Fuji Electric

Innovating Energy Technology

FUJI SERVO SYSTEM
ALPHA7 VC type
USER'S MANUAL

ALPHA7

24C7-E-0147b

This manual is "User's Manual for Fuji AC Servo System ALPHA7 Series".
The user's manual is in one volume and covers all handling methods of the product.

The following documents are included in the package of each device.

Device	Document name	Doc. No.
Servomotor	Operation Manual Fuji AC servomotor (GYS/GYG/GYB Series)	ING-SI47-0863
Servo amplifier	Operation manual Fuji AC servo ALPHA7 Series servo amplifier (RYT□□□F7-**2)	INR-SI47-2058-JE

The target model of this manual is shown below.

Device	Model
Servomotor	GYS□□□D7-**□ or GYG□□□C (B) 7-**□ or GYB□□□D7-**□
Servo amplifier	RYT□□□F7-VC2

* "□" in the model indicates a decimal point or number.
* "*" in the model indicates an alphabet or blank.

For uncertainties in the product or description given in this manual, contact the dealer or our sales office shown at the end of this volume.

■ Manual

Description given in this manual may be inconsistent to the product due to improvements added to the product. Description given in this manual is subject to change without notice.
Illustrations included in this manual show the servo amplifier or servomotor of a specific capacity and they may be different from the appearance of the product you purchased.

This product is not designed or manufactured for use in devices or systems related to human lives.
To use this product for aeronautic devices, traffic controllers, space industry devices, nuclear reactor controllers, medical devices or systems including those devices, contact our sales window.
To use the product for equipment in which failure of the product will be engaged with human lives or serious material losses, install safety devices matching the equipment.

■ Icon

The following icons are used in the description of the manual when necessary.

Note	Negligence of description shown with this sign will undermine the true performance of the product.
Hint	Reference items helpful for operation and data entry of the servomotor or servo amplifier are described.

Contents

CHAPTER 2 WIRING 2-1

CHAPTER 13 PC LOADER 13-1

CHAPTER 14 STANDARDS COMPLIANCE 14-1

CHAPTER 15 APPENDIXES 15-1

CHAPTER 0 INTRODUCTION

0

0.1 Safety Precautions

(1) Types and meanings of warning signs

Before starting installation, wiring work, maintenance or inspection, read through this manual and other attached documents.
Be familiar with the device, safety information and precautions before using.
In this manual, safety precautions are described in two categories: "WARNING" and "CAUTION."

Warning sign	Meaning
⚠ WARNING	Negligence of description will cause danger in which deaths or serious injuries may be caused.
⚠ CAUTION	Negligence of description will cause danger in which minor or medium injuries or material losses may be caused.

Description given in the "CAUTION" category may cause serious results under some circumstances.
All descriptions are critical and should be strictly observed.
After reading, keep the manual in a place where users can refer to it at any time.

(2) Graphic symbols

Graphic symbols are used when necessary.

Graphic symbol	Meaning
	Do not touch
	Do not disassemble
	Notice of general prohibition

Graphic symbol	Meaning
	Make sure to make grounding

Precautions on use

⚠ WARNING

- Do not touch the inside of the servo amplifier.
  There is a risk of electric shock.
- Make sure to ground the grounding terminal of the servo amplifier and servomotor.
  There is a risk of electric shock.
- Before performing wiring or inspection, turn the power off and wait for at least five minutes, and check that the charge LED is unlit.
  There is a risk of electric shock.
- Do not give damage or unreasonable stress to cables. Do not place a heavy matter on them or do not pinch them.
  It might cause failure, breakage and electric shock.
- Do not touch the rotating part of the servomotor during operation.
  It might cause injuries.

⚠ CAUTION

- Use the servomotor and servo amplifier in a designated set.
  It might cause fire and failure.
- Carry out wiring work properly and securely.
  It might cause a failure.
- Never use at places susceptible to water splashes, in corrosive atmosphere, in flammable gas atmosphere or near flammable matters.
  It might cause fire and failure.
- As the servo amplifier, servomotor and peripheral devices temperature will become high and requires careful considerations.
  There is a risk of burns.
- Do not touch the heat sink of the servo amplifier, braking resistor, servomotor and so on while they are turned on and for a while after they are turned off due to high temperature.
  There is a risk of burns.
- If the surface temperature of the servomotor exceeds 70 [°C] during operation of the servomotor of the final assembly, affix a "hot" caution label.
- If a braking resistor is used, take measures to turn the power off upon a fault signal output from the servo amplifier.
  Otherwise the braking resistor may be overheated and cause fire in the event of failure of the braking transistor.

0

■ Precautions on storage

⚠ CAUTION

- Do not store at places susceptible to rain or water splashes or toxic gases or liquid.
  It might cause failure.
- Store at places without direct sunshine within the predetermined temperature and humidity range (between -20 [°C] and +60 [°C] , between 10 [%] and 90 [%] RH, without condensation).
  It might cause failure.
- To store in the installed state.
  Cover the entire servomotor with a sheet to protect against vapor, oil and water. Apply an anticorrosive agent on machined surfaces such as the shaft and flange face.
  To avoid rust on bearings, turn manually or operate for five minutes without a load about once a month.

■ Precautions on transportation

⚠ CAUTION

- Do not hold cables or motor shaft when transporting.
  It might cause failure and injuries.
- Overloaded products will cause collapse of cargo, hence observe the requirements.
- The eye bolt of the servomotor shall be applied exclusively for transportation of the servomotor. Do not use it to transport machineries.
  It might cause failure and injuries.
- For detailed description regarding lithium batteries, refer to "CHAPTER 10　10.1.2."
- Fumigation process before shipment
  The internal parts of servo amplifiers may get corroded due to a halogen compound gas such as methyl bromide which is used for fumigation process in packaging, resulting in damage of the product.
  When shipping servo amplifiers by installing them to a board or unit, pack them using wooden materials which have been processed with fumigation treatment.

■ Precautions on installation

⚠ CAUTION

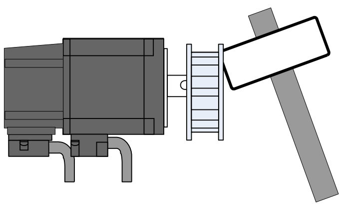
- Do not ride on the servomotor or place a heavy matter on it.
  It might cause failure, breakage, electric shock and injuries.
- Do not block the exhaust port or do not allow foreign substance to enter.
  It might cause fire and electric shock.
- Observe the installation orientation of the servo amplifier.
  Otherwise, it might cause fire and failure.
- Do not apply strong impact.
  It might cause failure.
- The shaft-through hole of the servomotor is not water proof or oil proof. Take measures on the machine side to block entry of water, coolant or similar from entering inside the servomotor.
  It might cause failure.
- If case of application when massive water or oil is splashed on the main body of the servomotor, install a water or oil splash guard or take similar measures on the machine side.
- In a humid and high oil mist environment, install the lead wires and connectors in a face down orientation.
  It might cause poor insulation, short circuit and resultant failure.

Do not disassemble

- Never remodel the servomotor and servo amplifier.
  It might cause fire and failure. It will not be covered by the warranty.

Do not hammer

- Do not apply strong impact on the output shaft of the servomotor.
  It might cause damage to the encoder inside the motor.



0

■ Precautions on wiring

⚠ CAUTION

- Never apply the commercial power supply to the U, V and W terminals of the servomotor.
  It might cause fire and failure.
- Do not connect the grounding (E) cable to the U, V and W terminals of the servomotor. Do not connect the U, V and W terminals in inappropriate order.
  It might cause fire or failure.
- Do not connect the ground (E) to the servomotor side U, V, or W terminals, or connect the U, V, or W terminals in the wrong order.
  It may cause a fire or failure. Furthermore, there is a risk of damage to the customer's machine if the motor malfunctions.
- If fabricating an encoder cable, be careful not to mistake the BAT+ and BAT- polarity.
  If a battery is connected with incorrect BAT+ and BAT- polarity, both ends of the battery will short circuit, and the battery may overheat or suffer damage.
- Never perform a dielectric, Megger or buzzer test to the encoder terminals.
  Otherwise the encoder will be damaged.
- To perform a dielectric, Megger or buzzer test to the U, V and W terminals of the servomotor, disconnect the servo amplifier.
- Do not connect encoder terminals in inappropriate order.
  Otherwise the encoder and servo amplifier will be damaged.
- In an adverse power supply environment, insert a protective device such as the AC reactor so that the voltage fluctuation is contained within the rating.
  Otherwise the servo amplifier will be damaged.
- Install a circuit breaker or similar safety devices for short circuits in external wiring.
  There is a risk of fire or failure.
- Do not remove the cover or disconnect the cable, connector or optional device with the servo amplifier turned on.
  There is a risk of electric shock to human body, product operation stop, and burnout.
- Use the servo system under the specified voltage range.
- Do not tie signal cables or route them in the same duct with main power cable or servo amplifier motor output cable.
- Use the designated wiring material. In particular, use the option cable or equivalent for the encoder cable.
- Do not insert a phase advance capacitor, various filter, reactor or similar on the output side of the servo amplifier.
- The servo amplifier cannot be fully protected from ground fault.

Ground

- Be sure to connect the grounding terminal of the servo amplifier to a grounding electrode.
  There is a risk of electric shock.

■ Precautions on operation

⚠ CAUTION

- In order to avoid unstable motions, never change adjustment radically.
  It might cause injuries.
- To perform test operation, fix the servomotor and leave it disconnected from the mechanical system. After checking the motion, connect to the machine.
  Otherwise, it might cause injuries.
- The retention brake incorporated in the servo motor is not a stopping unit for assuring safety of the machine. Install a stopping unit on the machine side to assure safety.
  It might cause failure and injuries.
- When an alarm occurs, resolve the cause and assure safety before performing alarm reset and restarting operation.
  It might cause injuries.
- Stay away from the machine after power failure and power restoration because sudden restart may be triggered. (Design the machine so that personal safety is secured even if the machine restarts suddenly.)
  It might cause injuries.
- The brake incorporated in the servomotor is for retention. Do not use it for regular braking operation.
  It might cause failures and injuries.
- Install an external emergency stop circuit so that operation can be stopped immediately and the power can be turned off.
  Otherwise, it might cause fire, failure, burns and injuries.
- Before installing to the machine and starting operation, enter parameters matching the machine. If the machine is operated without entering parameters, the machine may unexpectedly malfunction and cause failure.
- To use the servomotor in a vertical travel, install a safety device (Such as external brake) to prevent the mechanical movable part from dropping in case of alarm or similar.
- If auto tuning is not used, be sure to enter the "inertia ratio."

■ General precautions

⚠ CAUTION

- Drawings in this manual may show the state without covers or shields for safety to explain in details. Restore the covers and shields in the original state when operating the product.
- In case of disposal of the product, comply with the following two laws and act in accordance with each regulation. These laws are effected in Japan. Outside Japan, local laws have priority. When necessary, give notification or indication on the final assembly to be compliant with legal requirements.

(1) Law Concerning Promotion of Effective Use of Resources (Law for Promotion of Effective Utilization of Resources)
Recycle and collect resources from the product to be discarded, as far as possible.
It is recommended to disassemble the product into iron dust, electric parts and so on and sell them to appropriate subcontractors to recycle and collect resources.

(2) Waste Disposal and Public Cleaning Law (Waste disposal & law public cleansing law)
It is recommended to recycle and collect resources from the product, which is to be discarded, according to the aforementioned law (Law for Promotion of Effective Utilization of Resources, and to reduce waste.)
In case unnecessary product cannot be sold and will be discarded, the product falls in the category of industrial waste described in the law. The industrial waste must be handled in due course including to request an authenticated subcontractor to dispose of the product and control manifesto.
The battery used in the product falls in the category of called "primary battery" and must be discarded in the due course as required by the corresponding local government.

■ Harmonics suppression measures (for Japan)

(1) All models of the servo amplifier used by the special customer are applicable to "guideline of harmonics suppression measures for high voltage or special high voltage customers." The guideline requires the customer to calculate the equivalent capacity and harmonics outflow current according to the guideline and, if the harmonics current exceeds the limit stipulated for the contract wattage, corresponding countermeasures must be taken.
For details, refer to JEM-TR225.

(2) The servo amplifier was excluded from the scope of "guideline of harmonics suppression measure for electric appliances and general purpose products" from January 2004. JEMA is preparing a new technical document in the position to educate total harmonics suppression measures. Harmonics suppression measures of the discrete device should be taken as far as possible.

Source: The Japan Electrical Manufacturers' Association (JEMA)

■ Compliance with EU directives

EU directives aim at integration of regulations among the EU member countries to promote distribution of safety assured products. It is required to satisfy basic safety requirements including machine directive (2006/42/EC), EMC directive (2014/30/EU), and low voltage directive (2014/35EU) and affix a CE mark (CE marking) on the product sold in EU member countries. Machines and devices housing the servo system are subjected to CE marking.
The servo system does not function independently but is a component to be used in combination with machines and equipments. For this reason, the servo system is not applicable to the EMC directive but the machine or equipment including the servo system is applicable.
In order to facilitate CE marking declaration on the assembly machine or equipment of the servo system, optional devices that are compliant with the low voltage directive and that support compliant with the EMC directive as well as a relevant guideline are prepared.

■ Service life of EEPROM

This product is equipped with EEPROM for retaining parameter data in the event of power failure. The write enable frequency of EEPROM is about 100,000 cycles. After the following operation is repeated 100,000 times or more, the risk of the servo amplifier failure becomes higher.
- Parameter editing
- Position preset of absolute position system
- Batch transfer of parameters

■ Compliance with EU Directives and UL/CSA Standard

- Safety Standard for North America (UL/cUL)

	UL standard (UL File No.)	cUL standard (UL File No.)
Servo amplifier	UL61800-5-1 (E132902)	CSA 22.2 No.274 (E132902)
Servomotor	UL1004 (E102475)	CSA-C22.2 No.100 (E102475)

- EC Directives

	Low voltage directive	EMC directive	
		EMI	EMS
Servo amplifier	EN61800-5-1	EN61800-3	EN61800-3
Servomotor	EN60034-1 EN60034-6	—	—

Note: The certification for the machine is required because the servo amplifier and the servomotor are assembled into one unit.

0

0.2 Outline of System

ALPHA 7 Series is an AC servo system that supports various host interfaces and realizes the best motion control for the target machine.

0.2.1 Servomotor

Three types of servomotor are available; an ultra-low inertia type (GYS), and two medium inertia types (GYG/GYB).

Model	Rated speed (Max. speed)	Power supply	Rated output capacity	Servomotor type		Protective construction	Encoder	Type
				Without brake	With brake			
 GYS motor Ultra-low Inertia	3000 r/min (0.75 kW or lower: 6000r/min 1.0kW or higher: 5000r/min)	200V series	11 types 0.05 to 5.0 kW	●	●	IP67*1	24-bit ABS	GYS***D7-E□2 (-B)
							24-bit INC	GYS***D7-N□2 (-B)
 GYB motor Medium Inertia	3000 r/min (6000r/min)		3 types 0.2, 0.4, 0.75kW	●	●	IP67*1	24-bit ABS	GYB***D7-E□2 (-B/-C/-D)
							24-bit INC	GYB***D7-N□2 (-B/-C/-D)
 GYG motor Medium Inertia	2000 r/min (3000r/min)		2 type 1.0 kW, 1.5 kW	●	●	IP67*1	24-bit ABS	GYG***C7-E□2 (-B)
							24-bit INC	GYG***C7-N□2 (-B)
	1500 r/min (3000r/min)		2 type 0.85 kW, 1.3 kW	●	●	IP67*1	24-bit ABS	GYG***B7-E□2 (-B)
							24-bit INC	GYG***B7-N□2 (-B)

*1: Except for shaft-through part (also except connectors for GYS motors of 0.75kW or lower and GYB motors of lead wire type).

0.2.2 Servo Amplifier

General-purpose interface type (VV), high-speed serial bus type (VS, LS), and EtherCAT compatible type (VC) servo amplifiers are available (high-speed serial bus type servo amplifiers are Fuji's SX-bus compatible products).

Type		Command interface	Control mode				Power supply	Capacity	Model	Supported motor series
			Positioning Function	Position	Speed	Torque				
 High-speed serial bus	VS type	SX-bus		●	●	●	Single-phase or three-phase 200 to 240 VAC	0.05 to 0.75 kW	RYT***F7-VS2	GYS GYB GYG
							Three-phase 200 to 240 VAC	1.0 to 5.0 kW		
	LS type		●	●			Single-phase or three-phase 200 to 240 VAC	0.05 to 0.75 kW	RYT***F7-LS2	
							Three-phase 200 to 240 VAC	1.0 to 5.0 kW		
 General-purpose interface	VV type	General-purpose (pulse/ analog/ positioning/ Modbus)	●	●	●	●	Single-phase or three-phase 200 to 240 VAC	0.05 to 0.75 kW	RYT***F7-VV2	GYS GYB GYG
							Three-phase 200 to 240 VAC	1.0 to 5.0 kW		
 EtherCAT	VC type	EtherCAT		●	●	●	Single-phase or three-phase 200 to 240 VAC	0.05 to 0.75 kW	RYT***F7-VC2	GYS GYB GYG
							Three-phase 200 to 240 VAC	1.0 to 5.0 kW		

0

0.3 Model Nomenclature

■ When unpacking

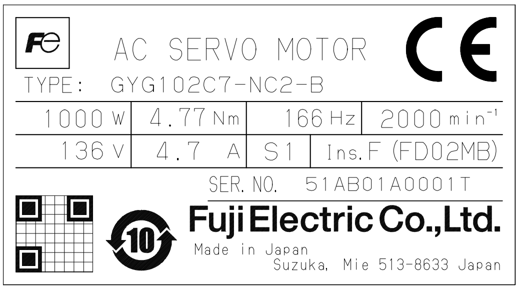
Check the following items.

- Check if the delivered item is what you have ordered.
- Check if the product is damaged during transportation.
- Check if the instruction manual is included.

> If you have any uncertainties, contact the seller.

0.3.1 Servomotor

■ Rating plate (servomotors)



■ Model nomenclature (servomotors)

		2			3	4		5	6	7		8
GYS	5	0	0	D	7	-	E	B	2	-	B	

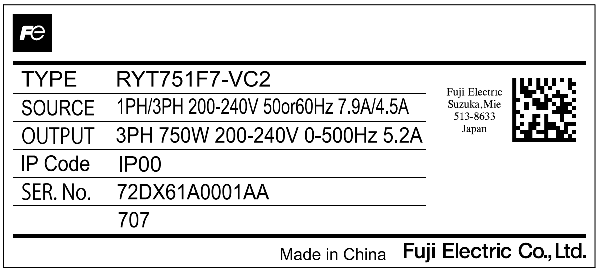
Digit	Specification	Code
1	Basic type	
	Ultra-low Inertia	GYS
	Medium Inertia	GYB
	Medium Inertia	GYG
2	Capacity	
	50×10^{0}=50 W	500
	10×10^{1}=100 W	101
	20×10^{1}=200 W	201
	40×10^{1}=400 W	401
	75×10^{1}=750 W	751
	85×10^{1}=850 W	851
	10×10^{2}=1.0 kW	102
	13×10^{2}=1.3 kW	132
	15×10^{2}=1.5 kW	152
	20×10^{2}=2.0 kW	202
	30×10^{2}=3.0 kW	302
	40×10^{2}=4.0 kW	402
	50×10^{2}=5.0 kW	502
3	Series	
	3000 r/min series	D
	2000 r/min series	C
	1500 r/min series	B
4	Development order	
	7	7
5	Encoder	
	24-bit ABS (with support for functional safety)	E
	24-bit INC (with support for functional safety)	N
6	Oil seal/shaft	
	Without oil seal, straight shaft, with key	A
	Without oil seal, straight shaft, without key	B
	Without oil seal, straight shaft, with key, tapped	C
	With oil seal, straight shaft, with key	E
	With oil seal, straight shaft, without key	F
	With oil seal, straight shaft, with key, tapped	G
7	Input voltage	
	3-phase 200VAC	2
8	Wire connection/brake*	
	Lead wire,without brake	No marking
	Lead wire,with brake	B
	Connector,without brake	C
	Connector,with brake	D

*: Connector specification only for GYS motor 1 kW or more, GYG motor

0.3.2 Servo Amplifier

■ Rating plate (servo amplifier)

The model and serial number are also marked on the front panel of the main body of the servo amplifier.



■ Model nomenclature (servo amplifier)

2 3 4 5 6

RYT 2 0 1 F 7 - V C 2

Digit	Specification	Code
1	Basic type	
	ALPHA series	RYT
2	Applicable motor output	
	50×10^0=50 W	500
	10×10^1=100 W	101
	20×10^1=200 W	201
	40×10^1=400 W	401
	75×10^1=750 W	751
	10×10^2=1.0 kW	102
	15×10^2=1.5 kW	152
	20×10^2=2.0 kW	202
	30×10^2=3.0 kW	302
	40×10^2=4.0 kW	402
	50×10^2=5.0 kW	502
3	Series	
	1500 to 3000 r/min series	F
4	Development order	
	7	7
5	Major functions	
	SX bus (Position, speed and torque control)	VS
	SX bus (Built-in positioning function)	LS
	EtherCAT	VC
	General-purpose interface (pulse, analog, positioning)	VV
6	Input voltage	
	3-phase 200V	2

0

0.4 Combination between Servomotor and Servo Amplifier

0.4.1 VC Type

Use the servomotor and servo amplifier in one of the following sets.

Do not use in other sets.

Applicable motor / Servo amplifier	Applicable motor output	 GYS motor ultra-low inertia	 GYB motor medium inertia	 GYB motor medium inertia	 GYB motor medium inertia
		3000 [r/min] brake: without (with)	3000 [r/min] brake: without (with)	2000 [r/min] brake: without (with)	1500 [r/min] brake: without (with)
RYT500F7-VC2	0.05 W	GYS500D7-□□2(-B)	—	—	—
RYT101F7-VC2	0.1 kW	GYS101D7-□□2(-B)	—	—	—
RYT201F7-VC2	0.2 kW	GYS201D7-□□2(-B)	GYB201D7-□□2/-C(-B/-D)	—	—
RYT401F7-VC2	0.4 kW	GYS401D7-□□2(-B)	GYB401D7-□□2/-C(-B/-D)	—	—
RYT751F7-VC2	0.75 kW	GYS751D7-□□2(-B)	GYB751D7-□□2/-C(-B/-D)	—	—
RYT102F7-VC2	0.85 kW	—	—	—	GYG851B7-□□2(-B)
	1.0 kW	GYS102D7-□□2(-B)	—	GYG102C7-□□2(-B)	—
RYT152F7-VC2	1.5 kW	GYS152D7-□□2(-B)	—	—	—
RYT202F7-VC2	1.3 kW	—	—	—	GYG132B7-□□2(-B)
	1.5 kW	—	—	GYG152C7-□□2(-B)	—
	2.0 kW	GYS202D7-□□2(-B)	—	—	—
RYT302F7-VC2	3.0 kW	GYS302D7-□□2(-B)	—	—	—
RYT402F7-VC2	4.0 kW	GYS402D7-□□2(-B)	—	—	—
RYT502F7-VC2	5.0 kW	GYS502D7-□□2(-B)	—	—	—

0.5 Trademark

EtherCAT® is patented technology licensed from Beckhoff Automation GmbH (Germany), and is a registered trademark.

CHAPTER 1 INSTALLATION

1.1 Servomotor

1.1.1 Storage Environment

Select the following environment when storing the servomotor, or when resting the machine under the state without power distribution.

Item	Environmental condition
Ambient temperature	-20 [°C] to +60 [°C] (no freezing allowed)
Ambient humidity	10 [%] to 90 [%] RH (no condensation allowed)

1.1.2 Operating Environment

Operate the servomotor in the following environment.

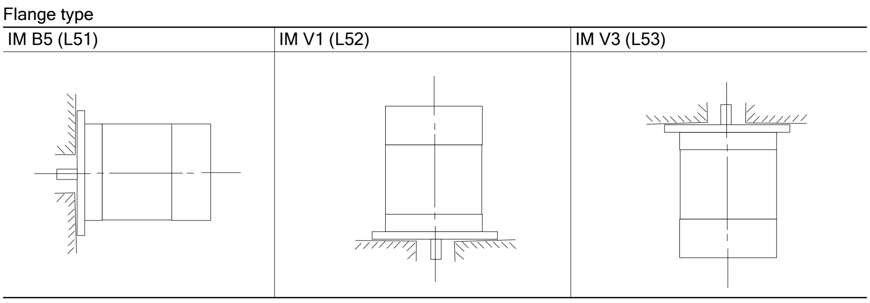
Item	Environmental condition
Ambient temperature	-10 [°C] to +40 [°C] (no freezing allowed)
Ambient humidity	10 [%] to 90 [%] RH (no condensation allowed)
Vibration	49 [m/s^2] or less (3000 [r/min], 0.75 [kw] or less) 24.5 [m/s^2] or less (3000 [r/min], 1 [kw] or more) 24.5 [m/s^2] or less (1500 [r/min], 2000 [r/min])

Observe the following when operating.

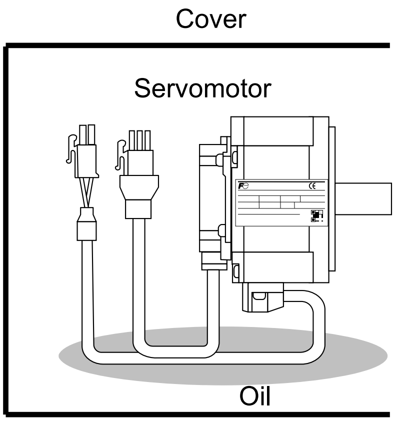
- Install indoors at a place free from rainwater and direct sunshine.
- Do not operate in corrosive atmosphere including hydrogen sulfides, sulfurous acid, chlorine, ammonia, sulfur, chlorine-based gases, acids, alkalis or salts or near flammable gases or matters.
- Install at a place free from splashes of coolant, oil mist, iron powder and chips.
- Install in a well ventilated environment with less vapor, oil and water content.
- Install at a place advantageous for inspection and cleaning.
- Install at a place with less vibration.
- Do not install in an airtight environment.

1.1.3 Installing the Servomotor

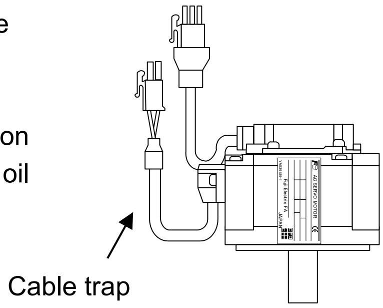
The servomotor can be installed horizontally or vertically with the shaft facing up or down. The same rule applies to the brake-incorporated servomotor and gear head.
The symbol in the figure is the installation method symbol specified by JEM. Description in parentheses ( ) indicates the earlier JEM symbol.



1.1.4 Water Proof and Oil Proof Properties



- The servomotor itself has resistance against splashes in relatively small amount. However, the shaft-through part is not water proof or oil proof. Take mechanical protective measures to block entry of water and oil*. Keep the temperature inside the cover to 40-degree or less.
- Install a cover in environments susceptible to much water, oil or oil mist.
- Do not operate with cables immersed in oil.
- Some coolant types can provide on sealant, cable, case or similar.
- To install the servomotor horizontally, install so that the servomotor cables face down.
  To install the servomotor vertically or at an oblique direction, route the cables to secure a cable trap (see the figure on the right).
- In case of a servomotor equipped with an oil seal, although noise might be created from the oil seal, it will not effect any functional operation.
- To install the servomotor equipped with an oil seal in an orientation with the shaft facing up, take measures to avoid accumulation of oil at the oil seal lip.

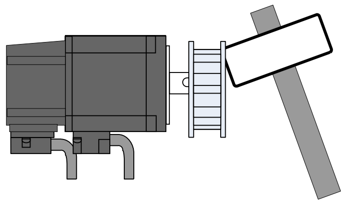


* The protection level is the initial property.

1.1.5 Servomotor Handling Precautions

Do not hammer

- Do not give a strong impact on the output shaft of the servomotor.
  Otherwise the encoder inside the motor will be broken.



- Align the center when connecting with the machine system. Use a flexible coupling.
  Use rigid one designed exclusively for servomotors whenever possible.
- Do not use a rigid coupling which does not allow errors between shafts.
  Otherwise mechanical vibration will be caused, resulting in damaged bearings and/or shorter service life.
- Do not supply commercial power directly to the servomotor. It will cause burnout.
  Test run with commercial power also shall not be performed.

1.1.6 Notes on Stress Given to Cable

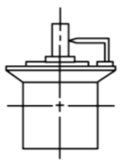
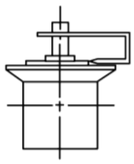
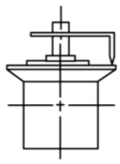
- In applications where the servomotor and machine movable part move, take measures to avoid stress given on the cable.
- Route the encoder cable and motor power cable in CABLEVEYOR.
- Fix the encoder cable and motor power cable attached to the servomotor (routed from the motor) with cable clamps or similar.
- Design the radius of bend as large as possible.
- Do not allow bending stress or stress caused by the self weight, at joints of the cable.

1.1.7 Assembling Accuracy

The assembling accuracy of the servomotor is shown below.

Unit: [mm]

Servomotor model	Runout at shaft end	Misalignment (flange)	Perpendicularity of flange face
GYS□□□D7	Within 0.02	Within 0.06	Within 0.08
GYG□□□□7			
GYB□□□D7			

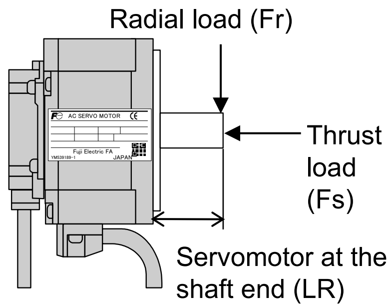
Runout at shaft end	Misalignment (flange)	Perpendicularity of flange face
		

1.1.8 Allowable Load

1

The allowable radial load (Fr) and allowable thrust load (Fs) of the servomotor at the shaft end (LR) are shown below.

Motor model	Radial load Fr[N]	Thrust load Fs[N]	Servomotor at the shaft end LR[mm]
GYS500D7-□□2	127	19	25
GYS101D7-□□2	127	19	25
GYS201D7-□□2	264	58	30
GYS401D7-□□2	264	58	30
GYS751D7-□□2	676	147	40
GYS102D7-□□2	637	107	45
GYS152D7-□□2	637	107	45
GYS202D7-□□2	637	107	45
GYS302D7-□□2	921	166	63
GYS402D7-□□2	921	166	63
GYS502D7-□□2	921	166	63
GYG102C7-□□2	510	253	55
GYG152C7-□□2	510	253	55
GYG851B7-□□2	449	253	58
GYG132B7-□□2	449	253	58
GYB201D7-□□2	245	98	25
GYB401D7-□□2	245	98	25
GYB751D7-□□2	392	147	35



Radial load: the load applied vertically to the motor shaft
Thrust load: the load applied horizontally to the motor shaft

1.1.9 Cautionary Items on Servomotor Equipped with a Brake

- Brake noise
  The brake lining may issue chattering noise during operation of the motor equipped with a brake. As it is caused by brake structure and is not abnormal, the noise will not effect functional operation.
- Others (shaft end magnetization)
  The shaft end of the servomotor equipped with a brake is subject to leaking magnetic flux during energization of the brake coil (when the brake is released). At the instance, chips, screws and other magnetic bodies will be attracted. Cautions are required.
- Brake power source
  There is no polarity for the brake power source input.

1.2 Servo Amplifier

1.2.1 Storage Environment

If storing the servo amplifier, or when not turning ON the power at such times as when the machine is stopped, ensure that the following environmental conditions are observed.

Temporary storage

Table 1.2-1 Storage and transportation environment

Item	Environmental conditions
Ambient temperature	-25 to 80 °C (there should be no freezing)
Ambient humidity	10 to 90 [%] RH or less (there should be no condensation)
Atmosphere	The product should be stored indoors at an altitude of 1,000 [m] or lower, and there should be no dust, direct sunlight, corrosive gas, flammable gas, oil mist, steam, water droplets, or vibrations. There should be minimal salt content. (0.01 mg/cm^2/year or less)
Atmospheric pressure	86 to 106kPa (during storage) 70 to 106kPa (during transport)

■ Temporary storage precautions

(1) Do not leave directly on the floor.

(2) If the atmosphere does not satisfy the storage environment in Table 1.2-1, store the product after sealing and packaging it with a plastic sheet.

(3) When there is a risk of the WSU-ST1 being adversely affected by moisture, place desiccant (silica gel, etc.) inside the product, and then seal and package with a plastic sheet.

Long-term storage

If not using the product for a long period of time following purchase, store in the following condition.

(1) Ensure that the temporary storage environmental conditions are satisfied.
However, if the storage period is 3 months or longer, ensure an ambient temperature of between -10 and +30 °C to prevent electrolytic capacitor deterioration due to temperature.

(2) Package very carefully to prevent the intrusion of moisture, etc. Fill the packaging with desiccant (silica gel, etc.), and ensure a relative humidity inside the packaging of 70% or less.

(3) If left in environments exposed to moisture or dust (if installed in equipment or cabinets, etc. installed in workplaces in which construction work is being carried out), temporarily remove, and then store in the environment indicated in Table 1.2-1.

1

■ If storing for 1 year or longer

The properties of electrolytic capacitors will deteriorate if the power is not turned ON for a long period of time, and therefore the product should be connected to a power supply once a year, and turned ON for 30 to 60 minutes. Do not wire or run the output side (secondary side).

1.2.2 Operating Environment

Operate the servo amplifier in the following environment. The servo amplifier is neither dust proof nor water proof.

Item	Environmental condition
Ambient temperature	-10 [°C] to +55 [°C] (no freezing allowed)
Ambient humidity	10 [%] to 90 [%] RH (no condensation allowed)
Location	Indoors at altitude ≤ 1000 [m] free from powder dust, corrosive gases and direct sunshine
Vibration	3 mm: less than 2 to 9 Hz, 9.8 m/s^2: less than 9 to 20 Hz, 2 m/s^2: less than 20 to 55 Hz, 1 m/s^2: less than 55 to 200 Hz

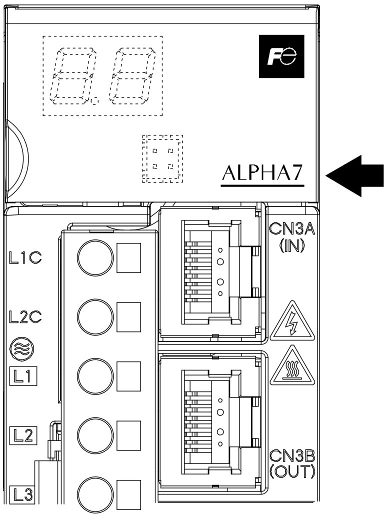
Observe the following when operating.

- Install indoors at a place free from rainwater and direct sunshine.
- Do not operate in corrosive atmosphere including hydrogen sulfides, sulfurous acid, chlorine, ammonia, sulfur, chlorine-based gases, acids, alkalis or salts or near flammable gases or matters.
- Install in a well ventilated environment with less vapor, oil and water content.
- Install at a place with less vibration.
- Use in locations with oil, water vapor or corrosive gas, or in dusty locations
- Use in intense electric fields or in ferromagnetic fields
- Use in the same control panel as that used for high-voltage (2 kV) equipment
- Use with the same power supply as devices which generate a lot of noise
- Other surrounding environments in which use prohibited
  - (i) Locations with powerful electromagnetic waves
  - (ii) Vacuum
  - (iii) In explosive atmosphere
  - (iv) Under acceleration, vibration conditions

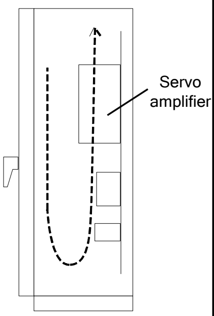
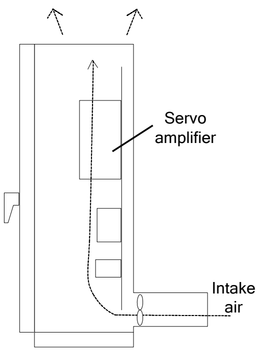
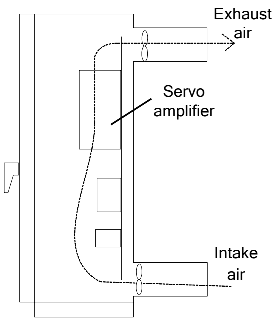
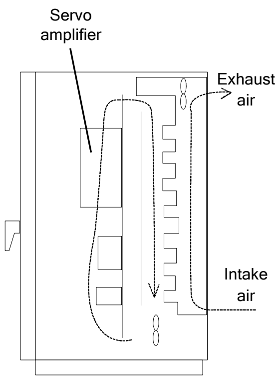
1.2.3 Installing the Servo Amplifier

(1) Install the servo amplifier vertically to the ground so that the "ALPHA7" characters (see the arrow in the figure on the right) on the front panel of the servo amplifier is horizontal.
Use M4 screws with length between 12 and 20 mm for the mounting to the control panel.

Use screws together with plane washers or spring lock washers or use 3-piece sems screw to avoid looseness.
When using plane washers, select the finished round type (large size with ϕ 9 mm).



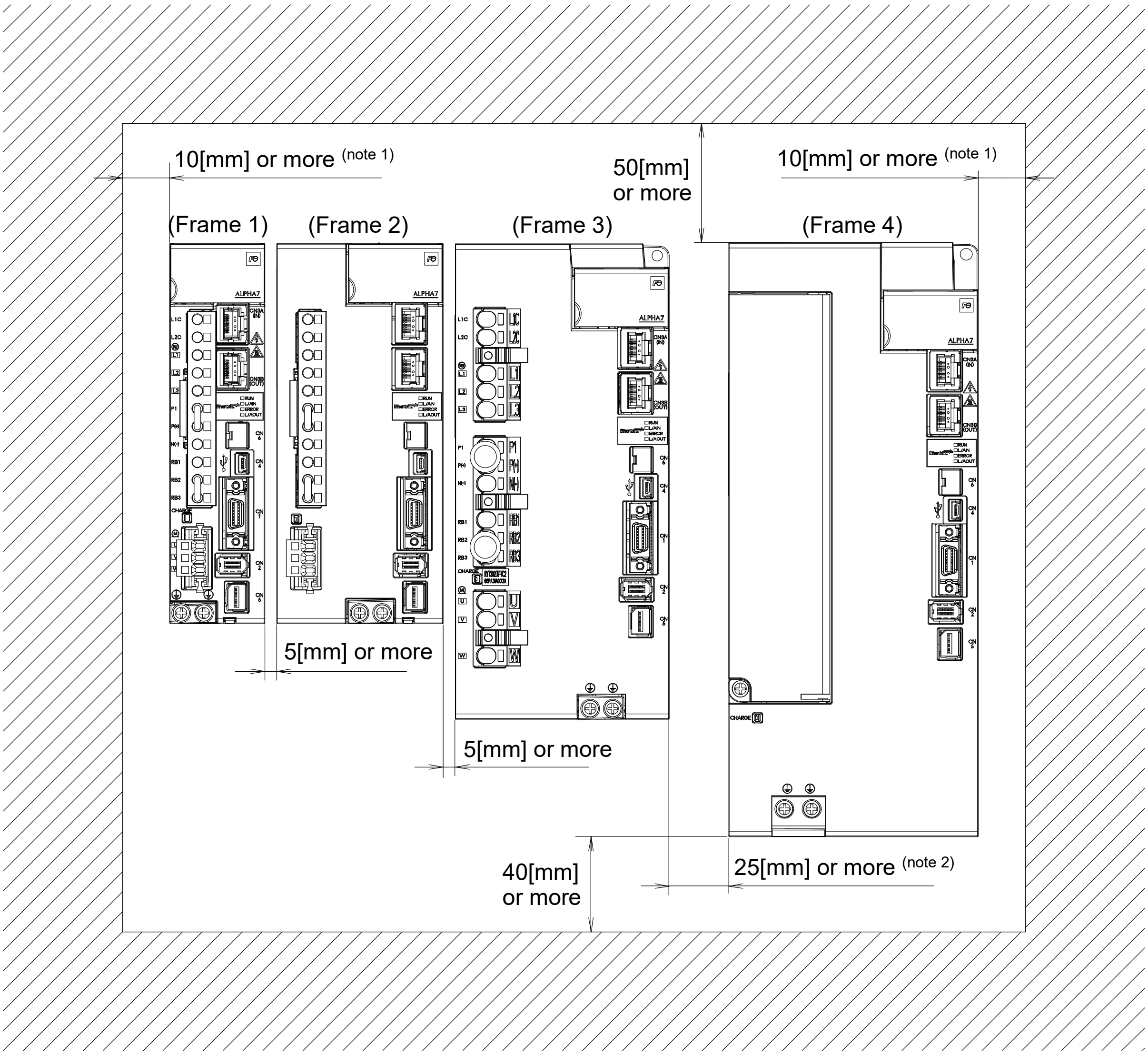
(2) Some parts of the servo amplifier generate heat during operation.
Cool the surroundings if the servo amplifier is installed inside the control panel.

Natural convection, air tight structure (totally enclosed type)	Air purge	Forced ventilation	Heat exchanger
			

(3) To install two or more servo amplifiers in the same control panel, the following shall be taken into consideration.
Arrange transverse alignment in principle. The RYT type servo amplifier can be installed side by side closely. If servo amplifiers are installed completely side by side closely, operate them at the 80 [%ED] rating.
If the ambient temperature is 45 [°C] or lower in the close installation state, 100 [%ED] can be achieved.
If there is a clearance of 5 [mm] or over between adjacent servo amplifiers, there is no limitation in the operation frequency.

1

(4) To suppress rises in servo amplifier temperature, secure the interval shown in the following diagram between servo amplifiers and from peripheral equipment.

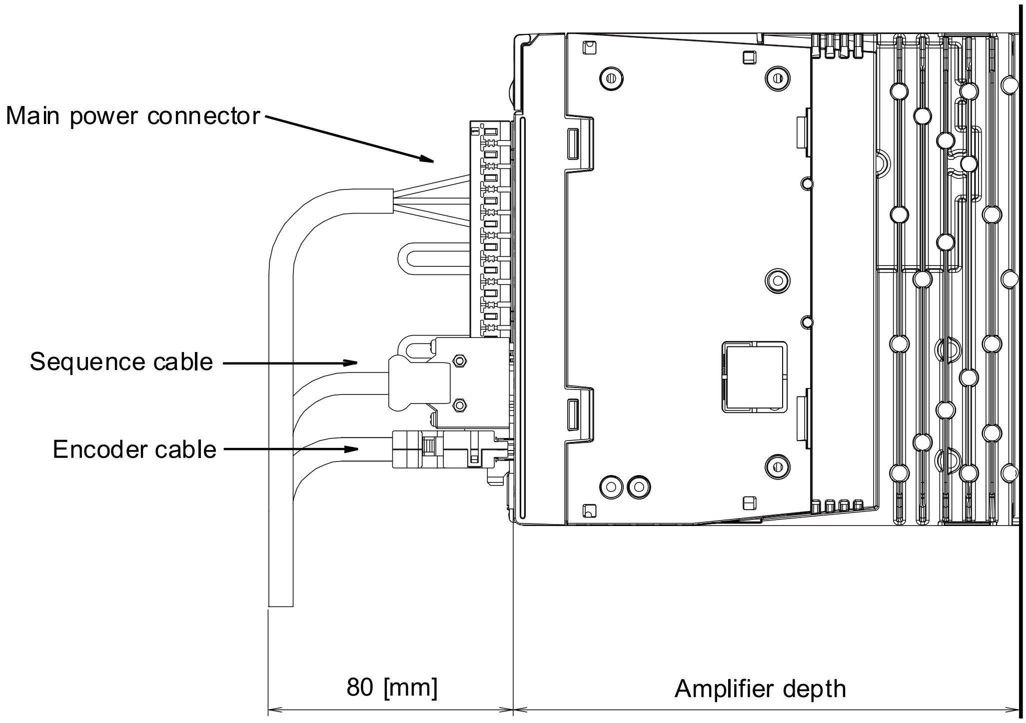


(Note 1) A space of 10 mm or more from the left and right walls is necessary, regardless of the servo amplifier frame size.
(Note 2) A space of 25 mm or more is required for wiring at the left side of the frame 4 servo amplifier.

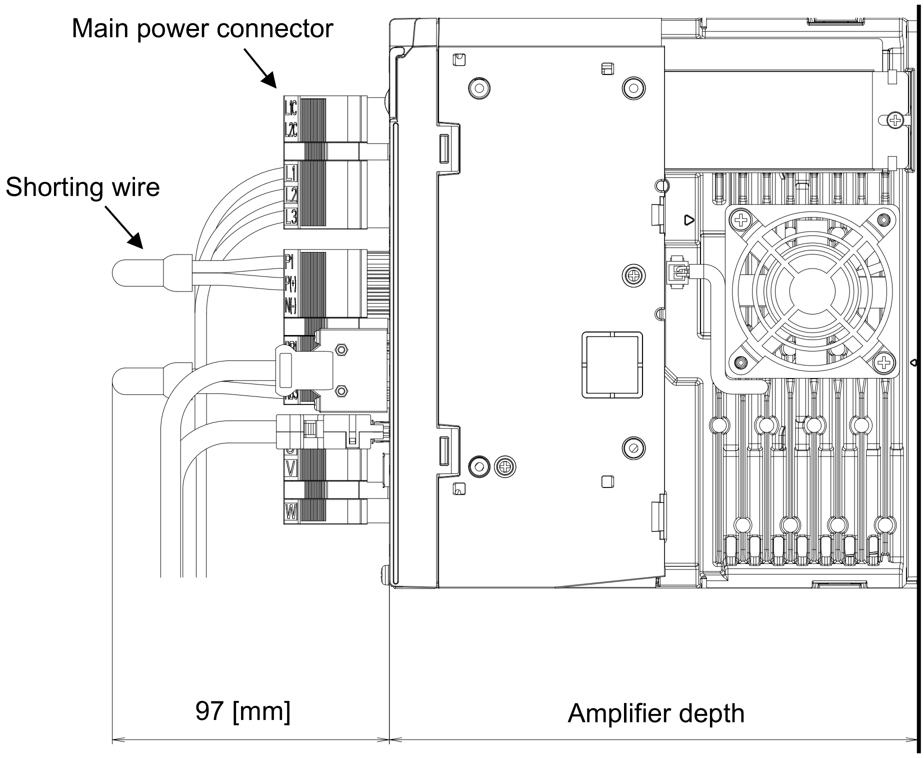
1.2.4　Depth of Control Panel

Secure a space of 80 to 97 [mm] in front of the servo amplifier if sequence I/O cables, an encoder cable, or shorting wire are connected.

(Frame 1 / Frame 2 / Frame 4)



(Frame 3)



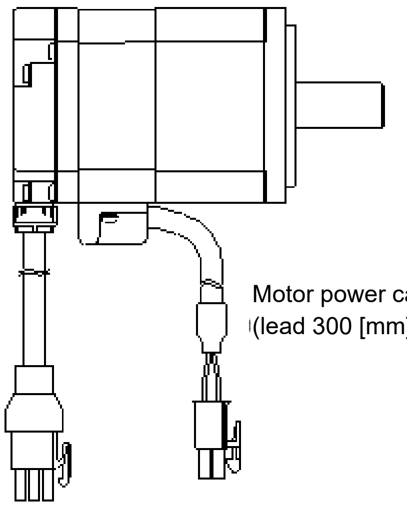
CHAPTER 2 WIRING

2.1 Configuration

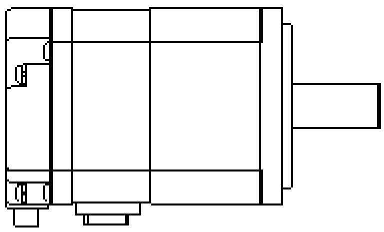
2.1.1 Part Name

- Servomotors

GYS, GYB (lead wire specification): 0.75kW or less

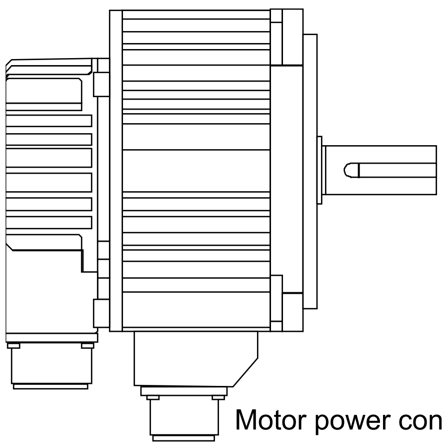


GYB (connector connection specification): 0.75kW or less



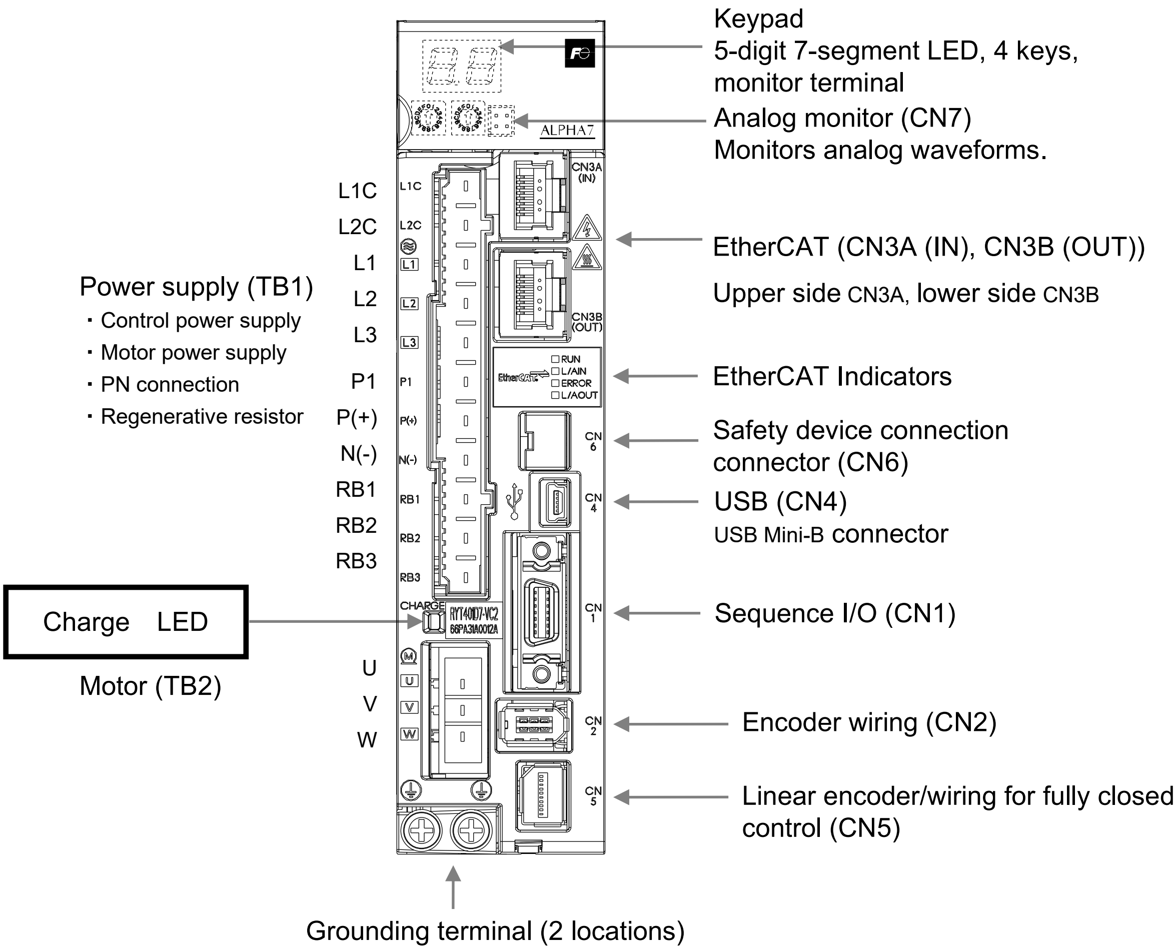
- Servomotor

GYS model: 1kW or higher/GYG model

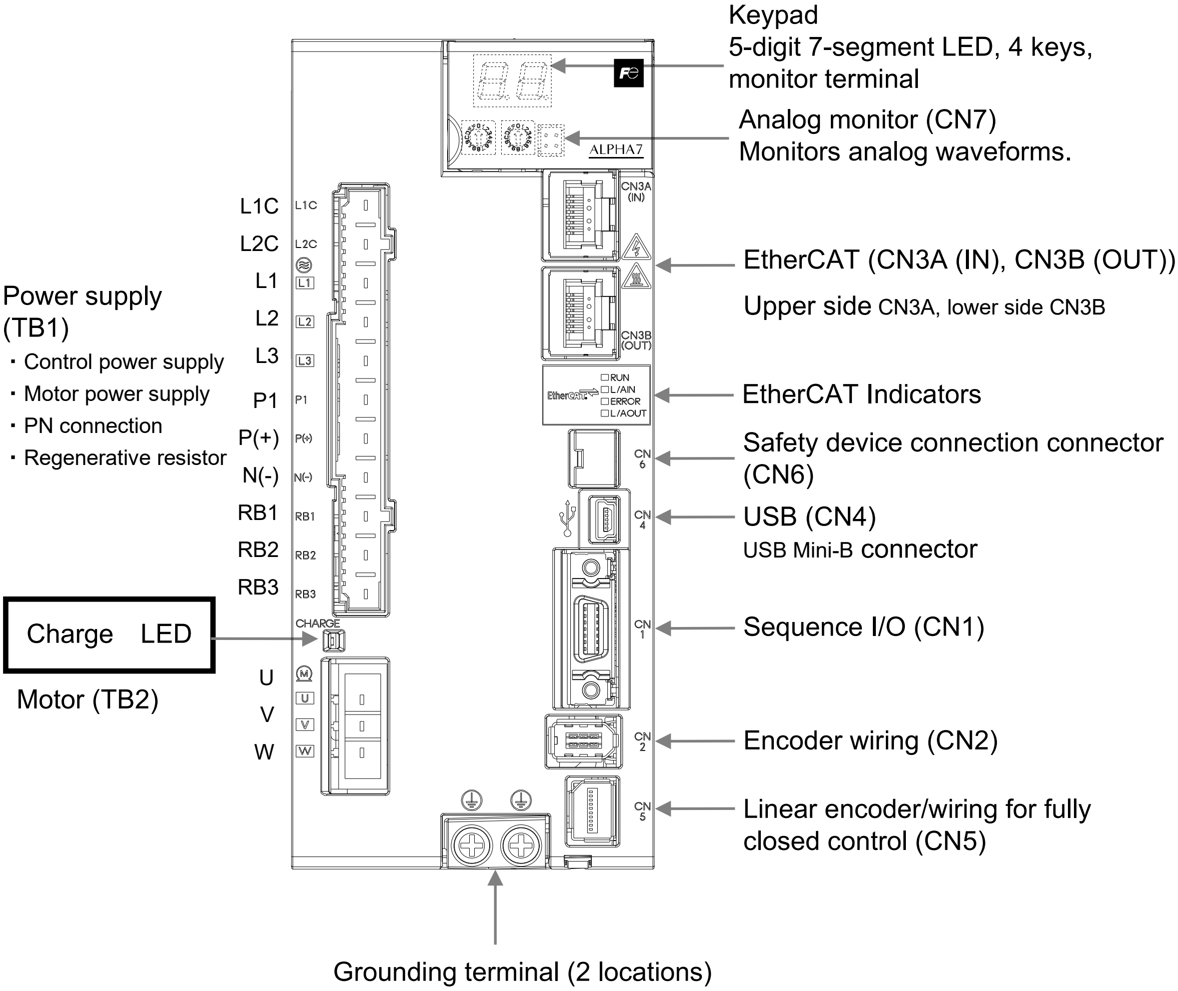


2

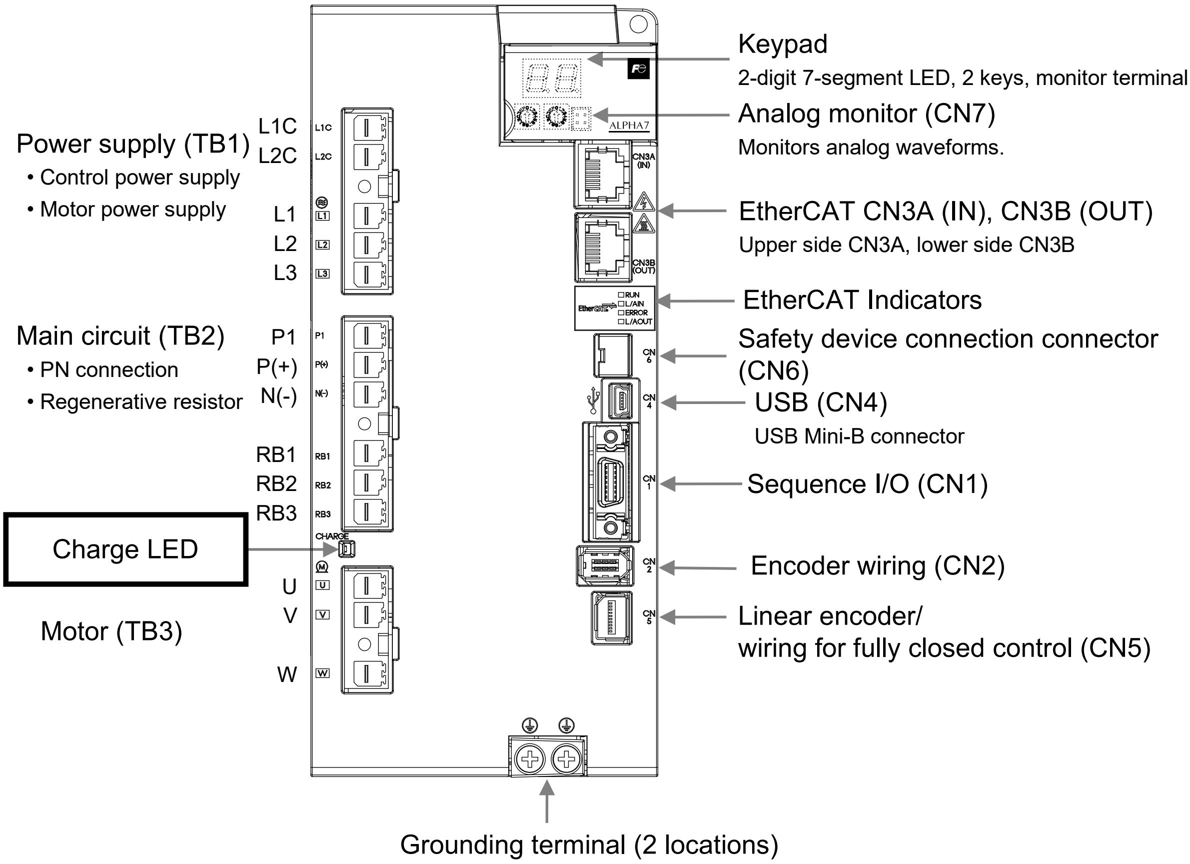
■ Servo amplifier (frame 1)



■ Servo amplifier (frame 2)

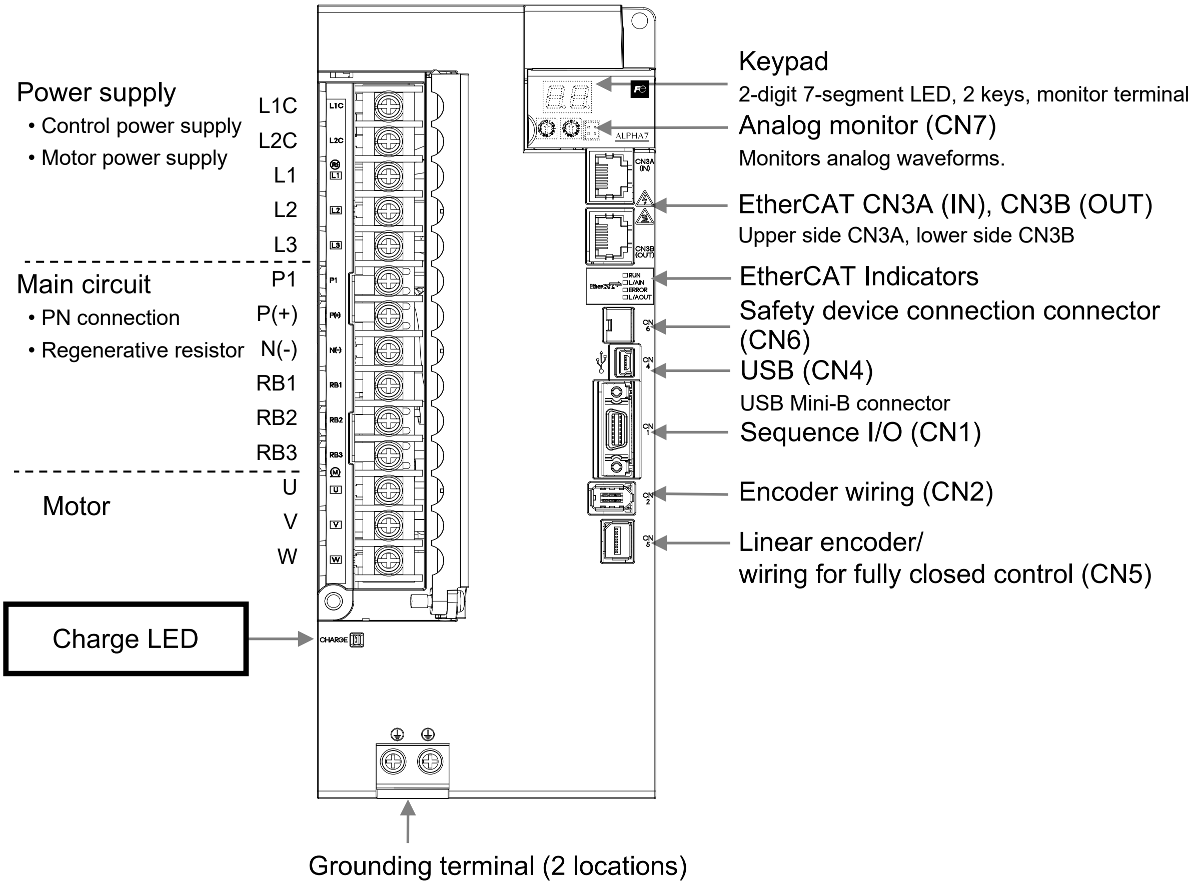


■ Servo amplifier (frame 3)



2

■ Servo amplifier (frame 4)



2.1.2 Configuration

The following pages shows the general configuration of devices. There is no need to connect alldevices.

- The size on each device in the figure is not drawn at the uniform scale. (same as other chapters)
- To supply single-phase power to the servo amplifier, use the L1 and L2 terminals.
  Supply power control power terminals L1C and L2C is required.
- Connectors TB1 and TB2 (TB1 to TB3 for frame size 3) are provided with the servo amplifier.
- Adopt a configuration for turning the main power off upon alarm detection (activation of protective function of servo amplifier).
  Otherwise overheat of the braking resistor, such as braking resistor transistor failure may cause fire.
- The maximum wiring length between the servo amplifier and servomotor is 50 [m].
- You may not turn the power wiring of the servo amplifier or servomotor on or off with a contactor or you may not drive multiple servomotors selectively with a single servo amplifier.
- The following devices cannot be connected to the power wiring between the servo amplifier and servomotor.
  ・Phase advancing capacitor ・Various reactors ・Noise filter ・Surge absorber
- Be sure to ground the protective ground terminal of the servo amplifier (terminal provided with a grounding mark) to the protective ground of the control panel to avoid electric shock.

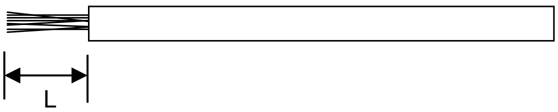
■ Connect servo amplifier frame size 1 and 2 connectors TB1 and TB2, and frame size 3 connectors TB1, TB2, and TB3 to the terminals as follows.

- Wiring connection and removal

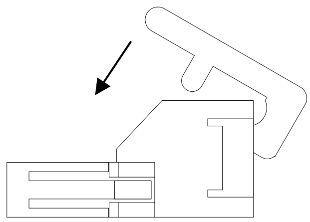
Note	Connect wiring with connectors disconnected from the servo amplifier.

Servo amplifier frame size 1, 2 (when using twisted wire)

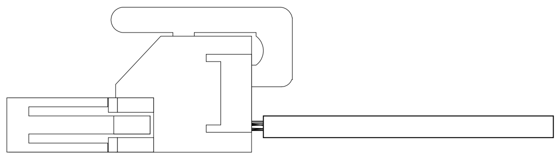
1. Peel off the wiring sheath to ensure the following dimensions.
   TB1: L = 8 to 9 mm
   TB2: L = 9 to 10 mm



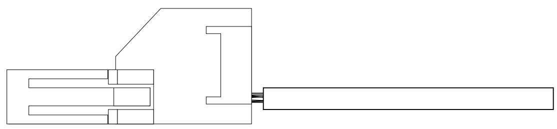
2. Insert the tip of the accessory tool into the top of the connector.



3. Push the tool toward the connector to insert the cable.



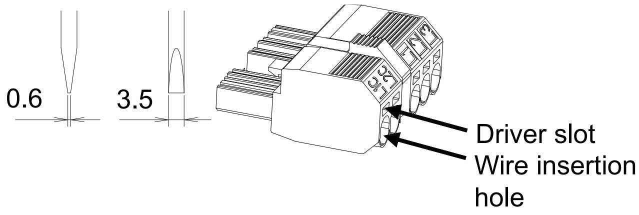
4. Release the tool. The cable is fixed.



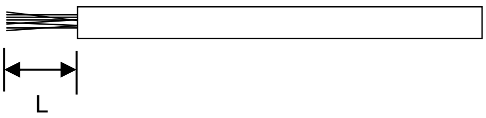
・ Use the opposite procedure to disconnect the wiring.

Wiring connection for servo amplifier frame size 3 (when using twisted wire)

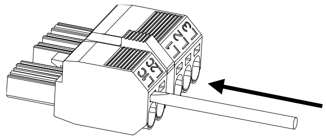
Recommended tool: flathead screwdriver
(Blade thickness: 0.6 mm,
blade width: 3.5 mm, DIN 5264)



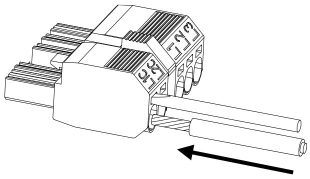
1. Peel off the wiring sheath to ensure the following dimensions.
   TB1, TB2, TB3 … L = 11 to 13 mm



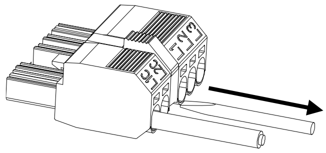
2. Insert the flathead screwdriver blade into the driver slot. Insert the driver until the spring opens fully, and then hold the driver at this position.



3. Insert the wiring until the conductor contacts the clamp.



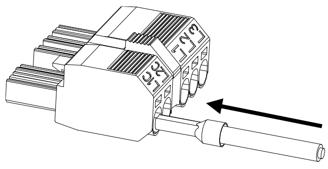
4. Remove the driver from the slot to release the spring lock. Pull the wiring slowly, and ensure that the conductor is firmly secured in the clamp.



Note	Do not solder the wires. If using twisted wire, ensure that there are no sharp kinks in the wire.

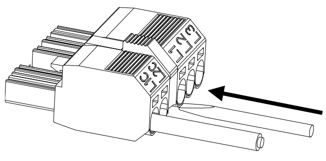
Wiring connection for servo amplifier frame size 3 (when using solid wire or wire with ferrule terminal)

1. Insert the wiring until the conductor contacts the clamp.
   The clamp spring will open of its own accord, and the wiring will be secured.
   Pull the wiring slowly, and ensure that the conductor is firmly secured in the clamp.

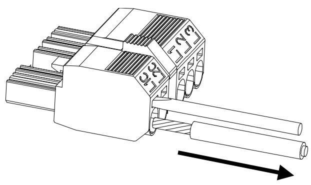


Disconnecting wiring for servo amplifier frame size 3 (when using twisted wire, solid wire, or wire with ferrule terminal)

1. Insert the flathead screwdriver blade into the driver slot. Insert the driver until the spring opens fully, and then hold the driver at this position.

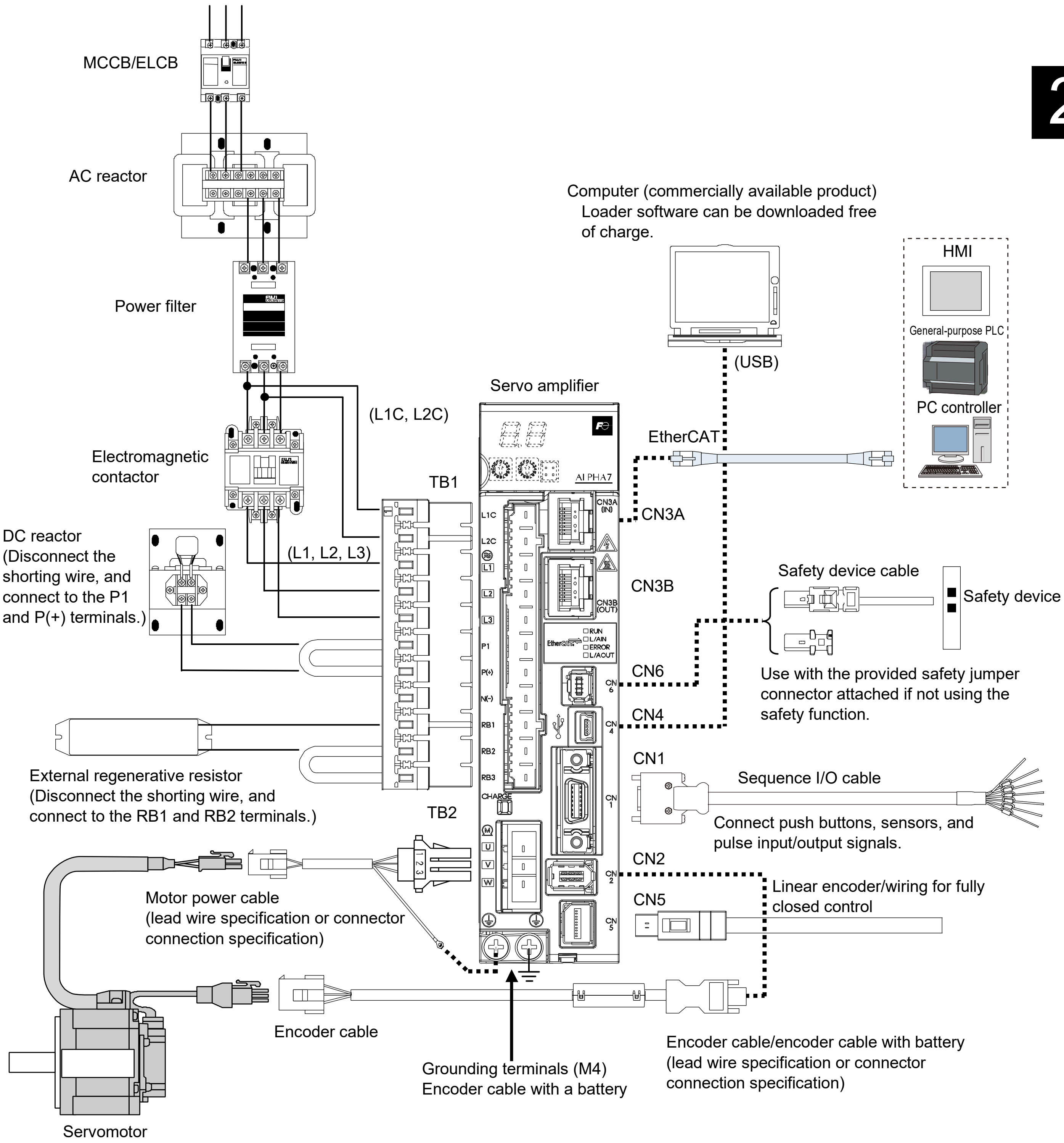


2. Disconnect the wiring.

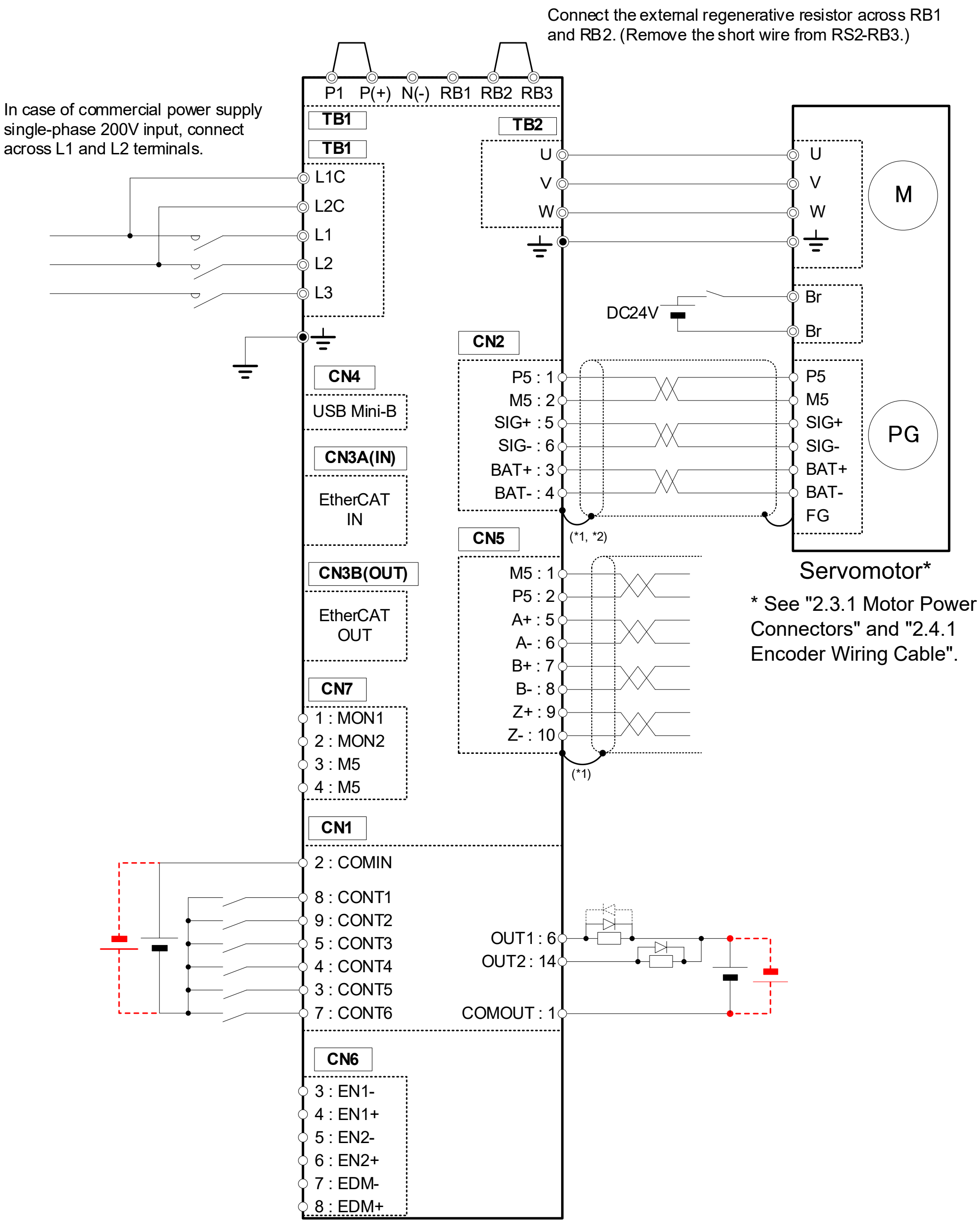


1) For servo amplifier frames 1

Wire the motor as follows if it is a lead-out type or connector connection type.



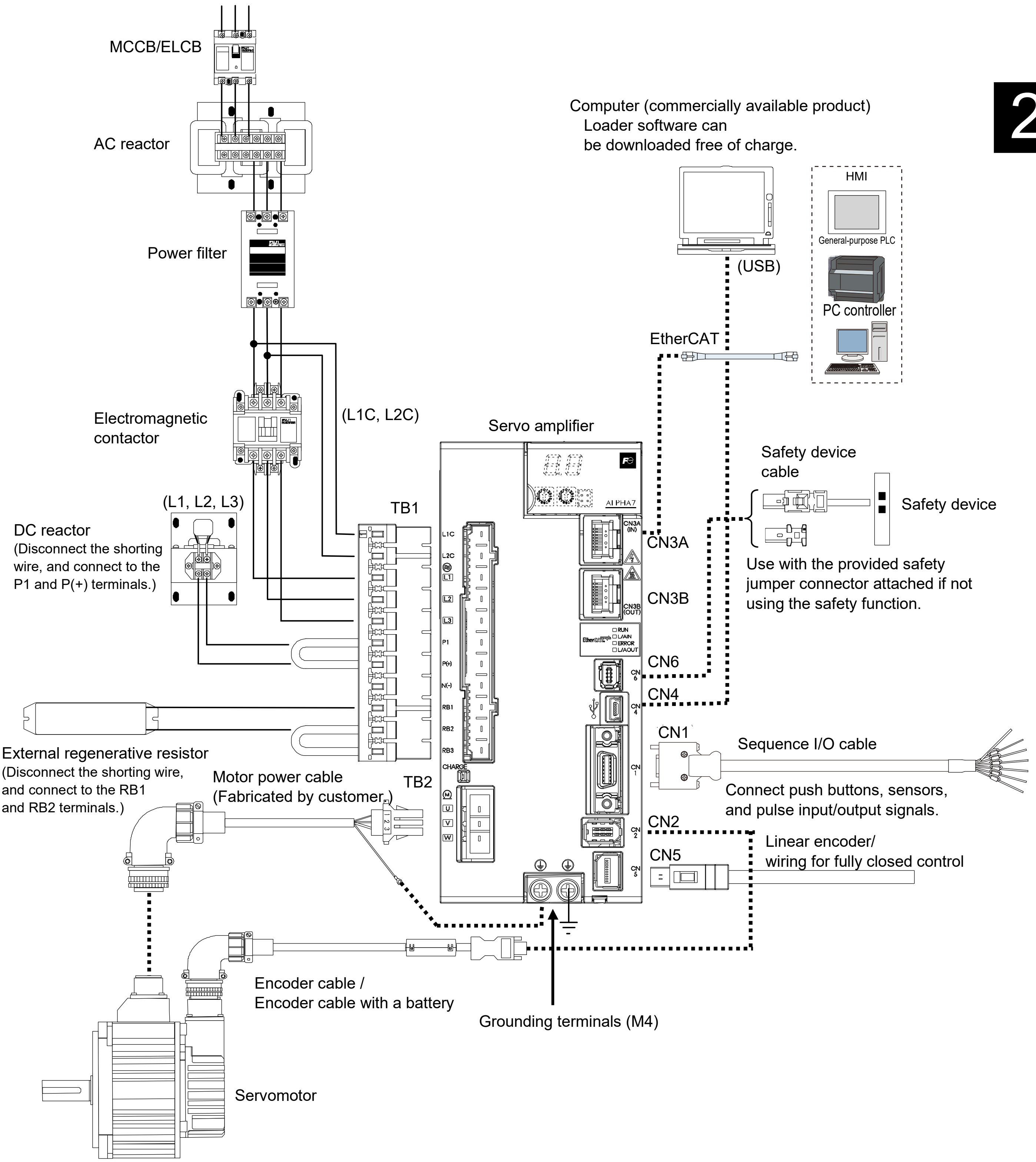
Connection Diagram (Servo amplifier frame 1)



*1: Connect the shielding wire to the connector shell on the servo amplifier side.
*2: Use an encoder cable with battery for ABS encoders.

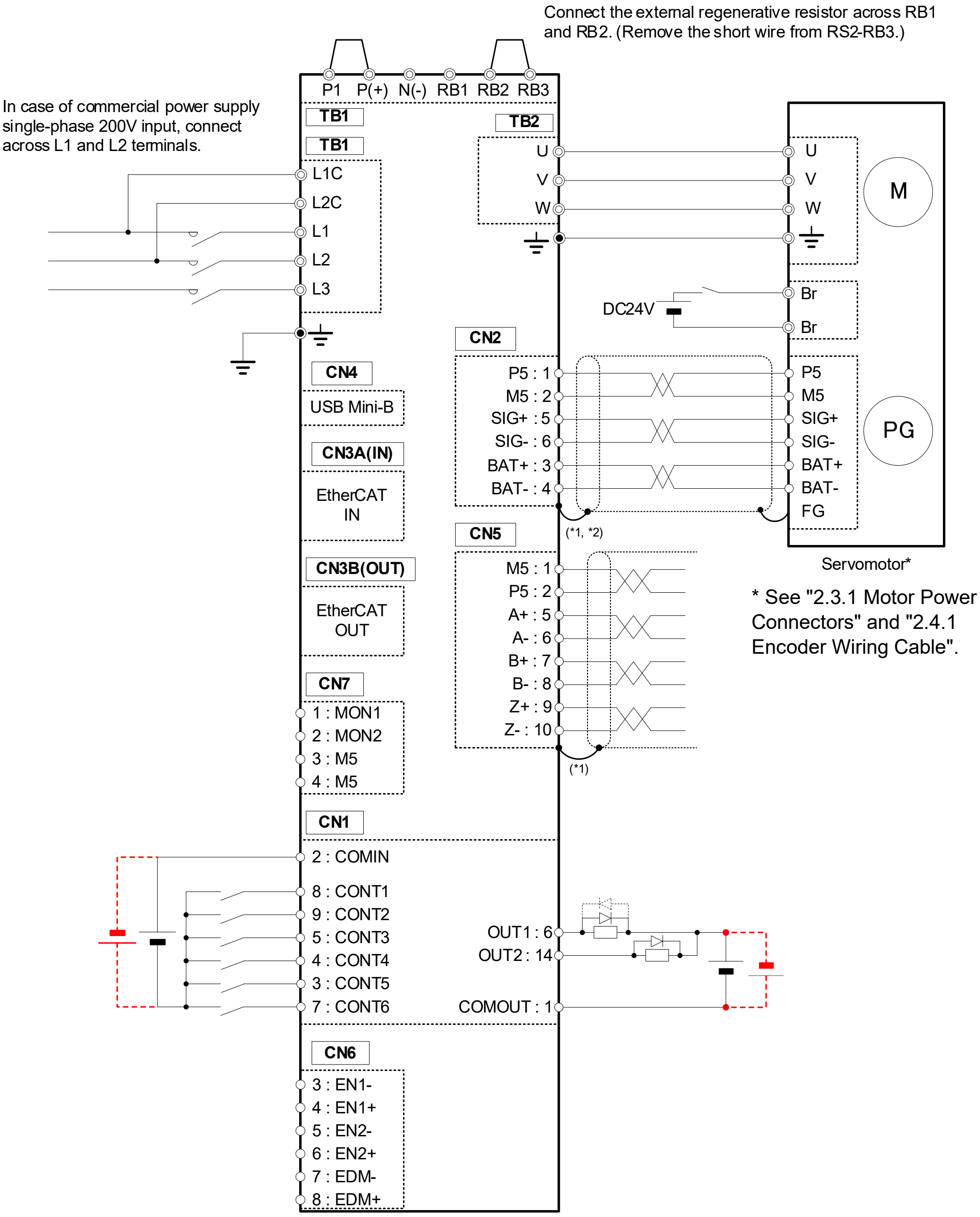
2) For servo amplifier frames 2 (excl. certain combinations)

For Cannon connector type motors, connect cables as shown below.



2

Connection Diagram (Servo amplifier frame 2)

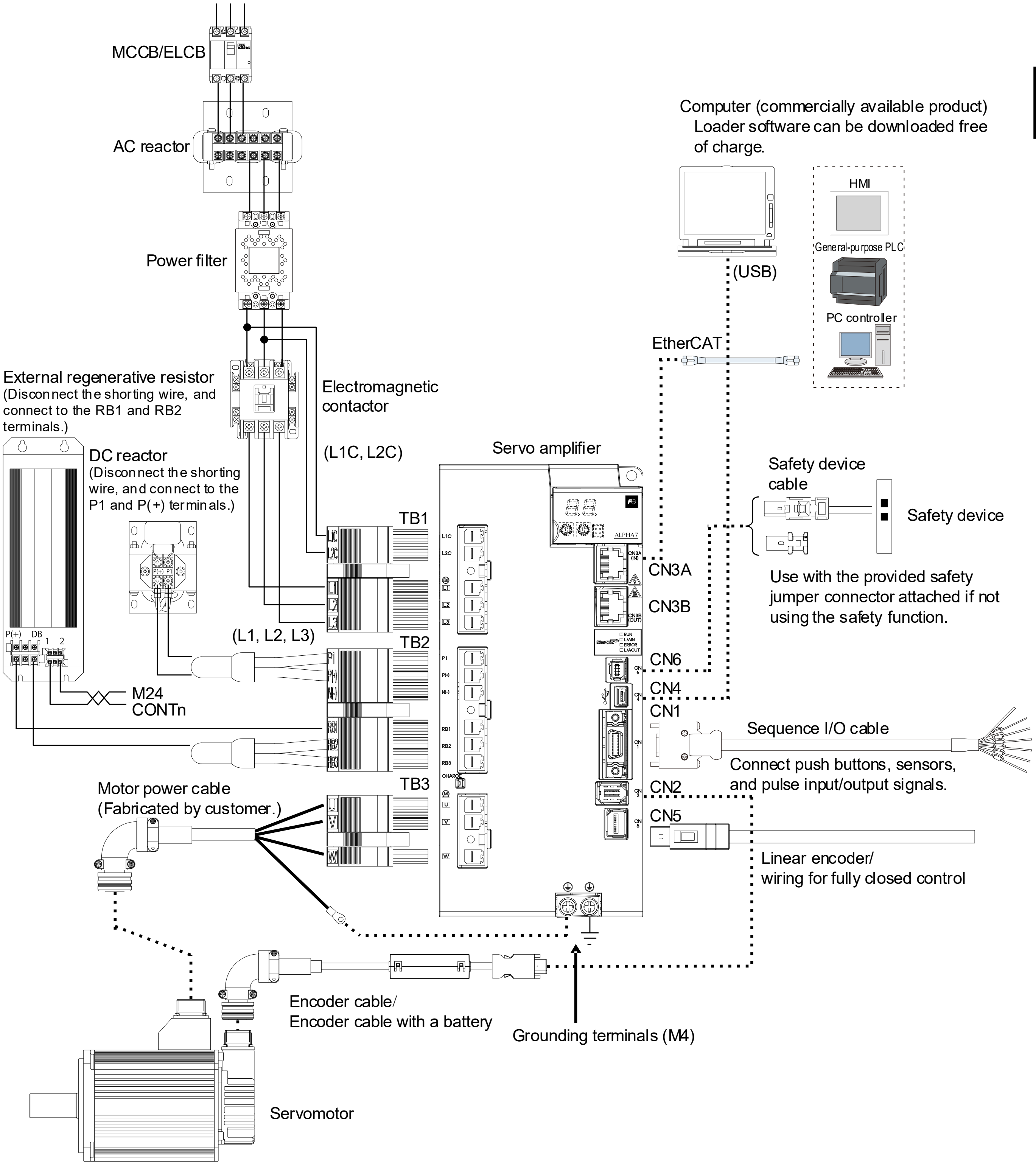


*1: Connect the shielding wire to the connector shell on the servo amplifier side.

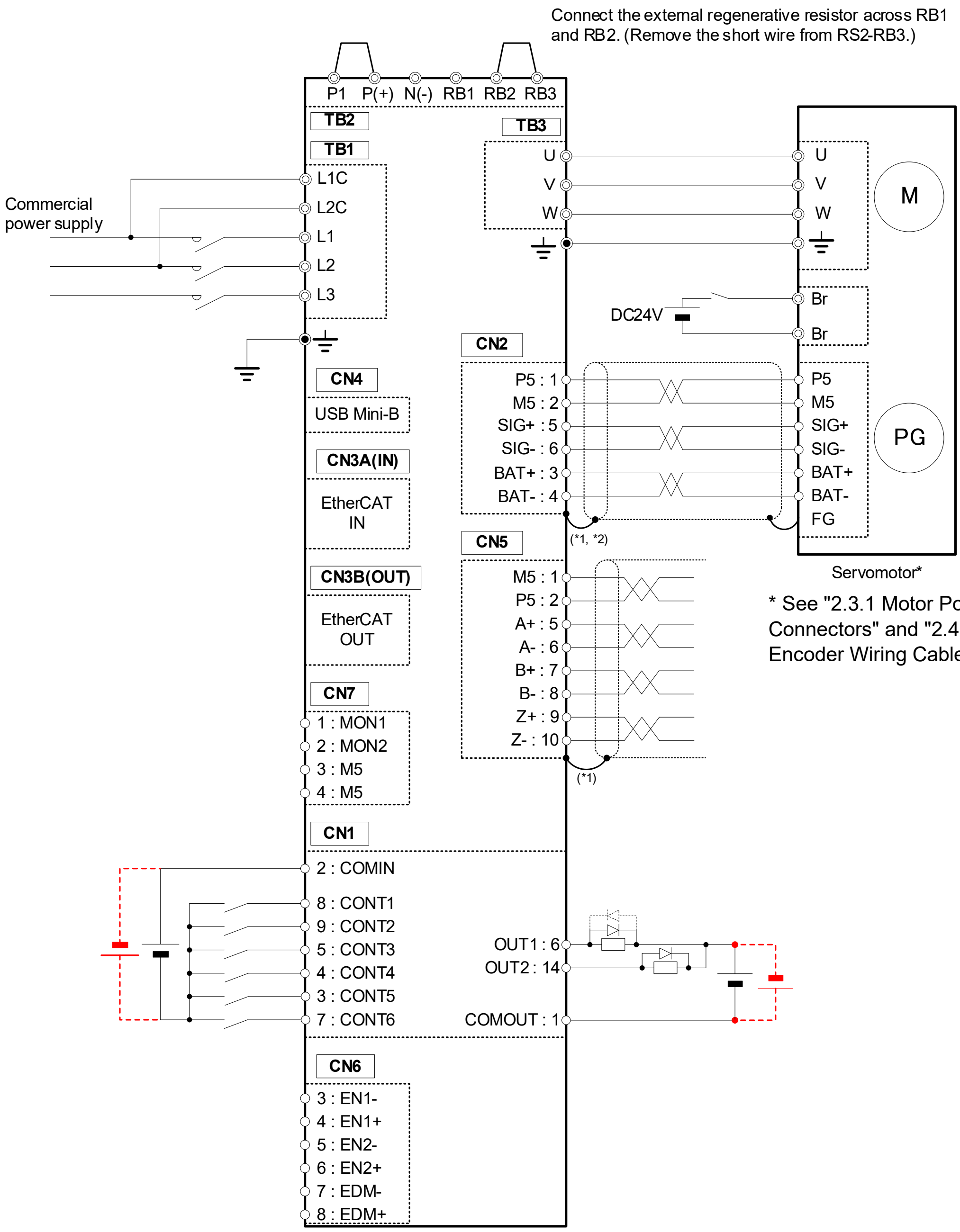
*2: Use an encoder cable with battery for ABS encoders.

3) For servo amplifier frames 3

For Cannon connector type motors, connect cables as shown below.



Connection Diagram (Servo amplifier frame 3)



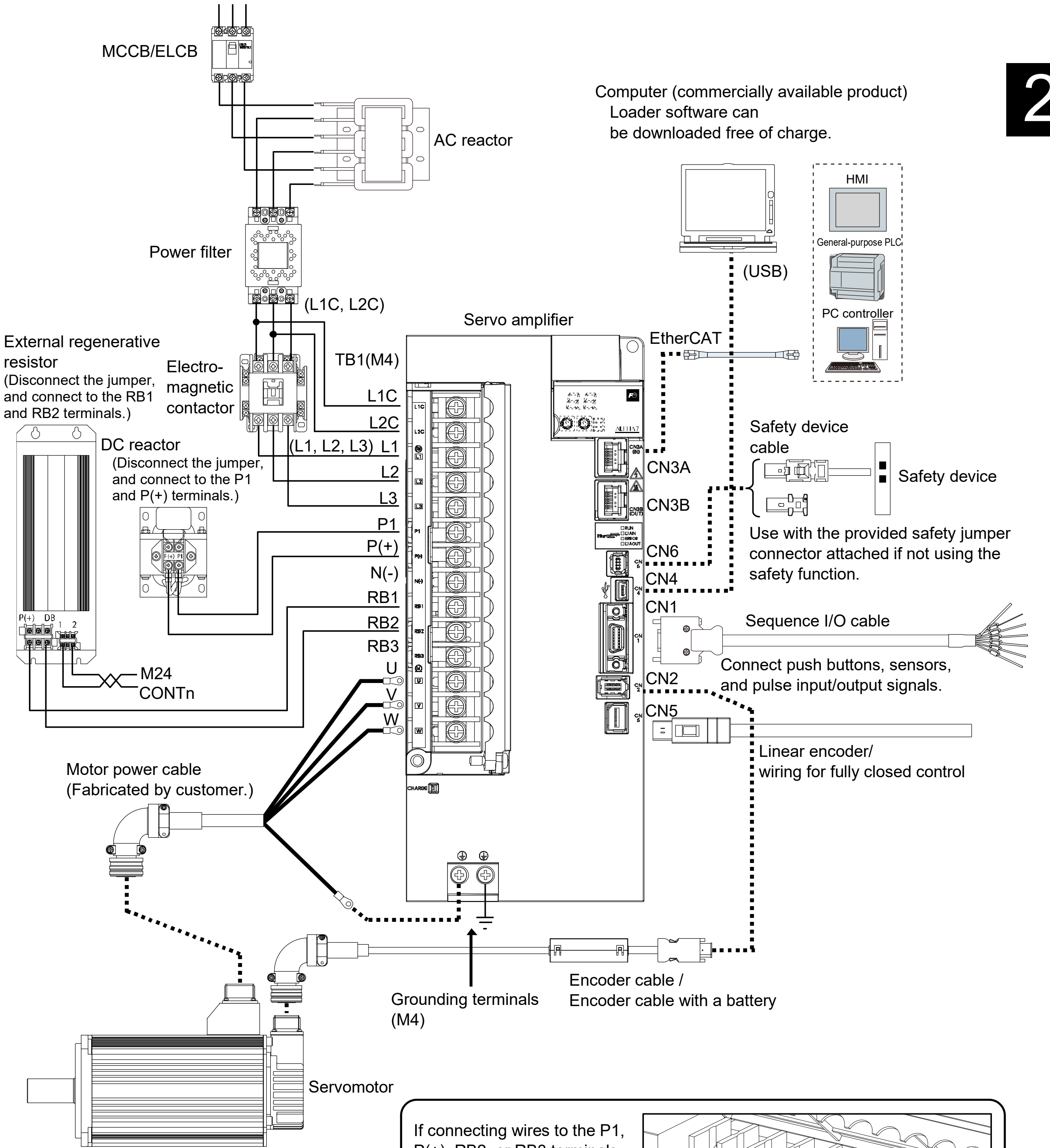
* See "2.3.1 Motor Power Connectors" and "2.4.1 Encoder Wiring Cable".

*1: Connect the shielding wire to the connector shell on the servo amplifier side.

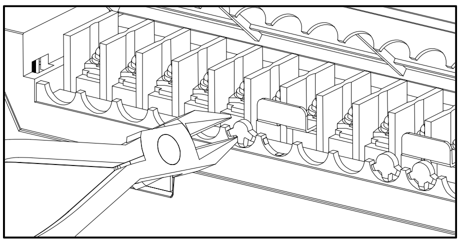
*2: Use an encoder cable with battery for ABS encoders.

4) For servo amplifier frames 4

For Cannon connector type motors, connect cables as shown below.

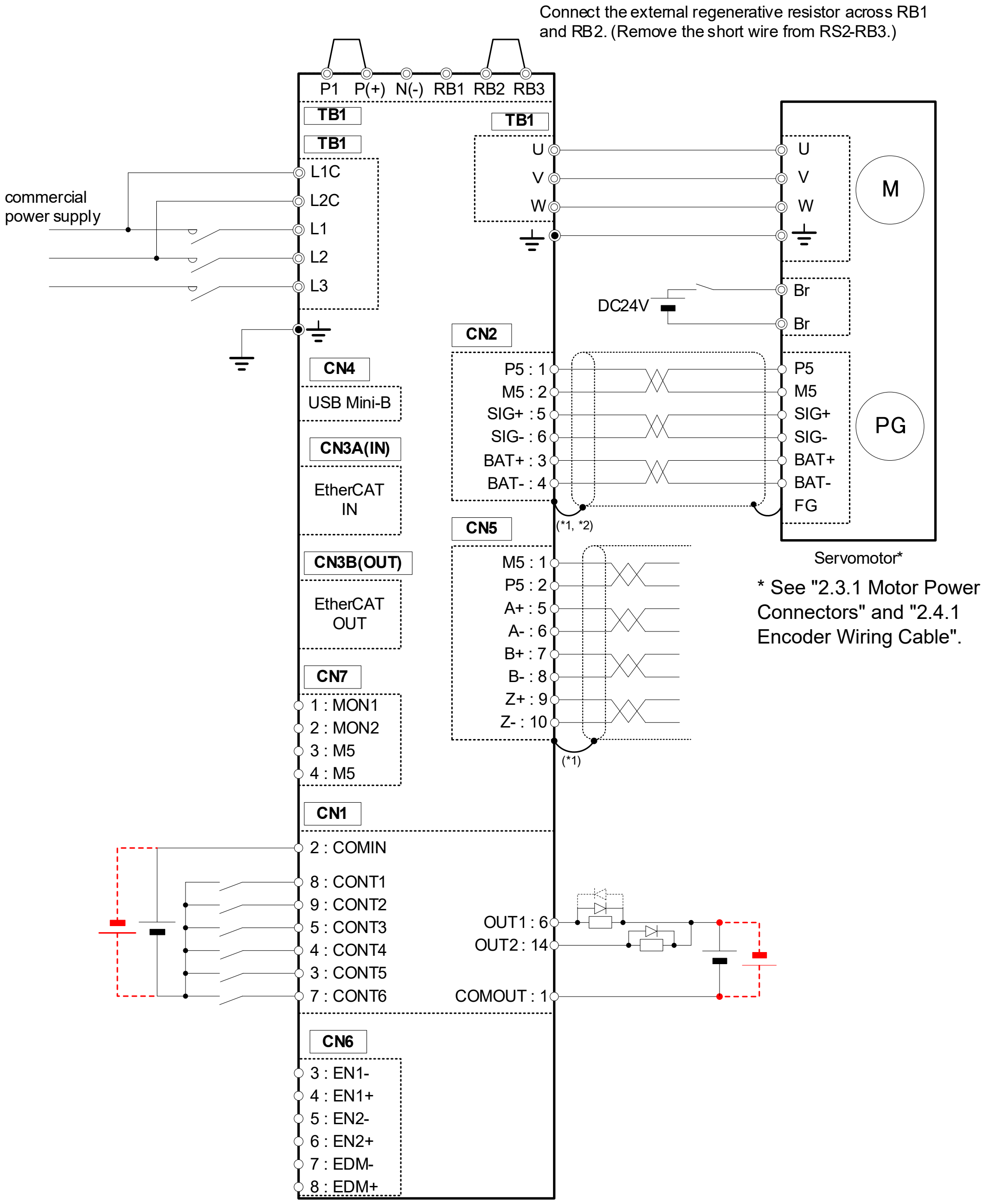


If connecting wires to the P1, P(+), RB2, or RB3 terminals, do so after cutting the cover as shown in the diagram on the right.



2

Connection Diagram (Servo amplifier frame 4)



* See "2.3.1 Motor Power Connectors" and "2.4.1 Encoder Wiring Cable".

*1: Connect the shielding wire to the connector shell on the servo amplifier side.

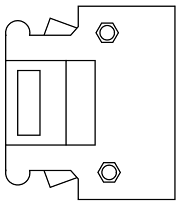
*2: Use an encoder cable with battery for ABS encoders.

2

2.1.3 Sequence I/O

The wiring connector is not included in the servo amplifier.

1	COMOUT	8	CONT1
2	COMIN	9	CONT2
3	CONT5	10	N.C
4	CONT4	11	N.C
5	CONT3	12	N.C
6	OUT1	13	N.C
7	CONT6	14	OUT2



No.	Terminal symbol	Function
8	CONT1	Sequence input (sink/source compatible) These terminals input command signals to the servo amplifier. 12 to 24 [V] DC/approx. 8 [mA] (per point) Photocoupler isolation COMIN is the reference potential terminal. (Excl. soft filter 0.5 [ms], agreement of two scans, interrupt input) (With interrupt input, the hardware filter detection delay is 0.1 [ms].)
9	CONT2	
5	CONT3	
4	CONT4	
3	CONT5	
7	CONT6	
2	COMIN	
6	OUT1	Sequence output (sink/source compatible) These terminals output signals from the servo amplifier. Max. 30 [V] DC/50 [mA] Photocoupler isolation COMOUT is the reference potential terminal.
14	OUT2	
1	COMOUT	
10	N.C	Use prohibited
11	N.C	Use prohibited
12	N.C	Use prohibited
13	N.C	Use prohibited

2

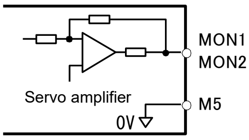
2.1.3.1 Analog Monitor Output (MON1, MON2, M5)

The analog monitor output is the analog voltage output terminal of the servo amplifier. The output is specified with a parameter.

Observe after 2 seconds or longer have elapsed since turning ON the power.

The output voltage will be unstable immediately after turning ON the power, and after turning OFF the power.

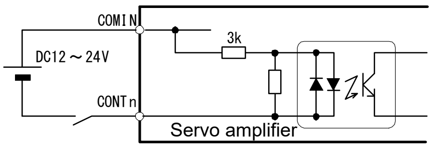
- Max. ±10 [V]/0.5 [mA]
- Resolution: 14-bit/± full scale



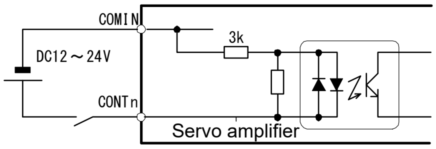
2.1.3.2 Sequence Input (CONT1, CONT2, CONT3, ... COMIN)

These are input terminals for sequence control.

- They are compatible with both sink input and source input.
- Use in the 12 to 24 VDC range.
- Approximately 8[mA] (for 24 VDC) is consumed per point.
- Terminal functions are set with parameters.
  Refer to “2.5.3Signal Descriptions” onward for details on assignable signals.



(Source input)

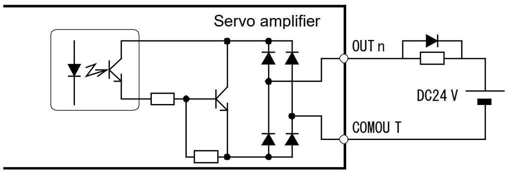


(Sink input)

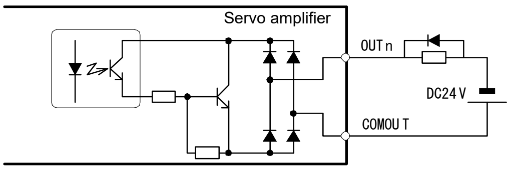
2.1.3.3 Sequence Output (OUT1, OUT2, ... COMOUT)

These are output terminals for sequence control.

- They are compatible with both sink output and source output.
- Use in the 30 [V] DC/50[mA] range.
- Terminal functions are set with parameters.
  Refer to “2.5.3Signal Descriptions” onward for details on assignable signals.
- If the load is a relay, connect a diode near the coil.
  Reverse diode connection may cause damage to the servo amplifier.



(Sink output)



(Source output)

2.1.4 EtherCAT Communication (CN3)

EtherCAT communication is used to connect to other servo amplifiers or host controllers.

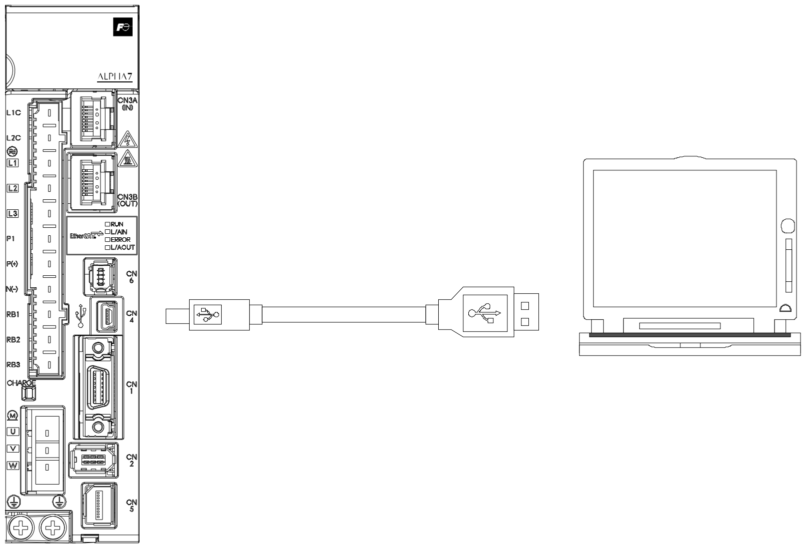
Use a dedicated EtherCAT cable.

There is no need to connect a terminating resistor.

Refer to "CHAPTER 11 ETHERCAT COMMUNICATION" for details.

2.1.5　USB (CN4)

USB-miniB type 4-pin connector. Use a marketed cable.



2.1.6　Safety Function (CN6)

This is a safety stop function (STO) regulated by EN60204 Stop Category 0.

The motor is slowly stopped (free-run stop) by turning OFF [EN1+] and [EN2+] inputs.
If not using the safety stop function (STO), use with the provided jumper connector attached.

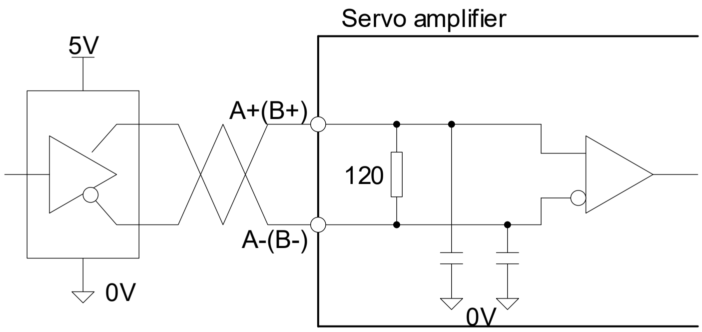
Refer to “2.7 Safety Function” for details on the function.

2.1.7　Linear Encoder/Full-closed wire (CN5)

Connector for signal input of linear encoder/feedback scale for full-closed control.

2

- Amplifier side connector model
  MUF-RS10SK-GKX-TB(LF)/JST Mfg. Co., Ltd
- Connector kit model
  MUF-PK10K-X/Nippon Crimp Terminal Mfg. Co., Ltd
  Contents : Housing
  : Cable clamp
  : Screws (2 pcs)
  : Metal shell (A/B)
  : Cover housing (A/B)
- Applicable cable
  Shielded Twisted Pair Cable (AWG #28 to #24) Wire Cover
  External Dimensions : ø1.2 mm or less
  Cable outline : ø 6.8 mm or less
  Maximum length : 30 [m] *1
  Connect the amplifier side of the shielded wire to the shell (FG) of the connector, and the feedback scale side to the FG part of the feedback scale.

No.	Terminal symbol	Function
1	M5	Reference potential
2	P5	Power supply output voltage for feedback scale: DC +5 [V] ± 5 % Maximum current: 300 [mA]
3	—	Not used. Do not connect anything.
4	—	
5	A+	A/B phase pulse-input • Form: 90° phase difference signal • Maximum input frequency: 5.0 [MHz] (after multiplication by 4)*2 < Input circuit > 5V line driver (equivalent to RS422)
6	A-	
7	B+	
8	B-	
9	Z+	Z-phase pulse input • Form: Origin mark signal • Pulse width : 0.4μsec or more < Input circuit > Same as AB-phase pulse input circuit
10	Z-	

*1: This is the maximum length in our evaluation environment and does not guarantee operation in your environment. It may be shortened due to the power supply voltage drop, the specification of the feedback scale, or the noise environment.

*2: If Duty ratio of the input-signal waveform is not 50%, the input-signal waveform may not be read correctly.

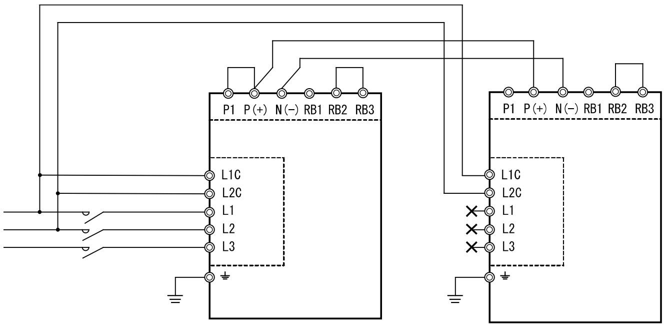
2.2 P-N Junction

Connect the DC intermediate voltages of two servo amplifiers directly to facilitate power transfer.
By doing so, power can be supplied by the regenerative side (brake side) servo amplifier to the powering side (drive side) servo amplifier, allowing overall power consumption to be reduced.

Application examples

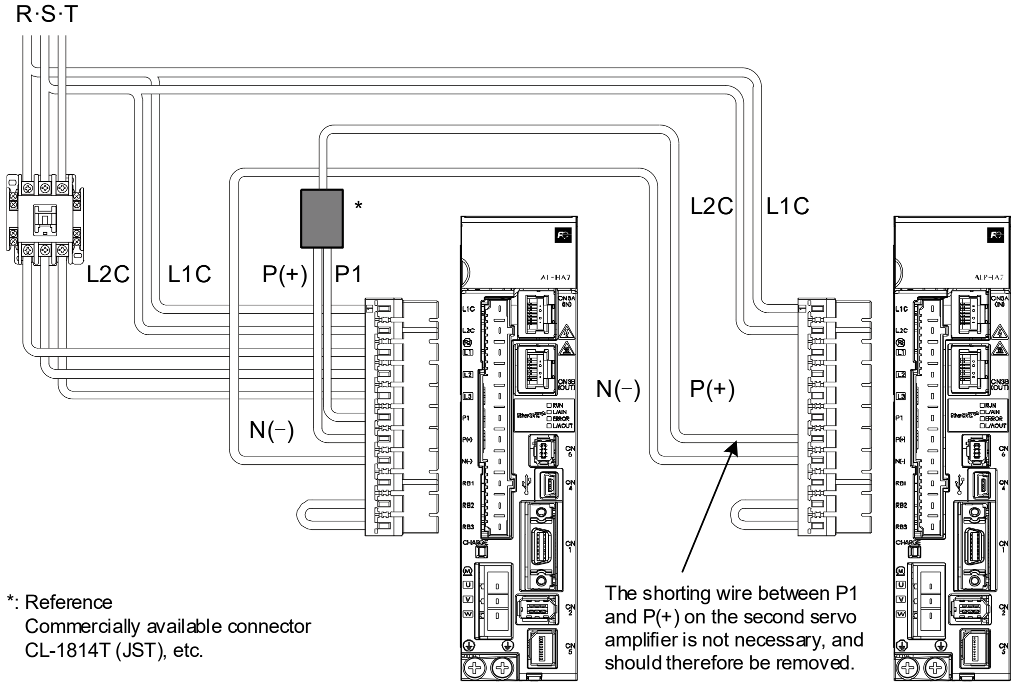
- Winding systems
- Take-out robots
- Printing machines

Restrictions apply to combinations of connected servo amplifier. Please contact Fuji if using with a PN junction.



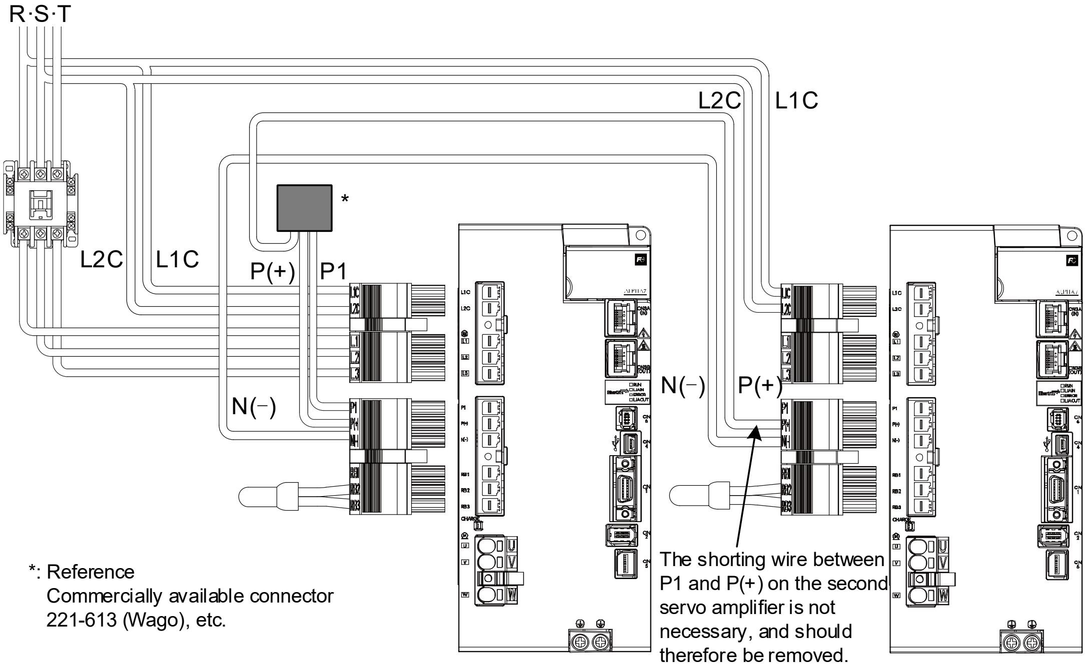
If employing a PN connection as shown in the diagram, it is not possible to connect two wires to the spring clamp connector P1 or P(+) terminals on servo amplifiers of frame size 3 or less, and therefore it is recommended that a separate commercially available branch connector be used.

■ Servo amplifier (frame 1, frame 2)



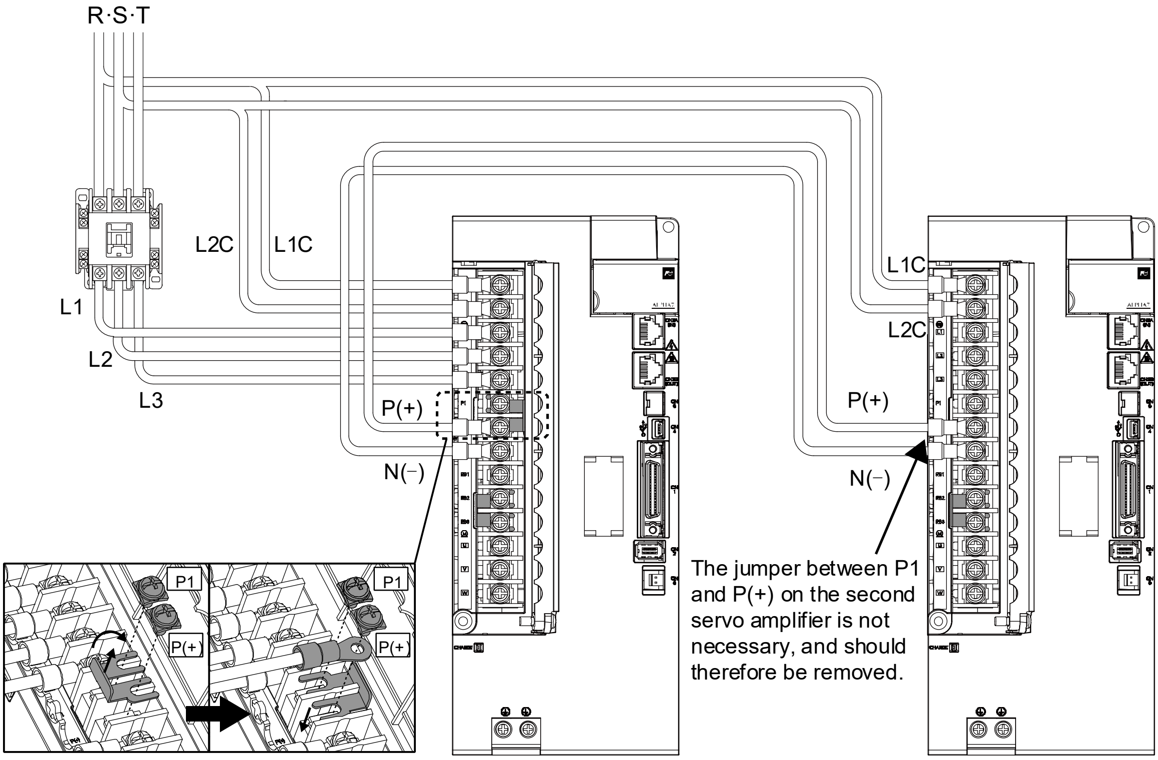
2

■ Servo amplifier (frame 3)



*: Reference
Commercially available connector
221-613 (Wago), etc.

■ Servo amplifier (frame 4)



If employing a PN connection as shown in the diagram, attach the jumper between P1 and P(+) on the 1st servo amplifier after changing the direction by 180°, and then connect the P(+) terminal wire.

2.3 Servomotor

There are wiring of the main body of the servomotor and that of the brake (servomotor equipped with a brake).

⚠CAUTION

- Keep consistency in the phase order between the servomotor and servo amplifier.
- Do not connect commercial power to the servomotor. Otherwise it may cause failure.

2.3.1 Motor Power Connectors

Connector kit models:

WSK-M04P-E (GYS model 0.75kW or less/GYB model lead wire specification servomotor side)

WSK-M04P-CA (GYS model 1.0kW or higher servomotor side)

WSK-M04P-CC (GYG model servomotor side)

WSK-M06P-CA (GYS model 1.0 [kW] or more servomotor with brake side)

WSK-M06P-CC (GYG model servomotor with brake side)

Connector terminal symbol

Application range	GYS				GYB				GYG	
	0.75kW or less		1.0kW or more		0.75kW or less					
Connection specification	Lead wire specification		Connector connection specification		Lead wire specification		Connector connection specification		Connector connection specification	
	Without brake	With brake	Without brake	With brake	Without brake	With brake	Without brake	With brake	Without brake	With brake
U phase	1		A		1		4		A	B
V phase	2		B		2		3		B	I
W phase	3		C		3		2		C	F
E (ground)	4		D		4		1		D	D

Attach and tighten the connector at the GYB motor side using the screws provided (tightening torque: 0.2 N·m).

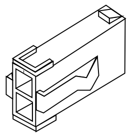
2.3.2 Brake Connector

Connector kit type:

WSK-M02P-E (GYS model: 0.75kW or less/GYB model: lead wire specification servomotor side)

Connector terminal symbol

1	Br
2	Br



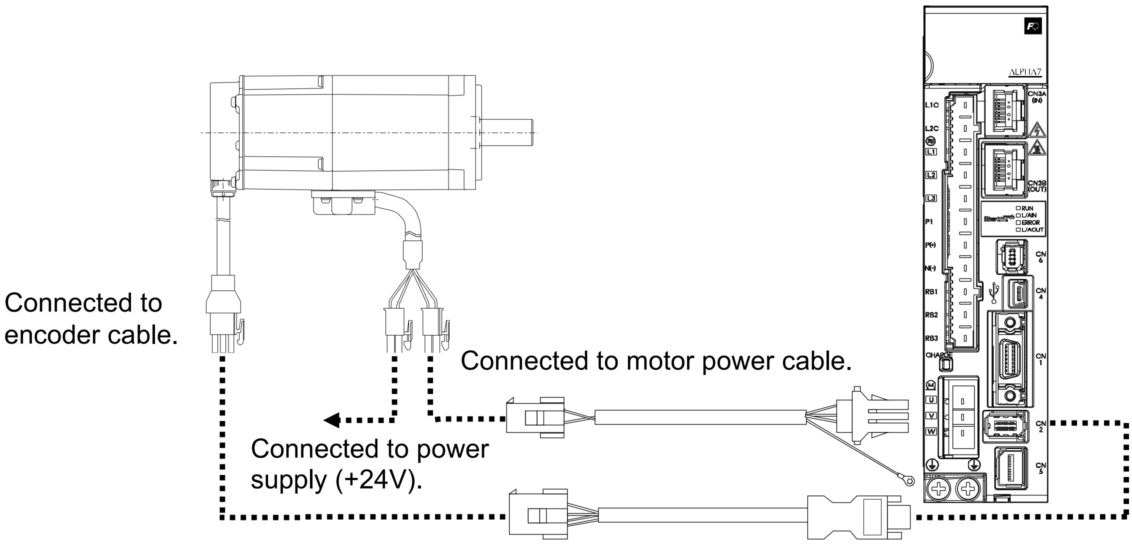
The brake of the servomotor equipped with a brake is a non-exciting brake. To turn the servomotor, +24 [V] must be supplied. There is no polarity in the brake input circuit.

If the brake is left released, although the periphery of the brake becomes hot it is not a fault.

Use a relay or solid state relay (SSR) as the brake cannot be released directly in the sequence output terminal (DC+30V/50mA).

The GYS model 1.0 to 1.5kW brake terminal is located inside the WSK-M06P-CA motor power connector, and the GYG model 1.0 to 1.5kW brake terminal is located inside the WSK-M06P-CC motor power connector.

Attach and tighten the connector at the GYB motor side using the screws provided (tightening torque: 0.2 N·m).



2.4 Encoder

2.4.1 Encoder Wiring Cable

Connector kit models:

WSK-P09P-D (GYS model: 0.75kW or less/GYB model: lead wire specification servomotor side)
WSK-P06P-C (GYS model: 1.0 to 1.5kW servomotor side)
WSK-P06P-J (GYG model: 1.0 to 1.5kW servomotor side)

Connector terminal symbol

Application range	GYS		GYB		GYG
	0.75kW or less	1.0kW or more	0.75kW or less		
Connection specification	Lead wire specification	Connector connection specification	Lead wire specification	Connector connection specification	Connector connection specification
P5	7	H	7	6	6
M5	8	G	8	3	7
BAT+	1	T	1	5	8
BAT-	2	S	2	2	9
SIG+	5	C	5	4	2
SIG-	4	D	4	7	1

Use the specified shielded wire for the servomotor encoder wiring.
The optional cable for the servomotor is a bending resistant UL Standard cable.
If neither the servomotor nor cable move, use a standard twisted pair common shielded wire.
Attach and tighten the connector at the GYB motor side using the screws provided (tightening torque: 0.2 N·m).

2

■ Shield cables (twisted pair type)

- GYS model/GYB model lead wire specification
  30V 80°C UL VW-1 AWG#25/2P + AWG#22/2C or AWG#23/3P shielded cable
  (For wiring length of 10 m or shorter)
  30V 80°C UL VW-1 AWG#25/2P + AWG#17/2C shielded cable or equivalent
  (For wiring length > 10 m ≤ 50 m)
- GYB model connector connection specification/GYG model
  30V 80°C UL VW-1 AWG#24/2P + AWG#22/2C shielded cable or equivalent
  (For wiring length of 10 m or shorter)
  Please contact Fuji if using wiring of length 10 m to 50 m.

The relationship between AWG and mm is shown below.

Gauge		SI unit		Inch unit	
A.W.G	In [mm^2]	Diameter [mm]	Cross section [mm^2]	Diameter [mil]	Cross section [CM]
16	1.25	1.291	1.309	50.82	2583
17	-	1.150	1.037	45.26	2048
18	-	1.024	0.8226	40.30	1624
19	-	0.9116	0.6529	35.89	1288
20	-	0.8118	0.5174	31.96	1021
21	-	0.7299	0.4105	28.46	810.0
22	-	0.6438	0.3256	25.35	642.6
23	-	0.5733	0.2518	22.57	509.4
24	-	0.5106	0.2024	20.10	404.0
25	-	0.4547	0.1623	17.90	320.4

2.4.2 Encoder Cable Fabrication Method

To fabricate the encoder cable by yourself, take care of the following.

- Do not install a relaying terminal block between the servo amplifier and motor.
- Use a shielded cable.
- Connect the shielded cable with the designated connector pin, connector shell or cable clamp on both sides.
  The servo amplifier communicates with the encoder built in the servomotor through high speed serial communications.
  The shield treatment is important for the assurance of reliability of serial communications.
  The maximum encoder wiring length is 50m.
- In case of twisted wire, please conduct according to the signal combination below:
  P5 and M5, SIG+ and SIG-, BAT+ and BAT- (See “Connection diagram (example)” in section 2.1.2.)
- Wrong wiring may cause encoder or battery trouble, please be careful.

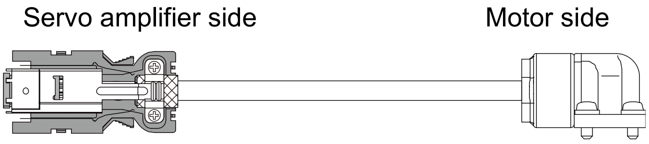
Perform shield treatment at the encoder according to the procedure specified below.
Despite motor capacity, wiring treatment at the servo amplifier is the same.

2.4.2.1 Encoder cable fabrication method

GYS model 0.75kW or less/GYB model lead wire specification

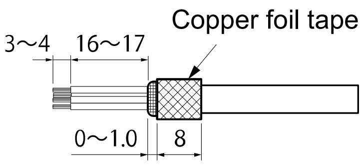
Connect the shielded end of the connector at the motor side to pin No. 3.
Relay the shielded wire with a lead wire of AWG #22 to #26,
and then crimp it to the connector pin.

GYB model connector connection specification

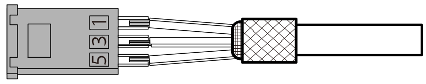


There is no need to connect the shielded end of the connector at the motor side.

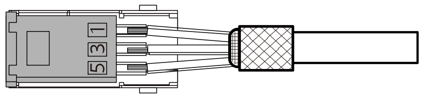
[1] Peel off approximately 22 mm of the end of the shielded wire.
Fold back the shield.
Wind copper foil tape two to three times around the shield.



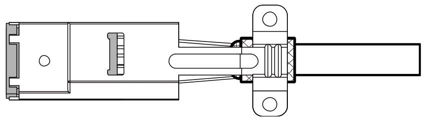
[2] Solder the wiring to the connector.
Fitting a shrinkable tube to each wire ensures safety.



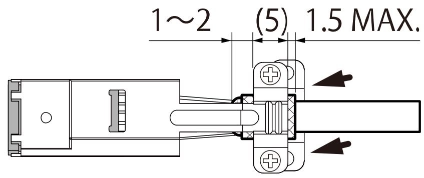
[3] Fit the shell body to the connector.



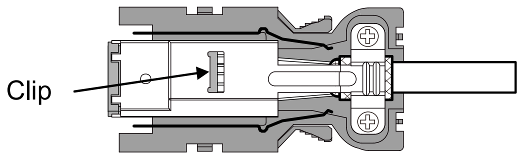
[4] Align the shell cover with the clips on both sides of the shell body and attach.



[5] Fit the cable clamp to the assembled shell, and secure with the screws.



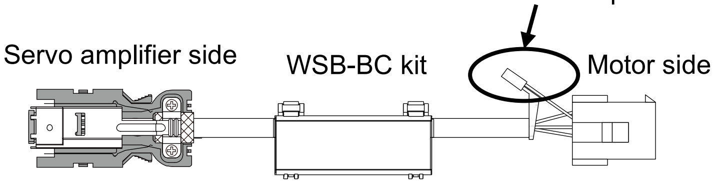
[6] Secure by aligning the clip with the mold cover.



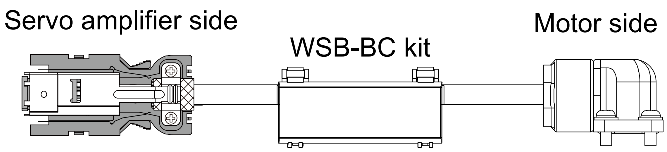
2.4.2.2 Encoder Cable With Battery Fabrication Method

GYS model 0.75kW or less/GYB model lead wire specification

Connect the shielded end of the connector at the motor side to pin No. 3.
Relay the shielded wire with a lead wire of AWG #22 to #26. and then crimp it to the connector pin.

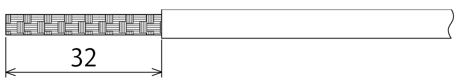


GYB model connector connection specification

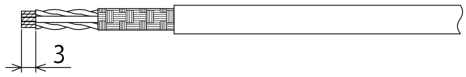


There is no need to connect the shielded end of the motor side connector.

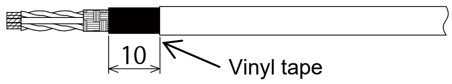
[1] Peel off approximately 32 mm from the end of the shielded wire.



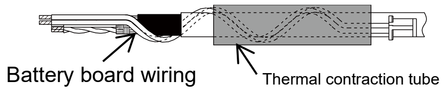
[2] Peel off approximately 3 mm from the end of the core wire.
Cut the braided wire approximately in half.



[3] Wrap vinyl tape 2 to 3 times around approximately 10 mm of the base of the braided wire for insulation.

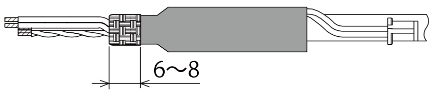


[4] Wrap the battery board wiring 2 to 3 times around the shield wire, and pass through the thermal contraction tube.

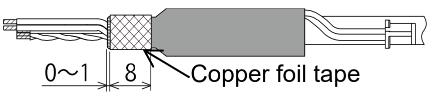


[5] Leave approximately 7 mm of the braided wire, and contract the thermal contraction tube.

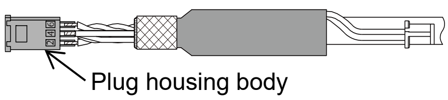
[6] Fold back 6 to 8 mm of the braided wire.



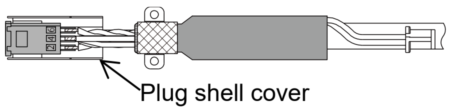
[7] Wrap copper foil tape 2 to 3 times around the braided wire.



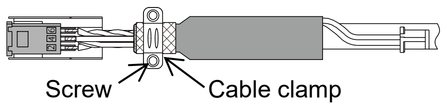
[8] Solder the encoder cable core wire and battery board wiring to the plug housing body.
Fitting a tube to each soldered part ensures safety.



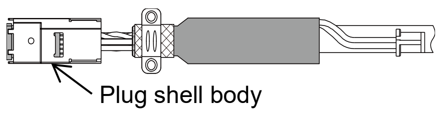
[9] Secure the plug housing body to the plug shell cover.



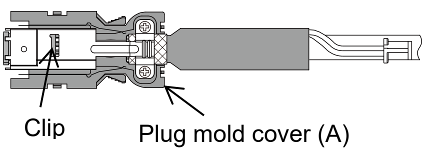
[10] Secure the cable clamp from the rear with screws.



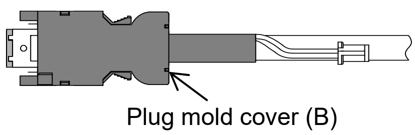
[11] Fit the plug shell body while aligning the clips on both sides.



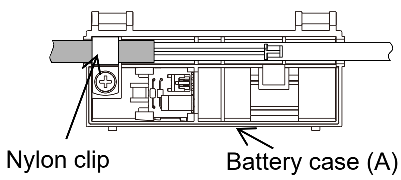
[12] Turn over the connector, and secure by aligning the clip position with plug mold cover (A).



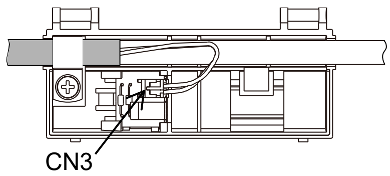
[13] Secure plug mold cover (B) by aligning the clips at 4 locations. When doing so, take care not to trap the wires.



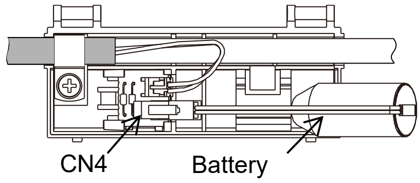
[14] Use the nylon clip to hold down the encoder cable, and secure to battery case (A) with a screw from the top, and a nut from the rear.



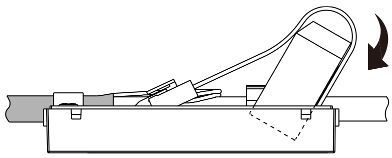
[15] Connect the battery board wiring to CN3.



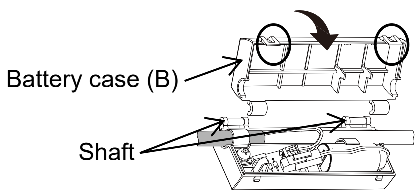
[16] Connect the battery to CN4.

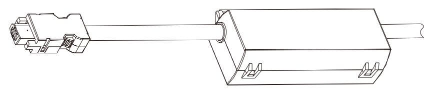


[17] Store the battery in battery case (A).



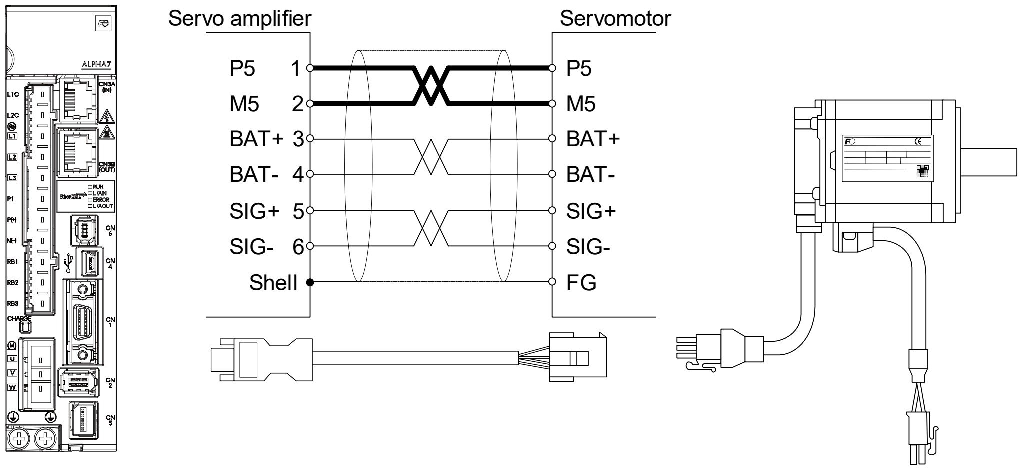
[18] Hook battery case (B) onto the shaft, and secure by aligning the clips at 2 locations.





[Complete]

■ Encoder cable wire size



Signal name	Servo amplifier side Connector No.	Motor side Connector No.	Lead wire diameter	
			Wiring length 10 m or shorter	Wiring length between 10 m and 50 m
P5	1	See “2.4.1Encoder Wiring Cable”.	AWG23	AWG17*1
M5	2		AWG23	AWG17*1
BAT+	3		AWG25	
BAT-	4		AWG25	
SIG+	5		AWG25	
SIG-	6		AWG25	
FG	Shell		AWG25	

*1: Please inquire regarding GYB model connector connection specification/GYG model.

2

2.5 Description of I/O Signals

2.5.1 List of input signals

Specify the signals to be assigned to sequence input terminals by using parameters.

No.	Name	Setting range	Default value	Change
PA03_01	CONT1 signal assignment	Select from sequence input signal (1)	49	Power
PA03_02	CONT2 signal assignment		0	
PA03_03	CONT3 signal assignment		0	
PA03_04	CONT4 signal assignment		0	
PA03_05	CONT5 signal assignment		0	
PA03_06	CONT6 signal assignment		0	
PA03_07	CONT7 signal assignment	Select from sequence input signal (2)	0	
PA03_08	CONT8 signal assignment		0	

■ Sequence input signals

(1) Signals assignable to CONT1 to 6 (sequence input terminal)

No.	Function
6	Home position LS [LS]
7	+OT
8	-OT
10	Forced stop [EMG]
34	External regenerative resistor overheat
49	Interrupt input (Touch Probe1)
59	Interrupt input (Touch Probe2)

(2) Signals assignable to CONT7, CONT8 (communication)

No.	Function
16	Position preset
17	Servo response change
29	P action
54	Free run
57	Anti resonance frequency 0
58	Anti resonance frequency 1
82	Full-closed control disabled
83	Clear external/motor deviation
84	Accumulated pulse clear

2.5.2 List of output signals

Specify the signals to be assigned to sequence output terminals by using parameters.

No.	Name	Setting range	Default value	Change
PA03_51	OUT1 signal assignment	Select from OUT signal assignment functions (see next page).	0	Power supply
PA03_52	OUT2 signal assignment		0	
PA03_53	OUT3 signal assignment		0	
PA03_54	OUT4 signal assignment		0	
PA03_55	OUT5 signal assignment		0	
PA03_56	OUT6 signal assignment		0	
PA03_57	OUT7 signal assignment		0	
PA03_58	OUT8 signal assignment		0	
PA03_59	OUT9 signal assignment		0	
PA03_60	OUT10 signal assignment		0	
PA03_61	OUT11 signal assignment		0	
PA03_62	OUT12 signal assignment		0	

Sequence output signal

No.	Function	No.	Function
1	Ready for servo-on [RDY]	40	Home position LS detection
2	In-position [INP]	41	Forced stop detection
11	Speed limit detection	45	Battery warning
14	Brake timing	46	Life warning
16	Alarm detection (Normally open contact)	47	Synchronization complete
20	OT detection	48	Full-closed control in progress
22	Homing completion	49	External/motor deviation over forecast
23	Zero deviation	75	Position preset completion
24	Zero speed	76	Alarm detection (Normally closed contact)
25	Speed coincidence	86	Interference detection
26	Torque limit detection	89	Functional safety SS1
27	Overload warning	90	Functional safety SLS
28	Servo control ready	91	Digital Output1*1
38	+OT detection	92	Digital Output2*1
39	-OT detection		

*1: Digital Output can be assigned to OUT1/OUT2 only.

2.5.3 Signal Descriptions

Input signal

Homing position LS [LS]: Sequence input signal (Reference value 6)

2

This signal is used as the homing mode home switch signal.

- Function

With the ALPHA7 Series built-in EtherCAT communication type, homing is performed based on the homing profile (1 to 37) selected at the controller.

Refer to “15.1.7 Homing Mode Specifications” for details on homing mode.

- Parameter setting

If assigning home position LS to a sequence input terminal, set the value (6) corresponding to the input terminal function setting parameter.

If this signal is not assigned to a sequence input terminal, it is handled as always OFF.

Over-travel in positive direction [+OT]: Sequence input signal (Reference value 7)
Over-travel in negative direction [-OT]: Sequence input signal (Reference value 8)

A signal from a limit switch or similar can forcibly stop the machine travel.

■ Function

The signal is an input from a limit switch for avoiding over-travel (OT) beyond the limit of machine travel.
Each signal is always enabled except under torque control.
If the over-travel signal is turned off during operation, the servomotor decelerates and stops at the control value set at PA2_60 (third torque limit) or deceleration time set at Quick stop deceleration (6085H) based on the PA2_63 (action sequence at main power shutoff, OT detection) setting.
Pulse input in the direction opposite to the detection direction can be executed (contact b).
The servomotor is forcibly stopped if an OT signal is detected while performing position control, and as a result, the command current position and feedback current position may be different.
Take care of the reference value and sensor position so that the OT signal will not be detected during regular operation.

■ Parameter setting

To assign the +OT signal to a sequence input terminal, specify the corresponding value ("7") to the input terminal function setting parameter. For the -OT signal, specify ("8").

This signal is handled to be always turned on if it is not assigned to the sequence input terminal.

■ Relevant description

(1) Direction of detection

The +OT signal is detected during a travel of the servomotor in the positive direction. The positive direction indicates the direction of forward rotation if PA1_4 (rotation direction selection) is set at "0" (positive direction).

Note

If the servomotor rotation direction and OT signal direction are the opposite of one another, the servo motor will not stop even if the OT signal is detected. There is a possibility of equipment failure due to such reasons as a collision at the equipment end, and therefore it is necessary to ensure that the rotation direction and OT signal direction match.
Failure to observe this may result in a fault.

2

(2)　Output signal: +OT detection (38), -OT detection (39), OT detection (20)

The +OT detection and -OT detection signals indicate that the servo amplifier detects the limit of travel in the mechanical system. A sequence output signal to the host controller can be notified the fact of detecting the +OT or -OT signal.

The OT detection signal turns on upon detection of either +OT (7) or -OT (8), or the software OT specified at 607DH: Software position limit.

If the host controller is equipped with an OT input, connect to the host controller in general cases.

To specify this function, specify "38" (+OT detection), "39" (-OT detection) or "20" (OT detection) in the output terminal function setting parameter.

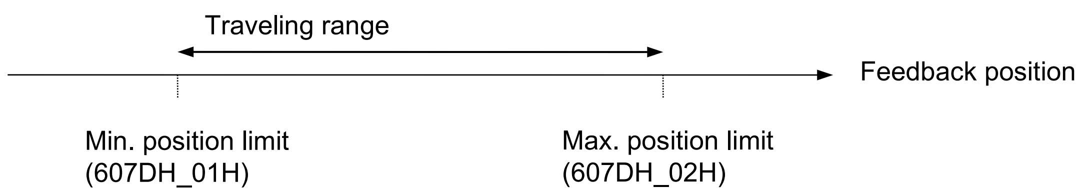
(3)　Software OT

If PA2_25 (Software OT selection/Position command format) is set to “1” (enable), operation is possible when the current position is in the range between 607DH_02H: Max. position limit and 607DH_01H: Min. position limit.

If this range is exceeded, forced stop will be caused with the OT detection sequence output.

The signal will turn off if the range is exceeded when traveling in the direction opposite to the detection direction, allowing travel in both directions.

The +OT (-OT) sequence input is for mechanical position detection, while software OT is for position detection of the servo amplifier.



Forced stop [EMG]: Sequence input signal (Reference value 10)

Used to forcibly stop the servomotor.

■ Function

(1) Forced stop

The servomotor is forcibly stopped while the forced stop [EMG] signal remains turned off.

This signal is enabled in all control modes and it is given the highest priority. Because the safety and detection speed are significant, the forced stop signal is generally connected to the servo amplifier directly.

A self-locked pushbutton switch (command switch) (normally closed contact) provided on the operation panel or similar is connected in regular cases.

If the forced stop signal is turned off during operation, the status changes to Quickstop active, and the servomotor decelerates and stops at the control value set at PA2_60 (third torque limit) or deceleration time set at Quick stop deceleration (6085H) based on the Quick stop option code (605AH) setting.

■ Parameter setting

To assign forced stop to a sequence input terminal, specify the corresponding value ("10") to the input terminal function setting parameter.

This signal is handled to be always turned on if it is not assigned to the sequence input terminal.

■ Relevant description

(1) Ready for servo-on [RDY]

If the forced stop signal is assigned to a sequence input terminal, the ready for servo-on [RDY] signal turns on if the servo-on status and forced stop signal are on, making it possible for the servomotor output shaft to rotate. To assign the ready for servo-on signal to a sequence output terminal, specify the corresponding value ("1") to the output terminal function setting parameter.

(2) Forced stop detection

When the forced stop signal is turned off, the forced stop detection signal is turned on so that external equipment recognizes.

To assign forced stop detection to a sequence output terminal, specify the corresponding value ("41") to the output terminal function setting parameter.

(3) State of forced stop

If the forced stop signal is turned off under position or speed control, the servomotor is stopped in the zero speed state with the zero rotation speed command. At this time, all rotation commands are ignored.

The present position is not retained in the zero speed state. Because the present position is controlled, there is no need to perform a homing motion again even if the forced stop signal is turned off. Turn the forced stop signal on to arrange the state ready to operate.

After canceling the forced stop signal, there is no need to reset the alarm.

If the forced stop signal is turned off under torque control, the torque command becomes zero and the servomotor free-run.

2

Position preset: Sequence input signal (Reference value 16)

This signal presets (rewrites) the command current position and feedback current position.

■ Function

This signal sets the command current position and feedback current position to the 607CH: Home offset setting value at the ON edge.

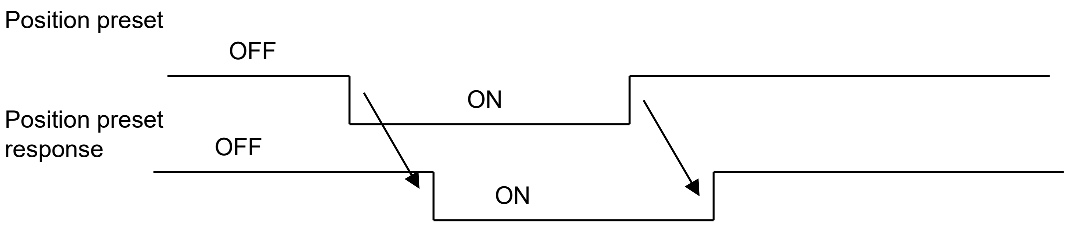
However, the feedback current position is the value after the deviation has been subtracted.

The ON edge is the point where the sequence input signal OFF status changes to ON.

This signal can be executed while the speed zero [NZERO] signal is ON, and so it is recommended that position preset be performed while the servomotor is stopped. By applying position preset, homing will be complete.

The following alarm detection can be reset.

- ABS data loss (dL1, dL2, dL3)
- Multi-turn overflow



The position preset response turns OFF when position preset is turned OFF.

■ Parameter setting

If assigning position preset to the sequence input terminal, set the value (16) corresponding to the input terminal function setting parameter.

If this signal is not assigned to the sequence input terminal, it is handled as always OFF.

Servo response change: Sequence input signal (Reference value 17)

This signal changes the servo system gain (responsiveness).

■ Function

By setting PA1_61 (gain changing factor) to “3” (external switch: CONT signal), the servo system gain can be changed by turning the CONT signal to which this function is assigned ON and OFF.
The control gain parameters enabled by changing the servo response are shown in the following table.
This is used at such times as when wishing to change the outward and return servo system gain when performing reciprocal operation, etc.

Servo response	Control gain
OFF	PA1_55: Position loop gain 1
	PA1_56: Speed loop gain 1
	PA1_57: Speed loop integration time constant 1
	PA1_58: Feed forward gain 1
ON	PA1_64: Position loop gain 2
	PA1_65: Speed loop gain 2
	PA1_66: Speed loop integration time constant 2
	PA1_67: Feed forward gain 2

■ Parameter setting

If assigning servo response change to the sequence input terminal, set the value (17) corresponding to the input terminal function setting parameter.
If this signal is not assigned to the sequence input terminal, it is handled as always OFF.

P action: Sequence input signal (Reference value 29)

This signal sets the servo amplifier control method to proportional band control.

■ Function

Turns P action ON while the servomotor shaft is mechanically locked in the servo-on status.

By turning P action ON while the servomotor is rotating, position control will become unstable.

Do not turn ON while the servomotor is rotating.

If the brake is applied with the servo locked when performing position control, an overload (oL) alarm is detected.

This is because the servo is performing PI control, and an attempt is made to return the servomotor to its original position, producing torque even if there is only the slightest deviation. If the brake is applied externally, be sure to turn P action ON.

■ Parameter setting

If assigning P action to the sequence input terminal, set the value (29) corresponding to the input terminal function setting parameter.

If this signal is not assigned to the sequence input terminal, it is handled as always OFF.

External regenerative resistor overheat: Sequence input signal (Reference value 34)

The thermistor signal of the external braking resistor forcibly stops the servomotor.

■ Function

If regenerative electric power is high, use an external regenerative resistor, and connect the resistor thermistor signal to the CONT signal assigned to the external regenerative resistor signal. If the external regenerative resistor overheat input signal turns OFF (contact b), an external regenerative resistor overheat (AL.rH2) alarm will occur.

■ Parameter setting

If assigning external regenerative resistor overheat to the sequence input terminal, set a value (34) corresponding to the input terminal function setting parameter.
This signal is handled to be always turned on if it is not assigned to the sequence input terminal.

Interrupt input: Sequence input signal (Reference value 49)
Interrupt input 2: Sequence input signal (Reference value 59)

These signals are used as touch probe function external latch input signals.

■ Function

The ALPHA7 Series built-in EtherCAT communication type supports the touch probe function.
Refer to “15.1.8 Touch Probe Function” for details on the touch probe function.

■ Parameter setting

If assigning interrupt input signals to the sequence input terminal, set the value (49) corresponding to the input terminal function setting parameter. Set (59) for the interrupt input 2 signal.
If this signal is not assigned to the sequence input terminal, it is handled as always OFF.

Free run [BX]: Sequence input signal (Reference value 54)

This signal is used to make the servomotor free run forcibly.
This is a valid signal that is given priority in all control modes.

■ Function

Servo amplifier output is stopped, and the servomotor free runs while the free run [BX] signal assigned to the CONT input signal is ON.
The servomotor output shaft decelerates (accelerates) at load torque.
Free run is valid in all control states (position control, speed control, and torque control).

If used for vertical conveyance applications, etc., caution is advised due to the danger of conveyed objects falling. Furthermore, the servomotor will be in a free run state while the signal is ON when performing position control, and so if performing positioning control in csp mode, etc., the number of pulses output by the host control device will not match the amount of servomotor rotation.

■ Parameter setting

If assigning free run to the sequence input terminal, set the value (54) corresponding to the input terminal function setting parameter.
If this signal is not assigned to the sequence input terminal, it is handled as always OFF.

Anti resonance frequency selection 0: Sequence input signal (Reference value 57)
Anti resonance frequency selection 1: Sequence input signal (Reference value 58)

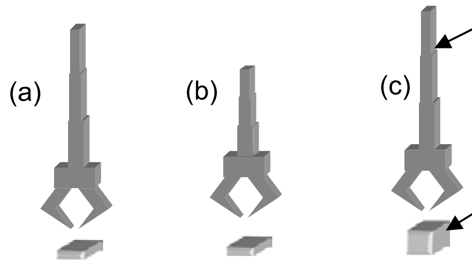
Selects the anti resonance frequency (vibration suppression function).

■ Function

With structures employing spring systems such as robot arms and conveyors, the tip of workpieces will vibrate when the servomotor accelerates or decelerates suddenly. Vibration suppression is a function used to suppress workpiece vibrations on such systems for the purpose of performing high tact positioning.

4 points can be set by combining anti resonance frequency selection 0 and anti resonance frequency selection 1.

The anti resonance points may differ depending on the length of the arm and the weight of the load.



The anti resonance frequency selections are shown in the following table.

Anti resonance frequency selection 1	Anti resonance frequency selection 0	Vibration suppressing anti resonance frequency	Vibration suppressing workpiece inertia ratio
OFF	OFF	PA1_78	PA1_79
OFF	ON	PA1_80	PA1_81
ON	OFF	PA1_82	PA1_83
ON	ON	PA1_84	PA1_85

■ Parameter setting

If assigning anti resonance frequency selection 0 or 1 to the sequence input terminal, set values (57) or (58) corresponding to the input terminal function setting parameter.

If these signals are not assigned to the sequence input signal, they are handled as always OFF.

In this case, PA1_78 (vibration suppressing anti resonance frequency 0) is always enabled.

To disable anti resonance frequency, set the value to 300.0 Hz.

Shocks will occur if the anti resonance frequency is changed while the servomotor is running, and therefore the value must be changed while the servomotor is stopped.

Furthermore, it is recommended that PA1_52 (low-pass filter (for S-curve) time constant) be used in combination with this function.

Full-closed control disabled: Sequence input signal (Reference value 82)

This signal switches to semi-closed control with full-closed system enabled.

This signal sets the parameter PA4_32 (full-closed system setting) to 1□□□ (full-closed system setting). This function is available only when "Stem enabled" is selected.

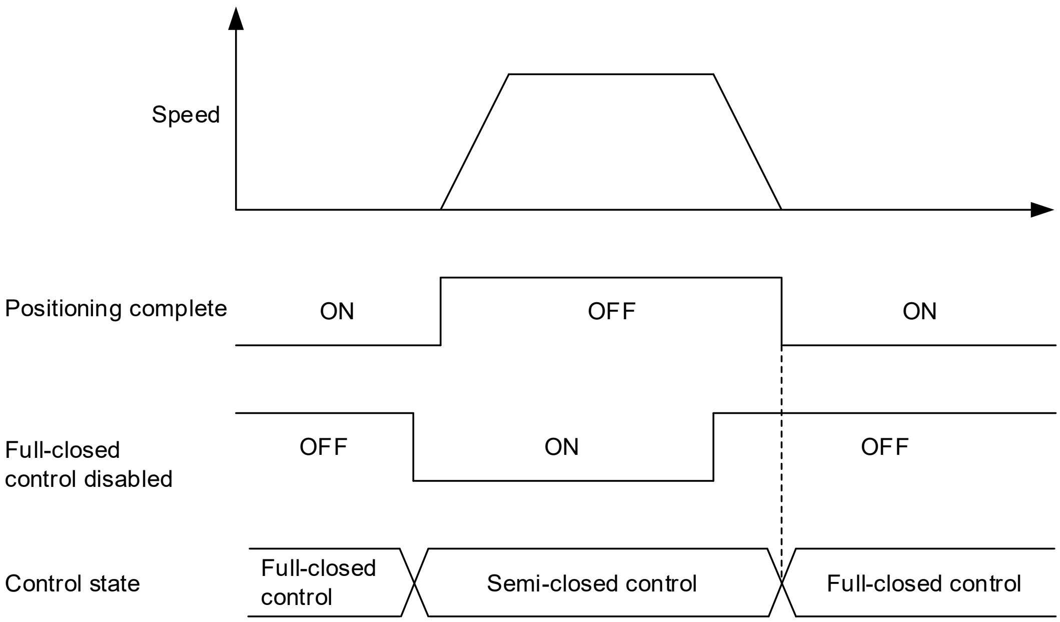
2

■ Function

When this signal is turned ON, semi-closed control is performed.

This signal can be accepted even while the motor is rotating. However, the condition that the control status actually changes is that the positioning complete signal is ON.

If there is a difference between the motor encoder pulse and the external encoder pulse, etc., the motor may move during switching operation by this signal. Be careful when switching.



■ Parameter setting

To assign a full-closed control disable signal to a sequence input signal, set a numerical value (82) corresponding to the input terminal function setting parameter. When this signal is not assigned to the sequence input pins, the signal is always treated as OFF.

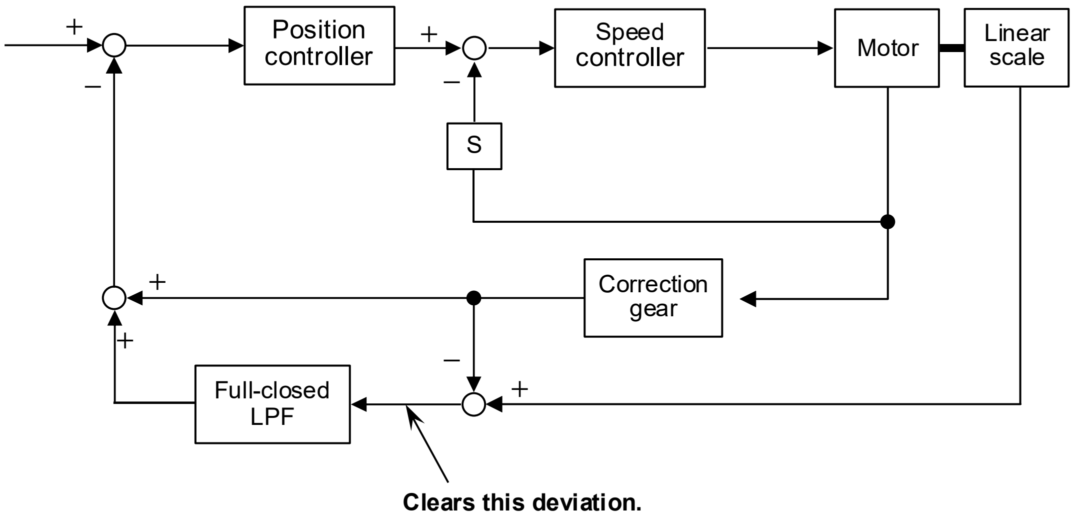
Clear external/motor deviation: Sequence input signal (Reference value 83)

The difference (deviation) between the external encoder pulse and the motor encoder pulse is set to 0. This signal sets the parameter PA4_32 (full-closed system setting) to 1□□□ (full-closed system setting).This function is available only when "Stem enabled" is selected.

2

■ Function

he difference (deviation) between the external encoder pulse and the motor encoder pulse is set to 0 at the ON edge of the external/motor deviation clear signal (the time to turn ON must be 2ms or more).



■ Parameter setting

To assign the external/motor deviation clear signal to the sequence input signal, set a numerical value (83) corresponding to the input terminal function setting parameter. When this signal is not assigned to the sequence input pins, the signal is always treated as OFF.

Accumulated pulse clear: Sequence input signal (Reference value 84)

Cears various accumulated pulses.

■ Function

The accumulated pulses cleared by the accumulated pulse clear signal are as follows.

- Command accumulated pulse
- Feedback integration pulse
- External accumulated pulse

■ Parameter setting

To assign the accumulated pulse clear signal to the sequence input signal, set a numerical value (84) corresponding to the input terminal function setting parameter. Always when this signal is not assigned to a sequence input pin.It is handled as a OFF.

Output signal

Ready for servo-on [RDY]: Sequence output signal (Reference value 1)

This signal is turned on if the servomotor is ready to operate.

■ Function

The ready for servo-on signal is turned on if the conditions shown in the table below are satisfied.

Signal division	Signal name	Function No.	Signal status
CONT input	Forced stop [EMG]	10	ON
OUT output	Alarm detection [ALM]	16	OFF
	Servo ready [S-RDY]	28	ON
Safety function	EN1, EN2	-	ON

The host sequence unit checks the ready for servo-on [RDY] signal to check if the servomotor is ready to rotate.

■ Parameter setting

To assign the ready for servo-on [RDY] to a sequence output terminal, specify the corresponding value ("1") to the output terminal function setting parameter.

■ Relevant description

The servo control ready [S-RDY] (reference value 28) signal can be output.
The servo control ready signal is turned on if the conditions shown in the table below are satisfied.

Signal division	Signal name	Function No.	Signal status
CONT input	Forced stop [EMG]	10	ON
OUT output	Alarm detection [ALM]	16	OFF
Safety function	EN1, EN2	-	ON
The internal CPU operates correctly.		-	
The L1, L2 and L3 terminals are turned on.		-	

In-position [INP]: Sequence output signal (Reference value 2)

This signal is turned on after a positioning motion is finished.

■ Function

(1) Status of in-position signal

The state under position control is shown in the table below.

Factor	Sequence status	Status of in-position signal
Servo-off status	Free-run	ON
Servo-on status	Servo lock	ON
Upon OT detection	Servo lock	ON
If forced stop [EMG] is turned off	Zero speed	ON
Upon alarm	Free-run	OFF

This signal is always turned on under speed control and torque control.

■ Parameter setting

To assign the in-position [INP] to a sequence output terminal, specify the corresponding value ("2") to the output terminal function setting parameter.

■ Signal activation condition

(1) At power-on

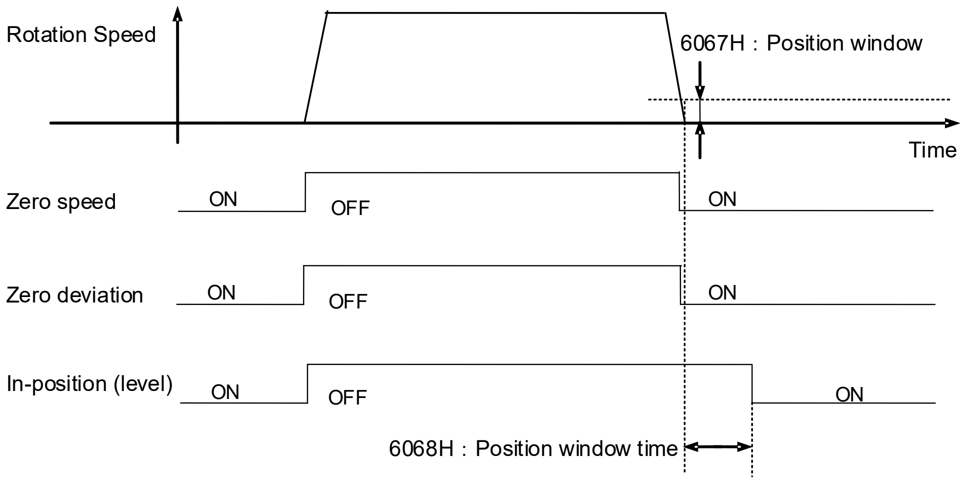
Level: ON

(2) During CSP operation

Level: The signal is turned on if conditions (A) and (B) below are satisfied.

(A) The rpm of the servomotor is within the setting of PA1_30 (zero speed range).

(B) The difference (deviation amount) between the command position and feedback position is within the 6067H: Position window setting value, and after the 6068H: Position window time setting time has elapsed.



Speed limit detection: Sequence output signal (Reference value 11)

This signal turns ON when the speed command value to the servo amplifier reaches the speed limit value.

■ Function

This signal is output externally when the speed command value to the servo amplifier reaches the speed limit value.

- Under speed control and position control, the speed limit depends on the setting of PA1_25 (maximum rotation speed).
- Under torque control, the speed limit depends on the setting of PA1_26 (maximum rotation speed (for torque control)).
  However, when PA2_56 (speed limit selection) is set to "1", the limit value set at 607FH: Max profile velocity is valid.

■ Parameter setting

To assign the speed limit detection to a sequence output terminal, specify the corresponding value ("11") to the output terminal function setting parameter.

Brake timing: Sequence output signal (Reference value 14)

The timing signal for applying or releasing the brake of the servomotor.

The signal is turned on during operation, while it is turned off after operation is stopped.

■ Function

The brake timing output turns off when the servo-off status turns on. The ready for servo-on [RDY] signal turns off once the brake holding time (PA2_64) has elapsed.

■ Parameter setting

To assign the brake timing output to a sequence output terminal, specify the corresponding value ("14") to the output terminal function setting parameter.

The brake timing is issued at the specified OUT terminal.

This signal is handled to be always turned off if it is not assigned to the sequence output terminal.

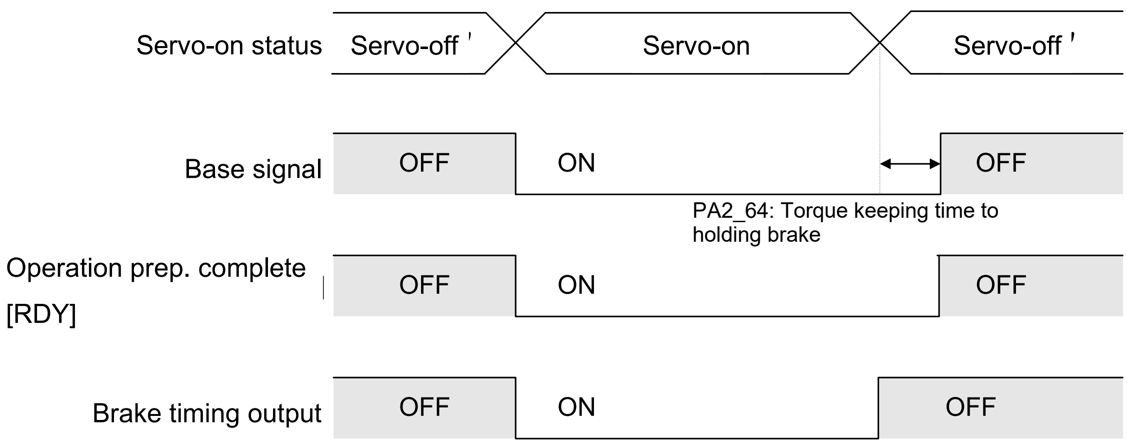
Use a relay or solid state relay (SSR) as the brake cannot be released directly in the sequence output terminal (DC+30V/50mA).

Note	• The brake attached to the servomotor is "for retention." Do not use it for braking. • Do not use the 24 [V] power supply for sequence I/O signals in parallel. Be sure to prepare a separate power supply for the brake. • If turning the brake on and off using the brake timing output, be sure that the servo-off status is on before turning off the power.

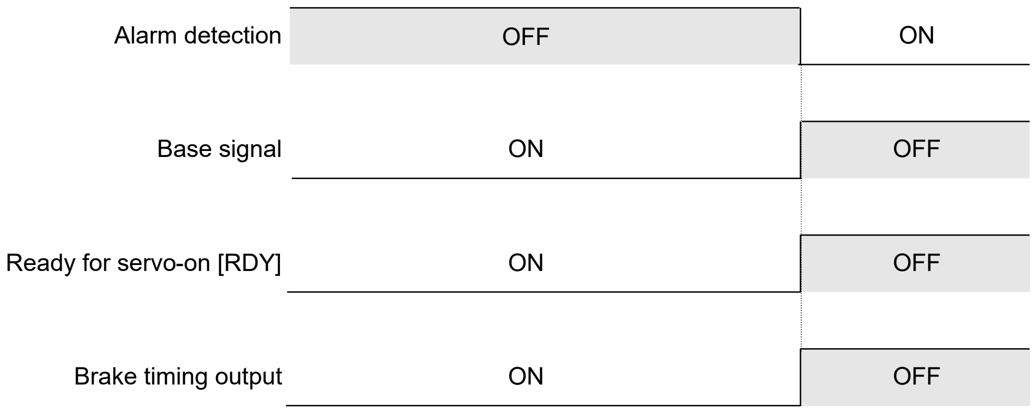
■ Relevant description

Timing chart

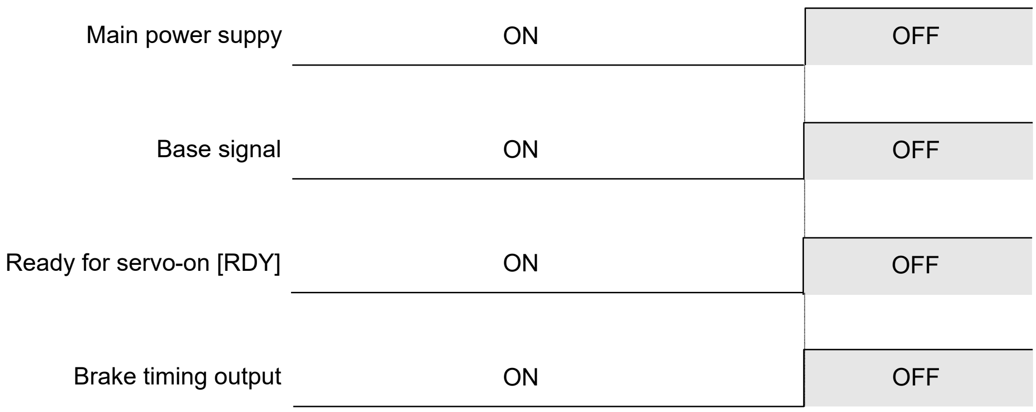
(1) Servo-on status



(2) Upon alarm



(3) Upon main power supply OFF



Alarm detection (normally open contact): Sequence output signal (Reference value 16)
Alarm detection (normally closed contact): Sequence output signal (Reference value 76)

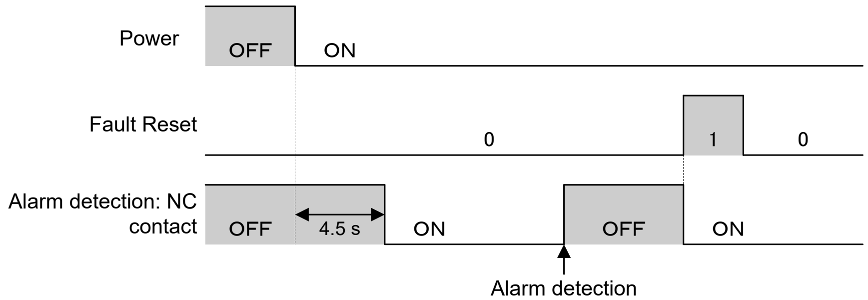
Signals are turned on (off in case of normally closed contact) if the servo amplifier detects an alarm (activation of a protective function).

■ Function

The alarm state is retained at the servo amplifier if the amplifier detects an alarm. The signal can be turned off (operation possible) by eliminating the cause of the alarm, and turning 6040H: Controlword (bit 7: Fault Reset) from “0” to “1”.

Alarm can be checked by having the host controller recognizes the alarm detection.

Precautions for using a normally closed contact for alarm detection



The contact remains turned off for about 4.5 seconds after the power is turned on.

Note	There are alarms that cannot be reset with Fault Reset. Refer to "■ Alarm reset" in "6.2.3 Alarm Display List" for details on alarms that can be reset with the Fault Reset.

■ Parameter setting

To assign the alarm detection (normally open contact) to a sequence output terminal, specify the corresponding value ("16") to the output terminal function setting parameter.

For alarm detection (normally closed contact), specify ("76").

2

OT detection: Sequence output signal (Reference value 20)

This signal is output if the over-travel (OT) signal is turned off.

■ Function

The OT detection ("20") sequence output is issued while the +OT (7) or -OT (8) sequence input signal terminal remains turned off.

In addition, OT detection ("20") is turned on if the current position reaches the reference value of the software OT detection position.

The software OT function can be enabled or disabled with PA2_25 (Software OT selection/position command format).

■ Parameter setting

To assign the OT detection to a sequence output terminal, specify the corresponding value ("20") to the output terminal function setting parameter.

■ Relevant description

(1) +OT detection (38)/-OT detection (39)

A + OT signal is detected during servomotor travel in the positive direction, while a - OT signal is detected during travel in the negative direction.

Use sequence output signals to notify the host controller of detection of the + OT or - OT signal. Connect to the host controller in general if the host controller is equipped with OT inputs.

(2) Software OT

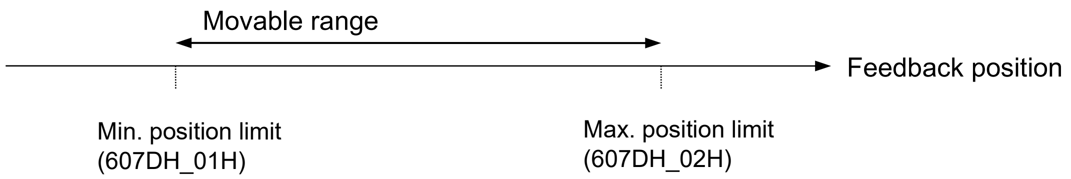
If PA2_25 (Software OT selection/position command format) is set to “1” (enable), operation is possible when the current position is in the range between 607DH_02H: Max. position limit and 607DH_01H: Min. position limit.

This function is valid following homing or position preset.

If the range is exceeded, the motion is forcibly stopped with the OT detection ("20") sequence output turned on.

The signal will turn off if the range is exceeded when traveling in the direction opposite to the detection direction, allowing travel in both directions.

The + OT (or - OT) sequence input is mechanical position detection, while software OT is position detection of the servo amplifier. Software OT to reverse the homing motion shall not be applied.



Homing completion: Sequence output signal (Reference value 22)

This signal is turned on after the homing motion is finished.

- Function

  This signal will always be on after the homing motion is completed normally.

  The home position is the stopping point after a homing motion is finished, or a position at which position preset is executed. It does not mean the "0" position.

- Parameter setting

  To assign the homing completion to a sequence output terminal, specify the corresponding value ("22") to the output terminal function setting parameter.

Zero deviation: Sequence output signal (Reference value 23)

The signal turns on while the deviation (deviation amount) retained in the servo amplifier lies within the setting value under position control.

Whether the servomotor has reached close to the command position can be checked.

- Function

  The signal turns on if the difference (deviation amount) between the current command position and current feedback position is within the 6067H: Position window setting value.

- Parameter setting

  To assign the zero deviation to a sequence output terminal, specify the corresponding value ("23") to the output terminal function setting parameter.

Zero speed [NZERO]: Sequence output signal (Reference value 24)

The signal turns on while the servomotor rotation speed lies within the setting value.

- Function

  The signal is turned on if the servomotor rotation speed is within the reference value of PA1_30 (zero speed range).

  The signal can be used as a motor stopping condition signal.

- Parameter setting

  To assign the zero speed [NZERO] to a sequence output terminal, specify the corresponding value ("24") to the output terminal function setting parameter.

Speed coincidence [NARV]: Sequence output signal (Reference value 25)

The signal is turned on after the servomotor rotation speed has reached the command speed.

■ Function

The signal is turned on if the servomotor rotation speed is within the reference value of PA1_29 (speed coincidence range).

The command speed is the PA1_41 to 47 (Manual feed speed 1 to 7), 60FFH: Target velocity, 6081H: Profile velocity, or 6099H: Target velocity setting value.

"The signal is enabled in pp, pv, hm, and csv operation modes. The signal turns off in csp and cst operation modes."

When operating at manual feed speed, the signal is not output under the following conditions.

- If the speed does not reach due to PA1_25 (max. rotation speed (for position and speed control))
- If the deceleration time is too long to reach the command speed

■ Parameter setting

To assign the speed coincidence [NARV] signal to a sequence output terminal, specify the corresponding value ("25") to the output terminal function setting parameter.

■ Relevant description

PA1_25 (max. rotation speed (for position and speed Control))

Specify the upper limit of the servomotor rotation speed which is specified with a parameter.

Torque limit detection: Sequence output signal (Reference value 26)

The signal remains turned on while the output torque of the servomotor is at the torque limit value.

■ Function

The torque limit value setting can be changed based on the conditions. Refer to “PA2_57 to 60 Torque limit settings” in section 3.5.2 for details.

The torque limit detection (26) output is enabled in all control modes.

■ Parameter setting

To assign the torque limit detection to a sequence output terminal, specify the corresponding value ("26") to the output terminal function setting parameter.

Overload warning detection: Sequence output signal (Reference value 27)

The signal is turned on if the servomotor load factor is at the reference value.
A warning can be issued before the servomotor is suddenly stopped due to an overload alarm or similar.

■ Function

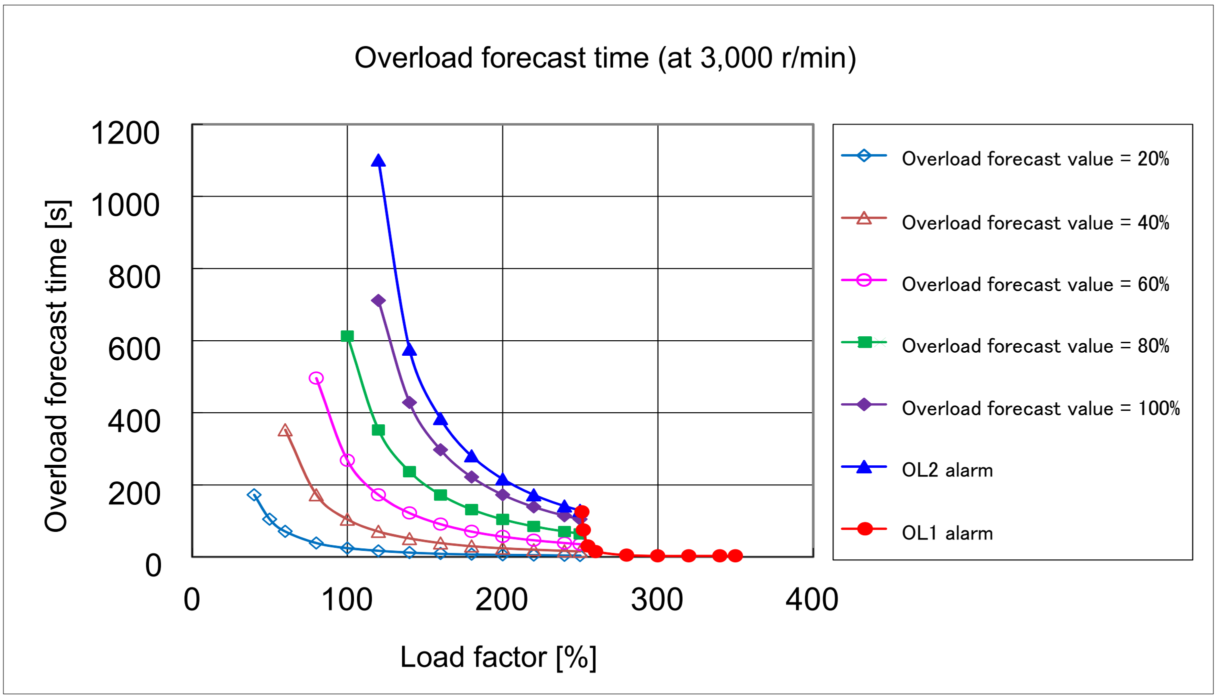
The signal is turned on if the load factor of the servomotor reaches the overload warning level of PA2_70 (overload warning value).
The signal is automatically turned off if the factor falls below the overload warning level. (There is no way to reset with a sequence input signal.)
The signal can be issued before the servo amplifier trips due to an overload alarm. Determine the reference value while referring to the characteristics diagram specified on the next page.

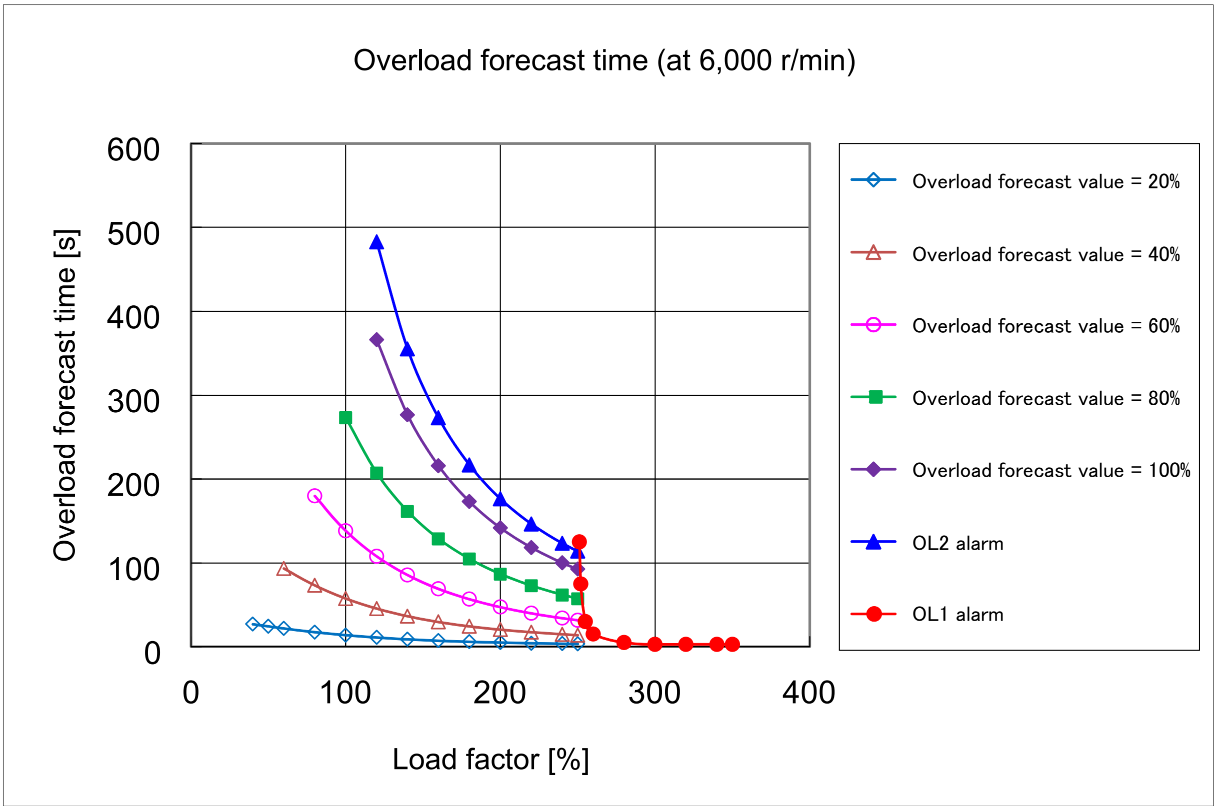
■ Parameter setting

To assign the overload warning detection to a sequence output terminal, specify the corresponding value ("27") to the output terminal function setting parameter.

2

■ Standard series





Servo control ready [S-RDY]: Sequence output signal (Reference value 28)

Use the signal to check that the servo amplifier and servomotor operate correctly.

■ Function

The servo control ready signal remains turned on while the conditions listed in the table below are satisfied.

Signal division	Signal name	Function No.	Signal status
CONT input	Forced stop [EMG]	10	ON
OUT output	Alarm detection	16	OFF
Safety function	EN1, EN2	-	ON
The internal CPU operates correctly.		-	
The L1, L2 and L3 terminals are turned on.		-	

■ Parameter setting

To assign the servo control ready to a sequence output terminal, specify the corresponding value ("28") to the output terminal function setting parameter.

+OT detection: Sequence output signal (Reference value 38)
-OT detection: Sequence output signal (Reference value 39)

The state of over-travel (±OT) is output.

■ Function

The corresponding + OT or - OT detection sequence output is turned on while the +OT or -OT sequence input signal terminal remains turned off.

■ Parameter setting

To assign the positive or negative OT detection to a sequence output terminal, specify the corresponding value ("38" or "39") to the output terminal function setting parameter.

■ Relevant description

(1) OT detection

The signal is turned on when the servomotor detects the OT signal in either the positive or negative direction. For details, refer to "Over-travel in positive direction [+OT]: Sequence input signal (Reference value 7), Over-travel in negative direction [-OT]: Sequence input signal (Reference value 8)".

(2) Software OT

If PA2_25 (Software OT selection/position command format) is set to “1”, operation is possible when the current position is in the range between 607DH_02H: Max. position limit and 607DH_01H: Min. position limit.
Refer to “PA2_25 Software OT selection/position command format” in section 3.4.2 for details.

Home position LS detection: Sequence output signal (Reference value 40)

The signal is output while the home position LS signal (input signal) remains turned on.

■ Function

The sequence output corresponding to home position LS detection is turned on while the home position LS sequence input signal remains turned on.

■ Parameter setting

To assign the home position LS detection to a sequence output terminal, specify the corresponding value ("40") to the output terminal function setting parameter.

Forced stop detection: Sequence output signal (Reference value 41)

The signal turns on while the forced stop signal (input signal) remains off, or when in the Quick stop active status.

■ Function

Forced stop detection is turned on when the forced stop sequence input signal is turned off. For details, refer to "Forced stop [EMG]: Sequence input signal (Reference value 10)" signal description.

■ Parameter setting

To assign the forced stop detection to a sequence output terminal, specify the corresponding value ("41") to the output terminal function setting parameter.

Battery warning: Sequence output signal (Reference value 45)

The signal is output if the battery voltage is smaller than the rated value.

■ Function

If the battery voltage is smaller than the rated value in an established ABS system (absolute system), a battery warning signal is turned on.

■ Parameter setting

To assign the battery warning to a sequence output terminal, specify the corresponding value ("45") to the output terminal function setting parameter.
Replace the battery immediately if this signal is turned on.

Life warning: Sequence output signal (Reference value 46)

The life of internal main circuit capacitors of the servo amplifier and that of the cooling fan are calculated and output its signal.

■ Function

The life of internal main circuit capacitors of the servo amplifier and that of the cooling fan are calculated and, if either exceeds the rated time, a life warning is turned on.

Use the PC Loader Statusword warning bit (6041H-bit7) or keypad (warning display) to determine whether the warning applies to the life of the main circuit capacitors or the cooling fan.

* To check the warning display at the keypad, it is necessary to set PA2_78 (Display transition at warning detection" to "1" (Transition to warning display).

■ Parameter setting

To assign the life warning to a sequence output terminal, specify the corresponding value ("46") to the output terminal function setting parameter.

Synchronization completion: Sequence output signal (Reference value 47)

This signal is valid when the EtherCAT synchronization mode is DC synchronization or SM2 synchronization.

■ Function

This signal turns on if the ALPHA7 internal processing cycle displacement is ±1 μs or less for EtherCAT SYNC0 input or IRQ input.

The signal turns off if the displacement is 16 μs or higher due to such reasons as an error occurring at the controller.

■ Parameter setting

If assigning synchronization completion to the sequence output terminal, set the value (47) corresponding to the output terminal function setting parameter.

Full-closed control in progress: Sequence output signal (Reference value 48)

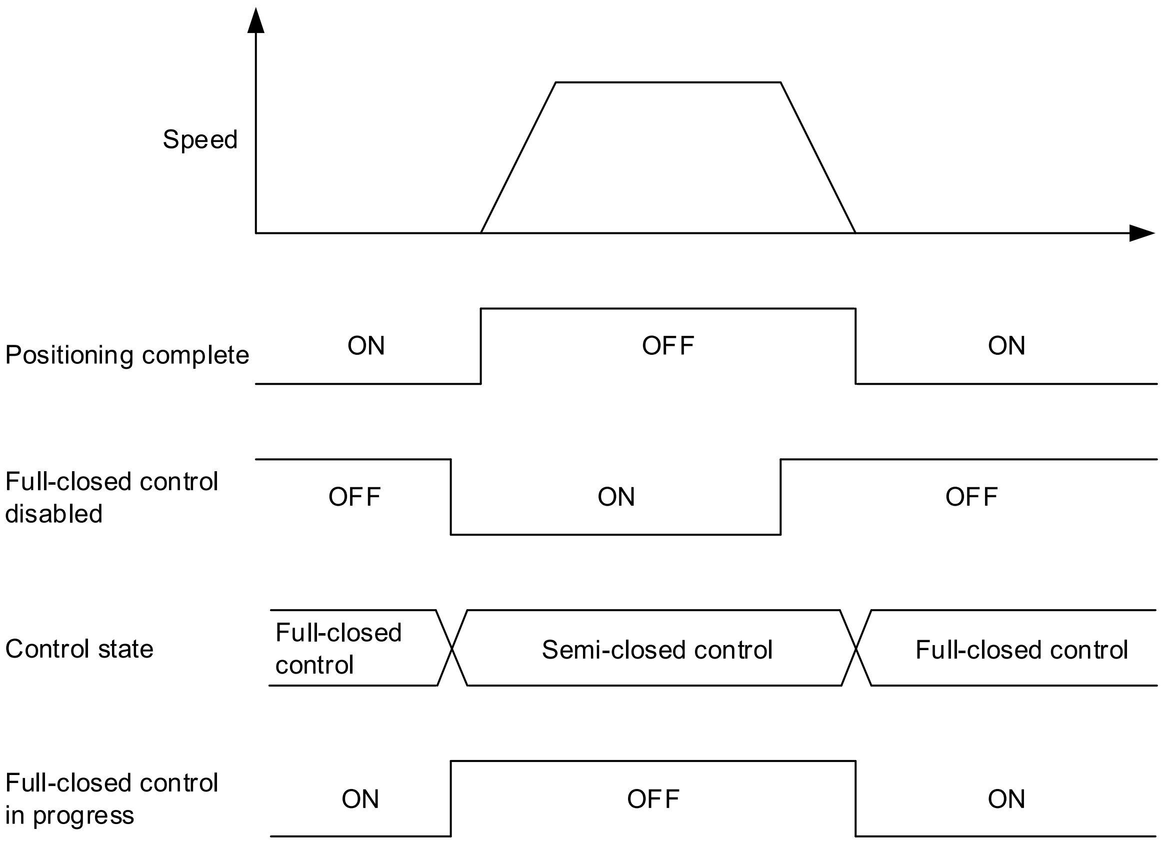
This signal turns ON during full-closed control.

This signal sets the parameter PA4_32 (fully closed system setting) to 1□□□ (fully closed system setting). This function is available only when "Stem enabled" is selected.

2

■ Function

This can be used as a signal to check the control status of the servo amplifier when switching the control status with the full-closed control invalid input signal



■ Parameter setting

To assign a full-closed control in progress signal to a sequence output signal, set a numerical value (48) corresponding to the output terminal function setting parameter.

External/motor deviation over forecast: Sequence output signal (Reference value 49)

This signal turns ON when the external/motor deviation exceeds the level set in the parameter.
This signal sets the parameter PA4_32 (full- closed system setting) to 1□□□ (full- closed system setting). This function is available only when "Stem enabled" is selected

■ Function

This relay turns ON when the external/motor deviation exceeds the setting value of PA4_37: External/motor deviation over-forecast value. It can be used when you want to know the timing to clear the external/motor deviation in a system that can tolerate a certain amount of error, such as when a deviation over alarm caused by external/motor deviation is known in advance, or when there is slippage in the motor shaft and mechanism.

■ Parameter setting

To assign an external/motor deviation over forecast signal to a sequence output signal, set a numerical value (49) corresponding to the output terminal function setting parameter.

Position preset completion: Sequence output signal (Reference value 75)

The signal is output after position preset (position change) is executed and completed.

■ Function

If position preset is executed in an established ABS system (absolute system) to reset from an alarm or change the current position, the sequence output corresponding to position preset completion is turned on after position preset is finished.

■ Parameter setting

To assign the position preset completion to a sequence output terminal, specify the corresponding value ("75") to the output terminal function setting parameter.

2

Interference detection: Sequence output signal (Reference value 86)

The signal turns on when the servo amplifier interference detection function detects interference.

This signal is valid only when parameter PA4_06 (interference detection enable/disable) is "1" (enable).

■ Function

The signal turns on when the function detects interference until the motor has been retracted to a position where no interference will occur, making it possible to verify whether the interference detection function has activated.

■ Parameter setting

To assign interference detection to a sequence output terminal, specify the value ("86") corresponding to the output terminal function setting parameter.

■ Relevant description

Refer to "3.8 Extension Function 2 Setting Parameters, 3.8.2 Description of Each Parameter" for details on the interference detection function.

■ How to return to regular operation

If the interference detection function is triggered and the servomotor has retreated in the direction of no interference, normal operation will be possible after the interference detection turns OFF.
However, one of the operations indicated in the following table will be required to recover normal operation.

Recovery method
・ Restart the servo amplifier. ・ Switch to the servo-off state. ・ Change Controlword (6040H) Fault reset (bit 7) from "OFF" to "ON".

In pp or hm mode, in addition to the above, operation is resumed by turning Controlword (6040H) bit 4 (New set-point (pp), Homing operation start (hm)) from OFF to ON.
However, the status prior to interference detection is not retained, and operation is performed with the status at the time of recovery as the initial status.

Function safety SS1: Sequence output signal (Reference value 89)

This signal turns on while the safe stop 1 (SS1) function is running.

This signal is valid only when using the SS1 function.

* The SS1 function is a function contained in safety module (WSU-ST1) function.

■ Function

The signal turns on while the function is running when the input terminal to which the SS1 function is assigned turns off (open circuit).

The signal turns off while the function is not running when the input terminal to which the SS1 function is assigned turns on (short circuit).

However, if used with restart function enabled, the signal turns off when operation is resumed after a restart signal has been input.

■ Parameter setting

To assign function safety SS1 to a sequence output terminal, specify the value (89) corresponding to the output terminal function setting parameter.

■ Relevant description

Refer to the User's Manual of function safety module (WSU-ST1) for details on the SS1 function.

Function safety SLS: Sequence output signal (Reference value 90)

This signal turns on while the Safe-Limited Speed (SLS) function is running.

This signal is valid only when using the SLS function.

* The SLS function is a function contained in function safety module (WSU-ST1).

■ Function

The signal turns on while the function is running when the input terminal to which the SLS function is assigned turns off (open circuit).

The signal turns off while the function is not running when the input terminal to which the SLS function is assigned turns on (short circuit).

However, if used with restart function enabled, the signal turns off when operation is resumed after a restart signal has been input.

■ Parameter setting

To assign function safety SLS to a sequence output terminal, specify the value (“90”) corresponding to the output terminal function setting parameter.

■ Relevant description

Refer to the User's Manual of function safety module (WSU-ST1) for details on the SLS function.

Digital output1: Sequence output signal (Reference value 91)
Digital output2: Sequence output signal (Reference value 92)

This function is used to output digital output signals from hardware OUT signals.

■ Function

Signals set at 60FEH_01H: Physical outputs can be output from hardware OUT signals (OUT1 to 2).

■ Parameter setting

To assign a Digital Output signal to a sequence output terminal, set the values (91, 92) corresponds to the parameter of output terminal function setting. The setting values to the relevant signals are as follows.

PA3_51 to 52

No.	Name	Setting range	Change
51	OUT1 signal assignment	0 to 92 91 : Digital output1 92 : Digital output2	Power
52	OUT2 signal assignment		

2.6 Connection Example to Host Controller

For products not described in this manual, be sure to refer to the manual attached to the corresponding product.
Connector 4 (CN4) is for the PC Loader. It is irrelevant to operation or stopping of the servomotor.
To drive a servomotor, the main power and control power must be supplied. To edit parameters or perform similar operation without rotating the motor, supply only the control power.
Prepare separate power supplies for 24 [V] DC sequence I/O (CN1) and 24 [V] DC brake.
This is to isolate the effects of voltage fluctuation caused by counter electromotive force generated by power-on and -off of the brake coil. There is no polarity in the brake power supply input.
Connector 5 (CN5) connection is used for linear scale feedback, or for wiring the DD motor (scheduled for support in near future).
The connector 6 (CN6) connection is a safety terminal. Wire if necessary. Refer to "2.7 Safety Function" for details.

2.7 Safety Function

2.7.1 Overview

With the ALPHA7 Series, the servo amplifier output transistor is stopped by hardware circuit, and the motor is slowly stopped (free-run stop) by opening (turning OFF) safety device connection connector CN6 [EN1+] and [EN2+] inputs. This is the Cat.0 (uncontrolled stoppage) safety stop function (STO) regulated by EN60204-1, and complies with functional safety standards.
If constructing a safety system, a safety shutoff device was required outside the servo amplifier, however, this is no longer required by using the safety stop function (STO).

Table 2.7.1-1 Functional safety performance

EN ISO 13849-1: 2015		
	Category	3
	Performance level	e
	Average diagnostic coverage	90% or higher (DCave medium)
	Response time / Fault reaction time	50 ms or less (response time)
	Mean time to dangerous failure for each channel	62 years or longer (MTTFd)
EN 61508-1 to -7 EN 61800-5-2		
	Safety function	Output torque OFF function (STO)
	Safety level	SIL3
	Hardware fault tolerance	1 (HFT)
	Safe failure fraction	90% or higher (SFF)
	Probability of failure per hour	Less than 1.5 x 10^{-8} (PFH)
	Probability of failure on demand average [h^{-1}]	Less than 1.5 x 10^{-4} (PFDavg)
	Proof test interval	10 years

WARNING

- The servo amplifier output cutoff function uses the safety stop function (STO) regulated by IEC61800-5-2, however, this is not designed to completely cut off the power supply and motor electrically. Consequently, depending on the servo system application, it will be necessary to employ such mechanisms as a brake for mechanical locking, or motor terminal protection to prevent electric shock in order to ensure the safety of end users.
- The servo amplifier output cutoff function does not completely cut off the power supply and motor electrically, and therefore the servo amplifier power supply should be completely cut off, and wiring and maintenance work carried out after 5 minutes or longer have elapsed.
  Voltage occurs at the servomotor terminals during free-run triggered by the output cutoff function, and therefore maintenance, inspection, and wiring work should be carried out after ensuring that the servomotor has come to a complete stop.

Failure to observe this could result in electric shock.

2.7.2 Usage Precautions

2.7.2.1 Terminal Wiring

The [EN1+], [EN1-], [EN2+], and [EN2-] terminals are used for safety circuit wiring. When carrying out terminal wiring, use shielded wire, and wire in such a way as to ensure no shorting between terminals.

- For terminal input, performing switching with devices such as safety switches or safety relays certified for safety level of EN ISO13849-1 PL=e Cat.3 or higher to ensure that inputs can be properly opened.
- The machine manufacturer must take responsibility for ensuring that there is no shorting or other faults in the wiring of external safety devices connected between the [EN1+] and [EN2+] terminals and 24 V power supply.

  Example:
  - Current may continue to flow to the [EN1+] and [EN2+] terminals, hindering the safety function, even if the [EN1+] or [EN2+] terminal wiring becomes trapped in the control panel doors, causing a short circuit, and safety components turn OFF.
  - Current may continue to flow to the [EN1+] and [EN2+] terminals, hindering the safety function if the safety circuit wiring comes into contact with other wiring.

2.7.2.2 Safety Stop Function (STO) Related Precautions

- If constructing a product safety system with the safety stop function (STO), the machine manufacturer is responsible for carrying out a risk assessment not of external devices and wiring connected to the [EN1+] and [EN2+] terminals, but of the entire machinery including other equipment, devices, or wiring for product safety systems required by the manufacturer, and for ensuring that the entire machinery is compatible with the product safety system. Furthermore, a periodic inspection must be carried out to determine whether the product safety system is functioning properly for the purpose of preventive maintenance.
- To comply with functional safety, install the servo amplifier inside a control panel offering protective construction of IP54 or higher.
- To comply with functional safety, it is also necessary to comply with European standards EN61800-5-1 and EN61800-3.
- The safety stop function (STO) is designed to slowly stop motors (free-run stop).
- Input a test pulse to the [EN1+] and [EN2+] terminals for less than 1 ms when performing a diagnosis with the safety PLC.
- Turn input terminals OFF for 20 ms or longer to activate the safety stop function (STO) properly.

- Employ double [EN1+] and [EN2+] inputs (with redundancy circuit) to ensure that the safety stop function (STO) is not lost due to a single fault.
  If a single fault is detected by the safety cutoff circuit, an alarm is output to external devices, and the servo amplifier slowly stops the motor (free-run stop), even if the [EN1+] and [EN2+] status is ON. (The alarm output function does not guarantee that an alarm will be output for all single faults, however, compatibility with EN ISO13849-1 PL=e Cat. 3 is possible.)
- The safety stop function (STO) is not designed to completely cut off the power supply and motor electrically. Cut off the servo amplifier input power supply completely, and begin wiring and maintenance work after 5 minutes or longer have elapsed.

A motor rotation equivalent to electrical angle of 180° may occur following a servo amplifier fault. Employ designs that present no danger based on load conditions.

2.7.2.3 Safety Stop (STO) Test

Conduct a check once a day to ensure that the safety stop function (STO) is functioning normally.

2.7.3 Specifications

2.7.3.1 Function Block Diagram

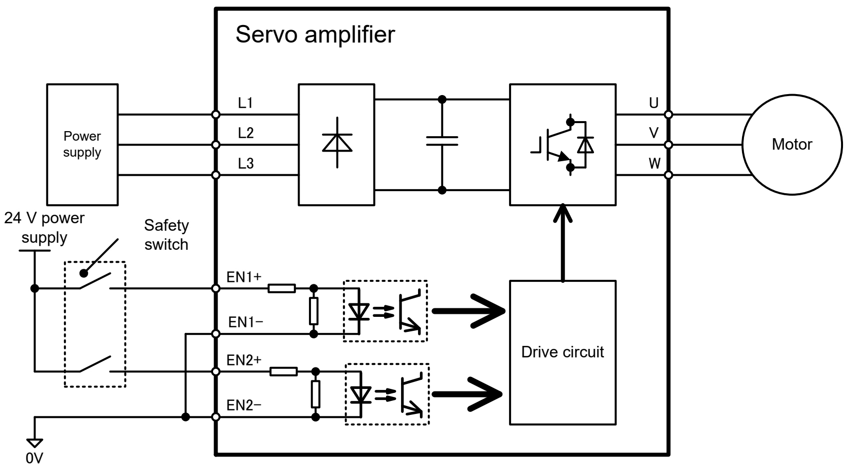


Fig. 2.7.3-1 Function block diagram

2.7.3.2 Operating Sequences

The signal ON/OFF definition given in the safety function description refers to the following statuses.

ON: The safety switch is closed, and current is flowing to the signal line.

OFF: The safety switch is open, and current is not flowing to the signal line.

(1) Servo amplifier output status if safety stop function (STO) activated

The servo amplifier will be in the safety stop (STO) condition if [EN1+] and [EN2+] are turned OFF. Fig. 2.7.3-2 shows the servo amplifier output status if [EN1+] and [EN2+] are turned OFF while the servo amplifier is stopped. Preparation for servo amplifier operation will be complete when [EN1+] and [EN2+] input turn ON.

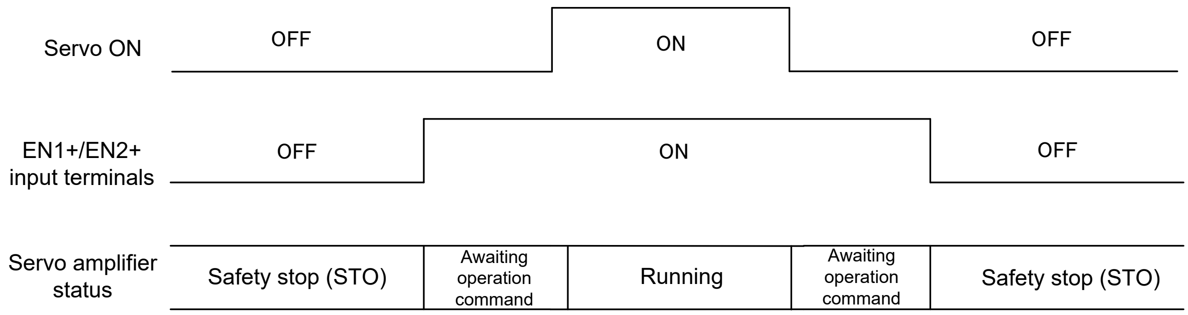


Fig. 2.7.3-2 Servo amplifier output status if safety stop (STO) occurs while servo amplifier stopped

Fig. 2.7.3-3 shows the timing chart when the EMERGENCY STOP button is pushed during servo amplifier operation. Input to [EN1+] and [EN2+] turns OFF, the servo amplifier is in the safety stop (STO) condition, and the motor comes to a slow stop (free-run stop).

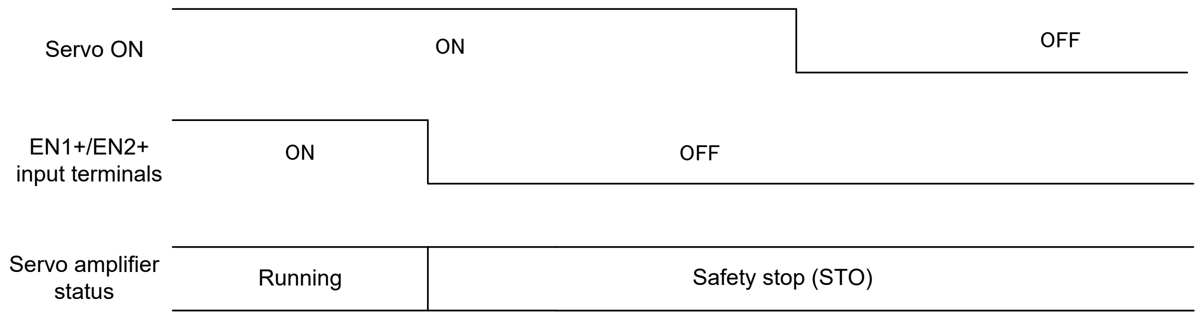


Fig. 2.7.3-3 Servo amplifier output status if safety stop (STO) occurs during servo amplifier operation

(2) SFtY alarm (logic mismatch) and servo amplifier output status

Fig. 2.7.3-4 shows the timing chart for the SFtY alarm following an [EN1+] and [EN2+] input mismatch.

The servo amplifier will be in the safety stop (STO) condition if [EN1+] and [EN2+] input turns OFF. If the [EN1+] and [EN2+] input mismatch lasts longer than 50 ms, the servo amplifier will interpret that logic is in disagreement, and an SFtY alarm is output. The alarm is cleared when the power is rebooted.

To correctly diagnose the safety stop function (STO) by turning the [EN1+] and [EN2+] terminal ON and OFF, turn [EN1+] and [EN2+] ON and OFF for 2.0 seconds or longer.

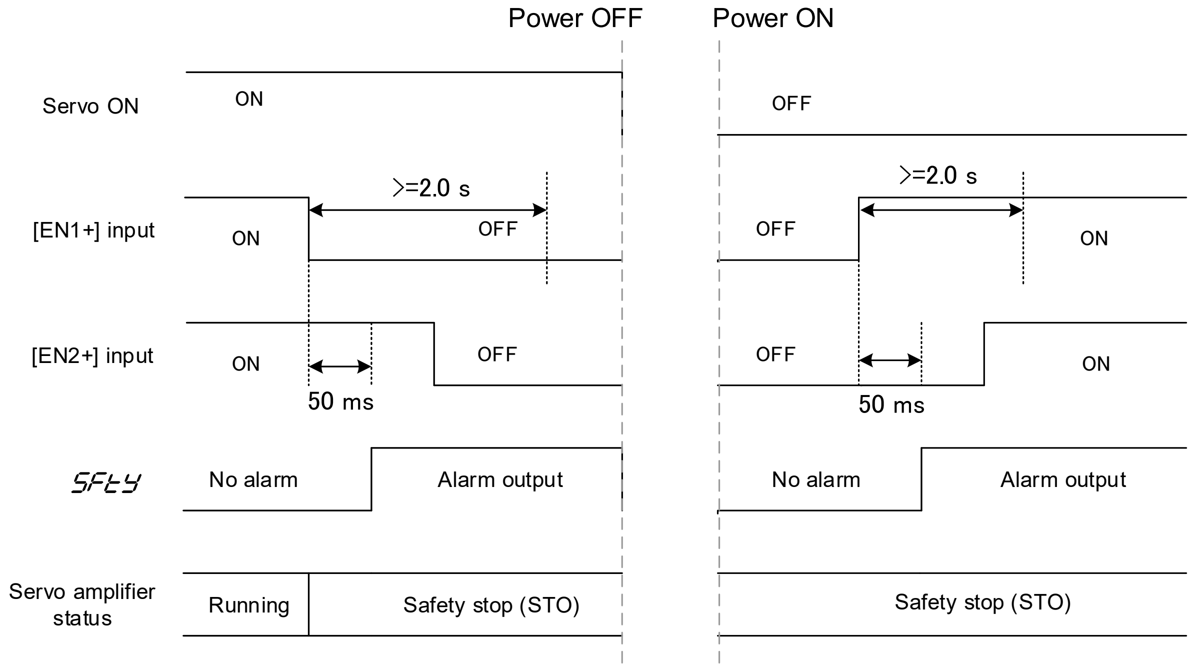


Fig. 2.7.3-4　SFtY alarm (logic mismatch) and servo amplifier output status

2.7.3.3 Description of Signals

The signal specifications for the safety device connection connector (CN6) are shown below.

No.	Symbol	Specification
1	N.C	Use is prohibited. Do not wire.
2	N.C	Use is prohibited. Do not wire.
3	EN1-	This is the [EN1+] input signal common terminal.
4	EN1+	This is the safety stop (STO) input signal. The servo amplifier will be in the safety stop (STO) condition when input is OFF. • Input voltage: 24 VDC ±10% • Current when ON: 10mA or less • Turn ON/OFF simultaneously with the [EN2+] terminal.
5	EN2-	This is the [EN2+] input signal common terminal.
6	EN2+	This is the safety stop (STO) input signal. The servo amplifier will be in the safety stop (STO) condition when input is OFF. • Input voltage: 24 VDC ±10% • Current when ON: 10mA or less • Turn ON/OFF simultaneously with the [EN1+] terminal.
7	EDM-	This signal outputs the safety stop function (STO) operating status. • Max. voltage: 30 VDC • Max. ON current: 50mA
8	EDM+	(see below)

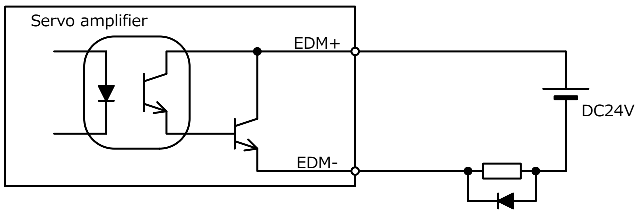


Fig. 2.7.3-5 Connection drawing

Input signal		SFtY alarm	Output signal	Servo amplifier status
[EN1+]	[EN2+]		[EDM] *1	
ON	ON	Not output	OFF	Operation preparation complete
		Output	OFF	Safety stop (STO)
OFF	OFF	Not output	ON	Safety stop (STO)
		Output	OFF	Safety stop (STO)
ON	OFF	Output	OFF	Safety stop (STO)
OFF	ON	Output	OFF	Safety stop (STO)

*1 EDM output ON/OFF is defined as follows.
ON: Status in which the transistor between the [EDM+] and [EDM-] terminals is ON
OFF: Status in which the transistor between the [EDM+] and [EDM-] terminals is OFF

CHAPTER 3   PARAMETER

3.1 Parameter Division

⚠ CAUTION

- Never add an extreme change to parameters. Otherwise machine motion will become unstable.
  Risk of injuries
- In addition to parameters, VC type amplifiers are equipped with a function used to adjust operation with an Object Dictionary.
  Refer to “15.1.14 Servo Amplifier Profile Objects” for details on the Object Dictionary.

Parameters of the ALPHA7 servo amplifiers are divided into the following setting items according to the function.

Parameter setting item	Major description	Ref. chapter
Basic parameters (No.PA1_01 to 50)	Be sure to check or enter these parameters before starting operation.	3.2
Control gain and filter setting parameters (No.PA1_51 to 99)	Use to adjust the gain manually.	3.3
Automatic operation setting parameters (No.PA2_01 to 50)	Use to specify settings for, or make changes to functions relating to automatic operation.	3.4
Extension function 1 setting parameters (No.PA2_51 to 99)	Use to enter or change the extended functions such as the torque limit.	3.5
Input terminal function setting parameters (No.PA3_01 to 50)	Use to enter or change input signals of the servo amplifier.	3.6
Output terminal function setting parameters (No.PA3_51 to 99)	Use to enter or change output signals of the servo amplifier.	3.7
Extension function 2 setting parameters (No.PA4_01 to 99)	Use to specify settings for, or make changes to functions newly supported from the ALPHA7 Series.	3.8

3.2 Basic Parameters

Note	Parameters marked "○" in the "Power" field are enabled after the control power is turned off then turned on again. (Check that the keypad (7-segment display) of the servo amplifier is unlit when the control power is turned off.)

3.2.1 List (PA1_□□)

<table>
<tr><th rowspan="2">No.
PA1_</th><th rowspan="2">Name</th><th rowspan="2">Default value</th><th rowspan="2">Power</th><th colspan="3">Control mode</th><th rowspan="2">Record of reference value</th></tr>
<tr><th>Position</th><th>Speed</th><th>Torque</th></tr>
<tr><td>02</td><td>INC/ABS system selection</td><td>0</td><td>○</td><td>○</td><td>○</td><td>○</td><td></td></tr>
<tr><td>04</td><td>Rotation direction selection</td><td>0</td><td>○</td><td>○</td><td>○</td><td>○</td><td></td></tr>
<tr><td>12</td><td>Z-phase position offset</td><td>0</td><td>○</td><td>○</td><td>○</td><td>○</td><td></td></tr>
<tr><td>13</td><td>Tuning mode selection</td><td>0</td><td>-</td><td>○</td><td>○</td><td>○</td><td></td></tr>
<tr><td>14</td><td>Load inertia ratio</td><td>1.0</td><td>-</td><td>○</td><td>○</td><td>○</td><td></td></tr>
<tr><td>15</td><td>Auto tuning gain 1</td><td>12</td><td>-</td><td>○</td><td>○</td><td>○</td><td></td></tr>
<tr><td>16</td><td>Auto tuning gain 2</td><td>4</td><td>-</td><td>○</td><td>-</td><td>-</td><td></td></tr>
<tr><td>20</td><td>Easy tuning: stroke setting</td><td>2.00</td><td>-</td><td>○</td><td>○</td><td>○</td><td></td></tr>
<tr><td>21</td><td>Easy tuning: speed setting</td><td>500.00</td><td>-</td><td>○</td><td>○</td><td>○</td><td></td></tr>
<tr><td>22</td><td>Easy tuning: timer setting</td><td>1.500</td><td>-</td><td>○</td><td>○</td><td>○</td><td></td></tr>
<tr><td>23</td><td>Easy tuning: direction selection</td><td>0</td><td>-</td><td>○</td><td>○</td><td>○</td><td></td></tr>
<tr><td>25</td><td>Max. rotation speed
(for position and speed control)</td><td rowspan="2">6000.00
（GYS,GYB 750W or less）
5000.00 (GYS 1kW or more)
3000.00 (GYG)</td><td>-</td><td>○</td><td>○</td><td>-</td><td></td></tr>
<tr><td>26</td><td>Max. rotation speed
(for torque control)</td><td>-</td><td>-</td><td>-</td><td>○</td><td></td></tr>
<tr><td>27</td><td>Forward rotation torque limit</td><td rowspan="2">350: GYB
300: other than GYB</td><td>-</td><td>○</td><td>○</td><td>○</td><td></td></tr>
<tr><td>28</td><td>Reverse rotation torque limit</td><td>-</td><td>○</td><td>○</td><td>○</td><td></td></tr>
<tr><td>29</td><td>Speed coincidence range</td><td>50</td><td>-</td><td>○</td><td>○</td><td>-</td><td></td></tr>
<tr><td>30</td><td>Zero speed range</td><td>50</td><td>-</td><td>○</td><td>○</td><td>○</td><td></td></tr>
<tr><td>37</td><td>Acceleration time 1</td><td>100.0</td><td rowspan="2">-</td><td>○</td><td>○</td><td>○</td><td></td></tr>
<tr><td>38</td><td>Deceleration time 1</td><td>100.0</td><td>○</td><td>○</td><td>○</td><td></td></tr>
<tr><td>41</td><td>Manual feed speed 1/speed limit 1 for torque control</td><td>100.00</td><td rowspan="7">-</td><td>○</td><td>○</td><td>○</td><td></td></tr>
<tr><td>42</td><td>Manual feed speed 2/speed limit 2 for torque control</td><td>500.00</td><td>○</td><td>○</td><td>○</td><td></td></tr>
<tr><td>43</td><td>Manual feed speed 3/speed limit 3 for torque control</td><td>1000.00</td><td>○</td><td>○</td><td>○</td><td></td></tr>
<tr><td>44</td><td>Manual feed speed 4/speed limit 4 for torque control</td><td>100.00</td><td>○</td><td>○</td><td>○</td><td></td></tr>
<tr><td>45</td><td>Manual feed speed 5/speed limit 5 for torque control</td><td>100.00</td><td>○</td><td>○</td><td>○</td><td></td></tr>
<tr><td>46</td><td>Manual feed speed 6/speed limit 6 for torque control</td><td>100.00</td><td>○</td><td>○</td><td>○</td><td></td></tr>
<tr><td>47</td><td>Manual feed speed 7/speed limit 7 for torque control</td><td>100.00</td><td>○</td><td>○</td><td>○</td><td></td></tr>
</table>

Parameters marked "○" in the table are enabled in the corresponding control mode.

3

3.2.2 Description of Each Parameter

PA1_02 INC/ABS system selection

No.	Name	Setting range	Default value	Change
02	INC/ABS selection	0: Incremental system 1:Absolute system 2: Non-overflow absolute system	0	Power

Select either the relative position (incremental) system or absolute position system.

Reference value	Function	Description
0	Relative position (incremental) system	The current position is lost after the control power is turned off. Homing must be performed again.
1	Absolute position system	The current position is stored in memory even after the control power is turned off. Homing is unnecessary. You can operate in the limited range. If the operation range is exceeded, an alarm and stoppage are caused. (Operation range: between -32767 and +32766 revolutions of motor shaft)
2	Non-overflow absolute system (not detect the multi-turn overflow)	The current position is stored in memory even after the control power is turned off. Homing is unnecessary. Because there is no limit in the operation range, this system is best for the control of the rotating body. (The multi-turn data over flow alarm is not detected.) Multi-rotation data should be processed at the host controller suitably. Refer to ■ Precautions when setting endless ABS for precaution relating to this setting value.

To establish an absolute position system, set this parameter at "1" or "2." In addition, install the optional absolute backup battery.
Because a multi-rotation data loss alarm (dL1 alarm) is detected when the power is turned on, perform position presetting to remove the alarm and start operation.

- To use in an absolute position system, refer to "CHAPTER 10 ABSOLUTE POSITION SYSTEM."

■ Precaution when setting ABS, endless ABS

<Precaution on electronic gear settings>

(1) Set electronic gears as follows.
When setting ABS: 6091H-01H: Motor revolutions / 6091H-02H: Shaft revolutions $\geq 2^8$
When setting endless ABS: 6091H-01H: Motor revolutions / 6091H-02H: Shaft revolutions = 2^n ($n \geq 8$)
With single-turn counter of 24 bits, and multi-turn counter of 16 bits, the ABS encoder functions as a ring counter with a total of 40 bits. As the current position output to the host device at the EtherCAT Object is 32-bit data, it is necessary to ensure the appropriate size when setting electronic gears.

■ Setting endless ABS in pp mode

"pp mode is not compatible with the endless ABS system. Operation is not guaranteed when endless ABS is set, and therefore it must never be set."

3

PA1_04 Rotation direction selection

No.	Name	Setting range	Default value	Change
04	Rotation direction selection	0: CCW direction with positive value 1: CW direction with positive value	0	Power

This parameter ensures that the servomotor rotation direction matches the machine travel direction.

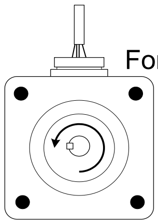
If performing operation based on position control (csp, pp)
Select the rotation position when the Target Position (command position) is greater than the Actual Position Value (feedback position).

If performing operation based on speed control (csv, pv)
Select the servomotor rotation direction when a positive value is set for Target Velocity.

If performing operation based on torque control (cst)
Select the direction in which the servomotor applies torque when a positive value is set for Target Torque.

■ Forward rotation/reverse rotation

The counterclockwise direction (CCW: diagram on right) when the servomotor output shaft is viewed from the front is forward rotation. The clockwise direction (CW) is reverse rotation.



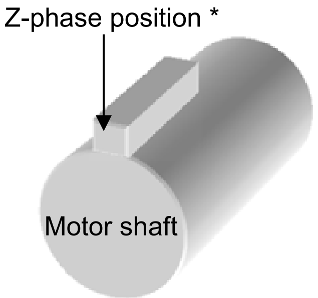
PA1_12 Z-phase position offset

No.	Name	Setting range	Default value	Change
12	Z-phase position offset	0 to 16777215 [pulse]	0	Power

The Z-phase output position shifts. The Z-phase output position shifts in the CCW direction by the specified pulse amount.
This parameter is irrelevant to the rotation direction selection (parameter PA1_04).
This setting is invalid for the external encoder Z-phase (enabled only for the encoder Z-phase).

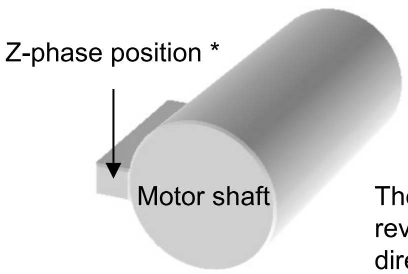
■ Z-phase output position

・If the Z-phase position offset is [0]



・If the Z-phase position offset is [4194304]

$$\frac{4194304 \text{ pulses}}{16777216 \text{ pulses/revolution}} = 0.25 \text{ [revolutions]}$$



* The position of the key is not always the Z-phase position.
The position of the key is supposed to be the Z-phase position in this explanation.

PA1_13 Tuning mode selection

No.	Name	Setting range	Default value	Change
13	Tuning mode selection	0: Auto tuning 1: Semi-auto tuning 2: Manual tuning 3: Interpolation control mode	0	Always

Select the tuning method of the servo amplifier. Refer to the following description to select the mode.

3

- Auto tuning (default value)

  In this mode, the ratio of moment of inertia of the load of the machine is always assumed inside the amplifier and the gain is automatically adjusted to the best one. "0" is entered, too, in case of easy tuning.

- Semi-auto tuning

  Use this mode if the load inertia ratio of the machine has relatively large fluctuation or the load inertia ratio is not estimated correctly inside the amplifier.
  The gain is automatically adjusted to the best one in relation to the setting of PA1_14 (load inertia ratio).

- Manual tuning

  Use this mode if auto tuning and semi-auto tuning modes do not function satisfactorily. Manually enter the load inertia ratio and various gains.

- Interpolation control mode

  Use this mode to adjust responses of each shaft to the command during interpolation of two or more servomotor axes of an X-Y table or similar.
  In this mode, PA1_51 (moving average S-curve time) and PA1_54 (position command response time constant) that determine the following characteristics to commands must be entered manually.
  As well, PA1_14 (load inertia ratio) must be entered, too, manually.
  The other gain adjustment parameters are automatically entered.

Parameters that must be entered in each tuning mode and automatically adjusted parameters are shown below.

No. PA1_	Name	Tuning mode selection			
		0: Auto	1: Semi-auto	2: Manual	3: Interpolation control
14	Load inertia ratio	-	○	○	○
15	Auto tuning gain 1	○	○	×	○
51	Moving average S-curve time	-	-	○	○
54	Position command response time constant	-	-	○	○
55	Position loop gain 1	-	-	○	-
56	Speed loop gain 1	-	-	○	-
57	Speed loop integration time constant 1	-	-	○	-
59	Torque filter time constant for position and speed control	△	△	△	△
87	Model torque filter time constant	-	-	○	-
88	Position loop integration time constant	-	-	○	-

○: Items that must be entered

△: The item is entered automatically or manually according to a parameter (PA1_94: torque filter setting mode).

- : Entry is unnecessary. (The item is automatically calculated inside the amplifier and the result is reflected on the parameter.)

×: Entry can be made, but the setting is ineffective.

- For detail description of tuning, refer to "CHAPTER 5 SERVO ADJUSTMENT."

PA1_14 Load inertia ratio

No.	Name	Setting range	Default value	Change
14	Load inertia ratio	GYS and GYB, 750 W or less: 0.0 to 300.0 [times] GYS, 1 kW or more: 0.0 to 100.0 [times] GYG : 0.0 to 30.0 [times]	1.0	Always

Enter the moment of inertia of the load of the mechanical system in relation to the motor shaft (moment of inertia of load converted to motor shaft) in a ratio to the moment of inertia of the motor.

$$\text{Load inertia ratio} = \frac{\text{Load inertia of converted to motor shaft}}{\text{Inertia of motor}}$$

The parameter must be entered according to some settings of PA1_13 (tuning mode selection).
With auto tuning, the value is automatically updated and saved in EEPROM every 10 minutes.
The value must be entered in the semi-auto, manual and interpolation control modes.

3

■ How to enter the ratio of inertia of load

(1) Setting the monitored value

Monitoring can be performed with the PC Loader monitor function (digital monitor).

Enter the monitored value.

- If the value drifts, enter an average value.
  If fluctuation is substantial and the ratio of the maximum to the minimum exceeds two, adopt entry method (2).

(2) Entering the calculated value

Calculate the moment of inertia of load converted to the motor shaft and enter the ratio to the moment of inertia of the motor. For the moment of inertia calculation method, refer to "CHAPTER 15 APPENDIXES"

PA1_15 Auto tuning gain 1

No.	Name	Setting range	Default value	Change
15	Auto tuning gain 1	1 to 40 (in increments of 1)	12	Always

Specify the response of the servomotor of auto tuning, semi-auto tuning and interpolation control modes.
This parameter adjusts the disturbance response. Increasing the parameter value shortens the command following characteristic and positioning settling time, however, a too large value causes vibration of the motor.

Approximate reference value

Mechanical configuration (division by mechanism)	Auto tuning gain 1 (approximate reference value)
Large transfer machine	1 to 10
Arm robot	5 to 20
Belt mechanism	10 to 25
Ball screw + Belt mechanism	15 to 30
Mechanism directly coupled with ball screw	20 to 40

- For details of tuning, refer to "CHAPTER 4 SERVO ADJUSTMENT."

PA1_16 Auto tuning gain 2

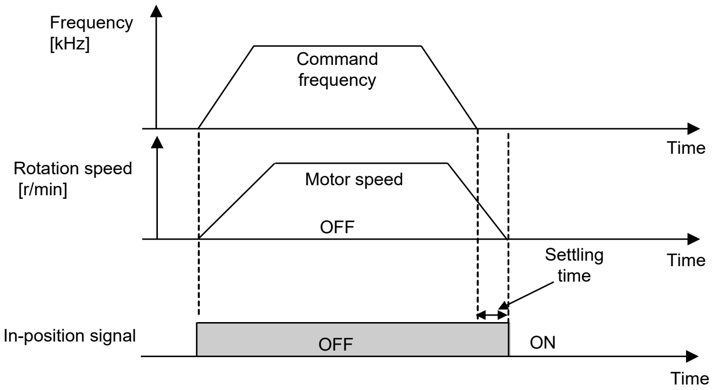
No.	Name	Setting range	Default value	Change
16	Auto tuning gain 2	1 to 12 (in increments of 1)	4	Always

This parameter is enabled only under position control.
The parameter is enabled if PA1_13 (tuning mode selection) is 0 (auto tuning) or 1 (semi-auto tuning).
This parameter adjusts the command response. Adjust auto tuning gain 1 before adjusting this parameter.
With this parameter, the positioning settling time of auto tuning and semi-auto tuning is reduced, so that the cycle time is effectively reduced. While a larger value reduces the positioning settling time, an overshoot is likely to be caused.
PA1_51 (moving average S-curve time) and PA1_54 (position command response time constant) are automatically adjusted in relation to the reference value of this parameter.

Hint

What is positioning settling time

Time from completion of issuance of command frequency to issuance of in-position signal
The time varies according to various conditions such as the frequency matching the traveling distance, acceleration/deceleration rate, and stopping accuracy. Adjustment of the entire system including the host and servo to optimum conditions is necessary to reduce the positioning settling time.



- For details of tuning, refer to "CHAPTER 4 SERVO ADJUSTMENT."

PA1_20 to 23 Easy tuning settings

No.	Name	Setting range	Default value	Change
20	Easy tuning: stroke setting	0.01 [rev] to 200.00 [rev] (in increments of 0.01)	2.00	Always
21	Easy tuning: speed setting	10.00 [r/min] to Max. rotation speed [r/min] (in increments of 0.1)	500.00	Always
22	Easy tuning: timer setting	0.000 [s] to 5.000 [s] (in increments of 0.001)	1.500	Always
23	Easy tuning: direction selection	0: Forward ⇔ reverse rotation 1: Forward rotation only 2: Reverse rotation only	0	Always

Enter the parameter to perform easy tuning.

- For details of tuning, refer to "CHAPTER 4 SERVO ADJUSTMENT."

PA1_25 Max. rotation speed (for position and speed control)
PA1_26 Max. rotation speed (for torque control)

No.	Name	Setting range	Default value	Change
25	Max. rotation speed (for position and speed control)	GYS and GYB, 750 W or less : 0.01 to 6000 [r/min] GYS,1 kW or more : 0.01 to 5000 [r/min] GYG : 0.01 to 3000 [r/min]	6000 (GYS and GYB of 750 W or less) 5000 (GYS of 1 kW or more) 3000 (GYG)	Always
26	Max. rotation speed (for torque control)			

Enter the maximum rotation speed of the sevomotor for position, speed and torque control.

There is a difference of about 100 [r/min] between the reference value and actual servomotor rotation speed under torque control when PA4_21 (torque control speed limit method) is set to "1" (older model compatibility).

In this case, use PA1_96 (speed limit gain for torque control) to adjust the error.

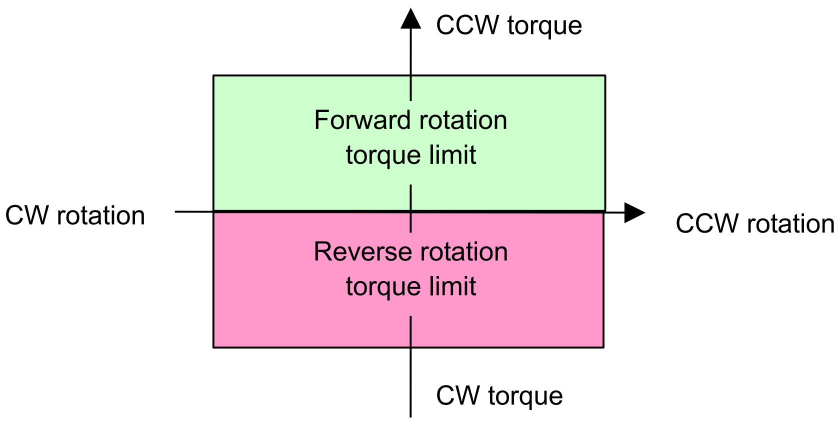
Note

- When performing csp operation, ensure that commands from the host device do not apply to speed limiting.
- Operation should normally be performed with command values which ensure a speed of PA1_25: Max. rotation speed (for position and speed control) or less.
- The motor will move as follows if the command applies to speed limiting.
  - (1) A position deviation will occur if a command exceeding the speed limit value is issued, and will continue to build up while the command is applied to speed limiting.
  - (2) If the position deviation builds to the PA2_69: Deviation detection overflow value, a deviation over alarm will occur.
  - (3) If the command is reduced to a value smaller than the speed limit value before the deviation over alarm occurs, the motor will continue to rotate due to speed limiting until the built up position deviation is offset, and subsequent operation will be based on the command.
  - (4) If the speed limit value increases before the deviation over alarm occurs, the motor will accelerate to the speed limit value.
    - If the speed limit value becomes greater than the command value, the operation will be as described in item (3).
    - If the speed limit value remains smaller than the command value, the operation will be as described in items (1) and (2).

PA1_27 Forward rotation torque limit
PA1_28 Reverse rotation torque limit

No.	Name	Setting range	Default value	Change
27	Forward rotation torque limit	GYB: 0 [%] to 350 [%] Other than GYB: 0 [%] to 300 [%]	GYB: 350 [%] Other than GYB: 300 [%]	Always
28	Reverse rotation torque limit			

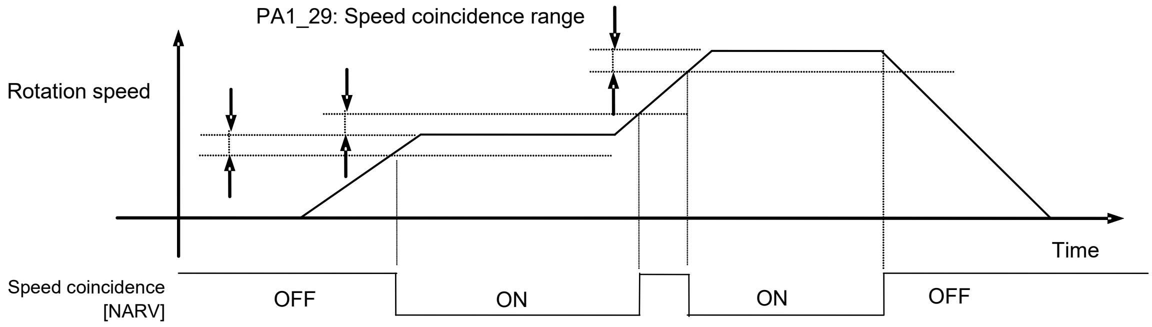
Enter the limit to be set on the output torque of the servomotor.
This limit value is valid when PA2_57 (Torque limit setting) is set to "0" (Parameter).



PA1_29 Speed coincidence range

No.	Name	Setting range	Default value	Change
29	Speed coincidence range	10 [r/min] to max. rotation speed [r/min]	50	Always

Enter the range in which the "speed coincidence" output signal is turned on.
The speed coincidence signal is turned on if the actual servomotor rotation speed is nearly the command speed.
In case of a default value of 50 [r/min], the speed coincidence signal is turned on in the range of ±50 [r/min] to the command speed.
The signal turns off if the command speed is not reached at PA1_25 (Max. rotation speed), etc.



- For the speed coincidence signal, refer to "Speed coincidence [NARV]" 2.5.3 Signal Descriptions.

PA1_30 Zero speed range

No.	Name	Setting range	Default value	Change
30	Zero speed range	10 [r/min] to max. rotation speed [r/min]	50	Always

Enter the activation level of the "zero speed" output signal.
The signal is turned on at servomotor rotation speeds within the reference value.

PA1_37 Acceleration time (manual operation)
PA1_38 Deceleration time (manual operation)

No.	Name	Setting range	Default value	Change
37	Acceleration time 1	0.0 [ms] to 99999.9 [ms]	100.0	Always
38	Deceleration time 1		100.0	

Sets the servomotor acceleration and deceleration time.
The parameter is enabled for acceleration and deceleration movement when performing speed control or position control (manual operation), and for speed limit acceleration and deceleration movement when performing torque control (manual operation).
Acceleration and deceleration follow these parameters during profile operation, too.
These parameters are disabled when performing operation with commands from EtherCAT.
The time set for this parameter is the time taken for the motor to reach 2000 [r/min] from 0 [r/min].

PA1_41 to 47 Manual feed speed 1 to 7/speed limit 1 to 7 for torque control

No.	Name	Setting range	Default value	Change
41	Manual feed speed 1/speed limit 1 for torque control	0.01 [r/min] to max. rotation speed [r/min]	100.00	Always
42	Manual feed speed 2/speed limit 2 for torque control		500.00	Always
43	Manual feed speed 3/speed limit 3 for torque control		1000.00	Always
44	Manual feed speed 4/speed limit 4 for torque control		100.00	Always
45	Manual feed speed 5/speed limit 5 for torque control		100.00	Always
46	Manual feed speed 6/speed limit 6 for torque control		100.00	Always
47	Manual feed speed 7/speed limit 7 for torque control		100.00	Always

The speed set with these parameters is for test operation.

When PA2_56 (torque control speed limit selection) is set to "1", the speed limit values when performing torque control (manual operation) will be valid.

3.3 Control Gain and Filter Setting Parameters

Note	Parameters marked "○" in the "Power" field is enabled after the control power is turned off then turned on again. (Check that the keypad (7-segment display) of the servo amplifier is unlit when the control power is turned off.)

3.3.1 List (PA1_□□)

3

Default value: *** Determined in auto tuning.

No. PA1_	Name	Default value	Power	Control mode			Record of reference value
				Position	Speed	Torque	
51	Moving average S-curve time	***	-	○	-	-	
52	Low-pass filter (for S-curve) time constant	0.0	-	○	○	-	
53	Command pulse smoothing function	0	-	○	-	-	
54	Position command response time constant	***	-	○	-	-	
55	Position loop gain 1	***	-	○	-	-	
56	Speed loop gain 1	***	-	○	○	○	
57	Speed loop integration time constant 1	***	-	○	○	○	
58	Feed forward gain 1	0.000	-	○	-	-	
59	Torque filter time constant for position and speed control	***	-	○	○	-	
60	Torque filter time constant for torque control	0.00	-	-	-	○	
61	Gain changing factor	1	-	○	○	-	
62	Gain changing level	50	-	○	○	-	
63	Gain changing time constant	1	-	○	○	-	
64	Position loop gain 2	100	-	○	-	-	
65	Speed loop gain 2	100	-	○	○	○	
66	Speed loop integration time constant 2	100	-	○	○	○	
67	Feed forward gain 2	100	-	○	-	-	
70	Automatic notch filter selection	1	-	○	○	-	
71	Notch filter 1, frequency	4000	-	○	○	-	
72	Notch filter 1, attenuation	0	-	○	○	-	
73	Notch filter 1, width	2	-	○	○	-	
74	Notch filter 2, frequency	4000	-	○	○	-	
75	Notch filter 2, attenuation	0	-	○	○	-	
76	Notch filter 2, width	2	-	○	○	-	
77	Vibration suppressing function selection	0	-	○	-	-	
78	Vibration suppressing anti resonance frequency 0	300.0	-	○	-	-	
79	Vibration suppressing workpiece inertia ratio 0 (vibration suppressing antiresonant frequency)	0	-	○	-	-	
80	Vibration suppressing anti resonance frequency 1	300.0	-	○	-	-	
81	Vibration suppressing workpiece inertia ratio 1 (vibration suppressing antiresonant frequency)	0	-	○	-	-	
82	Vibration suppressing anti resonance frequency 2	300.0	-	○	-	-	
83	Vibration suppressing workpiece inertia ratio 2 (vibration suppressing antiresonant frequency)	0	-	○	-	-	
84	Vibration suppressing anti resonance frequency 3	300.0	-	○	-	-	

No. PA1_	Name	Default value	Power	Control mode			Record of reference value
				Position	Speed	Torque	
85	Vibration suppressing workpiece inertia ratio 3 (vibration suppressing antiresonant frequency)	0	-	○	-	-	
86	Vibration suppressing damping coefficient	0.0000	-	○	-	-	
87	Model torque filter time constant	***	-	○	○	-	
88	Position loop integration time constant	***	-	○	-	-	
89	Position loop integration limiter	0	-	○	-	-	
90	Load torque observer	0	-	○	○	-	
91	P/PI automatic change selection	0	-	○	○	-	
92	Friction compensation: speed range	10.0	-	○	○	-	
93	Friction compensation: torque setting value	0	-	○	○	-	
94	Torque filter setting mode	1	-	○	○	-	
95	Model torque calculation selection, speed observer selection	3	-	○	○	-	
96	Speed limit gain for torque control	10.0	-	-	-	○	

Paremeters marked "○" in the table are enabled in the corresponding control mode.

3.3.2 Description of Each Parameter

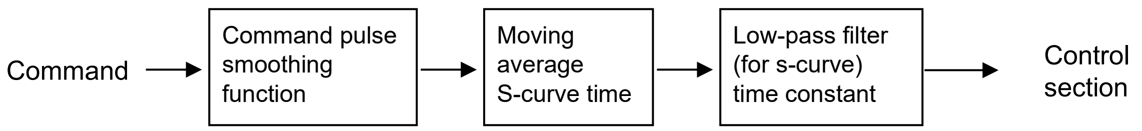
PA1_51 to 53 Command filter settings

No.	Name	Setting range	Default value	Change
51	Moving average S-curve time	0, 2 to 500 (×0.05 [ms])	***	Always
52	Low-pass filter (for S-curve) time constant	0.0 [ms] to 1000.0 [ms]	0.0	Always
53	Command pulse smoothing function	0: Disable 1: Enable	0	Always

Filters can be added to commands for smoother follow-up.

Moving average S-curve time	This parameter is enabled under position control. Specify the moving average S-curve filter time to position commands. A larger setting at low command pulse frequencies or large electronic gear ratios can reduce the torque ripple caused by fluctuation of the command pulse. The new setting of this parameter is reflected when both the position command and filter accumulation pulse are "0". If PA1_13 (tuning mode selection) is 0 (auto tuning) or 1 (semi-auto tuning), automatic adjustment is made inside the amplifier.
Low-pass filter (for S-curve) time constant	Enter the low-pass filter (for S-curve) filter time constant in relation to position commands and speed commands. Acceleration and deceleration are made so that an approximate S-curve is drawn.
Command pulse smoothing function	The parameter is enabled under position control. If the function is enabled, smoothing is added to the position command every 2 [ms] intervals. By enabling the setting when the command pulse frequency is low, or when the electronic gear ratio is large, torque ripples caused by command pulse fluctuations can be reduced. While the setting can be changed at any time, the new setting is reflected when both the position command and filter accumulation pulse are "0".

Function configuration block



- For details of tuning, refer to "CHAPTER 4 SERVO ADJUSTMENT."

PA1_54 Position command response time constant

No.	Name	Setting range	Default value	Change
54	Position command response time constant	0.00 [ms] to 250.00 [ms]	***	Always

Specify the following response characteristics to commands. A smaller setting improves the response characteristics.
Automatic adjustment is made inside the amplifier if PA1_13 (tuning mode selection) is 0 (auto tuning) or 1 (semi-auto tuning).

PA1_55 to 57 Response to disturbance settings

No.	Name	Setting range	Default value	Change
55	Position loop gain 1	1 [rad/s] to 2000 [rad/s]	***	Always
56	Speed loop gain 1	1 [Hz] to 2000 [Hz]	***	Always
57	Speed loop integration time constant 1	0.5 [ms] to 1000.0 [ms]	***	Always

Position loop gain 1: Position disturbance response setting. A larger setting improves the response characteristics.
Speed loop gain 1: Speed disturbance setting. A larger setting improves the response characteristics.
Speed loop integration time constant 1: Integration time constant setting of speed response. A smaller setting improves the response.
Too much a response characteristic may cause vibration or noise.
When PA4_21 (torque control speed limit method) is set to "0" (PI control), the response characteristics with operations by speed limit at torque control are determined by the setting values of PA1_56 and PA1_57.
Automatic adjustment is made inside the amplifier if PA1_13 (tuning mode selection) is other than 2 (manual tuning).

PA1_58 Feed forward gain 1

No.	Name	Setting range	Default value	Change
58	Feed forward gain 1	0.000 to 1.500	0.000	Always

A larger setting decreases the position deviation amount, improving the response characteristics.
Set at 1.000 to reduce the position deviation at a constant speed to almost zero (except during acceleration or deceleration).
Use this parameter to increase the synchronization accuracy between two axes of synchronous control or similar.
For regular point-to-point operation, set the parameter at 0.500 or less (approximate value).

PA1_59 Torque filter time constant for position and speed control
PA1_60 Torque filter time constant for torque control

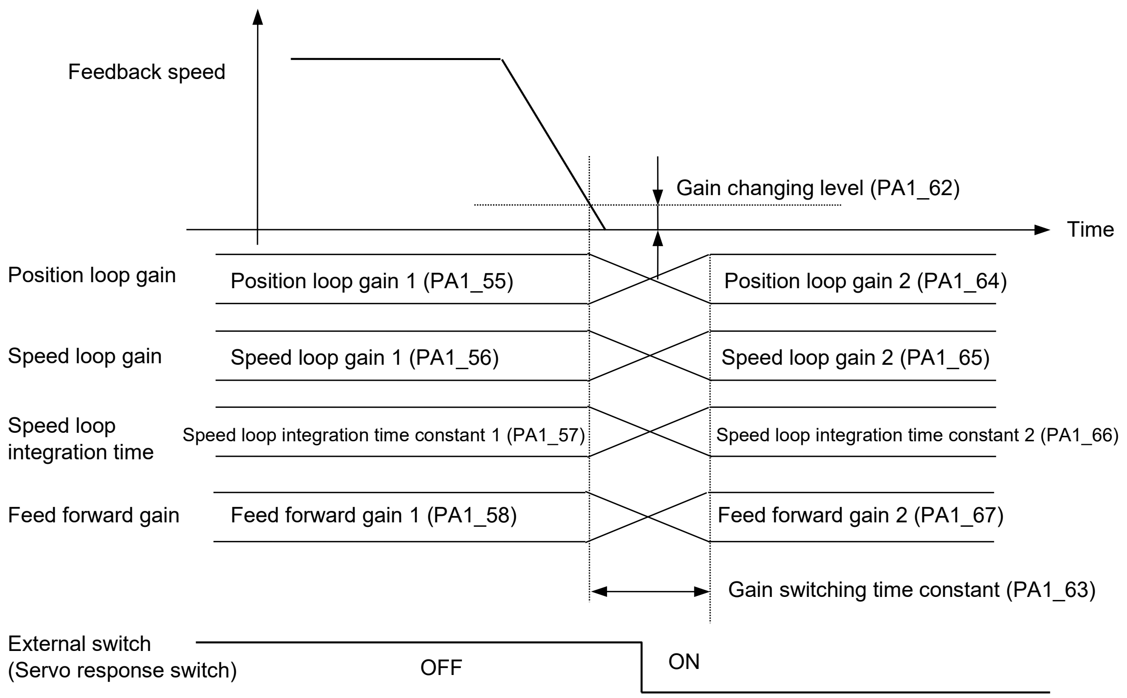
No.	Name	Setting range	Default value	Change
59	Torque filter time constant for position and speed control	0.00 [ms] to 20.00 [ms]	***	Always
60	Torque filter time constant for torque control	0.00 [ms] to 20.00 [ms]	0.00	Always

Torque filter time constant for position and speed control	This parameter is enabled under speed and position control. Add a filter to internal torque commands. The response of the servo system is improved and resonance is suppressed. In particular, the reference value should be larger with large load inertia. Automatic adjustment is made inside the amplifier in other than the manual tuning mode. Set PA1_94 at 0 to allow manual settings.
Torque filter time constant for torque control	The parameter is enabled under torque control. Add a filter to external torque commands. Good effects can be expected for a system prone to electric noise or one with fluctuation in the command voltage.

PA1_61 to 67 Second gain settings

No.	Name	Setting range	Default value	Change
61	Gain changing factor	0: Position deviation (×10) 1: Feedback speed 2: Command frequency (position control)/command speed (speed contorl) 3: External switch (use CONT signal)	1	Always
62	Gain changing level	1 to 1000 (in increments of 1)	50	Always
63	Gain changing time constant	0 [ms] to 100 [ms] (in increments of 1)	1	Always
64	Position loop gain 2	30 [%] to 200 [%] (in increments of 1)	100	Always
65	Speed loop gain 2	30 [%] to 200 [%] (in increments of 1)	100	Always
66	Speed loop integration time constant 2	30 [%] to 200 [%] (in increments of 1)	100	Always
67	Feed forward gain 2	30 [%] to 200 [%] (in increments of 1)	100	Always

The gain of the servo system is switched from the first gain (PA1_55 to _58) to the second gain (PA1_64 to _67).
Noise and vibration during stoppage can be reduced through gain switching.
Select the gain changing factor with PA1_61.
The unit of the reference value of the second gain (PA1_64 to _67) is "%." Specify the ratio to the first gain.
[Example] If PA1_56 (speed loop gain 1) is 100 [Hz] and PA1_65 (speed loop gain 2) is 80 [%], the second gain is 80 [Hz]. PA1_64 (position loop gain 2) is similar. If PA1_57 (speed loop integration time constant 1) is 20 [ms] and PA1_66 (speed loop integration time constant 2) is 50 [%], integration time constant 2 is 40 [ms].
The timing chart of each signal is shown below.



If external switch is selected as a gain changing factor, changeover to the second gain occurs during OFF-to-ON transition as shown on the last page. In this case, you can turn on or off at an arbitrary timing without relations to the motor motion.
The gain of the go stroke and that of the return stroke of a reciprocal motion can be switched.

PA1_70 to 76 Notch filter settings

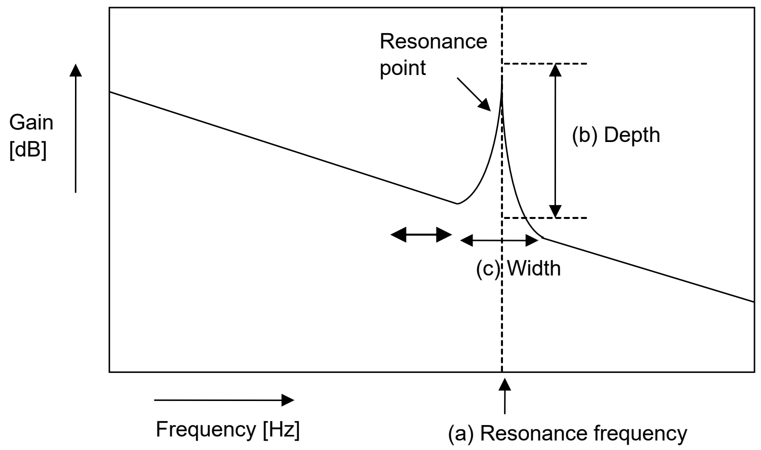
No.	Name	Setting range	Default value	Change
70	Automatic notch filter selection	0: Disable 1: Enable 2: Enabled(Only notch filter 1 is auto)	1	Always
71	Notch filter 1, frequency	10 [Hz] to 4000 [Hz] (in increments of 1)	4000	Always
72	Notch filter 1, attenuation	0 [dB] to 40 [dB] (in increments of 1)	0	Always
73	Notch filter 1, width	0 to 3	2	Always
74	Notch filter 2, frequency	10 [Hz] to 4000 [Hz] (in increments of 1)	4000	Always
75	Notch filter 2, attenuation	0 [dB] to 40 [dB] (in increments of 1)	0	Always
76	Notch filter 2, width	0 to 3	2	Always

Specify to suppress resonance of the mechanical system. Resonance points at up to five locations can be suppressed by combining with settings PA4_51 to PA4_59. By setting the automatic notch filter selection to 1 (enabled), the notch filter is automatically adjusted to the optimum value to suppress resonance at up to 2 locations.
Parameters automatically adjusted in this case include PA1_71 to _76. Values are stored in the EEPROM every 10 minutes.

■ How to set the notch filter

(1) If there is resonance in the mechanical system, a notch filter is automatically set. If resonance is not suppressed, set PA1_70 (automatic notch filter selection) at 0 (disable) and follow the procedure below to manually adjust the notch filter.

(2) Using the servo analyze function of PC Loader, determine the resonance point of the machine.



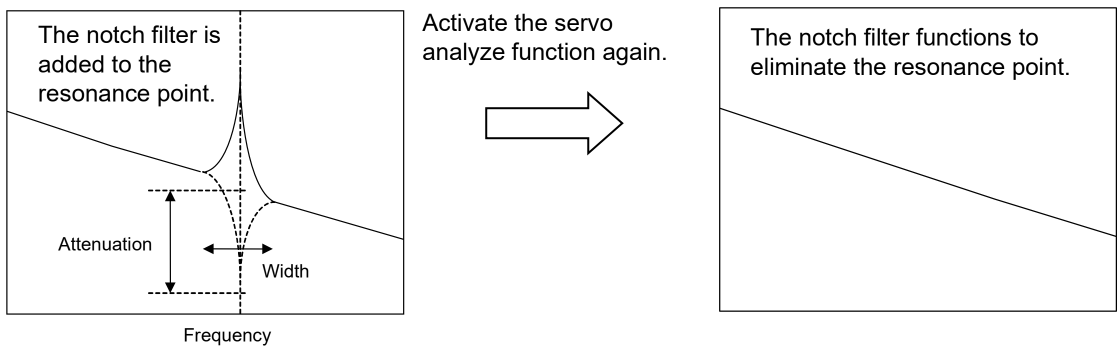
(3) Enter the resonance frequency of and attenuation of the resonance point of the machine into parameters.

(a) Resonance frequency PA1_71: Notch filter 1, frequency

(b) Depth PA1_72: Notch filter 1, attenuation *

(c) Width PA1_73: Notch filter 1, width

* Too much attenuation may undermine stability of the control. Do not enter too much setting. (Set at 0dB to disable the notch filter.)



(4) Approximate reference value

Refer to the table below for the approximate reference value.

Frequency [Hz]	200	500	700	1000
Attenuation [dB]	-5	-10	-15	-20
Width	2,3			

PA1_77 to 86 Vibration suppressing control settings

No.	Name	Setting range	Default value	Change
77	Vibration suppressing function selection	0: Terminal setting 1: Learning 2: IQ area 3: 2 point simultaneous setting	0	Always
78	Vibration suppressing anti resonance frequency 0	1 [Hz] to 300.0 [Hz] (in increments of 1)	300.0	Always
79	Vibration suppressing workpiece inertia ratio 0 (vibration suppressing antiresonant frequency)	0 [%] to 80 [%] (in increments of 1)	0	Always
80	Vibration suppressing anti resonance frequency 1	1 [Hz] to 300.0 [Hz] (in increments of 1)	300.0	Always
81	Vibration suppressing workpiece inertia ratio 1 (vibration suppressing antiresonant frequency)	0 [%] to 80 [%](in increments of 1)	0	Always
82	Vibration suppressing anti resonance frequency 2	1 [Hz] to 300.0 [Hz] (in increments of 1)	300.0	Always
83	Vibration suppressing workpiece inertia ratio 2 (vibration suppressing antiresonant frequency)	0 [%] to 80 [%] (in increments of 1)	0	Always
84	Vibration suppressing anti resonance frequency 3	1 [Hz] to 300.0 [Hz] (in increments of 1)	300.0	Always
85	Vibration suppressing workpiece inertia ratio 3 (vibration suppressing antiresonant frequency)	0 [%] to 80 [%] (in increments of 1)	0	Always
86	Vibration suppressing damping coefficient	0.0000 to 0.1000	0.0000	Always

These parameters are enabled only under position control.
Use these parameters to specify the anti resonance frequency to suppress workpiece vibration (vibration control).
Set at 300.0 [Hz] (factory shipment setting) to disable vibration suppressing control function.
Set PA1_77 (Vibration suppressing function selection) at 1 (Learning) to repeat starting and stopping the motor multiple times while automatically detecting the anti resonance frequency of the machine and adjusting PA1_78 (vibration suppressing anti resonance frequency 0) to the best value.
To use this function, always reserve 1.5s or longer stopping time.
Vibration suppressing workpiece inertia ratio 0 (vibration suppressing antiresonant frequency) sets the inertia of vibrations produced by the arm, etc. as a percentage of the inertia for the entire workpiece.
The enabled parameter is selected through the CONT input signal as shown in the table below.

Anti resonance frequency 1	Anti resonance frequency 0	Enabled vibration suppressing anti resonance frequency	Enabled vibration suppressing workpiece inertia ratio
OFF	OFF	PA1_78	PA1_79
OFF	ON	PA1_80	PA1_81
ON	OFF	PA1_82	PA1_83
ON	ON	PA1_84	PA1_85

By setting PA1_77 (Vibration suppression function selection) to “3” (2 point simultaneous setting), two anti resonance frequencies can be applied simultaneously.
The anti resonance frequencies that become enabled when this function is used are fixed at PA1_78 (Vibration suppressing anti resonance frequency 0) and PA1_80 (Vibration suppressing anti resonance frequency 1), and the vibration suppressing anti resonance frequency selected with CONT input signal becomes disabled.

Note	If using “2 point simultaneous setting”, be sure to change the “Vibration suppressing anti resonance frequency 0 and 1” settings while the motor is stopped. An unexpected operation may occur if changed while the motor is rotating.

For details of vibration suppressing control, refer to "Section 4.9 Special Adjustment (Vibration Suppression)."

PA1_87 Model torque filter time constant

No.	Name	Setting range	Default value	Change
87	Model torque filter time constant	0.00 [ms] to 20.00 [ms]	***	Always

Specify the feed forward control filter time constant of the torque for a model of inertia moment.
Automatic adjustment is made inside the amplifier in other than the manual tuning mode.

PA1_88 Position loop integration time constant
PA1_89 Position loop integration limiter

No.	Name	Setting range	Default value	Change
88	Position loop integration time constant	1.0 [ms] to 1000.0 [ms]	***	Always
89	Position loop integration limiter	0 [r/min] to Max. rotation speed [r/min]	0	Always

Use to improve interpolation accuracy of axes when interpolating two or more servomotor axes of an X-Y table or similar.
PA1_88 (position loop integration time constant) is automatically adjusted inside the amplifier in other than the manual tuning mode.
The position loop integration time constant is disabled if PA1_89 (position loop integration limiter) is 0.
To enter manually, enter settings so that the following equation is satisfied: Position loop integration time constant ≥ Speed loop integration time constant x 5

PA1_90 Load torque observer

No.	Name	Setting range	Default value	Change
90	Load torque observer	0: Disable 1: Enable	0	Always

Set at 1 (enable) to suppress effects of load disturbance torque and improve speed fluctuation.
Use the parameter to reduce the positioning settling time due to effects of the load torque such as friction.

PA1_91 P/PI automatic change selection

No.	Name	Setting range	Default value	Change
91	P/PI automatic change selection	0: Disable 1: Enable	0	Always

The speed adjuster switches to P (proportional) or PI (proportional + integral) control.
Set at 1 (enable) to automatically switch according to the setting of PA1_61 (gain changing factor).
The switching level follows the reference value of PA1_62 (gain changing level).
The state at switching is shown below.

PA1_61: Gain changing factor	Condition	State
Position deviation, feedback speed, command speed	Reference value level or over	P control
	Reference value level or less	PI control
External signal switch (CONT signal switch)	ON	P control
	OFF	PI control

To apply the brake from an external unit, arrange the P control state.

PA1_92 and 93 Friction compensation settings

No.	Name	Setting range	Default value	Change
92	Friction compensation: speed range	0.1 [r/min] to 20.0 [r/min]	10.0	Always
93	Friction compensation: torque setting value	0 [%] to 50 [%]	0	Always

Specify in a system with reversing speeds if smooth reversing motions are not obtained due to friction.
Specify the speed at which static friction changes to dynamic friction, in these parameters.
Set PA1_92 (Speed range for friction compensation) to between 1.0 [r/min] and 10.0 [r/min].
Set the torque equivalent to the dynamical friction (coulomb friction) for PA1_93 (Coulomb friction torque for friction compensation).
Friction compensation is disabled when PA1_93 (Coulomb friction torque for friction compensation) is set to “0”.

PA1_94 Torque filter setting mode

No.	Name	Setting range	Default value	Change
94	Torque filter setting mode	0: Do not configure the torque filter automatically in auto tuning. 1: Configure the torque filter automatically in auto tuning.	1	Always

This parameter is enabled under position and speed control.
Select either to automatically set the torque filter automatically or not during auto tuning operation.
Set at 0 (not set automatically) to manually specify PA1_59 (torque command filter) without relations to the setting of PA1_13 (tuning mode selection).
Set at 1 (set automatically) to automatically adjust inside the amplifier in other than the manual tuning mode.

PA1_95 Model torque calculation selection, speed observer selection

<table>
<tr><th>No.</th><th>Name</th><th>Setting range</th><th>Default value</th><th>Change</th></tr>
<tr><td>95</td><td>Model torque calculation selection, speed observer selection</td><td><table>
<tr><th>Setting</th><th>Model torque calculation</th><th>Speed observer</th></tr>
<tr><td>0</td><td>Disable</td><td>Disable</td></tr>
<tr><td>1</td><td>Enable</td><td>Disable</td></tr>
<tr><td>2</td><td>Disable</td><td>Enable</td></tr>
<tr><td>3</td><td>Enable</td><td>Enable</td></tr>
</table></td><td>3</td><td>Always</td></tr>
</table>

This parameter is enabled under position and speed control.
Select whether model torque calculation and speed observer are enabled or disabled.
If model torque calculation is disabled, the torque feed forward calculation using a model of moment of inertia of load is disabled.
Use the parameter to perform position and speed control at the host controller.
Select "enable" for speed observer during regular operation. Speed compensation is made and stability is improved.
Parameters related to response of the control system are automatically adjusted according to the setting of auto tuning 1 or 2. However, the function of PA1_54 (position command response time constant) is canceled internally.

PA1_96 Speed limit gain for torque control

No.	Name	Setting range	Default value	Change
96	Speed limit gain for torque control	0.0 to 50.0	10.0	Always

This parameter is enabled when performing torque control and PA4_21 (torque control speed limit method) is set to "1" (older model compatibility).
If the rotation speed exceeds the speed limit value when performing torque control, the command torque is lowered to bring the rotation speed near the setting value. At this time, an error is caused in the rotation speed in relation to the reference value. Take into consideration that the parameter adjusts the error. While a larger reference value decreases the error, excessive value will cause instability.

3

3.4 Automatic Operation Setting Parameters

Note	Parameters marked "○" in the "Power" field are enabled after the control power is turned off then turned on again. (Check that the keypad (7-segment display) of the servo amplifier is unlit when the control power is turned off.)

3.4.1 List (PA2_□□)

No. PA2_	Name	Default value	Power	Control mode			Record of reference value
				Position	Speed	Torque	
09	Reverse traveling unit amount for homing	0	-	○	-	-	
14	Home position shift unit amount	0	-	○	-	-	
15	Deceleration operation for creep speed	0	○	○	-	-	
25	Software OT selection/Position command format	0	○	○	○	-	

Parameters marked "○" in the table are enabled in the corresponding control mode.

3.4.2 Description of Each Parameter

PA2_09 Reverse traveling unit amount for homing

No.	Name	Setting range	Default value	Change
09	Reverse traveling unit amount for homing	0 to 2000000000 [unit amount]	0	Always

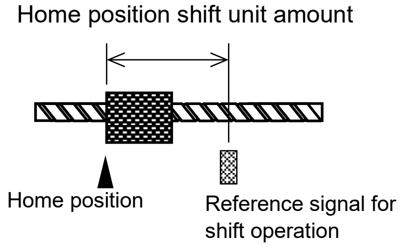
<u>These are not necessary setting items. This function is valid only when the Homing method is 9 or 10, 13, 14.</u>

Specify the reverse traveling amount taken in the direction opposite to the starting direction for homing at the start of homing motion.
If a reference signal for homing (deceleration starting signal) or reference signal for shift operation is detected during reverse travel, movement toward the homing direction after reference signal detection begins. Use the setting to reduce the homing time.
Use if the stopping position is in the direction opposite to the starting direction for homing and the maximum distance from the stopping position to the zero position is always known.
The unit amount is determined by 6091H: Gear ratio.
If neither the reference signal for homing (deceleration starting signal) nor reference signal for shift operation is detected during reverse motion, movement in the starting direction for homing begins after reverse motion by the preset traveling amount.

PA2_14 Home position shift unit amount

No.	Name	Setting range	Default value	Change
14	Home position shift unit amount	0 to 2000000000 [unit amount]	0	Always

Specify the distance (traveling amount) from the reference signal for shift operation to the home position.



Homing method (6098H)	Reference signal for shift operation
1-14	Z-phase
19-20	Home position LS
33, 34	Z-phase
35, 37	-

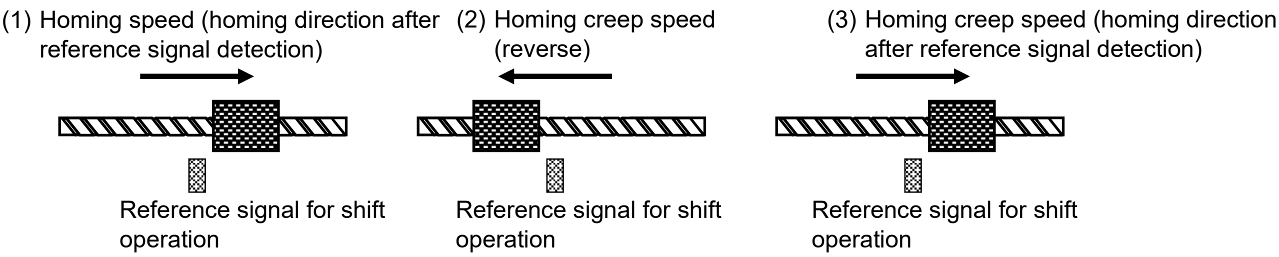
PA2_15 Deceleration operation for creep speed

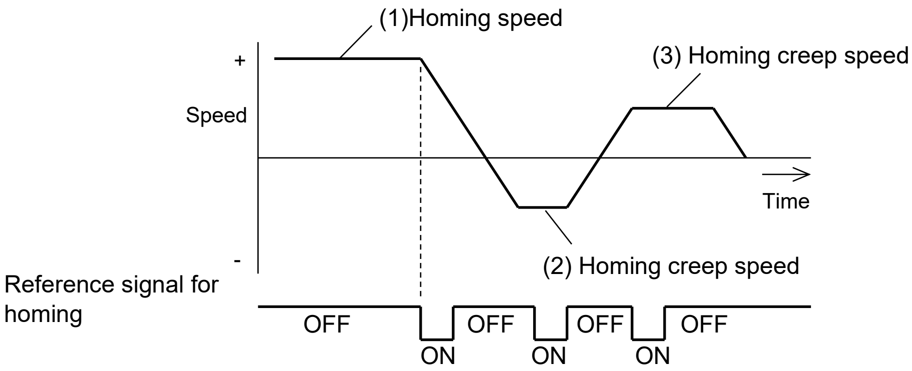
No.	Name	Setting range	Default value	Change
15	Deceleration operation for creep speed	0: Reverse rotation is disabled 1: Reverse rotation is enabled	0	Power

These are not necessary setting items. This function is valid only when the Homing method is 3 to 14,19, or 20.

Specify 1 (reverse rotation enable) to return upon detection of the reference signal for shift operation during movement at the homing speed in the homing direction after reference signal detection temporarily to the point ahead of the reference signal for shift operation and move at the creep speed for homing again in the homing direction after reference signal detection to the position (home position) the home position shift unit amount away from the reference signal for shift operation.

Accurate homing can be executed only with the reference signal for shift operation without a reference signal for homing (deceleration starting signal).



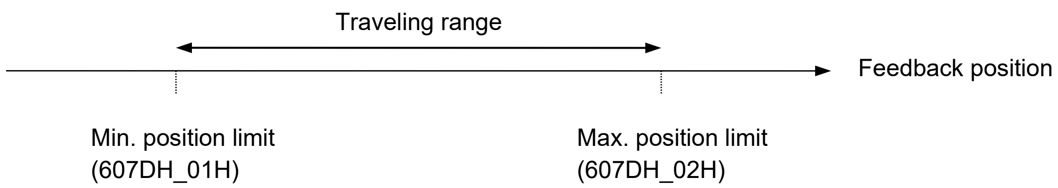


PA2_25 Software OT selection/Position command format

No.	Name	Setting range	Default value	Change
25	Software OT selection/Position command format	0: Disable, endless 1: Enable, normal PTP	0	Power

(1) Software OT selection.

Forced stop is caused, different from +OT or -OT external input signal, if the servomotor position exceeds the reference value.
Enter settings so that Positive software OT detection position is larger than Negative software OT detection position.



(2) Position command format

This function is enabled when performing pp control, and offers compatibility with VV type and LS type positioning operation. This should normally be set to “1” (Normal PTP).
Endless: Repeated rotation is possible in the same direction.
The position is preset each time pp control starts, and all Target Positions (607AH) are handled as INC.
Normal PTP: Operation is performed in the -2000000000 to 2000000000 [unit amount] range."

3

3.5 Extended Function Setting Parameters

Note	Parameters marked "○" in the "Power" field are enabled after the control power is turned off then turned on again. (Check that the keypad (7-segment display) of the servo amplifier is unlit when the control power is turned off.)

3

3.5.1 List (PA2_□□)

No. PA2_	Name	Default value	Power	Control mode			Record of reference value
				Position	Speed	Torque	
56	Speed limit selection	0	○	○	○	○	
57	Torque limit selection	0	○	○	○	–	
60	Third torque limit	350: GYB 300: other than GYB	–	○	○	–	
61	Servo ON = OFF operation sequence	0001	○	○	○	○	
62	Action sequence at alarm	0000	○	○	○	○	
63	Action sequence at main power supply OFF, OT detection	2000	○	○	○	○	
64	Torque keeping time to holding brake	0.00	–	○	○	○	
65	Braking resistor selection	1	○	○	○	○	
66	Flying start selection in speed control	0	○	–	○	–	
67	Alarm detection at undervoltage	1	○	○	○	○	
68	Main power shutoff detection time	35	○	○	○	○	
69	Deviation detection overflow value	15.0	–	○	–	–	
70	Overload warning value	50	–	○	○	○	
72	ID-Selector value offset	0	○	○	○	○	
74	Parameter write protection	0	–	○	○	○	
78	Display transition at warning detection	0	○	○	○	○	
80	Parameter in RAM 1	0	○	○	○	○	
81	Parameter in RAM 2						
82	Parameter in RAM 3						
83	Parameter in RAM 4						
84	Parameter in RAM 5	0	○	○	○	○	
85	Parameter in RAM 6						
89	Sequence test mode: mode selection	0	○	○	○	○	
90	Sequence test mode: encoder selection	4	○	○	○	○	
91	Position command delay time	0.000	–	○	○	○	
92	EtherCAT extension	0	○	○	○	○	

Parameters marked ○ in the table are enabled in the corresponding control mode.

3.5.2 Description of Each Parameter

PA2_56 Speed limit selection

No.	Name	Setting range	Default value	Change
56	Speed limit selection	0: Parameter 1: Communication setting	0	Power

Select the method for applying speed limiting.
If the setting is 0, the reference value of PA1_25・PA1_26 (maximum rotation speed) is the speed limit.
If the setting is 1, the speed limit value set at Profile max velocity (607FH) is applied.

PA2_57 to 60 Torque limit settings

No.	Name	Setting range	Default value	Change
57	Torque limit selection	0: Parameter 1: Communication setting	0	Power
60	Third torque limit	GYB: 0 [%] to 350 [%] Other than GYB: 0 [%] to 300 [%]	GYB: 350 [%] Other than GYB: 300 [%]	Always

The enabled torque limit is described below.

(1) When performing normal operation

The torque limit values are as follows based on the PA2_57 (Torque limit selection) setting.
If setting = 0: PA1_27 (Forward rotation torque limit), PA1_28 (Reverse rotation torque limit)
If setting = 1: 60E0H (Positive torque limit value), 60E1H (Negative torque limit value)

(2) Third torque limit value

This parameter is valid when performing position control or speed control.
The setting value for this parameter will be the torque limit value under the following conditions.

- Deceleration stop (if Quick stop option code (605AH) = 3 or 7) by setting Forced stop (EMG) to OFF
- Rapid deceleration stop with ± over travel (±OT) set to OFF
- Deceleration stop (if Fault reaction option code (605EH) = 3) following occurrence of minor fault alarm
- Deceleration stop with halt (Halt option code (605DH) = 3)

PA2_61 to 63 Action sequence settings

No.	Name	Setting range	Default value	Change
61	Operating sequence when servo-on = OFF	0000 to 0011	0001	Power supply
62	Action sequence at alarm	0000 to 1011	0000	Power supply
63	Action sequence at main power supply OFF, OT detection	0000 to 3011	2000	Power supply

Set the action status when decelerating and stopping under each condition.

This parameter selects functions for each digit.

Digit	PA2_61	PA2_62	PA2_63
1	Stop sequence at servo-on OFF 0: DB 1: Free-run	Stop sequence at alarm 0: DB 1: Free-run	Stop sequence at main power shutoff 0: DB 1: Free-run
2	Deceleration sequence at servo-on OFF 0: DB 1: Free-run	Deceleration sequence at major failure alarm 0: DB 1: Free-run	Deceleration sequence at main power shutoff 0: DB 1: Free-run
3	Not used (No possible to set value other than 0.)	Not used (No possible to set value other than 0.)	Not used (No possible to set value other than 0.)
4	Not used (No possible to set value other than 0.)	Deceleration sequence at minor failure alarm 0: DB 1: Free-run	Deceleration sequence at OT detection 2: Rapid deceleration 3: Deceleration time

- DB: Dynamic brake

  When using the DB, Use under the following conditions.

  - Usage frequency = once every 10 minutes
  - Usage count = within 1,000 times
- Rapid deceleration: The motor will decelerate at the deceleration torque set for PA2_60 (third torque limit).

  (However, the above torque may not be achieved depending on the load conditions.)
- Deceleration time: The motor decelerates based on the deceleration time set for Quick stop deceleration (0x6085).

The STO operation is based on the operation setting when PA2_61 servo-on is OFF.

PA2_64 Torque keeping time to holding brake

No.	Name	Setting range	Default value	Change
64	Torque keeping time to holding brake	0.00 [s] to 9.99 [s]	0.00	Always

Assign the "brake timing (function No. 14)" signal to the output signal.
The reference value for this parameter is the delay time to free run when the FSA status changes from Operation Enabled to output stopped.
Specify a time larger than the one taken from excitation of the brake to actual brake application.
The brake timing signal turns off when the status changes to output stopped.

PA2_65 Braking resistor selection

No.	Name	Setting range	Default value	Change
65	Braking resistor selection	0: None 1: Internal resistor 2: External resistor	1	Power

Select the braking resistor.
If the reference value is 1, the temperature of the braking resistor is calculated inside the amplifier and monitored as a regenerative thermal value. 100 [%] indicates an overheated internal braking resistor (RH1).
To install an external braking resistor for elevator operation or high operation frequency, set at 2.
If the reference value is 2, connect the thermistor of the external resistor to the external braking resistor overheat (function No. 34).
Because of a normally closed contact, shutoff indicates an overheated external braking resistor (RH2).

3

PA2_66 Flying start selection in speed control

No.	Name	Setting range	Default value	Change
66	Flying start selection in speed control	0: No flying start 1: Flying start	0	Power

The parameter is enabled under speed control.
If servo-on turns on during free run operation, the speed at that timing is used, and acceleration begins from that speed.
If the control power of the servo amplifier is turned off, the dynamic brake is applied, causing sudden stop.
The speed at the timing of control power-on is not picked in this case.

PA2_67 Alarm detection at undervoltage

No.	Name	Setting range	Default value	Change
67	Alarm detection at undervoltage	0: No detection 1: Detection (main circuit undervoltage: detection when power restored) 2: Detection (main circuit undervoltage: detection when power turned off)	1	Power

Select whether or not to detect alarms when undervoltage is detected.
The detected alarms include control power undervoltage and main power undervoltage.

PA2_68 Main power shutoff detection time

No.	Name	Setting range	Default value	Change
68	Main power shutoff detection time	35 [ms] to 1000 [ms]	35	Power

Specify the time for detecting shutoff of the main power. Power supply phases to be detected are L1 and L2.
The AC power is detected.
If power is restored after the time specified in this parameter elapses after the main power turns off with servo-on turned on, a main circuit power undervoltage alarm (LVP) occurs.
Avoid repeating turning on or off frequently in a short time.
However, if power is restored after the time specified in this parameter and 1 [s], no alarm is detected.
To supply DC power, set at 1000 [ms]. If this is the case, the detection function is canceled.
To supply AC power, leave the default value unchanged in regular cases.

PA2_69 Deviation detection overflow value

No.	Name	Setting range	Default value	Change
69	Deviation detection overflow value	0.1 [rev] to 100.0 [rev]	15.0	Always

Specify the value for detecting an "Deviation overflow" alarm.
Enter the parameter in a rotation amount of the motor output shaft.

PA2_70 Overload warning value

No.	Name	Setting range	Default value	Change
70	Overload warning value	10 [%] to 100 [%]	50	Always

Specify the output level of the "overload warning (27)" signal that is issued as an output signal (OUT signal).
Use the signal as a warning of an "overload (OL)" alarm.
Characteristics of the overload warning are specified in "CHAPTER 8 CHARACTERISTICS."

3

PA2_72 ID-Selector Value offset

No.	Name	Setting range	Default value	Change
72	ID-Selector value offset	0 to 65535	0	Power

This offset is added to ID-Selector value set with the rotary switch on the front of the ALPHA7.
Consequently, the actual ID-Selector value is expressed with the following equation.

ID-Selector value = Front rotary switch setting + PA2_72 setting value

PA2_74 Parameter write protection

No.	Name	Setting range	Default value	Change
74	Parameter write protection	0: Write enable 1: Write protect	0	Always

Specify parameter write protection.
When set to “1”, parameter editing at PC Loader is prohibited. While set to “1”, PC Loader is able to rewrite this parameter only.

PA2_78 Display transition at warning detection

No.	Name	Setting range	Default value	Change
78	Display transition at warning detection	0: No transition 1: Transition to warning display	0	Power

Set whether a warning is displayed at the keypad on the front panel of the amplifier when a "cooling fan life expiration," "main circuit capacitor life expiration”, "low battery voltage", overload warning, or over travel (OT) warning content is detected.

3

PA2_80 to 85 Parameter in RAM 1 to 6

No.	Name	Setting range	Default value	Change
80	Parameter in RAM 1	0: No designation 1 to 399: Parameter No.	0	Power
81	Parameter in RAM 2			
82	Parameter in RAM 3			
83	Parameter in RAM 4			
84	Parameter in RAM 5			
85	Parameter in RAM 6			

If you change some parameters frequently, store them in RAM.
With this setting, you can change parameters infinitely.
Parameters that can be stored in RAM are those marked "Always" in the "Change" field.
The parameter stored in RAM is in the default value when the amplifier is turned on.
[Setting example] 1 to 99 = PA1_1 to 99, 101 to 199 = PA2_1 to 99, 201 to 299 = PA3_1 to 99, 301 to 399 = PA4_1 to 99

PA2_89 and 90 Sequence test mode: Mode selection and encoder selection

No.	Name	Setting range	Default value	Change
89	Sequence test mode: Mode selection	0: Normal mode 1: Sequence test mode	0	Power
90	Sequence test mode: Encoder selection	4: 24 bit	4	Power

PA2_89 (sequence test mode):

When Sequence test mode: Function selection is set to “0”, sequence test mode is started from PC Loader. Turn the power off then on again to return to normal mode.
Specify the encoder bit according to the type of the servomotor.

PA2_89 (sequence test mode):

Select 1 to always start the sequence test mode. To return to the normal mode, change PA2_89 to 0 and turn the power off then on again.
Specify the encoder bit according to the type of the servomotor.
In sequence test mode, the servo amplifier keypad flashes (once every 2 seconds.)

PA2_90: Specify the parameter according to the connected motor encoder bit.

* Sequence test mode does not support the functions of safety options (WSU-ST1) and full-closed control.
When the sequence test mode is executed while the full-state control is enabled, it operates in semi-closed control.

PA2_91 Position command delay time

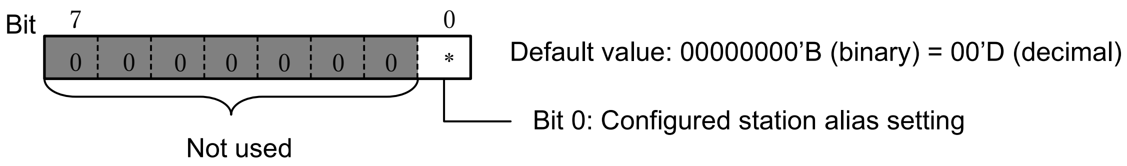
No.	Name	Setting range	Default value	Change
91	Position command delay time	0.000 [ms] to 12.000 [ms]	0.000	Always

Sets the time from the point a position command is sent from the controller to the servo amplifier in CSP mode until issuance of the position command is complete.
If set to 0.000 [ms], the Interpolation time (60C2) value will be valid.
When setting the command delay time with this parameter, take the communication cycle and master jitters into consideration when doing so.

PA2_92 EtherCAT extended function

No.	Name	Setting range	Default value	Change
92	EtherCAT extended function	See table below.	0	Power supply

PA2_92 is expressed in binary notation, and the various function selections are assigned to each bit.



■ Configured station alias setting (bit 0)

If bit 0 is "1", set the ID-Selector value set with the front rotary switch and PA2_72 for the ESC register Configured station alias (0012h) when transitioning from Init to Pre-OP.
If bit 0 is "0" (default value), the SII area (0004h) value is set for Configured station alias.
If using with this bit set to "1", it is necessary to pass EEPROM access permission from the master to ALPHA7 when transitioning from Init to Pre-OP. Caution is advised.

3.6 Input Terminal Function Setting Parameters

Note	Parameters marked "○" in the "Power" field are enabled after the control power is turned off then turned on again. (Check that the keypad (7-segment display) of the servo amplifier is unlit when the control power is turned off.)

3

3.6.1 List (PA3_□□)

No. PA3_	Name	Default value	Power	Control mode			Record of reference value
				Position	Speed	Torque	
01	CONT1 signal assignment	4.6.2 Description of Each Parameter	○	○	○	○	
02	CONT2 signal assignment						
03	CONT3 signal assignment						
04	CONT4 signal assignment						
05	CONT5 signal assignment						
06	CONT6 signal assignment						
07	CONT7 signal assignment						
08	CONT8 signal assignment						
25	CONT signal inversion	000000	○	○	○	○	
26	CONT always ON 1	0	○	○	○	○	
27	CONT always ON 2						
28	CONT always ON 3						
29	CONT always ON 4						
30	CONT always ON 5						

Paremeters marked "○" in the table are enabled in the corresponding control mode.

3.6.2 Description of Each Parameter

PA3_01 to 08 CONT signal assignment

No.	Name	Setting range	Default value	Change
01	CONT1 signal assignment	Select from CONT signal assignment functions (see next page).	49	Power supply
02	CONT2 signal assignment		0	
03	CONT3 signal assignment		0	
04	CONT4 signal assignment		0	
05	CONT5 signal assignment		0	
06	CONT6 signal assignment		0	
07	CONT7 signal assignment		0	
08	CONT8 signal assignment		0	

(1) Input terminal (CONT input signal) list

Select the input terminal function assigned to the CONT signal in the table below.
The “No.” and the function “Name” have one-on-one relationship. To set a function, set the corresponding “No.” in the CONT1 to CONT8 signal assignment.
Set input signals from sequence input/output (CN1) to CONT1 to CONT8.
For details of each function, refer to "CHAPTER 2 WIRING."

Sequence input signals

Signals assignable to CONT1 to 6 (sequence input terminal)

No.	Function
6	Home position LS [LS]
7	+OT
8	-OT
10	Forced stop [EMG]
34	External regenerative resistor overheat
49	Interrupt input (Touch Probe 1)
59	Interrupt input 2 (Touch Probe 2)

Signals assignable to CONT7, CONT8 (communication)

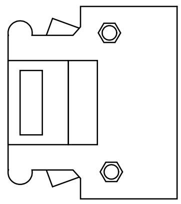
No.	Function
16	Position preset
17	Servo response change
29	P action
54	Free run
57	Anti resonance frequency 0
58	Anti resonance frequency 1
82	Full-closed control disabled
83	Clear external/motor deviation
84	Accumulated pulse clear

(2) Connector pin layout

The pin layout of each signal is shown in the figure below.

Signals to which used functions are assigned are CONT1 to CONT6.

1	COMOUT	8	CONT1
2	COMIN	9	CONT2
3	CONT5	10	N.C
4	CONT4	11	N.C
5	CONT3	12	N.C
6	OUT1	13	N.C
7	CONT6	14	OUT2

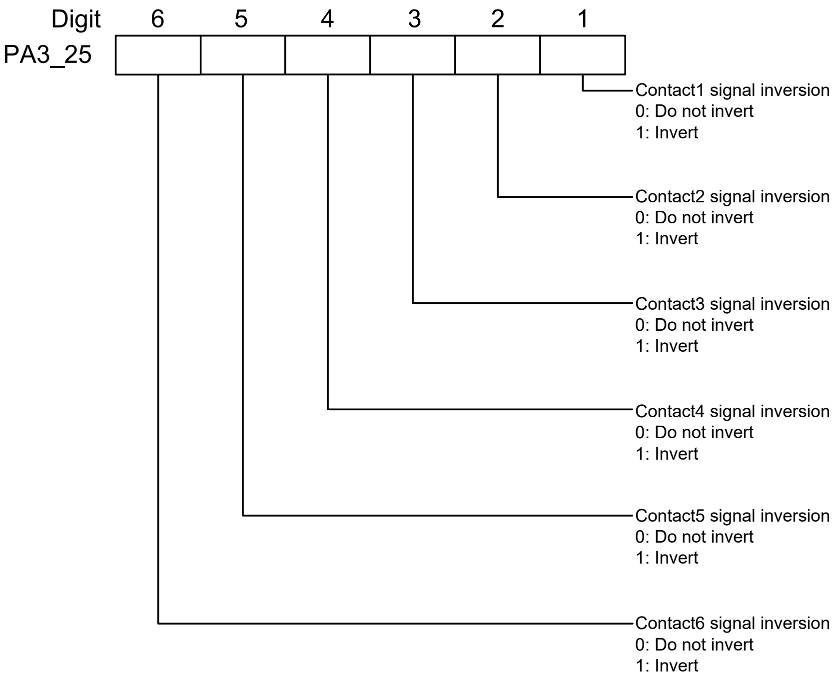


PA3_25 CONT signal inversion

No.	Name	Setting range	Default value	Change
25	CONT signal inversion	000000 to 111111	000000	Power supply

Set if wishing to invert the status (ON/OFF) of signals input to sequence input terminals CONT1 to CONT6.

This parameter selects functions for each digit, and by setting 1 for each digit, the input signal logic is reversed.



PA3_26 to 30 CONT always ON 1 to 5

No.	Name	Setting range	Default value	Change
26	CONT always ON 1	Specify the number corresponding to desired function (0 to 58)	0	Power
27	CONT always ON 2			
28	CONT always ON 3			
29	CONT always ON 4			
30	CONT always ON 5			

Specify the CONT input signal that is always enabled after the power is turned on.

The normally open contact signal is always turned on. The normally closed contact signal is always turned off.

■ The functions that cannot be set with a contact A signal are interrupt input and interrupt input 2.

Functions that may not be specified with a normally closed signal include forced stop and external braking resistor overheat. (Functions that can be specified with a normally closed signal are +OT and -OT.)

The signal assigned to CONT input signal can be also assigned to CONT always enabled setting redundantly.

3

3.7 Output Terminal Function Setting Parameters

Note	Parameters marked "○" in the "Power" field are enabled after the control power is turned off then turned on again. (Check that the keypad (7-segment display) of the servo amplifier is unlit when the control power is turned off.)

3.7.1 List (PA3_□□)

No. PA3_	Name	Default value	Power	Control mode			Record of reference value
				Position	Speed	Torque	
51	OUT1 signal assignment	4.7.2 Description of Each Parameter	○	○	○	○	
52	OUT2 signal assignment						
53	OUT3 signal assignment						
54	OUT4 signal assignment						
55	OUT5 signal assignment						
56	OUT6 signal assignment						
57	OUT7 signal assignment						
58	OUT8 signal assignment						
59	OUT9 signal assignment						
60	OUT10 signal assignment						
61	OUT11 signal assignment						
62	OUT12 signal assignment						
72	OUT signal inversion	00	○	○	○	○	
81	Monitor 1 signal assignment	2	-	○	○	○	
82	Monitor 2 signal assignment	3	-	○	○	○	
83	Monitor 1 scale	7.0	-	○	○	○	
84	Monitor 1 offset	0	-	○	○	○	
85	Monitor 2 scale	6.0	-	○	○	○	
86	Monitor 2 offset	0	-	○	○	○	
87	Monitor 1/Monitor 2 output form	0	-	○	○	○	
89	Feedback speed sampling time for monitor	1	-	○	○	○	

Paremeters marked "○" in the table are enabled in the corresponding control mode.

3.7.2 Description of Each Parameter

PA3_51 to 60 OUT signal assignment

No.	Name	Setting range	Default value	Change
51	OUT1 signal assignment	Select from OUT signal assignment functions (see next page).	0	Power supply
52	OUT2 signal assignment		0	
53	OUT3 signal assignment		0	
54	OUT4 signal assignment		0	
55	OUT5 signal assignment		0	
56	OUT6 signal assignment		0	
57	OUT7 signal assignment		0	
58	OUT8 signal assignment		0	
59	OUT9 signal assignment		0	
60	OUT10 signal assignment		0	
61	OUT11 signal assignment		0	
62	OUT12 signal assignment		0	

(1) Output terminal (OUT input signal) list
Select the input terminal function assigned to the OUT signal in the table below.
The “No.” and the function “Name” have one-on-one relationship.
To set a function, set the corresponding “No.” in OUT1 to OUT12.
For details of each function, refer to "CHAPTER 2 WIRING."

List of functions that can be set

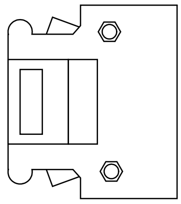
No.	Function	No.	Function
1	Operation prep. complete [RDY]	40	Home position LS detection
2	In-position [INP]	41	Forced stop detection
11	Speed limit detection	45	Battery warning
14	Brake timing	46	Life expectancy warning
16	Alarm detection (contact a)	47	Synchronization complete
20	OT detection	48	Full-closed control in progress
22	Homing complete	49	External/motor deviation over forecast
23	Deviation zero	75	Position preset complete
24	Speed zero	76	Alarm detection (contact b)
25	Speed arrival	86	Interference detection
26	Torque limit detection	89	Function safety SS1
27	Overload warning	90	Function safety SLS
28	Servo ready	91	Digital Output 1*1
38	+OT detection	92	Digital Output 2*1
39	-OT detection		

*1: Digital Output can be assigned to OUT1/OUT2 only.

(2) Connector pin layout

The pin layout of each signal is shown in the figure below.
Signals to which used functions are assigned are OUT1 to OUT2.

1	COMOUT	8	CONT1
2	COMIN	9	CONT2
3	CONT5	10	N.C
4	CONT4	11	N.C
5	CONT3	12	N.C
6	OUT1	13	N.C
7	CONT6	14	OUT2



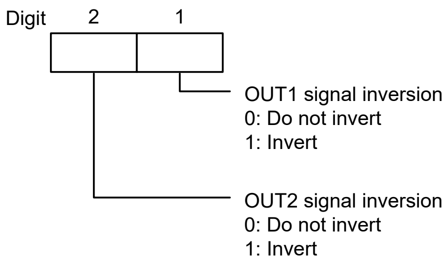
PA3_72 OUT signal inversion

No.	Name	Setting range	Default value	Change
72	OUT signal inversion	0000000000 to 1111111111	0000000000	Power supply

Set if wishing to invert the status (ON/OFF) of signals output from sequence output terminal (OUT1 to OUT10).

Parameter PA3_72 (OUT signal inversion) selects functions for each digit for OUT1 to OUT10.

By setting 1 for each digit, the output signal logic is reversed.



PA3_81 to 87 Monitor output scale and offset settings

No.	Name	Setting range	Default value	Change
81	Monitor 1 signal assignment	1: Command speed. 2: Feedback speed. 3: Torque command. 4: Position deviation [unit amount/pulse]. 5: Position deviation 1/10 [unit amount]. 6: Position deviation 1/100 [unit amount]. 8: Speed deviation. 9: Motor current. 10: Effective torque. 11: DC link voltage. 12: OL thermal value. 13: Braking resistor thermal value. 14: Power (W). 15: Motor temperature. 16: Command speed (filtered) 17: Forced output	2	Always
82	Monitor 2 signal assignment		3	Always
83	Monitor 1 scale	±2.0 [V] to ±100.0 [V]	7.0	Always
84	Monitor 1 offset	-50 to 50	0	Always
85	Monitor 2 scale	±2.0 [V] to ±100.0 [V]	6.0	Always
86	Monitor 2 offset	-50 to 50	0	Always
87	Monitor 1/2 output format	0: Monitor 1 (both voltage output) / Monitor 2 (both voltage output) 1: Monitor 1 (single voltage output) / Monitor 2 (both voltage output) 2: Monitor 1 (both voltage output) / Monitor 2 (single voltage output) 3: Monitor 1 (single voltage output) / Monitor 2 (single voltage output)	0	Always

3

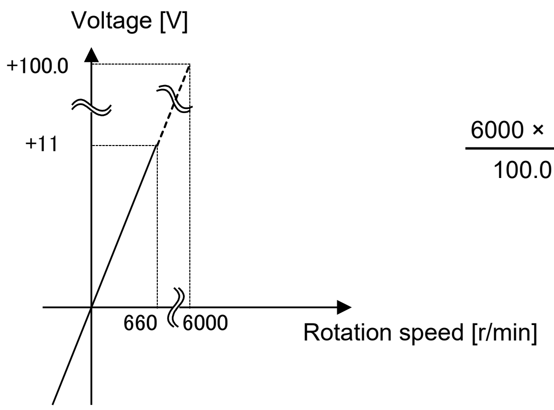
■ Monitor 1/2 signal assignment

Specify the data to be output at the monitor 1 [MON1] and monitor 2 [MON2] terminals.

Monitoring item	Description	Specifications
1: Command speed	Speed command given to servomotor	Output voltage corresponding to maximum rotation speed
2: Feedback speed	Actual rotation speed given to servomotor	
3: Torque command	Torque reference value given to servomotor	Output voltage corresponding to maximum torque
4: Position deviation	Difference (deviation) between position command and position feedback	Output voltage corresponding to 1000 [unit amount]
5: Position deviation (1/10)		Output voltage corresponding to 10000 [unit amount]
6: Position deviation (1/100)		Output voltage corresponding to 100000 [unit amount]
8: Speed deviation	Difference between speed command and speed feedback	Output voltage corresponding to maximum speed
9: Motor current	Amperage supplied to servomotor	Output voltage corresponding to maximum current
10: Effective torque	Effective torque given to servomotor	Output voltage corresponding to rated torque
11: DC link voltage	DC voltage inside servo amplifier	Output voltage corresponding to 400 [V]
12: OL thermal value	Load factor	Output voltage to 100 [%]
13: Braking resistor thermal value	Load factor of braking resistor	Output voltage to 100 [%]
14: Power (W)	Motor power (W)	Output voltage corresponding to rated rotation speed and rated torque
15: Motor temperature	Internal detected temperature of encoder	Output voltage corresponding to 100 [°C]
16: Command speed (filtered)	Speed reference value after internal filter	Output voltage corresponding to maximum rotation speed
17: Forced output	Arbitrary voltage between -11 [V] and +11 [V]	Voltage value set in PA3_83 and PA3_85

■ Monitor 1/2 scale

Specify the full scale to be output at the monitor 1 [MON1] and monitor 2 [MON2] terminals.
Specify a negative sign to reverse the polarity of the output voltage.
Though up to 100.0 [V] can be entered, the maximum output voltage is 11.0 [V].
[Example] If the monitor 1 scale is set at 100.0 [V] (with a maximum rotation speed of 6000 [r/min])



$$\frac{6000 \times 11}{100.0} = 660 \text{ [r/min]}$$

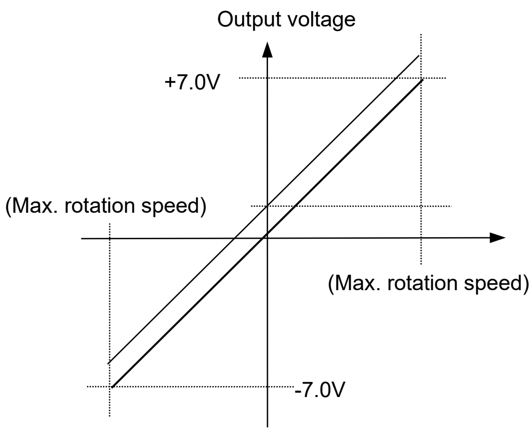
■ Monitor 1/2 offset

The offset voltage between the monitor 1 [MON1] and monitor 2 [MON2] terminals can be adjusted. The setting range is from -50 to 0 to 50 in increments of 1. The reference value has no unit.
Every increment corresponds to about 6.1 [mV].

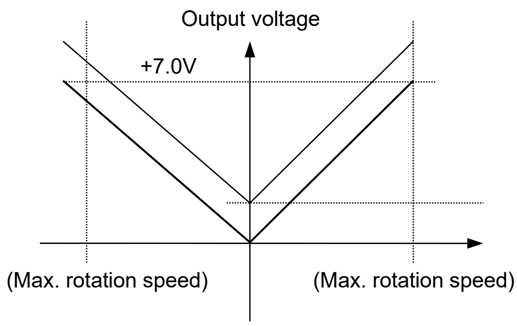
■ Monitor 1/2 output format

You can select either swing on both sides or swing on a single side for the signal, scale and offset assigned to the monitor 1 [MON1] and monitor 2 [MON2] terminals.

Monitor 1 terminal (swing on both sides)



Monitor 1 terminal (swing on single side)



Specify the negative sign for the monitor 1/2 scale to reverse the polarity of the output voltage.

■ Resolution of monitor 1/2 output

The resolution is 14 bits (16384) at the full scale (between -12.5 [V] and +12.5 [V]).
The resolution (*) is 1.5 [mV] (-12.5 to +12.5) [V]/2^{14}).
* While the maximum or minimum output voltage is ±11 [V], ±12.5 [V] is used for the calculation of the resolution.

PA3_89 Feedback speed sampling time for monitor

No.	Name	Setting range	Default value	Change
89	Feedback speed sampling time for monitor	0: 50 [μs] 1: 100 [μs] 2: 200 [μs], 3: 400 [μs] 4: 800 [μs] 5: 1.6 [ms], 6: 3.2 [ms] 7: 6.4 [ms]	1	Always

Specify the feedback speed sampling time for monitor.
The sampling time is for the monitoring function. No effect is caused to the control even if the value is changed.

3

3.8 Extension Function 2 Setting Parameters

Note	Parameters with "○" in the parameter list "Power supply" column are enabled by turning OFF the control power and then turning it back ON (ensure that servo amplifier keypad (7-segment display) is OFF when the control power is OFF).

3.8.1 List (PA4_□□)

No. PA4_	Name	Default value	Power supply	Control mode				Record of reference value
				Position	Speed	Torque	Full-closed	
01	Interference detection level	350: GYB 300: other than GYB	-	○	○	-	○	
02	Interference detection return amount	0	-	○	-	-	○	
03	Interference detection return speed	500.00	-	○	-	-	○	
04	Interference detection LPF time constant	20.0	-	○	○	-	○	
05	Interference detection HPF time constant	100.0	-	○	○	-	○	
06	Enable/disable interference detection	0	-	○	○	-	○	
10	Enable/disable SEMI F47 compatible function	0	○	○	○	○	○	
11	Function safety amplifier operation selection	00	○	○	○	○	○	
12	Function safety SLS speed limit value	6000.00 (GYS and GYB 750W or less) 5000.00 (GYS 1kW or more) 3000.00 (GYG)	-	○	○	○	○	
21	Torque control speed limit method	0	○	-	-	○	-	
32	Full-closed system setting	0000	○	-	-	-	○	
35	Full-closed LPF time-constant	1.0	-	-	-	-	○	
36	External/motor deviation over detection value	25600	-	-	-	-	○	
37	External/motor deviation over forecast value	12800	-	-	-	-	○	
38	Frequency divider denominator for external/motor deviation monitor	100	-	-	-	-	○	
51	Notch filter 3 frequency	4000	-	○	○	-	○	
52	Notch filter 3 attenuation	0	-	○	○	-	○	
53	Notch filter 3 width	2	-	○	○	-	○	
54	Notch filter 4 frequency	4000	-	○	○	-	○	
55	Notch filter 4 attenuation	0	-	○	○	-	○	
56	Notch filter 4 width	2	-	○	○	-	○	
57	Notch filter 5 frequency	4000	-	○	○	-	○	

○ mark in the table is a parameter that is enabled in each control mode.

No. PA4_	Name	Default value	Power supply	Control mode				Record of reference value
				Position	Speed	Torque	Full-closed	
58	Notch filter 5 attenuation	0	-	○	○	-	○	
59	Notch filter 5 width	2	-	○	○	-	○	
60	Cogging torque compensation	0	-	○	○	-	○	
61	Tuningless function Enable/disable	0	○	○	○	-	○	
62	Tuningless level	4	-	○	○	-	○	
63	Tuningless load level	3	-	○	○	-	○	
64	New vibration suppressing damping coefficient	0	-	○	-	-	○	
65	New vibration suppressing workpiece inertia ratio	40	-	○	-	-	○	

○ mark in the table is a parameter that is enabled in each control mode.

3.8.2 Description of Each Parameter

PA4_01 to 06 Interference detection function settings

No.	Name	Setting range	Default value	Change
01	Interference detection level	GYB: 0 [%] to 350 [%] GYB other than: 0 [%] to 300 [%]	GYB: 350 [%] other than GYB: 300 [%]	Always
02	Interference detection return amount	0 to 2000000000 [unit amount]	0	Always
03	Interference detection return speed	GYS, GYB 750W or less: 0.01 to 6000.00 [r/min] GYS 1kW or more: 0.01 to 5000.00 [r/min] GYG: 0.01 to 3000.00 [r/min]	500.00	Always
04	Interference detection LPF time constant	0.0 to 200.0 [ms]	20.0	Always
05	Interference detection HPF time constant	0.0 to 200.0 [ms]	100.0	Always
06	Enable/disable interference detection	0: Disable 1: Enable	0	Always

The servo amplifier detects disturbance torque caused by a collision (interference) with the machine end or other axes, and retracts the motor automatically in the direction of no interference.
This function is used if wishing to minimize damage to the machine caused by collisions.

[PA4_01: Interference detection level]

Set the torque level used for detecting collisions.

Collisions can be detected quickly by setting a small value, however, collisions may be mistakenly detected if set to small.

[PA4_04: Interference detection LPF time constant, PA4_05: Interference detection HPF time constant]

Set the filter time constant for extracting disturbance torque from the command torque.

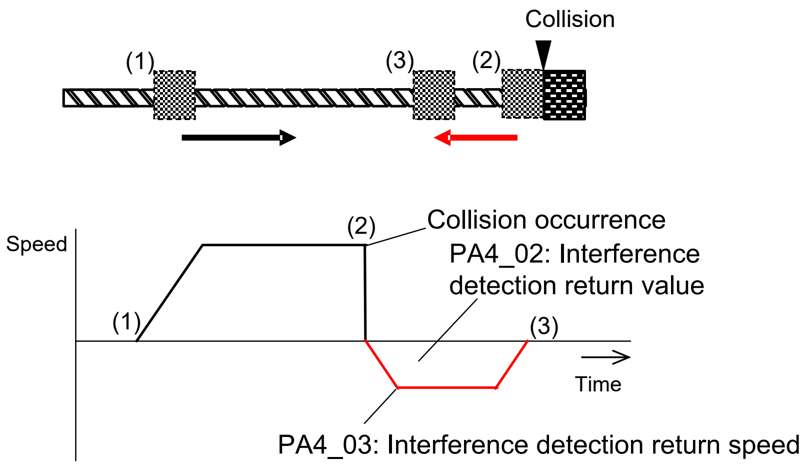
Collisions can be detected quickly by setting a small value, however, collisions may be mistakenly detected if set to small.

[PA4_02: Interference detection return amount, PA4_03: Interference detection return speed]

Set the return amount and speed following interference detection.

The acceleration/deceleration time at this time is based on the PA1_37 to 38: Acceleration/ deceleration time settings.

If in speed control mode, the return operation following interference detection is not performed.



[How to return to regular operation]

If the interference detection function is triggered and the servomotor has retreated in the direction of no interference, normal operation will be possible after the interference detection turns OFF. However, one of the operations indicated in the following table will be required to recover normal operation.

Recovery method
• Restart the servo amplifier. • Switch to the servo-off state. • Change Controlword (6040H) Fault reset (bit 7) from “OFF” to “ON”.

In pp or hm mode, in addition to the above, operation is resumed by turning Controlword (6040H) bit 4 (New set-point (pp), Homing operation start (hm)) from OFF to ON.

However, the status prior to interference detection is not retained, and operation is performed with the status at the time of recovery as the initial status.

PA4_10 Enable/disable SEMI F47 compatible function

No.	Name	Setting range	Default value	Change
10	Enable/disable SEMI F47 compatible function	0: Disable, 1: Enable	0	Power supply

This setting ensures compatibility with the SEMI F47 standard.

By setting this parameter to “1: Enable”, the control power undervoltage alarm level and main power shutoff detection time will be changed, allowing operation stoppages due to alarms to be circumvented, and operation to be continued.

• The main power supply is a three-phase power supply, and is compatible with no loads and light loads. This parameter is not applicable for use with single-phase power supplies.
• When set to "1: Enable", the settings of PA2_68 (Main power shutoff detection time) are disabled.
• Be sure to carry out a detailed check for the SEMI F47 standard on the actual customer’s equipment.

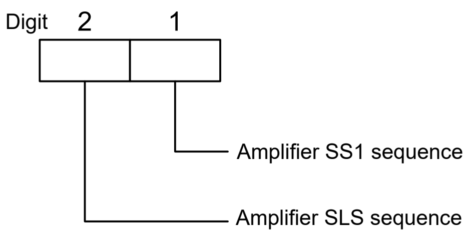
PA4_11 to 12 Function safety operation settings

No.	Name	Setting range	Default value	Change
11	Function safety amplifier operation selection	00 to 11	00	Power supply
12	Function safety SLS speed limit value	GYS, GYB 750W or less: 0.01 to 6000.00 [r/min] GYS 1kW or more: 0.01 to 5000.00 [r/min] GYG: 0.01 to 3000.00 [r/min]	GYS, GYB 750W or less: 6000.00 GYS 1kW or more: 5000.00 GYG: 3000.00	Always

Use this parameter only if using the servo amplifier in combination with the function safety module (WSU-ST1).

Set this parameter if wishing to automatically bring the motor to a decelerated stop or limit the motor speed at the servo amplifier when the SS1 (Safety Stop 1) function or SLS (Safety-Limited Speed) function becomes active at the function safety module.

Select this function with PA4_11: Function safety amplifier operation selection.
This parameter selects functions for each digit, and by setting 1 for each digit, the function is enabled.
The function is disabled when the setting value for each digit is 0.



By enabling the servo amplifier SS1 operation with PA4_11: Function safety amplifier operation selection, the motor will be brought to a decelerated stop at the servo amplifier when the SS1 function becomes active at the function safety module.
The deceleration time at this time is based on Quick stop deceleration (6085H).
By enabling the servo amplifier SLS operation with PA4_11: Function safety amplifier operation selection, the motor speed is limited to the PA4_12: Function safety SLS speed limit value at the servo amplifier when the SLS function becomes active at the function safety module.
The deceleration time at this time is the active deceleration time (PA1_38).

Note	• In csp mode, ensure that commands from the host device do not apply to speed limiting. • Operation should normally be performed with command values which ensure a speed of PA1_25: Max. rotation speed (for position and speed control) or less. • If activating the servo amplifier SLS function in combination with the function safety module (WSU-ST1), process commands in such a way that the speed is PA4_12: Function safety SLS speed limit value or less even at the host device side when the SLS function becomes active. If the servo amplifier SLS function alone is activated, a deviation over alarm will occur, and the motor may not move as commanded when the SLS function is canceled as described below. • The motor will move as follows if the speed limit is exceeded. (1) A position deviation will occur if a command exceeding the speed limit value is issued, and will continue to build up while the command is applied to speed limiting. (2) If the position deviation builds to the PA2_69: Deviation detection overflow value, a deviation over alarm will occur. (3) If the command is reduced to a value smaller than the speed limit value before the deviation over alarm occurs, the motor will continue to rotate at the speed limit value until the built up position deviation is offset, and subsequent operation will be based on the command. (4) If the speed limit value increases before the deviation over alarm occurs (when SLS canceled), the motor will accelerate to the speed limit value. • If the speed limit value becomes greater than the command value, the operation will be as described in item (3). • If the speed limit value remains smaller than the command value, the operation will be as described in items (1) and (2).

PA4_21 Torque control speed limit method

No.	Name	Setting range	Default value	Change
21	Torque control speed limit method	0: PI control (PA1_56, PA1_57, PA1_65, PA1_66) 1: Older model compatibility (PA1_96)	0	Power supply

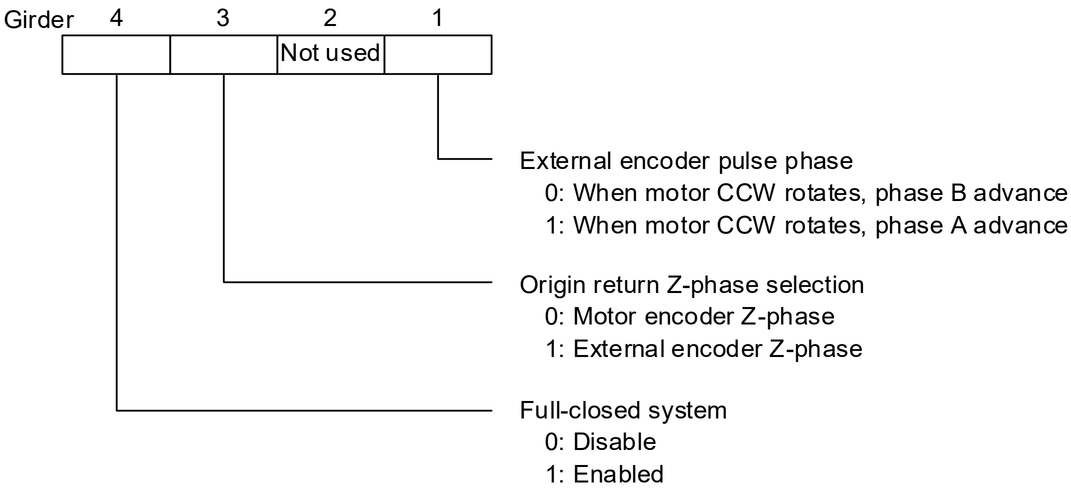
Select the speed limit method in torque control.

Set 1 (older model compatibility) to make speed limiting responses compatible with older models when performing torque control.

PA4_32 Full-closed system setting

No.	Name	Setting range	Default value	Change
32	Full-closed system setting	0000 to 1101	0000	Power

Enables the full-closed control and sets the functions related to the external encoder. This parameter is a type to select the function for each digit.



PA4_35 Full-closed LPF time-constant

No.	Name	Setting range	Default value	Change
35	Full-closed LPF time-constant	0.0 to 100.0 [ms]	1.0	Always

Since the impact of mechanical resonance, etc. of the external encoder is more remarkable than that of the motor encoder, if it is controlled only by the detection value of the external encoder, the performance may not be achieved without increasing the control gain.

In such a case, stable operation can be achieved by using this filter.

Increasing the setting value will not be affected by the external encoder. However, the settling time will be longer. Adjust the setting time so that the settling time can be satisfied within the range of stable operation.

By setting this setting value to 0, control can be performed only with the position information of the external encoder.

3

PA4_36 External/motor deviation over detection value
PA4_37 External/motor deviation over forecast value

No.	Name	Setting range	Default value	Change
36	External/motor deviation over detection value	0 to 16777216 [×100 pulse]	25600	Always
37	External/motor deviation over forecast value	0 to 16777216 [×100 pulse]	12800	Always

External/motor deviation over alarm (touch panel display: AL.oF) and output signal (OUT signal) "External"

Sets the level to output /Motor deviation over forecast.

When a deviation of the value set in this parameter occurs in the encoder pulse amount of the motor, an alarm is detected or OUT signal turns ON.

* This parameter is not required to be set, so set it as necessary

PA4_38 Frequency divider denominator for external/motor deviation monitor

No.	Name	Setting range	Default value	Change
38	Frequency divider denominator for external/motor deviation monitor	0 to 100000	100	Always

The deviation amount to be output to the external/motor deviation for PC loader waveform trace is divided by the value set in this parameter and output.

$$\text{External/motor deviation (for waveform trace)} = \frac{\text{External/Motor Daviation}}{\text{PA4\_38 Setting value}}$$

* This parameter is not required to be set, so set it as necessary.

PA4_51 to 59 Notch filter settings

No.	Name	Setting range	Default value	Change
51	Notch filter 3 frequency	10 to 4000[Hz]	4000	Always
52	Notch filter 3 attenuation	0 to 40 [dB]	0	Always
53	Notch filter 3 width	0 to 3	2	Always
54	Notch filter 4 frequency	10 to 4000[Hz]	4000	Always
55	Notch filter 4 attenuation	0 to 40 [dB]	0	Always
56	Notch filter 4 width	0 to 3	2	Always
57	Notch filter 5 frequency	10 to 4000[Hz]	4000	Always
58	Notch filter 5 attenuation	0 to 40 [dB]	0	Always
59	Notch filter 5 width	0 to 3	2	Always

Notch filter settings are used to suppress machine system resonance.

Resonance points at up to five locations can be suppressed with PA1_71 to PA1_76.

PA4_51 to PA4_59 are not automatically adjusted, even if PA4_51: Automatic notch filter selection = 1 (enabled).

Refer to "PA1_70 to 76 Notch filter settings" in "3.3.2Description of Each Parameter" for details on the setting method.

PA4_60 Cogging torque compensation

No.	Name	Setting range	Default value	Change
60	Cogging torque compensation	0: Disable 1: Enable 2: Learning 3: Clear learning result	0	Always

Speed fluctuations resulting from servomotor cogging torque can be suppressed.

Use this parameter if wishing to suppress speed fluctuations during operation.

This function can be used by setting the parameter to 2 (learning), rotating the servomotor 10 times or more, and after the servo amplifier has learned the cogging torque (the parameter is automatically set to 1: Enable when learning is complete.)

To reset the learned result, set to 3 (clear learning result) (the parameter is automatically set to 0: Disable when the result is cleared.)

Note

- Run the servomotor under the following operating conditions when performing learning.
  If the following conditions are not satisfied, it may not be possible to perform learning correctly.
  (5) Run the servomotor on its own before installing it on the machine.
  (6) When performing learning, run the servomotor at a constant rotation speed of approximately 100 [r/min].
- If learning is not completed, it will not be possible to set this parameter to 1: Enable. A data error will occur when an attempt is made to set the parameter.
- The cogging torque differs for each motor. Perform teaching again when a motor is replaced.
- There may be no effect, even when using this function, for such reasons as the cogging torque being too low. If no effect is observed, set this function to “0: Disable”.

PA4_61 to 63 Tuningless function settings

No.	Name	Setting range	Default value	Change
61	Tuningless function Enable/disable	0: Disable 1: Enable	0	Power supply
62	Tuningless level	0 to 7	4	Always
63	Tuningless load level	0 to 3	3	Always

Set these parameters when using the tuningless function.

Refer to "4.2 Tuningless Function" for details on settings and adjustment, etc.

PA4_64 to 65　New vibration suppressing settings

No.	Name	Setting range	Default value	Change
64	New vibration suppressing damping coefficient	0 to 99 [%]	0	Always
65	New vibration suppressing workpiece inertia ratio	5 to 80 [%]	40	Always

These parameters are valid only for position control.

They are used to suppress (vibration suppression) vibrations at the tip of workpieces.

If vibrations persist despite adjusting vibration suppression (PA1_78 to PA1_86), suppression is possible using these parameters.

By increasing the PA4_64: New vibration suppressing damping coefficient setting value, the amount of compensation applied with this function increases, however, vibration may increase if the value is too high.

PA4_65: New vibration suppressing workpiece inertia ratio sets the inertia of vibrating parts such as the arm as a percentage of the inertia for the entire workpiece.

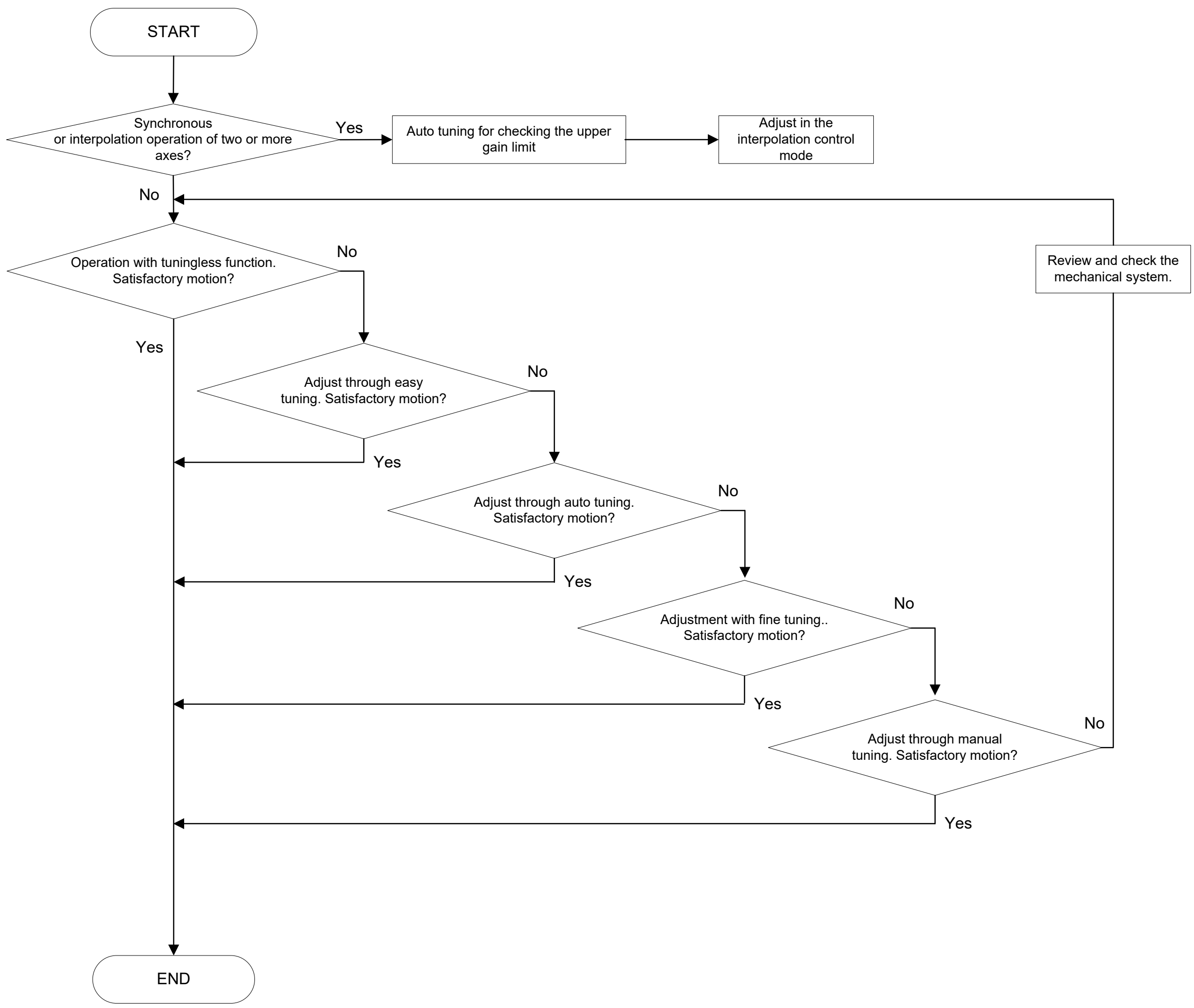
Refer to "4.9 Special Adjustment (Vibration Suppression)" for details on vibration suppression.

CHAPTER 4 SERVO ADJUSTMENT

4.1 Adjustment Procedure

Adjustment (tuning) of the servo amplifier is necessary so that the servomotor operates according to commands sent from the host control unit.
Proceed servo amplifier tuning as in the following chart.

■ Using the tuning procedure and mode selection



4.2 Tuningless Function

4.2.1 What is the Tuningless Function?

With the tuningless function, the servo amplifier adjusts parameters automatically to provide almost the same response based on the machine model or load fluctuations, eliminating the need to make manual adjustments.

4.2.2 Setting Parameters

The tuningless function is disabled by default.
To enable this function, change PA4_61 (Tuningless function selection) to “1” (Enable), and turn the servo amplifier power ON again.

No.	Name	Setting range	Default value	Change
PA4_61	Tuningless function selection	0: Disable 1: Enable	0	Power supply

4.2.3 Operating Procedure

The tuningless function is used to automatically adjust internal servo amplifier parameters based on the load condition, and therefore the function will remain ON continuously after the function is enabled. There is generally no need to change or adjust parameter setting values, however, if vibrations or oscillations occur during operation, or if unsatisfied with operation, the following parameter settings should be specified.

No.	Name	Setting range	Default value	Change
PA4_62	Tuningless level	0 to 7 0: Low response to 7: high response	4	Always
PA4_63	Tuningless load level	0 to 3 0: Light load to 3: heavy load	3	Always

PA4_62: The tuning level parameter is used to set the servo response when using this function, and the greater the value, the higher the response.
If vibrations or oscillations occur with the default value (setting value = 4), adjust this setting to a smaller value.

PA4_63: The tuningless load level parameter selects the size of the load inertial moment.
If the load inertial moment is small, adjust this setting to a smaller value.
* Setting guideline
0 (light load): load inertial moment ratio = 3 times or less
3 (heavy load): load inertial moment ratio = 30 times or more

4.2.4 Disabled Functions and Parameters

If the tuningless function is enabled, the following functions and parameters will be disabled.
Furthermore, this function will be disabled if the control mode is torque control mode.

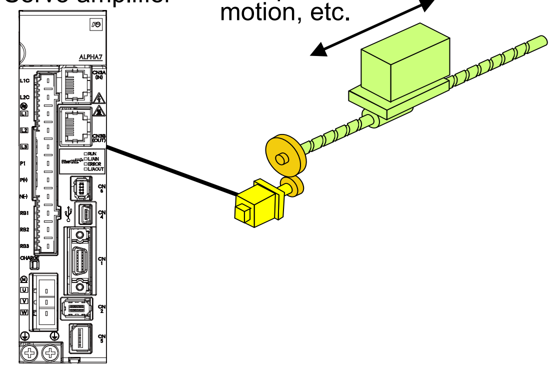
No.	Name
PA1_13	Tuning mode selection
PA1_14	Load inertia ratio
PA1_15	Auto tuning gain 1
PA1_16	Auto tuning gain 2
PA1_61 to PA1_67	Second gain settings
PA1_77 to PA1_86	Vibration suppressing control settings

Note	When using this function, use with an operation pattern that does not involve torque limiting. When using this function, auto tuning function (easy tuning and fine tuning) is disabled.

4.3 Easy Tuning

4.3.1 What is Easy Tuning?

Disconnect the servo amplifier from the host control unit and operate only the servo amplifier and servomotor to automatically tune internal parameters of the amplifier.
With this function, even if the host control unit program is incomplete, the servomotor can be operated in advance which can lead to the reduction of the setup time.



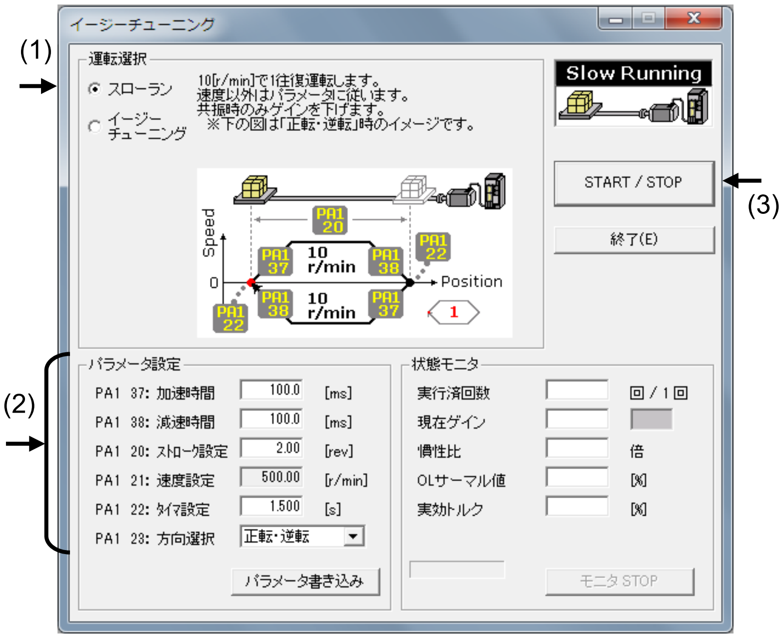
4.3.2 Easy Tuning Operation Profile

Easy tuning is performed from PC Loader.
To install PC Loader, refer to "CHAPTER 13 PC LOADER."

Note	Start operation after checking no collision exists in the moving parts of the machine.

[1] Slow running

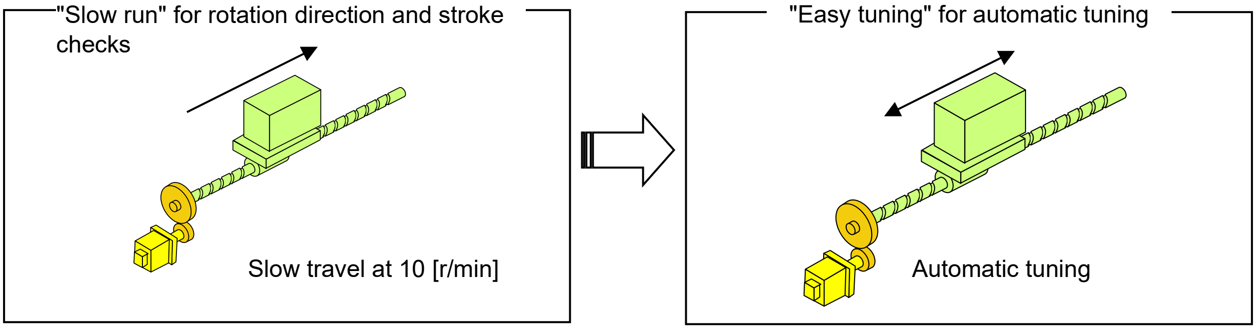
For machines with a linear driving system, follow the procedure below to perform slow running before performing easy tuning.
Turn the motor at 10 [r/min] (fixed) while checking the rotation direction and stroke.
Select "slow running" (1) on the PC Loader screen shown on the right and enter the "stroke setting" and "direction selection" parameters (2), and then press the "START/STOP" button (3).



Hint	Slow running is unnecessary for machines with a rotary driving system.

[2] Easy tuning

Select "easy tuning" on the aforementioned screen . Enter the "stroke," "speed" and other particulars and press the "START/STOP" button. Up to 25 reciprocal motions occur while parameters are automatically tuned.



4.3.3 Description of Operation

Two operation patterns of easy tuning are described.

■ Slow running

Starting conditions

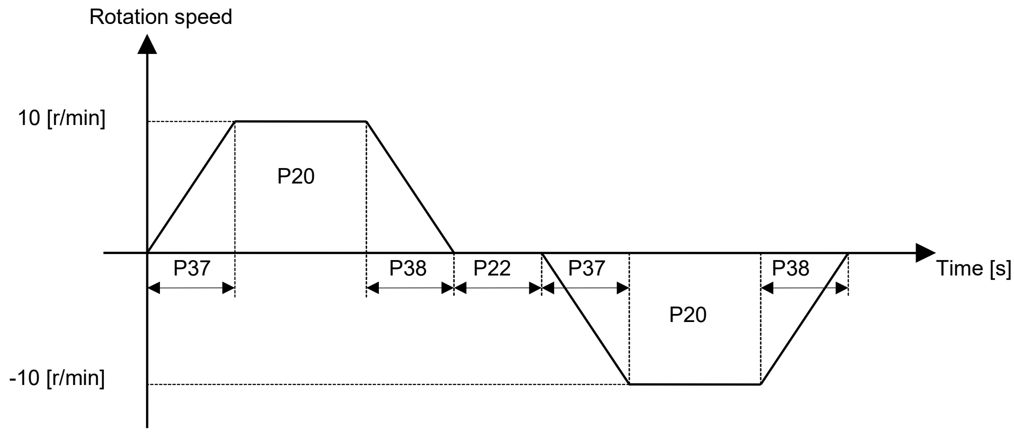
Conditions for starting slow running are indicated "○" in the table below.
Slow running does not start if the conditions shown below are not satisfied ("NG1" is indicated).
If none of conditions are satisfied during operation, operation is stopped ("NG2" is indicated).
The gain reference value at the time of the start is kept as far as no resonance is observed.

Power supply to main circuit	No alarm	Neither ±OT nor EMG	BX signal OFF	Auto tuning*1	Parameter write enable*2	Tuningless function disable*3
○	○	○	○	○	○	○

*1) PA1_13 (tuning mode selection): other than 2 (manual tuning)
*2) PA2_74: Parameter write protection = 0 (write enable)
*3) PA4_61: Tuningless function selection = 0 (disable)

Operation pattern (in case of reciprocal motion)

The operation pattern is shown below. "P□□" in the table indicates the number of the basic setting parameter (PA1_□□).



Traveling distance	Operation frequency	Acceleration time	Deceleration time	Rotation speed	Timer	Rotation direction	
						Go stroke	Return stroke
P20	Once	P37	P38	10 [r/min]	P22	P23	

Details of tuning

No tuning is performed in slow running.
However, the auto tuning gain is automatically decreased if resonance is observed in the machine.
In this case, the automatic notch filter function is activated.

Details of completion of action

The action completion method includes three patterns: normal completion, interruption by user, and faulty termination. Each profile is described below.

Normal completion	Interruption by user	Faulty termination	
		NG2	NG3
Stopped after the specified stroke action. If mechanical resonance is found, the notch filter is automatically adjusted and the auto tuning gain automatically decreases.	The auto tuning gain at the start of operation is restored.	The auto tuning gain at the start of operation is restored.	The auto tuning gain automatically changes to the one that will suppress resonance (re-adjustment is necessary).

■ Easy tuning

Starting condition

Conditions necessary to start easy tuning are indicated "○" in the table below.
Easy tuning does not start if the following conditions are not satisfied ("NG1" is indicated).
Easy tuning is interrupted if any condition is unsatisfied during operation ("NG2" is indicated).

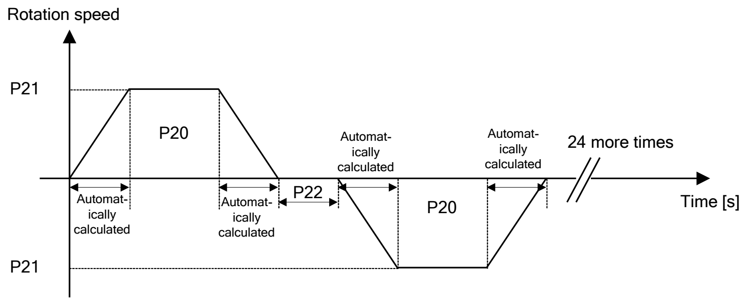
Power supply to main circuit	No alarm	Neither ±OT nor EMG	BX signal OFF	Auto tuning[*1]	Parameter write enable[*2]	Tuningless function disable[*3]
○	○	○	○	○	○	○

*1) PA1_13 (tuning mode selection): other than 2 (manual tuning)
*2) PA2_74: Parameter write protection = 0 (write enable)
*3) PA4_61: Tuningless function selection = 0 (disable)

Hint	Easy tuning may not function correctly in mechanisms listed below. • Machines susceptible to vibration due to small rigidity • Machines with large backlash • Machines with large viscous friction • Machines with very small rotation speed (example: 100 [r/min] or less) • Machines with large load inertia of load(GYG motor：30 times or over、others：100 times or over) • Machines with large and fluctuating load inertia

Operation profile (in case of reciprocal motion)

The operation profile is shown below. "P□□" in the table indicates the number of the basic setting parameter (PA1_□□).



Traveling distance	Operation frequency	Acceleration time	Deceleration time	Rotation speed	Timer	Rotation direction*1	
						Go stroke	Return stroke
P20	Max. 25 times	Automatically calculated*1	Automatically calculated*1	P21	P22*2	P23	

*1) The result of automatic calculation can be checked with the PC Loader.
*2) 1 [s] or less reference values are assumed to be 1 [s] for easy tuning.

The frequency of a reciprocal motion is 25 cycles maximum, and that of a single-direction motion is 50 cycles maximum.

Details of tuning

Up to 50 easy tuning cycles are repeated while auto tuning gain 1 is automatically adjusted in the range from 5 to 30.

Details of completion of action

The action completion method includes three profiles: normal completion, interruption by user, and faulty termination. Each profile is described below.

Normal completion	Interruption by user	Faulty termination	
		NG2	NG3
Completion of easy tuning is indicated. Auto tuning gain 1 (range between 5 and 30) is automatically adjusted to the best value.	Auto tuning gain 1 at the start of operation is restored.	Auto tuning gain 1 at the start of operation is restored.	Auto tuning gain 1 automatically changes to the one that will suppress resonance (re-adjustment is necessary).

Results of easy tuning

After easy tuning is normally finished, the gain and load inertia ratio automatically adjusted in tuning are reflected on parameters. (See the table below.)
If resonance is observed during easy tuning, a notch filter is automatically set to suppress resonance, and the filter is reflected on parameters.
Perform regular operation under the above status and if satisfactory actions are obtained, there is no need to perform tuning described on following pages.

<Parameters set with the easy tuning function>

Number: PA1_	Name
14	Load inertia ratio
51	Moving average S-curve time
54	Position command response time constant
55	Position loop gain 1
56	Speed loop gain 1
57	Speed loop integration time constant 1
87	Model torque filter time constant
88	Position loop integration time constant

Notes on easy tuning

With easy tuning, automatic operation is performed according to functions of the servo amplifier. Sufficient care should be taken on the safety.
If ill effects are expected to the machine due to resonance of the motor with the mechanical system, assign the servo-on (S-ON) signal to a CONT signal before starting easy tuning.
If a fault is found during operation, turn the signal off immediately.
If the excessive stroke cause damage to the machine, assign ± over-travel (±OT) signals to CONT signals and install over-travel sensors at both ends of the motion stroke before starting easy tuning.

Easy tuning for vertical transportation

When performing easy tuning with the servomotor for vertical transportation, to prevent a carried object from falling due to its own weight, turn the servo-on signal to ON and check that the servo lock is activated before releasing the brake.
Then performe easy tuning, refer to P4-6 procedure.

4.4 Auto Tuning

If satisfactory results are not obtained after easy tuning, perform "auto tuning." In this mode, the load inertia ratio of the machine is always estimated, and optimum gain is automatically settled.

4.4.1 Conditions for Auto Tuning

Auto tuning may not function correctly if the following conditions are not satisfied.

- The load inertia ratio of the mechanical system is within 100 times of the servomotor.
- Required time to reach 2000 [r/min] is 5 [s] or shorter with the acceleration/deceleration time constant.
- The motor rotation speed is 100 [r/min] or more.
- There is no substantial load fluctuation during operation or acceleration/deceleration.
- The friction force is not large and does not apply pressure.

4.4.2 Parameters Used for Auto Tuning

Parameters used for gain adjustment are listed in the table below.

No.	Name	Approximate reference value	
PA1_13	Tuning mode selection	0: Auto tuning	1: Semi-auto tuning
PA1_14	Load inertia ratio	No need to enter (automatically updated)	Enter a stable estimated value (or average value).
PA1_15	Auto tuning gain 1	Refer to "4.4.3Approximate Reference Value of Auto Tuning Gain 1" for adjustment.	
PA1_16	Auto tuning gain 2	Enter when necessary.	

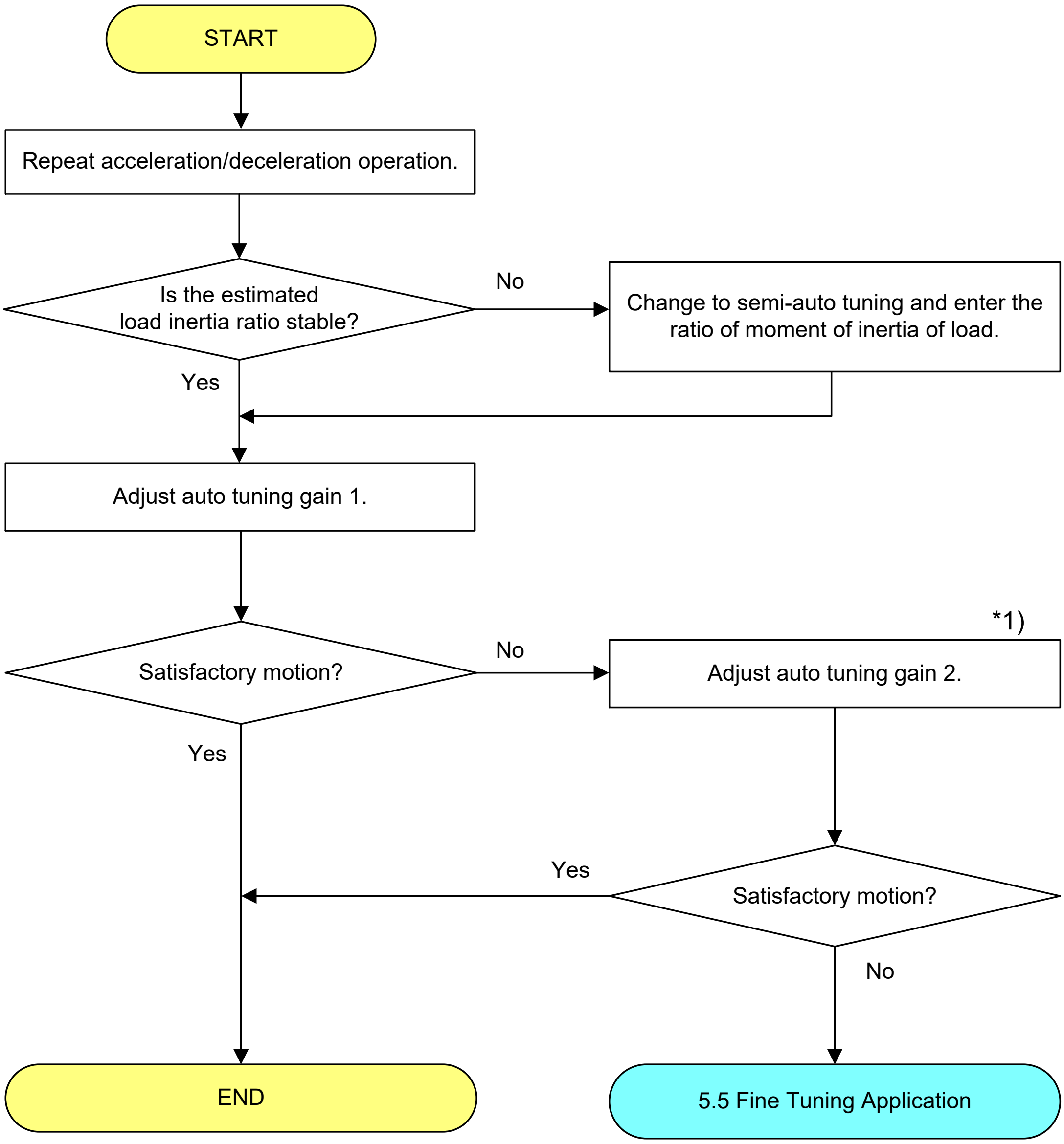
- During auto tuning, by adjusting PA1_15: auto tuning gain 1, other parameters are automatically adjusted. The values are always updated.
- During semi-auto tuning, enter PA1_14: load interia ratio and by adjusting PA1_15: auto tuning gain 1 other parameter are automatically adjusted.
  Values are fixed as far as the setting is left unchanged.

4.4.3 Approximate Reference Value of Auto Tuning Gain 1

By increasing auto tuning gain, response will be improved while possibly causing vibration or other ill effects. Change the value at intervals of about 2 points.
If resonance with the mechanical system or abnormal noises are not caused, auto tuning gain 1 can be increased and the settling time can be decreased.

Machine configuration (Division by mechanism)	Auto tuning gain 1 (Approximate reference value)
Large transfer machine	1 to 10
Arm robot	5 to 20
Belt mechanism	10 to 25
Ball screw + Belt mechanism	15 to 30
Mechanism directly coupled with ball screw	20 to 40

4.4.4 Auto Tuning Adjustment Procedure



*1) There is no need to adjust auto tuning gain 2 under speed control.

4.5 Fine Tuning

4.5.1 What is Fine Tuning?

If unsatisfied with operation using "easy tuning" or "auto tuning" adjustments, adjustments can be made using the "fine tuning" function.

The status of the motor run with the servo amplifier is observed with PC Loader, and this function is used to set optimum control gain and filter setting values based on the operating status.

* PC Loader is required to use this function.

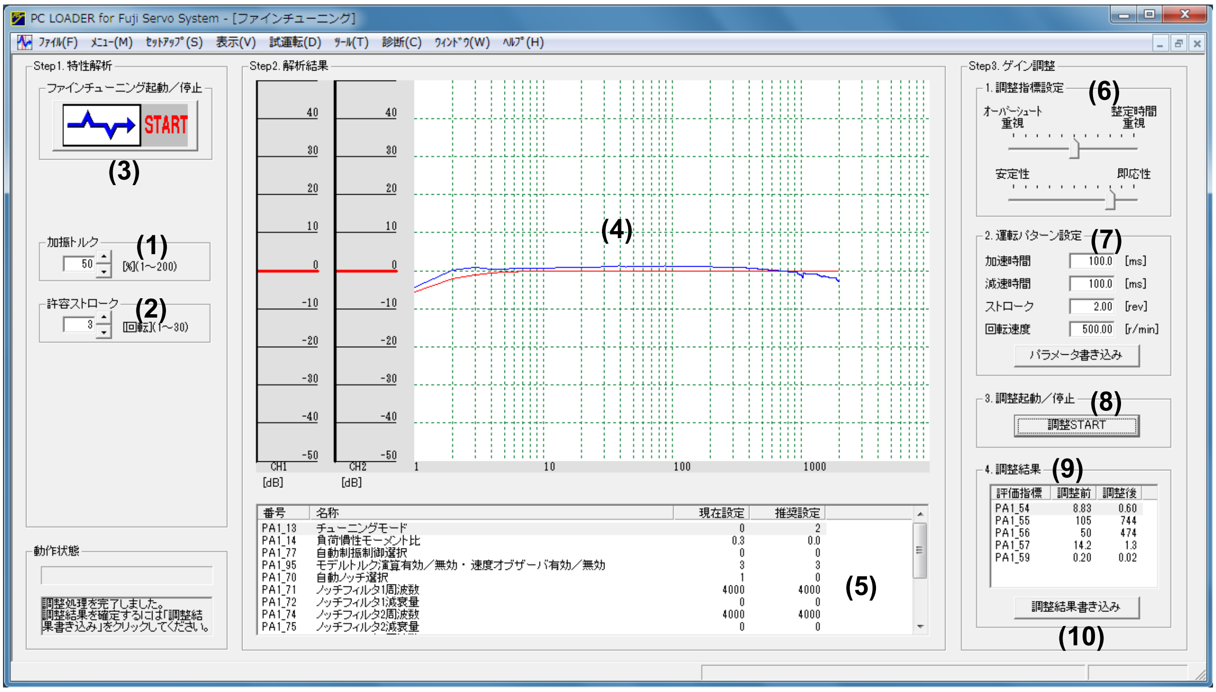
4.5.2 Adjusted Parameters

No.	Name
PA1_13	Tuning mode selection
PA1_14	Load inertia ratio
PA1_51	Moving average S-curve time
PA1_54	Position command response time constant
PA1_55	Position loop gain 1
PA1_56	Speed loop gain 1
PA1_57	Speed loop integration time constant 1
PA1_59	Torque filter time constant for position and speed control
PA1_71 to PA1_76	Notch filter settings
PA1_77	Vibration suppression function selection
PA1_78	Vibration suppressing anti resonance frequency 0
PA1_79	Vibration suppressing workpiece inertia ratio 0 (vibration suppressing antiresonant frequency)
PA1_80	Vibration suppressing anti resonance frequency 1
PA1_81	Vibration suppressing workpiece inertia ratio 1 (vibration suppressing antiresonant frequency)
PA1_86	Vibration suppressing damping coefficient
PA1_87	Model torque filter time constant
PA1_92	Friction compensation: speed range
PA1_95	Model torque calculation selection, speed observer selection
PA4_51	Notch filter 3 frequency
PA4_52	Notch filter 3 attenuation
PA4_53	Notch filter 3 width

4.5.3 Operating Procedure

The screen below appears when the fine tuning function is selected.
By specifying settings and performing operations using the following procedure, the servo amplifier adjusts the optimum gain and filter settings.

Note	The fine tuning function involves motor movement. • Perform the following procedure after ensuring safety near moving parts of the machine. • Carry out a thorough check to ensure that motor movement will not result in any danger.



[Step 1. Characteristic analysis]

Acquire data required for machine frequency analysis.

(1) Set the vibration torque required for the servo amplifier to analyze characteristics.

(2) Set the permissible stroke when performing vibration motion.

(3) Press the "START" button to begin vibration motion.

[Step 2. Analysis results]

Calculate the machine frequency analysis from the results of the vibration motion performed at Step 1.

(4) Analysis results are displayed when the vibration motion is complete.

(5) Display the recommended control gain and filter setting values (default values when adjusting gain) from the frequency characteristics.

[Step 3. Gain adjustment]

Adjust the parameters to optimum values at the servo amplifier while running the motor.

(6) Set the adjustment indicator.

- Emphasis on command response/emphasis on disturbance response
  Select whether to perform adjustment emphasizing the response to commands to the servo amplifier, or adjustment emphasizing the response to disturbances.
  * By placing emphasis on command response, settling time will be shorter, however, the response to disturbances will drop.
  If placing emphasis on disturbance response, the response to disturbances will increase, however, settling time will be longer.
- Stability level
  Select the margin for the maximum setting range for the control gain calculated from frequency characteristics.
  The greater the value, the greater the margin (stability), however, the response will drop.

(7) Set the operation profile. (Forward/reverse rotation is repeated based on the set gain.)

(8) Press the adjustment "START" button to begin operation and gain adjustment.

(9) The adjustment results for gain and filter settings are displayed.

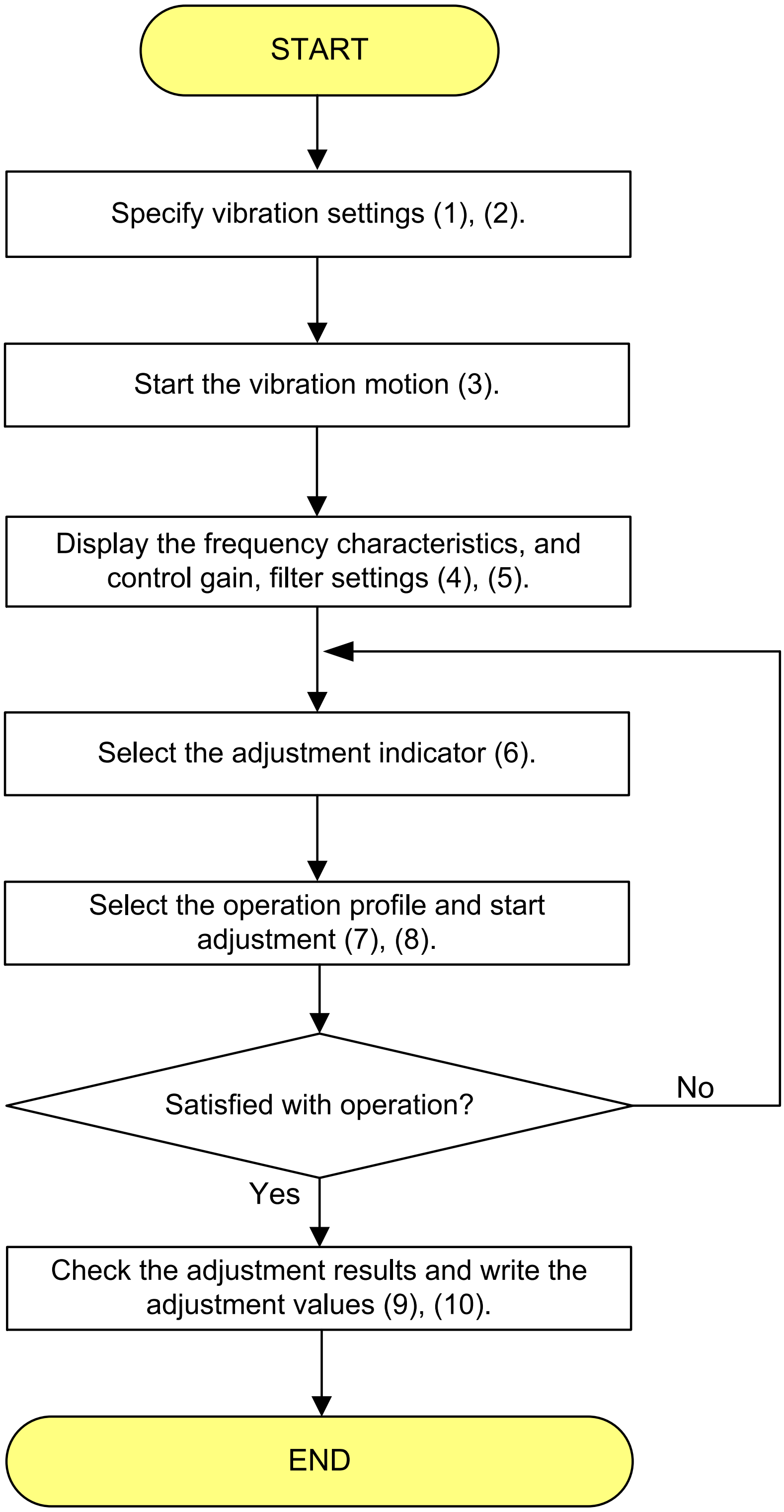
(10) If there are no problems with the adjustment values at (9), press the [Write Adjustment Results] button to complete adjustment.
If unsatisfied with operation based on the adjustment values at (9), reset the adjustment indicator at (6), and perform adjustment again.

■ Starting conditions

Conditions necessary to start fine turning are indicated “○” in the table below.

Before activating fine tuning, allow the condition to be ready for servo-on and deactivate the automatic gain adjustment functions (tuningless function, easy tuning) and the PC loader function.

Power supply to main circuit	○
No alarm	○
Neither ±OT nor EMG	○
BX signal OFF	○
Tuningless function disable	○
Not in easy tuning mode	○
Other PC loader functions OFF	○


START
Specify vibration settings (1), (2).
Start the vibration motion (3).
Display the frequency characteristics, and control gain, filter settings (4), (5).
Select the adjustment indicator (6).
Select the operation profile and start adjustment (7), (8).
Satisfied with operation?
No
Yes
Check the adjustment results and write the adjustment values (9), (10).
END

4.6 Manual Tuning

If the result of "auto tuning application" is not satisfactory or if faster response is intended, perform manual adjustment of all gains.

4.6.1 Conditions for Manual Tuning

Check the following conditions when adjusting.
- The load inertia ratio of the mechanical system is within 100 times of the servomotor.
- The backlash of the mechanical system is not large and the belt is free from deflection.
- Auto tuning has been performed.

4

4.6.2 Parameters Used for Manual Tuning

Parameters used for gain adjustment are shown in the table in the next section.

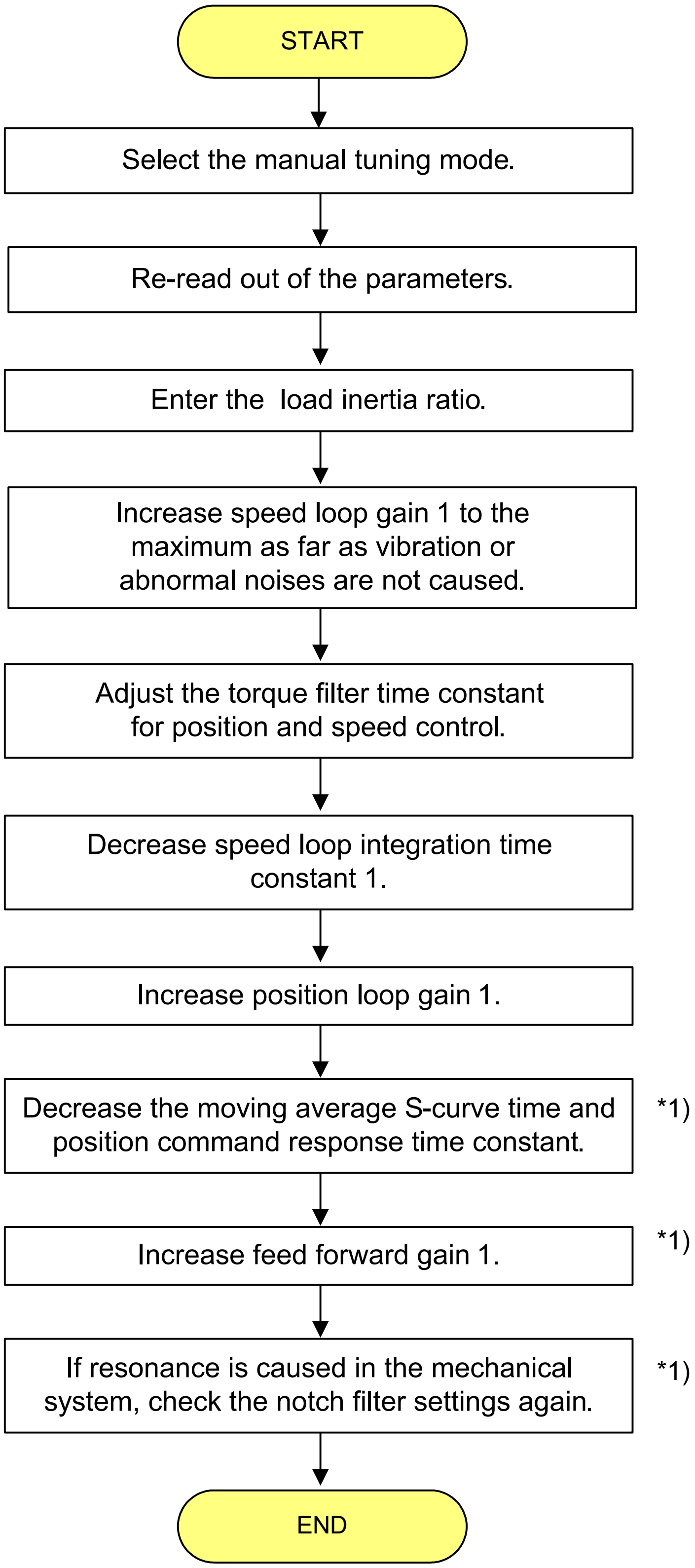
4.6.3 Approximate Gain Reference Value

Note	If manual tuning is performed to change parameters without performing auto tuning, the control system in the servo amplifier becomes imbalanced and triggers hazard. Be sure to perform re-read out of the parameters after auto tuning, and conduct adjustment based on those parameters.

No.	Name	Approximate reference value	Position control	Speed control
PA1_13	Tuning mode selection	2: Manual tuning	○	○
PA1_14	Load inertia ratio (JI)	Enter a stable assumed value (or average value).	○	○
PA1_51	Moving average S-curve time	16 or over	○	-
PA1_54	Position command response time constant (Kpt)	Kpt ≥ 600/Kp1	○	-
PA1_55	Position loop gain 1 (Kp1)	Kp1 ≤ Kv1 × (1 to 3)	○	-
PA1_56	Speed loop gain 1 (Kv1)	Kv1 ≤ 2000/ (1+JI)	○	○
PA1_57	Speed loop integration time constant 1 (Ki1)	Ki1 ≥ 500/Kv1	○	○
PA1_58	Feed forward gain 1	Specify when necessary.	○	-
PA1_59	Torque filter time constant for position and speed control (Tt)	0.1 ≤ Tt ≤ 1.0	○	○

Approximate values specified in the table above are reference values for a general mechanical configuration of the transfer system.
The approximate gain reference value varies according to the configuration of the mechanical system, load inertia ratio, etc.
Refer to the next page for the adjustment procedure. Parameters marked "-" in the speed control field in the table above need no adjustment.

4.6.4 Manual Tuning Adjustment Procedure



*1) Adjustment is unnecessary under speed control.

4

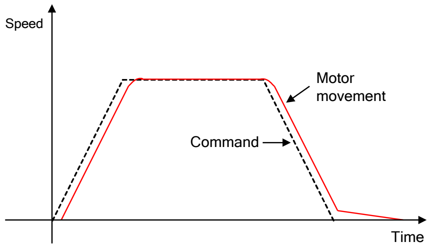
4.6.5 Individual Adjustment

The adjustment method for the individual case is described (for position control).
The method varies according to the configuration of the mechanical system and other particulars.
Use the procedure as a basic adjustment procedure.
Before making adjustment, use historical trace of the PC Loader to measure the action time and output timing of in-position signal.

■ Adjustment for faster response (reduced settling time)

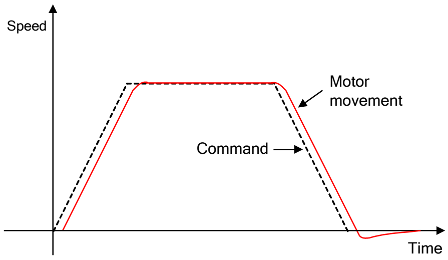
In case of shortage in travel

(1) Decrease PA1_51 (moving average S-curve time).
(2) Decrease PA1_54
(position command response time constant).
(3) Increase PA1_58 (feed forward gain 1).
(4) Decrease PA1_14 (load inertia ratio).
(Each change should be within ±10 [%].)



In case of overshoot

(1) Increase PA1_51 (moving average S-curve time).
(2) Increase PA1_54
(position command response time constant).
(3) Decrease PA1_58 (feed forward gain 1).
(4) Increase PA1_14 (load inertia ratio).
(Each change should be within ±10 [%].)



■ Adjustment checking method

The overshoot unit amount and settling time can be monitored with PC Loader during adjustment to reduce the settling time.
The motion waveform can be monitored, as well.
For details, refer to "CHAPTER 13 PC LOADER."

4.7 Interpolation Control Mode

Use the "interpolation control mode" to adjust command responses of a system with two or more servomotor axes such as the X-Y table when performing synchronous operation or interpolation operation.

4.7.1 Conditions for Interpolation Control Mode

Check the following conditions to perform adjustment.

- Keep consistency in the mechanical configuration and specifications of each axis to the largest extent (ball screw pitch, diameter, length, etc.).
- The backlash of the mechanical system is not large and the belt is free from deflection.
- Commands sent from the host are common among axes.

4.7.2 Parameters Used for Interpolation Control Mode

Parameters used for gain adjustment are shown in the table below.

No.	Name	Approximate reference value
PA1_13	Tuning mode selection	3: Interpolation control mode
PA1_14	Load inertia ratio	Enter a stable assumed value (or average value).
PA1_15	Auto tuning gain 1	Enter while referring to "4.4.3Approximate Reference Value of Auto Tuning Gain 1."
PA1_51	Moving average S-curve time	0
PA1_54	Position command response time constant	5 or over

The other parameters are automatically adjusted.
However, auto tuning gain 2 becomes disabled.

4.7.3 Adjustment Procedure in Interpolation Control Mode

[1] Specify PA1_13 (semi-auto tuning mode).
[2] Specify PA1_14 (load inertia ratio).
[3] Increase PA1_15 (auto tuning gain 1).
[4] If vibration or abnormal noises are caused in the mechanical system, reset the gain and set that value as the upper limit.
[5] Select the interpolation control mode with PA1_13.
[6] Set PA1_51 (moving average S-curve time) at 0.
[7] Gradually decrease PA1_54 (position command response time constant) (min: 5).
[8] Position command response time constant shall tune to the larger parameter between two axes.
[9] While observing interpolation characteristics and rotation state, finely adjust PA1_15 (auto tuning gain 1) and PA1_54 (position command response time constant).

4.8 Profile Operation

4.8.1 What is Profile Operation?

Even if the host control unit is not connected, automatic operation can be executed according to the specified operation pattern.

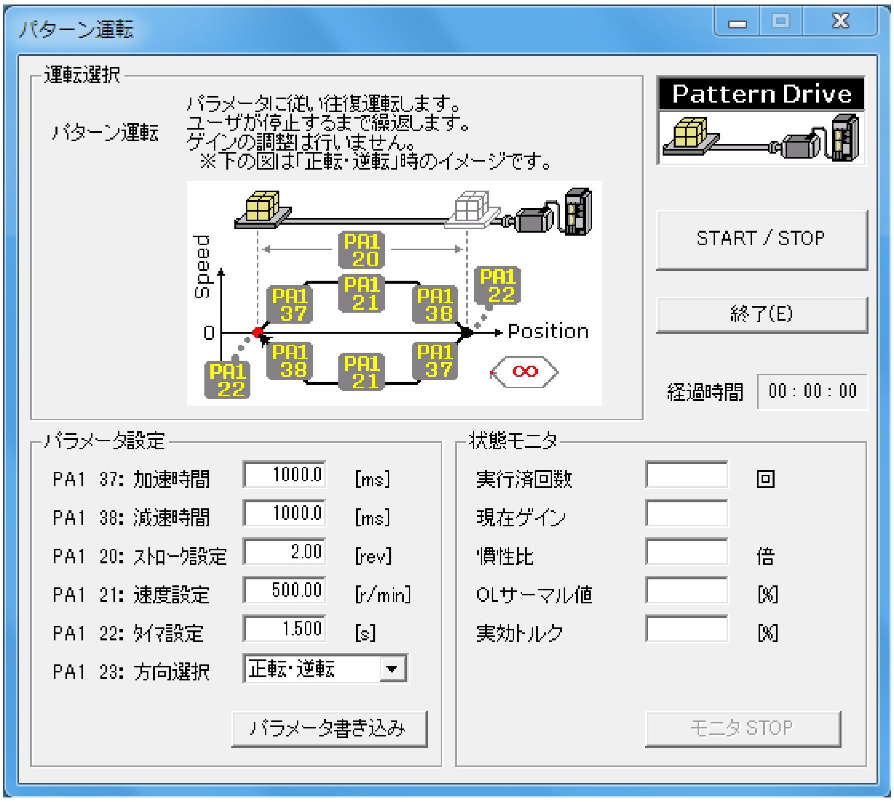
The motion continues until the user stops it. Use this feature to check the load condition of the mechanical system, effective torque, etc.

During profile operation, parameters are not tuned.

Profile operation can be performed from PC Loader.

Select the operation pattern and press the "START/STOP" button to start to operate.

4



4.8.2 Description of Operation

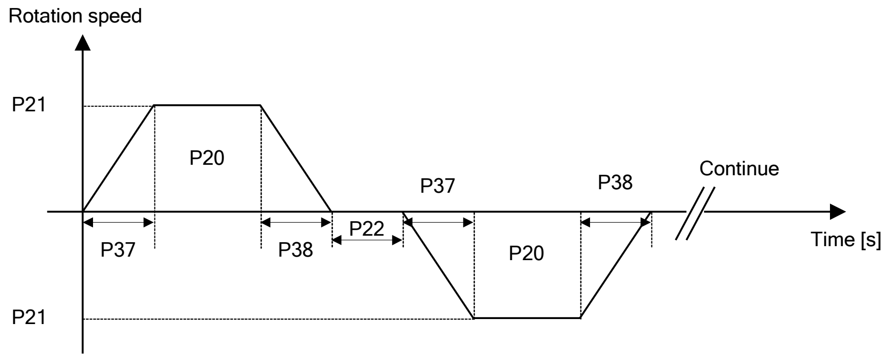
Starting conditions

Conditions for starting profile operation are described. Necessary conditions are indicated with "○."
The operation does not start if the following conditions are not satisfied ("NG1" is indicated).
Operation is interrupted if any condition is dissatisfied during operation ("NG2" is indicated).
The gain reference value is left unchanged at the start level as far as resonance is not observed.

Power supply to main circuit	No alarm state	BX signal turned off	Neither ±OT nor EMG
○	○	○	○

Operation pattern

The operation pattern is shown below. "P□□" in the table indicates the number of the basic setting parameter (PA1_□□).



Moving distance	Operation frequency	Acceleration time	Deceleration time	Rotation speed	Timer	Rotation direction	
						Go stroke	Return stroke
P20	Continuous	P37	P38	P21	P22	P23	

How to stop profile operation

Profile operation is stopped by the user or upon an error*.
* The error includes the following events.

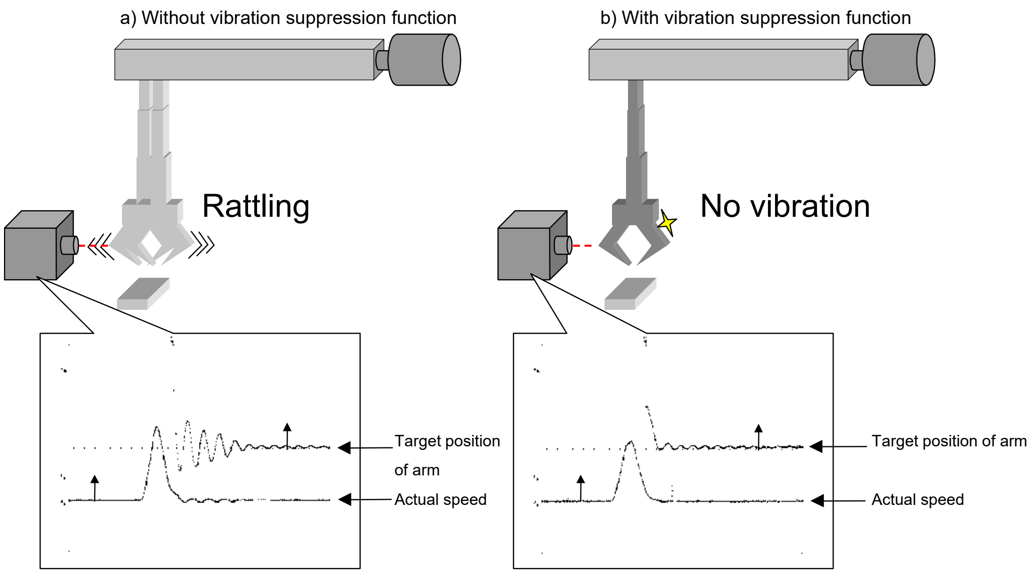
- ±OT, EMG or external braking resistor overheat is detected in the middle.
- BX (Free-run signal) is turned on in the middle.
- The servo-on (S-ON) signal is turned off in the middle.

4.9 Special Adjustment (Vibration Suppression)

4.9.1 What is Vibration Suppression ?

■ Purpose of vibration suppression

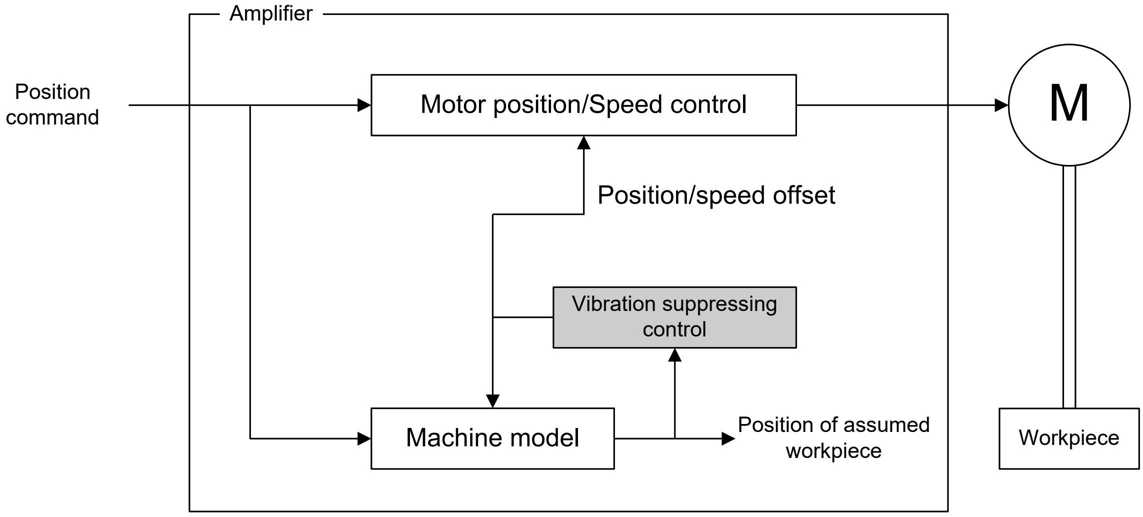
The end of the workpiece held in a structure having a spring characteristic such as the robot arm and transfer machine vibrates during quick acceleration or deceleration of the motor. The vibration suppression function aims at suppression of the workpiece and realization of positioning in a shorter cycle time in such a system.



Hint	Not only vibration of the tip of the machine but also vibration of the entire machine can be suppressed. • System without vibration suppression At motor acceleration / deceleration, torque tends to reach maximum value. This acceleration / deceleration shock could cause vibration to the entire machine. • System with vibration suppression Because the torque is controlled during acceleration / deceleration of the motor, the shock of acceleration/deceleration is reduced, and even with machine that is relatively less rigid, the vibration to the entire machine can be reduced.

■ Principles of vibration suppression

A machine model is contained inside, and the control works inside the model to eliminate vibration of the position of the assumed workpiece held in the model. The control amount is added as an offset to the position and speed control of the motor, thereby suppressing vibration of the actual workpiece position.



■ Mechanical characteristics and conditions that make vibration suppression effective

Applicable machine characteristics and conditions

- Vibration is caused at the end of the arm due to the shock of traveling/stopping of the robot arm or similar.
- The machine itself vibrates due to the shock of traveling / stopping of a part of the machine.
- The vibration frequency is about 1 [Hz] to 300 [Hz].

Inapplicable mechanical characteristics and conditions

- Vibration is observed continuously without relations to traveling / stopping.
- Eccentric vibration is caused in synchronization to the rotation of the motor or machine.
- The vibration frequency is less than 1 [Hz] or more than 300 [Hz].
- The traveling time is less than the vibration period.
- There is backlash in the mechanical joint to the vibrating mechanism.
- (Numerator 0 of electronic gear ratio / Denominator of electronic gear ratio) > 10000
- If the command pulse train frequency is equal to or less than 20 [kHz]

4.9.2 Automatic Vibration Suppression

Automatic vibration suppression is a function for automatically adjusting the vibration suppressing anti resonance frequency to the optimum value.
Follow the procedure below.

■ Automatic vibration suppression setting procedure

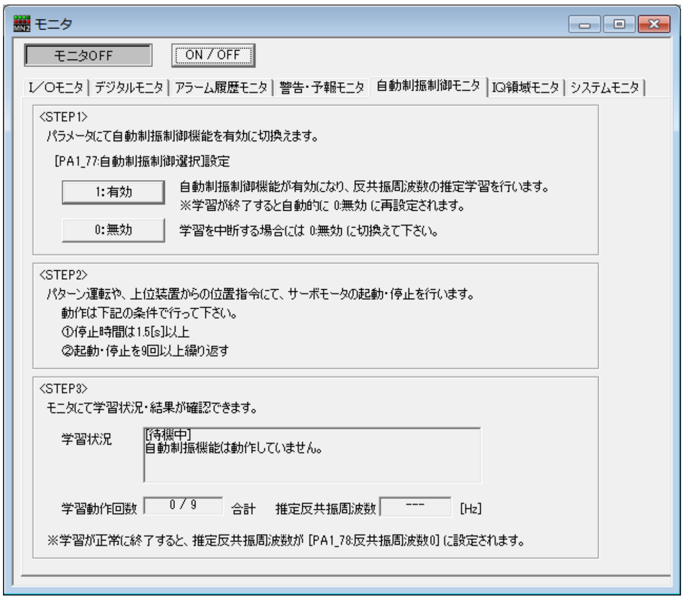
[1] Set PA1_77 (Vibration suppression function selection) at 1 (enable).
[2] Perform profile operation or issue position commands from the host unit to start and stop the servomotor nine times.
[3] Set the dwell at 1.5 [s] or longer.
[4] After operation is normally finished, the optimum value is automatically stored in PA1_78 (vibration suppressing anti resonance frequency 0).
[5] Upon a fault (if no effect is verified), PA1_78 (vibration suppressing anti resonance frequency 0) remains the default value.
[6] After normal or faulty completion, PA1_77 (Vibration suppressing function selection) automatically changes to 0 (disable).

* The applicable frequency is 1 [Hz] to 100 [Hz].

If the procedure is interrupted at eight or fewer cycles and the main power is turned off, the cycle count begins from 1 again.

■ Learning state of automatic vibration suppression

Use the monitor of the PC Loader to monitor the learning state of the automatic vibration suppression.

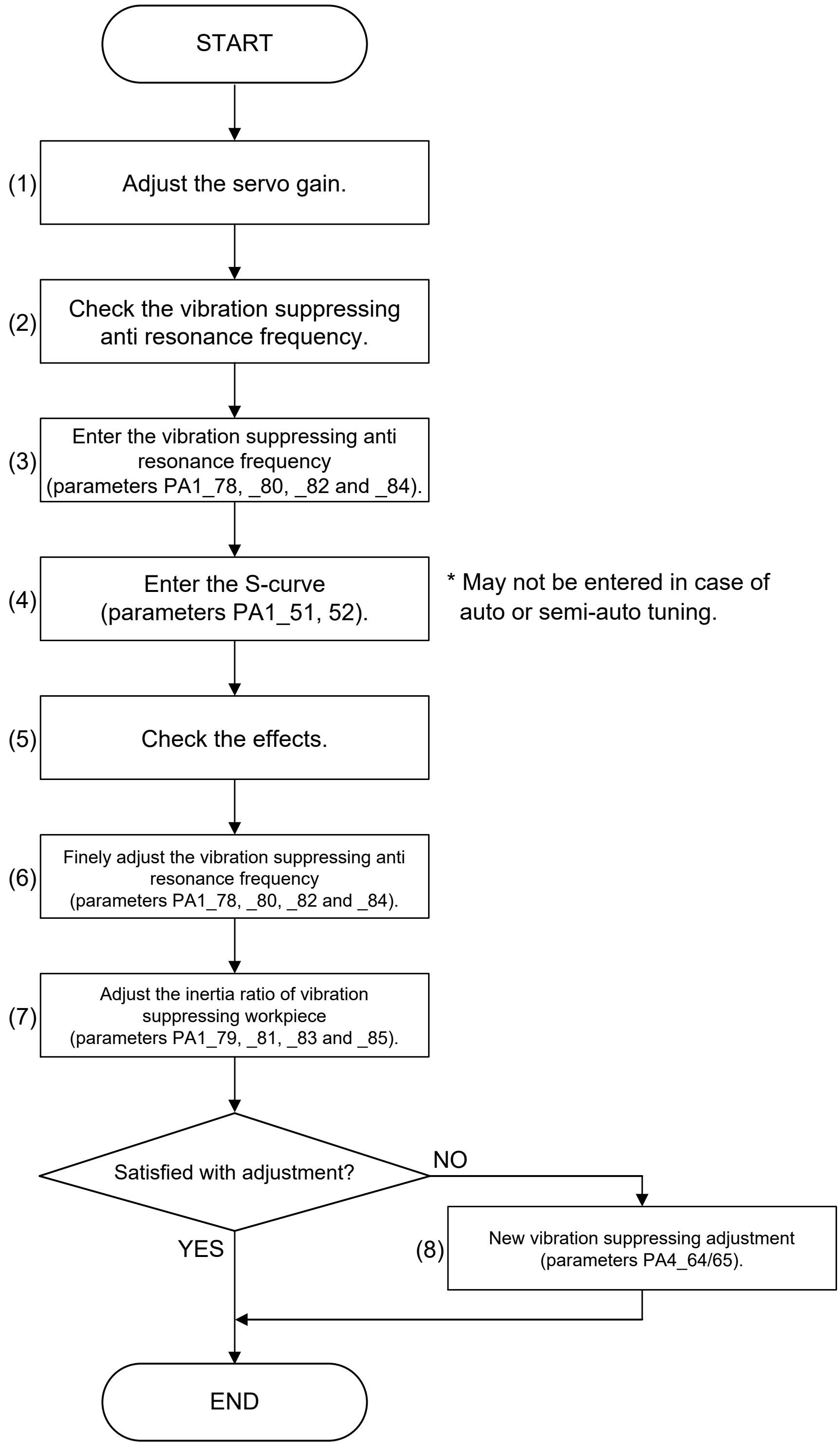


If no expected effect is obtained under automatic vibration suppression, refer to the following "4.9.3Manual Adjustment of Vibration Suppression."

Note	It may not be possible to learn normally when the full-closed loop control is enabled. Use automatic vibration suppression control with the full-closed loop control disabled.

4.9.3 Manual Adjustment of Vibration Suppression

■ Adjustment flow chart

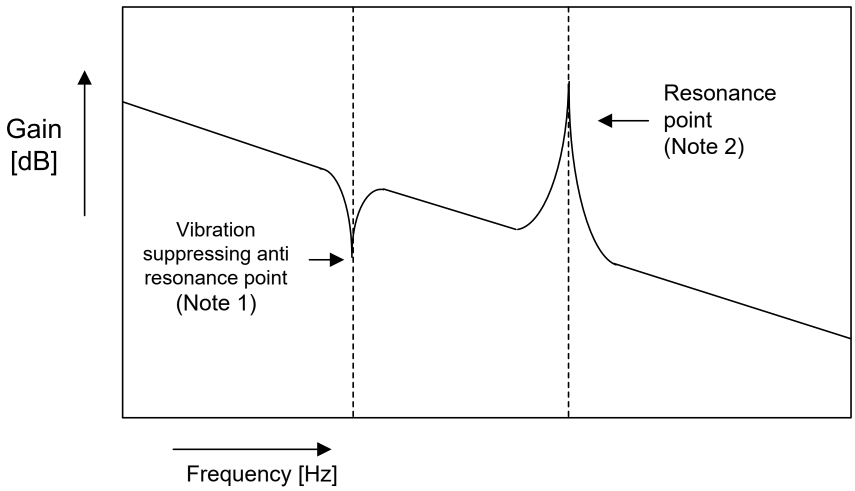


(1) Adjusting the servo gain
To ignore the vibration of the tip of the machine and reserve smooth stopping action of the servomotor free from overshoot, refer to the description given in sections 4.1 through 4.7 to adjust the servo gain.

Note	If gain-related parameters are adjusted after the vibration suppressing anti resonance frequency is set, the vibration suppressing anti resonance frequency must be adjusted again. Perform gain adjustment first.

(2) Checking the vibration suppressing anti resonance frequency
Using the PC Loader

Use the servo analyze function to check the vibration suppressing anti resonance point.



Note 1 The vibration suppressing anti resonance point may not be observed with the servo analyze function in the following machine configuration.
- Machine with large friction
- Machine with relatively large mechanical loss such as reduction gear and ball screw

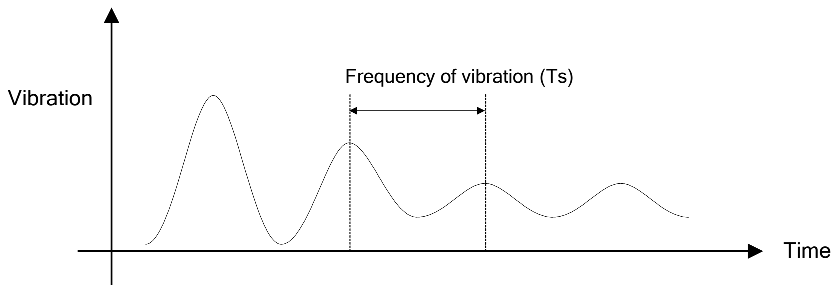
Note 2 Use the notch filter for the resonance point.

Hint	What are the resonance point and vibration suppressing anti resonance point? Vibration of the machine includes the "resonance point" and "vibration suppressing anti resonance point." The "resonance point" and "vibration suppressing anti resonance point" mentioned here are machine characteristics viewed from the motor. "Resonance point": Frequency at which the motor vibrates without arm tip vibration "Vibration suppressing anti resonance point": Frequency at which the arm tip vibrates without vibration of the motor shaft In general, the vibration suppressing anti resonance frequency is less than the resonance frequency.

Not using the PC Loader

There are two checking methods.
If measurement of the vibration frequency can be made with a laser displacement gauge or similar, adopt method 1). In other cases, adopt method 2).

1) Measure the vibration of the arm tip with a laser displacement gauge or similar.



$$\text{Vibration suppressing anti resonance frequency} = \frac{1}{Ts}\ [\text{Hz}]$$

2) Starting at 300.0 [Hz] (maximum setting), decrease the reference values of parameters PA1_78, _80, _82 and _84 gradually while visually checking vibration, to find the best value.

(3) Entering the vibration suppressing anti resonance frequency

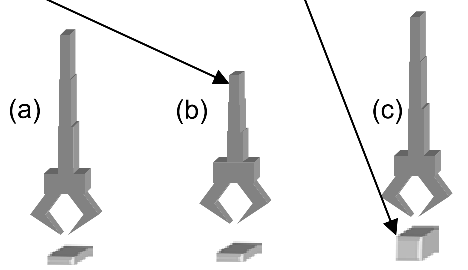
Enter the vibration suppressing anti resonance frequency obtained in step (2) to one of parameters PA1_78, _80, _82 and _84*.

No.	Name	Setting range	Default value	Change
PA1_78	Vibration suppressing anti resonance frequency 0	1.0 to 300.0 [Hz] (in increments of 0.1)	300.0	Always
PA1_80	Vibration suppressing anti resonance frequency 1	1.0 to 300.0 [Hz] (in increments of 0.1)	300.0	Always
PA1_82	Vibration suppressing anti resonance frequency 2	1.0 to 300.0 [Hz] (in increments of 0.1)	300.0	Always
PA1_84	Vibration suppressing anti resonance frequency 3	1.0 to 300.0 [Hz] (in increments of 0.1)	300.0	Always

* Parameters for up to four points can be entered.

While combining the "anti resonance frequency selection 0" and "anti resonance frequency selection 1" CONT input signals, up to four points can be specified.

The vibration suppressing anti resonance point may vary according to the arm length and weight of the load.



The vibration suppressing anti resonance frequency varies according to conditions a, b and c.

In such a case, assign this function to CONT input signals and switch the vibration suppressing anti resonance frequency setting.

Anti resonance frequency selection 1	Anti resonance frequency selection 0	Vibration suppressing anti resonance frequency
OFF	OFF	PA1_78 *
OFF	ON	PA1_80
ON	OFF	PA1_82
ON	ON	PA1_84

* This signal is always handled to be turned off if it is not assigned to the sequence input signal. In this case, PA1_78 (vibration suppressing anti resonance frequency 0) is always enabled.

To disable the vibration suppressing anti resonance frequency, set the vibration suppressing anti resonance frequency at 300.0 Hz.

Be sure to switch while the motion is stopped. Otherwise shock will be caused.

(4) Entering the S-curve

To attain effective vibration suppression, enter the S-curve.

Enter either PA1_51 (moving average S-curve time*) or PA1_52 (low-pass filter for S-curve time constant).

The approximate reference value is shown below.

No.	Name	Setting range	Default value	Change
PA1_51	Moving average S-curve time*	0 and 2 to 500[× 0.125ms] (in increments of 1)	20	Always
PA1_52	low-pass filter for S-curve time constant	0.0 to 1000.0[ms] (in increments of 0.1)	0.0	Always

* Cannot be set during auto or semi-auto tuning.

PA1_78/80/82/84 (Vibration suppressing anti resonance frequency)	α／β *1 ≦2000（PG=24bit）		α／β *1 ≦10000（PG=24bit）	
	PA1_51 *2 (Moving average S-curve time)	PA1_52 (Low-pass filter for S-curve time constant)	PA1_51 *2 (Moving average S-curve time)	PA1_52 (Low-pass filter for S-curve time constant)
< 10Hz	80	10ms	160	20ms
10Hz to 20Hz	40	5ms	80	10ms
> 20Hz	16 to 24	2 to 3ms	40	5ms

* 1 $\frac{\alpha}{\beta} = \frac{\text{PA1\_06 (numerator 0 of electronic gear)}}{\text{PA1\_07 (denominator of electronic gear)}}$

* 2 Cannot be set during auto or semi-auto tuning.

(5) Checking the effects

There are three checking methods.

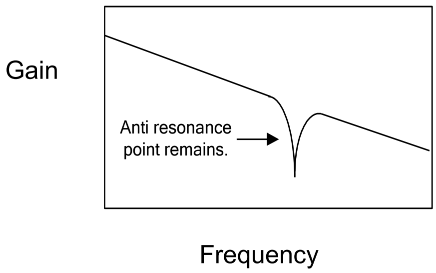
(1) Observe vibration of the arm tip with a laser displacement gauge or similar measuring instrument.

(2) Take a motion picture of the arm tip with a high speed video to check vibration.

(3) Visually observe.

Note

The vibration suppressing anti resonance frequency is not reflected on the servo analyze function even if it is entered.



(6) Finely adjusting the vibration suppressing anti resonance frequency

While checking effects of vibration suppression, finely adjust the reference value (in increments of 0.1 or 0.2).

(7) Entering the vibration suppressing workpiece inertia ratio

Ratio of the inertia of the vibrating point such as the arm specifies the portion of the total load inertia. By setting the vibration suppressing workpiece inertia ratio which is equivalent to amount to be applied when receiving reaction force from mechanical system (workpiece), the vibration can be further suppressed.

Setting method

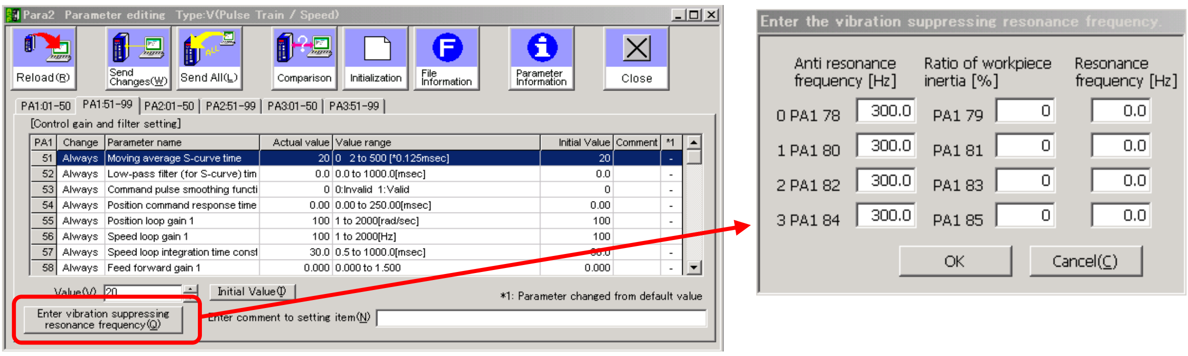
[1] Calculate the inertia of the vibrating point according to specifications of the machine.

$$\text{Vibration suppressing workpiece inertia ratio} = \frac{\text{Vibrating point inertia}}{\text{Entire load inertia}}$$

[2] Entering with the PC Loader

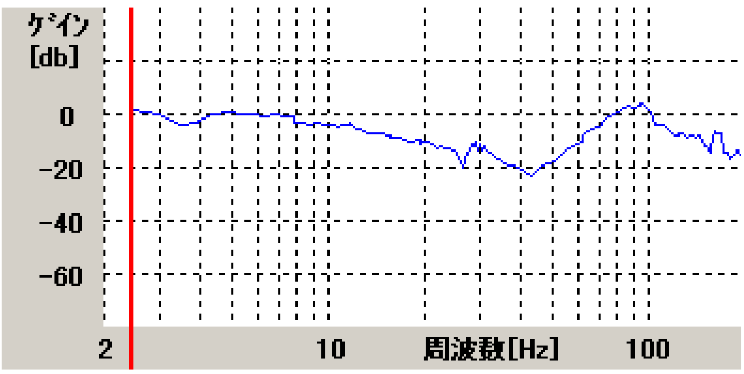
(1) Check the anti resonance frequency and resonance frequency by using the servo analyze function.

(2) Select [Parameter Edit] - [PA1: Control Gain - Filter Setting] and press the "enter vibration suppressing anti resonance frequency" button to open the exclusive window.
Enter the anti resonance frequency and resonance frequency* to automatically calculate the ratio of inertia of the workpiece.



* The resonance frequency is not the resonance frequency suppressed with the notch filter.
Use the servo analyze function to check this resonance frequency.
This resonance frequency appears as a set with the anti resonance frequency, and it is about two times the anti resonance frequency.

[Example of resonance frequency]



(8) New vibration suppressing adjustment

If vibrations persist even after performing adjustment at steps (3) to (7), vibrations can be further suppressed by performing this adjustment.

Setting method

[1] PA4_64 (New vibration suppressing damping coefficient)

Increase the value in increments of 0.1 while checking vibration to adjust to the most effective adjustment value.

Adjust using the following guideline as a reference. The greater the value, the more effective the adjustment will be, however, vibration may increase if the value is too high.

Adjustment guideline: 0.000 to 0.500

[2] PA4_65 (New vibration suppressing workpiece inertia ratio)

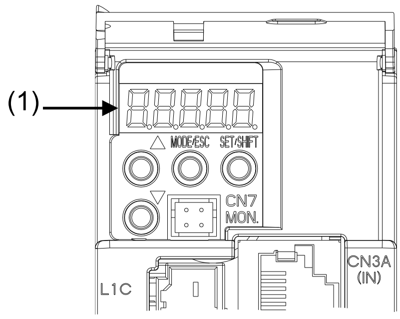
There is generally no need to change the default value.

If vibrations persist even after performing the adjustment at [1], set the workpiece inertia ratio calculated at (7).

CHAPTER 5 KEYPAD

5.1 Display

The servo amplifier is equipped with a keypad (see the figure on the right).
The keypad is fixed.
The keypad is equipped with a 2-digit 7-segment LED (1) (lift the front cover).
The 2-digit 7-segment LED displays both numbers and characters.

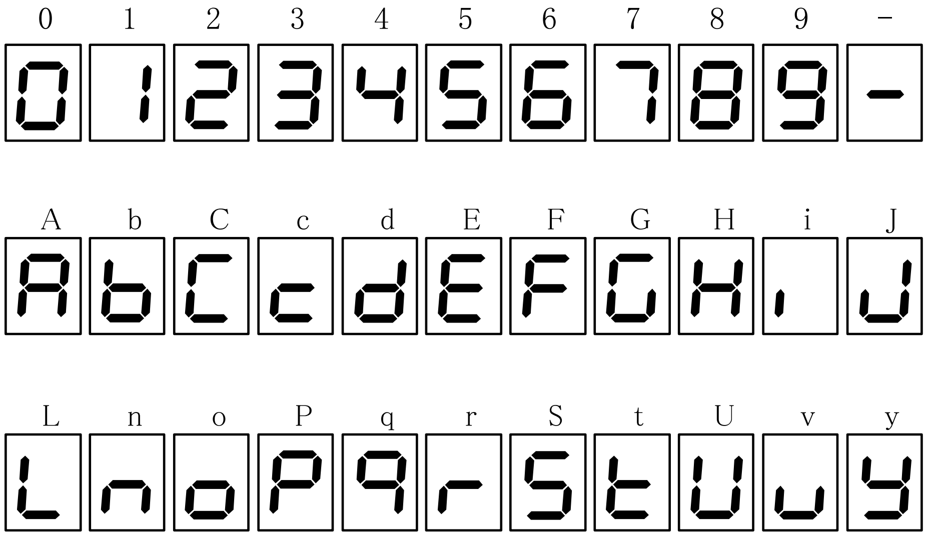


5.1.1 Mode

5

The keypad has 2 modes.
Some modes are unavailable for some models of the servo amplifier.
- Sequence mode: The control and operation statuses of the servo amplifier are displayed.
- Maintenance mode: Displays alarms and warnings that are occurring.

7-segment display



5.1.2 Flashing Display

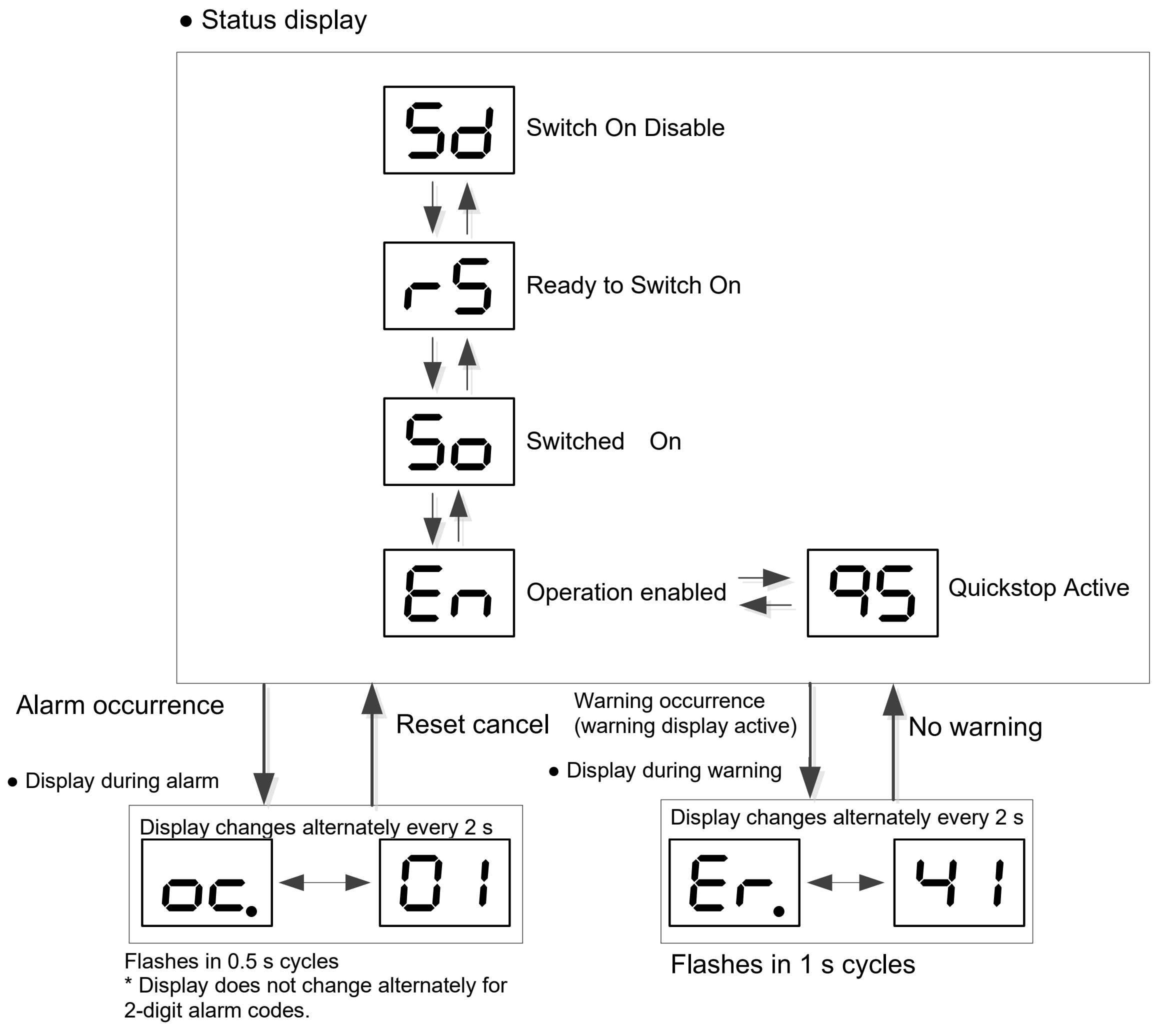
There are times when the keypad flashes.
The flashing and ON status and meanings are shown in the following table.

Flashing interval	Status	Recovery method
None (ON)	Normal status	-
0.5 second cycle	Alarm occurring	Restart the servo amplifier or reset the alarm.
Once every 2 seconds	In sequence test mode	Restart the servo amplifier after changing PA2_89 to “0”.
1 second cycle	Warning occurring	Clear the warning item.
Twice every 2 seconds	Restart notification	*Restart the servo amplifier.

5

5.1.3 Displayed content

The transition for each display is shown below.



5.2　Function List

In the parameter edit mode and the positioning edit mode, the setting values can be checked and changed.

Mode	Status	Display example
Sequence display	Switch On Disable	Sd
	Ready to Switch On	rS
	Swiched On	So
	Operation enabled	En
	Quickstop Active	qS
Alarm display	Display of 2 digits or more	oc ↔ 01
	2 digit display	oS
Warning display		Er. ↔ 41

· Refer to “6.2.3 Alarm Display List” for details on alarm display.
· Refer to “6.2.4 Warning Display List” for details on warning display.

CHAPTER 6   MAINTENANCE AND INSPECTION

6.1 Inspection

The servo amplifier and servomotor are maintenance free and no special daily inspection is necessary. However, to avoid accidents and operate the devices for a long term at a stable reliability, perform periodical inspection.

⚠ WARNING

- After turning the power off, wait for at least five minutes and check that the charge LED is unlit before performing inspection.
  There is a risk of electric shock.
- Do not touch the servomotor, servo amplifier and cables in the power-on state.
  There is a risk of electric shock.
- Never disassemble or remodel the servomotor and servo amplifier.
  It might cause fire and failure. It will not be covered by the warranty.

■ Periodic inspection items

The periodic inspection items are shown below.

Device	Description of inspection
Servomotor	• There is no deviation *1) in the linkage between the servomotor shaft and mechanical system. • The servomotor is free from direct splashes of water, vapor or oil. • The servomotor itself does not vibrate excessively.
Servo amplifier	• Screws of the terminal block and mounting sections are not loose. • Connectors are inserted correctly. • There is no massive dust on the servo amplifier. • There is no malodor, damage, breakage or faults in appearance. • There should be no characters missing at the keypad display. • The cooling fan should be running. • The fan should not be clogged. • The safety function (STO) should function normally (every 3 months).

*1) Indicates faults in installation such as an angle error, parallelism eccentricity, axial displacement or similar in the linkage between the servomotor shaft and mechanical system.

Note	Before checking cables of the servomotor and servo amplifier, turn the power off and wait at least five minutes and check that the charge LED is unlit.

⚠ CAUTION

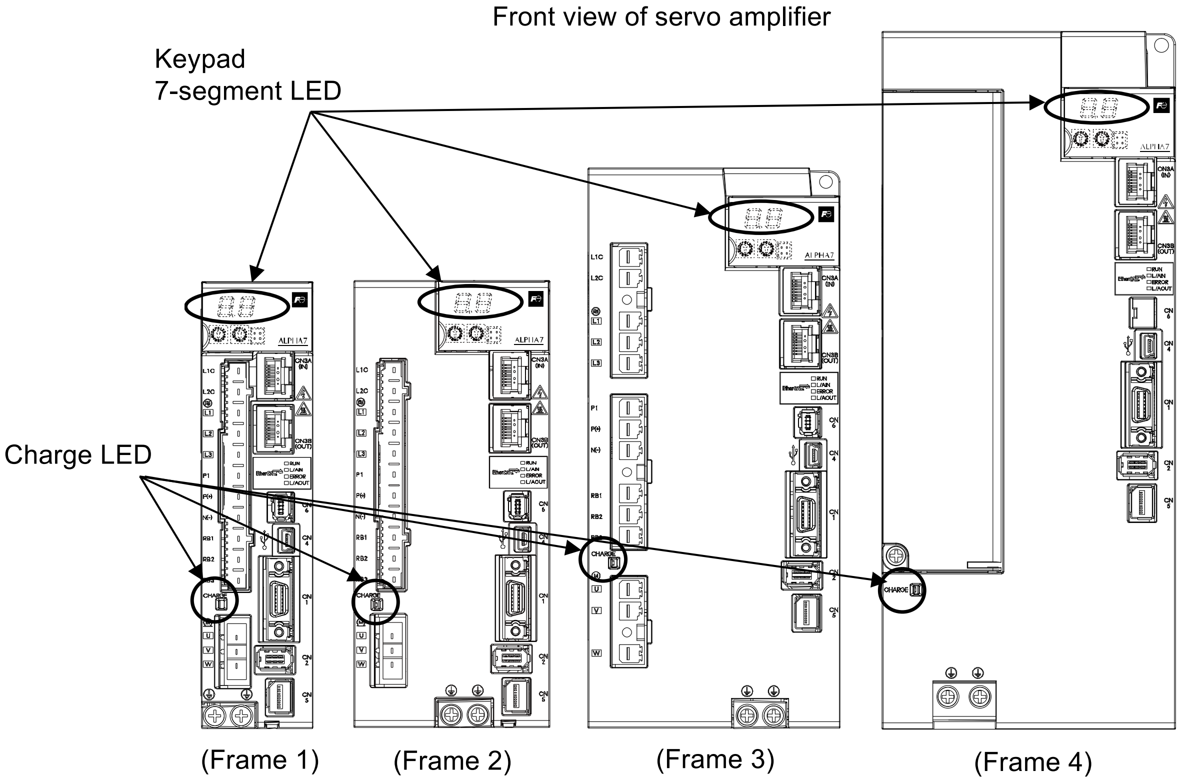
- Do not perform a Megger test of the printed circuit board and terminal block.
  Otherwise the servo amplifier or the encoder built in the servomotor may be damaged.

6.2 Status Display

6.2.1 Initial State

(1) After the control power (L1C, L2C) is supplied to the servo amplifier, the seven-segment LED of the keypad lights up.
(2) After the main circuit power (L1, L2, L3) is supplied to the servo amplifier, the "charge LED" lights up.

To operate the servomotor, states (1) and (2) must be arranged.
If nothing is displayed even though the power is supplied or either (1) or (2) is not arranged, perform "13.5.9 Diagnosis to be Made if the Servomotor Fails to Start", or contact us.



6.2.2 State at Alarm

If an alarm is alerted, display of the servo amplifier will be as follows.
(1) An alarm code is displayed at the seven-segment LED of the keypad.
For the description of display, refer to the following pages.
(2) The keypad is flashing (The keypad repeatedly flashes and turns OFF in 0.5 second intervals.)

Be sure to check the alarm code to clarify the cause of the alarm.

6.2.3 Alarm Display List

When an alarm is detected, the keypad of the servo amplifier automatically shows alarm data.
The content of alarms is displayed with either 2 digits or 4 digits.
If displayed with 4 digits, 2 digits are displayed alternately every 2 seconds.

Order	Display		Name	English	Type
1	oc	01	Overcurrent 1	Over Current 1	Major fault
	oc	02	Overcurrent 2	Over Current 2	
2	oS		Overspeed	Over Speed	
3	Lu	cn	Control power undervoltage	Circuit Low Voltage	
4	Hu		Overvoltage	High Voltage	
5	Et	01	Encoder error 1	Encoder Trouble 1	
	Et	02	Encoder error 2	Encoder Trouble 2	
6	dE		Memory error	Date Error	
7	cE		Motor combination error	Combination Error	
8	Ec		Encoder communication error	Encoder Communication Error	
9	co	nt	CONT overlap	Cont (CONTrol Signal) Error	
10	oL	01	Overload 1	Over Load 1	
	oL	02	Overload 2	Over Load 2	
11	rH	04	Inrush current suppressing circuit error	Inrush Current Suppression Circuit Trouble	
12	SF	ty	Safety function error	Safety Function Error	

Order	Display		Name	English	Type
13	Lu	Po	Main circuit undervoltage	Power Low Voltage	Minor fault
14	rH	01	Internal regenerative resistor heating	Internal Resistor Heat	
15	rH	02	External regenerative resistor heating	External Resistor Heat	
16	rH	03	Regenerative transistor error	Resistor Tr Error	
17	oF		Deviation overflow	Over Flow	
18	AH		Amplifier heating	Amp Heat	
19	EH		Encoder heating	Encoder Heat	
20	dL	01	ABS encoder loss 1	Absolute Date Lost 1	
	dL	02	ABS encoder loss 2	Absolute Date Lost 2	
	dL	03	ABS encoder loss 3	Absolute Date Lost 3	
21	AF		Multi-turn overflow	Absolute Date Over Flow	
22	iE		Initial error	Initial Error	
23	HF		Command pulse frequency error	Pulse Frequency Error	
24	oL	03	Overload 3	Over Load 3	
25	cy		Cycle communication error	Cyclic Communication Error	

To reset the alarm, perform one of the following methods.

- Turn Controlword_bit7 (Fault Reset) from “0” to “1”.
  Change to another status after returning this bit to “0”.
- From the PC Loader, use alarm reset in the "monitor" command.
- Turn OFF the input power supply and then turn it back ON.

■ Alarm reset

There are alarms that cannot be canceled by resetting. Alarms that cannot canceled by resetting should be reset by turning the power OFF and then ON again.

Alarms that can be canceled by resetting

Display		Name
oc	01	Overcurrent 1
oc	02	Overcurrent 2
oS		Overspeed
Lu	cn	Control power undervoltage
Hu		Overvoltage
Ec		Encoder communication error
oL	01	Overload 1
oL	02	Overload 2
oL	03	Overload 3
Lu	Po	Main circuit undervoltage
rH	01	Internal regenerative resistor overheat
rH	02	External regenerative resistor overheat
oF		Deviation overflow
AH		Amplifier overheat
EH		Encoder overheat
HF		Command pulse frequency error
cy		Cycle communication error

Alarms that cannot be canceled through alarm resetting

Display		Name
Et	01	Encoder error 1
Et	02	Encoder error 2
dE		Memory error
cE		Motor combination error
co	nt	CONT overlap
rH	03	Regenerative transistor error
rH	04	Inrush current suppressing circuit error
dL	01	ABS encoder loss 1
dL	02	ABS encoder loss 2
dL	03	ABS encoder loss 3
AF		Multi-turn overflow
iE		Initial error
SF	ty	Safety function error

6.2.4 Warning Display List

When a warning is detected, the content of the warning is automatically displayed on the servo amplifier keypad.

A 4-digit warning is divided up into two sets of 2 digits, each of which is displayed every 2 seconds.

Display		Name	English
Er.	41	Battery warning	Battery Warning
Er.	42	Main circuit capacitor life warning	Main Circuit Capacitor Life
Er.	43	Cooling fan life warning	Cooling Fan Life Warning
Er.	44	Overload warning	Overload warning
Er.	45	OT+	+Over-travel
Er.	46	OT-	-Over-travel

6.3 Troubleshooting Method

1. Overcurrent

[Display]

oc 01

oc 02

[Description of detected alarm]

The output current of the servo amplifier exceeds the rated value.

OC01: Direct detection by internal transistor of servo amplifier

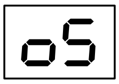
OC02: Indirect detection with software of servo amplifier

[Cause and remedy]

Cause	Remedy
Wrong servomotor output wiring	• Correct the wiring of power cables (U, V and W). • Check cables visually or through continuity check and replace the defective cable.
Short circuit or grounding fault in servomotor output wiring	
Servomotor insulation fault	• Measure the insulation resistance. (Several MΩ or over to ground)
Failure of servomotor	• Measure the resistance across cables. (Several Ω between cables)
Incorrect resistance of braking resistor	• Replace with the braking resistor within the rating.
Current imbalance caused by an encoder fault	• Replace the servomotor.
Unconnected grounding cable	• Connect the grounding cable.

2. Overspeed

[Display]

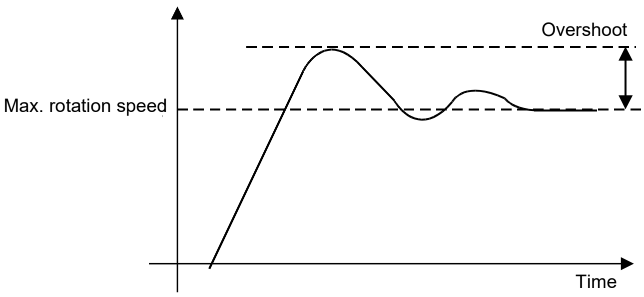


[Description of detected alarm]

The rotation speed of the servomotor exceeds 1.1 times the maximum speed.

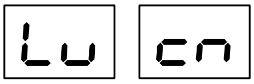
[Cause and remedy]

Cause	Remedy
Wrong servomotor output wiring	• Correct the wiring of power cables (U, V and W).
The rotation speed of the servomotor overshoots.	Check the speed waveform during acceleration with the PC Loader or similar (see the figure below) and take the following countermeasures. • Increase PA1_37 (acceleration time). • Increase PA1_52 (S-curve time constant). • Increase PA1_56 (speed loop gain 1).



3. Control Power Undervoltage

[Display]



[Description of detected alarm]

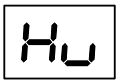
The voltage of the control power supplied to the servo amplifier temporarily drops below the minimum specification limit.

[Cause and remedy]

Cause	Remedy
The source voltage drops due to momentary power failure or similar.	• Check the power supply environment for momentary power failure and improve the power supply environment. • Check and improve the power supply capacity and transformer capacity.
Poor power supply capacity of transformer, etc.	• Replace the transformer, etc.

4. Overvoltage

[Display]



[Description of detected alarm]

The DC voltage inside the servo amplifier exceeds the upper limit.

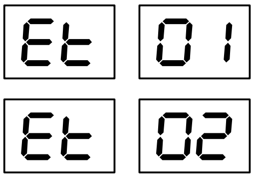
[Cause and remedy]

Cause	Remedy
The source voltage is too high (immediately after power-on).	• Check if the source voltage is within the specification limits. • Insert a reactor if there is a power factor improvement capacitor.
Unconnected internal regenerative resistor	• Check the short-circuit wire between the RB2 and RB3 terminals.
The regenerative energy is high	• Use an external regenerative resistor.
Unconnected external braking resistor or wrong wiring	• Connect the external braking resistor. • Correct the wiring of the external braking resistor.
Broken braking transistor	• Replace the servo amplifier.

An overvoltage is detected when the servo amplifier internal DC voltage exceeds approximately 420 [V].
Approximately over 420 [V], overvoltage is detected.

5. Encoder Trouble

[Display]



[Description of detected alarm]

There is a fault in the encoder built in the servomotor.
(Communications are normal.)

- Et01: Single revolution position detection fault of encoder
- Et02: Encoder memory data reading fault

[Cause and remedy]

Cause	Remedy
Fault in data sent from encoder	• Use shielded cables to eliminate noise effects.
Failure of encoder	• Replace the servomotor.

6. Memory Error

[Display]

dE

[Description of detected alarm]

The parameter data stored in the servo amplifier is damaged.

[Cause and remedy]

Cause	Remedy
Failure of stored data	• Using the PC Loader, read parameters and enter those indicated in red. • Initialize parameters. • Turn the power off then on again. If restoration is not obtained, replace the servo amplifier.
The parameter overwriting frequency has exceeded 100,000 cycles.	• Replace the servo amplifier.
The servo-on is turned on without turning the power off and then on after the parameter was initialized.	• Supply the power again.

7. Motor Combination Error

[Display]

cE

[Description of detected alarm]

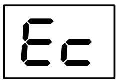
The capacity and model of the servo amplifier do not agree with those of the connected servomotor.

[Cause and remedy]

Cause	Remedy
The capacity and model of the servo amplifier do not agree with those of the servomotor.	• Check the capacity and model of the servomotor and those of the servo amplifier.

8. Encoder Communication Error

[Display]



[Description of detected alarm]

Communications with the internal encoder of the servomotor fails.

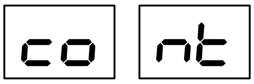
[Cause and remedy]

Cause	Remedy
Interrupted encoder communications	• Check cables visually and through continuity check and correct faults. • Check for the broken wire in the encoder cable and correct. • Insert ferrite cores.
Broken wire or poor contact	

The servo amplifier and encoder communicate through high speed serial communications. The encoder cable has a voltage amplitude of about +5 [V]. Do not route the encoder cable in a strong magnetic or electric field. Route the encoder cable separately from the main body of the servo amplifier, inverter, electromagnetic contactor or similar (reserve at least 100 [mm]).

9. CONT (control signal) Error

[Display]



[Description of detected alarm]

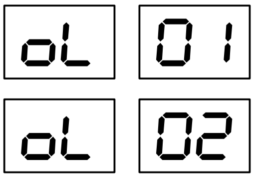
There is duplication in allocation of sequence input terminals of the servo amplifier.

[Cause and remedy]

Cause	Remedy
The same input signal is allocated to two or more terminals.	• Do not specify the same number among CONT signal settings.

10. Overload

[Display]



[Description of detected alarm]

- OL01: Instantaneous alarm such as a locked shaft.
- OL02: The effective torque exceeds the allowable limit of the servomotor. (Detection at electronic thermal relay built in servo amplifier)
- Overload level: See "8.2 Overload Characteristics".

[Cause and remedy]

Cause	Remedy
The servomotor fails to rotate mechanically.	• Check if the brake is active.
The mechanical system is too heavy against the servomotor capacity.	• Examine the servomotor capacity, based on the load factor. • If the rotation speed can be reduced, add a reduction gear. • Apply the brake to retain a stopped elevator.
The acceleration/deceleration frequency and operation frequency are too high.	• Increase the cycle time and decrease the operation frequency.
Servo amplifier is damaged.	• Replace the servo amplifier.

If an OL02 alarm is caused but no damaged servo amplifier or incorrect wiring is found, the servomotor capacity must be examined.
Check the OL thermal value at PC Loader in either case.

11. Inrush Current Suppression Circuit Trouble

[Display]

rH 04

[Description of detected alarm]

The circuit inside the servo amplifier which suppresses the inrush current generated at the power on may be broken.

[Cause and remedy]

Cause	Remedy
The servo amplifier is damaged.	• Replace the servo amplifier
The ambient temperature exceeds 55°C.	• Keep the ambient temperature 55°C or lower (40°C or below is recommended). • Move heat generating bodies near the servo amplifier as far away as possible.
The power is frequently supplied.	• Reduce the frequency of turning the power on/off. (Reference: once an hour or less)

Note	If this alarm is detected even when the ambient temperature is below 55°C, replace the servo amplifier without attempting operating it.

12. Safety function error

[Display]

SF ty

[Description of detected alarm]

- Safety input signal mismatch
- Internal circuit error
- The function safety module (WSU-ST1) output an alarm.

[Cause and remedy]

Cause	Remedy
The [EN1+], [EN2+] terminal input mismatch continued for 50 ms or longer.	• Check for wiring abnormalities such as disconnection or shorting in the [EN1+], [EN2+] terminal wiring. • Reduce the [EN1+], [EN2+] terminal input mismatch time to 50 ms or less.
The function safety module (WSU-ST1) output an alarm. (If function safety module LED indicator "ERR" is ON)	• Refer to the function safety module (WSU-ST1) User's Manual.
A servo amplifier or function safety module (WSU-ST1) fault occurred.	• When the situation is not resolved even after turning the power ON again, replace the servo amplifier or function safety module. • Check the function safety module mounting condition on the servo amplifier.

The display is the same as when a function safety module (WSU-ST1) alarm occurs.

Refer to the separate User's Manual for details.

13. Main Power Undervoltage

[Display]

Lu Po

[Description of detected alarm]

The power supplied to the servo amplifier falls below the minimum specification voltage limit.

[Cause and remedy]

Cause	Remedy
The source voltage drops due to momentary power failure or similar.	• Check the power supply environment whether momentary power failure is generated or not, and improve the power supply environment. • Check and improve the power supply capacity and transformer capacity.
The power is turned on or off intentionally.	• Do not turn the power on after the time specified in PA2_68 (main power shutoff detection time) has elapsed. (Detection fails after about 2 [s].)
DC input is under execution.	• Set PA2_68 (main power shutoff detection time) at 1000 [ms].

If the power supply environment is adverse, PA2_67 (alarm detection at undervoltage) can be applied to ignore undervoltage detection. In this case, operation can be continued with the setting of PA2_66 (flying start at speed control) in the event of momentary power failure. Undervoltage detection is set at about 200 [V] by the DC voltage in the servo amplifier.

14. Internal Braking Resistor Overheat

[Display]

rH 01

[Description of detected alarm]

The power consumption of the braking resistor built in the servo amplifier exceeds the upper limit. (Detection is made at the internal electronic thermal relay of the servo amplifier.)

[Cause and remedy]

Cause	Remedy
Excessive source voltage (immediately after power-on)	• Check if the source voltage is within specification limits. • Insert a reactor if there is a power factor improvement capacitor.
Due to vertical transfer or winding purpose, etc. the regenerative power cannot be consumed.	• Increase the deceleration time. • Decrease the servomotor rotation speed. • Increase the cycle time and decrease the operation frequency.
	• Connect an external braking resistor. • Install a counterweight.

15. External Braking Resistor Overheat

[Display]

rH 02

[Description of detected alarm]

The external braking resistor overheat signal (normally closed contact signal) is turned off.

[Cause and remedy]

Cause	Remedy
Excessive source voltage (immediately after power-on)	• Check if the source voltage is within the specification limits.
Due to vertical transfer or winding purpose, etc. the regenerative, power cannot be consumed.	• Increase the deceleration time. • Decrease the servomotor rotation speed. • Increase the cycle time and decrease the operation frequency.
	• Connect an external braking resistor. • Install a counterweight.
Wrong wiring of external braking resistor overheat signal	• Connect correctly.

16. Braking Transistor Error

[Display]

rH 03

[Description of detected alarm]

The regeneration handling transistor built in the servo amplifier is damaged.

[Cause and remedy]

Cause	Remedy
The braking transistor is short circuited or damaged.	• Turn the power off then on again. If the alarm persists, replace the servo amplifier.

Note	If the braking transistor is short circuited or damaged, fire may be caused. If the braking transistor fault alarm signal is output, turn the power off immediately.

17. Deviation Overflow

[Display]

oF

[Description of detected alarm]

A position deviation amount equivalent to servomotor revolutions specified in PA2_69 (deviation detection overflow value) is accumulated inside the servo amplifier.
When full-closed control is enabled, the position deviation for the amount of pulses set in PA4_36: External/Motor deviation over detection value has been accumulated inside the servo amplifier.

[Cause and remedy]

Cause	Remedy
Wrong connection of power cables (The alarm is alerted immediately when servo-on is turned on.)	• Check and correct the wiring of power cables (U, V and W).
The servomotor fails to rotate mechanically.	• Check if the brake is applied.
Low output torque	• Increase PA1_27 and 28 (torque limit values).
The deviation detection width is small.	• PA2_69: Increase the deviation overflow detection value. • PA4_36: Increase the external/motor deviation over detection value.
The amplifier is in the P control mode.	• Turn off the P motion signal.
Low gain	• Perform gain adjustment.
Acceleration/deceleration of pulse train frequency is too rapid.	• Increase the acceleration/deceleration time.
The relationship between the external pulse phase and the motor rotation direction is not correct.	• Check the set value of PA4_32 (1st digit: external pulse phase selection).

The default setting of PA2_69 (deviation detection overflow value) is 15 (rev), that is, 20 bits x 15 pulses. During regular servo system operation, the deviation amount increases in proportion to the rotation speed.

18. Amplifier Overheat

[Display]

AH

[Description of detected alarm]

The temperature of the servo amplifier has exceeded the allowable limit.

[Cause and remedy]

Cause	Remedy
The ambient temperature exceeds 55 [°C].	• Reduce the ambient temperature to 55 [°C] or lower. (40 [°C] or lower temperatures are recommended for regular operation.)
	• Move heat generating bodies near the servo amplifier as far away as possible.

Perform operation at a continuous load factor within 100%.

19. Encoder Overheat

[Display]

EH

[Description of detected alarm]

The encoder inside the servomotor may be overheated.

[Cause and remedy]

Cause	Remedy
Excessive ambient temperature	• Reduce the ambient temperature of the servomotor to 40 [°C] or lower. • Remove shields interrupting heat radiation, if there are any.
The effective torque exceeds the rating.	• Increase the cycle time and reduce the operation frequency.

The main body of the encoder detects this alarm according to results of self-diagnosis.

20. Absolute Data Lost

[Display]

dL 01

dL 02

dL 03

[Description of detected alarm]

The absolute data of the encoder is lost.

- dL01: Battery voltage drop, broken encoder cable, loss of multi-rotation data
- dL02: Multi-turn data fault in encoder
- dL03: Detection at power-on after an Et alarm

[Cause and remedy]

Cause	Remedy
dL01 alarm	• Replace the battery and preset the position. If it still can not be solved, please check if the encoder cable is not broken and correct. • A warning is displayed at the keypad if the battery voltage is low. (If PA2_78 is set at 1)
dL02 alarm	• Perform position preset. If the alarm persists, replace the servomotor.
dL03 alarm	• After position preset, dL03 is canceled but the Et alarm persists. • If the Et alarm is not canceled, replace the servomotor.

For details, refer to "CHAPTER 10 ABSOLUTE POSITION SYSTEM."

21. Multi-turn Data Overflow

[Display]

AF

[Description of detected alarm]

Rotation of the output shaft of the servomotor exceeds the range between -32766 and +32765.

[Cause and remedy]

Cause	Remedy
Excessive servomotor revolutions	• Check the servomotor revolutions. • Use the PC Loader or take similar measures to check the current position.

22. Initial Error

[Display]

iE

[Description of detected alarm]

The initial position inside the encoder is not established.

[Cause and remedy]

Cause	Remedy
The encoder is damaged.	• Replace the servomotor.
The power is turned on while the servomotor rotates due to an external force (at 100 [r/min] or over).	• Stop the servomotor and turn the power off then on again. If restoration is not obtained, replace the servomotor.

23. Command Pulse Frequency Error

[Display]

HF

[Description of detected alarm]

- GearRatio (6091H), Additional position encoder resolution (60E6H) are changed during CSP, PP, or HM operation.
- The input frequency of the full-closed control has exceeded the maximum input specification.

[Cause and remedy]

Cause	Remedy
Gear Ratio was changed.	• Review the master processing.
The set value of pulse such as electronic gear setting is large.	• Set the ratio of pulses to an appropriate setting value.

24. Overload 3

[Display]

oL 03

[Description of detected alarm]

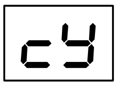
OL3 = This is an alarm at output open-phase.

[Cause and remedy]

Cause	Remedy
The servomotor fails to rotate mechanically.	• Check the wiring of power cables (U, V and W) and correct faults.

25. Cycle communication error

[Display]



[Detected error]

An error occurred during EtherCAT communication.

[Cause and remedy]

Cause	Remedy
An error occurred during EtherCAT communication.	• Check the condition of the communication cable (disconnection, etc.), and fix if necessary. • Insert a ferrite core into the communication cable. • Adjustment the interval between the communication timing and DC timing. • Check whether the ESM State is other than OP with servo-on.

6.4 Items to be Inquired upon Trouble

If an alarm is alerted due to any cause, take corrective actions according to description given in "7.3 Troubleshooting Method." If the servo amplifier is reset to continue operation though the cause is unknown, damage may be caused to the servomotor and/or servo amplifier. When contacting us, notify the following information.

Item	Information to Be Provided
Description of nameplate	Model of servomotor and that of servo amplifier [Example] RYT201F7-VC2
Device configuration	Host control unit, external braking resistor, etc. [Example] External braking resistor (model: WSR-401)
Configuration of mechanical system	Outline of configuration of mechanical system driven by motor [Example] Spring feed, vertical, reduction ratio 1/2
Details of trouble	(1) Operation years, whether the equipment has functioned correctly even once or not (2) Frequency of alarm detection and control method (csp mode, etc.) and other circumstances [Example] An alarm is displayed whenever a certain device functions. (3) Description of alarm display (4) Repeatability of alarm (5) Timing of alarm occurrence - during acceleration, during rotation at constant speed, during deceleration, ... (6) Difference in alarm occurrence between forward and reverse rotation (7) Whether the alarm occurs under certain circumstances or not [Example] When the servo-on (S-ON) signal is turned on [Example] When the table advances to reach a certain point (8) Whether the similar phenomenon is observed or not if the servo amplifier is replaced with another one used for a machine of the same specification

6.5 Maintenance and Discarding

6.5.1 Operating Environment

Use in the operating environment specified in "CHAPTER 1 INSTALLATION."

(1) Power-on
Power can be supplied continuously to the servo amplifier.

⚠ WARNING
• Do not touch the servomotor, servo amplifier or cables in the power-on state. There is a risk of electric shock.

(2) Specifications
The rating of the GYS, GYG and GYB type servomotors is continuous rating.

(3) Power supply
Avoid repeating power-on and shutdown of the commercial power supply to start or stop the servomotor. The service life of parts inside the servo amplifier may be affected.

(4) Radio noise
The servomotor and servo amplifier are devices for general industrial machines and no countermeasures against radio noise are taken. For this reason, noise effects may be observed under the following circumstances.
- Electric noise may be observed at AM radios placed near the servo amplifier or servomotor.
- Electric noise may be added to radio broadcasting systems or similar installed near cables.
- Electric noise may be added to measuring instruments and commercial devices.

For countermeasures against electric noise and installation method, refer to "CHAPTER 9 PERIPHERAL EQUIPMENT."

6.5.2 Life

The servomotor and servo amplifier have service lives even if they are used under regular operating conditions.
Contact our service division for parts replacement. Never disassemble or repair by yourself.

(1) Bearing of servomotor
The service life of the servomotor varies according to the operating conditions.
Replacement is necessary if abnormal noise or excessive vibration is found during inspection.

(2) Cooling fan built in servo amplifier
Set parameter PA2_78 (Display transition at warning detection) at 1 to show a warning on the keypad of the front panel of the servo amplifier when the limit of the service life of the cooling fan draws near.
The cooling fan runs normally when the control power supply is turned ON. It is necessary to replace the cooling fan if it does not rotate in this condition.
The remaining life can be checked using the PC Loader. For details, refer to "CHAPTER 13 PC LOADER."

(3) Brake built in servomotor
The brake built in the servomotor is a non-exciting type retention-only brake. Do not use it for braking. Failure will be caused if the brake is used for braking, resulting in substantial reduction of the service life. Use it only for retention of a stopped servomotor.

(4) Capacitor built in servo amplifier
The electrolytic capacitors used for the main circuit and control circuit of the servo amplifier have service lives.
For capacitors used in the main circuit, set parameter PA2_78 (Display transition at warning detection) at 1 to show a warning at the keypad on the front panel of the servo amplifier when the limit of the service life draws near.
The remaining life can be checked using the PC Loader. For details, refer to "CHAPTER 13 PC LOADER."

(5) Battery (for ABS system)
The battery used in an absolute position system has a service life.
If the battery voltage is lower than the rated value, a warning is displayed at the keypad on the front panel of the servo amplifier.
Replace the battery soon while leaving the control power turned on.
In case that the battery life is extremely short, there is possibility of wrong wiring of encoder cable.

6.5.3 Discarding

If this product is damaged, the following two laws apply, and restrictions apply to each of the respective laws. These law are effective inside Japan. Local laws shall take precedence if outside Japan. Announce this for, or indicate this on the final product if required.

- Law for the Promotion of Effective Utilization of Resources

  Please make every effort to regenerate or recycle products that are no longer required.
  When recycling, it is recommended that products be separated into scrap iron and electronic products and so on, and then sold to a suitable recycling company.

- Waste Management and Public Cleansing Law

  It is recommended that products that are no longer required be recycled in accordance with the previous item (Law for the Promotion of Effective Utilization of Resources), and that the volume of waste be reduced.
  If products that are no longer required are being disposed of because they cannot be sold, products shall apply to industrial waste as stipulated in this law. The disposal of industrial waste must be consigned to an industrial waste disposal company permitted by this law, and waste must be disposed of in an appropriate manner, including the management of manifests.
  Batteries used in this product apply to what are referred to as "primary batteries", and should be disposed of in accordance with the disposal methods specified by each local government.

6.6 Approximate Replacement Timing

The approximate replacement timings of parts for the following operating conditions are shown below. However, note that the timing varies according to the operation method, environmental conditions and so on. For the replacement method, contact us.

[Operating conditions]

Ambient temperature: Annual average 30 [°C]
Load factor: Within 80 [%]
Operation rate: Within 20 hours/day

■ Servomotor

Part name	Standard service life	Method
Bearing	20,000 to 30,000 hours	Send the product back to us for repair.
Oil seal	5000 hours	

■ Servo amplifier

Part name	Standard service life	Method
Capacitors of main circuit	73,000 hours	Send the product back to us for repair.
Cooling fan	73,000 hours	
Battery for absolute system	35,000 hours *1	Replace with a new part.

*1 Cumulative operation hours without tuning the power on

CHAPTER 7 SPECIFICATIONS

7

7.1 Specifications of Servomotor

7.1.1 GYS Motor

200V series

■ Standard specifications

Motor type	GYS500D7 -□□2	GYS101D7 -□□2	GYS201D7 -□□2	GYS401D7 -□□2	GYS751D7 -□□2
Rated output [kW]	0.05	0.1	0.2	0.4	0.75
Rated torque [N·m]	0.159	0.318	0.637	1.27	2.39
Rated speed [r/min]	3000				
Max. speed [r/min]	6000				
Max. torque [N·m]	0.478	0.955	1.91	3.82	7.17
Inertia moment [kg·m^2]	0.0192×10^{-4}	0.0371×10^{-4}	0.135×10^{-4}	0.246×10^{-4}	0.853×10^{-4}
Rated current [A]	0.85	0.85	1.5	2.7	4.8
Max. current [A]	2.55	2.55	4.5	8.1	14.4
Insulation class	Class B				
Degree of enclosure protection	Totally enclosed, self-cooled (IP67, excluding the shaft-through and connectors)				
Terminals (motor)	Cable 0.3m (with connector)				
Terminals (encoder)	Cable 0.3m (with connector)				
Overheat protection	Not provided (The servo amplifier detects temperature.)				
Mounting method	By securing motor flange IMB5 (L51), IMV1 (L52), IMV3 (L53)				
Encoder	24-bit serial encoder (absolute/incremental)				
Vibration level *1	V5 or below				
Installation place, environment	For indoor use (free from direct sunlight), locations without corrosive and flammable gases, oil mist and dust				
Altitude	Altitude ≤ 1000m				
Ambient temperature, humidity	-10 to +40°C (there should be no freezing), within 90% RH max. (without condensation)				
Vibration resistance [m/s^2]	49				
Mass [kg]	0.45	0.55	1.2	1.8	3.4
Standards	UL/cUL (UL1004), CE marking (EN60034-1, EN60034-6), RoHS directive				

*1: The vibration value is the property of flange type IMV1 (L52).

■ Brake specifications (motor equipped with a brake)

Motor type	GYS500D7 -□□2-B	GYS101D7 -□□2-B	GYS201D7 -□□2-B	GYS401D7 -□□2-B	GYS751D7 -□□2-B
Rated output [kW]	0.05	0.1	0.2	0.4	0.75
Rated torque [N·m]	0.159	0.318	0.637	1.27	2.39
Max. torque [kg·m^2]	0.0223×10^{-4}	0.0402×10^{-4}	0.159×10^{-4}	0.270×10^{-4}	0.949×10^{-4}
Static friction torque [N·m]	0.34		1.27		2.45
Rated voltage [V]	DC24±10%				
Attraction time [ms]	35		40		60
Release time [ms]	10		20		25
Power consumption [W]	6.1 (at 20°C)		7.3 (at 20°C)		8.5 (at 20°C)
Mass [kg]	0.62	0.72	1.7	2.3	4.2

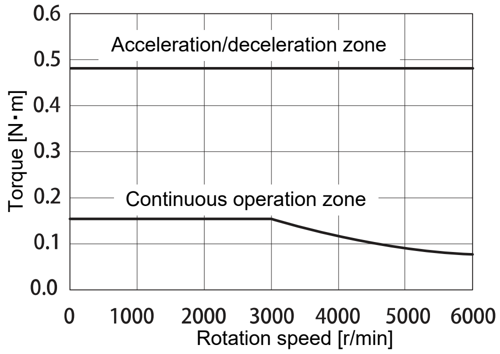
Motor type	GYS102D7 -□□2	GYS152D7 -□□2	GYS202D7 -□□2	GYS302D7 -□□2	GYS402D7 -□□2	GYS502D7 -□□2
Rated output [kW]	1.0	1.5	2.0	3.0	4.0	5.0
Rated torque [N･m]	3.18	4.78	6.37	9.55	12.7	15.9
Rated speed [r/min]	3000					
Max. speed [r/min]	5000					
Max. torque [N･m]	9.55	14.3	19.1	28.7	38.2	47.8
Max. torque [kg･m^2]	1.73×10^{-4}	2.37×10^{-4}	3.01×10^{-4}	8.32×10^{-4}	10.8×10^{-4}	12.8×10^{-4}
Rated current [A]	7.1	9.6	12.6	18.0	24.0	30.0
Max. current [A]	21.3	28.8	37.8	54.0	72.0	90.0
Insulation class	Class F					
Degree of enclosure protection	Totally enclosed, self-cooled (IP 67, excluding the shaft-through) *1					
Terminals (motor)	Cannon connector					
Terminals (encoder)	Cannon connector					
Overheat protection	Not provided (The servo amplifier detects temperature.)					
Mounting method	By securing motor flange IMB5 (L51), IMV1 (L52), IMV3 (L53)					
Encoder	24-bit serial encoder (absolute/incremental)					
Vibration level *2	Up to rated rotation speed: V10 or below Over rated rotation speed and up to 5000r/min: V15 or below					
Installation place, environment	For indoor use (free from direct sunlight), locations without corrosive and flammable gases, oil mist and dust					
Altitude	Altitude ≤ 1000m					
Ambient temperature, humidity	-10 to +40°C (there should be no freezing), within 90%RH max. (without condensation)					
Vibration resistance [m/s2]	24.5					
Mass [kg]	4.4	5.2	6.3	11.0	13.5	16.0
Standards	UL/cUL(UL1004), CE marking (EN60034-1, EN60034-6), RoHS directive					

*1: When using the product under such an environment as specified in IP67, make sure that the connector for wiring is compatible with IP67.
*2: The vibration value is the property of flange type IMV1 (L52).

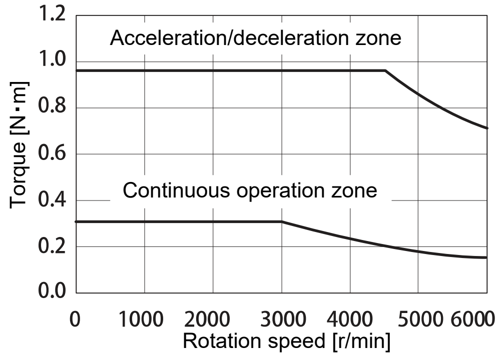
Motor type	GYS102D7 -□□2-B	GYS152D7 -□□2-B	GYS202D7 -□□2-B	GYS302D7 -□□2-B	GYS402D7 -□□2-B	GYS502D7 -□□2-B
Rated output [kW]	1.0	1.5	2.0	3.0	4.0	5.0
Rated torque [N･m]	3.18	4.78	6.37	9.55	12.7	15.9
Max. torque [kg･m^2]	2.03×10^{-4}	2.67×10^{-4}	3.31×10^{-4}	10.42×10^{-4}	12.9×10^{-4}	14.9×10^{-4}
Static friction torque [N･m]	6.86			17		
Rated voltage [V]	DC24 ±10%					
Attraction time [ms]	100			120		
Release time [ms]	40			30		
Power consumption [W]	17.7 (at 20°C)			12 (at20°C)		
Mass [kg]	5.9	6.8	7.9	13.0	15.5	18.0

■ Torque characteristics drawing
(at 3-phase 200 [V] or single-phase 230 [V] source voltage*)

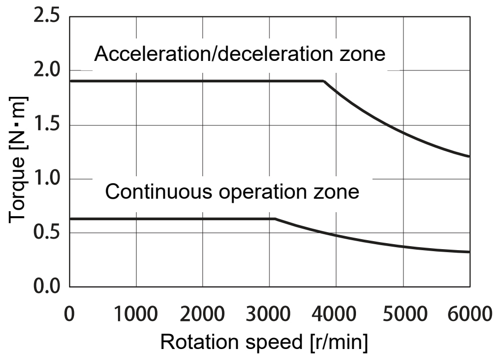
GYS500D7-□□2 (0.05 [kW])



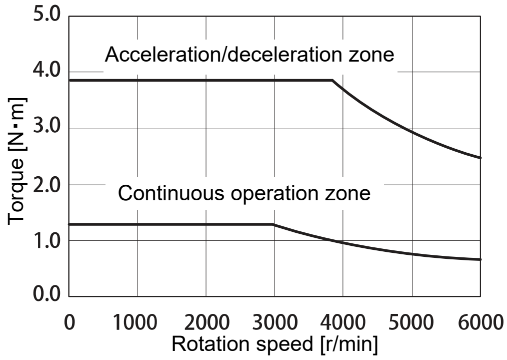
GYS101D7-□□2 (0.1 [kW])



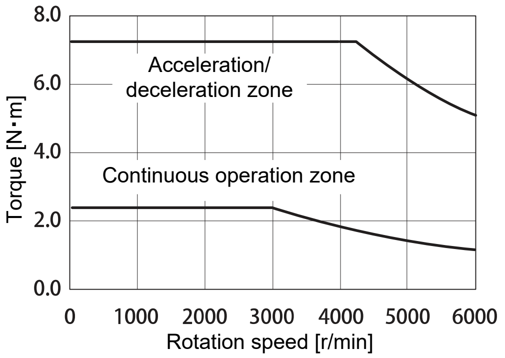
GYS201D7-□□2 (0.2 [kW])



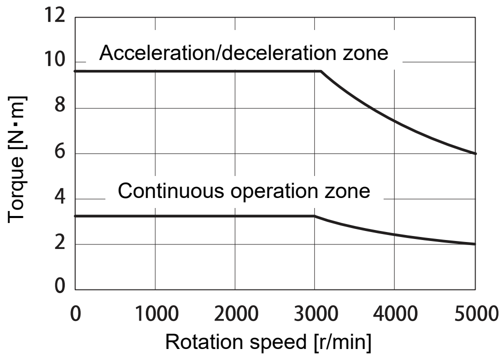
GYS401D7-□□2 (0.4 [kW])



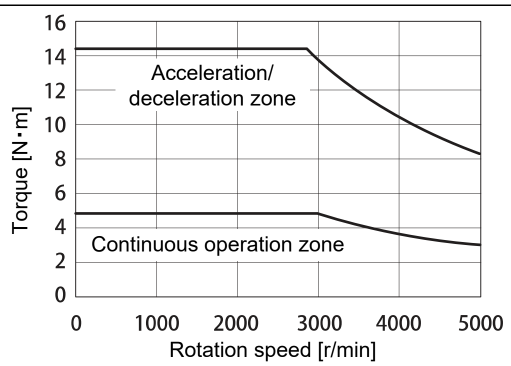
GYS751D7-□□2 (0.75 [kW])



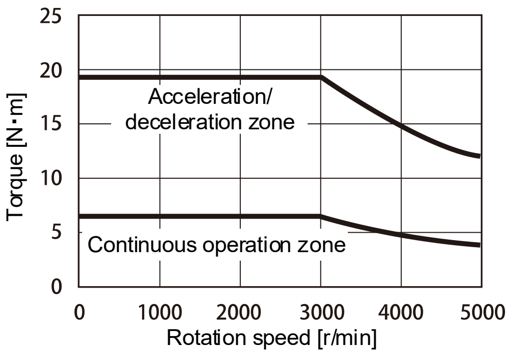
GYS102D7-□□2 (1.0 [kW])



GYS152D7-□□2 (1.5 [kW])



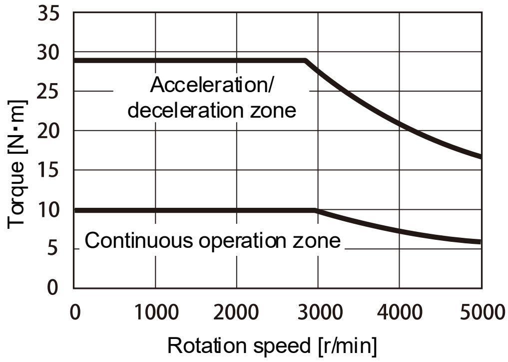
GYS202D7-□□2 (2.0 [kW])



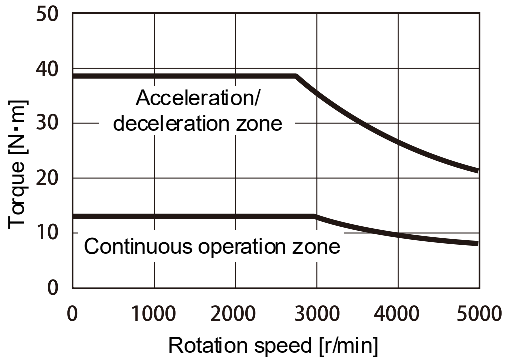
*: 0.75 [kW] or less for single-phase 230 [V]

7

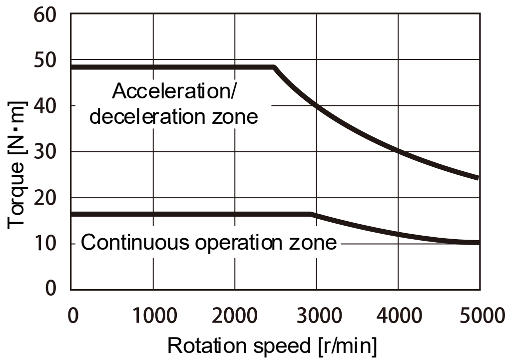
GYS302D7-☐☐2 (3.0 [kW])



GYS402D7-☐☐2 (4.0 [kW])



GYS502D7-☐☐2 (5.0 [kW])



These characteristics indicate typical values of each servomotor combined with the corresponding servo amplifier.
The rated torque indicates the value obtained when the servo amplifier is installed to the following aluminum heat sink.

- Model GYS500, 101 : 200 × 200 × 6 [mm]
- Model GYS201, 401 : 250 × 250 × 6 [mm]
- Model GYS751 : 300 × 300 × 6 [mm]
- Model GYS102, 152, 202 : 350 × 350 × 8 [mm]
- Model GYS302, 402, 502 : 400 × 400 × 12 [mm]

7

7.1.2 GYB Motor

■ Standard specifications

Motor type	GYB201D7-□□2-□	GYB401D7-□□2-□	GYB751D7-□□2-□
Rated output [kW]	0.2	0.4	0.75
Rated torque [N·m]	0.637	1.27	2.39
Rated speed [r/min]	3000		
Max. speed [r/min]	6000		
Max. torque [N·m]	2.23	4.46	8.36
Max. torque [kg·m^2]	0.33×10^{-4}	0.57×10^{-4}	1.53×10^{-4}
Rated current [A]	1.4	2.7	4.9
Max. current [A]	6.0	12.0	18.0
Insulation class	Class B		
Degree of enclosure protection	Totally enclosed, self-cooled (IP 67, excluding the shaft-through and lead wire connectors) *1		
Terminals (motor)	Connector (lead wire)		
Terminals (encoder)	Connector (lead wire)		
Overheat protection	Not provided (The servo amplifier detects temperature.)		
Mounting method	By securing motor flange IMB5 (L51), IMV1 (L52), IMV3 (L53)		
Encoder	24-bit serial encoder (absolute/incremental)		
Vibration level *2	V5 or below		
Installation place, environment	For indoor use (should not be exposed to direct sunlight), there should be no corrosive or flammable gases, oil mist, or dust.		
Altitude	Altitude ≤ 1000m		
Ambient temperature, humidity	-10 to +40°C (without freezing), within 90%RH max. (without condensation)		
Vibration resistance [m/s^2]	49		
Mass [kg]	0.9	1.2	2.3
Standards	UL/cUL (UL1004), CE marking (EN60034-1, EN60034-6), RoHS directive		

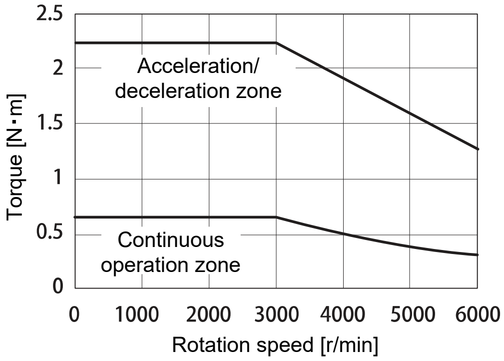
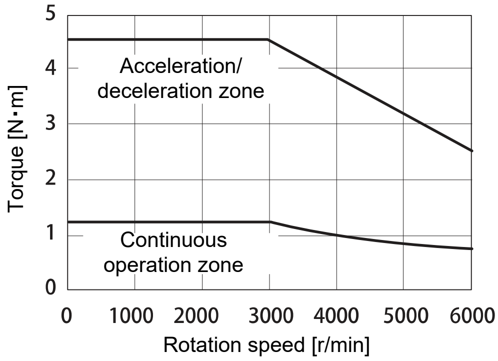
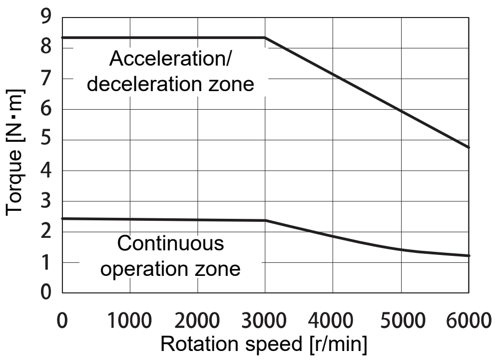
*1: When using the product under such an environment as specified in IP67, make sure that the connector for wiring is compatible with IP67.

*2: The vibration value is a characteristic when fitted with flange mounting IMV1 (L52).

■ Brake specifications (motor equipped with a brake)

Motor type	GYB201D7-□□2-□	GYB401D7-□□2-□	GYB751D7-□□2-□
Rated output [kW]	0.2	0.4	0.75
Rated torque [N·m]	0.637	1.27	2.39
Max. torque [kg·m^2]	0.37×10^{-4}	0.62×10^{-4}	1.71×10^{-4}
Static friction torque [N·m]	1.5		3.0
Rated voltage [V]	DC24 ±10%		
Attraction time [ms]	40		60
Release time [ms]	20		20
Power consumption [W]	7.2 (at 20°C)		8.5 (at 20°C)
Mass [kg]	1.3	1.8	3.2

■ Torque characteristics drawing
(at 3-phase 200 [V] or single-phase 230 [V] source voltage)

GYB201D7-□□2-□ (0.2 [kW])	GYB401D7-□□2-□ (0.4 [kW])
	
GYB751D7-□□2-□ (0.75 [kW])	
	

These characteristics indicate typical values when each servomotor is combined with the corresponding servo amplifier.
The rated torque indicates the value obtained when the servo amplifier is installed to the following aluminum heat sink.

- Model GYB201, 401 : 250 × 250 × 6 [mm]
- Model GYB751 : 300 × 300 × 6 [mm]

7.1.3 GYG Motor

■ Standard specifications

Motor type	GYG102C7-□□2	GYG152C7-□□2	GYG851B7-□□2	GYG132B7-□□2
Rated output [kW]	1.0	1.5	0.85	1.3
Rated torque [N·m]	4.77	7.16	5.41	8.28
Rated speed [r/min]	2000		1500	
Max. speed [r/min]	3000			
Max. torque [N·m]	14.3	21.5	16.2	24.8
Max. torque [kg·m²]	11.8×10^{-4}	17.8×10^{-4}	11.8×10^{-4}	17.8×10^{-4}
Rated current [A]	4.7	8.9	5.4	10.1
Max. current [A]	18.0	30.0	22.0	37.0
Insulation class	Class F			
Rated rotation speed	Continuous rating			
Degree of enclosure protection	Totally enclosed, self-cooled (IP 67, excluding the shaft-through) *1			
Terminals (motor)	Cannon connector			
Terminals (encoder)	Cannon connector			
Overheat protection	Not provided (The servo amplifier detects temperature.)			
Mounting method	By securing motor flange IMB5 (L51), IMV1 (L52), IMV3 (L53)			
Finishing color	N1.5			
Encoder	24-bit serial encoder (absolute/incremental)			
Vibration level *2	V10 or below			
Installation place, environment	For indoor use (should not be exposed to direct sunlight), there should be no corrosive or flammable gases, oil mist, or dust.			
Altitude	Altitude ≤ 1000m			
Ambient temperature, humidity	-10 to +40°C (there should be no freezing), within 90%RH max. (without condensation)			
Vibration resistance [m/s²]	24.5			
Mass [kg]	5.6	7.3	5.6	7.3
Standards	UL/cUL (UL1004), CE marking (EN60034-1, EN60034-6), RoHS directive			

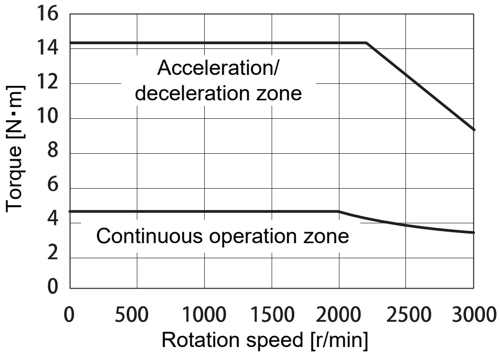
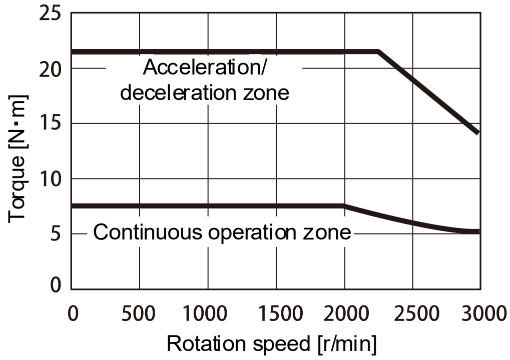
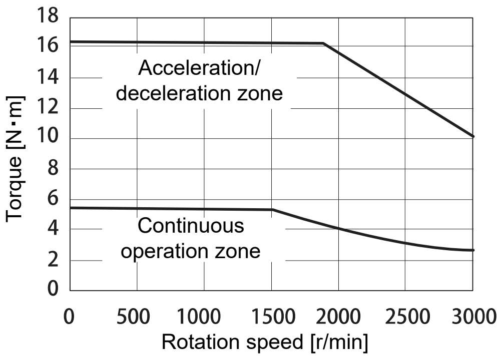
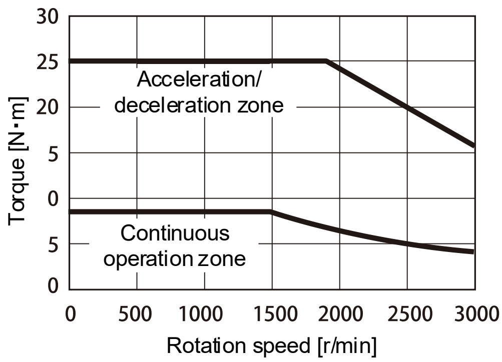
*1: When using the product under such an environment as specified by IP67, make sure that the connector for wiring is also compatible with IP67.

*2: The vibration value is a characteristic when fitted with flange mounting IMV1 (L52).

■ Brake specifications (motor equipped with a brake)

Motor type	GYG102C7-□□2-B	GYG152C7-□□2-B	GYG851B7-□□2-B	GYG132B7-□□2-B
Rated output [kW]	1.0	1.5	0.85	1.3
Rated torque [N·m]	4.77	7.16	5.41	8.28
Max. torque [kg·m²]	13.8×10^{-4}	19.8×10^{-4}	13.8×10^{-4}	19.8×10^{-4}
Static friction torque [N·m]	17			
Rated voltage [V]	DC24 ±10%			
Attraction time [ms]	120			
Release time [ms]	30			
Power consumption [W]	12 (at 20°C)			
Mass [kg]	7.8	9.5	7.8	9.5

■ Torque characteristics drawing (servo amplifier power supply voltage: 3-phase 200 [V])

<table>
<tr><td>GYG102C7-□□2 (1.0 [kW])</td><td>GYG152C7-□□2-B (1.5 [kW])</td></tr>
<tr><td>
</td><td>
</td></tr>
<tr><td>GYG851B7-□□2 (0.85 [kW])</td><td>GYG132B7-□□2-B (1.3 [kW])</td></tr>
<tr><td>
</td><td>
</td></tr>
</table>

These characteristics indicate typical values when each servomotor is combined with the corresponding servo amplifier.
The rated torque indicates the value obtained when the servo amplifier is installed to the following aluminum heat sink.

- Model GYG102, 851 : 300 × 300 × 12 [mm]
- Model GYG152,132 : 400 × 400 × 12 [mm]

7.2 Specifications of Servo Amplifier

7.2.1 Common Specifications

Item											
Servo amplifier capacity [kW]	0.05	0.1	0.2	0.4	0.75	1.0	1.5	2.0	3.0	4.0	5.0
Amplifier type RYT□□□F7-VC2	500	101	201	401	751	102	152	202	302	402	502
Outer frame number	Frame 1				Frame 2			Frame 3		Frame 4	
Mass [kg]	0.9	0.9	0.9	0.9	1.5	1.5	1.5	2.5	2.5	3.8	3.8
Protective construction/cooling	Open/natural cooling				Open/mechanical cooling						
Power supply / Main power supply / Phases	Single-phase, 3-phase					3-phase					
Power supply / Main power supply / Voltage/frequency	AC200 to 240 [V], 50/60 [Hz]										
Power supply / Main power supply / Allowable voltage fluctuation	3-phase: AC170 to 264 [V], Single-phase: AC190 to 264V										
Power supply / Control power supply / Phases	Single-phase										
Power supply / Control power supply / Voltage/frequency	AC200 to 240 [V], 50/60 [Hz]										
Power supply / Control power supply / Allowable voltage fluctuation	AC170 to 264V										
Control system	Fully-digital sinusoidal PWM drive										
Carrier frequency	10 [kHz]							5 [kHz]			
Overload capability	Overload capability varies from motor to motor										
Max voltage for regenerative resistance [W] / Built-in resistor	—	—	—	8	20	20	20	30	30	60	60
Max voltage for regenerative resistance [W] / External resistor *1	17	17	17	17	50	50	50	260	260	300	300
Dynamic brake	Built-in *2										
Feedback	Absolute 24-bit serial encoder, incremental 24-bit serial encoder										
Speed fluctuation ratio *3 / Load fluctuation	±0.01% or less (load fluctuation 0 to 100% at rated speed)										
Speed fluctuation ratio *3 / Power supply fluctuation	0% (power supply fluctuation -10% to +10% at rated speed)										
Speed fluctuation ratio *3 / Temperature fluctuation	±0.2% or less (25°C±10°C, at rated speed with analog voltage directive)										
Performance and functionality / VC type / Speed control	Closed loop control with speed regulator, acceleration/deceleration time setting, manual feedrate/max. rotation speed, etc.										
Performance and functionality / VC type / Position control	Closed loop control with position regulator, electronic gear, output pulse setting, feed forward, home position return, interrupt positioning, etc.										
Performance and functionality / VC type / Torque control	Closed-loop control by current adjuster (current and torque in open-loop control in proportional relation), torque limit, speed limit at torque control, etc.										
Performance and functionality / VC type / Auxiliary function	Easy tuning, profile operation, sequence test mode, auto tuning, auto-notch filter, online leaning of vibration suppression control, etc.										
Protective function (Alarm display)	Overcurrent (oc01, oc02), overspeed (oS), control power supply undervoltage (Lvcn), overvoltage (Hv), encoder error (Et01, Et02), memory error (dE), motor combination error (cE), encoder communication error (Ec), CONT duplication (cont), overload (oL01, oL02, oL03), main circuit power supply undervoltage (LvPo), braking resistor overheating (rH01, rH02), braking transistor error (rH03), inrush current suppression circuit error (rH04), deviation over (oF), servo amplifier overheating (AH), encoder overheating (EH), ABS data loss (dL01, dL02, dL03), multi-rotation overflow (AF), initial error (iE), command pulse frequency error (HF), function safety error (SFty), EtherCAT communication error (cy)										
Operation and display section of main body	2-digit alphanumeric display with 7-seg LED Rotary switch										
Working conditions / Installation place	Indoors at altitude ≤ 1000m, free from dust, corrosive gases and direct sunlight In case of compliance with CE marking: Pollution Degree=2 Over Voltage Category=Ⅲ										
Working conditions / Temperature/humidity/atmospheric pressure	-10 to 55°C/10 to 90%RH (without condensation)/70 to 106kPa										
Working conditions / Vibration	3 [mm]: 2 to less than 9 [Hz], 9.8 [m/s^2]: 9 to less than 20 [Hz] 2 [m/s^2]: 20 to less than 55 [Hz], 1 [m/s^2]: 55 to less than 200 [Hz]										
Working conditions / Shock resistance	19.6 [m/s^2]										

<table>
<tr><td colspan="2">Servo amplifier capacity [kW]</td><td>0.05</td><td>0.1</td><td>0.2</td><td>0.4</td><td>0.75</td><td>1.0</td><td>1.5</td><td>2.0</td><td>3.0</td><td>4.0</td><td>5.0</td></tr>
<tr><td colspan="2">Amplifier type RYT□□□F7-VC2</td><td>500</td><td>101</td><td>201</td><td>401</td><td>751</td><td>102</td><td>152</td><td>202</td><td>302</td><td>402</td><td>502</td></tr>
<tr><td colspan="2">Outer frame number</td><td colspan="4">Frame 1</td><td colspan="3">Frame 2</td><td colspan="2">Frame 3</td><td colspan="2">Frame 4</td></tr>
<tr><td colspan="2">Standards</td><td colspan="11">UL standard : UL61800-5-1
CE marking Low voltage directive : EN61800-5-1
EMC directive : EN61800-3
Machine directive : EN ISO 13849-1 : Cat.3 PL = e
EN 60204-1 : Stop Category 0
EN 61508 : SIL3
EN 61800-5-2 : SIL3 (Functional Safety : STO)
EN 62061 : SIL CL3</td></tr>
<tr><td rowspan="6">Control function</td><td>Frequency response</td><td colspan="11">3, 200Hz</td></tr>
<tr><td>Tuning features</td><td colspan="11">Auto tuning, semi-auto tuning, interpolation control mode, manual tuning</td></tr>
<tr><td>Auto adjustment features</td><td colspan="11">Tuningless features, easy tuning, fine tuning</td></tr>
<tr><td>Notch filter</td><td colspan="11">5-step</td></tr>
<tr><td>Vibration suppression control</td><td colspan="11">2-step (number of steps that can be configured at the same time)</td></tr>
<tr><td>Compensation features</td><td colspan="11">Friction compensation, interference detection, cogging torque compensation</td></tr>
</table>

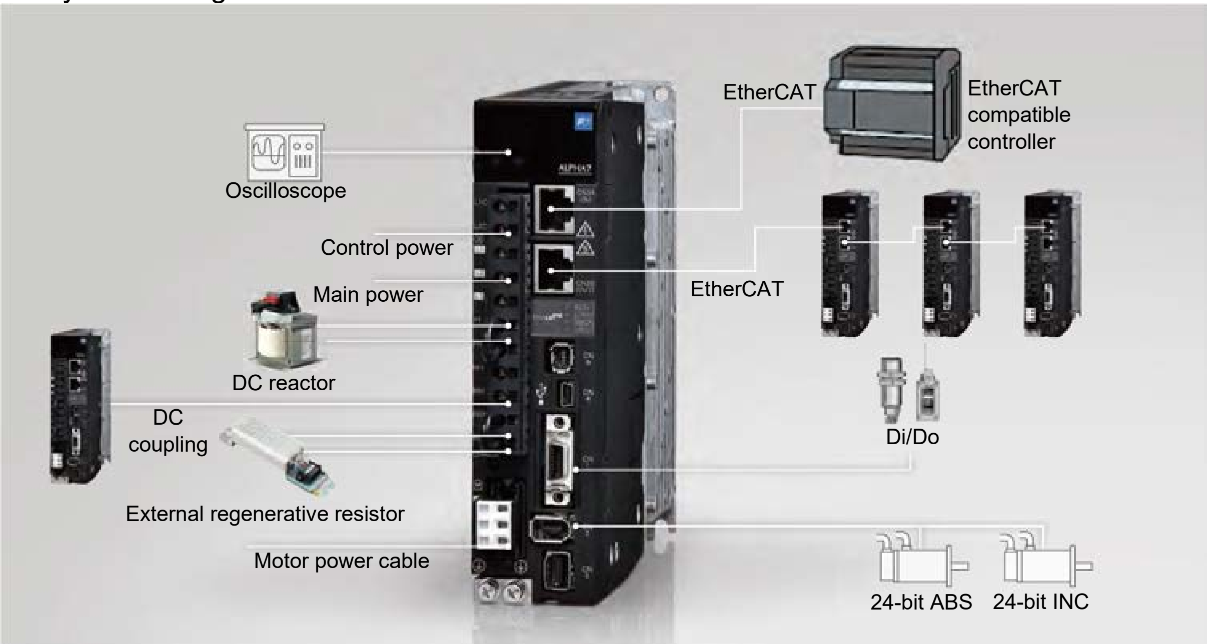
*1: This value assumes that the external resistor dedicated to each amplifier is connected.

*2: We will accept custom orders for models without a dynamic brake.

*3: This value represents the average value of the speed fluctuation that is generated from static load fluctuation, power supply fluctuation, and temperature fluctuation as the percentage to the rated rotation speed.

7.2.2 VC Type Specifications

■ System configuration overview



7

■ Interface specifications

Interface type		Specification
Command interface	Position control	EtherCAT CiA402 drive profile
	Speed control	
	Torque control	
Communication interface		EtherCAT (for command interface, parameter editing, monitor)
		Can application over EtherCAT
		100 Mbps

■ EtherCAT communication specifications

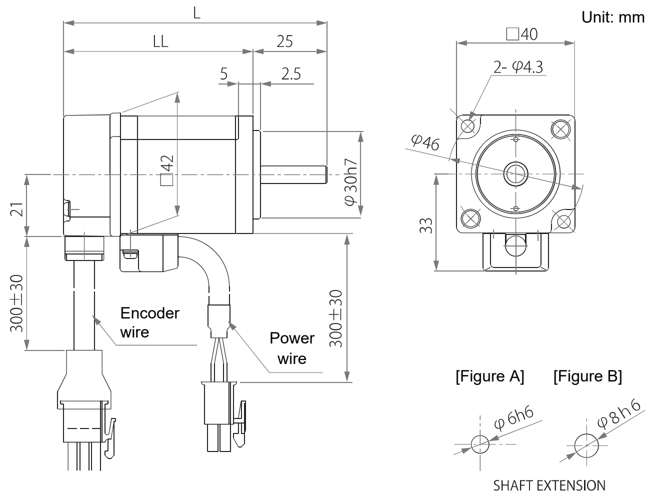
Item	Specification
Physical layer	100Base-TX [IEEE802.3]
Baud rate	100 [Mbps] (full duplex)
Topology	Line
Communication cable	Twisted pair cable CAT5e
Communication distance	Distance between nodes: max. 100 m
Number of slaves	65535 * The number of slaves which can be controlled with PDO is restricted by the communication cycle and data length.
Communication port	2 ports (RJ45 connector)
Station alias (Station Alias)	Setting: 0 to 65535
Device profile	Can application over EtherCAT
Cia402 drive profiles	pp: Profile position mode
	pv: Profile velocity mode
	hm: Homing mode
	csp: Cyclic synchronous position mode
	csv: Cyclic synchronous velocity mode
	cst: Cyclic synchronous torque mode
Touch probe	Supported (2 inputs)

Item		Specification
Synchronization method	Synchronization mode	DC: Distribute clock
		SM2: Cyclic PDO communication
	Asynchronous mode	Free run
Communication cycle		125 [μs], 250 [μs], 500 [μs], 1000 [μs], 2000 [μs], 4000 [μs]
Communication format		SDO, PDO
SDO message		Normal Request, Normal Response
Free PDO Mapping		Supported * Only objects defined as possible with Fuji Electric specification
Max. PDO data count		4 × 16 [Entry/PDO] (RxPDO) + 4 × 16 [Entry/PDO] (TxPDO)
Max. PDO data length		128 [bytes] (Rx PDO) + 128 [bytes] (Tx PDO)

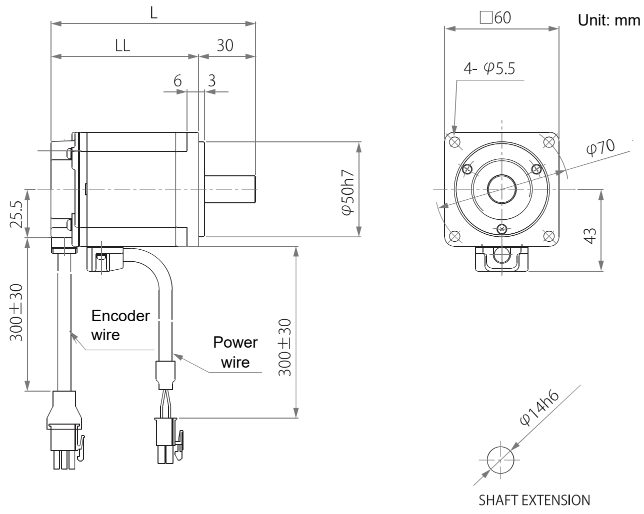
Terminal name	Symbol	Specification
Analog monitor voltage output	MON1 MON2	From 0 VDC ±10 V Resolution: 14-bit/±full scale Output content is based on input parameters.
	M5	M5 is reference potential (0 V).
Sequence input/output common	COMIN	Sequence input signal common
	COMOUT	Sequence output signal common
Sequence input signals	CONT1 to CONT6	ON with contact shorting, OFF with open 12 VDC - 10% to 24 VDC +10% Current consumption: 8 mA (per contact, used with circuit voltage of 24 VDC) All signal functions are based on parameter settings. Compatible with both sync/source input methods.
Sequence output signal	OUT1 to OUT2	Contact shorting when ON, open circuit when OFF 30 VDC/50 mA (max.) All signal functions are based on parameter settings. Compatible with both sync/source output methods.

7.3 Dimensions of Servomotor

7.3.1 GYS Motor (With no Brake)

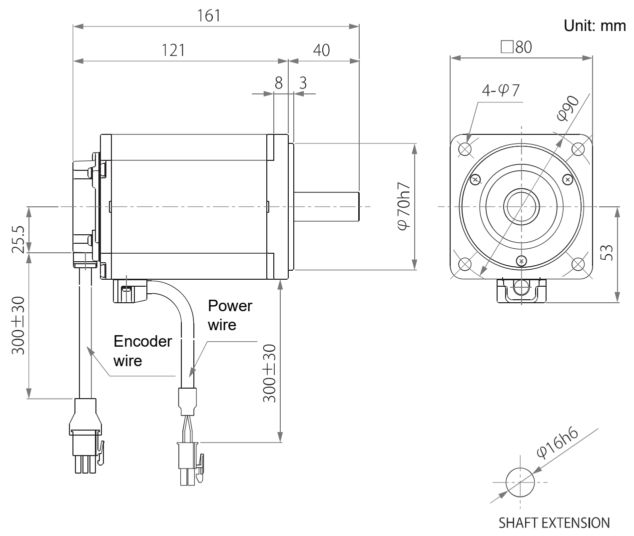


Rated speed	Rated output	Type	Shaft shape	Overall length	Dimensions (Flange)	Mass [kg]
				L	LL	
3000 r/min	0.05 kW	GYS500D7-□B2	Figure A	89	64	0.45
	0.1 kW	GYS101D7-□B2	Figure B	107	82	0.55

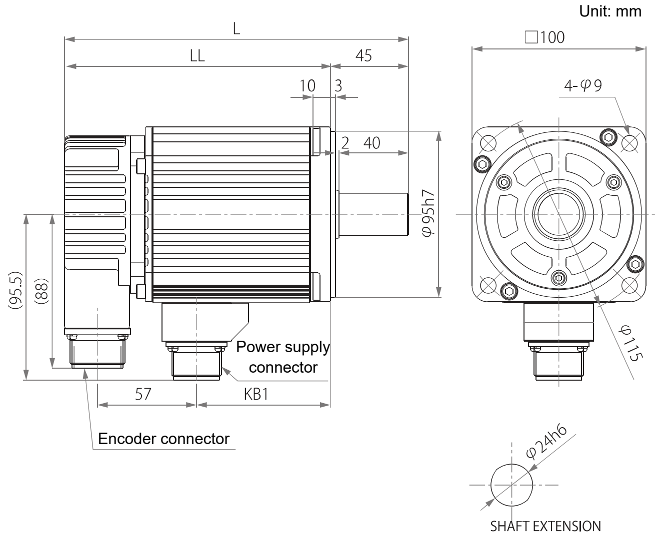


Rated speed	Rated output	Type	Overall length	Dimensions (Flange)	Mass [kg]
			L	LL	
3000 r/min	0.2 kW	GYS201D7-□B2	107.5	77.5	1.2
	0.4 kW	GYS401D7-□B2	135.5	105.5	1.8

* See “7.5 Optional Specification of Shaft Extension [With a Key, Tapped]” for the shaft extension specifications of the motor with a key.

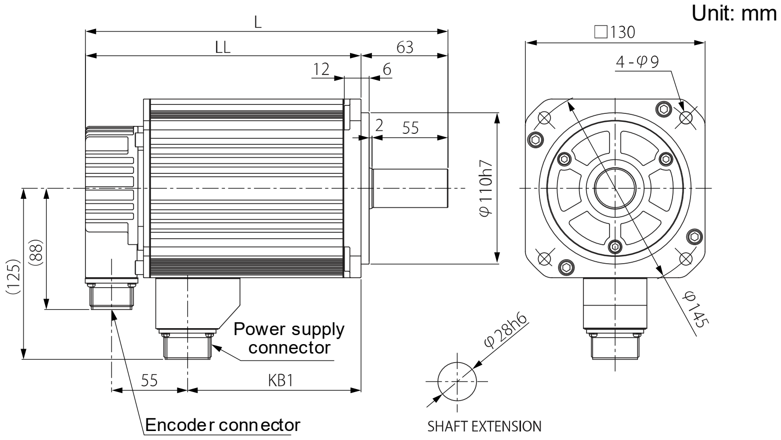


Rated speed	Rated output	Type	Mass [kg]
3000 r/min	0.75 kW	GYS751D7-□B2	3.4



Rated speed	Rated output	Type	Overall length	Dimensions (Flange)	Terminal portion	Mass [kg]
			L	LL	KB1	
3000 r/min	1.0 kW	GYS102D7-□B2	198	153	77	4.4
	1.5 kW	GYS152D7-□B2	220.5	175.5	99.5	5.2
	2.0 kW	GYS202D7-□B2	243	198	122	6.3

* See “7.5 Optional Specification of Shaft Extension [With a Key, Tapped]” for the shaft extension specifications of the motor with a key.

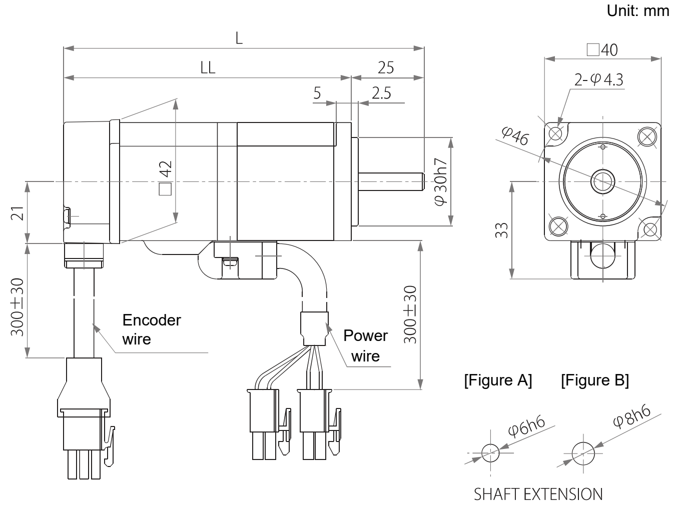


Rated speed	Rated output	Type	Overall length	Dimensions (Flange)	Terminal portion	Mass [kg]
			L	LL	KB1	
3000 r/min	3.0 kW	GYS302D7-□B2	262.5	199.5	125.5	11
	4.0 kW	GYS402D7-□B2	292.5	229.5	155.5	13.5
	5.0 kW	GYS502D7-□B2	322.5	259.5	185.5	16

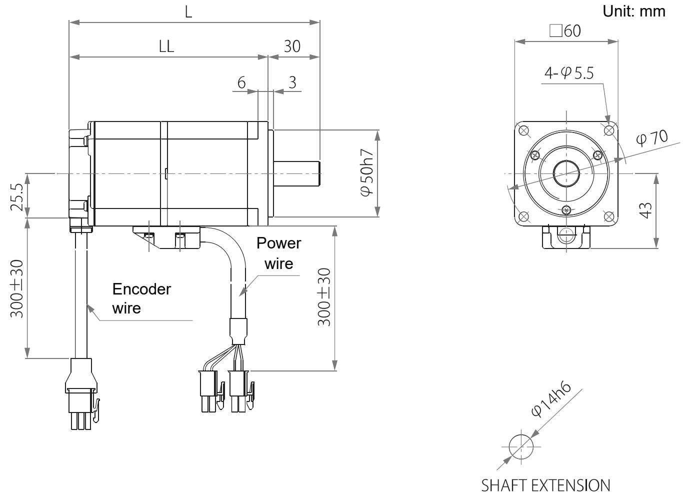
7

* See “7.5 Optional Specification of Shaft Extension [With a Key, Tapped]” for the shaft extension specifications of the motor with a key.

7.3.2 GYS Motor (With a Brake)



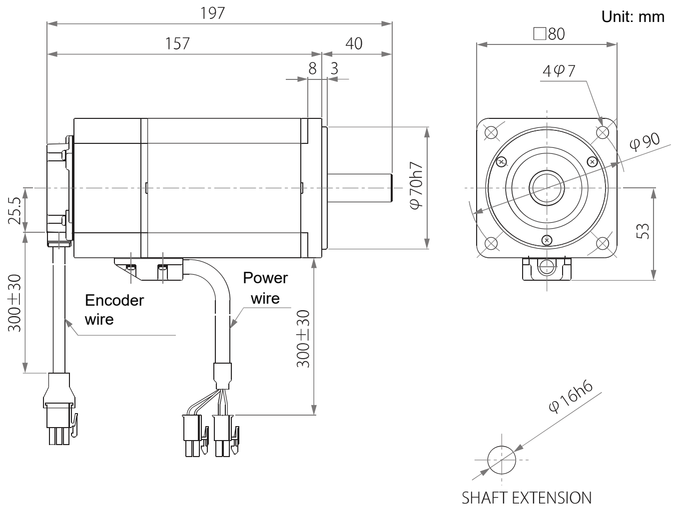
Rated speed	Rated output	Type	Shaft shape	Overall length	Dimensions (Flange)	Mass [kg]
				L	LL	
3000 r/min	0.05 kW	GYS500D7-□B2-B	Figure A	123.5	98.5	0.62
	0.1 kW	GYS101D7-□B2-B	Figure B	141.5	116.5	0.72



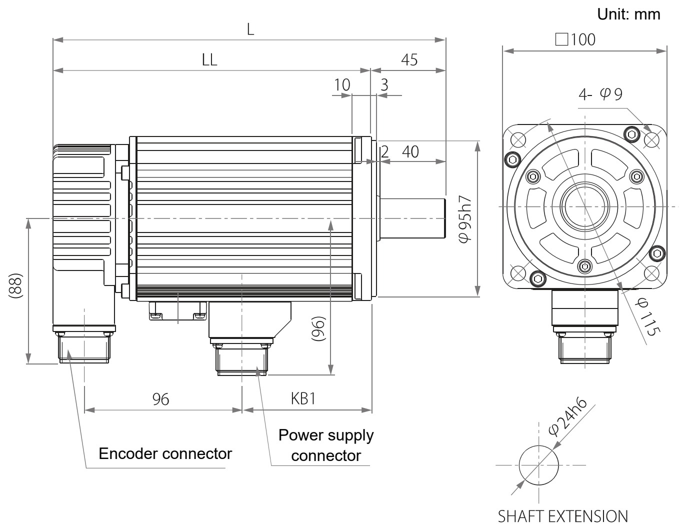
Rated speed	Rated output	Type	Overall length	Dimensions (Flange)	Mass [kg]
			L	LL	
3000 r/min	0.2 kW	GYS201D7-□B2-B	145.5	115.5	1.7
	0.4 kW	GYS401D7-□B2-B	173.5	143.5	2.3

* See "7.5 Optional Specification of Shaft Extension [With a Key, Tapped]" for the shaft extension specifications of the motor with a key.

7

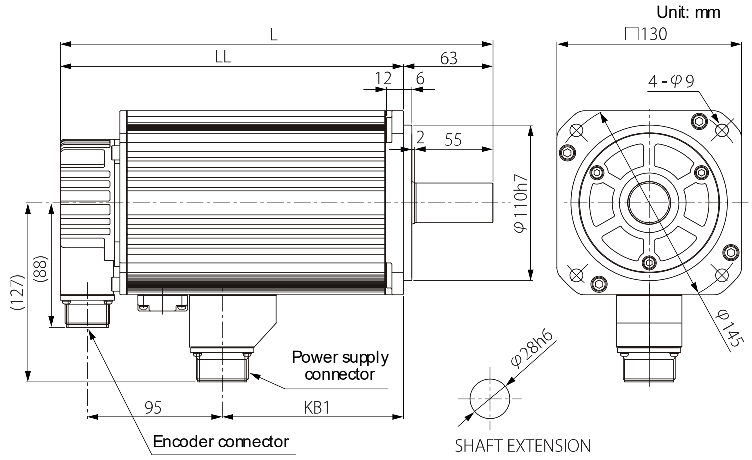


Rated speed	Rated output	Type	Mass [kg]
3000 r/min	0.75 kW	GYS751D7-□B2-B	4.2



Rated speed	Rated output	Type	Overall length	Dimensions (Flange)	Terminal portion	Mass [kg]
			L	LL	KB1	
3000 r/min	1.0 kW	GYS102D7-□B2-B	239	194	79	5.9
	1.5 kW	GYS152D7-□B2-B	261.5	216.5	101.5	6.8
	2.0kW	GYS202D7-□B2-B	284	239	124	7.9

* See “7.5 Optional Specification of Shaft Extension [With a Key, Tapped]” for the shaft extension specifications of the motor with a key.

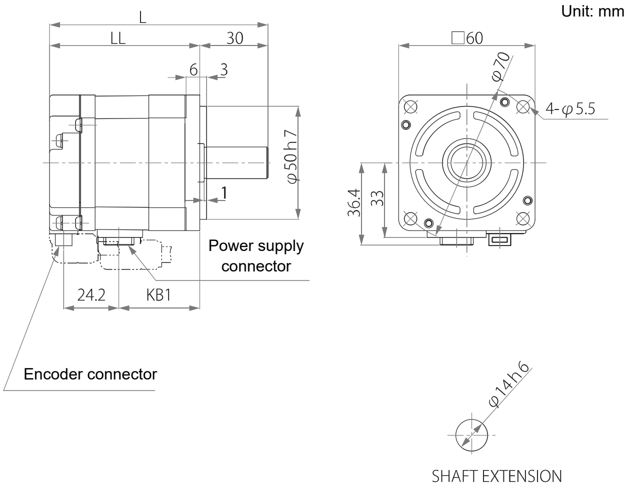


Rated speed	Rated output	Type	Overall length	Dimensions (Flange)	Terminal portion	Mass [kg]
			L	LL	KB1	
3000 r/min	3.0 kW	GYS302D7-□B2-B	304.5	241.5	127.5	13
	4.0 kW	GYS402D7-□B2-B	334.5	271.5	157.5	15.5
	5.0 kW	GYS502D7-□B2-B	364.5	301.5	187.5	18

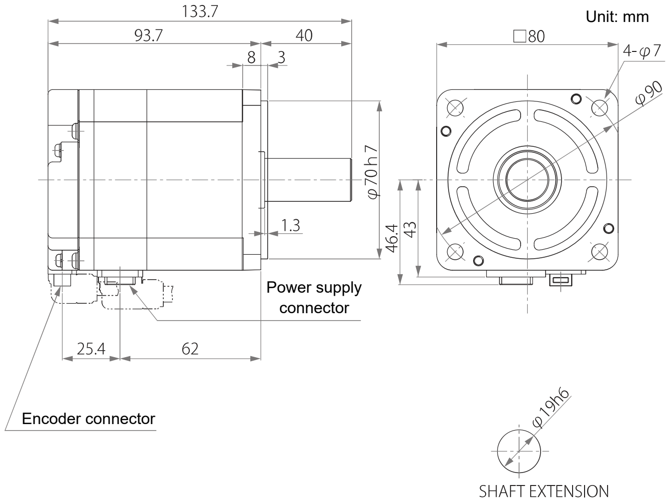
* See “7.5 Optional Specification of Shaft Extension [With a Key, Tapped]” for the shaft extension specifications of the motor with a key.

7

7.3.3 GYB Motor (Connector Type)



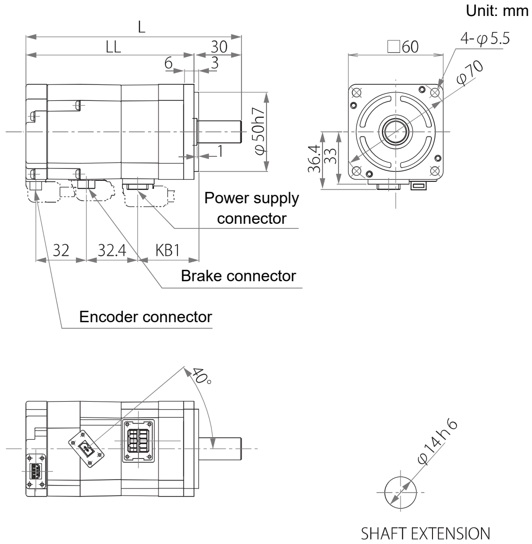
Rated speed	Rated output	Type	Overall length	Dimensions (Flange)	Terminal portion	Mass [kg]
			L	LL	KB1	
3000 r/min	0.2 kW	GYB201D7-□B2-C	96.2	66.2	35.7	0.9
	0.4 kW	GYB401D7-□B2-C	114	84	53.5	1.2



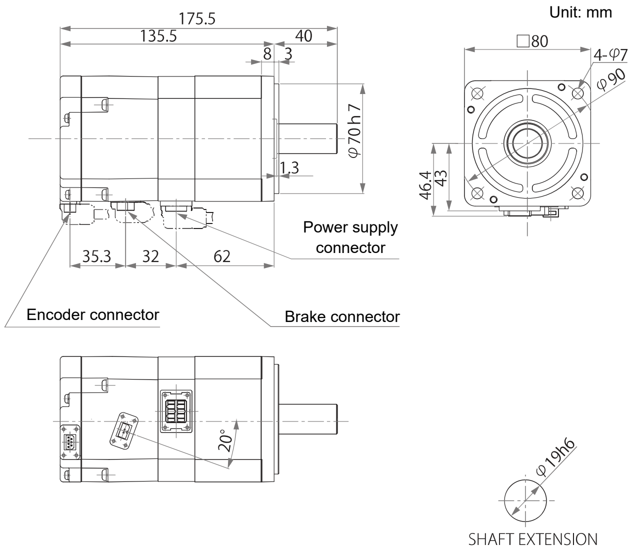
Rated speed	Rated output	Type	Mass [kg]
3000 r/min	0.75 kW	GYB751D7-□B2-C	2.3

* See “7.5 Optional Specification of Shaft Extension [With a Key, Tapped]” for the shaft extension specifications of the motor with a key.

7.3.4 GYB Motor (Connector Type) (With a Brake)



Rated speed	Rated output	Type	Overall length	Dimensions (Flange)	Terminal portion	Mass [kg]
			L	LL	KB1	
3000 r/min	0.2 kW	GYB201D7-□B2-D	136.3	106.3	35.7	1.3
	0.4 kW	GYB401D7-□B2-D	154.1	124.1	53.5	1.8

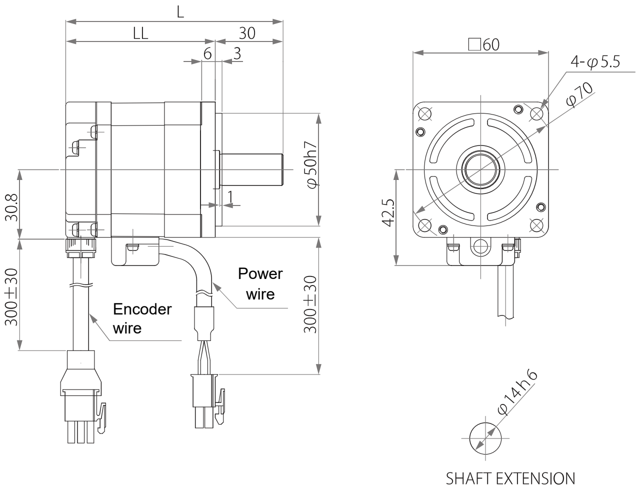


Rated speed	Rated output	Type	Mass [kg]
3000 r/min	0.75 kW	GYB751D7-□B2-D	3.2

* See “7.5 Optional Specification of Shaft Extension [With a Key, Tapped]” for the shaft extension specifications of the motor with a key.

7.3.5 GYB Motor (Lead Wire Type)

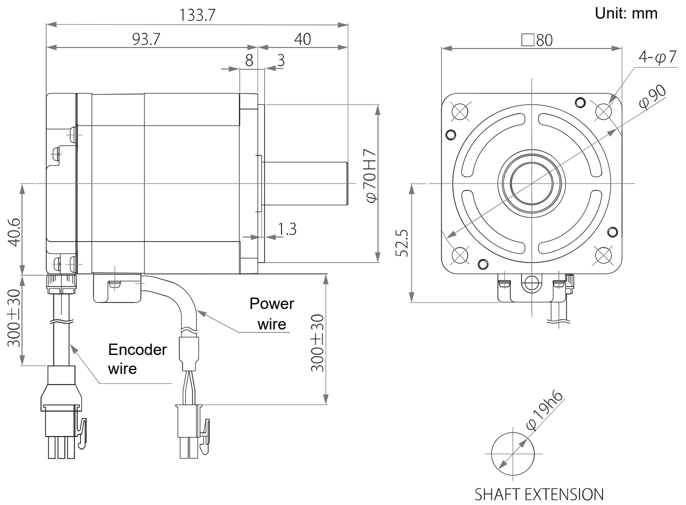
Unit: mm



Rated speed	Rated output	Type	Overall length	Dimensions (Flange)	Mass [kg]
			L	LL	
3000 r/min	0.2 kW	GYB201D7-☐B2	96.2	66.2	0.9
	0.4 kW	GYB401D7-☐B2	114	84	1.2

7

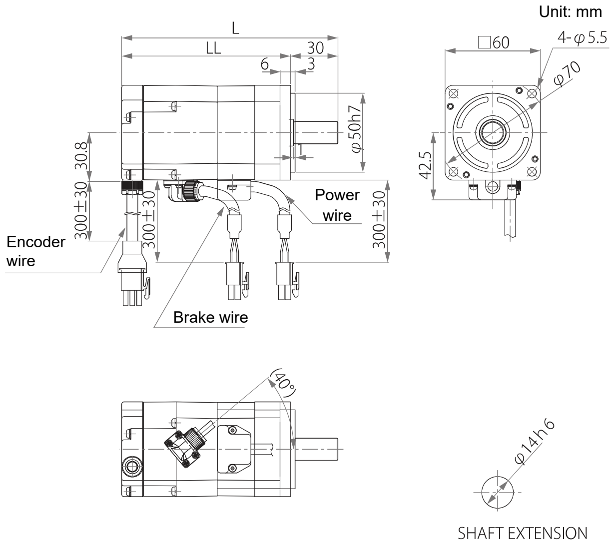
Unit: mm



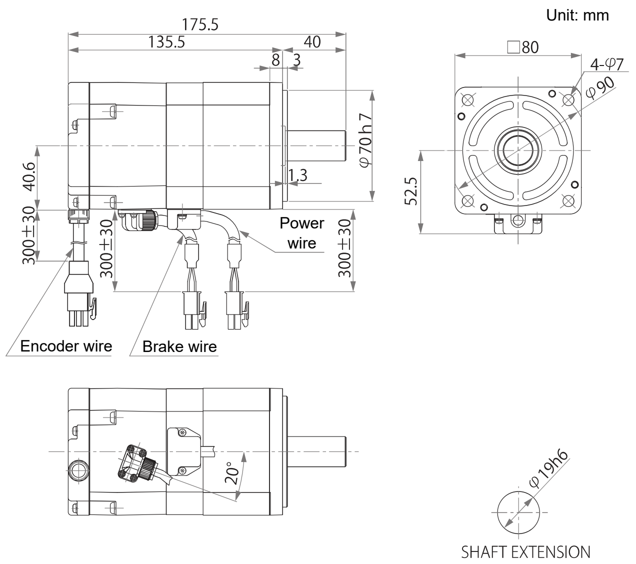
Rated speed	Rated output	Type	Mass [kg]
3000 r/min	0.75 kW	GYB751D7-☐B2	2.3

* See “7.5 Optional Specification of Shaft Extension [With a Key, Tapped]” for the shaft extension specifications of the motor with a key.

7.3.6 GYB Motor (Lead Wire Type) (With a Brake)



Rated speed	Rated output	Type	Overall length	Dimensions (Flange)	Mass [kg]
			L	LL	
3000 r/min	0.2 kW	GYB201D7-□B2-B	136.3	106.3	1.3
	0.4 kW	GYB401D7-□B2-B	154.1	124.1	1.8

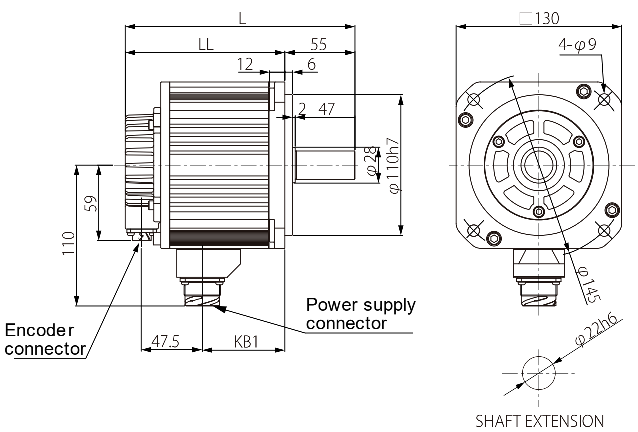


Rated speed	Rated output	Type	Mass [kg]
3000 r/min	0.75 kW	GYB751D7-□B2-B	3.2

* See "7.5 Optional Specification of Shaft Extension [With a Key, Tapped]" for the shaft extension specifications of the motor with a key.

7.3.7　GYG Motor (2000 [r/min])

Unit: mm

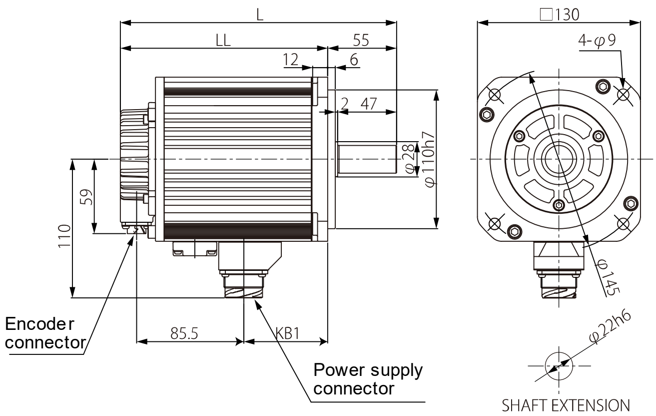


Rated speed	Rated output	Type	Overall length	Dimensions (Flange)	Terminal portion	Mass [kg]
			L	LL	KB1	
2000 r/min	1.0 kW	GYG102C7-□B2	180.5	125.5	65	5.6
	1.5 kW	GYG152C7-□B2	198	143	82.5	7.3

* See “7.5 Optional Specification of Shaft Extension [With a Key, Tapped]” for the shaft extension specifications of the motor with a key.

7.3.8　GYG Motor (2000 [r/min]) (With a Brake)

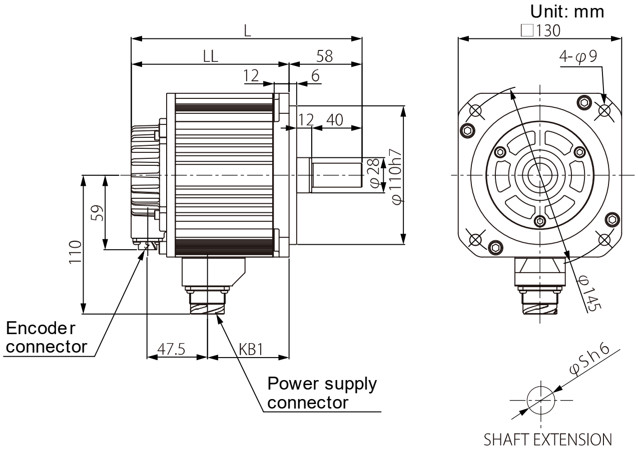
Unit: mm



Rated speed	Rated output	Type	Overall length	Dimensions (Flange)	Terminal portion	Mass [kg]
			L	LL	KB1	
2000 r/min	1.0 kW	GYG102C7-□B2-B	220.5	165.5	67	7.8
	1.5 kW	GYG152C7-□B2-B	238	183	84.5	9.5

* See “7.5 Optional Specification of Shaft Extension [With a Key, Tapped]” for the shaft extension specifications of the motor with a key.

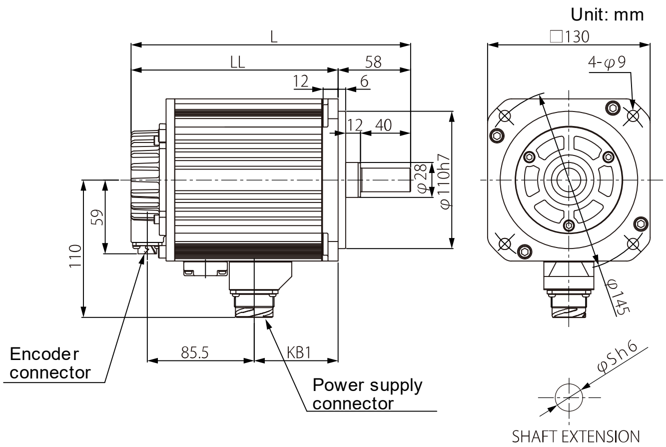
7.3.9 GYG Motor (1500 [r/min])



Rated speed	Rated output	Type	Overall length	Dimensions (Flange)	Terminal portion	Shaft diameter	Mass [kg]
			L	LL	KB1	S	
1500 r/min	0.85 kW	GYG851B7-□B2	183.5	125.5	65	19	5.6
	1.3 kW	GYG132B7-□B2	201	143	82.5	22	7.3

* See “7.5 Optional Specification of Shaft Extension [With a Key, Tapped]” for the shaft extension specifications of the motor with a key.

7.3.10 GYG Motor (1500 [r/min]) (With a Brake)



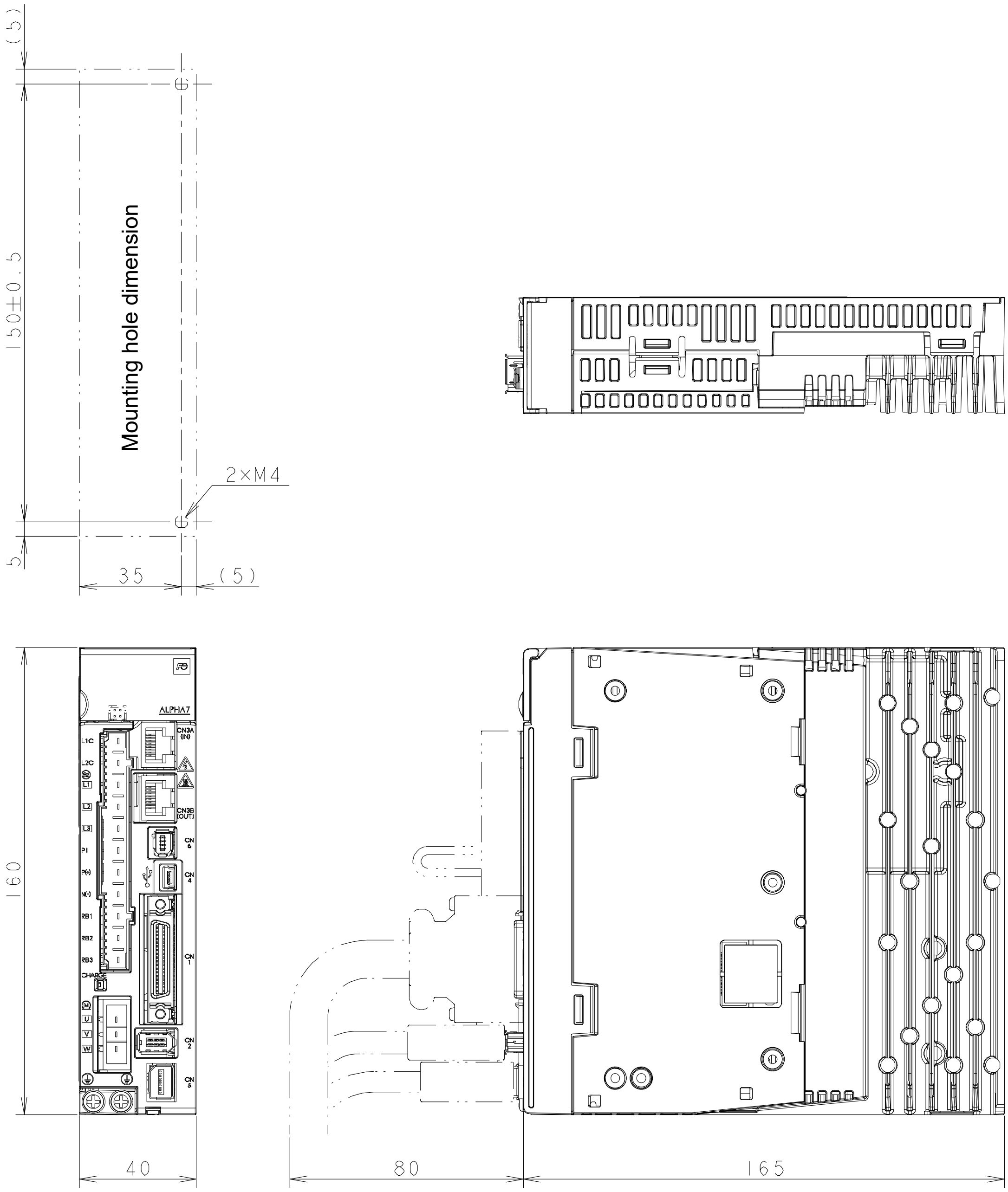
Rated speed	Rated output	Type	Overall length	Dimensions (Flange)	Terminal portion	Shaft diameter	Mass [kg]
			L	LL	KB1	S	
1500 r/min	0.85 kW	GYG851B7-□B2-B	223.5	165.5	67	19	7.8
	1.3 kW	GYG132B7-□B2-B	241	183	84.5	22	9.5

* See “7.5 Optional Specification of Shaft Extension [With a Key, Tapped]” for the shaft extension specifications of the motor with a key.

7

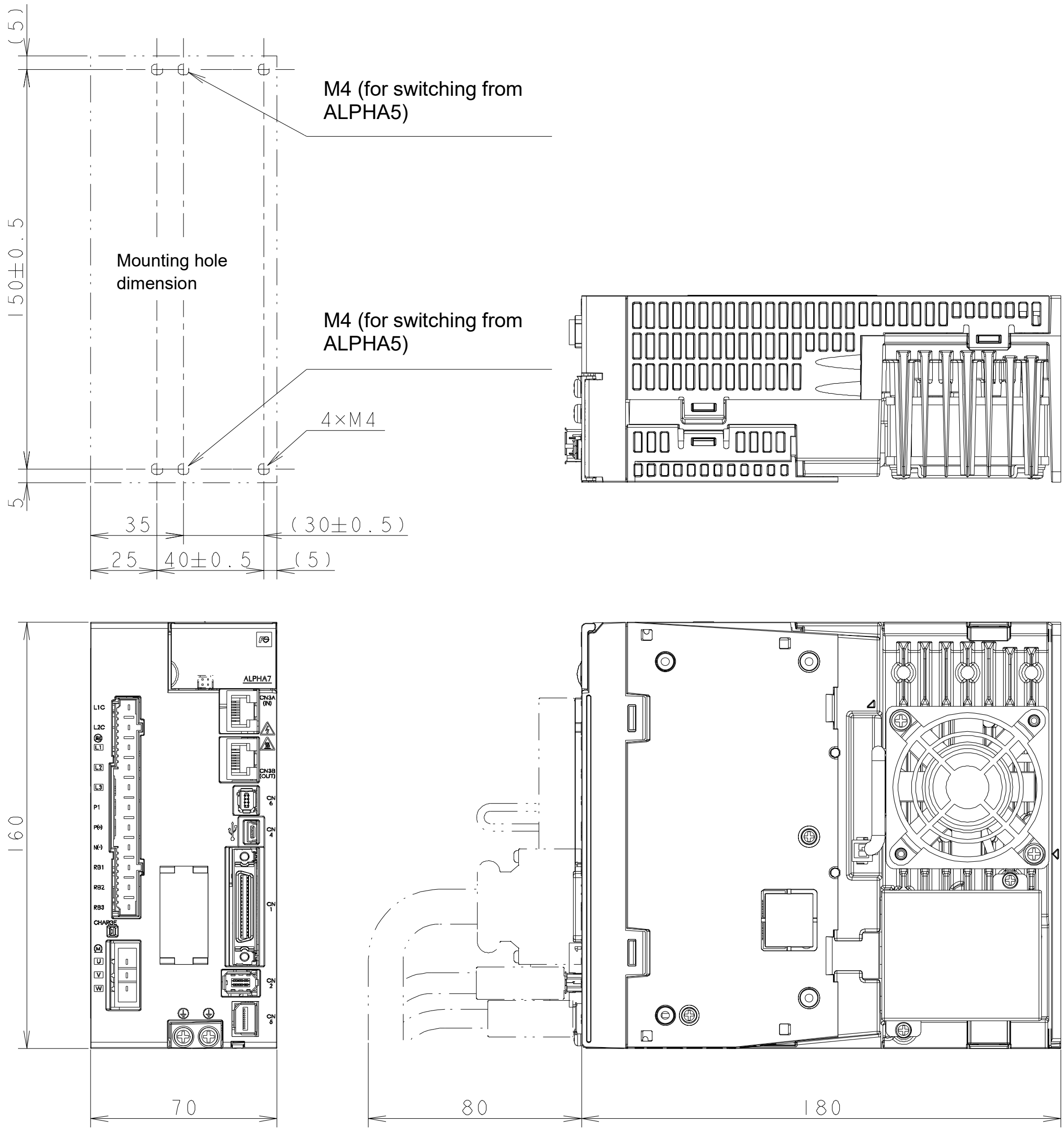
7.4 Dimensions of Servo Amplifier

Frame 1



Power supply	Type	Mass [kg]
200V series	RYT500F7-VC2	0.9
	RYT101F7-VC2	
	RYT201F7-VC2	
	RYT401F7-VC2	

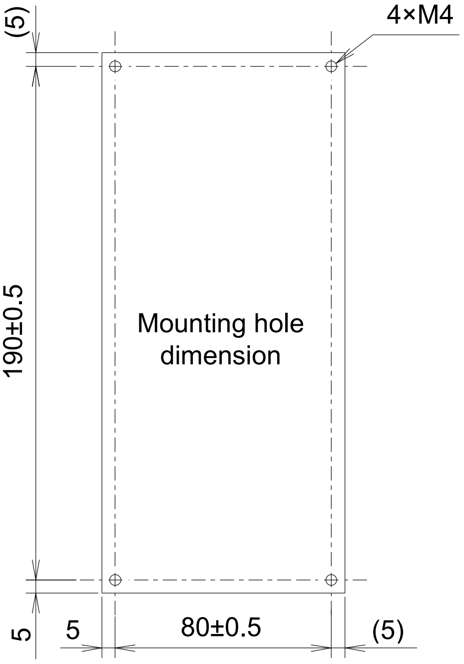
Frame 2

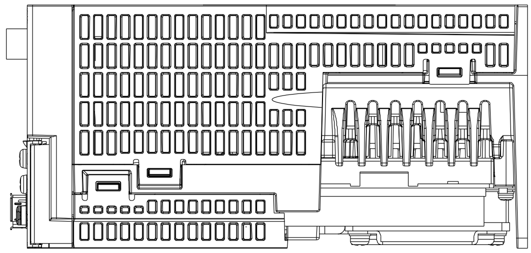


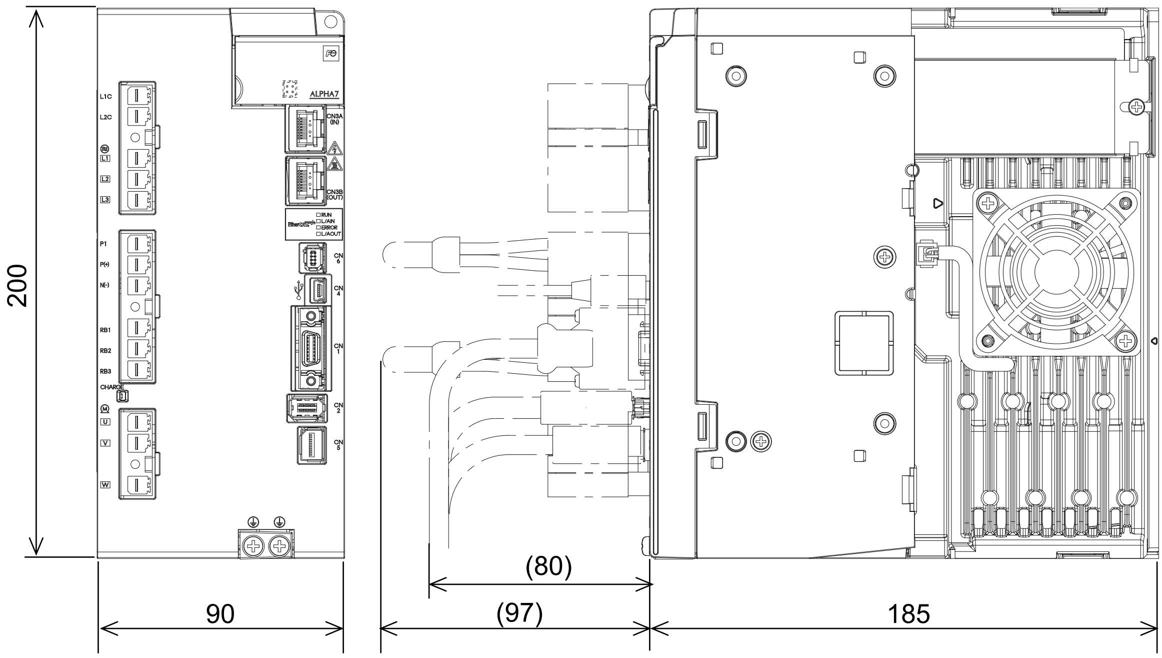
Power supply	Type	Mass [kg]
200V series	RYT751F7-VC2	1.5
	RYT102F7-VC2	
	RYT152F7-VC2	

Frame 3

Unit: mm



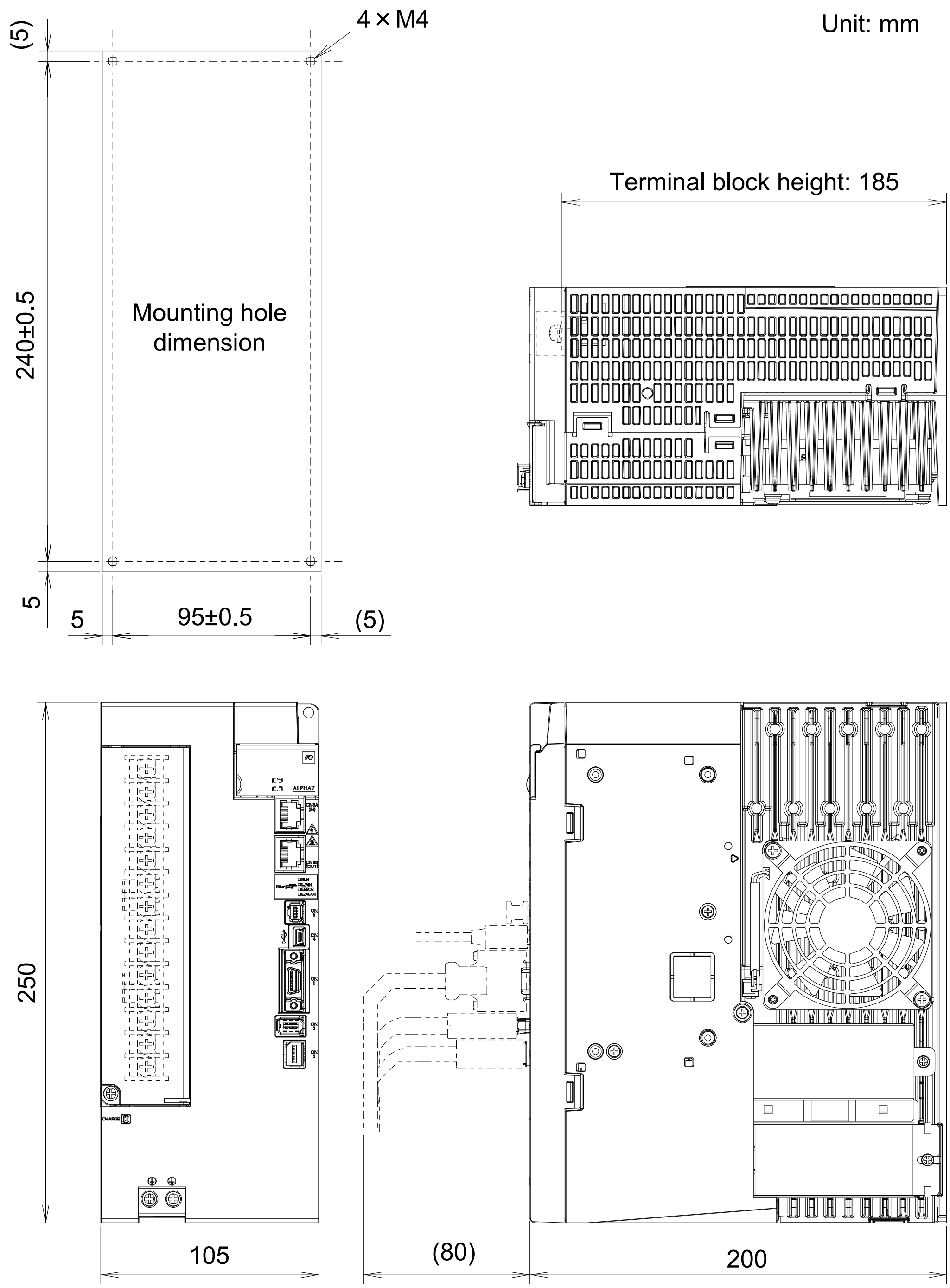




Power supply	Type	Mass [kg]
200V series	RYT202F7-VC2	2.5
	RYT302F7-VC2	

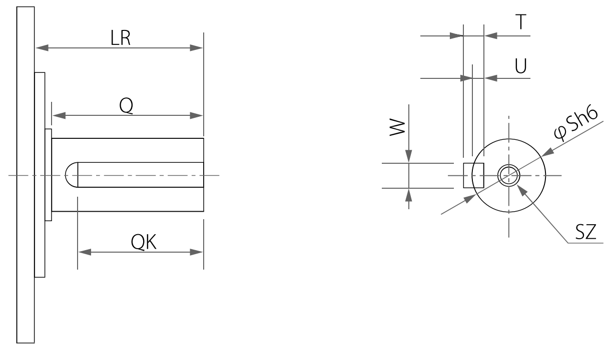
7

Frame 4



Power supply	Type	Mass [kg]
200V series	RYT402F7-VC2	3.8
	RYT502F7-VC2	

7.5 Optional Specification of Shaft Extension [With a Key, Tapped]



Unit: mm

Motor type	LR	Q	QK	S	T	U	W	SZ
GYS motor 3000 r/min								
GYS500D7-☐A2-☐*	25	—	14	6	2	1.2	2	—
GYS101D7-☐A2-☐*	25	—	14	8	3	1.8	3	—
GYS201D7-☐C2-☐	30	—	20	14	5	3	5	M5 depth: 8
GYS401D7-☐C2-☐	30	—	20	14	5	3	5	M5 depth: 8
GYS751D7-☐C2-☐	40	—	30	16	5	3	5	M5 depth: 8
GYS102D7-☐C2-☐	45	40	32	24	7	4	8	M8 depth: 16
GYS152D7-☐C2-☐	45	40	32	24	7	4	8	M8 depth: 16
GYS202D7-☐C2-☐	45	40	32	24	7	4	8	M8 depth: 16
GYS302D7-☐C2-☐	63	55	45	28	7	4	8	M8 depth: 16
GYS402D7-☐C2-☐	63	55	45	28	7	4	8	M8 depth: 16
GYS502D7-☐C2-☐	63	55	45	28	7	4	8	M8 depth: 16
GYB motor 3000 r/min								
GYB201D7-☐C2-☐	30	—	14	14	5	3	5	M5 depth: 8
GYB401D7-☐C2-☐	30	—	14	14	5	3	5	M5 depth: 8
GYB751D7-☐C2-☐	40	—	22	19	6	3.5	6	M6 depth: 10
GYG motor 2000 r/min								
GYG102C7-☐C2-☐	55	47	35	22	7	4	8	M8 depth: 16
GYG152C7-☐C2-☐	55	47	35	22	7	4	8	M8 depth: 16
GYG motor 1500 r/min								
GYG851B7-☐C2-☐	58	40	30	19	6	3.5	6	M6 depth: 12
GYG132B7-☐C2-☐	58	40	30	22	7	4	8	M8 depth: 16

* The shaft extension of the GYS motors of 0.1kW or less is not tapped.

CHAPTER 8 CHARACTERISTICS

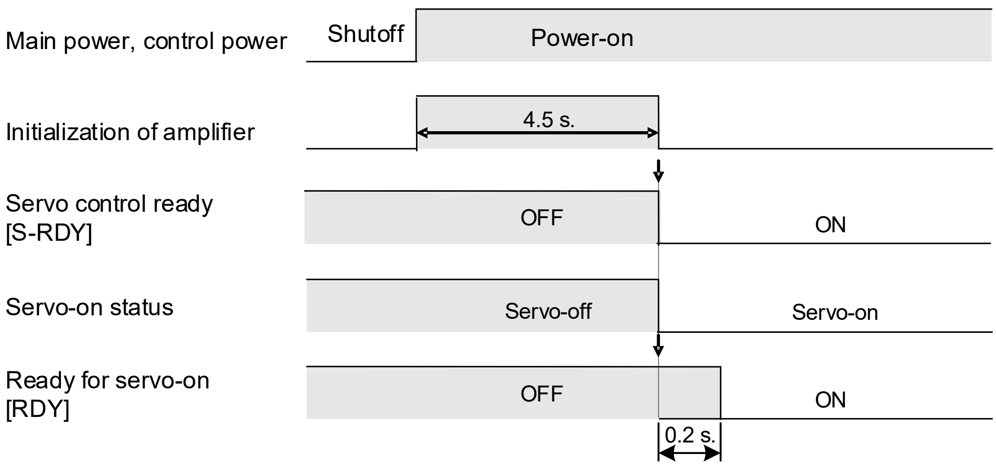
8

8.1 Timing Chart

8.1.1 Power-On Timing

■ If the motor power and control power are turned on simultaneously

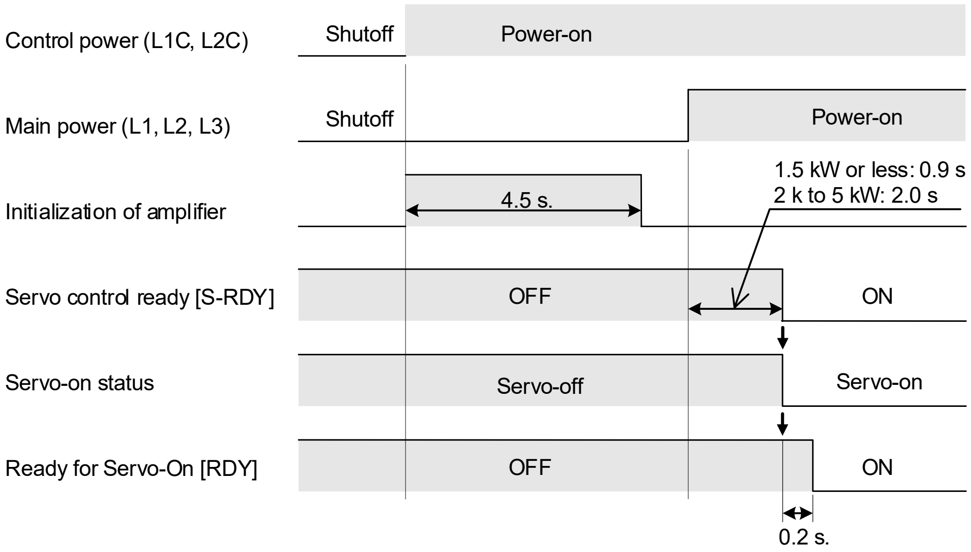
(1) After power-on, it takes about 4.5 seconds until initialization of the servo amplifier is finished. It may take 4.5 seconds or longer if using an option module. Refer to the option module manual.
(2) Completion of initialization is indicated by activation of servo control ready [S-RDY].
(3) Turn the servo on after checking (2).
(4) After ready for servo-on [RDY] is turned on, the servo amplifier is ready to operate.



8

■ If the control power is turned on first

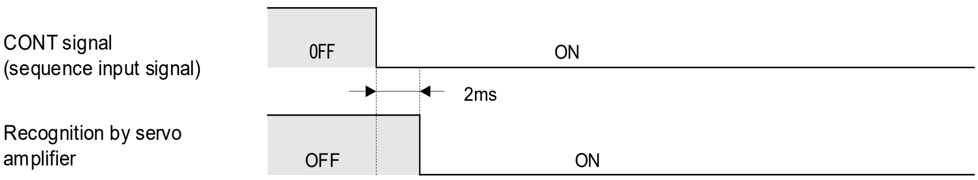
(1) It takes about 4.5 seconds until initialization of the servo amplifier is finished since the control power is turned on.
(2) Completion of initialization is indicated by activation of the servo control ready [S-RDY] signal after power-on.
(3) Turn on the power supply to turn the servo on after checking (2).
(4) After ready for servo-on [RDY] is turned on, the servo amplifier is ready to operate.



8.1.2 Each Signal Timing

■ Sequence input signal response time

The response time from sequence signal activation to signal recognition inside the servo amplifier is 2 [ms]. Leave the sequence input signal turned on for at 1 [ms] or more.

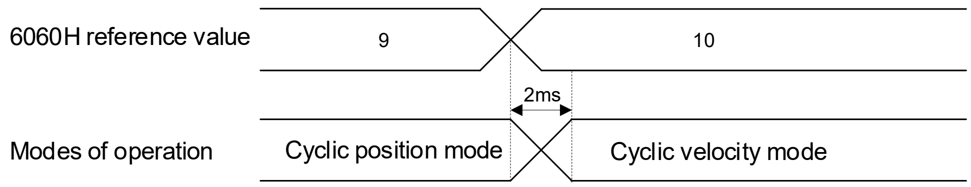


8.1.3 Control Mode Selection Timing

Transition time for each control mode is 2 [ms].

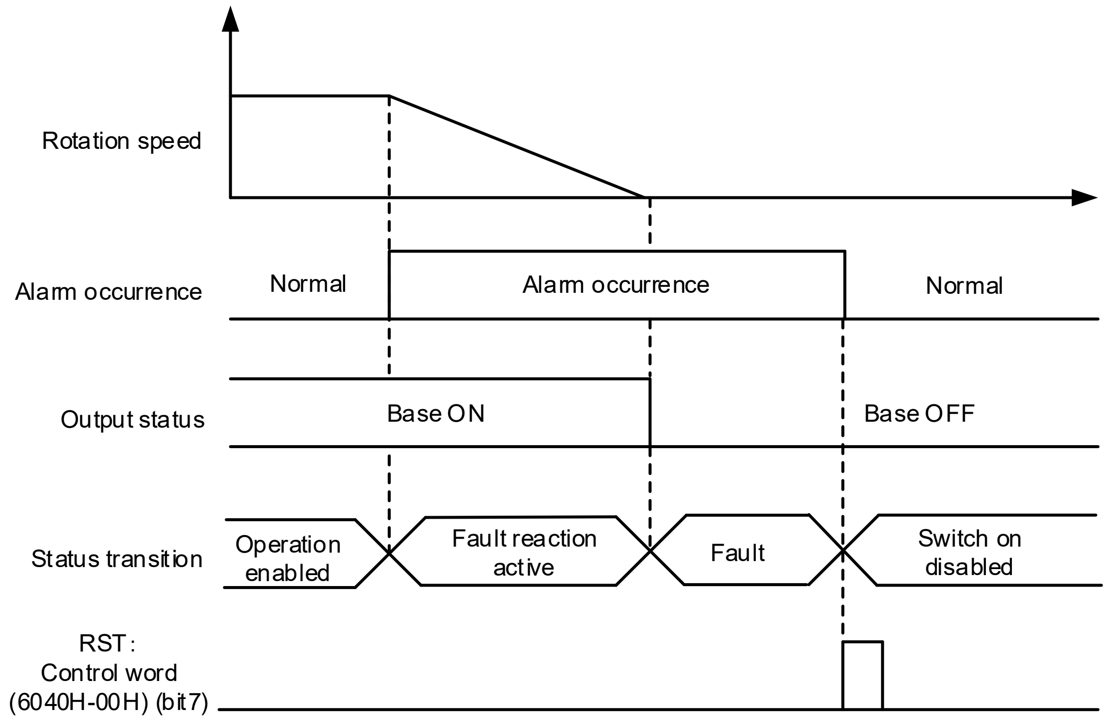
After issuing a selection signal, wait for 2 [ms] or more before issuing next commands.

[Example] Switching from position control to speed control



8.1.4 Alarm Reset Timing

The alarm reset timing chart is shown below.

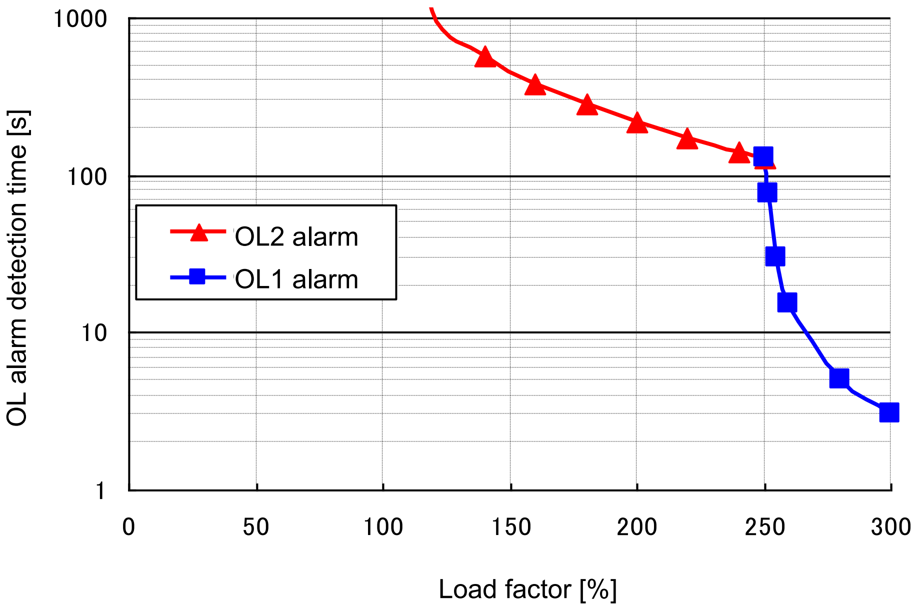


8.2 Overload Characteristic

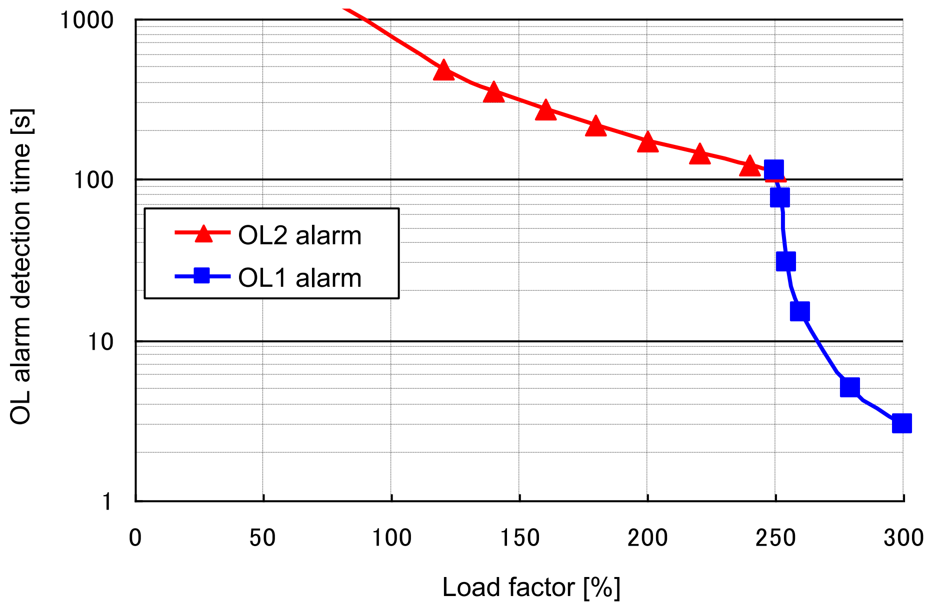
The detection time and load factor characteristics until an overload alarm (OL1/OL2) occurs are indicated by rotation speed.

8.2.1 GYS Motor

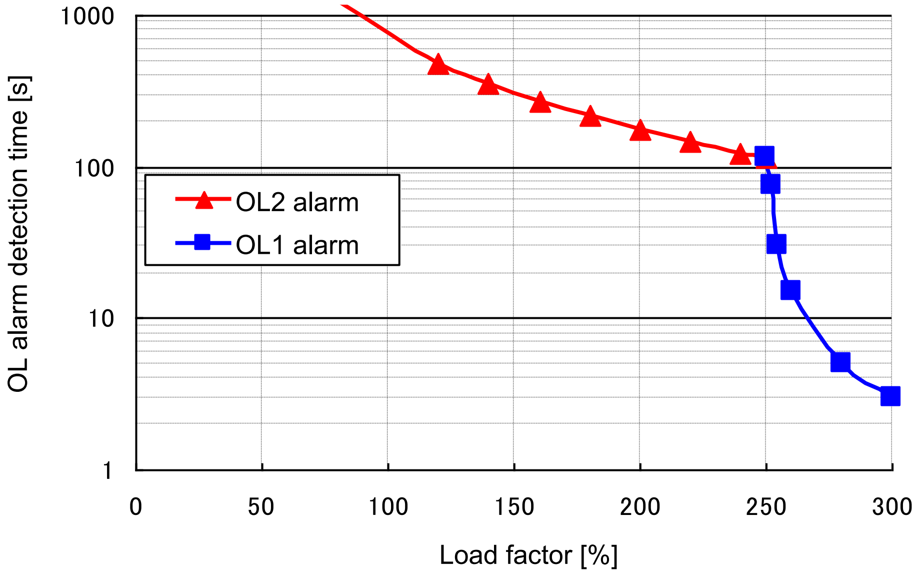
(1) In case of operation at rated rotation speed (3000 [r/min])



(2) In case of operation at maximum rotation speed (6000 [r/min])



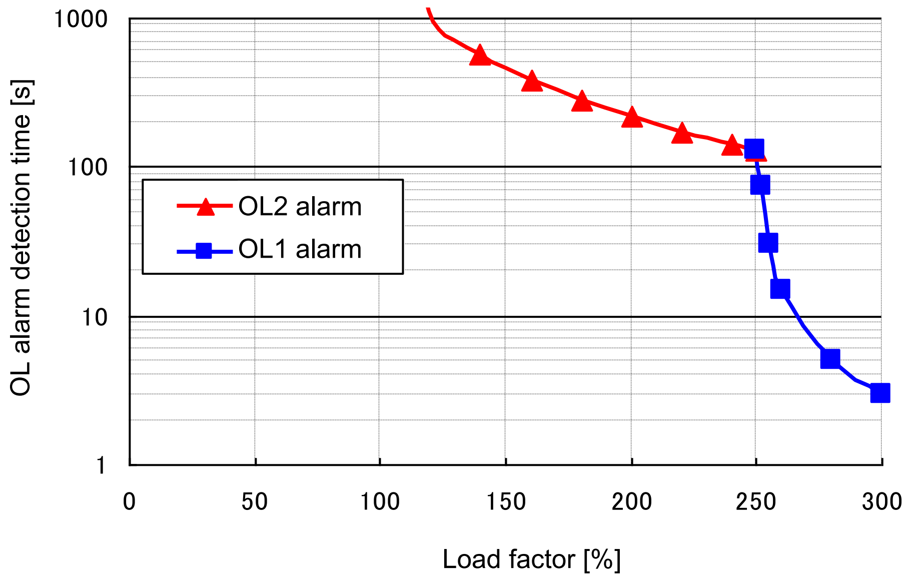
(3) In case of operation at max. rotation speed (5000 [r/min])
Target capacity: 1.0 [kW]



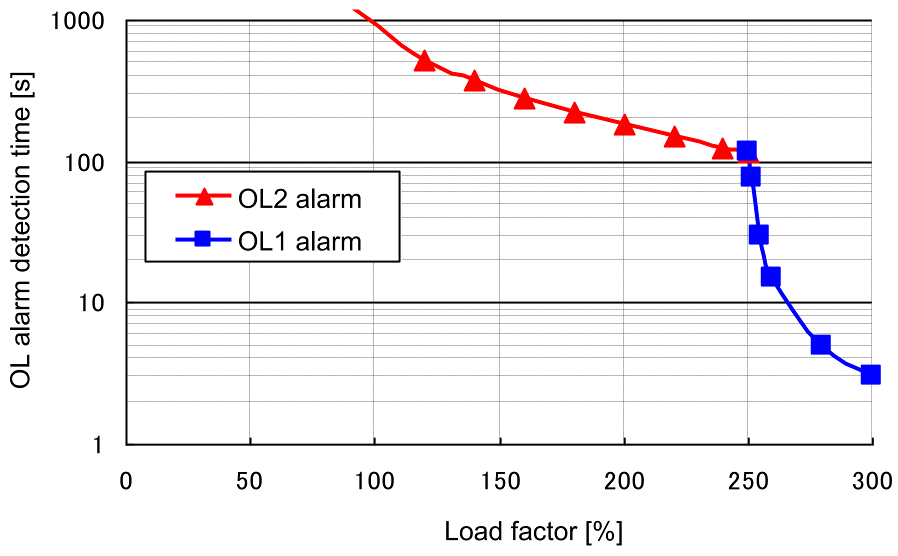
8

8.2.2 GYG Motor

(1) In case of operation at rated rotation speed (1500/2000 [r/min])

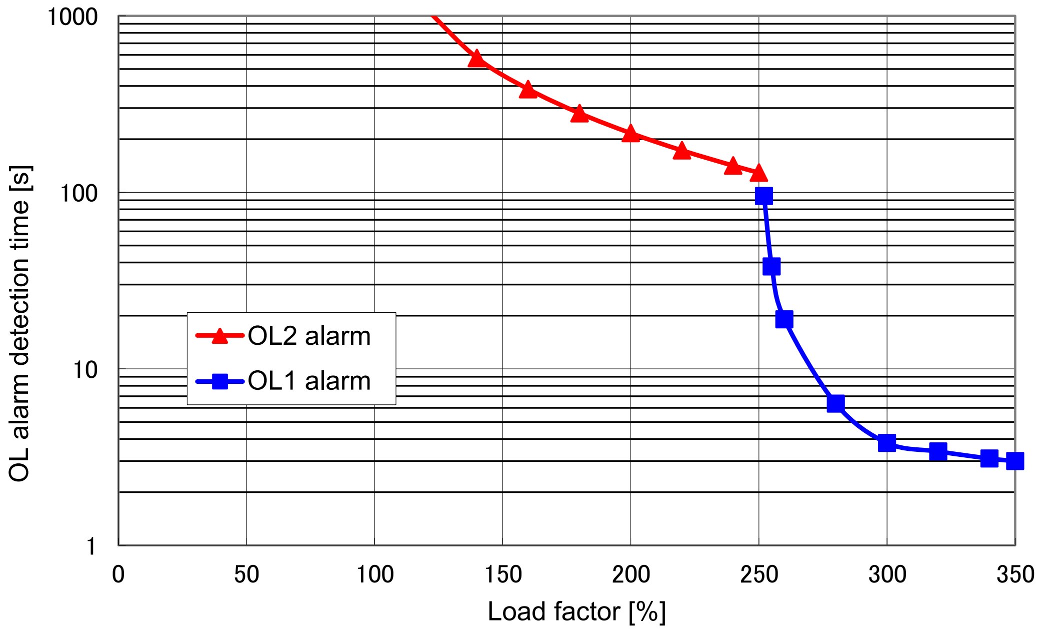


(2) In case of operation at max. rotation speed (3000 [r/min])

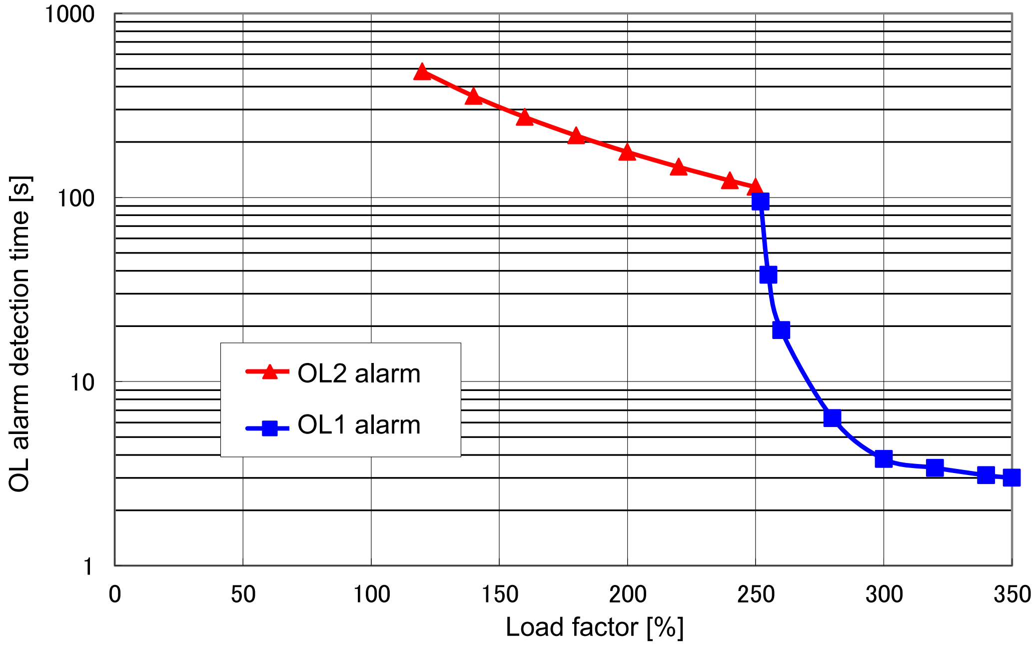


8.2.3 GYB Motor

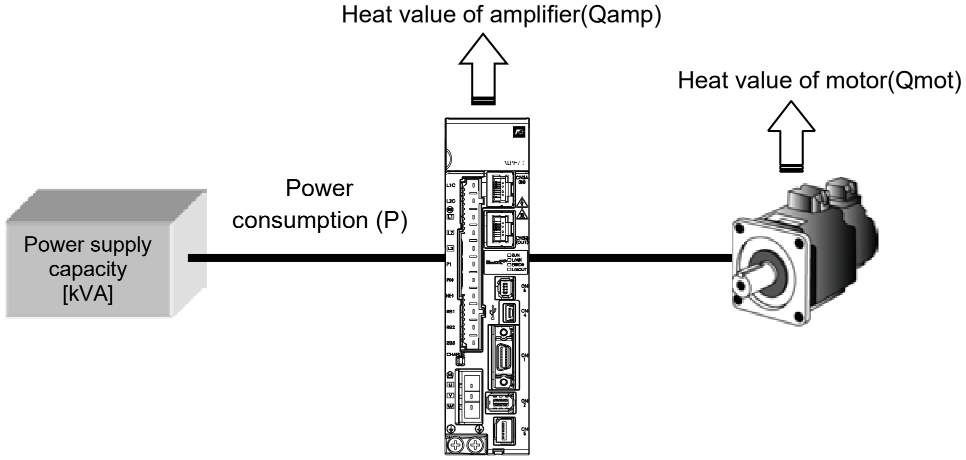
(1) 3000 [r/min] or less



(2) 6000 [r/min] or less



8.3 Power Supply Capacity and Generated Loss



Rated rotation speed	Servo amplifier model	Servomotor model	Capacity [kW]	Power supply capacity [kVA]	Power consumption (P) [kW]	Heat value of amplifier (Qamp) [kW]	Heat value of motor (Qmot) [kW]
3000 [r/min]	RYT500F7-VC2	GY□500D7-□□2	0.05	0.1	0.074	0.018	0.006
	RYT101F7-VC2	GY□101D7-□□2	0.1	0.2	0.13	0.021	0.011
	RYT201F7-VC2	GY□201D7-□□2	0.2	0.4	0.25	0.027	0.022
	RYT401F7-VC2	GY□401D7-□□2	0.4	0.8	0.48	0.038	0.044
	RYT751F7-VC2	GY□751D7-□□2	0.75	1.5	0.89	0.059	0.083
	RYT102F7-VC2	GY□102D7-□□2	1.0	2.0	1.2	0.073	0.11
	RYT152F7-VC2	GY□152D7-□□2	1.5	2.9	1.8	0.103	0.17
	RYT202F7-VC2	GY□202D7-□□2	2	3.9	2.4	0.13	0.22
	RYT302F7-VC2	GY□302D7-□□2	3	5.9	3.5	0.19	0.33
	RYT402F7-VC2	GY□402D7-□□2	4	7.8	4.7	0.25	0.44
	RYT502F7-VC2	GY□502D7-□□2	5	9.8	5.9	0.31	0.56
2000 [r/min]	RYT102F7-VC2	GY□102C7-□□2	1.0	2.0	1.20	0.073	0.11
	RYT202F7-VC2	GY□152C7-□□2	1.5	2.9	1.8	0.103	0.17
1500 [r/min]	RYT102F7-VC2	GY□851B7-□□2	0.85	1.7	1.00	0.065	0.094
	RYT202F7-VC2	GY□132B7-□□2	1.3	2.6	1.50	0.091	0.140

8.4　Inrush Current

The allowable inrush current of the servo amplifier is specified below.

Servo amplifier model	Inrush current [A]
RYT500F7-VC2	5.1
RYT101F7-VC2	
RYT201F7-VC2	
RYT401F7-VC2	
RYT751F7-VC2	
RYT102F7-VC2	
RYT152F7-VC2	
RYT202F7-VC2	23.6
RYT302F7-VC2	
RYT402F7-VC2	47.1
RYT502F7-VC2	

8

・Input voltage = 200 [V] AC

・The inrush current indicates the maximum peak current.

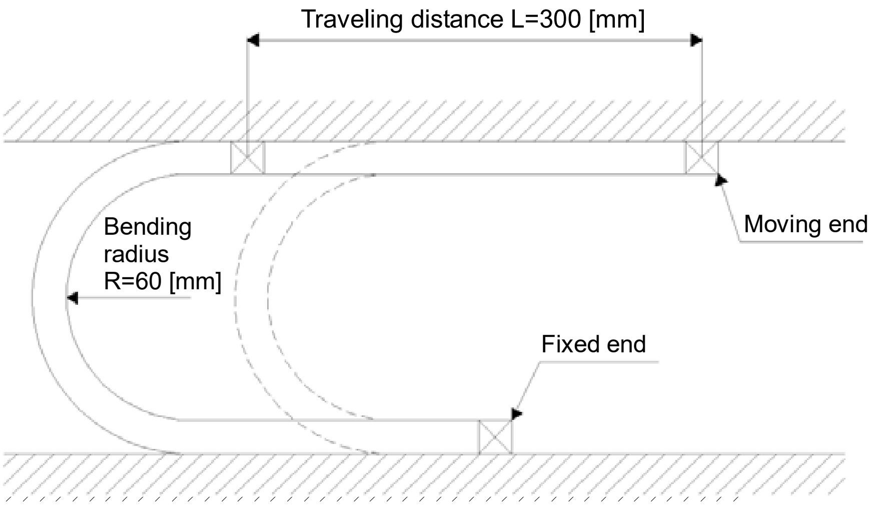
8.5 Bending Strength of Cable

If using an option cable (for motor power wiring/encoder wiring/brake wiring) provided by Fuji at recommended bend radius R=60 [mm] or higher, the bend life will be 5 millions times or greater under the following test conditions.

<Testing conditions>

(1) Use testing apparatus shown in the figure below to cause the cable to be bent in a traveling distance L = 300 [mm].

(2) Count each reciprocal test cycle. Count the bending frequency until conductors are broken.

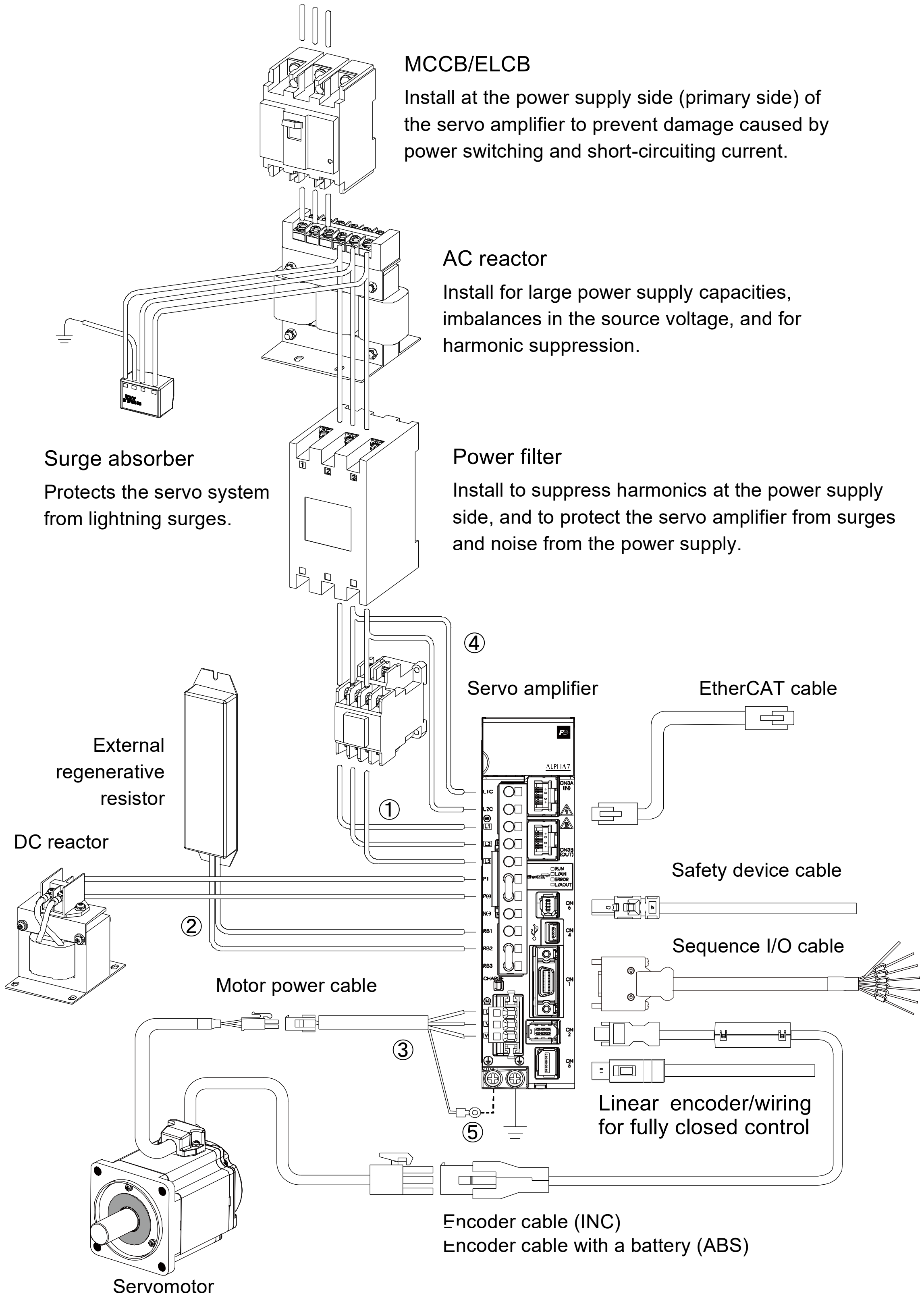


Note	The cable life depends largely on the handling method. The bending life is a reference value for the testing conditions specified above.

CHAPTER 9 PERIPHERAL EQUIPMENT

9

9.1 Overall Configuration of Peripheral Equipment



Recommended cable sizes for cables (1) to (5) above are listed in "9.2.1 Main Circuit Section Cable Size".

9.2 Cable Size

■ Main circuit section

600V class 2 vinyl cable, or 600V polyethylene insulated cable (HIV cable)

When compared with the IV cable, the cable size is smaller and the cable is superior in flexibility and the maximum allowable temperature as an insulated cable is as high as 75 [°C]. Therefore this cable is used both for the main circuit and for the control circuit.

However, if the cable is used for the control circuit, the wiring distance must be short and the cable must be twisted.

600V cross linked polyethylene insulated cable (CV cable)

Mainly used for the main circuit and grounding circuit. When compared with the IV and HIV cables, the cable size is smaller and the cable is superior in flexibility. Due to these features, the cable is used for higher ambient temperatures (50 [°C], etc.), reduced cable space, improved actuation efficiency, etc. The maximum allowable temperature as an insulated cable is 90 [°C].

[Example]: BOARDLEX made by FURUKAWA ELECTRIC

■ Control circuit section

Twisted shielded cable for electronic and electric devices

Used for control circuits. Use this cable for applications susceptible to (potential) radiant noise and inductive noise. The cable has a large shielding effect. Even inside panels, use this cable without fail if the wiring distance is long.

[Example]: BEAMEX S shielded cable XEBV or XEWV made by FURUKAWA ELECTRIC

■ Encoder section

The encoder cable of the servomotor is a composite 2C (cable), 2P (pair) shielded cable housing different cable sizes shown below.

Cross linked polyethylene vinyl sheath cable for robot travel (composite cable) (DAIDEN Co., Ltd.)

Wiring length ≤ 10 [m]: RMCV-SB (UL2464) AWG#25/2P + AWG#23/2C

10 [m] < wiring length ≤ 50 [m]: RMCV-SB (UL2464) AWG#25/2P + AWG#17/2C

Please inquire regarding GYB model connector connection specification/GYG model.

9.2.1 Main Circuit Section Cable Size

The following cable sizes are recommended for parts (1), (2), (3), (4) and (5) specified “9.1 Overall Configuration of Peripheral Equipment”.

■ Single-phase 200V

Servo amplifier capacity [W]	Recommended cable size [mm²]				
	(1) Power supply (L1,L2,L3) (3) Motor power (U,V,W) (5) Earthing (E)		(2) Braking resistor (RB1, RB2, RB3)		(4) Control power (L1C,L2C)
	75 [°C] (HIV)	90 [°C] (CV)	75 [°C] (HIV)	90 [°C] (CV)	Common
50 to 750	1.25	0.75	1.25	1.25	0.75

■ 3-phase 200V

<table>
<tr><th rowspan="3">Servo amplifier capacity [W]</th><th colspan="5">Recommended cable size [mm²]</th></tr>
<tr><th colspan="2">(1) Power supply (L1,L2,L3)
(3) Motor power (U,V,W)
(5) Earthing (E)</th><th colspan="2">(2) Braking resistor (RB1, RB2, RB3)</th><th>(4) Control power (L1C,L2C)</th></tr>
<tr><th>75 [°C] (HIV)</th><th>90 [°C] (CV)</th><th>75 [°C] (HIV)</th><th>90 [°C] (CV)</th><th>Common</th></tr>
<tr><td>50 to 1000</td><td>1.25</td><td rowspan="3">0.75</td><td rowspan="6">1.25</td><td rowspan="6">1.25</td><td rowspan="6">0.75</td></tr>
<tr><td>1500</td><td rowspan="3">2.0</td></tr>
<tr><td>2000</td></tr>
<tr><td>3000</td><td>1.25</td></tr>
<tr><td>4000</td><td rowspan="2">3.5</td><td>2.0</td></tr>
<tr><td>5000</td><td>3.5</td></tr>
</table>

If the servo system requires to fit the overseas standard, use the following cable size.
(Cable: 75 [°C] (HIV))

<Power supply and motor power>
(1) 1kW or less = 1.25mm²
(2) 1.5kW = 2.0mm²
(3) 2.0, 3.0kW＝5.5mm²
(4) 4.0, 5.0kW＝8.0mm²

9.2.2 Encoder Cable

Use the specified shielded wire for the servomotor encoder wiring.

The optional cable for the servomotor is a UL-rated cable having bend resistance.

Use a regular twisted pair batch shield cable if the servomotor and cable do not move.

■ Shield cables (twisted pair type)

- GYS model/GYB model lead wire specification
  30V 80°C UL VW-1 AWG#25/2P + AWG#22/2C or AWG#23/3P shielded cable
  (For wiring length of 10 [m] or shorter)
  30V 80°C UL VW-1 AWG#25/2P + AWG#17/2C shielded cable or equivalent
  (For wiring length > 10 [m] ≤ 50 [m])
- GYB model connector connection specification/GYG model
  30V 80°C UL VW-1 AWG#24/2P + AWG#22/2C shielded cable or equivalent
  (For wiring length of 10 [m] or shorter)
  Please contact Fuji if using wiring of length 10 [m] to 50 [m].

The relationship between AWG and mm is shown below.

Gauge		SI unit		Inch unit	
A.W.G	In [mm^2]	Diameter [mm]	Cross section [mm^2]	Diameter [mil]	Cross section [CM]
16	1.25	1.291	1.309	50.82	2583
17	-	1.150	1.037	45.26	2048
18	-	1.024	0.8226	40.30	1624
19	-	0.9116	0.6529	35.89	1288
20	-	0.8118	0.5174	31.96	1021
21	-	0.7299	0.4105	28.46	810.0
22	-	0.6438	0.3256	25.35	642.6
23	-	0.5733	0.2518	22.57	509.4
24	-	0.5106	0.2024	20.10	404.0
25	-	0.4547	0.1623	17.90	320.4

9.2.3 How to Calculate the Servo Amplifier Input Current

Calculate the servo amplifier input current in the following equation to select peripheral equipment.

Formula

Input current (single-phase 200 [V]): $I_{in} = (P_o + P_i) / (V_{ac} \times 1.35 \times \eta_{amp} \times \eta_{mot}) \times 1.27 \times \sqrt{3}$

Input current (3-phase 200 [V]): $I_{in} = (P_o + P_i) / (V_{ac} \times 1.35 \times \eta_{amp} \times \eta_{mot}) \times 1.27$

η_{amp} (amplifier efficiency) = 0.95 and η_{mot} (motor efficiency) = 0.90 are common among all models.

■ In case of single-phase 200V

Servo amplifier capacity (Po) [W]	Input voltage (Vac) [V]	Internal power consumption (Pi) [W]	Input current (Iin) [A]	Input current for selection of peripheral equipment (Iin×1.5) [A]
50	190*	15	0.7	1.0
100			1.2	1.7
200			2.2	3.2
400			4.2	6.2
750			7.7	11.5

*-5% of 200V

■ In case of 3-phase 200V

Servo amplifier capacity (Po) [W]	Input voltage (Vac) [V]	Internal power consumption (Pi) [W]	Input current (Iin) [A]	Input current for selection of peripheral equipment (Iin×1.5) [A]
50	170*	15	0.4	0.6
100			0.7	1.1
200			1.4	2.1
400			2.7	4.0
750			5.0	7.4
1000			6.6	9.8
1500			9.8	14.7
2000			13.0	19.5
3000			19.5	29.3
4000			26.0	39.0
5000			32.5	48.8

*-15% of 200V

9.2.4 Conditions for Selecting Peripheral Equipment of Servo Amplifier

■ To select peripheral equipment for a single servo amplifier

Obtain "1.5 times" the input current (Iin) obtained above.

■ To select peripheral equipment for two or more servo amplifiers

Multiply "1.5 times" the sum of the input currents (Iin) of all servo amplifiers.

[Example] In case of two 200 [W] units and three 400 [W] units (In case of 3-phase 200V)

$I = \{(1.4 \times 2) + (2.7 \times 3)\} \times 1.5 = 16.35$ [A]

Select peripheral equipment having 16.35 [A] or a larger rated current.

9

9.3 MCCB/ELCB (Molded Case Circuit Breaker/Earth Leakage Breaker)

Install MCCB (molded case circuit breaker) or ELCB (earth leakage breaker) in the primary circuit (power supply circuit) of the servo amplifier to protect the servo amplifier against losses caused by the power switching current and short circuit current. Models for a single servo amplifier are described here. Because the servo amplifier is provided with protective functions against output circuits such as the overcurrent, protective devices such as the thermal relay are unnecessary.

Model of molded case circuit breaker and earth leakage breaker

■ In case of single-phase 200V

Servo amplifier capacity [kW]	MCCB	ELCB (Sensed current: 30mA)
0.05	BW32AAG-2P003	EW32AAG-2P003
0.1		
0.2	BW32AAG-2P005	EW32AAG-2P005
0.4	BW32AAG-2P010	EW32AAG-2P010
0.75	BW32AAG-2P015	EW32AAG-2P015

■ In case of 3-phase 200V

Servo amplifier capacity [kW]	MCCB	ELCB (Sensed current: 30mA)
0.05	BW32AAG-3P003	EW32AAG-3P003
0.1		
0.2		
0.4	BW32AAG-3P005	EW32AAG-3P005
0.75	BW32AAG-3P010	EW32AAG-3P010
1.0	BW32AAG-3P015	EW32AAG-3P015
1.5	BW32AAG-3P020	EW32AAG-3P020
2	BW32AAG-3P030	EW32AAG-3P030
3	BW50AAG-3P040	EW50AAG-3P040
4	BW50AAG-3P050	EW50AAG-3P050
5		

9.4 Electromagnetic Contactor

Connect the electromagnetic contactor to disconnect the servo amplifier from the power supply with an external signal or to turn the power on or off from a remote operation panel.
The model is to turn the primary circuit of a single servo amplifier of 500 [kVA] or less power capacities with the designated cable size and 20 [m] or less wiring length.
If the power supply capacity exceeds 500 [kVA], connect an AC reactor.

Model of electromagnetic contactor

■ In case of single-phase 200V

Servo amplifier capacity [kW]	MC
0.05	SC-03
0.1	
0.2	
0.4	
0.75	SC-0

■ In case of 3-phase 200V

Servo amplifier capacity [kW]	MC
0.05	SC-03
0.1	
0.2	
0.4	
0.75	
1.0	
1.5	SC-4-1
2.0	
3.0	SC-N1
4.0	SC-N2
5.0	

9.5 Surge Absorber

■ For protection from lightning surge

Install a surge absorber to protect servo system from the surge approaching from the power line (induced lightning surge).

Serge absorber absorbs lightning surge, preventing malfunction or damage of a servo system.

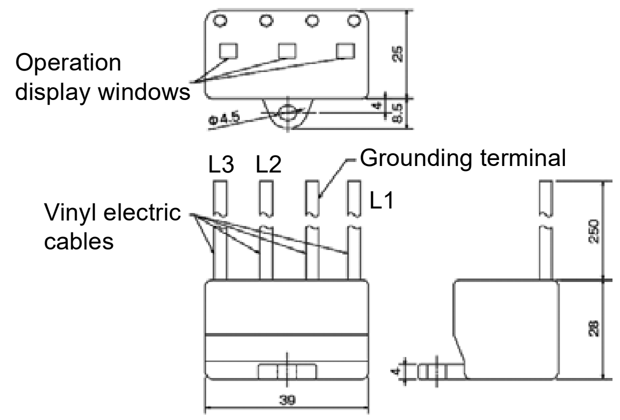
Recommendation [Soshin Electric product]

Single phase: LT-C12G801WS *

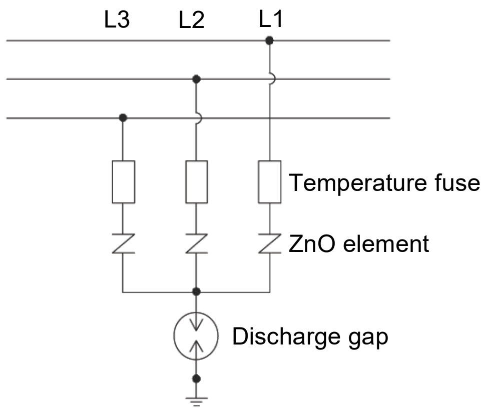
Three-phase: LT-C32G801WS

* The product for single phase has no L2 terminals.

<External dimensions>



<Internal connection diagram>

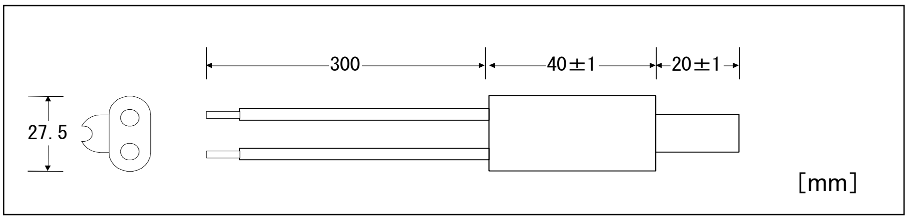


■ For protection from open/close surge of peripheral equipment

To install a surge absorber to peripheral equipment (electromagnetic contactor, solenoid, electromagnetic brake, etc.) of the servo amplifier, use the following one.
When an inductive load such as the clutch and solenoid is turned off, a counter electromotive force of several hundreds or several thousands of volts [V] is generated. The surge absorber suppresses the surge voltage.
For DC devices, install a diode to suppress the surge voltage.

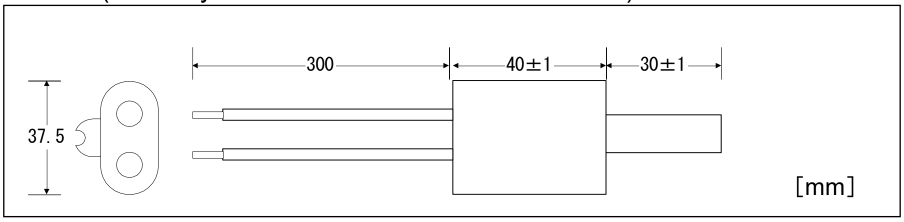
Control relay, etc.

Model: S1-B-0 (made by OKAYA ELECTRIC INDUSTRIES)



Electromagnetic contactor, etc.

Model: S2-A-0 (made by OKAYA ELECTRIC INDUSTRIES)

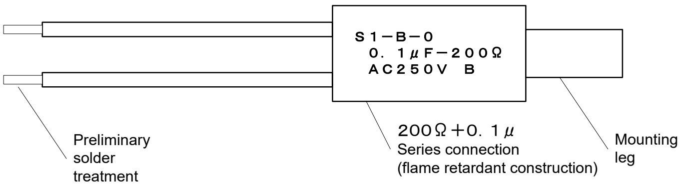


Applicable to 250 [V] AC or less voltages

A non-inductive capacitor and a non-inductive resistor are connected in series and filled in epoxy resin.

S1-B-0: 200Ω (1/2 [W])+0.1 [μF]

S2-A-0: 500Ω (1/2 [W])+0.2 [μF]

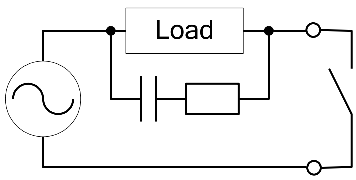


The purpose of the surge absorber is suppression of the surge voltage.

・Protection in AC circuit

C-R circuit

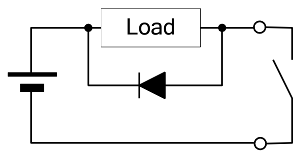
(Protection of the DC circuit is also provided.)



・Protection in DC circuit

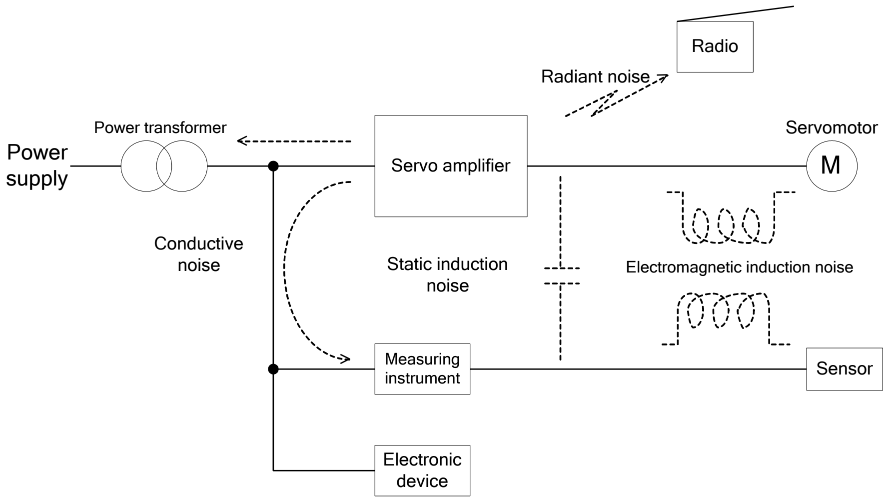
Diode

(Be aware of the orientation of the diode.)



9.6 Power Filter

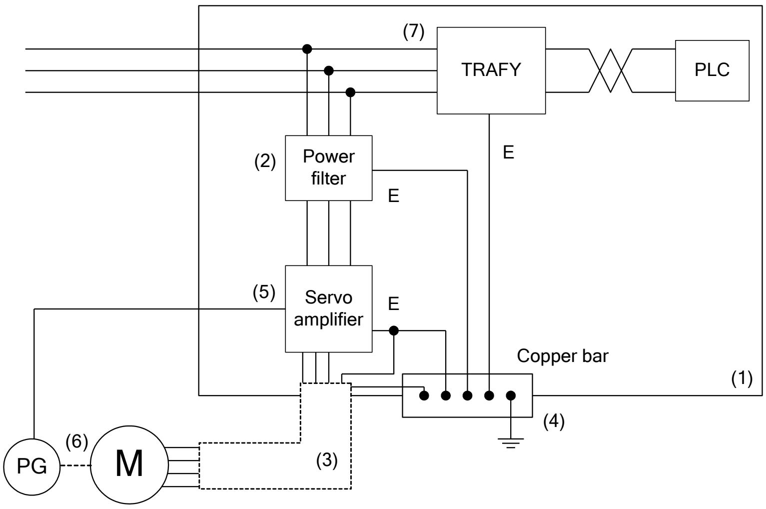
The servo amplifier performs high frequency switching under PWM control similarly to general-purpose inverters. Therefore radiant noise, conductive noise and so on may give effect on peripheral equipment.
The following method is effective as a countermeasure.



(1) House the servo amplifier in an iron (conductive) control panel and ground the control panel. Do not install a PC or measuring instrument nearby.
(2) If devices connected to the same power supply are affected, install a power filter in the primary circuit of the servo amplifier.
If devices in different power supplies are affected, install an obstruction wave preventive transformer (TRAFY).
(3) Route cables between the servo amplifier and servomotor in a conductive duct and ground the duct (multi-point grounding allowed).
(4) Use a grounding cable as thick and short as possible.
Connect the grounding cable directly from the copper bar to individual device (do not use a jumper cable). A twisted or net cable has a larger effect.
(5) Never connect the following signals.

Grounding terminal FG (Frame ground)	×	0 [V] of +24 [V] DC power supply for sequence I/O	×	0 [V] of encoder power supply

(6) Do not tie the main circuit cable and control circuit cable together. Do not route these cables in parallel.
Main circuit: Commercial power supply, motor power cable between servo amplifier and servomotor
Control circuit: +24 [V] DC or less voltage signal cable
Servomotor encoder cable
(7) Use an obstruction wave preventive transformer (TRAFY) to connect 100 [V] devices (such as the programmable logic controller and general-purpose PC) to the 200 [V] power supply.



Numbers (1), (2), ... in the figure indicate the paragraph number given on the previous page.

Power filter model

■ In case of single-phase 200V

Servo amplifier capacity [kW]	Power filter
0.05	RNFTD06-20
0.1	
0.2	
0.4	RNFTD10-20
0.75	RNFTD20-20

■ In case of 3-phase 200V

Servo amplifier capacity [kW]	Power filter
0.05	RNFTC06-20
0.1	
0.2	
0.4	
0.75	RNFTC10-20
1.0	
1.5	RNFTC20-20
2.0	
3.0	RNFTC30-20
4.0	RNFTC50-20
5.0	

The purpose of the power filter is suppression of high frequency voltage fluctuation caused by the servo amplifier in the commercial power supply.

Because the filter effect is bi-directional, the servo amplifier is also protected against high frequency voltage fluctuation in the power supply.

9.7 AC/DC Reactor

Connect an AC or DC reactor in following cases.

(1) Large power supply capacity
With power supply capacities exceeding 500 [kVA], the power-on input current fed to the servo amplifier may become too large and cause damage to the internal rectifying diode.
(The power supply capacity depends on the 20 [m] wiring length and the designated cable size.)

(2) Imbalance in source voltage
If there is imbalance in the source voltage, the current gathers to the phase of a higher voltage. Connect the AC reactor if the ratio of voltage imbalance is 3 [%] or above.

$$\text{(Ratio of power supply imbalance)} = \frac{\text{(Max. voltage [V]) - (Min. voltage [V])}}{\text{(Average voltage of three phases [V])}} \times 100$$

Insert an AC reactor to balance the input current among phases. The AC reactor also provides protection against loss of source voltage or similar hazards.

(3) Suppression of harmonics
The servo amplifier generates harmonics currents because it is a capacitor input type. The AC reactor suppresses current distortion in the power supply system, protecting devices in the same system against damage. Imbalance in the source voltage increases harmonics currents. Insert an AC reactor in the primary circuit of the servo amplifier. Heat generation is caused with types of a small rated conductive current, and the suppression effect is reduced with types of a large rated conductive current.

9

Model of AC/DC reactor

■ In case of single-phase 200V

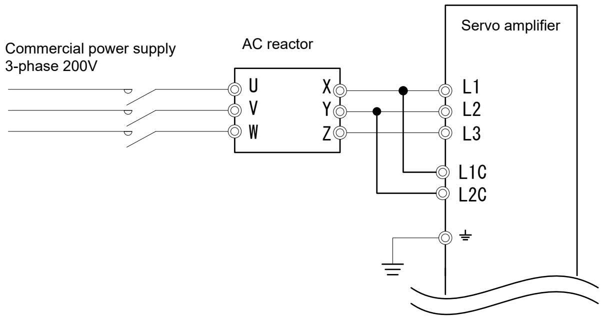
Servo amplifier capacity [kW]	AC reactor	DC reactor
0.05	ACR2-0.4A	DCR2-0.2
0.1		DCR2-0.4
0.2	ACR2-0.75A	DCR2-0.75
0.4	ACR2-1.5A	DCR2-1.5
0.75	ACR2-2.2A	DCR2-2.2

■ In case of 3-phase 200V

Servo amplifier capacity [kW]	AC reactor	DC reactor
0.05	ACR2-0.4A	DCR2-0.2
0.1		
0.2		DCR2-0.4
0.4	ACR2-0.75A	DCR2-0.75
0.75	ACR2-1.5A	DCR2-1.5
1.0	ACR2-2.2A	DCR2-2.2
1.5		
2.0	ACR2-3.7A	DCR2-3.7
3.0	ACR2-5.5A	DCR2-5.5
4.0	ACR2-7.5A	DCR2-7.5
5.0	ACR2-11A	DCR2-11

- How to connect the AC reactor

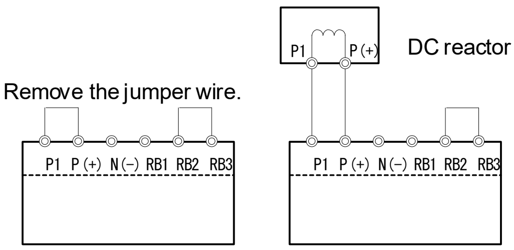
  Connect in the primary circuit of the servo amplifier as shown in the figure below.



Purpose of AC reactor
(1) Improvement of input power factor
(2) Protection against imbalance in voltage or similar
(3) Harmonics suppression
(4) Suppression of power supply capacity

- How to connect the DC reactor

  Disconnect the jumper wire from the P1 and P(+) terminals and connect the DC reactor.



Purpose of DC reactor
(1) Improvement of input power factor
(2) Protection against imbalance in voltage or similar
(3) Harmonics suppression
(4) Suppression of power supply capacity

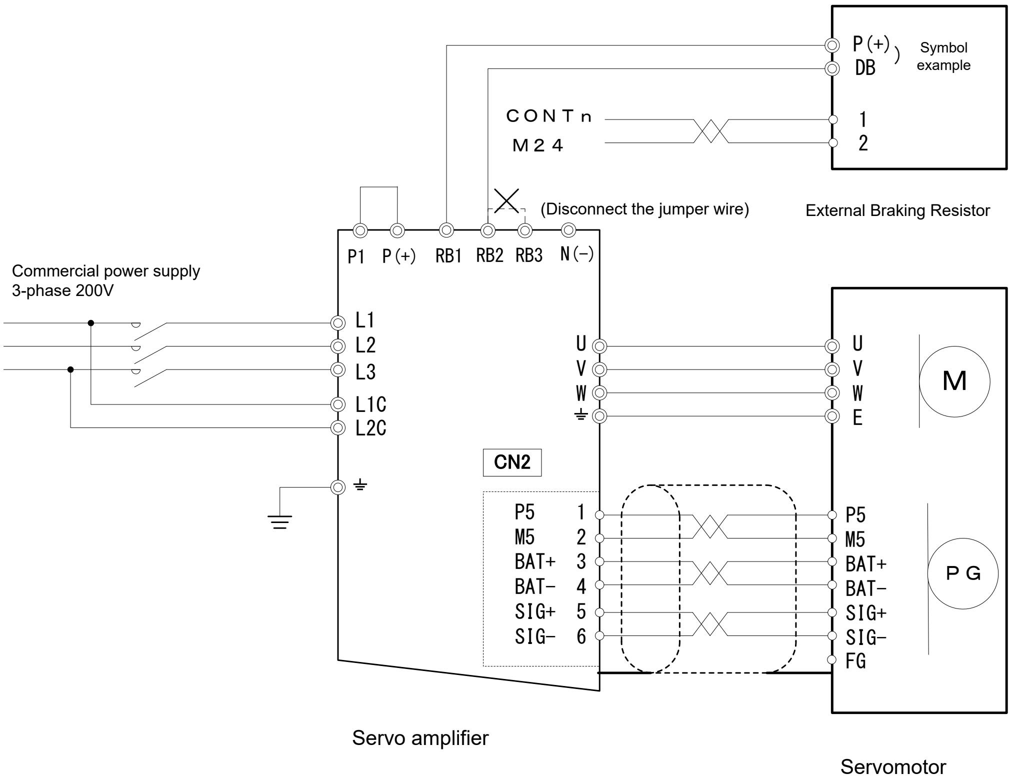
9.8 External Braking Resistor

The external braking resistor consumes regenerative power generated by the servomotor.
Use an external braking resistor if the elevating load is large and the operation frequency is high.

Servo amplifier model	Capacity [kW]	Built-in resistor*	External Braking Resistor	Applicable resistance [Ω]
RYT500F7-VC2	0.05	—	WSR-401 (68Ω,17W)	39 to 160
RYT101F7-VC2	0.1	—		
RYT201F7-VC2	0.2	—		
RYT401F7-VC2	0.4	8W/40Ω		39 to 80
RYT751F7-VC2	0.75	20W/15Ω	WSR-152 (15Ω, 50W)	15 to 40
RYT102F7-VC2	1.0			12 to 27
RYT152F7-VC2	1.5			
RYT202F7-VC2	2.0	30W/12Ω	DB11-2 (10Ω, 260W)	7.5 to 20
RYT302F7-VC2	3.0			7.5 to 13
RYT402F7-VC2	4.0	60W/6Ω	DB22-2 (5.8Ω, 300W)	3.9 to 8
RYT502F7-VC2	5.0			

* The allowable wattage of the built-in braking resistor varies according to the ambient temperature.

■ To connect the optional external braking resistor



To use an external braking resistor, wiring and parameter setting are necessary.

- Wiring of thermistor output of external braking resistor
  - Be sure to connect to the host device, turn on the thermistor, and turn off the servo amplifier main power.*
  - Allocate external braking resistor overheat (34) to a CONT input terminal.
- Parameter setting
  - Set PA2_65 (braking resistor selection) at 2 (external resistor).

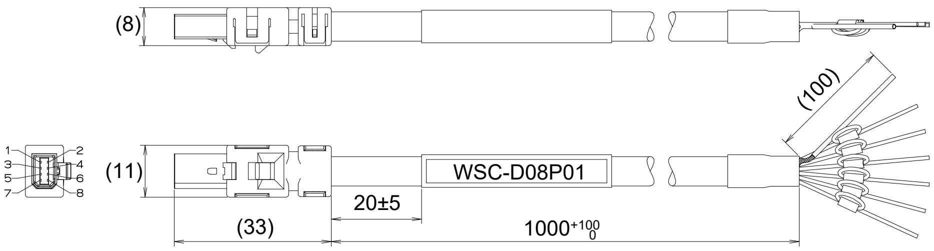
Note	* The external braking resistor will become excessively hot in the event of failure of the braking transistor, possibly causing fire.

9.9 Optional Equipment

Safety device connection cable

Model: WSC-D08P01

Application range: Common to all models (for CN6)



■ Model/manufacturer

Servo amplifier side connector

INDUSTRIAL MINI I/O D-SHAPE TYPE 1	2013595-1

TE Connectivity Corporation

Cable

CM/2464-1061/II A-SB LF	3P×26AWG

Taiyo Cabletec Corporation

9

■ Wire color

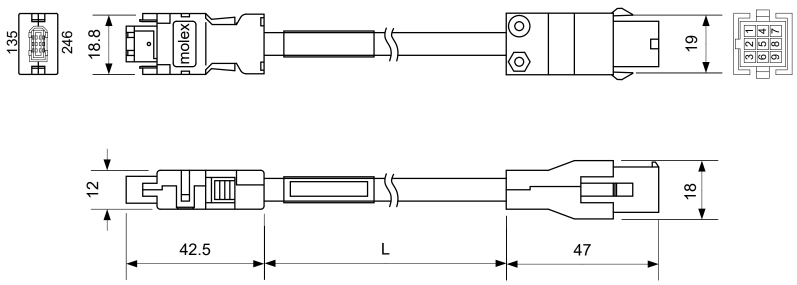
Pin No.	1	2	3	4	5	6	7	8	Case (shield)
Insulator color	-	-	White	White	Light gray	Light gray	Orange	Orange	Black (protective tube)
Dot mark color	-	-	Black	Red	Black	Red	Black	Red	
Signal name	Not connected	Not connected	EN1-	EN1+	EN2-	EN2+	EDM-	EDM+	-

- The connector manufacturer may be changed without prior notice.
- Movable cables are used for cables.

Encoder cable (1)

Model: WSC-P06P02-E to WSC-P06P20-E

Applicable range: GYS/GYB (lead wire specification) model ..... 0.75 [kW] or less (for CN2)



■ Model/manufacturer

Servo amplifier side connector

Plug housing body	54180-0619
Plug shell cover	58299-0626
Plug shell body	58300-0626
Plug mold cover (A)	54181-0615
Plug mold cover (B)	54182-0605
Cable clamp	58303-0000
Clamp screw	59832-0009

Molex Japan LLC

Servomotor side connector

Cap housing	1-172332-9
Socket	170361-1
Cover (x 2)	316455-1
Screw (x 2)	M2.6 x 10
Nut (x 2)	M2.6

TE Connectivity Corporation

■ Wire color

Servo amplifier side		1	2	3	4	5	6	Shell
Servomotor side		7	8	1	2	5	4	3
Wire color	(1)	Red	Black	Orange	Orange/white	Blue/white	Blue	Shield
	(2)	White	Black	Yellow	Brown	Blue	Red	Shield
Signal name		P5	M5	BAT+	BAT-	SIG+	SIG-	FG

The wire color will be either (1) or (2).

■ Length

Model	L [mm]
WSC-P06P02-E	2000^{+200}_{0}
WSC-P06P05-E	5000^{+500}_{0}
WSC-P06P10-E	10000^{+1000}_{0}
WSC-P06P20-E	20000^{+2000}_{0}

- The connector manufacturer may be changed without prior notice.
- Movable cables are used for cables.

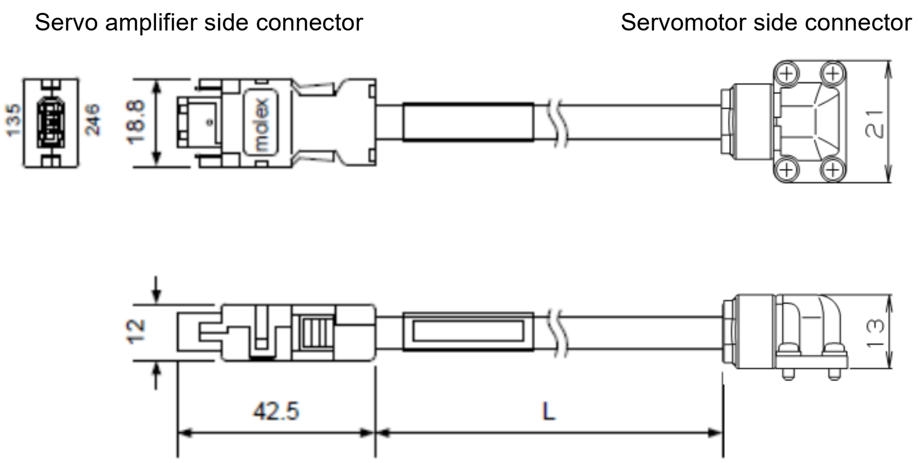
Caution

Connect two or more encoder cables, and do not extend the wiring distance.
A sudden stoppage may occur due to a voltage drop resulting from connector contact resistance.

Encoder cable (2)

Model: WSC-P06P02-K to WSC-P06P20-K

Application range: GYB (connector connection specification) model (for CN2)



■ Model/manufacturer

Servo amplifier side connector

Plug housing body	54180-0619
Plug shell cover	58299-0626
Plug shell body	58300-0626
Plug mold cover (A)	54181-0615
Plug mold cover (B)	54182-0605
Cable clamp	58303-0000
Clamp screw	59832-0009

Molex Japan LLC

Servomotor side connector

Plug	JN6FR07SM2
Contact	LY10-C1-A1-10000

Japan Aviation Electronics Industry, Limited

■ Wire color

Servo amplifier side	1	2	3	4	5	6	Shell
Servomotor side	6	3	5	2	4	7	-
Wire color	Red	Black	Orange	Orange/white	Blue/white	Blue	Shield
Signal name	P5	M5	BAT+	BAT-	SIG+	SIG-	FG

■ Length

Model	L [mm]
WSC-P06P02-K	2000^{+200}_{0}
WSC-P06P05-K	5000^{+500}_{0}
WSC-P06P10-K	10000^{+1000}_{0}
WSC-P06P20-K	20000^{+2000}_{0}

- The connector manufacturer may be changed without prior notice.
- Movable cables are used for cables.
- This cable is the type that leads out to the output shaft side.
  Please contact Fuji if leading the cable out to the side opposite the output shaft.

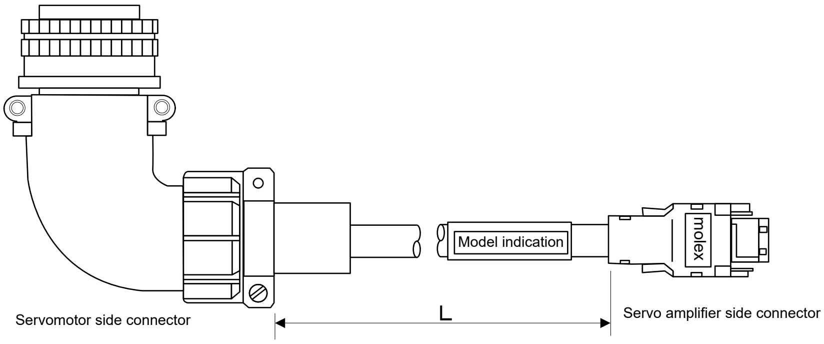
Caution

Connect two or more encoder cables, and do not extend the wiring distance.
A sudden stoppage may occur due to a voltage drop resulting from connector contact resistance.

Encoder cable (3)

Model: WSC-P06P05-C to WSC-P06P20-C

Application range: GYS model ..... 1.0 to 5.0 [kW] (for CN2)



■ Model/manufacturer

Servomotor side connector

L-type clamp	MS3108B20-29S
Cable clamp	MS3057-12A

DDK Ltd.

Servo amplifier side connector

Plug housing body	54180-0619
Plug shell cover	58299-0626
Plug shell body	58300-0626
Plug mold cover (A)	54181-0615
Plug mold cover (B)	54182-0605
Cable clamp	58303-0000
Clamp screw	59832-0009

Molex Japan LLC

■ Wire color

Servomotor side		H	G	T	S	C	D
Servo amplifier side		1	2	3	4	5	6
Wire color	(1)	Red	Black	Orange	Orange/white	Blue	Blue/white
	(2)	White	Black	Yellow	Brown	Red	Blue
Signal name		P5	M5	BAT+	BAT-	SIG+	SIG-

The wire color will be either (1) or (2).

■ Length

Model	L [mm]
WSC-P06P05-C	5000^{+500}_{0}
WSC-P06P10-C	$10000^{+1,000}_{0}$
WSC-P06P20-C	$20000^{+2,000}_{0}$

- The connector manufacturer may be changed without prior notice.
- Movable cables are used for cables.

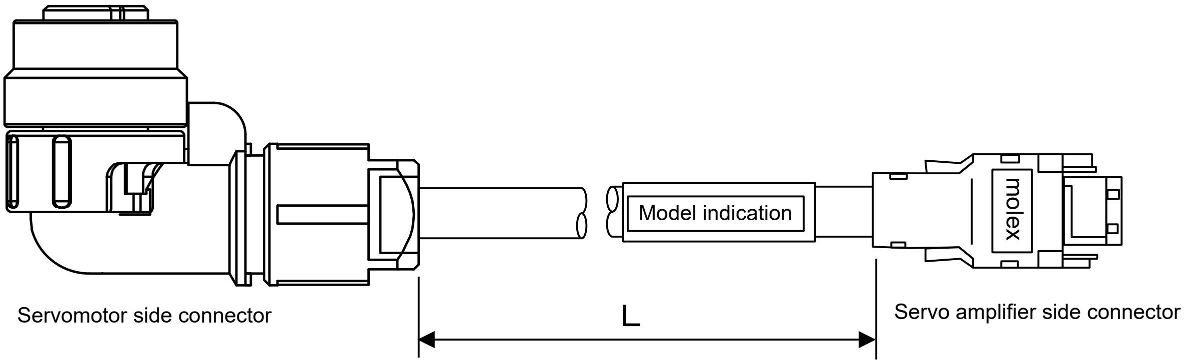
⚠ Caution

Connect two or more encoder cables, and do not extend the wiring distance.
A sudden stoppage may occur due to a voltage drop resulting from connector contact resistance.

Encoder cable (4)

Model: WSC-P06P05-J to WSC-P06P20-J

Application range: GYG model (for CN2)



■ Model/manufacturer

Servomotor side connector

Plug	JN2FS10SL1-R

Japan Aviation Electronics Industry, Limited

Servo amplifier side connector

Plug housing body	54180-0619
Plug shell cover	58299-0626
Plug shell body	58300-0626
Plug mold cover (A)	54181-0615
Plug mold cover (B)	54182-0605
Cable clamp	58303-0000
Clamp screw	59832-0009

Molex Japan LLC

■ Wire color

Servomotor side	6	7	8	9	2	1
Servo amplifier side	1	2	3	4	5	6
Wire color	Red	Black	Orange	Orange/white	Blue/white	Blue
Signal name	P5	M5	BAT+	BAT-	SIG+	SIG-

■ Length

Model	L [mm]
WSC-P06P05-J	5000^{+500}_{0}
WSC-P06P10-J	10000^{+1000}_{0}
WSC-P06P20-J	20000^{+2000}_{0}

- The connector manufacturer may be changed without prior notice.
- Movable cables are used for cables.

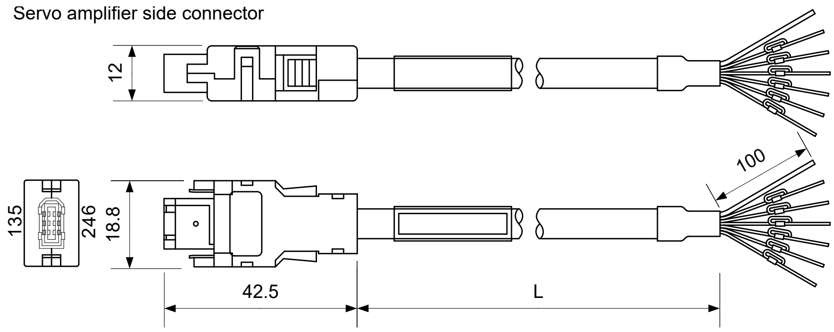
⚠ Caution

Connect two or more encoder cables, and do not extend the wiring distance.
A sudden stoppage may occur due to a voltage drop resulting from connector contact resistance.

Encoder cable (5)

Model: WSC-P06P05-W to WSC-P06P20-W

Application range: Common to all models (for CN2)



■ Model/manufacturer

Servo amplifier side connector

Plug housing body	54180-0619
Plug shell cover	58299-0626
Plug shell body	58300-0626
Plug mold cover (A)	54181-0615
Plug mold cover (B)	54182-0605
Cable clamp	58303-0000
Clamp screw	59832-0009

Molex Japan LLC

■ Wire color

Pin No.		1	2	3	4	5	6	Case
Wire color	(1)	Red	Black	Orange	Orange/ white	Blue	Blue/ white	Protective tube
	(2)	White	Black	Yellow	Brown	Red	Blue	
Signal name		P5	M5	BAT+	BAT-	SIG+	SIG-	-

The wire color will be either (1) or (2).

■ Length

Model	L [mm]
WSC-P06P05-W	5000^{+500}_{0}
WSC-P06P10-W	10000^{+1000}_{0}
WSC-P06P15-W	15000^{1500}_{0}
WSC-P06P20-W	20000^{+2000}_{0}

- The connector manufacturer may be changed without prior notice.
- Movable cables are used for cables.

⚠ Caution

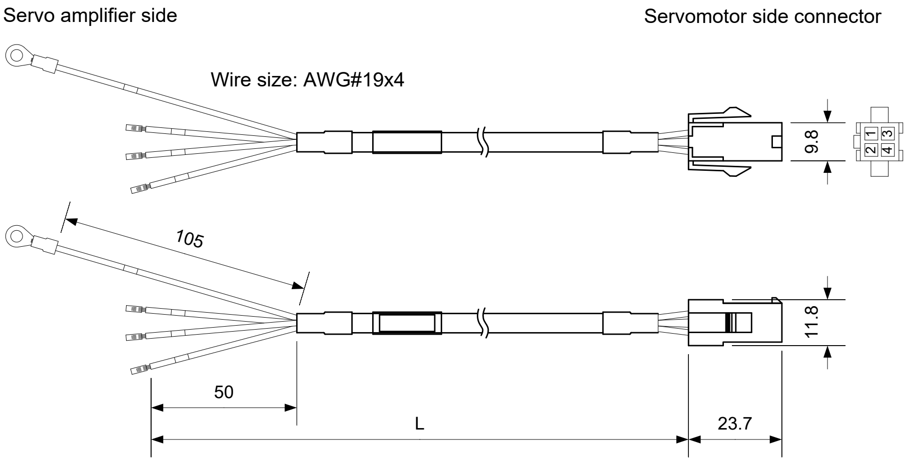
Connect two or more encoder cables, and do not extend the wiring distance.
A sudden stoppage may occur due to a voltage drop resulting from connector contact resistance.

9

Motor power cable (1)

Model: WSC-M04P02-E to WSC-M04P20-E

Applicable range: GYS/GYB (lead wire specification) model: 0.75 [kW] or less



■ Model/manufacturer

Servomotor side connector

Cap housing	172159-9
Socket	170362-1

TE Connectivity Corporation

■ Wire color

Servo amplifier side	U	V	W	E
Servomotor side	1	2	3	4
Wire color	Red	White	Black	Green/yellow
Signal name	U	V	W	E

■ Length

Model	L [mm]
WSC-M04P02-E	2000^{+200}_{0}
WSC-M04P05-E	5000^{+500}_{0}
WSC-M04P10-E	10000^{+1000}_{0}
WSC-M04P20-E	20000^{+2000}_{0}

- The connector manufacturer may be changed without prior notice.
- Movable cables are used for cables.

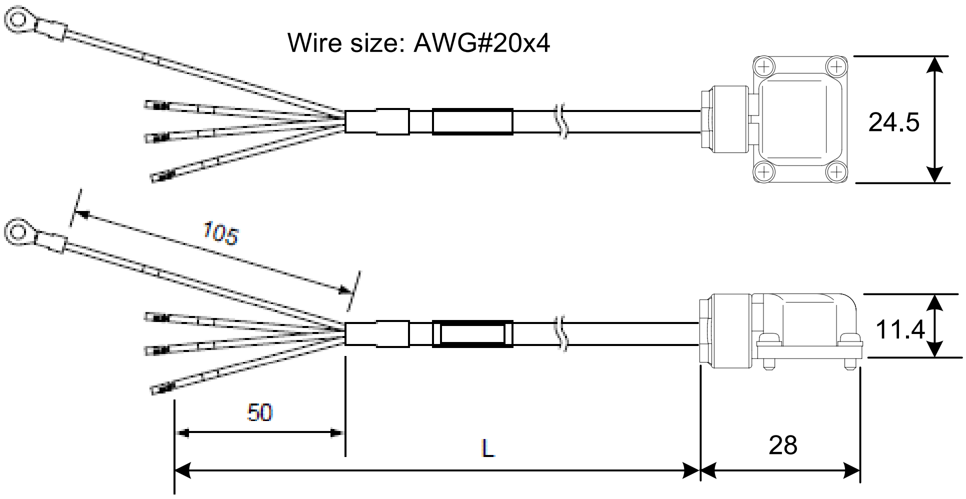
Motor power cable (2)

Model: WSC-M04P02-K to WSC-M04P20-K

Application range: GYB (connector connection specification) model

Servo amplifier side

Servomotor side connector



■ Model/manufacturer

Servomotor side connector

Plug	JN6FS04SJ2
Contact	ST-JN5-S-C1B-2500

Japan Aviation Electronics Industry, Limited

■ Wire color

Servo amplifier side	U	V	W	E
Servomotor side	4	3	2	1
Wire color	Red	White	Black	Green/yellow
Signal name	U	V	W	E

■ Length

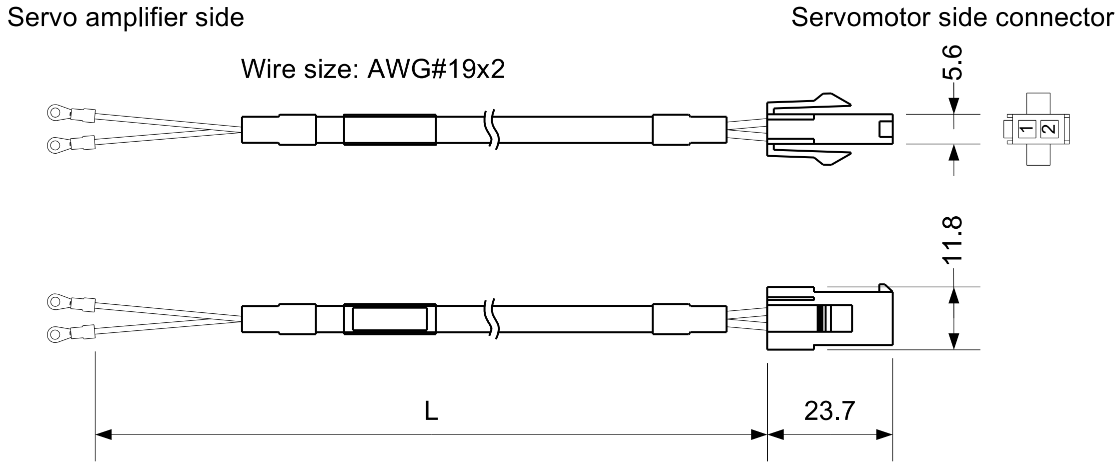
Model	L [mm]
WSC-M04P02-K	2000^{+200}_{0}
WSC-M04P05-K	5000^{+500}_{0}
WSC-M04P10-K	10000^{+1000}_{0}
WSC-M04P20-K	20000^{+2000}_{0}

- The connector manufacturer may be changed without prior notice.
- Movable cables are used for cables.
- This cable is the type that leads out to the output shaft side.
  Please contact Fuji if leading the cable out to the side opposite the output shaft.

Brake cable (1)

Model: WSC-M02P02-E to WSC-M02P20-E

Applicable range: GYS/GYB (lead wire specification) model ..... 0.75 [kW] or less (with brake)



■ Model/manufacturer

Servomotor side connector

Cap housing	172157-9
Socket	170362-1

TE Connectivity Corporation

■ Wire color

Servo amplifier side	-	-
Servomotor side	1	2
Wire color	Red	Black
Signal name	B	B

■ Length

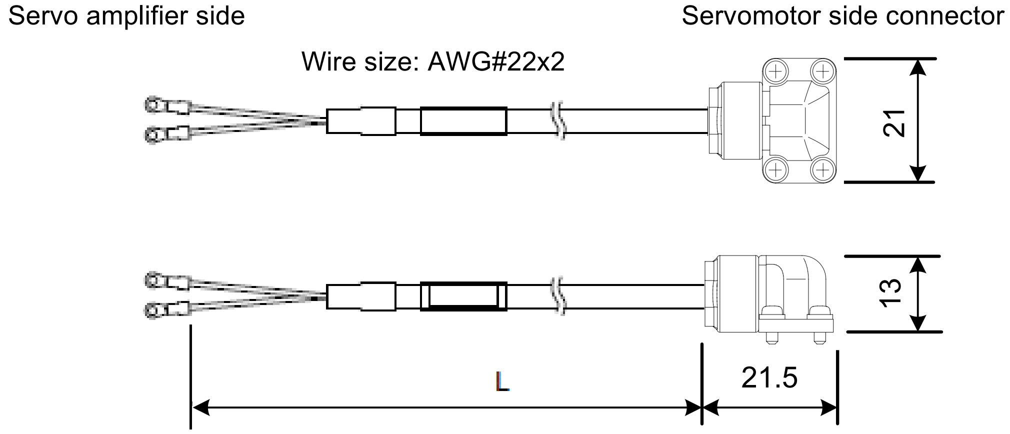
Model	L [mm]
WSC-M02P02-E	2000^{+200}_{0}
WSC-M02P05-E	5000^{+500}_{0}
WSC-M02P10-E	10000^{+1000}_{0}
WSC-M02P20-E	20000^{+2000}_{0}

- The connector manufacturer may be changed without prior notice.
- Movable cables are used for cables.

Brake cable (2)

Model: WSC-M02P02-K to WSC-M02P20-K

Application range: GYB (connector connection specification) model (with brake)



■ Model/manufacturer

Servomotor side connector

Plug	JN6FR02SM1
Contact	LY10-C1-A1-10000

Japan Aviation Electronics Industry, Limited

■ Wire color

Servo amplifier side	-	-
Servomotor side	1	2
Wire color	White	Black
Signal name	B	B

■ Length

Model	L [mm]
WSC-M02P02-K	2000^{+200}_{0}
WSC-M02P05-K	5000^{+500}_{0}
WSC-M02P10-K	10000^{+1000}_{0}
WSC-M02P20-K	20000^{+2000}_{0}

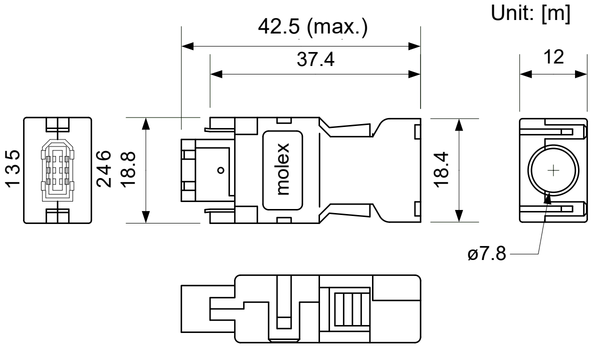
- The connector manufacturer may be changed without prior notice.
- Movable cables are used for cables.
- This cable is the type that leads out to the output shaft side.
  Please contact Fuji if leading the cable out to the side opposite the output shaft.

Encoder connector kit (amplifier side)

Model: WSK-P06P-M

Application range: Common to all models

■ External dimensions



■ Model/manufacturer

Plug housing body	54180-0619
Plug shell cover	58299-0626
Plug shell body	58300-0626
Plug mold cover (A)	54181-0615
Plug mold cover (B)	54182-0605
Cable clamp	58303-0000
Clamp screw	59832-0009

Molex Japan LLC

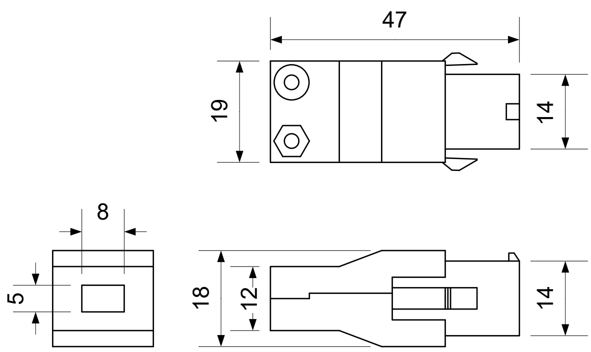
- The connector kit model differs from the optional cable.
- The connector manufacturer may be changed without prior notice.

Encoder connector kit (motor side) (1)

Model: WSK-P09P-D

Applicable range: GYS/GYB (lead wire specification) model ..... 0.75 [kW] or less

■ External dimensions

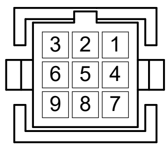


■ Model/manufacturer

Cap	172161-9
Cap cover	316455-1
Socket (SIG+, SIG-, FG)	170365-1 (bulk) 170361-1 (chain)
Socket (P5, M5)	170366-1 (bulk) 170362-1 (chain)

TE Connectivity Corporation

■ Terminal layout



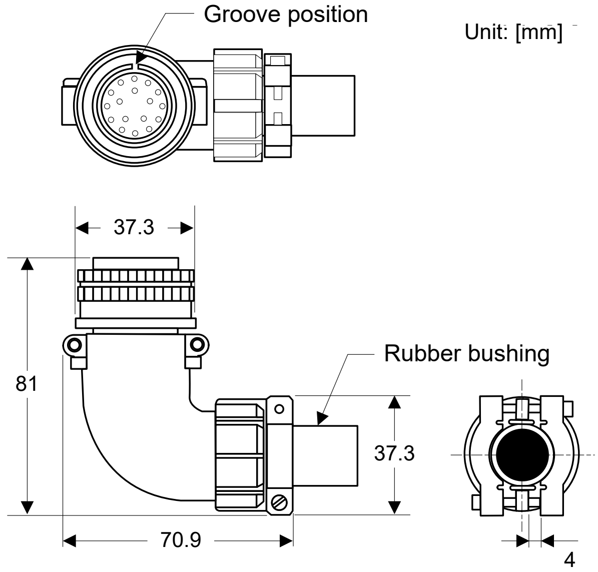
- The connector model differs from the optional cable.
- The connector manufacturer may be changed without prior notice.

Encoder connector kit (motor side) (2)

Model: WSK-P06P-C

Application range: GYS model ..... 1.0 to 5.0 [kW]

■ External dimensions

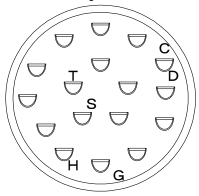


■ Model/manufacturer

L-type clamp	MS3108B20-29S
Cable clamp	MS3057-12A

DDK Ltd.

■ Terminal layout



H	P5
G	M5
C	SIG+
D	SIG-
T	BAT+
S	BAT-

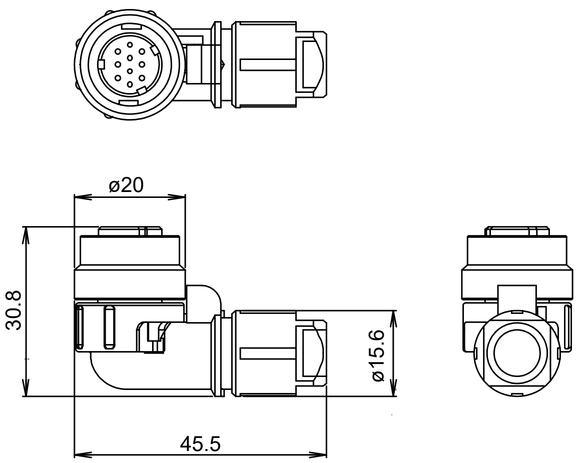
- The connector model differs from the optional cable.
- The connector manufacturer may be changed without prior notice.

Encoder connector kit (motor side) (3)

Model: WSK-P10P-J

Application range: GYG model

■ External dimensions

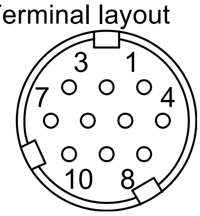


■ Model/manufacturer

Plug	JN2FS10SL2-R (Applicable wire diameter: ø5.7 to ø7.3 [mm])

Japan Aviation Electronics Industry, Limited

■ Terminal layout



1	SIG-
2	SIG+
6	P5
7	M5
8	BAT+
9	BAT-

- The connector model differs from the optional cable.
- The connector manufacturer may be changed without prior notice.

9

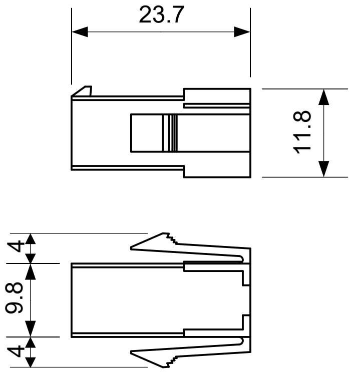
Motor power connector kit (motor side) (1)

Model: WSK-M04P-E

Applicable range: GYS/GYB (lead wire specification) model ..... 0.75 [kW] or less

■ External dimensions

Unit: [mm]

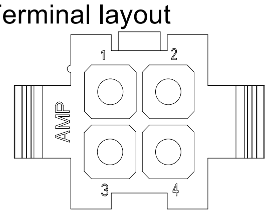


■ Model/manufacturer

Cap housing	172159-1
Socket	170362-1 (for 0.75 mm^2) 171637-1 (for 1.25 mm^2)

TE Connectivity Corporation

■ Terminal layout



1	U
2	V
3	W
4	E

- The connector model differs from the optional cable.
- The connector manufacturer may be changed without prior notice.

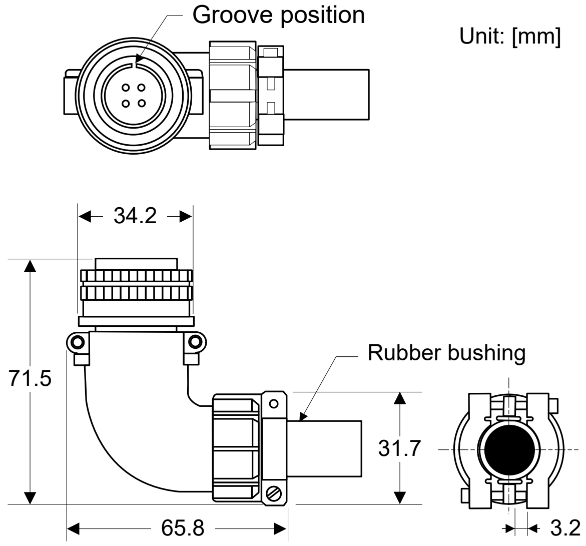
Motor power connector kit (motor side) (2)

Model: WSK-M04P-CA

Application range: GYS model ..... 1.0 to 2.0 [kW]

■ External dimensions

Unit: [mm]

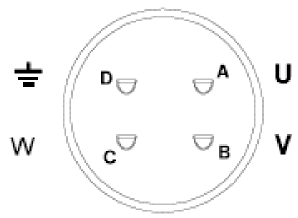


■ Model/manufacturer

L-type clamp	MS3108B18-10S
Cable clamp	MS3057-10A

DDK Ltd.

■ Terminal layout



A	U
B	V
C	W
D	⏚

- The connector model differs from the optional cable.
- The connector manufacturer may be changed without prior notice.

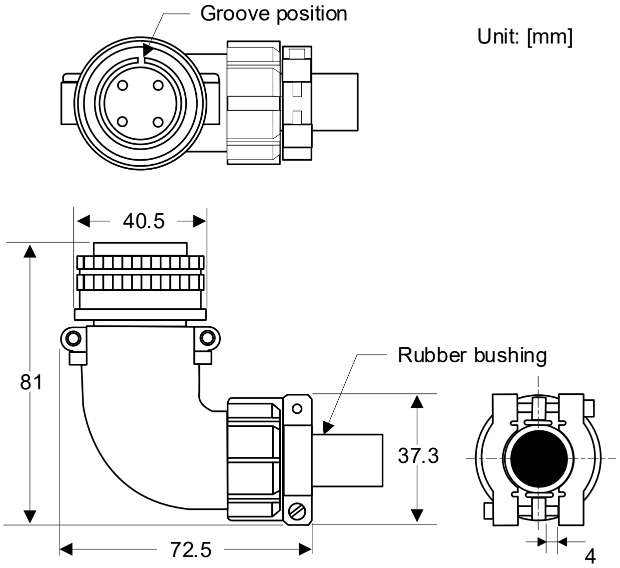
Motor power connector kit (motor side) (3)

Model: WSK-M04P-CB

Application range: GYS model ..... 3.0 to 5.0 [kW]

■ External dimensions

Unit: [mm]

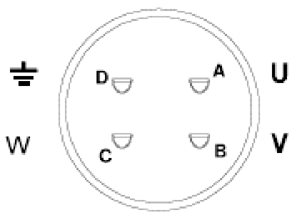


■ Model/manufacturer

L-type clamp	MS3108B22-22S
Cable clamp	MS3057-12A

DDK Ltd.

■ Terminal layout



A	U
B	V
C	W
D	⏚

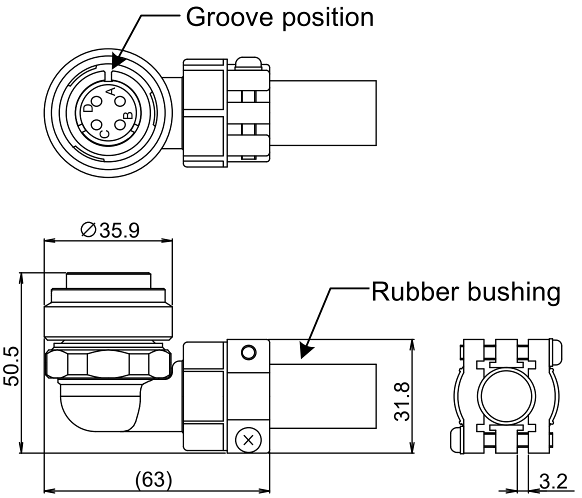
- The connector manufacturer may be changed without prior notice.

Motor power connector kit (motor side) (4)

Model: WSK-M04P-CC

Application range: GYG model

■ External dimensions

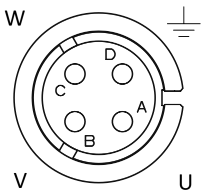


■ Model/manufacturer

Plug	JL10-8A18-10SE-EB
Cable clamp	JL04-18CK(13)-R (Applicable wire diameter: ø11 to ø14.1 [mm])

Japan Aviation Electronics Industry, Limited

■ Terminal layout



A	U
B	V
C	W
D	⏚

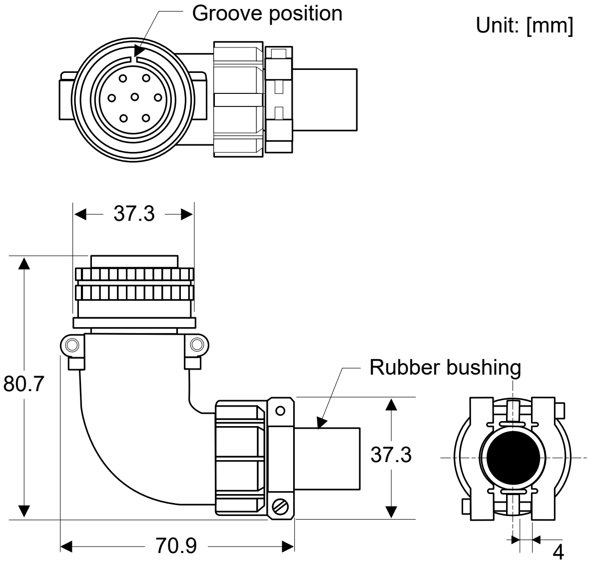
- The connector model differs from the optional cable.
- The connector manufacturer may be changed without prior notice.

Motor power connector kit (motor side: with brake) (1)

Model: WSK-M06P-CA

Application range: GYS model ..... 1.0 to 2.0 [kW] (with brake)

■ External dimensions

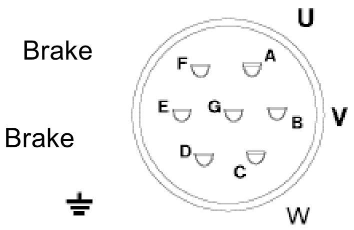


■ Model/manufacturer

L-type clamp	MS3108B20-15S
Cable clamp	MS3057-12A

DDK Ltd.

■ Terminal layout



A	U
B	V
C	W
D	⏚
E	Br
F	Br
G	-

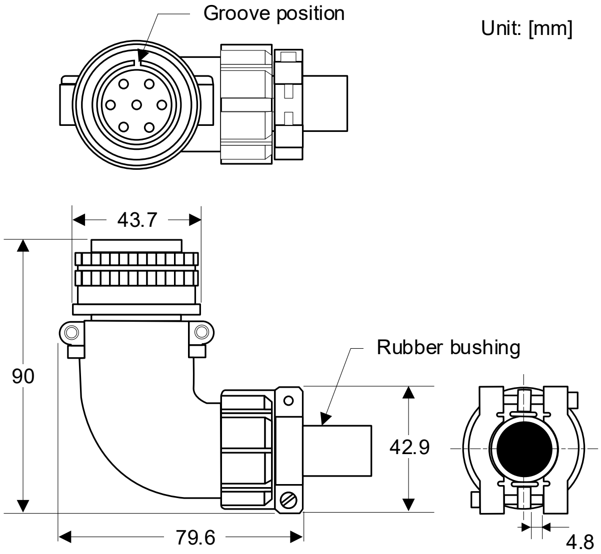
- The connector model differs from the optional cable.
- The connector manufacturer may be changed without prior notice.

Motor power connector kit (motor side: with brake) (2)

Model: WSK-M06P-CB

Application range: GYS model ..... 3.0 to 5.0 [kW] (with brake)

■ External dimensions

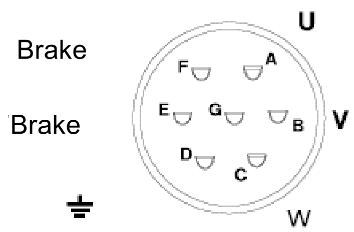


■ Model/manufacturer

L-type clamp	MS3108B24-10S
Cable clamp	MS3057-16A

DDK Ltd.

■ Terminal layout



A	U
B	V
C	W
D	⏚
E	Br
F	Br
G	-

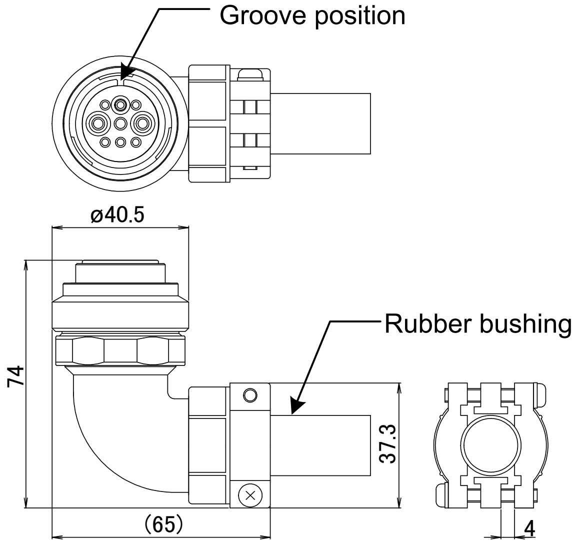
- The connector manufacturer may be changed without prior notice.

Motor power connector kit (motor side: with brake) (3)

Model: WSK-M06P-CC

Application range: GYG model

■ External dimensions

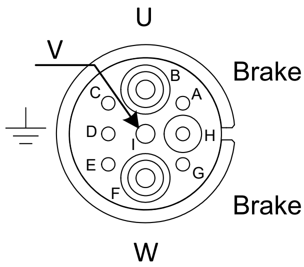


■ Model/manufacturer

Plug	JL10-8A20-18SE-EB
Cable clamp	JL04-2022CK(14)-R (Applicable wire diameter: ø12.9 to ø16 [mm])

Japan Aviation Electronics Industry, Limited

■ Terminal layout



A	Br
B	U
D	⏚
F	W
G	Br
I	V

- The connector model differs from the optional cable.
- The connector manufacturer may be changed without prior notice.

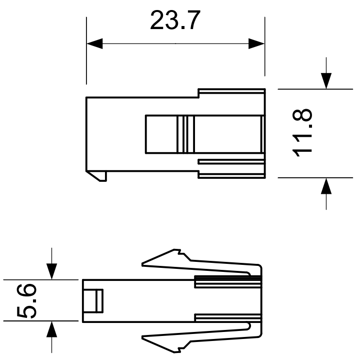
Brake connector kit (motor side) (1)

Model: WSK-M02P-E

Applicable range: GYS/GYB (lead wire specification) model ..... 0.75 [kW] or less (with brake)

■ External dimensions

Unit: [mm]

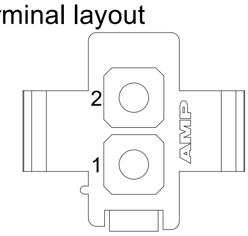


■ Model/manufacturer

Cap housing	172157-9
Socket	170362-1

TE Connectivity Corporation

■ Terminal layout



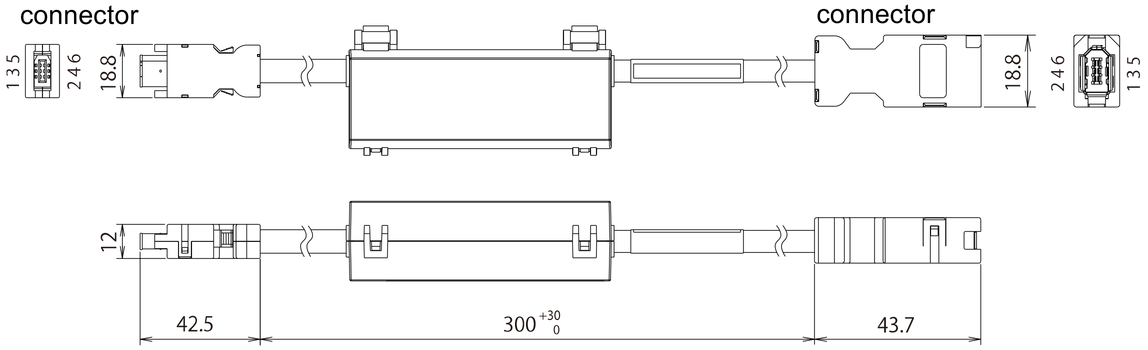
1	B
2	B

- The connector model differs from the optional cable.
- The connector manufacturer may be changed without prior notice.

Encoder relay cable with battery

Model: WSC-P06P0R3-BG

Application range: Common to all models (for CN2)



■ Model/manufacturer

Servo amplifier side connector

Plug housing body	54180-0619
Plug shell cover	58299-0626
Plug shell body	58300-0626
Plug mold cover (A)	54181-0615
Plug mold cover (B)	54182-0605
Cable clamp	58303-0000
Clamp screw	59832-0009

Molex Japan LLC

Servomotor side connector

Socket housing body	53988-0619
Socket shell cover	58302-0628
Socket mold cover (A)	53989-0605
Socket mold cover (B)	53990-0605
Cable clamp	58303-0000
Clamp screw	59832-0009

Molex Japan LLC

■ Wire color

Servo amplifier side	1	2	3	4	5	6	Shell
Servomotor side	1	2	3	4	5	6	Shell
Wire color	Red	Black	Orange	Orange/white	Blue	Blue/white	Shield
Signal name	P5	M5	BAT+	BAT-	SIG+	SIG-	FG

- 1 battery is provided.
- The connector manufacturer may be changed without prior notice
- Movable cables are used for cables.

⚠ CAUTION

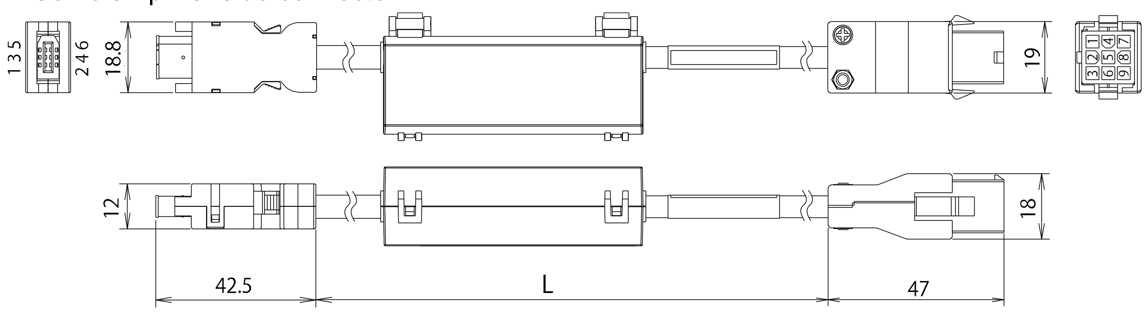
Connect two or more encoder cables to the relay cable, and do not extend the wiring distance.
A sudden stoppage may occur due to a voltage drop resulting from connector contact resistance.

Encoder cable with battery (1)

Model: WSC-P06P02-BE to WSC-P06P20-BE

Applicable range: GYS/GYB (lead wire specification) model ..... 0.75 [kW] or less (for CN2)

Servo amplifier side connector　　　　Servomotor side connector



■ Model/manufacturer

Servo amplifier side connector

Plug housing body	54180-0619
Plug shell cover	58299-0626
Plug shell body	58300-0626
Plug mold cover (A)	54181-0615
Plug mold cover (B)	54182-0605
Cable clamp	58303-0000
Clamp screw	59832-0009

Molex Japan LLC

Servomotor side connector

Cap housing	1-172332-9
Socket	170361-1
Cover (x 2)	316455-1
Screw (x 2)	M2.6 x 10
Nut (x 2)	M2.6

TE Connectivity Corporation

■ Wire color

Servo amplifier side		1	2	3	4	5	6	Shell
Servomotor side		7	8	1	2	5	4	3
Wire color	(1)	Red	Black	Orange	Orange/white	Blue/white	Blue	Shield
	(2)	White	Black	Yellow	Brown	Blue	Red	Shield
Signal name		P5	M5	BAT+	BAT-	SIG+	SIG-	FG

The wire color will be either (1) or (2).

■ Length

Model	L [mm]
WSC-P06P02-BE	2,000 $^{+20}_{0}$
WSC-P06P05-BE	5,000 $^{+50}_{0}$
WSC-P06P10-BE	10,000 $^{+1,00}_{0}$
WSC-P06P20-BE	20,000 $^{+2,00}_{0}$

- 1 battery is provided.
- The connector manufacturer may be changed without prior notice
- Movable cables are used for cables.

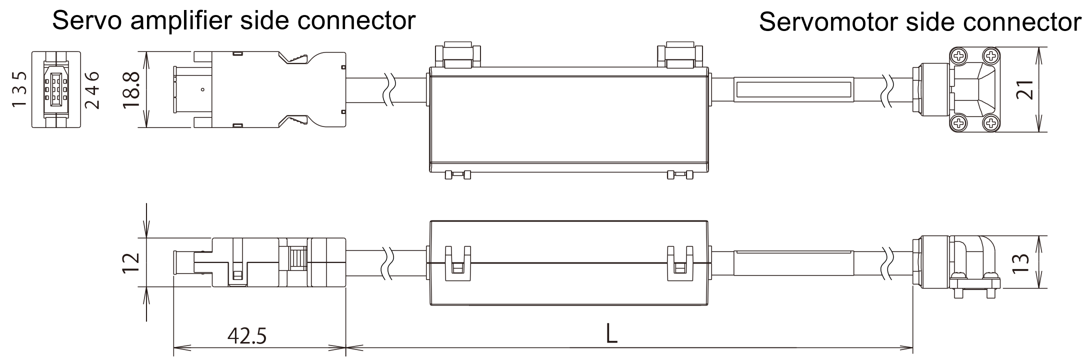
⚠ CAUTION

Connect two or more encoder cables, and do not extend the wiring distance.
A sudden stoppage may occur due to a voltage drop resulting from connector contact resistance.

Encoder cable with battery (2)

Model: WSC-P06P02-BK to WSC-P06P20-BK

Application range: GYB (connector connection specification) model (for CN2)



■ Model/manufacturer

Servo amplifier side connector

Plug housing body	54180-0619
Plug shell cover	58299-0626
Plug shell body	58300-0626
Plug mold cover (A)	54181-0615
Plug mold cover (B)	54182-0605
Cable clamp	58303-0000
Clamp screw	59832-0009

Molex Japan LLC

Servomotor side connector

Plug	JN6FR07SM2
Contact	LY10-C1-A1-10000

Japan Aviation Electronics Industry, Limited

■ Wire color

Servo amplifier side	1	2	3	4	5	6	Shell
Servomotor side	6	3	5	2	4	7	-
Wire color	Red	Black	Orange	Orange/white	Blue/white	Blue	Shield
Signal name	P5	M5	BAT+	BAT-	SIG+	SIG-	FG

■ Length

Model	L [mm]
WSC-P06P02-BK	$2,000^{+20}_{0}$
WSC-P06P05-BK	$5,000^{+50}_{0}$
WSC-P06P10-BK	$10,000^{+1,00}_{0}$
WSC-P06P20-BK	$20,000^{+2,00}_{0}$

- 1 battery is provided.
- The connector manufacturer may be changed without prior notice
- Movable cables are used for cables.
- This cable is the type that leads out to the output shaft side.
  Please contact Fuji if leading the cable out to the side opposite the output shaft.

⚠ CAUTION

Connect two or more encoder cables, and do not extend the wiring distance.
A sudden stoppage may occur due to a voltage drop resulting from connector contact resistance.

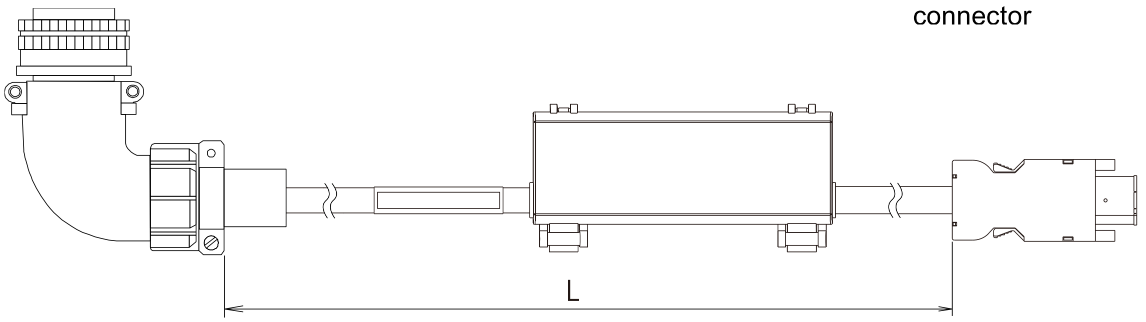
Encoder cable with battery (3)

Model: WSC-P06P02-BC to WSC-P06P20-BC

Application range: GYS model ..... 1.0 to 5.0kW (for CN2)

Servomotor side connector

Servo amplifier side connector



■ Model/manufacturer

Servomotor side connector

L-type clamp	MS3108B20-29S
Cable clamp	MS3057-12A

DDK Ltd.

Servo amplifier side connector

Plug housing body	54180-0619
Plug shell cover	58299-0626
Plug shell body	58300-0626
Plug mold cover (A)	54181-0615
Plug mold cover (B)	54182-0605
Cable clamp	58303-0000
Clamp screw	59832-0009

Molex Japan LLC

■ Wire color

Servo amplifier side		1	2	3	4	5	6
Servomotor side		H	G	T	S	C	D
Wire color	(1)	Red	Black	Orange	Orange/white	Blue	Blue/white
	(2)	White	Black	Yellow	Brown	Red	Blue
Signal name		P5	M5	BAT+	BAT-	SIG+	SIG-

The wire color will be either (1) or (2).

■ Length

Model	L [mm]
WSC-P06P02-BC	$2,000^{+20}_{0}$
WSC-P06P05-BC	$5,000^{+50}_{0}$
WSC-P06P10-BC	$10,000^{+1,00}_{0}$
WSC-P06P20-BC	$20,000^{+2,00}_{0}$

- 1 battery is provided.
- The connector manufacturer may be changed without prior notice
- Movable cables are used for cables.

⚠ CAUTION

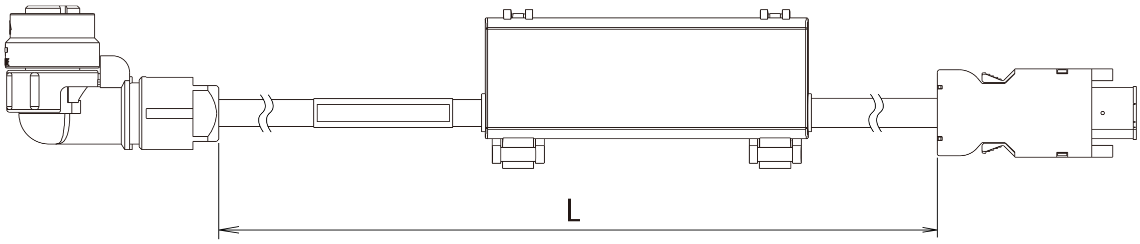
Connect two or more encoder cables, and do not extend the wiring distance.
A sudden stoppage may occur due to a voltage drop resulting from connector contact resistance.

Encoder cable with battery (4)

Model: WSC-P06P02-BJ to WSC-P20P20-BJ

Application range: GYG model (for CN2)

Servomotor side connector　　　　Servo amplifier side connector



■ Model/manufacturer

Servomotor side connector

Plug	JN2FS10SL2-R

Japan Aviation Electronics Industry, Limited

Servo amplifier side connector

Plug housing body	54180-0619
Plug shell cover	58299-0626
Plug shell body	58300-0626
Plug mold cover (A)	54181-0615
Plug mold cover (B)	54182-0605
Cable clamp	58303-0000
Clamp screw	59832-0009

Molex Japan LLC

■ Wire color

Servo amplifier side	1	2	3	4	5	6
Servomotor side	6	7	8	9	2	1
Wire color	Red	Black	Orange	Orange/white	Blue/white	Blue
Signal name	P5	M5	BAT+	BAT-	SIG+	SIG-

■ Length

Model	L [mm]
WSC-P06P02-BJ	$2{,}000^{+20}_{0}$
WSC-P06P05-BJ	$5{,}000^{+50}_{0}$
WSC-P06P10-BJ	$10{,}000^{+1,00}_{0}$
WSC-P06P20-BJ	$20{,}000^{+2,00}_{0}$

- 1 battery is provided.
- The connector manufacturer may be changed without prior notice
- Movable cables are used for cables.

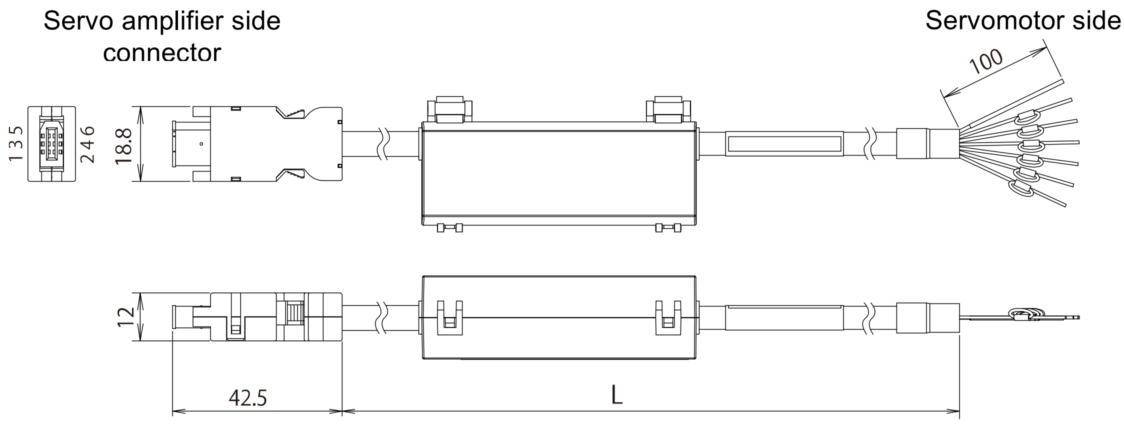
⚠ CAUTION

Connect two or more encoder cables, and do not extend the wiring distance.
A sudden stoppage may occur due to a voltage drop resulting from connector contact resistance.

Encoder cable with battery (5)

Model: WSC-P06P02-BW to WSC-P06P20-BW

Application range: Common to all models (for CN2)



■ Model/manufacturer

Servo amplifier side connector

Plug housing body	54180-0619
Plug shell cover	58299-0626
Plug shell body	58300-0626
Plug mold cover (A)	54181-0615
Plug mold cover (B)	54182-0605
Cable clamp	58303-0000
Clamp screw	59832-0009

Molex Japan LLC

■ Wire color

Servo amplifier side		1	2	3	4	5	6	Case
Wire color	(1)	Red	Black	Orange	Orange/white	Blue	Blue/white	Protective tube
	(2)	White	Black	Yellow	Brown	Red	Blue	
Signal name		P5	M5	BAT+	BAT-	SIG+	SIG-	-

The wire color will be either (1) or (2).

■ Length

Model	L [mm]
WSC-P06P02-BW	$2{,}000^{+20}_{0}$
WSC-P06P05-BW	$5{,}000^{+50}_{0}$
WSC-P06P10-BW	$10{,}000^{+1{,}00}_{0}$
WSC-P06P20-BW	$20{,}000^{+2{,}00}_{0}$

- 1 battery is provided.
- The connector manufacturer may be changed without prior notice
- Movable cables are used for cables.

⚠ CAUTION

Connect two or more encoder cables, and do not extend the wiring distance.
A sudden stoppage may occur due to a voltage drop resulting from connector contact resistance.

9

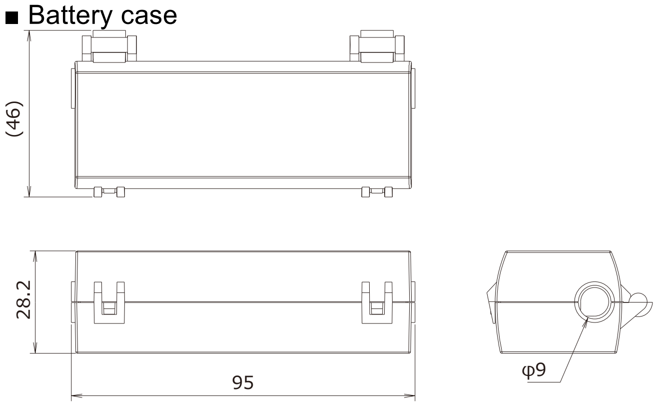
Battery case kit for encoder cable

Model: WSB-BC

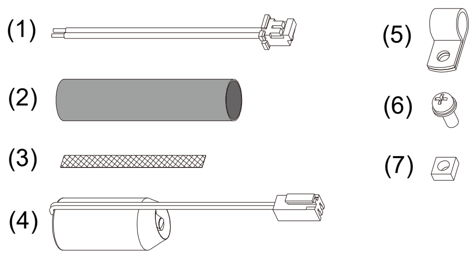
Application range: Common to all models (for CN2)

Use if fabricating your own encoder cable with battery.

■ Battery case



■ Accessories



(1) Battery wiring
(2) Contraction tube
(3) Copper foil tape
(4) Battery
(5) Nylon clip
(6) Screw
(7) Nut

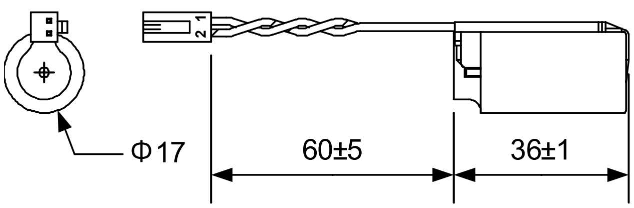
- The connector manufacturer may be changed without prior notice
- Refer to “2.4.2.2 Encoder Cable With Battery Fabrication Method” for details on the wiring processing method.

Replacement battery

Model: WSB-S

Application range: All models

■ External dimensions



■ Model/manufacturer

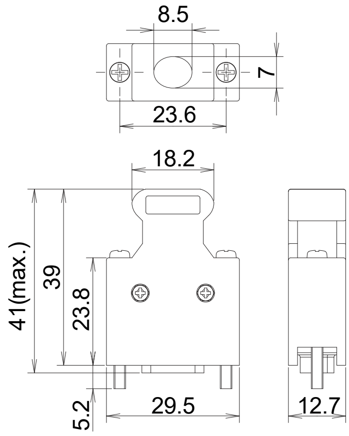
Battery	ER17/33WK41 1PP

Hitachi Maxell, Ltd.

Connector for sequential I/O (CN1)

This connector is not available as an option. Recommended products are as follows.

■ External dimensions

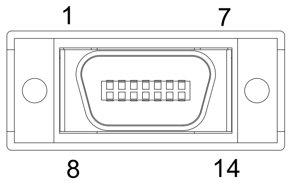


■ Model/manufacturer

Solder plug	10114-3000PE
Shell kit	1033146-52A0-008

3M Japan Limited

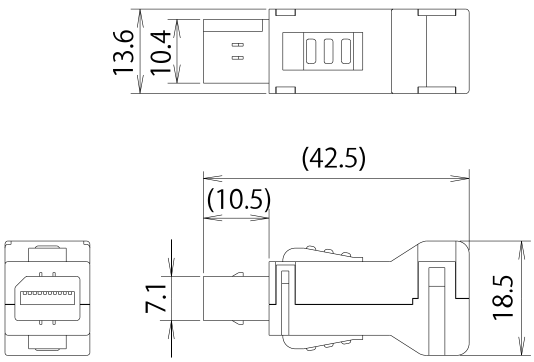
■ Terminal layout



Connector for linear encoder/fully closed wiring (CN5)

This connector is not available as an option. Recommended products are as follows.

■ External dimensions

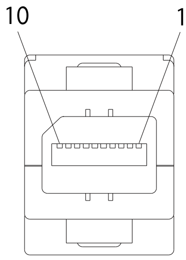


■ Model/manufacturer

MUF plug kit	MUF-PK10K-X

Japan Solderless Terminal

■ Terminal layout



Safety equipment connector (CN6)

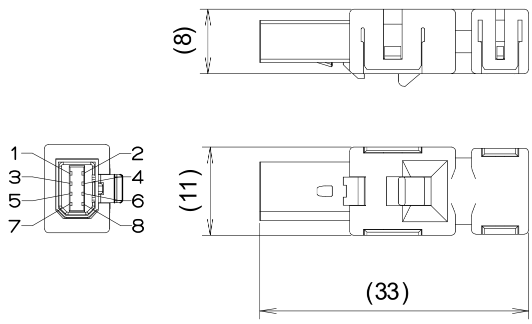
This connector is not available as an option.

Product name : INDUSTRIAL MINI I/O D-SHAPE TYPE 1

Form : 2013595-1

Maker : TE Connectivity

* The cable is not provided.



Monitor (CN7)

Connect a measuring instrument, etc. to servo amplifier connector 7 (CN7).

This is an analog output voltage signal for measuring instruments, and is not required for servo amplifier operation.

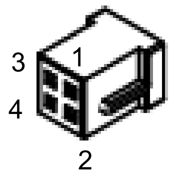
This connector is not available as an option.

9

■ Model/manufacturer

Crimp socket	DF11-4DS-2C
Crimp terminal	DF11-2428SC

HIROSE ELECTRIC CO., LTD.

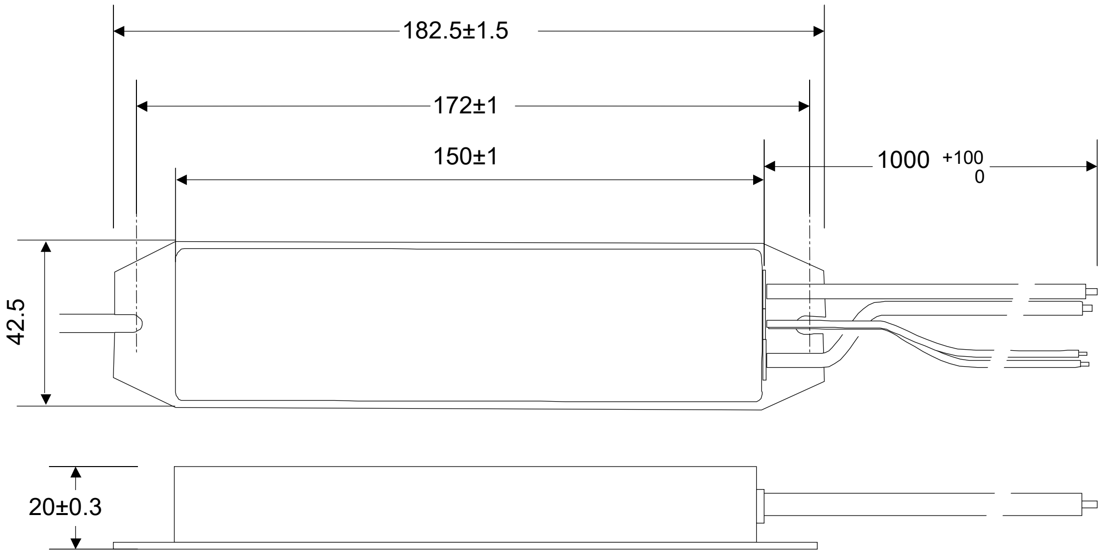


1	MON1	3	M5(0V)
2	MON2	4	M5(0V)

External regenerative resistor (1)

Model: WSR-401

Application range: Amplifier models RYT500F7 to RYT401F7



* Attachment part thickness: 1.2 mm

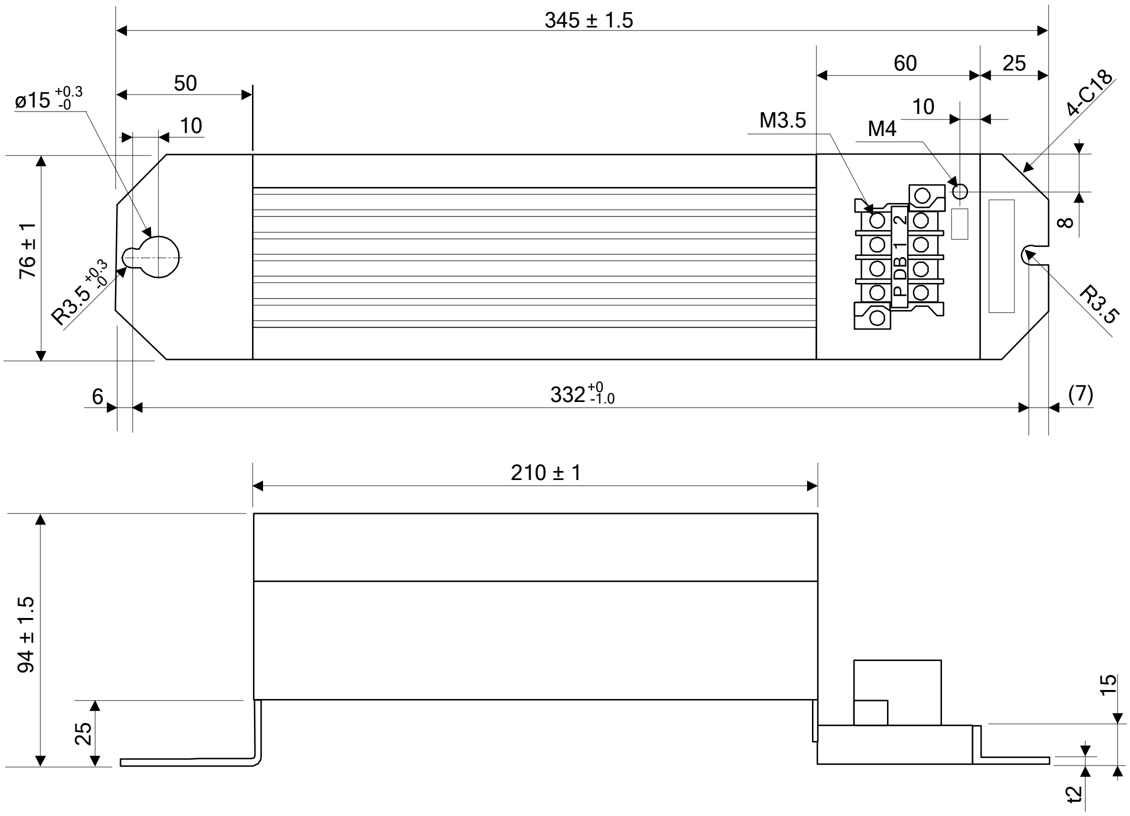
Item		Specification
Model		WSR-401
Resistor	Resistance	68Ω
	Allowable power	17W (cont.)
Thermostat	Operating temperature	Open at 135 ±10 °C
	Dielectric strength	1 minute at 1.5 kVAC
	Contact capacity	30 VDC, 3A

- Connect the external regenerative resistor to the servo amplifier with a 10 [m] or shorter cable.
- The external regenerative resistor becomes hot. Do not install flammable objects in the vicinity.
- Refer to "9.8 External Braking Resistor" for details on external regenerative resistors.

External regenerative resistor (2)

Model: WSR-152

Application range: Amplifier models RYT751F7 to RYT152F7



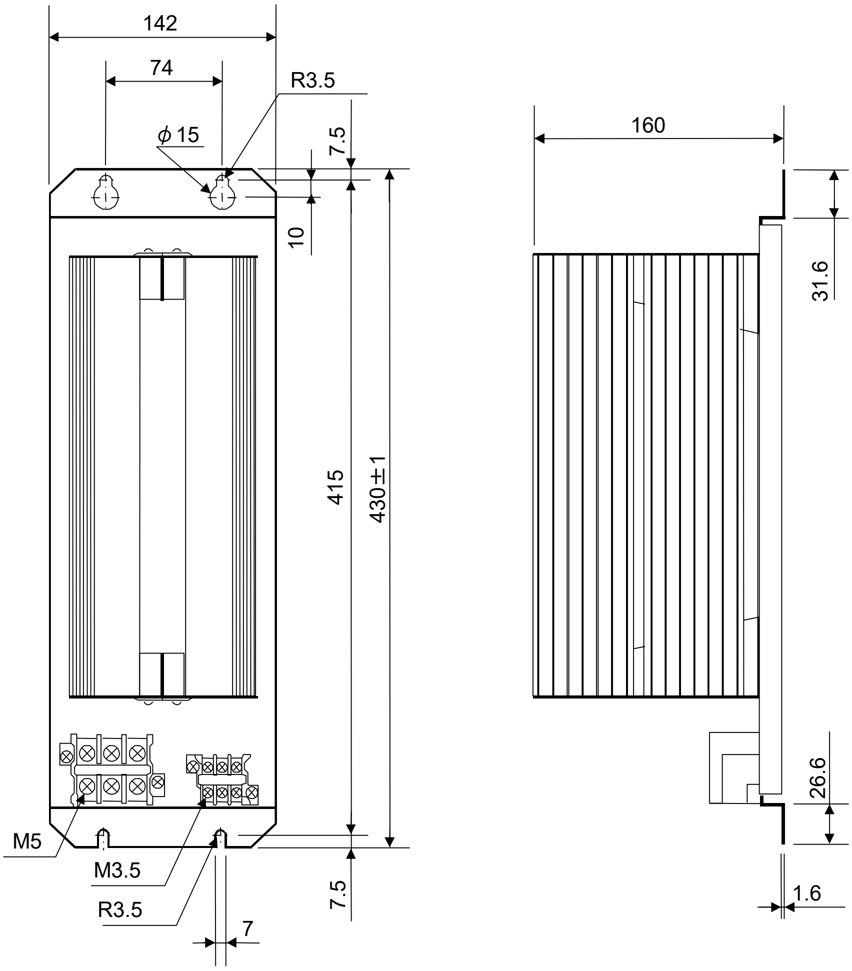
Item		Specification
Model		WSR-152
Resistor	Resistance	15Ω
	Allowable power	50W (cont.)
Thermostat	Operating temperature	Open at 150 ±10 °C
	Dielectric strength	1 minute at 2.5 kVAC
	Contact capacity	30 VDC, 3A

- Connect the external regenerative resistor to the servo amplifier with a 10 [m] or shorter cable.
- The external regenerative resistor becomes hot. Do not install flammable objects in the vicinity.
- Refer to "9.8 External Braking Resistor" for details on external regenerative resistors.

External regenerative resistor (3)

Model: DB11-2

Application range: Amplifier models RYT202F7 to RYT302F7



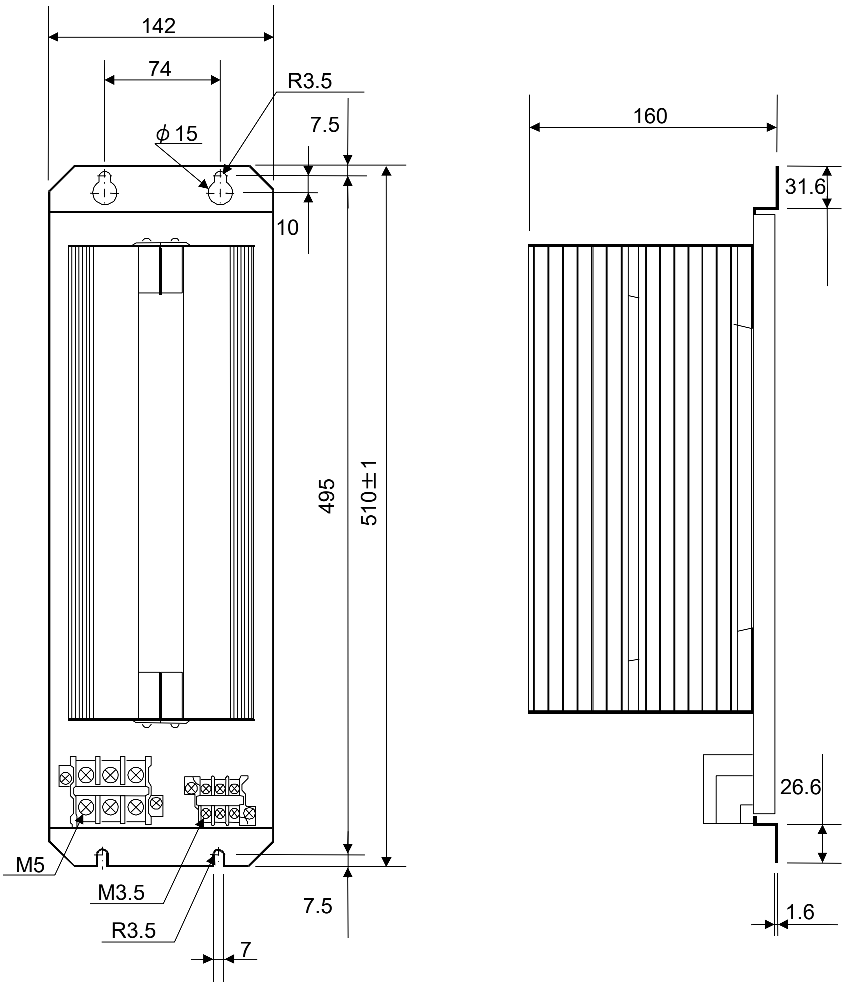
Item		Specification
Model		DB11-2
Resistor	Resistance	10 Ω
	Allowable power	260 W (cont.)
Thermostat	Operating temperature	Open at 150 ±10 °C
	Dielectric strength	2.5 kV AC for 1 minute
	Contact capacity	120 V AC/30 V DC, 0.1 A

- Connect the external regenerative resistor to the servo amplifier with a 10 [m] or shorter cable.
- The external regenerative resistor becomes hot. Do not install flammable objects in the vicinity.
- Refer to "9.8 External Braking Resistor" for details on external regenerative resistors.

External regenerative resistor (4)

Model: DB22-2

Application range: Amplifier models RYT402F7 to RYT502F7



Item		Specification
Model		DB22-2
Resistor	Resistance	5.8 Ω
	Allowable power	300 W (cont.)
Thermostat	Operating temperature	Open at 150 ±10 °C
	Dielectric strength	2.5 kV AC for 1 minute
	Contact capacity	120 V AC/30 V DC, 0.1 A

- Connect the external regenerative resistor to the servo amplifier with a 10 [m] or shorter cable.
- The external regenerative resistor becomes hot. Do not install flammable objects in the vicinity.
- Refer to "9.8 External Braking Resistor" for details on external regenerative resistors.

CHAPTER 10 ABSOLUTE POSITION SYSTEM

10.1 Specifications

10.1.1 Specification List

Item	Description
Method	Battery backup method
Battery	Lithium battery (primary battery, nominal +3.6 [V])
Max. rotation range	Home position ±32767 [rev]
Max. rotation speed at power failure	6000 [r/min]
Service life of battery	About 35000 hours (life without power turned on)
Lithium content	0.5 [g]

Hint	It is recommended to replace the battery periodically (every three years or more frequently) despite the power-on or shutdown state.

10.1.2 Precautions

■ Marine or air transport of battery (lithium-metal battery)

If transporting lithium-metal batteries on their own, packaged together with devices, or installed in devices, it may be necessary to file a dangerous object application.

Please contact the transport company if transporting lithium-metal batteries.

■ Conditions blocking establishment of absolute position system

The absolute position system is not established under the following conditions.

- The electronic gear setting is changed after position preset.
- The command pulse ratio is changed after position preset.

The absolute position system can be established even under speed control or torque control.

■ Encoder cable

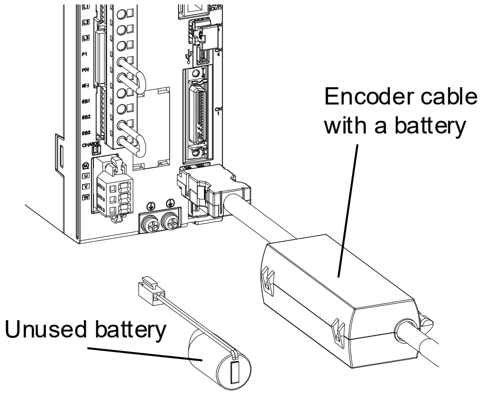
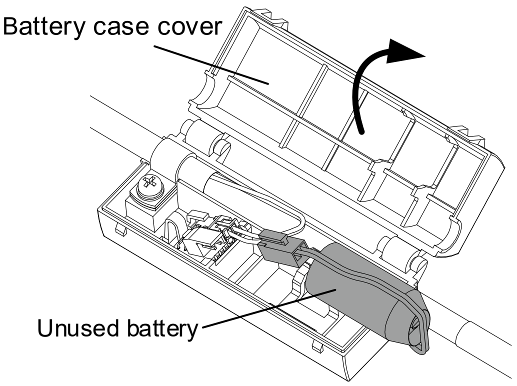
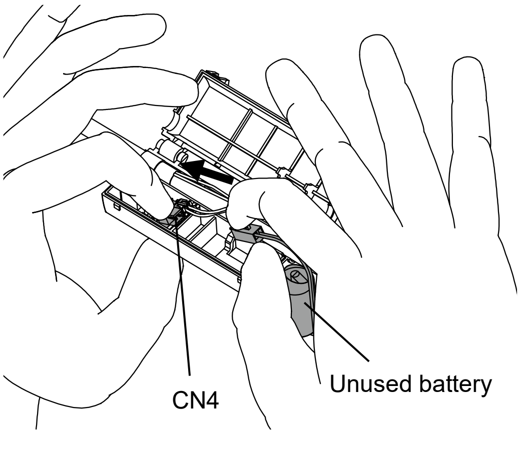
Use an encoder cable with battery.

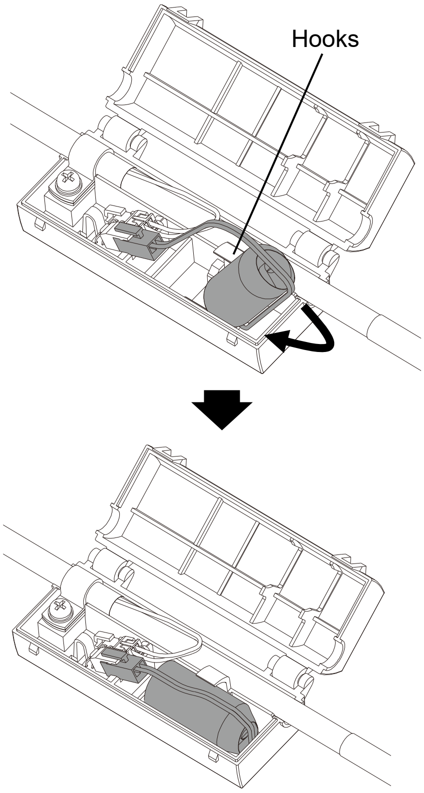
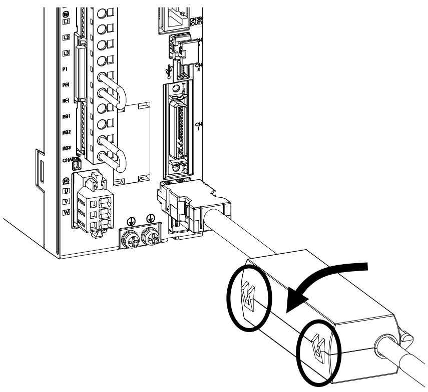
10.2 Battery Installation and Replacement Procedures

10.2.1 Battery Installation Procedure (Amplifier models: RYT☐☐☐F7-VC2)

Install the battery in the following procedure.

To install the battery, an encoder cable with a battery (optional) is required.

[1]		Prepare an unused battery. Battery model: WSB-S
[2]		Open the battery case of the encoder cable and remove the old battery from the connector if it’s inside. The battery case cover can be removed.
[3]		Connect the unused battery to connector CN4 while pressing down the board.

[4]		Fix the battery with the hooks in the case, and push in the electric wire to the side of the connector.
[5]		Close the battery case of the encoder cable. Check if the catches are engaged at both two positions. Battery installation is finished.

- An encoder cable with battery (option) is required to install the battery.
- The battery is already fitted to the encoder cable with battery.

Note	• Be sure to leave the control power supplied when working (turn the main power off). • Leave the encoder cable connected.

10.3 Starting Up Procedure

Follow the procedure below to start up the absolute position system.

	Step	Description
[1]	Install the battery	Connect the battery to the encoder wiring correctly as described in section 11.2.
[2]	Enter PA1_02	Set PA1_02 (INC/ABS system) at 1 (ABS) or 2 (endless non-overflow ABS).
[3]	Turn the main power and control power off then on again.	To make new parameters enabled, turn the power off then on again.
	dL ↔ 01	
[4]	Perform position preset	An absolute data lost alarm (dL1) is caused when the power is turned on first after the absolute position system is established. Execute position preset to remove the alarm.
[5]	Perform homing	To establish the coordinate system of the absolute position system, execute regular homing.
[6]	Execute regular operation	After above steps [1] through [5] are finished, the absolute position system is established. You can start regular operation.

- If the encoder cable is disconnected due to transportation or device changes, repeat the procedure from step [4].

10

10.4 Battery Warning

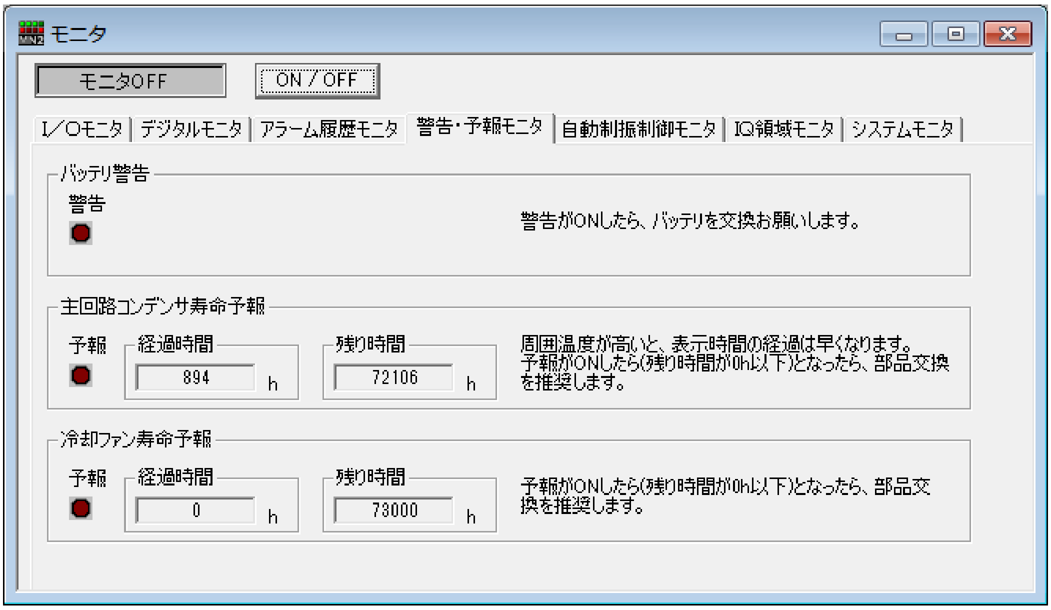
A battery warning is issued if the battery voltage is lower than the value preset in the servo amplifier.
If this warning* is issued, replace the battery immediately.

*: The battery warning is detected when the control power is turned on. If the battery is kept installed and the system is left shut off for a long time, the battery life limit may be reached before the battery warning is issued.

The following three methods can be used to check battery warnings.

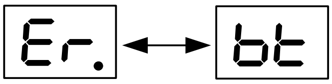
(1) OUT signal (assignment number: 45)

(2) [Monitor] - [Warning/Forecast monitor] of PC Loader



(3) Keypad display

By setting PA2_78 (Display transition at warning detection) to “1: Transition to warning display”, the keypad will automatically display the following when a warning occurs.



10.5 Calculation of Battery Life

The battery life elapses if the control power of the servo amplifier is left turned off for 35,000 hours. During actual operation, the power-on and shutoff cycles are repeated. An example of calculation of the service life in this case is shown as a reference. Note that the value is merely a calculated value and it is not guaranteed. Note, too, that the service life becomes shorter under some ambient environmental conditions.

■ Operation condition

	Operation	No operation
1 day	10 hours	14 hours
1 year*	About 261 days (= 365 days x 5 / 7)	About 104 days (= 365 days x 2 / 7)

* Assumption: operation on Monday through Friday, no operation on Saturday and Sunday

■ Current consumption

Current consumption in power-on phase: 0.0075 [mA]

Current consumption in shutoff phase: 0.0415 [mA] (= 0.0075 [mA] + 0.034 [mA])

■ Calculation of service life

Annual battery capacity consumption

(10 [Hr] × 0.0075 [mA] + 14 [Hr] × 0.0415 [mA]) × 261 [days] + 24 [Hr] × 0.0415 [mA] × 104 [days] = 275 [mAh]

Annual battery life estimation

1600 [mAh] / 275 [mAh/year] = 5.8 [years]

Hence the service life of the battery is about 5.8 years* under the above operation conditions.

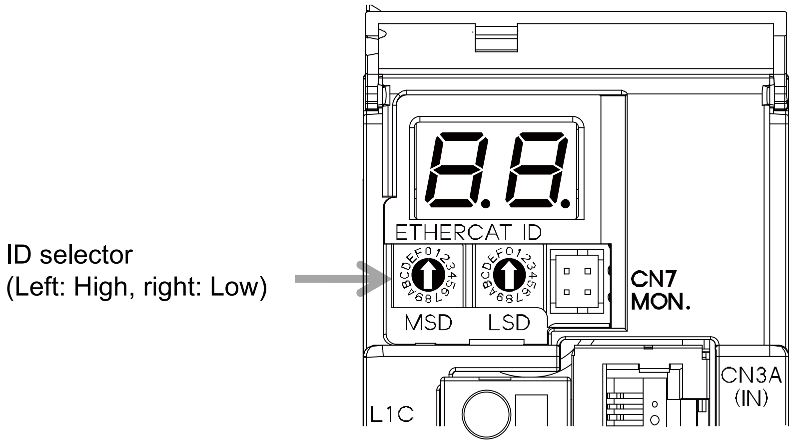
* However, the battery manufacturer recommends to stop using the battery after three years of operation. Periodic replacement within three years is recommended without relations to the operation conditions.
* In case of wrong wiring of encoder cable, the battery life is possible to be extremely short.

10

CHAPTER 11 EtherCAT COMMUNICATION

11.1 Display and Settings

11.1.1 Explicit Device ID



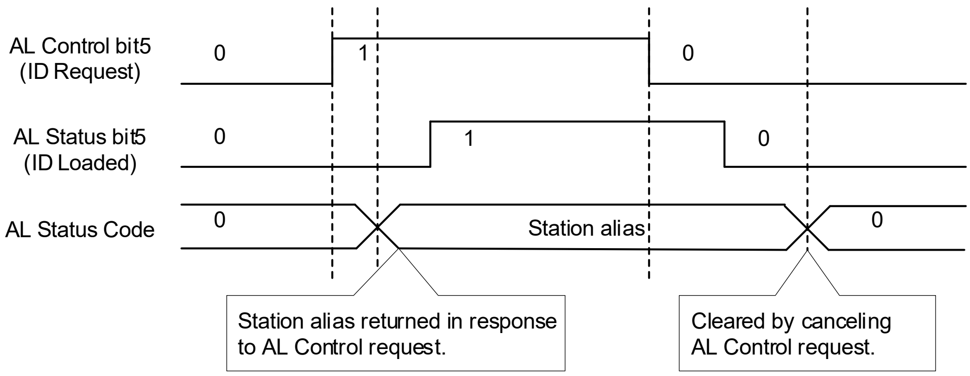
Rotary switch value reading with AL Status Codes (Explicit Device ID)

Front panel rotary switch and PA2_72: This describes the method used to read the value set with the ID-Selector value offset from 0134H: AL Status Code.
The value read here is not the value registered in ESC register 0012H: Configured Station Alias.

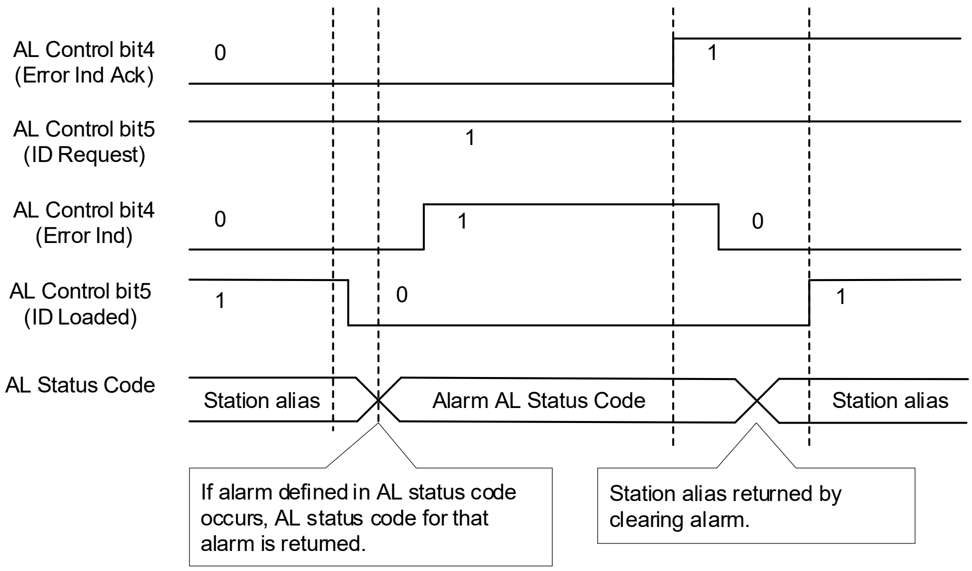
Hint	To ensure compatibility with older specification controllers, the Explicit Device ID can be copied to 0012H: Configured Station Alias by changing the PA2_92 (5002H-5CH) setting. Refer to “3.5 Extended Function Setting Parameters” for details.

11

(1) Set AL Control (0120h) bit 5 (ID Request) to “1”.
(2) The Station Alias set with the rotary switch and PA2_71 (Explicit Deice ID offset) is returned to the AL Status Code (0134h).
(3) “1” is returned to AL Status (0130h) bit 5 (ID Loaded).
(4) Set AL Control (0120h) bit 5 (ID Request) to “0”.
(5) “0” is returned to AL Status (0130h) bit 5 (ID Loaded).
(6) AL Status Code (0134h) is cleared.

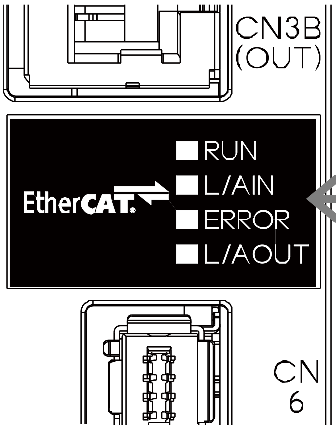


If an alarm (EtherCAT communication related errors Err 80.0 to 7, Err 81.0 to 7, or Err 85.0 to 7) defined in the AL status code occurs while Station Alias is being returned, the AL status code for that alarm is returned.
Station Alias is returned again if the alarm defined in the AL status code is cleared.
(See “8.1.4. Alarm Reset Timing” for details on how to clear alarms.)



11

11.1.2 Status LEDs

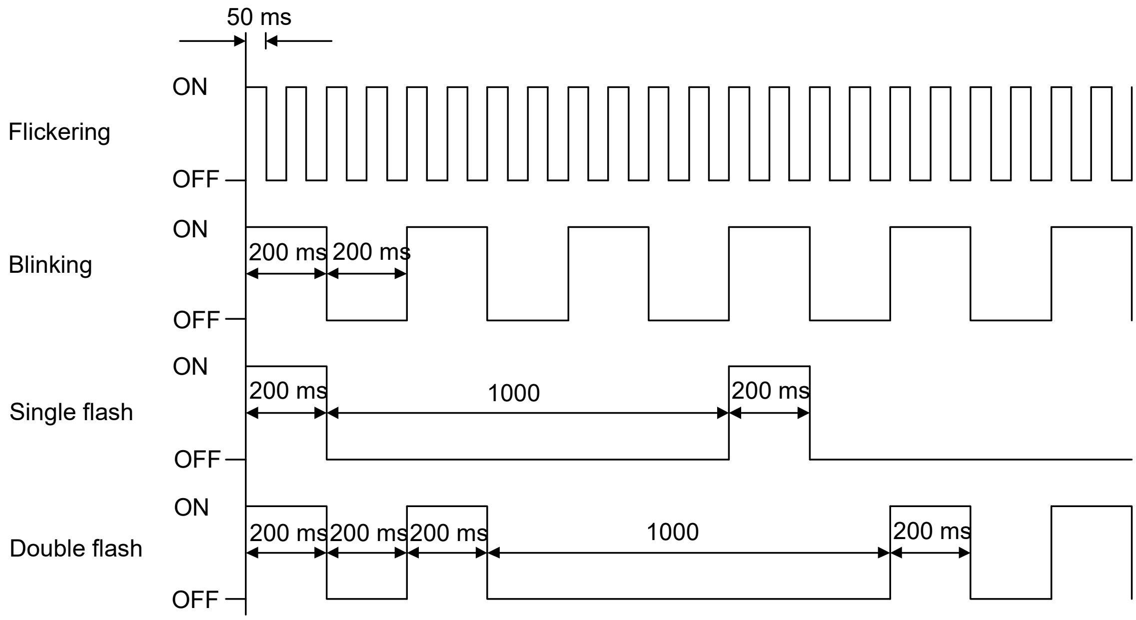


EtherCAT indicators
RUN (green)
L/A IN (green)
ERROR (red)
L/A OUT (green)

The display status and details of EtherCAT status LEDs are shown below.

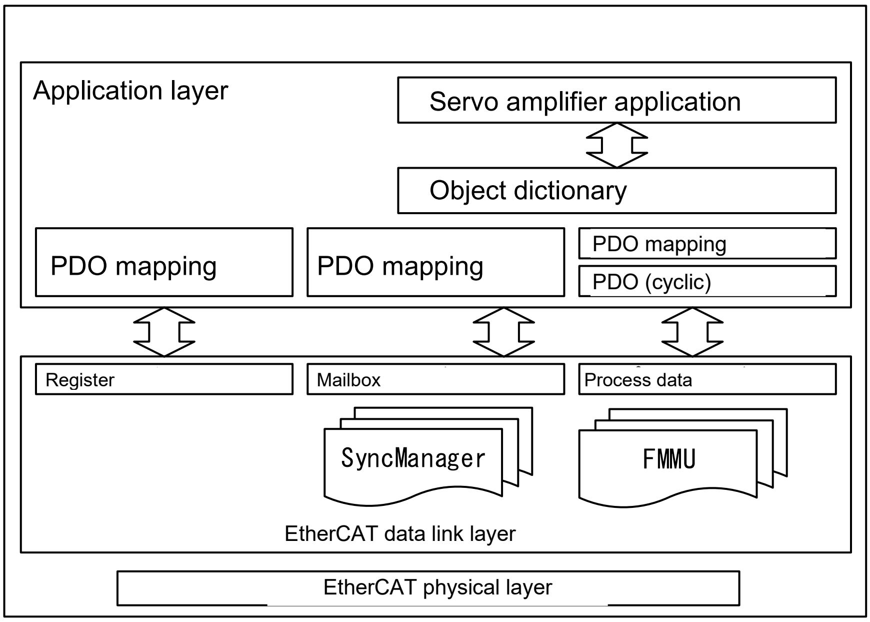
Name	Color	Status	Details
RUN	Green	OFF	Initialization status
		Blinking	Pre-operational status
		Single flash	Safe operational status
		ON	Operational status
ERROR	Red	OFF	No error
		Blinking	Communication setting error
		Single flash	Synchronization error, communication data error
		Double flash	Application watchdog timeout
		Flickering	Boot error
		ON	PDI watchdog timeout
L/A IN	Green	OFF	Physical layer LINK not established
		ON	Physical layer LINK probability
		Flickering	Running following LINK probability
L/A OUT	Green	OFF	Physical layer LINK not established
		ON	Physical layer LINK probability
		Flickering	Running following LINK probability

Refer to the following diagram for the LED status.



11.2 CAN application protocol over EtherCAT Structure

The CAN application protocol over EtherCAT (CoE) structure for the ALPHA7 Series built-in EtherCAT communication type is shown below.

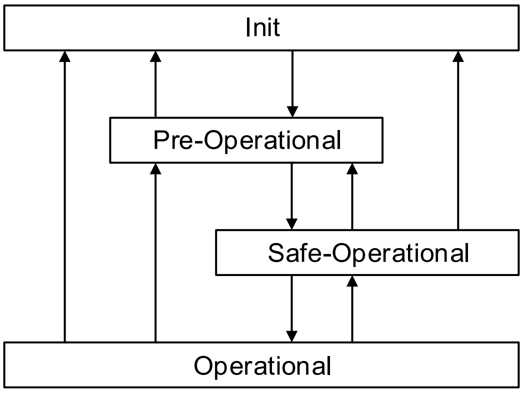


With EtherCAT, multiple protocols can normally be transferred. With the ALPHA7 Series built-in EtherCAT communication type, the IEC61800-7 (CiA 402) drive profile is used.
The application layer object dictionary contains parameter and application data, and PDO mapping information between the process data interface and application.
Process data objects (PDOs) are configured with an object dictionary that can be mapped to PDOs. The process data content is defined with PDO mapping.
Process data communication involves cyclically reading and writing PDOs. With mailbox communication (SDO), all object dictionaries can be read and written with asynchronous message communication.

11

11.3 Communication Status Transition

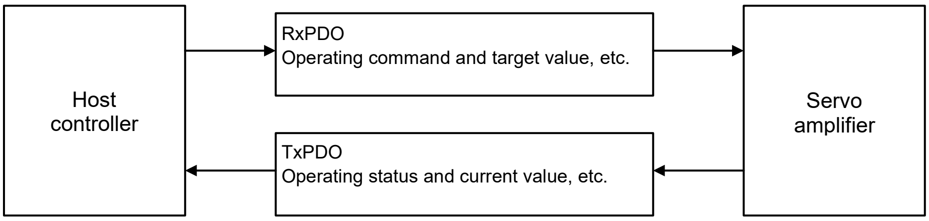
EtherCAT slave state machines are controlled with the EtherCAT master.



Status	SDO communication	PDO receipt	PDO transmission	Description
Init	Not possible	Not possible	Not possible	The communication section is being initialized. Communication is not possible.
Pre-Op	Possible	Not possible	Not possible	Only mailbox communication is possible. This status follows initialization, and involves the processing of network default settings.
Safe-Op	Possible	Not possible	Possible	In addition to mailbox communication, PDO transmission is possible. The status, etc. can be sent from the servo amplifier through cyclic communication in DC mode.
Op	Possible	Possible	Possible	This is the normal operation status. Motors can be controlled through cyclic communication in DC mode.

11.4 Process Data Objects (PDOs)

Real-time data transfer with cyclic communication uses process data objects (PDOs). PDOs contain an RxPDO data input, which receives data from the controller, and a TxPDO data output, which transmits the status from the servo amplifier to the host controller.

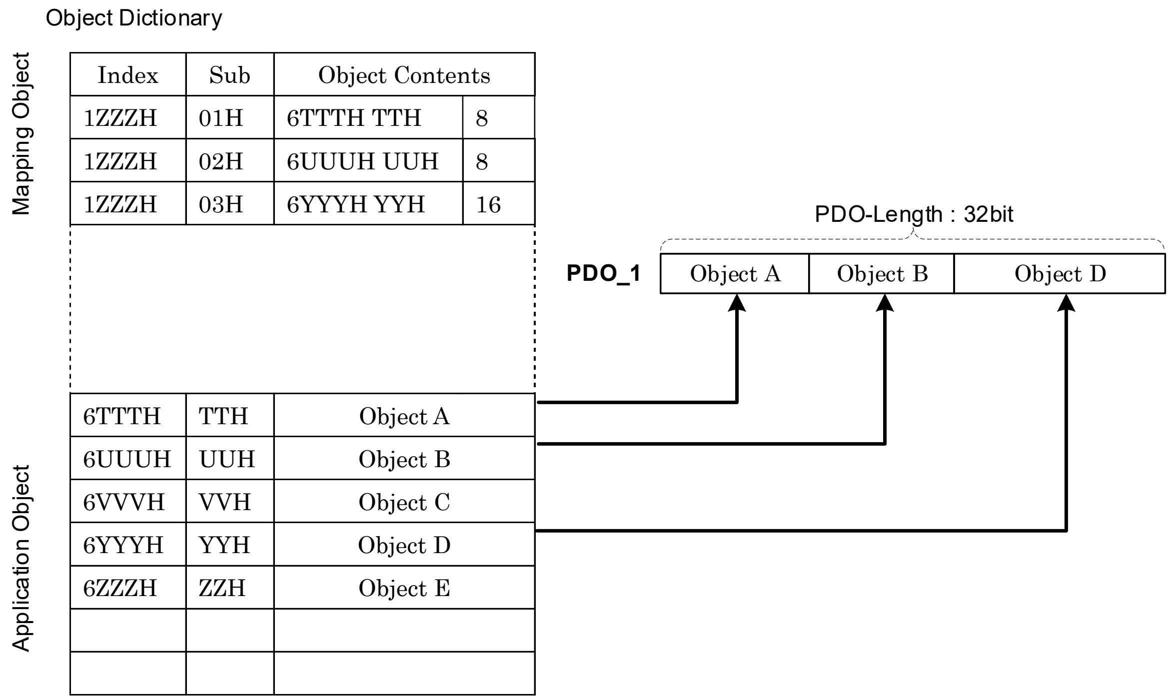


Multiple objects can be held in the EtherCAT application layer, allowing all kinds of servo amplifier process data to be transferred. The process data content is described in the PDO Mapping object and the Sync Manager PDO assignment object.
The ALPHA7 Series supports PDO mapping for position control when the power is ON.

11.4.1 PDO Mapping Settings

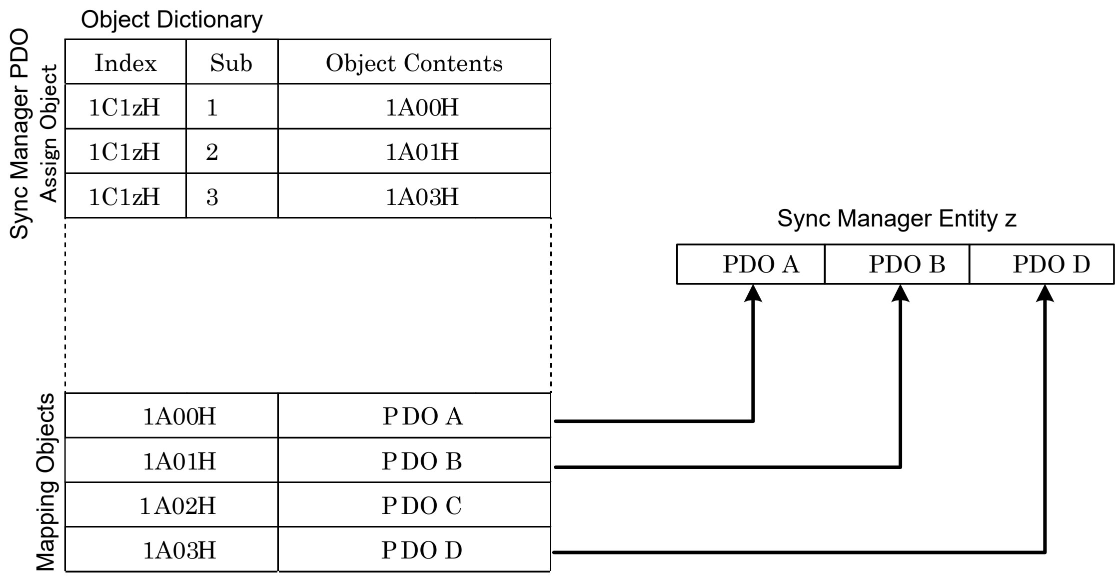
PDO mapping refers to mapping for application objects (real-time process data) from the object dictionary to the PDO.
In the mapping table, the number of mapped objects is indicated in sub-index 00H. In this mapping table, index 1600H to 17FFH are for RxPDO, and index 1A00H to 1BFFH are for TxPDO.
With ALPHA7 Series servo amplifiers, indices can be selected for use from 1600H to 1603H for RxPDO, and from 1A00H to 1A03H for TxPDO.

The following diagram shows an example of PDO mapping.



11.4.2 Sync Manager PDO Assignment Settings

Sync Manager channels can be configured with multiple PDOs. The Sync Manager PDO assignment object describes the relationship between the PDO and Sync Manager.
In the Sync Manager PDO assignment table, the number of PDOs is indicated in sub-index 00h. In this table, index 1C12h is for RxPDO, and index 1C13 is for TxPDO.
The following diagram shows an example of Sync Manager PDO mapping.



11.4.3 PDO Mapping

With ALPHA7 Series servo amplifiers, the objects being mapped can be changed.
PDO mapping related objects can only be changed when the EtherCAT communication status is Pre-Op. Changed content is not saved to the EEPROM, and therefore settings must be specified each time the power is turned ON if the servo amplifier is used with settings which differ from the default settings.

■ Default settings

RxPDO (1600H)	Controlword (6040H), Target position (607AH), Touch probe function (60B8H)
TxPDO (1A00H)	Error code (603FH), Statusword (6041H), Position actual value (6064H), Touch probe status (60B9H), Touch probe 1 positive position value (60BAH), Touch probe 2 positive position value (60BCH), Digital inputs (60FDH)

■ Maximum number of objects and maximum total object size that can be mapped

PDO mapping object	Max. number of objects	Max total object size
RxPDO (1600H to 1603H)	16	128
TxPDO (1A00H to 1A03H)	16	128

Note	• The communication cycle that can be set differs depending on the total size of the mapped object. Refer to “15.1.3 Communication Cycles and Corresponding Synchronization Mode” for details. • Refer to “15.1.11 PDO Mapping Objects” for details on mappable objects.

11.4.4 Multiple PDO Mappings

With ALPHA7 Series servo amplifiers, PDO mappings can be combined and specified.
Specify two or more PDO mappings with 1C12H: Sync manager 2 PDO assignment and 1C13H: Sync manager 3 PDO assignment.
The object set at sub-index 01H is mapped, and this is followed by the object set at sub-index 02H.
If the same object is mapped multiple times with TxPDO mapping, the last object value will be valid.
These objects can only be changed when the EtherCAT communication status is Pre-Op. Changed content is not saved to the EEPROM, and therefore settings must be specified each time the power is turned ON if the servo amplifier is used with settings different from the default settings.

Note	• The communication cycle that can be set differs depending on the total size of the mapped object. Refer to "15.1.3 Communication Cycles and Corresponding Synchronization Mode" for details.

11

11.5 Service Data Objects (SDOs)

ALPHA7 Series servo amplifiers support SDO communication. Use SDO communication to set ALPHA7 Series servo amplifier objects and monitor the status. Objects can be set, and the status monitored by writing and reading data to and from entries in the object dictionary at the host controller.

11.5.1 Abort Codes

Abort codes used when SDO communication errors occur are shown in the following table.

Value	Meaning
05030000H	No toggle bit change
05040000H	SDO protocol timeout
05040001H	Invalid/unknown client/server command designator
05040005H	Outside memory range
06010000H	No support access to object
06010001H	Read access to write only object
06010002H	Write access to read only object
06020000H	Object that does not exist in object directory
06040041H	Unable to map object to PDO
06040042H	Mapped object quantity/length exceeds PDO length
06040043H	General parameter mismatch
06040047H	Device general internal mismatch
06060000H	Access failure due to hardware error
06070010H	Data type mismatch, service parameter length mismatch
06070012H	Data type mismatch, service parameter too long
06070013H	Data type mismatch, service parameter too short
06090011H	Sub-index does not exist
06090030H	Parameter value lies outside range (write access only)
06090031H	Written parameter value is too big
06090032H	Written parameter value is too small
06090036H	Max. value is smaller than min. value
08000000H	General error
08000020H	Data cannot be transferred to/stored in application
08000021H	Control performed locally[*1], and so data cannot be transferred to/stored in application
08000022H	Data cannot be transferred to/stored in application with current device status
08000023H	Object dictionary dynamic generation failure, or object dictionary does not exist

*1 The slave runs locally, and cannot be controlled from the EtherCAT Master.

11

11.6 Synchronization with Distributed Clock

A mechanism known as Distributed Clock (DC) is used for synchronization with EtherCAT communication. The ALPHA7 Series also uses DC mode to realize high-accuracy control with multi-axis systems.
In DC mode, synchronization is realized by having the master and slave share the same clock.
At slaves, an interrupt (Sync0) is produced in accurate cycles based on this clock.
Servo amplifiers are controlled with this accurate timing.

11.6.1 Communication Cycles (DC Cycles)

The communication cycle is determined at the master side by setting the Sync0 signal output cycle.

Setting range: 125 μs / 250 μs / 500 μs / 1 ms / 2 ms / 4 ms

Note	The communication cycles that can be set differ depending on conditions such as the operation mode used. Refer to “15.1.3 Communication Cycles and Corresponding Synchronization Mode” for details on the communication cycles that can be set.

11.7 ESI Files

Please down ESI files from the following websites.
(Member registration is required (free).)
URL: https://felib.fujielectric.co.jp/download/

Note	Ensure that ESI files registered in the master match the servo amplifier Revision No. If the Revision No. is no known, it can also be checked from the PC Loader Object monitor

CHAPTER 12 BASIC CONTROL FUNCTIONS

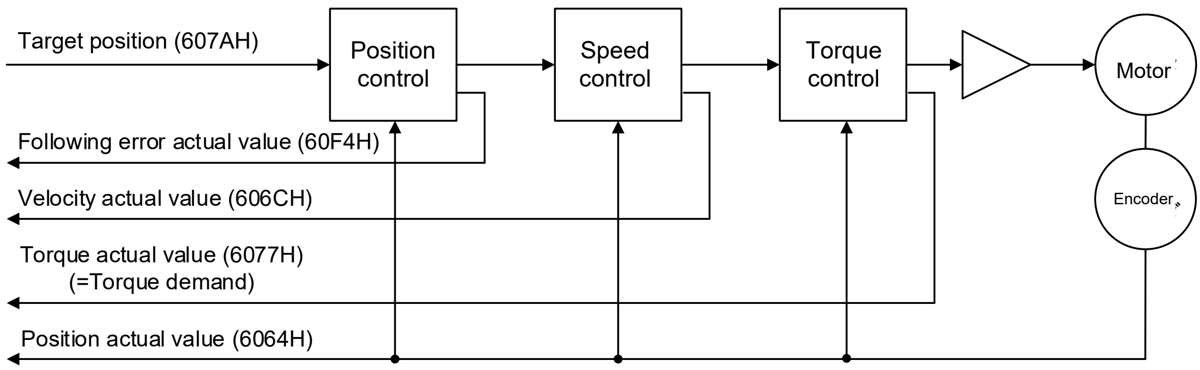
12

12.1 Cyclic Synchronous Position Mode

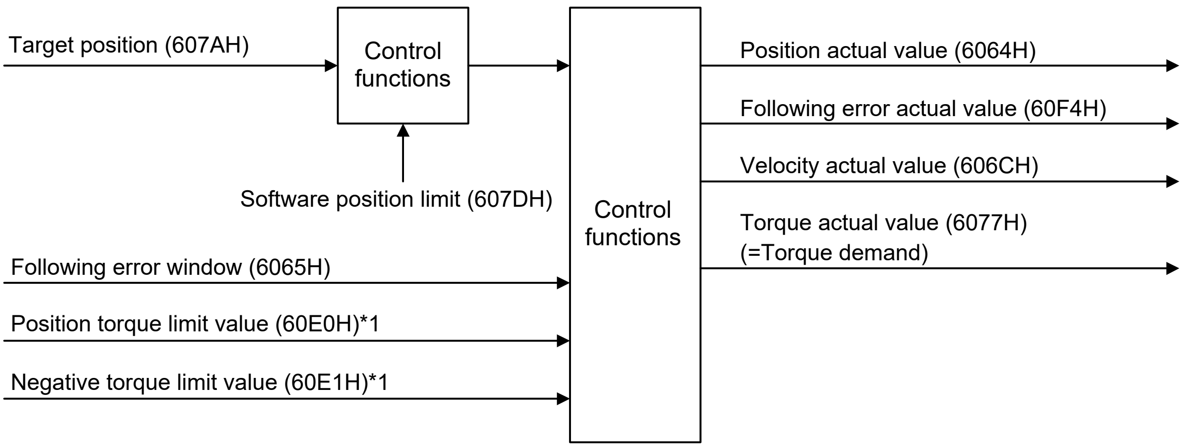
In this operation mode, the controller uses a trajectory generation function (operation profile operation function) to provide the servo amplifier with the target position with cyclic synchronization. Position control, speed control, and torque control are performed inside the servo amplifier.

Cyclic synchronous position mode configuration

The cyclic synchronous position mode configuration is as follows.



The configuration of cyclic synchronous position mode control functions is as follows.



*1 The Position torque limit value and Negative torque limit value are not enabled when the product is shipped from the factory. When using these parameters, set PA2_57 (5002H-39H) to “1”.

12

12.1.1 Related Objects

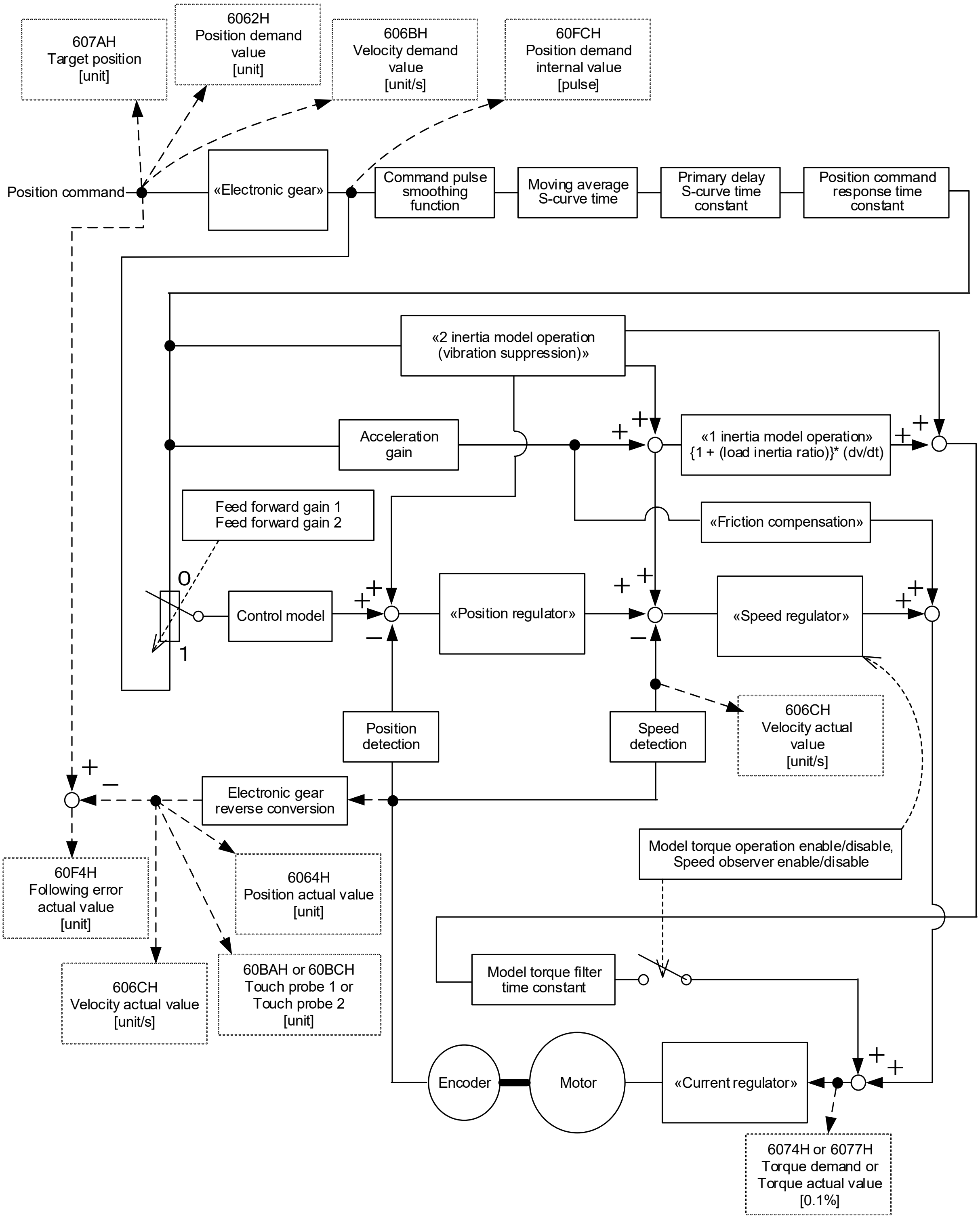
Index	Sub-index	Name	Access	Size	Unit	Setting range	Default value
6040H	00H	Controlword	RW	U16	0 to FFFFH	-	0000H
6060H	00H	Modes of operation	RW	INT8	-	0 to 10	00H
607AH	00H	Target position	RW	INT32	Command unit	-2147483648 to 2147483647	0000H
6065H *1)	00H	Following error window	RW	U32	Command unit	1 to 4294967295	4294967295
6041H	00H	Statusword	RO	U16	0 to FFFFH	-	0000H
6064H	00H	Position actual value	RO	INT32	Command unit	-2147483648 to 2147483647	0000H
606CH	00H	Velocity actual value	RO	INT32	Command unit/s	-2147483648 to 2147483647	0000H
6077H	00H	Torque actual value	RO	INT16	0.1%	-350.0 to 300.0%	0.0%
60E0H	00H	Positive torque limit value	RW	UINT16	0.1%	0.0 to 350.0%	350.0%
60E1H	00H	Negative torque limit value	RW	UINT16	0.1%	0.0 to 350.0%	350.0%
60F4H	00H	Following error actual value	RO	INT32	Command unit	-2147483648 to 2147483647	0000H

*1) The 6065H: Following error window setting range is “1 to 4294967295”. Note that Following error detection will be disabled if “4294967295” is set for the setting value.

12

12.1.2 Cyclic Synchronous Position Mode Block Diagram

RY□□□F7-VC2 Series position control is configured as follows.



* Refer to “15.3 Control Circuit Block Diagram” for details on the control circuit.

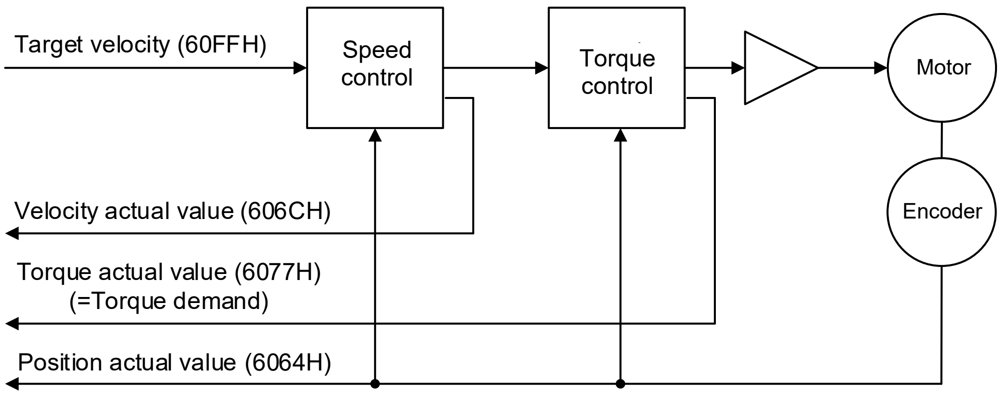
12

12.2 Cyclic Synchronous Velocity Mode

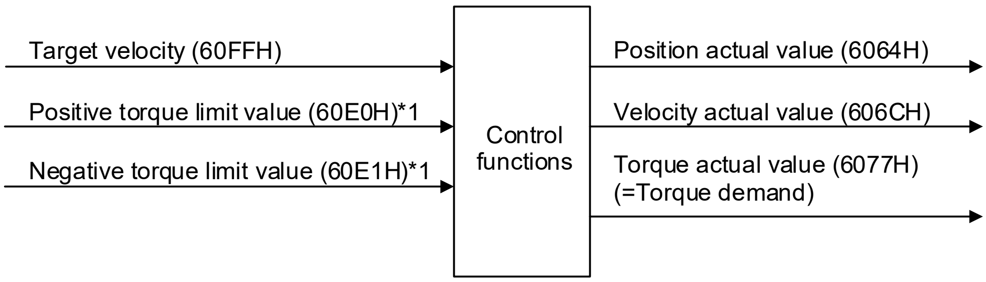
In this operation mode, the controller uses a trajectory generation function (operation profile operation function) to provide the servo amplifier with the target speed with cyclic synchronization. Speed control and torque control are performed inside the servo amplifier.

Cyclic synchronous velocity mode configuration

The cyclic synchronous velocity mode configuration is as follows.



The configuration of cyclic synchronous velocity mode control functions is as follows.



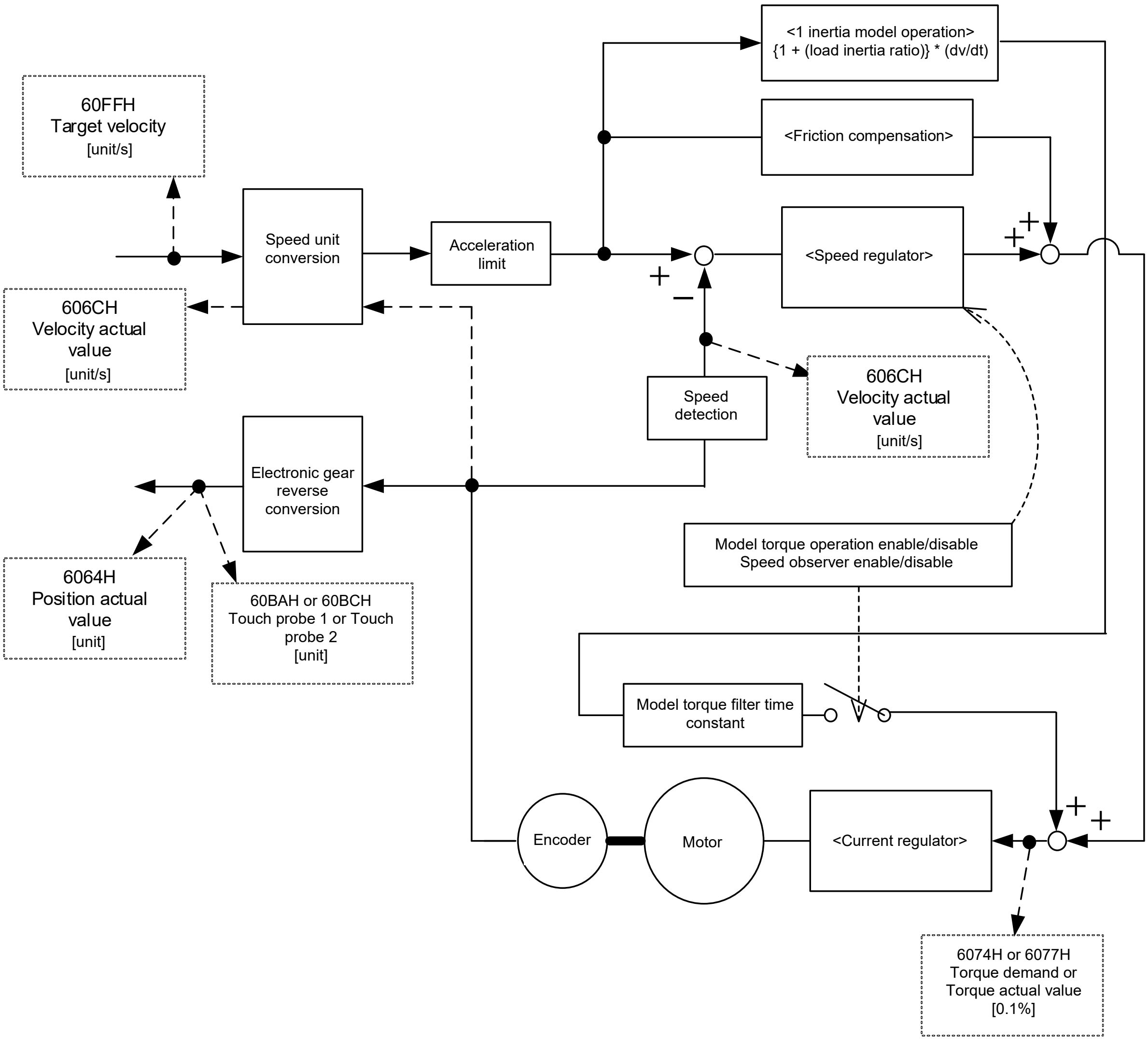
*1 The Position torque limit value and Negative torque limit value are not enabled when the product is shipped from the factory. When using these parameters, set PA2_57 (5002H-39H) to “1”.

12.2.1 Related Objects

Index	Sub-index	Name	Access	Size	Unit	Setting range	Default value
6040H	00H	Controlword	RW	U16	0 to FFFFH	-	0000H
6060H	00H	Modes of operation	RW	INT8	-	0 to 10	00H
60FFH	00H	Target velocity	RW	INT32	Command unit	-2147483648 to 2147483647	0000H
6041H	00H	Statusword	RO	U16	0 to FFFFH	-	0000H
6064H	00H	Position actual value	RO	INT32	Command unit	-2147483648 to 2147483647	0000H
606CH	00H	Velocity actual value	RO	INT32	Command unit/s	-2147483648 to 2147483647	0000H
6077H	00H	Torque actual value	RO	INT16	0.1%	-350.0 to 350.0%	0.0%
60E0H	00H	Positive torque limit value	RW	UINT16	0.1%	0.0 to 350.0%	350.0%
60E1H	00H	Negative torque limit value	RW	UINT16	0.1%	0.0 to 350.0%	350.0%

12.2.2 Cyclic Synchronous Velocity Mode Block Diagram

RYT□□□F7-VC2 Series speed control is configured as follows.



* Refer to “15.3 Control Circuit Block Diagram” for details on the control circuit.

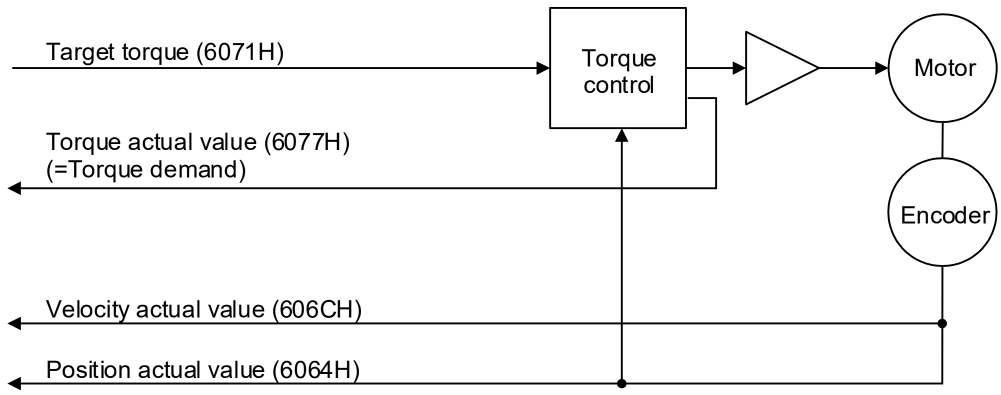
12

12.3 Cyclic Synchronous Torque Mode

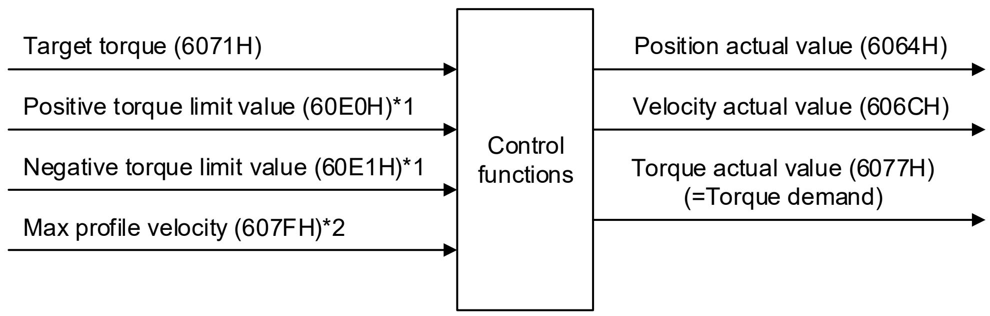
In this operation mode, the controller uses a trajectory generation function (operation profile operation function) to provide the servo amplifier with the target torque with cyclic synchronization. Torque control is performed inside the servo amplifier.

Cyclic synchronous torque mode configuration

The cyclic synchronous torque mode configuration is as follows.



The configuration of cyclic synchronous torque mode control functions is as follows.



*1 The Position torque limit value and Negative torque limit value are not enabled when the product is shipped from the factory. When using these parameters, set PA2_57 (5002H-39H) to “1”.

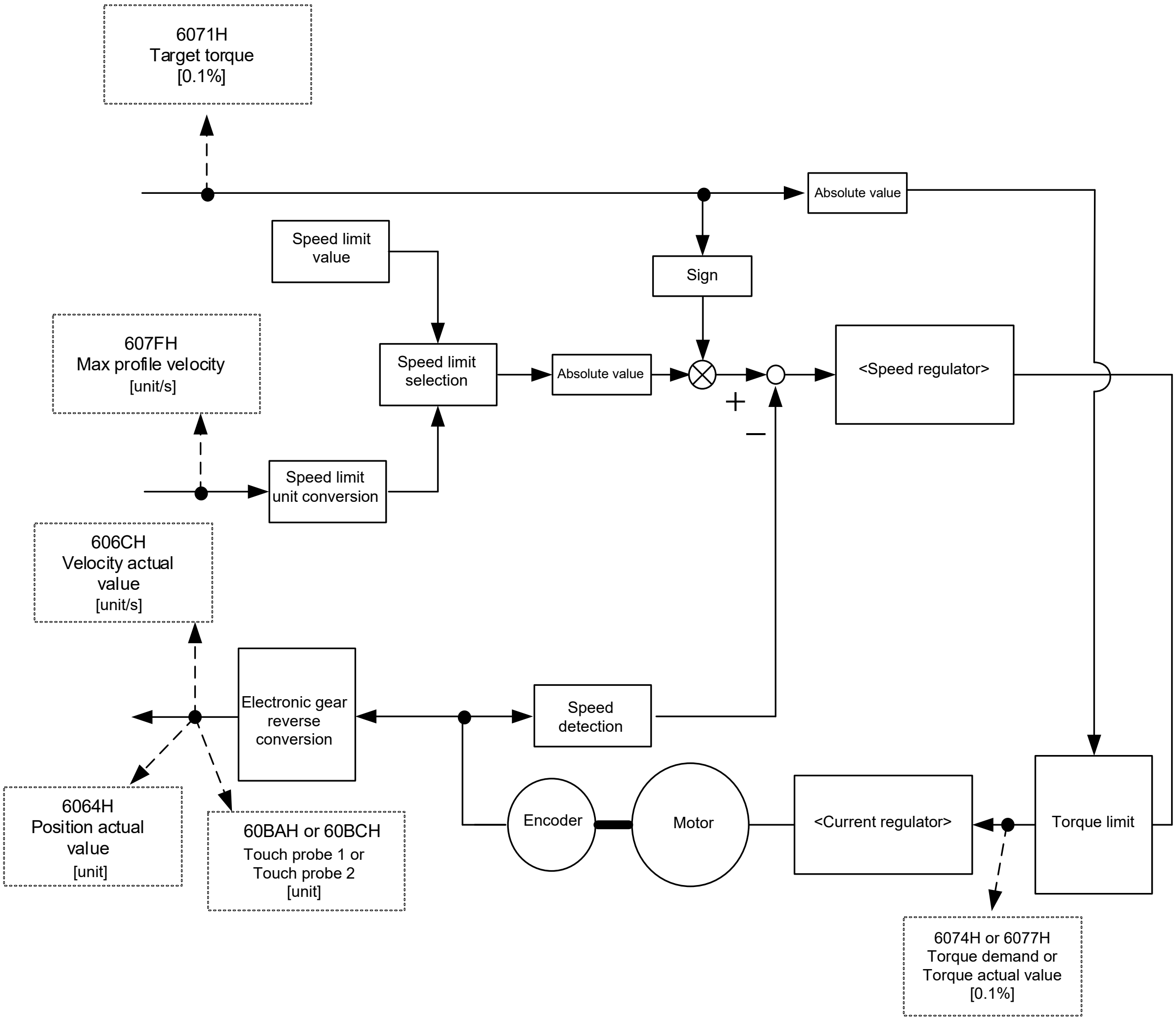
*2 Max profile velocity is not enabled when the product is shipped from the factory. When using this parameter, set PA2_56 (5002H-38H) to “1”.

12.3.1 Related Objects

Index	Sub-index	Name	Access	Size	Unit	Setting range	Default value
6040H	00H	Controlword	RW	U16	0 to FFFFH	-	0000H
6060H	00H	Modes of operation	RW	INT8	-	0 to 10	00H
6071H	00H	Target torque	RW	INT16	0.1%	-350.0 to 350.0%	0.0%
607FH	00H	Max profile velocity	RW	U32	Command unit/s	0 to 2147483647	1677721600
6041H	00H	Statusword	RO	U16	0 to FFFFH	-	0000H
6064H	00H	Position actual value	RO	INT32	Command unit	-2147483648 to 2147483647	0000H
606CH	00H	Velocity actual value	RO	INT32	Command unit/s	-2147483648 to 2147483647	0000H
6077H	00H	Torque actual value	RO	INT16	0.1%	-350.0 to 350.0%	0.0%
60E0H	00H	Positive torque limit value	RW	UINT16	0.1%	0.0 to 350.0%	350.0%
60E1H	00H	Negative torque limit value	RW	UINT16	0.1%	0.0 to 350.0%	350.0%

12.3.2 Cyclic Synchronous Torque Mode Block Diagram

RYT□□□F7-VC2 Series torque control is configured as follows.



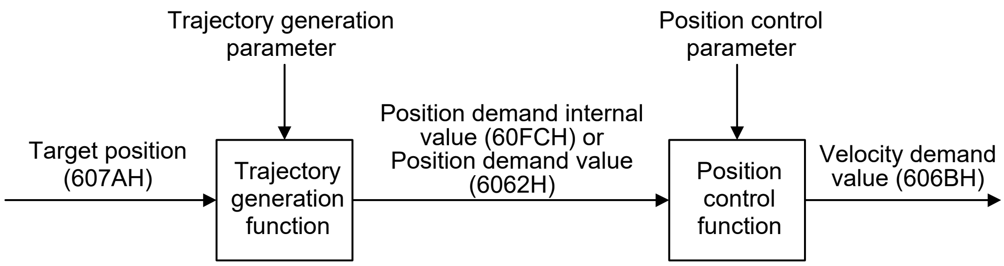
* Refer to “15.3 Control Circuit Block Diagram” for details on the control circuit.

12

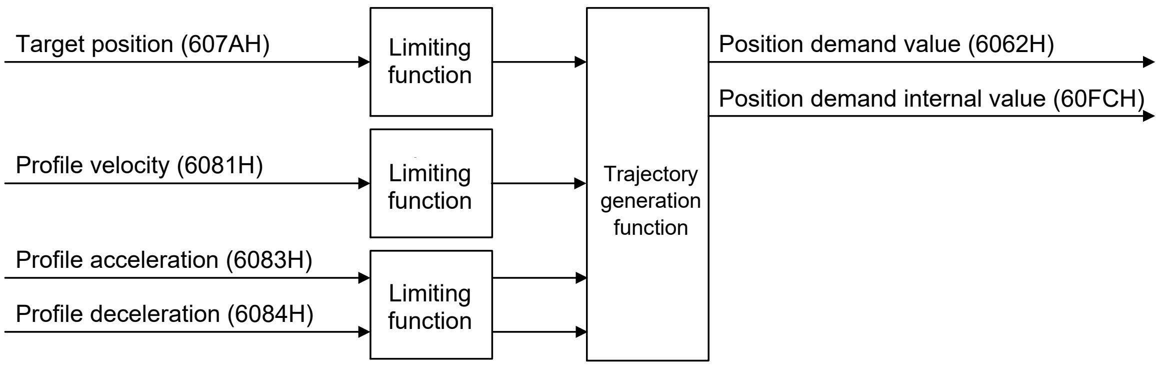
12.4 Profile Position Mode

Note	When using profile position mode, PA2_25 (5002H-19H) must be changed from the default factory setting to “1” as a rule. Refer to “3.4 Automatic Operation Setting Parameters” for details.

In this operation mode, the servo amplifier internal trajectory generation function (operation profile operation function) is used to perform PTP positioning. Automatic operation is performed based on 607AH: Target position, 6081H: Profile velocity, 6083H: Profile acceleration, 6084H: Profile deceleration and so on.



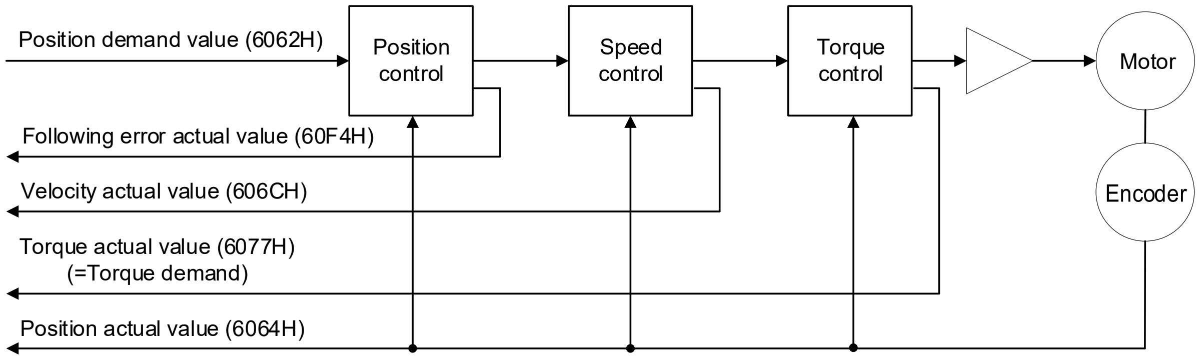
The trajectory generation function configuration is as follows.



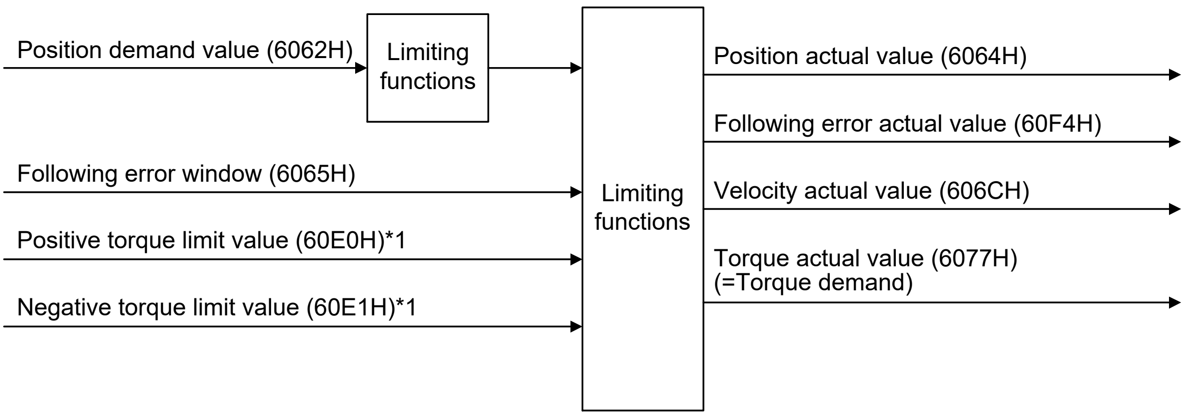
12

Profile position mode configuration

The profile position mode configuration is as follows.



The configuration of profile position mode control functions is as follows.



*1 The Position torque limit value and Negative torque limit value are not enabled when the product is shipped from the factory. When using these parameters, set PA2_57 (5002H-39H) to “1”.

12

12.4.1 Related Objects

Index	Sub-index	Name	Access	Size	Unit	Setting range	Default value
6040H	00H	Controlword	RW	U16	0 to FFFFH	-	0000H
6060H	00H	Modes of operation	RW	INT8	-	0 to 10	00H
6065H *1)	00H	Following error window	RW	U32	Command unit	1 to 424967925	424967925
607AH	00H	Target position	RW	INT32	Command unit	-2147483648 to 2147483647	0000H
607DH	01H	Min position limit	RW	INT32	Command unit	-2000000000 to 2000000000	-2000000000
	02H	Max position limit	RW	INT32	Command unit	-2000000000 to 2000000000	2000000000
6081H	00H	Profile velocity	RW	U32	Command unit/s	0 to 2147483647	279620267
6083H	00H	Profile acceleration	RW	U32	Command unit/s^2	0 to 2147483647	559240533
6084H	00H	Profile deceleration	RW	U32	Command unit/s^2	0 to 2147483647	559240533
6041H	00H	Statusword	RO	U16	0 to FFFFH	-	0000H
6062H	00H	Position demand value	RO	INT32	Command unit	-2147483648 to 2147483647	0
6064H	00H	Position actual value	RO	INT32	Command unit	-2147483648 to 2147483647	0000H
606CH	00H	Velocity actual value	RO	INT32	Command unit/s	-2147483648 to 2147483647	0000H
6077H	00H	Torque actual value	RO	INT16	0.1%	-350.0 to 350.0%	0.0%
60E0H	00H	Positive torque limit value	RW	UINT16	0.1%	0.0 to 350.0%	350.0%
60E1H	00H	Negative torque limit value	RW	UINT16	0.1%	0.0 to 350.0%	350.0%
60F4H	00H	Following error actual value	RO	INT32	Command unit	-2147483648 to 2147483647	0000H
60FCH	00H	Position demand internal value	RO	INT32	Encoder unit	-2147483648 to 2147483647	0

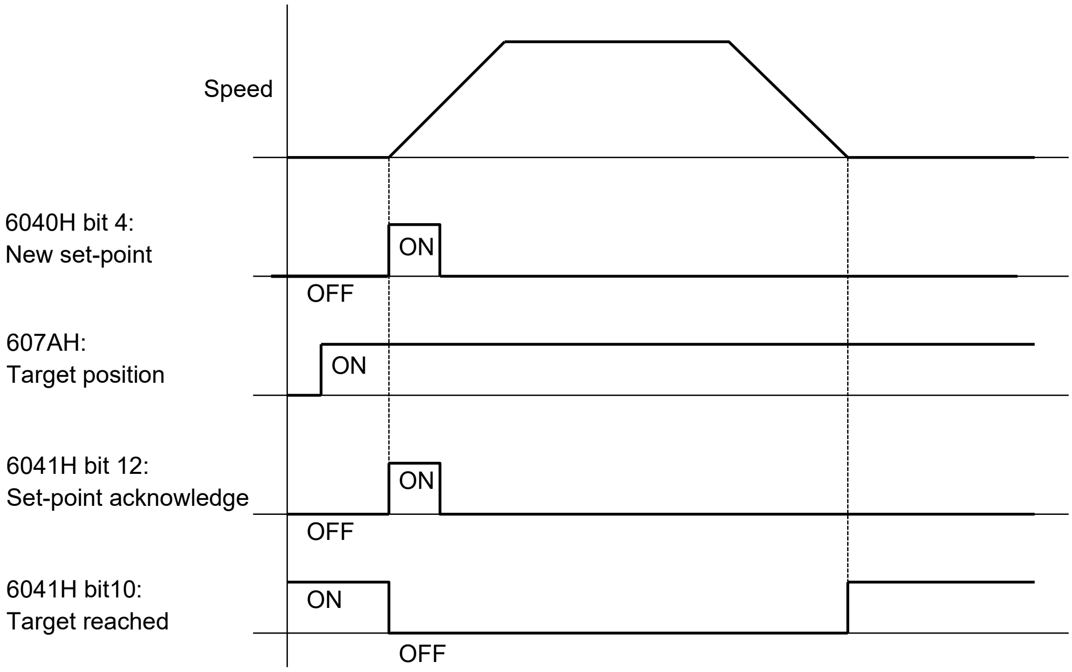
*1) The 6065H: Following error window setting range is “1 to 4294967295”. Note that Following error detection will be disabled if “4294967295” is set for the setting value.

12.4.2 Function Description

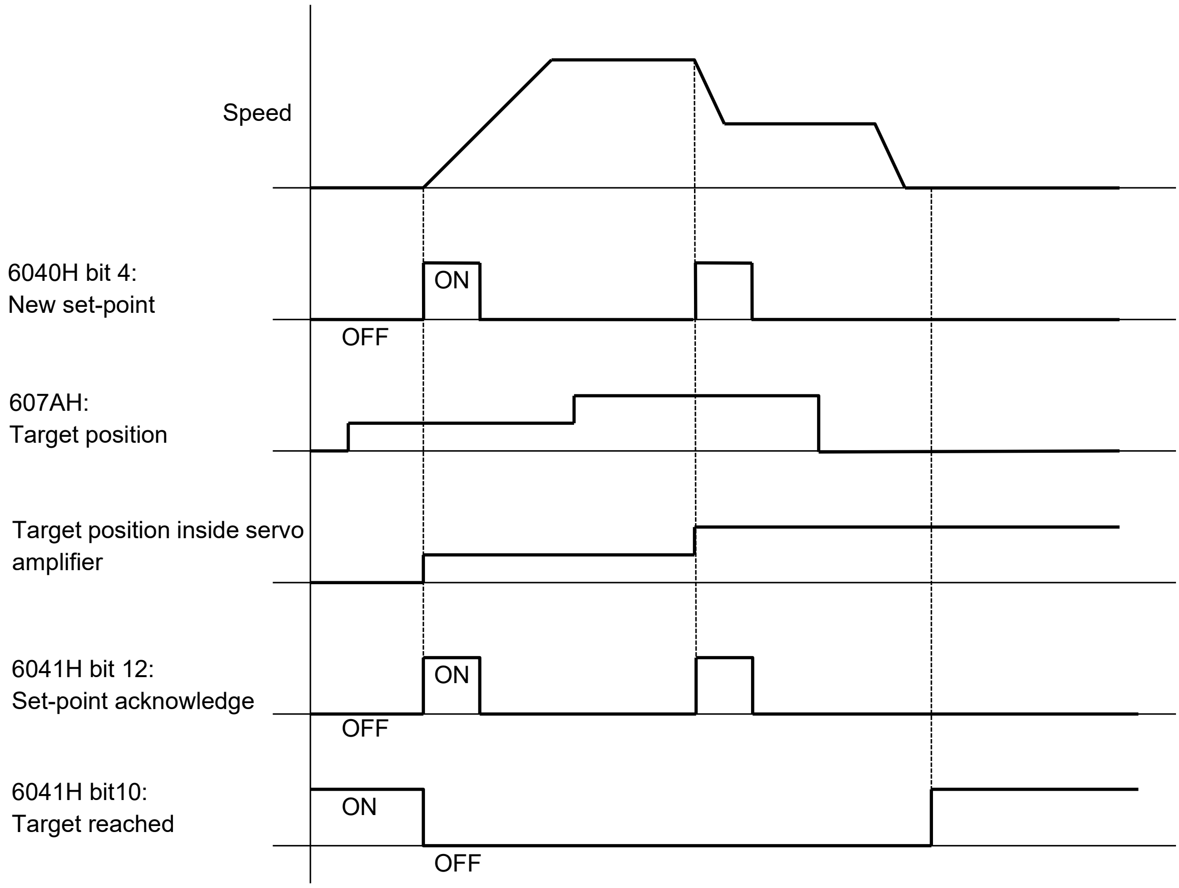
ALPHA7 Series servo amplifiers are capable of performing PTP positioning.

Set 6040H: Controlword bit 5: Change set immediately to “1”.

By setting 607AH: Target position, 6081H: Profile velocity, 6083H: Profile acceleration, and 6084H: Profile deceleration, and changing 6040H: Controlword bit 4: New set-point from “0” to “1”, positioning to the set target position is started.



The target value can be changed while performing PTP positioning.
By changing the 607AH: Target position and 6081H: Profile velocity values, setting 6040H: Control word Bit 5: Change set immediately to “1”, and then changing Bit 4: New set-point from “0” to “1” during operation, positioning is performed based on the changed values.



12

12.4.3 Controlword (6040H) in Profile Position Mode

Bit	Name	Description
4	New set-point	Positioning is started at the “0” to “1” rising edge. At this time, the 607AH: Target position, 6081H: Profile velocity, 6083H: Profile acceleration, and 6084H: Profile deceleration values are read.
5	Change set immediately	Use set to “1”. Operation is not guaranteed when set to “0”.
6	Abs	Use set to “0”. Operation is not guaranteed when set to “1”.
8	Halt	Positioning is started or continued when set to “0”. Operation stops based on the 605DH: Halt option code when set to “1”.
9	Change on Set-point	This is not supported on the ALPHA7 Series.

12.4.4 Profile Position Mode Statusword (6041H)

Bit	Name	Value	Description
10	Target reached	0	Halt bit = “0”: not in position Halt bit = “1”: axis is decelerating
		1	Halt bit = “0”: in position Halt bit = “1”: axis speed is zero
12	Set-point acknowledge	0	Awaiting new target position
		1	Receiving target position updates (overwriting)
13	Following error	0	No deviation counter over
		1	Deviation counter over

12.5 Homing Mode

In this operation mode, the servo amplifier trajectory generation function (operation profile operation function) is used to perform the homing operation from the controller based on the specified homing method.

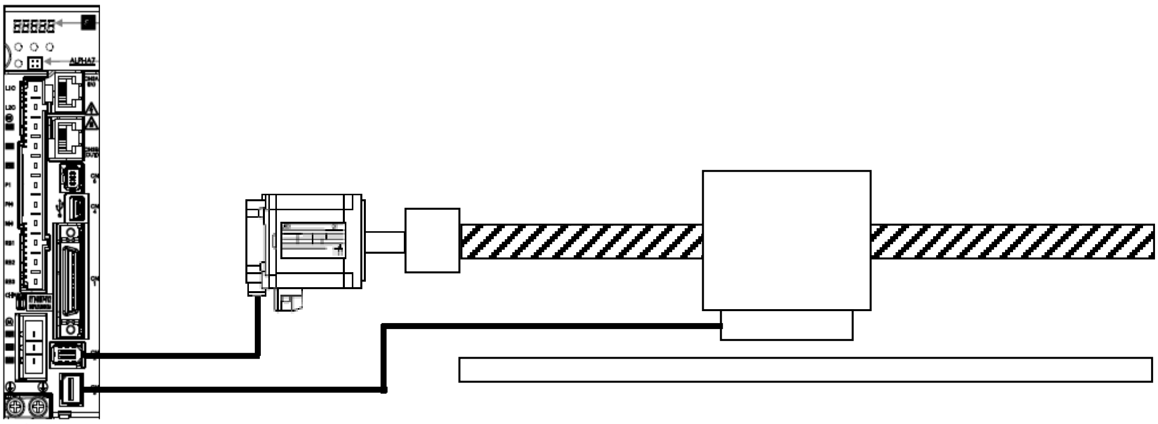
Depending on the controller side specifications, the following two homing methods are available.

- Method 1
  A homing operation profile is created at the controller side, and a command is given to the servo amplifier in cyclic synchronous position mode (csp).
- Method 2
  The servo amplifier homing mode is used. The controller side specifies the homing method supported by the servo amplifier, and issues a homing start command.

Refer to the controller manual if performing homing using method 1.
Refer to the controller manual and "15.1.7 Homing Mode Specifications" in this manual if performing homing using method 2.

12.6 Full-closed Control

In full-closed control, position control is performed using the position detection value of the external encoder connected to the mechanical end in addition to the position detection value of the motor encoder.
When PA4_32 (Fully Closed System Setting) is set to 1□□□ (Fully Closed System Enable), Fully Closed Control is enabled.
Fully closed control can be executed only for position control (PP, HM, CSP) (speed control (PV, CSP) and torque control (CST) are not available).

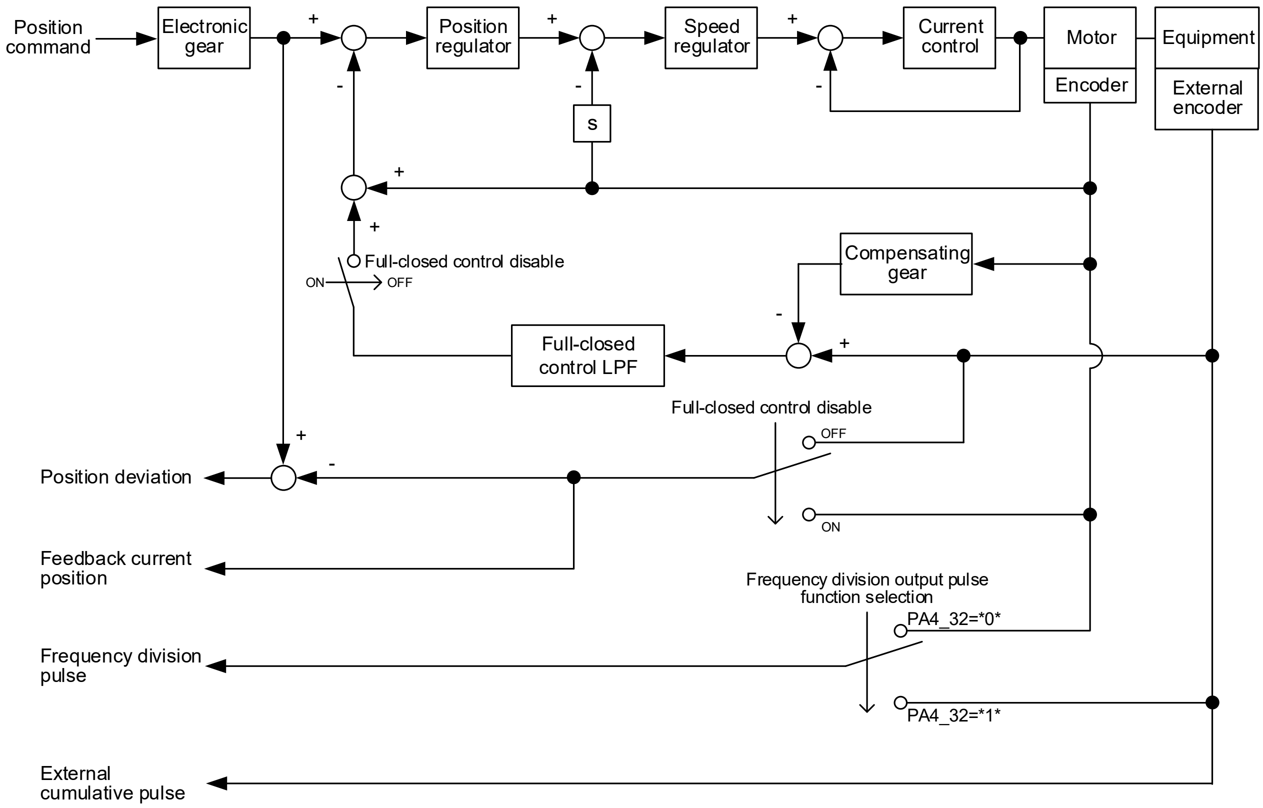


When using in full-closed control, set the following parameters.

No.	Name	Setting range	Default value	Change
PA4_32	Full-closed system setting	0000 to 1101 ***□: External encoder pulse phase selection *□**: Origin return Z-phase selection □***: Full-closed system enabled	0000	Power
PA4_35	Full-closed LPF time-constant	0.0 to 100.0[ms]	1.0	Always
PA4_36	External/motor deviation over detection value	1 to 16777216[×100pulse]	25600	Always
PA4_37	External/motor deviation over forecast value	1 to 16777216[×100pulse]	12800	Always
PA4_38	Frequency divider denominator for external/motor deviation monitor	1 to 100000	100	Always

Index	Sub-Idx	Name	Setting range	Default value	EEPROM
60E6H	01H	Additional position encoder resolution (1st additional position encoder resolution)	1 to16777216	32768	YES

■ Control block diagram when full-closed control is enabled (PA4_32=1□□□)



■ Safety Precautions

(1) UNIT QUANTITY

Since the positioning accuracy in full-closed control is an external pulse unit, **adjust the unit amount to the external pulse unit** so that the same unit is used for the command pulse, target position, current position, etc.

1st additional position encoder resolution(60E6-01H) = external pulse count per moter rotation

GearRatio (6091H) (MotorRevolutions / ShaftRevolution) =

Motor encoder pulse count/1st additional position encoder resolution (60E6-01H)

(2) PA1_32 (deviation zero range/positioning complete range)

Do not set the zero deviation width to less than the external pulse width.

Since the positioning accuracy in full-closed control is an external pulse unit, if the unit amount is finer than the external pulse, positioning within the deviation zero width cannot be performed, so the deviation zero or positioning completion cannot be detected, and the next operation cannot be started. (Pre-operation does not end.)

12.7 Electronic Gears

Electronic gear settings can be specified from 6091H: Gear Ratio 6091H-01H: Motor revolutions and 6091H-02H: Shaft revolutions.
The following formula is used to calculate.

■ Motor revolutions / Shaft revolutions calculation formula

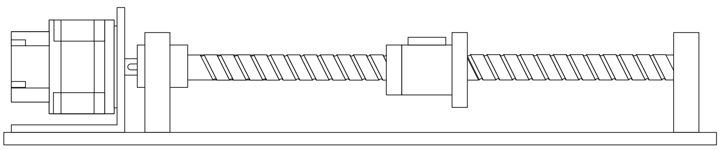
Cancel down so that Motor revolutions/Shaft revolutions is an integer (67108864 or less).

$$\frac{\text{(Mechanical system travel amount per servomotor revolution)}}{\text{Encoder pulse count*}} \times \frac{\text{Motor revolutions}}{\text{Shaft revolutions}} = \text{(unit amount) *}$$

* The unit amount is a value such as "1", "0.1", "0.01", or "0.001". Unit is expressed as [unit].
* The encoder pulse count is the value for "24 bits = 16777216 pulses".

$$\frac{\text{Motor revolutions}}{\text{Shaft revolutions}} = \frac{\text{Encoder pulse count}}{\text{(Mechanical system travel amount per servomotor revolution)}} \times \text{(unit amount)}$$

[Example of calculation of electronic gear ratio]
To connect the ball screw (lead 10 [mm]) directly to the output shaft of the servomotor and set the unit amount at 1/100, the number of encoder pulses (24-bits) is 16777216 revolutions.



$$\frac{\text{(Mechanical system travel amount per servomotor revolution)}}{\text{16777216 pulses/revolution}} \times \frac{\text{Motor revolutions}}{\text{Shaft revolutions}} = \text{(unit amount)}$$

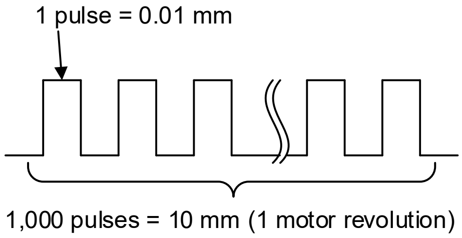
$$\frac{\text{10 mm}}{\text{16777216 pulses/revolution}} \times \frac{\text{Motor revolutions}}{\text{Shaft revolutions}} = 1 / 100$$

$$\frac{\text{Motor revolutions}}{\text{Shaft revolutions}} = 1 / 100 \times \frac{\text{16777216 pulses/revolution}}{\text{10 mm}} = \frac{2097152}{125}$$

Consequently, the Motor revolutions will be 2097152, and Shaft revolutions will be 125.

Hint

If the mechanical system travel amount per servomotor revolution includes π, you can approximate to 355/113.



To set with the number of command input pulses per servomotor revolution, set as follows:

$$\frac{\text{Motor revolutions}}{\text{Shaft revolutions}} = \frac{\text{Encoder pulse count (24 bits = 16777216)}}{\text{Command input pulse count per servo motor revolution}}$$

For example, to set the number of command input pulses per servomotor revolution to 1024, set the number of Motor revolutions to 1677216, and the number of Shaft revolutions to 1024.

CHAPTER 13 PC LOADER

13

13.1 Operating Environment

A PC with the following environment is required to use PC Loader.

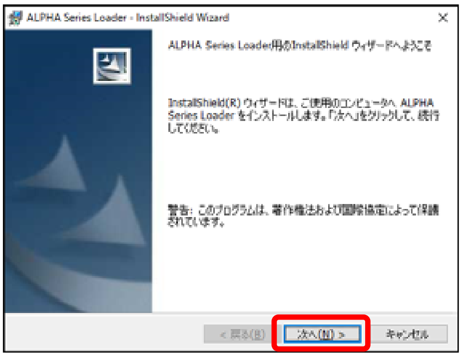
- Operating system
  Windows 10
  Windows 8.1
  Windows 7
- CPU
  1[GHz] or higher
- Memory environment
  2 [GB] or more (1 [GB] or more for 32-bit system)
- Display
  Windows compatible display with XGA (1024 × 768 [pixels]) resolution or higher
- Available hard disk capacity
  200 [MB] or more

13.2 Installation Method

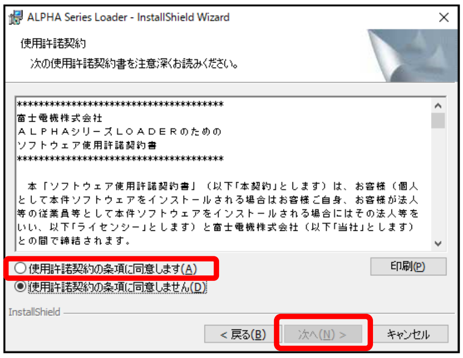
Exit Message Manager (MM) prior to installation.

[1] Start the ALPHA7 Series PC Loader setup program.
Click “setup.exe”.

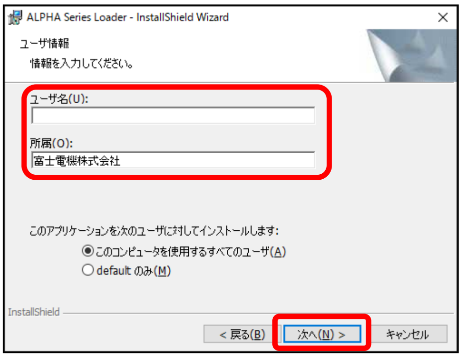
[2] The installation preparation screen is displayed.
Click [Next].



[3] The license agreement for the ALPHA7 Series PC Loader software is displayed.
Read the content of the license agreement carefully.
If there are no problems, click “I accept the terms of the license agreement”, and then click [Next].

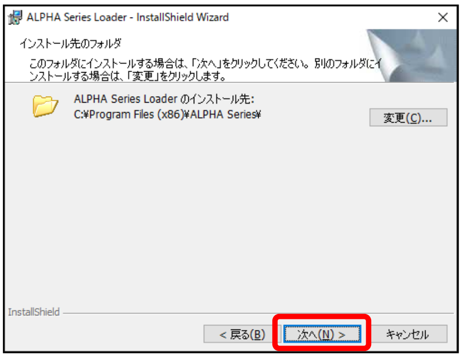


[4] Enter user information.
Enter your user name and the division you belong to.
Furthermore, specify the user(s) who will be using PC Loader.
After entering information and selecting the applicable user(s), click [Next].



[5] Select the installation folder.

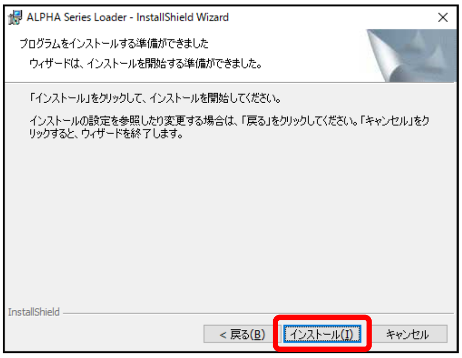
Select the folder in which PC Loader is to be installed, and click [Next].



[6] The installation preparation start screen is displayed.

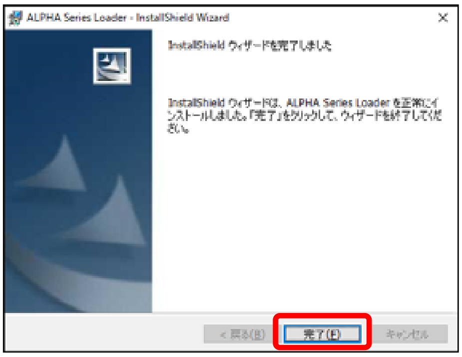
Click [Install].

File copying is started.



[7] The installation complete screen is displayed.

Click [Finish] to complete the installation.



13

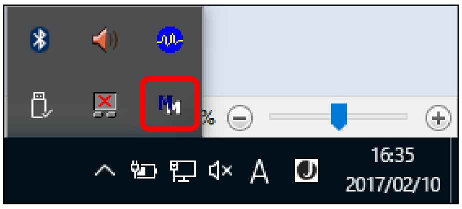
■ Message Manager (MM)

Message Manager (MM): hereinafter referred to as MM) is management software that allows communication ports to be shared when running multiple loader software. MM starts automatically when ALPHA7 Series PC Loader is started. Do not exit MM while ALPHA7 Series PC Loader is in use.

If using PC Loader for the following Fuji Electric products, MM used to manage computer communication functions starts up in addition to the Loader software for each device. If the Loader version for each device is one of the following, start ALPHA7 Series PC Loader after exiting MM. The versions of MM for PC Loader (versions) in the following list are old, and therefore it will not be possible to run ALPHA7 Series PC Loader.
If ALPHA7 Series PC Loader is started first, the versions of PC Loader in the following list can be used as is.

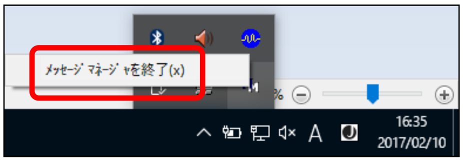
Applicable device	Applicable model	Loader name/model
Fuji integrated controllers	MICREX-SX	SX Programmer Expert (D300winVer2) / NP4H-SEDBV2
		SX Programmer Expert (D300winVer3) / NP4H-SEDBV3
		SX Programmer Standard / NP4H-SWN
		SX communication middleware / NP4N-MDLW
Fuji inverters	FRENIC-Mini FRENIC-Eco	The FRENIC Loader
	FRENIC-Multi	FRENIC Loader 2
	FRENIC-MEGA	FRENIC Loader 3

The Windows task bar can be used to check whether MM is running.

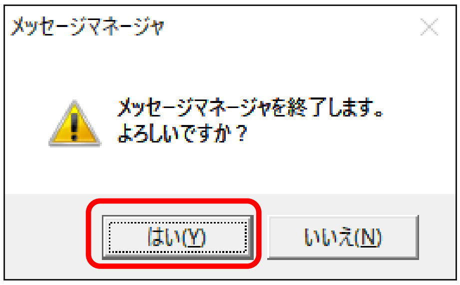


The following procedure can be used to exit MM (explanation based on use of right-hand mouse).

[1] By aligning the mouse cursor with the MM icon and right-clicking, “Exit Message Manager” is displayed.



[2] By aligning the mouse cursor with “Exit Message Manager” and left-clicking, an exit confirmation screen is displayed. Align the mouse cursor with [Yes] and left-click.

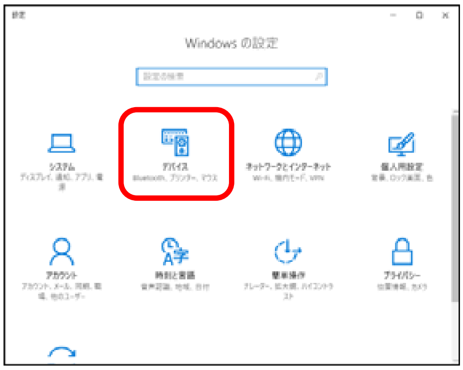


[3] MM is exited (the  icon disappears from the task bar).

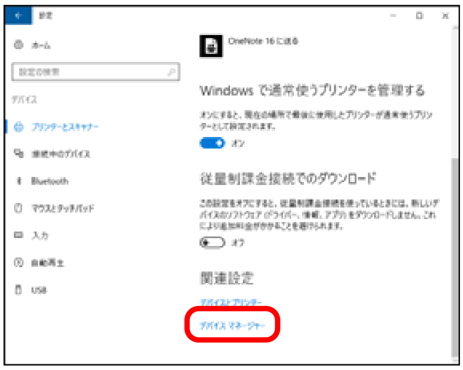
■ USB hardware search wizard procedure

Windows 10 edition

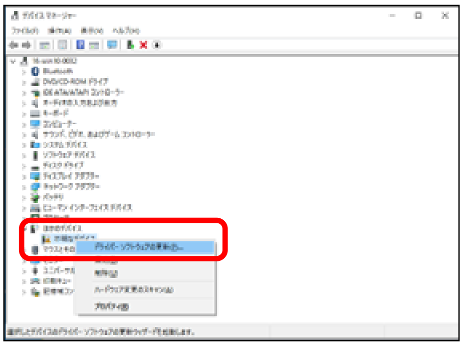
[1] Connect the computer and servo amplifier with a USB cable, and select [Control Panel] - [Devices].



[2] Select Device Manager.

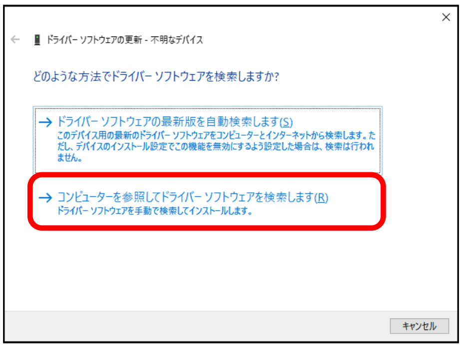


[3] Right-click "Unknown device", and then left-click "Update Driver Software...".

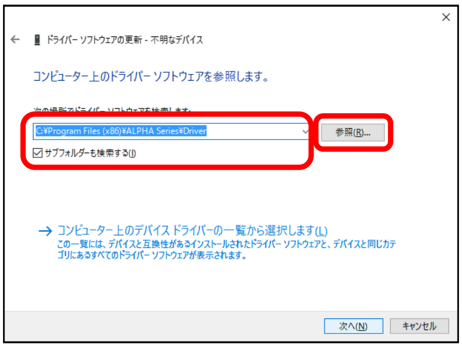


[4] Select the USB driver file.
Click [Browse].

[5] Select "Browse my computer for driver software".



[6] Select the USB driver file.
Click [Browse].
The USB driver is copied to the folder on which PC Loader is installed.

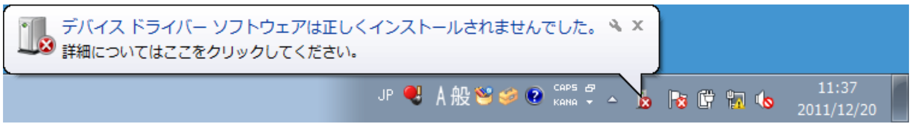


[7] The file is copied, and the completion screen is displayed.
Click [Close] to complete the driver installation.

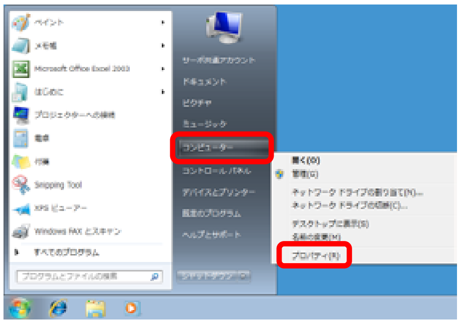
13

Windows 7 edition

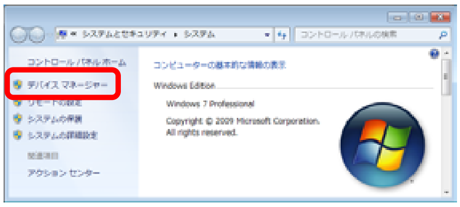
[1]　Connect the computer and servo amplifier with a USB cable. By connecting, the computer recognizes the USB device, and a message is displayed.



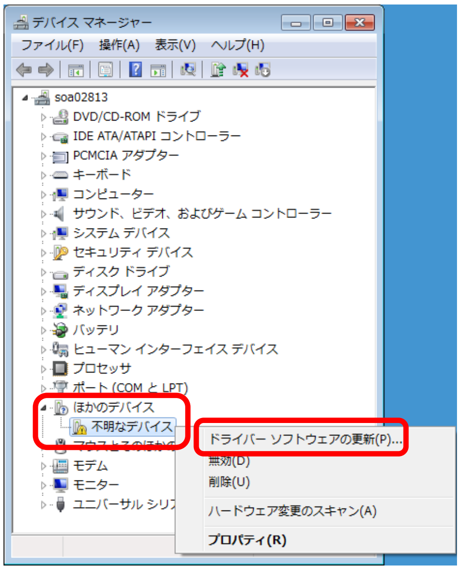
[2]　The wizard used to install the USB driver does not start automatically, and therefore the following procedure should be used to install the driver. Click the Start button, right-click "Computer", and then select "Properties" from the list that appears.



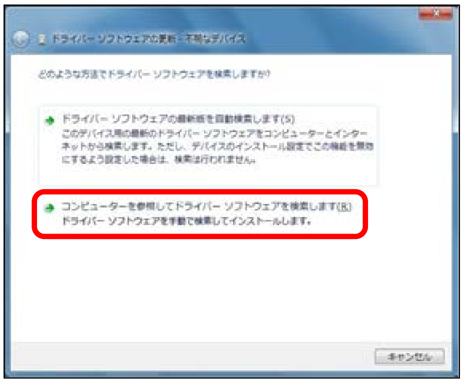
[3]　Click "Device Manager".



[4]　Right-click "Unknown device", and then left-click "Update Driver Software...".

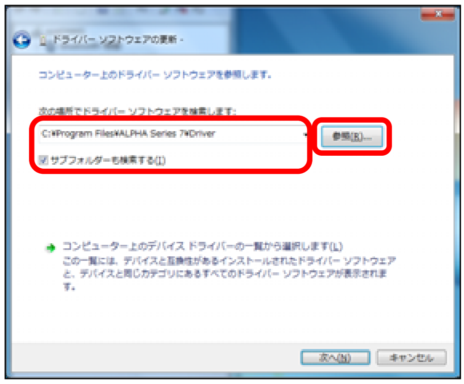


[5] Select "Browse my computer for driver software".



[6] Select the USB driver file.

Click [Browse].

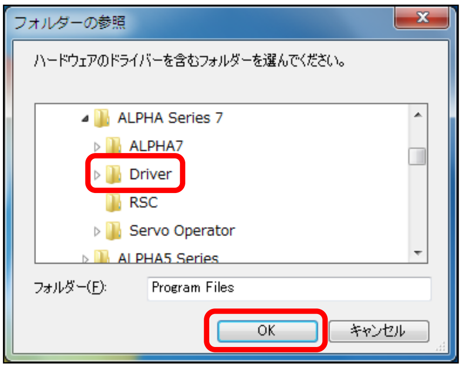


[7] Select the folder which contains the driver file.

The USB driver is copied to the folder * on which PC Loader is installed.

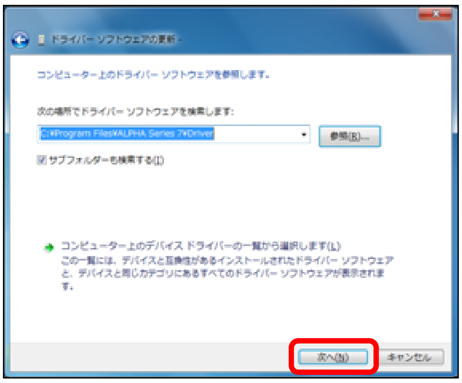
* ALPHA Series PC Loader example

Select the "C:¥Program Files¥ALPHA Series 7¥Driver" folder and click [OK].



[8] The folder is specified.

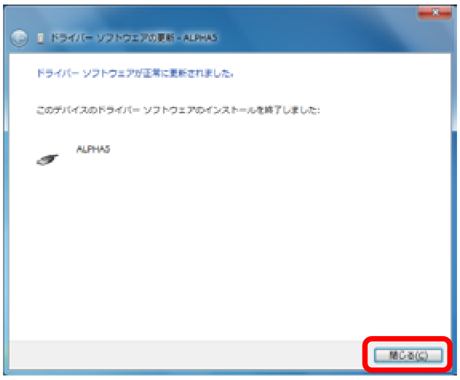
Click [Next].



[9] Install the driver.

By clicking [Install], the driver installation begins.

[10] The file is copied, and the completion screen is displayed. Click [Close] to complete the driver installation.



13.3 List of Functions

The following basic menu is displayed when PC Loader starts up.

- Real-time Trace

  Speed and torque waveforms, etc. can be obtained easily with a single click.

- Historical Trace

  Detailed waveforms can be obtained from real-time traces by setting triggers.

- Monitor

  [I/O Check], [All Value Information], [Alarm History], [Warning, Forecast Monitor], [Automatic Vibration Suppression Monitor], and [System Configuration] can be monitored.

- Parameter Edit

  Parameters can be edited, transferred, compared, and initialized.

- Positioning Data Edit

  Positioning data can be edited, transferred, compared, and initialized.

- Communication Settings

  Sets communication conditions between the servo amplifier and computer.

- Test Operation

  Various types of test operation can be performed between the servo amplifier and servomotors only.

- Servo Analyze

  Investigates machine system resonance points / anti resonance points.

- Safety Loader

  Safety parameters can be edited and transferred, etc.

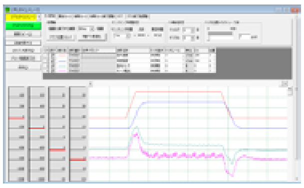
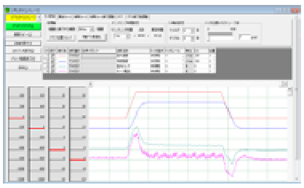
  Refer to the function safety module User's Manual for details on the operation method and so on.

Refer to PC Loader Help for a description of each screen button.

13

13.4 Setup Procedure

Use the following procedure to ensure smooth equipment setup.

Procedure	Details	Check item	PC LOADER operation
[1]	Run the motor independently to ensure that it is running normally.	• Perform manual operation [JOG], and ensure that the equipment functions as instructed.	Select [Test Operation] → [Manual Operation].  Verify the operation waveform with a real-time trace.  <Acquired waveforms reference)> Ch1: Command speed (analog) Ch2: Feedback speed (analog) Ch3: Command torque (analog) Ch4: Motor current (analog)
[2]	Connect to the host controller and perform an operation check to ensure that the sequence program is normal.	• Perform an I/O check. • Perform OUT forced output/forced pulse output if required.	Check the monitor I/O monitor. 
		• Issue a command from the host, and ensure that the equipment functions as instructed.	Check the command pulse frequency and input cumulative pulse at the monitor digital monitor. 
[3]	Equip the machine with a motor and run it to ensure that the machinery is running normally.	• Run the motor in its final form, and ensure that there are no abnormalities.	Verify the operation waveform with a real-time trace.  <Acquired waveforms (reference)> Ch1: Command speed (analog) Ch2: Feedback speed (analog) Ch3: Command torque (analog) Ch4: Motor current (analog)

13.5 Detailed Function Description

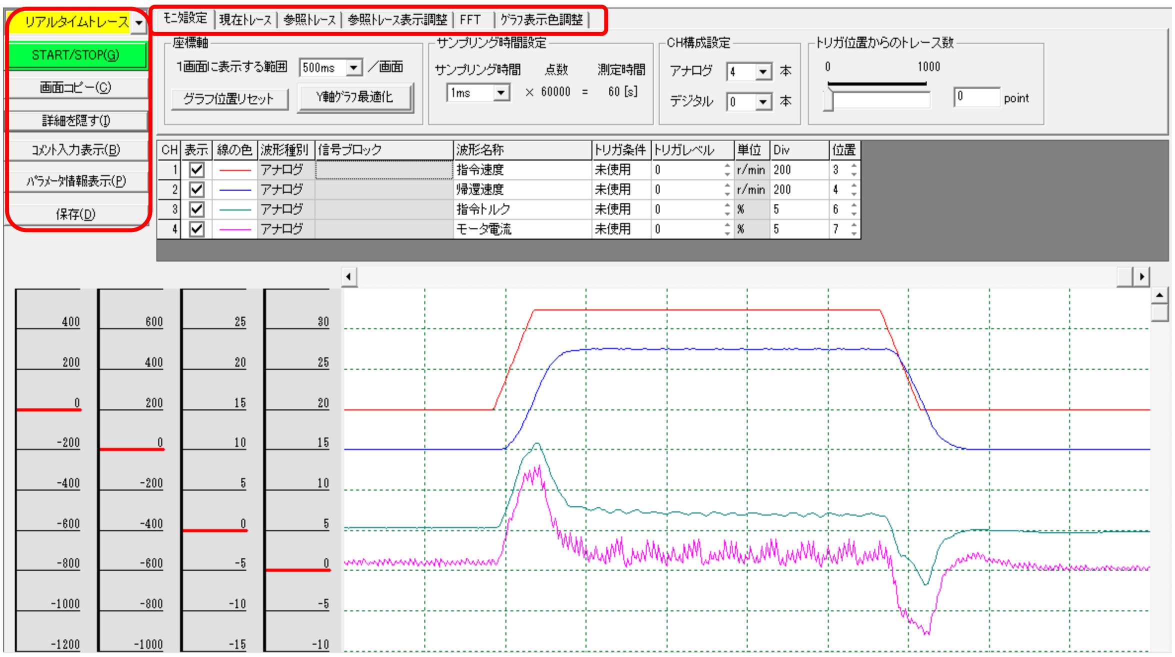
13.5.1 Real-time Trace

This function draws the servomotor operation waveform. Data for approximately 60,000 points is acquired continuously.
The trace ends automatically when 60,000 points are exceeded.
The waveform can be acquired by setting the waveform to be acquired, and then pressing the [START/STOP] button.

Relationship between sampling time and trace time

Sampling time [ms]	Trace possible time [s]
1	60
2	120
5	300
10	600
20	1200
50	3000
100	6000
200	12000

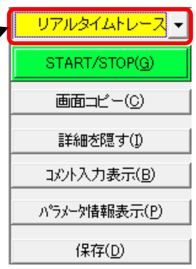
[Real-time Trace screen example]



Functions such as displaying between two cursors, superimposing waveforms, FFT analysis, copying screens, acquired waveform parameter information, and waveform saving (CSV format supported) are available at this screen.
Refer to PC Loader Help for a detailed description of each tab and button.

Tabs

Buttons



The display can be switched between real-time trace and historical trace.

■ Trace procedure

[1] Select the waveform to be acquired.

[2] Select the sampling time.

[3] Press the [START/STOP] button to start the trace.

[4] Press the [START/STOP] button to stop the trace.

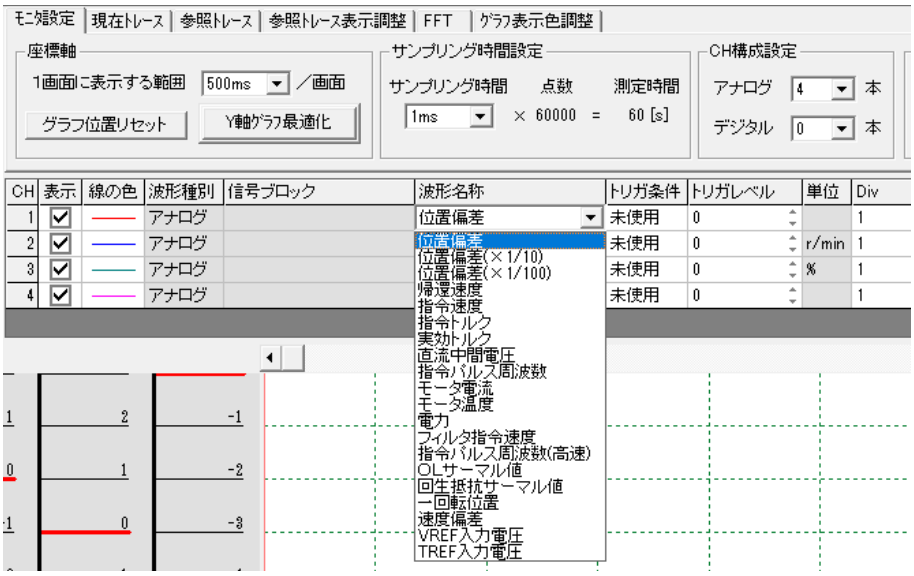
■ Waveforms that can be acquired

Analog signal and digital signals can be acquired for a total of 10 channels *.

Waveforms that can be acquired are as follows (all digital input/output signals can be traced.)

* Analog signals and digital signals can be acquired for up to 5 channels in total, respectively.

[Analog signal selection screen example]



[Digital signal selection screen example]

13.5.2 Historical Trace

This function draws the servomotor operation waveform.

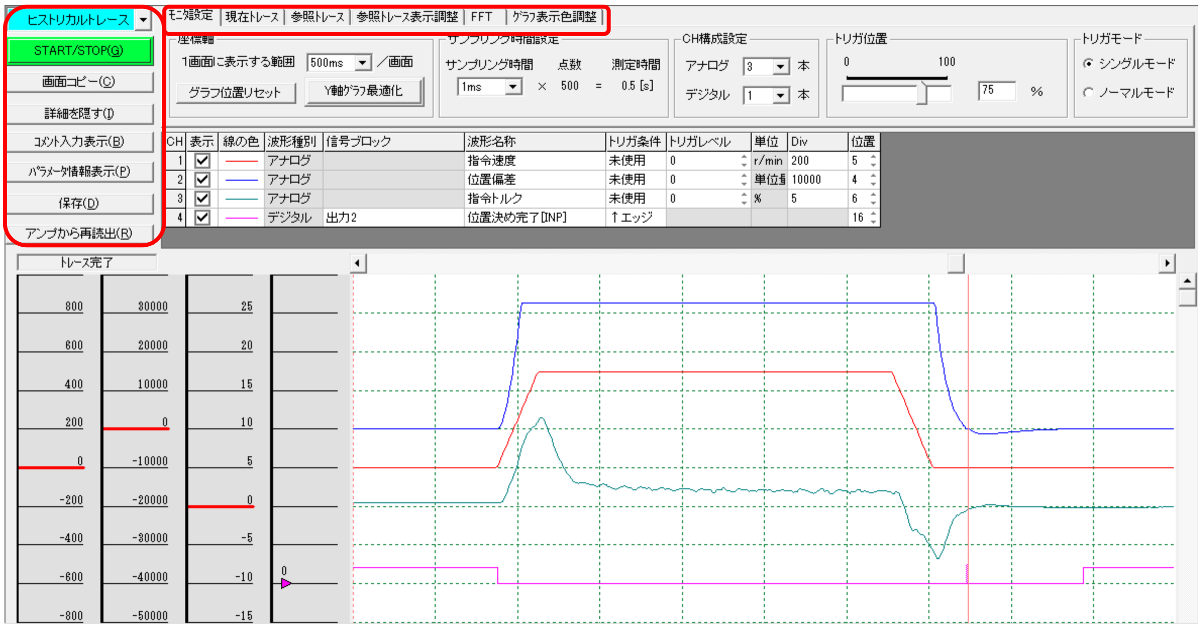
Data for approximately 500 points is acquired.

By setting a trigger, the waveform for the section to be viewed can be picked up and acquired.

Relationship between sampling time and trace time

Sampling time [ms]	Trace possible time [s]
0.1	0.05
0.2	0.1
0.5	0.25
1	0.5
2	1
5	2.5
10	5
20	10
50	25
100	50
200	100

[Historical Trace screen]



Functions such as displaying between two cursors, superimposing waveforms, FFT analysis, re-reading waveforms, copying screens, acquired waveform parameter information, and waveform saving (CSV format supported) are available at this screen.

Refer to PC Loader Help for a detailed description of each tab and button.

Tabs

Buttons

The display can be switched between real-time trace and historical trace.

■ Trace procedure

[1] Select the waveform to be acquired.

[2] Set trigger conditions.

[3] Select the sampling time.

[4] Set the number of traces from the trigger position.

[5] Press the [START/STOP] button to start the trace.

When trigger conditions are met, the waveform is acquired, and acquisition then automatically stops.

■ Waveforms that can be acquired

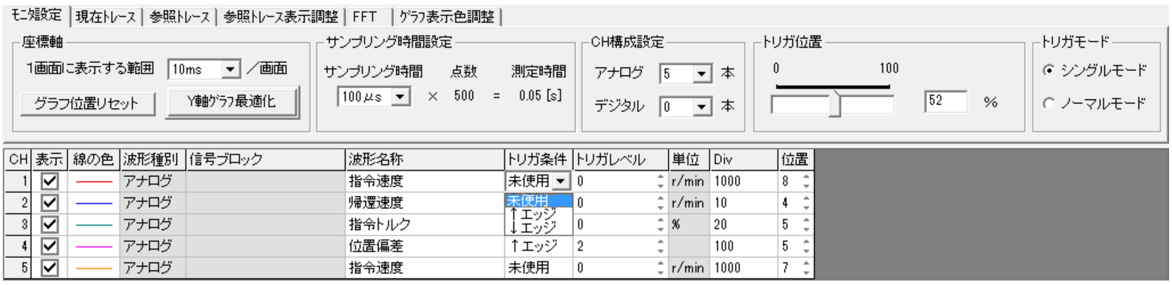
The waveforms that can be acquired are the same as those for real-time trace.

■ Trigger settings

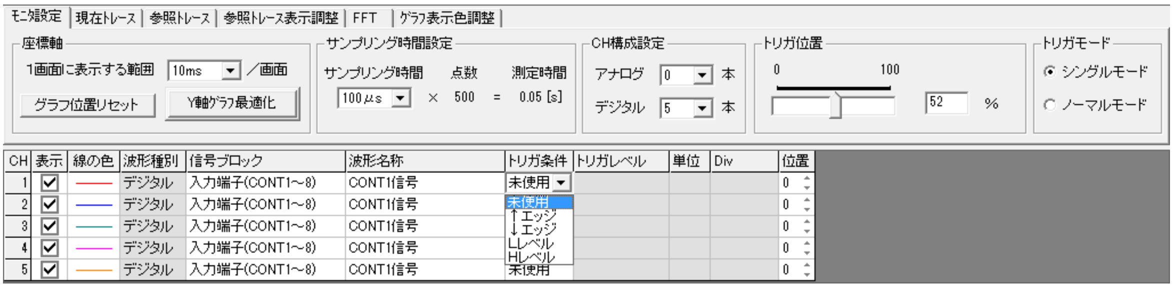
Trigger settings * can be specified for either analog waveforms or digital waveforms.

* Analog trigger setting: 1 channel only Digital trigger setting: Multiple channels are available

[Analog trigger settings]



[Digital trigger settings]



13

■ Setting method example if waveform measured during stoppage

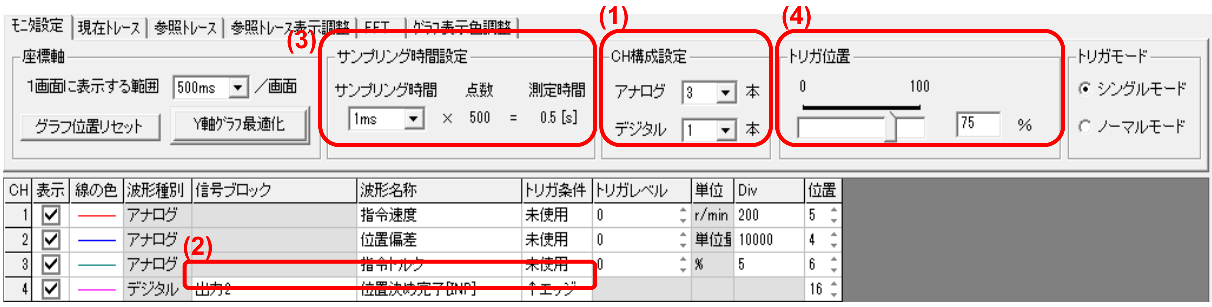
(1) Set analog waveform x 3 (command speed, position deviation, command torque), and digital waveform x 1 (positioning complete (INP)).

(2) Set the digital trigger signal for the digital waveform (positioning complete (INP)) to “Use with ↑ edge”.

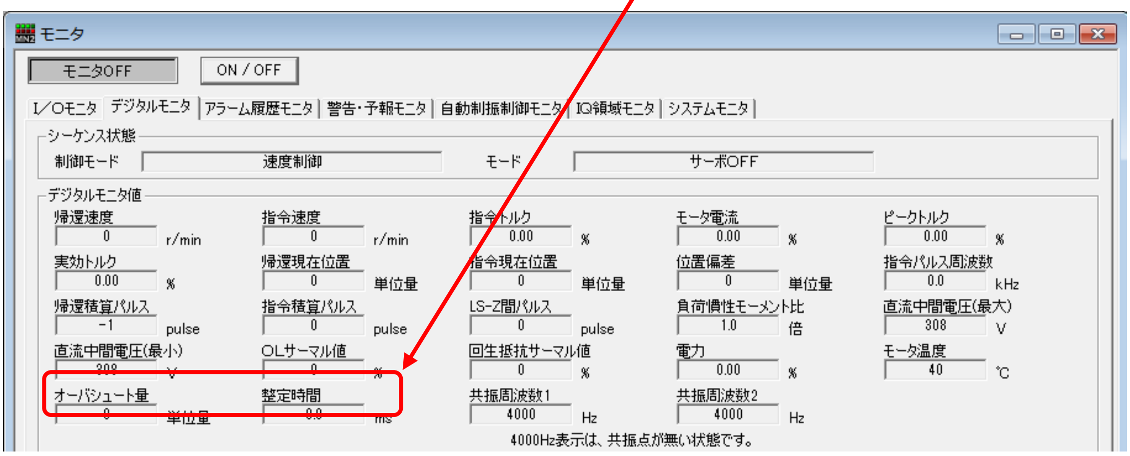
(3) Set the sampling time to “1 ms”.

(4) Set the trigger position to 75%.

After specifying the above settings, press the [START/STOP] button to start the trace.

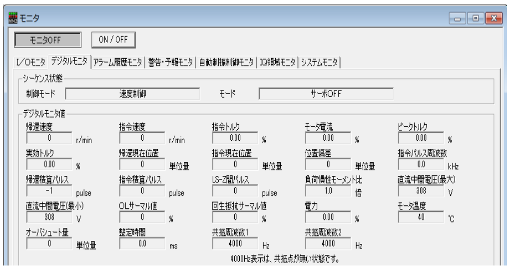


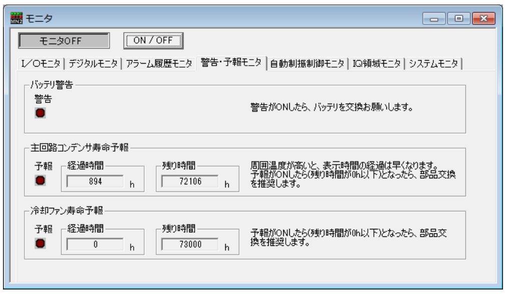
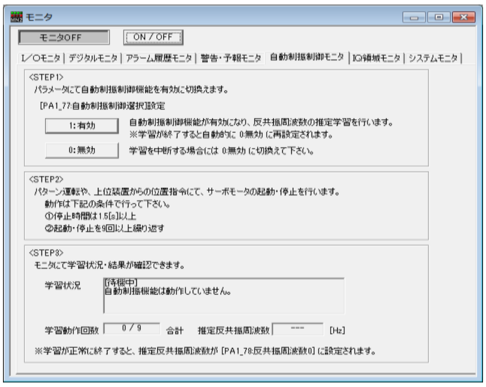
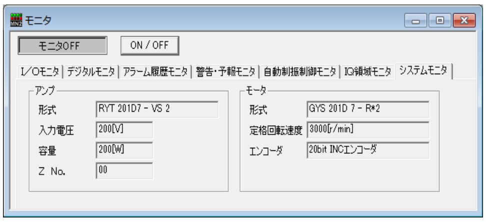
Hint	By selecting [Monitor] → [Digital Monitor], the amount of overshoot and settling time are displayed in real time.



13.5.3 Monitors

The monitors listed in the following table are used to monitor the servo amplifier and servomotor status.

Item	Details	Screen example
I/O monitor	Checks whether digital input/output signals turn ON and OFF. Lamps light up to indicate that signals are ON, and turn OFF to indicate that signals are OFF.	
Digital monitor	Monitors all kinds of operating condition data * (data cannot be saved). * Data that can be monitored in keypad monitor mode	
Alarm history monitor	Displays history (incl. supplementary information *) for the past 20 alarms. * This includes information such as the feedback speed, torque command, and intermediate DC voltage when an alarm occurs.	

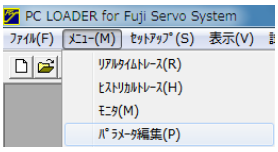
Warning, forecast monitor	Displays the warning and forecast status occurring at the servo amplifier. Displays such information as battery warnings, remaining main circuit capacitor time, and remaining cooling fin time.	
Automatic vibration suppression monitor	Displays the automatic vibration suppression learning state.	
System monitor	Displays such information as the model and capacity of connected servo amplifiers and servomotors.	

13

13.5.4 Parameter Editing

Servo amplifier parameters are edited at this screen.

Select [Menu] - [Parameter Edit] to start the parameter editor.



The following functions can be used at this screen.

(1) Re-read

Reads parameters from the connected servo amplifier.

(2) Send Changes

Sends changed parameters to the connected servo amplifier.

(3) Send All

Sends all parameters to the connected servo amplifier.

(4) Compare

Compares the parameters currently being edited with those in the connected servo amplifier, or with already saved files.

(5) Initialize

Returns all of the parameters in the currently connected servo amplifier *, or parameters currently being edited to their default values.

* This can only be performed while the servo is off. Turn the servo amplifier power off and on again following initialization.

(6) File Info.

This is the information in the parameter file currently being edited. The model, date, and comments and so on for connected servo amplifiers and servomotors can be viewed when reading.

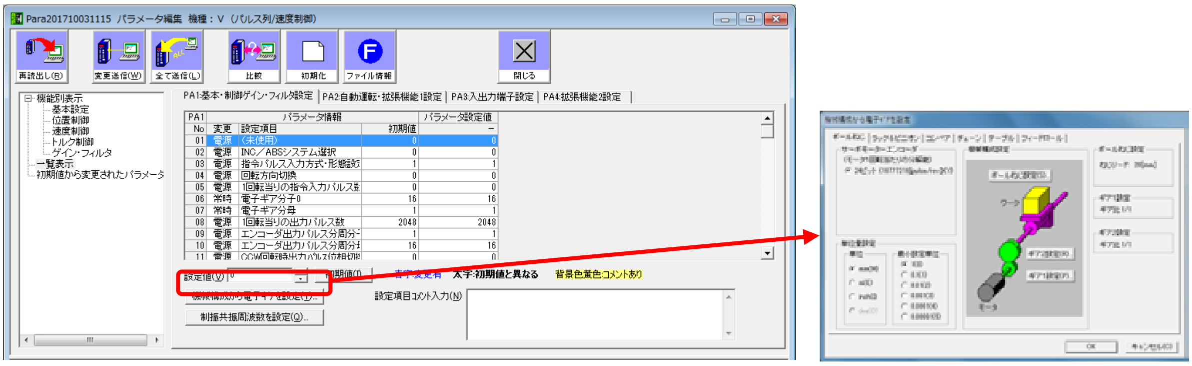
(7) Function based display function

Parameters can be displayed based on function.

Note	In the interests of safety, send parameters with (2) and (3) while servomotors are stopped. Operating characteristics will change, resulting in a risk of damage to equipment.

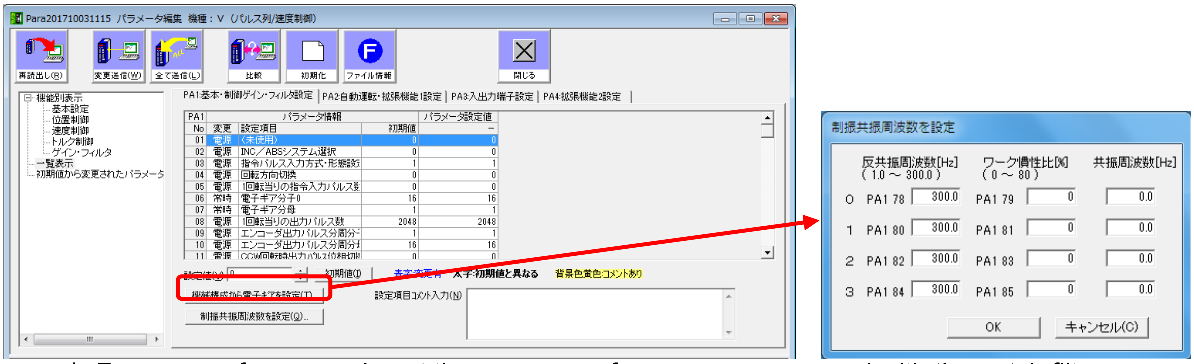
■ Automatic electronic gear calculation

By selecting [PA1: Basic Settings] - [Set Electronic Gear from Machine Configuration], a dedicated window appears. By entering all machine system specifications, electronic gear calculation is performed automatically.



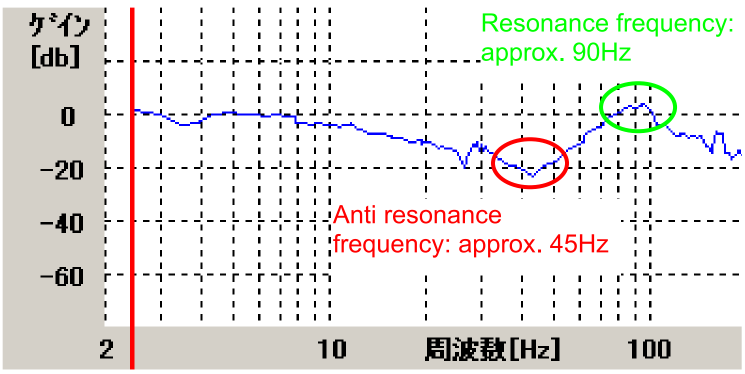
■ Automatic workpiece inertia ratio calculation

By selecting [PA1: Control Gain, Filter Settings] - [Set Vibration Suppressing Anti Resonance Frequency], workpiece inertia ratio can also be automatically calculated by entering the anti resonance frequency and resonance frequency *.



* Resonance frequency is not the resonance frequency suppressed with the notch filter.
This resonance frequency can be checked with the Servo Analyze function.
This resonance frequency is produced as the counterpart to anti resonance frequency, and the value is approximately twice the anti resonance frequency.

[Resonance frequency example]



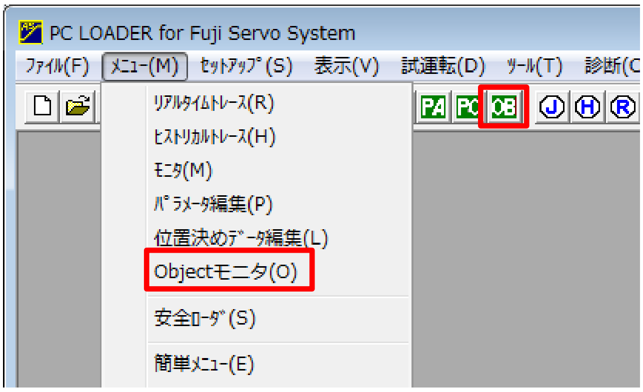
13

13.5.5 Object Monitor

The object monitor is used to monitor and edit setting values for each object.

(1) Screen startup

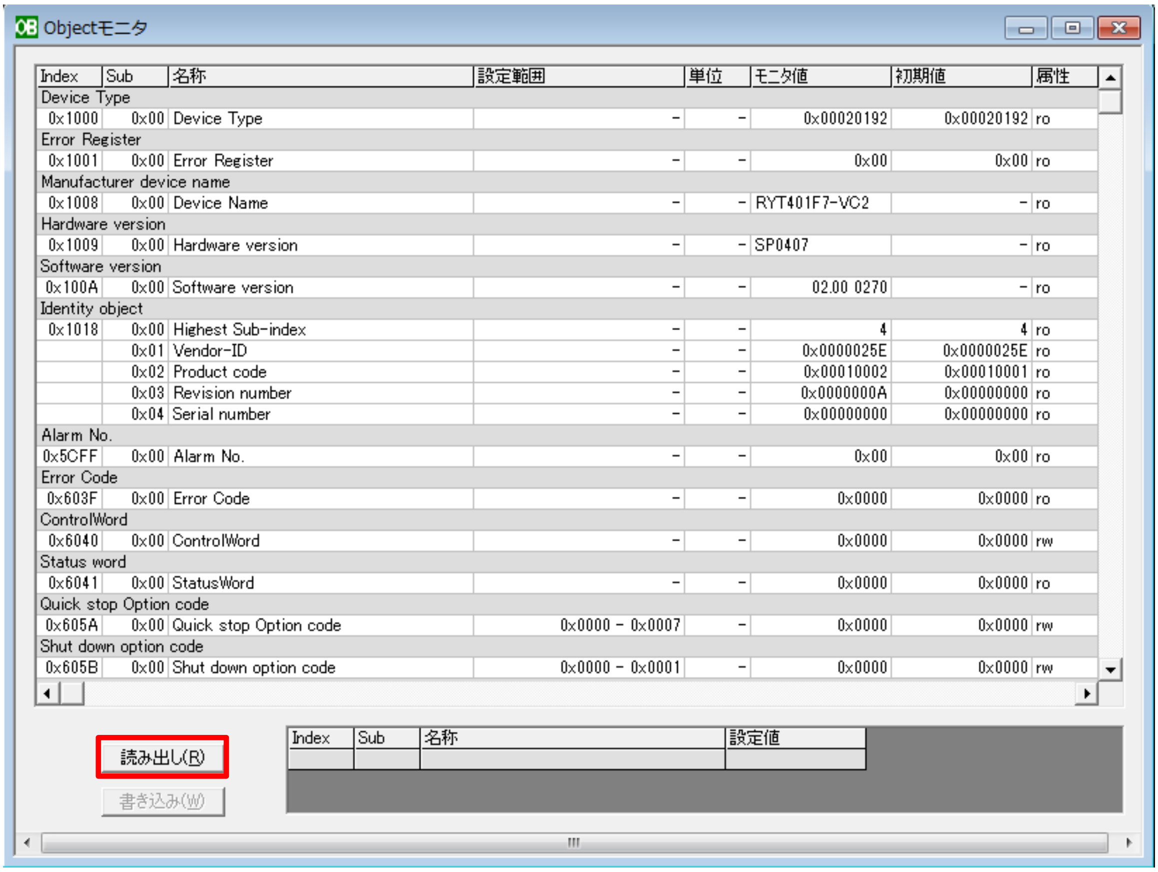
Select [Menu] - [Object Monitor], or click the icon.



(2) Monitor method and editing method

The current setting values are displayed when the screen is started at (1).

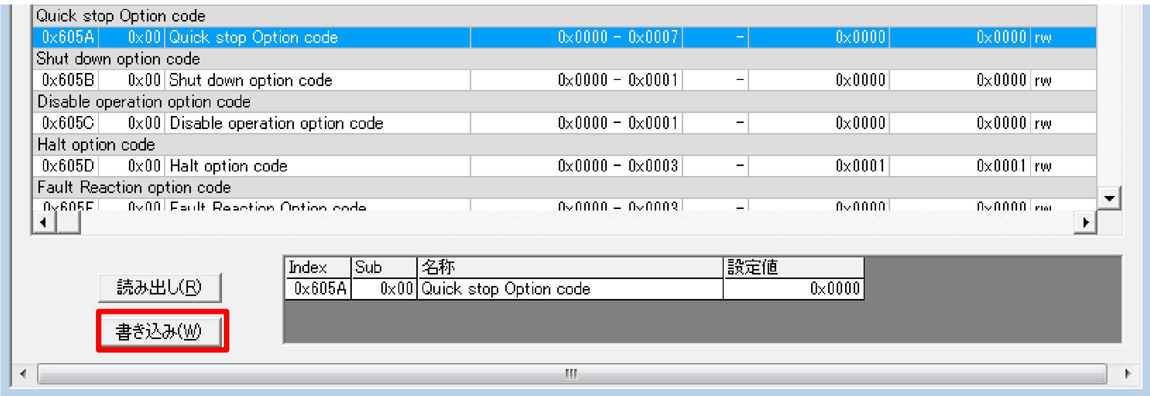
By clicking the [Read] button, monitor values are updated.



If the attribute is “rw”, setting values can be edited.

By selecting an object that can be edited, the [Write] button becomes active.

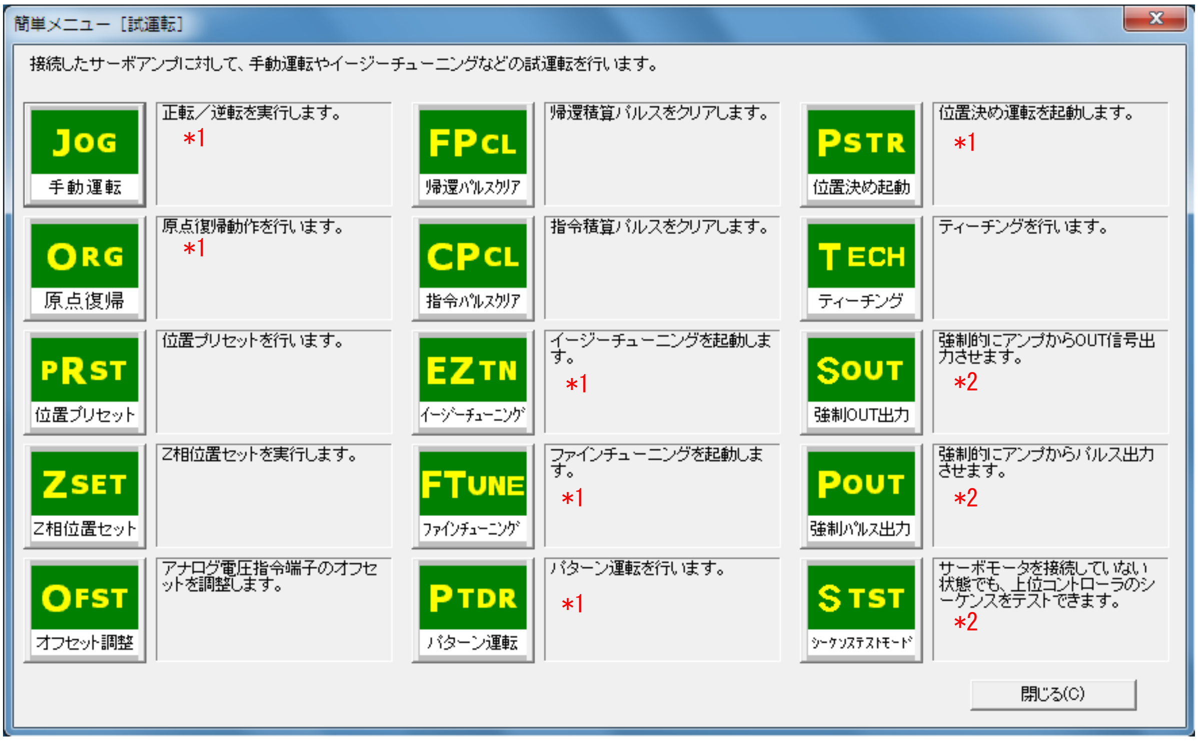
Enter a value in the “Setting value” field and click the [Write] button to write the entered value.



13.5.6 Test Operation

Turn the servo amplifier offline, and test run a servomotor from the servo amplifier.

Use this function at such times as when the servomotor does not function normally with commands from the host, if the motor does not move, or if wishing to check the rotation direction.



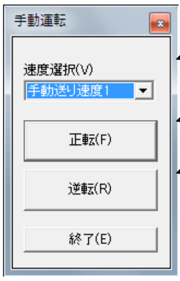
*1 The servo turns on automatically, and the motor rotates. Caution is advised.

*2 The system will not return to normal mode until the servo amplifier power supply is turned off. Caution is advised.

13

■ Test operation screens

(1) Manual Operation

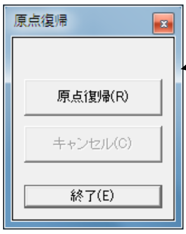


Selects the speed (parameters PA1_41 to 47).

The motor rotates in the forward direction while clicked.

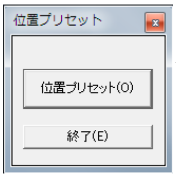
The motor rotates in the backward direction while clicked.

(2) Origin Return



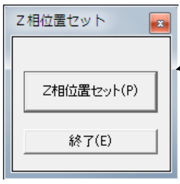
This function is not supported on the VC type.

(3) Position Preset



By pressing the [Position Preset] button, the current position is rewritten to the 607CH: Home offset parameter value.

(4) Set Z-phase Position

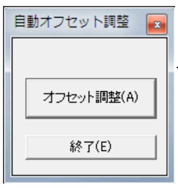


By pressing the [Set Z-phase Position] button, the Z-phase is output at the current position (the PA1_12 (Z-phase position offset) parameter is automatically rewritten).

* The Z-phase position cannot be set under the following conditions.

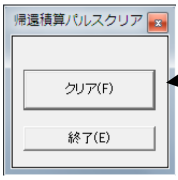
- When PA2_74 (parameter write protection) is set to "1: Write protect".
- When the encoder origin position (Z-phase) is not set.
  At such times, rotate the motor shaft twice or more.

(5) Offset Adjust



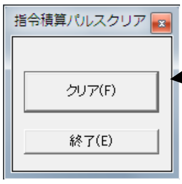
This function is not supported on the VC type.

(6) Feedback Cumulative Pulse Clear



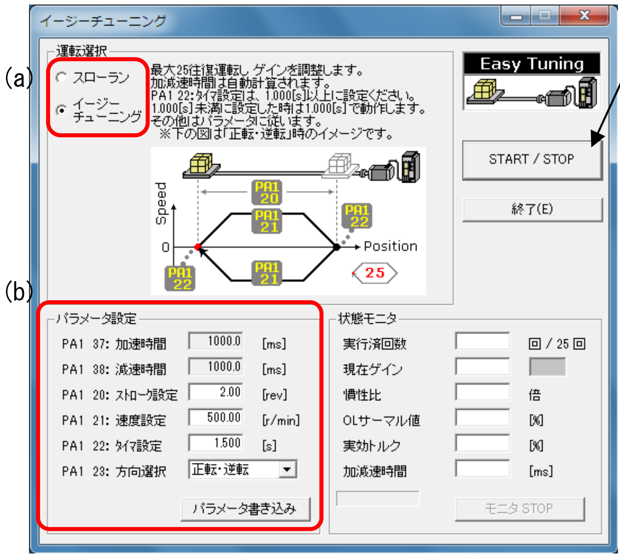
By pressing the [Clear] button, the feedback cumulative pulse count is set to “0”.

(7) Command Cumulative Pulse Clear



This function is not supported on the VC type.

(8) Easy Tuning



By pressing the [START/STOP] button, the operation selected at (a) starts.

Furthermore, by pressing the [START/STOP] button during operation, the operation stops at that location.

- Slow run

  Operation is performed based on the (b) parameter setting.

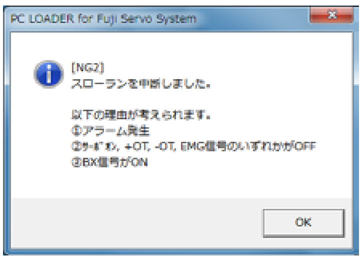
  However, the speed is fixed at 10 [r/min].

  This is for checking the travel amount and direction.

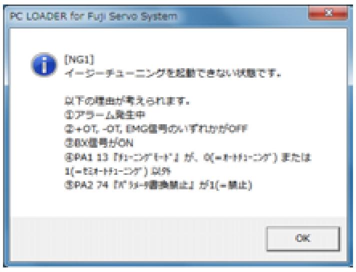
- Easy tuning

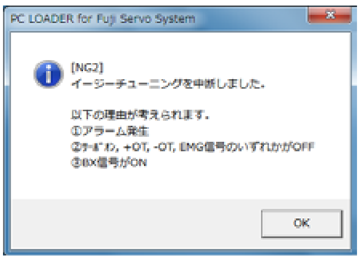
  Operation is performed based on the (2) parameter setting, and auto tuning gain 1 is set as the optimum value. However, the acceleration and deceleration time is adjusted automatically.

[Slow run NG screen]



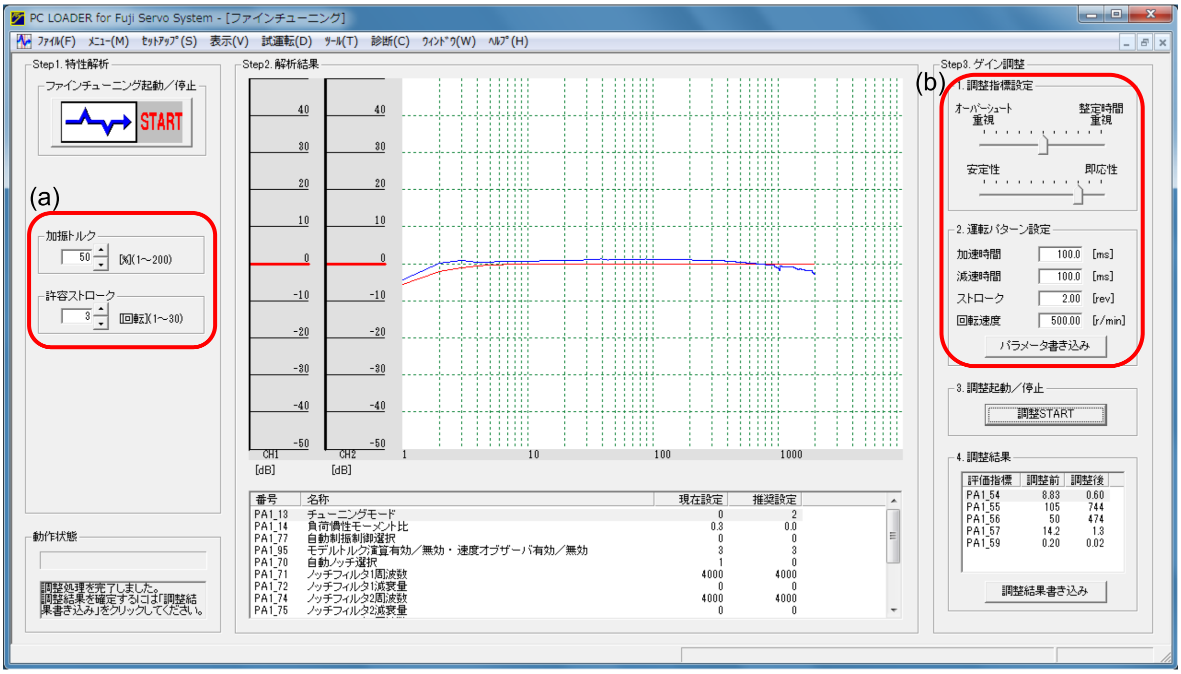
[Easy tuning NG screen]





13

(9) Fine tuning



Step 1.

By pressing the [Start] button, characteristics analysis is started based on the conditions set at (a).

Step 2.

The analysis result is drawn, and the recommended setting values are displayed.

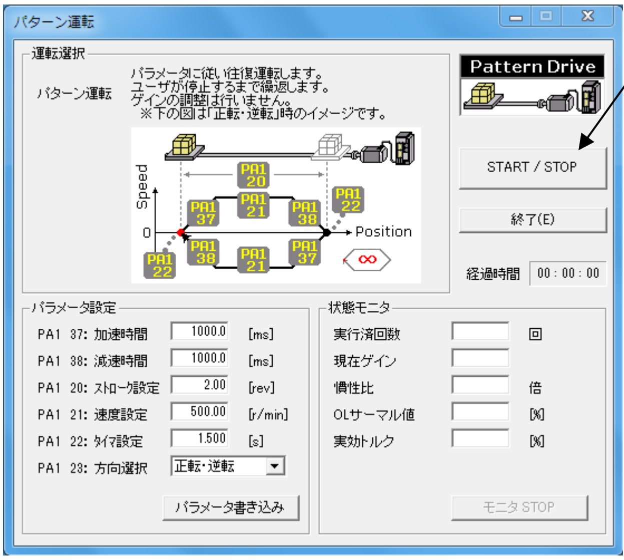
Step 3.

By pressing the [Adjust Start] button, reciprocal operation is started based on the conditions set at (b), and the adjustment result is displayed when reciprocal operation is complete.

Refer to "4.5 Fine Tuning" for details.

13

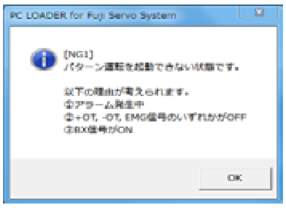
(10) Pattern operation

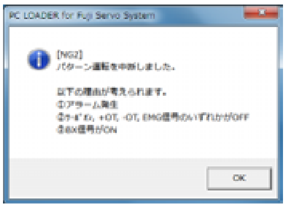


By pressing the [START/STOP] button, pattern operation starts.

Furthermore, by pressing the [START/STOP] button during operation,

[Pattern operation NG screen]





(11) Forced OUT Signal Output

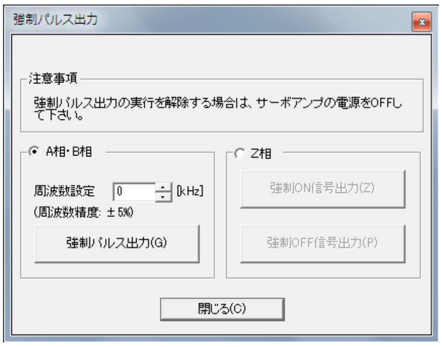
(a)

(b)

Select the OUT signal to be operated at (a), and turn the OUT signal ON or OFF with the (b) [ON] or [OFF] buttons.

Turn off the power to cancel this mode.

(12) Forced Pulse Output



This function is not supported on the VC type.

(13) Sequence test mode

It is possible to simulate a servomotor connected state even when not connected.

Doing so allows host program debug work to be carried out efficiently.

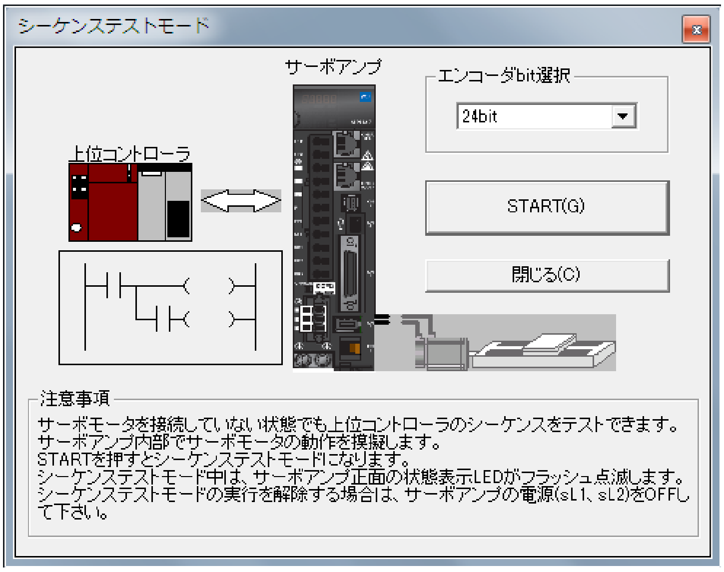
Precautions

- The conditions under which operation is possible, as well as the input/output signal functions are the same as when the servomotor is connected.
- One of the conditions for operation is that the main power supply (L1, L2, L3) must be supplied to the servo amplifier.
- Simulation is carried out based on the encoder bit count, and therefore the encoder bit count must be set.
- Current does not flow to the servomotor (furthermore, the main circuit transistor does not turn on and off.)
- The motor current, effective torque, OL thermal value, and regenerative resistor thermal value do not change.
- The overload forecast function does not work.
- The INC/ABS system selection (PA1_2) is handled internally as 0: INC (simulation is not possible with ABS systems.)
- When exiting sequence test mode, turn off the servo amplifier control power (L1C, L2C).

Sequence test mode status check

When the servo amplifier is in sequence test mode, all digits on the 7-segment LED flash every two seconds (they do not flash when performing key operations.)

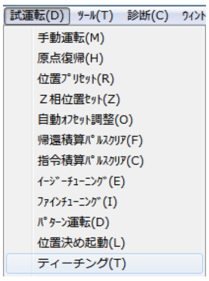
Startup screen



13

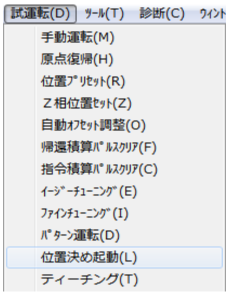
(14) Positioning startup

This function is not supported on the VC type.



(15) Teaching

This function is not supported on the VC type.

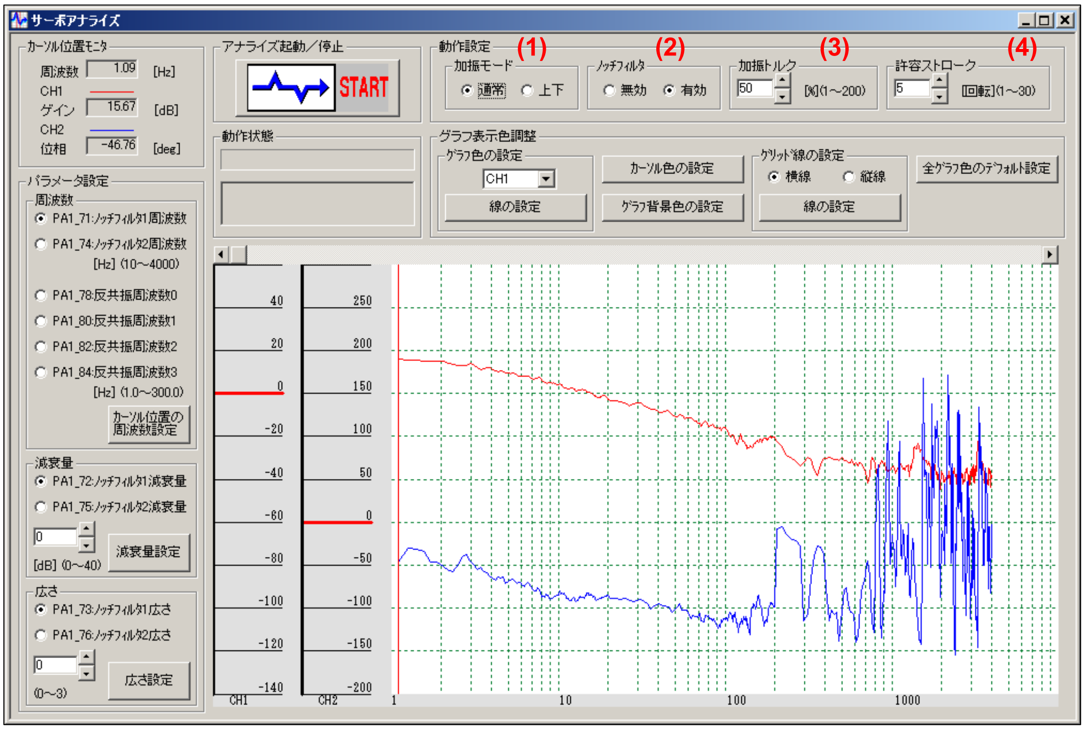


13

13.5.7 Servo Analyze

Servo Analyze is a tool used to measure machinery frequency characteristics.
By running Servo Analyze, machinery resonance points and anti resonance points and so on are displayed visually, providing the user with a guide for setting these parameters (anti resonance frequency, notch filter related).

Running Servo Analyze performs torque vibration operation three times. The servomotor actually moves at this time. Furthermore, by setting the vibration torque, the motor may rotate greatly, and so caution is advised (can be limited by setting the permissible stroke).



■ Settings

(1) Vibration mode

Set to “Normal” for horizontal drive machines, and to “Vertical” for vertical drive machines.

(2) Notch filter

Set to “Disable” to verify machine characteristics such as resonance points.

Set to “Enable” to verify the notch filter effect.

(3) Vibration torque

The greater this value, the better the accuracy, however, the shock will be greater, placing a burden on the machine.

A value of “50 [%]” of the default value should normally be used.

(4) Permissible stroke

An error will occur if the servomotor attempts to move at a value higher than this setting.

This does not mean that the servomotor will travel by this amount of rotation.

13.5.8 Changing the Language

This PC Loader supports Japanese, English, and Korean only.

■ Applicable version

PC Loader supports Japanese, English, and Korean from version V1.1.0 and later.

■ Changing the language

Select [Setup] - [Language] from the menu, and select the desired language.

The following screen appears.

Click [OK] to close PC Loader.

The language will be changed when PC Loader is next started up.

CHAPTER 14 STANDARDS COMPLIANCE

14.1 European Standards Compatibility (CE)

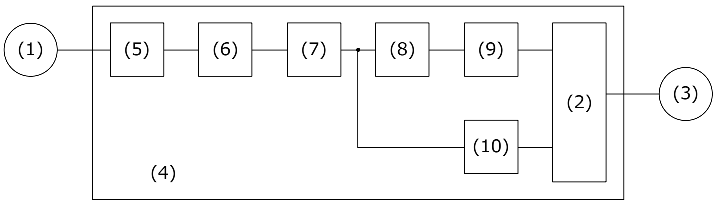
The CE marking on Fuji products indicates that they comply with the essential requirements of European Council of Ministers Directive (EMC Directive) 2014/30/EU, Low Voltage Directive 2014/35/EU, and Machinery Directive 2006/42/EC relating to electromagnetic compatibility (EMC).

Table14.1-1 Compatible standards

	Compatible standards	
EMC Directive Note 1	EN 61800-3 Immunity: Emissions:	 Second environment (industrial) Category C2 (when equipped with recommended filter)
Low Voltage Directive	EN 61800-5-1	
Machine Directives	EN ISO 13849-1: EN 60204-1: EN 61508: EN 61800-5-2: EN 62061:	Cat.3 PL = e Stop Category 0 SIL3 SIL3 (Functional Safety: STO) SIL CL3

Note 1: If classified into EN61800-3 "Category C2" and used in a general household environment, products may interfere with home appliances or office equipment.
In such cases, additional mitigation measures will be required.

■ Device configuration example



(1) Power supply
(2) Servo amplifier
(3) Servomotor
(4) Control panel (metal)
(5) Transformer
(6) Earth leakage breaker
(7) Molded case circuit breaker
(8) Fuse
(9) Noise filter
(10) 24 VDC power supply (reinforced insulation)

14.1.1 Compatibility with EMC Standards

The CE marking on servo amplifiers does not certify that all machinery and equipment using Fuji products are compatible with the EMC Directive. Consequently, if affixing CE marking to machinery and equipment, the responsibility for doing so lies with the machinery manufacturer. The reason for this is that the CE marking on Fuji products indicates the condition that the product is used in such a way that satisfies certain conditions.
Various other devices other than Fuji products are generally used with machinery and equipment. It is therefore necessary that machinery manufacturers give consideration to all equipment.

■ Noise filters

Please use the product with an external noise filter in order to comply with standards. No matter what the application, please install noise filters using the following recommended installation method. It is recommended that noise filters be installed inside metal cabinets to ensure more reliable compatibility with standards.
[Recommended filter] HF3000C-SZA Series (SOSHIN ELECTRIC CO., LTD.)

■ Recommended installation method

Servo amplifier and servomotor wiring work should carried out by an electrician. To comply with the EMC Directive, it is necessary to carry out installation and wiring using the following method whenever possible.

Noise filter installation method

(1) Install servo amplifiers and noise filters on a metal plate such as a grounded panel surface. Use shielded wires for power cables and motor cables, and make them as short as possible. Clamp shields (20 m or shorter) securely to a metal plate. Furthermore, connect shields and motor grounding terminals electrically.

(2) Use shielded wire for servo amplifier control terminal wiring. Clamp shields securely to a grounded panel surface in the same manner as that for motor cables. Use cables of length no longer than 20 m.

14.1.2 Compatibility with European Low Voltage Directive

Servo amplifiers are subject to compatibility with the European Low Voltage Directive. The CE marking on servo amplifiers represents a self-declaration that the product complies with the Low Voltage Directive.

■ Precautions

If using as a European Low Voltage Directive compatible product, compatibility with Low Voltage Directive 2014/35/EU is achieved by installing the product as follows.

Compatible European standards

Adjustable speed electrical power drive systems.

Part 5-1: Safety requirements. Electrical, thermal and energy. IEC/EN61800-5-1

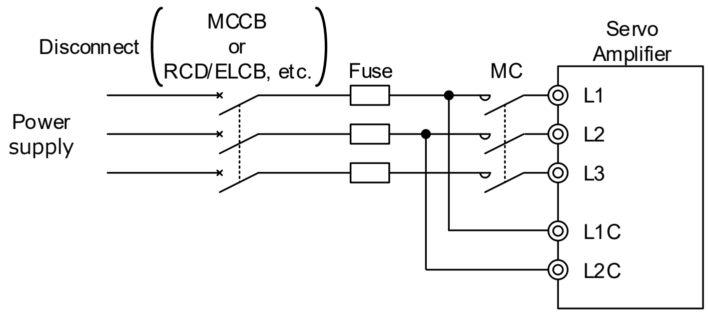
Compatibility with European Low Voltage Directive

⚠ WARNING ⚠

1. Install servo amplifiers inside metal control panels.
2. Always ground the grounding terminal E, and do not attempt to provide electric shock protection simply with an earth leakage circuit breaker* RCD (Residual-current-operated protective) or ELCB (Earth Leakage Circuit Breaker). Always ground grounding wires, and do not secure two or more wires together.
   * With overcurrent protection function
3. This offers protection against the risk of high voltage or accidents that may result in servo amplifier damage, and therefore a fuse of specification indicated in the following table must be installed at the power supply side.
   · Breaking capacity of 10kA or higher, rated voltage of 500 V or lower, IEC/EN 60269-2

Power supply	Servo amplifier output capacity [kW]	Servo amplifier model	Fuse rating [A]
200 V	0.05	RYT500F7-■■2	10
	0.1	RYT101F7-■■2	10
	0.2	RYT201F7-■■2	10
	0.4	RYT401F7-■■2	10
	0.75	RYT751F7-■■2	15
	1.0	RYT102F7-■■2	30
	1.5	RYT152F7-■■2	30
	2.0	RYT202F7-■■2	50
	3.0	RYT302F7-■■2	50
	4.0	RYT402F7-■■2	90
	5.0	RYT502F7-■■2	90

Note) The ■ in the servo amplifier model is replaced by a letter of the alphabet indicating the type.



Compatibility with European Low Voltage Directive (cont.)

WARNING

4. Use a molded case circuit breaker (MCCB), earth leakage breaker (RCD/ELCB), or magnetic contactor (MC) compatible with EN or IEC standards.
5. If using an earth leakage circuit breaker (RCD/ELCB) to provide either direct or indirect electric shock protection, always install a Type B earth leakage circuit breaker (RCD/ELCB) at the servo amplifier input side (primary side). If this is not the case, it is necessary to isolate servo amplifiers from peripheral equipment with double insulation, reinforced insulation, or insulation between the servo amplifier and main using a transformer.

Servo amplifiers			Molded case circuit breaker (MCCB) or earth leakage circuit breaker (RCD/ELCB) *1 rated current	
Power supply system	Output capacity [kW]	Model	Single-phase input	Three-phase input
200 V	0.05	RYT500F7-■■2	3	3
	0.1	RYT101F7-■■2	3	3
	0.2	RYT201F7-■■2	5	3
	0.4	RYT401F7-■■2	10	5
	0.75	RYT751F7-■■2	15	10
	1.0	RYT102F7-■■2	—	15
	1.5	RYT152F7-■■2	—	20
	2.0	RYT202F7-■■2	—	30
	3.0	RYT302F7-■■2	—	40
	4.0	RYT402F7-■■2	—	50
	5.0	RYT502F7-■■2	—	50

Note) The ■ in the servo amplifier model is replaced by a letter of the alphabet indicating the type.

*1 The molded case circuit breaker (MCCB) or earth leakage breaker (RCD/ELCB) (with overcurrent protection function) frame size and model will differ based on the power transformer capacity. Refer to the related technical material for details on the selection method.

6. Use the servo amplifier in a pollution degree 2 environment. When using in a pollution degree 3 or 4 environment, install inside a panel offering protection of IP54 or higher.
7. To provide electric shock protection when people come into contact with live parts, install the servo amplifier, AC reactor (ACR) or DC reactor (DCR), and noise filter inside a panel offering protection of IP2X or higher. If the panel can be easily touched by people, ensure that the top of the panel offers protection of IP4X or higher.
8. Do not connect copper wire directly to grounding terminals. Connect using crimped terminals with tin or similar plating.
9. Use an interface power supply with reinforced insulation across inputs and outputs.
10. Abnormal heat generation may occur at regenerative resistors if regenerative circuits built into servo amplifiers fail. Ensure that power supply side molded case circuit breakers or electromagnetic contactors are shut off when an alarm signal is output from the servo amplifier.

14.2 UL Standards and Canadian Standards (cUL Certification) Compliance

14.2.1 General

UL Standards (Underwriters Laboratories Inc. standards) are North American safety standards used to prevent fire and other such accidents, and offer protection to users, service technicians, and the general public.
cUL indicates that products which comply with CSA standards are certified by UL. cUL certified products are as effective as those certified as complying with CSA standards.

14.2.2 UL Standards and Canadian Standards (cUL Certification) Compatibility

Compatibility with UL Standards and Canadian Standards (cUL certification) is ensured by installing servo amplifiers with UL/cUL marking in accordance with the following.

UL Standards and Canadian Standards (cUL certification) compatibility

⚠ CAUTION
Integral solid state short circuit protection does not provide branch circuit protection. Branch circuit protection must be provided in accordance with the National Electrical Code and any additional local codes. 内蔵の電子式短絡保護回路は分岐回路保護としての機能を有していない為，米国電気工事規定及びその地域の関連規定に従って分岐回路保護を実施してください。 1. Install the servo amplifier inside a metal control panel. サーボアンプは金属製の制御盤内に設置してください。 2. Maximum Surrounding Air Temperature : 55°C 最高周囲温度 ： 55℃ 3. Overload protection This servo amplifier is equipped with a built-in servo motor overload protective function. (110% of motor FLA) See "Overload Characteristics" in section 9.2. 過負荷保護 サーボモータ過負荷保護機能を内蔵しています。(110% of motor FLA) 「9.2 過負荷特性」を参照してください。 4. Use Cu wire only. 電線は，銅線を使用してください。 5. Field wiring connections must be made by a UL Listed and CSA Certified closed-loop terminal connector sized for the wire gauge involved. Connector must be fixed using the crimp tool specified by the connector manufacturer. 端子配線を行う際には，推奨電線サイズを参照の上，UL・CSA認定の丸形圧着端子を使用してください。圧着端子は，メーカ推奨の圧着工具を使用して圧着してください。

14

UL Standards and Canadian Standards (cUL certification) compatibility (cont.)

⚠ CAUTION

6. The protection circuit inside this servo amplifier does not conform to UL Standards' "branch circuit protection".
   It is necessary to install "branch circuit protection" conforming to the National Electrical Code or similar standard outside the amplifier.
   本サーボアンプ内部の保護回路は，UL 規格の「branch circuit protection」に適合しません。米国「National Electric Code」又は同等の規格に適合した「branch circuit protection」をアンプ外部に備え付ける必要があります。
7. This servo amplifier does not offer the motor overheat protection described in UL Standards.
   本サーボアンプは，UL 規格記載のモータ過熱保護を提供しません。
8. Short circuit rating（短絡定格）
   "Suitable For Use On A Circuit Of Delivering Not More Than 5,000 rms Symmetrical Amperes, 240 Volts Maximum when protected by Class J Fuses.
   定格遮断容量が 5,000A 以上かつ最大定格電圧 240V 以上のクラス J ヒューズで保護したとき，最大電源電圧が 240V の電源に接続できます。
9. Use the servo amplifier in a pollution degree 2 environment.
   サーボアンプは汚染度 2 の環境でご使用ください。
10. Install UL certified fuses or circuit breaker between the power supply and the inverter, referring to the table below.
    下表を参照の上，電源とサーボアンプの間に UL 認定品のヒューズを設置してください。

<table>
<tr><th rowspan="2">Power supply voltage 電源系列</th><th rowspan="2">Servo Amplifier type
サーボアンプ形式</th><th rowspan="2">Class J fuse size (A)
ヒューズ定格 [A]</th><th>Required torque
締め付けトルク
lb-in (N・m)</th><th colspan="3">Wire size AWG (mm²) *1
電線サイズ</th></tr>
<tr><th>接地端子
Grounding terminal</th><th>L1,L2,L3,U,V,W</th><th>L1C,L2C</th><th>接地線
Grounding wire</th></tr>
<tr><td rowspan="11">200V</td><td>RYT500F7-■■2</td><td>10</td><td rowspan="11">15.9 (1.8)</td><td rowspan="6">16 (1.25)</td><td rowspan="11">18 (0.75)</td><td rowspan="6">16 (1.25)</td></tr>
<tr><td>RYT101F7-■■2</td><td>10</td></tr>
<tr><td>RYT201F7-■■2</td><td>10</td></tr>
<tr><td>RYT401F7-■■2</td><td>10</td></tr>
<tr><td>RYT751F7-■■2</td><td>15</td></tr>
<tr><td>RYT102F7-■■2</td><td>30</td></tr>
<tr><td>RYT152F7-■■2</td><td>30</td><td>14 (2.0)</td><td>14 (2.0)</td></tr>
<tr><td>RYT202F7-■■2</td><td>50</td><td rowspan="2">10 (5.5)</td><td rowspan="2">10 (5.5)</td></tr>
<tr><td>RYT302F7-■■2</td><td>50</td></tr>
<tr><td>RYT402F7-■■2</td><td>90</td><td rowspan="2">8 (8.0)</td><td rowspan="2">8 (8.0)</td></tr>
<tr><td>RYT502F7-■■2</td><td>90</td></tr>
</table>

*1 Use 75°C (167°F) Cu wire only.
最高許容温度 75℃の銅線を使用してください。

14.3 Radio Waves Act (South Korea)

■ 韓国電波法への対応

使用者案内文

本製品は業務用の環境で使用する目的で適合性評価を受けた機器であり，家庭外の地域で使用するのを目的とします。

本対象は，形式 RYT△△△□7-□□2 のみ対象となります。

（△にはサーボアンプ容量，□にはバリエーションを示す英数字がはいります。）

■ 한국 전파법 대응

사용자안내문

이 기기는 업무용 환경에서 사용할 목적으로 적합성평가를 받은 기기로서 가정용 환경에서 사용하는 경우 전파간섭의 우려가 있습니다.

으로 합니다. 해당제품은 형식 RYT△△△□7-□□2 의 제품만 대상이 됩니다.

(△는 인버터용량, □는 전압시리즈를 표시하는 영숫자가 표기됩니다.)

■ Compliance with the Radio Waves Act (South Korea)

User guidance

This product has undergone a conformity assessment for the purpose of use in a work environment, and is intended for use in areas outside the home.

Only the following type of the products is applicable to this certification.

Type: RYT△△△□7-□□2

(△ and □ are replaced with alphanumeric characters indicating the servo amplifier capacity and variation, respectively.)

Applicant	: Fuji Electric Korea
Equipment Name	: Servo amplifier
Country of Origin	: Described on the nameplate
Date of Manufacture	: Described on the nameplate
Manufacturer	: Fuji Electric Co.,Ltd

14.4 Complying with "Guideline for Suppressing Harmonics by Customers Receiving High Voltage or Special High Voltage"

The Public Utilities Department of the Ministry of International Trade and Industry's Agency for Natural Resources and Energy enacted the following two guidelines relating to harmonic suppression on September 30, 1994.

(1) "Guideline to Reduce Harmonic Emissions Caused by Electrical and Electronic Equipment for Household and General Use"
(2) "Guideline for Suppressing Harmonics by Customers Receiving High Voltage or Special High Voltage"

These guidelines were enacted based on the assumption that the use of electronic devices generating harmonic current would continue to rise in the future, and that they would lead to the prevention of harmonic interference at devices connected to systems by applying regulations beforehand. These guidelines apply to all electrical and electronic devices used with a commercial power supply and which generate harmonic current, however, the following explanation applies only to "servo amplifiers".

14.4.1 Servo Amplifier Application

14.4.1.1 Application for Other Than Special Customers

From January 2004, servo amplifiers (input current of 20A or less) were excluded from the "Guideline to Reduce Harmonic Emissions Caused by Electrical and Electronic Equipment for Household and General Use" (established September, 1994) enacted by the Ministry of Economy, Trade and Industry. Customers for whom the "Guideline for Suppressing Harmonics by Customers Receiving High Voltage or Special High Voltage" does not apply are recommended to connect the "DC reactor" indicated in the catalog or User's Manual to the servo amplifier as in the past.

14.4.1.2 Application for "Guideline for Suppressing Harmonics by Customers Receiving High Voltage or Special High Voltage"

All customers receiving high voltage or special high voltage fall under the scope of the "Guideline for Suppressing Harmonics by Customers Receiving High Voltage or Special High Voltage". Devices generating harmonic current such as "servo amplifiers" are not regulated directly, but for each customer using a power supply. It is necessary to calculate such values as the amount of harmonic current generated by individual devices.

(1) Regulation scope

Generally speaking, regulations apply if the following two conditions are satisfied.

- The device is receiving high or extra-high voltage.
- Converter load "equivalent capacity" exceeds the standard value (50kVA when receiving 6.6 kV) for the receiving voltage.

If calculating "equivalent capacity" in accordance with the guidelines, a supplementary description is provided in "14.4.2.1 Equivalent Capacity Calculation".

(2) Regulation method

Regulate the size (calculated value) of the harmonic current flowing from the customer's power receipt point to the system. Regulation values are proportional to contracted demand. Guideline regulation values are shown in Table 14.4-1.

If calculating "harmonic current" in accordance with the guidelines, a supplementary description is provided in "14.4.2 Complying with "Guideline for Suppressing Harmonics by Customers Receiving High Voltage or Special High Voltage".

Table 14.4-1 Harmonic outflow current upper limit per 1kW of contracted demand (mA/kW)

Receiving voltage	5th	7th	11th	13th	17th	19th	23rd	25th and above
6.6 kV	3.5	2.5	1.6	1.3	1.0	0.90	0.76	0.70
22 kV	1.8	1.3	0.82	0.69	0.53	0.47	0.39	0.36

14.4.2 Complying with "Guideline for Suppressing Harmonics by Customers Receiving High Voltage or Special High Voltage"

If performing calculations for "servo amplifiers" in accordance with the guidelines, do so as follows.

14.4.2.1 Equivalent Capacity Calculation

Equivalent capacity is calculated by multiplying the (input rated capacity) by (conversion factor), however, the input rated capacity value is not indicated in servo amplifier catalogs, and is therefore described below.

14

(1) Servo amplifier rated capacity equivalent to Pi

- In the guidelines, a 6-pulse converter is used as a reference for conversion factor 1, and therefore it is necessary to express the servo amplifier input rated capacity as a value including the harmonic current equivalent to conversion factor 1.
- To be more specific, input fundamental harmonic current I1 is calculated as follows from the kW rating and efficiency of the motor (load) and efficiency of the servo amplifier:

Three-phase input: Input rated capacity = √3 x (power supply voltage) x I1 x 1.0228/1000 (kVA)
Single-phase input: Input rated capacity = (power supply voltage) x I1 x 1.0228/1000 (kVA) Here, 1.0228 is the 6-pulse converter (effective value current)/(fundamental harmonic current) value.

Hint	The "input rated capacity" expressed here can be applied only if performing the calculation indicated in the harmonic guidelines, and cannot be used to select servo amplifier power supply side devices and wiring size, etc., and therefore caution is required.

Refer to manufacturer catalogs or technical material for information on peripheral equipment capacity selection.

Table14.4-2 Servo amplifier input rated capacity and fundamental harmonic input current

Motor rated capacity [kW]	Input rated capacity [kVA]	Fundamental harmonic input current [A]	
		Single-phase	Three-phase
		200 V	200 V
0.1	0.22	1.05	0.61
0.2	0.35	1.70	0.98
0.4	0.57	2.81	1.61
0.75	0.97	4.76	2.74
0.85	1.10	—	3.11
1.0	1.30	—	3.66
1.5	1.95	—	5.50
2.0	2.56	—	7.24
3.0	3.77	—	10.6
4.0	4.97	—	14.0
5.0	6.17	—	17.4

14

(2) Ki (conversion factor) size

The conversion factors in the guidelines appendix apply based on the optional ACR (AC reactor) and/or DCR (DC reactor) usage status. The conversion factor sizes are shown in Table14.4-3.

Table14.4-3 Servo amplifier "conversion factor Ki" determined by reactor

Circuit class	Circuit type	Reactor	Conversion factor
3	Three-phase bridge (capacitor smoothing)	Not used	3.4
		Used (AC side)	1.8
		Used (DC side)	1.8
		Used (AC, DC side)	1.4
4	Single-phase bridge (capacitor smoothing)	Not used	2.9
		Used (AC side)	1.3

(3) Rated input current (receiving voltage conversion value) calculation

Rated input current (receiving voltage conversion value) is calculated with the following equation.

$$I_{\mathrm{H}} = I_{\mathrm{I}} \times \frac{V_i}{V_{\mathrm{H}}} \times 10^3$$

I_{H}: Rated input current (receiving voltage conversion value) (mA)
I_{I}: Fundamental harmonic input current (A)
V_i: Power supply voltage (V)
V_{H}: Receiving voltage (V)

(4) Servo amplifier operation rate

Servomotors are run based on the operation pattern in Fig.14.4-1, and therefore servo amplifier operation rate A is calculated with the following equation.

$$A = \left(\frac{T_{\mathrm{a}}}{2} \times \tau_{\mathrm{a}} + T_{\mathrm{c}} \times \tau_{\mathrm{c}} \right) \times \frac{2\pi \times N_{\mathrm{c}}}{60} \times \frac{1}{T_{\mathrm{o}}} \times \frac{1}{P_{\mathrm{M}}}$$

A: Operation rate
T_o: Time for 1 servomotor cycle when performing repeat operation (s)
T_a: Servomotor acceleration time (not necessary to consider deceleration time) (s)
T_c: Running time when servomotor running at steady rotation speed (s)
τ_a: Servomotor acceleration torque (not necessary to consider deceleration torque) (N·m)
τ_c: Servomotor load torque (N·m)
N_c: Servomotor steady rotation speed (min^{-1})
P_M: Servomotor rated capacity (W)

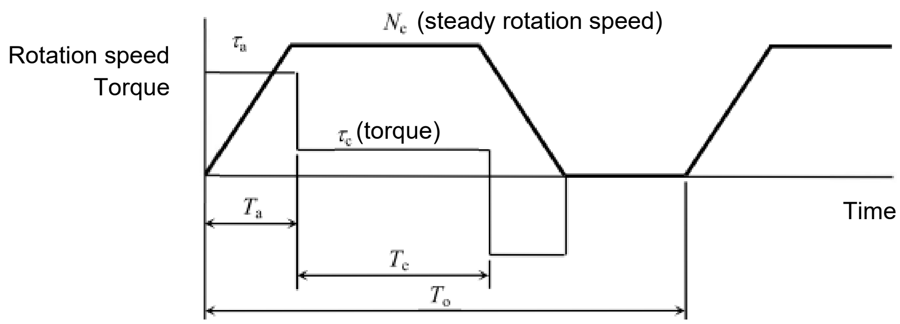


Fig.14.4-1 Servomotor operation pattern

14.4.2.2 Harmonic Current Calculation

(1) Harmonic current calculation

Generally speaking, harmonic current is calculated using "Table 3 Three-phase bridge (capacitor smoothing)" in "Guidelines - Appendix 2". Refer to Table14.4-4 for the guidelines appendices.

Table14.4-4 Amount of harmonic current generation (%), three-phase bridge (capacitor smoothing)

Degree	5th	7th	11th	13th	17th	19th	23rd	25rd
No reactor used	65	41	8.5	7.7	4.3	3.1	2.6	1.8
Reactor used (AC side)	38	14.5	7.4	3.4	3.2	1.9	1.7	1.3
Reactor used (DC side)	30	13	8.4	5.0	4.7	3.2	3.0	2.2
Reactor used (AC, DC side)	28	9.1	7.2	4.1	3.2	2.4	1.6	1.4

- AC side reactor: 3%
- DC side reactor: Stored energy is equivalent to 0.08 to 0.15 ms (100% load conversion)
- Smoothing capacitor: Stored energy is equivalent to 15 to 30 ms (100% load conversion)
- Load: 100%

The harmonic current for each degree is obtained as follows.

$$\text{nth degree harmonic current (A)} = \text{fundamental harmonic current (A)} \times \frac{\text{Amount of nth degree harmonic current generation (\%)}}{100} \times \text{operation rate}$$

CHAPTER 15 APPENDIXES

15

15.1 CiA402 Drive Profiles

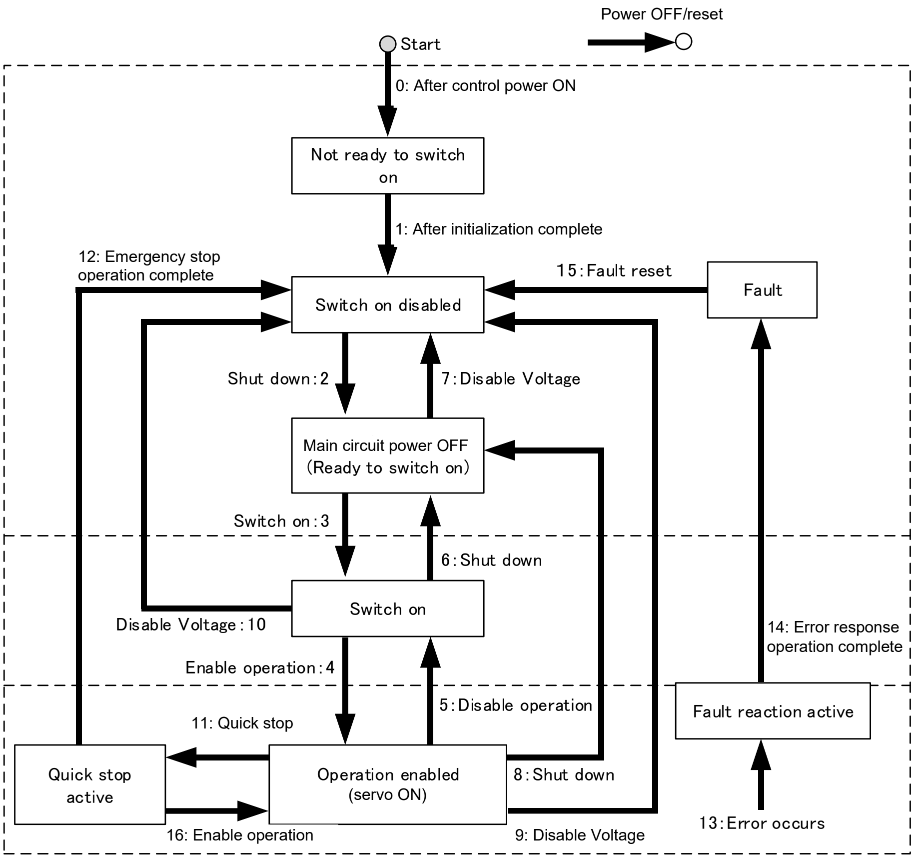
This section describes the profiles used to control servo amplifiers.

15.1.1 Servo Amplifier Status Control

With the ALPHA7 Series built-in EtherCAT communication type, the servo amplifier status is referred to as the “PDS status”.
The PDS status is controlled based on 6040H: Controlword.
Furthermore, the respective PDS statuses are displayed with 6041H: Statusword.

Status transition

The status transition for the ALPHA7 Series is as follows.
The text inside the boxes in the diagram indicates the statuses, and numbers 2 to 10 and 15 indicate status control commands.
Refer to “Description of each status” for details on statuses, and “Status control commands” for details on status control commands.



Control circuit power OFF/reset	Main circuit power	Servo ON/OFF
ON	ON or OFF	OFF
ON	ON	OFF
ON	ON	ON

Description of each status

Status	Description
Not ready to switch on	The control circuit power is ON, and the servo amplifier is being initialized.
Switch on disabled	Initialization is complete. Servo amplifier parameters can be set.
Ready to switch on	The main circuit power may be turned ON. Servo amplifier parameters can be set.
Switched on	The main circuit power is ON (servo ready). Servo amplifier parameters can be set.
Operation enabled	Servo ON status Servo amplifier parameters can be set.
Fault reaction active	An error occurred at the servo amplifier, and the motor is being stopped. Servo amplifier parameters can be set.
Fault	An error has occurred at the servo amplifier. Servo amplifier parameters can be set.

Status control commands

The status is controlled with a combination of the 6040H: Controlword bits shown in the following table.

fr = fault reset, eo = enable operation, qs = quick stop, ev = enable voltage, so = switch on

Command	Controlword bit					Transition
	Bit 7 fr	Bit 3 eo	Bit 2 qs	Bit 1 ev	Bit 0 so	
Shutdown	X	X	1	1	0	2, 6, 8
Switch on	X	0	1	1	1	3
Switch on + enable operation	X	1	1	1	1	3 + 4*1
Disable voltage	X	X	X	0	X	7, 9, 10, 12
Quick stop	X	1	0	1	1	11
Disable operation	X	0	1	1	1	5
Enable operation	X	1	1	1	1	4, 6
Fault reset	0 → 1*2 *3	X	X	X	X	15

*1 Automatically changes to the Operation enabled status.

*2 Operation when Bit 7: Fault reset is rising

Fault status: The error that is occurring is reset, and the status changes to Switch on disabled.

Other than Fault status: The status changes based on the command for bits 0 to 3.

*3 After Fault reset is executed at bit 7, return to “0” prior to issuing the next command.

Status display

Each status is indicated with a combination of the 6041H: Statuswords shown in the following table.

Status	Bit 6 sod*1	Bit 5 qs*2	Bit 4 ve*3	Bit 3 f*4	Bit 2 oe*5	Bit 1 so*6	Bit 0 rtso*7
Not ready to switch on	0	0	0	0	0	0	0
Switch on disabled	1	X	X	0	0	0	0
Ready to switch on	0	1	X	0	0	0	1
Switched on	0	1	X	0	0	1	1
Operation enabled	0	1	X	0	1	1	1
Fault reaction active	0	X	X	1	1	1	1
Fault	0	X	X	1	0	0	0

*1 sod = switch on disabled
*2 qs = quick stop
*3 ve = voltage enabled
*4 f = fault
*5 oe = operation enabled
*6 so = switched on
*7 rtso = ready to switch on

Stop action sequences

If transitioning from Operation Enabled to another status, the servo amplifier performs deceleration operation or stop operation. Furthermore, if the deceleration operation for each object is set to 0 (no operation), the dynamic brake is applied based on the parameter setting. The relationship between each status, object, and parameter is as follows.

Status	Object	Parameter	
		When decelerating	When stopping
Quick stop active	605AH: Quick stop option code	—*1	—*1
Switch on disabled / Ready to switch on	605BH: Shut down option code	PA2_63 2nd digit	PA2_63 1st digit
Switch on	605CH: Disable operation option code	PA2_61 2nd digit	PA2_61 1st digit
Fault reaction active (minor fault)	605EH: Fault reaction option code	PA2_62 4th digit (minor fault)	—
Fault reaction active (major fault)	—	PA2_62 2nd digit (major fault)	—
Fault	—	—	PA2_62 1st digit

*1 The servomotor is fixed to free-run in the case of no operation.
The servo lock is applied in the case of stoppages other than free-run.

Refer to "15.1.14 Servo Amplifier Profile Objects" for details on the setting method for each object, and to "CHAPTER 3 PARAMETERS" for details on the setting method for each parameter.

15

15.1.2 Operation Modes

The ALPHA7 Series built-in EtherCAT communication type supports the following operation modes.

- csp: Cyclic synchronous position mode
- csv: Cyclic synchronous velocity mode
- cst: Cyclic synchronous torque mode
- pp: Profile position mode
- pv: Profile velocity mode
- hm: Homing mode

Modes of operation (6060H) is used to set the operation mode. The operation mode currently running is displayed in Modes of operation display (6061H).
The operation modes supported by the servo amplifier can be checked in Supported drive modes (6502H).
Do not specify unsupported operation modes.

15.1.3 Communication Cycles and Corresponding Synchronization Mode

The available synchronization modes are restricted based on the communication cycle.
Please refer to the following table for details.

Communication cycle *1) [μs]	Synchronization mode
125	DC, Free Run
250	DC, Free Run
500	DC, SM2, Free Run
1000	DC, SM2, Free Run
2000	DC, SM2, Free Run
4000	DC, SM2, Free Run

*1) The communication cycle is set at the controller. Refer to the manual for the connected controller for details on the setting method.

15.1.4 Objects Synchronized with DC

By registering the following objects in PDO, data is returned following a DC occurrence when performing DC synchronous communication.
With Freerun, SM2 synchronization, and objects other than the following, the most recent internal data is sent when performing communication.

Index	Sub-index	Name	Access	Size	Unit	Setting range	Default value
6062H	00H	Position demand value	ro	INT32	unit	-2147483648 to 2147483647	0
6064H	00H	Position actual value	ro	INT32	unit	-2147483648 to 2147483647	0
606CH	00H	Velocity actual value	ro	INT32	unit/s	-2147483648 to 2147483647	0
6074H	00H	Torque demand	ro	INT16	0.1%	-350.0% to 350.0%	0
6077H	00H	Torque actual value	ro	INT16	0.1%	-350.0% to 350.0%	0

15.1.5 Operation Modes and Advanced Functions

The relationship between the ALPHA7 Series built-in EtherCAT communication type operation modes and advanced functions is shown in the following table.

Function	Operation mode		
	csp pp hm	csv pv	cst
Notch filter (notch 1 to 5)	○	○	—
Vibration suppressing function	○	—	—
Model torque calculation	○	○	—
Command filter for each position	○	—	—
Auto tuning	○	○	○ *1)
Speed observer	○	○	—

*1) This is valid only when PA4_21 (torque control speed limit method) is set to "0".

15

15.1.6 Changing the Operation Mode

This section describes how to change the ALPHA7 Series built-in EtherCAT communication type operation mode.

■ Operation mode change method

By setting the operation mode at the controller, the servo amplifier control mode can be changed and the motor run based on the selected control mode.

The operation mode is changed by changing the 6060H: Modes of operation stetting value.

When changing the operation mode, update the object command value mapped to RxPDO at the same time.
With cyclic synchronous position mode (csp) (a position control mode), for example, 607AH: Target position is valid as the command value, however, with cyclic synchronous velocity mode (csv), (a speed control mode), 60FFH: Target velocity is valid as the command value.
Consequently, a valid command value should be set for 60FFH: Target velocity at the same time as the operation mode is changed from a position control mode to a speed control mode.

The actual servo amplifier operation mode can be checked at 6061H: Modes of operation display.

Note	• Change the operation mode when the motor is stopped. If changed while the motor is running, motor operation will be affected.

■ Operation mode display

The actual operation mode can be checked at 6061H: Modes of operation display.
The operation mode display will be as follows based on the servo amplifier status.

Driver status	Operation mode display
Offline status (Remote (6040h-bit9) ≠ 1)	0: Not specified
Servo OFF	0: Not specified
Servo ON	Based on LPHA7 internal control mode

15

■ Modes of operation display (6061H) dependent bit display

The 6041H (Statusword) bit contains a bit dependent on the control mode, and the relationship with Modes of operation display is shown in the following table.

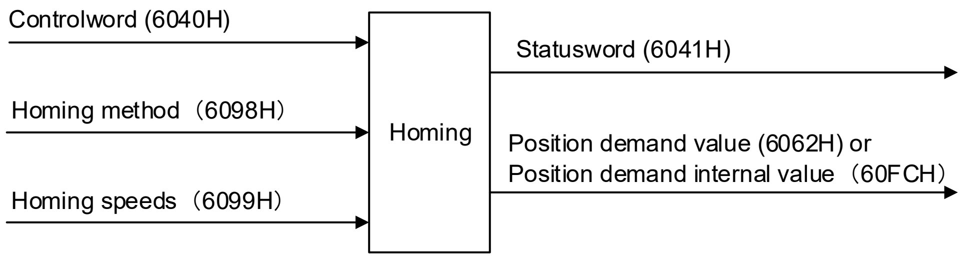
<table>
<tr><th rowspan="3">Object</th><th rowspan="3">Bit</th><th colspan="6">6061H: Modes of operation display</th></tr>
<tr><th colspan="3">Position control mode</th><th colspan="2">Speed control mode</th><th>Torque control mode</th></tr>
<tr><th>csp</th><th>pp</th><th>hm</th><th>csv</th><th>pv</th><th>cst</th></tr>
<tr><td rowspan="3">6041H</td><td>10</td><td>0</td><td>Target reached</td><td>Target reached</td><td>0</td><td>—</td><td>0</td></tr>
<tr><td>12</td><td>Target position ignored</td><td>Set-point acknowledge</td><td>Home attained</td><td>Target velocity ignored</td><td>Speed bit</td><td>Target torque ignored</td></tr>
<tr><td>13</td><td>Following error</td><td>Following error</td><td>Homing error</td><td>0</td><td>—</td><td>0</td></tr>
</table>

15.1.7 Homing Mode Specifications

This section describes ALPHA7 Series (built-in EtherCAT communication type) homing mode specifications.

Homing mode configuration

The homing mode configuration is as follows.



Corresponding homing method

The homing methods supported by the ALPHA7 Series (built-in EtherCAT communication type) are as follows.
Refer to “Homing operation” for details on each homing method.

Homing method	Description
0	No setting
1	Homing based on -OT and Z-phase
2	Homing based on +OT and Z-phase
3, 4	Homing based on home position LS edge input (positive logic)
5, 6	Homing based on home position LS edge input (negative logic) and Z-phase
7 to 10	Homing based on homing LS and Z-phase (movement start in forward direction)
11 to 14	Homing based on homing LS and Z-phase (movement start in reverse direction)
19	Homing based on homing LS (movement start in forward direction)
20	Homing based on homing LS (movement start in reverse direction)
33	Homing based on Z-phase (movement start in reverse direction)
34	Homing based on Z-phase (movement start in forward direction)
35, 37	Current position home position preset *1

*1: Methods 35 and 37 have the same function, however, when designing new systems, do so in accordance with ETG standards, and use Method 37.

15

Related objects

Index	Sub-index	Name	Access	Size	Unit	Setting range	Default value
6040H	00H	Controlword	RW	UINT16	0 to FFFFH	—	0000H
6060H	00H	Modes of operation	RW	INT8	—	0 to 10	0
6098H	00H	Homing method	RW	INT8	—	0 to 37	0
6099H	01H	Speed during search for switch	RW	UINT32	unit/s	—	139810133
	02H	Speed during search for zero	RW	UINT32	unit/s	—	13981013
609AH	00H	Homing acceleration	RW	UINT32	unit/s^2	0 to 2147483637	559240533
6041H	00H	Statusword	RO	UINT32	0 to FFFFH	—	0000H

Controlword (6040H) in homing mode

Bit	Name	Value	Description
4	Homing operation start	0	Homing stop
		1	Homing start
8	Halt	0	Homing continue
		1	Stop based on Halt option code

Bits 5 and 6 are not used.

Refer to 6040H: Controlword for all other bits.

15

Statusword (6041H) in homing mode

Bit 13, bit 12, bit 10 (operation mode specific):

Bit	Name	Value	Description
10	Target reached	0	Running
		1	Stopped
12	Homing attained	0	Homing operation incomplete
		1	Homing operation successfully completed
13	Homing error	0	No homing error
		1	Homing error occurred

The bit 13, bit 12, and bit 10 value combinations are as follows.

Bit 13	Bit 12	Bit 10	Description
0	0	0	Performing homing.
0	0	1	Homing has been interrupted, or has not started.
0	1	0	The motor is near the home position, but the target position has not been reached.
0	1	1	Homing is complete.
1	0	0	A homing error occurred, but the speed is not 0.
1	0	1	A homing error occurred, and the speed is 0.
1	1	0	Reserved
1	1	1	Reserved

15

Homing operation

This section describes the corresponding homing method operations.

■ Replacement of terminology

This chapter uses terminology based on descriptions in IEC FDIS 61800-7-201 to explain the homing method. Consequently, when carryout wiring work or specifying settings for ALPHA7, replace the terminology as follows when doing so.

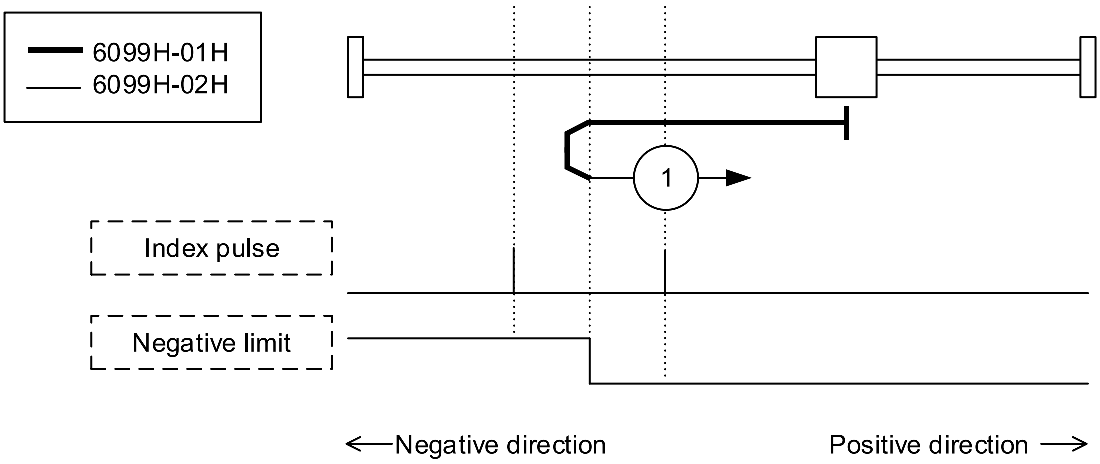
Expressions used in this section (terminology based on ETG)	Function in ALPHA7
Index Pulse	Z-phase
Home Switch	Home position LS
Negative Limit	-OT
Positive Limit	+OT

■ Operation after arriving at home position detection position

ALPHA7 performs deceleration based on the Homing acceleration (609AH) setting value when the motor arrives at the home position detection position, however, the motor may pass through the home position detection position while it is decelerating. When this occurs, the motor continues to decelerate based on the Homing acceleration (609AH) setting value, and the overshoot is automatically reversed at the Speed during search for zero (6099H-02H), before the motor comes to a stop at the home position detection position.

■ Method 1

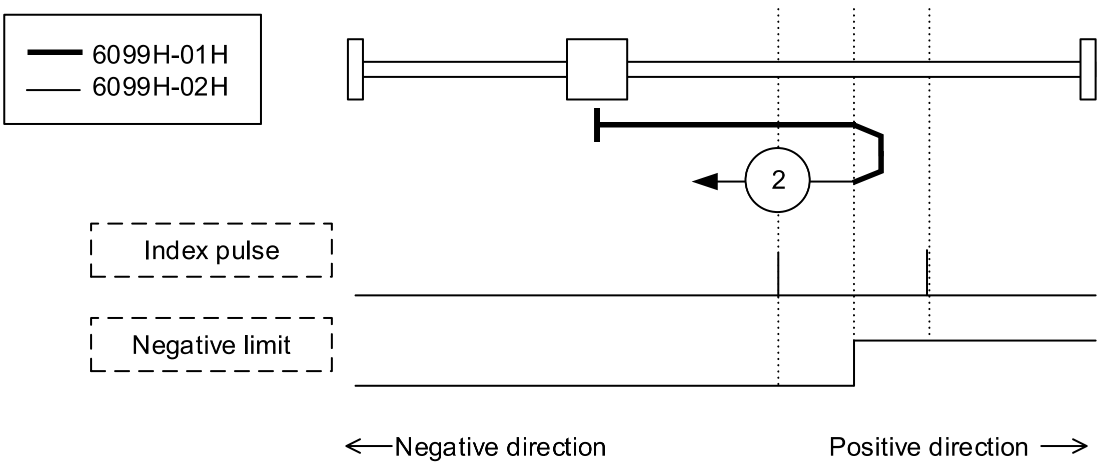
- With this method, the initial movement direction is negative if the Negative limit switch is inactive. (The inactive status is indicated by the low level status in the drawing.)
- The home position detection position is the initial index pulse detection position at the positive side position after the negative limit signal becomes inactive.



Homing on negative limit switch and index pulse

■ Method 2

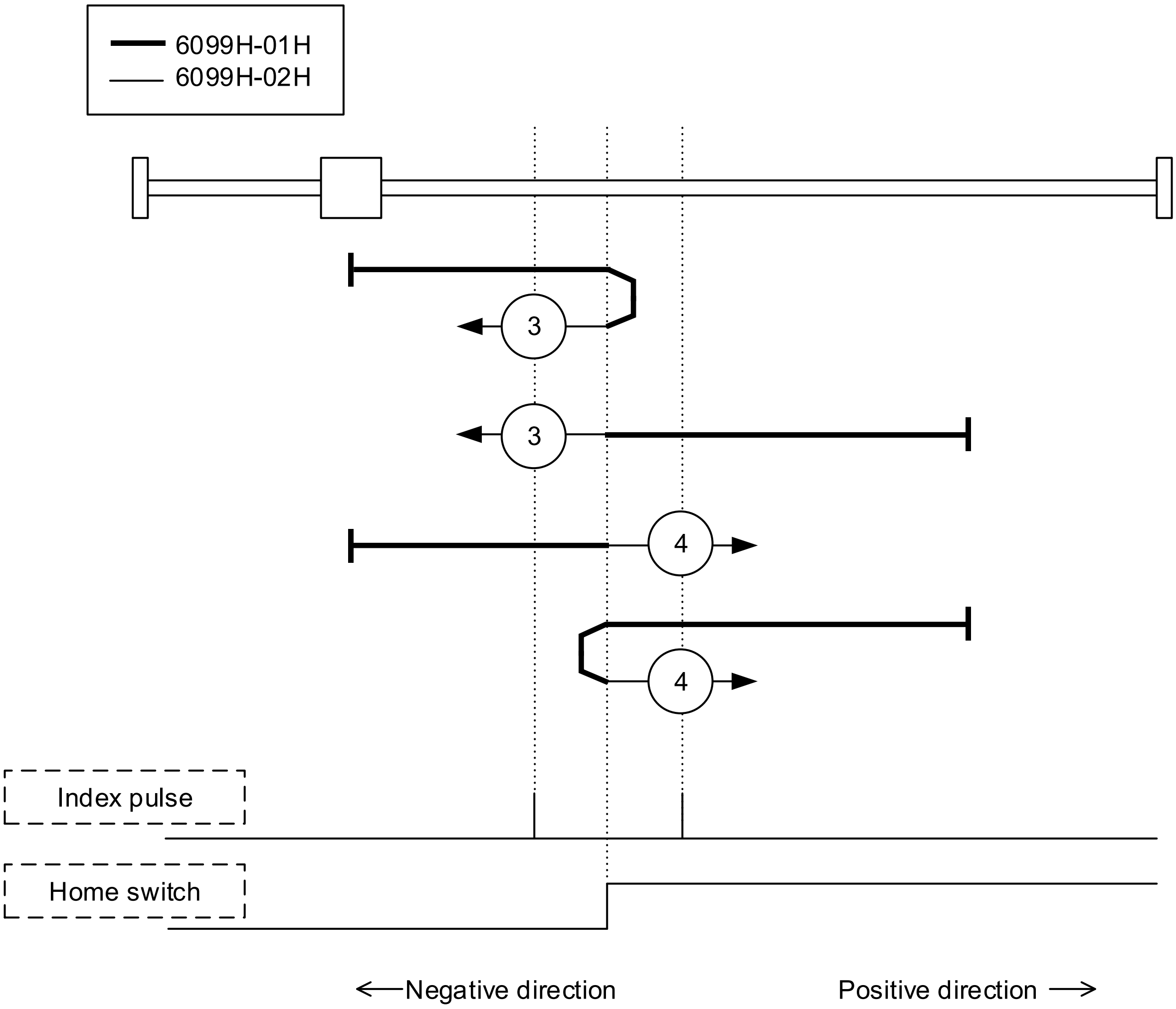
- With this method, the initial movement direction is positive if the Positive limit switch is inactive. (The inactive status is indicated by the low level status in the drawing.)
- The home position detection position is the initial index pulse detection position at the negative side position after the positive limit signal becomes inactive. (See drawing.)



Homing on positive limit switch and index pulse

■ Method 3, 4

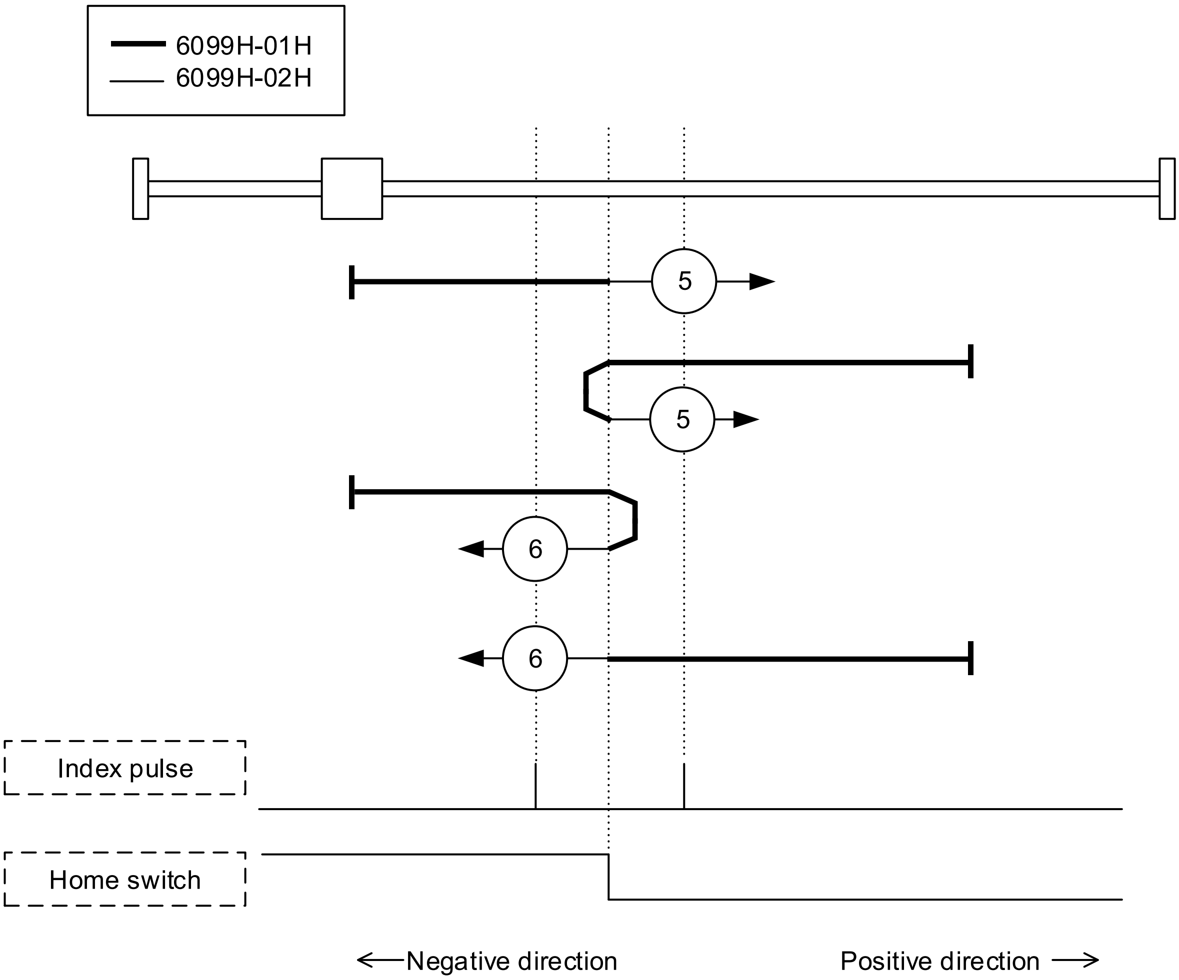
- With these methods, the initial movement direction changes based on the home switch status at startup.
- The home position detection position is the initial index pulse detection position at the negative side or positive side after the home switch status has changed. (See drawing.)



Homing on positive home switch and index pulse

■ Method 5, 6

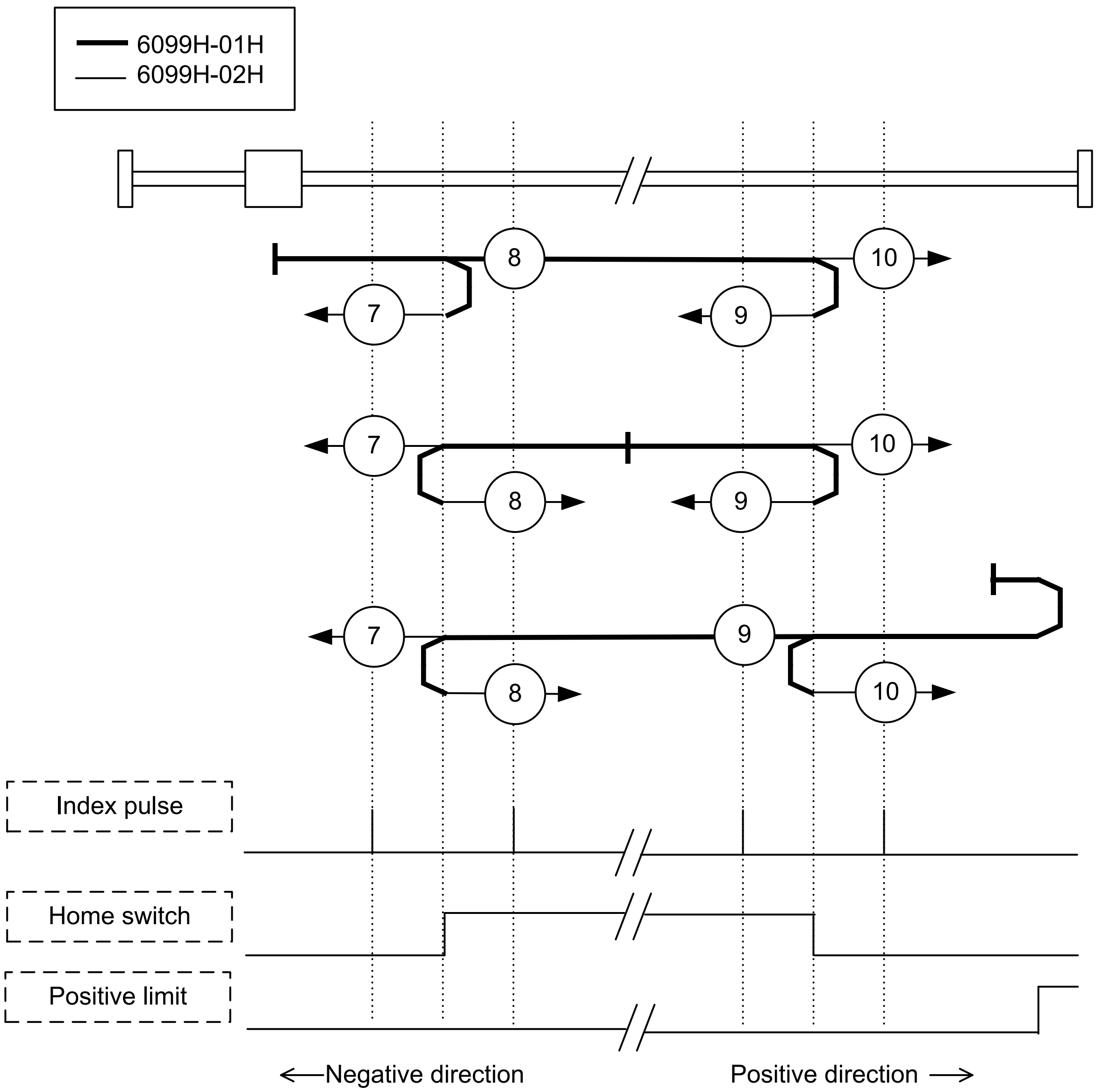
- With these methods, the initial movement direction changes based on the home switch status at startup.
- The home position detection position is the initial index pulse detection position at the negative side or positive side after the home switch status has changed. (See drawing.)



Homing on negative home switch and index pulse

■ Method 7, 8, 9, 10

- These methods use the home switch and index pulse.
- The method 7 and 8 initial movement direction is the negative direction if the home switch is active when movement starts.
- The method 9 and 10 initial movement direction is the positive direction if the home switch is active when movement starts.
- The home position detection position is the index pulse near the home switch rising edge or falling edge. (See drawing.)

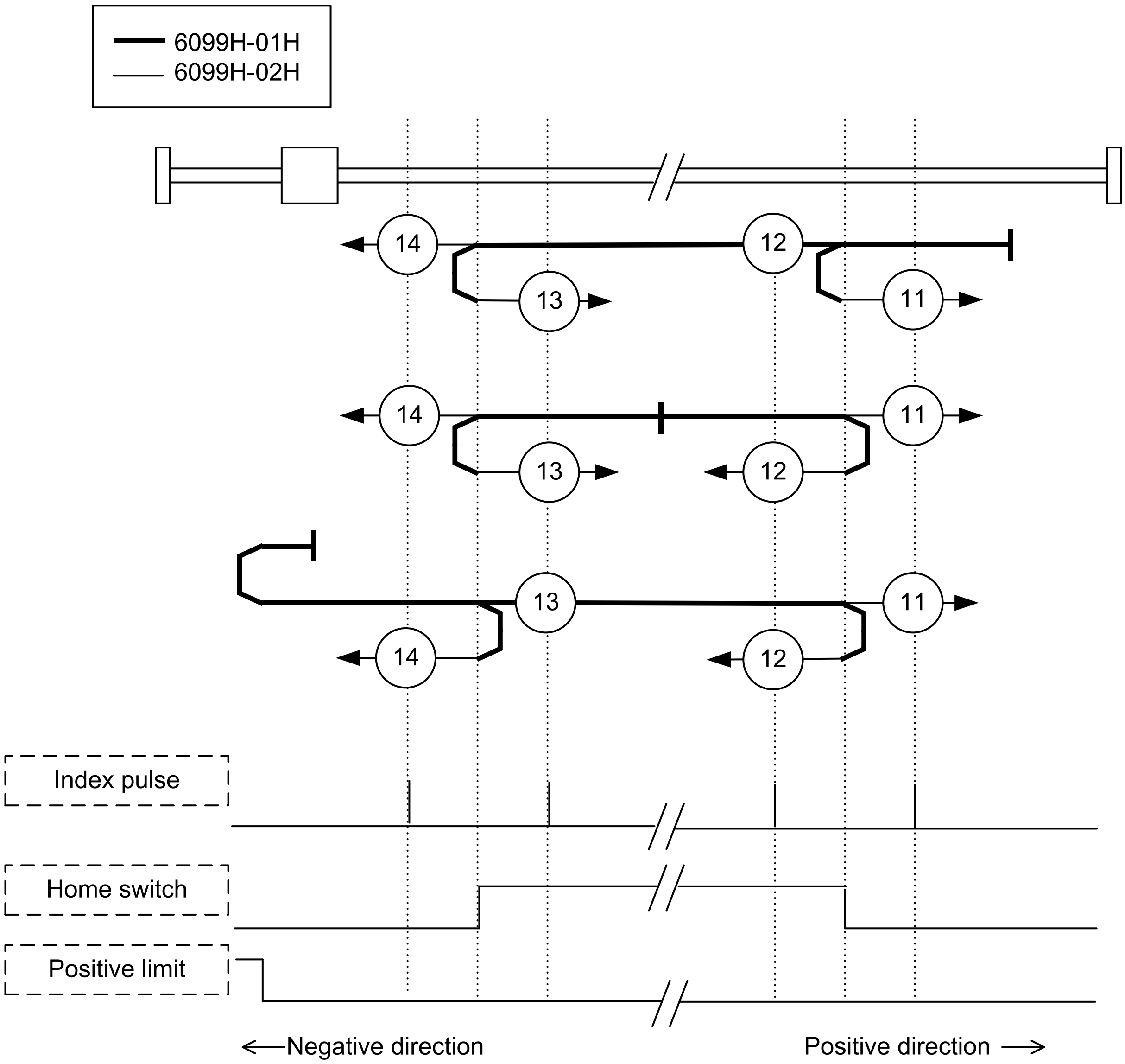


Homing on home switch and index pulse − positive initial motion

15

■ Method 11, 12, 13, 14

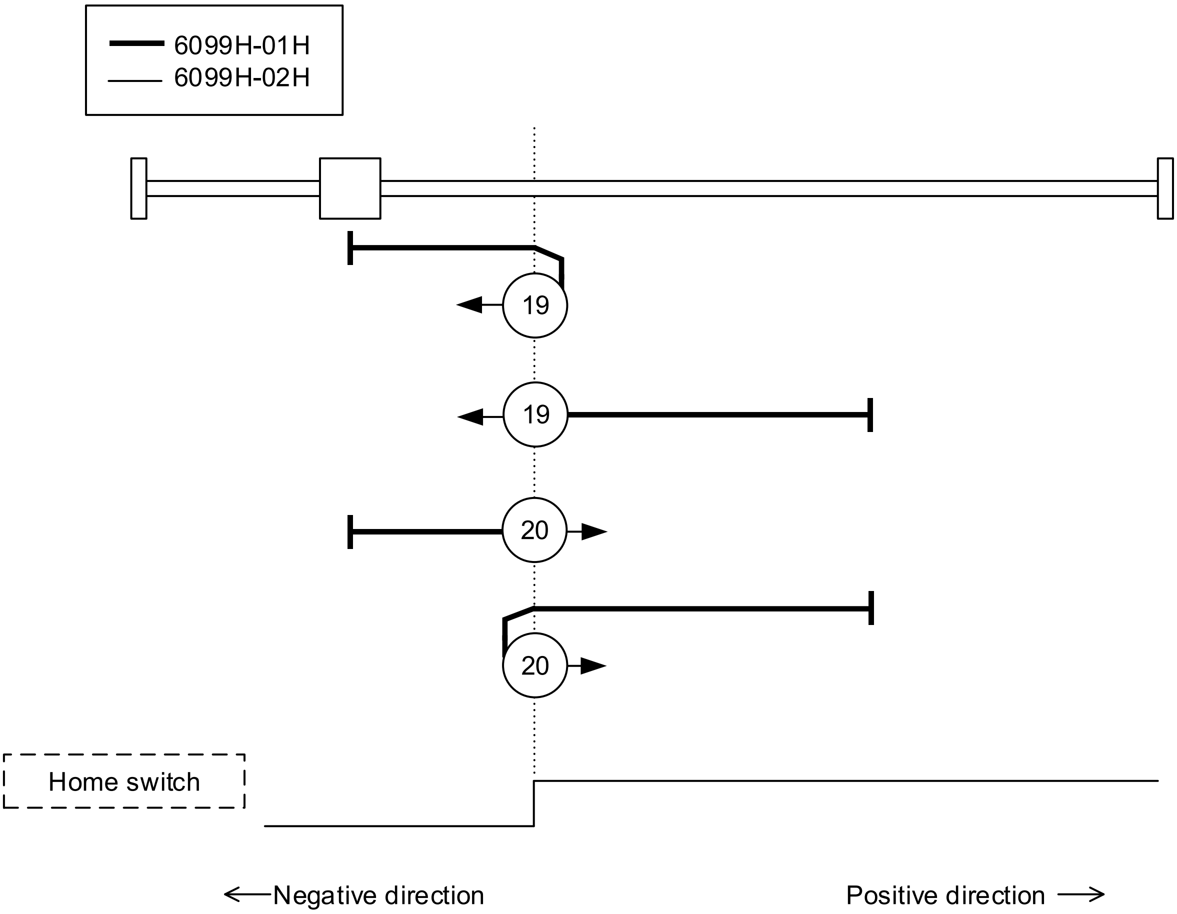
- These methods use the home switch and index pulse.
- The method 11 and 12 initial movement direction is the positive direction if the home switch is active when movement starts.
- The method 13 and 14 initial movement direction is the negative direction if the home switch is active when movement starts.
- The home position detection position is the index pulse near the home switch rising edge or falling edge. (See drawing.)



Homing on home switch and index pulse − negative initial motion

■ Method 19, 20

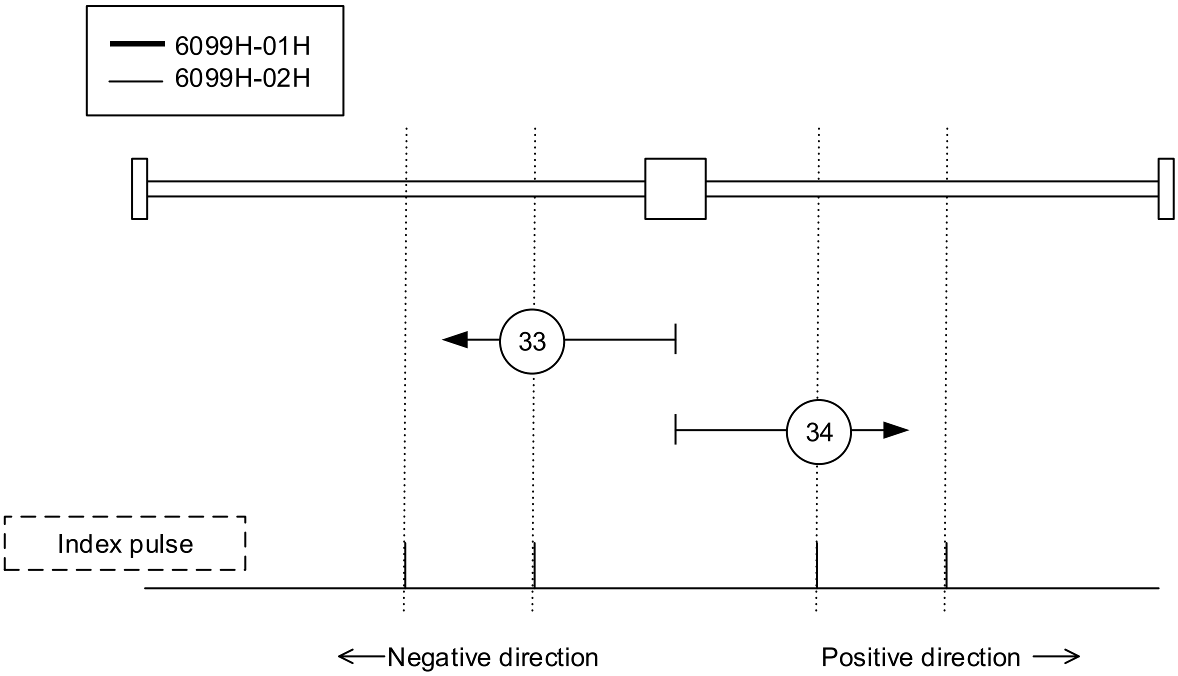
- These methods are similar to methods 3 and 4.
  The difference is that the home position detection position is not the index pulse, but the position for which the home switch has changed.
  (See drawing.)



Homing on positive home switch and index pulse − negative initial motion

■ Method 33, 34

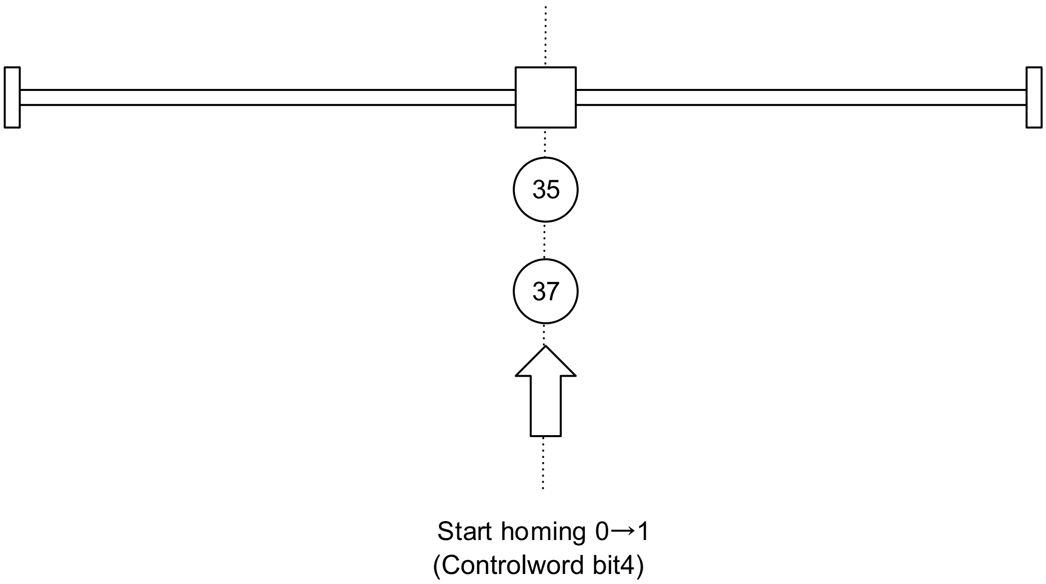
- These methods use the index pulse only.
- The motor moves in the direction shown in the diagram, and the detected index pulse is the home position detection position.



Homing on index pulse

■ Method 35, 37

- Use if setting the servo amplifier coordinate system (position information setting).
  This position is used as the reference when homing starts, and the following objects are initialized (preset).
  6062H (Position demand value) = 6064H (Position actual value) = 607CH (Home offset)
  6063H (Position actual internal value) = 60FCH (Position demand internal value) = 0
  (Note) 607CH (Home offset) is added to 6062H and 6064H.
- The PDS status can be run even if not in the Operation Enabled status.
- Wait 100 ms or longer after stopping the command position before running methods 35 and 37.
- Methods 35 and 37 have the same function, however, when designing new systems, do so in accordance with ETG standards, and use Method 37.



15.1.8 Touch Probe (Latch Function)

The touch probe is a function used to latch feedback positions with external latch input signals, or with the rising edge of the encoder Z-phase. The ALPHA7 Series is equipped with 2 latch functions.

Related Objects

Index	Sub-index	Name	Description
60B8H	00H	Touch probe function	Controls the touch probe function.
60B9H	00H	Touch probe status	Indicates the touch probe function status.
60BAH	00H	Touch probe 1 positive position value	This is the touch probe 1 rising edge latch position.
60BBH	00H	Touch probe 1 negative position value	This is the touch probe 1 falling edge latch position.
60BCH	00H	Touch probe 2 positive position value	This is the touch probe 2 rising edge latch position.
60BDH	00H	Touch probe 2 negative position value	This is the touch probe 2 falling edge latch position.

Trigger Signal Settings

The touch probe trigger can be selected from a CONT signal or the encoder Z-phase. The function for CONT1 to 6 can be set with PA3_01 to PA3_06.
Specify the trigger as an external latch signal or Z-phase with Touch probe function (60B8H) bit 2 or bit 10.

(1) CONT signal assignment

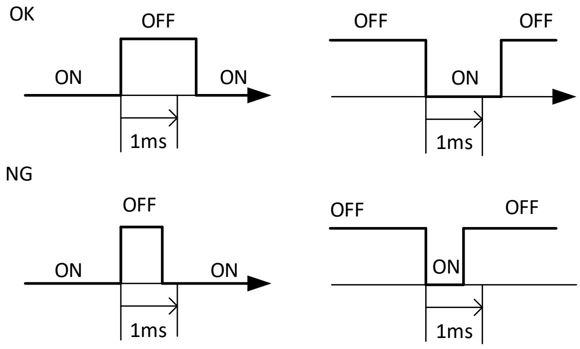
Signal	Parameter	Setting
CONT1	PA3_01	49: Interrupt input(Touch probe 1) 59: Interrupt input 2(Touch probe 2)
CONT2	PA3_02	
CONT3	PA3_03	
CONT4	PA3_04	
CONT5	PA3_05	
CONT6	PA3_06	

(2) 60B8H: Touch probe function

Bit 2	Trigger	Bit 10	Trigger
0	Interrupt input	0	Interrupt input 2
1	Z-phase	1	Z-phase

Restrictions When Using CONT Terminals

If using a CONT terminal as the touch probe trigger, ensure a trigger pulse width of 1 ms or greater as shown in the following diagram. If the pulse width is less than 1 ms, it will not be possible to detect the position correctly.



Action Sequences

Starting and stopping

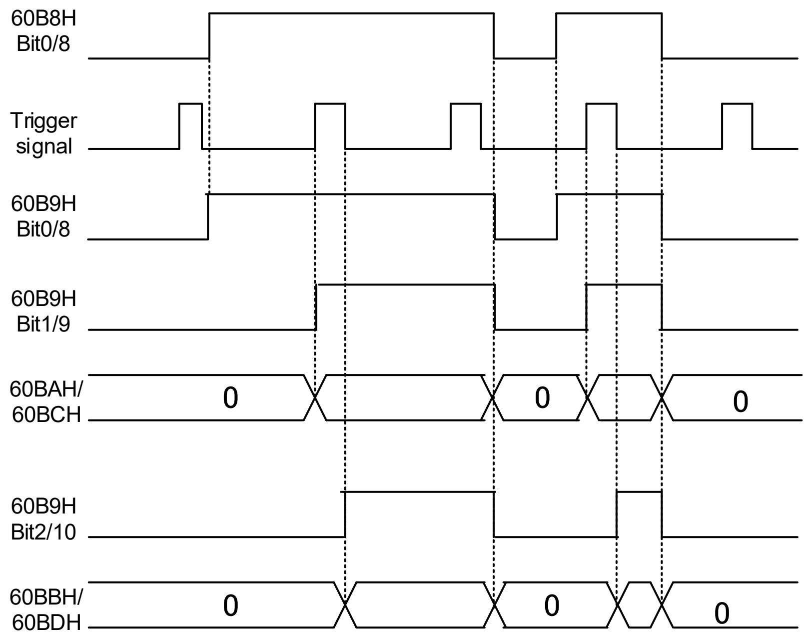
The touch probe function is started and stopped with Touch probe function (60B8H) bit 0/8. To start the function, set bit 0/8 to 1. By setting bit 0/8 to 0, the function stops, and all Position value (60BAH to 60BDH) values are cleared.
Furthermore, the edge to be updated can be selected with bit 4/5/12/13. The relationship between setting and updated position is as follows.

Bit 4/bit 12	Bit 5/bit 13	Positive position value (60BAH / 60BCH)	Negative position value (60BBH / 60BDH)
0	0	Not updated	Not updated
0	1	Not updated	Updated
1	0	Updated	Not updated
1	1	Updated	Updated

Update first time only [60B8H bit 1/9 = 0: initial detection retained]

This mode is used to detect the position only with the first trigger signal following startup.

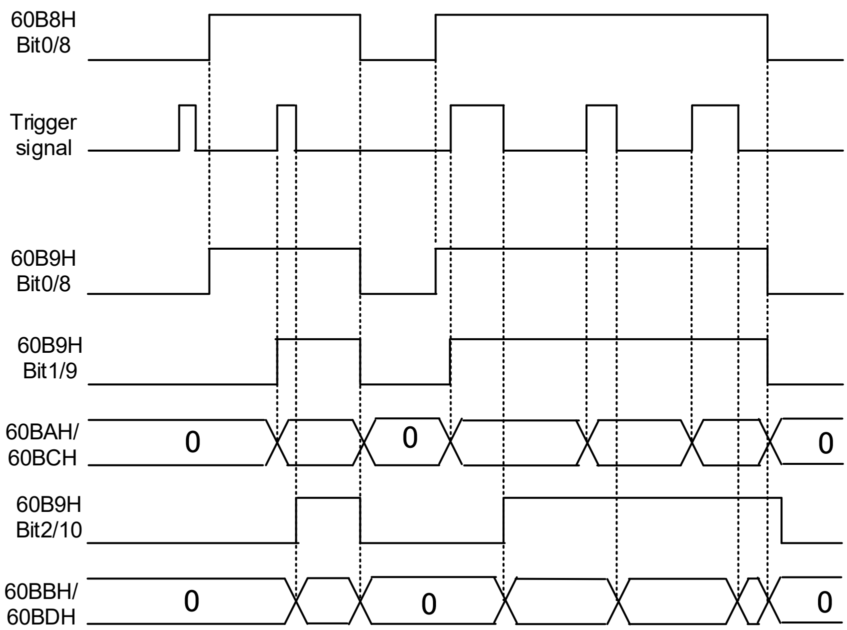
It is necessary to restart the touch probe function to read the signal again.



Update every time [60B8H bit 1/9 = 1: updated every detection]

This mode is used to latch each time a trigger signal is detected following startup.

The read value is retained until the next trigger signal.



15

15.1.9 Object Dictionary

The CAN application protocol over EtherCAT (CoE) protocol is based on an object dictionary. All objects are assigned a 4-digit hexadecimal index, and are configured from the areas shown in the following table.

Index	Area	Details
0000H to 0FFFH	Data type area	This is the data type definition.
1000H to 1FFFH	CoE communication area	This is the definition of a variable which can be used for all servers for the purpose of dedicated communication.
2000H to 5FFFH	Manufacturer specific area	This is a variable defined in the ALPHA7 Series.
6000H to 9FFFH	Device profile area	For servo amplifiers, this is the variable defined in the CiA402 drive profile.
A000H – FFFFH	Reserved area	This is an area reserved for future use.

Data type

With this profile, the data types in the following table are used.

Data type	Abbreviation	Size	Range
Boolean	BOOL	1 bit	0 to 1
Unsigned8	UINT8	1 byte	0 to 255
Unsigned16	UINT16	2 bytes	0 to 65535
Unsigned32	UINT32	4 bytes	0 to 4294967295
Integer8	INT8	1 byte	-128 to 127
Integer16	INT16	2 bytes	-32768 to 32767
Integer32	INT32	4 bytes	-2147483648 to 2147483647
Visible string	VS	—	—
Octet string	OS	—	—

EEPROM

Object Dictionary content other than manufacturer specific areas is lost when the control power is turned OFF, and values return to their default values when the power is turned ON again. However, by using 1010H-01H: Store parameters (Save Objects) for content whose EEPROM attribute is Yes, current object values are saved to the EEPROM, allowing the content to be restored when the power is turned ON again.

15.1.10 Communication Objects

Index	Name					
1000H	Device type					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
00H	—	UINT32	ro	No	00020192H	No
	Setting range					
	00 02 0192 H 0192H: Device profile (DS402d) 02: Servo Drive					

- Indicates the CoE device profile number.

Setting value description

Bit	Name	Details
0 to 15	Device profile number	402 (192H): drive profile
16 to 23	Typ	02: servo amplifier
25 to 31	Mode	0: Manufacturer specific

Index	Name					
1001H	Error register					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
00H	—	UINT8	ro	No	00H	No
	Setting range					
	Error register Bit 7: Reserved Bit 6: Reserved Bit 5: Definition device profile error Bit 4: Communication error Bit 3: Temperature error Bit 2: Voltage error Bit 1: Current error Bit 0: General error					

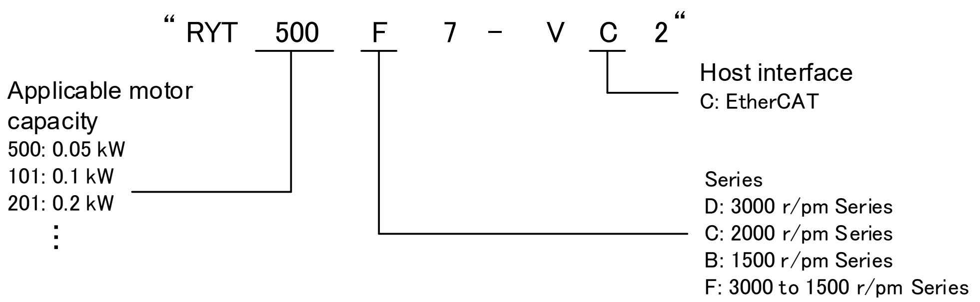
- Displays the type of error occurring at the servo amplifier. On the ALPHA7 Series, bit 0 is “1” when an alarm occurs.

15

Setting value description

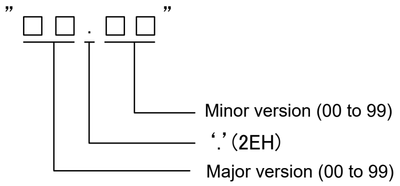
Bit	Description	Bit	Description
0	General error	4	Communication error (not used)
1	Current error (not used)	5	Error specific to device profile (not used)
2	Voltage error (not used)	6	(Reserved)
3	Temperature error (not used)	7	Manufacturer specific error (not used)

Index	Name					
1008H	Manufacturer device name					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
00H	—	VS	ro	No	—	No
	Setting range					
	Indicates the product type.					



Index	Name					
1009H	Manufacturer hardware version					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
00H	—	VS	ro	No	—	No
	Setting range					
	The display is fixed at “SP0407”.					

Index	Name					
100AH	Manufacturer software version					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
00H	—	VS	ro	No	—	No
	Setting range					
	Indicates the software version.					



Index	Name					
1010H	Store parameters					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
01H	Save Objects	UINT32	rw	No	00000000H	No
	Setting range					
	Saves the Object Dictionary current value to the EEPROM. Write as follows if using this object. "save" (ISO8859/ character) MSB LSB string 65h 76h 61h 73h					

Index	Name					
1011H	Restore default parameters					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
01H	Restore all default parameters	UINT32	rw	No	00000000H	No
	Setting range					
	Restores the ALPHA7 default parameters, except the Object Dictionary. Write as follows if using this object. "load" (ISO8859/ character) MSB LSB string 64h 61h 6Fh 6Ch Turn the power OFF and back ON again after writing is complete.					

Index	Name					
1018H	Identity object					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
00H	Number of entries	UINT8	ro	No	04H	No
	Setting range					
	04H					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
01H	Vendor ID	UINT32	ro	No	0000025EH	No
	Setting range					
	0000025EH: Fuji Electric Co.,LTD					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
02H	Product code	UINT32	ro	No	00010002H	No
	Setting range					
	00010002H: ALPHA7					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
03H	Revision number	UINT32	ro	No	00000000H	No
	Setting range					
	Manages the product revision number. With ALPHA7, the Revision No. is updated each time the Object Dictionary specifications or setting ranges change.					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
04H	Serial number	UINT32	ro	No	00000000H	No
	Setting range					
	With this product, this object is not supported. This is fixed at "0".					

Index	Name					
10E0H	Device identification reload object					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
00H	Number of entries	UINT8	ro	No	03H	No
	Setting range					
	03H					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
01H	Configured Station Alias register value	UINT16	rw	No	0000H	No
	Setting range					
	0000H to FFFFH This is a copy of the Configured station alias (0012H) value.					

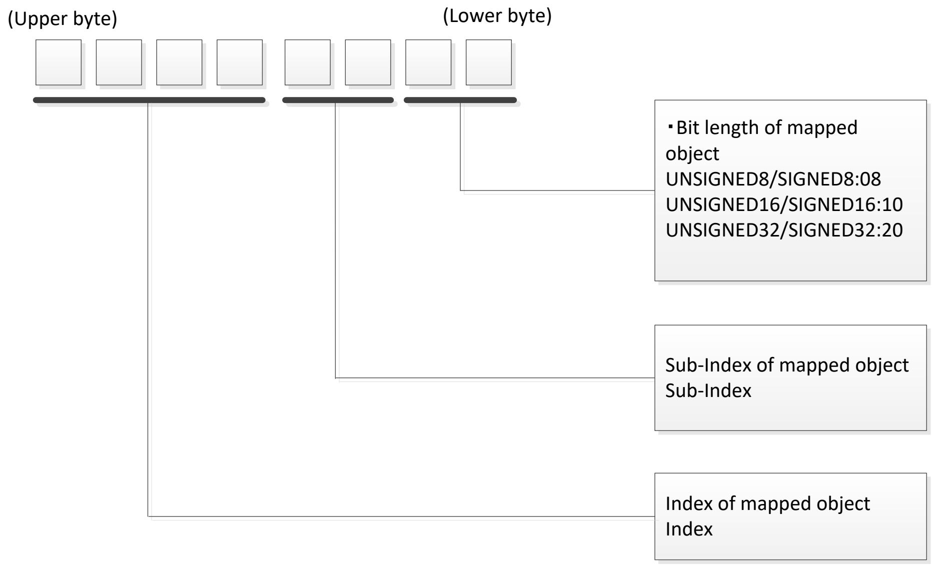
Sub	Name	Data type	Access	PDO	Default value	EEPROM
02H	Write Configured Station Alias persistent	BOOL	rw	No	0000H	No
	Setting range					
	FALSE: Do not update the value set in 10E0-01H to the SII Configured Station Alias. TRUE: Update the value set in 10E0-01H to the SII Configured Station Alias.					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
03H	Reload ID-selector value	UINT16	rw	No	0000H	No
	Setting range					
	0000H to FFFFH The value set as the ID-Selector (panel front rotary switch, PA2_72) is displayed. PA2_92: If EtherCAT extended function bit 0 is set to “1”, this value is copied to Configured station alias (0012H) when writing 0000H. It is not possible to write values other than 0000H, or write when PA2_92 (EtherCAT extended function) bit 0 is set to “0”.					

Index	Name					
10F1H	Error settings					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
00H	Highest Sub-index	UINT8	ro	No	02H	No
	Setting range					
	02H					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
02H	Sync error counter limit	UINT16	rw	No	0000H	No
	Setting range					
	0000H to FFFFH					

15

15.1.11 PDO Mapping Objects

PDO mapping is set using the 1600H to 1603H, 1A00H to 1A03H, 1C12H, and 1C13H objects. Set the values set for objects 1600H to 1603H and 1A00H to 1A03H as follows.



Index	Name					
1600H	1st receive PDO mapping					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
00H	Number of entries	UINT8	rw	No	03H	No
	Setting range					
	00H to 10H					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
01H	Mapping entry 1	UINT32	rw	No	60400010H	No
	Setting range					
	60400010H: Controlword					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
02H	Mapping entry 2	UINT32	rw	No	607A0020H	No
	Setting range					
	607A0020H: Target position					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
03H	Mapping entry 3	UINT32	rw	No	60B80010H	No
	Setting range					
	60B80010H: Touch probe function					

Sub	Name	Data type	Access	PDO	Default value	EEPROM
04H to 10H	Mapping entry 4 to 16	UINT32	rw	No	00000000H	No
	Setting range					
	Set the 4th to 16th RxPDO mapping data length and address.					

Index	Name					
1601H	2nd receive PDO mapping					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
00H	Number of entries	UINT8	rw	No	00H	No
	Setting range					
	00H to 10H					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
01H to 10H	Mapping entry 1 to 16	UINT32	rw	No	00000000H	No
	Setting range					
	Set the 1st to 16th RxPDO mapping data length and address.					

Index	Name					
1602H	3rd receive PDO mapping					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
00H	Number of entries	UINT8	rw	No	00H	No
	Setting range					
	00H to 01H					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
01H to 10H	Mapping entry 1 to 16	UINT32	rw	No	00000000H	No
	Setting range					
	Set the 1st to 16th RxPDO mapping data length and address.					

Index	Name					
1603H	4th receive PDO mapping					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
00H	Number of entries	UINT8	rw	No	00H	No
	Setting range					
	00H to 10H					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
01H to 10H	Mapping entry 1 to 16	UINT32	rw	No	00000000H	No
	Setting range					
	Set the 1st to 16th RxPDO mapping data length and address.					

Index	Name					
1A00H	1st transmit PDO mapping					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
00H	Number of entries	UINT8	rw	No	08H	No
	Setting range					
	00H to 10H					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
01H	Mapping entry 1	UINT32	rw	No	60410010H	No
	Setting range					
	60410010H: Statusword					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
02H	Mapping entry 2	UINT32	rw	No	60640020H	No
	Setting range					
	60640020H: Position actual value					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
03H	Mapping entry 3	UINT32	rw	No	60B90010H	No
	Setting range					
	60B90010 H: Touch probe status					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
04 H	Mapping entry 4	UINT32	rw	No	60BA0020H	No
	Setting range					
	60BA0020H: Touch probe 1 positive position value					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
05H	Mapping entry 5	UINT32	rw	No	60BC0020H	No
	Setting range					
	60BC0020H: Touch probe 2 positive position value					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
06H	Mapping entry 6	UINT32	rw	No	603F0010H	No
	Setting range					
	603F0010H: Error code					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
07H	Mapping entry 7	UINT32	rw	No	60FD0020H	No
	Setting range					
	60FD0020H: Digital inputs					

Sub	Name	Data type	Access	PDO	Default value	EEPROM
08H to 10H	Mapping entry 8 to 16	UINT32	rw	No	00000000H	No
	Setting range					
	Set the 8th to 16th TxPDO mapping data length and address.					

Index	Name					
1A01H	2nd transmit PDO mapping					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
00H	Number of entries	UINT8	rw	No	00H	No
	Setting range					
	00H to 10H					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
01H to 10H	Mapping entry 1 to 16	UINT32	rw	No	00000000H	No
	Setting range					
	Set the 1st to 16th TxPDO mapping data length and address.					

Index	Name					
1A02H	3rd transmit PDO mapping					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
00H	Number of entries	UINT8	rw	No	00H	No
	Setting range					
	00H to 10H					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
01H to 10H	Mapping entry 1 to 16	UINT32	rw	No	00000000H	No
	Setting range					
	Set the 1st to 16th TxPDO mapping data length and address.					

Index	Name					
1A03H	4th transmit PDO mapping					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
00H	Number of entries	UINT8	rw	No	00H	No
	Setting range					
	00H to 16H					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
01H to 10H	Mapping entry 1 to 16	UINT32	rw	No	00000000H	No
	Setting range					
	Set the 1st to 16th TxPDO mapping data length and address.					

15.1.12 SyncManager Communication Objects

The way in which the EtherCAT communication memory is used is set at objects 1C00H to 1C33H.

Index	Name					
1C00H	Sync manager communication type					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
00H	Number of entries	UINT8	ro	No	04H	No
	Setting range					
	04H					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
01H	Communication type sync manager 0	UINT8	ro	No	01H	No
	Setting range					
	1: Mail Box Transmit (Master to slave)					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
02H	Communication type sync manager 1	UINT8	ro	No	02H	No
	Setting range					
	2: Mail Box Transmit (Slave to master)					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
03H	Communication type sync manager 2	UINT8	ro	No	03H	No
	Setting range					
	3: Output Process Data					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
04H	Communication type sync manager 3	UINT8	ro	No	04H	No
	Setting range					
	4: Input Process Data					

- The following settings are specified at SyncManager.
  SM0: Mailbox receipt (master → slave)
  SM1: Mailbox transmission (slave → master)
  SM2: Process data output (master → slave)
  SM3: Process data input (slave → master)

15

Index	Name					
1C10H	Sync manager 0 PDO assignment					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
00H	—	UINT8	rw	No	00H	No
	Setting range					
	Number of PDO assignments at SM0 00H: This is fixed.					

Index	Name					
1C11H	Sync manager 1 PDO assignment					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
00H	—	UINT8	rw	No	00H	No
	Setting range					
	Number of PDO assignments at SM1 00H: This is fixed.					

Index	Name					
1C12H	Sync manager 2 PDO assignment					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
00H	Number of entries	UINT8	rw	No	01H	No
	Setting range					
	00H to 04H					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
01H	1st PDO mapping Object index of assigned PDO	UINT16	rw	No	1600H	No
	Setting range					
	1600H (RXPDO 1st) to 1603H (RXPDO 4th)					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
02H	2nd PDO mapping Object index of assigned PDO	UINT16	rw	No	0000H	No
	Setting range					
	Same as 1st PDO mapping Object index of assigned PDO (1C12H: 01H)					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
03H	3rd PDO mapping Object index of assigned PDO	UINT16	rw	No	0000H	No
	Setting range					
	Same as 1st PDO mapping Object index of assigned PDO (1C12H: 01H)					

15

Sub	Name	Data type	Access	PDO	Default value	EEPROM
04H	4th PDO mapping Object index of assigned PDO	UINT16	rw	No	0000H	No
	Setting range					
	Same as 1st PDO mapping Object index of assigned PDO (1C12H: 01H)					

Index	Name					
1C13H	Sync manager channel 3 PDO assignment					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
00H	Number of entries	UINT8	rw	No	01H	No
	Setting range					
	00H to 04H					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
01H	1st PDO mapping Object index of assigned PDO	UINT16	rw	No	1A00H	No
	Setting range					
	1A00H (TXPDO1st) to 1A03H (TxPDO4th)					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
02H	2nd PDO mapping Object index of assigned PDO	UINT16	rw	No	0000H	No
	Setting range					
	Same as 1st PDO mapping Object index of assigned PDO (1C13H: 01H)					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
03H	3rd PDO mapping Object index of assigned PDO	UINT16	rw	No	0000H	No
	Setting range					
	Same as 1st PDO mapping Object index of assigned PDO (1C13H: 01H)					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
04H	4th PDO mapping Object index of assigned PDO	UINT16	rw	No	0000H	No
	Setting range					
	Same as 1st PDO mapping Object index of assigned PDO (1C13H: 01H)					

<table>
<tr><th>Index</th><th colspan="6">Name</th></tr>
<tr><td>1C32H</td><td colspan="6">Sync manager channel 2 synchronization</td></tr>
<tr><th>Sub</th><th>Name</th><th>Data type</th><th>Access</th><th>PDO</th><th>Default value</th><th>EEPROM</th></tr>
<tr><td rowspan="3">00H</td><td>Number of entries</td><td>UINT8</td><td>ro</td><td>No</td><td>20H</td><td>No</td></tr>
<tr><th colspan="6">Setting range</th></tr>
<tr><td colspan="6">20H</td></tr>
<tr><th>Sub</th><th>Name</th><th>Data type</th><th>Access</th><th>PDO</th><th>Default value</th><th>EEPROM</th></tr>
<tr><td rowspan="3">01H</td><td>Synchronization type</td><td>UINT16</td><td>rw</td><td>No</td><td>02H</td><td>No</td></tr>
<tr><th colspan="6">Setting range</th></tr>
<tr><td colspan="6">00H: Not synchronized (free run)
01H: SM2 Synchronized
02H: DC Sync0 (Sync0 hardware signal synchronous)
03H: Reserved</td></tr>
<tr><th>Sub</th><th>Name</th><th>Data type</th><th>Access</th><th>PDO</th><th>Default value</th><th>EEPROM</th></tr>
<tr><td rowspan="3">02H</td><td>Cycle time</td><td>UINT32</td><td>ro</td><td>No</td><td>000F4240H
(1ms)</td><td>No</td></tr>
<tr><th colspan="6">Setting range</th></tr>
<tr><td colspan="6">125000 ns (125 μs): 0001E848H 1000000 ns (1 ms): 000F4240H
250000 ns (250 μs): 0003D090H 2000000 ns (2 ms): 001E8480H
500000 ns (500 μs): 0007A120H 4000000 ns (4 ms): 003D0900H

Note
DC synchronization is possible for any of the above cycles.
Transition from Pre OP to Safe OP is not possible for values other than the above.
For SM2 synchronization, communicate in any of the above cycles of 500 μs or greater.</td></tr>
<tr><th>Sub</th><th>Name</th><th>Data type</th><th>Access</th><th>PDO</th><th>Default value</th><th>EEPROM</th></tr>
<tr><td rowspan="3">03H</td><td>Shift time</td><td>UINT32</td><td>ro</td><td>No</td><td>00000000H</td><td>No</td></tr>
<tr><th colspan="6">Setting range</th></tr>
<tr><td colspan="6">This object is not supported. (fixed at 0 μs)</td></tr>
<tr><th>Sub</th><th>Name</th><th>Data type</th><th>Access</th><th>PDO</th><th>Default value</th><th>EEPROM</th></tr>
<tr><td rowspan="3">04H</td><td>Synchronization types supported</td><td>UINT16</td><td>ro</td><td>No</td><td>0007H</td><td>No</td></tr>
<tr><th colspan="6">Setting range</th></tr>
<tr><td colspan="6">Bit 0: Free run (supported)
Bit 1: SM2 event
Bit 2: DC Sync0 event
Bit 3: DC Sync1 event
Bit 4: Slave application cycle
Bit 5 to 6: Output shift support
Bit 7 to 15: Reserved
“0”: Not supported “1”: Supported</td></tr>
</table>

Sub	Name	Data type	Access	PDO	Default value	EEPROM
05H	Minimum cycle time	UINT32	ro	No	0001E848H (125μs)	No
	Setting range					
	125 μs (0001E848H) Note: Use SM2 synchronization in communication cycles of 500 μs or greater.					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
06H	Calc and copy time	UINT32	ro	No	0000EA60H (60μs)	No
	Setting range					
	60 μs * This is a reference value. Operation is not guaranteed.					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
08H	Get cycle time	UINT16	rw	No	0000H	No
	Setting range					
	This object is not supported. (00H) (fixed))					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
09H	Delay time	UINT32	ro	No	00000000H (0μs)	No
	Setting range					
	This object is not supported. (00H) (fixed))					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
0AH	Sync0 cycle time	UINT32	ro	No	00000000H	No
	Setting range					
	The same value as that for Cycle time is displayed.					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
0BH	SM-event missed	UINT16	ro	No	0000H	No
	Setting range					
	With Sync0 events, SM-event missed objects increase by 3 when process output data is not updated (when (SM2) events are not received). When process output data is updated successfully, the internal error counter decreases by 1. SM-event missed objects are reset when the ESM status changes from OP to SAFEOP.					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
0CH	Cycle time too small	UINT16	ro	No	0000H	No
	Setting range					
	This object is not supported.					

Sub	Name	Data type	Access	PDO	Default value	EEPROM
0DH	Shift time too short	UINT16	ro	No	0000H	No
	Setting range					
	This object is not supported.					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
0EH	RxPDO toggle failed	UINT16	ro	No	0000H	No
	Setting range					
	This object is not supported.					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
0FH	Minimum cycle distance	UINT32	ro	No	00000000H	No
	Setting range					
	This object is not supported.					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
10H	Maximum cycle distance	UINT32	ro	No	00000000H	No
	Setting range					
	This object is not supported.					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
11H	Minimum SM sync distance	UINT32	ro	No	00000000H	No
	Setting range					
	This object is not supported.					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
12H	Maximum SM sync distance	UINT32	ro	No	00000000H	No
	Setting range					
	This object is not supported.					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
20H	Sync error	BOOL	ro	No	00H	No
	Setting range					
	00H: No error 01H: Sync error					

Index	Name					
1C33H	Sync manager channel 3 synchronization					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
00H	Number of entries	UINT8	ro	No	20H	No
	Setting range					
	20H					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
01H	Synchronization type	UINT16	rw	No	0002H	No
	Setting range					
	00H: Not synchronized (free run) 01H: Reserved 02H: DC Sync0 (SYNC0 hardware signal synchronous) 03H: Reserved					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
02H	Cycle time	UINT32	ro	No	000F4240H	No
	Setting range					
	125000 ns (125 μs): 0001E848H 1000000 ns (1 ms): 000F4240H 250000 ns (250 μs): 0003D090H 2000000 ns (2 ms): 001E8480H 500000 ns (500 μs): 0007A120H 4000000 ns (4 ms): 003D0900H Note: DC synchronization is possible for any of the above cycles. Transition from Pre OP to Safe OP is not possible for values other than the above. For SM2 synchronization, communicate in any of the above cycles of 500 μs or greater.					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
03H	Shift time	UINT32	ro	No	00000000H	No
	Setting range					
	This object is not supported. (00H) (fixed))					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
04H	Synchronization types supported	UINT16	ro	No	0007H	No
	Setting range					
	Bit 0: Free run (supported) Bit 1: SM2 event Bit 2: DC Sync0 event Bit 3: DC Sync1 event Bit 4: Slave application cycle Bit 5 to 6: Output shift support Bit 7 to 15: Reserved “0”: Not supported “1”: Supported					

Sub	Name	Data type	Access	PDO	Default value	EEPROM
05H	Minimum cycle time	UINT32	ro	No	0001E848H	No
	Setting range					
	125 μs (fixed) Note: SM2 synchronization should be used with a communication cycle of 500μs or more					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
06H	Calc and copy time	UINT32	ro	No	000124F8H (75 μs)	No
	Setting range					
	75μs * This is a reference value. Operation is not guaranteed.					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
08H	Get Cycle Time	UINT16	rw	No	0000H	No
	Setting range					
	This parameter is not supported.					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
09H	Delay time	UINT32	ro	No	00000000H (0 μs)	No
	Setting range					
	0 μs					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
0AH	Sync0 Cycle time	UINT32	ro	No	00000000H	No
	Setting range					
	This parameter is not supported.					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
0BH	SM-event missed	UINT16	ro	No	0000H	No
	Setting range					
	This parameter is not supported.					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
0CH	Cycle time too small	UINT16	ro	No	0000H	No
	Setting range					
	This parameter is not supported.					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
0DH	Shift time too short	UINT16	ro	No	0000H	No
	Setting range					
	This parameter is not supported.					

Sub	Name	Data type	Access	PDO	Default value	EEPROM
0EH	RxPDO toggle failed	UINT16	ro	No	0000H	No
	Setting range					
	This parameter is not supported.					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
20H	Sync error	BOOL	ro	No	0	No
	Setting range					
	This parameter is not supported.					

15.1.13 Manufacturer Objects

This section describes objects unique to Fuji Electric.

Index	Name					
3002H	Vibration suppressing anti resonance frequency					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
00H	—	UINT16	rw	Yes	0BB8H	No
	Setting range					
	0.0 Hz: Disable 1.0 to 300.0 Hz					

Index	Name					
3003H	Vibration suppressing workpiece inertia ratio					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
00H	—	UINT16	rw	Yes	0000H	No
	Setting range					
	0 to 80%					

If enabling Anti-resonance frequency (3002H) or Workpiece inertia ratio (3003H) with vibration suppression, set PA1_77 (Vibration suppressing function selection) to “2: IQ area”.

Index	Name					
5001H	Parameter (PA1)					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
00H	Highest sub idx supported	UINT8	ro	No	63H	No
	Setting range					
	63H					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
00H	Parameter (PA1) 1 to 99	UINT32	rw	No	00000000H	No
	Setting range					
	00000000H to FFFFFFFFH					

15

Index	Name					
5002H	Parameter (PA2)					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
00H	Highest sub idx supported	UINT8	ro	No	63H	No
	Setting range					
	63H					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
00H	Parameter (PA2) 1 to 99	UINT32	rw	No	00000000H	No
	Setting range					
	00000000H to FFFFFFFFH					

Index	Name					
5003H	Parameter (PA3)					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
00H	Highest sub idx supported	UINT8	ro	No	63H	No
	Setting range					
	63H					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
00H	Parameter (PA3) 1 to 99	UINT32	rw	No	00000000H	No
	Setting range					
	00000000H to FFFFFFFFH					

Index	Name					
5004H	Parameter (PA4)					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
00H	Highest sub idx supported	UINT8	ro	No	63H	No
	Setting range					
	63H					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
00H	Parameter (PA4) 1 to 99	UINT32	rw	No	00000000H	No
	Setting range					
	00000000H to FFFFFFFFH					

Servo amplifier parameters can be set and monitored with objects 5001H to 5004H.

Each object is linked to each parameter based on the following rule.

Index = 50□□ Sub = xx

- □□

Data indicates the written (or read) parameter type.

01H: PA1

02H: PA2

03H: PA3

04H: PA4

- xx

Indicates the parameter number.

* Example: PA2_1 → Index: 5002 Sub0x01

15

15.1.14 Servo Amplifier Profile Objects

This section describes objects defined in the CiA402 drive profiles supported by the ALPHA7 Series.

Index	Name					
6040H	Controlword					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
00H	—	UINT16	rw	Yes	0000H	No

Bit	Name	Description
0	Switch on	Refer to “Bit 7, bit 3 to 0 command definition” below.
1	Enable voltage	Refer to “Bit 7, bit 3 to 0 command definition” below.
2	Quick stop	Refer to “Bit 7, bit 3 to 0 command definition” below.
3	Enable operation	Refer to “Bit 7, bit 3 to 0 command definition” below.
4 to 6	Operation mode specific	This is a bit peculiar to each operation mode. Refer to "Definition of bit 9, bit 6 to 4 for each operation mode".
7	Fault reset	Refer to “Bit 7, bit 3 to 0 command definition” below.
8	Halt	Specify the halt method with Halt option code (605DH).
9	Operation mode specific	These bit definitions are dependent on the control mode. These bits are not supported.
10	Reserved	Set this bit to "0".
11	CONT7	Function assignment is possible with PA3_07.
12	CONT8	Function assignment is possible with PA3_08.
13 to 15	Reserved	Set this bit to "0".

- Bit 7, bit 3 to 0 command definition

Operation	Controlword (6040)					Transition No.
	b7	b3	b2	b1	b0	
Shut Down	0	X	1	1	0	2, 6, 8
Switch on	0	0	1	1	1	3
Disable Voltage	0	X	X	0	X	7, 9, 10, 12
Quick Stop	0	1	0	1	1	11
Disabled Operation	0	0	1	1	1	5
Enable Operation *1	0	1	1	1	1	4, 16
Fault Reset	0⇒1	X	X	X	X	15

*1: When the status is “Ready to switch on”, and the servo amplifier receives commands for which operation is possible, the status automatically changes to “Enable Operation”.

- Definition of bit 9, bit 6 to 4 for each operation mode

Operation mode	Control word			
	Bit 9	Bit 6	Bit 5	Bit 4
pp	— *1	— *1	Change set immediately	New set-point
pv	—	—	—	—
hm	—			Homing operation start
csp	—	—	—	—
csv	—	—	—	—
cst	—	—	—	—

*1: Operation for these bits is not supported.

Index	Name					
6041H	Statusword					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
00H	—	UINT16	ro	Yes	0000H	No

Bit	Name	Description
0	Ready to switch on	Refer to "FSA status (bit 6 to 5, bit 3 to 0)".
1	Switch on	Refer to "FSA status (bit 6 to 5, bit 3 to 0)".
2	Operation enabled	Refer to "FSA status (bit 6 to 5, bit 3 to 0)".
3	Fault	Refer to "FSA status (bit 6 to 5, bit 3 to 0)".
4	Voltage enabled	When this bit is “1”, it means that the main power supply is "ON”.
5	Quick stop	Refer to "FSA status (bit 6 to 5, bit 3 to 0)".
6	Switch on disabled	Refer to "FSA status (bit 6 to 5, bit 3 to 0)".
7	Warning	This bit is “1” when warnings have occurred.
8	Manufacturer specific	This bit is not used.
9	Remote	This bit is “1” while operation from the controller is possible.
10	Operation mode specific	Refer to "Definition of bit 10, 12, 13 for each operation mode".
11	Internal limit value	This bit is “1” while a torque limit is applied, or when an OT has occurred.
12	Operation mode specific	Refer to "Definition of bit 10, 12, 13 for each operation mode".
13	Operation mode specific	Refer to "Definition of bit 10, 12, 13 for each operation mode".
14	OUT3	Function assignment is possible with PA3_53.
15	OUT4	Function assignment is possible with PA3_54.

• FSA status (bit 6 to 5, bit 3 to 0)

No.	FSA status	Statusword bit					
		Bit 6	Bit 5	Bit 3	Bit 2	Bit 1	Bit 0
[A]	Not ready to Switch on	0	X	0	0	0	0
[B]	Switch on Disabled	1	X	0	0	0	0
[C]	Ready to Switch on	0	1	0	0	0	1
[D]	Switch on	0	1	0	0	1	1
[E]	Operation enabled	0	1	0	1	1	1
[F]	Quick stop active	0	0	0	1	1	1
[G]	Fault reaction active	0	X	1	1	1	1
[H]	Fault	0	X	1	0	0	0

• Definition of bit 10, 12, 13 for each operation mode

Operation mode	Status word		
	Bit 13	Bit 12	Bit 10
pp	Following error	Set-point acknowledge	Target reached
pv	— *1	Speed	— *1
hm	Homing error	Homing attained	Target reached
csp	Following error	Target position ignored *2	— *1
csv	—	Target velocity ignored *2	— *1
cst	—	Target torque ignored *2	— *1

*1: Operation for these bits is not supported.

*2: Target value ignored is “0” if unable to follow the command.

Index	Name					
603FH	Error code					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
00H	—	UINT16	ro	Yes	0000H	No

15

The following table is a list of error codes.

Alarm details	Alarm display (7SEG LED)		Error Code	Error register (1001H)	
No alarm (during normal operation)	—	—	0000H	—	
Overcurrent 1	oc	01	FF01H	Bit 0	
Overcurrent 2	oc	02	FF02H	Bit 0	
Overspeed	oS		FF03H	Bit 0	
Control power undervoltage	Lu	cn	FF04H	Bit 0	
Overvoltage	Hu		FF05H	Bit 0	
Encoder error 1	Et	01	FF06H	Bit 0	
Encoder error 2	Et	02	FF07H	Bit 0	
Memory error	dE		FF09H	Bit 0	
Motor combination error	cE		FF0BH	Bit 0	
Encoder communication error	Ec		FF0DH	Bit 0	
CONT overlap	co	nt	FF0EH	Bit 0	
Overload 1	oL	01	FF0FH	Bit 0	
Overload 2	oL	02	FF10H	Bit 0	
Inrush current suppressing circuit error	rH	04	FF11H	Bit 0	
Safety function error	SF	ty	FF12H	Bit 0	
Main circuit undervoltage	Lu	Po	FF21H	Bit 0	
Internal regenerative resistor overheat	rH	01	FF22H	Bit 0	
External regenerative resistor overheat	rH	02	FF23H	Bit 0	
Braking transistor error	rH	03	FF24H	Bit 0	
Deviation over	oF		FF25H	Bit 0	
Amplifier overheat	AH		FF26H	Bit 0	
Encoder overheat	EH		FF27H	Bit 0	
ABS data loss 1	dL	01	FF28H	Bit 0	
ABS data loss 2	dL	02	FF29H	Bit 0	
ABS data loss 3	dL	03	FF2AH	Bit 0	
Multi-turn overflow	AF		FF2BH	Bit 0	
Initial error	iE		FF2CH	Bit 0	
Command pulse frequency error	HF		FF2DH	Bit 0	
Overload 3	oL	03	FF2EH	Bit 0	
Cycle communication error	cy		FF2FH	Bit 0	

Index	Name					
605AH	Quick stop option code					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
00H	—	INT16	rw	No	1	Yes
	Setting range					
	Stipulate operation when inputting an EMG signal, or when the status changes to Quick stop active. 0: Free run (automatically changes to Switch on disabled). 1: Decelerates and stops based on Profile deceleration (automatically changes to Switch on disabled). 2: Decelerates and stops based on Quick stop deceleration (automatically changes to Switch on disabled). 3: Decelerates and stops based on Third torque limit (automatically changes to Switch on disabled). 4: Reserved *1 5: Decelerates and stops based on Profile deceleration. 6: Decelerates and stops based on Quick stop deceleration. 7: Decelerates and stops based on third torque limit. *1: Do not set.					

Index	Name					
605BH	Shut down option code					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
00H	—	INT16	rw	No	1	Yes
	Setting range					
	Set the deceleration operation when the main power supply is turned OFF. Following deceleration, operation is based on the PA2_63 (1st digit) setting. 0: Decelerates based on PA2_63 (2nd digit). 1: Decelerates and stops based on Profile deceleration.					

Index	Name					
605CH	Disable operation option code					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
00H	—	INT16	rw	No	1	Yes
	Setting range					
	Set the deceleration method when the servo is OFF. Following deceleration, operation is based on the PA2_61 (1st digit) setting. 0: Operation is based on PA2_61 (2nd digit). 1: Decelerates and stops based on Profile deceleration.					

Index	Name					
605DH	Halt option code					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
00H	—	INT16	rw	No	1	Yes
	Setting range					
	Set the deceleration method when the Halt command is input.. 1: Decelerates and stops based on Profile deceleration. 2: Decelerates and stops based on Quick stop deceleration. 3: Decelerates and stops based on third torque limit.					

Index	Name					
605EH	Fault reaction option code					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
00H	—	INT16	rw	No	2	Yes
	Setting range					
	Set the deceleration method when an alarm occurs. The motor stops immediately (base OFF) when a major failure occurs.					

<table>
<tr><th rowspan="2">Setting value</th><th colspan="2">When decelerating</th><th rowspan="2">After deceleration stop</th></tr>
<tr><th>Minor fault</th><th>Major fault</th></tr>
<tr><td>0</td><td>Operation is based on the PA2_62 (4th digit) setting.</td><td rowspan="4">Operation is based on the PA2_62 (2nd digit) setting.</td><td rowspan="4">Operation is based on the PA2_62 (1st digit) setting.</td></tr>
<tr><td>1</td><td>Decelerates and stops based on Profile deceleration.</td></tr>
<tr><td>2</td><td>Decelerates and stops based on Quick stop deceleration.</td></tr>
<tr><td>3</td><td>Decelerates and stops based on Third torque limit</td></tr>
</table>

Index	Name					
6060H	Modes of operation					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
00H	—	INT8	rw	Yes	0	No
	Setting range					
	Set the control mode to be used for this object. Begin operation after setting this object. 0: No mode 1: Profile position mode 3: Profile velocity mode 6: Homing mode 8: Cyclic synchronous position mode 9: Cyclic synchronous velocity mode 10: Cyclic synchronous torque mode Other than above: Do not set.					

Index	Name					
6061H	Modes of operation display					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
00H	—	INT8	ro	Yes	0	No
	Setting range					
	0: No mode 1: Profile position mode 3: Profile velocity mode 6: Homing mode 8: Cyclic synchronous position mode 9: Cyclic synchronous velocity mode 10: Cyclic synchronous torque mode					

Index	Name					
6062H	Position demand value					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
00H	—	INT32	ro	Yes	0	No
	Setting range					
	-2147483648 to 2147483647 units Displays the internal position command value.					

Index	Name					
6063H	Position actual value					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
00H	—	INT32	ro	Yes	0	No
	Setting range					
	-2147483648 to 2147483647 pulses Displays the internal feedback position in pulse units with the home position as 0.					

Index	Name					
6064H	Position actual value					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
00H	—	INT32	ro	Yes	0	No
	Setting range					
	-2147483648 to 2147483647 units Displays the feedback position.					

Index	Name					
6065H	Following error window					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
00H	—	UINT32	rw	No	FFFFFFFFH	UINT32
	Setting range					
	1 to 4294967295 units Sets the Controlword (0x6040) Following Error (bit 13) detection value in CSP and PP mode. The servomotor will not run when the default value of 4294967295 is set, and therefore this object should be used after setting to the desired value.					

Index	Name					
6066H	Following error time out					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
00H	—	UINT16	rw	No	0000H	Yes
	Setting range					
	0 to 1000 ms Sets the Controlword (0x6040) Following Error (bit 13) detection time in CSP and PP mode. The Following Error will be 1 if the condition in which the position deviation exceeds the Following error window (0x6065) setting value continues for the Following error timeout (0x6066) time.					

Index	Name					
6067H	Position window					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
00H	—	UINT32	rw	No	00000064H	Yes
	Setting range					
	1 to 2000000 units					

Set the Controlword (0x6040) Target reached (bit 10) detection value in PP mode. If the distance from the current position to the target position drops below this setting value, the value will be 1.
Furthermore, the following ALPHA7 output signal (OUT signal) levels should also be set.

- Zero deviation range
  Set the activation level for the "zero deviation" output signal (OUT signal).
  The signal is turned on at position deviation within the reference value.
- In-position range
  Set the deviation condition for the "in-position (INP)" output signal (OUT signal).
  The in-position (INP) signal is turned on if position deviation is within this reference value and the motor rotation speed is within the reference value of the "zero speed range."

15

However, conditions also apply to the completion of pulse elimination inside the servo amplifier when performing a position control trial run in PP mode or HM mode.

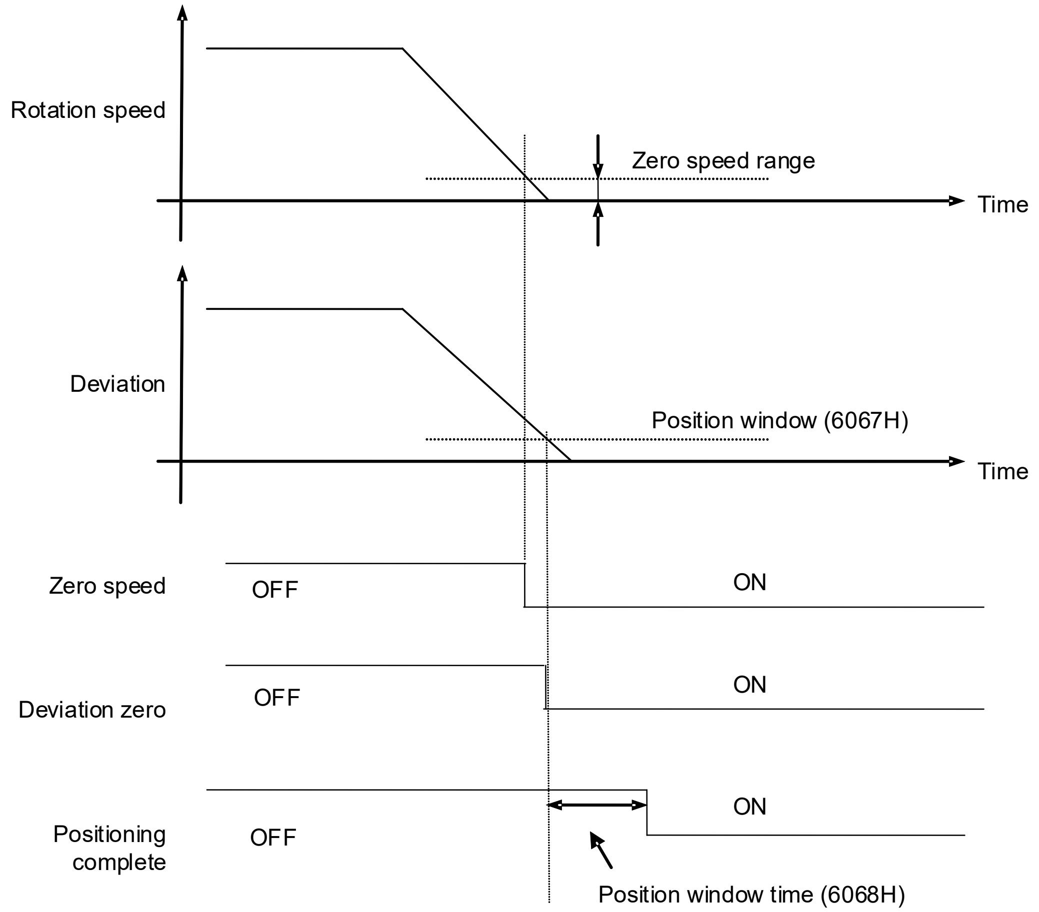
Hint

■ In-position signal

The in-position signal is turned on if position deviation is within the reference value of "zero deviation range" and the motor rotation speed is within the reference value of "zero speed range" (AND condition of zero speed and zero deviation).

Refer to the following timing chart.

■ Timing chart



15

Index	Name					
6068H	Position window time					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
00H	—	UINT16	rw	No	0000H	Yes
	Setting range					
	0 to 1000 ms Set the judgment time until in-position [INP] is recognized.					

Index	Name					
606BH	Velocity demand value					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
00H	—	INT32	ro	Yes	0	No
	Setting range					
	-2147483648 to 2147483647 unit/s Displays the internal speed command value.					

Index	Name					
606CH	Velocity actual value					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
00H	—	INT32	ro	Yes	0	No
	Setting range					
	-2147483648 to 2147483647 unit/s Displays the motor feedback speed.					

Index	Name					
6071H	Target torque					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
00H	—	INT16	rw	Yes	0	No
	Setting range					
	-350.0% to 350.0% Adjust in 0.1% units with motor rated torque of 100% as the reference.					

Index	Name					
6074H	Torque demand					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
00H	—	INT16	ro	Yes	0	No
	Setting range					
	-350.0% to 350.0% The value is output in 0.1% units with motor rated torque of 100% as the reference. The value is the same as that for Torque actual value (6077H).					

Index	Name					
6077H	Torque actual value					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
00H	—	INT16	ro	Yes	0	No
	Setting range					
	-350.0% to 350.0% The value is output in 0.1% units with motor rated torque of 100% as the reference. The value is the same as that for Torque demand (6074H).					

Index	Name					
607AH	Target position					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
00H	—	INT32	rw	Yes	0	No
	Setting range					
	-2147483648 to 2147483647 Set the absolute target position.					

Index	Name					
607CH	Home offset					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
00H	—	INT32	rw	No	0	Yes
	Setting range					
	-2000000000 to +2000000000 Set an offset for the Homing Mode stop position.					

Index	Name					
607DH	Software position limit					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
00H	Number of entries	UINT8	ro	No	02H	No
	Setting range					
	02H					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
01H	Min position limit	INT32	rw	No	2000000000	Yes
	Setting range					
	-2000000000 to 2000000000 unit					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
02H	Max position limit	INT32	rw	No	-2000000000	Yes
	Setting range					
	-2000000000 to 2000000000 unit					

Index	Name					
607FH	Max profile velocity					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
00H	—	UINT32	rw	Yes	64000000H	No
	Setting range					
	0 to 2147483647 unit/s Set the maximum speed. (This is common, regardless of the control mode.)					

* Set PA2_56 to “1” when this object is enabled.

Index	Name					
6081H	Profile velocity					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
00H	—	UINT32	rw	Yes	10AAAAABH	No
	Setting range					
	0 to 2147483647 unit/s Set the operating speed in PP mode.					

15

Index	Name					
6083H	Profile acceleration					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
00H	—	UINT32	rw	Yes	21555555H	No
	Setting range					
	0 to 2147483647 unit/s^2 Set the acceleration during operation when in PP mode or PV mode.					

Index	Name					
6084H	Profile deceleration					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
00H	—	UINT32	rw	Yes	21555555H	No
	Setting range					
	0 to 2147483647 unit/s^2 Set the deceleration during operation when in PP mode or PV mode.					

Note

- If Profile deceleration is assigned to the PDO, an unexpected operation may occur when the program at the host side stops, and so caution is advised.

Index	Name					
6085H	Quick stop deceleration					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
00H	—	UINT32	rw	No	21555555H	Yes
	Setting range					
	0 to 2147483647 unit/s^2 Set the deceleration when performing a rapid deceleration stop.					

Set the deceleration time in deceleration units when bringing the motor to a decelerated stop with a forced stop, etc.

The motor decelerates based on this parameter setting under the following conditions.

- When performing a forced stop (if Quick stop option code (605AH) set to deceleration stop with Quick stop deceleration)
- When OT detected (if deceleration operation set for deceleration time with PA2_63)
- When function safety module SS1 function active (if servo amplifier SS1 sequence enabled with PA4_11)

If the motor is decelerated based on the deceleration time following OT detection, take care not to exceed the machine system range of motion.

Index	Name					
608FH	Position encoder resolution					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
00H	Number of entries	UINT8	ro	No	02H	No
	Setting range					
	02H					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
01H	Encoder increments	UINT32	ro	No	00000001H	No
	Setting range					
	By setting this parameter, the servomotor encoder resolution is set automatically.					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
02H	Motor revolutions	UINT32	ro	No	00000001H	No
	Setting range					
	This parameter is fixed at "1".					

Index	Name					
6091H	Gear ratio					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
00H	Number of entries	UINT8	ro	No	02H	No
	Setting range					
	02H					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
01H	Motor revolutions	UINT32	rw	No	00000001H	Yes
	Setting range					
	1 to 67108864					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
02H	Shaft revolutions	UINT32	rw	No	00000001H	Yes
	Setting range					
	1 to 67108864					

This setting defines the relationship between the command unit amount and encoder pulse count.
The following equation is used to calculate.

[Motor revolutions / Shaft revolutions calculation formula]

Cancel down so that Motor revolutions/Shaft revolutions is an integer (67108864 or less).

$$\frac{\text{(Mechanical system travel amount per servomotor revolution)}}{\text{Encoder pulse count*}} \times \frac{\text{Motor revolutions}}{\text{Shaft revolutions}} = \text{(unit amount) *}$$

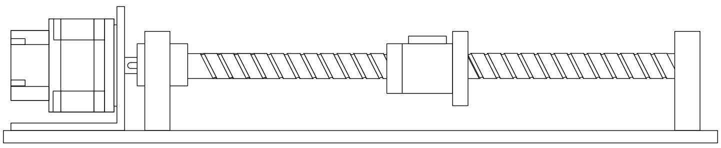
* The unit amount is a value such as “1”, “0.1”, “0.01”, or “0.001”. Unit is expressed as [unit].

* The encoder pulse count is the value for “24 bits = 16777216 pulses”.

$$\frac{\text{Motor revolutions}}{\text{Shaft revolutions}} = \frac{\text{Encoder pulse count}}{\text{(Mechanical system travel amount per servomotor revolution)}} \times \text{(unit amount)}$$

[Calculation example]

To connect the ball screw (lead 10 [mm]) directly to the output shaft of the servomotor and set the unit amount at 1/100, the number of encoder pulses (24 bits) is 16777216 revolutions.

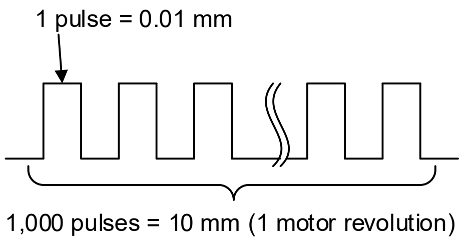


$$\frac{\text{(Mechanical system travel amount per servomotor revolution)}}{\text{16777216 pulses/revolution}} \times \frac{\text{Motor revolutions}}{\text{Shaft revolutions}} = \text{(unit amount)}$$

$$\frac{\text{10 mm}}{\text{16777216 pulses/revolution}} \times \frac{\text{Motor revolutions}}{\text{Shaft revolutions}} = 1 / 100$$

$$\frac{\text{Motor revolutions}}{\text{Shaft revolutions}} = 1 / 100 \times \frac{\text{16777216 pulses/revolution}}{\text{10 mm}} = \frac{2097152}{125}$$

Consequently, the Motor revolutions will be 2097152, and Shaft revolutions will be 125.

Hint	If the mechanical system travel amount per servomotor revolution includes π, you can approximate to 355/113. 

Index	Name					
6092H	Feed Constant					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
00H	Highest sub-index supported	UINT8	ro	No	02H	No
	Setting range					
	02H					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
01H	Feed	UINT32	ro	No	00000001H	No
	Setting range					
	By setting this parameter, the same value as that for Encoder increments (608FH-01H) is set automatically.					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
02H	Driving shaft revolutions	UINT32	ro	No	00000001H	No
	Setting range					
	This parameter is fixed at "1".					

Index	Name					
6098H	Homing method					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
00H	—	INT8	rw	No	0	Yes
	Setting range					
	Select the homing (Homing mode) operation mode (method). Internal parameters change based on this mode.					

Index	Name					
6099H	Homing speeds					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
00H	Number of entries	UINT8	ro	No	02H	No
	Setting range					
	02H					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
01H	Speed during search for switch	UINT32	rw	No	08555555H	Yes
	Setting range					
	0 to 214783647 unit/s Set the speed up to the point where operation changes to creep conditions when performing homing.					

15

Sub	Name	Data type	Access	PDO	Default value	EEPROM
02H	Speed during search for zero	UINT32	rw	No	00D55555H	Yes
	Setting range					
	0 to 214783647 unit/s This is the creep speed when performing homing.					

Index	Name					
609AH	Homing acceleration					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
00H	—	UINT32	rw	No	21555555H	Yes
	Setting range					
	0 to 2147483647 unit/s^2 Set the acceleration and deceleration time when performing homing.					

Index	Name					
60B8H	Touch probe function					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
00H	—	UINT16	rw	Yes	0000H	No
	Setting range					
	Bit 0: Touch probe 1 switch Bit 1: Behavior of touch probe trigger Bit 2: Select touch probe 1 trigger Bit 3: Reserved *1 Bit 4: Touch probe 1 switch at rising edge Bit 5: Touch probe 1 switch at falling edge Bit 6-7: Reserved *1 Bit 8: Touch probe 2 switch Bit 9: Behavior of touch probe trigger Bit 10: Select touch probe 2 trigger Bit 11: Reserved *1 Bit 12: Touch probe 2 switch at positive edge Bit 13: Touch probe 2 switch at negative edge Bit 14, 15: Reserved *1 *1: Set this bit to “0”. This sets touch probe function operation.	-0: Disable Touch probe 1 -1: Enable Touch probe 1 -0: Maintain initial detection -1: Update each time detected -0: Touch probe 1 signal -1: Z-phase input -0: Disable -1: Enable -0: Disable -1: Enable -0: Disable Touch probe 2 -1: Enable Touch probe 2 -0: Maintain initial detection -1: Update each time detected -0: Touch probe 2 input -1: Encoder Z-phase -0: Disable -1: Enable -0: Disable -1: Enable				

Index	Name					
60B9H	Touch probe status					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
00H	—	UINT16	ro	Yes	0000H	No
	Setting range					
	Bit 0: Touch probe 1 switch -0: Disable Touch probe 1 -1: Enable Touch probe 1 Bit 1: Touch probe 1 positive edge -0: No detection -1: Detection complete Bit 2: Touch probe 1 negative edge -0: No detection -1: Detection complete Bit 3-7: Reserved *1 Bit 8: Touch probe 2 switch -0: Disable Touch probe 2 -1: Enable Touch probe 2 Bit 9: Touch probe 2 positive edge -0: No detection -1: Detection complete Bit 10: Touch probe 2 negative edge -0: No detection -1: Detection complete Bit 11 - 15 Reserved *1 *1: Do not use these bits. This sets touch probe function operation.					

Index	Name					
60BAH	Touch probe 1 positive position value					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
00H	—	INT32	ro	Yes	0	No
	Setting range					
	-2147483648 to 2147483647 unit This is the Touch probe1 rising detection position.					

Index	Name					
60BBH	Touch probe 1 negative position value					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
00H	—	INT32	ro	Yes	0	No
	Setting range					
	-2147483648 to 2147483647 unit This is the Touch probe1 falling detection position.					

Index	Name					
60BCH	Touch probe 2 positive position value					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
00H	—	INT32	ro	Yes	0	No
	Setting range					
	-2147483648 to 2147483647 unit This is the Touch probe2 rising detection position.					

Index	Name					
60BDH	Touch probe 2 negative position value					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
00H	—	INT32	ro	Yes	0	No
	Setting range					
	-2147483648 to 2147483647 unit This is the Touch probe2 falling detection position.					

Index	Name					
60C2H	Interpolation time period					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
00H	Number of entries	UINT8	ro	No	02H	No
	Setting range					
	02H					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
01H	Interpolation time period value	UINT8	rw	No	03H	Yes
	Setting range					
	0 to 255 *1*2					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
02H	Interpolation time index	INT8	rw	No	-3	Yes
	Setting range					
	-6 to -3 *1*2					

*1: Any time value of 12 ms or higher will be regarded as 12 ms.

*2: This object is automatically set when in DC synchronous mode or PA2_92 ≠ 0.

15

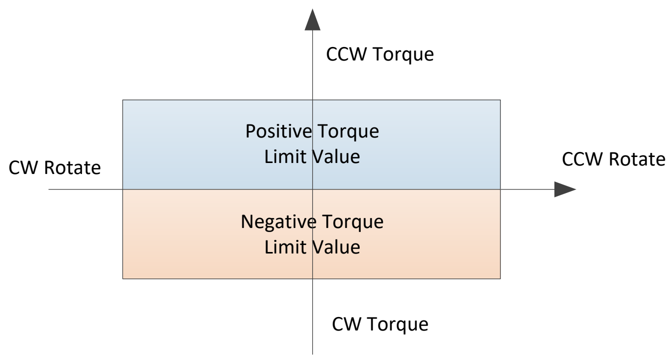
The command delay time is set with the following definitional equation.

$$\textit{Command delay time [s]} \quad = IntepolationTimePeriodValue \times 10^{(InterPolationTimeIndex)}$$

Index	Name					
60E0H	Positive torque limit value					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
00H	—	UINT16	rw	Yes	0DACH	No
	Setting range					
	0.0% to 350.0%					

Index	Name					
60E1H	Negative torque limit value					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
00H	—	UINT16	rw	Yes	0DACH	No
	Setting range					
	0.0% to 350.0%					

Adjust the Positive torque limit value and Negative torque limit value in 0.1% units with motor rated torque of 100% as the reference. The definition of torque limit positive and negative is as follows. The Positive torque limit value and Negative torque limit value settings are not enabled when the product is shipped form the factory. When using the product, set PA2_57 (5002H-39H) to “1”.



Index	Name					
60E3H	Supported homing methods					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
00H	Number of entries	UINT8	ro	No	14H	No
	Setting range					
	14H					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
01H	1st supported homing method	INT8	ro	No	1	No
	Setting range					
	1: Homing based on -OT and Z-phase					

15

Sub	Name	Data type	Access	PDO	Default value	EEPROM
02H	2nd supported homing method	INT8	ro	No	2	No
	Setting range					
	2: Homing based on +OT and Z-phase					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
03H	3rd supported homing method	INT8	ro	No	3	Yes
	Setting range					
	3: Homing 1 based on home position LS (positive logic) and Z-phase					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
04H	4th supported homing method	INT8	ro	No	4	Yes
	Setting range					
	4: Homing 2 based on home position LS (positive logic) and Z-phase					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
05H	5th supported homing method	INT8	ro	No	5	No
	Setting range					
	5: Homing 1 based on home position LS (negative logic) and Z-phase					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
06H	6th supported homing method	INT8	ro	No	6	No
	Setting range					
	6: Homing 2 based on home position LS (negative logic) and Z-phase					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
07H	7th supported homing method	INT8	ro	No	7	No
	Setting range					
	7: Homing - positive direction startup 1 based on +OT, home position LS, and Z-phase					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
08H	8th supported homing method	INT8	ro	No	8	No
	Setting range					
	8: Homing - positive direction startup 2 based on +OT, home position LS, and Z-phase					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
09H	9th supported homing method	INT8	ro	No	9	No
	Setting range					
	9: Homing - positive direction startup 3 based on +OT, home position LS, and Z-phase					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
0AH	10th supported homing method	INT8	ro	No	10	No
	Setting range					
	10: Homing - positive direction startup 4 based on +OT, home position LS, and Z-phase					

Sub	Name	Data type	Access	PDO	Default value	EEPROM
0BH	11th supported homing method	INT8	ro	No	11	No
	Setting range					
	11: Homing - negative direction startup 1 based on -OT, home position LS, and Z-phase					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
0CH	12th supported homing method	INT8	ro	No	12	No
	Setting range					
	12: Homing - negative direction startup 2 based on -OT, home position LS, and Z-phase					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
0DH	13th supported homing method	INT8	ro	No	13	No
	Setting range					
	13: Homing - negative direction startup 3 based on -OT, home position LS, and Z-phase					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
0EH	14th supported homing method	INT8	ro	No	14	No
	Setting range					
	14: Homing - negative direction startup 4 based on -OT, home position LS, and Z-phase					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
0FH	15th supported homing method	INT8	ro	No	19	No
	Setting range					
	19: Homing 1 based on home position LS (positive logic)					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
10H	16th supported homing method	INT8	ro	No	20	No
	Setting range					
	20: Homing 2 based on home position LS (positive logic)					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
11H	17th supported homing method	INT8	ro	No	33	No
	Setting range					
	33: Homing (negative direction) based on Z-phase					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
12H	18th supported homing method	INT8	ro	No	34	No
	Setting range					
	34: Homing (positive direction) based on Z-phase					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
13H	19th supported homing method	INT8	ro	No	35	No
	Setting range					
	35: Current position home position preset (old standard)					

Sub	Name	Data type	Access	PDO	Default value	EEPROM
14H	20th supported homing method	INT8	ro	No	37	No
	Setting range					
	37: Current position home position preset					

Index	Name					
60E4H	Additional position actual value					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
00H	Number of entries	UINT8	ro	No	01H	No
	Setting range					
	01H					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
01H	1st additional position actual value	INT32	ro	YES	0	No
	Setting range					
	-2147483648 to 2147483647 unit					

Index	Name					
60E6H	Additional position encoder resolution					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
00H	Number of entries	UINT8	ro	No	01H	No
	Setting range					
	01H					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
01H	1st additional position encoder resolution	UINT32	rw	No	32768	Yes
	Setting range					
	1 to 16777216 pulse/rev					

Set the resolution of the external encoder pulse as the resolution per revolution of the servo motor. If the deceleration mechanism is in the device, compensate it by considering the reducer ratio.

(e.g) Reduction gear (1/15), Ball screw (Lead 10 [mm/rev]),
When using linear scale (1000 [pulse/mm] (4times))

60E6H-01H = Reduction ratio × Lead length × External encoder resolution

$$= \frac{1}{15} \times 10 \times 4 \times 1000 \fallingdotseq 2667 \text{ [pulse/rev]}$$

Index	Name					
60F4H	Following error actual value					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
00H	—	INT32	ro	Yes	0	No
	Setting range					
	Displays the position deviation. -2147483648 to 2147483647 unit					

Index	Name					
60FCH	Position demand internal value					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
00H	—	INT32	ro	Yes	0	No
	Setting range					
	Displays the internal position command value in pulse units with the home position as 0. -2147483648 to 2147483647 pulse					

Index	Name
60FDH	Digital inputs

Sub	Name	Data type	Access	PDO	Default value	EEPROM
00H	—	UINT32	ro	Yes	00000000H	No
	Setting range					

Bit 31	Bit 30	Bit 29	Bit 28	Bit 27	Bit 26	Bit 25	Bit 24
OUT12	OUT11	OUT10	OUT9	OUT8	OUT7	OUT6	OUT5

Bit 23	Bit 22	Bit 21	Bit 20	Bit 19	Bit 18	Bit 17	Bit 16
EN2	EN1	CONT6	CONT5	CONT4	CONT3	CONT2	CONT1

Bit 15 to bit 3	Bit 2	Bit 1	Bit 0
Reserved	Home [LS]	+OT	-OT

Index	Name
60FEH	Digital outputs

Sub	Name	Data type	Access	PDO	Default value	EEPROM
00H	Number of entries	UINT8	ro	No	0	No
	Setting range					
	02H					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
01H	Physical outputs	UINT32	rw	Yes	00000000H	No
	Setting range					

Bit 31 to bit 18	Bit 17	Bit 16
Reserved	Digital output 2	Digital output 1

Bit 15 to bit 0
Reserved

*1: Use this object if performing OUT signal operations using EtherCAT.
When using this object, set “91 (Digital Output 1)” and “92 (Digital Output 2)” for PA3_51 and PA3_52.

Sub	Name	Data type	Access	PDO	Default value	EEPROM
02H	Bit mask	UINT32	rw	No	00030000H	No
	Setting range					
	The definition for bit position is the same as that for Physical outputs (60FE: 01). Digital output is enabled while the Bitmask applicable bit is “1”, and disabled while the bit is “0”.					

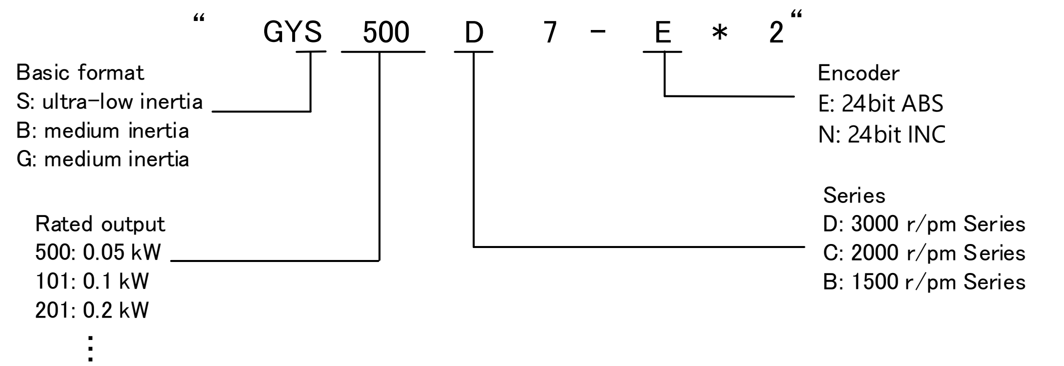
15

- Example: If PA3_51 = 91 (OUT1 signal set to Digital Output1)

Bit Mask (60FE:01)	Physical output (60FE:01)	OUT1
00000000H	00000000H	OFF
	00010000H	OFF
00010000H	00000000H	OFF
	00010000H	ON

Index	Name					
60FFH	Target velocity					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
00H	—	INT32	rw	Yes	0	No
	Setting range					
	-2147483648 to 2147483647 unit/s Set the command speed in PV and CSV mode.					
Index	Name					
6402H	Motor type					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
00H	—	UINT16	ro	No	0003H	No
	Setting range					
	0003H: PM synchronous motor Displays the corresponding motor.					

Index	Name					
6403H	Motor catalogue number					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
00H	—	VS	ro	No	—	No
	Setting range					
	Indicates the applicable model type.					

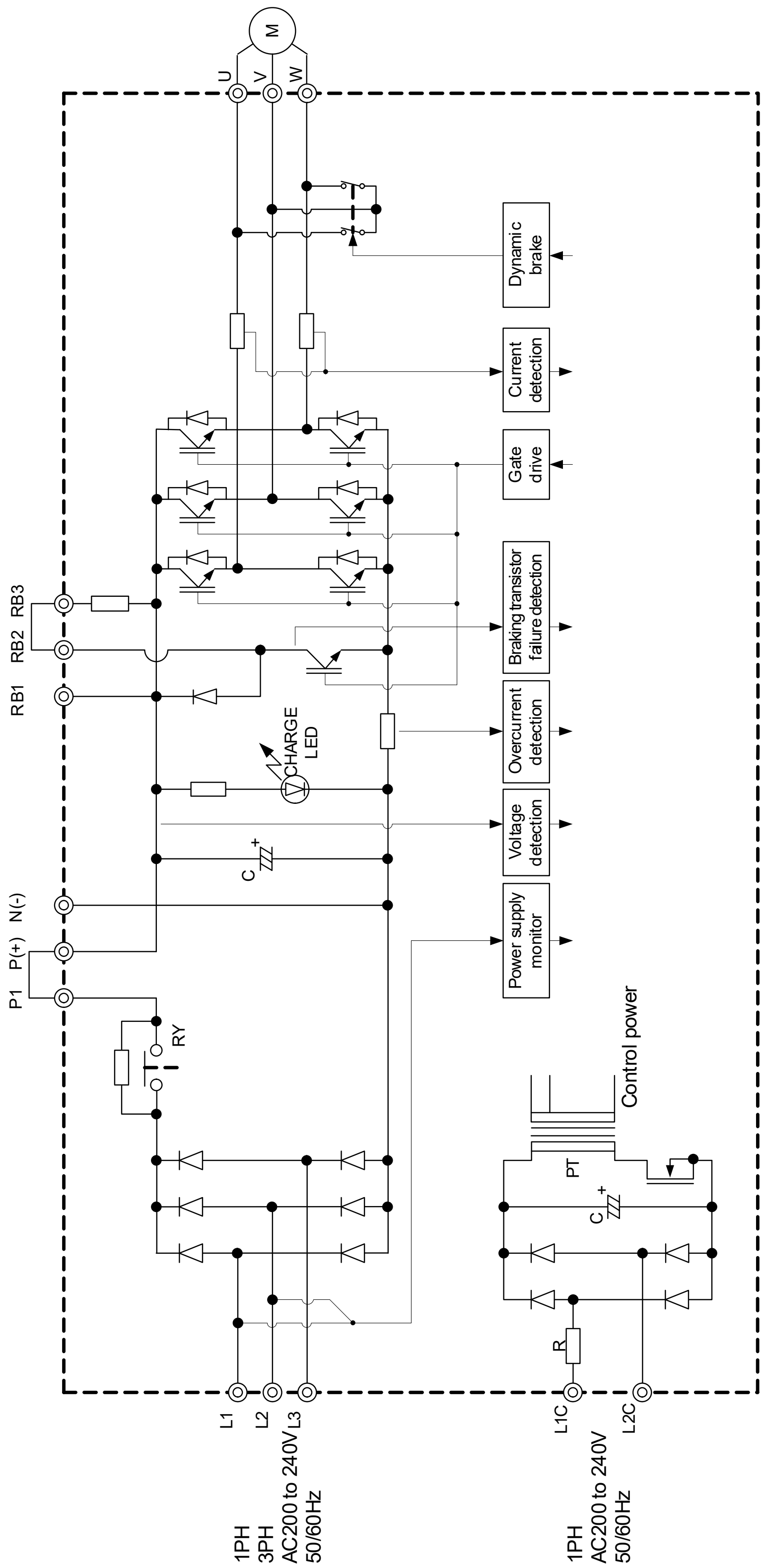


Index	Name					
6502H	Supported drive modes					
Sub	Name	Data type	Access	PDO	Default value	EEPROM
00H	—	UINT32	ro	No	000003A5H	No
	Setting range					
	Bit 0: PP Bit 1: VL Bit 2: PV Bit 3: TQ Bit 4: Reserved *1 Bit 5: HM Bit 6: IP Bit 7: CSP Bit 8: CSV Bit 9: CST Bit 10 to bit 32: Reserved *1 *1: These bits are not used. Displays control modes that can be used.					

15.2 Main Circuit Block Diagrams

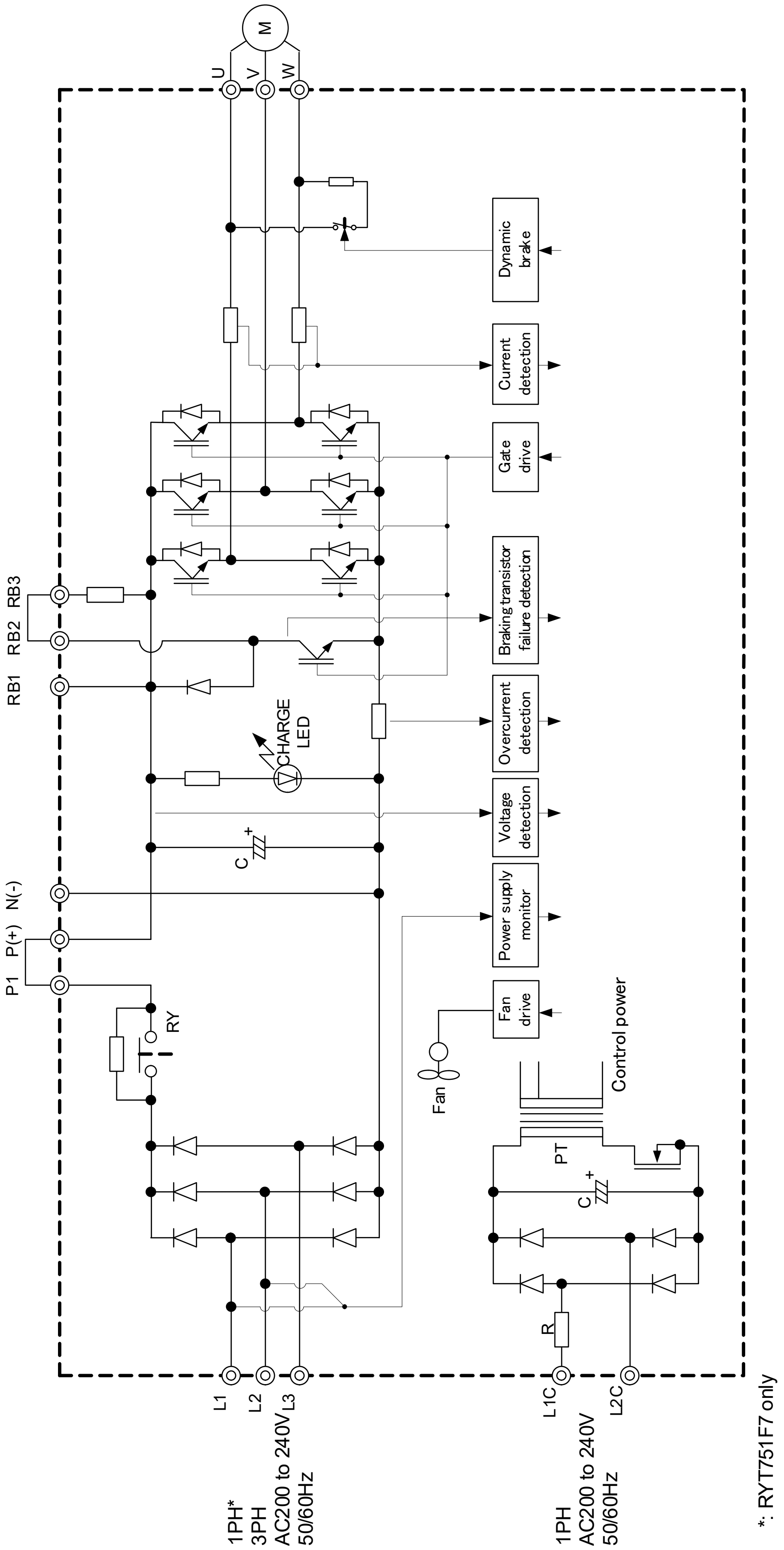
Applicable models

RYT500F7 to RYT401F7

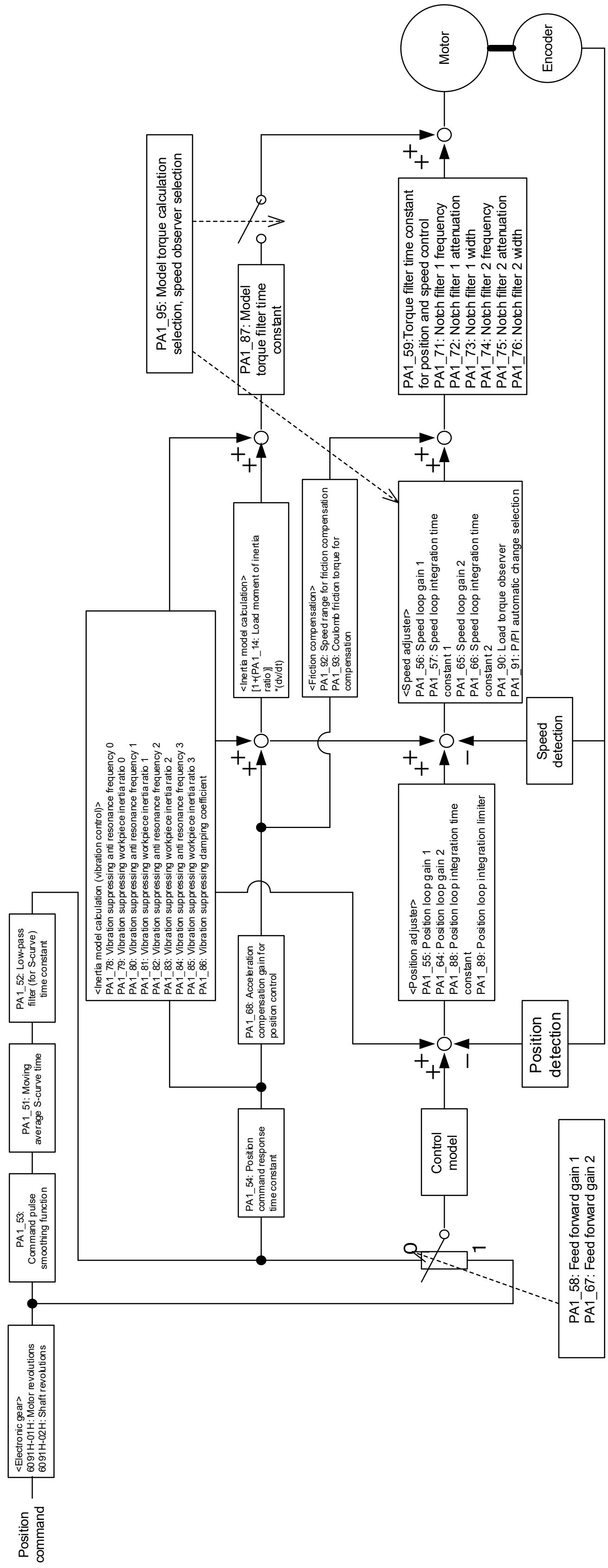


Applicable models

RYT751F7 to RYT502F7



15.3 Control Circuit Block Diagram



15

15.4 Parameter List

■ PA1_: Basic setting parameters

No.	Name	Power supply	Record of reference value
02	INC/ABS system selection	○	
04	Rotation direction selection	○	
12	Z-phase offset	○	
13	Tuning mode selection	—	
14	Load moment of inertia ratio	—	
15	Auto tuning gain 1	—	
16	Auto tuning gain 2	—	
20	Easy tuning: stroke setting	—	
21	Easy tuning: speed setting	—	
22	Easy tuning: timer setting	—	
23	Easy tuning: direction selection	—	
25	Max. rotation speed (for position and speed control)	—	
26	Max. rotation speed (for torque control)	—	
27	Forward rotation torque limit	—	
28	Reverse rotation torque limit	—	
29	Speed coincidence range	—	
30	Zero speed range	—	
37	Acceleration time 1	—	
38	Deceleration time 1	—	
41	Manual feed speed 1/torque control speed limit 1	—	
42	Manual feed speed 2/torque control speed limit 2	—	
43	Manual feed speed 3/torque control speed limit 3	—	
44	Manual feed speed 4/torque control speed limit 4	—	
45	Manual feed speed 5/torque control speed limit 5	—	
46	Manual feed speed 6/torque control speed limit 6	—	
47	Manual feed speed 7/torque control speed limit 7	—	

■ PA1_: Control gain and filter setting parameters

No.	Name	Power supply	Record of reference value
51	Moving average S-curve time	—	
52	First order lag S-curve time constant	—	
53	Command pulse smoothing function	—	
54	Position command response time constant (Kpt)	—	
55	Position loop gain 1	—	
56	Speed loop gain 1	—	
57	Speed loop integration time constant 1	—	
58	Feed forward gain 1	—	
59	Torque filter time constant for position and speed control	—	
60	Torque setting filter	—	
61	Gain changing factor	—	
62	Gain changing level	—	
63	Gain changing time constant	—	
64	Position loop gain 2	—	
65	Speed loop gain 2	—	
66	Speed loop integration time constant 2	—	
67	Feed forward gain 2	—	
70	Automatic notch selection	—	
71	Notch filter 1 frequency	—	
72	Notch filter 1 attenuation	—	
73	Notch filter 1 width	—	
74	Notch filter 2 frequency	—	
75	Notch filter 2 attenuation	—	
76	Notch filter 2 width	—	
77	Vibration suppression function selection	—	
78	Vibration suppressing anti resonance frequency 0	—	
79	Vibration suppressing workpiece inertia ratio 0 (vibration suppressing antiresonant frequency)	—	
80	Vibration suppressing anti resonance frequency 1	—	
81	Vibration suppressing workpiece inertia ratio 1 (vibration suppressing antiresonant frequency)	—	
82	Vibration suppressing anti resonance frequency 2	—	
83	Vibration suppressing workpiece inertia ratio 2 (vibration suppressing antiresonant frequency)	—	
84	Vibration suppressing anti resonance frequency 3	—	

No.	Name	Power supply	Record of reference value
85	Vibration suppressing workpiece inertia ratio 3 (vibration suppressing antiresonant frequency)	—	
86	Vibration suppressing damping coefficient	—	
87	Model torque filter time constant	—	
88	Position loop integration time constant	—	
89	Position loop integration limiter	—	
90	Load torque observer	—	
91	P/PI automatic change selection	—	
92	Friction compensation: speed range	—	
93	Friction compensation: torque setting value	—	
94	Torque filter setting mode	—	
95	Model torque calculation selection, speed observer selection	—	
96	Speed limit gain for torque control	—	

■ PA2_: Automatic operation setting parameters

No.	Name	Power supply	Record of reference value
09	Reverse traveling unit amount for homing	—	
14	Home position shift unit amount	—	
25	Software OT selection/ position command form	○	

■ PA2_: Extended function 1 setting parameters

No.	Name	Power supply	Record of reference value
56	Speed limit selection	○	
57	Torque limit selection	○	
60	Third torque limit value	—	
61	When servo-on = OFF	○	
62	Action sequence at alarm	○	
63	Action sequence at main power supply OFF, OT detection	○	
64	Brake holding time	—	
65	Braking resistor selection	○	
66	Speed control flying start selection	○	
67	Alarm detection at undervoltage	○	
68	Main power shutoff detection time	○	
69	Deviation detection overflow value	—	
70	Overload warning value	—	
72	ID-Selector offset	○	
74	Parameter write protection	—	
78	Display transition at warning detection	○	
80	Parameter in RAM 1	○	
81	Parameter in RAM 2	○	
82	Parameter in RAM 3	○	
83	Parameter in RAM 4	○	
84	Parameter in RAM 5	○	
85	Parameter in RAM 6	○	
89	Sequence test mode: mode selection	○	
90	Sequence test mode: encoder bit selection	○	
91	Position command delay time	—	
92	EtherCAT extended function	○	

■ PA3_: Input terminal function setting parameters

No.	Name	Power supply	Record of reference value
01	CONT1 signal assignment	○	
02	CONT2 signal assignment	○	
03	CONT3 signal assignment	○	
04	CONT4 signal assignment	○	
05	CONT5 signal assignment	○	
06	CONT6 signal assignment	○	
07	CONT7 signal assignment	○	
08	CONT8 signal assignment	○	
25	CONT signal inversion	○	
26	CONT always ON 1	○	
27	CONT always ON 2	○	
28	CONT always ON 3	○	
29	CONT always ON 4	○	
30	CONT always ON 5	○	

■ PA3_: Output terminal function setting parameters

No.	Name	Power supply	Record of reference value
51	OUT1 signal assignment	○	
52	OUT2 signal assignment	○	
53	OUT3 signal assignment	○	
54	OUT4 signal assignment	○	
55	OUT5 signal assignment	○	
56	OUT6 signal assignment	○	
57	OUT7 signal assignment	○	
58	OUT8 signal assignment	○	
59	OUT9 signal assignment	○	
60	OUT10 signal assignment	○	
61	OUT11 signal assignment	○	
62	OUT12 signal assignment	○	
72	OUT signal inversion	○	
81	Monitor 1 signal assignment	—	
82	Monitor 2 signal assignment	—	
83	Monitor 1 scale	—	
84	Monitor 1 offset	—	
85	Monitor 2 scale	—	
86	Monitor 2 offset	—	
87	Monitor 1/2 output form	—	
89	Feedback speed sampling time for monitor	—	

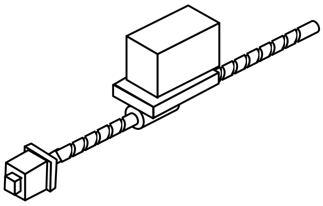
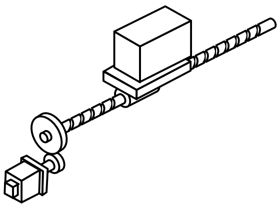
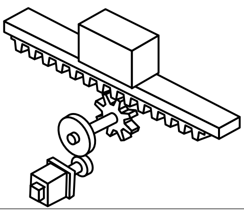
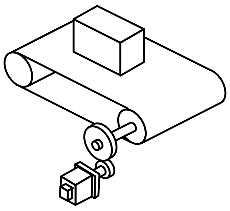
■ PA4_: Extended function 2 setting parameters

No.	Name	Power supply	Record of reference value
01	Interference detection level	—	
02	Interference detection return amount	—	
03	Interference detection return speed	—	
04	Interference detection LPF time constant	—	
05	Interference detection HPF time constant	—	
06	Interference detection selection	—	
10	SEMI F47 support function selection	○	
11	Functional safety body action selection	○	
12	Functional safety SLS speed limit value	—	
21	Torque control speed limit selection	○	
32	Full-closed system setting	○	
35	Full-closed LPF time-constant	—	
36	External/motor deviation over detection value	—	
37	External/motor deviation over forecast value	—	
38	Frequency divider denominator for external/motor deviation monitor	—	
51	Notch filter 3: frequency	—	
52	Notch filter 3: attenuation	—	
53	Notch filter 3: width	—	
54	Notch filter 4: frequency	—	
55	Notch filter 4: attenuation	—	
56	Notch filter 4: width	—	
57	Notch filter 5: frequency	—	
58	Notch filter 5: attenuation	—	
59	Notch filter 5: width	—	
60	Cogging torque compensation	—	
61	Tuningless function selection	○	
62	Tuningless level	—	
63	Tuningless load level	—	
64	New vibration suppressing control damping coefficient	—	
65	New vibration suppressing control workpiece inertia ratio	—	

15.5 Capacity Selection Calculation

15.5.1 Mechanical System Types

Mechanical systems driven by a variable speed motor generally include the following types.

Mechanism	Features
	Ball screw (direct coupling) Used for relatively short distance, high-accuracy positioning. The motor and ball screw are connected only via a coupling, and no play is included.
	Ball screw (geared) A speed reducer is used to increase the torque transferred to the mechanical system. Compensation is required to counter gear backlash.
	Rack & pinion Used for positioning over relatively long distances (carrier drive, etc.) Compensation is required to counter the π value contained in each pinion rotation.
	Timing belt (conveyor) This type has a relatively large degree of freedom compared with the chain, and is used mainly for light loads. Compensation is required to counter the π value contained in the travel distance for each pulley rotation.

Be aware of the following points when applying the servo system to a mechanical system.

(1) Reduction ratio

Use close to the rated speed of the motor to take advantage of the servomotor power. The continuous output torque at maximum rotation speed is smaller than the rated torque.

(2) Pre-load torque

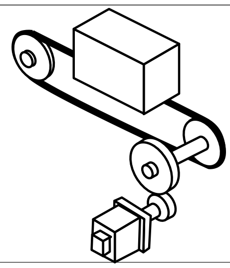
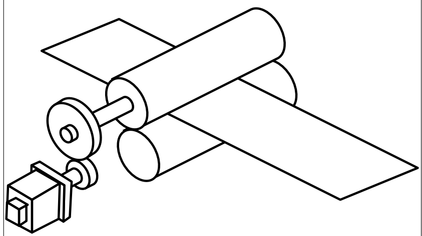
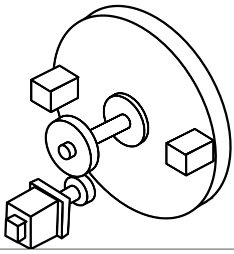
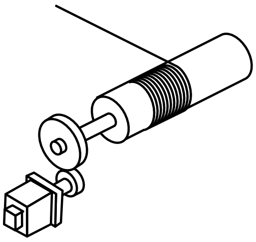
Rigidity increases by applying a pre-load to the ball screw, however, the load torque value increases.

Refer to the ball screw specifications for friction torque caused by the pre-load.

(3) Holding torque

With lifting equipment, the servomotor continues to output holding power when stopped.

Use of a holding brake is recommended if time allows.

Mechanism	Features
	Chain drive This type is used mainly for transfer lines, and requires countermeasures to counter elongation of the chain itself. It is used mainly for relatively large reduction ratios, and the traveling speed of the mechanical system is low.
	Feed roll Material on a plate (band) is sandwiched between rollers and fed. As the roller diameter is not accurately obtained, errors tend to occur over long distances, requiring π compensation. Sudden acceleration causes slippage, resulting in insufficient feed.
	Table indexing A sufficiently large reduction ratio is required due to the large moment of inertia of the table. The table rotation speed is low, and a worm gear is often used.
	Spindle drive Wire material windings result in greater moment of inertia, requiring a sufficiently large reduction ratio. To ensure a constant peripheral speed, a study must be conducted that includes peripheral equipment.

■ Approximate machine constants

Approximate friction

Mechanism	Friction coefficient
Rail and iron wheel (carrier and crane)	0.05
Linear guide	0.05 to 0.2
Ball spline	
Roller table	
Roller system	

Material density

Material	Density kg/m^3
Copper	8.96×10^3
Brass	8.54×10^3
Stainless steel	7.91×10^3
Iron	7.85×10^3
Aluminum	2.7×10^3
Polyacetals	1.43×10^3

Approximate mechanical

Mechanism	Mechanical efficiency
Trapezoidal screw thread	0.5 to 0.8
Ball screw	0.9
Rack & pinion	0.8
Gear reducer	0.8 to 0.95
Worm reducer (starting)	0.5 to 0.7
Worm reducer (during operation)	0.6 to 0.8
Belt transmission	0.95
Chain transmission	0.9

Module

$$(\text{Module}) = \frac{(\text{Pitch circle diameter of gear})}{(\text{Number of teeth})}$$

* Module
0.5 0.75 0.8 1 1.5 2 2.5 3 4 5 6 7

* Metric gear

Chain size

No.	Pitch	No.	Pitch
15	4.762	80	25.4
25	6.35	100	31.75
35	9.525	120	38.1
40	12.7	140	44.45
50	15.875	160	50.8
60	19.05	180	57.15

15.5.2 Capacity Selection Calculation

Capacity selection calculation is performed to obtain the servomotor capacity necessary for the machine specifications (configuration).

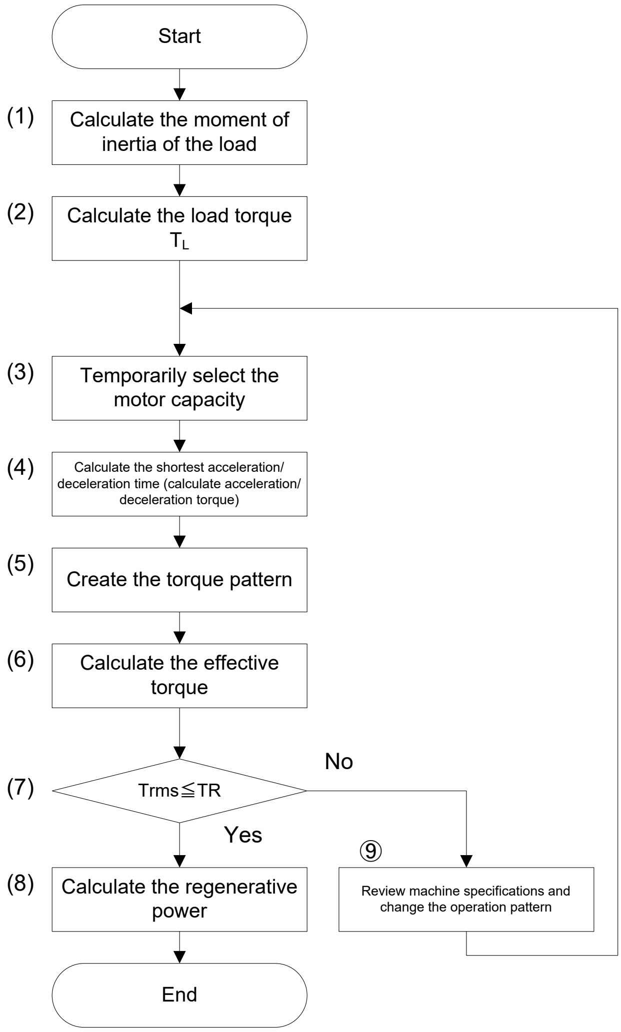
Items necessary for capacity selection calculation include the following.

- Load moment of inertia (mechanical system moment of inertia)
- Load torque (torque necessary to move the machine)
- Acceleration/deceleration time
- Operation profile

In general, there is no way to measure the mechanical system moment of inertia and load torque, and therefore approximate values must be calculated based on the machine configuration.

Use the procedure below to perform the capacity selection calculation.

Capacity selection flow chart



(1) Calculate the load moment of inertia based on the machine configuration.

(2) Calculate the load torque based on the machine configuration.

(3) Temporarily select the motor capacity.

(4) Verify the shortest acceleration/deceleration time. If the time is specified, calculate the required acceleration/deceleration torque.

(5) Create a torque profile based on the operation profile.

(6) Calculate the effective torque based on the torque profile.

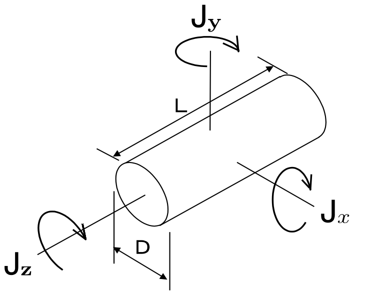
(7) If the effective torque (Trms) is smaller than the rated torque (TR), operation can be performed with the specified operation profile.

(8) Calculate the regenerative electric power and, if necessary, select a braking resistor.

(9) Review the machine specifications as best as possible.

■ Moment of inertia calculation

Shapes

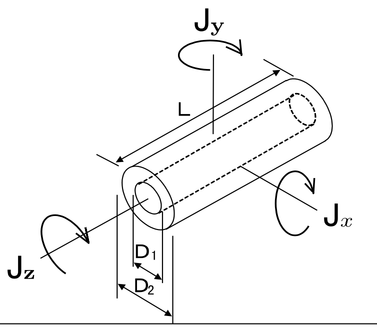


$$J_z = \frac{W}{8}\left(\frac{D}{10^3}\right)^2 = \frac{\pi\rho}{32}\left(\frac{L}{10^3}\right)\left(\frac{D}{10^3}\right)^4$$

$$J_x = J_y = \frac{W}{16}\left(\frac{D}{10^3}\right)^2 + \frac{W}{12}\left(\frac{L}{10^3}\right)^2$$

$$W = \frac{\pi\rho}{4}\left(\frac{L}{10^3}\right)\left(\frac{D}{10^3}\right)^2$$

W : [kg]
D : [mm]
L : [mm]
ρ : [kg/m^3]

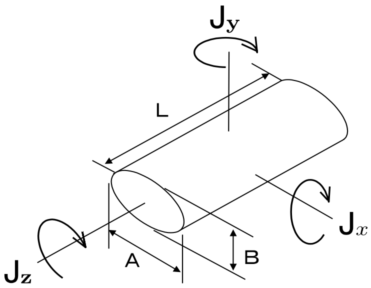


$$J_z = \frac{W}{8}\left\{\left(\frac{D_2}{10^3}\right)^2 + \left(\frac{D_1}{10^3}\right)^2\right\} = \frac{\pi\rho}{32}\left(\frac{L}{10^3}\right)\left\{\left(\frac{D_2}{10^3}\right)^4 - \left(\frac{D_1}{10^3}\right)^4\right\}$$

$$J_x = J_y = \frac{W}{16}\left\{\left(\frac{D_2}{10^3}\right)^2 + \left(\frac{D_1}{10^3}\right)^2\right\} + \frac{W}{12}\left(\frac{L}{10^3}\right)^2$$

$$W = \frac{\pi\rho}{4}\left(\frac{L}{10^3}\right)\left\{\left(\frac{D_2}{10^3}\right)^2 - \left(\frac{D_1}{10^3}\right)^2\right\}$$

W : [kg]
D : [mm]
L : [mm]
ρ : [kg/m^3]



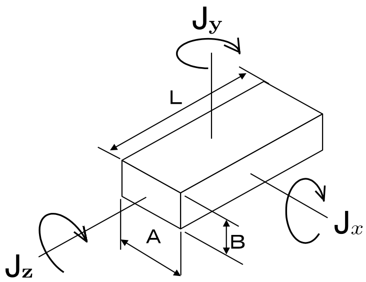
$$J_z = \frac{W}{16}\left\{\left(\frac{A}{10^3}\right)^2 + \left(\frac{B}{10^3}\right)^2\right\}$$

$$J_x = \frac{W}{16}\left(\frac{B}{10^3}\right)^2 + \frac{W}{12}\left(\frac{L}{10^3}\right)^2$$

$$J_y = \frac{W}{16}\left(\frac{A}{10^3}\right)^2 + \frac{W}{12}\left(\frac{L}{10^3}\right)^2$$

$$W = \frac{\pi\rho}{4}\left(\frac{A}{10^3}\right)\left(\frac{B}{10^3}\right)\left(\frac{L}{10^3}\right)$$

W : [kg]
L : [mm]
A : [mm]
B : [mm]
ρ : [kg/m^3]



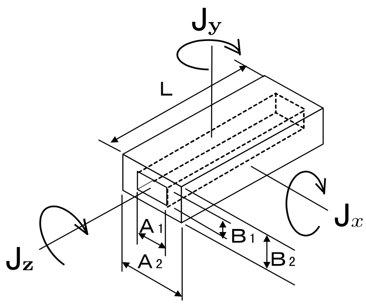
$$J_x = \frac{W}{12}\left\{\left(\frac{B}{10^3}\right)^2 + \left(\frac{L}{10^3}\right)^2\right\}$$

$$J_y = \frac{W}{12}\left\{\left(\frac{L}{10^3}\right)^2 + \left(\frac{A}{10^3}\right)^2\right\}$$

$$J_z = \frac{W}{12}\left\{\left(\frac{A}{10^3}\right)^2 + \left(\frac{B}{10^3}\right)^2\right\}$$

$$W = \rho\left(\frac{A}{10^3}\right)\left(\frac{B}{10^3}\right)\left(\frac{L}{10^3}\right)$$

W : [kg]
L : [mm]
A : [mm]
B : [mm]
ρ : [kg/m^3]



$$J_x = \frac{W_2}{12}\left\{\left(\frac{B_2}{10^3}\right)^2 + \left(\frac{L}{10^3}\right)^2\right\} - \frac{W_1}{12}\left\{\left(\frac{B_1}{10^3}\right)^2 + \left(\frac{L}{10^3}\right)^2\right\}$$

$$J_y = \frac{W_2}{12}\left\{\left(\frac{A_2}{10^3}\right)^2 + \left(\frac{L}{10^3}\right)^2\right\} - \frac{W_1}{12}\left\{\left(\frac{A_1}{10^3}\right)^2 + \left(\frac{L}{10^3}\right)^2\right\}$$

$$J_z = \frac{W_2}{12}\left\{\left(\frac{A_2}{10^3}\right)^2 + \left(\frac{B_2}{10^3}\right)^2\right\} - \frac{W_1}{12}\left\{\left(\frac{A_1}{10^3}\right)^2 + \left(\frac{B_1}{10^3}\right)^2\right\}$$

$$W = \rho\left\{\left(\frac{A_2}{10^3}\right)\left(\frac{B_2}{10^3}\right) - \left(\frac{A_1}{10^3}\right)\left(\frac{B_1}{10^3}\right)\right\}\left(\frac{L}{10^3}\right)$$

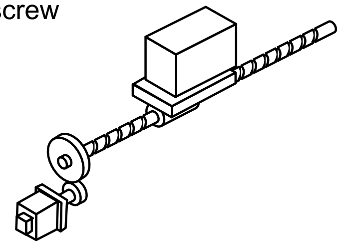
$$W_2 = \rho\left(\frac{A_2}{10^3}\right)\left(\frac{B_2}{10^3}\right)\left(\frac{L}{10^3}\right) \qquad W_1 = \rho\left(\frac{A_1}{10^3}\right)\left(\frac{B_1}{10^3}\right)\left(\frac{L}{10^3}\right)$$

W : [kg]
L : [mm]
A : [mm]
B : [mm]
ρ : [kg/m^3]

15

Conversion

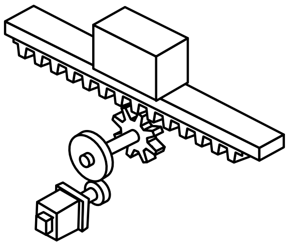
Ball screw



$$J_1 = W\left(\frac{1}{2\pi} \times \frac{BP}{10^3}\right)^2 \times GL^2$$

W: Total weight of moving parts [kg]
BP: Screw lead [mm]
GL: Reduction ratio (no unit)

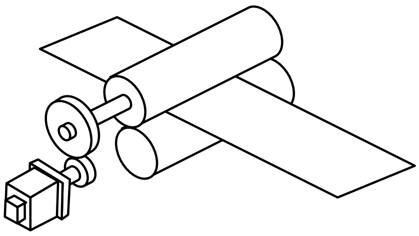
Rack & pinion, conveyor and chain drive



$$J_2 = \frac{W}{4}\left(\frac{D}{10^3}\right)^2 \times GL^2$$

W: Total weight of moving parts [kg]
D: Pinion diameter [mm]
Sprocket diameter [mm]
GL: Reduction ratio (no unit)

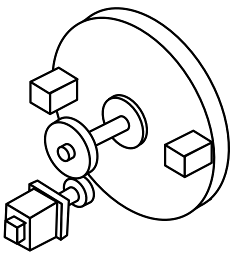
Feed roll



$$J_3 = \frac{W}{4}\left(\frac{D}{10^3}\right)^2 \times GL^2$$

W: Total weight of moving parts [kg]
D: Roll diameter [mm]
GL: Reduction ratio (no unit)

Rotating body and table drive



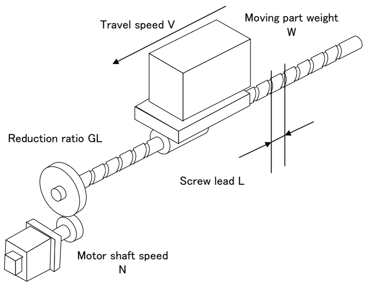
Obtain the moment of inertia for the sum of each shape.
Moment of inertia of body located at distance from rotational axis (J_4)

$$J_4 = \left(J + W\left(\frac{L}{10^3}\right)^2\right) \times GL^2$$

J: Moment of inertia passing through body center of gravity
W: Weight of body [kg]
L: Distance between body and rotational axis [mm]
GL: Reduction ratio (no unit)

■ Load torque (T_L) calculation

Ball screw



$$T_L = \frac{(\mu W + F) \times 9.81}{2\pi\eta} \left(\frac{BP}{10^3}\right) \times GL$$

μ: Friction coefficient BP: Screw lead [mm]

W, W_1: Weight of moving parts [kg]

W_2: Weight of counterweight [kg]

GL: Reduction ratio (no unit) F: Thrust [kg]

・Lifting (vertically)

$$T_L = \frac{((\mu + 1) W_1 - W_2) \times 9.81}{2\pi\eta} \left(\frac{BP}{10^3}\right) \times GL$$

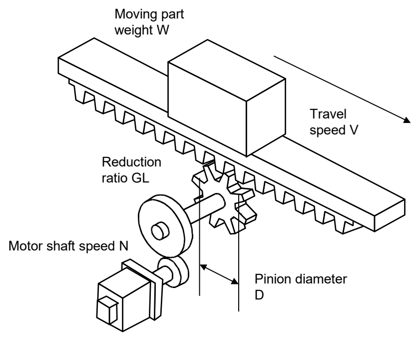
・Lowering (vertically)

$$T_L = \frac{((\mu - 1) W_1 - W_2) \times 9.81}{2\pi\eta} \left(\frac{BP}{10^3}\right) \times GL$$

・At stop (vertically)

$$T_L = \frac{(W_1 - W_2) \times 9.81}{2\pi\eta} \left(\frac{BP}{10^3}\right) \times GL$$

Conveyor, rack & pinion



$$T_L = \frac{(\mu W + F) \times 9.81}{\eta} \left(\frac{D}{2} \times \frac{1}{10^3}\right) \times GL$$

μ: Friction coefficient D: Diameter [mm]

W, W_1: Weight of moving parts [kg]

W_2: Weight of counterweight [kg]

GL: Reduction ratio (no unit)

・Lifting (vertically)

$$T_L = \frac{((\mu + 1) W_1 - W_2) \times 9.81}{\eta} \left(\frac{D}{2} \times \frac{1}{10^3}\right) \times GL$$

・Lowering (vertically)

$$T_L = \frac{((\mu - 1) W_1 - W_2) \times 9.81}{\eta} \left(\frac{D}{2} \times \frac{1}{10^3}\right) \times GL$$

・At stop (vertically)

$$T_L = \frac{(W_1 - W_2) \times 9.81}{\eta} \left(\frac{D}{2} \times \frac{1}{10^3}\right) \times GL$$

15

(1) Calculate the load moment of inertia (J_L).

Calculate the load moment of inertia (J_L) for the mechanical system converted to the motor shaft. Calculate the moment of inertia of parts rotating (moving) together as the motor rotates, and obtain the sum of all of these values.

(2) Calculate the load torque (T_L).

Calculate the load torque converted to the motor shaft.

(3) Temporarily select the motor capacity.

Select the motor capacity satisfying the following two conditions.

• Permissible load moment of inertia

$J_L \leq J_M \times 100$ (30) ………………… In case of slow travel under speed control

$J_L \leq J_M \times 30$ (10) …………………… In case of positioning under position control

$J_L \leq J_M \times 10$ (-) ……………………… In case of frequent positioning (Guideline: Starting and stopping once every 0.5 seconds or more)

Values in ( ) parentheses indicate operation with the GYG motor.

• Load torque

$T_L \leq T_R \times 0.9$ ……………………… 0.9 indicates a typical safety factor.

(4) Calculate the shortest acceleration/deceleration time (calculate the acceleration/deceleration torque).

Verify the shortest acceleration/deceleration taking load conditions into consideration. If the acceleration/deceleration time has been specified, calculate the acceleration/deceleration torque.

• Shortest acceleration/deceleration time

$$t_{AC} = \frac{(J_M + J_L) \times 2\pi \times (N_1 - N_0)}{60\,(T_{AC} - T_L)}$$

• Acceleration/deceleration torque

$$T_{AC} = \frac{(J_M + J_L) \times 2\pi \times (N_1 - N_0)}{60\,(t_{AC})} + T_L$$

t_{AC}: Acceleration/deceleration time [s]

J_M: Servomotor moment of inertia [kgm^2]

J_L: Load moment of inertia converted to motor shaft [kgm^2]

T_L: Load torque converted to motor shaft [N·m]

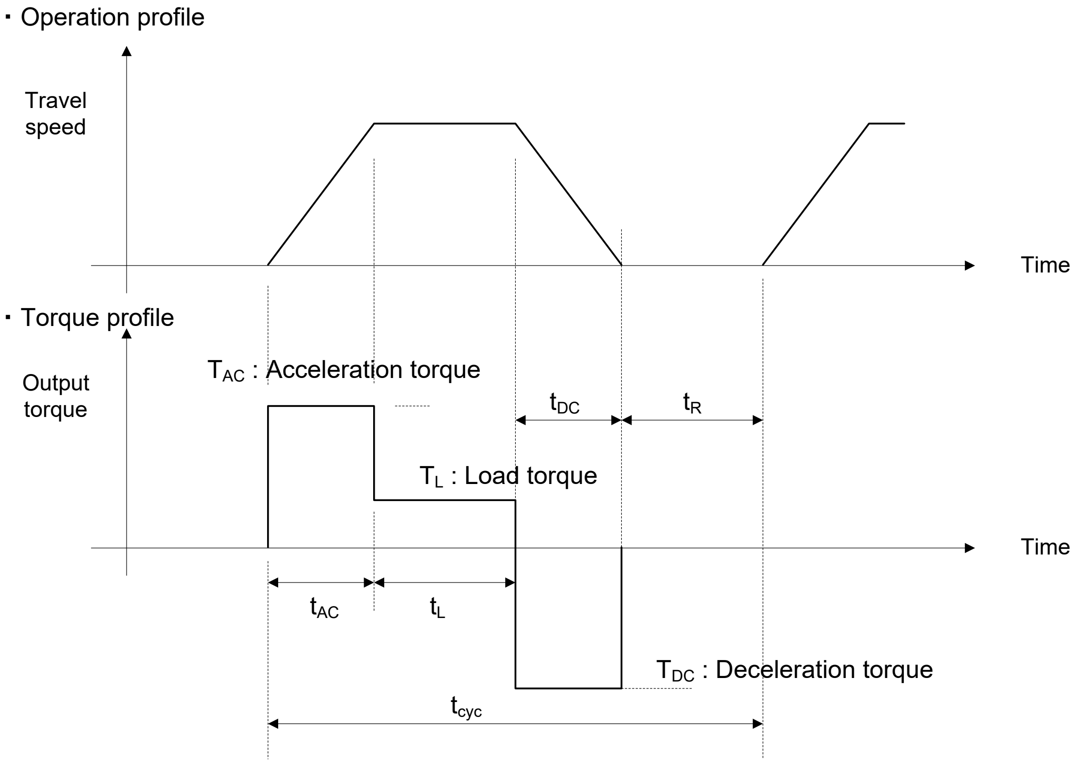
T_{AC}: Acceleration/deceleration torque [N·m]

N_1: Rotation speed after speed change [r/min]

N_0: Rotation speed before speed change [r/min]

(5) Create a torque profile.

Create an output torque profile based on the operation profile.



(6) Calculate the effective torque (T_{rms}).

Calculate the effective torque for each cycle of the operation profile.

$$T_{rms} = \sqrt{\frac{(T_{AC}^2 \times t_{AC}) + (T_L^2 \times t_L) + (T_{DC}^2 \times t_{DC})}{t_{CYC}}}$$

This is the value obtained by taking the product of the square of each output torque multiplied by the output time and dividing it by the time for each cycle, and obtaining the square root of the result.

(7) $T_{rms} \leq T_R$

If the effective torque is equal to or lower than the rated torque, continuous operation is possible with the specified operation profile.

15

(8) Calculate the regenerative electric power.

Regenerative operation is generally performed under the following conditions.

Horizontal feed: during deceleration

Vertical feed: during constant speed feed or while decelerating when lowering

Regenerative electric power during deceleration (P_1)

P_1 [W] = (2π/60) × T_{DC} [N·m] × N_1 r/min] × (1 / 2)

Lowering at constant feedrate (P_2)

P_2 [W] = (2π/60) × T_{DC} [N·m] × N_1 [r/min]

Calculate the average regenerative electric power (P) for each operation profile cycle, and ensure that it is below the braking resistor capacity.

If not, an external braking resistor will be required.

(9) Review the operation profile and mechanical configuration.

If T_{rms} exceeds T_R, review the following items.

・Increase the acceleration/deceleration time a little within the permissible range.

・Increase the operation frequency (cycle time for 1 cycle).

・If the rotation speed allows, increase the reduction ratio.

・Increase the motor capacity.

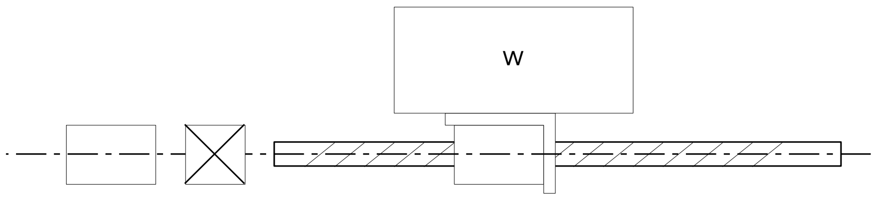
・If stopping lifting equipment for long periods of time, employ a mechanical brake.

・If performing high-frequency operation, increase the reduction ratio as much as possible, and reduce the moment of inertia.

15.5.3 Capacity Selection Calculation Example

■ Machine configuration

Reduction ratio of 1/1 (direct coupling)



Screw pitch 10 [mm], transfer weight 20 [kg], thrust 0 [kg] (none)

(1) Max. travel speed (v)

With reduction ratio of 1/1, and motor shaft rotation speed of 3000 [r/min]

v = (3000/60) × 10 × (1/1) = 500 [mm/s]

(2) Load moment of inertia converted to motor shaft (J_L)

A screw (J_1) with diameter of ϕ20 and length of 500 [mm] is assumed.

$$J_1 = \frac{\pi\rho}{32}\left[\frac{L}{1000}\right]\left[\frac{D_1}{1000}\right]^4 \times GL^2$$

$$= \frac{\pi \times 7.85 \times 10^3}{32}\left[\frac{500}{1000}\right]\left[\frac{20}{1000}\right]^4 \times (1/1)^2$$

$$= 0.6 \times 10^{-4}\ [\mathrm{kg/m^2}]$$

A moving part (J_2) with transfer weight of 20 [kg] is assumed.

$$J_2 = W\left[\frac{1}{2\pi}\ \frac{BP}{1000}\right]^2 \times (GL)^2$$

$$= 20\left[\frac{1}{2\pi}\ \frac{10}{1000}\right]^2 \times (1/1)^2$$

$$= 0.5 \times 10^{-4}\ [\mathrm{kg/m^2}]$$

$$J_L = 1.1 \times 10^{-4}\ [\mathrm{kg/m^2}]$$

(3) Load torque converted to motor shaft [T_L]

A transfer weight of 20 [k], friction coefficient (μ) of 0.1, and machine efficiency (η) of 0.9 are assumed.

$$T_L = \frac{(\mu W + F) \times 9.81}{2\pi\eta}\left[\frac{BP}{1000}\right] \times GL$$

$$= \frac{(0.1 \times 20 + 0) \times 9.81}{2\pi \times 0.9}\left[\frac{10}{1000}\right] \times (1/1)$$

$$= 0.03\ [\mathrm{N \cdot m}]$$

15

(4) Capacity selection conditions

$T_L \leq T_R \times 0.9$
$J_L \leq J_M \times 5$ (high-frequency feed)

$T_L = 0.03$ [N·m]
$J_L = 1.1 \times 10^{-4}$ [kg/m²]

(5) Temporary selection
GYS201D7-HB2 (0.2 [kW]) is obtained based on the capacity selection conditions.
($J_M = 0.135 \times 10^{-4}$ [kg/m²], $T_R = 0.637$ [N·m], $T_{AC} = 1.91$ [N·m])

(5) Shortest acceleration/deceleration time (t_{AC})

$$t_{AC} = \frac{(J_M + J_L) \times 2\pi \times N}{60\,(T_{AC} - T_L)}$$

$$= \frac{(0.135 \times 10^{-4} + 1.1 \times 10^{-4}) \times 2\pi \times 3000}{60\,(1.91 - 0.03)}$$

$$= 0.021 \text{ [s]}$$

Acceleration/deceleration torque at acceleration/deceleration time of 0.05 seconds

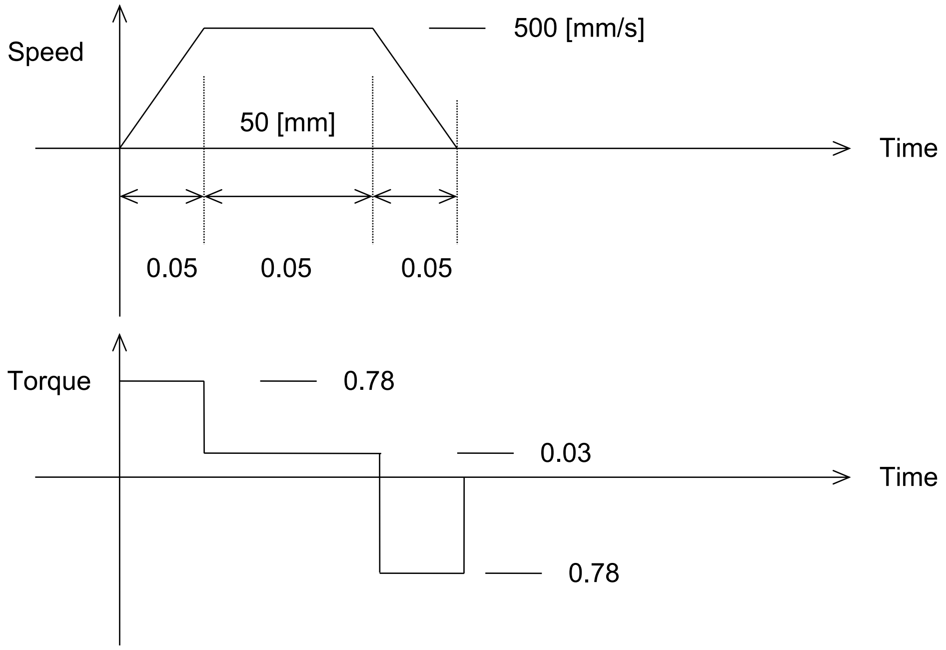
$$T_{AC} = \frac{(J_M + J_L) \times 2\pi \times N}{60\,(t_{AC})} + T_L$$

$$= \frac{(0.135 \times 10^{-4} + 1.1 \times 10^{-4}) \times 2\pi \times 3000}{60 \times 0.05} + 0.03$$

$$= 0.78 \text{ [N·m]}$$

15

(7) Operation profile



This is the profile used for capacity selection. An operation time per cycle of 0.5 seconds is assumed.

(8) Effective torque (T_{rms})

This is the time-average for output torque.

$$T_{rms} = \sqrt{\frac{T_{AC}^2 \times t_a + T_L^2 \times t_L + T_{DC}^2 \times t_d}{t_{cyc}}}$$

$$= \sqrt{\frac{(0.78^2 \times 0.05) \times 2 + (0.03^2 \times 0.05) \times 1}{0.5}}$$

$$= 0.25 \text{ [N·m]}$$

As the result is equal to or lower than the rated torque for the GYS201D7-HB2 type, operation can be continued with the specified profile.

(9) Selection result

Servomotor: GYS201D7-HB2 (0.2 [kW])

(10) Regenerative electric power

Regenerative electric power is returned during deceleration.

P_1 [W] = (2π/60) × T [N·m] × N [r/min] × (1/2)

= (2π/60) × 0.78 × 3000 × (1/2)

≈ 123 [W]

Average regenerative electric power for 1 cycle of operation

P = (123 × 0.05)/0.5

≈ 12.3 [W]

The RYT201D7 type servo amplifier is not equipped with a built-in braking resistor.

Use the following procedure to determine whether a braking resistor is required.

[1] Obtain the amount of energy (E_G) held by the mechanical system during deceleration.

$$E_G = \frac{1}{2}(J_M + J_L)\cdot(2\pi N/60)^2$$

$$= \frac{1}{2}(0.135\times10^{-4} + 1.1\times10^{-4})\times\left(\frac{2\pi\times3000}{60}\right)^2$$

$$= 6.1\ [J]$$

[2] Calculate the amount of energy (E_L) consumed by the load torque.

$E_L = (2\pi/60) \times T_L \times N \times t_{DC} \times (1/2)$

= (2π/60) × 0.03 × 3000 × 0.05 × (1/2)

= 0.24 [J]

[3] Calculate the amount of energy (E_M) consumed by the servomotor coil.

$E_M = 3 \times (R \times I^2) \times t_{DC}$

$= 3 \times R \times ((T_{DC}/T_R \times I_R)^2) \times t_{DC}$

$= 3 \times 2.3 \times ((0.78/0.637 \times 1.5)^2) \times 0.05$

= 1.2 [J]

GYS201D7-HB2 type phase resistance: 2.3 [Ω]

Calculate the energy (E_S) that can be absorbed by the servo amplifier.

$$E_S = \frac{1}{2} C (V_{DB}^2 - V_{DC}2)$$

$$= \frac{1}{2} (300 \times 10^{-6}) \times (390^2 - (200 \times \sqrt{2})^2)$$

$$= 10.8 \text{ [J]}$$

• DC intermediate capacitor (RYT201): 300 [μF], power supply voltage: 200 [V] (effective value)

• The capacitor for a servo amplifier of 0.2 [kW] or smaller is 300 [μF].

• V_{DB}: DB transistor ON level (390 [V]), V_{DC}: DC intermediate voltage (200 x √2 [V])

The amount of energy that can be processed by the mechanical system, servo amplifier and servomotor is:

$E_L + E_M + E_S = 0.24 + 1.2 + 10.8 \approx 12.2$ [J]

As $E_G = 6.1$ [J], no external braking resistor is required.

■ Constants

■ 200V Series

Series	Capacity [kW]	Rated current [A]	Phase resistance [Ω]	Moment of inertia 10^{-4} [kg/m^2]	Capacitor capacity [μF]
GYS	0.05	0.85	4.7	0.0192	440
	0.1		7.8	0.0371	
	0.2	1.5	2.3	0.135	
	0.4	2.7	1.1	0.246	720
	0.75	4.8	0.36	0.853	940
	1.0	7.1	0.35	1.73	1360
	1.5	9.6	0.25	2.37	
	2.0	12.6	0.19	3.01	2,040
	3.0	18	0.07	8.32	2,400
	4.0	24	0.05	10.8	4,000
	5.0	30	0.05	12.8	4,000

Series	Capacity [kW]	Rated current [A]	Phase resistance [Ω]	Moment of inertia 10^{-4} [kg/m^2]	Capacitor capacity [μF]
GYG 2000 r/min	1.0	4.7	0.54	11.8	1,360
	1.5	7.1	0.25	17.8	2,040
GYG 1500 r/min	0.85	5.4	0.54	11.8	1,360
	1.3	10.1	0.25	17.8	2,040

Series	Capacity [kW]	Rated current [A]	Phase resistance [Ω]	Moment of inertia 10^{-4} [kg/m^2]	Capacitor capacity [μF]
GYB	0.2	1.4	3.5	0.33	440
	0.4	2.7	1.8	0.57	660
	0.75	4.9	0.5	1.53	1,360

15.6 Revision History

Print date	Index	Revision details
December 2018	None	First release
October 2019	a	Capacity increased (up to 5 kW)
August 2020	b	Full-closed function added

15.7 Product Warranty

Please take the following items into consideration when placing your order.

When requesting an estimate and placing your orders for the products included in these materials, please be aware that any items such as specifications which are not specifically mentioned in the contract, catalog, specifications or other materials will be as mentioned below.
In addition, the products included in these materials are limited in the use they are put to and the place where they can be used, etc., and may require periodic inspection. Please confirm these points with your sales representative or directly with this company.
Furthermore, regarding purchased products and delivered products, we request that you take adequate consideration of the necessity of rapid receiving inspections and of product management and maintenance even before receiving your products.

1. Free of Charge Warranty Period and Warranty Range

1-1 Free of charge warranty period

(1) The product warranty period is "1 year from the date of purchase" or 24 months from the manufacturing date imprinted on the name place, whichever date is earlier.
(2) However, in cases where the use environment, conditions of use, use frequency and times used, etc., have an effect on product life, this warranty period may not apply.
(3) Furthermore, the warranty period for parts restored by Fuji Electric's Service Department is "6 months from the date that repairs are completed."

1-2 Warranty range

(1) In the event that breakdown occurs during the product's warranty period which is the responsibility of Fuji Electric, Fuji Electric will replace or repair the part of the product that has broken down free of charge at the place where the product was purchased or where it was delivered. However, if the following cases are applicable, the terms of this warranty may not apply.

1) The breakdown was caused by inappropriate conditions, environment, handling or use methods, etc. which are not specified in the catalog, operation manual, specifications or other relevant documents.
2) The breakdown was caused by the product other than the purchased or delivered Fuji's product.
3) The breakdown was caused by the product other than Fuji's product, such as the customer's equipment or software design, etc.
4) Concerning the Fuji's programmable products, the breakdown was caused by a program other than a program supplied by this company, or the results from using such a program.
5) The breakdown was caused by modifications or repairs affected by a party other than Fuji Electric.
6) The breakdown was caused by improper maintenance or replacement using consumables, etc. specified in the operation manual or catalog, etc.
7) The breakdown was caused by a chemical or technical problem that was not foreseen when making practical application of the product at the time it was purchased or delivered.
8) The product was not used in the manner the product was originally intended to be used.
9) The breakdown was caused by a reason which is not this company's responsibility, such as lightning or other disaster.

(2) Furthermore, the warranty specified herein shall be limited to the purchased or delivered product alone.
(3) The upper limit for the warranty range shall be as specified in item (1) above and any damages (damage to or loss of machinery or equipment, or lost profits from the same, etc.) consequent to or resulting from breakdown of the purchased or delivered product shall be excluded from coverage by this warranty.

1-3 Trouble diagnosis

As a rule, the customer is requested to carry out a preliminary trouble diagnosis. However, at the customer's request, this company or its service network can perform the trouble diagnosis on a chargeable basis. In this case, the customer is asked to assume the burden for charges levied in accordance with this company's fee schedule.

2. Exclusion of Liability for Loss of Opportunity, etc.

Regardless of whether a breakdown occurs during or after the free of charge warranty period, this company shall not be liable for any loss of opportunity, loss of profits, or damages arising from special circumstances, secondary damages, accident compensation to another company, or damages to products other than this company's products, whether foreseen or not by this company, which this company is not be responsible for causing.

3. Repair Period after Production Stop, Spare Parts Supply Period (Holding Period)

Concerning models (products) which have gone out of production, this company will perform repairs for a period of 7 years after production stop, counting from the month and year when the production stop occurs. In addition, we will continue to supply the spare parts required for repairs for a period of 7 years, counting from the month and year when the production stop occurs. However, if it is estimated that the life cycle of certain electronic and other parts is short and it will be difficult to procure or produce those parts, there may be cases where it is difficult to provide repairs or supply spare parts even within this 7-year period. For details, please confirm at our company's business office or our service office.

4. Transfer Rights

In the case of standard products which do not include settings or adjustments in an application program, the products shall be transported to and transferred to the customer and this company shall not be responsible for local adjustments or trial operation.

5. Service Contents

The cost of purchased and delivered products does not include the cost of dispatching engineers or service costs. Depending on the request, these can be discussed separately.

6. Applicable Scope of Service

Please inquiry the supplier or Fuji Electric China for details of above.

⚠ SAFETY PRECAUTIONS

1. This catalog is intended for use in selecting required servo systems. Before actually using these products, carefully read their instruction manuals and understand their correct usage.
2. Products described in this catalog are neither designed nor manufactured for combined use with a system or equipment that will affect human lives.
   If you are considering using these products for special purposes, such as atomic energy control, aerospace, medical application, or traffic control, please consult our sales office.
3. If you use our product with equipment that is expected to cause serious injury or damage to your property in case of failure, be sure to take appropriate safety measures for the equipment.

Fuji Electric Co., Ltd.

Gate City Ohsaki, East Tower, 11-2,
Osaki 1-chome, Shinagawa-ku,
Tokyo 141-0032, Japan
Phone: +81-3-5435-7066 Fax: +81-3-5435-7475
URL: www.fujielectric.com/

Information in this catalog is subject to change without notice. 2020-08 (H20b/A19) CM 00 FOLS