E1 Series Servo Drive

User Manual

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MD09UE01-2112_V2.2

Revision History

The version of the manual is also indicated on the bottom of the front cover.

MD09UE01-2112_V2.2

Version

Release Date

Release Date	Version	Applicable Product	Revision Contents
Dec. 30th, 2021	2.2	E1 series servo drive	1. Update **Approvals**. 2. Update section 2.2 **Servo drive and servo motor combination**. 3. Update section 3.1.2 **Model explanation.** 4. Update section 4.1.3 **Power specification.** 5. Update section 4.4 **Selecting no-fuse breaker (NFB)**. 6. Update section 5.2.3 **Power terminal suggested wire size**. 7. Update section 5.3.2 **400 V input power**. 8. Add section 7.5.4 **Analog Hall**. 9. Update section 8.13 **Setting position trigger function.** 10. Update section 8.16.1 **Full-closed loop control**. 11. Add section 10.7.6 **Gain multiplier**. 12. Update section 11.3.2 **Scope and data collection**. 13. Update section 13.2.1 **Alarm list**. 14. Update section 13.2.2 **Causes and corrective actions for alarms**. 15. Update section 15.2.1 **Parameters for setting basic function (Pt0XX)**. 16. Update section 15.2.2 **Parameters for tuning (Pt1XX)**. 17. Update section 15.2.5 **Torque-related parameters (Pt4XX)**. 18. Update section 15.2.8 **Parameters for internal homing (Pt7XX)**. 19. Update section 16.1.6 **Communication cable**. 20. Update section 16.2.3 **Power supply filter and accessories**.
Oct. 15th, 2021	2.1	E1 series servo drive	1. Update section **Approvals.** 2. Update section 3.5.1 **ESC hardware**. 3. Update section 4.1.3 **Power specification.** 4. Update section 8.11.1 **Setting internal homing.** 5. Update section 8.13 **Setting position trigger function.** 6. Update section 8.16.5 **Setting motor rotation direction and load moving direction.** 7. Update section 10.7.4 **P/PI mode switching selection.** 8. Update section 16.2.5 **Regenerative resistor**

Preface

This manual aims to assist users to operate E1 series servo drive. The contents in this manual, including manual preface, evaluation of mechanism design, precautions for electrical planning, software setting, operation and troubleshooting, are arranged in accordance with the procedure of configuring a machine. Carefully read through this manual to correctly operate E1 series servo drive.

Approvals

Servo Drive Model	Approvals		
	EU Directives		UL Approval
	EMC Directives IEC / EN 61800-3: 2004/A1: 2012 (Category C3)	Low-voltage Directives IEC / EN 61800-5-1:2007 (PD2, OVC III)	UL 61800-5-1 CSA C22.2 No. 274-17
ED1□-□□-0422-□□	CE		cULus
ED1□-□□-1022-□□			
ED1□-□□-2032-□□			N/A

Note:

EN: Europischen Normen = European standard

Servo Drive Model	Approvals		
	EU Directives		UL Approval
	EMC Directives EN 61800-3:2018 IEC 61800-3: 2017 BS EN 61800-3: 2018 (Category C3)	Low-voltage Directives EN 61800-5-1: 2007+ A1:2017 IEC 61800-5-1: 2007 + A1:2016 BS EN 61800-5-1: 2007; A1: 2017+A11: 2021 (PD2, OVC III)	UL 61800-5-1 CSA C22.2 No. 274-17
ED1□-□□-0422-□□-□□	CE UKCA		cULus
ED1□-□□-0522-□□-□□			
ED1□-□□-1022-□□-□□			
ED1□-□□-1222-□□-□□			
ED1□-□□-2032-□□-□□			
ED1□-□□-4032-□□-□□			
ED1□-□□-5033-□□-□□			N/A
ED1□-□□-7533-□□-□□			

Note：

EN: Europischen Normen = European standard

CE refers to European standards.

(Publication of harmonised standards under Union harmonisation legislation)

IEC: International Electrotechnical Commission

UKCA: UK Conformity Assessed

The Certificate and the Declaration of Conformity can be downloaded from the HIWIN MIKROSYSTEM CORP. website. (https://www.hiwinmikro.tw/en/download)

Content	Item	
STO (Safe Torque Off)	IEC 61508 Parts 1-7: 2010 IEC 61800-5-2: 2016 IEC 62061: 2015 ISO 13849-1: 2015 IEC 60204-1: 2016 (in extracts)	TÜVRheinland® CERTIFIED Functional Safety www.tuv.com ID 0600000000

	Item			
	EU Directives		Federal Communications Commission	
Excellent Smart Cube (ESC) Model	EMC Directives IEC / EN 61800-3: 2004/A1: 2012 (Category C3)	Low-voltage Directives IEC / EN 61800-5-1:2007 (PD2 ,OVC III)	Conducted Emission ANSI C63.4-2014, FCC Part 15 Subpart B, KDB174176 CISPR PUB. 22	Radiated Emission ANSI C63.4-2014, FCC Part 15 Subpart B, KDB174176 CISPR PUB. 22
ESC-□□-□□□	CE		FC	

General Precautions

Before using the product, please carefully read through this manual. HIWIN Mikrosystem (HIWIN) is not responsible for any damage, accident or injury caused by failure in following the installation instructions and operating instructions stated in this manual.

- Do not disassemble or modify the product. The design of the product has been verified by structural calculation, computer simulation and actual testing. HIWIN is not responsible for any damage, accident or injury caused by disassembly or modification done by users.
- Before installing or using the product, ensure there is no damage on its appearance. If any damage is found after inspection, please contact HIWIN or local distributors.
- Carefully read through the specification noted on the product label or technical document. Install the product according to its specification and installation instructions stated in this manual.
- Ensure the product is used with the power supply specified on the product label or in the product requirement. HIWIN is not responsible for any damage, accident or injury caused by using incorrect power supply.
- Ensure the product is used with the rated load. HIWIN is not responsible for any damage, accident or injury caused by improper usage.
- Do not subject the product to shock. HIWIN is not responsible for any damage, accident or injury caused by improper usage.
- If an error occurs in the servo drive, please refer to chapter 6 and follow the instructions for troubleshooting. After the error is cleared, power on the servo drive again.
- Do not repair the product by yourselves when it malfunctions. The product can only be repaired by qualified technician from HIWIN.

HIWIN offers 1-year warranty for the product. The warranty does not cover damage caused by improper usage (refer to the precautions and instructions stated in this manual.) or natural disaster.

⚠CAUTION

◆ Servo drive with rated input voltage 220 V or 400 V:

(1) The maximum ambient temperature must be below 45 ºC.
(2) The product can only be installed in an environment with pollution degree not exceeding 2.
(3) Before inspection, please turn off the power and wait for at least 15 minutes. To avoid electric shock, ensure the residual voltage between P and N terminals has dropped to 50 VDC or lower by using multimeter.
(4) The short circuit protection for internal circuits does not support branch circuit protection. Branch circuit protection must be implemented in accordance with the National Electrical Code and any additional local codes. Refer to the table below for the suggested fuses used in both the main input power (L1, L2, L3) and control input power (L1C, L2C) of the servo drive.

Servo Drive Model	Suggested Model	BCP Fuse Class	BCP Fuse Rating
ED1□-□□-0422	Littelfuse / JLLN006.T	Class T	300 V, 6 A
ED1□-□□-0522			
ED1□-□□-1022	Littelfuse / JLLN015.T	Class T	300 V, 15 A
ED1□-□□-1222			
ED1□-□□-2032	Littelfuse / JLLN050.T	Class T	300 V, 50 A
ED1□-□□-4032	Littelfuse / JLLN070.V	Class T	300 V, 70 A
ED1□-□□-5033	Littelfuse / JLLS040.T	Class T	600 V, 40 A
ED1□-□□-7533	Littelfuse / JLLS060.T	Class T	600 V, 60 A

(5) Suitable for circuit with maximum symmetrical short circuit current 5000 Arms and maximum 240 V.
(6) The level of motor overload protection is the percentage of full-load current. (120 % of full-load current)
(7) The servo drive does not provide motor over-temperature protection.
(8) Use copper conductors of rated temperature 60/75 °C.

Safety Precautions

- Carefully read through this manual before installation, transportation, maintenance and examination. Ensure the product is correctly used.
- Carefully read through electromagnetic (EM) information, safety information and related precautions before using the product.
- Safety precautions in this manual are classified into “Warning”, “Attention”, “Prohibited” and “Required”.

Signal Word	Description
Warning	If the precaution is not observed, it is likely to cause property loss, serious injury or death.
Attention	The precaution must be observed.
Prohibited	Prohibited activity
Required	Mandatory activity

DANGER

- Ensure the servo drive is correctly grounded. Use PE bar as reference potential in control box. Perform low-ohmic grounding for safety reason.
- Do not remove the motor power cable from the servo drive when it is still power-on, or there is a risk of electric shock or damage to contact.
- Do not touch the live parts (contacts or bolts) within 15 minutes after disconnecting the servo drive from its power supply. For safety reason, we suggest measuring the voltage in the intermediate circuit and wait until it drops to 50 VDC.

- Operation

Warning	◆ Do not touch the terminals or internal parts of the product when power on, or it may cause electric shock. ◆ Do not touch the terminals and internal parts of the product within fifteen minutes after power off, or the residual voltage may cause electric shock. ◆ Do not modify wiring when power on, or it may cause electric shock. ◆ Do not damage, apply excessive force to, place heavy object on the cables. Or put the cables between two objects. Otherwise, it may cause electric shock or fire.
Attention	◆ Do not use the product in location which is subject to humidity, corrosive materials, flammable gas or flammable materials.

- Storage

Prohibited	◆ Do not store the product in location which is subject to water, water drop, harmful gas, harmful liquid or direct sunlight.

■ Transportation

Attention	◆ Carefully move the product to avoid damage. ◆ Do not apply excessive force to the product. ◆ Do not stack the products to avoid collapse.

■ Installation site

Required	◆ Do not install the product in location with high ambient temperature and high humidity or location which is subject to dust, iron powder or cutting powder. ◆ Install the product in location with ambient temperature stated in this manual. Use cooling fan if the ambient temperature is too high. ◆ Do not install the product in location which is subject to direct sunlight. ◆ The product is not drip-proof or waterproof, so do not install or operate the product outdoor or in location which is subject to water or liquid. ◆ Install the product in location with less vibration. ◆ Motor generates heat while running for a period of time. Use cooling fan or disable the motor when it is not in use, so the ambient temperature will not exceed its specification.

■ Installation

Attention	◆ Do not place heavy object on the product, or it may cause injury. ◆ Prevent any foreign object from entering the product, or it may cause fire. ◆ Install the product in the specified orientation, or it may cause fire. ◆ Avoid strong shock to the product, or it may cause malfunction or injury. ◆ While installing the product, take its weight into consideration. Improper installation may cause damage to the product. ◆ Install the product on noncombustible object, such as metal to avoid fire.

■ Wiring

Attention	◆ Ensure wiring is correctly performed. Otherwise, it may lead to product malfunction or burn-out. There could be a risk of injury or fire. ◆ The peripheral devices, including controller, must share the same power supply system with the servo drive. Otherwise, the voltage difference between the devices and the servo drive could result in burn-out.

■ Operation and transportation

Attention	◆ Use power supply specified in product specification, or it may cause injury or fire. ◆ The product may suddenly start to operate after power supply recovers. Please do not get too close to the product.
Required	◆ Set external wiring for emergency stop to stop the motor at any time.

■ Maintenance

Prohibited	◆ Do not disassemble or modify the product. ◆ If the product malfunctions, do not repair the product by yourselves, please contact HIWIN for repair.

Chapter Overview

Chapter	Title	Contents
1	E1 series servo motor	This chapter introduces servo motor models.
2	E1 series servo drive	This chapter introduces servo drive models and regenerative resistor selection.
3	Excellent Smart Cube (ESC)	This chapter provides model explanation of Excellent Smart Cube (ESC).
4	Specification	This chapter provides specification, dimensions and installation instructions of the servo drive.
5	Electrical planning	This chapter provides wiring precautions and connector introduction.
6	Basic function settings before operation	This chapter describes basic functions which need to be set before operation.
7	Software settings and trial operation	This chapter describes how to do servo drive settings via Thunder.
8	Application function	This chapter provides introduction of general-purpose digital inputs, general-purpose digital outputs, control mode settings and full-closed loop function.
9	Trial operation when connected to controller	This chapter describes parameters which need to be set when connected to controller.
10	Tuning	This chapter describes servo tuning tools.
11	Monitoring	This chapter describes servo drive status, I/O status and physical quantity monitoring.
12	Safety function	This chapter describes the supported safety function.
13	Troubleshooting and maintenance	This chapter describes servo drive alarms and troubleshooting.
14	Panel operation	This chapter describes functions and operation of the servo drive panel.
15	Parameters	This chapter provides function parameters and parameter numbers.
16	Appendix	This chapter provides the required accessories for servo drive setup.

Table of Contents

1. E1 series servo motor

1.1 Model explanation of servo motor (AC)

The model explanation of E1 series servo motor is provided in table 1.1.1. Refer to the catalogue of EM1 servo motor if detailed motor parameters are needed for evaluation of machine design.

Table1.1.1

Code	1	2	3	-	4	-	5	-	6	7	-	8	-	9	-	10	-	11	-	12
Example	E	M	1	-	A	-	M	-	0	5	-	2	-	B	-	E	-	0	-	A
1, 2, 3: E1 Series Servo Motor	EM1																			
4: Rated Velocity/Maximum Velocity (rpm)	A = 2000/3000 C = 3000/6000 D = 2000/5000																			
5: Inertia	M = Medium inertia																			
6, 7: Rated Power Output	05 = 50 W 10 = 100 W 20 = 200 W 40 = 400 W 75 = 750 W 1K = 1000 W 1A = 1200 W 2K = 2000 W																			
8: AC Voltage	2 = 220 V 4 = 400 V																			
9: Brake	0 = Without brake B = With brake																			
10: Serial Encoder	E = 23 bit incremental (Battery is not required.) F = 23 bit multi-turn absolute (Battery is required.)																			
11: Reserved	0 = Standard 1 = Customized																			
12: Shaft Type	A = Round shaft/without oil seal B = Round shaft/with oil seal C = With key/without oil seal D = With key/with oil seal																			

2. E1 series servo drive

2.1 Model explanation of servo drive

2.1.1 Nameplate

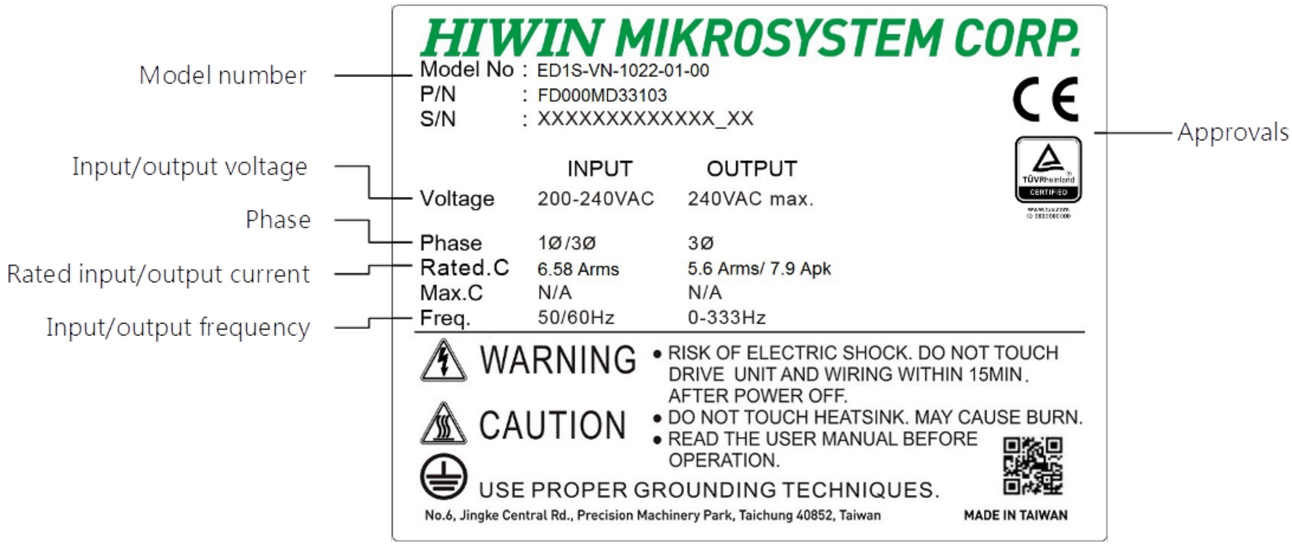


Figure2.1.1.1

2.1.2 Model explanation

The model explanation of E1 series servo drive is provided in table below. For detailed functions of the servo drive, please refer to this manual.

Table2.1.2.1

Code	1	2	3	4	-	5	6	-	7	8	9	10	-	11	12	-	13	14
Example	E	D	1	S	-	V	G	-	0	4	2	2	-	0	1	-	0	0
1, 2, 3: E1 Series Servo Drive	ED1																	
4: Type	S = Standard								F = Fieldbus									
5: Control Interface	V = Voltage command and pulse								E = EtherCAT H = mega-ulink (For HIMC motion controller or API/MPI library) L = MECHATROLINK III P = PROFINET									
6: Special Function	G = Gantry N = No special function																	
7, 8: Rated Output	04 = 400 W 05 = 500 W 10 = 1 kW 12 = 1.2 kW 20 = 2 kW 40 = 4 kW 50 = 5 kW 75 = 7.5 kW																	
9: AC Phase	2 = Single/Three-phase (For 400 W/500 W/1 kW/1.2 kW model) 3 = Three-phase (For 2 kW/4 kW/5 kW/7.5 kW model)																	
10: AC Power	2 = 110 V/220 V (100 Vac ~ 240 Vac) 3 = 400 V (380 Vac ~ 480 Vac)																	
11:Applicable Category	0 = AC, LM, DM and TM A = AC only T = GT																	
12: Reserved	1 = STO function security approval																	
13、14：Reserved	Reserved																	

Note：

(1) Servo drive model no. 12 digits(ED1□-□□-□□□□-□0): STO function without security approval.

(2) Servo drive model no. 14 digits (ED1□-□□-□□□□-□1-□□): STO function with security approval.

(3) For the communication settings and details about fieldbus servo drive (ED1F-E), please refer to **E1 Series Servo Drive EtherCAT(CoE) Comminications Command Manual**.

(4) For the communication settings and details about fieldbus servo drive (ED1F-L), please refer to **E1 Series Servo Drive MECHATROLINK-III Communication Command Manual**.

(5) For the settings and details about gantry function servo drive (ED1□-□G), please refer to **E1 Series Servo Drive Gantry Control System User Manual**.

(6) When the 10th digit of the model number is 2 and the AC voltage is 100 ~ 120 Vac, only single phase input power can be used.

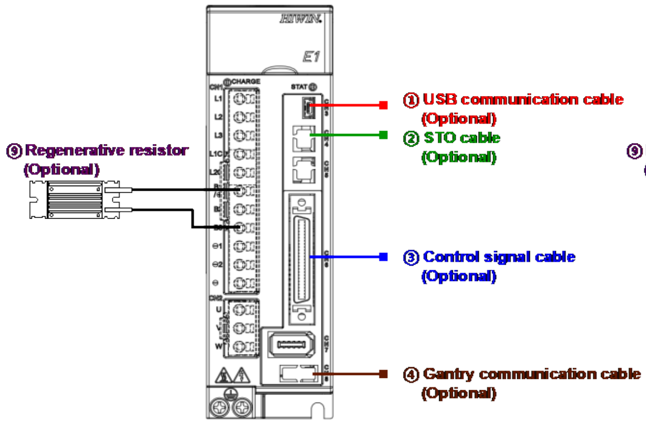
(7) 400 V servo drives (ED1□-□□-□□□3) and gantry function servo drives (ED1□-□G) only support Thunder 1.6.11.0 or later versions.

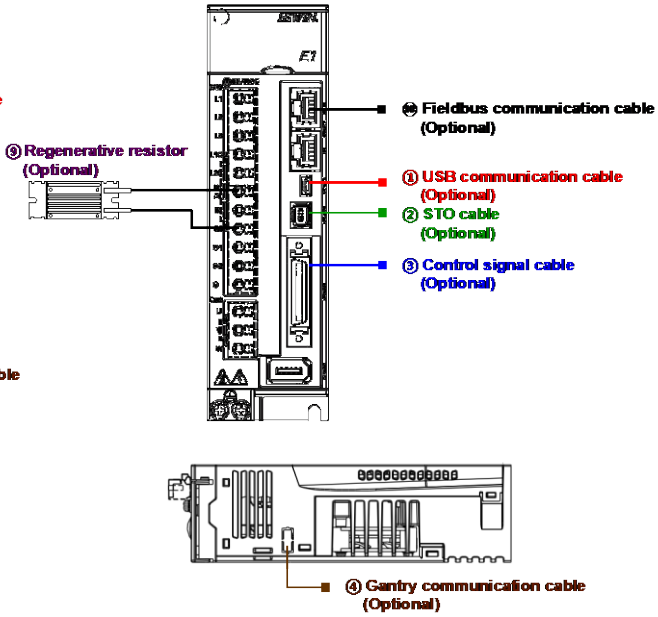
(8) If the 10^{th} digit = 2, the following drives are supported: 400 W/500 W/1 kW/1.2 kW/2 kW/4 kW. If the 10^{th} digit = 3, the following drives are supported: 5 kW/7.5 kW.

2.2 Servo drive and servo motor combination

The configuration diagrams of servo drives and cables are shown as follows.

Configuration diagram of servo drive	
Standard servo drive	Fieldbus servo drive





Note: The port of gantry communication cable for Fieldbus servo drive is on the top of servo drive.

Figure 2.2.1

The optional cables and accessories are listed in the table below.

Table 2.2.1

Cable Name	Configuration	HIWIN Part No.	Specifications
① USB communication cable	Connect servo drive and PC.	051700800366	Length 1.8 m
② STO cable	Connect servo drive and STO safety device.	HE00EJ6DH000	Length 3 m
③ Control signal cable	Connect standard servo drive via CN6.	HE00EJ6DA300	Standard 50 pin, length 3 m
	Connect Fieldbus servo drive via CN6.	HE00EJ6DC300	Fieldbus 36 pin, length 3 m
④ Gantry communication cable	Connect two servo drives which both support gantry function via CN8.	HE00EJ6DD000	Length 0.5 m
⑨ Regenerative resistor	Connect external regenerative resistor to B1 and B3 terminals of servo drive.	050100700001	68 Ohm/100 W
		050100700004	190 Ohm/1000 W
⑩ Fieldbus communication cable	Connect servo drive and host controller or other servo drive via CN9.	920200500007	Length 0.2 m

Note:

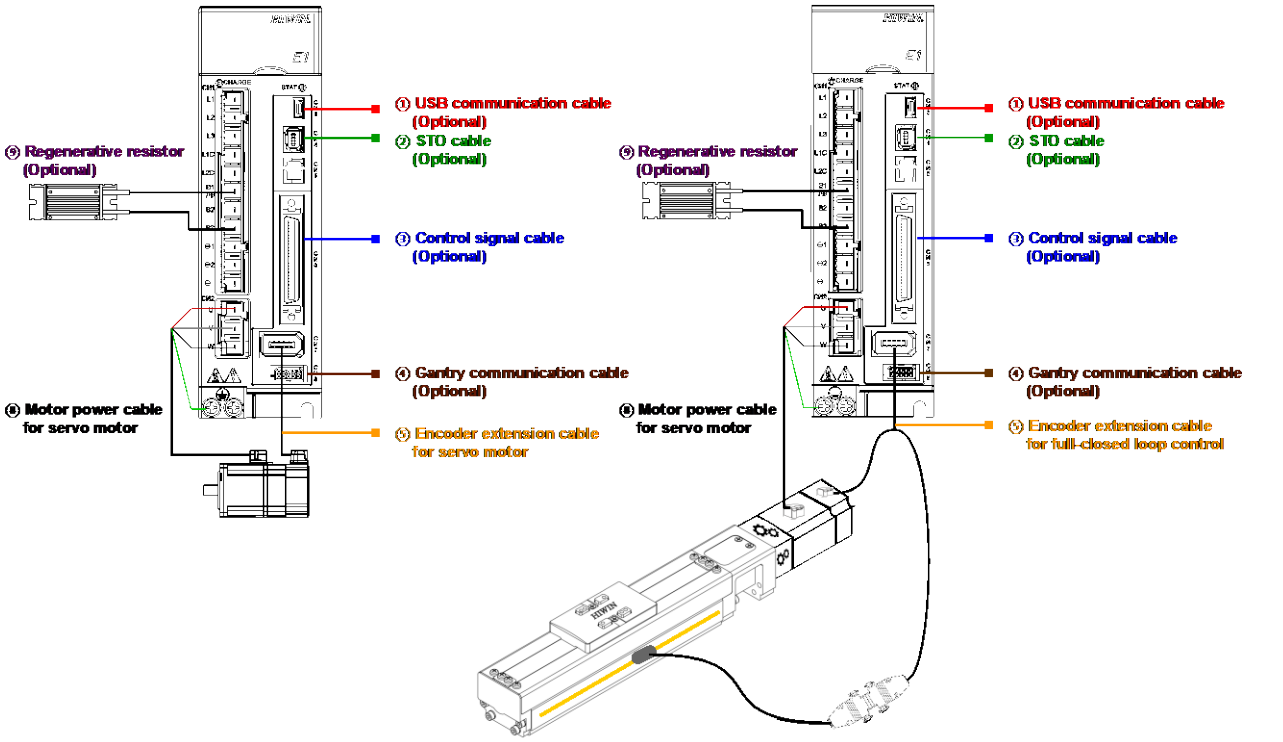
(1) Gantry communication cable is only appicable to servo drive which supports gantry function (ED1□-□G).

(2) Fieldbus communication cable is applicable to Fieldbus servo drive (ED1F) which supports EtherCAT, mega-ulink or PROFINET communication. If the communication format is MECHATROLINK-III, it cannot be used.

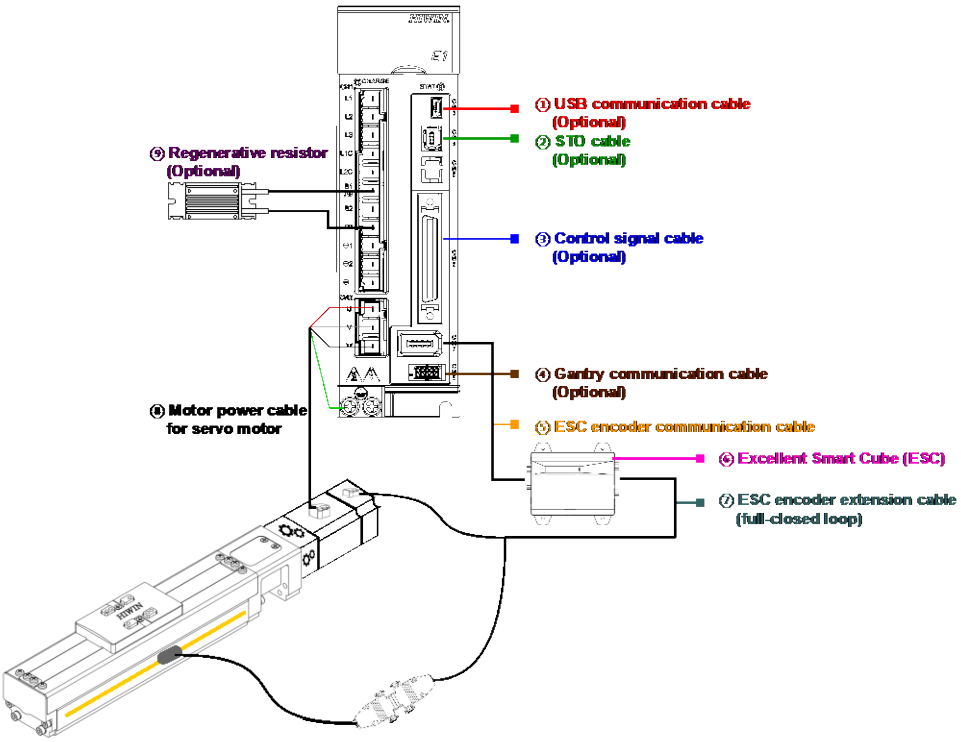
2.2.1 Servo motor (AC)

In this section, the servo motor refers to HIWIN EM1 series servo motor. EM1 series can be directly connected to servo drive for operation. Full-closed loop control is also supported. If the external encoder of full-closed loop is digital TTL, it can be directly connected to servo drive. If the external encoder is analog, BiSS-C or EnDat, Excellent Smart Cube (ESC) is required.

Configuration diagram of servo drive and servo motor	
EM1 series servo motor	Full-closed loop: EM1 motor + external encoder (Digital TTL)



Full-closed loop: EM1 motor + external encoder (Analog, BiSS-C, EnDat); ESC is required.



Note: If servo drive for AC (ED1□-□□-□□22-A□) is used, full-closed loop internal encoder only supports EM1 series AC servo motor.

Figure 2.2.1.1

The related cables to combine servo drive and motor are listed in the table below.

Table 2.2.1.1

Cable Name	Configuration	HIWIN Part No.	Specifications
⑤ Encoder extension cable for servo motor	Connect motor encoder end to servo drive via CN7.	HVE23IAB□□MB	For 50 W ~ 750 W motor, serial incremental.
		HVE23AAB□□MB	For 50 W ~ 750 W motor, serial absolute (with battery box).
⑤ Encoder extension cable for full-closed loop control		HE00817DR□00	For 50 W ~ 750 W motor, suitable for full-closed loop control.
⑤ ESC encoder communication cable	Connect communication port for ESC encoder to servo drive via CN7.	HE00EJUDA□00	-
⑥ Excellent Smart Cube (ESC)	Connect ESC encoder communication cable and ESC encoder extension cable.	FD000SCSSS01	ESC-SS-S01
⑦ ESC encoder extension cable	Connect motor encoder end to connection port for ESC encoder.	-	Select the cable according to the encoder format.
⑧ Motor power cable for servo motor	Connect motor power cable end to servo drive via CN2.	HVPS04AB□□MB	For 50 W ~ 750 W motor, without brake cable.
		HVPS06AB□□MB	For 50 W ~ 750 W motor, with brake cable.

Note:

(1) □ or □□ represents cable length. Please fill in Part No. based on cable length.

(2) For the information of applicable servo motors and cables, please refer to section 16.1.1 and 16.1.2.

The allowable combinations of servo drives and servo motors are listed in table below.

Table 2.2.1.2

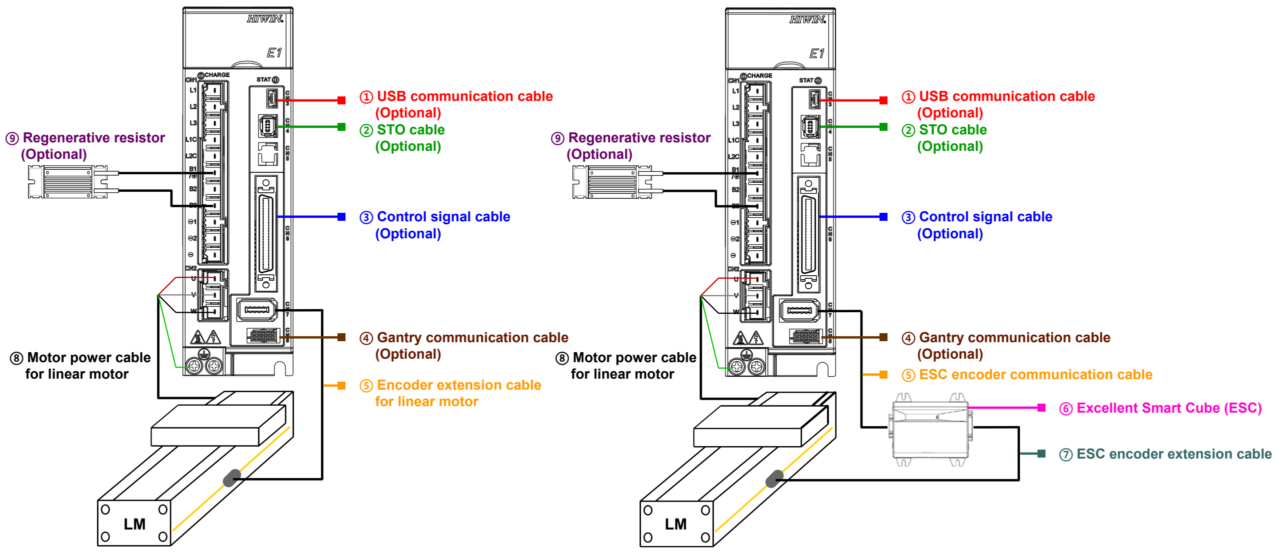
Servo Motor Model	Capacity	Servo Drive
EM1-□-□-05-2	50 W	ED1□-□□-0422-A□
EM1-□-□-10-2	100 W	
EM1-□-□-20-2	200 W	
EM1-□-□-40-2	400 W	
EM1-□-□-75-2	750 W	ED1□-□□-1022-A□
EM1-□-□-1K-2	1 kW	
EM1-□-□-1A-2	1.2 kW	ED1□-□□-2032-A□
EM1-□-□-2K-2	2 kW	

2.2.2 Linear motor (LM)

The linear motor cable configuration is different according to the encoder format. If the encoder is a digital TTL, it can be directly connected to servo drive. Excellent Smart Cube (ESC) is required when thermal sensor (PTC) or one of the following signals is used as feedback signal of linear motor.

(1) Analog (sin/cos) encoder signal
(2) EnDat encoder
(3) BiSS-C encoder
(4) Digital Hall signal (Used with analog encoder or digital encoder)

Configuration diagram of servo drive and linear motor	
Digital TTL encoder (ESC is not required)	Analog, BiSS-C, EnDat encoder (ESC is required)



Note: For the information of ESC, please refer to chapter 3.

Figure 2.2.2.1

The related cables to combine servo drive and motor are listed in the table below.

Table 2.2.2.1

Cable Name	Configuration	HIWIN Part No.	Specifications
⑤ Encoder extension cable for linear motor	Connect motor encoder end to servo drive via CN7.	HE00EJ6DF□00	For Renishaw linear digital encoder (female copper pillar)
		HE00817EK□00	For Renishaw linear digital encoder (male screw)
		HE00EJ6DB□00	The cable is with open ends.
⑤ ESC encoder communication cable	Connect communication port for ESC encoder to servo drive via CN7.	HE00EJUDA□00	-

Cable Name	Configuration	HIWIN Part No.	Specifications
⑥ Excellent Smart Cube (ESC)	Connect ESC encoder communication cable and ESC encoder extension cable.	FD000SCSSS01	ESC-SS-S01
		FD000SCANS01	ESC-AN-S01
⑦ ESC encoder extension cable	Connect motor encoder end to connection port for ESC encoder.	-	Select the cable according to the encoder format.
⑧ Motor power cable for linear motor	Connect motor power cable end to servo drive via CN2.	-	Please refer to the catalogue of linear motor.

Note:
(1) □ represents cable length. Please fill in Part No. based on cable length.
(2) For the information of cables, please refer to section 16.1.3 and 16.1.4.

The maximum velocity supported by each encoder resolution when linear digital encoder is used is listed in table below.

Table 2.2.2.2

Encoder resolution	Maximum velocity
50 nm	1 m/s
0.1 um	2 m/s
0.5 um	10 m/s
1 um	20 m/s

2.2.3 Direct drive motor (DM)

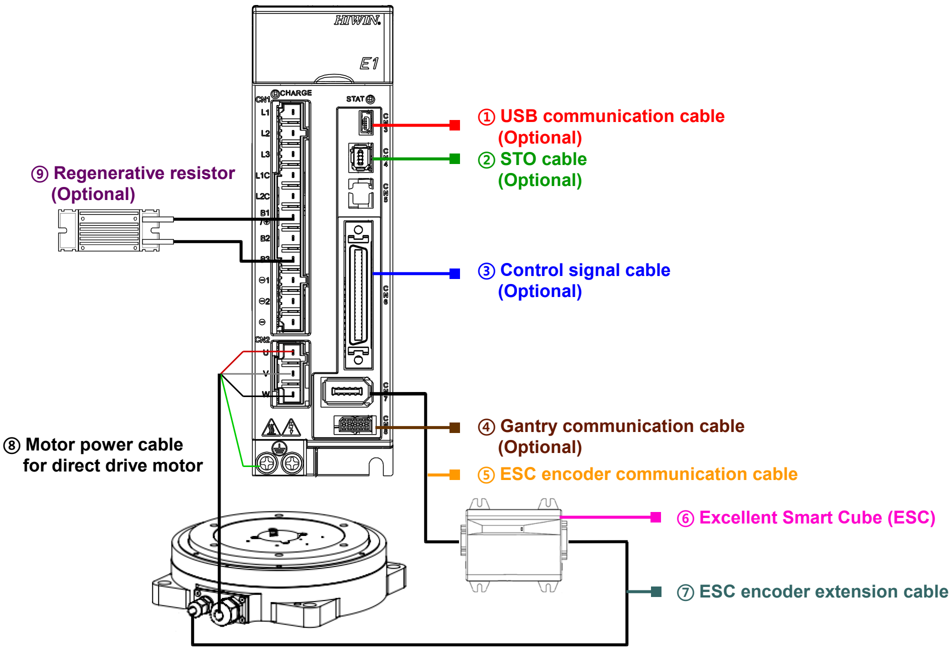
■ Direct drive motor (DM) with incremental feedback system

Excellent Smart Cube (ESC) is required when thermal sensor (PTC) or one of the following signals is used as feedback signal of direct drive motor.

(1) Analog (sin/cos) encoder signal

(2) Digital Hall signal (Optional)

Configuration diagram of servo drive and direct drive motor with incremental feedback system
ESC is required



Note: When HIWIN direct drive motor with incremental feedback system is used, ESC-AN or ESC-SS is generally used. For the information, please refer to chapter 3.

Figure 2.2.3.1

The related cables to combine servo drive and motor are listed in the table below.

Table 2.2.3.1

Cable Name	Configuration	HIWIN Part No.	Specifications
⑤ ESC encoder communication cable	Connect communication port for ESC encoder to servo drive via CN7.	HE00EJUDA□00	-
⑥ Excellent Smart Cube (ESC)	Connect ESC encoder communication cable and ESC encoder extension cable.	FD000SCSSS01	ESC-SS-S01
		FD000SCANS01	ESC-AN-S01

Cable Name	Configuration	HIWIN Part No.	Specifications
⑦ ESC encoder extension cable	Connect motor encoder end to connection port for ESC encoder.	-	Select the cable according to the encoder format.
⑧ Motor power cable for direct drive motor	Connect motor power cable end to servo drive via CN2.	HE00841001□□	For direct drive motor, without brake cable.

Note:

(1) □ or □□ represents cable length. Please fill in Part No. based on cable length.

(2) For the information of cables, please refer to section 16.1.1 and 16.1.4.

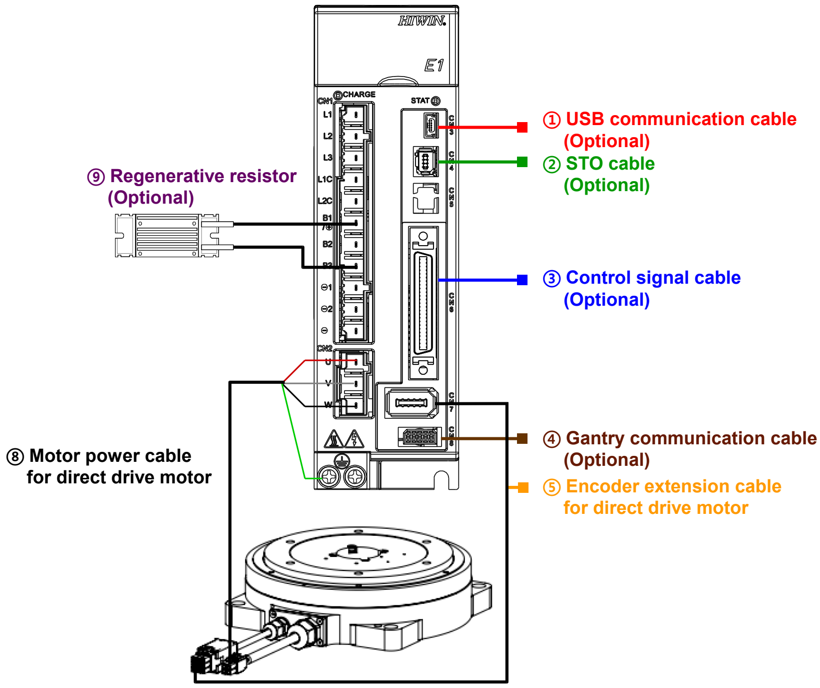
■ Direct drive motor (DM) with absolute feedback system

Excellent Smart Cube (ESC) is not required for HIWIN direct drive motor (DM) with absolute feedback system. The cable configuration is the same as servo motors and the following feedback signals can be supported:

(1) Serial signal 19 bit/rev (DM□□□-A)

(2) Serial signal 20 bit/rev (DM□□□-B)

Configuration diagram of servo drive and direct drive motor with absolute feedback system
ESC is not required



Note:

(1) When HIWIN direct drive motor with absolute feedback system is used, ESC is not required.

(2) The default values of Pt308 and Pt316 will be changed. The default setting of Pt002 is using single-turn absolute encoder. The default setting of Pt009 is enabling error map function.

Figure 2.2.3.2

The related cables to combine servo drive and motor are listed in the table below.

Table 2.2.3.2

Cable Name	Configuration	HIWIN Part No.	Specifications
⑤ Encoder extension cable for direct drive motor	Connect motor encoder end to servo drive via CN7.	HVE23IAB□□MB	For HIWIN direct drive motor with absolute feedback system, serial incremental.

Cable Name	Configuration	HIWIN Part No.	Specifications
⑧ Motor power cable for direct drive motor	Connect motor power cable end to servo drive via CN2.	HVPS04AB□□MB	For HIWIN direct drive motor with absolute feedback system, without brake cable.

Note:

(1) □□ represents cable length. Please fill in Part No. based on cable length.

(2) For the information of cables, please refer to section 16.1.1 and 16.1.2.

Table 2.2.3.3

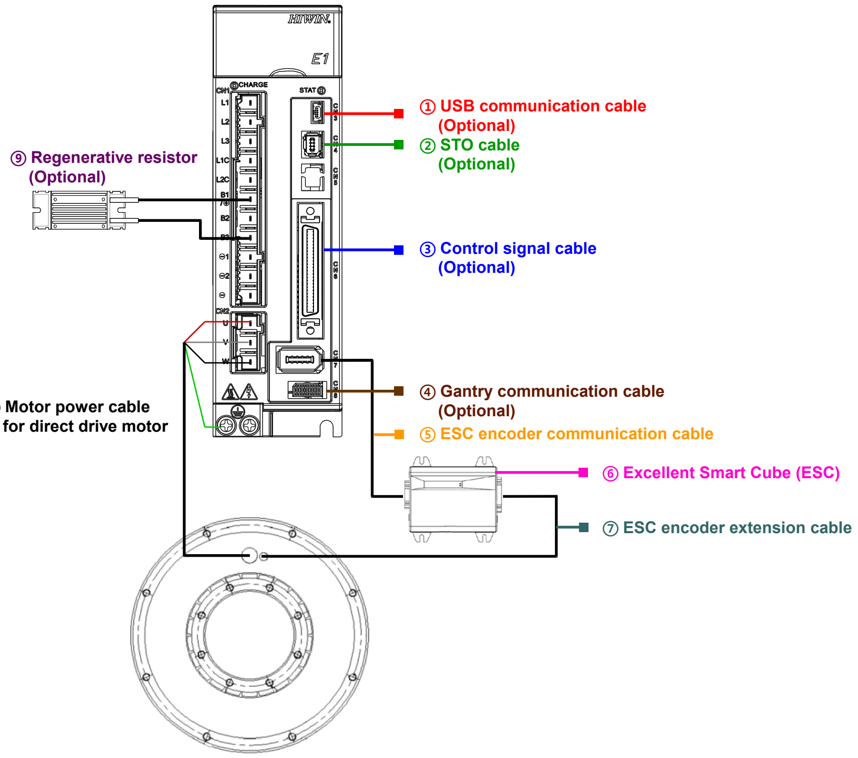
Motor Model	Servo Drive
DMN21-A	ED1□-□□-04□□
DMN22-A	
DMN42-A	
DMN44-A	
DMYA3-B	
DMYA5-B	
DMN71-B	ED1□-□□-10□□
DMN93-B	
DMY44-B	
DMY48-B	
DMY63-B	
DMY65-B	
DMY68-B	
DMYAA-B	

2.2.4 Torque motor (TM)

Excellent Smart Cube (ESC) is required when thermal sensor (PTC) or one of the following signals is used as feedback signal of direct drive motor.

(1) Analog (sin/cos) encoder signal
(2) EnDat encoder
(3) BiSS-C encoder
(4) Digital Hall signal

Configuration diagram of servo drive and torque motor
ESC is required



Note: When HIWIN TMRW torque motor is used, users generally need to install the encoder by themselves.
For the information of ESC, please refer to chapter 3.

Figure 2.2.4.1

The related cables to combine servo drive and motor are listed in the table below.

Table 2.2.4.1

Cable Name	Configuration	HIWIN Part No.	Specifications
⑤ ESC encoder communication cable	Connect communication port for ESC encoder to servo drive via CN7.	HE00EJUDA□00	-

Cable Name	Configuration	HIWIN Part No.	Specifications
⑥ Excellent Smart Cube (ESC)	Connect ESC encoder communication cable and ESC encoder extension cable.	FD000SCSSS01	ESC-SS-S01
		FD000SCANS01	ESC-AN-S01
⑦ ESC encoder extension cable	Connect motor encoder end to connection port for ESC encoder.	-	Select the cable according to the encoder format.
⑧ Motor power cable for direct drive motor	Connect motor power cable end to servo drive via CN2.	HE00841001□□	For direct drive motor, without brake cable.

Note:

(1) □ or □□ represents cable length. Please fill in Part No. based on cable length.

(2) For the information of cables, please refer to section 16.1.1 and 16.1.4.

2.2.5 Motor current and servo drive current

The continuous current and peak current of a motor must not exceed the output current of the connected servo drive. If not, the motor is unable to generate its rated force. Refer to table below to find proper servo drive power.

Table 2.2.5.1

Comparison of Continuous Current	Comparison of Peak Current	Output Force (Torque)
Servo drive > Motor	Servo drive > Motor	The motor is able to generate the rated force (torque) and instantaneous force (torque) of its specification. This combination is suggested.
Servo drive > Motor	Servo drive < Motor	The motor is able to generate the rated force (torque),but is unable to generate the instantaneous force (torque) of its specification. This combination could be used depending on users' operating conditions.
Servo drive < Motor	Servo drive < Motor	The combination is not suggested. Use servo drive with larger output power.

Note:

(1) Before selecting motor, the equivalent current (current at acceleration, current at constant-speed motion, current at deceleration and average current at dwell time) of motion must be calculated. It must be lower than the continuous current of the motor and servo drive to ensure the average load rate is lower than 100%.

(2) The maximum current at acceleration and deceleration must be lower than the peak current of the motor and servo drive, so the required acceleration and deceleration can be reached.

(3) For motor selection and calculation for equivalent current and maximum current, go to the official website of HIWIN Mikrosystem. Click on **Support** and select **Calculation**.

2.2.6 Operation voltage of servo drive and motor

The main circuit input voltage will be transformed to DC bus voltage. While choosing a suitable motor, a user should pay attention if the DC bus voltage transformed from input voltage will be over the operaton voltage of the motor. This is to avoid the input voltage destroys the insulation resistance of the motor and results in a burn out.

DC bus voltage = Servo drive main circuit input voltage *1.414

■ 110 V / 220 V input power (ED1□-□□-□□□2)

Table 2.2.6.1

Servo drive main circuit input voltage	Servo drive DC bus voltage	Servo drive undervoltage alarm threshold
100 ~ 120 V_{AC}	141.4 ~ 169.7 V_{DC}	below 60 V_{DC}
200 ~ 240 V_{AC}	282.8 ~ 339.3 V_{DC}	below 184 V_{DC}

■ 400 V input power (ED1□-□□-□□33)

Table 2.2.6.2

Servo drive main circuit input voltage	Servo drive DC bus voltage	Servo drive undervoltage alarm threshold
380 ~ 400 V_{AC}	537.3 ~ 565.6 V_{DC}	below 435 V_{DC}
460 ~ 480 V_{AC}	650.4 ~ 678.7 V_{DC}	below 460 V_{DC}

Note:

For the maximum motor operation voltage, please refer to “Linear Motor Technical Information” and “Torque Motor and Direct Drive Motor Technical Information”, which can be downloaded from the official website.

2.3 Selecting regenerative resistor

The energy used to drive motor returns to servo drive as the motor decelerates. If the returned energy exceeds the capacity of the servo drive capacitors, regenerative resistor should be installed to protect the servo drive by absorbing the extra energy. Regenerative resistor is frequently required for motion with heavy load or on Z axis. Whether to install regenerative resistor mainly depends on load and operating conditions. Users can follow the procedure provided below to see if regenerative resistor should be installed in their applications.

Step 1: Calculate the regenerative energy generated as motor decelerates.
m is the total mass of moving parts (The total weight of forcer and load; kg).
V is the maximum velocity (m/s).
E_dec (The regenerative energy during deceleration; Joule) = $(1/2)*(m*V^2)$

Step 2: Calculate the energy used by the motor.
Kf is the force constant of the motor (N/Arms).
T_decel is the deceleration time (s).
F is the required force for motor to decelerate (N).
a is the deceleration (m/s^2).
R is the motor resistance (line to line).
F = ma
P_motor (Watt) = $(3/4)*R*(F/Kf*\sqrt{2})^2$
E_motor (Joule) = P_motor*T_decel

Step 3: Calculate the generated regenerative energy.
E_returned (The generated regenerative energy) = E_dec-E_motor

Step 4: Calculate the energy absorbed by the servo drive.
C is the capacitance of the servo drive (uF).
V_regen is regenerative voltage (370 Vdc).
V_mains is input voltage (220 Vac).
W_capacity (The energy absorbed by the servo drive) = $1/2*C*[V\_regen^2-(1.414*V\_mains)^2]$

Step 5: Check if regenerative resistor should be installed.
If E_returned > W_capacity, regenerative resistor (built-in or external) must be used.
E_regen (The energy during deceleration) = E_returned-W_capacity
P_pulse (The power during deceleration) = E_regen/T_decel
R (Regenerative resistor) = $(V\_regen^2)/P\_pulse$

- If regenerative resistor is overheating or regenerative energy is too large, change the regenerative resistor or how the regenerative resistor is connected. The resistance in parallel must not lower than the minumum allowable resistance.
- For the informaton about built-in regenerative resistor and capacitor of E1 series servo drives, please refer to table 4.1.3.1 and 4.2.3.1.

3. Excellent Smart Cube (ESC)

3.1 Model explanation of Excellent Smart Cube (ESC)

Excellent Smart Cube (ESC) converts signals, such as encoder signal, signal of thermal sensor, Hall signal, etc. from the motor side into serial communication format for E1 series servo drive. For model explanation of Excellent Smart Cube (ESC), please refer to table below.

Note:
(1) ESC is not required when HIWIN EM1 series servo motor is used.
(2) ESC is not required when EM1 series servo motor is used with digital signal full-closed loop application.
(3) ESC-SS is required when EM1 series servo motor is used with analog signal or serial signal full-closed loop.
(4) For information of cables, please refer to section 16.1.4.
(5) The ESC should be installed in a control box or in a machine. Grounding should be used.

3.1.1 Nameplate

Figure3.1.1.1

3.1.2 Model explanation

Table3.1.2.1

Code	1	2	3		4	5		6	7	8
Example	E	S	C	-	A	N	-	S	0	1
1, 2, 3: E1 series Excellent Smart Cube (ESC)	ESC: Excellent Smart Cube									
4, 5: Encoder Signal Type	AN: Analog encoder Thermal sensor (TS) signal and digital Hall sensor function are supported. SS: Two serial encoders, one analog encoder and one digital encoder (for dual-loop) Thermal sensor (TS) signal and digital Hall sensor function are supported.									
6, 7, 8: Reserved	S01: Standard type									

Note:

ESC supports EnDat 2.1/2.2 or BiSS-C serial encoder.

3.2 Dimensions of Excellent Smart Cube (ESC)

The dimensions of Excellent Smart Cube (ESC) are shown as below.

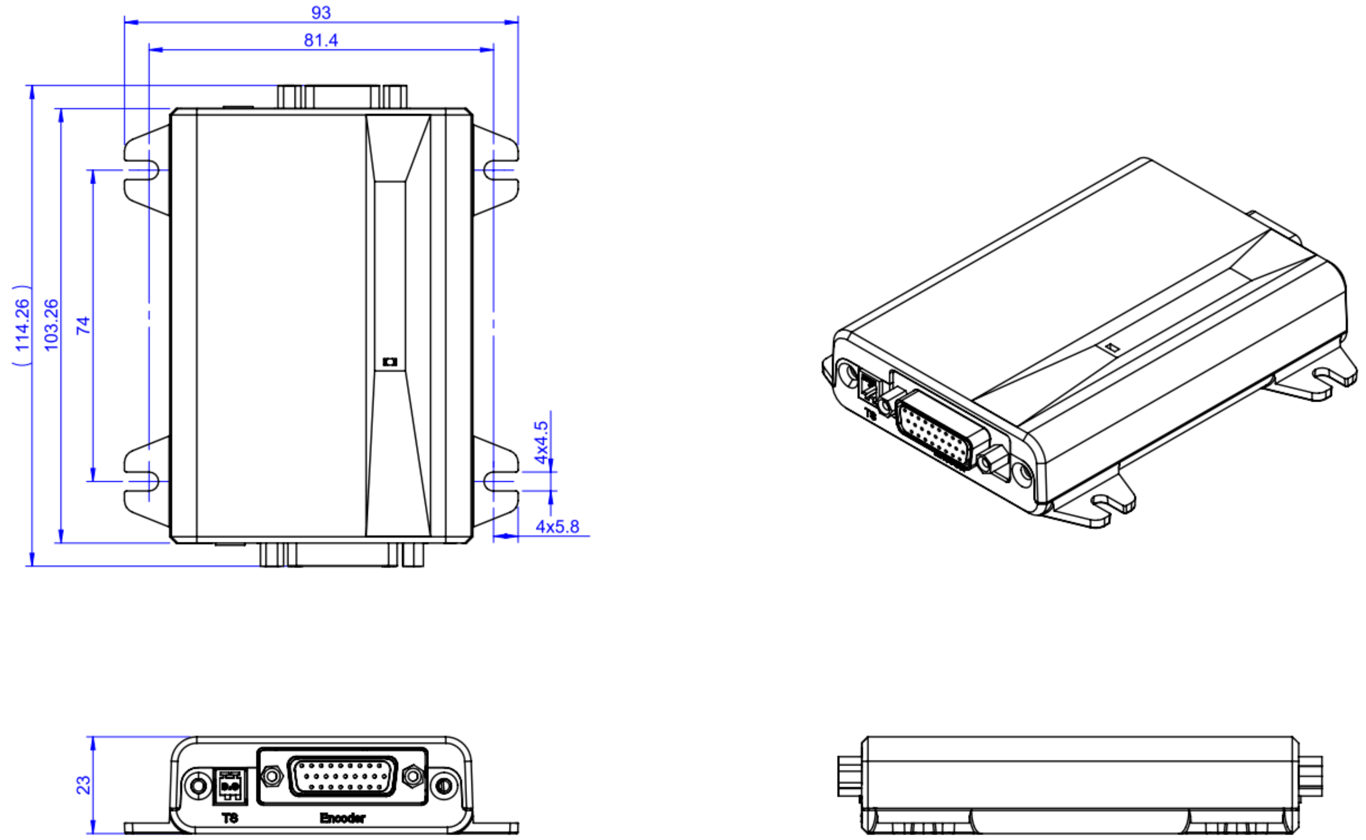


Figure3.2.1

3.3 Terminals of Excellent Smart Cube (ESC)

3.3.1 Terminal symbols and terminal names

Terminal for connecting Excellent Smart Cube (ESC) and E1 series servo drive is listed in table below.

Table3.3.1.1

Terminal Symbol	Terminal Name	Description
Comm.	Communication port for Excellent Smart Cube (ESC)	Communication port for Excellent Smart Cube (ESC) and E1 series servo drive.

Terminals for connecting Excellent Smart Cube (ESC) and motor are listed in table below.

Table3.3.1.2

Terminal Symbol	Terminal Name	Description
Encoder	Connection port for encoder	Connection port for motor encoder and Excellent Smart Cube (ESC).
TS	Connection port for thermal sensor	For thermal sensor signal of motor (HIWIN linear motor)

Terminal for position trigger output signal of Excellent Smart Cube (ESC) is listed in table below.

Table3.3.1.3

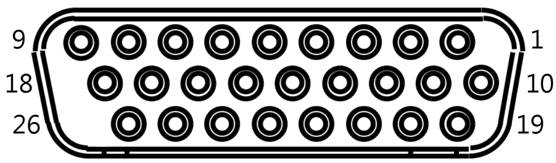
Terminal Symbol	Terminal Name	Description
PT	Position trigger output signal	Position trigger output signal can be output to user's equipment.

3.3.2 Pin definition

- Model: ESC-AN

  ESC-AN Excellent Smart Cube (ESC) is required when motor is used with analog encoder, digital Hall sensor and thermal sensor.

ESC end, 3 rows, 26 PIN, female



Encoder

Figure3.3.2.1

Table3.3.2.1

Pin	Signal	Description
1	SIN	Analog incremental signal input: SIN+
2	COS	Analog incremental signal input: COS+
3	REF	Analog signal reference point input: REF+
4	+5VE	Encoder power output
5	+5VE	Encoder power output
6	N/A	N/A
7	N/A	N/A
8	Hall U	Input for digital Hall sensor: U
9	Hall W	Input for digital Hall sensor: W
10	/SIN	Analog incremental signal input: SIN-
11	/COS	Analog incremental signal input: COS-
12	/REF	Analog signal reference point input: REF-
13	SG	Signal grounding
14	SG	Signal grounding
15	Inner Shield	Inner shield
16	N/A	N/A
17	N/A	N/A
18	Hall V	Input for digital Hall sensor: V
19	SG	Signal grounding
20	SG	Signal grounding
21	SG	Signal grounding
22	SG	Signal grounding
23	SG	Signal grounding
24	SG	Signal grounding
25	TS	Input for thermal sensor: TS+ (HIWIN DM)
26	/TS	Input for thermal sensor: TS- (HIWIN DM)

■ Model: ESC-SS

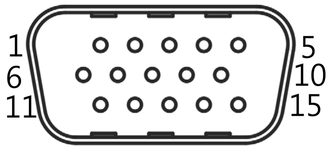
ESC-SS Excellent Smart Cube (ESC) is required when motor is used with analog encoder, digital encoder, serial encoder (EnDat or BiSS-C), digital Hall sensor and thermal sensor. Please refer to figure 3.3.2.1.

Table3.3.2.2

Pin	Signal	Description	Note
1	SIN	Analog incremental signal input: SIN+	-
2	COS	Analog incremental signal input: COS+	-
3	REF, ENC_IND, DATA2	Analog signal reference point input: REF+ Digital signal reference point input: Index+ Second serial signal input: DATA2+	1. Depend on the encoder type of motor 2. When only one serial encoder is used, DATA2 has no function.
4	+5VE	Encoder power output	Power for encoder
5	+5VE	Encoder power output	Power for encoder
6	CLK2	Digital encoder alarm signal input: ERR + Second serial signal clock input: CLK2+	1. Depend on the encoder type of motor 2. When only one serial encoder is used, CLK2 has no function.
7	ERR、CLK1	First serial signal clock input: CLK1+	1. When only one serial signal is used, CLK1 will be used first. 2. Digital incremental encoder can be used with ERR signal.
8	Hall U	Digital Hall sensor signal input: U	Can be used with digital or analog encoder
9	Hall W	Digital Hall sensor signal input: W	Can be used with digital or analog encoder
10	/SIN	Analog incremental signal input: SIN-	-
11	/COS	Analog incremental signal input: COS-	-
12	/REF, / ENC_IND, /DATA2	Analog signal reference point input: REF- Digital signal reference point input: Index- Second serial signal input: DATA2-	1. Depend on the encoder of motor 2. When only one serial encoder is used, /DATA2 has no function.
13	SG	Signal grounding	-
14	SG	Signal grounding	-
15	Inner Shield	Inner shield	-
16	/CLK2	Second serial signal clock input: CLK2-	1. Depend on the encoder of motor 2. When only one serial encoder is used, /CLK2 has no function.
17	/ERR、/CLK1	Digital encoder alarm signal input: ERR - First serial signal clock input: CLK1-	1. When only one serial signal is used, /CLK1 will be used first. 2. Digital incremental encoder can be used with ERR signal.
18	Hall V	Digital Hall sensor signal input: V	Can be used with digital or analog encoder
19	ENC_A	Digital incremental signal input: A+	-
20	/ENC_A	Digital incremental signal input: A-	-
21	ENC_B	Digital incremental signal input: B+	-
22	/ENC_B	Digital incremental signal input: B-	-
23	REF2 ENC_IND2 DATA1	First serial signal input: DATA1+ Analog signal reference point input : REF2+ Digital signal reference point input : Index2+	When only one serial signal is used, this will be used first.
24	/REF2 /ENC_IND2 /DATA1	First serial signal input: DATA1- Analog signal reference point input : REF2- Digital signal reference point input : Index2-	When only one serial signal is used, this will be used first.
25	TS	Thermal sensor signal input: TS+ (HIWIN DM)	For HIWIN direct drive motor with incremental feedback system
26	/TS	Thermal sensor signal input: TS- (HIWIN DM)	For HIWIN direct drive motor with incremental feedback system

■ Connecting to the servo drive

ESC end, 3 rows, 15 PIN, male



Comm.

Figure3.3.2.2

Table3.3.2.3

Pin	Signal	Description
1	+5Vdc	+5 V input power
2	ENC_Z+	Digital differential signal input: Z+
3	ENC_B+	Digital differential signal input: B+
4	ENC_A+	Digital differential signal input: A+
5	PS+	Encoder serial signal: PS+
6	SG	Signal grounding
7	ENC_Z-	Digital differential signal input: Z-
8	ENC_B-	Digital differential signal input: B-
9	ENC_A-	Digital differential signal input: A-
10	PS-	Encoder serial signal: PS-
11	Inner Shield	Inner shield
12	Inner Shield	Inner shield
13	D.N.C.	Do not connect.
14	RX	Serial communication signal
15	TX	Serial communication signal

3.4 Status indicator

After Excellent Smart Cube (ESC) is connected to the servo drive, the status indicator on ESC will display its current status.

Status Indicator	
Display	Status
Blinking green	ESC is not set by the servo drive.
Solid green	Setting completes. ESC is in operation.
Solid red	Error occurs.

3.5 Hardware, wire specifications and suggested brands

3.5.1 ESC hardware

Table3.5.1.1

Item	Description					
Maximum Output Voltage/Current (DC)	+5.0 V ±5%/ 650 mA					
Supported Signal Type	Digital Hall Sensor	Analog Incremental Signal	Digital Incremental Signal	Absolute Type[*2]		
	Hall U/V/W	SIN/COS/Reference	A/B/Index	BiSS-C	Tamagawa	EnDat 2.1/2.2
Maximum Signal Bandwidth	2 kHz	1 MHz (Minimum multiplier factor: 4 times)[*1] (Maximum multiplier factor: 4096 times)	4 MHz	5 MHz	5 MHz	4 MHz
Maximum Data Length	-	-	-	-	-	64 bits
Input Signal Format	5V CMOS / TTL	Differential signal (RS-422) 0.4 Vpp ~ 1.2 Vpp	Differential signal (RS-422) 5 V TTL	Differential signal (RS-485)		
Motor Thermal Protection (TS)	Supports thermal sensor based on positive temperature coefficient (PTC) thermistor					
Operating Temperature	0 ℃ to +45 ℃					
Storage Temperature	-20 ℃ to +65 ℃					
Ingress Protection Rating	IP20					

Note:
(1) A multiplier factor should be a multiply of 4.
(2) The counting length of the travel distance can not be more than 32 bits. For example, if the resolution is 1nm/count, the total travel distance can not be more than 4.29 m.

3.5.2 ESC cables

For the cables of ESC, please refer to section 16.1.4. If user would like to make encoder communication cable or encoder extension cable by himself, the wires of the cables must comply with the specifications stated in the table below.

Table3.5.2.1

Item	Specification
ESC encoder communication cable	The cable length(distance to the servo drive) must be less than 3 meters. • **Operating distance within 3 meters** The outer diameters of wires at the power supply end (+5 V, GND) must be AWG24 (wire resistance must be under 84.2 Ohm/km).The outer diameters of wires at the signal end must be AWG28. • **Operating distance between 4 to 15 meters** The outer diameters of wires at the power supply end (+5 V, GND) must be AWG18 (wire resistance must be under 21 Ohm/km).The outer diameters of wires at the signal end must be AWG28.
ESC encoder extension cable	• **Operating distance within 3 meters** The outer diameters of wires at the power supply end (+5 V, GND) must be AWG24 (wire resistance must be under 84.2 Ohm/km). The outer diameters of wires at the signal end must be AWG28. • **Operating distance between 4 to 15 meters** The outer diameters of wires at the power supply end (+5 V, GND) must be AWG18 (wire resistance must be under 21 Ohm/km). The outer diameters of wires at the signal end must be AWG28.

Note:

(1) For double circuit application, the cable length should not be longer than 5 meters because this may result in voltage decrease and affects the performance of the encoder.
(2) The cable length of encoder communication cable and encoder extension cable should not be longer than 18 meters because this may result in voltage decrease and affects the performance of the encoder.

3.5.3 Suggested encoder brands and model number

In this section we'll provide suggested encoder brands and model numbers to work with ESC.

- Signal type: Analoge(SIN/COS)

Table 3.5.3.1

Brand	Model No.
RENISHAW	RGH41A, RGH41B
RSF Elektronik	MS15, MS82

- Signal type: EnDat 2.1/2.2

Table 3.5.3.2

Brand	Model No.
HEIDENHAIN	ECN113,ECN125,ECN225,EQN437,LC483,ECI1319
RSF Elektronik	MC15

- Signal type: BiSS-C

Table 3.5.3.3

Brand	Model No.
RENISHAW	RA26BAA104B99A,RGH24Z50D00A,LA11DAA2D0KA10DF00,LA11DCA2D0KA10DA00
GIVI	AGMM1A528VB1VM02/S
FAGOR	SAB-50-170-5-A
YUHENG OPTICS	JFT-10B-640C3,JFT-40B-620C3,JKN-2C-H20-26PB-G3.6~14BL,PTN-1-100A-26F-G05BL

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4. Specification

4.1 110 V / 220 V input power

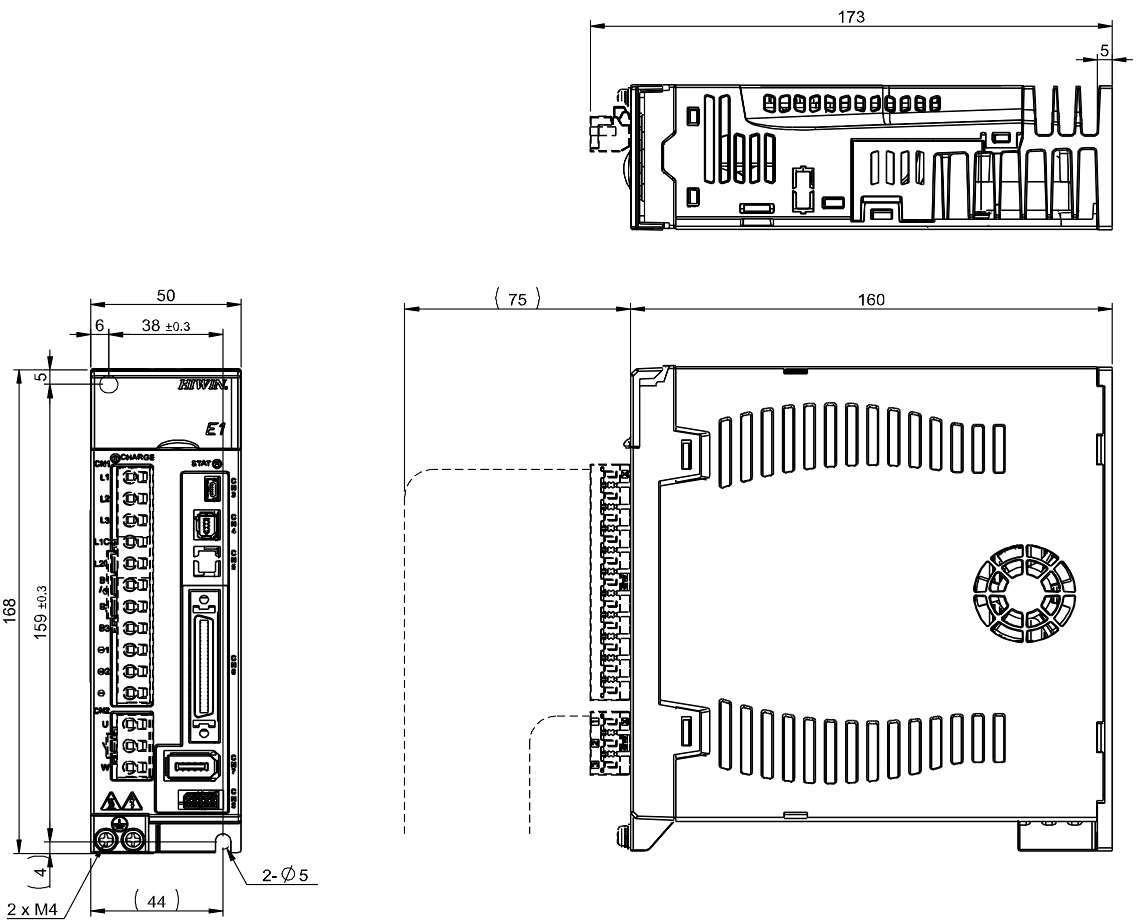
4.1.1 Dimensions

The dimensions and locations of installation holes of E1 series servo drives (Standard and Fieldbus) are provided in sections 4.1.1.1 and 4.1.1.2 The dimensions are shown in millimeters (mm). The diameter of installation hole is 5 mm.

4.1.1.1 Standard models

The model number of standard servo drive is ED1S.

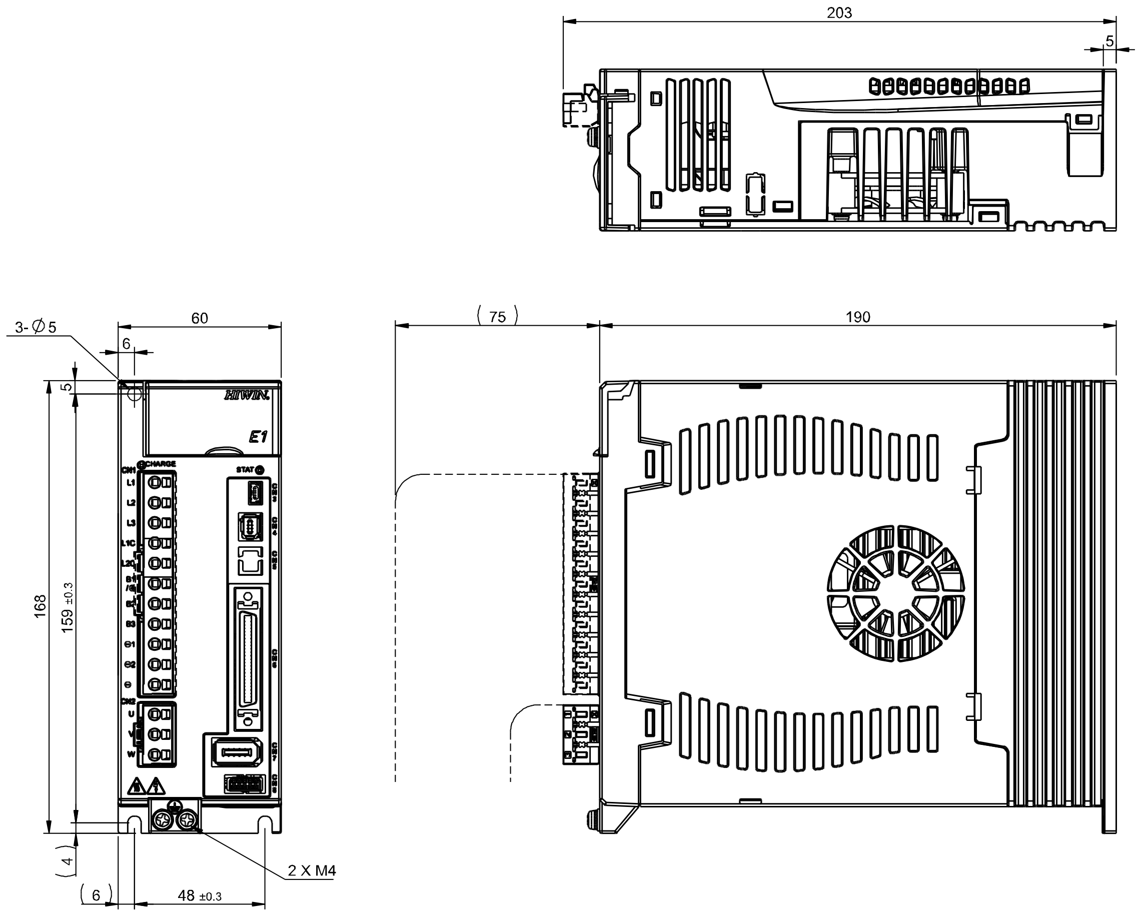
- 400 W/500 W servo drive (Standard)



Weight: 1.1 Kg

Figure4.1.1.1.1 The dimensions of 400 W/500 W servo drive (Standard)

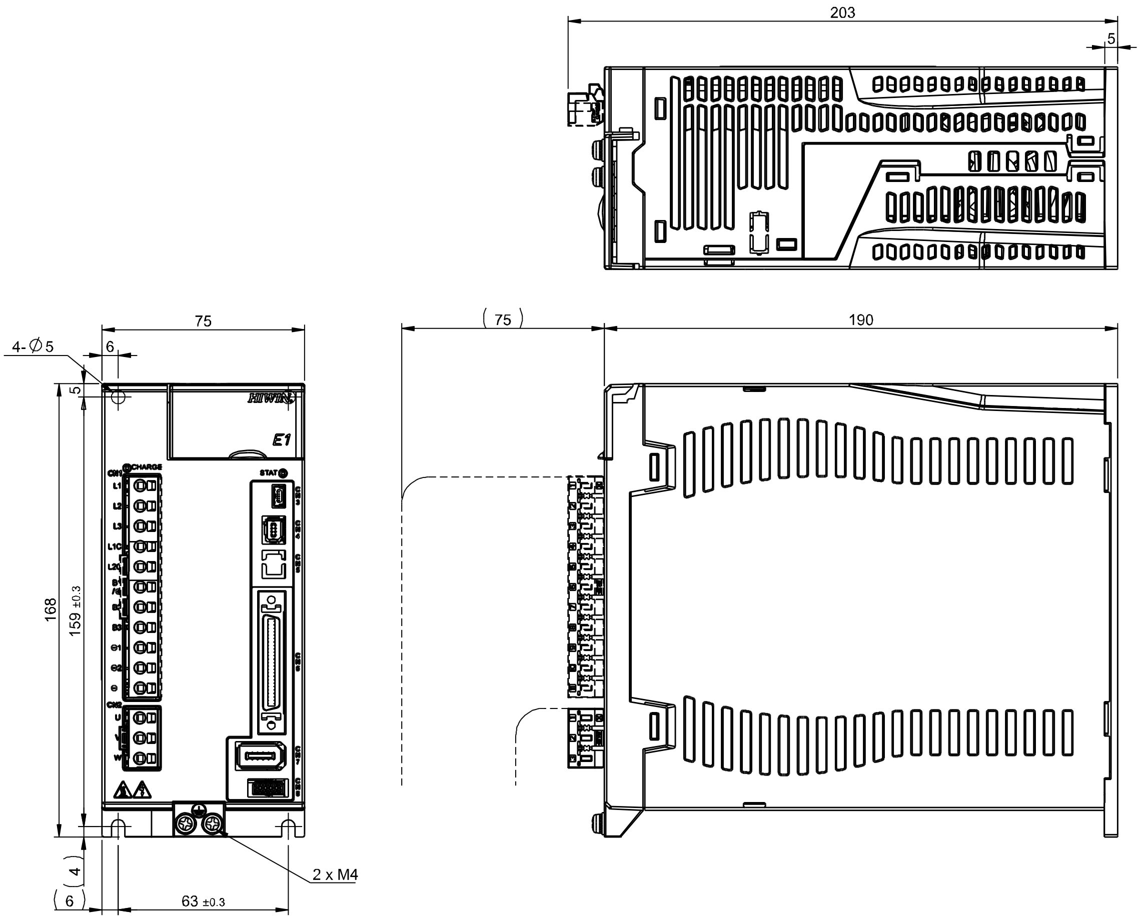
■ 1 kW/1.2 kW servo drive (Standard)



Weight: 1.6 Kg

Figure4.1.1.1.2 The dimensions of 1 kW/1.2 kW servo drive (Standard)

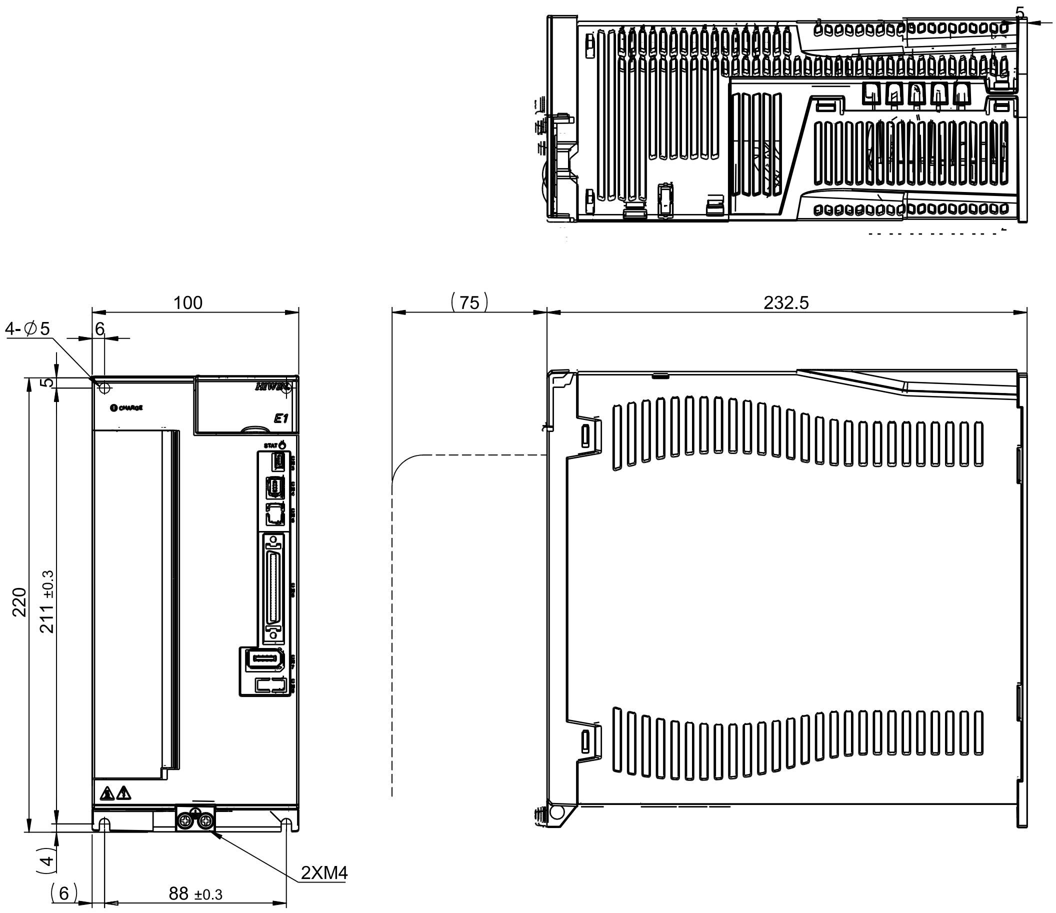
■ 2 kW servo drive (Standard)



Weight: 1.9 Kg

Figure4.1.1.1.3 The dimensions of 2 kW servo drive (Standard)

■ 4 kW servo drive (Standard)



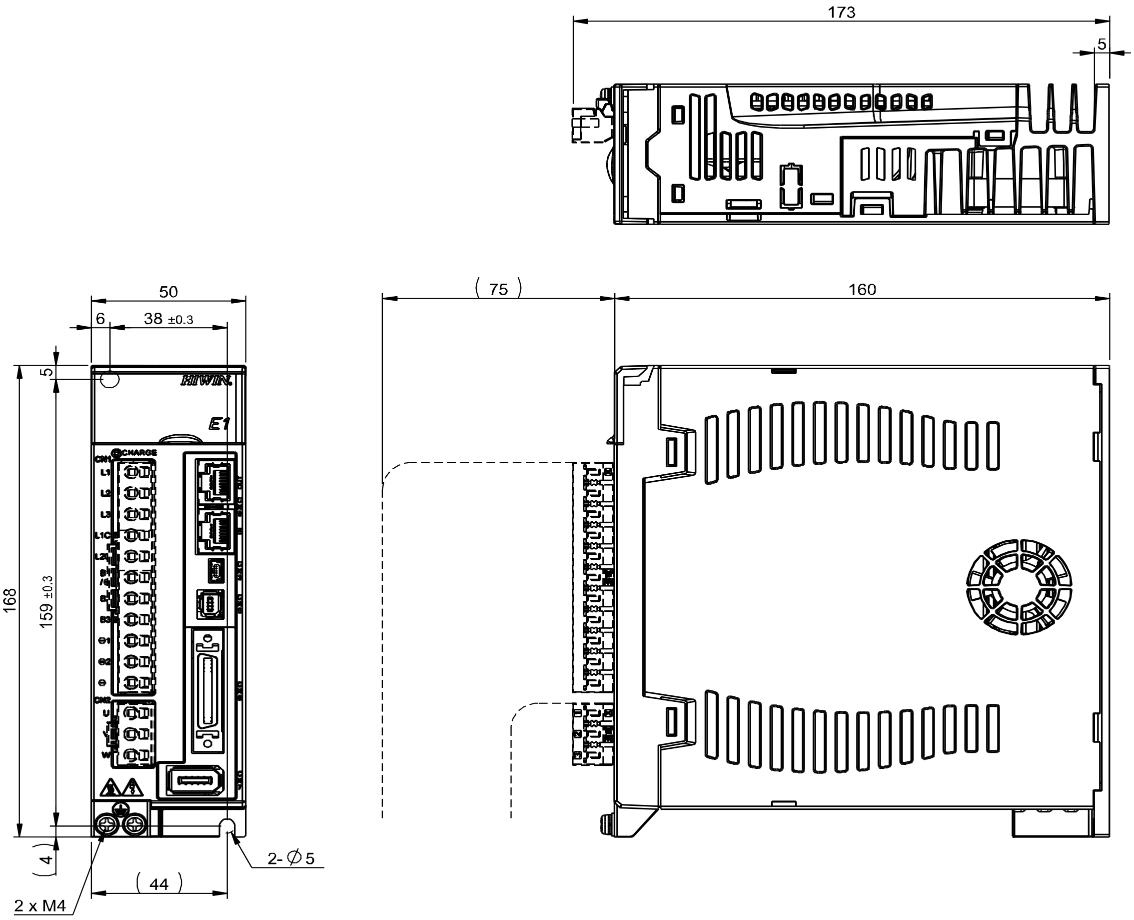
Weight: 3.4 Kg

Figure4.1.1.1.4 The dimensions of 4 kW servo drive (Standard)

4.1.1.2 Fieldbus models

The model number of Fieldbus servo drive is ED1F.

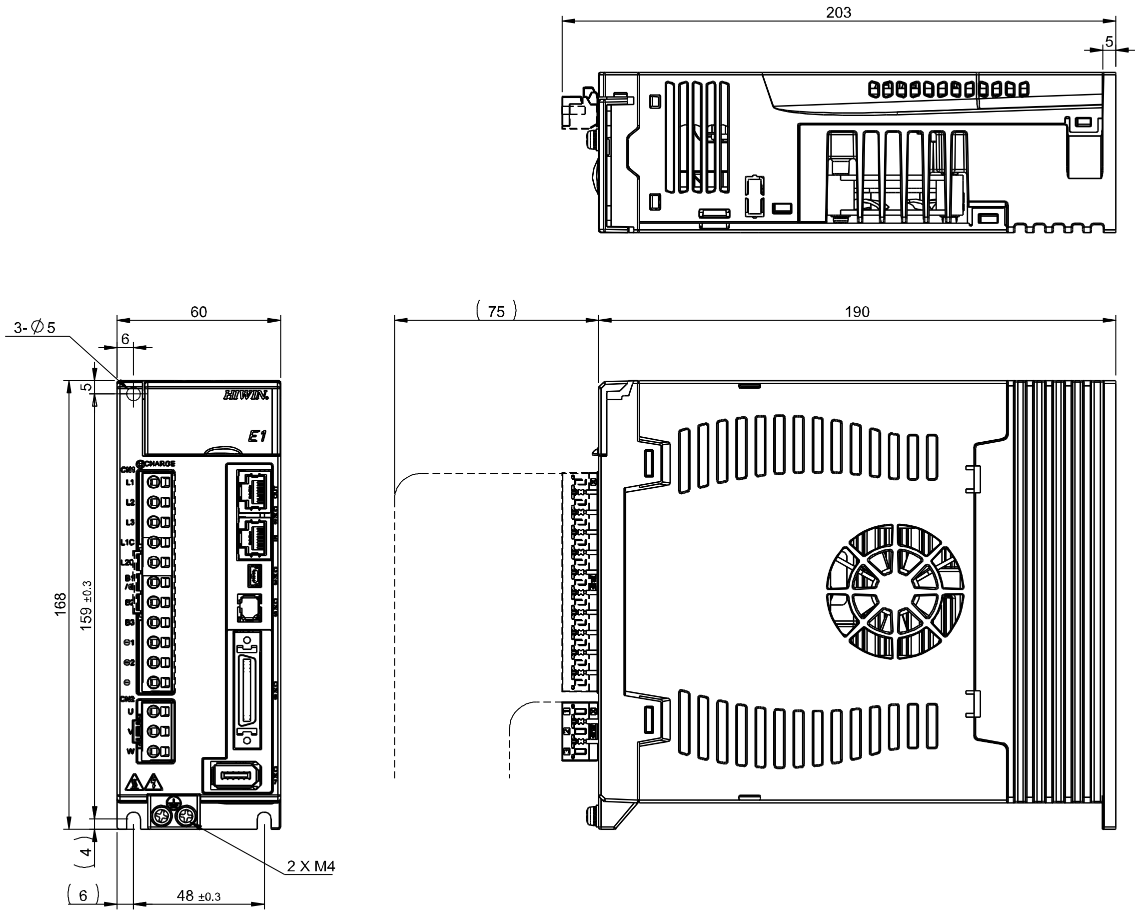
- 400 W/500 W servo drive (Fieldbus)



Weight: 1.1 Kg

Figure4.1.1.2.1 The dimensions of 400 W/500 W servo drive (Fieldbus)

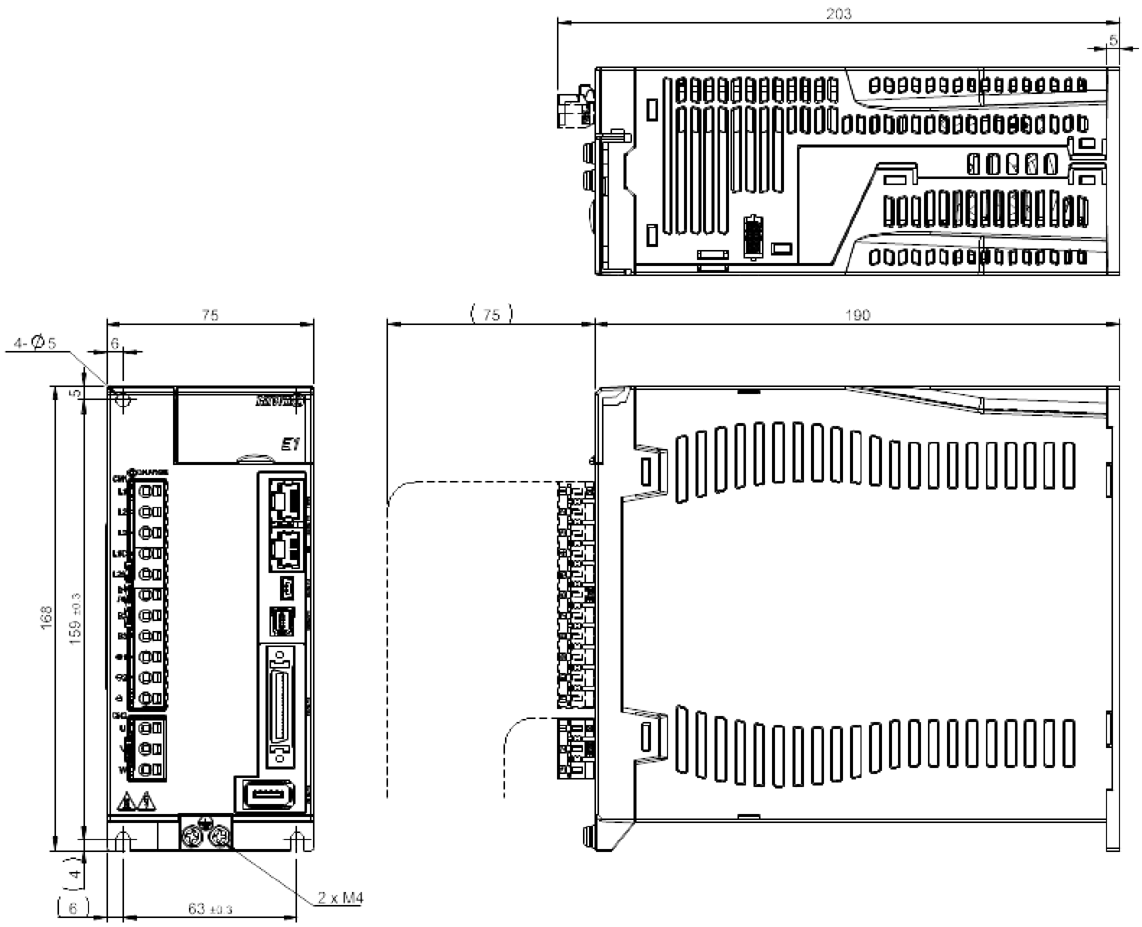
- 1 kW/1.2 kW servo drive (Fieldbus)



Weight: 1.6 Kg

Figure4.1.1.2.2 The dimensions of 1 kW/1.2 kW servo drive (Fieldbus)

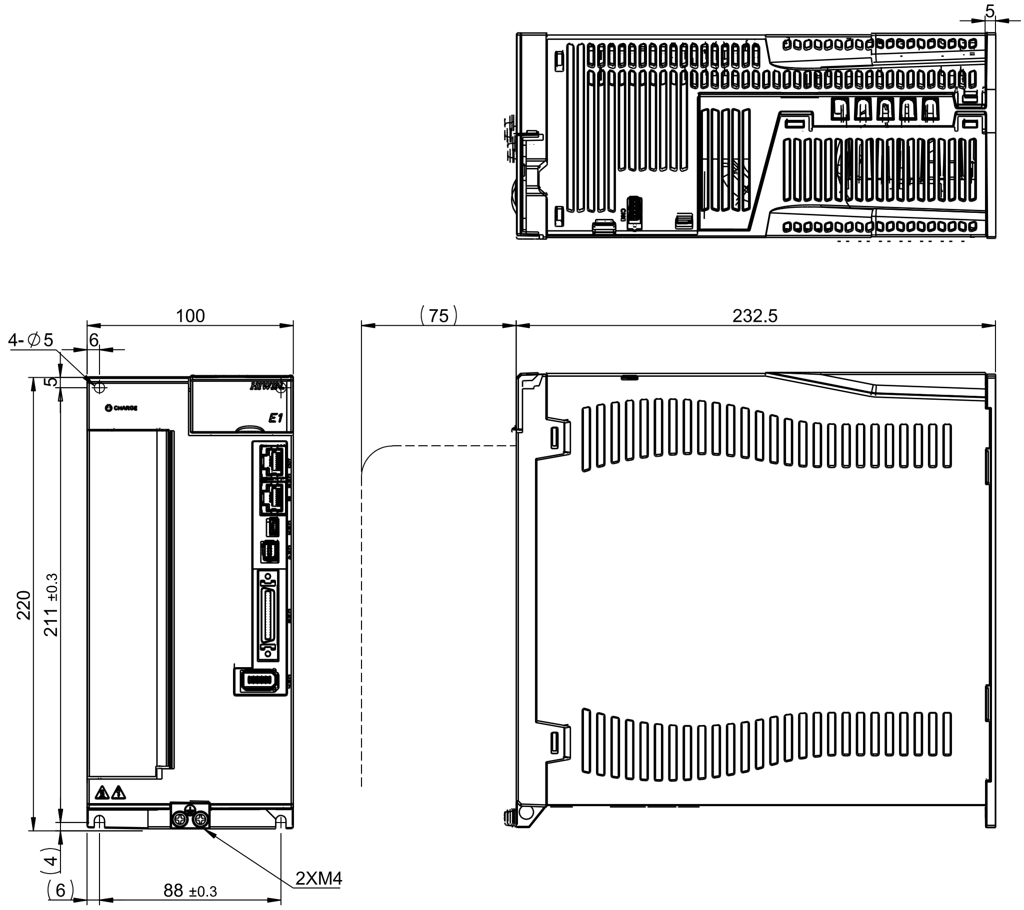
- 2 kW servo drive (Fieldbus)



Weight: 1.9 Kg

Figure4.1.1.2.3 The dimensions of 2 kW servo drive (Fieldbus)

■ 4 kW servo drive (Fieldbus)



Weight: 3.4 Kg

Figure4.1.1.2.4 The dimensions of 4 kW servo drive (Fieldbus)

4.1.2 Installation

If the servo drive is installed in a control box, ensure it is mounted with conductive screws. The insulating materials, such as paint, on the contact surface of the control box must be removed for grounding the servo drive through the control box. When the input power of the servo drive is 220 V, the grounding resistance must be lower than 50 Ω; when the input power of the servo drive is 110 V, the grounding resistance must be lower than 100 Ω. The suction hole and vent hole of the servo drive must not be obstructed. Install the servo drive according to the specified orientation; otherwise, it may malfunction.

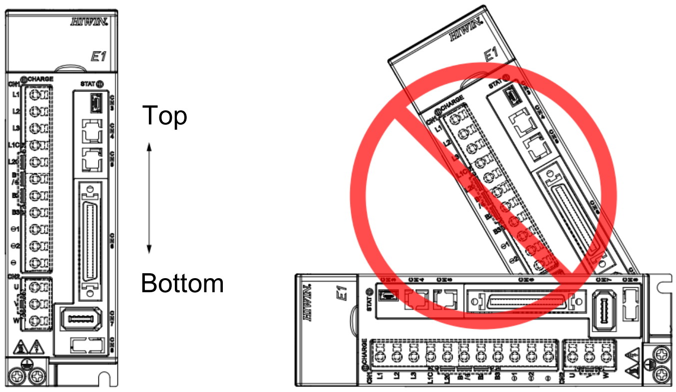


Figure4.1.2.1 Correct and incorrect mounting directions

For well cooling and circulation effect, there must be enough clearance between the servo drive and the adjacent objects or baffle plates. While installing multiple servo drives, the clearance between two servo drives must be at least 20 mm. Install a fan in the control box to facilitate heat dissipation.

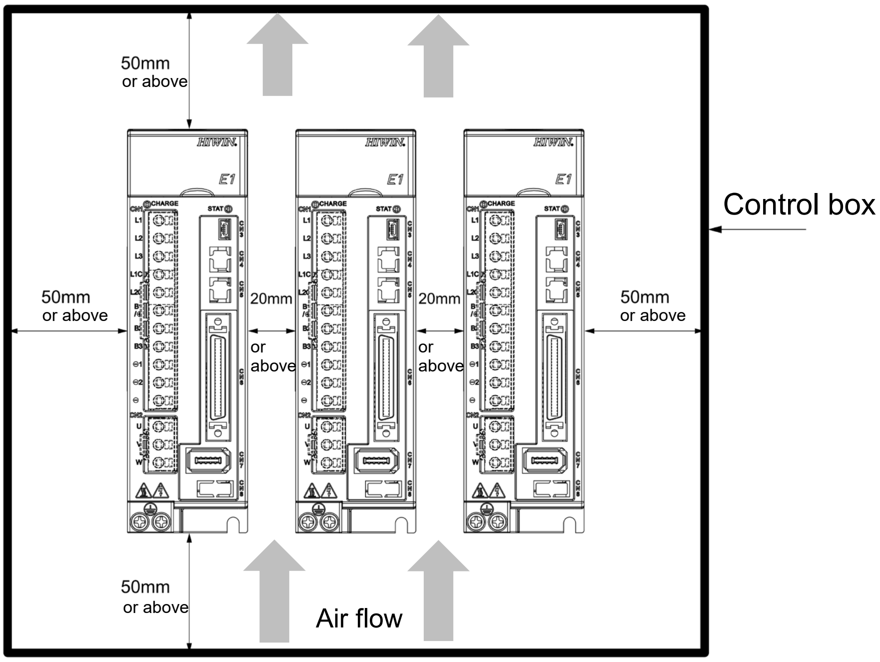


Figure4.1.2.2 Installing multiple servo drives

4.1.3 Power specification

Table4.1.3.1 110 V / 220 V servo drive

Rated Output			400 W	500 W	1 kW	1.2 kW	2 kW	4 kW
Input Power	Single Phase Main Power	Rated Voltage (Line to Line)	AC 100 ~ 120 Vrms，50~60 Hz AC 200 ~ 240 Vrms，50~60 Hz				AC 200 ~ 240 Vrms，50~60 Hz	-
		Rated Current (Arms)	2.9	3.8	6.58	11.1	11.1	-
	Three Phase Main Power	Rated Voltage (Line to Line)	AC 200 ~ 240 Vrms，50~60 Hz					
		Rated Current (Arms)	1.46	2.1	3.3	5.78	11.3	17.0
	Control Power		1 Ø/AC 100 ~120 Vrms，50~60 Hz 1 Ø/AC 200 ~240 Vrms，50~60 Hz					
	Inrush Current of Main Power (Apk)		14.2	14.2	23.4	23.4	24	36.2
	Inrush Current of Control Power (Apk)		17.7	17.7	17.7	17.7	17.7	17.7
Output Power	Phase Voltage		3 Ø/AC 240 Vrms max.					
	Max Rated Power (W)		400	500	1 k	1.2 k	2 k	4 k
	Peak Current (Arms)		10	10	23.3	23.3	42	75
	Rated Current (Arms)		2.5	3	5.6	9	12(9)*	25
Power Loss Data (W)			< 40	< 40	< 80	< 80	< 160	< 320
PWM Modulation Frequency			16 kHz			8 kHz		
Dynamic Brake			• Built-in dynamic brake circuit • 400 W/500 W: no built-in dynamic brake resistor • Delay time of relay: 20 ms					
Built-in Resistor for Dynamic Brake			-		10 Ohm /10 W			27 Ohm /40 W
Regenerative Energy Protection	Regenerative Resistor		• 400 W/500 W: Without built-in regenerative resistor Connect to external regenerative resistor if needed. • 1 kW/1.2 kW/2 kW/4 kW: With built-in regenerative resistor.Connect to external regenerative resistor to increase regenerative capacity.					
	Built-in Regenerative Resistor		-		40 Ohm /40 W		12 Ohm /60 W	13 Ohm /120 W
	Power Capacity [uF]		820		1410		2240	3280
	Protection of Regenerative Resistor Enabled		+HV > 370 Vdc					
	Protection of Regenerative Resistor Disabled		+HV < 360 Vdc					
	Overvoltage Protection		390 Vdc					
Environment	Operating Temperature		0~45℃ (45~50℃ is acceptable when derated value is applied. Please refer to section 4.5)					

Rated Output	400 W	500 W	1 kW	1.2 kW	2 kW	4 kW
Weight (kg)	1.1	1.1	1.6	1.6	1.9	3.4

Note: *When using 1-phase 200 V AC to 240 V AC power supply, operate the servo amplifier at 75% (9 Arms) or smaller effective load ratio.

4.2 400 V input power

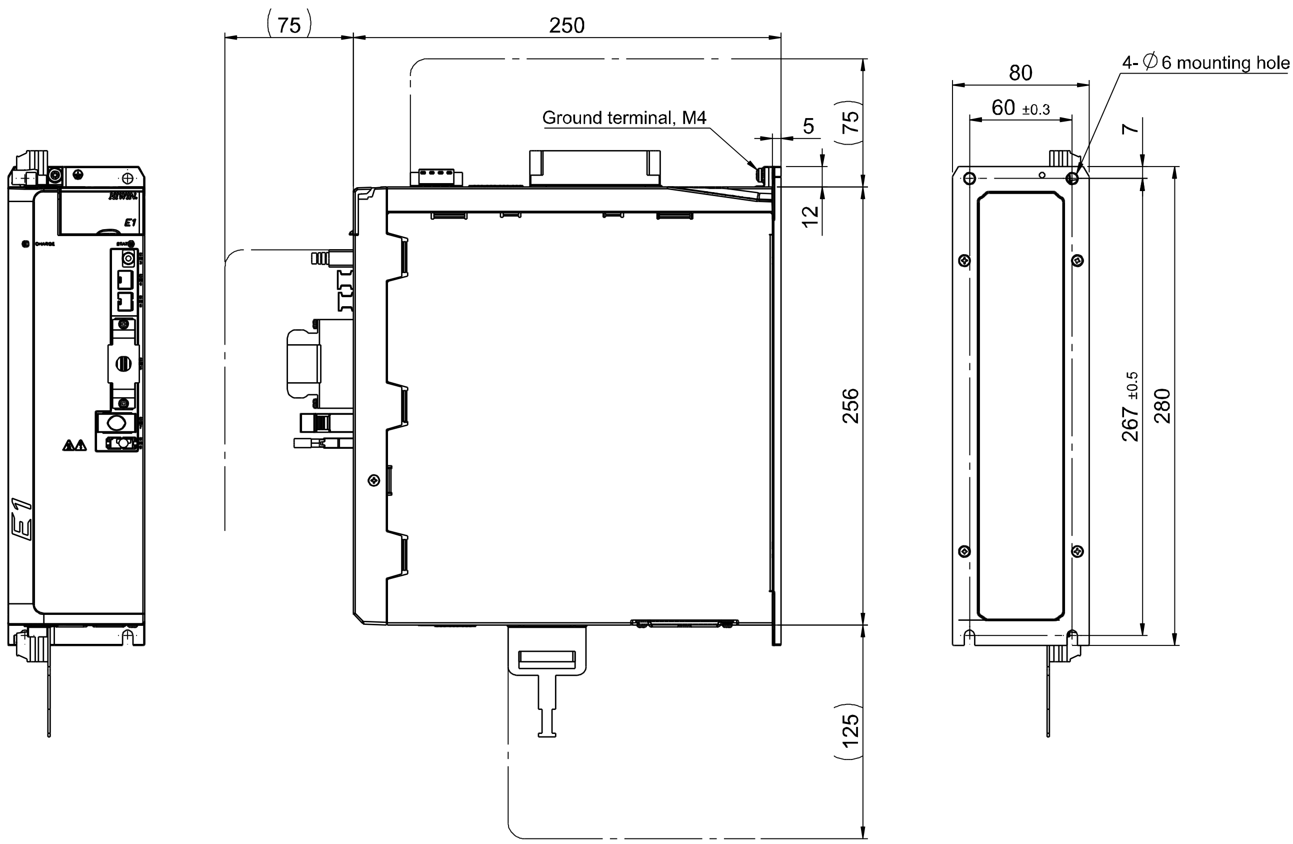
4.2.1 Dimensions

The dimensions and locations of installation holes of E1 series servo drives (Standard and Fieldbus) are provided in sections 4.2.1.1 and 4.2.1.2 The dimensions are shown in millimeters (mm). The diameter of installation hole is 6 mm.

4.2.1.1 Standard models

The model number of standard servo drive is ED1S.

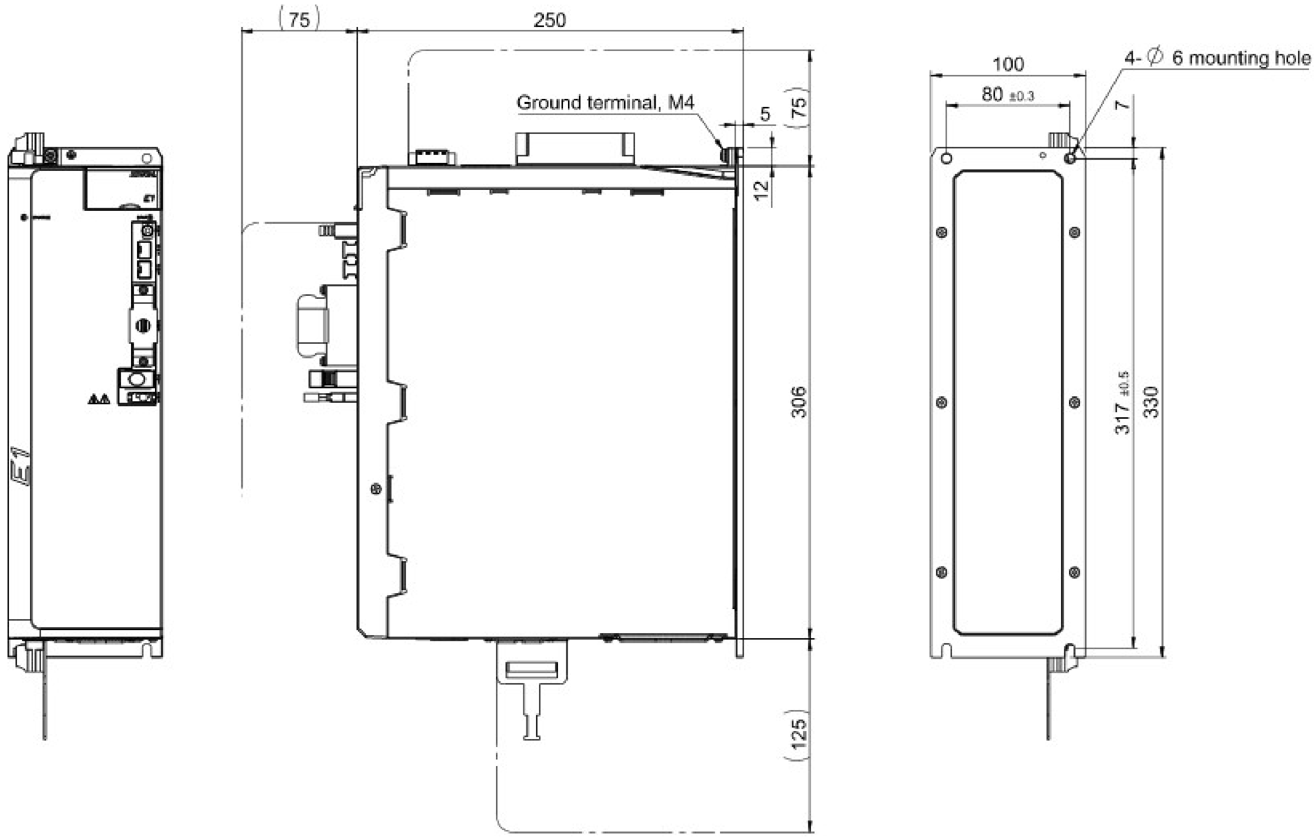
■ 5 kW servo drive (Standard)



Weight: 4.0 Kg

Figure4.2.1.1.1 The dimensions of 5 kW servo drive (Standard)

■ 7.5 kW servo drive (Standard)



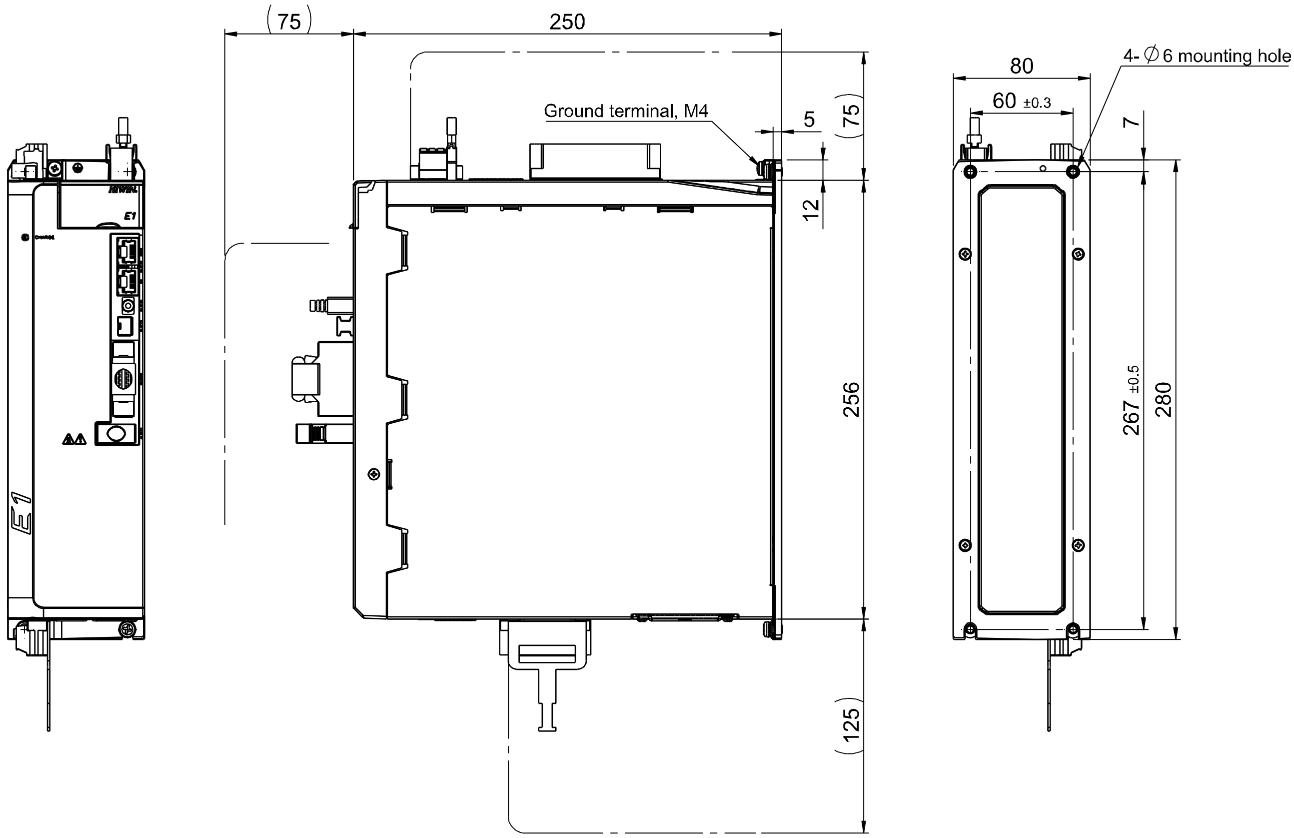
Weight: 5.3 Kg

Figure4.2.1.1.2 The dimensions of 7.5 kW servo drive (Standard)

4.2.1.2 Fieldbus models

The model number of Fieldbus servo drive is ED1F.

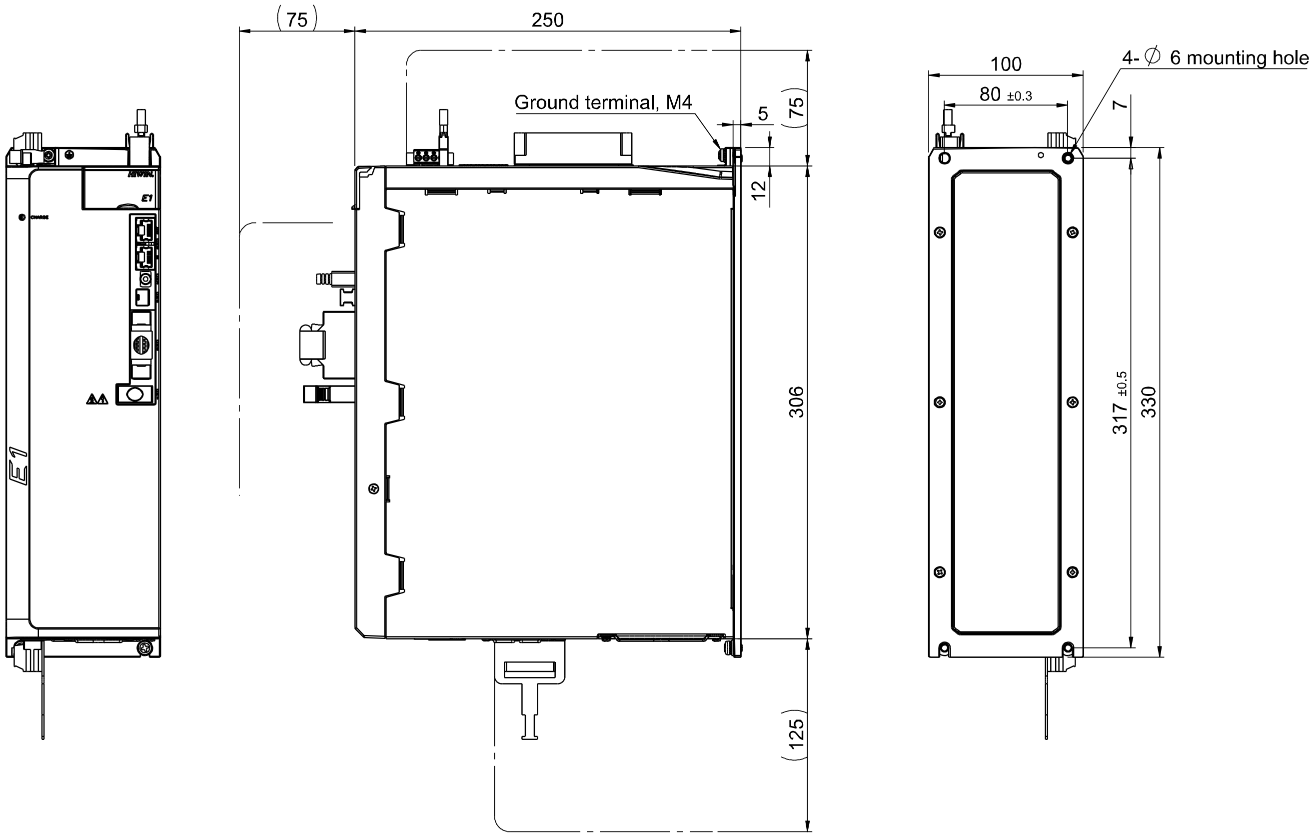
- 5 kW servo drive (Fieldbus)



Weight: 4.0 Kg

Figure4.2.1.2.1 The dimensions of 5 kW servo drive (Fieldbus)

■ 7.5 kW servo drive (Fieldbus)



Weight: 5.3 kg

Figure4.2.1.2.2 The dimensions of 7.5 kW servo drive (Fieldbus)

4.2.2 Installation

If the servo drive is installed in a control box, ensure it is mounted with conductive screws. The insulating materials, such as paint, on the contact surface of the control box must be removed for grounding the servo drive through the control box. When the input power of the servo drive is 400 V, the grounding resistance value shoule be less than 10 Ω. The suction hole and vent hole of the servo drive must not be obstructed. Install the servo drive according to the specified orientation; otherwise, it may malfunction.

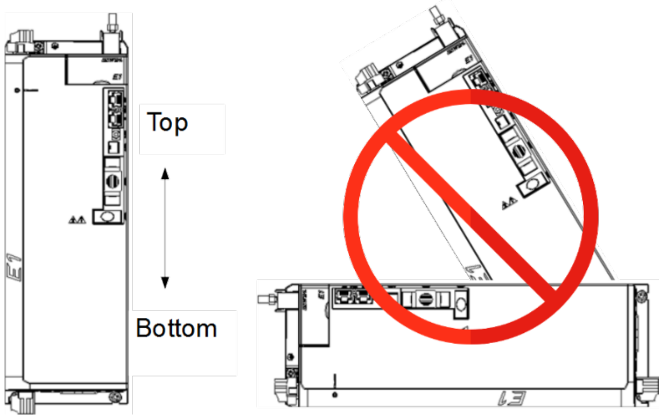


Figure4.2.2.1 Correct and incorrect mounting directions

For well cooling and circulation effect, there must be enough clearance between the servo drive and the adjacent objects or baffle plates. While installing multiple servo drives, the clearance between two servo drives must be at least 20 mm. Install a fan in the control box to facilitate heat dissipation.

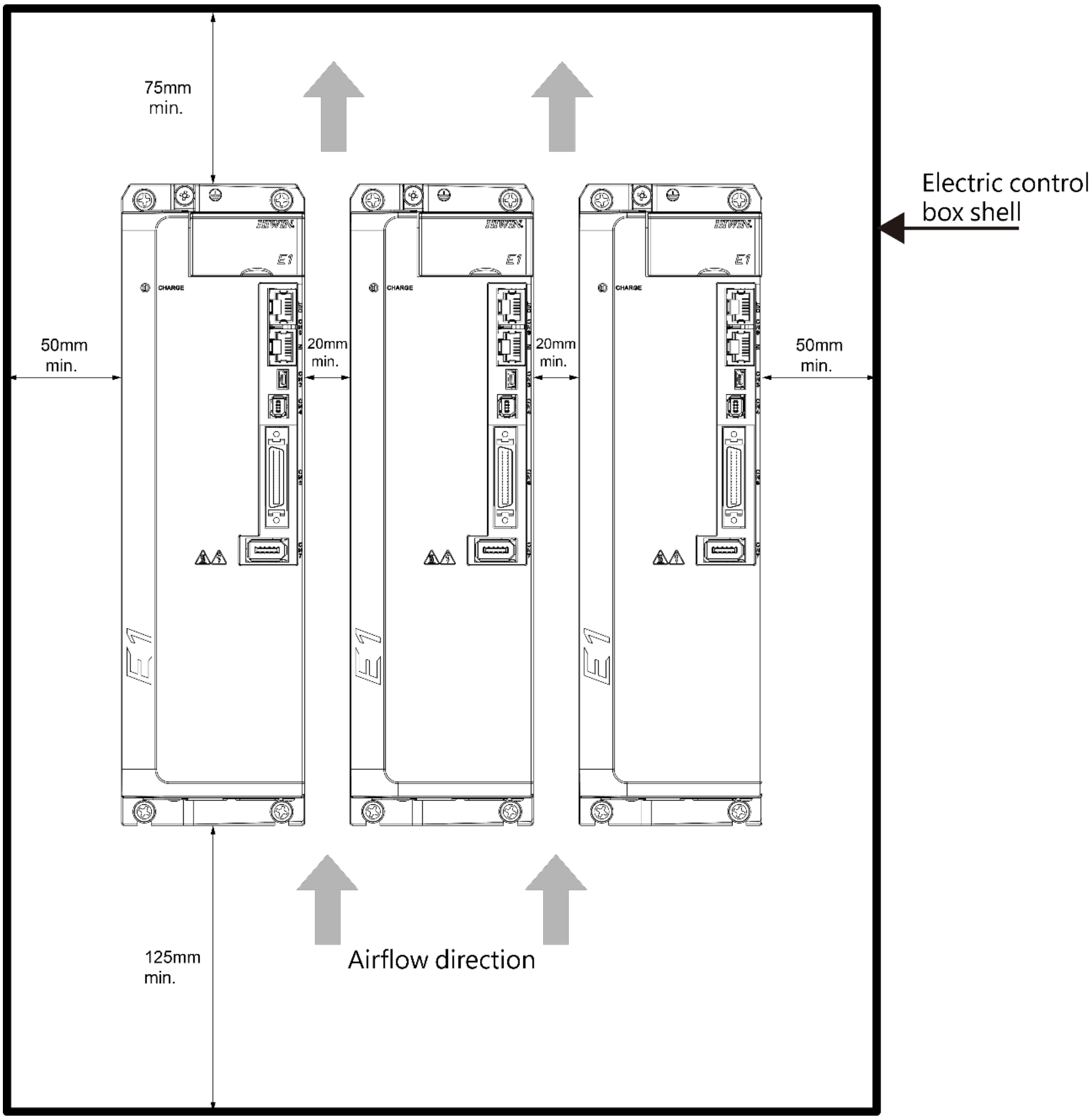


Figure4.2.2.2 Installing multiple servo drives

4.2.3 Power specification

Table4.2.3.1 400 V servo drive

<table>
<tr><td colspan="3">Rated Output</td><td>5 kW</td><td>7.5 kW</td></tr>
<tr><td rowspan="4">Input Power</td><td rowspan="3">Three Phase Main Power</td><td>Rated Voltage (Line to line)</td><td colspan="2">AC 380 ~ 480 Vrms，50~60 Hz</td></tr>
<tr><td>Rated Current (Arms)</td><td>12.6</td><td>17.6</td></tr>
<tr><td>Inrush Current(Apk)</td><td colspan="2">50</td></tr>
<tr><td colspan="2">Control Power</td><td colspan="2">DC 24 V±15%，2A</td></tr>
<tr><td rowspan="4">Output Power</td><td colspan="2">Phase Voltage</td><td colspan="2">3 Ø/AC 480 Vrms max.</td></tr>
<tr><td colspan="2">Maximum Rated Power (W)</td><td>5 k</td><td>7.5 k</td></tr>
<tr><td colspan="2">Peak Current (Arms)</td><td>42</td><td>85</td></tr>
<tr><td colspan="2">Rated Current (Arms)</td><td>16</td><td>27.4</td></tr>
<tr><td colspan="3">Power Loss Data (W)</td><td>< 250</td><td>< 525</td></tr>
<tr><td colspan="3">PWM Modulation Frequency</td><td colspan="2">8 kHz</td></tr>
<tr><td colspan="3">Dynamic Brake</td><td colspan="2">• Built-in dynamic brake circiut
• No built-in dynamic brake resistor
• Delay time of relay: 20 ms</td></tr>
<tr><td colspan="3">Lowest Value allowed for External Dynamic Brake Resistor</td><td colspan="2">10 Ohm</td></tr>
<tr><td rowspan="9">Regenerative Energy Protection</td><td colspan="2">Regenerative Resistor</td><td colspan="2">• 5 kW:
With built-in regenerative resistor.
Connect to external regenerative resistor to increase regenerative capacity.
• 7.5 kW:
Without built-in regenerative resistor.
Connect to external regenerative resistor if needed.</td></tr>
<tr><td colspan="2">Built-in Regenerative Resistor</td><td>27 Ohm /180 W</td><td>-</td></tr>
<tr><td colspan="2">Power Capacity [uF]</td><td>560</td><td>840</td></tr>
<tr><td rowspan="2">AC 380 V</td><td>Protection of Regenerative Resistor Enabled</td><td colspan="2">+HV > 620 Vdc</td></tr>
<tr><td>Protection of Regenerative Resistor Disabled</td><td colspan="2">+HV < 600 Vdc</td></tr>
<tr><td rowspan="2">AC 480 V</td><td>Protection of Regenerative Resistor Enabled</td><td colspan="2">+HV > 770 Vdc</td></tr>
<tr><td>Protection of Regenerative Resistor Disabled</td><td colspan="2">+HV < 755 Vdc</td></tr>
<tr><td colspan="2">Overvoltage Protection</td><td colspan="2">800 Vdc</td></tr>
<tr><td colspan="2">Environment</td><td colspan="2"></td></tr>
<tr><td colspan="3">Weight (kg)</td><td>4.0</td><td>5.3</td></tr>
</table>

4.3 General specification

Please refer to below table for the general specification of E1 servo drive series.

Table4.3.1 E1 Servo drive general specification

<table>
<tr><th colspan="4">Category</th><th>Servo drive specification</th></tr>
<tr><td colspan="4">Cooling Method</td><td>Fan cooling</td></tr>
<tr><td colspan="4">Control Method</td><td>IGBT PWM space vector control</td></tr>
<tr><td colspan="4">Applicable Motor</td><td>AC/DM/LM (Depending on encoder type, Excellent Smart Cube (ESC) may be required.)</td></tr>
<tr><td colspan="4">STAT LED Indicator</td><td>• Blinking red: Error
• Blinking green: Ready
• Green: Enabled
• There is no STAT LED indicator on Fieldbus servo drive.</td></tr>
<tr><td colspan="4">CHARGE LED Indicator</td><td>• Red: The main power is supplied.
• No light: The main power is not supplied.</td></tr>
<tr><td colspan="4">Analog Output</td><td>• Channel: 2
• Resolution: 12 bit
• Output voltage range: ±10 V
• Accuracy: ±2%
• Maximum output current: ± 10 mA</td></tr>
<tr><td rowspan="16">Control Function</td><td rowspan="6">Position Mode</td><td colspan="2">Command Source</td><td>Pulse command from controller</td></tr>
<tr><td colspan="2">Signal Type</td><td>• Pulse/Direction
• CW/CCW
• AqB</td></tr>
<tr><td colspan="2">Isolated Circuit</td><td>High-speed optical coupler</td></tr>
<tr><td colspan="2">Input Signal</td><td>Differential input (2.8 V≦ high and low potential difference ≦ 3.7 V) or single-ended input(12~24 VDC)</td></tr>
<tr><td colspan="2">Maximum Input Bandwidth</td><td>• Differential: 5 Mpps
• Single-ended: 200 kpps</td></tr>
<tr><td colspan="2">Electronic Gear</td><td>Gear ratio: pulses/counts
Pulses: 1~1,073,741,824
Counts: 1~1,073,741,824</td></tr>
<tr><td rowspan="5">Velocity Mode</td><td colspan="2">Command Source</td><td>DC voltage command from controller</td></tr>
<tr><td rowspan="4">Analog Input</td><td>Impedance</td><td>14 kOhm</td></tr>
<tr><td>Signal Format</td><td>±10 Vdc</td></tr>
<tr><td>Maximum Input Bandwidth</td><td>100 Hz</td></tr>
<tr><td>Specification</td><td>16 bit A/D input (V-REF+/-)</td></tr>
<tr><td rowspan="5">Torque Mode</td><td colspan="2">Command Source</td><td>DC voltage command from controller</td></tr>
<tr><td rowspan="4">Analog Input</td><td>Impedance</td><td>14 kOhm</td></tr>
<tr><td>Signal Format</td><td>±10 Vdc</td></tr>
<tr><td>Maximum Input Bandwidth</td><td>100 Hz</td></tr>
<tr><td>Specification</td><td>16 bit A/D input (T-REF+/-)</td></tr>
<tr><td colspan="4">Control Mode</td><td>1. Position mode
2. Velocity mode
3. Torque mode
4. Full-closed loop mode (Dual loop mode)</td></tr>
<tr><td colspan="2">Computer Communication</td><td colspan="2">Standard USB2.0 (Mini USB type)</td><td>Connect the servo drive with your computer to set parameters, monitor physical quantities and execute trial operation via Thunder.</td></tr>
</table>

Encoder	Power Supply		+5.1 Vdc ±5%, 700 mA
	Signal Format		• Serial signal Resolution: 23 bit (Single-turn/multi-turn absolute encoder) Bandwidth: 5 MHz • Incremental signal (Digital differential TTL signal) AqB and Z-phase signals The maximum input bandwidth of each phase is 5 MHz. Quadruple frequency, 20 Mcounts/s
	Safety Function		• Encoder power malfunction detection • Short circuit protection • Undervoltage protection • Overvoltage protection • Encoder alarm protection (Digital differential TTL signal)
	Position Counting Range		-2,147,483,648~2,147,483,647 (32 bit)
	Linear Motor/Direct Drive Motor		Depending on encoder type, Excellent Smart Cube (ESC) may be required.
Encoder Output	Emulated Encoder Output (Fieldbus servo drive does not support)	Z Phase	1. Serial encoder and incremental encoder (AqB、sin/cos) are supported. 2. The width of output signal can be adjusted by parameter. 3. Digital differential signal output 4. Z-phase open collector output is supported. 5. Two output methods can be selected. ➢ Only outputs one Z-phase signal for total travel distance. ➢ Outputs one Z-phase signal per one revolution.
		A/B Phase	1. Serial encoder and digital encoder (AqB) are supported. 2. Differential signal output. The maximum output bandwidth is 18 Mcount/s. 3. The scaling of output can be adjusted. For instance, ten encoder counts = one emulated encoder count.
	Buffered Encoder Output	Z Phase	1. Only supports digital encoder (AqB). 2. Differential signal output 3. Supports Z phase open-collector output.
		A/B Phase	1. Only supports digital encoders (AqB). 2. Differential signal output, maximum output bandwidth 20 Mcount/s
General-purpose I/O	Input		The functions of general-purpose inputs (Optical couplers) can be defined by users. E1 series servo drive provides ten general-purpose inputs (I1 to I10). Fieldbus servo drive only provides eight general-purpose inputs (I1 to I8) 24 V/5 mA (Each input pin)
	Output		The functions of general-purpose outputs (Optical couplers) can be defined by users. E1 series servo drive provides five general-purpose outputs (O1 to O5) 24 V/0.1 A (Each output pin)
	Position Trigger (PT)		The pins for position trigger (PT) output function are CN6-46 and 47 (Differential signal). Differential 3.3 V, maximum current 20 mA, maximum output bandwidth 10 MHz.
Optional Function			Gantry synchronization control function
Environment	Storage Temperature		-20 °C~65 °C
	Humidity		Operating and storage temperature: 20 to 85% RH (Non-condensing)
	Altitude		Altitude 1,000 M or lower above sea level

		(1000~2000M is acceptable when derated value is applied. Please refer to section 4.5)
	Vibrating	Less than 0.5 G Frequency 10 to 500 Hz (No continuous use under resonance frequency)
	IP Rating	IP20

4.4 Selecting no-fuse breaker (NFB)

While using no-fuse breaker for current shunt, its rated capacity should be 1.5 to 2.5 times of the rated current of the servo drive and the inrush current of the servo drive must be considered as well. Refer to the instructions below to select no-fuse breaker.

(1) While using one servo drive:

$I_B = C \times I_n$

(2) While using two or more servo drives, but do not power on at the same time:

$I_B = (\Sigma I_n - I_{nMAX}) \times K + C_{MAX}\ I_{nMAX}$

(3) While using two or more servo drives, and power on at the same time:

$I_B = C1 \times I_{n1} + C2 \times I_{n2} + \cdot\cdot\cdot\cdot + CN \times I_{nN}$

Note:

I_B: The rated current of no-fuse breaker

I_n: The rated current of the servo drive

I_{nMAX}: The largest rated current of servo drive while using servo drives of different specifications

C: Multiple for the rated current of the servo drive

The multiple is usually 1.5 to 2.5. (Note: If users are not sure about the multiple, please use 1.5.)

C_{MAX}: Multiple for the largest rated current of servo drive while using servo drives of different specifications

K: Demand rate (Note: If users are not sure about the demand rate, please use 1.)

Example:

If five ED1□-□□-04□□ and one ED1□-□□-10□□ are used:

We assume C and C_{MAX} are 2.

Do not use multiple servo drives at the same time: I_B = (2.9×5+6.58x1–6.58)×1+6.58×2=<u>27.66</u> A_{rms}

Use multiple servo drives at the same time: I_B = 2×2.9+2×2.9+2×2.9+2×2.9+2×2.9+2×6.58=<u>42.16</u> A_{rms}

- Suggested specifications of breaker and fuse used with E1 series servo drive

  If several servo drives use the same breaker, the current of the breaker must be: the required current of the breaker for each servo drive x the number of the servo drives. For instance, two ED1□-□□-04□□ share the same breaker, so the specification of the breaker must be at least: 10 A x 2 = 20 A.

Table4.4.1

Servo Drive Model	Rated Input Current	Breaker	Fuse (Class T)
ED1□-□□-0422	2.9 A_{rms}	10 A	300 V, 6 A
ED1□-□□-0522	3.8 A_{rms}		
ED1□-□□-1022	6.5 A_{rms}	15 A	300 V, 15 A
ED1□-□□-1222	11.1 A_{rms}	30 A	
ED1□-□□-2032	11.3 A_{rms}	30 A	300 V, 50 A
ED1□-□□-4032	17.0 A_{rms}	50 A	300 V, 70 A
ED1□-□□-5033	12.6 A_{rms}	30 A	600 V, 40 A
ED1□-□□-7533	17.6 A_{rms}	50 A	600 V, 60 A

- The inrush current of E1 series servo drive

  When selecting breaker, the inrush current as power is supplied to the servo drive in the first 100 ms must be considered. If several servo drives share the same breaker, please add up the inrush currents of all the used servo drives to select a suitable breaker which can withstand the total inrush current.

Table4.4.2

Servo Drive Model	Inrush Current of Main Power	Inrush Current of Control Power
ED1□-□□-0422	14.2 A_{rms}	17.7 A_{rms}
ED1□-□□-0522	14.2 A_{rms}	17.7 A_{rms}
ED1□-□□-1022	23.4 A_{rms}	17.7 A_{rms}
ED1□-□□-1222	23.4 A_{rms}	17.7 A_{rms}
ED1□-□□-2032	24.0 A_{rms}	17.7 A_{rms}
ED1□-□□-4032	36.2 A_{rms}	17.7 A_{rms}

Table4.4.3

Servo Drive Model	Inrush Current of Main Power
ED1□-□□-5033	50.0 A_{rms}
ED1□-□□-7533	50.0 A_{rms}

Note:

If leakage breaker is used, ensure it meets the following specifications to prevent false operation:

(1) Sensitivity current: Above 200 mA

(2) Operating time: Above 100 ms

4.5 Derated value

When the drive is operated under condition of temperature 45~50℃ or altitude 1000~2000M, please use the drive according to the decrease rate of deration, which is displayed in below figures.

- Rated output of the drive: 400 W/500 W/1 kW/1.2 kW/2 kW/4 kW

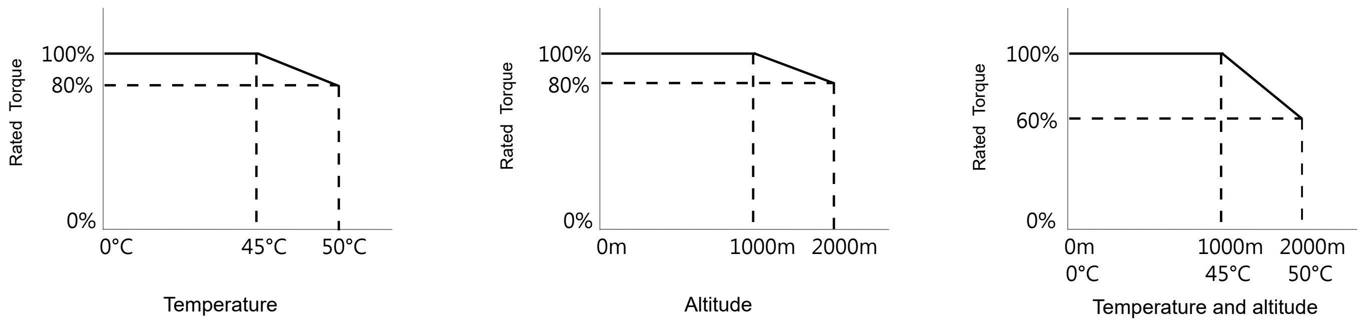


Figure4.5.1

5. Electrical planning

5.1 Wiring precautions

5.1.1 General precautions

DANGER

- Do not modify wiring when power on.
  Do not modify wiring when power on, or it may cause electric shock or injury.

WARNING

- Wiring or examination must be performed by professional technician.
  If this is not followed, it may cause electric shock or product malfunction.
- Ensure wiring is correctly performed and the specified power is provided.
  Short circuit may occur in output circuits due to incorrect wiring or voltage. If short circuit is caused by the above reasons, brake will not be enabled. And this may cause machine damage, injury or death.
- Connect AC main power to the terminals of the servo drive.
  - If AC main power is used, connect to terminals L1, L2, L3 and L1C, L2C on the servo drive.

  If this is not followed, it may cause product malfunction or fire.

CAUTION

- Wiring and examination must be performed at least five minutes after power off and the indicator goes off. The residual voltage inside the servo drive could still be high after power off. Do not touch the power terminals when the indicator goes on. If this is not followed, it may cause electric shock.
- Wiring and trial operation must be performed in accordance with the precautions and procedures given in this manual. If brake circuit malfunctions due to incorrect wiring or voltage, this may cause product malfunction, machine damage, injury or death.
- Wiring must be correctly performed. Connectors and pin definitions vary with different models. Before wiring, refer to the technical documents of your model. If this is not followed, it may cause product malfunction or false operation.
- Connect wires to the power terminals and motor terminals by following the given instructions. If this is not followed, the wires and terminal blocks could overheat due to poor connection. And this may cause fire.
- Use shielded twisted-pair cables or shielded multi-core twisted-pair cables for I/O signal cable and encoder cable.
- While wiring the terminals of the servo drive main circuit, please pay attention to the following.
  (1) Turn on the power after wiring completes.
  (2) While wiring a connector, remove the connector from the servo drive first.
  (3) Insert one wire per one terminal socket.
  (4) Ensure there is no short circuit among wires.
- Use circuit breaker or other safety device as protection for short circuit of external wiring. If this is not followed, it may cause fire or product malfunction.

NOTICE

- ◆ Use the cables specified by HIWIN while wiring.
  If cables which are not specified by HIWIN are used, perform wiring by using the wiring materials specified by HIWIN or equivalent products after checking the rated current of the servo drive and environment.
- ◆ Ensure the screws on cable connectors are tightened and the servo drive is securely installed inside the control box.
  If the screws are not tightened, the cable connectors could fall off during operation.
- ◆ Do not put high power cables (such as main circuit power cable) and low power cables (such as I/O signal cable and encoder cable) in the same cable tray or tie them together. If high power cable and low power cable are not put in separate cable trays, they should be at least 30 cm apart.
  If this is not followed, false operation may occur when low power cable is interfered.
- ◆ Encoder battery must be installed on encoder cable.
- ◆ While installing encoder battery, pay attention to its polarity.
  A broken battery may cause encoder malfunction.

Note

- ➢ Circuit breaker or fuse must be applied to protect the main circuit.
  If the servo drive is directly connected to a commercial power supply and is not insulated by transformer or other device, circuit breaker or fuse must be used to prevent the servo system from being affected by external system.
- ➢ Earth leakage circuit breaker must be applied.
  The servo drive has no protective circuit for grounding fault. To have a safer system, it is suggested to install earth leakage circuit breaker or earth leakage circuit breaker with molded-case circuit breaker to prevent overload or short circuit.
- ➢ Do not frequently turn on or turn off the power of the servo drive.
  - The internal components of the servo drive may be deteriorated if the power is frequently turned on or off.
  - The interval between power on and power off must be at least one hour after

For a safe and stable servo system, the following must be followed while wiring.

(1) Use the cables specified by HIWIN. While designing and configuring a system, the cables must be as short as possible.

(2) The conductors of signal cable must be $0.2\ mm^2$ or $0.3\ mm^2$. Do not bend or apply tension to the cable.

5.1.2 Countermeasures against interference

The servo drive has sophisticated microprocessors. If wiring or grounding is not correctly performed, the servo drive could be interfered by peripheral equipment. To avoid false operation caused by interference, follow the instructions below to configure the servo drive.

(1) Do not put main circuit power cable, control signal cable and encoder cable in the same cable tray, or tie them together. If they are not put in separate cable trays, they should be at least 30 cm apart while wiring.

(2) The servo drive must not share the same power supply with electric welding machine or electric discharge machine. If there is high frequency generator near the servo drive, install noise filter at the input sides of main circuit power cable and control circuit power cable. For installation instruction of noise filter, please refer to the following.

(3) Grounding must be correctly performed. For information of grounding, please refer to section 5.1.3.

(4) While using motor with large capacity, the servo drive could be interfered by noise from conduction or radiation. Use shielded motor power cable and its shield must be connected to the grounding of electric control panel.

(5) While using 400 V input power servo drive with large capacity motor，please refer to 5.1.4 shielding of motor power cables.

Note:
For suggested filter, please refer to section 16.2.3

■ Wiring diagram for noise filter

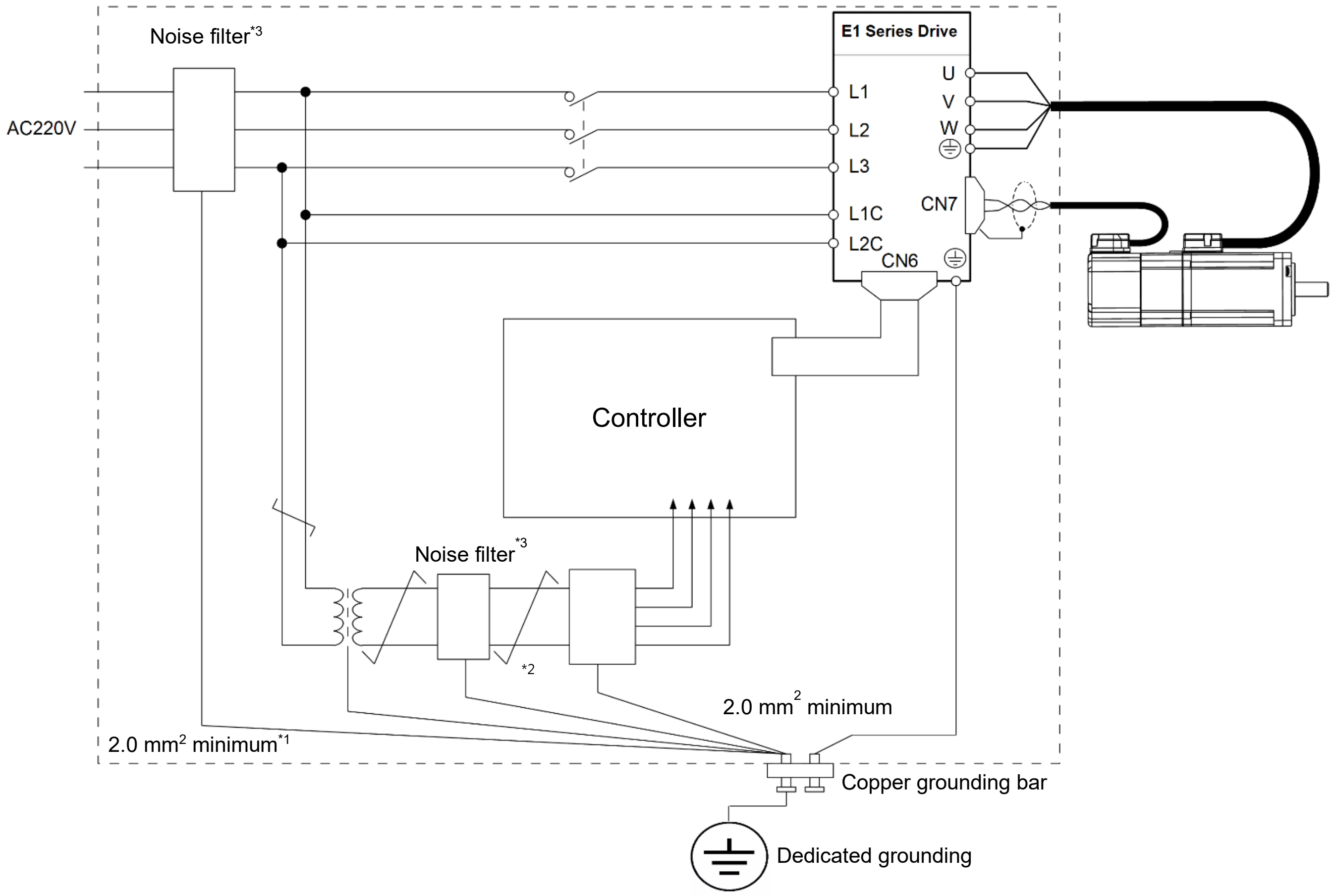


Figure5.1.2.1

Note:

(1) The ground wire must be at least 2.0 mm^2. (Flat braided copper wire is suggested.)

(2) Use twisted-pair wire for connection marked with ≠.

(3) For precautions while using noise filter, please refer to the following.

■ Precautions for wiring and connecting noise filter

The input cables and output cables of noise filter must be separated. Do not put them in the same cable tray or tie them together.

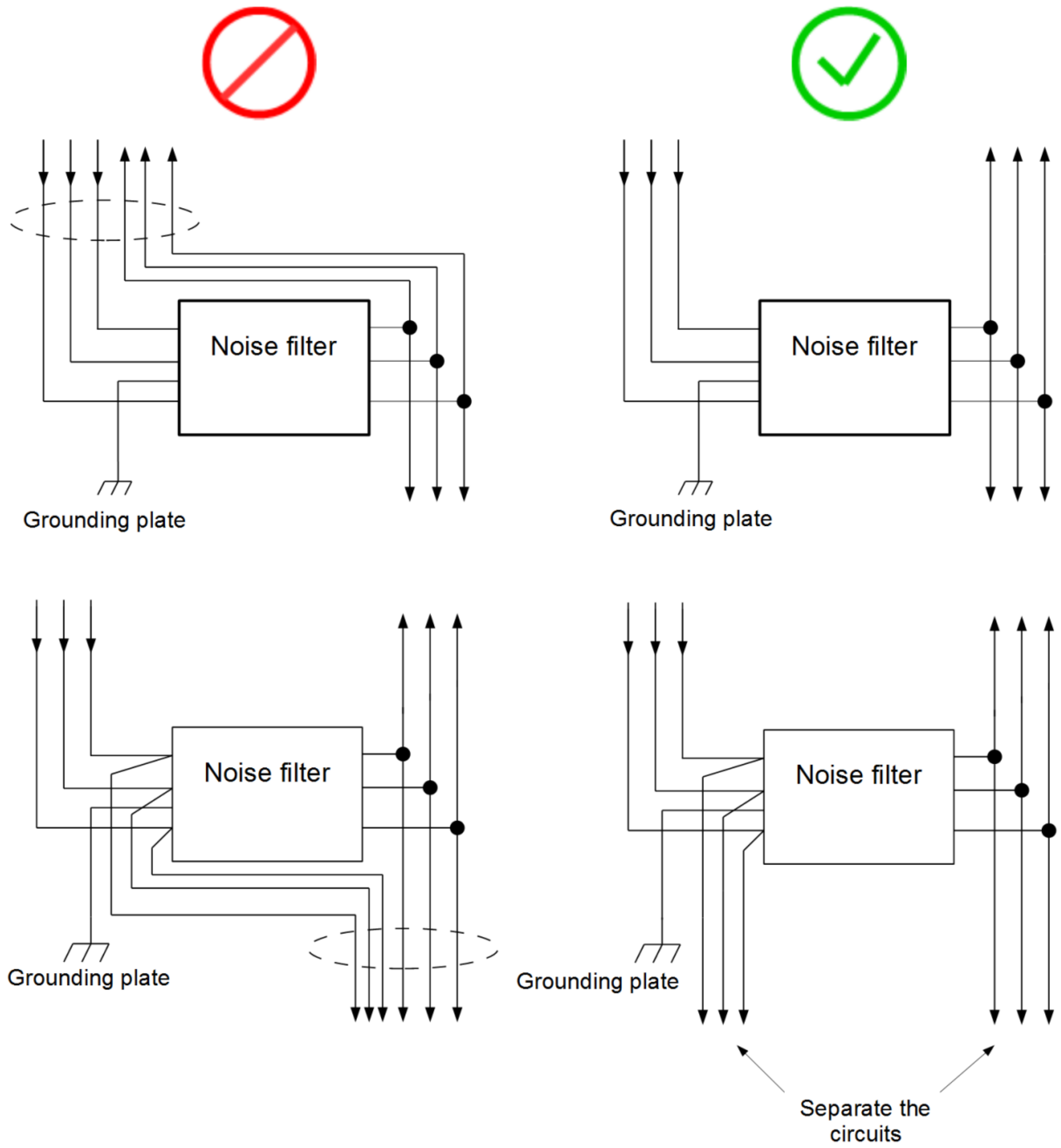


Figure5.1.2.2

■ The ground wire must be separated from the output cables.

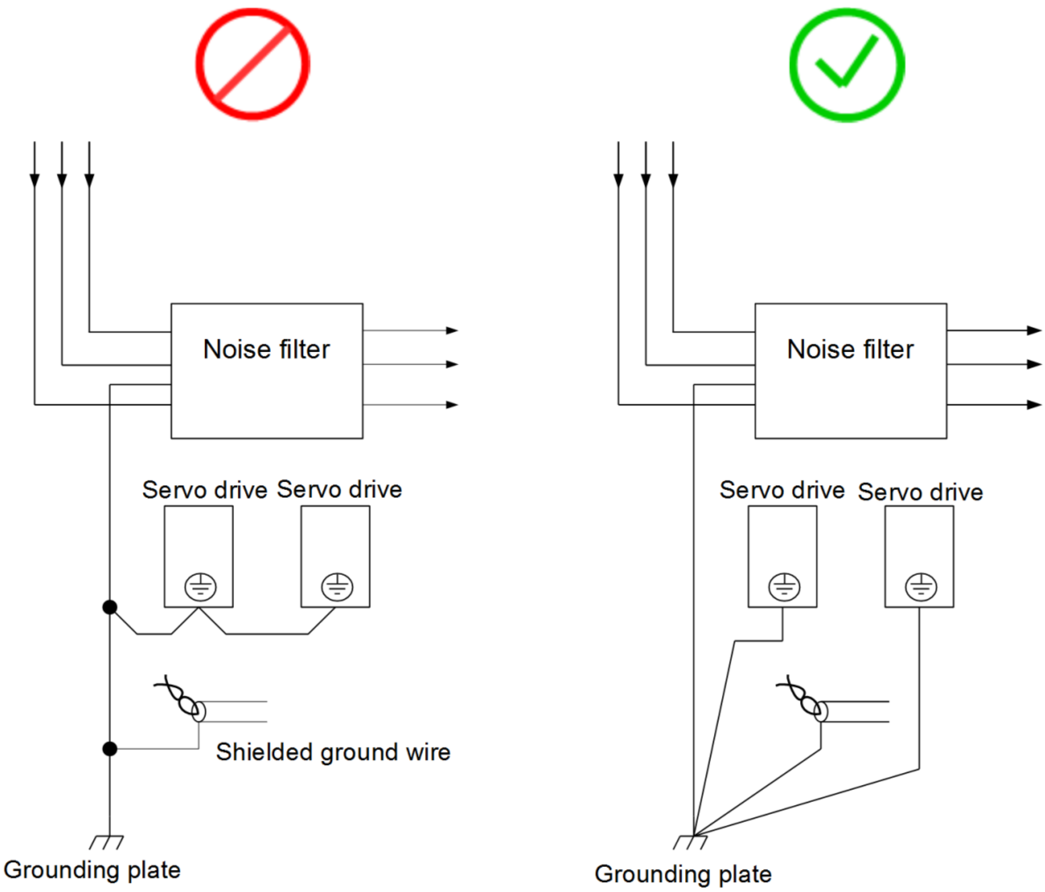


Figure5.1.2.3

- Do not put the ground wire, output cables and other signal cables in the same cable tray or tie them together.

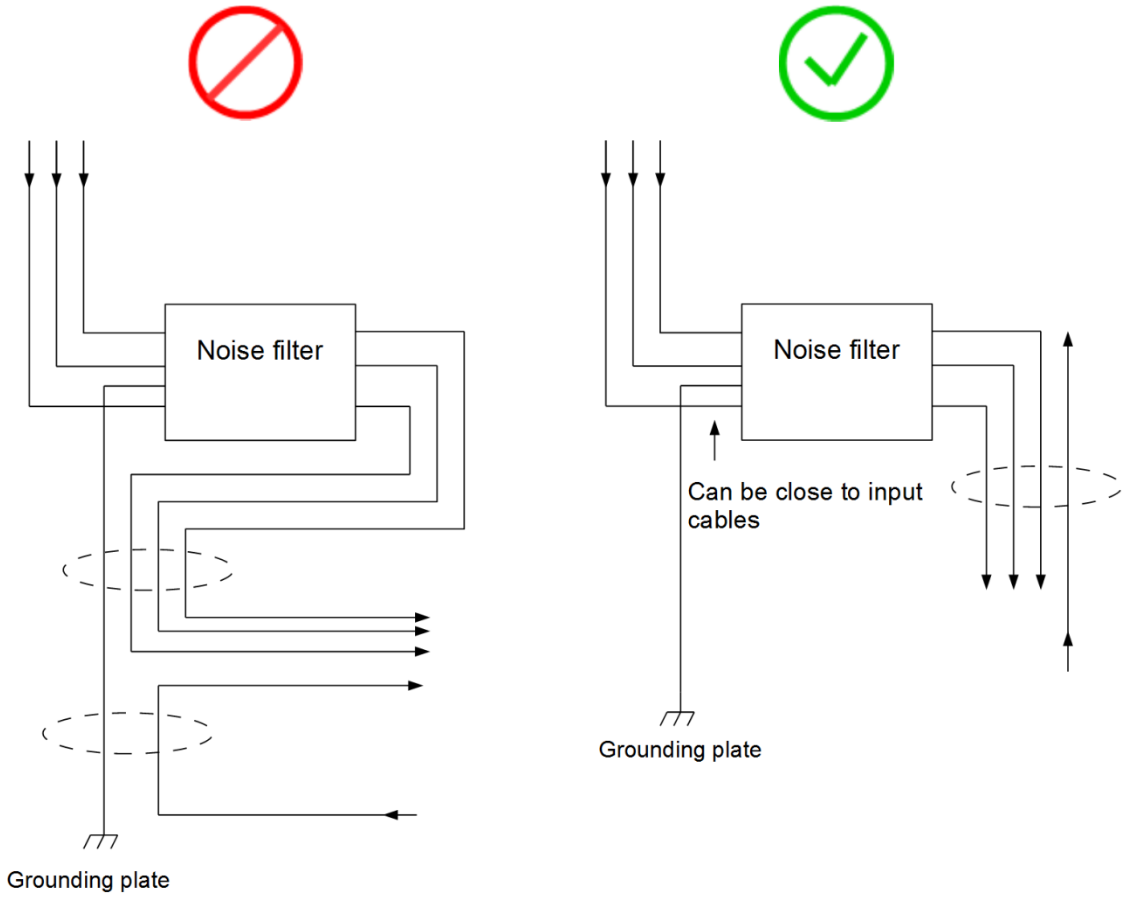


Figure5.1.2.4

- If noise filter is installed inside a control box, connect the ground wires of the noise filter and other device to the grounding plate of the control box. Then ground the grounding plate.

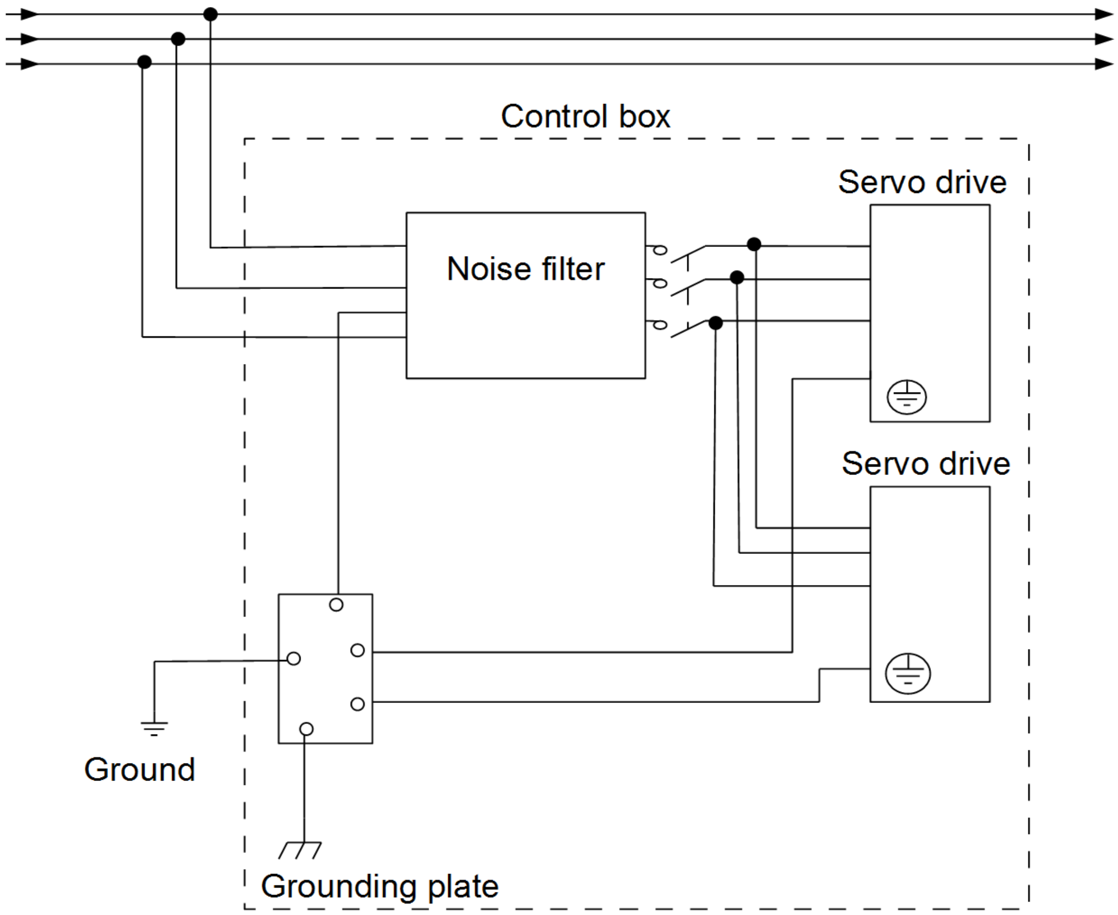


Figure5.1.2.5

- While connecting multiple servo drives, the control signal cables (CN6) must be away from the main power cables to prevent signal from being interfered.

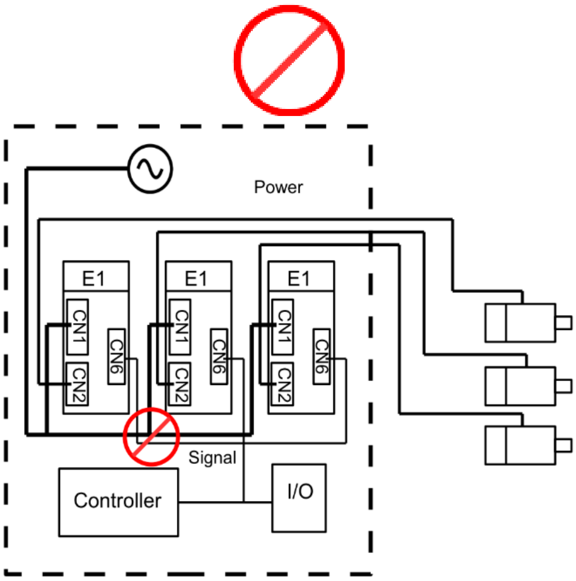


Figure5.1.2.6

5.1.3 Grounding

To prevent interference from causing false operation, perform grounding by following the instructions below.

(1) Use the third type grounding or D type grounding (Grounding resistance must be below 100 Ω.).

(2) The servo drive cannot share the same power supply with electric welding machine or electric discharge machine. If there is high frequency generator near the servo drive, install noise filter at the input sides of main circuit power cable and control circuit power cable. For installation instructions of noise filter, please refer to section 5.1.2.

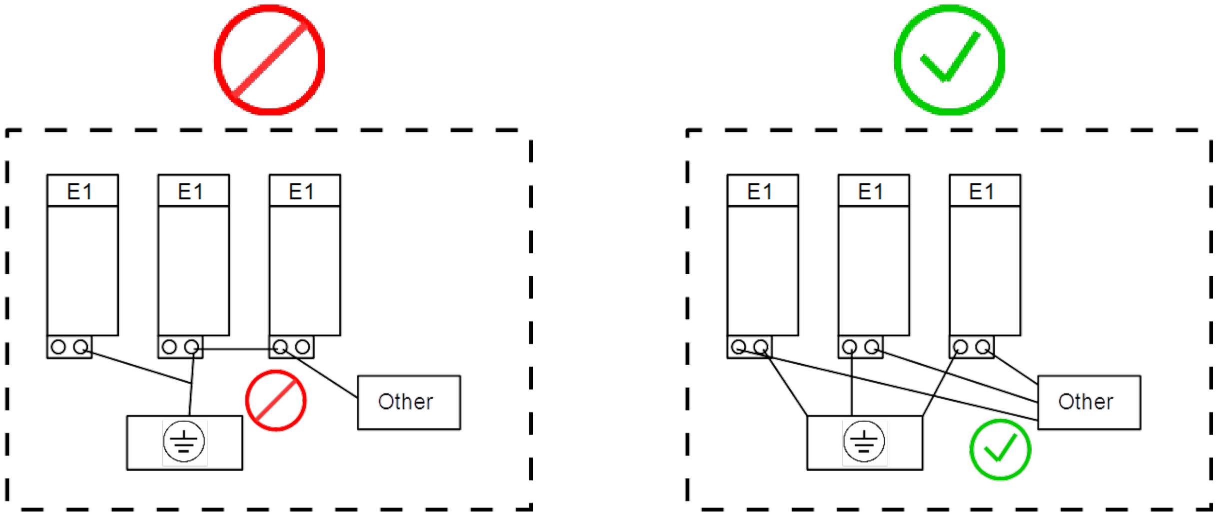


Figure5.1.3.1

(3) The ground wire must be as short as possible. Parallel and single-point grounding is suggested.

(4) If servo motor is insulated from machine, ground the servo motor directly.

(5) If there is high frequency generator (such as electric welding machine, electric discharge machine or frequency converter) in servo system, the high frequency generator must be grounded independently to avoid interference to other device.

(6) When servo motor is grounded through a machine, switching noise current may flow out from the servo drive main circuit via the stray capacitance of the servo motor. To avoid the above situation, connect the frame or grounding terminal of the servo motor to the grounding terminal ⏚ of the servo drive. Then ground the grounding terminal ⏚ of the servo drive. When linear motor is used, both the forcer and stator must be grounded.

(7) When control signal cable is interfered, connect its shield to its connector shell. Then perform grounding.

5.1.4 Shielding of motor power cable

The goal of this section is to show how to make effective grounding of motor power cable shielding when 400 V input power servo drive is used.

The noise created during the operation of a motor may disturb the work of a servo drive through transmission and radiation.If the power cable is not shielded, the noise will transmit to the ground to form common mode signal voltage through stray capacitance. The common mode noise from the power cable will copule with signals nearby through stray capacitance. To avoid the distribution, a user has to shield the power cable and make the grounding from the motor directly to the servo drive.

(1) Get a 1.5 CM heat shrink tube and put the cable through it. Remove the insulating tube for around 4.5-5.5 CM so the conductor and separation net in the cable can be seen, as shown below.

Figure5.1.4.1

(2) Circle the copper foil tape (around 10 CM) on the insulating tube. Fold back the separation net to the insulating tube. Fix them together with the copper foil tape (around 10 CM).

Figure5.1.4.2

(3) Peel off the insulating material of the inner cable (around 1 CM) so the metal conductors can be seen.

Figure5.1.4.3

(4) Get another 2 CM heat shrink to fix the copper foil tape and the inner conductors.

Figure5.1.4.4

(5) Fix the four conductors to the terminals according to the servo CN2B drive terminal indicators. Please make sure the the shielding back panel contacts the copper foil tape.

Figure5.1.4.5

(6) Use the cable tie in the servo drive accessory kit to fix the shielding back panel and the copper foil tape together (make sure they are firmly fastened).

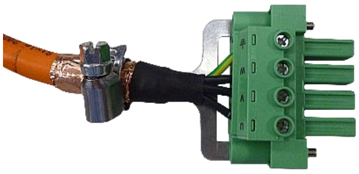


Figure5.1.4.6

(7) Move the 1.5 CM heat shrink tube in step (1) to the copper foil tape. Make sure the copper foil tape is firmly fastened by the tube.

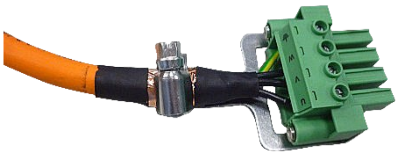


Figure5.1.4.7

Note:
The shielding should fully cover the motor power cable from motor to servo drive. The shielding effect will be affected if the cover is broken.

5.2 Wiring diagrams

5.2.1 Connections to peripheral devices

5.2.1.1 110 V / 220 V input power

■ Servo drive 400 W-2 kW

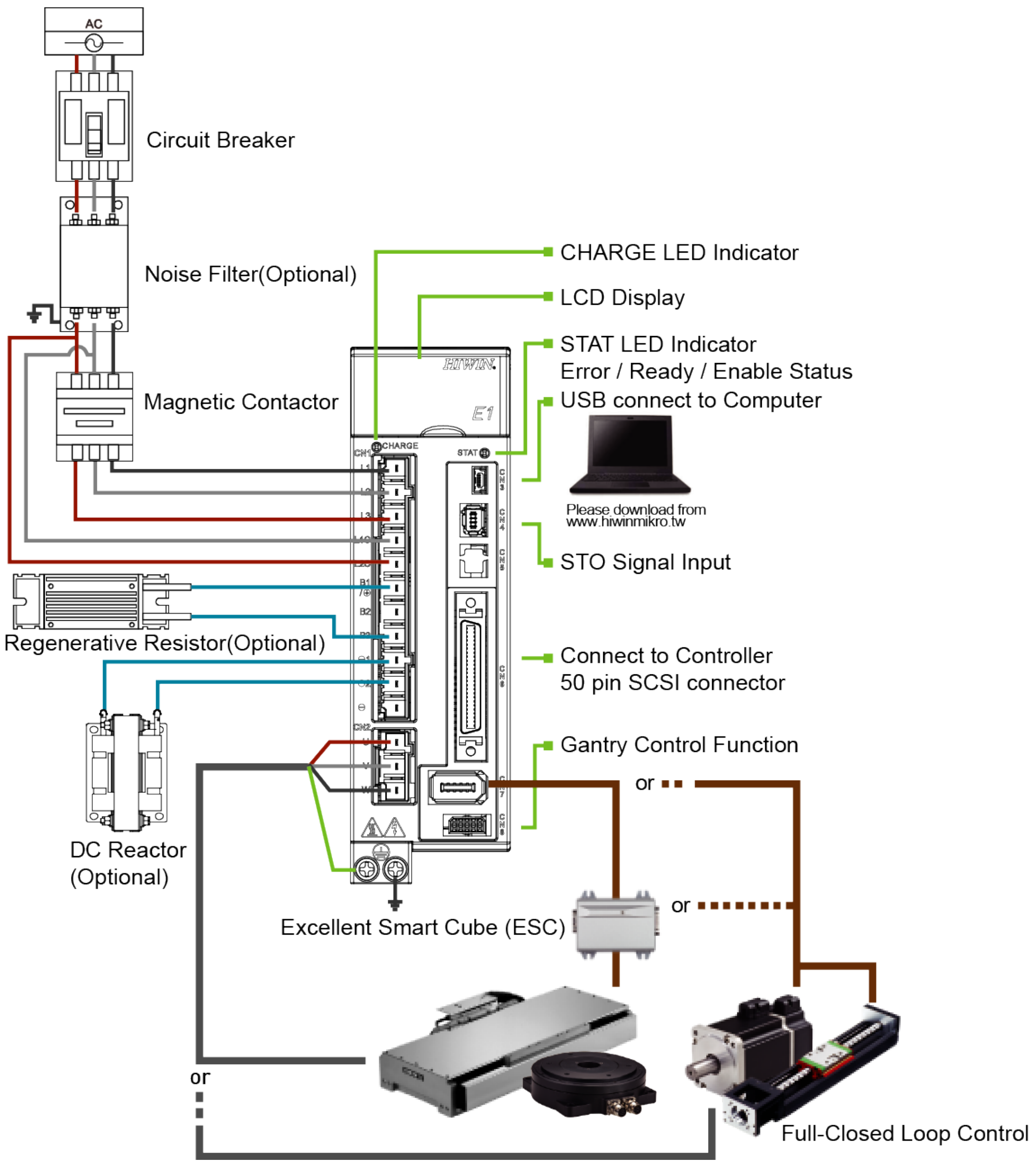


Figure5.2.1.1.1

■ Servo drive 4 kW

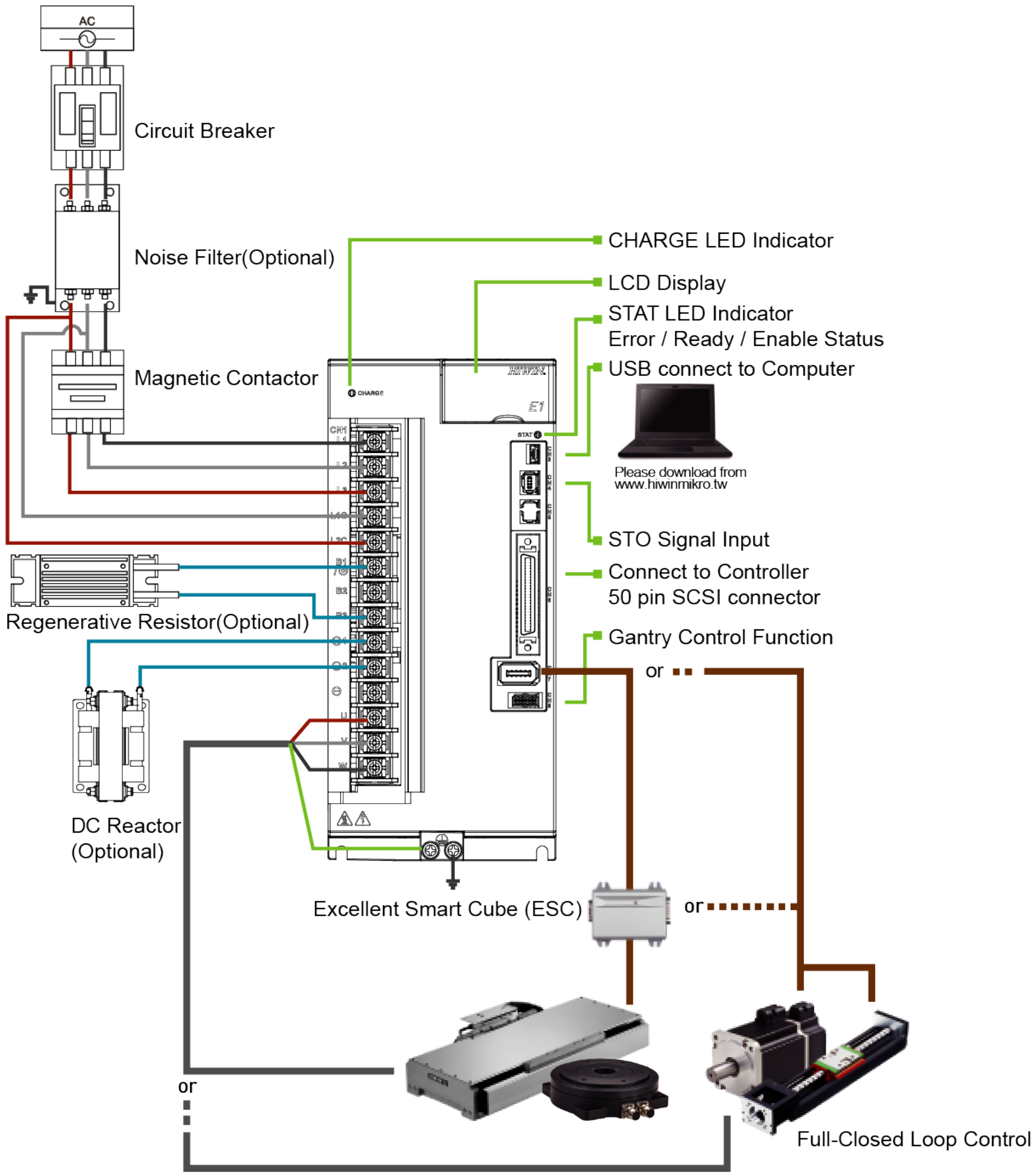


Figure5.2.1.1.2

5.2.1.2 400 V input power

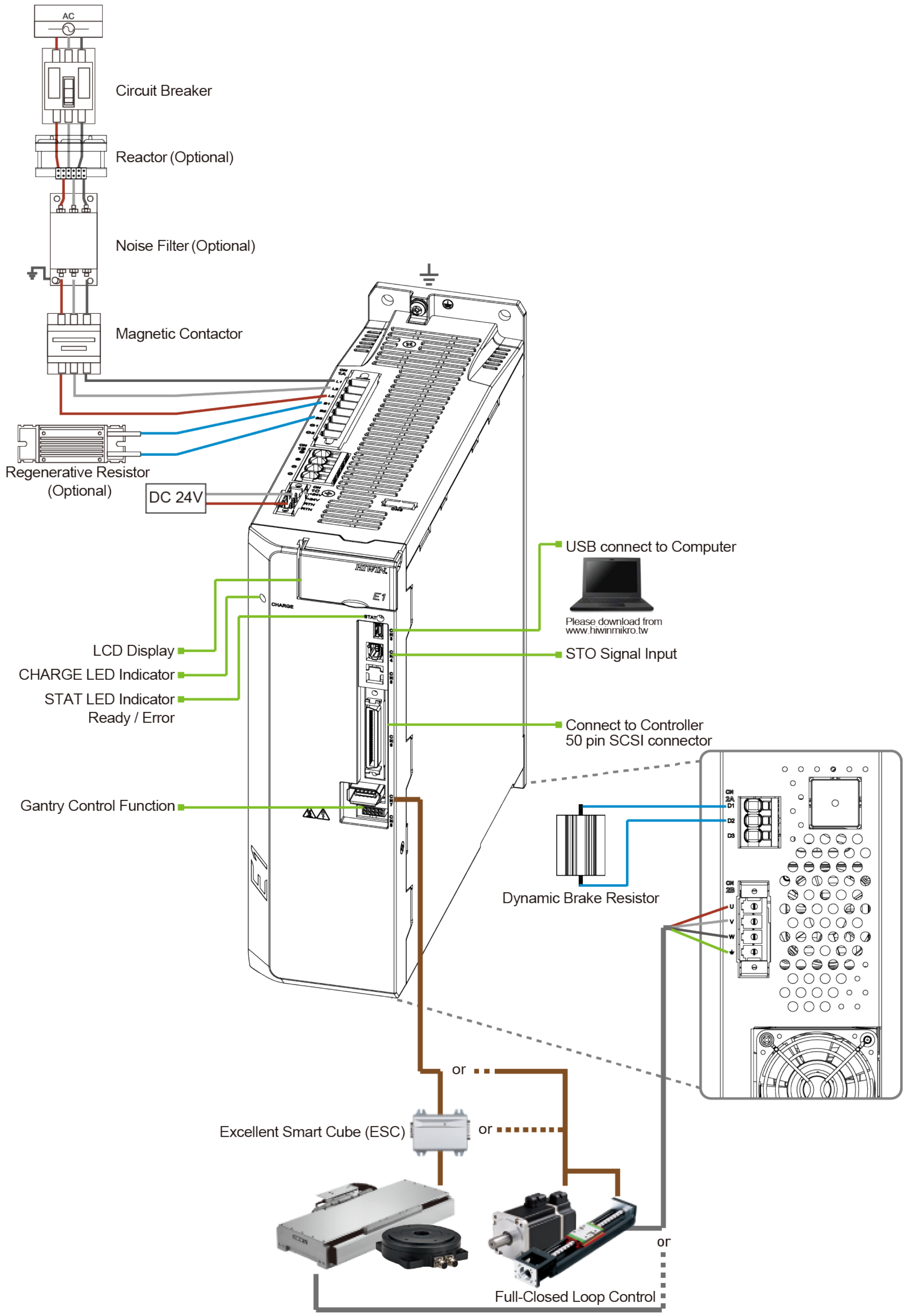


Figure5.2.1.2.1

5.2.2 Wiring diagrams for different modes

- Position mode-Standard model, ED1S

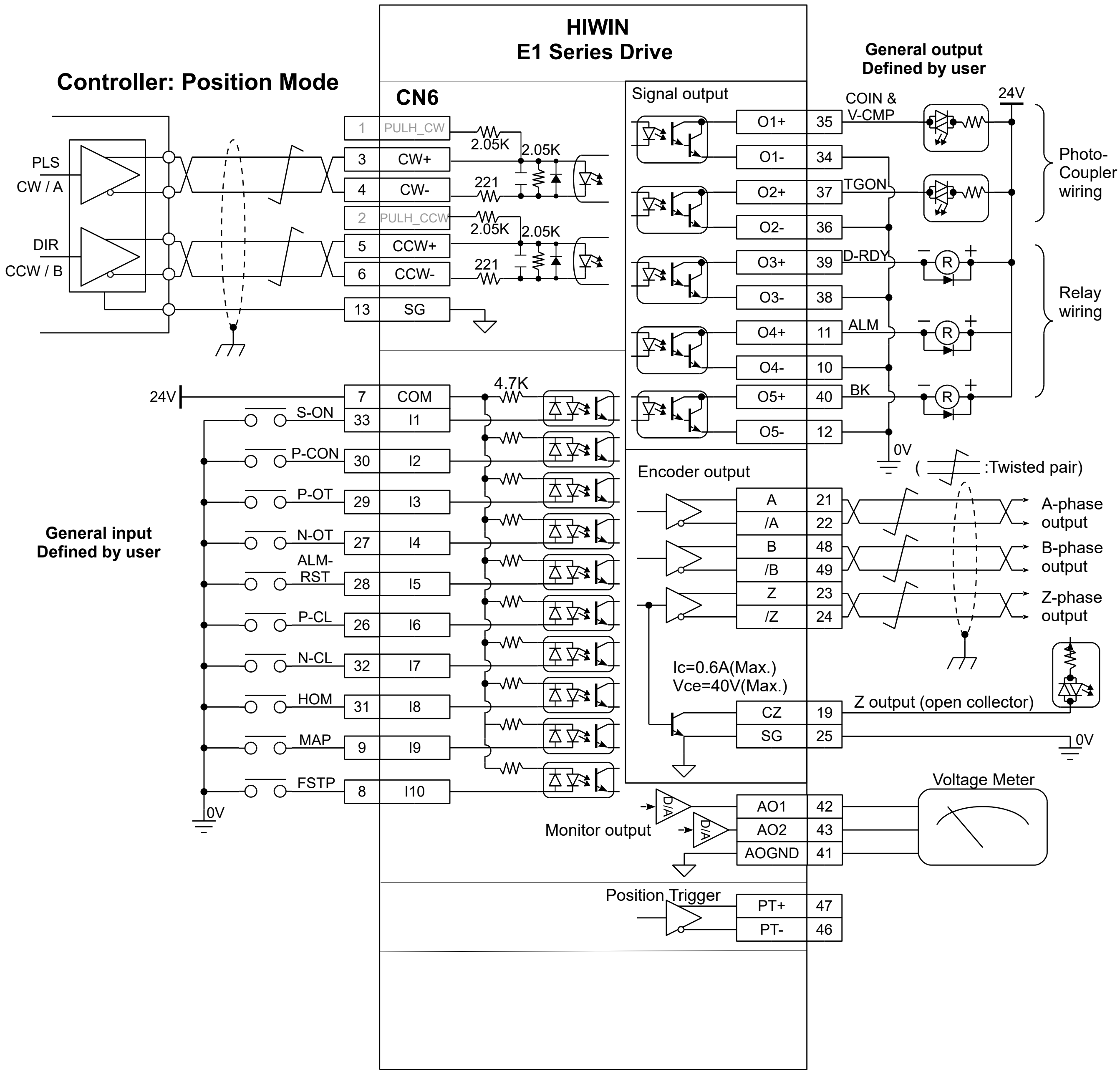


Figure5.2.2.1

- Velocity mode-Standard model, ED1S

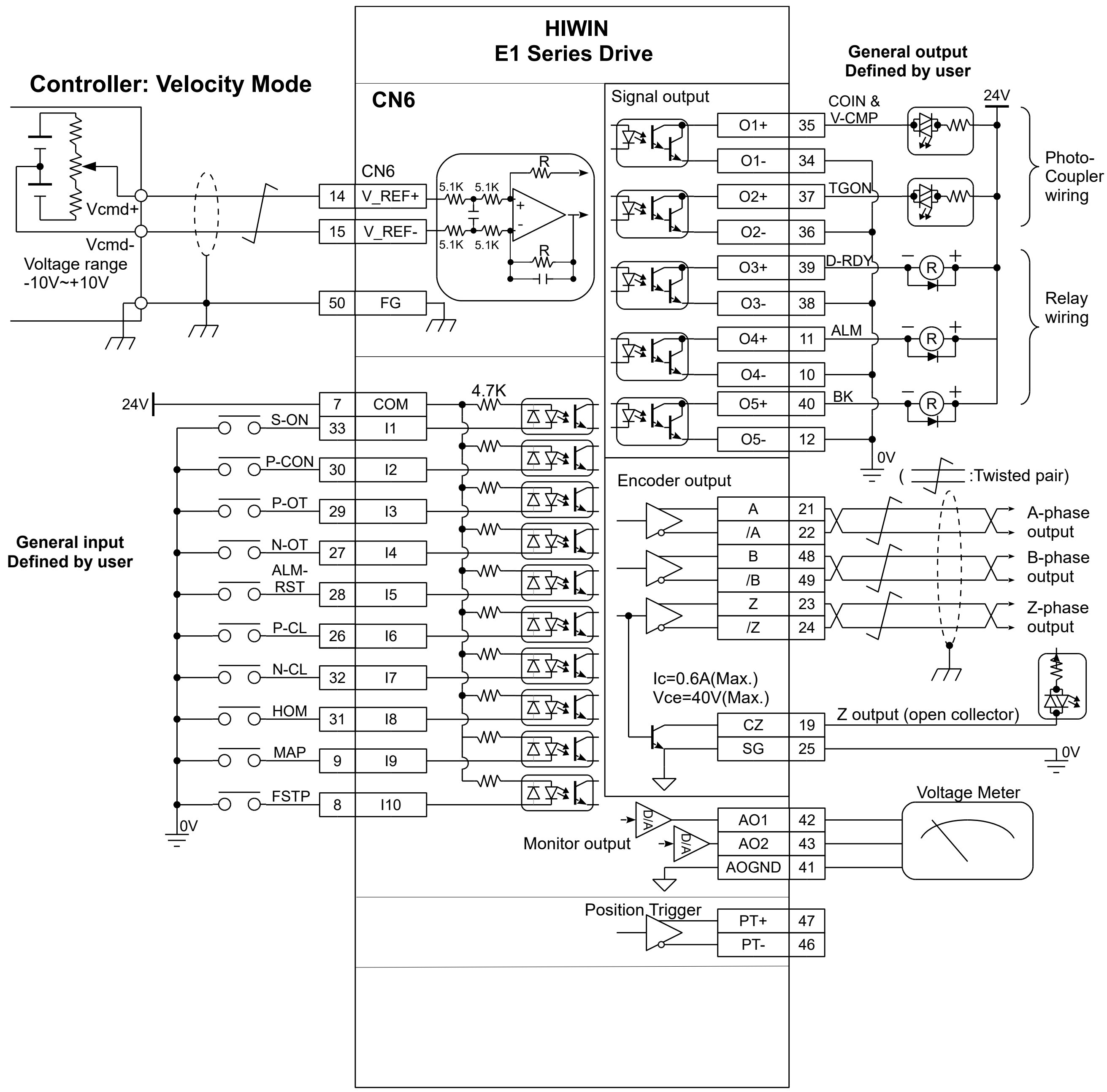


Figure5.2.2.2

■ Torque mode-Standard model, ED1S

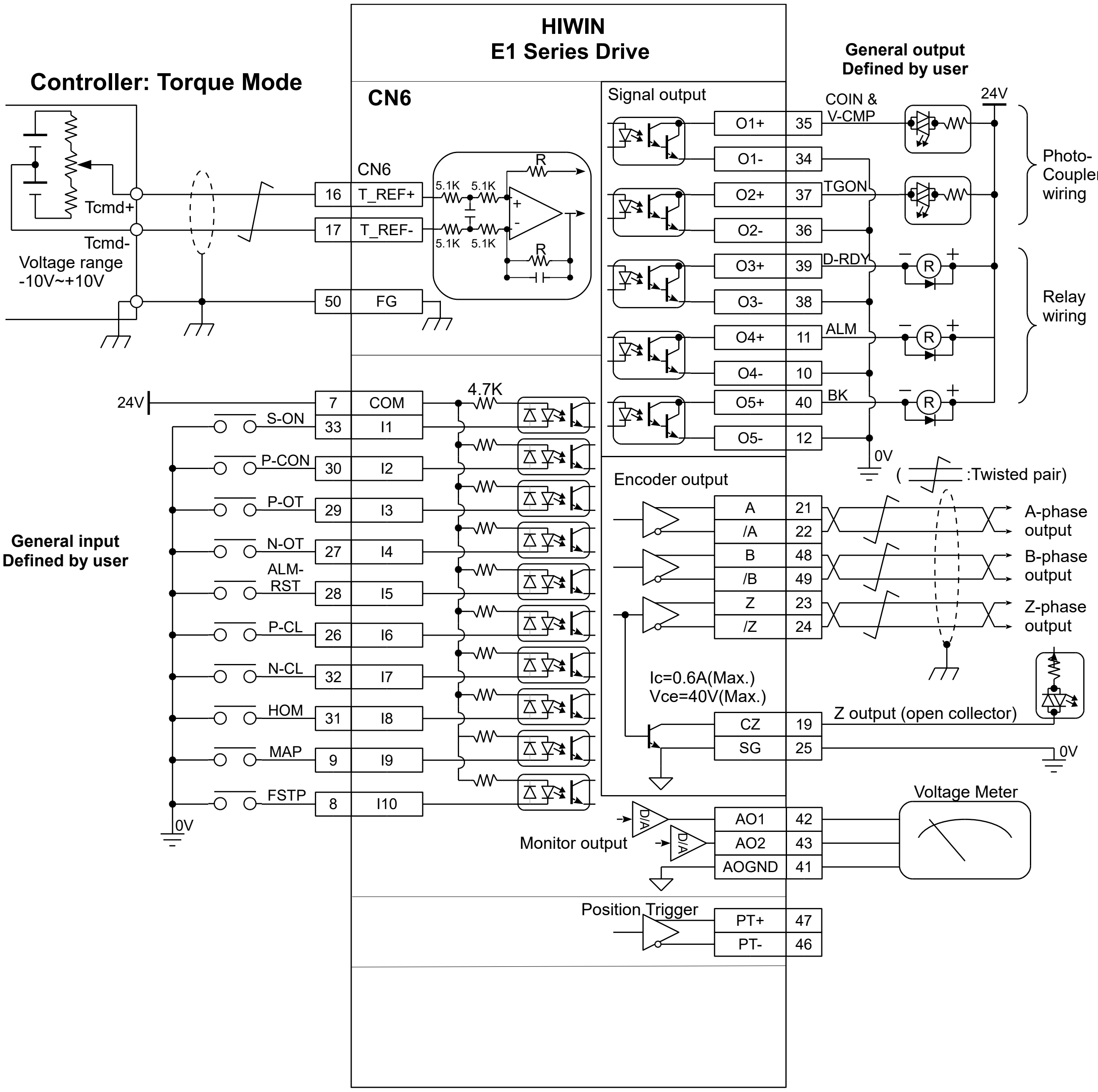


Figure5.2.2.3

■ Fieldbus model, ED1F

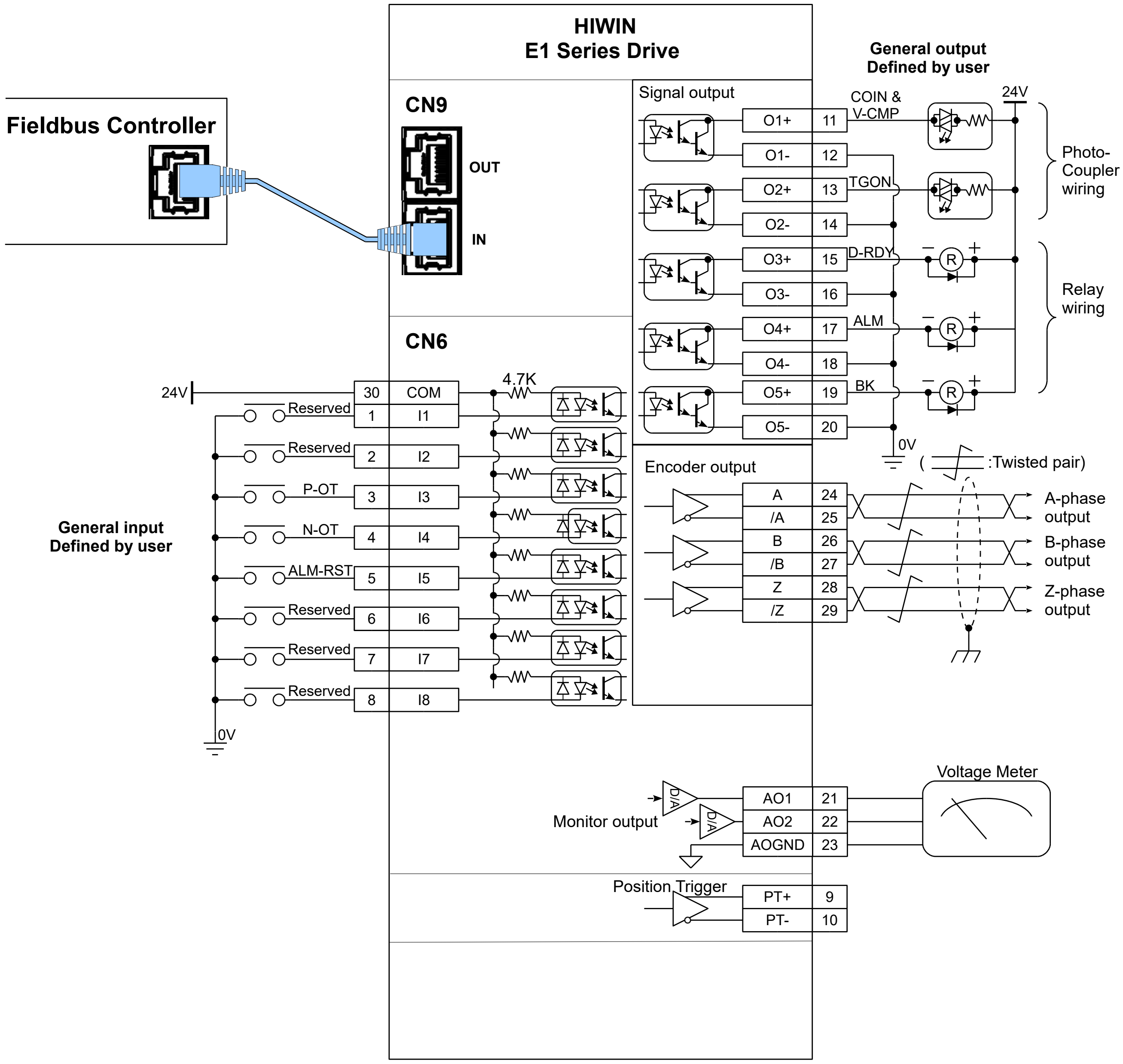


Figure5.2.2.4

5.2.3 Power terminal suggested wire size

Table5.2.3.1 Rated input voltage 110 VAC / 220 VAC 400 W~2 kW suggested wire size

<table>
<tr><th colspan="2" rowspan="2">Suggested wire size</th><th colspan="6">Terminal signal</th></tr>
<tr><th colspan="4">CN1
European terminal</th><th>CN2
European terminal</th><th>Frame
R type
terminal
(M4)</th></tr>
<tr><th>Model No.</th><th>Input power</th><th>L1、L2、L3</th><th>L1C、L2C</th><th>B1/⊕、B2、B3</th><th>⊖1、⊖2</th><th>U、V、W</th><th>⏚</th></tr>
<tr><td>ED1□-□□-0422</td><td>Single phase</td><td>20 AWG/600 V</td><td rowspan="9">22 AWG
/600 V</td><td rowspan="9">14 AWG
/600 V</td><td rowspan="9">14 AWG
/600 V</td><td>20 AWG/600 V</td><td rowspan="9">14 AWG
/600 V</td></tr>
<tr><td>ED1□-□□-0522</td><td>Single phase</td><td>20 AWG/600 V</td><td>20 AWG/600 V</td></tr>
<tr><td>ED1□-□□-1022</td><td>Single phase</td><td>16 AWG/600 V</td><td>18 AWG/600 V</td></tr>
<tr><td>ED1□-□□-1222</td><td>Single phase</td><td>16 AWG/600 V</td><td>18 AWG/600 V</td></tr>
<tr><td>ED1□-□□-0422</td><td>Three phase</td><td>22 AWG/600 V</td><td>20 AWG/600 V</td></tr>
<tr><td>ED1□-□□-0522</td><td>Three phase</td><td>22 AWG/600 V</td><td>20 AWG/600 V</td></tr>
<tr><td>ED1□-□□-1022</td><td>Three phase</td><td>20 AWG/600 V</td><td>18 AWG/600 V</td></tr>
<tr><td>ED1□-□□-1222</td><td>Three phase</td><td>20 AWG/600 V</td><td>18 AWG/600 V</td></tr>
<tr><td>ED1□-□□-2032</td><td>Three phase</td><td>14 AWG/600 V</td><td>14 AWG/600 V</td></tr>
</table>

Note: (1) Do not connect and use CN1 signal ⊖ terminal. (2) 2 kW servo drives only support three-phase 220 VAC input power.

Table5.2.3.2 Rated input voltage 220 VAC 4 kW suggested wire size

<table>
<tr><th colspan="2" rowspan="2">Suggested wire size</th><th colspan="6">Terminal signal</th></tr>
<tr><th colspan="5">CN1
R type terminal (M4)</th><th>Frame
R type
terminal
(M4)</th></tr>
<tr><th>Model No.</th><th>Input power</th><th>L1、L2、L3</th><th>L1C、L2C</th><th>B1/⊕、B2、B3</th><th>⊖1、⊖2</th><th>U、V、W</th><th>⏚</th></tr>
<tr><td>ED1□-□□-4032</td><td>Three phase</td><td>10 AWG/600 V</td><td>22 AWG
/600 V</td><td>12 AWG
/600 V</td><td>12 AWG
/600 V</td><td>8 AWG/600 V</td><td>14 AWG
/600 V</td></tr>
</table>

Note: Do not connect and use CN1 signal ⊖ terminal.

Table5.2.3.3 Rated input voltage 400 VAC suggested wire size

<table>
<tr><th colspan="2" rowspan="2">Suggested wire size</th><th colspan="6">Terminal signal</th></tr>
<tr><th colspan="2">CN1A
European terminal</th><th>CN1C
European
terminal</th><th>CN2B
European
terminal</th><th>CN2A
European
terminal</th><th>Frame
R type
terminal
(M4)</th></tr>
<tr><th>Model No.</th><th>Input power</th><th>L1、L2、L3</th><th>B1、B2、B3</th><th>24V、RTN</th><th>U、V、W、
⏚</th><th>D1、D2、D3</th><th>⏚</th></tr>
<tr><td>ED1□-□□-5033</td><td>Three phase</td><td>12 AWG/600 V</td><td rowspan="2">10 AWG/600 V</td><td rowspan="2">20 AWG
/600 V</td><td>12 AWG
/600 V</td><td rowspan="2">10 AWG
/600 V</td><td rowspan="2">14 AWG
/600 V</td></tr>
<tr><td>ED1□-□□-7533</td><td>Three phase</td><td>10 AWG/600 V</td><td>8 AWG
/600 V</td></tr>
</table>

Note: Do not connect and use CN1B signal ⊕,⊖ terminal.

5.3 Wiring for power supply

5.3.1 110 V / 220 V input power

5.3.1.1 Terminal symbols and terminal names (CN1)

AC 110 V / AC 220 V wirings for main circuit power supply and control circuit power supply are described as below.

⚠CAUTION
◆ Wiring must be correctly performed by referring to this section. Incorrect wiring may cause product malfunction and fire.

The input power for the 400 W~1.2 kW servo drive main circuit can be three-phase AC 220 V or single-phase AC 110 V / AC 220 V.

The input power for the 2 kW and 4 kW servo drive main circuit should be three-phase AC 220 V.

(1) Three-phase AC 220 V input power (400 W-2 kW servo drives)

Table5.3.1.1.1

Terminal Symbol	Function	Description
L1, L2, L3	AC main input power terminals	Three-phase AC 200 V ~ 240 V, 50/60 Hz
L1C, L2C	Control input power terminals	Single-phase AC 200 V ~ 240 V, 50/60 Hz
B1/⊕, B2, B3	Terminals for regenerative resistor	When the capacity of internal regenerative resistor is insufficient, use B1/⊕ and B3 terminals to connect to external regenerative resistor. External regenerative resistor is an optional purchase. B2 terminal is for internal regenerative resistor.
⊖1, ⊖2	Terminals for DC reactor	The terminals are used to connect to DC reactor to suppress high order harmonic and improve power factor. If DC reactor is not used, connect the terminals with the wire provided with the servo drive.
⊖	–	Do not connect.

(2) Three-phase AC 220 V input power terminal and motor power output terminal (4 kW servo drives)

Table5.3.1.1.2

erminal Symbol	Function	Description
L1, L2, L3	AC main input power terminals	Three phase AC 200 V ~ 240 V, 50/60 Hz Suggested: R type terminal (M4)
L1C, L2C	Control input power terminals	Singal phase AC 200 V ~ 240 V, 50/60 Hz Suggested: R type terminal (M4)
B1/⊕, B2, B3	Terminals for regenerative resistor	When the capacity of internal regenerative resistor is insufficient, use B1/⊕ and B3 terminals to connect to external regenerative resistor. External regenerative resistor is an optional purchase. B2 terminal is for internal regenerative resistor. Suggested: R type terminal (M4)
⊖1, ⊖2	Terminals for DC reactor	The terminals are used to connect to DC reactor to suppress high order harmonic and improve power factor. If DC reactor is not used, connect the terminals with the wire provided with the servo drive. Suggested: R type terminal (M4)
⊖	–	Do not connect.
U, V, W	Motor power output terminal	While using HIWIN motor power cable, connect to the corresponding terminals by referring to the symbols indicated on the cable. Suggested: R type terminal (M4)

(3) Single-phase AC 110 V / AC 220 V input power (400 W~1.2 kW servo drives)

Table5.3.1.1.3

Terminal Symbol	Function	Description
L1, L2	AC main input power terminals	Single-phase AC 100 V ~ 120 V, 50/60 Hz Single-phase AC 200 V ~ 240 V, 50/60 Hz
L1C, L2C	Control input power terminals	Single-phase AC 100 V ~ 120 V, 50/60 Hz Single-phase AC 200 V ~ 240 V, 50/60 Hz
B1/⊕, B2, B3	Terminals for regenerative resistor	When the capacity of internal regenerative resistor is insufficient, use B1/⊕ and B3 terminals to connect to external regenerative resistor. External regenerative resistor is an optional purchase. B2 terminal is for internal regenerative resistor.
⊖1, ⊖2	Terminals for DC reactor	The terminals are used to connect to DC reactor to suppress high order harmonic and improve power factor. If DC reactor is not used, connect the terminals with the wire provided with the servo drive.
⊖	–	Do not connect.

While using single-phase AC 220 V as main circuit power supply, set Pt00B = t.□1□□ (Three-phase/single-phase input power selection). For more information, please refer to section 6.3.1.

5.3.1.2 Wiring for main circuit connector

⚠CAUTION

- Wiring or examination must be performed by professional technician.
- The power must be turned off before wiring or examination to avoid short circuit or electric shock.
- The residual voltage inside the servo drive could still be high after power off. Wiring should be performed five minutes after power off and the indicator goes off.

5.3.1.3 Power-on sequence

Pay attention to the following while designing power-on sequence.

(1) The control power supply must be turned on before the main circuit power supply. After 20 ms, the servo drive outputs drive ready output (D-RDY) signal. Ensure the control power supply is turned on prior to the main circuit power supply while designing power-on sequence. For information of D-RDY signal, please refer to section 8.1.5.

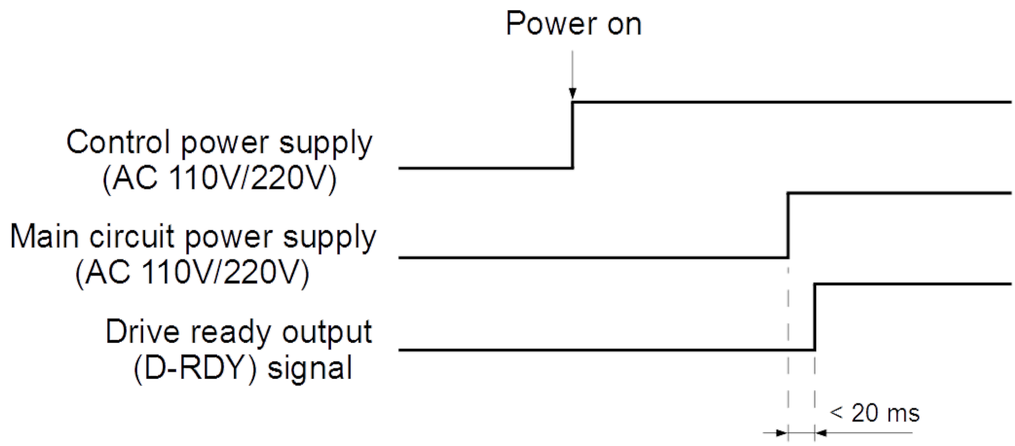


Figure5.3.1.3.1

(2) Ensure the components are compatible with the input power.

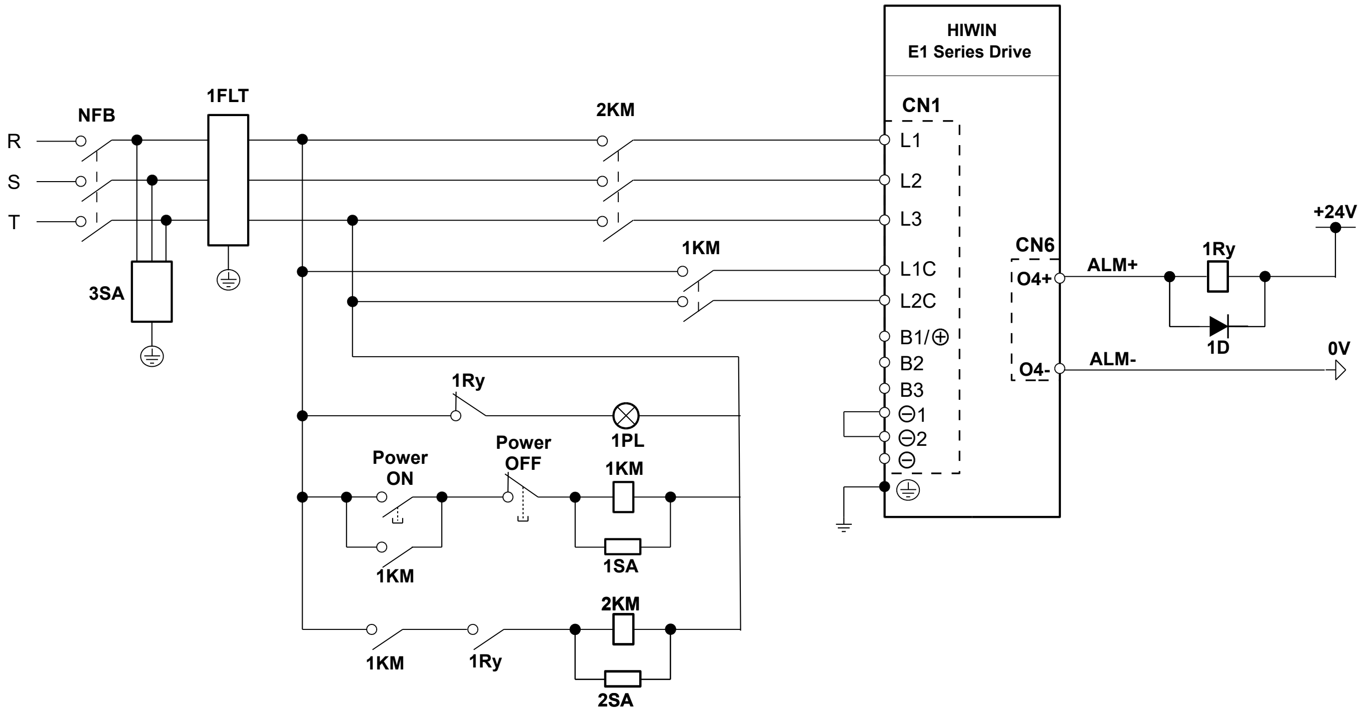
Note	
	➢ The main circuit power supply and control power supply must be turned on at the same time. Or the control power supply must be turned on before the main circuit power supply. ➢ While turning off the main circuit power supply and control power supply, turn off the main circuit power supply before the control power supply.

WARNING

◆ The residual voltage inside the servo drive could still be high after power off. To avoid electric shock, do not touch the power terminals. After the voltage discharges, the indicator goes off. Ensure the indicator goes off before wiring or examination.

5.3.1.4 Wiring diagram for power supply

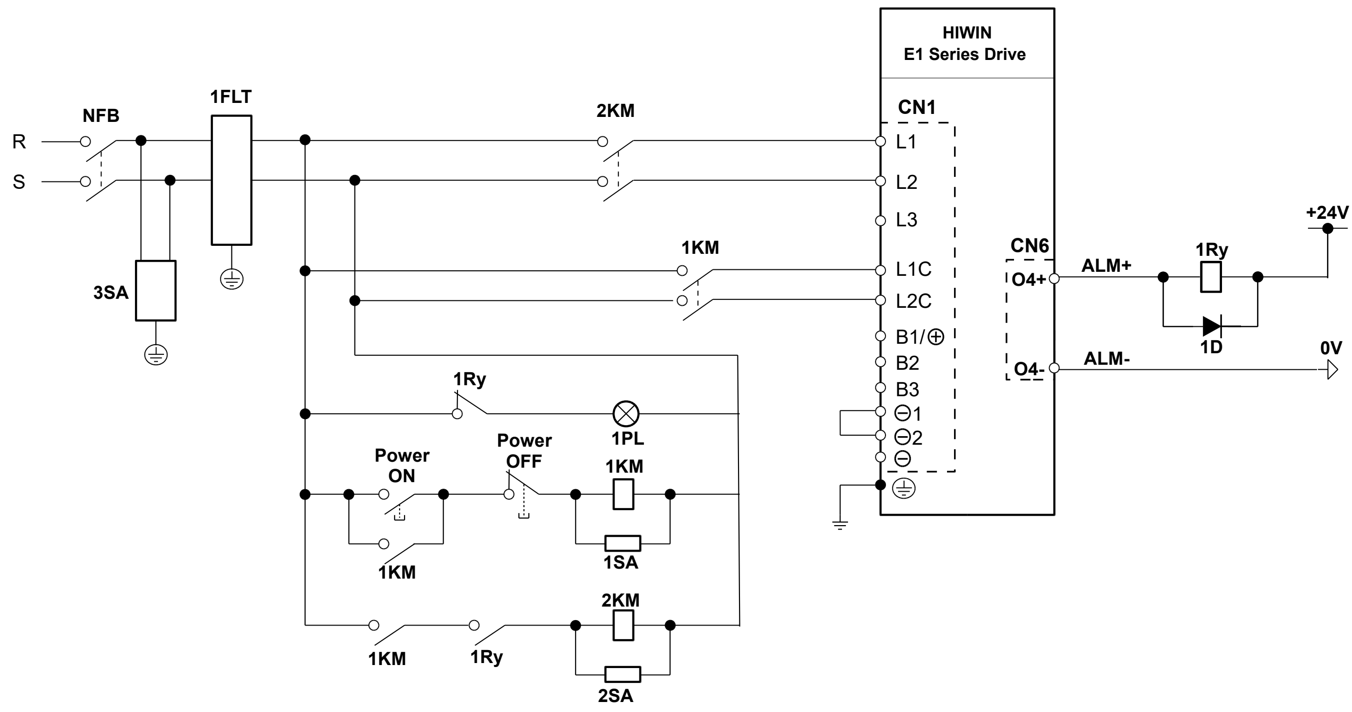
■ Wiring diagram for three-phase AC 220 V power supply



NFB: No-fuse breaker
1FLT: Noise filter
1KM: Magnetic contactor (control power supply)
2KM: Magnetic contactor (main circuit power supply)
1Ry: Relay
1PL: Indicator
1D: Bypass diode
1SA/2SA/3SA: Surge absorber

Figure5.3.1.4.1

■ Wiring diagram for single-phase AC 220 V power supply

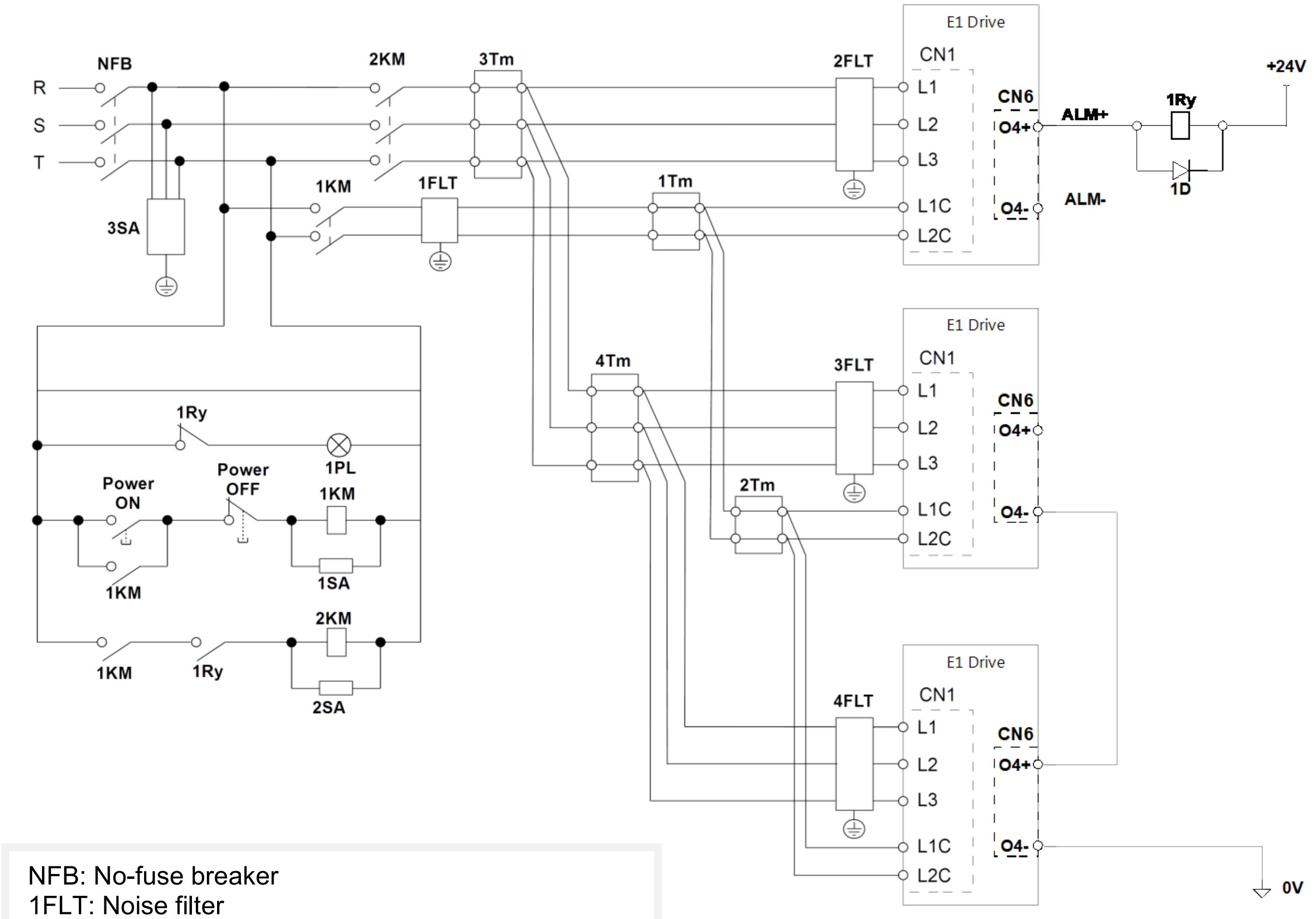


NFB: No-fuse breaker
1FLT: Noise filter
1KM: Magnetic contactor (control power supply)
2KM: Magnetic contactor (main circuit power supply)
1Ry: Relay
1PL: Indicator
1D: Bypass diode
1SA/2SA/3SA: Surge absorber

Figure5.3.1.4.2

■ Wiring diagram for connecting multiple servo drives (Three-phase AC 220 V power supply)

Multiple servo drives can share the same noise filter. But the noise filter must have sufficient capacity for the total power capacity of the servo drives. The load condition must be considered as well.



NFB: No-fuse breaker
1FLT: Noise filter
2FLT: Noise filter
3FLT: Noise filter
4FLT: Noise filter
1KM: Magnetic contactor (control power supply)
2KM: Magnetic contactor (main circuit power supply)
1Ry: Relay
1PL: Indicator
1D: Bypass diode
1SA/2SA/3SA: Surge absorber
1Tm/2Tm/3Tm/4Tm: Relay terminal

Figure5.3.1.4.3

5.3.1.5 Wiring for regenerative resistor

This section will describe how to connect to regenerative resistor.

WARNING

- ◆ The wiring of external regenerative resistor must be correctly performed. Do not directly connect B1/⊕ and B3. If B1/⊕ and B3 are directly connected, it may cause damage to the regenerative resistor as well as the servo drive and it may cause fire.

■ Connecting to external regenerative resistor

For input rated voltage 110 VAC / 220 VAC, please connect to external regenerative resistor via B1/⊕ and B3 terminals of the servo drive.

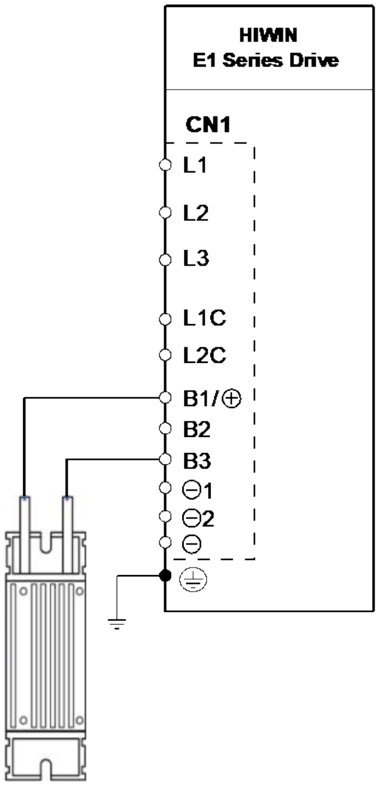


Figure 5.3.1.5.1 110 V / 220 V servo drive external regenerative resistor wiring

- Using built-in regenerative resistor

  For input rated voltage 110 VAC / 220 VAC, to use built-in regenerative resistor, please connect B1/⊕ and B2 terminals of the servo drive.

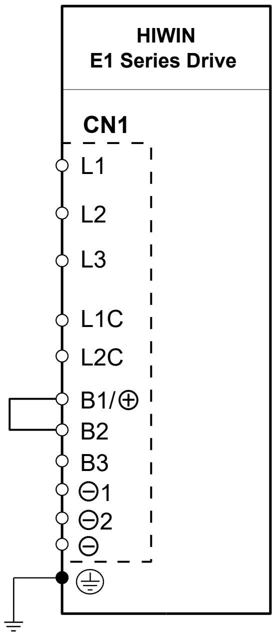


Figure 5.3.1.5.2 110 V / 220 V servo drive built-in regenerative resistor wiring

- Built-in regenerative resistor of the servo drive

Table 5.3.1.5.1

Servo drive power			400 W	500 W	1 kW	1.2 kW	2 kW	4 kW
Regenerative Resistor	Built-in Regenerative Resistor	Resistance [Ω]	-	-	40	40	12	13
		Pt603 [10 mΩ] Regenerative Resistance	-	-	4000	4000	1200	1300
		Capacity [W]	-	-	40	40	60	120
		Pt600 [10 W] Regenerative Resistor Capacity	-	-	4	4	6	12
	Minimum Allowable Resistance of External Regenerative Resistor [Ω]		40	40	40	40	40	13

Note	
	➢ Pt600 (Regenerative resistor capacity) and Pt603 (Resistance of regenerative resistor) must be correctly set when external regenerative resistor or built-in regenerative resistor is used. Otherwise, AL.320 (Regenerative energy overflow) may not be detected. And this may cause damage to the regenerative resistor, injury or fire. ➢ When Pt600 (Regenerative resistor capacity) and Pt603 (Resistance of regenerative resistor) are not set, external regenerative resistor or built-in regenerative resistor has no function. ➢ Ensure the capacity of regenerative resistor is suitable. If not, this may cause regenerative resistor burn-out, injury or fire.

5.3.1.6 Wiring for DC reactor

DC reactor is mainly used to improve power factor and suppress high order harmonic. Terminals for connecting DC reactor, ⊖1 and ⊖2 terminals, are connected as the servo drive is shipped out. Remove the wire to connect to DC reactor. If there is no need to connect to DC reactor, do not remove the wire between ⊖1 and ⊖2 terminals.

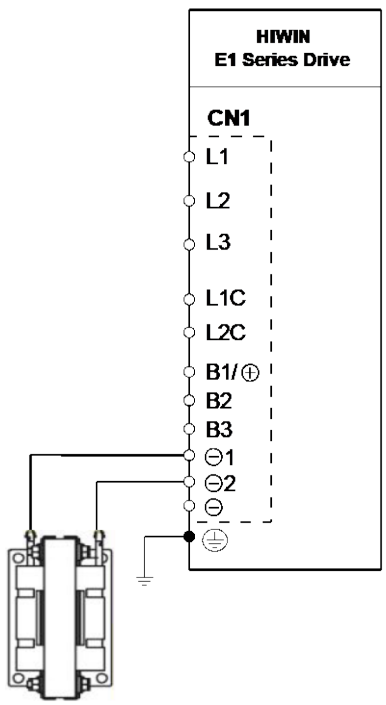


Figure 5.3.1.6.1 Wiring for DC reactor for input rated voltage 110 V / 220 V servo drives

Note	
	➢ If users remove the wire between ⊖1 and ⊖2 terminals without connecting to DC reactor, alarm AL.410 (Undervoltage) will occur.

5.3.2 400 V input power

5.3.2.1 Terminal symbols and terminal names (CN1A/CN1C)

AC 400 V servo drive wirings for main circuit power supply and control circuit power supply are described as below.

⚠CAUTION
◆ Wiring must be correctly performed by referring to this section. Incorrect wiring may cause product malfunction and fire.

The main circuit input power for the 400 V servo drives should be three-phase AC 400 V and control input power should be DC 24 V.

Table 5.3.2.1.1

Terminal Name	Terminal Symbol	Function	Description
CN1A	L1, L2, L3	AC main input power terminals	Three-phase AC 380 V ~ 480 V, 50/60 Hz Main circuit AC input power.
	B1, B2, B3	Terminals for regenerative resistor	When the capacity of internal regenerative resistor is insufficient, use B1 and B3 terminals to connect to external regenerative resistor. External regenerative resistor is an optional purchase. B1 and B2 short circuit is for built-in regenerative resistor. There is no built-in regenerative resistor for 7.5 kW servo drive.
	⊕, ⊖	-	Do not connect.
CN1C	+24V、RTN	Control input power terminals	DC 24 V±15%，2A. Two sets of +24V、RTN terminals are allowed for the parallel of multiple servo drive control powers. However, please pay attention to the capacity of the power supply.

5.3.2.2 Wiring for main circuit connector

⚠CAUTION
◆ Wiring or examination must be performed by professional technician. ◆ The power must be turned off before wiring or examination to avoid short circuit or electric shock. ◆ The residual voltage inside the servo drive could still be high after power off. Wiring should be performed five minutes after power off and the indicator goes off.

5.3.2.3 Power-on sequence

Pay attention to the following while designing power-on sequence.

(1) The control power supply must be turned on before the main circuit power supply. After 20 ms, the servo drive outputs drive ready output (D-RDY) signal. Ensure the control power supply is turned on prior to the main circuit power supply while designing power-on sequence. For information of D-RDY signal, please refer to section 8.1.5.

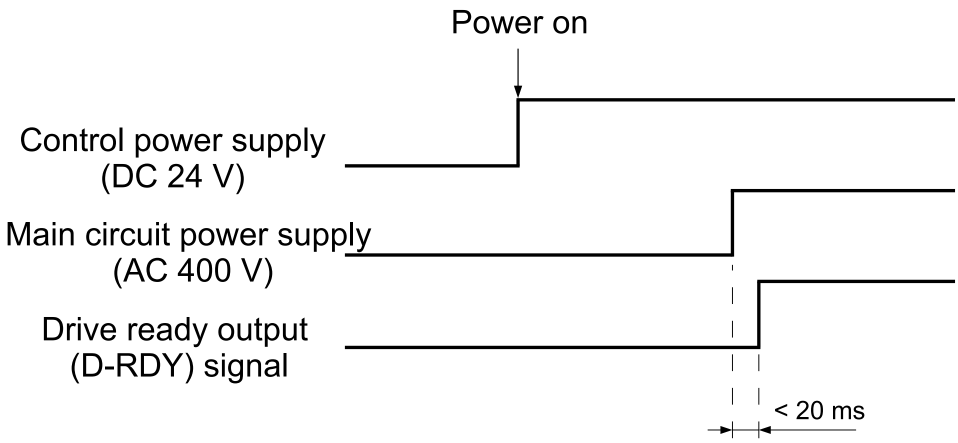


Figure5.3.2.3.1

(2) Ensure the components are compatible with the input power.

Note	
Note	➢ The main circuit power supply and control power supply must be turned on at the same time. Or the control power supply must be turned on before the main circuit power supply. ➢ While turning off the main circuit power supply and control power supply, turn off the main circuit power supply before the control power supply.

⚠WARNING
◆ The residual voltage inside the servo drive could still be high after power off. To avoid electric shock, do not touch the power terminals. After the voltage discharges, the indicator goes off. Ensure the indicator goes off before wiring or examination.

5.3.2.4 Wiring diagram for power supply

- Wiring diagram for three-phase AC 400 V power supply

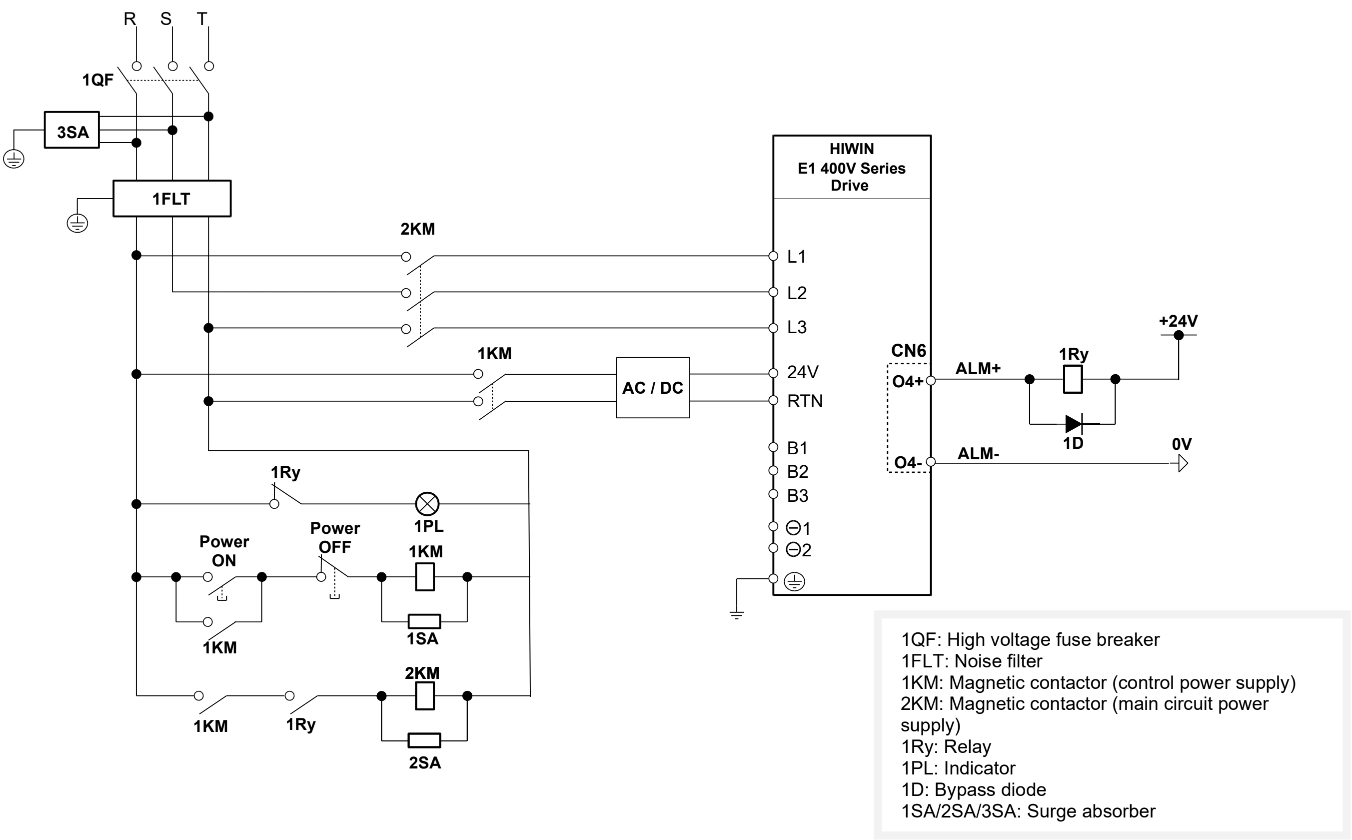
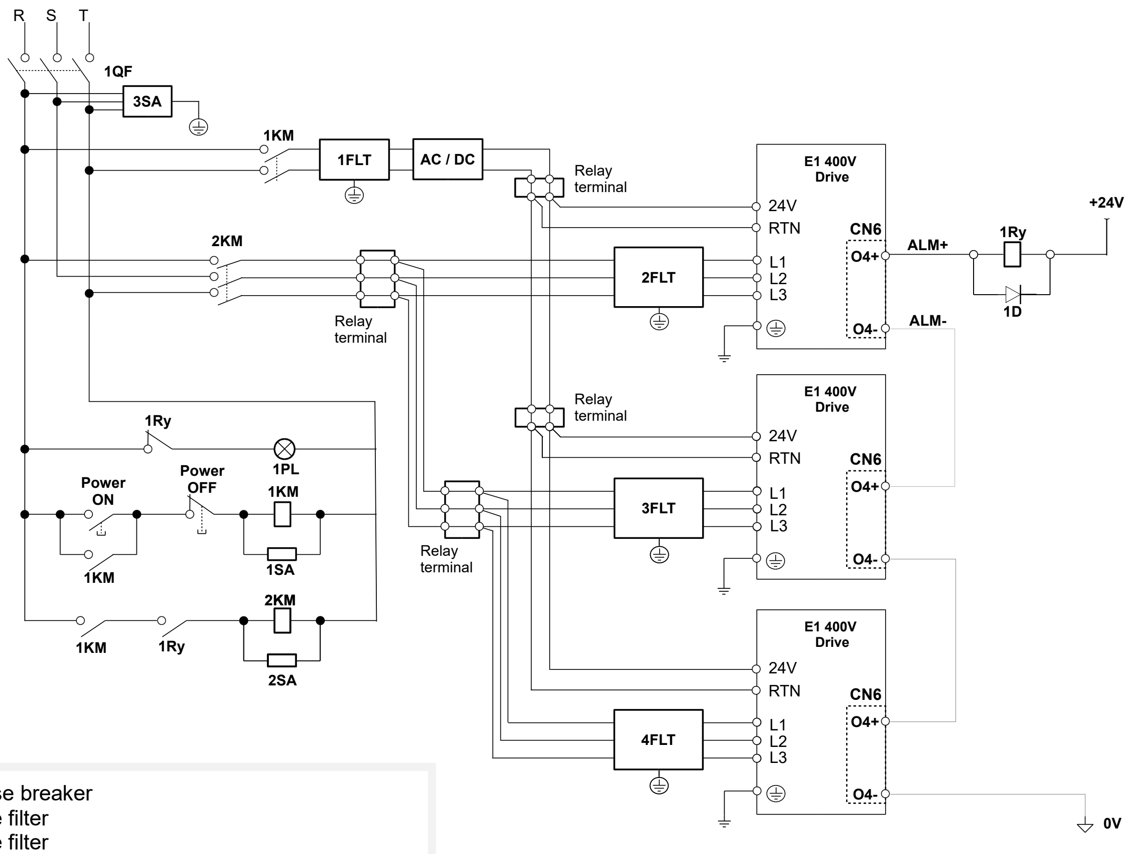


Figure 5.3.2.4.1

■ Wiring diagram for connecting multiple servo drives (Three-phase AC 400 V power supply)



1QF: No-fuse breaker
1FLT: Noise filter
2FLT: Noise filter
3FLT: Noise filter
4FLT: Noise filter
1KM: Magnetic contactor (control power supply)
2KM: Magnetic contactor (main circuit power supply)
1Ry: Relay
1PL: Indicator
1D: Bypass diode
1SA/2SA/3SA: Surge absorber
1Tm/2Tm/3Tm/4Tm: Relay terminal

Figure 5.3.2.4.2

5.3.2.5 Wiring for regenerative resistor

■ Connecting to external regenerative resistor

For input rated voltage 400 VAC, please connect to external regenerative resistor via B1 and B3 terminals of the servo drive.

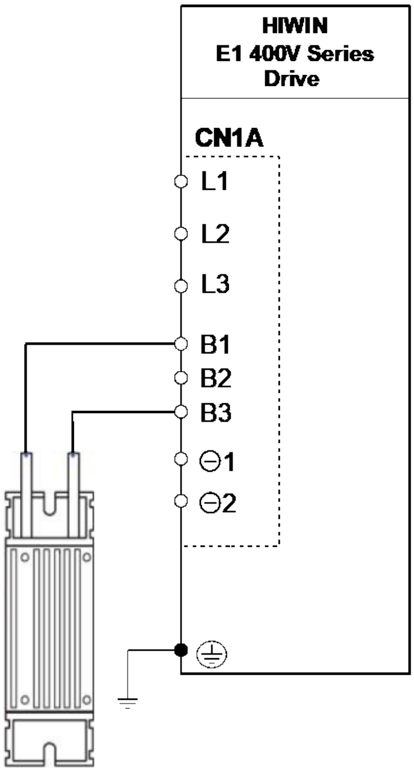


Figure 5.3.2.5.1 Wiring of 400 V servo drive external regenerative resistor

- Using built-in regenerative resistor

Please connect terminal B1 and B2 to use built-in regenerative resistor.

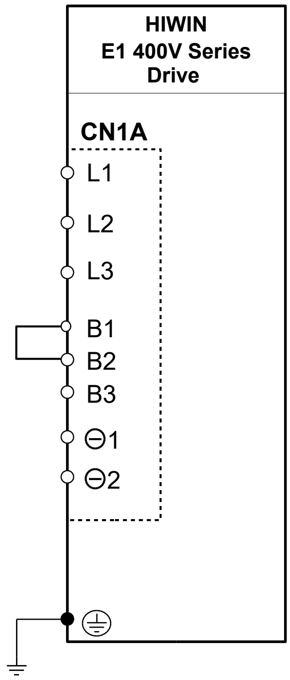


Figure 5.3.2.5.2 Wiring of 400V servo drive internal regenerative resistor

- Built-in regenerative resistor of the servo drive

Table 5.3.2.5.1

Servo drive power			5 kW	7.5 kW
Regenerative Resistor	Built-in Regenerative Resistor	Resistance [Ω]	27	-
		Pt603 [10 mΩ] Regenerative Resistance	2700	-
		Capacity [W]	180	-
		Pt600 [10 W] Regenerative Resistor Capacity	18	-
	Minimum Allowable Resistance of External Regenerative Resistor [Ω]		27	18

Note:

There is no built-in regenerative resistor for 7.5 kW servo drives.

5.3.2.6 Wiring for reactor

AC reactor is mainly used to improve power factor and suppress high order harmonic. The related wiring is shown below.

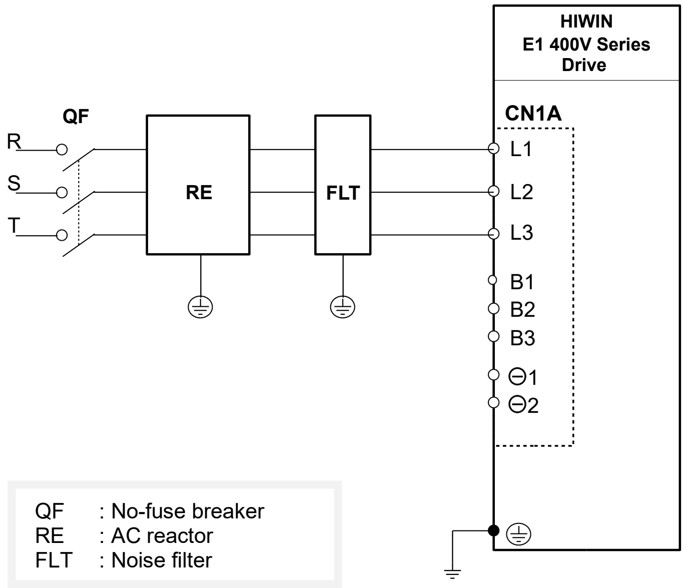


Figure 5.3.2.6.1 Wiring for AC reactor for input rated voltage 400 V servo drives

5.4 Wiring for servo motor

5.4.1 Terminal symbols and terminal names

The terminals and connectors used for connecting servo drive and motor are listed in table below.

Table5.4.1.1 110 V / 220 V input power servo drives (400 W~2 kW)

Terminal/Connector Symbol	Terminal/Connector Name	Description
CN2	Motor power connector	While using HIWIN motor power cable, connect to the terminals on CN2 by referring to the symbols indicated on the cable.
⏚	Grounding terminal	The ground wire of the motor must be connected to the grounding screw on the servo drive frame.
CN7	Encoder connector	Connect to encoder or ESC.

Note:

There is no CN2 connector for 220 V input power 4 kW servo drive. Please connect the motor cable to CN1.

Table5.4.1.2 400 V input power servo drives

Connector Symbol	Connector Name	Description
CN2B	Motor power connector	While using HIWIN motor power cable, connect to the terminals on CN2B by referring to the symbols indicated on the cable.
CN7	Encoder connector	Connect to encoder or ESC.

5.4.2 Motor power connector (CN2/CN2B)

The terminals used for connecting servo drives and motors are listed in table below.

■ 110 V / 220 V input power servo drives (400 W~2 kW) motor power connector (CN2)

Table5.4.2.1

Terminal Symbol	Function	Description
U	U phase motor power supply	Adaptable with 400 W~2 kW servo drives. While using HIWIN motor power cable, connect to the corresponding terminals by referring to the symbols indicated on the cable.
V	V phase motor power supply	
W	W phase motor power supply	

Note:

There is no CN2 connector for 220 V input power 4 kW servo drive. Please connect the motor cable to CN1.

■ 400 V input power servo drives motor power connector (CN2B)

Table5.4.2.2

Terminal Symbol	Function	Description
U	U phase motor power supply	Adaptable with 400 V servo drives. While using HIWIN motor power cable, connect to the corresponding terminals by referring to the symbols indicated on the cable.
V	V phase motor power supply	
W	W phase motor power supply	
⏚	Motor PE grounding	

5.4.3 Encoder connector (CN7)

The encoder connector and its pin definition are shown as below. E1 series servo drive supports AC servo motor with single-turn or multi-turn absolute encoder, dual loop control (AC servo motor and digital optical scale) and linear motor with digital optical scale. For information of encoder setting, please refer to section 6.12.

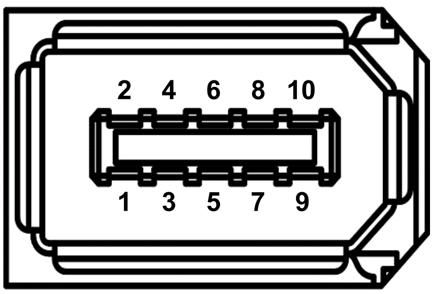


Figure5.4.3.1 Encoder connector

Table5.4.3.1

Pin	Signal	Description
1	+5VE	Encoder power
2	SG	Signal grounding
3	PS+ /E+	Encoder serial signal: PS+ Encoder alarm signal: E+
4	PS- /E-	Encoder serial signal: PS- Encoder alarm signal: E-
5	ENC_A+	Digital differential signal input: A+
6	ENC_A-	Digital differential signal input: A-
7	ENC_B+	Digital differential signal input: B+
8	ENC_B-	Digital differential signal input: B-
9	ENC_IND+	Digital differential signal input: Index+
10	ENC_IND-	Digital differential signal input: Index-
SHIELD	FG	Shield

Table5.4.3.2

Parameter		Description	Effective	Category
Pt00F	t.0□□□ (Default)	Do not detect incremental encoder signal error.	After power on	Setup
	t.1□□□	Detect incremental encoder signal error.		

Note:

(1) When linear motor with digital incremental encoder is used, digital differential encoder alarm signal (E+/E-) can be supported.

(2) This function is supported only for Thunder 1.6.11.0 or later versions.

(3) When default dual loop control (AC servo motor and digital optical scale) is used, detection of incremental encoder signal error is not supported.

While using multi-turn absolute encoder to record motor revolutions, please install battery.

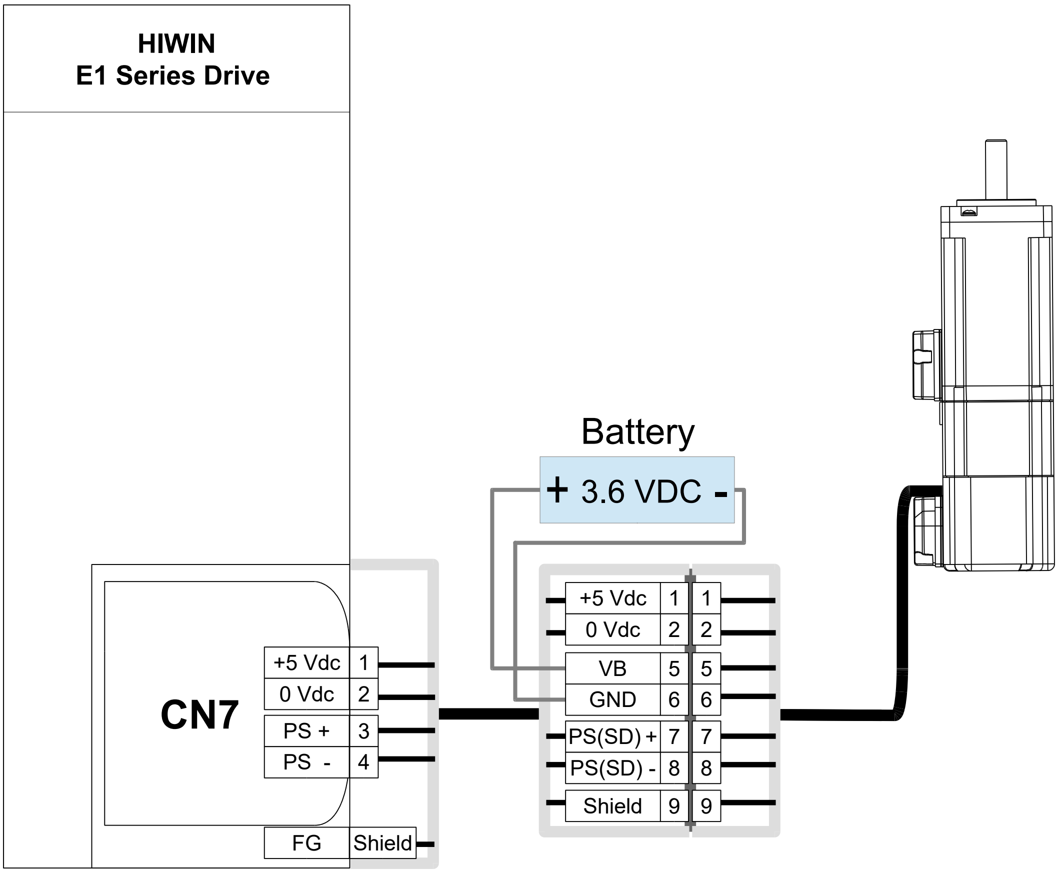


Figure5.4.3.2

Note:

(1) The battery must not be installed at the motor side to prevent interference with the machine. The battery should be installed at the servo drive side and inside the control box.

(2) For information of encoder extension cable, please refer to section 16.1.2.

(3) For information of battery box and battery, please refer to section 16.2.4.

5.4.4 Wiring for brake

5.4.4.1 Using the brake

Note

- For standard servo drive (ED1S), the default pins for brake control output (BK) signal are CN6-40/12 (O5). To change pin assignment, please refer to section 6.8.2.
- For Fieldbus servo drive (ED1F), the default pins for brake control output (BK) signal are CN6-19/20 (O5). To change pin assignment, please refer to section 6.8.2.
- While using brake, DC 24 V for brake and power for I/O signals (CN6) must not share the same power supply to avoid false operation.
- Use relay which has built-in surge absorbing diode or add surge absorbing diode by yourself to avoid digital output burn-out.

■ The wiring when brake is used with relay

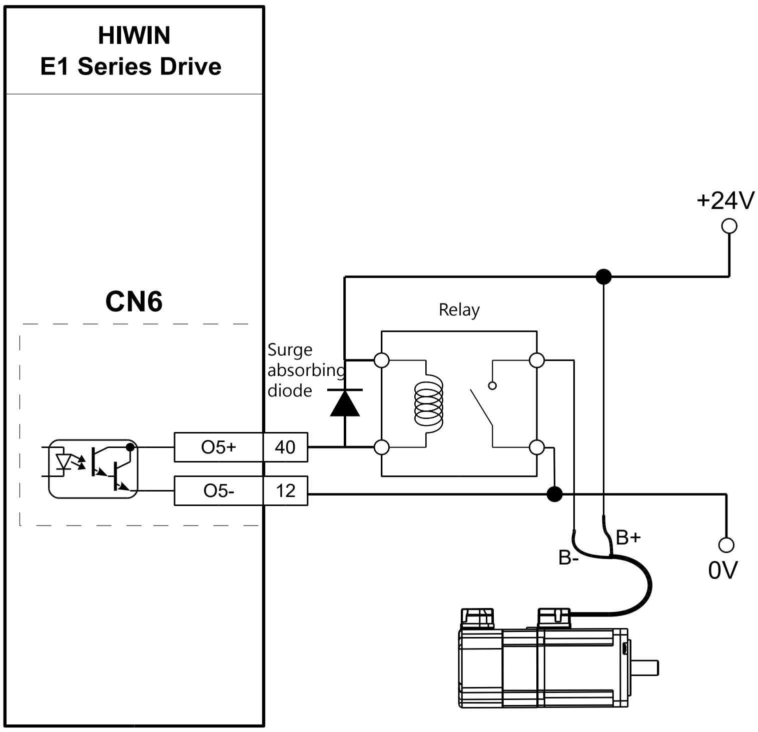


Figure5.4.4.1.1

Note:

For Fieldbus servo drive (ED1F), the default pins for brake control output (BK) signal are CN6-19/20 (O5+/O5-).

5.4.4.2 Dynamic brake

■ Procedure for setting dynamic brake (110 V / 220 V input power)

For input rated voltage 110 V / 220 V input power 1 kW E1 series servo drive or above, dynamic brake resistor is already installed inside the servo drive. However, when the motor operates over rated speed or the operating brake distance is too long, a user can connect to external dynamic brake resistor and relay or magnetic contactor according to figures below. Aluminum housed power resistor with lower resistance is suggested to improve braking distance.

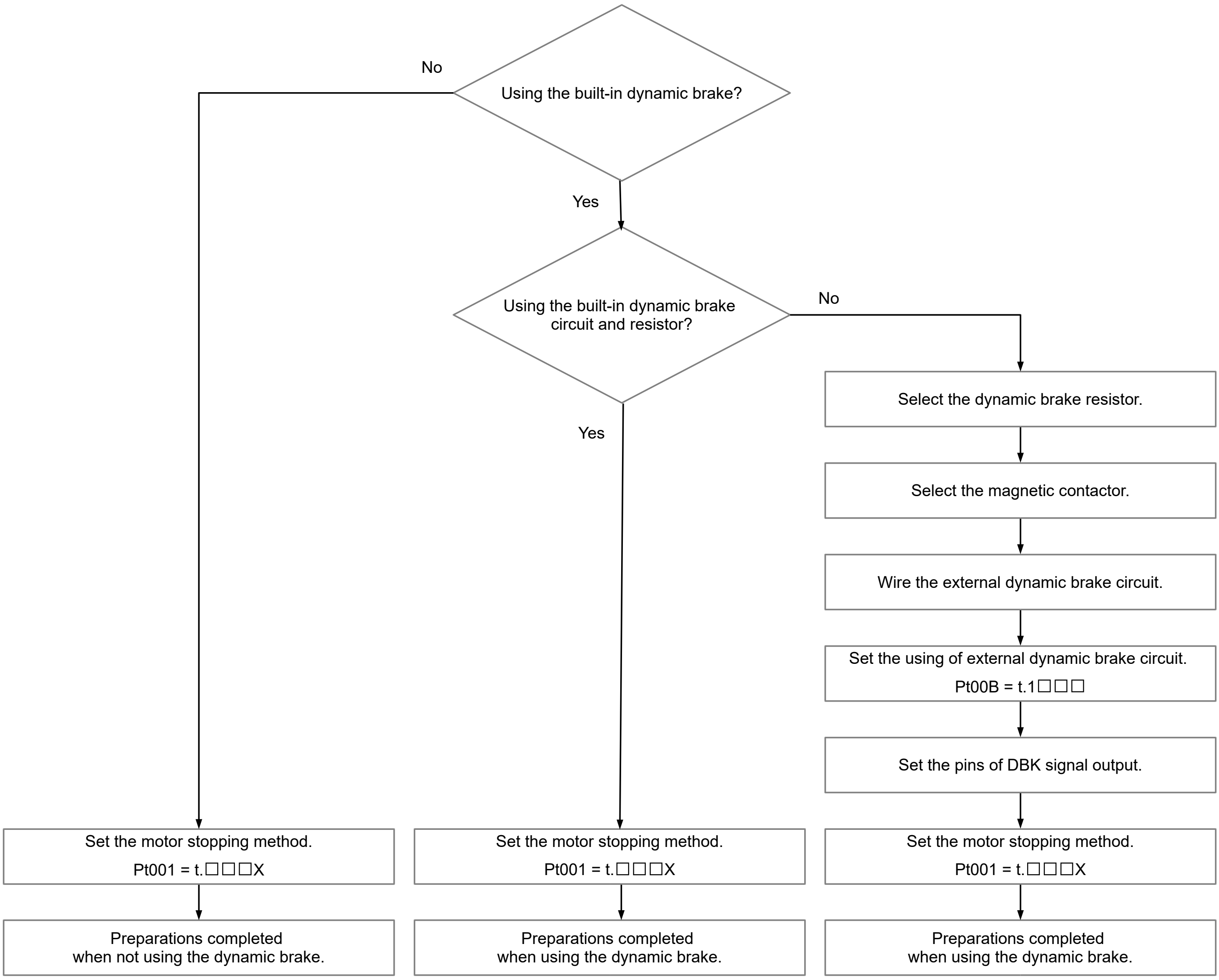
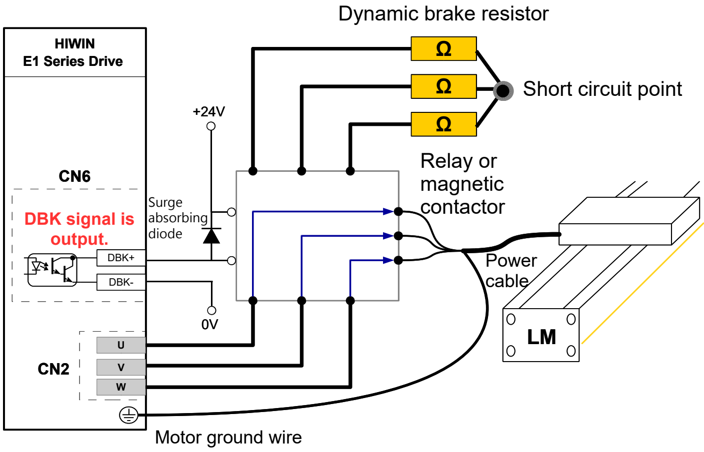
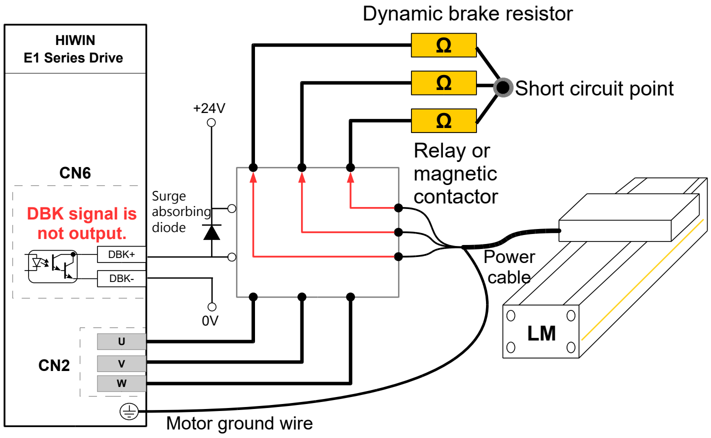


Figure 5.4.4.2.1



When DBK signal is output, the wiring between servo drive and motor is short - circuited. Motor can be enabled.



When DBK signal is not output, the wiring between servo drive and motor is open-circuited. Motor cannot be enabled. Dynamic brake resistor starts to absorb the kinetic energy of motor.

Figure5.4.4.2.2

Table5.4.4.2.1

Parameter		Description	Effective	Category
Pt00B	t.0□□□ (Default)	Use the built-in dynamic brake resistor.	After power on	Setup
	t.1□□□	Use external dynamic brake resistor.		

Note:

(1) When external dynamic brake resistor is required, use aluminum housed power resistor. The installation site must be with well ventilation and heat dissipation to avoid overheating.

(2) Use the built-in calculation function for dynamic brake resistor to calculate the resistance and power of aluminum housed power resistor. For proper braking performance, the smaller the resistance is, the larger the power should be.

(3) Pay attention to the contact point current when relay is used. If the current is too large, use magnetic contactor and the contact point of the magnetic contactor must be able to withstand large current.

■ Procedure for setting dynamic brake (400 V input power)

For input rated voltage 400 V input power servo drive or above, dynamic brake resistor is not installed inside the servo drive. A user can connect to external dynamic brake resistor according to figures below. Aluminum housed power resistor with lower resistance is suggested to improve braking distance.

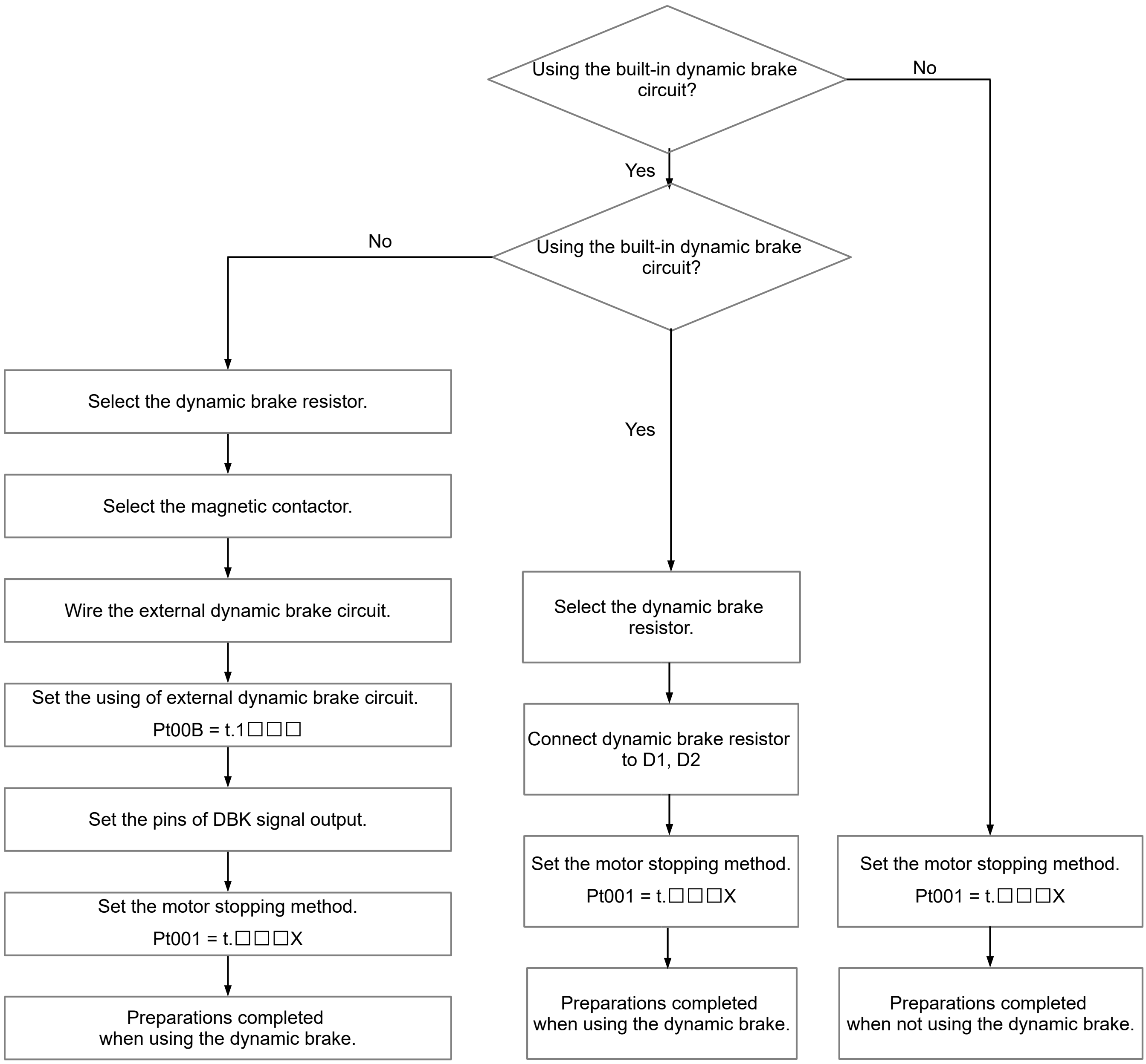


Figure5.4.4.2.3

400 V input power servo drive external dynamic brake resistor connector is CN2A. Terminals used for the connection of external dynamic brake resistor are as below.

Table5.4.4.2.2

<table>
<tr><th>Terminal Symbol</th><th>Function</th><th>Description</th></tr>
<tr><td>D1</td><td>Connection to dynamic brake resistor</td><td rowspan="3">Suitable for 400 V servo drive. If a user need to use dynamic brake, please use D1 and D2 to connect external dynamic brake resistor. External dynamic brake resistor accessory is an optional purchase. 400 V servo drive is not equipped with internal dynamic brake resistor. D3 is not allowed for use.</td></tr>
<tr><td>D2</td><td>Connection to dynamic brake resistor</td></tr>
<tr><td>D3</td><td>-</td></tr>
</table>

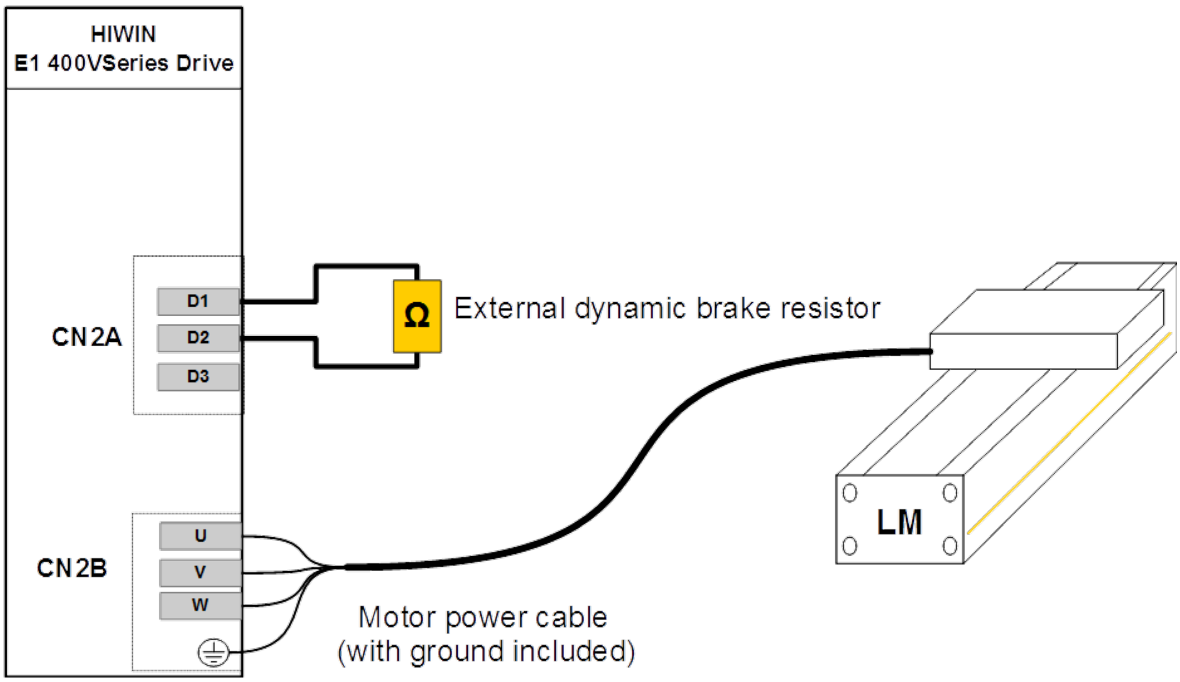


Figure5.4.4.2.4

Note:

The lowest value allowed for external dynamic brake resistor is 10 Ohm.

For the connection of external dynamic brake circuit and external dynamic brake resistor of 400 V servo drive, please check the figure as below:

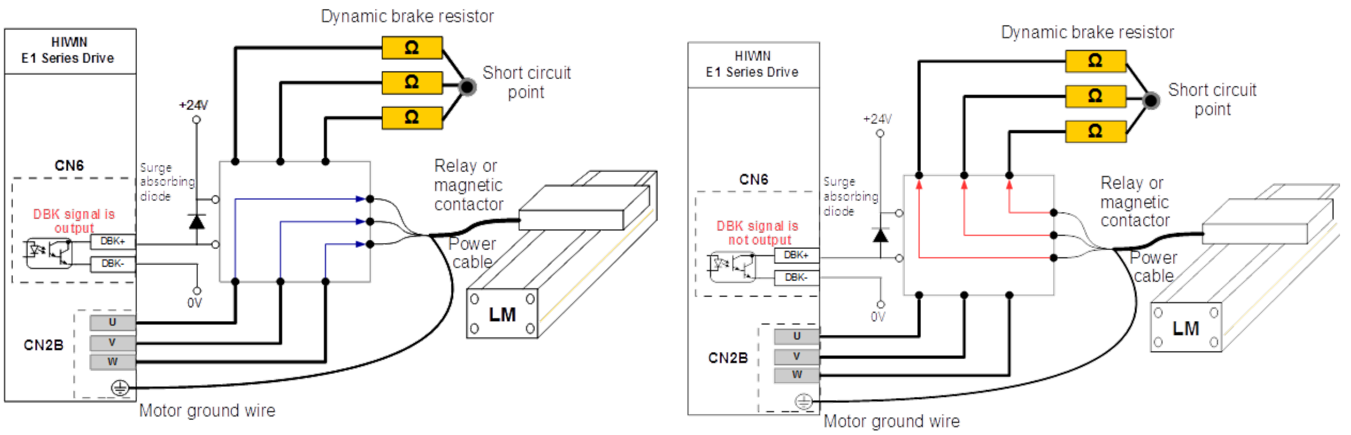


Figure5.4.4.2.5 using external dynamic brake circuit and external dynamic brake resistor

Note:

A user needs to set Pt00B (Table 5.4.4.2.1) while using external dynamic brake circuit and external dynamic brake resistor.

5.5 Control signals (CN6)

5.5.1 Control signal connector

The pin definition of control signal connector is provided in table below. Perform wiring according to the control mode and I/O signals in use.

Note:
For information of control signal cable, please refer to table 16.1.5.1 in section 16.1.5.

- E1 series servo drive (CN6)-Standard (ED1S)

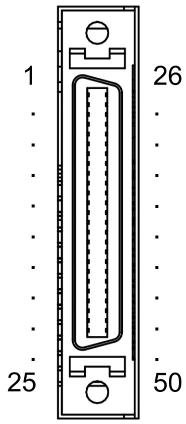


Figure5.5.1.1 Pin definition of CN6-Standard (ED1S)

Table5.5.1.1 Pin definition of CN6-Standard (ED1S)

Control Mode	Category	Pin	Signal	Description
All Control Modes	Digital Input	7	COM	Common point for digital signal inputs The wiring for digital signals must be sink or source type.
		33	I1	General-purpose input signals Users are allowed to use the default setting in each control mode or configure input functions by themselves, please refer to section 8.1.1.
		30	I2	
		29	I3	
		27	I4	
		28	I5	
		26	I6	
		32	I7	
		31	I8	
		9	I9	
		8	I10	
	Digital Output	35	O1+	General-purpose output signals Users are allowed to use the default setting in each control mode or configure output functions by themselves, please refer to section 8.1.2.
		34	O1-	
		37	O2+	
		36	O2-	
		39	O3+	
		38	O3-	
		11	O4+	
		10	O4-	
		40	O5+	
		12	O5-	

Control Mode	Category	Pin	Signal	Description
	Analog Output	42	AO1	Analog output (+/-10 V) Monitors motor torque.
		43	AO2	Analog output (+/-10 V) Monitors motor velocity.
		41	AOGND	Analog signal grounding
	Encoder Output	21	A	Outputs pulse signals (Pulse type: AqB) according to the setting for encoder output. For more information of encoder output setting, please refer to section 8.6.
		22	/A	
		48	B	
		49	/B	
		23	Z	Outputs one Z-phase signal per one revolution.
		24	/Z	
		19	CZ	Outputs one Z-phase signal per one revolution (single-ended signal).
		25	SG	Signal grounding.
	Special Application	47	PT+	For the wiring for position trigger output function, please refer to section 5.5.3. Use Pt00E=t.□□□X to enable or disable position trigger output function.
		46	PT-	
	Grounding	50	FG	Frame grounding
Position Mode	Pulse Input	1	PULH_CW	Pulse command inputs For the wirings for pulse command inputs, please refer to section 5.2.
		2	PULH_CCW	
		3	CW+	
		4	CW-	
		5	CCW+	
		6	CCW-	
		13	SG	Pulse signal grounding
Velocity Mode	Analog Input	14	V_REF+	Velocity command inputs (Input voltage +/-10 V) For wiring diagram for velocity command, please refer to section 5.5.2. (ED1□-P□ servo drive is not supported.)
		15	V_REF-	
Torque Mode	Analog Input	16	T_REF+	Torque command inputs (Input voltage +/-10 V) For wiring diagram for torque command, please refer to section 5.5.2.
		17	T_REF-	

■ E1 series servo drive (CN6)-Fieldbus (ED1F)

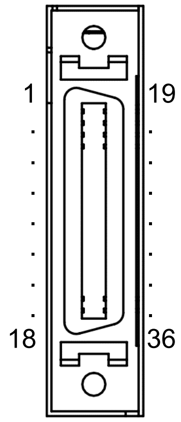


Figure5.5.1.2 Pin definition of CN6-Fieldbus (ED1F)

Table5.5.1.2 Pin definition of CN6-Fieldbus (ED1F)

Control Mode	Category	Pin	Signal	Description
Fieldbus Model	Digital Input	30	COM	Common point for digital signal inputs The wiring for digital signals must be sink or source type.
		1	I1	General-purpose input signals Users are allowed to use the default setting in each control mode or configure input functions by themselves, please refer to section 8.1.1.
		2	I2	
		3	I3	
		4	I4	
		5	I5	
		6	I6	
		7	I7	
		8	I8	
	Digital Output	11	O1+	General-purpose output signals Users are allowed to use the default setting in each control mode or configure output functions by themselves, please refer to section 8.1.2.
		12	O1-	
		13	O2+	
		14	O2-	
		15	O3+	
		16	O3-	
		17	O4+	
		18	O4-	
		19	O5+	
		20	O5-	
	Encoder Output	24	A	Outputs pulse signals (Pulse type: AqB) according to the setting for encoder output. For more information of encoder output setting, please refer to section 8.6.
		25	/A	
		26	B	
		27	/B	
		28	Z	Outputs one Z-phase signal per one revolution.
		29	/Z	
	Special Application	9	PT+	For the wiring for position trigger output function, please refer to section 5.5.3. Use Pt00E=t.□□□X to enable or disable position trigger output function.
		10	PT-	
	Analog Output	21	AO1	Analog output (+/-10 V) Monitors motor torque.
		22	AO2	Analog output (+/-10 V) Monitors motor velocity.
		23	AOGND	Analog signal grounding.
	Grounding	35	SG	Signal grounding.
		36	FG	Frame grounding.

5.5.2 Wiring example of control mode

- Position mode (Pulse command is only supported in ED1S model.)

(1) Differential signal input

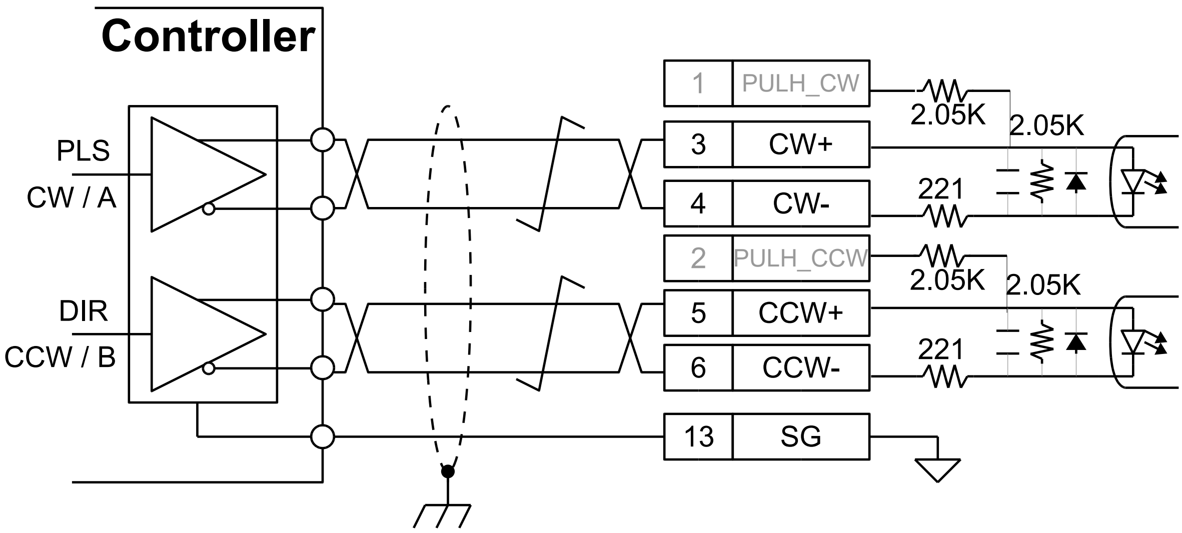
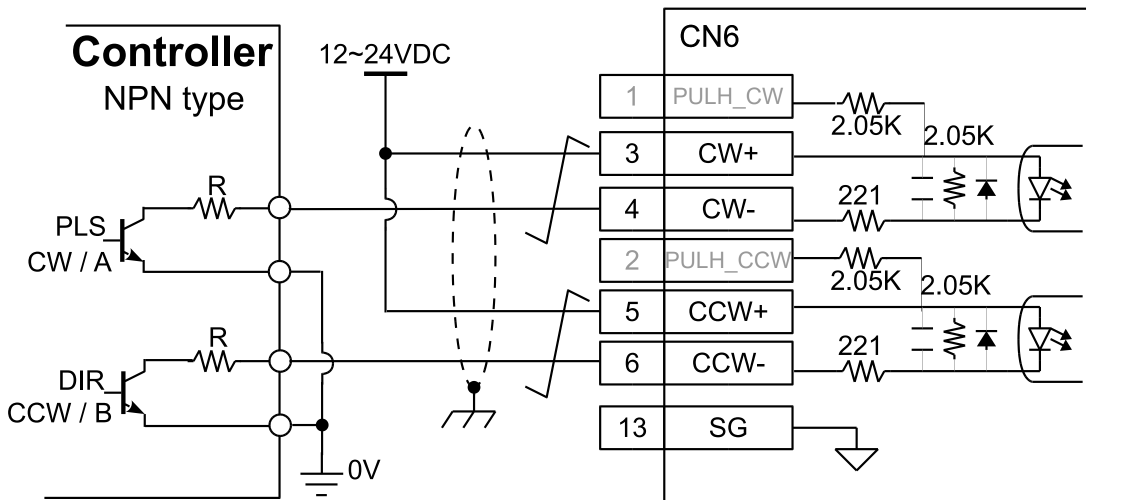


Figure5.5.2.1

(2) Single-ended (NPN) interface with resistor



Vdc	Resistor (R)
12V	1KΩ , 0.5W
24V	2KΩ , 0.5W

Figure5.5.2.2

(3) Single-ended (NPN) interface without resistor

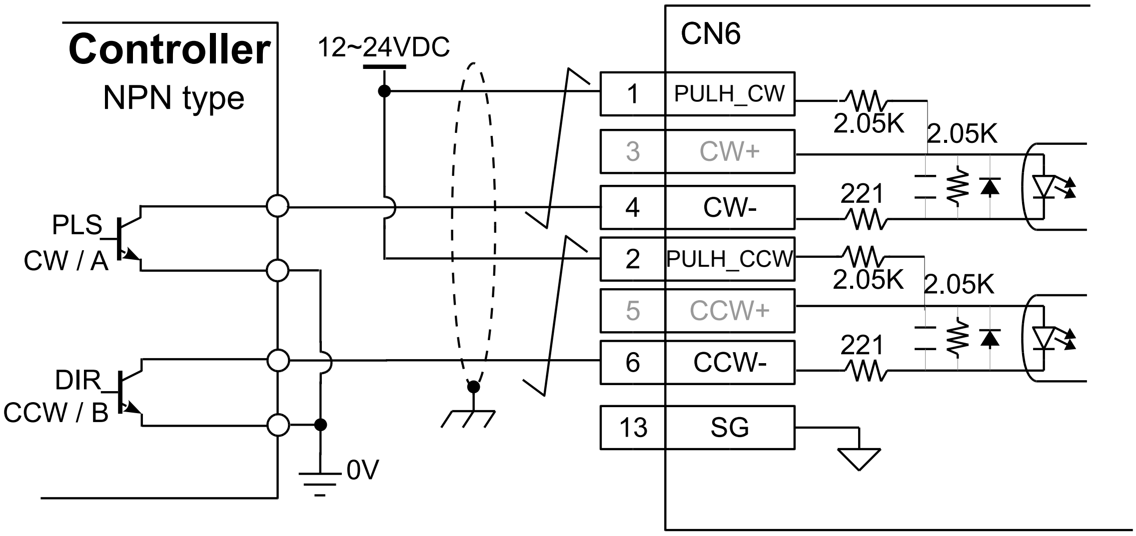
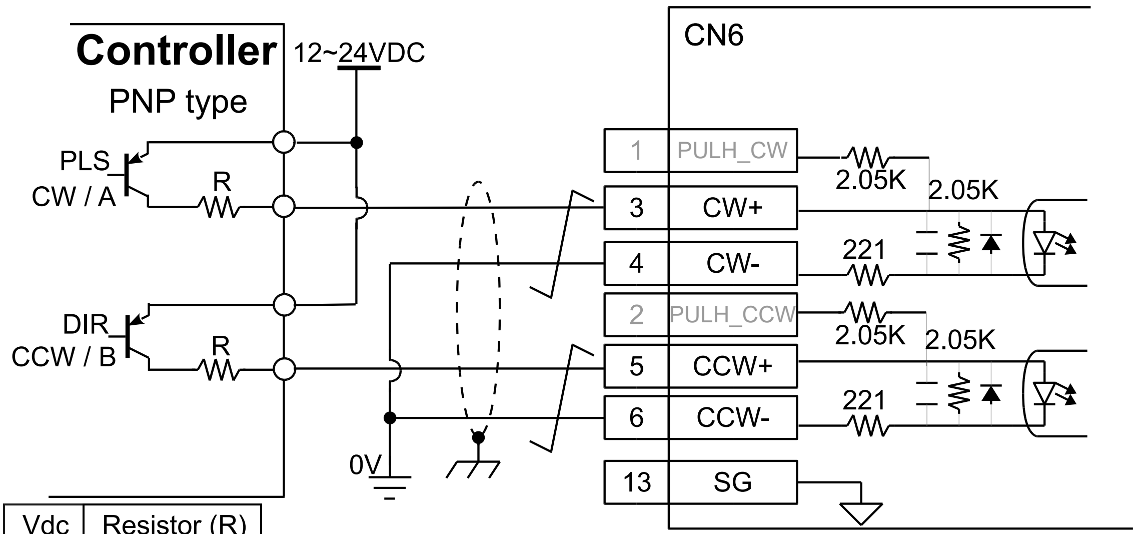


Figure5.5.2.3

(4) Single-ended (PNP) interface with resistor



Vdc	Resistor (R)
12V	1KΩ , 0.5W
24V	2KΩ , 0.5W

Figure5.5.2.4

(5) Single-ended (PNP) interface without resistor

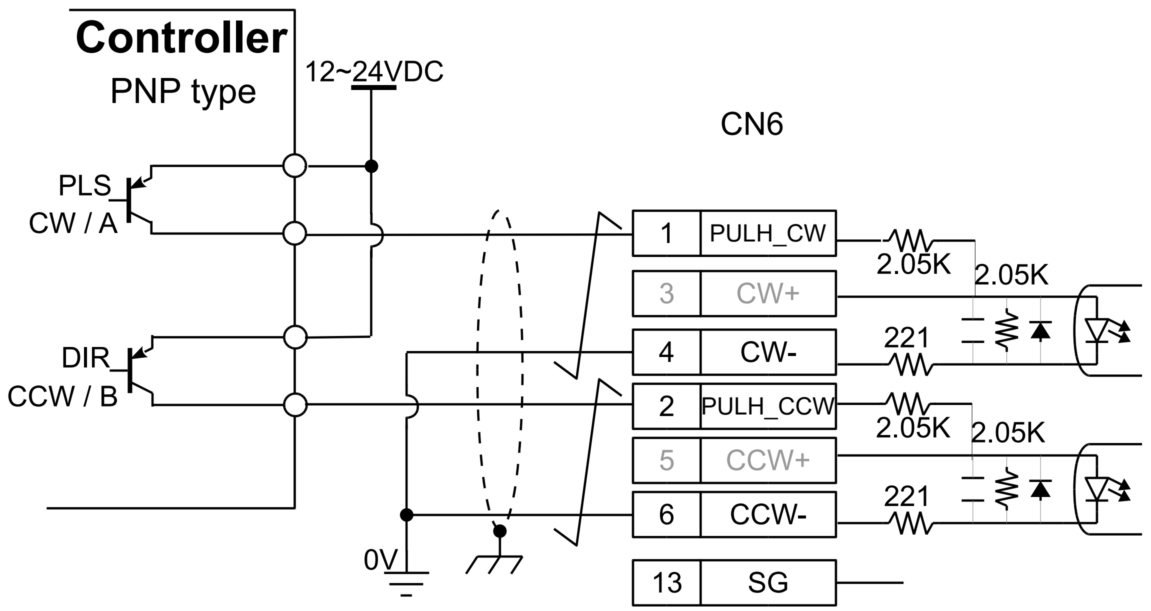


Figure5.5.2.5

(6) 5V TTL interface

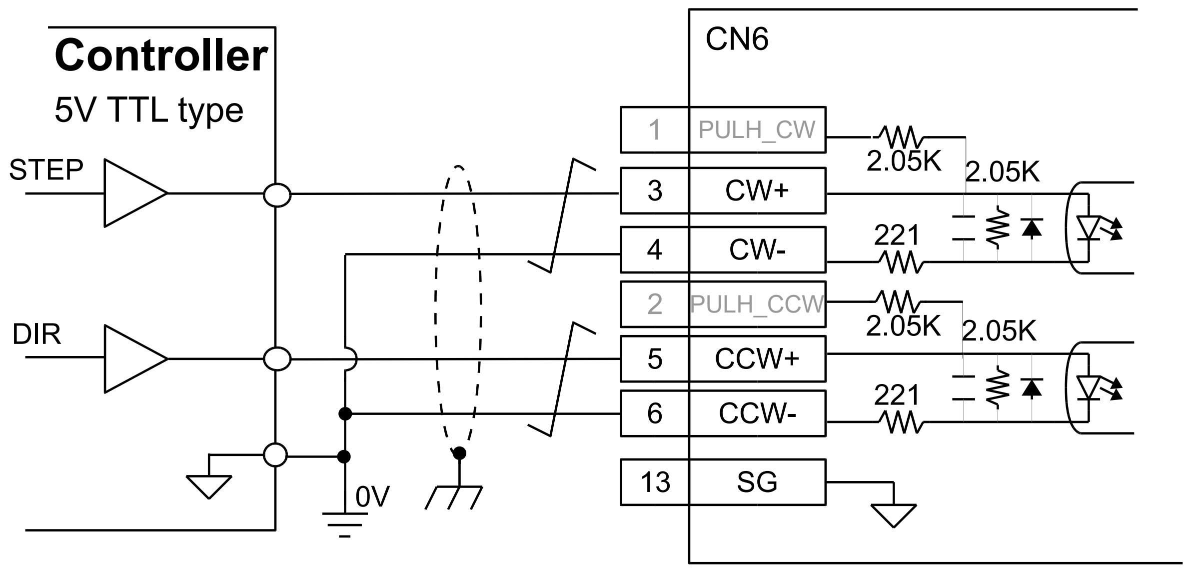


Figure5.5.2.6

- Velocity mode (Analog command is only supported in ED1S model.)
  Motor velocity is controlled by analog voltage (+/-10 V).

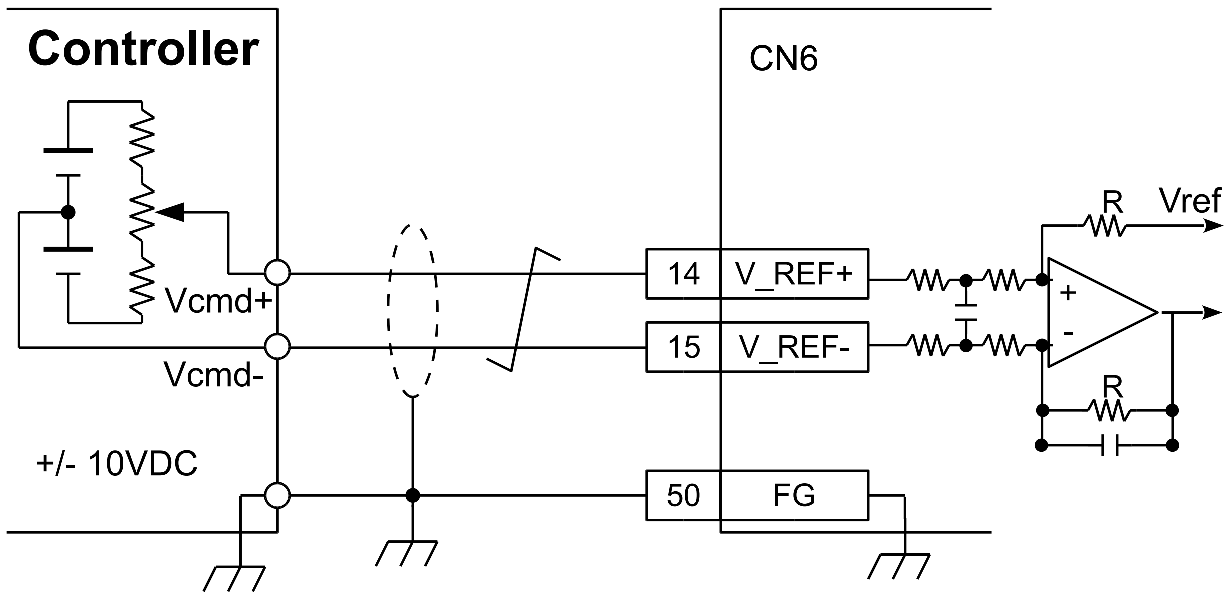


Figure5.5.2.7

- Torque mode (Analog command is only supported in ED1S model.)
  Motor torque or force is controlled by analog voltage (+/-10 V).

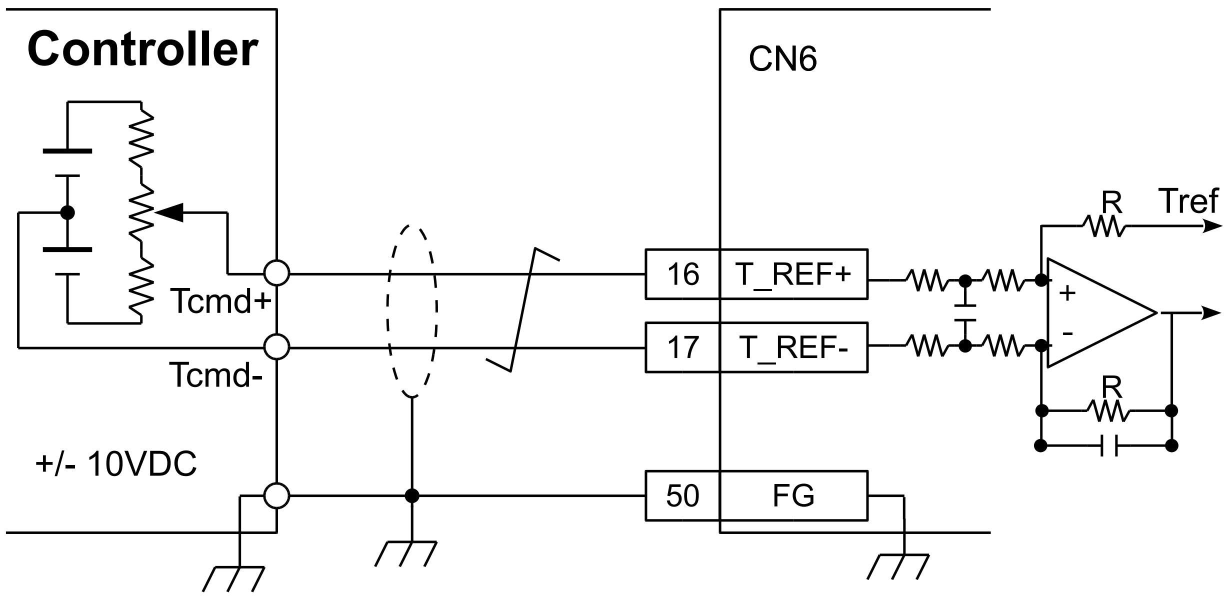


Figure5.5.2.8

5.5.3 Wirings for digital inputs and digital outputs

The pin definitions of standard servo drive (ED1S) and Fieldbus servo drive (ED1F) are different, please refer to section 5.5.1.

- Wiring for digital inputs of standard servo drive
  Digital input signal is input via optical coupler. The external power could be 12~24 VDC. The wiring could be sink or source type. Digital input functions can be user-defined.

(1) Wiring for digital inputs (Sink) (Switch or transistor)

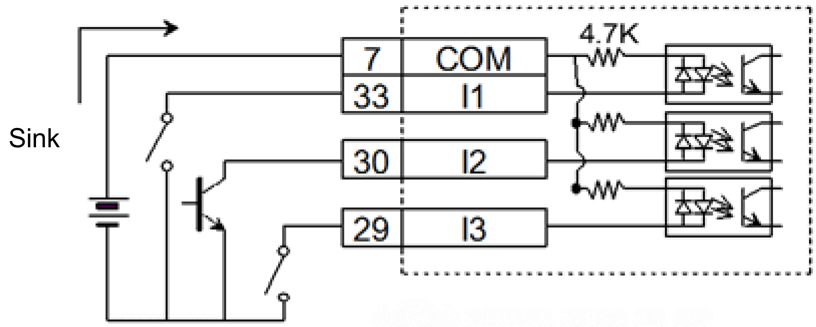


Figure5.5.3.1

Note:
The pin definition of Fieldbus servo drive (ED1F) is different from what is shown in the figure above. COM is at CN6-30. I1 is at CN6-1. I2 is at CN6-2. I3 is at CN6-3.

(2) Wiring for digital inputs (Source) (Switch or transistor)

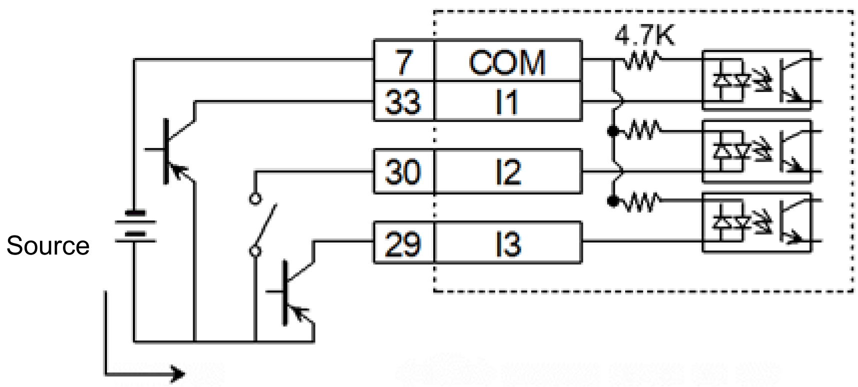


Figure5.5.3.2

Note:
The pin definition of Fieldbus servo drive (ED1F) is different from what is shown in the figure above. COM is at CN6-30. I1 is at CN6-1. I2 is at CN6-2. I3 is at CN6-3.

- Wiring for digital outputs of standard servo drive
  Digital output signal is output via optical coupler. The external power must not exceed 24 VDC. The digital outputs are independent open-collector outputs. The maximum allowable current is 100 mA. Digital output functions can be user-defined.

  (1) Wiring for digital outputs (Relay or optical coupler)

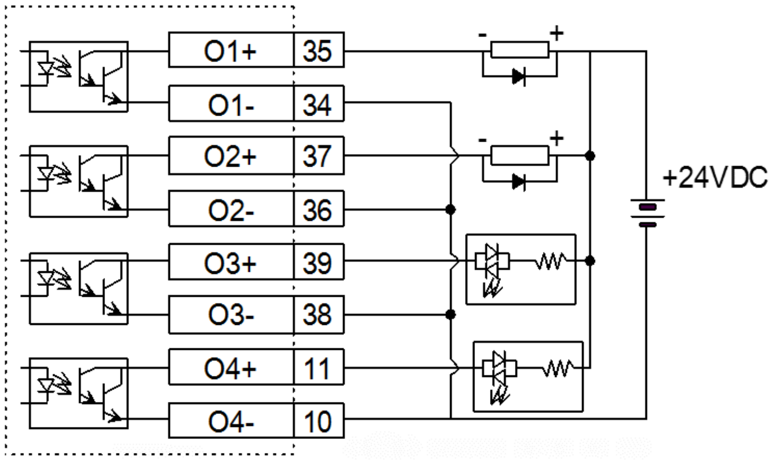


Figure5.5.3.3

Note:

(1) The pin definition of Fieldbus servo drive (ED1F) is different. O1+/O1- are at CN6-11/12. O2+/O2- are at CN6-13/14. O3+/O3- are at CN6-15/16. O4+/O4- are at CN6-17/18.

(2) The default digital output for BK signal is O5, please refer to section 5.4.4.

(3) Use relay which has built-in surge absorbing diode or add surge absorbing diode by yourself to avoid digital output burn-out.

- Wiring for analog outputs of standard servo drive
  Analog outputs are used to monitor motor torque (AO1) and motor velocity (AO2). The voltage range is +-10 V.

  (1) Wiring for analog outputs

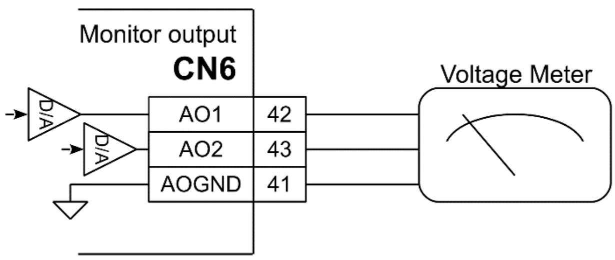


Figure5.5.3.4

Note:The pin definition of Fieldbus servo drive (ED1F) is different from what is shown in the figure above. AO1 is at CN6-21. AO2 is at CN6-22. AOGND is at CN6-23

- Position trigger output (PT) signal of standard servo drive

  Enable or disable position trigger output function by Pt00E=t.□□□X.

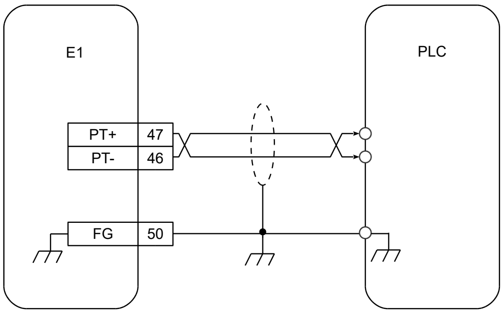


Figure5.5.3.5

Note:

The pin definition of Fieldbus servo drive (ED1F) is different from what is shown in the figure above. PT+ is at CN6-9. PT- is at CN6-10. FG is at CN6-36.

5.6 STO connector (CN4)

5.6.1 Pin definition of STO connector

For more information of STO safety function, please refer to chapter 6. Before using STO safety function, pay attention to the pin definition. If STO safety function is not used, plug the safety jumper connector provided with the servo drive into CN4. If it is not plugged in, the servo drive will not output current to the motor.

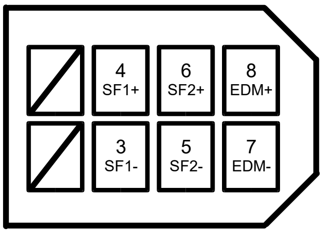


Figure5.6.1.1

Table5.6.1.1

Pin	Signal	Description
1	Reserved	Do not use.
2		
3	SF1-	SF1 and SF2 signals are input via two independent circuits. If SF1 and SF2 signals are not input, the internal power module of the servo drive will be shut down to cut off the output current.
4	SF1+	
5	SF2-	
6	SF2+	
7	EDM-	Monitors if safety function is normal.
8	EDM+	
Shield	FG	Frame grounding

5.6.2 Wiring for STO safety function

Ensure you have safety device connector (HIWIN part number: 051500400404) or STO signal trasmission cable (HIWIN part number: HE00EJ6DH00) before wiring. For the specification of the connector, please refer to chapter 16.

■ Wiring for STO safety function

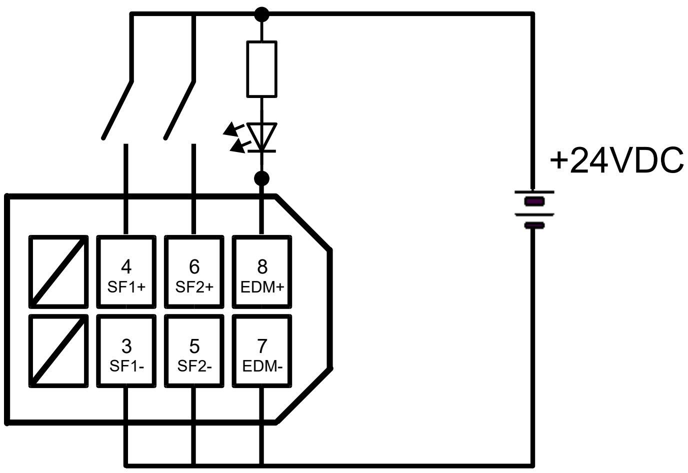


Figure5.6.2.1

■ Wiring example of STO safety function

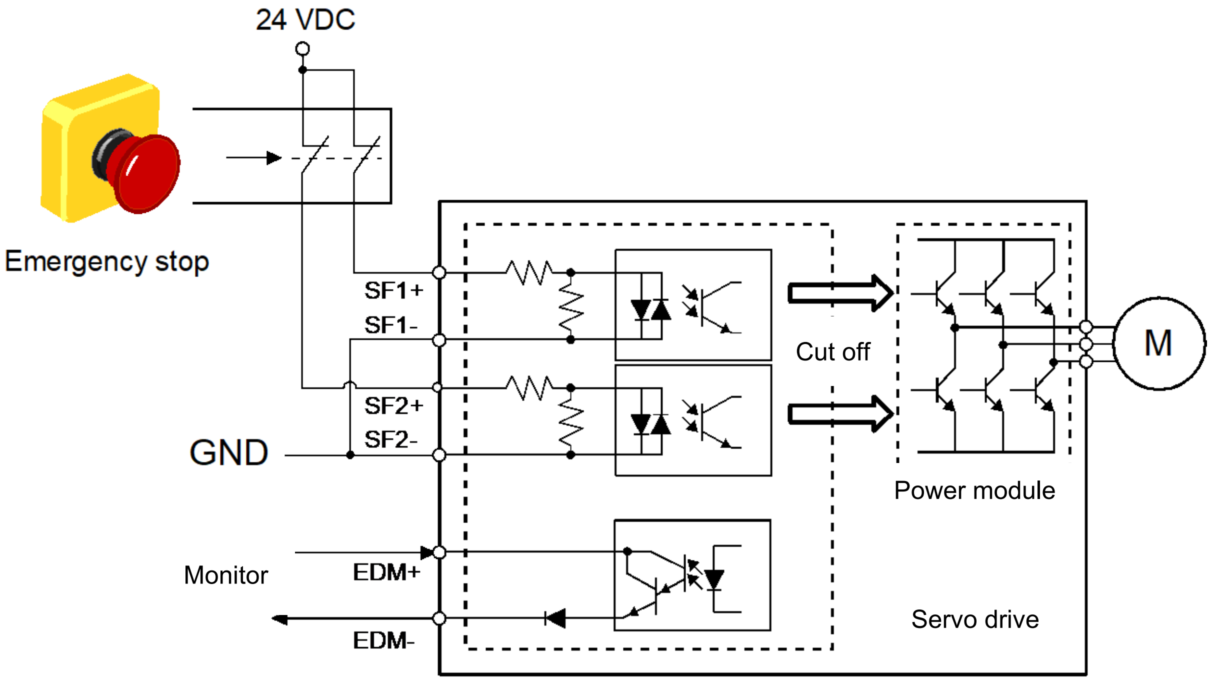


Figure5.6.2.2

5.7 Other connectors

5.7.1 Connector for PC communication (CN3)

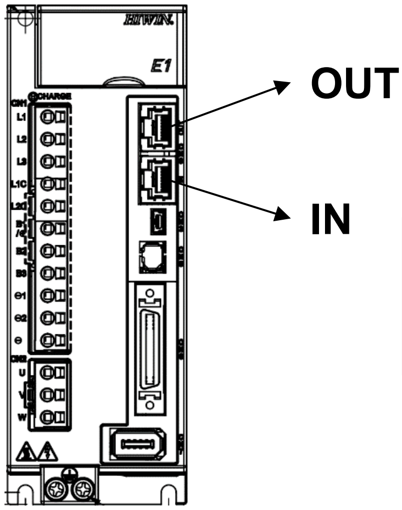
Use mini USB cable to connect to PC by CN3 for monitoring, trial operation or parameter setting via Thunder.

5.7.2 Connector for Fieldbus communication (CN9)

If Fieldbus servo drive (ED1F) is used, connect to CN9 via metal shielded RJ-45 connector and Ethernet communication cable. The communication cable must be CAT-5 or above.

Note:
For MECHATROLINK III communication (ED1F-L□), use RJ-45 connector (FA), CAT5e STP communication cable (which can be made by users) or cables suggested by MECHATROLINK Members Association.

There are two communication ports on CN9, OUT port and IN port, please refer to below.



OUT	Connect to the IN port on other servo drive or other slave. If the servo drive is the last station, do not connect to this port.
IN	Connect to controller (master), OUT port on other servo drive or other slave.

Figure 5.7.2.1

Figure below shows the example of connecting HIWIN Fieldbus motion controller (HIMC) and ED1F-H□ servo drives.

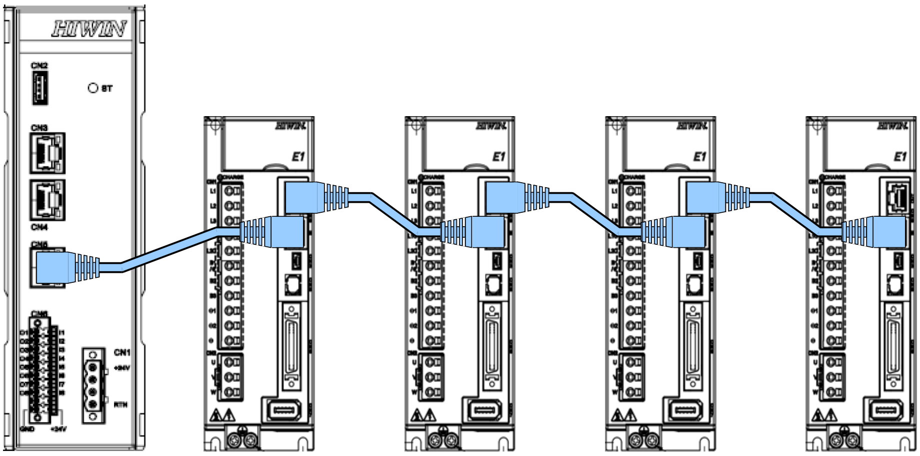


Figure 5.7.2.2

6. Basic function settings before operation

6.1 Parameters

This section provides descriptions of parameter definition, parameter list and parameter setting.

6.1.1 Parameter definition

The parameters of E1 series servo drive are divided into two categories.

Table6.1.1.1

Category	Description
Setup parameter	Parameter for basic setting
Tuning parameter	Parameter for servo tuning

For how to set setup parameters and tuning parameters, please refer to below.

- Setting setup parameters

  Setup parameters can be set via the servo drive panel or Thunder.

Note	➢ It is suggested to set setup parameters via Thunder. Users can follow the instructions given by Configuration Wizard in Thunder to set control mode, I/O signals and parameters for trial operation. Configuration Wizard in Thunder is shown in figure 6.1.1.1.

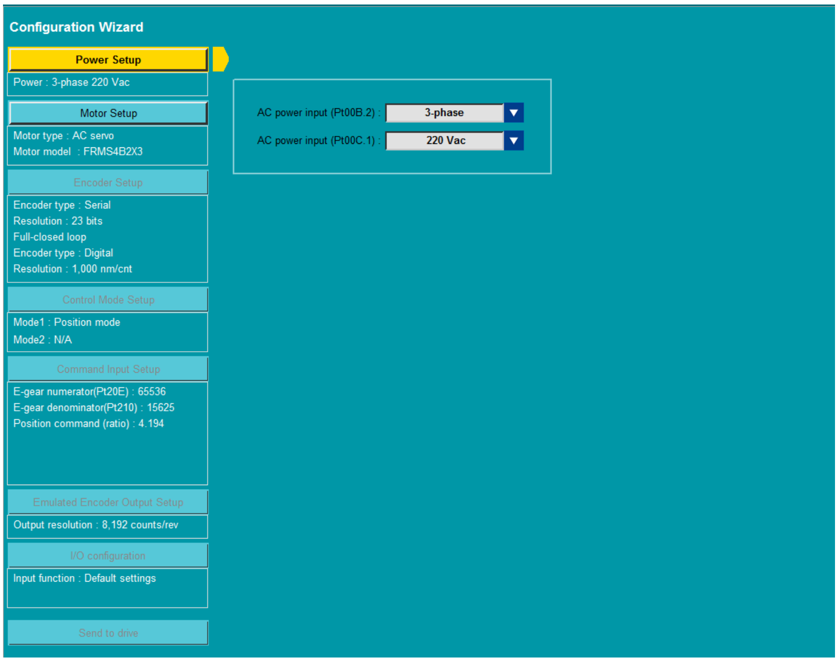


Figure6.1.1.1 Configuration Wizard in Thunder

- Setting tuning parameters

  Users do not need to set tuning parameters respectively. To improve response performance, users can use the tuning functions provided in Thunder to adjust tuning parameters. For more information, please refer to chapter 6.

6.1.2 Parameter list

There are two types of parameter setting methods. One is to input value (Table 6.1.2.1) and the other one is to select function (Table 6.1.2.2).

- Parameter that needs to input value

Table6.1.2.1

Parameter	Pt212	Range	64~1073741824	Control Mode	Position mode, velocity mode and torque mode
Default	8192	Effective	After power on	Unit	Edge of pulse signal
Description					
Set the number of output pulses for one revolution.					

(1) Parameter: parameter number
(2) Default: default value
(3) Description: function description
(4) Range: setting range
(5) Effective: when the setting becomes effective
(6) Control mode: in which mode the parameter is effective (Control mode: velocity mode, position mode, torque mode, internal position mode and internal velocity mode)
(7) Unit: the minimum unit of the parameter

■ Parameter that needs to select function

Table6.1.2.2

Parameter	Pt000	Range	0~E	Control Mode	Position mode, velocity mode and torque mode
Default	t.□□1□	Effective	After power on	Unit	-

Description

Set control mode. In E1 series servo drive, there are position mode, velocity mode, torque mode, internal position mode, internal velocity mode and dual mode.
Pt000 = t.□□X□

Value	Control Mode	Value	Control Mode
0	Velocity mode	8	Position mode ↔Torque mode
1	Position mode	9	Torque mode ↔Velocity mode
2	Torque mode	A	Internal position mode
3	Internal velocity mode	B	Internal position mode ↔Position mode
4	Internal velocity mode ↔Position mode	C	Internal position mode ↔Velocity mode
5	Internal velocity mode ↔Velocity mode	D	Internal position mode ↔Torque mode
6	Internal velocity mode ↔Torque mode	E	Internal velocity mode ↔Internal position mode
7	Position mode ↔Velocity mode		

Note:

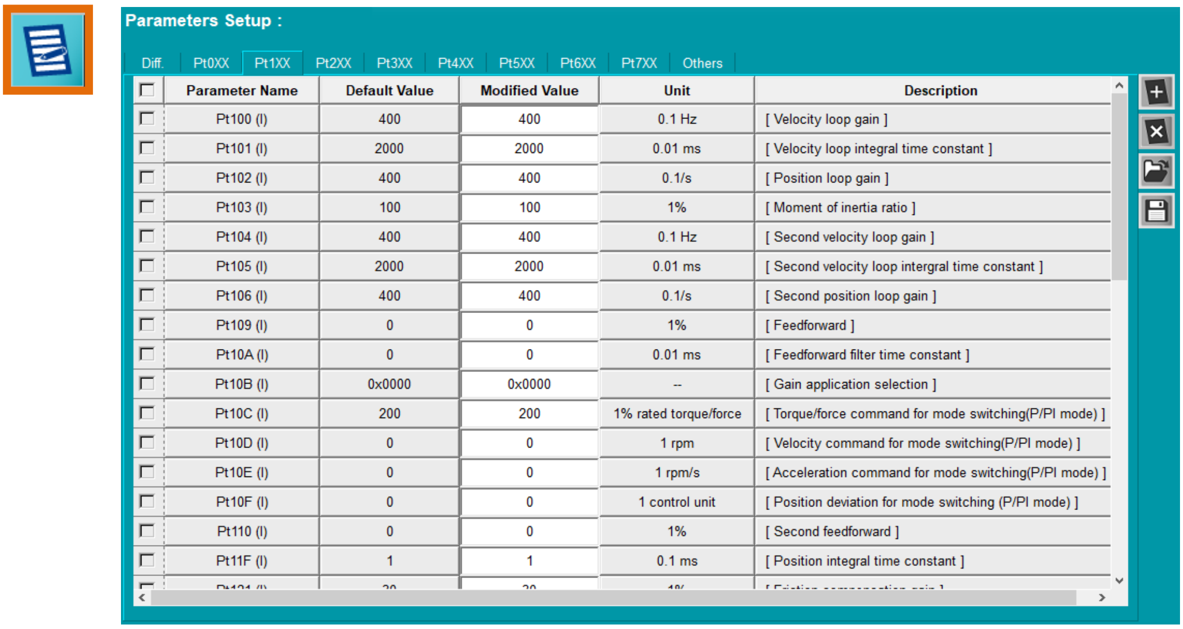
(1) t.□□□□ means users need to select function for this parameter. The setting value in □ is hexadecimal.

(2) Pt000 = t.□□X□ means the value of X needs to be set. For instance, Pt000 needs to be set to t.□□3□ when users would like to change the control mode to internal velocity mode.

6.1.3 Parameter setting

Parameters can be set via the parameter list in Thunder or the servo drive panel.

- Set parameters via the parameter list in Thunder



Parameter Name	Default Value	Modified Value	Unit	Description
Pt100 (I)	400	400	0.1 Hz	[Velocity loop gain]
Pt101 (I)	2000	2000	0.01 ms	[Velocity loop integral time constant]
Pt102 (I)	400	400	0.1/s	[Position loop gain]
Pt103 (I)	100	100	1%	[Moment of inertia ratio]
Pt104 (I)	400	400	0.1 Hz	[Second velocity loop gain]
Pt105 (I)	2000	2000	0.01 ms	[Second velocity loop intergral time constant]
Pt106 (I)	400	400	0.1/s	[Second position loop gain]
Pt109 (I)	0	0	1%	[Feedforward]
Pt10A (I)	0	0	0.01 ms	[Feedforward filter time constant]
Pt10B (I)	0x0000	0x0000	--	[Gain application selection]
Pt10C (I)	200	200	1% rated torque/force	[Torque/force command for mode switching(P/PI mode)]
Pt10D (I)	0	0	1 rpm	[Velocity command for mode switching(P/PI mode)]
Pt10E (I)	0	0	1 rpm/s	[Acceleration command for mode switching(P/PI mode)]
Pt10F (I)	0	0	1 control unit	[Position deviation for mode switching (P/PI mode)]
Pt110 (I)	0	0	1%	[Second feedforward]
Pt11F (I)	1	1	0.1 ms	[Position integral time constant]

Figure6.1.3.1 The Parameter list in Thunder

- Set parameters via servo drive panel

  Refer to section 14.2.

6.1.4 Parameter initialization

Parameters can be set to factory default by parameter initialization function or servo drive panel.

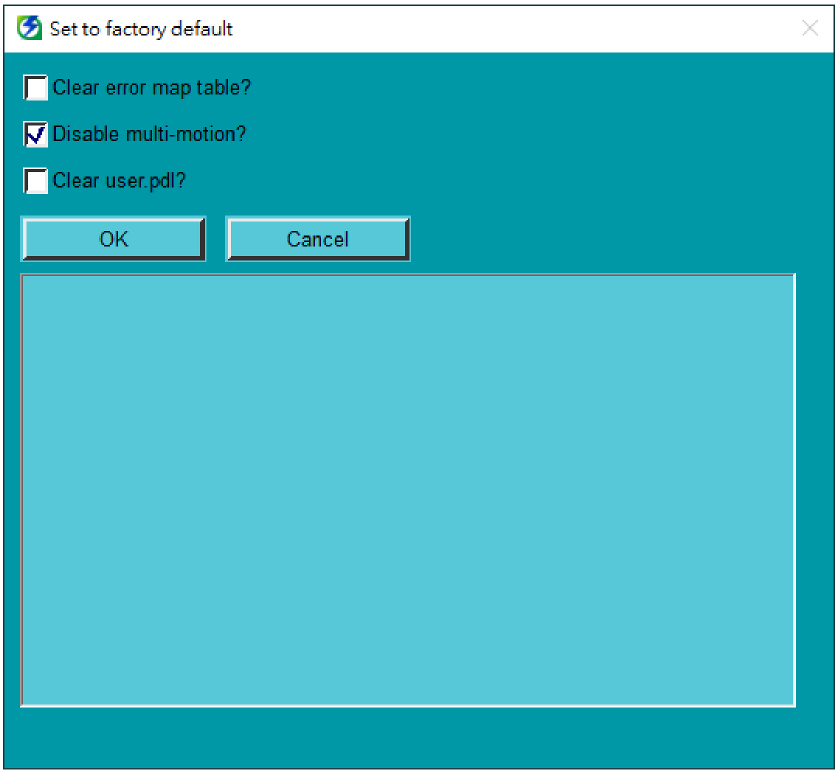
Note	➢ After parameter initialization function is executed, all the parameter settings will be cleared. Then the servo drive will be automatically turned off and turned on again. And the parameters are set to factory default.

- Before executing parameter initialization function

  (1) Must be in servo off state.

  (2) If you would like to use the original parameter settings later, ensure you have made a backup.

■ How to execute parameter initialization function



Step 1:
Click on **Tools** on the menu bar of Thunder. Select **Set drive to factory default**. **Set drive to factory default** window appears.

Step 2:
Click on **OK** button to clear the parameter settings. If the checkboxes of **Clear error map table?** and **Clear user.pdl?** are checked, the error map table and user.pdl will be cleared at the same time.

Step 3:
The servo drive will be automatically turned off and turned on again after the parameter settings are cleared.

Figure6.1.4.1 **Set drive to factory default** window

■ Perform parameter initialization via servo drive panel

Refer to section 14.4.5.

6.2 Control modes

E1 series servo drive supports velocity mode, position mode, torque mode, internal velocity mode and internal position mode. Set control mode by Pt000 = t.□□X□.

Table6.2.1

Selections of Control Modes			
Pt000 = t.□□X□	Control Mode	Description	Reference
t.□□0□	Velocity mode	Analog voltage is used as velocity command to control motor velocity. This control mode is suitable for: (1) Velocity control (2) Controller controls position loop by using the encoder pulse outputs received from the servo drive.	Refer to section 8.3.
t.□□1□ (Default)	Position mode	Pulse commands are input into the servo drive from controller. The position of the motor is determined by the number of pulses. The velocity of the motor is determined by the frequency of input pulses. This control mode is suitable for application which requires positioning control.	Refer to section 8.4.
t.□□2□	Torque mode	Analog voltage is used as torque command to control motor torque. This control mode is suitable for: (1) Torque control (Pressing) (2) Controller controls position and velocity loops by using the encoder pulse outputs received from the servo drive.	Refer to section 8.5.
t.□□3□	Internal velocity mode	Use parameters to set three internal velocity settings inside the servo drive. Use digital input signal to switch among the velocity settings. External analog command is not needed in this control mode.	Refer to section 8.8.
t.□□4□	Internal velocity mode↔Position mode	Dual mode is the combination of internal velocity mode and other control mode. Users can switch between two control modes according to their applications.	Refer to section 8.9.
t.□□5□	Internal velocity mode↔Velocity mode		
t.□□6□	Internal velocity mode↔Torque mode		
t.□□7□	Position mode↔Velocity mode	Dual mode is the combination of any two modes of position mode, velocity mode and torque mode. Users can switch between two control modes according to their applications.	Refer to section 8.9.
t.□□8□	Position mode↔Torque mode		
t.□□9□	Torque mode↔Velocity mode		
t.□□A□	Internal position mode	Motion procedures are set inside the servo drive. Position control is performed by digital input signal. External pulse command is not needed in this control mode.	Refer to section 8.7.
t.□□B□	Internal position mode↔Position mode	Dual mode is the combination of internal position mode and other control mode. Users can switch between two control modes according to their applications.	Refer to section 8.9.
t.□□C□	Internal position mode↔Velocity mode		
t.□□D□	Internal position mode↔Torque mode		
t.□□E□	Internal velocity mode↔Internal position mode		

6.3 Setting main circuit power supply

The main circuit power supply for E1 series servo drive can be single-phase or three-phase. Related information is provided as below.

6.3.1 Setting single-phase/three-phase AC input power

Users need to specify what power supply is used for the servo drive (single-phase AC 110 V / 220 V, three-phase AC 220 V or three-phase AC 400 V) by setting Pt00B = t.□X□□. An alarm will occur if the input power is different from the setting.

Table6.3.1.1

Parameter		Description	Effective	Category
Pt00B	t.□0□□ (Default)	Use three-phase AC input power.	After power on	Setup
	t.□1□□	Use single-phase AC input power or three-phase AC input power.		

Note	
	➢ If Pt00B is set to t.□0□□ when single-phase AC power is input, AL.F10 (Power cable open phase) will occur. ➢ The performance of the motor varies with the input power (single-phase AC 110 V / 220 V, three-phase AC 220 V or three-phase AC 400 V).Select suitable input power according to the specification of the motor. ➢ Three-phase AC 220 V or three-phase AC 400 V power must be supplied for 2 kW servo drive or model above. Pt00B must be set to t.□1□□.

For wiring for power supply, please refer to section 5.3.

6.3.2 Operation during momentary power interruption

By setting Pt509 (Momentary power interruption hold time), even when the servo drive power for the main circuit is momentarily off, power can still be supplied to the motor(Servo ON) accroding to the time set in this parameter.

Table6.3.2.1

Parameter	Pt509	Range	20~50000	Control Mode	Position mode, velocity mode and torque mode
Default	20	Effective	Immediately	Unit	1 ms
Description					
Momentary power interruption hold time					

When the main power momentary off time is shorter than the setting of Pt509, power will be kept supplying to the motor. On the other hand, when it’s longer than the setting of Pt509, the power supply to the motor will be stopped. It will resume when the power for the main circuit is back to on.

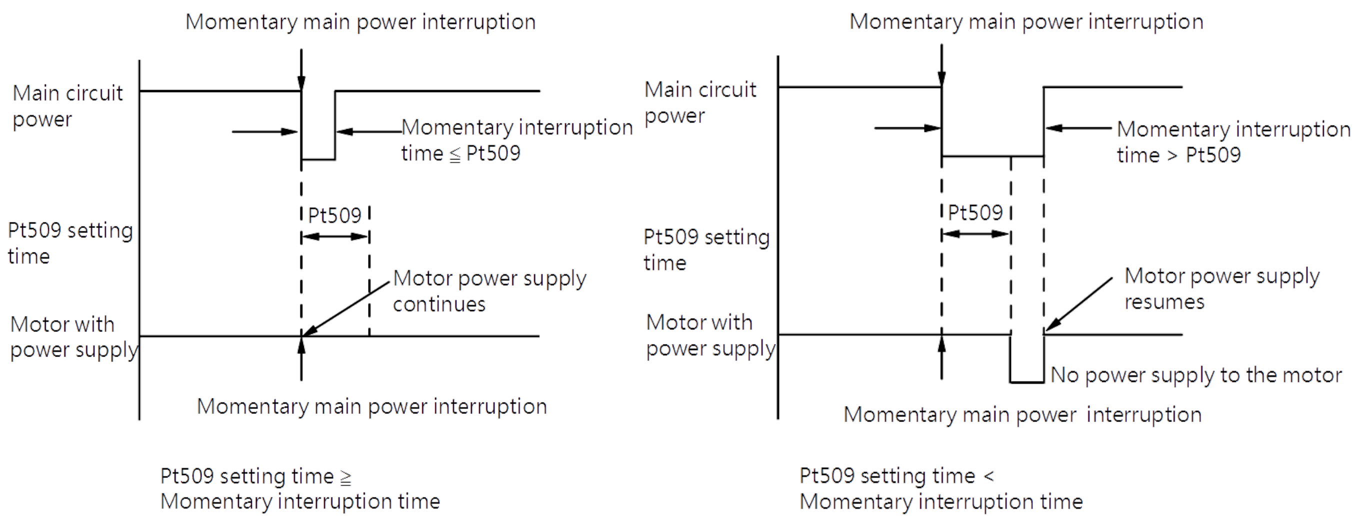


Figure6.3.2.1

Note:

(1) When the momentary power interruption time is longer than the setting of Pt509,the servo drive D-RDY signal is OFF and servo is OFF.

(2) This function can deal with power interruption for more than 1000ms when there is not any power-off protection device in control power and main curcuit power.

(3) The setting of Pt509 will be invalid if there is no power supply to the control power, which means the power status is not in control.

Note	➢ The hold time of the main circuit power will differ according to the output of the control power. If the load of the motor is big and results in AL.410(Undervoltage) during the momentary power interruption, the setting of Pt509 will be invalid.

6.3.3 SEMI F47 Function

The SEMI F47 function detects an AL.971 warning (Undervoltage) and limits the output current if the DC main circuit power supply voltage drops to a specified value or lower because the power was momentarily interrupted or the main circuit power supply voltage was temporarily reduced.

This function complies with the SEMI F47 standards for semiconductor manufacturing equipment.

You can combine this function with the momentary power interruption hold time (Pt509) to allow the drive to continue operating without stopping for an alarm or without recovery work even if the power supply voltage drops.

Execution Sequence

This function can be executed either with the upper controller or with the parameters of the drive. Use Pt008 = t.□□X□ (Function Selection for Undervoltage) to specify whether the function is executed by the upper controller or by the drive.

■ Execution with the upper controller (Pt008 = t.□□1□)

The upper controller limits the torque in response to an AL.971 warning (Undervoltage).

The upper controller removes the torque limit after the undervoltage warning is cleared.

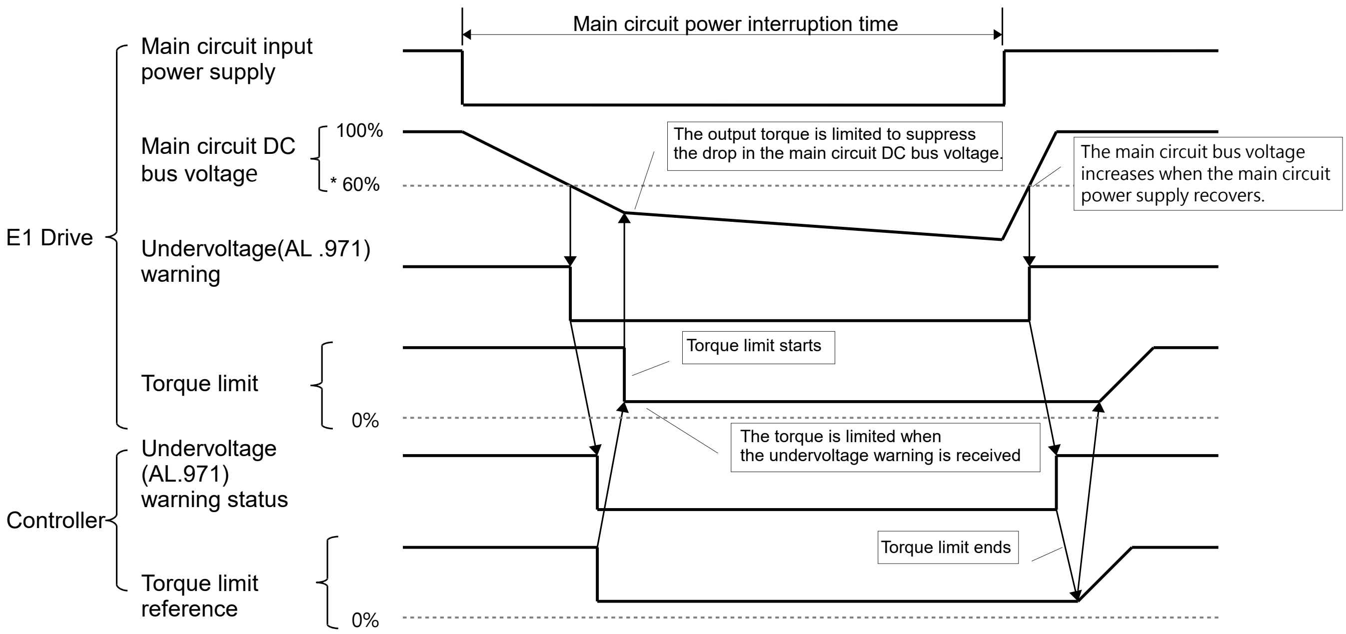


Figure6.3.3.1

■ Execution of torque limit from the drive (Pt008 = t.□□2□)

The torque is limited in the drive in response to the undervoltage warning.

The drive controls the torque limit for the set time after the Undervoltage warning is cleared.

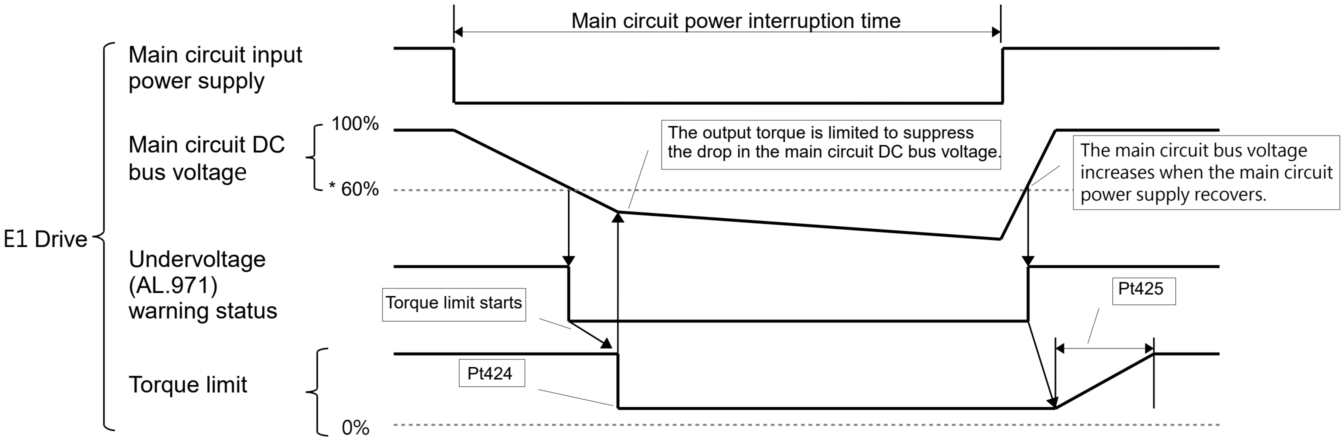


Figure6.3.3.2

Note: *The low voltage ratio of main circuit DC bus voltage will be different accroding to power input. Please refer to below table.

Table6.3.3.1

AC power input	Low voltage ratio of DC bus voltage
110 V/220 V	60%
380 V	83.8%
480 V	70%

Setting for AL.971 Warnings (Undervoltage)

You can set whether or not to detect AL.971 warnings (Undervoltage).

Table6.3.3.2

Parameter		Description	Effective	Category
Pt008	t.□□0□	Do not detect undervoltage warning (AL.971).	After power on	Setup
	t.□□1□ (Default)	Detect undervoltage warning.		
	t.□□2□	Detect undervoltage warning and limit torque with Pt424 and Pt425.		

■ Related parameters

Parameters related to SEMI F47 functions are as below.

Table6.3.3.3

Parameter	Pt424	Range	0~100	Control Mode	Position mode, velocity mode and torque mode
Default	50	Effective	Immediately	Unit	1% (The percentage of rated torque)
Description					
Torque limit at main circuit voltage drop.					

Table6.3.3.4

Parameter	Pt425	Range	0~50000	Control Mode	Position mode, velocity mode and torque mode
Default	100	Effective	Immediately	Unit	1 ms
Description					
Release time for torque limit at main circuit voltage drop.					

Table6.3.3.5

Parameter	Pt509	Range	20~50000	Control Mode	Position mode, velocity mode and torque mode
Default	20	Effective	Immediately	Unit	1 ms
Description					
Momentary power interruption hold time					

Note: If you will use the SEMI F47 function, please set the time to 1,000 ms.

Note

- This function handles momentary power interruptions for the voltage and time ranges stipulated in SEMI F47. An uninterruptible power supply (UPS) is required as a backup for momentary power interruptions that exceed these voltage and time ranges.
- Set the upper controller or torque limit so that a torque reference that exceeds the specified acceleration torque will not be output when the power supply for the main circuit is restored.
- For a vertical axis, do not limit the torque to a value that is lower than the holding torque.
- This function limits torque within the range of the drive’s capability for power interruptions. It is not intended for use under all load and operating conditions. Set the parameters while monitoring operation on the actual machine.
- You can set the momentary power interruption hold time to increase the amount of time from when the power supply is turned OFF until power supply to the motor is stopped. To stop thepower supply to the motor immediately, execute the servo on (S-ON) command to set the ON/OFF.

6.4 Automatic motor identification

E1 series servo drive supports rotary motor (AC servo motor or direct drive motor) and linear motor. The encoder of the motor must be connected to CN7 connector on the servo drive. If HIWIN serial encoder is connected, the servo drive will automatically identify the type and related parameters of the connected motor. And users do not need to set the parameters again.

6.5 Function and setting of servo on input (S-ON) signal

After servo on input (S-ON) signal is input, the motor will be enabled and can be operated. The function and setting of S-ON signal will be described as below.

6.5.1 Function of servo on input (S-ON) signal

Table6.5.1.1

Type	Signal	Hardware Pin	Status	Description
Input	S-ON	CN6-33 (I1)	ON	The motor is enabled. Motion control can be performed.
			OFF	The motor is disabled. Motion control cannot be performed.

Use Pt50A = t.□□□X (Allocation of servo on input (S-ON) signal) to allocate S-ON signal to another pin. For more information, please refer to section 8.1.1.

6.5.2 Setting S-ON signal to be always on

When Pt50A = t.□□□X (Allocation of servo on input (S-ON) signal) is set to A (The signal is always active.), it means the motor will be enabled when the power is turned on.

Table6.5.2.1

Parameter		Description	Effective	Category
Pt50A	t.□□□0 (Default)	User S-ON signal for servo on or servo off.	After power on	Setup
	t.□□□A	S-ON signal is always ON.		

Set Pt513 to t.1□□□ to allocate signal to the desired pin. For more information, please refer to section 8.1.1.

Note

- If S-ON signal is set to be always ON, when the main circuit power for the servo drive is input, the motor will be enabled. Ensure safety measure is implemented to avoid false operation if command is input at the same time.
- When servo off (Power is not supplied to the motor.) occurs due to an alarm which is resettable, the motor will automatically be in servo on state after the alarm is reset. Please be noted that if the cause of the alarm is not cleared, the alarm may still occur after servo on.

6.5.3 Time relationship between S-ON signal input and motor enabling

When S-ON signal is input, motor will not be enabled immediately. There will be a delay before motor is enabled (Servo ready). If external dynamic brake is connected, Pt504 (External dynamic brake command-servo on delay time) must be set to enable the motor after the delay in activating magnetic contactor or relay.

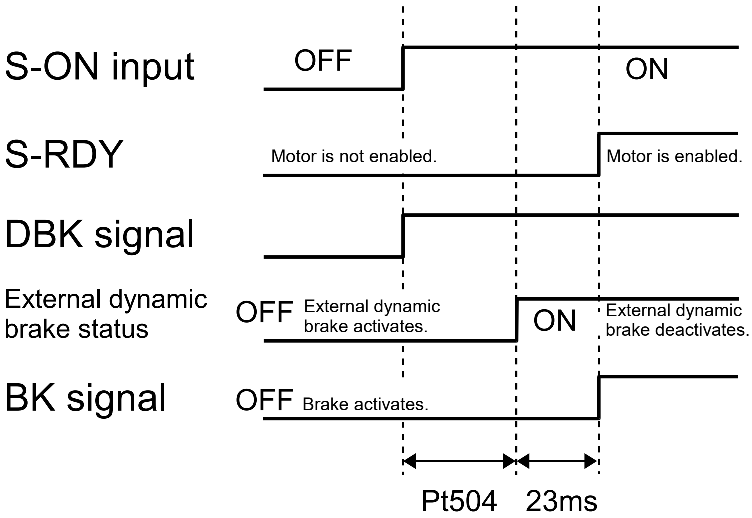


Figure6.5.3.1

Table6.5.3.1

Parameter	Pt504	Range	0~1000	Control Mode	Position mode, velocity mode and torque mode
Default	0	Effective	Immediately	Unit	1 ms
Description					
Set external dynamic brake command-servo on delay time.					

6.6 Setting the moving direction of motor

When the actual moving direction of the motor is different from the command from the controller, users can change the moving direction by Pt000 = t.□□□X without changing the polarity of velocity command or position command. Though the moving direction will be changed, the relationship between A phase and B phase of encoder pulse output will remain the same. For more information of encoder pulse output, please refer to section 0.

- Rotary motor

  The default forward direction is that while observing from the load side of the servo motor, counterclockwise direction is the forward direction.

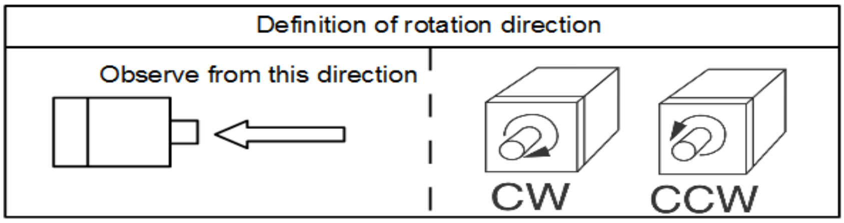
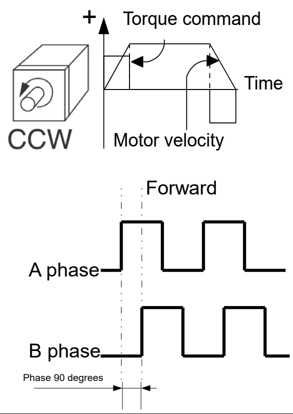
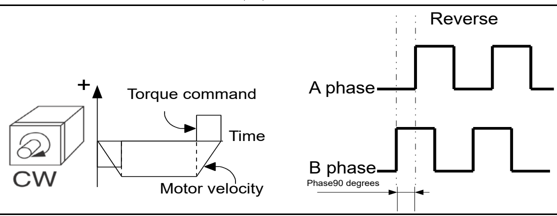
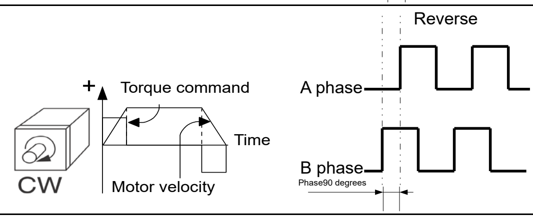
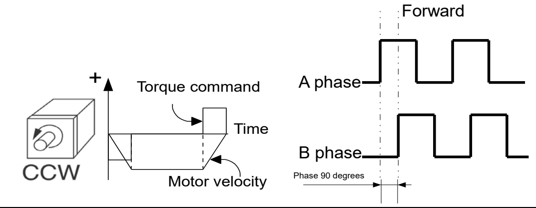


Figure6.6.1

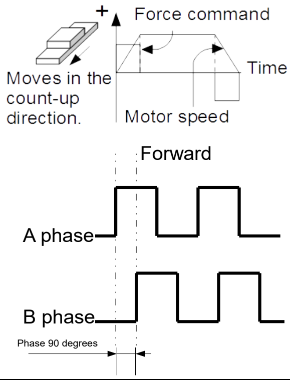
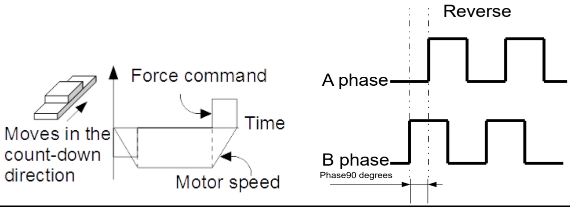
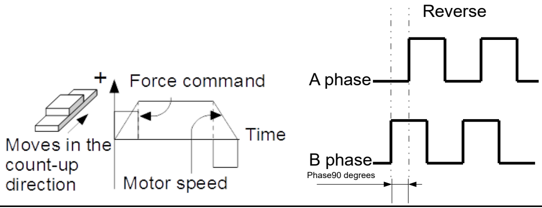
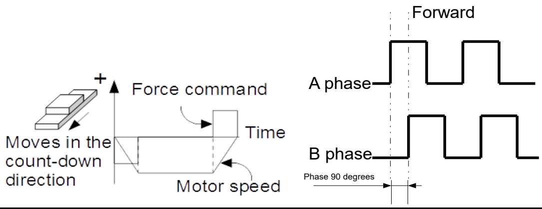
Table6.6.1

Parameter		Forward/Reverse Command	Moving Direction And Encoder Pulse Output Signal	Overtravel Signal (OT)
Pt000	t.□□□0 CCW is the forward direction (Default)	Forward command		Forward prohibition input (P-OT) signal
		Reverse command		Reverse prohibition input (N-OT) signal
	t.□□□1 CW is the forward direction. (Reverse mode)	Forward command		Forward prohibition input (P-OT) signal

		Reverse command		Reverse prohibition input (N-OT) signal

■ Linear motor

Table6.6.2

Parameter		Forward/Reverse Command	Moving Direction And Encoder Pulse Output Signal	Overtravel Signal (OT)
Pt000	t.□□□0 Use the direction in which the linear encoder counts up as the forward direction. (Default)	Forward command		Forward prohibition input (P-OT) signal
		Reverse command		Reverse prohibition input (N-OT) signal
	t.□□□1 Use the direc-tion in which the linear encoder counts down as the forward direction.	Forward command		Forward prohibition input (P-OT) signal
		Reverse command		Reverse prohibition input (N-OT) signal

6.7 Overtravel function

For operational safety, machine will restrict the travel distance of its moving parts by means of hardware devices such as end stops and limit switches as well as software signals such as software limits planned by controller. E1 series servo drive provides overtravel signals (P-OT and N-OT signals) which can be used with limit switches for protecting the machine.

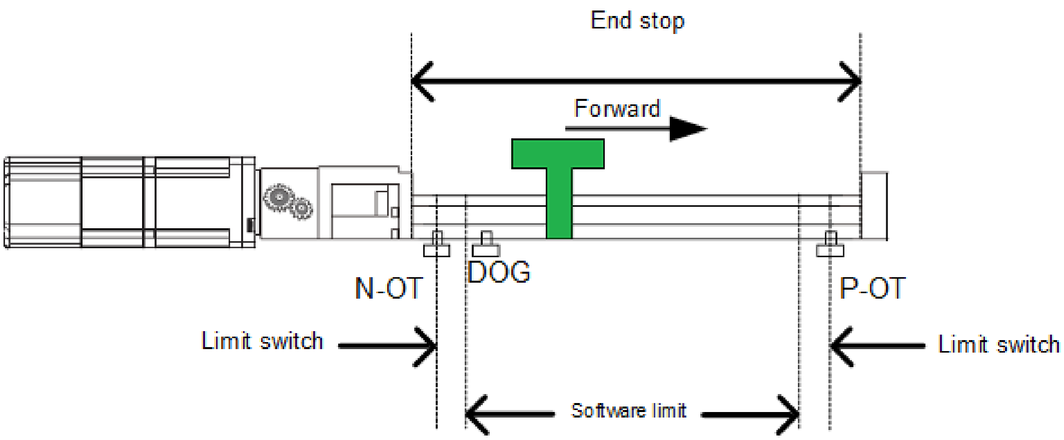


Figure6.7.1

Note:
(1) Please adjust the installation position of the limit switch according to the motor stopping methods after P-OT and N-OT is activated.
(2) If P-OT or N-OT signal is used for homing, please adjust controller's software limits.
(3) If the limit switch is activated before the servo drive is ready, rL or LL will be displayed.

When overtravel function is not needed for rotating application or conveyor, wiring for overtravel function is not required. The related parameters of overtravel function are described as below.

⚠CAUTION	
◆	Ensure normally closed contacts (b contacts) are used for limit switches to avoid accident caused by poor contact or disconnection. The polarity of input pins for overtravel signals can be user-defined.
◆	When motor is used in vertical axis, load could fall if overtravel occurs. To prevent load from falling, Pt001 must not be t.□□0□ (The motor runs freely after the motor decelerates to a stop.).
◆	Though the motor goes into STO state after overtravel occurs and the motor stops, the motor could still be moving due to external force from the load side. To avoid the above situation, please set Pt001 to t.□□1□.
◆	When overtravel function is enabled, the servo drive can still receive pulse commands from the controller. When overtravel function is disabled, please be aware that if there is excessive position deviation between the actual position and the command position since the motor may operate at high velocity.

6.7.1 Overtravel signals

Overtravel signals include forward prohibition input (P-OT) signal and reverse prohibition input (N-OT) signal.

Table6.7.1.1

Type	Signal	Hardware Pin	Status	Description
Input	P-OT	CN6-29 (I3)	ON	Forward prohibition (Overtravel protection in forward direction)
			OFF	Movement in forward direction is allowed. (Normal operation)
	N-OT	CN6-27 (I4)	ON	Reverse prohibition (Overtravel protection in reverse direction)
			OFF	Movement in reverse direction is allowed. (Normal operation)

In overtravel state, the motor can still operate in opposite direction.

6.7.2 Enabling/disabling overtravel function

Pt50A = t.□X□□ (Allocation of forward prohibition input (P-OT) signal) and Pt50A = t.X□□□ (Allocation of reverse prohibition input (N-OT) signal) are used to allocate ovetravel signals to input pins. If overtravel function is not needed, wiring for overtravel function is not required.

Table6.7.2.1

Parameter		Description	Effective	Category
Pt50A	t.□2□□	Forward overtravel function is enabled. Forward prohibition input (P-OT) signal is input via CN6-29 (I3).	After power on	Setup
	t.□B□□	Forward overtravel function is disabled.		
Pt50A	t.3□□□	Reverse overtravel function is enabled. Reverse prohibition input (N-OT) signal is input via CN6-27 (I4).		
	t.B□□□	Reverse overtravel function is disabled.		

Set Pt513 to t.1□□□ to allocate signal to the desired pin. For more information, please refer to section 8.1.1.

6.7.3 Motor stopping method for overtravel

The motor stopping method for overtravel can be set by Pt001 = t.□□XX (Stopping method for servo off and Gr.A alarm, and stopping method for overtravel (OT)).

Table6.7.3.1

<table>
<tr><th colspan="2">Parameter</th><th>Motor Stopping Method</th><th>Motor State After Stop</th><th>Effective</th><th>Category</th></tr>
<tr><td rowspan="7">Pt001</td><td>t.□□00</td><td>Dynamic brake</td><td rowspan="3">Free run</td><td rowspan="7">After power on</td><td rowspan="7">Setup</td></tr>
<tr><td>t.□□01</td><td>Dynamic brake</td></tr>
<tr><td>t.□□02</td><td>Free run</td></tr>
<tr><td>t.□□1□</td><td rowspan="2">The motor decelerates according to the setting of Pt406.</td><td>Zero clamp</td></tr>
<tr><td>t.□□2□</td><td>Free run</td></tr>
<tr><td>t.□□3□ (Default)</td><td rowspan="2">The motor decelerates according to the setting of Pt30A.</td><td>Zero clamp</td></tr>
<tr><td>t.□□4□</td><td>Free run</td></tr>
</table>

Note:
In torque mode, the servo motor cannot decelerate to a stop. Use dynamic brake to stop the servo motor or let the servo motor run freely to a stop by setting Pt001 = t.□□□X. The motor goes into free run state after stop.

When ED1F model is used, only Pt001=t.□□3□ is supported. The motor decelerates according to the setting of Pt30A and the motor state after it stops is zero clamp.

For other motor stopping methods, please refer to section 6.9.

- Set emergency stop torque to stop servo motor
  Set Pt406 (Emergency stop torque) to stop servo motor by emergency stop torque. When Pt001 = t.□□X□ is set to 1 or 2, Pt406 will be used as the maximum torque to decelerate servo motor. The default of Pt406 is 800% in order not to limit the performance of motor. The maximum torque depends on the specification of motor.

Table6.7.3.2

<table>
<tr><td>Parameter</td><td>Pt406</td><td>Range</td><td>0~800</td><td>Control Mode</td><td>Position mode, velocity mode and torque mode</td></tr>
<tr><td>Default</td><td>800</td><td>Effective</td><td>Immediately</td><td>Unit</td><td>1% (The percentage of rated torque)</td></tr>
<tr><td colspan="6">Description</td></tr>
<tr><td colspan="6">Set emergency stop torque.</td></tr>
</table>

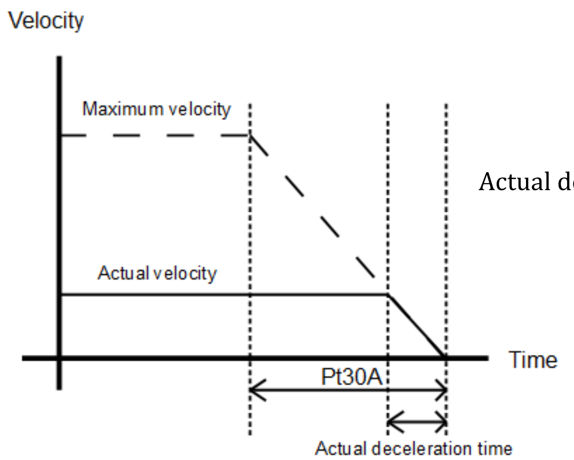
■ Set deceleration time to stop servo motor

Set Pt30A (Deceleration time for servo off and forced stop) to stop servo motor by deceleration time.

Table6.7.3.3

Parameter	Pt30A	Range	0~10000	Control Mode	Position mode and velocity mode
Default	0	Effective	Immediately	Unit	1 ms
Description					
Set deceleration time for servo off and forced stop to decelerate the motor from maximum velocity to a stop. If the setting value is 0, it means the motor is stopped with zero velocity.					

The deceleration time set in Pt30A is the time to decelerate the motor from maximum velocity to a stop.



$$\text{Actual deceleration time} = \frac{\text{Actual velocity}}{\text{Maximum velocity}} \times \text{Deceleration time (Pt30A)}$$

Figure6.7.3.1

6.7.4 Overtravel warning

Overtravel warning is to detect warning AL.9A0 (Overtravel detected when servo ON (P-OT or N-OT signal is received.)) when P-OT or N-OT signal is triggered.

Note	➢ If warning AL.9A0 (Overtravel detected when servo ON (P-OT or N-OT signal is received.)) occurs during operation, the motor will stop but the controller can still proceed to the following commands. If not, please check the controller. ➢ When overtravel occurs, the motor cannot reach the target position. Check if the axis stops at safe position with feedback position.

Table6.7.4.1

Parameter		Description	Effective	Category
Pt00D	t.0□□□	Do not detect overtravel warning.	Immediately	Setup
	t.1□□□ (Default)	Detect overtravel warning.		

Note:

Set Pt513 to t.1□□□ to allocate signal to the desired pin. For more information, please refer to section 8.1.

Timing diagram of overtravel warning detection is as below.

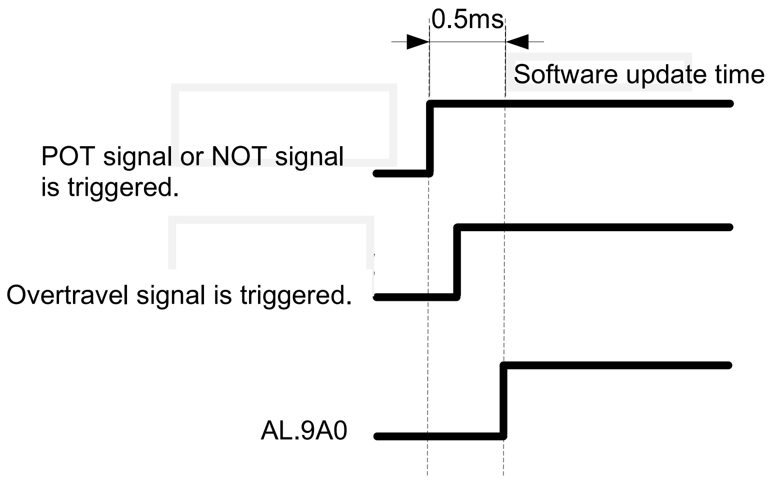


Figure6.7.4.1

6.8 Brake

E1 series servo drive provides brake control output (BK) signal to be used with external brake to protect motor and mechanism. Brake is usually used to prevent motor from moving due to external force or gravity when servo off.

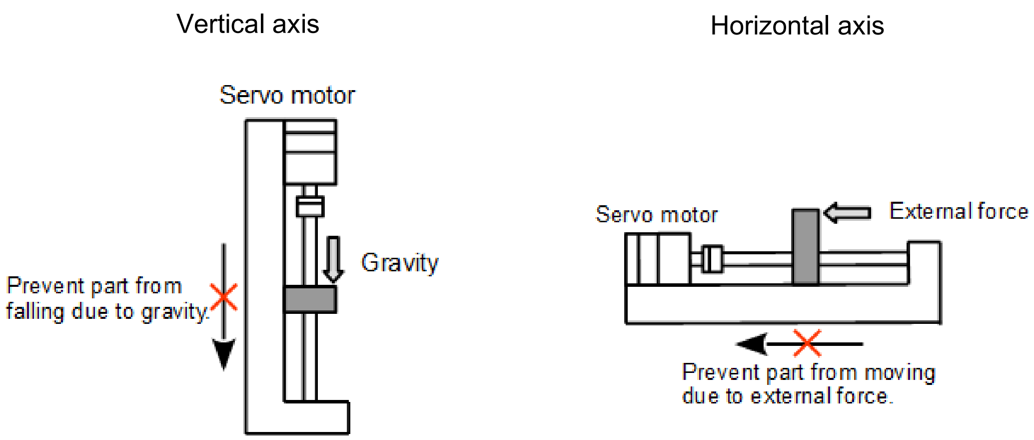


Figure6.8.1

6.8.1 Brake operating sequence

When servo on input (S-ON) signal is OFF or an alarm occurs in the servo drive, brake will be enabled after the time set in Pt508 or the motor decelerates to the velocity set in Pt507. After the time set in Pt506, the motor will be truly disabled.

Note:
If mechanism slips or friction sound is heard, please adjust Pt506, Pt507 and Pt508.

- When brake is connected to relay
  The default output pins of brake control output (BK) signal are CN6-40 (O5+) and CN6-12 (O5-). Users can also define the pin assignment by themselves. While using brake control output (BK) signal, we suggest using relay and additional power supply to avoid false operation caused by insufficient current, please refer to section 5.4.4.

6.8.2 Brake control output (BK) signal

In standard servo drive (ED1S), the default output pins of brake control output (BK) signal are CN6-40 (O5+) and CN6-12 (O5-). Set Pt516 to t.□□□X to modify pin assignment.

Table6.8.2.1

Type	Signal	Hardware Pin	Status	Description
Output	BK	CN6-40/12 (O5)	ON	The brake is disabled.
			OFF	The brake is enabled.

Note	
	➢ In overtravel state, the brake is disabled when BK signal is ON. ➢ Ensure the wiring is correct while connecting external brake and relay.

6.8.3 Output timing of BK signal when motor stops

If S-ON signal is OFF when servo motor stops, BK signal will also be OFF. Pt506 (Brake command-servo off delay time) can set the time when BK signal is OFF to the time when the power supplied to the motor is cut off (S-RDY signal is OFF.). You may refer to figure below.

Table6.8.3.1

Parameter	Pt506	Range	0~50	Control Mode	Position mode, velocity mode and torque mode
Default	10	Effective	Immediately	Unit	10 ms
Description					
Set the time when BK signal is OFF to the time when the power supplied to the motor is cut off (S-RDY signal is OFF.).					

In application that motor is used in vertical axis or load is affected by external force, the mechanism may slightly move when brake is enabled. Pt506 can prevent the motor from moving after the brake is enabled.

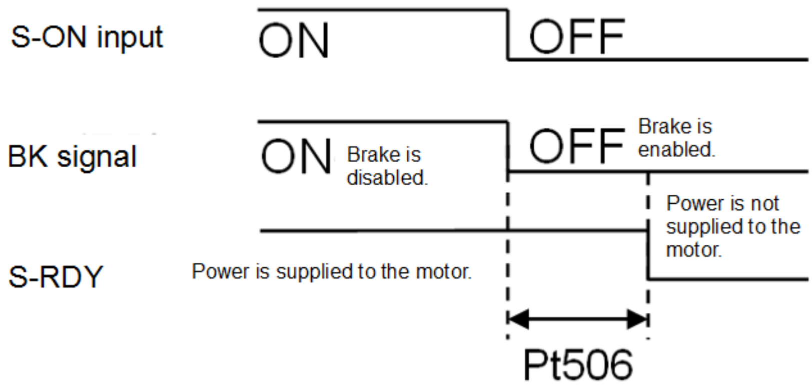


Figure6.8.3.1

Note	➢ When an alarm occurs, servo motor will be disabled immediately. The load may slightly move due to external force before brake is enabled.

6.8.4 Output timing of BK signal when motor is operating

If an alarm occurs when servo motor is operating, the servo motor will stop and BK signal will be OFF. Use Pt507 (Brake command output velocity value) and Pt508 (Servo off-brake command waiting time) to adjust the output timing of BK signal. When one of the settings in Pt507 and Pt508 is satisfied, BK signal will be output. Refer to figures 6.8.4.1 and 6.8.4.2.

Note:
If the motor stopping method for alarm is to stop the motor with zero velocity, the operation will follow the setting of Pt506 (Brake command-servo off delay time) after the motor stops.

- Rotary servo motor

Table6.8.4.1

Parameter	Pt507	Range	0~10000	Control Mode	Position mode, velocity mode and torque mode
Default	100	Effective	Immediately	Unit	rpm
Description					
Brake command output velocity value When motor velocity is lower than the setting value of Pt507, the brake is enabled.					

Table6.8.4.2

Parameter	Pt508	Range	10~100	Control Mode	Position mode, velocity mode and torque mode
Default	50	Effective	Immediately	Unit	10 ms
Description					
When servo off and the time set in Pt508 elapses, brake is enabled.					

- Linear servo motor

Table6.8.4.3

Parameter	Pt583	Range	0~10000	Control Mode	Position mode, velocity mode and torque mode
Default	10	Effective	Immediately	Unit	1 mm/s
Description					
Brake command output velocity value (linear servo motor) When motor velocity is lower than the setting value of Pt583, brake is enabled.					

Table6.8.4.4

Parameter	Pt508	Range	10~100	Control Mode	Position mode, velocity mode and torque mode
Default	50	Effective	Immediately	Unit	10 ms
Description					
When servo off and the time set in Pt508 elapses, brake is enabled.					

Brake will be enabled when one of the conditions below is satisfied.

a. Power is not supplied to motor and motor velocity is lower than the setting value of Pt507.

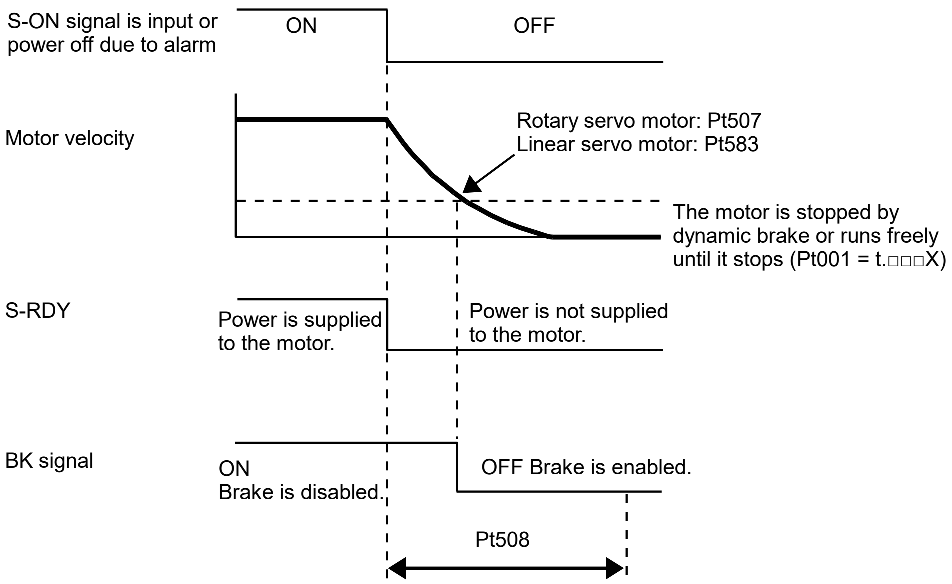


Figure6.8.4.1

b. Power is not supplied to motor and the time set in Pt508 elapses.

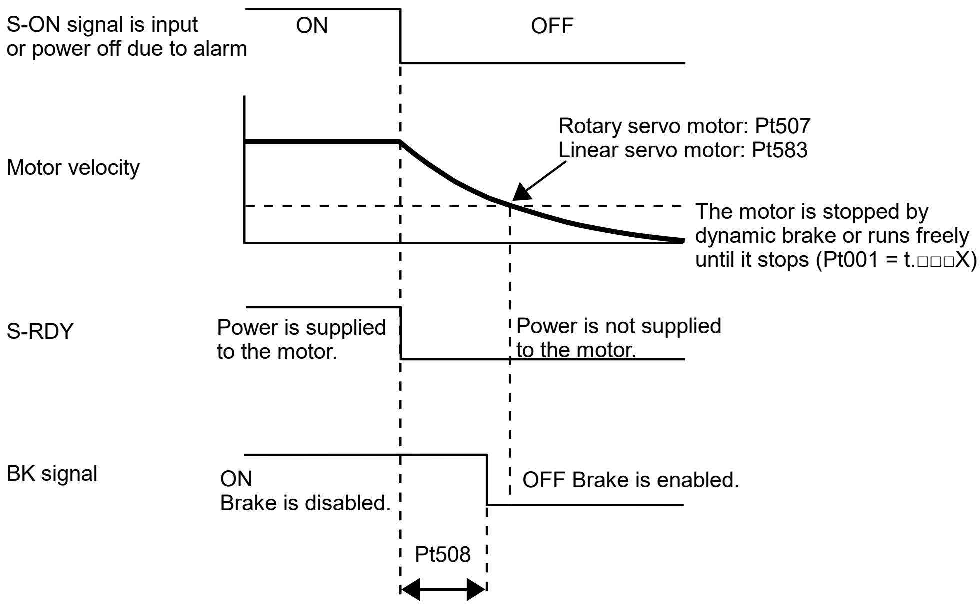


Figure6.8.4.2

6.9 Motor stopping methods for servo off and alarm

Motor stopping methods for servo off and alarm are listed in table 6.9.1.

Table6.9.1

Motor Stopping Method	Description
Dynamic brake	After servo off, the circuit of motor is short-circuited to create reluctance to stop the motor.
Free run	The motor naturally stops due to friction.
Zero clamp	Set velocity command to 0 to stop the motor.
Motor decelerates to a stop.	Use emergency stop torque to let the motor decelerate to a stop.

Motor states after stop are listed in table 6.9.2.

Table6.9.2

Motor State After Stop	Description
Dynamic brake	Use reluctance force to let the motor remain at stop.
Free run	The servo drive stops controlling the motor. If there is external force (gravity), the load may move.
Zero clamp	The servo drive is in internal position mode or position mode. The motor remains at current position.

Note

- Servo off to stop the motor can only be used for emergency.
- During operation, when main circuit power supply or control circuit power supply is OFF, the motor stopping method is to use dynamic brake to stop the motor. This setting cannot be modified by parameter.
- To reduce the movement caused by inertia, the default motor stopping method when alarm occurs is zero clamp. But in different mechanisms, stopping the motor by dynamic brake could be more suitable.
- User can choose to use internal dynamic brake (Default) or external dynamic brake (Brake resistor must be installed by user.).

6.9.1 Motor stopping method when servo off

The motor stopping method when servo off is set by Pt001 = t.□□□X (Stopping method for servo off and Gr.A alarm).

Table6.9.1.1

<table>
<tr><th colspan="2">Parameter</th><th>Servo Motor Stopping Method</th><th>Servo Motor State After Stop</th><th>Effective</th><th>Category</th></tr>
<tr><td rowspan="3">Pt001</td><td>t.□□□0 (Default)</td><td rowspan="2">Dynamic brake</td><td>Dynamic brake</td><td rowspan="3">After power on</td><td rowspan="3">Setup</td></tr>
<tr><td>t.□□□1</td><td>Free run</td></tr>
<tr><td>t.□□□2</td><td>Free run</td><td>Free run</td></tr>
</table>

6.9.2 Motor stopping methods for alarm

The alarms of E1 series servo drive can be divided into two types, Gr.A and Gr.B. The parameters used to set motor stopping methods for Gr.A alarm and Gr.B alarm are different. To identify an alarm belongs to Gr.A or Gr.B type, please refer to chapter 6.

■ Motor stopping method for Gr.A alarm
If a Gr.A alarm occurs, the servo motor stops according to the setting of Pt001 = t.□□□X. The default stopping method is to stop the motor by dynamic bake, please refer to section 6.9.1.

■ Motor stopping method for Gr.B alarm
If a Gr.B alarm occurs, the servo motor stops according to the settings of Pt001 = t.□□□X, Pt00A = t.□□□X and Pt00B = t.□□X□. The default stopping method is zero clamp.

◆ Pt001 = t.□□□X (Stopping method for servo off and Gr.A alarm)
◆ Pt00A = t.□□□X (Stopping method for Gr.B alarm)
◆ Pt00B = t.□□X□ (Stopping method for Gr.B alarm)

In torque mode, motor stopping method for Gr.A alarm is usually used. Set Pt00B to t.□□1□ to use the same motor stopping method when Gr.A alarm occurs. The parameter settings and motor stopping methods are listed in table below.

Table6.9.2.1

<table>
<tr><th colspan="3">Parameter</th><th rowspan="2">Motor Stopping Method</th><th rowspan="2">Motor State After Stop</th><th rowspan="2">Effective</th><th rowspan="2">Category</th></tr>
<tr><th>Pt00B</th><th>Pt00A</th><th>Pt001</th></tr>
<tr><td rowspan="3">t.□□0□ (Default)</td><td rowspan="3">-</td><td>t.□□□0 (Default)</td><td rowspan="3">Zero clamp</td><td>Dynamic brake</td><td rowspan="21">After power on</td><td rowspan="21">Setup</td></tr>
<tr><td>t.□□□1</td><td rowspan="2">Free run</td></tr>
<tr><td>t.□□□2</td></tr>
<tr><td rowspan="3">t.□□1□</td><td rowspan="3">-</td><td>t.□□□0 (Default)</td><td rowspan="2">Dynamic brake</td><td>Dynamic brake</td></tr>
<tr><td>t.□□□1</td><td rowspan="2">Free run</td></tr>
<tr><td>t.□□□2</td><td>Free run</td></tr>
<tr><td rowspan="15">t.□□2□</td><td rowspan="3">t.□□□0 (Default)</td><td>t.□□□0 (Default)</td><td rowspan="2">Dynamic brake</td><td>Dynamic brake</td></tr>
<tr><td>t.□□□1</td><td rowspan="2">Free run</td></tr>
<tr><td>t.□□□2</td><td>Free run</td></tr>
<tr><td rowspan="3">t.□□□1</td><td>t.□□□0 (Default)</td><td rowspan="6">Pt406 is used as the maximum torque to decelerate the motor.</td><td>Dynamic brake</td></tr>
<tr><td>t.□□□1</td><td rowspan="2">Free run</td></tr>
<tr><td>t.□□□2</td></tr>
<tr><td rowspan="3">t.□□□2</td><td>t.□□□0 (Default)</td><td rowspan="3">Free run</td></tr>
<tr><td>t.□□□1</td></tr>
<tr><td>t.□□□2</td></tr>
<tr><td rowspan="3">t.□□□3</td><td>t.□□□0 (Default)</td><td rowspan="6">Pt30A is used to decelerate the motor.</td><td>Dynamic brake</td></tr>
<tr><td>t.□□□1</td><td rowspan="2">Free run</td></tr>
<tr><td>t.□□□2</td></tr>
<tr><td rowspan="3">t.□□□4</td><td>t.□□□0 (Default)</td><td rowspan="3">Free run</td></tr>
<tr><td>t.□□□1</td></tr>
<tr><td>t.□□□2</td></tr>
</table>

Note:

(1) When Pt001 is set to t.□□0□ or t.□□1□, the setting of Pt00A is ignored.

(2) Pt00A = t.□□□X is only effective in position mode and velocity mode. In torque mode, the setting of Pt00A = t.□□□X is ignored and only the setting of Pt001 = t.□□□X will be applied.

(3) For more information of Pt406 (Emergency stop torque), please refer to section 6.7.3.

(4) For more information of Pt30A (Deceleration time for servo off and forced stop), please refer to section 6.7.3.

6.10 Protection for motor overload

Motor overload protection is used to detect overload warning, overload alarm or I^2T alarm to prevent a motor from overheating when the motor has been continuously used with load which exceeds its rating. For an E1 user, different types of software overload protection can be chosen by setting parameters.

- Motor overload protection 1(Default):

The detection timings of AL.910 (Overload) and AL.720 (Overload (continuous maximum load)) can be set by parameters, so an user can adjust the timing of the detection. However, the detection value of AL.710 (Overload (instantaneous maximum load)) cannot be changed.

- Motor overload protection 2:

I^2T current limit algorithm is used for this protection.The drive takes samplings of the motor current and makes an accumulation. When the value of the accumulation exceeds the load, the drive limits the output current to the continuous current limit of the motor or the drive. When this happens, I^2T alarm will be activated.

Note:

(1) The two types of motor overload protections use software algorithm to accumulate the countings to check motor overloads. If the drive control power(L1C,L2C) is cut or the drive is reset, the accumulation will be cleared. However, the motor may not be in room temperature when this happens. Please check if the motor is overheated.
(2) A user can choose either protection 1 or 2. If motor overload protection1 is used, I^2T alarm (AL.924) will not be detected. On the other hand, if protection2 is used, warning (AL.910) and alarm (AL.710 or AL.720) will not be detected.

Table 6.10.1

Parameter		Description	Effective	Category
Pt007	t.0□□□ (Default)	Motor overload protection1,with warning (AL.910) or alarm (AL.710 or AL.720)。	After power on	Setup
	t.1□□□	Motor overload protection2,with I^2T alarm (AL.924)。		

6.10.1 Detection timing for overload warning (AL.910)

The default detection timing for overload warning is 20% of the detection timing for overload alarm. The detection timing for overload warning can be changed by Pt52B (Overload warning value). Use overload warning as overload protection to have a safer system. In figure 6.10.1.1, when Pt52B (Overload warning value) is changed from 20% to 50%, the detection timing for overload warning becomes half of the detection timing for overload alarm (50%).

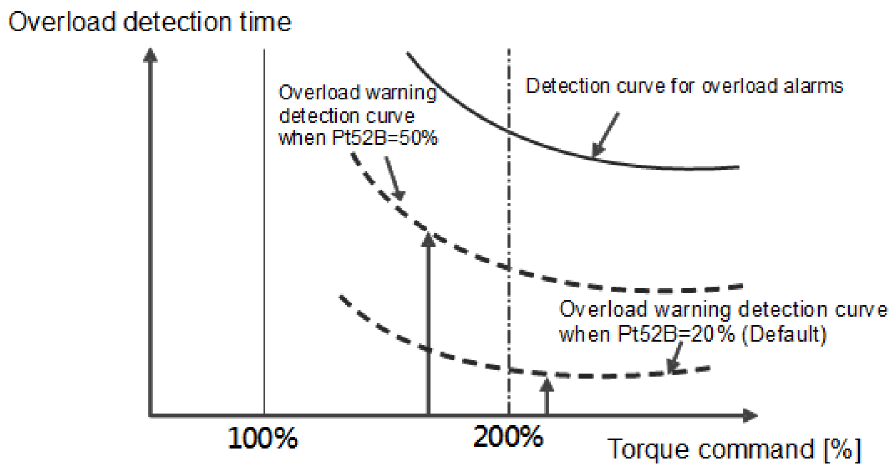


Figure6.10.1.1

Table6.10.1.1

Parameter	Pt52B	Range	1~100	Control Mode	Position mode, velocity mode and torque mode
Default	20	Effective	Immediately	Unit	1%
Description					
Set overload warning value.					

6.10.2 Detection timing for continuous overload alarm (AL.720)

When a motor is constantly operated beyond continuous current, it will be overheated and this may lead to a burn out. According to the motor continuous current, the overload protection will estimate if the drive needs to activate the alarm to remind the user to decrease the load or use lower operating conditions.

If the heat dissipation of motor is not ideal, decrease the detection value of overload alarm to activate the alarm earlier to avoid overheating. The detection value can be adjusted by Pt52C (Current derating value at motor overload detection).

Table6.10.2.1

Parameter	Pt52C	Range	10~100	Control Mode	Position mode, velocity mode and torque mode
Default	100	Effective	After power on	Unit	1%
Description					
Set current derating value at motor overload detection.					

Motor overload can be avoided if overload alarm (AL.720) is detected earlier.

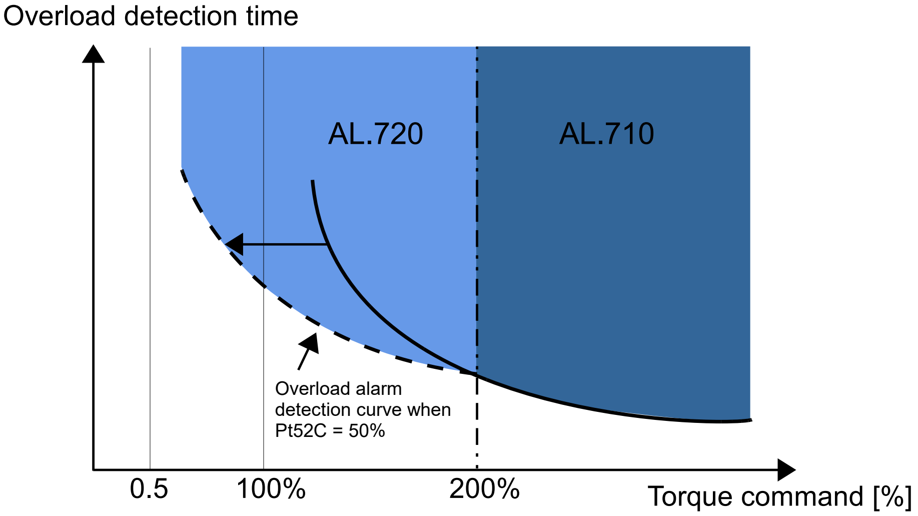


Figure6.10.2.1

6.10.3 Detection timing for instantaneous overload(AL.710)

When motor has been continuously supplied with its rated peak current, it could result in overheating and damage the motor. Set Pt52E (Maximum duration for motor peak current) to provide software protection. When the servo drive detects the output current reaches the value of motor peak current, after the time set in Pt52E elapses, alarm AL.710 (Overload (instantaneous maximum load)) occurs.

Table6.10.3.1

Parameter	Pt52E	Range	5~600	Control Mode	Position mode, velocity mode and torque mode
Default	10	Effective	After power on	Unit	100 ms
Description					
Set the maximum duration for motor peak current.					

Note:

(1) Set Pt52E according to the specification of your motor. Otherwise, the motor could be damaged.

(2) If you are using standard HIWIN AC servo motor, Pt52E will be automatically set after the motor is connected.

6.10.4 Detection method for overload warning I2T(AL.924)

The I^2T current limit algorithm continuously monitors the current being delivered to the motor by the drive.When the drive output current is greater than the motor parameter continuous current, the value will be incrementally increased. The value will be incrementally decreased in opposite situation. The value will be recorded in the drive as accumulator variable. Whenever the current delivered to the motor exceeds the I^2T setpoint, the drive will limit the output current to the continuous current limit. I^2T warning**(AL.924)** will be detected at the same time. The output current of the drive will not exceed the motor continuous current limit until the motion is stopped or operating conditions are lowered, which makes the value lower than I^2T setpoint.

The I^2T setpoint value is calculated as below. The I^2T setpoint value has units of **Amperes^2-seconds (A^2S)**. Peak Current Limit and Continuous Current Limit are set from the motor parameter. I^2T Time Limit has units of seconds, which can be set from Pt554.

I^2T setpoint =(Peak Current Limit^2 – Continuous Current Limit^2) * Maximum duration for I^2T peak current

Table6.10.4.1

Parameter	Pt554	Range	8~600	Control Mode	Position mode, velocity mode and torque mode
Default	10	Effective	After power on	Unit	100 ms
Description					
Maximum duration for I^2T peak current					

Note:

(1) When I^2T warning(AL.924) is activated, the drive will be forced to limit the output current to the motor.If the original operating conditions are not changed, abnormal motor motion may happen and results in activation of other alarms.

(2) If the set value of of I^2T Time Limit is too high, this could lead to failure of motor overload protection.

6.11 Electronic gear ratio

6.11.1 Introduction to electronic gear ratio

Controller controls the position of motor by inputting pulses. If the resolution of motor encoder is high and the motor operates at high velocity, the output bandwidth of the controller or the input bandwidth of the servo drive could be insufficient. At this time, users can use electronic gear ratio for adjustment. The setting of electronic gear ratio affects the control unit displayed in Thunder. Control unit is the minimum unit that the load moves for one pulse. Encoder resolution is required while setting electronic gear ratio. For a 23-bit servo motor, 8388608 pulses need to be input for the motor to rotate for one revolution. The examples of using and not using electronic gear ratio are provided as below.

- How many pulses should be input to let the load in figure below move for 15 mm in one second?

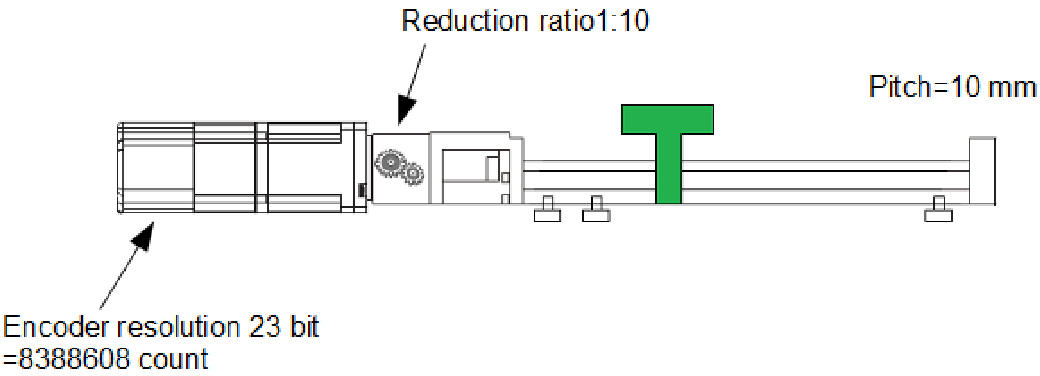


Figure6.11.1.1

Calculate the required revolutions to move the load for 15 mm.

Revolutions of screw=moving distance/screw pitch = 15/10 = 1.5

Revolutions of motor=revolutions of screw/reduction ratio = 1.5/0.1 = 15

Electronic gear ratio is not applied.

Pulse command from the controller: 15*8388608 = 125829120 pulse/s => Bandwidth: At least 125.8 MConfiguration diagram of servo drive and servo motor

Calculation is complicated and the required bandwidth is high.

Electronic gear ratio is applied.

Control unit is 0.001 mm by setting electronic gear ratio. Pulse command from the controller: 15/0.001 = 15000 pulse/s => Bandwidth: 0.015 M

Calculation is simple and the required bandwidth is low.

Figure6.11.1.2

6.11.2 Setting electronic gear ratio

Set electronic gear ratio by Pt20E and Pt210.

Note:

(1) If electronic gear ratio is set by controller, the electronic gear ratio of servo drive is usually set to 1:1.

(2) If command pulse input multiplier is enabled, one pulse = n control unit. n = the value of command pulse input multiplier (Pt218).

Table6.11.2.1

Parameter	Pt20E	Range	1~1073741824	Control Mode	Position mode
Default	32	Effective	After power on	Unit	1
Description					
Set electronic gear ratio (numerator).					

Table6.11.2.2

Parameter	Pt210	Range	1~1073741824	Control Mode	Position mode
Default	1	Effective	After power on	Unit	1
Description					
Set electronic gear ratio (denominator).					

Calculating the setting value of electronic gear ratio:

- Commonly-used physical unit of motion control
  - Linear motion: meter (m), millimeter (mm), micrometer (um) and nanometer (nm).
  - Rotary motion: degree (deg), radian (rad) and revolution (rev).

- Rotary motor
  - AC servo motor

    The reduction ratio of motor shaft and load side is n/m. (When the motor rotates for m revolutions, the load shaft rotates for n revolutions.) The setting value of electronic gear ratio can be obtained by the formula below.

$$\text{Electronic gear ratio} = \frac{\text{Pt20E}}{\text{Pt210}} = \frac{\text{Encoder resolution}}{\text{Movement of one revolution of load shaft} \div \text{Control unit}} \times \frac{m}{n}$$

Example:

The resolution of rotary encoder is 8388608 count/rev. The screw pitch is 10 mm/rev. The reduction ratio is 1/10. The control unit set by the controller for each pulse is 1 um. The calculation is as below.

$$\text{Electronic gear ratio} = \frac{\text{Pt20E}}{\text{Pt210}} = \frac{8388608\ \text{count/rev}}{10000(\text{um/rev}) \div 1\text{um}} \times \frac{10}{1}$$

Set Pt20E to 1048576 and Pt210 to 125. Then the load side moves 1 um when the controller inputs one pulse.

➢ Direct drive motor (DM)

Example:

When HIWIN DMS03G direct drive motor is used, the resolution is 4325376 count/rev. Direct drive motor usually does not have speed reduction mechanism. The control unit set by the controller for each pulse is 1 deg. The calculation is as below.

$$\text{Electronic gear ratio} = \frac{\text{Pt20E}}{\text{Pt210}} = \frac{4325376\ \text{count/rev (Encoder resolution)}}{360\ \text{deg/rev (Movement per one revolution)} \div 1\ \text{deg (control unit)}}$$

Set Pt20E to 4325376 and Pt210 to 360. Then the load side moves 1 deg when the controller inputs one pulse.

■ Linear servo motor

When linear servo motor or full-closed loop control system is used, use electronic gear ratio to change control unit.

Example 1:

The resolution of linear digital encoder is 0.5 um/count. The control unit set by the controller for each pulse is 0.1 um. The calculation is as below.

$$\text{Electronic gear ratio} = \frac{\text{Pt20E}}{\text{Pt210}} = \frac{0.1\text{um}}{0.5\text{um}}$$

Set Pt20E to 1 and Pt210 to 5. When the controller inputs five pulses, the load side moves 0.5 um.

Example 2:

The scale pitch of linear analog encoder is 20 um. The analog encoder multiplier factor is 250. The encoder resolution is 20 um/(250 x 4)=0.02 um. The control unit for each pulse is 0.1 um. The calculation is as below.

$$\text{Electronic gear ratio} = \frac{\text{Pt20E}}{\text{Pt210}} = \frac{0.1\text{um}}{0.02\text{um}}$$

Set Pt20E to 50 and Pt210 to 1. When the controller inputs one pulse, the load side moves 0.1 um.

Note	➢ While setting electronic gear ratio, the value of Pt20E/Pt210 needs to be between 0.001 and 64000.

6.12 Setting encoder

When a system installed with absolute encoder is used for the first time (For example, EM1 servo motor), the absolute encoder must be initialized. Therefore, AL.800 (Encoder absolute position lost) may occur when the power of the servo drive is turned on for initialization. After the absolute encoder has been initialized, encoder data and related alarms will be reset. In the following occasions, absolute encoder must be initialized.

(1) Perform tuning for the first time after a machine is installed. Or encoder extension cable has been removed from motor.
(2) AL.800 (Encoder absolute position lost)) occurs.
(3) Multi-turn absolute encoder is reset or its battery has been replaced.

⚠CAUTION
◆ After multi-turn absolute encoder has been initialized, the home position of the machine will change. Therefore, the home position must be readjusted. If the home position is not readjusted, false operation may occur and cause injury or damage to the machine.

Note	➢ In the following occasions, there will be no multi-turn data (The multi-turn data is usually 0.). Initializing absolute encoder is not required. Alarms related to absolute encoder (AL.800) will not occur. (1) Use single-turn absolute encoder or absolute optical (magnetic) scale. (2) Use multi-turn absolute encoder as single-turn absolute encoder (Pt002 = t.□2□□).

6.12.1 Precautions for initialization

(1) Initialize encoder when servo off.

(2) When AL.800 (Encoder absolute position lost) occurs, the absolute encoder must be initialized.

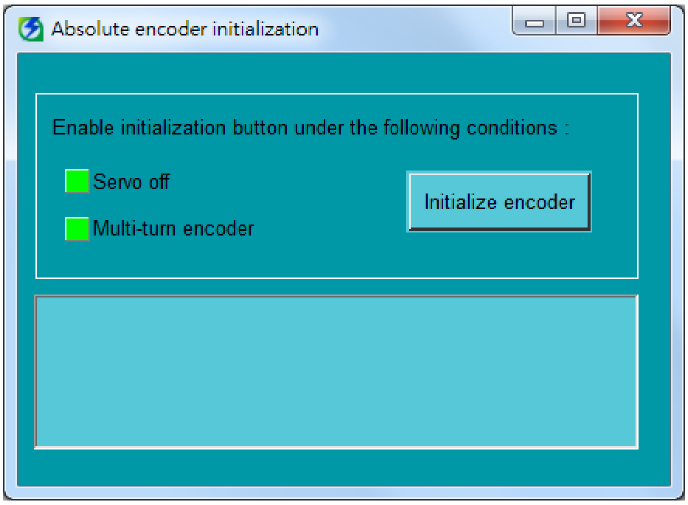
(3) AL.8□□ alarms cannot be cleared by alarm reset input (ALM-RST) signal. Turn off and turn on the servo drive to clear the alarm.

Note:
The function of initializing encoder is supported only when EM1 series AC servo motor is used.

6.12.2 Tool

Users are allowed to use the following tool to initialize encoder.

■ Thunder



Step 1:
Click on **Tools** on the menu bar of Thunder and select **Absolute encoder initialization**.

Step 2:
Ensure **Servo off** indicator is green. Click on **Initialize encoder** button and wait till encoder initialization completes.

Step 3:
Turn off and turn on the servo drive.

Figure6.12.2.1

■ Servo drive panel
Refer to section 14.4.7.

6.12.3 Parameter settings for encoder

Absolute encoder records the stop position of motor after power is turned off. Therefore, homing is not required when the power is turned on again. Encoder type can be set by Pt002 = t.□X□□. E1 series servo drive is able to support three types of encoders. Specify the usage of encoder by setting Pt002 = t.□X□□.

■ Parameter setting when multi-turn absolute encoder is used
For example, EM1 servo motor or torque motor with multi-turn absolute encoder (BiSS or EnDat)

Table6.12.3.1

Parameter		Description	Effective	Category
Pt002	t.□0□□ (Default)	Use the encoder as a multi-turn absolute encoder. Battery is required. (The position won’t change after power on.)	After power on	Setup
	t.□1□□	Use the encoder as an incremental encoder. Battery is not required.		
	t.□2□□	Use the multi-turn absolute encoder as a single-turn absolute encoder. Battery is not required. (No matter the original position is positive or negative, the position of the encoder will become positive single-turn position after power on.)		

■ Parameter setting when single-turn absolute encoder or absolute optical (magnetic) scale is used
For example, torque motor with single-turn absolute encoder or linear motor with absolute scale (BiSS or EnDat)

Table6.12.3.2

Parameter		Description	Effective	Category
Pt002	t.□0□□ (Default)	(1) Rotary: Use the encoder as a single-turn absolute encoder. Battery is not required. (2) Linear: Use the encoder as an absolute encoder. Battery is not required. (The position won’t change after power on.)	After power on	Setup
	t.□1□□	Use the encoder as an incremental encoder. Battery is not required.		
	t.□2□□	(1) Rotary: Use the encoder as a single-turn absolute encoder. Battery is not required. (2) Linear: Use the encoder as an absolute encoder. Battery is not required. (No matter the original position is positive or negative, the position of the encoder will become positive single-turn position after power on.)		

■ Parameter setting when incremental encoder is used

For example, linear motor with digital encoder (5V TTL signal), linear motor with analog encoder (sin/cos signal), HIWIN direct drive motor.

Table6.12.3.3

Parameter		Description	Effective	Category
Pt002	t.□0□□ (Default)	Use the encoder as an incremental encoder. Battery is not required.	After power on	Setup
	t.□1□□	Use the encoder as an incremental encoder. Battery is not required.		
	t.□2□□	Use the encoder as an incremental encoder. Battery is not required.		

Note:
When an incremental encoder is used, no matter what the setting of Pt002= t.□X□□ is, it can only be used as an incremental encoder.

6.12.4 Encoder delay time

When the control power for the servo drive is turned on, the servo drive detects if the encoder is ready or not. If the power-on time of the encoder (or external encoder) is too long, the servo motor may not be successfully enabled due to failure in detecting electrical angle. In this case, users can set encoder delay time by Pt52D. Encoder delay time may need to be set while using encoder other than Renishaw optical scale.

Note:
(1) When E1 series AC servo motor is used, Pt52D must be higher than the default value. Otherwise, the motor may not be successfully enabled.
(2) For full-closed loop control, check the power-on time of the external encoder. If the power-on time is larger than the default value of Pt52D, Pt52D must be increased.

Table6.12.4.1

Parameter	Pt52D	Range	10~2000	Control Mode	Position mode, velocity mode and torque mode
Default	600	Effective	After power on	Unit	1 ms
Description					
Set encoder delay time.					

6.13 Setting regenerative resistor

Regenerative resistor is used to absorb the regenerative energy generated by servo motor when it decelerates. When external regenerative resistor is connected, Pt600 (Regenerative resistor capacity) and Pt603 (Resistance of regenerative resistor) must be set.

⚠CAUTION

- ◆ When external regenerative resistor is connected, Pt600 and Pt603 must be correctly set. If not, AL.320 (Regenerative energy overflow) may not be detected. And this may cause damage to the external regenerative resistor, injury or fire.
- ◆ Ensure the capacity of regenerative resistor is suitable. If not, this may cause damage to the external regenerative resistor, injury or fire.

Table6.13.1

Parameter	Pt600	Range	0~65535	Control Mode	Position mode, velocity mode and torque mode
Default	0	Effective	Immediately	Unit	10 W
Description					
Set the capacity of regenerative resistor.					

Note:

The capacity of regenerative resistor should be set as a value evaluated from the capacity of external regenerative resistor. The value should be decided according to the cooling method of the external regenerative resistor.

(1) Natural cooling (cooling by natural air movement): the value should below 20% of regenerative resistor capacity.

(2) Fan cooling: the value should below 50% of regenerative resistor capacity.

Example:

When the capacity of external regenerative resistor is 1000 W, 1000 W*20% = 200 W, the value of Pt600(external regenerative resistor capacity) should be "20". (Unit: 10 W)

Table6.13.2

Parameter	Pt603	Range	0~65535	Control Mode	Position mode, velocity mode and torque mode
Default	0	Effective	Immediately	Unit	10 mΩ
Description					
Set the resistance of regenerative resistor.					

Note

- ➢ If an external regenerative resistor is used at the rated load ratio, the resistor temperature will rise to 200°C ~ 300°C. Decrease the rated value before usage. For information of the resistor load, please contact its manufacturer.
- ➢ For safety, it is suggested to use external regenerative resistor with thermoswitch.

6.14 Setting and wiring for over temperature protection

Over temperature protection is to avoid motor coil burn-out caused by high internal temperature inside motor. To use over temperature protection, thermal sensor (TS) must be installed inside the motor. If the motor has been continuously used with current which exceeds its rated current or with heavy load, its temperature becomes high. At this time, a signal will be output to the servo drive to immediately stop the motor. Thermal sensor is usually installed on direct drive motor (DM) or linear motor (LM). To use over temperature protection, Excellent Smart Cube (ESC) is required.

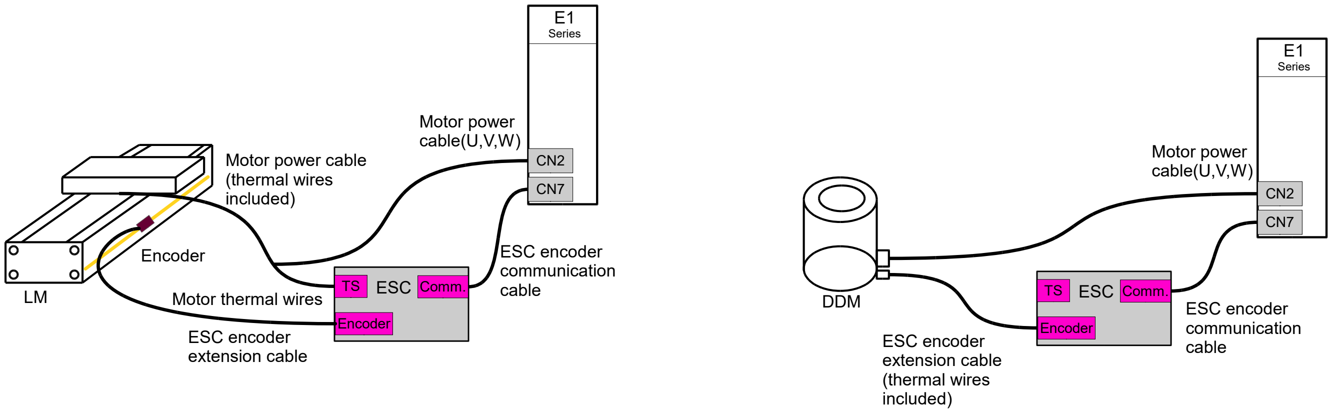


Figure6.14.1

When HIWIN LM is used, if the distance between ESC and the servo drive is over 0.5 m, the thermal wires may not be connected to the ESC due to its lengths. At this time, use ESC temperature cable to connect to the ESC, please refer to the figure below.

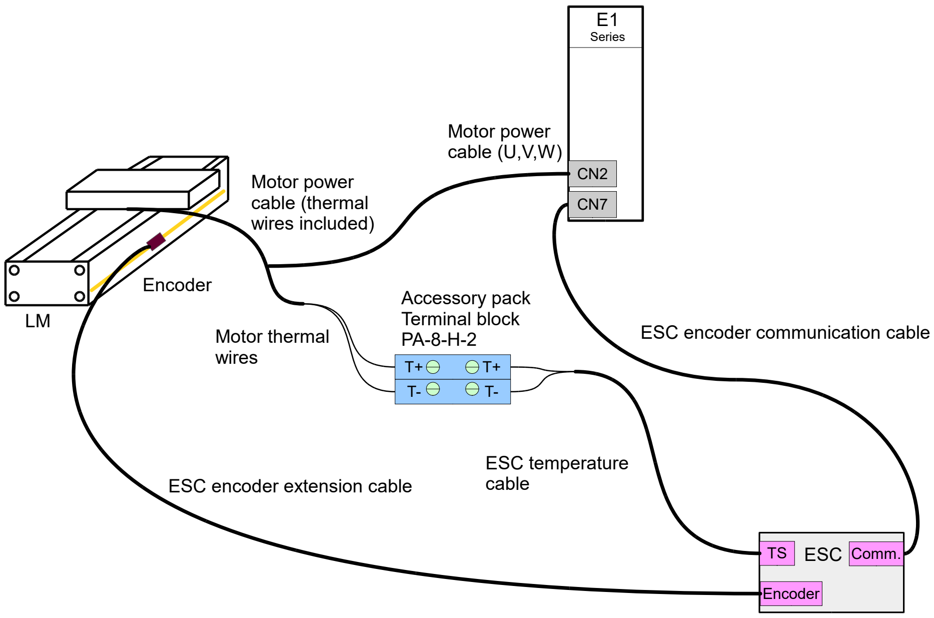


Figure6.14.2

Note:

(1) When HIWIN LM is used, the thermal wires are included in the power cable. Connect the thermal wires to the **TS** connector on ESC.

(2) When HIWIN DM is used, the thermal wires are included in the encoder cable. Connect the encoder cable to the **Encoder** connector on ESC.

(3) For cables for ESC, please refer to section 16.1.4.

■ Related parameter

Table6.14.1

Parameter		Description	Effective	Category
Pt008	t.0□□□ (Default)	Do not detect over temperature by thermal sensor.	After power on	Setup
	t.1□□□	Detect over temperature by thermal sensor.		

Note:

The supported thermal sensor is positive temperature coefficient (PTC) thermistor.

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7. Software settings and trial operation

7.1 Trial operation procedure

The human machine interface of E1 series servo drive is Thunder. After the servo drive and PC are connected by mini USB cable, users are allowed to do initialization, setting, operation, trial operation and parameter writing via Thunder. This section will describe how to install Thunder and start trial operation.

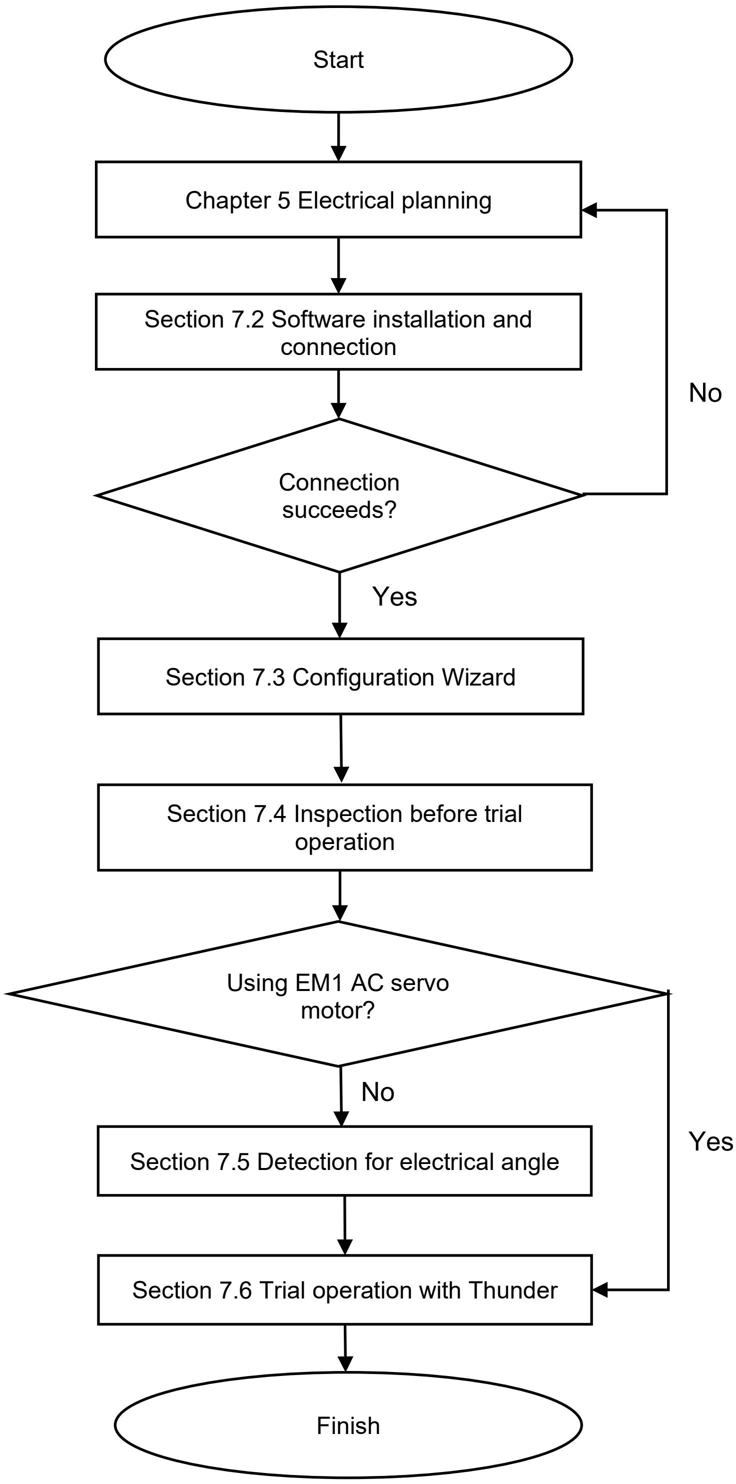
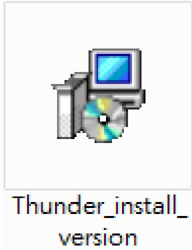


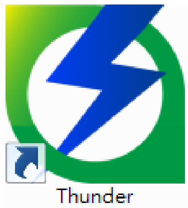
Figure7.1.1 Trial operation procedure

7.2 Software installation and connection

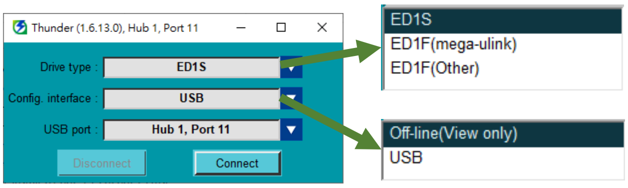
Step 1:
Download the setup file of Thunder from the official website of HIWIN Mikrosystem. Correctly install Thunder into PC.



Step 2:
Connect the servo drive and PC by mini USB cable. Then open Thunder.exe.



Step 3:
Select the servo drive and click on **Connect** button.



Step 4:
The figure on the right is the main screen of Thunder. Control mode, servo drive information, firmware version and motor type are shown in the left column.

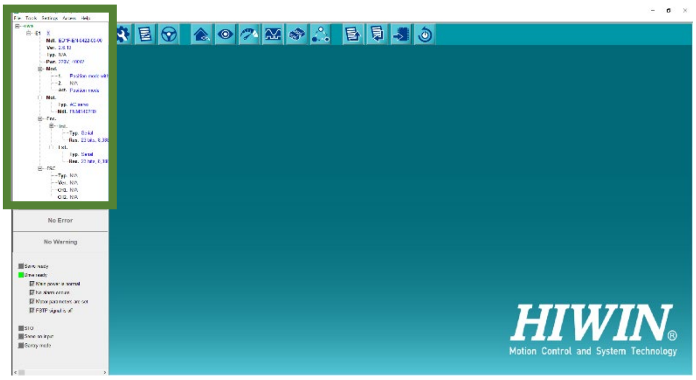


Figure7.2.1

7.3 Configuration Wizard

Step 5:
Continue with step 4. Click on the icon of Open Configuration Wizard in the upper left corner.

Step 6:
Check the parameter settings in each page of Configuration Wizard by following the sequence below.

→Power Setup
→Motor Setup
→Encoder Setup
→Control Mode Setup
→Command Input Setup
→Emulated Encoder Output Setup
→I/O configuration
→Send to drive

After that, click on **Ok** button to write parameters to the servo drive.

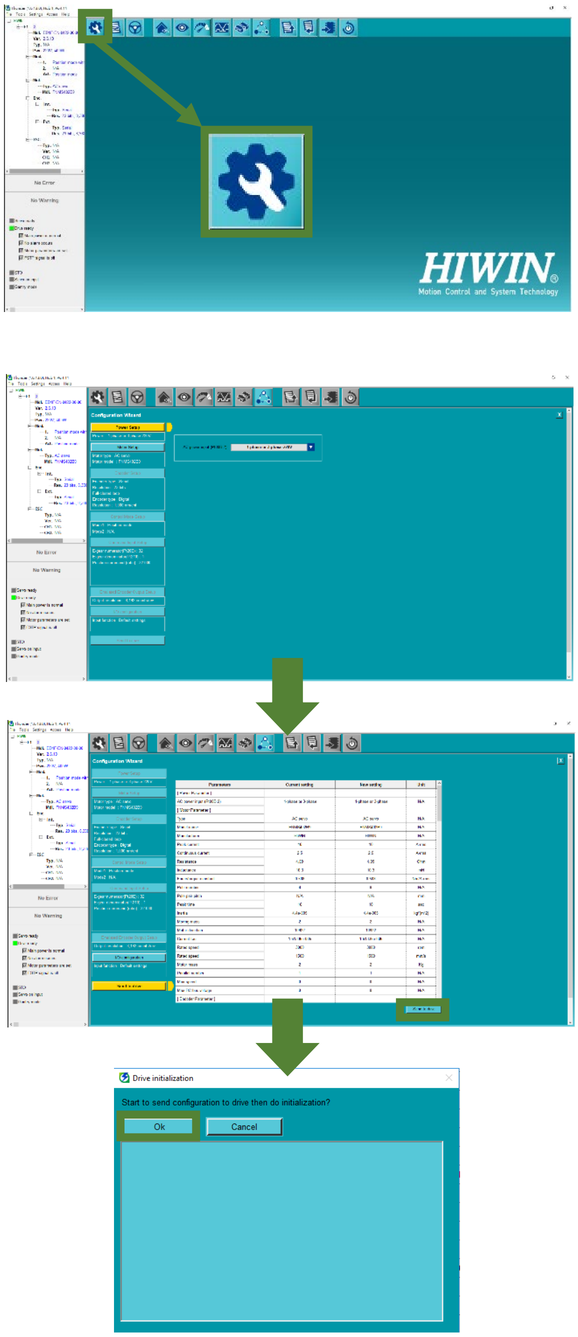


Figure7.3.1

7.4 Inspection before trial operation

Inspection procedures before trial operation are provided in the following sections. Do not connect motor and mechanism while executing trial operation. If the motor cannot be removed from the mechanism, its load must be removed. The purpose of trial operation is to check the combination of the servo drive and motor as well as the wiring of servo drive. Perform inspection by referring to the inspection procedure of the motor in use.

7.4.1 Inspection procedure for servo motor (AC)

While using HIWIN EM1 series servo motor, perform inspection by referring to the procedure provided in table 7.4.1.1.

Table7.4.1.1 Inspection procedure for servo motor (AC)

Item	Description	Reference
Hardware	Step 1: Check if the servo drive is correctly installed inside the control box. Step 2: Check the wiring of the servo drive. ➢ CN1 power-Check the voltage of the input power. Check if the connectors are firmly connected. ➢ CN2 motor power-Check if the UVW power terminals on the servo drive and motor power cable are correctly wired. Check if the terminals are secure. ➢ CN7 encoder-Check if the motor and the servo drive are firmly connected. Step 3: Confirm the encoder information. Ensure the software setting is correct. Step 4: Loosen the coupling. Do not connect the motor and mechanism.	Refer to section 4.1.2.
Software	Step 5: Download the latest version of Thunder. And connect to the servo drive.	Refer to section 7.2.
	Step 6: Do software setting by following the procedures provided in Thunder.	Refer to section 7.3.
	Step 7: Check the moving direction. Execute trial operation, such as JOG or point-to-point (P2P) motion.	Refer to section 7.6.
	Step 8: Operate with controller.	Refer to section 10.1.

7.4.2 Inspection procedure for other motor

While using customized servo motor, linear motor, direct drive motor or torque motor, detection for electrical angle must be completed before operation. The combinations of motors and encoder signals are provided in table 7.4.2.1.

Table7.4.2.1 Combinations of customized AC/LM/DM/TM and encoder signals

Motor	Encoder Signal	Excellent Smart Cube (ESC)
Customized servo motor	Tamagawa 2.5 MHz	Not required
Linear motor	Digital TTL signal	Not required
Linear motor	Digital TTL signal+digital Hall sensor signal	Required (ESC-SS)
HIWIN direct drive motor with absolute feedback system	Absolute serial signal	Not required
Linear motor, direct drive motor with incremental feedback system or torque motor	Analog sin/cos signal	Required (ESC-AN)
Linear motor and torque motor	Serial EnDat or BiSS-C signal	Required (ESC-SS)
Linear motor, direct drive motor or torque motor	Analog sin/cos signal+digital Hall sensor signal	Required (ESC-AN)

Table7.4.2.2 Inspection procedure for customized AC/LM/DM/TM

Item	Description	Reference
Hardware	Step 1: Check if the servo drive is correctly installed inside the control box. Step 2: Check the wiring of the servo drive. ➢ CN1 power-Check the voltage of the input power. Check if the connectors are firmly connected. ➢ CN2 motor power-Check if the UVW power terminals on the servo drive and motor power cable are correctly wired. Check if the terminals are secure. ➢ CN7 encoder-Check if the motor and the servo drive are firmly connected. If Hall sensor is installed, check if the wiring and connectors are secure. Step 3: Confirm the encoder information. Ensure the software setting is correct. Step 4: Loosen the coupling. Do not connect the motor and mechanism.	Refer to section 4.1.2.
Software	Step 5: Download the latest version of Thunder. And connect to the servo drive. Step 6: Do software setting by following the procedures provided in Thunder. Step 7: Check the moving direction. Complete detection for electrical angle. Step 8: Execute trial operation, such as JOG or point-to-point (P2P) motion. Step 9: Operate with controller.	Refer to section 7.2. Refer to section 7.3. Refer to section 7.5. Refer to section 7.6. Refer to section 10.1.

7.5 Detection for electrical angle

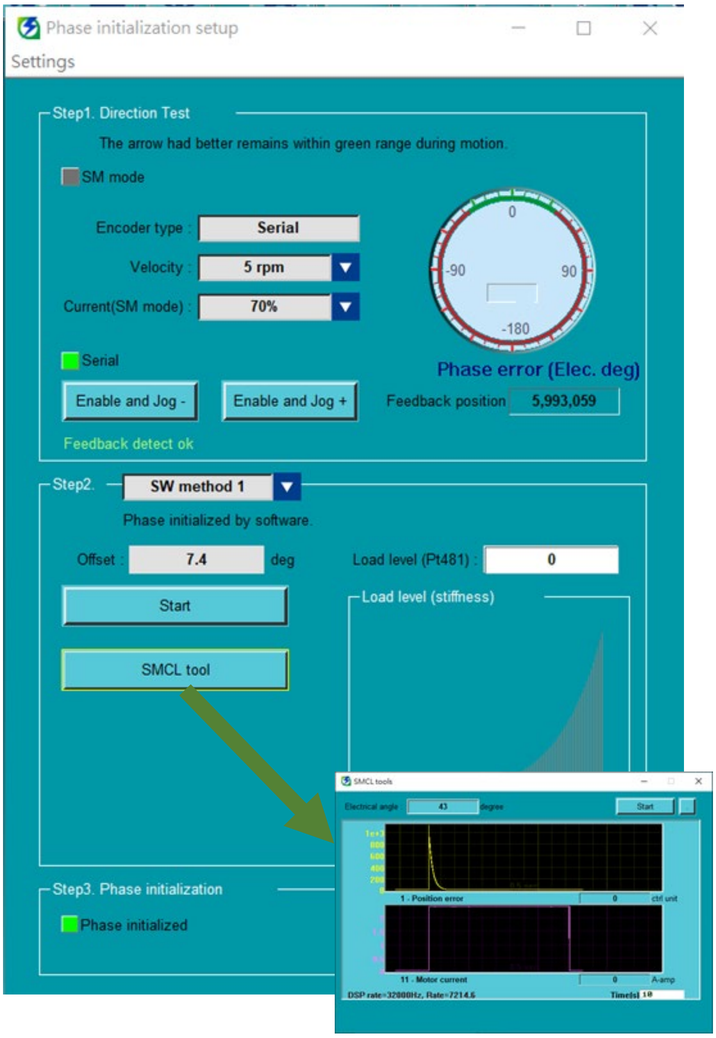
While using customized servo motor (AC), linear motor (LM), direct drive motor (DM) with incremental feedback system or torque motor (TM), detection for electrical angle must be completed before closed loop control. E1 series servo drive provides three detection methods: SW method 1, STABS test/tune, Digital Hall and Analog Hall.

7.5.1 SW method 1

While detecting electrical angle by SW method 1, refer to table 7.5.1.1 for applicable combinations of motors and encoder signals.

Table7.5.1.1 Applicable combinations for SW method 1

Motor	Encoder Signal	Excellent Smart Cube (ESC)
Customized servo motor	Tamagawa 2.5 MHz	Not required
Linear motor	Digital TTL signal	Not required
Linear motor, direct drive motor or torque motor	Analog sin/cos signal	Required (ESC-AN)



Step1:
Select velocity and current for detecting electrical angle. Click on **Enable and Jog+** and **Enable and Jog-** buttons to move the motor. While the motor is moving, check if the electrical angle falls in the range colored in green.

Step 2:
Select **SW method 1** and click on **Start** button for three times. The difference of offset must not exceed 5 deg.

Example:
Offset: 73.5 deg
Offset: 74.1 deg
Offset: 72.3 deg

Open **SMCL tool** and observe position deviation during execution. If the position deviation is not close to 0 within one second, it means the gain is improper, please adjust load level.

Step 3:
Click on **Start phase initialization** button. Wait till detection for electrical angle completes and check **Phase initialized** indicator. If **Phase initialized** indicator is green, it means electrical angle has been successfully detected.

Note:
(1) If SW method 1 is executed under open loop control, the motor will be automatically disabled to avoid overheating when it stops for a period of time.
(2) If the load level is too high, it may cause mechanical resonance.
(3) If the motor vibrates during the execution of SW metohd1, the user can adjust Pt489 and Pt48A until the vibration stops. Then SMCL tool can be used to confirm that the convergence is good, and the user can go to step 3.

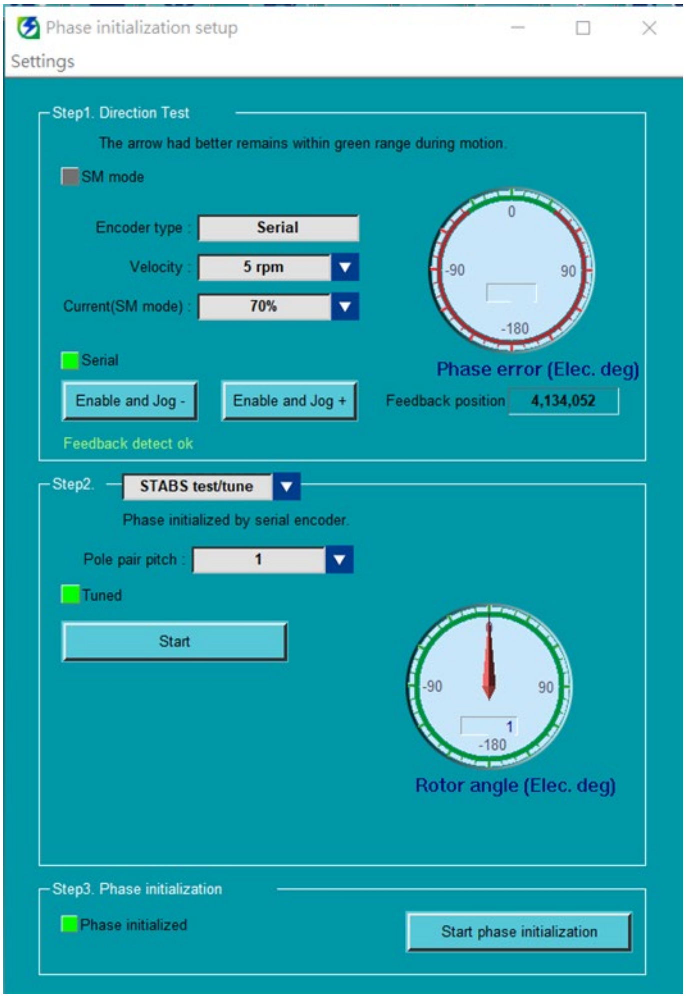
Figure7.5.1.1 Operating procedure of SW method 1

7.5.2 STABS test/tune

While detecting electrical angle by STABS tes/tune, refer to table 7.5.2.1 for applicable combinations of motors and encoder signals.

Table7.5.2.1 Applicable combinations for STABS test/tune

Motor	Encoder Signal	Excellent Smart Cube (ESC)
Customized servo motor	Tamagawa 2.5 MHz	Not required
Linear motor, direct drive motor or torque motor	Serial EnDat or BiSS-C signal	Required (ESC-SS)



Step1:
Select velocity and current for detecting electrical angle. Click on **Enable and Jog+** and **Enable and Jog-** buttons to move the motor. While the motor is moving, check if the electrical angle falls in the range colored in green.

Step 2:
Select **STABS test/tune**, select the range of pole pair pitch and click on **Start** button. Wait until **Tuned** lights up in green.

Step 3:
Click on **Start phase initialization** button. Wait till detection for electrical angle completes and check **Phase initialized** indicator. If **Phase initialized** indicator is green, it means electrical angle has been successfully detected.

Figure7.5.2.1 Operating procedure of STABS test/tune

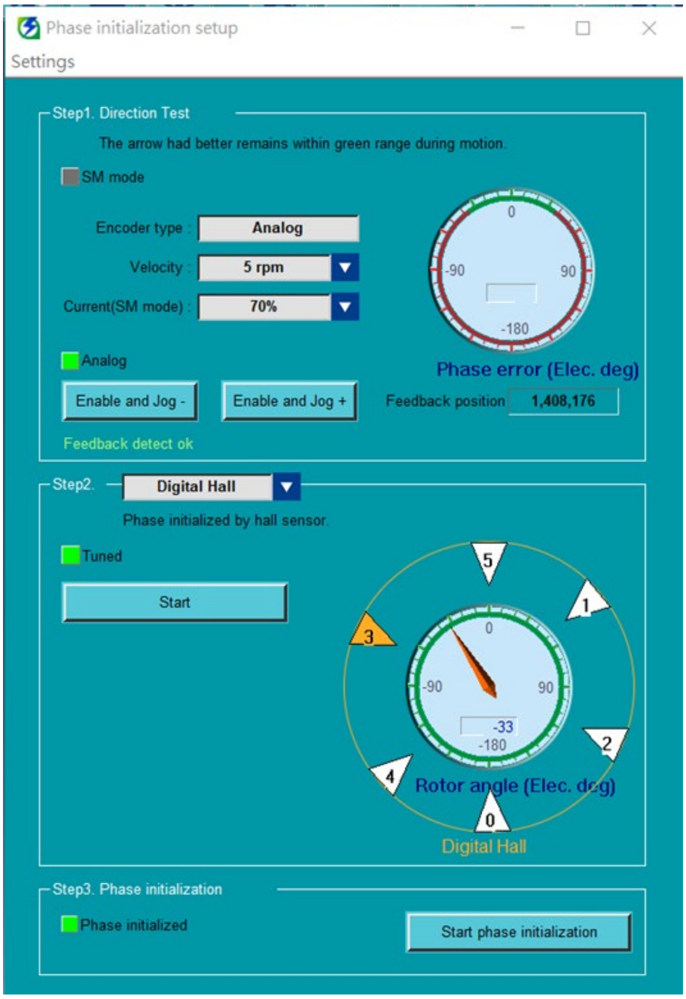
Note:
If the motor shakes severely during the execution of STABs test/tune and the initialization fails, the user can extend the Pt488 waiting time for polarity detection and perform step 2 again until the completion indicator lights up.

7.5.3 Digital Hall

While detecting electrical angle by Digital Hall, refer to table 7.5.3.1 for applicable combinations of motors and encoder signals.

Table7.5.3.1 Applicable combinations for Digital Hall

Motor	Encoder Signal	Excellent Smart Cube (ESC)
Linear motor or direct drive motor	Analog sin/cos signal+digital Hall sensor signal	Required (ESC-AN)
Linear motor	Digital TTL signal+ digital Hall sensor signal	Required (ESC-SS)



Step1:
Select velocity and current for detecting electrical angle. Click on **Enable and Jog+** and **Enable and Jog-** buttons to move the motor. While the motor is moving, check if the electrical angle falls in the range colored in green.

Step 2:
Select **Digital Hall** and click on **Start** button. Wait till detection for electrical angle completes.

Step 3:
Click on **Start phase initialization** button. Wait till detection for electrical angle completes and check **Phase initialized** indicator. If **Phase initialized** indicator is green, it means electrical angle has been successfully detected.

Figure7.5.3.1 Operating procedure of Digital Hall

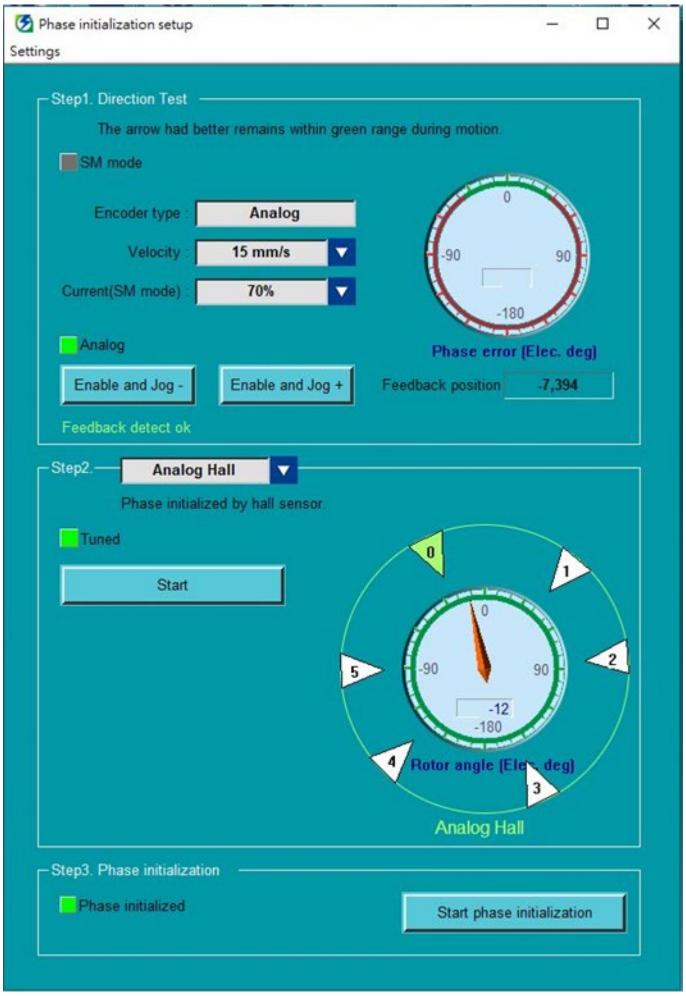
Note:
If the motor shakes severely during the execution of the Digital Hall and the initialization fails, the user can extend the Pt488 waiting time for polarity detection and perform step 2 again until the completion indicator lights up.

7.5.4 Analog Hall

While detecting electrical angle by Analog Hall, refer to table 7.5.4.1 for applicable combinations of motors and encoder signals.

Table7.5.4.1 Applicable combinations for Analog Hall

Motor	Encoder Signal	Excellent Smart Cube (ESC)
Linear motor	Analog Hall sensor signal	Required (ESC-SS)



Step1:
Select velocity and current for detecting electrical angle. Click on **Enable and Jog+** and **Enable and Jog-** buttons to move the motor. While the motor is moving, check if the electrical angle falls in the range colored in green.

Step 2:
Select **Analog Hall** and click on **Start** button. Wait till detection for electrical angle completes.

Step 3:
Click on **Start phase initialization** button. Wait till detection for electrical angle completes and check **Phase initialized** indicator. If **Phase initialized** indicator is green, it means electrical angle has been successfully detected.

Figure7.5.4.1 Operating procedure of Analog Hall

Note:
If the motor shakes severely during the execution of the Analog Hall and the initialization fails, the user can extend the Pt488 waiting time for polarity detection and perform step 2 again until the completion indicator lights up.

7.6 Trial operation with Thunder

The trial operation described in sections 7.6.1 and 7.6.2 is relatively simple. The purpose of trial operation is to check the combination of the servo drive and motor as well as the wiring of the servo drive.

Note:
If overtravel signal (P-OT or N-OT) is triggered during JOG or P2P motion, the motor will be disabled immediately.

7.6.1 JOG

After motion parameters are confirmed, click on **Enable** button to jog the motor. If an emergency occurs, press **F12** key to immediately stop the motor.

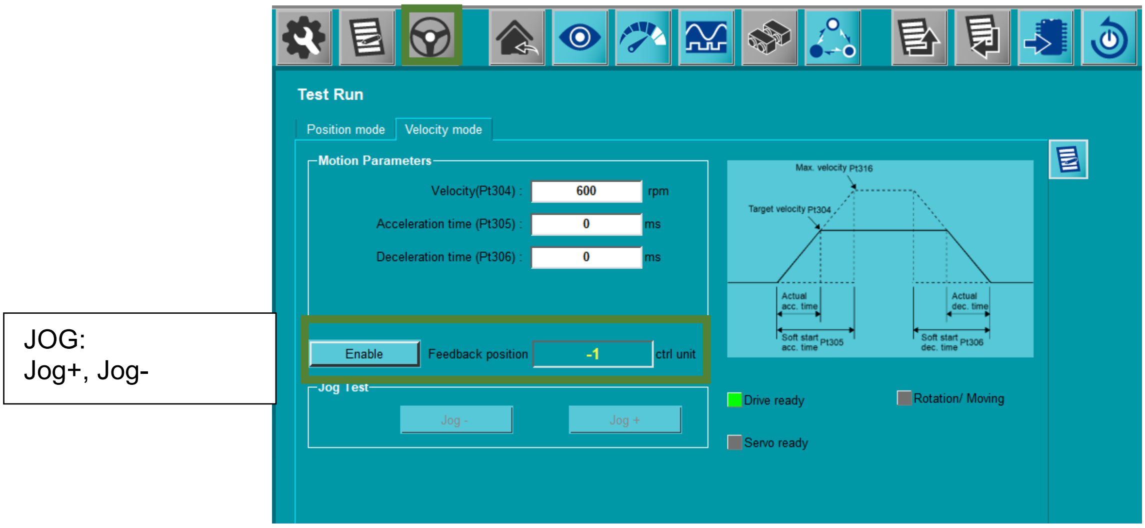


Figure7.6.1.1 JOG

7.6.2 Point-to-point (P2P) motion / Relative move

After motion parameters are confirmed, click on **Enable** button to start point-to-point motion / relative move. The performance of motor can be observed from its move time and settling time.

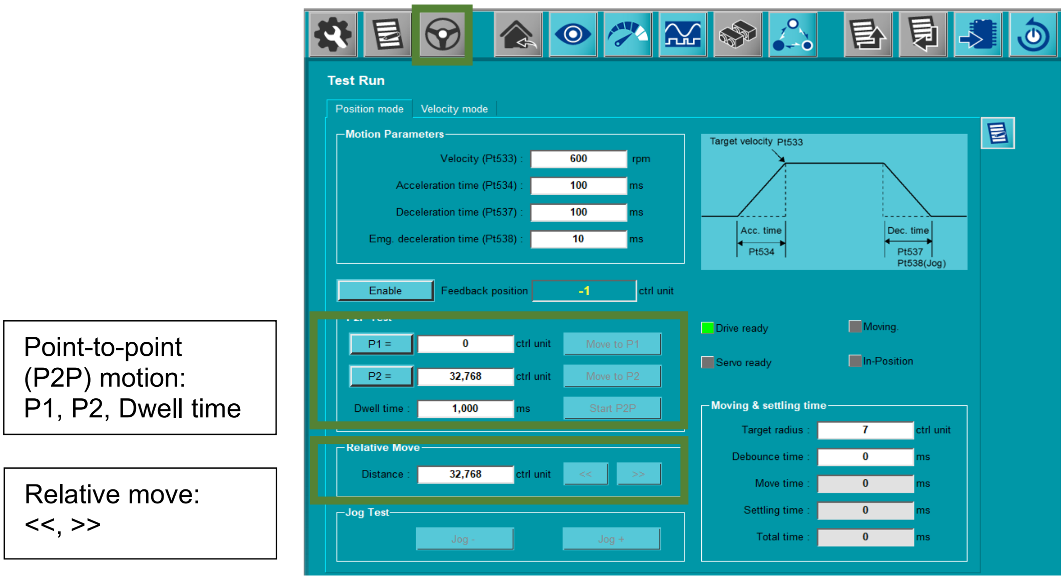


Figure7.6.2.1 Point-to-point (P2P) motion / Relative move

8. Application function

8.1 I/O signal settings

8.1.1 Digital input signal allocation

This section describes how to allocate digital input signals to the desired pins. Each pin is allocated with one default digital input signal when the servo drive is shipped out. The allocated digital input signal of each pin varies with the selected control mode. Users can choose to use the default setting or allocate digital input signals by themselves.

■ Use the default setting

The default allocations of digital input signals in different control modes are listed in table 8.1.1.1. Use Pt000 to select control mode and set Pt513 to t.0□□□ to use the default setting.

Table8.1.1.1

<table>
<tr><th rowspan="2">Pt000 = t.□□X□</th><th rowspan="2">Control Mode</th><th colspan="10">CN6 Pin (ED1S)</th></tr>
<tr><th>33 (I1)</th><th>30 (I2)</th><th>29 (I3)</th><th>27 (I4)</th><th>28 (I5)</th><th>26 (I6)</th><th>32 (I7)</th><th>31 (I8)</th><th>9 (I9)</th><th>8 (I10)</th></tr>
<tr><td>0</td><td>Velocity mode</td><td rowspan="15">S-ON</td><td rowspan="3">P-CON</td><td rowspan="15">P-OT</td><td rowspan="15">N-OT</td><td rowspan="15">ALM-RST</td><td rowspan="3">P-CL</td><td rowspan="3">N-CL</td><td rowspan="15">HOM</td><td rowspan="15">MAP</td><td rowspan="15">FSTP</td></tr>
<tr><td>1</td><td>Position mode</td></tr>
<tr><td>2</td><td>Torque mode</td></tr>
<tr><td>3</td><td>Internal velocity mode</td><td rowspan="4">SPD-D</td><td rowspan="4">SPD-A</td><td rowspan="4">SPD-B</td></tr>
<tr><td>4</td><td>Internal velocity mode ↔Position mode</td></tr>
<tr><td>5</td><td>Internal velocity mode ↔Velocity mode</td></tr>
<tr><td>6</td><td>Internal velocity mode ↔Torque mode</td></tr>
<tr><td>7</td><td>Position mode↔Velocity mode</td><td rowspan="3">C-SEL</td><td rowspan="8">P-CL</td><td rowspan="8">N-CL</td></tr>
<tr><td>8</td><td>Position mode↔Torque mode</td></tr>
<tr><td>9</td><td>Torque mode↔Velocity mode</td></tr>
<tr><td>A</td><td>Internal position mode</td><td>P-CON</td></tr>
<tr><td>B</td><td>Internal position mode ↔Position mode</td><td rowspan="3">C-SEL</td></tr>
<tr><td>C</td><td>Internal position mode ↔Velocity mode</td></tr>
<tr><td>D</td><td>Internal position mode ↔Torque mode</td></tr>
<tr><td>E</td><td>Internal velocity mode ↔Internal position mode</td><td>SPD-D</td><td>SPD-A</td><td>SPD-B</td></tr>
</table>

- Allocating digital input signals

  Set Pt513 to t.1□□□ to use the allocation set by yourselves. Digital input signals which can be allocated and parameters used to allocate them are listed in table 8.1.1.2.

Note
- Do not allocate more than one digital input signal to one pin. Otherwise, this may result in logic error which leads to false operation.

Table8.1.1.2

Digital Input Signal	Description	Parameter
*S-ON	Servo on input signal	Pt50A = t.□□□X
*P-CON	Proportional control input signal	Pt50A = t.□□X□
P-OT	Forward prohibition input signal	Pt50A = t.□X□□
N-OT	Reverse prohibition input signal	Pt50A = t.X□□□
ALM-RST	Alarm reset input signal	Pt50B = t.□□□X
*P-CL	Forward external torque limit input signal	Pt50B = t.□□X□
*N-CL	Reverse external torque limit input signal	Pt50B = t.□X□□
*C-SEL	Control method switching input signal	Pt50B = t.X□□□
*SPD-D	Motor rotation direction input signal	Pt50C = t.□□□X
*SPD-A	Internal set velocity 1 input signal	Pt50C = t.□□X□
*SPD-B	Internal set velocity 2 input signal	Pt50C = t.□X□□
*ZCLAMP	Zero clamp input signal	Pt50C = t.X□□□
INHIBIT	Command pulse inhibition input signal	Pt50D = t.□□□X
G-SEL	Gain switching input signal	Pt50D = t.□X□□
PSEL	Command pulse multiplication switching input signal	Pt50D = t.X□□□
RST	Servo drive reset input signal	Pt50E = t.□□□X
DOG	Near home sensor input signal	Pt50E = t.□□X□
*HOM	Servo drive built-in homing procedure input signal	Pt50E = t.□X□□
*MAP	Servo drive error map input signal	Pt50E = t.X□□□
FSTP	Forced stop input signal	Pt50F = t.□□□X
*CLR	Position deviation clear input signal	Pt50F = t.□□X□

Note:

ED1F does not support below functions:
S-ON、P-CON、P-CL、N-CL、C-SEL、SPD-D、SPD-A、SPD-B、ZCLAMP、HOM、MAP、CLR.

■ Parameter setting values and hardware pin assignment

Table8.1.1.3

Parameter Setting Value	Signal	CN6 Pin (ED1S)	CN6 Pin (ED1F)	Description
0	I1	33	1	Hardware pin can be set to activate or deactivate the allocated digital input function when signal is input or is not input. Refer to table 8.1.1.2. Pt511, Pt512 and Pt513 are used to set the pin polarity of I1~I10 signals. Refer to table 8.1.1.4.
1	I2	30	2	
2	I3	29	3	
3	I4	27	4	
4	I5	28	5	
5	I6	26	6	
6	I7	32	7	
7	I8	31	8	
8	I9	9	N/A	
9	I10	8	N/A	
A	-		-	The signal is always active.
B	-		-	The signal is always inactive.

■ Set pin polarity

Table8.1.1.4

Parameter	Description
Pt511	Pt511 t.XXXX is used to set the pin polarity of I1~I4 signals. Setting value 0 means the digital input function is activated as signal is input and is deactivated as signal is not input. Setting value 1 means digital input function is activated as signal is not input and is deactivated as signal is input. t.□□□X Set the pin polarity of I1 signal. t.□□X□ Set the pin polarity of I2 signal. t.□X□□ Set the pin polarity of I3 signal. t.X□□□ Set the pin polarity of I4 signal.
Pt512	Pt512 t.XXXX is used to set the pin polarity of I5~I8 signals. Setting value 0 means the digital input function is activated as signal is input and is deactivated as signal is not input. Setting value 1 means the digital input function is activated as signal is not input and is deactivated as signal is input. t.□□□X Set the pin polarity of I5 signal. t.□□X□ Set the pin polarity of I6 signal. t.□X□□ Set the pin polarity of I7 signal. t.X□□□ Set the pin polarity of I8 signal.
Pt513	Pt513 t.□□XX is used to set the pin polarity of I9~I10 signals. Setting value 0 means the digital input function is activated as signal is input and is deactivated as signal is not input. Setting value 1 means the digital input function is activated as signal is not input and is deactivated as signal is input. t.□□□X Set the pin polarity of I9 signal. t.□□X□ Set the pin polarity of I10 signal.

Note:
ED1F does not support I9, I10 signals.

- Example of allocating digital input signal

  The example is not using the default signal allocation. S-ON signal is set to be always ON and ALM-RST signal is allocated to CN6-29.

Table8.1.1.5

Parameter	Before Modification	After Modification	Description
Pt513	t.0□□□	t.1□□□	Do not use the default signal allocation.
Pt50A	t.□□□X	t.□□□A	S-ON signal is always ON.
Pt50B	t.□□□X	t.□□□2	ALM-RST signal is allocated to CN6-29.

- Example of setting pin polarity

  The pin polarity of I2 and I8 signals is set to that when no signal is input, the digital input functions are activated.

Table8.1.1.6

Parameter	Before Modification	After Modification	Description
Pt511	t.□□0□	t.□□1□	The digital input function is activated as no signal is input.
Pt512	t.0□□□	t.1□□□	The digital input function is activated as no signal is input.

8.1.2 Digital output signal allocation

This section describes how to allocate digital output signals to the desired pins. Each pin is allocated with one default digital output signal when the servo drive is shipped out. Users can choose to use the default setting or allocate digital output signals by themselves. Refer to the description below.

- Use the default setting

  The default allocations of digital output signals are listed in table 8.1.2.1.

Table8.1.2.1

Pt000 = t.□□X□	Control Mode	CN6 Pin (ED1S)				
		35, 34 (O1)	37, 36 (O2)	39, 38 (O3)	11, 10 (O4)	40, 12 (O5)
0	Velocity mode	COIN & V-CMP	TGON	D-RDY	ALM	BK
1	Position mode					
2	Torque mode					
3	Internal velocity mode					
4	Internal velocity mode ↔Position mode					
5	Internal velocity mode ↔Velocity mode					
6	Internal velocity mode ↔Torque mode					
7	Position mode ↔Velocity mode					
8	Position mode↔Torque mode					
9	Torque mode↔Velocity mode					
A	Internal position mode					
B	Internal position mode ↔Position mode					
C	Internal position mode ↔Velocity mode					
D	Internal position mode ↔Torque mode					
E	Internal velocity mode ↔Internal position mode					

- Allocating digital output signals

Note

- In control mode which does not support a certain output signal, the output signal will be OFF.
- If the polarity of the pin for brake control output (BK) signal is inverted and the brake operation is changed to negative logic, when the signal is OFF, the brake will stop operating. Check the brake operation when power off and power on to avoid problem.

Table8.1.2.2

Digital Output Signal	Description	Parameter
ALM	Alarm output signal	Pt514 = t.□□□X
COIN	Positioning completion output signal	Pt514 = t.□□X□
V-CMP	Velocity reach output signal	Pt514 = t.□X□□
TGON	Rotation detection/movement detection output signal	Pt514 = t.X□□□
D-RDY	Drive ready output signal	Pt515 = t.□□□X
S-RDY	Servo ready output signal	Pt515 = t.□□X□
CLT	Torque limit detection output signal	Pt515 = t.□X□□
VLT	Velocity limit detection output signal	Pt515 = t.X□□□
BK	Brake control output signal	Pt516 = t.□□□X
WARN	Warning output signal	Pt516 = t.□□X□
NEAR	Positioning near output signal	Pt516 = t.□X□□
PSELA	Command pulse multiplication switching output signal	Pt516 = t.X□□□
PT	Position trigger digital output (PT) signal	Pt517 = t.□□□X
DBK	External dynamic brake output signal	Pt517 = t.□X□□
HOMED	Servo drive homing completion output signal	Pt517 = t.X□□□

Note:

If PT signal is allocated to general-purpose output pins, its output response is lower than the dedicated pins for PT signal (CN6-46 and 47).

- Parameter setting values and hardware pin assignment

Table8.1.2.3

Parameter Setting Value	Signal	CN6 Pin (ED1S)	CN6 Pin (ED1F)	Description
0	-	-	-	Do not use.
1	O1	35/34	11/12	When output condition is satisfied, signal will be output or will not be output from the specified pin. Use Pt519 and Pt51A to set pin polarity of O1~O5 signals.
2	O2	37/36	13/14	
3	O3	39/38	15/16	
4	O4	11/10	17/18	
5	O5	40/12	19/20	

- Set pin polarity

Table8.1.2.4

Parameter	Description
Pt519	Pt519 t.XXXX is used to set the pin polarity of O1~O4 signals. Setting value 0 means that the signal will be output when the output condition is satisfied and will not be output when the output condition is not satisfied. Setting value 1 means that the signal will be output when the output condition is not satisfied and will not be output when the output condition is satisfied. t.□□□X Set the pin polarity of O1 signal. t.□□X□ Set the pin polarity of O2 signal. t.□X□□ Set the pin polarity of O3 signal. t.X□□□ Set the pin polarity of O4 signal.
Pt51A	Pt51A t.□□□X is used to set the pin polarity of O5 signal. Setting value 0 means that the signal will be output when the output condition is satisfied and will not be output when the output condition is not satisfied. Setting value 1 means that the signal will be output when output condition is not satisfied and will not be output when the output condition is satisfied. t.□□□X Set the pin polarity of O5 signal.

- Example of allocating digital output signal

  Change O2 signal from the default TGON signal to S-RDY signal.

Table8.1.2.5

Parameter	Before Modification	After Modification	Description
Pt514	t.2□□□	t.0□□□	TGON signal is disabled.
Pt515	t.□□0□	t.□□2□	Set S-RDY signal as O2 signal.

- Example of setting pin polarity

  The pin polarity of O1 and O5 signals is set to that when the output condition is satisfied, no signal will be output.

Table8.1.2.6

Parameter	Before Modification	After Modification	Description
Pt519	t.□□□0	t.□□□1	The O1 signal will not be output when the output condition is satisfied.
Pt51A	t.□□□0	t.□□□1	The O5 signal will not be output when the output condition is satisfied.

8.1.3 Alarm output (ALM) signal

Alarm output (ALM) signal is output when an alarm occurs.

- Resetting alarm

Note	➢ For safety, the main circuit power of the servo drive must be turned off as ALM signal is output while doing electrical planning.

Table8.1.3.1

Type	Signal	Hardware Pin	Status	Description
Output	ALM	CN6-11/10 (O4 signal) (Default)	ON	The servo drive is in alarm state.
			OFF	The servo drive is in normal state.

For more information about alarm reset, please refer to chapter 6.

8.1.4 Warning output (WARN) signal

Warning means the value of monitoring item is approaching the critical value. If the servo drive continues remaining in warning state, an alarm may occur.

Table8.1.4.1

Type	Signal	Hardware Pin	Status	Description
Output	WARN	User-defined	ON	The servo drive is in warning state.
			OFF	The servo drive is in normal state.

Use Pt516 = t.□□X□ to define the output pin of WARN signal.

8.1.5 Drive ready output (D-RDY) signal

This status means the servo drive is ready to receive S-ON signal and to enable motor. At the same time, the servo drive outputs drive ready output (D-RDY) signal. Only after D-RDY signal is output, the received S-ON signal is effective. Conditions for D-RDY signal output are as below:

(1) No alarm is detected for the drive.

(2) Encoder communication is ready.

(3) Basic parameters are already set or loaded in the configuration wizard.

(4) AC main power is ready.

(5) Master and slave are in D-RDY status (For gantry type drives. Only works when gantry communication is on).

Table8.1.5.1

Type	Signal	Hardware Pin	Status	Description
Output	D-RDY	CN6-39/38 (O3 signal) (Default)	ON	The servo drive is ready to receive S-ON signal.
			OFF	The servo drive is not ready to receive S-ON signal yet.

8.1.6 Servo ready output (S-RDY) signal

Servo ready output (S-RDY) signal is used to identify if motor is enabled. After S-ON signal is received, the servo drive will execute enabling procedure and BK sequence. When the motor is enabled, S-RDY signal will be output. Only after S-RDY signal is output, the received control command is effective.

Table8.1.6.1

Type	Signal	Hardware Pin	Status	Description
Output	S-RDY	User-defined	ON	The servo drive and motor are ready to receive control command.
			OFF	The servo drive and motor are not ready to receive control command yet.

8.1.7 Rotation detection output (TGON) signal

When servo motor is moving, TGON signal is output. TGON signal can be used to identify if servo motor is moving. Pt502 is for setting rotation detection value (rotary motor) and Pt581 is for setting movement detection value (linear motor). The default pints for TGON signal are CN6-37 and 36.

Table8.1.7.1

Type	Signal	Hardware Pin	Status	Motor Type	Description
Output	TGON	CN6-37/36 (O2 signal) (Default)	ON	Rotary	The rotary motor is rotating at a velocity higher than the value of Pt502.
				Linear	The linear motor is moving at a velocity higher than the value of Pt581.
			OFF	Rotary	The rotary motor is rotating at a velocity lower than the value of Pt502.
				Linear	The linear motor is moving at a velocity lower than the value of Pt581.

■ **Setting detection value**

Set the velocity detection value for TGON signal.

Table8.1.7.2

Parameter	Pt502	Range	1~10000	Control Mode	Position mode, velocity mode and torque mode
Default	20	Effective	Immediately	Unit	1 rpm
Description					
Set rotation detection value.					

Table8.1.7.3

Parameter	Pt581	Range	1~10000	Control Mode	Position mode, velocity mode and torque mode
Default	20	Effective	Immediately	Unit	1 mm/s
Description					
Set movement detection value (linear servo motor).					

8.2 Setting maximum motor velocity

Set maximum motor velocity by Pt316 (rotary) or P385 (linear). Alarm AL.510 (Overspeed) occurs as motor velocity exceeds the value of Pt316 (rotary) or P385 (linear). The performance of motor will be affected if the value of Pt316 (rotary) or P385 (linear) is too small.

Table8.2.1

Parameter	Pt316	Range	0~65535	Control Mode	Position mode, velocity mode and torque mode
Default	10000	Effective	After power on	Unit	1 rpm
Description					
Set maximum motor velocity.					

Table8.2.2

Parameter	Pt385	Range	0~100	Control Mode	Position mode, velocity mode and torque mode
Default	50	Effective	After power on	Unit	100 mm/s
Description					
Set maximum motor velocity (linear servo motor).					

8.3 Velocity mode

In velocity mode, controller controls motor velocity by outputting analog command (analog voltage). Set Pt000 to t.□□0□ to select velocity mode.

Table8.3.1

Parameter		Description	Effective	Category
Pt000	t.□□0□ (Default)	Control mode: velocity mode	After power on	Setup

8.3.1 Setting velocity mode

In velocity mode, motor velocity is controlled by analog voltage. This section describes velocity command input signal (V-REF), velocity command input gain and velocity command offset adjustment. The range of input voltage must be DC +10 V ~ -10 V.

■ Velocity command input signal (V-REF)

Table8.3.1.1

Signal	CN6 Pin	Description
V_REF+	14	Velocity command input
V_REF-	15	Signal grounding of velocity command input

Example of inputting velocity command:

Use Pt300 to set the ratio of analog voltage to the rated velocity of motor. If Pt300 is set to 600 (Default), this means the motor will operate at the rated velocity when analog voltage 6 V is input. When using controller for position control, please connect the above pins to the velocity command output pins of the controller.

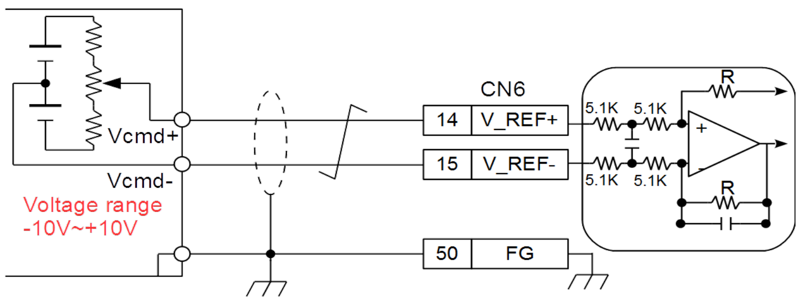


Figure8.3.1.1

■ Velocity command input gain

Set the ratio of analog voltage to the rated velocity of motor.

Table8.3.1.2

Parameter	Pt300	Range	150~3000	Control Mode	Position mode, velocity mode and torque mode
Default	600	Effective	Immediately	Unit	0.01V/Rated Velocity
Description					
Set velocity command input gain.					

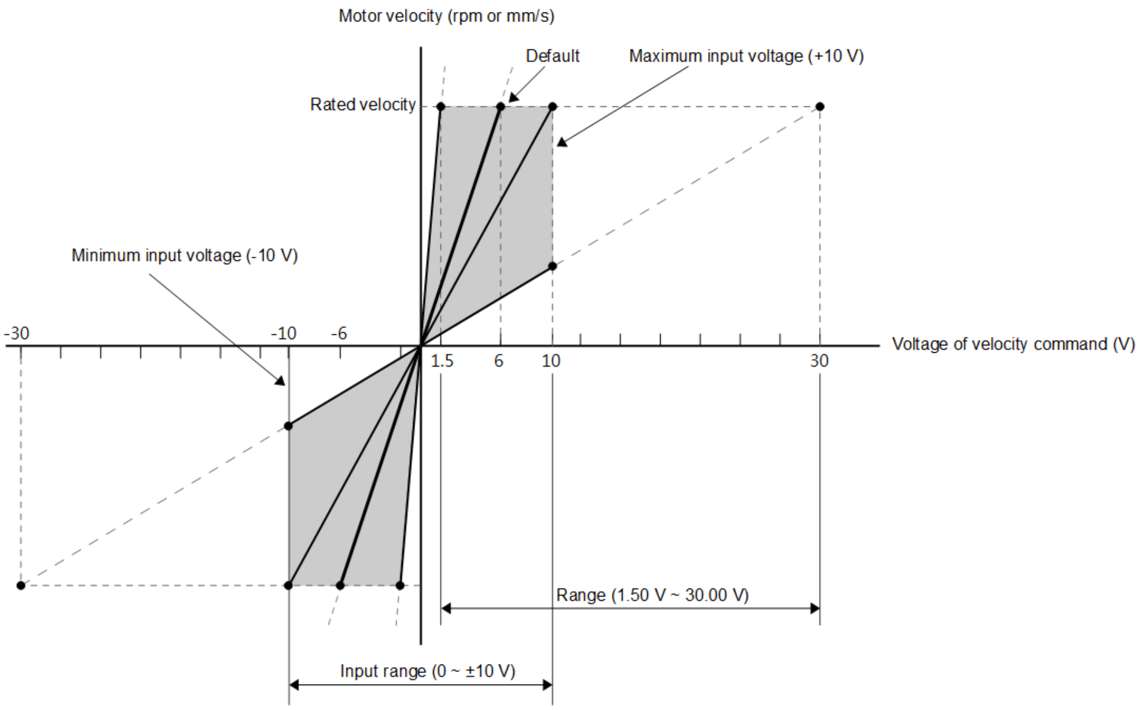


Figure 8.3.1.2 Input range of velocity command voltage

8.3.2 Velocity command offset adjustment

In velocity mode, motor may slightly move even when velocity command is 0 V. That is because there is an offset while the servo drive is detecting voltage. This problem can be solved by velocity command offset adjustment.

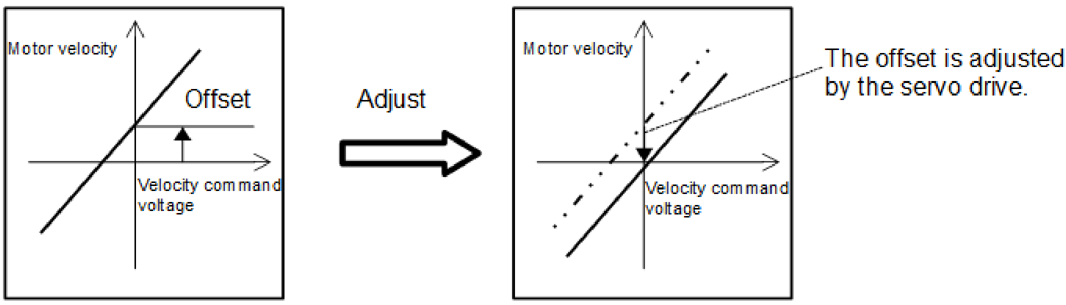


Figure8.3.2.1

■ Automatic offset adjustment

Automatic offset adjustment is that after the servo drive measures the offset, it automatically adjusts the analog voltage of velocity command. The offset needs to be saved to the servo drive. (Save RAM to Flash) If not, automatic offset adjustment must be done after the servo drive is turned on again. The conditions for performing automatic offset adjustment are: (a) The servo drive is in servo OFF state. (b) The controller does not input any signal.

Click on **Tools** in the main screen of Thunder and select **Analog offset**. Click on **Set zero** button in **Analog offset** window to automatically adjust offset.

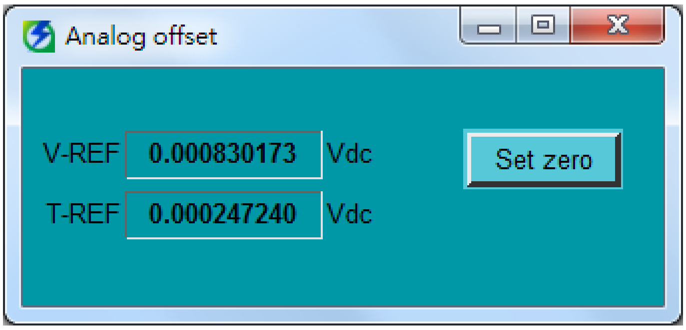


Figure 8.3.2.2 Offset adjustment tool in Thunder

■ Dead band for velocity command input

After automatic offset adjustment completes, the analog voltage of velocity command could still jitter. Set Pt30D (Dead band for velocity command input) to ignore the velocity command of a certain range.

Table 8.3.2.1

Parameter	Pt30D	Range	0~3000	Control Mode	Position mode, velocity mode and torque mode
Default	0	Effective	Immediately	Unit	1 mV
Description					
Set the dead band for velocity command input.					

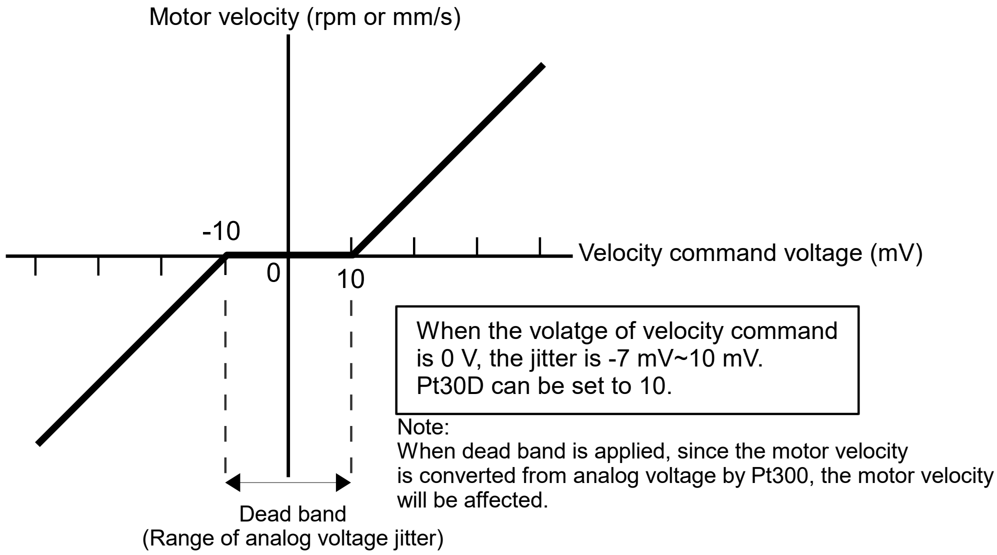


Figure 8.3.2.3

8.3.3 Soft start

Velocity command becomes smoother during acceleration and deceleration when soft start function is applied. The related parameters of soft start function are described as below. (Note: Improper settings may affect the performance and planning of motion.)

Table8.3.3.1

Parameter	Pt305	Range	0~10000	Control Mode	Velocity mode
Default	0	Effective	Immediately	Unit	1 ms
Description					
Set the acceleration time of soft start.					

Table8.3.3.2

Parameter	Pt306	Range	0~10000	Control Mode	Velocity mode
Default	0	Effective	Immediately	Unit	1 ms
Description					
Set the deceleration time of soft start.					

Pt305: The required time for the motor to accelerate from stop to its maximum velocity.

Pt306: The required time for the motor to decelerate from its maximum velocity to stop.

The calculations of the actual acceleration time and deceleration time are:

$$\text{Actual acceleration time} = \frac{\text{Target velocity}}{\text{Maximum velocity}} \times \text{Soft start acceleration time (Pt305)}$$

$$\text{Actual deceleration time} = \frac{\text{Target velocity}}{\text{Maximum velocity}} \times \text{Soft start deceleration time(Pt306)}$$

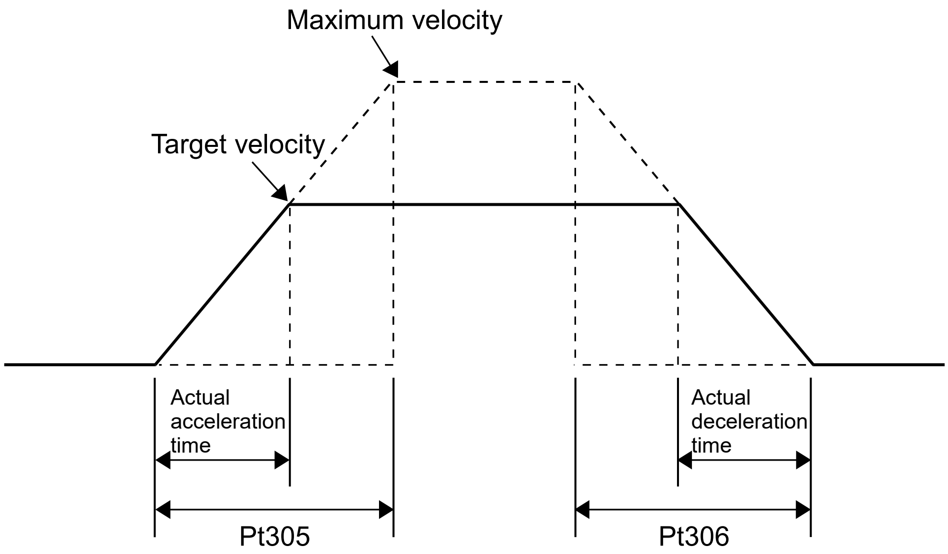


Figure8.3.3.1

8.3.4 Velocity command filter

Velocity command filter is used for velocity command input signal (V-REF). Velocity command becomes smoother after velocity command filter is applied. The higher the setting value is, the smoother the velocity command becomes. If the setting value is too large, the response of velocity command decreases.

Table8.3.4.1

Parameter	Pt307	Range	0~65535	Control Mode	Position mode, velocity mode and torque mode
Default	40	Effective	Immediately	Unit	0.01 ms
Description					
Set velocity command filter time constant.					

8.3.5 Zero clamp input (ZCLAMP) signal

After zero clamp input (ZCLAMP) signal is input, zero clamp function is enabled when velocity command is lower than the zero clamp level. Velocity command is ignored when zero clamp function is enabled. The motor stops at current position. When velocity command is higher than the zero clamp level, zero clamp function is disabled.

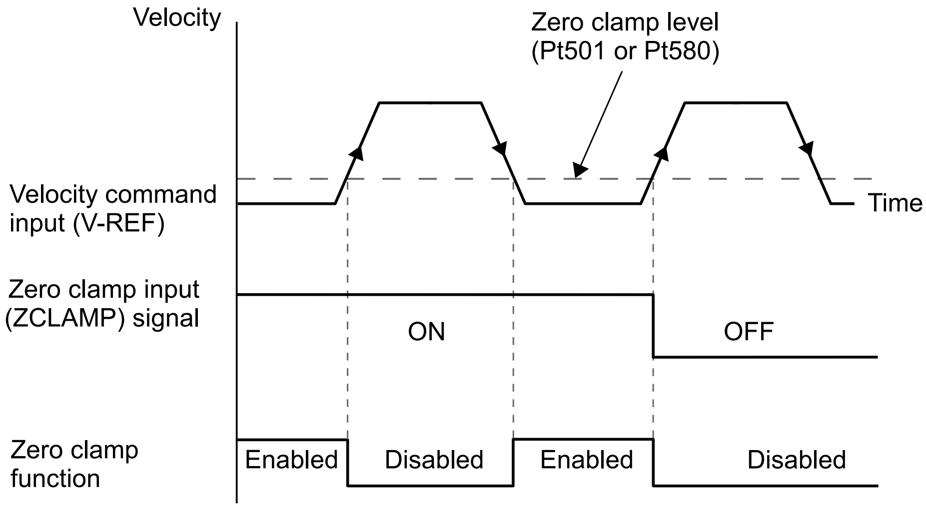


Figure8.3.5.1

- Allocating digital input signal

  The input pin for ZCLAMP signal is user-defined. Set by Pt50C = t.X□□□.

Table8.3.5.1

Type	Signal	Hardware Pin	Status	Description
Input	ZCLAMP	User-defined	ON	If the analog voltage of velocity command input signal (V-REF) is lower than the zero clamp level (Pt501 or Pt580), zero clamp function is enabled.
			OFF	Zero clamp function is disabled.

- Setting zero clamp function

  Zero clamp function can only be applied in velocity mode and internal velocity mode. If you are using dual mode, please switch to velocity mode or internal velocity mode to use zero clamp function.

Table8.3.5.2

Parameter	t.□□X□	Control Mode	Input Signal	Effective	Category
Pt000	t.□□0□	Velocity mode	ZCLAMP	After power on	Setup
	t.□□3□	Internal velocity mode	ZCLAMP, SPD-A, SPD-B, SPD-D, CSEL		
	t.□□4□	Internal velocity mode ↔Position mode	ZCLAMP, SPD-A, SPD-B, SPD-D, CSEL		
	t.□□5□	Internal velocity mode ↔Velocity mode	ZCLAMP, SPD-A, SPD-B, SPD-D, CSEL		
	t.□□6□	Internal velocity mode ↔Torque mode	ZCLAMP, SPD-A, SPD-B, SPD-D, CSEL		
	t.□□7□	Position mode ↔Velocity mode	ZCLAMP, CSEL		
	t.□□9□	Torque mode ↔Velocity mode	ZCLAMP, CSEL		
	t.□□C□	Internal position mode ↔Velocity mode	ZCLAMP, CSEL		
	t.□□E□	Internal velocity mode ↔Internal position mode	ZCLAMP, SPD-A, SPD-B, SPD-D, CSEL		

■ Related parameters

Zero clamp level (Pt501 or Pt580) sets the velocity for zero clamp function. If zero clamp level is set to be higher than the maximum velocity of servo motor, the maximum velocity of servo motor will be its upper limit.

(1) Rotary servo motor

Table8.3.5.3

Parameter	Pt501	Range	0~10000	Control Mode	Velocity mode and internal velocity mode
Default	10	Effective	Immediately	Unit	1 rpm
Description					
Set zero clamp level (rotary motor).					

(2) Linear servo motor

Table8.3.5.4

Parameter	Pt580	Range	0~10000	Control Mode	Velocity mode and internal velocity mode
Default	10	Effective	Immediately	Unit	1 mm/s
Description					
Set zero clamp level (linear motor).					

8.3.6 Velocity reach output (V-CMP) signal

When motor velocity is in accordance with the input velocity command from the controller, velocity reach output (V-CMP) signal is output.

Table8.3.6.1

Type	Signal	Hardware Pin	Status	Function
Output	V-CMP	CN6-35/34 (O1 signal) (Default)	ON	The motor reaches the command velocity.
			OFF	The motor does not reach the command velocity.

Note:
The output pins for V-CMP signal can be user-defined. Set by Pt514 = t.□X□□. Output range of velocity reach signal is set by Pt503.

■ Setting output range of velocity reach signal

Table8.3.6.2

Parameter	Pt503	Range	0~100	Control Mode	Velocity mode and internal velocity mode
Default	10	Effective	Immediately	Unit	1 rpm
Description					
Set output range of velocity reach signal.					

Table8.3.6.3

Parameter	Pt582	Range	0~100	Control Mode	Velocity mode and internal velocity mode
Default	10	Effective	Immediately	Unit	1 mm/s
Description					
Set output range of velocity reach signal (linear servo motor).					

If Pt503 = 100 and the velocity command is 2000 rpm, V-CMP signal is output when the motor velocity is 1900 ~ 2100 rpm.

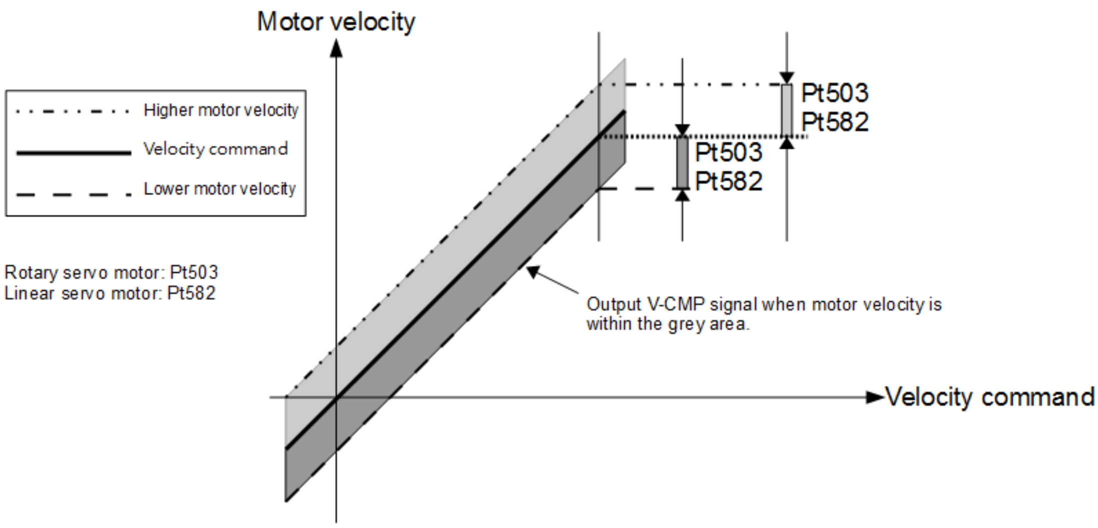


Figure8.3.6.1

8.4 Position mode

In position mode, motor position is controlled by pulse command. Motor position and velocity are determined by the number of pulses and the frequency of input pulses. Set Pt000 to t.□□1□ to select position mode.

Table8.4.1

Parameter		Description	Effective	Category
Pt000	t.□□1□	Control mode: position mode	After power on	Setup

The control block diagram for position mode is as below.

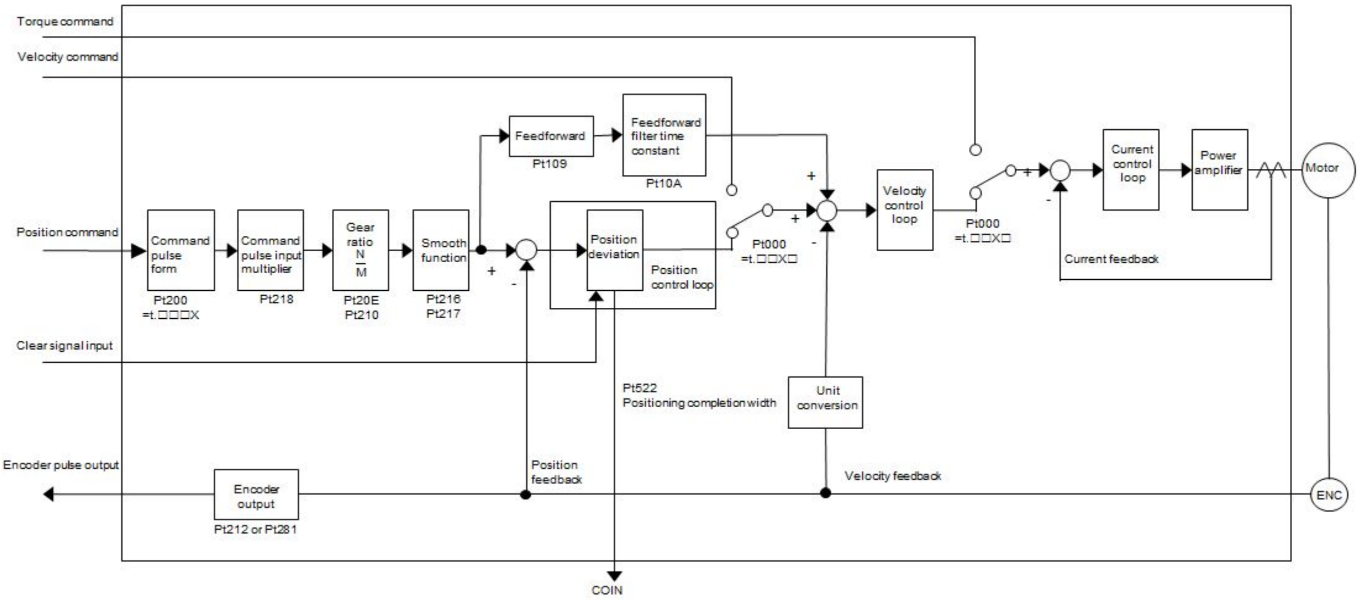


Figure8.4.1

8.4.1 Setting position mode

Pulse command type and pulse command input filter are described in the following.

- Pulse command type

  Set pulse command type by Pt200 according to the pulse command from controller.

Table8.4.1.1

Parameter		Description	Effective	Category
Pt200	t.□□□0 (Default)	Pulse signal (pulse + direction) (positive logic)	After power on	Setup
	t.□□□1	Pulse signal (CW + CCW) (positive logic)		
	t.□□□4	Differential pulse signal with 90 degrees phase difference (A phase + B phase) x 4 (positive logic)		
	t.□□□5	Pulse signal (pulse + direction) (negative logic)		
	t.□□□6	Pulse signal (CW + CCW) (negative logic)		

■ Pulse command input filter

Table8.4.1.2

Parameter		Description	Effective	Category
Pt200	t.0□□□ (Default)	The command input is differential signal (1~5 Mpps).	After power on	Setup
	t.1□□□	The command input is single-ended signal (1~200 kpps).		

■ Wiring for position mode-Differential signal

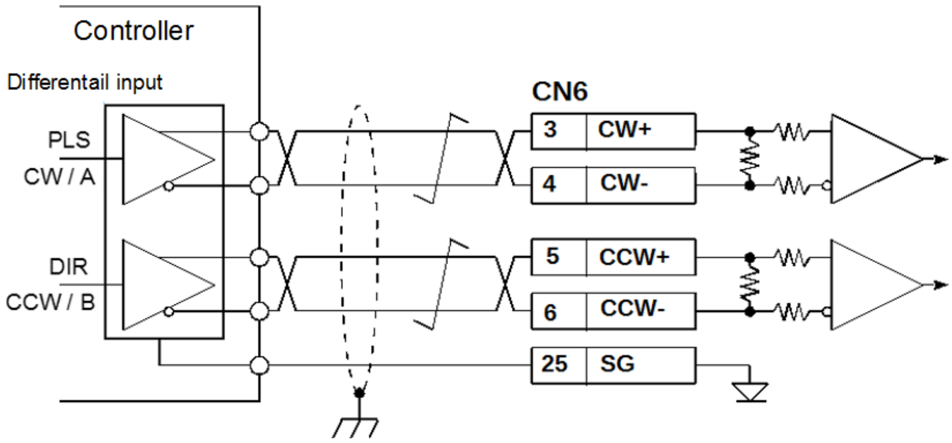


Figure8.4.1.1

8.4.2 Command pulse multiplication switching function

Command pulse can be multiplied by 1 or any number within the range of 1 to 100 by Pt218 (Maximum setting value: 100). Command pulse multiplication switching input (PSEL) signal is used to enable or disable command pulse multiplication switching function. If command pulse multiplication switching output (PSELA) signal is output, it means the function is enabled. The signals and setting of the function are described in the following.

■ Command pulse multiplication switching input (PSEL) signal
Command pulse multiplication switching input (PSEL) signal is used to enable or disable multiplication switching function. Use Pt50D = t.X□□□ to allocate PSEL signal to the desired pin.

Table8.4.2.1

Type	Signal	Hardware Pin	Status	Description
Input	PSEL	User-defined	ON	Enable the command pulse input multiplier.
			OFF	Disable the command pulse input multiplier. The multiplier is 1.

■ Command pulse multiplication switching output (PSELA) signal

After multiplication switching function is enabled, command pulse multiplication switching output (PSELA) signal is output. Allocate PSELA signal to the desired pins by Pt516 = t.X□□□.

Table8.4.2.2

Type	Signal	Hardware Pin	Status	Description
Output	PSELA	User-defined	ON	The command pulse input multiplier is enabled.
			OFF	The command pulse input multiplier is disabled.

⚠CAUTION

◆ After command pulse multiplication switching input (PSEL) signal is input, ensure the command pulse input multiplier is enabled by using command pulse multiplication switching output (PSELA) signal. If pulse command is input before the command pulse input multiplier is enabled, it may cause false operation.

■ Command pulse input multiplier

Table8.4.2.3

Parameter	Pt218	Range	1~100	Control Mode	Position mode
Default	1	Effective	Immediately	Unit	-
Description					
Set command pulse input multiplier.					

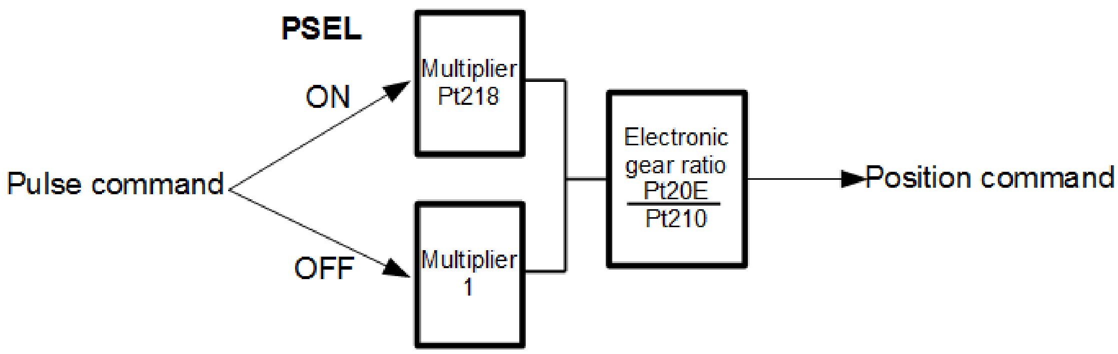


Figure8.4.2.1

⚠CAUTION
◆ After Pt218 is modified, perform trial operation for the motor solely to ensure the operation is normal first. Then connect the motor to the mechanism.

■ Timing diagram of command pulse multiplication switching

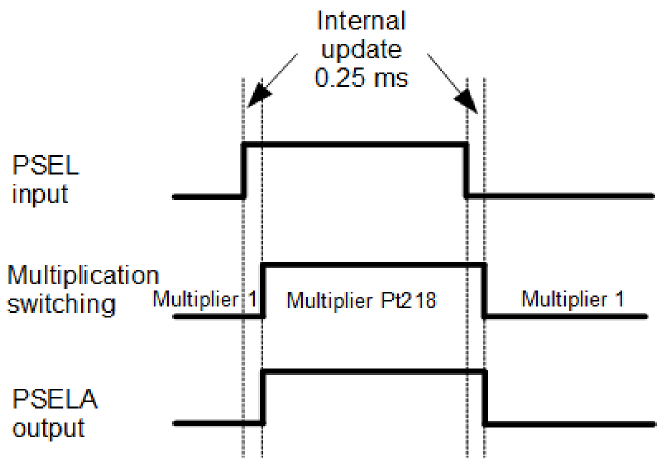


Figure8.4.2.2

8.4.3 Smooth function

Smooth function is used to have smoother motion and avoid machine vibration when motor accelerates and decelerates. Smooth function does not affect the positioning accuracy of motor. Applications which are suitable for using smooth function are: (a) Path planning during acceleration and deceleration are not done by controller (b) The output frequency of the pulse command from controller is too low. While setting smooth function, please do not input pulse command and the motor must be stopped.

Table8.4.3.1

Parameter	Pt216	Range	0~16384	Control Mode	Position mode
Default	0	Effective	After the motor stops	Unit	0.25 ms
Description					
Set the acceleration time and deceleration time for position command.					

Table8.4.3.2

Parameter	Pt217	Range	0~1000	Control Mode	Position mode
Default	0	Effective	After the motor stops	Unit	0.25 ms
Description					
Set average position command movement time.					

■ Position command acceleration/deceleration filter

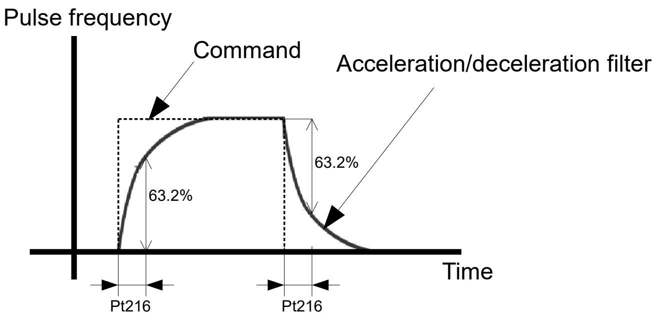


Figure8.4.3.1

■ Average position command movement filter

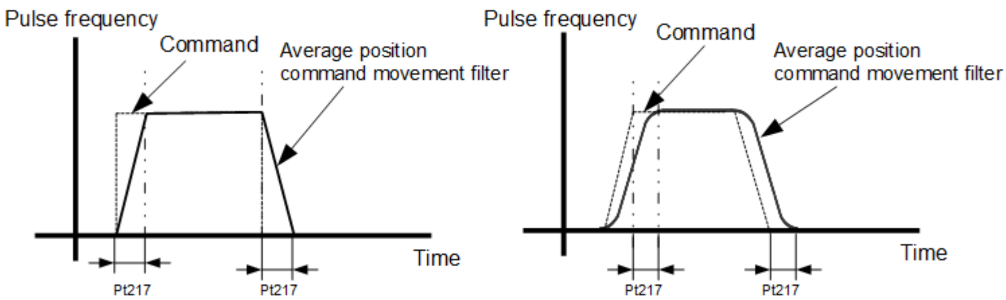


Figure8.4.3.2

Note:

(1) If controller is doing path planning, please pay attention to the setting of smooth function, since smooth function may influence the path planning of the controller.

(2) While using controller to execute multi-axis synchronization, please do not use Pt216 and Pt217. This is to avoid decreasing the effect of interpolation.

8.4.4 Positioning completion output (COIN) signal

After motor reaches the target position, positioning completion output (COIN) signal is output when the position deviation is smaller than the positioning completion width (Pt522) and debounce time (Pt523) elapses. If the position deviation is larger than the positioning completion width, COIN signal will not be output. Total time is the time when motion starts to the time COIN signal is output as well as the sum of move time and settling time.

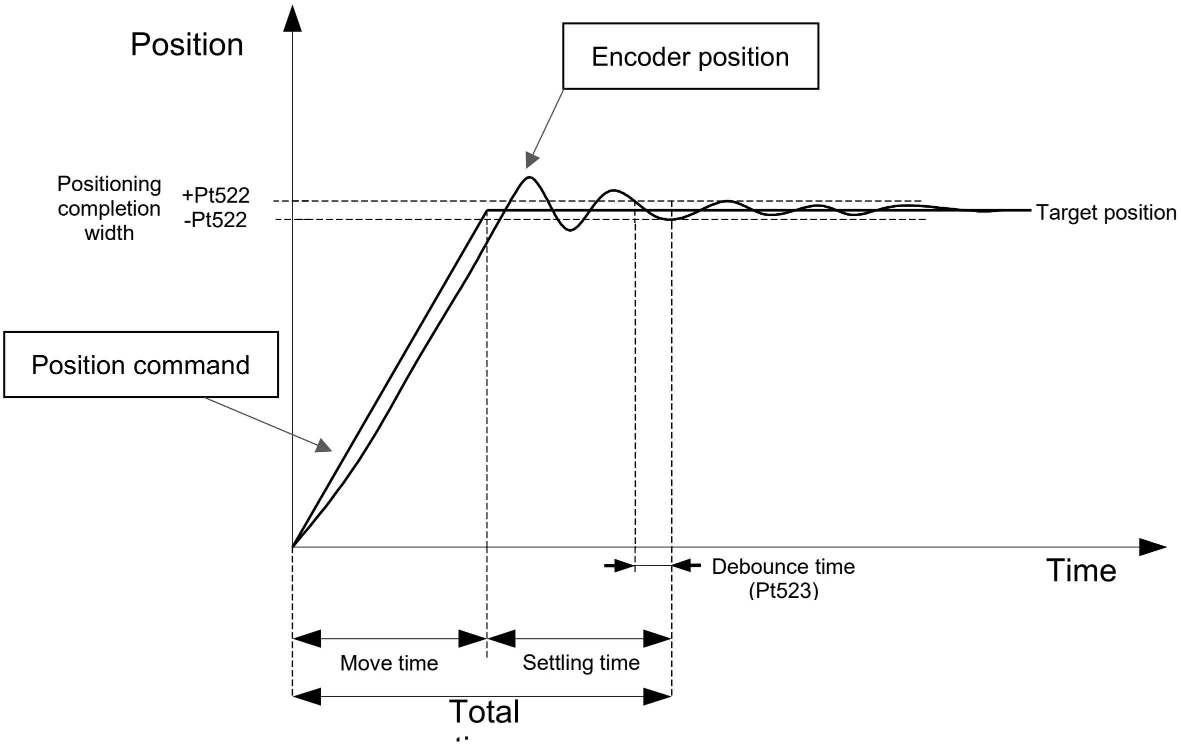


Figure8.4.4.1

Positioning completion output (COIN) signal is output when position deviation is smaller than the positioning completion width to inform controller that the pulse command has been completed and the controller can proceed to the next motion planning.

Table8.4.4.1

Type	Signal	Hardware Pin	Status	Description
Output	COIN	CN6-35/34 (O1 signal) (Default)	ON	Positioning is completed.
			OFF	Positioning is not completed yet.

Note:
Allocate COIN signal to the desired pins by Pt514 = t.□□X□.

■ Setting positioning completion width

COIN signal is output when position deviation is smaller than the positioning completion width.

Table8.4.4.2

Parameter	Pt522	Range	0~1073741824	Control Mode	Position mode
Default	7	Effective	Immediately	Unit	Control unit
Description					
Set positioning completion width.					

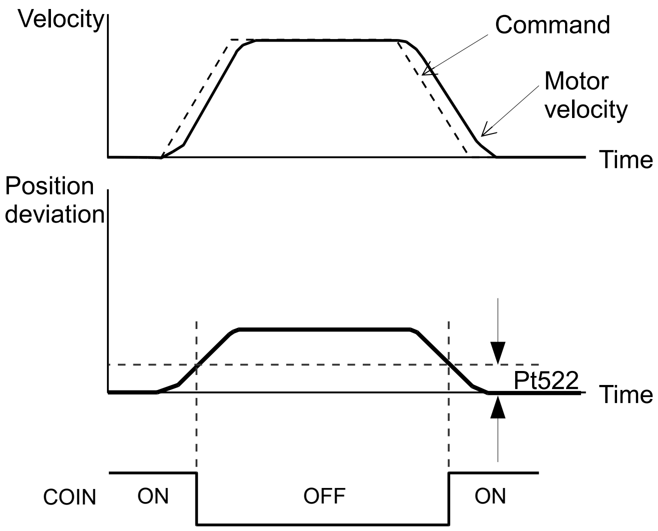


Figure8.4.4.2

■ Output timing of positioning completion output (COIN) signal

Users can set to output COIN signal at three different timings. Pt207 = t.X□□□ provides three output conditions for COIN signal when position deviation is smaller than the positioning completion width. Pt207 is suggested to set as t.1□□□or t.2□□□. If a user uses default Pt207=t.0□□□, the position deviation will be close to 0 during the operation, which may result in the output of COIN.

Table8.4.4.3

Parameter		Description	Effective	Category
Pt207	t.0□□□ (Default)	Output COIN signal when the absolute value of position deviation is less than the setting value of positioning completion width (Pt522).	After power on	Setup
	t.1□□□	Output COIN signal when the absolute value of position deviation is less than the setting value of positioning completion width (Pt522) and position command stops after being filtered.		
	t.2□□□	Output COIN signal when the absolute value of position deviation is less than the setting value of positioning completion width (Pt522) and position command stops.		

Note:

When Pt207 = t.1□□□, a user has to delay the filtering time of Pt216 and Pt217 to output COIN signal after the position command ends.

- Debounce time

  Users can set debounce time (Pt523) to output positioning completion output (COIN) signal after debounce time elapses.

Table8.4.4.4

Parameter	Pt523	Range	0~1000	Control Mode	Position mode
Default	0	Effective	Immediately	Unit	1 ms
Description					
Set debounce time.					

8.4.5 Positioning near output (NEAR) signal

When position deviation is smaller than NEAR signal width (Pt524), positioning near output (NEAR) signal is output to inform controller that pulse command is soon to be completed and the controller can proceed to the next motion planning. Normally, NEAR signal is used with COIN signal. Its value must be larger than positioning completion width (Pt522).

Table8.4.5.1

Type	Signal	Hardware Pin	Status	Description
Output	NEAR	User-defined	ON	Position deviation is smaller than NEAR signal width (Pt524).
			OFF	Position deviation is larger than NEAR signal width (Pt524).

Note:

Allocate NEAR signal to the desired pins by Pt516 = t.□X□□.

■ Setting NEAR signal width

When position deviation is smaller than NEAR signal width (Pt524), NEAR signal is output.

Table8.4.5.2

Parameter	Pt524	Range	1~1073741824	Control Mode	Position mode
Default	1073741824	Effective	Immediately	Unit	1 control unit
Description					
Set NEAR signal width.					

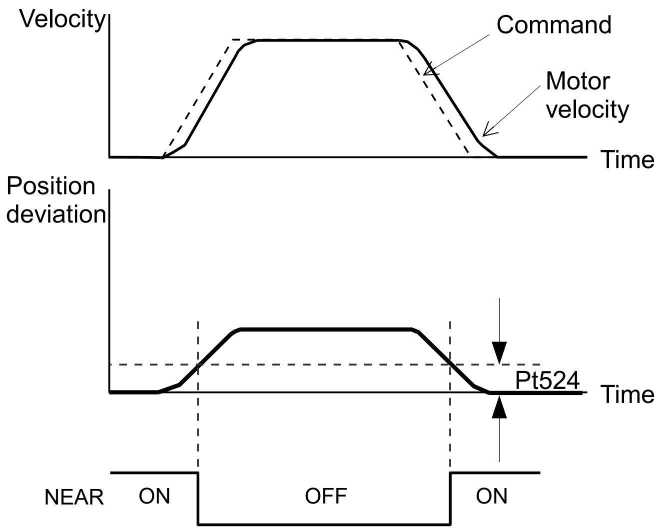


Figure8.4.5.1

8.4.6 Command pulse inhibition input (INHIBIT) signal

When command pulse inhibition input (INHIBIT) signal is ON, the servo drive will ignore external pulse command until INHIBIT signal is OFF. This signal is only effective in position mode.

Table8.4.6.1

Type	Signal	Hardware Pin	Status	Description
Input	INHIBIT	User-defined	ON	Stop receiving external pulse command.
			OFF	Receive external pulse command.

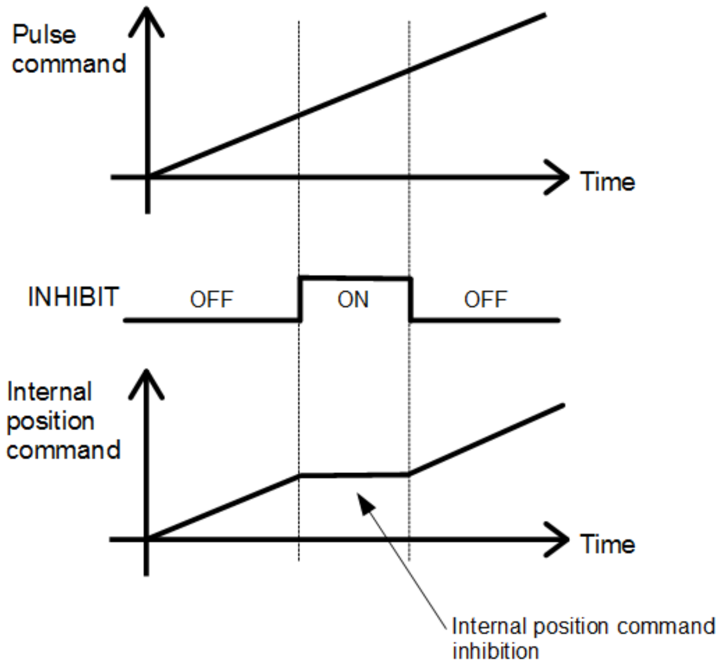


Figure8.4.6.1

■ Setting command pulse inhibition input function

Table8.4.6.2

Parameter		Control Mode	Input Signal	Effective	Category
Pt000	t.□□1□	Position mode	INHIBIT	After power on	Setup
	t.□□4□	Internal velocity mode ↔Position mode	INHIBIT, C-SEL, SPD-A, SPD-B, SPD-D		
	t.□□7□	Position mode ↔Velocity mode	INHIBIT, C-SEL		
	t.□□8□	Position mode ↔Torque mode	INHIBIT, C-SEL		
	t.□□B□	Internal position mode ↔Position mode	INHIBIT, C-SEL		

8.4.7 Position deviation clear input (CLR) signal

Position deviation clear input (CLR) signal is used to clear the deviation counter in the servo drive. When CLR signal is ON, the deviation counter is 0. At this time, position loop control cannot be performed.

Note:

(1) The deviation counter shows the deviation between command pulses from controller and feedback pulses from encoder.

(2) When position deviation clear input (CLR) signal is ON, do not input pulse command.

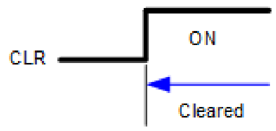
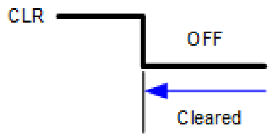
Table8.4.7.1

Type	Signal	Hardware Pin	Status	Description
Input	CLR	User-defined	ON	Position deviation clear input (CLR) signal is input and the deviation counter is 0.
			OFF	Start to count position deviation.

■ Setting position deviation clear input (CLR) signal

CLR signal is set by Pt200 = t.□□X□ (Clear signal form).

Table8.4.7.2

Parameter		Control Mode	Input Signal	Effective	Category
Pt200	t.□□0□ (Default)	Clear position deviation when the input signal is at high level.		After power on	Setup
	t.□□1□	Clear position deviation when the input signal is at low level.			

Note:

The width of CLR signal must satisfy the following condition:

If Pt200 = t.□□X□ is 0 or 1, the signal width must be larger than 0.5 ms to ensure the signal is received by the servo drive.

8.5 Torque mode

In torque mode, motor torque or force is controlled by analog command (analog voltage). Set Pt000 to t.□□2□ to select torque mode.

Table8.5.1

Parameter		Description	Effective	Category
Pt000	t.□□2□	Control mode: torque mode	After power on	Setup

8.5.1 Setting torque mode

The range of input voltage must be DC +10 V ~ -10 V.

Table8.5.1.1

Signal	CN6 Pin	Description
T_REF+	16	Torque command input
T_REF-	17	Signal grounding of torque command input

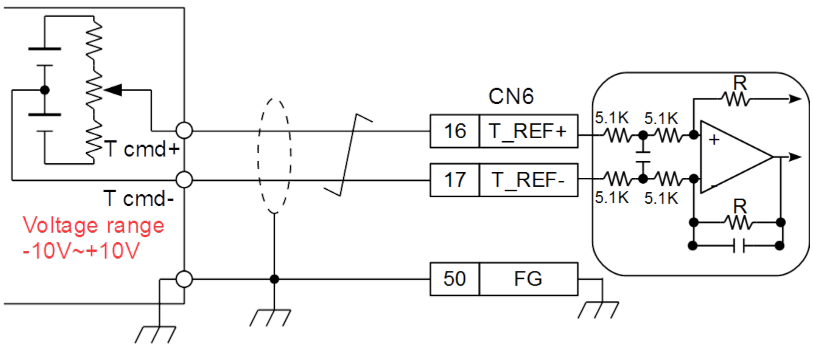


Figure8.5.1.1

■ Torque command input gain

Table8.5.1.2

Parameter	Pt400	Range	10~100	Control Mode	Position mode, velocity mode and torque mode
Default	30	Effective	Immediately	Unit	0.1 V
Description					
Set torque command input gain.					

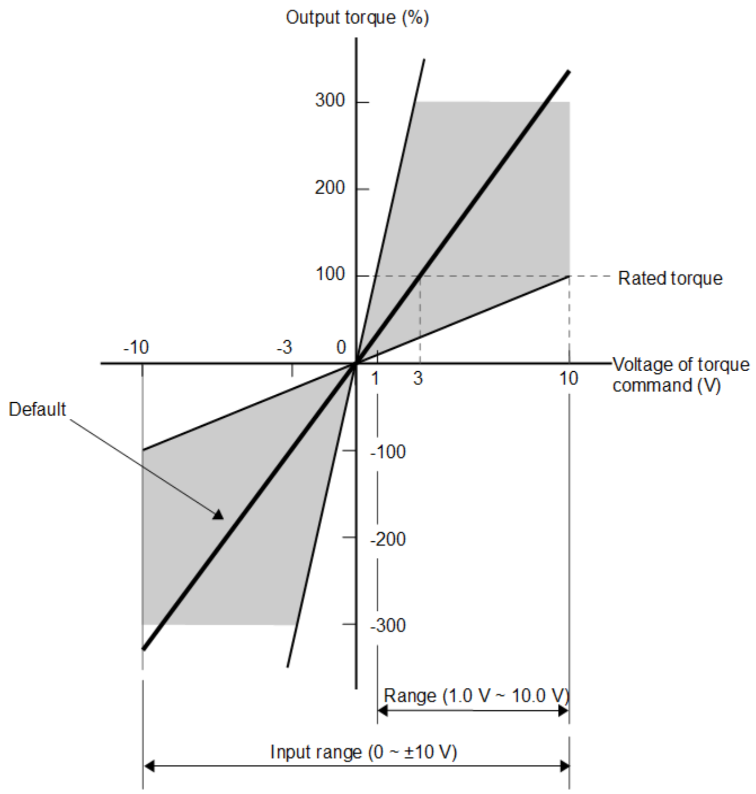


Figure8.5.1.2 Input range of torque command voltage

Note:

Torque command which exceeds the rated torque can be input. But alarm overload (instantaneous maximum load) (AL.710) or overload (continuous maximum load) (AL.720) may occur if torque which exceeds the rating has been output for a period of time. For more information, please refer to the following.

8.5.2 Torque command offset adjustment

- Automatic offset adjustment

  Refer to section 8.3.2.

- Dead band for torque command input

  After automatic offset adjustment completes, the analog voltage of torque command could still jitter. Set Pt429 (Dead band for torque command input) to ignore the torque command of a certain range.

Table 8.5.2.1

Parameter	Pt429	Range	0~3000	Control Mode	Position mode, velocity mode and torque mode
Default	0	Effective	Immediately	Unit	1 mV
Description					
Set the dead band for torque command input.					

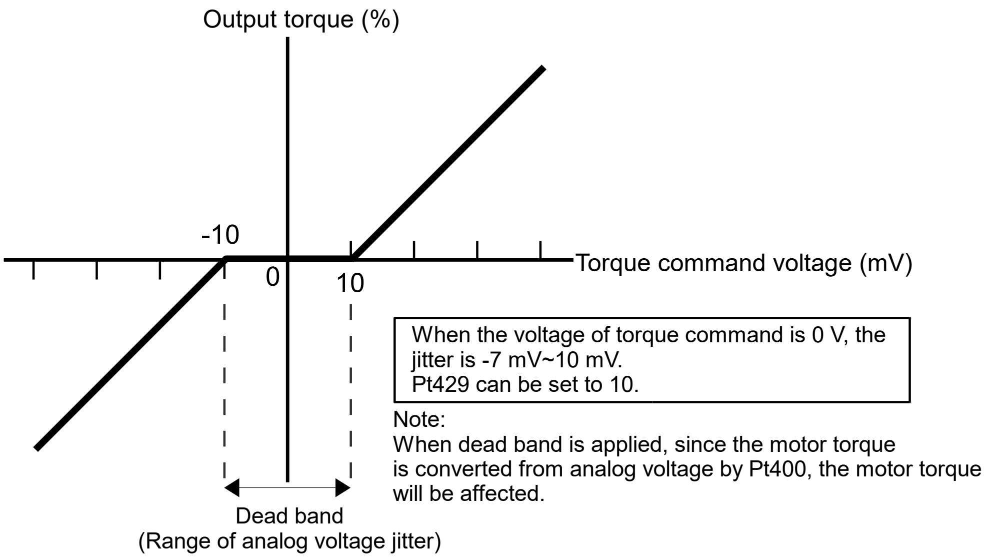


Figure 8.5.2.1

8.5.3 Torque command filter

Torque command filter is used for torque command input signal (T-REF). Torque command becomes smoother after torque command filter is applied. The higher the setting value is, the smoother the torque command becomes. If the setting value is too large, the response of torque command decreases.

Table8.5.3.1

Parameter	Pt415	Range	0~65535	Control Mode	Position mode, velocity mode and torque mode
Default	0	Effective	After the motor stops	Unit	0.01 ms
Description					
Set T-REF filter time constant.					

8.5.4 Velocity limit function in torque mode

The velocity limit function is to limit the velocity of motor to avoid damage to mechanism due to overspeed. Select external velocity limit or internal velocity limit by parameter. If the velocity of motor is limited, velocity limit detection output (VLT) signal is output.

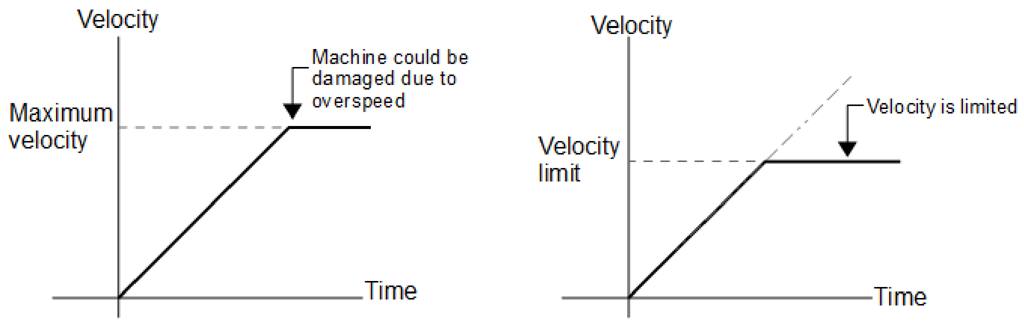


Figure8.5.4.1

Velocity limit detection output (VLT) signal

If the velocity of motor is limited, VLT signal is output.

Table8.5.4.1

Type	Signal	Hardware Pin	Status	Description
Output	VLT	User-defined	ON	The velocity of motor is limited.
			OFF	The velocity of motor is not limited.

Note:

Allocate VLT signal to the desired pins by Pt515 = t.X□□□.

Velocity/position control selection (V-REF signal is used.)

Select velocity limit in torque mode by Pt002 = t.□□X□. When Pt002 = t.□□1□ (Use V-REF signal as external velocity limit.), the velocity of motor is limited by V-REF signal and Pt300.

Table8.5.4.2

Parameter		Description	Effective	Category
Pt002	t.□□0□ (Default)	Use internal velocity limit. Pt407 or Pt480 is used as the velocity limit value.	After power on	Setup
	t.□□1□	Use external velocity limit. The velocity of motor is limited by V-REF signal and Pt300.		

■ Internal velocity limit

Set Pt002 to t.□□0□ to use internal velocity limit. Set velocity limit value by Pt407 (Velocity limit during toque control) or Pt480 (Velocity limit during force control).

Table8.5.4.3

Parameter	Pt407	Range	0~10000	Control Mode	Torque mode
Default	10000	Effective	Immediately	Unit	1 rpm
Description					
Set the velocity limit value during torque control (rotary servo motor).					

Table8.5.4.4

Parameter	Pt480	Range	0~10000	Control Mode	Torque mode
Default	10000	Effective	Immediately	Unit	1 mm/s
Description					
Set the velocity limit value during force control (linear servo motor).					

■ External velocity limit

Set Pt002 to t.□□1□ to use external velocity limit. The velocity of motor is limited by V-REF signal and Pt300 (Velocity command input gain).

Table8.5.4.5

Type	Signal	Hardware Pin	Description
Input	V-REF+	CN6-14	Velocity command input
	V-REF-	CN6-15	Signal grounding of velocity command input

Note:

(1) When Pt002 = t.□□1□, the smaller value of V-REF signal and Pt407 or Pt480 is used.

(2) The voltage value of velocity limit depends on the setting of Pt300. The polarity has no effect.

(3) When Pt300 = 6.00 (Default), if 6 V V-REF signal is input, the velocity of motor is limited to the rated velocity.

8.6 Encoder pulse output

For a servo drive, the encoder pulse output provides feedback position for controller.With Pt207 = t.□□□X, users can decide whether to enable buffered encoder output or not. The default is to disable buffered encoder output. The servo drive outputs pulse signal to controller according to the set encoder output ratio. The pulse signal type is A/B phase signal. Before using this function, please check the output bandwidth of the servo drive, the input bandwidth of controller, and the maximum velocity of motor. If users decide to enable buffered encoder output, the servo drive takes the original encoder signal as output. Therefore, users cannot change the output ratio and only digital encoder is available.

Table8.6.1

Parameter		Description	Effective	Category
Pt207	t.□□□0 (Default)	Disable buffered encoder output.	After power on	Setup
	t.□□□1	Enable buffered encoder output.		

Note:

Fieldbus drives(ED1F) only supports buffered encoder output

8.6.1 Encoder pulse output signal

The encoder pulse output signal is 5 V differential signal. If you would like to use cable made by yourselves, please use twisted-pair cable to avoid electronic interference.

Table8.6.1.1

Type	Signal	CN6 Pin	Description
Output	A	21	Differential signal with 90 degrees phase difference (A phase + B phase) which indicates the movement of motor
	/A	22	
	B	48	
	/B	49	
	Z	23	One Z-phase signal is output per one revolution.
	/Z	24	
	CZ	19	One Z-phase signal is output per one revolution. (Single-ended signal)

■ Wiring for encoder pulse output

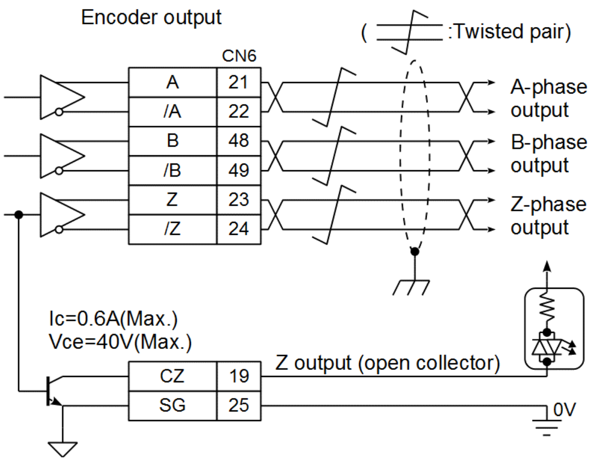


Figure8.6.1.1

■ Moving direction of motor

When A phase leads B phase, it means the motor is moving in forward direction. When B phase leads A phase, it means the motor is moving in reverse direction.

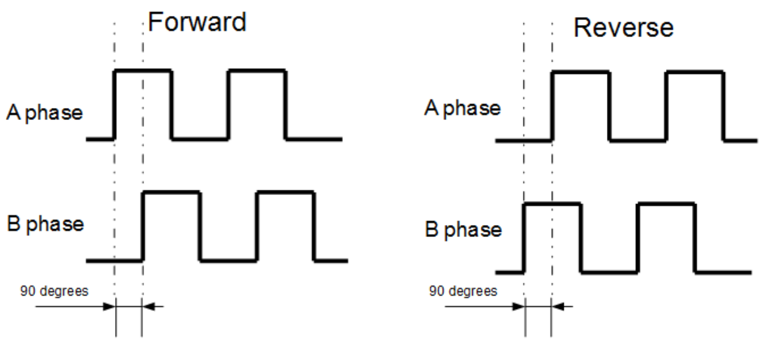


Figure8.6.1.2

8.6.2 Setting encoder pulse output

Before setting encoder pulse output, please check the output bandwidth of the servo drive and the input bandwidth of controller to ensure pulse signal can be normally output and input. If buffered encoder output is enabled, the setting of encoder pulse output will be invalid. Since the servo drive takes the original encoder signal as output, users cannot change the output ratio and only digital encoder is available.

■ Setting number of encoder output pulses (rotary servo motor)
Set the output pulses per one revolution by Pt212.

Table8.6.2.1

Parameter	Pt212	Range	64~1073741824	Control Mode	Position mode, velocity mode and torque mode
Default	8192	Effective	After power on	Unit	1 pulse edge
Description					
Set the number of output pulses when motor rotates for one revolution.					

■ Setting encoder output resolution for linear encoder
Set the output pulses of linear motor (or full-closed loop control) by Pt281.

Example 1:
When Pt281 is set to 2000, 2000 pulse edges (500 pulses) are output for every 100 mm. If the motor velocity is 100 mm/s, the encoder output bandwidth is:
100 mm/s x Pt281 (2000 pulse edges/100 mm) = 2000 pulse edge/s

Example 2:
When Pt281 is set to 10000000, 10000000 (2500000 pulses) pulse edges are output for every 100 mm. If the motor velocity is 200 mm/s, the encoder output bandwidth is:
200 mm/s x Pt281 (10000000 pulse edges/100 mm) = 20000000 pulse edge/s
At this time, the output bandwidth exceeds 18 M/s, AL.511 (Encoder pulse output overspeed) occurs.

Table8.6.2.2

Parameter	Pt281	Range	2000~1073741824	Control Mode	Position mode, velocity mode and torque mode
Default	100000	Effective	After power on	Unit	1 pulse edge/100 mm
Description					
Set encoder output resolution (linear motor and full-closed loop control).					

■ Z-phase signal width

Z-phase signal width varies with the setting of Pt212 or Pt281.

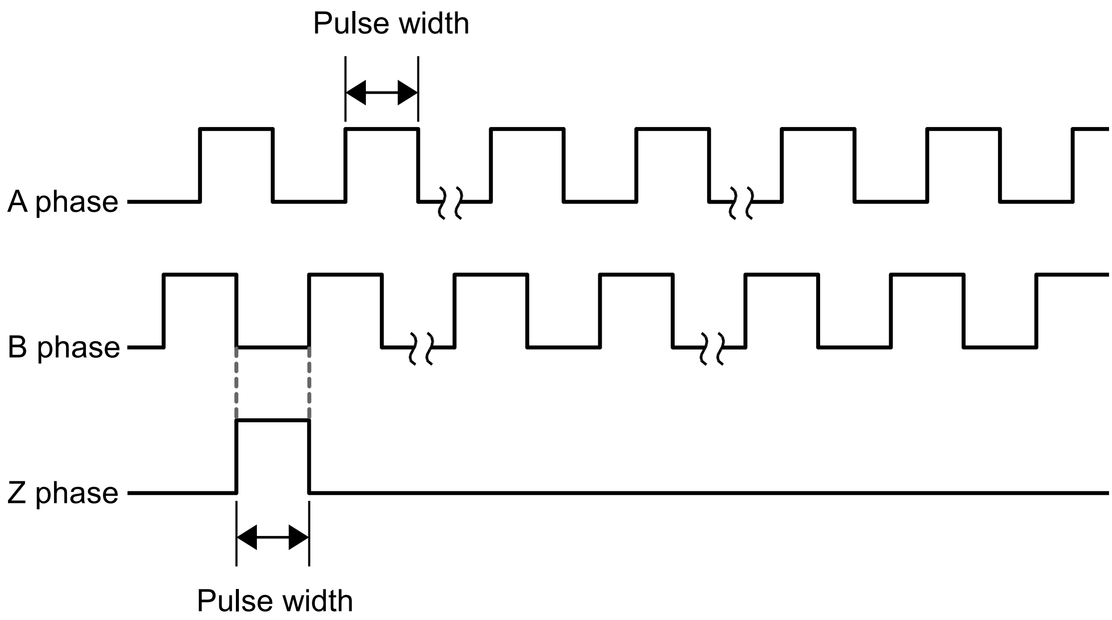


Figure8.6.2.1

Note:

If the resolution of Pt281 is larger than the encoder resolution, the width of Z-phase pulse is larger than that of A-phase pulse.

■ Multi-turn home position output (rotary motor)

Use Pt00A= t.X□□□ to set to output one Z-phase signal for every revolution.

Table8.6.2.3

Parameter		Description	Effective	Category
Pt00A	t.0□□□	Do not use multi-turn home position output.	After power on	Setup
	t.1□□□ (Default)	Use multi-turn home position output.		

Note:

Pt00A has no function when linear motor or closed loop function is used.

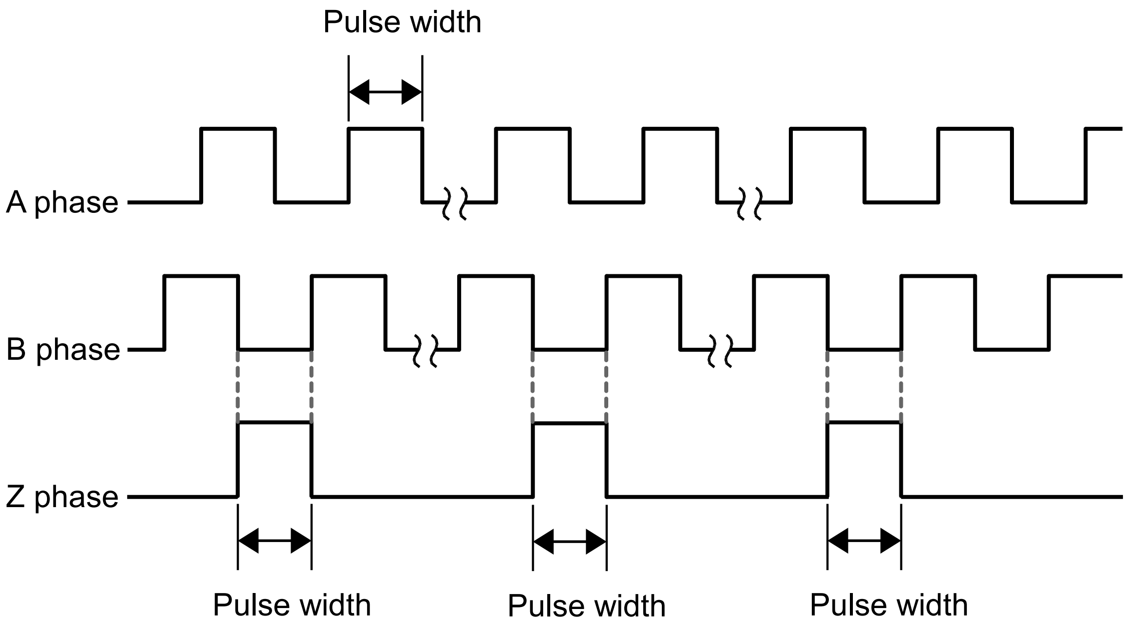


Figure8.6.2.2 Pt00A = t.1□□□ Use multi-turn home position output.

- Multi index (reference point) output for linear platform

  Set Pt70A= t.□□□X to output one Z-phase signal every time when linear platform reaches reference point.

Table8.6.2.4

Parameter		Description	Effective	Category
Pt70A	t.□□□0	Disable multi index output.	After power on	Setup
	t.□□□1 (Default)	Enable multi index output.		

Note:

(1) Linear platform includes linear motor and full-closed loop control.

(2) When rotary motor is used, Pt70A= t.□□□X has no function.

(3) When gantry control function is performed, Pt70A= t.□□□X has no function.

- Disable multi index output and motor reaches index signal after power is supplied.
  After index signal (reference mark) is detected for the first time, the servo drive records its position. Then the servo drive outputs Z- phase signal based on this coordinates.

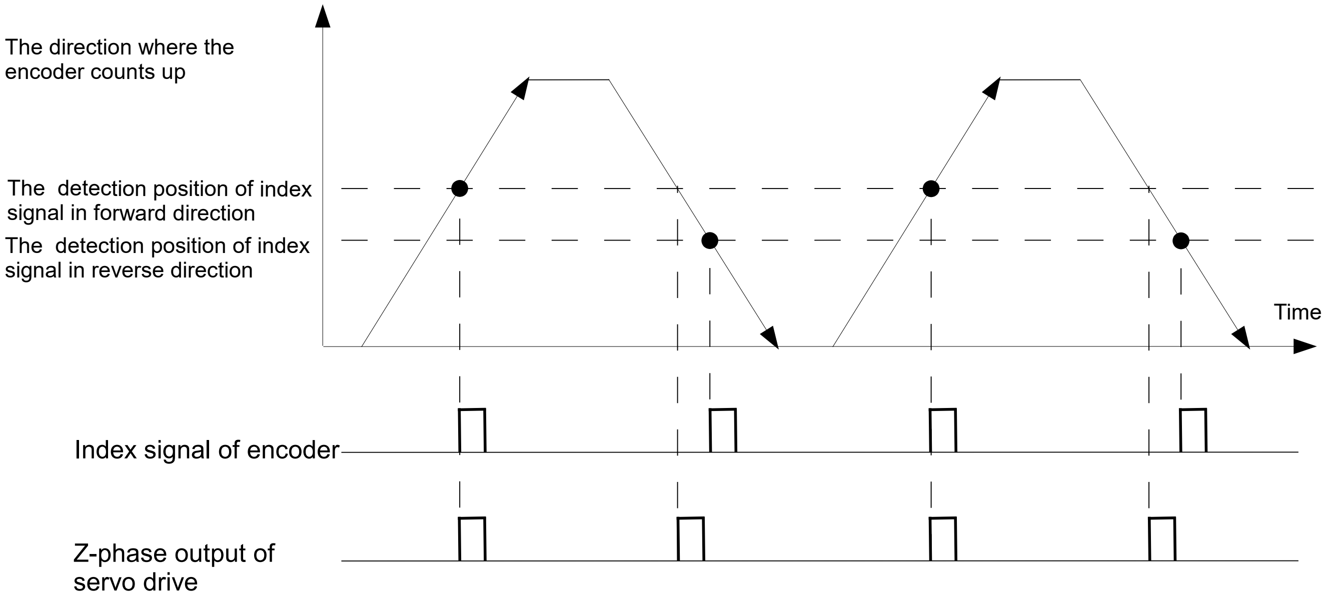


Figure8.6.2.3 Pt70A = t.□□□0 Disable multi index output

- Enable multi index output and motor reaches index signal after power is supplied.
  Index signal (reference mark) is output from linear encoder. Z-phase signal is output after the servo drive detects index signal.

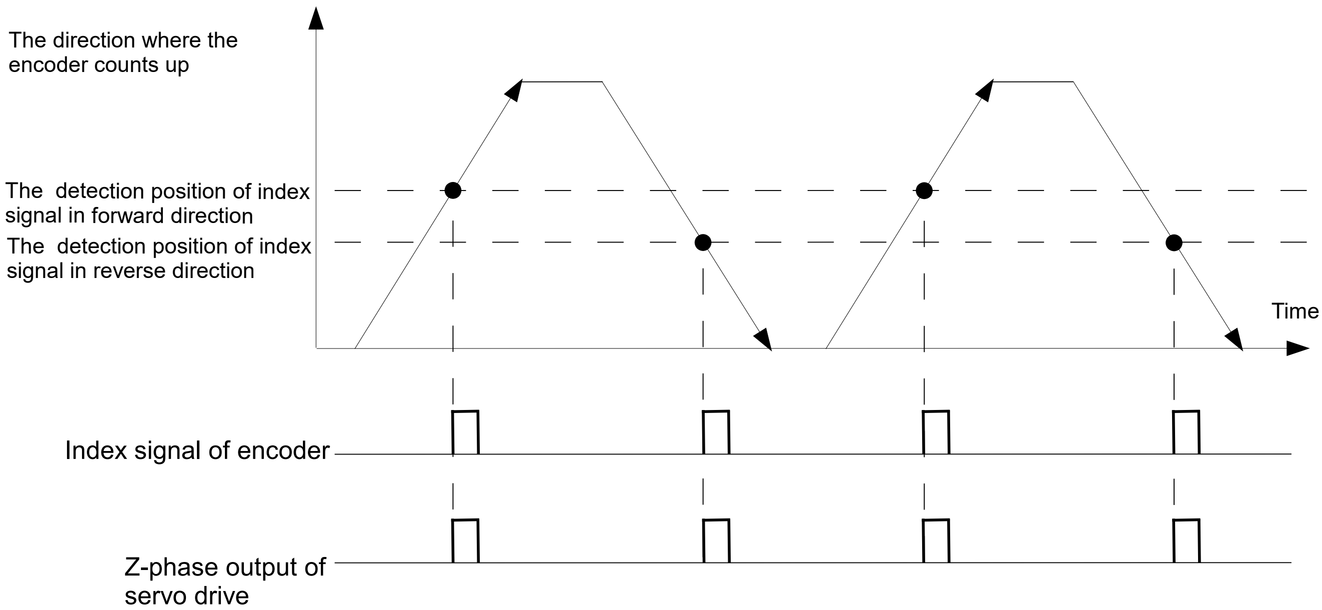


Figure8.6.2.4 Pt70A = t.□□□1 Enable multi index output

- Explanation of term

  Pulse edge: Pulse signal goes from low level to high level. This is called one pulse edge.

  Pulse: Pulse signal goes from low level to high level and returns to low level. This is called one pulse.

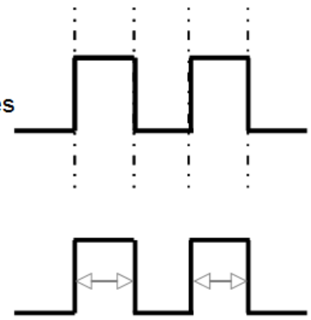


Figure8.6.2.5

8.7 Internal position mode

In internal position mode, motor is controlled by the internal procedure of the servo drive. No pulse command or analog command from controller is required. Set Pt000 to t.□□A□ to select internal position mode. The servo drive handles all the control loops.

Table8.7.1

Parameter		Description	Effective	Category
Pt000	t.□□A□	Control mode: internal position mode	After power on	Setup

8.7.1 Setting internal position mode

■ Rotary motor

Setting for trial operation (P2P)

Table8.7.1.1

Parameter	Description	Default	Range	Unit	Effective	Category
Pt531	Program P2P travel distance P1	0	-1073741824 ~ 1073741822	1 control unit	Immediately	Setup
Pt532	Program P2P travel distance P2	32768	-1073741823 ~ 1073741823	1 control unit	Immediately	Setup
Pt533	Program P2P velocity	600/60*	1~10000	1 rpm	Immediately	Setup
Pt534	Program P2P acceleration time	100	2~10000	1 ms	Immediately	Setup
Pt535	Program P2P waiting time	1000	0~60000	1 ms	Immediately	Setup
Pt537	Program P2P deceleration time	100	2~10000	1 ms	Immediately	Setup
Pt538	Program P2P emergency deceleration time	10	2~1000	1 ms	Immediately	Setup

Note:

(1) Pt532 must be always larger than Pt531. If Pt531 is set to 100 control units and Pt532 is set to 99 control units, Pt532 will be forcibly modified to 101 control units.

(2) *While using direct drive motor, the default values of Pt304 and Pt533 are set to 60 rpm.

(3) AL.040 occurs if Pt531(P1) or Pt532(P2) x electronic gear ratio is larger than the allowable range.

$$(2^{31}-1) \geq Pt531 \times \frac{Pt20E}{Pt210} \geq (-2^{31}+1)$$

$$(2^{31}-1) \geq Pt532 \times \frac{Pt20E}{Pt210} \geq (-2^{31}+1)$$

■ Linear motor

Setting for trial operation (P2P)

Table8.7.1.2

Parameter	Description	Default	Range	Unit	Effective	Category
Pt585	Program jog velocity (linear servo motor)	50	1~10000	1 mm/s	Immediately	Setup
Pt534	Program jog acceleration time	100	2~10000	1 ms	Immediately	Setup
Pt537	Program jog deceleration time	100	2~10000	1 ms	Immediately	Setup
Pt538	Program jog emergency deceleration time	10	2~1000	1 ms	Immediately	Setup

8.7.2 Smooth function

Refer to section 8.4.3.

8.7.3 Positioning completion output (COIN) signal

Refer to section 8.4.4.

8.7.4 Positioning near output (NEAR) signal

Refer to section 8.4.5.

8.8 Internal velocity mode

In internal velocity mode, users are allowed to switch among three different velocity settings and rotation direction by digital input signals. The motor is controlled by the servo drive internally, so analog command is not required from the controller. Set Pt000 to t.□□3□ to select internal velocity mode.

Table8.8.1

Parameter		Description	Effective	Category
Pt000	t.□□3□	Control mode: internal velocity mode	After power on	Setup

An user can set sutiable velocity in internal velocity mode after doing trial operation(JOG) in Thunder.

- Rotary motor

Setting for trial operation (JOG)

Table8.8.2

Parameter	Description	Default	Range	Unit	Effective	Category
Pt304	Jog velocity	600/60*	0~10000	1 rpm	Immediately	Setup
Pt305	Soft start acceleration time	0	0~10000	1 ms	Immediately	Setup
Pt306	Soft start deceleration time	0	0~10000	1 ms	Immediately	Setup

■ Linear motor

Setting for trial operation (JOG)

Table8.8.3

Parameter	Description	Default	Range	Unit	Effective	Category
Pt383	Jog velocity	50	0~10000	1 mm/s	Immediately	Setup
Pt305	Soft start acceleration time	0	0~10000	1 ms	Immediately	Setup
Pt306	Soft start deceleration time	0	0~10000	1 ms	Immediately	Setup

8.8.1 Setting internal velocity mode

The digital input signals and pins used for internal velocity mode are listed as below.

■ Default setting

Table8.8.1.1

Signal	Default Signal	CN6 Pin	Description
SPD-D	I2	30	Change rotation direction.
SPD-A	I6	26	Internal set velocity 1 input signal
SPD-B	I7	32	Internal set velocity 2 input signal

■ Allocating input signals

Table8.8.1.2

Type	Signal	Hardware Pin	Parameter	Description
Input	SPD-D	User-defined	Pt50C = t.□□□X	Change rotation direction.
	SPD-A		Pt50C = t.□□X□	Internal set velocity 1 input signal
	SPD-B		Pt50C = t.□X□□	Internal set velocity 2 input signal

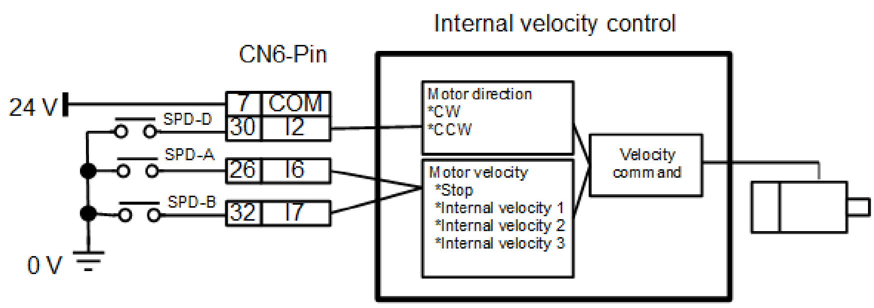


Figure8.8.1.1

8.8.2 Setting internal velocity

Table8.8.2.1

Parameter	Description	Default	Range	Unit	Effective	Category
Pt301	Internal set velocity 1 Switch to internal set velocity 1 by SPD-A and SPD-B signals.	100	0~10000	1 rpm	Immediately	Setup
Pt302	Internal set velocity 2 Switch to internal set velocity 2 by SPD-A and SPD-B signals.	200	0~10000	1 rpm	Immediately	Setup
Pt303	Internal set velocity 3 Switch to internal set velocity 3 by SPD-A and SPD-B signals.	300	0~10000	1 rpm	Immediately	Setup

Table8.8.2.2

Parameter	Description	Default	Range	Unit	Effective	Category
Pt380	Internal set velocity 1 (Linear servo motor) Switch to internal set velocity 1 by SPD-A and SPD-B signals.	10	0~10000	1 mm/s	Immediately	Setup
Pt381	Internal set velocity 2 (Linear servo motor) Switch to internal set velocity 2 by SPD-A and SPD-B signals.	20	0~10000	1 mm/s	Immediately	Setup
Pt382	Internal set velocity 3 (Linear servo motor) Switch to internal set velocity 3 by SPD-A and SPD-B signals.	30	0~10000	1 mm/s	Immediately	Setup

8.8.3 Switching internal set velocity by input signal

Switch to the desired set velocity by SPD-A and SPD-B signals. Select rotation direction by SPD-D signal.

Table8.8.3.1

Digital Input Signal			Rotation Direction	Velocity
SPD-A	SPD-B	SPD-D		
OFF	OFF	OFF	Forward	Use internal set velocity control-stop
OFF	ON			Use internal set velocity 1(Pt301 or Pt380)
ON	ON			Use internal set velocity 2 (Pt302 or Pt381)
ON	OFF			Use internal set velocity 3 (Pt303 or Pt382)
OFF	OFF	ON	Reverse	Use internal set velocity control-stop
OFF	ON			Use internal set velocity 1 (Pt301 or Pt380)
ON	ON			Use internal set velocity 2 (Pt302 or Pt381)
ON	OFF			Use internal set velocity 3 (Pt303 or Pt382)

The example of using internal set velocity control is as figure 8.8.3.1. While switching to different set velocity, soft start acceleration time (Pt305) or soft start deceleration time (Pt306) will be used to reduce the impact caused by velocity change.

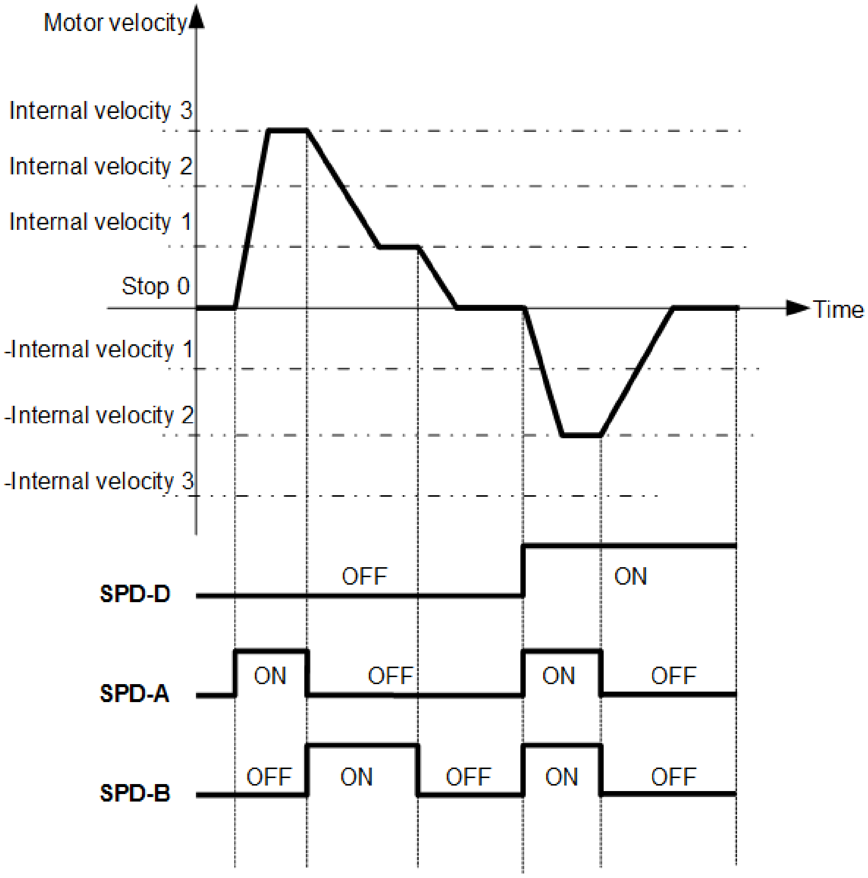


Figure8.8.3.1

8.9 Dual mode

E1 series servo drive supports five control modes: position mode, velocity mode, torque mode, internal position mode and internal velocity mode. In addition to the above five control modes, users can use dual mode. Dual mode is the combination of two control modes. In dual mode, users can use control method switching input (C-SEL) signal to switch between two control modes.

Table8.9.1

Parameter		Description
Pt000	t.□□4□	Internal velocity mode↔Position mode
	t.□□5□	Internal velocity mode↔Velocity mode
	t.□□6□	Internal velocity mode↔Torque mode
	t.□□7□	Position mode↔Velocity mode
	t.□□8□	Position mode↔Torque mode
	t.□□9□	Torque mode↔Velocity mode
	t.□□B□	Internal position mode↔Position mode
	t.□□C□	Internal position mode↔Velocity mode
	t.□□D□	Internal position mode↔Torque mode
	t.□□E□	Internal velocity mode↔Internal position mode

For more information of control modes, please refer to sections 8.3, 8.4, 8.5, 8.7 and 8.8.

- Allocating input signal

  The pin for control method switching input (C-SEL) signal is user-defined.

Table8.9.2

Type	Signal	Hardware Pin	Status	Description
Input	C-SEL	User-defined	OFF	Switch to control mode 1.
			ON	Switch to control mode 2.

Table8.9.3

Parameter		OFF	ON
		Control Mode 1	Control Mode 2
Pt000	t.□□4□	Internal velocity mode	Position mode
	t.□□5□	Internal velocity mode	Velocity mode
	t.□□6□	Internal velocity mode	Torque mode
	t.□□7□	Position mode	Velocity mode
	t.□□8□	Position mode	Torque mode
	t.□□9□	Torque mode	Velocity mode
	t.□□B□	Internal position mode	Position mode
	t.□□C□	Internal position mode	Velocity mode
	t.□□D□	Internal position mode	Torque mode
	t.□□E□	Internal velocity mode	Internal position mode

8.9.1 Pt000=t.□□X□ (control method selection) is set to 4, 5, 6 or E

When Pt000=t.□□X□ is set to 4, 5, 6 or E and Pt513 is set to t.0□□□, use SPD-D, SPD-A and SPD-B signals to switch control mode and internal set velocity. The control mode can be changed from position mode, velocity mode, torque mode or internal position mode to internal velocity mode even when the motor is operating.

- Rotary servo motor

Table8.9.1.1

Input Signal			Motor Rotation Direction	Pt000=t.□□X□			
SPD-D	SPD-A	SPD-B		t.□□4□	t.□□5□	t.□□6□	t.□□E□
OFF	OFF	OFF	Forward	Position mode	Velocity mode	Torque mode	Internal position mode
	OFF	ON		Operate at the internal set velocity 1 set by Pt301.			
	ON	ON		Operate at the internal set velocity 2 set by Pt302.			
	ON	OFF		Operate at the internal set velocity 3 set by Pt303.			
ON	OFF	OFF	Reverse	Position mode	Velocity mode	Torque mode	Internal position mode
	OFF	ON		Operate at the internal set velocity 1 set by Pt301.			
	ON	ON		Operate at the internal set velocity 2 set by Pt302.			
	ON	OFF		Operate at the internal set velocity 3 set by Pt303.			

■ Linear servo motor

Table8.9.1.2

Input Signal			Motor Moving Direction	Pt000=t.□□X□			
SPD-D	SPD-A	SPD-B		t.□□4□	t.□□5□	t.□□6□	t.□□E□
OFF	OFF	OFF	Forward	Position mode	Velocity mode	Torque mode	Internal position mode
	OFF	ON		Operate at the internal set velocity 1 (linear servo motor) set by Pt380.			
	ON	ON		Operate at the internal set velocity 2 (linear servo motor) set by Pt381.			
	ON	OFF		Operate at the internal set velocity 3 (linear servo motor) set by Pt382.			
ON	OFF	OFF	Reverse	Position mode	Velocity mode	Torque mode	Internal position mode
	OFF	ON		Operate at the internal set velocity 1 (linear servo motor) set by Pt380.			
	ON	ON		Operate at the internal set velocity 2 (linear servo motor) set by Pt381.			
	ON	OFF		Operate at the internal set velocity 3 (linear servo motor) set by Pt382.			

The example shown in figure 8.9.1.1 is Pt000 = t. □□4□ (Internal velocity mode⇔Position mode). Soft start function is applied in the example to reduce the impact caused by velocity change.

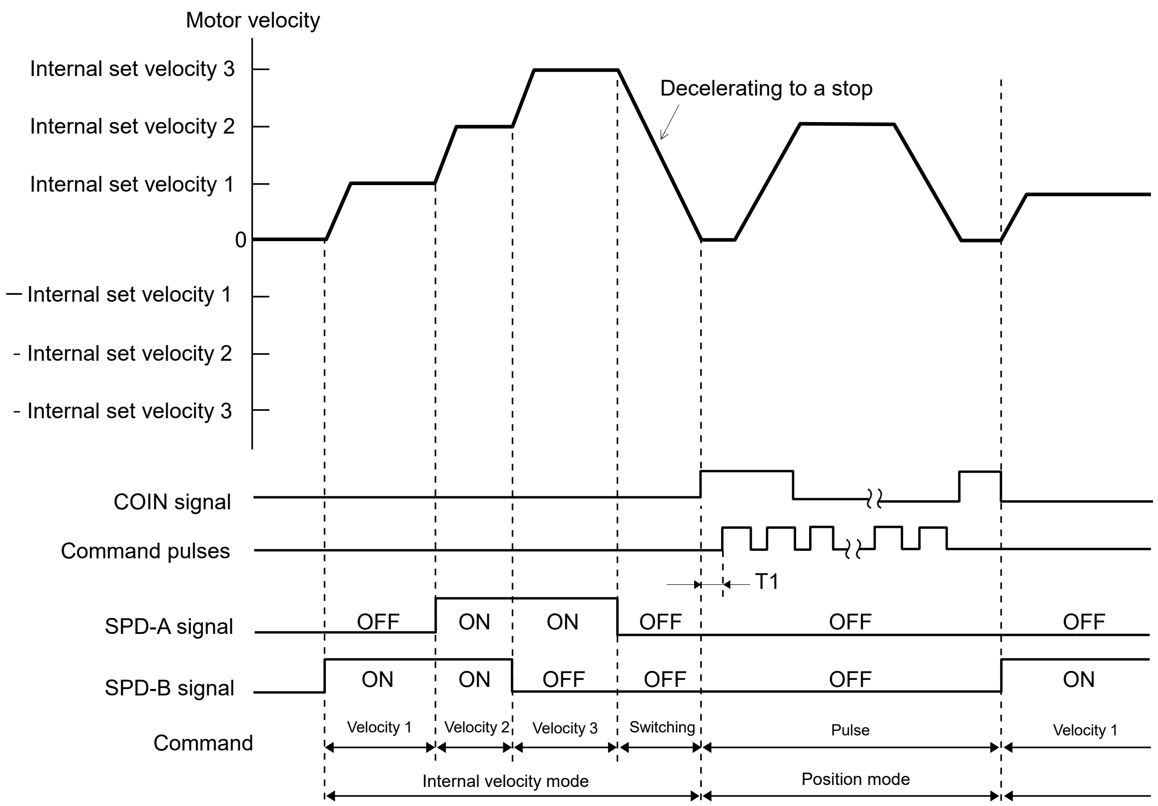


Figure8.9.1.1

Note:

(1) When controller is used, T1 must be greater than 2 ms. Soft start function does not affect the value of T1.

(2) A maximum 2 ms delay may occur for the switching of SPD-A and SPD-B signals.

(3) While switching from internal velocity mode to position mode, Pt306 (Soft start deceleration time) is applied to decelerate the motor to a stop. Then the control mode is switched to position mode. The servo drive accepts pulse command after the control mode is switched to position mode. Pulse command must be input after the control mode is switched. Positioning completion output (COIN) signal is output after the control mode is switched to position mode. Use COIN signal to check if the control mode is switched to position mode.

8.10 Torque limit function

E1 series servo drive provides four methods to limit output torque.

Table8.10.1

Torque Limiting Method	Description	Control Mode
Internal torque limit	The torque is limited by parameter.	All control modes
External torque limit	The torque is limited by input signal.	
Limiting torque with analog command	The torque is limited by analog command.	Position mode, velocity mode, internal position mode and internal velocity mode
Limiting torque with external torque limit and analog command	The torque is limited by external torque limit and analog command.	

Different wiring may be required for different torque limiting method. Select torque limiting method by Pt002 = t.□□□X.

Note:

The actual torque is limited to the maximum rated torque when the setting value exceeds the maximum rated torque.

Table8.10.2

Type	Signal	Default Signal	CN6 Pin	Description
Input	T-REF+	-	16	T-REF signal is used as torque limit.
	T-REF-	-	17	
	P-CL	I6	26	Forward external torque limit input (P-CL) signal is used as external torque limit.
	N-CL	I7	32	Reverse external torque limit input (N-CL) signal is used as external torque limit.

8.10.1 Internal torque limit

The internal torque limit of rotary servo motor is set by Pt402 (Forward torque limit) and Pt403 (Reverse torque limit) to limit the maximum output torque. The internal force limit of linear servo motor is set by Pt483 (Forward force limit value for internal force limit (linear servo motor)) and Pt484 (Reverse force limit value for internal force limit (linear servo motor)) to limit the maximum output force.

Note:
Additional wiring is not required for internal torque limit.

Table8.10.1.1

Parameter	Pt402	Range	0~800	Control Mode	Position mode, velocity mode and torque mode
Default	800	Effective	Immediately	Unit	1%*
Description					
Internal torque limit (rotary servo motor)-torque limit value for forward direction					

Table8.10.1.2

Parameter	Pt403	Range	0~800	Control Mode	Position mode, velocity mode and torque mode
Default	800	Effective	Immediately	Unit	1%*
Description					
Internal torque limit (rotary servo motor)-torque limit value for reverse direction					

Note:
(1) If Pt402 or Pt403 is too small, the torque could be insufficient for acceleration or deceleration.
(2) *The percentage of rated torque

Table8.10.1.3

Parameter	Pt483	Range	0~800	Control Mode	Position mode, velocity mode and torque mode
Default	30	Effective	Immediately	Unit	1%*
Description					
Internal force limit (linear servo motor)-force limit value for forward direction					

Table8.10.1.4

Parameter	Pt484	Range	0~800	Control Mode	Position mode, velocity mode and torque mode
Default	30	Effective	Immediately	Unit	1%*
Description					
Internal force limit (linear servo motor)-force limit value for reverse direction					

Note:

(1) If Pt483 or Pt484 is too small, the force could be insufficient for acceleration or deceleration.

(2) *The percentage of rated force

8.10.2 External torque limit

When external toque limit is used, the toque is limited by forward external torque limit input (P-CL) signal and reverse external torque limit input (N-CL) signal. After P-CL and N-CL signals are input, the smaller value of external torque limit and internal torque limit will be the torque limit value.

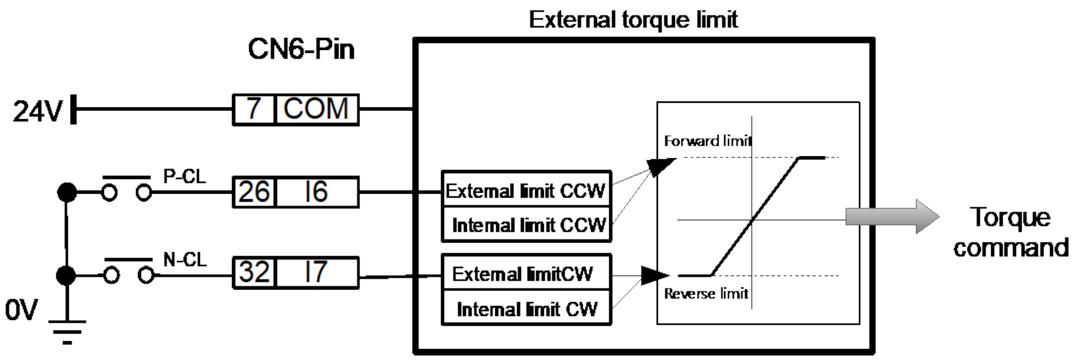


Figure8.10.2.1

The default pins for P-CL and N-CL signals are listed in table 8.10.2.1. If users would like to reallocate the signals, please set by Pt50B = t.□□X□ and t.□X□□.

Table8.10.2.1

Type	Signal	Hardware Pin	Status	Description
Input	P-CL	CN6-26 (Default)	ON	When P-CL signal is ON, the smaller value of Pt402 and Pt404 will be used as the torque limit value.
			OFF	When P-CL signal is OFF, the value of Pt402 will be used as the torque limit value.
	N-CL	CN6-32 (Default)	ON	When N-CL signal is ON, the smaller value of Pt403 and Pt405 will be used as the torque limit value.
			OFF	When N-CL signal is OFF, the value of Pt403 will be used as the torque limit value.

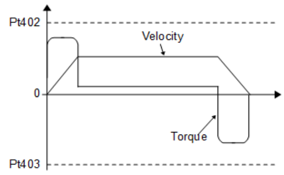
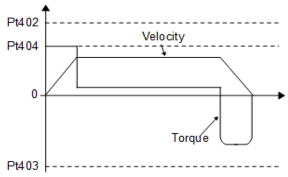
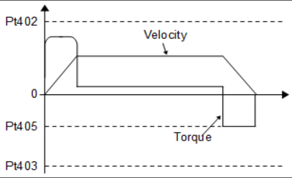
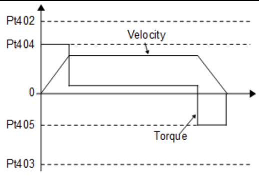
■ Output torque variation of external torque limit

The default setting of internal torque limit is 800% of rated torque.

(1) Rotary servo motor

In the example given in table 8.10.2.2, Pt000 is set to t.□□□0 (CCW is the forward direction.).

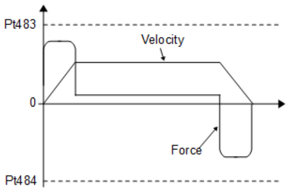
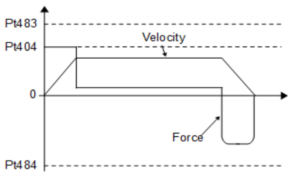
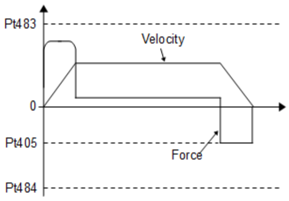
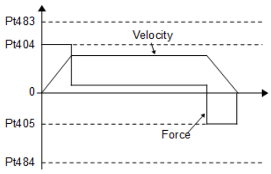
Table8.10.2.2

Status		P-CL Signal	
		OFF	ON
N-CL Signal	OFF		
	ON		

(2) Linear servo motor

In the example given in table 8.10.2.3, Pt000 is set to t.□□□0 (The direction where the linear encoder counts up is the forward direction.).

Table8.10.2.3

Status		P-CL Signal	
		OFF	ON
N-CL Signal	OFF		
	ON		

■ Related parameters

(1) Rotary servo motor

If Pt402, Pt403, Pt404 or Pt405 is too small, the torque could be insufficient for acceleration or deceleration.

Table8.10.2.4

Parameter	Pt402	Range	0~800	Control Mode	Position mode, velocity mode and torque mode
Default	800	Effective	Immediately	Unit	1%*
Description					
Internal torque limit-torque limit value for forward direction					

Table8.10.2.5

Parameter	Pt403	Range	0~800	Control Mode	Position mode, velocity mode and torque mode
Default	800	Effective	Immediately	Unit	1%*
Description					
Internal torque limit-torque limit value for reverse direction					

Table8.10.2.6

Parameter	Pt404	Range	0~800	Control Mode	Position mode, velocity mode and torque mode
Default	100	Effective	Immediately	Unit	1%*
Description					
External torque (force) limit-torque limit value for forward direction					

Table8.10.2.7

Parameter	Pt405	Range	0~800	Control Mode	Position mode, velocity mode and torque mode
Default	100	Effective	Immediately	Unit	1%*
Description					
External torque (force) limit-torque limit value for reverse direction					

Note:

*The percentage of rated torque

(2) Linear servo motor

If Pt483, Pt484, Pt404 or Pt405 is too small, the force could be insufficient for acceleration and deceleration.

Table 8.10.2.8

Parameter	Pt483	Range	0~800	Control Mode	Position mode, velocity mode and torque mode
Default	30	Effective	Immediately	Unit	1%*
Description					
Internal force limit-force limit value for forward direction (linear servo motor)					

Table8.10.2.9

Parameter	Pt484	Range	0~800	Control Mode	Position mode, velocity mode and torque mode
Default	30	Effective	Immediately	Unit	1%*
Description					
Internal force limit-force limit value for reverse direction (linear servo motor)					

Table8.10.2.10

Parameter	Pt404	Range	0~800	Control Mode	Position mode, velocity mode and torque mode
Default	100	Effective	Immediately	Unit	1%*
Description					
External torque (force) limit-torque limit value for forward direction					

Table8.10.2.11

Parameter	Pt405	Range	0~800	Control Mode	Position mode, velocity mode and torque mode
Default	100	Effective	Immediately	Unit	1%*
Description					
External torque (force) limit-torque limit value for reverse direction					

Note:

*The percentage of rated force

8.10.3 Limiting torque with analog command

While limiting torque with analog command, the servo drive compares T-REF signals with the setting values of internal torque limits (Pt402 and Pt403). The smaller value will be used as torque limit value.

Note:
While using linear servo motor, the internal torque limits are set by Pt483 and Pt484.

- Rotary servo motor

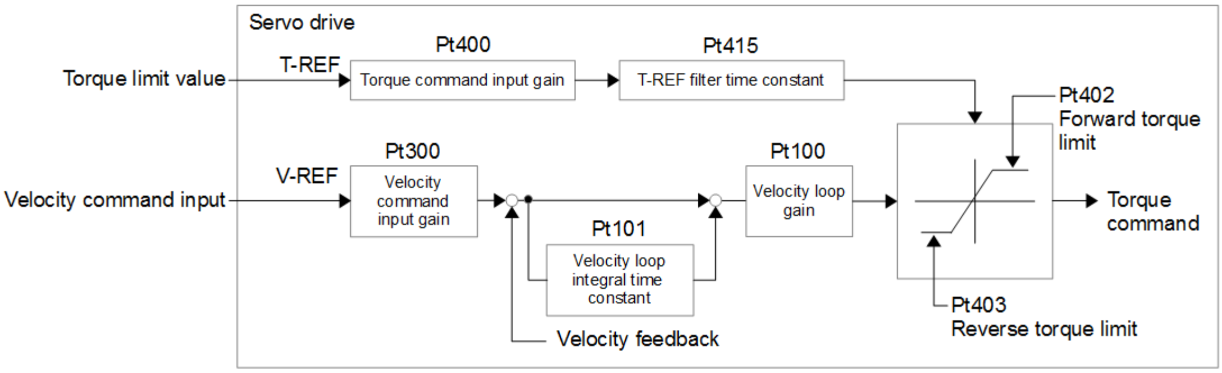


Figure8.10.3.1

- Linear servo motor

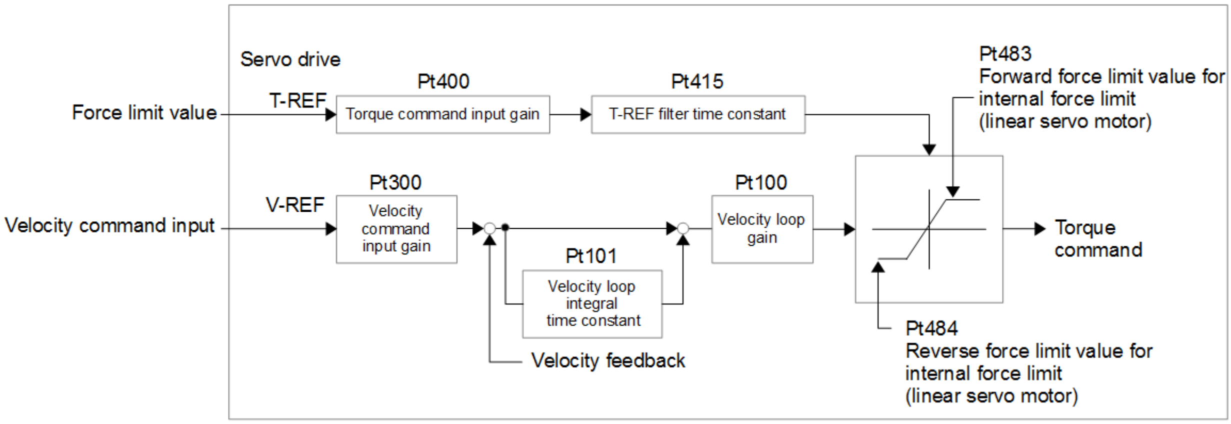


Figure8.10.3.2

Torque command input (T-REF) signal

The input signal used to limit toque with analog command is described as below.

- Limiting toque with analog command

  Set Pt002 to t.□□□1. T-REF+ and T-REF- signals are used as input signals for torque limit.

Table8.10.3.1

Parameter		Description	Effective	Category
Pt002	t.□□□1	Use T-REF signals as torque limit.	After power on	Setup

- Related parameters

Table8.10.3.2

Parameter	Pt400	Range	10~100	Control Mode	Position mode, velocity mode and torque mode
Default	30	Effective	Immediately	Unit	0.1 V
Description					
Set torque command input gain.					

Table8.10.3.3

Parameter	Pt402	Range	0~800	Control Mode	Position mode, velocity mode and torque mode
Default	800	Effective	Immediately	Unit	1%*
Description					
Internal torque limit-torque limit value for forward direction					

Table8.10.3.4

Parameter	Pt403	Range	0~800	Control Mode	Position mode, velocity mode and torque mode
Default	800	Effective	Immediately	Unit	1%*
Description					
Internal torque limit-torque limit value for reverse direction					

Table8.10.3.5

Parameter	Pt415	Range	0~65535	Control Mode	Position mode, velocity mode and torque mode
Default	0	Effective	Immediately	Unit	0.01 ms
Description					
Set T-REF filter time constant.					

Note: *The percentage of rated torque

8.10.4 Limiting torque with external torque limit and analog command

The external input signals (P-CL and N-CL signals) and analog command (T-REF+ and T-REF- signals) can be used for limiting torque at the same time. When forward external torque limit input (P-CL) signal or reverse external torque limit input (N-CL) signal is ON, the smallest value of internal torque limit, external toque limit and analog command is used as torque limit value. When P-CL or N-CL signal is OFF, only internal torque limit will be used.

Note:
While limiting torque with analog command, the analog command is input via the pins for torque command input signals, so this function cannot be used in torque mode.

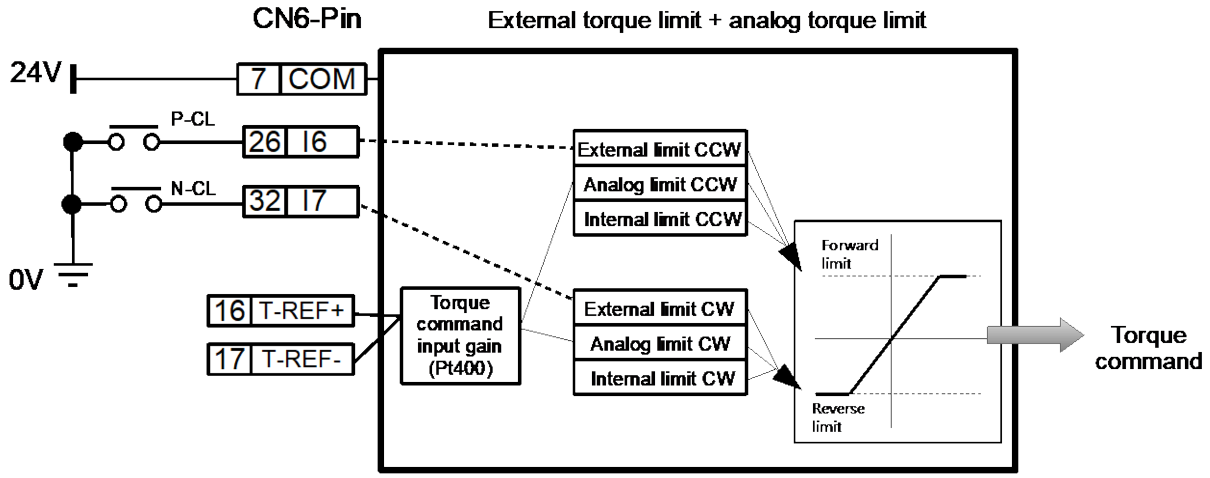


Figure8.10.4.1

Forward external torque limit input (P-CL) signal, reverse external torque limit input (N-CL) signal and analog command (T-REF+ and T-REF- signals) are described as below.

- Analog command (T-REF+ and T-REF- signals)

Table8.10.4.1

Type	Signal	CN6 Pin	Description
Input	T-REF+	16	Torque command input
	T-REF-	17	Signal grounding of torque command input

■ External torque limit

External torque limit is enabled by forward external torque limit input (P-CL) signal and reverse external torque limit input (N-CL) signal. P-CL and N-CL signals can be reallocated to other input pins by Pt50B = t.□□X□ and t.□X□□.

(1) Rotary servo motor

Table8.10.4.2

Type	Signal	Hardware Pin	Status	Description
Input	P-CL	CN6-26 (Default)	ON	When P-CL signal is ON, the smallest value of analog command, Pt402 and Pt404 will be used as the torque limit value.
			OFF	When P-CL signal is OFF, the value of Pt402 will be used as the torque limit value.
	N-CL	CN6-32 (Default)	ON	When N-CL signal is ON, the smallest value of analog command, Pt403 and Pt405 will be used as the torque limit value.
			OFF	When N-CL signal is OFF, the value of Pt403 will be used as the torque limit value.

(2) Linear servo motor

Table8.10.4.3

Type	Signal	Hardware Pin	Status	Description
Input	P-CL	CN6-26 (Default)	ON	When P-CL signal is ON, the smallest value of analog command, Pt483 and Pt404 will be used as the torque limit value.
			OFF	When P-CL signal is OFF, the value of Pt483 will be used as the torque limit value.
	N-CL	CN6-32 (Default)	ON	When N-CL signal is ON, the smallest value of analog command, Pt484 and Pt405 will be used as the torque limit value.
			OFF	When N-CL signal is OFF, the value of Pt484 will be used as the torque limit value.

■ Limiting torque with external torque limit and analog command

Set Pt002 to t.□□□3. When P-CL or N-CL signal is ON, T-REF signal is used as torque limit.

Table8.10.4.4

Parameter		Description	Effective	Category
Pt002	t.□□□3	When P-CL or N-CL signal is ON, T-REF signal is used as torque limit.	After power on	Setup

■ Related parameters

The parameters used for limiting torque with external torque limit and analog command are as below. To disable internal torque limit, set Pt402, Pt403, Pt483 and Pt484 to their maximum values.

Table8.10.4.5

Parameter	Pt400	Range	10~100	Control Mode	Position mode, velocity mode and torque mode
Default	30	Effective	Immediately	Unit	0.1 V
Description					
Set torque (force) command input gain.					

Table8.10.4.6

Parameter	Pt402	Range	0~800	Control Mode	Position mode, velocity mode and torque mode
Default	800	Effective	Immediately	Unit	1%*
Description					
Internal torque limit-torque limit value for forward direction					

Table8.10.4.7

Parameter	Pt403	Range	0~800	Control Mode	Position mode, velocity mode and torque mode
Default	800	Effective	Immediately	Unit	1%*
Description					
Internal torque limit-torque limit value for reverse direction					

Table8.10.4.8

Parameter	Pt404	Range	0~800	Control Mode	Position mode, velocity mode and torque mode
Default	100	Effective	Immediately	Unit	1%*
Description					
External torque limit-torque (force) limit value for forward direction					

Table8.10.4.9

Parameter	Pt405	Range	0~800	Control Mode	Position mode, velocity mode and torque mode
Default	100	Effective	Immediately	Unit	1%*
Description					
External torque limit-torque (force) limit value for reverse direction					

Table8.10.4.10

Parameter	Pt415	Range	0~65535	Control Mode	Position mode, velocity mode and torque mode
Default	0	Effective	Immediately	Unit	0.01 ms
Description					
Set T-REF filter time constant.					

Table8.10.4.11

Parameter	Pt483	Range	0~800	Control Mode	Position mode, velocity mode and torque mode
Default	30	Effective	Immediately	Unit	1%*
Description					
Internal force limit-force limit value for forward direction (linear servo motor)					

Table8.10.4.12

Parameter	Pt484	Range	0~800	Control Mode	Position mode, velocity mode and torque mode
Default	30	Effective	Immediately	Unit	1%*
Description					
Internal force limit-force limit value for reverse direction (linear servo motor)					

Note:
*The percentage of rated torque (force)

8.10.5 Torque limit detection output (CLT) signal

When motor torque is limited, no matter what torque limiting method is used, the servo drive outputs torque limit detection output (CLT) signal.

Table8.10.5.1

Type	Signal	Hardware Pin	Status	Description
Output	CLT	User-defined	ON	The motor torque is limited.
			OFF	The motor torque is not limited.

Allocate CLT signal to the desired pins by Pt515 = t.□X□□, refer to section 8.1.2.

8.11 Internal homing

The purpose of homing is to find the user-defined absolute coordinates on a mechanism. Normally, homing is done by controller, but it can also be done by the internal homing procedure of the servo drive. The internal homing procedure will do motion planning for the motor in order to find the absolute coordinates. In addition to the internal homing procedures in accordance with the design principle of CiA402, the servo drive also provides several homing procedures defined by HIWIN. The internal homing procedures can only be used in internal position mode or position mode.

8.11.1 Setting internal homing

Allocate required input or output signals to the hardware pins according to the homing method in use. For connecting to controller while using internal homing procedure, please refer to below.

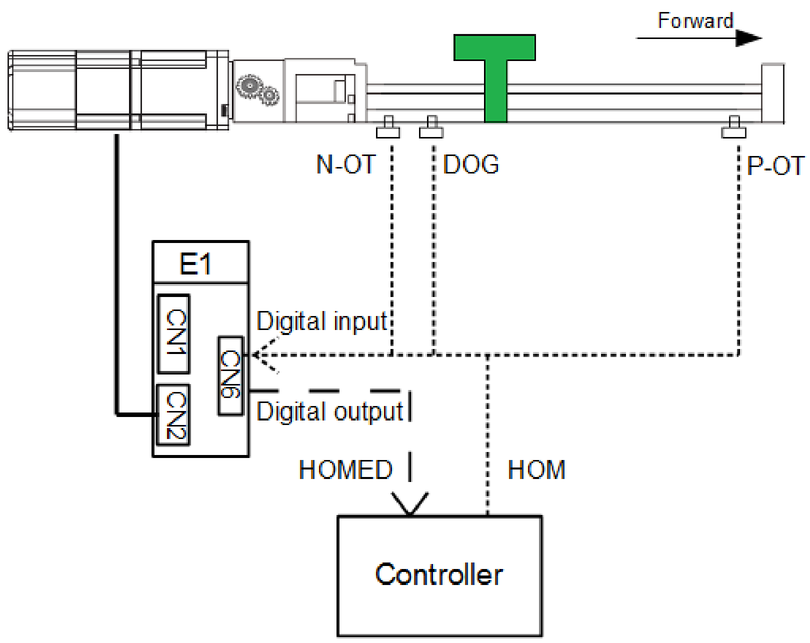


Figure8.11.1.1 Connecting to controller while using internal homing procedure

- Explanation of term
  (1) The reference point of Z-phase signal: During homing, the motor moves at fast homing velocity to search for the reference point of Z-phase signal. The reference point of Z-phase signal can be reverse prohibition input (N-OT) signal, forward prohibition input (P-OT) signal, near home sensor input (DOG) signal (Home switch) or hard stop.

(2) Home offset: Home offset is used to adjust the position after homing completes. Two offset methods are supported.

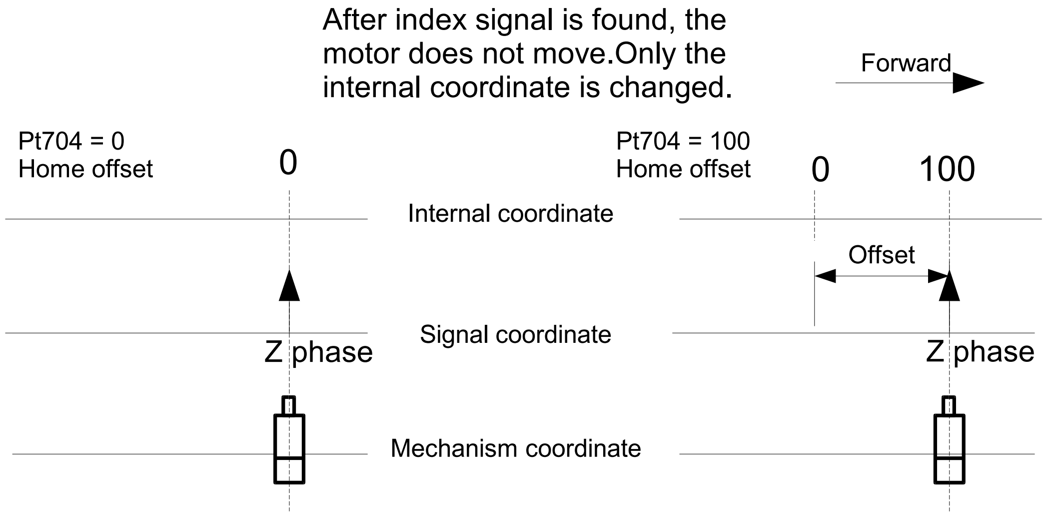


Figure8.11.1.2 Description of home offset

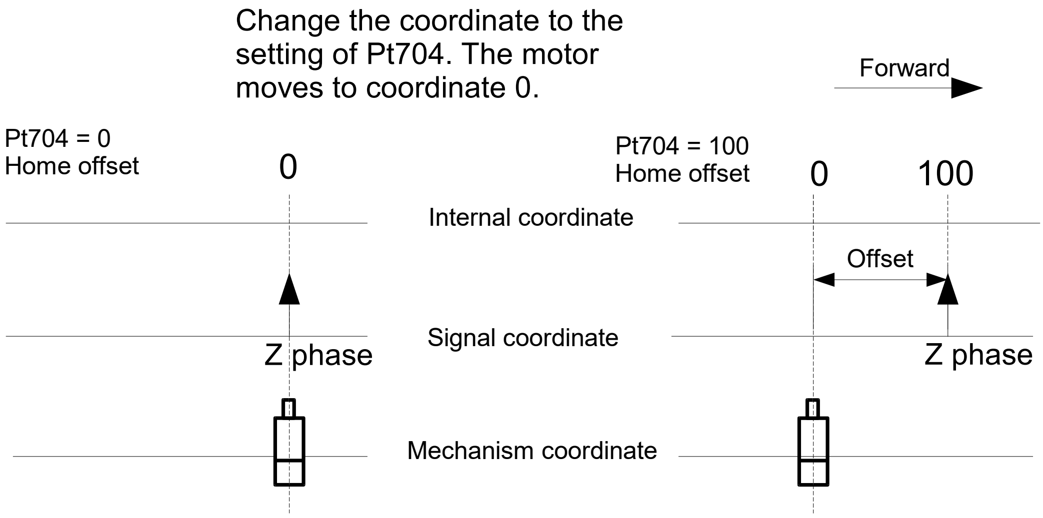


Figure8.11.1.3 Description of home offset

Table8.11.1.1

Parameter		Description	Effective	Category
Pt70A	t.□□0□ (Default)	After index signal is found during homing procedure, the current position will be set as Pt704.	After power on	Setup
	t.□□1□	After index signal is found during homing procedure, the current position will be set as Pt704 and the motor will be moved to 0.		

Note:

Pt70A = t. □□1□ does not support Pt700=-3. When Pt700=-3, the current position will be set as 0 during homing procedure.

Table8.11.1.2

Parameter	Description	Default	Range	Unit
Pt700	Set homing method. The servo drive supports several homing methods, but some of the homing methods may not be available due to motor type or machine condition.	1	-6~37	The number of homing method
Pt701	Set the velocity for finding near home sensor (rotary servo motor). The applicable rotary servo motors are servo motor and direct drive motor. Search for the reference point of Z-phase signal at fast homing velocity.	20	0~3000	1 rpm
Pt705	Set the velocity for finding near home sensor (linear servo motor). Search for the reference point of Z-phase signal at fast homing velocity.	10	0~1000	1 mm/s
Pt702	Set the velocity for finding home position (rotary servo motor). The applicable rotary servo motors are servo motor and direct drive motor. Search for the reference point of Z-phase signal at slow homing velocity.	6	0~3000	1 rpm
Pt706	Set the velocity for finding home position (linear servo motor) Search for Z-phase signal at slow homing velocity.	3	0~1000	1 mm/s
Pt703	Set the time limit for homing procedure. If the time of performing homing procedure exceeds the time limit, it will be regarded as homing failure and homing procedure will be stopped.	50	0~300	Second
Pt704	Set home offset. Adjust the position after homing completes.	0	-1073741824~1073741824	Control unit
Pt707	Homing acceleration time	100	2~10000	ms
Pt708	Homing deceleration time	100	2~10000	ms
Pt709	Homing emergency deceleration time	10	2~1000	ms
Pt70C	Homing position command acceleration/deceleration time constant	0	0~16384	0.25 ms
Pt70D	Homing average position command movement time	0	0~1000	0.25 ms
Pt70E	Index tolerance Note: This parameter can only be used on single-turn absolute encoder and multi-turn absolute encoder. Pt700 must be set to 33 or 34.	0	0~1073741824	Control unit

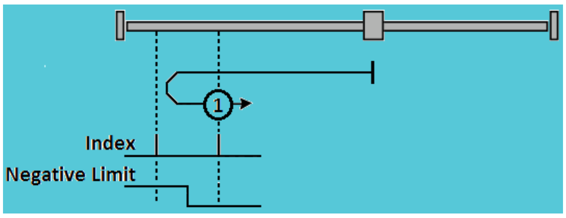
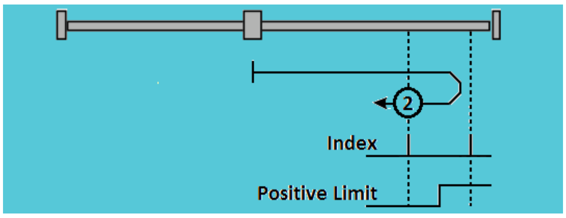
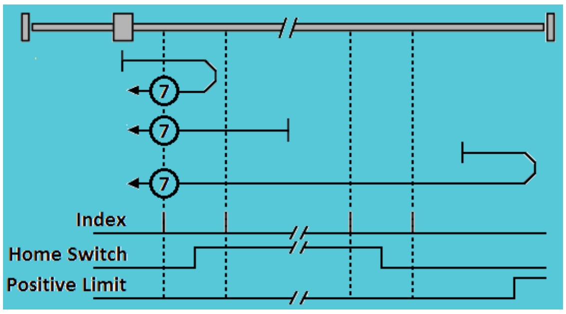
⚠CAUTION

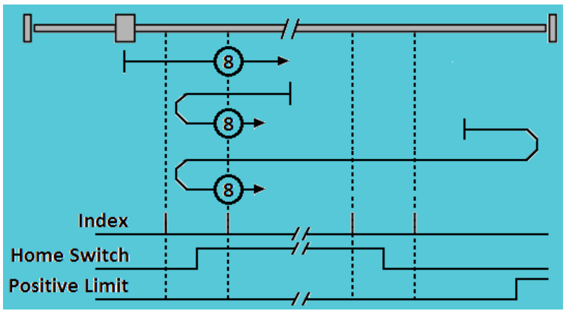
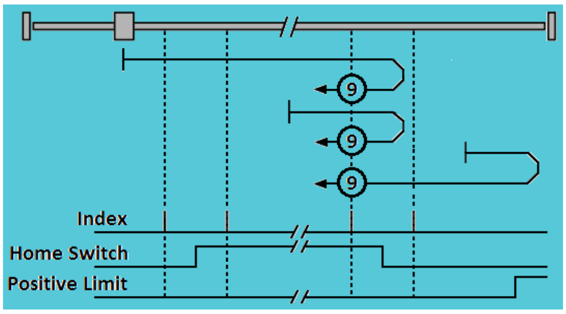
◆ Before executing homing prcedure, please make sure the motor positioning can be completed. Otherwise, the homing prcedure may fail due to exceeding time limit.
(Note: possible causes for the positioning failure 1. Inappropriate setting of positioning completion width(Pt522) 2. Low servo stiffness. Please refer to section 8.4.4)

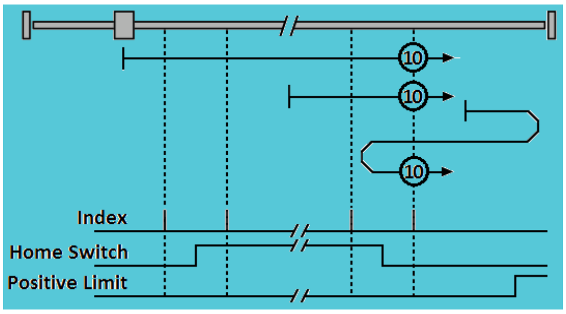
8.11.2 Internal homing methods

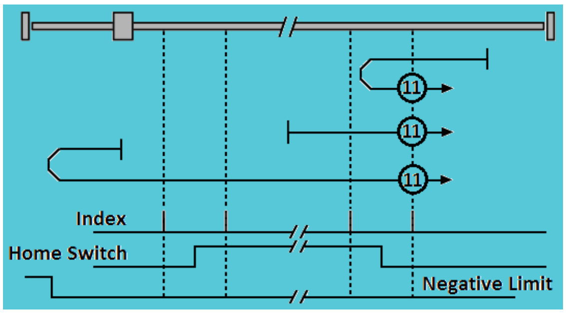
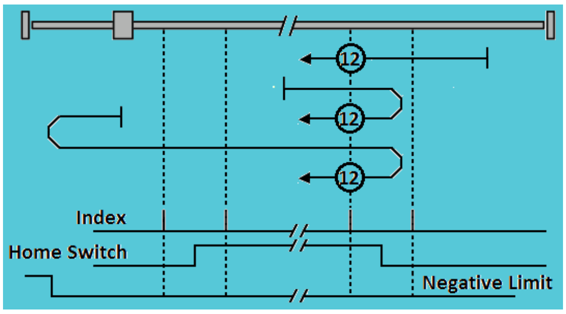
To complete homing, the servo drive may need to detect multiple signals during the process. (For example, when homing method Pt700=7 is used, P-OT signal, DOG signal and index signal must be detected.) When a signal is detected, motor decelerates to a stop according to the setting of Pt709. The next signal will not be detected until the motor stops.

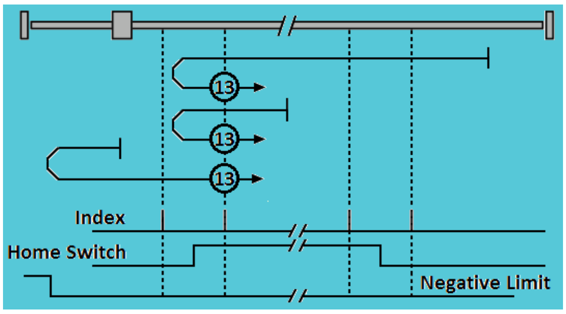
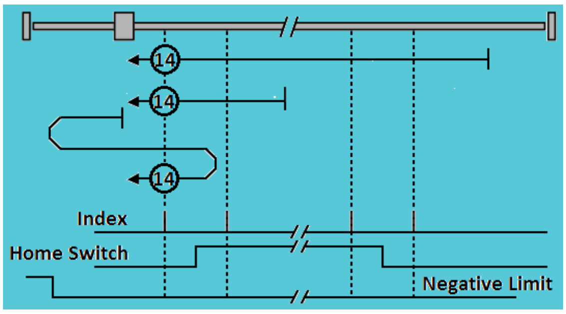
The signal detection will not work during the deceleration, which may result in fault of homing.

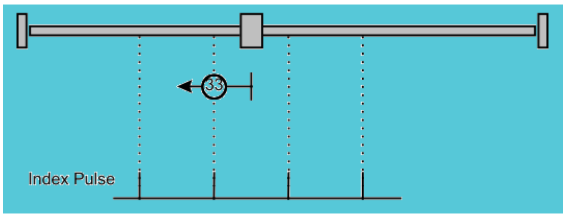
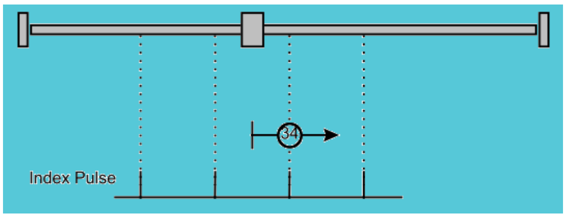
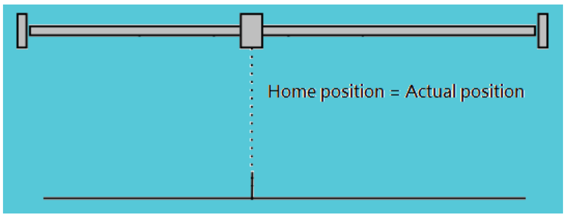
Parameter Setting	Description	Figure
Pt700=1	Homing with the index signal on the right of N-OT signal from negative direction. Search for N-OT signal in negative direction at the velocity for finding near home sensor (rotary servo motor) (Pt701). After N-OT signal is found, search for the index signal in positive direction at the velocity for finding home position (rotary servo motor) (Pt702).	
Pt700=2	Homing with the index signal on the left of P-OT signal from positive direction. Search for P-OT signal in positive direction at the velocity for finding near home sensor (rotary servo motor) (Pt701). After P-OT signal is found, search for the index signal in negative direction at the velocity for finding home position (rotary servo motor) (Pt702).	
Pt700=7	Homing with the index signal on the left of DOG signal. (1) Outside DOG signal: Search for the rising edge of DOG signal in positive direction at the velocity for finding near home sensor (rotary servo motor) (Pt701). After the rising edge of DOG signal is found, search for the index signal on the left of DOG signal in negative direction at the velocity for finding home position (rotary servo motor) (Pt702). (2) Inside DOG signal: Search for the falling edge of DOG signal in negative direction at the velocity for finding near home sensor (rotary servo motor) (Pt701). After the falling edge of DOG signal is found, search for the index signal on the left of DOG signal in negative direction at the velocity for finding home position (rotary servo motor) (Pt702).	

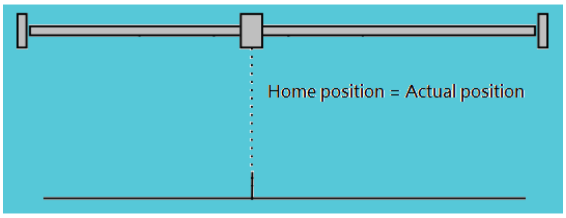
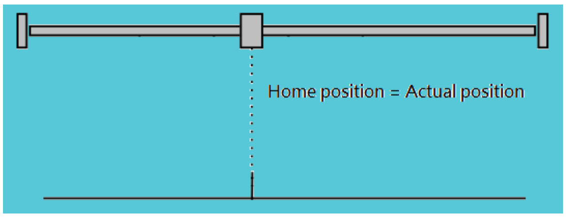
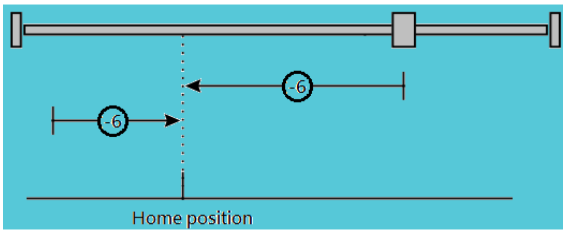
Parameter Setting	Description	Figure
	(3) Outside DOG signal: Search for P-OT signal in positive direction at the velocity for finding near home sensor (rotary servo motor) (Pt701). After P-OT signal is found, search for the index signal on the left of DOG signal in negative direction at the velocity for finding home position (rotary servo motor) (Pt702).	
Pt700=8	Homing with the index signal on the right of DOG signal. (1) Outside DOG signal: Search for the rising edge of DOG signal in positive direction at the velocity for finding near home sensor (rotary servo motor) (Pt701). After the rising edge of DOG signal is found, search for the index signal on the right of DOG signal in positive direction at the velocity for finding home position (rotary servo motor) (Pt702). (2) Inside DOG signal: Search for the falling edge of DOG signal in negative direction at the velocity for finding near home sensor (rotary servo motor) (Pt701). After the falling edge of DOG signal is found, search for the index signal on the right of DOG signal in positive direction at the velocity for finding home position (rotary servo motor) (Pt702). (3) Outside DOG signal: Search for P-OT signal in positive direction at the velocity for finding near home sensor (rotary servo motor) (Pt701). After P-OT signal is found, search for the falling edge of DOG signal in negative direction. After the falling edge of DOG signal is found, search for the index signal on the right of DOG signal in positive direction at the velocity for finding home position (rotary servo motor) (Pt702).	
Pt700=9	Homing with the index signal on the left of the falling edge of DOG signal from positive direction. (1) Outside DOG signal: Search for the falling edge of DOG signal in positive direction at the velocity for finding near home sensor (rotary servo motor) (Pt701). After the falling edge of DOG signal is found, search for the index signal on the left of DOG signal in negative direction at the velocity for finding home position (rotary servo motor) (Pt702). (2) Inside DOG signal: Search for the falling edge of DOG signal	

Parameter Setting	Description	Figure
	in positive direction at the velocity for finding near home sensor (rotary servo motor) (Pt701). After the falling edge of DOG signal is found, search for the index signal on the left of DOG signal in negative direction at the velocity for finding home position (rotary servo motor) (Pt702). (3) Outside DOG signal: Search for P-OT signal in positive direction at the velocity for finding near home sensor (rotary servo motor) (Pt701). After P-OT signal is found, search for the rising edge of DOG signal in negative direction. After the rising edge of DOG signal is found, search for the index signal on the left of DOG signal in negative direction at the velocity for finding home position (rotary servo motor) (Pt702).	
Pt700=10	Homing with the index signal on the right of the falling edge of DOG signal from positive direction. (1) Outside DOG signal: Search for the falling edge of DOG signal in positive direction at the velocity for finding near home sensor (rotary servo motor) (Pt701). After the falling edge of DOG signal is found, search for the index signal on the right of DOG signal in positive direction at the velocity for finding home position (rotary servo motor) (Pt702). (2) Inside DOG signal: Search for the falling edge of DOG signal in positive direction at the velocity for finding near home sensor (rotary servo motor) (Pt701). After the falling edge of DOG signal is found, search for the index signal on the right of DOG signal in positive direction at the velocity for finding home position (rotary servo motor) (Pt702). (3) Outside DOG signal: Search for P-OT signal in positive direction at the velocity for finding near home sensor (rotary servo motor) (Pt701). After P-OT signal is found, search for the rising edge of DOG signal in negative direction. After the rising edge of DOG signal is found, search for the index signal on the right of DOG signal in positive direction at the velocity for finding home position (rotary servo motor) (Pt702).	

Parameter Setting	Description	Figure
Pt700=11	Homing with the index signal on the right of the rising edge of DOG signal from negative direction. (1) Outside DOG signal: Search for the rising edge of DOG signal in negative direction at the velocity for finding near home sensor (rotary servo motor) (Pt701). After the rising edge of DOG signal is found, search for the index signal on the right of DOG signal in positive direction at the velocity for finding home position (rotary servo motor) (Pt702). (2) Inside DOG signal: Search for the falling edge of DOG signal in positive direction at the velocity for finding near home sensor (rotary servo motor) (Pt701). After the falling edge of DOG signal is found, search for the index signal on the right of DOG signal in positive direction at the velocity for finding home position (rotary servo motor) (Pt702). (3) Outside DOG signal: Search for N-OT signal in negative direction at the velocity for finding near home sensor (rotary servo motor) (Pt701). After N-OT signal is found, search for the falling edge of DOG signal in positive direction. After the falling edge of DOG signal is found, search for the index signal on the right of DOG signal in positive direction at the velocity for finding home position (rotary servo motor) (Pt702).	
Pt700=12	Homing with the index signal on the left of the rising edge of DOG signal from negative direction. (1) Outside DOG signal: Search for the rising edge of DOG signal in negative direction at the velocity for finding near home sensor (rotary servo motor) (Pt701). After the rising edge of DOG signal is found, search for the index signal on the left of DOG signal in negative direction at the velocity for finding home position (rotary servo motor) (Pt702). (2) Inside DOG signal: Search for the falling edge of DOG signal in positive direction at the velocity for finding near home sensor (rotary servo motor) (Pt701). After the falling edge of DOG signal is found, search for the index signal on the left of DOG signal in negative direction at the velocity for finding home position (rotary servo motor) (Pt702).	

Parameter Setting	Description	Figure
	(3) Outside DOG signal: Search for N-OT signal in negative direction at the velocity for finding near home sensor (rotary servo motor) (Pt701). After N-OT signal is found, search for the falling edge of DOG signal in positive direction. After the falling edge of DOG signal is found, search for the index signal on the left of DOG signal in negative direction at the velocity for finding home position (rotary servo motor) (Pt702).	
Pt700=13	Homing with the index signal on the right of the falling edge of DOG signal from negative direction. (1) Outside DOG signal: Search for the falling edge of DOG signal in negative direction at the velocity for finding near home sensor (rotary servo motor) (Pt701). After the falling edge of DOG signal is found, search for the index signal on the right of DOG signal in positive direction at the velocity for finding home position (rotary servo motor) (Pt702). (2) Inside DOG signal: Search for the falling edge of DOG signal in negative direction at the velocity for finding near home sensor (rotary servo motor) (Pt701). After the falling edge of DOG signal is found, search for the index signal on the right of DOG signal in positive direction at the velocity for finding home position (rotary servo motor) (Pt702). (3) Outside DOG signal: Search for N-OT signal in negative direction at the velocity for finding near home sensor (rotary servo motor) (Pt701). After N-OT signal is found, search for the rising edge of DOG signal in positive direction. After the rising edge of DOG signal is found, search for the index signal on the right of DOG signal in positive direction at the velocity for finding home position (rotary servo motor) (Pt702).	
Pt700=14	Homing with the index signal on the left of the falling edge of DOG signal from negative direction. (1) Outside DOG signal: Search for the falling edge of DOG signal in negative direction at the velocity for finding near home sensor (rotary servo motor) (Pt701). After the falling edge of DOG signal is found, search for the index signal on the left of DOG signal in negative direction at the velocity for	

Parameter Setting	Description	Figure
	finding home position (rotary servo motor) (Pt702). (2) Inside DOG signal: Search for the falling edge of DOG signal in negative direction at the velocity for finding near home sensor (rotary servo motor) (Pt701). After the falling edge of DOG signal is found, search for the index signal on the left of DOG signal in negative direction at the velocity for finding home position (rotary servo motor) (Pt702). (3) Outside DOG signal: Search for N-OT signal in negative direction at the velocity for finding near home sensor (rotary servo motor) (Pt701). After N-OT signal is found, search for the rising edge of DOG signal in positive direction. After the rising edge of DOG signal is found, search for the index signal on the left of DOG signal in negative direction at the velocity for finding home position (rotary servo motor) (Pt702).	
Pt700=33	Homing with index signal from negative direction. Search for index signal in negative direction at the velocity for finding home position (rotary servo motor) (Pt702).	
Pt700=34	Homing with index signal from positive direction. Search for index signal in positive direction at the velocity for finding home position (rotary servo motor) (Pt702).	
Pt700=35	Homing with current position. The current position of the motor is regarded as home position. (This homing method is the same as homing method 37, but it is for EtherCAT controller which does not support CiA 402 homing method.)	

Parameter Setting	Description	Figure
Pt700=37	Homing with current position. The current position of the motor is regarded as home position.	
Pt700=-3	Homing with current position. The current position of the motor is regarded as new index. This homing method is suitable for application using multi-turn absolute encoder. After the setting is done, this position will be used as index when other homing methods are used. Note: If Pt002 = t.□X□□ is not correctly set, homing could fail.	
Pt700=-6	Homing with home position. Move the motor to the home position set by homing method -3 at the velocity for finding near home sensor (rotary servo motor) (Pt701). This homing method is suitable for application using multi-turn absolute encoder. Note: If Pt002 = t.□X□□ is not correctly set, homing could fail.	

8.11.3 Using internal homing procedure with controller

The internal homing procedure is used to assist controller in finding the absolute coordinates on a mechanism. The controller only needs to trigger the internal homing procedure by inputting servo drive built-in homing procedure input (HOM) signal.

After the homing procedure completes, servo drive homing completion output (HOMED) signal is output. Then the controller can proceed to the next motion planning. If the internal homing procedure fails or exceeds the time limit, it is regarded as homing failure, please check the velocity setting of the motor or the sensor for external input signal.

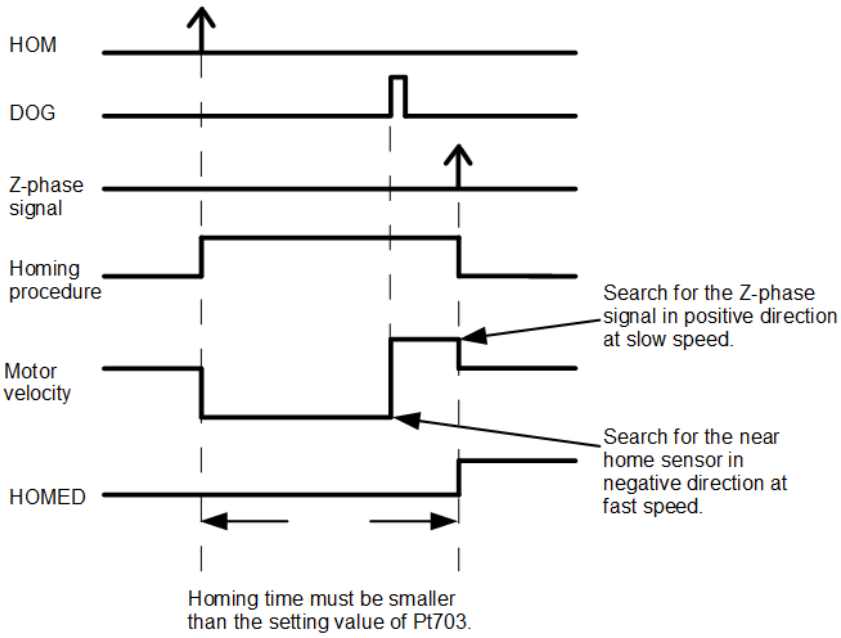


Figure8.11.3.1 Timing diagram while using the internal procedure with controller

Note:

If the internal homing procedure fails, the servo drive does not output servo drive homing completion output (HOMED) signal. Controller must have a timer to measure the execution time of the internal homing procedure. If the execution time is too long, it is regarded as homing failure.

Table8.11.3.1

Type	Signal	Hardware Pin	Status	Description
Input	HOM	CN6-31 (Default)	Edge-triggered	Enable the internal homing procedure.

Table8.11.3.2

Type	Signal	Hardware Pin	Status	Description
Output	HOMED	User-defined	ON	Homing completes.
			OFF	Homing does not complete.

8.12 Error map

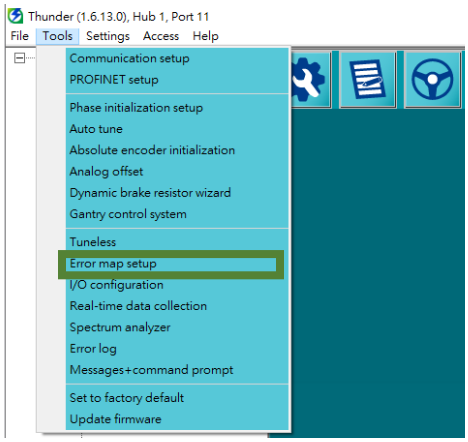
The accuracy of positioning platform usually depends on the encoder in use. The accuracy is measured by laser interferometer and an error map table can be obtained afterwards. E1 series servo drive provides error map function for users to save error map table to the servo drive flash via Thunder. The servo drive calculates compensation values between fixed intervals by linear interpolation to increase positioning accuracy.

After the errors between fixed intervals are known, set interval and total points and input the errors into the error map table.

Note:
The error map function can only be enabled after homing completes, since the error map function starts from home position and compensates the errors in positive direction.

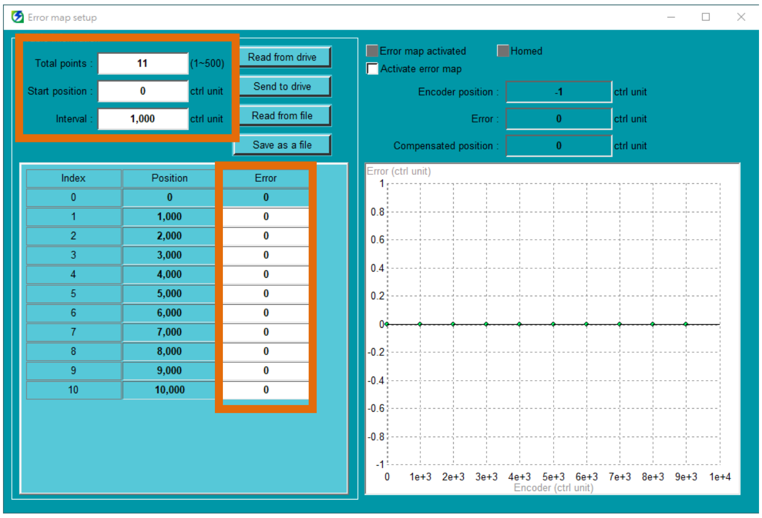
Open Thunder and connect to the servo drive to use error map table.

Step 1:
Select **Tools** on the menu bar and click on **Error map setup**.



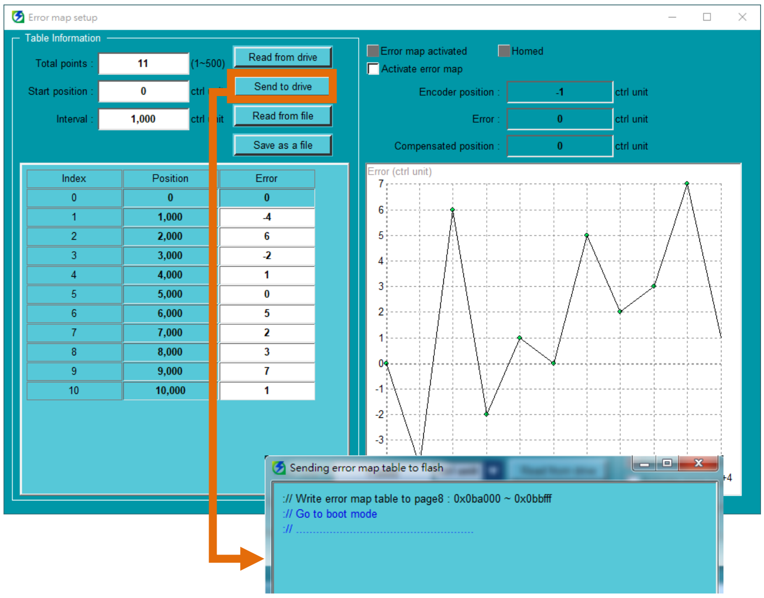
Step 2:
Set **Total points** and **Interval**. Select the unit of compensation value. Input compensation values in the column of **Error**. The compensation positions will be shown on the lower right area.

Note:
The more the points are, the better the positioning accuracy can be.
Select other unit from the drop-down list. Pay attention to the conversion with control unit.



Step 3:
Click on **Send to drive** button to save the error map table to the servo drive flash. A processing window appears. After the error map table is saved, the processing window closes.

Note:
(1) Click on **Save as a file** button to save the error map table to PC.
(2) Click on **Read from file** button to read error map table from PC.
(3) Click on **Read from drive** button to read the error map table from the servo drive memory.



Step 4:
After homing completes, check if **Homed** indicator is green. Check the checkbox of **Activate error map**. If **Error map activated** indicator is green, it means error map function is enabled.

Note:
(1) Error map function must be enabled only after homing completes.
(2) The checkbox of **Activate error map** cannot be checked or unchecked when the motor is enabled.
(3) Error map function must be disabled if you would like to perform homing.

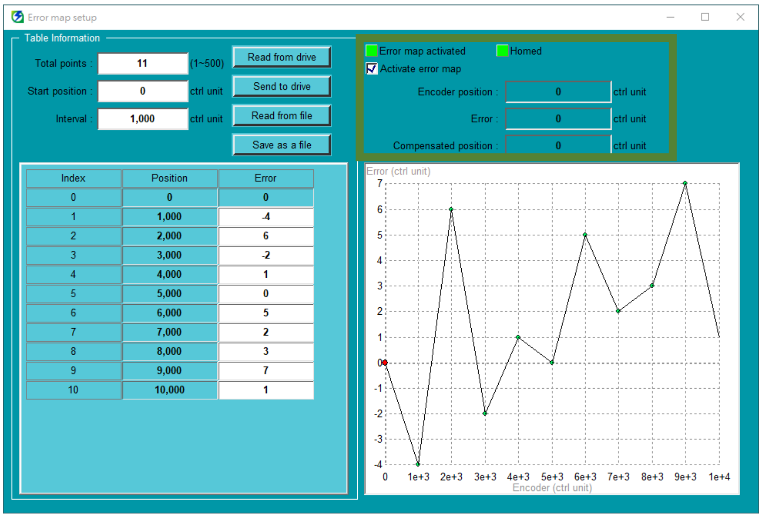


Figure8.12.1

After the related settings of error map table are set, the servo drive is able to perform error map function. This section provides two methods of using error map function as your reference.

(1) Homing with controller

The controller sends motion command to the servo drive by pulse command or analog voltage command (velocity or torque) to command the motor to do homing. The controller outputs servo drive error map input (MAP) signal to the servo drive after homing completes. The servo drive regards homing has been completed after the signal is input.

Note:
The servo drive sets the current position (feedback position) as 0 when servo drive error map input (MAP) signal is input.

Table8.12.1

Type	Signal	Hardware Pin	Status	Description
Input	MAP	CN6-9 (Default)	Edge-triggered	Servo drive error map input signal

(2) Using the internal homing procedure of the servo drive

Perform internal homing procedure by referring to section 8.11.

(3) Open the error map table after using EtherCAT controller with Touch probe function.
When fieldbus servo drive with model no. ED1F-E is used with EtherCAT controller, please follow below steps to open the error map table if Touch probe homing is executed.

Step1: Set corresponding Pt parameter(Pt009 = t.□□□3 or t.□□□4) according to axis(single axis or gantry axis) in error map table.

Step2: Set controller object 0x3060(Use touch probe enable Errormap) as 1.

Step3: Executing Touch proble homing.

Step4: When Touch probe homing is completed, disable the motor and activate error map function.

Note:

(1) If a user wants to refresh the starting point of error map table, just re-executing Touch probe homing when 0x3060 = 1.

(2) After the error map table is opened by Touch probe function, a user can re-activate the Touch probe function for other applications without affecting original error mappings when 0x3060 = 0.

(3) EtherCAT object 0x3060(Use touch probe enable Errormap) definition:0 means Touch probe function will not be used to open error map table. 1 means to open the error map table with Touch probe function.

(4) If absolute encoder homing is executed, please follow below steps to open the error map table:

Step1: Set Pt70A.all = t.□1□□,activate this parameter after power on.

Step2: Execute internal homing procedure(Pt700=-3),activate this parameter after power on.

Step3: Keep the homing completed status and activate error map function.

- Related parameters

Set to perform error map function on which axis by Pt009= t.□□□X.

Table8.12.2

Parameter		Description	Effective	Category
Pt009	t.□□□0 (Default)	After internal homing is completed, enable error map function for single axis.	After power on	Setup
	t.□□□1	After internal homing is completed, enable error map function for gantry axis.		
	t.□□□2	Automatically enable error map function for specific motor.		
	t.□□□3	After Touch Probe homing is completed, enable error map function for single axis.		
	t.□□□4	After Touch Probe homing is completed, enable error map function for gantry axis.		
	t.0□□□ (Default)	Disable error map function.	Motor is disabled	
	t.1□□□	Enable error map function.		

Table8.12.3

Parameter		Description	Effective	Category
Pt00F	t.□0□□ (Default)	Disable function of automatically activating error map.	After power on	Setup
	t.□1□□	Enable function of automatically activating error map.		

Note:

Built-in error map table will be opened automatically when HIWIN absolute direct drive motors are used. Any other error mapping can not be performed for the accurancy.

Table8.12.4

Parameter		Description	Effective	Category
Pt70A	t.□0□□ (Default)	Disable automatical execution of homing after power on.	After power on	Setup
	t.□1□□	Enable automatical execution of homing after power on.		

Note:

This parameter should be used with internal homing procedure(Pt700=-3) so it only supports absolute encoder.

8.13 Setting position trigger function

E1 series servo drive provides position trigger (PT) function. This function supports fixed interval pulse trigger, random interval pulse trigger and random interval trigger status mode. Take pulse trigger output for example, when motor moves to the set position, the servo drive simultaneously outputs a pulse signal. The width and polarity of the pulse signal can be user-defined, as shown in figure 8.13.1. A user can refer to table 8.13.1 for detailed specification and function descrptions. Position trigger function has no human machine interface, so its related parameters must be set via PDL or MPI. The hardware pins for position trigger digital output (PT) signal are CN6 46 and 47 (3.3 V/50 mA). The signal can be allocated to digital outputs O1~O5 (24 V), if users cannot support such voltage level. Position trigger (PT) function is mainly used in application which requires simultaneous in-position signal for high-speed and high-precision processing, such as laser equipment, line scan camera and lithography equipment.

Table8.13.1

Specification	Description		
	Digital Output	Specific PT Output Pulse	Specific PT Output Status
Pulse Width	0.25 ms~1000 ms	0.02 us~81 us	-
Position Tigger Time	0.25 ms	60 ns	80 ns
Output Voltage	12~24 V	3.3 V	3.3 V
Position Update Frequency	4 kHz	1 MHz	32 kHz
Output Pins	O1~O5，please refer to section 8.1.2	PT- and PT+ signal (CN6 pin 46 and 47)	PT- and PT+ signal (CN6 pin 46 and 47)
Applicable Encoder	Digital encoder		
Specification	fixed interval/ random interval output mode		random interval output mode

Note:

(1) Random interval mode is only supported in Thunder versions after 1.6.19.0.

(2) The update frequency of specific PT output pulse position is increased to 1 MHz after Thunder 1.6.19.0.

(3) Digital output's position trigger function only supports pulse output. It doesn't support status output.

Note

- Position trigger time is the time from the motor reaches the position to the signal is triggered.
- Accuracy of position trigger time for specific PT output: ±1 count up to 16.6M counts/sec

■ Pt00E = t.□□1□ : fixed interval position trigger function (pulse output)

Function description:

When the motor moves to the set start position (Pt230), the driver will output the first pulse signal synchronously. When the motor moves to the position of next pulse interval (Pt231), the drive will output next pulse signal. The driver will synchronously output pulse signals in sequence until the motor moves beyond the end position (Pt232), as shown in Figure 8.13.1.

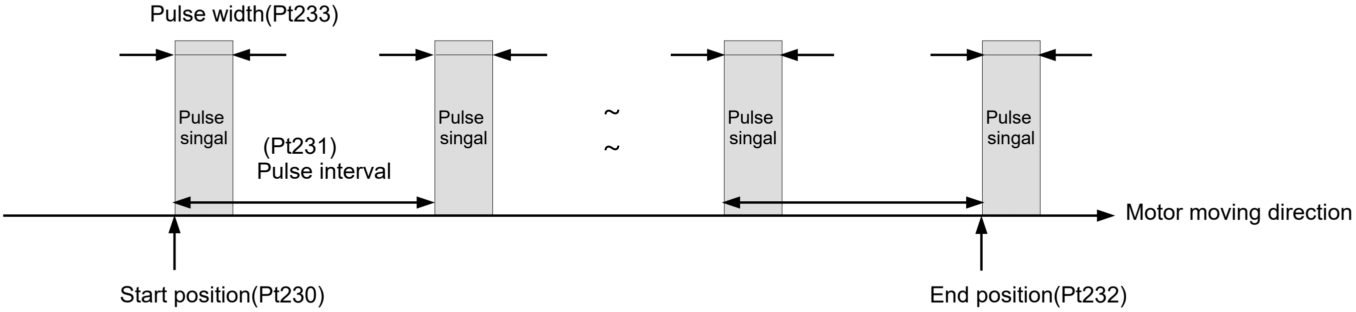


Figure8.13.1

■ Pt00E = t.□□2□ : random interval position trigger function (pulse output)

Function description:

According to the index and corresponding positon defined by the user, when the motor moves to the corresponding positon of set start index (Pt235), the driver will output the first pulse signal synchronously. When the motor moves to next corresponding positon of index, the drive will output next pulse signal. The driver will synchronously output pulse signals in sequence until the motor moves beyond the corresponding positon of end index (Pt236), as shown in Figure 8.13.2.

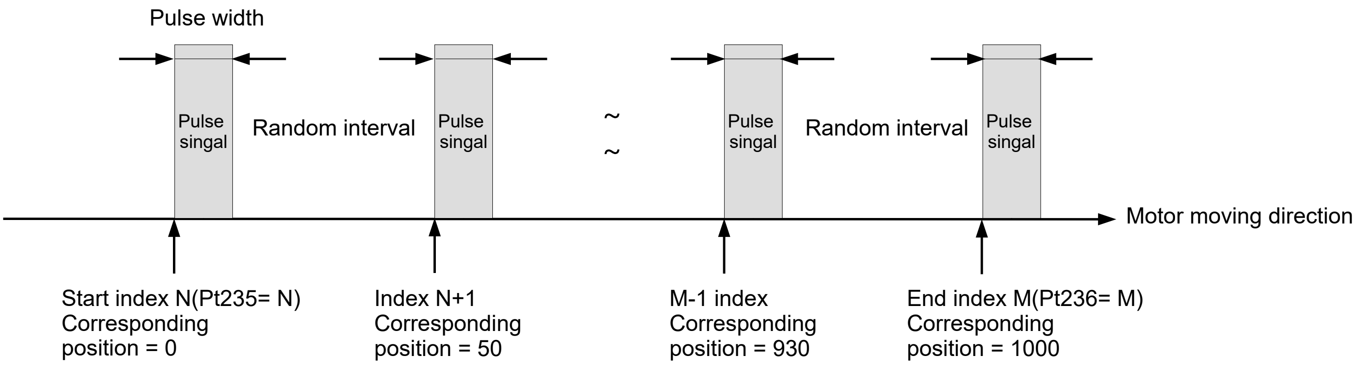


Figure8.13.2

Table8.13.2

Index	N	N+1	...	M-1	M
Trigger position (count)	0	50	...	930	1000

■ Pt00E = t.□□3□ : random interval position trigger function (status output)

Function description:

According to the index and corresponding status defined by the user, when the motor moves to the corresponding positon of set start index (Pt235), the driver will change signal status synchronously. When the motor moves to next corresponding positon of index, the drive will change next signal status. The driver will synchronously change signal status in sequence until the motor moves beyond the corresponding positon of end index (Pt236), as shown in Figure 8.13.3.

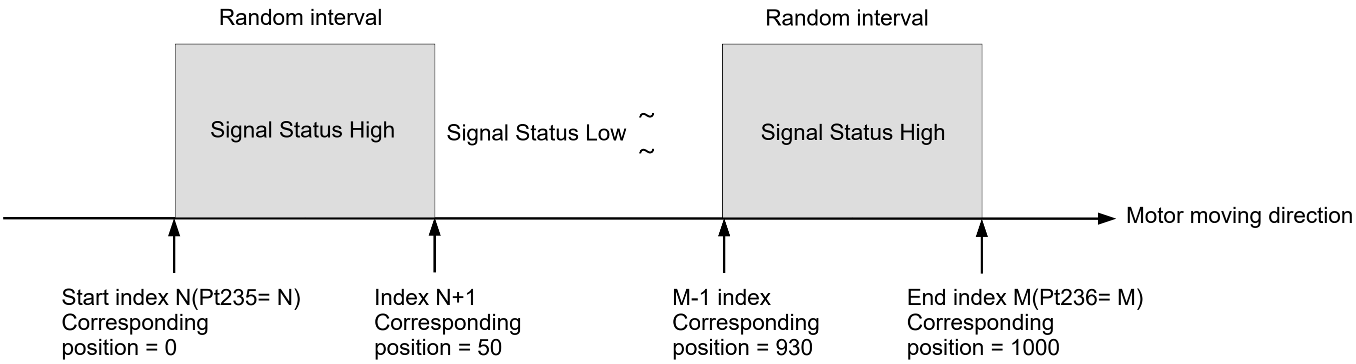


Figure8.13.3

Table8.13.3

Index	N	N+1	...	M-1	M
Trigger position (count)	0	50	...	930	1000
Trigger status	High	Low		High	Low

The related parameters used for position trigger function are as below.

Table8.13.4

Parameter		Description	Effective	Category
Pt00E	t.□□□0	Disable position trigger function.	After power on	Setup
	t.□□□1 (Default)	Enable position trigger function.		
	t.□□0□	Reserved		
	t.□□1□ (Default)	Fixed interval position trigger function (pulse output)		
	t.□□2□	Random interval position trigger function (pulse output)		
	t.□□3□	Random interval position trigger function (status output)		
	t.□0□□	Signal output voltage is high level.		
	t.□1□□ (Default)	Signal output voltage is low level.		
	t.X□□□ (Default)	Reserved		

Table8.13.5

Parameter	Pt230	Range	$-2^{30}+1\sim+2^{30}-1$	Control Mode	Position mode, velocity mode and torque mode
Default	0	Effective	Immediately	Unit	1 control unit
Description					
Set the start position for fixed interval of position trigger function.					

Table8.13.6

Parameter	Pt231	Range	$0\sim+2^{30}-1$	Control Mode	Position mode, velocity mode and torque mode
Default	0	Effective	Immediately	Unit	1 control unit
Description					
Set the output interval for fixed interval of position trigger function.					

Table8.13.7

Parameter	Pt232	Range	$-2^{30}+1\sim+2^{30}-1$	Control Mode	Position mode, velocity mode and torque mode
Default	0	Effective	Immediately	Unit	1 control unit
Description					
Set the stop position for fixed interval of position trigger function.					

Table8.13.8

Parameter	Pt233	Range	1~4095	Control Mode	Position mode, velocity mode and torque mode
Default	20	Effective	Immediately	Unit	20 ns
Description					
Set the pulse output width of position trigger function.					

Table8.13.9

Parameter	Pt234	Range	1~4000	Control Mode	Position mode, velocity mode and torque mode
Default	1	Effective	Immediately	Unit	0.25 ms
Description					
Set the digital signal output width of position trigger function.					

Table8.13.10

Parameter	Pt235	Range	0~255	Control Mode	Position mode, velocity mode and torque mode
Default	0	Effective	Immediately	Unit	-
Description					
Start index for random interval of position trigger function.					

Table8.13.11

Parameter	Pt236	Range	0~255	Control Mode	Position mode, velocity mode and torque mode
Default	0	Effective	Immediately	Unit	-
Description					
End index for random interval of position trigger function.					

Note:
If Pt230~Pt236 are modified during the time that PT function is enabled, users must disable PT function and enable PT function again to make them be effective.

The enabling and disabling conditions of PT function

(1) Enabling conditions (All the following conditions must be satisfied.)
  a. Use digital encoder.
  b. Complete homing.
  c. Enable position trigger function (Set X_PT_Enable to 1.).

(2) Disabling conditions (One of the following conditions must be satisfied.)
   a. PT function is disabled automatically when the stop position (Pt232 or the corresponding position of Pt236 index) is reached.
   b. Disable position trigger function (Set X_PT_Enable to 0.).

Note:

(1) Position trigger function is still effective after the motor is disabled.

(2) After position trigger function is disabled, if you would like to execute this function again, set X_PT_Enable to 1.

(3) For a fieldbus servo drive(ED1F), if the control interface is EtherCAT, an user can use the communication object 0x3061 "Enable position trigger function" to enable or disable position trigger function. (the function is the same as setting parameter X_PT_Enable).

■ Example of fixed interval position trigger function (pulse output)

Homing must be completed before using position trigger function. The motor must be installed with digital encoder. In this example, we assume the encoder resolution is 1 count = 1 um. The electronic gear ratio is 1:1. The output position of the first position trigger pulse is 25 mm. Then one position trigger pulse will be output every 1 um. Use default setting for the polarity of pulse (Signal output is low level.) The width of pulse is 0.4 us. The output position of the last position trigger pulse is 100 mm. The PDL program codes are as below.

```
_SetPT:
Pt230   = 25000;     // Start position of position trigger function
Pt231   = 1;      // Output interval of position trigger function
Pt232   = 100000;    // Stop position of position trigger function
Pt233   = 20;        // Output pulse width of position trigger function
X_PT_Enable = 1;     // Execute position trigger function
ret;
```

Precautions:

(1) Set Pt230 to 25000 to output the first pulse at the start position of position trigger function.

(2) Pulse may not be output at the stop position of position trigger function. Pulse will only be output as start position + intervals = stop position (Pt232).

(3) The direction of position trigger function depends on the settings of Pt230 and Pt232. In this example, Pt230 < Pt232, so one pulse will be output every 1 mm in positive direction. If Pt230 > Pt232, one pulse will be output every 1 mm in negative direction.

(4) There is a limitation between motor velocity and output interval. In this example, the update frequency of E1 series servo drive is 1 MHz. The required pulse interval is 1 um and the motor velocity must not exceed 1000 (mm/s). The calculation is as below:

The maximum motor velocity < Pulse output interval (Pt231) x Position update frequency
= 0.001 (mm) x 1M(1/s) = 10000 (mm/s)

The limitation between the motor velocity and output interval depends on the position update frequency. Therefore, the smaller the output interval is, the stricter the limit on motor velocity is. The maximum velocities for different output intervals of E1 series servo drive are listed in table 8.13.8.

Table8.13.12

Output Interval (um)	Maximum Velocity (mm/s)
100	100,000,000
10	10,000,000
1	1000,000

(5) Please ensure that the output pulse width setting must be less than the actual output pulse interval time;otherwise it cannot be guaranteed whether the trigger position is updated normally. In this example, when the actual movement speed is close to the upper limit of 1000 mm/s, the pulse output interval time is approximately:

0.001(mm) / 1000(mm/s) = 0.000001 s = 1 us

Therefore, please make sure to set the output pulse width less than 1us to avoid malfunction.

➢ **Precautions:**

The unit of Pt230~Pt232 is 1 control unit. The setting values must be within the upper limits and lower limits. And their values must comply with the formulas below. Otherwise, AL.040 may occur.

$$(2^{31}-1) \geq Pt230 \times \frac{Pt20E}{Pt210} \geq (-2^{31}+1)$$

$$(2^{31}-1) \geq Pt231 \times \frac{Pt20E}{Pt210} \geq 0$$

$$(2^{31}-1) \geq Pt232 \times \frac{Pt20E}{Pt210} \geq (-2^{31}+1)$$

■ Example for random interval position trigger function (pulse output)

This example is a continue of the previous one. If a user wants to change to random interval position trigger function (pulse output), please set Pt00E = t.□□2□ and save it to restart after power off.In this example, it is assumed that the first position trigger pulse output position is still 25 mm, and the next position is shown as in Figure 8.13.4. The pulse polarity setting signal output is high level, and the pulse width is 0.4 us. The PDL code example for the PT function setting is as follows:

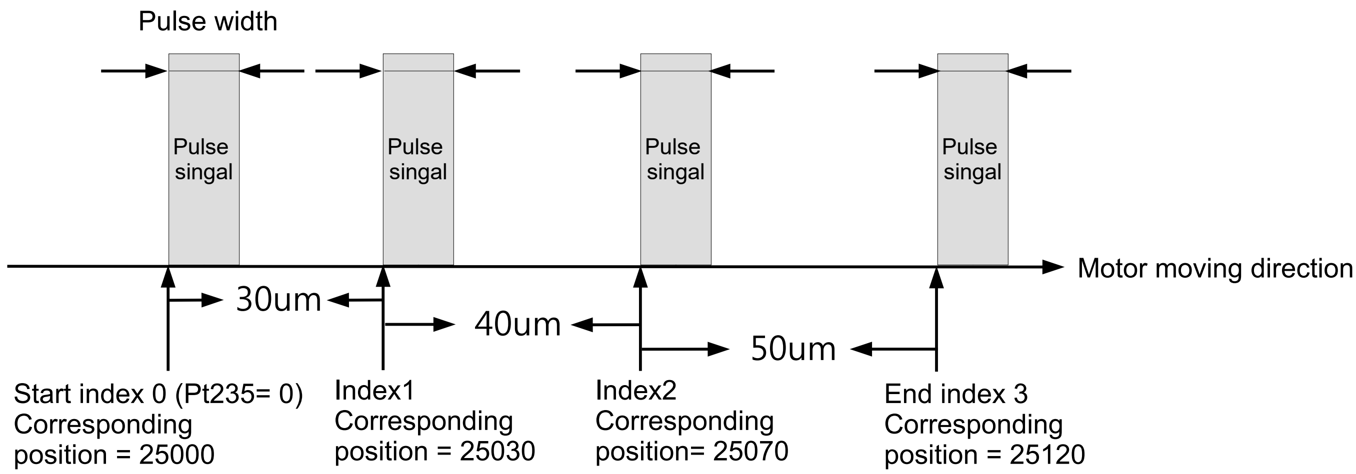


Figure8.13.4

```
_SetPT:
//Set the position to trigger the corresponding position of the array
Write_PosTrigArray(0, 25000); // Set index value 0 and position data 25000
Write_PosTrigArray(1, 25030); // Set index value 1 and position data 25030
Write_PosTrigArray(2, 25070); // Set index value 2 and position data 25070
Write_PosTrigArray(3, 25120); // Set index value 3 and position data 25120
Pt235 = 0; // Set the position trigger function to start from the position data of the start index value
Pt236 = 3; // Set the position trigger function to end from the position data of the end index value
Pt233 = 20; // Position trigger function output pulse width
X_PT_Enable = 1; // Perform position trigger function
ret;
```

➢ **Precautions**

(1) In the Write_PosTrigArray(long A, long B) function, A represents the position array index value, and B represents the position data (Unit: count).

(2) For MPI/API users, please set PT_Array_Index (position array index value), PT_Array_Data (position data), and call the tag Write_PosTrigArray to perform the writing.

■ Example for random interval position trigger function (status output)

This example is a continue of the previous one. If a user wants to change to random interval position trigger function (status output), please set Pt00E = t.□□3□ and save it to restart after power off.In this example, it is assumed that the first position trigger pulse output position is still 25 mm, and the next position is shown as in Figure 8.13.5. The pulse polarity setting signal output is high level. The PDL code example for the PT function setting is as follows:

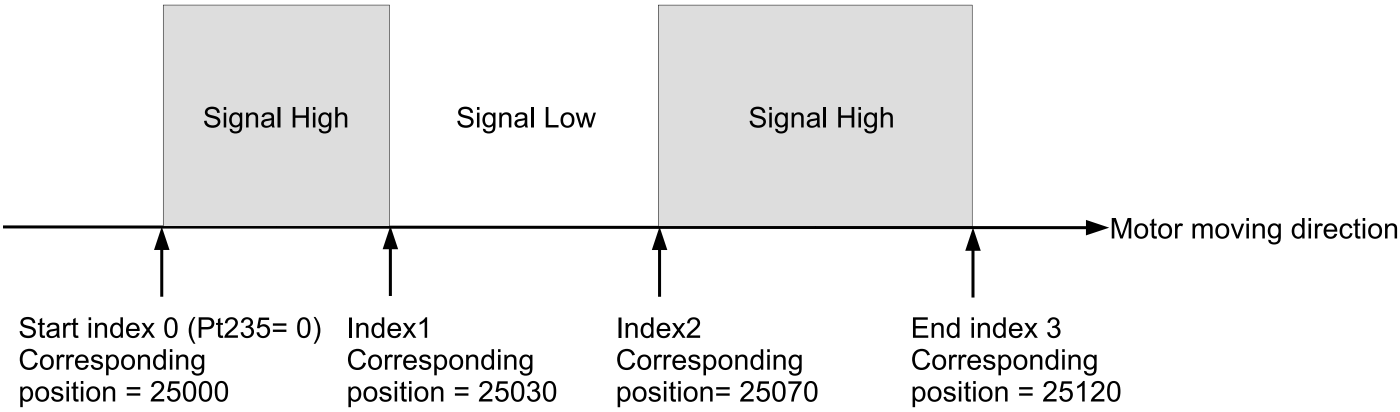


Figure8.13.5

```
_SetPT:
//Set the position to trigger the corresponding position of the array
Write_PosTrigArray(0, 25000); // Set index value 0 and corresponding position 25000
Write_PosTrigArray(1, 25030); // Set index value 1 and corresponding position 25030
Write_PosTrigArray(2, 25070); // Set index value 2 and corresponding position 25070
Write_PosTrigArray(3, 25120); // Set index value 3 and corresponding position 25120
Write_PosTrigState(0, 0x00000005); // Set the corresponding status of index value 0-3 as 0101b
Pt235 = 0; // Set the position trigger function to start from the corresponding postion of the start index value.
Pt236 = 3; // Set the position trigger function to end from the corresponding postion of the end index value.
Pt233 = 20; // Position trigger function output pulse width
X_PT_Enable = 1; // Perform position trigger function
ret;
```

➢ **Precautions:**

(1) In the Write_PosTrigArray(long A, long B) function, A represents the position array index value, and B represents the corresponding position (Unit: count).
(2) For MPI/API users, please set PT_Array_Index (position array index value), PT_Array_Data (position data), and call the tag Write_PosTrigArray to perform the writing.
(3) In the Write_ PosTrigState (long A, long B) function, A represents the state array index value, and B represents the state data. Please refer to Table 8.13.13 for details.
(4) For MPI/API users, please set PT_State_Index (state array index value), PT_State_Data (state data), and call the tag Write_PosTrigState to perform the writing.

Table8.13.13

Position array index	Status array index	Status data	Descriptions
0~31	0	0x5	1. The data of the state array [0] represents the state description of the 0~31 groups of position arrays 2. Take 0x5 as an example (its binary display is 00000000 00000101(b)) Bit 0 is 1-the motor moves to 25000 and the signal is High Bit 1 is 0-the motor moves to 25030 and the signal is Low Bit 2 is 1-the motor moves to 25070 and the signal is High Bit 3 is 0-the motor moves to 25120 and the signal is Low
32~63	1	-	The data of the status array [1] represents the status description of the 32~63 groups of position arrays
64~95	2	-	The data of the status array [2] represents the status description of the 64~95 groups of position arrays
...			
192~223	6	-	The data of the status array [6] represents the status description of the 192~223 groups of position arrays
224~255	7	-	The data of the status array [7] represents the status description of the 224~255 groups of position arrays

8.14 Restarting the servo drive via software

Confirm the following before restarting the servo drive via software.

(1) The motor is disabled.
(2) The motor is stopped.

When the servo drive is restarted via software, the internal calculation of the servo drive restarts. The parameter data will be retrieved from the servo drive flash. Before restarting the servo drive via software, ensure parameter data are stored to the flash and to PC as well. (Note: If parameters are set via Thunder and have not been stored to the flash, the parameter settings will not be effective.) For how to restart the servo drive via software, please refer to below.

Method 1:
Stop inputting control power to terminals L1C and L2C on CN1. Then input the control power again.

Method 2:
Click on  in the main screen of Thunder to restart the servo drive via software.

Method 3:
Input servo drive reset input (RST) signal to restart the servo drive via software. The input pin for RST signal is user-defined.

8.15 Function and setting of forced stop input (FSTP) signal

Forced stop input (FSTP) signal can forcibly stop the motor. The function and setting of FSTP signal are described in the following sections.

8.15.1 Function of forced stop input (FSTP) signal

Table8.15.1.1

Type	Signal	Hardware Pin	Status	Description
Input	FSTP	CN6-8 (I10)	ON	Forced stop The servo motor is disabled.
			OFF	Normal operation Motion control can be performed.

During forced stop, the motor is disabled and the servo drive panel displays “Stp”.

⚠CAUTION

◆ To avoid accident caused by poor connection or disconnection, the forced stop input switch must be normally-closed (b contact). The polarity of the input pin for forced stop input (FSTP) signal can be user-defined.

8.15.2 Enabling/disabling forced stop function

Use Pt50F = t.□□□X (Allocation of forced stop input (FSTP) signal) to allocate FSTP signal. If you are not using forced stop function, wiring for FSTP signal is not required.

Table8.15.2.1

Parameter		Description	Effective	Category
Pt50F	t.□□□9	Enable forced stop function and input forced stop input (FSTP) signal from CN6-8 (I10).	After power on	Setup
	t.□□□B	Disable forced stop function.		

Set Pt513 to t.1□□□ to allocate signal to the desired pin. For more information, please refer to section 8.1.1.

8.15.3 Motor stopping method for forced stop

The motor stopping method for forced stop is set by Pt00A = t.□□X□ (Stopping method for forced stop) and Pt001 = t.□□□X (Stopping method for servo off and Gr.A alarm), please refer to below.

Table8.15.3.1

Parameter		Motor Stopping Method	Status After Stop	Effective	Category
Pt00A	Pt001				
t.□□0□ (Default)	t.□□□0 (Default)	Dynamic brake	Dynamic brake	After power on	Setup
	t.□□□1	Dynamic brake	Free run		
	t.□□□2	Free run			
t.□□1□	t.□□□0 (Default)	Use the setting value of Pt406 as the maximum torque to decelerate the motor to a stop.	Dynamic brake		
	t.□□□1		Free run		
	t.□□□2				
t.□□2□	t.□□□0 (Default)		Free run		
	t.□□□1				
	t.□□□2				
t.□□3□	t.□□□0 (Default)	The motor decelerates according to the setting of Pt30A.	Dynamic brake		
	t.□□□1		Free run		
	t.□□□2				
t.□□4□	t.□□□0 (Default)		Free run		
	t.□□□1				
	t.□□□2				

Note:

(1) In torque mode, the servo motor cannot decelerate to a stop. Use Pt001 = t.□□□X to stop the motor by dynamic brake or let the motor run freely until it stops.

(2) For more information of Pt406 (Emergency stop torque), please refer to section 6.7.3.

(3) For more information of Pt30A (Deceleration time for servo off and forced stop), please refer to section 6.7.3.

8.15.4 Resetting forced stop state

When FSTP signal is ON, the servo motor is disabled. If FSTP signal is OFF, the servo drive is in drive ready (D-RDY) state. If S-ON signal is ON when FSTP signal is ON, the servo drive remains in drive ready (D-RDY) state even when FSTP signal is OFF. The servo drive will only be in servo ready (S-RDY) state after S-ON signal goes from ON to OFF and then is input again.

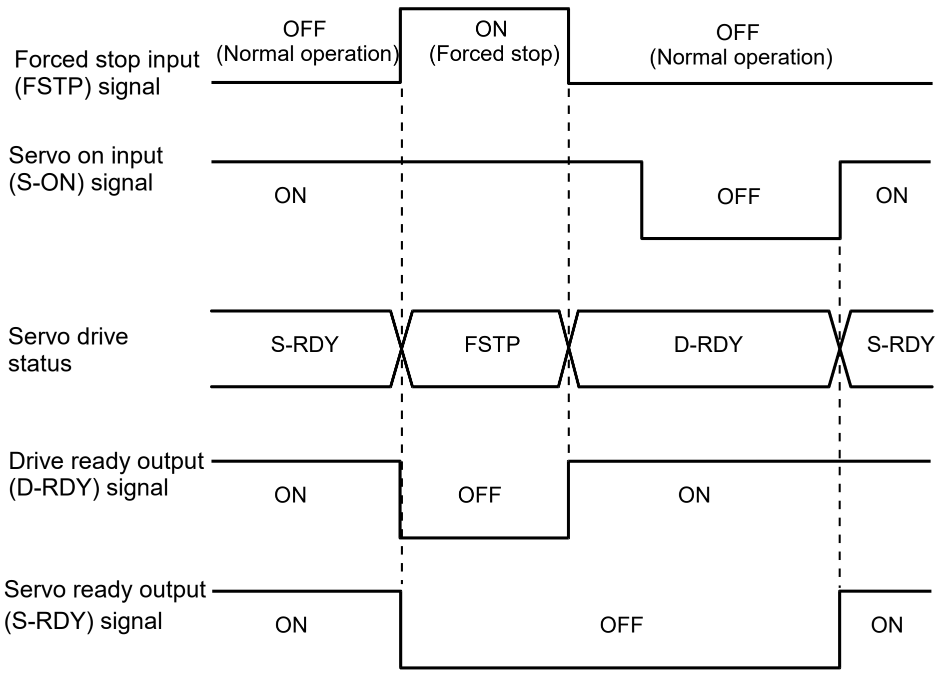


Figure8.15.4.1

Note:

When forced stop function is used, do not set servo on input (S-ON) signal to be always active (Pt50F = t.□□□A). Otherwise, FSTP state cannot be reset.

8.16 Full-closed loop function

8.16.1 Full-closed loop control

In full-closed loop control, an external linear encoder is installed to detect the machine position at load side. The external encoder provides the servo drive with the information of machine position. High precision positioning can be realized since the actual machine position can be obtained and is not affected by coupling, screw backlash and other mechanism. However, loose or twisted mechanical part could result in unstable positioning or vibration in full-closed loop control. Therefore, the servo drive provides parameters for users to set for detecting alarms in full-closed loop control. The configuration of full-closed loop control is shown as below.

Arrangement supporting default dual-loop

Note:
(1) ESC is not needed in this example. Use external encoder (reader) which outputs digital signal.
(2) For information of cables, please refer to table 16.1.1.1 in section 16.1.1 and table 16.1.2.3 in section 16.1.2.
(3) No matter what type of encoder (absolute or incremental) is used on the AC servo motor in the inner loop, it is used as incremental encoder.
(4) The drive can be used with EM1 motor alone or with ESC for full-closed loop control. However, the gain-related parameters cannot be shared and need to be re-adjusted; otherwise, the performance cannot be optimized.

Pin Definition		
Function	D-Sub 15Pin (Female)	E1 Drive CN7
5VE	7	1
	8	
SG	2	2
	9	
A+	14	5
A-	6	6
B+	13	7
B-	5	8
Index+	12	9
Index-	4	10
FG(Shield)	15	FG (Shield)

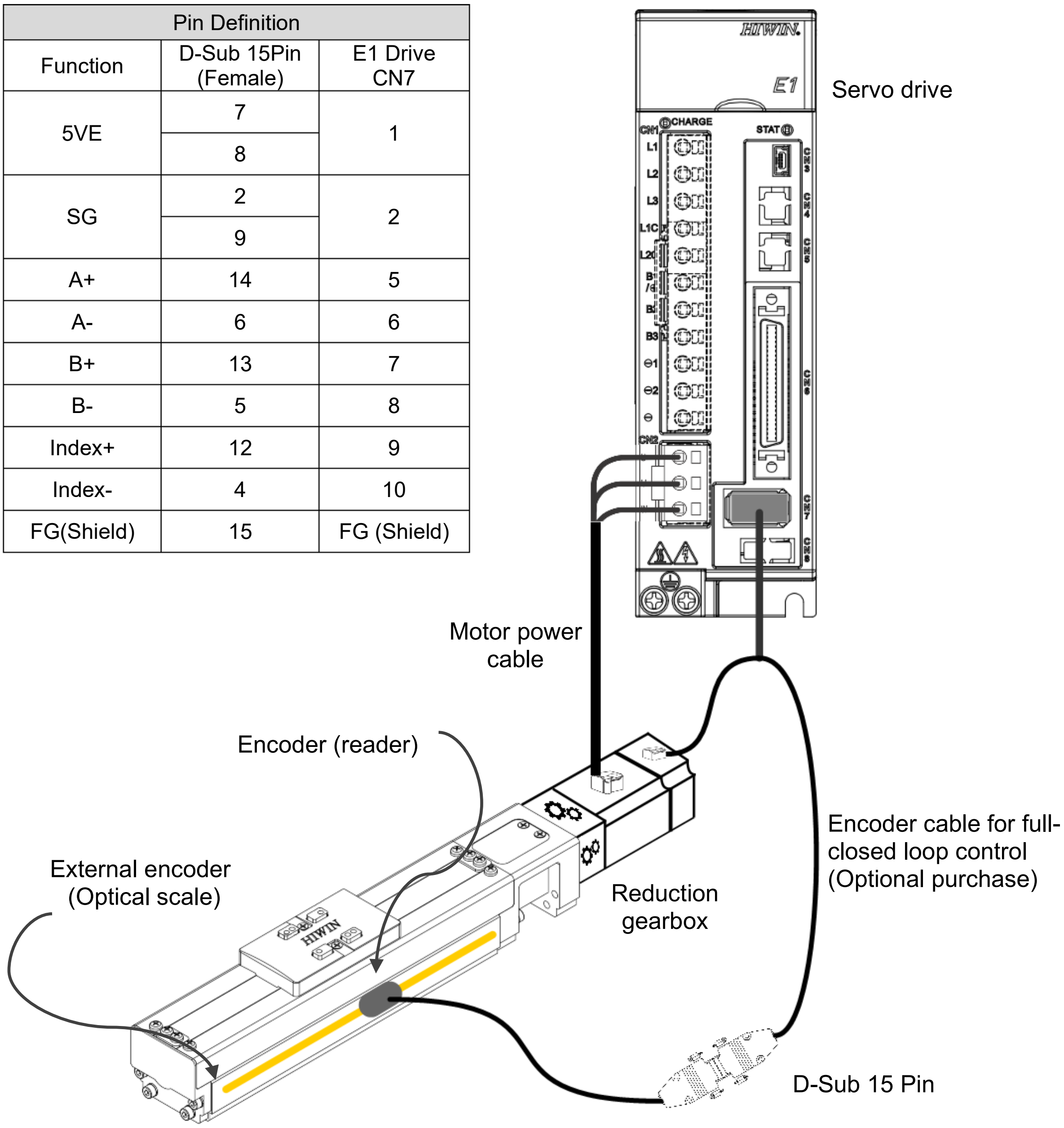


Figure8.16.1.1

■ Arrangement supporting ESC-SS full-closed loop

Table 8.16.1.1

Encoder form in the motor	Encoder form for external loading	ESC-SS signal arrangement and pin definition(Encoder, 26 PIN)
Incremental：Analog SIN/COS	Serial Communication：BiSS-C or EnDat	Internal analog signal：+5VE(4)、SG(13)、SIN(1)、/SIN(10)、COS(2)、/COS(11)、REF2(23)、/REF2(24) External serial signal：+5VE(5)、SG(14)、CLK2(6)、/CLK2(16)、DATA2(3)、/DATA2(12)
Incremental：Digital A/B	Serial Communication：BiSS-C or EnDat	Internal digital signal：+5VE(4)、SG(13)、ENC_A(19)、/ENC_A(20)、ENC_B(21)、/ENC_B(22)、ENC_IND2(23)、/ENC_IND2 (24)、ERR(7)、/ERR(17) External serial signal：+5VE(5)、SG(14)、CLK2(6)、/CLK2(16)、DATA2(3)、/DATA2(12)
Serial Communication ：BiSS-C	Serial Communication：BiSS-C or EnDat	Internal serial signal：+5VE(4)、SG(13)、CLK1(7)、/CLK1(17)、DATA1(23)、/DATA1(24) External serial signal：+5VE(5)、SG(14)、CLK2(6)、/CLK2(16)、DATA2(3)、/DATA2(12)
	Incremental：Analog SIN/COS	Internal serial signal：+5VE(4)、SG(13)、CLK2(6)、/CLK2(16)、DATA2(3)、/DATA2(12) External analog signal：+5VE(5)、SG(14)、SIN(1)、/SIN(10)、COS(2)、/COS(11)、REF(23)、/REF(24)
	Incremental：Digital A/B	Internal serial signal：+5VE(4)、SG(13)、CLK2(6)、/CLK2(16)、DATA2(3)、/DATA2(12) External digital signal：+5VE(5)、SG(14)、ENC_A(19)、/ENC_A(20)、ENC_B(21)、/ENC_B(22)、ENC_IND (23)、/ENC_IND (24)、ERR(7)、/ERR(17)
Serial Communication ：EnDat	Serial Communication：BiSS-C or EnDat	Internal serial signal：+5VE(4)、SG(13)、CLK1(7)、/CLK1(17)、DATA1(23)、/DATA1(24) External serial signal：+5VE(5)、SG(14)、CLK2(6)、/CLK2(16)、DATA2(3)、/DATA2(12)
	Incremental：Analog SIN/COS	Internal serial signal：+5VE(4)、SG(13)、CLK2(6)、/CLK2(16)、DATA2(3)、/DATA2(12) External analog signal：+5VE(5)、SG(14)、SIN(1)、/SIN(10)、COS(2)、/COS(11)、REF(23)、/REF(24)
	Incremental：Digital A/B	Internal serial signal：+5VE(4)、SG(13)、CLK2(6)、/CLK2(16)、DATA2(3)、/DATA2(12) External digital signal：+5VE(5)、SG(14)、ENC_A(19)、/ENC_A(20)、ENC_B(21)、/ENC_B(22)、ENC_IND (23)、/ENC_IND (24)、ERR(7)、/ERR(17)
HIWIN EM1 Series	Serial Communication：BiSS-C or EnDat	Internal serial signal：+5VE(4)、SG(13)、DATA2(3)、/DATA2(12) External serial signal：+5VE(5)、SG(14)、CLK1(7)、/CLK1(17)、DATA1(23)、/DATA1(24)
	Incremental：Analog SIN/COS	Internal serial signal：+5VE(4)、SG(13)、DATA2(3)、/DATA2(12) External analog signal：+5VE(5)、SG(14)、SIN(1)、/SIN(10)、COS(2)、/COS(11)、REF2(23)、/REF2(24)
	Incremental：Digital A/B	Internal serial signal：+5VE(4)、SG(13)、DATA2(3)、/DATA2(12) External digital signal：+5VE(5)、SG(14)、ENC_A(19)、/ENC_A(20)、ENC_B(21)、/ENC_B(22)、ENC_IND (23)、/ENC_IND (24)、ERR(7)、/ERR(17)

Note:

(1) please use signal arrangement in this table for ESC-SS with dual-loop.

(2) Full-closed loop only supports structures of rotary(internal) with linear(external).

(3) If a user wants to use self-made cables, please make the cables following ESC cable specifications in 3.5.2.

8.16.2 Operating procedure of full-closed loop control

Table8.16.2.1

Step	Contents	Operation	Parameter	Command
1	Operate without load in semi-closed loop control (Do not use external encoder). Items to check • Power supply circuit wiring • Servo motor wiring • Encoder wiring • I/O signal wiring to the controller • Rotation direction and motor velocity of servo motor • Protection function, such as brake or overtravel function is normal.	Set parameters and check the operation without load is normal in semi-closed loop control (Pt002 = t.0□□□). Check the following items. • The servo drive is normal. • Use **Test run** in Thunder to check if P2P motion is normal. • I/O signals can be ON/OFF normally. • Power has been supplied to the servo motor after servo on input (S-ON) signal is input. • Input position command from the controller to see if the servo motor operates normally.	• Basic function selection 0 (Pt000) • Application function selection 1 (Pt001) • Usage of external encoder (Pt002 = t.X□□□) • Electronic gear ratio (numerator, Pt20E) • Electronic gear ratio (denominator, Pt210) • Input signal selection (Pt50A, Pt50B, Pt511, Pt515, Pt516) • Output signal selection (Pt50E, Pt50F, Pt510, Pt514, Pt517)	Use **Test run** in Thunder first. Then input position command from the controller.
2	Check the operation in semi-closed loop control when the external load and servo motor are connected. Items to check • The response after the load is connected. • Input position command from the controller. Check the moving direction, moving distance and moving velocity at the load side.	Connect servo motor to the machine. If you would like to use auto tuning, please disable tuneless function (Pt170 = t.□□□0) first. Check the moving direction, moving distance and moving velocity at the load side are in accordance with the command of the controller.	• Tuneless function selection (Pt170) • Application function selection 1 (Pt001)	Check the response by **Test run** in Thunder. Input command from the controller to check the moving direction, moving distance and moving velocity at the load side.
3	Check the external encoder. Item to check • Check if the external encoder signal can be received by the servo drive normally.	Set parameters used for full-closed loop control. Do not enable the motor. Move the load manually and observe the following via Thunder. • When the servo motor moves in forward direction, control unit counts up. Observe motor-load position deviation in Scope. If the value increases, it means the setting of	• Usage of external encoder (Pt002 = t.X□□□) • Rotation/movement direction selection (Pt000 = t.□□□X) • Feed length of external encoder (Pt20A) • Linear unit length (resolution) of external encoder (Pt20B) • Gear ratio at motor side (full-closed loop) (Pt20C) • Gear ratio at load side (full-closed loop) (Pt20D) • Electronic gear ratio (numerator, Pt20E)	N/A

Step	Contents	Operation	Parameter	Command
		direction is incorrect. Change the moving direction of motor or the setting of external encoder. If the setting of direction is correct, the value does not increase. • Check if the moving distance is correct after one revolution.	• Electronic gear ratio (denominator, Pt210) • Encoder output resolution (Pt281) • Detection value for overflow motor-load position deviation (Pt51B) • Positioning completion width (Pt522) • Multiplier per one full-closed loop rotation (Pt52A)	
4	Perform P2P motion in **Test run**. Item to check • Check if the servo motor operates normally in full-closed loop control.	Perform P2P motion and check if the moving distance is correct. While performing P2P motion, slowly increase the velocity from low velocity to the required velocity.	• P2P motion and JOG in **Test run**.	Servo drive
5	Operate in full-closed loop control. Item to check • Check if the operation (including the controller) in full-closed loop control is normal.	Input position command from the controller and check if full-closed loop control is normal. Slowly increase the velocity from low velocity to the required velocity.	N/A	Controller

8.16.3 Parameter settings for full-closed loop control

The parameters used for full-closed loop control are described in table 8.16.3.1.

Table8.16.3.1

Parameter	Contents	Position Control	Velocity Control	Torque Control
Pt000= t.□□□X	Rotation/movement direction selection	V	V	V
Pt002= t.X□□□	Usage of external encoder	V	V	V
Pt20A, Pt20B, Pt20C, Pt20D	Feed length of external encoder, linear unit length (resolution) of external encoder, gear ratio at motor side (full-closed loop), gear ratio at load side (full-closed loop)	V	V	V
Pt281	Encoder output resolution	V	V	V
Pt20E, Pt210	Electronic gear ratio (numerator)	V	-	-
Pt51B	Detection value for overflow motor-load position deviation	V	-	-
Pt52A	Multiplier per one full-closed loop rotation	V	-	-
Pt006/Pt007	Analog monitor signal	V	V	V
Pt22A= t.X□□□	Velocity feedback selection during full-closed loop control	V	-	-

8.16.4 Control block diagram for full-closed loop control

The control block diagram for full-closed loop control is as below.

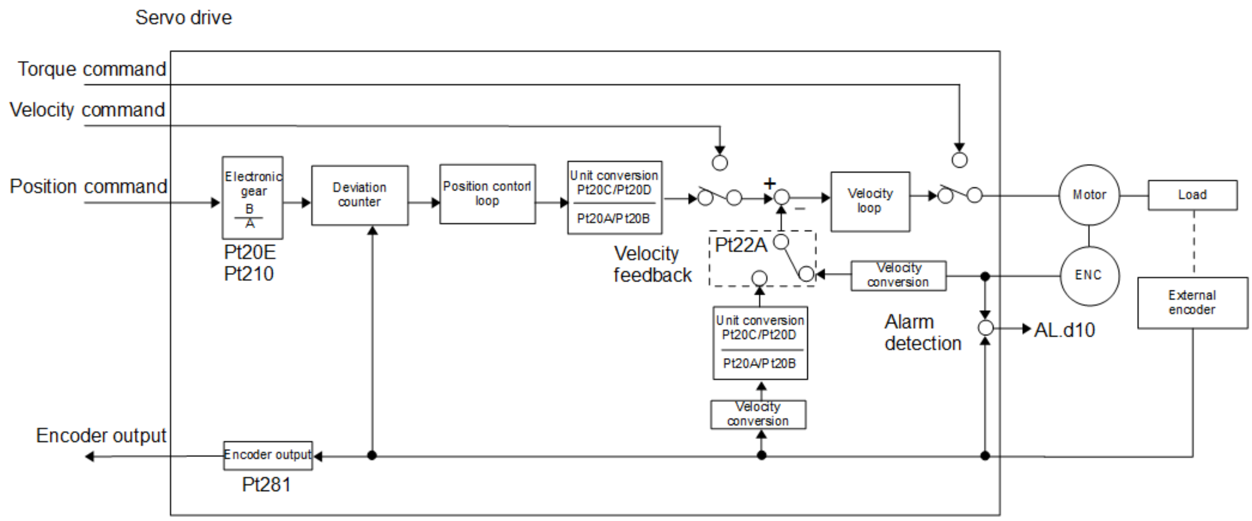


Figure8.16.4.1

8.16.5 Setting motor rotation direction and load moving direction

In full-closed loop control, Pt000 = t.□□□X (Rotation/movement direction selection) and Pt002 = t.X□□□ (Usage of external encoder) must be set.

Table8.16.5.1

<table>
<tr><th colspan="3" rowspan="2">Parameter</th><th colspan="4">Pt002= t.X□□□ (Usage of external encoder)</th></tr>
<tr><th colspan="2">t.1□□□</th><th colspan="2">t.3□□□</th></tr>
<tr><td rowspan="6">Pt000= t.□□□X (Rotation/movement direction selection)</td><td rowspan="3">t.□□□0</td><td>Command Direction</td><td>Forward command</td><td>Reverse command</td><td>Forward command</td><td>Reverse command</td></tr>
<tr><td>Rotation Direction</td><td>CCW</td><td>CW</td><td>CCW</td><td>CW</td></tr>
<tr><td>External Encoder</td><td>Moving in forward direction</td><td>Moving in reverse direction</td><td>Moving in reverse direction</td><td>Moving in forward direction</td></tr>
<tr><td rowspan="3">t.□□□1</td><td>Command Direction</td><td>Forward command</td><td>Reverse command</td><td>Forward command</td><td>Reverse command</td></tr>
<tr><td>Rotation Direction</td><td>CW</td><td>CCW</td><td>CW</td><td>CCW</td></tr>
<tr><td>External Encoder</td><td>Moving in reverse direction</td><td>Moving in forward direction</td><td>Moving in forward direction</td><td>Moving in reverse direction</td></tr>
</table>

Note:
Please confirm the set value of Pt002 = t.X□□□ with methods below:

(1) Please confirm the mechanism of motor and load is able to operate safely. In addition, external encoder has been well installed.
(2) Set Pt002 = t.1□□□. (Motor rotates in CCW direction. External encoder moves in forward direction).
(3) Make the motor load move in forward direction. The definition of forward direction is according to the setting of Pt000 = t.□□□X.
(4) While the motor load is moving, use scope in Thunder to monitor. Observe physical quantity 2-position feedback and physical quantity 22-internal position feedback.
    - If both count up, there is no need to change the setting of Pt002.
    - If the two count in opposite directions, please set Pt002 = t.3□□□.

■ Related parameters

(1) Rotation direction selection

Table8.16.5.2

Parameter		Description	Effective	Category
Pt000	t.□□□0 (Default)	CCW is the forward direction.	After power on	Setup
	t.□□□1	CW is the forward direction. (reverse mode)		

(2) Usage of external encoder

Table8.16.5.3

Parameter		Description	Effective	Category
Pt002	t.0□□□ (Default)	Do not use external encoder.	After power on	Setup
	t.1□□□	The external encoder moves in forward direction for motor CCW rotation.		
	t.2□□□	Reserved (Do not modify.)		
	t.3□□□	The external encoder moves in reverse direction for motor CCW rotation.		
	t.4□□□	Reserved (Do not modify.)		

8.16.6 Related settings of unit conversion

Set the feed value (ball screw lead) of external encoder (optical scale) for one motor revolution by Pt20A. Set linear unit length (resolution) of external encoder by Pt20B. If reduction gearbox is used, set gear ratio at motor side (full-closed loop) by Pt20C and gear ratio at load side (full-closed loop) by Pt20D.

Example:

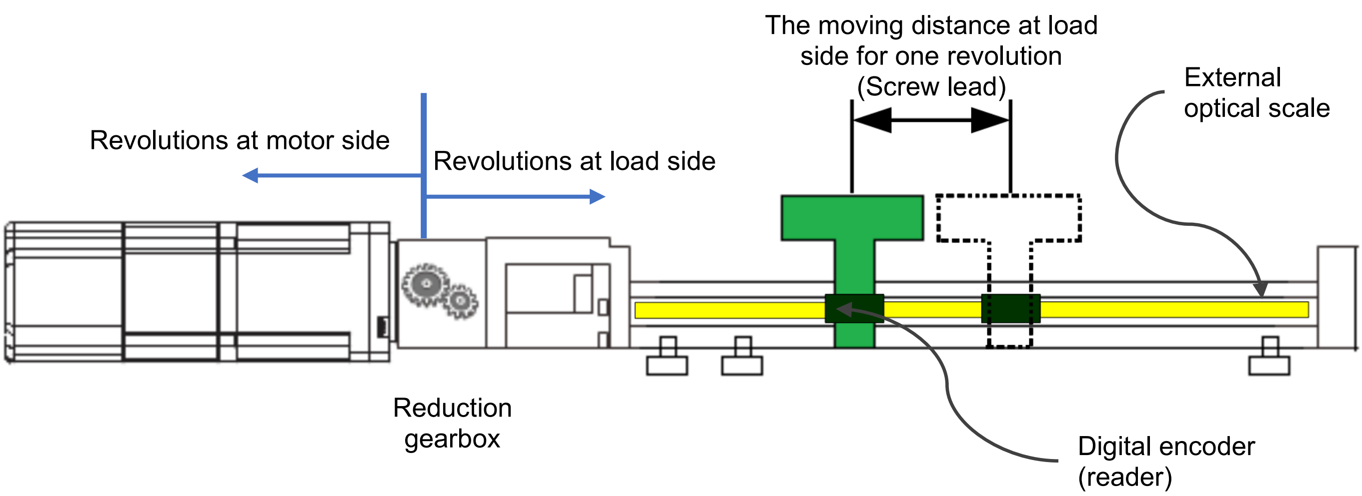


Figure8.16.6.1

The screw lead of load side for one revolution is 10 mm. Set Pt20A to 10000 um/rev.
The resolution of external encoder digital optical scale is 0.1 um. Set Pt20B to 100 nm/cnt.
The reduction ratio is 10:1. It means when the motor side rotates for 10 revolutions, the load side rotates for one revolution. Set Pt20C to 10 and Pt20D to 1.

■ Related parameters

(1) Feed length of external encoder

Table8.16.6.1

Parameter	Pt20A	Range	1~1000000	Control Mode	Position mode
Default	20000	Effective	After power on	Unit	1 um/rev
Description					
Set the feed length of external encoder.					

(2) Linear unit length of external encoder (resolution)

Table8.16.6.2

Parameter	Pt20B	Range	1~100000	Control Mode	Position mode
Default	1000	Effective	After power on	Unit	1 nm
Description					
Set the linear unit length of external encoder (resolution).					

able8.16.6.3

Parameter	Pt20C	Range	1~65535	Control Mode	Position mode
Default	1	Effective	After power on	Unit	1 revolution
Description					
Set gear ratio at motor side (full-closed loop).					

Table8.16.6.4

Parameter	Pt20D	Range	1~65535	Control Mode	Position mode
Default	1	Effective	After power on	Unit	1 revolution
Description					
Set gear ratio at load side (full-closed loop).					

8.16.7 Encoder output resolution in full-closed loop control

For setting encoder output resolution (Pt281) in full-closed loop control, please refer to section 0.

8.16.8 Electronic gear ratio setting in full-closed loop control

For setting electronic gear ratio (Pt20E and Pt210) in full-closed loop control, please refer to section 6.11.2.

8.16.9 Alarm detection setting for full-closed loop control

■ Setting detection value for overflow motor-load position deviation (Pt51B)

This setting detects the position deviation between the feedback position of motor rotary encoder and the feedback load position of external encoder. If the position deviation exceeds the setting value, alarm AL.d10 (Motor-load position deviation overflow) occurs.
The example below is the example provided in section 8.16.6. When the directions of internal encoder and external encoder are different, detection value for overflow motor-load position deviation (Pt51B) must be set for protection.

Calculation:
Detection value for overflow motor-load position deviation Pt51B ≤
2*(Pt20D/Pt20C)*(Pt20A/(Pt20B*0.001)*(Pt210/Pt20E):

Pt20A: Feed length of external encoder = 10000 um/rev
Pt20B: Linear unit length (resolution) of external encoder = 100 nm/cnt
Pt20C: Gear ratio at motor side (full-closed loop) = 10 rev
Pt20D: Gear ratio at load side (full-closed loop) = 1 rev
Pt51B ≤ 2 x (1/10) x [10000/(100 x 0.001)] x (1/32) = 625 control units

Table8.16.9.1

Parameter	Pt51B	Range	0~1073741824	Control Mode	Position mode
Default	625	Effective	Immediately	Unit	1 control unit
Description					
Set the detection value for overflow motor-load position deviation.					

Note:
If the setting value is 0, alarm AL.d10 will not occur.

■ Setting multiplier per one full-closed loop rotation (Pt52A)

Set the coefficient of deviation between motor and external encoder for one rotation. This setting can avoid malfunction caused by damage of external encoder or detect belt slippage.

Example:

If the belt slips excessively, increase Pt52A. If Pt52A is set to 0, the servo drive reads the feedback position from the external encoder directly. If the setting is 20, in the second rotation, the deviation of the first rotation will be multiplied by 0.8.

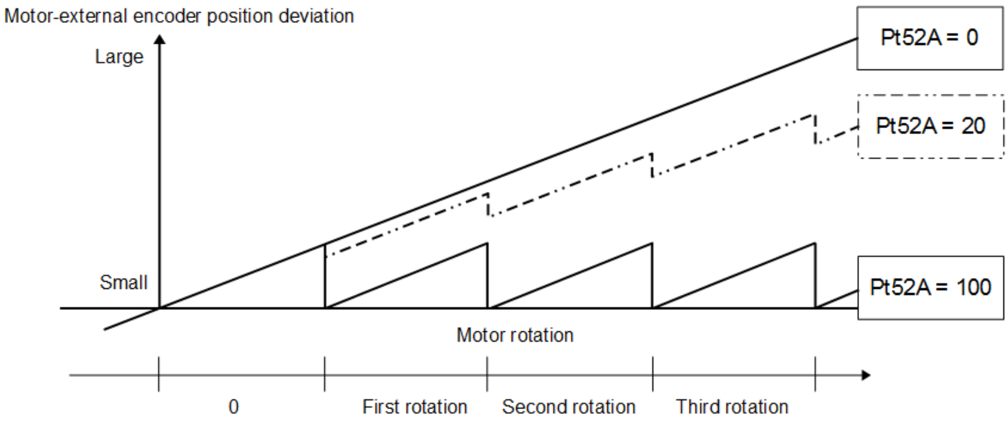


Figure8.16.9.1

Table8.16.9.2

Parameter	Pt52A	Range	0~100	Control Mode	Position mode
Default	0	Effective	Immediately	Unit	1%
Description					
Set the multiplier per one full-closed loop rotation.					

8.16.10 Setting analog monitor signal for full-closed loop control

Motor-load position deviation can be monitored.

Table8.16.10.1

Parameter		Name	Description	Effective	Category
Pt006	t.□□07	Analog monitor 1 signal selection	Motor-load position deviation (0.01 V/1 control unit)	Immediately	Setup
Pt007	t.□□07	Analog monitor 2 signal selection	Motor-load position deviation (0.01 V/1 control unit)		

8.16.11 Selecting feedback velocity in full-closed loop control

In full-closed loop control, feedback velocity from motor encoder (Pt22A = t.0□□□) will be used. If high-resolution external encoder is used, please use the feedback velocity from external encoder (Pt22A = t.1□□□).

Table8.16.11.1

Parameter		Description	Effective	Category
Pt22A	t.0□□□ (Default)	From motor encoder.	After power on	Setup
	t.1□□□	From external encoder.		

9. Trial operation when connected to controller

9.1 Trial operation with controller

Check the following items before performing trial operation with controller.

(1) Ensure commands from the controller and I/O signals are correct.

(2) Ensure the wiring between the servo drive and controller (control signal cable) and the polarity of I/Os are correct.

(3) Ensure the setting of the servo drive is correct.

The procedure to perform single-axis trial operation with controller is as below.

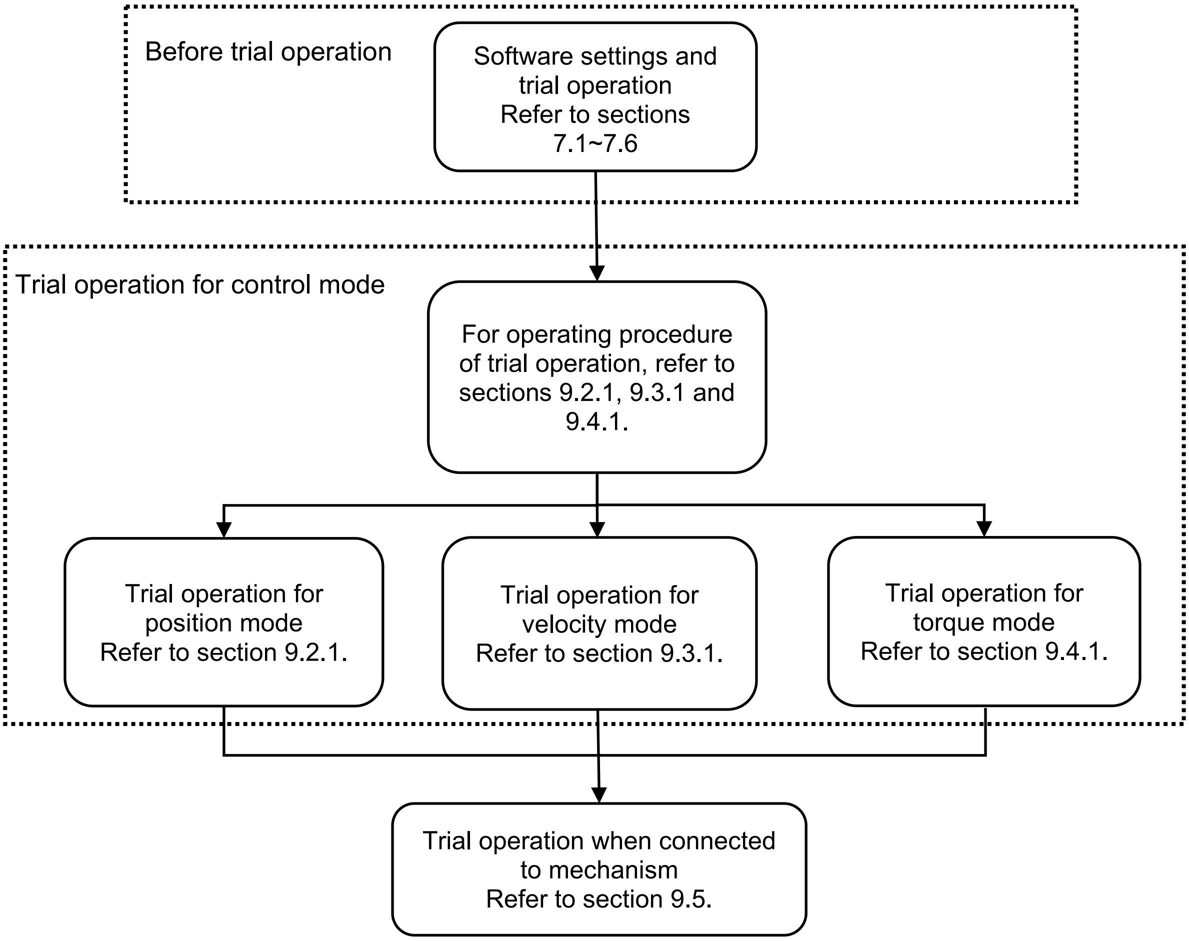


Figure9.1.1

CAUTION

◆ While performing trial operation with controller, ensure the motor does not connected to load (The coupling or belt is removed.) to avoid accident.

9.2 Trial operation for position mode

9.2.1 Operating procedure

The procedure of trial operation with controller for position mode is provided as below.

Step 1: The controller stops inputting S-ON signal. The servo drive becomes servo OFF.

Step 2: Check the settings and states of input signals. The basic signals used in position mode are listed in table 9.2.1.1. The configuration can be user-defined.

Table9.2.1.1

Signal	State
Servo on input (S-ON) signal	OFF
Proportional control input (P-CON) signal	OFF
Forward prohibition input (P-OT) signal	OFF
Reverse prohibition input (N-OT) signal	OFF
Alarm reset input (ALM-RST) signal	OFF
Forward external torque limit input (P-CL) signal	OFF
Reverse external torque limit input (N-CL) signal	OFF
Servo drive built-in homing procedure input (HOM) signal	OFF
Servo drive error map input (MAP) signal	OFF
Forced stop input (FSTP) signal	OFF

Step 3: Manually move the load to where the positive and negative limit switches (P-OT and N-OT) locate to ensure the signals and settings are correct.

Step 4: Use Pt200 = t.□□□X (Pulse command form) to select the pulse type of the controller.

Step 5: Set electronic gear ratio (Pt20E and Pt210) according to the control unit of the controller.

Step 6: Write parameters to the servo drive and turn on the power of the servo drive again.

Step 7: Input S-ON signal from the controller. The servo drive becomes servo ON.

Step 8: Input low-speed pulse commands from the controller for trial operation. For safety, the velocity must not exceed:

- ◆ Rotary motor: 100 rpm
- ◆ Linear motor: 100 mm/s

Step 9: Check if the moving direction of the servo motor is in accordance with the direction defined by the controller. If the moving direction is different, change the setting by referring to section 6.6.

Step 10: Check if the received command pulses are in accordance with the position commands from the controller.

Step 11: Click on  to open **Interface signal monitor** window and record the variation of **Pulse input**. Check if the actual moving distance is the same with the received pulses.

Step 12: Click on  to open **Interface signal monitor** window and record the variation of **AqB encoder** or **Serial encoder**.

Step 13: Check if the variations of **Pulse input** and feedback pulse counter (**AqB encoder** or **Serial Encoder**) satisfy the following calculation:

Variation of position command = Variation of feedback pulse counter × (Pt20E/Pt210)

Step 14: Input pulse command from the controller and let the motor operate at the maximum required velocity of the machine.

Step 15: Use **Scope** in Thunder to monitor **Position reference velocity**. Check the velocity of the pulse input into the servo drive by the input command pulse velocity monitoring.

- Thunder

  The input command pulse velocity monitoring uses the following formulas.

  - Rotary motor (23-bit encoder)

$$\text{Input command pulse velocity monitoring} =$$

$$\underbrace{\text{Input command pulse velocity (pulse/s)} \times 60}_{\text{Input command pulse velocity/min}} \times \underbrace{\frac{Pt20E}{Pt210}}_{\text{Electronic gear ratio}} \times \underbrace{\frac{1}{2^{23}(=8388608)}}_{\text{Encoder resolution}}$$

- Rotary motor (Analog encoder)

$$\text{Input command pulse velocity monitoring} =$$

$$\underbrace{\text{Input command pulse velocity (pulse/s)} \times 60}_{\text{Input command pulse velocity/min}} \times \underbrace{\frac{Pt20E}{Pt210}}_{\text{Electronic gear ratio}} \times \underbrace{\frac{1}{\text{Resolution of rotary analog encoder}}}_{\text{Encoder resolution}}$$

- Resolution of rotary analog encoder

  Normally the line number of one revolution is indicated by the output sine waves and cosine waves. For instance, HIWIN direct drive motor (TMS32) outputs 3600 sine waves and cosine waves for one revolution. The line number is 3600 line/rev. If analog encoder multiplier factor is 1000, the actual resolution is:

  $$3600\ line/rev \times 1000 = 3600000\ counts/rev$$

- Linear motor (Digital encoder)

$$\text{Input command pulse velocity monitoring} =$$

$$\text{Input command pulse velocity (pulse/s)} \times \underbrace{\frac{Pt20E}{Pt210}}_{\text{Electronic gear ratio}} \times \underbrace{\text{Linear digital encoder resolution}}_{\text{Linear encoder resolution}}$$

- Resolution of linear digital encoder

  If Renishaw digital encoder is used, the displayed resolution of the reader is 1 um. The resolution is:

$$1\ um \div 1000 = 0.001\ mm$$

- Linear motor (Analog encoder)

$$\text{Input command pulse velocity monitoring} =$$

$$\text{Input command pulse velocity (pulse/s)} \times \underbrace{\frac{Pt20E}{Pt210}}_{\text{Electronic gear ratio}} \times \underbrace{\frac{\text{Line of linear analog encoder}}{\text{Multiplier factor}}}_{\text{Linear encoder resolution}}$$

◆ Resolution of linear analog encoder

If Renishaw analog encoder is used, the straight distance of one sine wave or one cosine wave is 20 um. Then the line is 20 um/line. If analog encoder multiplier factor is 2000, the actual resolution is:

$$20\ um/line \div 2000 = 0.01\ um/count$$

■ Explanation of term

Line:

The position feedback signal of analog encoder consists of sine wave and cosine wave. The length of one sine wave is called one line or grating period.

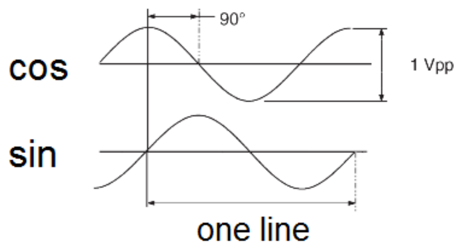


Figure9.2.1.1

Multiplier Factor:

If analog encoder sine wave signal is sub-divided, higher resolutions can be achieved. A user can set the multiplier factor by Thunder software when an E1 servo drive is operating with ESC. The maximum resolution can be up to 4096 times and the the minimum is 4 times.

Step 16: Check the motor velocity. Use **Scope** to check if **Motor velocity** is in accordance with the pulse velocity.

Step 17: Check if the input command pulse velocity and the motor velocity are the same (The values in step 15 and 16 are the same.).

Step 18: The controller stops inputting pulse commands.

Step 19: The controller stops inputting S-ON signal. The servo drive becomes servo OFF.

Note

- If any of the result in the above step is incorrect, check the settings by referring to sections 7.1~7.6 and 9.2.
- If the actual operation is different from the pulse command, please check the electronic gear ratio and wiring.

9.3 Trial operation for velocity mode

9.3.1 Operating procedure

The procedure of trial operation with controller for velocity mode is provided as below.

Step 1: Adjust velocity command input gain (Pt300). The default setting of Pt300 is 6 V/rated velocity. You may not need to adjust it if you are using the same setting. For changing the setting of Pt300, please refer to section 8.3.1.

Step 2: Check the settings and states of input signals. The basic signals used in velocity mode are listed in table 9.3.1.1. The configuration can be user-defined.

Table9.3.1.1

Signal	State
Servo on input (S-ON) signal	OFF
Proportional control input (P-CON) signal	OFF
Forward prohibition input (P-OT) signal	OFF
Reverse prohibition input (N-OT) signal	OFF
Alarm reset input (ALM-RST) signal	OFF
Forward external torque limit input (P-CL) signal	OFF
Reverse external torque limit input (N-CL) signal	OFF
Servo drive built-in homing procedure input (HOM) signal	OFF
Servo drive error map input (MAP) signal	OFF
Forced stop input (FSTP) signal	OFF

Step 3: Manually move the load to where the positive and negative limit switches (P-OT and N-OT) locate to ensure the signals and the settings are correct.

Step 4: Set the velocity command input (V-REF+, V-REF-voltage) from the controller to 0 V. Check the rotation of the servo motor. If the servo motor rotates slightly, adjust offset till the motor stops rotating.

Step 5: Input a constant-speed and low-speed command from the controller to operate the servo motor. For safety, the velocity must not exceed:

- Rotary motor: 60 rpm
- Linear motor: 60 mm/s

Step 6: Check if the moving direction of the motor is correct. If the moving direction is different from the command, change the setting by referring to section 6.6.

Step 7: Increase the velocity command input from the controller from 0 V.

Step 8: Check if the velocity command is in accordance with the motor velocity. If Pt300 is set to 6 V/rated velocity, the motor velocity should be one-sixth of the rated velocity when analog voltage 1 V is input. Check the motor velocity via **Scope**.

Step 9: Open **Interface signal monitor** window and check analog voltage input (V-REF).

Step 10: Check if **Motor velocity** is in accordance with the command via **Scope**.

Step 11: Set the velocity command input from the controller back to 0 V.

Step 12: Save the modified parameter settings. These parameter settings become effective after power on.

Step 13: Turn off the power of the servo drive.

Note	➢ If any of the result in the above step is incorrect, check the settings by referring to sections 7.1~7.6 and 9.3.

9.4 Trial operation for torque mode

9.4.1 Operating procedure

The procedure of trial operation with controller for torque mode is provided as below.

Step 1: Adjust torque command input gain (Pt400). The default setting of Pt400 is 3 V/rated torque. You may not need to adjust it if you are using the same setting. For changing the setting of Pt400, please refer to section 8.5.1.

Step 2: Check the settings and states of input signals. The basic signals used in torque mode are listed in table 9.4.1.1. The configuration can be user-defined.

Table9.4.1.1

Signal	State
Servo on input (S-ON) signal	OFF
Proportional control input (P-CON) signal	OFF
Forward prohibition input (P-OT) signal	OFF
Reverse prohibition input (N-OT) signal	OFF
Alarm reset input (ALM-RST) signal	OFF
Forward external torque limit input (P-CL) signal	OFF
Reverse external torque limit input (N-CL) signal	OFF
Servo drive built-in homing procedure input (HOM) signal	OFF
Servo drive error map input (MAP) signal	OFF
Forced stop input (FSTP) signal	OFF

Step 3: Manually move the load to where the positive and negative limit switches (P-OT and N-OT) locate to ensure the signals and the settings are correct.

Step 4: Set the torque command input (T-REF+, T-REF-voltage) from the controller to 0 V. Check the rotation of the servo motor. If the servo motor rotates slightly, adjust offset till the motor stops rotating.

Step 5: Input a constant-torque and low-torque command from the controller to operate the servo motor.

Step 6: Check if the moving direction of the motor is correct. If the moving direction is different from the command, change the setting by referring to section 6.6.

Step 7: Adjust torque command input from the controller and check if the command is in accordance with the torque.

Step 8: Resume the torque command input from the controller to 0 V.

Step 9: Save the modified parameter settings. These parameter settings become effective after power on.

Step 10: Turn off the power of the servo drive.

Note	➢ If any of the result in the above step is incorrect, check the settings by referring to sections 7.1~7.6 and 9.4.

9.5 Trial operation when connected to mechanism

This section provides the procedure of trial operation when servo motor is connected with mechanism.

9.5.1 Precautions

⚠WARNING
◆ If operation failure occurs when servo motor is connected to mechanism, it may cause machine damage or injury.

Note	➢ It overtravel function (P-OT and N-OT) is disabled for trial operation for motor solely, enable overtravel function (P-OT and N-OT) in order to provide protection.

If brake is used, pay attention to the following while performing trial operation.

(1) Ensure protective measures have been implemented when mechanism falls due to gravity or external force before checking the operation of brake.
(2) Check the operation of motor and brake separately. After that, connect the motor to its mechanism and perform trial operation again.
(3) Check the setting of brake control output (BK) signal and its related wiring, please refer to sections 5.5 and 6.8.

Note	➢ Servo drive malfunction and damage caused by incorrect wiring of brake or incorrect voltage input may result in mechanism damage, injury or death. Perform wiring and trial operation by following the precautions and procedures given in this user manual.

9.5.2 Operating procedure

Step 1: Enable overtravel signals.

Step 2: Set STO safety function, overtravel function and brake. Refer to the sections below.

- Section 5.5 **Control signals (CN6)**
- Section 5.6 **STO connector (CN4)**
- Section 6.7 **Overtravel function**
- Section 6.8 **Brake**

Step 3: Set the required parameters according to the control mode in use. Refer to the sections below.

- Section 8.3 **Velocity mode**
- Section 8.4 **Position mode**
- Section 8.5 **Torque mode**

Step 4: Turn off control circuit power supply and main circuit power supply.

Step 5: Connect servo motor and mechanism.

Step 6: Turn on the machine power, control circuit power supply and main circuit power supply.

Step 7: Check if protective functions such as overtravel function and brake can operate normally. To avoid accident in the following operation, ensure emergency stop can be activated anytime.

Step 8: Input servo on input (S-ON) signal from the controller to enable the motor.

Step 9: Perform trial operation according to the control mode in use. Ensure the result is the same while performing trial operation for the motor solely.

Step 10: Adjust servo gains to improve the response.

Step 11: For maintenance in the future, please use one of the following methods to save parameter setting.

- Save the setting to PC via Thunder.
- Record the setting manually.

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10. Tuning

10.1 Tuning overview and function

10.1.1 Flow chart for tuning

Tuning can optimize the response of motor by adjusting servo gains. Servo gains are set by several parameters (position loop gain, velocity loop gain, filter, vibration suppression and feedforward compensation). Gain-related parameters can affect the performance of each other, so please consider the balance among their settings. The default settings of gain-related parameters are set to have relatively stable servo gains. Use tuning functions provided in E1 series servo drive to improve response performance according to your mechanism and operating condition. The flow chart for tuning procedure is as below.

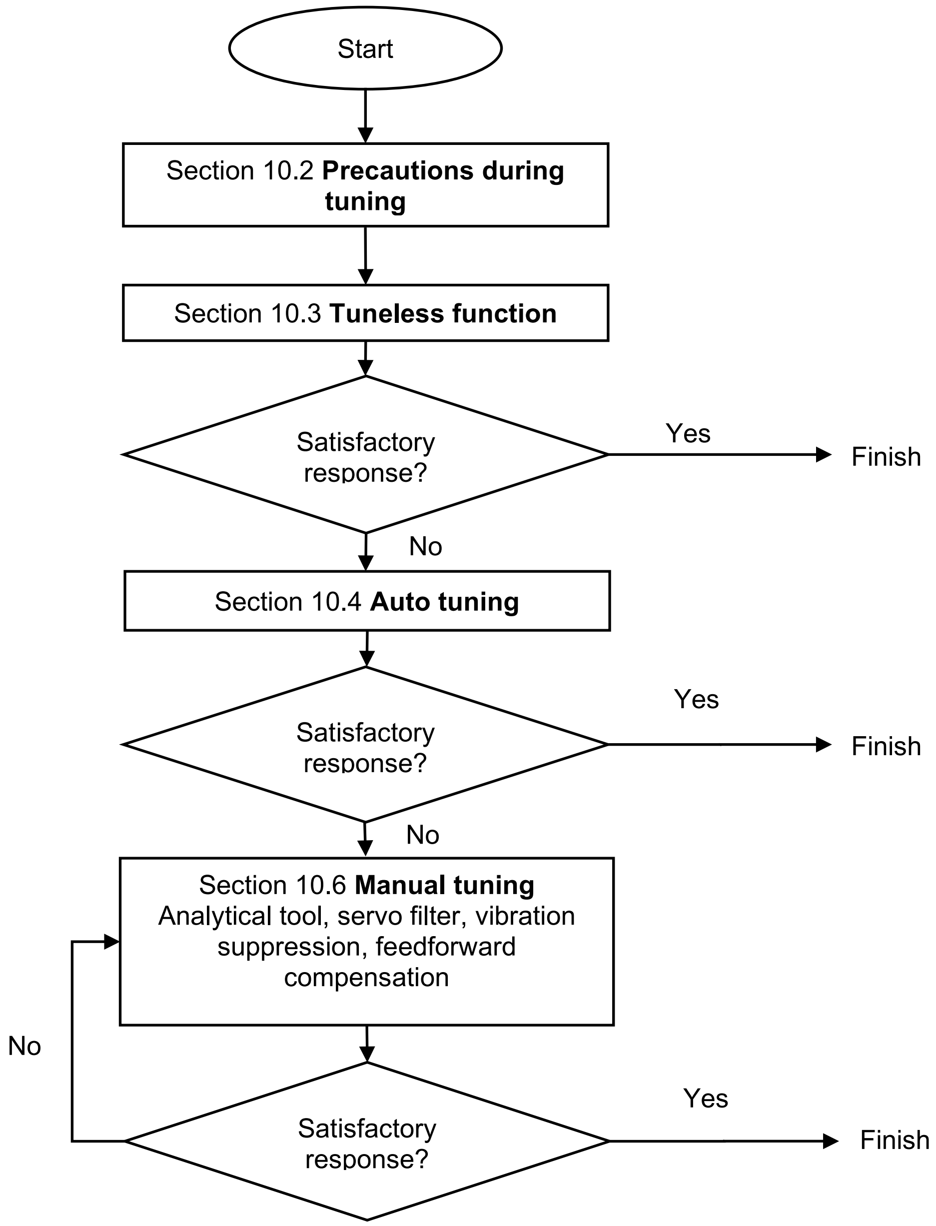


Figure10.1.1.1

10.1.2 Tuning functions

The tuning functions provided in E1 series servo drive are listed in table below.

Table10.1.2.1

Tuning Function	Description	Control Mode	Reference
Tuneless	Tuneless function can be applied for any machine type and load variation to have stable response performance.	Velocity mode, position mode and torque mode	Refer to section 10.3.
Auto tuning	The servo drive automatically adjusts control loops without receiving commands from the controller. During the process, parameters will be adjusted according to mechanical characteristics.	Velocity mode, position mode and torque mode	Refer to section 10.4.
Manual tuning	Manually adjust servo gains to improve response.	Velocity mode, position mode and torque mode	Refer to section 10.6.
Feedforward Compensation	Use model-based control provided by the servo drive.	Position mode	Refer to section 10.6.5.
Vibration suppression	Suppress 1 Hz~100 Hz low-frequency vibration caused by machine vibration during positioning.	Position mode	Refer to section 10.6.4.
Ripple compensation	Suppress low speed ripple caused by the magnetic poles of motor.	Velocity mode and position mode	Refer to section 10.6.5.
Friction compensation	Compensate viscous friction fluctuation and regular load fluctuation.	Velocity mode and position mode	Refer to section 10.6.6.

10.2 Precautions during tuning

⚠CAUTION

- Ensure the precautions below are followed when tuning.
  (1) Do not touch the rotating parts of motor when servo ON.
  (2) Ensure emergency stop can be activated anytime when motor is in operation.
  (3) Perform tuning after trial operation is completed.
  (4) For safety, install a stopping device on mechanism.

For settings to be checked, please refer to sections 10.2.1, 10.2.2 and 10.2.3.

10.2.1 Overtravel setting

Overtravel setting is set to forcibly stop the motor by using the signals from limit switches when the moving parts of mechanism exceed the allowable travel distance. For more information, please refer to section .

10.2.2 Torque limit setting

After the required torque for operation is known, torque limit can be used to limit output torque to prevent it from exceeding the required torque. Torque limit can also moderate the impact caused by mechanical interference or collision. If torque limit is smaller than the required torque for operation, the required operating condition could not be satisfied. For more information, please refer to section 8.10.

10.2.3 Setting alarm value for overflow position deviation

Position deviation overflow alarm is a protective function for position control. When the motor operation is different from the command, if alarm value for overflow position deviation is set, it can be detected immediately and the motor will be stopped. Position deviation is the difference between position command and actual position.

- Alarm value for overflow position deviation (Pt520 or Pt521) [Setting unit: 1 control unit]

(1) Rotary motor (In the example, the resolution is 23 bit)

$$\mathrm{Pt520} > \frac{\text{Motor velocity [rpm]}}{60} \times \frac{8388608}{Pt102[0.1/s]/10} \times \frac{Pt210}{Pt20E} \times Safety\ coefficient\ (Suggested: 1.2\sim2)$$

(2) Rotary motor (Analog encoder, 3600 line/rev, multiplier factor: 250, encoder resolution: 3600000 counts/rev)

$$\mathrm{Pt520} > \frac{\text{Motor velocity [rpm]}}{60} \times \frac{3600000}{Pt102[0.1/s]/10} \times \frac{Pt210}{Pt20E} \times Safety\ coefficient\ (Suggested: 1.2\sim2)$$

(3) Linear motor (In the example, the resolution is 0.5 um.)

$$\mathrm{Pt521} > \frac{\text{Motor velocity } [mm/s]}{Pt102[0.1/s]/10} \times \frac{1}{0.5um/1000} \times \frac{Pt210}{Pt20E} \times Safety\ coefficient\ (Suggested: 1.2\sim2)$$

(4) Linear motor (Analog encoder, pitch: 20 um, analog encoder multiplier factor: 500, encoder resolution: 20 um/(500 X 4)=0.01 um)

$$\mathrm{Pt521} > \frac{\text{Motor velocity } [mm/s]}{Pt102[0.1/s]/10} \times \frac{1}{0.01um/1000} \times \frac{Pt210}{Pt20E} \times Safety\ coefficient\ (Suggested\text{: } 1.2\sim2)$$

When the acceleration or deceleration of position command is too high, the motor may not be able to follow the position command. At this time, the positon deviation may not satisfy the above formulas. Decrease the acceleration or deceleration of the position command, or increase the alarm value for overflow position deviation.

■ Related parameter and alarm

Table10.2.3.1

Parameter	Pt520	Range	1 ~ 1073741823	Control Mode	Position mode
Default	5242880	Effective	Immediately	Unit	1 control unit
Description					
Set the alarm value for overflow position deviation (rotary servo motor).					

Table10.2.3.2

Parameter	Pt521	Range	1 ~ 1073741823	Control Mode	Position mode
Default	500000	Effective	Immediately	Unit	1 control unit
Description					
Set the alarm value for overflow position deviation (linear servo motor).					

Table10.2.3.3

Alarm Number	Alarm Name	Contents	Alarm Type	Alarm Reset
AL.d00	Position deviation overflow	Position deviation exceeds the alarm value for overflow position deviation (Pt520 or Pt521) when servo ON.	Gr.A	Yes

10.3 Tuneless function

Tuneless function can be applied for any machine type and load variation to have stable response performance. Tuneless function is automatically enabled after servo ON.

⚠CAUTION

- Tuneless function cannot be applied in torque control.
- When the allowable load moment of inertia is exceeded, the motor may vibrate. At this time, decrease stiffness level of tuneless function (Pt170 = t.□X□□).
- While executing tuneless function, ensure emergency stop can be activated anytime.

10.3.1 Operating procedure

When tuneless function is enabled, some of the control functions listed in table 10.3.1.1 are limited.

Table10.3.1.1

Function	Effective	Note
Auto tuning	×	Auto tuning can only be executed after tuneless function is disabled (Pt170 = t.□□□0).
Vibration suppression	○	-
Gain switching	×	Gain switching function can only be executed after tuneless function is disabled (Pt170 = t.□□□0).
Frequency analyzer	○	-
Ripple compensation	×	Ripple compensation function can only be executed after tuneless function is disabled (Pt170 = t.□□□0).
Friction compensation		Friction compensation function can only be executed after tuneless function is disabled (Pt170 = t.□□□0).

Note:

○: Yes

×: No

Tuneless function is enabled in default setting when AC servo motor is used. Use Pt170 to enable or disable tuneless function.

Note:

Tuneless function is disabled in the default setting for motors other than AC servo motor.

Table10.3.1.2

Parameter		Description	Effective	Category
Pt170	t.□□□0	Disable tuneless function.	After power on	Setup
	t.□□□1 (Default)	Enable tuneless function.		

10.3.2 Setting tuneless function

When vibration or position deviation overflow occurs, adjust stiffness level of tuneless function via Thunder or the servo drive panel.

(1) Before adjusting stiffness level
Ensure tuneless function (Pt170 = t.□□□1) is enabled before adjusting stiffness level of tuneless function.

(2) Stiffness level of tuneless function

Table10.3.2.1

Parameter		Description	Effective	Category
Pt170	t.□1□□	Stiffness level of tuneless function 1 (Low)	Immediately	Setup
	t.□2□□	Stiffness level of tuneless function 2		
	t.□3□□	Stiffness level of tuneless function 3		
	t.□4□□	Stiffness level of tuneless function 4		
	t.□5□□	Stiffness level of tuneless function 5		
	t.□6□□	Stiffness level of tuneless function 6		
	t.□7□□	Stiffness level of tuneless function 7		
	t.□8□□	Stiffness level of tuneless function 8		
	t.□9□□	Stiffness level of tuneless function 9		
	t.□A□□	Stiffness level of tuneless function 10		
	t.□B□□	Stiffness level of tuneless function 11		
	t.□C□□	Stiffness level of tuneless function 12		
	t.□D□□	Stiffness level of tuneless function 13		
	t.□E□□	Stiffness level of tuneless function 14		
	t.□F□□	Stiffness level of tuneless function 15 (High)		

10.3.3 Alarm and corrective action

When resonance sound or larger vibration during position control occurs, please refer to the following.

(1) Resonance sound
Decrease the setting value of Pt170 = t.□X□□ or suppress resonance sound by notch filter (Refer to section 10.6.3.).

(2) Larger vibration during position control occurs
Decrease the setting value of Pt170 = t.□X□□.

10.3.4 Ineffective parameters while executing tuneless function

The parameters which cannot be used when tuneless function is enabled (Pt170 = t. □□□1) are listed in table 10.3.4.1.

Table10.3.4.1

Item	Parameter Name	Parameter Number
Gain-related	Velocity loop gain Second velocity loop gain	Pt100 Pt104
	Velocity loop integral time constant Second velocity loop integral time constant	Pt101 Pt105
	Position loop gain Second position loop gain	Pt102 Pt106
	Moment of inertia ratio	Pt103
Advanced control	Friction compensation function	Pt408 = t.X□□□
Gain switching	Gain switching selection	Pt139 = t.□□□X

10.3.5 Related parameters of tuneless function

The parameters listed in table below will be automatically adjusted while executing tuneless function. Do not modify the parameters after tuneless function is enabled.

Table10.3.5.1

Parameter	Parameter Name
Pt401	First stage first torque command filter time constant
Pt40F	Second stage second torque command filter frequency
Pt410	Second stage second torque command filter Q value

10.4 Auto tuning

10.4.1 Overview

In auto tuning, the servo drive automatically adjusts control loops without receiving commands from the controller. During the process, parameters will be adjusted according to mechanical characteristics.

- The items of auto tuning
  (1) Gain: velocity loop gain, position loop gain and moment of inertia ratio
  (2) Filter: torque command filter and notch filter

Note:
Auto tuning cannot be performed when tuneless function is enabled (Pt170 = t.□□□1). Before performing auto tuning, please disable tuneless function (Pt170 = t.□□□0) first.

10.4.2 Precautions before executing auto tuning

⚠WARNING
◆ During auto tuning, the motor slightly vibrates. If it vibrates severely, please immediately turn off the power. Pay attention to the following. ● Check if the mechanism can be operated safely. Ensure emergency stop (Power OFF) can be activated anytime while performing auto tuning, as the motor will slightly vibrate. Besides, make sure mechanism can be operated in both directions and implement protective measures.

- Auto tuning cannot be performed on the following systems
  (1) The mechanism only operates towards one direction.
  (2) The motor is controlled by external brake. The brake must be disabled.

- Auto tuning cannot be correctly performed on the following systems
  (1) The range for motion is limited.
  (2) The load is changed when auto tuning is executed.
  (3) The dynamic friction of machine is too large.
  (4) The stiffness of machine is low and vibration occurs during positioning.
  (5) Position integration function is enabled.
  (6) Set or use velocity feedforward and torque feedforward.
  (7) The load inertia ratio is over 100.

- Items to check before performing auto tuning
  (1) The main circuit power must be ON.
  (2) No overtravel occurs.
  (3) Must be in servo OFF state.
  (4) No alarm or warning occurs.
  (5) Tuneless function must be disabled (Pt170 = t.□□□0).
  (6) While performing auto tuning, the control mode must be position mode. After auto tuning finishes, the control mode can be changed to other mode, such as velocity mode.
  (7) Gain switching selection must be set to manual gain switching (Pt139 = t.□□□X).

10.4.3 Causes and corrective actions for auto tuning failure

- Causes and corrective actions for auto tuning failure

Table10.4.3.1

Cause	Corrective Action
Main circuit power OFF	Connect main circuit power supply.
Alarm or warning occurs.	Clear the cause for alarm or warning.
Overtravel occurs.	Clear the cause for overtravel.
STO safety function is enabled.	Disable STO safety function.
Tuneless function is enabled.	Disable tuneless function (Pt170 = t.□□□0).
Second gain is selected by gain switching selection.	Disable automatic gain switching.

- Cause of error or failure during auto tuning

Table10.4.3.2

Contents	Cause	Corrective Action
Auto tuning does not correctly complete.	The machine vibrates or the motor stops.	Set stiffness level from 2 to 3.
Auto tuning fails.	The load is too heavy. The inertia ratio is over 100.	Decrease the load and re-evaluate the motor.

10.4.4 Related parameters of auto tuning

After auto tuning completes, the parameters listed in table 10.4.4.1 are automatically adjusted.

Table10.4.4.1

Parameter	Parameter Name
Pt100	Velocity loop gain
Pt101	Velocity loop integral time constant
Pt102	Position loop gain
Pt103	Moment of inertia ratio
Pt109	Feedforward
Pt140	Model-based control selection
Pt14A	Vibration suppression frequency
Pt14B	Vibration suppression compensation
Pt401	First stage first torque command filter time constant
Pt40F	Second stage second torque command filter frequency
Pt408	Torque related function selection
Pt409	First stage notch filter frequency
Pt40A	First stage notch filter Q value
Pt40C	Second stage notch filter frequency
Pt40D	Second stage notch filter Q value
Pt416	Torque related function selection 2
Pt417	Third stage notch filter frequency
Pt418	Third stage notch filter Q value
Pt41A	Fourth stage notch filter frequency
Pt41B	Fourth stage notch filter Q value

10.5 Adjusting application function

10.5.1 Setting current gain level

Current gain level (Pt13D) and current loop integral gain level (Pt13E) are used to adjust the internal current of the servo drive based on velocity loop gain (Pt100). Noise can be reduced if current gain level is decreased. However, the response of servo loop could be lower as current gain level is decreased. Current gain level (Pt13D) and current loop integral gain level (Pt13E) cannot be used in torque mode (Pt000 = t.□□2□). The default value of Pt13D is 2000. At this time, the current bandwidth is 5 KHz (maximum).

Table10.5.1.1

Parameter	Pt13D	Range	100~2000	Control Mode	Velocity mode and position mode
Default	2000	Effective	Immediately	Unit	1%
Description					
Current gain					

Table10.5.1.2

Parameter	Pt13E	Range	1~5000	Control Mode	Velocity mode and position mode
Default	100	Effective	Immediately	Unit	1%
Description					
Current loop integral gain					

Note:
Since velocity loop response changes as current loop parameter is adjusted, servo tuning must be performed again.

10.5.2 Selecting velocity detection method

The velocity change becomes smoother by setting velocity detection method. To let motor velocity become smoother, set Pt009 to t.□1□□ (Use velocity detection 2).

⚠CAUTION

- When tuneless function is enabled, velocity detection method cannot be used.
- After velocity detection method is changed, the response of velocity loop changes accordingly. Therefore, servo tuning must be performed again.
- When linear motor is used, velocity detection 2 is not supported.

Table10.5.2.1

Parameter		Description	Effective	Category
Pt009	t.□0□□ (Default)	Use velocity detection 1.	After power on	Tuning
	t.□1□□	Use velocity detection 2. (Do not support linear motor.)		

10.5.3 P (proportional) control

Input proportional control input (P-CON) signal from controller to switch to P control or PI control. In velocity mode, if velocity command is 0 and PI control is selected for velocity loop control, the motor may move due to integration. To avoid the above situation, PI control must be switched to P control. Use Pt000 = t.□□X□ and P-CON signal to switch to P control. P-CON signal is the signal used to switch between P control and PI control.

Table10.5.3.1

Type	Signal	Hardware Pin	Status	Description
Input	P-CON	CN6-30 (I2 signal) (Default)	ON	P control (Proportional control)
			OFF	PI control (Proportional-integral control)

■ Set the sensitivity when switching between P and PI controls
While switching between P control and PI control, use Pt183 (Sensitivity for mode switching (P/PI mode)) set the sensitivity when switching. Setting Pt183 aims to avoid overshoot during switching. The higher Pt183 is, the faster the switching is.

Table10.5.3.2

Parameter	Pt183	Range	0~100	Control Mode	Position mode and velocity mode
Default	10	Effective	Immediately	Unit	-
Description					
Sensitivity for P/PI switching					

10.6 Manual tuning

10.6.1 Adjusting servo gains

Users must have thorough understanding about the configuration and characteristics of the servo loop before manually adjusting servo gains. In most cases, if one parameter is largely adjusted, other parameters will also need to be adjusted again. To check the response of the servo loop, use measuring instrument to observe the output waveforms via analog monitor. The servo loop consists of position loop, velocity loop and current loop. The inner the loop is, the better the response must be. If this principle is not followed, it may result in poor response or vibration. Users do not need to adjust current loop, since current loop gain is set by the servo drive automatically.

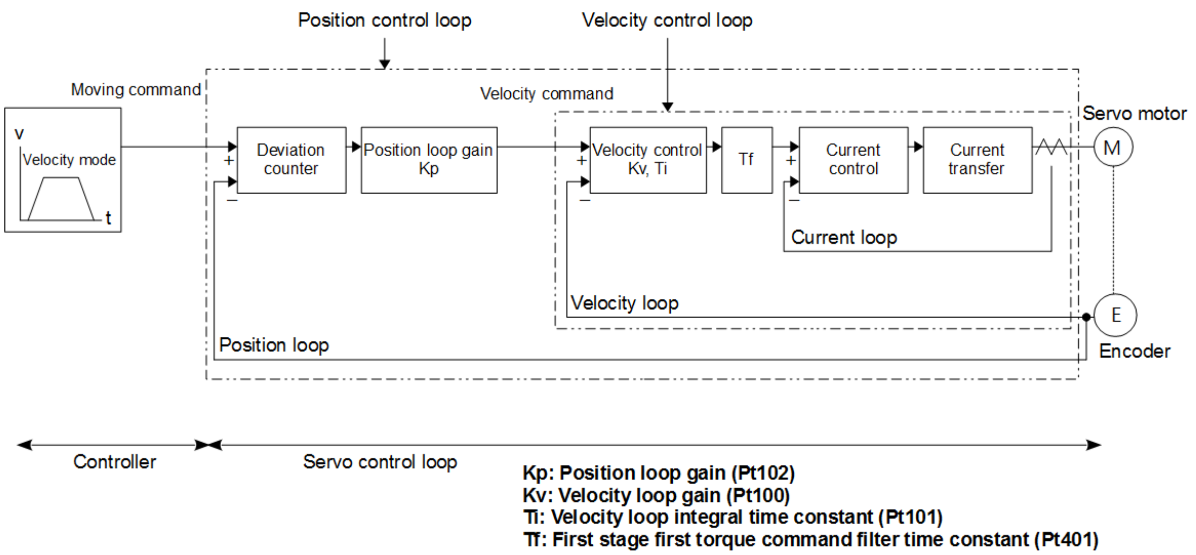


Figure10.6.1.1 Servo drive gain control

The response of the servo drive could be improved by manually adjusting servo gains. For instance, the positioning time could be shorter in position control. Manual tuning is suggested in the following cases.

(1) The desired tuning result is not achieved, after auto tuning is performed.

(2) The servo gains must be increased after auto tuning is performed.

Users can directly start manual tuning from the default settings of parameters or after auto tuning is performed.

- Precaution
  Install emergency stop device to immediately stop the motor when vibration occurs.

- Manual tuning procedure (Only position loop and velocity loop can be manually adjusted.)

  Step 1: Adjust first stage first torque command filter time constant (Pt401) so vibration does not occur.

  Step 2: Increase velocity loop gain (Pt100) as much as possible and decrease velocity loop integral time constant (Pt101) within the range that does not cause vibration.

  Step 3: Repeat step 1 and step 2. If vibration occurs, decrease the modified value by 10~20%.

  Step 4: In position control, increase position loop gain (Pt102) as much as possible within the range that does not cause vibration.

  While adjusting servo gains, if one parameter is largely adjusted, other parameters will also need to be adjusted again. Do not largely adjust one parameter only. While adjusting gain-related parameter, increase or decrease the value by 5% each time. For adjusting gain-related parameters, please refer to below.

- To increase response
  (1) Decrease first stage first torque command filter time constant (Pt401)
  (2) Increase velocity loop gain (Pt100)
  (3) Decrease velocity loop integral time constant (Pt101)
  (4) Increase position loop gain (Pt102)

- To decrease response to avoid vibration and overshoot
  (1) Decrease position loop gain (Pt102)
  (2) Increase velocity loop integral time constant (Pt101)
  (3) Decrease velocity loop gain (Pt100)
  (4) Increase first stage first torque command filter time constant (Pt401)

10.6.2 Gain parameters

■ Position loop gain

The response of the position loop in the servo drive is determined by position loop gain. The higher the position loop gain is, the better the response and the shorter the positioning time are. Normally, position loop gain cannot be too high. Otherwise, the machine may vibrate. To increase position loop gain, the mechanical stiffness must be improved.

When executing position mode multi-axis synchronization (circular interpolation, linear interpolation) with controller, a user has to adjust the position loop gain to be the same. This is to ensure the position response and error constants of each axis are the same.

Table10.6.2.1

Parameter	Pt102	Range	10 ~ 40000	Control Mode	Position mode
Default	400	Effective	Immediately	Unit	0.1/s
Description					
Position loop gain					

For machine with lower mechanical stiffness, since position loop gain cannot be too high, position deviation overflow alarm may occur while operating at high speed. At this time, increase the alarm value for overflow position deviation (Pt520 or Pt521) to increase the allowable range for position deviation.

◆ Alarm value for overflow position deviation (Pt520 or Pt521) (Setting unit: 1 control unit), please refer to section 10.2.3.

Table10.6.2.2

Parameter	Pt520	Range	1 ~ 1073741823	Control Mode	Position mode
Default	5242880	Effective	Immediately	Unit	1 control unit
Description					
Alarm value for overflow position deviation (rotary servo motor)					

Table10.6.2.3

Parameter	Pt521	Range	1 ~ 1073741823	Control Mode	Position mode
Default	500000	Effective	Immediately	Unit	1 control unit
Description					
Alarm value for overflow position deviation (linear servo motor)					

■ Velocity loop gain

Pt100 defines the response of velocity loop. Poor response in velocity loop leads to poor response in position loop. Due to this, overshoot may occur or velocity becomes stable slowly. Therefore, within the range that does not cause vibration, increase the setting value of velocity loop gain as much as possible to have better response.

Table10.6.2.4

Parameter	Pt100	Range	10 ~ 20000	Control Mode	Position mode and velocity mode
Default	400	Effective	Immediately	Unit	0.1 Hz
Description					
Velocity loop gain					

10.6.3 Torque command filter for resonance suppression

E1 series servo drive provides delay filters and notch filters shown in figure 10.6.3.1 for torque command to suppress resonance. Each filter operates independently. Use Pt408 = t.□□□X and t.□X□□ to disable or enable notch filter.

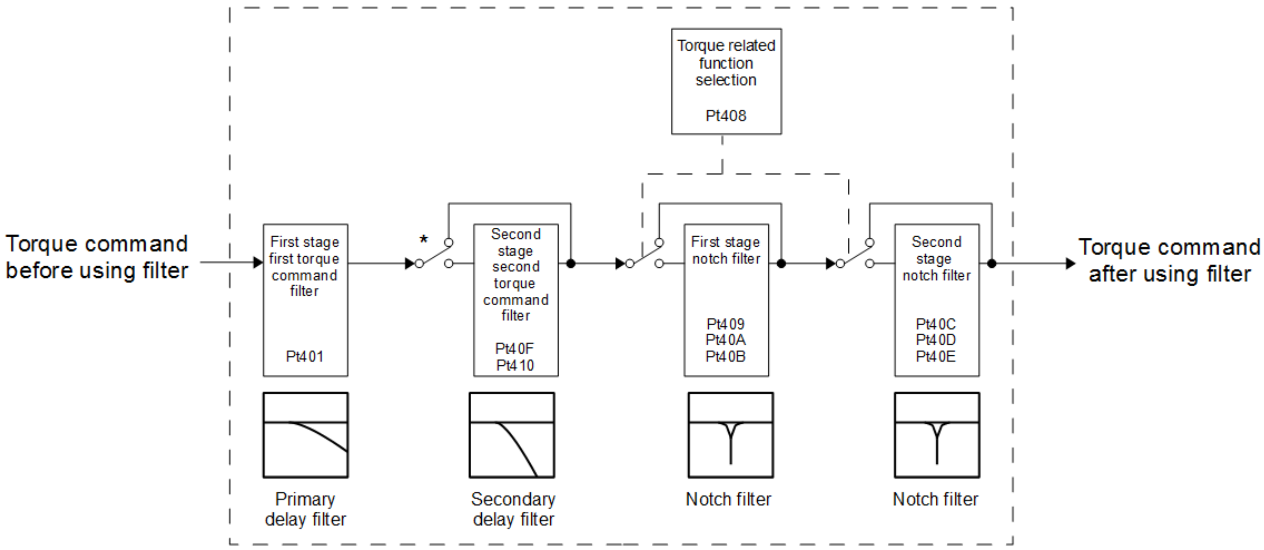


Figure10.6.3.1 Torque command filter

Note:

Second stage second torque command filter has no function when Pt40F = 5000 (Default). To use second stage second torque command filter, let Pt40F<5000.

- Torque command filter

If machine vibrates, adjust the following parameters to eliminate vibration.

Table10.6.3.1

Parameter	Pt401	Range	1~ 65535	Control Mode	Position mode, velocity mode and torque mode
Default	100	Effective	Immediately	Unit	0.01 ms
Description					
First stage first torque command filter time constant					

Table10.6.3.2

Parameter	Pt40F	Range	100 ~ 5000	Control Mode	Position mode and velocity mode
Default	5000	Effective	Immediately	Unit	1 Hz
Description					
Second stage second torque command filter frequency					

Table10.6.3.3

Parameter	Pt410	Range	50 ~ 100	Control Mode	Position mode and velocity mode
Default	50	Effective	Immediately	Unit	0.01
Description					
Second stage second torque command filter Q value					

- Notch filter

Notch filter removes certain vibration frequency. Gain curve is shown in figure 10.6.3.2. A notch is created on a certain frequency (notch frequency) to eliminate or reduce resonance point around notch frequency. To use notch filter, notch filter frequency, notch filter Q value and notch filter depth must be set. Notch filter Q value and notch filter depth are explained as below.

- Notch filter Q value

  Notch filter Q value defines the width of filtering frequency. The width of notch varies with the setting of notch filter Q value. As notch filter Q value increases, the width of filtering frequency becomes narrower.

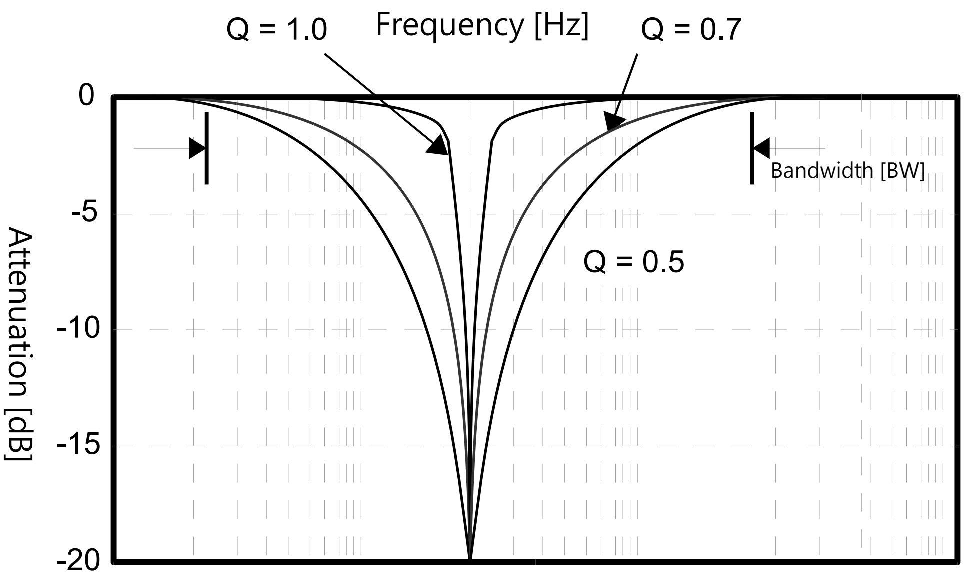


Figure10.6.3.2 Notch filter Q value

Q value and the bandwidth of notch filter are relevant. The formula for calculating the bandwidth is: Bandwidth (BW) = The frequency of notch filter (fc)/Q value

Table10.6.3.4

Q value	Bandwidth (Hz)
0.5	BW=fc/0.5
0.7	BW=fc/0.7
1	BW=fc/1

Example:

The frequency of notch filter is 200. The Q value is 0.5. Then the bandwidth (BW) is approximately 400 Hz.

- **Notch filter depth**

  Notch filter depth defines the depth of filtering frequency. The depth of notch varies with the setting of notch filter depth. As the value of notch filter depth decreases, the notch deepens and vibration suppression becomes more effective. Please be noted that vibration may be greater if the value is set to be too small. Set d = 1.0 (For example, Pt419 = 1000) to disable notch filter.

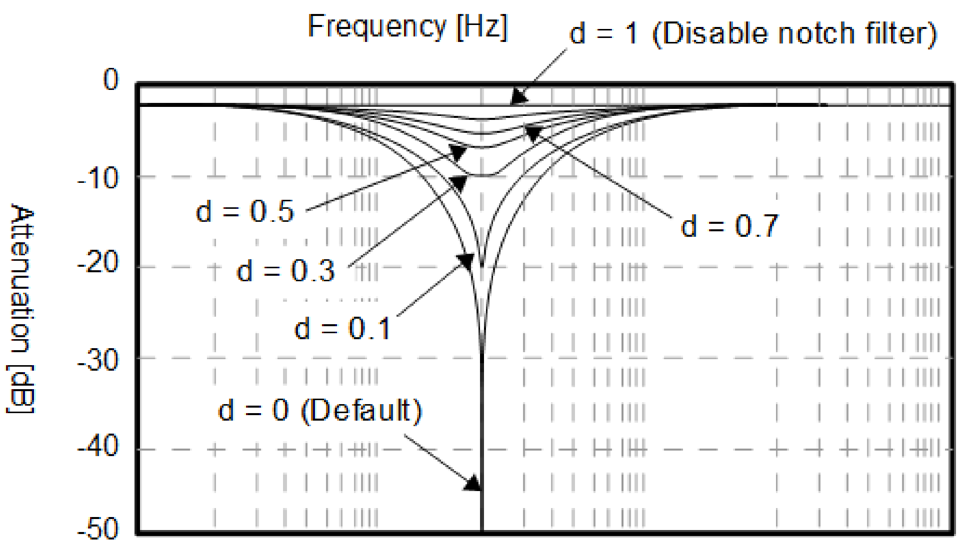


Figure10.6.3.3 Notch filter d value

d value defines the depth of notch filter. The formula for calculating the depth is: 20*log(d).

Table10.6.3.5

d Value	Depth (dB)
0	-∞ (The ideal value is negative infinity.)
0.1	-20
0.3	-10.457
0.5	-6.02
0.7	-3.098
1	0 (Notch filter has no function.)

◆ Parameters for setting notch filter

Table10.6.3.6

Parameter		Description	Effective	Category
Pt408	t.□□□0 (Default)	Disable first stage notch filter.	Immediately	Setup
	t.□□□1	Enable first stage notch filter.		
	t.□0□□ (Default)	Disable second stage notch filter.		
	t.□1□□	Enable second stage notch filter.		
Pt416	t.□□□0 (Default)	Disable third stage notch filter.		
	t.□□□1	Enable third stage notch filter.		
	t.□□0□ (Default)	Disable fourth stage notch filter.		
	t.□□1□	Enable fourth stage notch filter.		
	t.□0□□ (Default)	Disable fifth stage notch filter.		
	t.□1□□	Enable fifth stage notch filter.		

Table10.6.3.7

Parameter	Pt409	Range	50 ~ 5000	Control Mode	Position mode and velocity mode
Default	5000	Effective	Immediately	Unit	1 Hz
Description					
First stage notch filter frequency					

Table10.6.3.8

Parameter	Pt40A	Range	50 ~ 1000	Control Mode	Position mode and velocity mode
Default	70	Effective	Immediately	Unit	0.01
Description					
First stage notch filter Q value					

Table10.6.3.9

Parameter	Pt40B	Range	0 ~1000	Control Mode	Position mode and velocity mode
Default	0	Effective	Immediately	Unit	0.001
Description					
First stage notch filter depth					

Table10.6.3.10

Parameter	Pt40C	Range	50 ~ 5000	Control Mode	Position mode and velocity mode
Default	5000	Effective	Immediately	Unit	1 Hz
Description					
Second stage notch filter frequency					

Table10.6.3.11

Parameter	Pt40D	Range	50 ~ 1000	Control Mode	Position mode and velocity mode
Default	70	Effective	Immediately	Unit	0.01
Description					
Second stage notch filter Q value					

Table10.6.3.12

Parameter	Pt40E	Range	0 ~ 1000	Control Mode	Position mode and velocity mode
Default	0	Effective	Immediately	Unit	0.001
Description					
Second stage notch filter depth					

Table10.6.3.13

Parameter	Pt417	Range	50 ~ 5000	Control Mode	Position mode and velocity mode
Default	5000	Effective	Immediately	Unit	1 Hz
Description					
Third stage notch filter frequency					

Table10.6.3.14

Parameter	Pt418	Range	50 ~ 1000	Control Mode	Position mode and velocity mode
Default	70	Effective	Immediately	Unit	0.01
Description					
Third stage notch filter Q value					

Table10.6.3.15

Parameter	Pt419	Range	0 ~ 1000	Control Mode	Position mode and velocity mode
Default	0	Effective	Immediately	Unit	0.001
Description					
Third stage notch filter depth					

Table10.6.3.16

Parameter	Pt41A	Range	50 ~ 5000	Control Mode	Position mode and velocity mode
Default	5000	Effective	Immediately	Unit	1 Hz
Description					
Fourth stage notch filter frequency					

Table10.6.3.17

Parameter	Pt41B	Range	50 ~ 1000	Control Mode	Position mode and velocity mode
Default	70	Effective	Immediately	Unit	0.01
Description					
Fourth stage notch filter Q value					

Table10.6.3.18

Parameter	Pt41C	Range	0 ~ 1000	Control Mode	Position mode and velocity mode
Default	0	Effective	Immediately	Unit	0.001
Description					
Fourth stage notch filter depth					

Table10.6.3.19

Parameter	Pt41D	Range	50 ~ 5000	Control Mode	Position mode and velocity mode
Default	5000	Effective	Immediately	Unit	1 Hz
Description					
Fifth notch filter frequency					

Table10.6.3.20

Parameter	Pt41E	Range	50 ~ 1000	Control Mode	Position mode and velocity mode
Default	70	Effective	Immediately	Unit	0.01
Description					
Fifth notch filter Q value					

Table10.6.3.21

Parameter	Pt41F	Range	0 ~ 1000	Control Mode	Position mode and velocity mode
Default	0	Effective	Immediately	Unit	0.001
Description					
Fifth notch filter depth					

Note

(1) The setting value of notch filter frequency (Pt409, Pt40C, Pt417, Pt41A and Pt41D) must not be too close to the setting value of velocity loop gain (Pt100). It should be at least four times larger than the setting value of velocity loop gain (Pt100). Pt103 (Moment of inertia ratio) must be correctly set. Incorrect setting may cause vibration and damage to machine.

(2) Notch filter frequency (Pt409, Pt40C, Pt417, Pt41A and Pt41D) must be set when the motor stops. Modifying notch filter frequency while the motor is still operating may cause vibration.

10.6.4 Vibration suppression

Vibration suppression function can suppress low-frequency vibration (1 Hz~200 Hz) caused by machine vibration when positioning. It is an effective solution to vibration frequency which cannot be tackled by notch filter and is especially useful when load is installed on cantilever beam which causes obvious vibration. The related parameters of vibration suppression function are automatically set when auto tuning is performed.

⚠CAUTION

- ◆ Do not change vibration suppression frequency (Pt14A) and vibration suppression compensation (Pt14B) when the motor is moving, or it may cause unexpected vibration and error.
- ◆ Do not enable or disable vibration suppression function (Pt140= t.□□X□) when the motor is moving, or it may cause unexpected vibration and error.
- ◆ Vibration suppression function can be used when tuneless function is enabled or disabled (Pt170= t.□□□X).

- Item which affects performance

  If vibration continues when motor stops, vibration suppression function may not be able to suppress the vibration successfully. In this case, please perform auto tuning.

- Parameters for vibration suppression

Table10.6.4.1

Parameter		Description	Effective	Category
Pt140	t.□□0□ (Default)	Do not perform vibration suppression.	Immediately	Tuning
	t.□□1□	Perform vibration suppression on specific frequency.		

Table10.6.4.2

Parameter	Pt14A	Range	10~2000	Control Mode	Position mode
Default	800	Effective	Immediately	Unit	0.1 Hz
Description					
Set vibration suppression frequency.					

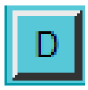
Table10.6.4.3

Parameter	Pt14B	Range	10 ~ 1000	Control Mode	Position mode
Default	500	Effective	Immediately	Unit	1%
Description					
Set vibration suppression compensation.					

- Procedure of using vibration suppression function

  For how to find vibration frequency and enable vibration suppression filter, please refer to below.

  Step 1: Set acceleration, deceleration, velocity, dwell time and travel distance. Perform point-to-point (P2P) motion. (This can be performed in **Test run** of Thunder.)

  Step 2: Click on  in Thunder and then click on 

in **Scope**. Observe position error (X_pos_err), reference velocity (X_vel_ff_int) and reference position (X_ref_pos).

  Step 3: After the motor moves between P1 and P2 for more than three times, record the waveforms.

Step 4: Observe the waveform of reference velocity (X_vel_ff_int) during dwell time (The segment when velocity command stops and starts) and enlarge the waveform of positon error (X_pos_err). Select the range and click on the icon indicated in figure below to zoom in.

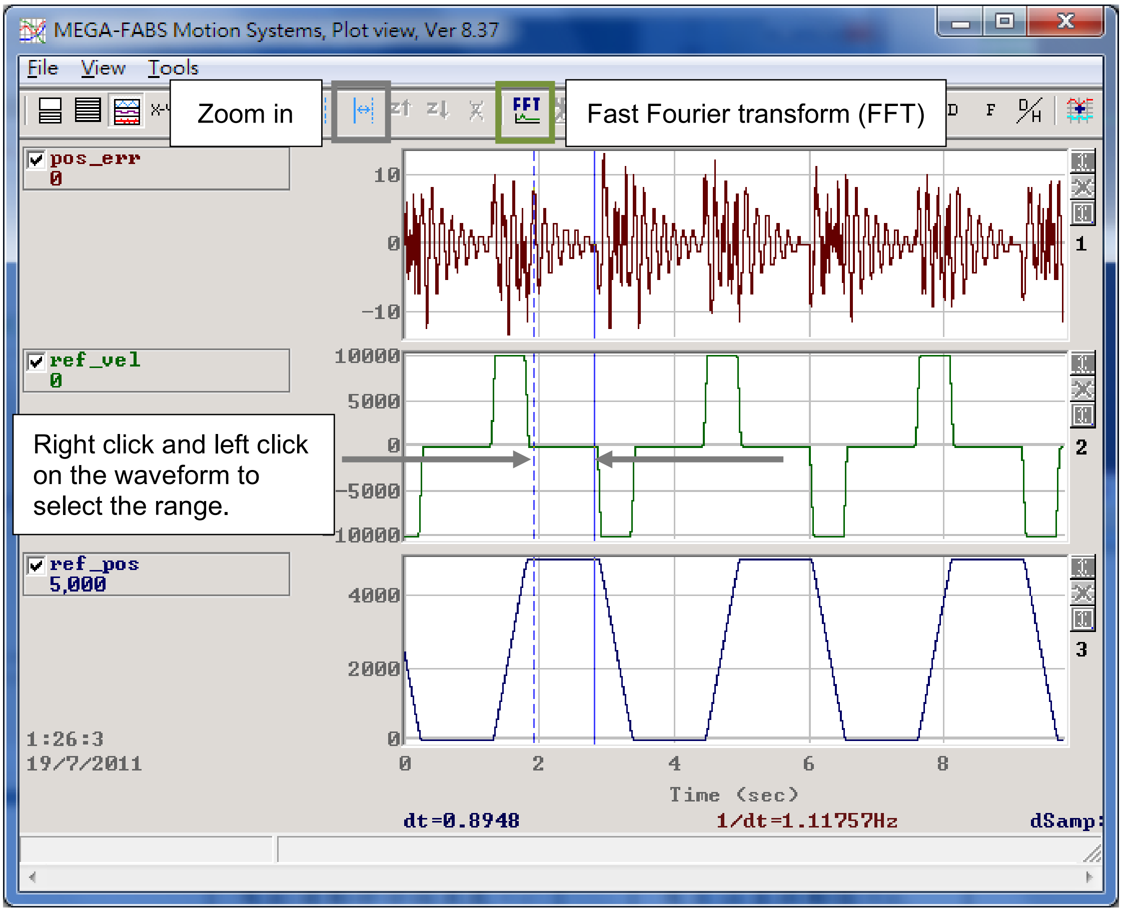


Figure10.6.4.1

Step 5: Click on the icon indicated in figure below to do fast Fourier transform of positon error (X_pos_err).

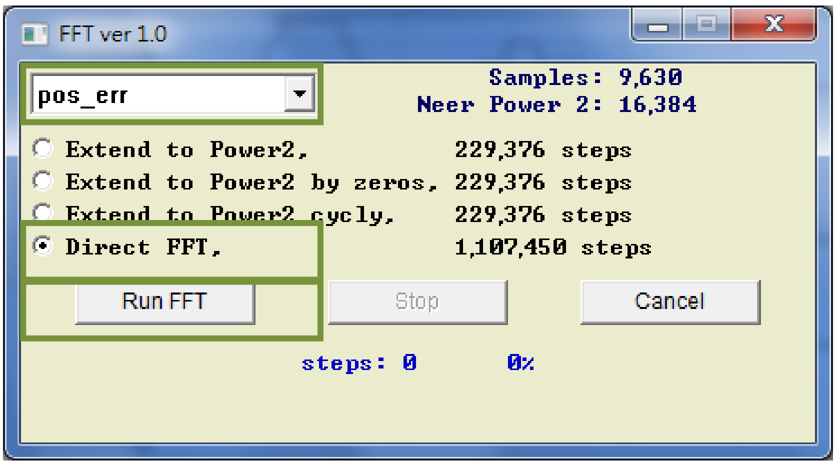


Figure10.6.4.2

Step 6: After fast Fourier transform completes, zoom in on the segment of low frequency.

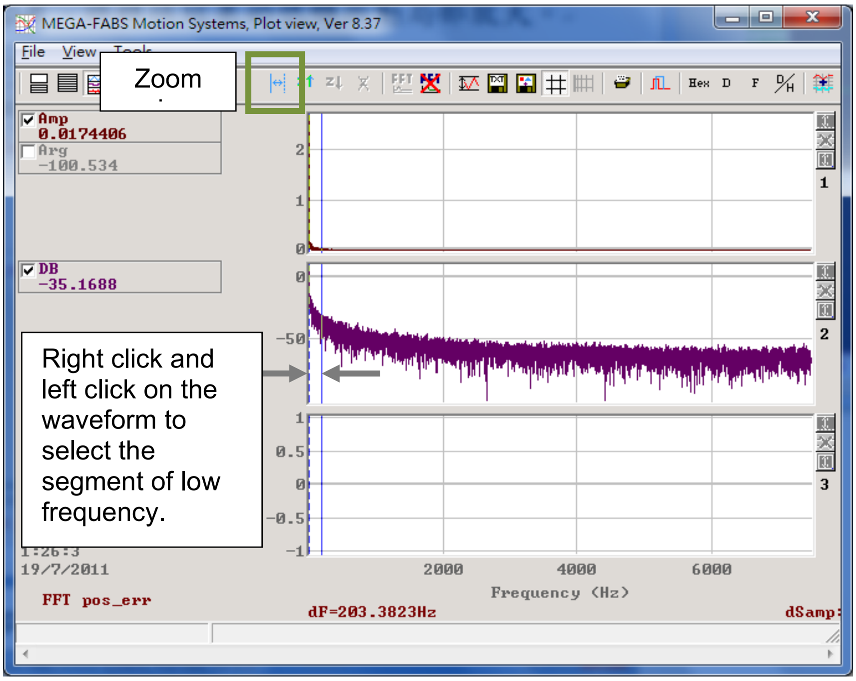


Figure10.6.4.3

Step 7: Observe the maximum amplitude.

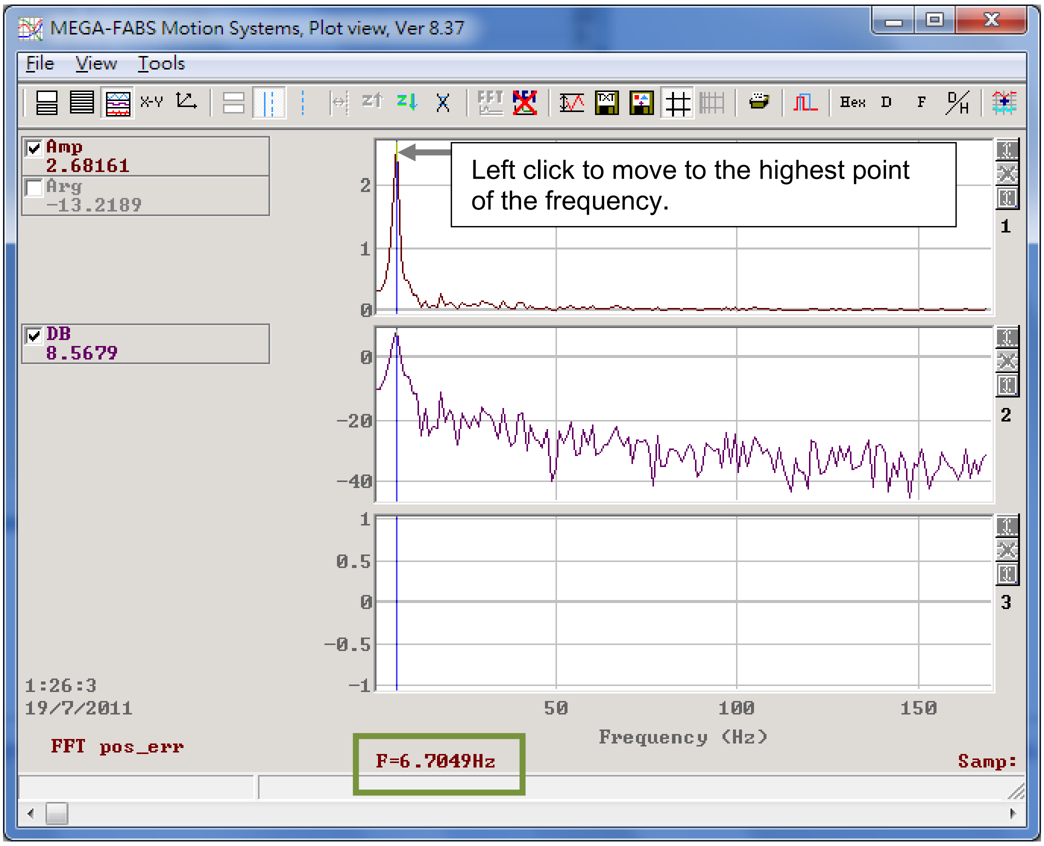


Figure10.6.4.4

Step 8: Set the frequency (In figure 10.6.4.4, the frequency is 6.7 Hz.) of low-frequency vibration in vibration suppression frequency (Pt14A). Set vibration suppression compensation (Pt14B). The higher the value, the greater the effect. Users can use the default value for testing first.

Step 9: Ensure the motor stops and set Pt140 to t.□□1□ to enable vibration suppression function. Check if the vibration is suppressed. Record the waveform to see if the position error decreases and adjust vibration suppression compensation (Pt14B). To adjust Pt14B, the motor must be stopped and vibration suppression function must be disabled (Pt140 = t.□□0□).

10.6.5 Ripple compensation function

Ripple compensation function is used to suppress low speed ripple caused by the magnetic poles of motor. Low speed ripple is a low-frequency vibration which varies with velocity.

Table10.6.5.1

Parameter		Description	Effective	Control Mode	Category
Pt423	t.□□□0 (Default)	Disable velocity ripple compensation.	After power on	Position mode and velocity mode	Setup
	t.□□□1	Enable velocity ripple compensation.			

⚠CAUTION

◆ Ripple compensation function can only be used after tuneless function is disabled (Pt170= t.□□□X).

Table10.6.5.2

Parameter		Description	Effective	Category
Pt423	t.0□□□	Ripple compensation sensitivity level 0 (Low)	Immediately	Setup
	t.1□□□	Ripple compensation sensitivity level 1		
	t.2□□□	Ripple compensation sensitivity level 2		
	t.3□□□	Ripple compensation sensitivity level 3		
	t.4□□□	Ripple compensation sensitivity level 4		
	t.5□□□	Ripple compensation sensitivity level 5		
	t.6□□□	Ripple compensation sensitivity level 6		
	t.7□□□	Ripple compensation sensitivity level 7		
	t.8□□□	Ripple compensation sensitivity level 8		
	t.9□□□	Ripple compensation sensitivity level 9		
	t.A□□□	Ripple compensation sensitivity level 10		
	t.B□□□	Ripple compensation sensitivity level 11		
	t.C□□□	Ripple compensation sensitivity level 12		
	t.D□□□	Ripple compensation sensitivity level 13		
	t.E□□□	Ripple compensation sensitivity level 14		
	t.F□□□	Ripple compensation sensitivity level 15 (High)		

Note:
Please adjust the servo gain to suitable condition before enabling ripple compensation function.

■ Measurement procedure for velocity ripple

In motion control, motion stability at the constant-velocity phase can be estimated by velocity ripple. Motor cogging force, cable chain, air pipeline and guideway friction are the main factors causing velocity variation at the constant-velocity phase. The velocity ripple is usually used for scanning or detecting machines which require high stability at the constant-velocity phase. The equation of velocity ripple is:

$$\text{Velocity ripple (ripA)} = \frac{V_{max} - V_{min}}{V_{average}} \times 100\%$$

In the equation, $V_{average}$ is the average velocity, V_{max} is the maximum velocity at the constant-velocity phase, and V_{min} is the minimum velocity at the constant-velocity phase.

The steps of measuring velocity ripple are shown as below.

Step 1: Click “Open Test Run” icon  in the toolbar to open “Test Run” window. After setting motion parameters (e.g., target velocity, acceleration time, deceleration time), click **Enable** to enable the motor.

Step 2: Set **P1** and **P2** to execute point-to-point (P2P) test or set **Distance** to execute relative move test. By doing so, the motor will move back and forth between the travel distance to be tested.

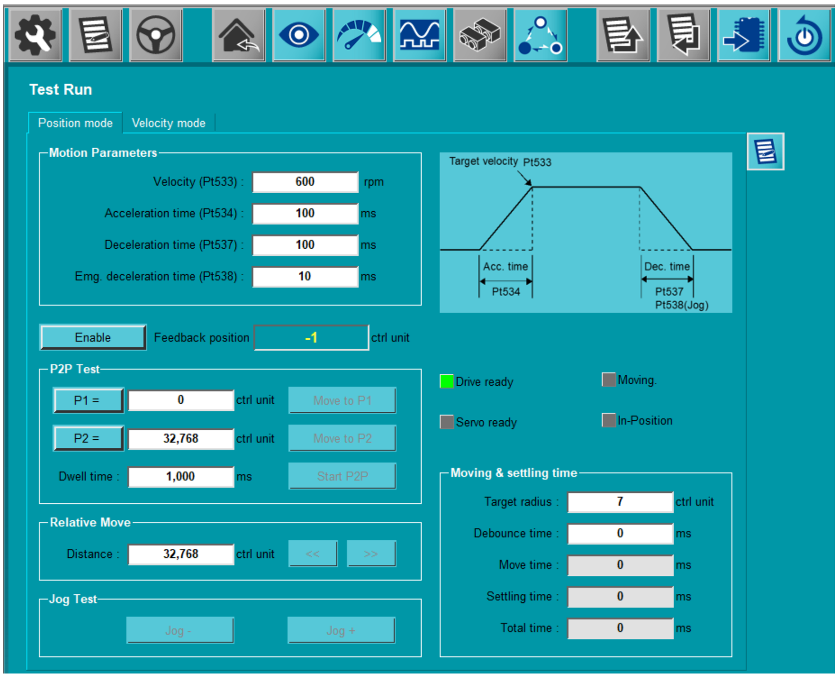


Figure 10.6.5.1

Step 3: Click “Open Scope” icon  in the toolbar to open “Scope” window. Set the monitoring item as **7 - Motor velocity**.

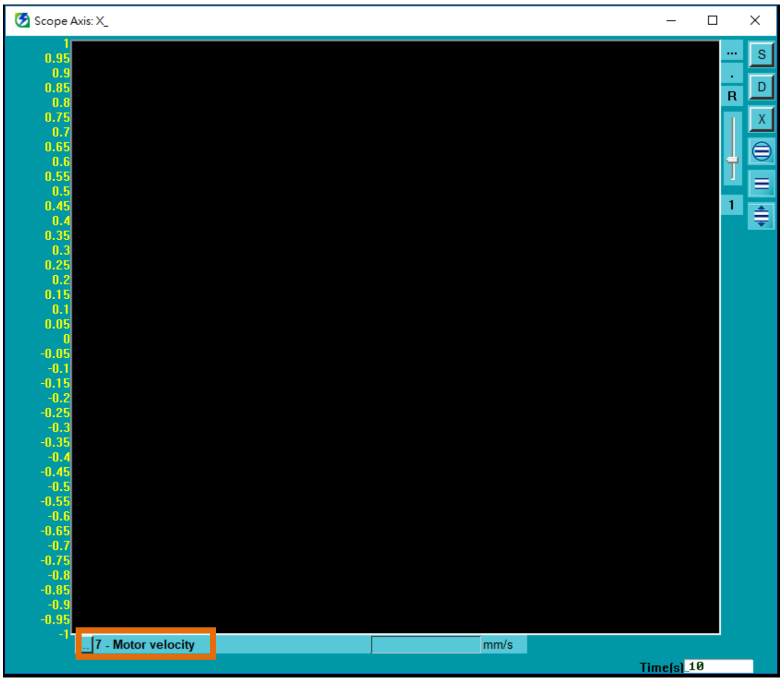
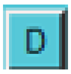


Figure 10.6.5.2

Step 4: Click  to open “Real-time data collection” window.

Step 5: Click **Start(F5)** button to start collecting data.

Step 6: After the motor has moved back and forth for two or three times, click **Stop** button to stop collecting data and click **Graph** button to open “Plot view” window.

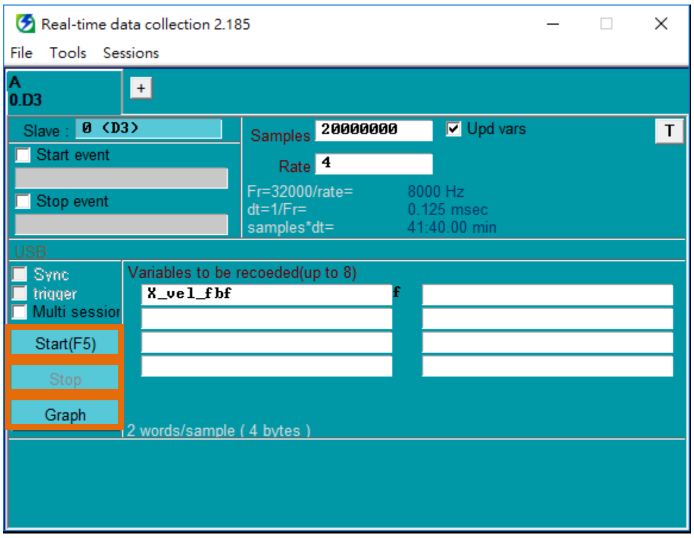


Figure 10.6.5.3

Step 7: In “Plot view” window, get blue solid line (left-click) and get blue dashed line (right-click) to frame the constant-velocity phase to be observed.

Step 8: Click “Zoom the area between cursors” icon  to zoom in the framed waveform.

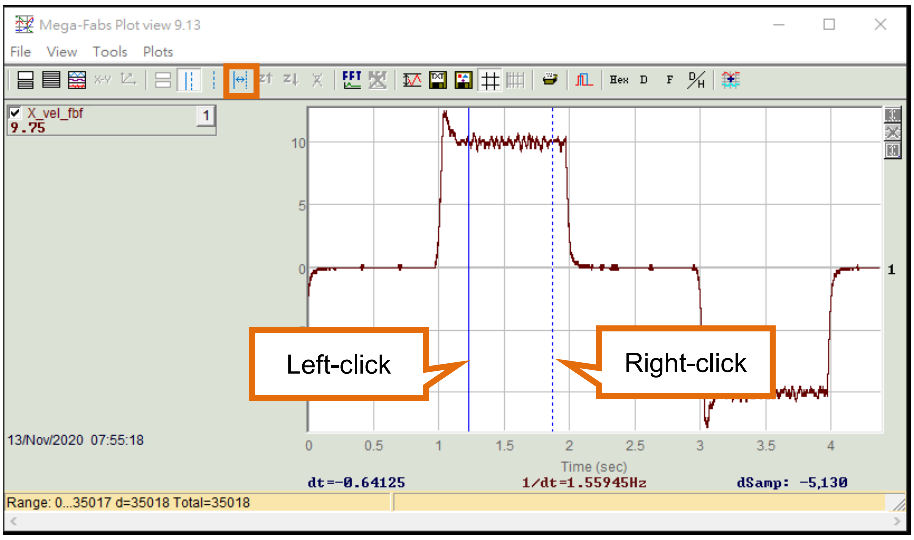


Figure 10.6.5.4

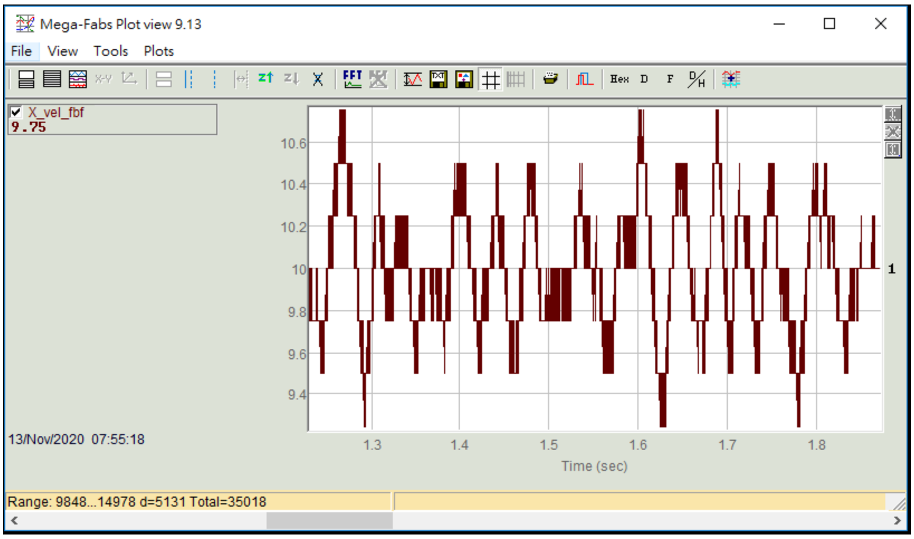
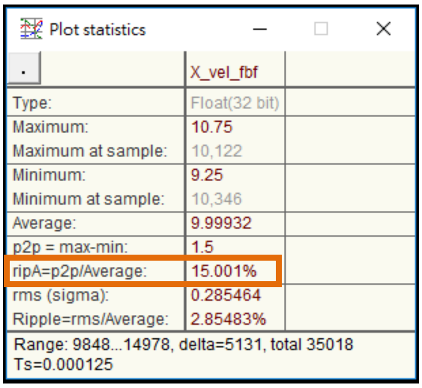


Figure 10.6.5.5

Step 9: Click “Statistics table” icon  to open “Plot statistics” window.

Find out **ripA** corresponding to parameter **X_vel_fbf**, then users can get the velocity ripple (%).



Plot statistics

.	X_vel_fbf
Type:	Float(32 bit)
Maximum:	10.75
Maximum at sample:	10,122
Minimum:	9.25
Minimum at sample:	10,346
Average:	9.99932
p2p = max-min:	1.5
ripA=p2p/Average:	15.001%
rms (sigma):	0.285464
Ripple=rms/Average:	2.85483%

Range: 9848...14978, delta=5131, total 35018
Ts=0.000125

Figure 10.6.5.6

10.6.6 Friction compensation function

Friction compensation function is used to compensate viscous friction fluctuation and regular load fluctuation.

Table10.6.6.1

Parameter		Description	Effective	Applicable Mode	Category
Pt408	t.0□□□ (Default)	Disable friction compensation function.	Immediately	Position mode and velocity mode	Setup
	t.1□□□	Enable friction compensation function.			

⚠CAUTION

◆ Friction compensation function can only be executed after tuneless function is disabled (Pt170 = t.□□□X).

Table10.6.6.2

Parameter	Pt121	Range	1~ 1000	Control Mode	Position mode and velocity mode
Default	30	Effective	Immediately	Unit	1%
Description					
Friction compensation gain					

Table10.6.6.3

Parameter	Pt122	Range	1~ 1000	Control mode	Position mode and velocity mode
Default	30	Effective	Immediately	Unit	1%
Description					
Second friction compensation gain					

Table10.6.6.4

Parameter	Pt126	Range	0~ 10000	Control Mode	Position mode and velocity mode
Default	0	Effective	Immediately	Unit	rpm
Description					
Dead band of velocity command for friction compensation (rotary servo motor)					

Table10.6.6.5

Parameter	Pt127	Range	0~ 10000	Control Mode	Position mode and velocity mode
Default	0	Effective	Immediately	Unit	mm/s
Description					
Dead band of velocity command for friction compensation (linear servo motor)					

10.6.7 Speed feedback filter

When a motor is equipped with an encoder with lower resolution, the high frequency response of the servo drive may result in high frequency noise. A user can use speed feedback filter to depress the noise during the operation.

This is usually used when the linear motor reader resolution is more than 0.5 um/count.

Table10.6.7.1

Reader resolution um/count	Pt308
0.5	10
1	15
5	30

Table 10.6.7.2

Parameter	Pt308	Range	1 ~ 65535	Control Mode	Position mode
Default	1	Effective	Immediately	Unit	0.01 ms
Description					
Speed feedback filter time constant.					

10.7 Common functions for tuning

10.7.1 Feedforward

Feedforward is used to shorten decrease position deviation during motion with constant velocity in position control.

When executing position mode multi-axis synchronization with controller(circular interpolation, linear interpolation), a user has to adjust the position loop gain to be the same.

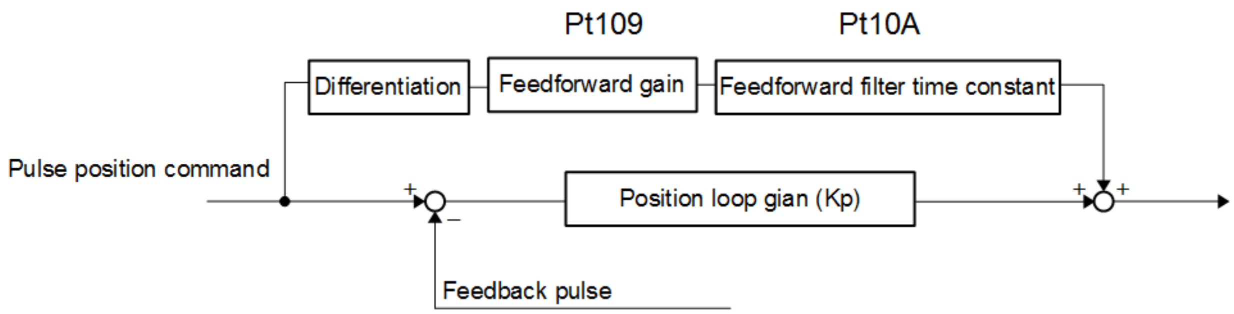


Figure10.7.1.1 Feedforward command control

Table10.7.1.1

Parameter	Pt109	Range	0 ~ 100	Control Mode	Position mode
Default	0	Effective	Immediately	Unit	1%
Description					
Feedforward					

Table10.7.1.2

Parameter	Pt10A	Range	0 ~ 6400	Control Mode	Position mode
Default	0	Effective	Immediately	Unit	0.01 ms
Description					
Feedforward filter time constant					

Note:
If feedforward is too large, the machine may vibrate. The setting value of feedforward must be under 80%.

10.7.2 Torque feedforward and velocity feedforward

Torque feedforward and velocity feedforward can shorten settling time. Torque feedforward and velocity feedforward are set after position command is differentiated by controller.

- Torque feedforward
  Torque feedforward can be used in velocity mode and position mode. Torque feedforward command is input from controller with velocity command. Velocity command (V-REF) is input via CN6-14 and CN6-15. Torque feedforward command (T-REF) is input via CN6-16 and CN6-17.

- Velocity feedforward
  Velocity feedforward can only be used in position mode. Velocity feedforward command is input from controller with position command. Velocity feedforward command (V-REF) is input via CN6-14 and CN6-15.

- Setting related parameters
  (1) Torque feedforward
  Torque feedforward is set by torque control selection (using T-REF signal) (Pt002 = t. □□□X), torque command input gain (Pt400) and T-REF filter time constant. In default setting, Pt400 is set to 30. Therefore, when torque feedforward is set to ±3 V, it is 100% of torque (rated torque).

Table10.7.2.1

Parameter		Description	Effective	Category
Pt002	t.□□□0 (Default)	Do not use T-REF signal.	After power on	Setup
	t.□□□1	Use T-REF signal as external torque limit.		
	t.□□□2	Use T-REF signal as torque feedforward input.		
	t.□□□3	When P-CL or N-CL signal is ON, use T-REF signal as external torque limit input.		

Table10.7.2.2

Parameter	Pt400	Range	10 ~ 100	Control Mode	Position mode and velocity mode
Default	30	Effective	Immediately	Unit	0.1 V/rated torque
Description					
Torque command input gain					

Table10.7.2.3

Parameter	Pt415	Range	0~65535	Control Mode	Position mode and velocity mode
Default	0	Effective	Immediately	Unit	0.01 ms
Description					
T-REF filter time constant					

Table10.7.2.4

Parameter	Pt426	Range	0 ~ 500	Control Mode	Position mode and velocity mode
Default	0	Effective	Immediately	Unit	0.25 ms
Description					
Average torque feedforward movement time					

Note:

(1) If torque feedforward command is set to be too large, overshoot may occur. Observe the response when tuning.

(2) Do not use it while limiting torque with analog command.

(2) Velocity feedforward

Set velocity feedforward by position control selection (Pt207 = t.□□X□) and velocity command input gain (Pt300). In default setting, Pt300 is set to 600. Therefore, when velocity feedforward is set to ±6 V, it will be the rated velocity.

Table10.7.2.5

Parameter		Description	Effective	Category
Pt207	t.□□0□ (Default)	Do not use V-REF signal.	After power on	Setup
	t.□□1□	Use V-REF signal as velocity feedforward input.		

Table10.7.2.6

Parameter	Pt300	Range	150~3000	Control Mode	Position mode, velocity mode and torque mode
Default	600	Effective	Immediately	Unit	0.01 V/rated velocity
Description					
Velocity command input gain					

Table10.7.2.7

Parameter	Pt307	Range	0~65535	Control Mode	Position mode, velocity mode and torque mode
Default	40	Effective	Immediately	Unit	0.01 ms
Description					
Velocity command filter time constant					

Table10.7.2.8

Parameter	Pt30C	Range	0~500	Control Mode	Position mode, velocity mode and torque mode
Default	0	Effective	Immediately	Unit	0.25 ms
Description					
Average velocity feedforward movement time					

Note:
If velocity feedforward command is set to be too large, overshoot may occur. Observe the response when
tuning.

10.7.3 Position integration

Set the integration function for position loop by Pt11F (Position integral time constant).

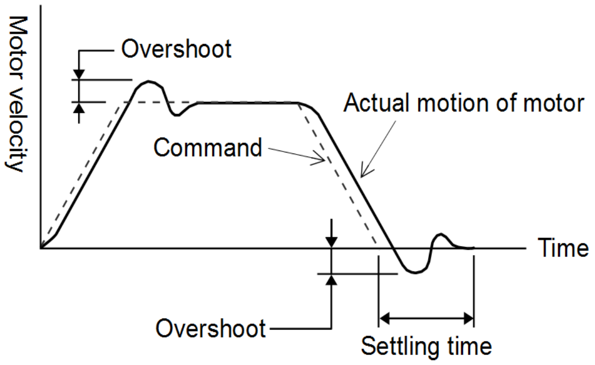
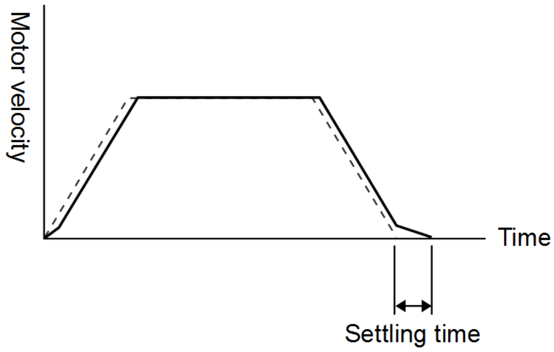
Table10.7.3.1

Parameter	Pt11F	Range	1 ~ 50000	Control Mode	Position mode
Default	1	Effective	Immediately	Unit	0.1 ms
Description					
Position integral time constant					

10.7.4 P/PI mode switching selection

P/PI mode switching selection is used to automatically switch between P control and PI control under different operating condition. Set switching condition and its level by parameters to suppress overshoot during acceleration and deceleration and shorten settling time.

Table10.7.4.1

P/PI mode switching selection is not applied.	P/PI mode switching selection is applied.
	

■ Related parameters

Set switching condition by Pt10B = t.□□□X (Mode switching selection (P/PI mode)).

Table10.7.4.2

Parameter		P/PI Mode Switching Selection	Parameter for Level of Switching Condition		Effective	Category
			Rotary	Linear		
Pt10B	t.□□□0 (Default)	Use internal torque command as the switching condition for mode switching.	Pt10C		Immediately	Setup
	t.□□□1	Use velocity command as the switching condition for mode switching.	Pt10D	Pt181		
	t.□□□2	Use acceleration command as the switching condition for mode switching.	Pt10E	Pt182		
	t.□□□3	Use position deviation as the switching condition for mode switching.	Pt10F			
	t.□□□4	Do not use mode switching function.	N/A			

- Parameters for setting switching condition level and sensitivity

  Set the sensitivity for P/PI mode switching

  While using P/PI mode switching function, set the switching sensitivity byPt183 (Sensitivity for mode switching (P/PI mode)). The higher the setting value is, the faster the switching is.

Table10.7.4.3

Parameter	Pt183	Range	0~100	Control Mode	Position mode and velocity mode
Default	10	Effective	Immediately	Unit	-
Description					
Sensitivity for mode switching (P/PI mode)					

(1) Rotary servo motor

Table10.7.4.4

Parameter	Pt10C	Range	0~800	Control Mode	Position mode and velocity mode
Default	200	Effective	Immediately	Unit	1% rated torque
Description					
Set P/PI mode switching (torque command).					

Note:
If the set value of Pt10C is too small, it is possible that P control keeps on with the existence of position error. This will lead to the result that position error can not gradually become smaller with integration process.

Table10.7.4.5

Parameter	Pt10D	Range	0~10000	Control Mode	Position mode and velocity mode
Default	0	Effective	Immediately	Unit	1 rpm
Description					
Set P/PI mode switching (velocity command).					

Table10.7.4.6

Parameter	Pt10E	Range	0~30000	Control Mode	Position mode and velocity mode
Default	0	Effective	Immediately	Unit	1 rpm/s
Description					
Set P/PI mode switching (acceleration).					

Table10.7.4.7

Parameter	Pt10F	Range	0~10000	Control Mode	Position mode
Default	0	Effective	Immediately	Unit	1 control unit
Description					
Set P/PI mode switching (position deviation).					

(2) Linear servo motor

Table10.7.4.8

Parameter	Pt10C	Range	0~800	Control Mode	Position mode and velocity mode
Default	200	Effective	Immediately	Unit	1% rated force
Description					
Set P/PI mode switching (force command).					

Note:

If the set value of Pt10C is too small, it is possible that P control keeps on with the existence of position error. This will lead to the result that position error can not gradually become smaller with integration process.

Table10.7.4.9

Parameter	Pt181	Range	0~10000	Control Mode	Position mode and velocity mode
Default	0	Effective	Immediately	Unit	1 mm/s
Description					
Set mode switching (velocity command).					

Table10.7.4.10

Parameter	Pt182	Range	0~30000	Control Mode	Position mode and velocity mode
Default	0	Effective	Immediately	Unit	1 mm/s^2
Description					
Set mode switching (acceleration).					

Table10.7.4.11

Parameter	Pt10F	Range	0~10000	Control Mode	Position mode
Default	0	Effective	Immediately	Unit	1 control unit
Description					
Set P/PI mode switching (position deviation).					

■ Use torque command as P/PI mode switching condition (Default)

When torque command exceeds the torque set in torque/force command for mode switching (P/PI mode)(Pt10C), velocity loop is switched to P control. In default setting, the torque command value is set to 200%.

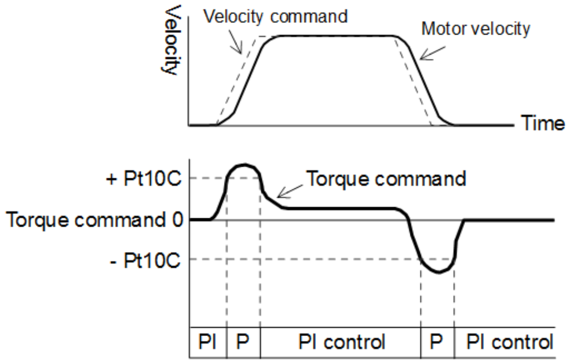


Figure10.7.4.1

■ Use velocity command as P/PI mode switching condition

(1) Rotary servo motor

When velocity command exceeds the velocity set in velocity command for mode switching (P/PI mode) (Pt10D), velocity loop is switched to P control.

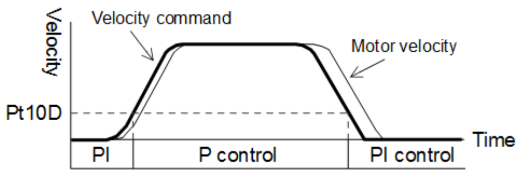


Figure10.7.4.2

(2) Linear servo motor

If velocity command exceeds the velocity set in velocity command for mode switching (P/PI mode) (Pt181), velocity loop is switched to P control.

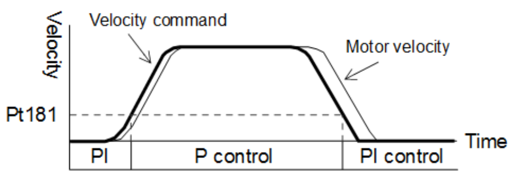


Figure10.7.4.3

- Use acceleration as P/PI mode switching condition

(1) Rotary servo motor

When acceleration exceeds the acceleration set in acceleration command for mode switching (P/PI mode) (Pt10E), velocity loop is switched to P control.

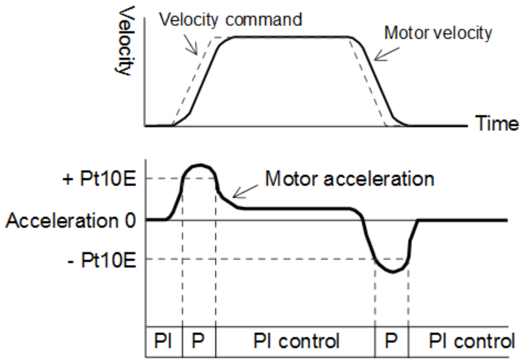


Figure10.7.4.4

(2) Linear servo motor

When acceleration exceeds the acceleration set in acceleration command for mode switching (P/PI mode) (Pt182), velocity loop is switched to P control.

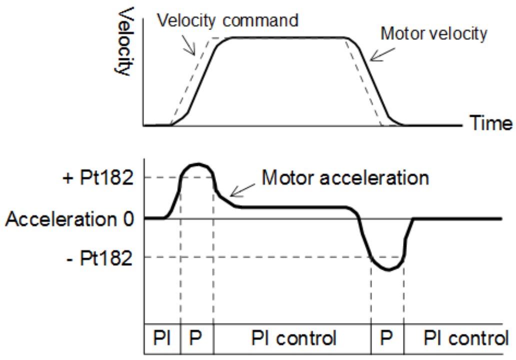


Figure10.7.4.5

- Use position deviation as P/PI mode switching condition

  When position deviation exceeds the value set in position deviation for mode switching (P/PI mode) (Pt10F), velocity loop is switched to P control. This setting can only be used in position mode.

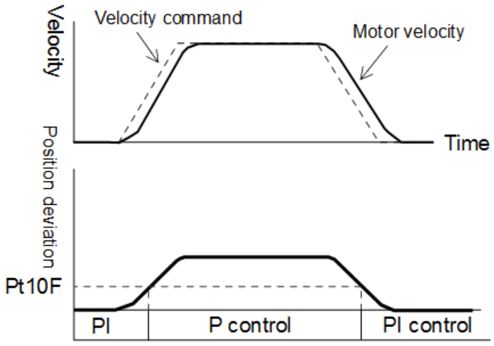


Figure10.7.4.6

10.7.5 Gain switching

Gain switching function has two switching modes: manual gain switching and automatic gain switching. For manual gain switching, the gain is selected by external input signal. For automatic gain switching, the gain is automatically changed according to the set condition. When gain switching function is used, gain can be increased during positioning to shorten settling time and it can be decreased when the motor stops to suppress vibration.

Table10.7.5.1

Parameter		Description	Effective	Category
Pt139	t.□□□0 (Default)	Manual gain switching	Immediately	Tuning
	t.□□□2	Automatic gain switching		

Note:

t.□□□1 is reserved (Do not modify.).

■ Combinations of gain switching

Table10.7.5.2

Gain Switching	Velocity Loop Gain	Velocity Loop Integral Time Constant	Positon Loop Gain	Torque Command Filter	Feedforward	Velocity Loop Gain in Gantry Control System	Velocity Loop Integral Time Constant in Gantry Control System	Position Loop Gain in Gantry Control System
First gain	Velocity loop gain (Pt100)	Velocity loop integral time constant (Pt101)	Position loop gain (Pt102)	First stage first torque command filter time constant (Pt401)	Feedforward (Pt109)	Velocity loop gain in gantry control system (Pt190)	Velocity loop integral time constant in gantry control system (Pt191)	Position loop gain in gantry control system (Pt192)
Second gain	Second velocity loop gain (Pt104)	Second velocity loop integral time constant (Pt105)	Second position loop gain (Pt106)	First stage second torque command filter time constant (Pt412)	Second feedforward (Pt110)	Second velocity loop gain in gantry control system (Pt194)	Second velocity loop integral time constant in gantry control system (Pt195)	Second position loop gain in gantry control system (Pt196)

■ Manual gain switching

For manual gain switching, use external input signal (G-SEL) to switch between first gain and second gain.

Table10.7.5.3

Type	Signal	Hardware Pin	Status	Description
Input	G-SEL	User-defined	ON	Switch to second gain.
			OFF	Switch to first gain.

■ Automatic gain switching

Table10.7.5.4

Parameter		Switching Condition	Switching Gain	Waiting Time	Switching Time
Pt139	t.□□□2	Condition A is satisfied.	First gain→Second gain	Waiting time 1 (Pt135)	Switching time 1 (Pt131)
		Condition A is not satisfied.	Second gain→First gain	Waiting time 2 (Pt136)	Switching time 2 (Pt132)

■ The switching condition A of automatic gain switching can be set in Pt139=t.□□X□.

Table10.7.5.5

Parameter		Switching Condition A in Position Control	Other Control Mode	Effective	Category
Pt139	t.□□0□ (Default)	Positioning completion output (COIN) signal is ON.	Fixed at first gain.	Immediately	Tuning
	t.□□1□	Positioning completion output (COIN) signal is OFF.	Fixed at second gain.		
	t.□□2□	Positioning near output (NEAR) signal is ON.	Fixed at first gain.		
	t.□□3□	Positioning near output (NEAR) signal is OFF.	Fixed at second gain.		
	t.□□4□	Position command filter output stops outputting and input pulse command is OFF.	Fixed at first gain.		
	t.□□5□	Position input pulse command is ON.	Fixed at second gain.		

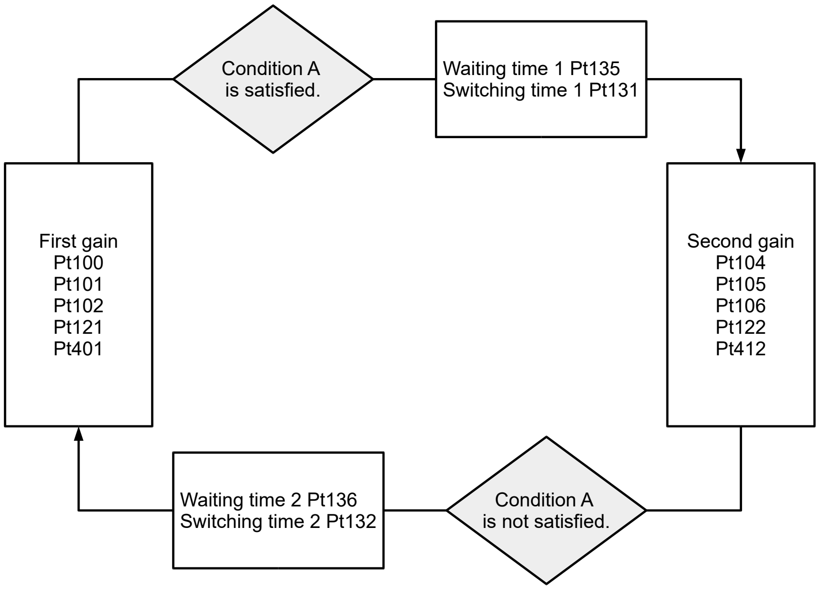


Figure10.7.5.1

■ The relationship between waiting time and switching time

For example, use automatic gain switching and set switching condition A as when positioning completion output (COIN) signal is ON. After switching condition A is satisfied, the gain is changed from position loop gain (Pt102) to second position loop gain (Pt106). Refer to the figure below. After positioning completion output (COIN) signal is ON and waiting time (Pt135) elapses, the gain is linearly changed from Pt102 to Pt106 within switching time (Pt131).

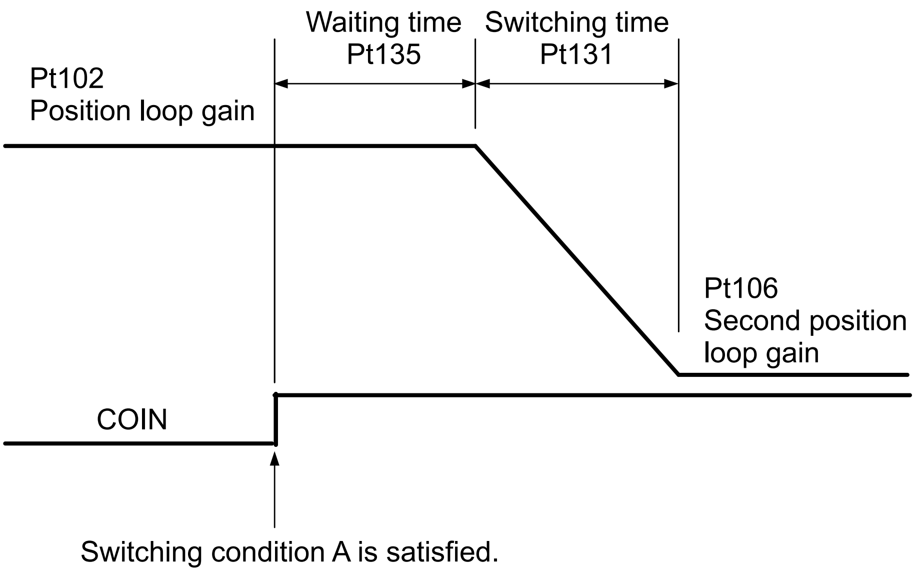


Figure10.7.5.2

■ Related parameters

Table10.7.5.6

Parameter	Pt100	Range	10 ~ 20000	Control Mode	Position mode and velocity mode
Default	400	Effective	Immediately	Unit	0.1 Hz
Description					
Velocity loop gain					

Table10.7.5.7

Parameter	Pt101	Range	15 ~ 51200	Control Mode	Positon mode and velocity mode
Default	2000	Effective	Immediately	Unit	0.01 ms
Description					
Velocity loop integral time constant					

Table10.7.5.8

Parameter	Pt102	Range	10 ~ 40000	Control Mode	Position mode
Default	400	Effective	Immediately	Unit	0.1/s
Description					
Position loop gain					

Table10.7.5.9

Parameter	Pt109	Range	0 ~ 100	Control Mode	Position mode
Default	0	Effective	Immediately	Unit	1%
Description					
Feedforward					

Table10.7.5.10

Parameter	Pt190	Range	10 ~ 20000	Control Mode	Position mode and velocity mode
Default	400	Effective	Immediately	Unit	0.1 Hz
Description					
Velocity loop gain in gantry control system					

Table10.7.5.11

Parameter	Pt191	Range	15 ~ 51200	Control Mode	Position mode and velocity mode
Default	2000	Effective	Immediately	Unit	0.01 ms
Description					
Velocity loop integral time constant in gantry control system					

Table10.7.5.12

Parameter	Pt192	Range	10 ~ 40000	Control Mode	Position mode
Default	400	Effective	Immediately	Unit	0.1/s
Description					
Position loop gain in gantry control system					

Table10.7.5.13

Parameter	Pt401	Range	1 ~ 65535	Control Mode	Position mode, velocity mode and torque mode
Default	100	Effective	Immediately	Unit	0.01 ms
Description					
First stage first torque command filter time constant					

Table10.7.5.14

Parameter	Pt104	Range	10 ~ 20000	Control Mode	Position mode and velocity mode
Default	400	Effective	Immediately	Unit	0.1 Hz
Description					
Second velocity loop gain					

Table10.7.5.15

Parameter	Pt105	Range	15 ~ 51200	Control Mode	Position mode and velocity mode
Default	2000	Effective	Immediately	Unit	0.01 ms
Description					
Second velocity loop integral time constant					

Table10.7.5.16

Parameter	Pt106	Range	10 ~ 40000	Control Mode	Position mode
Default	400	Effective	Immediately	Unit	0.1/s
Description					
Second position loop gain					

Table10.7.5.17

Parameter	Pt110	Range	0 ~ 100	Control Mode	Position mode
Default	0	Effective	Immediately	Unit	1%
Description					
Second feedforward					

Table10.7.5.18

Parameter	Pt194	Range	10 ~ 20000	Control Mode	Position mode and velocity mode
Default	400	Effective	Immediately	Unit	0.1 Hz
Description					
Second velocity loop gain in gantry control system					

Table10.7.5.19

Parameter	Pt195	Range	15 ~ 51200	Control Mode	Position mode and velocity mode
Default	2000	Effective	Immediately	Unit	0.01 ms
Description					
Second velocity loop integral time constant in gantry control system					

Table10.7.5.20

Parameter	Pt196	Range	10 ~ 40000	Control Mode	Position mode
Default	400	Effective	Immediately	Unit	0.1/s
Description					
Second position loop gain in gantry control system					

Table10.7.5.21

Parameter	Pt412	Range	1 ~ 65535	Control Mode	Position mode, velocity mode and torque mode
Default	100	Effective	Immediately	Unit	0.01 ms
Description					
First stage second torque command filter time constant					

■ Related parameters of automatic gain switching

Table10.7.5.22

Parameter	Pt131	Range	0 ~ 65535	Control Mode	Position mode
Default	0	Effective	Immediately	Unit	1 ms
Description					
Gain switching time 1					

Table10.7.5.23

Parameter	Pt132	Range	0 ~ 65535	Control Mode	Position mode
Default	0	Effective	Immediately	Unit	1 ms
Description					
Gain switching time 2					

Table10.7.5.24

Parameter	Pt135	Range	0 ~ 65535	Control Mode	Position mode
Default	0	Effective	Immediately	Unit	1 ms
Description					
Gain switching waiting time 1					

Table10.7.5.25

Parameter	Pt136	Range	0 ~ 65535	Control Mode	Position mode
Default	0	Effective	Immediately	Unit	1 ms
Description					
Gain switching waiting time 2					

■ Setting analog monitor signal

Table10.7.5.26

Parameter		Name	Description		Effective	Category
Pt006	t.□□0B	Analog monitor 1 signal selection	1 V	First gain is effective.	Immediately	Setup
			2 V	Second gain is effective.		
Pt007	t.□□0B	Analog monitor 2 signal selection	1 V	First gain is effective.		
			2 V	Second gain is effective.		

10.7.6 Gain multiplier

This function is mainly used to adjust the output servo gain of each motion section by time table for gain multiplier. By doing so, the servo gain requirement of each motion section (moving, settling, in-position) can be satisfied. Users can adjust the scale of the gain in the motion section with the parameter to shorten settling time and suppress vibration.

- Time table for gain multiplier

  A motion can be roughly divided into three sections (Please refer to section 8.4.4):
  - Moving section: From the start of path planning to the end of path planning.
  - Settling section: From the end of path planning to in-position section.
  - In-position section: Output in-position signal.

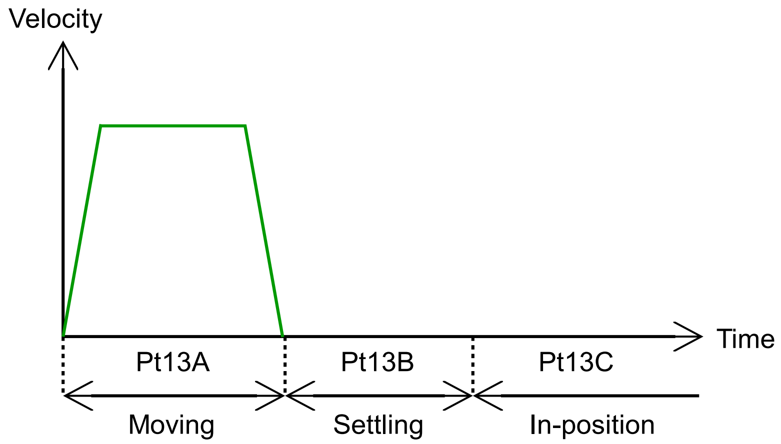


Figure 10.7.6.1

- Adjustment method

  The three sections divided by time table for gain multiplier correspond to three parameters, moving section gain multiplier (Pt13A), settling section gain multiplier (Pt13B) and in-position section gain multiplier (Pt13C). Parameter adjustment is the scale of overall gain, and the default is 100%. Please adjust the parameters based on time table for gain multiplier to meet the requirement of each motion section. For example, setting moving section gain multiplier (Pt13A) as 200 means the servo gain activated in moving section is twice the size of overall gain.

■ Related parameters

Table 10.7.6.1

Parameter	Pt13A	Range	1~1000	Control Mode	Position mode
Default	100	Effective	Immediately	Unit	1%
Description					
Moving section gain multiplier.					

Table 10.7.6.2

Parameter	Pt13B	Range	1~1000	Control Mode	Position mode
Default	100	Effective	Immediately	Unit	1%
Description					
Settling section gain multiplier.					

Table 10.7.6.3

Parameter	Pt13C	Range	1~1000	Control Mode	Position mode
Default	100	Effective	Immediately	Unit	1%
Description					
In-position section gain multiplier.					

Note: After auto tuning is executed, the default gain multiplier parameters will all be adjusted to 100 (default value).

10.7.7 Field weakening control

When the motor needs to run faster than the rated speed, field weakening control can be enabled to increase the motor speed.

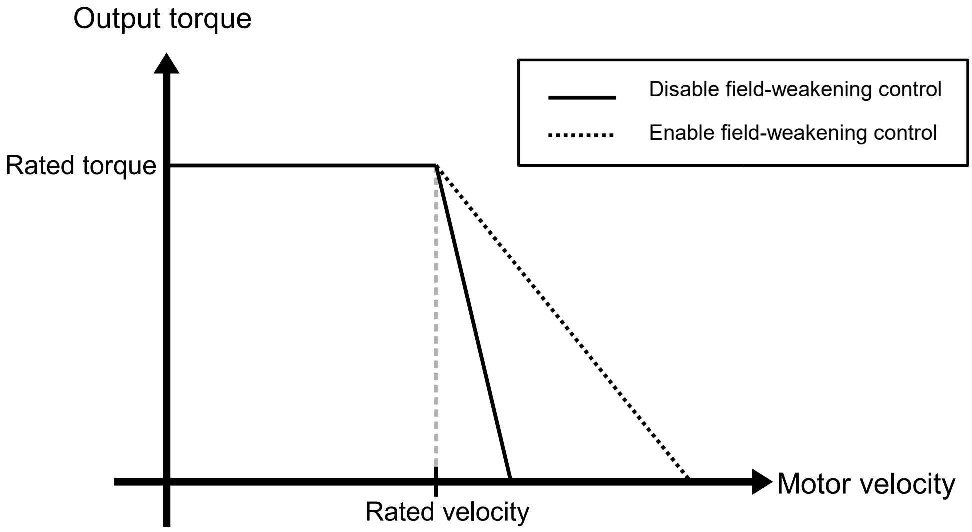


Figure10.7.6.1

Table10.7.6.1

Parameter		Description	Effective	Category
Pt00D	t.□□0□ (Default)	Disable field-weakening control	After power on	Setup
	t.□□1□	Enable field-weakening control		

- Field weakening control response

Table10.7.6.2

Parameter	Pt4A0	Range	1 ~ 100	Control Mode	Position mode, velocity mode and torque mode
Default	10	Effective	Immediately	Unit	1 %
Description					
Gain ratio for field-weakening control					

Note:
This parameter is mainly for the acceleration and deceleration response during field weakening control. The higher the value, the faster the response. Generally speaking, there is no need to adjust this parameter.

■ Field weakening control voltage utilization

Table10.7.6.3

Parameter	Pt4A1	Range	85 ~ 100	Control Mode	Position mode, velocity mode and torque mode
Default	85	Effective	Immediately	Unit	1 %
Description					
Ratio of voltage utilization rate for field-weakening control					

Note:

This parameter mainly adjusts the output voltage of the drive that enters the field weakening control. The larger the value, the greater the voltage output by the drive and the closer to the rated voltage of the motor. However, if the setting is too large, the performance of the field weakening control may be affected.

⚠CAUTION

- The field weakening control is not applicable to all motors.Theferfore, before enabling the field weakening control, be sure to confirm the motor's running capability and characteristics; otherwise, the motor may be damaged.
- Be sure to set the correct value for Pt52E. Otherwise, it will cause the motor overheat.
- Different input power will affect the maximum velocity of the motor in the field weakening control.

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11. Monitoring

11.1 Servo drive information

11.1.1 Monitoring servo drive information

The servo drive information can be found in the left column of the main screen of Thunder.

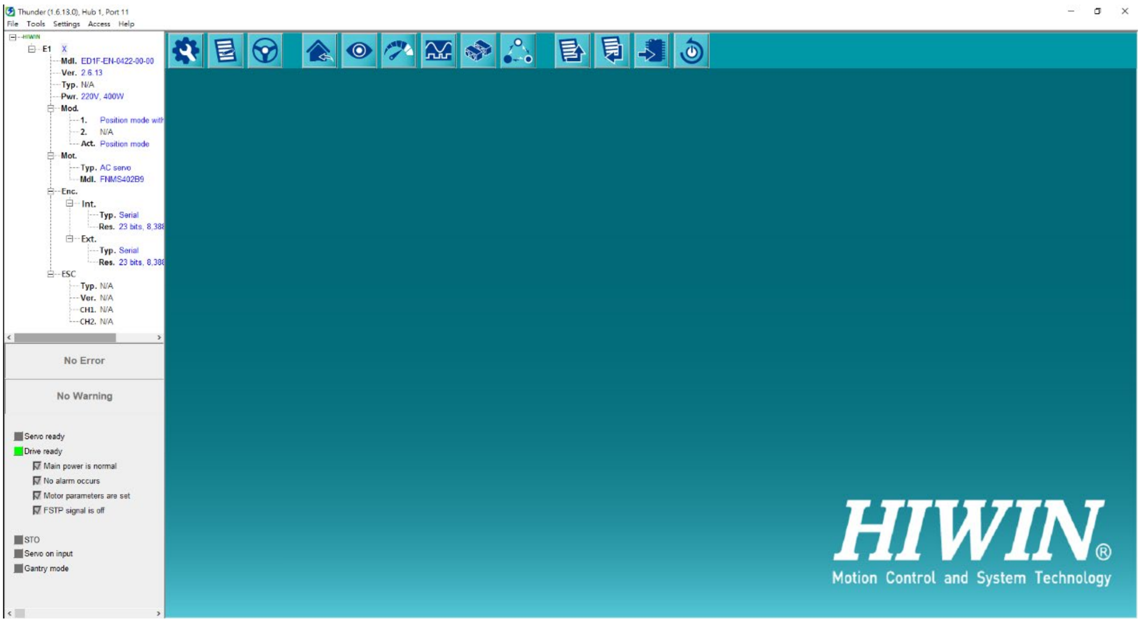


Figure11.1.1.1 The information displayed in the main screen of Thunder

11.1.2 Monitoring items of servo drive information

The servo drive information displayed in the main screen of Thunder is shown in table 11.1.2.1.

Table11.1.2.1

Servo Drive Information	(1) Servo drive model (2) Servo drive firmware version (3) Servo drive frame and rated output
Motor Information	(1) Motor type (2) Motor model
Encoder Information	(1) Encoder type (2) Encoder resolution
Information Of Excellent Smart Cube (ESC)	(1) ESC model (2) ESC firmware version

11.2 Servo drive status

11.2.1 Monitoring servo drive status

Click on  in the main screen of Thunder to open **Interface signal monitor** window to monitor servo drive status.

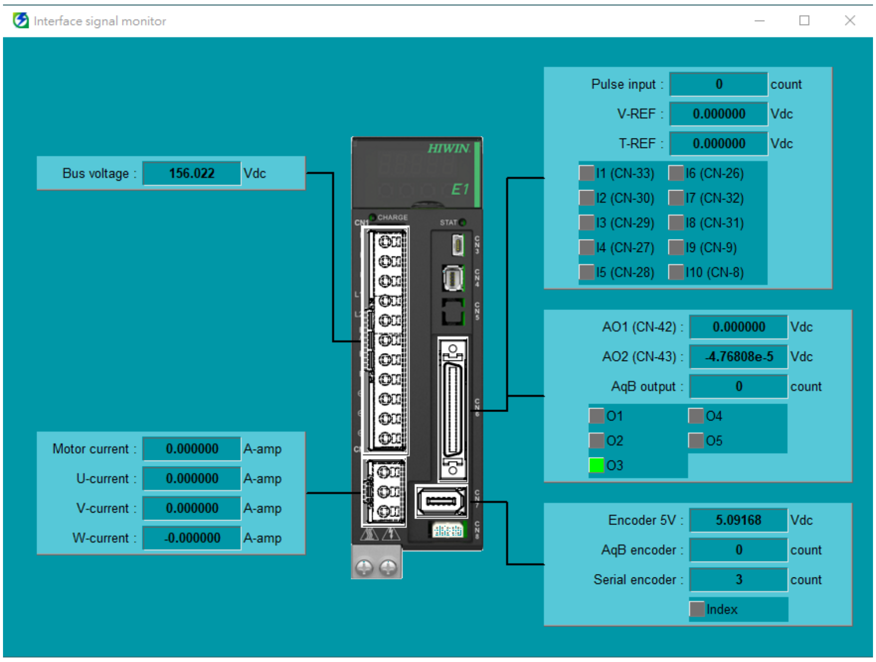


Figure11.2.1.1 The displayed information in **Interface signal monitor** window

11.2.2 Monitoring items of servo drive status

The monitoring items displayed in **Interface signal monitor** window are shown in table 11.2.2.1.

Table11.2.2.1

Monitoring Items	
Internal Status	I/O Signal Status
(1) The voltage of main power cable (Bus voltage) (2) The position information of serial encoder (Serial encoder) (3) The position information of incremental encoder (AqB encoder) (4) The 5 Vdc voltage for encoder (Encoder 5V) (5) The current of motor (Motor current) (6) Three-phase current (U, V, W) (U, V, W-current)	(1) Pulse command input pulses (Pulse input) (2) Encoder output pulses (AqB output) (3) Velocity command voltage (V-REF) (4) Torque command voltage (T-REF) (5) Digital input signals (I1~I10) (6) Digital output signals (O1~O5) (7) Analog signal output voltage (AO1, AO2)

11.3 Monitoring physical quantity and servo status

11.3.1 Monitoring physical quantity

The physical quantities which can be monitored are shown in the grey boxes in figure 11.3.1.1 and listed in table 11.3.1.1.

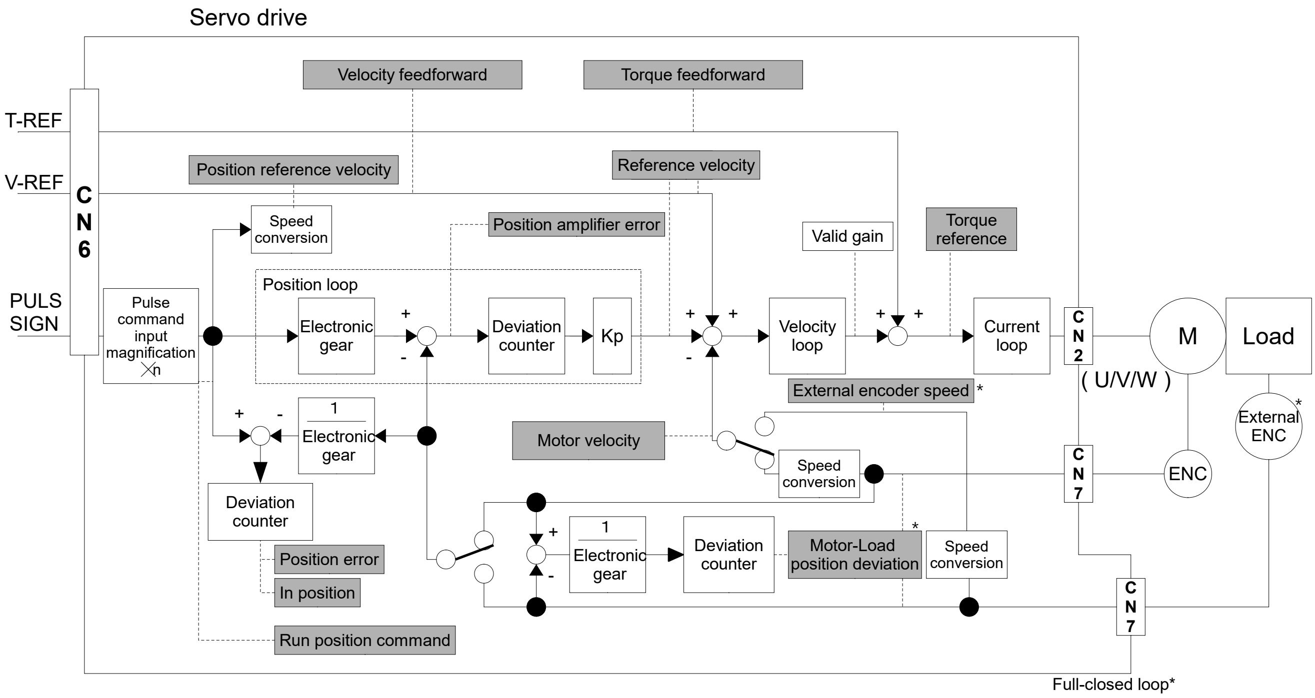
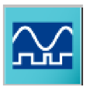


Figure11.3.1.1 Monitoring physical quantity

Table11.3.1.1 Physical quantities which can be monitored

Physical Quantity
(1) Position error
(2) In position
(3) Run position command
(4) Position amplifier error
(5) Position reference speed
(6) Motor-Load position deviation
(7) Velocity feedforward
(8) Reference velocity
(9) Motor velocity
(10) Torque feedforward
(11) Torque reference
(12) Command current

11.3.2 Scope and data collection

Thunder provides **Scope** for users to monitor physical quantity and motion state in real time. Click on  in the main screen of Thunder to open **Scope**. Eight channels (maximum) can be monitored at the same time. Select the physical quantity and motion state to be monitored from the drop-down list.

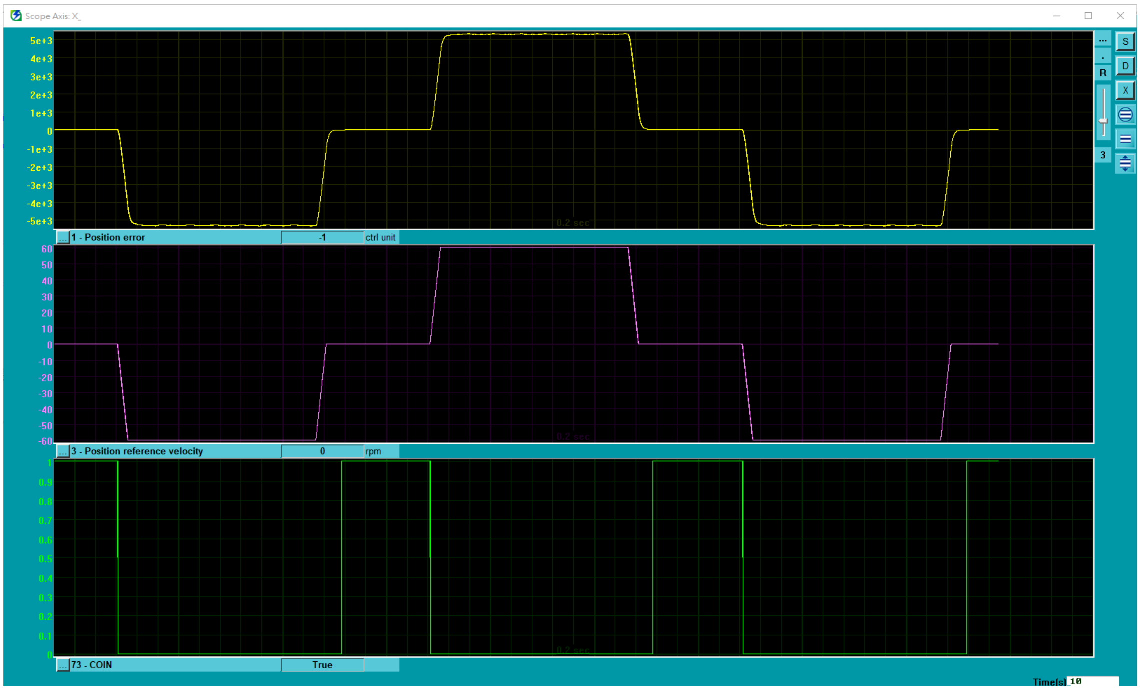
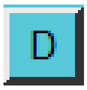


Figure11.3.2.1 Monitoring motion state from **Scope**

To closely monitor physical quantity and motion state, click on **Tools** on the menu bar of Thunder. Select **Real-time data collection** from the submenu or click on 

in the upper right corner of **Scope** window to open the window shown in figure 11.3.2.2.

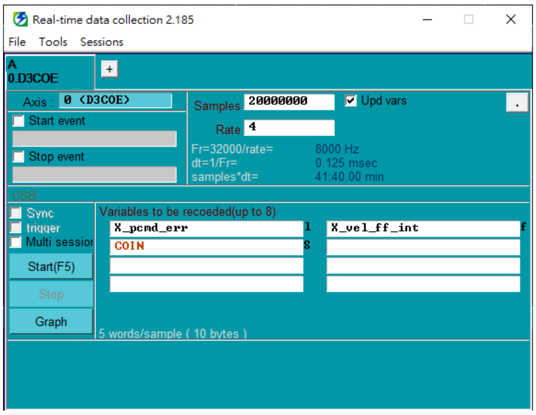


Figure11.3.2.2 **Real-time data collection** setting window

Table11.3.2.1 Monitoring items in **Scope**

Monitoring Items	
Physical Quantity	Servo Signal Status
(1) Position error	(51) S-ON //servo on input signal
(2) Feedback position	(52) P-CON //proportional control input signal
(3) Position reference velocity	(53) P-OT //forward prohibition input signal
(4) Motor-Load position deviation	(54) N-OT //reverse prohibition input signal
(5) Velocity feedforward	(55) ALM-RST //alarm reset input signal
(6) Reference velocity	(56) P-CL //forward external torque limit input signal
(7) Motor velocity	(57) N-CL //reverse external torque limit input signal
(8) Torque feedforward	(58) C-SEL //control method switching input signal
(9) Torque reference	(59) SPD-D //motor rotation direction input signal
(10) Command current	(60) SPD-A //internal set velocity input signal
(11) Motor current	(61) SPD-B //internal set velocity input signal
(12) Servo voltage percentage	(62) ZCLAMP //zero clamp input signal
(13) Digital hall signal	(63) INHIBIT //command pulse inhibition input signal
(14) Motor overload protection	(64) G-SEL //gain switching input signal
(15) Position amplifier error	(65) PSEL //command pulse multiplication switching input signal
(16) Velocity error	(66) RST //servo drive reset input signal
(17) Master feedback position	(67) DOG //near home sensor input signal
(18) Slave feedback position	(68) HOM //servo drive built-in homing procedure input signal
(19) Yaw position	(69) MAP //servo drive error map input signal
(20) Run position command	(70) FSTP //forced stop input signal
(21) Effective gain	(71) CLR //position deviation clear input signal
(22) Internal feedback position	(72) ALM //alarm output signal
(23) Gantry linear command current	(73) COIN //positioning completion output signal
(24) Gantry yaw command current	(74) V-CMP //velocity reach output signal
(25) Gantry yaw postion error	(75) TGON //rotation detection/movement detection output signal
(26) Load side single-turn position (multi-motion only)	(76) D-RDY //drive ready output signal
	(77) S-RDY //servo ready output signal
	(78) CLT //torque limit detection output signal
	(79) VLT //velocity limit detection output signal
	(80) BK //brake control output signal
	(81) WARN //warning output signal
	(82) NEAR //positioning near output signal
	(83) PSELA //command pulse multiplication switching output signal
	(84) PT //position trigger digital output signal
	(85) DBK //external dynamic brake output signal
	(86) HOMED //servo drive homing completion output signal
	(87) PAO //encoder divided pulse output signal-A phase
	(88) PBO //encoder divided pulse output signal-B phase
	(89) PZO //encoder divided pulse output signal-Z phase
	(90) INDEX //index signal

11.4 Using measuring instrument

11.4.1 Changing scale and offset

Users can change the scales and offset voltage of analog monitor 1 and analog monitor 2. The relationship of scale, offset voltage and output voltage is shown in figure 11.4.1.1.

Analog monitor 1 output voltage = { Analog monitor 1 signal selection (Pt006 = t.□□xx) × Analog monitor 1 scale (Pt552) + Analog monitor 1 offset voltage (Pt550) }

Analog monitor 2 output voltage = { Analog monitor 2 signal selection (Pt007 = t.□□xx) × Analog monitor 2 scale (Pt553) + Analog monitor 2 offset voltage (Pt551) }

The related parameters are provided as below.

Table11.4.1.1

Parameter	Pt550	Range	-10000~10000	Control Mode	Position mode, velocity mode and torque mode
Default	0	Effective	Immediately	Unit	0.01 V
Description					
Analog monitor 1 offset voltage					

Table11.4.1.2

Parameter	Pt551	Range	-10000~10000	Control Mode	Position mode, velocity mode and torque mode
Default	0	Effective	Immediately	Unit	0.01 V
Description					
Analog monitor 2 offset voltage					

Table11.4.1.3

Parameter	Pt552	Range	-10000~10000	Control Mode	Position mode, velocity mode and torque mode
Default	100	Effective	Immediately	Unit	x 0.01
Description					
Analog monitor 1 scale					

Table11.4.1.4

Parameter	Pt553	Range	-10000~10000	Control Mode	Position mode, velocity mode and torque mode
Default	100	Effective	Immediately	Unit	x 0.01
Description					
Analog monitor 2 scale					

Example:

The motor velocity is being monitored (Pt006 = t.□□XX).

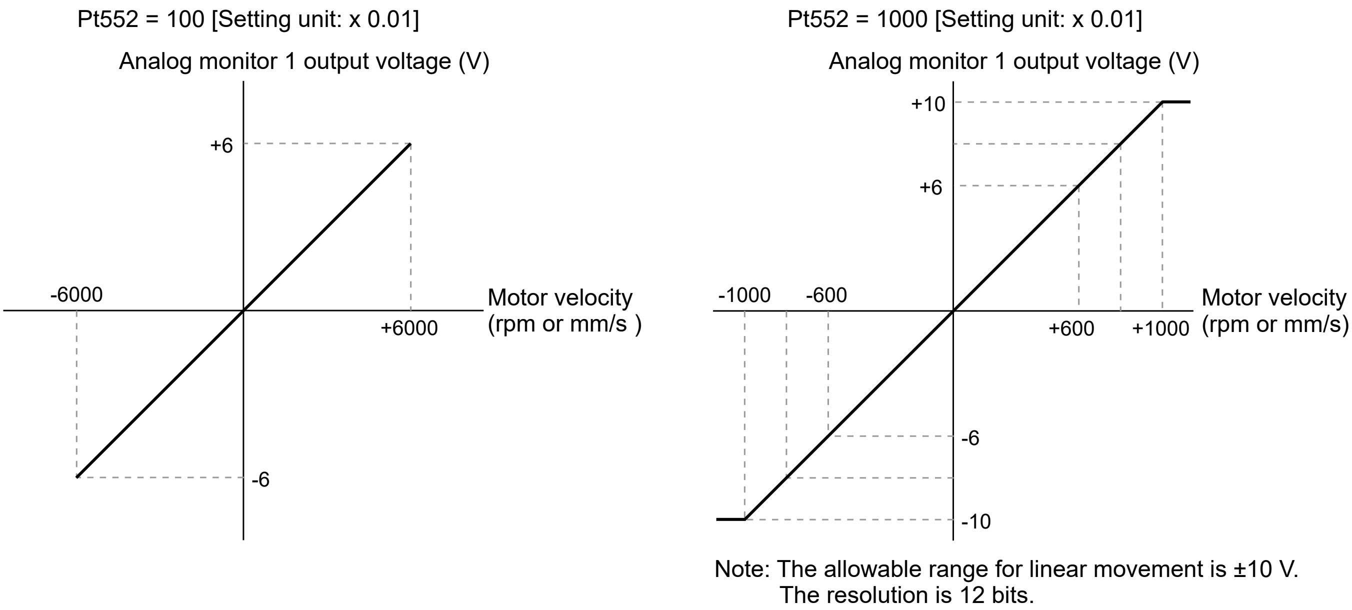


Figure11.4.1.1

12. Safety function

12.1 Overview of STO safety function

12.1.1 Information about this safety manual

This safety document is aimed at planners, developers and operators of systems into which the E1 motor drive is to be integrated. It’s also intended for people who perform the following tasks:

- Electrical connection
- Setup
- Operation
- Maintenance
- Troubleshooting and error elimination
- Operator interface
- The following signal words and hazard levels are used:
  DANGER! WARNING! CAUTION! NOTICE!

12.1.2 Conditions

We assume that Staff is trained in the safe operation and these instructions have read and understood completely.

12.1.3 Availability

Always keep the safety manual available to all persons who work with or on the motor drive.

12.1.4 Description of safety instructions

Safety is always a signal word and sometimes also with a specific hazard symbol marked.

The following signal words and hazard levels are used:

⚠DANGER
Immediate danger! Failure to observe the safety instructions in serious injury or death are the result!

⚠WARNING
Possibly dangerous situation! Failure to observe the safety instructions could result in serious injury or death!

⚠CAUTION
Possibly dangerous situation! In case of non-compliance with safety threaten moderate to minor injuries!

⚠NOTICE
Possibly dangerous situation! In case of non-compliance with safety threaten property damage or pollution!

12.1.5 Support

For any technical questions please contact:

HIWIN MIKROSYSTEM CORP.

Email:business@hiwinmikro.tw

Tel : +886-4-2355-0110

Fax: +886-4-2355-0123

Address: No.6, Jingke Central Rd., Precision Machinery Park, Taichung 408226, Taiwan

12.1.6 Device malfunction

In case of device malfunction please replace them immediately and send back to the Address listed in chapter 12.1.5.

12.2 Overview of STO safety function

12.2.1 Introduction to STO safety function

The built-in STO safety function aims to avoid personnel injury caused by machine moving parts as well as to improve safety and reduce risk. It is able to protect operation personnel as machine malfunctions or is maintained.

12.2.2 Safety precautions for STO safety function

⚠WARNING
◆ Ensure STO safety function complies with the safety requirement of your application. Improper usage may cause injury. ◆ When STO safety function is enabled, the motor could still be moving due to external force, such as gravity on vertical axis. Use mechanical brake as protection. Improper usage may cause injury. ◆ If the servo drive malfunctions as STO safety function is enabled, the motor could move within a small range. ◆ STO safety function is independent from dynamic brake or brake. Ensure there is no danger if these components malfunction when STO safety function is enabled. ◆ When STO safety function is used as emergency stop function, please be noted that only the power supplied to the internal power module of the servo drive will be cut off. The main circuit power can still be normally input, so another device must be installed to cut off the main circuit power. Improper usage may cause injury. ◆ STO safety function must only be used for emergency and cannot be used to cut off the power of the servo drive. Use other measure to cut off the power of the servo drive for maintenance.

12.3 Definitions

The safety function STO ("Safe Torque Off") is described in IEC 61800-5-2: 2016 and required a shuts off the motor torque safely. It is not necessary to interrupt the main power for example one/three phase 220 VAC.

The safety function STO is equivalent to an uncontrolled stop in accordance with stop category 0 of IEC 60204-1:2016.

⚠WARNING
◆ **However, the safety function STO is not equivalent to the safety function “safe off” of IEC 60204-1:2016**, since it does not provide any galvanic insulation. This means that the motor terminals can still have dangerous voltage when in STO state.

12.4 Function

12.4.1 Function principle

The STO safety function integrated into the E1 can be used to implement an "EMERGENCY STOP" for STO.

The STO safety function is triggered via 2 redundant inputs (SF1 and SF2). The circuits of the two inputs must be separate so that there are two channels. The motor can no longer generate torque or force and coasts down without braking. It can be restarted after removing input power.

After re-power the input power, can clear the error message to enable it again.A monitor output (EDM) is used for monitoring the state of safety function.

12.4.2 Description of connectors and function (CN4)

Prepare and wire the optional connector as specified below, perform wiring according to the instructions provided in section. Please refer to section 5.6 STO connector (CN4).

⚠NOTICE

- ◆ Use shielded twisted-pair cables or screened shielded multi-twisted-pair cables for STO Cables.
- ◆ Fault exclusion measures against the short circuit fault between lines SF1+ / SF2+ and power supply line +24 VDC shall be implemented
- ◆ Permanently connected (fixed) and protected against external damage, e.g. by cable ducting, armouring,
- ◆ Within an electrical enclosure, provided both the conductors and enclosure meet the appropriate requirements (see IEC 60204-1).

⚠WARNING

- ◆ **LOSS OF SAFETY FUNCTION**
  Incorrect usages of safety By-pass plug cause loss of the safety function.
  Observe the requirements for using the safety function.

Table 12.4.2.1

Safety input	High level	[Vdc]	**20 V … 24 V**
	Low level	[Vdc]	**0 V … 1 V**

⚠WARNING

- The STO safety function must be operated under the Idle-Current principle.
- The STO input circuitry must be powered by a SELV/PELV power supply.

12.4.3 External device monitoring output (EDM) signal

External device monitoring output (EDM) signal is used to monitor if STO safety function malfunctions. Connect it as a feedback signal to safety module.

■ External device monitoring output (EDM) signal

The relationship of EDM, SF1 and SF2 signals are shown in table 12.4.3.1. EDM signal is used to monitor if SF1 or SF2 signal malfunctions.

Table 12.4.3.1

Signal	Description	Logic			
Safety input	SF1	High	High	Low	Low
	SF2	High	Low	High	Low
STO	--	OFF	ON	ON	ON
EDM output	EDM	OFF	OFF	OFF	ON

⚠CAUTION

- The EDM output signal is not for diagnostic purpose but just for the indication of whether it is in STO status or not.

12.4.4 Transition time of STO safety function

When STO safety function is enabled by setting SF1 and SF2 signals to OFF, the power supplied to the motor will be cut off in 15 ms. The servo drive changes from Normal Mode to Safe Mode (STO Mode).

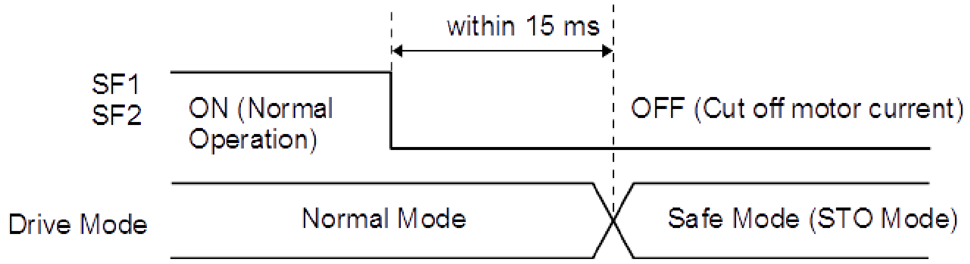


Figure 12.4.4.1

12.4.5 STO safety function enabling state

The servo drive state when STO safety function is enabled is shown in figure 12.4.5.1 When SF1 and SF2 signals are OFF, STO safety function is enabled. The servo drive goes into STO safety function enabling state (STO state).

■ STO safety function enabling state

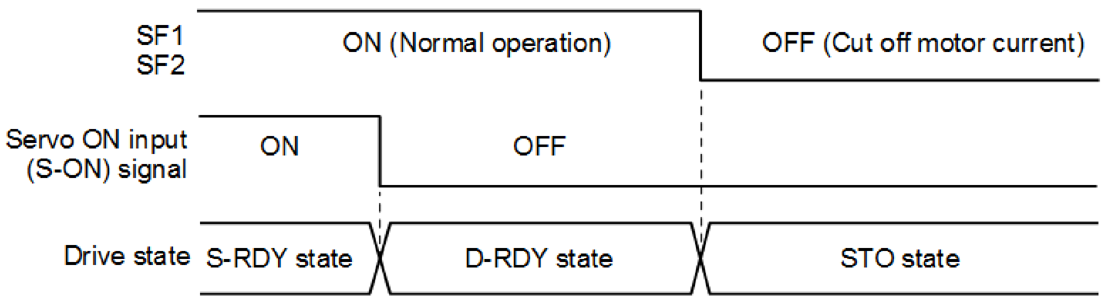


Figure 12.4.5.1

12.4.6 Resetting STO state

When S-ON signal is OFF, power is not supplied to servo motor. If SF1 and SF2 signals are OFF, the servo drive is in STO state. In STO state, after SF1 and SF2 signals are ON, the servo drive is in D-RDY state. After S-ON signal is ON, the servo drive is in S-RDY state.

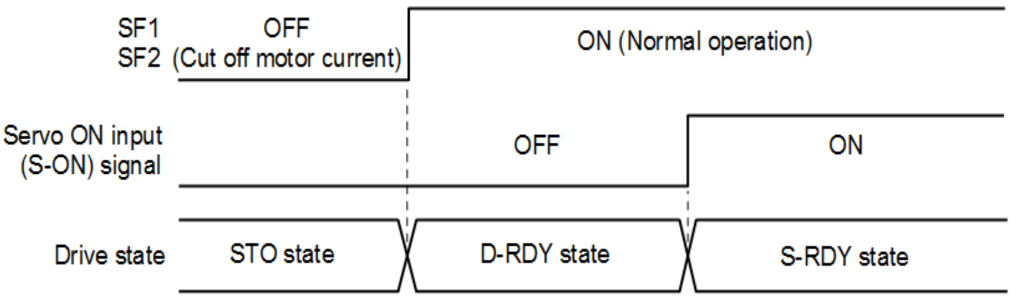


Figure 12.4.6.1

If S-ON signal is ON when SF1 and SF2 signals are OFF, STO remains even when SF1 and SF2 signals are ON afterwards. Once S-ON signal is OFF, the servo drive goes into D-RDY state. After S-ON signal is input again, the servo drive goes into S-RDY state.

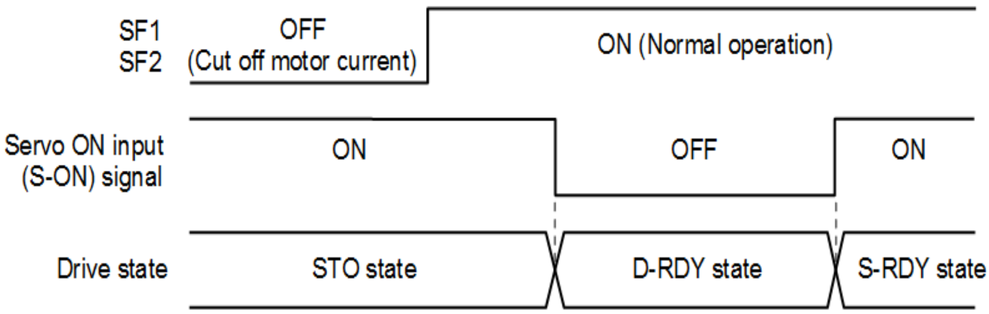


Figure12.4.6.2

Note:

While using STO function, do not set servo on input (S-ON) signal to be always active (Pt50A = t.□□□A). Otherwise, STO state cannot be reset.

12.4.7 Error detection of STO safety function

If SF1 or SF2 signal is input first and the other signal is not input within 10 seconds, alarm AL.Eb1 (Safety function signal input timing error) will occur. Use alarm AL.Eb1 to identify if STO signals are correctly input.

When an error in safety function hardware, alarm AL.Eb2 (Safety function module error) will occur. It could be servo drive malfunction, please replace the servo drive.

⚠CAUTION
◆ Alarm AL.Eb1 (Safety function signal input timing error) can be used to check if STO signals are correctly input. But STO safety function can still normally operate.

12.4.8 Drive ready output (D-RDY) signal

When servo on input (S-ON) signal is input in STO state, drive ready output (D-RDY) signal will still be OFF. When SF1 and SF2 signals are both ON and servo on input (S-ON) signal is OFF, drive ready output (D-RDY) signal will be ON.

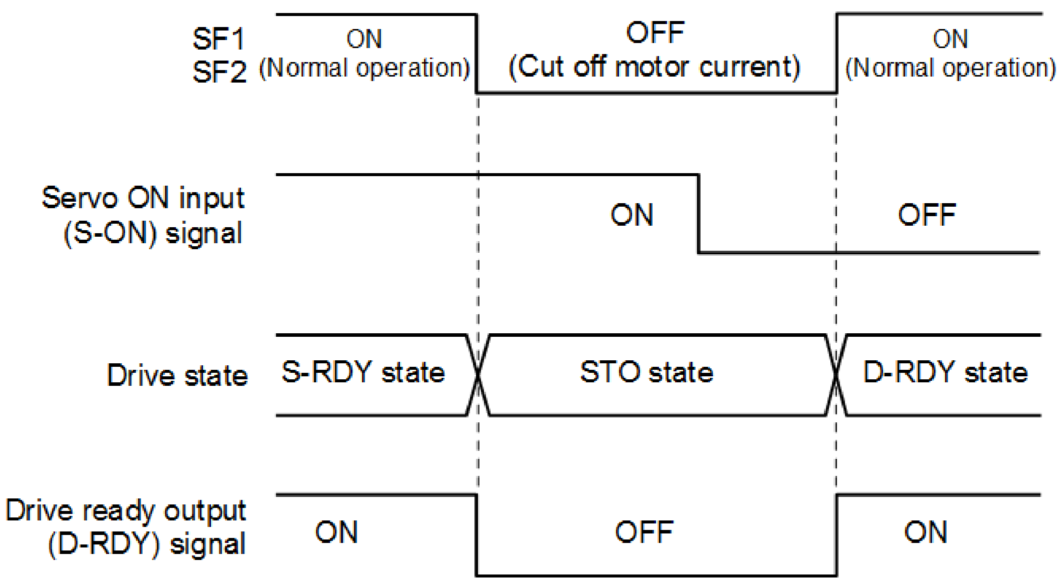


Figure12.4.8.1

12.4.9 Brake control output (BK) signal

When SF1 and SF2 signals are OFF and STO safety function is enabled, brake control output (BK) signal is OFF. At this time, Pt506 (Brake command-servo off delay time) has no function. Therefore, before the brake operates, the motor could move due to external force or gravity after brake control output (BK) signal is OFF.

⚠CAUTION
◆ Since brake control output (BK) signal and STO safety function operate independently, while designing your system, ensure even when brake control output (BK) signal malfunctions in STO state, there will be no danger.

12.4.10 Motor stopping method for STO safety function

When SF1 and SF2 signals are OFF and STO safety function is enabled, the servo motor will stop according to the setting of stopping method for servo off and Gr.A alarm (Pt001 = t.□□□X). Pay attention to the following, when motor is stopped by dynamic brake (Pt001 = t.□□□0 or t.□□□1).

⚠CAUTION
◆ Since dynamic brake and STO safety function operate independently, while designing your system, ensure even when the motor runs freely in STO state, there will be no danger. ◆ In application that STO safety function is frequently applied, stopping the motor by dynamic brake could deteriorate the internal components of the servo drive. To avoid deteriorating the internal components of the servo drive, the motor must be stopped before going into STO state.

12.5 Diagnosis of STO Function

12.5.1 Diagnosis of STO Function

To ensure the availability of the STO function it is necessary to perform diagnosis on the availability and correct operation of this safety function.

- Diagnosis shall be done at least:

(1) after first setup

(2) during each maintenance cycle - at least once per three months

Note:
The diagnosis itself shall have no influence on the availability of the safety function that is realized by means of the STO function.

Test pulses may be used by safety devices (ex. safety PLC) that are connected to the SF1/SF2 inputs to detect. These pules are not filtered out by the SF1/SF2 input circuit. The average duration of these test pulses are 1ms, See Figure 12.5.1.1.

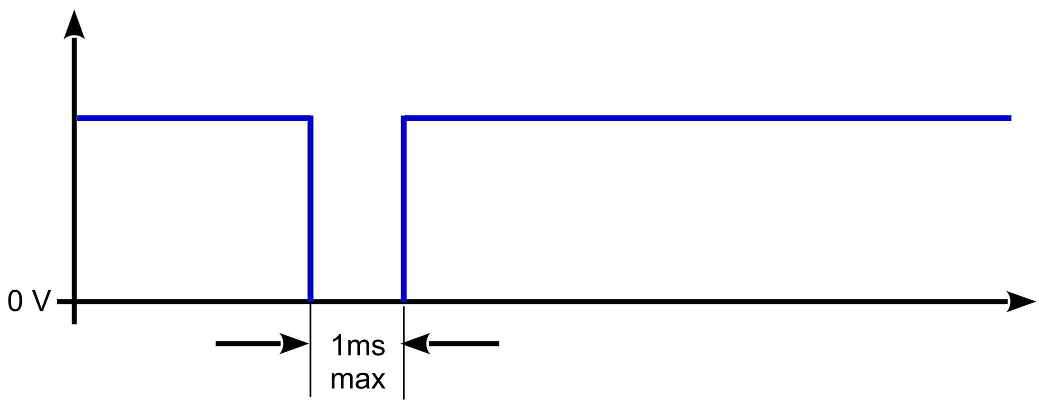


Figure 12.5.1.1

12.5.2 STO wiring test connectors

Figure 12.5.2.1 shows an example for an emergency push button in combination with a circuit that performs the diagnosis steps as described in this chapter.

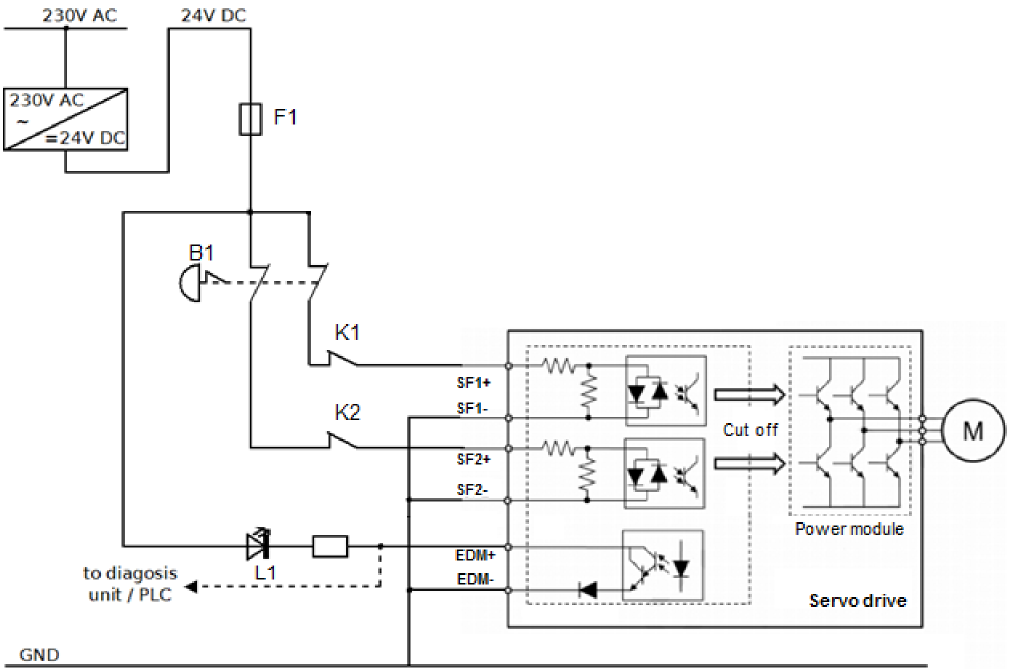


Figure 12.5.2.1

The following sequence of measures describes the diagnosis procedure for the STO function. Figure 12.5.2.1 shows the naming of the corresponding contactors and indicators:

- Supply SF1 (K1 closed) and SF2 (K2 closed) with 24 V dc Voltage and enable the motor.
Motor will be energized, (L1 OFF)

- Disconnect first SF1 (K1 open), drive goes in error **"Safety function is enabled."**
Motor is not energized, (L1 OFF)

- Reconnect SF1 (K1 closed), re-power on after removing input power
Motor will be energized, (L1 OFF)

- Disconnect first SF2 (K2 open), drive goes in error **"Safety function is enabled."**
Motor is not energized, (L1 OFF)

- Reconnect SF2 (K2 closed), re-power on after removing input power
Motor will be energized, (L1 OFF)

- Disconnect SF1 (K1 open) and SF2 (K2 open) in the same time, drive goes in error **"Safety function is enabled."**
Motor is not energized, (L1 ON)

- Reconnect SF1 (K1 closed) and SF2 (K2 closed), re-power on after removing input power
Motor must energize, (L1 OFF)

12.5.3 Reaction of Diagnosis Issues

In case of one or both SF inputs do not produce the desired effect after applying the described sequence in chapter 12.5.2 (drive goes in error) or after reconnected SF1 and SF2, the motor doesn't energize, please contact the manufacturer for support (see information in 12.1.5).

12.6 Requirements for using the safety function

DANGER

- **ELECTRIC SHOCK CAUSED BY INCORRECT USE**
  The safety function STO (Safe Torque Off) does not cause electric isolation. The DC bus voltage is still present.
  Turn off the mains voltage using an appropriate switch to achieve a voltage-free condition.
- **Failure to follow these instructions will result in death or serious injury.**

WARNING

- **LOSS OF SAFETY FUNCTION**
  Incorrect usage may cause a hazard due to the loss of the safety function.
  Observe the requirements for using the safety function.
- **UNINTENDED MOTOR MOVEMENT**
  During the STO function the motor without an external brake system can be unintendedly moved by external load.
- **Failure to follow these instructions can result in death or serious injury.**

12.6.1 Safe Torque Off (STO)

During the STO, the motor rotates or coasts down in an uncontrolled way. If access to the machine rotating or coasting down involves a hazard, you must take appropriate measures.

12.6.2 Unintended restart

In order to prevent the motor from restarting unexpectedly, the STO state can be released by re-power the input power.

12.6.3 Degree of protection when the safety function is used

You must ensure that conductive substances cannot get into the product (pollution degree 2). Conductive substances may cause the safety function to become inoperative.

In order to maintain the pollution degree 2 the device shall be mounted in a cabinet of IP 54 or pollution controlled environment.

12.6.4 Protected cable installation

User must use shielded twisted-pair cables or screened shielded multi-twisted-pair cables for STO cables.

In the case of unprotected cable installation, if the cable is damaged, the safety function may malfunction.

12.6.5 Data for maintenance plan and safety calculations table

The safety function must be requested and tested at regular intervals. The interval depends on the hazard and risk analysis of the total system. The minimum interval is three months (high demand mode as per IEC 61508).

Use the following data of the safety function STO for your maintenance plan and the safety calculations:

Table 12.6.5.1

Item	Standards	Performance Level
Safety architecture	IEC 61508	1oo1 and 1oo2 mixed
Safety Integrity Level	IEC 61508	SIL3
	IEC 62061	SILCL3
Probability of Dangerous Failure per Hour	IEC 61508 IEC 62061	PFH = 9.0×10^{-9}[1/h] (9.0% of SIL3)
Safe Failure Fraction	IEC 61508	SFF > 99% (1oo1 part)
		SFF > 90% (1oo2 part)
Performance Level	ISO 13849-1	PLe (Category 3)
Mean Time to Dangerous Failure of Each Channel	ISO 13849-1	MTTFd: High
Average Diagnostic Coverage	ISO 13849-1	DCavg: High
Stop Category	IEC 60204-1	Stop category 0
Safety Function	IEC 61800-5-2	STO
Hardware Fault Tolerance	IEC 61508	HFT = 0 (1oo1 part)
		HFT = 1 (1oo2 part)

Remark: FMEDA temperature is calculated using 55 ° C

12.6.6 Hazard and risk analysis

As a system integrator you must conduct a hazard and risk analysis of the entire system. The results must be taken into account in the application of the safety function.

The type of circuit resulting from the analysis may differ from the following application examples. Additional safety components may be required. The results of the hazard and risk analysis have priority.

12.7 Application examples

Connecting to the safety module of machine by referring to the example below.

12.7.1 Wiring example of STO safety function

Wiring example of STO safety function, perform wiring according to the instructions provided in section.5.6 STO connector (CN4).

An EMERGENCY STOP is requested. This request leads to safe torque off.

The power stage is immediately disabled via the inputs SF1 and SF2 of the safety function STO. Power can no longer be supplied to the motor.

⚠NOTICE
◆ If the motor has not yet stopped when the delay time has elapsed, it coasts down in an uncontrolled way (uncontrolled stop).

12.7.2 Wiring example

The wiring example for safety module G9SX-BC202 from Omron is as below.

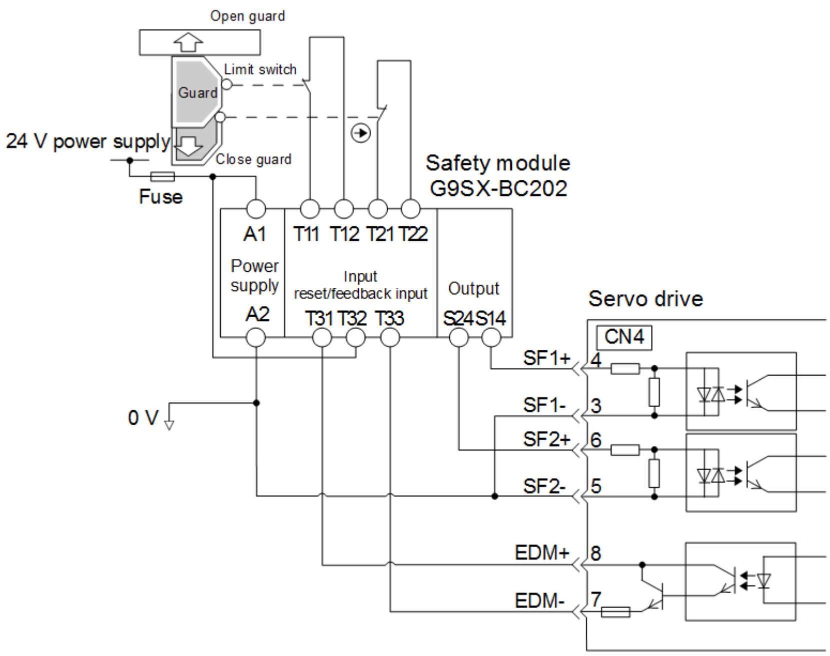


Figure 12.7.2.1

When the guard is opened, SF1 and SF2 signals are both OFF and EDM signal is ON. When the guard is closed, the servo drive is reset. After SF1 and SF2 signals are both ON, the machine is in servo ready state.

12.7.3 Malfunction detection method of STO safety function

If SF1 or SF2 signal remains ON, EDM signal will not be ON. Therefore, the system will not be reset even when the guard is closed. The machine cannot be in servo ready state. This could be caused by malfunction of peripheral device, such as disconnection and short circuit of external wiring or malfunction of servo drive. Find the cause and perform corrective action.

12.7.4 Operating procedure of STO safety function

Step 1: Operation personnel requests to open the guard.

Step 2: If the motor is operating, input a stop command from the controller.

Step 3: Open the guard.

Step 4: When SF1 and SF2 signals are OFF and the servo drive is in STO state, operation is allowedinside the guard.

Step 5: Operation completes. Operation personnel leaves the guarded area.

Step 6: Close the guard.

Step 7: Input servo on input (S-ON) signal from the controller.

12.7.5 Examination of STO safety function

If the servo drive or wiring is changed during maintenance, perform the examination of STO safety function described as below.

(1) Ensure when SF1 and SF2 signals are OFF and the servo drive is in STO state, the motor is stopped.

(2) Monitor SF1 and SF2 signals. If their states are different from the displays, it could be caused by malfunction of peripheral device, such as disconnection and short circuit of external wiring or malfunction of servo drive. Find the cause and perform corrective action.

(3) Ensure EDM signal is OFF when the servo drive is in normal mode by feedback circuit input displayof the connected device.

12.7.6 Connecting to safety module

Step 1: Remove the safety jumper connector from STO connector (CN4).

Step 2: Use safety device connector. Perform wiring according to the instructions provided in section 5.6 STO connector (CN4).

Step 3: Connect safety module to CN4.

Note:
The safety module could be G9SX-BC202 from Omron, UE410-MU3T5 from SICK, etc.

13. Troubleshooting and maintenance

13.1 Alarm display

13.1.1 Alarm display

When an alarm or a warning occurs, users can view its alarm code or warning code from the servo drive panel. Users can also check if an alarm or a warning occurs from the lower left area of Thunder.

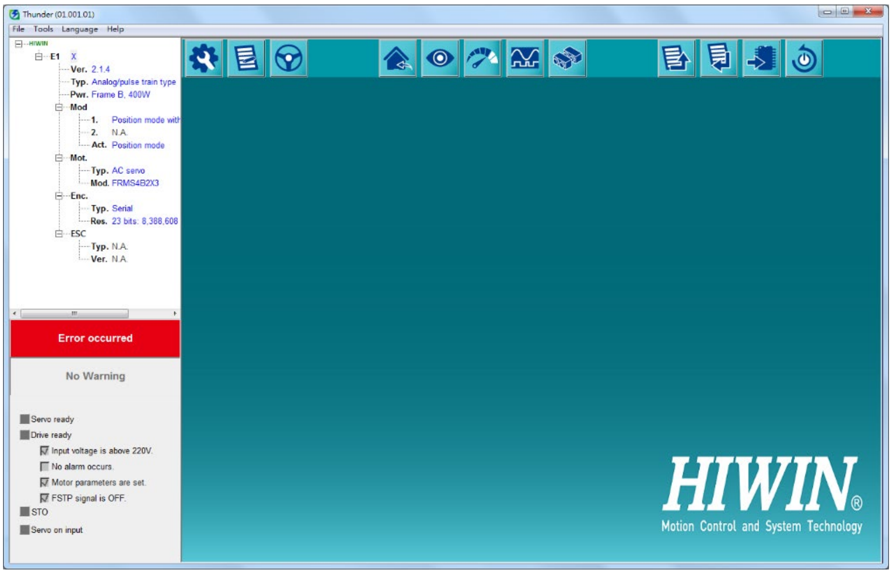


Figure13.1.1.1 The main screen of Thunder when an alarm occurs

13.1.2 Error log

To view error log, users can click on **Tools** on the menu bar to open **ErrorLog** window.

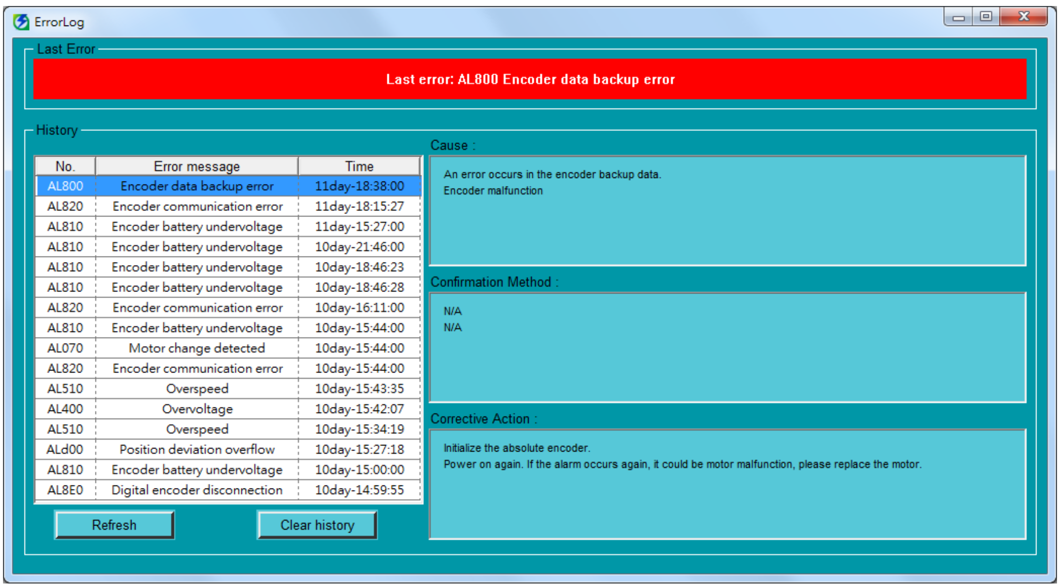


Figure13.1.2.1 Error log in Thunder

Note:

(1) If the same alarm occurs for several times in less than one hour, only the first alarm is recorded. If the same alarm occurs after one hour, all the alarms will be recorded.

(2) The error log can only be deleted when **Clear history** button is clicked on. Resetting alarm or turning off main power cannot clear the error log. As many as 16 error logs can be recorded.

13.1.3 Deleting error log

The error log will not be deleted after alarm reset or the main circuit power is cut off. To clear the error log, please follow the procedure below. Tools used to delete error log are described as below.

(1) Servo drive panel

Refer to section 14.4.6 **Deleting error log (Ft006)**.

(2) Thunder

Click on **Tools** on the menu bar to open **ErrorLog** window. Click on **Clear histories** button indicated in figure below.

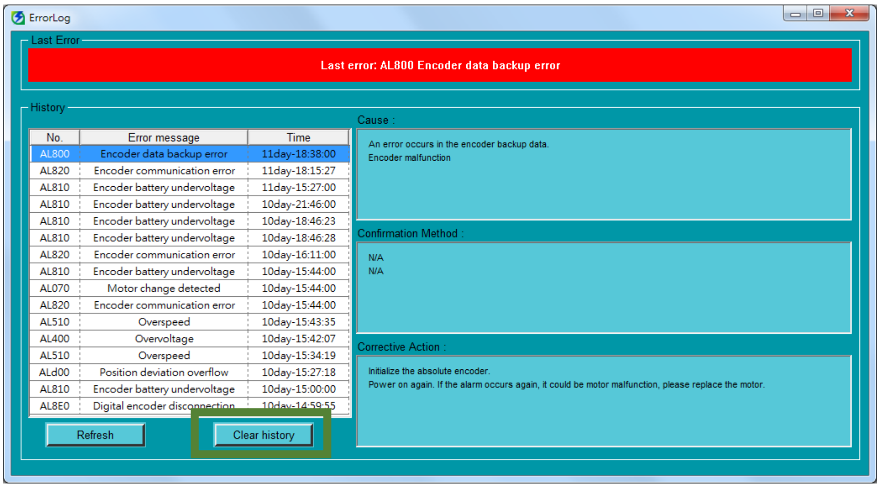


Figure13.1.3.1

13.2 Alarm

13.2.1 Alarm list

The alarms of the servo drive are listed in table 13.2.1.1. If an alarm occurs, perform troubleshooting by referring to the alarm contents. Alarm type is used to distinguish the stopping method of motor when an alarm occurs. The stopping method varies with different alarm types. For more information of the stopping method of motor, please refer to section 6.9.2. To check if an alarm can be cleared by alarm reset input (ALM-RST) signal, please refer to Alarm Reset column of table below.

Table13.2.1.1 Alarm list

Alarm Number	Alarm Name	Alarm Contents	Alarm Type	Alarm Reset
AL.024	System alarm 1	An error occurs in the internal program of the servo drive.	Gr.A	No
AL.025	System alarm 2	An error occurs in the internal program of the servo drive.	Gr.A	No
AL.030	Main circuit malfunction	An error occurs in the main circuit.	Gr.A	Yes
AL.040	Parameter setting error	The parameter setting exceeds the allowable setting range.	Gr.A	No
AL.050	Combination error	The maximum operating voltage of servo motor does not match the power input of servo drive.	Gr.A	No
AL.070	Motor change detected	The motor has been changed.	Gr.A	No
AL.0b0	Invalid servo on command	After the servo drive is turned on, the motor is enabled by external enabling method or other enabling method (Thunder or servo drive panel).	Gr.A	Yes
AL.100	Overcurrent detected	Power transistor overcurrent or heat sink overheating.	Gr.A	Yes
AL.320	Regenerative energy overflow	Excessive regenerative energy.	Gr.B	Yes
AL.400	Overvoltage	The DC voltage of the main circuit is too high.	Gr.A	Yes
AL.410	Undervoltage	The DC voltage of the main circuit is too low.	Gr.B	Yes
AL.510	Overspeed	The motor velocity exceeds the maximum velocity.	Gr.A	Yes
AL.511	Encoder pulse output overspeed	The maximum bandwidth for encoder pulse output (18 M/s) is exceeded.	Gr.A	Yes

Alarm Number	Alarm Name	Alarm Contents	Alarm Type	Alarm Reset
AL.710	Overload (instantaneous maximum load)	The motor has been operated with torque exceeding its rated value for a few seconds.	Gr.B	Yes
AL.720	Overload (continuous maximum load)	The motor has been continuously operated with torque exceeding its rated value.	Gr.B	Yes
AL.7A2	Power board temperature error	The power board overheats.	Gr.B	No
AL.800	Encoder absolute position lost	Encoder absolute position lost.	Gr.A	No
AL.810	Encoder battery undervoltage	The battery of the absolute encoder is abnormal.	Gr.A	No
AL.820	Encoder communication error	Encoder communication error.	Gr.A	No
AL.830	Encoder data error	Encoder data reading error.	Gr.A	No
AL.840	Encoder communication crc error	Encoder communication interference.	Gr.A	No
AL.850	Encoder counting error	Encoder counting error.	Gr.A	No
AL.860	Encoder data writing error	Encoder parameter writing error.	Gr.A	No
AL.861	Motor overheating	Motor overheating.	Gr.A	Yes
AL.870	Encoder overheating	The encoder overheats because the motor overheats (EM1 series motors only).	Gr.A	No
AL.880	Incremental encoder signal phase order error	Incremental encoder signal phase order error.	Gr.A	No
AL.890	Excellent Smart Cube (ESC) - incremental encoder disconnection	The incremental encoder signal is not received.	Gr.A	No
AL.891	incremental encoder signal error	The incremental encoder signal is abnormal.	Gr.A	No
AL.8A0	First set of encoder - Excellent Smart Cube (ESC) signal error	Excellent Smart Cube (ESC) does not receive signal from the first set of encoder.	Gr.A	No
AL.8b0	First set of encoder - encoder signal error	First set of encoder malfunctions.	Gr.A	No
AL.8C0	Second set of encoder - Excellent Smart Cube (ESC) signal error	Excellent Smart Cube (ESC) does not receive signal from the second set of encoder.	Gr.A	No
AL.8d0	Second set of encoder - encoder signal error	Second set of encoder malfunctions.	Gr.A	No
AL.8E0	Digital encoder disconnection	Digital encoder signal is not received.	Gr.A	No

Alarm Number	Alarm Name	Alarm Contents	Alarm Type	Alarm Reset
AL.8F0	Excellent Smart Cube (ESC) internal error	An error occurs in the internal program of Excellent Smart Cube (ESC).	Gr.A	No
AL.b10	Velocity command A/D converter error	The A/D converter for velocity command input malfunctions.	Gr.A	Yes
AL.b20	Torque command A/D converter error	The A/D converter for torque command input malfunctions.	Gr.A	Yes
AL.b33	Current detection malfunction	Current sensor malfunction.	Gr.A	Yes
AL.C10	Motor out of control	Due to electrical angle detection error, motion control cannot be performed with the linear motor.	Gr.A	Yes
AL.C20	Phase detection error	Electrical angle detection error.	Gr.A	Yes
AL.C21	Hall sensor error	The Hall sensor has no function.	Gr.A	Yes
AL.C50	Electrical angle detection failure	The electrical angle cannot be detected.	Gr.A	Yes
AL.C51	Overtravel detected during electrical angle detection	Overtravel (OT) occurs during electrical angle detection.	Gr.A	Yes
AL.C52	Electrical angle detection incomplete	Phase initialization has not been performed yet.	Gr.A	No
AL.d00	Position deviation overflow	The position deviation exceeds the allowable range.	Gr.A	Yes
AL.d10	Motor-load position deviation overflow	In full-closed loop control, the position deviation between the motor position and the load position is too large.	Gr.A	Yes
AL.Eb0	Safety function alarm	Safety function (STO) is triggered.	Gr.A	Yes
AL.Eb1	Safety function signal input timing error	The input timing of safety function signal is abnormal.	Gr.A	Yes
AL.Eb2	Safety function module error	An error occurs in safety function hardware.	Gr.A	No
AL.F10	Power cable open phase	The voltage of R, S or T phase (L1, L2 or L3) has been low for as least one second after the main power is turned on.	Gr.A	Yes
AL.F50	Motor main circuit cable disconnection	The motor power cable and the servo drive are disconnected.	Gr.A	Yes
AL.FA0	Encoder power error	The DC 5 V power supplied to the encoder is abnormal.	Gr.A	Yes

Alarm Number	Alarm Name	Alarm Contents	Alarm Type	Alarm Reset
AL.FB0	Fieldbus communication hardware malfunction	The Fieldbus communication board is not connected with the servo drive or is broken.	Gr.A	Yes
AL.FB1	Fieldbus communication error	Fieldbus communication error.	Gr.A	Yes
AL.FB2	Fieldbus communication setup error	The setting of the communication hardware or parameters is out of the product specification or not fulfill the communication requirement.	Gr.A	No
AL.FC0	Group control system communication error	Communication error of gantry control system.	Gr.A	Yes
AL.FC1	Slave axis error in group control system	An error occurs in the slave axis of gantry control system.	Gr.A	Yes
AL.Fd0	Electronic cam control system alarm	An alarm occurs in electronic cam control system.	Gr.A	Yes

13.2.2 Causes and corrective actions for alarms

Table13.2.2.1 Causes and corrective actions for alarms

Alarm Number And Alarm Name	Cause	Confirmation Method	Corrective Action
AL.024 System alarm 1	An error occurs in the internal program of the servo drive.	N/A	Replace the servo drive.
AL.025 System alarm 2	An error occurs in the internal program of the servo drive.	N/A	Replace the servo drive.
AL.030 Main circuit malfunction	An error occurs in the main circuit.	N/A	Replace the servo drive.
AL.040 Parameter setting error	Servo drive malfunction	N/A	Replace the servo drive.
	The parameter setting is not within the allowable setting range.	Check the setting range of the parameter.	Set the parameter value to the allowable range.
	The setting of electronic gear ratio is incorrect.	Check if the value of Pt20E/Pt210 is between 0.001 to 64000.	Adjust the values of Pt20E and Pt210. The value of Pt20E/Pt210 must be between 0.001 to 64000.
	The setting of position trigger function is incorrect.	Check if after Pt230~Pt232 multiply electronic gear ratio (Pt20E/Pt210), their	Adjust the values of Pt230~Pt232. After Pt230~Pt232 multiply electronic gear ratio

Alarm Number And Alarm Name	Cause	Confirmation Method	Corrective Action
		values are larger than 2^{31}-1.	(Pt20E/Pt210), their values must be between $-2^{31}+1$ to $2^{31}-1$.
	The setting of home offset is incorrect.	Check if after Pt704 multiply electronic gear ratio (Pt20E/Pt210), its value is larger than $2^{31}-1$.	Adjust the value of Pt704. After Pt704 multiplies electronic gear ratio (Pt20E/Pt210), its value must be between $-2^{31}+1$ to $2^{31}-1$.
	The detection level for position deviation overflow alarm is not correctly set.	Check if after Pt520 or Pt521 multiplies electronic gear ratio (Pt20E/Pt210), its value is larger than 2^{30}-1.	Adjust the value of Pt520 or Pt521. After Pt520 or Pt521 multiplies electronic gear ratio (Pt20E/Pt210), its value must be between 1 to $2^{30}-1$.
	The setting values of program jog travel distance are incorrect.	Check if after Pt531 and Pt532 multiply electronic gear ratio (Pt20E/Pt210), their values are larger than 2^{31} -1.	Adjust the values of Pt531 and Pt532. After Pt531 and Pt532 multiply electronic gear ratio (Pt20E/Pt210), their values must be between -2^{31} +1 to 2^{31} -1.
	The setting values of program jog relative travel distance are incorrect.	Check if after Pt539 multiply electronic gear ratio (Pt20E/Pt210), their values are larger than 2^{31} - 1.	Adjust the values of Pt539. After Pt539 multiply electronic gear ratio (Pt20E/Pt210), their values must be between -2^{31} +1 to 2^{31} -1.
AL050 Combination error	The maximum operating voltage of servo motor does not match the power input of servo drive.	Check if the maximum operating voltage of servo motor matches the power input of servo drive.	Change servo motor or modify the setting of AC power input (Pt00C).
AL.070 Motor change detected	The servo motor is changed.	Check if the combination of the servo drive and motor is correct.	Replace the motor or initialize the parameters.
AL.0b0 Invalid servo on command	After the motor is enabled by Thunder or servo drive panel, S-ON signal is input. After S-ON signal is input to enable the motor, use Thunder or servo drive panel to enable the motor.	N/A	Perform software reset or power on the servo drive again.
AL.100 Overcurrent detected	The wiring of the main circuit power cable or motor power cable is incorrect, or the connection is poor.	Check if the wiring is correct, please refer to section 5.3.	Correct the wiring.
	There is internal short circuit or grounding fault in the main circuit power cable or motor power cable.	Check if there is short circuit among the U, V and W phases of the motor power cable, or between the ground and U, V and W phases.	Replace the cable.

Alarm Number And Alarm Name	Cause	Confirmation Method	Corrective Action
	There is short circuit or grounding fault in the motor.	Check if there is short circuit among the U, V and W terminals, or between the ground and U, V and W terminals. Or check if an error occurs in the insulation resistance of the motor.	Replace the motor.
	There is short circuit or grounding fault in the servo drive.	Check if there is short circuit among the U, V and W terminals, or between the ground and U, V and W terminals. Or check if the power transistor of the servo drive is burned out.	Replace the servo drive.
	The wiring of the regenerative resistor is incorrect or the connection is poor.	Check if the wiring is correct.	Correct the wiring.
	The dynamic brake is frequently used.	Check the operating frequency of the dynamic brake by the power consumption of the dynamic brake resistor.	Replace the servo drive and adjust the operating condition and load to decrease the operating frequency of the dynamic brake.
	The regenerative energy exceeds the processing capability of the servo drive.	Check the operating frequency of the regenerative resistor.	Decrease the acceleration, deceleration and load. Or evaluate if external regenerative resistor is needed.
	The resistance of the external regenerative resistor is too small.	Check the operating frequency of the regenerative resistor.	Replace the external regenerative resistor. Its resistance must be higher than the minimum resistance that the servo drive allows.
	Heavy load is applied to the servo motor when it stops or operates at low speed.	Check if the operating condition exceeds the specification of the servo drive.	Reduce the load or operate at higher speed.
	False operation occurs due to noise interference.	Improve the wiring or reduce the interference source and monitor if the error occurs again.	Apply countermeasures for electromagnetic interference. For instance, wiring for frame grounding (FG) must be correctly performed by using the cables which conform to the specified specifications.
	Servo drive malfunction	N/A	Replace the servo drive.
AL.320 Regenerative energy overflow	The power supply voltage is not within the specified range.	Check if the power supply voltage is normal.	Use the power supply voltage within the specified range.

Alarm Number And Alarm Name	Cause	Confirmation Method	Corrective Action
	The resistance of the external regenerative resistor is too low or its capacity is insufficient. Or the motor is in regenerating state for a period of time.	Check the operating condition or the capacity of the external regenerative resistor.	Adjust the operating condition or replace the external regenerative resistor.
	The motor is in regenerating state due to load.	Check if the load is too heavy or the operating condition is appropriate.	Adjust the load or operating condition.
	The setting value of regenerative resistor capacity (Pt600) is smaller than the capacity of the external regenerative resistor.	Check if the external regenerative resistor is connected and the setting value of regenerative resistor capacity (Pt600).	Adjust the setting value of regenerative resistor capacity (Pt600).
	The setting value of resistance of regenerative resistor (Pt603) is smaller than the external regenerative resistance.	Check if the external regenerative resistor is connected and the setting value of resistance of regenerative resistor (Pt603).	Adjust the setting value of resistance of regenerative resistor (Pt603).
	The resistance of the external regenerative resistor is too large.	Check if the resistance of the external regenerative resistor is appropriate.	Replace the external regenerative resistor.
	Servo drive malfunction	N/A	Replace the servo drive.
AL.400 Overvoltage	The AC power supply is unstable or is influenced by lightning surge.	Measure the power supply voltage.	Improve the power supply or install surge absorber, and power on again. If the alarm occurs again, it could be servo drive malfunction, please replace the servo drive.
	The voltage of the AC power supply is not within the specified range.	Check the voltage of the AC power supply and the velocity and force of the motor.	Adjust the voltage of the AC power supply to the specified range.
	The regenerative energy exceeds the processing capability of the external regenerative resistor.	Check the operating condition and the resistance of the external regenerative resistor.	Select external regenerative resistor according to the operating condition and load.
	The motion is not within the allowable inertia ratio.	Check if the inertia ratio is within the allowable range.	Decrease deceleration or reduce load.
	Servo drive malfunction	N/A	When power is not supplied to the main circuit, turn on the power supplied to the control circuit again. If the alarm occurs again, it could be servo drive malfunction, please replace the servo drive.

Alarm Number And Alarm Name	Cause	Confirmation Method	Corrective Action
AL.410 Undervoltage	The voltage of AC power supply is below the specifications.	Use multimeter to measure if the voltage of AC power supply is below the specifications. Or observe if **Bus voltage** is below the specifications from **Interface signal monitor** in Thunder. Refer to section 2.2.6 for the specifications of the operation voltage.	Adjust the voltage of the AC power supply to the specified range.
	The power supply voltage drops during operation.	Measure the power supply voltage.	Check if the power supply voltage is correct.
	Momentary power interruption occurs.	N/A	Replace the servo drive and connect to reactor.
	The fuse of the servo drive is blown out.	N/A	It could be servo drive malfunction, please replace the servo drive.
	Servo drive malfunction	N/A	Replace the servo drive.
AL.510 Overspeed	The order of U, V and W phases in the motor wiring is incorrect.	Check the wiring of the servo motor.	Check if the wiring is correct.
	The command value exceeds the maximum velocity.	Check the command value.	Decrease the command value or adjust the gain.
	The motor velocity exceeds the maximum velocity.	Monitor and check the waveform of motor velocity.	Decrease the velocity command input gain and adjust the servo gain or operating condition.
	Servo drive malfunction	N/A	It could be servo drive malfunction, please replace the servo drive.
AL.511 Encoder pulse output overspeed	The encoder pulse output frequency is too large and exceeds the output bandwidth of the servo drive.	Check the output setting of encoder pulse.	Decrease the setting of encoder output resolution (Pt281) or number of encoder output pulses (Pt212).
	The encoder pulse output frequency exceeds the output bandwidth of the servo drive, since the motor velocity is too high.	Check the output setting of encoder pulse and motor velocity.	Decrease the motor velocity.
AL.710	The wiring of the motor is poor or the signal of the linear encoder is poor.	Check the wiring.	Check if the wirings of the motor and linear encoder are correct.

Alarm Number And Alarm Name	Cause	Confirmation Method	Corrective Action
Overload (instantaneous maximum load) AL.720 Overload (continuous maximum load)	The motor motion exceeds the overload detection value.	Check the overload detection value and motion command.	Re-calculate and adjust the load and operating condition. Or select a new motor.
	Overload occurs since the motor cannot be operated due to mechanical factor (such as mechanical interference).	Check the motion command and motor velocity. Check if the friction of the mechanism is too large or there is interference.	Improve the mechanism. Decrease the load and adjust the operating condition.
	The resolution setting of the encoder is incorrect.	Check the setting value of encoder resolution.	Set the encoder resolution to a proper value.
	The phase sequence of the motor is incorrect.	Check the phase sequence of motor and the installation direction of encoder.	Adjust the setting value of Pt000 = t.□□□X.
	Servo drive malfunction	N/A	It could be servo drive malfunction, please replace the servo drive.
AL.7A2 Power board temperature error	The power board overheats.	N/A	It could be servo drive malfunction, please replace the servo drive.
AL.800 Encoder absolute position lost	The connector of the encoder-side is removed, so the absolute position of encoder is lost.	N/A	Initialize the absolute encoder.(Tools -> Absolute encoder initialization -> Initialize encoder)
	Encoder malfunction	N/A	Power on again. If the alarm occurs again, it could be motor malfunction, please replace the motor.
AL.810 Encoder battery undervoltage	The usage of encoder is not correctly set.	Check if the encoder you use is absolute type.	Check if Pt002 = t.□X□□ is set according to the encoder in use.
	The battery of the absolute encoder is abnormal.	Check if the battery voltage is 5 V.	Replace the battery or encoder cable.
	Encoder malfunction	N/A	Power on again. If the alarm occurs again, it could be motor malfunction, please replace the motor.
AL.820 Encoder communication error	The encoder communication is interfered or the encoder cable disconnects.	Check if there is interference source and the encoder cable is correctly connected or the connection is poor.	(1) Add ferrite ring or replace the encoder cable. (2) Check if the encoder cable is correctly connected.
	Encoder malfunction	N/A	Power on again. If the alarm occurs again, it could be motor malfunction, please replace the motor.

Alarm Number And Alarm Name	Cause	Confirmation Method	Corrective Action
	Excellent Smart Cube (ESC) malfunction	N/A	Power on again. If the alarm occurs again, it could be ESC malfunction, please replace the ESC.
	Excellent Smart Cube (ESC) setting incorrect.	N/A	Check if the ESC is connected correctly, and the setting value of Pt00A = t.OXOO is set according to your setup.
AL.830 Encoder data error	An error occurs while reading the encoder data.	N/A	The encoder of the motor could be broken, please replace the motor.
	Encoder malfunction	N/A	Power on again. If the alarm occurs again, it could be motor malfunction, please replace the motor.
AL.840 Encoder communication crc error	Encoder communication check (crc) error	Check if there is interference source and the encoder cable is correctly connected or the connection is poor.	(1) Add ferrite ring or replace the encoder cable. (2) Check if the encoder cable is correctly connected.
	Encoder malfunction	N/A	Power on again. If the alarm occurs again, it could be motor malfunction, please replace the motor.
AL.850 Encoder counting error	Encoder malfunction	N/A	Power on again. If the alarm occurs again, it could be motor malfunction, please replace the motor.
	Servo drive malfunction	N/A	Power on again. If the alarm occurs again, it could be servo drive malfunction, please replace the servo drive.
AL.860 Encoder data writing error	Encoder parameter writing error	Check if there is interference source and the encoder cable is correctly connected or the connection is poor.	(1) Add ferrite ring or replace the encoder cable. (2) Check if the encoder cable is correctly connected.
	Encoder malfunction	N/A	Power on again. If the alarm occurs again, it could be motor malfunction, please replace the motor.
AL.861 Motor overheating	Motor overheating	N/A	(1) Re-calculate and adjust the load and operating condition. Or select a new motor. (2) Improve ambient temperature.

Alarm Number And Alarm Name	Cause	Confirmation Method	Corrective Action
	Encoder malfunction	N/A	Power on again. If the alarm occurs again, it could be motor malfunction, please replace the motor.
AL.870 Encoder overheating	The encoder overheats because the motor overheats (EM1 series motors only)	N/A	(1) Re-calculate and adjust the load and operating condition. Or select a new motor. (2) Improve ambient temperature.
AL.880 Incremental encoder signal phase error	The signal of the incremental encoder is abnormal.	Check if the signal of the linear encoder is normal.	Replace the linear encoder or encoder cable.
AL.890 Excellent Smart Cube (ESC) - incremental encoder disconnection	The incremental signal input of Excellent Smart Cube (ESC) is abnormal or not received.	(1) Check if the encoder cable is correctly connected or the connection is poor. (2) Correctly install the encoder based on its specifications and ensure the signal of the encoder is normal.	(1) Reconnect the encoder cable. (2) .Correctly install the encoder based on its specifications and ensure the signal of the encoder is normal.
	Encoder malfunction	N/A	Power on again. If the alarm occurs again, it could be motor malfunction, please replace the motor.
	Excellent Smart Cube (ESC) malfunction	N/A	Power on again. If the alarm occurs again, it could be ESC malfunction, please replace the ESC.
AL.891 incremental encoder signal error	The incremental encoder signal is abnormal or the encoder cable disconnects.	Check if the signal of the linear encoder is normal and the encoder cable is connected.	Replace the linear encoder or encoder cable.
AL.8A0 First set of encoder - Excellent Smart Cube (ESC) signal error	The first set of encoder signal is abnormal or not received by Excellent Smart Cube (ESC).	Check if the encoder cable is correctly connected or the connection is poor.	Reconnect the encoder cable.
AL.8b0 First set of encoder - encoder signal error	First set of encoder malfunctions.	N/A	Power on again. If the alarm occurs again, it could be motor or encoder malfunction, please replace the motor or encoder.
AL.8C0 Second set of encoder - Excellent Smart Cube (ESC) signal error	The second set of encoder signal is abnormal or not received by Excellent Smart Cube (ESC).	Check if the encoder cable is correctly connected or the connection is poor.	Reconnect the encoder cable.

Alarm Number And Alarm Name	Cause	Confirmation Method	Corrective Action
AL.8d0 Second set of encoder - encoder signal error	Second set of encoder malfunctions.	N/A	Power on again. If the alarm occurs again, it could be motor or encoder malfunction, please replace the motor or encoder.
AL.8E0 Digital encoder disconnection	Digital encoder signal is not received when the motor is enabled.	Check if the encoder cable is correctly connected or the connection is poor.	Reconnect the encoder cable.
	Encoder malfunction	N/A	Power on again. If the alarm occurs again, it could be motor malfunction, please replace the motor.
AL.8F0 Excellent Smart Cube (ESC) internal error	Encoder parameter mistakes	Please check if the settings of encoder parameters are correct:	(1) Please check encoder resolution. (2) Please check encoder clock frequency. (3) Please check Pt52D encoder power-on time. (4) For analoge encoders, please check grating period, multiplier factor, disconnection threshold of Pt208.
	The encoder communication is interfered or the encoder cable disconnects.	Check if there is interference source and the encoder cable is correctly connected or the connection is poor.	(1) Add ferrite ring or replace the encoder cable. (2) Check if the encoder cable is correctly connected.
	The internal program of Excellent Smart Cube (ESC) is abnormal.	N/A	Power on again. If the alarm occurs again, it could be ESC malfunction, please replace the ESC.
AL.b10 Velocity command A/D converter error	Input pins for velocity command malfunction	N/A	Reset the alarm and restart operation.
	Servo drive malfunction	N/A	Power on again. If the alarm occurs again, it could be servo drive malfunction, please replace the servo drive.
AL.b20 Torque command A/D converter error	Input pins for torque command malfunction	N/A	Reset the alarm and restart operation.
	Servo drive malfunction	N/A	Power on again. If the alarm occurs again, it could be servo drive malfunction, please replace the servo drive.
AL.b33 Current detection malfunction	Current sensor malfunction	N/A	Replace the servo drive.

Alarm Number And Alarm Name	Cause	Confirmation Method	Corrective Action
AL.C10 Motor out of control	The motor power cable is not connected.	Check the wiring of the servo motor.	Check if the motor wiring is correct.
	The load is too heavy or the output current is insufficient.	Check if the load is too heavy or the operating condition is appropriate.	Adjust the load or operating condition.
	Encoder malfunction	N/A	Replace the encoder.
	Servo drive malfunction	N/A	Power on again. If the alarm occurs again, it could be servo drive malfunction, please replace the servo drive.
AL.C20 Phase detection error	Electrical angle detection error	Check if the motor can move smoothly during electrical angle detection.	(1) Remove the obstacle on the moving path of the motor. (2) Reduce the load. (3) Perform electrical angle detection by using larger current command.
AL.C21 Hall sensor error	The Hall sensor has no function.	Check the setting of Hall sensor.	(1) Set digital Hall sensor and perform electrical angle detection again. (2) Power on again. If the alarm occurs again, it could be ESC malfunction, please replace the ESC. (3) Check if ESC is used. (4) Replace the motor.
AL.C50 Electrical angle detection failure	Phase initialization is not performed.	Phase initialization must be done before using linear motor or torque motor. Check if phase initialization is done.	Perform phase initialization via Thunder and ensure **Phase initialized** indicator is green. Save the parameters and power on the servo drive again.
	Incorrect parameter setting	(1) Check if the parameters of the encoder are correctly set and the feedback signal is correct. (2) Check if the parameters of the motor are correct.	Correctly set the parameters of the motor and the encoder resolution again. Perform phase initialization again. Save the parameters and power on the servo drive again.
	The optical scale is interfered.	(1) Check if the adapter of the optical scale is correctly grounded. (2) Check if the ground wire of the motor is correctly grounded.	Check if the grounding is correctly performed.
	The load to forcer is too heavy or friction is too large.	Check if the force applied to the forcer is too large or the brake is locked.	(1) Release the brake. (2) Reduce the load.

Alarm Number And Alarm Name	Cause	Confirmation Method	Corrective Action
AL.C51 Overtravel detected during electrical angle detection	Overtravel signal is triggered during electrical angle detection.	Check if overtravel occurs.	Turn off the main circuit power supply and move the forcer. Power on again and perform electrical angle detection at a position where overtravel signal will not be triggered.
AL.C52 Electrical angle detection incomplete	S-ON signal is input when phase initialization is not completed yet.	N/A	Perform phase initialization via Thunder and ensure **Phase initialized** indicator is green. Save the parameters and power on the servo drive again.
AL.d00 Position deviation overflow	The wiring of the U, V or W phase is incorrect.	When servo on, the position deviation exceeds the alarm value for overflow position deviation (Pt520 or Pt521).	Check if the motor power cable or encoder cable is correctly connected.
	The frequency of input command pulse is too high.	Decrease the frequency of input command pulse. Then start operation again.	Decrease the frequency of input command pulse or command acceleration. Or adjust the electronic gear ratio.
	The command acceleration is too high.	Decrease the command acceleration. Then start operation again.	Set position command acceleration/deceleration time constant (Pt216).
	The setting value of alarm value for overflow position deviation (Pt520 or Pt521) is too low.	Check if the setting value of alarm value for overflow position deviation (Pt520 or Pt521) is appropriate.	Adjust the setting value of alarm value for overflow position deviation (Pt520 or Pt521)
	Servo drive malfunction	N/A	Power on again. If the alarm occurs again, it could be servo drive malfunction, please replace the servo drive.
AL.d10 Motor-load position deviation overflow	The rotation direction of motor is different from the installation direction of external encoder.	Check the rotation direction of the motor and the installation direction of the external encoder.	Install the external encoder in the opposite direction or set the rotation direction to the opposite direction by Pt002 = t.X□□□ (Usage of external encoder).
	The load and the external encoder are disconnected.	Check if the load and the external encoder are disconnected. For instance, check if the coupling is loose.	Tighten the load and the external encoder.
AL.Eb0 Safety function alarm	Safety function (STO) is triggered.	N/A	Reset safety function.
	The wiring of safety function is abnormal.	Check the wiring.	Check if the wiring is normal.

Alarm Number And Alarm Name	Cause	Confirmation Method	Corrective Action
AL.Eb1 Safety function signal input timing error	The delay between SF1 and SF2 signal inputs is ten seconds or longer.	Measure the delay between SF1 and SF2 signal inputs.	Check if the output circuits of SF1 and SF2 signals or the signal input circuits of the machine and servo drive are normal.
AL.Eb2 Safety function module error	An error occurs in safety function hardware.	N/A	It could be servo drive malfunction, please replace the servo drive.
AL.F10 Power cable open phase	The wiring of three-phase AC main power cable is poor.	Check the wiring.	Check if the wiring is normal.
	The three-phase AC main power is unbalanced.	Measure the voltage of each phase of the three-phase power.	Adjust the wiring.
	Single-phase AC main power is used, but its setting in Configuration Wizard has not been modified or the related parameter (Pt00B = t.□1□□) has not been set.	Check the power and parameter setting.	Modify the setting in Configuration Wizard or use correct parameter setting (Pt00B = t.□1□□).
	Servo drive malfunction.	N/A	Power on again. If the alarm occurs again, it could be servo drive malfunction, please replace the servo drive.
AL.F50 Motor main circuit cable disconnection	Servo drive malfunction.	N/A	It could be servo drive malfunction, please replace the servo drive.
	The wiring of motor power cable is poor or the connection is poor.	Check the wiring.	Check if the wiring of the motor power cable is correct.
AL.FA0 Encoder power error	Servo drive malfunction	N/A	It could be servo drive malfunction, please replace the servo drive.
AL.FB0 Fieldbus communication hardware malfunction	The Fieldbus communication board is not connected with the servo drive or is broken.	Check if the communication indicator is normal.	Replace the servo drive.
	Servo drive malfunction	N/A	Power on again. If the alarm occurs again, it could be servo drive malfunction, please replace the servo drive.
AL.FB1 Fieldbus communication error	Fieldbus communication cannot be established due to signal cable disconnection or poor connection.	Check if the communication cable is correctly connected.	Replace the communication cable or correctly connect the communication cable, and power on the servo drive again. If the error still occurs, it could be servo drive

Alarm Number And Alarm Name	Cause	Confirmation Method	Corrective Action
			malfunction, please replace the servo drive.
AL.FB2 Fieldbus communication setup error	The setting of the communication hardware or parameters is out of the product specification or not fulfill the communication requirement.	Check the communication settings. **EtherCAT:** N/A **mega-ulink:** N/A **MECHATROLINK:** (1) Check the setting of the station address is in the range of 0x03 to 0xEF. (2) Check the setting of the data length shoule be 32bytes or 48bytes. (3) Check if the station address setting is duplicated.	After confirm the communication settings, restart the drive. If the abnormality still occurs, it may be the drive failure, please replace the drive.
AL.FC0 Group control system communication error	Communication is interrupted. It could be disconnection of the communication cable or poor connection.	Check if the communication cable is correctly connected.	Check if the communication cable is correctly connected.
	Communication is interfered.	Check if there is interference source or the communication cable is not correctly connected.	Add ferrite ring or replace the communication cable.
	Power off or reset one of the axes.	N/A	Perform alarm reset on master axis via Thunder or external signal. Or reset both axes.
	The group control mode settings are different.	Check if the group control mode settings of both axes are the same.	Set the group control mode (Pt003 = t. □□□X) of both axes as the same value based on usage.
AL.FC1 Slave axis error in group control system	An error occurs in the slave axis of group control system.	Check the cause of the error.	After the cause of the error is cleared, perform alarm reset on master axis via Thunder or external signal, or reset both axes.
AL.Fd0 Electronic cam control system alarm	An alarm occurs in electronic cam control system.	Check the causes of the alarm.	After the causes of the alarm are cleared, perform alarm reset on both axes via Thunder or external signal, or reset both axes.

Note:

The detection timing of AL.F50 (Motor main circuit cable disconnection) is when the motor velocity drops to the value set in Pt507 or Pt583.

13.2.3 Alarm reset

After alarm output (ALM) signal is output, reset the servo drive by the method provided below when the root cause is cleared. Alarm related to encoder may not be reset by alarm reset input (ALM-RST) signal. In this case, please turn off the control power to reset.

■ Reset by alarm reset input (ALM-RST) signal

Table13.2.3.1

Type	Signal	Hardware Pin	Status	Description
Input	ALM-RST	User-defined	Edge-triggered	Reset alarm.

13.3 Warning

13.3.1 Warning list

Table13.3.1.1 Warning list

Warning Number	Warning Name	Warning Contents
AL.900	Position deviation overflow	The position deviation exceeds the value of (Pt520 x Pt51E)/100 or the value of (Pt521 x Pt51E)/100.
AL.910	Overload	This warning appears before overload alarm (AL.710 or AL.720). If the operation continues, an alarm could occur.
AL.923	Internal fan stop	The internal fan of the servo drive stops operating.
AL.924	I^2T	Motor overload protection alarm. Limit the drive output current.
AL.930	Encoder battery malfunction	The battery of absolute encoder is abnormal.
AL.941	Parameter or function that goes into effect after saving or power off has been modified.	Parameter or function that goes into effect after saving or power off has been modified.
AL.943	Fieldbus synchronous cycle time warning	The synchronous cycle time of Fieldbus communication is unstable.
AL.944	System warning	An error occurs in the internal program of the servo drive.
AL.945	Torque limit warning	Torque command exceeds the torque limit value.
AL.946	Encoder communication warning	Encoder communication is abnormal.
AL.947	Multi-motion function does not work	Incorrect motor options. Control mode setting error. Pt20E/Pt210 setting error. Homing procedure is not executed. Abnormal in-position signal.
AL.971	Undervoltage	This warning appears before undervoltage alarm (AL.410). If the operation continues, an alarm could occur.
AL.9A0	Overtravel detected when servo ON (P-OT or N-OT signal is received.)	Overtravel signal (P-OT or N-OT signal) is detected when servo on.
AL.9A1	P-OT signal is received.	P-OT signal is detected when servo off.
AL.9A2	N-OT signal is received.	N-OT signal is detected when servo off.
AL.9F0	Main circuit overvoltage	The voltage of main circuit is too high.

13.3.2 Causes and corrective actions for warnings

Table13.3.2.1 Causes and corrective actions for warnings

Warning Number And Warning Name	Cause	Confirmation Method	Corrective Action
AL.900 Position deviation overflow	The wiring of the U, V or W phase of the motor is incorrect.	Check the wiring of the motor power cable.	Check if the connection of the motor power cable or encoder cable is poor.
	The servo gain of the servo drive is too low.	Check if the servo gain of the servo drive is too low.	Obtain proper servo gain by auto tuning.
	The inputting frequency of command pulse is too high.	Decrease the inputting frequency of command pulse. Then start operation again.	Decrease the inputting frequency of command pulse or command acceleration. Or adjust the electronic gear ratio.
	The command acceleration is too high.	Decrease the command acceleration. Then start operation again.	Set position command acceleration/deceleration time constant (Pt216).
	The setting value of alarm value for overflow position deviation (Pt520 or Pt521) is low when compared to the operating condition.	Check if the setting value of alarm value for overflow position deviation (Pt520 or Pt521) is appropriate.	Adjust the setting value of alarm value for overflow position deviation (Pt520 or Pt521).
	Servo drive malfunction	N/A	Power on again. If the alarm occurs again, it could be servo drive malfunction, please replace the servo drive.
AL.910 Overload	The wiring of motor or encoder is poor or the connection is poor.	Check the wiring.	Check if the wirings of the motor and encoder are correct.
	The motor motion exceeds the detection value of overload.	Check the detection value of overload and motion command.	Re-calculate and adjust the load and operating condition. Or select a new motor.
	Overload occurs since the motor cannot be operated due to mechanical factor.	Check the motion command and motor velocity.	Improve mechanical factor.
	Servo drive malfunction	N/A	It could be servo drive malfunction, please replace the servo drive.
AL.923 Internal fan stop	The internal fan of the servo drive stops operating.	Check if there is foreign object inside the internal fan.	If the alarm occurs again after the foreign object is removed, it could be servo drive malfunction, please replace the servo drive.

Warning Number And Warning Name	Cause	Confirmation Method	Corrective Action
AL.924 I^2T	The wiring of motor or encoder is poor or the connection is poor.	Check the wiring.	Check if the wirings of the motor and encoder are correct.
	The motor motion exceeds the detection value of overload.	Check the value of Pt554(Maximum duration for I^2T peak current)	Re-calculate and adjust the load and operating condition. Or select a new motor.
	Overload occurs since the motor cannot be operated due to mechanical factor.	Check the motion command and motor velocity.	Improve mechanical factor.
	Servo drive malfunction..	N/A	It could be servo drive malfunction, please replace the servo drive.
AL.930 Encoder battery malfunction	The battery of absolute encoder is abnormal.	Check if the battery voltage is 5 V.	Change the battery or encoder cable.
	Encoder malfunction	N/A	Power on again. If the warning occurs again, it could be motor malfunction, please replace the motor.
AL.941 Change of parameters and functions with save and restart requirement	Change of parameters and functions with save and restart requirement.	N/A	Save parameters and restart.
AL.943 Fieldbus synchronous cycle time warning	The synchronous cycle time of Fieldbus communication is unstable.	N/A	Increase Fieldbus communication cycle time.
AL.944 System warning	An error occurs in the internal program of the servo drive.	N/A	Perform software reset or power on the servo drive again.
AL.945 Torque limit warning	Torque command exceeds the torque limit value.	Check if the torque limit value is too small.	Adjust torque limit value.
AL.946 Encoder communication warning	The encoder communication is interfered or the encoder cable disconnects.	Check if there is interference source or the encoder cable is correctly connected. Or the connection is poor.	(1) Add ferrite ring or replace the encoder cable. (2) Check if the encoder cable is correctly connected.
AL.947 Multi-motion function does not work	Incorrect motor options.	Check if the motor is direct drive motor or linear motor.	(1) Please change the motor as direct drive motor or linear motor. (2) If linear motor is used, indexing movement is not supported.

Warning Number And Warning Name	Cause	Confirmation Method	Corrective Action
	Control mode setting error.	Check if the control mode is internal position mode.	Please set the control mode as internal position mode.
	Pt20E/Pt210 setting error.	Check if Pt20E and Pt210 are set as 1.	Please set Pt20E and Pt210 as 1.
	Homing procedure is not executed.	Check if the homing procedure is completed if incremental encoder is used.	Please confirm if the homing process is completed.
	Abnormal in-position signal.	Check the in-position signal.	Please confirm the signal status when the motor is stopped.
AL.971 Undervoltage	The voltage of AC power supply is below 140 V.	Measure the voltage of AC power supply.	Adjust the voltage of the AC power supply to the specified range.
	The power supply voltage drops during operation.	Measure the power supply voltage.	Increase power supply capacity.
	Momentary power interruption occurs.	Measure the power supply voltage.	Provide stable power supply.
	The fuse of the servo drive is blown out.	N/A	It could be servo drive malfunction, please replace the servo drive.
	Servo drive malfunction	N/A	Replace the servo drive.
AL.9A0 Overtravel detected when servo ON (P-OT or N-OT signal is received.)	Overtravel signal (P-OT or N-OT signal) is detected when servo on.	Check the status of overtravel signals via Thunder.	(1) Check the wirings for overtravel signals. (2) Adopt countermeasure against interference.
AL.9A1 P-OT signal is received.	P-OT signal is detected when servo off.	Check the status of overtravel signal via Thunder.	(1) Check the wirings for overtravel signals. (2) Adopt countermeasure against interference.
AL.9A2 N-OT signal is received.	N-OT signal is detected when servo off.	Check the status of overtravel signal via Thunder.	(1) Check the wirings for overtravel signals. (2) Adopt countermeasure against interference.
AL.9F0 Main circuit overvoltage	The motor velocity is too high.	Check motion command and motor velocity.	Adjust load or operating condition.

Warning Number And Warning Name	Cause	Confirmation Method	Corrective Action
	The voltage of the main power supply is too low.	Check the voltage of the AC power supply.	Adjust the voltage of the AC power supply to the specified range.

13.4 Causes and corrective actions for abnormal operation

Table13.4.1 Causes and corrective actions for abnormal operation

Operation	Cause	Confirmation Method	Corrective Action
The servo drive is not ready.	The voltage of control power is below 220 Vac.	Use multimeter to measure if the voltage of control power is below 220 Vac. Or observe if **Bus voltage** is below 300 Vdc from **Interface signal monitor** window in Thunder.	Adjust the voltage of the control power to the specified range.
	An alarm occurs and has not been cleared.	Check the alarm number from the servo drive panel or check the alarm number displayed in **Last Error** from **ErrorLog** window.	Refer to section 13.2.2 and perform corrective action.
	Motor parameters are not set.	Check if the setting has been done in Configuration Wizard.	Refer to section 7.3 and set motor parameters.
	Forced stop input (FSTP) signal is ON.	Check if the servo drive panel displays “Stp”. Or observe if the indicator for FSTP signal input in **Interface signal monitor** window of Thunder is green.	(1) Set FSTP signal to OFF. (2) If you are not using forced stop function, please set this function to be always inactive by Pt50F=t.□□□X (Allocation of forced stop input (FSTP) signal).
The servo motor is not operating.	Servo on input (S-ON) signal is OFF.	Check if the servo drive panel displays “nrd”. Or observe if **Servo on input** indicator on the left of the main screen of Thunder does not light up.	(1) Set S-ON signal to ON. (2) Check the setting of Pt50A=t.□□□X (Allocation of servo on input (S-ON) signal) and input signal from the allocated pin. (3) Check if the signal output from the controller is correct.
	The wiring for motor (CN2), encoder (CN7) or control signals (CN6) is poor. Or the connection is poor.	Check the wiring.	Check if the wiring of the servo drive is correct.
	Overtravel occurs when servo ON.	Check if the position of the forcer is not within the allowable range.	Check if the position of the forcer is not within the allowable range.
	The control mode is incorrect.	Check if the selected control mode is correct from **Parameters Setup** window.	Check if the selected control mode is correct by Pt000=t.□□X□ (Control method selection).

Operation	Cause	Confirmation Method	Corrective Action
	The pulse command input is incorrect (position mode).	Check the input command value.	Check if the command output from the controller is correct.
	The selection of pulse command form is incorrect.	Check if the selected pulse command form is correct from **Parameters Setup** window.	Check if the selected pulse command form is correct by Pt200=t.□□□X (Pulse command form).
	Command pulse inhibition input (INHIBIT) signal is ON.	Check if the indicator for INHIBIT signal input in **Interface signal monitor** window of Thunder is green.	(1) Set INHIBIT signal to OFF. (2) Check the setting of Pt50D=t.□□□X (Allocation of command pulse inhibition input (INHIBIT) signal) and input signal from the allocated pin. (3) Check if the signal output from the controller is correct.
	Velocity command input is incorrect (velocity mode).	Check the input command value.	Check if the command from the controller is correct.
	The gain of velocity command is incorrect (velocity mode).	Check velocity command input gain from **Parameters Setup** window.	Refer to section 8.3.1 and modify Pt300 (Velocity command input gain).
	Torque command input is incorrect (torque mode).	Check the input command value.	Check if the command output from the controller is correct.
	The gain of torque command is incorrect (torque mode).	Check torque command input gain from **Parameters Setup** window.	Refer to section 8.5.1 and modify Pt400 (Torque command input gain).
	Torque limit value is too small.	Check if the servo drive panel displays AL.945. Or if “AL.945 Torque limit warning” displays on the left of the main screen.	Refer to section 8.10 and modify torque limit value.
	Overload occurs since the motor cannot be operated due to mechanical factor (such as mechanical interference).	Check if the resistance applied to the forcer is too large or the brake is locked.	(1) Check if there is any interference. (2) Release the brake. (3) Decrease the load.
	Servo drive malfunction	N/A	It could be servo drive malfunction, please replace the servo drive.

13.5 Maintenance

This section describes servo drive inspection and part replacement.

13.5.1 Regular inspection

The servo drive does not need to be inspected daily, but the items listed in table below must be inspected every half year or annually.

Table13.5.1.1

Item	Frequency	Inspection	Corrective Action
Appearance and Environment	Half year or annually	No litter, dust, oil and stain, etc.	Clean the environment and the servo drive.
Screws		Parts must be tightened, such as terminal block, connector and screw, etc.	Tighten the parts with screw driver.

13.5.2 Replacement standard

The electronic parts inside the servo drive are subject to mechanical wear or deterioration. Table below provides the replacement standards for the electronic parts.

Table13.5.2.1

Part	Replacement Standard	Note
Fan	4~5 years	• Ambient temperature: average 30°C • Operation time: 20 hours/day
Electrolytic Capacitor	2 years	
Relay	Power on for 30,000 times.	Frequency: 1 time/hour
Battery	2.5 years (No power is supplied.)	Storage temperature: 20°C

When replacement standard is met, contact HIWIN or our distributors to check if replacement is required.

13.5.3 Replacing battery

When battery voltage drops to 2.7 V or below, alarm encoder battery undervoltage (AL.810) occurs. Then the battery must be replaced.

■ Replacing battery

(1) When battery is installed on controller

Step1: Turn on the control power of the servo drive only.

Step2: Remove the battery and installed a new battery.

Step3: Turn off the control power of the servo drive to clear alarm AL.810.

Step4: Turn on the control power of the servo drive again.

Step5: Check if the alarm is cleared. Then, the servo drive can be operated normally.

(2) Encoder cable with battery box is used

Step1: Turn on the control power of the servo drive only.

Step2: Open the lid of the battery box.

Step3: Remove the battery and installed a new battery.

Step4: Close the lid.

Step5: Turn off the control power of the servo drive to clear alarm AL.810.

Step6: Turn on the control power of the servo drive again.

Step7: Check if the alarm is cleared. Then, the servo drive can be operated normally.

14. Panel operation

14.1 Panel description

14.1.1 Key names and functions

Users are allowed to perform auxiliary functions, set parameters as well as monitor the status and values* of the servo drive by panel. The names and functions of the keys on the servo drive panel are described as below.

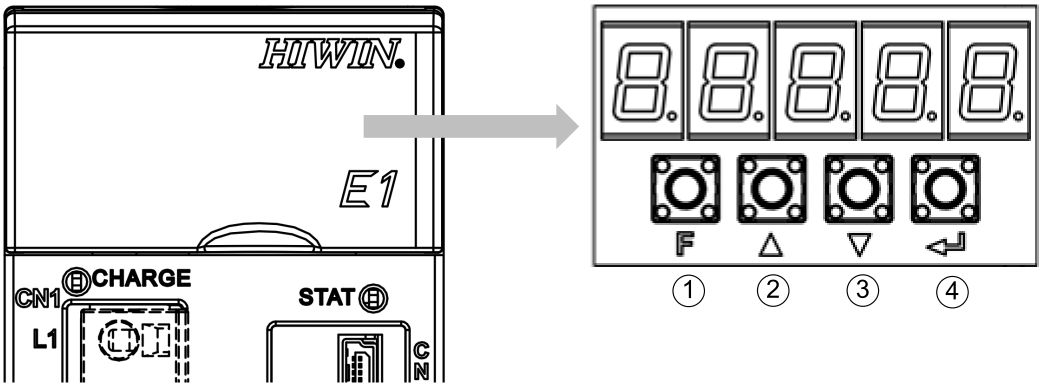


Figure14.1.1.1

Table14.1.1.1

Key Number	Key Name	Function
①	**F** key	(1) Switch function. (2) Confirm setting value.
②	**UP** key	Increase setting value.
③	**DOWN** key	Decrease setting value.
④	**DATA/SHIFT** key	(1) Display setting value. Press **DATA/SHIFT** key for one second to display setting value. (2) While a digit is flashing, use this key to move to the next digit on its left.

Note:

*For Fieldbus servo drive, users can only monitor the servo drive status from the panel since there is no key on Fieldbus servo drive.

14.1.2 Switching function

Press **F** key to switch among functions as figure 14.1.2.1. For operation of each function, please refer to the following.

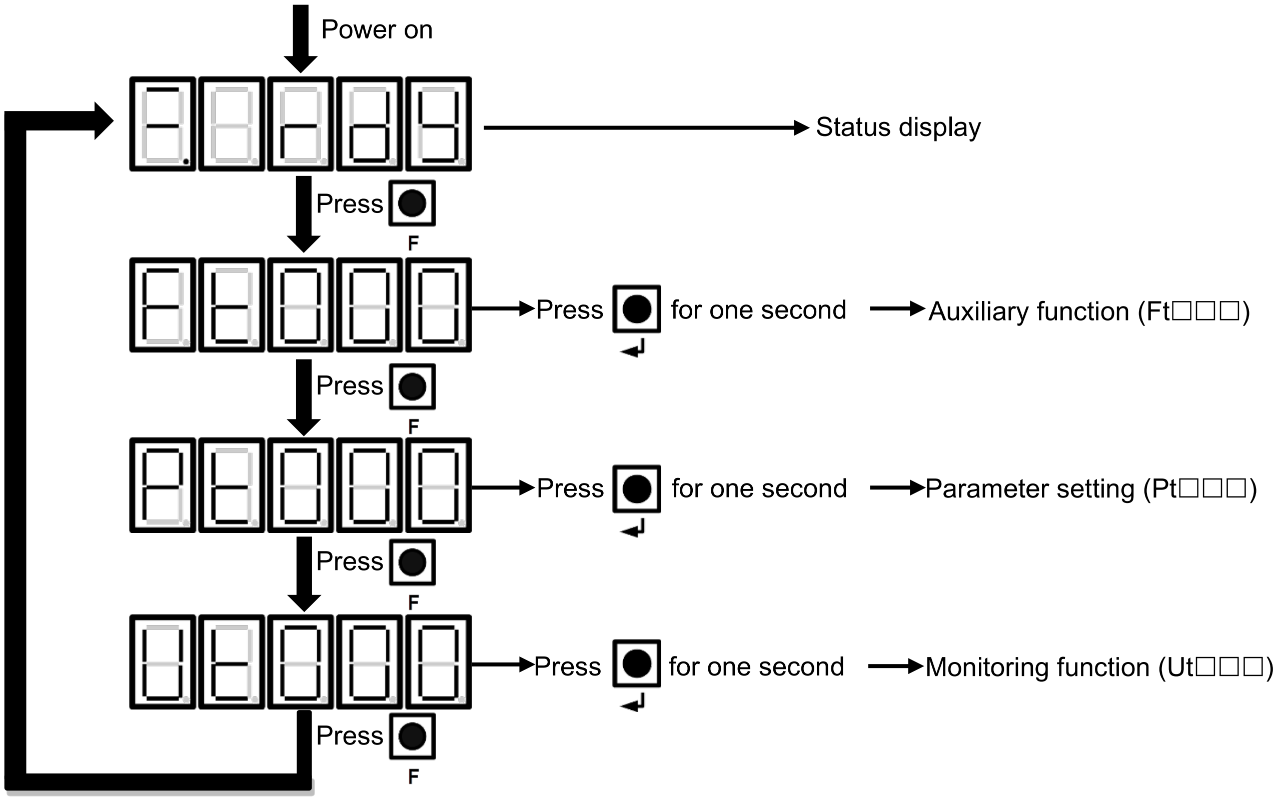


Figure14.1.2.1

14.1.3 Status display

The status is displayed as figure 14.1.3.1.

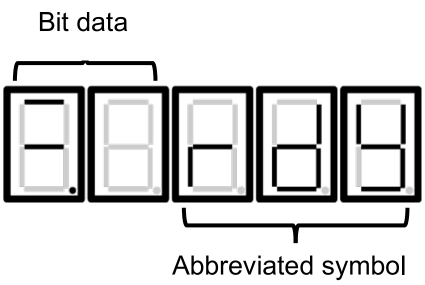
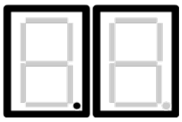
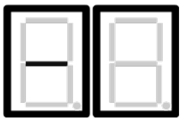
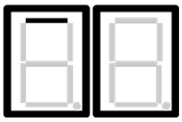
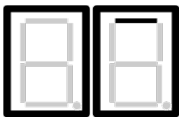
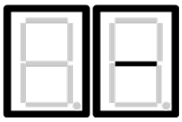
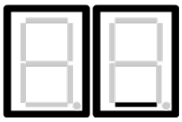
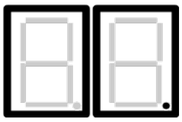


Figure14.1.3.1

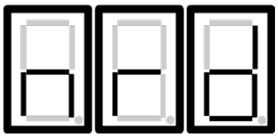
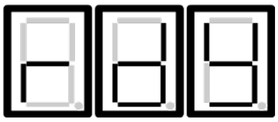
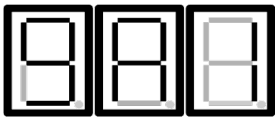
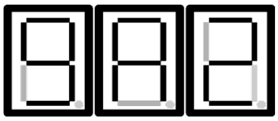
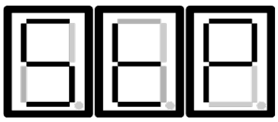
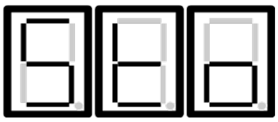
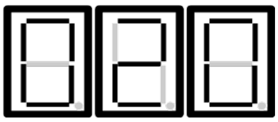
■ Bit data

Table14.1.3.1

Display	Function Description
	Control power supply status Light up when the control power supply is ON. Do not light up when the control power supply is OFF.
	Servo status Light up when servo OFF. Do not light up when servo ON.
	(1) Status of velocity reach output (V-CMP) signal (velocity control) Light up when the difference between the servo motor velocity and velocity command is within the setting value. (Set via Pt503 or Pt582. The default setting is 10 rpm or 10 mm/s) Do not light up when the difference exceeds the setting value. Always light up during torque control. If analog command is interfered by noise,“-“ of the leftmost digit will be flashing, please refer to section 5.1.2. (2) Status of positioning completion output (COIN) signal (position control) Light up when the difference between the servo motor position and position command is within the setting value. (Set via Pt522. The default setting is seven control units.) Do not light up when the difference exceeds the setting value.
	Status of rotation detection output (TGON) signal Light up when the rotary velocity of the servo motor exceeds the setting value. (Set via Pt502 or Pt581. The default setting is 20 rpm or 20 mm/s.) Do not light up when the rotary velocity of the servo motor is below the setting value.
	(1) Status of velocity command input (velocity control) Light up when the input velocity command exceeds the setting value. (Set via Pt502 or Pt581. The default setting is 20 rpm or 20 mm/s.) Do not light up when the input velocity command is below the setting value. (2) Status of pulse command input (position control) Light up when pulse command is input. Do not light up when pulse command is not input.
	(1) Display of torque command input (torque control) Light up when the input torque command exceeds the setting value (10% of rated torque) Do not light up when the input torque command is below the setting value. (2) Display of position deviation clear input (CLR) signal (position control) Light up when position deviation clear input (CLR) signal is input. Do not light up when position deviation clear input (CLR) signal is not input.
	Main power supply status Light up when the main circuit power supply is ON. Do not light up when the main circuit power supply is OFF.

■ Abbreviated symbol

Table14.1.3.2

Display	Function Description
	The motor is not enabled. The display means servo OFF.
	The motor is enabled. The display means servo ON.
	The motor is prohibited to operate in forward direction. The display means forward prohibition input (P-OT) signal is ON.
	The motor is prohibited to operate in reverse direction. The display means reverse prohibition input (N-OT) signal is ON.
	Forced stop The display means the servo drive receives forced stop input (FSTP) signal. The servo drive is in emergency stop state.
	Safety function is enabled. The display means safety function is enabled and the servo drive is in STO state.
	Alarm The display means an alarm occurs. The alarm number will be flashing.

Note:
*Fieldbus servo drive can only display one symbol at a time.

14.2 Parameter setting (Pt□□□)

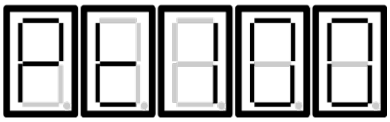
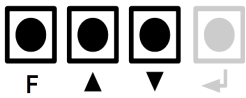
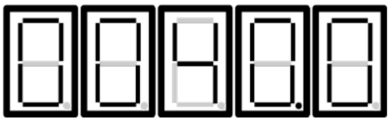
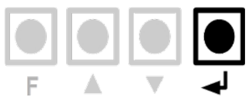
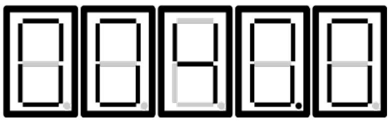
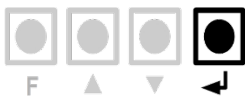
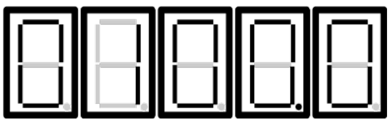
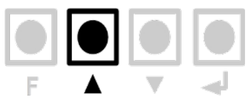
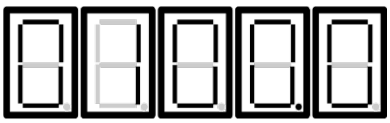
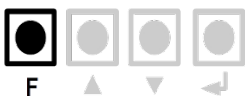
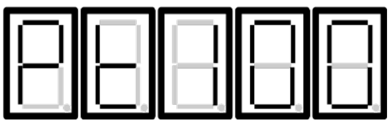
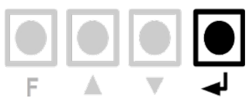
For how to set parameters via panel, please refer to the following.

14.2.1 Setting numeric parameter

Table 14.2.1.1 describes how to change the setting value of velocity loop gain (Pt100) from 40.0 to 100.0 via panel.

Note:
To display and modify numeric parameters via servo drive panel, please refer to section 14.2.2 and set Pt00B = t.□□□1 (Display all parameters)

Table14.2.1.1

Step	Display	Key	Operation
1			Press **F** key to go to parameter setting mode. If the displayed parameter is not Pt100, press **UP** or **DOWN** key to display Pt100.
2			Press **DATA/SHIFT** key for one second to display the current setting value of Pt100.
3			Press **DATA/SHIFT** key to move among digits. If a digit is flashing, it means it is editable.
4			Press **UP** key for six times to change the setting value to 100.0. For setting values with more than six digits, please refer to figure 14.2.1.1.
5			Press **F** key and the value will be flashing. After that, the setting value is changed from 40.0 to 100.0.
6			Press **DATA/SHIFT** key for one second. Then the display will return to Pt100.
7	To save parameter to servo drive Flash, execute Ft001 by referring to section 14.4.2.		

Note

Setting negative value

- For parameter that can be set to negative value, press **DOWN** key from 00000 to set negative value.
- While setting negative value, press **DOWN** key to increase the value and **UP** key to decrease the value.

- Setting value with more than six digits

  The panel can only display 5-digit value. For setting value with more than six digits, please refer to figure 14.2.1.1.

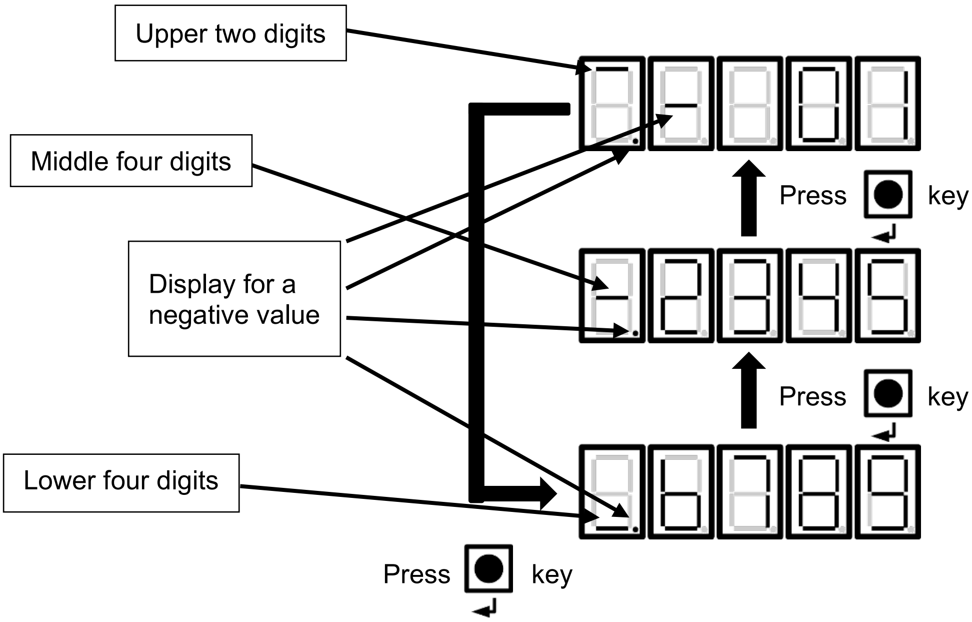
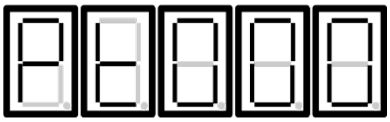
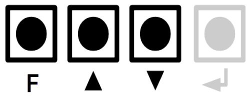
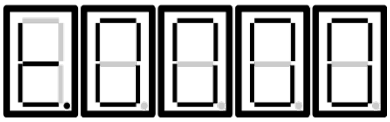
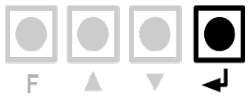
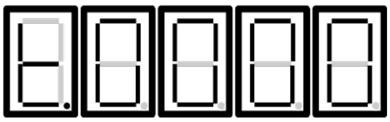
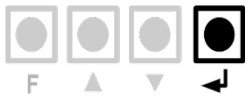
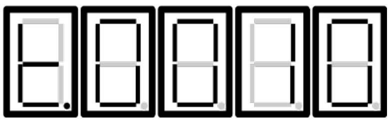
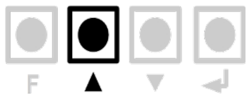
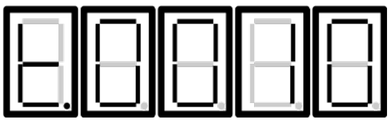
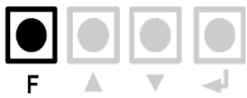
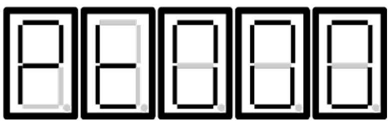
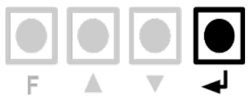


Figure14.2.1.1

14.2.2 Setting function selection parameter

Table 14.2.2.1 describes how to change from velocity mode to position mode via panel.

Table14.2.2.1

Step	Display	Key	Operation
1			Press **F** key to go to parameter setting mode. If the displayed parameter is not Pt000, press **UP** or **DOWN** key to display Pt000.
2			Press **DATA/SHIFT** key for one second to display the current setting value of Pt000.
3			Press **DATA/SHIFT** key to move among digits. If a digit is flashing, it means it is editable.
4			Press **UP** key for one time to change the setting value to t.0010 to change from velocity mode to position mode.
5			Press **F** key and the value will be flashing. After that, the control mode is changed from velocity mode to position mode.
6			Press **DATA/SHIFT** key for one second. Then the display will return to Pt000.
7	To save parameters to servo drive Flash, execute Ft001 by referring to section 14.4.2.		
8	The modification will be effective after the servo drive is powered on again.		

14.3 Monitoring function (Ut□□□)

Users are allowed to monitor physical quantity and I/O signal via panel. The number of monitoring item starts with a beginning of “Ut”. The example below is monitoring motor velocity (Ut000).

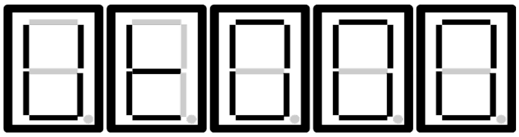


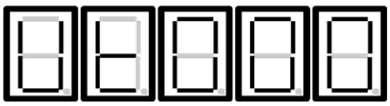
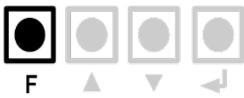
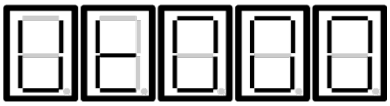
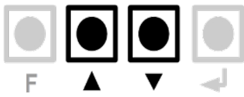
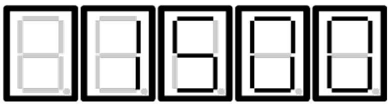
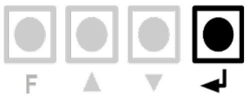
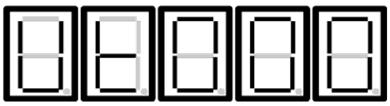
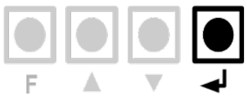
Figure14.3.1

For basic operation of monitoring function and the numbers of monitoring items, please refer to the following.

14.3.1 Basic operation of monitoring function

Table 14.3.1.1 describes how to monitor motor velocity (Ut000).

Table14.3.1.1

Step	Display	Key	Operation
1			Press **F** key to go to monitoring function mode (Ut).
2			Press **UP** or **DOWN** key to select the Ut number to be monitored.
3			Press **DATA/SHIFT** key for one second to display the contents of Ut number. If the displayed value is with more than six digits, please refer to figure 14.2.1.1.
4			Press **DATA/SHIFT** key for one second to return to the display of step 1.

14.3.2 Monitoring input signals

Ut005 is used to monitor input signals. The state of input signal is displayed by the segment of LED.

- Display

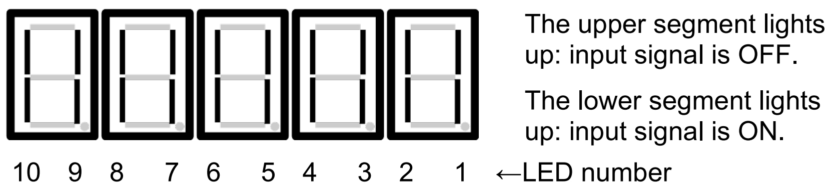


Figure14.3.2.1

- LED numbers and their corresponding input signals

Table14.3.2.1

LED Number	Input Hardware Pin	Signal (Default)
1	CN6-33	S-ON
2	CN6-30	P-CON
3	CN6-29	P-OT
4	CN6-27	N-OT
5	CN6-28	ALM-RST
6	CN6-26	P-CL
7	CN6-32	N-CL
8	CN6-31	HOM
9	CN6-9	MAP
10	CN6-8	FSTP

- Display example

(1) Servo on input (S-ON) signal is ON.

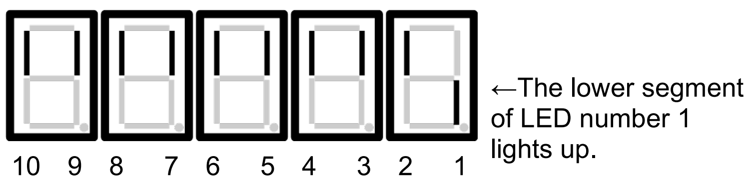


Figure14.3.2.2

(2) Servo on input (S-ON) signal is OFF.

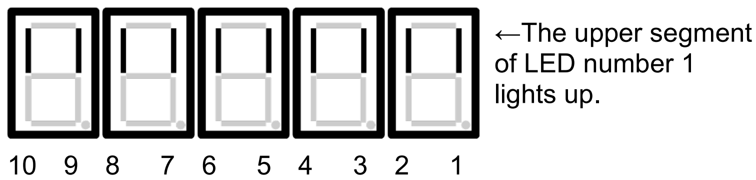


Figure14.3.2.3

(3) Forward prohibition input (P-OT) signal is ON.

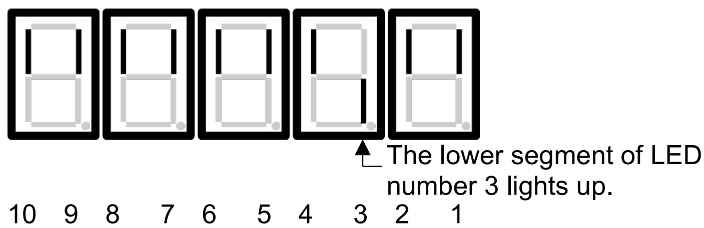


Figure14.3.2.4

14.3.3 Monitoring output signals

Ut006 is used to monitor output signals. The state of output signal is displayed by the segment of LED.

■ Display

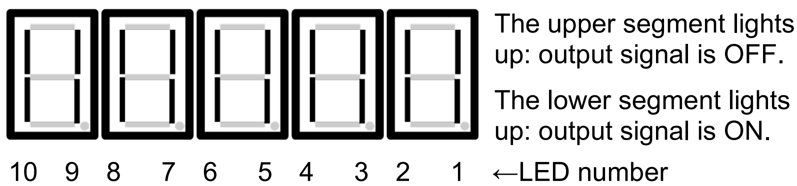


Figure14.3.3.1

■ LED numbers and their corresponding output signals

Table14.3.3.1

LED Number	Output Hardware Pin	Signal (Default)
1	CN6-35, 34	COIN & V-CMP
2	CN6-37, 36	TGON
3	CN6-39, 38	D-RDY
4	CN6-11, 10	ALM
5	CN6-40, 12	BK
6	-	Reserved
7	-	Reserved
8	-	Reserved
9	-	Reserved
10	-	Reserved

■ Display example

(1) Alarm output (ALM) signal is ON.

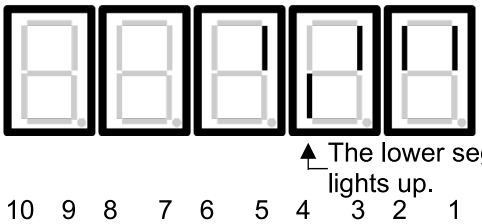


Figure14.3.3.2

14.3.4 List of monitoring items

The supported monitoring items and their numbers are listed in table 14.3.4.1.

Table14.3.4.1

Number	Monitoring Item	Unit
Ut000	Motor velocity	rpm
Ut001	Velocity command	rpm
Ut005	Input signal monitoring	-
Ut006	Output signal monitoring	-
Ut007	Command pulse velocity (for position control only)	rpm
Ut008	Position deviation (for position control only)	Control unit
Ut00C	Command pulse counter	Control unit
Ut00D	Feedback pulse counter	Encoder pulse
Ut00E	Feedback pulse counter (full-closed loop)	count
Ut013	Feedback pulse counter (unit: control unit)	Control unit
Ut020	Rated velocity of motor	rpm
Ut021	Maximum velocity of motor	rpm
Ut041	Single-turn absolute position	Encoder pulse

14.4 Auxiliary function (Ft□□□)

Users can use auxiliary functions for servo drive setup, tuning and parameter saving. The number of auxiliary function starts with a beginning of “Ft”. In figure 14.4.1, the example is alarm display (Ft000).

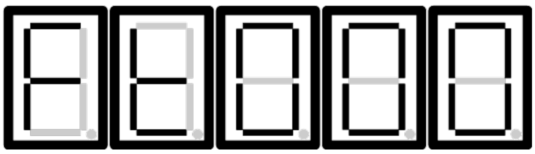
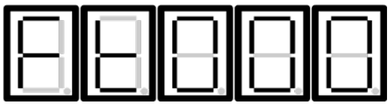
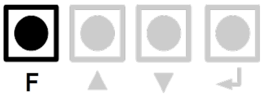
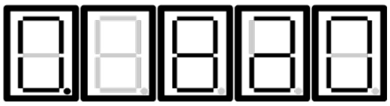
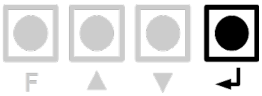
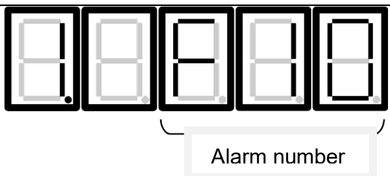
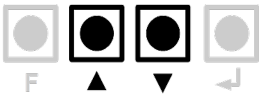
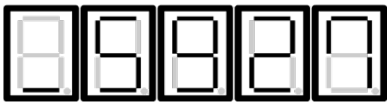
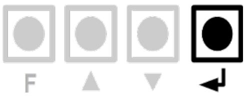
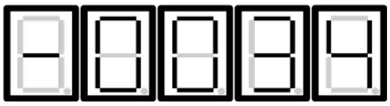
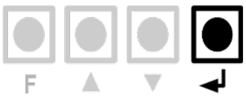
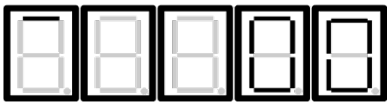
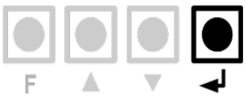
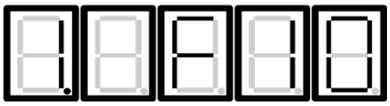
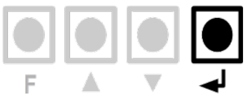
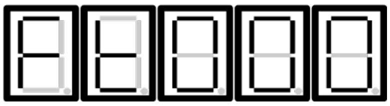
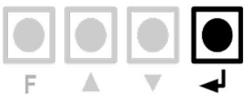


Figure14.4.1

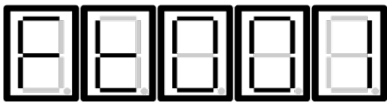
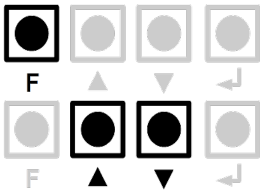
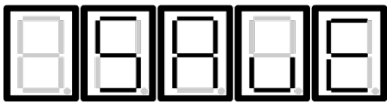
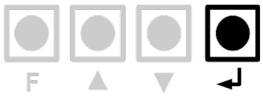
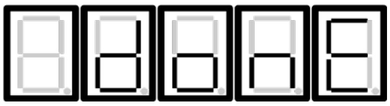
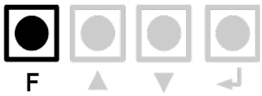
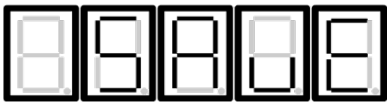
14.4.1 Displaying alarm history (Ft000)

Table14.4.1.1

Step	Display	Key	Operation
1			Press **F** key to go to auxiliary function mode (Ft). If the displayed number is not Ft000, press **UP** or **DOWN** key to display Ft000.
2			Press **DATA/SHIFT** key for one second to display the latest alarm.
3			Press **UP** key to display previous alarm. Press **DOWM** key to display next alarm. The larger the leftmost digit is, the older the displayed alarm is. For information of alarm, please refer to section 13.2.
4			Press **DATA/SHIFT** key to display the lower four digits of time stamp.
5			Press **DATA/SHIFT** key to display the middle four digits of time stamp.
6			Press **DATA/SHIFT** key to display the upper two digits of time stamp.
7			Press **DATA/SHIFT** key to display alarm number.
8			Press **DATA/SHIFT** key for one second to display Ft000.

14.4.2 Saving parameter to servo drive (Ft001)

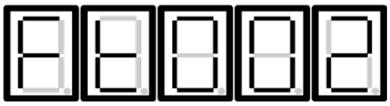
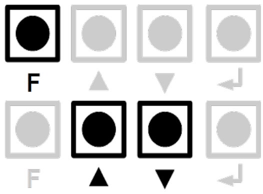
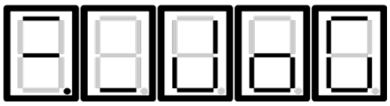
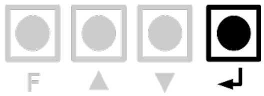
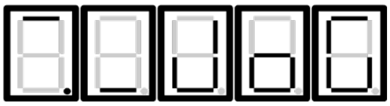
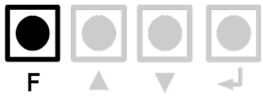
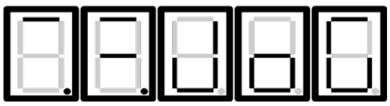
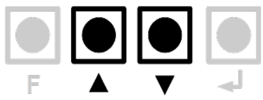
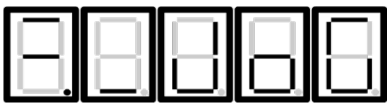
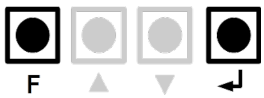
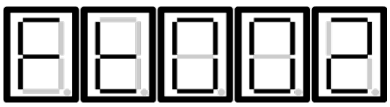
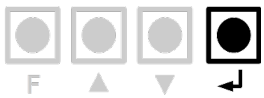
Table14.4.2.1

Step	Display	Key	Operation
1			Press **F** key to go to auxiliary function mode (Ft). Press **UP** or **DOWN** key to display Ft001.
2			Press **DATA/SHIFT** key for one second to show the display on the left.
3	 (Blinking)		Press **F** key to save parameter to Flash. When the saving completes, the display on the left shows.
4		-	After parameter is saved to Flash, the display on the panel automatically returns to the display on the left.
5	After parameter is saved to Flash, reconnect the control power of the servo drive. Then, the modification becomes effective.		

14.4.3 JOG (Ft002)

For related parameters of JOG, please refer to section 8.7.1.

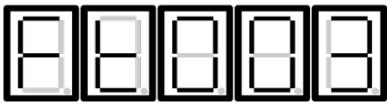
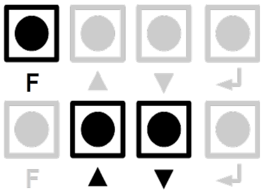
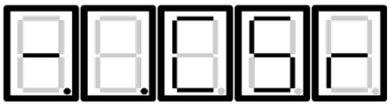
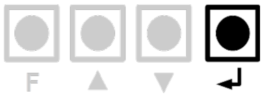
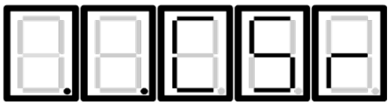
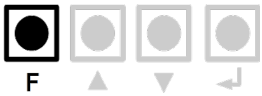
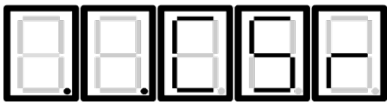
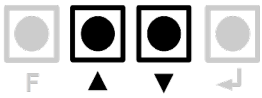
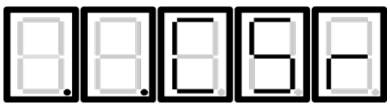
Table14.4.3.1

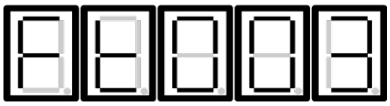
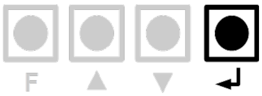
Step	Display	Key	Operation
1			Press **F** key to go to auxiliary function mode (Ft). Press **UP** or **DOWN** key to display Ft002.
2			Press **DATA/SHIFT** key for one second to show the display on the left.
3			Press **F** key to go to servo ON state. The display on the left shows.
4			Press **UP** key (forward) or **DOWN** key (reverse). The servo motor operates at the setting set by Pt304 (rotary motor) or Pt383 (linear motor).
5			Press **F** key to go to servo OFF state. Note: Users can also press **DATA/SHIFT** key for one second to servo off.
6			Press **DATA/SHIFT** key for one second to display Ft002.

14.4.4 Homing (Ft003)

For related parameters of homing, please refer to section 8.11.

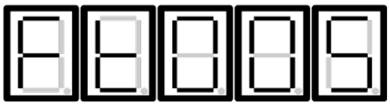
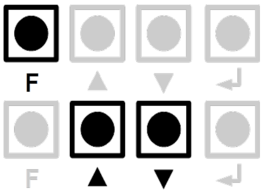
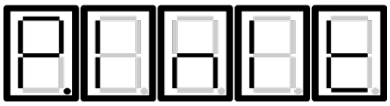
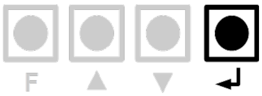
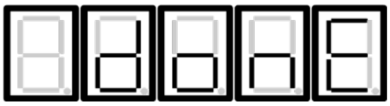
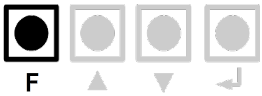
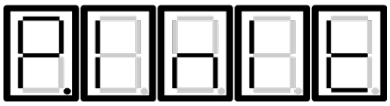
Table14.4.4.1

<table>
<tr><th>Step</th><th>Display</th><th>Key</th><th>Operation</th></tr>
<tr><td>1</td><td></td><td></td><td>Press F key to go to auxiliary function mode (Ft). Press UP or DOWN key to display Ft003.</td></tr>
<tr><td>2</td><td></td><td></td><td>Press DATA/SHIFT key for one second to show the display on the left.</td></tr>
<tr><td>3</td><td></td><td></td><td>Press F key to go to servo ON state. The display on the left shows.</td></tr>
<tr><td>4</td><td></td><td></td><td>Press UP key, the motor moves in forward direction. Press DOWN key, the motor moves in reverse direction. For Pt000 = t.□□□X (Rotation/movement direction selection), please refer to below.
● Rotary motor
<table>
<tr><th colspan="2">Parameter</th><th>UP</th><th>DOWN</th></tr>
<tr><td rowspan="2">Pt000</td><td>t.□□□0</td><td>CCW</td><td>CW</td></tr>
<tr><td>t.□□□1</td><td>CW</td><td>CCW</td></tr>
</table>
Note:
Observe from the load side.
● Linear motor
<table>
<tr><th colspan="2">Parameter</th><th>UP</th><th>DOWN</th></tr>
<tr><td rowspan="2">Pt000</td><td>t.□□□0</td><td>Linear encoder counts up.</td><td>Linear encoder counts down.</td></tr>
<tr><td>t.□□□1</td><td>Linear encoder counts down.</td><td>Linear encoder counts up.</td></tr>
</table>
Note:
Set the direction where the linear encoder counts up is the forward direction. For more information, please refer to section 6.5.3.</td></tr>
<tr><td>5</td><td>
(Blinking)</td><td>-</td><td>After homing completes, the display blinks.</td></tr>
</table>

Step	Display	Key	Operation
6			Press **DATA/SHIFT** key for one second to display Ft003.

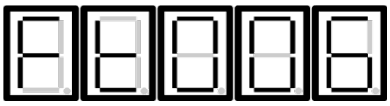
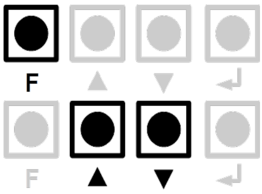
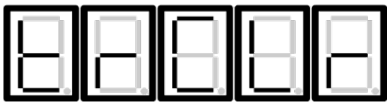
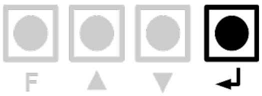
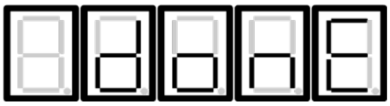
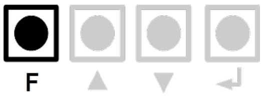
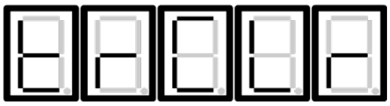
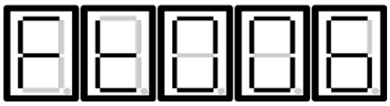
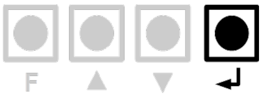
14.4.5 Parameter initialization (Ft005)

Table14.4.5.1

Step	Display	Key	Operation
1			Press **F** key to go to auxiliary function mode (Ft). Press **UP** or **DOWN** key to display Ft005.
2			Press **DATA/SHIFT** key for one second to show the display on the left.
3	 (Blinking)		Press **F** key to perform parameter initialization. After parameter initialization completes, the display on the left shows.
4		-	After parameter initialization completes, the display on the panel automatically returns to the display on the left.
5	To let the setting become effective, after phase initialization completes, save parameter to servo drive Flash by Ft001.		

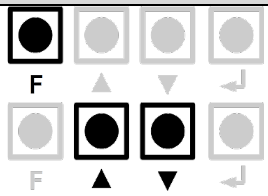
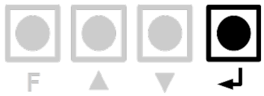
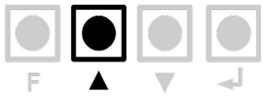
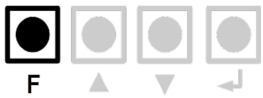
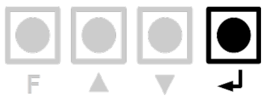
14.4.6 Deleting alarm history (Ft006)

Table14.4.6.1

Step	Display	Key	Operation
1			Press **F** key to go to auxiliary function mode (Ft). Press **UP** or **DOWN** key to display Ft006.
2			Press **DATA/SHIFT** key for one second to show the display on the left.
3	 (Blinking)		Press **F** key to delete alarm history. After alarm history is deleted, the display on the left shows.
4		-	After alarm history is deleted, the display on the panel automatically returns to the display on the left.
5			Press **DATA/SHIFT** key for one second to display Ft006.

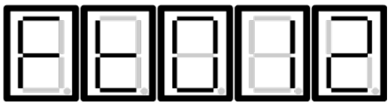
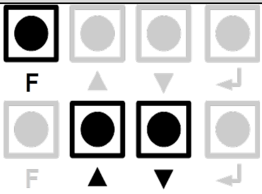
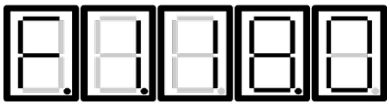
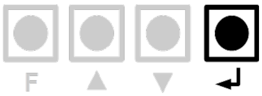
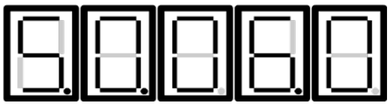
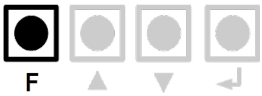
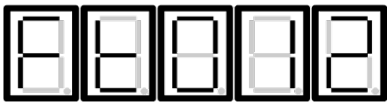
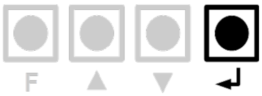
14.4.7 Setting absolute encoder (Ft008)

Table14.4.7.1

Step	Display	Key	Operation
1	Ft008		Press **F** key to go to auxiliary function mode (Ft). Press **UP** or **DOWN** key to display Ft008.
2	PGCL1		Press **DATA/SHIFT** key for one second to show the display on the left.
3	PGCL5		Press **UP** key until "PGCL5" displays. Note: If another key is pressed during the process, "no_oP" will display for one second. At this time, please start from step 1 again.
4	donE (Blinking)		Press **F** key to set (initialize) absolute encoder. After the setting (initialization) completes, the display on the left shows for one second.
5	PGCL5	-	After the setting (initialization) completes, the display on the panel automatically returns to the display on the left.
6	Ft008		Press **DATA/SHIFT** key for one second to display Ft008.
7	The setting becomes effective after the power of the servo drive is turned on again.		

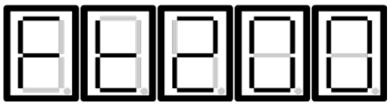
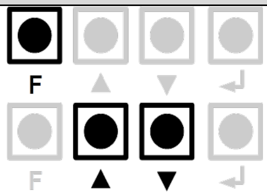
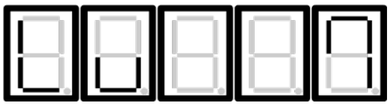
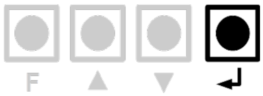
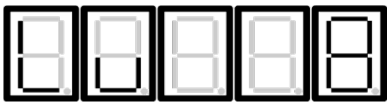
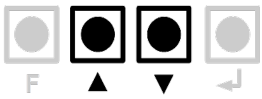
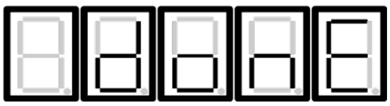
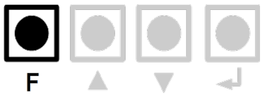
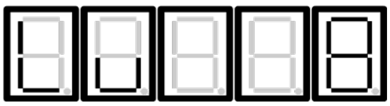
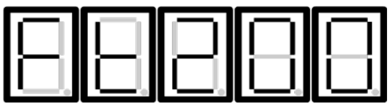
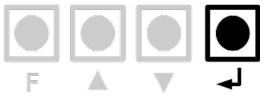
14.4.8 Displaying firmware version (Ft012)

Table14.4.8.1

Step	Display	Key	Operation
1			Press **F** key to go to auxiliary function mode (Ft). Press **UP** or **DOWN** key to display Ft012.
2			Press **DATA/SHIFT** key for one second to display the firmware version of the servo drive.
3			Press **F** key to display the version of CPU2.
4			Press **DATA/SHIFT** key for one second to display Ft012.

14.4.9 Setting stiffness level for tuneless function (Ft200)

Table14.4.9.1

Step	Display	Key	Operation
1			Press **F** key to go to auxiliary function mode (Ft). Press **UP** or **DOWN** key to display Ft200.
2			Press **DATA/SHIFT** key for one second to set stiffness level for tuneless function.
3			Press **UP** or **DOWN** key to select stiffness level from 1~F. The higher the stiffness level is, the higher the gain and response are. (Default: 7) Note: If the stiffness level is too high, vibration could occur. At this time, please decrease stiffness level.
4	 (Blinking)		Press **F** key to set stiffness level. After the setting completes, the display on the left shows for one second.
5		-	After the setting completes, the display on the panel automatically returns to the display on the left.
6			Press **DATA/SHIFT** key for one second to display Ft200.

15. Parameters

15.1 Introduction to parameter

The parameter list is described as below.

This column indicates the applicable motor for the parameter.

- All: The parameter can be used with rotary motor and linear motor.
- Rotary: The parameter can only be used with rotary motor.
- Linear: The parameter can only be used with linear motor.

Pt No.	Pt000				
Size	2	Setting Range	0000~00E1	Default	0010
Name	Basic function selection 0	Unit	-	Applicable Motor	All
Effective	After power on	Category	Setup	Reference	-
Description					

This column indicates when the parameter becomes effective after being modified.

There are two types of parameters: tuning parameter and setup parameter.

t.□□□X	Rotation/movement direction selection		Reference
	0	CCW is the forward direction.	-
		The direction where the linear encoder counts up is the forward direction.	
	1	CW direction is the forward direction. (reverse mode)	
		The direction where the linear encoder counts down is the forward direction. (reverse mode)	

15.2 List of parameters

15.2.1 Parameters for setting basic function (Pt0XX)

Pt No.	Pt000				
Size	2	Setting Range	0000~00E1	Default	0010
Name	Basic function selection 0	Unit	-	Applicable Motor	All
Effective	After power on	Category	Setup	Reference	-

Description

t.□□□X	Rotation/movement direction selection		Reference
	0	CCW is the forward direction.	-
		The direction where the linear encoder counts up is the forward direction.	
	1	CW is the forward direction. (reverse mode)	
		The direction where the linear encoder counts down is the forward direction. (reverse mode)	

t.□□X□	Control method selection		Reference
	0	Velocity mode (analog command)	-
	1	Position mode (pulse command)	
	2	Torque mode (analog command)	
	3	Internal velocity mode (contact command)	
	4	Internal velocity mode (contact command)↔position mode (pulse command)	
	5	Internal velocity mode (contact command)↔velocity mode (analog command)	
	6	Internal velocity mode (contact command)↔torque mode (analog command)	
	7	Position mode (pulse command)↔velocity mode (analog command)	
	8	Position mode (pulse command)↔torque mode (analog command)	
	9	Torque mode (analog command)↔velocity mode (analog command)	
	A	Internal position mode (contact command)	
	B	Internal position mode (contact command)↔position mode (pulse command)	
	C	Internal position mode (contact command)↔velocity mode (analog command)	
	D	Internal position mode (contact command)↔torque mode (analog command)	
	E	Internal velocity mode (contact command)↔internal position mode (contact command)	

t.□X□□	Reserved (Do not modify.)

t.X□□□	Reserved (Do not modify.)

Pt No.	Pt001				
Size	2	Setting Range	0000~0042	Default	0030
Name	Application function selection 1	Unit	-	Applicable Motor	All
Effective	After power on	Category	Setup	Reference	-

Description

t.□□□X	Stopping method for servo off and Gr.A alarm		Reference
	0	Use dynamic brake to stop the motor. The dynamic brake remains activated after the motor stops.	-
	1	Use dynamic brake to stop the motor. The dynamic brake is deactivated after the motor stops.	-
	2	Do not use dynamic brake. Let the motor run freely until it stops.	-

t.□□X□	Stopping method for overtravel (OT)		Reference
	0	Use dynamic brake to stop the motor or let the motor run freely until it stops. The stopping method is the same as Pt001 = t.□□□X.	-
	1	Use the setting value of Pt406 as the maximum torque to decelerate the motor to a stop. The motor stops in zero clamp state.	
	2	Use the setting value of Pt406 as the maximum torque to decelerate the motor to a stop. The motor runs freely afterwards.	
	3	Use the deceleration time set in Pt30A to decelerate the motor to a stop. The motor stops in zero clamp state.	
	4	Use the deceleration time set in Pt30A to decelerate the motor to a stop. The motor runs freely afterwards.	

t.□X□□	Power input selection		Reference
	0	Use AC power input.	-
	1	Use DC power input (Apply to GT model).	-

t.X□□□	Reserved (Do not modify.)

Pt No.	Pt002				
Size	2	Setting Range	0000~4213	Default	0000
Name	Application function selection 2	Unit	-	Applicable Motor	-
Effective	After power on	Category	Setup	Reference	-

Description

t.□□□X	Torque control selection (using T-REF signal)		Applicable Motor	Reference
	0	Do not use T-REF signal.	All	-
	1	Use T-REF signal as external torque limit.		
	2	Use T-REF signal as torque feedforward input.		
	3	When P-CL or N-CL signal is ON, use T-REF signal as external torque limit input.		

t.□□X□	Velocity/position control selection (using V-REF signal)		Applicable Motor	Reference
	0	Do not use V-REF signal.	All	-
	1	Use V-REF signal as external velocity limit.		

t.□X□□	Usage of encoder		Applicable Motor	Reference
	0	Use the encoder as a multi-turn absolute encoder. Battery is required.	All	-
	1	Use the encoder as an incremental encoder. Battery is not required.		
	2	Use the multi-turn absolute encoder as a single-turn absolute encoder. Battery is not required.	Rotary	

t.X□□□	Usage of external encoder		Applicable Motor	Reference
	0	Do not use external encoder.	Rotary	-
	1	The external encoder moves in forward direction for motor CCW rotation.		
	2	Reserved (Do not modify.)		
	3	The external encoder moves in reverse direction for motor CCW rotation.		
	4	Reserved (Do not modify.)		

Pt No.	Pt003				
Size	2	Setting Range	0000~2112	Default	0000
Name	Application function selection 3	Unit	-	Applicable Motor	All
Effective	-	Category	Setup	Reference	-

Description

t.□□□X	Group control mode selection		Effective	Reference
	0	Gantry control mode.	After power on	-
	1	Electronic cam control mode.		
	2	2D dynamic error compensation control mode (Apply to GT model.		

t.□□X□	Signal source for electronic cam master axis		Effective	Reference
	0	From position command.	After power on	-
	1	From encoder feedback.		

t.□X□□	Electronic cam clutch engaged mode		Effective	Reference
	0	Controlled by mark input (MARK) signal.	Immediately	-
	1	Engage immediately.		

t.X□□□	Electronic cam clutch disengaged mode		Effective	Reference
	0	Disengage after emergency stop.	Immediately	-
	1	Disengage immediately.		
	2	Disengage after the last cam cycle is done.		

Pt No.	Pt006				
Size	2	Setting Range	0000~005F	Default	0002
Name	Application function selection 6	Unit	-	Applicable Motor	All
Effective	Immediately	Category	Setup	Reference	-

Description

t.□□XX	Analog monitor 1 signal selection	
	00	Motor velocity* (1 V/1000 rpm)
		Motor velocity (1 V/1000 mm/s)
	01	Velocity command* (1 V/1000 rpm)
		Velocity command (1 V/1000 mm/s)
	02	Torque command (1 V/100% rated torque)
		Force command (1 V/100% rated force)
	03	Position deviation (0.05 V/1 control unit)
	04	Position amplifier deviation (after electronic gear ratio) (0.05 V/1 encoder pulse unit)
		Position amplifier deviation (after electronic gear ratio) (0.05 V/1 linear encoder pulse unit)
	05	Position command velocity* (1 V/1000 rpm)
		Position command velocity (1 V/1000 mm/s)
	06	Reserved (Do not modify.)
	07	Motor-load position deviation (0.01 V/1 control unit)
	08	Positioning completion (positioning completed: 5 V; positioning not completed: 0 V)
	09	Velocity feedforward* (1 V/1000 rpm)
		Velocity feedforward (1 V/1000 mm/s)
	0A	Torque feedforward (1 V/100% rated torque)
		Force feedforward (1 V/100% rated force)
	0B	Active gain (first gain: 1 V; second gain: 2 V)
	0C	Completion of position command distribution (distribution completed: 5 V; distribution not completed: 0 V)
	0D	External encoder velocity (1 V/1000 rpm: value at the motor shaft)
	0E	Motor torque (1 V/100% rated torque)
		Motor force (1 V/100% rated force)
	0F	Reserved (Do not modify.)
	10	Main circuit DC voltage
	11~5F	Reserved (Do not modify.)

t.□X□□	Reserved (Do not modify.)

t.X□□□	Reserved (Do not modify.)

Note:

For direct drive motor, the ratio is 1 V/100 rpm.

Pt No.	Pt007				
Size	2	Setting Range	0000~015F	Default	0100
Name	Application function selection 7	Unit	-	Applicable Motor	All
Effective	Immediately	Category	Setup	Reference	-

Description

t.□□XX	Analog monitor 2 signal selection	
	00	Motor velocity* (1 V/1000 rpm)
		Motor velocity (1 V/1000 mm/s)
	01	Velocity command* (1 V/1000 rpm)
		Velocity command (1 V/1000 mm/s)
	02	Torque command (1 V/100% rated torque)
		Force command (1 V/100% rated force)
	03	Position deviation (0.05 V/1 control unit)
	04	Position amplifier deviation (after electronic gear ratio) (0.05 V/1 encoder pulse unit)
		Position amplifier deviation (after electronic gear ratio) (0.05 V/1 linear encoder pulse unit)
	05	Position command velocity* (1 V/1000 rpm)
		Position command velocity (1 V/1000 mm/s)
	06	Reserved (Do not modify.)
	07	Motor-load position deviation (0.01 V/1 control unit)
	08	Positioning completion (positioning completed: 5 V; positioning not completed: 0 V)
	09	Velocity feedforward* (1 V/1000 rpm)
		Velocity feedforward (1 V/1000 mm/s)
	0A	Torque feedforward (1 V/100% rated torque)
		Force feedforward (1 V/100% rated force)
	0B	Active gain (first gain: 1 V; second gain: 2 V)
	0C	Completion of position command distribution (distribution completed: 5 V; distribution not completed: 0 V)
	0D	External encoder velocity (1 V/1000 rpm: value at the motor shaft)
	0E	Motor torque (1 V/100% rated torque)
		Motor force (1 V/100% rated force)
	0F	Reserved (Do not modify.)
	10	Main circuit DC voltage
	11~5F	Reserved (Do not modify.)

t.□X□□	Motor out of control alarm (AL.C10)		Reference
	0	Do not detect motor out of control alarm.	-
	1	Detect motor out of control alarm.	-

t.X□□□	Motor protection method selection		Reference
	0	Motor overload protection1, output warning (AL.910) or alarm (AL.710 or AL.720).	-
	1	Motor overload protection2, output I2T warning (AL.924).	-

Note:

For direct drive motor, the ratio is 1 V/100 rpm.

Pt No.	Pt008				
Size	2	Setting Range	0000~1021	Default	0010
Name	Application function selection 8	Unit	-	Applicable Motor	Rotary
Effective	After power on	Category	Setup	Reference	-

Description

t.□□□X	Alarm/warning selection for battery undervoltage		Reference
	0	Output alarm AL.810 when battery voltage is low.	-
	1	Output warning AL.930 when battery voltage is low.	-

t.□□X□	Function selection for undervoltage		Reference
	0	Do not detect undervoltage warning (AL.971).	-
	1	Detect undervoltage warning.	-
	2	Detect undervoltage warning and limit torque with Pt424 and Pt425.	-

t.□X□□	Reserved (Do not modify.)

t.X□□□	Thermal sensor detection		Reference
	0	Disable thermal sensor detection.	-
	1	Enable thermal sensor detection.	-

Pt No.	Pt009				
Size	2	Setting Range	0000~1104	Default	0000
Name	Application function selection 9	Unit	-	Applicable Motor	All
Effective	-	Category	Setup	Reference	-

Description

t.□□□X	Selection of error map function.		Effective
	0	After internal homing is completed, enable error map function for single axis.	After power on
	1	After internal homing is completed, enable error map function for gantry axis.	
	2	Automatically enable error map function for specific motor.	
	3	After Touch Probe homing is completed, enable error map function for single axis.	
	4	After Touch Probe homing is completed, enable error map function for gantry axis.	
	5	After internal homing is completed, enable 2D dynamic error compensation function for single axis (Apply to GT model).	
	6	After Touch Probe homing is completed, enable 2D dynamic error compensation function for single axis (Apply to GT model).	

t.□□X□	Reserved (Do not modify.)

t.□X□□	Velocity detection method selection.		Effective
	0	Use velocity detection 1.	After power on
	1	Use velocity detection 2.	

t.X□□□	Error map function.		Effective
	0	Disable error map function.	Motor is disabled
	1	Enable error map function.	

Pt No.	Pt00A				
Size	2	Setting Range	0000~1144	Default	1000
Name	Application function selection A	Unit	-	Applicable Motor	All
Effective	After power on	Category	Tuning	Reference	-

Description

	Stopping method for Gr.B alarm		Reference
t.□□□X	0	Use dynamic brake to stop the motor or let the motor run freely until it stops. The stopping method is the same as Pt001 = t.□□□X.	-
	1	Use the setting value of Pt406 as the maximum torque to decelerate the motor to a stop. The motor state after the motor stops is set by Pt001 = t.□□□X.	-
	2	Use the setting value of Pt406 as the maximum torque to decelerate the motor to a stop. The motor runs freely afterwards.	-
	3	Use the deceleration time set in Pt30A to decelerate the motor to a stop. The motor state after the motor stops is set by Pt001 = t.□□□X.	-
	4	Use the deceleration time set in Pt30A to decelerate the motor to a stop. The motor runs freely afterwards.	-

	Stopping method for forced stop		Reference
t.□□X□	0	Use dynamic brake to stop the motor or let the motor run freely until it stops. The stopping method is the same as Pt001 = t.□□□X.	-
	1	Use the setting value of Pt406 as the maximum torque to decelerate the motor to a stop. The motor state after the motor stops is set by Pt001 = t.□□□X.	-
	2	Use the setting value of Pt406 as the maximum torque to decelerate the motor to a stop. The motor runs freely afterwards.	-
	3	Use the deceleration time set in Pt30A to decelerate the motor to a stop. The motor state after the motor stops is set by Pt001 = t.□□□X.	-
	4	Use the deceleration time set in Pt30A to decelerate the motor to a stop. The motor runs freely afterwards.	-

	Excellent Smart Cube (ESC) (do not support drives of "AC only")		Reference
t.□X□□	0	Do not use ESC to read encoder signal.	-
	1	Use ESC to read encoder signal.	-

	Multi-turn home position output (rotary motor)		Reference
t.X□□□	0	Do not use multi-turn home position output.	-
	1	Use multi-turn home position output.	-

Note:

(1) The default value of Pt00A for Fieldbus servo drive is 1030.

(2) If an Excellent Smart Cube(ESC) is used, please do not set Pt00A=t.□0□□.

Pt No.	Pt00B				
Size	2	Setting Range	0000~1121	Default	0000
Name	Application function selection B	Unit	-	Applicable Motor	All
Effective	After power on	Category	Setup	Reference	-

Description

t.□□□X	Parameter display on panel		Reference
	0	Display setup parameters only.	-
	1	Display all parameters.	-

t.□□X□	Stopping method for Gr.B alarm		Reference
	0	Zero velocity stop (Velocity command is set to 0 to stop the motor.)	-
	1	Use dynamic brake to stop the motor or let the motor run freely until it stops. The stopping method is the same as Pt001 = t.□□□X.	-
	2	Use the stopping method set in Pt00A = t.□□□X.	-

t.□X□□	Three-phase/single-phase input power selection		Reference
	0	Use three-phase AC input power.	-
	1	Use single-phase AC input power or three-phase AC input power.	-

t.X□□□	Dynamic brake resistor selection		Reference
	0	Use the built-in dynamic brake resistor.	-
	1	Use external dynamic brake resistor.	-

Pt No.	Pt00C				
Size	2	Setting Range	0000~0040	Default	0010
Name	Application function selection C	Unit	-	Applicable Motor	All
Effective	After power on	Category	Setup	Reference	-

Description

t.□□□X	DC power input selection (Apply to GT model)		Reference
	0	Use 96 V DC power input.	-
	1	Use 120 V DC power input.	

t.□□X□	Selections of AC input power.		Reference
	0	Use 110 V AC input power.	-
	1	Use 220 V AC input power.	
	2	Use 380 V AC input power.	
	3	Reserved (Do not modify)	
	4	Use 480 V AC input power.	

t.□X□□	Reserved (Do not modify.)
t. X□□□	Reserved (Do not modify.)

Note:

the default value is 0020 for 400 V servo drives (the 10^{th} code in the model number is 3).

Pt No.	Pt00D				
Size	2	Setting Range	0000~1012	Default	1002
Name	Application function selection D	Unit	-	Applicable Motor	All
Effective	-	Category	Setup	Reference	-

Description

t.□□□X	Group communication axis selection		Effective
	0	Slave axis in group communication.	After power on
	1	Master axis in group communication.	
	2	No group communication.	

t.□□X□	Field-weakening control		Effective
	0	Disable field-weakening control.	After power on
	1	Enable field-weakening control.	

t.□X□□	Auto switching for gantry control		Effective
	0	Disable auto switching for gantry control.	Immediately
	1	Enable auto switching for gantry control.	

t.X□□□	Overtravel warning detection selection		Effective
	0	Do not detect overtravel warnings.	Immediately
	1	Detect overtravel warnings.	

Pt No.	Pt00E				
Size	2	Setting Range	0000~0111	Default	0111
Name	Position trigger function setting	Unit	-	Applicable Motor	Motor with digital encoder
Effective	After power on	Category	Setup	Reference	-

Description

t.□□□X	Position trigger function		Reference
	0	Disable position trigger function.	-
	1	Enable position trigger function.	-

t.□□X□	Position trigger/position capture function switching		Reference
	0	Position capture function(Not supported yet).	-
	1	Fixed interval of position trigger function (Pulse output).	-
	2	Random interval of position trigger function (Pulse output).	-
	3	Random interval of position trigger function (State output).	-

t.□X□□	Inversion of signal output voltage		Reference
	0	Signal output voltage is high level.	-
	1	Signal output voltage is low level.	-

t.X□□□	Reserved (Do not modify.)

Pt No.	Pt00F				
Size	2	Setting Range	0000~1110	Default	0010
Name	Application function selection F	Unit	-	Applicable Motor	All
Effective	After power on	Category	Setup	Reference	-

Description

t.□□□X	Reserved (Do not modify.)

t.□□X□	Latch undervoltage alarm(AL.410)		Reference
	0	Do not latch undervoltage alarm(AL.410).	-
	1	Latch undervoltage alarm(AL.410).	-

t.□X□□	Function of automatically activating error map as homing is completed		Reference
	0	Disable function of automatically activating error map.	-
	1	Enable function of automatically activating error map.	-

t.X□□□	Incremental encoder signal error detection selection		Reference
	0	Do not detect incremental encoder signal error.	-
	1	Detect incremental encoder signal error.	-

Pt No.	Pt010				
Size	2	Setting Range	0000~0001	Default	0001
Name	Application function selection 10	Unit	-	Applicable Motor	All
Effective	After power on	Category	Setup	Reference	-

Description

t.□□□X	Mastership setting for Fieldbus servo drive.		Reference
	0	Set the mastership to MPI/API.	-
	1	Set the mastership to controller.	-

t.□□X□	Digital encoder Z-phase signal detection selection.		Reference
	0	Do not detect digital encoder Z-phase signal disconnection.	-
	1	Detect digital encoder Z-phase signal disconnection.	-

t.□X□□	Gantry enable method selection.		Reference
	0	Use gantry enable method 1.	-
	1	Use gantry enable method 2.	-

t.X□□□	Detection of safety function alarm (AL.Eb0)		Reference
	0	Do not detect safety function alarm.	-
	1	Detect safety function alarm.	-

15.2.2 Parameters for tuning (Pt1XX)

Pt No.	Pt100				
Size	2	Setting Range	10~20000	Default	400
Name	Velocity loop gain	Unit	0.1 Hz	Applicable Motor	All
Effective	Immediately	Category	Tuning	Reference	-

Pt No.	Pt101				
Size	2	Setting Range	15~51200	Default	2000
Name	Velocity loop integral time constant	Unit	0.01 ms	Applicable Motor	All
Effective	Immediately	Category	Tuning	Reference	-

Pt No.	Pt102				
Size	2	Setting Range	10~40000	Default	400
Name	Position loop gain	Unit	0.1/s	Applicable Motor	All
Effective	Immediately	Category	Tuning	Reference	-

Pt No.	Pt103				
Size	2	Setting Range	0~50000	Default	100
Name	Moment of inertia ratio	Unit	1%	Applicable Motor	All
Effective	Immediately	Category	Tuning	Reference	-

Pt No.	Pt104				
Size	2	Setting Range	10~20000	Default	400
Name	Second velocity loop gain	Unit	0.1 Hz	Applicable Motor	All
Effective	Immediately	Category	Tuning	Reference	-

Pt No.	Pt105				
Size	2	Setting Range	15~51200	Default	2000
Name	Second velocity loop integral time constant	Unit	0.01 ms	Applicable Motor	All
Effective	Immediately	Category	Tuning	Reference	-

Pt No.	Pt106				
Size	2	Setting Range	10~40000	Default	400
Name	Second position loop gain	Unit	0.1/s	Applicable Motor	All
Effective	Immediately	Category	Tuning	Reference	-

Pt No.	Pt109				
Size	2	Setting Range	0~100	Default	0
Name	Feedforward	Unit	1%	Applicable Motor	All
Effective	Immediately	Category	Tuning	Reference	-

Pt No.	Pt10A				
Size	2	Setting Range	0~6400	Default	0
Name	Feedforward filter time constant	Unit	0.01 ms	Applicable Motor	All
Effective	Immediately	Category	Tuning	Reference	-

Pt No.	Pt10B				
Size	2	Setting Range	0000~0004	Default	0000
Name	Gain application selection	Unit	-	Applicable Motor	All
Effective	-	Category	Setup	Reference	-

Description

t.□□□X	Mode switching selection (P/PI mode)		Effective	Reference
	0	Use internal torque command as the switching condition for mode switching. (setting parameter: Pt10C)	Immediately	-
	1	Use velocity command as the switching condition for mode switching. (setting parameter: Pt10D)		
		Use velocity command as the switching condition for mode switching. (setting parameter: Pt181)		
	2	Use acceleration command as the switching condition for mode switching. (setting parameter: Pt10E)		
		Use acceleration command as the switching condition for mode switching. (setting parameter: Pt182)		
	3	Use position deviation as the switching condition for mode switching. (setting parameter: Pt10F)		
	4	Do not use mode switching function.		

t.□□X□	Reserved (Do not modify.)

t.□X□□	Reserved (Do not modify.)

t.X□□□	Reserved (Do not modify.)

Pt No.	Pt10C				
Size	2	Setting Range	0~800	Default	200
Name	Torque/force command for mode switching (P/PI mode)	Unit	1% rated torque/force	Applicable Motor	All
Effective	Immediately	Category	Tuning	Reference	-

Pt No.	Pt10D				
Size	2	Setting Range	0~10000	Default	0
Name	Velocity command for mode switching (P/PI mode)	Unit	1 rpm	Applicable Motor	Rotary
Effective	Immediately	Category	Tuning	Reference	-

Pt No.	Pt10E				
Size	2	Setting Range	0~30000	Default	0
Name	Acceleration command for mode switching (P/PI mode)	Unit	1 rpm/s	Applicable Motor	Rotary
Effective	Immediately	Category	Tuning	Reference	-

Pt No.	Pt10F				
Size	2	Setting Range	0~10000	Default	0
Name	Position deviation for mode switching (P/PI mode)	Unit	1 control unit	Applicable Motor	All
Effective	Immediately	Category	Tuning	Reference	-

Pt No.	Pt110				
Size	2	Setting Range	0~100	Default	0
Name	Second feedforward	Unit	1%	Applicable Motor	All
Effective	Immediately	Category	Tuning	Reference	-

Pt No.	Pt11F				
Size	2	Setting Range	1~50000	Default	1
Name	Position integral time constant	Unit	0.1 ms	Applicable Motor	All
Effective	Immediately	Category	Tuning	Reference	-

Pt No.	Pt121				
Size	2	Setting Range	1~1000	Default	30
Name	Friction compensation gain	Unit	1 %	Applicable	All
Effective	Immediately	Category	Tuning	Motor	-

Pt No.	Pt122				
Size	2	Setting Range	1~1000	Default	30
Name	Second friction compensation gain	Unit	1 %	Applicable	All
Effective	Immediately	Category	Tuning	Motor	-

Pt No.	Pt126				
Size	2	Setting Range	1~10000	Default	0
Name	Dead band of velocity command for friction compensation (rotary servo motor)	Unit	rpm	Applicable	Rotary
Effective	Immediately	Category	Tuning	Motor	-

Pt No.	Pt127				
Size	2	Setting Range	1~10000	Default	0
Name	Dead band of velocity command for friction compensation (linear servo motor)	Unit	mm/s	Applicable	Linear
Effective	Immediately	Category	Tuning	Motor	-

Pt No.	Pt131				
Size	2	Setting Range	0~65535	Default	0
Name	Gain switching time 1	Unit	1 ms	Applicable Motor	All
Effective	Immediately	Category	Tuning	Reference	-

Pt No.	Pt132				
Size	2	Setting Range	0~65535	Default	0
Name	Gain switching time 2	Unit	1 ms	Applicable Motor	All
Effective	Immediately	Category	Tuning	Reference	-

Pt No.	Pt135				
Size	2	Setting Range	0~65535	Default	0
Name	Gain switching waiting time 1	Unit	1 ms	Applicable Motor	All
Effective	Immediately	Category	Tuning	Reference	-

Pt No.	Pt136				
Size	2	Setting Range	0~65535	Default	0
Name	Gain switching waiting time 2	Unit	1 ms	Applicable Motor	All
Effective	Immediately	Category	Tuning	Reference	-

Pt No.	Pt139				
Size	2	Setting Range	0000~0052	Default	0000
Name	Automatic gain switching selection	Unit	-	Applicable Motor	All
Effective	Immediately	Category	Tuning	Reference	-

Description

t.□□□X	Gain switching selection	
	0	Manual gain switching. Manually switch the gain with gain switching input (G-SEL) signal.
	1	Reserved (Do not modify).
	2	Automatic gain switching. When switching condition A is satisfied, the gain will be automatically switched from the first gain to the second gain.When switching condition A is not satisfied,the gain will be automatically switched from the second gain to the first gain.

t.□□X□	Switching condition A in position control	
	0	Positioning completion output (COIN) signal is ON.
	1	Positioning completion output (COIN) signal is OFF.
	2	Positioning near output (NEAR) signal is ON.
	3	Positioning near output (NEAR) signal is OFF.
	4	Position command filter output stops outputting and input pulse command is OFF.
	5	Position input pulse command is ON.

t.□X□□	Reserved (Do not modify.)

t. X□□□	Reserved (Do not modify.)

Pt No.	Pt13A				
Size	2	Setting Range	1~1000	Default	100
Name	Moving section gain multiplier	Unit	1%	Applicable Motor	All
Effective	Immediately	Category	Tuning	Reference	-

Pt No.	Pt13B				
Size	2	Setting Range	1~1000	Default	100
Name	Settling section gain multiplier	Unit	1%	Applicable Motor	All
Effective	Immediately	Category	Tuning	Reference	-

Pt No.	Pt13C				
Size	2	Setting Range	1~1000	Default	100
Name	In-position section gain multiplier	Unit	1%	Applicable Motor	All
Effective	Immediately	Category	Tuning	Reference	-

Pt No.	Pt13D				
Size	2	Setting Range	100~2000	Default	2000
Name	Current gain level	Unit	1%	Applicable Motor	All
Effective	Immediately	Category	Tuning	Reference	-

Pt No.	Pt13E				
Size	2	Setting Range	1~5000	Default	100
Name	Current loop integral gain level	Unit	1%	Applicable Motor	All
Effective	Immediately	Category	Tuning	Reference	-

Pt No.	Pt140				
Size	2	Setting Range	0000~0010	Default	0000
Name	Model-based control selection	Unit	-	Applicable Motor	All
Effective	Immediately	Category	Tuning	Reference	-

Description

t.□□□X	Reserved (Do not modify.)	

t.□□X□	Vibration suppression selection	
	0	Do not perform vibration suppression.
	1	Perform vibration suppression on specific frequency.

t.□X□□	Reserved (Do not modify.)

t.X□□□	Reserved (Do not modify.)

Pt No.	Pt14A				
Size	2	Setting Range	10~2000	Default	800
Name	Vibration suppression frequency	Unit	0.1 Hz	Applicable Motor	All
Effective	Immediately	Category	Tuning	Reference	-

Pt No.	Pt14B				
Size	2	Setting Range	10~1000	Default	500
Name	Vibration suppression compensation	Unit	1%	Applicable Motor	All
Effective	Immediately	Category	Tuning	Reference	-

Pt No.	Pt170				
Size	2	Setting Range	0100~0F01	Default	0701
Name	Tuneless function selection	Unit	-	Applicable Motor	All
Effective	-	Category	Setup	Reference	-

Description

	Tuneless function		Effective
t.□□□X	0	Disable tuneless function.	After power on
	1	Enable tuneless function.	

t.□□X□	Reserved (Do not modify.)

	Stiffness level of tuneless function		Effective
t.□X□□	1 ~ F	Set stiffness level of tuneless function.	Immediately

t.X□□□	Reserved (Do not modify.)

Pt No.	Pt181				
Size	2	Setting Range	0~10000	Default	0
Name	Velocity command for mode switching (P/PI mode)	Unit	1 mm/s	Applicable Motor	Linear
Effective	Immediately	Category	Tuning	Reference	-

Pt No.	Pt182				
Size	2	Setting Range	0~30000	Default	0
Name	Acceleration command for mode switching (P/PI mode)	Unit	1 mm/s^2	Applicable Motor	Linear
Effective	Immediately	Category	Tuning	Reference	-

Pt No.	Pt183				
Size	2	Setting Range	0~100	Default	10
Name	Sensitivity for mode switching (P/PI mode)	Unit	-	Applicable Motor	All
Effective	Immediately	Category	Tuning	Reference	-

Pt No.	Pt190				
Size	2	Setting Range	10~20000	Default	400
Name	Velocity loop gain in gantry control system	Unit	0.1 Hz	Applicable Motor	All
Effective	Immediately	Category	Tuning	Reference	-

Pt No.	Pt191				
Size	2	Setting Range	15~51200	Default	2000
Name	Velocity loop integral time constant in gantry control system	Unit	0.01 ms	Applicable Motor	All
Effective	Immediately	Category	Tuning	Reference	-

Pt No.	Pt192				
Size	2	Setting Range	10~40000	Default	400
Name	Position loop gain in gantry control system	Unit	0.1/s	Applicable Motor	All
Effective	Immediately	Category	Tuning	Reference	-

Pt No.	Pt193				
Size	2	Setting Range	0~50000	Default	100
Name	Moment of inertia ratio in gantry control system	Unit	1%	Applicable Motor	All
Effective	Immediately	Category	Tuning	Reference	-

Pt No.	Pt194				
Size	2	Setting Range	10~20000	Default	400
Name	Second velocity loop gain in gantry control system	Unit	0.1 Hz	Applicable Motor	All
Effective	Immediately	Category	Tuning	Reference	-

Pt No.	Pt195				
Size	2	Setting Range	15~51200	Default	2000
Name	Second velocity loop integral time constant in gantry control system	Unit	0.01 ms	Applicable Motor	All
Effective	Immediately	Category	Tuning	Reference	-

Pt No.	Pt196				
Size	2	Setting Range	10~40000	Default	400
Name	Second position loop gain in gantry control system	Unit	0.1/s	Applicable Motor	All
Effective	Immediately	Category	Tuning	Reference	-

15.2.3 Position-related parameters (Pt2XX)

Pt No.	Pt200				
Size	2	Setting Range	0000~1016	Default	0000
Name	Position command form selection	Unit	-	Applicable Motor	All
Effective	After power on	Category	Setup	Reference	-

Description

t.□□□X	Pulse command form		Reference
	0	Pulse signal (pulse + direction) (positive logic)	-
	1	Pulse signal (CW + CCW) (positive logic)	
	2	Reserved (Do not modify.)	
	3	Reserved (Do not modify.)	
	4	Differential pulse signal with 90 degrees phase difference (A phase + B phase) x 4 (positive logic)	
	5	Pulse signal (pulse + direction) (negative logic)	
	6	Pulse signal (CW + CCW) (negative logic)	

t.□□X□	Clear signal form		Reference
	0	Clear position deviation when the input signal is at high level.	-
	1	Clear position deviation when the input signal is at low level.	

t.□X□□	Reserved (Do not modify.)

t.X□□□	Filter (high speed and low speed) selection		Reference
	0	The command input is differential signal (1~5 Mpps).	-
	1	The command input is single-ended signal (1~200 kpps).	

Pt No.	Pt207				
Size	2	Setting Range	0000~2011	Default	0000
Name	Position control function selection	Unit	-	Applicable Motor	All
Effective	After power on	Category	Setup	Reference	-

Description

t.□□□X	Buffered encoder output selection		Reference
	0	Disable buffered encoder output.	-
	1	Enable buffered encoder output.	

t.□□X□	Position control selection (using V-REF signal)		Reference
	0	Do not use V-REF signal.	-
	1	Use V-REF signal as velocity feedforward input.	

t.□X□□	Analog encoder feedback filter selection		Reference
	0	Disable analog encoder feedback filter.	-
	1	Enable analog encoder feedback filter.	

t.X□□□	Output timing of positioning completion output (COIN) signal		Reference
	0	Output COIN signal when the absolute value of position deviation is less than the setting value of positioning completion width (Pt522).	-
	1	Output COIN signal when the absolute value of position deviation is less than the setting value of positioning completion width (Pt522) and position command stops after being filtered.	
	2	Output COIN signal when the absolute value of position deviation is less than the setting value of positioning completion width (Pt522) and position command stops.	

Pt No.	Pt208				
Size	2	Setting Range	0000~0002	Default	0002
Name	Excellent Smart Cube (ESC) function selection	Unit	-	Applicable Motor	All
Effective	After power on	Category	Setup	Reference	-

Description

t.□□□X		Excellent Smart Cube (ESC)-analog encoder signal error detection threshold selection. (support ESC-SS firmware version 1.03 or later.)	Reference
	0	Detect ESC-analog encoder signal error when the peak-to-peak amplitude of encoder signal is within 0.62 Vp-p.	-
	1	Detect ESC-analog encoder signal error when the peak-to-peak amplitude of encoder signal is within 0.48 Vp-p.	-
	2	Detect ESC-analog encoder signal error when the peak-to-peak amplitude of encoder signal is within 0.33 Vp-p.	

t.□□X□	Reserved (Do not modify)
t.□X□□	Reserved (Do not modify)
t. X□□□	Reserved (Do not modify)

Pt No.	Pt209				
Size	2	Setting Range	0~7	Default	1
Name	Encoder feedback interpolation compensation	Unit	1 time	Applicable Motor	All
Effective	After power on	Category	Setup	Reference	-

Pt No.	Pt20A				
Size	4	Setting Range	1~1000000	Default	20000
Name	Feed length of external encoder	Unit	1 µm	Applicable Motor	Rotary
Effective	After power on	Category	Setup	Reference	-

Pt No.	Pt20B				
Size	4	Setting Range	1~100000	Default	1000
Name	Linear unit length (resolution) of external encoder	Unit	1 nm	Applicable Motor	Rotary
Effective	After power on	Category	Setup	Reference	-

Pt No.	Pt20C				
Size	2	Setting Range	1~65535	Default	1
Name	Gear ratio at motor side (full-closed loop)	Unit	1	Applicable Motor	Rotary
Effective	After power on	Category	Setup	Reference	-

Pt No.	Pt20D				
Size	2	Setting Range	1~65535	Default	1
Name	Gear ratio at load side (full-closed loop)	Unit	1	Applicable Motor	Rotary
Effective	After power on	Category	Setup	Reference	-

Pt No.	Pt20E				
Size	4	Setting Range	1~1073741824	Default	32
Name	Electronic gear ratio (numerator)	Unit	1	Applicable Motor	All
Effective	After power on	Category	Setup	Reference	-

Pt No.	Pt210				
Size	4	Setting Range	1~1073741824	Default	1
Name	Electronic gear ratio (denominator)	Unit	1	Applicable Motor	All
Effective	After power on	Category	Setup	Reference	-

Pt No.	Pt212				
Size	4	Setting Range	64~1073741824	Default	8192
Name	Number of encoder output pulses	Unit	1 pulse edge	Applicable Motor	Rotary
Effective	After power on	Category	Setup	Reference	-

Pt No.	Pt216				
Size	2	Setting Range	0~16384	Default	0
Name	Position command acceleration/ deceleration time constant	Unit	0.25 ms	Applicable Motor	All
Effective	After motor stops	Category	Setup	Reference	-

Pt No.	Pt217				
Size	2	Setting Range	0~1000	Default	0
Name	Average position command movement time	Unit	0.25 ms	Applicable Motor	All
Effective	After motor stops	Category	Setup	Reference	-

Pt No.	Pt218				
Size	2	Setting Range	1~100	Default	1
Name	Command pulse input multiplier	Unit	x 1	Applicable Motor	All
Effective	Immediately	Category	Setup	Reference	-

Pt No.	Pt219				
Size	2	Setting Range	1~100	Default	100
Name	Ratio for linear unit length (resolution) of external encoder	Unit	1 %	Applicable Motor	Rotary
Effective	After power on	Category	設定	Reference	-

Pt No.	Pt22A				
Size	2	Setting Range	0000~1000	Default	0000
Name	Full-closed loop control selection	Unit	-	Applicable Motor	Rotary
Effective	After power on	Category	Setup	Reference	-

Description

t.□□□X	Reserved (Do not modify.)

t.□□X□	Reserved (Do not modify.)

t.□X□□	Reserved (Do not modify.)

t.X□□□	Velocity feedback selection during full-closed loop control	
	0	From motor encoder
	1	From external encoder

Pt No.	Pt230				
Size	2	Setting Range	$-2^{30}+1\sim+2^{30}-1$	Default	0
Name	Start position for fixed interval of position trigger function	Unit	1 control unit	Applicable Motor	All
Effective	Immediately	Category	Setup	Reference	-

Pt No.	Pt231				
Size	2	Setting Range	$0\sim+2^{30}-1$	Default	0
Name	Output interval for fixed interval of position trigger function	Unit	1 control unit	Applicable Motor	All
Effective	Immediately	Category	Setup	Reference	-

Pt No.	Pt232				
Size	2	Setting Range	$-2^{30}+1\sim+2^{30}-1$	Default	0
Name	Stop position for fixed interval of position trigger function	Unit	1 control unit	Applicable Motor	All
Effective	Immediately	Category	Setup	Reference	-

Pt No.	Pt233				
Size	2	Setting Range	1~4095	Default	20
Name	Pulse output width of position trigger function	Unit	20 ns	Applicable Motor	All
Effective	Immediately	Category	Setup	Reference	-

Pt No.	Pt234				
Size	2	Setting Range	1~4000	Default	1
Name	Digital signal output width for position trigger function	Unit	0.25 ms	Applicable Motor	All
Effective	Immediately	Category	Setup	Reference	-

Pt No.	Pt235				
Size	2	Setting Range	0~255	Default	0
Name	Start index for random interval of position trigger function	Unit	1	Applicable Motor	All
Effective	Immediately	Category	Setup	Reference	-

Pt No.	Pt236				
Size	2	Setting Range	0~255	Default	0
Name	End index for random interval of position trigger function	Unit	1	Applicable Motor	All
Effective	Immediately	Category	Setup	Reference	-

Pt No.	Pt281				
Size	2	Setting Range	2000~1073741824	Default	100000
Name	Encoder output resolution	Unit	1 pulse edge/100 mm	Applicable Motor	All
Effective	After power on	Category	Setup	Reference	-

15.2.4 Velocity-related parameters (Pt3XX)

Pt No.	Pt300				
Size	2	Setting Range	150~3000	Default	600
Name	Velocity command input gain	Unit	0.01 V/rated velocity	Applicable Motor	All
Effective	Immediately	Category	Setup	Reference	-

Pt No.	Pt301				
Size	2	Setting Range	0~10000	Default	100
Name	Internal set velocity 1	Unit	Rotary motor: 1 rpm	Applicable Motor	Rotary
Effective	Immediately	Category	Setup	Reference	-

Pt No.	Pt302				
Size	2	Setting Range	0~10000	Default	200
Name	Internal set velocity 2	Unit	Rotary motor: 1 rpm	Applicable Motor	Rotary
Effective	Immediately	Category	Setup	Reference	-

Pt No.	Pt303				
Size	2	Setting Range	0~10000	Default	300
Name	Internal set velocity 3	Unit	Rotary motor: 1 rpm	Applicable Motor	Rotary
Effective	Immediately	Category	Setup	Reference	-

Pt No.	Pt304				
Size	2	Setting Range	0~10000	Default	600/60*2
Name	Jog velocity	Unit	Rotary motor: 1 rpm	Applicable Motor	Rotary
Effective	Immediately	Category	Setup	Reference	-

Pt No.	Pt305				
Size	2	Setting Range	0~10000	Default	0
Name	Soft start acceleration time	Unit	1 ms	Applicable Motor	All
Effective	Immediately	Category	Setup	Reference	-

Pt No.	Pt306				
Size	2	Setting Range	0~10000	Default	0
Name	Soft start deceleration time	Unit	1 ms	Applicable Motor	All
Effective	Immediately	Category	Setup	Reference	-

Pt No.	Pt307				
Size	2	Setting Range	0~65535	Default	40
Name	Velocity command filter time constant	Unit	0.01 ms	Applicable Motor	All
Effective	Immediately	Category	Setup	Reference	-

Pt No.	Pt308				
Size	2	Setting Range	1~65535	Default	1
Name	Velocity feedback filter time constant	Unit	0.01 ms	Applicable Motor	All
Effective	Immediately	Category	Tuning	Reference	-

Pt No.	Pt30A				
Size	2	Setting Range	0~10000	Default	0
Name	Deceleration time for servo off and forced stop	Unit	1 ms	Applicable Motor	All
Effective	Immediately	Category	Setup	Reference	-

Pt No.	Pt30C				
Size	2	Setting Range	0~500	Default	0
Name	Average velocity feedforward movement time	Unit	0.25 ms	Applicable Motor	All
Effective	Immediately	Category	Setup	Reference	-

Pt No.	Pt30D				
Size	2	Setting Range	0~3000	Default	0
Name	Dead band for velocity command input	Unit	1 mV	Applicable Motor	All
Effective	Immediately	Category	Setup	Reference	-

Pt No.	Pt316				
Size	2	Setting Range	0~65535	Default	10000
Name	Maximum motor velocity	Unit	1 rpm	Applicable Motor	Rotary
Effective	After power on	Category	Setup	Reference	-

Pt No.	Pt380				
Size	2	Setting Range	0~10000	Default	10
Name	Internal set velocity 1 (linear servo motor)	Unit	1 mm/s	Applicable Motor	Linear
Effective	Immediately	Category	Setup	Reference	-

Pt No.	Pt381				
Size	2	Setting Range	0~10000	Default	20
Name	Internal set velocity 2 (linear servo motor)	Unit	1 mm/s	Applicable Motor	Linear
Effective	Immediately	Category	Setup	Reference	-

Pt No.	Pt382				
Size	2	Setting Range	0~10000	Default	30
Name	Internal set velocity 3 (linear servo motor)	Unit	1 mm/s	Applicable Motor	Linear
Effective	Immediately	Category	Setup	Reference	-

Pt No.	Pt383				
Size	2	Setting Range	0~10000	Default	50
Name	Jog velocity	Unit	1 mm/s	Applicable Motor	Linear
Effective	Immediately	Category	Setup	Reference	-

Pt No.	Pt385				
Size	2	Setting Range	0~100	Default	50
Name	Maximum motor velocity (linear servo motor)	Unit	100 mm/s	Applicable Motor	Linear
Effective	After power on	Category	Setup	Reference	-

Pt No.	Pt390				
Size	4	Setting Range	0 ~ 6553500	Default	300000
Name	Velocity reference value*4 (rotary servo motor)	Unit	0.01 rpm	Applicable Motor	Rotary
Effective	Immediately	Category	Setup	Reference	-

Pt No.	Pt391				
Size	4	Setting Range	0 ~ 60000	Default	12000
Name	Velocity reference value*4 (linear servo motor)	Unit	0.01 m/min	Applicable Motor	Linear
Effective	Immediately	Category	Setup	Reference	-

15.2.5 Torque-related parameters (Pt4XX)

Pt No.	Pt400				
Size	2	Setting Range	10~100	Default	30
Name	Torque command input gain	Unit	0.1 V/rated torque	Applicable Motor	All
Effective	Immediately	Category	Setup	Reference	-

Pt No.	Pt401				
Size	2	Setting Range	1~65535	Default	100
Name	First stage first torque command filter time constant	Unit	0.01 ms	Applicable Motor	All
Effective	Immediately	Category	Tuning	Reference	-

Pt No.	Pt402				
Size	2	Setting Range	0~800	Default	800
Name	Forward torque limit	Unit	1%[*1]	Applicable Motor	Rotary
Effective	Immediately	Category	Setup	Reference	-

Pt No.	Pt403				
Size	2	Setting Range	0~800	Default	800
Name	Reverse torque limit	Unit	1%[*1]	Applicable Motor	Rotary
Effective	Immediately	Category	Setup	Reference	-

Pt No.	Pt404				
Size	2	Setting Range	0~800	Default	100
Name	Forward external torque limit	Unit	1%[*1]	Applicable Motor	All
Effective	Immediately	Category	Setup	Reference	-

Pt No.	Pt405				
Size	2	Setting Range	0~800	Default	100
Name	Reverse external torque limit	Unit	1%[*1]	Applicable Motor	All
Effective	Immediately	Category	Setup	Reference	-

Pt No.	Pt406				
Size	2	Setting Range	0~800	Default	800
Name	Emergency stop torque	Unit	1%*1	Applicable Motor	All
Effective	Immediately	Category	Setup	Reference	-

Pt No.	Pt407				
Size	2	Setting Range	0~10000	Default	10000
Name	Velocity limit during toque control	Unit	1 rpm	Applicable Motor	Rotary
Effective	Immediately	Category	Setup	Reference	-

Pt No.	Pt408				
Size	2	Setting Range	0000~0101	Default	0000
Name	Torque related function selection	Unit	-	Applicable Motor	All
Effective	-	Category	Setup	Reference	-

Description

t.□□□X	Notch filter selection 1		Effective	Reference
	0	Disable first stage notch filter.	Immediately	-
	1	Enable first stage notch filter.		

t.□□X□	Reserved (Do not modify.)

t.□X□□	Notch filter selection 2		Effective	Reference
	0	Disable second stage notch filter.	Immediately	-
	1	Enable second stage notch filter.		

t.X□□□	Friction compensation function		Effective	Reference
	0	Disable friction compensation function.	Immediately	-
	1	Enable friction compensation function.		

Pt No.	Pt409				
Size	2	Setting Range	50~5000	Default	5000
Name	First stage notch filter frequency	Unit	1 Hz	Applicable Motor	All
Effective	Immediately	Category	Tuning	Reference	-

Pt No.	Pt40A				
Size	2	Setting Range	50~1000	Default	70
Name	First stage notch filter Q value	Unit	0.01	Applicable Motor	All
Effective	Immediately	Category	Tuning	Reference	-

Pt No.	Pt40B				
Size	2	Setting Range	0~1000	Default	0
Name	First stage notch filter depth	Unit	0.001	Applicable Motor	All
Effective	Immediately	Category	Tuning	Reference	-

Pt No.	Pt40C				
Size	2	Setting Range	50~5000	Default	5000
Name	Second stage notch filter frequency	Unit	1 Hz	Applicable Motor	All
Effective	Immediately	Category	Tuning	Reference	-

Pt No.	Pt40D				
Size	2	Setting Range	50~1000	Default	70
Name	Second stage notch filter Q value	Unit	0.01	Applicable Motor	All
Effective	Immediately	Category	Tuning	Reference	-

Pt No.	Pt40E				
Size	2	Setting Range	0~1000	Default	0
Name	Second stage notch filter depth	Unit	0.001	Applicable Motor	All
Effective	Immediately	Category	Tuning	Reference	-

Pt No.	Pt40F				
Size	2	Setting Range	100~5000	Default	5000
Name	Second stage second torque command filter frequency	Unit	1 Hz	Applicable Motor	All
Effective	Immediately	Category	Tuning	Reference	-

Pt No.	Pt410				
Size	2	Setting Range	50~100	Default	50
Name	Second stage second torque command filter Q value	Unit	0.01	Applicable Motor	All
Effective	Immediately	Category	Tuning	Reference	-

Pt No.	Pt412				
Size	2	Setting Range	1~65535	Default	100
Name	First stage second torque command filter time constant	Unit	0.01 ms	Applicable Motor	All
Effective	Immediately	Category	Tuning	Reference	-

Pt No.	Pt415				
Size	2	Setting Range	0~65535	Default	0
Name	T-REF filter time constant	Unit	0.01 ms	Applicable Motor	All
Effective	Immediately	Category	Setup	Reference	-

Pt No.	Pt416				
Size	2	Setting Range	0000~0111	Default	0000
Name	Torque related function selection 2	Unit	-	Applicable Motor	All
Effective	Immediately	Category	Setup	Reference	-

Description

t.□□□X	Notch filter selection 3	
	0	Disable third stage notch filter.
	1	Enable third stage notch filter.

t.□□X□	Notch filter selection 4	
	0	Disable fourth stage notch filter.
	1	Enable fourth stage notch filter.

t.□X□□	Notch filter selection 5	
	0	Disable fifth stage notch filter.
	1	Enable fifth stage notch filter.

t.X□□□	Reserved (Do not modify.)

Pt No.	Pt417				
Size	2	Setting Range	50~5000	Default	5000
Name	Third stage notch filter frequency	Unit	1 Hz	Applicable Motor	All
Effective	Immediately	Category	Tuning	Reference	-

Pt No.	Pt418				
Size	2	Setting Range	50~1000	Default	70
Name	Third stage notch filter Q value	Unit	0.01	Applicable Motor	All
Effective	Immediately	Category	Tuning	Reference	-

Pt No.	Pt419				
Size	2	Setting Range	0~1000	Default	0
Name	Third stage notch filter depth	Unit	0.001	Applicable Motor	All
Effective	Immediately	Category	Tuning	Reference	-

Pt No.	Pt41A				
Size	2	Setting Range	50~5000	Default	5000
Name	Fourth stage notch filter frequency	Unit	1 Hz	Applicable Motor	All
Effective	Immediately	Category	Tuning	Reference	-

Pt No.	Pt41B				
Size	2	Setting Range	50~1000	Default	70
Name	Fourth stage notch filter Q value	Unit	0.01	Applicable Motor	All
Effective	Immediately	Category	Tuning	Reference	-

Pt No.	Pt41C				
Size	2	Setting Range	0~1000	Default	0
Name	Fourth stage notch filter depth	Unit	0.001	Applicable Motor	All
Effective	Immediately	Category	Tuning	Reference	-

Pt No.	Pt41D				
Size	2	Setting Range	50~5000	Default	5000
Name	Fifth notch filter frequency	Unit	1 Hz	Applicable Motor	All
Effective	Immediately	Category	Tuning	Reference	-

Pt No.	Pt41E				
Size	2	Setting Range	50~1000	Default	70
Name	Fifth notch filter Q value	Unit	0.01	Applicable Motor	All
Effective	Immediately	Category	Tuning	Reference	-

Pt No.	Pt41F				
Size	2	Setting Range	0~1000	Default	0
Name	Fifth notch filter depth	Unit	0.001	Applicable Motor	All
Effective	Immediately	Category	Tuning	Reference	-

Pt No.	Pt423				
Size	2	Setting Range	0000~F001	Default	5000
Name	Velocity ripple compensation selection	Unit	-	Applicable Motor	All
Effective	-	Categor y	Setup	Reference	-

Description

t.□□□X	Velocity ripple compensation		Effective
	0	Disable velocity ripple compensation.	After power on
	1	Enable velocity ripple compensation.	

t.□□X□	Reserved (Do not modify.)

t.□X□□	Reserved (Do not modify.)

t.X□□□	Sensitivity level for velocity ripple compensation		Effective
	0~F	Set sensitivity level for velocity ripple compensation.	Immediately

Pt No.	Pt424				
Size	2	Setting Range	0~100	Default	50
Name	Torque limit at main circuit voltage drop	Unit	1%*1	Applicable Motor	All
Effective	Immediately	Category	Setup	Reference	-

Pt No.	Pt425				
Size	2	Setting Range	0~50000	Default	100
Name	Release time for torque limit at main circuit voltage drop	Unit	1 ms	Applicable Motor	All
Effective	Immediately	Category	Setup	Reference	-

Pt No.	Pt426				
Size	2	Setting Range	0~500	Default	0
Name	Average torque feedforward movement time	Unit	0.25 ms	Applicable Motor	All
Effective	Immediately	Category	Setup	Reference	-

Pt No.	Pt428				
Size	2	Setting Range	0~100	Default	80
Name	Current ratio of linear axis in gantry control system	Unit	1%	Applicable Motor	All
Effective	Immediately	Category	Tuning	Reference	-

Pt No.	Pt429				
Size	2	Setting Range	0~3000	Default	0
Name	Dead band for torque command input	Unit	1 mV	Applicable Motor	All
Effective	Immediately	Category	Setup	Reference	-

Pt No.	Pt480				
Size	2	Setting Range	0~10000	Default	10000
Name	Velocity limit during force control (linear servo motor)	Unit	1 mm/s	Applicable Motor	All
Effective	Immediately	Category	Setup	Reference	-

Pt No.	Pt481				
Size	2	Setting Range	0~100	Default	0
Name	Polarity detection loop gain	Unit	Stiffness level	Applicable Motor	All
Effective	Immediately	Category	Tuning	Reference	-

Pt No.	Pt483				
Size	2	Setting Range	0~800	Default	30
Name	Forward force limit value for internal force limit (linear servo motor)	Unit	1% (rated force)	Applicable Motor	All
Effective	Immediately	Category	Setup	Reference	-

Pt No.	Pt484				
Size	2	Setting Range	0~800	Default	30
Name	Reverse force limit value for internal force limit (linear servo motor)	Unit	1% (rated force)	Applicable Motor	All
Effective	Immediately	Category	Setup	Reference	-

Pt No.	Pt488*1				
Size	2	Setting Range	0~5000	Default	1000
Name	Waiting time for polarity detection command	Unit	1 ms	Applicable Motor	All
Effective	Immediately	Category	Tuning	Reference	-

Pt No.	Pt489*2				
Size	2	Setting Range	1~1000	Default	200
Name	Polarity detection low-pass filter frequency	Unit	1 Hz	Applicable Motor	All
Effective	Immediately	Category	Tuning	Reference	-

Pt No.	Pt48A*2				
Size	2	Setting Range	0~1000	Default	0
Name	Polarity detection second-order low-pass filter frequency	Unit	1 Hz	Applicable Motor	All
Effective	Immediately	Category	Tuning	Reference	-

Pt No.	Pt498*1				
Size	2	Setting Range	0~30	Default	30
Name	Allowable error range for polarity detection	Unit	1 deg	Applicable Motor	All
Effective	Immediately	Category	Tuning	Reference	-

Pt No.	Pt4A0				
Size	2	Setting Range	1~100	Default	10
Name	Gain ratio for field-weakening control	Unit	1 %	Applicable Motor	All
Effective	Immediately	Category	Setup	Reference	-

Pt No.	Pt4A1				
Size	2	Setting Range	85~100	Default	85
Name	Ratio of voltage utilization rate for field-weakening control	Unit	1 %	Applicable Motor	All
Effective	Immediately	Category	Setup	Reference	-

Note:

*1. Pt488 and Pt498 are applicable to the electrical angle detection methods of STABS test/tune, Digital Hall and Analog Hall.

*2. Pt489 and Pt48A are applicable to the electrical angle detection methods of SW method1.

15.2.6 Parameters for I/O setting (Pt5XX)

Pt No.	Pt501				
Size	2	Setting Range	0~10000	Default	10
Name	Zero clamp level	Unit	1 rpm	Applicable Motor	Rotary
Effective	Immediately	Category	Setup	Reference	-

Pt No.	Pt502				
Size	2	Setting Range	1~10000	Default	20
Name	Rotation detection value	Unit	1 rpm	Applicable Motor	Rotary
Effective	Immediately	Category	Setup	Reference	-

Pt No.	Pt503				
Size	2	Setting Range	0~100	Default	10
Name	Output range of velocity reach signal	Unit	1 rpm	Applicable Motor	Rotary
Effective	Immediately	Category	Setup	Reference	-

Pt No.	Pt504				
Size	2	Setting Range	0~1000	Default	0
Name	External dynamic brake command-servo on delay time	Unit	1 ms	Applicable Motor	All
Effective	Immediately	Category	Setup	Reference	-

Pt No.	Pt506				
Size	2	Setting Range	0~50	Default	10
Name	Brake command-servo off delay time	Unit	10 ms	Applicable Motor	All
Effective	Immediately	Category	Setup	Reference	-

Pt No.	Pt507				
Size	2	Setting Range	0~10000	Default	100
Name	Brake command output velocity value	Unit	1 rpm	Applicable Motor	Rotary
Effective	Immediately	Category	Setup	Reference	-

Pt No.	Pt508				
Size	2	Setting Range	10~100	Default	50
Name	Servo off-brake command waiting time	Unit	10 ms	Applicable Motor	All
Effective	Immediately	Category	Setup	Reference	-

Pt No.	Pt509				
Size	2	Setting Range	20~50000	Default	20
Name	Momentary power interruption hold time	Unit	1 ms	Applicable Motor	All
Effective	Immediately	Category	Setup	Reference	-

Pt No.	Pt50A				
Size	2	Setting Range	0000~BBBB	Default	3210
Name	Input signal selection 1	Unit	-	Applicable Motor	All
Effective	After power on	Category	Setup	Reference	-

Description

		Allocation of servo on input (S-ON) signal	Reference
t.□□□X	0	Active when CN6-33 (I1) input signal is ON.	-
	1	Active when CN6-30 (I2) input signal is ON.	
	2	Active when CN6-29 (I3) input signal is ON.	
	3	Active when CN6-27 (I4) input signal is ON.	
	4	Active when CN6-28 (I5) input signal is ON.	
	5	Active when CN6-26 (I6) input signal is ON.	
	6	Active when CN6-32 (I7) input signal is ON.	
	7	Active when CN6-31 (I8) input signal is ON.	
	8	Active when CN6-9 (I9) input signal is ON.	
	9	Active when CN6-8 (I10) input signal is ON.	
	A	The signal is always active.	
	B	The signal is always inactive.	

		Allocation of proportional control input (P-CON) signal	Reference
t.□□X□	0~B	The allocation is the same as the one of servo on input (S-ON) signal.	-

		Allocation of forward prohibition input (P-OT) signal	Reference
t.□X□□	0~B	The allocation is the same as the one of servo on input (S-ON) signal.	-

		Allocation of reverse prohibition input (N-OT) signal	Reference
t.X□□□	0~B	The allocation is the same as the one of servo on input (S-ON) signal.	-

Pt No.	Pt50B				
Size	2	Setting Range	0000~BBBB	Default	B654
Name	Input signal selection 2	Unit	-	Applicable Motor	All
Effective	After power on	Category	Setup	Reference	-

Description

t.□□□X	Allocation of alarm reset input (ALM-RST) signal		Reference
	0~B	The allocation is the same as the one of servo on input (S-ON) signal.	-

t.□□X□	Allocation of forward external torque limit input (P-CL) signal		Reference
	0~B	The allocation is the same as the one of servo on input (S-ON) signal.	-

t.□X□□	Allocation of reverse external torque limit input (N-CL) signal		Reference
	0~B	The allocation is the same as the one of servo on input (S-ON) signal.	-

t.X□□□	Allocation of control method switching input (C-SEL) signal		Reference
	0~B	The allocation is the same as the one of servo on input (S-ON) signal.	-

Pt No.	Pt50C				
Size	2	Setting Range	0000~BBBB	Default	BBBB
Name	Input signal selection 3	Unit	-	Applicable Motor	All
Effective	After power on	Category	Setup	Reference	-

Description

	Allocation of motor rotation direction input (SPD-D) signal		Reference
t.□□□X	0	Active when CN6-33 (I1) input signal is ON.	-
	1	Active when CN6-30 (I2) input signal is ON.	
	2	Active when CN6-29 (I3) input signal is ON.	
	3	Active when CN6-27 (I4) input signal is ON.	
	4	Active when CN6-28 (I5) input signal is ON.	
	5	Active when CN6-26 (I6) input signal is ON.	
	6	Active when CN6-32 (I7) input signal is ON.	
	7	Active when CN6-31 (I8) input signal is ON.	
	8	Active when CN6-9 (I9) input signal is ON.	
	9	Active when CN6-8 (I10) input signal is ON.	
	A	The signal is always active.	
	B	The signal is always inactive.	

	Allocation of internal set velocity 1 input (SPD-A) signal		Reference
t.□□X□	0~B	The allocation is the same as the one of motor rotation direction input (SPD-D) signal.	-

	Allocation of internal set velocity 2 input (SPD-B) signal		Reference
t.□X□□	0~B	The allocation is the same as the one of motor rotation direction input (SPD-D) signal.	-

	Allocation of zero clamp input (ZCLAMP) signal		Reference
t.X□□□	0~B	The allocation is the same as the one of motor rotation direction input (SPD-D) signal.	-

Pt No.	Pt50D				
Size	2	Setting Range	0000~BBBB	Default	BBBB
Name	Input signal selection 4	Unit	-	Applicable Motor	All
Effective	After power on	Category	Setup	Reference	-

Description

t.□□□X	Allocation of command pulse inhibition input (INHIBIT) signal		Reference
	0~B	The allocation is the same as the one of motor rotation direction input (SPD-D) signal.	-

t.□□X□	Reserved (Do not modify.)

t.□X□□	Allocation of gain switching input (G-SEL) signal		Reference
	0~B	The allocation is the same as the one of motor rotation direction input (SPD-D) signal.	-

t.X□□□	Allocation of command pulse multiplication switching input (PSEL) signal		Reference
	0~B	The allocation is the same as the one of motor rotation direction input (SPD-D) signal.	-

Pt No.	Pt50E				
Size	2	Setting Range	0000~BBBB	Default	87BB
Name	Input signal selection 5	Unit	-	Applicable Motor	All
Effective	After power on	Category	Setup	Reference	-

Description

t.□□□X	Allocation of servo drive reset input (RST) signal		Reference
	0	Active when CN6-33 (I1) input signal is ON.	-
	1	Active when CN6-30 (I2) input signal is ON.	
	2	Active when CN6-29 (I3) input signal is ON.	
	3	Active when CN6-27 (I4) input signal is ON.	
	4	Active when CN6-28 (I5) input signal is ON.	
	5	Active when CN6-26 (I6) input signal is ON.	
	6	Active when CN6-32 (I7) input signal is ON.	
	7	Active when CN6-31 (I8) input signal is ON.	
	8	Active when CN6-9 (I9) input signal is ON.	
	9	Active when CN6-8 (I10) input signal is ON.	
	A	The signal is always active.	
	B	The signal is always inactive.	

t.□□X□	Allocation of near home sensor input (DOG) signal		Reference
	0~B	The allocation is the same as the one of servo drive reset input (RST) signal.	-

t.□X□□	Allocation of servo drive built-in homing procedure input (HOM) signal		Reference
	0~B	The allocation is the same as the one of servo drive reset input (RST) signal.	-

t.X□□□	Allocation of servo drive error map input (MAP) signal		Reference
	0~B	The allocation is the same as the one of servo drive reset input (RST) signal.	-

Pt No.	Pt50F				
Size	2	Setting Range	0000~BBBB	Default	BBB9
Name	Input signal selection 6	Unit	-	Applicable Motor	All
Effective	After power on	Category	Setup	Reference	-

Description

t.□□□X	Allocation of forced stop input (FSTP) signal		Reference
	0~B	The allocation is the same as the one of servo drive reset input (RST) signal.	-

t.□□X□	Allocation of position deviation clear input (CLR) signal		Reference
	0~B	The allocation is the same as the one of servo drive reset input (RST) signal.	-

t.□X□□	Allocation of electronic cam input (ECAM) signal.		Reference
	0~B	The allocation is the same as the one of servo drive reset input (RST) signal.	-

t.X□□□	Allocation of mark input (MARK) signal.		Reference
	0~B	The allocation is the same as the one of servo drive reset input (RST) signal.	-

Pt No.	Pt511				
Size	2	Setting Range	0000~1111	Default	0000
Name	Input signal inverse setting 1	Unit	-	Applicable Motor	All
Effective	After power on	Category	Setup	Reference	-

Description

t.□□□X	I1 signal inversion	
	0	The signal is not inverted.
	1	The signal is inverted.

t.□□X□	I2 signal inversion	
	0	The signal is not inverted.
	1	The signal is inverted.

t.□X□□	I3 signal inversion	
	0	The signal is not inverted.
	1	The signal is inverted.

t.X□□□	I4 signal inversion	
	0	The signal is not inverted.
	1	The signal is inverted.

Pt No.	Pt512				
Size	2	Setting Range	0000~1111	Default	0000
Name	Input signal inverse setting 2	Unit	-	Applicable Motor	All
Effective	After power on	Category	Setup	Reference	-

Description

t.□□□X	I5 signal inversion	
	0	The signal is not inverted.
	1	The signal is inverted.

t.□□X□	I6 signal inversion	
	0	The signal is not inverted.
	1	The signal is inverted.

t.□X□□	I7 signal inversion	
	0	The signal is not inverted.
	1	The signal is inverted.

t.X□□□	I8 signal inversion	
	0	The signal is not inverted.
	1	The signal is inverted.

Pt No.	Pt513				
Size	2	Setting Range	0000~1011	Default	0000
Name	Input signal inverse setting 3	Unit	-	Applicable Motor	All
Effective	After power on	Category	Setup	Reference	-

Description

t.□□□X	I9 signal inversion		Reference
	0	The signal is not inverted.	-
	1	The signal is inverted.	

t.□□X□	I10 signal inversion		Reference
	0	The signal is not inverted.	-
	1	The signal is inverted.	

t.□X□□	Reserved (Do not modify.)

t.X□□□	Allocation of input signals		Reference
	0	Use the default signal allocation.	-
	1	Use user-defined signal allocation.	

Pt No.	Pt514				
Size	2	Setting Range	0000~5555	Default	2114
Name	Output signal selection 1	Unit	-	Applicable Motor	All
Effective	After power on	Category	Setup	Reference	-

Description

t.□□□X	Allocation of alarm output (ALM) signal		Reference
	0	Disabled	-
	1	Output signal from CN6-35 and 34 (O1).	
	2	Output signal from CN6-37 and 36 (O2).	
	3	Output signal from CN6-39 and 38 (O3).	
	4	Output signal from CN6-11 and 10 (O4).	
	5	Output signal from CN6-40 and 12 (O5).	

t.□□X□	Allocation of positioning completion output (COIN) signal		Reference
	0~5	The allocation is the same as the one of alarm output (ALM) signal.	-

t.□X□□	Allocation of velocity reach output (V-CMP) signal		Reference
	0~5	The allocation is the same as the one of alarm output (ALM) signal.	-

t.X□□□	Allocation of rotation detection/movement detection output (TGON) signal		Reference
	0~5	The allocation is the same as the one of alarm output (ALM) signal.	-

Pt No.	Pt515				
Size	2	Setting Range	0000~5555	Default	0003
Name	Output signal selection 2	Unit	-	Applicable Motor	All
Effective	After power on	Category	Setup	Reference	-

Description

t.□□□X	Allocation of drive ready output (D-RDY) signal		Reference
	0~5	The allocation is the same as the one of alarm output (ALM) signal.	-

t.□□X□	Allocation of servo ready output (S-RDY) signal		Reference
	0~5	The allocation is the same as the one of alarm output (ALM) signal.	-

t.□X□□	Allocation of torque limit detection output (CLT) signal		Reference
	0~5	The allocation is the same as the one of alarm output (ALM) signal.	-

t.X□□□	Allocation of velocity limit detection output (VLT) signal		Reference
	0~5	The allocation is the same as the one of alarm output (ALM) signal.	-

Pt No.	Pt516				
Size	2	Setting Range	0000~5555	Default	0005
Name	Output signal selection 3	Unit	-	Applicable Motor	All
Effective	After power on	Category	Setup	Reference	-

Description

t.□□□X	Allocation of brake control output (BK) signal		Reference
	0	Disabled	-
	1	Output signal from CN6-35 and 34 (O1).	
	2	Output signal from CN6-37 and 36 (O2).	
	3	Output signal from CN6-39 and 38 (O3).	
	4	Output signal from CN6-11 and 10 (O4).	
	5	Output signal from CN6-40 and 12 (O5).	

t.□□X□	Allocation of warning output (WARN) signal		Reference
	0~5	The allocation is the same as the one of brake control output (BK) signal.	-

t.□X□□	Allocation of positioning near output (NEAR) signal		Reference
	0~5	The allocation is the same as the one of brake control output (BK) signal.	-

t.X□□□	Allocation of command pulse multiplication switching output (PSELA) signal		Reference
	0~5	The allocation is the same as the one of brake control output (BK) signal.	-

Pt No.	Pt517				
Size	2	Setting Range	0000~5505	Default	0000
Name	Output signal selection 4	Unit	-	Applicable Motor	All
Effective	After power on	Category	Setup	Reference	-

Description

t.□□□X	Allocation of position trigger digital output (PT) signal		Reference
	0~5	The allocation is the same as the one of brake control output (BK) signal.	-

t.□□X□	Allocation of electronic cam synchronous area output (AREA) signal.		Reference
	0~5	The allocation is the same as the one of alarm output (BK) signal.	-

t.□X□□	Allocation of external dynamic brake (DBK) signal		Reference
	0~5	The allocation is the same as the one of brake control output (BK) signal.	-

t.X□□□	Allocation of servo drive homing completion output (HOMED) signal		Reference
	0~5	The allocation is the same as the one of brake control output (BK) signal.	-

Pt No.	Pt519				
Size	2	Setting Range	0000~1111	Default	0000
Name	Output signal inverse setting 1	Unit	-	Applicable Motor	All
Effective	After power on	Category	Setup	Reference	-

Description

t.□□□X	O1 signal inversion	
	0	The signal is not inverted.
	1	The signal is inverted.

t.□□X□	O2 signal inversion	
	0	The signal is not inverted.
	1	The signal is inverted.

t.□X□□	O3 signal inversion	
	0	The signal is not inverted.
	1	The signal is inverted.

t.X□□□	O4 signal inversion	
	0	The signal is not inverted.
	1	The signal is inverted.

Pt No.	Pt51A				
Size	2	Setting Range	0000~0001	Default	0000
Name	Output signal inverse setting 2	Unit	-	Applicable Motor	All
Effective	After power on	Category	Setup	Reference	-

Description

t.□□□X	O5 signal inversion	
	0	The signal is not inverted.
	1	The signal is inverted.

t.□□X□	Reserved (Do not modify.)
t.□X□□	Reserved (Do not modify.)
t.X□□□	Reserved (Do not modify.)

Pt No.	Pt51B				
Size	4	Setting Range	0~1073741824	Default	625
Name	Detection value for overflow motor-load position deviation	Unit	1 control unit	Applicable Motor	Rotary
Effective	Immediately	Category	Setup	Reference	-

Pt No.	Pt51E				
Size	2	Setting Range	10~100	Default	100
Name	Warning value for overflow position deviation	Unit	1%	Applicable Motor	All
Effective	Immediately	Category	Setup	Reference	-

Pt No.	Pt520				
Size	4	Setting Range	1~1073741823	Default	5242880
Name	Alarm value for overflow position deviation (rotary servo motor)	Unit	1 control unit	Applicable Motor	Rotary servo motor
Effective	Immediately	Category	Setup	Reference	-

Pt No.	Pt521				
Size	4	Setting Range	1~1073741823	Default	500000
Name	Alarm value for overflow position deviation (linear servo motor)	Unit	1 control unit	Applicable Motor	Linear servo motor
Effective	Immediately	Category	Setup	Reference	-

Pt No.	Pt522				
Size	4	Setting Range	0~1073741824	Default	7
Name	Positioning completion width	Unit	1 control unit	Applicable Motor	All
Effective	Immediately	Category	Setup	Reference	-

Pt No.	Pt523				
Size	4	Setting Range	0~1000	Default	0
Name	Debounce time	Unit	1 ms	Applicable Motor	All
Effective	Immediately	Category	Setup	Reference	-

Pt No.	Pt524				
Size	4	Setting Range	1~1073741824	Default	1073741824
Name	NEAR signal width	Unit	1 control unit	Applicable Motor	All
Effective	Immediately	Category	Setup	Reference	-

Pt No.	Pt52A				
Size	2	Setting Range	0~100	Default	0
Name	Multiplier per one full-closed loop rotation	Unit	1%	Applicable Motor	Rotary
Effective	Immediately	Category	Tuning	Reference	-

Pt No.	Pt52B				
Size	2	Setting Range	1~100	Default	20
Name	Overload warning value	Unit	1%	Applicable Motor	All
Effective	Immediately	Category	Setup	Reference	-

Pt No.	Pt52C				
Size	2	Setting Range	10~100	Default	100
Name	Current derating value at motor overload detection	Unit	1%	Applicable Motor	All
Effective	After power on	Category	Setup	Reference	-

Pt No.	Pt52D				
Size	2	Setting Range	10~2000	Default	600
Name	Encoder delay time	Unit	1 ms	Applicable Motor	All
Effective	After power on	Category	Setup	Reference	-

Pt No.	Pt52E				
Size	2	Setting Range	5~600	Default	10
Name	Maximum duration for motor peak current	Unit	100 ms	Applicable Motor	All
Effective	After power on	Category	Setup	Reference	-

Pt No.	Pt531				
Size	4	Setting Range	-1073741824 ~ 1073741822	Default	0
Name	Program P2P travel distance P1	Unit	1 control unit	Applicable Motor	All
Effective	Immediately	Category	Setup	Reference	-

Pt No.	Pt532				
Size	4	Setting Range	-1073741823 ~ 1073741823	Default	32768
Name	Program P2P travel distance P2	Unit	1 control unit	Applicable Motor	All
Effective	Immediately	Category	Setup	Reference	-

Pt No.	Pt533				
Size	2	Setting Range	1~10000	Default	600/60[*2]
Name	Program P2P velocity	Unit	1 rpm	Applicable Motor	Rotary
Effective	Immediately	Category	Setup	Reference	-

Pt No.	Pt534				
Size	2	Setting Range	2~10000	Default	100
Name	Program P2P acceleration time	Unit	1 ms	Applicable Motor	All
Effective	Immediately	Category	Setup	Reference	-

Pt No.	Pt535				
Size	2	Setting Range	0~60000	Default	1000
Name	Program P2P waiting time	Unit	1 ms	Applicable Motor	All
Effective	Immediately	Category	Setup	Reference	-

Pt No.	Pt537				
Size	2	Setting Range	2~10000	Default	100
Name	Program P2P deceleration time	Unit	1 ms	Applicable Motor	All
Effective	Immediately	Category	Setup	Reference	-

Pt No.	Pt538				
Size	2	Setting Range	2~1000	Default	10
Name	Program P2P emergency deceleration time	Unit	1 ms	Applicable Motor	All
Effective	Immediately	Category	Setup	Reference	-

Pt No.	Pt539				
Size	4	Setting Range	1~1073741824	Default	32768
Name	Program P2P relative travel distance	Unit	1 control unit	Applicable Motor	All
Effective	Immediately	Category	Setup	Reference	-

Pt No.	Pt550				
Size	2	Setting Range	-10000~10000	Default	0
Name	Analog monitor 1 offset voltage	Unit	0.01 V	Applicable Motor	All
Effective	Immediately	Category	Setup	Reference	-

Pt No.	Pt551				
Size	2	Setting Range	-10000~10000	Default	0
Name	Analog monitor 2 offset voltage	Unit	0.01 V	Applicable Motor	All
Effective	Immediately	Category	Setup	Reference	-

Pt No.	Pt552				
Size	2	Setting Range	-10000~10000	Default	100
Name	Analog monitor 1 scale	Unit	x 0.01	Applicable Motor	All
Effective	Immediately	Category	Setup	Reference	-

Pt No.	Pt553				
Size	2	Setting Range	-10000~10000	Default	100
Name	Analog monitor 2 scale	Unit	x 0.01	Applicable Motor	All
Effective	Immediately	Category	Setup	Reference	-

Pt No.	Pt554				
Size	2	Setting Range	8~600	Default	10
Name	Maximum duration for I2T peak current	Unit	100 ms	Applicable Motor	All
Effective	After power on	Category	Setup	Reference	-

Pt No.	Pt580				
Size	2	Setting Range	0~10000	Default	10
Name	Zero clamp level (linear servo motor)	Unit	1 mm/s	Applicable Motor	Linear
Effective	Immediately	Category	Setup	Reference	-

t No.	Pt581				
Size	2	Setting Range	1~10000	Default	20
Name	Movement detection value (linear servo motor)	Unit	1 mm/s	Applicable Motor	Linear
Effective	Immediately	Category	Setup	Reference	-

Pt No.	Pt582				
Size	2	Setting Range	0~100	Default	10
Name	Output range of velocity reach signal (linear servo motor)	Unit	1 mm/s	Applicable Motor	Linear
Effective	Immediately	Category	Setup	Reference	-

Pt No.	Pt583				
Size	2	Setting Range	0~10000	Default	10
Name	Brake command output velocity value (linear servo motor)	Unit	1 mm/s	Applicable Motor	Linear
Effective	Immediately	Category	Setup	Reference	-

Pt No.	Pt585				
Size	2	Setting Range	1~10000	Default	50
Name	Program jog velocity (linear servo motor)	Unit	1 mm/s	Applicable Motor	Linear
Effective	Immediately	Category	Setup	Reference	-

15.2.7 Parameters for regenerative resistor setting (Pt6XX)

Pt No.	Pt600				
Size	2	Setting Range	0~65535	Default	0
Name	Regenerative resistor capacity*2	Unit	10 W	Applicable Motor	All
Effective	Immediately	Category	Setup	Reference	-

Pt No.	Pt603				
Size	2	Setting Range	0~65535	Default	0
Name	Resistance of regenerative resistor	Unit	10 mΩ	Applicable Motor	All
Effective	Immediately	Category	Setup	Reference	-

15.2.8 Parameters for internal homing (Pt7XX)

Pt No.	Pt700				
Size	2	Setting Range	-6~37	Default	1
Name	Homing method	Unit	The number of homing method	Applicable Motor	All
Effective	Immediately	Category	Setup	Reference	-

Pt No.	Pt701				
Size	2	Setting Range	0~3000	Default	20
Name	Velocity for finding near home sensor (rotary servo motor)	Unit	1 rpm	Applicable Motor	Rotary
Effective	Immediately	Category	Setup	Reference	-

Pt No.	Pt702				
Size	2	Setting Range	0~3000	Default	6
Name	Velocity for finding home position (rotary servo motor)	Unit	1 rpm	Applicable Motor	Rotary
Effective	Immediately	Category	Setup	Reference	-

Pt No.	Pt703				
Size	2	Setting Range	0~300	Default	50
Name	Time limit for homing procedure	Unit	Second	Applicable Motor	All
Effective	Immediately	Category	Setup	Reference	-

Pt No.	Pt704				
Size	4	Setting Range	-1073741824 ~ 1073741824	Default	0
Name	Home offset	Unit	1 control unit	Applicable Motor	All
Effective	Immediately	Category	Setup	Reference	-

Pt No.	Pt705				
Size	2	Setting Range	0~1000	Default	10
Name	Velocity for finding near home sensor (linear servo motor)	Unit	1 mm/s	Applicable Motor	Linear
Effective	Immediately	Category	Setup	Reference	-

Pt No.	Pt706				
Size	2	Setting Range	0~1000	Default	3
Name	Velocity for finding home position (linear servo motor)	Unit	1 mm/s	Applicable Motor	Linear
Effective	Immediately	Category	Setup	Reference	-

Pt No.	Pt707				
Size	2	Setting Range	2~10000	Default	100
Name	Homing acceleration time	Unit	1 ms	Applicable Motor	All
Effective	Immediately	Category	Setup	Reference	-

Pt No.	Pt708				
Size	2	Setting Range	2~10000	Default	100
Name	Homing deceleration time	Unit	1 ms	Applicable Motor	All
Effective	Immediately	Category	Setup	Reference	-

Pt No.	Pt709				
Size	2	Setting Range	2~1000	Default	10
Name	Homing emergency deceleration time	Unit	1 ms	Applicable Motor	All
Effective	Immediately	Category	Setup	Reference	-

Pt No.	Pt70A				
Size	2	Setting Range	0000~0111	Default	0001
Name	Single axis home application selection	Unit	-	Applicable Motor	All
Effective	After power on	Category	Setup	Reference	-

Description

t.□□□X	Multi index output selection	
	0	Disable multi index output.
	1	Enable multi index output.

t.□□X□	Automatically moving to home offset position	
	0	After index signal is found during homing procedure, the current position will be set as Pt704.
	1	After index signal is found during homing procedure, the current position will be set as Pt704 and the motor will be moved to 0.

t.□X□□	Automatical execution of homing with absolute encoder	
	0	Disable automatical execution of homing after power on.
	1	Enable automatical execution of homing after power on.

t.X□□□	Reserved (Do not modify.)

Note:

This parameter should be used with internal homing procedure(Pt700=-3) so it only supports absolute encoder.

Pt No.	Pt70C				
Size	2	Setting Range	0~16384	Default	0
Name	Homing position command acceleration/ deceleration time constant	Unit	0.25 ms	Applicable Motor	All
Effective	After motor stops	Category	Setup	Reference	-

Pt No.	Pt70D				
Size	2	Setting Range	0~1000	Default	0
Name	Homing average position command movement time	Unit	0.25 ms	Applicable Motor	All
Effective	After motor stops	Category	Setup	Reference	-

Pt No.	Pt70E				
Size	2	Setting Range	0~1073741824	Default	0
Name	Index tolerance	Unit	1 control unit	Applicable Motor	All
Effective	Immediately	Category	Setup	Reference	-

Pt No.	Pt710				
Size	2	Setting Range	0000~0211	Default	0000
Name	Gantry control system home application selection	Unit	-	Applicable Motor	All
Effective	Immediately	Category	Setup	Reference	-

Description

t.□□□X	Locking function for yaw axis in gantry control system	
	0	Disable yaw axis locking function for gantry control system.
	1	Enable yaw axis locking function for gantry control system.

t.□□X□	Option of searching DOG signal	
	0	Search DOG signal in both axes.
	1	Search DOG signal only in master axis.

t.□X□□	Option of searching index signal for slave axis.	
	0	Search index signal only.
	1	Search index signal after rising edge of DOG signal is found.
	2	Search index signal after falling edge of DOG signal is found.

t.X□□□	Reserved (Do not modify.)

Pt No.	Pt711				
Size	4	Setting Range	-1073741824 ~ 1073741824	Default	0
Name	Home offset of yaw axis in gantry control system	Unit	1 control unit	Applicable Motor	All
Effective	Immediately	Category	Setup	Reference	-

Pt No.	Pt712				
Size	4	Setting Range	-1073741824 ~ 1073741824	Default	0
Name	Locking position of yaw axis in gantry control system	Unit	1 control unit	Applicable Motor	All
Effective	Immediately	Category	Setup	Reference	-

Note:

*1. The percentage of rated torque.

*2. While using direct drive motor, the default values of Pt304 and Pt533 are set to 60 rpm.

*3. The setting value of this parameter is normally 0. When external regenerative resistor is used, the parameter should be set to the capacity (W) of the external regenerative resistor.

*4. The reference velocity of the command 100%.This parameter is only available for PROFINET drives.

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16. Appendix

16.1 Cables

16.1.1 Motor power cable

- Servo motor

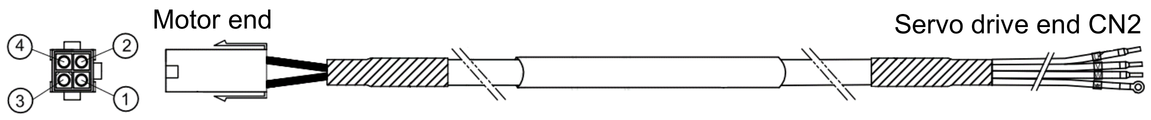

Figure16.1.1.1 Servo motor power cable (HVPS04AB□□MB, without brake cable)

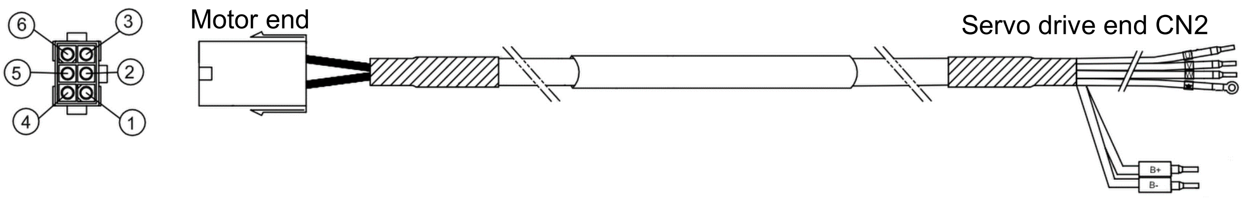

Figure16.1.1.2 Servo motor power cable (HVPS06AB□□MB, with brake cable)

Table16.1.1.1 Motor power cable for servo motor

Name	HIWIN Part Number	Description
Servo motor power cable	HVPS04AB□□MB	For 50 W ~ 750 W servo motor, without brake cable, highly bendable (This cable can also be used with HIWIN direct drive motor with absolute feedback system.)
	HVPS06AB□□MB	For 50 W ~ 750 W servo motor, with brake cable, highly bendable
	HVPM04BB□□MB	For 1 kW~2 kW servo motor, without brake cable, straight type connector, highly bendable
	HVPM06BB□□MB	For 1 kW~2 kW servo motor, with brake cable, straight type connector, highly bendable
	HVPM04CB□□MB	For 1 kW~2 kW servo motor, without brake cable, L-type connector, highly bendable
	HVPM06CB□□MB	For 1 kW~2 kW servo motor, with brake cable, L-type connector, highly bendable

□□ stands for cable length, please refer to below.

Table16.1.1.2

□□	03	05	07	10
Cable Length (m)	3	5	7	10

Note:

(1) For the detailed information of cable, please refer to the catalogue of EM1 servo motor.

(2) The model number of HIWIN direct drive motor with absolute feedback system is DM□□□-A or DM□□□-B.

(3) This power cable is only suitable for 110 V / 220 V input power servo drive (ED1□-□□-□□□2).

■ Direct drive motor

Please use below power cable when HIWIN incremental direct drive motor is used.

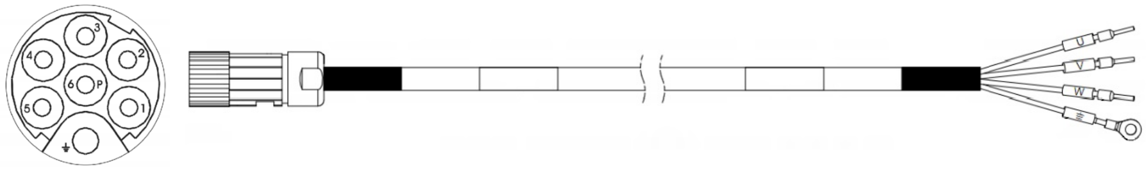

Figure16.1.1.3 Direct drive motor power cable (HE00841001□□)

Table16.1.1.3 Motor power cable for direct drive motor

Name	HIWIN Part Number	Description
Direct drive motor power cable	HE00841001□□	For direct drive motor, without brake cable, highly bendable.

□□ stands for cable length, please refer to below.

Table16.1.1.4

□□	71-80	81-90	95
Cable Length (m)	1-10	11-20	25

16.1.2 Encoder extension cable for motor

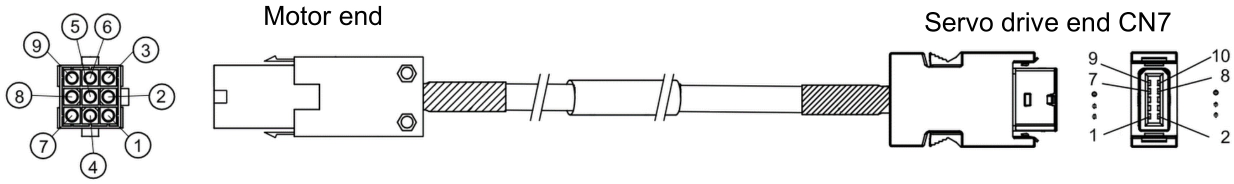

Figure16.1.2.1 Encoder extension cable (HVE23IAB□□MB, serial incremental type, without battery box)

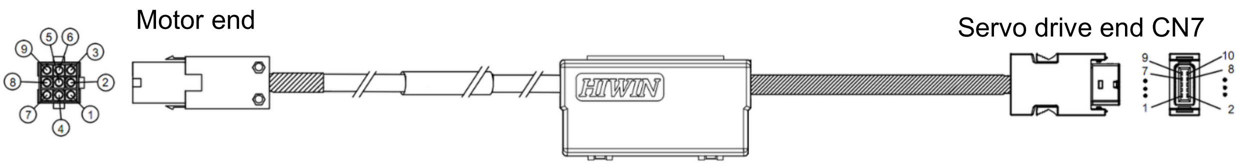

Figure16.1.2.2 Encoder extension cable (HVE23AAB□□MB, serial absolute type, with battery box)

Table16.1.2.1 Encoder extension cable for servo motor

Name	HIWIN Part Number	Description
Encoder extension cable	HVE23IAB□□MB	For 50 W ~ 750 W motor, serial incremental, highly bendable (This cable can also be used with HIWIN direct drive motor with absolute feedback system.)
	HVE23AAB□□MB	For 50 W ~ 750 W motor, serial absolute (with battery box), highly bendable
	HVE23IBB□□MB	1 kW~2 kW servo motor, serial incremental, straight type connector, highly bendable
	HVE23ABB□□MB	1 kW~2 kW servo motor, serial absolute (with battery box), straight type connector, highly bendable
	HVE23ICB□□MB	1 kW~2 kW servo motor, serial incremental, L type connector, highly bendable
	HVE23ACB□□MB	1 kW~2 kW servo motor, serial absolute (with battery box), L-type connector, highly bendable

Note:

The model number of HIWIN absolute direct drive motor is DM□□□-A or DM□□□-B.

□□ stands for cable length, please refer to below.

Table16.1.2.2

□□	03	05	07	10
Cable Length (m)	3	5	7	10

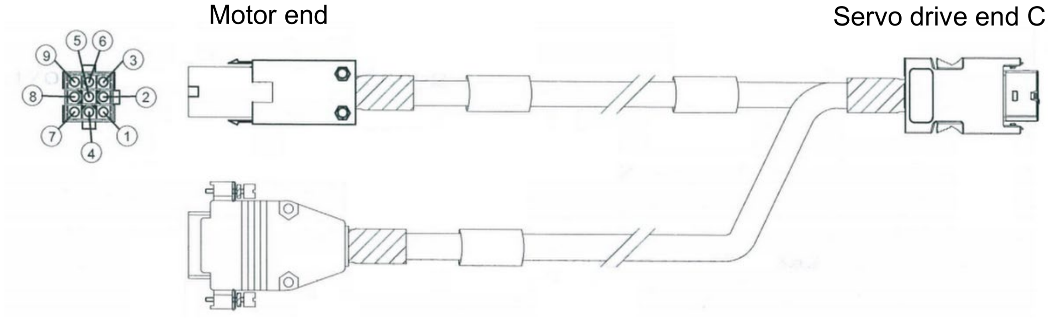

Figure16.1.2.3 Encoder extension cable (HE00817DR□00, serial incremental type for full-closed loop control, without battery box)

Table16.1.2.3 Encoder extension cable for full-closed loop control

Name	HIWIN Part Number	Description
Encoder extension cable	HE00817DR□00	For 50 W ~ 750 W motor, full-closed loop control

□ stands for cable length, please refer to below.

Table16.1.2.4

□	3	5	7	A
Cable Length (m)	3	5	7	10

Note:

For the detailed information of cable, please refer to the catalogue of EM1 servo motor.

16.1.3 Encoder extension cable for linear motor

When using linear motor with digital TTL signal linear scale, the cable below is required.

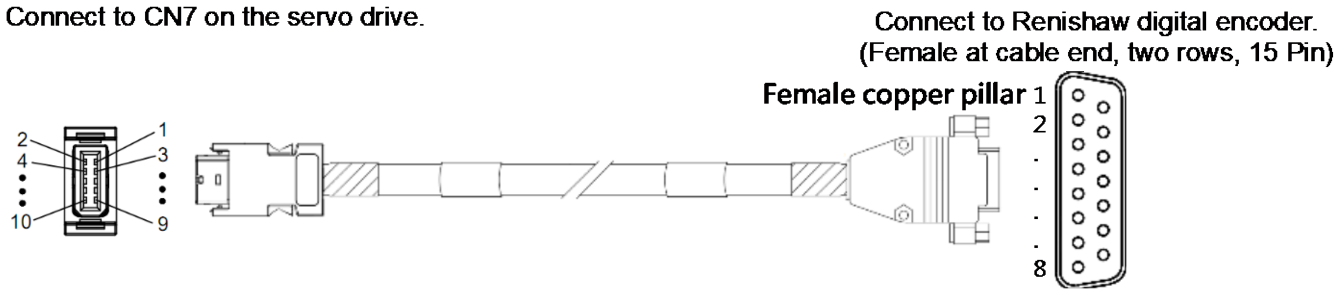

Figure16.1.3.1 HE00EJ6DF□00 Encoder extension cable (For Renishaw digital encoder)

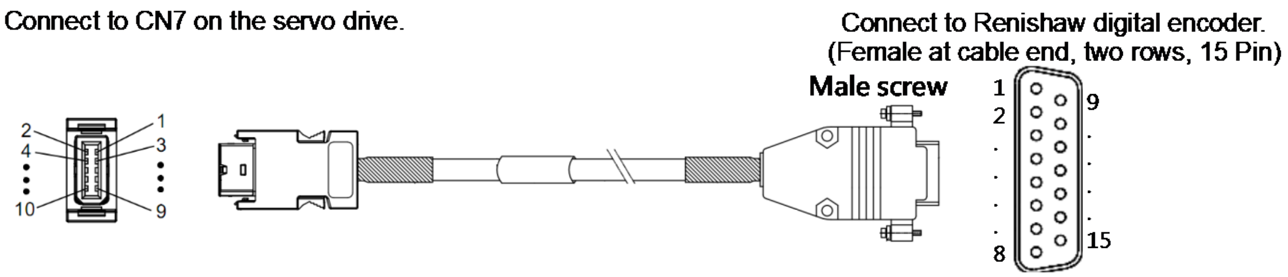

Figure16.1.3.2 HE00817EK□00 Encoder extension cable (For Renishaw digital encoder)

Figure16.1.3.3 HE00EJ6DB□00 Encoder extension cable (open ends)

Table16.1.3.1

Name	HIWIN Part Number	Description
Encoder extension cable	HE00EJ6DF□00	Extension cable used to connect to CN7 on the servo drive For Renishaw linear digital encoder, highly bendable (female copper pillar)
	HE00817EK□00	Extension cable used to connect to CN7 on the servo drive For Renishaw linear digital encoder, highly bendable (male screw)
	HE00EJ6DB□00	Extension cable used to connect to CN7 on the servo drive The encoder extension cable is with open ends for customized connector by users.

□ stands for cable length, please refer to below.

Table16.1.3.2

□	0	3	5	7	A
Cable Length (m)	0.5	3	5	7	10

Table16.1.3.3 Wire color table for encoder extension cable, HE00EJ6DB□00 (open ends)

Function	CN7 Pin	Wire Color	Function	CN7 Pin	Wire Color
5V	1	Brown	B-	8	Red
		Pink			
0V	2	White	Z+	9	Purple
		Black			
A+	5	Green	Z-	10	Gray
A-	6	Yellow	Inner shielding	2	
B+	7	Blue	Outer shielding	Case	

Table16.1.3.4 encoder extension pin definition, HE00EJ6DF□00, HE00817EK□00

Function	D-Sub 15 Pin Double Row Female (Renishaw digital)	Wire Color	CN7 Pin
5V	7	Brown	1
	8	Pink	
0V	2	White	2
	9	Black	
A+	14	Green	5
A-	6	Yellow	6
B+	13	Blue	7
B-	5	Red	8
Z+	12	Purple	9
Z-	4	Gray	10
Inner shielding	15	Inner shielding	2
Outer shielding	Case	Outer shielding	Case

16.1.4 ESC encoder extension cable

ESC encoder extension cable and ESC encoder communication cable are required if ESC is used. In this section we'll provide information of the cables and pin definitions to work with ESC. Since ESC is required when using linear motor with analog encoder or HIWIN direct drive motor with incremental feedback system, the cable below is required.

Table16.1.4.1 ESC encoder extension cable

Name	HIWIN Part Number	Description
ESC encoder extension cable	HE00EK1DA□00	For connecting ESC to Renishaw analog encoder, D-Sub connector 15 Pin (Female)
	HE00EJVDA□00	For connecting ESC to Renishaw analog encoder, D-Sub connector 15 Pin (Female) External digital Hall signal, D-Sub connector 9 Pin (Female)
	HE00EJWDA□00	For connecting ESC to HIWIN direct drive motor with incremental feedback system (analog encoder) Internal digital Hall signal and thermal signal supported

□ stands for cable length, please refer to below.

Table16.1.4.2

□	3	5	7	A
Cable Length (m)	3	5	7	10

Table16.1.4.3 Encoder extension pin definition, HE00EK1DA□00, HE00EJVDA□00(encoder signal)

Function	D-Sub 15 Pin Double Row Female (Renishaw Analog)	VGA 26Pin Three Row Male
5V	4	4
	5	5
0V	12	13
	13	14
SIN+	9	1
SIN-	1	10
COS+	10	2
COS-	2	11
REF+	3	3
REF-	11	12
Inner shielding	15	15
Outer shielding	Case	Case

Table16.1.4.4 Encoder extension pin definition, HE00EJVDA□00 (external digital Hall signal)

Function	D-Sub 9 Pin Double Row Female (Renishaw Analog)	VGA 26Pin Three Row Male
5V	1	5
Hall U	2	8
Hall V	3	18
Hall W	4	9
0V	5	14
Outer shielding	Case	Case

ESC-SS is required when linear motors, customized direct drive motors or torque motors are used with serial encoder or digital encoder (encoder alarm supported). Below cables are optional.

Table16.1.4.5 ESC-SS encoder extension

Name	HIWIN Part Number	Description
ESC-SS encoder extension cable	HE00EKTDB□00	For connecting ESC to Renishaw digital encoder, encoder alarm signal supported, D-Sub connector 15 Pin (Female)
	HE00EKTDA□00	For connecting ESC to Renishaw digital encoder, encoder alarm signal supported, D-Sub connector 15 Pin (Female) External digital Hall signal, D-Sub connector 9 Pin (Female)
	HE00EKSDA□00	For connecting ESC to Renishaw serial BiSS-C encoder, D-Sub connector 9 Pin (Female)
	HE00EKSDC□00	For connecting ESC to serial BiSS-C encoder, analog signal supported, D-Sub connector 15 Pin (Female)
	HE00EKSDJ□00	For connecting ESC to serial EnDat encoder, analog signal supported, D-Sub connector 15 Pin (Female)

Table16.1.4.6

□	3	5	7	A
Cable Length (m)	3	5	7	10

Table16.1.4.7 Encoder extension pin definition, HE00EKTDB□00,HE00EKTDA□00 (encoder signal)

Function	D-Sub 15 Pin Double Row Female (Renishaw Digital)	VGA 26Pin Three Row Male
5V	7	4
	8	
0V	2	13
	9	
A+	14	19
A-	6	20
B+	13	21
B-	5	22
Z+	12	3
Z-	4	12
E+	11	7
E-	3	17
Inner shielding	15	15
Outer shielding	Case	Case

Note:

For HE00EKTDA□00 external digital Hall signal, please refer to Table16.1.4.4.

Table16.1.4.8 Encoder extension pin definition, HE00EKSDA□00

Function	D-Sub 9 Pin Double Row Female (Renishaw BiSS-C)	VGA 26Pin Three Row Male
5V	4	4
	5	5
0V	8	13
	9	14
SLO+, DATA+	6	23
SLO-, DATA-	7	24
MA+, CLK+	2	7
MA-, CLK-	3	17
Outer shielding	Case	Case

Table16.1.4.9 Encoder extension pin definition, HE00EKSDC□00

Function	D-Sub 15 Pin Double Row Female (BiSS-C analog signal included)	VGA 26Pin Three Row Male
5V	7	4
	8	5
0V	2	13
	15	14
SIN+	5	1
SIN-	10	10
COS+	6	2
COS-	11	11
SLO+, DATA+	13	23
SLO-, DATA-	14	24
MA+, CLK+	3	7
MA-, CLK-	4	17
Outer shielding	Case	Case

Note:

It can work with RLS LA11 BiSS-C 15-pin D-sub male.

Table16.1.4.10 Encoder extension pin definition, HE00EKSDJ□00

Function	D-Sub 15 Pin Double Row Female (EnDat analog signal included)	VGA 26Pin Three Row Male
5V	4	4
	12	5
0V	2	13
	10	14
A+(SIN+)	1	1
A-(SIN-)	9	10
B+(COS+)	3	2
B-(COS-)	11	11
DATA	5	23
/DATA	13	24
CLOCK	8	7
/CLOCK	15	17
Outer shielding	Case	Case

Note:

It can work with HEIDENHAIN EnDat 15-pin D-sub male.

When HIWIN E1 motor is used with ESC-SS full-closed loop, below cables are optional.

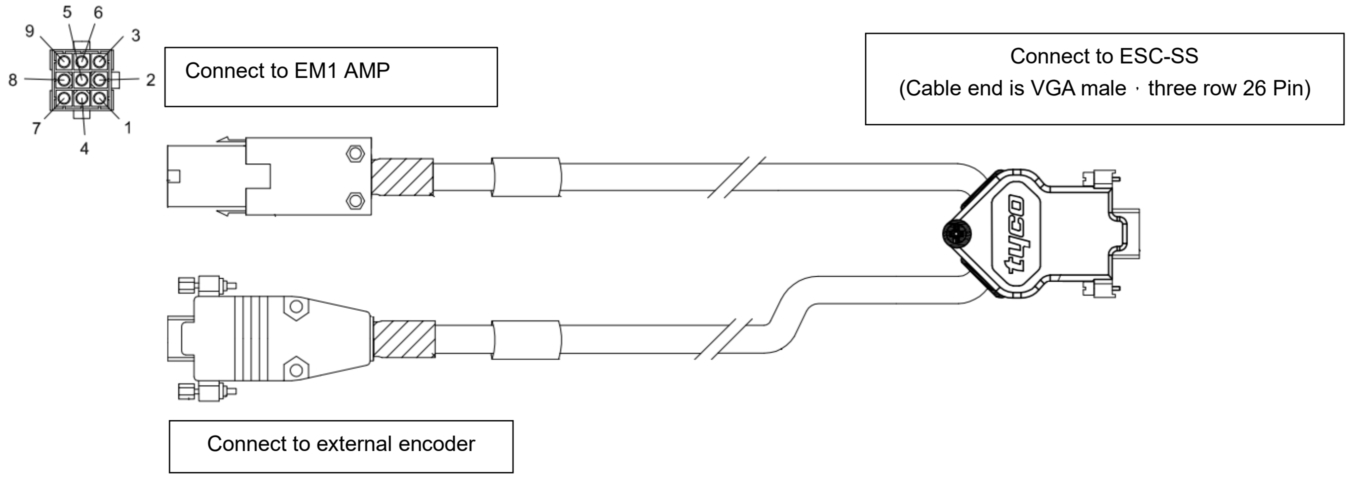

Figure 16.1.4.1 ESC-SS full-closed loop encoder extension, HE00EKSDD□00, HE00EKSDF□00, HE00EKSDE□00

Table16.1.4.11 EM1 with ESC-SS full-closed loop encoder extension

Name	HIWIN Part Number	Description
ESC-SS encoder extension cable (full-closed loop)	HE00EKSDD□00	For connecting ESC to EM1 motor, AMP 9 Pin (male) External Renishaw serial BiSS-C encoder, D-Sub connector 9 Pin (Female)
	HE00EKSDF□00	For connecting ESC to EM1 motor, AMP 9 Pin (male) External Renishaw analog encoder, D-Sub connector 15 Pin (Female)
	HE00EKSDE□00	For connecting ESC to EM1 motor, AMP 9 Pin (male) External Renishaw digital encoder, encoder alarm signal supported, D-Sub connector 15 Pin (Female)

Table16.1.4.12

□	3	5	7	A
Cable Length (m)	3	5	7	10

Table16.1.4.13 Encoder extension pin definition, HE00EKSDD□00,HE00EKSDF□00,HE00EKSDE□00,EM1 signal

Function	AMP 9Pin AMP (Connect to EM1 Motor)	VGA 26Pin Three Row Male
5V	1	4
0V	2	13
CLK+(Reserved)	3	6
CLK-(Reserved)	4	16
PS+	7	3
PS-	8	12
Outer shielding	9	Case

Note:

For HE00EKSDD□00 external Renishaw serial BiSS-C encoder pine definition, please refer to Table 16.1.4.8.

Table16.1.4.14 Encoder extension pin definition, HE00EKSDF□00 (analog encoder signal)

Function	D-Sub 15 Pin Double Row Female (Renishaw Analog)	VGA 26Pin Three Row Male
5V	4	4
	5	5
0V	12	13
	13	14
SIN+	9	1
SIN-	1	10
COS+	10	2
COS-	2	11
REF+	3	3
REF-	11	12
Inner shielding	15	15
Outer shielding	Case	Case

Table16.1.4.15 Encoder extension pin definition, HE00EKSDE□00 (digital encoder signal)

Function	D-Sub 15 Pin Double Row Female (Renishaw Digital)	VGA 26Pin Three Row Male
5V	7	4
	8	
0V	2	13
	9	
A+	14	19
A-	6	20
B+	13	21
B-	5	22
Z+	12	23
Z-	4	24
E+	11	7
E-	3	17
Inner shielding	15	15
Outer shielding	Case	Case

ESC encoder communication cable is required when ESC-AN or ESC-SS are used.

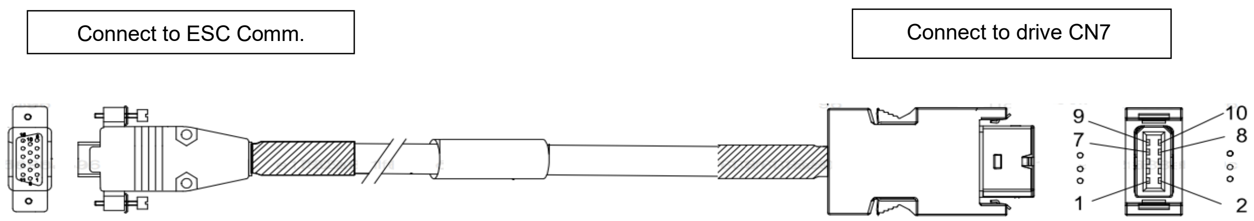

Table16.1.4.16 ESC encoder communication cable

Name	HIWIN Part Number	Description
ESC encoder communication cable	HE00EJUDA□00	For connecting ESC to CN7 on the servo drive

□ stands for cable length, please refer to below.

Table16.1.4.17

□	1	3	5	7
Cable Length (m)	1	3	5	7

Note:

(1) For other cable lengths, please contact local distributor.

(2) If ESC-SS is used, the version of ESC encoder communication cable must be the later version of A3.

Table16.1.4.18 ESC temperature cable

Name	HIWIN Part Number	Description
ESC temperature cable	HE00EKDDA□00	For extending thermal wires This cable may be required if the distance between ESC and the servo drive is over 0.5 m.

□ stands for cable length, please refer to below.

Table16.1.4.19

□	1	2	3
Cable Length(m)	1	2	3

Note:

For other cable lengths, please contact local distributor.

16.1.5 Control signal cable

Table16.1.5.1

Name	HIWIN Part Number	Description
Servo drive pulse cable (Standard 50 pins)	HE00EJ6DA300	Connect servo drive (standard) to controller via CN6 to receive or send pulse command, voltage command, I/O signal, analog monitoring output signal, encoder output signal, etc. The cable (3 m) is with open ends.

Note:

For other cable lengths, please contact local distributor.

Table 16.1.5.2 Wire color table (standard servo drive)

Pin	Wire Color	Pin	Wire Color
1	Brown	26	Light Green/Black
2	Brown/White	27	Light Green/Yellow
3	Red	28	Light Green/Green
4	Red/Black	29	Blue
5	Red/Blue	30	Blue/White
6	Red/White	31	Light Blue
7	Orange	32	Light Blue/Black
8	Orange/Black	33	Light Blue/Red
9	Pink	34	Light Blue/Yellow
10	Pink/Red	35	Light Blue/Green
11	Pink/Blue	36	Purple
12	Pink/Black	37	Purple/White
13	Pink/Yellow	38	Gray
14	Yellow	39	Gray/Black
15	Yellow/Black	40	Light Blue/Blue
16	Yellow/Red	41	Gray/Red
17	Yellow/Blue	42	Gray/Blue
18	Green	43	Gray/Yellow
19	Pink/White	44	White
20	Green/Black	45	White/Black
21	Green/Blue	46	White/Red
22	Light Green/Red	47	White/Blue
23	Green/White	48	White/Yellow
24	Light Green/Blue	49	White/Green
25	Light Green	50	Gray/Green
Shield	Case		

Table16.1.5.3

Name	HIWIN Part Number	Description
Servo drive signal cable (Fieldbus 36 pins)	HE00EJ6DC300	Send or receive I/O signal, analog monitoring output signal, encoder output signal, etc. via CN6 on Fieldbus servo drive. The cable (3 m) is with open ends.

Note:

For other cable lengths, please contact local distributor.

Table16.1.5.4 Wire color table (Fieldbus servo drive)

Pin	Wire Color	Pin	Wire Color
1	Brown	19	Green
2	Brown/White	20	Green/Black
3	Red	21	Purple
4	Red/Black	22	Purple/White
5	Red/Blue	23	Light Green
6	Red/White	24	Gray
7	Orange	25	Gray/Black
8	Orange/Black	26	Gray/Red
9	Pink	27	Gray/Blue
10	Pink/Black	28	Gray/Yellow
11	Pink/Red	29	Gray/Green
12	Pink/Blue	30	Light Green/Black
13	Pink/Yellow	31	Light Green/Yellow
14	Pink/White	32	Light Green/Green
15	Yellow	33	Light Green/Red
16	Yellow/Black	34	Green/Blue
17	Yellow/Red	35	Green/White
18	Yellow/Blue	36	Light Green/Blue
Shield	Case		

16.1.6 Communication cable

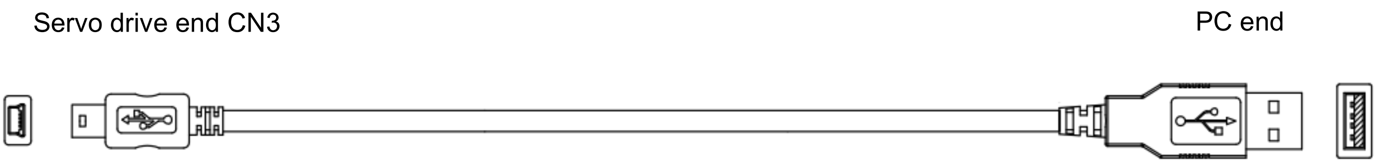

Figure16.1.6.1 USB communication cable

Table16.1.6.1

Name	HIWIN Part Number	Description
USB communication cable	051700800366	USB2.0 Type A to mini-B 5 Pin; 1.8 M, mini-B connector (servo drive side) To use Thunder, the servo drive must be connected to PC via CN3.

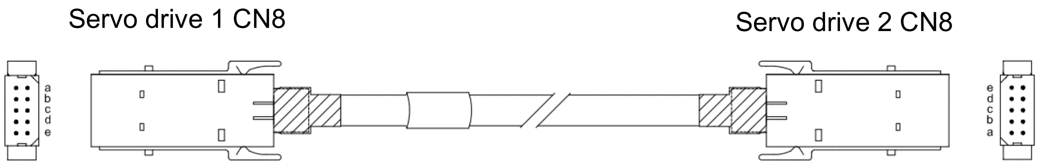

Figure16.1.6.2 Servo drive communication cable (for gantry control system)

Table16.1.6.2 Communication cable for gantry function

Name	HIWIN Part Number	Description
Servo drive communication cable	HE00EJ6DD000	Connect two servo drives which both support gantry function via CN8. (0.5 m)

Figure16.1.6.3 Fieldbus communication cable

Table16.1.6.3 Fieldbus communication cable

Name	HIWIN Part Number	Description
Fielbus communication cable	920200500007	Connect servo drive and host controller or other servo drive via CN9. (0.2 m) It is appicable to Fieldbus servo drive (ED1F) which supports EtherCAT, mega-ulink or PROFINET communication. If the communication format is MECHATROLINK-III, it cannot be used.

16.1.7 Wiring for STO safety function

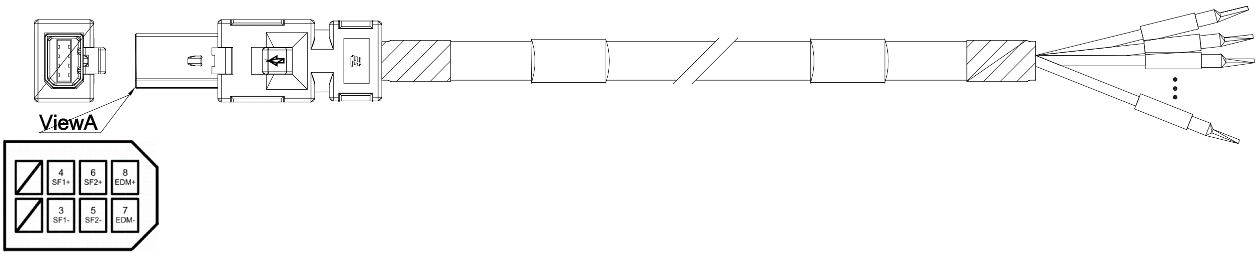

Figure16.1.7.1 STO signal communication cable

Table 16.1.7.2 STO signal communication cable

Name	HIWIN Part Number	Description
STO Cable	HE00EJ6DH000	Connect servo drive and STO safety device(CN4)（3 m）.

Table 16.1.7.3 STO signal communication cable color

Pin	Cable Color	Signal
3	Yellow	SF-
4	Purple	SF+
5	Red	SF2-
6	Blue	SF2+
7	White	EDM-
8	Black	EDM+
Case	Shield	FG

16.2 Accessories

16.2.1 Accessory kit

The accessory kit of E1 series servo drive is included when the servo drive is shipped out. For the contents inside the accessory kit, please refer to the table below.

Table16.2.1.1 Input rated voltage 110 VAC / 220 VAC

Name	HIWIN Part Number	Description	Qty.
ED1 CK1 accessory kit (400 W~2 kW Standard)	051800200158	CN1: AC main input power terminal, control input power terminal, terminal for regenerative resistor and terminal for DC reactor (11 pins, TE 1-2229794-1-PT1)	1
		CN2: Motor power connector (3 pins, TE 3-2229794-1)	1
		CN4: STO connector (TE 1971153-1)	1
		CN6: Control signal connector (50 pins welded type EUMAX XDR-10350AS)	1
		Headers and wire housings for CN1 and CN2 connectors (TE 1981045-1)	2
ED1 CK2 accessory kit (400 W~2 kW Fieldbus)	051800200159	CN1: AC main input power terminal, control input power terminal, terminal for regenerative resistor and terminal for DC reactor (11 pins, TE 1-2229794-1-PT1)	1
		CN2: Motor power connector (3 pins, TE 3-2229794-1)	1
		CN4: STO connector (TE 1971153-1)	1
		CN6: Control signal connector (36 pins welded type EUMAX XDR-10336AS)	1
		Headers and wire housings for CN1 and CN2 connectors (TE 1981045-1)	2
ED1 CK3 accessory kit (4 kW Standard)	180600100003	CN4：STO connector (TE 1971153-1)	1
		CN6：Control signal connector (50 pins welded type EUMAX XDR-10350AS)	1
ED1 CK4 accessory kit (4 kW Fieldbus)	180600100004	CN4：STO connector (TE 1971153-1)	1
		CN6：Control signal connector (36 pins welded type EUMAX XDR-10336AS)	1

Table16.2.1.2 Input rated voltage 400 VAC

ED1 HV CK1 accessory kit (5 kW~7.5 kW 400 V Standard)	180600100005	CN1A：AC main input power terminal、terminal for regenerative resistor, terminal for DC reactor.(8 pins, PC 5/8-STF1-7,62-1777891)	1
		CN1C：control input power terminal (4 pins, R-2ESDVM-04P)	1
		CN2B：Motor power connector (4 pins, R-PC5/4-STF-SH1-7.62 (1778191), female,Pitch：7.62mm	1
		CN4：STO connector. (TE 1971153-1)	1
		CN6 : Control signal connector .(50 pins welded type EUMAX XDR-10350AS)	1
ED1 HV CK2 accessory kit (5 kW~7.5 kW 400 V Fieldbus)	180600100006	CN1A：AC main input power terminal、terminal for regenerative resistor, terminal for DC reactor.(8 pins, PC 5/8-STF1-7,62-1777891)	1
		CN1C：control input power terminal (4 pins, R-2ESDVM-04P)	1
		CN2B：Motor power connector (4 pins, R-PC5/4-STF-SH1-7.62 (1778191), female,Pitch:7.62mm	1
		CN4：STO connector.(TE 1971153-1)	1
		CN6 : Control signal connector.(36 pins welded type EUMAX XDR-10336AS)	1

The accessory kit of Excellent Smart Cube (ESC) is included when ESC is shipped out. For the contents inside the accessory kit, please refer to the table below.

Table16.2.1.3

Name	HIWIN Part Number	Description	Qty.
ESC accessory kit (Applicable to all ESC models)	051800200172	TS: PTC thermal sensor input 2 pins, FK-MC 0.5/ 2-ST-2.5	1
		PT: Position trigger signal output 2 pins, FK-MC 0.5/ 2-ST-2.5	1
		Terminal block for connecting motor thermal wires and ESC temperature cable AVC Corp. PA-8-H-2, without washer	1

16.2.2 Connector specification

- The connectors for E1 series servo drive

Table16.2.2.1 Input rated voltage 110 VAC / 220 VAC

Connector (Cable Side)	HIWIN Part Number	Description
Main circuit connector (CN1)	051500400681	AC main input power terminal, control input power terminal, terminal for regenerative resistor and terminal for DC reactor D3950/one row 11 Port/7.5 mm/cable side/X key TE Connectivity 1-2229794-1
Connector for motor power cable (CN2)	051500400572	D3950/one row 3 Port/7.5 mm/cable side/X key TE Connectivity 3-2229794-1
Mini USB communication connector (CN3)		USB 2.0 Type A to mini-B 5 Pin (1.8 M) (Shielding)
Safety bypass connector (CN4)	051500400545	INDUSTRIAL MINI I/O BYPASS CONNECTOR TYPE I TE Connectivity 1971153-1
Safety device connector (CN4)	051500400404	INDUSTRIAL MINI I/O PLUG CONNECTOR KIT D-SHAPE TYPE 1 TE Connectivity 2013595-1 Connect to external safety device.
Control signal connector (CN6) (For standard servo drive)	051500100141	50 pins, .050” mini D Ribbon (MDR), standard welding-type connector SCSI 50PIN (male) Wire size: 24-30 AWG
Control signal connector (CN6) (For Fieldbus servo drive)	051500100213	36 pins, .050” mini D Ribbon (MDR), standard welding-type connector SCSI 36PIN (male) Wire size: 24-30 AWG
Encoder connector (CN7)	180600100002	Shielded compact ribbon (SCR) connectors (363 series)
Connector for gantry communication (CN8)		HIWIN standard communication cable

Table16.2.2.2 Input rated voltage 400 VAC

Connector (Cable Side)	HIWIN Part Number	Description
Main circuit connector (CN1A)	934201900018	AC main input power terminal, terminal for regenerative resistor and terminal for DC reactor. PC 5/8-STF1-7,62-1777891 / one row 8 Port / 7.62mm / cable side PHOENIX 1777891
(CN1B)		Do not use
Control input power connector(CN1C)	934201900017	Control input power terminal. 2ESDVM / one row 4 Port / 5.08mm / cable side DINKLE 2ESDVM-04P
External dynamic brake connector resistor (CN2A)	934201900021	Connect external dynamic brake resistor terminal. Do not use terminal D3.

Connector (Cable Side)	HIWIN Part Number	Description
		0177-86XX / one row 3Port / 7.5mm / board side DINKLE 0177-8603-GN
Connector for motor power cable (CN2B)	051500400304	Motor power connector. PC 5/ 4-STF-SH1-7,62 -1778191 / one row 4 Port / 7.62mm / cable side PHOENIX 1778191
Mini USB communication connector (CN3)		USB 2.0 Type A to mini-B 5 Pin (1.8 M) (Shielding)
Safety bypass connector (CN4)	051500400545	INDUSTRIAL MINI I/O BYPASS CONNECTOR TYPE I TE Connectivity 1971153-1
Safety device connector (CN4)	051500400404	INDUSTRIAL MINI I/O PLUG CONNECTOR KIT D-SHAPE TYPE 1 TE Connectivity 2013595-1 Connect to external safety device.
Control signal connector (CN6) (For standard servo drive)	051500100141	50 pins, .050”mini D Ribbon (MDR),standard welding-type connector SCSI 50PIN (male) Wire size:24-30 AWG
Control signal connector (CN6) (For Fieldbus servo drive)	051500100213	36 pins, .050”mini D Ribbon (MDR),standard welding-type connector SCSI 36PIN (male) Wire size:24-30 AWG
Encoder connector (CN7)	180600100002	Shielded Compact Ribbon (SCR) connectors (363 Series)
Connector for gantry communication (CN8)		HIWIN standard communication cable

■ The connectors for Excellent Smart Cube (ESC)

Table16.2.2.3

Connector (Cable Side)	HIWIN Part Number	Description
Thermal sensor (TS) connector and position trigger (PT) output connector	051500400745	Thermal sensor input and position trigger signal output 2 pins, FK-MC 0.5/ 2-ST-2.5 Wire size: 26-20 AWG
Terminal block	051600600103	Terminal block for connecting motor thermal wires and ESC temperature cable AVC Corp. PA-8-H-2, without washer Wire size: 26-16 AWG

16.2.3 Power supply filter and accessories

■ Power supply filter (Optional)

Table16.2.3.1 Input rated voltage 110 VAC / 220 VAC

Name	HIWIN Part Number	Description
Filter (For single-phase power supply)	051800200044	Single-phase filter FN2090-10-06, for 400 W ~ 1.2 kW models (rated current: 10 A, leakage current: 0.67 mA)
Filter (For three-phase power supply)	051800200071	Three-phase filter FN3025HL-20-71, for 400 W ~ 4 kW model (rated current: 20 A, leakage current: 0.4 mA)

Table16.2.3.2 Input rated voltage 400 VAC

Name	HIWIN Part Number	Description
Filter (For three-phase power supply)	920301400009	Three-phase filter FN3270HQ1-20-44, for 5 kW 400 V models (rated current: 20 A, leakage current: 0.4 mA)
Filter (For three-phase power supply)	920301400010	Three-phase filter FN3270HQ1-35-33, for 7.5 kW 400 V model (rated current: 35 A, leakage current: 0.4 mA)

■ Fuse accessory kit

Table16.2.3.3

Name	HIWIN Part Number	Description
Fuse accessory kit (400 W, 500W)	180600600002	Fuse: JLLN006.T, Class T 300 Vac / 6 A / Time-lag, Qty: 3 Fuse holder: LFT300303C, Class T 300 Vac / 30 A, Qty: 1 Fuse stand cover: LFT30030FBC, Qty:3 For three-phase input power of 400 W, 500 W servo drive
Fuse accessory kit (1 kW, 1.2 kW)	180600600003	Fuse: JLLN015.T, Class T 300 Vac / 15 A / Time-lag, Qty: 3 Fuse holder: LFT300303C, Class T 300 Vac / 30 A, Qty: 1 Fuse stand cover: LFT30030FBC, Qty:3 For three-phase input power of 1 kW, 1.2 kW servo drive
Fuse accessory kit (2 kW)	180600600004	Fuse: JLLN050.T, Class T 300 Vac / 50 A / Time-lag, Qty: 3 Fuse holder: LFT300603C, Qty: 1 Fuse stand cover: LFT30060FBC, Qty:3 For three-phase input power of 2 kW servo drive
Fuse accessory kit (4 kW)	180600600005	Fuse: JLLN070.V, Class T 300 Vac / 70 A / Time-lag, Qty: 3 Fuse holder: LFT301003CS, Qty: 1 Fuse stand cover: LFT30100FBC, Qty:3 For three-phase input power of 4 kW servo drive
Fuse accessory kit (5 kW)	180600600006	Fuse: JLLS040.T, Class T 600 Vac / 40 A / Time-lag, Qty: 3 Fuse holder: LFT600603C, Qty: 1 Fuse stand cover: LFT60060FBC, Qty:3 For three-phase input power of 5 kW servo drive

Fuse accessory kit (7.5 kW)	180600600007	Fuse: JLLS060.T, Class T 600 Vac / 60 A / Time-lag, Qty: 3 Fuse holder: LFT600603C, Qty: 1 Fuse stand cover: LFT60060FBC, Qty:3 For three-phase input power of 7.5 kW servo drive

Note:

For UL certification, filter (For three-phase power supply) and fuse accessory kit are required.

- Power reactor (optional)

Table16.2.3.4

Name	HIWIN Part Number	Description
Reactor (three phase 400 V input power)	920302200001	Reactor GOOVAR GP-40010, for 400 V model (rated voltage: three phase AC 480 V, rated current: 30 A)

16.2.4 Accessories for absolute encoder

Table16.2.4.1

Name	HIWIN Part Number	Description
Lithium battery	051800100013	Voltage: 3.6 VDC
Battery box	051800400029	Battery box for the extension cable of absolute encoder

16.2.5 Regenerative resistor

Table16.2.5.1

Name	HIWIN Part Number	Description
Regenerative resistor	050100700001	68 Ohm/100W
Regenerative resistor	050100700004	190 Ohm/1000W

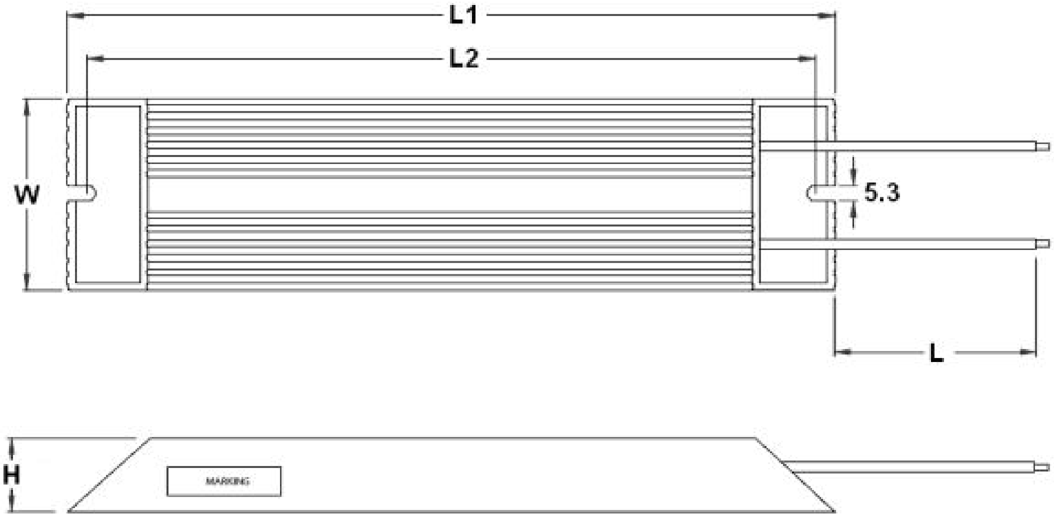

Figure16.2.5.1 Dimension of regenerative resistor 050100700001

For cable length please refer to below:

Table16.2.5.2

	L	L1±2	L2±2	W±0.5	H±0.5
Cable Length (mm)	500	165	150	40	20

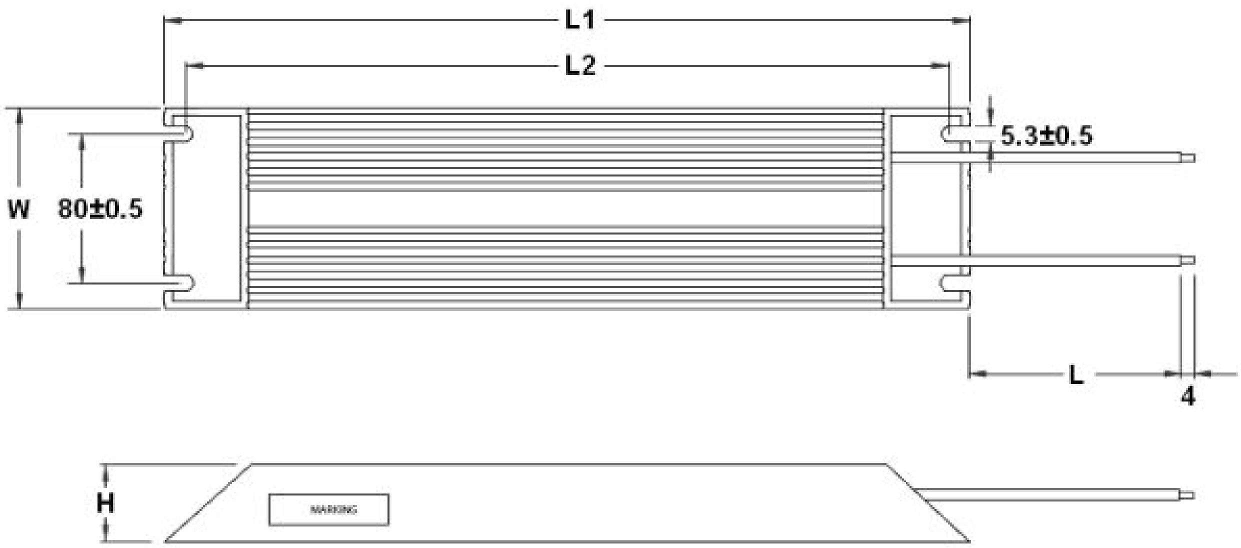

Figure16.2.5.2 Dimension of regenerative resistor 050100700004

For cable length please refer to below:

Table16.2.5.3

	L	L1±2	L2±2	W±1	H±1
Cable Length (mm)	200±20	400	385	100	50