data type	INTEGER32
Access	RW
PDO mapping	Yes
Setting range	INTEGER32
Default	0
Unit	PUU

Object function:

The PDO sets OD 60C1h every T ms until the PDO receives the SYNC message. The value of T is determined by OD 60C2h sub1. This object only works in Interpolated Position mode. For more details, refer to Section 11.3.2.

Object 60C2h: Interpolation time period

Index	60C2h
Name	Interpolation time period
Object code	RECORD
Data type	UNSIGNED8
Access	RW
PDO mapping	Yes

Sub-index	0h
Description	Number of sub-index
Data type	UNSIGNED8
Access	RO
PDO mapping	No
Setting range	2
Default	2

Sub-index	1h
Description	Interpolation time units
Data type	UNSIGNED8
Access	RW
PDO mapping	Yes
Setting range	UNSIGNED8
Default	1

Sub-index	2h
Description	Interpolation time index
Data type	INTEGER8
Access	RW
PDO mapping	Yes
Setting range	-128 to +63
Default	-3

Object function:

This object only works in Interpolated Position mode. The interpolation time period is calculated by OD 60C2h sub1 and OD 60C2h sub2. The calculation is as follows:

$$\text{Interpolation time period} = \text{OD 60C2h sub1} \times 10^{\text{OD 60C2h sub2}}$$

Example:

If you want to set the interpolation time period to 2 ms, set OD 60C2h sub1 to 2 and OD 60C2h sub2 to -3.

$$\text{Interpolation time period} = 2 \times 10^{-3} = 0.002 \text{ s} = 2 \text{ ms}$$

Object 60C5h: Max acceleration

Index	60C5h
Name	Max acceleration
Object code	VAR
Data type	UNSIGNED32
Access	RW
PDO mapping	Yes
Setting range	1 - 65500
Default	1
Unit	ms

Object function:

The time slope set by this object is the time required for the motor to accelerate from 0 rpm to 3,000 rpm.

Object 60C6h: Max deceleration

Index	60C6h
Name	Max deceleration
Object code	VAR
Data type	UNSIGNED32
Access	RW
PDO mapping	Yes
Setting range	1 - 65500
Default	1
Unit	ms

Object function:

The time slope set by this object is the time required for the motor to decelerate from 3,000 rpm to 0 rpm.

Object 60F4h: Following error actual value

Index	60F4h
Name	Following error actual value
Object code	VAR
Data type	INTEGER32
Access	RO
PDO mapping	Yes
Setting range	INTEGER32
Default	0
Unit	PUU

Object function:

The following error actual value is the difference between the position demand value (OD 6062h) and position actual value (OD 6064h). For more details, refer to the architecture diagrams in Section 11.3.

Object 60FCh: Position demand value

Index	60FCh
Name	Position demand value
Object code	VAR
Data type	INTEGER32
Access	RO
PDO mapping	Yes
Setting range	INTEGER32
Default	0
Unit	pulse

Object function:

This command is generated after being processed by the servo drive filter. For more details, refer to the architecture diagrams in Section 11.3.

11

Object 60FDh: Digital inputs

Index	60FDh
Name	Digital inputs
Object code	VAR
Data type	UNSIGNED32
Access	RO
PDO mapping	Yes
Setting range	UNSIGNED32
Default	0
Unit	-

Object function:

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	Reserved

Object 60FEh: Digital outputs

Index	60FEh
Name	Digital outputs
Object code	ARRAY
Data type	UNSIGNED32
Access	RW

Sub-Index	0h
Description	Number of sub-index
Data type	UNSIGNED8
Access	RO
PDO mapping	Yes
Setting range	2
Default	2

Sub-Index	1h
Description	Physical outputs
Data type	UNSIGNED32
Access	RW
PDO mapping	Yes
Setting range	0x00000000 to 0xFFFFFFFF
Default	0

Sub-Index	2h
Description	Bit mask
Data type	UNSIGNED32
Access	RW
PDO mapping	Yes
Setting range	0x00000000 to 0xFFFFFFFF
Default	0

Object function:

OD 60FEh sub1 (Physical outputs)

Bit	DO	Description
0 - 15	-	Reserved
16	DO1	0: off; 1: on
17	DO2	0: off; 1: on
18	DO3	0: off; 1: on
19	DO4	0: off; 1: on
20 - 31	-	Reserved

OD 60FEh sub2 (Bit mask)

Bit	DO	Description
0 - 15	-	Reserved
16	DO1	0: disable physical outputs; 1: enable
17	DO2	0: disable physical outputs; 1: enable
18	DO3	0: disable physical outputs; 1: enable
19	DO4	0: disable physical outputs; 1: enable
20 - 31	-	Reserved

- To use the software to control the DO output, you must first set the corresponding DO function code.
  When P2.018 = 0x0130, the output of DO1 is controlled by the software.
  When P2.019 = 0x0131, the output of DO2 is controlled by the software.
  When P2.020 = 0x0132, the output of DO3 is controlled by the software.
  When P2.021 = 0x0133, the output of DO4 is controlled by the software.

- DO output settings
  When the corresponding OD 60FEh sub2 bit of the DO is set to 1, the output status of this DO is determined by the corresponding bit of OD 60FEh sub1.
  When the corresponding OD 60FEh sub2 bit of the DO is set to 0, the output status of this DO is determined by P4.006.

- Example:
  1. Set P2.018 to 0x0130, which means the output of DO1 is controlled by the software.
  2. When OD 60FEh sub2 [Bit 16] is 1, the output status of DO1 is determined by OD 60FEh sub1 [Bit 16].
     When OD 60FEh sub2 [Bit 16] is 0, the output status of DO1 is determined by P4.006 [Bit 0].

Object 60FFh: Target velocity

Index	60FFh
Name	Target velocity
Object code	VAR
Data type	INTEGER32
Access	RW
PDO mapping	Yes
Setting range	INTEGER32
Default	0
Unit	0.1 rpm

Object function:

This object sets the target velocity. This object only works in Profile Velocity mode.

Object 6502h: Supported drive modes

Index	6502h
Name	Supported drive modes
Object code	VAR
Data type	UNSIGNED32
Access	RO
PDO mapping	Yes
Setting range	UNSIGNED32
Default	6Dh

Object function:

This object is read-only and provides the operation modes supported by Delta servo drives in CANopen mode.

Bit	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

Bit	Function
Bit 0	Profile Position mode
Bit 1	Reserved
Bit 2	Profile Velocity mode
Bit 3	Profile Torque mode
Bit 4	Reserved
Bit 5	Homing mode
Bit 6	Interpolated Position mode
Bit 7 - Bit 31	Reserved

11.5 Diagnostics and troubleshooting

This section provides diagnostics and troubleshooting information related to communication with the controller or interference elimination. For information about the servo drive alarms, refer to Chapter 14 Troubleshooting.

1. The SYNC communication cycle of the controller and servo drive is different

   Since the jitter of each controller is different, the time the servo drive receives the SYNC differs from the SYNC communication cycle time. When this happens, adjust the value of P3.009.U 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.

2. Eliminate interference

   Packets are particularly sensitive to interference in high-speed network communication applications. To achieve fast and high-precision control, the selection of the wire is extremely important. Use shielded cables for the communication wiring, and make sure that the shielded connector is firmly connected to the servo drive communication port. Also, ensure the ground wire is properly connected and grounded.

EtherCAT Mode 12

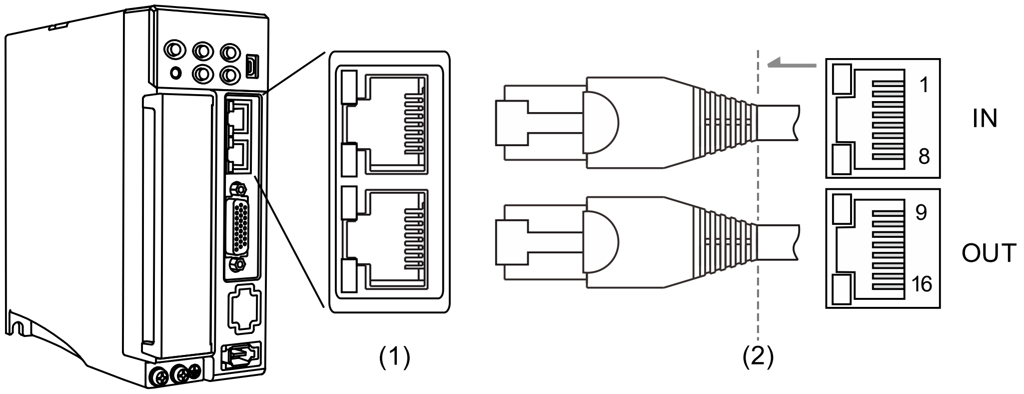
This chapter provides details for the required parameter settings when the servo communicates with the controller through the EtherCAT communication function.

12

12.1 Basic configuration

12.1.1 Hardware configuration

The pin assignments of the two ports of the EtherCAT connector (CN6) are the same. Note that the IN port is for connecting the controller or the previous servo drive, and the OUT port is for connecting the next servo drive or not connecting to other devices. Incorrect wiring will lead to communication error.

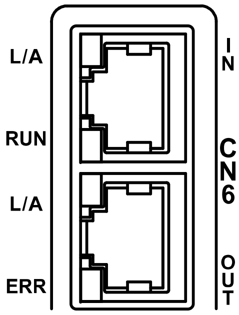


(1) CN6 connector (female); (2) CN6 connector (male)

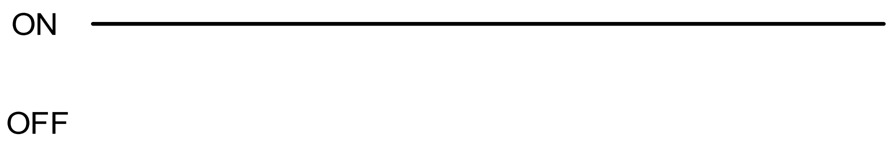
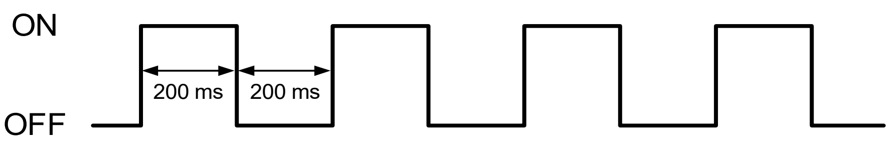
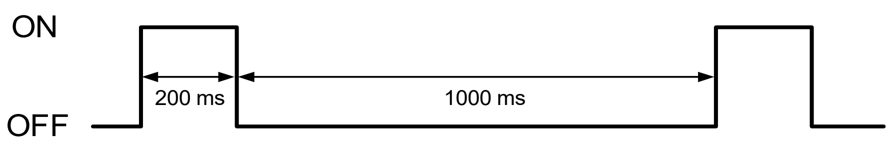
Pin assignment:

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

Description of each indicator for the CN6 connector:



■ LED indicator status description

Indicator	Description
On	
Blinking	
Single flash	
Off	

■ Network status indicator (L/A)

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

■ EtherCAT connection status indicator (RUN)

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

- EtherCAT error indicator (ERR)

Indicator	Status	Description
Off	No error	No error has occurred.
On	PDI Watchdog timeout	Servo drive malfunction. Contact the distributor for assistance.
Blinking	State change error	Parameter setting error causes the system unable to switch the state. Refer to Figure 12.1.1.1.
Single flash	Synchronization error / SyncManager error	The synchronization between the controller and the servo drive failed or the data was lost during data reception.

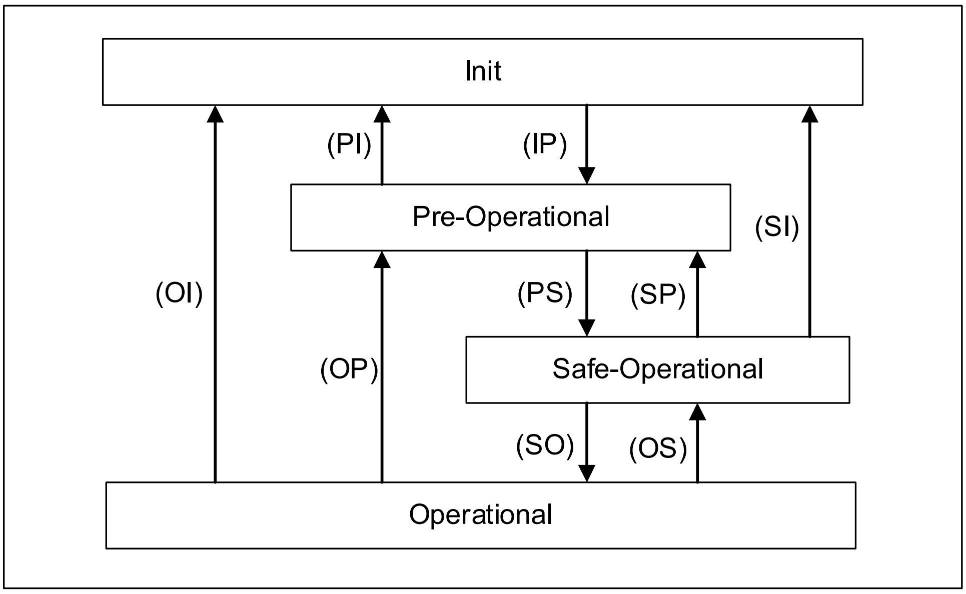
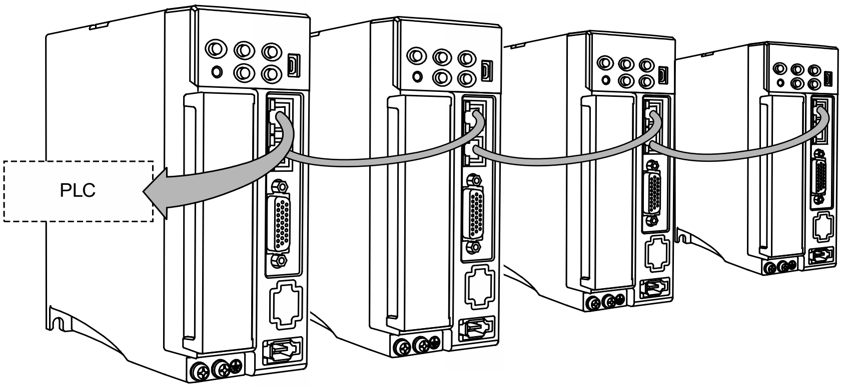


Figure 12.1.1.1 EtherCAT State Machine

Connecting multiple servo drives:



Note:

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

12.1.2 ESI file import

The EtherCAT motion control fieldbus is an open standard that requires using the ESI (EtherCAT Slave Information) file to configure the functions and related object properties for each slave device. Generally, the ESI file is an XML file.

Delta controller

No need to import ESI files.

Non-Delta controller

Import the ESI file of the slave device to the controller software, so the controller can recognize and control each slave device according to the configuration in the ESI file. An ESI file may contain data of multiple devices. Delta's A3-E and B3-E servo drives share the same ESI file. To import ESI files to non-Delta controllers, refer to the manufacturer's instruction manual.

Download the dedicated ESI file for the A3-E and B3-E servo drives from the Download Center of Delta's website.

After being imported to the non-Delta controller software, the ESI files are stored in the following paths:

Beckhoff TwinCAT

TwinCAT 2: C:\TwinCAT\IO\EtherCAT

TwinCAT 3: C:\TwinCAT\3.1\Config\Io\EtherCAT

Omron Sysmac Studio

C:\Program Files (x86)\OMRON\Sysmac Studio\IODeviceProfiles\EsiFiles\UserEsiFiles

Note: refer to the manufacturer's instruction manual of each controller for the actual storage path.

12.1.3 Parameter settings of EtherCAT mode

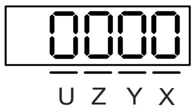
Follow these instructions to connect the EtherCAT controller and the servo drive:

1. Set to EtherCAT mode: set P1.001.YX to 0C.
2. Set the slave address: set P3.000 to 0x0001 - 0x007F.
3. It is suggested that you change the setting value of P3.012.Z from 0 (default) to 1 to enable the non-volatile setting for the parameter. Note that the default E-Gear ratio varies with the set value of P3.012.Z.

Settings	P3.012 = 0x0100 (Z = 1)		P3.012 = 0x0000 (Z = 0)	
	Servo parameter	Default	OD address	Default
Motor stop mode	P1.032	0x0000	605Bh	0
S-curve acceleration constant	P1.034	200	6087h	200
Zero speed range	P1.038	100 (0.1 rpm)	606Fh	100 (0.1 rpm)
E-Gear ratio - numerator N1	P1.044	16777216	6093h sub1	1
E-Gear ratio - denominator M	P1.045	100000	6093h sub2	1
Speed reached (DO.SP_OK) range	P1.047	10 (rpm)	606Dh	100 (0.1 rpm)
Accumulated time to reach desired speed	P1.049	0	606Eh	0
Maximum speed limit	P1.055	Depending on the motor (rpm)	607Fh	Depending on the motor (0.1 rpm)
			6080h	Depending on the motor (rpm)
Excessive deviation warning condition of Position command	P2.035	50331648	6065h	50331648
Positive software limit (PP / CSP / CSV / CST mode)	P5.008	2147483647	607Dh sub2	2147483647
Negative software limit (PP / CSP / CSV / CST mode)	P5.009	-2147483648	607Dh sub1	-2147483648
Origin definition (HM mode)	P6.001	0	607Ch	0

P3.009	Communication synchronization		Address: 0312H 0313H
Default:	0x5055	Control mode:	CANopen / EtherCAT
Unit:	-	Setting range:	0x1001 - 0x9FFF (-L, -M, -F, -P) 0x1001 - 0x9AFF (-E)
Format:	HEX	Data size:	16-bit

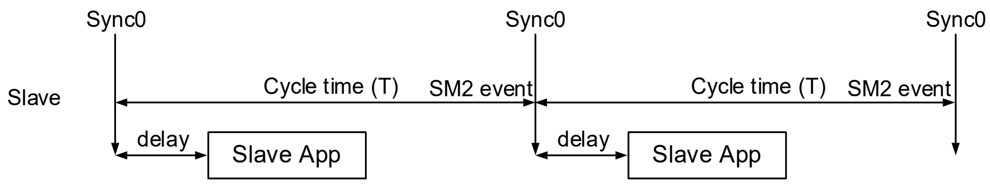
Settings:



Digit	Z
Function	Target value
Range	-M, -F, -L, -P models: 0 to F -E models: 0 to A

■ Z: adjusts the timing of the servo accessing the packets to ensure this timing is not in conflict with the timing of the controller sending the packets.

The delay time shown in the following figure is (T/10) x Z (μs).



P3.018	EtherCAT special function switch		Address: 0324H 0325H
Default:	0x00002000	Control mode:	EtherCAT
Unit:	-	Setting range:	0x00000000 - 0x00112211
Format:	HEX	Data size:	32-bit

Settings:

A	Source setting for the content loaded to the EtherCAT Station Alias Register 0x0012 after the servo drive is powered on	X	Unit selection for Target velocity (OD 60FFh) and Velocity actual value (OD 606Ch) when in the PV (Profile Velocity) mode or CSV (Cyclic Synchronous Velocity) mode
B	Reserved	Y	Reserved
C	Unit selection for the maximum speed of OD 607Fh and OD 6080h	Z	AL185 communication disconnection detection setting
D	Reserved	U	Reserved

- A: source setting for the content loaded to the EtherCAT Station Alias Register 0x0012 after the servo drive is powered on.

  0: determined by the EtherCAT EEPROM station number field (ADR 0x0004) setting, which needs to be set via the controller interface.

  1: determined by the address set with servo parameter P3.000.

- X: unit selection for Target velocity (OD 60FFh) and Velocity actual value (OD 606Ch) when in the PV (Profile Velocity) mode or CSV (Cyclic Synchronous Velocity) mode

  0: 0.1 rpm

  1: pulse/sec

- Z: AL185 communication disconnection detection setting

  0: disconnection detection starts after EtherCAT communication enters OP state.

  1: disconnection detection starts after EtherCAT communication enters Init state.

  2: disable disconnection detection.

  Note: when using the ring topology connection, set P3.018.Z to 2 to disable the disconnection detection.

- C: unit selection for the maximum speed of OD 607Fh and OD 6080h

  0: 0.1 rpm for OD 607Fh and rpm for OD 6080h.

  1: pulse/sec for OD 607Fh and OD 6080h.

P3.022	**EtherCAT PDO timeout setting**		**Address: 032CH 032DH**
Default:	0xFF04	Control mode:	EtherCAT
Unit:	-	Setting range:	0x0002 - 0xFF14
Format:	HEX	Data size:	16-bit

Settings:

When using the PDO to transmit data periodically, use this parameter to set the timeout setting. The following two sets of digits specify the trigger conditions for AL180 and AL3E3 respectively to ensure that the servo drive receives the PDO. When one of the alarm occurs, it means the allowable duration for packet loss exceeds the set range.

0020

U Z Y X

Digit	UZ	YX
Function	AL180 trigger condition	AL3E3 trigger condition
Range	0x00 (disabled) - 0xFF (default)	0x02 - 0x14

- YX: AL3E3 trigger condition (allowable cycle for elapsed time); applicable to CSP / CSV / CST mode.

  AL3E3 occurs when the servo drive does not receive the PDO within the set cycle.

  When the communication cycle is 4 ms and you set this parameter to 0x02 (allow two cycles), it means if the servo drive does not receive any PDO within 8 ms, AL3E3 occurs.

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- UZ: AL180 trigger condition (allowable duration for elapsed time); applicable to all operation modes.

  AL180 occurs when the servo drive does not receive the PDO within the set duration (unit: ms). For example, when you set P3.022.UZ to 0x01, the duration is 1 ms; when you set P3.022.UZ to 0x02, the duration is 2 ms; and when you set P3.022.UZ to 0xFF, the duration is 255 ms.

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

Settings:

Input the monitoring code to P0.002 to view changes to the variable on the panel. For the list of monitoring variables, refer to Table 8.3 Monitoring variables descriptions.

Monitoring variables related to EtherCAT communication are as follows.

Code	Variable name	Description
119 (77h)	EtherCAT state machine	1: Init 2: Pre-Operational (Pre-OP) 4: Safe-Operational (Safe-OP) 8: Operational (OP)
120 (78h)	Communication error rate	When this value continues to increase, it indicates that there is communication interference. In an interference-free environment, this value should not increase. (Available on all models except -L)

12.2 Communication function

12.2.1 Specifications

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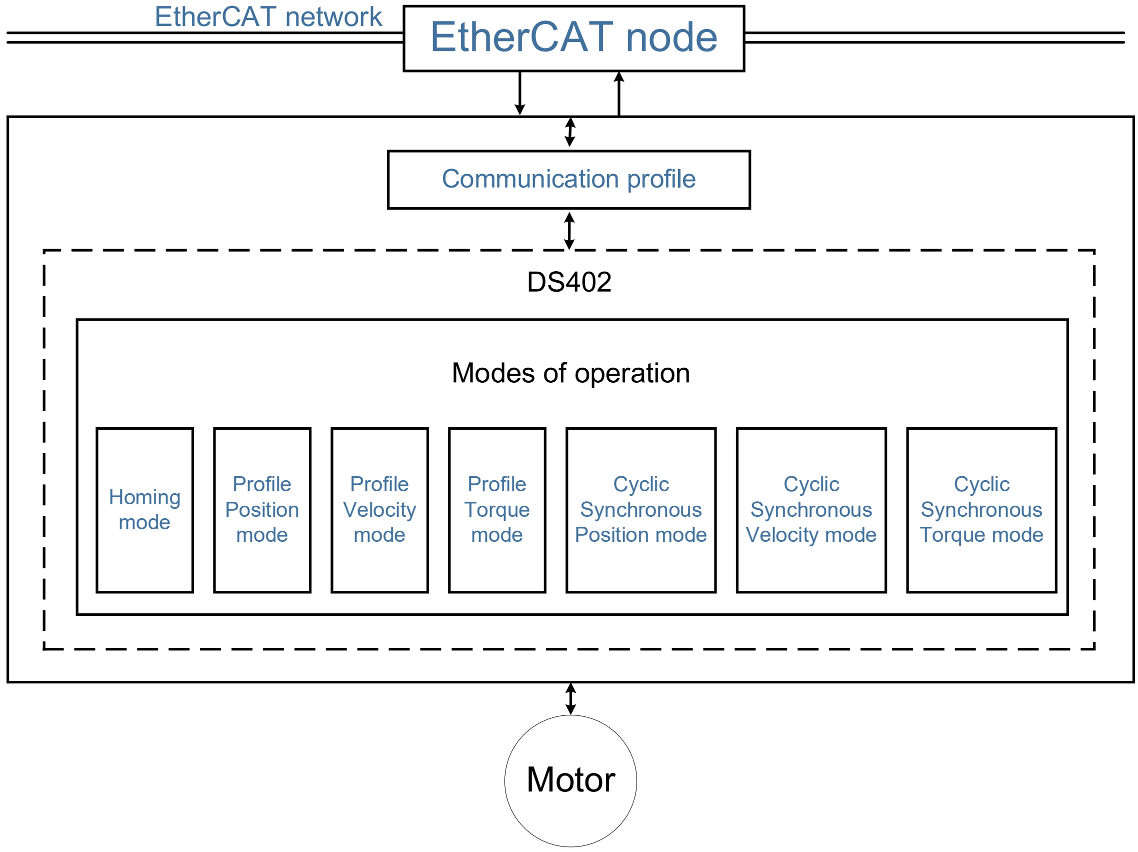
EtherCAT communication functions	Physical layer	100BASE-TX
	Communication interface	RJ45 × 2
	Network topology	Line connection
	Baud rate	2 x 100 Mbps (full duplex)
	Data frame length	Maximum 1,484 bytes
	SyncManager	SM0: mailbox output SM1: mailbox input SM2: process data output SM3: process data input
	Fieldbus Memory Management Units (FMMU)	FMMU0: process data output area FMMU1: process data input area FMMU2: mailbox status area
	Application layer protocol	CoE: CANopen over EtherCAT
	Synchronization mode	DC-Synchronous mode (SYNC0) Asynchronous mode (Free Run)
	Communication object	SDO: Service data object PDO: Process data object EMCY: Emergency object
	LED indicator (On RJ45 connector)	EtherCAT ERR × 1 EtherCAT Link / Activity (L/A) × 2 EtherCAT RUN × 1
	Application layer specifications	IEC 61800-7 CiA DS402 Drive Profile
Supported CiA DS402 operation modes		■ Profile Position (PP) mode ■ Profile Velocity (PV) mode ■ Profile Torque (PT) mode ■ Homing (HM) mode ■ Cyclic Synchronous Position (CSP) mode ■ Cyclic Synchronous Velocity (CSV) mode ■ Cyclic Synchronous Torque (CST) mode

The EtherCAT architecture of the servo drive is as follows:



- Communication profile: this protocol includes the communication objects (PDO, SDO, SYNC, and Emergency object) and related communication object dictionary.
- DS402 is the device profile for drives and motion control. It defines the behavior of each operation mode and the required object index settings for execution.

12.2.2 Synchronization mode

12.2.2.1 Synchronization modes of the servo drive

The servo drive supports two synchronization modes: Free Run mode and DC-Synchronous mode. Note that the Free Run mode is defined as a synchronous mode in the EtherCAT specification established by the EtherCAT Technology Group (ETG).

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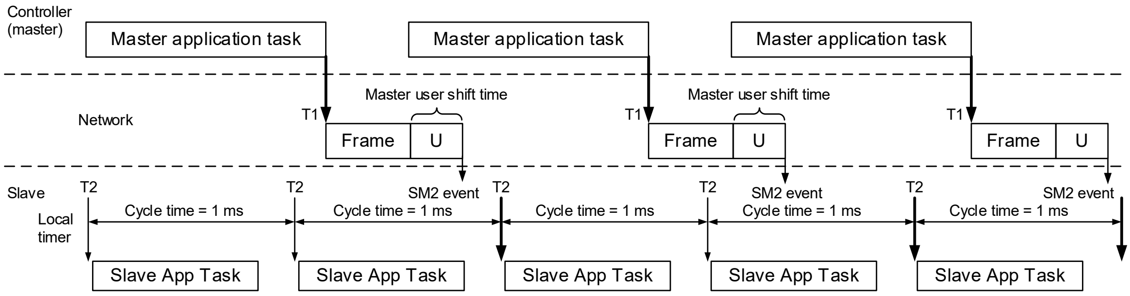
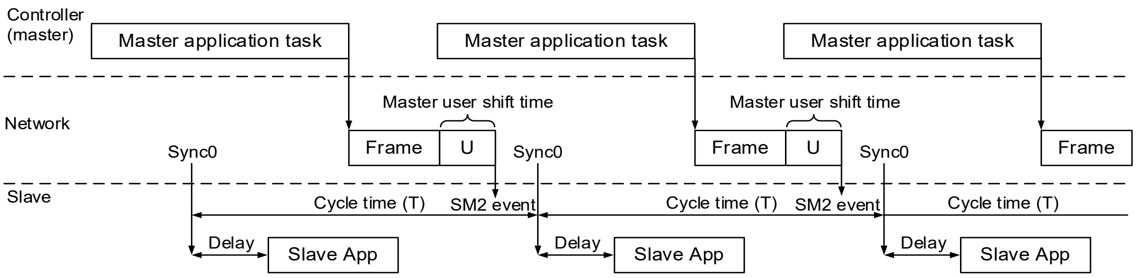
Free Run mode (Asynchronous)

Actually, the master and slave(s) run asynchronously in the Free Run mode. The slave clock runs independently of the master clock. That is, the clocks are not synchronized. The command and feedback between the master and slave(s) are transmitted sequentially rather than synchronously. For example, the master sends a PDO at the time T1, and the slave(s) receives the PDO at the time T2 after the SM2 event.



DC-Synchronous mode (SYNC0 synchronization)

There is precise time synchronization between the master and slave(s) in the DC-Synchronous mode. The master executes the control program and sends PDO packets at a fixed time cyclically according to the distributed clocks (DC), transmitting the command to and receiving the feedback from the slave(s). The slave(s) receives and updates the PDO data at a fixed time according to the distributed clocks.



Note: Delay = P3.009.Z * (T/10) (μs)

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12.2.2.2 Select Synchronization mode

Follow these steps to select DC-Synchronous or Free Run mode.

1. Select **Drive 3 (ASDA-B3-E CoE Drive)** in the left column of the TwinCAT System Manager window.

2. Under the **DC** tab in the right column, select **DC-Synchronous** or **Free Run** as the Operation Mode.

12.2.2.3 Distributed clocks setting

Follow these steps to set the data exchange cycle.

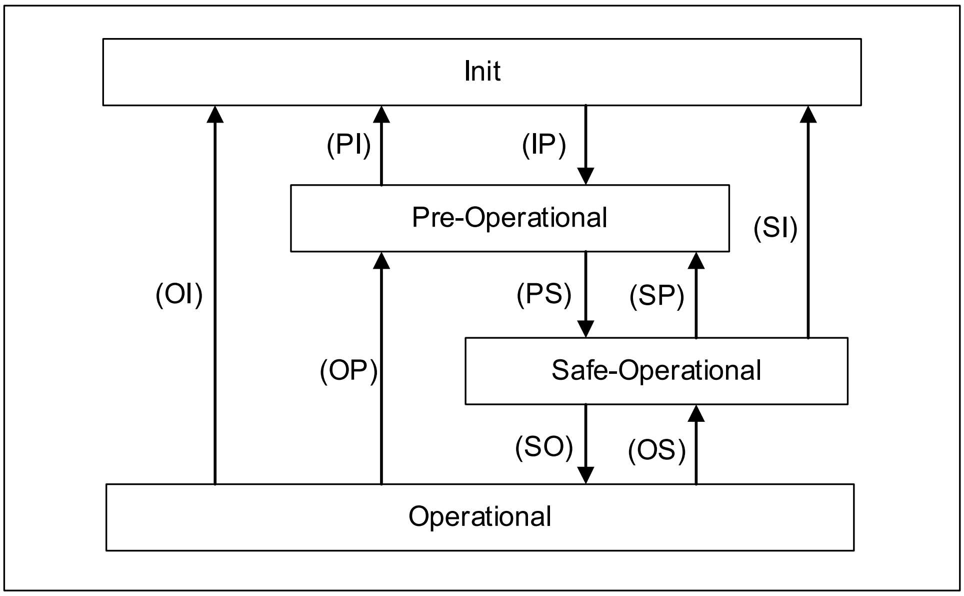
1. Select **NC-Task 1 SAF** in the left column.

2. Set the data exchange cycle in the **Cycle ticks** field under the **Task** tab in the right column.

The SYNC0 cycle is used to define the PDO cycle time. The minimum unit of the SYNC0 cycle for A3-E and B3-E is 125 μs. The SYNC0 cycles within 1 ms are 125 μs, 250 μs, and 500 μs in sequence. The SYNC0 cycles above 1 ms are accumulated at intervals of 1 ms, such as 1 ms, 2 ms, 3 ms…10 ms. If the configuration includes an A2-E servo drive, the unit is the minimum unit of A2-E (1 ms).

12.2.3 EtherCAT state machine

In EtherCAT communication, the servo drive's state machine can be in the following states. The controller (master) controls the servo (slave) based on the actual state. The controller needs to configure the servo drive according to the designated flow in the following figure. After the controller completes the initialization of the communication, the servo (slave) is in the Operational state and waits for the user's command to perform motion control. Use the monitoring variable P0.002 = 119 to monitor the current state of the EtherCAT state machine.



Value displayed on the panel when P0.002 = 119	State	Description
1	Init	The servo drive successfully completes initialization after being powered on without errors occurring. The packets cannot yet be transmitted in this state.
2	Pre-Operational (Pre-OP)	Data can be exchanged with SDOs. If an alarm occurs in the servo drive, an emergency message is sent to notify the controller.
4	Safe-Operational (Safe-OP)	The servo drive can use SDO and TxPDO data packets to exchange data with the controller.
8	Operational (OP)	All data exchanges including SDOs and PDOs (TxPDO and RxPDO) are allowed.

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The controller (master) issues corresponding commands to the servo (slave) according to the state transition.

State transition	Description
IP	■ The master confirms the VendorID, ProductCode and RevisionNumber of the slave. ■ The master calibrates the distributed clocks of the slave (DC-Synchronous mode). ■ The master defines the slave address as well as the SyncManager 0 and 1 (SM0 and SM1) register and establishes the mailbox communication. ■ The master issues the command and confirms that the slave switches to the Pre-Operational state.
PS	■ The master uses the SDOs to set the PDO mapping and DC related parameters. ■ The master defines the FMMU as well as the SyncManager 2 and 3 (SM2 and SM3) registers, and the slave continues to transmit PDO (TxPDO) packets to the master. ■ The master issues the command and confirms that the slave switches to the Safe-Operational state.
SO	■ The master starts transmitting PDOs (RxPDOs). ■ The DC synchronization process between the master and slave is started.
PI, SI, OI	■ The slave disables all communication functions, including the SDOs and PDOs. ■ The slave switches to the Init state.
SP, OP	■ The slave disables the PDO function. ■ The slave switches to the Pre-Operational state.
OS	■ The master stops transmitting PDOs (RxPDOs). ■ The slave switches to the Safe-Operational state.

12.2.4 PDO mapping configuration

The PDO mapping objects are allocated from OD 1600h to OD 1603h for RxPDOs and OD 1A00h to OD 1A03h for TxPDOs in the object dictionary. Each group of RxPDO and TxPDO supports updating the PDO data for up to 8 sets of 32-bit objects.

12.2.4.1 Default PDO mapping configuration

The following tables show the default PDO mapping configuration of the EtherCAT servo drive for data exchange. This is also defined in the XML file of the EtherCAT slave. You can modify the PDO mapping configuration according to the requirements. The fourth group of RxPDO and TxPDO is the suggested configuration for Omron controllers.

In Delta ASDA-x3-E rev0.04.xml, the first to fourth groups of PDO configuration are shown as follows:

First group of RxPDO mapping

RxPDO (OD 1600h)	Controlword (OD 6040h)	Target position (OD 607Ah)	Target velocity (OD 60FFh)	Touch probe function (OD 60B8h)

First group of TxPDO mapping

TxPDO (OD 1A00h)	Statusword (OD 6041h)	Position actual value (OD 6064h)	Velocity actual value (OD 606Ch)	Touch probe status (OD 60B9h)
	Touch probe pos1 pos value (OD 60BAh)	Digital inputs (OD 60FDh)		

Second group of RxPDO mapping (default)

RxPDO (OD 1601h)	Controlword (OD 6040h)	Target position (OD 607Ah)	Target velocity (OD 60FFh)	Target torque (OD 6071h)
	Touch probe function (OD 60B8h)			

Second group of TxPDO mapping (default)

TxPDO (OD 1A01h)	Statusword (OD 6041h)	Position actual value (OD 6064h)	Velocity actual value (OD 606Ch)	Torque actual value (OD 6077h)
	Touch probe status (OD 60B9h)	Touch probe pos1 pos value (OD 60BAh)	Digital inputs (OD 60FDh)	

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Third group of RxPDO mapping

RxPDO (OD 1602h)	Controlword (OD 6040h)	Target position (OD 607Ah)	Target velocity (OD 60FFh)	Target torque (OD 6071h)
	Modes of operation (OD 6060h)	Touch probe function (OD 60B8h)		

Third group of TxPDO mapping

TxPDO (OD 1A02h)	Statusword (OD 6041h)	Position actual value (OD 6064h)	Velocity actual value (OD 606Ch)	Torque actual value (OD 6077h)
	Modes of operation display (OD 6061h)	Touch probe status (OD 60B9h)	Touch probe pos1 pos value (OD 60BAh)	Digital inputs (OD 60FDh)

Fourth group of RxPDO mapping (for Omron controllers)

RxPDO (OD 1603h)	Controlword (OD 6040h)	Target position (OD 607Ah)	Target velocity (OD 60FFh)	Target torque (OD 6071h)
	Modes of operation (OD 6060h)	Positive torque limit (OD 60E0h)	Negative torque limit (OD 60E1h)	Touch probe function (OD 60B8h)

Fourth group of TxPDO mapping (for Omron controllers)

TxPDO (OD 1A03h)	Statusword (OD 6041h)	Position actual value (OD 6064h)	Torque actual value (OD 6077h)	Modes of operation display (OD 6061h)
	Touch probe status (OD 60B9h)	Touch probe pos1 pos value (OD 60BAh)	Error code (OD 603Fh)	Digital inputs (OD 60FDh)

12.2.4.2 Set PDO mapping

Take the second group of PDO configuration OD 1601h and OD 1A01h as an example, and the settings are as follows:

1. Disable the PDO configuration: set OD 1C12h sub0 to 0 (RxPDO) and OD 1C13h sub0 to 0 (TxPDO).
2. Disable the PDO mapping setting: set OD 1600h sub0 to 0 (RxPDO) and OD 1A01h sub0 to 0 (TxPDO).
3. Set OD 1601h sub1 - sub5 for the RxPDO mapping content, and set OD 1601h sub0 to 5 for the RxPDO mapping number.

Mapping parameter setting for RxPDO	Data			Description
OD 1601h sub1	6040h	00h	10h	Controlword (6040h); data length is 16-bit.
OD 1601h sub2	607Ah	00h	20h	Target position (607Ah); data length is 32-bit.
OD 1601h sub3	60FFh	00h	20h	Target velocity (60FFh); data length is 32-bit.
OD 1601h sub4	6071h	00h	10h	Target torque (6071h); data length is 16-bit.
OD 1601h sub5	60B8h	00h	10h	Touch probe function (60B8h); data length is 16-bit.
OD 1601h sub0	5			Set 5 for the RxPDO mapping number.

4. Set OD 1A01h sub1 - sub7 for the TxPDO mapping content, and set OD 1A01h sub0 to 7 for the TxPDO mapping number.

Mapping parameter setting for TxPDO	Data			Description
OD 1A01h sub1	6041h	00h	10h	Statusword (6041h); data length is 16-bit.
OD 1A01h sub2	6064h	00h	20h	Position actual value (6064h); data length is 32-bit.
OD 1A01h sub3	606Ch	00h	20h	Velocity actual value (606Ch); data length is 32-bit.
OD 1A01h sub4	6077h	00h	10h	Torque actual value (6077h); data length is 16-bit.
OD 1A01h sub5	60B9h	00h	10h	Touch probe status (60B9h); data length is 16-bit.
OD 1A01h sub6	60BAh	00h	20h	Touch probe pos1 pos value (60BAh); data length is 32-bit.
OD 1A01h sub7	60FDh	00h	20h	Digital inputs (60FDh); data length is 32-bit.
OD 1A01h sub0	7			Set 7 for the TxPDO mapping number.

5. Set the PDO mapping configuration: set OD 1C12h sub1 to 0x1601 (RxPDO) and OD 1C13h sub1 to 0x1A01 (TxPDO).
6. Enable the PDO configuration: set OD 1C12h sub0 to 1 (RxPDO) and OD 1C13h sub0 to 1 (TxPDO).

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12.2.4.3 PDO mapping object

Real-time data transmission can be achieved with Process data objects (PDOs). There are two types of PDOs: transmit PDOs (TxPDOs) and receive PDOs (RxPDOs). This definition is from the perspective of the servo drive, for example, the TxPDO refers to the object that the servo drive sends to the controller. Set the mapping parameters as shown in the following table to use the PDOs.

Communication object	Mapping object index
RxPDO1	1600h
RxPDO2	1601h
RxPDO3	1602h
RxPDO4	1603h

Communication object	Mapping object index
TxPDO1	1A00h
TxPDO2	1A01h
TxPDO3	1A02h
TxPDO4	1A03h

The format of PDO mapping parameter is:

Bit	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

Bit	Function
Bit 0 - Bit 7	Object data length
Bit 8 - Bit 15	Object sub-index
Bit 16 - Bit 31	Object index

12.2.4.4 SDO abort codes

The abort codes are as follows:

Abort code	Description
05040001h	Client / server command is invalid or does not exist.
06010002h	Attempt to write a read-only object.
06020000h	Object does not exist in the object dictionary.
06040041h	Unable to map the object to the PDO.
06040042h	The number and length of mapped objects exceed the PDO length.
06060000h	Access failed due to 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 an object is read from EEPROM.
080000a2h	An error occurred when an object is written to EEPROM.
080000a3h	Invalid range when accessing EEPROM.
080000a4h	EEPROM data content error occurred when EEPROM is accessed.
080000a5h	The entered password is incorrect when data is written 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.

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12.3 EtherCAT operation modes

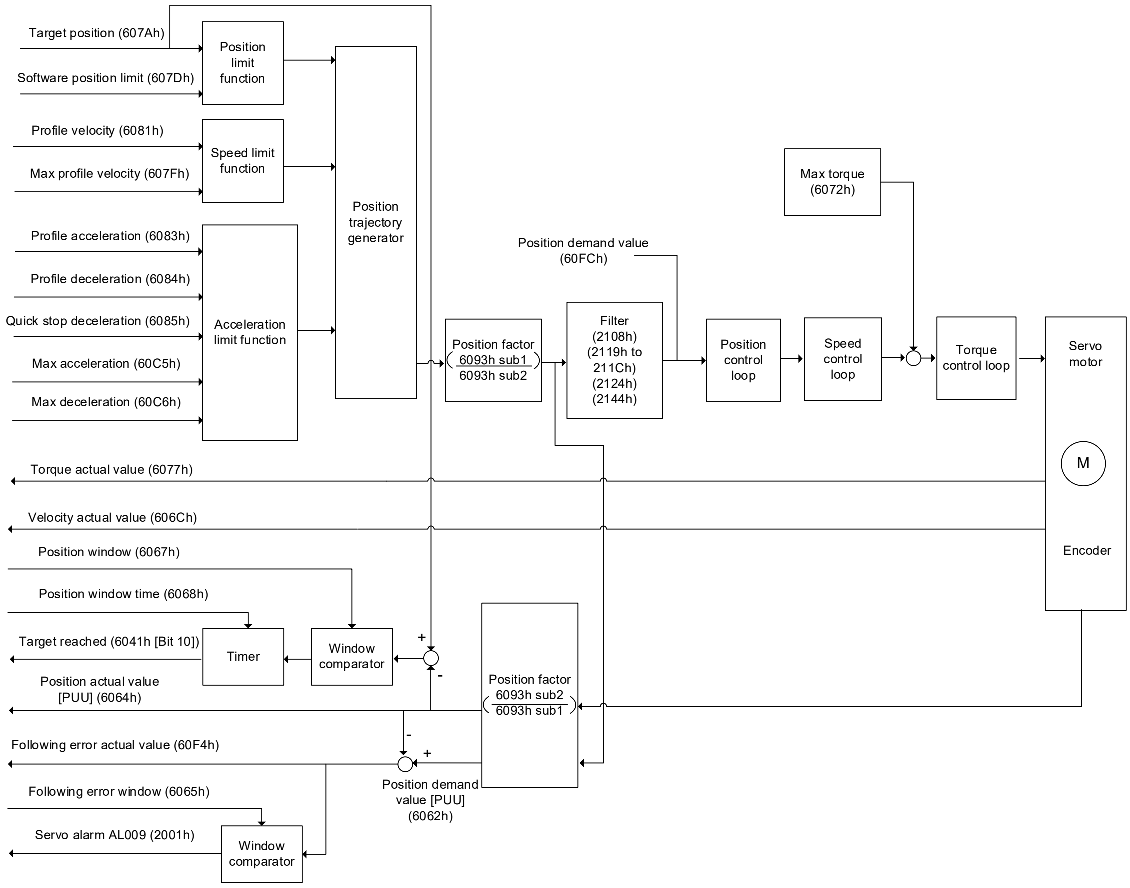
This section describes the modes of operation specified by CiA DS402 when the servo is in the EtherCAT mode. The content includes basic operation settings and related object descriptions.

12.3.1 Profile Position mode

After receiving the position command transmitted from the controller, the servo drive controls the servo motor to reach the target position.

In Profile Position (PP) mode, the controller only informs the servo drive of the target position, speed command, and acceleration / deceleration settings at the beginning. The motion planning from command triggering to the arrival of the target position is performed by the trajectory generator in the servo drive.

The following figure shows the Profile Position mode architecture of the servo drive:



Operation steps:

1. Set OD 6060h to 01h to set the mode as Profile Position mode.
2. Set OD 607Ah for the target position (unit: PUU).
3. Set OD 6081h for the profile velocity (unit: PUU/sec).
4. Set OD 6083h for the profile acceleration (unit: ms).
5. Set OD 6084h for the profile deceleration (unit: ms).
6. Set the Controlword (OD 6040h). Follow these steps for operation. 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 12.4.3.3.

Step	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Description
6.1	0	0	1	1	0	Shutdown.
6.2	0	0	1	1	1	Switch on (ready for Servo On).
6.3	0	1	1	1	1	Enable operation (Servo On).
6.4	1	1	1	1	1	Command triggering (rising-edge triggered)

7. After the servo completes the first motion command, the servo sets the target position, speed, and other conditions to execute the next motion command.
8. Set the Controlword (OD 6040h). Since the command is rising-edge triggered, switch Bit 4 to Off first and then to On.

Step	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Description
8.1	0	1	1	1	1	Enable operation (Servo On).
8.2	1	1	1	1	1	Command triggering (rising-edge triggered)

Read the servo drive information:

1. Read OD 6064h to obtain the actual value of the motor position at present.
2. Read OD 6041h to obtain the servo drive status, including the following error and notifications for set-point acknowledge and target reached.

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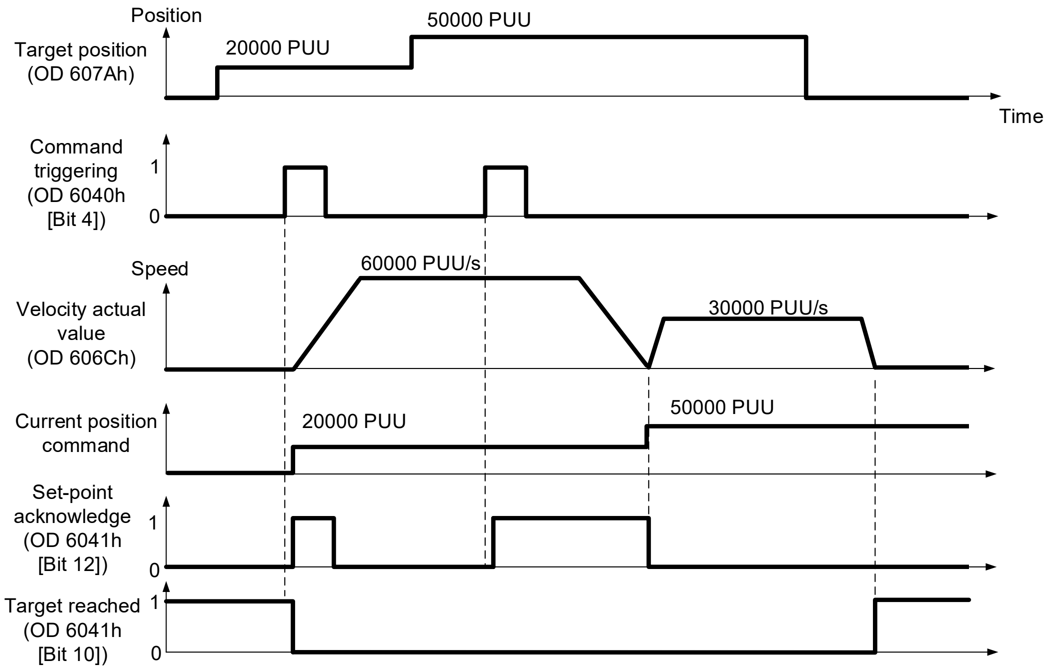
Function for the command to take immediate effect

In Profile Position mode, set the command to take effect immediately or not with OD 6040h [Bit 5].

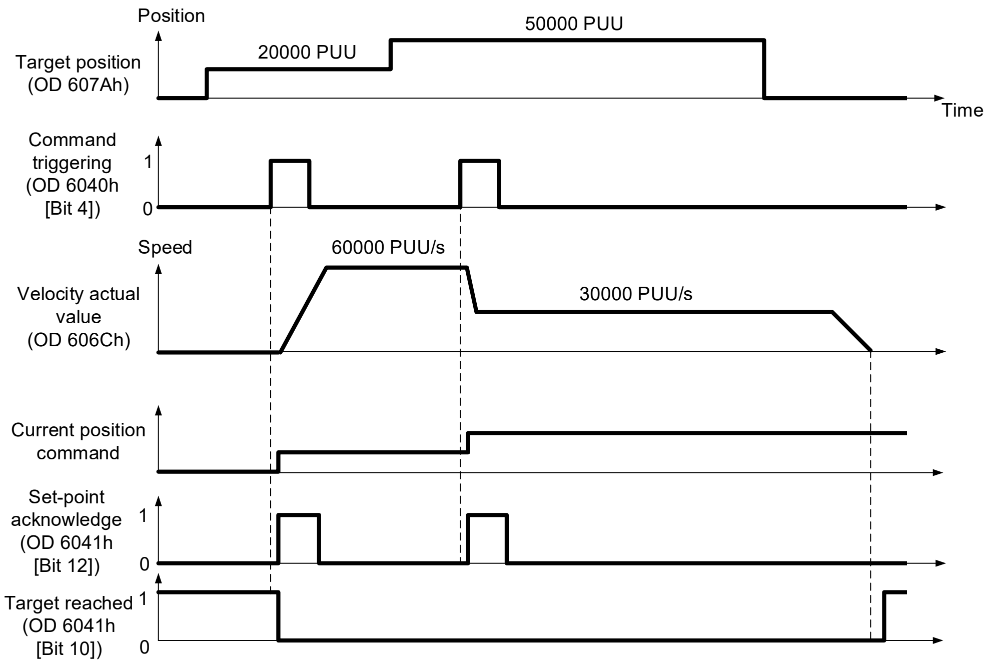
■ Set OD 6040h [Bit 5] to 0 to disable the command from taking immediate effect

If the command is not enabled to take immediate effect, when the current motion command is in execution (not yet complete), the servo continues to execute the current motion command even if a new command is triggered. The new command is acknowledged and executed only after the current command is complete.



- Set OD 6040h [Bit 5] to 1 to enable the command to take immediate effect is enabled (only valid in Profile Position mode).

If the command is enabled to take immediate effect, when the current motion command is in execution (not yet complete), the servo immediately interrupts the current command and executes the new command once receiving the new triggered command.



Relevant object list

Index	Name	Data type	Access
6040h	Controlword	UNSIGNED16	RW
6041h	Statusword	UNSIGNED16	RO
6060h	Modes of operation	INTEGER8	RW
6061h	Modes of operation display	INTEGER8	RO
6062h	Position demand value [PUU]	INTEGER32	RO
6063h	Position actual internal value [Pulse]	INTEGER32	RO
6064h	Position actual value [PUU]	INTEGER32	RO
6065h	Following error window	UNSIGNED32	RW
6067h	Position window	UNSIGNED32	RW
6068h	Position window time	UNSIGNED16	RW
606Ch	Velocity actual value	INTEGER32	RO
6072h	Max torque	UNSIGNED16	RW
6077h	Torque actual value	INTEGER16	RO
607Ah	Target position	INTEGER32	RW
607Dh	Software position limit	INTEGER32	RW
607Fh	Max profile velocity	UNSIGNED32	RW
6081h	Profile velocity	UNSIGNED32	RW
6083h	Profile acceleration	UNSIGNED32	RW
6084h	Profile deceleration	UNSIGNED32	RW
6085h	Quick stop deceleration	UNSIGNED32	RW
6093h	Position factor	UNSIGNED32	RW

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Index	Name	Data type	Access
60C5h	Max acceleration	UNSIGNED32	RW
60C6h	Max deceleration	UNSIGNED32	RW
60F4h	Following error actual value	INTEGER32	RO
60FCh	Position demand value	INTEGER32	RO

Note: for more details, refer to Section 12.4.3 Details of objects.

12.3.2 Profile Velocity mode

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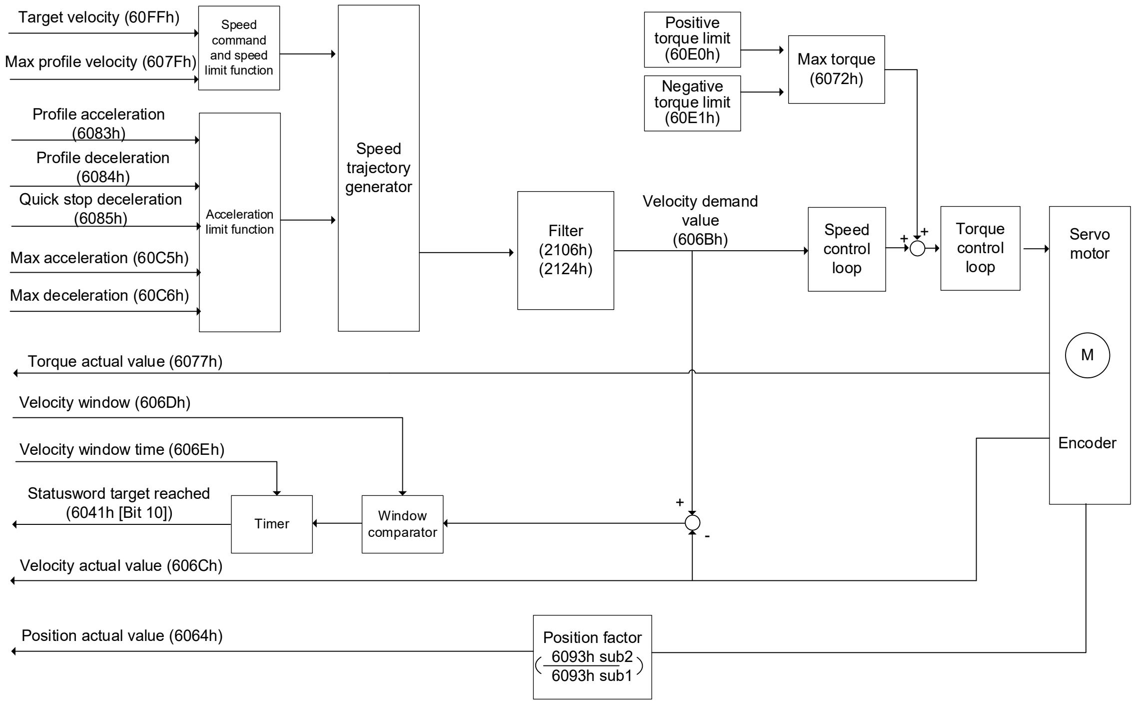
In Profile Velocity (PV) mode, the controller specifies the speed command and acceleration / deceleration conditions, and then the trajectory generator of the servo drive plans the motion path according to these conditions.



Operation steps:

1. Set OD 6060h to 03h to set the mode as Profile Velocity mode.
2. Set OD 6083h for the profile acceleration.
3. Set OD 6084h for the profile deceleration.
4. Set the target velocity (OD 60FFh) to 0. In Profile Velocity mode, the servo motor starts operating once the servo drive is switched to Servo On (Step 5). Therefore, setting the target velocity (OD 60FFh) to 0 is to ensure that the motor maintains at 0 rpm at the moment of Servo On.
5. Set the Controlword (OD 6040h). Follow these steps for operation. Steps 5.1 and 5.2 are to bring the servo drive's state machine into the ready state. For more details of the state machine, refer to the OD 6040h description in Section 12.4.3.3.

Step	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Description
5.1	0	0	1	1	0	Shutdown.
5.2	0	0	1	1	1	Switch on (ready for Servo On).
5.3	0	1	1	1	1	Enable operation (Servo On).

6. Set OD 60FFh for the target velocity.

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Read the servo drive information:

1. Read OD 6041h to obtain the servo drive status.
2. Read OD 606Ch to obtain the current velocity actual value.

Relevant object list

Index	Name	Data type	Access
6040h	Controlword	UNSIGNED16	RW
6041h	Statusword	UNSIGNED16	RO
6060h	Modes of operation	INTEGER8	RW
6061h	Modes of operation display	INTEGER8	RO
6064h	Position actual value [PUU]	INTEGER32	RO
606Bh	Velocity demand value	INTEGER32	RO
606Ch	Velocity actual value	INTEGER32	RO
606Dh	Velocity window	UNSIGNED16	RW
606Eh	Velocity window time	UNSIGNED16	RW
606Fh	Velocity threshold	UNSIGNED16	RW
6072h	Max torque	UNSIGNED16	RW
6077h	Torque actual value	INTEGER16	RO
607Fh	Max profile velocity	UNSIGNED32	RW
6083h	Profile acceleration	UNSIGNED32	RW
6084h	Profile deceleration	UNSIGNED32	RW
6085h	Quick stop deceleration	UNSIGNED32	RW
6093h	Position factor	UNSIGNED32	RW
60C5h	Max acceleration	UNSIGNED32	RW
60C6h	Max deceleration	UNSIGNED32	RW
60E0h	Positive torque limit	UNSIGNED16	RW
60E1h	Negative torque limit	UNSIGNED16	RW
60FFh	Target velocity	INTEGER32	RW

Note: for more details, refer to Section 12.4.3 Details of objects.

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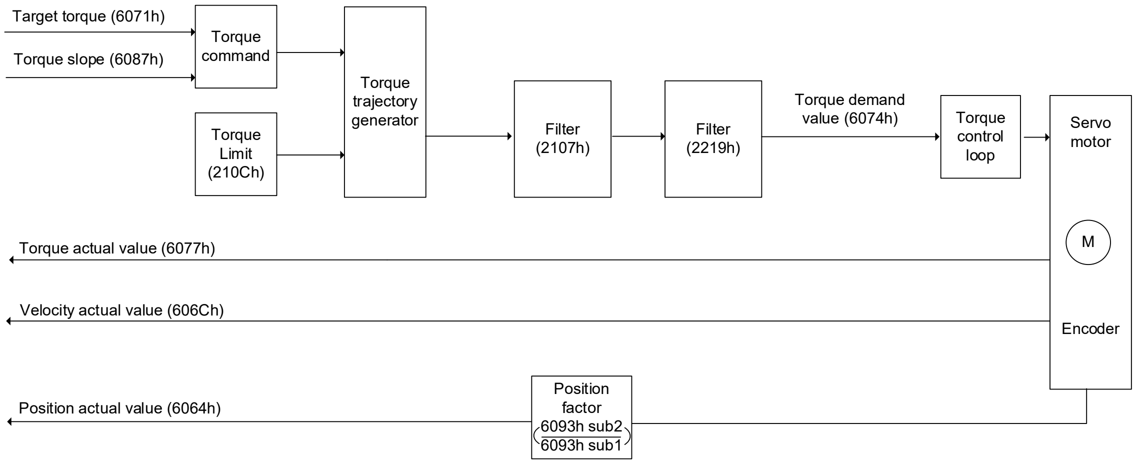
12.3.3 Profile Torque mode

In Profile Torque (PT) mode, the controller specifies the torque command and filtering conditions, and then the trajectory generator of the servo drive plans the torque slope according to these conditions.



Operation steps:

1. Set OD 6060h to 04h to set the mode as Profile Torque mode.
2. Set OD 6087h for the torque slope.
3. Set the target torque (OD 6071h) to 0. In Profile Torque mode, the servo target torque takes effect once the servo drive is switched to Servo On (Step 4). Therefore, set the target torque (OD 6071h) to 0 for safety reasons.
4. Set the Controlword (OD 6040h). Follow these steps for operation. Steps 4.1 and 4.2 are to bring the servo drive's state machine into the ready state. For more details of the state machine, refer to the OD 6040h description in Section 12.4.3.3.

Step	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Description
4.1	0	0	1	1	0	Shutdown.
4.2	0	0	1	1	1	Switch on (ready for Servo On).
4.3	0	1	1	1	1	Enable operation (Servo On).

5. Set OD 6071h for the target torque.

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Read the servo drive information:

1. Read OD 6041h to obtain the servo drive status.
2. Read OD 6077h to obtain the current torque actual value.

Relevant object list

Index	Name	Data type	Access
6040h	Controlword	UNSIGNED16	RW
6041h	Statusword	UNSIGNED16	RO
6060h	Modes of operation	INTEGER8	RW
6061h	Modes of operation display	INTEGER8	RO
6064h	Position actual value [PUU]	INTEGER32	RO
606Ch	Velocity actual value	INTEGER32	RO
6071h	Target torque	INTEGER16	RW
6074h	Torque demand value	INTEGER16	RO
6075h	Motor rated current	UNSIGNED32	RO
6077h	Torque actual value	INTEGER16	RO
6078h	Current actual value	INTEGER16	RO
6087h	Torque slope	UNSIGNED32	RW
6093h	Position factor	UNSIGNED32	RW

Note: for more details, refer to Section 12.4.3 Details of objects.

12.3.4 Homing mode

After homing is complete, the position system of the servo drive is established and the drive can start executing the position command issued by the controller. The Delta servo drive offers 39 homing methods, including homing on the home switch, positive or negative limit, motor Z pulse, and hard stop.

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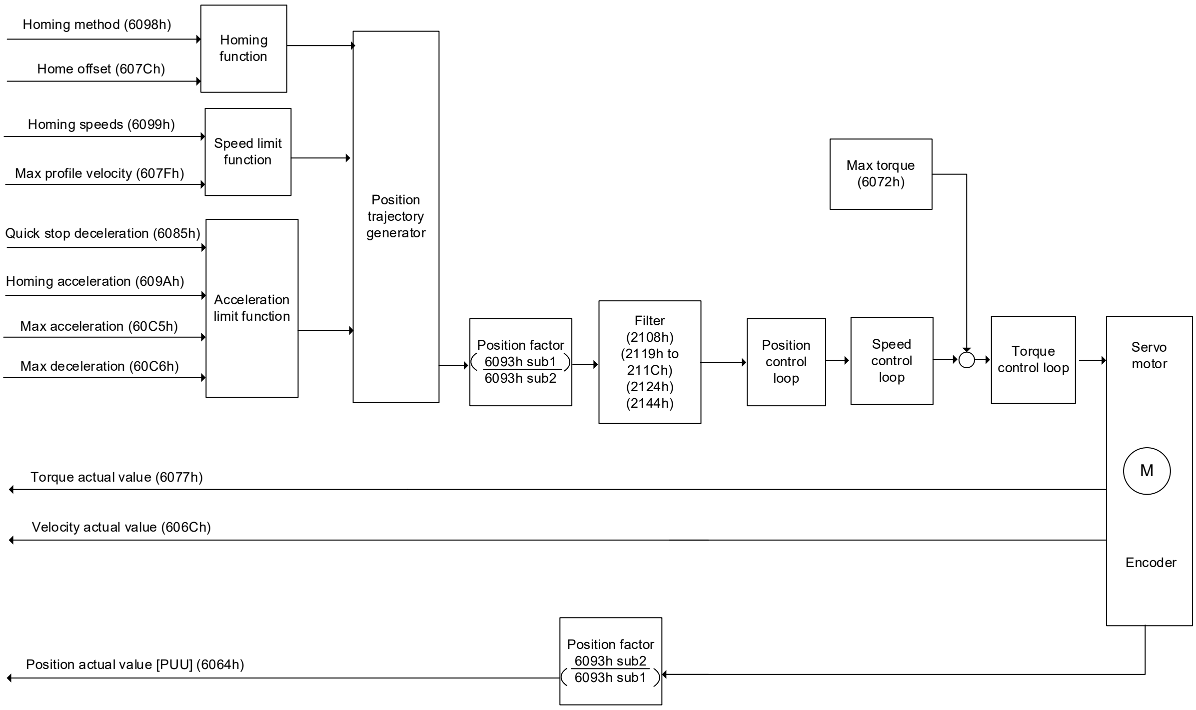

Operation steps:

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 homing method.
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.
7. Set the Controlword (OD 6040h). Follow these steps for operation. Steps 7.1 and 7.2 are to bring the servo drive's state machine into the ready state. For more details of the state machine, refer to the OD 6040h description in Section 12.4.3.3.

Step	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Description
7.1	0	0	1	1	0	Shutdown.
7.2	0	0	1	1	1	Switch on (ready for Servo On).
7.3	0	1	1	1	1	Enable operation (Servo On).
7.4	1	1	1	1	1	Homing (rising-edge triggered).

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Read the servo drive information:

1. Read OD 6041h to obtain the servo drive status.
2. Read OD 6064h to obtain the actual value of the motor position at present.

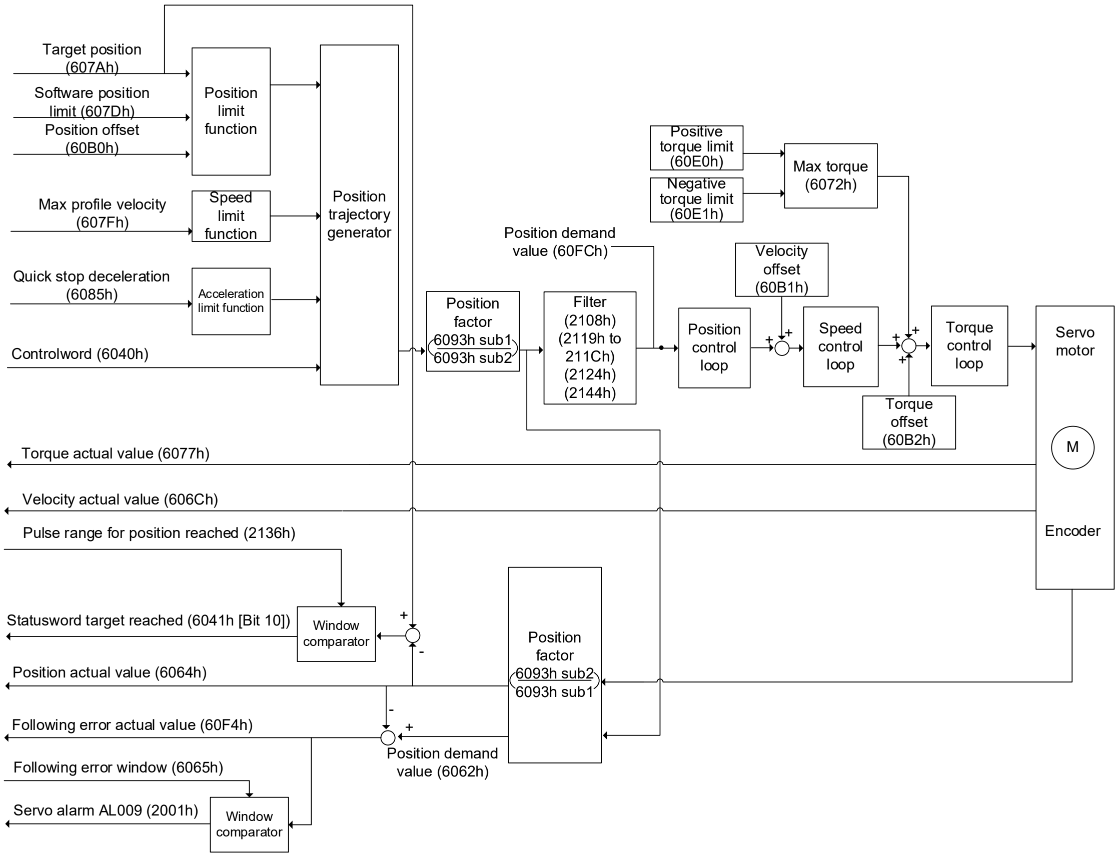
Relevant object list

Index	Name	Data type	Access
6040h	Controlword	UNSIGNED16	RW
6041h	Statusword	UNSIGNED16	RO
6060h	Modes of operation	INTEGER8	RW
6061h	Modes of operation display	INTEGER8	RO
6064h	Position actual value [PUU]	INTEGER32	RO
606Ch	Velocity actual value	INTEGER32	RO
6072h	Max torque	UNSIGNED16	RW
607Ch	Home offset	INTEGER32	RW
607Fh	Max profile velocity	UNSIGNED32	RW
6085h	Quick stop deceleration	UNSIGNED32	RW
6093h	Position factor	UNSIGNED32	RW
6098h	Homing method	INTEGER8	RW
6099h	Homing speeds	UNSIGNED32	RW
609Ah	Homing acceleration	UNSIGNED32	RW
60C5h	Max acceleration	UNSIGNED32	RW
60C6h	Max deceleration	UNSIGNED32	RW

Note: for more details, refer to Section 12.4.3 Details of objects.

12.3.5 Cyclic Synchronous Position mode

The controller plans the path in Cyclic Synchronous Position (CSP) mode and transmits PDOs to the servo drive periodically. In this mode, when the controller transmits each PDO, it simultaneously transmits the target position and controlword data to the servo drive. The velocity offset and torque offset can be used as the velocity and torque feed forward control setting.



Operation steps:

1. Set OD 6060h to 08h to set the mode as Cyclic Synchronous Position mode.
2. Set OD 607Ah for the target position (unit: PUU).
3. Set the Controlword (OD 6040h). Follow these steps for operation. Steps 3.1 and 3.2 are to bring the servo drive's state machine into the ready state. For the description of the state machine, refer to the OD 6040h description in Section 12.4.3.3.

Step	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Description
3.1	0	0	1	1	0	Shutdown.
3.2	0	0	1	1	1	Switch on (ready for Servo On).
3.3	0	1	1	1	1	Enable operation (Servo On).

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Relevant object list

Index	Name	Data type	Access
6040h	Controlword	UNSIGNED16	RW
6041h	Statusword	UNSIGNED16	RO
6060h	Modes of operation	INTEGER8	RW
6061h	Modes of operation display	INTEGER8	RO
6062h	Position demand value [PUU]	INTEGER32	RO
6064h	Position actual value [PUU]	INTEGER32	RO
6065h	Following error window	UNSIGNED32	RW
606Ch	Velocity actual value	INTEGER32	RO
6072h	Max torque	UNSIGNED16	RW
6077h	Torque actual value	INTEGER16	RO
607Ah	Target position	INTEGER32	RW
607Dh	Software position limit	INTEGER32	RW
607Fh	Max profile velocity	UNSIGNED32	RW
6085h	Quick stop deceleration	UNSIGNED32	RW
6093h	Position factor	UNSIGNED32	RW
60B0h	Position offset	INTEGER32	RW
60B1h	Velocity offset	INTEGER32	RW
60B2h	Torque offset	INTEGER16	RW
60E0h	Positive torque limit	UNSIGNED16	RW
60E1h	Negative torque limit	UNSIGNED16	RW
60F4h	Following error actual value	INTEGER32	RO
60FCh	Position demand value	INTEGER32	RO

Note: for more details, refer to Section 12.4.3 Details of objects.

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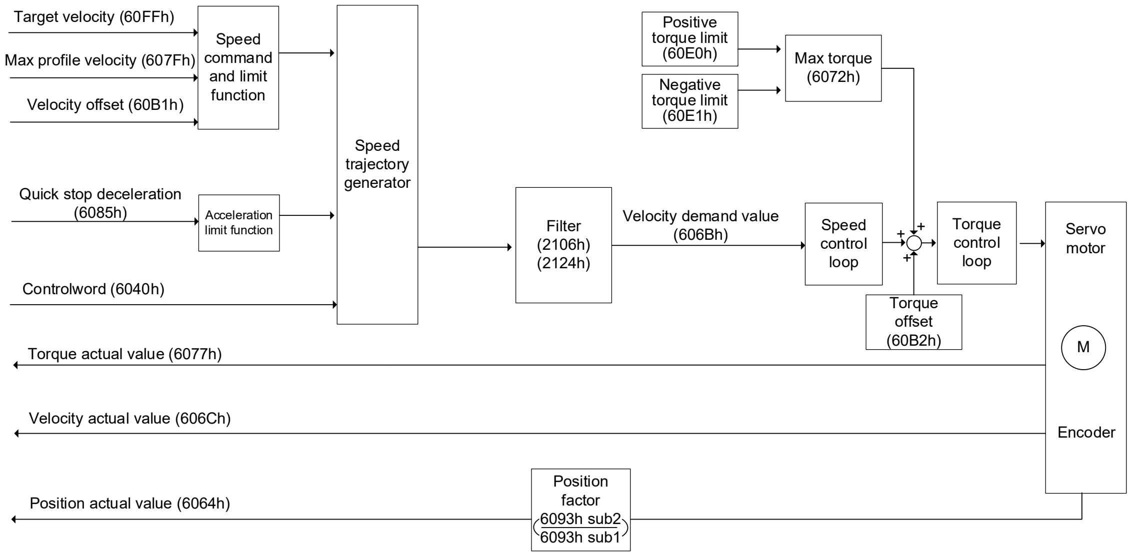
12.3.6 Cyclic Synchronous Velocity mode

The controller plans the speed in Cyclic Synchronous Velocity (CSV) mode and transmits PDOs to the servo drive periodically. In this mode, when the controller transmits each PDO, it simultaneously transmits the target velocity and controlword data to the servo drive. The velocity offset and torque offset can be used as the velocity and torque feed forward control setting.



Operation steps:

1. Set OD 6060h to 09h to set the mode as Cyclic Synchronous Velocity mode.
2. Set the target velocity (OD 60FFh) to 0. In Cyclic Synchronous Velocity mode, the servo motor starts operating once the servo drive is switched to Servo On (Step 3). Therefore, setting the target velocity (OD 60FFh) to 0 is to ensure that the motor maintains at 0 rpm at the moment of Servo On.
3. Set the Controlword (OD 6040h). Follow these steps for operation. Steps 3.1 and 3.2 are to bring the servo drive's state machine into the ready state. For the description of the state machine, refer to the OD 6040h description in Section 12.4.3.3.

Step	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Description
3.1	0	0	1	1	0	Shutdown.
3.2	0	0	1	1	1	Switch on (ready for Servo On).
3.3	0	1	1	1	1	Enable operation (Servo On).

4. Set OD 60FFh for the target velocity.

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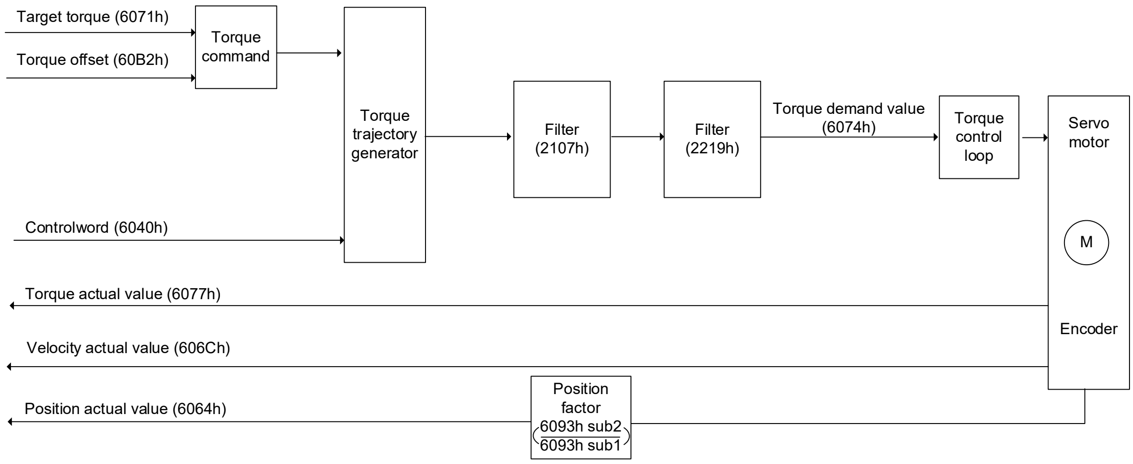
Relevant object list

Index	Name	Data type	Access
6040h	Controlword	UNSIGNED16	RW
6041h	Statusword	UNSIGNED16	RO
6060h	Modes of operation	INTEGER8	RW
6061h	Modes of operation display	INTEGER8	RO
6064h	Position actual value [PUU]	INTEGER32	RO
606Bh	Velocity demand value	INTEGER32	RO
606Ch	Velocity actual value	INTEGER32	RO
6072h	Max torque	UNSIGNED16	RW
6077h	Torque actual value	INTEGER16	RO
607Fh	Max profile velocity	UNSIGNED32	RW
6085h	Quick stop deceleration	UNSIGNED32	RW
6093h	Position factor	UNSIGNED32	RW
60B1h	Velocity offset	INTEGER32	RW
60B2h	Torque offset	INTEGER16	RW
60E0h	Positive torque limit	UNSIGNED16	RW
60E1h	Negative torque limit	UNSIGNED16	RW
60FFh	Target velocity	INTEGER32	RW

Note: for more details, refer to Section 12.4.3 Details of objects.

12.3.7 Cyclic Synchronous Torque mode

The controller plans the torque in Cyclic Synchronous Torque (CST) mode and transmits PDOs to the servo drive periodically. In this mode, when the controller transmits each PDO, it simultaneously transmits the target torque and controlword data to the servo drive. The torque offset can be used as the torque feed forward control setting.



Operation steps:

1. Set OD 6060h to 0Ah to set the mode as Cyclic Synchronous Torque mode.
2. Set the target torque (OD 6071h) to 0. In Cyclic Synchronous Torque mode, the servo target torque takes effect once the servo drive is switched to Servo On (Step 3). Therefore, set the target torque (OD 6071h) to 0 for safety reasons.
3. Set the Controlword (OD 6040h). Follow these steps for operation. Steps 3.1 and 3.2 are to bring the servo drive's state machine into the ready state. For more details of the state machine, refer to the OD 6040h description in Section 12.4.3.3.

Step	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Description
3.1	0	0	1	1	0	Shutdown.
3.2	0	0	1	1	1	Switch on (ready for Servo On).
3.3	0	1	1	1	1	Enable operation (Servo On).

4. Set OD 6071h for the target torque.

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Relevant object list

Index	Name	Data type	Access
6040h	Controlword	UNSIGNED16	RW
6041h	Statusword	UNSIGNED16	RO
6060h	Modes of operation	INTEGER8	RW
6061h	Modes of operation display	INTEGER8	RO
6064h	Position actual value [PUU]	INTEGER32	RO
606Ch	Velocity actual value	INTEGER32	RO
6071h	Target torque	INTEGER16	RW
6074h	Torque demand value	INTEGER16	RO
6077h	Torque actual value	INTEGER16	RO
6093h	Position factor	UNSIGNED32	RW
60B2h	Torque offset	INTEGER16	RW

Note: for more details, refer to Section 12.4.3 Details of objects.

12.3.8 Touch Probe function and Touch Probe status

The Touch Probe function can be triggered by high-speed digital inputs (only DI1 and DI2) or by the motor Z pulse. This function is used for high-speed measurement or packaging applications.

If the capture source is the motor Z pulse or DI of CN1, note the following:

1. When the capture source is set to the motor Z pulse, you can only use Touch Probe 1. Regardless of the settings of OD 60B8h [Bit 4] and [Bit 5], the command is rising-edge triggered and the data is stored in OD 60BAh.
2. When the capture source is set to the DI of CN1, the previously set function code for the DI is changed to 0x0100 so one DI does not have two functions.

Set the Touch Probe function with OD 60B8h. The definition of each bit is as follows.

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

Bit	Function	Description
Bit 0	Touch Probe 1 switch	0: disable Touch Probe 1. 1: enable Touch Probe 1.
Bit 1	Touch Probe 1 number of capturing times	0: capture one time. If the Touch Probe 1 signal is set to be both rising-edge and falling-edge triggered, the data is captured once for each triggering. 1: capture multiple times.
Bit 2	Touch Probe 1 capture source	0: DI1 of CN1 1: motor Z pulse
Bit 3	Reserved	-
Bit 4	Rising-edge trigger action of Touch Probe 1	0: N/A 1: start capturing when the Touch Probe 1 signal is rising-edge triggered and store the data in OD 60BAh.
Bit 5	Falling-edge trigger action of Touch Probe 1	0: N/A 1: start capturing when the Touch Probe 1 signal is falling-edge triggered and store the data in OD 60BBh.
Bit 6 - Bit 7	Reserved	-
Bit 8	Touch Probe 2 switch	0: disable Touch Probe 2. 1: enable Touch Probe 2.
Bit 9	Touch Probe 2 number of capturing times	0: capture one time. If the Touch Probe 2 signal is set to be both rising-edge and falling-edge triggered, the data is captured once for each triggering. 1: capture multiple times.
Bit 10	Touch Probe 2 capture source	0: DI2 of CN1
Bit 11	Reserved	-
Bit 12	Rising-edge trigger action of Touch Probe 2	0: N/A 1: start capturing when the Touch Probe 2 signal is rising-edge triggered and store the data in OD 60BCh.

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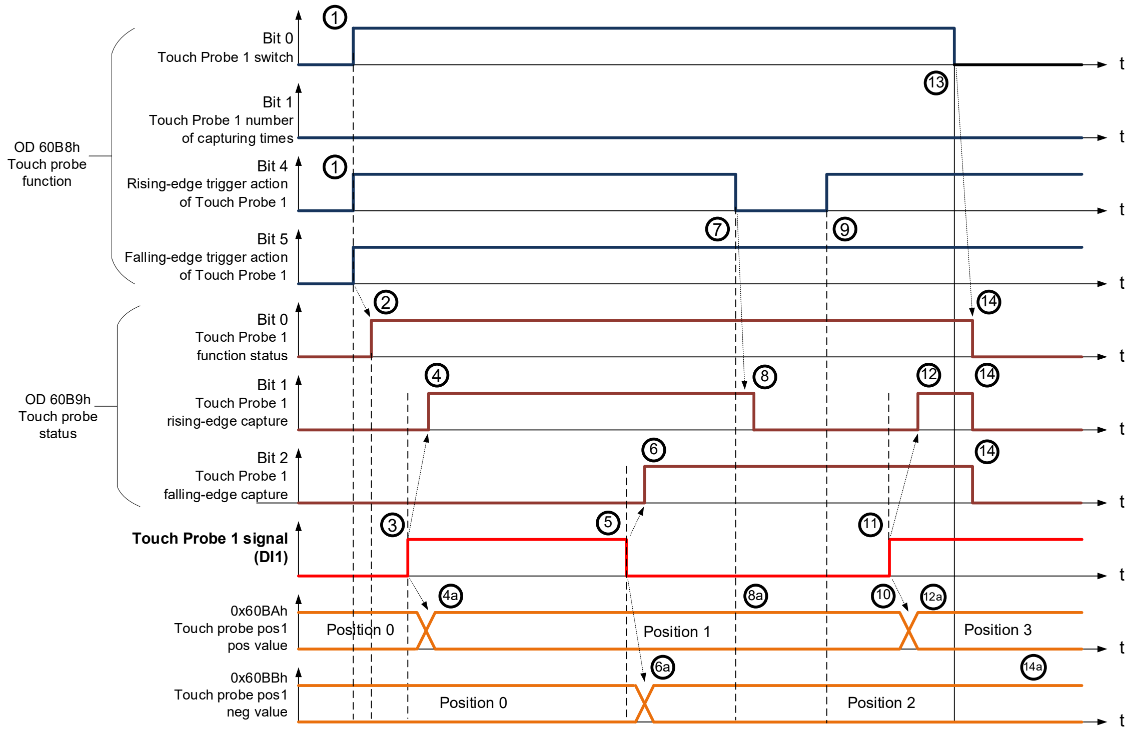
Bit	Function	Description
Bit 13	Falling-edge trigger action of Touch Probe 2	0: N/A 1: start capturing when the Touch Probe 2 signal is falling-edge triggered and store the data in OD 60BDh.
Bit 14 - Bit 15	Reserved	-

You can access the Touch Probe status with OD 60B9h. The definition of each bit is as follows.

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

Bit	Function	Description
Bit 0	Touch Probe 1 function status	0: Touch Probe 1 disabled. 1: Touch Probe 1 enabled.
Bit 1	Touch Probe 1 rising-edge capture	0: capturing is not triggered. 1: the Touch Probe 1 signal is rising-edge triggered and the data is successfully captured.
Bit 2	Touch Probe 1 falling-edge capture	0: capturing is not triggered. 1: the Touch Probe 1 signal is falling-edge triggered and the data is successfully captured.
Bit 3 - Bit 5	Reserved	-
Bit 6	Touch Probe 1 capture source	0: DI1 of CN1 1: motor Z pulse
Bit 7	Touch Probe 1 signal for capturing multiple times (Available when the function of OD 60B8h [Bit 1] Number of capturing times is enabled)	The status is reversed once the capturing succeeds. Refer to the timing diagram in Example 3.
Bit 8	Touch Probe 2 function status	0: Touch Probe 2 disabled. 1: Touch Probe 2 enabled.
Bit 9	Touch Probe 2 rising-edge capture	0: capturing is not triggered 1: the Touch Probe 2 signal is rising-edge triggered and the data is successfully captured.
Bit 10	Touch Probe 2 falling-edge capture	0: capturing is not triggered 1: the Touch Probe 2 signal is falling-edge triggered and the data is successfully captured.
Bit 11 - Bit 13	Reserved	-
Bit 14	Touch Probe 2 capture source	0: DI2 of CN1
Bit 15	Touch Probe 2 signal for capturing multiple times (Available when the function of OD 60B8h [Bit 9] Number of capturing times is enabled)	The status is reversed once the capturing succeeds.

Example 1: the following is the timing diagram for the Touch Probe 1 function. In this example, the Touch Probe 1 function is triggered by the external DI. When OD 60B8h [Bit 1] is set to 0 and OD 60B8h [Bit 4] & [Bit 5] are set to 1, the Touch Probe 1 signal is both rising-edge and falling-edge triggered, and the data is captured once for each triggering.



Status	Function	Description
(1)	OD 60B8h [Bit 0] = 1	Enable Touch Probe 1.
	OD 60B8h [Bit 1] = 0	Capture one time.
	OD 60B8h [Bit 4] = 1	Start capturing when the Touch Probe 1 signal is rising-edge triggered.
	OD 60B8h [Bit 5] = 1	Start capturing when the Touch Probe 1 signal is falling-edge triggered.
(2)	OD 60B9h [Bit 0] = 1	Touch Probe status: Touch Probe 1 function enabled.
(3)	-	Touch Probe 1 is rising-edge triggered by external signal.
(4)	OD 60B9h [Bit 1] = 1	Touch Probe status: Touch Probe 1 is rising-edge triggered and the data is successfully captured.
(4a)	OD 60BAh	Store the captured data in OD 60BAh when the Touch Probe 1 signal is rising-edge triggered.
(5)	-	Touch Probe 1 is falling-edge triggered by external signal.
(6)	OD 60B9h [Bit 2] = 1	Touch Probe status: Touch Probe 1 signal is falling-edge triggered and the data is successfully captured.
(6a)	OD 60BBh	Store the captured data in OD 60BBh when the Touch Probe 1 signal is falling-edge triggered.
(7)	OD 60B8h [Bit 4] = 0	Disable the rising-edge trigger action of Touch Probe 1.
(8)	OD 60B9h [Bit 1] = 0	Touch Probe status: reset the rising-edge capture status to non-triggered.
(8a)	OD 60BAh	Data at the rising-edge remains the same.
(9)	OD 60B8h [Bit 4] = 1	Start capturing when the Touch Probe 1 signal is rising-edge triggered.

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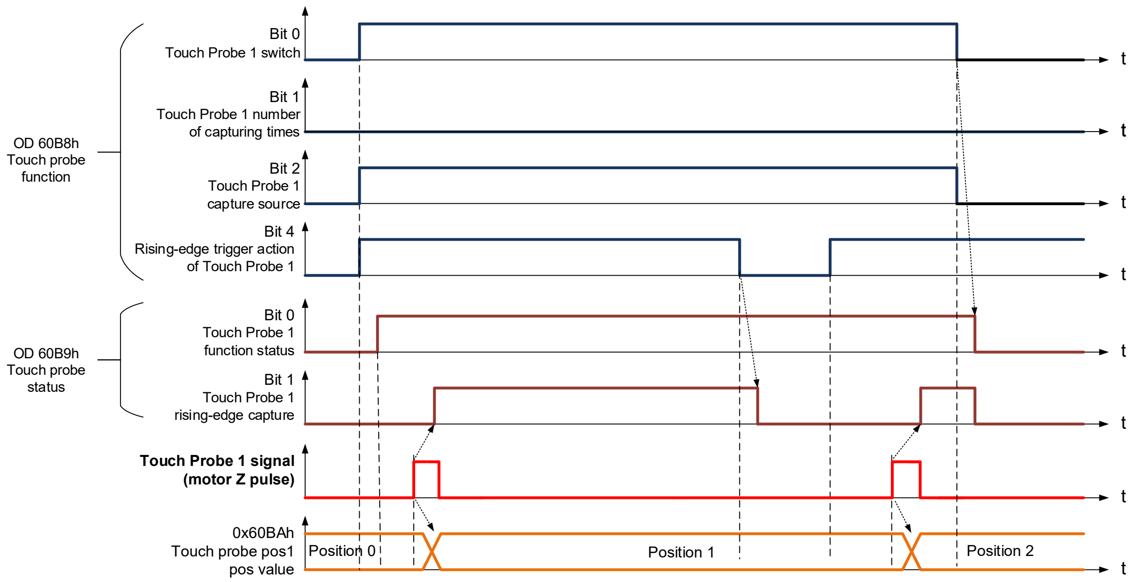
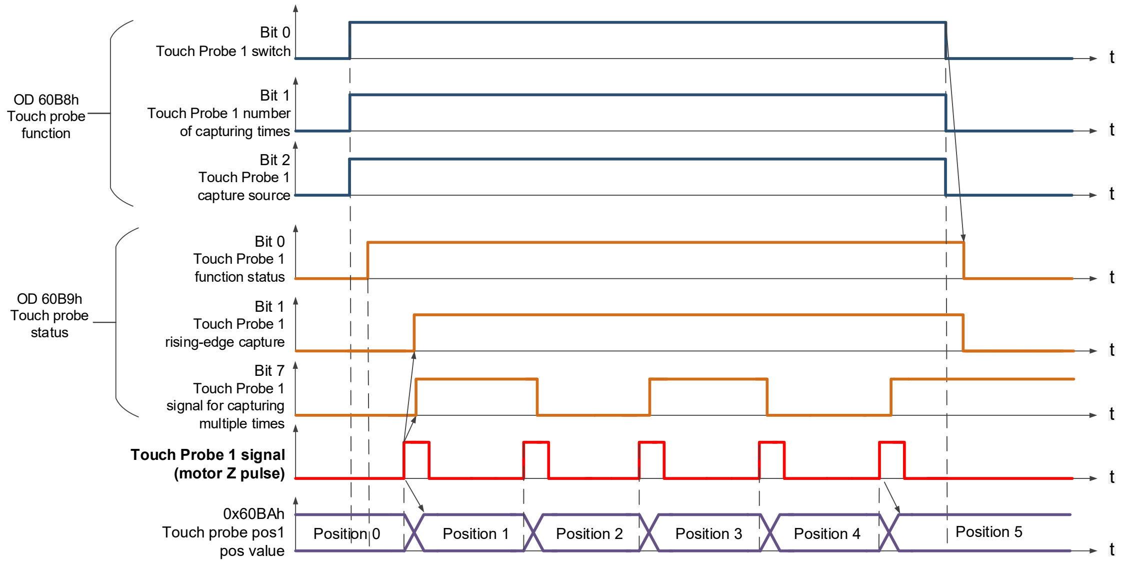
Status	Function	Description
(10)	OD 60BAh	Data at the rising-edge remains the same.
(11)	-	Touch Probe 1 is rising-edge triggered by external signal.
(12)	OD 60B9h [Bit 1] = 1	Touch Probe status: Touch Probe 1 signal is rising-edge triggered and the data is successfully captured.
(12a)	OD 60BAh	Store the captured data in OD 60BAh when the Touch Probe 1 signal is rising-edge triggered.
(13)	OD 60B8h [Bit 0] = 0	Disable Touch Probe 1.
(14)	OD 60B9h [Bit 0] = 0 OD 60B9h [Bit 1] = 0 OD 60B9h [Bit 2] = 0	Reset Touch Probe 1 status.
(14a)	OD 60BAh	The previously captured data remains the same.

Example 2: the following is the timing diagram for the Touch Probe 1 function. In this example, the Touch Probe 1 function is triggered by the motor Z pulse. The data is captured only once when the Touch Probe 1 signal is rising-edge triggered.



Example 3: the following is the timing diagram for the Touch Probe 1 function. In this example, the Touch Probe 1 function is triggered by the motor Z pulse. The data is captured **multiple times** when the Touch Probe 1 signal is rising-edge triggered.



Relevant object list

Index	Name	Data type	Access
60B8h	Touch probe function	UNSIGNED16	RW
60B9h	Touch probe status	UNSIGNED16	RO
60BAh	Touch probe pos1 pos value	INTEGER32	RO
60BBh	Touch probe pos1 neg value	INTEGER32	RO
60BCh	Touch probe pos2 pos value	INTEGER32	RO
60BDh	Touch probe pos2 neg value	INTEGER32	RO

Note: for more details, refer to Section 12.4.3 Details of objects.

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12.4 Object dictionary

This section details the EtherCAT objects supported by the servo. The contents include object index, name, data type, data length, and read / write permissions (access).

12.4.1 Specifications for objects

Object code

Object code	Description
VAR	A single value, such as an UNSIGNED8, Boolean, float, and INTEGER16.
ARRAY	An object of multiple data fields consisting of multiple variables of the same data type, such as an UNSIGNED16 array. The sub-index 0h 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 0h data type is UNSIGNED8, so it is not a RECORD data.

Data type

Refer to CANopen DS301.

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12.4.2 List of objects

OD 1XXXh communication object group

Index	Object code	Name	Data type	Access
1000h	VAR	Device type	UNSIGNED32	RO
1001h	VAR	Error register	UNSIGNED8	RO
1003h	ARRAY	Pre-defined error field	UNSIGNED32	RW
1006h	VAR	Communication cycle period	UNSIGNED32	RW
1600h - 1603h	RECORD	Receive PDO mapping parameter	UNSIGNED32	RW
1A00h - 1A03h	RECORD	Transmit PDO mapping parameter	UNSIGNED32	RW
1C12h	ARRAY	RxPDO assign	UNSIGNED16	RW
1C13h	ARRAY	TxPDO assign	UNSIGNED16	RW

Note: only 1001h can be mapped to PDO.

OD 2XXXh servo parameter group

Index	Object code	Name	Data type	Access	Mappable
2XXXh	VAR	Parameter mapping	INTEGER16/32	RW	Y

OD 6XXXh communication object group

Index	Object code	Name	Data type	Access	Mappable
603Fh	VAR	Error code	UNSIGNED16	RO	Y
6040h	VAR	Controlword	UNSIGNED16	RW	Y
6041h	VAR	Statusword	UNSIGNED16	RO	Y
605Bh	VAR	Shutdown option code	INTEGER16	RW	Y
6060h	VAR	Modes of operation	INTEGER8	RW	Y
6061h	VAR	Modes of operation display	INTEGER8	RO	Y
6062h	VAR	Position demand value [PUU]	INTEGER32	RO	Y
6063h	VAR	Position actual internal value [Pulse]	INTEGER32	RO	Y
6064h	VAR	Position actual value [PUU]	INTEGER32	RO	Y
6065h	VAR	Following error window	UNSIGNED32	RW	Y
6067h	VAR	Position window	UNSIGNED32	RW	Y
6068h	VAR	Position window time	UNSIGNED16	RW	Y
606Bh	VAR	Velocity demand value	INTEGER32	RO	Y
606Ch	VAR	Velocity actual value	INTEGER32	RO	Y
606Dh	VAR	Velocity window	UNSIGNED16	RW	Y
606Eh	VAR	Velocity window time	UNSIGNED16	RW	Y
606Fh	VAR	Velocity threshold	UNSIGNED16	RW	Y
6071h	VAR	Target torque	INTEGER16	RW	Y
6072h	VAR	Max torque	UNSIGNED16	RW	Y
6074h	VAR	Torque demand value	INTEGER16	RO	Y
6075h	VAR	Motor rated current	UNSIGNED32	RO	Y
6076h	VAR	Motor rated torque	UNSIGNED32	RO	Y
6077h	VAR	Torque actual value	INTEGER16	RO	Y
6078h	VAR	Current actual value	INTEGER16	RO	Y
607Ah	VAR	Target position	INTEGER32	RW	Y
607Ch	VAR	Home offset	INTEGER32	RW	Y

Index	Object code	Name	Data type	Access	Mappable
607Dh	ARRAY	Software position limit	INTEGER32	RW	Y
607Fh	VAR	Max profile velocity	UNSIGNED32	RW	Y
6080h	VAR	Max motor speed	UNSIGNED32	RW	Y
6081h	VAR	Profile velocity	UNSIGNED32	RW	Y
6083h	VAR	Profile acceleration	UNSIGNED32	RW	Y
6084h	VAR	Profile deceleration	UNSIGNED32	RW	Y
6085h	VAR	Quick stop deceleration	UNSIGNED32	RW	Y
6086h	VAR	Motion profile type	INTEGER16	RO	Y
6087h	VAR	Torque slope	UNSIGNED32	RW	Y
6093h	ARRAY	Position factor	UNSIGNED32	RW	Y
6098h	VAR	Homing method	INTEGER8	RW	Y
6099h	ARRAY	Homing speeds	UNSIGNED32	RW	Y
609Ah	VAR	Homing acceleration	UNSIGNED32	RW	Y
60B0h	VAR	Position offset	INTEGER32	RW	Y
60B1h	VAR	Velocity offset	INTEGER32	RW	Y
60B2h	VAR	Torque offset	INTEGER16	RW	Y
60B8h	VAR	Touch probe function	UNSIGNED16	RW	Y
60B9h	VAR	Touch probe status	UNSIGNED16	RO	Y
60BAh	VAR	Touch probe pos1 pos value	INTEGER32	RO	Y
60BBh	VAR	Touch probe pos1 neg value	INTEGER32	RO	Y
60BCh	VAR	Touch probe pos2 pos value	INTEGER32	RO	Y
60BDh	VAR	Touch probe pos2 neg value	INTEGER32	RO	Y
60C5h	VAR	Max acceleration	UNSIGNED32	RW	Y
60C6h	VAR	Max deceleration	UNSIGNED32	RW	Y
60E0h	VAR	Positive torque limit	UNSIGNED16	RW	Y
60E1h	VAR	Negative torque limit	UNSIGNED16	RW	Y
60F4h	VAR	Following error actual value	INTEGER32	RO	Y
60FCh	VAR	Position demand value	INTEGER32	RO	Y
60FDh	VAR	Digital inputs	UNSIGNED32	RO	Y
60FEh	ARRAY	Digital outputs	UNSIGNED32	RW	Y
60FFh	VAR	Target velocity	INTEGER32	RW	Y
6502h	VAR	Supported drive modes	UNSIGNED32	RO	Y

12.4.3 Details of objects

12.4.3.1 OD 1XXXh communication object group

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Object 1000h: Device type

Index	1000h
Name	Device type
Object code	VAR
Data type	UNSIGNED32
Access	RO
PDO mapping	No
Setting range	UNSIGNED32

Format of this object: (High word h) DCBA; (Low word L) UZYX

A	Bit 16 - Bit 31 Model type	X	Bit 0 - Bit 15 Device profile number
B		Y	
C		Z	
D		U	

Definitions are as follows:

- UZYX: device profile number (servo drive: 0192)
- DCBA: model type

DCBA	Model type
0402	A2
0602	M
0702	A3
0B02	B3
1002	E3

Object 1001h: Error register

Index	1001h
Name	Error register
Object code	VAR
Data type	UNSIGNED8
Access	RO
PDO mapping	Yes
Setting range	UNSIGNED8
Default	0

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Object function:

The bits and corresponding functions are as follows:

Bit	7	6	5	4	3	2	1	0

Bit	Function
Bit 0	Generic error
Bit 1	Current
Bit 2	Voltage
Bit 3	Temperature
Bit 4	Communication error
Bit 5 - Bit 7	Reserved

Object 1003h: Pre-defined error field

Index	1003h
Name	Pre-defined error field
Object code	ARRAY
Data type	UNSIGNED32
Access	RW
PDO mapping	No

Sub-index	0h
Description	Number of errors
Data type	UNSIGNED8
Access	RW
PDO mapping	No
Setting range	0 - 5
Default	0

Sub-index	1h – 5h
Description	Standard error field
Data type	UNSIGNED32
Access	RO
PDO mapping	No
Setting range	UNSIGNED32
Default	0

Format of this object: (High word h) DCBA; (Low word L) UZYX

A	Bit 16 - Bit 31 Delta servo alarm	X	Bit 0 - Bit 15 Error code
B		Y	
C		Z	
D		U	

Definitions are as follows:

- UZYX: error code. Refer to the error code definition in DS402.
- DCBA: Delta servo alarm. Refer to Chapter 14 Troubleshooting.

Example:

When you operate the servo, if the encoder cable is not correctly connected, the servo drive panel displays AL011 and its error code is stored in the OD 1003h array. The display is as follows:

Byte:	High word	Low word
	Delta servo alarm (UINT16)	Error code (UINT16)
	0x0011	0x7305

AL011 is defined as “CN2 communication failed” based on the Delta servo alarm.

Error code: 0x7305 is defined as “Incremental sensor 1 fault” according to DS402.

Object 1006h: Communication cycle period

Index	1006h
Name	Communication cycle period
Object code	VAR
Data type	UNSIGNED32
Access	RW
PDO mapping	No
Setting range	UNSIGNED32
Default	0
Unit	μs

Object function:

This object is to set the communication cycle, which is the interval between two SYNCs. If you are not using SYNC, set this object to 0.

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Objects 1600h - 1603h: Receive PDO mapping parameter

Index	1600h, 1601h, 1602h, 1603h
Name	Receive PDO mapping parameter
Object code	RECORD
Data type	PDO mapping
Access	RW
Note	The total length of objects in a group of PDO cannot exceed 64 bits.

Sub-index	0h
Description	Number of PDO mappings
Data type	UNSIGNED8
Access	RW
PDO mapping	No
Setting range	0: disable 1 - 8: set the number of PDO mapping and enable the function
Default	0

Sub-index	1h – 8h
Description	Specify the 1st (to 8th) object and its content to be mapped
Data type	UNSIGNED32
Access	RW
PDO mapping	No
Setting range	UNSIGNED32
Default	0

The format of this object is as follows:

Bit	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

Bit	Function
Bit 0 - Bit 7	Object data length
Bit 8 - Bit 15	Object sub-index
Bit 16 - Bit 31	Object index

Example:

To set the three PDOs, OD 6040h, OD 607Ah, and OD 6060h, in the first group of PDO, the setting is as follows.

Mapping parameter setting for RxPDO	Data			Description
OD 1600h sub0	3			Set 3 PDO mappings.
OD 1600h sub1	6040h	00h	10h	Mapping the Controlword (OD 6040h); data length is 16-bit
OD 1600h sub2	607Ah	00h	20h	Mapping the target position (OD 607Ah); data length is 32-bit
OD 1600h sub3	6060h	00h	08h	Mapping the operation mode (OD 6060h); data length is 8-bit
Note	The total length is 38h (56-bit) which meets the specification of less than 64-bit.			

Objects 1A00h - 1A03h: Transmit PDO mapping parameter

Index	1A00h, 1A01h, 1A02h, 1A03h
Name	Transmit PDO mapping parameter
Object code	RECORD
Data type	PDO mapping
Access	RW
Note	The total length of objects in a group of PDO cannot exceed 64 bits.

Sub-index	0h
Description	Number of PDO mappings
Data type	UNSIGNED8
Access	RW
PDO mapping	No
Setting range	0: disable 1 - 8: set the number of PDO mapping and enable the function
Default	0

Sub-index	1h- 8h
Description	Specify the 1st (to 8th) object and its content to be mapped
Data type	UNSIGNED32
Access	RW
PDO mapping	No
Setting range	UNSIGNED32
Default	0

Format of this object: (High word h) DCBA; (Low word L) UZYX

DCBA	Bit 16 - Bit 31 Object index	YX	Bit 0 - Bit 7 Object data length
		UZ	Bit 8 - Bit 15 Object sub-index

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Object 1C12h: RxPDO assign

Index	1C12h
Name	RxPDO assign
Object code	ARRAY
Data type	UNSIGNED16
Access	RW
PDO mapping	No

Sub-index	0h
Description	Number of sub-index
Data type	UNSIGNED8
Access	RW
PDO mapping	No
Setting range	0 - 1
Default	1

Sub-index	0h
Description	Specify the RxPDO index to be used
Data type	UNSIGNED16
Access	RW
PDO mapping	No
Setting range	0x1600, 0x1601, 0x1602, 0x1603
Default	0x1601

Object 1C13h: TxPDO assign

Index	1C13h
Name	TxPDO assign
Object code	ARRAY
Data type	UNSIGNED16
Access	RW
PDO mapping	No

Sub-index	0h
Description	Number of sub-index
Data type	UNSIGNED8
Access	RW
PDO mapping	No
Setting range	0 - 1
Default	1

Sub-index	0h
Description	Specify the TxPDO index to be used
Data type	UNSIGNED16
Access	RW
PDO mapping	No
Setting range	0x1A00, 0x1A01, 0x1A02, 0x1A03
Default	0x1A01

12.4.3.2 OD 2XXXh servo parameter group

Object 2XXXh: Parameter mapping

Index	2XXXh
Name	Parameter mapping
Object code	VAR
Data type	INTEGER16 / INTEGER32
Access	RW
PDO mapping	Yes
Setting range	INTEGER16 / INTEGER32
Default	N/A

Object function:

Access the corresponding servo parameters with the OD 2XXXh group. The conversion between the parameter number and object index is as follows:

Object index	Servo parameter	Description
2**aBC**h	P**a**.**bcd**	"**BC**" is the hexadecimal format of "**bcd**".

You can read the object index first to get the information of the parameter length, and then use SDO or PDO to change the data.

Example 1:

Object 2300h: Node-ID [P3.000]

Index	2300h
Name	Node-ID
Object code	VAR
Data type	INTEGER16
Access	RW
PDO mapping	Yes
Setting range	INTEGER16
Default	7F

Example 2:

Object 212Ch: Electronic gear [P1.044]

Index	212Ch
Name	Electronic gear
Object code	VAR
Data type	INTEGER32
Access	RW
PDO mapping	Yes
Setting range	INTEGER32
Default	1

12.4.3.3 OD 6XXXh communication object group

Object 603Fh: Error code (CANopen defined)

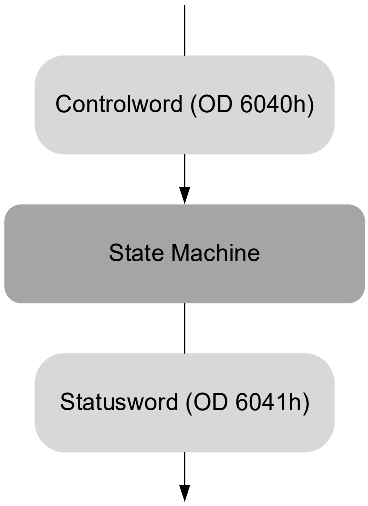
Index	603Fh
Name	Error code
Object code	VAR
Data type	UNSIGNED16
Access	RO
PDO mapping	Yes
Setting range	UNSIGNED16
Default	0

Object 6040h: Controlword

Index	6040h
Name	Controlword
Object code	VAR
Data type	UNSIGNED16
Access	RW
PDO mapping	Yes
Setting range	UNSIGNED16
Default	0x0004

Object function:

The Controlword contains many functions, such as Servo On, command triggering, fault reset, and quick stop. The state machine architecture is as follows:



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

Bit	Function	Description
Bit 0	Switch on	Ready for Servo On.
Bit 1	Enable voltage	-
Bit 2	Quick stop (B contact (NC))	-
Bit 3	Enable operation	Servo On.

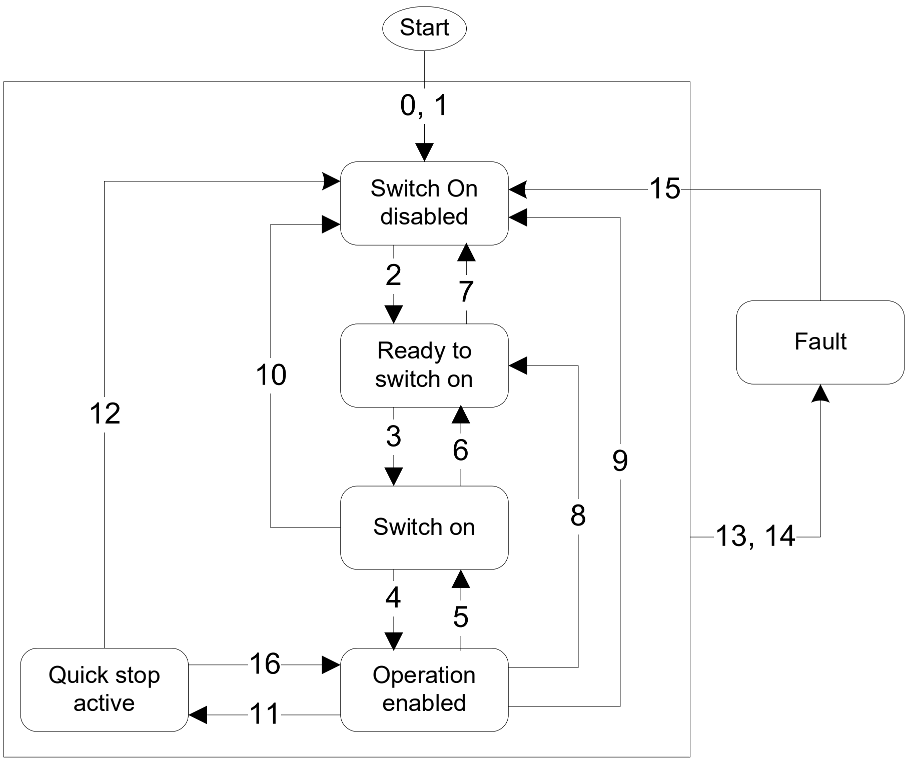
Bit	Function	Description
Bit 4 - Bit 6	Defined in each operation mode	These bits are individually defined according to the operation mode, as shown in the following table.
Bit 7	Fault reset	-
Bit 8	Halt	-
Bit 9 - Bit 15	Reserved	-

Bits 4 - 6 are individually defined according to the operation mode, as shown in the following table:

Bit	Definition in each operation mode		
	Profile Position mode	Homing mode	Profile Velocity mode Profile Torque mode Cyclic Synchronous Position mode Cyclic Synchronous Velocity mode Cyclic Synchronous Torque mode
Bit 4	Command triggering (rising-edge triggered)	Homing (rising-edge triggered)	-
Bit 5	Function for the command to take immediate effect	-	-
Bit 6	0: absolute position command 1: relative position command	-	-

Note: - indicates the bit is invalid.

Finite state machine (as shown in the following diagram) defines the behavior of a servo drive system. Each state represents an internal or external behavior. For example, the servo drive can execute point-to-point motion only in the Operation enabled state.



The state transition is defined as follows:

Transition	Event	Action
0, 1	Automatic transition after power-on	Device boot and initialization
2	Shutdown command	N/A
3	Switch on command	Servo is ready for Servo On
4	Enable operation command	Servo switches to Servo On and enters the mode in which the controller is allowed to issue a motion command
5	Disable operation command	Servo switches to Servo Off
6	Shutdown command	N/A
7	Disable voltage or quick stop command	N/A
8	Shutdown command	Servo switches to Servo Off
9	Disable voltage command	Servo switches to Servo Off
10	Disable voltage or quick stop command	N/A
11	Quick stop command The following two errors belong to this quick stop type: 1. Positive / negative limit switch triggered 2. Quick stop triggered by the Controlword (OD 6040h [Bit 2] = 0)	Quick stop function is enabled. The time setting for deceleration to a stop is different for the two errors. 1. OD 2503h (P5.003) 2. OD 6085h
12	Disable voltage command (OD 6040h = 0000 0110 or OD 6040h [Bit 1] = 0)	Servo switches to Servo Off
13, 14	Alarm occurs	Servo switches to Servo Off
15	Fault reset	N/A
16	Enable operation command; no alarm	Motion operation restart. The restart action is mode-dependent.

State transition can be achieved by issuing commands with the Controlword (OD 6040h).

The settings of OD 6040h for different commands are as follows:

OD 6040h					Command	Transition
Bit 7	Bit 3	Bit 2	Bit 1	Bit 0		
0	X	1	1	0	Shutdown	2, 6, 8
0	0	1	1	1	Switch on	3
0	1	1	1	1	Switch on + Enable operation	3 + 4
0	X	X	0	X	Disable voltage	7, 9, 10, 12
0	X	0	1	X	Quick stop	7, 10, 11
0	0	1	1	1	Disable operation	5
0	1	1	1	1	Enable operation	4, 16
	X	X	X	X	Fault reset	15

Object 6041h: Statusword

Index	6041h
Name	Statusword
Object code	VAR
Data type	UNSIGNED16
Access	RO
PDO mapping	Yes
Setting range	UNSIGNED16
Default	0

Object function:

The Statusword contains many statuses, such as Servo On, command statuses, fault signal, and quick stop. The state machine architecture is as follows:

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

Bit	Status		Description
Bit 0	Ready to switch on	Ready to be activated	Current status of the servo drive (see the following table for details).
Bit 1	Switched on	Servo ready	
Bit 2	Operation enabled	Servo On	
Bit 3	Fault	Fault signal	
Bit 4	Voltage enabled	Servo is powered on	
Bit 5	Quick stop	Quick stop	
Bit 6	Switch on disabled	Servo disabled	
Bit 7	Warning	Warning signal	When outputting the warning signal, the servo keeps outputting the Servo On signal.
Bit 8	Reserved	-	-
Bit 9	Remote	Remote control	-
Bit 10	Target reached	Target reached	-
Bit 11	Reserved	-	-
Bit 12 - Bit 13	-	-	These bits are individually defined according to the operation mode, as shown in the following table.
Bit 14	Positive limit	Positive limit	-
Bit 15	Negative limit	Negative limit	-

Bit 0 - Bit 6: current status of the servo drive.

Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Description
0	-	-	0	0	0	0	Not ready to switch on.
1	-	-	0	0	0	0	Switch on disabled.
0	1	-	0	0	0	1	Ready to switch on.
0	1	-	0	0	1	1	Switched on.
0	1	-	0	1	1	1	Operation enabled (Servo On).
0	0	-	0	1	1	1	Quick stop active.
0	-	-	1	1	1	1	Fault reaction active.
0	-	-	1	0	0	0	Servo fault (servo switches to Servo Off).

Note: 0 indicates the bit is off, 1 indicates the bit is on, and - indicates the bit is invalid.

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Bit 12 - Bit 13: current status of the servo drive.

Bit	Definition in each operation mode						
	PP	PV	PT	Homing	CSP	CSV	CST
Bit 12	Set-point acknowledge (servo received the command signal)	Zero speed	-	Homing is complete	Mode is in effect	Mode is in effect	Mode is in effect
Bit 13	Following error	-	-	Homing error	Following error	-	-

Note: - indicates the bit is invalid.

Object 605Bh: Shutdown option code

Index	605Bh
Name	Shutdown option code
Object code	VAR
Data type	INTEGER16
Access	RW
PDO mapping	Yes
Setting range	INTEGER16
Default	0

Object function:

OD 605Bh = 0: when Servo Off, the dynamic brake has no effect, so the motor runs freely and the machine stops only by friction.

OD 605Bh = -1: when Servo Off, the servo stops with the operation of the dynamic brake.

Note: when P3.012.Z is set to 1, the non-volatile setting for this object is enabled.

Object 6060h: Modes of operation

Index	6060h
Name	Modes of operation
Object code	VAR
Data type	INTEGER8
Access	RW
PDO mapping	Yes
Setting range	INTEGER8
Default	0

Object function:

This object sets the mode for operation.

Setting value	Mode
0	Reserved
1	Profile Position mode
2	Reserved
3	Profile Velocity mode
4	Profile Torque mode
5	Reserved
6	Homing mode
7	Reserved
8	Cyclic Synchronous Position mode
9	Cyclic Synchronous Velocity mode
10	Cyclic Synchronous Torque mode

Object 6061h: Modes of operation display

Index	6061h
Name	Modes of operation display
Object code	VAR
Data type	INTEGER8
Access	RO
PDO mapping	Yes
Setting range	INTEGER8
Default	0

Object function:

This object displays the current operation mode. Refer to the table in OD 6060h.

Object 6062h: Position demand value (PUU)

Index	6062h
Name	Position demand value
Object code	VAR
Data type	INTEGER32
Access	RO
PDO mapping	Yes
Setting range	INTEGER32
Default	0
Unit	PUU

Object function:

This position demand value is the interpolation command calculated by the servo internal interpolator. This command passes through the servo internal filter. For its detailed location, refer to the servo architecture diagram of each mode.

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Object 6063h: Position actual internal value (Pulse)

Index	6063h
Name	Position actual internal value
Object code	VAR
Data type	INTEGER32
Access	RO
PDO mapping	Yes
Setting range	INTEGER32
Default	0
Unit	Pulse (unit for encoder pulse resolution) The ASDA-A2 servo drive generates 1,280,000 pulses per motor revolution. The ASDA-A3 / ASDA-B3 servo drive generates 16,777,216 pulses per motor revolution.

Object 6064h: Position actual value (PUU)

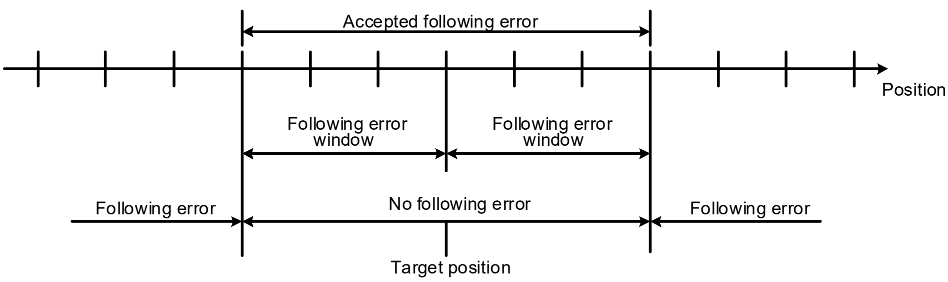
Index	6064h
Name	Position actual value
Object code	VAR
Data type	INTEGER32
Access	RO
PDO mapping	Yes
Setting range	INTEGER32
Default	0
Unit	PUU

Object 6065h: Following error window

Index	6065h
Name	Following error window
Object code	VAR
Data type	UNSIGNED32
Access	RW
PDO mapping	Yes
Setting range	UNSIGNED32
Default	50331648
Unit	PUU

Object function:

When the following error actual value (OD 60F4h) exceeds this setting range, AL009 (Excessive deviation of Position command) is triggered.



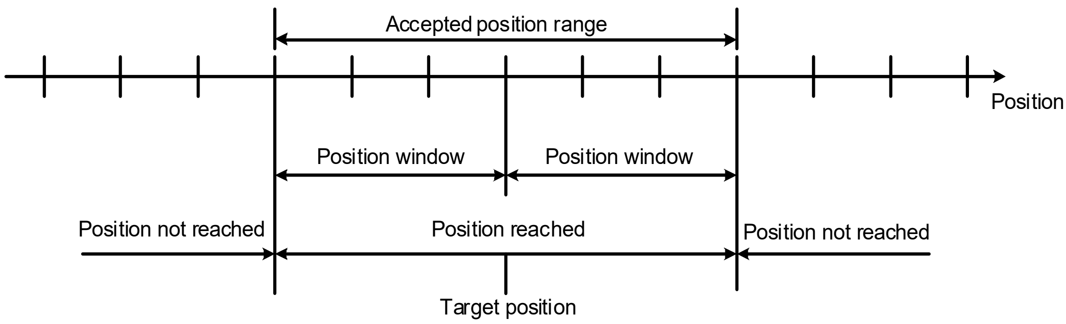
Note: when P3.012.Z is set to 1, the non-volatile setting for this object is enabled.

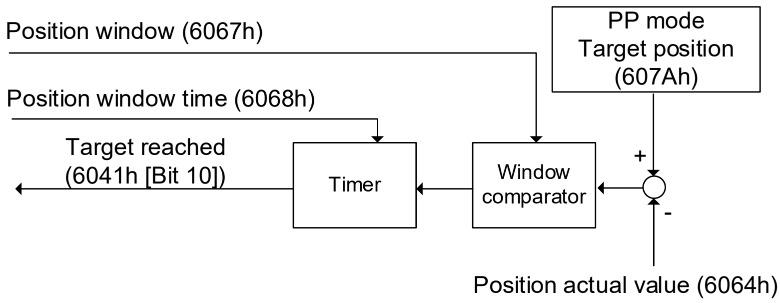
Object 6067h: Position window

Index	6067h
Name	Position window
Object code	VAR
Data type	UNSIGNED32
Access	RW
PDO mapping	Yes
Setting range	UNSIGNED32
Default	100
Unit	PUU

Object function:

When the difference (absolute value) between the target position (PP mode: OD 607Ah) and the position actual value (OD 6064h) is within the range set in OD 6067h (Position window), and the duration of this condition is longer than the time set in OD 6068h (Position window time), OD 6041h [Bit 10] (Target reached) is output.





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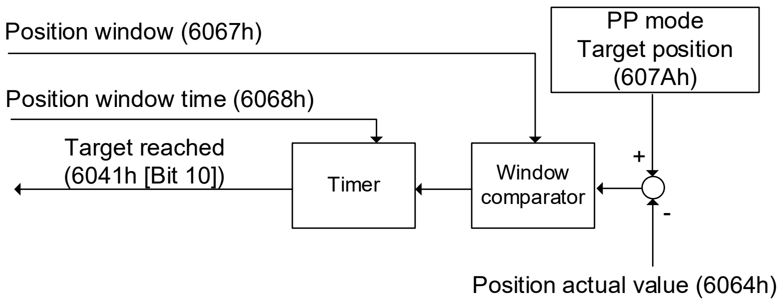
Object 6068h: Position window time

Index	6068h
Name	Position window time
Object code	VAR
Data type	UNSIGNED16
Access	RW
PDO mapping	Yes
Setting range	UNSIGNED16
Default	0
Unit	ms

Object function:

When the difference (absolute value) between the target position (PP mode: OD 607Ah) and the position actual value (OD 6064h) is within the range set in OD 6067h (Position window), and the duration of this condition is longer than the time set in OD 6068h (Position window time), OD 6041h [Bit 10] (Target reached) is output.



Object 606Bh: Velocity demand value

Index	606Bh
Name	Velocity demand value
Object code	VAR
Data type	INTEGER32
Access	RO
PDO mapping	Yes
Setting range	INTEGER32
Unit	0.1 rpm

Object function:

The velocity demand value is a command generated by the speed trajectory generator and filtered by the command filter of the drive. This object only works in Profile Velocity mode and Cyclic Synchronous Velocity mode.

Object 606Ch: Velocity actual value

Index	606Ch
Name	Velocity actual value
Object code	VAR
Data type	INTEGER32
Access	RO
PDO mapping	Yes
Setting range	INTEGER32
Unit	0.1 rpm

Object function:

Returns the motor speed at present for monitoring.

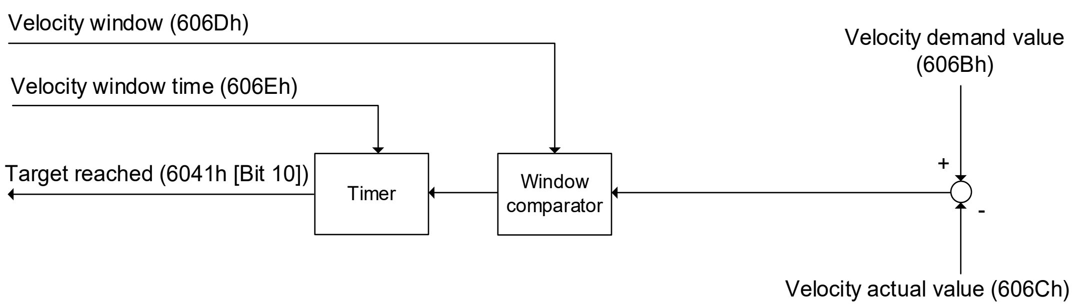
Object 606Dh: Velocity window

Index	606Dh
Name	Velocity window
Object code	VAR
Data type	UNSIGNED16
Access	RW
PDO mapping	Yes
Setting range	0 - 3000
Default	100
Unit	0.1 rpm

Object function:

The window comparator compares the speed difference with the velocity window (OD 606Dh). When the difference (absolute value) is within the range set in the velocity window and the duration of this condition is longer than the time set in the velocity window time (OD 606Eh), OD 6041h [Bit 10] (Target reached) is output. This object only works in Profile Velocity mode.

Note: when P3.012.Z is set to 1, the non-volatile setting for this object is enabled.



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Object 606Eh: Velocity window time

Index	606Eh
Name	Velocity window time
Object code	VAR
Data type	UNSIGNED16
Access	RW
PDO mapping	Yes
Setting range	UNSIGNED16
Default	0
Unit	ms

Object function:

Refer to OD 606Dh for the description of the object.

Note: when P3.012.Z is set to 1, the non-volatile setting for this object is enabled.

Object 606Fh: Velocity threshold

Index	606Fh
Name	Velocity threshold
Object code	VAR
Data type	UNSIGNED16
Access	RW
PDO mapping	Yes
Setting range	0 - 2000
Default	100
Unit	0.1 rpm

Object function:

This object sets the range for the zero-speed signal output. When the forward or reverse speed (absolute value) of the motor is lower than the setting value of OD 606Fh, OD 6041h [Bit 12] (zero-speed signal) outputs 1.

Note: when P3.012.Z is set to 1, the non-volatile setting for this object is enabled.

Object 6071h: Target torque

Index	6071h
Name	Target torque
Object code	VAR
Data type	INTEGER16
Access	RW
PDO mapping	Yes
Setting range	-3500 to +3500
Default	0
Unit	0.1%

Object function:

This object sets the target torque in Profile Torque mode and Cyclic Synchronous Torque mode. If OD 6071h = 1000 (100.0%), it corresponds to the motor rated torque.

Object 6072h: Max torque

Index	6072h
Name	Max torque
Object code	VAR
Data type	UNSIGNED16
Access	RW
PDO mapping	Yes
Setting range	0 - 3500
Default	3500
Unit	0.1%

Object function:

This object sets the maximum torque in Profile Torque mode and Cyclic Synchronous Torque mode.

Object 6074h: Torque demand value

Index	6074h
Name	Torque demand value
Object code	VAR
Data type	INTEGER16
Access	RO
PDO mapping	Yes
Setting range	INTEGER16
Default	0
Unit	0.1%

Object function:

The torque demand value is the command generated by the speed trajectory generator and filtered by the command filter of the drive. This object only works in Profile Torque mode and Cyclic Synchronous Torque mode.

Object 6075h: Motor rated current

Index	6075h
Name	Motor rated current
Object code	VAR
Data type	UNSIGNED32
Access	RO
PDO mapping	Yes
Setting range	UNSIGNED32
Default	0
Unit	mA

Object function:

This object displays the rated current specified on the motor nameplate.

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Object 6076h: Motor rated torque

Index	6076h
Name	Motor rated torque
Object code	VAR
Data type	UNSIGNED32
Access	RO
PDO mapping	Yes
Setting range	UNSIGNED32
Default	0
Unit	0.001 N-m

Object function:

This object displays the rated torque specified on the motor nameplate.

Object 6077h: Torque actual value

Index	6077h
Name	Torque actual value
Object code	VAR
Data type	INTEGER16
Access	RO
PDO mapping	Yes
Setting range	INTEGER16
Default	0
Unit	0.1%

Object function:

This object is the motor torque feedback in percentage at present.

Object 6078h: Current actual value

Index	6078h
Name	Current actual value
Object code	VAR
Data type	INTEGER16
Access	RO
PDO mapping	Yes
Setting range	INTEGER16
Default	0
Unit	0.1%

Object function:

This object is the motor current feedback in percentage at present.

Object 607Ah: Target position

Index	607Ah
Name	Target position
Object code	VAR
Data type	INTEGER32
Access	RW
PDO mapping	Yes
Setting range	INTEGER32
Default	0
Unit	PUU

Object function:

This object only works in Profile Position mode and Cyclic Synchronous Position mode. For more details, refer to Sections 12.3.1 and 12.3.5.

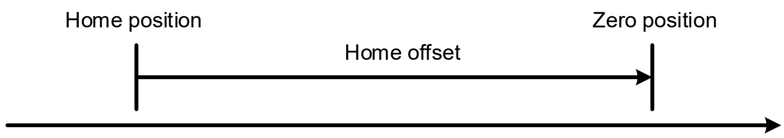
Object 607Ch: Home offset

Index	607Ch
Name	Home offset
Object code	VAR
Data type	INTEGER32
Access	RW
PDO mapping	Yes
Setting range	INTEGER32
Default	0
Unit	PUU

Object function:

The origin reference point which the system looks for during the homing procedure is Home position, 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 (Zero position), and the offset value is Home offset.

Note: when P3.012.Z is set to 1, the non-volatile setting for this object is enabled.



Object 607Dh: Software position limit

Index	607Dh
Name	Software position limit
Object code	ARRAY
Data type	INTEGER32
Access	RW

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Sub-index	0h
Description	Number of entries
Data type	UNSIGNED8
Access	RO
PDO mapping	Yes
Setting range	2
Default	2

Sub-index	1h
Description	Min position limit
Data type	INTEGER32
Access	RW
PDO mapping	Yes
Setting range	-2147483648 to +2147483647
Default	-2147483648
Unit	PUU

Sub-index	2h
Description	Max position limit
Data type	INTEGER32
Access	RW
PDO mapping	Yes
Setting range	-2147483648 to +2147483647
Default	+2147483647
Unit	PUU

Note: when P3.012.Z is set to 1, the non-volatile setting for this object is enabled.

Object 607Fh: Max profile velocity

Index	607Fh
Name	Max profile velocity
Object code	VAR
Data type	UNSIGNED32
Access	RW
PDO mapping	Yes
Setting range	UNSIGNED32
Default	Varies depending on the motor model
Corresponding servo parameter	P1.055 (rpm) / 10
Unit	0.1 rpm

Object function:

The unit of this object is 0.1 rpm, so dividing this object by 10 is equivalent to P1.055 (Maximum speed limit in units of 1 rpm).

Note: when P3.012.Z is set to 1, the non-volatile setting for this object is enabled.

Object 6080h: Max motor speed

Index	6080h
Name	Max motor speed
Object code	VAR
Data type	UNSIGNED32
Access	RW
PDO mapping	Yes
Setting range	UNSIGNED32
Default	Varies depending on the motor model
Corresponding servo parameter	P1.055
Unit	rpm

Object function:

OD 6080h is equivalent to P1.055 (Maximum speed limit).

Note: when P3.012.Z is set to 1, the non-volatile setting for this object is enabled.

Object 6081h: Profile velocity

Index	6081h
Name	Profile velocity
Object code	VAR
Data type	UNSIGNED32
Access	RW
PDO mapping	Yes
Setting range	UNSIGNED32
Default	10000
Unit	PUU/s

Object function:

This object only works in Profile Position mode. For more details, refer to Section 12.3.1.

Object 6083h: Profile acceleration

Index	6083h
Name	Profile acceleration
Object code	VAR
Data type	UNSIGNED32
Access	RW
PDO mapping	Yes
Setting range	1 - 65500
Default	200
Unit	ms

Object function:

The time slope set by this object is the time required for the motor to accelerate from 0 rpm to 3,000 rpm. This object only works in Profile Position mode and Profile Velocity mode.

Object 6084h: Profile deceleration

Index	6084h
Name	Profile deceleration
Object code	VAR
Data type	UNSIGNED32
Access	RW
PDO mapping	Yes
Setting range	1 - 65500
Default	200
Unit	ms

Object function:

The time slope set by this object is the time required for the motor to decelerate from 3,000 rpm to 0 rpm. This object only works in Profile Position mode and Profile Velocity mode.

Object 6085h: Quick stop deceleration

Index	6085h
Name	Quick stop deceleration
Object code	VAR
Data type	UNSIGNED32
Access	RW
PDO mapping	Yes
Setting range	1 - 65500
Default	200
Unit	ms

Object function:

The time slope set by this object is the time required for the motor to decelerate from 3,000 rpm to 0 rpm using the quick stop function.

Object 6086h: Motion profile type

Index	6086h
Name	Motion profile type
Object code	VAR
Data type	INTEGER16
Access	RO
PDO mapping	Yes
Setting range	0
Default	0

Object function:

This object sets the type of motion profile for operation. Currently, only linear ramp (trapezoidal profile) is available.

Setting value	Mode
0	Linear ramp (trapezoidal profile)

Object 6087h: Torque slope

Index	6087h
Name	Torque slope
Object code	VAR
Data type	UNSIGNED32
Access	RW
PDO mapping	Yes
Setting range	0 - 65500
Default	200
Unit	ms

Object function:

The time slope set by this object is the time required for the motor to change from 0% to 100% of the rated torque.

Note: when P3.012.Z is set to 1, the non-volatile setting for this object is enabled.

Object 6093h: Position factor

Index	6093h
Name	Position factor
Object code	ARRAY
Data type	UNSIGNED32
Access	RW
PDO mapping	Yes
Corresponding servo parameter	P1.044 and P1.045
Note	Position factor = Numerator / Feed_constant

Sub-index	0h
Description	Number of sub-index
Data type	UNSIGNED8
Access	RO
PDO mapping	No
Setting range	2
Default	2

Sub-index	1h
Description	E-Gear ratio numerator
Data type	UNSIGNED32
Access	RW
PDO mapping	Yes
Default	1
Corresponding servo parameter	P1.044
Note	For the E-Gear ratio setting, refer to Section 6.2.5.

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Sub-index	2h
Description	E-Gear ratio denominator
Data type	UNSIGNED32
Access	RW
PDO mapping	Yes
Default	1
Corresponding servo parameter	P1.045
Note	For the E-Gear ratio setting, refer to Section 6.2.5.

Note: when P3.012.Z is set to 1, the non-volatile setting for this object is enabled.

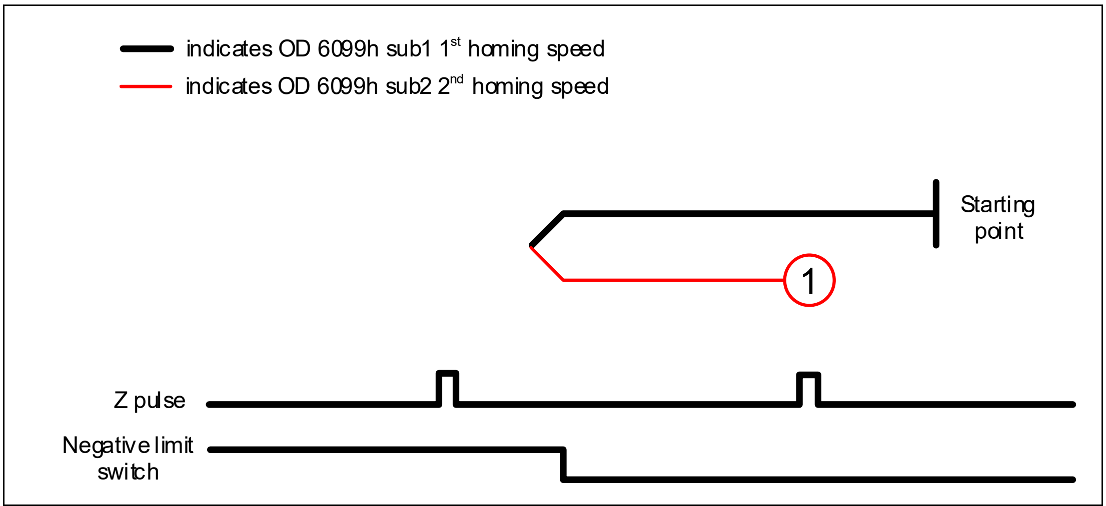
Object 6098h: Homing method

Index	6098h
Name	Homing method
Object code	VAR
Data type	INTEGER8
Access	RW
PDO mapping	Yes
Setting range	-4 to 35
Default	0

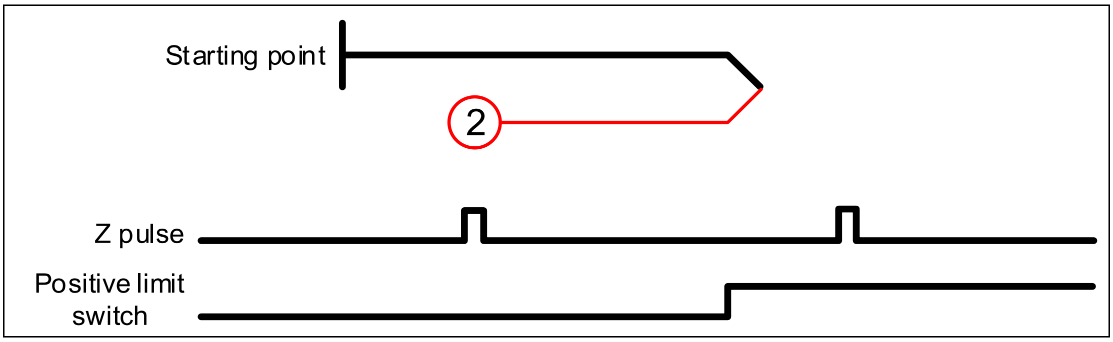
Object function:

The homing methods include looking for the Z pulse (Methods 1 - 14, 33, 34, 36, 37), not looking for the Z pulse (Methods 17 - 30), defining the current position as the origin (Method 35), and looking for the hard stop (Methods 36 - 39). Methods 15, 16, 31, and 32 are reserved. To use Methods 1 to 35, set OD 6098h to 1 to 35. To use Methods 36 to 39, set OD 6098h to -1 to -4.

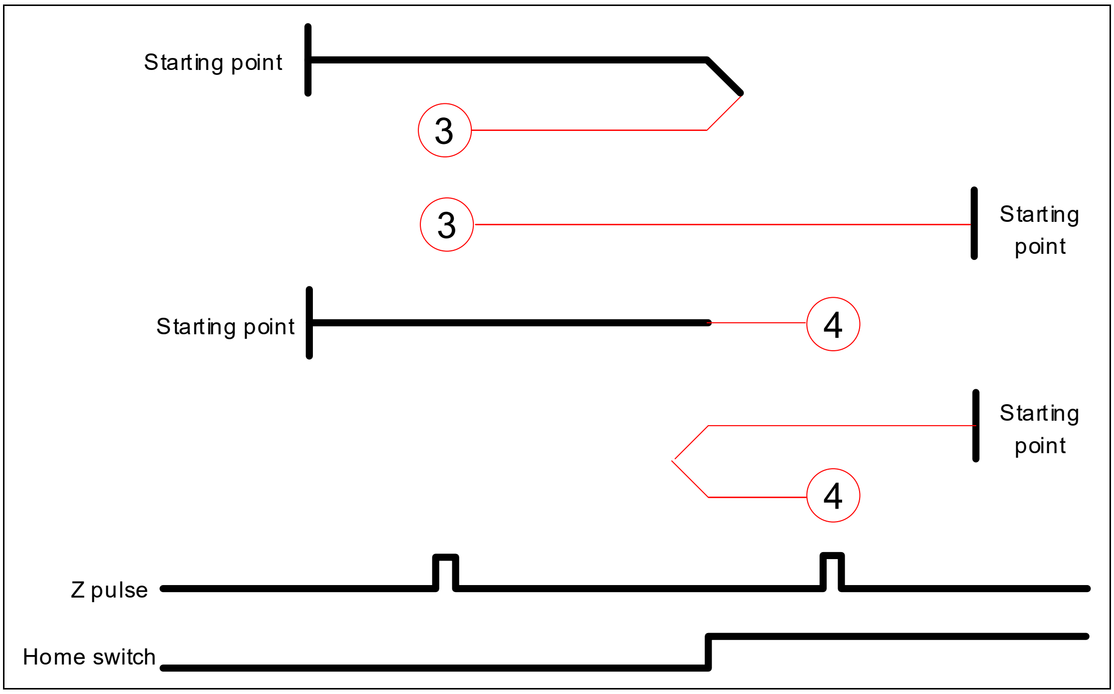
Method 1: homing on the negative limit switch and Z pulse



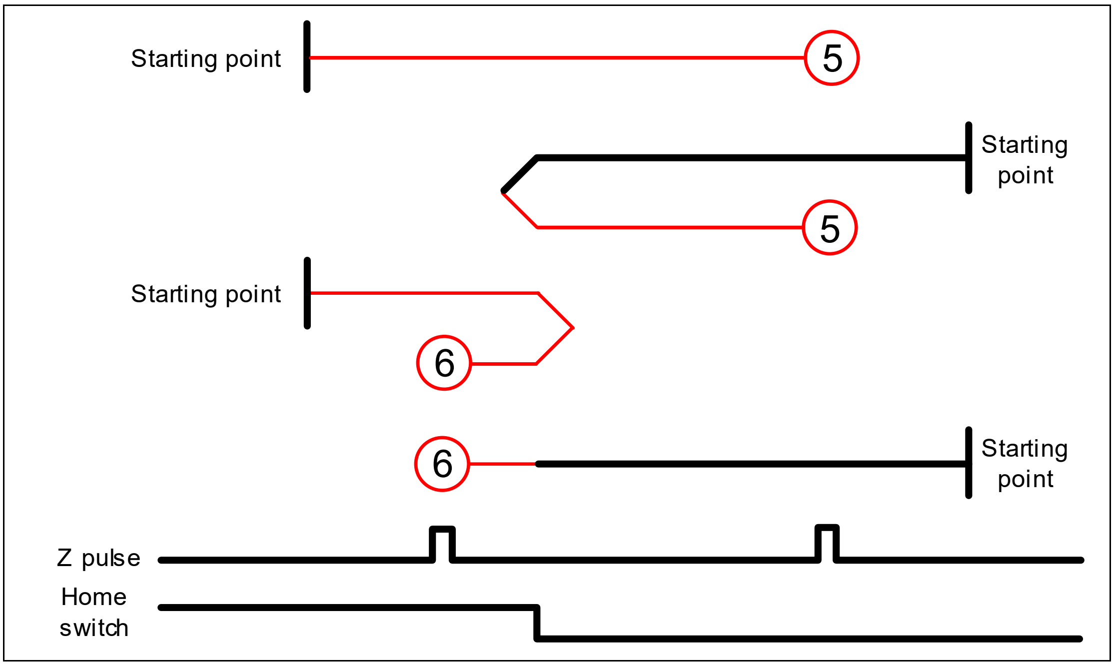
Method 2: homing on the positive limit switch and Z pulse



Methods 3 and 4: homing on the home switch and Z pulse



Methods 5 and 6: homing on the home switch and Z pulse



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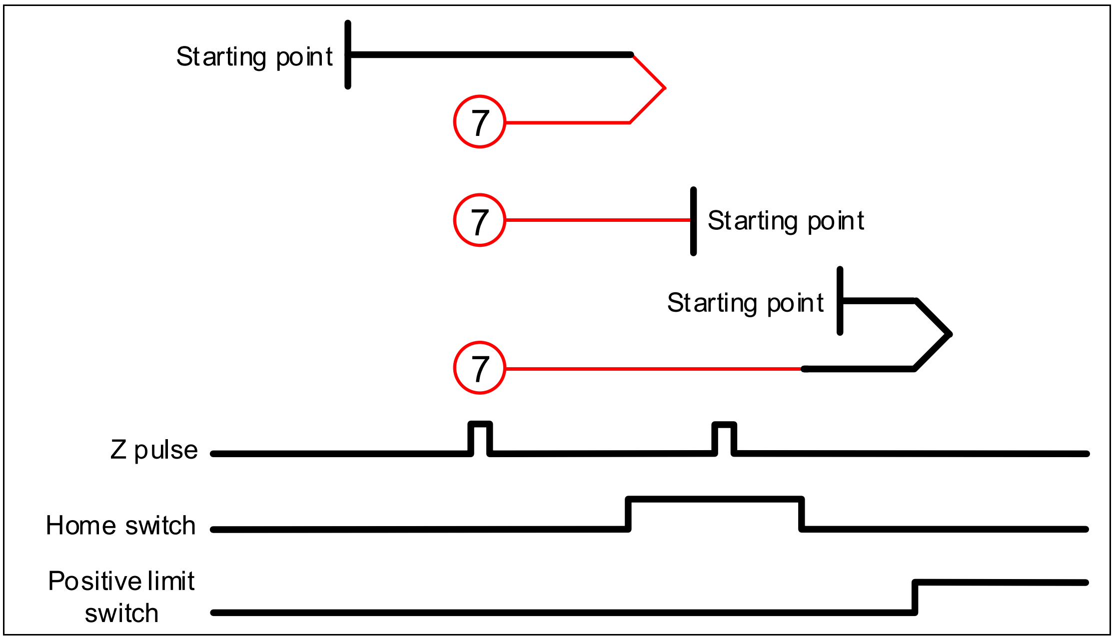
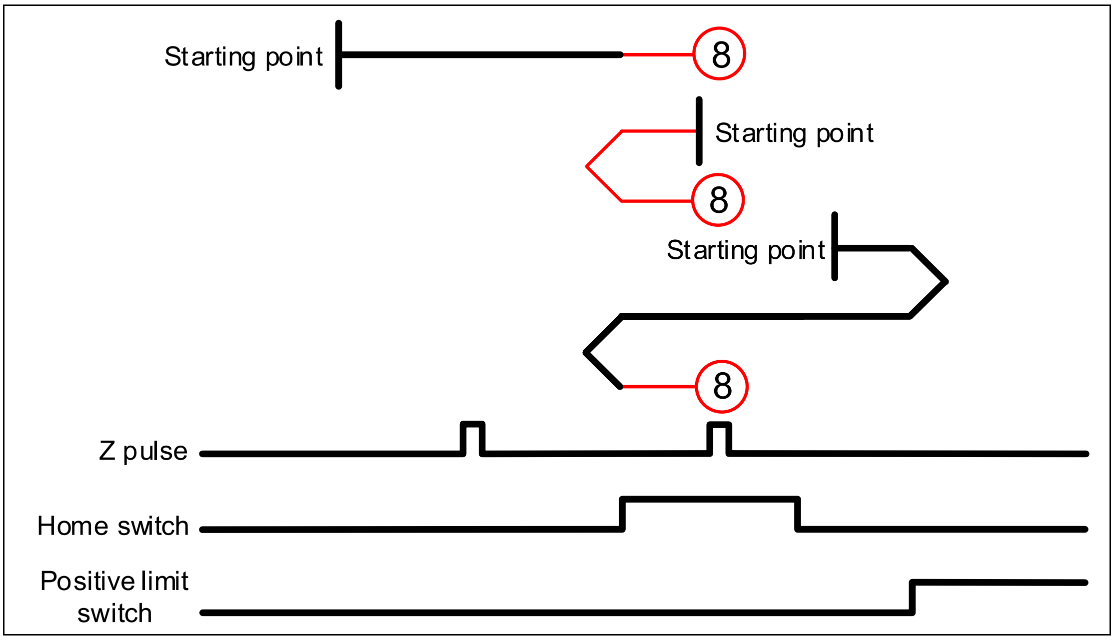
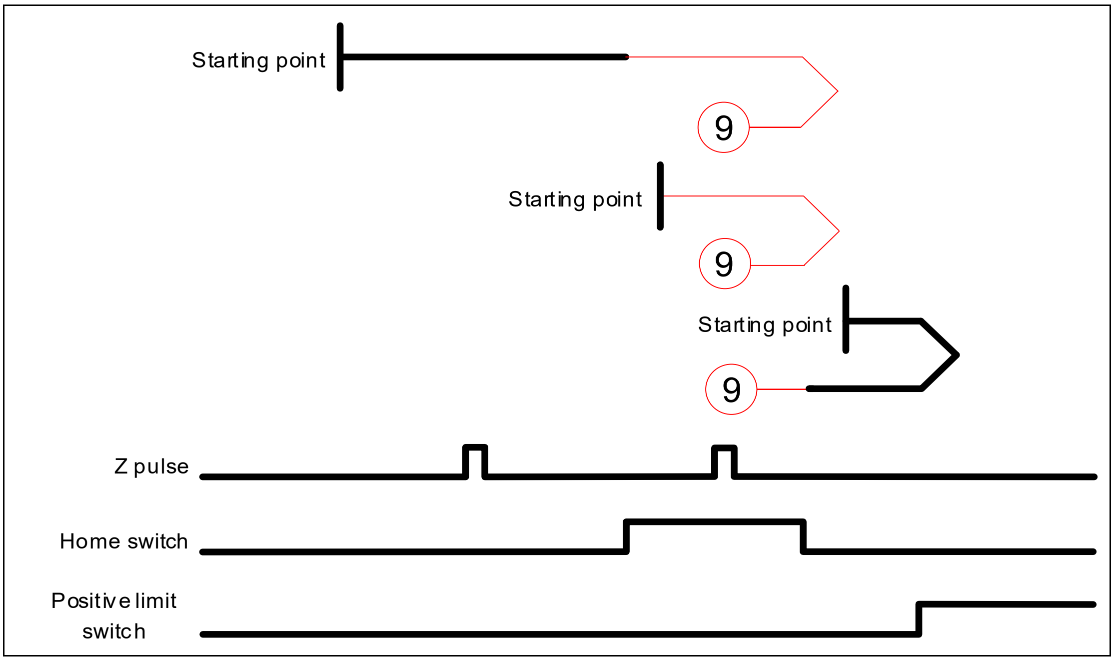
Method 7: homing on the positive limit switch, home switch, and Z pulse



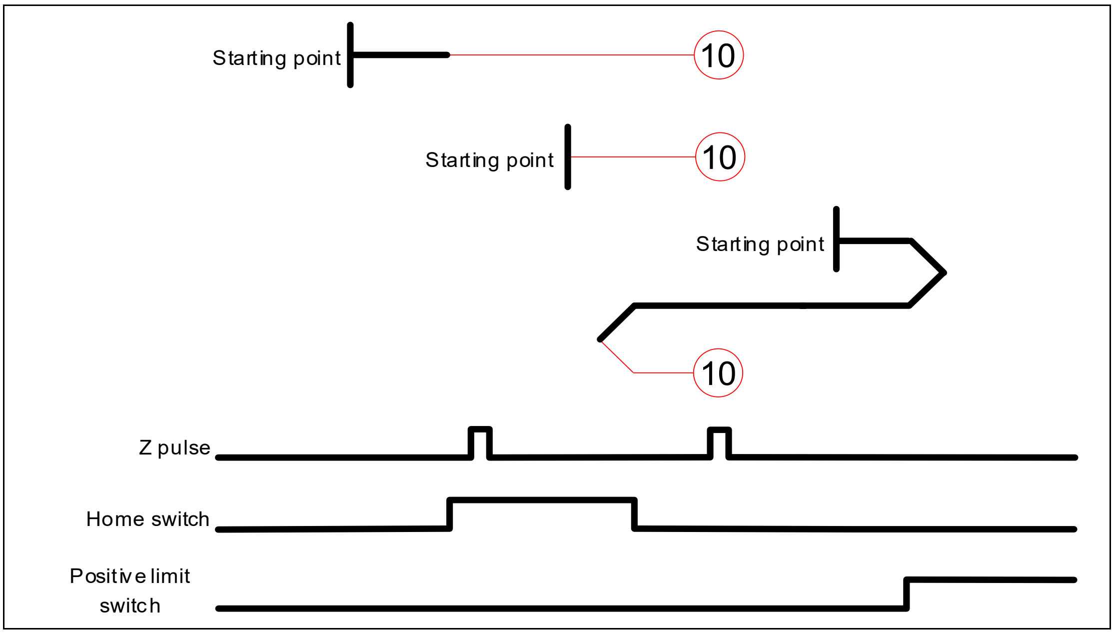
Method 8: homing on the positive limit switch, home switch, and Z pulse



Method 9: homing on the positive limit switch, home switch, and Z pulse



Method 10: homing on the positive limit switch, home switch, and Z pulse



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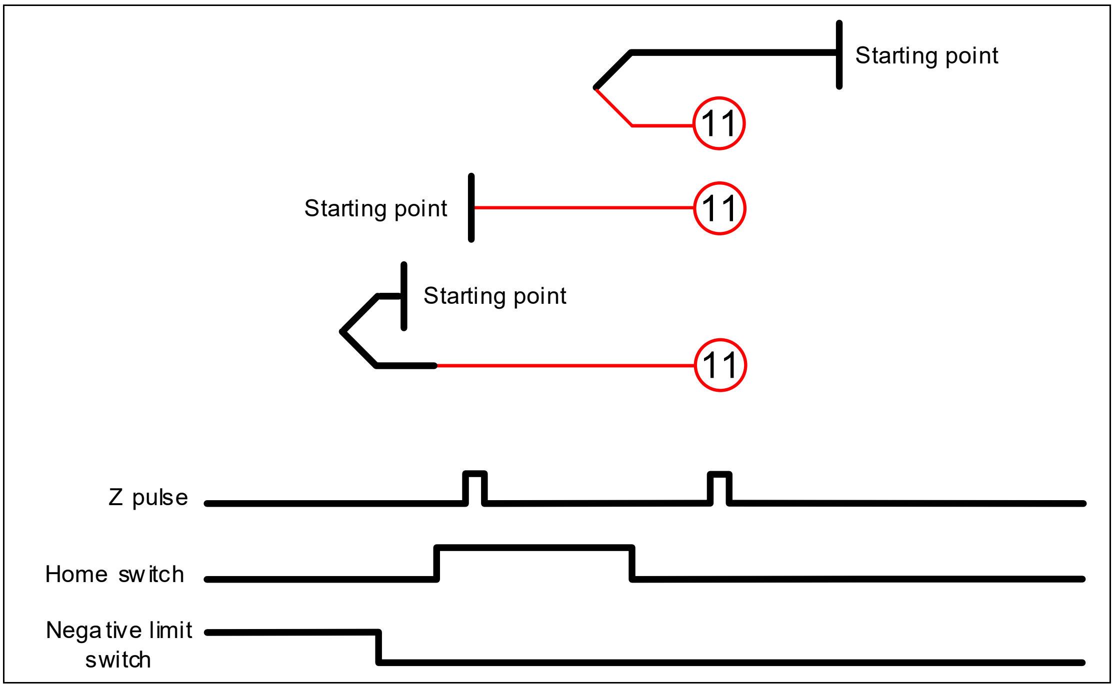
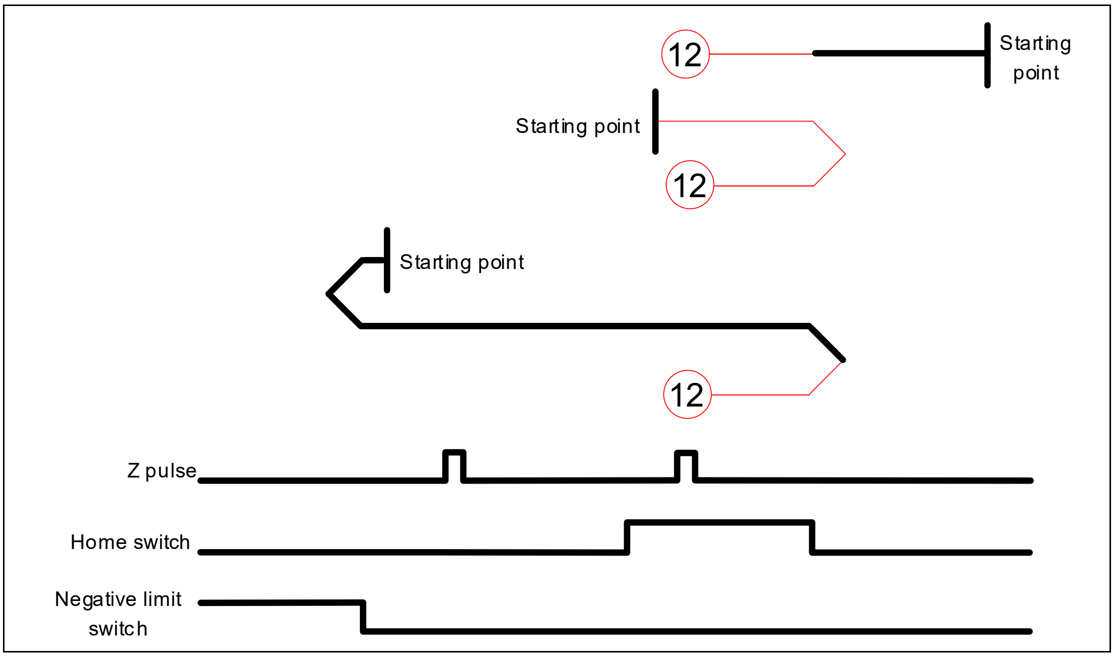
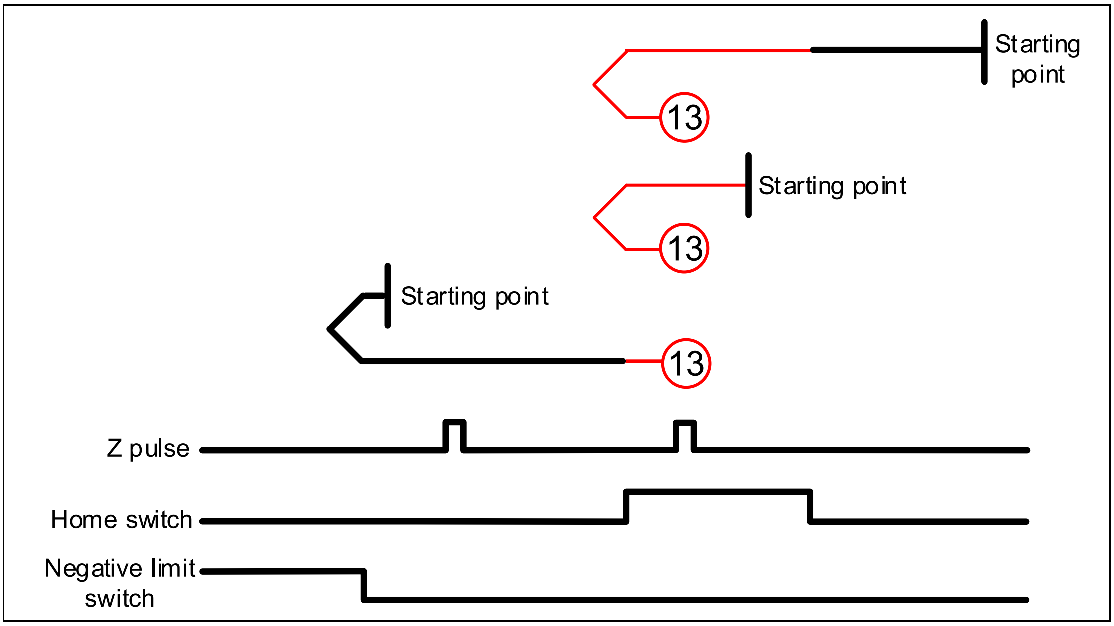
Method 11: homing on the negative limit switch, home switch, and Z pulse



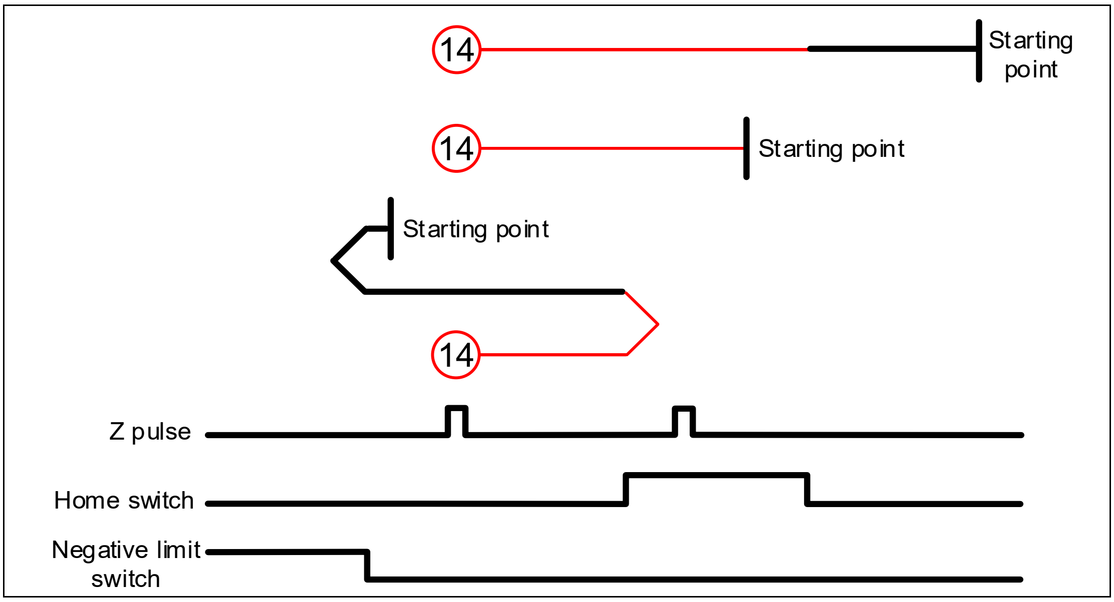
Method 12: homing on the negative limit switch, home switch, and Z pulse



Method 13: homing on the negative limit switch, home switch, and Z pulse



Method 14: homing on the negative limit switch, home switch, and Z pulse



Methods 15 and 16: reserved

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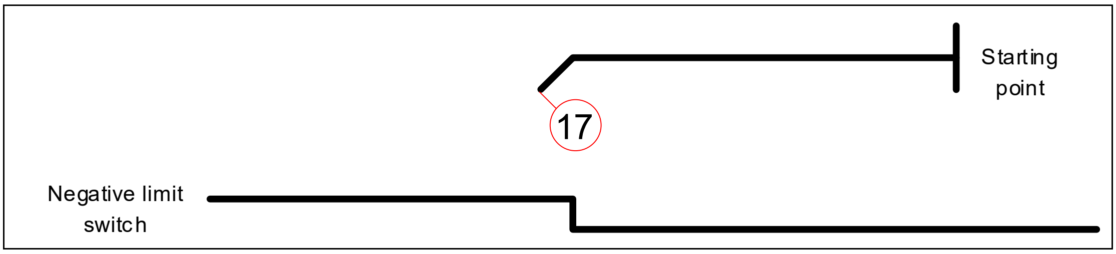
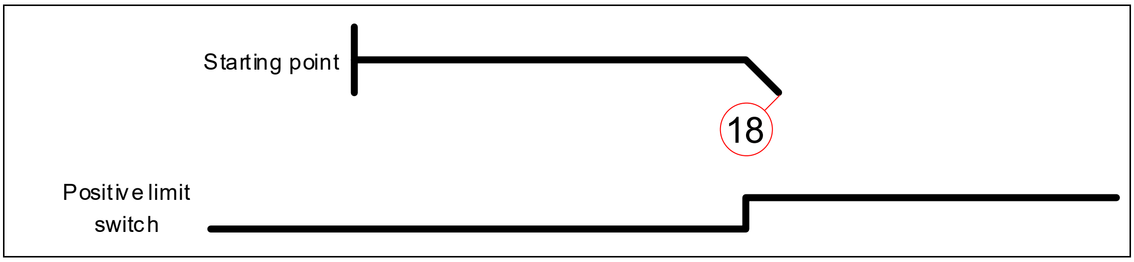
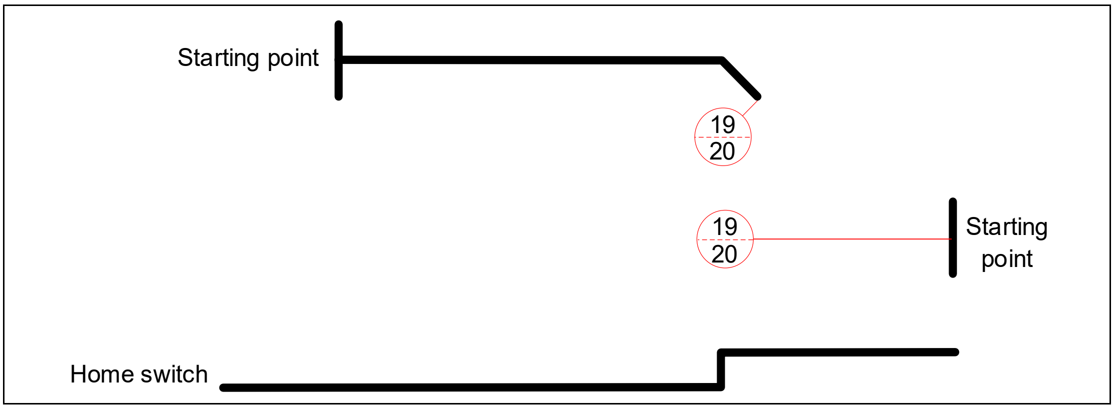
Method 17: homing on the negative limit switch



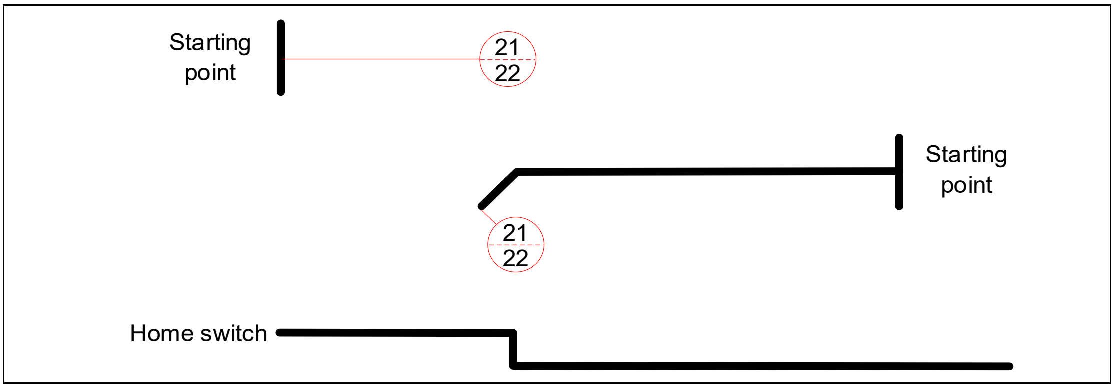
Method 18: homing on the positive limit switch



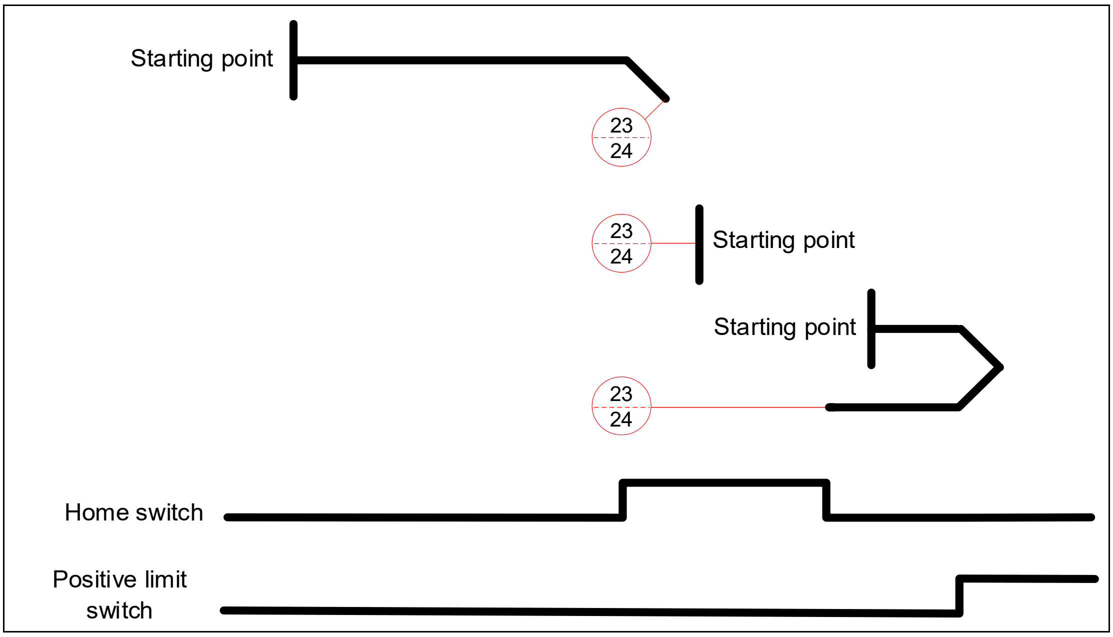
Methods 19 and 20: homing on the home switch



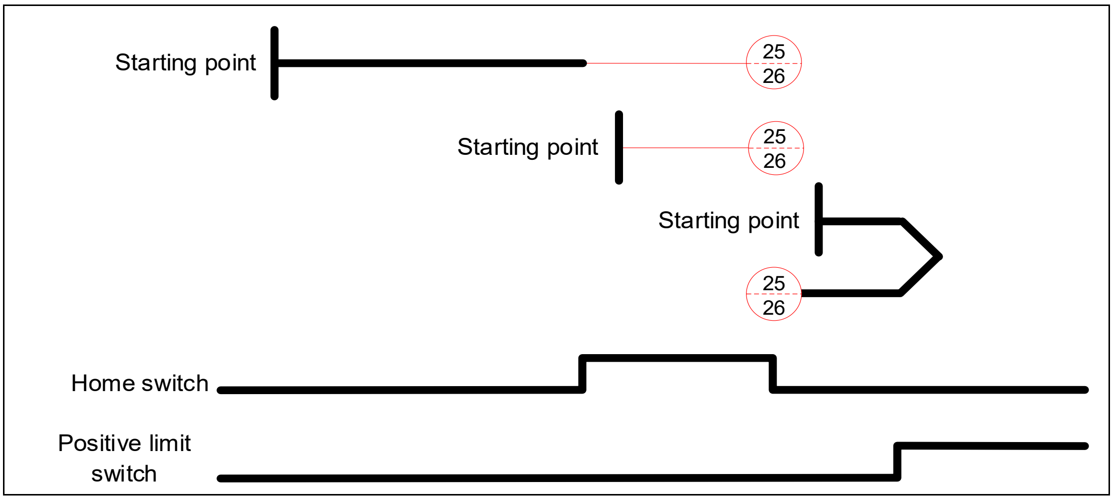
Methods 21 and 22: homing on the home switch



Methods 23 and 24: homing on the positive limit switch and home switch



Methods 25 and 26: homing on the positive limit switch and home switch



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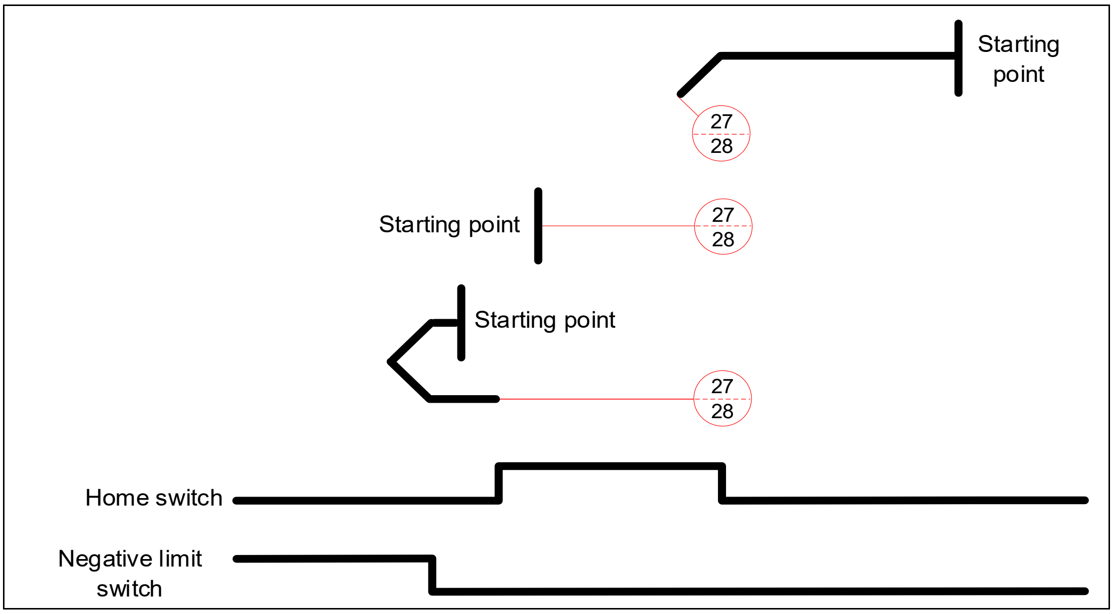
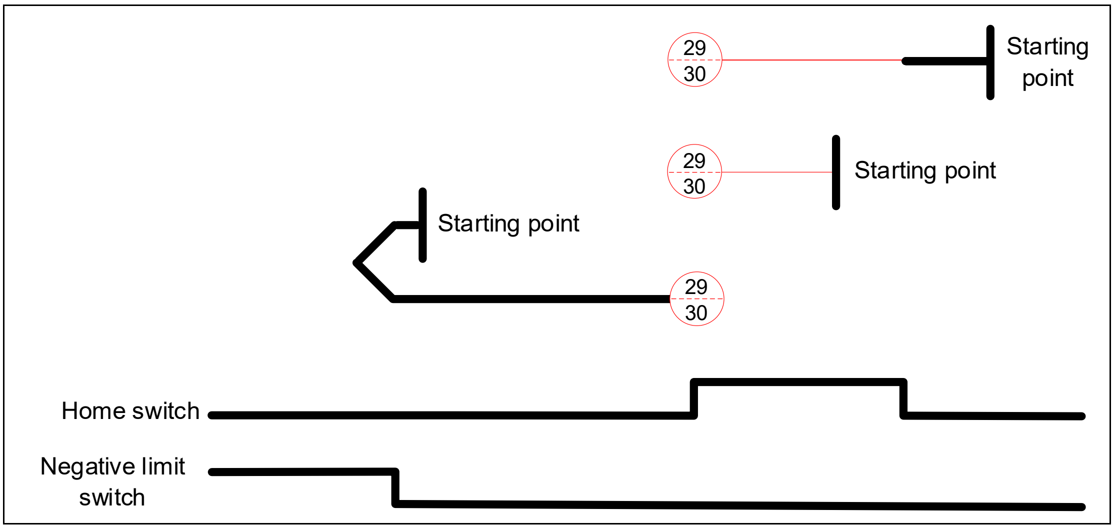
Methods 27 and 28: homing on the negative limit switch and home switch

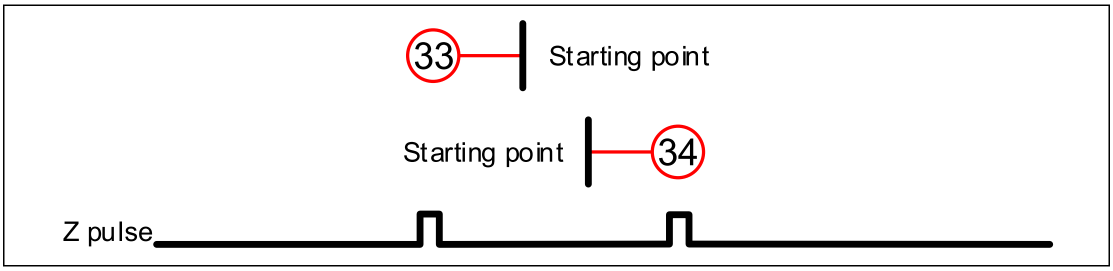


Methods 29 and 30: homing on the negative limit switch and home switch



Methods 31 and 32: reserved

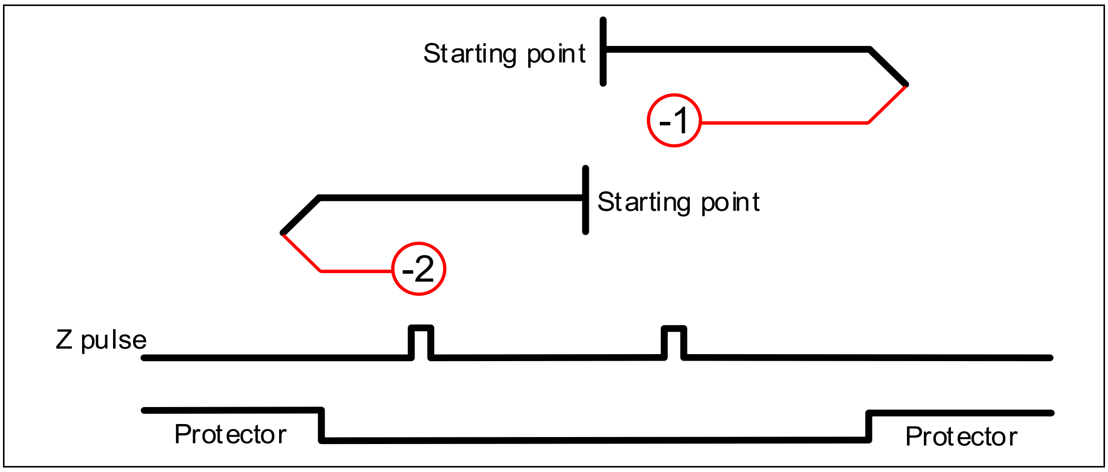
Methods 33 and 34: homing on the Z pulse



Method 35: defines the current feedback position as the origin

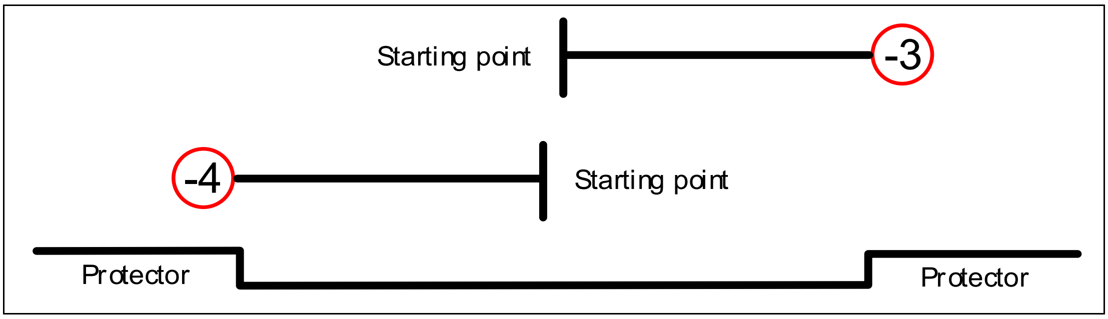
Methods 36 and 37:

When OD 6098h is set to -1 or -2: homing on the hard stop and Z pulse. Set the servo parameters P1.087 (torque level detection) and P1.088 (level reached timer) when using these homing methods.



Methods 38 and 39:

When OD 6098h is set to -3 or -4: homing on the hard stop. Set the servo parameters P1.087 (torque level detection) and P1.088 (level reached timer) when using these homing methods.



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Object 6099h: Homing speeds

Index	6099h
Name	Homing speeds
Object code	ARRAY
Data type	UNSIGNED32
Access	RW
PDO mapping	Yes

Sub-index	0h
Description	Number of sub-index
Data type	UNSIGNED8
Access	RO
PDO mapping	Yes
Setting range	2
Default	2

Sub-index	1h
Description	Speed during search for switch
Data type	UNSIGNED32
Access	RW
PDO mapping	Yes
Setting range	1 - 20000
Default	100
Unit	0.1 rpm

Sub-index	2h
Description	Speed during search for zero
Data type	UNSIGNED32
Access	RW
PDO mapping	Yes
Setting range	1 - 5000
Default	20
Unit	0.1 rpm

Object 609Ah: Homing acceleration

Index	609Ah
Name	Homing acceleration
Object code	VAR
Data type	UNSIGNED32
Access	RW
PDO mapping	Yes
Setting range	UNSIGNED32
Default	100
Unit	ms

Object function:

The time slope set by this object is the time required for the motor to accelerate from 0 rpm to 3,000 rpm and decelerate from 3,000 rpm to 0 rpm. This object only works in Homing mode.

Object 60B0h: Position offset

Index	60B0h
Name	Position offset
Object code	VAR
Data type	INTEGER32
Access	RW
PDO mapping	Yes
Setting range	INTEGER32
Default	0
Unit	PUU

Object function:

This object sets the position offset. For more details, refer to Section 12.3.5 Cyclic Synchronous Position mode.

Object 60B1h: Velocity offset

Index	60B1h
Name	Velocity offset
Object code	VAR
Data type	INTEGER32
Access	RW
PDO mapping	Yes
Setting range	INTEGER32
Default	0
Unit	0.1 rpm

Object function:

This object sets the velocity offset. For more details, refer to Section 12.3.6 Cyclic Synchronous Velocity mode.

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Object 60B2h: Torque offset

Index	60B2h
Name	Torque offset
Object code	VAR
Data type	INTEGER16
Access	RW
PDO mapping	Yes
Setting range	-3500 to +3500
Default	0
Unit	0.1%

Object function:

This object sets the torque offset. For more details, refer to Section 12.3.7 Cyclic Synchronous Torque mode.

Object 60B8h: Touch probe function

Index	60B8h
Name	Touch probe function
Object code	VAR
Data type	UNSIGNED16
Access	RW
PDO mapping	Yes
Setting range	UNSIGNED16
Default	0

Object function:

This object sets the Touch Probe related function settings. For the operation details, refer to Section 12.3.8 for the description of Touch Probe.

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

Bit	Function	Description
Bit 0	Touch Probe 1 switch	0: disable Touch Probe 1. 1: enable Touch Probe 1.
Bit 1	Touch Probe 1 number of capturing times	0: capture one time. If the Touch Probe 1 signal is set to be both rising-edge and falling-edge triggered, the data is captured once for each triggering. 1: capture multiple times.
Bit 2	Touch Probe 1 capture source	0: DI1 of CN1 1: motor Z pulse
Bit 3	Reserved	-
Bit 4	Rising-edge trigger action of Touch Probe 1	0: N/A 1: start capturing when the Touch Probe 1 signal is rising-edge triggered and store the data in OD 60BAh.
Bit 5	Falling-edge trigger action of Touch Probe 1	0: N/A 1: start capturing when the Touch Probe 1 signal is falling-edge triggered and store the data in OD 60BBh.

Bit	Function	Description
Bit 6 - Bit 7	Reserved	-
Bit 8	Touch Probe 2 switch	0: disable Touch Probe 2. 1: enable Touch Probe 2.
Bit 9	Touch Probe 2 number of capturing times	0: capture one time. If the Touch Probe 2 signal is set to be both rising-edge and falling-edge triggered, the data is captured once for each triggering. 1: capture multiple times.
Bit 10	Touch Probe 2 capture source	0: DI2 of CN1
Bit 11	Reserved	-
Bit 12	Rising-edge trigger action of Touch Probe 2	0: N/A 1: start capturing when the Touch Probe 2 signal is rising-edge triggered and store the data in OD 60BCh.
Bit 13	Falling-edge trigger action of Touch Probe 2	0: N/A 1: start capturing when the Touch Probe 2 signal is falling-edge triggered and store the data in OD 60BDh.
Bit 14 - Bit 15	Reserved	-

Object 60B9h: Touch probe status

Index	60B9h
Name	Touch probe status
Object code	VAR
Data type	UNSIGNED16
Access	RO
PDO mapping	Yes
Setting range	UNSIGNED16
Default	0

Object function:

You can access the Touch Probe status with this object. For the operation details, refer to Section 12.3.8 for the description of Touch Probe.

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

Bit	Function	Description
Bit 0	Touch Probe 1 function status	0: Touch Probe 1 disabled. 1: Touch Probe 1 enabled.
Bit 1	Touch Probe 1 rising-edge capture	0: capturing is not triggered. 1: the Touch Probe 1 signal is rising-edge triggered and the data is successfully captured.
Bit 2	Touch Probe 1 falling-edge capture	0: capturing is not triggered. 1: the Touch Probe 1 signal is falling-edge triggered and the data is successfully captured.
Bit 3 - Bit 5	Reserved	-
Bit 6	Touch Probe 1 capture source	0: DI1 of CN1 1: motor Z pulse

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Bit	Function	Description
Bit 7	Touch Probe 1 signal for capturing multiple times (Available when the function of OD 60B8h [Bit 1] Number of capturing times is enabled)	The status is reversed once the capturing succeeds. Refer to Section 12.3.8 for the timing diagram in Example 3.
Bit 8	Touch Probe 2 function status	0: Touch Probe 2 disabled. 1: Touch Probe 2 enabled.
Bit 9	Touch Probe 2 rising-edge capture	0: capturing is not triggered. 1: the Touch Probe 2 signal is rising-edge triggered and the data is successfully captured.
Bit 10	Touch Probe 2 falling-edge capture	0: capturing is not triggered. 1: the Touch Probe 2 signal is falling-edge triggered and the data is successfully captured.
Bit 11 - Bit 13	Reserved	-
Bit 14	Touch Probe 2 capture source	0: DI2 of CN1
Bit 15	Touch Probe 2 signal for capturing multiple times (Available when the function of OD 60B8h [Bit 9] Number of capturing times is enabled)	The status is reversed once the capturing succeeds.

Object 60BAh: Touch probe pos1 pos value

Index	60BAh
Name	Touch probe pos1 pos value
Object code	VAR
Data type	INTEGER32
Access	RO
PDO mapping	Yes
Setting range	INTEGER32
Default	0

Object function:

For the function of this object, refer to Section 12.3.8 for the description of Touch Probe.

Object 60BBh: Touch probe pos1 neg value

Index	60BBh
Name	Touch probe pos1 neg value
Object code	VAR
Data type	INTEGER32
Access	RO
PDO mapping	Yes
Setting range	INTEGER32
Default	0

Object function:

For the function of this object, refer to Section 12.3.8 for the description of Touch Probe.

Object 60BCh: Touch probe pos2 pos value

Index	60BCh
Name	Touch probe pos2 pos value
Object code	VAR
Data type	INTEGER32
Access	RO
PDO mapping	Yes
Setting range	INTEGER32
Default	0

Object function:

For the function of this object, refer to Section 12.3.8 for the description of Touch Probe.

Object 60BDh: Touch probe pos2 neg value

Index	60BDh
Name	Touch probe pos2 neg value
Object code	VAR
Data type	INTEGER32
Access	RO
PDO mapping	Yes
Setting range	INTEGER32
Default	0

Object function:

For the function of this object, refer to Section 12.3.8 for the description of Touch Probe.

Object 60C5h: Max acceleration

Index	60C5h
Name	Max acceleration
Object code	VAR
Data type	UNSIGNED32
Access	RW
PDO mapping	Yes
Setting range	1 - 65500
Default	1
Unit	ms

Object function:

The time slope set by this object is the time required for the motor to accelerate from 0 rpm to 3,000 rpm.

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Object 60C6h: Max deceleration

Index	60C6h
Name	Max deceleration
Object code	VAR
Data type	UNSIGNED32
Access	RW
PDO mapping	Yes
Setting range	1 - 65500
Default	1
Unit	ms

Object function:

The time slope set by this object is the time required for the motor to decelerate from 3,000 rpm to 0 rpm.

Object 60E0h: Positive torque limit

Index	60E0h
Name	Positive torque limit
Object code	VAR
Data type	UNSIGNED16
Access	RW
PDO mapping	Yes
Setting range	0 - 3000
Default	3000
Unit	0.1%

Object function:

This object sets the positive torque limit.

Object 60E1h: Negative torque limit

Index	60E1h
Name	Negative torque limit
Object code	VAR
Data type	UNSIGNED16
Access	RW
PDO mapping	Yes
Setting range	0 - 3000
Default	3000
Unit	0.1%

Object function:

This object sets the negative torque limit.

Object 60F4h: Following error actual value

Index	60F4h
Name	Following error actual value
Object code	VAR
Data type	INTEGER32
Access	RO
PDO mapping	Yes
Setting range	INTEGER32
Default	0
Unit	PUU

Object function:

The following error actual value is the difference between the position demand value (OD 6062h) and position actual value (OD 6064h). For more details, refer to the architecture diagrams in Section 12.3.

Object 60FCh: Position demand value

Index	60FCh
Name	Position demand value
Object code	VAR
Data type	INTEGER32
Access	RO
PDO mapping	Yes
Setting range	INTEGER32
Default	0
Unit	pulse

Object function:

This command is generated after being processed by the servo drive filter. For more details, refer to the architecture diagrams in Section 12.3.

Object 60FDh: Digital inputs

Index	60FDh
Name	Digital inputs
Object code	VAR
Data type	UNSIGNED32
Access	RO
PDO mapping	Yes
Setting range	UNSIGNED32
Default	0
Unit	-

Object function:

31 16	15 3	2	1	0
Manufacturer-specific	Reserved	Home switch	Positive limit switch	Negative limit switch
MSB				LSB

Bit	Function
Bit 0	Negative limit signal
Bit 1	Positive limit signal
Bit 2	Homing signal
Bit 3 - Bit 15	Reserved
Bit 16	DI1
Bit 17	DI2
Bit 18	DI3
Bit 19	DI4
Bit 20 - Bit 31	Reserved

Object 60FEh: Digital outputs

Index	60FEh
Name	Digital outputs
Object code	ARRAY
Data type	UNSIGNED32
Access	RW

Sub-Index	0h
Description	Number of sub-index
Data type	UNSIGNED8
Access	RO
PDO mapping	Yes
Setting range	2
Default	2

Sub-Index	1h
Description	Physical outputs
Data type	UNSIGNED32
Access	RW
PDO mapping	Yes
Setting range	0x00000000 to 0xFFFFFFFF
Default	0

Sub-Index	2h
Description	Bit mask
Data type	UNSIGNED32
Access	RW
PDO mapping	Yes
Setting range	0x00000000 to 0xFFFFFFFF
Default	0

Object function:

OD 60FEh sub1 (Physical outputs)

Bit	DO	Description
0 - 15	-	Reserved
16	DO1	0: off; 1: on
17	DO2	0: off; 1: on
18	DO3	0: off; 1: on
19	DO4	0: off; 1: on
20 - 31	-	Reserved

OD 60FEh sub2 (Bit mask)

Bit	DO	Description
0 - 15	-	Reserved
16	DO1	0: disable physical outputs; 1: enable
17	DO2	0: disable physical outputs; 1: enable
18	DO3	0: disable physical outputs; 1: enable
19	DO4	0: disable physical outputs; 1: enable
20 - 31	-	Reserved

- To use the software to control the DO output, you must first set the corresponding DO function code.
  When P2.018 = 0x0130, the output of DO1 is controlled by the software.
  When P2.019 = 0x0131, the output of DO2 is controlled by the software.
  When P2.020 = 0x0132, the output of DO3 is controlled by the software.
  When P2.021 = 0x0133, the output of DO4 is controlled by the software.

- DO output settings
  When the corresponding OD 60FEh sub2 bit of the DO is set to 1, the output status of this DO is determined by the corresponding bit of OD 60FEh sub1.
  When the corresponding OD 60FEh sub2 bit of the DO is set to 0, the output status of this DO is determined by P4.006.

- Example
  1. Set P2.018 to 0x0130, which means the output of DO1 is controlled by the software.
  2. When OD 60FEh sub2 [Bit 16] is 1, the output of DO1 is determined by 0x60FE sub1 [Bit 16]. When OD 60FEh sub2 [Bit 16] is 0, the output of DO1 is determined by P4.006 [Bit 0].

Object 60FFh: Target velocity

Index	60FFh
Name	Target velocity
Object code	VAR
Data type	INTEGER32
Access	RW
PDO mapping	Yes
Setting range	INTEGER32
Default	0
Unit	0.1 rpm

Object function:

This object sets the target velocity. This object only works in Profile Velocity mode and Cyclic Synchronous Velocity mode.

Object 6502h: Supported drive modes

Index	6502h
Name	Supported drive modes
Object code	VAR
Data type	UNSIGNED32
Access	RO
PDO mapping	Yes
Setting range	UNSIGNED32
Default	03ADh

Object function:

This object is read-only and provides the operation modes supported by Delta servo drives in EtherCAT mode.

Bit	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

Bit	Function
Bit 0	Profile Position mode
Bit 1	Reserved
Bit 2	Profile Velocity mode
Bit 3	Profile Torque mode
Bit 4	Reserved
Bit 5	Homing mode
Bit 6	Reserved
Bit 7	Cyclic Synchronous Position mode
Bit 8	Cyclic Synchronous Velocity mode
Bit 9	Cyclic Synchronous Torque mode
Bit 10 - Bit 31	Reserved

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12.5 Diagnostics and troubleshooting

This section provides diagnostics and troubleshooting information related to communication with the controller or interference elimination. For information about the servo drive alarms, refer to Chapter 14 Troubleshooting.

1. The SYNC communication cycle of the controller and servo drive is different

   Since the jitter of each controller is different, the time the servo drive receives the SYNC differs from the SYNC communication cycle time. When this happens, adjust the value of P3.009.Z 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.

2. Eliminate interference

   Packets are particularly sensitive to interference in high-speed network communication applications. To achieve fast and high-precision control, the selection of the wire is extremely important. Use shielded cables for the communication wiring, and make sure that the shielded connector is firmly connected to the servo drive communication port. Also, ensure the ground wire is properly connected and grounded.

12.5.1 EtherCAT Diagnosis

The EtherCAT automatic error diagnostic function must be used with the ASDA-Soft software of version 6.1.2.0 or above. To use this function, activate **EtherCAT Diagnosis** in ASDA-Soft and press **Diagnosis** to get the following EtherCAT connection information for error detection.

1. Check if the servo parameter P1.001.YX is set to 0C for communication mode.
2. Port hardware detection (check if Port0 or Port1 is connected).
3. Time synchronization status (Cycle time and DC time).
4. Physical address (Config ID) and logical address (P3.000) information.
5. Check the content of PDO mapping to determine if the configuration is correct.
6. SM0 - SM3: the channels used by the SDO & PDO and the channel length information.
7. FMMU0 - FMMU3 configuration information.
8. EtherCAT state machine display (Init ➔ Pre-Op ➔ Safe-Op ➔ Op).
9. Status display for EtherCAT communication initialization application layer (Application Layer Error Code).
10. EtherCAT communication error rate display.
11. Controlword (OD 6040h) and Statusword (OD 6041h) display.
12. EtherCAT operation mode status display (OD 6060h, 6061h, 6071h, 6072h, 6080h, 60FFh, 60E0h, 60E1h, and 607Ah)

Note: refer to the latest version of the ASDA-Soft software for the updated functions of **EtherCAT Diagnosis**.

12.5.2 Alarm list

Display	Alarm name	16-bit error code
AL001	Overcurrent	2310h
AL002	Overvoltage	3110h
AL003	Undervoltage	3120h
AL004	Motor combination error	7122h
AL005	Regeneration error	3210h
AL006	Overload	3230h
AL007	Excessive deviation of Speed command	8400h
AL008	Abnormal pulse command	8600h
AL009	Excessive deviation of Position command	8611h
AL010	Voltage error during regeneration	3210h
AL011	CN2 communication failed	7305h
AL013	Emergency stop	5441h
AL014	Negative limit error	5443h
AL015	Positive limit error	5442h
AL016	Abnormal IGBT temperature	4210h
AL017	EEPROM error	5330h
AL018	OA and OB output error	7306h
AL020	Serial communication timeout	7520h
AL022	RST power error	3130h
AL023	Early overload warning	3231h
AL024	Encoder initial magnetic field error	7305h
AL025	Encoder internal error	7305h
AL026	Encoder unreliable internal data	7305h
AL027	Encoder internal reset error	7305h
AL028	Battery voltage error or encoder internal error	7305h
AL029	Gray code error	7305h
AL02A	Number of revolutions of the encoder is in error	7305h
AL02B	Motor data error	7305h
AL02C	Servo drive overload	3230h
AL02F	Blocked rotor protection	0000h
AL030	Motor collision error	7121h
AL031	Motor power cable wiring error	3300h
AL032	Abnormal encoder vibration	7305h
AL033	Motor is in error	7305h
AL034	Encoder internal communication error	7305h
AL035	Encoder temperature exceeds the protective range	7305h
AL036	Encoder alarm status error	7305h
AL042	Voltage input for analog Speed command is too high	FF01h
AL044	Servo function operational warning	6100h
AL045	E-Gear ratio value error	6320h
AL048	OA and OB output error	7036h
AL053	Motor parameter error	0000h
AL056	Excessive motor speed	0000h
AL05C	Motor position feedback error	0000h
AL060	Absolute position is lost	7305h
AL061	Encoder undervoltage	7305h

Display	Alarm name	16-bit error code
AL062	Number of revolutions of the absolute encoder overflows (issued by encoder)	7305h
AL064	Encoder vibration warning	7305h
AL066	Number of revolutions of the absolute encoder overflows (issued by servo drive)	7305h
AL067	Encoder temperature warning	7305h
AL068	Absolute data transmitted by I/O is in error	7305h
AL069	Wrong motor type	0000h
AL06A	Absolute position is lost	7305h
AL06B	The error between the servo drive internal position and the encoder position is too large	7305h
AL06E	Encoder type is unidentifiable	7305h
AL06F	The absolute position is not established	7305h
AL070	Encoder did not complete the read / write procedure	7305h
AL071	Number of revolutions of the encoder is in error	7305h
AL072	Encoder overspeed	7305h
AL073	Encoder memory error	7305h
AL074	Encoder single-turn absolute position is in error	7305h
AL075	Encoder absolute number of revolutions is in error	7305h
AL077	Encoder internal error	7305h
AL079	Encoder parameter setting incomplete	7305h
AL07A	Encoder Z phase position is lost	7305h
AL07B	Encoder memory is busy	7305h
AL07C	Command to clear the absolute position is issued when the motor speed is over 200 rpm	7305h
AL07D	Motor stops operating when servo drive power is cycled before AL07C is cleared	7305h
AL07E	Error occurs when the encoder clears the procedure	7305h
AL07F	Encoder version error	7305h
AL083	Servo drive outputs excessive current	2310h
AL085	Regeneration setting error	3210h
AL086	Regenerative resistor overload	3110h
AL088	Servo function operational alarm	0000h
AL089	Current detection interference	6100h
AL08A	Auto tuning function - command error	7305h
AL08B	Auto tuning function - dwell time is too short	7305h
AL08C	Auto tuning function - inertia estimation error	7305h
AL099	DSP firmware error	5500h
AL09C	Parameter reset failed	5500h
AL09F	Capacitor charging error	0000h
AL0A6	Absolute positions of the servo drive and motor do not match	7305h
AL111	Buffer overflow occurs when SDO is received	8110h
AL112	Buffer overflow occurs when PDO is received	8110h
AL113	TxPDO transmission failed	8110h
AL121	Object’s index does not exist when PDO is accessed	8200h
AL122	Object’s sub-index does not exist when PDO is accessed	8200h
AL123	Data length error occurs when PDO is accessed	8200h
AL124	Data range error occurs when PDO is accessed	8200h

Display	Alarm name	16-bit error code
AL125	PDO object is read-only and write-protected	8200h
AL126	Specified object does not support PDO mapping	8200h
AL127	PDO object is write-protected when servo drive is on	8200h
AL128	Error occurs when PDO object is read from EEPROM	8200h
AL129	Error occurs when PDO object is written to EEPROM	8200h
AL130	Accessing address of EEPROM is out of range	8200h
AL131	EEPROM CRC calculation error	8200h
AL132	Parameter is write-protected	8200h
AL170	Bus communication timeout	8130h
AL180	Bus communication timeout	8130h
AL185	Bus hardware error	8120h
AL186	Bus data transmission error	8100h
AL201	Initialization error of object dictionary data	6310h
AL207	Parameter group of the data source for Type [8] PR is out of range	0207h
AL209	Parameter number of the data source for Type [8] PR is out of range	0209h
AL211	Parameter format setting of Type [8] PR is in error	0211h
AL213	Parameter setting of Type [8] PR is in error	0213h
AL215	Parameter written by Type [8] PR is read-only	0215h
AL217	Parameter written by Type [8] PR is write-protected when Servo On	0217h
AL219	Parameter written by Type [8] PR is write-protected	0219h
AL231	Monitoring variable code specified by Type [8] PR is out of range	0231h
AL235	Position counter overflow warning	0235h
AL237	Rotary axis position is undefined	0237h
AL245	PR positioning timeout	0245h
AL249	PR path number is out of range	0249h
AL283	Software positive limit	5444h
AL285	Software negative limit	5445h
AL289	Position counter overflows	7305h
AL301	CANopen synchronization failure	6200h
AL302	Synchronization signal of CANopen is sent too soon	6200h
AL303	CANopen synchronization signal timeout	6200h
AL304	Invalid interpolation mode command	6200h
AL305	SYNC period error	6200h
AL35F	Emergency stop during deceleration	6200h
AL380	Position offset alarm for DO.MC_OK	6200h
AL3CF	Emergency stop	6200h
AL3E1	Communication fails to synchronize	6200h
AL3E2	Communication synchronization signal is sent too soon	6200h
AL3E3	Communication synchronization signal timeout	6200h
AL3F1	Absolute position command of the communication type servo drive is in error	6200h
AL400	Rotary axis position setting error	FF05h
AL401	NMT reset command is received when servo is on	0000h
AL404	PR special filter setting value is too great	FF07h
AL422	Write-in failed caused by control power cut-off	0000h

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Display	Alarm name	16-bit error code
AL500	STO function is activated	9000h
AL501	SF1 lost (signal loss or signal error)	9000h
AL502	SF2 lost (signal loss or signal error)	9000h
AL503	STO self-diagnostic error	9000h
AL510	Internal parameter update program of the servo drive is abnormal	0000h
AL520	Calculation program timeout	0000h
AL521	Vibration elimination parameter error	6100h
AL555	System failure	-
AL809	PR motion setting error or command decoding error	0000h
ALC31	Motor power cable disconnection	3300h
ALCDB	Servo drive model type error	0000h

PROFINET Mode 13

This chapter provides details for the required parameter settings when the servo communicates with the controller through PROFINET communication.

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13.1 Basic configuration

13.1.1 Hardware configuration

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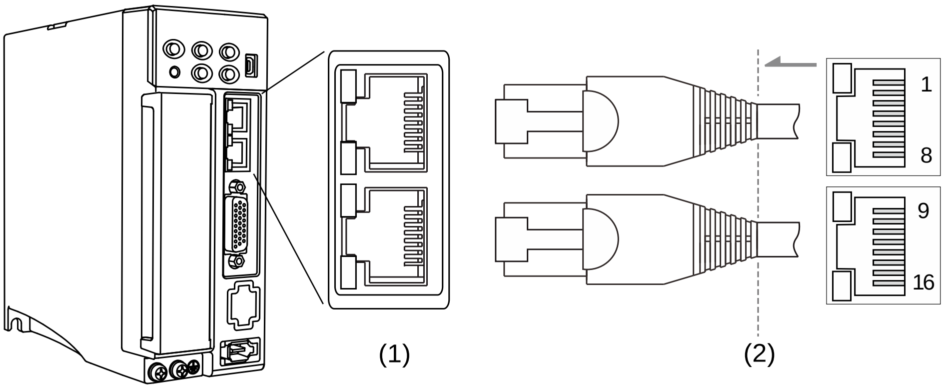
The CN6 connector of the B3A-P models allows you to connect the servo drive to the controller using standard RJ45 connectors and shielded network cables, controlling the position and speed of the motor, as well as accessing or monitoring the servo status with Siemens' PROFINET system.

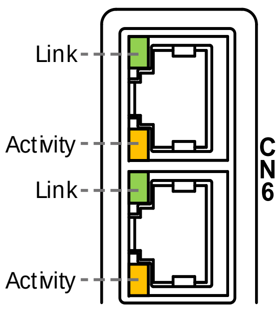


(1) CN6 connector (female); (2) CN6 connector (male)

Pin assignment:

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

Description of each indicator for the CN6 connector:



Name	Color	Status	Description
Link	Green	On	Network is connected.
		Off	No connection or connection error.
Activity	Orange	On	Data exchange in progress.
		Off	No data exchange.

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13.1.2 GSD file import

The PROFINET motion control fieldbus is an open standard that requires using the GSD (General Station Description) file to configure the functions and related object properties for each slave device. Generally, the GSD file is a standard XML file (GSDML).

Integration with Siemens SIMATIC S7-1200/1500 controllers

Import the GSD file of the slave into the Siemens TIA Portal software, so the controller can recognize and control each slave device according to the configuration in the GSD file. Download the GSD file from Delta's website and make sure the file version is V2.41 or above.

Follow these steps to import the GSD file:

1. Open the Siemens TIA Portal software, and then click **Project view** in the lower left of the software screen.
2. Go to the toolbar and click **Options** > **Manage general station description files (GSD)**.
3. In the Manage general station description files window, click "**...**" to select the source path, and then the following area shows the GSD file(s) in that source path. Select the check box and then click **Install** to import the GSD file.

After being imported into TIA Portal, the GSD file is stored in the following path:
C:\Users\user_name\Automaiton\project_name\AdditionalFiles\GSD

Note: refer to the controller manufacturer's instruction manuals for the actual storage path.

13.1.3 Install DriveLib

Install the DriveLib library in the Siemens TIA Portal software for the controller to access the servo data using the library function blocks. If you are using TIA Portal V17 or an older version, download the applicable DriveLib file from Siemens' website for installation.

13.1.4 Servo firmware version

Make sure the servo firmware version is v2.00009 sub10058 or above. You can check the firmware version and subversion with the servo parameters P0.000 and P5.000. To update the servo firmware successfully, use the Firmware Update Tool of the version V3.0.0.33.

13.1.5 Parameter settings of PROFINET mode

Follow these steps to connect the controller and the servo drive:

1. Set the servo to PROFINET mode by setting P1.001.YX to 0C.
2. Set P3.012.Z = 1 to enable the non-volatile setting for the parameters in the following table.

Function	P3.012 = 0x0100 (Z = 1)		P3.012 = 0x0000 (Z = 0)	
	Servo parameter	Default	PNU parameter	Default
Motor stop mode	P1.032	0x0000	PNU30	0x0000
Zero speed range	P1.038	100 (0.1 rpm)	PNU32	100 (0.1 rpm)
E-Gear ratio - numerator N1	P1.044	16777216	PNU33	1
E-Gear ratio - denominator M	P1.045	100000	PNU34	1
Speed reached (DO.SP_OK) range	P1.047	10 (1 rpm)	PNU35	100 (0.1 rpm)
Accumulated time to reach desired speed	P1.049	0	PNU36	0
Maximum speed limit	P1.055	Depending on the motor (1 rpm)	PNU37	Depending on the motor (0.1 rpm)
			PNU38	Depending on the motor (1 rpm)
Excessive deviation warning condition of Position command	P2.035	50331648 (pulse)	PNU39	50331648 (PUU)
Positive software limit	P5.008	2147483647 (PUU)	PNU40	2147483647 (PUU)
Negative software limit	P5.009	-2147483648 (PUU)	PNU41	-2147483648 (PUU)
Origin definition	P6.001	0	PNU11	0

Note: unit conversion: PUU = pulse x $\frac{\text{P1.044}}{\text{P1.045}}$

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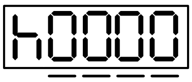
Set the following parameters based on the application requirements.

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:

High word



D C B A

Low word

U Z Y X

A	Reserved	X	Following error compensation switch
B	Reserved	Y	Reserved
C	Reserved	Z	DI.STP triggering method
D	[EtherCAT] / [CANopen] Power off movement function	U	[CANopen] Unit selection for PV mode [PROFINET] Unit selection for telegrams 1, 3, 102, and 105

- U: [CANopen] Unit selection for PV mode / [PROFINET] Unit selection for telegrams 1, 3, 102, and 105

  0: 0.1 rpm

  1: 0.01 rpm

P2.121	Special bit register 6		Address: 02F2H 02F3H
Default:	0x00000000	Control mode:	All
Unit:	-	Setting range:	0x00000000 - 0x000001FF
Format:	HEX	Data size:	32-bit

Settings:

Bit	Function	Description
Bit 1	[PROFINET] Behavior after homing in communication mode	0: after homing, execute absolute positioning to the position with the offset distance set in PNU11. 1: decelerate to a stop after homing.
Bit 2	[PROFINET] Definition of the settings for Origin definition (P6.001) and Home offset (PNU11) in communication mode	0: origin definition (P6.001) = - (setting of PNU11) 1: origin definition (P6.001) = PNU11
Bit 3	[PROFINET] Unit of Homing speeds (PNU12, PNU13) in communication mode	0: 0.1 rpm 1: 1 rpm

P3.011	**CANopen / DMCNET / PROFINET options**		**Address: 0316H 0317H**
Default:	0x0000	Control mode:	CANopen / DMCNET / PROFINET
Unit:	-	Setting range:	Shown as follows
Format:	HEX	Data size:	16-bit

Settings:

0000

U Z Y X

X	Store parameters in EEPROM or not	Z	Reserved
Y	Reserved	U	Reserved

- X: store parameters in EEPROM or not

  0: not to store parameters in EEPROM.

  1: when writing parameters with packets through cyclic synchronous communication, store parameters in EEPROM.

  Note: if you set X to 1 and continuously write parameters with packets through cyclic synchronous communication, it shortens the lifetime of the EEPROM.

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13.2 Communication function

13.2.1 Specifications

Physical layer	100BASE-TX
Communication interface	RJ45 x 2
Network protocol	Serial connection
Baud rate	2 x 100 Mbps (full duplex)
Transmission distance	When multiple servo drives are connected, the maximum distance between each drive is 50 m (164.04 ft).
Transmission cable	CAT5e STP cables with metal connectors
Number of controllable slaves	Maximum 65,535 slaves; the actual number is determined by the controller.
Data frame size	Maximum 1,440 bytes
RT / IRT mode	IRT mode (synchronous): 1 ms RT mode (asynchronous): 1 ms
Communication service	Cyclic I/O data transmission Acyclic I/O data transmission
Application layer	Meets the definitions in the PROFIdrive application profile, supporting the application classes AC1, AC3, and AC4.
Supported topology	■ Line topology ■ Star topology ■ Ring topology ■ Tree topology ■ Hybrid topology

13.2.2 RT / IRT mode

PROFINET communication supports two types of real-time data transmission: Real-Time (RT) mode and Isochronous Real-Time (IRT) mode.

13.2.2.1 Real-Time (RT) mode

The master and slave(s) run asynchronously in the RT mode. The slave clock runs independently of the master clock. That is, the clocks are not synchronized. The command and feedback between the master and slave(s) are transmitted sequentially rather than synchronously.

13.2.2.2 Isochronous Real-Time (IRT) mode

There is precise time synchronization between the master and slave(s) in the IRT mode. The master executes the control program and sends packets at a fixed time cyclically according to the synchronization clock, transmitting the command to and receiving the feedback from the slave(s). The slave(s) receives and updates the data at a fixed time according to the synchronization clock.

Note: in IRT mode, the Topology view in the Siemens TIA Portal software must be configured according to the actual wiring.

13.3 PROFINET application classes

Among the PROFINET application profiles, PROFIdrive is applicable to motion control. PROFIdrive is the standard profile for drive control on the data exchange between the controller and the servo drive. The PROFIdrive profile defines 6 application classes (AC1 to AC6), and the B3A-P model is currently applicable to AC1, AC3, and AC4.

13.3.1 AC1

In AC1, the servo drive is in Profile Velocity mode, where the motion planning is done using telegram 1 of the controller. The controller specifies the speed command and sets the acceleration / deceleration conditions, and then the trajectory generator in the servo drive plans the motion path according to these conditions. This mode is suitable for applications that do not require high responsiveness.

13.3.2 AC3

In AC3, the servo drive is in Profile Position mode, where the motion planning is done using telegram 111 of the controller. After receiving the position command from the controller, the servo drive controls the servo motor to reach the target position.

In Profile Position mode, the controller only informs the servo drive of the target position, speed command, and acceleration / deceleration settings at the beginning. The motion planning from command triggering to the arrival of the target position is performed by the trajectory generator in the servo drive. This mode is suitable for applications of single-axis positioning.

13.3.3 AC4

In AC4, the servo drive is in the Cyclic Synchronous Velocity mode, where the motion planning is done using telegram 3, 102, or 105 of the controller. The controller transmits the motion command to the servo drive cyclically. This mode is suitable for applications of multi-axis synchronization, motion path planning, and interpolation control.

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13.4 Supported telegrams

1. Directly change the telegram from the controller. Setting the servo parameters additionally is not necessary.
2. If you **change** the telegram when power is supplied to the servo, cycle power to the servo drive to have the change take effect.
3. This servo drive supports the following telegrams. Make sure the controller supports these telegrams before using them.

Telegram		RT / IRT mode	Maximum number of PZD	
			Receive word	Send word
Main telegram	Standard telegram 1	RT	2	2
	Standard telegram 3	IRT / RT	4	9
	Siemens telegram 102	IRT / RT	6	10
	Siemens telegram 105	IRT	10	10
	Siemens telegram 111	RT	12	12
Supplementary telegram	Siemens telegram 750	N/A	3	1

Note:

1. PZD is the process data for cyclic data transmission; one PZD is one word (16-bit).
2. Receive word / Send word is defined by the perspective of the servo drive.
3. The supplementary telegram cannot be used individually and must be used with the main telegram.

Telegrams used for speed control:

Telegram	1		3		102		105	
Application Class	AC1		AC4		AC4		AC4	
PZD1	STW1	ZSW1	STW1	ZSW1	STW1	ZSW1	STW1	ZSW1
PZD2	NSOLL_A	NIST_A	NSOLL_B	NIST_B	NSOLL_B	NIST_B	NSOLL_B	NIST_B
PZD3	Receive telegram from PROFINET	Send telegram to PROFINET						
PZD4			STW2	ZSW2	STW2	ZSW2	STW2	ZSW2
PZD5			G1_STW	G1_ZSW	MOMRED	MELDW	MOMRED	MELDW
PZD6			-	G1_XIST1	G1_STW	G1_ZSW	G1_STW	G1_ZSW
PZD7					-	G1_XIST1	XERR	G1_XIST1
PZD8				G1_XIST2				
PZD9						G1_XIST2	KPC	G1_XIST2
PZD10				-				

Telegram used for position control:

Telegram	111	
Application Class	AC3	
PZD1	STW1	ZSW1
PZD2	POS_STW1	POS_ZSW1
PZD3	POS_STW2	POS_ZSW2
PZD4	STW2	ZSW2
PZD5	OVERRIDE	MELDW
PZD6	MDI_TARPOS	XIST_A
PZD7		
PZD8	MDI_VELOCITY	NIST_B
PZD9		
PZD10	MDI_ACC	FAULT_CODE
PZD11	MDI_DEC	WARN_CODE
PZD12	User	User

PZDs used for supplementary telegram 750:

Telegram	750	
PZD1	M_ADD1	M_ACT
PZD2	M_LIMIT_POS	Send telegram to PROFINET
PZD3	M_LIMIT_NEG	
-	Receive telegram from PROFINET	

Note: the PZDs in gray are not yet supported.

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13.4.1 Descriptions of PZD (Process Data)

The following describes the PZDs of telegrams 1, 3, 102, 105, 111, and supplementary telegram 750.

PZD	Description	Received word / Send word*	Data type
STW1	Control word 1	Receive word	U16
STW2	Control word 2	Receive word	U16
NSOLL_A	Speed setpoint A (16-bit)	Receive word	I16
NSOLL_B	Speed setpoint B (32-bit)	Receive word	I32
MDI_TARPOS	MDI position	Receive word	I32
MDI_VELOCITY	MDI velocity	Receive word	I32
OVERRIDE	Position velocity override	Receive word	I16
MDI_ACC	MDI acceleration override	Receive word	I16
MDI_DEC	MDI deceleration override	Receive word	I16
POS_STW1	Positioning control word 1	Receive word	U16
POS_STW2	Positioning control word 2	Receive word	U16
G1_STW	Encoder 1 control word	Receive word	U16
MOMRED	Torque reduction	Receive word	I16
M_LIMIT_POS	Positive torque limit	Receive word	I16
M_LIMIT_NEG	Negative torque limit	Receive word	I16
G1_XIST1	Encoder 1 actual position 1	Send word	U32
G1_XIST2	Encoder 1 actual position 2	Send word	U32
ZSW1	Status word 1	Send word	U16
ZSW2	Status word 2	Send word	U16
NIST_A	Speed actual value A (16-bit)	Send word	I16
NIST_B	Speed actual value B (32-bit)	Send word	I32
XIST_A	Position actual value A	Send word	I32
FAULT_CODE	Alarm code	Send word	U16
WARN_CODE	Warning code	Send word	U16
G1_ZSW	Encoder 1 status word	Send word	U16
User	User-defined send word	Send word	I16
M_ACT	Actual torque	Send word	I16

Note: Receive word / Send word is defined by the perspective of the servo drive.

13.4.2 Control word definition

STW1 control word 1 (for telegram 1)

Important: STW1.10 must be set to 1 first for the servo to allow requests from the controller.

Signal	Function	Description
STW1.0	Servo On / Off	0: Servo Off 1: Servo On
STW1.1	Free-run stop (OFF2 triggering)	0: trigger OFF2; servo displays AL013 1: clear OFF2
STW1.2	PFQS (OFF3 triggering)	0: trigger OFF3; servo displays AL35F 1: clear OFF3
STW1.3	Enable / disable operation	0: disable operation 1: enable operation
STW1.4	Quick stop	0: servo is in the Quick stop state 1: disable the function
STW1.5	Halt	0: halt the command; once the function is disabled, the operation continues until the command is complete 1: disable the function
STW1.6	Trigger	0: disable the function 1: trigger the command
STW1.7	Fault reset	↑: reset the servo alarm
STW1.8 to 1.9	Reserved	-
STW1.10	Servo allows requests from controller	0: servo does not allow requests from the controller 1: servo allows requests from the controller
STW1.11 to 1.15	Reserved	-

STW1 control word 1 (for telegrams 3, 102, 105)

Important: STW1.10 must be set to 1 first for the servo to allow requests from the controller.

Signal	Function	Description
STW1.0	Servo On / Off	0: Servo Off 1: Servo On
STW1.1	Free-run stop (OFF2 triggering)	0: trigger OFF2 1: clear OFF2
STW1.2	PFQS (OFF3 triggering)	0: trigger OFF3 1: clear OFF3
STW1.3	Enable / disable operation	0: disable operation 1: enable operation
STW1.4	Quick stop	0: servo is in the Quick stop state 1: disable the function
STW1.5	Halt	0: halt the command; once the function is disabled, the operation continues until the command is complete 1: disable the function
STW1.6	Trigger	0: disable the function 1: trigger the command
STW1.7	Fault reset	↑: reset the servo alarm
STW1.8 to 1.9	Reserved	-
STW1.10	Servo allows requests from controller	0: servo does not allow requests from the controller 1: servo allows requests from the controller
STW1.11 to 1.15	Reserved	-

STW1 control word 1 (for telegram 111)

Important: STW1.10 must be set to 1 first for the servo to allow requests from the controller.

Signal	Function	Description
STW1.0	Servo On / Off	0: Servo Off 1: Servo On
STW1.1	Free-run stop (OFF2 triggering)	0: trigger OFF2; servo displays AL013 1: clear OFF2
STW1.2	PFQS (OFF3 triggering)	0: trigger OFF3; servo displays AL35F 1: clear OFF3
STW1.3	Enable / disable operation	0: disable operation 1: enable operation
STW1.4	Reject	0: reject the command; to continue the operation, the command must be issued again 1: disable the function
STW1.5	Halt	0: halt the command; once the function is disabled, the operation continues until the command is complete 1: disable the function
STW1.6	Trigger	↑: trigger the command
STW1.7	Fault reset	↑: reset the servo alarm
STW1.8 to 1.9	Jog	00: disable the function 01: execute Jog 1 10: execute Jog 2 11: disable the function
STW1.10	Servo allows requests from controller	0: servo does not allow requests from the controller 1: servo allows requests from the controller
STW1.11	Homing	0: disable the function 1: start homing
STW1.12 to 1.15	Reserved	-

STW2 control word 2

Signal	Function	Description
STW2.0 to 2.11	Reserved	-
STW2.12	Master sign-of-life, Bit 0	Controller sign-of-life, Bit 0
STW2.13	Master sign-of-life, Bit 1	Controller sign-of-life, Bit 1
STW2.14	Master sign-of-life, Bit 2	Controller sign-of-life, Bit 2
STW2.15	Master sign-of-life, Bit 3	Controller sign-of-life, Bit 3

G1_STW encoder 1 control word

Signal	Function	Description
G1_STW.0 to .12	Reserved	-
G1_STW.13	Absolute value cyclically	0: cancel the cyclic transfer of the absolute position value in G1_XIST2 1: servo requests the cyclic transfer of the absolute position value in G1_XIST2
G1_STW.14	Activate parking encoder	0: cancel the parking encoder 1: activate the parking encoder
G1_STW.15	Encoder alarm reset	↑: reset the absolute encoder alarms in the servo drive

POS_STW1 positioning control word 1

<table>
<tr><th>Signal</th><th>Function</th><th colspan="2">Description</th></tr>
<tr><td>POS_STW1.0 to 1.7</td><td>Reserved</td><td colspan="2">-</td></tr>
<tr><td>POS_STW1.8</td><td>MDI positioning mode</td><td colspan="2">0: relative positioning
1: absolute positioning</td></tr>
<tr><td>POS_STW1.9</td><td rowspan="2">MDI direction selection</td><td rowspan="2">When ModePos = 2 (absolute positioning)*1:
00: positioning through the shortest distance
01: positioning command in forward direction
10: positioning command in reverse direction
11: positioning through the shortest distance</td><td rowspan="2">When ModePos = 3 (positioning as setup)*2:
00: stop operation
01: forward operation
10: reverse operation
11: stop operation</td></tr>
<tr><td>POS_STW1.10</td></tr>
<tr><td>POS_STW1.11</td><td>Reserved</td><td colspan="2">-</td></tr>
<tr><td>POS_STW1.12</td><td>Command trigger</td><td colspan="2">0: trigger the command when STW1.6 =
1: trigger the command once the command is changed</td></tr>
<tr><td>POS_STW1.13</td><td>Reserved</td><td colspan="2">-</td></tr>
<tr><td>POS_STW1.14</td><td>Working mode</td><td colspan="2">0: signal positioning
1: signal setting-up</td></tr>
<tr><td>POS_STW1.15</td><td>MDI selection</td><td colspan="2">0: disable the MDI function
1: enable the MDI function</td></tr>
</table>

Note:

1. When STW1.8, STW1.9, STW1.11, and POS_STW1.14 are all set to 0, and POS_STW1.8 is set to 1, ModePos = 2.
2. When STW1.8, STW1.9, and STW1.11 are set to 0, and POS_STW1.8 and POS_STW1.14 are set to 1, ModePos = 3.
3. The MDI (Manual Data Input) positioning function enables the controller to inform the servo of the target position, speed, and acceleration / deceleration for the servo to perform the calculation. This function is not yet supported by the B3A-P model.

POS_STW2 positioning control word 2

Signal	Function	Description
POS_STW2.0	Reserved	-
POS_STW2.1	Set current feedback position as origin	0: disable the function 1: set the current feedback position as the origin
POS_STW2.2 to 2.4	Reserved	-
POS_STW2.5	Jog mode setting	0: jog (ModePos = 7) 1: incremental jogging (ModePos = 8)
POS_STW2.6 to 2.13	Reserved	-
POS_STW2.14	Software limit switch (ConfigEPos [Bit 2])	0: disable the function 1: enable the software limit switch
POS_STW2.15	Hardware limit switch (ConfigEPos [Bit 3])	0: disable the function 1: enable the hardware limit switch

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13.4.3 Status word definition

ZSW1 status word 1 (for telegrams 1, 3, 102, 105)

Signal	Function	Description
ZSW1.0	Switched On	0: not ready for Servo On 1: ready for Servo On
ZSW1.1	Ready for operation	0: operation disabled 1: operation enabled
ZSW1.2	Operation enabled	0: Servo Off 1: Servo On
ZSW1.3	Fault present	0: no servo alarm (ALM) 1: servo alarm (ALM) occurs
ZSW1.4	Free-run stop (OFF2 triggering)	0: OFF2 triggered 1: OFF2 cleared
ZSW1.5	PFQS (OFF3 triggering)	0: OFF3 triggered 1: OFF3 cleared
ZSW1.6	Switching on inhibited	0: operation allowed 1: operation inhibited
ZSW1.7	Warning present	0: servo warning triggered 1: servo warning cleared
ZSW1.8	Speed deviation within tolerance	0: speed deviation exceeded tolerance 1: speed deviation within tolerance
ZSW1.9	Control requested	0: controller request not allowed 1: controller request allowed
ZSW1.10 to 1.15	Reserved	-

ZSW1 status word 1 (for telegram 111)

Signal	Function	Description
ZSW1.0	Switched On	0: not ready for Servo On 1: ready for Servo On
ZSW1.1	Ready for operation	0: operation disabled 1: operation enabled
ZSW1.2	Operation enabled	0: Servo Off 1: Servo On
ZSW1.3	Fault present	0: no servo alarm (ALM) 1: servo alarm (ALM) occurs
ZSW1.4	Free-run stop (OFF2 triggering)	0: OFF2 triggered 1: OFF2 cleared
ZSW1.5	PFQS (OFF3 triggering)	0: OFF3 triggered 1: OFF3 cleared
ZSW1.6	Switching on inhibited	0: operation allowed 1: operation inhibited
ZSW1.7	Warning present	0: servo warning triggered 1: servo warning cleared
ZSW1.8	Speed deviation within tolerance	0: speed deviation exceeded tolerance 1: speed deviation within tolerance
ZSW1.9	Control requested	0: controller request not allowed 1: controller request allowed
ZSW1.10	Target reached	0: target not reached 1: target reached
ZSW1.11	Homing complete	0: homing not complete 1: homing complete
ZSW1.12	Reserved	-
ZSW1.13	Zero speed range	0: motor speed exceeds zero speed range 1: motor speed lower than zero speed range
ZSW1.14 to 1.15	Reserved	-

ZSW2 status word 2

Signal	Function	Description
ZSW2.0 to 2.11	Reserved	-
ZSW2.12	Slave sign-of-life, Bit 0	Servo drive sign-of-life, Bit 0
ZSW2.13	Slave sign-of-life, Bit 1	Servo drive sign-of-life, Bit 1
ZSW2.14	Slave sign-of-life, Bit 2	Servo drive sign-of-life, Bit 2
ZSW2.15	Slave sign-of-life, Bit 3	Servo drive sign-of-life, Bit 3

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G1_ZSW encoder 1 status word

Signal	Function	Description
G1_ZSW.0 to .10	Reserved	-
G1_ZSW.11	Encoder alarm status	0: encoder alarm status not reset 1: encoder alarm status reset
G1_ZSW.12	Reserved	-
G1_ZSW.13	Absolute value cyclically	0: cyclic transfer of the absolute position value in G1_XIST2 cancelled 1: absolute position value in G1_XIST2 is cyclically transferred
G1_ZSW.14	Activate parking encoder	0: parking encoder cancelled 1: parking encoder activated
G1_ZSW.15	Encoder fault	0: no absolute encoder alarm in the servo drive 1: absolute encoder alarm occurred in the servo drive

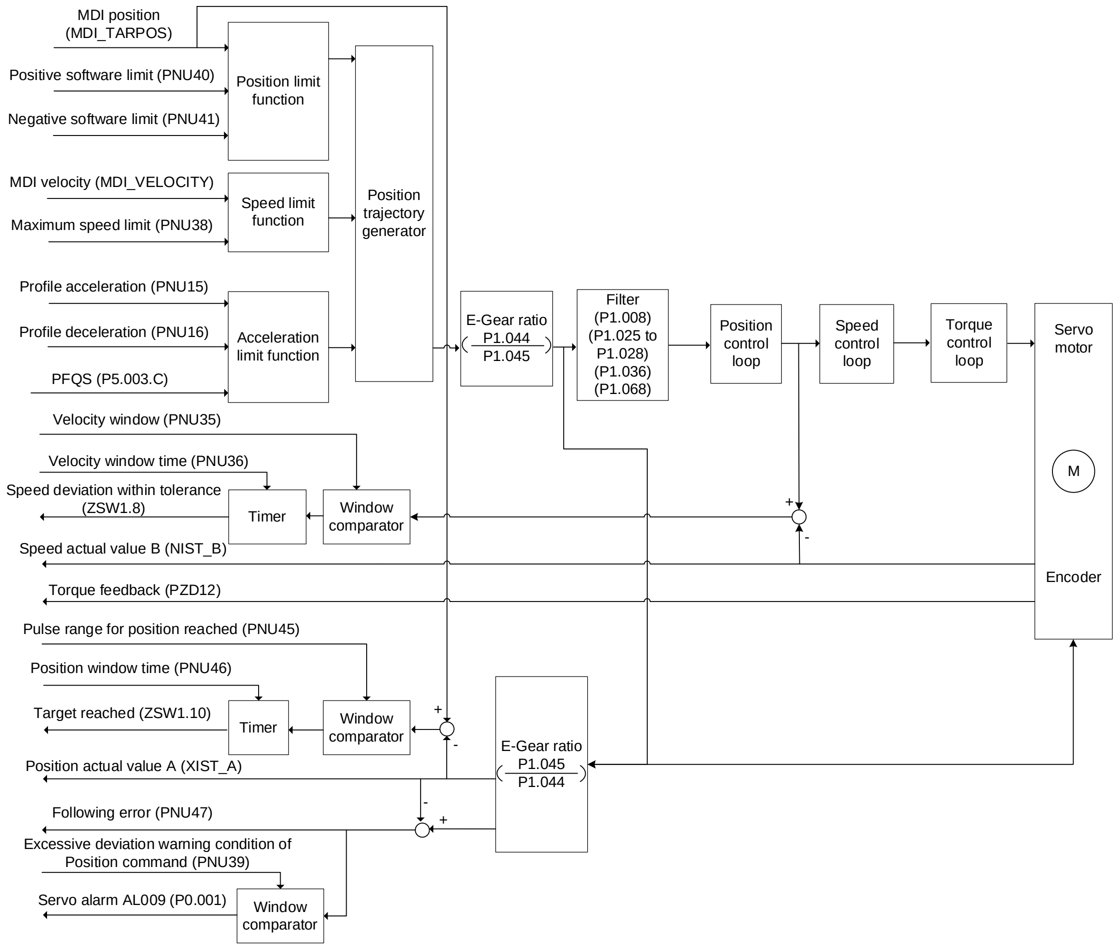
13.5 Using telegrams in PROFINET mode

This section describes the use of telegrams in PROFINET mode. The content includes basic operation settings and related object descriptions.

13.5.1 Telegram 111 (Profile Position mode)

After receiving the position command from the controller, the servo drive controls the servo motor to reach the target position. When telegram 111 is used, the controller only informs the servo drive of the target position, speed command, and acceleration / deceleration settings at the beginning. The motion planning from command triggering to the arrival of the target position is performed by the trajectory generator in the servo drive.

The following figure shows the Profile Position mode architecture of the servo drive when telegram 111 is used:



Using the function blocks in the DriveLib of TIA Portal can achieve the basic positioning control (SINA_POS, FB284) and access the PNU and servo parameters (SINA_PARA_S, FB287). The following are the examples of using these function blocks.

Note:
1. Refer to Section 13.6 for the descriptions of function block pins.
2. You need to install DriveLib for TIA Portal V17 or older versions. Download the file from Siemens' website for installation.

Jog / Incremental jogging

Operating condition: for FB284, the CancelTraversing and IntermediateStop pins must be set to 1 (disable the functions).

Step	FB	Pin	Input value	Description
1. Select the jog mode	FB284	ModePos	7 / 8	7: jog; continuous triggering 8: incremental jogging; level triggering
2. Set the jog velocity (PNU23 / PNU24)				Must be set when ModePos = 7 (jog) & ModePos = 8 (incremental jogging).
2.1 Enable the writing function for the PNU parameter	FB287	ReadWrite	1	0: enable the reading function 1: enable the writing function
2.2 Select PNU parameter	FB287	Parameter	23 / 24	23: EPOS Jog 1 Velocity 24: EPOS Jog 2 Velocity
2.3 Set the value to write	FB287	ValueWrite2	-	Unit: 1000 PUU/min
2.4 Start	FB287	Start	↑	↑: start accessing
3. Set the jog distance (PNU25 / PNU26)				Must be set when ModePos = 8 (incremental jogging).
3.1 Enable the writing function for the PNU parameter	FB287	ReadWrite	1	0: enable the reading function 1: enable the writing function
3.2 Select PNU parameter	FB287	Parameter	25 / 26	25: EPOS Jog 1 Distance 26: EPOS Jog 2 Distance
3.3 Set the value to write	FB287	ValueWrite2	-	Unit: PUU
3.4 Start	FB287	Start	↑	↑: start accessing
4. Set the servo to On	FB284	EnableAxis	1	0: Servo Off 1: Servo On
5. Execute jog operation				Execute either Jog 1 or Jog 2. Setting both to 1 is equivalent to disabling the function.
◆ Execute Jog 1	FB284	Jog 1	1	0: disable the function 1: execute Jog 1
◆ Execute Jog 2	FB284	Jog 2	1	0: disable the function 1: execute Jog 2
6. Set jog speed override	FB284	OverV	-	Setting range: 1 - 199%

Note:

1. When using the jog function, the positive and negative value of jog velocity (PNU23 or PNU24) determines the motor rotation direction. Meanwhile, jog distance (PNU25 or PNU26) can only be written in positive values.
2. EPOS Jog 1 Velocity (PNU23), EPOS Jog 2 Velocity (PNU24), EPOS Jog 1 Distance (PNU25), and EPOS Jog 2 Distance (PNU26) are volatile parameters.

Read the servo data:

Step	FB	Pin	Read value	Description
1. Read the motor feedback position at present	FB284	ActPosition	-	Unit: PUU
2. Read the motor feedback speed at present	FB284	ActVelocity	-	Unit: 16#40000000h indicates 100% of the motor rated speed For example, when the read value is 16#60000000h, the feedback speed is the rated speed*150%.

Relative / Absolute positioning

Operating condition: for FB284, the CancelTraversing and IntermediateStop pins must be set to 1 (disable the functions), and the Jog 1 and Jog 2 pins must be set to 0 (disable the function). You must establish the homing reference point (FB284 - AxisRef = 1) before executing absolute positioning (FB284 - ModePos = 2).

Step	FB	Pin	Input value	Description
1. Select the positioning function	FB284	ModePos	1 / 2	1: relative positioning 2: absolute positioning
2. Set the target position	FB284	Position	-	Unit: PUU
3. Set the speed command	FB284	Velocity	-	Unit: 1000 PUU/min
4. Set the Max acceleration (PNU43)				
4.1 Enable the writing function for the PNU parameter	FB287	ReadWrite	1	0: enable the reading function 1: enable the writing function
4.2 Select PNU parameter	FB287	Parameter	43	43: Max acceleration
4.3 Set the value to write	FB287	ValueWrite2	-	Unit: ms; the time for acceleration from 0 rpm to 3000 rpm
4.4 Start	FB287	Start	↑	↑: start accessing
5. Set the Max deceleration (PNU44)				
5.1 Enable the writing function for the PNU parameter	FB287	ReadWrite	1	0: enable the reading function 1: enable the writing function
5.2 Select PNU parameter	FB287	Parameter	44	44: Max deceleration
5.3 Set the value to write	FB287	ValueWrite2	-	Unit: ms; the time for deceleration from 3000 rpm to 0 rpm
5.4 Start	FB287	Start	↑	↑: start accessing
6. Set the Acceleration override	FB284	OverAcc	-	Setting range: 1 - 100%
7. Set the Deceleration override	FB284	OverDec	-	Setting range: 1 - 100%
8. Set the servo to On	FB284	EnableAxis	1	0: Servo Off 1: Servo On
9. Execute the command	FB284	ExecuteMode	↑	↑: execute commands of signal positioning and signal setting-up

Note: PNU43 (Max acceleration) and PNU44 (Max deceleration) are volatile parameters.

Read the servo data:

Step	FB	Pin	Read value	Description
1. Read the motor feedback position at present	FB284	ActPosition	-	Unit: PUU
2. Read the motor feedback speed at present	FB284	ActVelocity	-	Unit: 16#40000000h indicates 100% of the motor rated speed For example, when the read value is 16#60000000h, the feedback speed is the rated speed*150%.

Command to take immediate effect

When FB284 - ModePos = 2 (absolute positioning), you can have the command take effect immediately or not with the setting of FB284 - ConfigEPos [Bit 8].

Note: before switching to relative positioning (FB284 - ModePos = 1), make sure to “not” have the command take effect immediately (FB284 - ConfigEPos [Bit 8] = 0). Otherwise, the position command builds up and continuously operates the servo motor, which may cause the motor to crash.

Positioning as setup

Operating condition: for FB284, the CancelTraversing and IntermediateStop pins must be set to 1 (disable the functions), and the Jog 1 and Jog 2 pins must be set to 0 (disable the function).

Step	FB	Pin	Input value	Description
1. Select the mode of positioning as setup	FB284	ModePos	3	3: positioning as setup
2. Select the rotation direction				Select either Positive or Negative direction. Setting both to 1 is equivalent to disabling the function.
◆ Set to operate in positive direction	FB284	Positive	1	0: disable the function 1: operate in positive direction
◆ Set to operate in negative direction	FB284	Negative	1	0: disable the function 1: operate in negative direction
3. Set the speed command	FB284	Velocity	-	Unit: 1000 PUU/min
4. Set the Max acceleration (PNU43)				
4.1 Enable the writing function for the PNU parameter	FB287	ReadWrite	1	0: enable the reading function 1: enable the writing function
4.2 Select PNU parameter	FB287	Parameter	43	43: Max acceleration
4.3 Set the value to write	FB287	ValueWrite2	-	Unit: ms; the time for acceleration from 0 rpm to 3000 rpm
4.4 Start	FB287	Start	↑	↑: start accessing
5. Set the Max deceleration (PNU44)				
5.1 Enable the writing function for PNU parameters	FB287	ReadWrite	1	0: enable the reading function 1: enable the writing function
5.2 Select PNU parameter	FB287	Parameter	44	44: Max deceleration
5.3 Set the value to write	FB287	ValueWrite2	-	Unit: ms; the time for deceleration from 3000 rpm to 0 rpm
5.4 Start	FB287	Start	↑	↑: start accessing
6. Set the Acceleration override	FB284	OverAcc	-	Setting range: 1 - 100%
7. Set the Deceleration override	FB284	OverDec	-	Setting range: 1 - 100%
8. Set the servo to On	FB284	EnableAxis	1	0: Servo Off 1: Servo On
9. Execute the command	FB284	ExecuteMode	↑	↑: execute commands of signal positioning and signal setting-up

Note: PNU43 (Max acceleration) and PNU44 (Max deceleration) are volatile parameters.

Read the servo data:

Step	FB	Pin	Read value	Description
1. Read the motor feedback position at present	FB284	ActPosition	-	Unit: PUU
2. Read the motor feedback speed at present	FB284	ActVelocity	-	Unit: 16#40000000h indicates 100% of the motor rated speed For example, when the read value is 16#60000000h, the feedback speed is the rated speed*150%.

Command to take immediate effect

When FB284 - ModePos = 3 (positioning as setup), you can have the command take effect immediately or not with the setting of FB284 - ConfigEPos [Bit 8].

Homing

Operating condition: for FB284, the CancelTraversing and IntermediateStop pins must be set to 1 (disable the functions), and the Jog 1 and Jo g2 pins must be set to 0 (disable the function).

Step	FB	Pin	Setting value	Description
1. Select the homing mode	FB284	ModePos	4 / 5	4: homing mode 5: regard the current feedback position as the origin Note: if ModePos = 5, directly go to Step 7.
2. Set the Home offset (PNU11)				
2.1 Enable the writing function for the PNU parameter	FB287	ReadWrite	1	0: enable the reading function 1: enable the writing function
2.2 Select PNU parameter	FB287	Parameter	11	11: Home offset
2.3 Set the value to write	FB287	ValueWrite2	-	Unit: PUU
2.4 Start	FB287	Start	↑	↑: start accessing
3. Set the Homing method (PNU10)				
3.1 Enable the writing function for the PNU parameter	FB287	ReadWrite	1	0: enable the reading function 1: enable the writing function
3.2 Select PNU parameter	FB287	Parameter	10	10: Homing method
3.3 Set the value to write	FB287	ValueWrite2	-	Refer to the description of PNU10
3.4 Start	FB287	Start	↑	↑: start accessing
4. Set Homing speeds 1 (PNU12)				
4.1 Enable the writing function for the PNU parameter	FB287	ReadWrite	1	0: enable the reading function 1: enable the writing function
4.2 Select PNU parameter	FB287	Parameter	12	12: Homing speeds 1
4.3 Set the value to write	FB287	ValueWrite2	-	Unit: 0.1 rpm
4.4 Start	FB287	Start	↑	↑: start accessing
5. Set Homing speeds 2 (PNU13)				
5.1 Enable the writing function for the PNU parameter	FB287	ReadWrite	1	0: enable the reading function 1: enable the writing function
5.2 Select PNU parameter	FB287	Parameter	13	13: Homing speeds 2
5.3 Set the value to write	FB287	ValueWrite2		Unit: 0.1 rpm
5.4 Start	FB287	Start	↑	↑: start accessing
6. Set Homing acceleration (PNU14)				
6.1 Enable the writing function for the PNU parameter	FB287	ReadWrite	1	0: enable the reading function 1: enable the writing function
6.2 Select PNU parameter	FB287	Parameter	14	14: Homing acceleration
6.3 Set the value to write	FB287	ValueWrite2	-	Unit: ms; the time for acceleration from 0 rpm to 3000 rpm and deceleration from 3000 rpm to 0 rpm
6.4 Start	FB287	Start	↑	↑: start accessing
7. Set the servo to On	FB284	EnableAxis	1	0: Servo Off 1: Servo On
8. Execute the command	FB284	ExecuteMode	1	0: disable the function 1: command execution

Note: PNU10 (Homing method), PNU12 (Homing speeds 1), PNU13 (Homing speeds 2), and PNU14 (Homing acceleration) are volatile parameters. PNU11 (Home offset) is a non-volatile parameter only when P3.012.Z = 1.

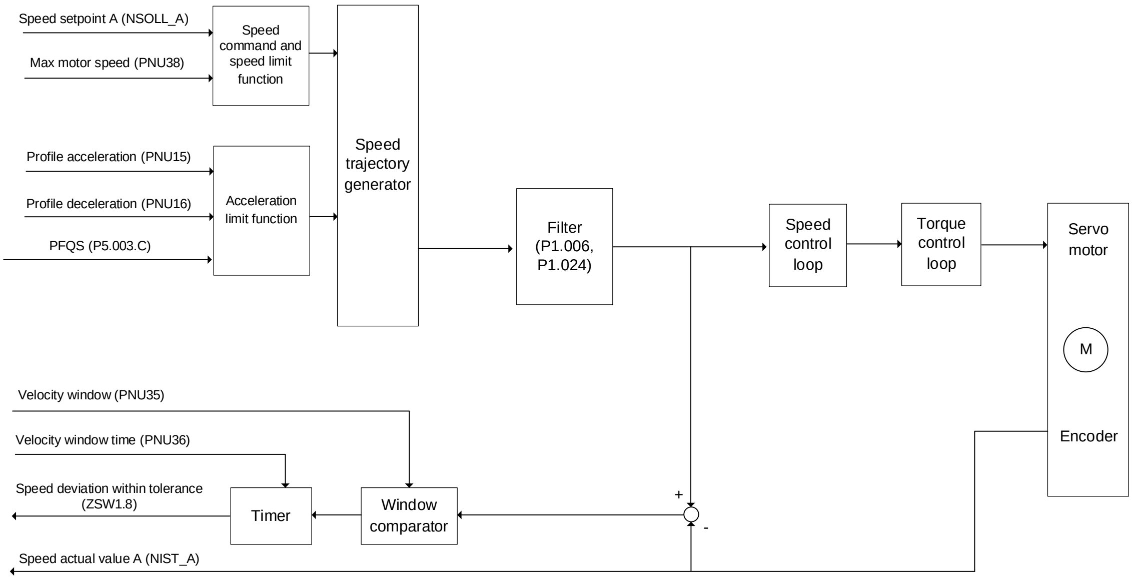
Read the servo data:

Step	FB	Pin	Read value	Description
1. Check if the homing reference point is established	FB284	AxisRef	-	0: reference point not set 1: reference point set

13.5.2 Telegram 1 (Profile Velocity mode)

When telegram 1 is used, the controller specifies the speed command and sets the acceleration / deceleration conditions, and then the trajectory generator in the servo drive plans the motion path according to these conditions.

The following figure shows the Profile Velocity mode architecture of the servo drive when telegram 1 is used:



Using the function blocks in the DriveLib of TIA Portal can achieve the basic speed control (SINA_SPEED, FB285) and access the PNU and servo parameters (SINA_PARA_S, FB287). The following is an example of using these function blocks.

Note:
1. Refer to Section 13.6 for the descriptions of function block pins.
2. You need to install DriveLib for TIA Portal V17 or older versions. Download the file from Siemens' website for installation.

Speed control

Operating condition: for FB285, the ConfigAxis pin must be set to 16#003F (default).

Step	FB	Pin	Setting value	Description
1. Set the rated speed	FB285	RefSpeed	-	Set the speed in units of rpm according to the motor specification.
2. Set the speed setpoint	FB285	SpeedSp	-	Unit: rpm
3. Set the Profile acceleration (PNU15)				
3.1 Enable the writing function for the PNU parameter	FB287	ReadWrite	1	0: enable the reading function 1: enable the writing function
3.2 Select PNU parameter	FB287	Parameter	15	15: Profile acceleration
3.3 Set the value to write	FB287	ValueWrite2	-	Unit: ms; the time for acceleration from 0 rpm to 3000 rpm
3.4 Start	FB287	Start	↑	↑: start accessing
4. Set the Profile deceleration (PNU16)				
4.1 Enable the writing function for the PNU parameter	FB287	ReadWrite	1	0: enable the reading function 1: enable the writing function
4.2 Select PNU parameter	FB287	Parameter	16	16: Profile deceleration
4.3 Set the value to write	FB287	ValueWrite2	-	Unit: ms; the time for deceleration from 3000 rpm to 0 rpm
4.4 Start	FB287	Start	↑	↑: start accessing
5. Set the servo to On	FB285	EnableAxis	1	0: Servo Off 1: Servo On

Note: PNU15 (Profile acceleration) and PNU16 (Profile deceleration) are volatile parameters.

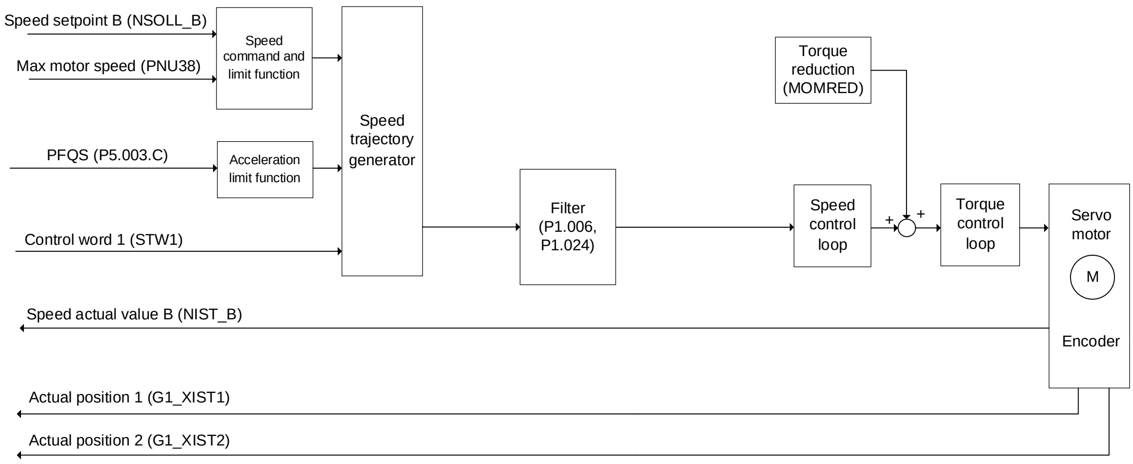
Read the servo data:

Step	FB	Pin	Read value	Description
1. Read the motor feedback speed at present	FB285	ActVelocity	-	Unit: rpm

13.5.3 Telegrams 3, 102, 105 (Cyclic Synchronous Velocity mode)

When telegram 3, 102, or 105 is used, the controller performs calculation for position control, and the servo drive is in charge of speed control. In this mode, every PZD the controller cyclically transmits to the servo drive contains both Speed setpoint B (NSOLL_B) data and Control word 1 (STW1) data. Currently, telegram 105 does not support dynamic servo control (DSC).

The following figure shows the Cyclic Synchronous Velocity mode architecture of the servo drive when telegram 3, 102, or 105 is used:



In TIA Portal, you can set the technology objects (TO) and MC function blocks for telegrams 3, 102, and 105 to perform motion control.

Note:

1. Only supports the Motion Control technology objects of V4.0, V5.0, V6.0.
2. When data is exchanged with the drive, the function of **Automatically apply drive values at runtime** is not available.
3. When data is exchanged with the encoder, the function of **Automatically apply encoder values at runtime** is not available.
4. Torque reduction (MOMRED) is only supported by telegrams 102 and 105; not supported by telegram 3.

Technology object configuration

Example:

1. Add new object → Add a new axis
2. Set the axis: Configuration → Hardware interface

(1) Drive

- Drive type: PROFIdrive
- Data connection: Drive
- Drive: [Drive device name].PROFIdrive Module AC1,3,4

(2) Encoder

- Data connection: Encoder
- Encoder: [Drive device name].PROFIdrive Module AC1,3,4
- Encoder type: Incremental, Cyclic absolute

Note: if using an absolute motor, set the Encoder type in the technology object Configuration window to “Cyclic absolute”.

(3) Data exchange with the drive

- Drive telegram: select telegram 3, 102, or 105
- Reference speed: corresponds to the rated speed of the rotary motor
- Maximum speed: corresponds to the maximum speed of the rotary motor
- Reference torque: corresponds to the maximum torque of the rotary motor
- Additional telegram: select supplementary telegram 750

Note:
1. B3A-P models do not support the function of **Automatically apply drive values at runtime**.
2. Reference torque can only be set in the Configuration window of telegrams 102 and 105. Incorrect setting may cause torque-related function errors.
3. The torque limits for technology object are in units of the physical quantity set in the Configuration window. Therefore, incorrectly setting the Reference torque causes the actual torque limit value to be wrong.
4. You need to select an Additional telegram after selecting the check box of **Torque data**.

(4) Data exchange with encoder

- Encoder telegram: select telegram 3, 102, or 105
- Measuring system: Rotary
- Set other fields according to the encode type.

<table>
<tr><th>Encoder type</th><th>Incremental</th><th>Absolute</th></tr>
<tr><td rowspan="2">Setting conditions</td><td colspan="2">Increments per revolution × 2^(Bits in Gx_XIST1) = Servo drive resolution</td></tr>
<tr><td>-</td><td>Increments per revolution × Number of revolutions × 2^(Bits in Gx_XIST2) = 2^{32}</td></tr>
<tr><td>Increments per revolution</td><td>65536 (recommended setting)</td><td>65536 (recommended setting)</td></tr>
<tr><td>Number of revolutions</td><td>-</td><td>256 (recommended setting)</td></tr>
<tr><td>Bits in Gx_XIST1</td><td>8 (recommended setting)</td><td>8 (recommended setting)</td></tr>
<tr><td>Bits in Gx_XIST2</td><td>-</td><td>8 (recommended setting)</td></tr>
</table>

Note: B3A-P models do not support the function of **Automatically apply encoder values at runtime**.

Motion command planning

You can add MC function blocks as required. The following briefly introduces the MC function blocks for planning the motion commands. Refer to the controller manual for detailed descriptions.

- MC_Power: enable or disable the technology object.
- MC_Reset: acknowledge the alarm and restart the technology object.
- MC_Home: execute homing for the technology object.
- MC_Halt: pause the axis.
- MC_Stop: stop the axis.
- MC_MoveAbsolute: perform absolute positioning of the axis.
- MC_MoveRelative: perform relative positioning of the axis.
- MC_MoveVelocity: move the axis at a constant velocity.
- MC_MoveJog: move the axis with jog operation.
- MC_MoveSuperimposed: start a relative positioning command which is superimposed on the current positioning command.
- MC_TorqueLimiting*: set the torque limit value for the axis.
- MC_TorqueRange*: set the upper and lower torque limits for the axis.

Note:
1. MC_TorqueLimiting is supported by telegrams 102 and 105 only.
2. MC_TorqueRange must be used with supplementary telegram 750.

Example of using the absolute positioning command:

Step	FB	Pin	Input value	Description
1. Enable or disable the technology object				
1.1 Set the axis	MC_Power	Axis	-	Axis name of the technology object
1.2 Set the servo to On	MC_Power	Enable	1	0: Servo Off 1: Servo On
2. Execute homing for the technology object				
2.1 Set the axis	MC_Home	Axis	-	Axis name of the technology object
2.2 Operating mode	MC_Home	Mode	-	Set the homing method according to the controller
2.3 Start	MC_Home	Execute	↑	↑: trigger the command
3. Perform absolute positioning of the axis			-	
3.1 Set the axis	MC_Move Absolute	Axis	-	Axis name of the technology object
3.2 Velocity setting	MC_Move Absolute	Velocity	-	Unit: the unit set by the controller/sec
3.3 Absolute target position	MC_Move Absolute	Position	-	Unit: the unit set by the controller
3.4 Start	MC_Move Absolute	Execute	↑	↑: trigger the command

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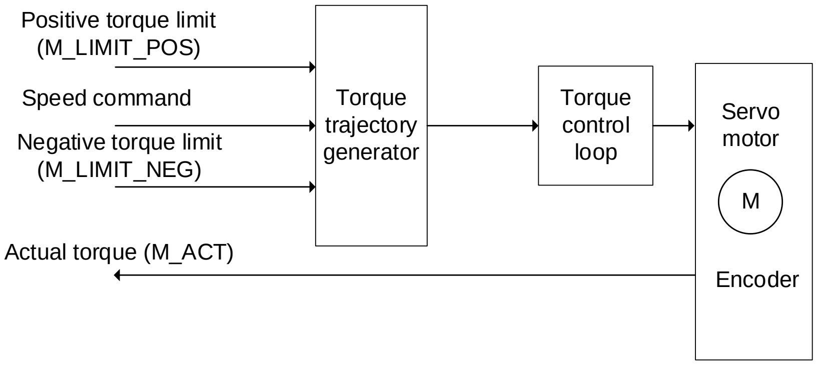
13.5.4 Supplementary telegram 750 (torque limits)

When you use the main telegram with a supplementary telegram 750, the servo drive supports the positive / negative torque limit functions and provides a real-time value of the Actual torque.



Main telegram	Supplementary telegram	Positive / negative torque limit setting method
Standard telegram 1	Siemens telegram 750	Through setting the M_LIMIT_POS and M_LIMIT_NEG of PZD.
Siemens telegram 111	Siemens telegram 750	
Standard telegram 3	Siemens telegram 750	Through the MC_TorqueRange.
Siemens telegram 102	Siemens telegram 750	
Siemens telegram 105	Siemens telegram 750	

Example of using telegrams 1 or 111 with supplementary telegram 750:

Step	FB	Pin	Input value	Description
1. Add a CALCULATE function block				Add a conversion function block for positive torque limit
1.1 Set the variable type	CALCULATE	-	REAL	Set the variable type of the formula
1.2 Add an input pin	CALCULATE	IN3	-	Add an input variable (IN3) for the formula
1.3 Enter the formula	CALCULATE		IN1 * IN2 / IN3	
2. Enter the conversion ratio	CALCULATE	IN2	16#4000	Unit: 16#4000h indicates the motor max. torque
3. Enter the percentage of the motor max. torque	CALCULATE	IN3	350.0	Servo drive max. output torque
4. Set the output address	CALCULATE	OUT	-	Set the M_LIMIT_POS address of PZD
5. Set the percentage of positive torque limit	CALCULATE	IN1	-	Setting range: 0 - 3500 Indicates the torque limit 0% - 350%
6. Add a CALCULATE function block				Add a conversion function block for negative torque limit
6.1 Set the variable type	CALCULATE	-	REAL	Set the variable type of the formula
6.2 Add an input pin	CALCULATE	IN3	-	Add an input variable (IN3) for the formula
6.3 Enter the formula	CALCULATE		IN1 * IN2 / IN3	
7. Enter the conversion ratio	CALCULATE	IN2	16#4000	Unit: 16#4000h indicates the motor max. torque
8. Enter the percentage of the motor max. torque	CALCULATE	IN3	350.0	Servo drive max. output torque
9. Set the output address	CALCULATE	OUT	-	Set the M_LIMIT_NEG address of PZD
10. Set the percentage of negative torque limit	CALCULATE	IN1	-	Setting range: 0 to -3500 Indicates the torque limit 0% to -350%

Note:

1. If you set the positive torque limit lower than 0 or larger than 3500, the torque limit will be clamped at 0% or 350% to protect the servo drive and motor.
2. If you set the negative torque limit larger than 0 or lower than -3500, the torque limit will be clamped at 0% or -350% to protect the servo drive and motor.

Example of using telegrams 3, 102, or 105 with supplementary telegram 750:

Step	FB	Pin	Input value	Description
1. Set the torque limits				
1.1 Set the axis	MC_TorqueRange	Axis	-	Axis name of the technology object
1.2 Set the upper torque limit	MC_TorqueRange	UpperLimit	-	Unit: according to the physical quantity set for the technology object
1.3 Set the lower torque limit	MC_TorqueRange	LowerLimit	-	Unit: according to the physical quantity set for the technology object
2. Activate the torque limits	MC_TorqueRange	Enable	1	0: cancel the torque limits 1: activate the torque limits

13.5.5 Accessing servo parameters

The controller can access the servo parameters with PNU2XXXX by using the function block SINA_PARA_S (FB287).

Parameter address conversion:

PNU parameter	Servo parameter
PNU2ABCD	PA.BCD

Example 1: set the servo parameter P1.044 to 16777216

Step	FB	Pin	Input value	Description
1. Enable the writing function for parameters	FB287	ReadWrite	1	0: enable the reading function 1: enable the writing function
2. Select PNU parameter	FB287	Parameter	21044	21044 corresponds to P1.044
3. Set the value to write	FB287	ValueWrite2	16777216	Servo parameter value Note: the input value should be in decimal. If the parameter value is in hex, convert it into a decimal value.
4. Start	FB287	Start	↑	↑: start accessing

Example 2: read the servo parameter P0.001

Step	FB	Pin	Input value	Description
1. Enable the reading function for parameters	FB287	ReadWrite	0	0: enable the reading function 1: enable the writing function
2. Select PNU parameter	FB287	Parameter	20001	20001 corresponds to P0.001
3. Start	FB287	Start	↑	↑: start accessing

Read the servo data:

Step	FB	Pin	Read value	Description
1. Read the servo parameter value	FB284	ValueRead2	-	The read value is displayed in decimal. If the parameter value is in hex, it is converted into a decimal value.

13.6 SINA function blocks and PNU parameters

13.6.1 Position control (SINA_POS, FB284)

When using telegram 111, you can achieve the basic positioning control with FB284. The description of the function block is as follows.

SINA_POS (FB284)				
Input pin	Data type	Default	Function	Description
ModePos	INT	0	Operating mode	1: relative positioning 2: absolute positioning 3: positioning as setup 4: homing 5: regard the current feedback position as the origin 6: reserved 7: jog 8: incremental jogging
EnableAxis	BOOL	0	Servo On / Off	0: Servo Off 1: Servo On
CancelTraversing	BOOL	1	Cancel current command	0: cancel the current command 1: disable the function Note: when this pin = 0, you need to reissue the command.
IntermediateStop	BOOL	1	Pause current command	0: pause the current command 1: disable the function
Positive	BOOL	0	Direction for signal positioning and signal setting-up: positive	0: disable the function 1: operate in positive direction
Negative	BOOL	0	Direction for signal positioning and signal setting-up: negative	0: disable the function 1: operate in negative direction
Jog 1	BOOL	0	Jog 1 function	0: disable the function 1: execute Jog 1
Jog 2	BOOL	0	Jog 2 function	0: disable the function 1: execute Jog 2
FlyRef	BOOL	0	Reserved	-
AckError	BOOL	0	Servo alarm reset	: reset the servo alarm
ExecuteMode	BOOL	0	Execute commands of signal positioning and signal setting-up	: execute commands of signal positioning and signal setting-up 1: start homing (only when ModePos = 4 or 5)
Position	DINT	0	Position setpoint when ModePos = 1 and 2	Unit: PUU
Velocity	DINT	0	Speed setpoint when ModePos = 1, 2, and 3	Unit: 1000 PUU/min
OverV	INT	100	Velocity override	Setting range: 0 - 199%
OverAcc	INT	100	Acceleration override	Setting range: 0 - 100% The percentage is based on PNU43 (Max acceleration)
OverDec	INT	100	Deceleration override	Setting range: 0 - 100% The percentage is based on PNU44 (Max deceleration)

SINA_POS (FB284)				
Input pin	Data type	Default	Function	Description
ConfigEPos	DWORD	16#3	Control bit of telegram 111	The motor runs only when Bit 0 and Bit 1 are both 1.
			Bit 0: free-run stop (OFF2 triggering)	0: trigger OFF2; servo displays AL013 1: clear OFF2
			Bit 1: PFQS (OFF3 triggering)	0: trigger OFF3; servo displays AL35F 1: clear OFF3
			Bit 2: software limit switch	0: disable the function 1: enable the software limit switch
			Bit 3: hardware limit switch	0: disable the function 1: enable the hardware limit switch
			Bit 4 - 7: reserved	-
			Bit 8: how the command becomes effective when ModePos = 2 or 3	0: effective when ExecuteMode is triggered 1: effective once the command setting value is changed
			Bit 9 - 15: reserved	-
HWIDSTW	HW_IO	0	Hardware ID of telegram 111	Hardware ID in the Device view; same as HWIDZTW.
HWIDZSW	HW_IO	0	Hardware ID of telegram 111	Hardware ID in the Device view; same as HWIDSTW.

Note: if OverAcc (Acceleration override) or OverDec (Deceleration override) = 0, the acceleration or deceleration time is 65500 ms.

SINA_POS (FB284)				
Output pin	Data type	Default	Function	Description
AxisEnabled	BOOL	0	Servo state	0: Servo Off 1: Servo On
AxisPosOk	BOOL	0	Target position reached	1: target position reached
AxisSpFixed	BOOL	0	Zero speed signal	1: zero speed signal
AxisRef	BOOL	0	Set reference point	1: reference point set
AxisWarn	BOOL	0	Servo error (warning)	1: servo error (warning)
AxisError	BOOL	0	Servo error (alarm)	1: servo error (alarm)
Lockout	BOOL	0	Servo switching on inhibited	0: operation allowed 1: operation inhibited Check if Bit 0 and Bit 1 of ConfigEPos are both 1
ActVelocity	DINT	0	Actual velocity	The actual velocity. Read value (unit: 16#40000000h indicates 100% of the motor rated speed) * rotary motor rated speed / 16#40000000h = Actual velocity (unit: rpm)
ActPosition	DINT	0	Actual position	Actual position (unit: PUU)
ActMode	INT	0	Current operating mode	Displays the setting value of ModePos
EPosZSW1	WORD	0	Status of EPosZSW1	Displays the status of EPosZSW1; not yet supported
EPosZSW2	WORD	0	Status of EPosZSW2	Displays the status of EPosZSW2; not yet supported
ActWarn	WORD	0	Servo error code (Warning)	Displays the error code of the warning. For instance, when the servo displays AL013, the output is 16#0013h.
ActFault	WORD	0	Servo error code (Alarm)	Displays the error code of the alarm. For instance, when the servo displays AL02A, the output is 16#002Ah.
Error	BOOL	0	Controller error present	0: controller is in normal operation 1: controller is in error
Status	WORD	0	Status	16#7002: no error; function block is in execution 16#8401: servo is in error 16#8402: servo switching on inhibited 16#8403: in operation; homing cannot be executed 16#8600: DPRD_DAT error 16#8601: DPWR_DAT error 16#8202: incorrect operating mode 16#8203: incorrect setpoints parameterized 16#8204: incorrect program block (the function is not yet supported)
DiagID	WORD	0	Communication error when SFB is called	SFB (system function block) is in error

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13.6.2 Speed control (SINA_SPEED, FB285)

When using telegram 1, you can achieve the basic speed control with FB285. The description of the function block is as follows.

SINA_SPEED (FB285)				
Input pin	Data type	Default	Function	Description
EnableAxis	BOOL	0	Servo On / Off	0: Servo Off 1: Servo On
AckError	BOOL	0	Servo alarm reset	↑: reset the servo alarm
SpeedSp	REAL	0.0	Speed setpoint	Unit: rpm
RefSpeed	REAL	0.0	Motor rated speed	Unit: rpm
ConfigAxis	WORD	16#003F	Control bit of telegram 1	The motor runs only when Bit 0 and Bit 1 are both 1.
			Bit 0: free-run stop (OFF2 triggering)	0: trigger OFF2; servo displays AL013 1: clear OFF2
			Bit 1: PFQS (OFF3 triggering)	0: trigger OFF3; servo displays AL35F 1: clear OFF3
			Bit 2: ready for operation	0: disable operation 1: enable operation
			Bit 3: Quick stop	0: servo is in the Quick stop state 1: disable the function
			Bit 4: Halt	0: halt the operation; once the halt function is disabled, the operation continues until the command is complete 1: disable the function
			Bit 5: command triggering	0: disable the function 1: trigger the command
			Bit 6 - 15: reserved	-
HWIDSTW	HW_IO	0	Hardware ID of telegram 1	Hardware ID in the Device view; same as HWIDZSW.
HWIDZSW	HW_IO	0	Hardware ID of telegram 1	Hardware ID in the Device view; same as HWIDSTW.

SINA_SPEED (FB285)				
Output pin	Data type	Default	Function	Description
AxisEnabled	BOOL	0	Servo state	0: Servo Off 1: Servo On
Lockout	BOOL	0	Servo switching on inhibited	0: operation allowed 1: operation inhibited Check if Bit 0 and Bit 1 of ConfigEPos are both 1
ActVelocity	REAL	0.0	Actual velocity	Unit: rpm
Error	BOOL	0	Servo error present	0: servo is in normal operation 1: servo is in error
Status	INT	0	Status	16#7002: no error; function block is in execution 16#8401: servo is in error 16#8402: servo switching on inhibited 16#8600: DPRD_DAT error 16#8601: DPWR_DAT error
DiagID	WORD	0	Communication error when SFB is called	SFB (system function block) is in error

13.6.3 Acyclic reading / writing (SINA_PARA_S, FB287)

When using telegram 1, 3, 102, 105, or 111, you can read and write PNU parameters with FB287. The description of the function block is as follows.

SINA_PARA_S (FB287)				
Input pin	Data type	Default	Function	Description
Start	BOOL	0	Start	↑: start accessing
ReadWrite	BOOL	0	Accessing	0: enable the reading function 1: enable the writing function
Parameter	INT	1	PNU parameter	Refer to Section 13.6.4 for PNU parameter numbers. PNU parameters are written through ValueWrite2.
Index	INT	0	PNU parameter index	Refer to the description of each PNU parameter.
ValueWrite1	REAL	0.0	Field for writing the parameter value (REAL)	No need to use this pin.
ValueWrite2	DINT	0	Field for writing the parameter value (DINT)	Currently used for all PNU parameters.
AxisNo	INT	1	Axis number	No need to change the number.
hardwareId	HW_IO	0	Hardware ID	Hardware ID in the Device view.

SINA_PARA_S (FB287)				
Output pin	Data type	Default	Function	Description
Ready	BOOL	0	Ready	This output pin only remains for one PLC scan cycle.
Busy	BOOL	0	Command being processed	1: reading / writing parameters
Done	BOOL	0	Command complete	1: finished reading / writing parameters
ValueRead1	REAL	0	Field for reading the parameter value (REAL)	No need to use this pin.
ValueRead2	DINT	0	Field for reading the parameter value (DINT)	The read value of PNU parameter.
Format	INT	0	Format of the read parameter	Parameter format code defined by the PROFIdrive profile.
ErrorNo	INT	0	Display of error code	Error code defined by the PROFIdrive profile.
Error	BOOL	0	Error present	1: controller error present
ErrorId	DWORD	0	Error ID	Contact the controller manufacturer.
DiagId	WORD	0	Communication error when SFB is called	SFB (system function block) is in error.

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13.6.4 PNU parameters

Important: currently only some PNU parameters are non-volatile. Refer to the description of P3.012.

PNU10: Homing method

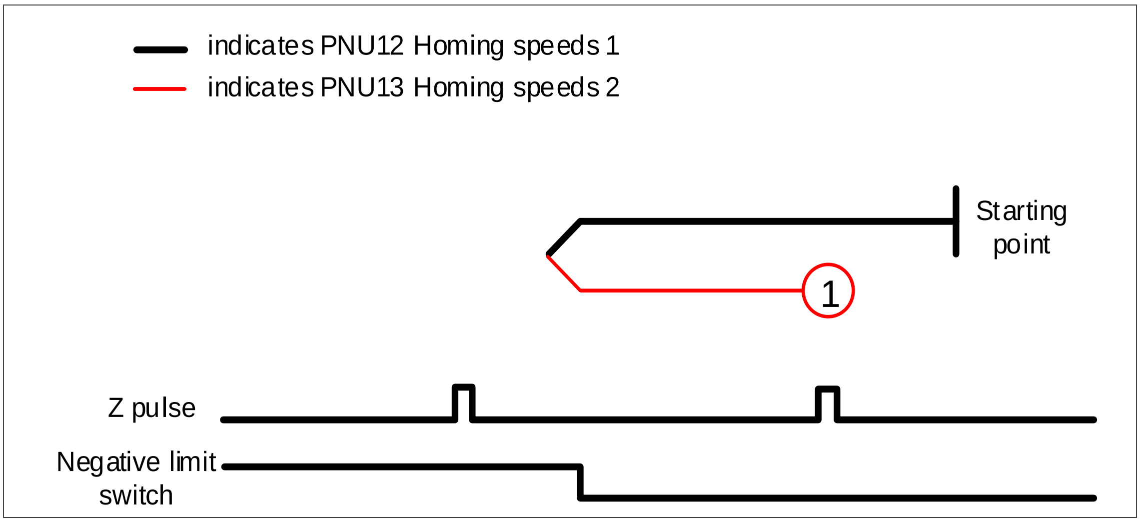
Index	0
Name	Homing method
Data type	INTEGER32
Access	RW
Setting range	0 - 35
Default	0
Applicable telegram	Telegram 111: Homing

Function:

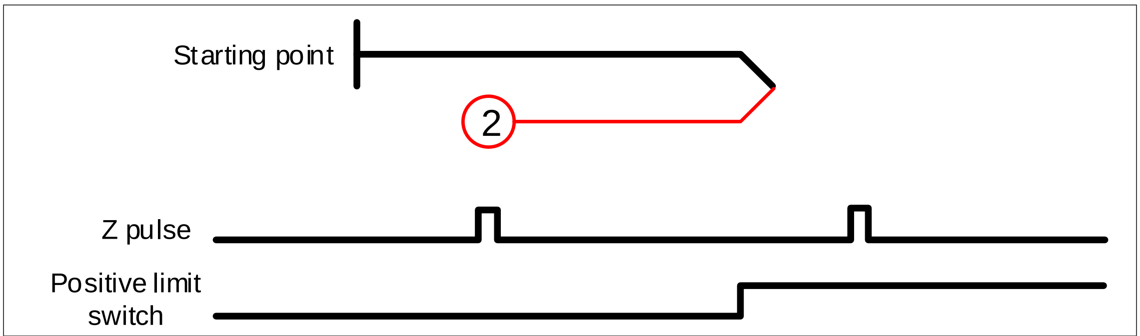
The homing methods include looking for the Z pulse (Methods 1 - 14, 33, 34), not looking for the Z pulse (Methods 17 - 30), and defining the current position as the origin (Method 35). Methods 15, 16, 31, and 32 are reserved.

To use Methods 1 to 35, set PNU10 = 1 to 35.

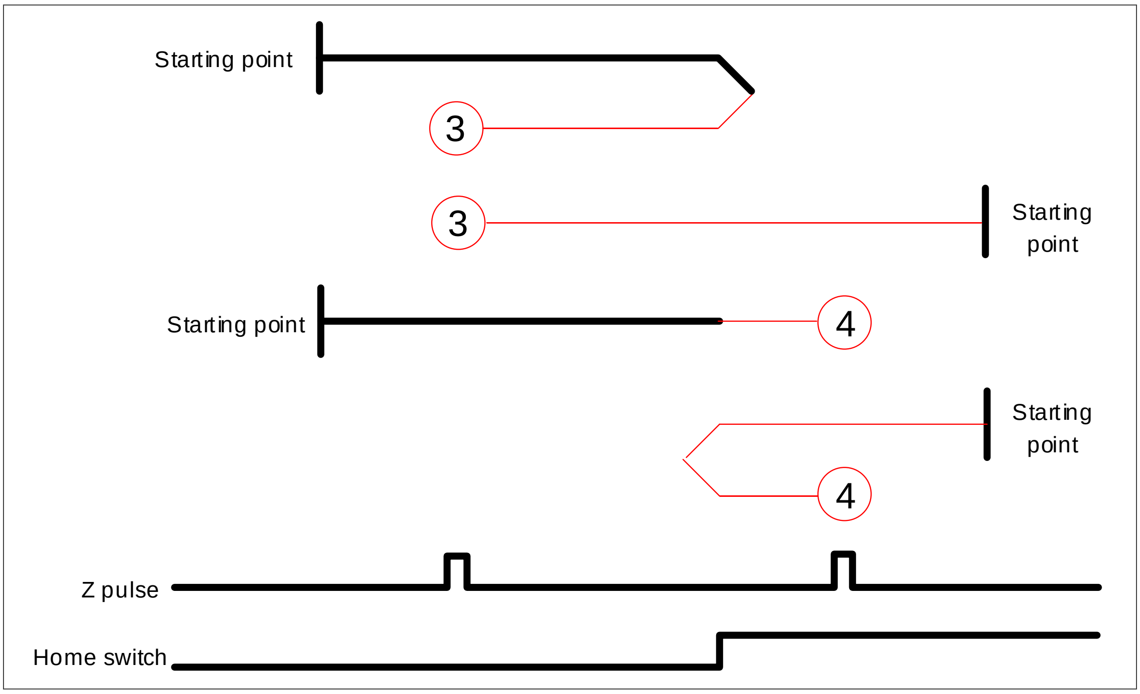
Method 1: homing on the negative limit switch and Z pulse



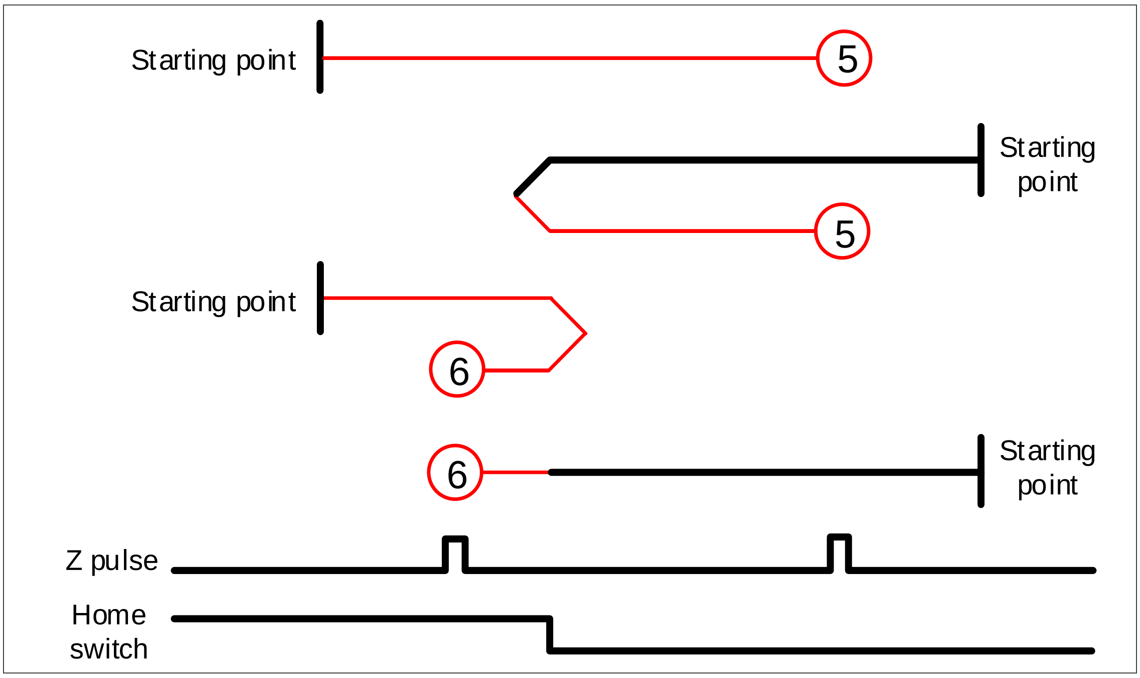
Method 2: homing on the positive limit switch and Z pulse



Methods 3 and 4: homing on the home switch and Z pulse



Methods 5 and 6: homing on the home switch and Z pulse



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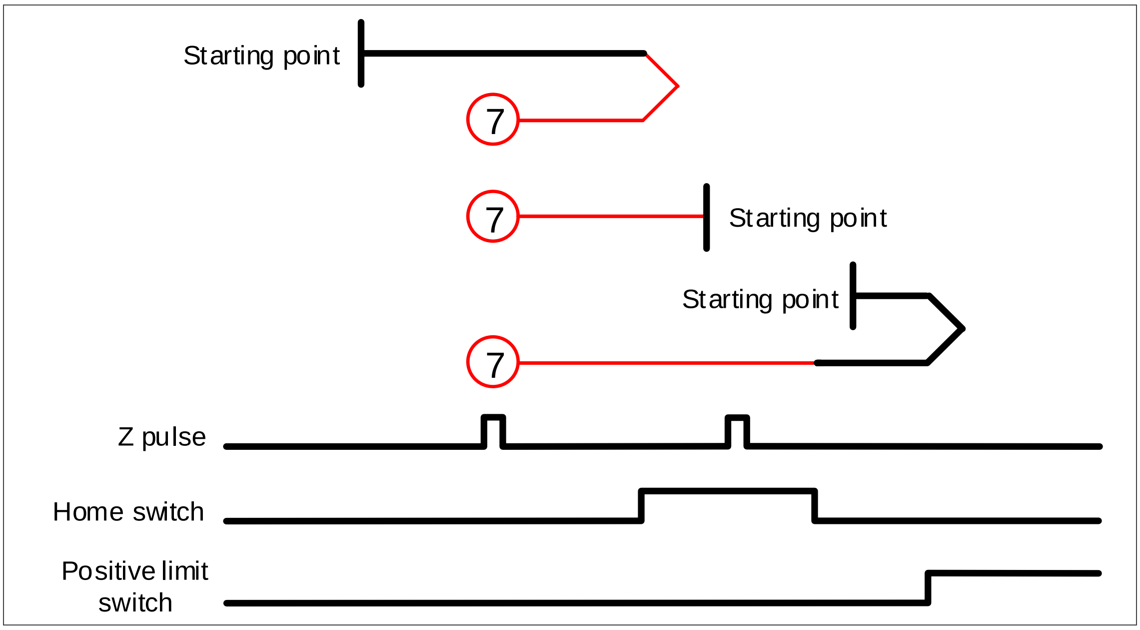
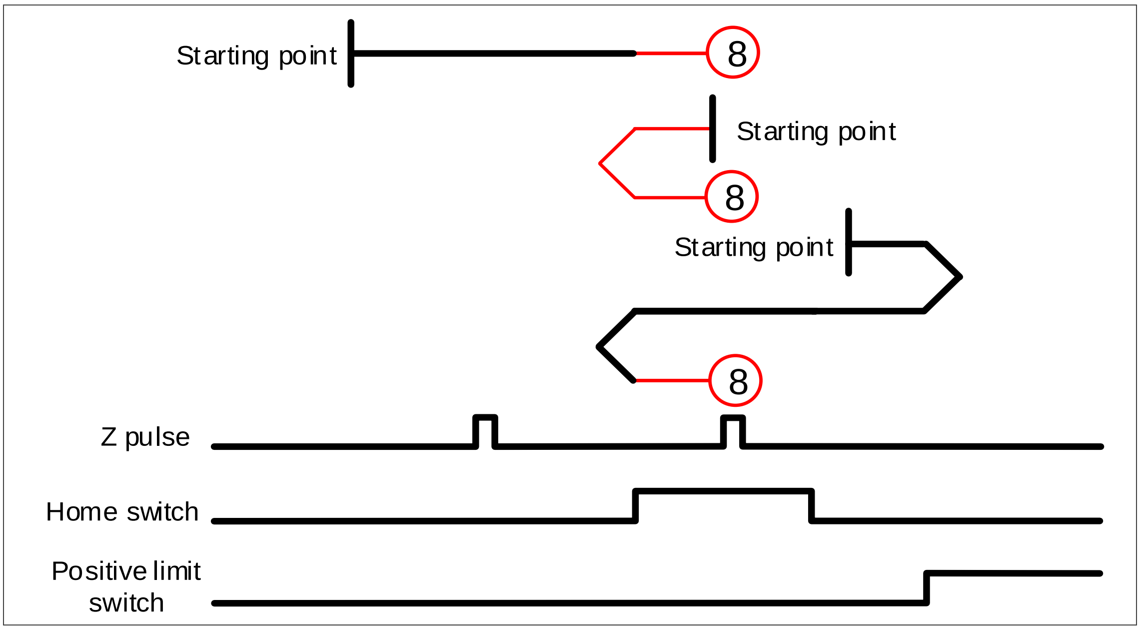
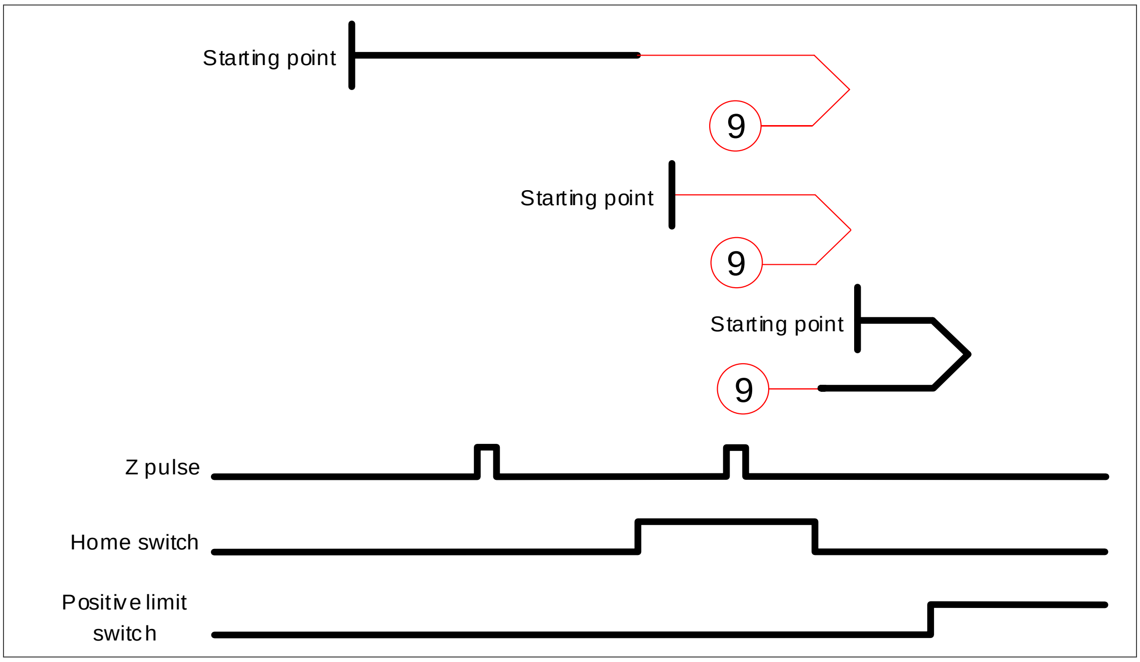
Method 7: homing on the positive limit switch, home switch, and Z pulse



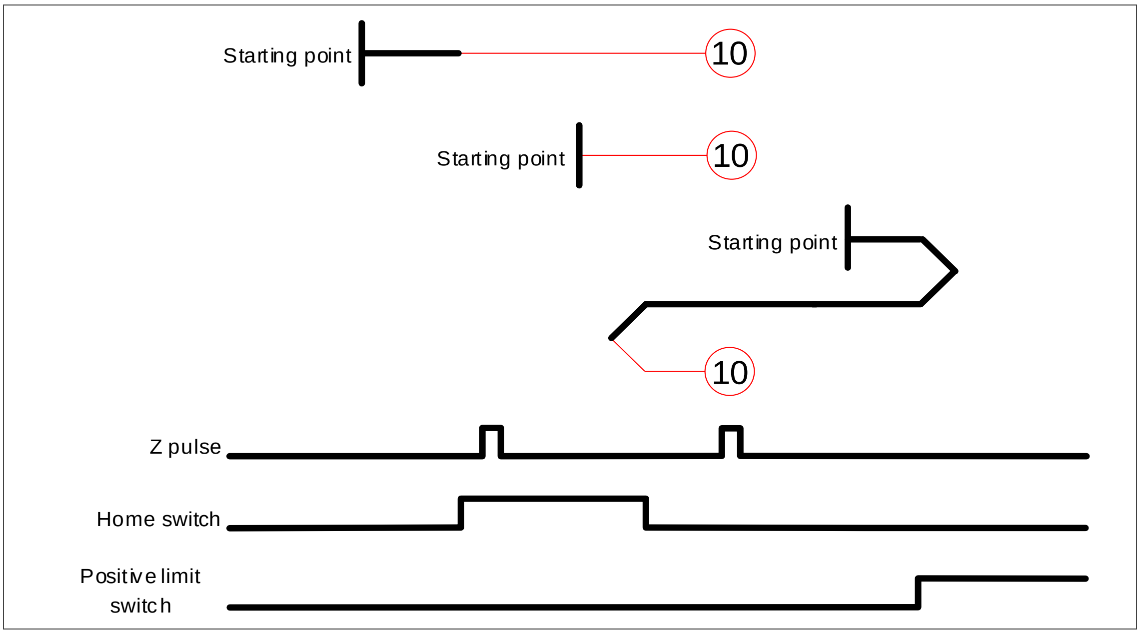
Method 8: homing on the positive limit switch, home switch, and Z pulse



Method 9: homing on the positive limit switch, home switch, and Z pulse



Method 10: homing on the positive limit switch, home switch, and Z pulse



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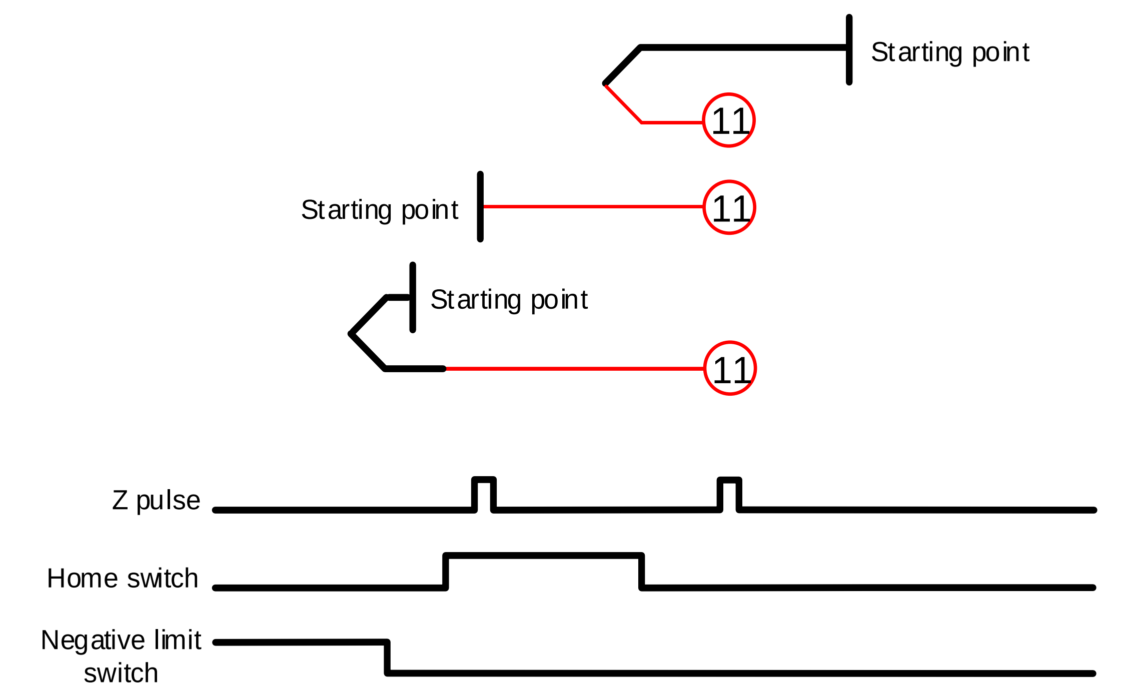
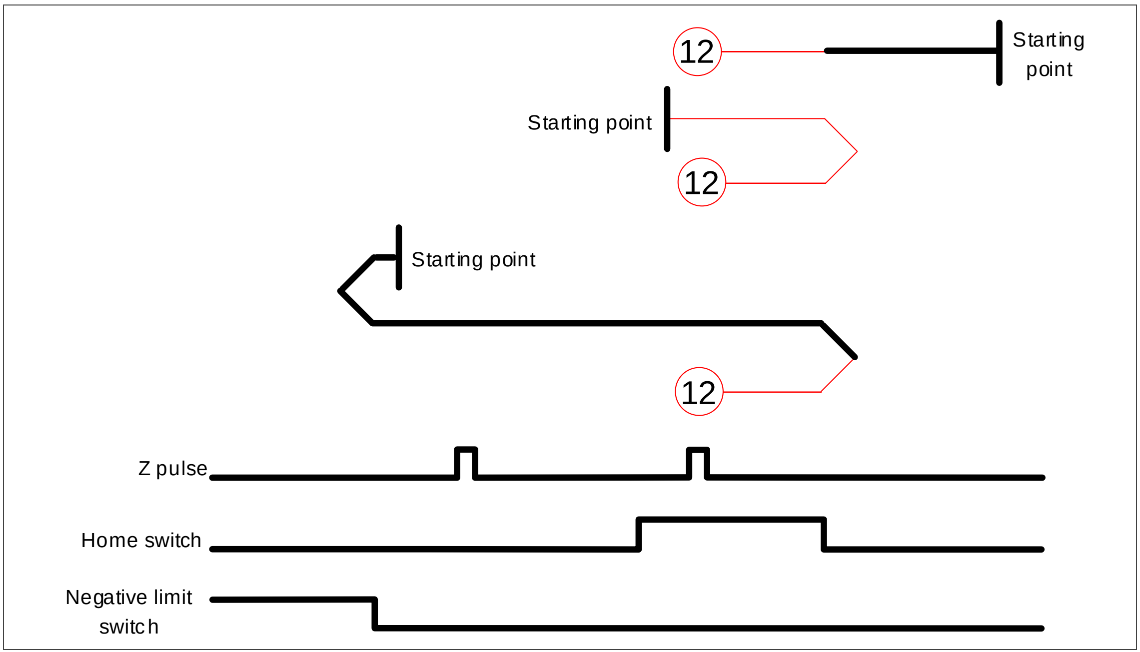
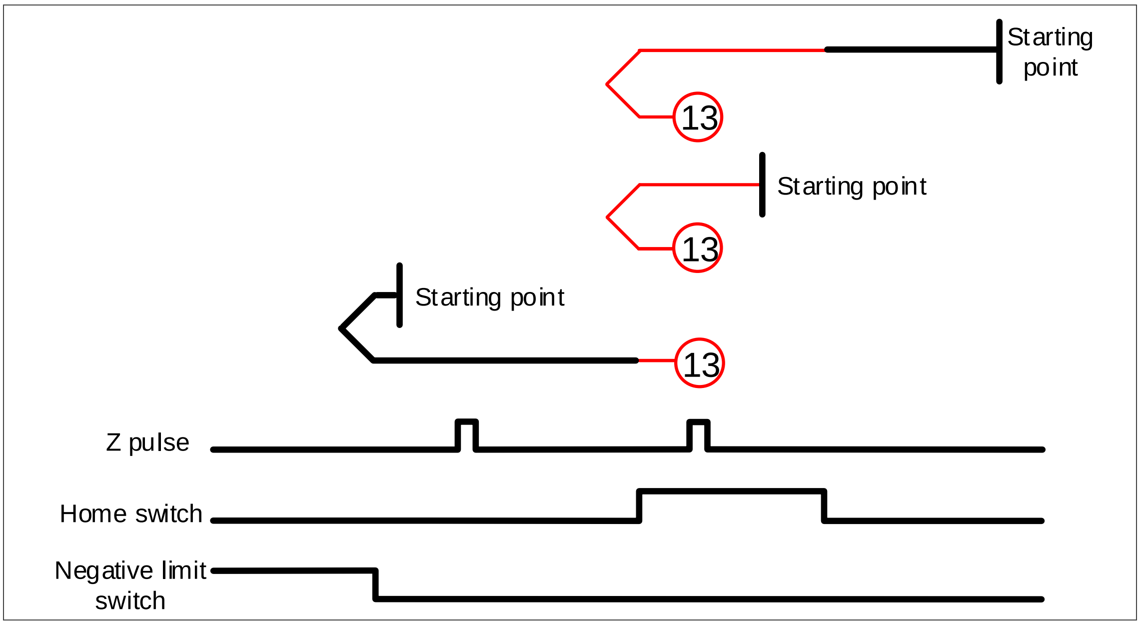
Method 11: homing on the negative limit switch, home switch, and Z pulse



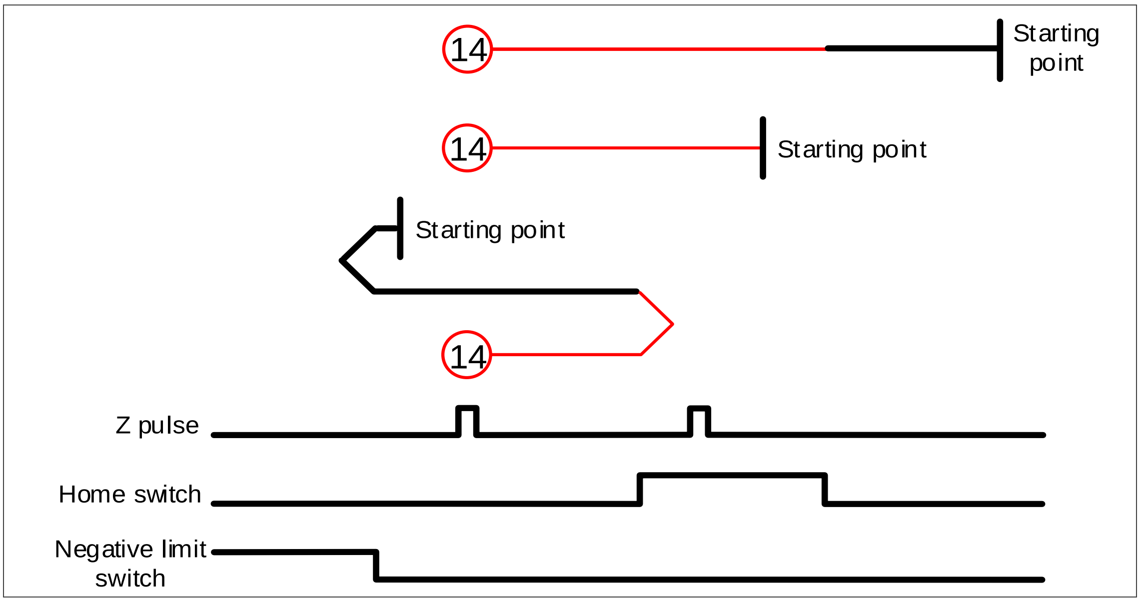
Method 12: homing on the negative limit switch, home switch, and Z pulse



Method 13: homing on the negative limit switch, home switch, and Z pulse



Method 14: homing on the negative limit switch, home switch, and Z pulse



Methods 15 and 16: reserved

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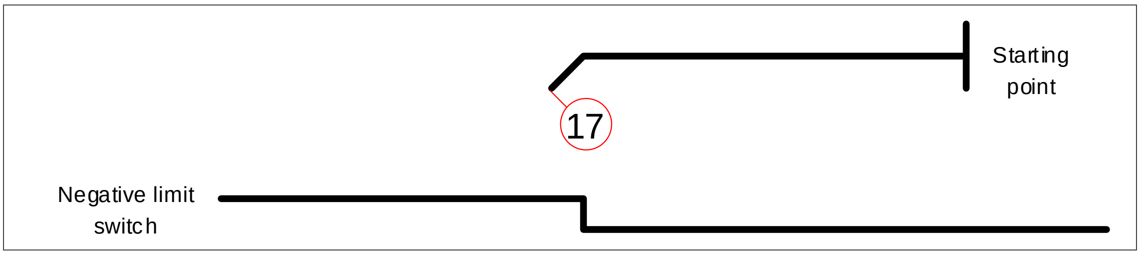
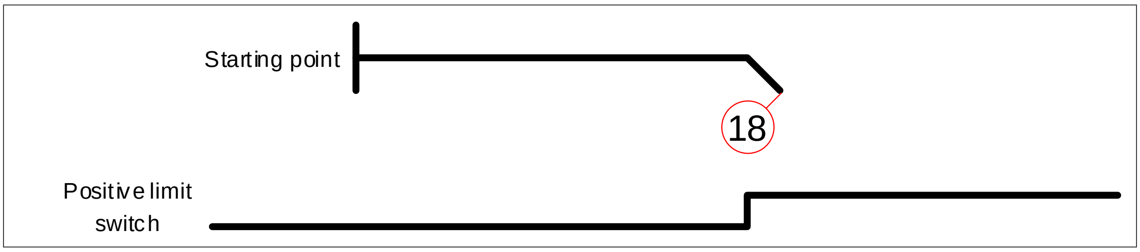
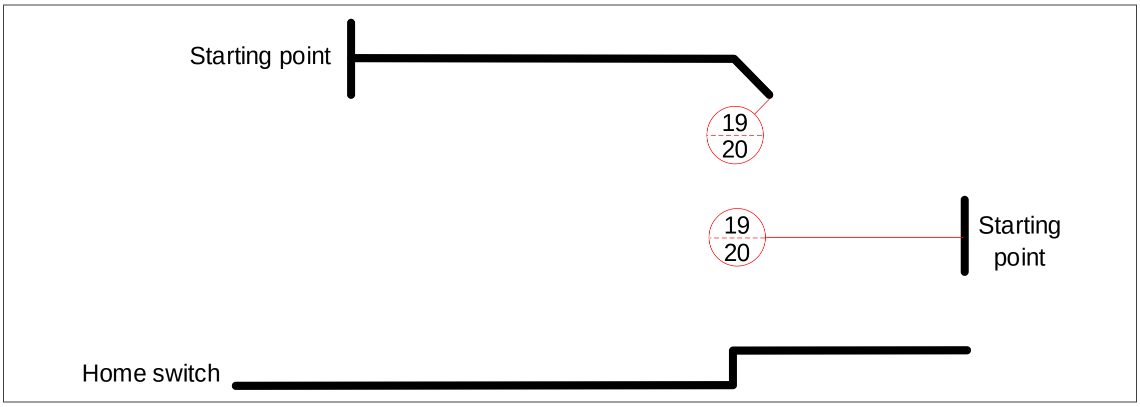
Method 17: homing on the negative limit switch



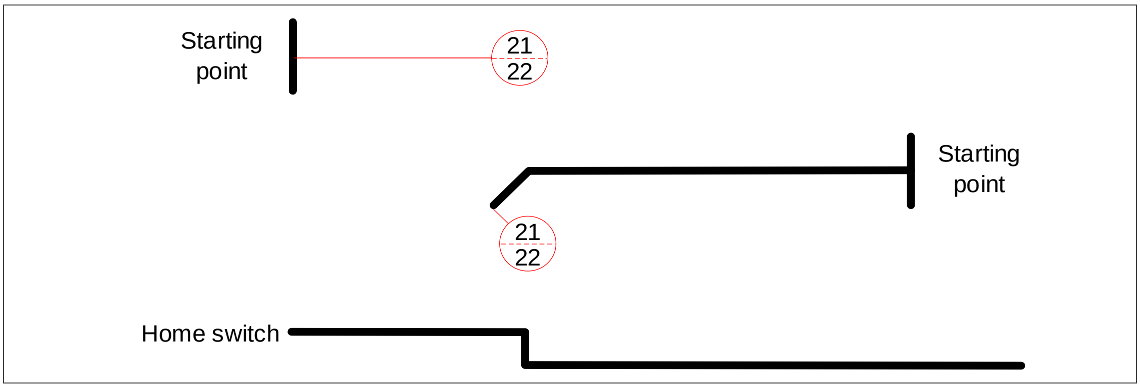
Method 18: homing on the positive limit switch



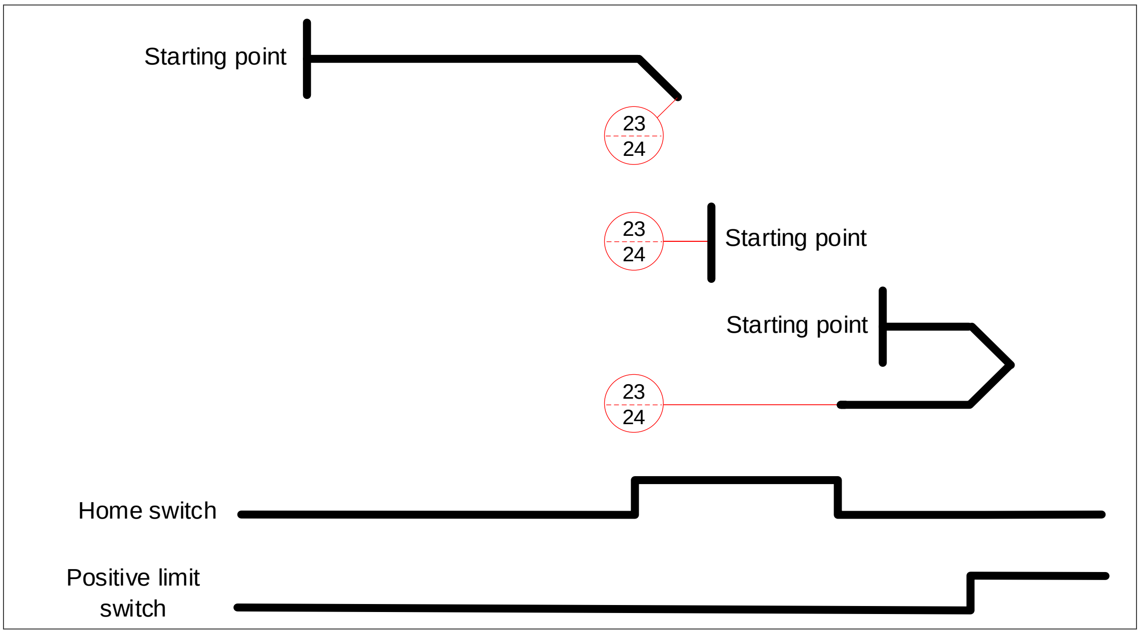
Methods 19 and 20: homing on the home switch



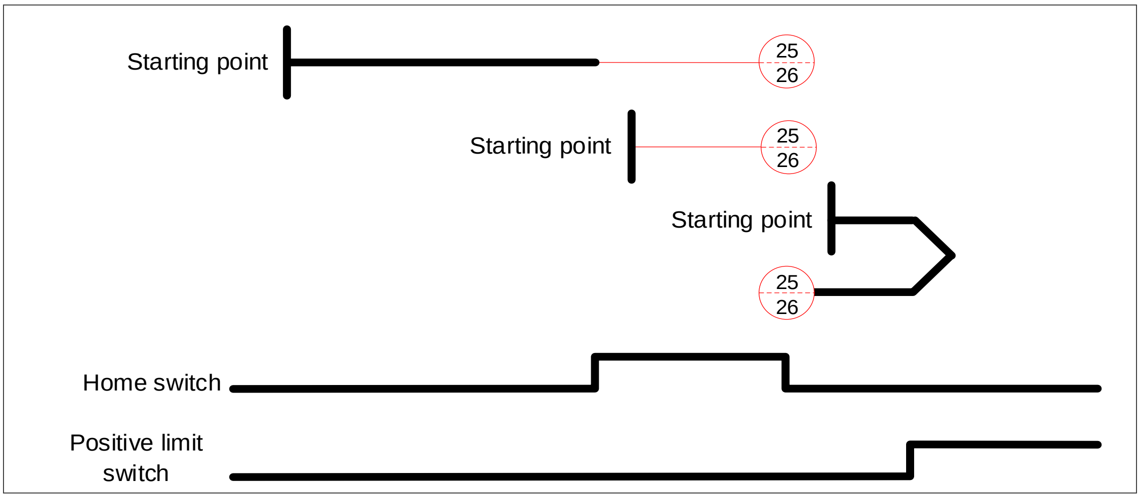
Methods 21 and 22: homing on the home switch



Methods 23 and 24: homing on the positive limit switch and home switch



Methods 25 and 26: homing on the positive limit switch and home switch



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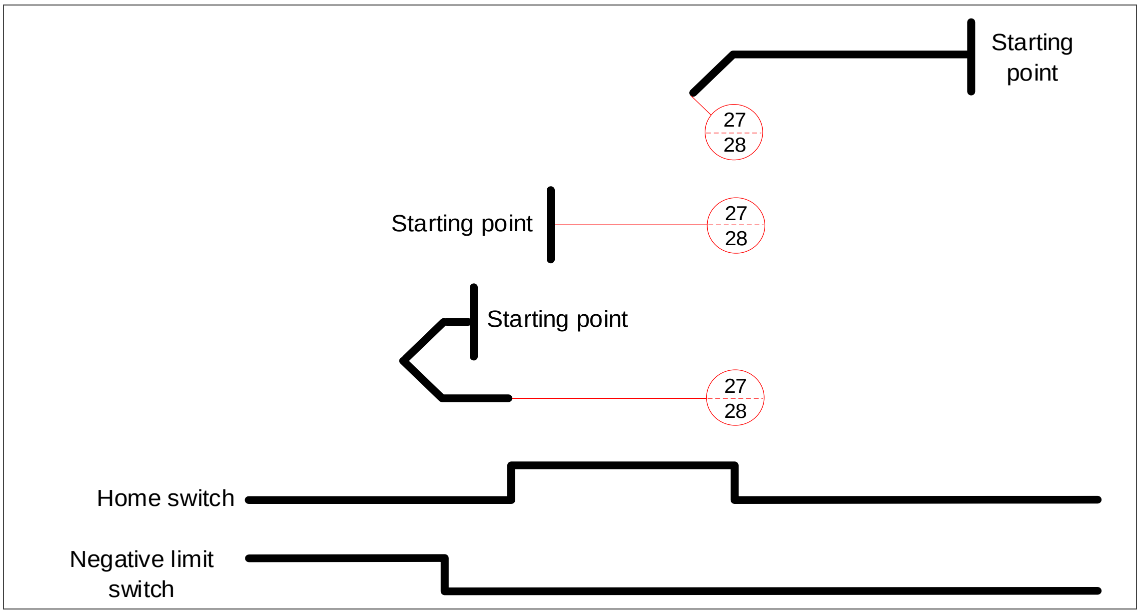
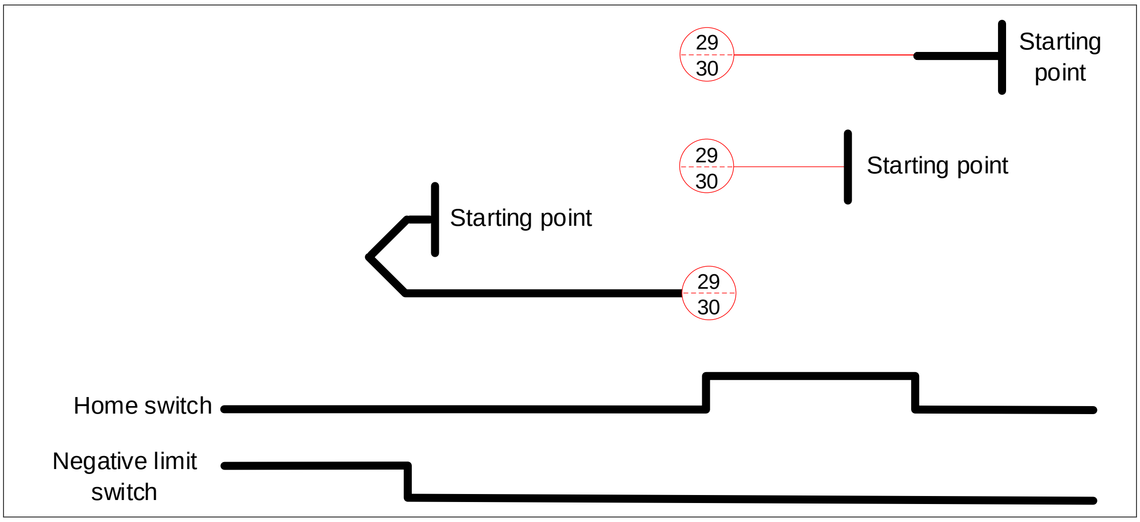
Methods 27 and 28: homing on the negative limit switch and home switch

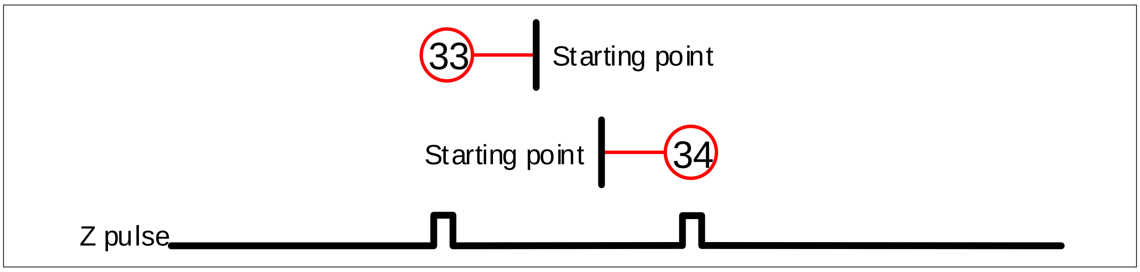


Methods 29 and 30: homing on the negative limit switch and home switch



Methods 31 and 32: reserved

Methods 33 and 34: homing on the Z pulse



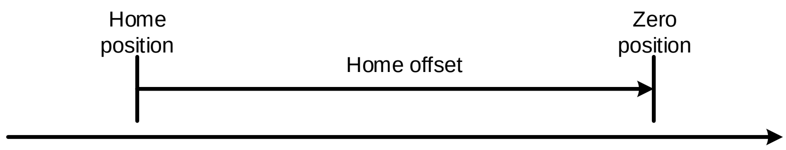
Method 35: define the current feedback position as the origin

PNU11: Home offset

Index	0
Name	Home offset
Data type	INTEGER32
Access	RW
Setting range	-2147483648 to +2147483647
Default	0
Unit	PUU
Applicable telegram	Telegram 111: Homing

Function:

The origin reference point the system looks for during the homing procedure is Home Position, 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 (Zero position), and the offset value is Home offset.



Note: when P3.012.Z = 1, the non-volatile setting for this parameter is enabled.

PNU12: Homing speeds 1

Index	0
Description	Speed during search for switch
Data type	UNSIGNED32
Access	RW
Setting range	1 - 20000
Default	100
Unit	0.1 rpm
Applicable telegram	Telegram 111: Homing

PNU13: Homing speeds 2

Index	0
Description	Speed during search for zero
Data type	UNSIGNED32
Access	RW
Setting range	1 - 5000
Default	20
Unit	0.1 rpm
Applicable telegram	Telegram 111: Homing

PNU14: Homing acceleration

Index	0
Name	Homing acceleration
Data type	UNSIGNED32
Access	RW
Setting range	1 - 65500
Default	100
Unit	ms
Applicable telegram	Telegram 111: Homing

Function:

Sets the time required for the motor to accelerate from 0 rpm to 3,000 rpm and decelerate from 3,000 rpm to 0 rpm.

PNU15: Profile acceleration

Index	0
Name	Profile acceleration
Data type	UNSIGNED32
Access	RW
Setting range	1 - 65500
Default	200
Unit	ms
Applicable telegram	Telegram 1 Telegram 111: read-only

Function:

Sets the time required for the motor to accelerate from 0 rpm to 3,000 rpm. When using telegram 111, this parameter is read-only for checking the actual profile acceleration; for the calculation of the actual acceleration, refer to the description of PNU43.

PNU16: Profile deceleration

Index	0
Name	Profile deceleration
Data type	UNSIGNED32
Access	Telegram 1: RW Telegram 111: RO
Setting range	1 - 65500
Default	200
Unit	ms
Applicable telegram	Telegram 1 Telegram 111: read-only

Function:

The time slope set by this parameter is the time required for the motor to decelerate from 3,000 rpm to 0 rpm. This parameter only works when telegram 111 (Profile Position mode) or telegram 1 (Profile Velocity mode) is used.

PNU23: EPOS Jog 1 Velocity

Index	0
Name	EPOS Jog 1 Velocity
Data type	INTEGER32
Access	RW
Setting range	-2000000000 to +2000000000
Default	-300
Unit	1000 PUU/min
Applicable telegram	Telegram 111: Jog / Incremental jogging

Function:

Sets the speed of Jog 1.

PNU24: EPOS Jog 2 Velocity

Index	0
Name	EPOS Jog 2 Velocity
Data type	INTEGER32
Access	RW
Setting range	-2000000000 to +2000000000
Default	-300
Unit	1000 PUU/min
Applicable telegram	Telegram 111: Jog / Incremental jogging

Function:

Sets the speed of Jog 2.

PNU25: EPOS Jog 1 Distance

Index	0
Name	EPOS Jog 1 Distance
Data type	INTEGER32
Access	RW
Setting range	0 - 2147483647
Default	1000
Unit	PUU
Applicable telegram	Telegram 111: Incremental jogging

Function:

Sets the moving distance of Jog 1.

PNU26: EPOS Jog 2 Distance

Index	0
Name	EPOS Jog 2 Distance
Data type	INTEGER32
Access	RW
Setting range	0 - 2147483647
Default	1000
Unit	PUU
Applicable telegram	Telegram 111: Incremental jogging

Function:

Sets the moving distance of Jog 2.

PNU30: Shutdown option code

Index	0
Name	Shutdown option code
Data type	INTEGER32
Access	RW
Setting range	-1 to 0
Default	0
Unit	-
Applicable telegram	Telegrams 1, 3, 102, 105, 111

Function:

PNU30 = 0: when Servo Off, the dynamic brake has no effect, so the motor runs freely and the machine stops only by friction.

PNU30 = -1: when Servo Off, the servo stops with the operation of the dynamic brake.

Note: when P3.012.Z = 1, the non-volatile setting for this parameter is enabled.

PNU32: Velocity threshold

Index	0
Name	Velocity threshold
Data type	UNSIGNED32
Access	RW
Setting range	0 - 2000
Default	100
Unit	0.1 rpm
Applicable telegram	Telegram 111

Function:

Sets the range for the zero speed signal output. When the forward or reverse speed (absolute value) of the motor is lower than the setting value of PNU32, the FB284 output pin AxisSpfixed (zero speed signal) outputs 1.

Note: when P3.012.Z = 1, the non-volatile setting for this parameter is enabled.

PNU33: Position factor - Numerator

Index	0
Name	Position factor - Numerator
Data type	UNSIGNED32
Access	RW
Setting range	1 - 536870911
Default	1
Unit	-
Applicable telegram	Telegram 111

Note: when P3.012.Z = 1, the default of this parameter is 16777216.

PNU34: Position factor - Denominator

Index	0
Name	Position factor - Denominator
Data type	UNSIGNED32
Access	RW
Setting range	1 - 2147482647
Default	1
Unit	-
Applicable telegram	Telegram 111

Note: when P3.012.Z = 1, the default of this parameter is 100000.

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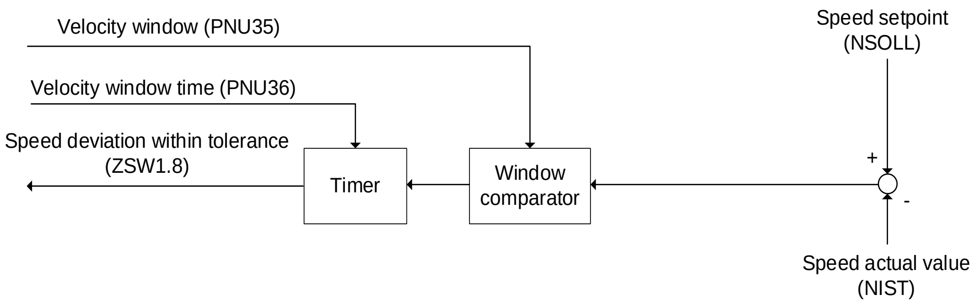
PNU35: Velocity window

Index	0
Name	Velocity window
Data type	UNSIGNED32
Access	RW
Setting range	0 - 30000
Default	100
Unit	0.1 rpm
Applicable telegram	Telegrams 1, 111

Function:

The window comparator compares the speed difference with the Velocity window (PNU35). When the difference (absolute value) is within the range set in the Velocity window and the duration of this condition is longer than the time set in the Velocity window time (PNU36), ZSW1.8 (Speed deviation within tolerance) is output.



Note: when P3.012.Z = 1, the non-volatile setting for this parameter is enabled.

PNU36: Velocity window time

Index	0
Name	Velocity window time
Data type	UNSIGNED32
Access	RW
Setting range	0 - 65535
Default	0
Unit	ms
Applicable telegram	Telegrams 1, 111

Function:

Refer to PNU35 for the description of this parameter.

Note: when P3.012.Z = 1, the non-volatile setting for this parameter is enabled.

PNU37: Max profile velocity

Index	0
Name	Max profile velocity
Data type	UNSIGNED32
Access	RW
Setting range	0 - 2147483647
Default	Varies depending on the motor model
Unit	0.1 rpm
Applicable telegram	Telegrams 1, 3, 102, 105, 111

Function:

The unit of PNU37 is 0.1 rpm, so dividing PNU37 by 10 is equivalent to P1.055 (Maximum speed limit in units of 1 rpm).

Note: when P3.012.Z = 1, the non-volatile setting for this parameter is enabled.

PNU38: Max motor speed

Index	0
Name	Max motor speed
Data type	UNSIGNED32
Access	RW
Setting range	0 - 2147483647
Default	Varies depending on the motor model
Unit	1 rpm
Applicable telegram	Telegrams 1, 3, 102, 105, 111

Function:

PNU38 is equivalent to P1.055 (Maximum speed limit).

Note: when P3.012.Z = 1, the non-volatile setting for this parameter is enabled.

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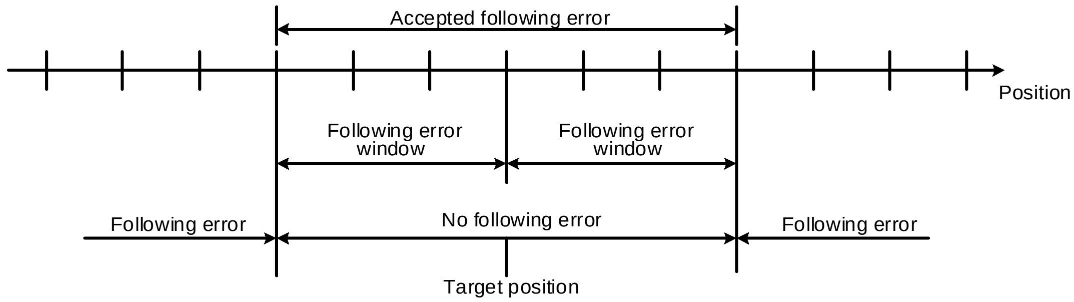
PNU39: Following error window

Index	0
Name	Following error window
Data type	UNSIGNED32
Access	RW
Setting range	1 - 2147483647
Default	50331648
Unit	PUU
Applicable telegram	Telegram 111

Function:

When the Following error actual value (PNU47) exceeds this setting range, AL009 (Excessive deviation of Position command) is triggered.



Note: when P3.012.Z = 1, the non-volatile setting for this parameter is enabled.

PNU40: Max. software position limit

Index	0
Name	Max. software position limit
Data type	INTEGER32
Access	RW
Setting range	-2147483648 to +2147483647
Default	2147483647
Unit	PUU
Applicable telegram	Telegram 111

Note: when P3.012.Z = 1, the non-volatile setting for this parameter is enabled.

PNU41: Min. software position limit

Index	0
Name	Min. software position limit
Data type	INTEGER32
Access	RW
Setting range	-2147483648 to +2147483647
Default	-2147483648
Unit	PUU
Applicable telegram	Telegram 111

Note: when P3.012.Z = 1, the non-volatile setting for this parameter is enabled.

PNU42: Quick stop deceleration

Index	0
Name	Quick stop deceleration
Data type	UNSIGNED32
Access	RW
Setting range	1 - 65500
Default	200
Unit	ms
Applicable telegram	Telegrams 1, 3, 102, 105, 111

Function:

When STW1.4 = 0, this PNU parameter sets the time required for the motor to decelerate from 3,000 rpm to 0 rpm.

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PNU43: Max acceleration

Index	0
Name	Max acceleration
Data type	UNSIGNED32
Access	RW
Setting range	1 - 65500
Default	1
Unit	ms
Applicable telegram	Telegrams 1, 111

Function:

Sets the time required for the motor to accelerate from 0 rpm to 3,000 rpm.

When using telegram 111, the calculation of the actual acceleration is as follows:

$$\text{Profile acceleration (PNU15)} = \frac{\text{PNU43 (ms)}}{\text{FB284 input pin OverAcc (\%)}}$$

PNU44: Max deceleration

Index	0
Name	Max deceleration
Data type	UNSIGNED32
Access	RW
Setting range	1 - 65500
Default	1
Unit	ms
Applicable telegram	Telegrams 1, 111

Function:

Sets the time required for the motor to decelerate from 3,000 rpm to 0 rpm.

When using telegram 111, the calculation of the actual deceleration is as follows:

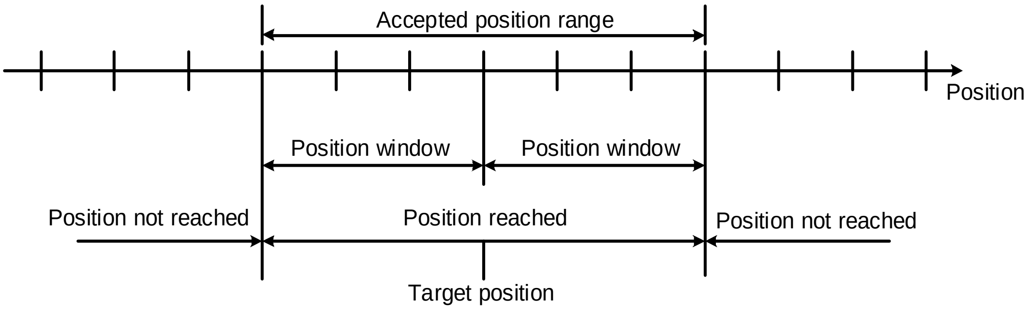
$$\text{Profile deceleration (PNU16)} = \frac{\text{PNU44 (ms)}}{\text{FB284 input pin OverDec (\%)}}$$

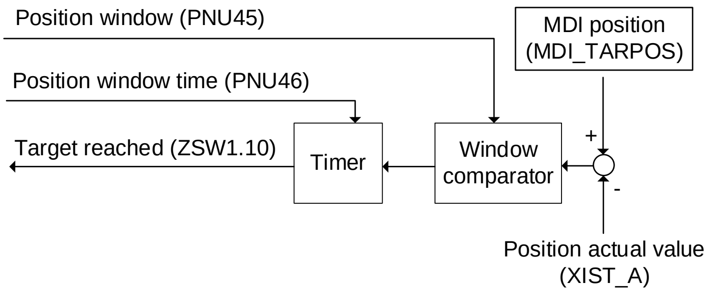
PNU45: Position window

Index	0
Name	Position window
Data type	UNSIGNED32
Access	RW
Setting range	0 - 2147483647
Default	100
Unit	PUU
Applicable telegram	Telegram 111

Function:

When the difference (absolute value) between the MDI position (MDI_TARPOS) and the Position actual value (XIST_A) is within the range set in PNU45 (Position window), and the duration of this condition is longer than the time set in PNU45 (Position window time), ZSW1.10 (Target reached) is output.





PNU46: Position window time

Index	0
Name	Position window time
Data type	UNSIGNED16
Access	RW
Setting range	0 - 65535
Default	0
Unit	ms
Applicable telegram	Telegram 111

Function:

Refer to PNU45 for the description of this parameter.

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PNU47: Following error actual value

Index	0
Name	Following error actual value
Data type	INTEGER32
Access	RO
Setting range	-
Default	-
Unit	PUU
Applicable telegram	Telegram 111

Function:

This parameter is the difference between the MDI position (MDI_TARPOS) and Position actual value (XIST_A).

13.7 Troubleshooting

This section provides troubleshooting information related to communication or interference with the controller. For information about the servo alarms, refer to Chapter 14.

1. Query the PZD and PNU values

- The PZD and PNU are mapped to the OD objects, so you can query their values using the Scope function of ASDA-Soft. The mapping data is as follows.

Name	Function	Mapping OD
MDI_TARPOS	MDI position	OD 607Ah
MDI_VELOCITY	MDI velocity	OD 6081h
NSOLL	Speed setpoint	OD 60FFh
XIST_A	Position actual value A	OD 6064h
NIST_A / NIST_B	Speed actual value	OD 606Ch
MOMRED	Torque reduction	OD 6072h
PNU10	Homing method	OD 6098h
PNU11	Home offset	OD 607Ch
PNU12	Homing speeds 1	OD 6099h sub1
PNU13	Homing speeds 2	OD 6099h sub2
PNU14	Homing acceleration	OD 609Ah
PNU15	Profile acceleration	OD 6083h
PNU16	Profile deceleration	OD 6084h
PNU23	EPOS Jog 1 Velocity	OD 650Ch
PNU24	EPOS Jog 2 Velocity	OD 650Dh
PNU25	EPOS Jog 1 Distance	OD 650Eh
PNU26	EPOS Jog 2 Distance	OD 650Fh
PNU30	Shutdown option code	OD 605Bh
PNU32	Velocity threshold	OD 606Fh
PNU33	Position factor - Numerator	OD 6093h sub1
PNU34	Position factor - Denominator	OD 6093h sub2
PNU35	Velocity window	OD 606D
PNU36	Velocity window time	OD 606E
PNU37	Max profile velocity	OD 607Fh
PNU39	Following error window	OD 6065h
PNU40	Max. software position limit	OD 607Dh sub2
PNU41	Min. software position limit	OD 607Dh sub1
PNU42	Quick stop deceleration	OD 6085h
PNU43	Max acceleration	OD 60C5h
PNU44	Max deceleration	OD 60C6h
PNU45	Position window	OD 6067h
PNU46	Position window time	OD 6068h
PNU47	Following error actual value	OD 60F4h

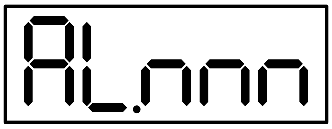
2. Eliminate interference
   - Packets are particularly sensitive to interference in high-speed network communication applications. To achieve fast and high-precision control, the selection of the wire is extremely important. Use shielded cables for the communication wiring, and make sure that the shielded connector is firmly connected to the servo drive communication port. Also, ensure the ground wire is properly connected and grounded.
3. Device name in PROFINET does not match the servo device name
   - The controller activates the servo with PROFINET to connect the servo and assign the servo device name based on DNS (Domain Name System). Therefore, the device name shown in PROFINET must match the servo device name, and each device name must be unique. If using the servo for the first time or desiring to change the servo via the controller, you have to assign the corresponding device name in the software (e.g., Siemens TIA Portal).
4. After adding telegram 750, the B3A-P servo drive is On, but the motor is unable to operate.
   - After adding telegram 750, you need to correctly set the Positive torque limit (M_LIMIT_POS) and Negative torque limit (M_LIMIT_NEG). Otherwise, the motor torque will be clamped at 0%.
5. Technology object error
   - Make sure you have cleared the check boxes of **Automatically apply drive values at runtime** and **Automatically apply encoder values at runtime** in the technology object Configuration window.
6. Unable to download the Siemens TIA Portal projects to the controller. (Telegrams 3, 102, 105)
   - Check that the connection between the PC and controller is normal.
   - If the controller is in the RUN status, check that the MC_POWER function block in the project is not under execution.
   - Switch the controller to the STOP status.
7. B3A-P displays no alarm, but the Error output pin is triggered when the controller is executing the MC function block. (Telegrams 3, 102, 105)
   - Check if there are uncleared TO alarms in the technology object Commissioning window.
8. The servo positioning is inaccurate under positioning control. (Telegram 105)
   - Check if the **Position control in the drive (DSC enabled)** in the technology object Configuration window is enabled (by default). Disable this function as the servo does not support the DSC function yet.

Troubleshooting 14

This chapter provides alarm descriptions and the corrective actions you can use for troubleshooting.

The alarms are divided into the following types: General, Motion control, STO, and Communication. The detailed information is as follows.

General type: alarms caused by hardware or encoder signal errors.
Motion control type: alarms caused by motion control command (in PR mode) errors.
STO type: alarms caused by improper use of STO functions.
Communication type: alarms caused by CANopen, DMCNET, EtherCAT, or PROFINET communication errors.
AL.nnn is the alarm format on the 7-segment display, as shown in the following figure.



If the recommended alarm clearing method is DI.ARST, set DI.ARST (alarm reset) to On or P0.001 to 0x0000 for clearing the alarm.

14.1 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	○			○
AL010	Voltage error during regeneration	○			○
AL011	CN2 communication failed	○			○
AL013	Emergency stop		○		○
AL014	Negative limit error		○	○	
AL015	Positive limit error		○	○	
AL016	Abnormal IGBT temperature	○			○
AL017	EEPROM error	○			○
AL018	OA and OB output error	○			○
AL020	Serial communication timeout		○	○	
AL022	RST power error		○		○
AL023	Early overload warning		○	○	
AL024	Encoder initial magnetic field error	○			○
AL025	Encoder internal error	○			○
AL026	Encoder unreliable internal data	○			○
AL027	Encoder internal reset error	○			○
AL028	Battery voltage error or encoder internal error	○			○
AL029	Gray code error	○			○
AL02A	Number of revolutions of the encoder is in error	○			○
AL02B	Motor data error	○			○
AL02C	Servo drive overload	○			○
AL02F	Blocked rotor protection	○			○
AL030	Motor collision error	○			○
AL031	Motor power cable wiring error	○			○
AL032	Abnormal encoder vibration	○			○
AL033	Motor is in error	○			○
AL034	Encoder internal communication error	○			○
AL035	Encoder temperature exceeds the protective range	○			○
AL036	Encoder alarm status error	○			○
AL042	Voltage input for analog Speed command is too high	○			○
AL044	Servo function operational warning		○	○	
AL045	E-Gear ratio value error	○			○
AL048	OA and OB output error	○			○
AL053	Motor parameter error	○			○
AL056	Excessive motor speed	○			○

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Display	Alarm name	Error type		Servo state	
		ALM	WARN	ON	OFF
AL05C	Motor position feedback error	○			○
AL060	Absolute position is lost		○	○	
AL061	Encoder undervoltage		○	○	
AL062	Number of revolutions of the absolute encoder overflows (issued by encoder)		○	○	
AL064	Encoder vibration warning		○	○	
AL066	Number of revolutions of the absolute encoder overflows (issued by servo drive)		○	○	
AL067	Encoder temperature warning		○	○	
AL068	Absolute data transmitted by I/O is in error		○	○	
AL069	Wrong motor type	○			○
AL06A	Absolute position is lost		○	○	
AL06B	The error between the servo drive internal position and the encoder position is too large		○	○	
AL06E	Encoder type is unidentifiable	○			○
AL06F	The absolute position is not established		○	○	
AL070	Encoder did not complete the read / write procedure		○	○	
AL071	Number of revolutions of the encoder is in error	○			○
AL072	Encoder overspeed	○			○
AL073	Encoder memory error	○			○
AL074	Encoder single-turn absolute position is in error	○			○
AL075	Encoder absolute number of revolutions is in error	○			○
AL077	Encoder internal error	○			○
AL079	Encoder parameter setting incomplete	○			○
AL07A	Encoder Z phase position is lost	○			○
AL07B	Encoder memory is busy	○			○
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	Error occurs when the encoder clears the procedure	○			○
AL07F	Encoder version error	○			○
AL083	Servo drive outputs excessive current	○			○
AL085	Regeneration setting error	○			○
AL086	Regenerative resistor overload	○			○
AL088	Servo function operational alarm	○			○
AL089	Current detection interference		○	○	
AL08A	Auto tuning function - command error		○	○	
AL08B	Auto tuning function - dwell time is too short		○	○	
AL08C	Auto tuning function - inertia estimation error		○	○	
AL099	DSP firmware error	○			○
AL09C	Parameter reset failed	○			○
AL09F	Capacitor charging error	○			○
AL0A6	Absolute positions of the servo drive and motor do not match		○	○	
AL35F	Emergency stop during deceleration		○	○	
AL3CF	Emergency stop		○		○
AL422	Write-in failed caused by control power cut-off	○			○
AL521	Vibration elimination parameter error	○			○

Display	Alarm name	Error type		Servo state	
		ALM	WARN	ON	OFF
ALC31	Motor power cable disconnection	○			○
ALCDB	Servo drive model type error	○			○

Note: if the servo drive shows an alarm that is not in this table, contact the local distributor or technician.

Motion control type

Display	Alarm name	Error type		Servo state	
		ALM	WARN	ON	OFF
AL207	Parameter group of the data source for Type [8] PR is out of range		○	○	
AL209	Parameter number of the data source for Type [8] PR is out of range		○	○	
AL211	Parameter format setting of Type [8] PR is in error		○	○	
AL213	Parameter setting of Type [8] PR is in error		○	○	
AL215	Parameter written by Type [8] PR is read-only		○	○	
AL217	Parameter written by Type [8] PR is write-protected when Servo On		○	○	
AL219	Parameter written by Type [8] PR is write-protected		○	○	
AL231	Monitoring variable code specified by Type [8] PR is out of range		○	○	
AL235	Position counter overflow warning		○	○	
AL237	Rotary axis position is undefined		○	○	
AL245	PR positioning timeout	○			○
AL249	PR path number is out of range	○			○
AL283	Software positive limit		○	○	
AL285	Software negative limit		○	○	
AL289	Position counter overflows		○	○	
AL380	Position offset alarm for DO.MC_OK		○	○	
AL3F1	Absolute position command of the communication type servo drive is in error	○			○
AL400	Rotary axis position setting error	○			○
AL404	PR special filter setting value is too great	○			○
AL510	Internal parameter update program of the servo drive is abnormal		○	○	
AL520	Calculation program timeout	○			○
AL555	System failure	○			○
AL809	PR motion setting error or command decoding error	○			○

Note: if the servo drive shows an alarm that is not in this table, contact the local distributor or technician.

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STO type

Display	Alarm name	Error type		Servo state	
		ALM	WARN	ON	OFF
AL500	STO function is activated	○			○
AL501	SF1 lost (signal loss or signal error)	○			○
AL502	SF2 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 SDO is received	○		○	
AL112	Buffer overflow occurs when PDO is received	○		○	
AL113	TxPDO transmission failed	○		○	
AL121	Object's index does not exist when PDO is accessed	○		○	
AL122	Object's sub-index does not exist when PDO is accessed	○		○	
AL123	Data length error occurs when PDO is accessed	○		○	
AL124	Data range error occurs when PDO is accessed	○		○	
AL125	PDO object is read-only and write-protected	○		○	
AL126	Specified object does not support PDO mapping	○		○	
AL127	PDO object is write-protected when servo drive is on	○		○	
AL128	Error occurs when PDO object is read from EEPROM	○		○	
AL129	Error occurs when PDO object is written to EEPROM	○		○	
AL130	Accessing address of EEPROM is out of range	○		○	
AL131	EEPROM CRC calculation error	○		○	
AL132	Parameter is write-protected	○		○	
AL170	Bus communication timeout	○		○	
AL180	Bus communication timeout	○			○
AL185	Bus hardware error	○			○
AL186	Bus data transmission error	○		○	
AL201	Initialization error of object dictionary data	○			○
AL301	CANopen synchronization failure		○	○	
AL302	Synchronization signal of CANopen is sent too soon		○	○	
AL303	CANopen synchronization signal timeout		○	○	
AL304	Invalid interpolation mode command		○	○	
AL305	SYNC period error		○	○	
AL3E1	Communication fails to synchronize	○			○
AL3E2	Communication synchronization signal is sent too soon	○			○
AL3E3	Communication 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.

14.2 Causes and corrective actions

AL001 Overcurrent	
Trigger condition and cause	Condition: main circuit current is greater than 1.5 times the maximum instantaneous current of the servo drive. Cause: 1. The servo drive output is short-circuited. 2. Motor wiring is in error. 3. IGBT error.
Checking method and corrective action	1. Check the connection between the motor and servo drive and make sure that the wire is not short-circuited. Do not expose the metal part of the wiring. Check if you have followed the wiring sequence for connecting the motor to the servo drive as described in this manual. 2. If the temperature of the heat sink is abnormal, send your servo drive back to the distributor or contact Delta. Check if the set value of the parameter is much greater than the default. It is recommended that you reset the parameter to the factory default setting and then modify the setting gradually.
How to clear the alarm?	After the alarm occurs, wait until the time set in P2.123 has elapsed and then reset the alarm.

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AL002 Overvoltage	
Trigger condition and cause	Condition: main circuit voltage exceeds the rated value. Cause: 1. The input voltage of the main circuit is higher than the allowable rated value. 2. Incorrect power input (incorrect power system). 3. Malfunction of the servo drive hardware. 4. Incorrect selection of the regenerative resistor or no connection to an external regenerative resistor.
Checking method and corrective action	1. Use a voltmeter to check if the input voltage of the main circuit is within the allowable rated value (refer to Appendix A Specifications) and check if the power system complies with the specifications. Use the correct power supply or connect the transformer and regulator in series to keep the voltage within the specified range. 2. If the alarm occurs when the input voltage of the main circuit measured by the voltmeter is within the allowable rated value, send your servo drive back to the distributor or contact Delta. 3. Check the connection for the regenerative resistor, re-calculate its resistance value, and correctly set the values of P1.052 and P1.053.
How to clear the alarm?	DI.ARST

AL003 Undervoltage	
Trigger condition and cause	Condition: 1. Main circuit voltage is below the rated value. The error type of AL003 is a warning by default. To set AL003 as an alarm, you can set P2.066 [Bit 9] to 1. 2. DC Bus voltage is below P4.024 × $\sqrt{2}$. Cause: 1. The input voltage of the main circuit is lower than the allowable rated value. 2. No voltage input to the main circuit. 3. Incorrect power input (incorrect power system).
Checking method and corrective action	1. Check if the wiring of the power supply is correct and the input voltage of the main circuit is normal. 2. Check the switch of the power supply and use a voltmeter to check the main circuit voltage. 3. Use a voltmeter to check if the power system complies with the specifications. If not, use the correct power supply or connect the transformer in series.
How to clear the alarm?	Set P2.066 [Bit 2] to clear AL003: 1. If P2.066 [Bit 2] is set to 0, use DI.ARST to clear the alarm after the voltage is back in the normal range. 2. If P2.066 [Bit 2] is set to 1, the alarm is automatically cleared after the voltage is back in the normal range.

AL004 Motor combination error	
Trigger condition and cause	Condition: an incorrect motor is used with the servo drive. Cause: 1. Motor combination error (the wrong motor is connected to the servo drive). 2. The encoder connector is loose. 3. The encoder is damaged.
Checking method and corrective action	1. Use the correct 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.

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AL005 Regeneration error	
Trigger condition and cause	Condition: an error occurs during regeneration. Cause: 1. Incorrect selection of the regenerative resistor or no connection to an external regenerative resistor. 2. P1.053 (Regenerative resistor capacity) is not set to 0 when the regenerative resistor is not connected. 3. Incorrect parameter settings for P1.052 and P1.053.
Checking method and corrective action	1. Check the connection for the regenerative resistor, re-calculate its resistance value, and correctly set the values of P1.052 and P1.053. If the issue persists, send your servo drive back to Delta. 2. Set P1.053 to 0 if not using a regenerative resistor. 3. Correctly set the regenerative resistor value (P1.052) and the regenerative resistor capacity (P1.053).
How to clear the alarm?	After the alarm occurs, wait until the time set in P2.123 has elapsed and then reset the alarm.

AL006 Overload	
Trigger condition and cause	Condition: overload of motor and servo drive. Cause: 1. The load is over the rated range and the servo drive is in a continuous overload condition. 2. Improper settings for the parameters of the control system. 3. Motor wiring error. 4. Encoder error.
Checking method and corrective action	1. Monitor if the average load rate [%] is continuously over 100% by setting P0.002 to 12. If so, increase the motor capacity or reduce the load. Refer to Appendix A for Graph of load ratio and operating time. 2. Check if there is any mechanical vibration or the setting for acceleration or deceleration is too drastic. 3. Check if the wiring of the motor power cable and encoder cable is correct. 4. Send your servo motor back to the distributor or contact Delta.
How to clear the alarm?	After the alarm occurs, wait until the time set in P2.123 has elapsed and then reset the alarm.

AL007 Excessive deviation of Speed command	
Trigger condition and cause	Condition: difference between the command speed and the speed feedback exceeds the allowable range set by P2.034. Cause: 1. A drastic change in the input Speed command. 2. Improper setting of P2.034 (Excessive deviation warning condition of Speed command). 3. Incorrect wiring of the motor power cable and encoder cable.
Checking method and corrective action	1. Use the signal detector to check if the input analog voltage signal is normal. If not, adjust the change rate of input signals or enable the filter function. 2. Check if the value of P2.034 (Excessive deviation warning condition of Speed command) is set properly. 3. Check if the wiring of the motor power cable and encoder cable is correct.
How to clear the alarm?	DI.ARST

AL008 Abnormal pulse command	
Trigger condition and cause	Condition: the input frequency of 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 input frequency and correctly set the input pulse frequency.
How to clear the alarm?	DI.ARST

AL009 Excessive deviation of Position command	
Trigger condition and cause	Condition: difference between the command position and the position feedback exceeds the allowable range set by P2.035. Cause: 1. The maximum allowable position deviation is set too low. 2. Gain value is set too low. 3. Torque limit or speed limit is set too low. 4. Excessive external load. 5. Improper setting for the E-Gear ratio. 6. The power cable is loose. 7. The maximum speed limit is set too low.
Checking method and corrective action	1. Check the set value of P2.035 (Excessive deviation of Position command warning). If the value is too low, set a higher value. 2. Check if the gain value is appropriate for the application. 3. When the speed and torque limit functions are not needed, disable P1.002; otherwise, check if the internal speed limit (P1.009 - P1.011) and internal torque limit (P1.012 - P1.014) are set correctly. 4. Check the external load. Reduce the external load or re-evaluate the motor capacity if necessary. 5. Check if the settings of P1.044 and P1.045 are appropriate for the application. If not, set them to proper values. 6. Check if the power cable is loose. 7. Check if the set value of P1.055 (Maximum speed limit) is too low.
How to clear the alarm?	DI.ARST

AL010 Voltage error during regeneration	
Trigger condition and cause	Condition: an error occurs during regeneration. Cause: 1. The regenerative voltage remains at 400V for a period of time during regeneration. This may be caused by using an incorrect regenerative resistor or not connecting an external regenerative resistor to the servo drive. 2. P1.053 (Regenerative resistor capacity) is not set to 0 when the regenerative resistor is not connected.
Checking method and corrective action	1. Check the connection for the regenerative resistor, re-calculate its resistance value, and correctly set the values of P1.052 and P1.053. If the issue persists, send your servo drive back to Delta. 2. Set P1.053 to 0 if not using a regenerative resistor.
How to clear the alarm?	DI.ARST

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AL011 CN2 communication failed	
Trigger condition and cause	Condition: encoder communication error. Cause: 1. CN2 wiring is incorrect. 2. CN2 connector is loose. 3. CN2 wiring is poor. 4. Connection to the encoder is cut off due to interference. 5. The encoder is damaged. 6. The motor is not supported by this servo drive series.
Checking method and corrective action	1. Check if the wiring follows the instructions in the user manual. If not, connect the wire correctly. 2. Check if the CN2 connector is properly connected to the CN2 port on the servo drive. Reconnect them if the connection is loose. 3. Check for the cable and connector which connect the motor 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 rate by setting P0.002 to -80. If this value increases continuously, it means there is interference. Check the following items: (a) Check if the motor is properly grounded. Make sure the ground end (yellow / green) of the power cable is connected to the servo drive heat sink. (b) Check if the connection for the encoder cable is normal. Make sure the encoder cable is separated from the power supply or any high-current cables to avoid interference. (c) Use a shielded encoder cable. Pull out the wire mesh and have it correctly grounded. 5. If you took all corrective actions but the issue persists, replace the motor. 6. Contact the distributor for the supported motor models or the communication specifications for the encoders.
How to clear the alarm?	Cycle power on the servo drive.

AL013 Emergency stop	
Trigger condition and cause	The emergency stop button is pressed.
Checking method and corrective action	Make sure the emergency stop button is off.
How to clear the alarm?	Set DI.EMGS to Off to clear the alarm.

AL014 Negative limit error	
Trigger condition and cause	Condition: negative limit switch is triggered. Cause: 1. Negative limit switch is triggered. 2. Servo system is unstable.
Checking method and corrective action	1. Make sure the negative limit switch is off. 2. Check the parameter setting or re-estimate the motor capacity.
How to clear the alarm?	The alarm is automatically cleared after the motor moves away from the limit.

AL015 Positive limit error	
Trigger condition and cause	Condition: positive limit switch is triggered. Cause: 1. Positive limit switch is triggered. 2. Servo system is unstable.
Checking method and corrective action	1. Make sure the positive limit switch is off. 2. Check the parameter setting or re-estimate the motor capacity.
How to clear the alarm?	The alarm is automatically cleared after the motor moves away from the limit.

AL016 Abnormal IGBT temperature	
Trigger condition and cause	Condition: temperature of IGBT is abnormal. Cause: 1. The load is over the rated range and the servo drive is in a continuous overload condition. 2. The servo drive output is short-circuited.
Checking method and corrective action	1. Check for servo drive overload or motor overcurrent. If so, try increasing the motor capacity or reducing the load. 2. Check if the wiring of servo drive output is correct.
How to clear the alarm?	After the alarm occurs, wait until the time set in P2.123 has elapsed and then reset the alarm.

AL017 EEPROM error	
Trigger condition and cause	Condition: error occurs when DSP accesses EEPROM. Cause: 1. Parameter writing error or the setting value exceeds the allowable range. 2. When power is supplied to the servo drive, the data in ROM is damaged or there is no data in ROM.
Checking method and corrective action	Press the SHIFT key and the panel displays EXGAB. X = 1, 2, 3 G = Group number of the parameter AB = Parameter number in hexadecimal format If the panel displays “E320A”, it indicates parameter P2.010. If the panel displays “E3610”, it indicates parameter P6.016. Check the value for the corresponding parameter. 1. The panel displays the parameter code. If this alarm occurs when power is supplied to the drive, it means a parameter value has exceeded the rated range. Modify the value and then cycle power on the servo drive. If the alarm occurs during normal operation, it means an error occurred when the parameter is written. Use DI.ARST to clear this alarm. 2. The panel displays “E100X” or “E0001”. If this alarm occurs when power is supplied to the drive, it is usually because the data in ROM is damaged or there is no data in ROM. Send your servo drive back to the distributor or contact Delta.
How to clear the alarm?	If this alarm occurs once the drive is on, reset the parameters and then cycle the power. If the alarm occurs during operation, set DI.ARST to On.

<table>
<tr><th colspan="2">AL018 OA and OB output error</th></tr>
<tr><td>Trigger condition and cause</td><td>Condition: the output frequency of the OA and OB pulses is higher than the maximum output frequency of the hardware.
Cause:
1. The resolution of the OA and OB pulses is set too high.
2. There is interference or damage to the encoder cable, causing communication error.
3. Encoder error.</td></tr>
<tr><td>Checking method and corrective action</td><td>1. Correctly set the parameters. The settings 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 rate by setting P0.002 to -80. If this value increases continuously, it means there is interference. Check the following items:
(a) Check if the motor is properly grounded. Make sure the ground end (yellow / green) of the power cable is connected to the servo drive heat sink.
(b) Check if the connection for the encoder cable is normal. Make sure the encoder cable is separated from the power supply or any high-current cables to avoid interference.
(c) Use a shielded encoder cable. Pull out the wire mesh and have it correctly grounded.
3. Check the fault record (P4.000 - P4.004) and see if any alarm (AL011, AL024, AL025, or AL026) has occurred. Use the checking methods and corrective actions to clear the alarm if any of them occurs.
4. If you do not need to use the OA and OB pulses, set P2.065 [Bit 13] to 1 to disable the function for OA and OB output error (AL018 / AL048) detection.</td></tr>
<tr><td>How to clear the alarm?</td><td>1. DI.ARST
2. Contact the distributor.</td></tr>
</table>

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AL020 Serial communication timeout	
Trigger condition and cause	Condition: RS-485 communication error. Cause: 1. Improper setting for P3.004 (Modbus communication timeout). 2. The servo drive has not received the communication command for a long time and has timed out (refer to P3.004).
Checking method and corrective action	1. Check and correctly set the value for the communication timeout parameter. 2. Check if the communication cable is loose or disconnected and make sure it is correctly wired.
How to clear the alarm?	DI.ARST

AL022 RST power error	
Trigger condition and cause	Condition: RST power cable is loose or there is no input power. The error type of AL022 is a warning by default. To set AL022 as an alarm, you can set P2.066 [Bit 12] to 1. Cause: RST power error.
Checking method and corrective action	Check if the RST power cable is loose or there is no power. For 1.5 kW (or below) ASDA-B3 servo drives, this alarm occurs when all three phases are not connected to the power supply. For 2 kW (or above) ASDA-B3 servo drives, this alarm occurs when one single phase is not connected to the power supply. Correctly connect the power to the servo drive. If the issue persists, send your servo drive back to the distributor or contact Delta.
How to clear the alarm?	DI.ARST

AL023 Early overload warning	
Trigger condition and cause	Early overload warning.
Checking method and corrective action	1. Check if the motor is overloaded and refer to the corrective actions of AL006 for troubleshooting. 2. Check if the value of P1.056 (Motor output overload warning level) is set too low. If so, set the value higher, or set the value greater than 100 to disable the warning function.
How to clear the alarm?	DI.ARST

AL024 Encoder initial magnetic field error	
Trigger condition and cause	Condition: the magnetic field of the encoder U, V, W signal is in error. Cause: the initial magnetic field of the encoder is in error (magnetic field of the encoder U, V, W signal is in error.)
Checking method and corrective action	1. Check if the motor is properly grounded. Make sure the ground end (yellow / green) of the power cable is connected to the servo drive heat sink. 2. Check if the connection for the encoder cable is normal. Make sure the encoder cable is separated from the power supply or any high-current cables to avoid interference. 3. Use a shielded encoder cable. Pull out the wire mesh and have it correctly grounded. If the issue persists, send your servo motor back to the distributor or contact Delta.
How to clear the alarm?	Cycle power on the servo drive.

AL025 Encoder internal error	
Trigger condition and cause	Condition: internal memory and counter of the encoder are in error. Cause: 1. Encoder internal error (internal memory and counter are in error). 2. When power is applied, the motor rotates because of the inertia of the mechanical parts or other causes.
Checking method and corrective action	1. If there is interference, check the following items: (a) Check if the motor is properly grounded. Make sure the ground end (yellow / green) of the power cable is connected to the servo drive heat sink. (b) Check if the connection for the encoder cable is normal. Make sure the encoder cable is separated from the power supply or any high-current cables to avoid interference. (c) Use a shielded encoder cable. Pull out the wire mesh and have it correctly grounded. 2. Make sure the motor shaft does not move when power is turned on.
How to clear the alarm?	Cycle power on the servo drive.

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AL026 Encoder unreliable internal data	
Trigger condition and cause	Condition: internal data error occurs three consecutive times. Cause: 1. External interference. 2. Malfunction of the encoder hardware.
Checking method and corrective action	If there is interference, check the following items: 1. Check if the motor is properly grounded. Make sure the ground end (yellow / green) of the power cable is connected to the servo drive heat sink. 2. Check if the connection for the encoder cable is normal. Make sure the encoder cable is separated from the power supply or any high-current cables to avoid interference. 3. Use a shielded encoder cable. Pull out the wire mesh and have it correctly grounded. 4. Check the communication error rate by setting P0.002 to -80. If the value is greater than 0 and increases continuously, check the previous three items again. If the value is 0, send your servo motor back to the distributor or contact Delta.
How to clear the alarm?	Cycle power on the servo drive.

AL027 Encoder internal reset error	
Trigger condition and cause	Condition: encoder reset error. Cause: encoder reset.
Checking method and corrective action	1. Check if there is poor contact for the encoder cable. 2. Check if the power supply for the encoder is stable and make sure to use shielded cable. 3. Check if the operating temperature is over 95°C (203°F). Fix the cause for the high temperature and do not restart the operation before the temperature falls within the allowable range. If the issue persists, send your servo motor back to the distributor or contact Delta.
How to clear the alarm?	Cycle power on the servo drive.

AL028 Battery voltage error or encoder internal error	
Trigger condition and cause	Condition: battery voltage is higher than the specification (> 3.8V) or the encoder signal is in error. Cause: 1. Voltage level of the battery is too high. 2. Encoder internal error.
Checking method and corrective action	1. Check if there is a charging circuit. Avoid incorrect wiring. If Pin 1 (5V) of CN2 is connected to BAT+ of the encoder connector, it means the 5V power of the servo drive is being charged to the battery. 2. Check if the battery is correctly installed. (voltage > 3.8V) 3. Check if the motor is properly grounded. Make sure the ground end (yellow / green) of the power cable is connected to the servo drive heat sink. 4. Check if the connection for the encoder cable is normal. Make sure the encoder cable is separated from the power supply or any high-current cables to avoid interference. 5. Use a shielded encoder cable. Pull out the wire mesh and have it correctly grounded. If the issue persists, send your servo drive and motor back to the distributor or contact Delta.
How to clear the alarm?	Cycle power on the servo drive.

AL029 Gray code error	
Trigger condition and cause	Absolute position within a single revolution is in error.
Checking method and corrective action	Cycle power on the servo drive to operate the motor. Then, check if the alarm occurs again. If the issue persists, replace the encoder.
How to clear the alarm?	Cycle power on the servo drive.

AL02A Number of revolutions of the encoder is in error	
Trigger condition and cause	Condition: the number of revolutions of the encoder is in error. Cause: the internal signal of the encoder is abnormal, causing error in the number of revolutions.
Checking method and corrective action	Send your servo motor back to the distributor or contact Delta.
How to clear the alarm?	N/A

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AL02B Motor data error	
Trigger condition and cause	Internal data access to the motor is in error.
Checking method and corrective action	Send your servo motor back to Delta.
How to clear the alarm?	N/A

AL02C Servo drive overload	
Trigger condition and cause	Condition: servo drive is overloaded. Cause: 1. The load is over the rated range and the servo drive is in a continuous overload condition. 2. Improper settings for the gain parameters or the motion profile of the control system. 3. Motor wiring error. 4. The encoder is damaged or malfunctioning.
Checking method and corrective action	1. Monitor the current feedback by setting P0.002 to 55. Check if the motor current exceeds the rated output current of the servo drive for a long period of time. 2. (a) Check if there is any mechanical vibration. If so, properly adjust the gain parameters. (b) Set a higher acceleration / deceleration time constant or a lower target speed. 3. Check if the wiring of the motor power cable and encoder cable is correct. 4. Replace the encoder.
How to clear the alarm?	After the alarm occurs, wait until the time set in P2.123 has elapsed and then reset the alarm.

AL02F Blocked rotor protection	
Trigger condition and cause	Condition: the servo drive is overloaded, and the motor speed is maintained at 10 rpm (or below) or the rotor is blocked. Cause: 1. The motor or the connected mechanical part is jammed, preventing the motor from rotating. 2. The motor is running at an extremely low speed or the rotor is blocked for a long time.
Checking method and corrective action	1. Set the motor speed higher to shorten the duration of the occurrence of blocked rotor. 2. Check if the mechanical part connected to the motor is working normally. 3. Check if the wiring of the motor power cable and encoder cable is correct. 4. Send your servo motor back to the distributor or contact Delta.
How to clear the alarm?	After the alarm occurs, wait until the time set in P2.123 has elapsed and then reset the alarm.

AL030 Motor collision error	
Trigger condition and cause	Condition: the motor hits the device, reaching the torque value set by P1.057 for the duration of the time set by P1.058. Cause: 1. Check if the protection function of motor hard stop (P1.057) is enabled. If so, set P1.057 to 0. 2. Check if the value set by P1.057 is too low and the time set by P1.058 is too short. Set P1.057 according to the actual torque. If P1.057 is set too low, it may lead to malfunction; if P1.057 is set too high, it may lose the protection function.
Checking method and corrective action	Cycle power on the servo drive to operate the motor. Then, check if the alarm occurs again. If the issue persists, replace the encoder.
How to clear the alarm?	DI.ARST

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AL031 Motor power cable wiring error	
Trigger condition and cause	Condition: incorrect wiring of the motor power cable (U, V, W) and ground (GND). Cause: incorrect wiring of the motor power cable (U, V, W) and ground (GND). The switch for wiring error detection is set by P2.065 [Bit 8], which is enabled by default.
Checking method and corrective action	Check if the wiring of the motor power cable (U, V, W) and ground (GND) is correct. Follow the instructions in this user manual for correct wiring and proper grounding.
How to clear the alarm?	Cycle power on the servo drive.

AL032 Abnormal encoder vibration	
Trigger condition and cause	Condition: abnormal vibration occurred in the encoder. Cause: the internal signal or mechanical part of the encoder is abnormal, so the encoder returns an error signal.
Checking method and corrective action	Check if the motor vibration range exceeds the specification of 2.5 G. If the vibration is within the range but the alarm still occurs, send your servo motor back to the distributor or contact Delta.
How to clear the alarm?	DI.ARST or cycle power on the servo drive.

AL033 Motor is in error	
Trigger condition and cause	The motor is in error.
Checking method and corrective action	1. Check if the encoder 5V power is lower than 4.3V. 2. Check if the cable complies with the specifications. Do not use cables exceeding the specified length or without wire mesh. 3. Check if the connection for the encoder cable is normal. Make sure the encoder cable is separated from the power supply or any high-current cables to avoid interference.
How to clear the alarm?	If the issue persists, send your servo motor back to the distributor or contact Delta.

AL034 Encoder internal communication error	
Trigger condition and cause	Condition: 1. Internal communication error for the absolute encoder. 2. Internal error for other types of encoders. 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 of the absolute encoder occurs. Replace the motor.
How to clear the alarm?	Cycle power on the servo drive.

AL035 Encoder temperature exceeds the protective range	
Trigger condition and cause	Condition: encoder temperature is over the upper limit of 100°C (212°F). Cause: encoder temperature is over 100°C.
Checking method and corrective action	Set P0.002 to -124 to read the temperature and check if it is below 100°C. If the encoder temperature is higher than 100°C, improve the heat dissipation to lower the temperature. If the temperature difference between the encoder and motor is over 30°C (54°F), send your servo motor back to Delta.
How to clear the alarm?	After the temperature becomes lower than 100°C, cycle power on the servo drive.

AL036 Encoder alarm status error	
Trigger condition and cause	Condition: abnormal state occurred in the encoder. Cause: the encoder sends out an alarm signal, but the alarm status of the encoder read by the servo drive shows no error.
Checking method and corrective action	1. Check if the motor is properly grounded. Make sure the ground end (yellow / green) of the power cable is connected to the servo drive heat sink. 2. Check if the connection for the encoder cable is normal. Make sure the encoder cable is separated from the power supply or any high-current cables to avoid interference. 3. Use a shielded encoder cable. Pull out the wire mesh and have it correctly grounded. 4. Check the motor speed and make sure it is within the rated range. If the issue persists, send your servo motor back to the distributor or contact Delta.
How to clear the alarm?	DI.ARST or cycle power on the servo drive.

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AL042 Voltage input for analog Speed command is too high	
Trigger condition and cause	Voltage input for the analog Speed command is higher than the level specified by P1.083.
Checking method and corrective action	Check and make sure the voltage source for the analog Speed command is correct. Check the value of P1.083, and if this function not required, set it to 0.
How to clear the alarm?	DI.ARST

AL044 Servo function operational warning	
Trigger condition and cause	Condition: too many motor control functions on the servo drive are enabled. Cause: servo function operational alarm.
Checking method and corrective action	1. If using a filter, see if using the filter is necessary. 2. Set P2.066 [Bit 4] to 1 to disable this alarm.
How to clear the alarm?	1. Disable the filter if it is not required, such as the low-pass filter (P1.006 - P1.008), moving filter (P1.068), low-frequency vibration suppression (P1.025 - P1.028), vibration elimination (P1.089 - P1.094), Notch filter (1^{st} to 5^{th} sets), percentage of friction compensation (P1.062), and motor hard stop (torque percentage) (P1.057). 2. Set P2.066 [Bit 4] to 1 and cycle power on the servo drive.

AL045 E-Gear ratio value error	
Trigger condition and cause	Condition: when the setting value of the E-Gear ratio exceeds the range (1 - 262144), this alarm occurs once power is cycled on the servo drive. Cause: E-Gear ratio value is found to be in error after the servo drive is powered on.
Checking method and corrective action	Check if the value of the E-Gear ratio is within the allowable range (1 - 262144). If not, correct the value and then cycle power on the servo drive.
How to clear the alarm?	Cycle power on the servo drive after correcting the value.

AL048 OA and OB output error	
Trigger condition and cause	Condition: the output frequency of the OA and OB pulses is higher than the maximum output frequency of the hardware. Cause: 1. The resolution of the OA and OB pulses is set too high. 2. There is interference or damage to the encoder cable, causing communication error. 3. Encoder error.
Checking method and corrective action	1. Correctly set the parameters. The settings 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 rate by setting P0.002 to -80. If this value increases continuously, it means there is interference. Check the following items: (a) Check if the motor is properly grounded. Make sure the ground end (yellow / green) of the power cable is connected to the servo drive heat sink. (b) Check if the connection for the encoder cable is normal. Make sure the encoder cable is separated from the power supply or any high-current cables to avoid interference. (c) Use a shielded encoder cable. Pull out the wire mesh and have it correctly grounded. 3. Check the fault record (P4.000 - P4.004) and see if any alarm (AL011, AL024, AL025, or AL026) has occurred. Use the corresponding checking methods and corrective actions to clear the alarm if any of them occurs. 4. If you do not need to use the OA and OB pulses, set P2.065 [Bit 13] to 1 to disable the function for OA and OB output error (AL018 / AL048) detection.
How to clear the alarm?	1. DI.ARST 2. Contact the distributor.

AL053 Motor parameter error	
Trigger condition and cause	Motor parameter is in error.
Checking method and corrective action	Check the motor barcode in the Device Information screen of the ASDA-Soft or replace the motor.
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 filtered motor speed exceeds the setting of P1.111, the servo drive immediately switches to the Servo Off state and displays this alarm. Cause: this alarm is to remind you that the motor speed has reached the maximum limit (setting value of P1.111).
Checking method and corrective action	1. Check the reason for the high motor speed, such as the set value of P1.111 is too low or the bandwidth is not set properly. 2. Evaluate the motor speed and the condition of the mechanical parts. If allowable, increase the speed and the set value of P1.111.
How to clear the alarm?	DI.ARST

AL05C Motor position feedback error	
Trigger condition and cause	Condition: sudden jumps occur to the motor position feedback. Cause: 1. Encoder feedback is abnormal or the encoder is damaged. 2. Encoder feedback is interfered.
Checking method and corrective action	1. Check if the feedback signal is abnormal. Use the Scope function of ASDA-Soft and select “Feedback position **[PUU]**” as the input signal for the channel and sample at 16 kHz or 20 kHz, and then operate the motor manually to monitor whether the feedback value has discontinuous sudden jumps. 2. Check if the feedback signal is interfered, causing sudden jumps to the motor position feedback. 3. Check if the communication error rate increases due to interference. For example, check the communication error rate by setting P0.017 to -80 and monitor whether the value of P0.009 is not 0 and continuously increases.
How to clear the alarm?	Cycle power on the servo drive.

AL060 Absolute position is lost	
Trigger condition and cause	Condition: losing the recorded number of revolutions because of low battery voltage or loss of power. Cause: 1. Voltage level of the battery is too low. 2. The battery is replaced when the control power of the servo drive is Off. 3. The battery is not installed when the absolute function is enabled. 4. Poor connection or disconnection of the battery power circuit.
Checking method and corrective action	1. Check if the battery voltage is below 2.9V. Re-establish the absolute origin position after replacing the battery. 2. Do not replace or remove the battery when the servo drive’s control power is Off. 3. Follow these instructions: (a) Install the battery. (b) Check the wiring between the battery box and the servo drive. (c) Check the encoder wiring. 4. Ensure the wiring is correct so that the battery power is supplied to the encoder and then re-establish the absolute origin position.
How to clear the alarm?	Connect or reconnect the wiring so that the battery power is supplied to the encoder and then re-establish the absolute origin position. For establishing the absolute origin position, refer to Section 10.3.4 for more details.

AL061 Encoder undervoltage	
Trigger condition and cause	Condition: voltage level of the absolute encoder battery is lower than 3.1V. Cause: voltage level of the battery is too low.
Checking method and corrective action	1. Monitor the battery voltage by setting P0.002 = 38 to see if it is below 3.1V. 2. Measure the battery voltage to see if it is below 3.1V. If the voltage is too low, replace the battery when the servo drive’s control power is On.
How to clear the alarm?	The alarm is cleared automatically when the battery voltage is higher than 3.1V.

AL062 Number of revolutions of the absolute encoder overflows (issued by encoder)	
Trigger condition and cause	Condition: the number of revolutions of the absolute motor exceeds the range of -32768 to +32767. Cause: motor's rotation cycle exceeds the allowable range.
Checking method and corrective action	1. Check if the number of revolutions of the motor during operation is within the range of -32768 to +32767. If not, re-establish the absolute origin position. 2. Make sure you have enabled the function of preventing rotary axis position offset when overflow occurs. If the function is disabled, set P2.069.Z to 1 to enable it.
How to clear the alarm?	Cycle power on the servo drive.

AL064 Encoder vibration warning	
Trigger condition and cause	Condition: abnormal vibration occurred in the encoder. Cause: the internal signal or mechanical part of the encoder is abnormal, so the encoder returns a warning signal.
Checking method and corrective action	Check if the motor vibration range is within the warning range (2.0 to 2.5 G). If the vibration is below the warning range but the alarm still occurs, send you servo motor back to the distributor or contact Delta.
How to clear the alarm?	DI.ARST or cycle power on the servo drive.

AL066 Number of revolutions of the absolute encoder overflows (issued by servo drive)	
Trigger condition and cause	Condition: 1. The number of revolutions of the absolute motor (P0.051) exceeds half the number of revolutions of the encoder. 2. The number of revolutions of a Delta motor is -32768 to +32767. Cause: motor's rotation cycle exceeds the allowable range.
Checking method and corrective action	1. Check if the motor's number of revolutions during operation is within the specified range. If not, re-establish the absolute origin position. 2. Make sure you have enabled the function of preventing rotary axis position offset when overflow occurs. If the function is disabled, set P2.069.Z to 1 to enable it.
How to clear the alarm?	Re-establish the absolute origin position.

AL067 Encoder temperature warning	
Trigger condition and cause	Condition: the encoder temperature is over the warning level of 85°C (185°F), but still under 100°C (212°F), which is within the protective range. Cause: encoder temperature warning (85°C to 100°C).
Checking method and corrective action	Set P0.002 to -124 to read the encoder temperature and check if it matches the motor temperature. If the temperature is too high, improve the heat dissipation or decrease the operating temperature. If the temperature difference between the encoder and motor is over 30°C (54°F), send your servo motor back to Delta.
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 time sequence is wrong when the absolute position is read by DI/O. Cause: 1. Time sequence is wrong. 2. Reading timeout.
Checking method and corrective action	1. Correct the time sequence for reading the data with DI/O: (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 when 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, switch DI.ABSQ On, and 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 whether your servo motor has an incremental or absolute encoder. 2. Check the setting of P2.069 and correctly set the value. Set P2.069.X to 0 if desiring to operate the absolute motor as an incremental motor.
How to clear the alarm?	Set P2.069.X to 0 and then cycle power on the servo drive.

AL06A Absolute position is lost	
Trigger condition and cause	There are two conditions that may cause the loss of absolute position. ■ Absolute position is not established. Condition: 1. The servo drive is used for the first time. 2. The battery is drained and the control power of the servo drive is cut off. 3. When the bus communication type servo drive is used with an absolute motor, the user issues an absolute position command after the first use or modification of the E-Gear ratio. Cause: 1. The servo drive is used for the first time, so the absolute origin position is not established. 2. Retaining the absolute position requires power supply, so when the battery is drained and the power supply of the servo drive is cut off, the absolute position of the servo is lost. 3. After the E-Gear ratio is modified, the position system of the communication type servo drive needs to be re-established. ■ Absolute origin position is established, but AL06A still occurs after power cycling of the servo drive Condition: 1. The encoder cable is damaged, including the exterior and internal wiring. 2. There is a momentary power failure in the battery power supply. 3. The absolute motor is in error. 4. The battery box is used, and J1 and J2 are connected reversely. 5. The voltage level of the battery is lower than 2.9V. Cause: 1. Power supply is unstable due to damage of the encoder cable. 2. The reason for the momentary power failure may be that the battery box connector is loose or excessive machine vibration. 3. The absolute encoder of this motor is in error. 4. If J1 and J2 are connected reversely, the battery cannot charge the capacitor. The capacitor functions as a buffer to supply power when the power supply of the servo drive power is switched to the battery due to a main power failure.
Checking method and corrective action	1. Check if the absolute origin position is established (refer to Section 10.3.1 for more information). 2. Replace the battery only when the servo drive is powered on, so the absolute encoder has continuous power supply. 3. Re-establish the absolute origin position. 4. Replace the encoder cable. Use X-ray to check if the internal wiring is damaged. 5. Check if the wiring is loose. If the wiring is fine, replace the battery box for cross-testing. 6. Replace the servo motor. 7. Ensure J1 is connected to the battery and J2 is connected to the servo drive.
How to clear the alarm?	The alarm is automatically cleared after you establish the absolute origin position.

AL06B The error between the servo drive internal position and the encoder position is too large	
Trigger condition and cause	Condition: when the absolute motor is powered by the battery, the number of motor rotations exceeds one-fourth the number of revolutions of the encoder. Cause: the error between the servo drive internal position and the encoder position is too large.
Checking method and corrective action	The mechanical parts are not properly fastened when the machine is being transported, causing rotation of the motor.
How to clear the alarm?	Re-establish the absolute origin position.

AL06E Encoder type is unidentifiable	
Trigger condition and cause	The servo drive cannot identify the encoder type.
Checking method and corrective action	N/A
How to clear the alarm?	Replace the motor immediately.

AL06F The absolute position is not established	
Trigger condition and cause	Condition: the establishment of the absolute position has timed out. Cause: the process for establishing the absolute position of the servo drive is in error.
Checking method and corrective action	If the issue persists after you cycle power on the servo drive and re-establish the absolute origin position, contact your local distributor or technician.
How to clear the alarm?	Cycle power on the servo drive and re-establish the absolute origin position.

AL070 Encoder did not complete the read / write procedure	
Trigger condition and cause	Reading and writing commands are not complete.
Checking method and corrective action	Check if the wiring is correct and firmly connected. If not, correctly connect the wire again. If the issue persists, contact Delta.
How to clear the alarm?	Cycle power on the servo drive.

AL071 Number of revolutions of the encoder is in error	
Trigger condition and cause	Condition: the number of revolutions of the encoder is in error. Cause: the internal signal of the encoder is abnormal, causing error in the number of revolutions.
Checking method and corrective action	If you executed DI.ARST but the issue persists, send your servo motor back to the distributor or contact Delta.
How to clear the alarm?	DI.ARST

AL072 Encoder overspeed	
Trigger condition and cause	1. When the encoder is powered by the servo drive: over 8,800 rpm. 2. When the encoder is powered by the battery: over 10,000 rpm. 3. Battery voltage is too low.
Checking method and corrective action	1. Check if the motor is properly grounded. Make sure the ground end (yellow / green) of the power cable is connected to the servo drive heat sink. 2. Check if the connection for the encoder cable is normal. Make sure the encoder cable is separated from the power supply or any high-current cables to avoid interference. 3. Use a shielded encoder cable. Pull out the wire mesh and have it correctly grounded. 4. Check the motor speed and make sure it is within the rated range. 5. Measure the battery voltage to see if it is below 3.1V. 6. Check if the battery wiring has poor contact. If the issue persists, send your servo motor back to the distributor or contact Delta.
How to clear the alarm?	Cycle power on the servo drive.

AL073 Encoder memory error	
Trigger condition and cause	An error occurs when the encoder is reading data from or writing data to EEPROM.
Checking method and corrective action	1. Check if the motor is properly grounded. Make sure the ground end (yellow / green) of the power cable is connected to the servo drive heat sink. 2. Check if the connection for the encoder cable is normal. Make sure the encoder cable is separated from the power supply or any high-current cables to avoid interference. 3. Use a shielded encoder cable. Pull out the wire mesh and have it correctly grounded. 4. Check the motor speed and make sure it is within the rated range. If the issue persists, send your servo motor back to the distributor or contact Delta.
How to clear the alarm?	Cycle power on the servo drive.

AL074 Encoder single-turn absolute position is in error	
Trigger condition and cause	The single-turn position in the encoder is in error.
Checking method and corrective action	1. Check if the motor is properly grounded. Make sure the ground end (yellow / green) of the power cable is connected to the servo drive heat sink. 2. Check if the connection for the encoder cable is normal. Make sure the encoder cable is separated from the power supply or any high-current cables to avoid interference. 3. Use a shielded encoder cable. Pull out the wire mesh and have it correctly grounded. 4. Check the motor speed and make sure it is within the rated range. If the issue persists, send your servo motor back to the distributor or contact Delta.
How to clear the alarm?	Cycle power on the servo drive.

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AL075 Encoder absolute number of revolutions is in error	
Trigger condition and cause	The absolute number of revolutions in the encoder is in error.
Checking method and corrective action	1. Check if the motor is properly grounded. Make sure the ground end (yellow / green) of the power cable is connected to the servo drive heat sink. 2. Check if the connection for the encoder cable is normal. Make sure the encoder cable is separated from the power supply or any high-current cables to avoid interference. 3. Use a shielded encoder cable. Pull out the wire mesh and have it correctly grounded. 4. Check the motor speed and make sure it is within the rated range. If the issue persists, send your servo motor back to the distributor or contact Delta.
How to clear the alarm?	Cycle power on the servo drive.

AL077 Encoder internal error	
Trigger condition and cause	Encoder internal error (internal computing error).
Checking method and corrective action	1. Check if the motor is properly grounded. Make sure the ground end (yellow / green) of the power cable is connected to the servo drive heat sink. 2. Check if the connection for the encoder cable is normal. Make sure the encoder cable is separated from the power supply or any high-current cables to avoid interference. 3. Use a shielded encoder cable. Pull out the wire mesh and have it correctly grounded. 4. Check the motor speed and make sure it is within the rated range. If the issue persists, send your servo motor back to the distributor or contact Delta.
How to clear the alarm?	Cycle power on the servo drive.

AL079 Encoder parameter setting incomplete	
Trigger condition and cause	The servo drive is not power cycled after the encoder parameter is written to the encoder, and therefore the parameter setting does not take effect.
Checking method and corrective action	Check if the encoder parameter is written. If so, cycle power to have the parameter setting take effect.
How to clear the alarm?	Cycle power on the servo drive.

AL07A Encoder Z phase position is lost	
Trigger condition and cause	Encoder Z phase position is in error.
Checking method and corrective action	Send your servo motor back to the distributor or contact Delta.
How to clear the alarm?	N/A

AL07B Encoder memory is busy	
Trigger condition and cause	The encoder memory is busy.
Checking method and corrective action	1. Check if the motor is properly grounded. Make sure the ground end (yellow / green) of the power cable is connected to the servo drive heat sink. 2. Check if the connection for the encoder cable is normal. Make sure the encoder cable is separated from the power supply or any high-current cables to avoid interference. 3. Use a shielded encoder cable. Pull out the wire mesh and have it correctly grounded. 4. Check the motor speed and make sure it is within the rated range. If the issue persists, send your servo motor back to the distributor or contact Delta.
How to clear the alarm?	Cycle power on the servo drive.

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	1. Check if a command to clear the absolute position is issued when the motor speed is over 200 rpm. If so, reduce the motor speed until the speed is lower than 200 rpm, and then follow the procedure for clearing the absolute position to clear this alarm. 2. Do not issue a command to clear the absolute position when the motor speed is over 200 rpm.
How to clear the alarm?	DI.ARST or cycle power on the servo drive.

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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 method and corrective action to clear AL07C.
How to clear the alarm?	DI.ARST or cycle power on the servo drive.

AL07E Error occurs when the encoder clears the procedure	
Trigger condition and cause	The number of retry attempts for the encoder to clear the procedure exceeds 11 times.
Checking method and corrective action	If the issue persists, check the communication quality of the encoder by setting P0.002 to -80. If the communication is normal, use DI.ARST to clear this alarm.
How to clear the alarm?	DI.ARST or cycle power on the servo drive.

AL07F Encoder version error	
Trigger condition and cause	The encoder version read by the servo drive is in error.
Checking method and corrective action	N/A
How to clear the alarm?	Replace the motor immediately.

AL083 Servo drive outputs excessive current	
Trigger condition and cause	Condition: during general operation, this alarm occurs when the servo drive outputs current that is over the allowable level specified by the firmware. This alarm protects IGBT from overheating or burning because of the high current. Cause: 1. UVW of the servo drive is short-circuited. 2. Motor wiring is in error. 3. The GND for the analog signal of the servo drive is interfered.
Checking method and corrective action	1. Check the motor power cable and its connector. If metal wire is exposed or the wire is torn, the UVW can short-circuit. In this case, replace the power cable to avoid a short circuit. 2. Refer to Chapter 3 Wiring and check the following items: (a) If you do not use the Delta standard power cable, make sure the UVW wiring sequence is correct. (b) Make sure the UVW wiring between the servo drive and motor is correctly connected. 3. Check if the GND for analog signal is mistakenly connected to another ground signal (incorrect connection can cause interference). Do not share the GND for analog signal with other signal sources. Follow the wiring instructions in Chapter 3.
How to clear the alarm?	DI.ARST

AL085 Regeneration setting error	
Trigger condition and cause	Condition: regeneration control error. Cause: regenerative resistor is not operating, but the regenerative voltage remains at 400V for a period of time.
Checking method and corrective action	Check the connection for the regenerative resistor, re-calculate its resistance value, and correctly set the values of P1.052 and P1.053. If the issue persists, send your servo drive back to Delta.
How to clear the alarm?	After the alarm occurs, wait until the time set in P2.123 has elapsed and then reset the alarm.

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AL086 Regenerative resistor overload	
Trigger condition and cause	Condition: excessive energy in the capacitor of the servo drive is released to the regenerative resistor, causing overload of the resistor. Cause: 1. Incorrect selection of the regenerative resistor or no connection to an external regenerative resistor. 2. Incorrect parameter settings for P1.052 and P1.053. 3. Other energy (such as interference) is input to the servo drive or the input voltage is higher than the allowable rated voltage. 4. Malfunction of the servo drive hardware.
Checking method and corrective action	1. Check the connection for the regenerative resistor and correctly set the values of P1.052 and P1.053. 2. Reassess whether the regenerative energy exceeds the value of P1.053. If so, use another regenerative resistor of higher capacity. 3. Use a voltmeter to measure if the input voltage from the power supply is within the allowable rated voltage (refer to Appendix A Specifications). If the input voltage exceeds the rated range, remove the interference source. 4. Measure the voltage between P3 and ⊖ terminals. If it does not match the DC Bus voltage monitored by setting P0.002 to 14, the servo drive may be malfunctioning. Send your servo drive back to the distributor or contact Delta. 5. If you took the preceding actions and the issue persists, use a scope with a differential probe to measure whether the input voltage has high-frequency signal interference. If there is interference, remove the interference source, and use the correct power supply or connect the regulator in series.
How to clear the alarm?	After the alarm occurs, wait until the time set in P2.123 has elapsed and then reset

AL088 Servo function operational alarm	
Trigger condition and cause	Condition: too many motor control functions on the servo drive are enabled. Cause: servo function operational alarm.
Checking method and corrective action	If using a filter, see if using the filter is necessary.
How to clear the alarm?	Disable the filter if it is not required, such as the low-pass filter (P1.006 - P1.008), moving filter (P1.068), low-frequency vibration suppression (P1.025 - P1.028), vibration elimination (P1.089 - P1.094), Notch filter (1st to 5th sets), percentage of friction compensation (P1.062), and motor hard stop - torque percentage (P1.057).

AL089 Current detection interference	
Trigger condition and cause	Condition: current detection interference. Cause: current detection in the servo drive is affected by an external interference source.
Checking method and corrective action	Check the environment around the servo drive to see if there is any interference source.
How to clear the alarm?	1. Remove the interference source or move the servo drive away from the interference source. 2. Set P2.112 [Bit 1] to 0 to disable AL089. 3. If the issue persists, send your servo drive back to the distributor or contact Delta.

AL08A Auto tuning function - command error	
Trigger condition and cause	Condition: no command is issued within 15 seconds after the servo drive starts the auto tuning procedure. Cause: 1. When the command source is the controller, neither the controller nor the position register issued the command. 2. When the command source is the servo drive, Position 1 and Position 2 specify the same position. 3. The signal cable is not connected or incorrectly connected so that the servo drive cannot receive the command.
Checking method and corrective action	1. Make sure a command is being issued. 2. Set Position 1 and Position 2 again. 3. Make sure the wiring between the controller and servo drive is correct.
How to clear the alarm?	DI.ARST

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AL08B Auto tuning function - dwell time is too short	
Trigger condition and cause	Condition: the dwell time is too short when the command source is the controller in the auto tuning procedure. The auto tuning algorithm requires a certain amount of time to perform the calculation. The tuning result is affected if the dwell time is too short. Cause: dwell time in the cycle is too short.
Checking method and corrective action	1. For a reciprocating motion between two points, 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 or deceleration time is too long. 2. Rotation speed is too slow. 3. Load inertia of the machine is too large. 4. Variation of the machine inertia 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 lowest speed should be no less than 200 rpm. It is suggested that you set the speed to 500 rpm or higher. 3. The load inertia should be less than 50 times the motor inertia. 4. Avoid applications that require drastic variation in the inertia.
How to clear the alarm?	DI.ARST

AL099 DSP firmware error	
Trigger condition and cause	EEPROM is not reset after DSP firmware is updated.
Checking method and corrective action	Check if the firmware is updated. If so, set P2.008 to 30 and then 28. Cycle power on the servo drive. If the issue persists, contact Delta.
How to clear the alarm?	Set P2.008 to 30 and then 28. Cycle power on the servo drive.

AL09C Parameter reset failed	
Trigger condition and cause	Condition: the parameter reset process is not complete. Cause: an error occurred during the parameter reset process, so the reset procedure could not be completed.
Checking method and corrective action	Check if the power is cut off during the reset process. Check the power wiring and switch.
How to clear the alarm?	Set P2.008 to 30 and then 28. Cycle power on the servo drive.

AL09F Capacitor charging error	
Trigger condition and cause	Condition: the charging time of the capacitor exceeds the normal range. Cause: 1. The input voltage of the main circuit is lower than the allowable rated value or the current is too low. 2. Incorrect setting value of P4.024 (Level of undervoltage error). 3. IGBT error.
Checking method and corrective action	1. Check if the voltage wiring is correct and the wiring of input voltage for the main circuit is normal. 2. Check the switch of the power supply and use a voltmeter to check the main circuit voltage. 3. Use a voltmeter to check if the power system complies with the specifications. If not, use the correct power supply or connect the transformer in series. 4. Check the wiring of the external regenerative resistor. 5. Send your servo drive back to distributors or contact Delta.
How to clear the alarm?	Cycle power on the servo drive.

AL0A6 Absolute positions of the servo drive and motor do not match	
Trigger condition and cause	Condition: suppose there are servo drive A, servo motor A, servo drive B, and servo motor B. Servo drive A and servo drive B have established the absolute origin coordinates with servo motor A and servo motor B respectively. In this case, if you operate servo drive A with servo motor B, AL0A6 will be triggered. Cause: replace the servo drive or servo motor.
Checking method and corrective action	Re-establish the absolute origin positions.
How to clear the alarm?	Re-establish the absolute origin positions.

AL111 Buffer overflow occurs when SDO is received	
Trigger condition and cause	SDO Rx Buffer overflows (the servo drive receives more than two SDOs within 1 ms).
Checking method and corrective action	Check if the servo drive or the master receives or sends more than one SDO within 1 ms.
How to clear the alarm?	NMT: reset node, OD 6040h [Bit 7] (Fault reset), or DI.ARST.

AL112 Buffer overflow occurs when PDO is received	
Trigger condition and cause	PDO Rx Buffer overflows (the servo drive receives more than two PDOs of COB-ID within 1 ms).
Checking method and corrective action	Check if the servo drive or the master receives or sends more than one PDO of the same COB-ID within 1 ms.
How to clear the alarm?	NMT: reset node, OD 6040h [Bit 7] (Fault reset), or DI.ARST.

AL113 TxPDO transmission failed	
Trigger condition and cause	PDO packet cannot be successfully sent.
Checking method and corrective action	Check if the communication circuit of the servo drive works normally.
How to clear the alarm?	NMT: reset node, OD 6040h [Bit 7] (Fault reset), or DI.ARST.

AL121 Object’s index does not exist when PDO is accessed	
Trigger condition and cause	When the servo drive receives the PDO from the controller, the specified object’s index number is incorrect, so 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, OD 6040h [Bit 7] (Fault reset), or DI.ARST.

AL122 Object's sub-index does not exist when PDO is accessed	
Trigger condition and cause	When the servo drive receives the PDO from the controller, the specified object's sub-index number is incorrect, so 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, OD 6040h [Bit 7] (Fault reset), or DI.ARST.

AL123 Data length error occurs when PDO is accessed	
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 of PDO mapping entry is changed when the servo drive receives or sends the PDO.
How to clear the alarm?	NMT: reset node, OD 6040h [Bit 7] (Fault reset), or DI.ARST.

AL124 Data range error occurs when PDO is accessed	
Trigger condition and cause	The data value in the message exceeds the range of the specified object.
Checking method and corrective action	Check if the written data is within range when the servo drive receives or sends the PDO.
How to clear the alarm?	NMT: reset node, OD 6040h [Bit 7] (Fault reset), or DI.ARST.

AL125 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 PDO mapping is read-only.
How to clear the alarm?	NMT: reset node, OD 6040h [Bit 7] (Fault reset), or DI.ARST.

AL126 Specified object does not support PDO mapping	
Trigger condition and cause	The specified object does not support PDO mapping.
Checking method and corrective action	Check if the specified object supports PDO mapping when the servo drive receives or sends the PDO.
How to clear the alarm?	NMT: reset node, OD 6040h [Bit 7] (Fault reset), or DI.ARST.

AL127 PDO object is write-protected when servo drive is on	
Trigger condition and cause	PDO object is write-protected (unchangeable) when the servo drive is on.
Checking method and corrective action	Make sure no specified object is written when the servo drive receives or sends the PDO in the Servo On state.
How to clear the alarm?	NMT: reset node, OD 6040h [Bit 7] (Fault reset), or DI.ARST.

AL128 Error occurs when PDO object is read from EEPROM	
Trigger condition and cause	An error occurs when the default value is loaded from ROM at start-up. All objects are automatically restored to default values.
Checking method and corrective action	Check if an error occurs because the specified object is read from EEPROM when the servo drive receives or sends the PDO.
How to clear the alarm?	NMT: reset node, OD 6040h [Bit 7] (Fault reset), or DI.ARST.

AL129 Error occurs when PDO object is written to EEPROM	
Trigger condition and cause	An error occurs when the PDO object is written to EEPROM.
Checking method and corrective action	Check if an error occurs because the specified object is written to EEPROM when the servo drive receives or sends the PDO.
How to clear the alarm?	NMT: reset node, OD 6040h [Bit 7] (Fault reset), or DI.ARST.

AL130 Accessing address of EEPROM is out of range	
Trigger condition and cause	The amount of 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 previous firmware version.
Checking method and corrective action	Check if the specified object causes the accessing address in EEPROM exceeds the range when the servo drive receives or sends the PDO.
How to clear the alarm?	NMT: reset node, OD 6040h [Bit 7] (Fault reset), or DI.ARST.

AL131 EEPROM CRC calculation error	
Trigger condition and cause	The data in ROM is damaged. All objects are automatically restored to default values.
Checking method and corrective action	Check if the specified object causes a CRC calculation error in EEPROM when the servo drive receives or sends the PDO. Usually, this alarm is caused by an error in DSP.
How to clear the alarm?	NMT: reset node, OD 6040h [Bit 7] (Fault reset), or DI.ARST.

AL132 Parameter is write-protected	
Trigger condition and cause	When data is written to the parameter using bus communication, the parameter is currently write-protected.
Checking method and corrective action	Refer to the corresponding parameter description to write data to the parameter.
How to clear the alarm?	NMT: reset node, OD 6040h [Bit 7] (Fault reset), or DI.ARST.

AL170 Bus communication timeout	
Trigger condition and cause	The servo drive does not receive any PDO data within the set communication cycle time.
Checking method and corrective action	1. Check if the communication is normal. 2. Check if the wiring is correct.
How to clear the alarm?	NMT: reset node, OD 6040h [Bit 7] (Fault reset), or DI.ARST.

AL180 Bus communication timeout	
Trigger condition and cause	The servo drive does not receive any PDO data within the set communication cycle time.
Checking method and corrective action	1. Check if the communication is normal. 2. Check if the wiring is correct.
How to clear the alarm?	NMT: reset node, OD 6040h [Bit 7] (Fault reset), or DI.ARST.

AL185 Bus hardware error	
Trigger condition and cause	Condition: bus communication is cut off. Cause: abnormal communication hardware.
Checking method and corrective action	1. Check if the communication cable is intact and firmly connected. 2. Check the communication quality; it is suggested that you use common grounding and shielded cable. 3. For communication type models, check if the value of monitoring variable 120 increases continuously.
How to clear the alarm?	NMT: reset node, OD 6040h [Bit 7] (Fault reset), or DI.ARST.

AL186 Bus data transmission error	
Trigger condition and cause	Bus data transmission error.
Checking method and corrective action	1. Check if the communication cable is properly connected and whether there is any noise interference. Replace the communication cable or eliminate the noise if necessary. 2. There are excessive slave stations and the communication cycle time is too short. Lengthen the communication cycle.
How to clear the alarm?	NMT: reset node, OD 6040h [Bit 7] (Fault reset), or DI.ARST.

AL201 Initialization error of object dictionary data	
Trigger condition and cause	Condition: an error has occurred when the servo drive loads data from EEPROM. Cause: initialization error of CANopen data.
Checking method and corrective action	1. If the alarm is cleared after power cycling of the servo drive, it means the error occurred at the moment when the servo drive reads the data. 2. If the issue persists after power cycling of 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 the CANopen object OD 1011h to complete the setting. (b) To write the current value, set the CANopen object OD 1010h. 3. If you took the corrective actions but the issue persists, it means the data array is incorrect. Set P2.008 to 10 to reset the parameters.
How to clear the alarm?	OD 6040h [Bit 7] (Fault reset), DI.ARST, or OD 1011h.

AL207 Parameter group of the data source for Type [8] PR is out of range	
Trigger condition and cause	Condition: when Type [8] PR command specifies Parameter as the data source, the parameter group is out of range. Cause: parameter group exceeds the range.
Checking method and corrective action	Write parameter using PR procedure: when the data source is Parameter and the group setting exceeds the range, check the setting range of the group for the written parameters.
How to clear the alarm?	DI.ARST

AL209 Parameter number of the data source for Type [8] PR is out of range	
Trigger condition and cause	Condition: when Type [8] PR command specifies Parameter as the data source, the parameter number is out of range. Cause: parameter number exceeds the range.
Checking method and corrective action	Write parameter using PR procedure: when the data source is Parameter and the parameter number setting exceeds the range, check the setting range of the number for the written parameters.
How to clear the alarm?	DI.ARST

AL211 Parameter format setting of Type [8] PR is in error	
Trigger condition and cause	Condition: parameter format setting of Type [8] PR command is in error. Cause: 1. Incorrect parameter format. 2. The ASDA-Soft software version and the firmware version are not compatible.
Checking method and corrective action	1. Check if the parameter format is correct. 2. Check if you are using the latest version of the ASDA-Soft software. If you took the corrective actions but the issue persists, contact the local distributor or technician.
How to clear the alarm?	DI.ARST

AL213 Parameter setting of Type [8] PR is in error	
Trigger condition and cause	Condition: when you use Type [8] PR command to write the parameter, the parameter value setting is incorrect. Cause: an error occurs when you write the parameter with Type [8] PR command.
Checking method and corrective action	Make sure the written parameter value is within the correct range.
How to clear the alarm?	DI.ARST

AL215 Parameter written by Type [8] PR is read-only	
Trigger condition and cause	Condition: the read-only parameter is written by Type [8] PR command. Cause: an error occurs when you write the parameter with Type [8] PR command.
Checking method and corrective action	The specified parameter is read-only.
How to clear the alarm?	DI.ARST

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AL217 Parameter written by Type [8] PR is write-protected when Servo On	
Trigger condition and cause	Condition: when you use Type [8] PR command to write the parameter, the parameter is write-protected when the servo drive is On or the parameter value exceeds the range. Cause: an error occurs when you write the parameter with Type [8] PR command.
Checking method and corrective action	Write the parameters when the servo drive is Off and make sure the parameter value is within the range.
How to clear the alarm?	Modify the PR command and the parameter.

AL219 Parameter written by Type [8] PR is write-protected	
Trigger condition and cause	Condition: the parameter written by Type [8] PR command 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 variable code specified by Type [8] PR is out of range	
Trigger condition and cause	Condition: when Type [8] PR command specifies Monitoring variable as the data source, the monitoring variable code is out of range. Cause: the monitoring variable code is out of range.
Checking method and corrective action	Write parameter using PR procedure: when the data source is Monitoring variable and the code exceeds the range, check the setting range of the code for the monitoring variable.
How to clear the alarm?	DI.ARST

AL235 Position counter overflow warning	
Trigger condition and cause	Condition: a positioning command is executed after the overflow of the position command counter. Cause: overflow of the position command counter.
Checking method and corrective action	Incremental system: When the motor keeps operating in one direction, this leads to overflow of the position feedback register (FB_PUU), and the position system cannot display the correct position. Executing a positioning command after overflow results in this error. Use the scope to check if the position feedback has overflowed and then execute the homing procedure. Absolute system: This error occurs when the absolute positioning command is issued in the following conditions: 1. Feedback position register (FB_PUU) overflows. 2. Absolute origin position is not established after the setting of P1.001.Z is changed. 3. Absolute origin position is not established after the E-Gear ratio (P1.044 and P1.045) is changed. 4. The absolute origin position is established, but the homing procedure is incomplete. 5. When AL060 and AL062 occur, use the scope to check if the position feedback has overflowed. Check whether the preceding conditions have occurred and then establish the absolute origin position.
How to clear the alarm?	Incremental system: perform homing procedure after using DI.ARST to clear the alarm. Absolute system: establish the absolute origin position.

AL237 Rotary axis position is undefined	
Trigger condition and cause	The starting point of the rotary axis position is not defined before you operate the rotary axis position control and execute the rotary axis positioning command. This alarm occurs because the servo drive cannot identify the rotary axis position system.
Checking method and corrective action	Check if the rotary axis position is undefined: perform the homing procedure before using the rotary axis position control to avoid triggering this alarm.
How to clear the alarm?	DI.ARST

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AL245 PR positioning timeout	
Trigger condition and cause	Condition: PR positioning function is triggered. Cause: the time for executing positioning is too long.
Checking method and corrective action	Check if the conditions for completing the PR commands are not set or not triggered, causing the PR command incomplete.
How to clear the alarm?	DI.ARST or cycle power on the servo drive.

AL249 PR path number is out of range	
Trigger condition and cause	Condition: the number of the triggered PR path exceeds the upper limit. Cause: the number of the triggered PR path 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 position feedback exceeds the software positive limit. Cause: the software positive limit is triggered.
Checking method and corrective action	Software positive limit triggering is determined by the position feedback. Set an appropriate deceleration time to achieve the desired effect. For more information, refer to the description of P5.003.
How to clear the alarm?	The alarm is automatically cleared after the motor moves away from the limit.

AL285 Software negative limit	
Trigger condition and cause	Condition: the position feedback exceeds the software negative limit. Cause: the software negative limit is triggered.
Checking method and corrective action	Software negative limit triggering is determined by the position feedback. Set an appropriate deceleration time to achieve the desired effect. For more information, refer to the description of P5.003.
How to clear the alarm?	The alarm is automatically cleared after the motor moves away from the limit.

AL289 Position counter overflows	
Trigger condition and cause	Position counter overflows.
Checking method and corrective action	1. Set the E-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. When P2.069.Z is set to 1 (enabling the function of preventing rotary axis position offset when overflow occurs), set P2.070 [Bit 2] to 1 (no overflow warning).
How to clear the alarm?	DI.ARST

AL301 CANopen synchronization failure	
Trigger condition and cause	Condition: the synchronization with the controller fails when you use the CANopen IP mode (B mode). Cause: communication fails to synchronize.
Checking method and corrective action	1. Make sure the communication between the servo drive and controller is good. 2. After eliminating any problems that you find, allow the controller to re-send the synchronization signal and ensure that it is sent successfully. 3. Modify the setting for P3.009 (the default value is suggested).
How to clear the alarm?	NMT: reset node or OD 6040h [Bit 7] (Fault reset).

AL302 Synchronization signal of CANopen is sent too soon	
Trigger condition and cause	Condition: the synchronization signal is received too early when you use the CANopen IP mode (B mode). Cause: the synchronization signal of CANopen is sent too soon.
Checking method and corrective action	1. Make sure the setting of communication cycle period (OD 1006h) is identical to that of the controller. 2. Relax the setting of synchronization error range (P3.009.U). (For -M and -F models.) 3. Ensure the correct time sequence of sending packets from the controller. A drift or delay in packet sending time causes synchronization failure.
How to clear the alarm?	NMT: reset node or OD 6040h [Bit 7] (Fault reset).

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AL303 CANopen synchronization signal timeout	
Trigger condition and cause	Condition: the synchronization with the controller fails when you use the CANopen IP mode (B mode). Cause: timeout of CANopen synchronization signal.
Checking method and corrective action	1. Make sure the communication between the servo drive and controller is good. 2. Make sure the setting of communication cycle period (OD 1006h) is identical to that of the controller. 3. Relax the setting of synchronization error range (P3.009.U). (For -M and -F models.) 4. Ensure the correct time sequence of sending packets from the controller. A drift or delay in packet sending time causes synchronization failure. 5. When the servo drive is in the operation mode of PV (Profile velocity mode), PT (Profile torque mode), or HM (Homing mode), check if P3.017 is set too low.
How to clear the alarm?	NMT: reset node or OD 6040h [Bit 7] (Fault reset).

AL304 Invalid interpolation mode command	
Trigger condition and cause	Condition: the servo drive cannot send the command when in IP mode (except the CANopen B mode). Cause: the interpolation command fails.
Checking method and corrective action	The computing time takes too long. Disable the USB monitoring function.
How to clear the alarm?	NMT: reset node or OD 6040h [Bit 7] (Fault reset).

AL305 SYNC period error	
Trigger condition and cause	Condition: CANopen 301 OD 1006h Data Error. Cause: SYNC period is in error.
Checking method and corrective action	Check the value of OD 1006h. If it is smaller than or equal to 0, this alarm occurs.
How to clear the alarm?	NMT: reset node or OD 6040h [Bit 7] (Fault reset).

AL35F Emergency stop during deceleration	
Trigger condition and cause	This alarm occurs when DI.PFQS (0x47) is rising-edge triggered. Then the motor decelerates to 0 and triggers AL3CF.
Checking method and corrective action	Check if the DI is set to 0x47 with any of the parameters, P2.010 - P2.017 and P2.036 - P2.040, and is triggered.
How to clear the alarm?	Cycle power on the service drive.

AL380 Position offset alarm for DO.MC_OK	
Trigger condition and cause	DO.MC_OK is on and then turns off.
Checking method and corrective action	Refer to the description of P1.048. After DO.MC_OK is on, it then turns off because DO.TPOS turns off. There might be an external force causing the position offset of the motor after positioning is complete. Disable this alarm by setting P1.048.Y to 0.
How to clear the alarm?	DI.ARST

AL3CF Emergency stop	
Trigger condition and cause	After AL35F is triggered and the motor has decelerated to 0, this alarm occurs.
Checking method and corrective action	Check if the DI is set to 0x47 with any of the parameters, P2.010 - P2.017 and P2.036 - P2.040, and is triggered.
How to clear the alarm?	DI.ARST

AL3E1 Communication fails to synchronize	
Trigger condition and cause	Condition: the communication synchronization with the controller fails in IP mode (except the CANopen B mode). Cause: communication fails to synchronize.
Checking method and corrective action	1. Make sure the communication between the servo drive and controller is good. 2. After eliminating any problems that you find, allow the controller to re-send the synchronization signal and ensure that it is sent successfully. 3. Modify the setting for P3.009 (the default value is suggested).
How to clear the alarm?	NMT: reset node or OD 6040h [Bit 7] (Fault reset).

AL3E2 Communication synchronization signal is sent too soon	
Trigger condition and cause	Condition: the synchronization signal is received too early. Cause: the communication synchronization signal is sent too soon.
Checking method and corrective action	1. Make sure the setting of communication cycle period (OD 1006h) is identical to that of the controller. 2. Relax the setting of synchronization error range (P3.009.U). (For -M and -F models.) 3. Ensure the correct time sequence of sending packets from the controller. A drift or delay in packet sending time causes synchronization failure.
How to clear the alarm?	NMT: reset node or OD 6040h [Bit 7] (Fault reset).

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AL3E3 Communication synchronization signal timeout	
Trigger condition and cause	The target command is not received within a continuous communication cycle in IP mode (except the CANopen B mode).
Checking method and corrective action	1. Make sure the communication between the servo drive and controller is good. 2. Make sure the setting of communication cycle period (OD 1006h) is identical to that of the controller. 3. Relax the setting of synchronization error range (P3.009.U). (For -M and -F models.) 4. Relax the setting of IP command timeout (P3.022.YX). (For -E models.) 5. Ensure the correct time sequence of sending packets from the controller. A drift or delay in packet sending time causes synchronization failure.
How to clear the alarm?	NMT: reset node or OD 6040h [Bit 7] (Fault reset).

AL3F1 Absolute position command of the communication type servo drive is in error	
Trigger condition and cause	Condition: when the bus communication type servo drive is used with an incremental motor and the position overflow occurs with the absolute origin position unestablished, the absolute positioning command is issued. Cause: 1. The absolute origin position is not established. 2. Overflow occurs since the motor keeps rotating in the same direction.
Checking method and corrective action	Establish the absolute origin position.
How to clear the alarm?	Establish the absolute origin position.

AL400 Rotary axis position setting error	
Trigger condition and cause	Condition: the position offset of the motor in 1 ms exceeds the setting of P2.052 (Rotary axis position scale). Cause: the value of P2.052 is set too small.
Checking method and corrective action	Check if P2.052 is set according to the specifications in the manual.
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.
How to clear the alarm?	NMT: reset node, OD 6040h [Bit 7] (Fault reset), or DI.ARST.

AL404 PR special filter setting value is too great	
Trigger condition and cause	The value of the PR command special filter (P1.022) is set too great, causing the following error of the internal position to exceed the allowable range.
Checking method and corrective action	Check the setting of P1.022. If the value is too great, the following error exceeds the allowable range in a short time. Adjust the value of P1.022.
How to clear the alarm?	DI.ARST

AL422 Write-in failed caused by control power cut-off	
Trigger condition and cause	Condition: When P2.069.Z is set to 1 (enabling the function of preventing rotary axis position offset when overflow occurs) and the control power is cut off, the motor fails to store the current position. Cause: 1. The load is over the rated range and the servo drive is in a continuous overload condition. 2. After firmware update, the internal variables vary with the firmware versions. 3. The servo drive hardware EEPROM is abnormal. 4. The hardware of the servo drive is short-circuited. 5. AL520 occurred and causes malfunction of the servo drive.
Checking method and corrective action	1. Monitor if the average load rate [%] is continuously over 100% by setting P0.002 to 12. If so, increase the motor capacity or reduce the load. Refer to Appendix A for Graph of load ratio and operating time. 2. If the issue persists, send your servo drive back to the distributor or contact Delta.
How to clear the alarm?	Cycle power on the servo drive.

AL500 STO function is activated	
Trigger condition and cause	Safe torque off function (STO) is activated.
Checking method and corrective action	Safe torque off function (STO) is activated. Check why it is activated.
How to clear the alarm?	1. Reset by using DI.ARST (Alarm reset), OD 6040h [Bit 7] (Fault reset), or setting P0.001 to 0x0000. 2. If not using the STO function, plug the STO connector into CN10 or do the short-circuit wiring for the connector. Follow the instructions in Chapter 3 for the STO wiring.

AL501 SF1 lost (signal loss or signal error)	
Trigger condition and cause	Loss of SF1 signal, or SF1 and SF2 signals are not synchronized for more than 1 second.
Checking method and corrective action	Make sure the wiring of SF1 is correct.
How to clear the alarm?	Cycle power on the servo drive.

AL502 SF2 lost (signal loss or signal error)	
Trigger condition and cause	Loss of SF2 signal, or SF1 and SF2 signals are not synchronized for more than 1 second.
Checking method and corrective action	Make sure the wiring of SF2 is correct.
How to clear the alarm?	Cycle power on the servo drive.

AL503 STO self-diagnostic error	
Trigger condition and cause	An error occurs during STO self-diagnosis, which may be caused by an abnormality in the STO circuit.
Checking method and corrective action	N/A
How to clear the alarm?	Contact the distributor.

AL510 Internal parameter update program of the servo drive is abnormal	
Trigger condition and cause	Internal parameter update program of the servo drive is abnormal.
Checking method and corrective action	Cycle power on the servo drive and re-execute the operation which is prior to the occurrence of this alarm.
How to clear the alarm?	Cycle power on the servo drive.

AL520 Calculation program timeout	
Trigger condition and cause	Servo drive calculation program timeout.
Checking method and corrective action	1. Cycle power on the servo drive. 2. If the issue persists, disable the vibration elimination function by setting [Bit 8] and [Bit 9] of P2.094 to 0.
How to clear the alarm?	N/A

AL521 Vibration elimination parameter error	
Trigger condition and cause	Condition: the input value for the vibration elimination parameter is not appropriate. Cause: 1. Your input value for the vibration elimination parameter is not appropriate. 2. The Bode plot is in error due to other factors when the System Analysis tool of ASDA-Soft is in operation.
Checking method and corrective action	Perform system analysis again and correctly set the value for the vibration elimination parameter.
How to clear the alarm?	1. Perform system analysis again and correctly set the value for the vibration elimination parameter. 2. If the issue persists, disable the vibration elimination function by setting [Bit 8] and [Bit 9] of P2.094 to 0.

AL555 System failure	
Trigger condition and cause	Servo drive DSP is in error.
Checking method and corrective action	If this alarm occurs, send your servo drive directly back to Delta without making any modification.
How to clear the alarm?	N/A

AL809 PR motion setting error or command decoding error	
Trigger condition and cause	Condition: an error occurs when the servo drive decodes the motion command. Cause: incorrect motion command or abnormal software compiling may cause error in the PR program.
Checking method and corrective action	1. If this alarm occurs when the servo is not in the PR mode, save the parameter file and provide it to the distributor. 2. For advanced users: save the scope screenshot when the alarm occurs. Set P5.007 and P0.001 for the two channels and save the oscillogram.
How to clear the alarm?	Cycle power on the servo drive.

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ALC31 Motor power cable disconnection	
Trigger condition and cause	Condition: disconnection of the motor power cable (U, V, W) and ground (GND). Cause: disconnection of the motor power cable (U, V, W) and ground (GND). The switch for disconnection detection is set by P2.065 [Bit 9], which is enabled by default.
Checking method and corrective action	Check if the motor power cable (U, V, W) and ground (GND) are firmly connected. Follow the instructions in this user manual to properly connect the motor power cable and ground wire.
How to clear the alarm?	Cycle power on the servo drive.

ALCDB Servo drive model type error	
Trigger condition and cause	Servo drive model type error.
Checking method and corrective action	1. Update the firmware again. 2. If the issue persists after the firmware is updated, send your servo drive back to Delta.
How to clear the alarm?	Cycle power on the servo drive.

Specifications Appendix A

A

A.1 ASDA-B3 series servo drive

A.1.1 Specifications of the ASDA-B3 servo drive

A.1.1.1 220V models

ASDA-B3			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
Main circuit power	Phase / Voltage		Single- / Three-phase 220 V_{AC}						Three-phase 220 V_{AC}	
Main circuit power	Permissible voltage		Single- / Three-phase 200 - 230 V_{AC}, -15% to +10%						Three-phase 200 - 230 V_{AC}, -15% to +10%	
Main circuit power	Input current (3PH) (Arms)		0.88	1.29	2.04	3.52	5.72	6.33	7.6	10.3
Main circuit power	Input current (1PH) (Arms)		1.47	2.35	3.74	6.47	10.4	11.7	-	-
Main circuit power	Inrush current (220V) (Arms)		5.50	5.50	5.50	5.50	12.45	12.45	12.45	12.45
Control circuit power	Phase / Voltage		Single-phase 220 V_{AC}							
Control circuit power	Permissible voltage		Single-phase 200 - 230 V_{AC}, -15% to +10%							
Control circuit power	Input current (220V) (Arms)		0.13	0.13	0.13	0.13	0.15	0.15	0.17	0.17
Control circuit power	Inrush current (220V) (Arms)		24.89	24.89	24.89	24.89	24.89	24.89	24.89	24.89
Continuous output current (Arms)			0.9	1.55	2.65	5.1	7.3	8.3	13.4	19.4
Max. instantaneous output current (Arms)			3.88	7.07	10.6	14.14	21.21	24.3	38.3	53.03
Regenerative resistor	Built-in	Resistance (Ohm)	-	-	100	100	100	100	20	20
Regenerative resistor	Built-in	Capacity (Watt)	-	-	40	40	40	40	80	80
Regenerative resistor	External	Minimum allowable resistance (Ohm)	60	60	60	60	30	30	15	15
Cooling method			Air convection cooling				Fan cooling			

Note:

1. The input current is the actual value measured when the servo drive is under the rated output condition with an AC power supply at 220V.
2. When an electronic transformer is used, the output of the servo drive will be derated to 70%.

Specification table

Item			Specification
Servo drive resolution			24-bit (16777216 p/rev)
Main circuit control			SVPWM control
Tuning mode			Manual / Auto
Position control mode	Pulse type		Pulse + symbol, CCW pulse + CW pulse, A phase + B phase
Position control mode	Max. input pulse frequency		Pulse + symbol: 4 Mpps CCW pulse + CW pulse: 4 Mpps A phase + B phase: single-phase 2 Mpps Open collector: 200 Kpps
Position control mode	Command source		External pulse / Register
Position control mode	Smoothing method		Low-pass filter; S-curve filter; moving filter
Position control mode	E-Gear ratio		E-Gear ratio: N/M times; $1 \le N/M \le 262144$
Position control mode	Torque limit		Parameter settings
Position control mode	Feedforward compensation		Parameter settings
Speed control mode	Analog command input	Voltage range	-10 to +10 V_{DC}
Speed control mode	Analog command input	Resolution	12-bit
Speed control mode	Analog command input	Input impedance	1 MΩ
Speed control mode	Analog command input	Time constant	25 μs
Speed control mode	Speed control range*1		1 : 6000
Speed control mode	Command source		External analog command / Register
Speed control mode	Smoothing method		Low-pass filter; S-curve filter; moving filter
Speed control mode	Torque limit		Parameter settings / Analog input
Speed control mode	Bandwidth		Maximum 3.1 kHz
Speed control mode	Speed calibration ratio*2		Max. ±0.01% at 0% to 100% load fluctuation
Speed control mode	Speed calibration ratio*2		Max. ±0.01% at ±10% power fluctuation
Speed control mode	Speed calibration ratio*2		Max. ±0.01% at ambient temperature between 0˚C to 50˚C (32˚F to 122˚F)
Torque control mode	Analog command input	Voltage range	-10 to +10 V_{DC}
Torque control mode	Analog command input	Input impedance	1 MΩ
Torque control mode	Analog command input	Time constant	25 μs
Torque control mode	Command source		External analog command / Register
Torque control mode	Smoothing method		Low-pass filter
Torque control mode	Speed limit		Parameter settings / Analog input
Analog monitor output			Monitor signal can be set by parameters (voltage output range: ±8V); resolution: 10-bit
Digital input			-L models: 9 DI points; -M, -F, and -E models: 4 DI points; -P models: 6 DI points. Refer to Chapter 8 for the function settings.

Item		Specification
Digital output		-L models: 6 DO points; -M, -F, and -E models: 2 DO points; -P models: 3 DO points. Refer to Chapter 8 for the function settings.
Protection function		Overcurrent, Overvoltage, Undervoltage, Overheat, Regeneration error, Overload, Excessive speed deviation, Excessive position deviation, CN2 communication failure, Emergency stop, Positive / negative limit error, Serial communication error, RST power error, Serial communication timeout, Short-circuit protection for terminals U, V, W.
Communication interface		RS-485 / Mini USB / CANopen / DMCNET / EtherCAT / PROFINET
Environment	Installation site	Indoors (avoid direct sunlight), no corrosive vapor (avoid fumes, flammable gases, and dust)
	Altitude	Less than 2,000 m above sea level
	Atmospheric pressure	86 kPa - 106 kPa
	Ambient temperature	0˚C to 55˚C (32˚F to 131˚F) (If the ambient temperature is above 45˚C (113˚F), forced cooling is required)
	Storage temperature	-20˚C to +65˚C (-4˚F to +176˚F)
	Humidity	0 - 90% RH (non-condensing)
	Vibration	10 Hz to 57 Hz: 0.075 mm amplitude; 58 Hz to 150 Hz: 1 G
	Pollution degree	Degree 2
	IP rating	IP20 *4
	Power system	TN system / TT system
	Approvals*5	IEC/EN/UL 61800-5-1

Note:

1. Within the rated load, the speed ratio is: the minimum speed (smooth operation) / rated speed.
2. Within the rated speed, the speed calibration ratio is: (rotation speed with no load - rotation speed with full load) / rated speed.
3. Use a single-phase three-wire power system for models using a single-phase power supply.
4. The terminal blocks are not IP20 rated.
5. Only some models of the B3A series has received the TÜV Functional Safety certification. For the actual certifications, see the product nameplates.
6. This equipment does not have functions of thermal memory for shutdown, thermal memory for loss of power, and speed sensitivity in accordance with EN 61800-5-1:2007/A1:2017.
7. To meet the functional safety requirement, install the servo drive in the control cabinet with a rating of IP54 or higher.

A.1.1.2 400V models

ASDA-B3			1 kW	1.5 kW	2 kW	3 kW	4 kW	4.5 kW	5.5 kW	7.5 kW	8 kW
			10	15	20	30	40	45	55	75	80
Main circuit power	Phase / Voltage		Three-phase 400 V_{AC}								
	Permissible voltage		Three-phase 380 - 440 V_{AC}, -10% to +10%								
	Input current (400V) (Arms)		2.91	3.52	5.06	6.14	10.60	12	14.5	20	20.5
	Inrush current (400V) (Arms)		5.66	5.66	5.66	5.66	37.72	37.72	37.72	37.72	37.72
Control circuit power	Phase / Voltage		Single-phase 400 V_{AC}								
	Permissible voltage		Single-phase 380 - 440 V_{AC}, -10% to +10%								
	Input current (400V) (Arms)		0.1	0.1	0.1	0.1	0.13	0.13	0.13	0.13	0.13
	Inrush current (400V) (Arms)		37.72	37.72	37.72	37.72	37.72	37.72	37.72	37.72	37.72
Continuous output current (Arms)			3.37	4.09	5.96	9.11	11	13.30	15.34	22.11	22.50
Max. instantaneous output current (Arms)			7.07	10.6	18.98	27.33	27.33	35.35	49.29	53.03	53.03
Regenerative resistor	Built-in	Resistance (Ohm)	100	100	50	50	35	35	35	35	35
		Capacity (Watt)	80	80	80	80	100	100	100	100	100
	External	Minimum allowable resistance (Ohm)	80	60	45	40	35	35	25	25	25
Cooling method			Fan cooling								

Note: the input current is the actual value measured when the servo drive is under the rated output condition with an AC power supply at 400V.

Specification table

Item			Specification
Servo drive resolution			24-bit (16777216 p/rev)
Main circuit control			SVPWM control
Tuning mode			Manual / Auto
Position control mode	Pulse type		Pulse + symbol, CCW pulse + CW pulse, A phase + B phase
	Max. input pulse frequency		Pulse + symbol: 4 Mpps CCW pulse + CW pulse: 4 Mpps A phase + B phase: single-phase 2 Mpps Open collector: 200 Kpps
	Command source		External pulse / Register
	Smoothing method		Low-pass filter; S-curve filter; moving filter
	E-Gear ratio		E-Gear ratio: N/M times; 1 ≤ N/M ≤ 262144
	Torque limit		Parameter settings
	Feedforward compensation		Parameter settings
Speed control mode	Analog command input	Voltage range	-10 to +10 V_{DC}
		Resolution	12-bit
		Input impedance	1 MΩ
		Time constant	25 μs
	Speed control range[*1]		1 : 6000
	Command source		External analog command / Register
	Smoothing method		Low-pass filter; S-curve filter; moving filter
	Torque limit		Parameter settings / Analog input
	Bandwidth		Maximum 3.1 kHz
	Speed calibration ratio[*2]		Max., ±0.01% at 0% to 100% load fluctuation
			Max. ±0.01% at ±10% power fluctuation
			Max. ±0.01% at ambient temperature between 0˚C to 50˚C (32˚F to 122˚F)
Torque control mode	Analog command input	Voltage range	-10 to +10 V_{DC}
		Input impedance	1 MΩ
		Time constant	25 μs
	Command source		External analog command / Register
	Smoothing method		Low-pass filter
	Speed limit		Parameter settings / Analog input
Analog monitor output			Monitor signal can be set by parameters (voltage output range: ±8V); resolution: 10-bit
Digital input			-L models: 9 DI points; -M, -F, and -E models: 4 DI points; -P models: 6 DI points. Refer to Chapter 8 for the function settings.

Item		Specification
Digital output		-L models: 6 DO points; -M, -F, and -E models: 2 DO points; -P models: 3 DO points. Refer to Chapter 8 for the function settings.
Protection function		Overcurrent, Overvoltage, Undervoltage, Overheat, Regeneration error, Overload, Excessive speed deviation, Excessive position deviation, CN2 communication failure, Emergency stop, Positive / negative limit error, Serial communication error, RST power error, Serial communication timeout, Short-circuit protection for terminals U, V, W.
Communication interface		RS-485 / Mini USB / CANopen / DMCNET / EtherCAT / PROFINET
Environment	Installation site	Indoors (avoid direct sunlight), no corrosive vapor (avoid fumes, flammable gases, and dust)
	Altitude	Less than 2,000 m above sea level
	Atmospheric pressure	86 kPa - 106 kPa
	Ambient temperature	0˚C to 55˚C (32˚F to 131˚F) (If the ambient temperature is above 45˚C (113˚F), forced cooling is required and the average load rate should be 80% or less)
	Storage temperature	-20˚C to +65˚C (-4˚F to +176˚F)
	Humidity	0 - 90% RH (non-condensing)
	Vibration	10 Hz to 57 Hz: 0.075 mm amplitude; 58 Hz to 150 Hz: 1 G
	Pollution degree	Degree 2
	IP rating	IP20 [*3]
	Power system	TN system / TT system
	Approvals[*4]	IEC/EN 61800-5-1 CE

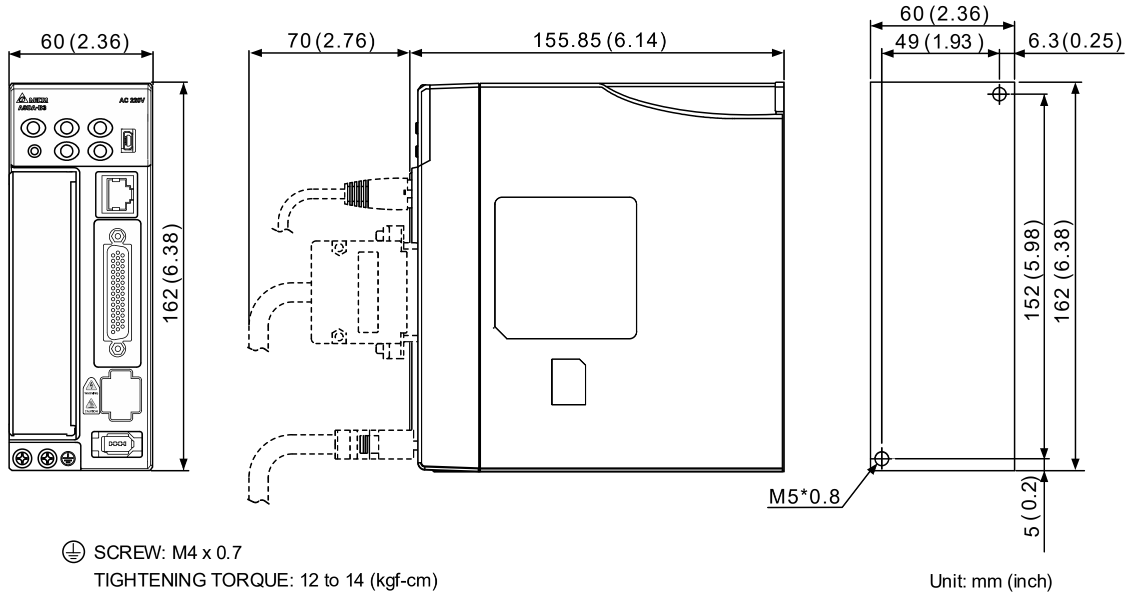
Note:

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: (rotation speed with no load - rotation speed with full load) / rated speed.
3. The terminal blocks are not IP20 rated.
4. TÜV Functional Safety application for the B3A series is in progress. For the actual certifications, see the product nameplates.
5. This equipment does not have functions of thermal memory for shutdown, thermal memory for loss of power, and speed sensitivity in accordance with EN 61800-5-1:2007/A1:2017.
6. To meet the functional safety requirement, install the servo drive in the control cabinet with a rating of IP54 or higher.

A.1.2 Dimensions of the servo drive

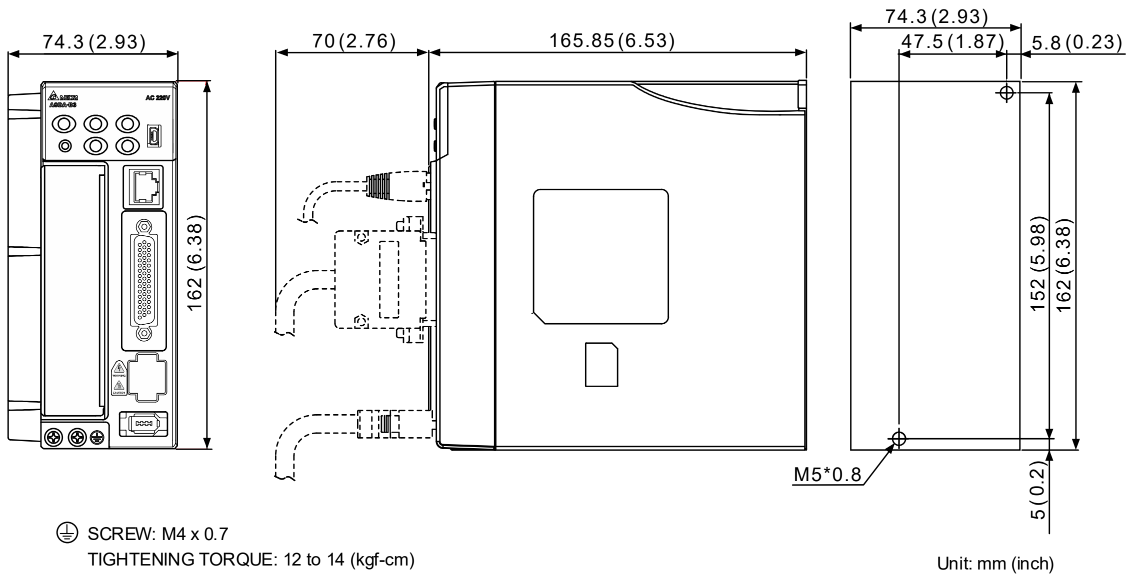
A.1.2.1 220V models

100 W / 200 W / 400 W



Weight	0.9 kg (1.98 lb)

750 W



Weight	1.2 kg (2.64 lb)

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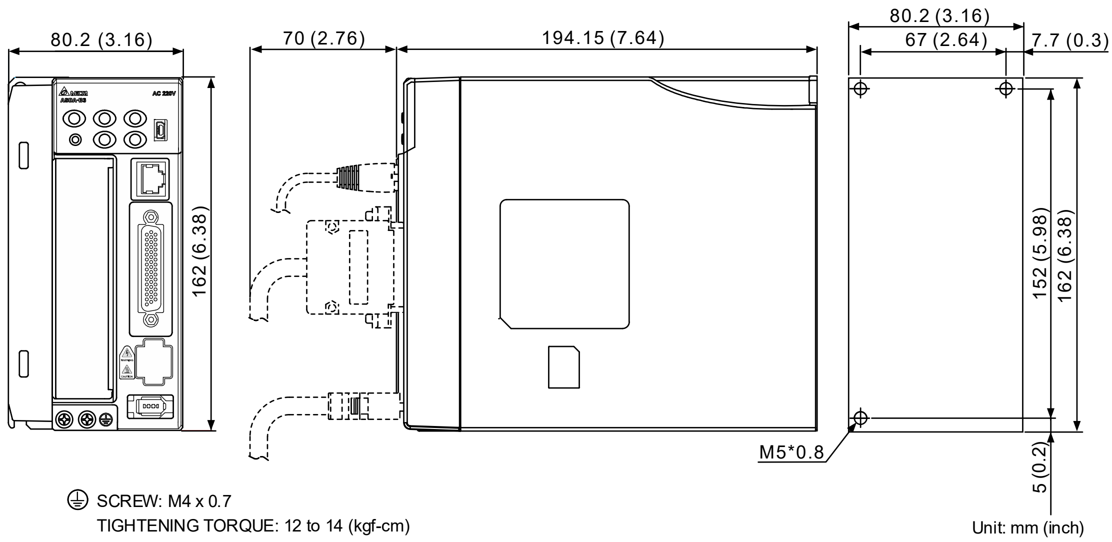
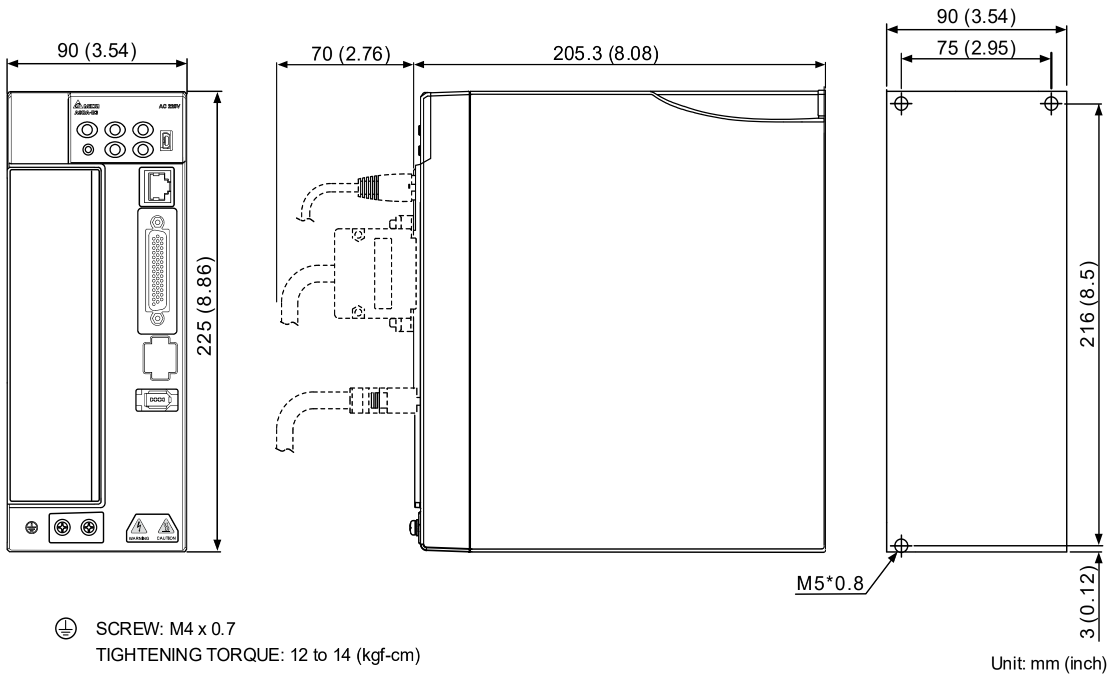
1 kW / 1.5 kW



Weight	1.8 kg (3.96 lb)

2 kW / 3 kW

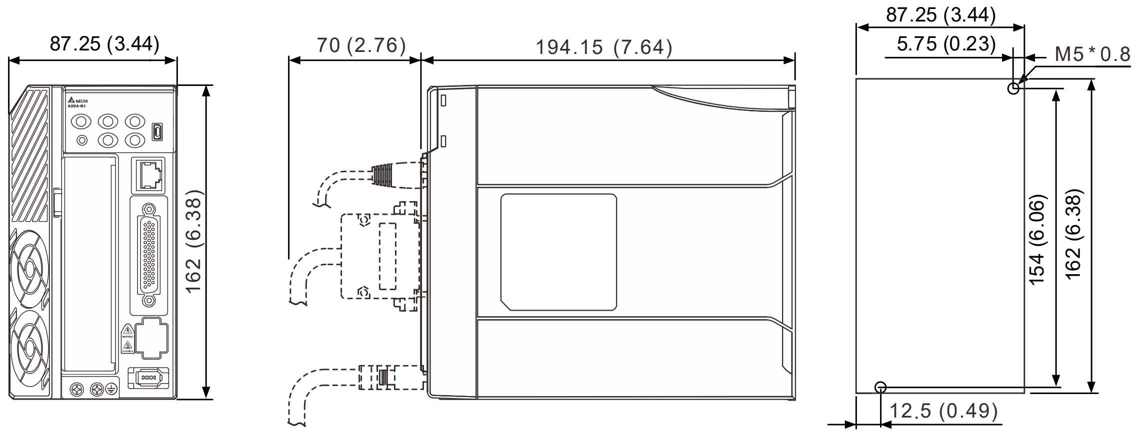


Weight	2.8 kg (6.17 lb)

Note: dimensions and weights of the servo drive may be updated without prior notice.

A.1.2.2 400V models

1 kW / 1.5 kW / 2 kW / 3 kW

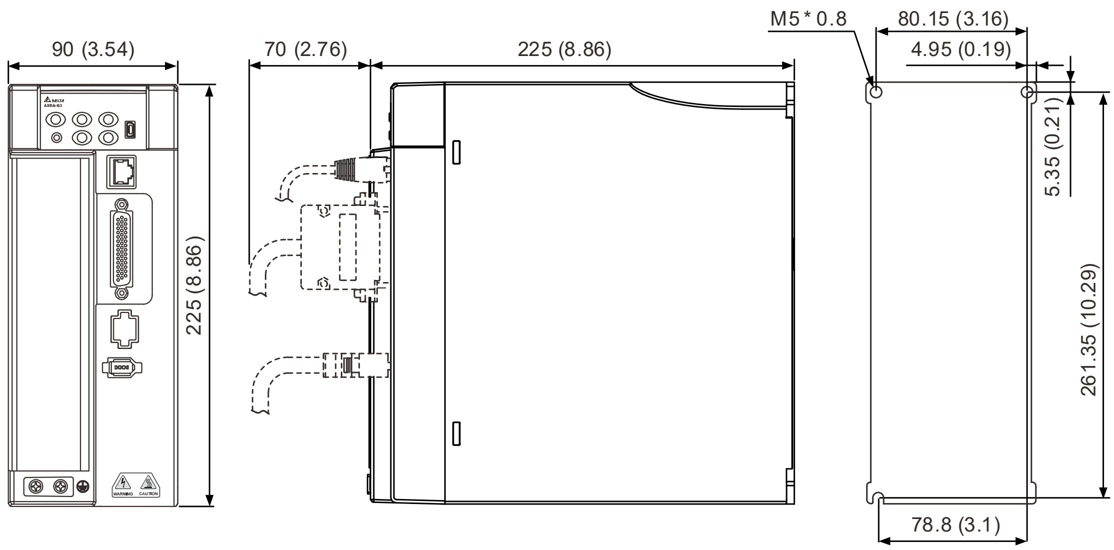


SCREW: M4 x 0.7
TIGHTENING TORQUE: 12 to 14 (kgf-cm)

Unit: mm (inch)

Weight	1.6 kg (3.53 lb)	1 kW / 1.5 kW
	1.7 kg (3.75 lb)	2 kW / 3 kW

4 kW / 4.5 kW / 5.5 kW / 7.5 Kw / 8 kW



SCREW: M4 x 0.7
TIGHTENING TORQUE: 12 to 14 (kgf-cm)

Unit: mm (inch)

Weight	2.9 kg (6.39 lb)	4 kW - 7.5 kW
	3.3 kg (7.28 lb)	8 kW

Note: dimensions and weights of the servo drive may be updated without prior notice.

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A.2 ECM-B3 series servo motor

A.2.1 Specifications of ECM-B3 motors

A.2.1.1 220V models

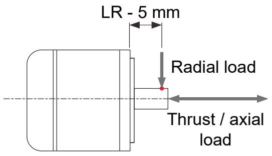
F80 and below motors (low & medium inertia)

ECM-		B3L-C□0401	B3M-C□0602	B3M-C□0604	B3M-C□0804	B3M-C□0807	B3M-C□0810
Rated power (kW)		0.1	0.2	0.4	0.4	0.75	1.0
Rated torque (N·m)*1		0.32	0.64	1.27	1.27	2.4	3.18
Max. torque (N·m)		1.12	2.24	4.45	4.45	8.4	11.13
Rated speed (rpm)		3000					
Max. speed (rpm)		6000					
Rated current (Arms)		0.857	1.42	2.40	2.53	4.27	5.00
Max. instantaneous current (Arms)		3.44	6.62	9.47	9.42	15.8	18.2
Change of rated power (kW/s)	w/o brake	34.25	29.05	63.50	24.89	53.83	73.8
	with brake	32.51	27.13	61.09	23.21	50.97	72.2
Rotor inertia (× 10^{-4} kg·m^2)	w/o brake	0.0299	0.141	0.254	0.648	1.07	1.37
	with brake	0.0315	0.151	0.264	0.695	1.13	1.40
Mechanical time constant (ms)	w/o brake	0.50	0.91	0.52	0.8	0.54	0.48
	with brake	0.53	0.97	0.54	0.86	0.57	0.49
Torque constant-KT (N·m/Arms)		0.374	0.45	0.53	0.5	0.56	0.64
Voltage constant-KE (mVrms/rpm)		13.8	16.96	19.76	18.97	20.17	23.15
Armature resistance (Ohm)		8.22	4.71	2.04	1.125	0.55	0.495
Armature inductance (mH)		19.1	12.18	6.50	5.14	2.81	2.63
Electrical time constant (ms)		2.32	2.59	3.19	4.57	5.11	5.31
Weight (kg)	w/o brake	0.5	0.9	1.2	1.7	2.34	2.82
	with brake	0.7	1.3	1.6	2.51	3.15	3.60
Max. radial load (N)		78	245	245	392	392	392
Max. axial load (N)		54	74	74	147	147	147
Brake operating voltage		24 V_{DC} ± 10%					
Brake power consumption (W) (at 20˚C (68°F))		6.1	7.6	7.6	8	8.5	10
Brake holding torque [N·m (Min)]*2		0.3	1.3	1.3	2.5	3.2	3.8
Brake release time [ms (Max)]		20	20	20	20	40	40
Brake pull-in time [ms (Max)]		35	50	50	60	60	80
Derating rate with oil seal (%)		10	10	5	5	5	5
Insulation class		Class A (UL), Class B (CE)					
Insulation resistance		100 MΩ min. (at 500 V_{DC})					
Insulation strength		1.8 kV_{AC}, 1 sec					
Vibration grade		V15					
Ambient temperature		-20˚C to +60˚C (-4°F to +140°F)*3					
Storage temperature		-20˚C to +80˚C (-4°F to +176°F)					
Ambient and storage humidity		20 - 90% RH (non-condensing)					

ECM-	B3L-C□0401	B3M-C□0602	B3M-C□0604	B3M-C□0804	B3M-C□0807	B3M-C□0810
Vibration capacity	2.5 G					
IP rating	IP67 (for models using waterproof connectors and shaft seals or oil seals)					
Approvals	CE cULus					

Note:

1. The rated torque is the continuous permissible torque when the servo motor mounted with the heat sink of the following dimensions is operating in a temperature range of 0˚C - 40˚C (32˚F - 104˚F).
   F40, F60, and F80: 250 mm x 250 mm x 6 mm
   Material: aluminum
2. The built-in servo motor brake is only for keeping the object installed on the motor in a stopped state. Do not use it for deceleration or as a dynamic brake.
3. If the ambient temperature is over 40˚C (104°F), refer to Section A.2.3 Power derating curves of the ECM-B3 motors.
4. Follow the load specification for the motor shaft during operation. The load for the motor shaft is defined as follows.



F80 and below motors (high inertia)

ECM-		B3H-C□0602	B3H-C□0604	B3H-C□0807
Rated power (kW)		0.2	0.4	0.75
Rated torque (N·m)[*1]		0.64	1.27	2.4
Max. torque (N·m)		2.43	4.83	9.12
Rated speed (rpm)		3000	3000	3000
Max. speed (rpm)		6700	6700	6700
Rated current (Arms)		1.51	2.21	4.19
Max. instantaneous current (Arms)		6.12	8.46	16.3
Change of rated power (kW/s)	w/o brake	15.5	30.8	37.2
	with brake	14.6	30.0	35.6
Rotor inertia (× 10^{-4} kg·m^2)	w/o brake	0.265	0.523	1.55
	with brake	0.280	0.538	1.62
Mechanical time constant (ms)	w/o brake	1.78	1.31	0.825
	with brake	1.88	1.34	0.862
Torque constant-KT (N·m/Arms)		0.424	0.575	0.573
Voltage constant-KE (mVrms/rpm)		15.3	20.8	20.2
Armature resistance (Ohm)		4.17	2.85	0.588
Armature inductance (mH)		2	3.5	1
Electrical time constant (ms)		0.48	1.23	1.70
Weight (kg)	w/o brake	0.70	1.05	2.15
	with brake	1.23	1.6	2.95
Max. radial load (N)		245	245	392
Max. axial load (N)		74	74	147
Brake operating voltage		24 V_{DC} ± 10%		
Brake power consumption (W) (at 20˚C (68°F))		7.6	7.6	8
Brake holding torque [N·m (Min)][*2]		1.3	1.3	2.5
Brake release time [ms (Max)]		20	20	20
Brake pull-in time [ms (Max)]		50	50	60
Derating rate with oil seal (%)		10	5	5
Insulation class		Class A (UL), Class B (CE)		
Insulation resistance		100 MΩ min. (at 500 V_{DC})		
Insulation strength		1.8 kV_{AC}, 1 sec		
Vibration grade		V15		
Ambient temperature		-20˚C to +60˚C (-4°F to +140°F)[*3]		
Storage temperature		-20˚C to +80˚C (-4°F to +176°F)		
Ambient and storage humidity		20 - 90% RH (non-condensing)		
Vibration capacity		2.5 G		
IP rating		IP67 (for models using waterproof connectors and shaft seals or oil seals)		
Approvals				

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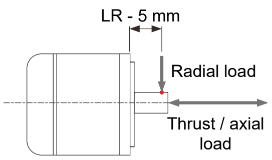
Note:

1. The rated torque is the continuous permissible torque when the servo motor mounted with the heat sink of the following dimensions is operating in a temperature range of 0˚C - 40˚C (32˚F - 104˚F).
   F40, F60, and F80: 250 mm x 250 mm x 6 mm
   Material: aluminum
2. The built-in servo motor brake is only for keeping the object installed on the motor in a stopped state. Do not use it for deceleration or as a dynamic brake.
3. If the ambient temperature is over 40˚C (104°F), refer to Section A.2.3 Power derating curves of the ECM-B3 motors.
4. Follow the load specification for the motor shaft during operation. The load for the motor shaft is defined as follows.



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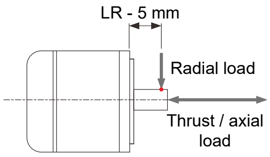
F100 motors (medium inertia)

ECM-		B3M-C□1010	B3M-C□1015	B3M-C□1020
Rated power (kW)		1	1.5	2
Rated torque (N·m)*1		3.18	4.77	6.37
Max. torque (N·m)		9.54	14.31	19.11
Rated speed (rpm)		3000		
Max. speed (rpm)		6000		
Rated current (Arms)		6.05	7.48	9.96
Max. instantaneous current (Arms)		18.4	22.8	30.7
Change of rated power (kW/s)	w/o brake	36.4	61.7	86.7
	with brake	33.0	57.3	82.0
Rotor inertia (× 10^{-4} kg·m^2)	w/o brake	2.78	3.69	4.68
	with brake	3.06	3.97	4.95
Mechanical time constant (ms)	w/o brake	0.741	0.552	0.523
	with brake	0.815	0.594	0.554
Torque constant-KT (N·m/Arms)		0.526	0.638	0.640
Voltage constant-KE (mVrms/rpm)		19.8	23.8	23.7
Armature resistance (Ohm)		0.265	0.217	0.162
Armature inductance (mH)		1.86	1.71	1.23
Electrical time constant (ms)		7.02	7.88	7.59
Weight (kg)	w/o brake	3.56	4.37	5.09
	with brake	4.88	5.68	6.51
Max. radial load (N)		490	490	490
Max. axial load (N)		196	196	196
Brake operating voltage		24 V_{DC} ± 10%		
Brake power consumption (W) (at 20˚C (68°F))		17.6	17.6	17.6
Brake holding torque [N·m (Min)]*2		9.5	9.5	9.5
Brake release time [ms (Max)]		50	50	50
Brake pull-in time [ms (Max)]		110	110	110
Derating rate with oil seal (%)		5	5	5
Insulation class		Class A (UL), Class B (CE)		
Insulation resistance		100 MΩ min. (at 500 V_{DC})		
Insulation strength		1.8 kV_{AC}, 1 sec		
Vibration grade		V15		
Ambient temperature		-20˚C to +60˚C (-4°F to +140°F)*3		
Storage temperature		-20˚C to +80˚C (-4˚F to +176˚F)		
Ambient and storage humidity		20 - 90% RH (non-condensing)		
Vibration capacity		2.5 G		
IP rating		IP67 (for models using shaft seals or oil seals)		
Approvals		CE cULus		

Note:

1. The rated torque is the continuous permissible torque when the servo motor mounted with the heat sink of the following dimensions is operating in a temperature range of 0˚C - 40˚C (32˚F - 104˚F).
   F100: 300 mm x 300 mm x 12 mm
   Material: aluminum
2. The built-in servo motor brake is only for keeping the object in a stopped state. Do not use it for deceleration or as a dynamic brake.
3. If the ambient temperature is over 40˚C (104°F), refer to Section A.2.3 Power derating curves of the ECM-B3 motors.
4. Follow the load specification for the motor shaft during operation. The load for the motor shaft is defined as follows.

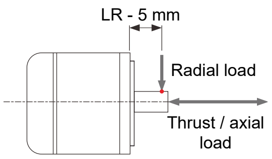


F130 motors (medium & high inertia)

ECM-		B3M-E□1310	B3M-E□1315	B3M-E□1320	B3H-F□1308	B3H-F□1313	B3H-F□1318
Rated power (kW)		1	1.5	2	0.85	1.3	1.8
Rated torque (N·m)[*1]		4.77	7.16	9.55	5.39	8.34	11.5
Max. torque (N·m)		14.3	21.48	28.65	16.17	25.02	34.5
Rated speed (rpm)		2000			1500		
Max. speed (rpm)		3000			4000		
Rated current (Arms)		5.96	8.17	10.59	6.65	7.70	11.5
Max. instantaneous current (Arms)		19.9	26.82	34.20	20.0	23.9	36.1
Change of rated power (kW/s)	w/o brake	29.21	45.69	62.25	23.4	38.6	58.5
	with brake	28.66	45.09	61.62	23.0	38.3	58.0
Rotor inertia (× 10^{-4} kg·m^2)	w/o brake	7.79	11.22	14.65	12.44	18.00	22.60
	with brake	7.94	11.37	14.8	12.62	18.14	22.80
Mechanical time constant (ms)	w/o brake	1.46	1.10	1.03	2.48	1.98	1.70
	with brake	1.49	1.12	1.04	2.52	1.99	1.71
Torque constant-KT (N·m/Arms)		0.80	0.88	0.90	0.811	1.08	1.00
Voltage constant-KE (mVrms/rpm)		29.30	31.69	32.70	29.8	38.8	35.3
Armature resistance (Ohm)		0.419	0.260	0.198	0.460	0.440	0.253
Armature inductance (mH)		4	2.81	2.18	2.50	2.76	1.70
Electrical time constant (ms)		9.55	10.81	11.01	5.43	6.27	6.72
Weight (kg)	w/o brake	4.9	6.0	7.0	6.0	7.0	8.0
	with brake	6.3	7.4	8.5	7.5	8.5	9.5
Max. radial load (N)		490	686	980	490	686	980
Max. axial load (N)		98	343	392	98	343	392
Brake operating voltage		$24\ V_{DC} \pm 10\%$					
Brake power consumption (W) (at 20˚C (68°F))		21.5	21.5	21.5	24	24	24
Brake holding torque [N·m (Min)][*2]		10	10	10	16	16	16
Brake release time [ms (Max)]		50	50	50	60	60	60
Brake pull-in time [ms (Max)]		110	110	110	120	120	120
Derating rate with oil seal (%)		5	5	5	5	5	5
Insulation class		Class A (UL), Class B (CE)			Class F (UL), Class F (CE)		
Insulation resistance		100 MΩ min. (at 500 V_{DC})					
Insulation strength		1.8 kV_{AC}, 1 sec					
Vibration grade		V15					
Ambient temperature		-20˚C to +60˚C (-4°F to +140°F)[*3]					
Storage temperature		-20˚C to +80˚C (-4°F to +176°F)					
Ambient and storage humidity		20 - 90% RH (non-condensing)					
Vibration capacity		2.5 G					
IP rating		IP67 (for models using shaft seals or oil seals)					
Approvals							

Note:

1. The rated torque is the continuous permissible torque when the servo motor mounted with the heat sink of the following dimensions is operating in a temperature range of 0˚C - 40˚C (32˚F - 104˚F).
   F130: 400 mm x 400 mm x 20 mm
   Material: aluminum
2. The built-in servo motor brake is only for keeping the object in a stopped state. Do not use it for deceleration or as a dynamic brake.
3. If the ambient temperature is over 40˚C (104°F), refer to Section A.2.3 Power derating curves of the ECM-B3 motors.
4. Follow the load specification for the motor shaft during operation. The load for the motor shaft is defined as follows.

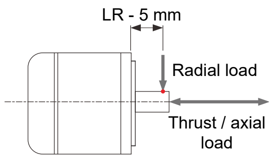


F180 motors (medium inertia)

ECM-		B3M-E□1820	B3M-F□1830
Rated power (kW)		2	3
Rated torque (N·m)[*1]		9.55	19.1
Max. torque (N·m)		28.65	57.29
Rated speed (rpm)		2000	1500
Max. speed (rpm)		3000	3000
Rated current (Arms)		11.43	18.21
Max. instantaneous current (Arms)		36.21	58.9
Change of rated power (kW/s)	w/o brake	31.33	68.02
	with brake	30.02	66.45
Rotor inertia (× 10^{-4} kg·m^2)	w/o brake	29.11	53.63
	with brake	30.38	54.9
Mechanical time constant (ms)	w/o brake	1.83	1.21
	with brake	1.91	1.24
Torque constant-KT (N·m/Arms)		0.836	1.05
Voltage constant-KE (mVrms/rpm)		31.6	37.9
Armature resistance (Ohm)		0.159	0.086
Armature inductance (mH)		2.34	1.52
Electrical time constant (ms)		14.72	17.67
Weight (kg)	w/o brake	10	13.9
	with brake	13.7	17.6
Max. radial load (N)		1470	1470
Max. axial load (N)		490	490
Brake operating voltage		24 V_{DC} ± 10%	
Brake power consumption (W) (at 20˚C (68°F))		31	31
Brake holding torque [N·m (Min)][*2]		25	25
Brake release time [ms (Max)]		30	30
Brake pull-in time [ms (Max)]		120	120
Derating rate with oil seal (%)		5	5
Insulation class		Class A (UL), Class B (CE)	
Insulation resistance		100 MΩ min. (at 500 V_{DC})	
Insulation strength		1.8 kV_{AC}, 1 sec	
Vibration grade		V15	
Ambient temperature		-20˚C to +60˚C (-4°F to +140°F)[*3]	
Storage temperature		-20˚C to +80˚C (-4˚F to +176˚F)	
Ambient and storage humidity		20 - 90% RH (non-condensing)	
Vibration capacity		2.5 G	
IP rating		IP67 (for models using shaft seals or oil seals)	
Approvals			

Note:

1. The rated torque is the continuous permissible torque when the servo motor mounted with the heat sink of the following dimensions is operating in a temperature range of 0˚C - 40˚C (32˚F - 104˚F).
   F180: 550 mm x 550 mm x 30 mm
   Material: aluminum
2. The built-in servo motor brake is only for keeping the object in a stopped state. Do not use it for deceleration or as a dynamic brake.
3. If the ambient temperature is over 40˚C (104°F), refer to Section A.2.3 Power derating curves of the ECM-B3 motors.
4. Follow the load specification for the motor shaft during operation. The load for the motor shaft is defined as follows.



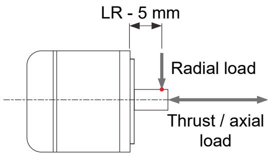
A.2.1.2 400V models

F80 and below motors (medium inertia)

ECM-		B3M-J□0807
Rated power (kW)		0.75
Rated torque (N·m)[*1]		2.4
Max. torque (N·m)		8.4
Rated speed (rpm)		3000
Max. speed (rpm)		6000
Rated current (Arms)		2.15
Max. instantaneous current (Arms)		7.90
Change of rated power (kW/s)	w/o brake	53.83
	with brake	50.97
Rotor inertia (× 10^{-4} kg·m^2)	w/o brake	1.07
	with brake	1.13
Mechanical time constant (ms)	w/o brake	0.55
	with brake	0.58
Torque constant-KT (N·m/Arms)		1.12
Voltage constant-KE (mVrms/rpm)		40.34
Armature resistance (Ohm)		2.20
Armature inductance (mH)		11.2
Electrical time constant (ms)		5.09
Weight (kg)	w/o brake	2.34
	with brake	3.15
Max. radial load (N)		392
Max. axial load (N)		147
Brake operating voltage		24 V_{DC} ± 10%
Brake power consumption (W) (at 20˚C (68°F))		8.5
Brake holding torque [N·m (Min)][*2]		3.2
Brake release time [ms (Max)]		40
Brake pull-in time [ms (Max)]		60
Derating rate with oil seal (%)		5
Insulation class		Class A (UL), Class B (CE)
Insulation resistance		100 MΩ min. (at 500 V_{DC})
Insulation strength		2.3 kV_{AC}, 1 sec
Vibration grade		V15
Ambient temperature		-20˚C to +60˚C (-4°F to +140°F)[*3]
Storage temperature		-20˚C to +80˚C (-4°F to +176°F)
Ambient and storage humidity		20 - 90% RH (non-condensing)
Vibration capacity		2.5 G
IP rating		IP67 (for models using waterproof connectors and shaft seals or oil seals)
Approvals		CE c UL us

Note:

1. The rated torque is the continuous permissible torque when the servo motor mounted with the heat sink of the following dimensions is operating in a temperature range of 0˚C - 40˚C (32˚F - 104˚F).
   F60 and F80: 250 mm x 250 mm x 6 mm
   Material: aluminum
2. The built-in servo motor brake is only for keeping the object in a stopped state. Do not use it for deceleration or as a dynamic brake.
3. If the ambient temperature is over 40˚C (104°F), refer to Section A.2.3 Power derating curves of the ECM-B3 motors.
4. Follow the load specification for the motor shaft during operation. The load for the motor shaft is defined as follows.

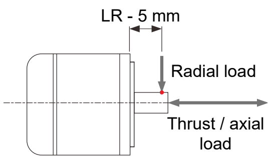


F100 motors (medium inertia)

ECM-		B3M-J□1010	B3M-J□1015	B3M-J□1020
Rated power (kW)		1	1.5	2
Rated torque (N·m)*1		3.18	4.77	6.37
Max. torque (N·m)		9.54	14.31	19.11
Rated speed (rpm)		3000		
Max. speed (rpm)		6000		
Rated current (Arms)		3.03	3.73	5.00
Max. instantaneous current (Arms)		9.21	11.4	15.3
Change of rated power (kW/s)	w/o brake	36.4	61.7	86.7
	with brake	33.0	57.3	82.0
Rotor inertia ($\times 10^{-4}$ kg·m^2)	w/o brake	2.78	3.69	4.68
	with brake	3.06	3.97	4.95
Mechanical time constant (ms)	w/o brake	0.737	0.546	0.528
	with brake	0.811	0.587	0.559
Torque constant-KT (N·m/Arms)		1.05	1.28	1.27
Voltage constant-KE (mVrms/rpm)		39.5	47.8	47.2
Armature resistance (Ohm)		1.05	0.864	0.646
Armature inductance (mH)		7.50	6.63	4.89
Electrical time constant (ms)		7.14	7.67	7.57
Weight (kg)	w/o brake	3.56	4.37	5.09
	with brake	4.88	5.68	6.505
Max. radial load (N)		490	490	490
Max. axial load (N)		196	196	196
Brake operating voltage		24 V_{DC} ± 10%		
Brake power consumption (W) (at 20˚C (68°F))		17.6	17.6	17.6
Brake holding torque [N·m (Min)]*2		9.5	9.5	9.5
Brake release time [ms (Max)]		50	50	50
Brake pull-in time [ms (Max)]		110	110	110
Derating rate with oil seal (%)		5	5	5
Insulation class		Class A (UL), Class B (CE)		
Insulation resistance		100 MΩ min. (at 500 V_{DC})		
Insulation strength		2.3 kV_{AC}, 1 sec		
Vibration grade		V15		
Ambient temperature		-20˚C to +60˚C (-4°F to +140°F)*3		
Storage temperature		-20˚C to +80˚C (-4°F to +176°F)		
Ambient and storage humidity		20 - 90% RH (non-condensing)		
Vibration capacity		2.5 G		
IP rating		IP67 (for models using shaft seals or oil seals)		
Approvals		CE c UL us		

Note:

1. The rated torque is the continuous permissible torque when the servo motor mounted with the heat sink of the following dimensions is operating in a temperature range of 0˚C - 40˚C (32˚F - 104˚F).
   F100: 300 mm x 300 mm x 12 mm
   Material: aluminum
2. The built-in servo motor brake is only for keeping the object in a stopped state. Do not use it for deceleration or as a dynamic brake.
3. If the ambient temperature is over 40˚C (104°F), refer to Section A.2.3 Power derating curves of the ECM-B3 motors.
4. Follow the load specification for the motor shaft during operation. The load for the motor shaft is defined as follows.



F130 motors (medium & high inertia)

ECM-		B3M-K□1310	B3M-K□1315	B3M-K□1320	B3H-L□1308	B3H-L□1313	B3H-L□1318
Rated power (kW)		1.0	1.5	2.0	0.85	1.3	1.8
Rated torque (N·m)*1		4.77	7.16	9.55	5.39	8.34	11.5
Max. torque (N·m)		14.3	21.48	28.65	16.17	25.02	34.5
Rated speed (rpm)		2000			1500		
Max. speed (rpm)		3000			4000		
Rated current (Arms)		3.00	4.09	5.30	3.35	3.85	5.75
Max. instantaneous current (Arms)		9.95	13.37	17.1	10.0	12.0	18.1
Change of rated power (kW/s)	w/o brake	29.21	45.69	62.25	23.4	38.6	58.5
	with brake	28.66	45.09	61.62	23.0	38.3	58.0
Rotor inertia ($\times 10^{-4}$ kg·m^2)	w/o brake	7.79	11.22	14.65	12.44	18.00	22.60
	with brake	7.94	11.37	14.80	12.62	18.14	22.80
Mechanical time constant (ms)	w/o brake	1.47	1.10	1.03	2.50	1.97	1.69
	with brake	1.50	1.12	1.04	2.54	1.99	1.71
Torque constant-KT (N·m/Arms)		1.59	1.75	1.80	1.61	2.17	2.00
Voltage constant-KE (mVrms/rpm)		58.60	63.38	65.40	59.5	77.6	70.7
Armature resistance (Ohm)		1.68	1.04	0.792	1.84	1.76	1.01
Armature inductance (mH)		16.0	11.2	8.72	10.0	11.0	6.80
Electrical time constant (ms)		9.52	10.8	11.0	5.43	6.25	6.73
Weight (kg)	w/o brake	4.9	6.0	7.0	6.0	7.0	8.0
	with brake	6.3	7.4	8.5	7.5	8.5	9.5
Max. radial load (N)		490	686	980	490	686	980
Max. axial load (N)		98	343	392	98	343	392
Brake operating voltage		24 V_{DC} ± 10%					
Brake power consumption (W) (at 20˚C (68°F))		21.5	21.5	21.5	24	24	24
Brake holding torque [N·m (Min)]*2		10	10	10	16	16	16
Brake release time [ms (Max)]		50	50	50	60	60	60
Brake pull-in time [ms (Max)]		110	110	110	120	120	120
Derating rate with oil seal (%)		5	5	5	5	5	5
Insulation class		Class A (UL), Class B (CE)			Class F (UL), Class F (CE)		
Insulation resistance		100 MΩ min. (at 500 V_{DC})					
Insulation strength		2.3 kV_{AC}, 1 sec					
Vibration grade		V15					
Ambient temperature		-20˚C to +60˚C (-4°F to +140°F)*3					
Storage temperature		-20˚C to +80˚C (-4°F to +176°F)					
Ambient and storage humidity		20 - 90% RH (non-condensing)					
Vibration capacity		2.5 G					
IP rating		IP67 (for models using shaft seals or oil seals)					
Approvals		CE cULus					

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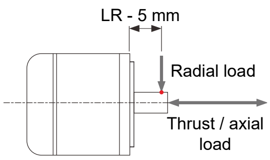
Note:

1. The rated torque is the continuous permissible torque when the servo motor mounted with the heat sink of the following dimensions is operating in a temperature range of 0˚C - 40˚C (32˚F - 104˚F).
   F130: 400 mm x 400 mm x 20 mm
   Material: aluminum
2. The built-in servo motor brake is only for keeping the object in a stopped state. Do not use it for deceleration or as a dynamic brake.
3. If the ambient temperature is over 40˚C (104°F), refer to Section A.2.3 Power derating curves of the ECM-B3 motors.
4. Follow the load specification for the motor shaft during operation. The load for the motor shaft is defined as follows.



F180 motors (medium inertia)

ECM-		B3M-K□1820	B3M-L□1830	B3M-L□1845	B3M-L□1855	B3M-L□1875
Rated power (kW)		2	3	4.5	5.5	7.5
Rated torque (N·m)*1		9.55	19.1	28.65	35.01	47.75
Max. torque (N·m)		28.65	57.29	71.6	105	119
Rated speed (rpm)		2000	1500	1500		
Max. speed (rpm)		3000	3000	4000		
Rated current (Arms)		5.7	9.1	13.3	15.3	22.1
Max. instantaneous current (Arms)		18.1	29.45	35.35	49.29	56.68
Change of rated power (kW/s)	w/o brake	31.33	68.02	121	124	169
	with brake	30.02	66.45	119	122	167
Rotor inertia ($\times 10^{-4}$ kg·m^2)	w/o brake	29.11	53.63	67.73	98.88	134.95
	with brake	30.38	54.9	69.15	100.1	136.24
Mechanical time constant (ms)	w/o brake	1.83	1.21	1.07	1.01	1.01
	with brake	1.91	1.24	1.09	1.02	1.02
Torque constant-KT (N·m/Arms)		1.68	2.10	2.15	2.29	2.16
Voltage constant-KE (mVrms/rpm)		63.2	75.8	78.8	81.8	77.4
Armature resistance (Ohm)		0.636	0.344	0.255	0.182	0.120
Armature inductance (mH)		9.36	6.08	4.68	3.48	2.27
Electrical time constant (ms)		14.72	17.67	18.4	19.1	18.9
Weight (kg)	w/o brake	10	13.9	16.5	21.2	27.2
	with brake	13.7	17.6	20.2	24.9	30.9
Max. radial load (N)		1470	1470	1470	1764	1764
Max. axial load (N)		490	490	490	588	588
Brake operating voltage		24 V_{DC} ± 10%				
Brake power consumption (W) (at 20˚C (68˚F))		31	31	31	31	31
Brake holding torque [N·m (Min)]*2		25	25	55	55	55
Brake release time [ms (Max)]		30	30	50	50	50
Brake pull-in time [ms (Max)]		120	120	150	150	150
Derating rate with oil seal (%)		5	5	0	0	0
Insulation class		Class A (UL), Class B (CE)		Class F (UL), Class F (CE)		
Insulation resistance		100 MΩ min. (at 500 V_{DC})				
Insulation strength		2.3 kV_{AC}, 1 sec				
Vibration grade		V15				
Ambient temperature		-20˚C to +60˚C (-4°F to +140°F)*3				
Storage temperature		-20˚C to +80˚C (-4°F to +176°F)				
Ambient and storage humidity		20 - 90% RH (non-condensing)				
Vibration capacity		2.5 G				
IP rating		IP67 (for models using shaft seals or oil seals)				
Approvals						

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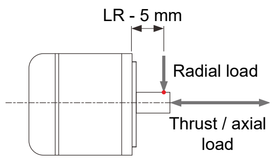
Note:

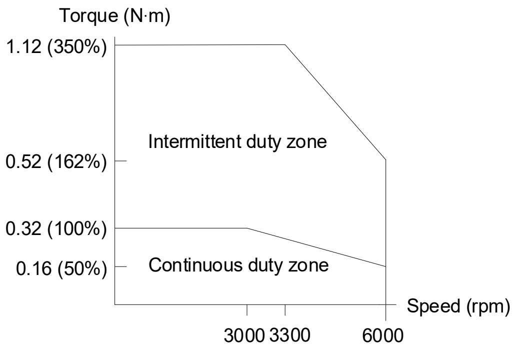
1. The rated torque is the continuous permissible torque when the servo motor mounted with the heat sink of the following dimensions is operating in a temperature range of 0˚C - 40˚C (32˚F - 104˚F).
   F180: 550 mm x 550 mm x 30 mm
   Material: aluminum
2. The built-in servo motor brake is only for keeping the object in a stopped state. Do not use it for deceleration or as a dynamic brake.
3. If the ambient temperature is over 40˚C (104°F), refer to Section A.2.3 Power derating curves of the ECM-B3 motors.
4. Follow the load specification for the motor shaft during operation. The load for the motor shaft is defined as follows.



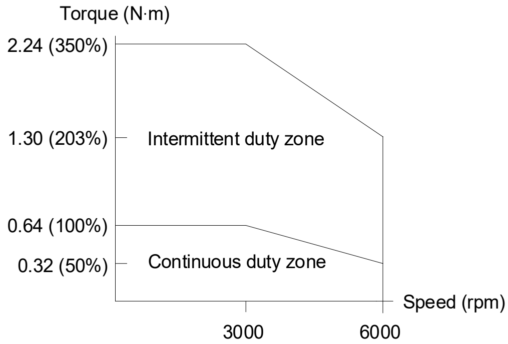
A.2.2 Torque features (T-N curves) of the ECM-B3 motors

A.2.2.1 220V models

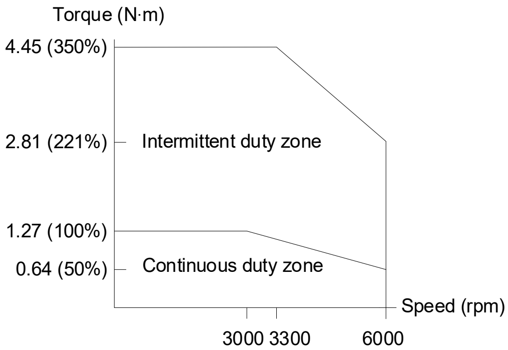
F80 and below motors



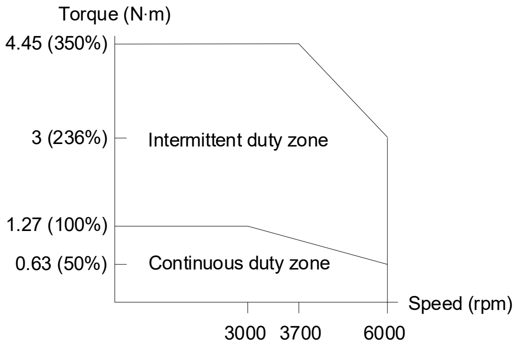
ECM-B3L-C□0401□□□



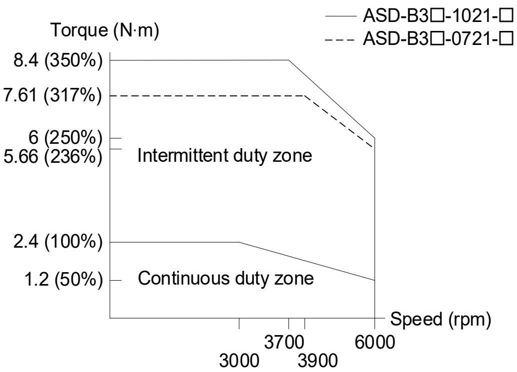
ECM-B3M-C□0602□□□



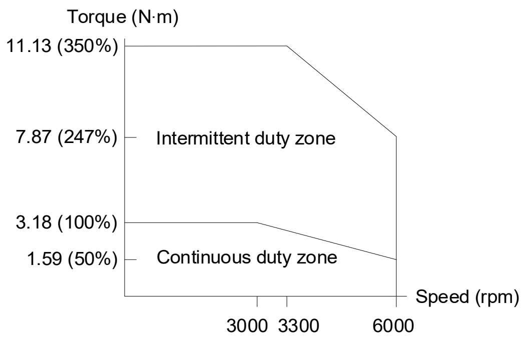
ECM-B3M-C□0604□□□



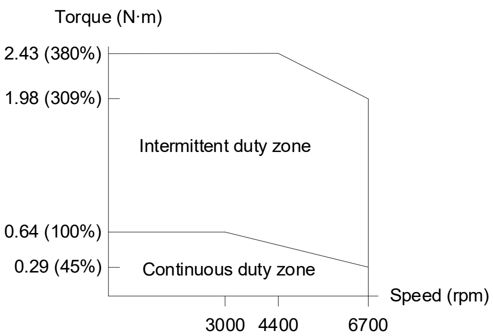
ECM-B3M-C□0804□□□



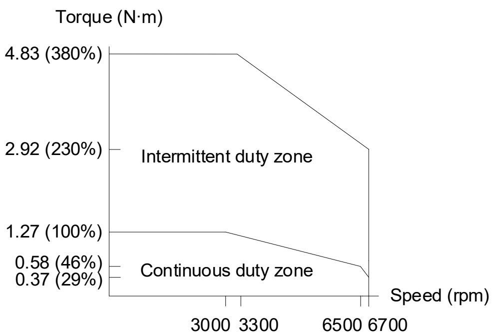
ECM-B3M-C□0807□□□



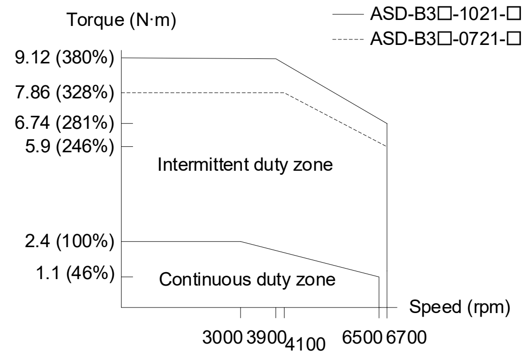
ECM-B3M-C□0810□□□



ECM-B3H-C□0602□□□



ECM-B3H-C□0604□□□



ECM-B3H-C□0807□□□

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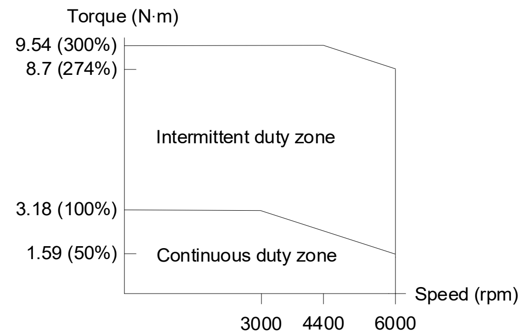
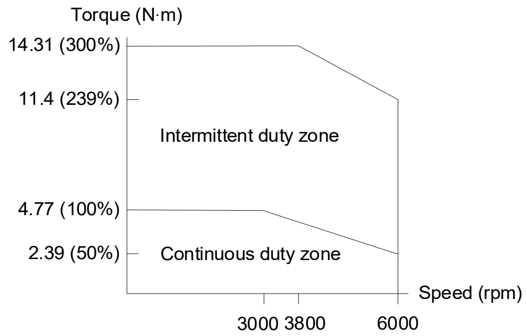
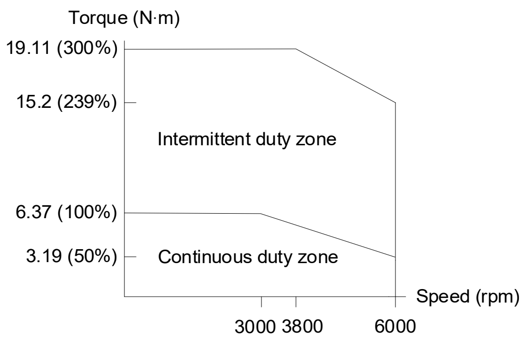
F100 motors



ECM-B3M-C□1010□□□



ECM-B3M-C□1015□□□



ECM-B3M-C□1020□□□

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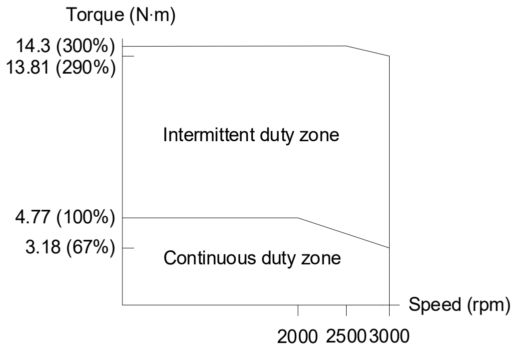
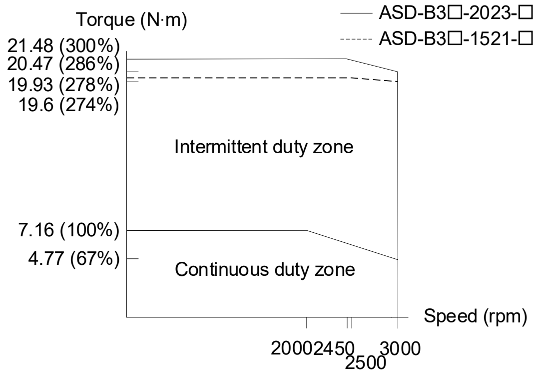
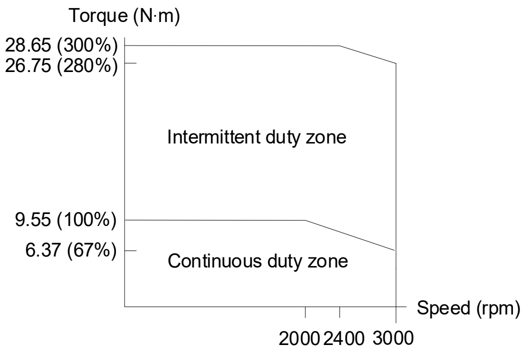
F130 motors



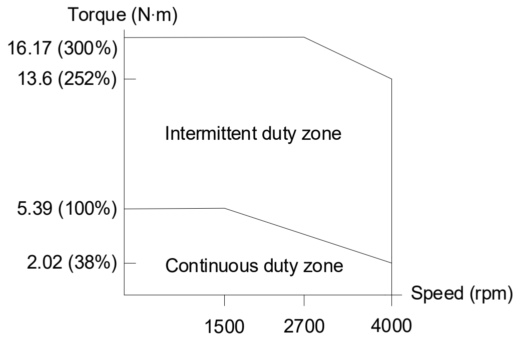
ECM-B3M-E□1310□□□



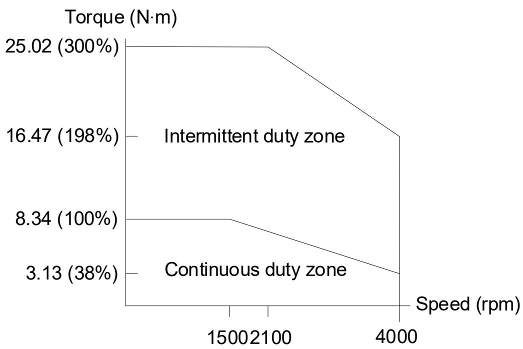
ECM-B3M-E□1315□□□



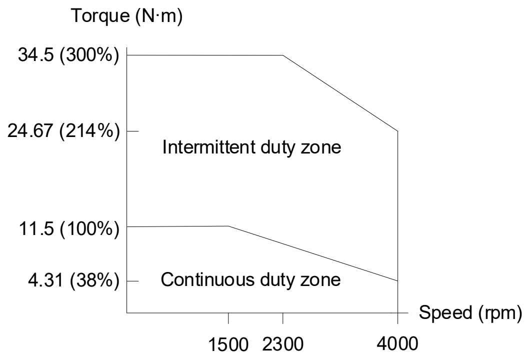
ECM-B3M-E□1320□□□



ECM-B3H-F□1308□□□

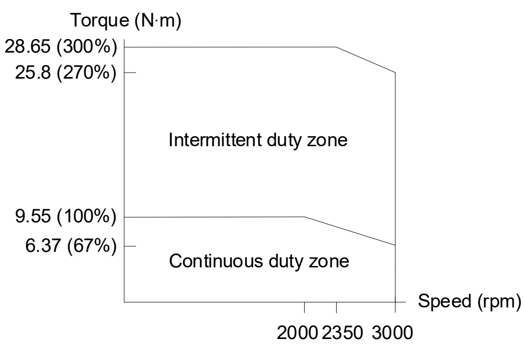


ECM-B3H-F□1313□□□

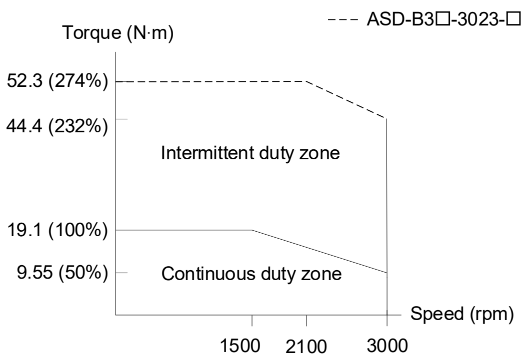


ECM-B3H-F□1318□□□

F180 motors



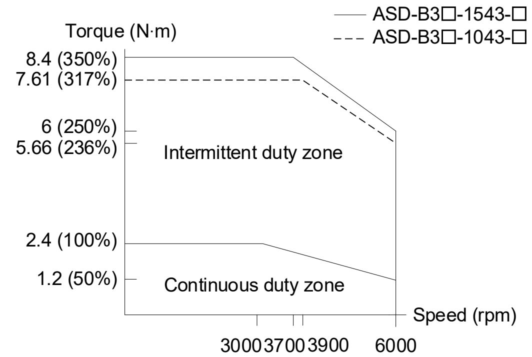
ECM-B3M-E□1820□□□



ECM-B3M-F□1830□□□

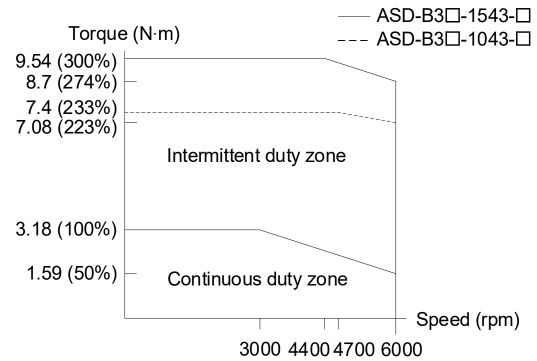
A.2.2.2 400V models

F80 motors

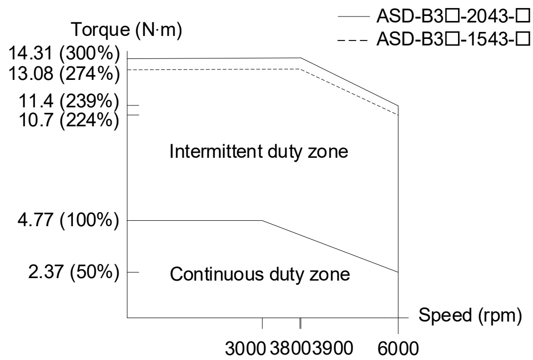


ECM-B3M-J□0807□□□

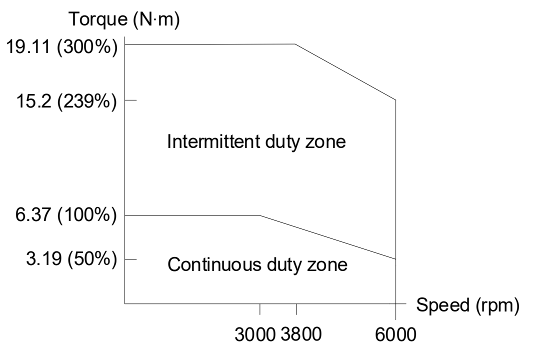
F100 motors



ECM-B3M-J□1010□□□

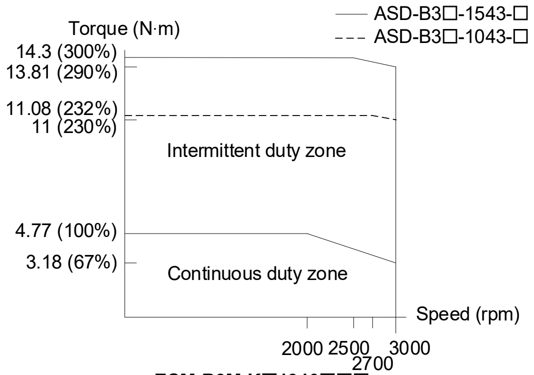


ECM-B3M-J□1015□□□

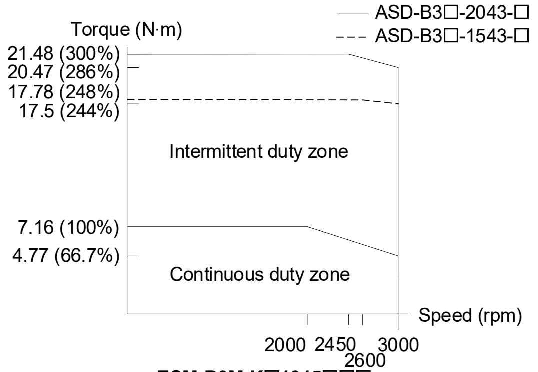


ECM-B3M-J□1020□□□

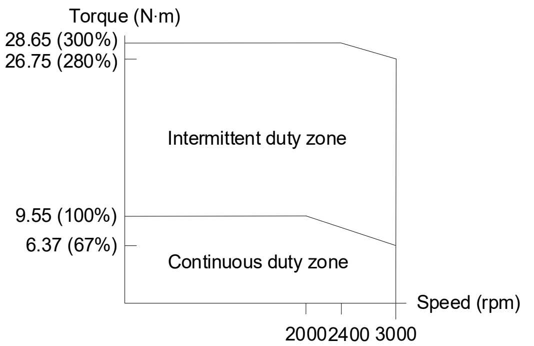
F130 motors



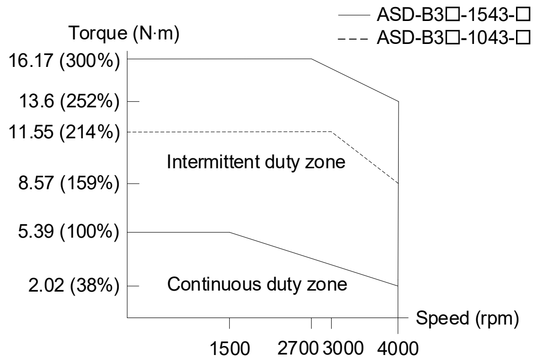
ECM-B3M-K□1310□□□



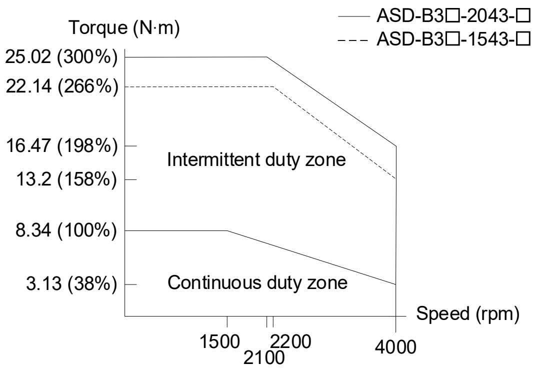
ECM-B3M-K□1315□□□



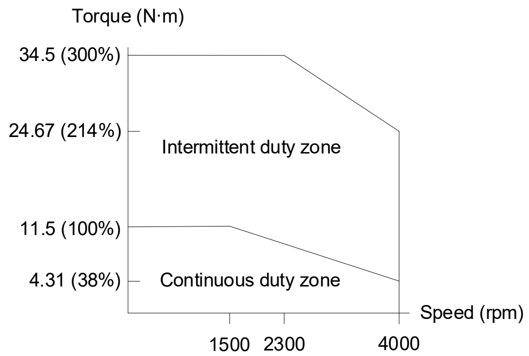
ECM-B3M-K□1320□□□



ECM-B3H-L□1308□□□



ECM-B3H-L□1313□□□



ECM-B3H-L□1318□□□

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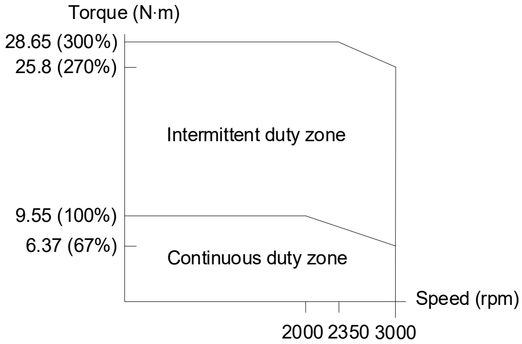
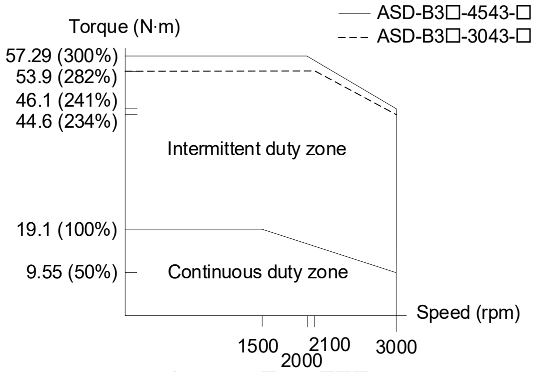
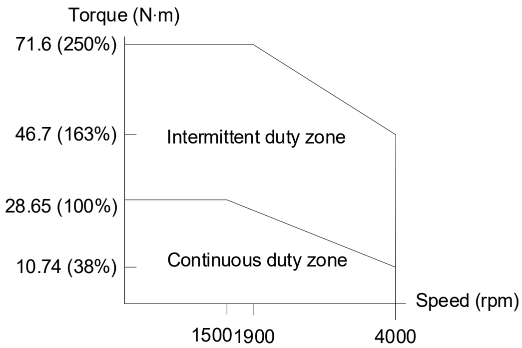
F180 motors



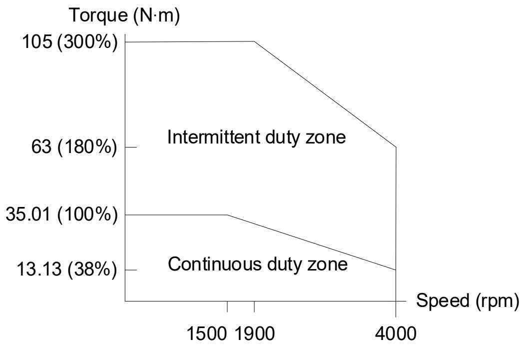
ECM-B3M-K□1820□□□



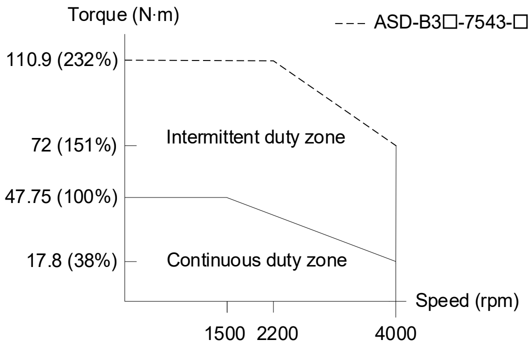
ECM-B3M-L□1830□□□



ECM-B3M-L□1845□□□



ECM-B3M-L□1855□□□



ECM-B3M-L□1875□□□

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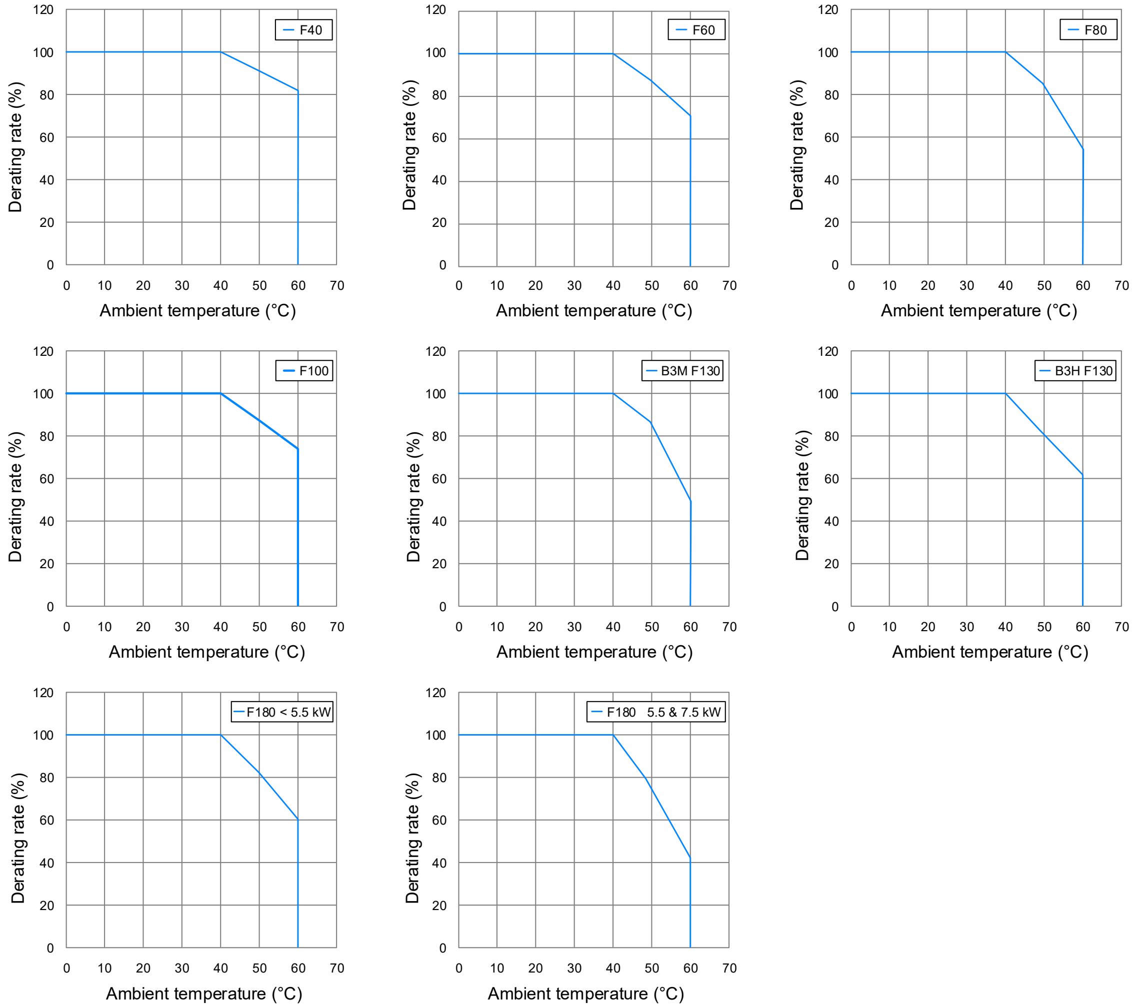
A.2.3 Power derating curves of the ECM-B3 motors



Note: the preceding specifications are applicable to 220V and 400V models.

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A.2.4 Overload features

Definition of overload protection

The overload protection prevents the motor from overheating.

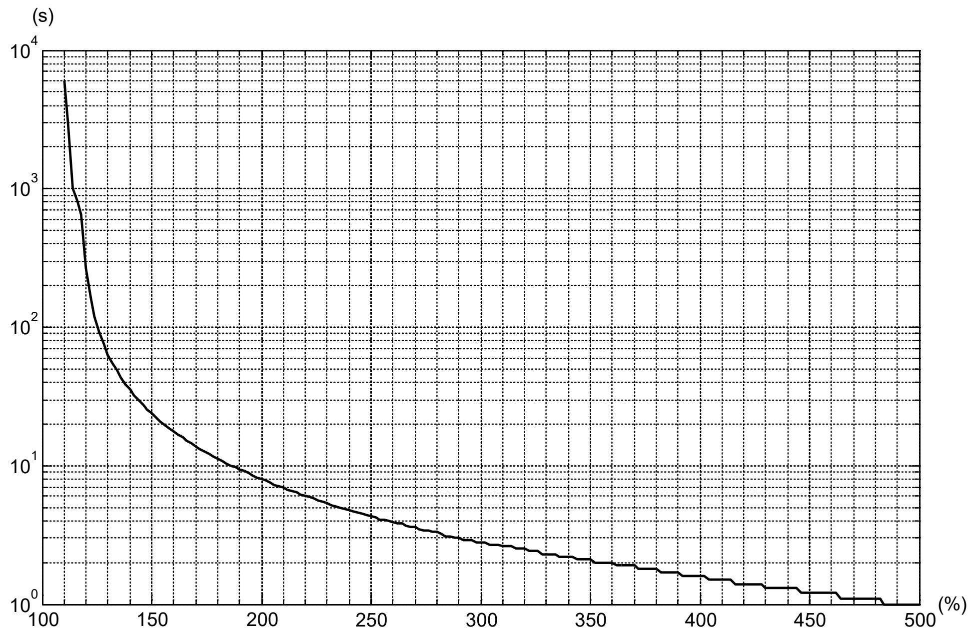
Causes of overload

1. The motor's operating torque exceeds the rated range and the operation exceeds the allowable operating time.
2. The inertia ratio is too high and the motor frequently accelerates and decelerates.
3. Incorrect wiring of the power and encoder cables.
4. Incorrect servo gain setting causes motor resonance.
5. A motor with a built-in brake operates without the brake released.

Graph of load ratio and operating time

220V models: low inertia (ECM-B3L motors), medium inertia (ECM-B3M-C motors), high inertia (ECM-B3H-C motors)

400V models: medium inertia (ECM-B3M-J motors)



Load ratio	120%	140%	160%	180%	200%	220%	240%
Operating time	263.8 s	35.2 s	17.6 s	11.2 s	8 s	6.1 s	4.8 s
Load ratio	260%	280%	300%	350%	400%	450%	500%
Operating time	3.9 s	3.3 s	2.8 s	2.1 s	1.6 s	1.2 s	1.0 s

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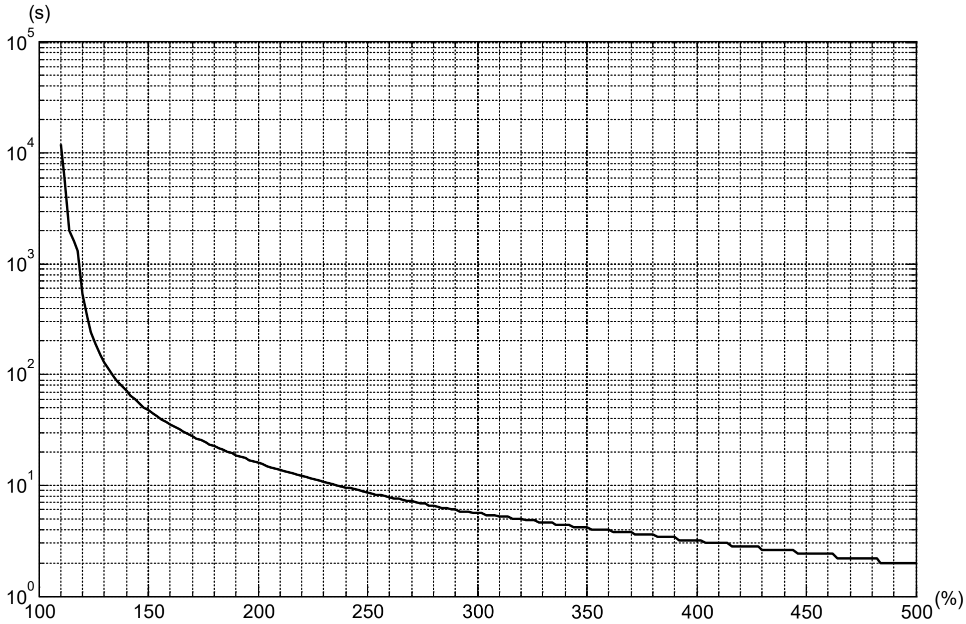
220V models: medium inertia (ECM-B3M-E / -F motors), high inertia (ECM-B3H-F motors)

400V models: medium inertia (ECM-B3M-K / -L motors), high inertia (ECM-B3H-L motors)



Load ratio	120%	140%	160%	180%	200%	220%	240%
Operating time	527.6 s	70.4 s	35.2 s	22.4 s	16 s	12.2 s	9.6 s
Load ratio	260%	280%	300%	350%	400%	450%	500%
Operating time	7.8 s	6.6 s	5.6 s	4.2 s	3.2 s	2.4 s	2.0 s

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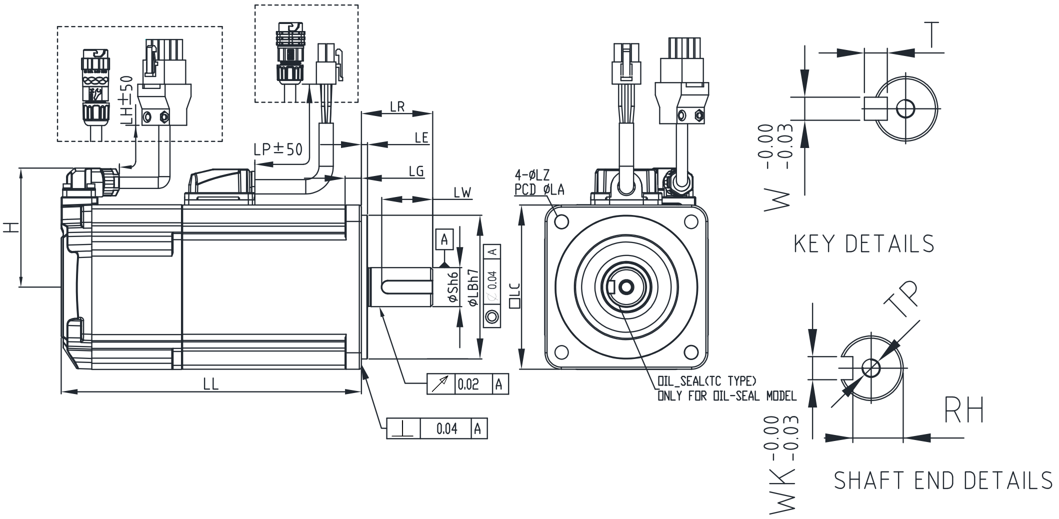
A.2.5 Dimensions of ECM-B3 series servo motor

A.2.5.1 220V models

F80 and below motors with cables (low & medium & high inertia)



Unit: mm

ECM-	B3L-C□ 0401□S1	B3M-C□ 0602□S1	B3M-C□ 0604□S1	B3M-C□ 0804□71	B3M-C□ 0807□S1	B3M-C□ 0810□S1	B3H-C□ 0602□S1	B3H-C□ 0604□S1	B3H-C□ 0807□S1
LC	40	60	60	80	80	80	60	60	80
LZ	4.5	5.5	5.5	6.6	6.6	6.6	5.5	5.5	6.6
LA	46	70	70	90	90	90	70	70	90
S	$8(^{+0}_{-0.009})$	$14(^{+0}_{-0.011})$	$14(^{+0}_{-0.011})$	$14(^{+0}_{-0.011})$	$19(^{+0}_{-0.013})$	$19(^{+0}_{-0.013})$	$14(^{+0}_{-0.011})$	$14(^{+0}_{-0.011})$	$19(^{+0}_{-0.013})$
LB	$30(^{+0}_{-0.021})$	$50(^{+0}_{-0.025})$	$50(^{+0}_{-0.025})$	$70(^{+0}_{-0.030})$	$70(^{+0}_{-0.030})$	$70(^{+0}_{-0.030})$	$50(^{+0}_{-0.025})$	$50(^{+0}_{-0.025})$	$70(^{+0}_{-0.030})$
LL (w/o brake)	77.6	72.5	91	86.7	105.2	118.7	69.6	87.45	105.2
LL (with brake)	111.7	109.4	127.9	126.3	144.8	158.3	106.5	124.35	144.8
LH	300	300	300	300	300	300	300	300	300
LP	300	300	300	300	300	300	300	300	300
H	40	48.5	48.5	58.5	58.5	58.5	48.5	48.5	58.5
LR	25	30	30	30	35	35	30	30	35
LE	2.5	3	3	3	3	3	3	3	3
LG	5	7.5	7.5	8	8	8	7.5	7.5	8
LW	16	20	20	20	25	25	20	20	25
RH	6.2	11	11	11	15.5	15.5	11	11	15.5
WK	3	5	5	5	6	6	5	5	6
W	3	5	5	5	6	6	5	5	6
T	3	5	5	5	6	6	5	5	6
TP	M3 Depth 8	M4 Depth 15	M4 Depth 15	M4 Depth 15	M6 Depth 20	M6 Depth 20	M4 Depth 15	M4 Depth 15	M6 Depth 20

Note: CHOGORI connectors (IP67) are available for F80 and below models. Refer to Chapter 1 for detailed model descriptions.

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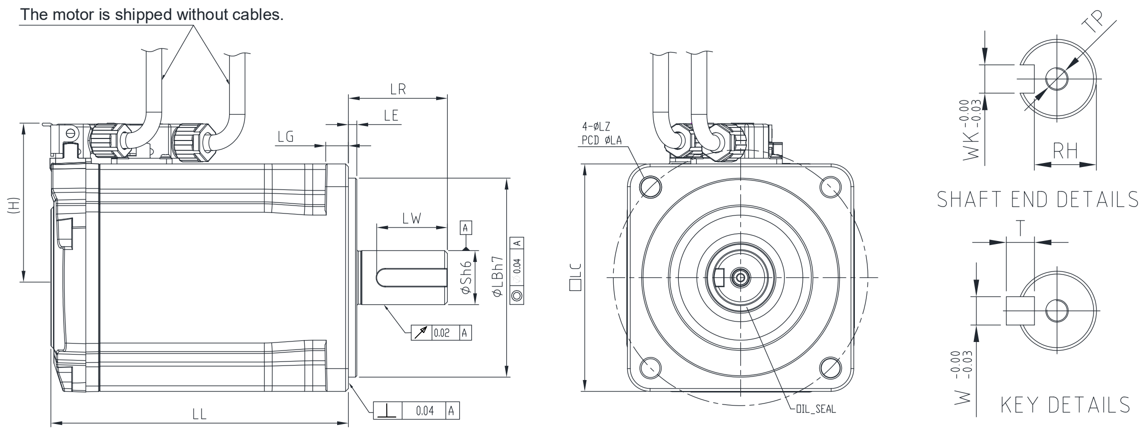
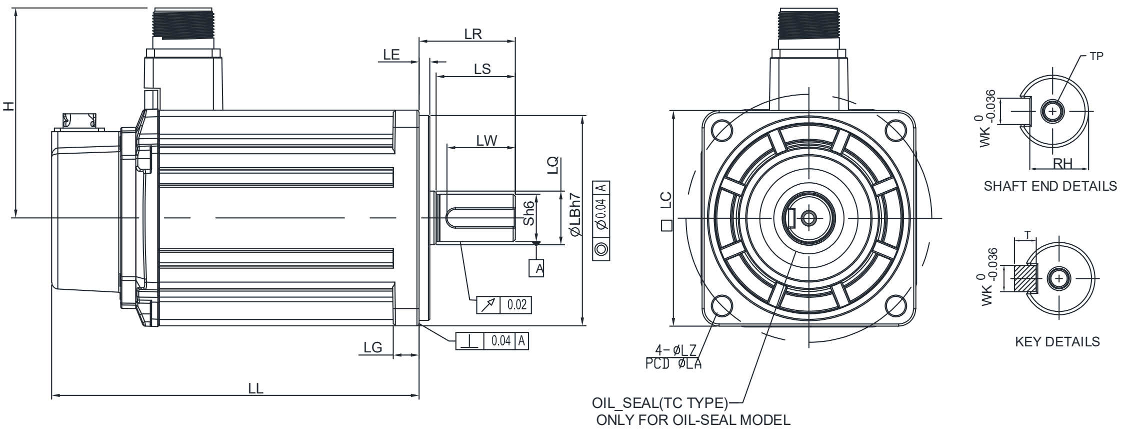
F80 and below motors with bulkhead receptacles (low & medium & high inertia)



Unit: mm

ECM-	B3L-C□ 0401□B1	B3M-C□ 0602□B1	B3M-C□ 0604□B1	B3M-C□ 0807□B1	B3H-C□ 0602□B1	B3H-C□ 0604□B1	B3H-C□ 0807□B1
LC	40	60	60	80	60	60	80
LZ	4.5	5.5	5.5	6.6	5.5	5.5	6.6
LA	46	70	70	90	70	70	90
S	$8(^{+0}_{-0.009})$	$14(^{+0}_{-0.011})$	$14(^{+0}_{-0.011})$	$19(^{+0}_{-0.013})$	$14(^{+0}_{-0.011})$	$14(^{+0}_{-0.011})$	$19(^{+0}_{-0.013})$
LB	$30(^{+0}_{-0.021})$	$50(^{+0}_{-0.025})$	$50(^{+0}_{-0.025})$	$70(^{+0}_{-0.030})$	$50(^{+0}_{-0.025})$	$50(^{+0}_{-0.025})$	$70(^{+0}_{-0.030})$
LL (w/o brake)	76.2	72.5	91	105.2	69.6	87.45	95.4
LL (with brake)	107.7	104.4	122.9	140.8	101.5	119.35	131
LH	300	300	300	300	300	300	300
LP	300	300	300	300	300	300	300
H	34	44	44	54	44	44	54
LR	25	30	30	35	30	30	35
LE	2.5	3	3	3	3	3	3
LG	5	7.5	7.5	8	7.5	7.5	8
LW	16	20	20	25	20	20	25
RH	6.2	11	11	15.5	11	11	15.5
WK	3	5	5	6	5	5	6
W	3	5	5	6	5	5	6
T	3	5	5	6	5	5	6
TP	M3 Depth 8	M4 Depth 15	M4 Depth 15	M6 Depth 20	M4 Depth 15	M4 Depth 15	M6 Depth 20

F100 motors (medium inertia)

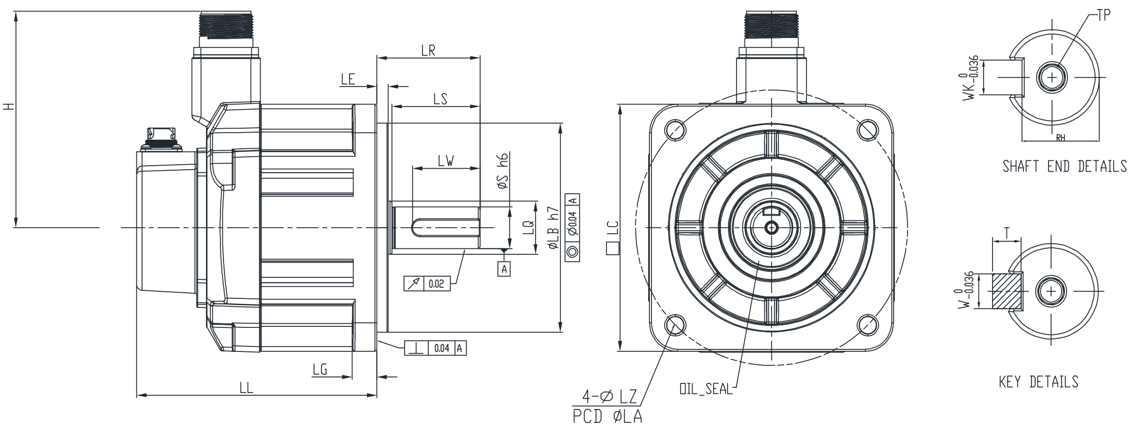


Unit: mm

ECM-	B3M-C□1010□S1	B3M-C□1015□S1	B3M-C□1020□S1
LC	100	100	100
LZ	9	9	9
LA	115	115	115
S	$22(^{+0}_{-0.013})$	$22(^{+0}_{-0.013})$	$22(^{+0}_{-0.013})$
LB	$95(^{+0}_{-0.03})$	$95(^{+0}_{-0.03})$	$95(^{+0}_{-0.03})$
LL (w/o brake)	141.8	156.8	171.8
LL (with brake)	179.9	194.9	209.9
H	97.4	97.4	97.4
LS	37	37	37
LR	45	45	45
LQ	25	25	25
LE	5	5	5
LG	12	12	12
LW	32	32	32
RH	18	18	18
WK	8	8	8
W	8	8	8
T	7	7	7
TP	M6 Depth 12	M6 Depth 12	M6 Depth 12

A

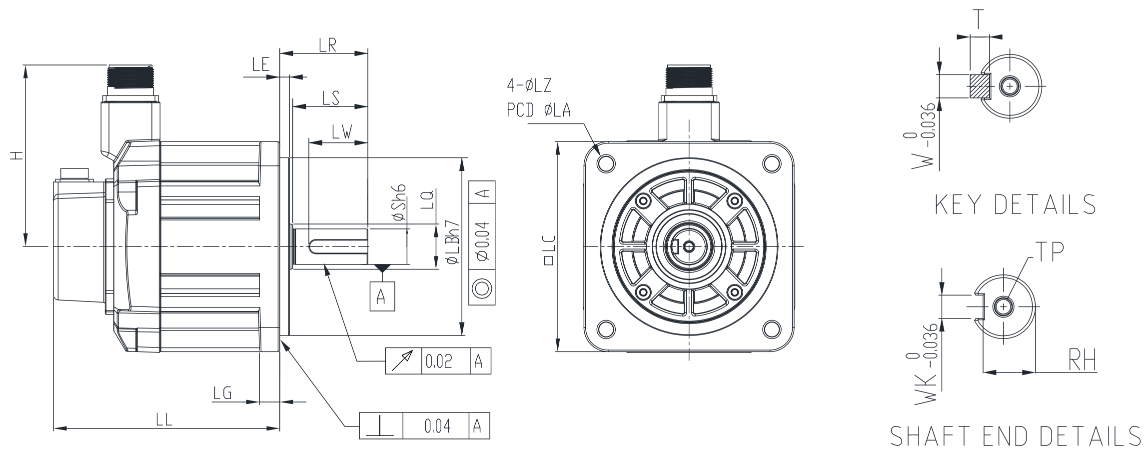
F130 motors (medium & high inertia)



Unit: mm

ECM-	B3M-E□ 1310□S1	B3M-E□ 1315□S1	B3M-E□ 1320□S1	B3H-F□ 1308□S1	B3H-F□ 1313□S1	B3H-F□ 1318□S1
LC	130	130	130	130	130	130
LZ	9	9	9	9	9	9
LA	145	145	145	145	145	145
S	$22(^{+0}_{-0.013})$	$22(^{+0}_{-0.013})$	$22(^{+0}_{-0.013})$	$22(^{+0}_{-0.013})$	$22(^{+0}_{-0.013})$	$22(^{+0}_{-0.013})$
LB	$110(^{+0}_{-0.035})$	$110(^{+0}_{-0.035})$	$110(^{+0}_{-0.035})$	$110(^{+0}_{-0.035})$	$110(^{+0}_{-0.035})$	$110(^{+0}_{-0.035})$
LL (w/o brake)	127.9	139.9	151.9	127.9	139.9	151.9
LL (with brake)	168.5	180.5	192.5	168.5	180.5	192.5
H	115	115	115	115	115	115
LS	47	47	47	47	47	47
LR	55	55	55	55	55	55
LQ	28	28	28	28	28	28
LE	6	6	6	6	6	6
LG	12.5	12.5	12.5	12.5	12.5	12.5
LW	36	36	36	36	36	36
RH	18	18	18	18	18	18
WK	8	8	8	8	8	8
W	8	8	8	8	8	8
T	7	7	7	7	7	7
TP	M6 Depth 12	M6 Depth 12	M6 Depth 12	M6 Depth 12	M6 Depth 12	M6 Depth 12

F180 motors (medium inertia)



Unit: mm

ECM-	B3M-E□1820□S1	B3M-F□1830□S1
LC	180	180
LZ	13.5	13.5
LA	200	200
S	$35(^{+0}_{-0.016})$	$35(^{+0}_{-0.016})$
LB	$114.3(^{+0}_{-0.035})$	$114.3(^{+0}_{-0.035})$
LL (w/o brake)	137.5	160.5
LL (with brake)	189.5	212.5
H	139	139
LS	73	73
LR	79	79
LQ	45	45
LE	4	4
LG	18	18
LW	63	63
RH	30	30
WK	10	10
W	10	10
T	8	8
TP	M12 Depth 25	M12 Depth 25

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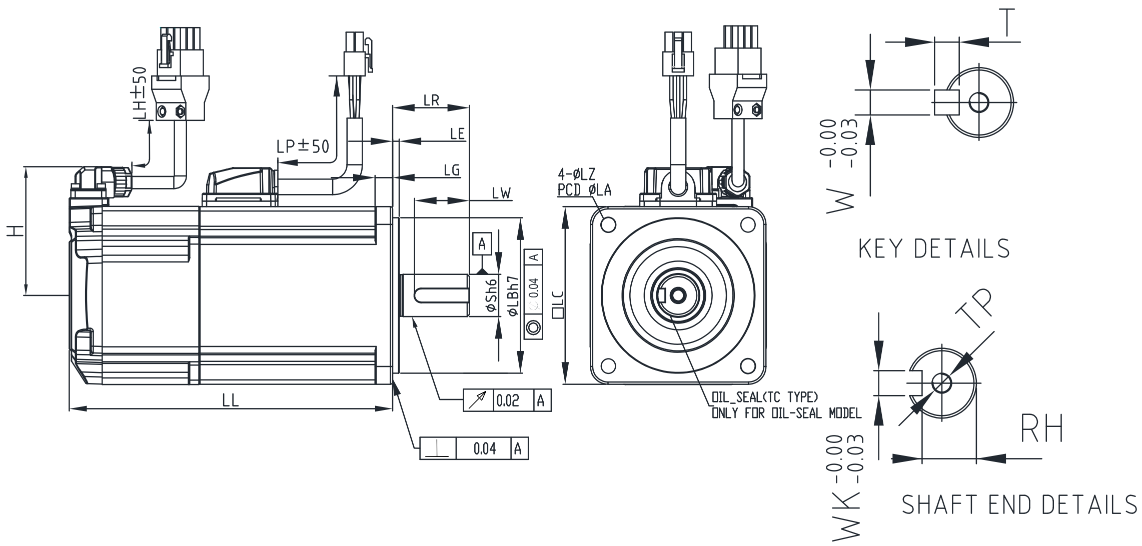
A.2.5.2 400V models

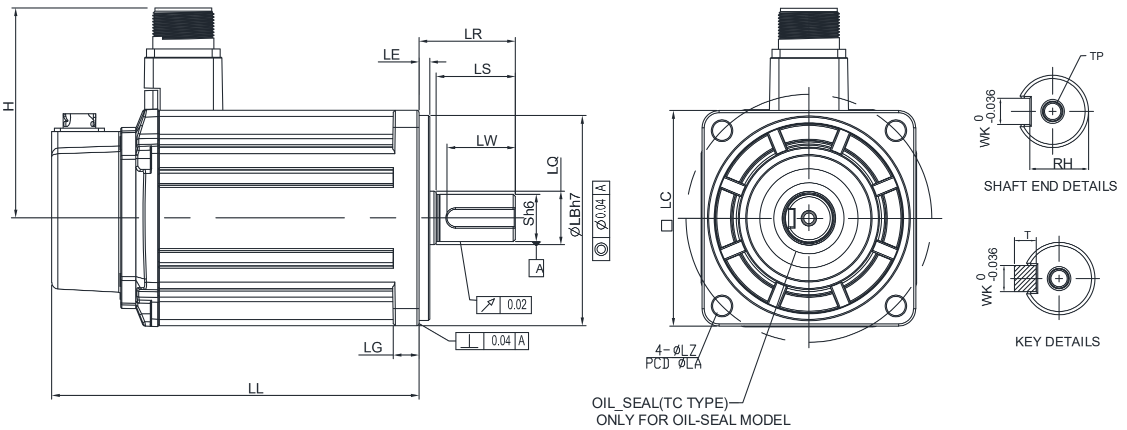
F80 and below motors with cables (medium inertia)



Unit: mm

ECM-	B3M-J□0807□S1
LC	80
LZ	6.6
LA	90
S	$19(^{+0}_{-0.013})$
LB	$70(^{+0}_{-0.030})$
LL (w/o brake)	105.2
LL (with brake)	144.8
LH	300
LP	300
H	58.5
LR	35
LE	3
LG	8
LW	25
RH	15.5
WK	6
W	6
T	6
TP	M6 Depth 20

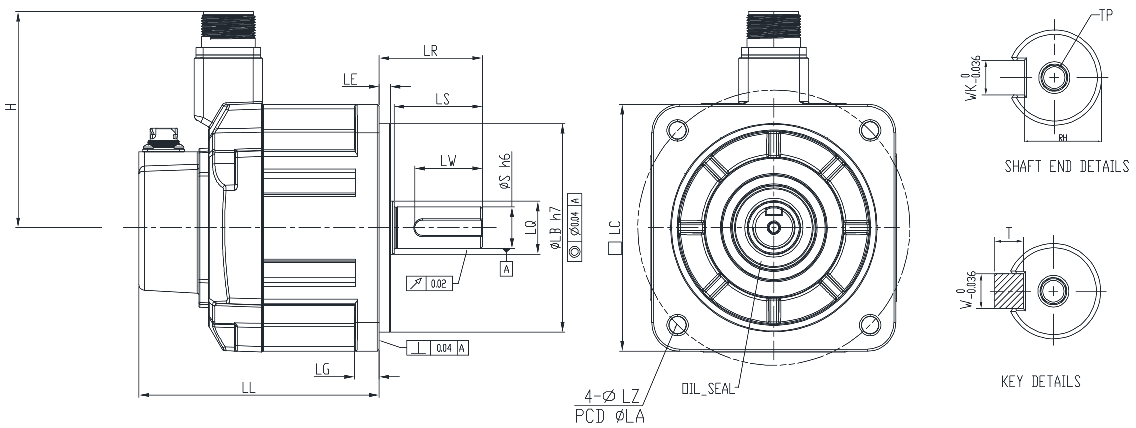
F100 motors (medium inertia)



Unit: mm

ECM-	B3M-J□1010□S1	B3M-J□1015□S1	B3M-J□1020□S1
LC	100	100	100
LZ	9	9	9
LA	115	115	115
S	$22(^{+0}_{-0.013})$	$22(^{+0}_{-0.013})$	$22(^{+0}_{-0.013})$
LB	$95(^{+0}_{-0.03})$	$95(^{+0}_{-0.03})$	$95(^{+0}_{-0.03})$
LL (w/o brake)	141.8	156.8	171.8
LL (with brake)	179.9	194.9	209.9
H	97.4	97.4	97.4
LS	37	37	37
LR	45	45	45
LQ	25	25	25
LE	5	5	5
LG	12	12	12
LW	32	32	32
RH	18	18	18
WK	8	8	8
W	8	8	8
T	7	7	7
TP	M6 Depth 12	M6 Depth 12	M6 Depth 12

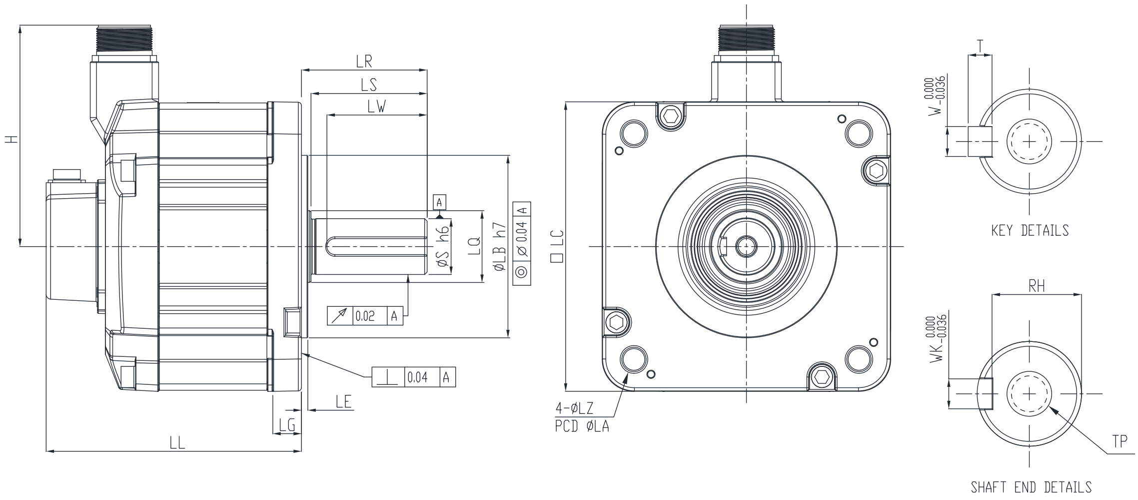
F130 motors (medium & high inertia)



Unit: mm

ECM-	B3M-K□ 1310□S1	B3M-K□ 1315□S1	B3M-K□ 1320□S1	B3H-L□ 1308□S1	B3H-L□ 1313□S1	B3H-L□ 1318□S1
LC	130	130	130	130	130	130
LZ	9	9	9	9	9	9
LA	145	145	145	145	145	145
S	$22(^{+0}_{-0.013})$	$22(^{+0}_{-0.013})$	$22(^{+0}_{-0.013})$	$22(^{+0}_{-0.013})$	$22(^{+0}_{-0.013})$	$22(^{+0}_{-0.013})$
LB	$110(^{+0}_{-0.035})$	$110(^{+0}_{-0.035})$	$110(^{+0}_{-0.035})$	$110(^{+0}_{-0.035})$	$110(^{+0}_{-0.035})$	$110(^{+0}_{-0.035})$
LL (w/o brake)	127.9	139.9	151.9	127.9	139.9	151.9
LL (with brake)	168.5	180.5	192.5	168.5	180.5	192.5
H	115	115	115	115	115	115
LS	47	47	47	47	47	47
LR	55	55	55	55	55	55
LQ	28	28	28	28	28	28
LE	6	6	6	6	6	6
LG	12.5	12.5	12.5	12.5	12.5	12.5
LW	36	36	36	36	36	36
RH	18	18	18	18	18	18
WK	8	8	8	8	8	8
W	8	8	8	8	8	8
T	7	7	7	7	7	7
TP	M6 Depth 12	M6 Depth 12	M6 Depth 12	M6 Depth 12	M6 Depth 12	M6 Depth 12

F180 motors (medium inertia)



Unit: mm

ECM-	B3M-K□1820□S1	B3M-L□1830□S1	B3M-L□1845□S1	B3M-L□1855□31	B3M-L□1875□31
LC	180	180	180	180	180
LZ	13.5	13.5	13.5	13.5	13.5
LA	200	200	200	200	200
S	$35(^{+0}_{-0.016})$	$35(^{+0}_{-0.016})$	$35(^{+0}_{-0.016})$	$42(^{+0}_{-0.016})$	$42(^{+0}_{-0.016})$
LB	$114.3(^{+0}_{-0.035})$	$114.3(^{+0}_{-0.035})$	$114.3(^{+0}_{-0.035})$	$114.3(^{+0}_{-0.035})$	$114.3(^{+0}_{-0.035})$
LL (w/o brake)	137.5	160.5	174	218	260.1
LL (with brake)	189.5	212.5	226	265	307.1
H	139	139	139	144.5	144.5
LS	73	73	73	108.5	108.5
LR	79	79	79	113	113
LQ	45	45	45	45	45
LE	4	4	4	4	4
LG	18	18	18	18	18
LW	63	63	63	90	90
RH	30	30	30	37	37
WK	10	10	10	12	12
W	10	10	10	12	12
T	8	8	8	8	8
TP	M12 Depth 25	M12 Depth 25	M12 Depth 25	M16 Depth 32	M16 Depth 32

A.3 ECM-A3 series servo motor

A.3.1 Specifications of ECM-A3L low inertia motors

ECM-A3L-		C□040F	C□0401	C□0602	C□0604	C□0804	C□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)	w/o brake	11	25.6	45.5	107.5	45.8	102.2
	with brake	9.9	24	34.1	89.6	39.5	93
Rotor inertia ($\times 10^{-4}$ kg.m^2)	w/o brake	0.0229	0.04	0.09	0.15	0.352	0.559
	with brake	0.0255	0.0426	0.12	0.18	0.408	0.614
Mechanical time constant (ms)	w/o brake	1.28	0.838	0.64	0.41	0.68	0.44
	with brake	1.44	0.892	0.85	0.5	0.78	0.48
Torque constant-KT (N·m/Arms)		0.241	0.356	0.441	0.479	0.488	0.469
Voltage constant-KE (mVrms/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
Weight (kg)	w/o brake	0.38	0.5	1.1	1.4	2.05	2.8
	with brake	0.68	0.8	1.6	1.9	2.85	3.6
Max. radial load (N)		78	78	245	245	392	392
Max. axial load (N)		54	54	74	74	147	147
Brake operating voltage		24 V_{DC} ± 10%					
Brake power consumption (W) (at 20˚C (68°F))		6.1	6.1	7.2	7.2	8	8
Brake holding torque [N·m (Min)][*2]		0.32	0.32	1.3	1.3	2.5	2.5
Brake release time [ms (Max)]		20	20	20	20	20	20
Brake pull-in time [ms (Max)]		35	35	50	50	60	60
Derating rate with oil seal (%)		20	10	10	5	5	5
Insulation class		Class A (UL), Class B (CE)					
Insulation resistance		100 MΩ min. (at 500 V_{DC})					
Insulation strength		1.8 kV_{AC}, 1 sec					
Vibration grade		V15					
Ambient temperature		0˚C to 40˚C (32˚F to 104˚F)					
Storage temperature		-10˚C to +80˚C (14˚F to 176˚F)					
Ambient and storage humidity		20 - 90% RH (non-condensing)					
Vibration capacity		2.5 G					
IP rating		IP67 (for models using waterproof connectors and shaft seals or oil seals)					
Approvals		CE cULus					

A

Note:

1. The rated torque is the continuous permissible torque when the servo motor mounted with the heat sink of the following dimensions is operating in a temperature range of 0˚C - 40˚C (32˚F - 104˚F).
   F40, F60, and F80: 250 mm x 250 mm x 6 mm
   Material: aluminum
2. The built-in servo motor brake is only for keeping the object in a stopped state. Do not use it for deceleration or as a dynamic brake.

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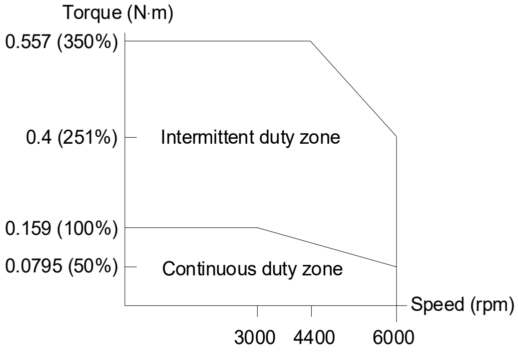
A.3.2 Specifications of ECM-A3H high inertia motors

ECM-A3H-		C□040F	C□0401	C□0602	C□0604	C□0804	C□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	16.4
Change of rated power (kW/s)	w/o brake	5.56	13.6	16.4	35.8	17.5	37.8
	with brake	4.89	12.5	14.6	33.6	15.07	34.41
Rotor inertia (× 10^{-4} kg.m^2)	w/o brake	0.0455	0.0754	0.25	0.45	0.92	1.51
	with brake	0.0517	0.0816	0.28	0.48	1.07	1.66
Mechanical time constant (ms)	w/o brake	2.52	1.43	1.38	0.96	1.32	0.93
	with brake	2.86	1.55	1.54	1.02	1.54	1.02
Torque constant-KT (N·m/Arms)		0.248	0.356	0.441	0.479	0.49	0.52
Voltage constant-KE (mVrms/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
Weight (kg)	w/o brake	0.38	0.5	1.1	1.4	2.05	2.8
	with brake	0.68	0.8	1.6	1.9	2.85	3.6
Max. radial load (N)		78	78	245	245	392	392
Max. axial load (N)		54	54	74	74	147	147
Brake operating voltage		24 V_{DC} ± 10%					
Brake power consumption (W) (at 20˚C (68°F))		6.1	6.1	7.2	7.2	8	8
Brake holding torque [N·m (Min)][*2]		0.32	0.32	1.3	1.3	2.5	2.5
Brake release time [ms (Max)]		20	20	20	20	20	20
Brake pull-in time [ms (Max)]		35	35	50	50	60	60
Derating rate with oil seal (%)		20	10	10	5	5	5
Insulation class		Class A (UL), Class B (CE)					
Insulation resistance		100 MΩ min. (at 500 V_{DC})					
Insulation strength		1.8 kV_{AC}, 1 sec					
Vibration grade		V15					
Ambient temperature		0˚C to 40˚C (32˚F to 104˚F)					
Storage temperature		-10˚C to +80˚C (14˚F to 176˚F)					
Ambient and storage humidity		20 - 90% RH (non-condensing)					
Vibration capacity		2.5 G					
IP rating		IP67 (for models using waterproof connectors and shaft seals or oil seals)					
Approvals							

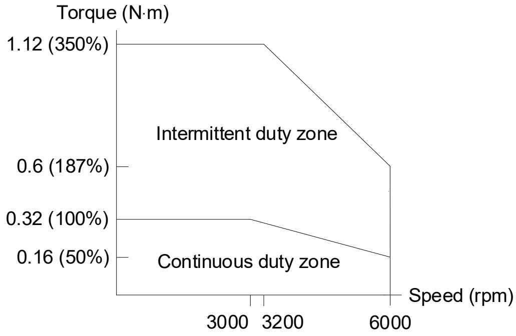
Note:

1. The rated torque is the continuous permissible torque when the servo motor mounted with the heat sink of the following dimensions is operating in a temperature range of 0˚C - 40˚C (32˚F - 104˚F).
   F40, F60, and F80: 250 mm x 250 mm x 6 mm
   Material: aluminum
2. The built-in servo motor brake is only for keeping the object in a stopped state. Do not use it for deceleration or as a dynamic brake.

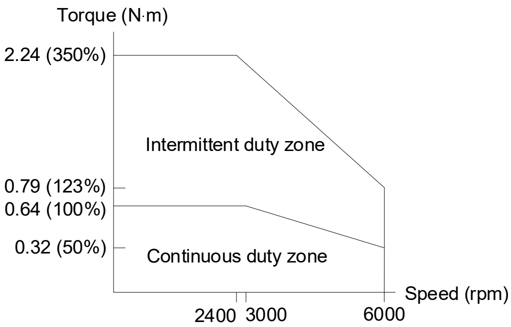
A.3.3 Torque features (T-N curves) of the ECM-A3 motors



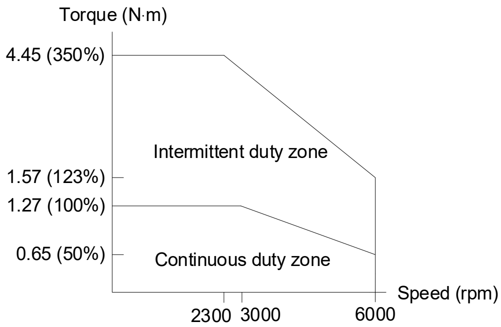
ECM-A3L-C□040F□□□



ECM-A3L-C□0401□□□



ECM-A3L-C□0602□□□



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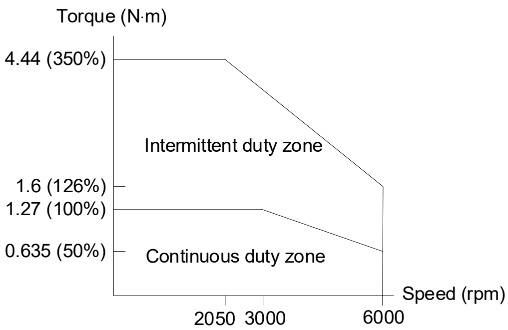
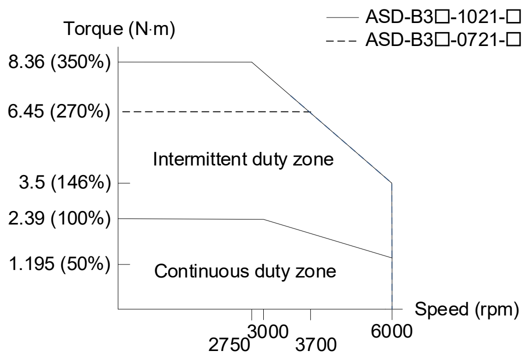
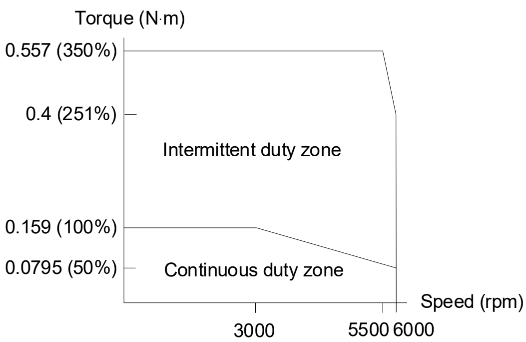


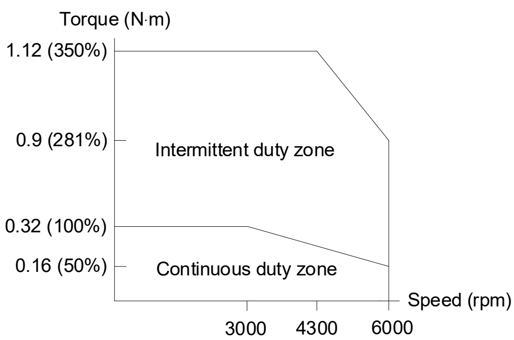
ECM-A3L-C□0804□□□



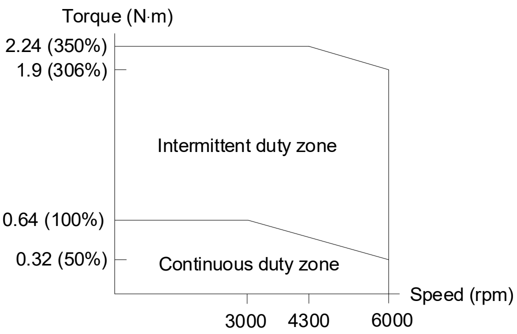
ECM-A3L-C□0807□□□



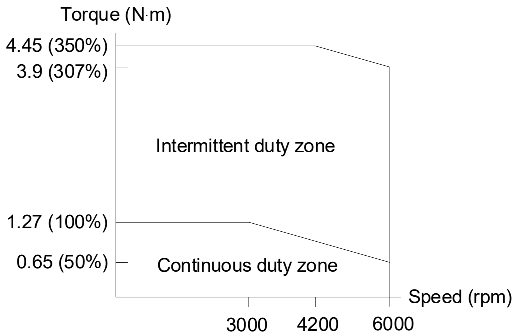
ECM-A3H-C□040F□□□



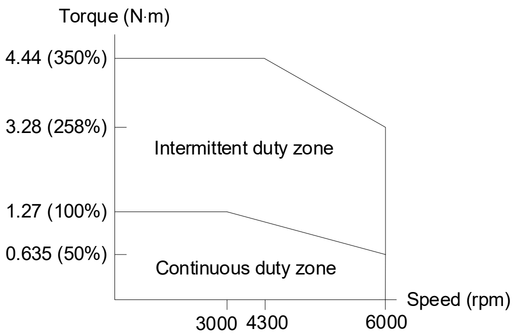
ECM-A3H-C□0401□□□



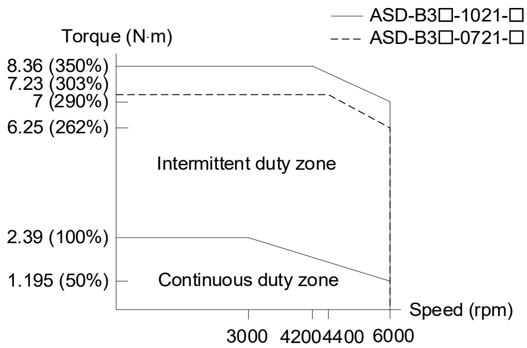
ECM-A3H-C□0602□□□



ECM-A3H-C□0604□□□



ECM-A3H-C□0804□□□



ECM-A3H-C□0807□□□

A.3.4 Overload features

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Definition of overload protection

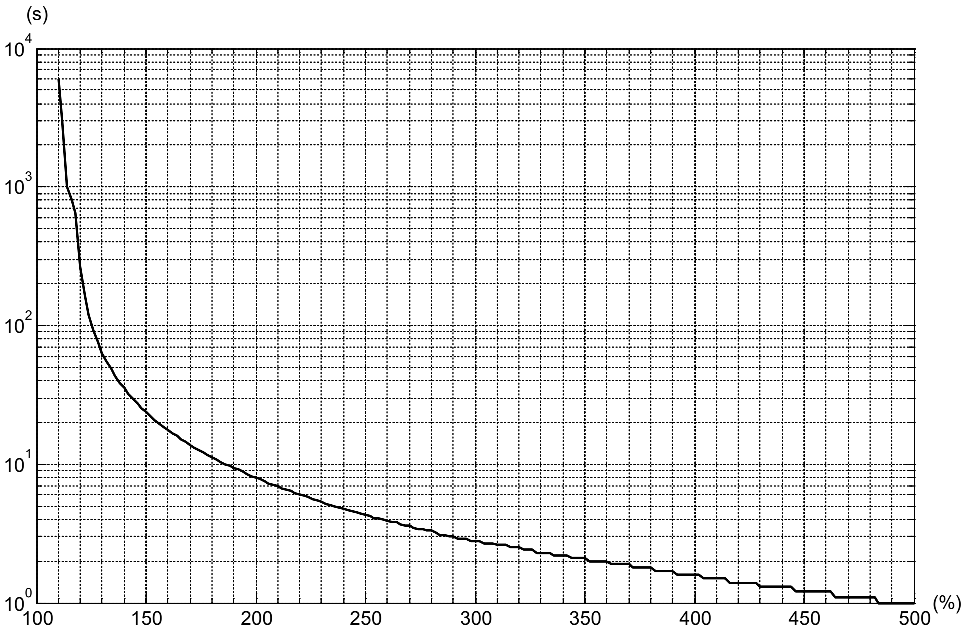
The overload protection prevents the motor from overheating.

Causes of overload

1. The motor's operating torque exceeds the rated range and the operation exceeds the allowable operating time.
2. The inertia ratio is too high and the motor frequently accelerates and decelerates.
3. Incorrect wiring of the power and encoder cables.
4. Incorrect servo gain setting causes motor resonance.
5. A motor with a built-in brake operates without the brake released.

Graph of load ratio and operating time

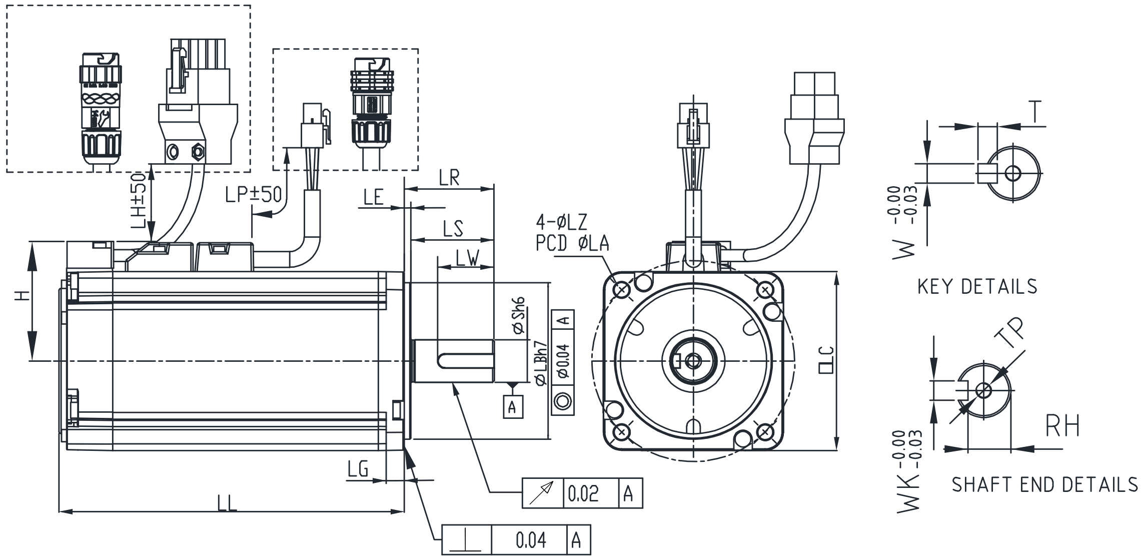
Low inertia (ECM-A3L motors), high inertia (ECM-A3H motors)



Load ratio	120%	140%	160%	180%	200%	220%	240%
Operating time	263.8 s	35.2 s	17.6 s	11.2 s	8 s	6.1 s	4.8 s
Load ratio	260%	280%	300%	350%	400%	450%	500%
Operating time	3.9 s	3.3 s	2.8 s	2.1 s	1.6 s	1.2 s	1.0 s

A.3.5 Dimensions of ECM-A3L / A3H series servo motor

F80 and below motors



Unit: mm

ECM-A3L- ECM-A3H-	C□040F□□□	C□0401□□□	C□0602□□□	C□0604□□□	C□0804□□□	C□0807□□□
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
LH	300	300	300	300	300	300
LP	300	300	300	300	300	300
H	34	34	43.5	43.5	54.5	54.5
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. When the special code (■) of C□0807□S■ is Z, LS = 32 and LR = 35.
2. CHOGORI connectors (IP67) are available for F80 and below models. Refer to Chapter 1 for detailed model descriptions.

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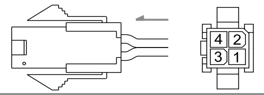
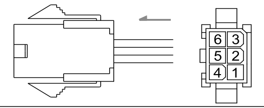
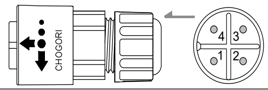
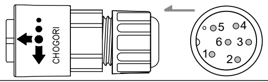
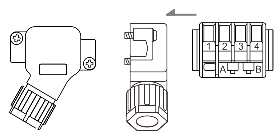
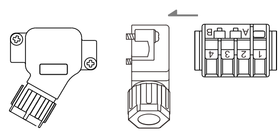
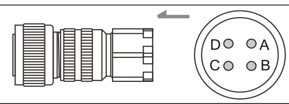
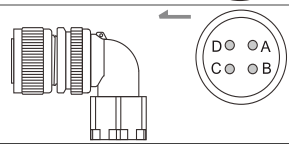
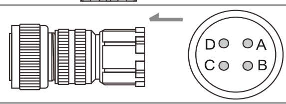
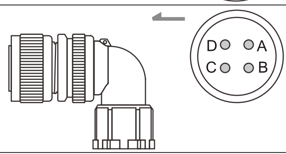
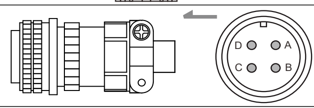
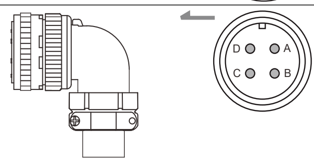
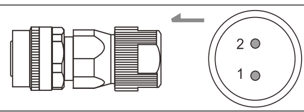
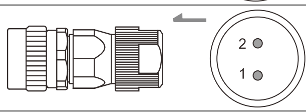
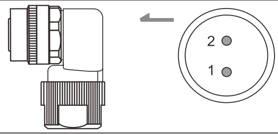
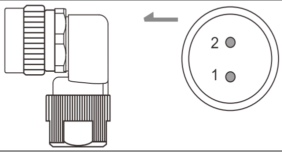
Accessories Appendix B

This chapter is a guide to select the accessories.

B

B.1 Power connector

Motor series	Frame size & power	Applicable model	Connector Type	Connector UVW	Connector Brake	Connector IP rating	Model number	Illustration
ECM-A3* ECM-B3	F40 - F80	220V 400V	Standard	●	-	IP20	ACS3-CAPW1000	
		220V 400V	Standard	●	●	IP20	ACS3-CAPW2000	
		220V	CHOGORI	●	-	IP67	ACS3-CNPW1A00	
		220V	CHOGORI	●	●	IP67	ACS3-CNPW2A00	
ECM-B3	F40 - F80	220V 400V	Bulkhead - cable exit direction towards motor shaft	●	●	IP67	ACS3-AFPWSS00	
		220V 400V	Bulkhead - cable exit direction towards encoder	●	●	IP67	ACS3-ABPWSS00	
	F100 - F130	220V 400V	Military - straight 3106A-18-10S	●	-	IP67	ACS3-CAPWA000	
		220V 400V	Military - right angle 3108A-18-10S	●	-	IP67	ACS3-CRPWA000	
	F180	220V 400V	Military - straight 3106A-22-22S	●	-	IP67	ACS3-CAPWC000	
		220V 400V	Military - right angle 3108A-22-22S	●	-	IP67	ACS3-CRPWC000	
	F180 5.5 kW or above	220V 400V	Military - straight 3106A-32-17S	●	-	IP42	ACS3-CAPWE000	
		220V 400V	Military - right angle 3108A-32-17S	●	-	IP42	ACS3-CRPWE000	
	F100 - F180	220V 400V	Military - straight CMV1-SP2S [bayonet]	-	●	IP67	ACS3-CABRA000	
		220V 400V	Military - straight [threaded, M17.5]	-	●	IP67	ACS3-CABRM000	

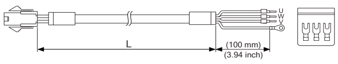
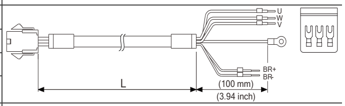
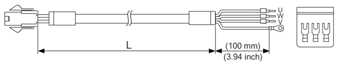
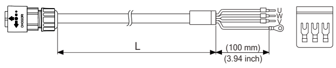
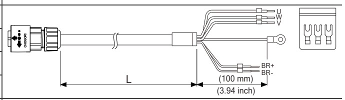
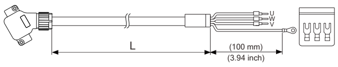
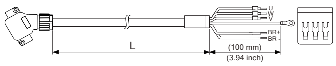
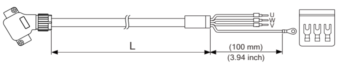
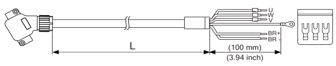
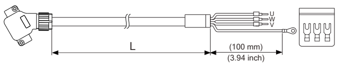
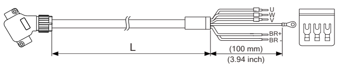
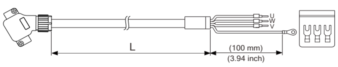
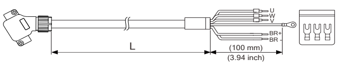
Motor series	Frame size & power	Applicable model	Connector				Model number	Illustration
			Type	UVW	Brake	IP rating		
ECM-B3	F100 - F180	220V 400V	Military - right angle CMV1-AP2S [bayonet]	-	●	IP67	ACS3-CRBRA000	
		220V 400V	Military - right angle [threaded, M17.5]	-	●	IP67	ACS3-CRBRM000	

Note:
1. ECM-A3 motors do not include 400V models.
2. Motors with bayonet receptacles are not compatible with threaded military connectors. See Section B.13 for details.

B

B.2 Power cable

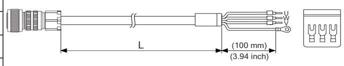
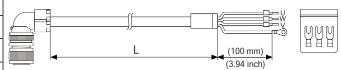
B.2.1 F40 - F80 motors

Motor series	Applicable model	Connector type	Wire spec. AWG (mm^2)		Length (L) mm (inch)	Model number		Illustration
			UVW	Brake		Standard	Flexible	
ECM-A3* ECM-B3	220V w/o brake	Standard	18 (0.82)	-	3000 ± 50 (118 ± 2)	ACS3-CAPW3103	ACS3-CAPF3103	
					5000 ± 50 (197 ± 2)	ACS3-CAPW3105	ACS3-CAPF3105	
					10000 ± 100 (394 ± 4)	ACS3-CAPW3110	ACS3-CAPF3110	
					20000 ± 100 (787 ± 4)	ACS3-CAPW3120	ACS3-CAPF3120	
	220V 400V with brake	Standard	18 (0.82)	22 (0.32)	3000 ± 50 (118 ± 2)	ACS3-CAPW2103	ACS3-CAPF2103	
					5000 ± 50 (197 ± 2)	ACS3-CAPW2105	ACS3-CAPF2105	
					10000 ± 100 (394 ± 4)	ACS3-CAPW2110	ACS3-CAPF2110	
					20000 ± 100 (787 ± 4)	ACS3-CAPW2120	ACS3-CAPF2120	
	400V w/o brake	Standard	18 (0.82)	-	3000 ± 50 (118 ± 2)	ACS3-CAPW3103	ACS3-CAPF3103	
					5000 ± 50 (197 ± 2)	ACS3-CAPW3105	ACS3-CAPF3105	
					10000 ± 100 (394 ± 4)	ACS3-CAPW3110	ACS3-CAPF3110	
					20000 ± 100 (787 ± 4)	ACS3-CAPW3120	ACS3-CAPF3120	
	220V w/o brake	CHOGORI	18 (0.82)	-	3000 ± 50 (118 ± 2)	ACS3-CAPW5103	ACS3-CAPF5103	
					5000 ± 50 (197 ± 2)	ACS3-CAPW5105	ACS3-CAPF5105	
					10000 ± 100 (394 ± 4)	ACS3-CAPW5110	ACS3-CAPF5110	
					20000 ± 100 (787 ± 4)	ACS3-CAPW5120	ACS3-CAPF5120	
	220V with brake	CHOGORI	18 (0.82)	22 (0.32)	3000 ± 50 (118 ± 2)	ACS3-CAPW6103	ACS3-CAPF6103	
					5000 ± 50 (197 ± 2)	ACS3-CAPW6105	ACS3-CAPF6105	
					10000 ± 100 (394 ± 4)	ACS3-CAPW6110	ACS3-CAPF6110	
					20000 ± 100 (787 ± 4)	ACS3-CAPW6120	ACS3-CAPF6120	
ECM-B3	220V w/o brake	Bulkhead - cable exit direction towards motor shaft	20 (0.52)	-	3000 ± 50 (118 ± 2)	ACS3-AFPWSR03	ACS3-AFPRSR03	
					5000 ± 50 (197 ± 2)	ACS3-AFPWSR05	ACS3-AFPRSR05	
					10000 ± 100 (394 ± 4)	ACS3-AFPWSR10	ACS3-AFPRSR10	
					20000 ± 100 (787 ± 4)	ACS3-AFPWSR20	ACS3-AFPRSR20	
	220V with brake	Bulkhead - cable exit direction towards motor shaft	20 (0.52)	24 (0.21)	3000 ± 50 (118 ± 2)	ACS3-AFPWSS03	ACS3-AFPRSS03	
					5000 ± 50 (197 ± 2)	ACS3-AFPWSS05	ACS3-AFPRSS05	
					10000 ± 100 (394 ± 4)	ACS3-AFPWSS10	ACS3-AFPRSS10	
					20000 ± 100 (787 ± 4)	ACS3-AFPWSS20	ACS3-AFPRSS20	
	400V w/o brake	Bulkhead - cable exit direction towards motor shaft	20 (0.52)	-	3000 ± 50 (118 ± 2)	ACS3-AFPWSA03	ACS3-AFPRSA03	
					5000 ± 50 (197 ± 2)	ACS3-AFPWSA05	ACS3-AFPRSA05	
					10000 ± 100 (394 ± 4)	ACS3-AFPWSA10	ACS3-AFPRSA10	
					20000 ± 100 (787 ± 4)	ACS3-AFPWSA20	ACS3-AFPRSA20	
	400V with brake	Bulkhead - cable exit direction towards motor shaft	20 (0.52)	24 (0.21)	3000 ± 50 (118 ± 2)	ACS3-AFPWSB03	ACS3-AFPRSB03	
					5000 ± 50 (197 ± 2)	ACS3-AFPWSB05	ACS3-AFPRSB05	
					10000 ± 100 (394 ± 4)	ACS3-AFPWSB10	ACS3-AFPRSB10	
					20000 ± 100 (787 ± 4)	ACS3-AFPWSB20	ACS3-AFPRSB20	
	220V w/o brake	Bulkhead - cable exit direction towards encoder	20 (0.52)	-	3000 ± 50 (118 ± 2)	ACS3-ABPWSR03	ACS3-ABPRSR03	
					5000 ± 50 (197 ± 2)	ACS3-ABPWSR05	ACS3-ABPRSR05	
					10000 ± 100 (394 ± 4)	ACS3-ABPWSR10	ACS3-ABPRSR10	
					20000 ± 100 (787 ± 4)	ACS3-ABPWSR20	ACS3-ABPRSR20	
	220V with brake	Bulkhead - cable exit direction towards encoder	20 (0.52)	24 (0.21)	3000 ± 50 (118 ± 2)	ACS3-ABPWSS03	ACS3-ABPRSS03	
					5000 ± 50 (197 ± 2)	ACS3-ABPWSS05	ACS3-ABPRSS05	
					10000 ± 100 (394 ± 4)	ACS3-ABPWSS10	ACS3-ABPRSS10	
					20000 ± 100 (787 ± 4)	ACS3-ABPWSS20	ACS3-ABPRSS20	
	400V w/o brake	Bulkhead - cable exit direction towards encoder	20 (0.52)	-	3000 ± 50 (118 ± 2)	ACS3-ABPWSA03	ACS3-ABPRSA03	
					5000 ± 50 (197 ± 2)	ACS3-ABPWSA05	ACS3-ABPRSA05	
					10000 ± 100 (394 ± 4)	ACS3-ABPWSA10	ACS3-ABPRSA10	
					20000 ± 100 (787 ± 4)	ACS3-ABPWSA20	ACS3-ABPRSA20	
	400V with brake	Bulkhead - cable exit direction towards encoder	20 (0.52)	24 (0.21)	3000 ± 50 (118 ± 2)	ACS3-ABPWSB03	ACS3-ABPRSB03	
					5000 ± 50 (197 ± 2)	ACS3-ABPWSB05	ACS3-ABPRSB05	
					10000 ± 100 (394 ± 4)	ACS3-ABPWSB10	ACS3-ABPRSB10	
					20000 ± 100 (787 ± 4)	ACS3-ABPWSB20	ACS3-ABPRSB20	

Note: ECM-A3 motors do not include 400V models.

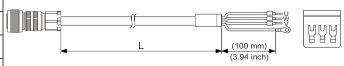
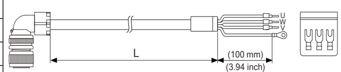
B

B.2.2 F100 - F130 motors

Motor series	Applicable model	Connector type	Wire spec. AWG (mm²) UVW	Length (L) mm (inch)	Model number Standard	Model number Flexible	Illustration
ECM-B3	220V 400V w/o brake with brake Note	Military - straight 3106A-18-10S	16 (1.3)	3000 ± 50 (118 ± 2)	ACS3-CAPWA203	ACS3-CAPFA203	
				5000 ± 50 (197 ± 2)	ACS3-CAPWA205	ACS3-CAPFA205	
				10000 ± 100 (394 ± 4)	ACS3-CAPWA210	ACS3-CAPFA210	
				20000 ± 100 (787 ± 4)	ACS3-CAPWA220	ACS3-CAPFA220	
			14 (2.1)	3000 ± 50 (118 ± 2)	ACS3-CAPWA303	ACS3-CAPFA303	
				5000 ± 50 (197 ± 2)	ACS3-CAPWA305	ACS3-CAPFA305	
				10000 ± 100 (394 ± 4)	ACS3-CAPWA310	ACS3-CAPFA310	
				20000 ± 100 (787 ± 4)	ACS3-CAPWA320	ACS3-CAPFA320	
	220V 400V w/o brake with brake Note	Military - right angle 3108A-18-10S	16 (1.3)	3000 ± 50 (118 ± 2)	ACS3-CRPWA203	ACS3-CRPFA203	
				5000 ± 50 (197 ± 2)	ACS3-CRPWA205	ACS3-CRPFA205	
				10000 ± 100 (394 ± 4)	ACS3-CRPWA210	ACS3-CRPFA210	
				20000 ± 100 (787 ± 4)	ACS3-CRPWA220	ACS3-CRPFA220	
			14 (2.1)	3000 ± 50 (118 ± 2)	ACS3-CRPWA303	ACS3-CRPFA303	
				5000 ± 50 (197 ± 2)	ACS3-CRPWA305	ACS3-CRPFA305	
				10000 ± 100 (394 ± 4)	ACS3-CRPWA310	ACS3-CRPFA310	
				20000 ± 100 (787 ± 4)	ACS3-CRPWA320	ACS3-CRPFA320	

Note: for models with brake, you need to purchase the brake cable listed in Section B.2.5.

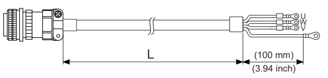
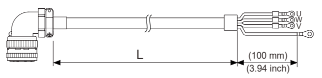
B.2.3 F180 4.5 kW or below motors

Motor series	Applicable model	Connector type	Wire spec. AWG (mm²) UVW	Length (L) mm (inch)	Model number Standard	Model number Flexible	Illustration
ECM-B3	220V 400V w/o brake with brake Note	Military - straight 3106A-22-22S	14 (2.1)	3000 ± 50 (118 ± 2)	ACS3-CAPWC303	ACS3-CAPFC303	
				5000 ± 50 (197 ± 2)	ACS3-CAPWC305	ACS3-CAPFC305	
				10000 ± 100 (394 ± 4)	ACS3-CAPWC310	ACS3-CAPFC310	
				20000 ± 100 (787 ± 4)	ACS3-CAPWC320	ACS3-CAPFC320	
			12 (3.3)	3000 ± 50 (118 ± 2)	ACS3-CAPWC403	ACS3-CAPFC403	
				5000 ± 50 (197 ± 2)	ACS3-CAPWC405	ACS3-CAPFC405	
				10000 ± 100 (394 ± 4)	ACS3-CAPWC410	ACS3-CAPFC410	
				20000 ± 100 (787 ± 4)	ACS3-CAPWC420	ACS3-CAPFC420	
			10 (5.3)	3000 ± 50 (118 ± 2)	ACS3-CAPWC503	ACS3-CAPFC503	
				5000 ± 50 (197 ± 2)	ACS3-CAPWC505	ACS3-CAPFC505	
				10000 ± 100 (394 ± 4)	ACS3-CAPWC510	ACS3-CAPFC510	
				20000 ± 100 (787 ± 4)	ACS3-CAPWC520	ACS3-CAPFC520	
			8 (8.4)	3000 ± 50 (118 ± 2)	ACS3-CAPWC603	ACS3-CAPFC603	
				5000 ± 50 (197 ± 2)	ACS3-CAPWC605	ACS3-CAPFC605	
				10000 ± 100 (394 ± 4)	ACS3-CAPWC610	ACS3-CAPFC610	
				20000 ± 100 (787 ± 4)	ACS3-CAPWC620	ACS3-CAPFC620	
	220V 400V w/o brake with brake Note	Military - right angle 3108A-22-22S	14 (2.1)	3000 ± 50 (118 ± 2)	ACS3-CRPWC303	ACS3-CRPFC303	
				5000 ± 50 (197 ± 2)	ACS3-CRPWC305	ACS3-CRPFC305	
				10000 ± 100 (394 ± 4)	ACS3-CRPWC310	ACS3-CRPFC310	
				20000 ± 100 (787 ± 4)	ACS3-CRPWC320	ACS3-CRPFC320	
			12 (3.3)	3000 ± 50 (118 ± 2)	ACS3-CRPWC403	ACS3-CRPFC403	
				5000 ± 50 (197 ± 2)	ACS3-CRPWC405	ACS3-CRPFC405	
				10000 ± 100 (394 ± 4)	ACS3-CRPWC410	ACS3-CRPFC410	
				20000 ± 100 (787 ± 4)	ACS3-CRPWC420	ACS3-CRPFC420	
			10 (5.3)	3000 ± 50 (118 ± 2)	ACS3-CRPWC503	ACS3-CRPFC503	
				5000 ± 50 (197 ± 2)	ACS3-CRPWC505	ACS3-CRPFC505	
				10000 ± 100 (394 ± 4)	ACS3-CRPWC510	ACS3-CRPFC510	
				20000 ± 100 (787 ± 4)	ACS3-CRPWC520	ACS3-CRPFC520	
			8 (8.4)	3000 ± 50 (118 ± 2)	ACS3-CRPWC603	ACS3-CRPFC603	
				5000 ± 50 (197 ± 2)	ACS3-CRPWC605	ACS3-CRPFC605	
				10000 ± 100 (394 ± 4)	ACS3-CRPWC610	ACS3-CRPFC610	
				20000 ± 100 (787 ± 4)	ACS3-CRPWC620	ACS3-CRPFC620	

Note: for models with brake, you need to purchase the brake cable listed in Section B.2.5.

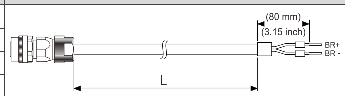
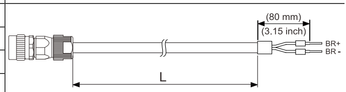
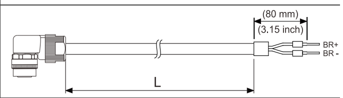
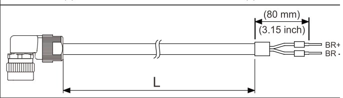
B

B.2.4 F180 5.5 kW or above motors

Motor series	Applicable model	Connector type	Wire spec. AWG (mm^2)	Length (L) mm (inch)	Model number		Illustration
			UVW		Standard	Flexible	
ECM-B3	220V 400V w/o brake with brake Note	Military - straight 3106A-32-17S	8 (8.4)	3000 ± 50 (118 ± 2)	ACS3-CAPWE603	ACS3-CAPFE603	
				5000 ± 50 (197 ± 2)	ACS3-CAPWE605	ACS3-CAPFE605	
				10000 ± 100 (394 ± 4)	ACS3-CAPWE610	ACS3-CAPFE610	
				20000 ± 100 (787 ± 4)	ACS3-CAPWE620	ACS3-CAPFE620	
			6 (13.3)	3000 ± 50 (118 ± 2)	ACS3-CAPWE703	ACS3-CAPFE703	
				5000 ± 50 (197 ± 2)	ACS3-CAPWE705	ACS3-CAPFE705	
				10000 ± 100 (394 ± 4)	ACS3-CAPWE710	ACS3-CAPFE710	
				20000 ± 100 (787 ± 4)	ACS3-CAPWE720	ACS3-CAPFE720	
			4 (21.2)	3000 ± 50 (118 ± 2)	ACS3-CAPWE803	ACS3-CAPFE803	
				5000 ± 50 (197 ± 2)	ACS3-CAPWE805	ACS3-CAPFE805	
				10000 ± 100 (394 ± 4)	ACS3-CAPWE810	ACS3-CAPFE810	
				20000 ± 100 (787 ± 4)	ACS3-CAPWE820	ACS3-CAPFE820	
	220V 400V w/o brake with brake Note	Military - right angle 3108A-32-17S	8 (8.4)	3000 ± 50 (118 ± 2)	ACS3-CRPWE603	ACS3-CRPFE603	
				5000 ± 50 (197 ± 2)	ACS3-CRPWE605	ACS3-CRPFE605	
				10000 ± 100 (394 ± 4)	ACS3-CRPWE610	ACS3-CRPFE610	
				20000 ± 100 (787 ± 4)	ACS3-CRPWE620	ACS3-CRPFE620	
			6 (13.3)	3000 ± 50 (118 ± 2)	ACS3-CRPWE703	ACS3-CRPFE703	
				5000 ± 50 (197 ± 2)	ACS3-CRPWE705	ACS3-CRPFE705	
				10000 ± 100 (394 ± 4)	ACS3-CRPWE710	ACS3-CRPFE710	
				20000 ± 100 (787 ± 4)	ACS3-CRPWE720	ACS3-CRPFE720	
			4 (21.2)	3000 ± 50 (118 ± 2)	ACS3-CRPWE803	ACS3-CRPFE803	
				5000 ± 50 (197 ± 2)	ACS3-CRPWE805	ACS3-CRPFE805	
				10000 ± 100 (394 ± 4)	ACS3-CRPWE810	ACS3-CRPFE810	
				20000 ± 100 (787 ± 4)	ACS3-CRPWE820	ACS3-CRPFE820	

Note: for models with brake, you need to purchase the brake cable listed in Section B.2.5.

B.2.5 Brake cables for F100 - F220 motors

Motor series	Applicable model	Connector type	Wire spec. AWG (mm^2)	Length (L) mm (inch)	Model number		Illustration
			Brake		Standard	Flexible	
ECM-B3	220V 400V with brake	Military - straight CMV1-SP2S [bayonet]	20 (0.52)	3000 ± 50 (118 ± 2)	ACS3-CABRA103	ACS3-CABFA103	
				5000 ± 50 (197 ± 2)	ACS3-CABRA105	ACS3-CABFA105	
				10000 ± 100 (394 ± 4)	ACS3-CABRA110	ACS3-CABFA110	
				20000 ± 100 (787 ± 4)	ACS3-CABRA120	ACS3-CABFA120	
		Military - straight [threaded, M17.5]	20 (0.52)	3000 ± 50 (118 ± 2)	ACS3-CABRM103	ACS3-CABFM103	
				5000 ± 50 (197 ± 2)	ACS3-CABRM105	ACS3-CABFM105	
				10000 ± 100 (394 ± 4)	ACS3-CABRM110	ACS3-CABFM110	
				20000 ± 100 (787 ± 4)	ACS3-CABRM120	ACS3-CABFM120	
		Military - right angle CMV1-AP2S [bayonet]	20 (0.52)	3000 ± 50 (118 ± 2)	ACS3-CRBRA103	ACS3-CRBFA103	
				5000 ± 50 (197 ± 2)	ACS3-CRBRA105	ACS3-CRBFA105	
				10000 ± 100 (394 ± 4)	ACS3-CRBRA110	ACS3-CRBFA110	
				20000 ± 100 (787 ± 4)	ACS3-CRBRA120	ACS3-CRBFA120	
		Military - right angle [threaded, M17.5]	20 (0.52)	3000 ± 50 (118 ± 2)	ACS3-CRBRM103	ACS3-CRBFM103	
				5000 ± 50 (197 ± 2)	ACS3-CRBRM105	ACS3-CRBFM105	
				10000 ± 100 (394 ± 4)	ACS3-CRBRM110	ACS3-CRBFM110	
				20000 ± 100 (787 ± 4)	ACS3-CRBRM120	ACS3-CRBFM120	

Note: motors with bayonet receptacles are not compatible with threaded military connectors. See Section B.13 for details.

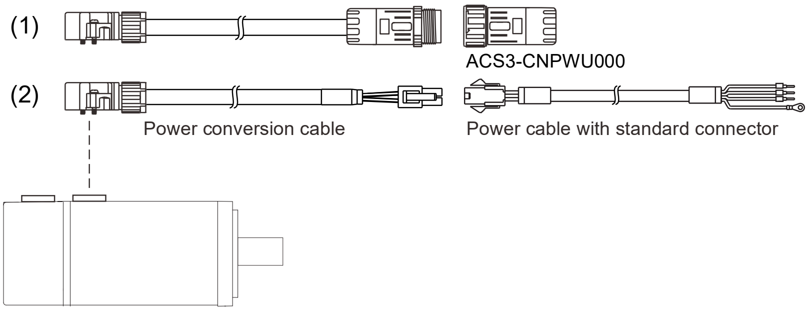
B.3 Power conversion cable / counterpart connector (for motors with bulkhead receptacles)

The power conversion cable is for connecting the motor with bulkhead receptacles to a non-bulkhead power connector. The following illustrates where it is installed.

Connection methods:

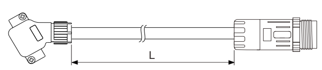
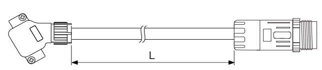
(1) Power conversion cable with waterproof connector + counterpart to waterproof connector; you need to make the cable by yourself.

(2) Power conversion cable with standard connector + power cable with standard connector

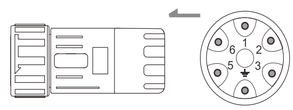


B.3.1 F40 - F80 motors

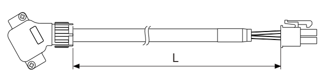
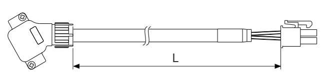
■ Power conversion cable with waterproof connector (IP67 rated): when mating the connector to the counterpart, ensure they are fully locked and meet the IP67 standard.

Motor series	Applicable model	Connector type	Wire spec. AWG (mm²)		Length (L) mm (inch)	Model number		Illustration
			UVW	Brake		Standard	Flexible	
ECM-B3	220V 400V w/o brake with brake	Bulkhead - cable exit direction towards motor shaft	20 (0.52)	24 (0.21)	300 ± 20 (11.8 ± 0.8)	ACS3-AFESSW0C	ACS3-AFEFSW0C	
	220V 400V w/o brake with brake	Bulkhead - cable exit direction towards encoder	20 (0.52)	24 (0.21)	300 ± 20 (11.8 ± 0.8)	ACS3-ABESSW0C	ACS3-ABEFSW0C	

■ Counterpart to the preceding waterproof connector

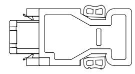
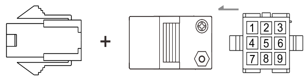
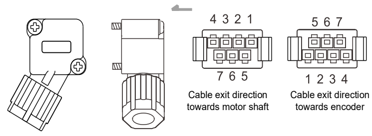
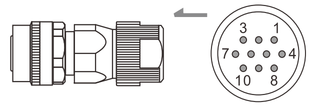
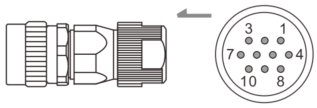
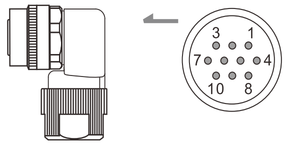
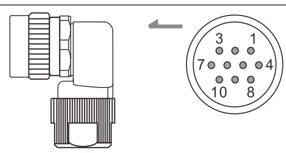
Motor series	Frame size	Applicable model	Connector				Model number	Illustration
			Type	UVW	Brake	IP rating		
-	F40 - F80	220V 400V w/o brake with brake	Dedicated conversion connector	●	●	IP67	ACS3-CNPWU000	

■ Power conversion cable with standard connector (not IP67 rated): do not use the cable in an environment which is exposed to oil or water.

Motor series	Applicable model	Connector type	Wire spec. AWG (mm²)		Length (L) mm (inch)	Model number		Illustration
			UVW	Brake		Standard	Flexible	
ECM-B3	220V 400V w/o brake with brake	Bulkhead - cable exit direction towards motor shaft	20 (0.52)	24 (0.21)	300 ± 20 (11.8 ± 0.8)	ACS3-AFPWSB0C	ACS3-AFPRSB0C	
	220V 400V w/o brake with brake	Bulkhead - cable exit direction towards encoder	20 (0.52)	24 (0.21)	300 ± 20 (11.8 ± 0.8)	ACS3-ABPWSB0C	ACS3-ABPRSB0C	

B

B.4 Encoder connector

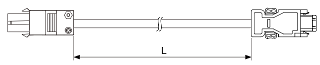
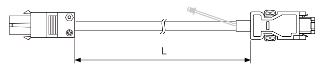
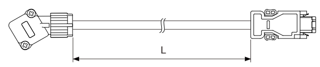
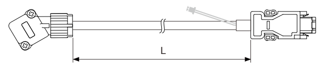
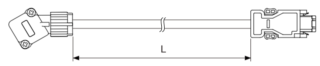
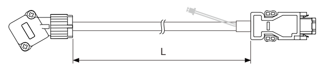
Motor series	Frame size	Connector type	IP rating	Model number	Illustration
ECM-B3	-	For connecting to the servo drive end	-	ACS3-CNENC200	
	F40 - F80	Standard	IP20	ACS3-CAEN0000	
ECM-B3	F40 - F80	Bulkhead - cable exit direction towards motor shaft	IP67	ACS3-AFEASA00	 The preceding figure illustrates the difference between the two cable exit directions; only one wiring terminal is attached.
		Bulkhead - cable exit direction towards encoder			
	F100 - F180	Military - straight CMV1-SP10S [bayonet]	IP67	ACS3-CAENA000	
		Military - straight [threaded, M17.5]	IP67	ACS3-CAENM000	
		Military - right angle CMV1-AP10S [bayonet]	IP67	ACS3-CRENA000	
		Military - right angle [threaded, M17.5]	IP67	ACS3-CRENM000	

Note: motors with bayonet receptacles are not compatible with threaded military connectors. See Section B.13 for details.

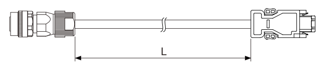
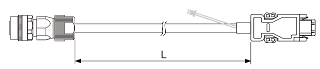
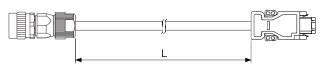
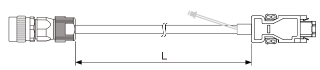
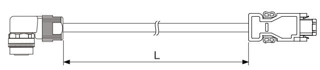
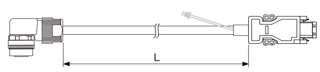
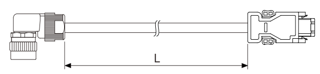
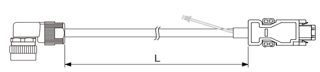
B

B.5 Encoder cable

B.5.1 F40 - F80 motors

Motor series	Connector type	Encoder type	Length (L) mm (inch)	Model number Standard	Model number Flexible	Illustration
ECM-B3	Standard	Incremental	3000 ± 50 (118 ± 2)	ACS3-CAEN0103	ACS3-CAEF0103	
			5000 ± 50 (197 ± 2)	ACS3-CAEN0105	ACS3-CAEF0105	
			10000 ± 100 (394 ± 4)	ACS3-CAEN0110	ACS3-CAEF0110	
			20000 ± 100 (787 ± 4)	ACS3-CAEN0120	ACS3-CAEF0120	
		Absolute	3000 ± 50 (118 ± 2)	ACS3-CAEA0103	ACS3-CAEB0103	
			5000 ± 50 (197 ± 2)	ACS3-CAEA0105	ACS3-CAEB0105	
			10000 ± 100 (394 ± 4)	ACS3-CAEA0110	ACS3-CAEB0110	
			20000 ± 100 (787 ± 4)	ACS3-CAEA0120	ACS3-CAEB0120	
ECM-B3	Bulkhead - cable exit direction towards motor shaft	Incremental	3000 ± 50 (118 ± 2)	ACS3-AFEASI03	ACS3-AFERSI03	
			5000 ± 50 (197 ± 2)	ACS3-AFEASI05	ACS3-AFERSI05	
			10000 ± 100 (394 ± 4)	ACS3-AFEASI10	ACS3-AFERSI10	
			20000 ± 100 (787 ± 4)	ACS3-AFEASI20	ACS3-AFERSI20	
		Absolute	3000 ± 50 (118 ± 2)	ACS3-AFEASA03	ACS3-AFERSA03	
			5000 ± 50 (197 ± 2)	ACS3-AFEASA05	ACS3-AFERSA05	
			10000 ± 100 (394 ± 4)	ACS3-AFEASA10	ACS3-AFERSA10	
			20000 ± 100 (787 ± 4)	ACS3-AFEASA20	ACS3-AFERSA20	
	Bulkhead - cable exit direction towards encoder	Incremental	3000 ± 50 (118 ± 2)	ACS3-ABEASI03	ACS3-ABERSI03	
			5000 ± 50 (197 ± 2)	ACS3-ABEASI05	ACS3-ABERSI05	
			10000 ± 100 (394 ± 4)	ACS3-ABEASI10	ACS3-ABERSI10	
			20000 ± 100 (787 ± 4)	ACS3-ABEASI20	ACS3-ABERSI20	
		Absolute	3000 ± 50 (118 ± 2)	ACS3-ABEASA03	ACS3-ABERSA03	
			5000 ± 50 (197 ± 2)	ACS3-ABEASA05	ACS3-ABERSA05	
			10000 ± 100 (394 ± 4)	ACS3-ABEASA10	ACS3-ABERSA10	
			20000 ± 100 (787 ± 4)	ACS3-ABEASA20	ACS3-ABERSA20	

B.5.2 F100 - F180 motors

Motor series	Connector type	Encoder type	Length (L) mm (inch)	Model number Standard	Model number Flexible	Illustration
ECM-B3	Military - straight CMV1-SP10S [bayonet]	Incremental	3000 ± 50 (118 ± 2)	ACS3-CAENA103	ACS3-CAEFA103	
			5000 ± 50 (197 ± 2)	ACS3-CAENA105	ACS3-CAEFA105	
			10000 ± 100 (394 ± 4)	ACS3-CAENA110	ACS3-CAEFA110	
			20000 ± 100 (787 ± 4)	ACS3-CAENA120	ACS3-CAEFA120	
		Absolute	3000 ± 50 (118 ± 2)	ACS3-CAEAA103	ACS3-CAEBA103	
			5000 ± 50 (197 ± 2)	ACS3-CAEAA105	ACS3-CAEBA105	
			10000 ± 100 (394 ± 4)	ACS3-CAEAA110	ACS3-CAEBA110	
			20000 ± 100 (787 ± 4)	ACS3-CAEAA120	ACS3-CAEBA120	
	Military - straight [threaded, M17.5]	Incremental	3000 ± 50 (118 ± 2)	ACS3-CAENM103	ACS3-CAEFM103	
			5000 ± 50 (197 ± 2)	ACS3-CAENM105	ACS3-CAEFM105	
			10000 ± 100 (394 ± 4)	ACS3-CAENM110	ACS3-CAEFM110	
			20000 ± 100 (787 ± 4)	ACS3-CAENM120	ACS3-CAEFM120	
		Absolute	3000 ± 50 (118 ± 2)	ACS3-CAEAM103	ACS3-CAEBM103	
			5000 ± 50 (197 ± 2)	ACS3-CAEAM105	ACS3-CAEBM105	
			10000 ± 100 (394 ± 4)	ACS3-CAEAM110	ACS3-CAEBM110	
			20000 ± 100 (787 ± 4)	ACS3-CAEAM120	ACS3-CAEBM120	
	Military - right angle CMV1-AP10S [bayonet]	Incremental	3000 ± 50 (118 ± 2)	ACS3-CRENA103	ACS3-CREFA103	
			5000 ± 50 (197 ± 2)	ACS3-CRENA105	ACS3-CREFA105	
			10000 ± 100 (394 ± 4)	ACS3-CRENA110	ACS3-CREFA110	
			20000 ± 100 (787 ± 4)	ACS3-CRENA120	ACS3-CREFA120	
		Absolute	3000 ± 50 (118 ± 2)	ACS3-CREAA103	ACS3-CREBA103	
			5000 ± 50 (197 ± 2)	ACS3-CREAA105	ACS3-CREBA105	
			10000 ± 100 (394 ± 4)	ACS3-CREAA110	ACS3-CREBA110	
			20000 ± 100 (787 ± 4)	ACS3-CREAA120	ACS3-CREBA120	
	Military - right angle [threaded, M17.5]	Incremental	3000 ± 50 (118 ± 2)	ACS3-CRENM103	ACS3-CREFM103	
			5000 ± 50 (197 ± 2)	ACS3-CRENM105	ACS3-CREFM105	
			10000 ± 100 (394 ± 4)	ACS3-CRENM110	ACS3-CREFM110	
			20000 ± 100 (787 ± 4)	ACS3-CRENM120	ACS3-CREFM120	
		Absolute	3000 ± 50 (118 ± 2)	ACS3-CREAM103	ACS3-CREBM103	
			5000 ± 50 (197 ± 2)	ACS3-CREAM105	ACS3-CREBM105	
			10000 ± 100 (394 ± 4)	ACS3-CREAM110	ACS3-CREBM110	
			20000 ± 100 (787 ± 4)	ACS3-CREAM120	ACS3-CREBM120	

Note: motors with bayonet receptacles are not compatible with threaded military connectors. See Section B.13 for details.

B.6 Encoder conversion cable / counterpart connector (for motors with bulkhead receptacles)

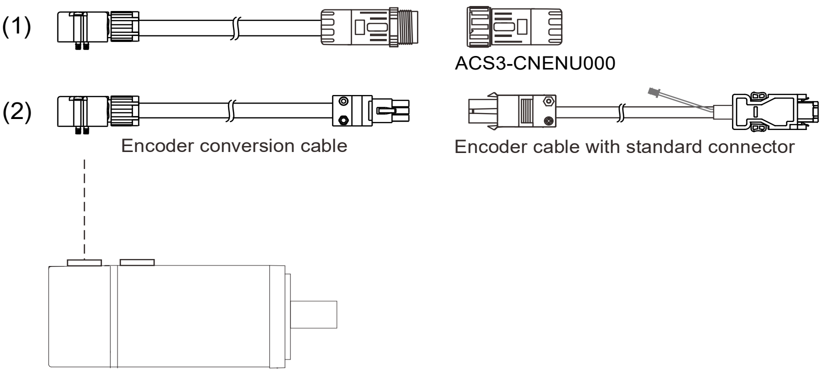
B

The encoder conversion cable is for connecting the motor with bulkhead receptacles to a non-bulkhead encoder connector. The following illustrates where it is installed.

Connection methods:

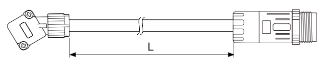
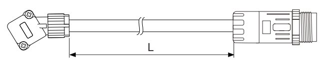
(1) Encoder conversion cable with waterproof connector + counterpart to waterproof connector; you need to make the cable by yourself.

(2) Encoder conversion cable with standard connector + encoder cable with standard connector.

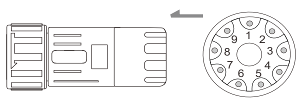


B.6.1 F40 - F80 motors

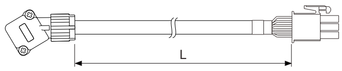
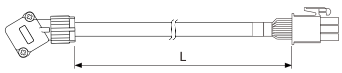
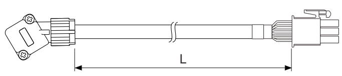
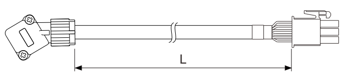
■ Encoder conversion cable with waterproof connector (IP67 rated): when mating the connector to the counterpart, ensure they are fully locked and meet the IP67 standard.

Motor series	Connector type	Encoder type	Length (L) mm (inch)	Model number		Illustration
				Standard	Flexible	
ECM-B3	Bulkhead - cable exit direction towards motor shaft	Incremental Absolute	300 ± 20 (11.8 ± 0.8)	ACS3-AFENSW0C	ACS3-AFEBSW0C	
	Bulkhead - cable exit direction towards encoder	Incremental Absolute	300 ± 20 (11.8 ± 0.8)	ACS3-ABENSW0C	ACS3-ABEBSW0C	

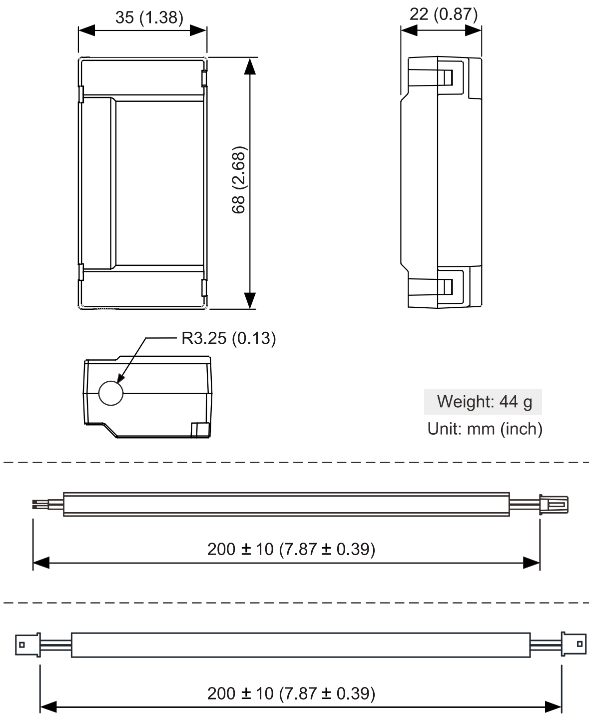
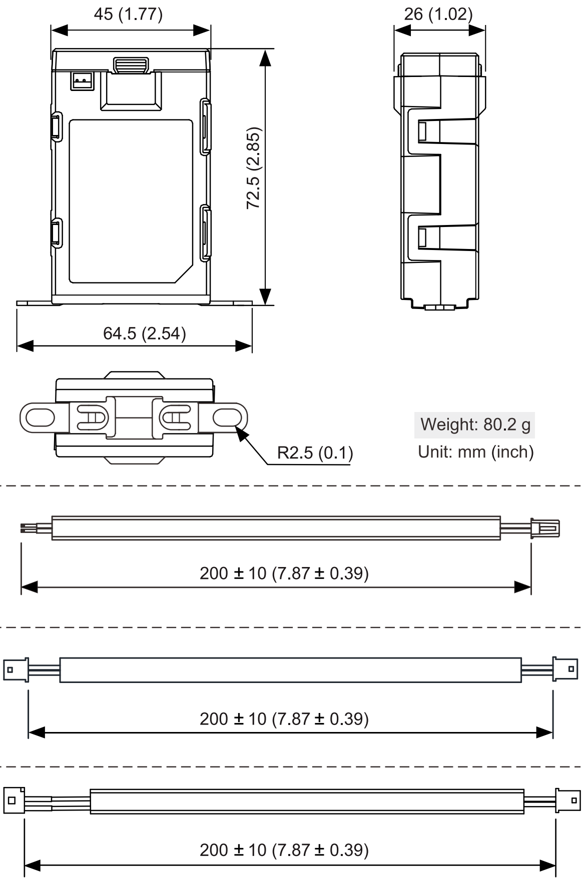
■ Counterpart to the preceding waterproof connector

Motor series	Frame size	Connector type	IP rating	Model number	Illustration
-	F40 - F80	Dedicated conversion connector	IP67	ACS3-CNENU000	

■ Encoder conversion cable with standard connector (not IP67 rated): do not use the cable in an environment which is exposed to oil or water.

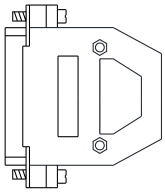
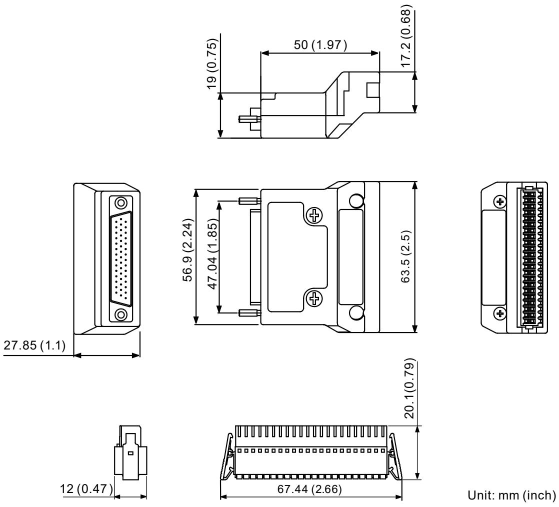
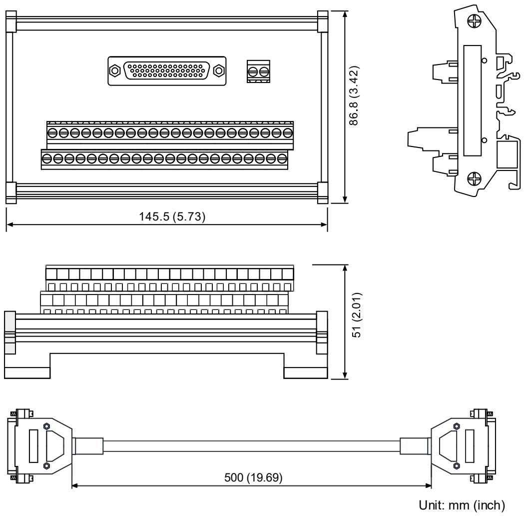
Motor series	Connector type	Encoder type	Length (L) mm (inch)	Model number		Illustration
				Standard	Flexible	
ECM-B3	Bulkhead - cable exit direction towards motor shaft	Incremental	300 ± 20 (11.8 ± 0.8)	ACS3-AFEASI0C	ACS3-AFERSI0C	
			500 ± 20 (19.7 ± 0.8)	ACS3-AFEASI0E	ACS3-AFERSI0E	
			700 ± 30 (27.6 ± 1.2)	ACS3-AFEASI0G	ACS3-AFERSI0G	
			900 ± 30 (35.4 ± 1.2)	ACS3-AFEASI0J	ACS3-AFERSI0J	
		Absolute	300 ± 20 (11.8 ± 0.8)	ACS3-AFEASA0C	ACS3-AFERSA0C	
			500 ± 20 (19.7 ± 0.8)	ACS3-AFEASA0E	ACS3-AFERSA0E	
			700 ± 30 (27.6 ± 1.2)	ACS3-AFEASA0G	ACS3-AFERSA0G	
			900 ± 30 (35.4 ± 1.2)	ACS3-AFEASA0J	ACS3-AFERSA0J	
	Bulkhead - cable exit direction towards encoder	Incremental	300 ± 20 (11.8 ± 0.8)	ACS3-ABEASI0C	ACS3-ABERSI0C	
			500 ± 20 (19.7 ± 0.8)	ACS3-ABEASI0E	ACS3-ABERSI0E	
			700 ± 30 (27.6 ± 1.2)	ACS3-ABEASI0G	ACS3-ABERSI0G	
			900 ± 30 (35.4 ± 1.2)	ACS3-ABEASI0J	ACS3-ABERSI0J	
		Absolute	300 ± 20 (11.8 ± 0.8)	ACS3-ABEASA0C	ACS3-ABERSA0C	
			500 ± 20 (19.7 ± 0.8)	ACS3-ABEASA0E	ACS3-ABERSA0E	
			700 ± 30 (27.6 ± 1.2)	ACS3-ABEASA0G	ACS3-ABERSA0G	
			900 ± 30 (35.4 ± 1.2)	ACS3-ABEASA0J	ACS3-ABERSA0J	

B.7 Battery box

Model number	Description	Illustration
ASD-MDBT0100	Single battery box (including one battery and two cables)	
ASD-MDBT0200	Dual battery box (including two batteries and three cables)	

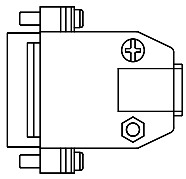
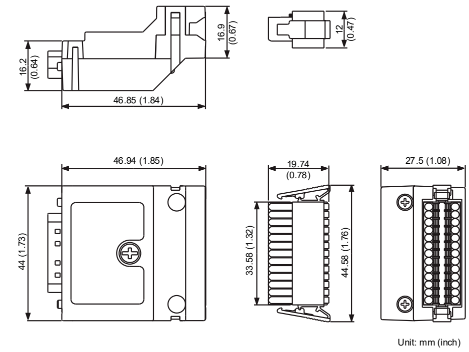
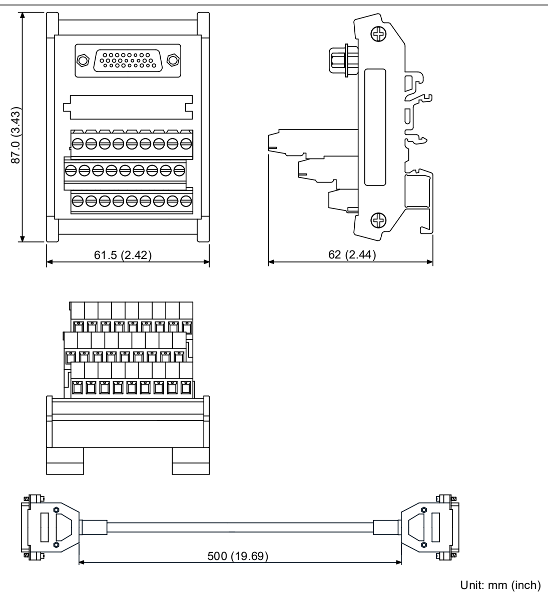
B.8 CN1 accessories

B.8.1 B3-L models

Model number	Description	Illustration
ACS3-CNTB0400	CN1 connector	
ACS3-IFSC4444	CN1 quick connector	
ACS3-MDTB4400	CN1 terminal block module	

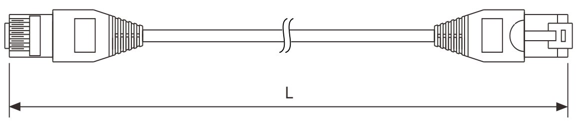
B

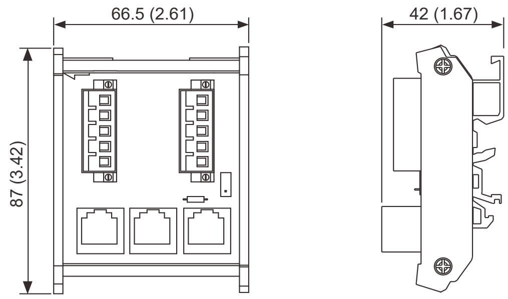
B.8.2 B3-M, B3-F, and B3-E models

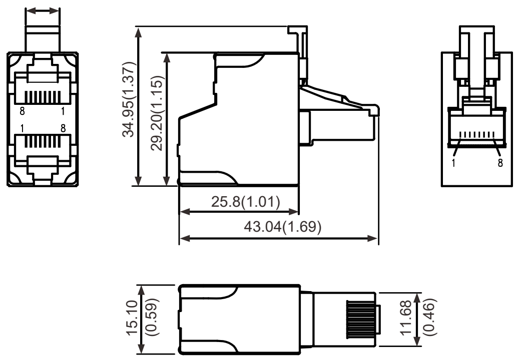
Model number	Description	Illustration
ACS3-CNTB0500	CN1 connector	
ACS3-IFSC2626	CN1 quick connector	
ACS3-MDTD2600	CN1 terminal block module	

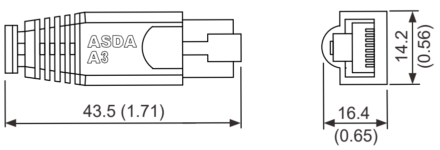
B

B.9 CN3 accessories

<table>
<tr><th>Model number</th><th>Description</th><th>Illustration</th></tr>
<tr><td>UC-CMC030-01A
UC-CMC050-01A</td><td>CANopen communication cable*</td><td>

<table>
<tr><th rowspan="2">Model number</th><th colspan="2">L</th></tr>
<tr><th>mm</th><th>inch</th></tr>
<tr><td>UC-CMC030-01A</td><td>300 ± 10</td><td>11 ± 0.4</td></tr>
<tr><td>UC-CMC050-01A</td><td>500 ± 10</td><td>19 ± 0.4</td></tr>
</table></td></tr>
<tr><td>TAP-CN03</td><td>CANopen distribution box</td><td>

Unit: mm (inch)</td></tr>
<tr><td>ACS3-CNADC3RC</td><td>RS-485 splitter</td><td>

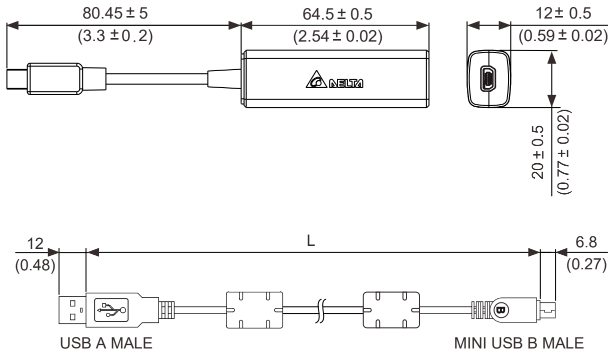
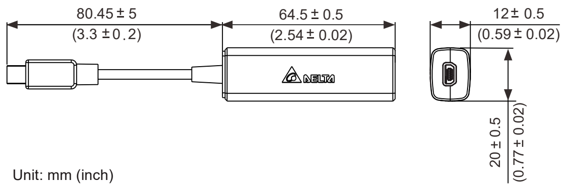
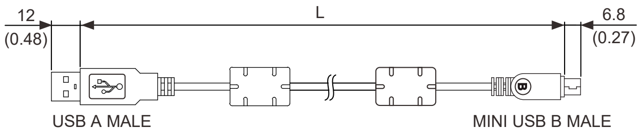
Unit: mm (inch)</td></tr>
<tr><td>ACS3-CNADC3TR</td><td>RS-485 / CANopen terminal resistor</td><td>

Unit: mm (inch)</td></tr>
</table>

Note: for cables of other lengths, refer to the Delta PLC / HMI Cable Selection Guide.

B

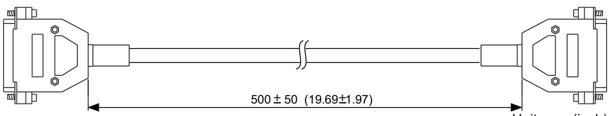
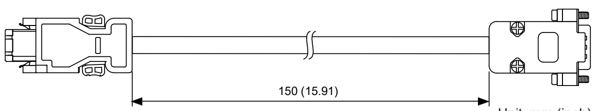
B.10 CN4 Mini USB communication module

Model number	Description	Illustration
UC-PRG015-01B UC-PRG030-01B	Including USB cable and isolator	 Unit: mm (inch)
UC-ADP01-A	USB isolator	 Unit: mm (inch)
UC-PRG015-01A UC-PRG030-01A	USB cable	 Unit: mm (inch)

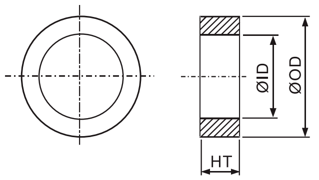
Model number	L	
	mm	inch
UC-PRG015-01B	1500 ± 100	59 ± 4
UC-PRG030-01B	3000 ± 100	118 ± 4

Model number	L	
	mm	inch
UC-PRG015-01A	1500 ± 100	59 ± 4
UC-PRG030-01A	3000 ± 100	118 ± 4

B.11 B3 / B2 conversion cable

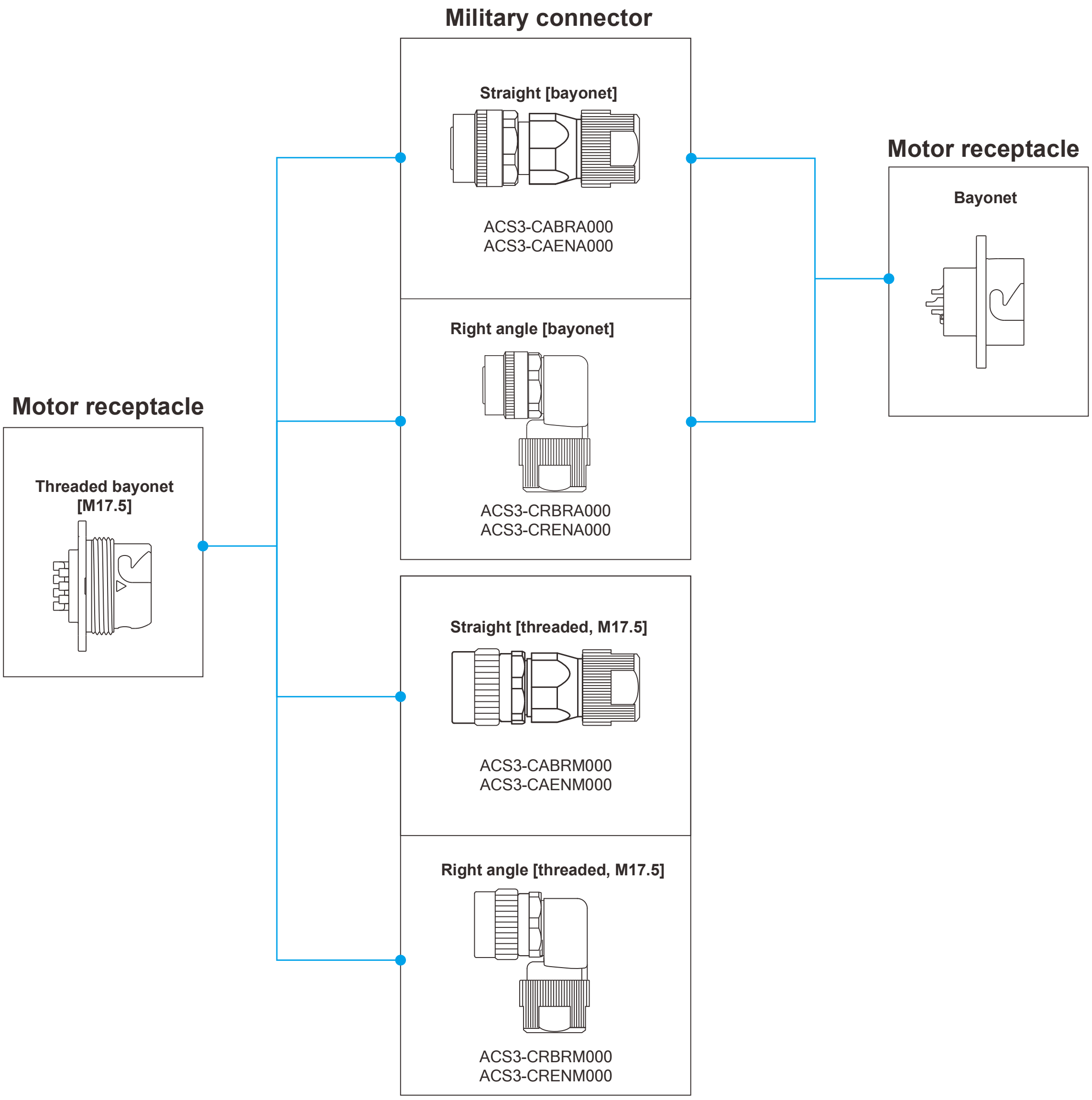
Model number	Description	Illustration
ACS3-CABDC1	CN1 conversion cable (applicable for -L models only)	 Unit: mm (inch)
ACS3-CABDC2	CN2 conversion cable	 Unit: mm (inch)

B.12 Ferrite ring

Model number	Description	Illustration
ASD-ACFC7K00	For suppressing high-frequency interference signals	

Item	mm (inch)
ΦOD (outer diameter)	68.0 ± 0.6 (2.68 ± 0.02)
ΦID (inner diameter)	44.0 ± 0.6 (1.73 ± 0.02)
HT (height)	13.5 ± 0.5 (0.53 ± 0.02)

B.13 Selection of brake / encoder connectors or cables for F100 - F180 motors



Revision History

Release date	Version	Chapter	Revision contents
January, 2025	V10.0 (Tenth edition)		Removed the numbers in the motor / encoder model number frames (☐) and the related notes. Added contents of 400V servo drives: ASD-B3☐-4043-☐ (4 kW) / ASD-B3☐-8043-☐ (8 kW)
		Preface	Added the section “Certification information”.
		1.1	Changed the section name from “Components of the servo set” to “Items to check after unpacking”.
		1.2.1	Added a figure for nameplate information. Changed the layout of the nameplate. Updated the specifications on the nameplate. Updated the serial number description.
		1.2.2	Added the Dynamic brake (hardware) function and related descriptions.
		1.3	Optimized the tables of servo drives and applicable motors.
		2.5	Added the circuit breaker, magnetic contactor and fuse specifications of control power supply. Modified the fuse specifications of main circuit power supply (R, S, T) for 220V 2 kW / 3 kW and 400V 7.5 kW models. Added the Maximum fault loop impedance tables.
		2.8	Only provide the Maximum regenerative energy that can be absorbed by the capacitor Ec (joule) for calculation based on different configurations. Modified the steps and example for regenerative resistor capacity calculation.
		2.9	Added descriptions for the figure of Wiring of the electromagnetic brake. Modified the motor model in the example of brake’s current calculation.

Release date	Version	Chapter	Revision contents
January, 2025	V10.0 (Tenth edition)	2.10	Added precautions for the use of cable.
		3	Optimized the connector specification tables. Modified the terms for consistency: V-REF → V_REF T-REF → T_REF
		3.1.4.5	Added the section “F100 - F180 motors – Brake connectors”.
		3.1.6.2 3.1.6.3	Updated the cable specifications.
		3.1.6.5 3.1.7.1	Updated the connector tables.
		3.1.7.4	Added the section “F100 - F180 motors – Brake / Encoder connectors".
		3.4.2	Added the section “F100 - F180 motors – Encoder cables”.
		3.8	Added the STO function description for TÜV SÜD.
		6	Modified the short names of dual modes.
		8	Modified the descriptions for parameters: P0.049, P1.003, 1.044, P1.045, P1.052, P1.053, P1.098, P1.112, P2.008, P2.027, P2.030, P2.047, P2.068, P2.069, P2.070, P2.121, P3.012, P3.019, P4.024, P4.027, P5.003, P5.004 Modified the setting range for parameters: P0.002, P0.017 - P0.021, P0.045, P2.047, P2.112 Modified the default for parameters: P2.023, P2.043, P2.045, P2.098, P2.101 Added the parameters: P2.123, P3.013 Modified the description for monitoring variable: 006 Added the monitoring variable: -248
		8.2	Removed the section ”List of parameters”.
		9.3	Modified the descriptions of Example 1 & 3 about the maximum allowable number of data for one read action.

Release date	Version	Chapter	Revision contents
January, 2025	V10.0 (Tenth edition)	10.1	Added 3 points of Precautions. Removed the supplier information from battery specifications and the battery accessories.
		10.2.1	Removed the wiring description of dual battery box. Removed the pin assignment of CN2 connector.
		10.2.2 10.3.4.2 10.3.5.2	Optimized the descriptions.
		10.3.4.4	Added the section “Establishing the absolute origin position with Homing methods of P1.001.X = C”.
		10.4	Removed the section “Parameters, DI/DO, and alarms related to absolute function”.
		11 & 12	Modified the diagrams of OD 6098h (Homing method).
		13	Modified the contents and function descriptions of the signals. Modified the descriptions and notes of the telegrams and functions. Added the supplementary telegram - Siemens telegram 750
		13.1.5	Added the parameter functions of setting P3.012 = 0x000. Added the parameter function: Origin definition. Added the description of P2.068.
		13.4.1	Added new PZD descriptions.
		table13.4.2	Divided the “STW1 control word 1” into sections “for telegram 1” and “for telegrams 3, 102 and 105”. Added sections “STW2 control word 2” and “G1_STW encoder 1 control word”.
		13.4.3	Divided the “ZSW1 status word 1” into sections “for telegrams 1, 3, 102, 105” and “for telegram 111”. Added sections “ZSW2 status word 2” and “G1_ZSW encoder 1 status word”.

Release date	Version	Chapter	Revision contents
January, 2025	V10.0 (Tenth edition)	13.5.1 13.5.2 13.5.3	Updated the architecture figures.
		13.5.3	Added the MC function blocks to the “Motion command planning” section: MC_Stop, MC_TorqueLimiting, MC_TorqueRange.
		13.5.4	Added the section ”Supplementary telegram 750 (torque limits)”.
		13.5.5	Modified the step descriptions.
		13.6.4	Modified the diagrams of PNU10 (Homing method). Modified the descriptions of parameters. Removed the parameters PNU20 - PNU22. Added the parameters PNU23 - PNU26, PNU30, PNU32 - PNU47.
		13.7	Added the mapping data Added and modified the descriptions of troubleshooting.
		14	Modified the description for alarms: AL001, AL005, AL006, AL016, AL02C, AL02F, AL033, AL06B, AL085, AL086.
		A.1.1.1 A.1.1.2	Added the pollution degree, TT power system, and notes.
		A.2 A.3	Removed the model explanations.
		A.2.1.1 A.2.1.2	Modified the brake related specifications of B3M-C☐0807, B3M-C☐0810, B3M-J☐0807.
		A.2.5.1 A.2.5.2	Modified the exterior diagrams of F130 motors (medium & high inertia).
		B	Optimized the layout and sequence of sections. Changed the “Military connector” to “Military connector [bayonet]”, and added “Military connector [threaded, M17.5]”.
		B.3	Added the section “Power conversion cable / counterpart connector (for motors with bulkhead receptacles)”.

Release date	Version	Chapter	Revision contents
January, 2025	V10.0 (Tenth edition)	B.6	Added the section “Encoder conversion cable / counterpart connector (for motors with bulkhead receptacles)”.
		B.7	Combined the Battery box cable section (originally Section B.6) into Section B.7 Battery box.
		B.13	Added the section “Selection of brake / encoder connectors or cables for F100 - F180 motors”.
		B.18	Removed the section “Optional accessories”.
October, 2023	V9.0 (Ninth edition)		Added the ECM-B3H-C□0602, ECM-B3H-C☐0604, and ECM-B3H-C☐0807 motors. Modified the terms for consistency: The terms “quick connector” and “9-pin connector” are changed to “standard connector”. The term “IP67 waterproof connector” is changed to “CHOGORI connector”. The term “IP67 waterproof military connector” is changed to “military connector”.
		Preface	Added the section of Disposal instructions and information about the replacement of motor parts.
		1.1.4	Added the B3A-P models.
		2.4.2	Removed the warning for motor installation.
		3.1.4.1	Modified the model numbers of the CHOGORI connectors. Added the specification for the bulkhead power connectors.
		3.1.4.2 to 3.1.4.4 3.1.5.2	Updated the recommended brands and model numbers for the F100 - F180 motor brake connectors and added the model numbers of recommended contacts.
		3.1.5.1	Added the specification of the bulkhead encoder connectors for the F40 - F80 motors.
		3.1.5.2	Updated the encoder connection diagram.
		3.1.6.2	Added the encoder cable specification for the motors with bulkhead connectors.

Release date	Version	Chapter	Revision contents
October, 2023	V9.0 (Ninth edition)	3.1.6.3	Added the power cable specification for the motors with bulkhead connectors.
		3.1.6.5	Added the wire diameters for the attached terminals of Delta connectors.
		3.1.7.1	Added the diameters of rubber rings and tightening torques for the bulkhead connectors.
		3.1.7.2	Added the wiring instructions for the bulkhead connectors.
		3.4 10.2.1	Added the pin assignment for the bulkhead connectors of the encoder cables.
		3.10.3 to 3.10.5	Added the standard wiring diagrams for B3A-P series drives.
		3.10.9	Added the standard wiring diagram for the PROFINET communication mode.
		6.1	Added the PROFINET communication mode.
		8.3	Modified the description for parameters: P0.056 - P0.061, P1.000, P1.001, P1.034 - P1.036, P1.044 - P1.046, P2.010 - P2.022, P2.052, P2.066, P2.068, P2.069, P2.107, P2.112, P2.121, P3.000, P3.001, P3.009, P3.011, P3.012, P4.010, P4.044, P6.002, P6.070, P6.099, P7.097 Modified the description for DIs: 0x06, 0x1F, 0x14, 0x15, 0x16, 0x17
		12.3.8	Corrected the description for Touch Probe Example 1.
		13	Added the chapter: PROFINET mode.
		14	Removed the alarms AL012 and AL095. Modified the description for alarms: AL283, AL285, AL3CF
		A.1.1.1 A.1.1.2	Modified the E-Gear ratio.
		A.2.5.2	Removed the B3M-J□0604 motor.
		B.1.1	Added the bulkhead power connectors.
		B.2.1	Added the power cables for motors with bulkhead connectors.
		B.3.1	Added the bulkhead encoder connectors.

Release date	Version	Chapter	Revision contents
October, 2023	V9.0 (Ninth edition)	B.4.1 B.5.1	Added the encoder cables for motors with bulkhead connectors.
		B.18	Updated the lists of optional accessories.
April, 2023	V8.0 (Eighth edition)		Added descriptions for the B3A-P model. Modified the terms: The term “brake resistor” is changed to” regenerative resistor”. The term “brake unit” is changed to “power regenerative unit”. STO_A is changed to SF1. STO_B is changed to SF2. Modified the minimum N/M value of E-Gear ratio. Added the specification for bulkhead connectors. Updated the model number for connectors.
		1.2.2	Updated the model type table for ASDA-B3 servo drive.
		1.3.1 1.3.2	Modified the max. torque for ECM-B3 series servo motor.
		2.8	Modified the model number and rotor inertia for 400V motors.
		3	Modified the precautions for connecting the external power when the source for the pulse input is open collector.
		3.1.6.3	Divided the power cable specifications for F40 - F80 motors into two sections: 220V and 400V series.
		3.3.2	Added the section: Communication type models (B3A-P model).
		3.7.3	Added the section: Wiring for the PROFINET communication connector.
		5	Updated the screenshots of ASDA-Soft.
		7	Updated the priority for high-speed position capture triggering (CAP).
		7.1.3.1	Modified the description for referencing the falling edge of the ORG signal.
		7.2.1	Modified the values of example 2 in Table 7.2.1.2.

Release date	Version	Chapter	Revision contents
April, 2023	V8.0 (Eighth edition)	8	Modified the control mode for P2.104. Modified the names for parameters: P2.105, P2.106, P3.000, P5.076. Modified the description for parameters: P0.009, P0.025, P0.035, P1.001, P1.038, P1.039, P1.045, P1.049, P1.057, P1.063, P1.076, P1.097, P1.098, P2.027, P2.028, P2.029, P2.043, P2.045, P2.047, P2.065, P2.069, P2.094, P2.105, P2.112, P2.121, P2.125, P3.000, P3.012, P3.018, P3.022, P4.005, P4.007, P5.003, P5.007, P5.010, P5.016, P5.020, P5.039, P5.097, P6.000, P6.002. Added the parameters: P2.113, P2.114. Modified the description for DIs: 0x03, 0x05, 0x1F, 0x18, 0x19, 0x20, 0x47. Modified the description for DOs: 0x10, ABSR, ABSD. Modified the name for monitoring variables: 042, 081, 084. Modified the description for monitoring variables: 005, 007, 018, 028, 033, 042, 082, 112, 113, 120.
		9.4	Modified the descriptions according to Chapter 8.
		11 & 12	Modified the object function description for OD 606Fh. Modified the unit of OD 6075h. Modified the maximum setting range of OD 6099h. Updated the description and added methods 36 - 39 for OD 6098h (Homing method).
		11.1.2	Updated the descriptions according to Section 3.5.2.
		12.1.1	Updated the descriptions according to Section 3.7.2.
		12.1.3	Updated the description for the parameters according to Chapter 8.

Release date	Version	Chapter	Revision contents
April, 2023	V8.0 (Eighth edition)	12.5.2	Updated the descriptions according to Chapter 13. Deleted error code for AL087. Added error codes for AL095, AL09F, ALC31 and ALCDB.
		13	Modified the name and description for alarms: AL031, AL053. Modified the description for alarms: AL002, AL017, AL045, AL111 - AL113, AL121 - AL132, AL170, AL180, AL185, AL186, AL201, AL301 - AL305, AL3E1 - AL3E3, AL401, AL500, AL510. Added the alarms: ALC31, ALCDB.
		A.2	Deleted the descriptions for ECM-B3M-J$\boxed{2}$ 0604.
		A.2.1.1	Modified the specification for ECM-B3M-C$\boxed{2}$ 0810.
		A.2.2.1	Modified the specification for ECM-B3H-F$\boxed{2}$ 1318$\boxed{3}\boxed{4}\boxed{5}$.
		A.2.2.2	Modified the specification for ECM-B3H-L$\boxed{2}$ 1318$\boxed{3}\boxed{4}\boxed{5}$.
		A.2.5.1	Added the section: Motor frame size: 80 mm and below (with bulkhead connectors).
		A.2.5.2	Modified the model numbers for motors with the frame size of 180 mm.
		B	Updated the sections and contents for Appendix B.
May, 2022	V7.0 (Seventh edition)	1 3.5.2	Added the information of B3□-M.
September, 2021	V6.0 (Sixth edition)	-	B3A series models has acquired the TUV certificate.
		1	Corrected the colors of the V and W connectors in the servo drive diagrams.
		13	Added alarms: AL02F, AL033, and AL09F.
		A	Modified the vibration specifications. Added the QR code for downloading the CE certificate.

Release date	Version	Chapter	Revision contents
August, 2021	V5.0 (Fifth edition)	1.3	Added the information of 750W motor corresponding to the 1 kW servo drive
		3.3.7	Added the maximum input pulse frequency specifications for differential signals Added the diode specification when an inductive load is connected to the drive for DO wirings.
		8.3	Added the parameter description for P1.000.
		12	Modified the trigger conditions, causes, and troubleshooting methods for alarms: AL009, AL018, AL020, AL028, AL044, AL060, AL062, AL06A, AL072, AL083, AL086, AL08A, AL099, AL129, AL237, AL303, AL3E3, and AL400. Added alarms: AL02A, AL02B, AL032, AL036, AL048, AL064, AL066, AL06B, AL06E, AL06F, AL071, AL07A, AL09C, AL0A6, AL113, AL211, AL219, AL422, AL510, and AL520
		13	New chapter: added the EtherCAT information.
		A.1.1	Modified the 750W servo drive specification: the maximum instantaneous output current is 14.14 Arms. Modified the maximum input pulse frequency for differential signals (A phase + B phase). Modified the input current specification. Added the inrush current specification for the main circuit power supply. Added the input current and inrush current specifications for the control power supply. Changed the descriptions in the DI / DO fields into the quantity of input / output points.
		A.1.1	Added the note for notifying that the B3A model is TUV certified.
		A.1.2	The tightening torque information is moved to Chapter 3.

Release date	Version	Chapter	Revision contents
August, 2021	V5.0 (Fifth edition)	A.2	Added the descriptions for encoder types and special codes.
		A.2.1	Added the operating voltage for the brake. Modified the operating and storage temperatures of the B3 motors.
		A.2.2	Added the torque feature (T-N curves) for using ECM-B3M-C$\boxed{2}$0807$\boxed{3}\boxed{4}\boxed{5}$ with ASD-B3$\boxed{1}$-0721-$\boxed{2}$.
		A.2.7	Updated the graphs and tables of load and operating time.
		A.3.3	Added the torque feature (T-N curve) for using ECM-A3L-C$\boxed{2}$0807$\boxed{3}\boxed{4}\boxed{5}$ with ASD-B3$\boxed{1}$ -0721-$\boxed{2}$. Added the torque feature (T-N curve) for using ECM-A3H-C$\boxed{2}$0807$\boxed{3}\boxed{4}\boxed{5}$ with ASD-B3$\boxed{1}$ -0721-$\boxed{2}$.
February, 2021	V4.0 (Fourth edition)	3.1.6	Added the unit of mm^2 for the wire diameter. Changed the UVW terminal selection information for the 2 kW and 3 kW models.
December, 2020	V3.0 (Third edition)	3, 10, B	Changed the term of torsion-resistant cable to flexible cable.
July, 2020	V2.0 (Second edition)	3.3.7	Optimized the pulse input wiring diagram.
		3.4	Added the warning messages. Added CN2 pin descriptions.
		3.10	Added the standard wiring diagram for open-collector pulse signals. Optimized the wiring diagram for differential pulse signals. Added CN2 pin descriptions.
		10.2.1	Added the warning messages. Added CN2 pin descriptions.
November, 2019	V1.0 (First edition)	-	-

For relevant information about [ASDA-B3], please refer to:

(1) ASDA-B2 User Manual

(2) ASDA-A3 User Manual

(3) ASDA-A2 User Manual

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