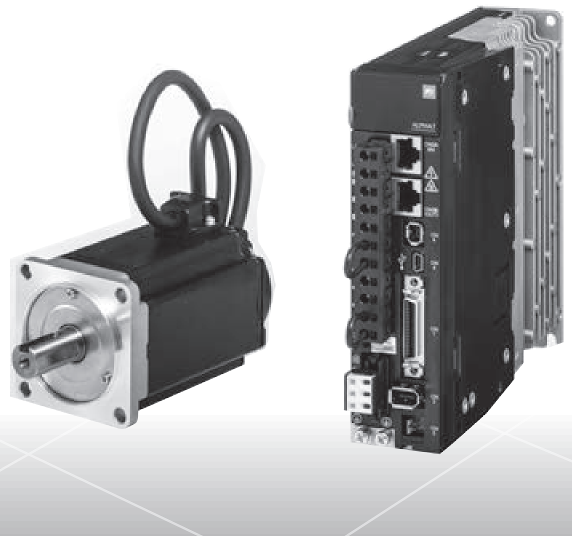
Fuji Electric

Innovating Energy Technology

FUJI SERVO SYSTEM
ALPHA7 VV type
USER'S MANUAL

ALPHA7



24C7-E-0146

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-**□)	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-*S□

* "□" 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 8 SPECIFICATIONS 8-1

CHAPTER 9 CHARACTERISTICS 9-1

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, regenerative 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 regenerative resistor is used, take measures to turn the power off upon a fault signal output from the servo amplifier.
  Otherwise the regenerative 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 11　11.1.2."
- 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 on a board or unit, pack them using wooden materials which have been fumigated.

0

■ Precautions on installation

⚠ CAUTION

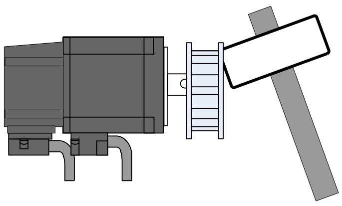
- Do not ride on the servomotor or place a heavy matter on it.
  It might cause failure, breakage, electric shock and injuries.
- Do not block the exhaust port or do not allow foreign substance to enter.
  It might cause fire and electric shock.
- Observe the installation orientation of the servo amplifier.
  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.
- Always ensure that motor power cables are not connected incorrectly. If there is a motor power cable wiring (U, V, W) phase interruption, the motor may not rotate, and an alarm (OL, OS, etc.) may be detected even if a command is input.
- 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."

0

■ 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.

0.2 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	3000r/min (0.75 kW or lower: 6000r/min 1.0kW or higher: 5000r/min)	200V series	7 types 0.05 to 1.5kW	●	●	IP67*1	24-bit ABS	GYS***D7-E□2 (-B)
							24-bit INC	GYS***D7-N□2 (-B)
 GYB motor Medium Inertia	3000r/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	2000r/min (3000r/min)		1 type 1.0kW	●	●	IP67*1	24-bit ABS	GYG***C7-E□2- (-B)
							24-bit INC	GYG***C7-N□2- (-B)
	1500r/min (3000r/min)		1 type 0.85kW	●	●	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) and high-speed serial bus type (VS, LS) servo amplifiers are available (high-speed serial bus type servo amplifiers are Fuji's SX-bus compatible products).

Model		Command interface	Control mode				Power supply	Capacity	Type	Applicable motor series
			Positioning function	Position	Speed	Torque				
 High-speed serial bus	VS type	SX bus		●	●	●	Single-phase or 3-phase 200 to 240VAC	0.05 to 0.75kW	RYT***F7-VS2	GYS GYB GYG
							3-phase 200 to 240VAC	1.0 to 1.5kW		
	LS type		●	●			Single-phase or 3-phase 200 to 240VAC	0.05 to 0.75kW	RYT***F7-LS2	
							3-phase 200 to 240VAC	1.0 to 1.5kW		
 General-purpose interface	VV type	General-purpose (pulse, analog, positioning, Modbus)	●	●	●	●	Single-phase or 3-phase 200 to 240VAC	0.05 to 0.75kW	RYT***F7-VV2	GYS GYB GYG
							3-phase 200 to 240VAC	1.0 to 1.5kW		

* Products with support for Open Network EtherCAT and general-purpose interface will be available soon.

0

0.3 Model Nomenclature

■ When unpacking

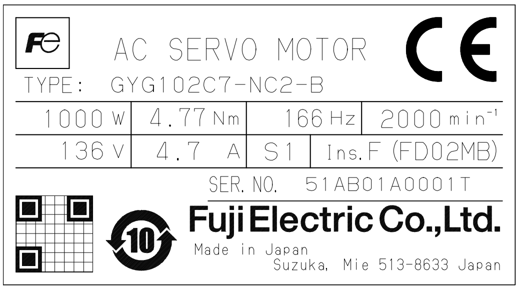
Check the following items.

- 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=50W	500
	10×10^1=100W	101
	20×10^1=200W	201
	40×10^1=400W	401
	75×10^1=750W	751
	85×10^1=850W	851
	10×10^2=1.0kW	102
	15×10^2=1.5kW	152
3	Series	
	3000r/min series	D
	2000r/min series	C
	1500r/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	Brake/wire connection	
	Without brake (lead wire type)	No marking
	With brake (lead wire type)	B
	Without brake (connector type)	C
	With brake (connector type)	D

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.

TYPE	RYT751F7-VV2
SOURCE	1PH/3PH 200-240V 50or60Hz 7.9A/4.5A
OUTPUT	3PH 750W 100V 0-400Hz 4.8A
IP Code	IP20
SER. No.	72DX61A0001AA
	707

Fuji Electric Suzuka, Mie 513 8633 Japan

Made in Japan **Fuji Electric Co., Ltd.**

■ Model nomenclature (servo amplifier)

	2	2	2	3	4		5	5	6
RYT	2	0	1	F	7	-	V	V	2

Digit	Specification	Code
1	Basic type	
	ALPHA series	RYT
2	Applicable motor output	
	50×10^0=50W	500
	10×10^1=100W	101
	20×10^1=200W	201
	40×10^1=400W	401
	75×10^1=750W	751
	10×10^2=1.0kW	102
	15×10^2=1.5kW	152
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

* To be available soon

0

0.4 Combination between Servomotor and Servo Amplifier

0.4.1 VV 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 capacity	 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-VV2	0.05W	GYS500D7-□□2(-B)	—	—	—
RYT101F7-VV2	0.1kW	GYS101D7-□□2(-B)	—	—	—
RYT201F7-VV2	0.2kW	GYS201D7-□□2(-B)	GYB201D7-□□2/-C(-B/-D)	—	—
RYT401F7-VV2	0.4kW	GYS401D7-□□2(-B)	GYB401D7-□□2/-C(-B/-D)	—	—
RYT751F7-VV2	0.75kW	GYS751D7-□□2(-B)	GYB751D7-□□2/-C(-B/-D)	—	—
RYT102F7-VV2	0.85kW	—	—	—	GYG851B7-□□2(-B)
	1.0kW	GYS102D7-□□2(-B)	—	GYG102C7-□□2(-B)	—
RYT152F7-VV2	1.5kW	GYS152D7-□□2(-B)	—	—	—

CHAPTER 1 INSTALLATION

1

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.

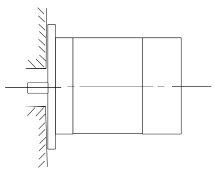
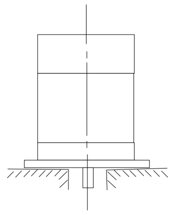
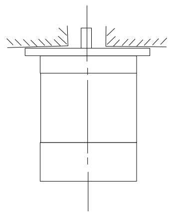
- Install indoors at a place free from rainwater and direct sunshine.
- Do not operate in corrosive atmosphere including hydrogen sulfides, sulfurous acid, chlorine, ammonia, sulfur, chlorine-based gases, acids, alkalis or salts or near flammable gases or matters.
- Install at a place free from splashes 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

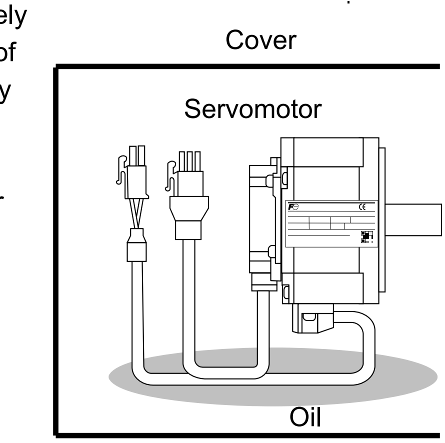
1.1.3 Installing the Servomotor

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.

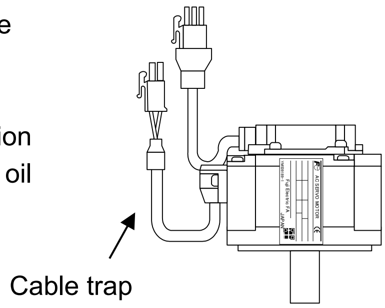
Flange type

IM B5 (L51)	IM V1 (L52)	IM V3 (L53)
		

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.

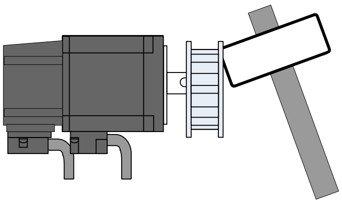


* The protection level is the initial property.

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

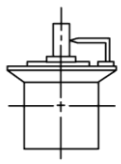
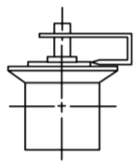
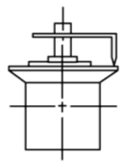
- In applications where the servomotor and machine movable part move, take measures to avoid stress given on the cable.
- Route the encoder cable and motor power cable in CABLEVEYOR.
- Fix the encoder cable and motor power cable attached to the servomotor (routed from the motor) with cable clamps or 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]

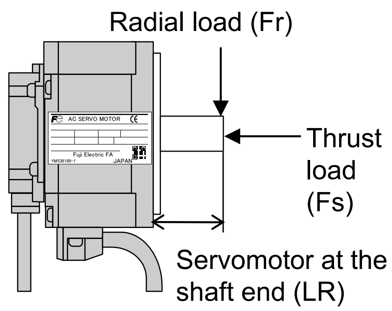
Servomotor model	Runout at shaft end	Misalignment (flange)	Perpendicularity of flange face
GYS□□□D7	Within 0.02	Within 0.06	Within 0.08
GYG□□□□7			
GYB□□□D7			

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

1.1.8 Allowable Load

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
GYG102C7-□□2	510	253	55
GYG851B7-□□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

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

Item	Environmental condition
Ambient temperature	-20 [°C] to +80 [°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(Max. amplitude): 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

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(Max. amplitude): 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

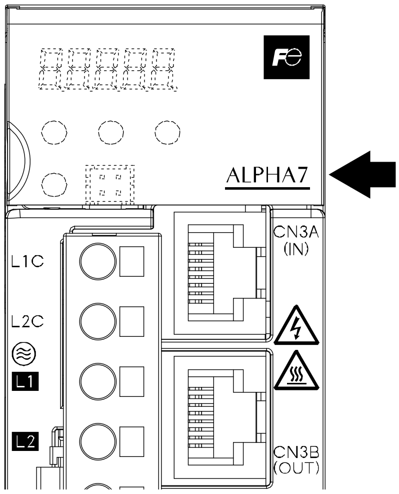
1

1.2.3 Installing the Servo Amplifier

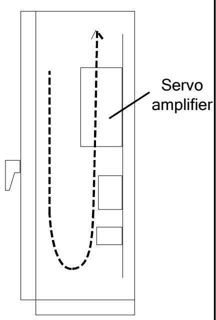
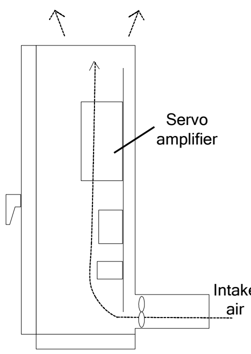
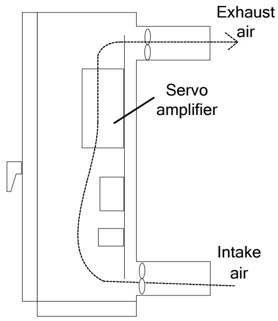
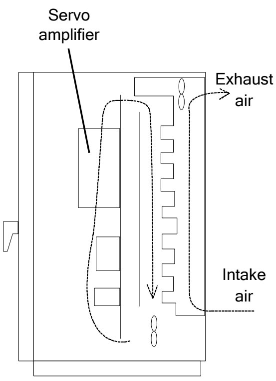
(1) Install the servo amplifier vertically to the ground so that the "ALPHA7"

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 plain washers or spring lock washers or use 3-piece sems screw to avoid looseness. When using plain washers, select the Normal series Product grade A (washer diameter is ϕ 9 mm).

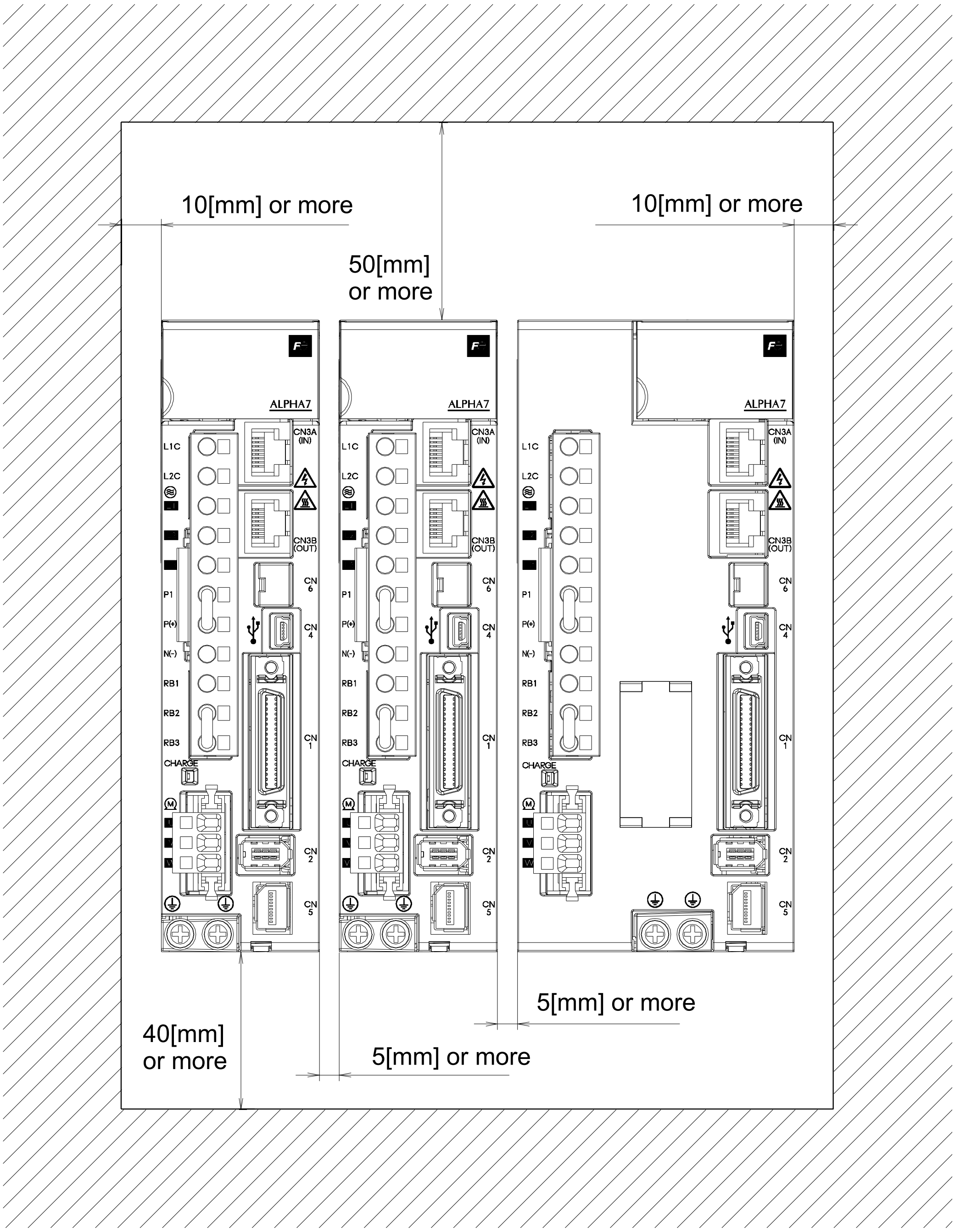


(2) Some parts of the servo amplifier generate heat during operation.
Cool the surroundings if the servo amplifier is installed inside the control panel.

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.

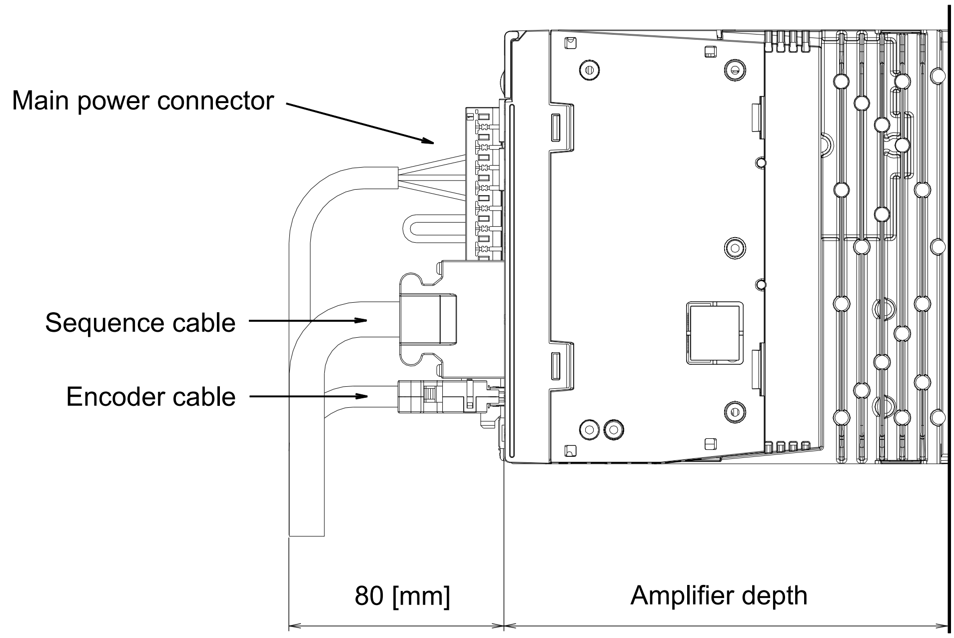
(4) To suppress rises in servo amplifier temperature, secure the interval shown in the following diagram between servo amplifiers and from peripheral equipment.



1

1.2.4 Depth of Control Panel

Reserve 80 [mm] or a wider space in front of the servo amplifier which is connected with sequence I/O cables and encoder cable.



CHAPTER 2 WIRING

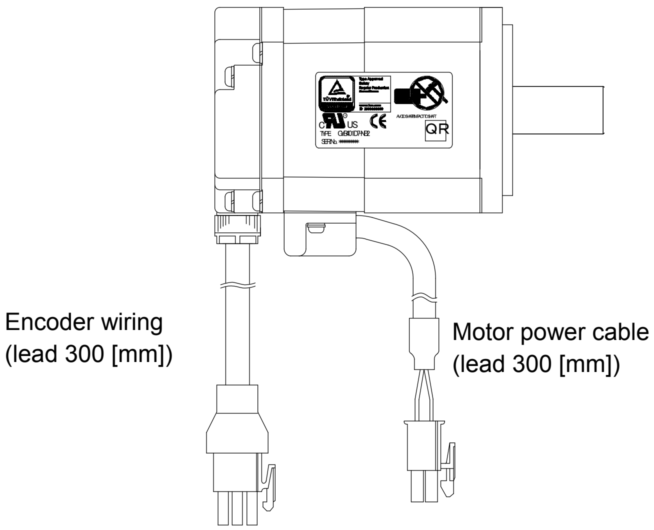
2

2.1 Configuration

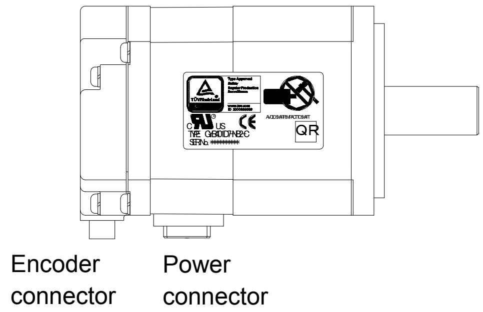
2.1.1 Part Name

■ Servomotors

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

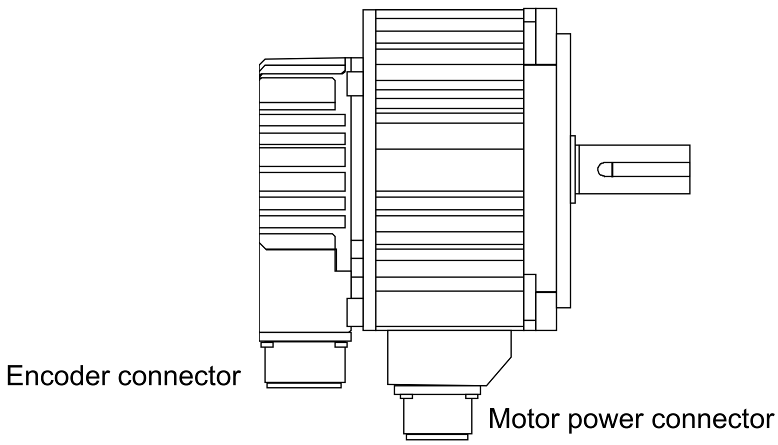


GYB (connector connection specification): 0.75kW or less



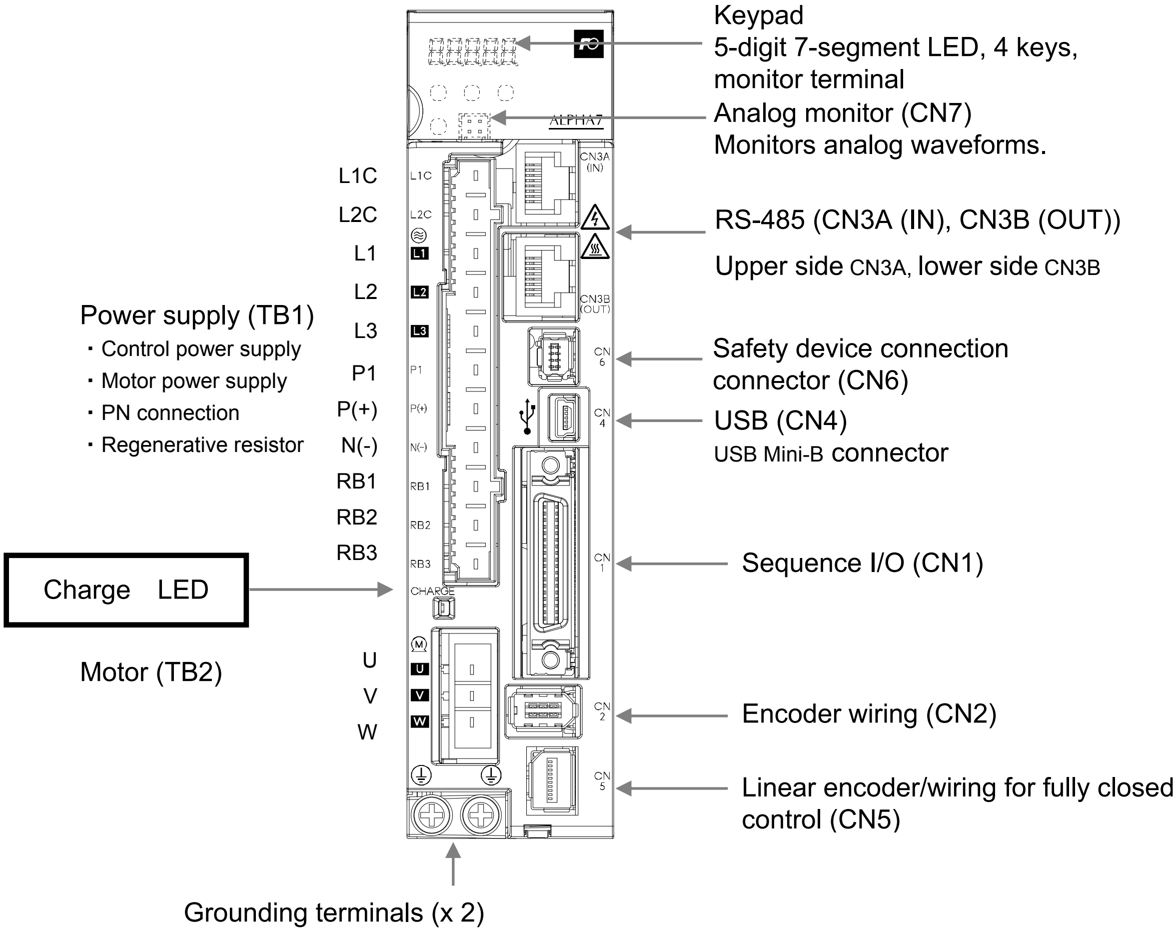
■ Servomotor

GYS model: 1kW or higher/GYG model

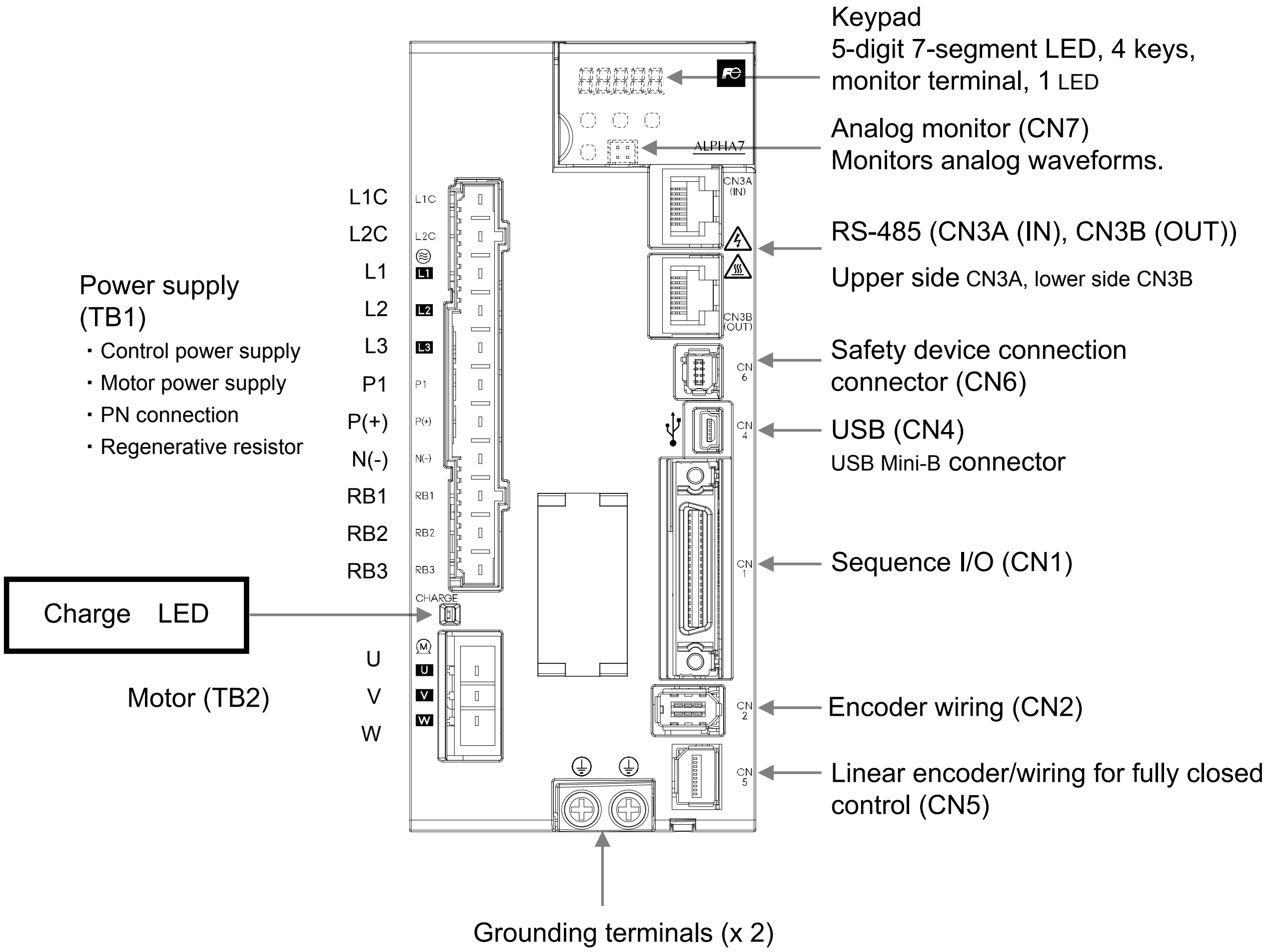


■ Servo amplifier (frame 1)

0.4kW or less



■ Servo amplifier (frame 2)



2.1.2 Configuration

The figure on page 2-6 shows the general configuration of devices. There is no need to connect all devices.

- 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.
- Wiring connectors TB1 and TB2 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 regenerative resistor, such as regenerative 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.
- Do not connect any of the following devices to the power wiring of the servo amplifier or 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.

■ Use the accessory tool in the following procedure to connect the terminal to TB1 and TB2.

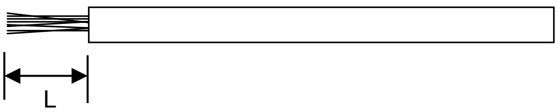
- Wiring method

Note	Connect wiring with connectors disconnected from the servo amplifier.

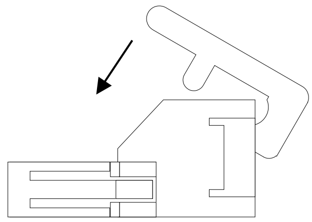
Peel off the wiring sheath to ensure the following dimensions.

TB1: L = 8 to 9 mm

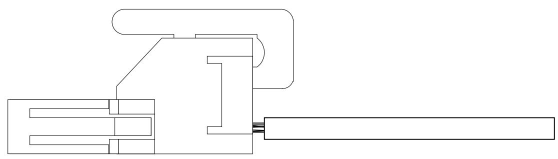
TB2: L = 9 to 10 mm



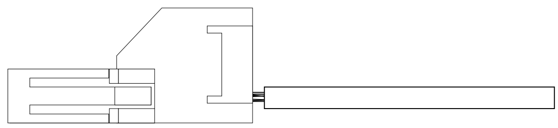
Insert the tip of the accessory tool into the top of the connector.



Push the tool toward the connector to insert the cable.



Release the tool. The cable is fixed.

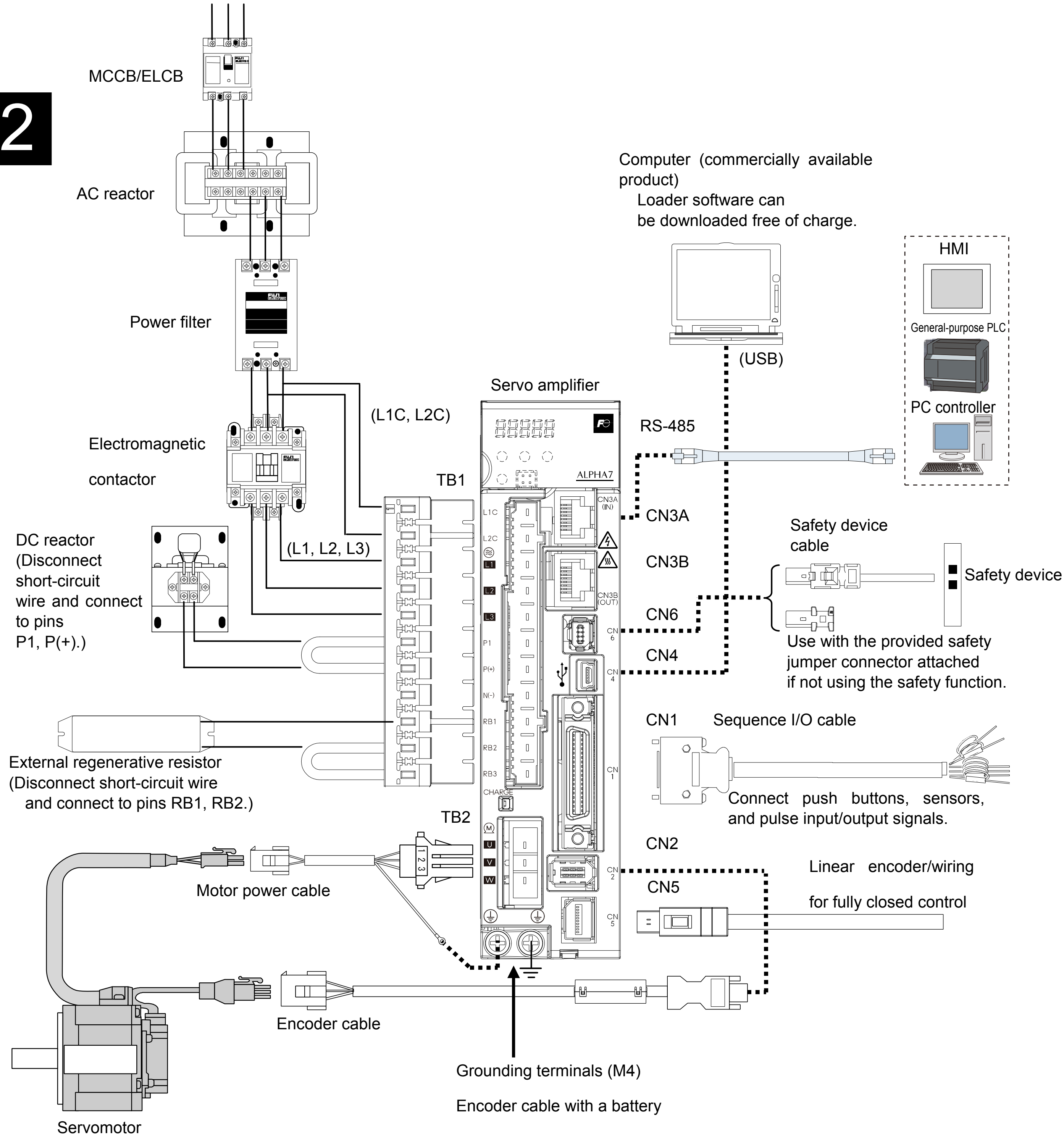


Note	Do not solder the cable. In case of the strand wire, do not twist cable forcibly.

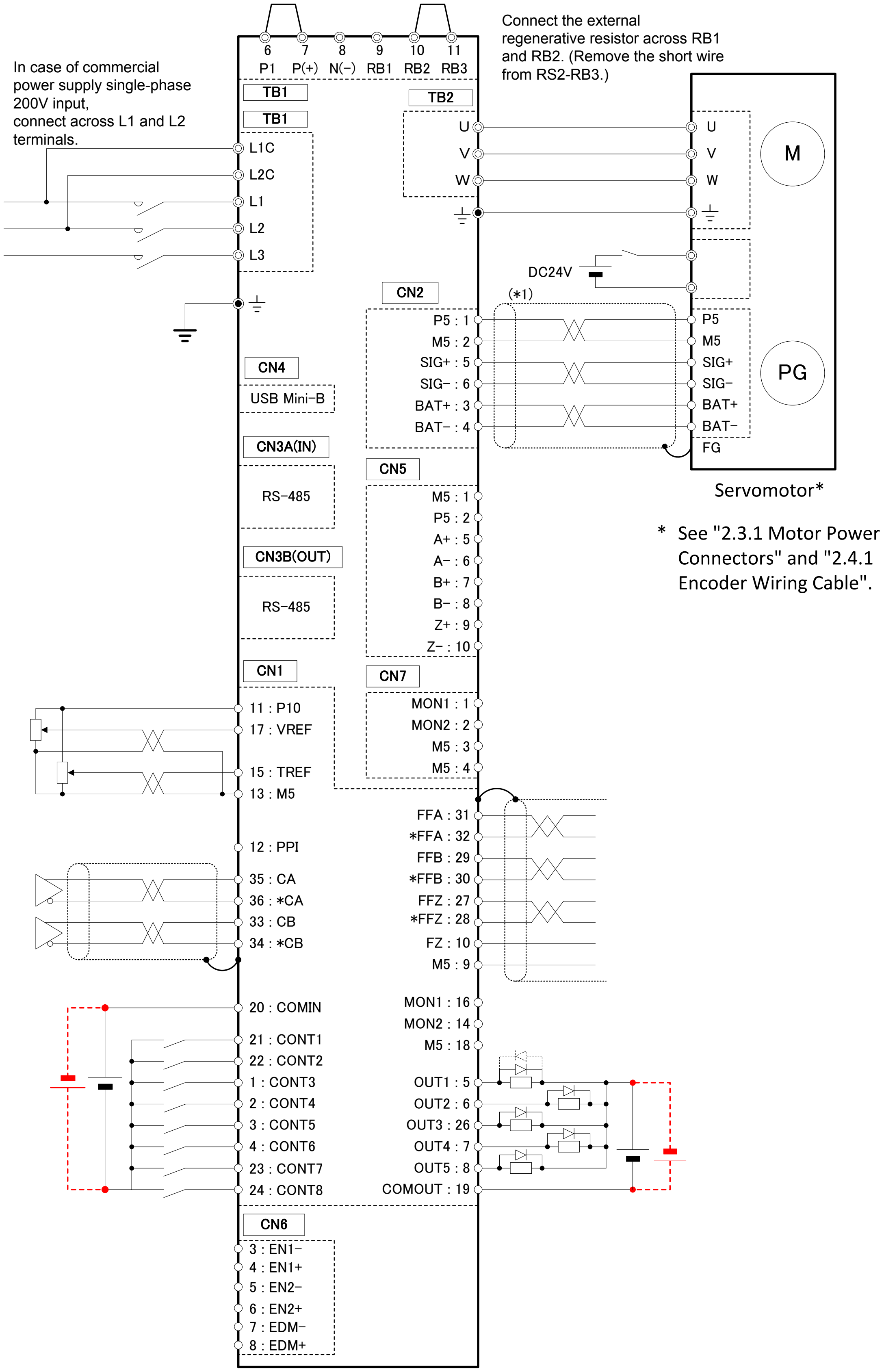
2

1) For servo amplifier frames 1

For lead wire type motors, connect cables as shown below.



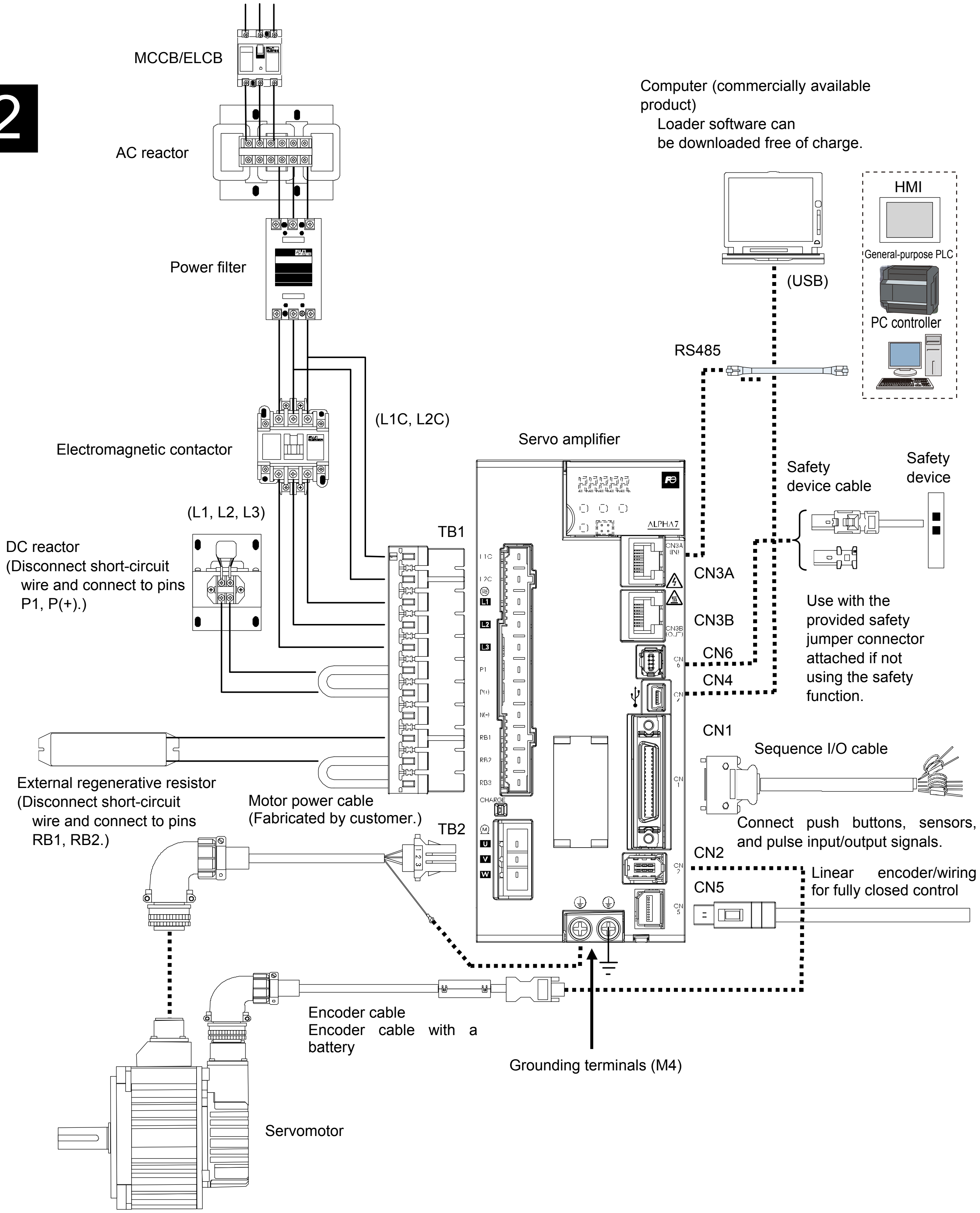
Connection Diagram (Servo amplifier frame 1)



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

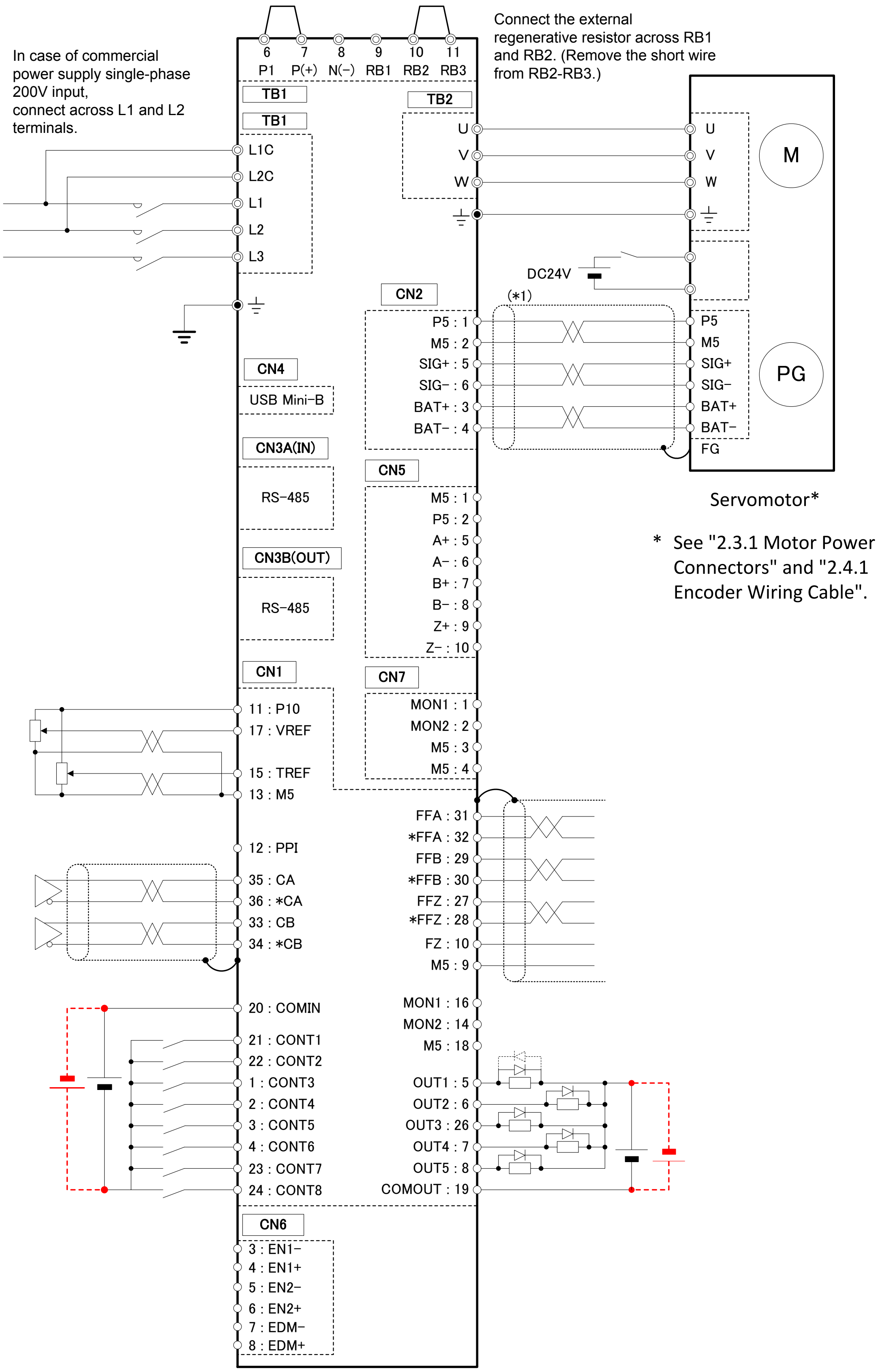
2) For servo amplifier frames 2 (except for 751D7 in frame 2)

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



2

Connection Diagram (Servo amplifier frame 2)



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

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

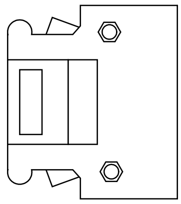
2.1.3 Sequence I/O

The wiring connector is not included in the servo amplifier.

Connector kit type: WSK-D36P

2

35	CA	36	*CA	17	VREF	18	M5
33	CB	34	*CB	15	TREF	16	MON1
31	FFA	32	*FFA	13	M5	14	MON2
29	FFB	30	*FFB	11	P10	12	PPI
27	FFZ	28	*FFZ	9	M5	10	FZ
25	M5	26	OUT3	7	OUT4	8	OUT5
23	CONT7	24	CONT8	5	OUT1	6	OUT2
21	CONT1	22	CONT2	3	CONT5	4	CONT6
19	COMOUT	20	COMIN	1	CONT3	2	CONT4

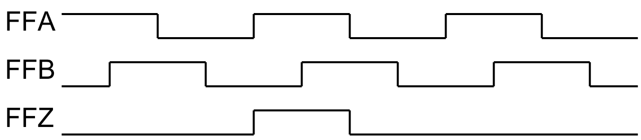


No	Terminal symbol	Function
12	PPI	Pull-up power input for pulse input 12 to 24 [V] DC
35	CA	Pulse input Max. input frequency 4 [MHz] (differential) or 200 [kHz] (open collector) Command pulse/direction, forward/reverse pulse, A/B phase pulse (A/B phase pulse are the frequency after multiplication by four.)
36	*CA	
33	CB	
34	*CB	
31	FFA	Pulse output (Differential output) The number of output pulses per motor revolution (16 to 4194304) can be designated. Or the output pulse division ratio can be designated. The output is issued in A/B phase pulse. The FFZ and *FFZ terminals are for single revolution single pulse signal.
32	*FFA	
29	FFB	
30	*FFB	
27	FFZ	
28	*FFZ	
10	FZ	Z-phase output (Open collector) The FZ terminal is for single revolution single pulse signal. The M5 terminal serves as a reference potential.
9	M5	
16	MON1	Analog monitor voltage output (±10 [V]/0.5 [mA] max.) Analog voltage output terminal for meters. Two outputs are provided. The M5 terminal serves as a reference potential. Resolution: 14 bits
14	MON2	
13	M5	
25	M5	

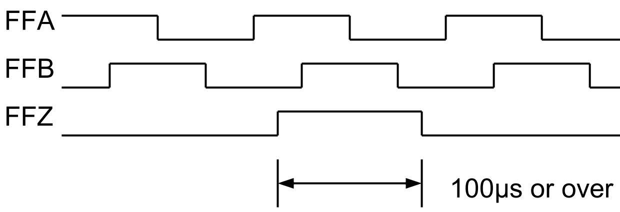
<table>
<tr><th>No.</th><th>Terminal symbol</th><th>Function</th></tr>
<tr><td>21</td><td>CONT1</td><td rowspan="9">Sequence input (For sink/source)
Supply command signals to the servo amplifier through these terminals.
12 to 24 [V] DC/approx. 8[mA] (per point).
Photo coupler isolated. The reference potential is the COMIN terminal.
(Soft filter 0.5 [ms], agreement of two scans, except for interrupt input)
(With interrupt input, the hardware filter detection delay is 0.1 [ms].)</td></tr>
<tr><td>22</td><td>CONT2</td></tr>
<tr><td>1</td><td>CONT3</td></tr>
<tr><td>2</td><td>CONT4</td></tr>
<tr><td>3</td><td>CONT5</td></tr>
<tr><td>4</td><td>CONT6</td></tr>
<tr><td>23</td><td>CONT7</td></tr>
<tr><td>24</td><td>CONT8</td></tr>
<tr><td>20</td><td>COMIN</td></tr>
<tr><td>5</td><td>OUT1</td><td rowspan="6">Sequence output (For sink/source)
Signal output terminals of servo amplifier. Max. 30 [V] DC/50 [mA].
Photo coupler isolated. The reference potential is the COMOUT terminal.</td></tr>
<tr><td>6</td><td>OUT2</td></tr>
<tr><td>26</td><td>OUT3</td></tr>
<tr><td>7</td><td>OUT4</td></tr>
<tr><td>8</td><td>OUT5</td></tr>
<tr><td>19</td><td>COMOUT</td></tr>
<tr><td>11</td><td>P10</td><td>Power supply for speed/torque command voltage +10 [V] / 30 [mA] (Max.)</td></tr>
<tr><td>17</td><td>VREF</td><td rowspan="3">Speed command voltage input ±10 [V] Resolution: 16bits/± full scale
Torque command voltage ±10 [V] Resolution: 16bits/± full scale
M5 is the reference potential terminal.</td></tr>
<tr><td>15</td><td>TREF</td></tr>
<tr><td>18</td><td>M5</td></tr>
</table>

The output format of the FFZ, *FFZ and FZ outputs varies according to the pulse output setting.

- If the number of pulses per revolution is designated (PA1_08: 16 to 4194304), synchronization is kept with the FFA and *FFA signals. Single pulse of FFA or *FFA is applicable.



- The output pulse division ratio designated with PA1_08 ("0"), PA1_09 and PA1_10 is asymmetrical to the FFA and *FFA signals. The pulse width is always 100µs or over.



2.1.3.1　Pulse Input (PPI, CA, *CA, CB, *CA)

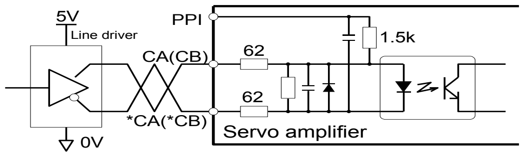
Pulse input terminal

- Format: Command pulse/direction, forward/reverse pulse, A/B phase pulse (parameter switch)
- Max. input frequency: 4[MHz] (differential input), 200[kHz] (open collector input)
  The 90° phase difference 2 signal is the frequency after multiplying by four. It is normally a multiple of four.

2

(1) Differential input

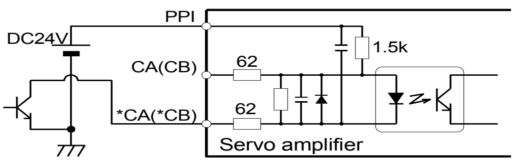
Do not use the PPI terminal.



(2) Open collector (24 [V] DC)

Use the PPI terminal.

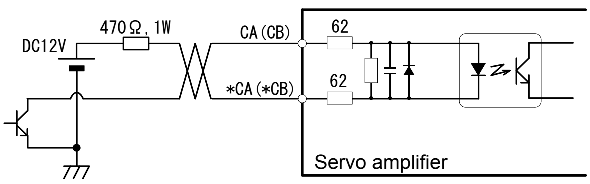
* The wiring with the host should be 3 m or less.



(3) Open collector output (12 [V] DC)

Use a resistor (470Ω, 1W), without a PPI terminal, and wire as follows.

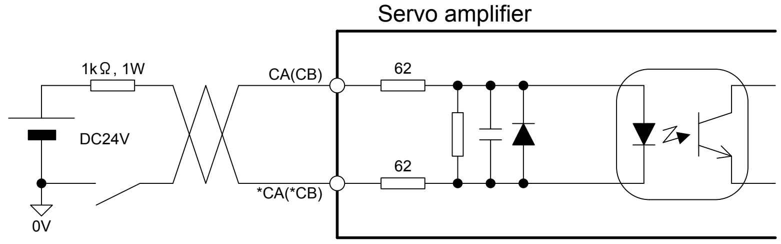
* The wiring with the host should be 3 m or less.



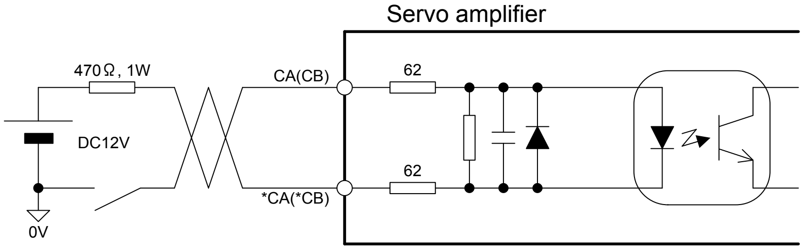
Note	Resistors (470Ω) may generate heat.

- The pulse input terminals can be used as a CONT input by changing the parameter (PA3_48, PA3_49).

<24 [V] DC input>



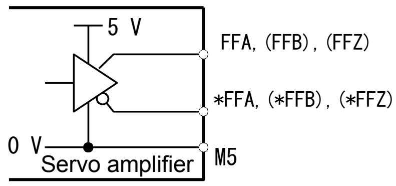
<12 [V] DC input>



2.1.3.2 Pulse Output (FFA, *FFA, FFB, *FFB, FFZ, *FFZ)

The pulses proportional to the motor revolutions are output as A/B phase pulse.

- The number of output pulses per motor revolution can be specified in the parameter (PA1_08).
- The output pulse frequency is proportionate to axis revolution speed.
- Max. output frequency: 1 [MHz]
- The output pulse phase (A or B phase advance) to the motor revolution direction can be specified in the parameter (PA1_11).
- The FFZ and *FFZ signals output one pulse per motor revolution. The output position can be adjusted in the parameter (PA1_12).

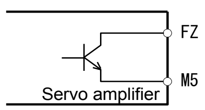


2.1.3.3 Z-Phase Output (FZ, M5)

The Z-phase output is an open collector output of the FFZ or *FFZ signal.

The current can flow up to 30 [V] DC/50 [mA].

The Z-phase output can be used as an OUT signal open collector output by changing the parameter (PA3_98).

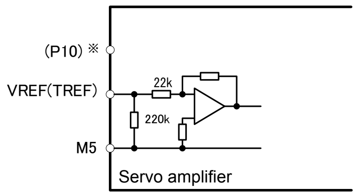


2

2.1.3.4　Analog Input (VREF [TREF], [P10] M5)

The analog input is the terminal used for speed/torque control by the analog command.

- Input voltage: 0 to ±10 [V] DC
- Variable resistor: 1 to 5 kΩ (1/2 W)
- Input impedance: 20 kΩ



* P10 is the service power supply.

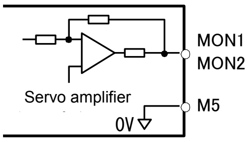
2.1.3.5　Analog Monitor Output (MON1, MON2, M5)

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.

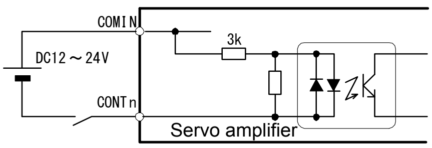
- Max. ±10 [V]/0.5 [mA]
- Resolution: 14-bit/± full scale



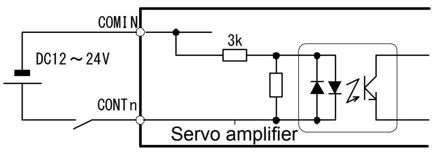
2.1.3.6　Sequence Input (CONT1, CONT2, CONT3, ... COMIN)

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 “2.5.3　Signal Descriptions” onward for details on assignable signals.



(Sink input)

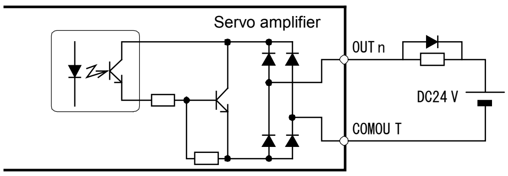


(Source input)

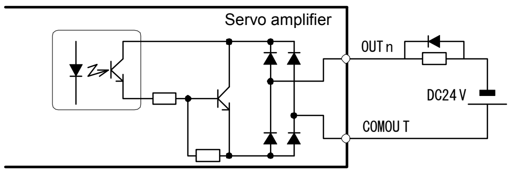
2.1.3.7 Sequence Output (OUT1, OUT2, ... COMOUT)

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 "2.5.3 Signal 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 RS-485 Communications (CN3)

Use the RS-485 communications by connecting other servo amplifiers, host controller or PC.

Use a marketed straight cable (RJ45) with all wires connected.

There is no need to connect the terminator.

Max. 31 servo amplifiers can be connected.

RS-485 communications can be applied in two communications: Modbus-RTU protocol communications and PC Loader protocol communications.

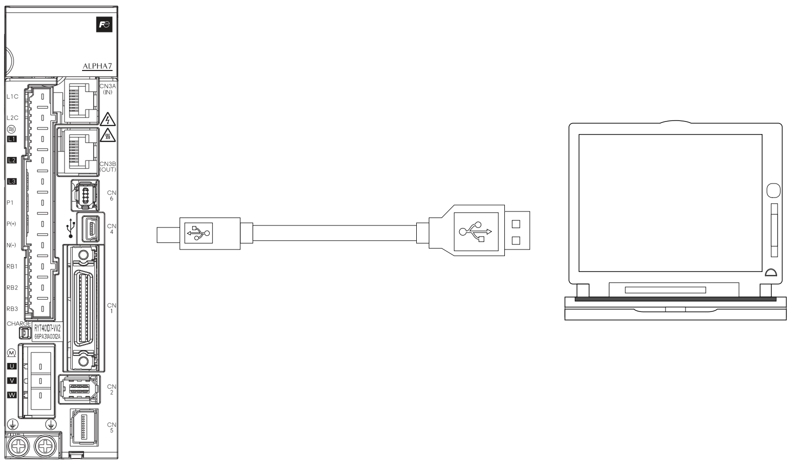
Use PA2_97 (communication protocol selection) to select the protocol.

However, select the Modbus-RTU protocol to perform immediate value operation.

For details, refer to "CHAPTER 13 MODBUS RTU COMMUNICATION"

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 EN60204-1 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.

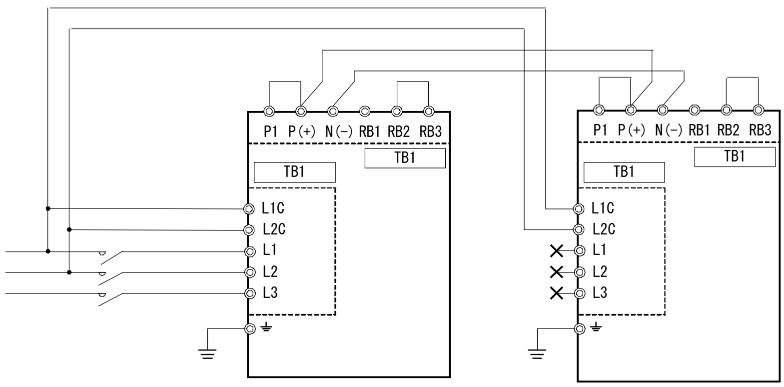
2

2.2 P-N Junction

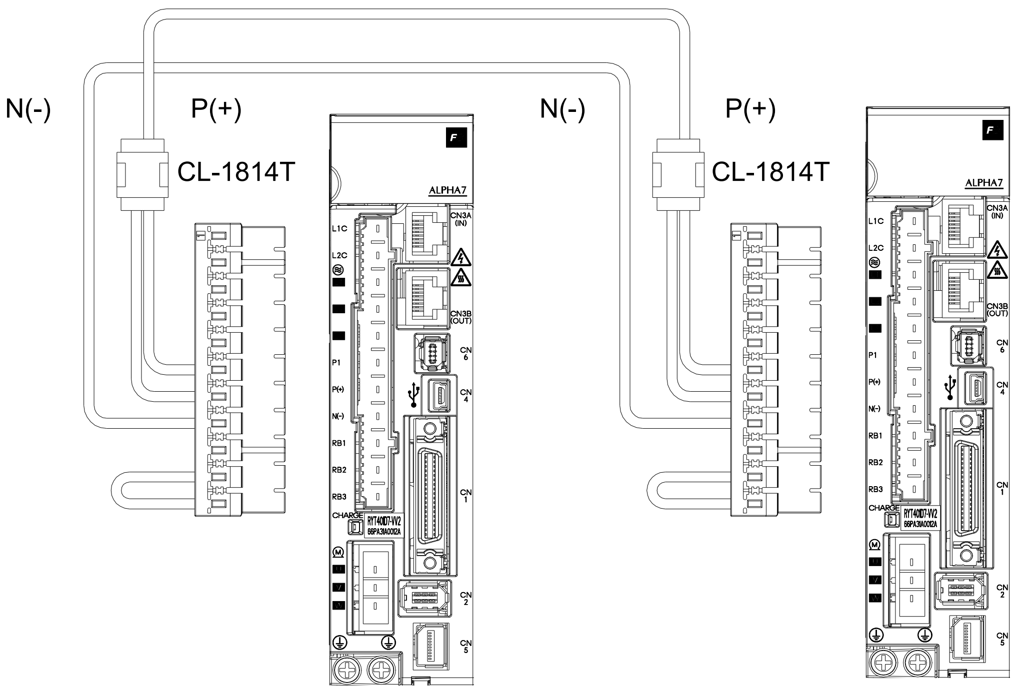
Connect the DC intermediate voltages of two servo amplifiers directly to facilitate power transfer.
By doing so, power can be supplied by the regenerative side (brake side) servo amplifier to the powering side (drive side) servo amplifier, allowing overall power consumption to be reduced.
Application 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 junction as shown in the diagram, it is not possible to connect two wires to the connector (TB1) on servo amplifiers of frame size 2 or less, and therefore it is recommended that a separate commercially available connector (CL-1814T (JST)) be used.



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

<table>
<tr><td rowspan="2">Application range</td><td colspan="4">GYS</td><td colspan="4">GYB</td><td colspan="2" rowspan="2">GYG</td></tr>
<tr><td colspan="2">0.75kW or less</td><td colspan="2">1.0kW or more</td><td colspan="4">0.75kW or less</td></tr>
<tr><td rowspan="2">Connection specification</td><td colspan="2">Lead wire specification</td><td colspan="2">Connector connection specification</td><td colspan="2">Lead wire specification</td><td colspan="2">Connector connection specification</td><td colspan="2">Connector connection specification</td></tr>
<tr><td>Without brake</td><td>With brake</td><td>Without brake</td><td>With brake</td><td>Without brake</td><td>With brake</td><td>Without brake</td><td>With brake</td><td>Without brake</td><td>With brake</td></tr>
<tr><td>U phase</td><td colspan="2">1</td><td colspan="2">A</td><td colspan="2">1</td><td colspan="2">4</td><td>A</td><td>B</td></tr>
<tr><td>V phase</td><td colspan="2">2</td><td colspan="2">B</td><td colspan="2">2</td><td colspan="2">3</td><td>B</td><td>I</td></tr>
<tr><td>W phase</td><td colspan="2">3</td><td colspan="2">C</td><td colspan="2">3</td><td colspan="2">2</td><td>C</td><td>F</td></tr>
<tr><td>E (ground)</td><td colspan="2">4</td><td colspan="2">D</td><td colspan="2">4</td><td colspan="2">1</td><td>D</td><td>D</td></tr>
</table>

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

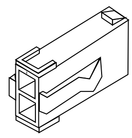
2.3.2 Brake Connector

Connector kit type:

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

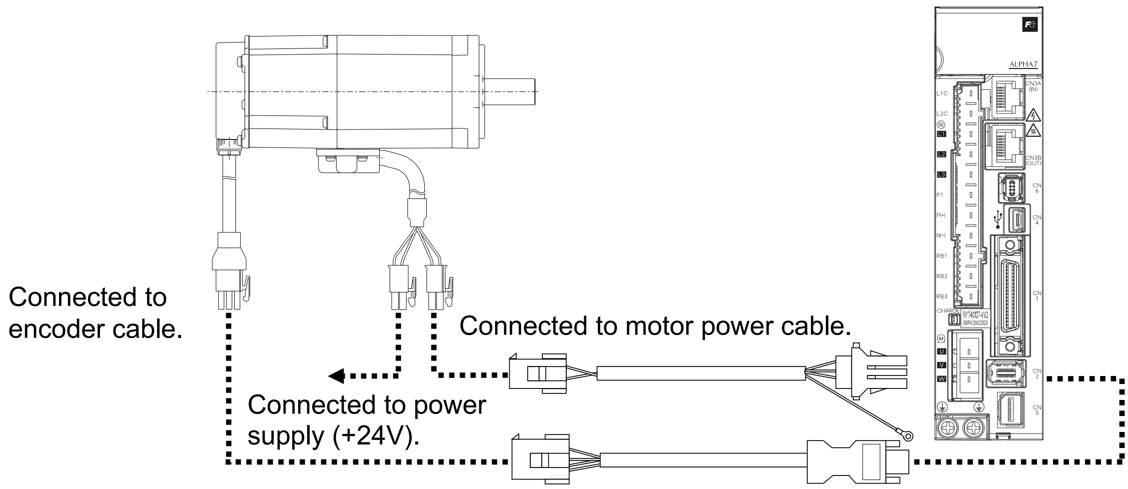
Connector terminal symbol

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).

■ 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.

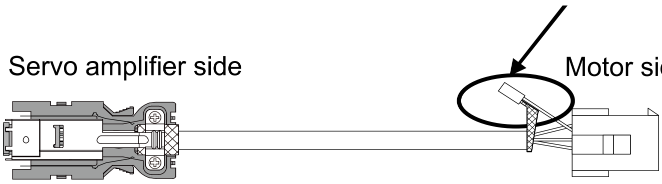
Perform shield treatment at the encoder according to the procedure specified below.
Despite motor capacity, wiring treatment at the servo amplifier is the same.

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.

Servo amplifier side　　Motor side

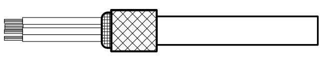


GYB model connector connection specification

Servo amplifier side　　Motor side

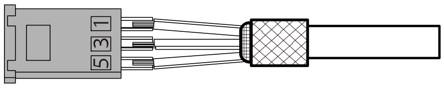
There is no need to connect the shielded end of the connector at the motor side.

[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.

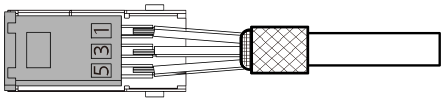


2

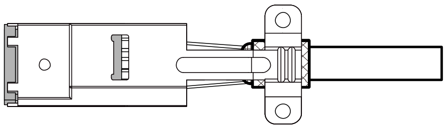
[2] Solder the wiring to the connector.
Fitting a shrinkable tube to each wire ensures safety.



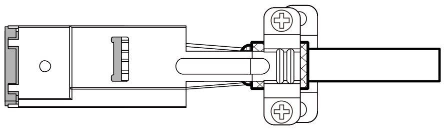
[3] Fit the shell body to the connector.



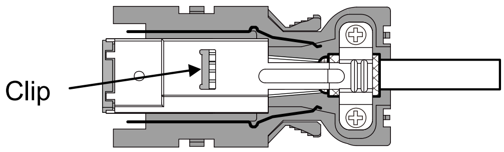
[4] Align the shell cover with the clips on both sides of the shell body and attach.



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

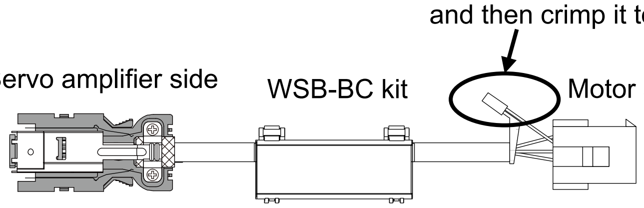


[6] Secure by aligning the clip with the mold cover.

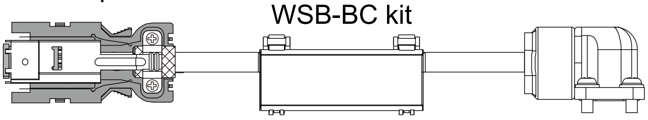


2.4.2.2 Encoder Cable With Battery Fabrication Method

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

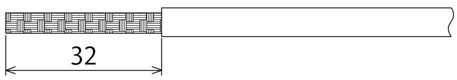


GYB model connector connection specification

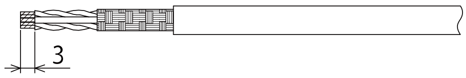


There is no need to connect the shielded end of the motor side connector.

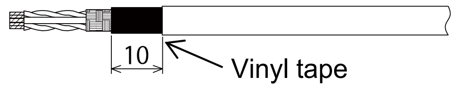
[1] Peel off approximately 32 mm from the end of the shielded wire.



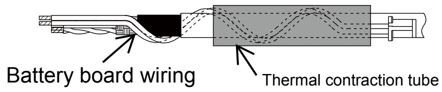
[2] Peel off approximately 3 mm from the end of the core wire.
Cut the braided wire approximately in half.



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

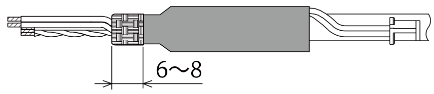


[4] Wrap the battery board wiring 2 to 3 times around the shield wire, and pass through the thermal contraction tube.

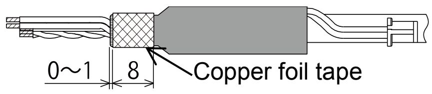


[5] Leave approximately 7 mm of the braided wire, and contract the thermal contraction tube.

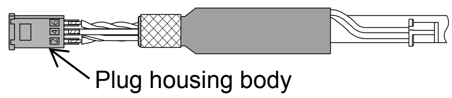
[6] Fold back 6 to 8 mm of the braided wire.



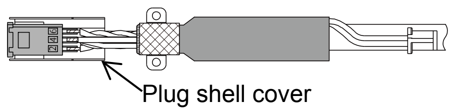
[7] Wrap copper foil tape 2 to 3 times around the braided wire.



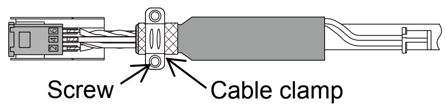
[8] Solder the encoder cable core wire and battery board wiring to the plug housing body.
Fitting a tube to each soldered part ensures safety.



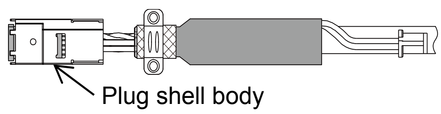
[9] Secure the plug housing body to the plug shell cover.



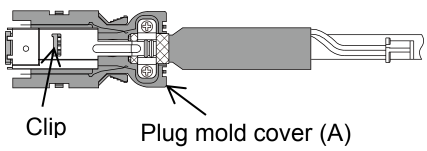
[10] Secure the cable clamp from the rear with screws.



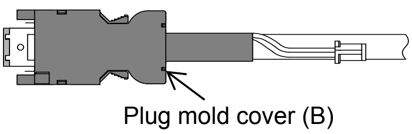
[11] Fit the plug shell body while aligning the clips on both sides.



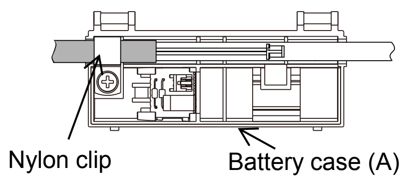
[12] Turn over the connector, and secure by aligning the clip position with plug mold cover (A).



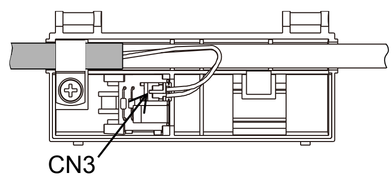
[13] Secure plug mold cover (B) by aligning the clips at 4 locations. When doing so, take care not to trap the wires.



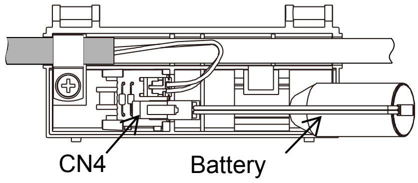
[14] Use the nylon clip to hold down the encoder cable, and secure to battery case (A) with a screw from the top, and a nut from the rear.



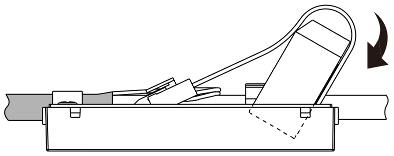
[15] Connect the battery board wiring to CN3.



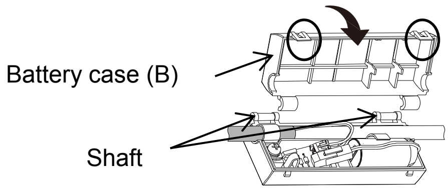
[16] Connect the battery to CN4.

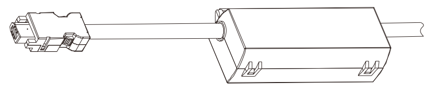


[17] Store the battery in battery case (A).



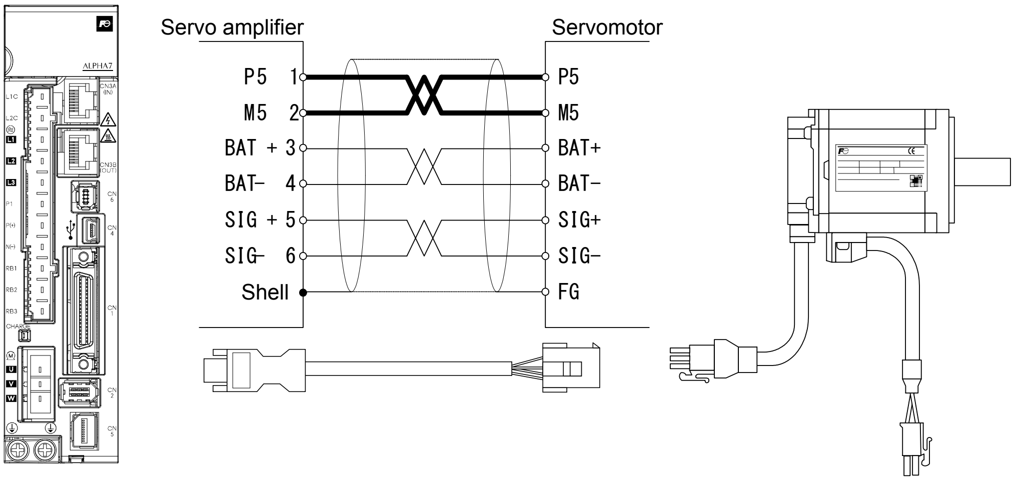
[18] Hook battery case (B) onto the shaft, and secure by aligning the clips at 2 locations.





[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 “2.4.1 Encoder 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	1 to 78	1	Power
PA03_02	CONT2 signal assignment		11	
PA03_03	CONT3 signal assignment		50	
PA03_04	CONT4 signal assignment		0	
PA03_05	CONT5 signal assignment		0	
PA03_06	CONT6 signal assignment		0	
PA03_07	CONT7 signal assignment		0	
PA03_08	CONT8 signal assignment		0	
PA03_48	CONT CA signal assignment		0	
PA03_49	CONT CB signal assignment		0	

PA03_48 (CONT CA signal assignment) and PA03_49 (CONT CB signal assignment) should be specified when using the pulse input terminal (CA, CB) as CONT signal function.

Sequence input signal

No.	Function	No.	Function	No.	Function
1	Servo-on [S-ON]	26	Command pulse inhibit	51	Multi-step speed selection 1 [X1]
2	Forward command [FWD]	27	Command pulse ratio 1	52	Multi-step speed selection 2 [X2]
3	Reverse command [REV]	28	Command pulse ratio 2	53	Multi-step speed selection 3 [X3]
4	Start positioning [START]	29	Proportional control	54	Free-run
5	Homing [ORG]	31	Pause	55	Edit permission
6	Home position LS [LS]	32	Positioning cancel	57	Anti resonance frequency selection 0
7	+OT	34	External regenerative resistor overheat	58	Anti resonance frequency selection 1
8	-OT	35	Teaching	60	AD0
10	Forced stop [EMG]	36	Control mode selection	61	AD1
11	Alarm reset [RST]	37	Position control	62	AD2
14	ACC0	38	Torque control	63	AD3

16	Position preset	43	Override enable	64	AD4
17	Gain switch	44	Override 1	77	Positioning data selection
19	Torque limit 0	45	Override 2	78	Broadcast cancel
20	Torque limit 1	46	Override 4		
22	Immediate value continuation	47	Override 8		
23	Immediate value change	48	Interrupt input enable		
24	Electronic gear numerator selection 0	49	Interrupt input		
25	Electronic gear numerator selection 1	50	Deviation 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	1 to 95	1	Power
PA03_52	OUT2 signal assignment		28	
PA03_53	OUT3 signal assignment		2	
PA03_54	OUT4 signal assignment		76	
PA03_55	OUT5 signal assignment		26	
PA03_98	OUT FZ signal assignment		0	

PA03_48 (OUT FZ signal assignment) should be specified when using the pulse output terminal (FZ) as OUT signal function.

Sequence output signal

No.	Function	No.	Function	No.	Function
1	Ready for servo-on [RDY]	30	Data error	66	MD6
2	In-position [INP]	31	Address error	67	MD7
11	Speed limit detection	32	Alarm code 0	75	Position preset completion
13	Over write completion	33	Alarm code 1	76	Alarm detection (Normally closed contact)
14	Brake timing	34	Alarm code 2	79	Immediate value continuation permission
16	Alarm detection (Normally open contact)	35	Alarm code 3	80	Immediate value continuation completion
17	Point detection, area 1	36	Alarm code 4	81	Immediate value change completion
18	Point detection, area 2	38	+OT detection	82	Command positioning completion
19	Limiter detection	39	-OT detection	83	Range1 of position
20	OT detection	40	Home position LS	84	Range2 of position

2

21	Cycle end detection	41	Forced stop detection	85	Interrupt positioning detection
22	Homing completion	45	Battery warning	86	Interference detection
23	Zero deviation	46	Life warning	89	Functional safety SS1
24	Zero speed	60	MD0	90	Functional safety SLS
25	Speed coincidence	61	MD1	91	CONTa Through
26	Torque limit detection	62	MD2	92	CONTb Through
27	Overload warning	63	MD3	93	CONTc Through
28	Servo control ready	64	MD4	94	CONTd Through
29	Edit permission response	65	MD5	95	CONTe Through

2.5.3 Signal Descriptions

Input signal

Servo-on [S-ON]: Sequence input signal (Reference value 1)

The signal makes the servomotor ready to rotate.

■ Function

The servomotor is ready to rotate while the servo-on [S-ON] signal remains turned on.
When the servo-on signal is turned off, the gate for IGBT is turned off and the servomotor does not rotate. At this time, the servomotor in free-run and all rotation commands are ignored.
If the signal is turned off during rotation, controlled stop is caused according to the setting of PA2_61 (action sequence at servo-on OFF). The stopping profile follows the setting of PA2_61 (action sequence at servo-on OFF), too.
If there is no alarm, activation of servo-on [S-ON] and forced stop [EMG] arranges the state ready to rotate.

■ Parameter setting

To assign the servo-on [S-ON] signal to a sequence input terminal, specify the corresponding value ("1") to the input terminal function setting parameter.

Forward command [FWD]: Sequence input signal (Reference value 2)
Reverse command [REV]: Sequence input signal (Reference value 3)

The signal makes the servomotor keep running while it remains turned on.

■ Function

The servomotor keeps rotating in the positive (negative-) direction while the forward command [FWD] (reverse command [REV]) signal remains turned on. Acceleration begins at the rising edge, while the trailing edge triggers deceleration.

Control mode	Conditions for valid FWD/REV signal	FWD/REV simultaneous signal ON
Speed control	ON level	Deceleration stop
Position control	ON edge (rising edge)	Behavior immediately before simultaneous ON is retained
Torque control	ON level	Deceleration stop

(1) Speed control

The motor rotates at a speed selected through combination of multi-step speed settings [X1] (= No. 51), [X2] (= No. 52) and [X3] (= No. 53) (see the table on the next page).

If both the forward command [FWD] and reverse command [REV] are turned on, the motor is controlled to stop.

X3	X2	X1	Rotation speed
OFF	OFF	OFF	Speed command (VREF terminal) voltage
OFF	OFF	ON	PA1_41: Manual feed speed 1
OFF	ON	OFF	PA1_42: Manual feed speed 2
ON	ON	ON	PA1_43: Manual feed speed 3
ON	OFF	OFF	PA1_44: Manual feed speed 4
ON	OFF	ON	PA1_45: Manual feed speed 5
ON	ON	OFF	PA1_46: Manual feed speed 6
ON	ON	ON	PA1_47: Manual feed speed 7

(2) Position control

In the position control mode, only pulse inputs are accepted.

To perform manual operation under position control, specify "6" to PA1_01 (control mode selection) and, while leaving the position control (37) signal turned on, turn the forward command [FWD] (or reverse command [REF]) signal on.

The speed setting is the same as that of speed control. The rising edge of the forward command [FWD] (or reverse command [REV]) signal starts to rotate at the ON level. Even if both signals are turned on simultaneously, no stoppage is caused.

To issue a reverse command after turning off a forward command [FWD], turn on the reverse command [REV] after controlled stop.

(3) Torque control

A torque is output at the servomotor shaft.

The torque is output according to the torque command [TREF terminal] voltage.

■ Parameter setting

To assign the forward command [FWD] signal to IQ area (sequence input terminal), specify the corresponding value ("3" for reverse command [REV]) to the input terminal function setting parameter.

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

Start positioning [START]: Sequence input signal (Reference value 4)

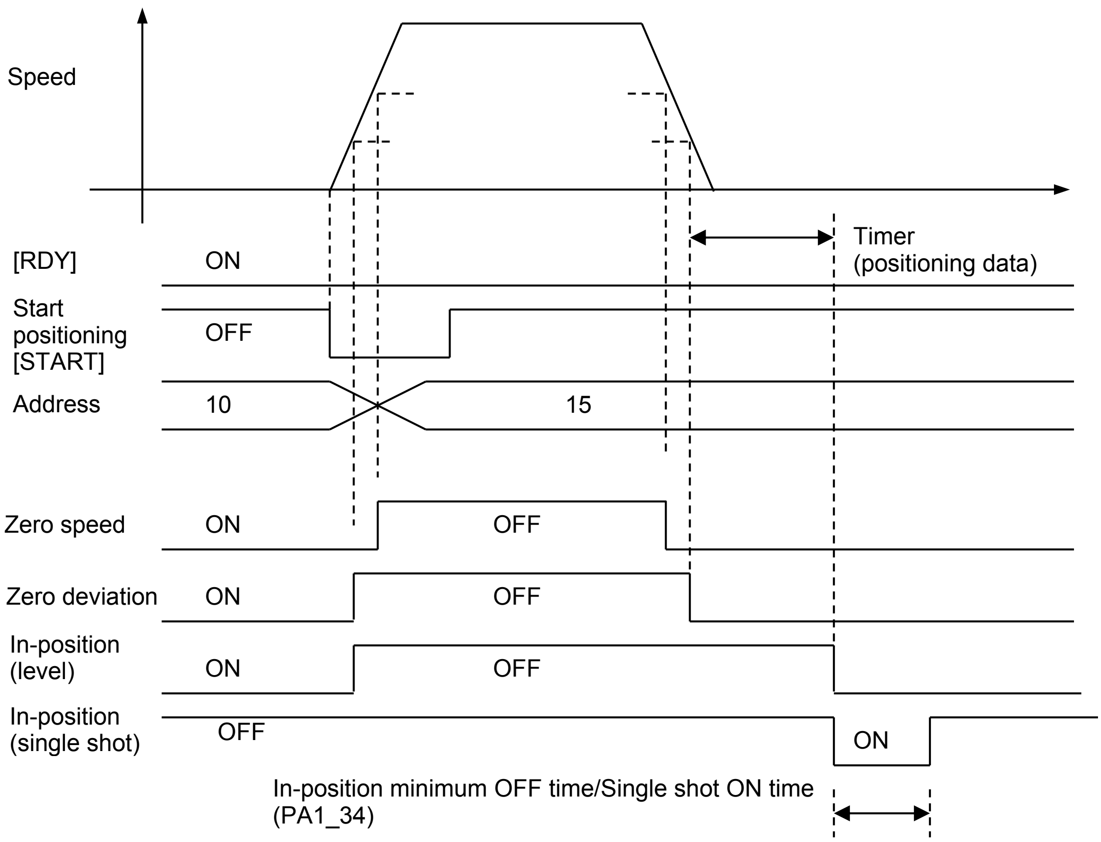
Positioning motion is executed according to positioning data or immediate value data sent via RS-485 communications.

<u>This function is enabled only if parameter PA1_01 is “7” (positioning operation).</u>

2

■ Function

The positioning motion starts at the activating edge of the start positioning signal.
If PA2_40 (internal positioning data selection) is “1” (enable), the internal positioning data is enabled. Positioning is made according to positioning addresses AD4 through AD3.
If PA2_40 (internal positioning data selection) is “0” (disable), positioning is made according to the position data and speed data sent via RS-485 communications.



Check for the active state of the in-position signal (level) to turn the start positioning signal on. The motor starts to rotate. After rotation begins, the in-position signal is turned off.

■ Parameter setting

To assign the start positioning signal to a sequence input terminal, specify the corresponding value (“4”) to the input terminal function setting parameter.
The signal is handled to be always turned off if it is not assigned to the input terminal.

■ Relevant description

(1) Internal positioning data selection

Set this parameter enable when performing positioning according to the positioning data.

If 0 (disable) is set, immediate value data operation with RS-485 (Modbus communication) will be performed.

No.	Name	Setting range	Default value	Change
PA2_40	Internal positioning data selection	0: Disable 1: Enable	0	Always

(2) Sequential start selection

Set this parameter enable when performing sequential start.

No.	Name	Setting range	Default value	Change
PA2_41	Sequential start selection	0: Disable 1: Enable	0	Always

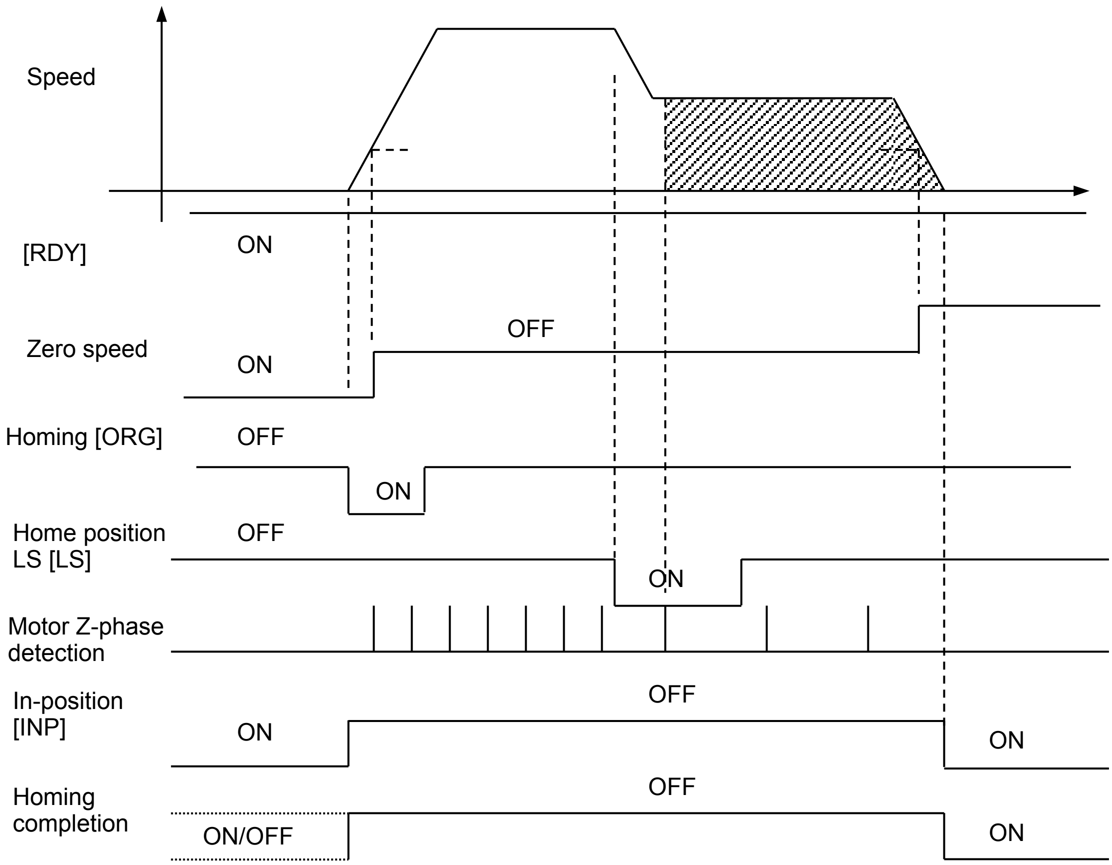
Homing [ORG]: Sequence input signal (Reference value 5)
Homing position LS [LS]: Sequence input signal (Reference value 6)
Interrupt input: Sequence input signal (Reference value 49)

2

A homing motion is executed and the home position is determined.
This signal is enabled only when parameter PA1_01 (control mode selection) is set to "6" (extension mode) or "7" (positioning function).

■ Function

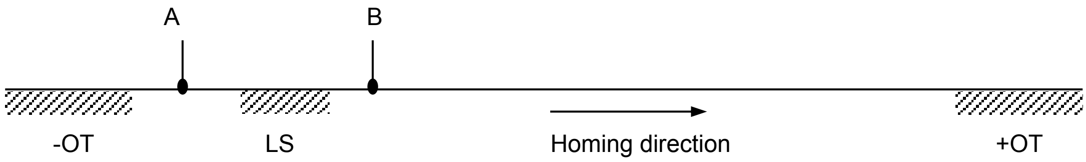
The rising edge of the homing signal starts a homing motion. The homing motion follows the settings of PA2_06 through PA2_18. If parameters are factory shipment settings, the following motion is executed.



(1) After checking that the in-position signal is turned on, turn on the homing command.
(2) Once the in-position signal is turned off, you can turn off the homing command.
The motor rotates in the direction of PA2_10 at a speed of PA2_06.
(3) When the home position LS signal is turned on, the speed changes to creep speed for homing (PA2_07).
(4) The motor moves the home position shift unit amount (PA2_14) from the first Z-phase after the rising (or trailing) edge of the home position LS, and then it is stopped.

(5) The in-position signal is turned on with the stopping position being home position after homing completion PA2_16. In addition, the homing completion signal is turned on.

To perform homing, use up positive over-travel [+OT] and negative over-travel [-OT] signals to assure safety.



- Detection of over-travel signal
  If homing is started from position A in the figure above, the home position LS is detected and stoppage is caused.
  If homing is started from position B in the figure above, the +OT signal is detected. In this case, the following motions follow.

(6) Upon detection of +OT, controlled stop is caused according to deceleration time at OT during homing PA2_18.
(7) A reverse travel begins at the homing speed.
(8) Upon detection of the home position LS, controlled stop is caused. Then the procedure (1) to (5) described above is executed.

- Starting direction for homing (PA2_08)
  If homing is executed from B in the figure above, the distance to +OT must be traveled in a round trip and therefore much time is taken.
  If homing is set to negative starting direction, the home position LS will be detected first.

- Reverse traveling unit amount for homing (PA2_09)
  If homing is executed from B in the figure above, the distance to +OT must be traveled in a round trip and therefore much time is taken.
  If the reverse traveling unit amount for homing is specified, the next action is performed at the start of homing.

(9) A travel occurs first at the homing speed by the reverse traveling unit amount for homing.

Thereafter the motion (1) to (5) described above is executed.

- Reference signal for shift operation (PA2_11)
  In regular cases, a travel occurs by the home position shift unit amount in reference to the encoder Z-phase signal. Stoppage is caused at an accuracy of a single encoder pulse. If the Z-phase is not used positively due to a reduction ratio of 2 or similar, the home position LS can be made the standard.
  If the moving range is extremely narrow to install a home position LS signal, the +OT and -OT signals can be referred as the standard.
  If a quick response sensor is used instead of the Z-phase of the encoder, the interrupt input signal can be applied.

- Home position LS signal edge selection (PA2_13)
  After the trailing edge of the LS is detected, the Z-phase signal after the home position LS is detected.

- Deceleration operation for creep speed (PA2_15)
  Controlled stop is caused during homing upon detection of the home position LS (or reference signal for shift operation), followed by reverse rotation until the point before the home position LS is reached, and then homing is performed again at the creep speed.
  The home position LS creep speed becomes the same despite the homing speed setting.

- Interruption of homing motion
  Forced stop (sequence input signal) can interrupt the homing motion.
  Positioning cancel (sequence input signal) can interrupt the homing motion.

- Interruption of homing motion
  While a travel in the opposite direction automatically occurs upon detection of positive over-travel [+OT] or negative over-travel [-OT], stoppage is caused in the following cases. In every case, the homing completion signal will not be turned on.
  - Reverse rotation after a +OT signal, followed by a -OT signal without detecting a home position LS (reference signal)
  - Detection of an over-travel signal in the opposite direction to the traveling direction
  - Detection of an over-travel signal during travel of the home position shift traveling amount

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 limit value set at PA2_60 (third torque limit) or deceleration time set at PA2_76 (third deceleration time) based on the PA2_63 (action sequence at mainpower shutoff, OT detection) setting.
Pulse input in the direction opposite to the detection direction, manual feed (forward/reverse command) and positioning (auto feed) can be executed (normally close contact).
If an OT signal is detected during positioning operation, the servomotor is forcibly stopped and therefore difference may be caused between the command position and feedback position.
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) 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 is turned on upon detection of either +OT (7) or -OT (8) or software OT specified in PA2_27/28 (software OT detection position).

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.

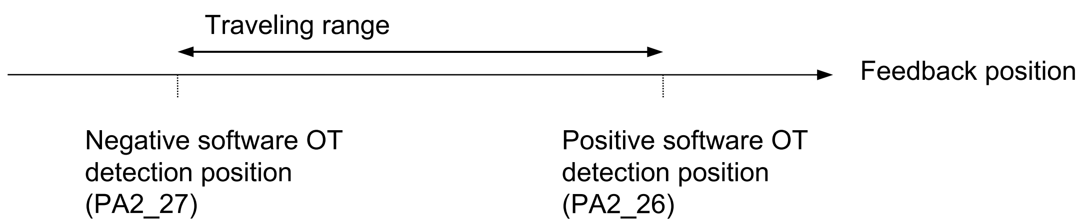
(3) Software OT

If set to PA2_25: Software OT selection = 1 (enable), operation is enabled when the current position is in the range between (PA2_26: Positive software OT detection position) and (PA2_27: Negative software OT detection position).

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

Supply a pulse input in the direction opposite to the detected direction or perform manual feed (forward / reverse command) to reset and 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 forced stop is turned off during operation, the servomotor decelerates and stops at the limit value set at PA2_60 (third torque limit) or deceleration time set at PA2_76 (third deceleration time) based on the PA2_61 (action sequence at servo-on off, forced stop) 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 is turned on with the servo-on [S-ON] signal and forced stop signal turned on, so that the output shaft of the servomotor becomes ready 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 removing the forced stop signal, there is no need to issue an alarm reset signal.
If the forced stop signal is turned off under torque control, the torque command becomes zero and the servomotor free-run.

Alarm reset [RST]: Sequence input signal (Reference value 11)

The alarm reset signal resets alarm detection of the servo amplifier.

■ Function

The sequence input signal resets alarm detection of the servo amplifier.

The rising edge of the alarm reset [RST] signal resets alarm detection.

By starting the test operation mode at the keypad, operating the PC Loader or turning the power on again, the alarm can be reset.

■ Parameter setting

To assign the alarm reset [RST] signal to a sequence input terminal, specify the corresponding value ("11") to the input terminal function setting parameter.

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

■ Relevant description

There are the following methods for resetting alarm detection.

- Rising edge of alarm reset [RST] of sequence input signal
- Press and hold the [SET/SHIFT] key for at least one second in the test operation mode [Fn_05].
- Press and hold the [∧] ad [∨] keys simultaneously for at least one second upon alarm detection [En_01].
- Alarm reset from PC Loader
- Shutdown and power-on again

Note	There are alarms that cannot be reset with the [RST] signal. Refer to "■ Alarm reset" in "7.2.3 Alarm Display List" for details on alarms that can be reset with the [RST] signal.

ACC0: Sequence input signal (Reference value 14)

ACC0 switches the acceleration/deceleration time.

■ Function

(1) Acceleration/deceleration time switch

The acceleration time and deceleration time of the servomotor follow the setting of PA1_37 to 40 (acceleration time, deceleration time). The acceleration time and deceleration time can be set separately.

The setting through ON/OFF of the ACC0 signal despite the direction of rotation, as shown in the table below can be switched.

ACC0	Acceleration time	Deceleration time
OFF	PA1_37	PA1_38
ON	PA1_39	PA1_40

■ Parameter setting

To assign the ACC0 (acceleration/deceleration time selection) signal to a sequence input terminal, specify the corresponding value ("14") to the input terminal function setting parameter. This signal is handled to be always turned off if it is not assigned.

2

Position preset: Sequence input signal (Reference value 16)

The present command position and feedback position are preset (overwritten).

■ Function

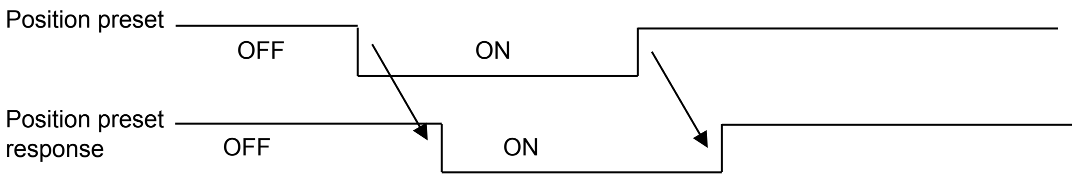
The present command position and the present feedback position are made the reference value of PA2_19 (preset position) at the rising edge. However, the deviation is subtracted from the feedback position.

The rising edge is the change point at which the sequence input signal having been switched off to on.

As zero speed signal [NZERO] can be performed during ON, it is recommended to conduct position preset while the servomotor is sustained. After position preset, homing is finished.

The following alarm detection can be reset.

- Absolute data lost (dL1, dL2, dL3)
- Multi-revolution overflow



The position preset response is turned off when position preset is turned off.

■ Parameter setting

To assign the position preset to a sequence input terminal, specify the corresponding value ("16") to the input terminal function setting parameter.

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

Gain swtich: Sequence input signal (Reference value 17)

To switch the gain (response capability) of the servo system.

■ Function

When PA1_61 (gain changing factor) is set at "3" (external switch: CONT signal), the CONT signal assigned to this function switches the gain of the servo system.
The control gain parameters that are enabled with the gain switch are listed in the table below.
Use the function to change the gain of the servo system between the going path and returning path in a reciprocal motion or similar.

Gain switch	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

To assign the gain switch to a sequence input terminal, specify the corresponding value ("17") to the input terminal function setting parameter.
This signal is handled to be always turned off if it is not assigned to the sequence input terminal.

2

Torque limit 0: Sequence input signal (Reference value 19)
Torque limit 1: Sequence input signal (Reference value 20)

Limitations are set on the output torque of the servomotor.

■ Function

Limitation on the output torque of the servomotor by turning on the torque limit signal can be set. Specify the torque limit in increments of 1 [%] in the range from "0" to the maximum output torque. The maximum output torque is 300 [%] if the rated torque is 100 [%].
Note that the setting of PA1_37 to 40 (acceleration and deceleration time) may be ineffective if the output torque is limited during acceleration or deceleration. The enabled torque limit is as follows.

- Torque limit under speed control and position control
  The following settings can be specified as a limitation set on the torque.

[1]	TREF terminal voltage
[2]	Forward rotation torque limit (PA1_27), reverse rotation torque limit (PA1_28)
[3]	Second torque limit (PA2_58)
[4]	Third torque limit (PA2_60)

If "0" is specified as torque limit selection (PA2_57), the settings of torque limit 0 and torque limit 1 are enabled. Only torque limit 1 is enabled for LS type.

Torque limit	Torque limit	Torque limit
OFF	OFF	Value of [2]
	ON	[2] or [1], whichever is smaller
ON	OFF	[3] or [2], whichever is smaller
	ON	[3] or [1], whichever is smaller

If forced stop or servo-on is turned off, or if an over-travel or minor failure alarm is detected, limitation is set at [4] third torque limit (PA2_62＝4 or 5 or 20□□) the setting can be changed.

Torque limit	Torque limit	Torque limit
OFF	OFF	[4] or [2], whichever is smaller
	ON	[4], [2] or [1], whichever is the smallest
ON	OFF	[4], [3] or [2], whichever is the smallest
	ON	[4], [3] or [1], whichever is the smallest

- Torque limit under torque control
  The limit [2] is always enabled.
- Deviation hold selection at torque limit
  Use deviation hold selection at torque limit (PA2_59) under position control to select the torque limit for retaining the deviation amount.

Torque limit	Torque limit	Torque limit
OFF	OFF	No torque limit
	ON	Value of [1]
ON	OFF	Value of [3]
	ON	PA2_59: 1, value of [3]. PA2_59: 2, value of [1]

■ Parameter setting

To assign the torque limit signal to a sequence input terminal, specify the corresponding value ("19" or "20") to the input terminal function setting parameter.

If the torque limit signal is not assigned to the sequence input terminal, the settings of PA1_27 (forward rotation torque limit) and PA1_28 (reverse rotation torque limit) are always enabled.

■ Relevant description

(1) Torque limit detection signal

This signal is turned on while the output torque of the servomotor is equal to or larger than the torque limit.

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

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

2

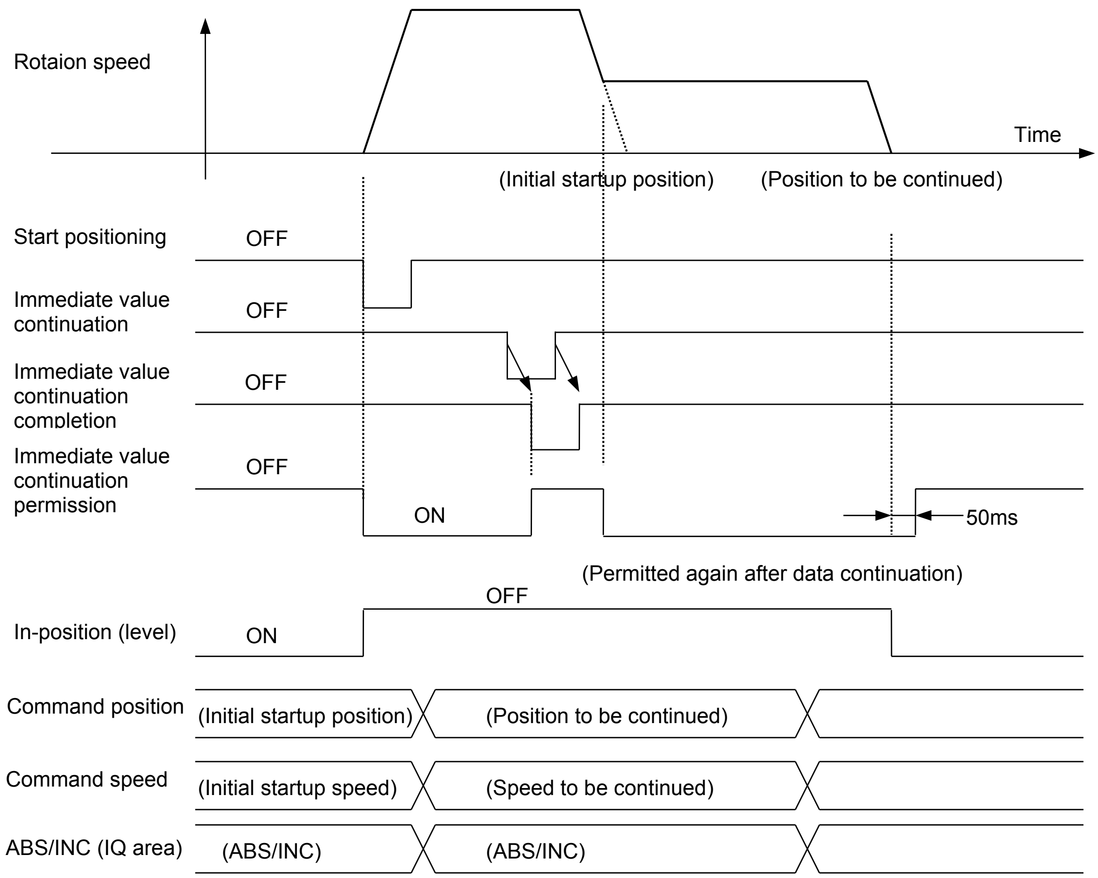
Immediate value continuation: Sequence input signal (Reference value 22)

Positioning motion can be continued according to the next data from the target position (speed) started in the immediate value mode.

This signal is enabled only when parameter PA1_01 (control mode selection) is set to "7" (positioning function).

■ Function

After immediate data operation starts with the first data, supply desired data in an immediate value continuation command. Operation continues with the next data, following execution of the first data.



■ Parameter setting

To assign the immediate value continuation command to a sequence input terminal, specify the corresponding value ("22") to the input terminal function setting parameter. Relevant signal reference values include following.

Assigned signal	No.
Immediate value continuation: sequence input signal	22
Immediate value continuation completion: sequence output signal	80
Immediate value continuation permission: sequence output signal	79

■ Relevant description

(1) Immediate value continuation permission signal

The signal is turned on when the immediate value continuation command is ready to be issued to the servo amplifier. The immediate value continuation permission signal remains enabled for 50 [ms] after positioning is completed.

(2) Immediate value continuation completion signal

The signal is turned on after the immediate value continuation process is executed according to an immediate value continuation command, and it is turned off after the immediate value continuation command is turned off.

(3) Command position / command speed / ABS/INC

Each piece of data can be changed arbitrarily. The immediate value data at the activating edge of the immediate value continuation command is enabled.

(4) Immediate value change command

When the immediate value continuation command and the immediate value change command are turned on simultaneously, priority is given to the immediate value change command.

(5) Positioning cancel / pause

These signals are enabled at an arbitrary timing.

Immediate value change: Sequence input signal (Reference value 23)

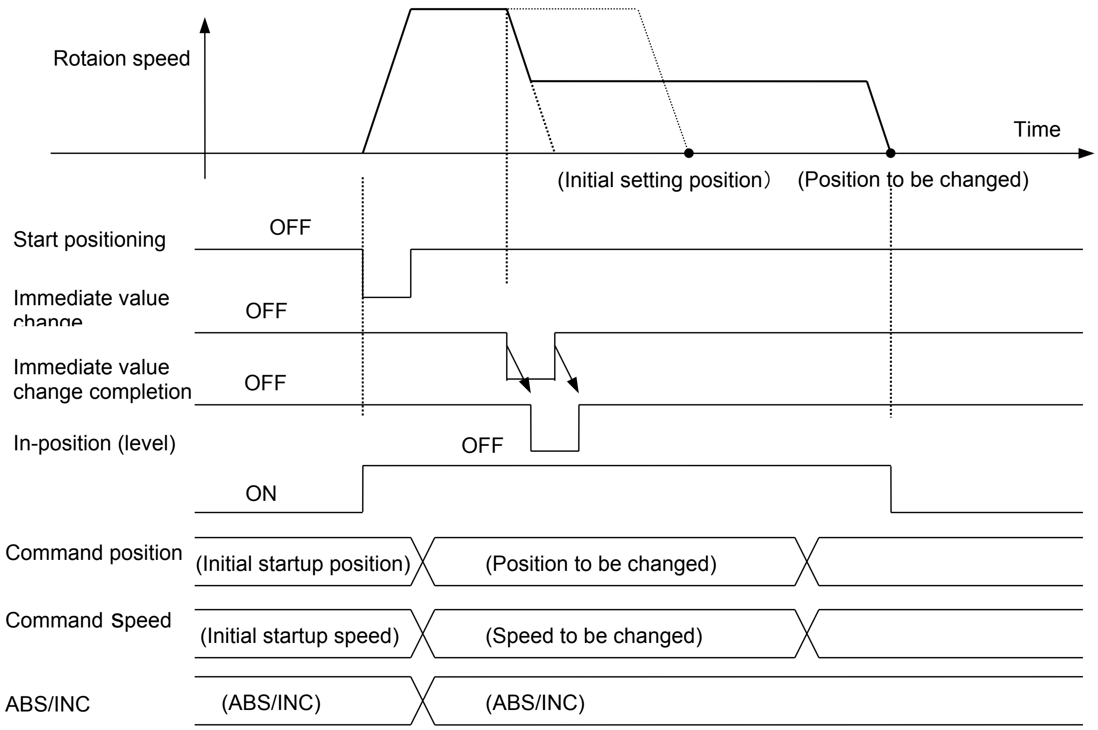
The target position and target speed of immediate data start can be changed at an arbitrary timing.
<u>This signal is enabled only when parameter PA1_01 (control mode selection) is set to "7" (positioning function).</u>

2

■ Function

After immediate data operation is started and the in-position signal is turned off, the target position and target speed can be changed at an arbitrary timing.

Even if the positioning motion of the first data is not finished, the next data is executed immediately when the change command is accepted.



The command position and command speed change at the activating edge of the immediate value change command. They can be changed at an arbitrary timing while the in-position signal remains inactive.

■ Parameter setting

To assign the immediate value change command to a sequence input terminal, specify the corresponding value ("23") to the input terminal function setting parameter. Enter value ("81") for the immediate value change completion signal.

■ Relevant description

(1) Change setting completion

The signal is turned on after the changing process is executed according to the immediate value change signal, and it is turned off after the immediate value change command is turned off.

(2) Command position / command speed / ABS/INC

Each piece of data can be changed arbitrarily. The immediate value data at the activating edge of the immediate value change command is enabled. However, the ABS/INC signal retains the state enabled at the activating edge of the start positioning signal.

(3) Immediate value continuation command

When the immediate value continuation command and the immediate value change command are turned on simultaneously, priority is given to the immediate value change command.

(4) Positioning cancel / pause

The signal is enabled at an arbitrary timing.

Electronic gear numerator selection 0: Sequence input signal (Reference value 24)
Electronic gear numerator selection 1: Sequence input signal (Reference value 25)

To change the multiplication of the traveling amount of the mechanical system.

■ Function

Switch electronic gear numerator 0 or electronic gear numerator 1 to select one of four command pulse offsets.

The numerator of the electronic gear can be changed through these functions assigned to the CONT input signal, as shown in the table below.

Electronic gear numerator selection 1	Electronic gear numerator selection 0	Enabled electronic gear numerator selection
OFF	OFF	PA1_6: Numerator 0 of electronic gear
OFF	ON	PA2_51: Numerator 1 of electronic gear
ON	OFF	PA2_52: Numerator 2 of electronic gear
ON	ON	PA2_53: Numerator 3 of electronic gear

■ Parameter setting

To assign numerator 0 of electronic gear or numerator 1 of electronic gear to a sequence input terminal, specify the corresponding value ("24" or "25") to the input terminal function setting parameter.

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

Command Pulse inhibit: Sequence input signal (Reference value 26)

The pulse input in the position control mode is enabled or disabled.

■ Function

The command pulse is not accepted while the command pulse inhibit signal remains turned on.

■ Parameter setting

To assign pulse command inhibit to a sequence input terminal, specify the corresponding value ("26") to the input terminal function setting parameter.
This signal is handled to be always turned off if it is not assigned to the sequence input terminal. Accordingly, pulse input is always enabled while servo-on [S-ON] is turned on.

Command pulse ratio 1: Sequence input signal (Reference value 27)
Command pulse ratio 2: Sequence input signal (Reference value 28)

This is used if changing the command input pulse multiplication during position control.
This signal is enabled only when parameter PA1_01 (control mode selection) is set to "6" (extension mode) or "7" (positioning function).

■ Function

While the command pulse ratio 1 (2) is tuned on, pulse input is enabled. To perform pulse operation, be sure to assign the command pulse ratio 1 or command ratio 2 to a CONT input signal to turn it on.
Turn servo-on on, position control on (only if PA1_01 = 6), and command pulse ratio 1 (2) on to enable pulse train operation.
If command pulse ratio 1 is turned on, the ratio set at PA2_54 (command pulse ratio 1) is enabled.
If command pulse ratio 1 is turned off, and command pulse ratio 2 is turned on, the ratio set at PA2_55 (command pulse ratio 2) is enabled.

The result of the following equation becomes the encoder-equivalent pulse.
(Number of input pulses) x ((Numerator 0 to 3 of electronic gear ratio)/(Denominator of electronic gear ratio)) x Command pulse ratio

While the command pulse ratio 1(2) is turned on and pulse input is enabled, the following functions are not enabled: manual feed, homing, start positioning, interrupt positioning, positioning cancel and pause, etc.

■ Parameter setting

To assign the command pulse ratio 1(2) to a sequence input terminal, specify the corresponding value ("27" or "28") to the input terminal function setting parameter.
This signal is handled to be always turned off if it is not assigned to the sequence input terminal.

Proportional control: Sequence input signal (Reference value 29)

Proportional band control is adopted as a servo amplifier control method.

■ Function

With [S-ON] signal turned on, the signal will be turned on while the servomotor shaft is mechanically locked.

If the proportional control is turned on during servomotor rotation, position control becomes unstable.

Do not turn on while the servomotor rotates.

If the brake is applied under position control with the servo locked, an overload (oL) alarm is detected. This is because the servo performs PI control, and generates a torque in an attempt to restore the original position even if fine deviation is produced. Be sure to turn off the proportional control before applying the brake from an external unit.

■ Parameter setting

To assign the proportional control to a sequence input terminal, specify the corresponding value ("29") to the input terminal function setting parameter.

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

Pause: Sequence input signal (Reference value 31)

This signal temporarily stops the start positioning, homing motion and interrupt positioning motion.

■ Function

Deceleration starts at the activating edge of the pause signal (31). While the signal is turned on, the start positioning, homing and interrupt positioning motions are interrupted and stopped. After the signal is turned off, the remaining motion continues.

The signal is ineffective to pulse ratio 1, pulse ratio 2, and manual forward and reverse rotation.

Deceleration follows the designated acceleration/deceleration time, different from forced stop (10).

The pause is enabled to the current positioning motion.

■ Parameter setting

To assign the pause to a a sequence input terminal, specify the corresponding value ("31") to the input terminal function setting parameter.

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

- Relevant description
  1. Positioning cancel
     If positioning cancel (32) is executed while the pause (31) signal remains turned on, the positioning motion is canceled.
  2. ABS/INC (positioning data)
     After the pause (31) signal is turned off, the remaining motion continues without relations to the absolute (ABS) or incremental (INC) mode of positioning data.
     This is not related to the parameter PA1_02: INC/ABS system selection setting value.
  3. Brake timing
     The brake is not applied in a pause.

Positioning cancel: Sequence input signal (Reference value 32)

To cancel the start positioning, homing motion and interrupt positioning motion on the way.

- Function

To resume homing motion, turn on the positioning cancel signal and then turn on the homing signal again.
The interrupt positioning motion is canceled after interrupt input is turned on.
This function is disabled for the pulse operation.
Unlike forced stop, controlled stop will be conducted within the selected deceleration time.

- Parameter setting

To assign positioning cancel to a sequence input terminal, specify the corresponding value ("32") to the input terminal function setting parameter.
This signal is handled to be always turned off if it is not assigned to the sequence input terminal.

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

The thermistor signal of the external regenerative 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.

Teaching: Sequence input signal (Reference value 35)

The current position of the servomotor is written as position data in the positioning data.

■ Function

The current command position of the servomotor is written as position data in the positioning data at the activating edge of the teaching signal. The status (position command status) is ABS (absolute position).

The signal can be always executed without relations to the status of the forced stop and servo-on signals.

You can check the over write completion signal, one of sequence output signals, to check if overwriting of the current position is completed.

Teaching is executed generally according to the following procedure.

(1) Specify the positioning data address to which the current position is to be written in the AD0 to AD3 range.

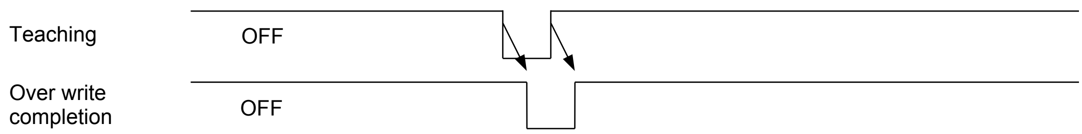
(2) Using the manual operation, pulse operation or the like, pulse operation or the like, feed the mechanical system to the target position.

(3) The current command position is written as position data in the positioning data at the activating edge of the teaching signal. When the teaching signal is turned off, the over write completion signal is turned off, too.

■ Parameter setting

To assign the teaching to a sequence input terminal, specify the corresponding value ("35") to the input terminal function setting parameter.

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



2

Control mode selection: Sequence input signal (Reference value 36)

To switch the control mode.

■ Function

This function is to be used to switch to the control mode (control state) during servomotor operation or similar.
Turn the control mode selection signal, which is assigned to a CONT input signal, on or off to switch the control mode.
Control mode selection is enabled only if PA1_1 (control mode selection) is set at 3, 4 or 5.

■ Control mode

The enabled control mode includes the following.

PA1_1: Control mode selection	Control mode selection	
	OFF	ON
3	Position control	Speed control
4	Position control	Torque control
5	Speed control	Torque control

For details, refer to "CHAPTER 4　PARAMETER."

■ Parameter setting

To assign control mode selection to a sequence input terminal, specify the corresponding value ("36") to the input terminal function setting parameter.
This signal is handled to be always turned off if it is not assigned to the sequence input terminal.

Note	To use vibration suppression control, change the control mode when the servo motor is stopped.

Position control: Sequence input signal (Reference value 37)

To be used to conduct position control (positioning by pulse) in the extension mode.
This signal is enabled only if “6” (extension mode) is selected for parameter PA1_01 (control mode selection).

■ Function

Turn on to perform position control in the extension mode.
The position control state continues while the position control signal assigned to a CONT input signal remains turned on. Positioning, interrupt positioning and other functions can be executed with a pulse input.

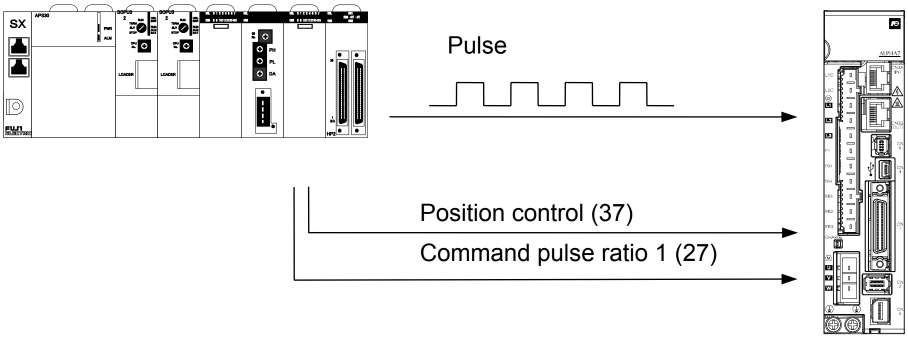
2

■ Parameter setting

To assign position control to a sequence input terminal, specify the corresponding value ("37") to the input terminal function setting parameter. For command pulse ratio 1, specify ("27"), while specify ("28") for command pulse ratio 2.
This signal is handled to be always turned off if it is not assigned to the sequence input signal.

[Example]　To conduct operation with a command pulse input

Operation with a command pulse input is enabled while command pulse ratio 1 or command pulse ratio 2 remains turned on after the position control signal is turned on.



■ Relevant description

(1) PA1_6: numerator 0 of electronic gear /PA1_7: denominator of electronic gear

In the factory shipment state, each pulse of a pulse input turns the servomotor by 16 encoder pulses.
With an incremental encoder, each revolution of the motor shaft corresponds to 16777216 pulses (24 bits).
Use the electronic gear to change the rotation amount of the servomotor corresponding to each pulse of the pulse input.

(2) PA2_54: command pulse ratio 1/PA2_55: command pulse ratio 2

Numerator 0 of electronic gear and denominator of electronic gear convert the traveling amount of the mechanical system per each pulse of the pulse input into a unit amount.
Or the multiplication of the traveling amount of the mechanical system can be changed with command pulse ratio 1 or command pulse ratio 2.

2

The conditions for enabling position control with the command pulse input are shown below.

Servo-on [S-ON] = ON
Forced stop [EMG] = ON
(Control output ready for servo-on [RDY] = ON)

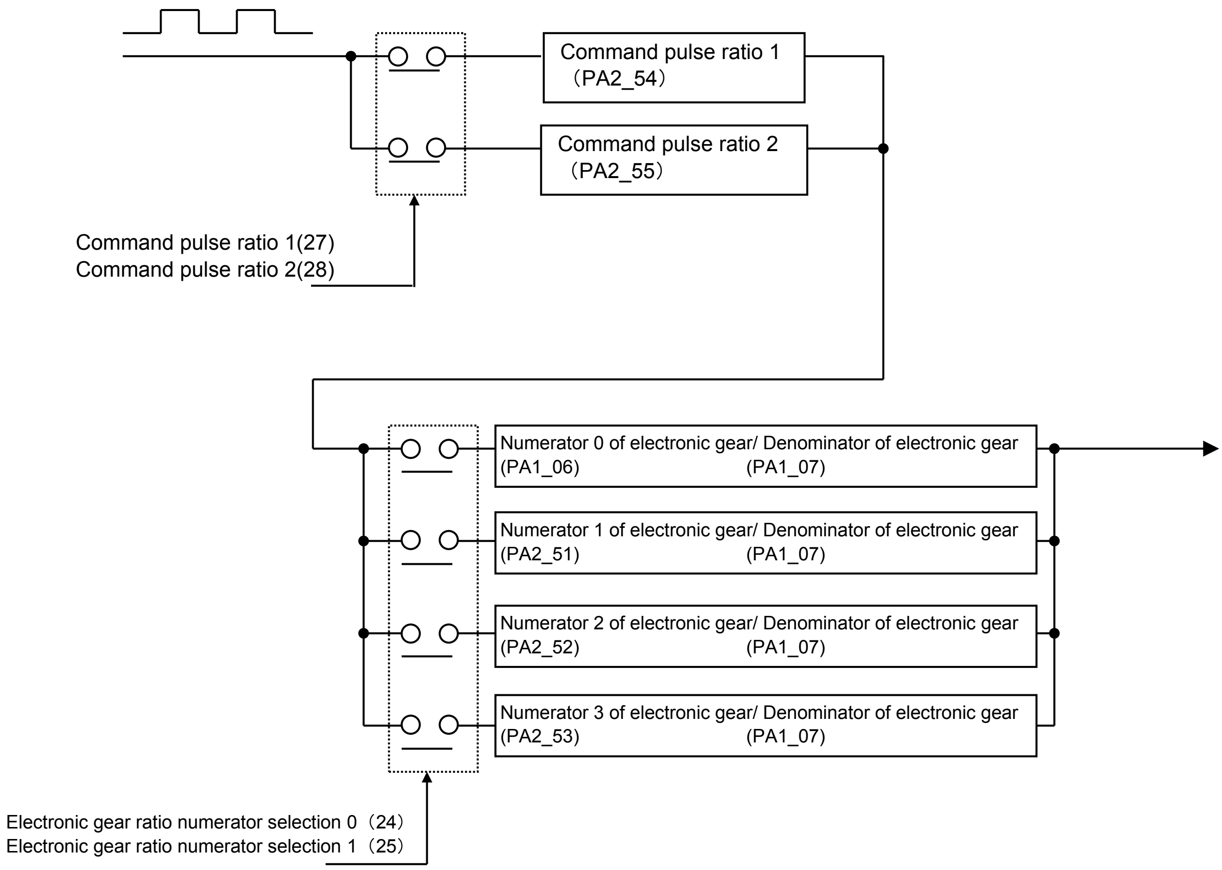
↓

Position control (37) = ON

↓

The command pulse is enabled while command pulse ratio 1 (27) or command pulse ratio 2 (28) remains turned on.

■ Function block diagram



Torque control: Sequence input signal (Reference value 38)

<u>This signal is enabled only when parameter PA1_01 (control mode selection) is set to "6" (extension mode).</u>

■ Function

Turn on to conduct torque control in the extension mode.
The servo amplifier is in the torque control mode while the torque control signal assigned to a CONT input signal remains turned on.
The torque of the output shaft of the servomotor can be controlled.
The torque is actually output while the forward command [FWD] or reverse command [REV] signal remains turned on.
The torque command value depends on the input voltage applied to the TREF terminal. (Refer to the table below.)
The direction of rotation varies between the forward command [FWD] and reverse command [REV] signals.

Voltage applied to TREF terminal	Output torque (rated torque 100 [%])
±3[V]	±100[%] *

* PA3_33: If the torque command scale value is the default value.

■ Parameter setting

To assign torque control to a sequence input terminal, specify the corresponding value ("38") to the input terminal function setting parameter.
This signal is handled to be always turned off if it is not assigned to the sequence input terminal.

■ Relevant description

(1) Maximum rotation speed

If there is no load connected to the servomotor, the rotation speed is subject to a limitation on PA1_26 (maximum rotation speed (for torque control)) with a variation of about ±100 [r/min] (due to lack of speed control).
The speed limit can be selected with the setting of PA2_56 (speed limit selection at torque control).
- VV type: input voltage of speed command [VREF] terminal, multi-step speed setting

(2) Torque setting filter

A filter can be set to the input voltage applied to the torque command [TREF] terminal with the setting of PA1_60 (torque setting filter).

(3) Torque command scale/offset

The scale and offset of the input voltage applied to the torque command [TREF] terminal can be adjusted, using PA3_33 (torque command scale) and PA3_34 (torque command offset).

(4) Output torque

The output torque of the servomotor has individual differences (variation) of about 0 to +5 [%] under torque control. Continuous operation can be made if the output torque is within the rated torque.

(5) Torque limit

Refer to “Torque limit 0: Sequence input signal (Reference value 19), Torque limit 1: Sequence input signal (Reference value 20)” for torque limiting.

Override enable: Sequence input signal (Reference value 43)
Override 1: Sequence input signal (Reference value 44)
Override 2: Sequence input signal (Reference value 45)
Override 4: Sequence input signal (Reference value 46)
Override 8: Sequence input signal (Reference value 47)

The rotation speed of the servomotor can be changed during operation.

■ Function

The rotation speed can be changed with the multiplication designated with override 1/2/4/8 while the override enable signal remains turned on. The speed can be increased up to 150 [%] of the current rotation speed (within the maximum rotation speed).

The weight of the multiplication corresponding to override 1/2/4/8 can be changed with the standard parameter.

This parameter is enabled for all rotation commands except for command pulse input (command pulse ratio 1/2). The function and corresponding number are shown below.

■ Parameter setting

To assign the override enable to a sequence input terminal, specify the corresponding value ("43") to the input terminal function setting parameter.

Similarly, specify the corresponding value ("44" to "47") for override 1/2/4/8.

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

■ Relevant description

(1) Override multiplication

The multiplication applicable while the override enable signal remains turned on is shown in the table on the right. If override enable is turned off, the original speed (100 [%] traveling speed) becomes effective. Signals not assigned to sequence input terminals are assumed to be turned off.

Override ratio

Override 8	Override 4	Override 2	Override 1	Traveling speed %
OFF	OFF	OFF	OFF	0
OFF	OFF	OFF	ON	10
OFF	OFF	ON	OFF	20
OFF	OFF	ON	ON	30
OFF	ON	OFF	OFF	40
OFF	ON	OFF	ON	50
OFF	ON	ON	OFF	60
OFF	ON	ON	ON	70
ON	OFF	OFF	OFF	80
ON	OFF	OFF	ON	90
ON	OFF	ON	OFF	100
ON	OFF	ON	ON	110
ON	ON	OFF	OFF	120
ON	ON	OFF	ON	130
ON	ON	ON	OFF	140
ON	ON	ON	ON	150

* If the weight of the override is the default value

(2) Weight of override

The weight can be changed, using PA2_36 to 39 (override 1/2/4/8).

No.	Name	Setting range	Default value	Change
PA2_36	Override 1	0[%] to 150[%] (In increments of 1)	10	Always
PA2_37	Override 2		20	
PA2_38	Override 4		40	
PA2_39	Override 8		80	

If all the override 1/2/4/8 settings are turned on, the weight is 150 (10 + 20 + 40 + 80). If the sum exceeds 150, the value immediately before is retained.

(3) Maximum rotation speed

Use the setting of PA1_25 (max. rotation speed (for position and speed control)) to specify the maximum rotation speed of the output shaft. However, the setting is disabled for command pulse inputs.

Interrupt input enable: Sequence input signal (Reference value 48)
Interrupt input: Sequence input signal (Reference value 49)

Use to realize the interrupt positioning function.

<u>This signal is enabled only when parameter PA1_01 (control mode selection) is set to "6" (extension mode) or "7" (positioning function).</u>

■ Function

If the interrupt input enable signal assigned to a CONT input signal is turned on, stoppage is caused after a travel of a certain amount since the interrupt input signal is turned on.
Specify the traveling amount after the interrupt input in PA2_20 (interrupt traveling unit amount).
The rotation speed is based on the X1, X2, and X3 signals, or the input voltage to the speed command [VREF] terminal.
The rotation speed after an interrupt input keeps the speed at the rising edge effective.
The override is enabled even after the rising edge.
To change the rotation speed in the interrupt positioning mode, use the override.

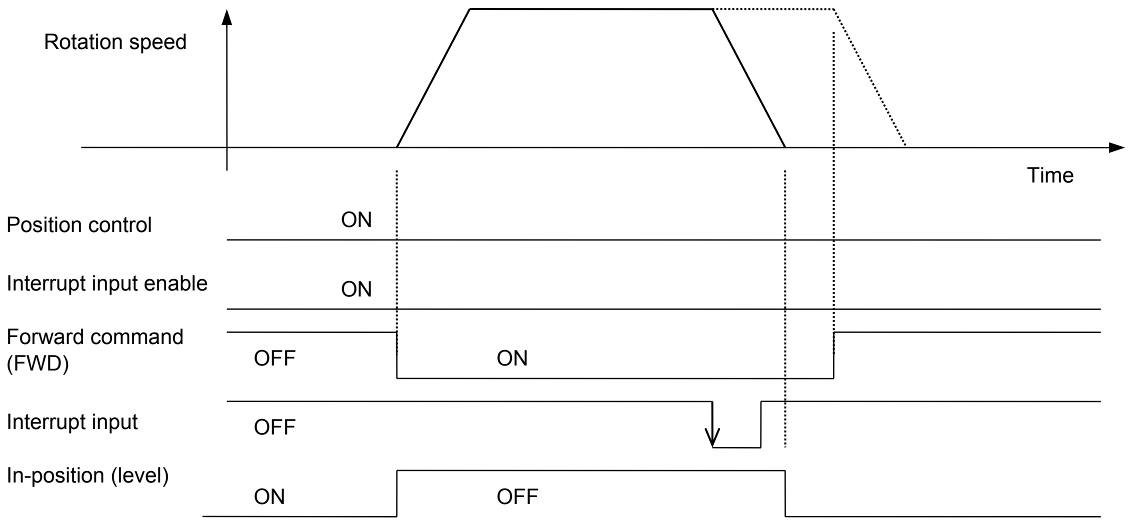
■ Parameter setting

To assign the interrupt enable to a sequence input terminal, specify the corresponding value ("48") to the input terminal function setting parameter. For the interrupt input, specify ("49").
These signals are handled to be always turned off if they are not assigned to sequence input terminals.

■ Relevant description

(1) Interrupt traveling unit amount

The traveling unit amount after the interrupt input signal is turned on is specified in PA2_20 (interrupt traveling unit amount).
The timing chart is shown in the figure below.



(2) Positioning accuracy

The traveling amount for interrupt positioning is the value corresponding to the present feedback position.
Therefore, the target position will not vary depending on a rotation speed (deviation amount) during the interrupt input signal ON.
The interrupt input signal is subject to the variation of the hardware filter (0.1 [ms]).
The positioning accuracy at a mechanical system traveling speed of 1000 [mm/s] (60m/min) is:
1000 ×0.0001 = 0.1 [mm].
Consideration must be taken for the response capability and other particulars of the sensor used for the interrupt input.

2

Deviation clear: Sequence input signal (Reference value 50)

The difference (deviation) between the command position and feedback position is zeroed.

■ Function

The difference (deviation) between the command position and the feedback position is zeroed while the deviation clear signal remains turned on.
The present command position changes to the present feedback position. This is enabled while the zero speed [NZERO] signal is turned on.
Use PA3_36 (deviation clear input form) to select either the edge or level signal.
If the edge is selected, deviation is reset at the rising edge.
The activation time must be 2 [ms] or over.

■ Parameter setting

To assign the deviation clear to a sequence input terminal, specify the corresponding value ("50") to the input terminal function setting parameter.
The signal is handled to be always turned off if it is not assigned to the sequence input terminal.

■ Relevant description

All rotation commands are ignored while the deviation clear signal is turned on.
If the deviation clear signal is turned on during servomotor rotation, the manual forward rotation [FWD] signal and so on are ignored. The feedback position does not change even if deviation clear is executed.
You can zero the accumulated deviation due to the mechanical stop or similar, thereby avoiding the travel by the deviation amount that may appear when the load is released.
After deviation clear is executed, the zero deviation sequence output signal is turned on.

Multi-step speed selection [X1]: Sequence input signal (Reference value 51)
Multi-step speed selection [X2]: Sequence input signal (Reference value 52)
Multi-step speed selection [X3]: Sequence input signal (Reference value 53)

Select the manual feed speed when in position control mode or speed control mode. This is used to select the speed limit value when in torque control mode.

■ Function

The rotation speed while the forward command [FWD] (reverse command [REV]) signal is turned on is selected.
When in torque control mode, the servomotor rotation speed is limited to the selected speed.
Select the speed with multi-step speed [X1], [X2] or [X3].
The setting speed is shown in the table below.

X3	X2	X1	Parameter No.	Rotation speed for enabling
OFF	OFF	OFF	-	Speed command terminal (VREF) voltage
OFF	OFF	ON	PA1_41	Manual feed speed 1/torque control speed limit 1
OFF	ON	OFF	PA1_42	Manual feed speed 2/torque control speed limit 2
OFF	ON	ON	PA1_43	Manual feed speed 3/torque control speed limit 3
ON	OFF	OFF	PA1_44	Manual feed speed 4/torque control speed limit 4
ON	OFF	ON	PA1_45	Manual feed speed 5/torque control speed limit 5
ON	ON	OFF	PA1_46	Manual feed speed 6/torque control speed limit 6
ON	ON	ON	PA1_47	Manual feed speed 7/torque control speed limit 7

■ Parameter setting

To assign the multi-step speed selection to a sequence input terminal, specify the corresponding value ("51", "52" and "53") to the input terminal function setting parameter.
These signals are handled to be always turned off if they are not assigned to sequence input terminals.

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

To put the servomotor forcibly into free-run (coast-to-stop).

Priority is given to this signal in all control modes.

■ Function

While the free-run [BX] signal assigned to a CONT input signal remains turned on, the output of the servo amplifier is shut off and the servomotor free-run.
The output shaft of the servomotor decelerates (accelerates) according to the torque of the load.
The free-run signal is enabled in all control modes (position control, speed control and torque control modes).
In case it is used for vertical transportation purpose, note that there is a risk of falling.
Under position control, the number of output pulses sent from the host controller deviates from the revolution amount of the servomotor because the servomotor free-run while the signal remains turned on.

■ Parameter setting

To assign the free-run to a sequence input terminal, specify the corresponding value ("54") to the input terminal function setting parameter.
This signal is handled to be always turned off if it is not assigned to the sequence input terminal.

Edit permission: Sequence input signal (Reference value 55)

Editing operation for parameters and so on is limited with an external sequence input signal.

■ Function

The edit permission assigned to a CONT input signal controls editing operation made at the keypad or PC Loader.
The following operation can be executed only while the edit permission remains turned on.

- Parameter edit mode
- Positioning data edit mode

This function can be used to avoid inadvertent operation of the keypad or PC Loader, thereby avoiding movement of the servomotor, drop of the machine, etc.

■ Parameter setting

To assign the edit permission to a sequence input terminal, specify the corresponding value ("55") to the input terminal function setting parameter.

■ Relevant description

(1) Parameter write protection

Specify "1" (write protection) to PA2_74 (parameter write protection) to disable key operation at the keypad and parameter editing at the PC Loader.
The relationship between the edit permission and PA2_74 (parameter write protection) is shown in the table below.

Edit permission	PA2_74	Parameter change operation	Edit permission response
Not assigned	0 : Write enable	ON	ON (Possible)
OFF	0 : Write enable	OFF	OFF (Impossible)
ON	0 : Write enable	ON	ON (Possible)
Not assigned	1: Write protect	OFF	OFF (Impossible)
OFF	1: Write protect	OFF	OFF (Impossible)
ON	1: Write protect	OFF	OFF (Impossible)

(2) Edit permission response

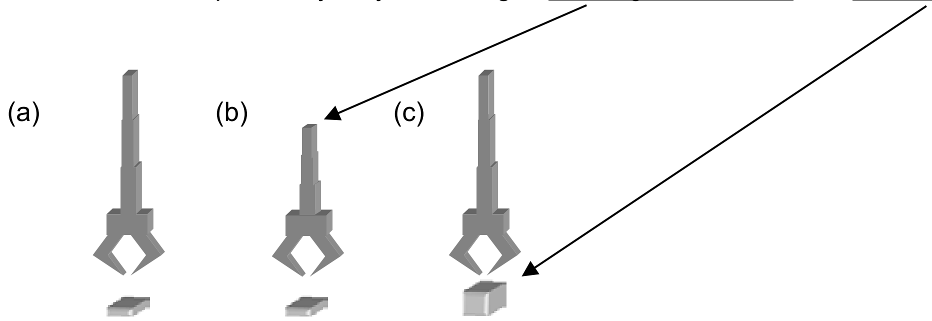
The edit permission response is an output signal.
The signal is output if it is assigned to an output signal and the edit permission is turned on.
To assign the edit permission response to a sequence output terminal, specify the corresponding value ("29") to the input terminal function setting parameter.

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

Select the anti resonance frequency, which is a vibration suppressing control function.

■ Function

In a spring characteristic structure such as the robot arm and transfer machine, vibration is caused at the end of the workpiece upon sudden acceleration or deceleration of the motor. Vibration suppressing control aims at suppression of vibration of the workpiece in such a system, thereby realizing positioning at a shorter cycle time.
Four points through combination of anti resonance frequency selection 0 and anti resonance frequency selection 1 can be specified.
The anti resonance point may vary according to the length of the arm and the weight of the load.



Selection of the anti resonance frequency is shown in the table below.

Anti resonance frequency selection 1	Anti resonance frequency selection 0	Vibration suppressing 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

To assign the anti resonance frequency selection 0 or anti resonance frequency selection 1 to a sequence input terminal, specify the corresponding value ("57" or "58") to the input terminal function setting parameter.
These signals are handled to be always turned off if they are not assigned to sequence input signals.
In this case, PA1_78 (vibration suppressing resonance frequency 0) is always enabled.
To disable the anti resonance frequency, set the anti resonance frequency at 300.0Hz.
Because in-cycle switching of the anti resonance frequency causes a shock, switch during stoppage without fail.
In addition, it is recommended to use PA1_52 (low-pass filter (for S-curve) time constant) in parallel.

AD0: Sequence input signal (Reference value 60)

AD1: Sequence input signal (Reference value 61)

AD2: Sequence input signal (Reference value 62)

AD3: Sequence input signal (Reference value 63)

AD4: Sequence input signal (Reference value 64)

Enter the address of positioning data to be followed, among AD0 to AD4.

Refer to the table below when entering.

<Address No. selection table>

Address No.	AD4	AD3	AD2	AD1	AD0	Sequential start selection PA2_41	Operation mode　In case of internal positioning data selection: PA2_40=1 (enable)
0	OFF	OFF	OFF	OFF	OFF	0: Disable	Address error
						1: Enable	Sequential start
						2: Homing	Homing operation
						3: Operation with immediate value data	Operation with immediate value data
1	OFF	OFF	OFF	OFF	ON	—	Operation with positioning data 1
2	OFF	OFF	OFF	ON	OFF	—	Operation with positioning data 2
3	OFF	OFF	OFF	ON	ON	—	Operation with positioning data 3
4	OFF	OFF	ON	OFF	OFF	—	Operation with positioning data 4
5	OFF	OFF	ON	OFF	ON	—	Operation with positioning data 5
6	OFF	OFF	ON	ON	OFF	—	Operation with positioning data 6
7	OFF	OFF	ON	ON	ON	—	Operation with positioning data 7
8	OFF	ON	OFF	OFF	OFF	—	Operation with positioning data 8
9	OFF	ON	OFF	OFF	ON	—	Operation with positioning data 9
10	OFF	ON	OFF	ON	OFF	—	Operation with positioning data 10
11	OFF	ON	OFF	ON	ON	—	Operation with positioning data 11
12	OFF	ON	ON	OFF	OFF	—	Operation with positioning data 12
13	OFF	ON	ON	OFF	ON	—	Operation with positioning data 13
14	OFF	ON	ON	ON	OFF	—	Operation with positioning data 14
15	OFF	ON	ON	ON	ON	—	Operation with positioning data 15
16	ON	OFF	OFF	OFF	OFF	—	Operation with positioning data 16
17	ON	OFF	OFF	OFF	ON	—	Operation with positioning data 17
18	ON	OFF	OFF	ON	OFF	—	Operation with positioning data 18

2

Address No.	AD4	AD3	AD2	AD1	AD0	Sequential start selection PA2_41	Operation mode In case of internal positioning data selection: PA2_40=1 (enable)
19	ON	OFF	OFF	ON	ON	—	Operation with positioning data 19
20	ON	OFF	ON	OFF	OFF	—	Operation with positioning data 20
21	ON	OFF	ON	OFF	ON	—	Operation with positioning data 21
22	ON	OFF	ON	ON	OFF	—	Operation with positioning data 22
23	ON	OFF	ON	ON	ON	—	Operation with positioning data 23
24	ON	ON	OFF	OFF	OFF	—	Operation with positioning data 24
25	ON	ON	OFF	OFF	ON	—	Operation with positioning data 25
26	ON	ON	OFF	ON	OFF	—	Operation with positioning data 26
27	ON	ON	OFF	ON	ON	—	Operation with positioning data 27
28	ON	ON	ON	OFF	OFF	—	Operation with positioning data 28
29	ON	ON	ON	OFF	ON	—	Operation with positioning data 29
30	ON	ON	ON	ON	OFF	—	Operation with positioning data 30
31	ON	ON	ON	ON	ON	—	Operation with positioning data 31

Positioning data selection: Sequence input signal (Reference value 77)

Positioning data operation and immediate value operation are switched over.

■ Function

The positioning method can be switched at an arbitrary timing between the following: positioning within 31 points with internal positioning data and positioning with immediate value data for frequent positioning data change.

If the CONT signal is turned on, the positioning data is enabled.

if the CONT signal is turned off, the immediate value data is enabled.

The switching timing is always enabled.

The data is recognized at the activating edge of the START signal.

If the timing is simultaneous, the data after signal change is enabled.

■ Parameter setting

To allocate positioning data selection to a sequence input terminal, enter the corresponding value (“77”) to the input terminal function setting parameter.

This signal is handled to be always turned off if it is allocated to none of sequence input terminals.

Broadcast cancel: Sequence input signal (Reference value 78)

The command using the broadcasting method via Modbus-RTU communications is canceled.

■ Function

The Modbus-RTU protocol can issue queries from the host controller, the master, to all the slave stations at the same time. For example, if the servo has a five-axis structure (of A, B, C, D, and E-axes), the servo at all the stations can be started with positioning simultaneously.

On the other hand, the Modbus-RTU protocol cannot perform the broadcast by allocating a group station no. separately. For example, if the servo has a five-axis structure (of A, B, C, D, and E-axes), the servo cannot be started with positioning simultaneously by selecting the A-axis and the B-axis only.

Thus by using this function, the broadcast in a separate group station no. can be performed. The broadcast enable/disable status can be switched using the broadcast cancel signal.

■ Parameter setting

To assign broadcast cancel to a sequence input terminal, enter the corresponding value ("78") to the input terminal function setting parameter.

Furthermore, if the broadcast cancel signal “78” is assigned to the parameter CONT always ON, the broadcast function is kept disabled. (The query of broadcast is always canceled.)

<Logic of broadcast cancel signals>

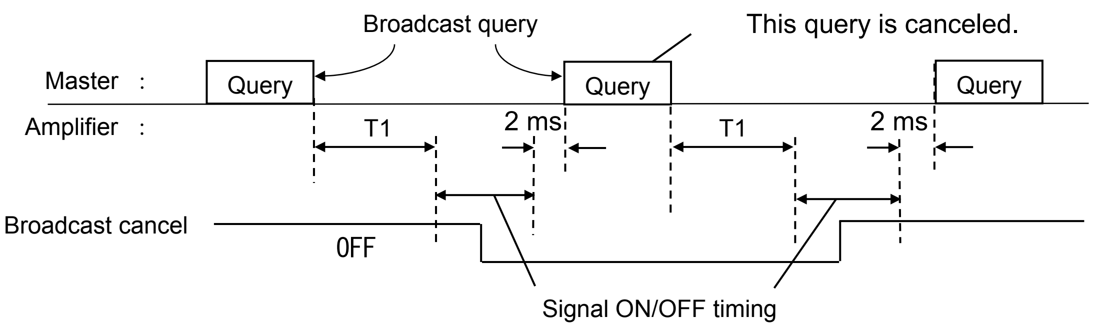
<table>
<tr><th>Broadcast cancel</th><th>Broadcast</th><th>Uni-cast</th></tr>
<tr><td>No allocation</td><td>Enabled</td><td rowspan="3">Enabled</td></tr>
<tr><td>OFF</td><td>Enabled</td></tr>
<tr><td>ON</td><td>Disabled
Cancels the queries of broadcast, without responding.</td></tr>
</table>

■ Relevant descriptions

<Signal switching timing>

1) When switching the broadcast cancellation status between ON and OFF using the CONT signals (CONT9 to 24) via communications, see "13.5.2 Communications timings" on page 13-33 The timing is determined based on the standard communications timing. There is no individual timing prepared for the broadcast cancel.

2) When switching the broadcast cancel status between ON and OFF by using the CONT signals (CONT 1 to 5) by hard signals, see the chart below. Switch the ON and OFF of broadcast cancel under the following conditions:
(1) T1 or longer duration has elapsed after the timing the query is issued (end of telegraph), and
(2) within 2 ms before the timing the query is issued (top of telegraph).
The value "T1" corresponds to the parameter PA2_73 (Communication baud rate), and is provided as in the table below.



PA2_73: Communication baud rate	T1
0 : 38400 bps	5 ms
1 : 19200 bps	10 ms
2 : 9600 bps	
3 : 115200 bps	1.7 ms

2

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	Servo-on [S-ON]	1	ON
	Forced stop [EMG]	10	ON
	Free-run [BX]	54	OFF
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
	Free-run [BX]	54	OFF
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.		-	

2

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
If servo-on [S-ON] is turned off	Free-run	ON
If servo-on [S-ON] is turned on	Servo lock	ON
Upon OT detection	Servo lock	ON
At deviation clear	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.

(2) In-position signal output format

PA1_33 (in-position output format) at either "0" (level) or "1" (single shot) can be set.

■ 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

Single shot: OFF

(2) During command pulse input operation

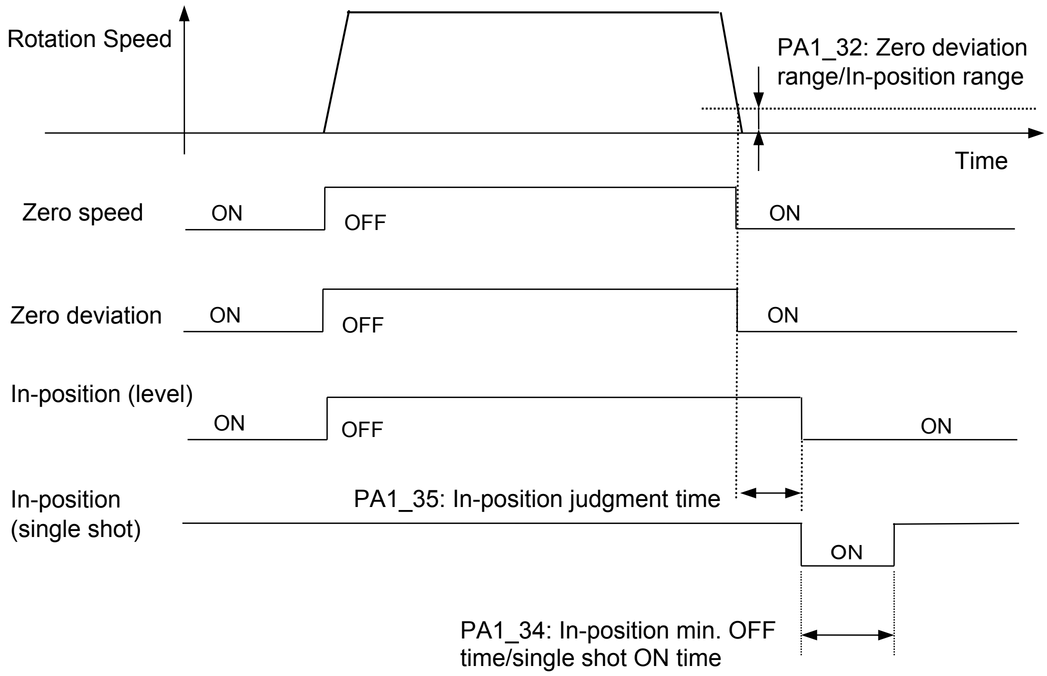
Level: The signal is turned on if conditions (A) and (B) below are satisfied.

(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 (command pulse input) and feedback position is within the setting of PA1_32 (zero deviation range/in-position range).

Single shot: If conditions (A) and (B) above are satisfied, the signal is turned on for time specified at PA1_34 (In-position min. OFF time/single shot ON time:) and then it is turned off.

However, if the zero deviation signal or the zero speed signal is turned off while the signal remains turned on, the signal is forcibly turned off.



(3) Interrupt positioning

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 (command pulse input) and feedback position is within the setting of PA1_32 (zero deviation range/in-position range).

Single shot: If conditions (A) and (B) above are satisfied, the signal is turned on for time specified at PA1_34 (In-position min. OFF time/single shot ON time:) and then it is turned off.

However, if the zero deviation signal or the zero speed signal is turned off while the signal remains turned on, the signal is forcibly turned off.

(4) Homing/start positioning

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 (command pulse input) and feedback position is within the setting of PA1_32 (zero deviation range/in-position range).

Single shot: If conditions (A) and (B) above are satisfied, the signal is turned on for time specified at PA1_34 (In-position min. OFF time/single shot ON time:) and then it is turned off.

However, if the zero deviation signal or the zero speed signal is turned off while the signal remains turned on, the signal is forcibly turned off.

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 (except for command pulse operation), 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, if PA2_56 (speed limit selection at torque control) is "1", the limit value selected with multi-stage speed selection [X1] to [X3] 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.

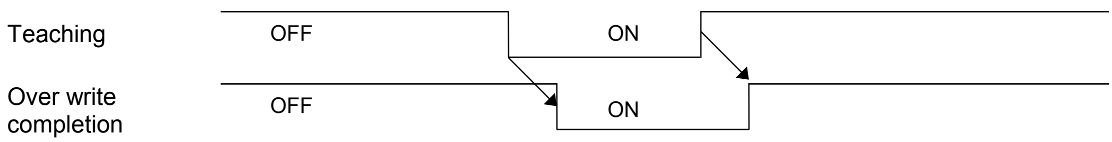
Over write completion: Sequence output signal (Reference value 13)

This signal is turned on after teaching is made and data is overwritten.

■ Function

(1) Data setting (overwriting)

The signal remains turned on while the teaching function enters data.



■ Parameter setting

To allocate the overwriting completion signal to a sequence output terminal, enter the corresponding value (“13”) 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 is turned off if the servo-on [S-ON] signal is turned off. The operation preparation complete [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.

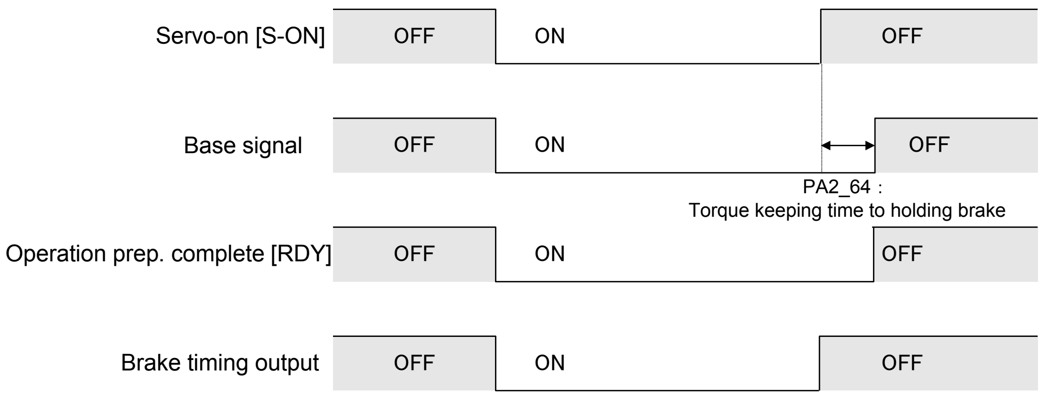
Use a relay or solid state relay (SSR) as the brake cannot be released directly in the sequence output terminal (DC+30V/50mA).

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. • To apply or release the brake with the brake timing output, turn the servo-on [S-ON] signal off first before turning the power off.

■ Relevant description

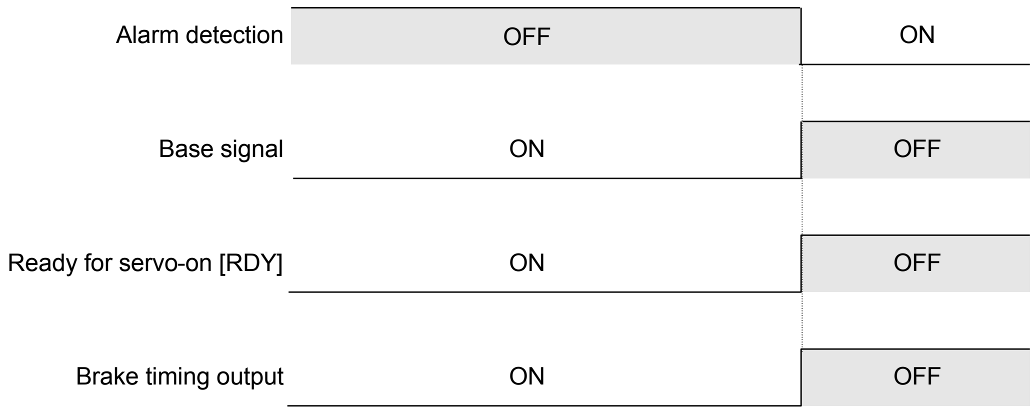
Timing chart

(1) ON/OFF of servo-on [S-ON] signal

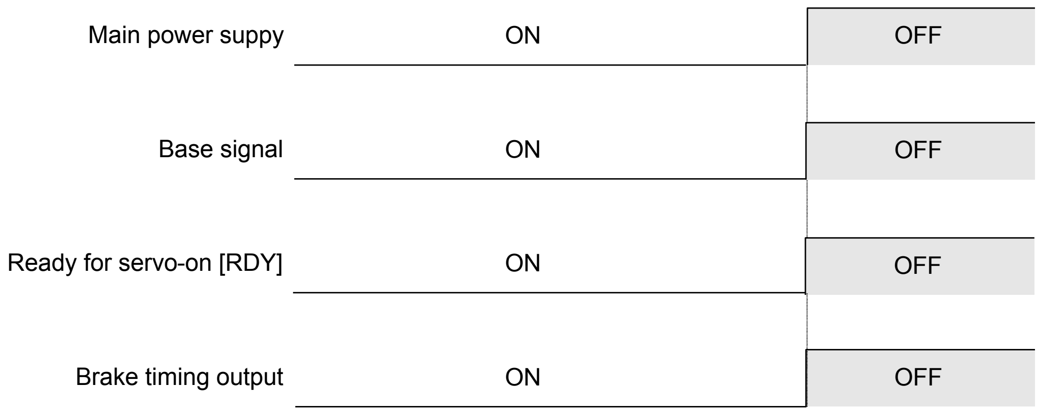


2

(2) Upon alarm



(3) Upon main power supply OFF



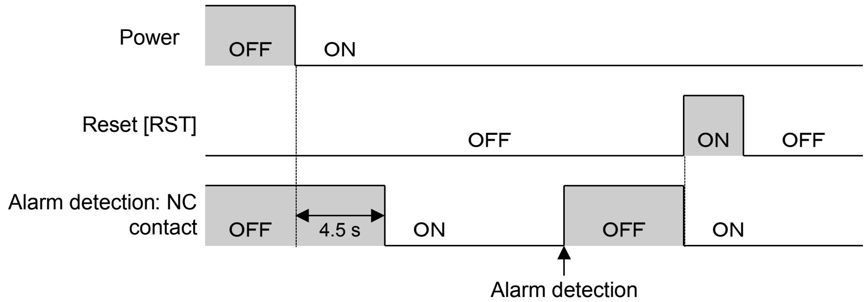
Alarm detection (normally open contact): Sequence output signal (Reference value 16)
Alarm detection (normally closed contact): Sequence output signal (Reference value 76)

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 signal is turned on if the servo amplifier detects an alarm, and the state is retained on the servo amplifier side. After the cause of the alarm is removed, the signal is turned off (to be ready to operation) upon a rising edge of the alarm reset [RST] signal.
Alarm can be checked by having the host controller recognizes the alarm detection.
It can be also checked when the servo-on [S-ON] is ON and ready for servo-on [RDY] is OFF.

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 an RST signal. Refer to "■ Alarm reset" in "7.2.3 Alarm Display List" for details on alarms that can be reset with the [RST] signal.

■ 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").

■ Relevant description

The nature of the detected alarm can be output to the sequence output terminal in a code.
Alarm code 4 [ALM4] (36)
Alarm code 3 [ALM3] (35)
Alarm code 2 [ALM2] (34)
Alarm code 1 [ALM1] (33)
Alarm code 0 [ALM0] (32)

Point detection, area detection 1: Sequence output signal (Reference value 17)
Point detection, area detection 2: Sequence output signal (Reference value 18)

The current position of the servomotor is detected and output in these signals.

This function is valid following homing or position preset.

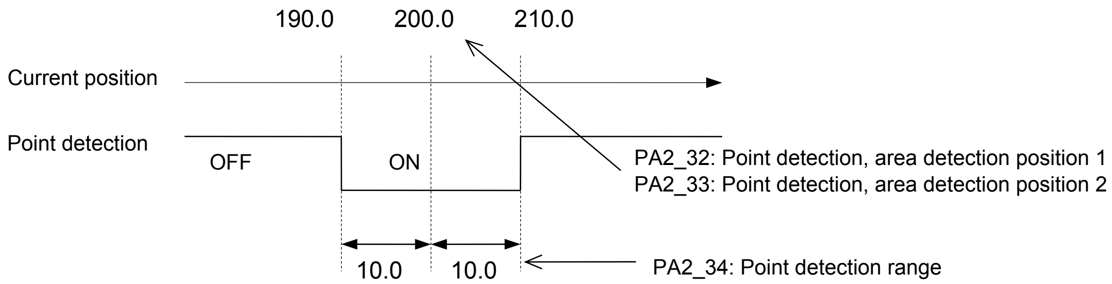
■ Function

Three types of the output format can be selected through settings of PA2_31 (point detection, area detection).

The signal can be output at two points with point detection, area detection 1, 2.

(1) PA2_31 (point detection, area detection) = 0: point detection

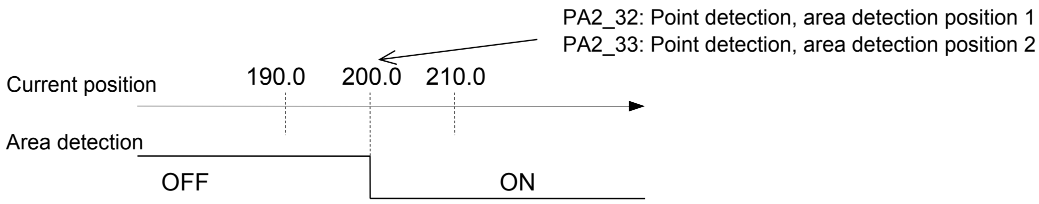
The signal is turned on near the position specified with PA2_32 or PA2_33.



(2) PA2_31 (point detection, area detection) = 1: area detection OFF → ON

The signal is turned on at a position beyond the setting of PA2_32 or PA2_33.

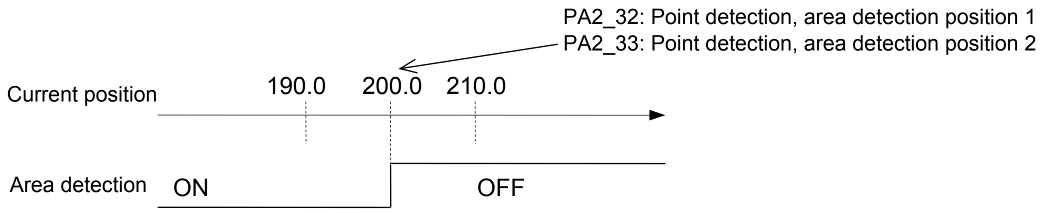
The signal is turned off below the setting.



(3) PA2_31 (point detection, area detection) = 2: area ON → OFF

The signal turns OFF when the current position is equal to or greater than the PA2_32 or PA2_33 setting value.

The signal turns ON when less than the setting value.



■ Parameter setting

To assign the point detection and area detection 1 to a sequence output terminal, specify the corresponding value ("17") to the output terminal function setting parameter. Specify ("18") for point detection and area detection 2.

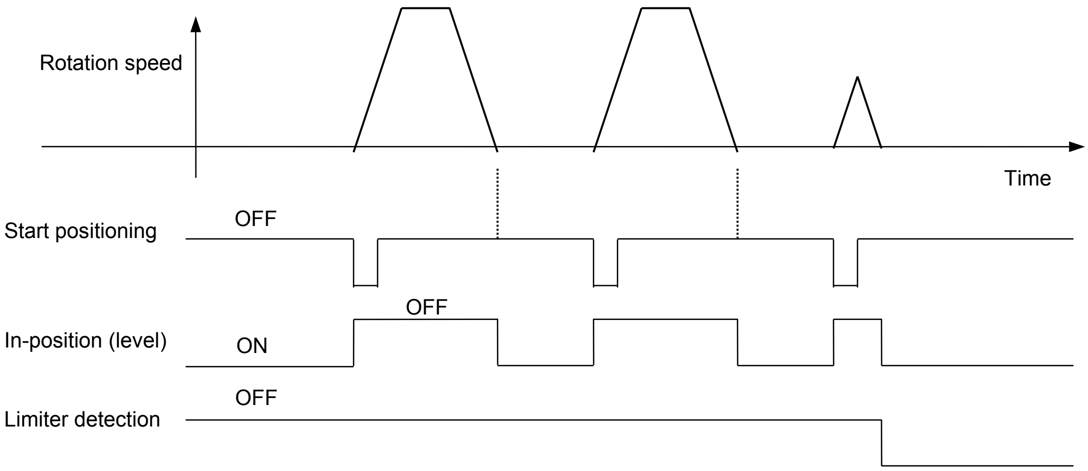
Limiter detection: Sequence output signal (Reference value 19)

Whether the limiter function is enabled or not is checked.

This function is valid following homing or position preset.

■ Function

The limiter function is valid in position control mode.
The limiter function does not function during interrupt positioning.
The limiter function ensures that the motor always stops at the detection position, even if a position command that exceeds the PA2_28: Positive limit detection position or PA2_29: Negative limiter detection position is issued (the limiter detection position is never exceeded.) The deceleration time when the motor stops is based on the parameter and positioning data settings (however, the motor comes to a rapid deceleration stop if performing pulse train operation.)
After stopping at the limiter detection position, a limiter detection signal is output under the same conditions as positioning complete signal output. To recover from the limiter detection status, issue a command in the opposite direction to the detection direction, and shift the current position. The limiter detection signal turns OFF, allowing the motor to move in both directions.



The above positioning data assumes uniform incremental positioning data.

■ Parameter setting

To assign the limiter detection to a sequence output terminal, specify the corresponding value ("19") to the output terminal function setting parameter.

■ Relevant description

The limiter function is helpful to move at a uniform interval to the preset parameter position.

There is no need to calculate the frequency of starting or remaining distance to go.

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 the parameter PA2_25 (software OT selection/position command format) setting.

■ 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

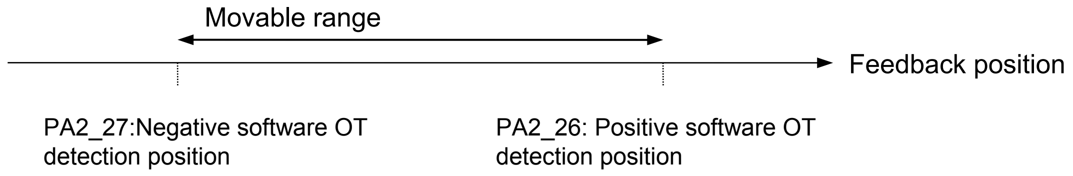
Set PA2_25 (software OT selection) at "1" (enable) to limit the position range of motion between (PA2_26 (positive software OT detection position)) and (PA2_27 (negative software OT detection position)).

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.

Supply pulse inputs in the direction opposite to the detection direction or perform manual feed (forward/reverse command) to return to the range. The signal will be turned off and movement in both directions will be possible.

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.



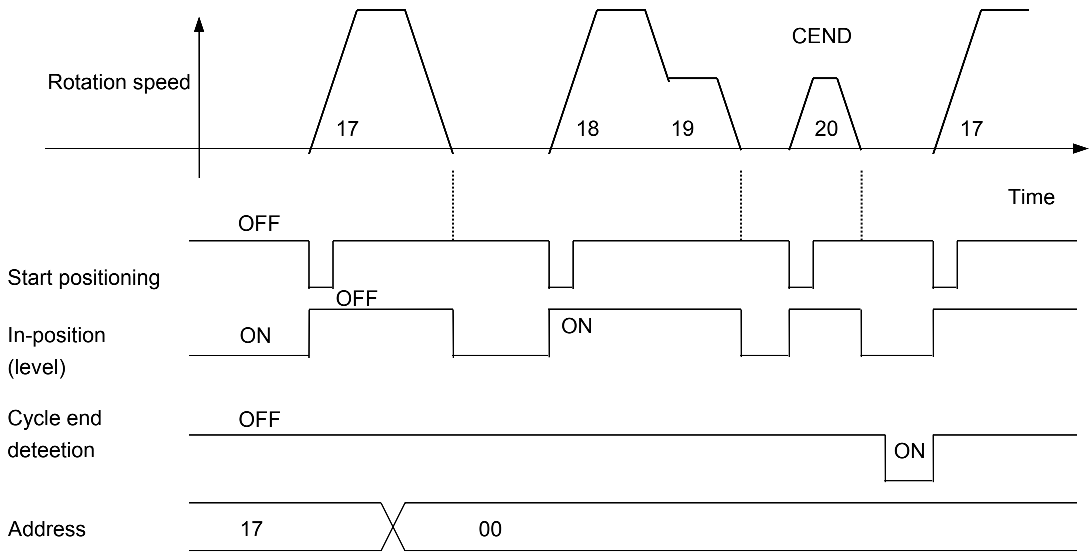
Cycle end detection: Sequence output signal (Reference value 21)

Add a cycle end to positioning data to check if the data position is reached. PA2_41 (sequential start selection) must be set at “1” (enable). Change PA2_40 (internal positioning data selection) to “1” (enable).

■ Function

Starting at the positioning data at an arbitrary address, execute positioning data with merely the start positioning signal sequentially until positioning data including the “CEND” status is reached.
Follow the procedure below to execute sequential start.

(1) Designate the first positioning data number and issue the start positioning signal to start the positioning motion.
(2) Turn all positioning data addresses off and issue the start positioning signal. The motion starts with the next positioning data.
(3) Step (2) is repeated until the positioning data including “CEND” is reached
(4) After positioning motions are completed up to the positioning data including “CEND,” the cycle end detection signal is turned on at the same timing as the in-position signal.
(5) You can supply the start positioning signal with all addresses turned off to repeat the above steps (1) through (4).



■ Parameter setting

To assign the cycle end detection to a sequence output terminal, specify the corresponding value ("21") to the output terminal function setting parameter.

2

■ Relevant description

The cycle end detection signal is not output if sequential start cannot be executed.

- If the servo-on signal is turned off
- If the pulse ratio is enabled or a homing cycle is executed during sequential operation
- If +OT or -OT is detected or if software OT is detected

Neither positioning cancel nor pause gives effects on cycle end detection.

When positioning data number 15 is reached during sequential operation, the cycle end process is executed.

If data continuation designation is included in positioning data, operation starts at the next data having no data continuation designation.

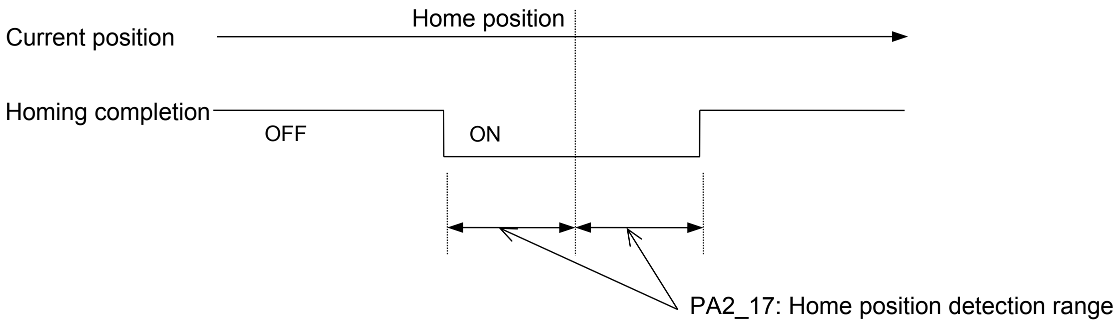
Homing completion: Sequence output signal (Reference value 22)

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

■ Function

This signal is turned on after the homing motion is normally finished. It remains turned on if the feedback position is within PA2_17 (home position detection range) around PA2_16 (home position after homing completion).

The signal is always turned on after homing if PA2_17 (home position detection range) is "0" or the maximum value.



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 is turned on if the difference (deviation amount) between the command position and feedback position is within the reference value of PA1_32 (zero deviation width/in-position range).
Position deviation will not be generated despite the reference value of PA1_32.

■ 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 reference values of PA1_41 to 47 (manual feed speed 1 to 7) or this is the speed command voltage to the VREF terminal.
The signal is enabled under speed control and position control (interrupt positioning) and in the homing cycle. It is turned off under torque control.
During manual operation, the signal is not output under the following conditions.

- If the [FWD] or [REV] signal is turned off
- 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. (Except for pulse input)

If the maximum rotation speed is exceeded due to an override or similar, the servomotor rotates at the specified value.

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 can be changed according to conditions. For details, refer to “Torque limit 0: Sequence input signal (Reference value 19), Torque limit 1: Sequence input signal (Reference value 20)” signal description.

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).

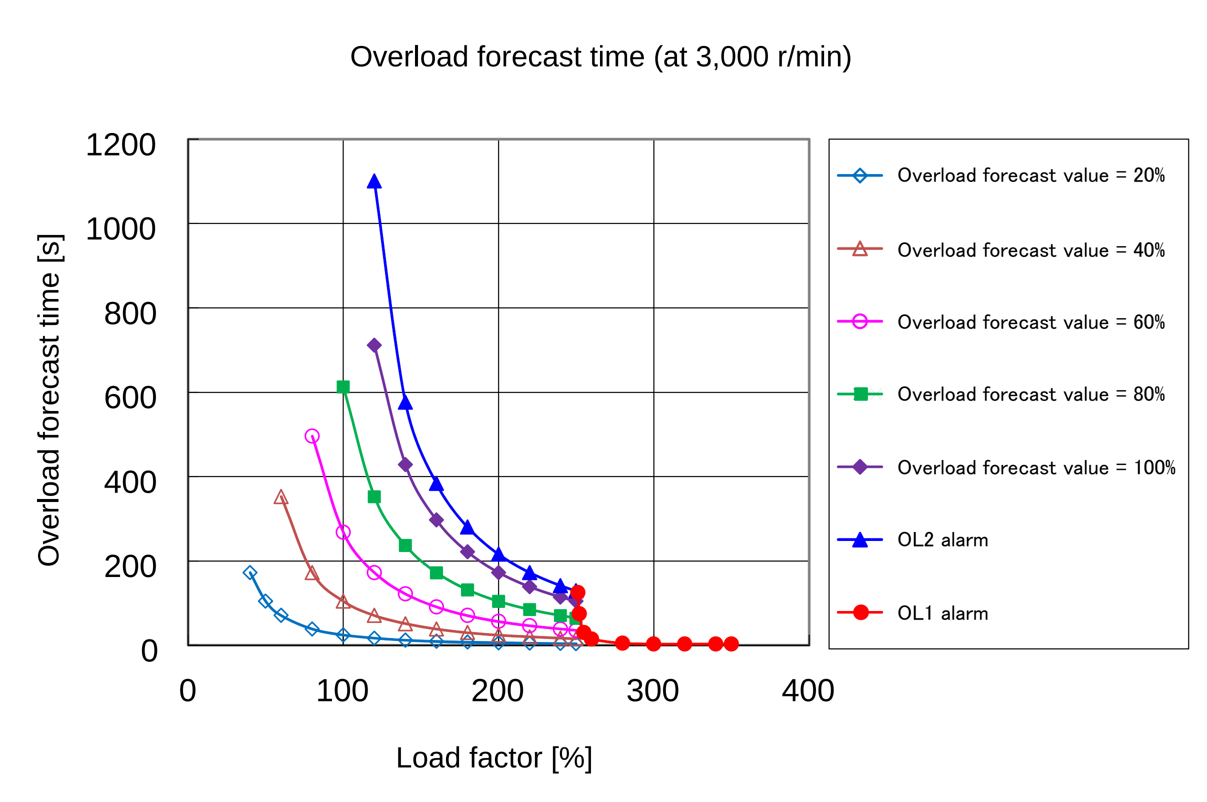
The signal is automatically turned off if the factor falls below the overload warning level. (There is no way to reset with a sequence input signal.)

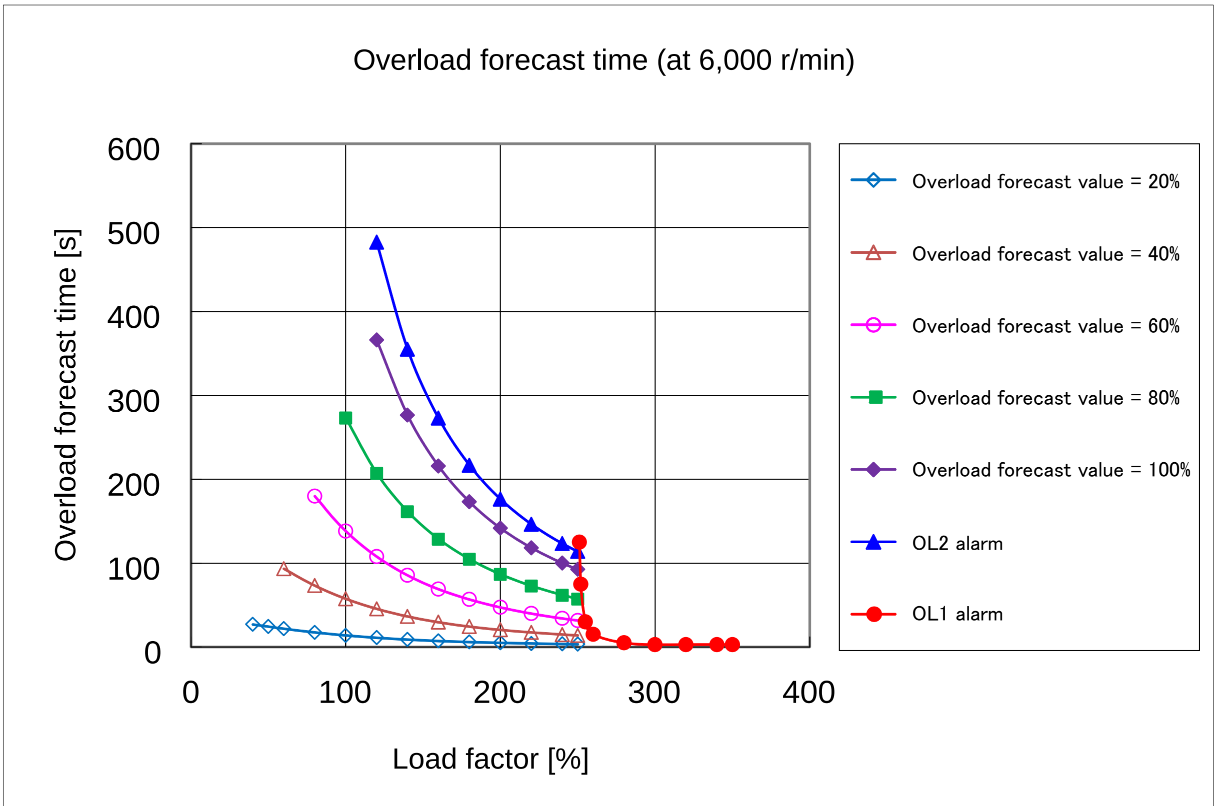
The signal can be issued before the servo amplifier trips due to an overload alarm. Determine the reference value while referring to the characteristics diagram specified on the next page.

■ 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.

■ Standard series





2

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
	Free-run [BX]	54	OFF
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.

Edit permission response: Sequence output signal (Reference value 29)

The signal is output if the "edit permission" input signal for enabling editing operation for parameters, etc. is turned on.

■ Function

After the edit permission assigned to a CONT input signal is turned on, under some conditions, the "edit permission response command" is turned on. The conditions are listed in the table below.

Edit permission	PA2_74	Parameter change operation	Edit permission response
Not assigned	0: Write enable	ON	Possible
OFF	0: Write enable	OFF	Impossible
ON	0: Write enable	ON	Possible
Not assigned	1: Write protect	OFF	Impossible
OFF	1: Write protect	OFF	Impossible
ON	1: Write protect	OFF	Impossible

■ Parameter setting

To assign the edit permission response to a sequence output terminal, specify the corresponding value ("29") to the output terminal function setting parameter.

■ Relevant description

For details, refer to “Edit permission: Sequence input signal (Reference value 55)” signal description.

Data error: Sequence output signal (Reference value 30)

The signal turns on if the data reading or rewriting process is not carried out successfully.

■ Function

The signal turns on when the address or data values are incorrect, or when data values are incorrect (outside specification values) when performing teaching.
When the teaching signal is turned off, the data error turns off.

■ Parameter settings

If assigning data errors to the sequence output terminal, set a value (30) corresponding to the output terminal function setting parameter.

Address error: Sequence output signal (Reference value 31)

The signal turns on if the positioning data number is out of the range.

■ Function

The signal turns on when AD3 to AD0 are all off, and the auto startup (4) signal turns on when PA2_41 (sequential start selection) is "0" (disable).
The signal turns OFF when starting (rewriting) with the correct positioning data No.

■ Parameter

To assign the address error to a sequence output terminal, specify the corresponding value ("31") to the output terminal function setting parameter.

2

Alarm code 0: Sequence output signal (Reference value 32)
Alarm code 1: Sequence output signal (Reference value 33)
Alarm code 2: Sequence output signal (Reference value 34)
Alarm code 3: Sequence output signal (Reference value 35)
Alarm code 4: Sequence output signal (Reference value 36)

Upon alarm, signal to output alarm details into code

■ Function

Alarm code 0 to 4 signals assigned to OUT output signals identifies the nature of the alarm.

■ Parameter setting

To assign alarm code 0 to 4 to sequence output terminals, specify the corresponding value ("32" to "36") to the output terminal function setting parameter. Correspondence between contents and numbers are as follows.

Alarm code 0 [ALM0] = (32), alarm code 1 [ALM1] = (33), alarm code 2 [ALM2] = (34), alarm code 3 [ALM3] = (35), alarm code 4 [ALM4] = (36),

■ List of alarm nature and code

Nature of alarm	ALM4	ALM3	ALM2	ALM1	ALM0	Code	Indication
No alarm (during correct operation)						00H	—
Overload 1					1	01H	oL1
Overload 2					1	01H	oL2
Overload 3					1	01H	oL3
Command pulse frequency error				1	0	02H	HF
Amplifier overheat				1	1	03H	AH
Internal regenerative resistor overheat			1	0	0	04H	rH1
External regenerative resistor overheat			1	0	0	04H	rH2
Braking transistor error			1	0	0	04H	rH3
Inrush current suppression circuit trouble			1	0	0	04H	rH4
Deviation overflow			1	0	1	05H	oF
Overcurrent 1			1	1	0	06H	oc1
Overcurrent 2			1	1	0	06H	oc2
Overspeed			1	1	1	07H	oS
Overvoltage		1	0	0	0	08H	Hu
Control power undervoltage		1	0	0	1	09H	Luc
Main power undervoltage		1	0	0	1	09H	LuP
Encoder trouble 1		1	0	1	0	0AH	Et1
Encoder trouble 2		1	0	1	0	0AH	Et2
Initial error		1	0	1	1	0BH	iE
Function safety error		1	1	0	0	0CH	EcF
Memory error		1	1	0	1	0DH	dE
Encoder communication error	1	0	0	0	0	10H	Ec
Motor combination error	1	0	0	0	1	11H	cE
CONT (Control signal) Error	1	0	0	1	1	13H	ctE
Encoder overheat	1	0	1	0	0	14H	EH
Absolute data lost 1	1	0	1	0	1	15H	dL1
Absolute data lost 2	1	0	1	0	1	15H	dL2
Absolute data lost 3	1	0	1	0	1	15H	dL3
Multi-turn data overflow	1	0	1	1	0	16H	AF

2

Type	Nature of alarm	Code
Address error	Out-of-range error	1AH
Data error	Out-of-range error	1DH
Maintenance function	Battery warning	17H
	Life warning	18H

- If two or more alarms occur simultaneously, alarms are output in the priority specified in the table above.
- The life warning is for the capacitors in the main circuit inside the servo amplifier and the cooling fan (OR condition).

+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

Set PA2_25 (software OT selection) at "1" to allow movement in the position range between (PA2_26 (Positive software OT detection position)) and (PA2_27 (Negative software OT detection position)).
For details, refer to 4.4.2 "PA2_25 to 27 Position operation type, software OT detection position".

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 is turned on while the forced stop signal (input signal) remains turned off.

■ 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.

2

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 or keypad (En_003) to discriminate between the main circuit capacitors and cooling fan.

■ Parameter setting

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

MD0: Sequence output signal (Reference value 60)
MD1: Sequence output signal (Reference value 61)
MD2: Sequence output signal (Reference value 62)
MD3: Sequence output signal (Reference value 63)
MD4: Sequence output signal (Reference value 64)
MD5: Sequence output signal (Reference value 65)
MD6: Sequence output signal (Reference value 66)
MD7: Sequence output signal (Reference value 67)

The M code of positioning data currently executed is output.

■ Function

Positioning data M codes are output as is during execution.
Unlike JIS B 3614, there are no specific functions for M00, M02, M30, M98, or M99, and all codes output are general-purpose codes.
There are no interlock functions such as MON or MOFF.
M codes are hexadecimal from 00 to FFH.
The default value M code output value is FFH (MD0 to MD are all ON).

■ Parameter setting

If assigning MD0 to the a sequence output terminal, set the value (60) corresponding to the output terminal function setting parameter.

■ Related

(1) M code setting range

M codes can be set in binary from 00h to FFh.

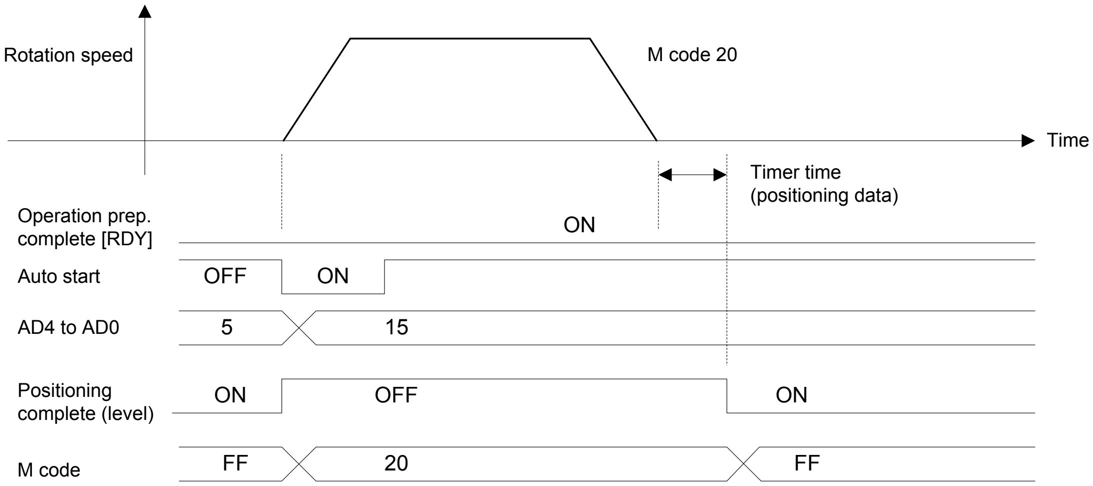
(2) Output at startup (during startup)/output at completion (after completion)

The M code output timing can be selected between during the execution of positioning data (output at startup) and after the execution of positioning data (output at completion).

Output at startup (during startup)

M codes are output from the start to completion of positioning operation. Output turns OFF when the positioning operation is complete.

Simultaneous M code simultaneous

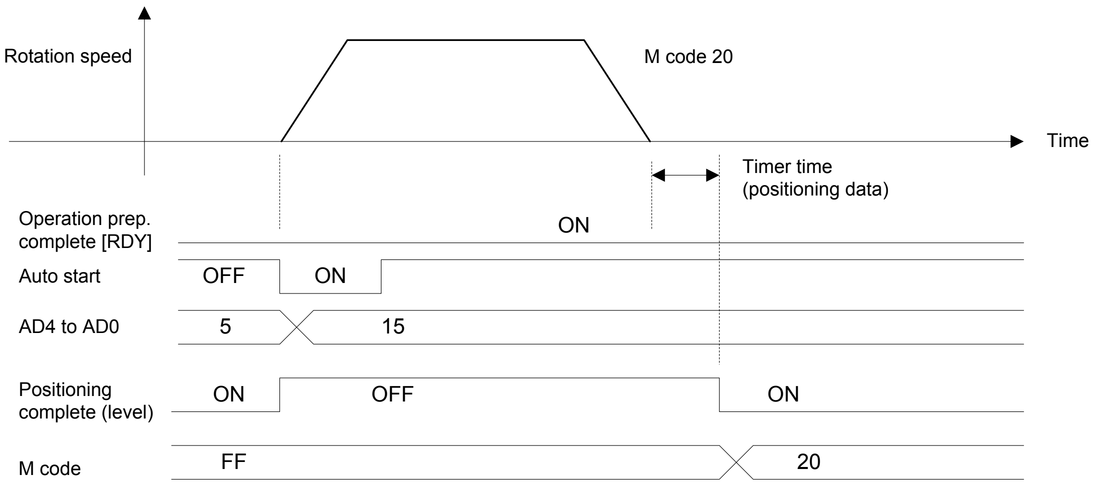


* Positioning data is executed while the timer time is counting up.
* The default M code is FF.

Output at completion (after completion)

M codes are output when the positioning operation is complete and then held.

Simultaneous M code simultaneous



* Positioning data is executed while the timer time is counting up.
* The default M code is FF.

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.

Immediate value continuation permission: Sequence output signal (Reference value 79)

The signal is turned on when the system is ready to accept an immediate value continuation command.

■ Function

The immediate value continuation command can be accepted only if this signal is turned on after immediate data operation is started.
The signal is turned off after the continuation setting completion signal is turned on. It is turned on again after data continuation is made.
The signal is turned off 50ms after positioning based on the post-continuation data.

For details, refer to "Immediate value continuation: Sequence input signal (Reference value 22)" signal description.

■ Parameter setting

To assign the immediate value continuation permission to a sequence output terminal, enter the corresponding value ("79") to the output terminal function setting parameter. Relevant signal reference values are shown below.

Assigned signal	No.
Immediate value continuation: sequence input signal	22
Immediate value continuation completion: sequence output signal	80
Immediate value continuation permission: sequence output signal	79

Immediate value continuation completion: Sequence output signal (Reference value 80)

The signal is turned on after continuation of immediate value operation is processed according to an immediate value continuation command, and it is turned off after the immediate value continuation command is turned off.

■ Function

After immediate data operation is started and positioning is completed, the positioning motion continues according to new target position (speed) data. The positioning motion continues even if deceleration is already started with immediate value operation data.
For details, refer to "Immediate value continuation: Sequence input signal (Reference value 22)" signal description.

■ Parameter setting

To assign the immediate value continuation completion to a sequence output terminal, enter the corresponding value ("80") to the output terminal function setting parameter. The relevant signal reference values are shown below.

Assigned signal	No.
Immediate value continuation: sequence input signal	22
Immediate value continuation completion: sequence output signal	80
Immediate value continuation permission: sequence output signal	79

Immediate value change completion: Sequence output signal (Reference value 81)

The signal is turned on when the changing process is executed according to an immediate value change signal, and it is turned off after the immediate value change is turned off.

■ Function

While the in-position signal is turned off after immediate value operation is started, the target position and target speed can be changed at an arbitrary timing.
For details, refer to "Immediate value continuation: Sequence input signal (Reference value 22)" signal description.
The command position and command speed change at the activating edge of the immediate value change command. While the positioning completion signal is turned off, they can be changed at an arbitrary timing.

■ Parameter setting

To assign the immediate value change completion to a sequence output terminal, enter the corresponding value ("81") to the output terminal function setting parameter. The relevant signal reference values are shown below.

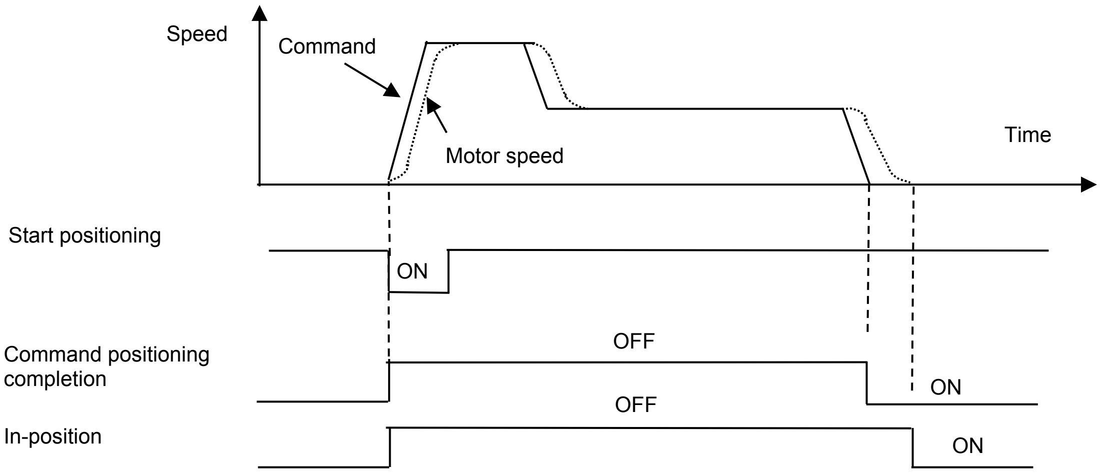
Assigned signal	No.
Immediate value change : sequence input signal	23
Immediate value change completion : sequence output signal	81

Command positioning completion: Sequence output signal (Reference value 82)

The signal is turned on after the command value inside the servo amplifier is completed.

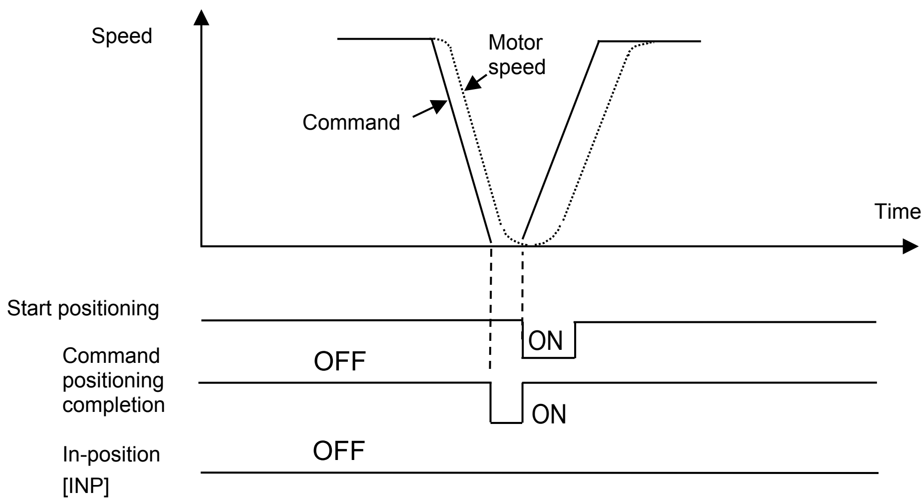
■ Function

The signal changes from ON to OFF when starting manual operation, automatic operation, homing, or interrupt positioning, and from OFF to ON when the internal command becomes zero. However, the OFF status will continue if still running, even if the command is zero such as while the automatic operation continue stop timer is still counting up for example. When continuation of operation is disabled due to alarm detection, emergency stop detection or OT detection, this signal is immediately turned on.



If the command positioning completion signal is assigned to an output signal, the condition for the next start signal is activation of the command positioning completion signal. Refer to the timing chart below.

(Example : Positioning continuation)



If a motion to the current position is started, the servomotor does not start but the in-position signal is turned off for the time specified in PA1_34 (in-position minimum OFF time / single shot ON time).

■ Parameter setting

To assign the command position completion to a sequence output terminal, specify the corresponding value ("82") to the output terminal function setting parameter.

Range 1 of position: Sequence output signal (Reference value 83)
Range 2 of position: Sequence output signal (Reference value 84)

This signal is issued upon detection of the current servomotor position.

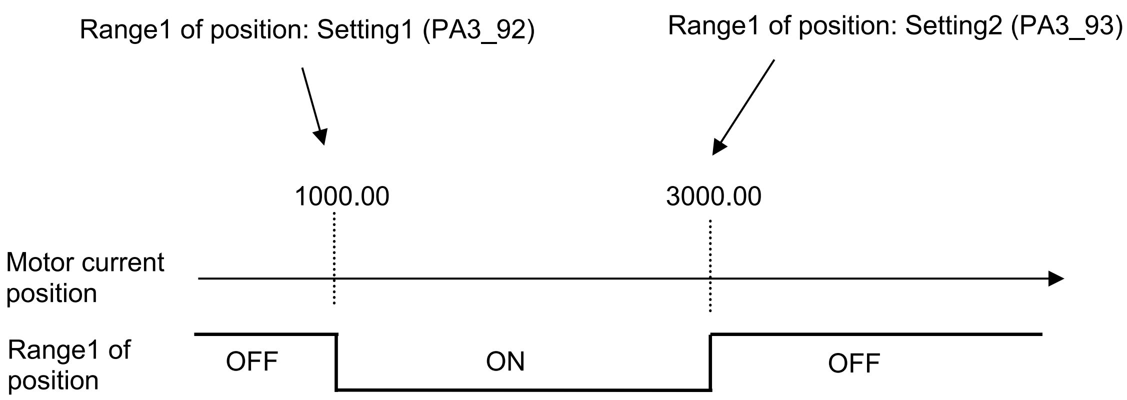
■ Parameter setting

The signal can be output at two positions: position range 1 and 2.

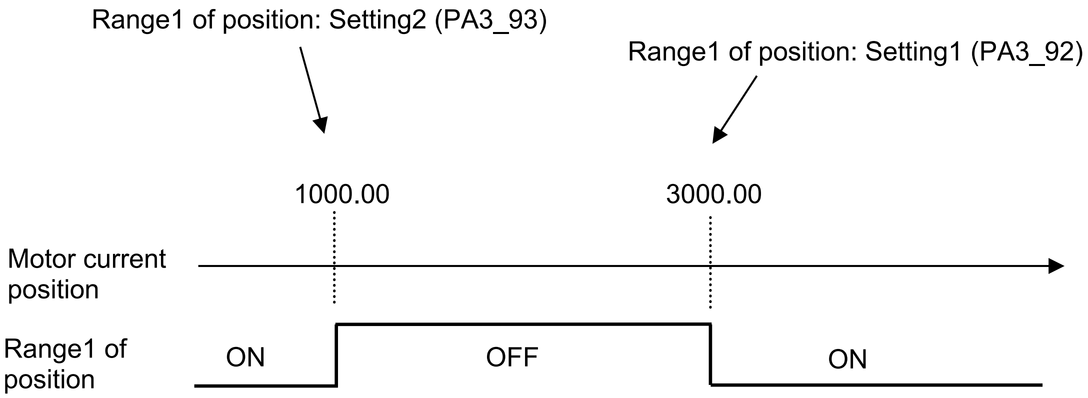
Range 1 of position: Enter at PA3_92 and _93.

Range 2 of position: Enter at PA3_94 and _95.

1) Setting value of PA3_92 < Setting value of PA3_93



2) Setting value of PA3_92 > Setting value of PA3_93



Note: If setting 1 of range 1 of position (PA3_92) is the same as setting 2 of range 1 of position (PA2_93), range 1 of position is always turned off. The same is true for range 2 of position.

■ Parameter setting

To assign range 1 or 2 of position to a sequence output terminal, specify the corresponding value ("83") or ("84") to the output terminal function setting parameter.

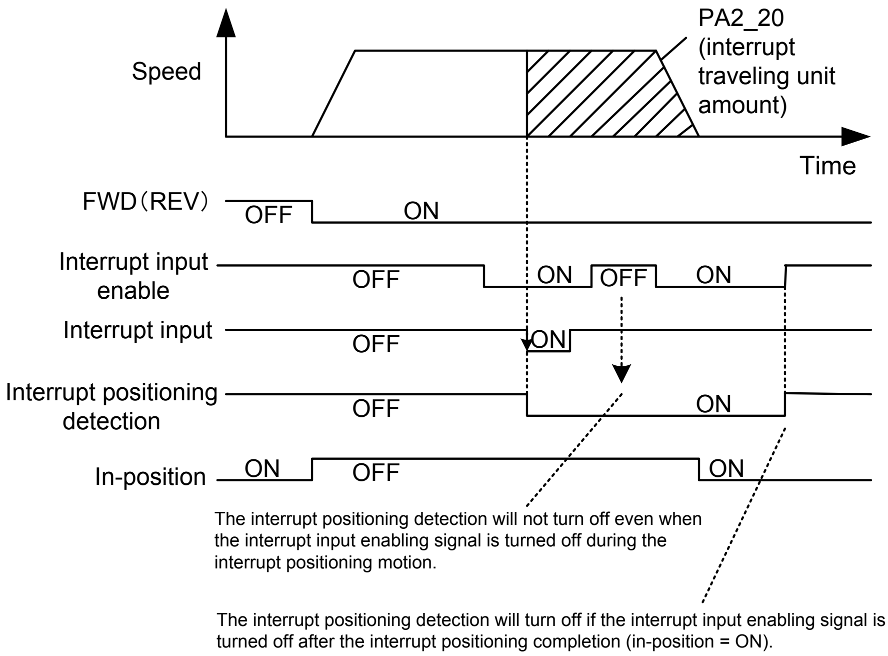
Interrupt positioning detection: Sequence output signal (Reference value 85)

This signal outputs the interrupt positioning motion mode status.

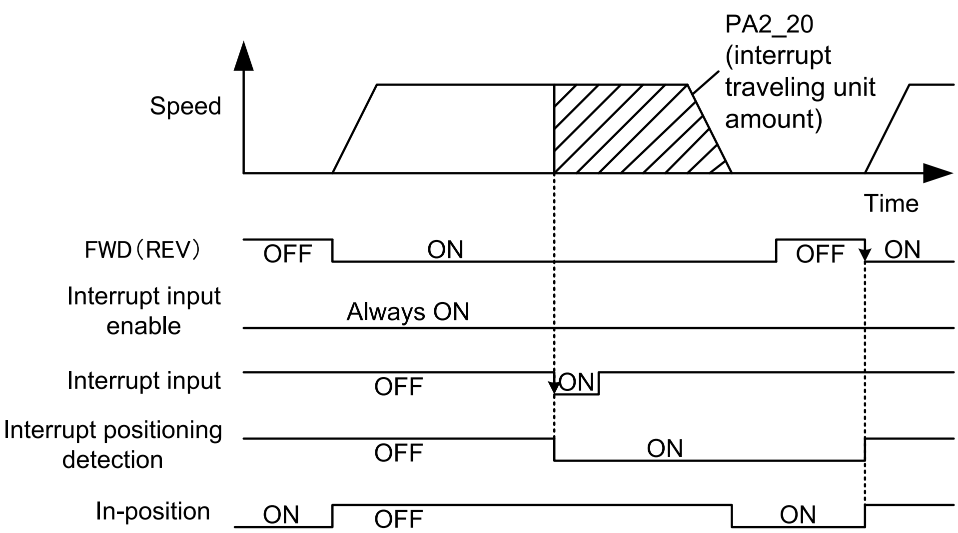
■ Function

The signal turns on during interrupt positioning motion, and turns off with any of the following conditions.

(1) When the interrupt input enabling signal is turned off after the positioning motion completion.



(2) When the next start signal (FWD, REV, START, or ORG) is turned on.



(3) When the positioning cancel signal is turned on during interrupt positioning motion.

(4) When changed to other than the position control servo-on mode from the interrupt positioning mode

Example) EMG: emergency stop by turning to OFF, alarm occurrence, changed to speed control, etc.

2

■ Parameter setting

To assign interrupt positioning detection to a sequence output terminal,specify the corresponding value (“85”) to the output terminal function setting parameter.

■ Relevant description

If the temporary stop is turned on during interrupt positioning motion, the mode is regarded as the interrupt positioning mode.

(The interrupt positioning detection signal remains on.)

Interference detection: Sequence output signal (Reference value 86)

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

<u>This signal is valid only when parameter PA4_06 (interference detection enable/disable) is “1” (enable).</u>

■ 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 "4.8 Extension Function 2 Setting Parameters, 4.8.2 Description of Each Parameter" for details on the interference detection function.

■ How to return to regular operation

If the interference detection function worked to make the motor retract in the direction of no interference, operation in a regular manner ais enabled after this signal is turned off.

In position control mode (pulse operation) and speed control mode, however, the operations in the following table must be performed to return to the regular operation:

Operation mode	Restoration method
Position control (pulse operation)	Restart the servo amplifier. Servo ON signal = OFF Alarm reset signal = ON
Speed control	Restart the servo amplifier. Servo ON signal = OFF FWD signal/REV signal = OFF

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.

CONTa Through: Sequence output signal (Reference value 91)
CONTb Through: Sequence output signal (Reference value 92)
CONTc Through: Sequence output signal (Reference value 93)
CONTd Through: Sequence output signal (Reference value 94)
CONTe Through: Sequence output signal (Reference value 95)

This function allows communications input signals to be output via OUT signals of the hardware.

■ Function

The signals set to CONT 20 to 24 can be output through OUT signals 1 to 3 of the hardware. When a CONT□ signal is allocated to an OUT signal, the ON/OFF status of the CONT signal is output as a through signal to the OUT signal regardless of the function allocation of the corresponding CONT signal.

CONT signals respectively correspond to CONT a to e

	Corresponding CONT signals
CONTa	CONT20
CONTb	CONT21
CONTc	CONT22
CONTd	CONT23
CONTe	CONT24

■ Parameter setting

To assign a CONT□ through signal to a sequence output terminal, set the values (91 to 95) corresponds to the parameter of output terminal function setting. The setting values to the relevant signals are as follows.

PA3_51 to 53

No.	Name	Setting range	Change
51	OUT1 signal assignment	0 to 95 91 : CONTa through 92 : CONTb through 93 : CONTc through 94 : CONTd through 95 : CONTe through	Power
52	OUT2 signal assignment		
53	OUT3 signal assignment		
54	OUT4 signal assignment		
55	OUT5 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. Refer to the connection diagram described here.

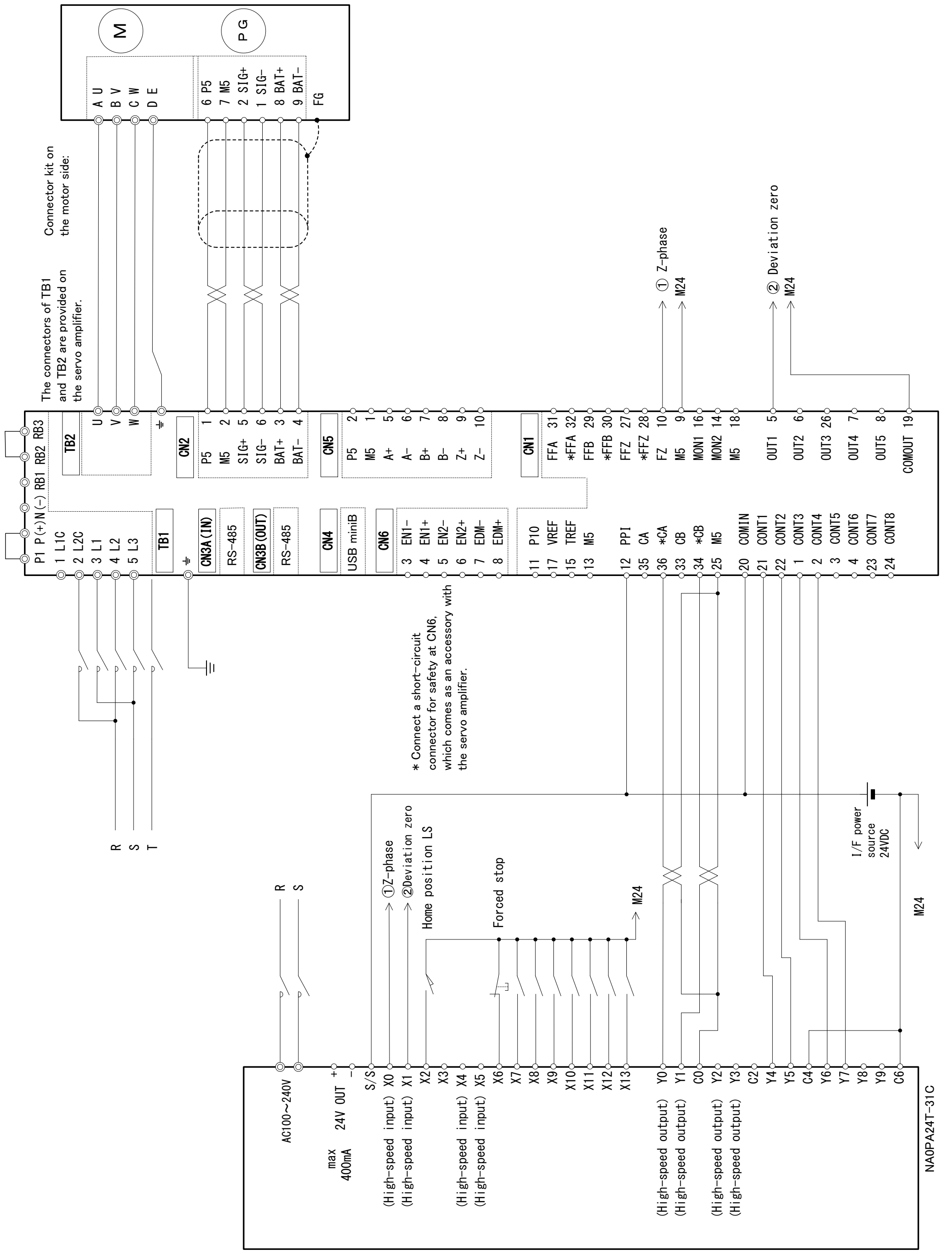
- Connector 4 (CN4) is for the PC Loader. It is irrelevant to operation or stopping of the servomotor.
- To drive a servomotor, the main power and control power must be supplied. To edit parameters or perform similar operation without rotating the motor, supply only the control power.
- Prepare separate 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.

2.6.1 Connection Example (MICREX-SX SPF Series: NA0PA24T-31C)

A connection example with high-functionality type of MICREX-SX SPF (four-axis pulse output) is shown below.

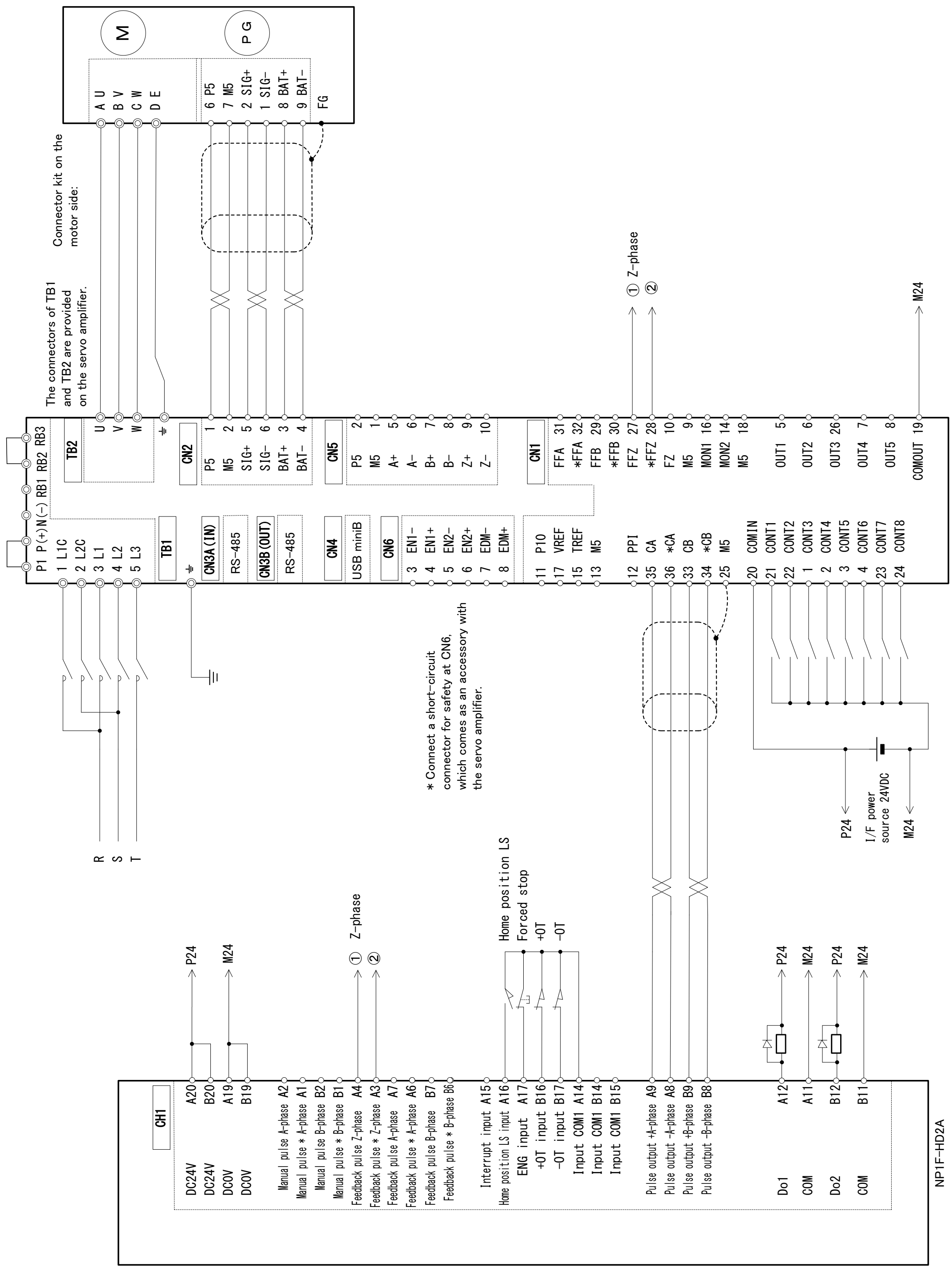
The maximum output frequency is 200kHz (at open collector input).

For details, refer to the manual of MICREX-SX SPF Series.



2.6.2 Connection Example (Positioning module: NP1F-HD2A)

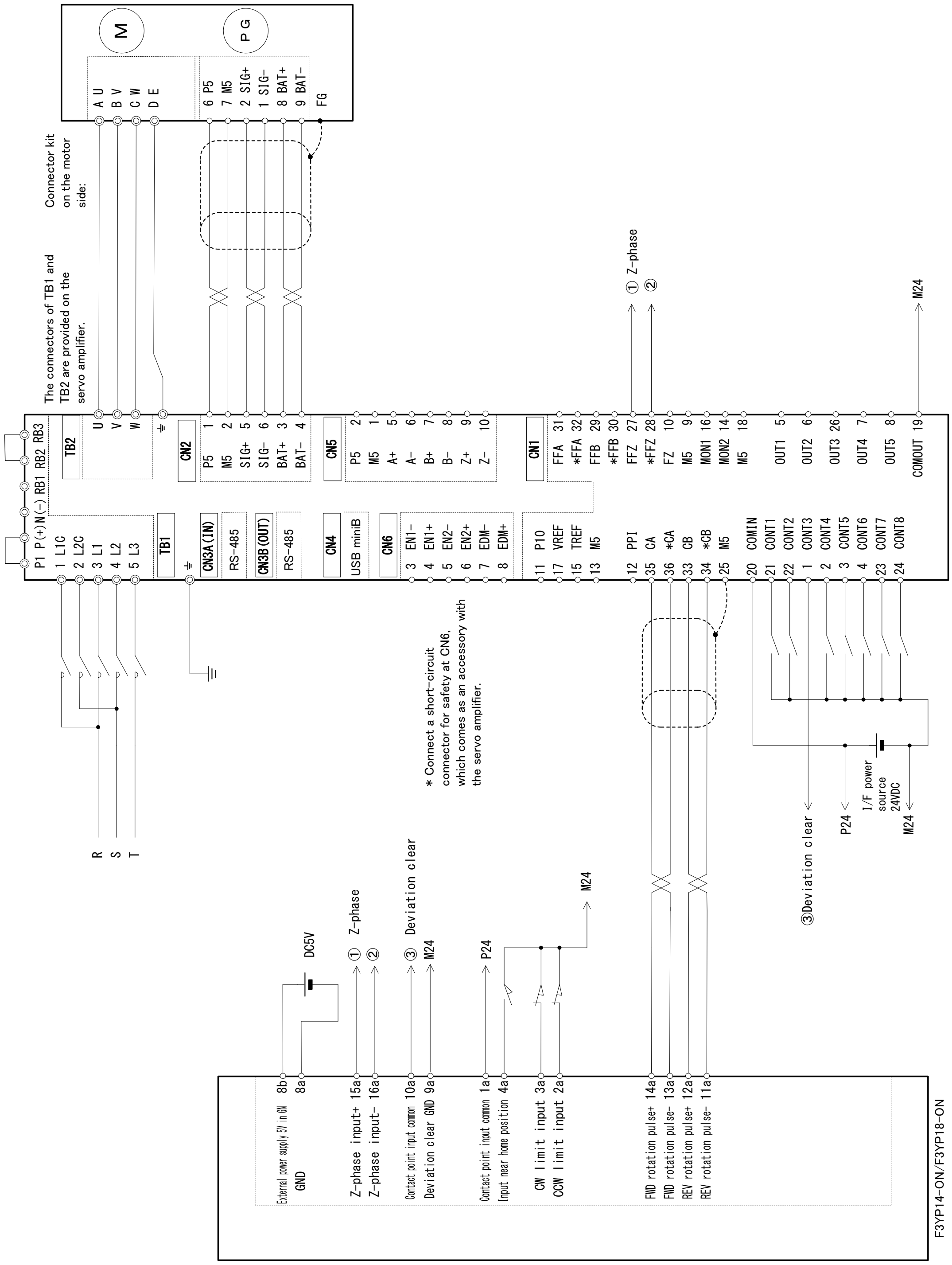
A connection example with MICREX-SX Series pulse two-axis positioning module is shown below. The maximum output frequency is 5.0MHz (at differential input). For details, refer to the manual of the positioning module.



2.6.3 Connection Example (Positioning module: F3YP14-0N/F3YP18-0N)

A connection example with F3YP14-0N type positioning module made by Yokogawa Electric is shown below.

For the PLC, refer to the corresponding manual.

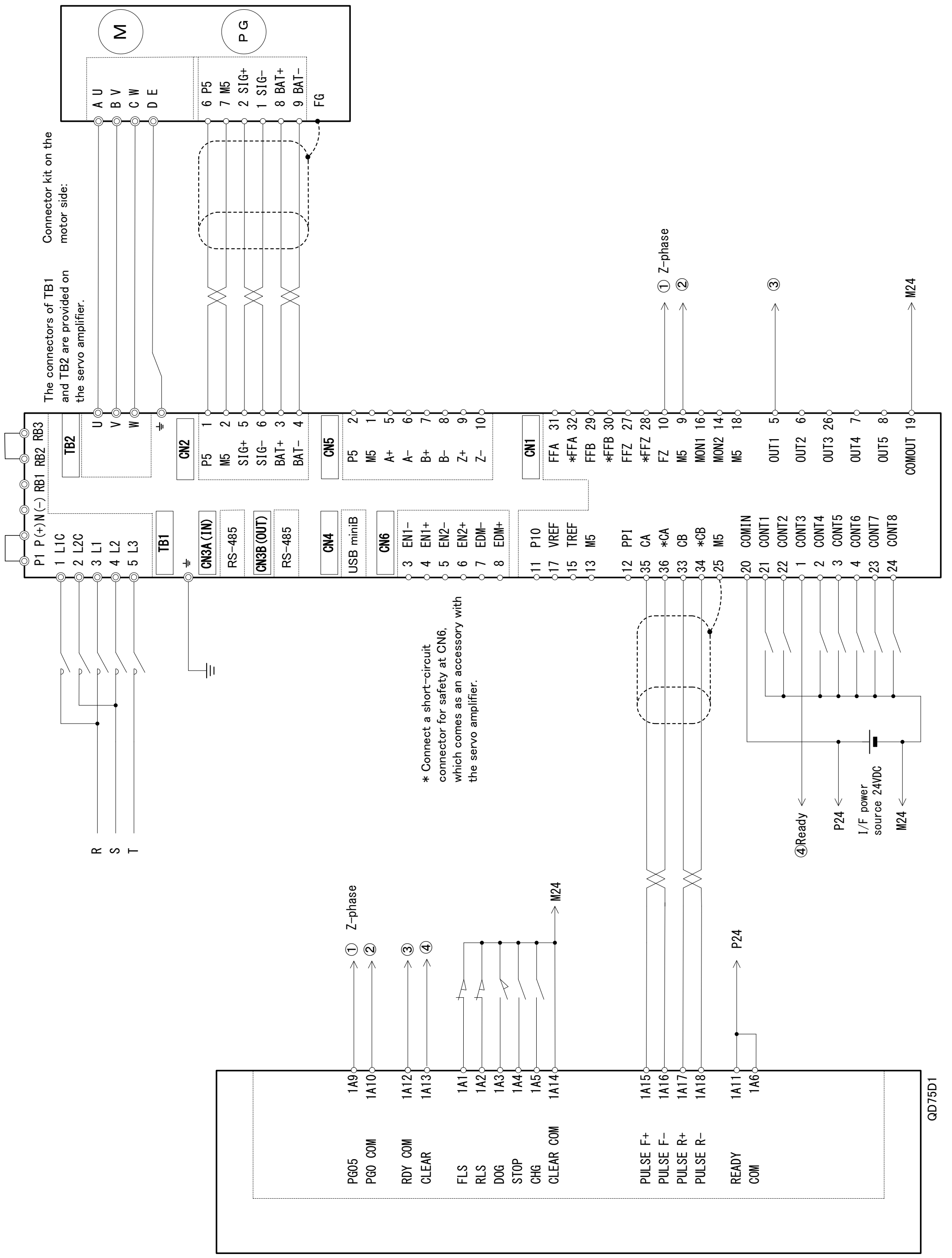


2.6.4 Connection Example (Positioning unit: QD75D1 type)

A connection example with QD75D1 type positioning unit made by Mitsubishi Electric is shown below

Connection between the QD75D1 type positioning unit and the servo amplifier is shown.

For the PLC, refer to the corresponding manual.



2

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 1.5×10^{-8} (PFH)
	Probability of failure on demand average [h^{-1}]	Less than 1.5×10^{-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

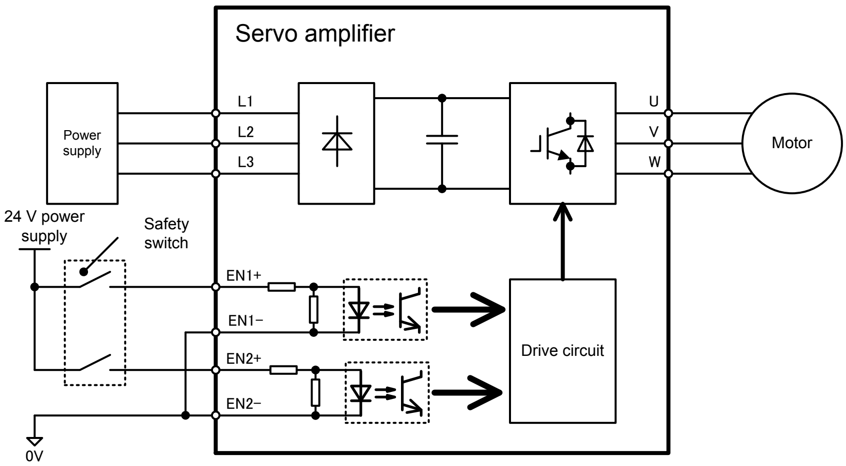


Fig. 2.7.3-1 Function block diagram

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.

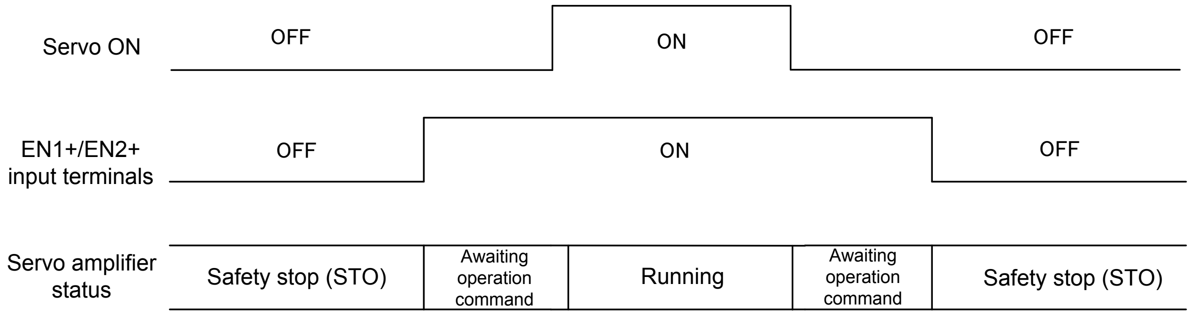


Fig. 2.7.3-2 Servo amplifier output status if safety stop (STO) occurs while servo amplifier stopped

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).

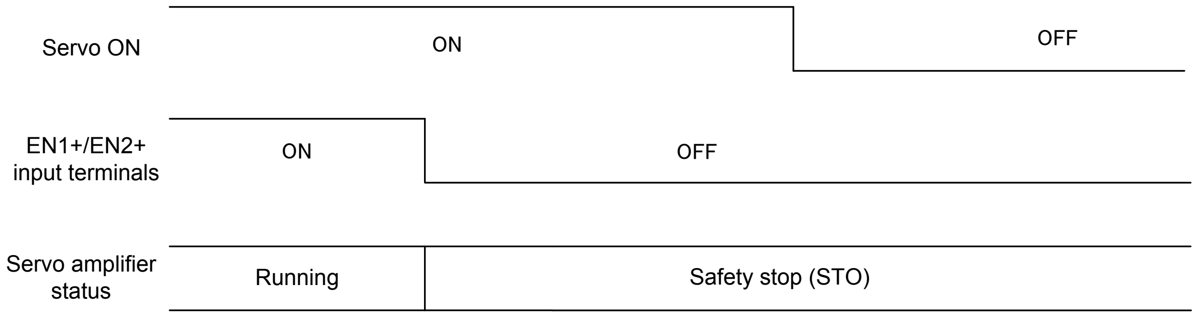


Fig. 2.7.3-3 Servo amplifier output status if safety stop (STO) occurs during servo amplifier operation

2

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

Fig. 2.7.3-4 shows the timing chart for the Ecf 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 Ecf 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.

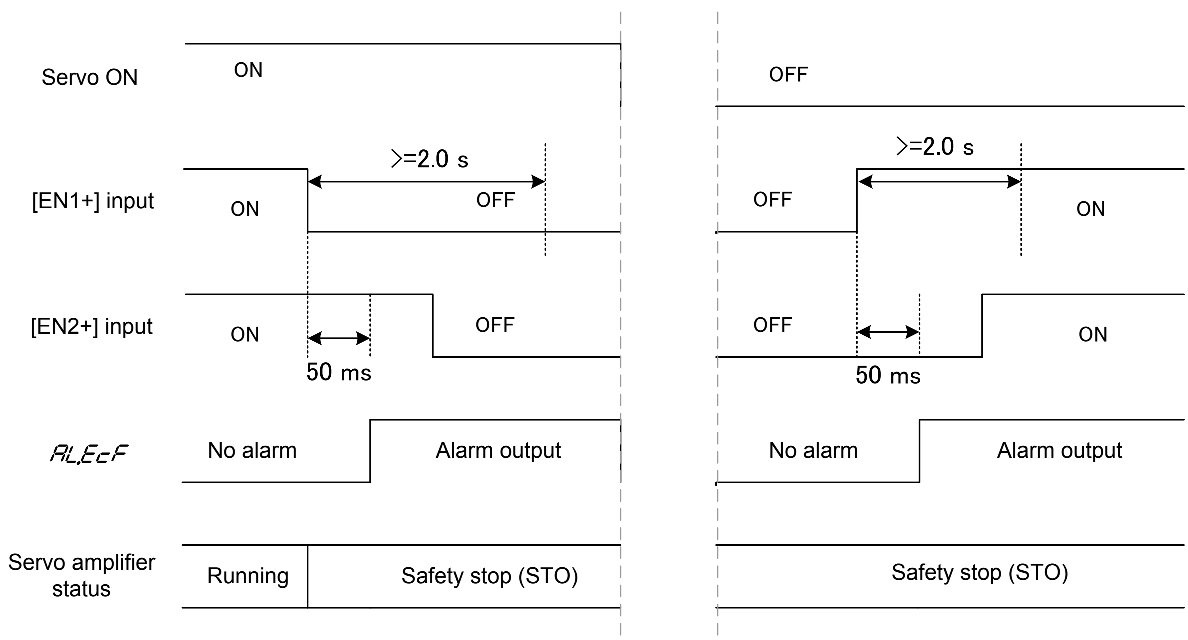


Fig. 2.7.3-4 EcF alarm (logic mismatch) and servo amplifier output status

2.7.3.3 Description of Signals

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

<table>
<tr><th>No.</th><th>Symbol</th><th>Specification</th></tr>
<tr><td>1</td><td>N.C</td><td>Use is prohibited. Do not wire.</td></tr>
<tr><td>2</td><td>N.C</td><td>Use is prohibited. Do not wire.</td></tr>
<tr><td>3</td><td>EN1-</td><td>This is the [EN1+] input signal common terminal.</td></tr>
<tr><td>4</td><td>EN1+</td><td>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.</td></tr>
<tr><td>5</td><td>EN2-</td><td>This is the [EN2+] input signal common terminal.</td></tr>
<tr><td>6</td><td>EN2+</td><td>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.</td></tr>
<tr><td>7</td><td>EDM-</td><td rowspan="2">This signal outputs the safety stop function (STO) operating status.
• Max. voltage: 30 VDC
• Max. ON current: 50mA

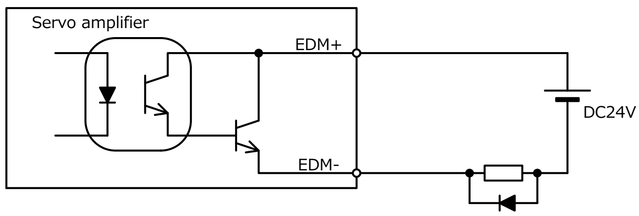


Fig. 2.7.3-5 Connection drawing

<table>
<tr><th colspan="2">Input signal</th><th rowspan="2">EcF alarm</th><th>Output signal</th><th rowspan="2">Servo amplifier status</th></tr>
<tr><th>[EN1+]</th><th>[EN2+]</th><th>[EDM] *1</th></tr>
<tr><td rowspan="2">ON</td><td rowspan="2">ON</td><td>Not output</td><td>OFF</td><td>Operation preparation complete</td></tr>
<tr><td>Output</td><td>OFF</td><td>Safety stop (STO)</td></tr>
<tr><td rowspan="2">OFF</td><td rowspan="2">OFF</td><td>Not output</td><td>ON</td><td>Safety stop (STO)</td></tr>
<tr><td>Output</td><td>OFF</td><td>Safety stop (STO)</td></tr>
<tr><td>ON</td><td>OFF</td><td>Output</td><td>OFF</td><td>Safety stop (STO)</td></tr>
<tr><td>OFF</td><td>ON</td><td>Output</td><td>OFF</td><td>Safety stop (STO)</td></tr>
</table>
*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</td></tr>
<tr><td>8</td><td>EDM+</td></tr>
</table>

2

CHAPTER 3 OPERATION

3

3

3.1 Signal Description (Priority among Input Signals)

Input signals of the servo amplifier for stopping the motor shaft are received first in view of safety.

Section	Description	Applicable function (Function No.)
01	Operation signal always given highest priority	・ STO (EN terminal input)
02	Operation signal always given priority	・ Free-run command (54) ・ Servo-on (1)
03	Operation signal always given priority	・ Forced stop (10) ・ External regenerative resistor overheat (34)
04	Signal for controlling the torque	・ Torque limit 0 (19) ・ Torque limit 1 (20)
05	Signal for stopping the motor	・ +OT (7) ・ -OT (8) ・ Pause (31) (LS type only) ・ Positioning cancel (32) ・ Deviation clear (50)
06	Signal for rotating the motor	・ FWD (2) ・ REV (3) ・ Start positioning (4) (LS type only) ・ Homing (5)
07	Signal for determining the home position	・ Home position LS (6) ・ +OT (7) ・ -OT (8) ・ Interrupt input (49) ・ Position preset (16)
08	Signal irrelevant to motor operation	・ Alarm reset (11) ・ Edit permission (55) (LS type only)

- When the STO function is triggered, the motor free runs to a stop.
  If the PA2_61: Action sequence at servo-on OFF setting value is other than free run, the dynamic brake is applied to stop the motor. If there are concerns over falling if using motors for lifting equipment, employ such means as a mechanical brake to ensure that safety is maintained.
- The moving part of the mechanical system of the elevator may drop if a free-run command is used. Do not assign the command unless necessary.
- If +OT (7) is detected during rotation caused by the FWD (2) signal, priority is given to the +OT (7) signal.
  Even if the +OT (7) signal is detected, priority is given to the torque limit (30) signals.
  Priority is given to forced stop (10) during operation with a torque command (30) signals. However, if the free-run command (34) signal is issued, the servo amplifier output is stopped.

The response time of the sequence input terminal and output terminal is about 1 [ms].

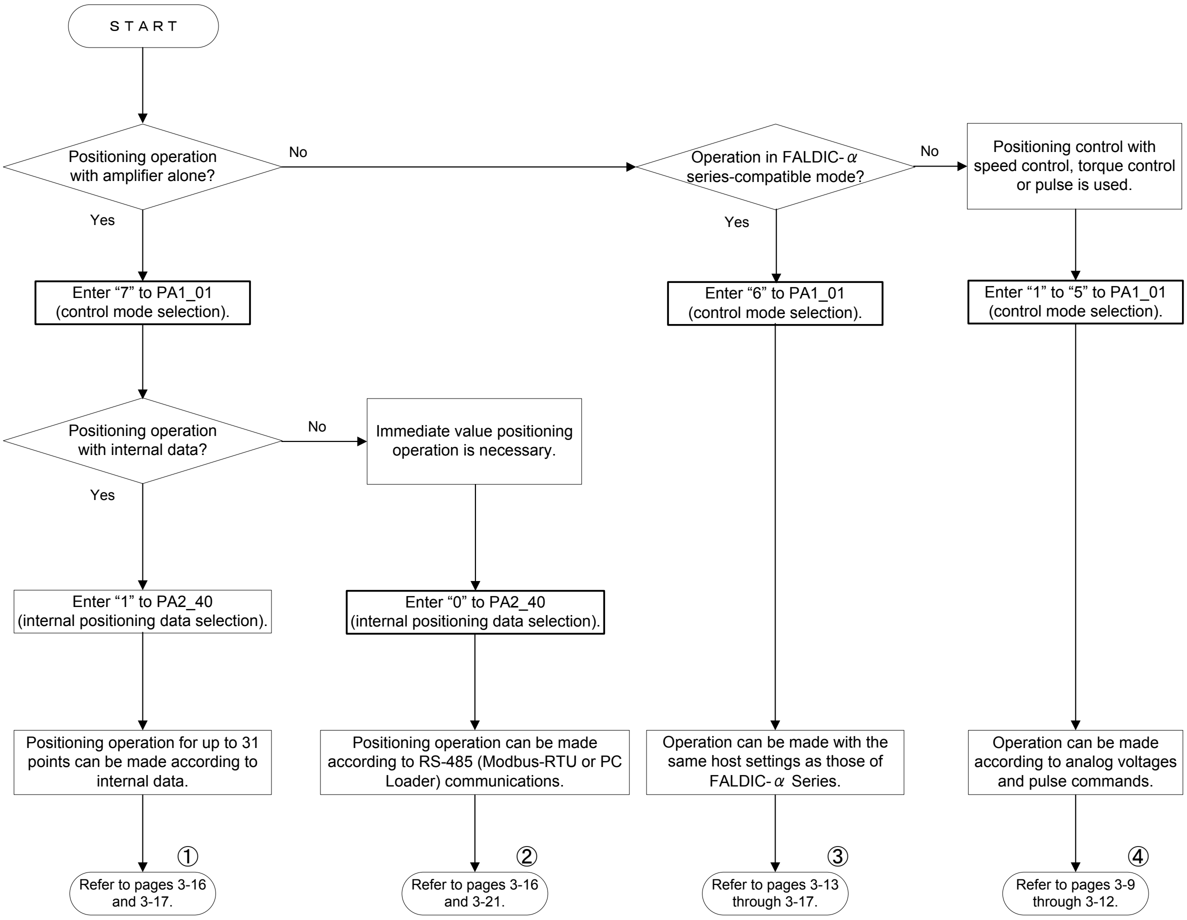
If the zero deviation signal setting or similar is too small, the host PLC may fail to recognize.

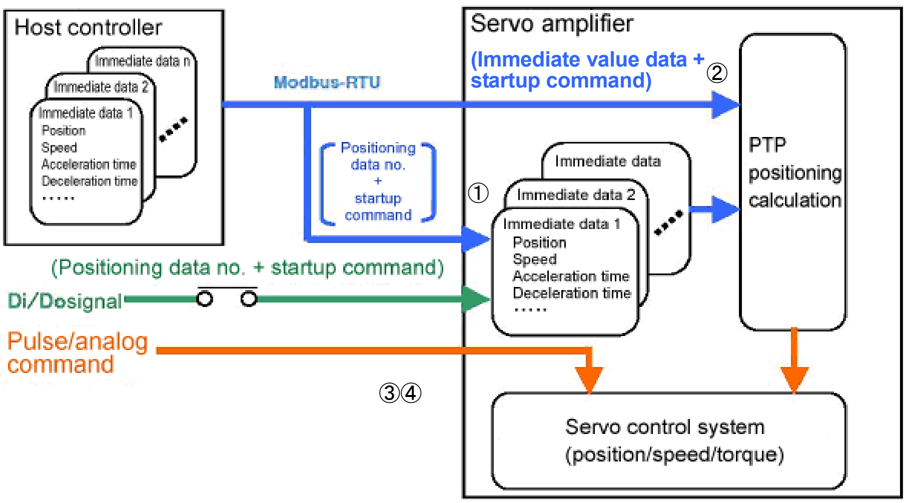
(The scanning cycle of a general PLC is several tens of milliseconds [ms].)

3.2 Selection of Operation Procedure

The VV type servo amplifier is capable of speed control and torque control with analog voltages, position control with pulse, positioning data operation with Di/Do signals or RS-485 communications, and immediate value data operation with RS-485 communications.

Follow the flow chart below to select the desired operation and enter parameters, etc.





3.3 Operation Check

3.3.1 Power-On

Connect the commercial power supply and the servomotor to the servo amplifier.

For the wiring method, refer to "CHAPTER 2 WIRING."

3

■ Supplying commercial power

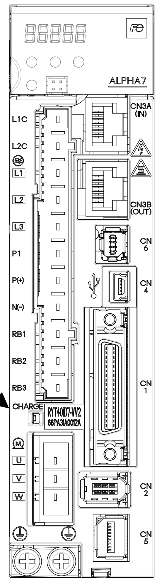
Operate MCCB/ELCB to supply power.

Supply main power simultaneously or later to the control power.

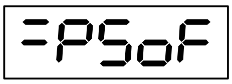
If necessary, insert an electromagnetic contactor in the upstream of the main power input so that the power can be shut off at any time.

The main power (L1, L2 and L3) and control power (L1C and L2C) are separated internally. Be sure to supply power to both of them. The following results indicate the correct state.

(1) The charge LED lights up in red.



(2) If the servo amplifier is in the factory shipment state, the keypad shows the following.



■ If the charge LED fails to light up

Appropriate voltage (200 [V] or 100 [V]) is not supplied to the main power terminals (L1, L2 and L3). Check the source voltage.

Furthermore, if using a three-phase 400 V power supply, supply power after first dropping the voltage to 200 V with a transformer (the servo amplifier will suffer damage with 400 V.)

- If the keypad does not light up

  Appropriate voltage (200 [V]) is not supplied to the control power terminals (L1C and L2C). Check the source voltage.
  In case of three-phase 400 [V], use a transformer to drop to 200 [V] to supply. (400 [V] will damage the servo amplifier.)

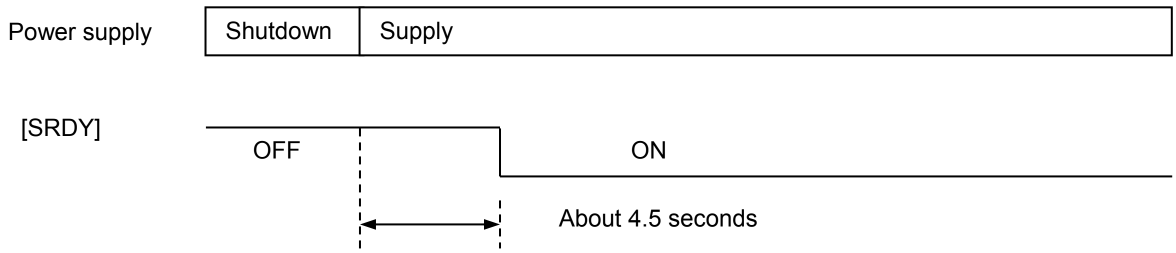
- If the keypad indicates differently

  If two characters from the left is "AL." an alarm is detected. In this case, the display blinks.

If the keypad shows those other than specified above, the servo amplifier is not in the factory shipment state.

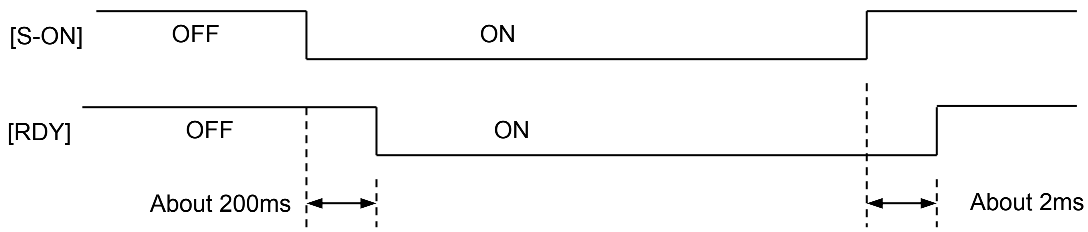
3.3.2 Power-On/Servo Control-Ready [S-RDY]

The servo control ready [S-RDY] signal is issued about 4.5 seconds after the control and main power supplies are turned on.
The CPU inside the servo amplifier diagnoses itself and, if the result is correct, the signal is issued and remains turned on until the power is shut down.
The servo ready [S-RDY] signal is not output during free-run or STO operation.



3.3.3 Servo-On [S-ON]/Ready for Servo-On [RDY]

This signal is used to supply power to the servomotor to enable rotation. If turned OFF while stopping the motor, it will decelerate and stop based on the parameter PA2_61 setting.
If the signal is turned off during motor rotation, the motor decelerates to stop and, after it is stopped, the motor free-run.
After servo-on is turned on and the motor becomes ready to rotate, the ready for servo-on [RDY] signal is turned on and the motor is in the ready-to-rotate state can be checked.



The servo amplifier input signal can be always enabled with parameters PA3_26 to PA3_30.
Servo-on [S-ON] turned on before power-on does not cause breakage to the servo amplifier.

3.3.4 Test Operation at Keypad

Using the test operation mode of the keypad, check the motor rotation.
In case of a servomotor equipped with a brake, supply 24 [V] DC to release the brake.
The motor rotates even without a sequence I/O signal.
The relevant parameter settings and default values are shown below.

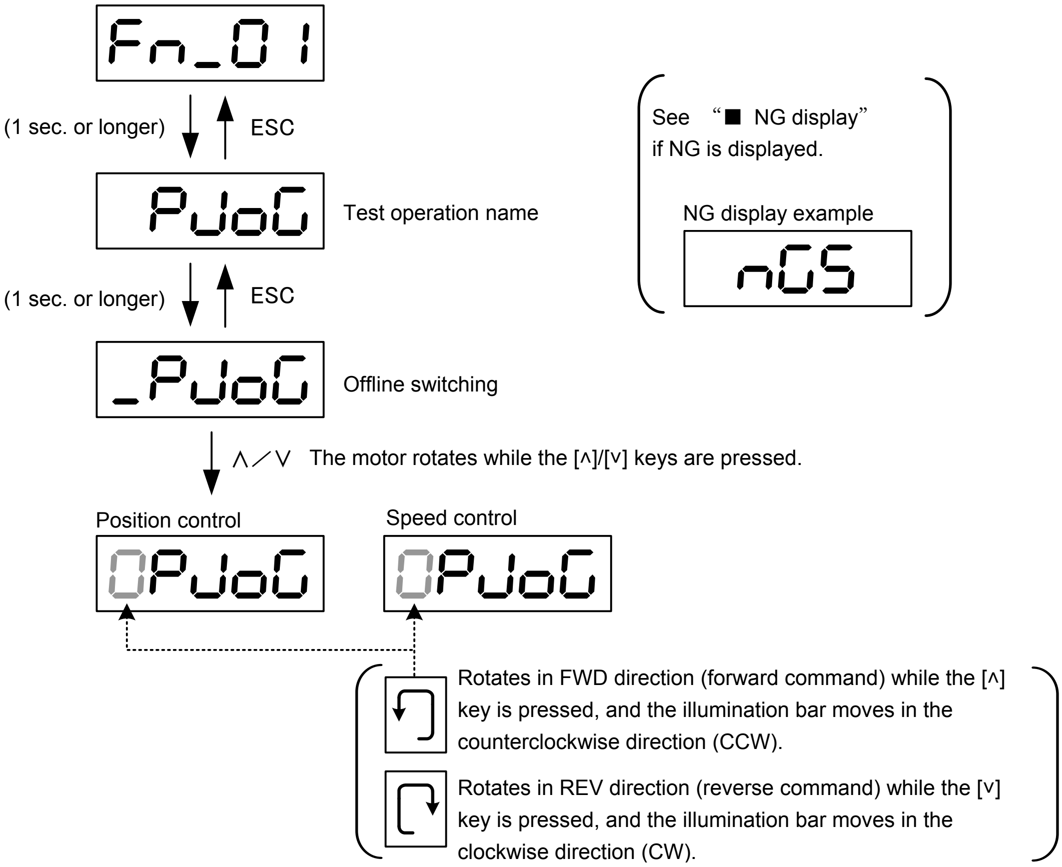
Parameter No.	Name	Setting range	Default value
PA1_37	Acceleration time 1	0.0 [ms] to 99999.9 [ms]	100.0 [ms]
PA1_38	Deceleration time 1	0.0 [ms] to 99999.9 [ms]	100.0 [ms]
PA1_41	Manual feed speed 1	0.01 [r/min] to (max. speed) [r/min]	100.0

■ Test operation at keypad

Follow the procedure below to check that the output shaft of the servomotor rotates.

[1] Use the [MODE/ESC] key to start the test operation mode [Fn_01].

[2] The servomotor rotates while the key on the keypad is held down.



After checking shaft rotation in the test operation mode, press the [MODE/ESC] key to return until [Fn_01] is displayed again.
Unless [Fn_01] is displayed again, rotation with the sequence I/O signal is impossible.

Hint	**Notation of key** In this chapter, keys on the keypad may be simply specified as shown below. • [MODE/ESC] key In the case of [MODE] function: MODE In the case of [ESC] function: ESC • [SET/SHIFT] key In the case of [SET] function: SET (1 sec. or above) In the case of [SHIFT] function: SHIFT

3.3.5 If the Servomotor Fails to Start

If the servomotor fails to start or unexpected indication is given, it is recommended to undergo the procedure described in “14.5.8 Diagnosis to be Made If the Servomotor Fails to Start”, using PC Loader.

3.3.6 Shutdown

If the power is turned off with the servo-on signal turned on, the servo amplifier detects a low voltage alarm.

- If the motor power supply is turned OFF for longer than the PA2_68: Main power shutoff detection time with the servo-on signal ON and then turned ON again, a main circuit power supply low voltage alarm (LVP) is detected.
- If the motor power supply is turned ON again after at least 1 second longer than the PA2_68: Main power shutoff detection time has elapsed with the servo-on signal ON, main circuit power supply low voltage is not detected.
- If the DC link voltage drops below about 200V and the power is restored within one second with the servo-on signal being turned on, the main power undervoltage is detected. If the duration exceeds one second, the main power undervoltage is not detected.

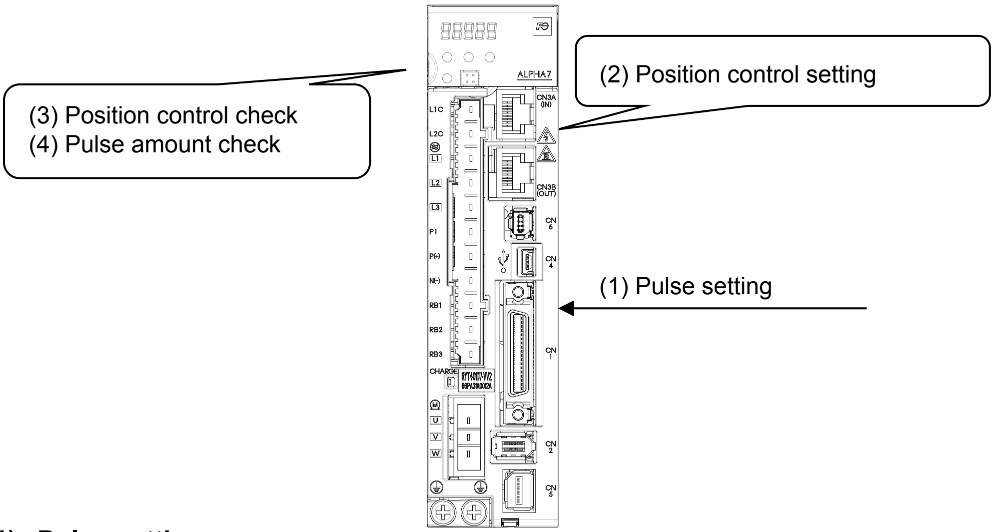
Even if the main power undervoltage alarm is detected, there is no effect on the servo amplifier.
However, do not repeat to turn the power on or off to start or stop the servomotor.
Repetitive power-on and shutdown will cause breakage to the servo amplifier.
If the operation command is turned OFF before the power supply is turned OFF, the main circuit power supply low voltage alarm is not detected.
The alarm reset signal resets alarm detection (activation of a protective function of the servo amplifier).
If the power is shut off during operation, the servo amplifier turns off the ready for servo-on [RDY] signal to stop the internal CPU.

3.4 Operation with VS Type

3.4.1 Position Control (Pulse)

The shaft rotation position is controlled under position control according to the pulse input of the servo amplifier.

The pulse operation procedure is shown below.



(1) Pulse setting

According to the pulse format of the host pulse generator, enter the following parameters.

No.	Name	Setting range	Default value
PA1_03	Command pulse frequency and form setting	1st (lower) digit: Signal form 0: Command pulse/direction 1: Forward/reverse pulse 2: A/B phase pulse 2nd (upper) digit: Input frequency 0: 1MHz or less 1: 200kHz or less 2: 4MHz or less	01
PA1_05	Number of command input pulses per revolution	0: Electronic gear is enabled 64 to 1048576 [pulses]	0
PA1_06	Numerator 0 of electronic gear ratio	1 to 4194304	16
PA1_07	Denominator of electronic gear ratio	1 to 4194304	1

- To assign 4000 pulses per revolution of the servomotor

  PA1_05 = 4000

- To connect a 5 [mm] ball screw directly and change the per-pulse mechanical system traveling amount to 0.001 [mm] (24-bit)

  Because (5/16777216)×(PA1_06/PA1_07) = 1/10000

  PA1_05=0,PA1_06=1048576,PA1_07 = 3125

(2) Position control setting

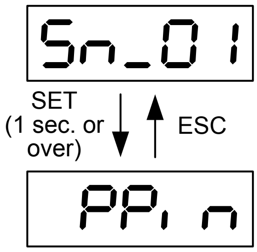
The factory shipment settings of the VV type (RYT□□□□5-VV□ type) servo amplifier are as follows.

- Assignment of input terminal (CONT input signal)
  CONT1: Servo-on [S-ON] (Function No. 1)
  CONT2: Alarm reset [RST] (Function No. 11)
  CONT3: Deviation clear (Function No. 50)
  CONT4 to CONT24: (No designation)
- Parameter PA1_01: Control mode selection 0 (position control)

Therefore the power-on state is the position control mode.
CONT1: Turn on servo-on [S-ON] and supply a pulse to turn the motor.

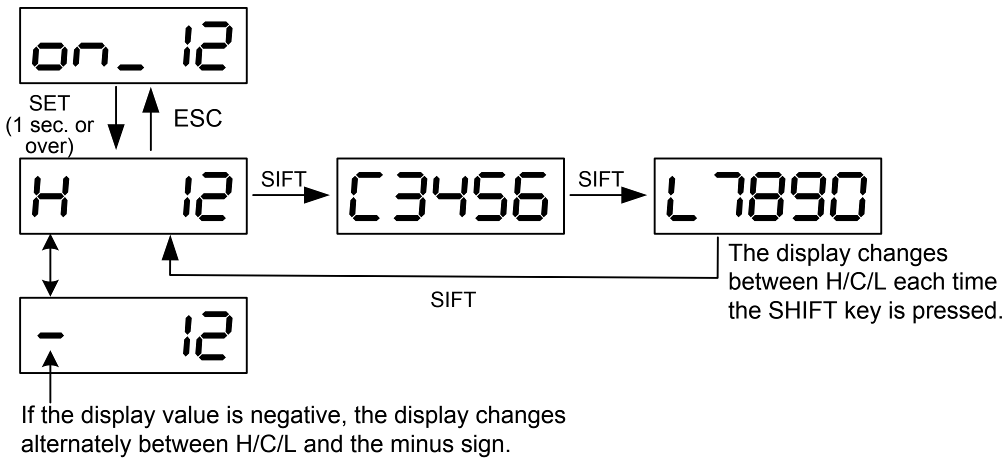
(3) Confirmation of position control

Confirm the position control mode. The third character "P" from the left indicates position control.



(4) Confirmation of pulse amount

Issue a pulse from the host controller. Check that the count agrees with that of the servo amplifier.

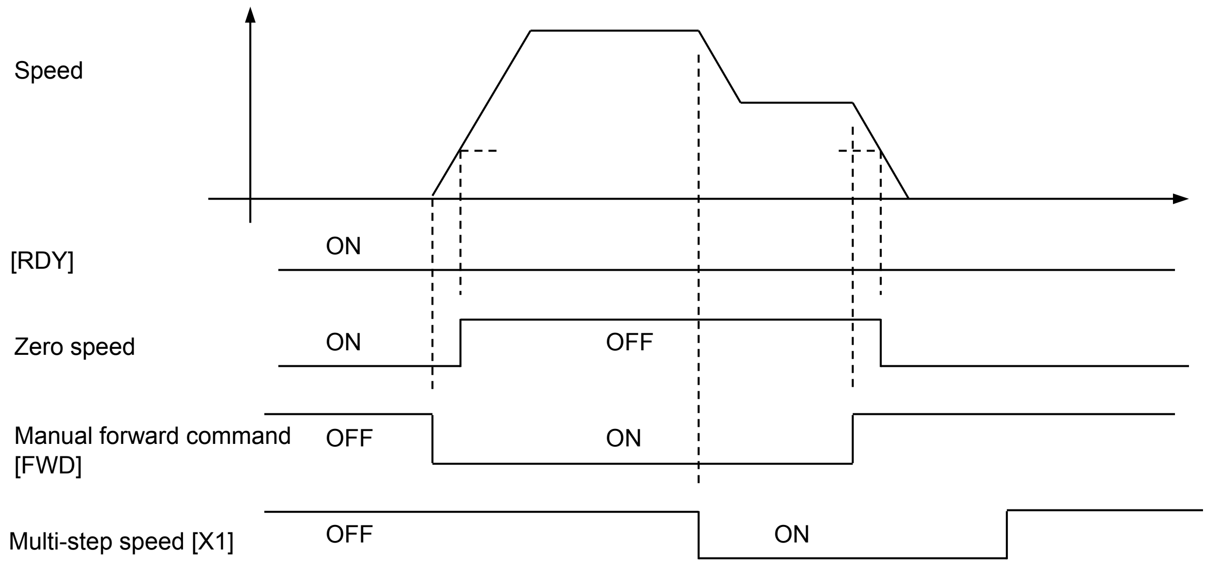


・ With A/B phase pulse, four times the pulse count is displayed.

3.4.2 Speed Control

The shaft rotation speed is controlled in the speed control mode according to the speed command voltage input [VREF] of the servo amplifier or parameter setting.
If parameter PA1_01 is set at "1," the speed control mode starts after the RDY signal is turned on.
While the manual forward command [FWD] or manual reverse command [REV] signal is turned on, the motor accelerates and turns at a constant speed, and deceleration starts when the signal is turned off.
Use the ACC (14) input signal to switch the acceleration/deceleration time.
The acceleration/deceleration time follows the parameter setting.
The rotation speed follows the X1 (51), X2 (52) and X3 (53) input signals or speed command voltage [VREF].

In the below chart, the operation is executed with the speed corresponding to VREF.
First when the X1 signal is turned on, the operation is executed with the speed corresponding to the X1 signal (rotation speed setting in PA1_41).
Then the operation decelerates and stops after turning the FWD signal off.



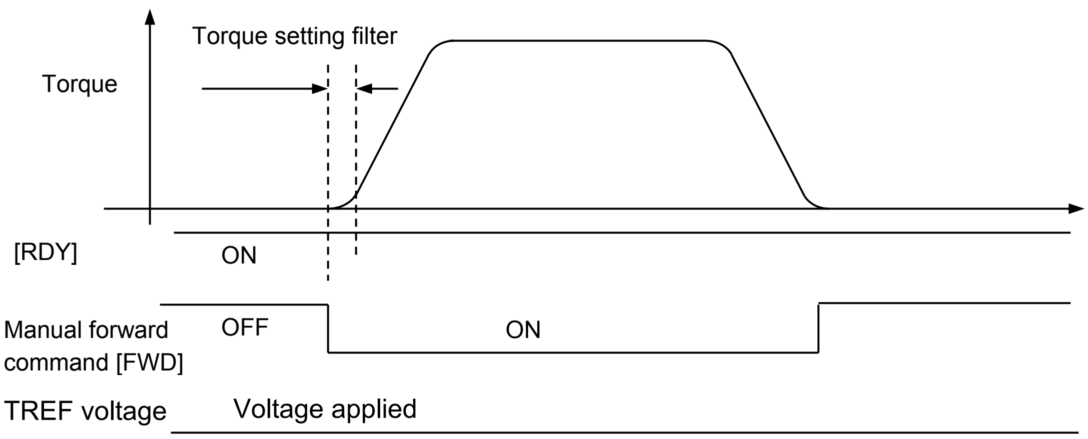
Use parameter PA3_35 to specify the zero clamp level in relation to the [VREF] input.

The following signal is active in the speed control mode.

- Zero speed
  The signal is turned on if the feedback speed of the motor (present shaft rotation speed of motor) falls below a certain value.

3.4.3 Torque Control

The shaft output torque is controlled under the torque control according to torque command voltage input [TREF] of the servo amplifier or a parameter setting.
If parameter PA1_01 is set at "2," the torque control mode starts after the RDY signal is turned on. The torque is output while the manual forward command [FWD] or manual reverse command [REV] signal is turned on, while the torque is reduced to zero after the signal is turned off.



Use parameter PA1_60 to specify the torque setting filter.

The maximum motor rotation speed can be controlled.

No.	Name	Setting
PA2_56	Speed limit selection at torque control	0: Limitation upon PA1_26 setting 1: Limitation at a speed selected with X3, X2 or X1

・ The speeds corresponding to X3, X2 and X1 are given with PA1_41 to PA1_47, or [VREF] terminal.
・ Because the speed control is not performed, the actual speed limit level is different.

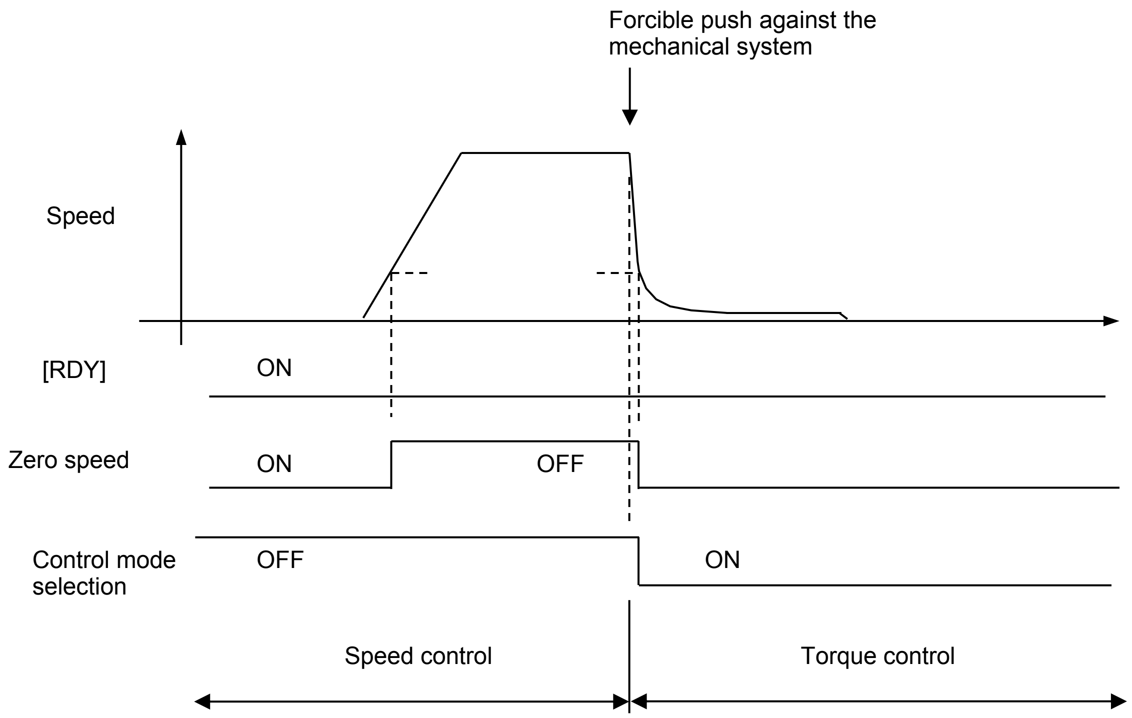
3.4.4 Mode Selection

The operation control mode can be changed with parameter settings shown below and control mode switching signal.

PA1_01:Control mode selection	Control mode (function No.36)	
	Control mode selection=OFF	Control mode selection=ON
3	Position control	Speed control
4	Position control	Torque control
5	Speed control	Torque control

3

The operation pattern with “5” specified in PA1_01 (speed control ⇔ torque control) is shown below.



To forcibly push against the mechanical system as shown in the figure above, torque limit should be adopted with a pushing material or the like.
For the torque control, refer to Section 3.4.3.
The control mode switching condition is activation of the zero speed signal.
The same rule applies to the case where the control mode is “6” (extension mode).

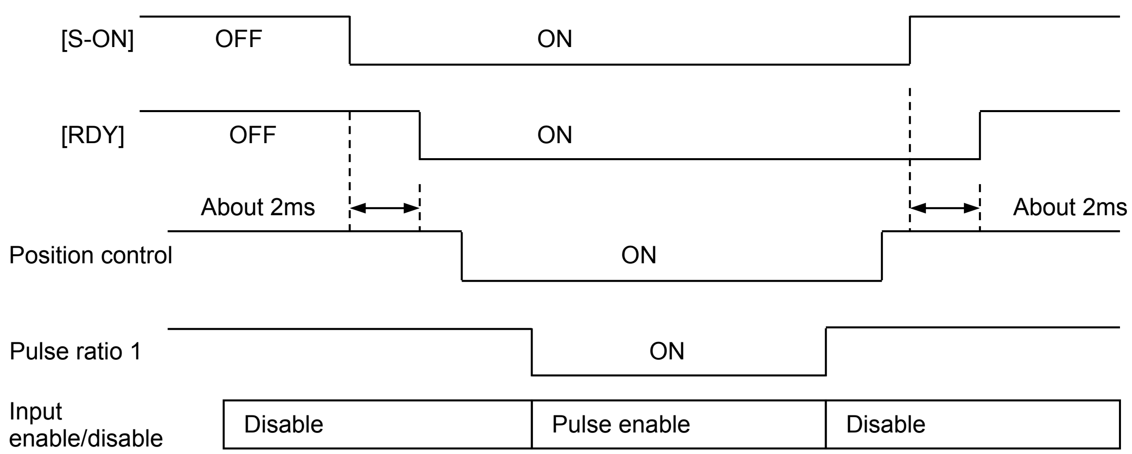
3.4.5 Extension Mode

Compatible mode with standard type of FALDIC-α Series

If parameter PA1_01 is “6,” operation is made with control signal inputs similar to those of the α Series.

If the pulse operation is performed, pulses are active while "position control" and "pulse ratio 1 (2)" are turned on.

3



■ Command pulse multiplication (PA1_01 = 0)

Numerator 0 of electronic gear (PA1_06), numerator 1 of electronic gear (PA2_51), numerator 2 of electronic gear (PA2_52) or numerator 3 of electronic gear (PA2_53) with an input signal can be selected.

■ Position control

The following signals are enabled in the position control mode.

- Zero deviation
  The difference between the command position (pulse input) and feedback position (present motor position) is the deviation. The signal is turned on if the present deviation is below a certain value. You can check that the motor has reached the command position.
- Zero speed
  The signal is turned on if the feedback speed of the motor (present shaft rotation speed of motor) is below a certain value.
- In-position
  Parameter PA1_34 to switch between level output and single-shot output can be used. The level output is the same as the zero deviation signal, The single-shot output is turned on for a certain time after the zero deviation signal is turned on.

3

- Deviation clear

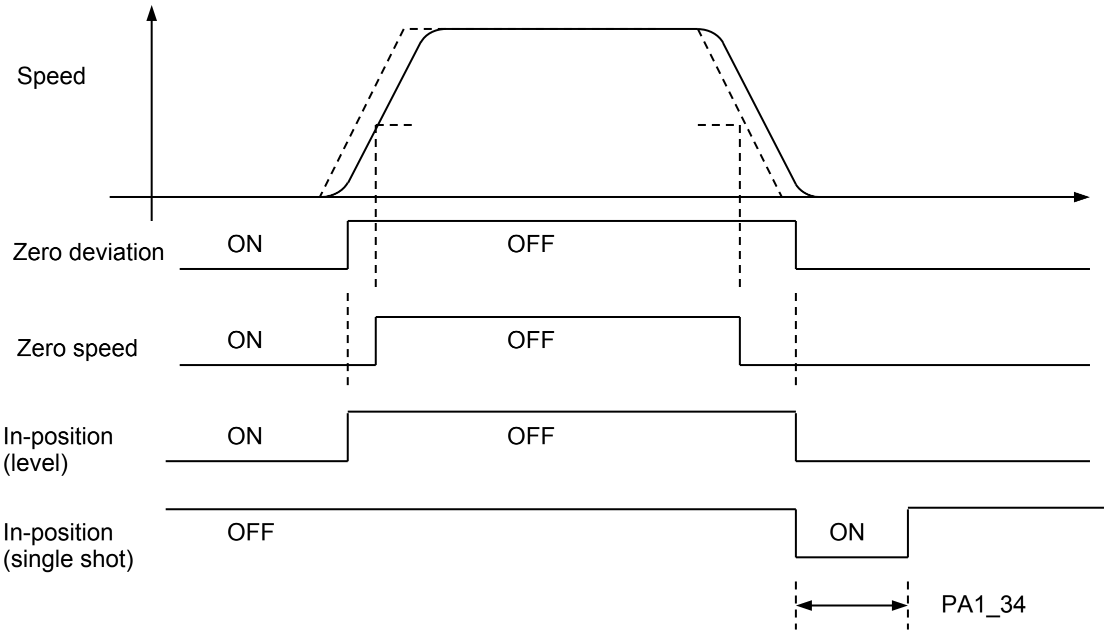
  The difference between the command position (pulse input) and feedback position (present motor position) is the deviation.

  Issue a deviation clear signal to zero the internal deviation. The command position becomes the same as the feedback position.

  Deviation clear is always effective and active even during rotation.

  Either edge or level can be selected with parameter PA3_36 to switch the input format of the deviation clear signal.

  Because the deviation is forcibly zeroed, the motor is stopped.



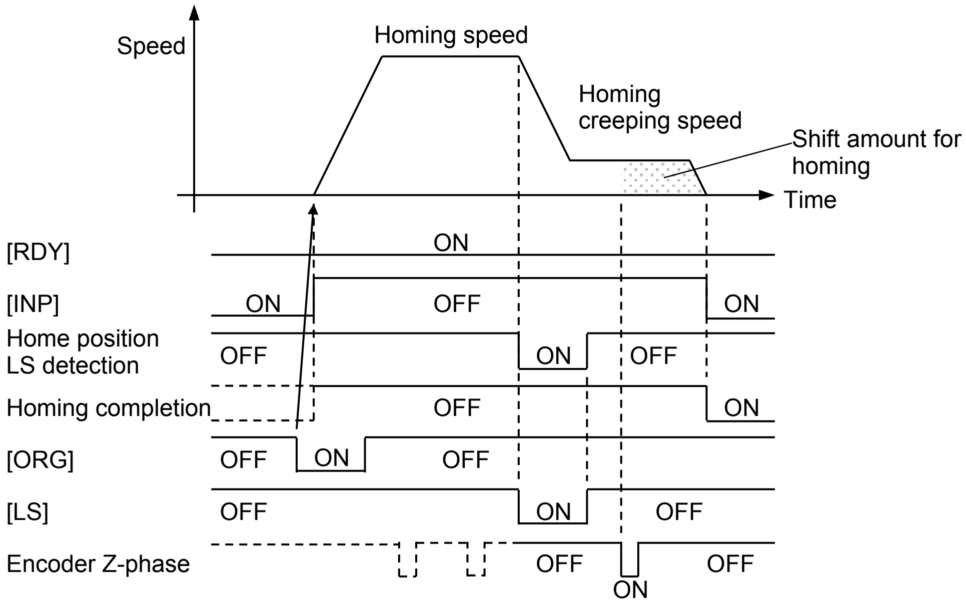
・The single-shot output is forcibly turned off if the zero deviation signal is turned off.

To perform homing and interrupt positioning, select the extension mode. For details, refer to the following pages.

3

3.4.6 Homing

When in-position [INP] is turned on, activation of the homing command [ORG] starts a homing motion. Enter parameters PA2_06 through 18 and 24 to configure the homing pattern.



For details of the homing pattern settings, refer to “CHAPTER 4 PARAMETER.”

The homing motion can be interrupted with forced stop [EMG].

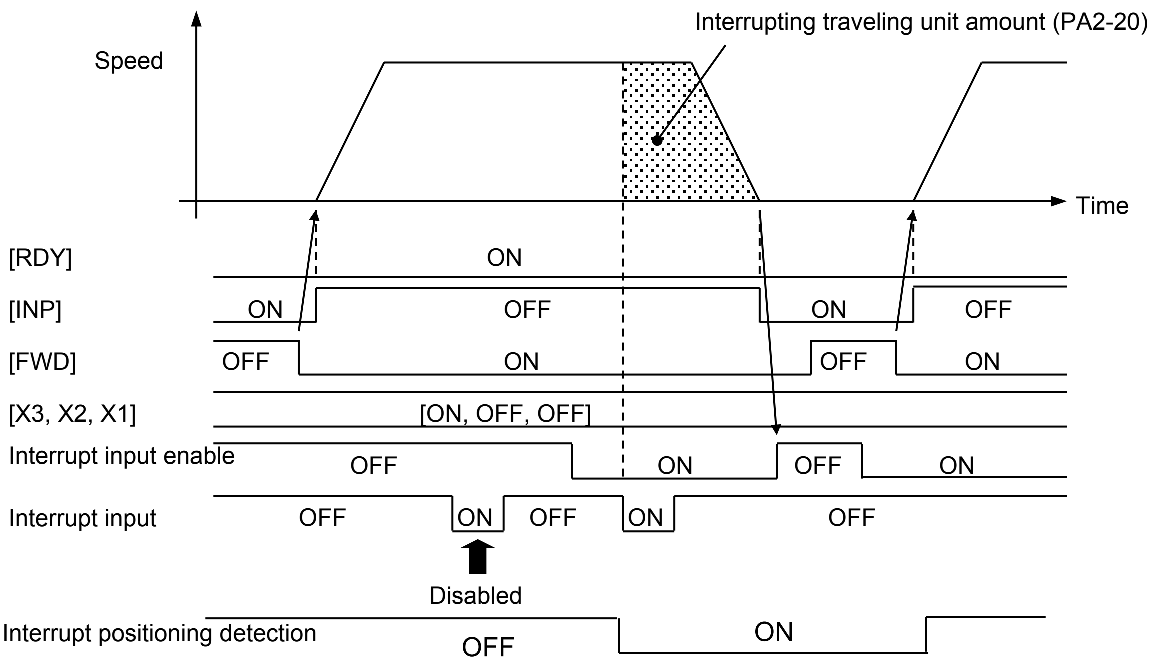
Note	The in-position [INP] signal shown in the figure assumes the level output mode. If positioning completion single shot output is selected with basic setting parameter No. 33, check for stoppage with an external circuit before executing operation.

3.4.7 Interrupt Positioning

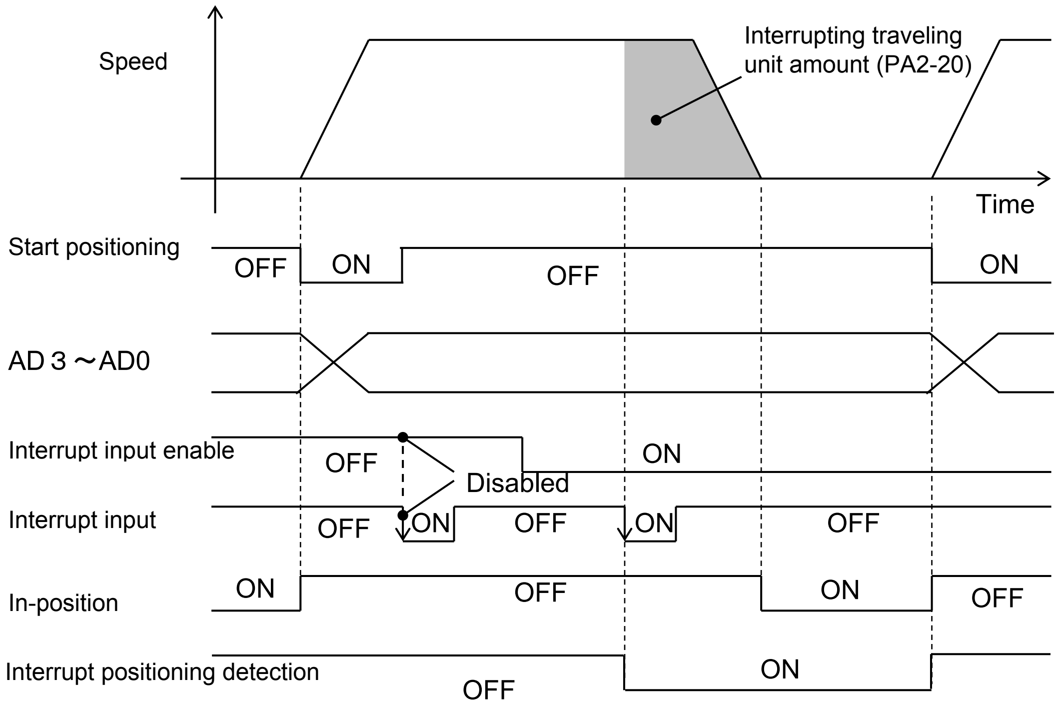
Turn interrupt input enable signal on during operation with a forward [FWD] or reverse [REV] rotation command to start to move by an interrupt traveling unit amount, which is specified at parameter PA2_20, at the activating edge (OFF-to-ON transition) of the interrupt input.

The function is enabled in the operation with positioning data.

(1) Position control, FWD/REV operation



(2) Positioning data operation



Note	(1) After the interrupt input enable signal is turned on, the activating edge (OFF-to-ON transition) of the first interrupt input is enabled. (2) Allocate the interrupt input to the CN1 terminal of CONT1 to 5. Generally, the sequence input and output signals are recognized in about 1 to 2 ms by the software, however, the interrupt input detects the signals by the hardware. Therefore, delay in signal detection (about 0.05 ms) occurs only with the filter circuit of CONT1 to 5. (3) The in-position [INP] signal shown in the figure assumes the level output mode.

3.4.8 Torque Limit

Torque limit is always enabled in the position control, speed control and torque control mode.

If the torque is limited under position or speed control, the designated position or designated speed may not be achieved.

(1) Position/Speed control

The following limits can be set through combination of the "torque limit 0" and "torque limit 1" sequence inputs.

Torque limit 1	Torque limit 0	Torque limit
OFF	OFF	Value set at PA1_27 and PA1_28
OFF	ON	Smaller value between torque command voltage [TREF] and PA1_27 (PA1_28)
ON	OFF	Smaller value between PA1_27 (PA1_28) and PA2_58
ON	ON	Smaller value between torque command voltage [TREF] and PA2_58

If neither "torque limit 0" nor "torque limit 1" is used, PA1_27 and PA1_28 are enabled.

(2) Torque control

Forward rotation torque limit PA1_27 and reverse rotation torque limit PA1_28 are always enabled under torque control.

The output torque is in proportion to the voltage applied at the torque command voltage [TREF] terminal.

(3) Forced stop

The torque limit in forced stop follows parameter PA2_60.

3

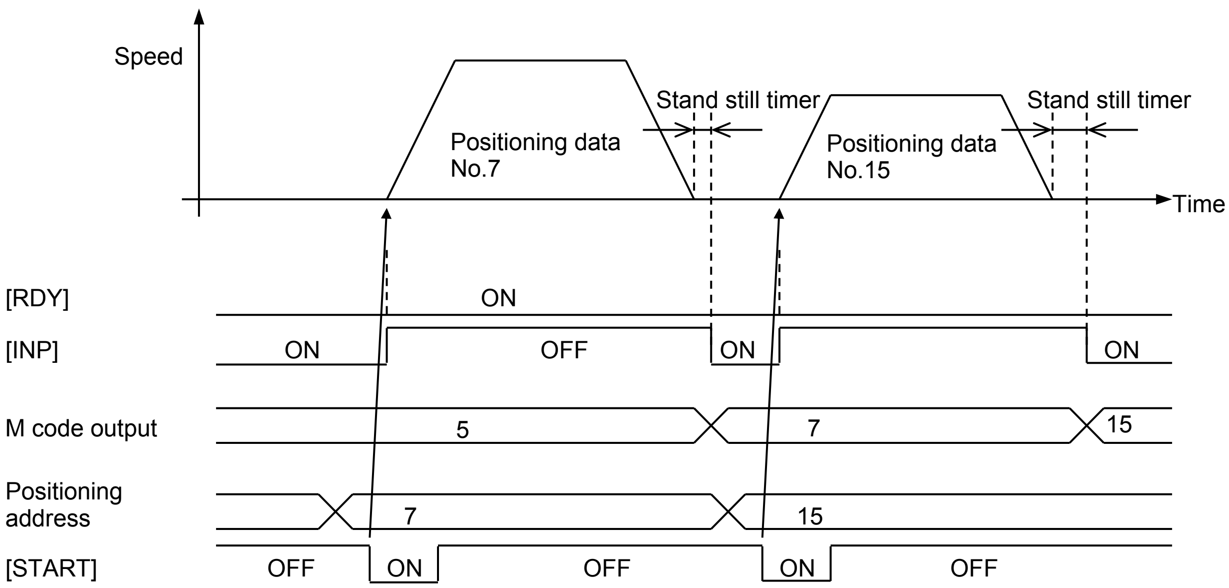
3.4.9 Positioning Data Operation

Enter “1” to parameter PA2_40 (internal positioning data selection) to perform positioning data operation. PTP (point-to-point) positioning operation is made according to Di/Do signals or commands sent via RS-485 communications.

When in-position [INP] is active, enter the desired positioning address (AD0 to AD4) and turn start positioning [START] on (activating edge) to execute positioning.

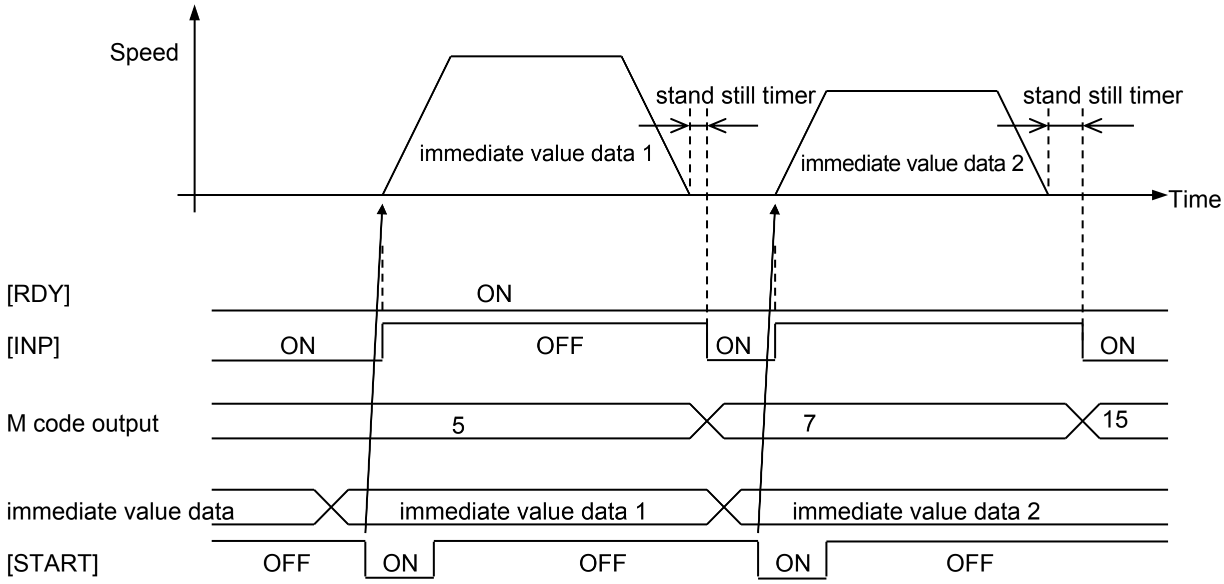
The positioning data can be registered with the PC Loader or keypad (front panel of amplifier) or through teaching. To enable positioning data operation, you can allocate “77” (positioning data selection) to a CONT signal and turn the signal on.

For details, refer to “CHAPTER 12 POSITIONING DATA.”



3.4.10　Immediate Value Data Operation

Enter “0” to parameter PA2_40 (internal positioning data selection) to enable operation with immediate value data. Point-to-point (PTP) positioning operation is made according to commands sent via RS-485 communications. When In-position [INP] is active, enter desired positioning data and so on and turn start positioning [START] on (activating edge) to execute positioning.
To enable immediate value data operation, you can allocate “77” (positioning data selection) to a CONT signal and turn the signal off. Use the Modbus-RTU protocol. (Immediate value data operation is impossible with the PC Loader protocol.)
For details, refer to “CHAPTER 13　MODBUS RTU COMMUNICATION”



Hint	To perform immediate value data operation with the Modbus-RTU protocol in a system consisting of two or more servo system axes, you can use broadcasting to start multiple axes simultaneously, so that pseudo interpolation operation is realized. For details, refer to “CHAPTER 13　MODBUS RTU COMMUNICATION”

3.4.11 Interrupting/Stopping Operation

The following input signals interrupt or stop each operation.

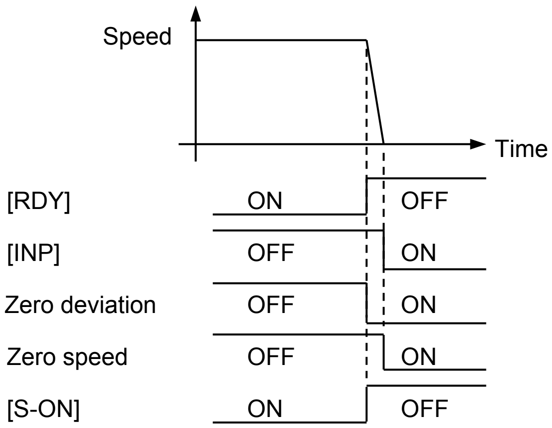
- STO (EN terminal input)
- Servo-on [S-ON]
- +OT/-OT
- Forced stop [EMG]
- Pause
- Positioning cancel
- Deviation clear
- Free-run

(1) STO (EN terminal input)

If terminals [EN1+] or [EN2+] are opened while the motor is running, the STO function will be triggered, and the motor will free run to a stop.
The operation when decelerating is based on the operation setting when PA2_61 servo-on is OFF. When servo-on is OFF, however, the operation when decelerating will be "dynamic brake operation" when the "Deceleration speed" is set.

(2) Servo-on [S-ON]

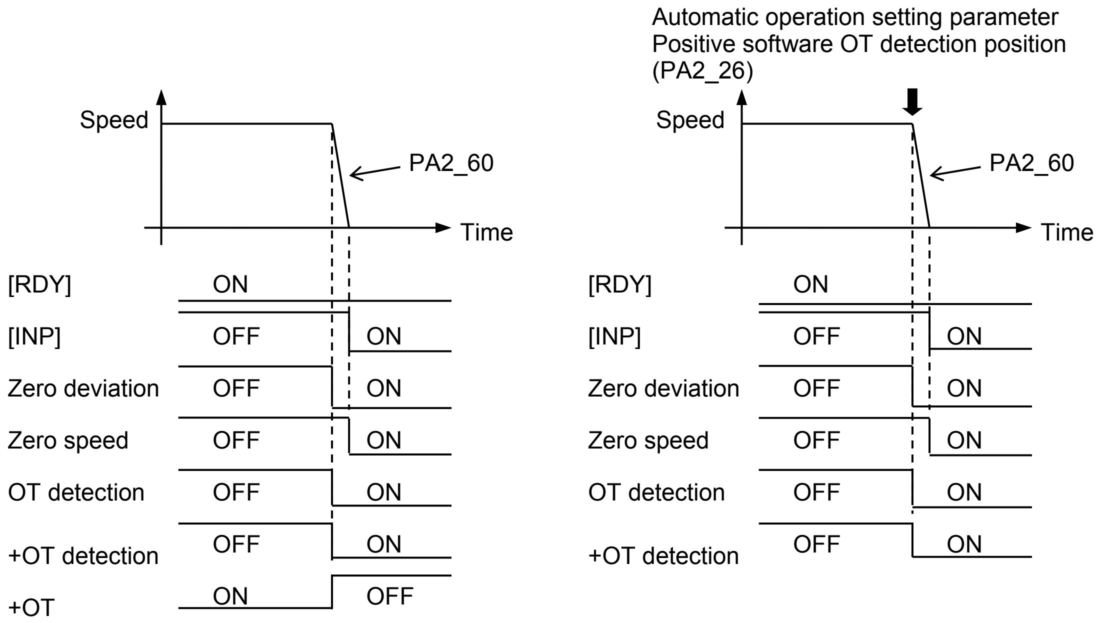
If servo-on [S-ON] is turned OFF while the motor is running, operation is stopped, and the motor is stopped based on the PA2_61: Action sequence at servo-on OFF setting. If rapid deceleration is selected, the motor will decelerate based on the PA2_60: Third torque limit torque.



Note	
	(1) If free-run when decelerating is selected with PA2_61: Action sequence at servo-on OFF, the motor will continue to run for a short while under its own inertia. (2) The in-position [INP] signal shown in the figure indicates the state in the level output mode.

(3) +OT/-OT / positive software OT / negative software OT

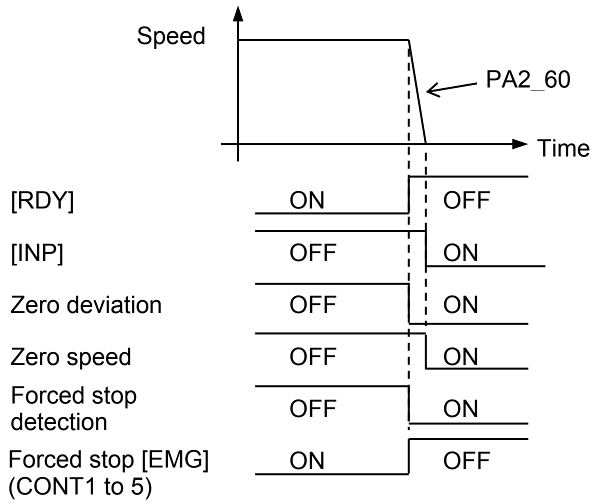
If +OT/-OT is detected (OFF because contact b) during motor operation, or if positive software OT or negative software OT is detected, operation is stopped, and the motor comes to a rapid deceleration stop based on the PA2_60: Third torque limit torque.



Note	(1) OT detection, +OT detection and -OT detection do not turn on if OT detection at homing is reverse. Furthermore, the motor decelerates based on the PA2_18: Deceleration time at OT during homing. (2) The in-position [INP] signal shown in the figure indicates the state in the level output mode. (3) If the PA1_27: Forward rotation torque limit or PA1_28: Reverse rotation torque limit setting is smaller than the PA2_60: Third torque limit, the PA1_27: Forward rotation torque limit and PA1_28: Reverse rotation torque limit torque settings will apply.

(4) Forced stop [EMG]

If a forced stop [EMG] is detected during motor operation, operation is stopped, and the motor comes to a rapid deceleration stop based on the PA2_60: Third torque limit torque. While forced stop [EMG] is detected, the motor is stopped at the zero speed and the current position is not retained.



Note

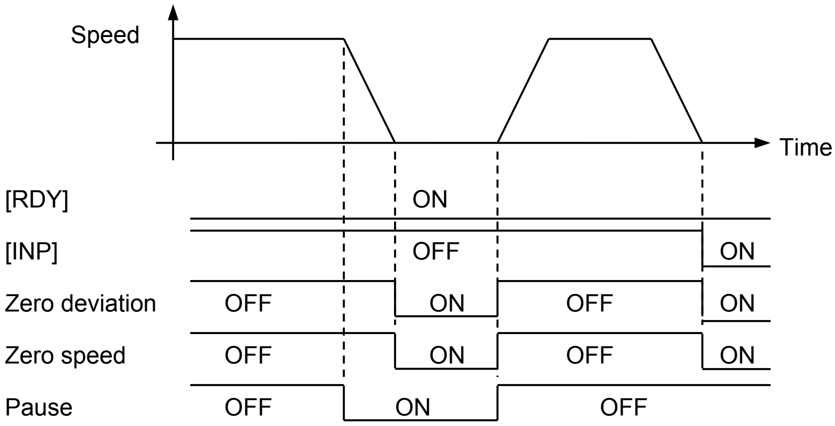
(1) Forced stop [EMG] is a normally closed contact signal if it is allocated to CONT 1 to 8 signals.

(2) The in-position [INP] signal shown in the figure indicates the state in the level output mode.

(3) If the PA1_27: Forward rotation torque limit or PA1_28: Reverse rotation torque limit setting is smaller than the PA2_60: Third torque limit, the PA1_27: Forward rotation torque limit and PA1_28: Reverse rotation torque limit torque settings will apply.

(5) Pause

If the pause signal is turned on during homing, interrupt positioning, positioning data operation or immediate value data operation, operation is interrupted and the motor is stopped while the signal remains turned on. After the signal is turned off, the operation continues. In-position [INP] is not turned on in a pause.

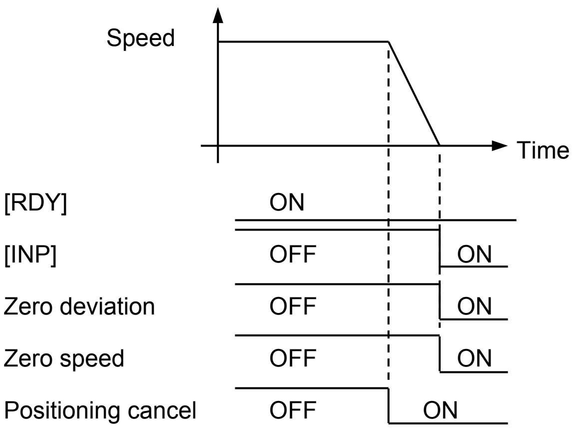


Note	
Note	(4) Acceleration/deceleration follows the settings of parameters PA1_37 through 40 and the state of input signal ACC0, or the settings of acceleration/deceleration time data. (5) The in-position [INP] signal shown in the figure indicates the state in the level output mode.

(6) Positioning cancel

If the positioning cancel signal is turned on during motor rotation, operation is stopped and controlled stop is caused according to the deceleration time setting. While the positioning cancel signal remains active, homing or position command operation does not start.

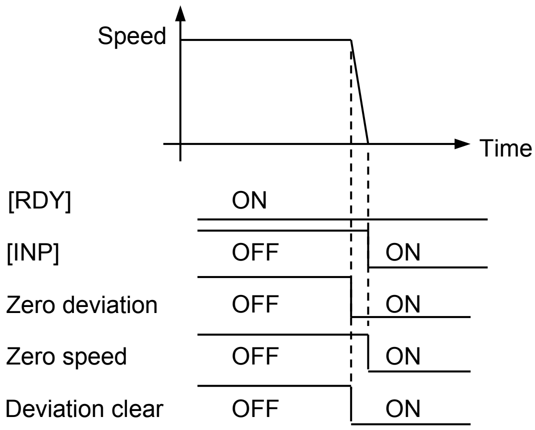
The signal is disabled for speed operation.



Note	
Note	(1) Acceleration and deceleration are based on PA1_37 to 40 and the input signal ACC0 setting, or acceleration time data/deceleration time data (IQ area). (2) The in-position [INP] signal shown in the figure indicates the state in the level output mode.

(7) Deviation clear

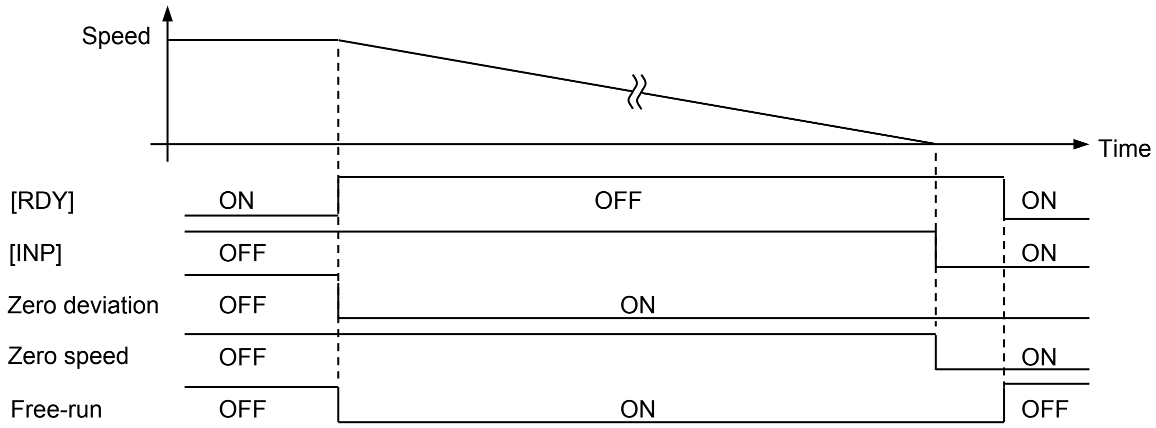
If the deviation clear signal is detected during motor rotation, operation is stopped and immediate controlled stop is caused according to the selected torque limit. (The maximum torque is assumed if parameter setting is selected with the default setting). If "1" (level signal) is selected with PA3_36: Deviation clear input form, the motor is stopped at zero speed and the current position is not held while the deviation clear signal remains ON.



Note	The in-position [INP] signal shown in the figure indicates the state in the level output mode.

(8) Free-run

While the free-run signal is turned on, outputs of the servo amplifier are turned off and the servomotor coasts to stop (at zero torque). (The motor rotation is not controlled.) If the free-run signal is turned on during motor rotation, operation is stopped and the motor keeps rotating due to the inertia of the load.



Note	In regular cases, free-run is not used for vertical traveling machines. If the function is used for a vertical traveling machine, examine adaptability with the brake carefully.

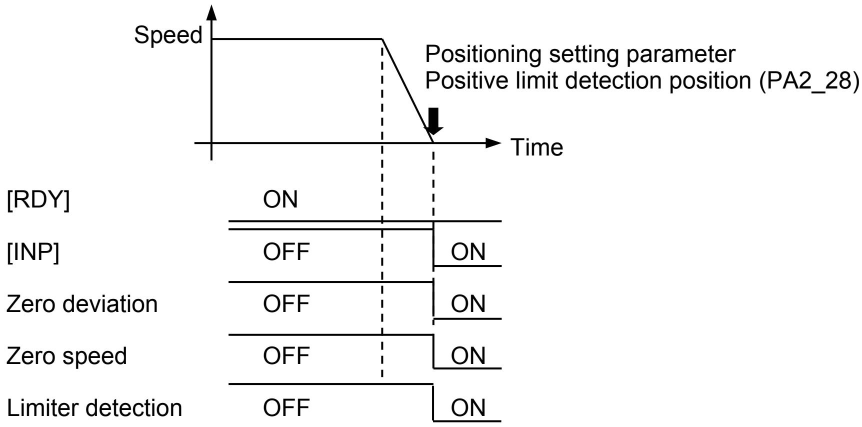
In addition to operation stop and interruption caused by input signals, detection of an alarm causes the operation to be stopped.

The stop operation when an alarm is detected is based on the PA2_62: Action sequence at alarm setting (serious alarms: fixed at free-run).

(9) Positive limiter detection / negative limiter detection

If the target position is set with overshooting positive/negative limiter detection value, operation is canceled before reaching to the target positon and stopped at positive/negative limiter detection position.

Limiter detection signals are turned on after the stopping.



Note

(3) Acceleration/deceleration follows the settings of parameters PA1_38 and 40 and the state of input signal ACC0, or the setting of deceleration time data.
(4) During pulse operation, the motor is stopped at the limiter detecting position when the pulse input position reaches the limiter detecting position. The stopping motion follows the torque limit specified in a parameter.
(5) The in-position [INP] signal shown in the figure indicates the state in the level output mode.

CHAPTER 4 PARAMETER

4.1 Parameter Division

⚠ CAUTION

- Never add an extreme change to parameters. Otherwise machine motion will become unstable.
  Risk of injuries

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

4

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.	4.2
Control gain and filter setting parameters (No.PA1_51 to 99)	Use to adjust the gain manually.	4.3
Automatic operation setting parameters (No.PA2_01 to 50)	Use to enter or change the positioning operation speed and homing function.	4.4
Extension function 1 setting parameters (No.PA2_51 to 99)	Use to enter or change the extended functions such as the torque limit.	4.5
Input terminal function setting parameters (No.PA3_01 to 50)	Use to enter or change input signals of the servo amplifier.	4.6
Output terminal function setting parameters (No.PA3_51 to 99)	Use to enter or change output signals of the servo amplifier.	4.7
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.	4.8

4.2 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.)

4.2.1 List (PA1_□□)

No. PA1_	Name	Default value	Power	Control mode			Record of reference value
				Position	Speed	Torque	
01	Control mode selection	0	○	○	○	○	
02	INC/ABS system selection	0	○	○	○	○	
03	Command pulse frequency/form setting	01	○	○	-	-	
04	Rotation direction selection	0	○	○	○	○	
05	Number of command input pulses per revolution	0	○	○	-	-	
06	Numerator 0 of electronic gear	16	-	○	-	-	
07	Denominator of electronic gear	1	-	○	-	-	
08	Number of output pulses per revolution	2048	○	○	○	○	
09	Numerator of electric gear for output pulses	1	○	○	○	○	
10	Denominator of electric gear for output pulses	16	○	○	○	○	
11	Output pulse phase selection at CCW rotation	0	○	○	○	○	
12	Z-phase position offset	0	○	○	○	○	
13	Tuning mode selection	0	-	○	○	○	
14	Load inertia ratio	1.0	-	○	○	○	
15	Auto tuning gain 1	12	-	○	○	○	
16	Auto tuning gain 2	4	-	○	-	-	
20	Easy tuning: stroke setting	2.00	-	○	○	○	
21	Easy tuning: speed setting	500.00	-	○	○	○	
22	Easy tuning: timer setting	1.500	-	○	○	○	
23	Easy tuning: direction selection	0	-	○	○	○	
25	Max. rotation speed (for position and speed control)	6000.00 (GYS,GYB 750W or less) 5000.00 (GYS 1kW or more) 3000.00 (GYG)	-	○	○	-	
26	Max. rotation speed (for torque control)		-	-	-	○	
27	Forward rotation torque limit	350: GYB 300: other than GYB	-	○	○	○	
28	Reverse rotation torque limit		-	○	○	○	
29	Speed coincidence range	50	-	○	○	-	
30	Zero speed range	50	-	○	○	○	
31	Deviation unit selection	0	-	○	-	-	
32	Zero deviation range/In-position range	100	-	○	-	-	
33	In-position output format	0	○	○	-	-	
34	In-position minimum OFF time/ single shot ON time	20	-	○	-	-	
35	In-position judgment time	0	-	○	-	-	

No. PA1_	Name	Default value	Power	Control mode			Record of reference value
				Position	Speed	Torque	
36	Acceleration / deceleration selection at speed control	0	-	-	○	-	
37	Acceleration time 1	100.0	-	○	○	○	
38	Deceleration time 1	100.0		○	○	○	
39	Acceleration time 2	500.0		○	○	○	
40	Deceleration time 2	500.0		○	○	○	
41	Manual feed speed 1/speed limit 1 for torque control	100.00	-	○	○	○	
42	Manual feed speed 2/speed limit 2 for torque control	500.00		○	○	○	
43	Manual feed speed 3/speed limit 3 for torque control	1000.00		○	○	○	
44	Manual feed speed 4/speed limit 4 for torque control	100.00		○	○	○	
45	Manual feed speed 5/speed limit 5 for torque control	100.00		○	○	○	
46	Manual feed speed 6/speed limit 6 for torque control	100.00		○	○	○	
47	Manual feed speed 7/speed limit 7 for torque control	100.00		○	○	○	

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

4.2.2 Description of Each Parameter

PA1_01 Control mode selection

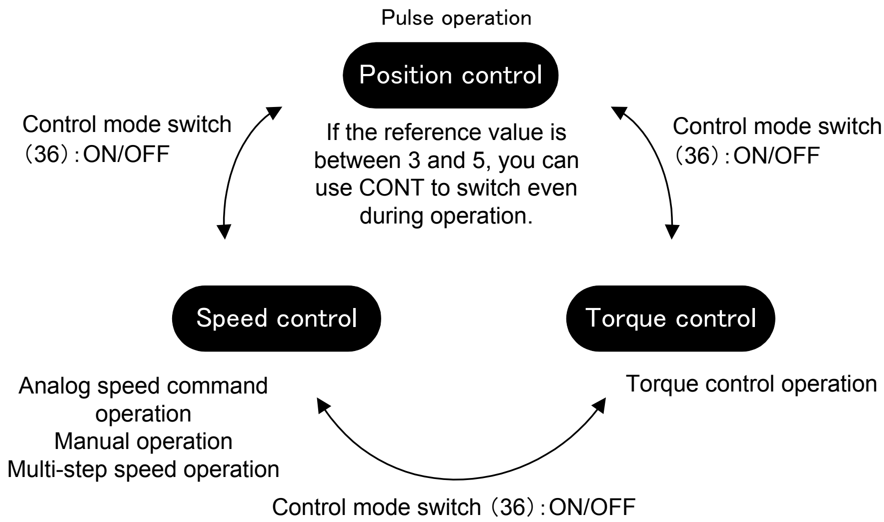
No.	Name	Setting range	Default value	Change
01	Control mode selection	0: Position 1: Speed 2: Torque 3: Position ⇔ speed 4: Position ⇔ torque 5: Speed ⇔ torque 6: Extended mode 7: Positioning operation	0	Power

Specify the desired control mode in the parameter with a value.
To switch during operation, change over the control mode selection (function No. 36) signal.
For details, refer to the table below.

Reference value of PA1_01 (control mode selection)	Control mode	
	Control mode selection = OFF	Control mode selection = ON
0	Position control	
1	Speed control	
2	Torque control	
3	Position control	Speed control
4	Position control	Torque control
5	Speed control	Torque control
6	Extended mode	
7	Positioning operation mode	

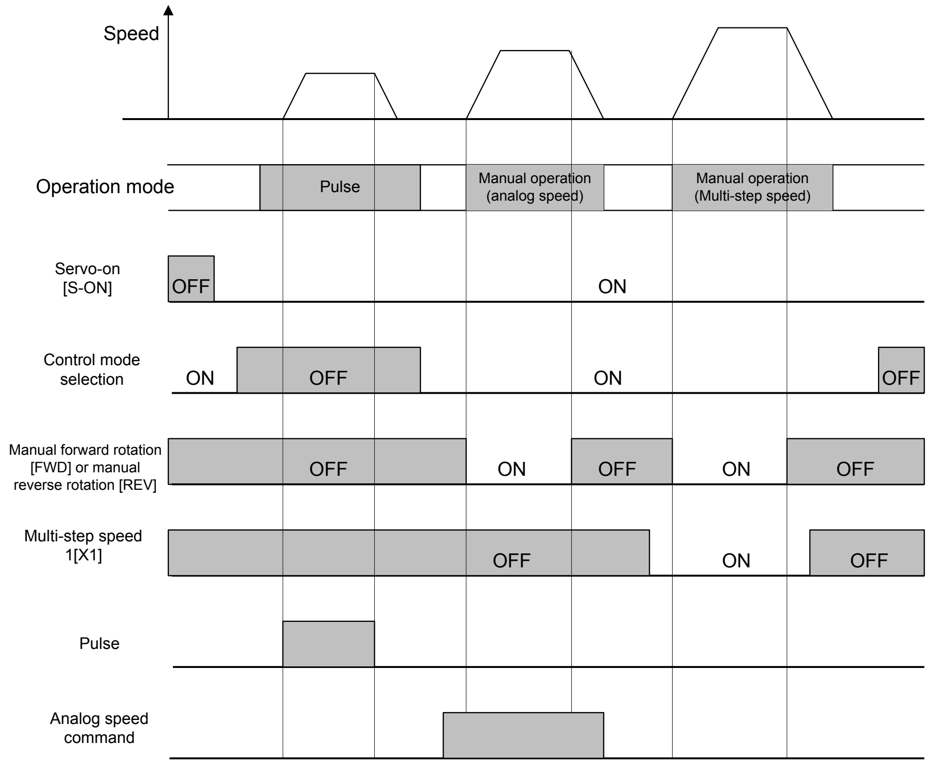
(1) If PA1_01 (control mode selection) is between 0 and 5

Change over the control mode selection (function No. 36) signal to change the control mode even during operation.
Position control can be made only during pulse operation.
For the transition of the control mode, see the figure below.



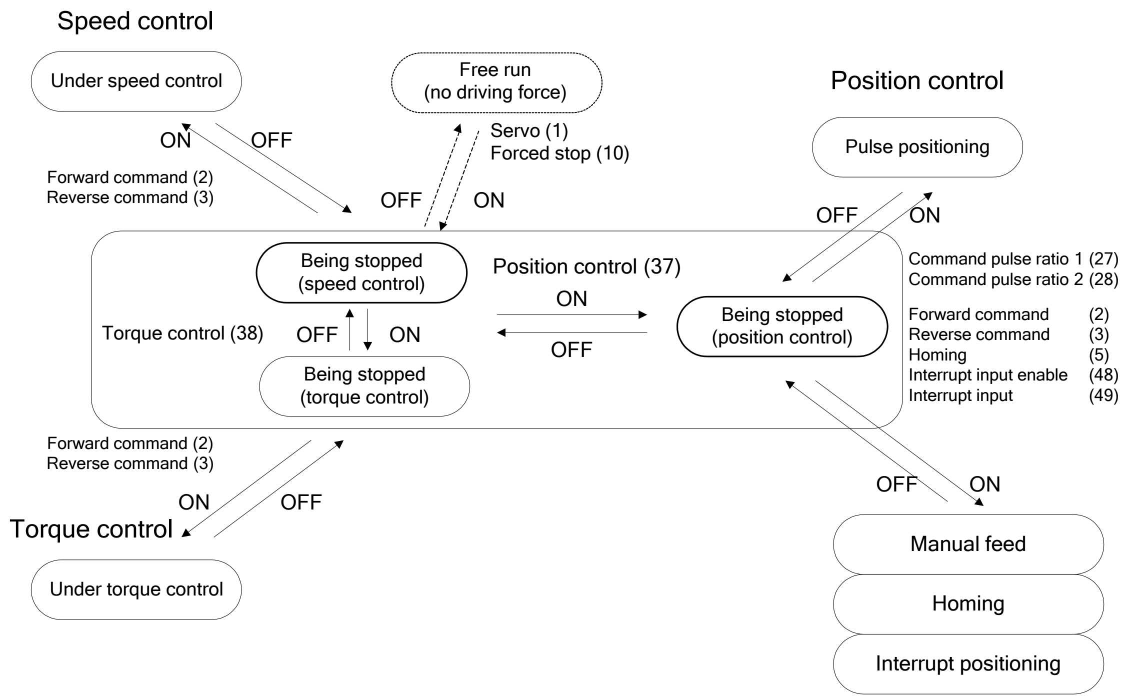
4

[Example] The operation pattern of control mode selection 3 (position ⇔ speed) is shown in the figure below.



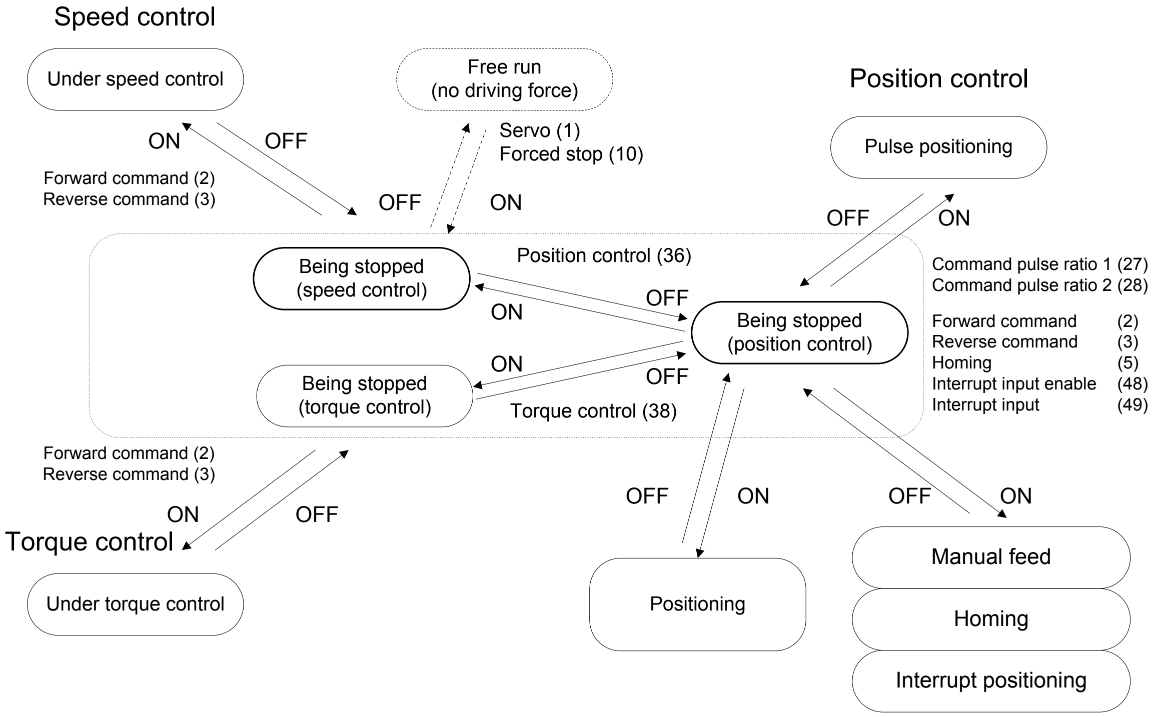
(2) If PA1_01 (control mode selection) is 6

This control mode is compatible with that of the existing α Series.
The power-on state is the speed control mode (see the figure below).
To perform homing and interrupt positioning, select this mode.



(3) If PA1_01 (positioning operation mode selection) is “7”

Positioning (positioning data operation, immediate value data operation and homing) can be made. The position control mode is selected immediately after the power is turned on (see the figure below).



4

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 11 ABSOLUTE POSITION SYSTEM."

■ Notes for setting endless ABS in positioning operation mode

<Notes regarding settings>

(1) Set the electronic gear so that it obtains: PA1_06/07 = 2^n (n ≥8)

The absolute system encode works as a 34-bit ring counter consisting of 18-bit single-turn counter and 16-bit multi-turn counter. On the other hand, as the current position output to the host device via Modbus-RTU is given a 32-bit data, the size must be matched each other using the electronic gear setting.

(2) Set the parameter PA2_25 (position command format) to "0" (normal PTP).

If set to "1" (endless), current position is reset (but the multi-turn data of the encoder is not cleared) every time the positioning operation (positioning data operation and immediate value operation) is started. Therefore, it will be difficult to recognize the current positions from the host device.

<Notes regarding functions>

(1) The following functions are disabled: hardware OT, software OT and limiter detection.

<Notes regarding operations>

(1) The positioning command range when the absolute system position command format is selected is;

$$-\left(\frac{40\ \text{bits}}{\text{electronic gear*}}\times\frac{1}{2}-1\right)\ \text{to}\ \left(\frac{40\ \text{bits}}{\text{electronic gear*}}\times\frac{1}{2}-1\right)$$

(2) The positioning command range when the incremental system position command format is selected is;

$$-\left(\frac{40\ \text{bits}}{\text{electronic gear*}}-1\right)\ \text{to}\ \left(\frac{40\ \text{bits}}{\text{electronic gear*}}-1\right)$$

$$\text{*) electronic gear} = \frac{\text{PA1\_06 (numerator of electronic gear)}}{\text{PA1\_07 (denominator of electronic gear)}}$$

(3) Do not apply the immediate value continuation operation.
If applied, the positioning after continuation will rely on the calculation timing if operation is shifted to continuous motion around the time when the multi-turn data is about to overflow.

(4) Do not apply the immediate value change function.

PA1_03 Command pulse frequency, form setting

No.	Name	Setting range	Default value	Change
03	Command pulse frequency, form setting	00 to 22	01	Power

This parameter is enabled only under position control. Set this parameter for each input pulse frequency and signal form.

This parameter should be selected for each digit.

Digit 2 1

Digit 1 — Signal form
- 0: Command pulse/sign
- 1: Forward/reverse pulse
- 2: A/B phase pulse

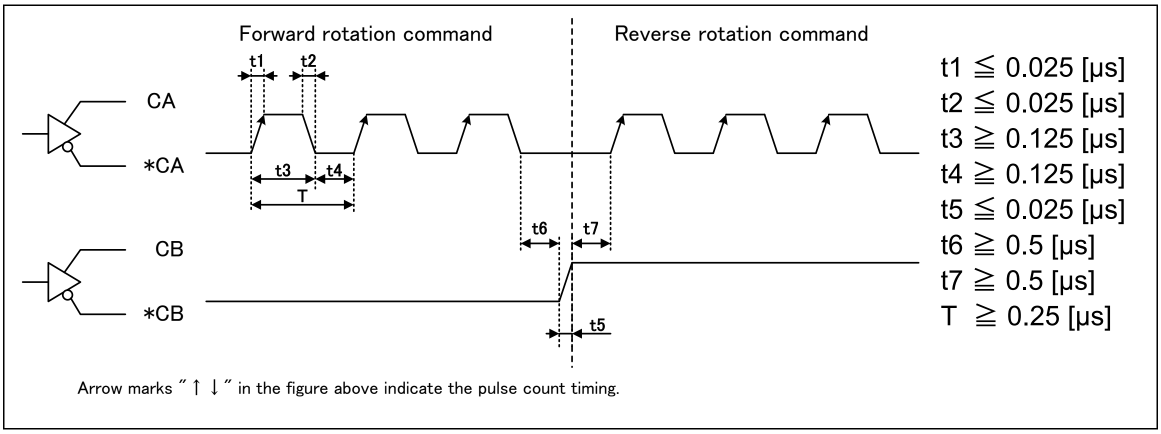
Digit 2 — Input frequency
- 0: 1 MHz or less
- 1: 200 kHz or less
- 2: 4 MHz or less

The maximum input frequency is 4.0 MHz at differential input or 200 kHz at open collector input. However, enter each signal so that the following conditions are satisfied (the same signal conditions apply to CA, *CA, CB and *CB). In case of A/B phase pulse, the rising or falling edge of the A-phase signal or B-phase signal is counted as a single pulse, so that a single-pulse input is equivalent to four pulse counts.

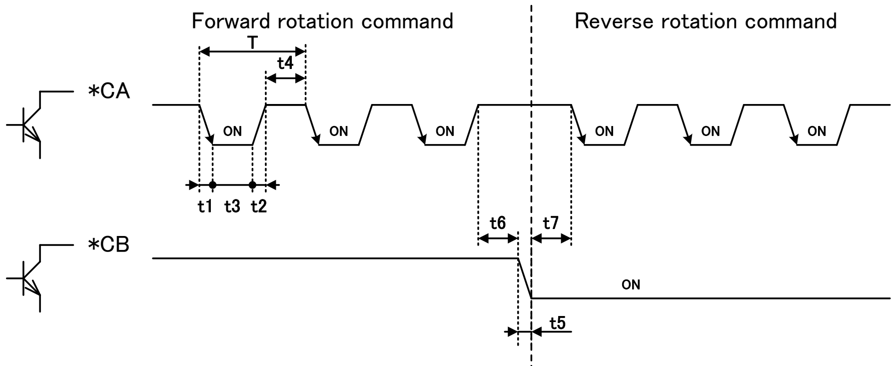
■ Command pulse / sign (reference value of parameter 03: □0)

The command pulse indicates the rotation amount (CA, *CA), while the command sign (CB, *CB) indicates the direction of rotation.
If (CB) is at the low level and (*CB) is at the high level, a forward direction command is issued.

• Differential input



• Open collector input



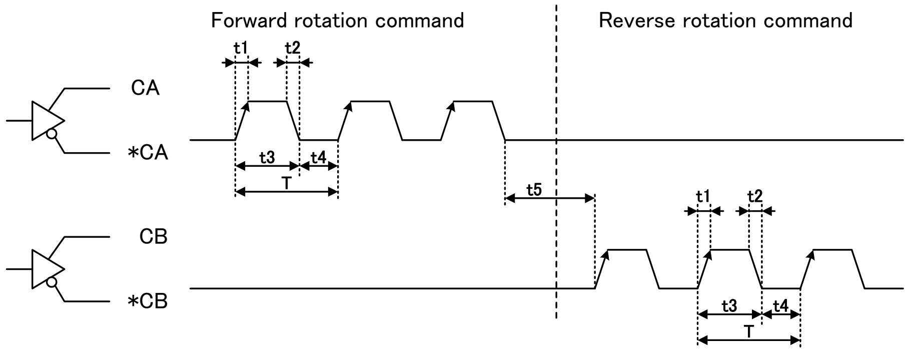
t1 ≦ 0.2 [μs]
t2 ≦ 0.2 [μs]
t3 ≧ 2.0 [μs]
t4 ≧ 2.0 [μs]
t5 ≧ 0.2 [μs]
t6 ≧ 2.5 [μs]
t7 ≧ 2.5 [μs]
T ≧ 5.0 [μs]

"ON" specified in the figure above indicates activation of the transistor, which means a low signal level.
Arrow mark " ↓ " in the figure above indicates the pulse count timing.

■ Forward / reverse pulse (reference value of parameter 03: □1)

The forward rotation pulse (CA, *CA) indicates the rotation amount in the forward direction, while the reverse rotation pulse (CB, *CB) indicates that in the reverse direction.

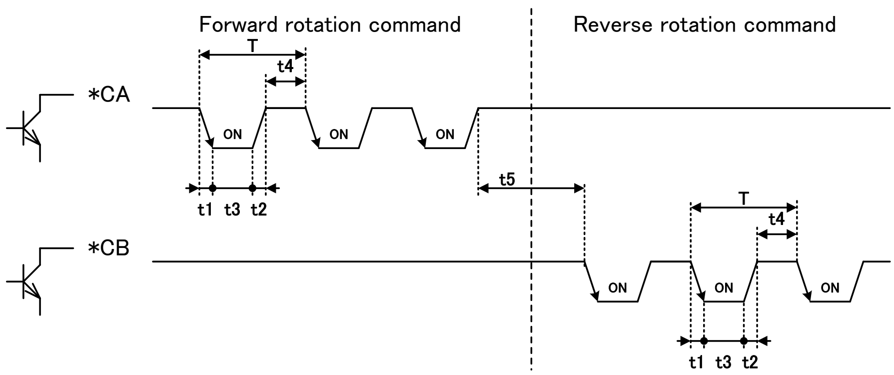
• Differential input



t1 ≦ 0.025 [μs]
t2 ≦ 0.025 [μs]
t3 ≧ 0.125 [μs]
t4 ≧ 0.125 [μs]
t5 ≧ 0.5 [μs]
T ≧ 0.25 [μs]

Arrow marks " ↑ ↓ " in the figure above indicate the pulse count timing.

• Open collector input



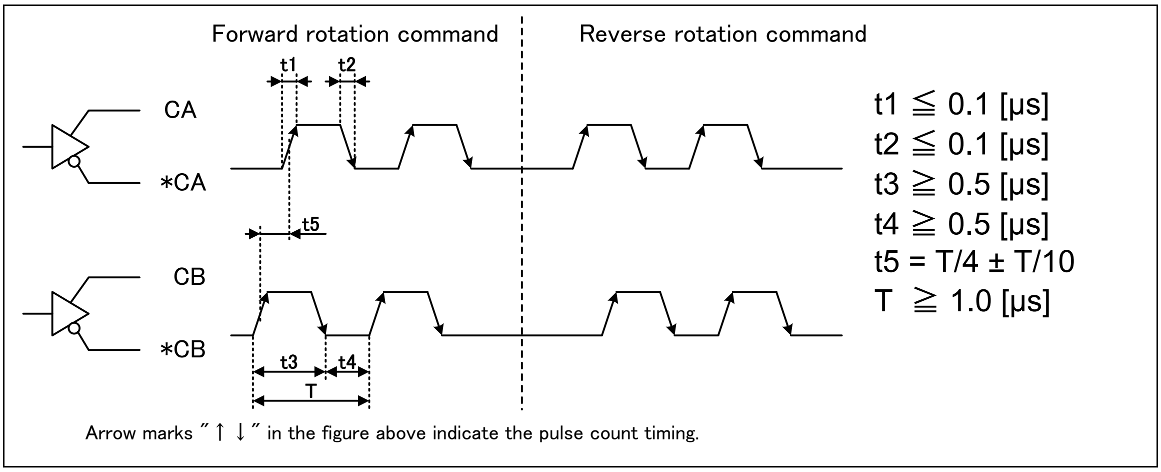
t1 ≦ 0.2 [μs]
t2 ≦ 0.2 [μs]
t3 ≧ 2.0 [μs]
t4 ≧ 2.0 [μs]
t5 ≧ 2.5 [μs]
T ≧ 5.0 [μs]

"ON" specified in the figure above indicates activation of the transistor, which means a low signal level.
Arrow mark " ↓ " in the figure above indicates the pulse count timing.

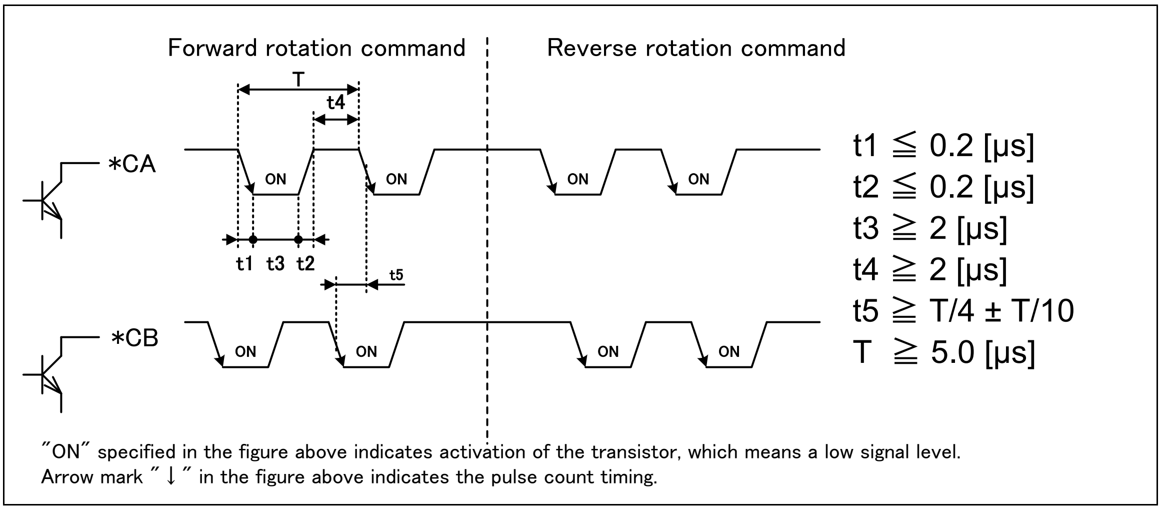
A/B phase pulse (reference value of parameter 03: □2)

The A-phase signal (CA, *CA) and B-phase signal (CB, *CB) indicate the direction of rotation and rotation amount, respectively.
Each edge of the A-phase and B-phase signals corresponds to one pulse. (It is four-fold frequency in the amplifier.)

• Differential input



• Open collector input



PA1_04 Rotation direction selection

No.	Name	Setting range	Default value	Change
04	Rotation direction selection	0: CCW rotation direction at forward command. 1: CW rotation direction at reverse command.	0	Power

This parameter keeps consistency between the direction of rotation of the servomotor and the traveling direction of the machine.

In case of operation with pulse

The direction of rotation caused upon an input of a forward rotation pulse and high level command sign or a B-phase pulse lead pulse with A / B phase pulse becomes the forward direction, making the servomotor rotate forward.

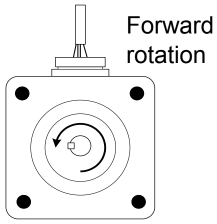
To switch the phase of the output pulse, select the phase of counterclockwise (CCW) rotation of the servomotor.

In case of operation with speed command voltage

The direction of rotation caused by a positive speed command voltage in a forward command (FWD) signal is the forward direction, causing the servomotor to rotate forward.

■ Forward/Reverse rotation

The servomotor rotates forward if it rotates counterclockwise (CCW: figure on the right) when the output shaft is viewed from the front. Clockwise rotation is reverse rotation.



PA1_05 Number of command input pulses per revolution

No.	Name	Setting range	Default value	Change
05	Number of command input pulses per revolution	0: Electronic gear is enabled 64 to 16777216 [pulses]: Number of command input pulses per revolution is enabled.	0	Power

This parameter is enabled only under position control.

Enter the number of command pulses necessary to rotate the servomotor a full turn.

The setting range is 64 to 1048576 [pulses]. However, if the end of the model number of the servomotor is "HB2" (18-bit encoder), the maximum value is 262144 [pulses].

With the default value ("0"), the settings of PA1_06 and _07 (electronic gear numerator and denominator) are enabled.

PA1_06 Numerator 0 of electronic gear, PA1_07 Denominator of electronic gear

No.	Name	Setting range	Default value	Change
06	Numerator 0 of electronic gear	1 to 67108864 (in increments of 1)	16	Always
07	Denominator of electronic gear	1 to 67108864 (in increments of 1)	1	Always

These parameters are enabled only under position control.
With these parameters, the traveling amount of the mechanical system per each command pulse is adjusted to a unit amount.
If parameter PA1_05 is "0," the settings of these parameters are enabled.
The following equation is used to calculate.

4

■ Equation of numerator 0 of electronic gear and denominator of electronic gear

Cancel down so that numerator 0 divided by the denominator of the electronic gear is an integer (67108864 or less).

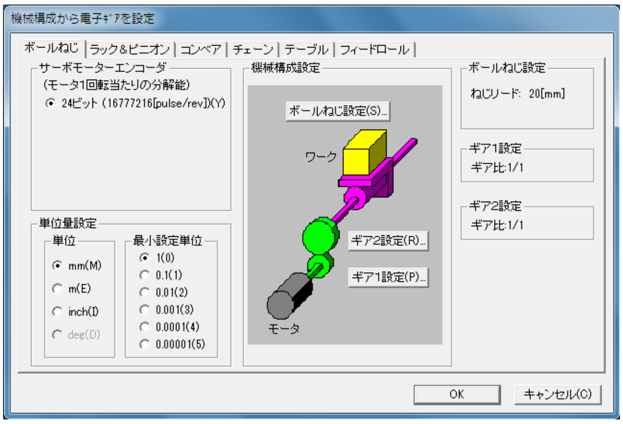
$$\frac{\text{(Traveling amount of mechanical system per servomotor revolution)}}{\text{Number of encoder pulses *}} \times \frac{\text{Numerator 0 of electronic gear}}{\text{Denominator of electronic gear}} = \text{(Unit amount) *}$$

* The unit amount is "1," "0.1," "0.01," "0.001," etc. Its unit is [unit].
* The number of encoder pulses is 16777216 for a 24-bit encoder.

$$\frac{\text{Numerator 0 of electronic gear}}{\text{Denominator of electronic gear}} = \frac{\text{Number of encoder pulses}}{\text{(Traveling amount of mechanical system per servomotor revolution)}} \times \text{(Unit amount)}$$

■ Entering from PC Loader

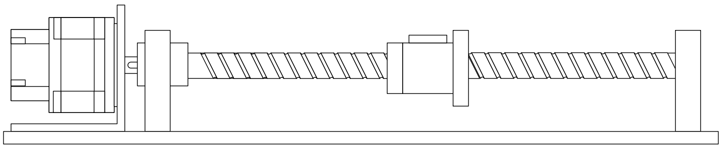
Use the "Mechanical settings calculation (T)" button provided at the lower part of the parameter editing screen (PA1: Basic setting) of PC Loader to specify the electronic gear simply.



Enter the specifications of the machine to automatically calculate the settings. Parameters grouped according to each mechanical configuration helps you enter simply.

[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.



$$\frac{\text{(Traveling amount of mechanical system per servomotor revolution)}}{\text{16777216 pulses/revolution}} \times \frac{\text{Numerator 0 of electronic gear}}{\text{Denominator of electronic gear}} = \text{(Unit amount)}$$

$$\frac{\text{10mm}}{\text{16777216 pulses/revolution}} \times \frac{\text{Numerator 0 of electronic gear}}{\text{Denominator of electronic gear}} = 1/100$$

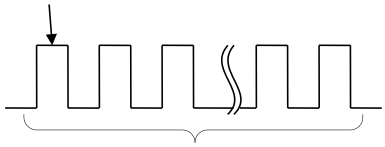
$$\frac{\text{Numerator 0 of electronic gear}}{\text{Denominator of electronic gear}} = 1/100 \times \frac{\text{16777216 pulses/revolution}}{\text{10mm}} = \frac{2097152}{125}$$

Therefore numerator 0 and denominator of the electronic gear are 2097152 and 125, respectively.

Hint

If the traveling amount of the mechanical system per servomotor revolution includes π, you can approximate to 355/113.

The number of output pulses is irrelevant to command pulse correction.



A / B phase pulse in B-phase advance are output according to the reference value of PA1_08 (number of output pulses per revolution) during forward rotation of the motor shaft.

PA1_08 Number of output pulses per revolution

No.	Name	Setting range	Default value	Change
08	Number of output pulses per revolution	0: Entered values at PA1_09 and _10 are enabled. 16 to 4194304 [pulses]: Number of command input pulses per revolution is enabled.	2048	Power

Enter the number of pulses output per motor rotation from pulse output terminal (FFA, *FFA, FFB and *FFB).
(The output pulse value is deducted -2bit from encoder resolution.)
If the reference value is other than 0, the Z-phase output synchronizes with the A-phase output, and an output having the same pulse width as that of the A-phase is obtained.
With default value "0," settings of parameters PA1_09 and _10 (The output pulse value is deducted -2bit from encoder resolution.) are followed.

PA1_09 Numerator of electric gear for output pulses
PA1_10 Denominator of electric gear for output pulses

No.	Name	Setting range	Default value	Change
09	Numerator of electric gear for output pulses	1 to 67108864 (in increments of 1)	1	Power
10	Denominator of electric gear for output pulses	1 to 67108864 (in increments of 1)	16	Power

Specify the ratio of the output pulse per revolution of the servomotor.
If parameter PA1_08 is "0," settings of these parameters are enabled.
Calculate according to the following equation. (The output pulse value is deducted -2bit from encoder resolution.)

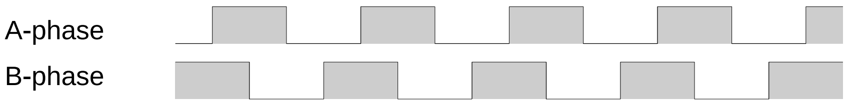
- Specify "1/32" to output 2048 (4194304 × 1/32) A-phase and B-phase pulses per revolution.
- The Z-phase output is issued asynchronously to the A- and B-phases at a constant pulse width of 100μs.
  Enter parameters so that PA1_09 ≤ PA1_10. If PA1_09 > PA1_10, the division ratio is 1.

PA1_11 Output pulse phase selection at CCW rotation

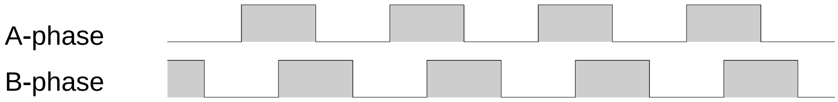
No.	Name	Setting range	Default value	Change
11	Output pulse phase selection at CCW rotation	0: B-phase pulse lead at CCW rotation 1: A-phase pulse lead at CCW rotation	0	Power

The phase of the output pulse of the servomotor is adjusted to the traveling direction of the machine.
Select the phase of forward rotation (CCW rotation) of the servomotor.
The pulse is output at connector CN1 (FFA, *FFA, FFB and *FFB).

・If the reference value is 0



・If the reference value is 1



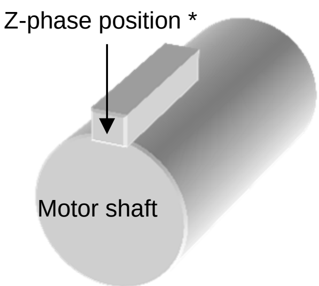
PA1_12 Z-phase position offset

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).
The Z-phase used for homing is also the position that is offset with this parameter.

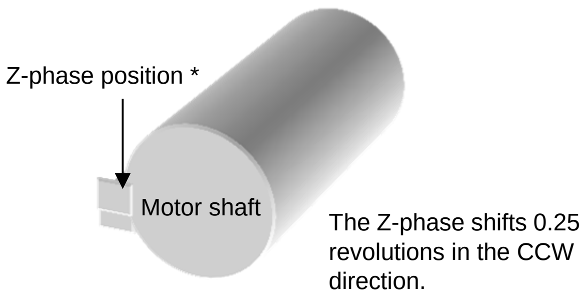
■ Z-phase output position

・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.

- 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.

■ How to enter the ratio of inertia of load

(1) Entering the value monitored at keypad

Use the monitor mode on_ 14 of the keypad to 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 16 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.

■ Setting method

(1) Parameter entry with PC Loader and keypad (parameter setting mode)
After the parameter is established, the setting is updated.
(2) Entry using "auto tuning gain setting (Fn_ 11)" of keypad (test operation mode)
After the value is switched, the setting is updated at real time.
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 5 SERVO ADJUSTMENT."

PA1_16 Auto tuning gain 2

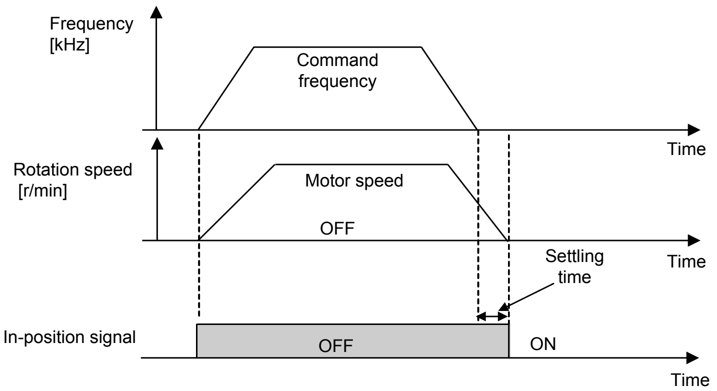
No.	Name	Setting range	Default value	Change
16	Auto tuning gain 2	1 to 12 (in increments of 1)	4	Always

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 5 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 5 SERVO ADJUSTMENT."

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

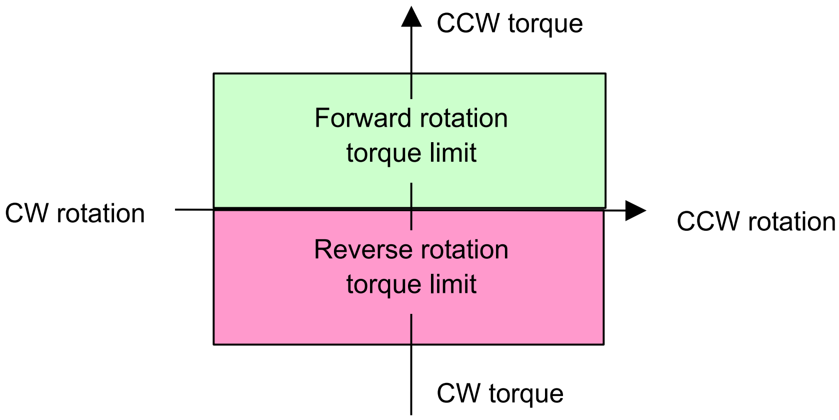
<table>
<tr><th>No.</th><th>Name</th><th>Setting range</th><th>Default value</th><th>Change</th></tr>
<tr><td>25</td><td>Max. rotation speed
(for position and speed control)</td><td rowspan="2">GYS and GYB,
750 W or less
: 0.01 to 6000 [r/min]
GYS,1 kW or more
: 0.01 to 5000 [r/min]
GYG : 0.01 to 3000 [r/min]</td><td rowspan="2">6000 (GYS and GYB of 750 W or less)
5000 (GYS of 1 kW or more)
3000 (GYG)</td><td rowspan="2">Always</td></tr>
<tr><td>26</td><td>Max. rotation speed
(for torque control)</td></tr>
</table>

Enter the maximum rotation speed of the sevomotor for position, speed and torque control.
However, this parameter is disabled during pulse operation.
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.

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			

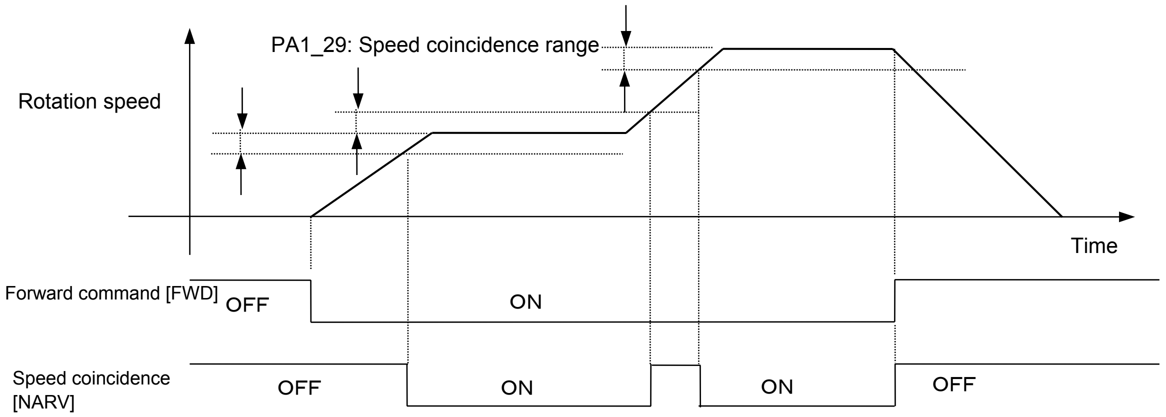
Enter the limit to be set on the output torque of the servomotor.
If the input signal (CONT signal: torque limit 0, 1, etc.) is turned off, this limit is enabled.
For description of the input signal (such as torque limit 0 and 1), refer to "CHAPTER 3 OPERATION."



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.
If the command speed is not reached due to PA1_25 (maximum rotation speed), override or similar, the signal is turned off.
The speed coincidence signal does not turn on if the [FWD] or [REV] signal is turned off.



- 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_31 Deviation unit selection

No.	Name	Setting range	Default value	Change
31	Deviation unit selection	0: Unit amount [unit amount] 1: Pulse amount [pulse]	0	Always

Enter the unit of position deviation.
Select 0 (unit amount) for the unit after multiplication by the electronic gear ratio. [Unit] is displayed.
Select 1 (pulse amount) for the unit before multiplication by the electronic gear ratio. (Unit of encoder pulse amount)
This setting is related to the unit of all position deviation monitored with the keypad, PC Loader or monitor 1/2 signal.

PA1_32 Zero deviation range/In-position range

No.	Name	Setting range	Default value	Change
32	Zero deviation range/ In-position range	0 [pulse] to 4000000 [pulse]/ [unit amount]	100	Always

- Zero deviation range
  Enter the activation level of the "zero deviation" output signal.
  The signal is turned on at position deviation within the reference value.
- In-position range
  Enter the deviation condition of the "in-position (INP)" output 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."
  However, the completion of pulse elimination inside the servo amplifier when performing automatic operation, homing, or manual position control is also added as a condition.
- <u>The setting unit is the one specified with PA1_31 (deviation unit selection).</u>

4

PA1_33 to 35 In-position output signals

No.	Name	Setting range	Default value	Change
33	In-position output format	0: Level 1: Single shot	0	Power
34	In-position minimum OFF time/single shot ON time	1 [ms] to 1000 [ms]	20	Always
35	In-position judgment time	0 [ms] to 1000 [ms]	0	Always

Enter the output format, minimum OFF time / Single shot ON time and judgment time of the in-position [INP] signal.

In-position output format: Select the format of the output signal (refer to the timing chart on the next page).

In-position minimum OFF time / Single shot ON time:
For the single shot output format, enter the time for which the output signal is turned on.

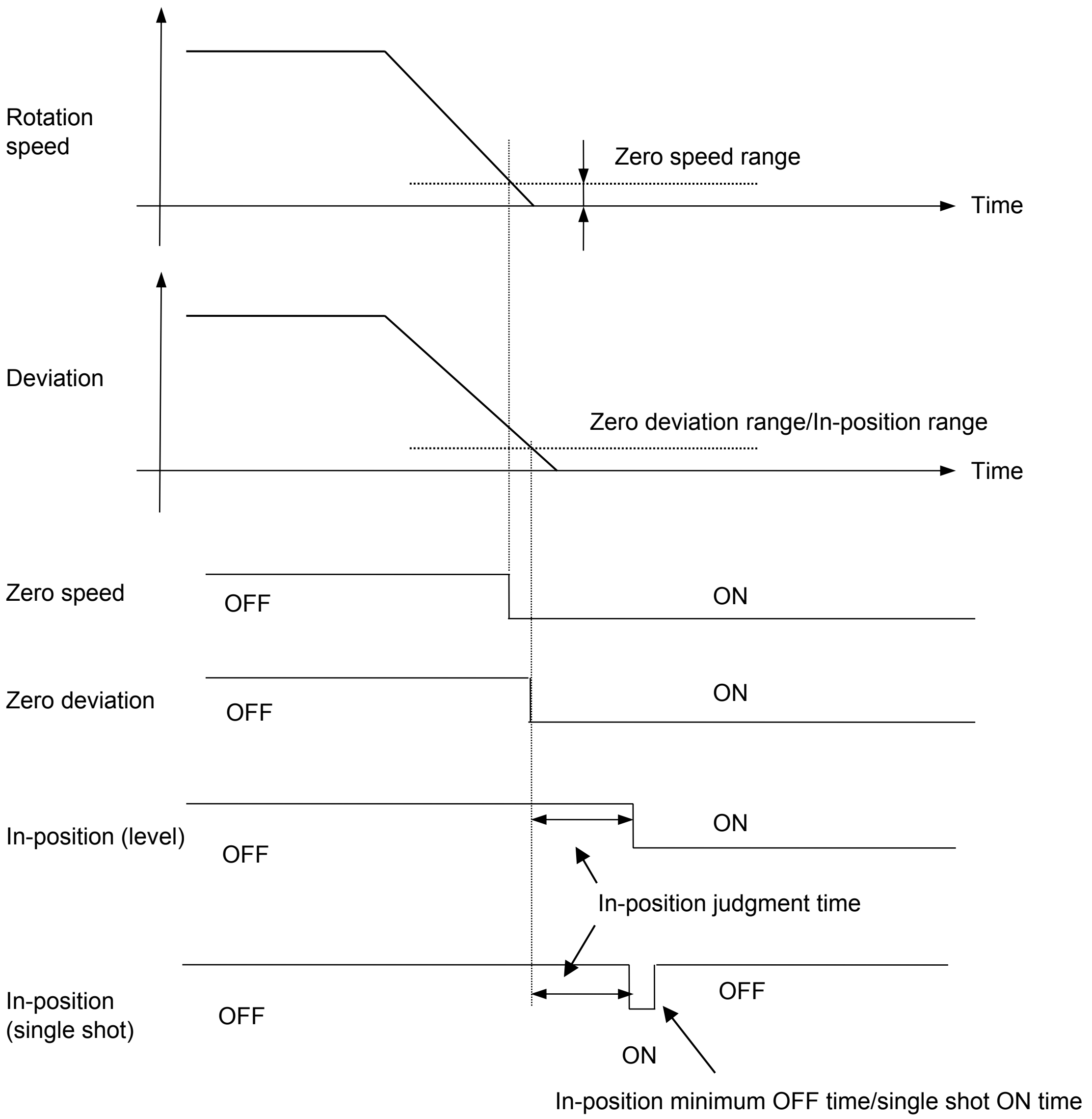
In-position judgment time: Enter the judgment time needed to recognize in-position.

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).
<u>The output timing of this signal substantially varies according to the setting of PA1_31 (deviation unit selection).</u>
Check the reference value to use. Refer to the following timing chart.

Timing chart



PA1_36 to 40 Acceleration / deceleration selection at speed control, Acceleration time and deceleration time settings

No.	Name	Setting range	Default value	Change
36	Acceleration / deceleration selection at speed control	0: Disable 1: Enable	0	Always
37	Acceleration time 1	0.0 [ms] to 99999.9 [ms]	100.0	Always
38	Deceleration time 1		100.0	
39	Acceleration time 2		500.0	
40	Deceleration time 2		500.0	

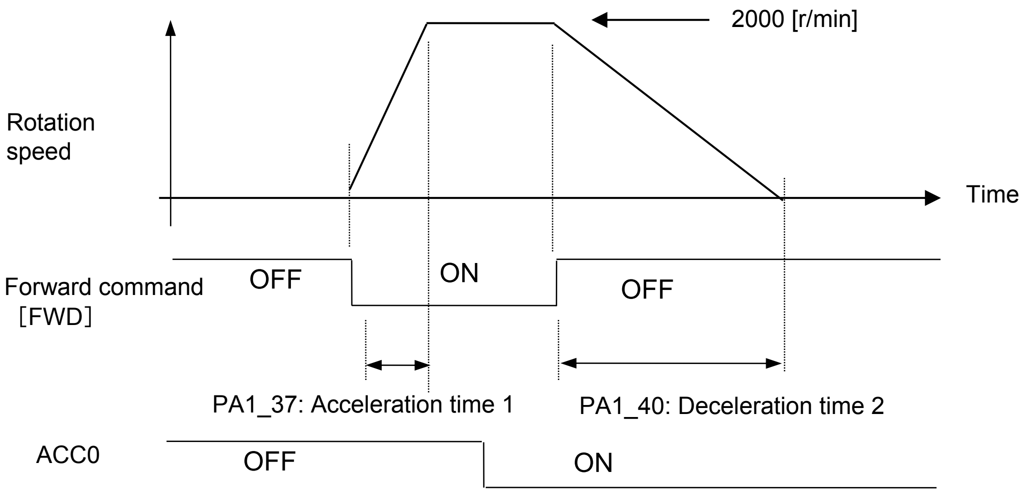
The parameter is enabled for acceleration and deceleration motions under speed control and position control (homing and manual position control operation) and for speed limit control with torque control.
The parameter is enabled for acceleration and deceleration motions uder speed control and position control (positioning, homing and manual position control operation).
Acceleration and deceleration follow these parameters during profile operation, too.
These parameters are disabled during pulse operation.
The acceleration/deceleration time setting indicates the time from 0 (zero) [r/min] to 2000 [r/min].

Acceleration time 2 and deceleration time 2 are enabled while the "ACC0" selection signal remains turned on.
ACC0 can be turned on or off at any time and the acceleration time and deceleration time are similarly changed.
ACC0 is assigned to an input signal (CONT signal). Selection follows the table below.
The deceleration time with a load in a carrier drive mechanism can be specified separately from that without a load.

ACC0 (14)	Acceleration time	Deceleration time
OFF	PA1_37	PA1_38
ON	PA1_39	PA1_40

Use PA1_36 (acceleration / deceleration selection at speed control) to select acceleration/deceleration of speed control.
To perform position control at the host control unit and to perform speed control at the servo system, enter "0" to PA1_36 (control method to output analog speed command voltage at host control unit).
To perform speed control independently in the servo system, enter "1" to PA1_36 to enable PA1_37 through PA1_40. At the time of homing and manual operation, PA1_37 through PA1_40 are enabled without relations to the setting of PA1_36.

Timing chart



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

In speed or position control, the speed setting will be that for manual feed.

In torque control, the setting value specified in PA1_26 (Max. rotation speed) is used as the speed limit when PA2_56 (torque control speed limit selection) is set to "0".

When PA2_56 (torque control speed limit selection) is set to "1", the speed limit values in the following table will be valid.

The speed setting values (speed limit values when performing torque control) are as shown in the following table with input signal (CONT signal): multi-step speed selection 1 [X1] to 3 [X3] combination.

Multi-step speed selection			Enabled parameter	
X3	X2	X1	Under speed/position control *1	Under torque control
OFF	OFF	OFF	VREF terminal voltage (analog speed limit)	VREF terminal voltage (analog speed limit)
OFF	OFF	ON	41: Manual feed speed 1	41: Speed limit for torque control1
OFF	ON	OFF	42: Manual feed speed 2	42: Speed limit for torque control2
OFF	ON	ON	43: Manual feed speed 3	43: Speed limit for torque control3
ON	OFF	OFF	44: Manual feed speed 4	44: Speed limit for torque control4
ON	OFF	ON	45: Manual feed speed 5	45: Speed limit for torque control5
ON	ON	OFF	46: Manual feed speed 6	46: Speed limit for torque control6
ON	ON	ON	47: Manual feed speed 7	47: Speed limit for torque control7

*1) Position control specified in the table above indicates the state of PA1_01 (control mode) set at "6" (extension mode) or “7” (positioning operation).

4.3 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.)

4.3.1 List (PA1_□□)

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	Automatic vibration suppression selection	0	-	○	-	-	
78	Vibration suppressing anti resonance frequency 0	300.0	-	○	-	-	
79	Vibration suppressing workpiece inertia ratio (vibration suppressing resonance frequency) 0	0	-	○	-	-	
80	Vibration suppressing anti resonance frequency 1	300.0	-	○	-	-	
81	Vibration suppressing workpiece inertia ratio (vibration suppressing resonance frequency) 1	0	-	○	-	-	
82	Vibration suppressing anti resonance frequency 2	300.0	-	○	-	-	
83	Vibration suppressing workpiece inertia ratio (vibration suppressing resonance frequency) 2	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 (vibration suppressing resonance frequency) 3	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	Speed range for friction compensation	10.0	-	○	○	-	
93	Coulomb friction torque for friction compensation	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.

4.3.2 Description of Each Parameter

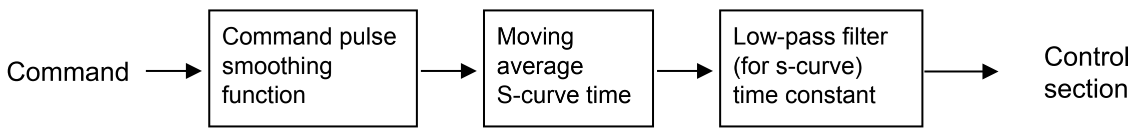
PA1_51 to 53 Command filter settings

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 5 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

4

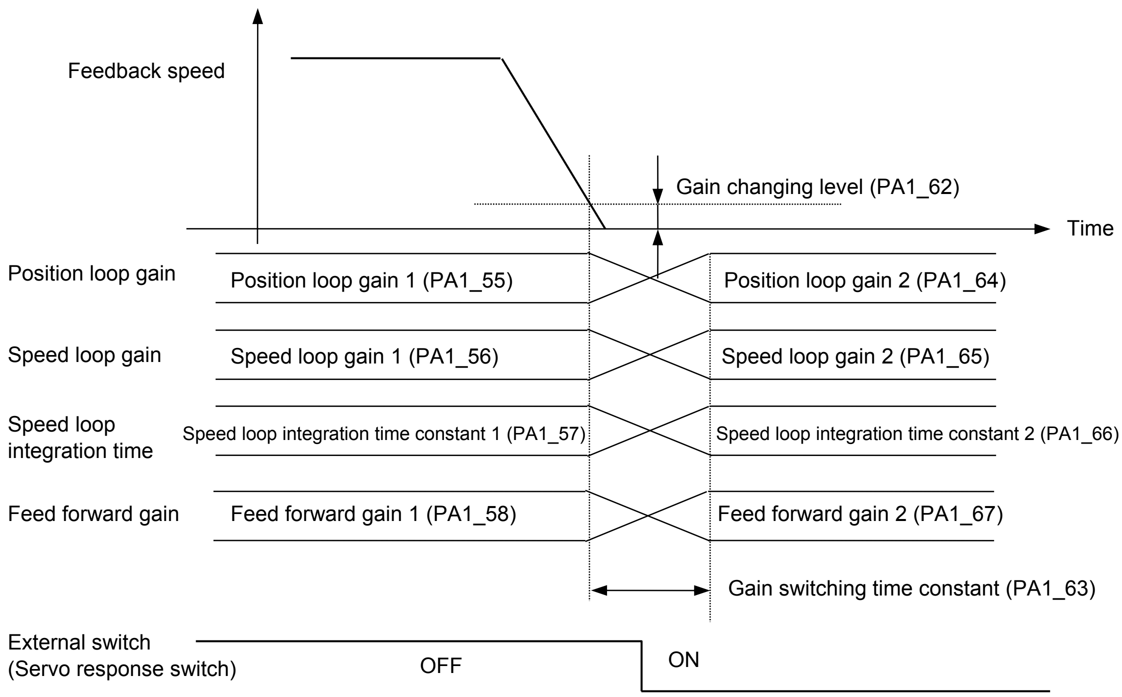
Torque filter time constant for position and speed control	This parameter is enabled under speed and position control. Add a filter to internal torque commands. The response of the servo system is improved and resonance is suppressed. In particular, the reference value should be larger with large load 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.

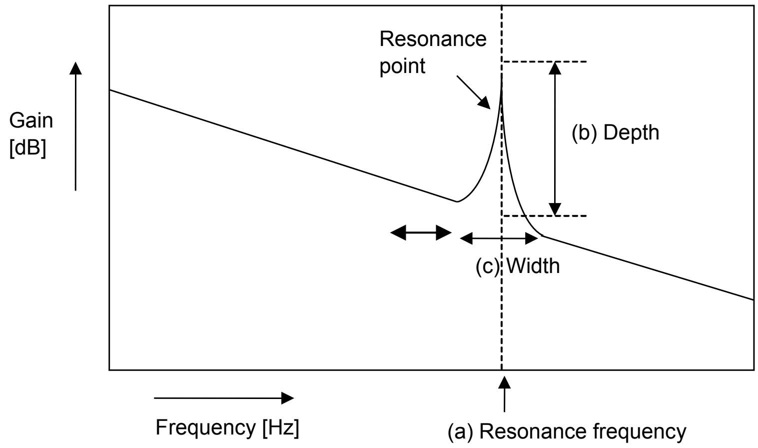
PA1_70 to 76 Notch filter settings

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. Up to two resonance points can be suppressed. Select 1 (enable) for automatic notch filter selection to adjust the notch filter automatically to the best value and suppress resonance.
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.



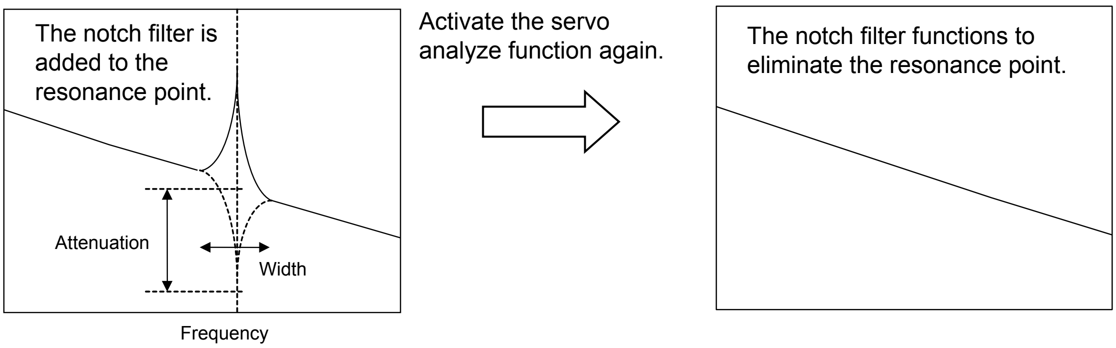
(3) Enter the resonance frequency of and attenuation of the resonance point of the machine into parameters.

(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	Automatic vibration suppressing selection	0: Disable 1: Enable 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 (vibration suppressing resonance frequency) 0	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 (vibration suppressing resonance frequency) 1	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 (vibration suppressing resonance frequency) 2	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 (vibration suppressing resonance frequency) 3	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 (automatic vibration suppressing control selection) at 1 (enable) 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.
Use vibration suppressing workpiece inertia ratio (vibration suppressing resonance frequency) 0 to enter the ratio of a vibrating inertial body such as the arm to the inertia of the entire system.
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 (Automatic vibration suppressing 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 5.9 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 frequency, 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	Speed range for friction compensation	0.1 [r/min] to 20.0 [r/min]	10.0	Always
93	Coulomb friction torque for friction compensation	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) at about 1.0 [r/min] to 10.0 [r/min].
Set PA1_93 (Coulomb friction torque for friction compensation) at the torque equivalent to dynamic friction (Coulomb friction).
Friction compensation is disabled if the friction compensation torque reference value is 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.

4.4 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.)

4.4.1 List (PA2_□□)

No. PA2_	Name	Default value	Power	Control mode			Record of reference value
				Position	Speed	Torque	
01	Decimal point position of positioning data	0	-	○	○	○	
06	Homing speed	500.00	-	○	-	-	
07	Creep speed for homing	50.00	-	○	-	-	
08	Starting direction for homing	0	○	○	-	-	
09	Reverse traveling unit amount for homing	0	-	○	-	-	
10	Homing direction after reference signal detection	0	○	○	-	-	
11	Reference signal for shift operation	1	○	○	-	-	
12	Reference signal for homing (Deceleration starting signal)	0	○	○	-	-	
13	Home position LS signal edge selection	0	○	○	-	-	
14	Home position shift unit amount	1000	-	○	-	-	
15	Deceleration operation for creep speed	0	○	○	-	-	
16	Home position after homing completion	0	-	○	-	-	
17	Home position detection range	0	-	○	-	-	
18	Deceleration time at OT during homing	100.0	-	○	-	-	
19	Preset position	0	-	○	-	-	
20	Interrupt traveling unit amount	100000	-	○	-	-	
22	Detection time for contact-stopper	0	-	○	-	-	
23	Torque limit for contact-stopper	0	-	○	-	-	
24	Selection of operation at OT during homing	0	○	○			
25	Software OT selection/position command format	0	○	○	○	-	
26	Positive software OT detection position	2000000000	-	○	○	-	
27	Negative software OT detection position	-2000000000	-	○	○	-	
28	Positive limiter detection time	2000000000	-	○	-	-	
29	Negative limiter detection time	-2000000000	-	○	-	-	
31	Point detection, area detection	0	-	○	○	○	
32	Point detection, area detection position 1	0	-	○	○	○	
33	Point detection, area detection position 2	0	-	○	○	○	
34	Point detection range	100	-	○	○	○	
36	Override 1	10	-	○	○	-	
37	Override 2	20	-	○	○	-	

No. PA2_	Name	Default value	Power	Control mode			Record of reference value
				Position	Speed	Torque	
38	Override 4	40	-	○	○	-	
39	Override 8	80	-	○	○	-	
40	Internal positioning data selection	0	○	○	○	-	
41	Sequential start selection	0	○	○	-	-	
42	Decimal point position of stand still timer	0	-	○	-	-	
43	Output selection at M code OFF	1	○	○	-	-	

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

4

4.4.2 Description of Each Parameter

PA2_01 Decimal point position of positioning data

No.	Name	Setting range	Default value	Change
01	Decimal point position of positioning data	0:0 1:0.1 2:0.01 3:0.001 4:0.0001 5:0.00001	0	Always

Specify the decimal point position of the displayed position data.

PA2_06 to 18 and 22 to 24 Homing settings

No.	Name	Setting range	Default value	Change
06*	Homing speed	0.01 [r/min] to Max. rotation speed [r/min]	500.00	Always
07	Creep speed for homing	0.01 [r/min] to Max. rotation speed [r/min]	50.00	Always
08*	Starting direction for homing	0:Forward rotation 1:Reserve rotation 2:Condition judgment start	0	Power
09	Reverse traveling unit amount for homing	0 to 2000000000 [unit amount]	0	Always
10*	Homing direction after reference signal detection	0: Forward rotation 1: Reverse rotation	0	Power
11*	Reference signal for shift operation	0: Home position LS 1: Encoder Z-phase 2: +OT 3:-OT 4: Interrupt input 5: Stopper	1	Power
12	Reference signal for homing (Deceleration starting signal)	0: Home position LS 1:+OT 2:-OT 3: Encoder Z-phase 4: Stopper	0	Power
13	Home position LS signal edge selection	0: Rising edge timing 1: Trailing edge timing	0	Power
14*	Home position shift unit amount	0 to 2000000000 [unit amount]	1000	Always
15	Deceleration operation for creep speed	0: Reverse rotation is disabled. 1: Reverse rotation is enabled.	0	Power
16	Home position after homing completion	-2000000000 to 2000000000 [unit amount]	0	Always

No.	Name	Setting range	Default value	Change
17	Home position detection range	0: Always ON after homing completion 1 to 2000000000 [unit amount]	0	Always
18	Deceleration time at OT during homing	0.0 [ms] to 99999.9 [ms]	100.0	Always
22	Detection time for contact-stopper	0 [ms] to 10000 [ms]	0	Always
23	Torque limit for contact-stopper	0 [%] to 100 [%]	0	Always
24	Selection of operation at OT during homing	0: Reverse rotation 1: Stop and cancel the homing	0	Power

*: Compulsory setting item

ALPHA7 can combine parameter settings to create the desired homing profile.
The homing profile is configured with combination of the following parameters.

(1) Starting direction for homing
Specify the starting direction (forward/reverse rotation) of homing. The direction opposite to the homing direction after reference signal detection can be specified.

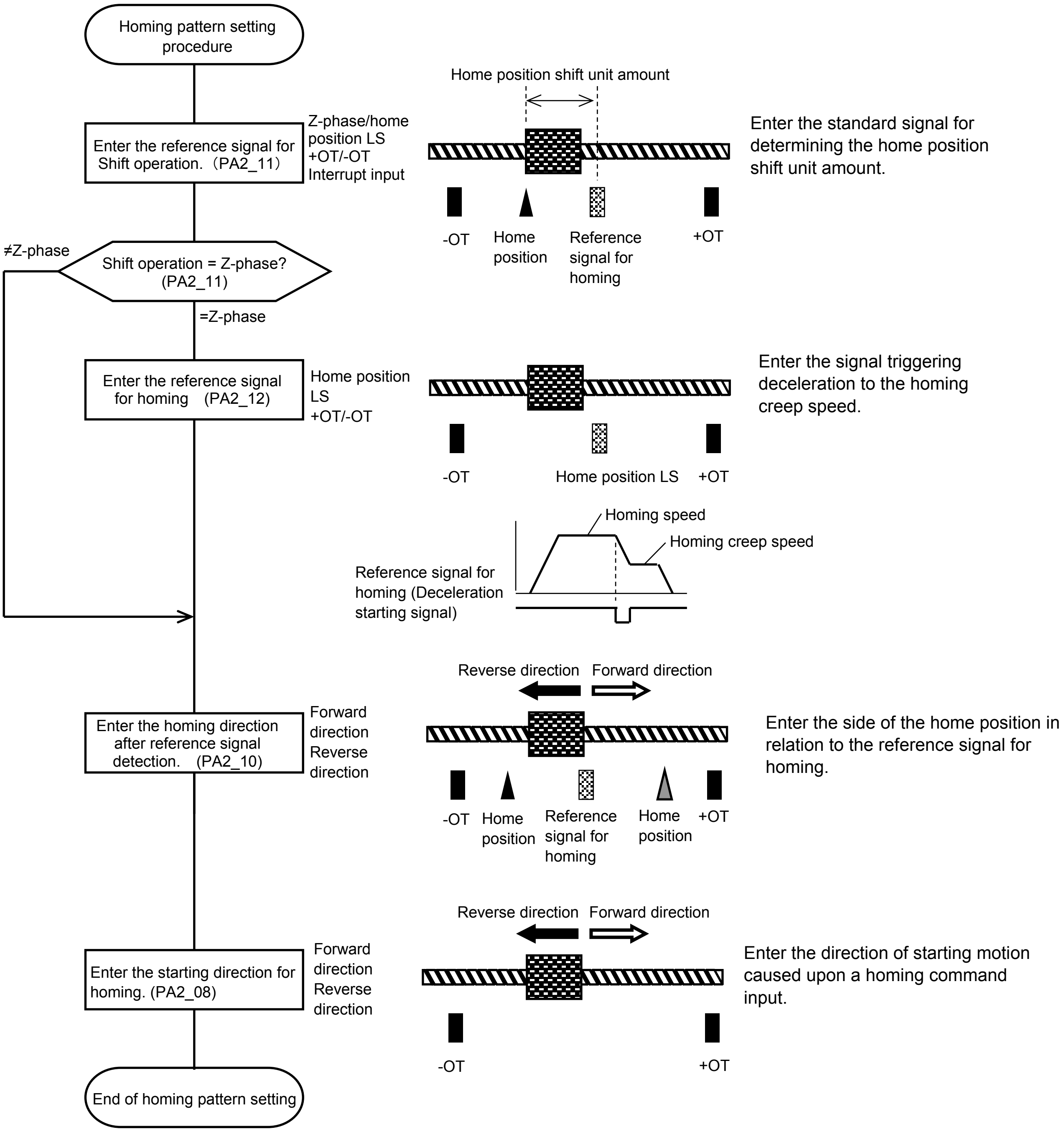
(2) Homing direction after reference signal detection
Select the side of the home position (forward or reverse rotation side) in relation to the reference signal for homing (Deceleration starting signal) and reference signal for shift operation.

(3) Reference signal for shift operation
Select the signal serving as the direct standard of the zero position. You can select +OT or -OT.

(4) Reference signal for homing (Deceleration starting signal)
Specify the creep speed deceleration signal that is used if the encoder Z-phase is selected as a reference signal for shift operation. You can select +OT or -OT. If encoder Z-phase is selected, the motor will move at creep speed when homing is started.

(1) Homing profile setting procedure

The basic procedure for specifying the homing profile (homing parameter) is described.



- An example of parameter settings for a typical homing profile can be found in " Typical homing profiles".

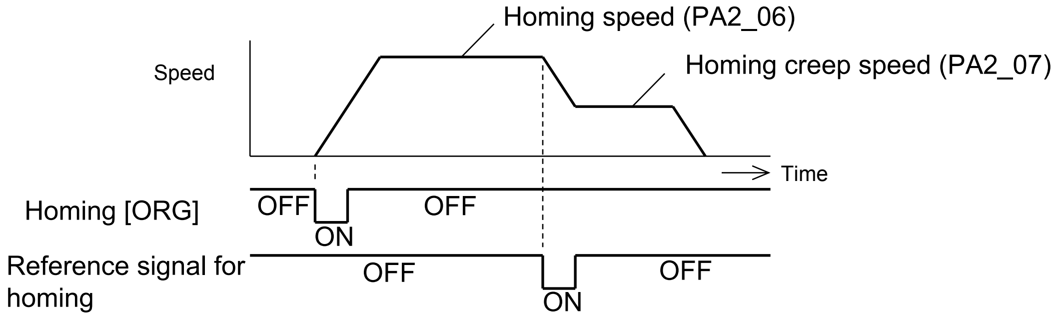
(2) Homing motion setting parameter

Parameters are combined to determine the homing motion.

PA2_06 Homing speed

No.	Name	Setting range	Default value	Change
06	Homing speed	0.01 [r/min] to Max. rotation speed [r/min]	500.00	Always

Specify the homing speed.



PA2_07 Creep speed for homing

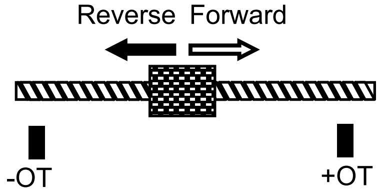
No.	Name	Setting range	Default value	Change
07	Creep speed for homing	0.01 [r/min] to Max. rotation speed [r/min]	50.00	Always

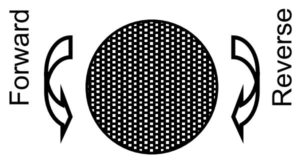
Specify the motion speed taken after the reference signal for homing (deceleration starting signal) is detected.

PA2_08 Starting direction for homing

No.	Name	Setting range	Default value	Change
08	Starting direction for homing	0:Forward rotation 1:Reverse rotation 2:Condition judgment start	0	Power

Specify the starting direction of the homing motion.





Refer to "Typical homing profiles" for details on the 2: Condition judgment start direction.

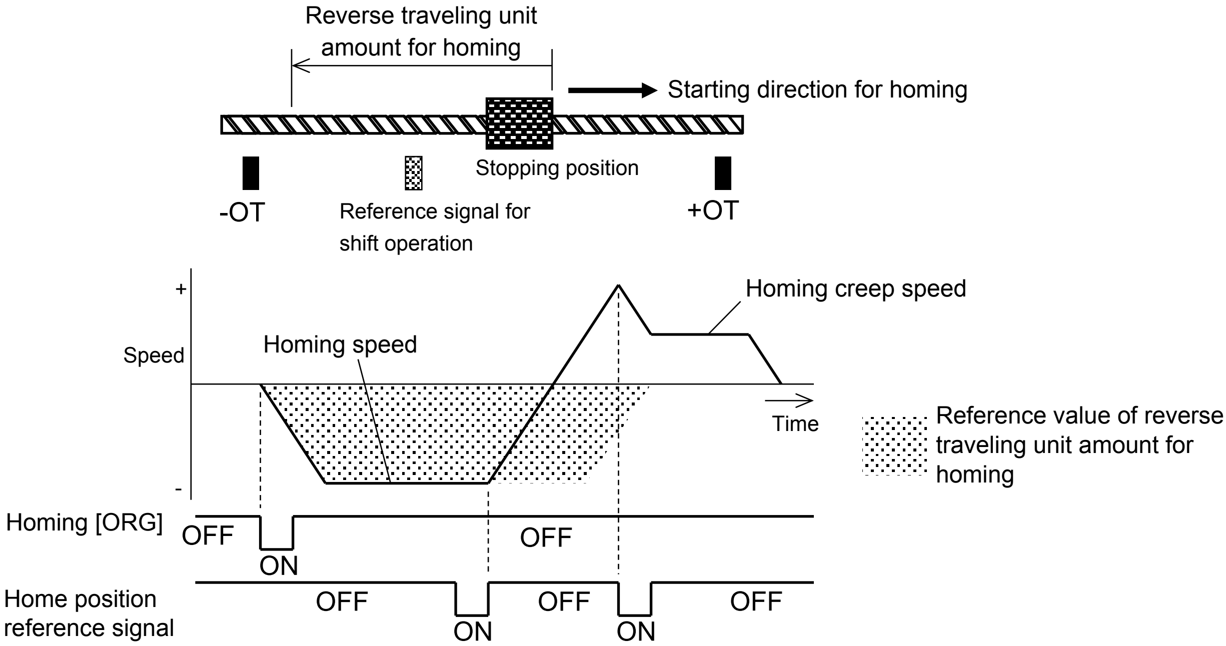
- Forward direction: direction of position increase Reverse direction: direction of position decrease
  The forward/reverse direction depends on parameter PA1_04 (rotation direction selection).

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>Not a compulsory item</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 depends on PA1_06 (numerator 0 of electronic gear) and PA1_07 (denominator of electronic gear).
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.

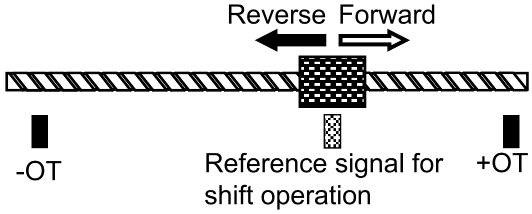


4

PA2_10 Homing direction after reference signal detection

No.	Name	Setting range	Default value	Change
10	Homing direction after reference signal detection	0: Forward rotation 1: Reverse rotation	0	Power

Specify the direction of the zero position when viewed from the reference signal for shift operation. The reference signal for shift operation is passed during home position shift unit amount travel in this direction.

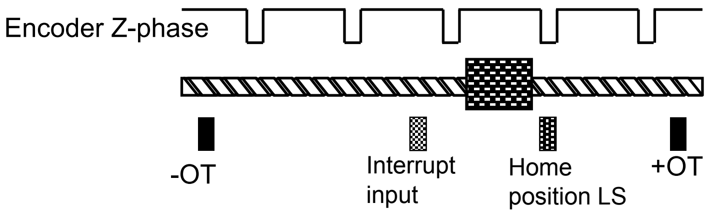


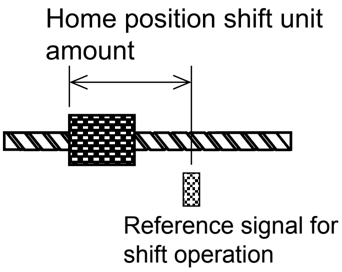
- If +OT, -OT, or stopper is set for the homing reference signal, this parameter will be disabled, and the direction opposite to that of the set OT signal or detected stopper will be the homing direction. Furthermore, this parameter will also be disabled if "Encode Z-phase" is selected for the homing reference signal, and the homing direction will be the homing starting direction.
  The definition of the direction of motion is shown below.
  Forward: direction of position increase Reverse: direction of position decrease

PA2_11 Reference signal for shift operation

No.	Name	Setting range	Default value	Change
11	Reference signal for shift operation	0: Home position LS 1: Encoder Z-phase 2: +OT 3:-OT 4: Interrupt input 5: Stopper	1	Power

Specify the signal serving as a standard of the home position.
The position of a travel from the specified reference signal toward the homing direction after reference signal detection by the home position shift unit amount is the home position.
The home position accuracy (reproducibility of zero position) is the highest with 3 (encoder Z-phase).
If the Z-phase is selected, the reference signal for shift operation (deceleration starting signal) can be installed.
Next to the encoder Z-phase, 4 (interrupt input) has the highest home position accuracy (reproducibility of zero position). This is because 4 (interrupt input) detects the interrupt position with a signal while 0 (home position LS), 2 (+OT) and 3 (-OT) detects a level.



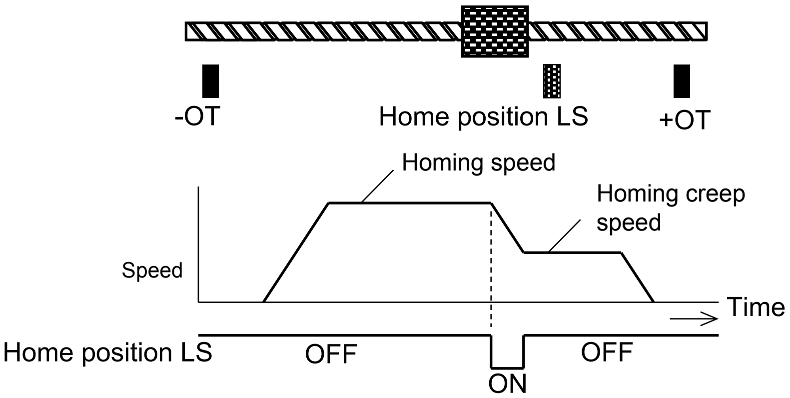


- If one among 0 (home position LS), 2 (+OT) and 3 (-OT) is selected, there is an error of ±250 [pulses] in the zero position at a creep speed for homing of 50 [r/min].

PA2_12 Reference signal for homing (Deceleration starting signal)

No.	Name	Setting range	Default value	Change
12	Reference signal for homing (Deceleration starting signal)	0: Home position LS 1:+OT 2:-OT 3: Encoder Z-phase 4: Stopper	0	Power

If the encoder Z-phase is selected as a reference signal for shift operation, specify the timing signal for deceleration to the creep speed for homing. The first encoder Z-phase after reference signal for shift operation detection is the starting point of the home position shift unit amount.
If "Encoder Z-phase" is selected, the speed when homing is started will be homing creep speed, and the initial encoder Z-phase after starting will be the home position shift amount starting point.



Example where the home position LS is the reference signal for homing

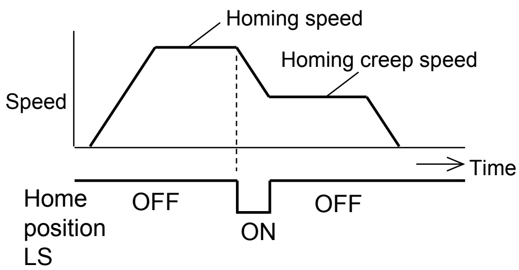
PA2_13 Home position LS signal edge selection

No.	Name	Setting range	Default value	Change
13	Home position LS signal edge selection	0: Rising edge timing 1: Trailing edge timing	0	Power

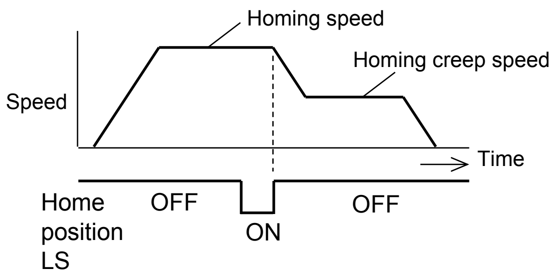
Not a compulsory item

Specify the enabling timing of the home position LS signal if the home position LS is specified as a reference signal for shift operation reference signal for homing (Deceleration starting signal).

[Home position LS timing selection = 0]



[Home position LS timing selection = 1]

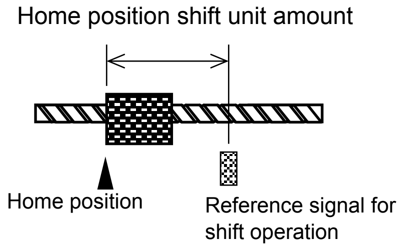


4

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]	1000	Always

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

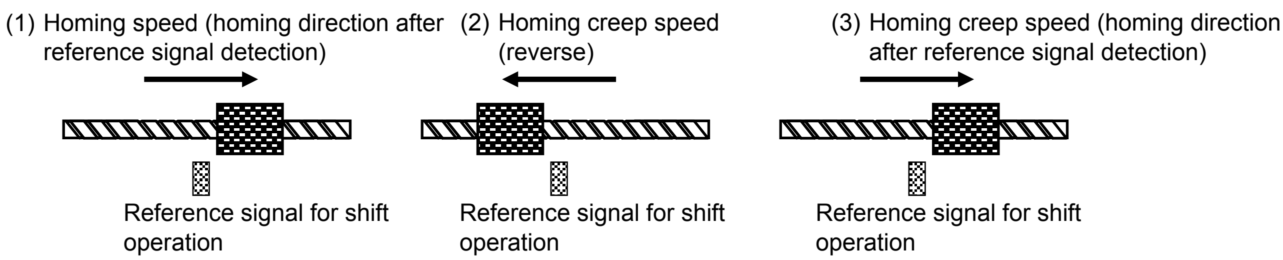


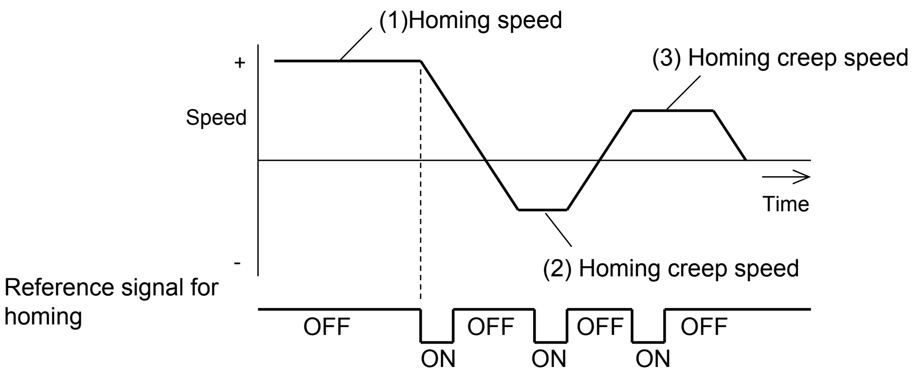
PA2_15 Deceleration operation for creep speed

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

Not a compulsory item

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).



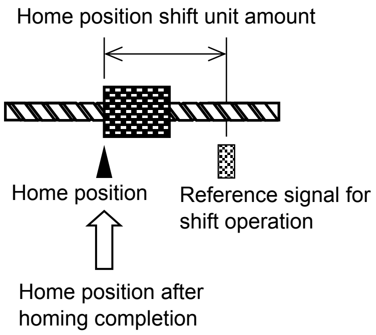


PA2_16 Home position after homing completion

No.	Name	Setting range	Default value	Change
16	Home position after homing completion	-2000000000 to 2000000000 [unit amount]	0	Always

Not a compulsory item

Specify the coordinate position of the homing completion point.
After a homing is normally finished, the current position is replaced with the reference value of this parameter.
Specify if the homing motion completion point is other than zero.



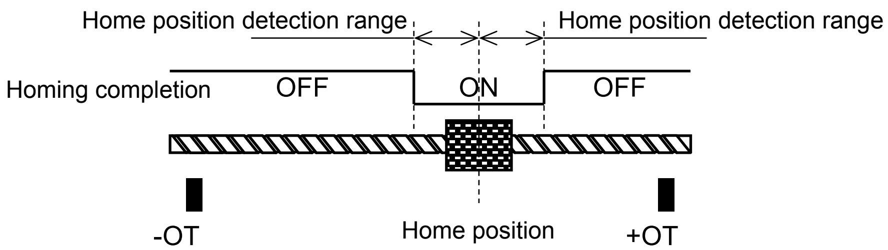
4

PA2_17 Home position detection range

No.	Name	Setting range	Default value	Change
17	Home position detection range	0: Always ON after homing completion 1 to 2000000000 [unit amount]	0	Always

Not a compulsory item

Specify the range in which the homing completion signal is turned on.
If the current position is between the positive home position detection range and negative home position detection range around the home position, homing completion is turned on.
Specify 0 to always turn the homing completion signal on after a homing is finished.



The zero position is not necessarily 0. The home position is the position specified as a home position after homing completion (PA2_16) or preset position (PA2_19).

PA2_18 Deceleration time at OT during homing

No.	Name	Setting range	Default value	Change
18	Deceleration time at OT during homing	0.0 [ms] to 99999.9 [ms]	100.0	Always

Specify the deceleration time taken after +OT or -OT is detected during homing motion.
Specify the time taken to decelerate from 2000 [r/min] to 0 [r/min]. Determine the setting under consideration of the homing speed and moving range after the OT sensor. (“0.7” in the equation indicates the safety factor.)

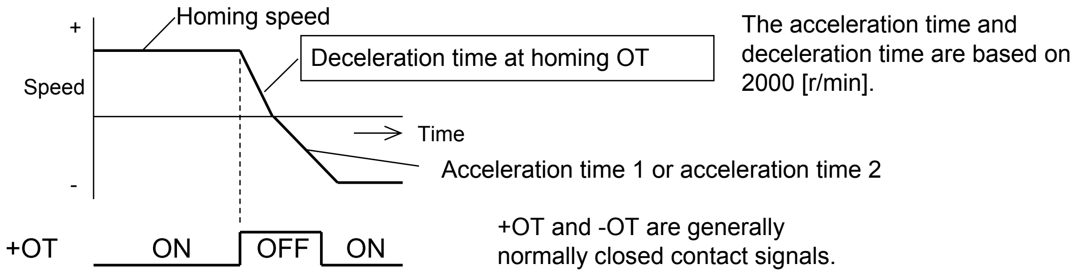
4

[Example of calculation of reference value]

Moving range after OT × 0.7 = Homing speed × Reduction ratio × Ball screw lead
× (Homing speed/2000 [r/min] × Deceleration time after homing OT/1000/60) × 1/2

30[mm] ×0.7 = 1000.00 [r/min] × (1/5) × 20 [mm]
× (1000.00 [r/min]/2000 [r/min] × Deceleration time at OT during homing /1000/60) × 1/2

Deceleration time at OT during homing = 1260.0 [ms]



- If 1 (stop) is selected with parameter PA2_24 (selection of operation at OT during homing), stoppage occurs according to parameter PA2_60 (third torque limit). In this case, the homing motion is stopped upon detection of OT.

PA2_22 Detection time for contact-stopper
PA2_23 Torque limit for contact-stopper

No.	Name	Setting range	Default value	Change
22	Detection time for contact-stopper	0 [ms] to 10000 [ms]	0	Always
23	Torque limit for contact-stopper	0 [%] to 100 [%]	0	Always

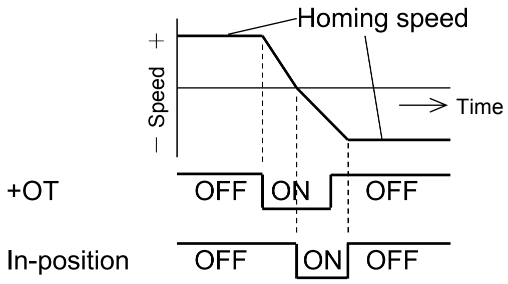
These parameters are enabled if “5” (Stopper) is selected for the reference signal for shift operation (PA2_11), or “1” (Encoder Z-phase) is selected for PA2_11 and “4” (Stopper) is selected for reference signal for homing (PA2_12).
Enter these parameters to perform homing in applications such as positioning of a cylinder or the like where the home position LS or +/-OT cannot be used.
Enter the stopper contact detection time and dead stop torque limit.
Refer to "Typical homing profiles" for details.

PA2_24 Selection of operation at OT during homing

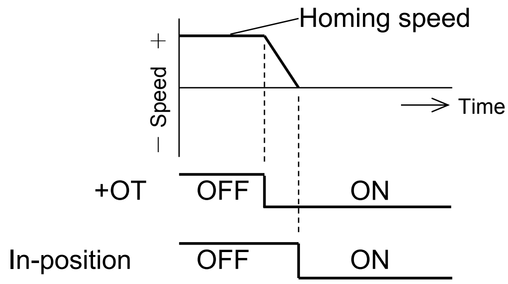
No.	Name	Setting range	Default value	Change
24	Selection of operation at OT during homing	0: Reverse rotation 1: Stop and cancel the homing	0	Power

Specify the motion taken upon first OT detection during homing motion.
Specify 0 to reverse the motion upon first OT detection.
Specify 1 to cancel homing and stop upon detection of OT.

Selection of operation at OT during homing = 0



Selection of operation at OT during homing = 1



4

■ Parameters related to homing

PA1_12 (Z-phase position offset)

No.	Name	Setting range	Default value	Change
12	Z-phase position offset	0 [pulse] to 16777216 [pulse]: 24 bit	0	Power

The encoder Z-phase position can be adjusted.
The Z-phase output position shifts by the pulse amount (pulse units) specified in the CCW direction.
If the encoder Z-phase is selected as a reference signal for shift operation, adjust the encoder Z-phase position with this parameter after motor replacement so that homing can be made to the original position without changing the reference signal for homing (deceleration starting signal) or homing parameters.
For details, refer to "PA1_12 Z-phase position offset".

PA1_37 to 40 (acceleration times, deceleration times)

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	
39	Acceleration time 2		500.0	
40	Deceleration time 2		500.0	

Specify acceleration and deceleration in the homing motion.
The acceleration/deceleration time is the time from 0 [r/min] to 2000 [r/min].
For details, refer to "PA1_36 to 40 Acceleration time and deceleration time settings", "4.5.2 Description of Each Parameter".

PA2_60 third torque limit

No.	Name	Setting range	Default value	Change
60	Third torque limit	GYB: 0 [%] to 350 [%] other than GYB: 0 [%] to 300 [%]	GYB: 350 [%] other than GYB: 300 [%]	Always

Specify the deceleration torque for stopping upon detection of +OT or -OT during homing motion.
If 1 (stop) is selected as parameter PA2_24 (selection of operation at OT during homing) and OT is detected, the homing process is canceled and controlled stop is caused according to this parameter.
For details, refer to "PA2_57 to 60 Torque limit settings", " 4.5.2　Description of Each Parameter".

■ Typical homing profiles

(1) Basic homing profile (equivalent to homing profile 1 of FALDIC-α Series)

Described here is the homing profile of the most basic motion, in which homing is started, the reference signal for homing (deceleration starting signal) is detected and deceleration to the creep speed for homing occurs, and the reference signal for shift operation is detected and movement by the home position shift unit amount is caused until the motion is stopped.
Use the profile if the machine stopping position is less than the reference signal for homing (deceleration starting signal) or reference signal for shift operation.
Because neither +OT nor -OT is installed for homing of a rotating body as an indicator of the traveling limit, this homing profile is used in principle.
[Parameter setting example]

PA2_

No.	Name	Setting	Default value	Change
06	Homing speed	500.00 [r/min]	500.00	Always
07	Creep speed for homing	50.00 [r/min]	50.00	Always
08	Starting direction for homing	0: Forward rotation	0	Power
09	Reverse traveling unit amount for homing	0 [unit amount]	0	Always
10	Homing direction after reference signal detection	0: Forward rotation	0	Power
11	Reference signal for shift operation	1: Encoder Z-phase	1	Power
12	Reference signal for homing (Deceleration starting signal)	0: Home position LS	0	Power
13	Home position LS signal edge selection	0: Rising edge timing	0	Power
14	Home position shift unit amount	1000 [unit amount]	1000	Always
15	Deceleration operation for creep speed	0: Reverse rotation is disabled	0	Power
16	Home position after homing completion	0 [unit amount]	0	Always
17	Home position detection range	0: Always ON after homing completion	0	Always
18	Deceleration time at OT during homing	100.0 [ms]	100.0	Always
24	Selection of operation at OT during homing	0: Reverse rotation	0	Power

- To cancel homing upon detection of +OT or -OT, specify 1 (stop) to parameter PA2_24 (selection of operation at OT during homing).

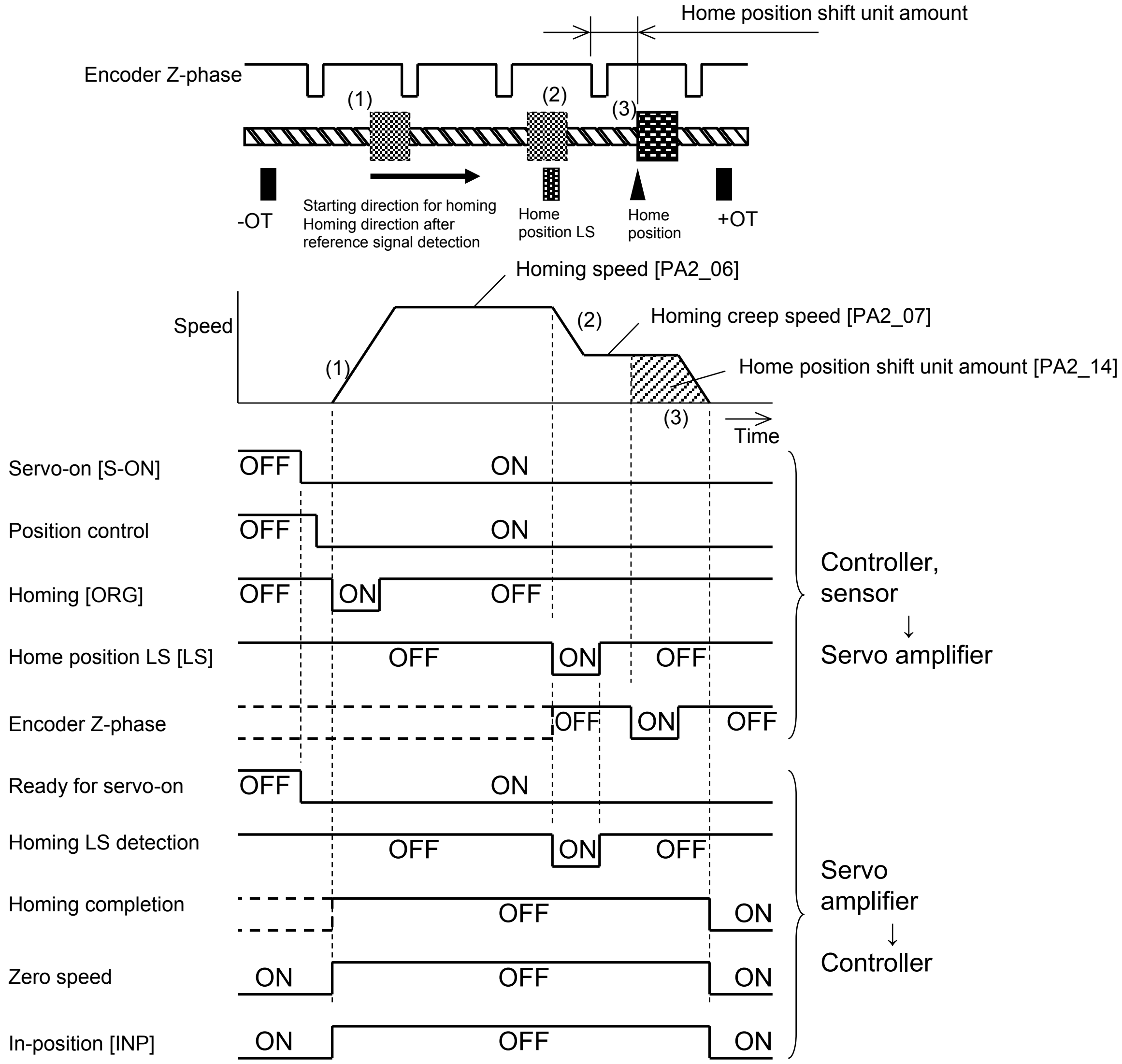
4

The motion proceeds in the following procedure.

(1) The motion starts upon homing [ORG] (OFF → ON) in the starting direction for homing (PA2_08) at homing speed (PA2_06).

(2) When the home position LS (PA2_12, PA2_13) is detected, the motion changes in the homing direction after reference signal detection (PA2_10) at the creep speed for homing (PA2_07).

(3) After the home position LS (PA2_12) is detected during travel in the homing direction after reference signal detection and the first encoder Z-phase (PA2_11) is detected, a travel occurs by the home position shift unit amount (PA2_14), followed by stoppage. The stopping point changes to the home position and homing completion is turned on and the homing process is finished.



(2) OT reference homing profile (equivalent to homing profile 2 of FALDIC-α Series)

If the OT located in the starting direction for homing is detected after homing is started before the reference signal for homing (deceleration starting signal) is detected, the motion reverses automatically and a travel occurs in the opposite direction for a reference signal for shift operation in this homing profile.
Secure homing is realized even if the direction of the reference signal for homing (deceleration stating signal) or reference signal for shift operation in relation to the machine stopping position is not known.

[Parameter setting example]

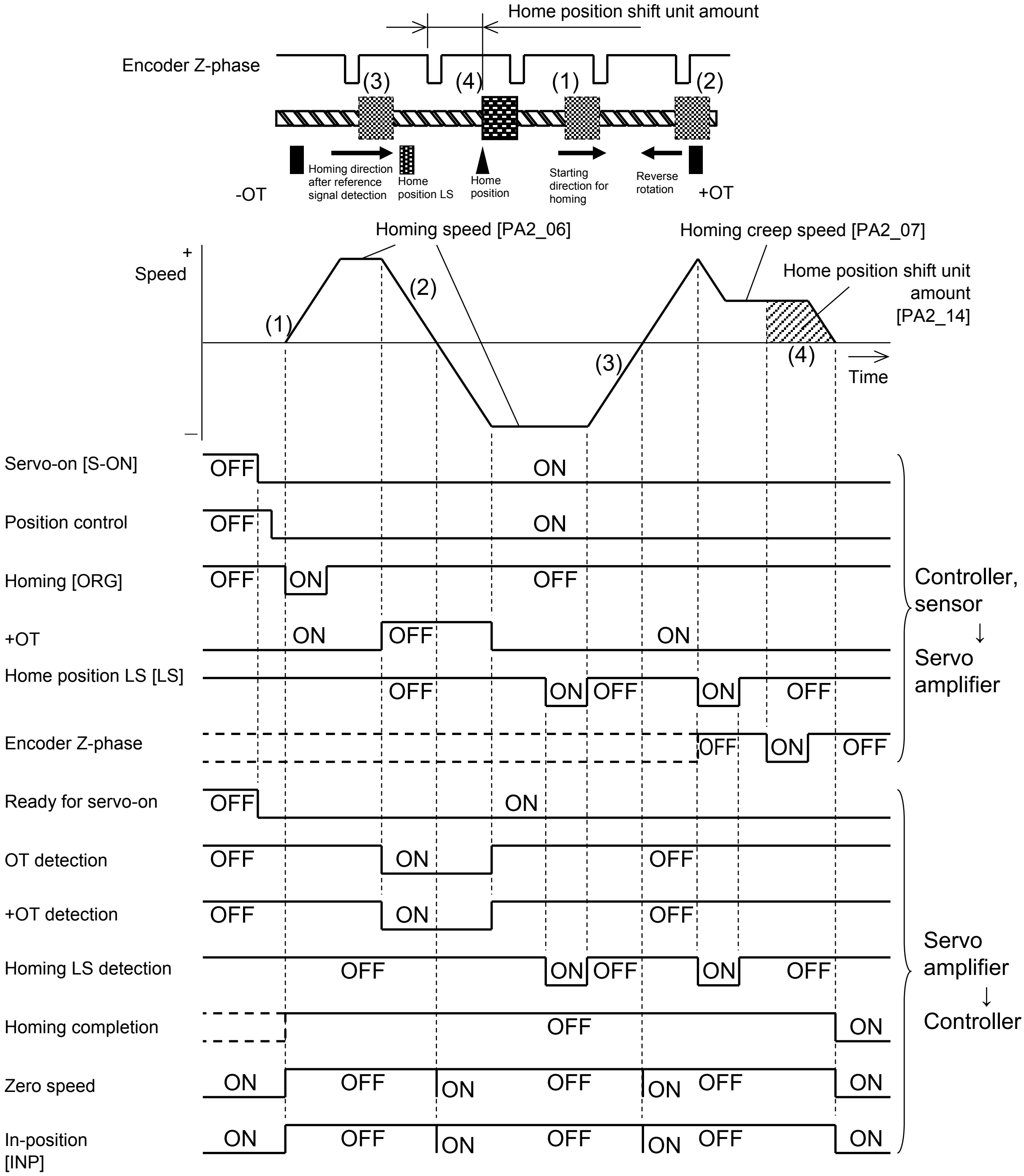
PA2_

No.	Name	Setting	Default value	Change
06	Homing speed	500.00 [r/min]	500.00	Always
07	Creep speed for homing	50.00 [r/min]	50.00	Always
08	Starting direction for homing	0: Forward rotation	0	Power
09	Reverse traveling unit amount for homing	0 [unit amount]	0	Always
10	Homing direction after reference signal detection	0: Forward rotation	0	Power
11	Reference signal for shift operation	1: Encoder Z-phase	1	Power
12	Reference signal for homing (Deceleration starting signal)	0: Home position LS	0	Power
13	Home position LS signal edge selection	0: Rising edge timing	0	Power
14	Home position shift unit amount	1000 [unit amount]	1000	Always
15	Deceleration operation for creep speed	0: Reverse rotation is disabled	0	Power
16	Home position after homing completion	0 [unit amount]	0	Always
17	Home position detection range	0: Always ON after homing completion	0	Always
18	Deceleration time at OT during homing	100.0 [ms]	100.0	Always
24	Selection of operation at OT during homing	0: Reverse rotation	0	Power

- Because the reverse rotation upon OT detection is enabled with the standard homing setting of ALPHA7, the OT reference homing is executed with the same parameter settings as those of the basic homing profile.
  If the reference signal for homing (deceleration starting signal) is detected before OT is detected, the motion profiles the same as that of (1) basic homing profile.

  If OT is detected in the starting direction for homing during homing motion, the motion proceeds in the following procedure.
  (1) The motion starts at the rising edge (OFF → ON) of homing [ORG] in the starting direction for homing (PA2_08) at the homing speed (PA2_06).
  (2) If OT is detected in the starting direction for homing (PA2_08) before the home position LS (PA2_12) is detected, the motion reverses at the homing speed (PA2_06).
  (3) If home position LS (PA_12) is detected during reverse rotation, the motor will move at homing speed (PA2_06) in the homing direction (PA2_10).

(4) If home position LS (PA2_12) is detected in the homing direction (PA2_10), the motor will begin traveling in the homing direction (PA2_10) at homing creep speed (PA2_07), and will stop after moving by the home position shift amount (PA2_14) from the point of initial encoder Z-phase (PA2_11) detection. Homing completion is turned ON with the stopping point as the home position, and the homing process is completed.



- At the rotation direction selection point with zero speed, zero speed and in-position [INP] are momentarily turned on. The signal change may fail to be sensed according to some scanning periods of the host controller.

(3) At-start reverse rotation homing profile1 (equivalent to homing profile 3 of FALDIC-α Series)

After homing is started, a travel occurs in the direction opposite to the starting direction for homing by the specified reverse traveling unit amount for homing while the reference signal for homing (deceleration starting signal) is searched for.

This profiles used if the machine stopping position is larger than the reference signal for homing (deceleration starting signal) or reference signal for shift operation.

[Parameter setting example]

PA2_

No.	Name	Setting	Default value	Change
06	Homing speed	500.00 [r/min]	500.00	Always
07	Creep speed for homing	50.00 [r/min]	50.00	Always
08	Starting direction for homing	0: Forward rotation	0	Power
09	Reverse traveling unit amount for homing	20000 [unit amount]	0	Always
10	Homing direction after reference signal detection	0: Forward rotation	0	Power
11	Reference signal for shift operation	1: Encoder Z-phase	1	Power
12	Reference signal for homing (Deceleration starting signal)	0: Home position LS	0	Power
13	Home position LS signal edge selection	0: Rising edge timing	0	Power
14	Home position shift unit amount	1000 [unit amount]	1000	Always
15	Deceleration operation for creep speed	0: Reverse rotation is disabled	0	Power
16	Home position after homing completion	0 [unit amount]	0	Always
17	Home position detection range	0: Always ON after homing completion	0	Always
18	Deceleration time at OT during homing	100.0 [ms]	100.0	Always
24	Selection of operation at OT during homing	0: Reverse rotation	0	Power

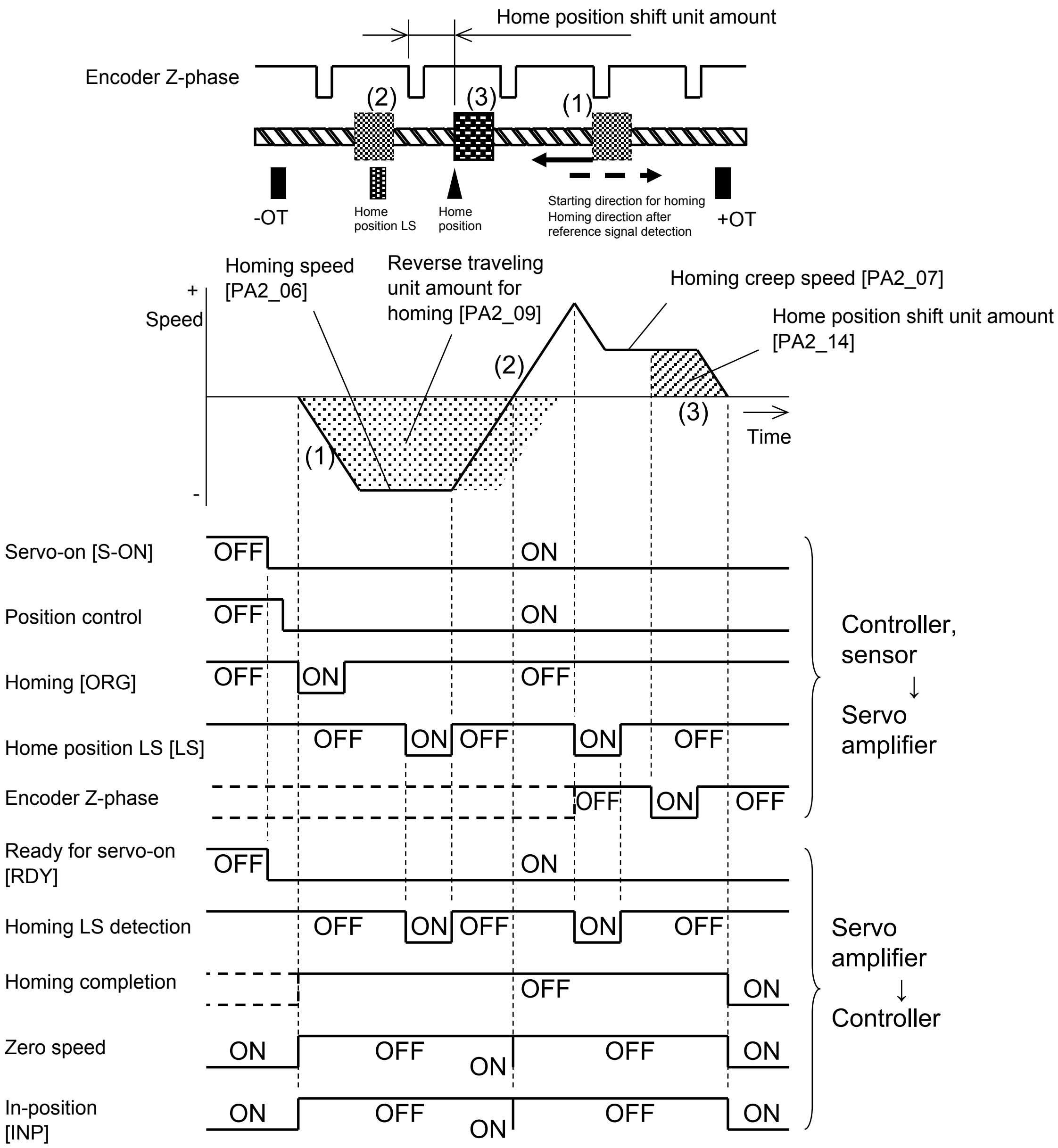
- Because rotation reverses in the direction opposite to the OT direction upon OT detection to detect the reference signal for homing (deceleration starting signal) and reference signal for shift operation, secure homing is realized. The reverse rotation after OT detection follows (2) OT reference homing profile.

The motion proceeds in the following procedure.

(1) The motion starts at the rising edge (OFF → ON) of homing [ORG] in the direction opposite to the starting direction for homing (PA2_08) at the homing speed (PA2_06).

(2) If the home position LS (PA2_12) is detected during travel by the reverse traveling unit amount for homing (PA2_09), the motion changes in the homing direction after reference signal detection (PA2_10) at the creep speed for homing (PA2_07).

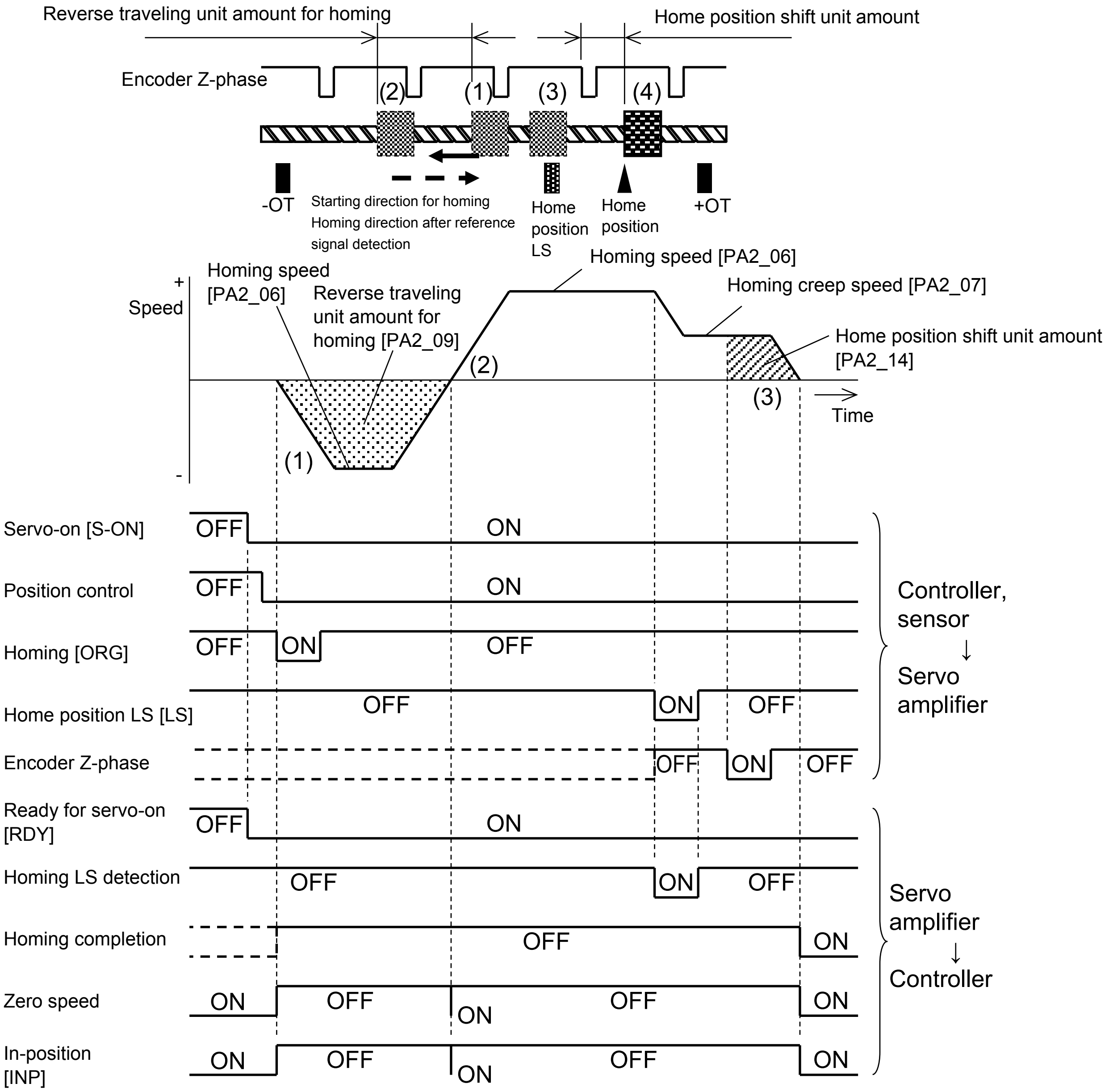
(3) Upon detection of the first encoder Z-phase (PA2_11) after detection of the home position LS (PA2_12) during travel in the homing direction after reference signal detection (PA2_10), a travel continues by the home position shift unit amount (PA2_14), followed by stoppage. The stopping point changes to the home position and homing completion is turned on and the homing process is finished.



- At the direction of rotation switch rotation direction selection point with zero speed, zero speed and in-position [INP] are momentarily turned on. The signal change may fail to be sensed according to some scanning periods of the host controller.

If the home position LS (PA2_12) is not found during travel from the homing starting position in the reverse traveling unit amount for homing (PA2_09), the motion continues in the starting direction for homing to search for the home position LS (PA2_12).

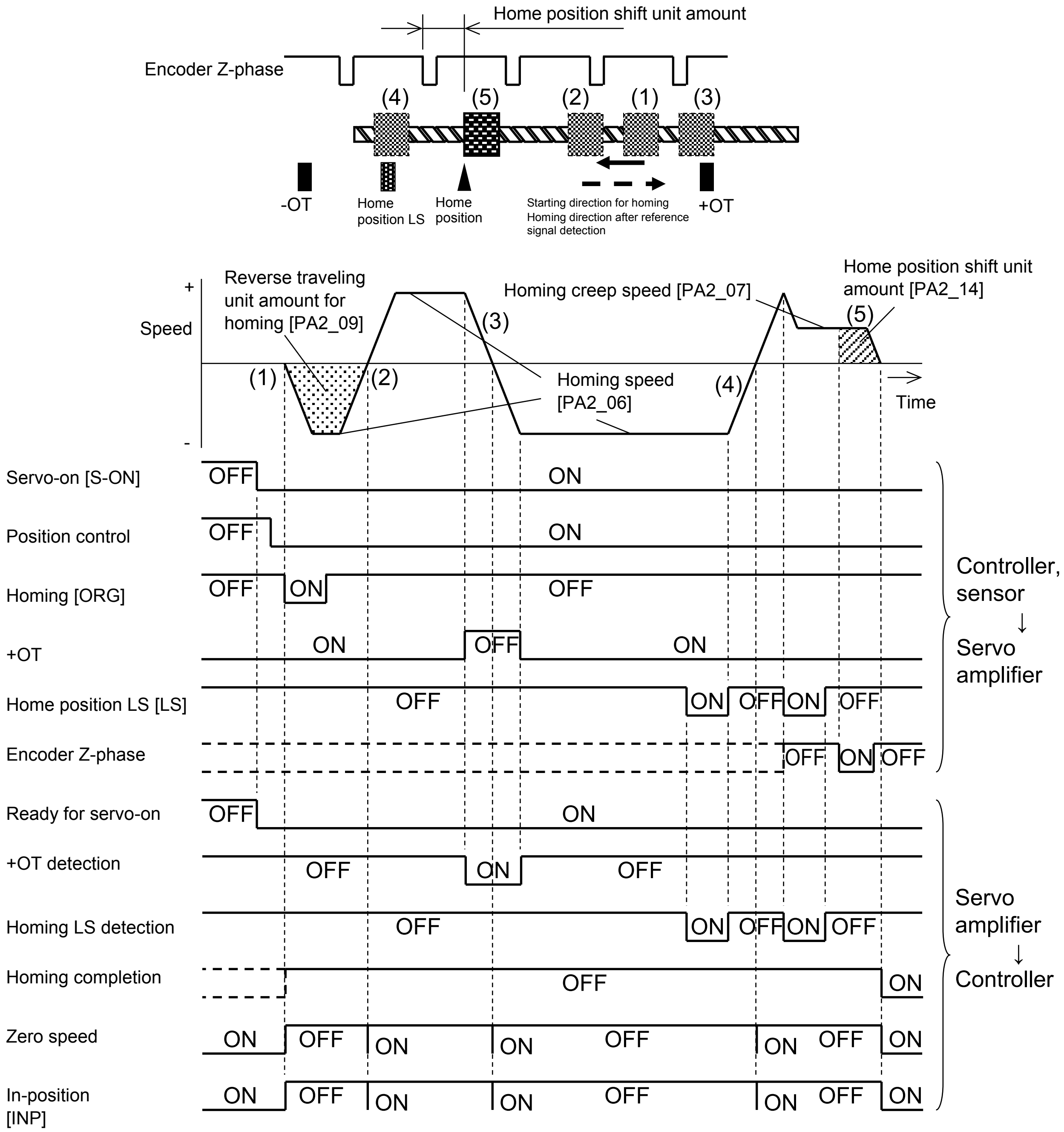
(1) The motion starts at the rising edge (OFF → ON) of homing [ORG] in the direction opposite to the starting direction for homing (PA2_08) at the homing speed (PA2_06).
(2) If the home position LS (PA2_12) is not found during travel by the reverse traveling unit amount for homing (PA2_09), the motion changes in the starting direction for homing (PA2_08) at the homing speed (PA2_06).
(3) If the home position LS (PA2_12, PA2_13) is detected, the motion changes in the homing direction after reference signal detection (PA2_10) at the creep speed for homing (PA2_07).
(4) Upon detection of the first encoder Z-phase (PA2_11) after detection of the home position LS (PA2_12) during travel in the homing direction after reference signal detection, a travel continues by the home position shift unit amount (PA2_14), followed by stoppage. The stopping point changes to the home position and homing completion is turned on and the homing process is finished.



- At the rotation direction selection point with zero speed, zero speed and in-position [INP] are momentarily turned on. The signal change may fail to be sensed according to some scanning periods of the host controller.

If the home position LS (PA2_12) is not found during travel from the homing starting position in the reverse traveling unit amount for homing (PA2_09), the motion changes in the starting direction for homing and the home position LS (PA2_12) is searched for. If the home position LS (PA2_12) is not found during the motion in the starting direction for homing until OT in the starting direction for homing is detected, the motion reverses and the reference signal for homing (Deceleration starting signal) and reference signal for shift operation are searched for.

(1) The motion starts upon at the rising edge (OFF → ON) of homing [ORG] in the direction opposite to the starting direction for homing (PA2_08) at the homing speed (PA2_06).
(2) If the home position LS (PA2_12) is not found during travel by the reverse traveling unit amount for homing (PA2_09), the motion changes in the starting direction for homing (PA2_08) at the homing speed (PA2_06).
(3) If OT in the starting direction for homing (PA2_08) is found while the home position LS (PA2_12) is not found, the motion reverses at the homing speed (PA2_06).
(4) If the home position LS (PA2_12) is found during reverse rotation, the motion changes in the homing direction after reference signal detection (PA2_10) at the creep speed for homing (PA2_07).
(5) Upon detection of the first encoder Z-phase (PA2_11) after detection of the home position LS (PA2_12) during travel in the homing direction after reference signal detection (PA2_10), a travel by the home position shift unit amount (PA2_14) continues, followed by stoppage. The stopping point changes to the home position and homing completion is turned on and the homing process is finished.



Home position shift unit amount
Encoder Z-phase
(4)
(5)
(2)
(1)
(3)
-OT
Home position LS
Home position
Starting direction for homing
Homing direction after reference signal detection
+OT
Reverse traveling unit amount for homing [PA2_09]
Homing creep speed [PA2_07]
Home position shift unit amount [PA2_14]
Speed
Homing speed [PA2_06]
Time
Servo-on [S-ON]
Position control
Homing [ORG]
+OT
Home position LS [LS]
Encoder Z-phase
Ready for servo-on
+OT detection
Homing LS detection
Homing completion
Zero speed
In-position [INP]
OFF
ON
Controller, sensor
↓
Servo amplifier
Servo amplifier
↓
Controller

(4) Reference signal for shift operation homing profile (equivalent to homing profile 4 of FALDIC-α Series)

Upon detection of a reference signal for shift operation after the start of homing, the motion reverses to the point ahead of the reference signal for shift operation, and then the motion continues at the creep speed for homing to detect the reference signal for shift operation and determine the home position.
Accurate homing (highly reproducible zero position) is realized only with the reference signal for shift operation without using the reference signal for homing (deceleration starting signal).

[Parameter setting example]

PA2_

No.	Name	Setting	Default value	Change
06	Homing speed	500.00 [r/min]	500.00	Always
07	Creep speed for homing	50.00 [r/min]	50.00	Always
08	Starting direction for homing	0: Forward rotation	0	Power
09	Reverse traveling unit amount for homing	0 [unit amount]	0	Always
10	Homing direction after reference signal detection	0: Forward rotation	0	Power
11	Reference signal for shift operation	0: Home position LS	1	Power
13	Home position LS signal edge selection	0: Rising edge timing	0	Power
14	Home position shift unit amount	1000 [unit amount]	1000	Always
15	Deceleration operation for creep speed	1: Reverse rotation is enabled	0	Power
16	Home position after homing completion	0 [unit amount]	0	Always
17	Home position detection range	0: Always ON after homing completion	0	Always
18	Deceleration time at OT during homing	100.0 [ms]	100.0	Always
24	Selection of operation at OT during homing	0: Reverse rotation	0	Power

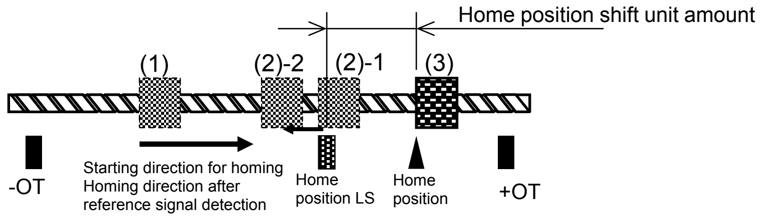
- Because rotation reverses in the direction opposite to the OT direction upon OT detection to detect the reference signal for homing (deceleration starting signal) and reference signal for shift operation, homing can be secured. The reverse rotation after OT detection follows (2) OT reference homing profile.

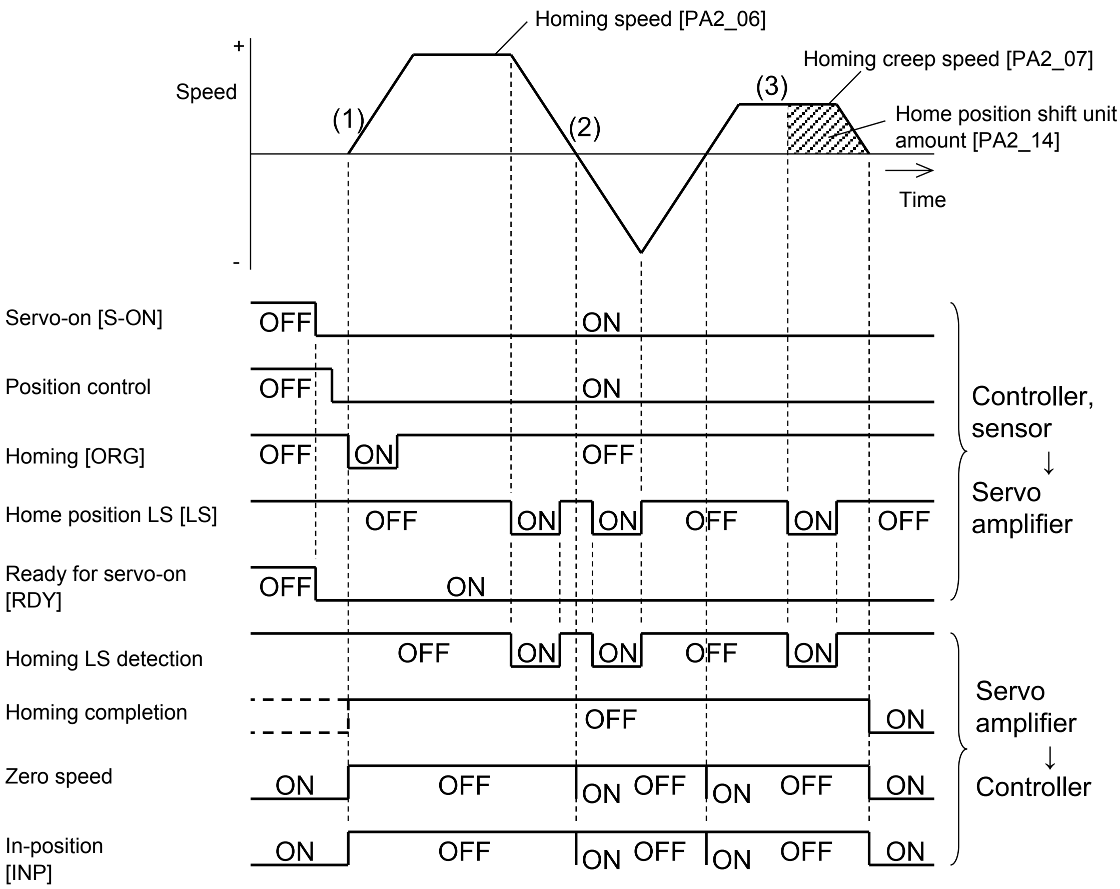
The motion proceeds in the following procedure.

(1) The motion starts at the rising edge (OFF → ON) of homing [ORG] in the starting direction for homing (PA2_08) at the homing speed (PA2_06).

(2) Upon detection of the home position LS (PA2_12, PA2_13), the motion reverses in the direction opposite to the homing direction after reference signal detection (PA2_10) to the point ahead of the home position LS (PA2_12).

(3) The motion changes in the homing direction after reference signal detection (PA2_10) to detect the home position LS (PA2_12, PA2_13), and it changes to the creep speed for homing (PA2_07) by the home position shift unit amount (PA2_14), followed by stoppage. The stopping point changes to the home position and homing completion is turned on and the homing process is finished.





- At the rotation direction selection point with zero speed, zero speed and in-position [INP] are momentarily turned on. The signal change may fail to be sensed according to some scanning periods of the host controller.

(5) At-start reverse rotation homing profile2

The motion occurs in the direction opposite to the homing direction after reference signal detection (direction of home position when viewed from the reference signal for homing) to detect the reference signal for homing (deceleration starting signal) and reference signal for shift operation. This profile is used if the machine stopping position is larger than the reference signal for homing or reference signal for homing.

[Parameter setting example]

PA2_

No.	Name	Setting	Default value	Change
06	Homing speed	500.00 [r/min]	500.00	Always
07	Creep speed for homing	50.00 [r/min]	50.00	Always
08	Starting direction for homing	1: Reverse rotation	0	Power
09	Reverse traveling unit amount for homing	0 [unit amount]	0	Always
10	Homing direction after reference signal detection	0: Forward rotation	0	Power
11	Reference signal for homing	1: Encoder Z-phase	1	Power
12	Reference signal for homing	0: Home position LS	0	Power
13	Home position LS signal edge selection	0: Rising edge timing	0	Power
14	Home position shift unit amount	1000 [unit amount]	1000	Always
15	Deceleration operation for creep speed	0: Reverse rotation is disabled	0	Power
16	Home position after homing completion	0 [unit amount]	0	Always
17	Home position detection range	0: Always ON after homing completion	0	Always
18	Deceleration time at OT during homing	100.0 [ms]	100.0	Always
24	Selection of operation at OT during homing	0: Reverse rotation	0	Power

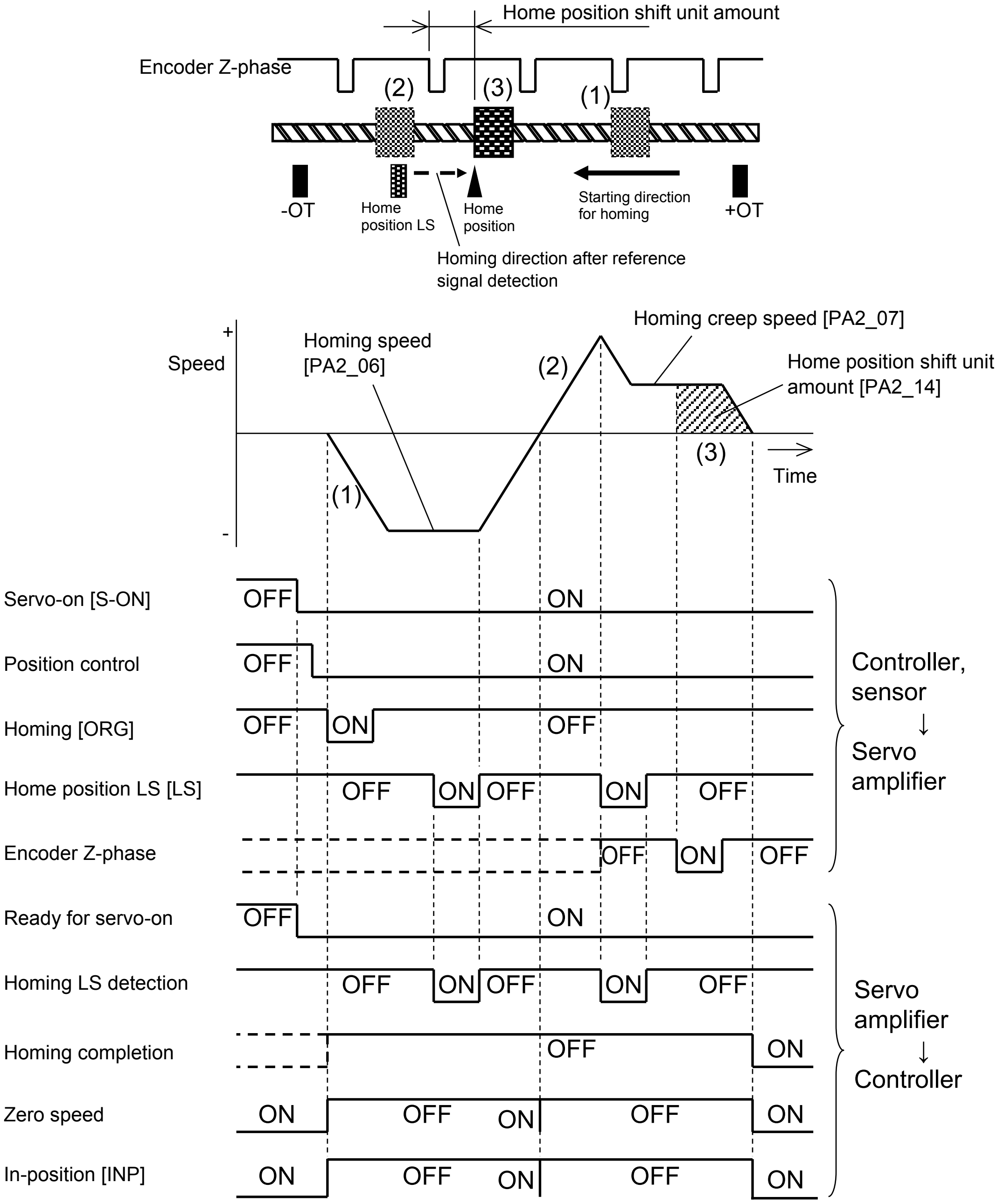
- Because rotation reverses in the direction opposite to the OT direction upon OT detection to detect the reference signal for homing (deceleration starting signal) and reference signal for shift operation, secure homing is realized. The reverse rotation after OT detection follows (2) OT reference homing profile.
- The direction of movement is defined as follows.
  Forward: direction of position increase Reverse: direction of position decrease.

The motion proceeds in the following procedure.

(1) The motion starts at the rising edge (OFF → ON) of homing [ORG] in the starting direction for homing (PA2_08; direction opposite to homing direction after reference signal detection in this case) at the homing speed (PA2_06).

(2) Upon detection of the home position LS (PA2_12, PA2_13), the motion changes in the homing direction after reference signal detection (PA2_10) at the creep speed for homing (PA2_07).

(3) Upon detection of the first encoder Z-phase (PA2_11) after detection of the home position LS (PA2_12), the travel continues by the home position shift unit amount (PA2_14), followed by stoppage. The stopping point changes to the home position and homing completion is turned on and the homing process is finished.



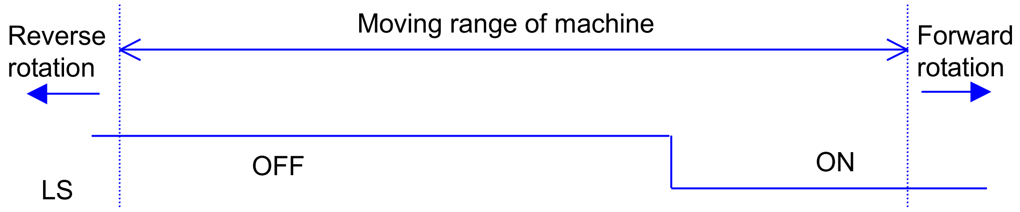
- At the rotation direction selection point with zero speed, zero speed and in-position [INP] are momentarily turned on. The signal change may fail to be sensed according to some scanning periods of the host controller.

4

(6) Homing profile without using OT

Below is an example of the setting for returning to the home position with the home position LS signal without the OT signal. Use this profile for mechanical configurations where one of directions of the moving part of the mechanical system is turned on with the home position LS signal as shown in the figure below. The starting direction for homing is automatically determined according to the setting of PA2_10 (homing direction after reference signal detection) and the ON/OFF state of the home position LS at which return begins.

[An example of relationship between moving range of machine and home position LS]



[Parameter setting example]

PA2_

No.	Name	Setting	Default value	Change
06	Homing speed	500.00 [r/min]	500.00	Always
07	Creep speed for homing	50.00 [r/min]	50.00	Always
08	Starting direction for homing	2: Condition judgment start	0	Power
09	Reverse traveling unit amount for homing	0 [unit amount]	0	Always
10	Homing direction after reference signal detection	0: Forward rotation	0	Power
11	Reference signal for shift operation	1: Z-phase of encoder	1	Power
12	Reference signal for homing (Deceleration starting signal)	0: Home position LS	0	Power
13	Home position LS signal edge selection	0: Rising edge timing	0	Power
14	Home position shift unit amount	1000 [unit amount]	1000	Always
15	Deceleration operation for creep speed	1: Reverse rotation is enabled	0	Power
16	Home position after homing completion	0 [unit amount]	0	Always
17	Home position detection range	0: Always ON after homing completion	0	Always

- PA2_13: Home position LS signal edge selection indicates selection of the edge of the home position LS corresponding to the direction of homing.

If PA2_08 is set at “2,” use of the home position LS is assumed. Accordingly the following conditions are included in combination conditions.

PA2_11 (Reference signal for shift operation) = 0 (home position LS) or

PA2_11 (Reference signal for shift operation) = 1 (encoder Z-phase) and PA2_12 (reference signal for homing) = 0 (home position LS)

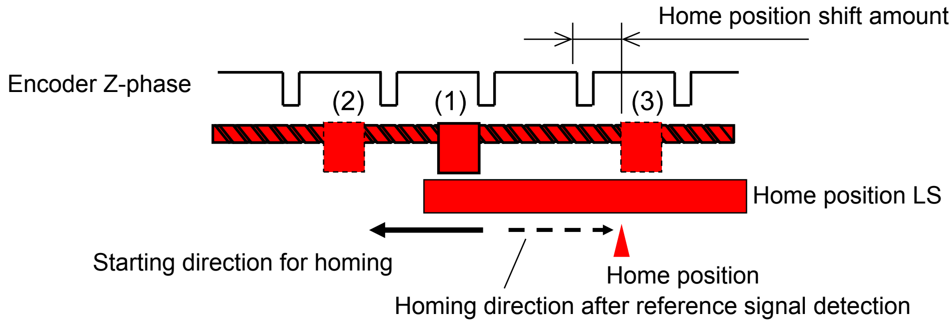
If PA2_08 = “2” and neither of the above conditions is satisfied, the starting direction for homing follows the setting of PA2_10 (homing direction after reference signal detection). If PA2_08 is set at “2,” PA2_09 (reverse traveling unit amount for homing) is internally handled as zero forcibly.

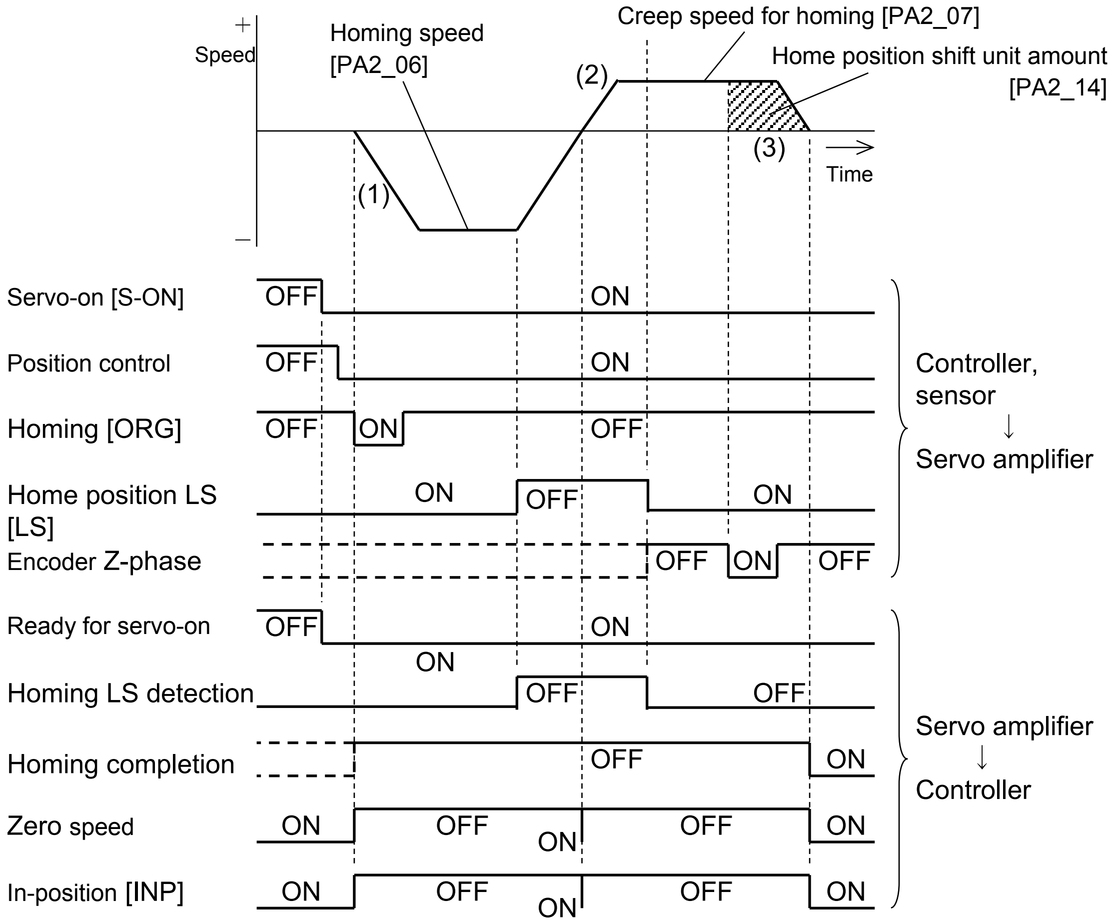
The motion proceeds in the following procedure.

(1) Condition judgment start is made upon the rising edge (OFF-to-ON transition) of homing [ORG] in the reverse rotation direction at the zero return speed (PA2_06).

(2) Upon deactivation of home position LS (PA2_12, PA2_13), movement is temporarily stopped, then continues in the homing direction after reference signal detection (PA2_10) at the creep speed for homing (PA2_07).

(3) The travel continues by the home position shift unit amount (PA2_14) after the first encoder Z-phase (PA2_11) is detected since the home position LS (PA_12) is detected, followed by stoppage. The stopping point changes to the home position and homing completion is turned on, finishing the homing process.

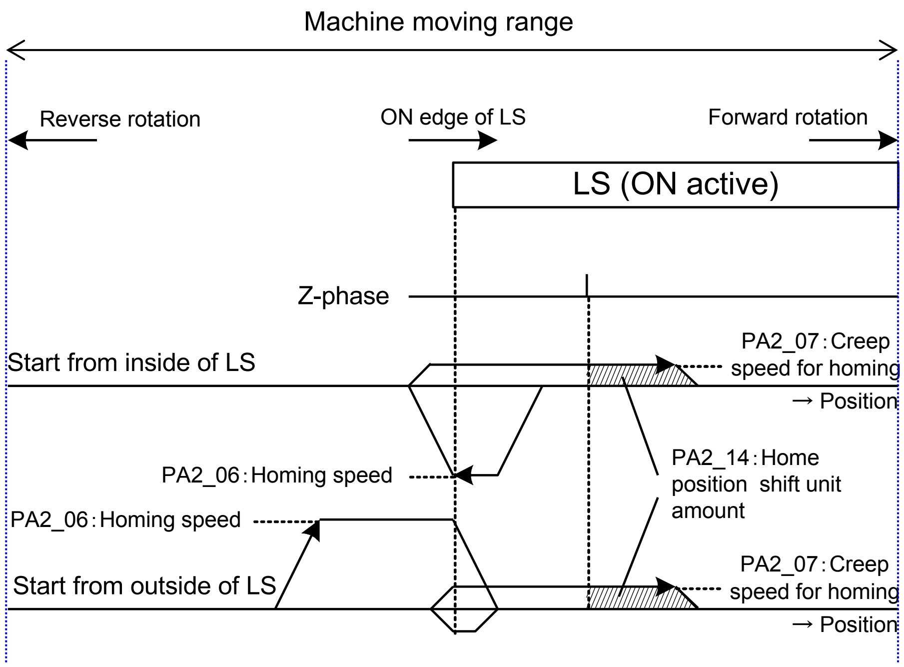




- Zero speed and in-position [INP] are temporarily turned on when the speed is reduced to zero at changeover of the direction of rotation. Signal transition may not be detected according to some scanning frequencies of the host controller.

- **[Supplement] Operation example showing the machine position in lateral direction**
  [Homing starting after LS activation]
  (1) A travel in the reverse direction starts at the homing speed (PA2_06).
  (2) When the falling edge (ON-to-OFF transition) of the zero LS is detected, reverse rotation continues to decelerate to the creep speed for homing (PA2_07).
  (3) When the first encoder Z-phase (PA2_11) is detected after the rising edge (OFF-to-ON transition) of the home position LS is detected, a travel is made by the home position shift unit amount (PA2_14), followed by stoppage.

  [Homing starting after LS deactivation]
  (1) A travel in the forward direction starts at the homing speed (PA2_06).
  (2) Because the deceleration operation for creep speed (PA2_15) is set at “1” (reverse rotation enable), reverse rotation is made upon detection of the rising edge (OFF-to-ON transition) of the home position LS while decelerating to the creep speed for homing (PA2_07).
  (3) Changeover to forward rotation is made again upon detection of the falling edge (ON-to-OFF transition) of the home position LS.
  (4) When the first encoder Z-phase (PA2_11) is detected after the rising edge (OFF-to-ON transition) of the home position LS is detected, a travel is made by the home position shift unit amount (PA2_14), followed by stoppage.



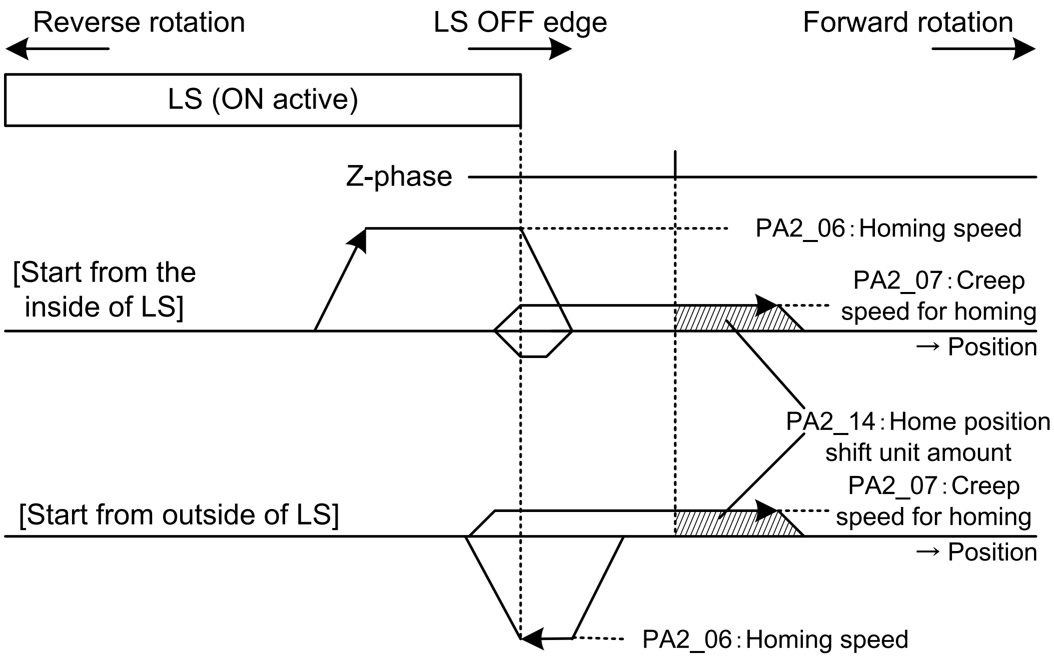
- Operation example at parameter setting change
  Operation examples after a parameter change necessitated due to the position, etc. of the home position LS (see Table a for the setting example) are shown in Figs. a to c.

Table a

No.	Name	Setting example of Fig. a	Setting example of Fig. b	Setting example of Fig. c
PA2_08	Starting direction for homing	2: Condition judgment start		
PA2_10	Homing direction after reference signal detection	0: Forward rotation	1: Reverse rotation	
PA2_11	Reference signal for shift operation	1: Encoder Z-phase		
PA2_12	Reference signal for homing (Deceleration starting signal)	0: Home position LS		
PA2_13	Home position LS signal edge selection	1: Trailing edge timing	0: Rising edge timing	1: Trailing edge timing
PA2_15	Deceleration operation for creep speed	1: Reverse rotation is enabled		

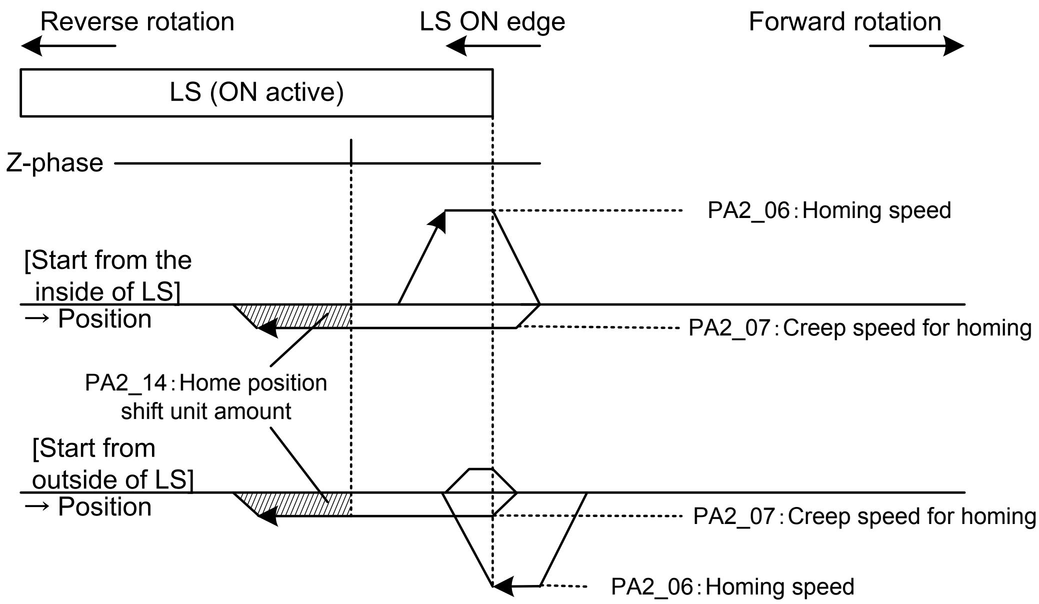
Figs. a through c assume that the machine position is in the lateral direction.

[Fig. a]

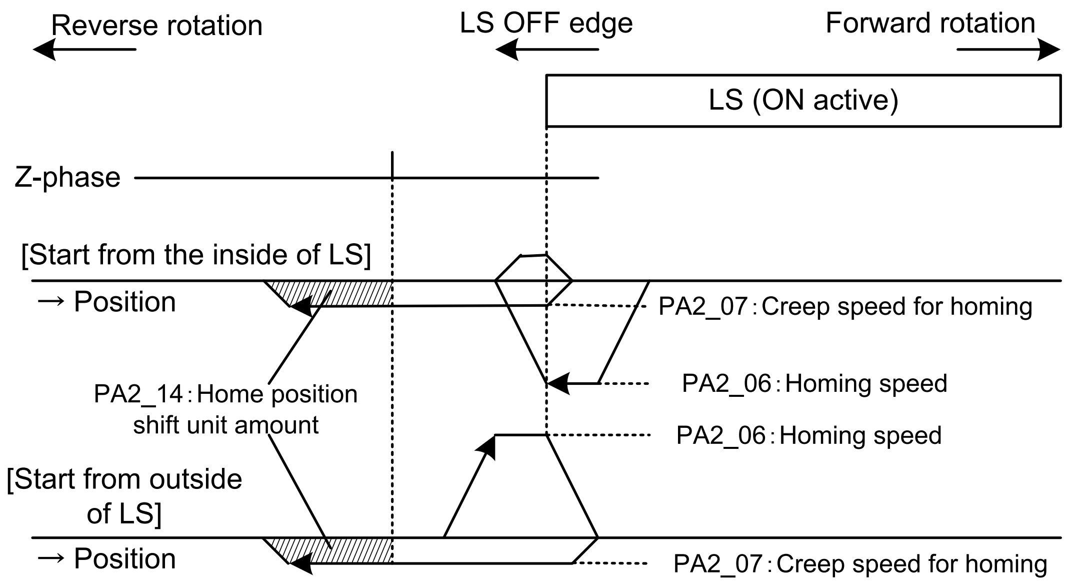


4

[Fig. b]


Reverse rotation
LS ON edge
Forward rotation
LS (ON active)
Z-phase
PA2_06 : Homing speed
[Start from the inside of LS]
→ Position
PA2_07 : Creep speed for homing
PA2_14 : Home position shift unit amount
[Start from outside of LS]
→ Position
PA2_07 : Creep speed for homing
PA2_06 : Homing speed

[Fig. c]


Reverse rotation
LS OFF edge
Forward rotation
LS (ON active)
Z-phase
[Start from the inside of LS]
→ Position
PA2_07 : Creep speed for homing
PA2_06 : Homing speed
PA2_14 : Home position shift unit amount
PA2_06 : Homing speed
[Start from outside of LS]
→ Position
PA2_07 : Creep speed for homing

(7) Profile using encoder Z-phase for home position reference signal

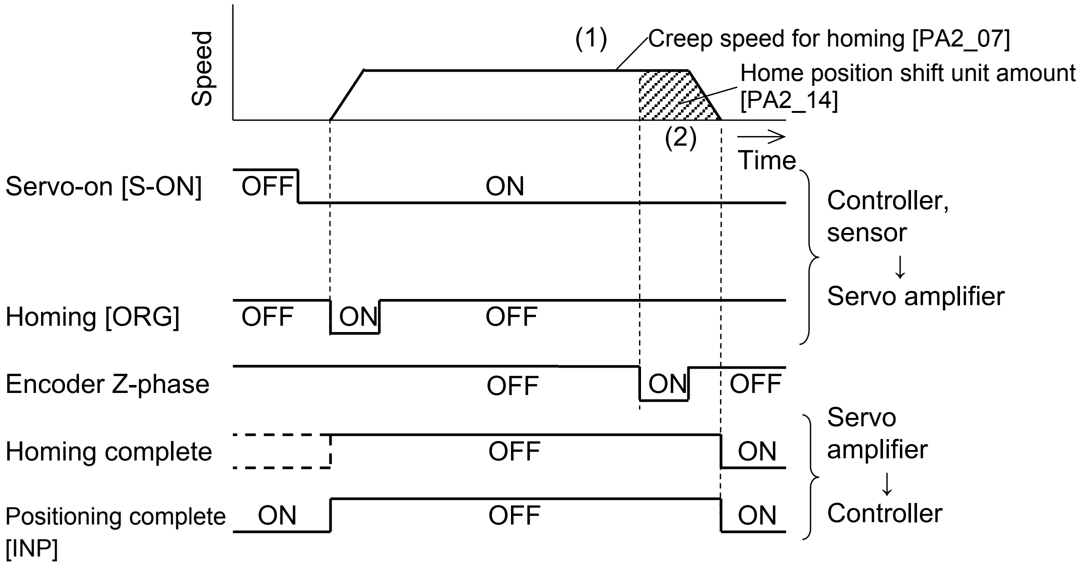
Set PA2_12: Reference signal for homing to "Encoder Z-phase" if using machines on which sensors such as limit switches cannot be installed.

[Parameter setting examples]

PA2_

No.	Name	Setting	Default value	Change
07	Creep speed for homing	50.00 [r/min]	50.00	Always
08	Starting direction for homing	0: Forward rotation	0	Power supply
12	Reference signal for homing	3: Encoder Z-phase	0	Power supply
14	Home position shift unit amount	1000 [unit amount]	1000	Always

- Timing chart
  (1) When homing starts, operation begins in the homing start direction at homing creep speed.
  (2) The first Z-phase is detected, the motor moves by the PA2_14: Home position shift unit amount in the homing start direction, and homing is completed.



- When PA2_12 is set to "3", the reference signal for shift operation will be the Z-phase, regardless of the PA2_11: Reference signal for shift operation setting.
- If ±OT is detected when homing starts, homing will not start, regardless of the PA2_24: Selection of operation at OT during homing setting. Furthermore, if ±OT is detected during homing, homing will be terminated and the motor will stop, regardless of the OT detection direction.

(8) Homing pattern using the stopper

[Parameter setting example]

PA2_

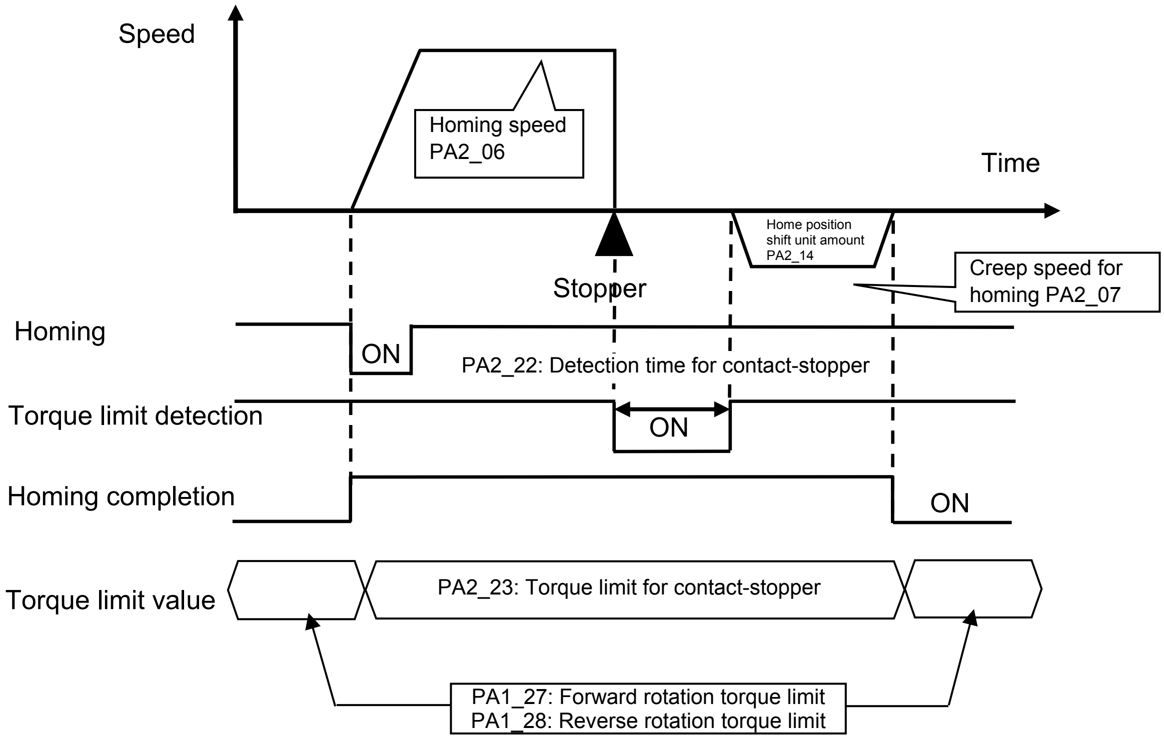
No.	Name	Setting	Default value	Change
06	Homing speed	500.00 [r/min]	500.00	Always
07	Creep speed for homing	50.00 [r/min]	50.00	Always
10	Homing direction after reference signal detection	0: Forward rotation	0	Power
11	Reference signal for shift operation	5: Stopper	1	Power
14	Home position shift unit amount	1000 [unit amount]	1000	Always
16	Home position after homing completion	0 [unit amount]	0	Always
17	Home position detection range	0: Always ON after homing completion	0	Always
22	Detection time for contact-stopper	50 [ms]	0	Always
23	Torque limit for contact-stopper	30 [%]	0	Always

- Select “5” (stopper) for the home position shift amount reference signal (PA2_11). Be sure to enter the output torque generated upon contact with the stopper, as a torque limit for contact-stopper (PA2_23), and enter the time between contact with the stopper and finishing the contact-stopper detection as a detection time for contact-stopper (PA2_22).

  (i) If the home position sift amount (PA2_14) is zero, homing is finished at the stopping position after the detection time for contact-stopper.

  (ii) If the home position shift amount (PA2_14) is other than zero, the motor moves by the home position shift amount from the stopping position after the detection time for contact-stopper in the reverse direction to the dead stop, and homing is finished there.

Timing chart



(1) The activating edge of the homing signal starts operation at the homing speed (PA2_06) in the homing starting direction (PA2_10).

(2) Upon contact with the stopper or the like, the motor is stopped and the output torque is limited to the torque limit for contact-stopper (PA2_23).
After limitation is set in the output torque, the detection time for contact-stopper (PA2_22) is counted for the specified time, then a return is caused by the home position shift amount (PA2_14), and homing is finished.
If the home position shift amount is zero, homing is finished at the contact position.

- If “1” (Encoder Z-phase) is selected for reference signal for shift operation (PA2_11), and “4” (Stopper) is selected for reference signal for homing (PA2_12), the motor will rotate in the opposite direction after contacting the stopper, the encoder Z-phase will be detected, and movement will be complete after moving by the home position shift amount.

PA2_19 Preset position

No.	Name	Setting range	Default value	Change
19	Preset position	-2000000000 to 2000000000 [unit amount]	0	Always

Specify the new position to be substituted with the current position upon an input signal ("position preset (16)" assigned to a CONT signal). After position preset is turned on, the current position changes to the reference value of this parameter.

PA2_20 Interrupt traveling unit amount

No.	Name	Setting range	Default value	Change
20	Interrupt traveling unit amount	1 to 2000000000 [unit amount]	100000	Always

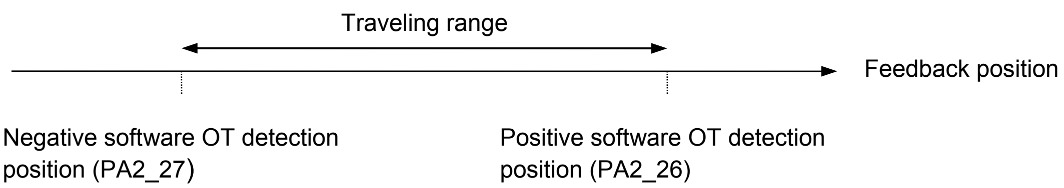
Specify to perform interrupt positioning.
Specify the traveling amount based on the position located at the timing of activation of an input signal ("interrupt input (49)" assigned to CONT signal).

PA2_25 to 27 Position operation type, software OT detection position

No.	Name	Setting range	Default value	Change
25	Software OT selection (PA1_01=1 to 6)	0: Disable 1: Enable	0	Power
	Position operation type (PA1_01=7)	0: Normal 1: Positioning start with zero position preset	0	Power
26	Positive software OT detection position	-2000000000 to 2000000000 [unit amount]	2000000000	Always
27	Negative software OT detection position	-2000000000 to 2000000000 [unit amount]	-2000000000	Always

(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

Normal PTP: Motion is conducted in the range from -2000000000 to 2000000000 [unit amount]. Absolute/incremental positioning data designation and various position detection functions can be used.

Non-overflow: Repetitive rotation in the same direction can be made.
The position is preset at the start, and all position data is handled as an incremental value. The OT function, software OT and hardware OT functions allocated to input signals are disabled.

PA2_28 and 29 Limiter detection position

No.	Name	Setting range	Default value	Change
28	Positive limiter detection position	-2000000000 to 2000000000 [unit amount]	2000000000	Always
29	Negative limiter detection position		-2000000000	

4

This parameter is enabled only when parameter PA1_01 (control mode selection) is set to "7" (positioning function).

Enter the position of the limiter detection function.

While each setting can be positive or negative, the setting of PA2_28 must not be smaller than the setting of PA2_29.

For detail description of limiter detection, refer to “CHAPTER 2 WIRING.”

PA2_31 to 34 Point detection, area detection settings

No.	Name	Setting range	Default value	Change
31	Point detection, area detection	0: Point detection 1: ON for positive side 2: ON for negative side	0	Always
32	Point detection, area detection position 1	-2000000000 to 2000000000 [unit amount]	0	Always
33	Point detection, area detection position 2	-2000000000 to 2000000000 [unit amount]	0	Always
34	Point detection range	0 to 2000000000 [unit amount]	100	Always

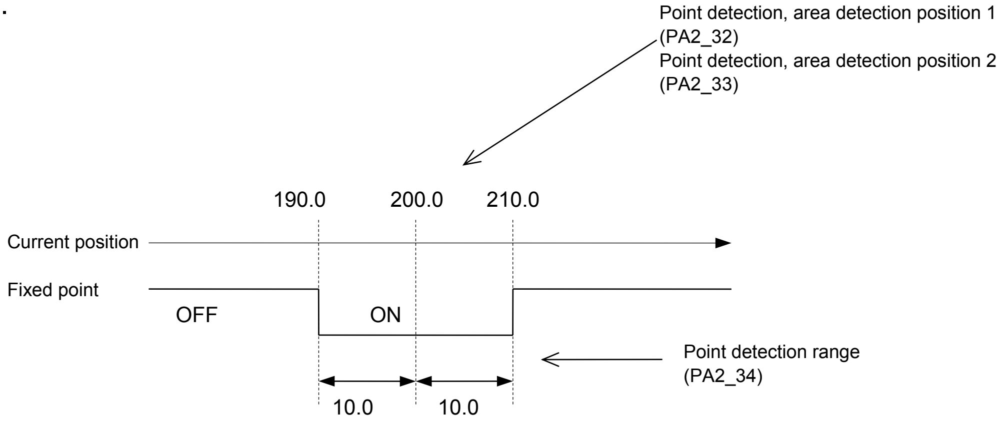
Specify the output format of the "point detection, area detection" signal that is output as an output signal (OUT signal).

In case of point detection setting, the signal is output if the servomotor is located nearly in the reference value (point detection range).

In case of area setting, the signal is turned on or off if the servomotor position exceeds the reference value. Refer to the chart below.

(1) Point detection (If PA2_31 (point detection, area detection) is 0)

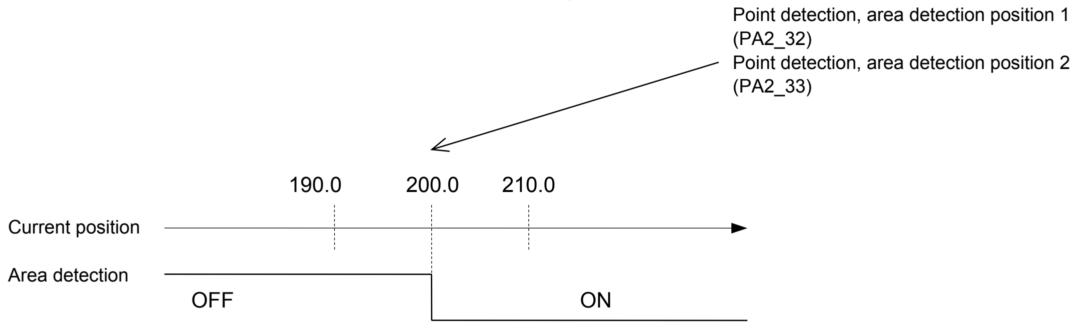
The signal is turned on if the current position is nearly the position specified in PA2_32 and PA2_33.



(2) Area OFF → ON (If PA2_31 (point detection, area detection) is 1)

The signal is turned on if the current position is exactly or larger than the setting of PA2_32 and PA2_33.

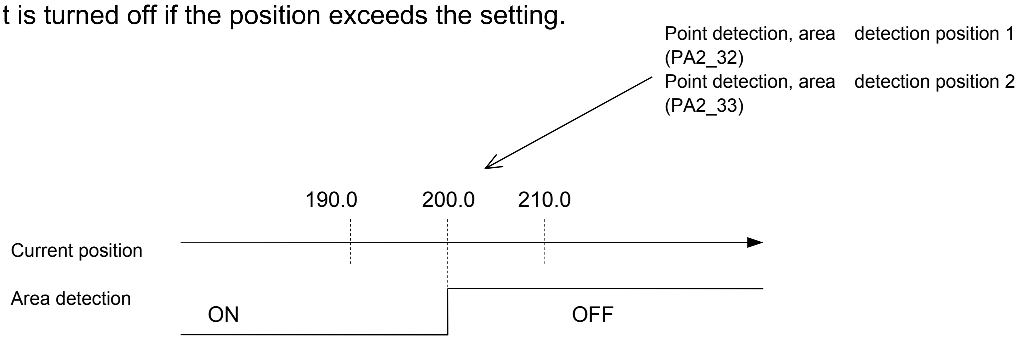
It is turned off if the position is less than the setting.



(3) Area ON → OFF (If PA2_31 (point detection, area detection) is 2)

The signal is turned on if the current position is exactly or less than the setting of PA2_32 and PA2_33.

It is turned off if the position exceeds the setting.



PA2_36 to 39 Override settings

No.	Name	Setting range	Default value	Change
36	Override 1	0 [%] to 150 [%]	10	Always
37	Override 2		20	Always
38	Override 4		40	Always
39	Override 8		80	Always

These parameters are enabled under speed and position control.
To use these signals, be sure to turn on "override enable."
With this setting, the speed can be changed during operation. For the weight of the override, refer to the table below.

Ratio of override

Override 8	Override 4	Override 2	Override 1	Traveling speed %
OFF	OFF	OFF	OFF	0
OFF	OFF	OFF	ON	10
OFF	OFF	ON	OFF	20
OFF	OFF	ON	ON	30
OFF	ON	OFF	OFF	40
OFF	ON	OFF	ON	50
OFF	ON	ON	OFF	60
OFF	ON	ON	ON	70
ON	OFF	OFF	OFF	80
ON	OFF	OFF	ON	90
ON	OFF	ON	OFF	100
ON	OFF	ON	ON	110
ON	ON	OFF	OFF	120
ON	ON	OFF	ON	130
ON	ON	ON	OFF	140
ON	ON	ON	ON	150

* For default override weight

PA2_40 Internal positioning data selection

No.	Name	Setting range	Default value	Change
40	Internal positioning data selection	0: Disable 1: Enable	0	Power

Select whether the internal positioning data is enabled or disabled.

For the immediate data start, setting the address FFH is not necessary when the parameter is set to "0".

When set to "1", it is necessary to set the address FFH.

PA2_41　Sequential start selection

No.	Name	Setting range	Default value	Change
41	Sequential start selection	0: Disable　　1: Enable 2: Homing　　3: Immediate value operation	0	Power

Select whether sequential start is enabled or disabled.

For details of sequential start, refer to “CHAPTER 12　POSITIONING DATA”

PA2_42　Decimal point position of stand still timer

No.	Name	Setting range	Default value	Change
42	Decimal point position of stand still timer	0: 0.01　　1: 0.001	0	Always

Select the least input increment of the stand still timer.

Selection can be made between 1 [ms] and 10 [ms].

PA2_43　Output selection at M code OFF

No.	Name	Setting range	Default value	Change
43	Output selection at M code OFF	0: 00’H　　1: FF’H	1	Power

Select the output signal status at M code shutoff.
For details of the M code, refer to “CHAPTER 12　POSITIONING DATA”

4

4

4.5 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.)

4.5.1 List (PA2_□□)

No. PA2_	Name	Default value	Power	Control mode			Record of reference value
				Position	Speed	Torque	
51	Numerator 1 of electronic gear ratio	1	–	○	–	–	
52	Numerator 2 of electronic gear ratio						
53	Numerator 3 of electronic gear ratio						
54	Command pulse ratio 1	1.00	–	○	–	–	
55	Command pulse ratio 2	10.00	–	○	–	–	
56	Speed limit selection at torque control	0	○	–	–	○	
57	Torque limit selection	0	○	○	○	–	
58	Second torque limit	350: GYB 300: other than GYB	–	○	○	–	
59	Deviation hold selection at torque limit	0	○	○	–	–	
60	Third torque limit	350: GYB 300: other than GYB	–	○	○	–	
61	Action sequence at servo-on = OFF, forced stop	2021	○	○	○	○	
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	Regenerative resistor selection	1	○	○	○	○	
66	Flying start at 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	Station number for communications	1	○	○	○	○	
73	Communication baud rate (RS-485)	0	○	○	○	○	
74	Parameter write protection	0	–	○	○	○	
75	Positioning data write protection	0	–	○	–	–	
76	No.3 deceleration time	100.0	–	○	○	○	
77	Initial display of the keypad	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						

No. PA2_	Name	Default value	Power	Control mode			Record of reference value
				Position	Speed	Torque	
84	Parameter in RAM 5	0	○	○	○	○	
85	Parameter in RAM 6						
86	Positioning data in RAM 1	0	○	○	–	–	
87	Positioning data in RAM 2	0	○				
88	Positioning data in RAM 3	0	○				
89	Sequence test mode: mode selection	0	○	○	○	○	
90	Sequence test mode: encoder selection	4	○	○	○	○	
93	Parity/stop bit selection (for Modbus)	0	○	○	–	–	
94	Response time (for Modbus)	0.00	–	○	–	–	
95	Communication time over time (for Modbus)	0	–	○	–	–	
97	Communication protocol selection	0	–	○	–	–	

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

4

4.5.2 Description of Each Parameter

PA2_51 to 53 Electronic gear ratio numerator 1, 2, 3

No.	Name	Setting range	Default value	Change
51	Numerator 1 of electronic gear ratio 1	1 to 67108864	1	Always
52	Numerator 1 of electronic gear ratio 2			
53	Numerator 1 of electronic gear ratio 3			

Specify the electronic gear ratio, using the input signal ("electronic gear numerator selection 0, 1" assigned to CONT signal).

Electronic gear numerator selection 1	Electronic gear numerator selection 0	Numerator of electronic gear
OFF	OFF	PA1_6 Basic setting
OFF	ON	PA2_51 Extended function setting
ON	OFF	PA2_52 Extended function setting
ON	ON	PA2_53 Extended function setting

Do not change the electronic gear ratio in case of interrupt positioning or homing.

PA2_54 and 55 Command pulse ratio 1, 2

No.	Name	Setting range	Default value	Change
54	Command pulse ratio 1	0.01 to 100.00	1.00	Always
55	Command pulse ratio 2		10.00	

Specify the multiplication of the command pulse.
The reference value selected with an input signal ("command pulse ratio 1, 2" assigned to a CONT signal) is enabled.

PA2_56 Speed limit selection at torque control

No.	Name	Setting range	Default value	Change
56	Speed limit selection at torque control	0: Parameter 1: Multi-step speed selection, VREF terminal voltage	0	Power

Select the method of setting limitation on the speed under torque control.
If the setting is 0, the reference value of PA1_26 (maximum rotation speed) is the speed limit.
If the setting is 1, the speed limit value selected with input signal (CONT signal): multi-step speed selection 1 [X1] to 3 [X3] combination is applied.

4

PA2_57 to 60 Torque limit settings

No.	Name	Setting range	Default value	Change
57	Torque limit selection	0: As per CONT signal torque limit 0/1 1:TREF	0	Power
58	Second torque limit	GYB: 0 [%] to 350 [%] Other than GYB: 0 [%] to 300 [%]	GYB: 350 [%] Other than GYB: 300 [%]	Always
59	Deviation hold selection at torque limit	0: No deviation hold 1: Deviation hold at second torque limit 2: TREF	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) In case of position control and speed control (If PA2_57 is 0)

CONT signal		State of each limit	Enabled torque limit	
Torque limit 1	Torque limit 0	TL: TREF (analog torque limit)	CCW: Powering, CW: Regeneration	CW: Powering, CCW: Regeneration
OFF	OFF	No condition judgment	Forward rotation torque limit	Reverse rotation torque limit
OFF	ON	TL ≥ Forward/Reverse rotation torque limit	Forward rotation torque limit	Reverse rotation torque limit
OFF	ON	TL < Forward/reverse rotation torque limit	TL	TL
ON	OFF	Second torque limit ≥ Forward/Reverse rotation torque limit	Forward rotation torque limit	Reverse rotation torque limit
ON	OFF	Second torque limit < Forward/Reverse torque limit	Second torque limit	Second torque limit
ON	ON	TL ≥ Second torque limit	Second torque limit	Second torque limit
ON	ON	TL < Second torque limit	TL	TL

Specify positive voltage to TL.
Negative voltage setting is limited to zero.
If PA2_57 is 1, the torque limit is always the same as the value of TL.

(2) In case of torque control

The forward rotation torque limit and reverse rotation torque limit are followed.

(3) Torque limit for controlled stop motion (under position or speed control) (If PA2_57 is 0)

If PA2_57 is 1, the torque limit is always the TL value.

CONT signal		State of each limit	Enabled torque limit	
Torque limit 1	Torque limit 0	TL: TREF (analog torque limit)	CW deceleration stop	CCW deceleration stop
OFF	OFF	Forward rotation torque limit ≥ Third torque limit	Third torque limit	Third torque limit
OFF	OFF	Forward/Reverse rotation torque limit < Third torque limit	Forward rotation torque limit	Reverse rotation torque limit
OFF	ON	TL, forward/reverse torque limit ≥ Third torque limit	Third torque limit	Third torque limit
OFF	ON	TL, forward/reverse torque limit < Third torque limit	TL or forward rotation torque limit, whichever is less	TL or reverse rotation torque limit, whichever is less
ON	OFF	Second torque limit, forward/reverse rotation torque limit ≥ Third torque limit	Third torque limit	Third torque limit
ON	OFF	Second torque limit, forward/reverse rotation torque limit < Third torque limit	Second torque limit or forward rotation torque, whichever is less	Second torque limit or reverse rotation torque, whichever is less
ON	ON	TL, second torque limit ≥ Third torque limit	Third torque limit	Third torque limit
ON	ON	TL, second torque limit < Third torque limit	TL or second torque limit, whichever is less	TL or second torque limit, whichever is less

(4) Third torque limit

This parameter is enabled under position or speed control.
The reference value of this parameter becomes the torque limit under the following conditions.

- Sudden controlled stop caused by servo-on (S-ON) turned off
- Sudden controlled stop caused by forced stop (ENG) turned off
- Sudden controlled stop caused by ±Overtravel (±OT) turned off
- Controlled stop caused by minor failure alarm (If PA2_62 is 4 or 5 or 20□□)

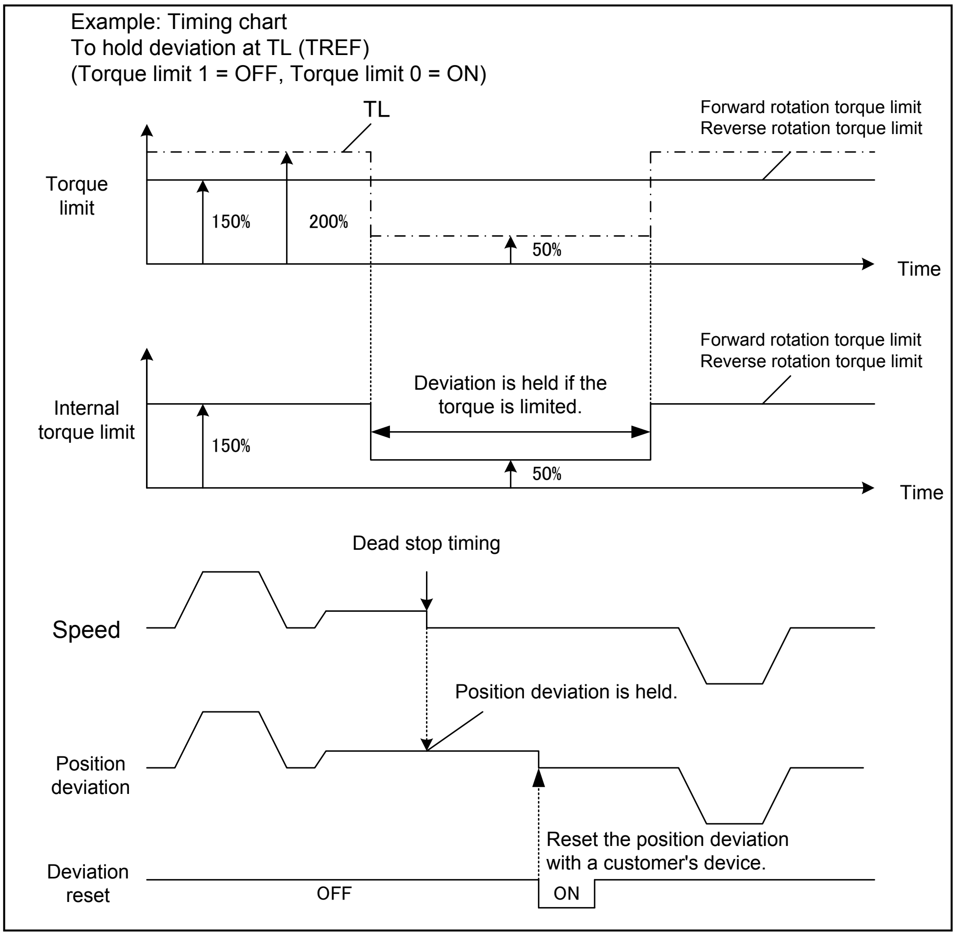
(5) Deviation holds selection at torque limit

This parameter is enabled under position control.
If a motion is stopped at a dead stop, position deviation is held with this function. Position deviation is held so that the position deviation count does not reach the limit at the dead stop.
The function is enabled under the following conditions (when PA2_57=0).

CONT signal		P59 Deviation hold selection at torque limit	Torque limit for holding deviation
Torque limit 1	Torque limit 0		
OFF	OFF	-	None
OFF	ON	1: Second torque limit	None
		2: TREF	TL
ON	OFF	1: Second torque limit	Second torque limit
		2: TREF	None
ON	ON	1: Second torque limit	Second torque limit
		2: TREF	TL

If PA2_57 is set to 1 with PA2_59 set to 2, TL is torque limit in IQ area.

[Reference example]



PA2_61 to 63　Action sequence settings

No.	Name	Setting range	Default value	Change
61	Action sequence at servo-on OFF	0000 to 3021	2021	Power supply
62	Action sequence at alarm	0000 to 2011	0000	Power supply
63	Action sequence at main power supply OFF, OT detection	0000 to 3021	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 2: Rapid deceleration	Deceleration sequence at major failure alarm 0: DB 1: Free-run	Deceleration sequence at main power shutoff 0: DB 1: Free-run 2: Rapid deceleration
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	Deceleration sequence at forced stop 2: Rapid deceleration 3: Deceleration time	Deceleration sequence at minor failure alarm 0: DB 1: Free-run 2: Rapid deceleration	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: This is regenerative braking with regenerating resistance.
- Deceleration time: The motor decelerates based on the deceleration time set for PA2_76: No.3 deceleration time.

Note	If upgrading from the ALPHA5 Series, by setting "0000" to "0005", the values will be the same as those for ALPHA5 parameter settings PA2_61 to 63. In this case, the deceleration operation when performing a forced stop or following OT detection will be fixed at rapid deceleration. Furthermore, the action sequence following either a minor or major failure alarm will be based on the PA2_62 setting. (With the ALPHA5 Series, the dynamic brake is applied and the motor decelerates when a major failure alarm occurs, regardless of the PA2_62.)

The STO operation is based on the operation setting when PA2_61 servo-on is OFF.
(When servo-on is OFF, however, the operation when decelerating will be "dynamic brake operation" when "Rapid deceleration" is set.)

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 of this parameter indicates the delay taken from shutoff of servo-on (function No. 1) CONT input signal to free-run.
Specify a time larger than the one taken from excitation of the brake to actual brake application.
The brake timing signal is turned off when servo-on is turned off.

PA2_65 Regenerative resistor selection

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

Select the regenerative resistor.
If the reference value is 1, the temperature of the regenerative resistor is calculated inside the amplifier and monitored as a regenerative thermal value. 100 [%] indicates an overheated internal regenerative resistor (RH1).
To install an external regenerative 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 regenerative resistor overheat (function No. 34).
Because of a normally closed contact, shutoff indicates an overheated external regenerative resistor (RH2).

PA2_66 Flying start at speed control

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

The parameter is enabled under speed control.
If servo-on is turned on during free-run operation, the speed at the timing is picked and acceleration begins at the 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	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 since the main power is turned off with servo-on turned on, a main circuit power undervoltage alarm (LVP) is caused.
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 9 CHARACTERISTICS."

PA2_72 Station number for communications

No.	Name	Setting range	Default value	Change
72	Station number for communications	1 to 31	1	Power

Set the servo amplifier station number. Set a station number for each servo amplifier.

PA2_73 Communication baud rate

No.	Name	Setting range	Default value	Change
73	Communication baud rate	0: 38400 [bps] 1: 19200 [bps] 2: 9600 [bps] 3: 115200 [bps]	0	Power

Specify the communication baud rate of RS-485 communications.

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.
Enter "1" to prohibit parameter editing. Only this parameter can be changed.

4

PA2_75 Positioning data write protection

No.	Name	Setting range	Default value	Change
75	Positioning data write protection	0: Write enable 1: Write protect	0	Always

Specify positioning data write protection.
Enter "1" to prohibit positioning data editing.

PA2_76: No.3 deceleration time

No.	Name	Setting range	Default value	Change
76	No.3 deceleration time	0.0 to 99999.9 [ms]	100.0	Always

Set the deceleration time 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 deceleration operation set for deceleration time with PA2_61)
- When OT detected (if deceleration operation set for deceleration time with PA2_63)
- When function safety module SS1 function active (if servo amplifier SS1 operation enabled with PA4_11)

<u>The time set for acceleration/deceleration is the time until the motor decelerates from 2000 to 0 [r/min].</u>
The movement from the time deceleration starts until the motor stops will increase based on the No.3 deceleration time and deceleration starting speed.
If the motor is decelerated based on the deceleration time following OT detection in particular, take care not to exceed the machine system range of motion.

PA2_77 Initial display of the keypad (Keypad)

No.	Name	Setting range	Default value	Change
77	Initial display of the keypad (Data displayed on keypad)	0: Sequence mode. 1: Feedback speed. 2: Command speed. 3: Command torque. 4: Motor current. 5: Peak torque. 6: Effective torque. 7: Feedback position. 8: Command position. 9: Position deviation. 10: Command pulse frequency. 11: Feedback cumulative pulse. 12: Command cumulative pulse. 13: LS-Z pulse. 14: Load inertia ratio. 15: DC link voltage (max.). 16: DC link voltage (min.). 17: VREF input voltage. 18: TREF input voltage. 19: Input signals. 20: Output signals. 21: OL thermal value. 22: Regenerative resistor thermal value. 23: Power (W). 24: Motor temperature. 25: Overshoot unit amount. 26: Settling time. 27: Resonance frequency 1. 28: Resonance frequency 2. 40: Station number. 41: Alarm at present. 42: Alarm history . 43: Warning at present. 44: Total time - main power supply. 45: Total time - control power supply. 46: Motor running time.	0	Power

Specify the data displayed on the keypad at the upper part of the front of the amplifier when the power is turned on.

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

Select whether or not a warning sign is displayed at the keypad on the front panel of the amplifier when a "cooling fan life expiration," "main circuit capacitor life expiration," or "low battery voltage" warning is detected.

If the replacement timing is drawing near after several years of operation, change this parameter to "1" to show a warning on the keypad in front of the servo amplifier.

4

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_86 to 88 Positioning data in RAM 1 to 3

No.	Name	Setting range	Default value	Change
86	Positioning data in RAM1	0: No designation 1 to 15: Positioning data No.	0	Power
87	Positioning data in RAM2			
88	Positioning data in RAM3			

If you change positioning data frequently, store them in RAM.
With this setting, you can change positioning data infinitely.
The positioning data stored in RAM is in the default value when the amplifier is turned on.

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):

Select 0 to start the sequence test mode from the PC Loader or keypad. Turn the power off then on again to return to the 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 safety option (WSU-ST1) function.

PA2_93 Parity/stop bit selection (for Modbus)

No.	Name	Setting range	Default value	Change
93	Parity/stop bit selection	0: Even parity with 1 stop bit 1: Odd parity with 1 stop bit 2: No parity with 1 stop bit 3: Even parity with 2 stop bits 4: Odd parity with 2 stop bits 5: No parity with 2 stop bits	0	Power

Set existence and logic of a parity and a stop bit length.

Characters are organized for each setting as follows:

PA2_93	LSB 0	1	2	3	4	5	6	7	8	9	10	MSB 11
0, 1	Start	Data (8 bits)								Parity	Stop	
2	Start	Data (8 bits)								Stop		
3, 4	Start	Data (8 bits)								Parity	Stop (2 bits)	
5	Start	Data (8 bits)								Stop (2 bits)		

PA2_94 Response time (for Modbus)

PA2_95 Communication time over time (for Modbus)

No.	Name	Setting range	Default value	Change
94	Response time	0.00 to 1.00 [s]	0.00	Always
95	Communication time over	0.00 [s]···No detection 0.01 to 9.99 [s]	0.00	Always

Enter the response time of the servo amplifier.

Enter the response time and communication time-over time when necessary.

For details, refer to “CHAPTER 13　MODBUS RTU COMMUNICATION”

4

PA2_97 Communication protocol selection

No.	Name	Setting range	Default value	Change
97	Communication protocol selection	0: PC Loader protocol 1: Modbus RTU	0	Always

Select either the PC Loader protocol or Modbus RTU communications.

<u>The factory shipment setting is “0” (PC Loader protocol). To use Modbus RTU communications, do not fail to change to “1.”</u>

4.6 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.)

4.6.1 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						
09	CONT9 signal assignment						
10	CONT10 signal assignment						
11	CONT11 signal assignment						
12	CONT12 signal assignment						
13	CONT13 signal assignment						
14	CONT14 signal assignment						
15	CONT15 signal assignment						
16	CONT16 signal assignment						
17	CONT17 signal assignment						
18	CONT18 signal assignment						
19	CONT19 signal assignment						
20	CONT20 signal assignment						
21	CONT21 signal assignment						
22	CONT22 signal assignment						
23	CONT23 signal assignment						
24	CONT24 signal assignment						
25	CONT signal inversion	00000000	○	○	○	○	

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						
31	Speed command scale	5.0					
32	Speed command offset	Shipment setting					
33	Torque command scale	3.0					
34	Torque command offset	Shipment setting					
35	Zero clamp level	0					
36	Deviation clear input form	0	○	○	-	-	
41	Address free assignment 1 (for Modbus)	00000000	○	○	○	○	
42	Address free assignment 2 (for Modbus)	00000000	○	○	○	○	
43	Address free assignment 3 (for Modbus)	00000000	○	○	○	○	
44	Address free assignment 4 (for Modbus)	00000000	○	○	○	○	
48	CONT CA signal assignment	0	○	○	○	○	
49	CONT CB signal assignment						
50	CONT CA/CB signal inversion	00	○	○	○	○	

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

4.6.2 Description of Each Parameter

PA3_01 to 24 CONT signal assignment
PA3_48 to 49 CONT CA assignment/CONT CB assignment

No.	Name	Setting range	Default value	Change
01	CONT1 signal assignment	Select from CONT signal assignment functions (see next page).	1	Power supply
02	CONT2 signal assignment		11	
03	CONT3 signal assignment		50	
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	
09	CONT9 signal assignment		0	
10	CONT10 signal assignment		0	
11	CONT11 signal assignment		0	
12	CONT12 signal assignment		0	
13	CONT13 signal assignment		0	
14	CONT14 signal assignment		0	
15	CONT15 signal assignment		0	
16	CONT16 signal assignment		0	
17	CONT17 signal assignment		0	
18	CONT18 signal assignment		0	
19	CONT19 signal assignment		0	
20	CONT20 signal assignment		0	
21	CONT21 signal assignment		0	
22	CONT22 signal assignment		0	
23	CONT23 signal assignment		0	
24	CONT24 signal assignment		0	
48	CONT CA signal assignment		0	
49	CONT CB signal assignment		0	

4

(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 specify a desired function, set the corresponding “No.” to the CONT signal assignment.
Set input signals from sequence input/output (CN1) to CONT1 to CONT8.
Set CONT signals from communication data to CONT9 to CONT24.
However, be sure to assign "49" (interrupt input) to CONT1 to 8.
For details of each function, refer to "CHAPTER 2 WIRING."

Function list

No.	Name	No.	Name
1	Servo-on [S-ON]	35	Teaching
2	Forward command [FWD]	36	Control mode selection
3	Reverse command [REV]	37	Position control
4	Start positioning [START]	38	Torque control
5	Homing [ORG]	43	Override enable
6	Home position LS [LS]	44	Override 1
7	+OT	45	Override 2
8	-OT	46	Override 4
10	Forced stop [EMG]	47	Override 8
11	Alarm reset [RST]	48	Interrupt input enable
14	ACC0	49	Interrupt input
16	Position preset	50	Deviation clear
17	Gain switch	51	Multi-step speed selection 1 [X1]
19	Torque limit 0	52	Multi-step speed selection 2 [X2]
20	Torque limit 1	53	Multi-step speed selection 3 [X3]
22	Immediate value continuation	54	Free-run
23	Immediate value change	55	Edit permission
24	Electronic gear numerator selection 0	57	Anti-resonance frequency selection 0
25	Electronic gear numerator selection 1	58	Anti-resonance frequency selection 1
26	Command pulse inhibit	60	AD0
27	Command pulse ratio 1	61	AD1
28	Command pulse ratio 2	62	AD2
29	Proportional control	63	AD3
31	Pause	64	AD4
32	Positioning cancel	77	Positioning data selection
34	External regenerative resistor overheat	78	Broadcast cancel

The logic of the following signals differs between those assigned to hardware CONT signals 1 to 8 and those to CONT signals 9 to 24.

* In “CHAPTER 2 WIRING” the signal logic is described with the case assigned to hardware CONT signals 1 to 8.

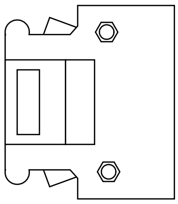
No.	Name	Signal logic	
		CONT1 to 8	CONT9 to 24
7	+OT	N.C.	N.O.
8	-OT	N.C.	N.O.
10	Forced stop [EMG]	N.C.	N.O.
34	External regenerative resistor overheat	N.C.	N.O.

(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 CONT8.
It is possible to use pulse input terminals (CA/CA*, CB/CB*) as CON signal function by assigning the function to PA3_48: CONT CA signal assignment and PA3_49: CONT CB signal assignment (pulse operation is not enabled in that case).

Connector kit type: WSK-D36P

35	CA	36	*CA	17	VREF	18	M5
33	CB	34	*CB	15	TREF	16	MON1
31	FFA	32	*FFA	13	M5	14	MON2
29	FFB	30	*FFB	11	P10	12	PPI
27	FFZ	28	*FFZ	9	M5	10	FZ
25	M5	26	OUT3	7	OUT4	8	OUT5
23	CONT7	24	CONT8	5	OUT1	6	OUT2
21	CONT1	22	CONT2	3	CONT5	4	CONT6
19	COMOUT	20	COMIN	1	CONT3	2	CONT4



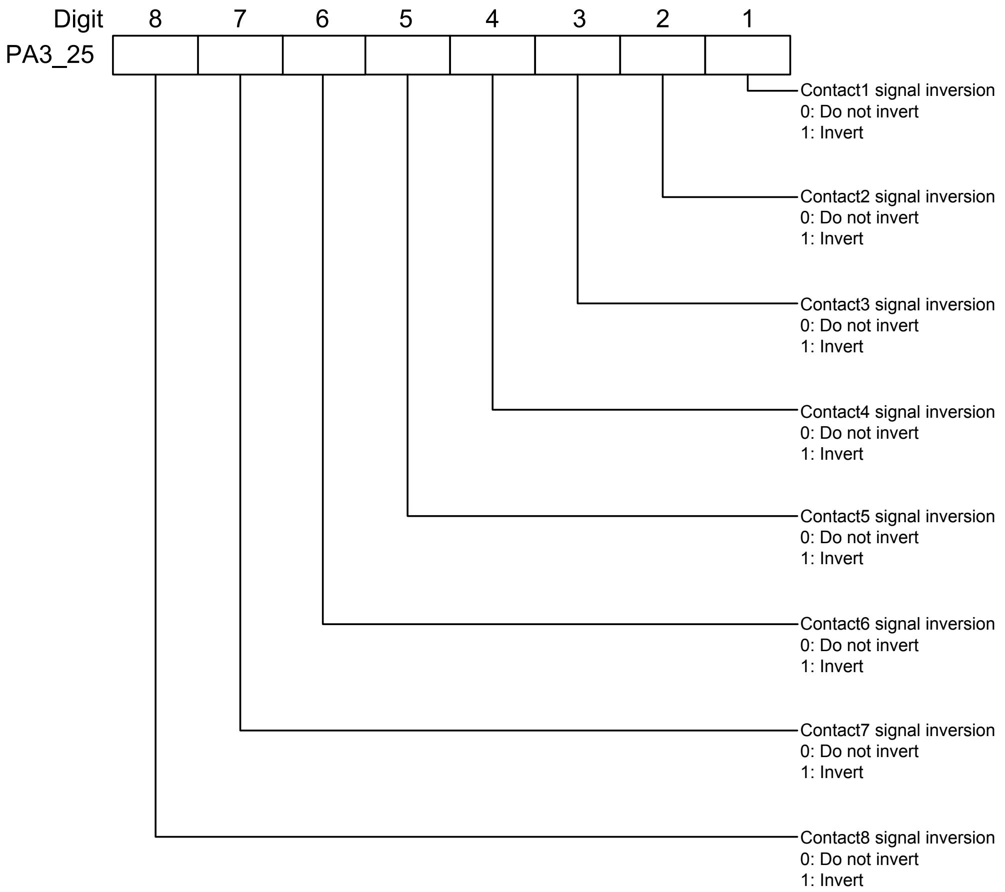
PA3_25 CONT signal inversion

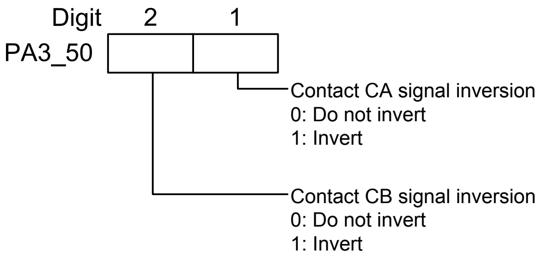
PA3_50 CONT CA/CB signal inversion

No.	Name	Setting range	Default value	Change
25	CONT signal inversion	00000 to 11111	00000	Power supply
50	CONT CA/CB signal inversion	00 to 11	00	Power

Set if wishing to invert the status (ON/OFF) of signals input to PA3_25: sequence input terminals CONT1 to CONT8.

Set if wishing to invert the status (ON/OFF) of signals input to PA3_50: sequence input terminals CONT CA/C.





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 78)	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.

Functions that may not be specified with a normally open signal include alarm reset, deviation clear and free-run.

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

For example, to turn forward command [FWD] always on, specify "2," which corresponds to the forward command, to one of CONT always ON signals 1 to 5.

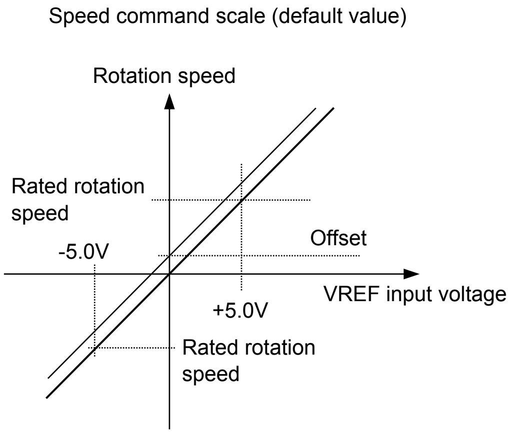
The signal assigned to CONT input signal can be also assigned to CONT always enabled setting redundantly.

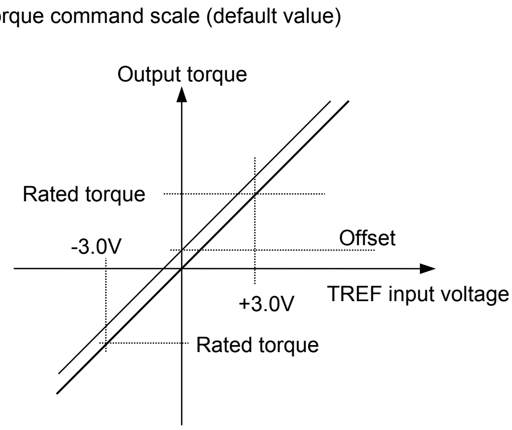
4

PA3_31 to 34 Speed and torque command scale and offset settings

No.	Name	Setting range	Default value	Change
31	Speed command scale	±1.0 [V]/ to ±100.0 [V]/ Rated rotation speed	5.0	Always
32	Speed command offset	-2000 [mV] to 2000 [mV]	Shipment setting	
33	Torque command scale	±1.0 [V] to ±10.0 [V]/ Torque command offset	3.0	
34	Torque command offset	-2000 [mV] to 2000 [mV]	Shipment setting	

Specify the scale (gain) and offset of the analog input signal.





PA3_35 Zero clamp level

No.	Name	Setting range	Default value	Change
35	Zero clamp level	0 [r/min] to 500 [r/min]	0	Always

Rotation speeds less than the specified value are clamped (fixed) at 0 [r/min].
This is used in such cases as when wishing to avoid the influence of offsets, etc. on analog input voltage used for the speed command value or speed limit value.

PA3_36 Deviation clear input form

No.	Name	Setting range	Default value	Change
36	Deviation clear input form	0: Edge 1: Level	0	Power

Specify the deviation clear input signal format.

Select 0 (edge) to reset position deviation at the rising edge timing.

PA3_39 Speed command fine adjustment gain

No.	Name	Setting range	Default value	Change
39	Speed command fine adjustment gain	0.8000 to 1.2000	1.0000	Always

The gain is finely adjusted in relation to the speed command.
In an X-Y table or similar where two or more servomotor axes are interpolated with analog speed commands, you can make the D/A scale of the host unit match the A/D scale of the servo amplifier. Interpolation accuracy is improved with this.
[Example]
If the VREF voltage is 5 [V] and PA3_39 is 1.0100, the speed command inside the servo amplifier is 5.05 [V] (5 x 1.0100).

4

PA3_40 Torque command fine adjustment gain

No.	Name	Setting range	Default value	Change
40	Torque command fine adjustment gain	0.8000 to 1.2000	1.0000	Always

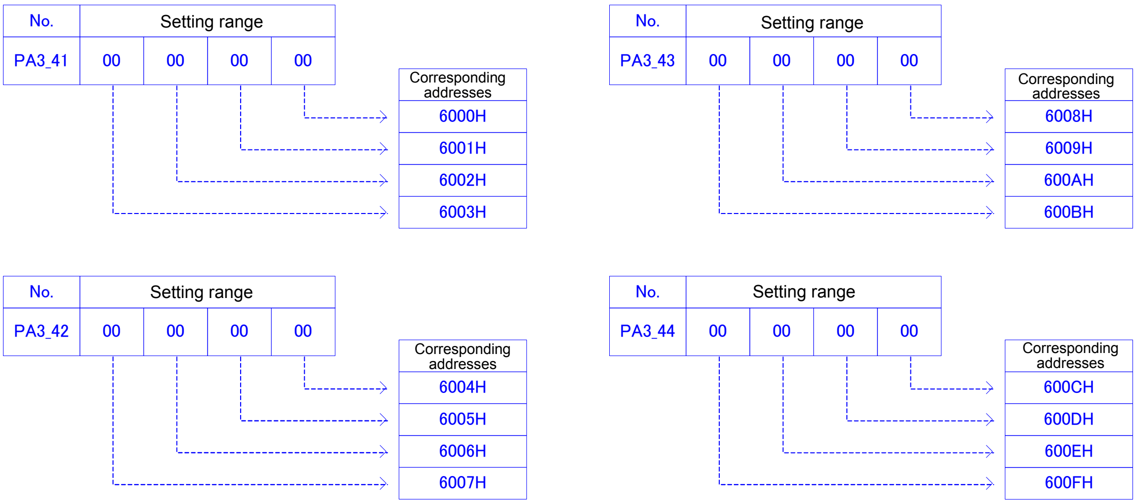
The gain can be finely adjusted in relation to the torque command.
The function is similar to that of PA3_39 (speed command fine adjustment gain).
[Example]
If TREF voltage is 3 [V] and PA3_40 is 1.0100, the torque command inside the servo amplifier is 3.03 [V] (3 × 1.0100).

PA3_41～44 Address free assignment 1 to 4 (for Modbus)

No.	Name	Setting range	Default value	Change
41	Address free assignment 1 (for Modbus)	00000000 to 99999999	00000000	Power
42	Address free assignment 2 (for Modbus)	00000000 to 99999999	00000000	Power
43	Address free assignment 3 (for Modbus)	00000000 to 99999999	00000000	Power
44	Address free assignment 4 (for Modbus)	00000000 to 99999999	00000000	Power

Parameter assignment corresponding address configuration and assignment No. details are as follows. Please note that the default value of 00000000 indicates the feedback speed.

■ Corresponding addresses:



These settings are valid only for addresses 6000H to 600FH.

- If function code (FC) 17H is used:
  Set as read and write data for parameters PA3_41 to PA3_42 (corresponding address area 6000H to 6007H), and as read data for parameters PA3_41 to PA3_44 (corresponding address area 6000H to 600FH).
  An exception code (02h) is returned if other than the above is set.
  If the same address is specified for both read data and write data, read out data is taken to be the same as write in data (value on this occasion).
  Set at least one item of read and write data. If less than this, an exception code (03h) is returned.
- If function code (FC) 03H is used:
  Set read data for parameters PA3_41 to PA3_44 (corresponding address area 6000H to 600FH).
  An exception code (02h) is returned if other than the above is set.
- If function code (FC) 10H is used:
  Set write data for parameters PA3_41 to PA3_42 (corresponding address area 6000H to 6007H).
  An exception code (02h) is returned if other than the above is set.

For details of settings, refer to the following items in CHAPTER 13:

3.3. Function codes.................................. FC17h (Read out/write in various data)
3.4. Addresses .... Data addresses

4.7 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.)

4.7.1 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						
63	OUT13 signal assignment						
64	OUT14 signal assignment						
65	OUT15 signal assignment						
66	OUT16 signal assignment						
67	OUT17 signal assignment						
68	OUT18 signal assignment						
69	OUT19 signal assignment						
70	OUT20 signal assignment						
71	OUT21 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 1/2 output format	0	-	○	○	○	
88	Command pulse frequency sampling time for monitor	3	-	○	-	-	
89	Feedback speed sampling time for monitor	1	-	○	○	○	
90	Output pulse frequency error	0	-	○	○	○	

92	Range1 of position: Setting1	0	-	○	-	-	
93	Range1 of position: Setting2	0	-	○	-	-	
94	Range2 of position: Setting1	0	-	○	-	-	
95	Range2 of position: Setting2	0	-	○	-	-	
98	OUT FZ signal assignment	0	○	○	○	○	
99	OUT FZ signal inversion	0	○	○	○	○	

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

4.7.2 Description of Each Parameter

PA3_51 to 71 OUT signal assignment
PA3_98 OUT FZ assignment

No.	Name	Setting range	Default value	Change
51	OUT1 signal assignment	Select from OUT signal assignment functions (see next page).	1	Power supply
52	OUT2 signal assignment		28	
53	OUT3 signal assignment		2	
54	OUT4 signal assignment		76	
55	OUT5 signal assignment		26	
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	
63	OUT13 signal assignment		0	
64	OUT14 signal assignment		0	
65	OUT15 signal assignment		0	
66	OUT16 signal assignment		0	
67	OUT17 signal assignment		0	
68	OUT18 signal assignment		0	
69	OUT19 signal assignment		0	
70	OUT20 signal assignment		0	
71	OUT21 signal assignment		0	
98	OUT FZ 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 specify a desired function, set the corresponding “No.” to the OUT signal assignment.
Set output signals from sequence input/output (CN1) to OUT1 to OUT5.
Set OUT signals from communication data to CONT6 to CONT21.
For details of each function, refer to "CHAPTER 2 WIRING."

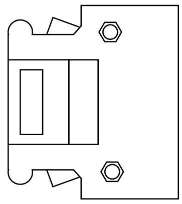
Function list

No.	Name	No.	Name
1	Ready for servo-on [RDY]	41	Forced stop detection
2	In-position [INP]	45	Battery warning
11	Speed limit detection	46	Life warning
13	Over write completion	60	MD0
14	Brake timing	61	MD1
16	Alarm detection (N.O.)	62	MD2
17	Point detection, area 1	63	MD3
18	Point detection, area 2	64	MD4
19	Limiter detection	65	MD5
20	OT detection	66	MD6
21	Cycle end detection	67	MD7
22	Homing completion	75	Position preset completion
23	Zero deviation	76	Alarm detection (N.C.)
24	Zero speed	79	Immediate value continuation permission
25	Speed coincidence	80	Immediate value continuation completion
26	Torque limit detection	81	Immediate value change completion
27	Overload warning	82	Command position completion
28	Servo control ready	83	Range 1 of position
29	Edit permission response	84	Range 2 of position
30	Data error	85	Interrupt positioning detection
31	Address error	86	Interference detection
32	Alarm code 0	89	Functional safety SS1
33	Alarm code 1	90	Functional safety SLS
34	Alarm code 2	91	CONTa through
35	Alarm code 3	92	CONTb through
36	Alarm code 4	93	CONTc through
38	+OT detection	94	CONTd through
39	-OT detection	95	CONTe through
40	Home position LS		

(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 OUT5.
It is possible to use pulse output terminals (FZ) as OUT signal function by assigning the function to PA3_98: OUT FZ signal assignment (then the FZ terminal cannot be used as Z-phase signal output function in that case).

Connector kit type: WSK-D36P

35	CA	36	*CA	17	VREF	18	M5
33	CB	34	*CB	15	TREF	16	MON1
31	FFA	32	*FFA	13	M5	14	MON2
29	FFB	30	*FFB	11	P10	12	PPI
27	FFZ	28	*FFZ	9	M5	10	FZ
25	M5	26	OUT3	7	OUT4	8	OUT5
23	CONT7	24	CONT8	5	OUT1	6	OUT2
21	CONT1	22	CONT2	3	CONT5	4	CONT6
19	COMOUT	20	COMIN	1	CONT3	2	CONT4



PA3_72 OUT signal inversion
PA3_99 OUT FZ signal inversion

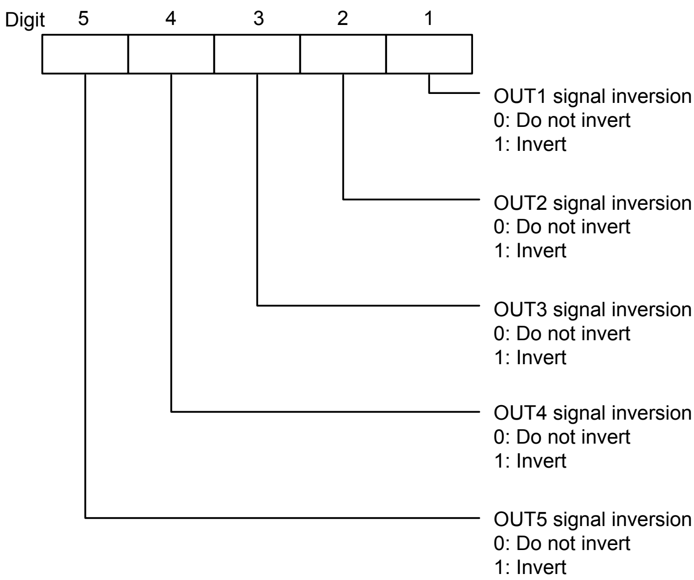
No.	Name	Setting range	Default value	Change
72	OUT signal inversion	00000 to 11111	00000	Power supply
99	OUT FZ signal inversion	0: No inversion, 1: Inversion	0	Power supply

4

Set if wishing to invert the status (ON/OFF) of signals output from sequence output terminal (OUT1 to OUT5, OUT FZ).

Parameter PA3_72 (OUT signal inversion) selects functions for each digit for OUT1 to OUT5.

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/pulse]. 6: Position deviation 1/100 [unit amount/pulse]. 7: Command pulse frequency. 8: Speed deviation. 9: Motor current. 10: Effective torque. 11: DC link voltage. 12: OL thermal value. 13: Regenerative 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

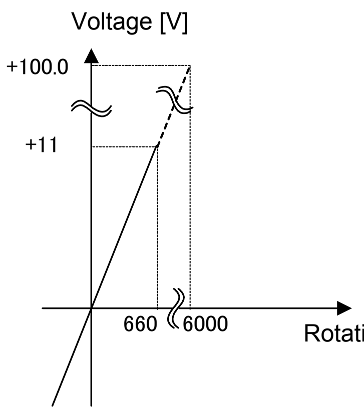
■ Monitor 1/2 signal assignment

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 [pulses]
5: Position deviation (1/10)		Output voltage corresponding to 10000 [pulses]
6: Position deviation (1/100)		Output voltage corresponding to 100000 [pulses]
7: Command pulse frequency	Input pulse frequency reference value	Output voltage corresponding to 1 [MHz]
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: Regenerative resistor thermal value	Load factor of regenerative 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])



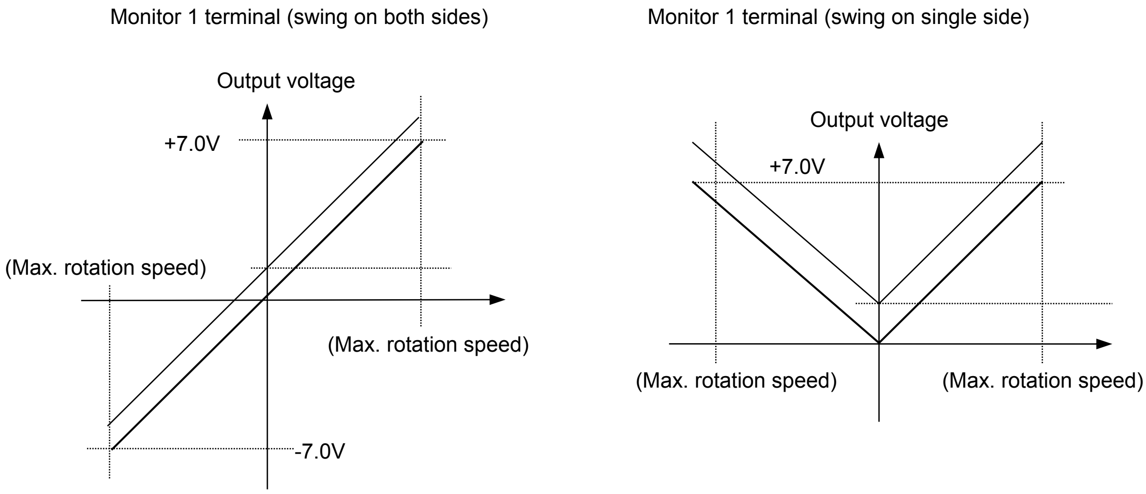
$$\frac{6000 \times 11}{100.0} = 660 \text{ [r/min]}$$

■ 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.



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_88 Command pulse frequency sampling time for monitor

No.	Name	Setting range	Default value	Change
88	Command pulse frequency 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]	3	Always

Specify the command pulse frequency 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.

4

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.

PA3_90 Output pulse frequency error

No.	Name	Setting range	Default value	Change
90	Output pulse frequency error	0: Disable 1: Enable	0	Always

PA3_92 Range1 of position: Setting1
PA3_93 Range1 of position: Setting2
PA3_94 Range2 of position: Setting1
PA3_95 Range2 of position: Setting2

No.	Name	Setting range	Default value	Change
92	Range1 of position: Setting1	-2000000000 to 2000000000 [unit amount]	0	Always
93	Range1 of position: Setting2	-2000000000 to 2000000000 [unit amount]	0	Always
94	Range2 of position: Setting1	-2000000000 to 2000000000 [unit amount]	0	Always
95	Range2 of position: Setting2	-2000000000 to 2000000000 [unit amount]	0	Always

The current servomotor position is detected and output in these signals.
The output signal can be turned on or off according to the current motor position. The parameter that can be specified for range 1 of position signal includes range 1 of position - setting 1 (PA3_92) and range 1 of position - setting 2 (PA3_93).
For example, if the setting of range 1 of position - setting 1 (PA3_92) is smaller than the setting of range 1 of position - setting 2 (PA3_93) and the position specified for range 1 of position - setting 1 (PA3_92) passes during forward motion, the range 1 of position signal undergoes OFF-to-ON transition. If the position specified for range 1 of position - setting 2 (PA3_93) passes, the range 1 of position signal undergoes ON-to-OFF transition.
Similarly to the above description, range 2 of position is related to parameters PA3_94 and 95.
This function is enabled after homing is finished.
For details of the position range, refer to “CHAPTER 2 WIRING”.

4.8 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).

4.8.1 List (PA4_□□)

No. PA4_	Name	Default value	Power supply	Control mode			Record of reference value
				Position	Speed	Torque	
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	○	-	-	○	
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	-	○	○	-	
58	Notch filter 5 attenuation	0	-	○	○	-	
59	Notch filter 5 width	2	-	○	○	-	
60	Cogging torque compensation	0	-	○	○	-	

No. PA4_	Name	Default value	Power supply	Control mode			Record of reference value
				Position	Speed	Torque	
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	-	○	-	-	

"○" in the table above indicates parameters that are valid in each control mode.

4.8.2 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.

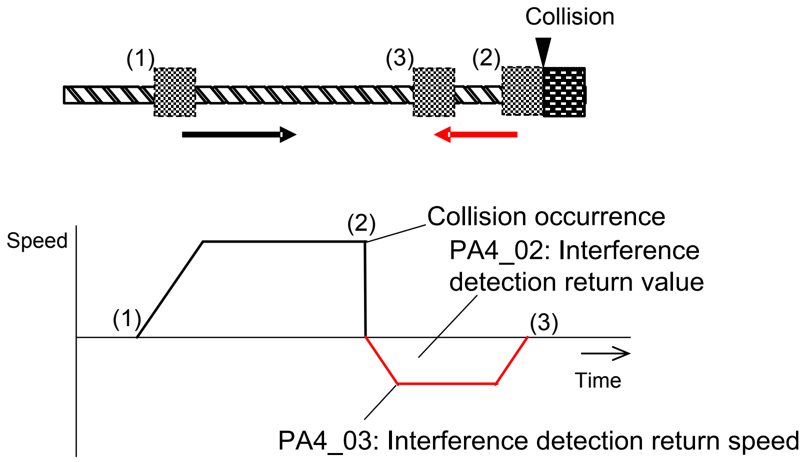
Collisions can be detected quickly by setting a small value, however, collisions may be mistakenly detected if set to small.

[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 40: 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 worked to make the motor retract in the direction of no interference, operation in a regular manner is enabled after this signal is turned off.

In position control mode (pulse operation) and speed control mode, however, the operations in the following table must be performed to return to the regular operation:

Operation mode	Restoration method
Position control (pulse operation)	Restart the servo amplifier. Servo ON signal = OFF Alarm reset signal = ON
Speed control	Restart the servo amplifier. Servo ON signal = OFF FWD signal/REV signal = OFF

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

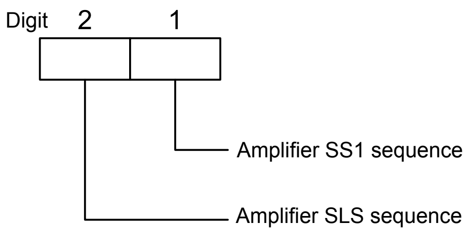
Use this parameter only if using the servo amplifier in combination with the function safety module (WSU-ST1).

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 PA2_76: No.3 deceleration time.

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, PA1_40, setting for deceleration time during positioning operation).

Note

- When performing pulse 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.
- 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_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 "4.3.2 Description 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.
  (1) Run the servomotor on its own before installing it on the machine.
  (2) 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 "5.2 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_64: 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.

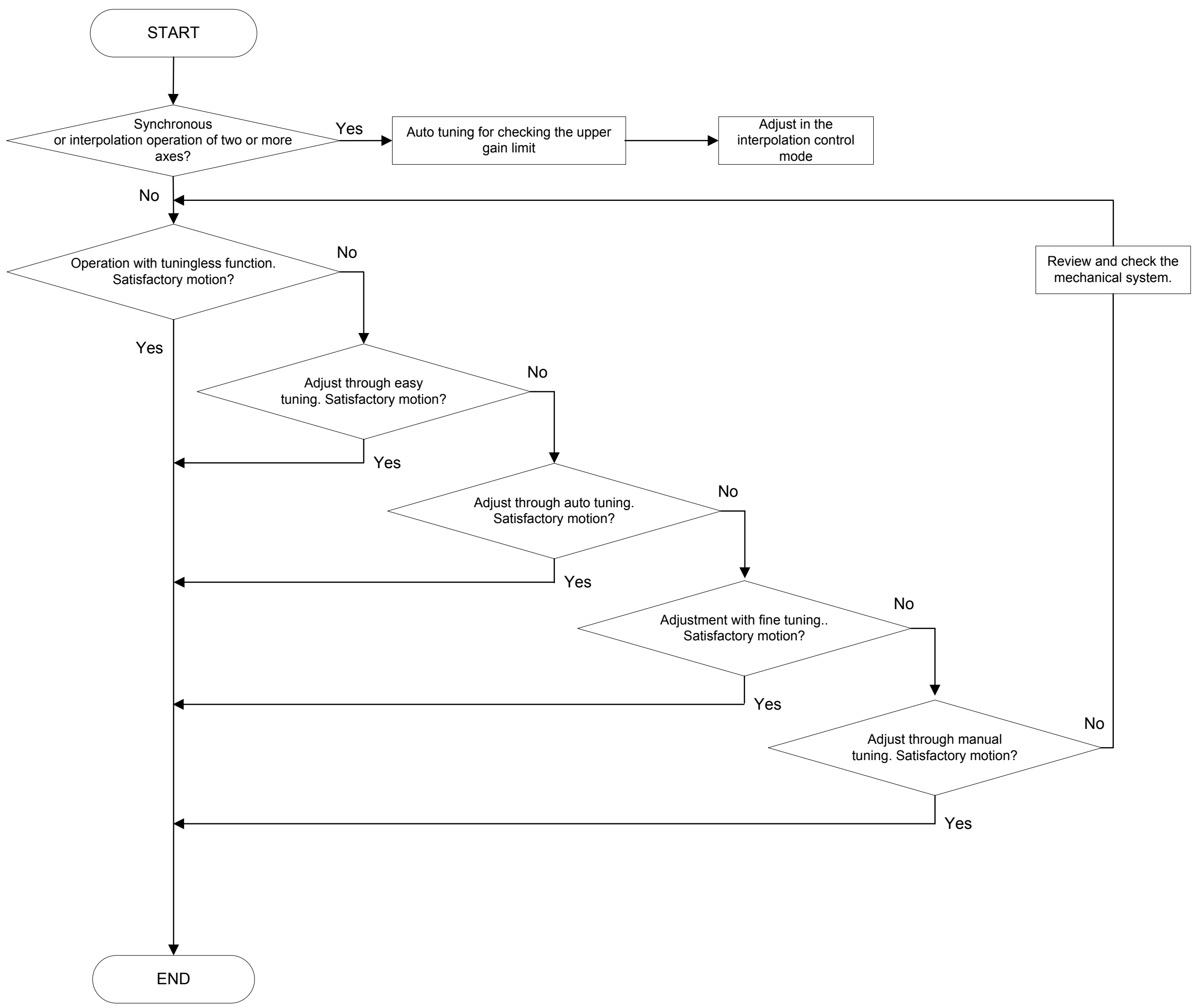
Refer to "5.9 Special Adjustment (Vibration Suppression)" for details on vibration suppression.

CHAPTER 5 SERVO ADJUSTMENT

5.1 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



5.2 Tuningless Function

5.2.1 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.

5.2.2 Setting Parameters

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

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

5.2.3 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

5.2.4 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.

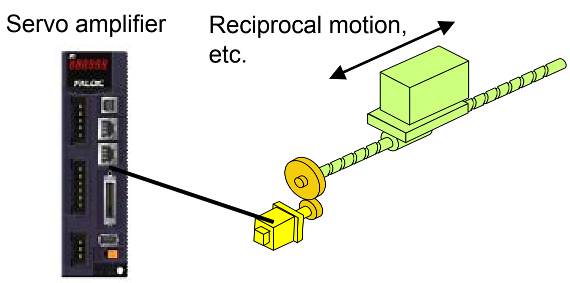
No.	Name
PA1_13	Tuning mode selection
PA1_14	Load inertia ratio
PA1_15	Auto tuning gain 1
PA1_16	Auto tuning gain 2
PA1_61 to PA1_67	Second gain settings
PA1_77 to PA1_86	Vibration suppressing control settings

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.

5.3 Easy Tuning

5.3.1 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.



5

5.3.2 Easy Tuning Operation Profile

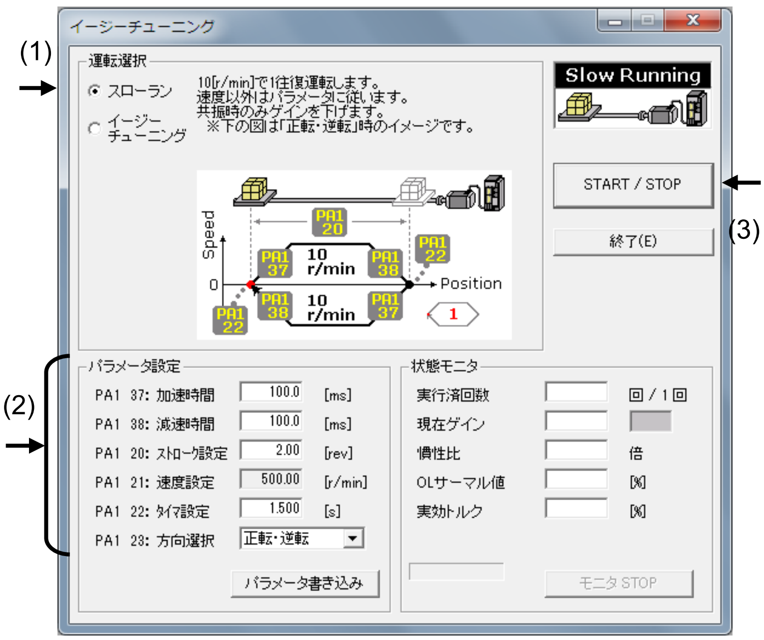
Easy tuning is operated by PC Loader or keypad.
To install PC Loader, refer to "CHAPTER 14 PC LOADER."

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

■ To operate with PC Loader

[1] Slow running

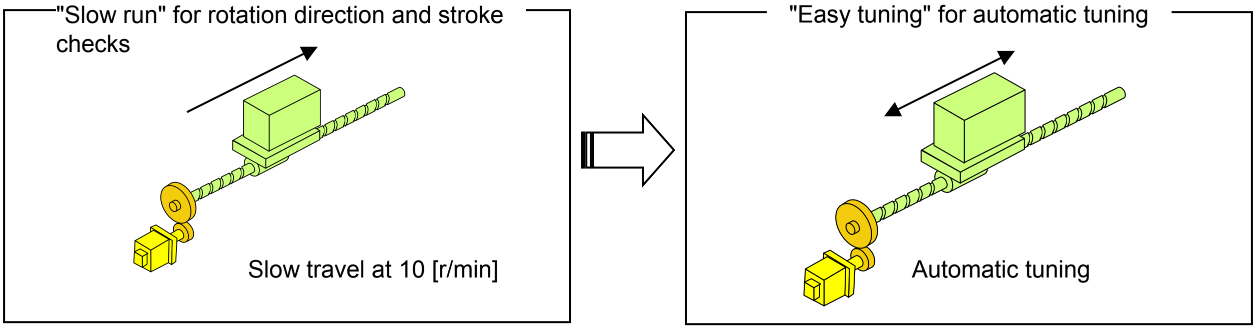
For machines with a linear driving system, follow the procedure below to perform slow running before performing easy tuning.
Turn the motor at 10 [r/min] (fixed) while checking the rotation direction and stroke.
Select "slow running" (1) on the PC Loader screen shown on the right and enter the "stroke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

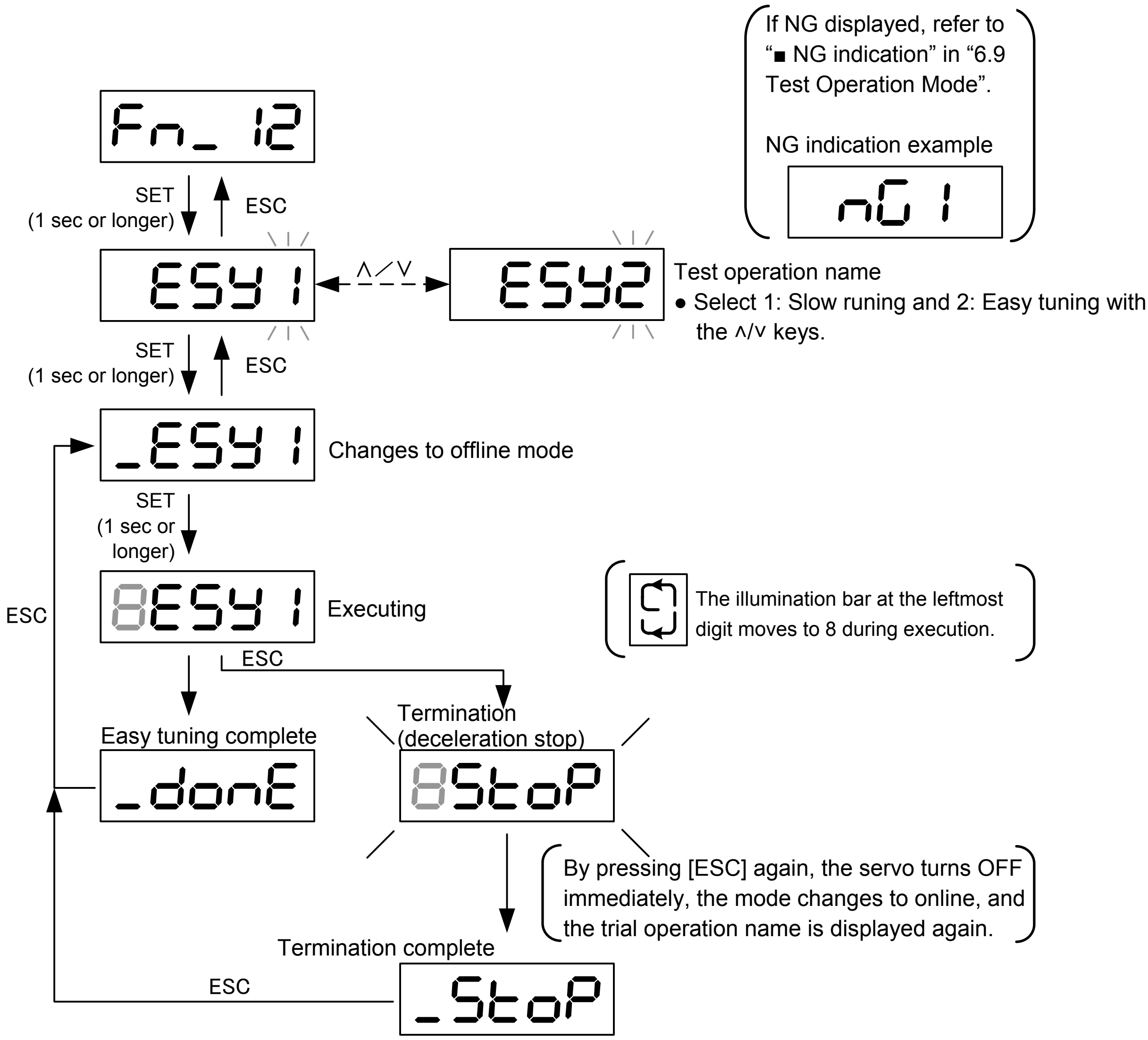
[2] Easy tuning

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.



5

■ To operate with keypad



5.3.3 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.

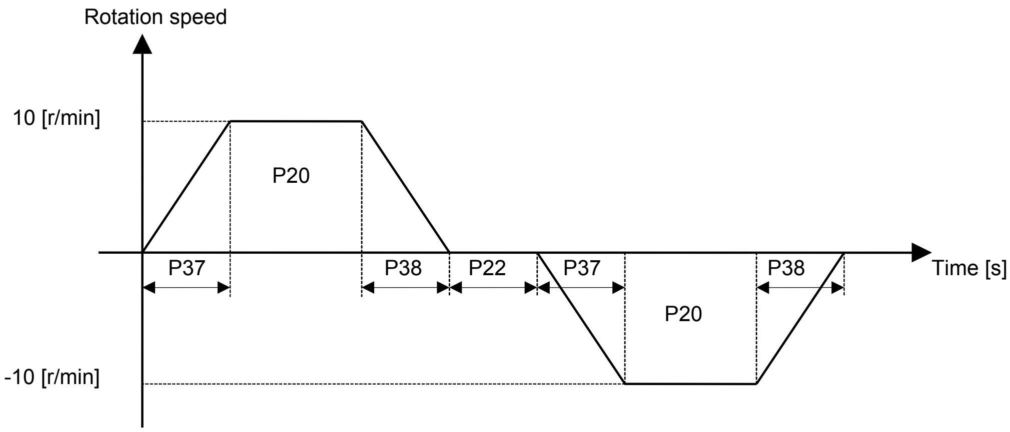
Power supply to main circuit	No alarm	Neither ±OT nor EMG	BX signal OFF	Auto tuning*1	Parameter write enable*2	Tuningless function disable*3
○	○	○	○	○	○	○

*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)

5

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).

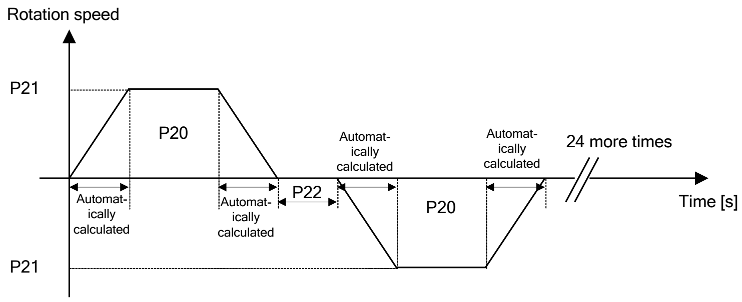
Power supply to main circuit	No alarm	Neither ±OT nor EMG	BX signal OFF	Auto tuning[*1]	Parameter write enable[*2]	Tuningless function disable[*3]
○	○	○	○	○	○	○

*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).

5

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 P5-6 procedure.

5.4 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.

5.4.1 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.

5.4.2 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 "5.4.3 Approximate Reference Value of Auto Tuning Gain 1" for adjustment.	
PA1_16	Auto tuning gain 2	Enter when necessary.	

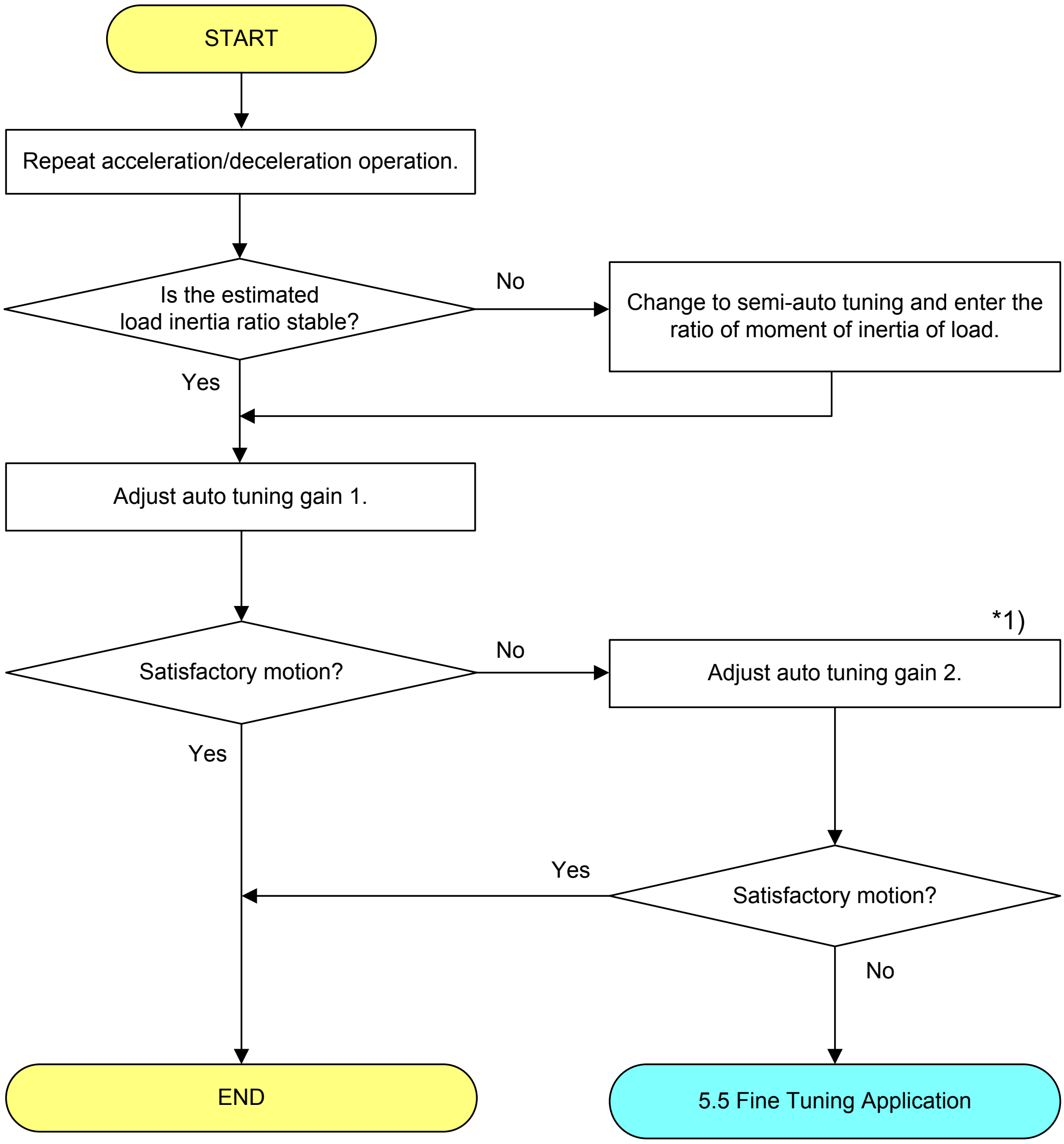
- During auto tuning, by adjusting PA1_15: auto tuning gain 1, other parameters are automatically adjusted. The values are always updated.
- During semi-auto tuning, enter PA1_14: load interia ratio and by adjusting PA1_15: auto tuning gain 1 other parameter are automatically adjusted.
  Values are fixed as far as the setting is left unchanged.

5.4.3 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

5.4.4 Auto Tuning Adjustment Procedure



*1) There is no need to adjust auto tuning gain 2 under speed control.

5.5 Fine Tuning

5.5.1 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.

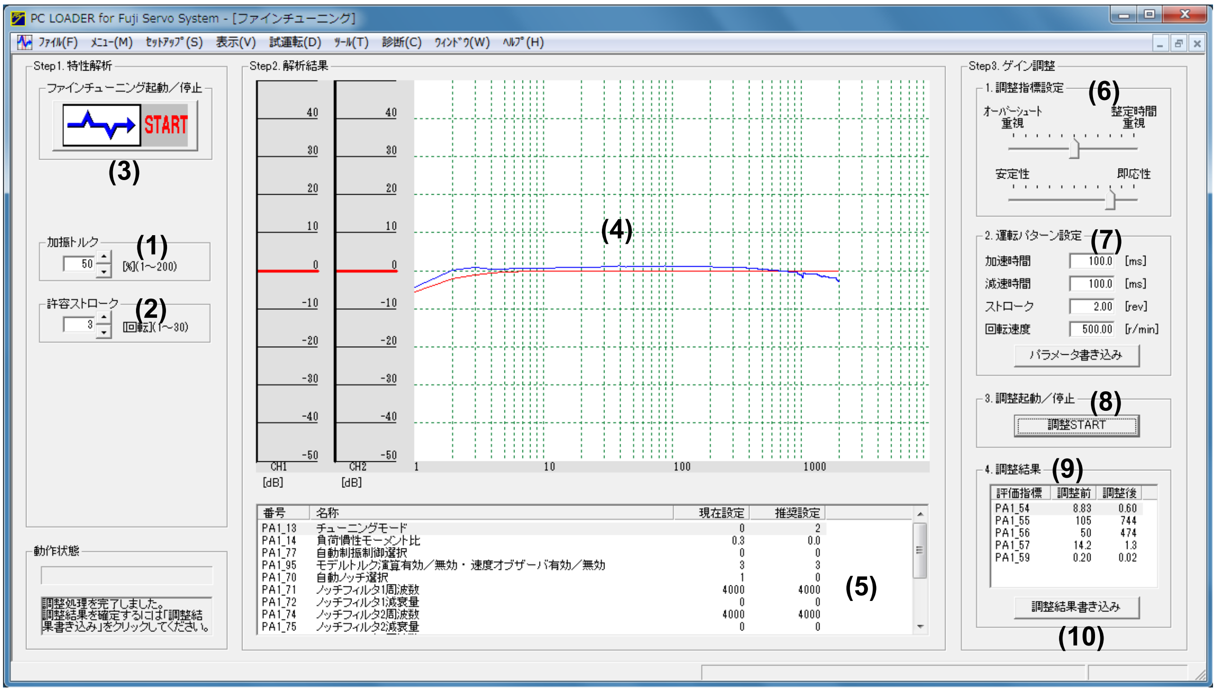
5.5.2 Adjusted Parameters

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	Automatic vibration suppressing selection
PA1_78	Vibration suppressing anti resonance frequency 0
PA1_79	Vibration suppressing workpiece inertia ratio 0
PA1_80	Vibration suppressing anti resonance frequency 1
PA1_81	Vibration suppressing workpiece inertia ratio 1
PA1_86	Vibration suppressing damping coefficient
PA1_87	Model torque filter time constant
PA1_92	Speed range for friction compensation
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

5.5.3 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.

注意	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.

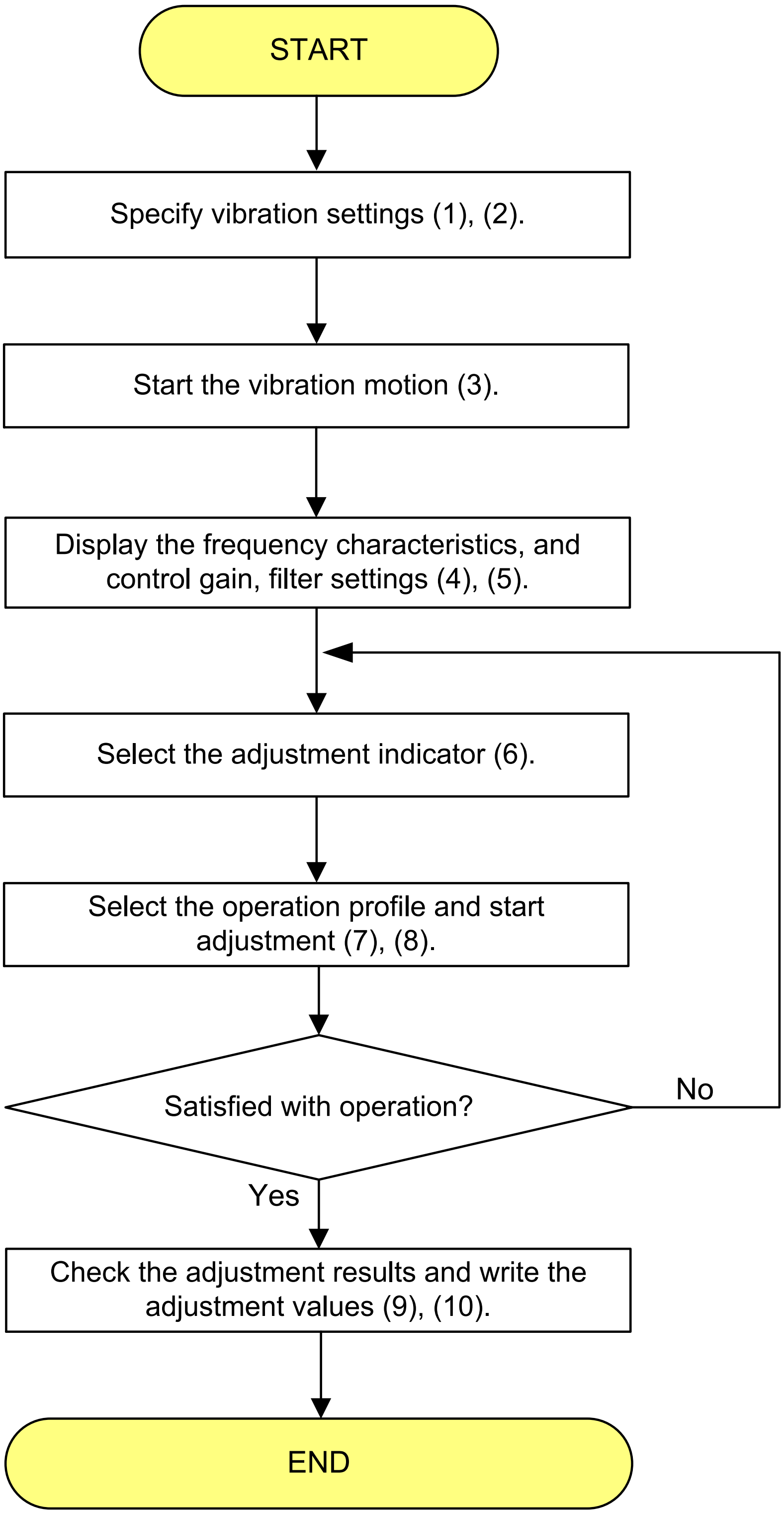
(10) If there are no problems with the adjustment values at (9), press the [Write Adjustment Results] button to complete adjustment.
If unsatisfied with operation based on the adjustment values at (9), reset the adjustment indicator at (6), and perform adjustment again.

■ 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

5.6 Manual Tuning

If the result of "auto tuning application" is not satisfactory or if faster response is intended, perform manual adjustment of all gains.

5.6.1 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.

5

5.6.2 Parameters Used for Manual Tuning

Parameters used for gain adjustment are shown in the table in the next section.

5.6.3 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.

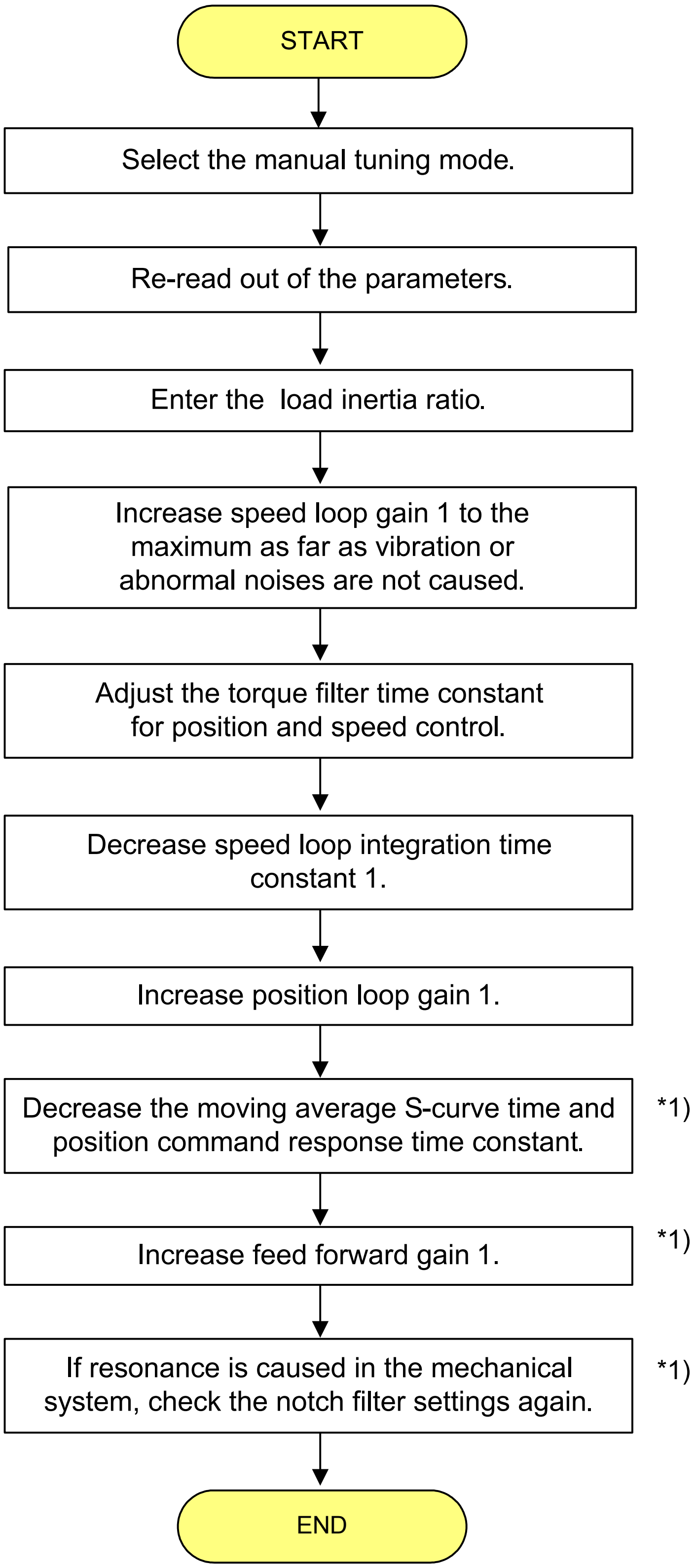
No.	Name	Approximate reference value	Position control	Speed control
PA1_13	Tuning mode selection	2: Manual tuning	○	○
PA1_14	Load inertia ratio (JI)	Enter a stable assumed value (or average value).	○	○
PA1_51	Moving average S-curve time	16 or over	○	-
PA1_54	Position command response time constant (Kpt)	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.

5.6.4 Manual Tuning Adjustment Procedure



*1) Adjustment is unnecessary under speed control.

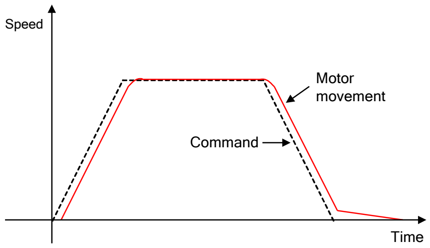
5.6.5 Individual Adjustment

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)

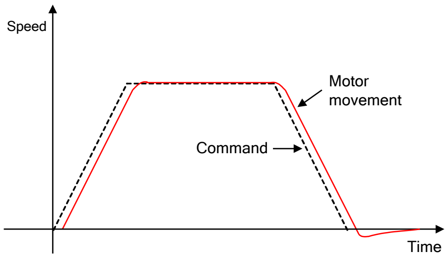
In case of shortage in travel

(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 14 PC LOADER."

5

5.7 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.

5.7.1 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.

5.7.2 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 "5.4.3 Approximate 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.

5.7.3 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).

5.8 Profile Operation

5.8.1 What is Profile Operation?

Even if the host control unit is not connected, automatic operation can be executed according to the specified operation pattern.

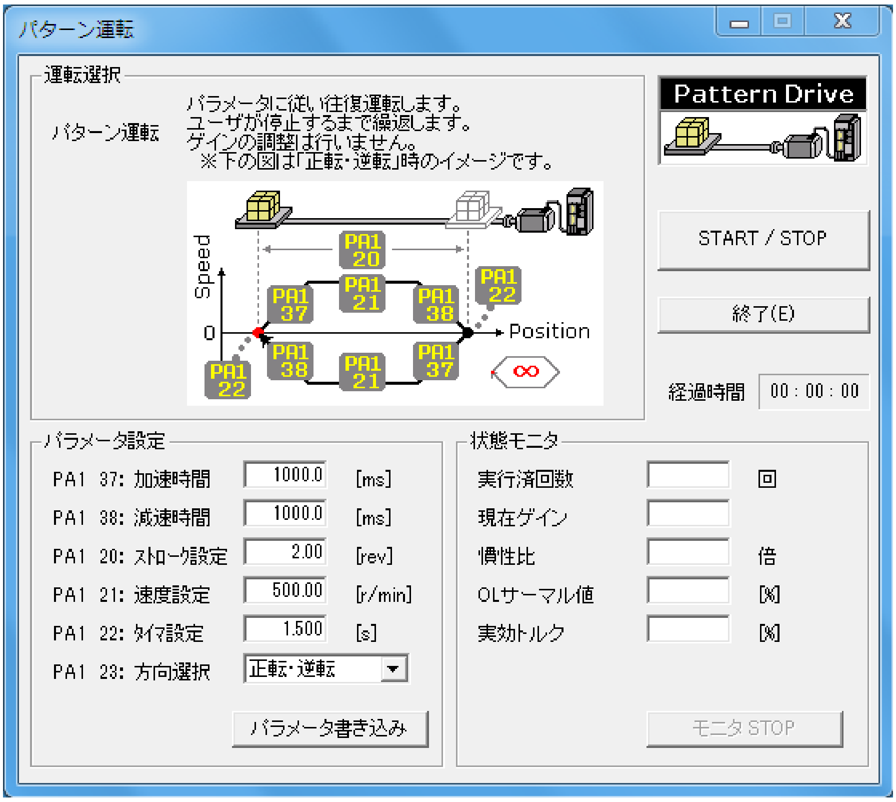
The motion continues until the user stops it. Use this feature to check the load condition of the mechanical system, effective torque, etc.

During profile operation, parameters are not tuned.

Operate the PC Loader or keypad to perform profile operation.

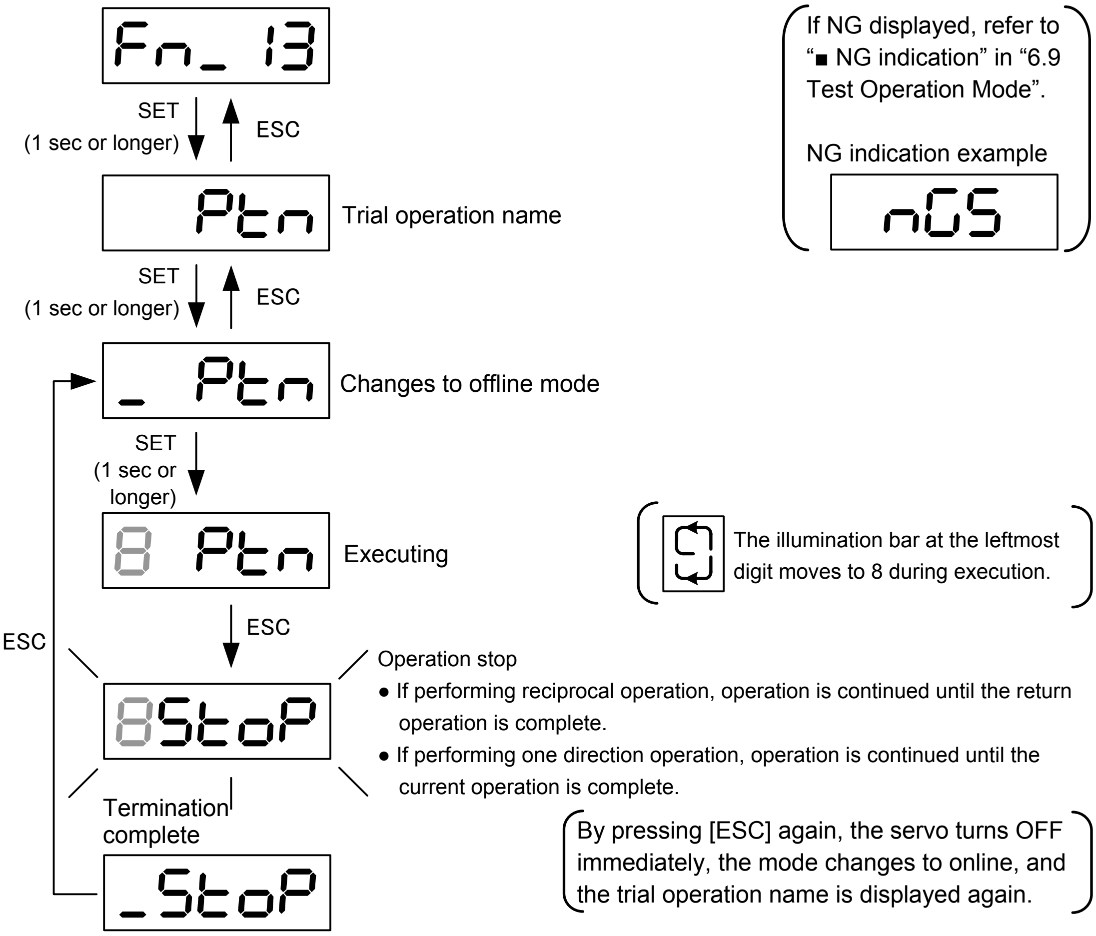
Select the operation pattern and press the "START/STOP" button to start to operate.

■ In case of operation at PC Loader



■ In case of operation at keypad

The following procedure illustrates how to perform profile operation from the keypad.



5.8.2 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).

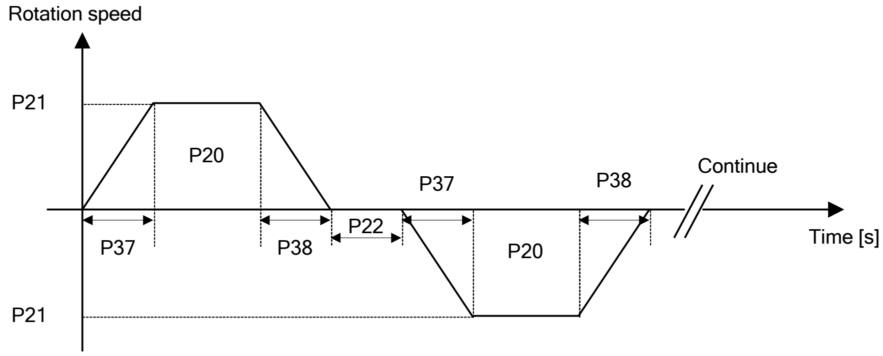
The gain reference value is left unchanged at the start level as far as resonance is not observed.

Power supply to main circuit	No alarm state	BX signal turned off	Neither ±OT nor EMG
○	○	○	○

5

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.

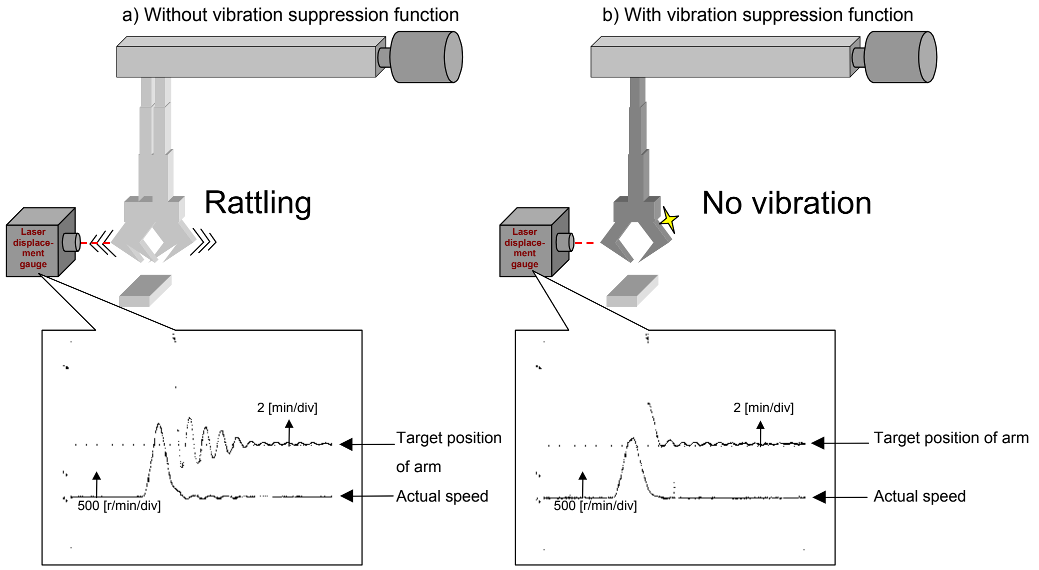
- ±OT, EMG or external regenerative resistor overheat is detected in the middle.
- BX (Free-run signal) is turned on in the middle.
- The servo-on (S-ON) signal is turned off in the middle.

5.9 Special Adjustment (Vibration Suppression)

5.9.1 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.



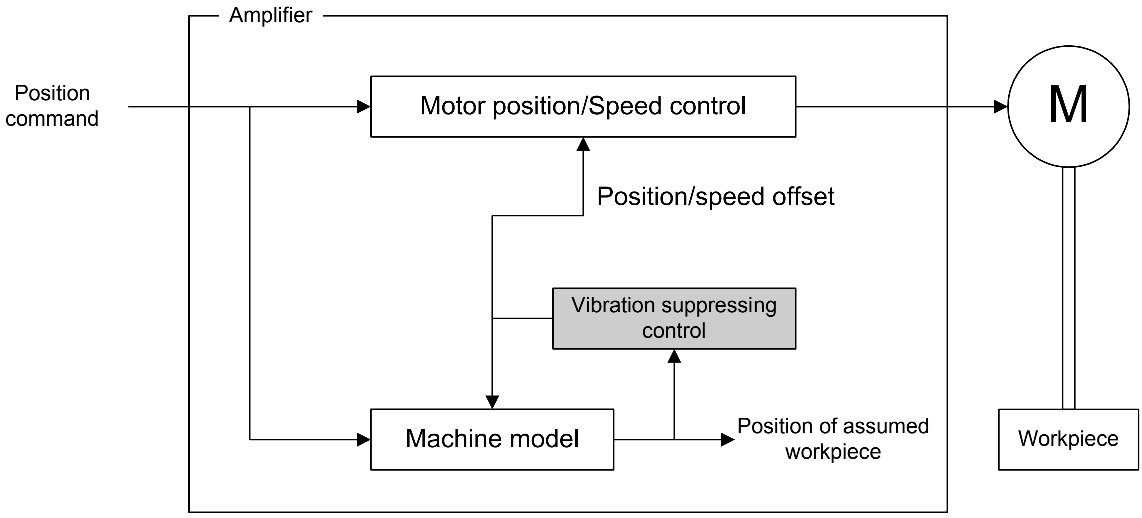
Hint

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]

5.9.2 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

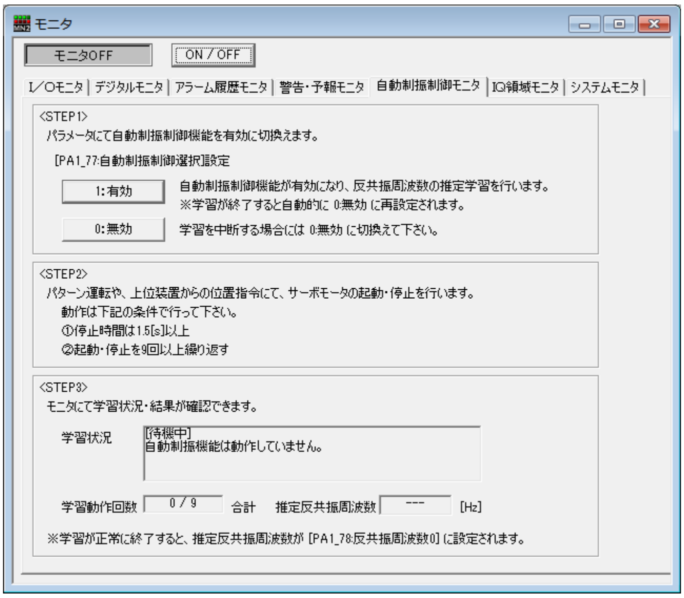
[1] Set PA1_77 (automatic vibration suppression selection) at 1 (enable).
[2] Perform profile operation or issue position commands from the host unit to start and stop the servomotor nine times.
[3] Set the dwell at 1.5 [s] or longer.
[4] After operation is normally finished, the optimum value is automatically 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 (automatic vibration suppression 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

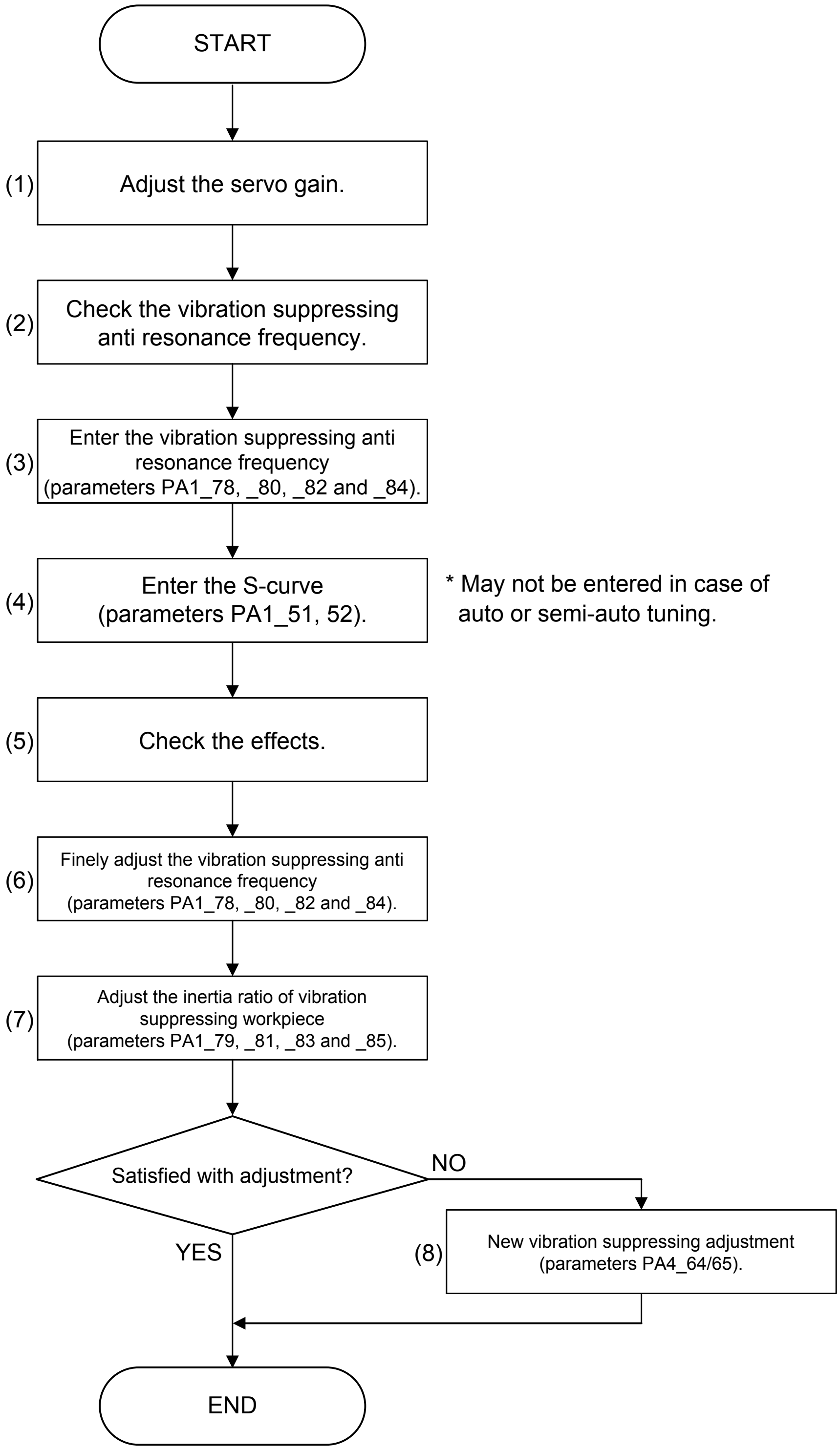
Use the monitor of the PC Loader to monitor the learning state of the automatic vibration suppression.



If no expected effect is obtained under automatic vibration suppression, refer to the following "5.9.3 Manual Adjustment of Vibration Suppression."

5.9.3 Manual Adjustment of Vibration Suppression

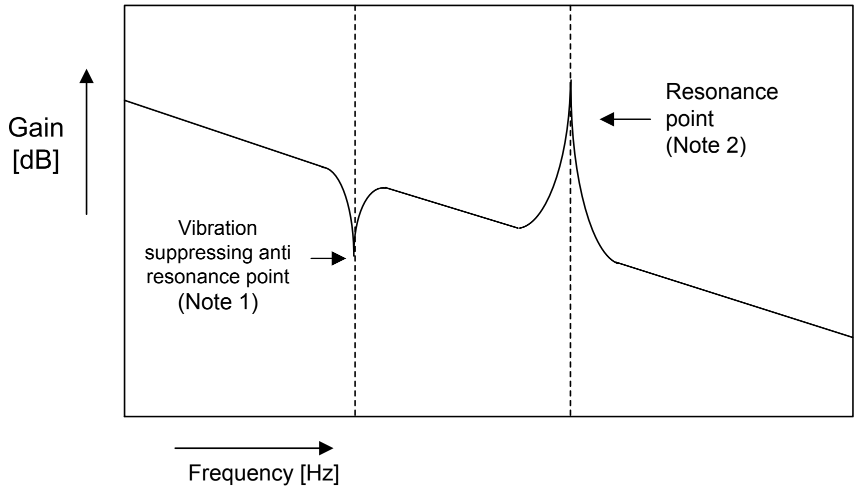
■ Adjustment flow chart



(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 5.1 through 5.7 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

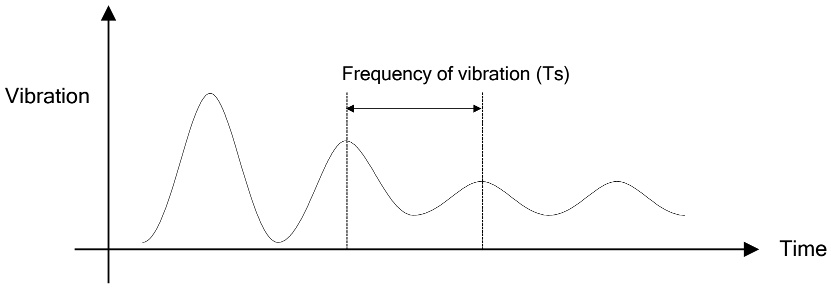
Note 2 Use the notch filter for the resonance point.

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.



$$\text{Vibration suppressing anti resonance frequency} = \frac{1}{Ts} \text{ [Hz]}$$

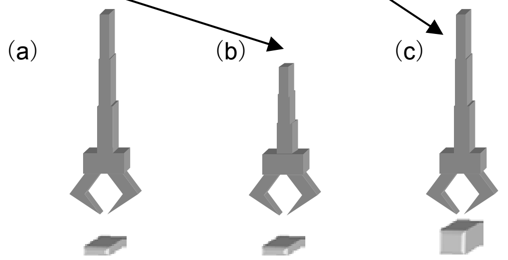
2) Starting at 300.0 [Hz] (maximum setting), decrease the reference values of parameters PA1_78, _80, _82 and _84 gradually while visually checking vibration, to find the best value.

(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 $\dfrac{\alpha}{\beta} = \dfrac{\text{PA1\_06 (numerator 0 of electronic gear)}}{\text{PA1\_07 (denominator of electronic gear)}}$

* 2 Cannot be set during auto or semi-auto tuning.

(5) Checking the effects

There are three checking methods.

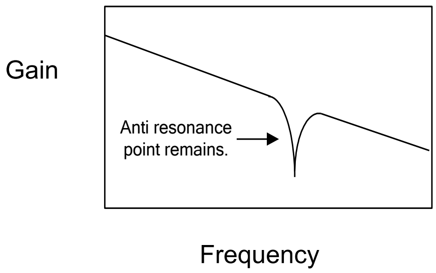
(1) Observe vibration of the arm tip with a laser displacement gauge or similar measuring instrument.

(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

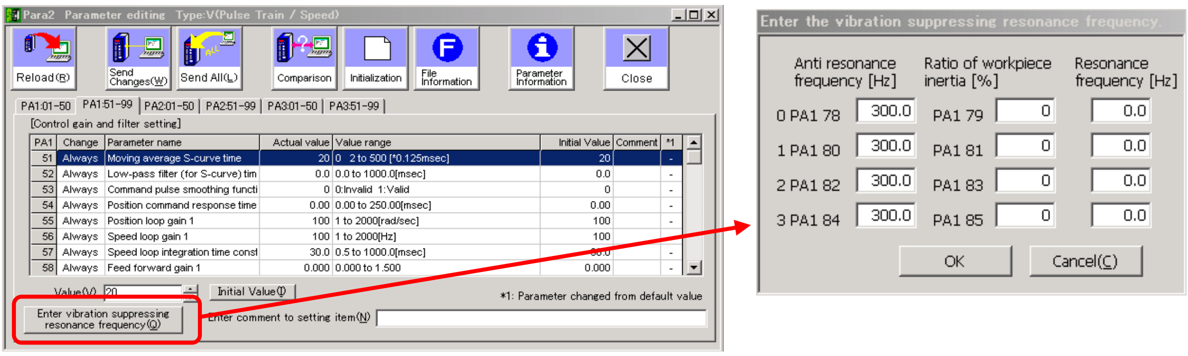
[1] Calculate the inertia of the vibrating point according to specifications of the machine.

$$\text{Vibration suppressing workpiece inertia ratio} = \frac{\text{Vibrating point inertia}}{\text{Entire load inertia}}$$

[2] Entering with the PC Loader

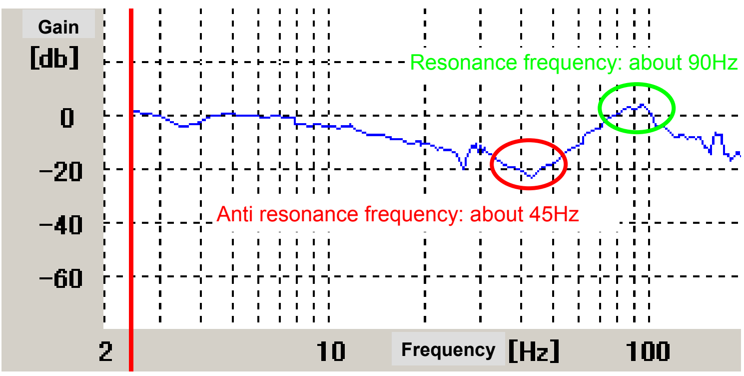
(1) Check the anti resonance frequency and resonance frequency by using the servo analyze function.

(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.

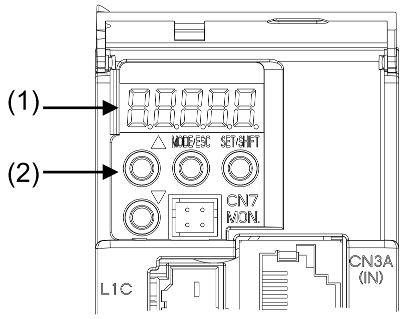
If vibrations persist even after performing the adjustment at [1], set the workpiece inertia ratio calculated at (7).

CHAPTER 6 KEYPAD

6

6.1 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 5-digit 7-segment LED (1) and 4 keys (2) (lift the front cover).
The 5-digit 7-segment LED displays both numbers and characters.
The four keys are 〔MODE/ESC〕, 〔∧〕, 〔∨〕, and 〔SET/SHIFT〕.
Refer to "6.1.2　Key" for a description of each key.



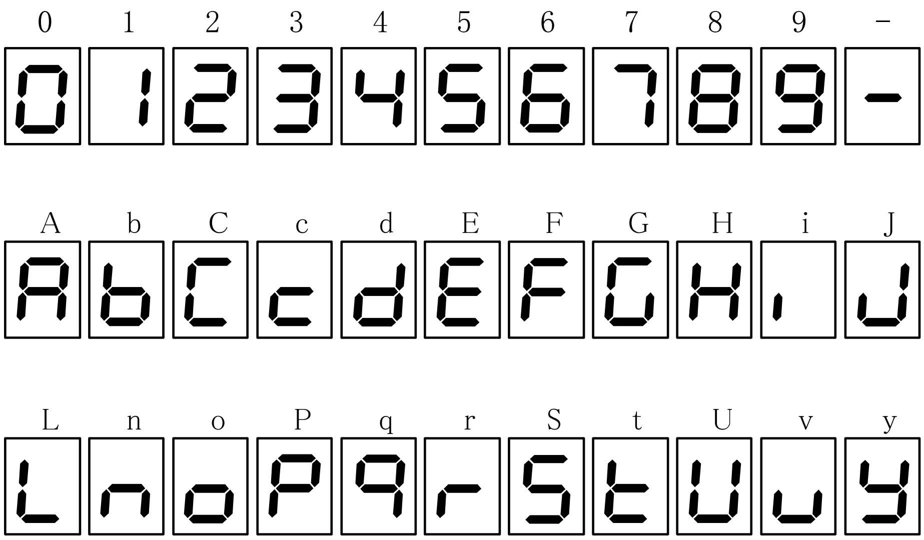
6.1.1 Mode

6

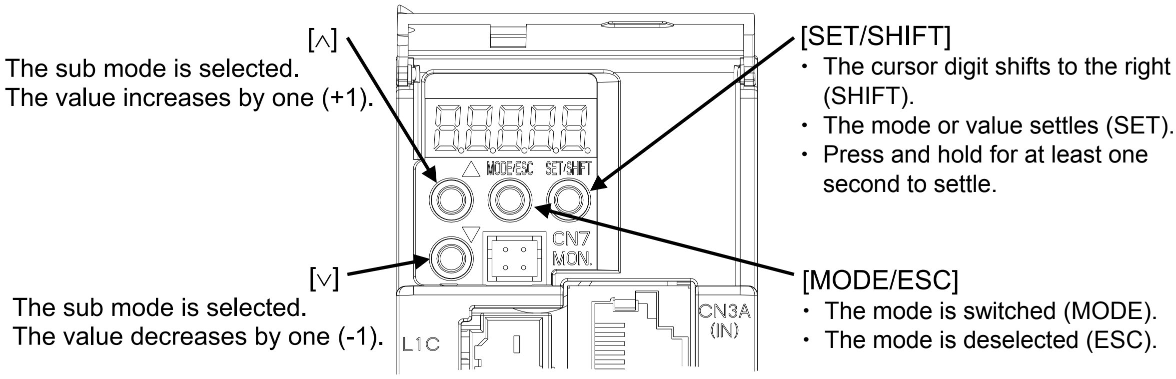
The keypad functions in seven modes.
Some modes are unavailable for some models of the servo amplifier.

- Sequence mode: The control and operation statuses of the servo amplifier are displayed.
- Monitor mode: Various servomotor states, I/O signals and so on are monitored.
- Station No. mode: The station number specified with a parameter is displayed.
- Maintenance mode: Alarm at presents and alarm history are displayed.
- Parameter edit mode: Parameters can be edited.
- Positioning data edit mode: Positioning data can be edited.
- Test operation mode: Servomotor operates through key operation at the keypad.

7-segment display



6.1.2 Key



- To display five or more digits, switch the display alternately between the four higher order digits and four lower order digits. (5-digit data with no symbol is displayed without switching the displayed digits.)
- To display nine or more digits, switch the display alternately between the four higher order digits, four middle order digits, and four lower order digits. (9-digit data with no symbol is displayed by switching between the five higher order digits and five lower order digits.)

6.1.3 Flashing Display

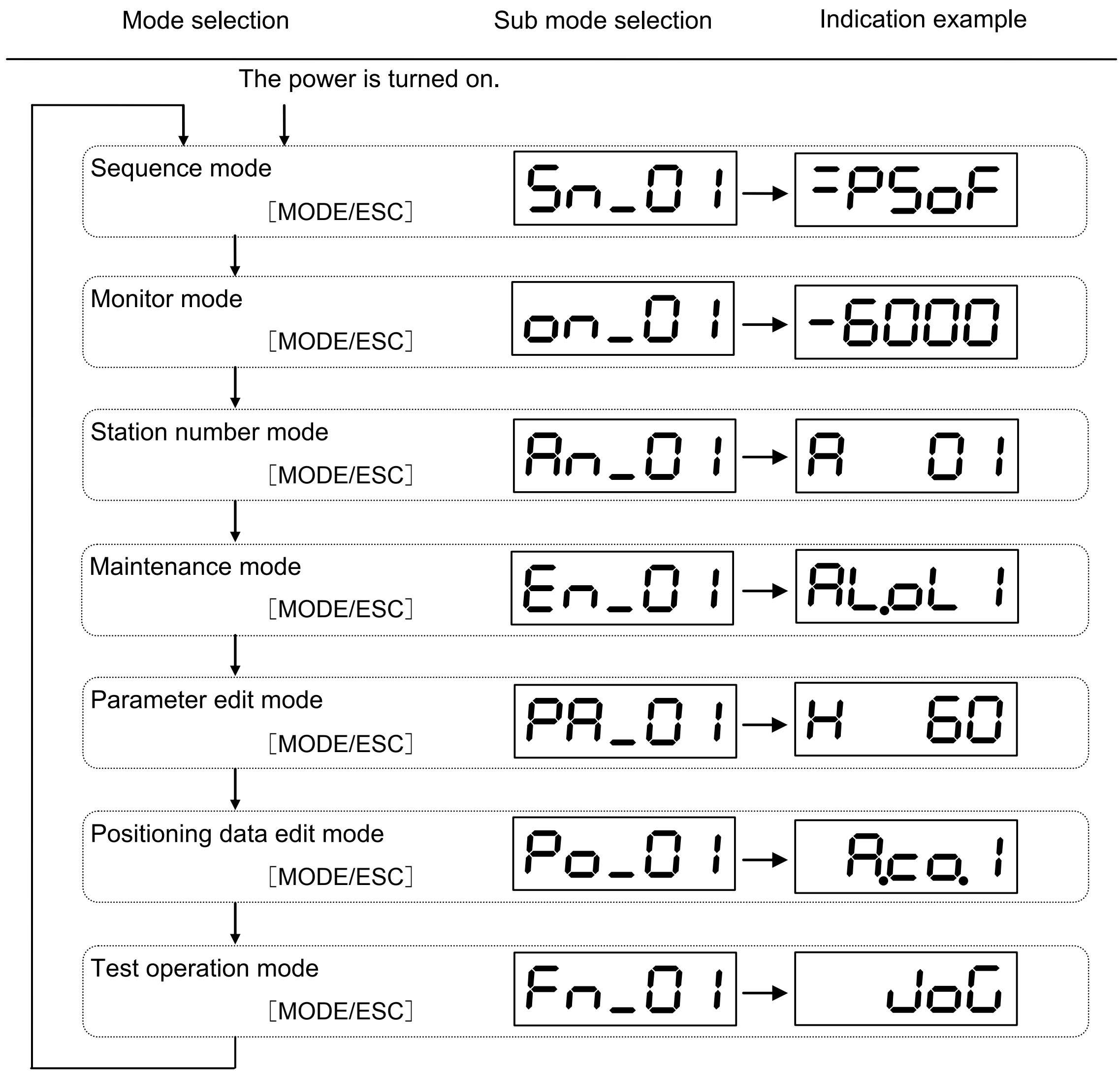
There are times when the keypad flashes.
The flashing status and meanings are shown in the following table.

Flashing interval	Duration	Status	Recovery method
1 second cycle	Continuous	Alarm occurring	Restart the servo amplifier or reset the alarm.
0.5 second cycle	3 seconds	Setting parameters	-
Once every 2 seconds	Continuous	In sequence test mode	Restart the servo amplifier or, change PA2_89 to 0 and then restart.
Twice every 2 seconds	Continuous	Restart notification *	Restart the servo amplifier.

*: If valid parameters changed after restarting the servo amplifier.

6.1.4 Mode Selection

Use the [MODE/ESC] key to select each mode.



6

6.2 Function List

In the parameter edit mode and the positioning edit mode, the setting values can be checked and changed.

Mode	Sub mode	Sub mode selection	Indication and entry example
Sequence mode	Sequence mode	Sn_01	=PSoF
	Amplifier setting	Sn_02	ud.201
	Motor setting	Sn_03	S.201.c
	Option information	Sn_04	St 1
Monitor mode	Feedback speed	on_01	-6000
	Command speed	on_02	-6000
	Command torque	on_03	- 300
	Motor current	on_04	- 300
	Peak torque	on_05	- 300
	Effective torque	on_06	- 300
	Feedback position	on_07	H 20
	Command position	on_08	H 20
	Position deviation	on_09	H 1
	Command pulse frequency	on_ 10	L 100.0

Mode	Sub mode	Sub mode selection	Indication and entry example
Monitor mode	Feedback cumulative pulse	on_ 11	H 20
	Command cumulative pulse	on_ 12	H 20
	LS-Z pulse	on_ 13	H 104
	Load inertia ratio	on_ 14	300.0
	DC link voltage (max.)	on_ 15	300
	DC link voltage (min.)	on_ 16	300
	VREF input voltage	on_ 17	- 10.00
	TREF input voltage	on_ 18	- 10.00
	Input signal	on_ 19	L ıı ıı ı
	Output signal	on_20	L ı ı
	OL thermal value	on_21	100
	Regenerative resistor thermal value	on_22	100
	Power	on_23	- 300
	Motor temperature	on_24	100
	Overshoot unit amount	on_25	H 1
	Settling time	on_26	1000.0
	Resonance frequency 1	on_27	1000

Mode	Sub mode	Sub mode selection	Indication and entry example
Monitor mode	Resonance frequency 2	on_28	1000
Station number mode	Station number display	An_01	A 01
Maintenance mode	Alarm at present	En_01	AL.oL 1
	Alarm history	En_02	AL.oL 1
	Warning at present	En_03	Er.0 10
	Total time - main power supply	En_04	10000
	Total time - control power supply	En_05	10000
	Motor running time	En_06	.05.30
Parameter edit mode	Parameter page 1	PA_01	H 60
	Parameter page 2	PA_02	C00 10
	Parameter page 3	PA_03	L9999
	Parameter page 4	PA_04	300
Positioning data edit mode	Positioning status	Po.0 1.1	A.co. 1
	Target position	Po.0 1.2	H -20
	Rotation speed	Po.0 1.3	H 60
	Stand still timer	Po.0 1.4	00 1.00
	M code	Po.0 1.5	FF

Mode	Sub mode	Sub mode selection	Indication and entry example
Test operation mode	Manual operation	Fn_01	JoG
	Position preset	Fn_02	PrSEt
	Homing	Fn_03	orG
	Automatic operation	Fn_04	AUto
	Alarm reset	Fn_05	AL.rSt
	Alarm history initialization	Fn_06	AL.ini
	Parameter initialization	Fn_07	PA.ini
	Positioning data initialization	Fn_08	Po.ini
	Auto offset adjustment	Fn_09	Ad.oFF
	Z-phase offset adjustment	Fn_10	En.oFF
	Auto tuning gain	Fn_11	At.tUn
	Easy tuning	Fn_12	ESy1
	Profile operation	Fn_13	Ptn
	Sequence test mode	Fn_14	Sq.tSt
	Teaching	Fn_15	tEAcH

6.3 Sequence Mode

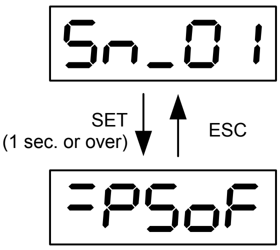
In the sequence mode, the state of the servo amplifier and amplifier setting are displayed.
Press the [MODE/ESC] key until [Sn_0n] is displayed, and press and hold the [SET/SHIFT] key for at least one second to show data.

Sn_01 :Sequence mode
Sn_02 :Amplifier setting
Sn_03 :Motor setting
Sn_04 :Option information

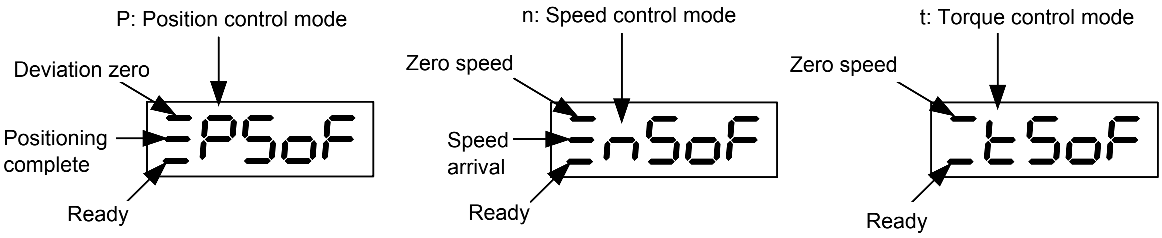
Hint	Key notation In this chapter, keypad keys may be simply described as shown below. • [MODE/ESC] key When using as a [MODE] key: MODE When using as an [ESC] key: ESC • [SET/SHIFT] key When using as a [SET] key: SET (for at least one second) When using as a [SHIFT] key: SHIFT

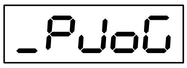
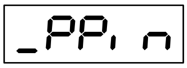
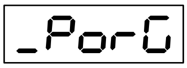
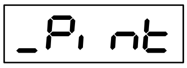
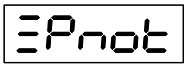
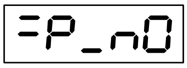
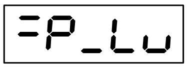
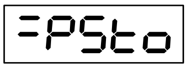
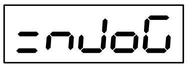
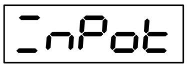
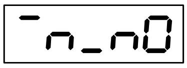
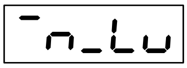
6

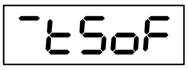
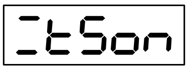
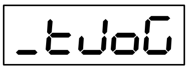
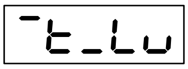
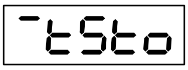
(1) Sequence mode
Displays the servo amplifier output signal status and operating state.



The status of the output signal of the servo amplifier and operation status are displayed.



Display	Control mode	Name	Description
	Position control	Servo off	The motor is not turned on. The servomotor has no driving force.
		Servo on	The servomotor is ready to rotate.
		Manual operation	Manual feed rotation state
		Pulse operation	During pulse input operation
		Positioning	Positioning is being executed.
		Homing	Homing is being executed.
		Interrupt positioning	Interrupt positioning is being executed.
		+OT	The positive over-travel signal is being detected.
		-OT	The negative over-travel signal is being detected.
		Zero speed stop	Stopped at zero speed due to forced stop signal.
		In LV	Refer to "7.3-3. Control Power Undervoltage" and "7.3-13. Main Power Undervoltage" for details.
		During STO	A safety stop (STO) is occurring.
	Speed control	Servo off	The motor is not turned on. The servomotor has no driving force.
		Servo on	The servomotor is ready to rotate.
		Manual operation	Manual feed rotation state.
		+OT	The positive over-travel signal is being detected.
		-OT	The negative over-travel signal is being detected.
		Zero speed stop	Stopped at zero speed due to forced stop signal.
		In LV	Refer to "7.3-3. Control Power Undervoltage" and "7.3-13. Main Power Undervoltage" for details.
		During STO	A safety stop (STO) is occurring.

Display	Control mode	Name	Description
	Torque control	Servo off	The motor is not turned on. The servomotor has no driving force.
		Servo on	The servomotor is ready to rotate.
		Manual operation	Manual feed rotation state.
		In LV	Refer to "7.3-3. Control Power Undervoltage" and "7.3-13. Main Power Undervoltage" for details.
		During STO	A safety stop (STO) is occurring.

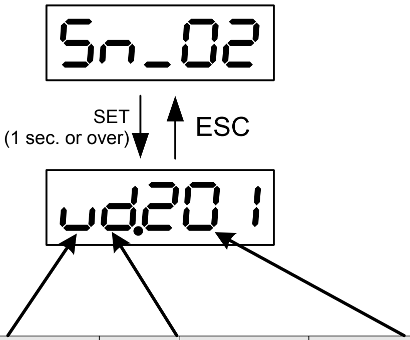
Hint	By turning the servo amplifier power ON, "Station No. mode station No. display" is displayed. The displayed content can be changed at parameter PA2_77 when the power is ON.

6

Reference value	Initial display	
0	Sn_01	Sequence mode
1	on_01	Feedback speed
2	on_02	Command speed
3	on_03	Command torque
4	on_04	Motor current
5	on_05	Peak torque
6	on_06	Effective torque
7	on_07	Feedback position
8	on_08	Command position
9	on_09	Position deviation
10	on_10	Command pulse frequency
11	on_11	Feedback cumulative pulse
12	on_12	Command cumulative pulse
13	on_13	LS-Z pulse
14	on_14	Load inertia ratio
15	on_15	DC link voltage (max.)
16	on_16	DC link voltage (min.)
17	on_17	VREF input voltage
18	on_18	TREF input voltage
19	on_19	Input signals
20	on_20	Output signals
21	on_21	OL thermal value
22	on_22	Regenerative resistor thermal value
23	on_23	Power
24	on_24	Motor temperature
25	on_25	Overshoot unit amount
26	on_26	Settling time
27	on_27	Resonance frequency 1
28	on_28	Resonance frequency 2
40	An_01	Station No
41	En_01	Alarm at present
42	En_02	Alarm history
43	En_03	Warning at present
44	En_04	Total time-main power supply
45	En_05	Total time-control power supply
46	En_06	Motor running time

(2) Amplifier setting

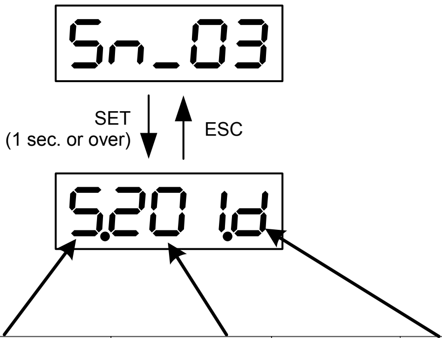
The servo amplifier control function, interface format and capacity are displayed.



Indication	Control function	Indication	Connection format	Indication	Capacity
u	Speed control	d	DI/DO standard	201	0.2kW (20×10^{1})
L	Positioning integration	S	SX bus	202	2kW (20×10^{2})

(3) Motor setting

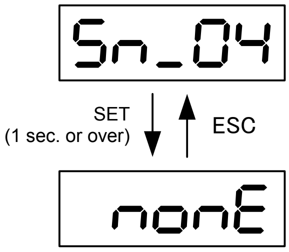
The type of servomotor connected to the servo amplifier, capacity and encode type are displayed.



Indication	Motor profile	Indication	Capacity	Indication	Encoder type
b	GYB	201	0.2kW (20×10^{1})	c	24bit-ABS
S	GYS	202	2kW (20×10^{2})	d	24bit-INC
G	GYG				

(4) Option information

Displays the option type connected to the servo amplifier.



Indication	Option type
nonE	None
St 1	WSU-ST1

6

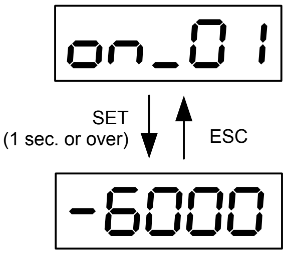
6.4 Monitor Mode

In the monitor mode, the servomotor rotation speed, cumulative input pulse and so on are displayed. Press the [MODE/ESC] key until [on_0n] is displayed, and press and hold the [SET/SHIFT] key for at least one second to display data.

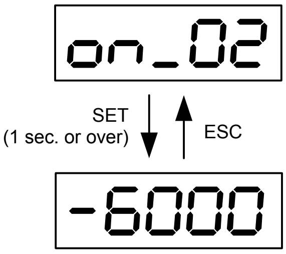
on_01 : Feedback speed
on_02 : Command speed
on_03 : Command torque
on_04 : Motor current
on_05 : Peak torque
on_06 : Effective torque
on_07 : Feedback position
on_08 : Command position
on_09 : Position deviation
on_10 : Command pulse frequency
on_11 : Feedback cumulative pulse
on_12 : Command cumulative pulse
on_13 : LS-Z pulse
on_14 : Load inertia ratio
on_15 : DC link voltage (max.)
on_16 : DC link voltage (min.)
on_17 : VREF input voltage
on_18 : TREF input voltage
on_19 : Input signal
on_20 : Output signal
on_21 : OL thermal value
on_22 : Regenerative resistor thermal value
on_23 : Power (W)
on_24 : Motor temperature
on_25 : Overshoot unit amount
on_26 : Settling time
on_27 : Resonance frequency 1
on_28 : Resonance frequency 2

6

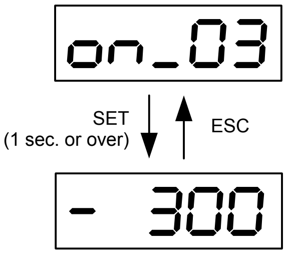
(1) Feedback speed (displayed digits: signed four digits)
Current rotation speed of servomotor.
The correct value is displayed even if the load (mechanical system) rotates the motor.
The speed is displayed in [r/min] and a negative sign is attached for reverse rotation (clockwise rotation when viewed against the motor shaft).



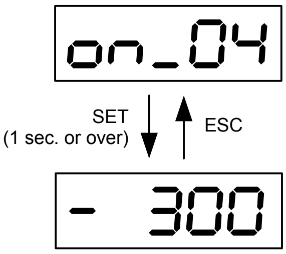
(2) Command speed (displayed digits: signed four digits)
Current speed command issued to the servomotor. The command speed is given in a speed command voltage, multi-step speed, pulse or similar. The speed is displayed in [r/min] and a negative sign is attached for reverse rotation (clockwise rotation when viewed against the motor shaft).



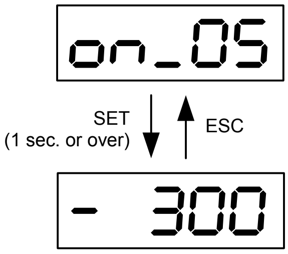
(3) Command torque (displayed digits: signed three digits)
Average torque issued from the servo amplifier to the servomotor; the torque is displayed in percent [%] to the rated torque. The range from 0 [%] to the maximum torque is displayed in increments of 1 [%]. In case of a negative average torque, a negative sign is attached to the most significant digit.



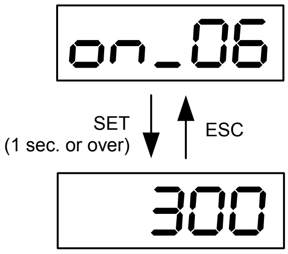
(4) Motor current (displayed digits: signed three digits)
Current flowing through the servomotor; the current is displayed in percent [%] to the rated current. The range from 0 [%] to the maximum current is displayed in increments of 1 [%]. In case of a negative motor current, a negative sign is attached to the most significant digit.



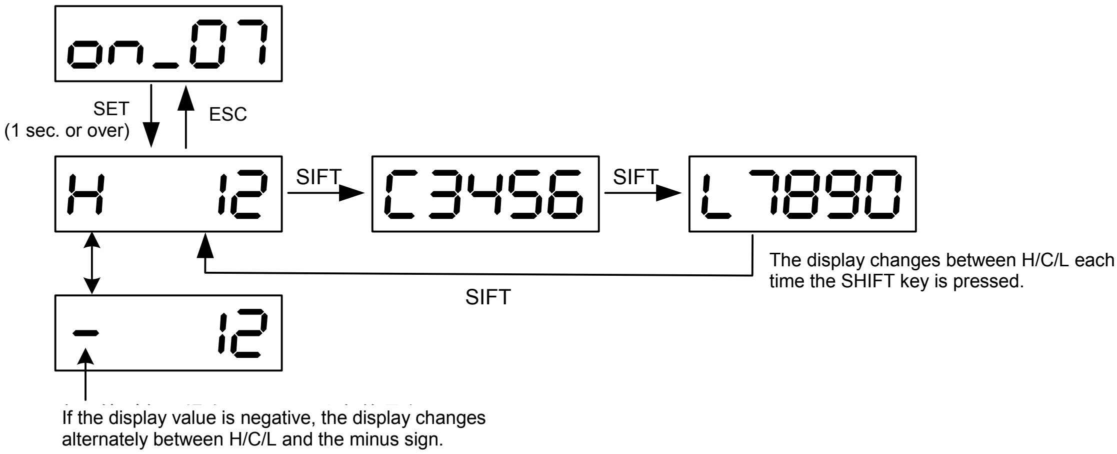
(5) Peak torque (displayed digits: signed three digits)
Peak torque value of the servomotor at every two seconds; the torque is displayed in percent [%] to the rated torque.
The range from 0 [%] to the maximum torque is displayed in increments of 1 [%]. In case of a negative peak torque, a negative sign is attached to the most significant digit.



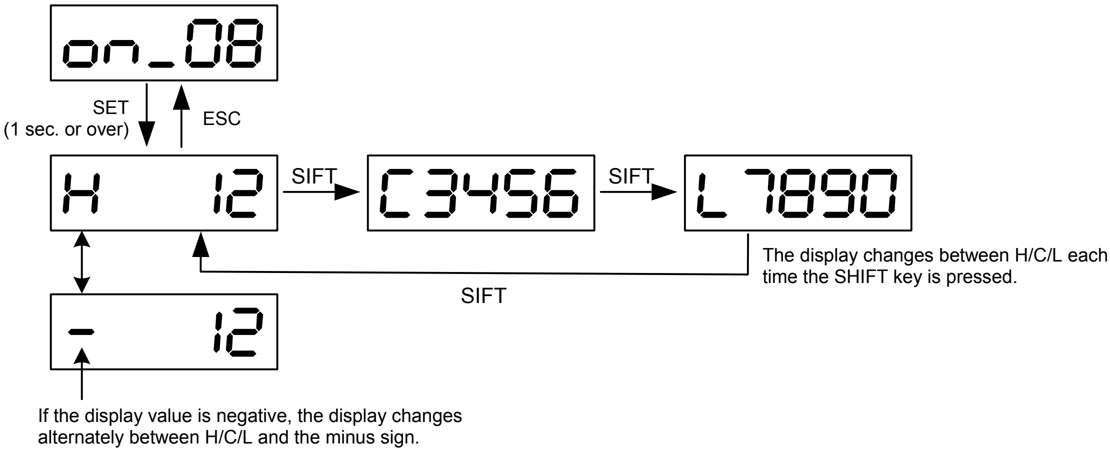
(6) Effective torque (Number of display digits: 3 digits with no symbol)
The load ratio of the servomotor; displayed in percent [%] to the rated torque.
The range from 0 [%] to the maximum torque is displayed in increments of 1 [%].



(7) Feedback position (displayed digits: signed 10 digits)
The rotation amount of the servomotor is displayed in the unit amount after correction with an electronic gear. If the electronic gear is unused, the data indicates the exact rotation amount of the motor shaft encoder (16777216 pulses/revolution for the 24-bit serial encoder).

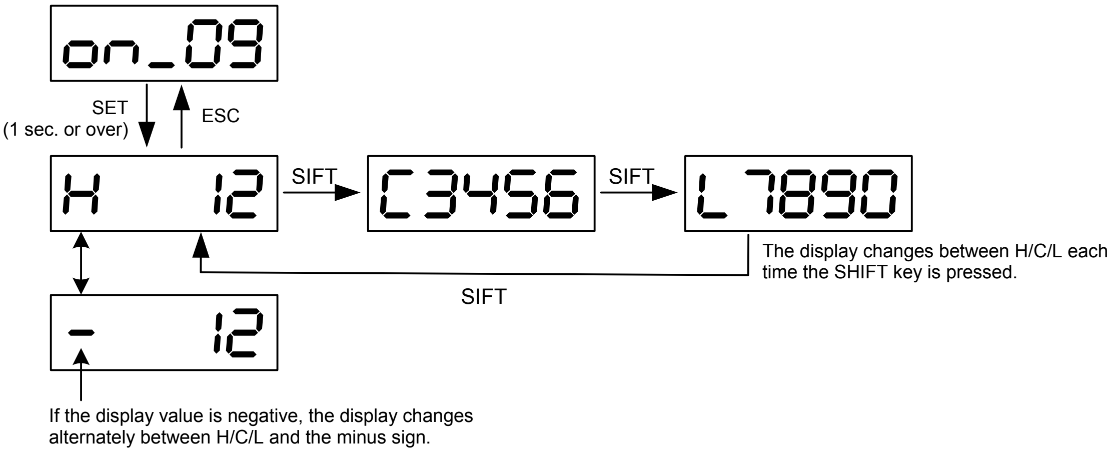


(8) Command position (displayed digits: signed 10 digits)
The position of the servomotor controlled by the servo amplifier is displayed in the unit amount after correction with an electronic gear. If the operation command is turned off and the load (mechanical system) rotates the motor after the target position is reached, the position is not correct. For indication, refer to "(7) Feedback position."



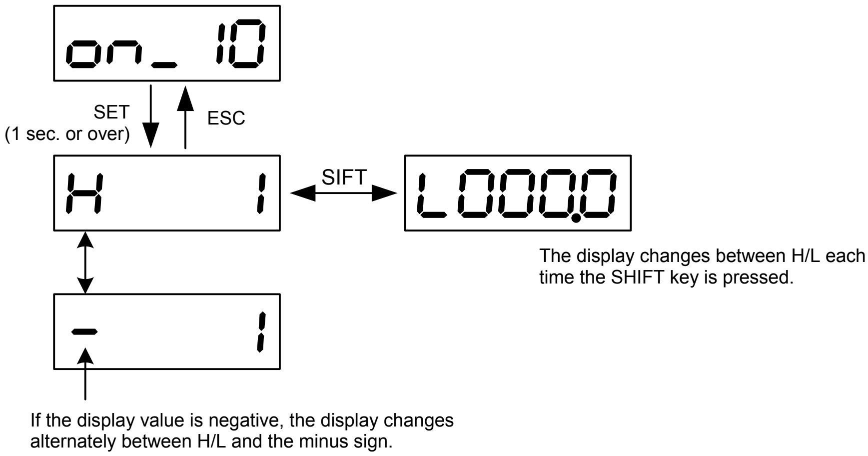
6

(9) Position deviation (displayed digits: signed 10 digits)
The difference between the command position and feedback position is displayed. The unit for the deviation amount is based on the deviation unit selection in PA1_31.



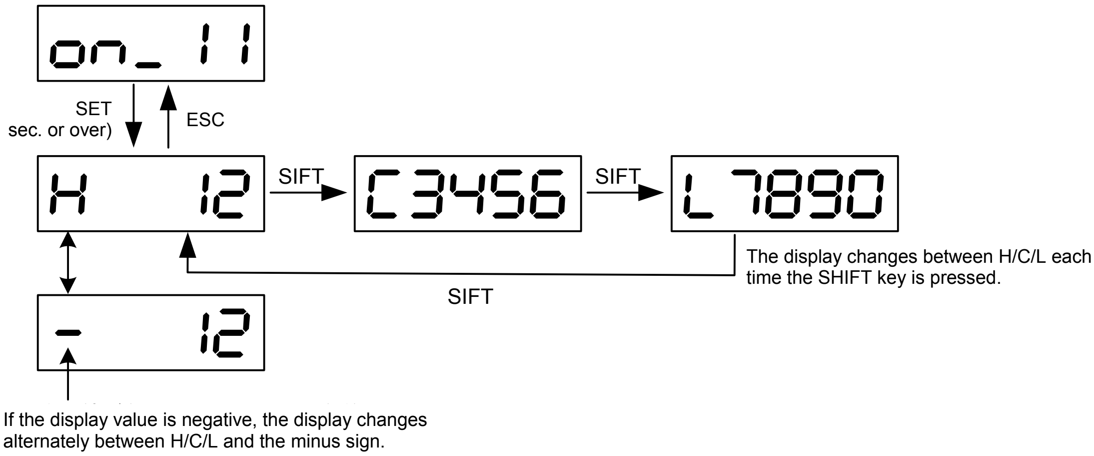
(10) Command pulse frequency (displayed digits: signed five digits)

The pulse frequency supplied to the pulse input terminal is displayed. The value is displayed in 0.1 [kHz].



(11) Feedback cumulative pulse (displayed digits: signed 10 digits)

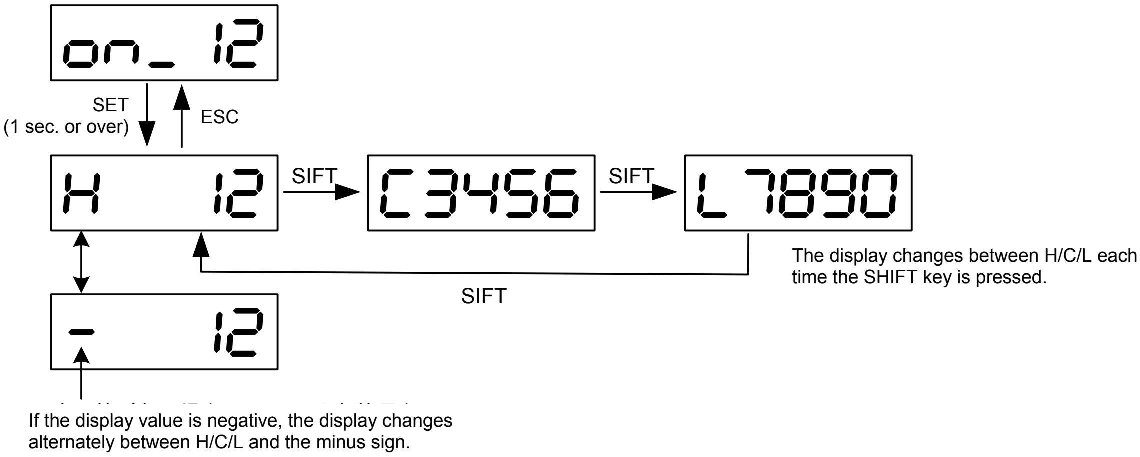
The cumulative pulses of servomotor rotation amount are displayed in encoder pulses (16777216 pulses/rotation if using a 24-bit encoder). Reverse rotation decreases the cumulative value. Even if the load (mechanical system) rotates the motor, the correct value is displayed.



Hint	Press and hold the [∧] and [∨] keys simultaneously for at least one second to reset the feedback cumulative pulses.

(12) Command cumulative pulse (displayed digits: signed 10 digits)

The number of pulses supplied to the pulse input terminal is displayed. The cumulative value increases upon forward direction pulses, while it decreases upon reverse direction pulses. With two signals at A/B phase pulse, each edge is counted (multiple of four). The count increases upon B-phase advance.

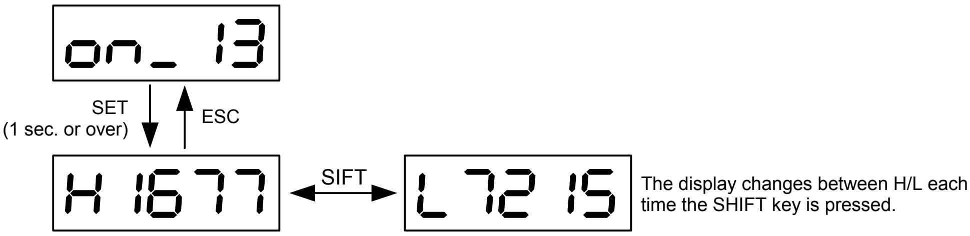


Hint	Press and hold the [∧] and [∨] keys simultaneously for at least one second to reset the command cumulative pulses.

(13) LS-Z pulse (displayed digits: unsigned eight digits)

The number of pulses in a homing counted since the home position LS signal is turned off until the Z-phase of the encoder of the servomotor is detected is displayed. The indication is updated every time homing is performed. Because the value is in the homing direction, no negative sign is attached.

- Displayed only if the Z-phase is enabled.

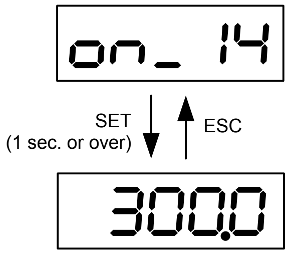


(14) Load inertia ratio (displayed digits: unsigned four digits)

The load inertia ratio recognized by the servo amplifier without relations to parameter PA1_13 (tuning mode selection) is displayed. The value is displayed in a multiple (in 0.1 increments) to the inertia of the servomotor itself.

The displaying range is from 0.0 to 300.0 times.

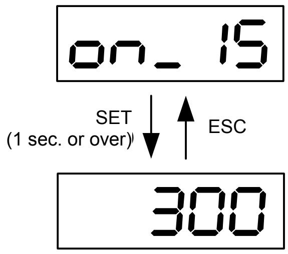
$$\text{(Load inertia ratio)} = \frac{\text{(Load inertia recognized by servo amplifier)}}{\text{(Inertia of servomotor itself)}}$$



(15) DC link voltage (max.) (displayed digits: unsigned three digits)

The DC link voltage (max.) of the servo amplifier at every two seconds is displayed.

The displaying range is from 0 [V] to 500 [V].

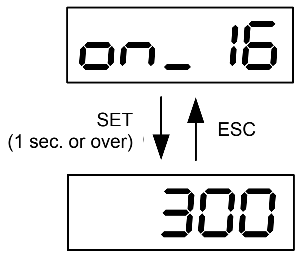


Hint	If the DC link voltage (max.) exceeds 390 [V] during operation, an external regenerative resistor is necessary. "HV" (overvoltage) is detected at 420 [V].

(16) DC link voltage (min.) (displayed digits: unsigned three digits)

The DC link voltage (min.) of the servo amplifier at every two seconds is displayed.

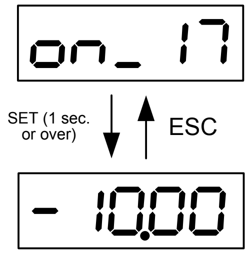
The displaying range is from 0 [V] to 500 [V].



Hint	"LV" (under-voltage) is detected at 200 [V].

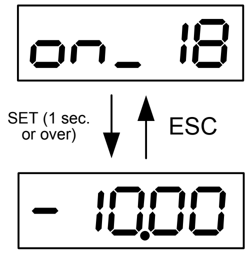
(17) VREF input voltage (displayed digits: signed four digits)

The input voltage of the analog input terminal [VREF] is displayed in 0.01 [V]. The negative sign indicates a negative voltage.



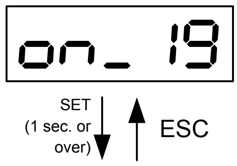
(18) TREF input voltage (displayed digits: signed four digits)

The input voltage of the analog input terminal [TREF] is displayed in 0.01 [V]. The negative sign indicates a negative voltage.

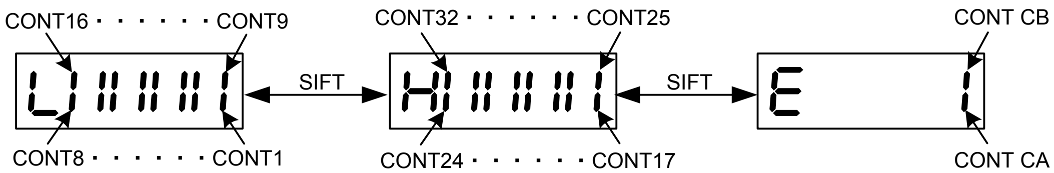


(19) Input signals

The ON/OFF status of sequence input signals supplied to the servo amplifier is displayed.
The corresponding LED lights up when the input signal is turned on.



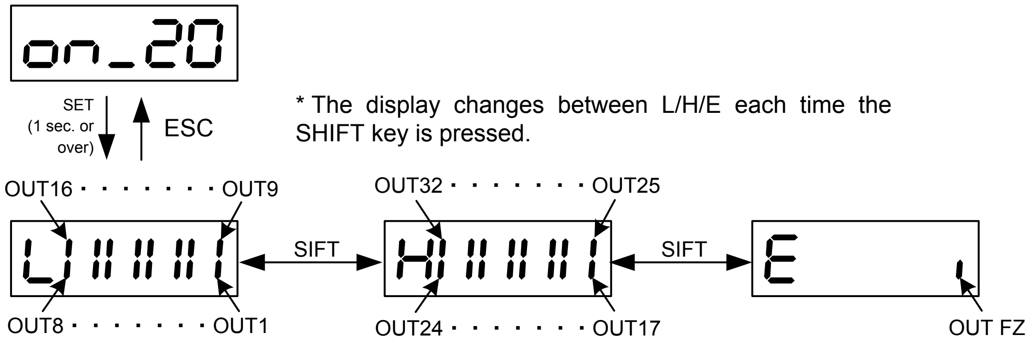
* The display changes between L/H/E each time the SHIFT key is pressed.



Hint	The number of sequence input signals varies according to the type of the servo amplifier. * CONT CA/CB are displayed only when input signal function is assigned to the pulse input terminal with PA3_48 or PA3_49.

(20) Output signals

The ON/OFF status of sequence output signals issued by the servo amplifier is displayed.
The corresponding LED lights up when the output signal is turned on.

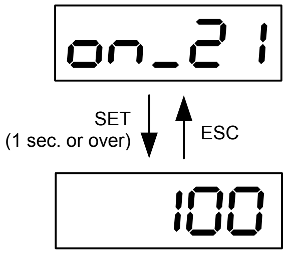


* The display changes between L/H/E each time the SHIFT key is pressed.

Hint	
Hint	The number of sequence output signals varies according to the type of the servo amplifier. * OUT FZ is displayed only when output signal function is assigned to the pulse output terminal with PA3_98.

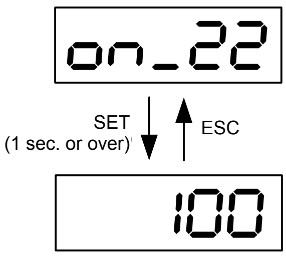
(21) OL thermal value (displayed digits: unsigned three digits)

The load ratio to the load alarm level is displayed in percent. An overload alarm is caused if this value reaches 100. The minimum increment is 1 [%]. The displaying range is from 0 [%] to 100 [%].

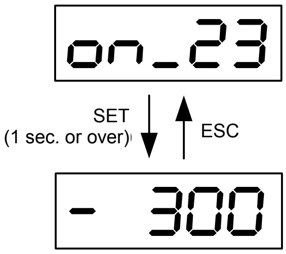


(22) Regenerative resistor thermal value (displayed digits: unsigned three digits)

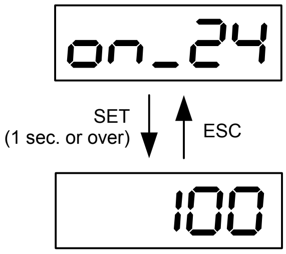
The regeneration load ratio to the regenerative resistor overheat alarm level is displayed in percent. A regenerative resistor overheat alarm is caused if this value is 100. The regeneration load ratio is calculated for 0.4 [kW] or larger motor capacities if PA2_65 (regenerative resistor selection) is set at 1 (internal resistor).
The minimum increment is 1 [%]. The displaying range is from 0 [%] to 100 [%].



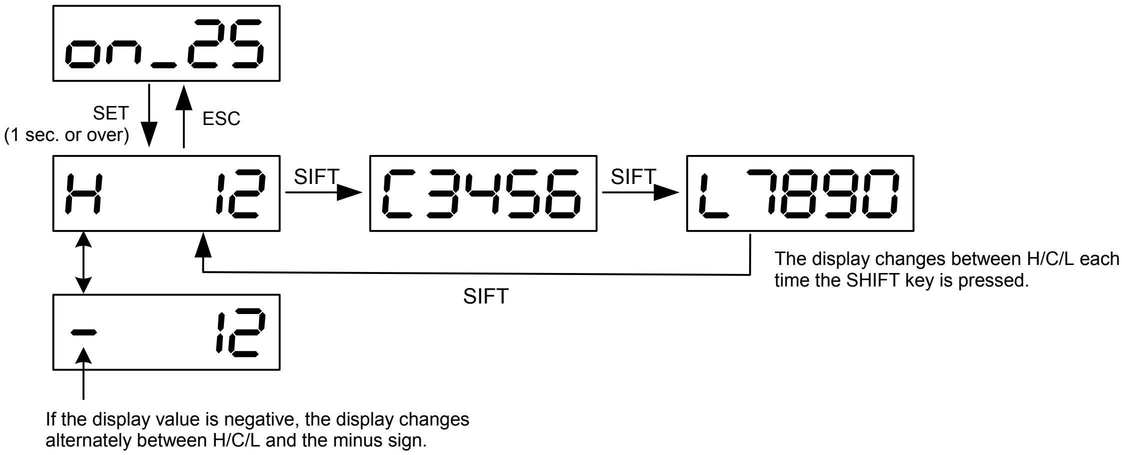
(23) Power (w) (displayed digits: signed three digits)
The servomotor power (w) is displayed in percent [%] to the rating.
The data is displayed in the range from 0 [%] to 900 [%] in increments of 1 [%].



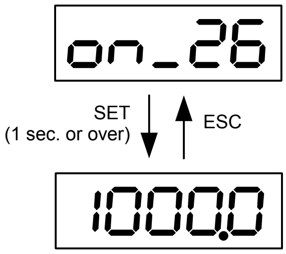
(24) Motor temperature (displayed digits: unsigned three digits)
The servomotor temperature is displayed. The range from 0 [°C] to 120 [°C] is displayed in increments of 1 [°C].



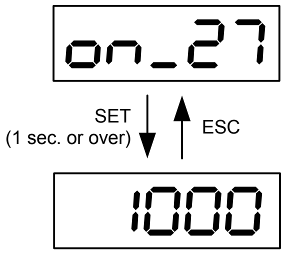
(25) Overshoot unit amount (displayed digits: signed 10 digits)
The overshoot unit amount under position control is displayed. The unit for the overshoot amount is based on the deviation unit selection in PA1_31.



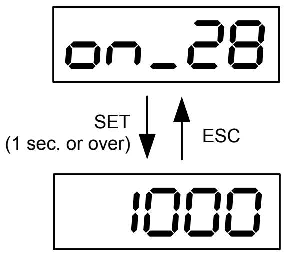
(26) Settling time (displayed digits: unsigned five digits)
The settling time under position control is displayed.
The displaying range is from 0 [ms] to 1000.0 [ms]. If the settling time exceeds 1000.0 [ms], 1000.0 [ms] is displayed.



(27) Resonance frequency 1 (displayed digits: unsigned four digits)
The resonance frequency recognized by the servo amplifier is displayed.
The displaying range is from 100 [Hz] to 2000 [Hz]. If no resonance is detected, "4000 [Hz]" is displayed.



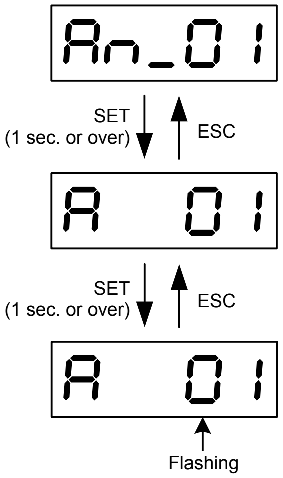
(28) Resonance frequency 2 (displayed digits: unsigned four digits)
The resonance frequency recognized by the servo amplifier is displayed.
The displaying range is from 100 [Hz] to 2000 [Hz]. If no resonance is detected, "4000 [Hz]" is displayed.

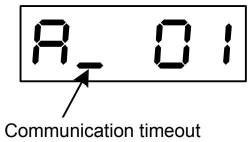


6.5 Station No Mode

In the station no mode, the station no of the servo amplifier is displayed and a new station no can be entered.
Press the [MODE/ESC] key until [An_01] is displayed, and press and hold the [SET/SHIFT] key for at least one second to display data.
By pressing and holding down the [SET/SHIFT] key for one second or longer while the station No. is displayed, the station No. (parameter PA2_72) can be edited.
Refer to "6.7　Parameter Edit Mode" for details on the editing method.

An_01 : Station no





Editing screen
- The station No. (PA2_72) can be changed.
- See "■ Display and editing" in "6.7　Parameter Edit Mode".

* Changes to station No. are valid after turning the power off and on again.

6

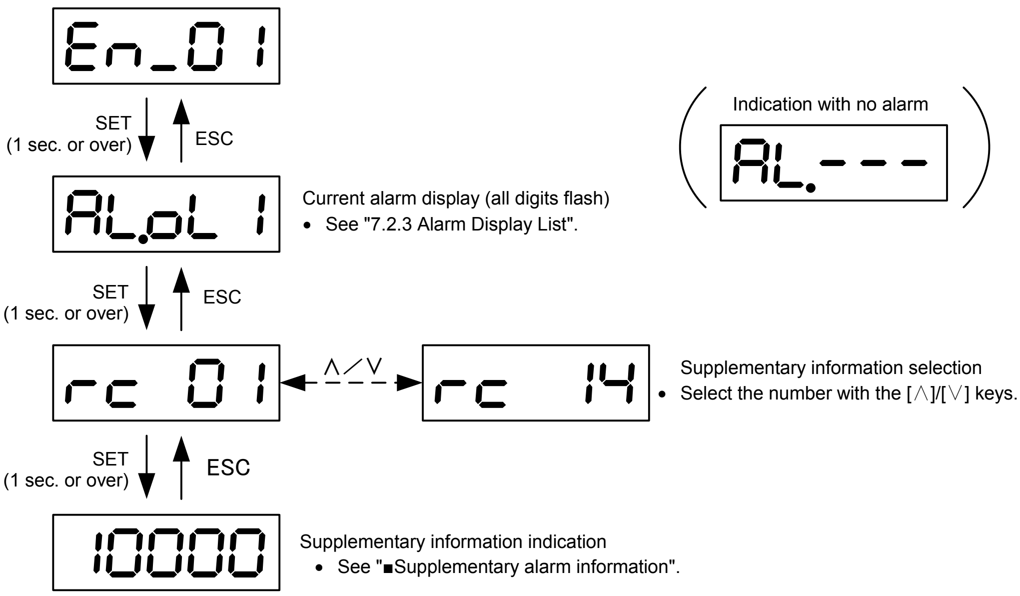
6.6 Maintenance Mode

In the maintenance mode, detected alarms, total time - main power supply and so on are displayed. Press the [MODE/ESC] key until [En_On] is displayed and press and hold the [SET/SHIFT] key for at least one second to display data.

En_01	: Alarm at present	En_04	: Total time - main power supply
En_02	: Alarm history	En_05	: Total time - control power supply
En_03	: Warning at present	En_06	: Motor running time

(1) Alarm at present

The alarm detected currently is displayed in a code.
The current alarm is automatically displayed when an alarm is detected.
By resetting the alarm, the display indicates "AL.---".
By pressing and holding down the [SET/SHIFT] key for one second or longer while the current alarm is displayed, supplementary alarm information can be checked.



Hint

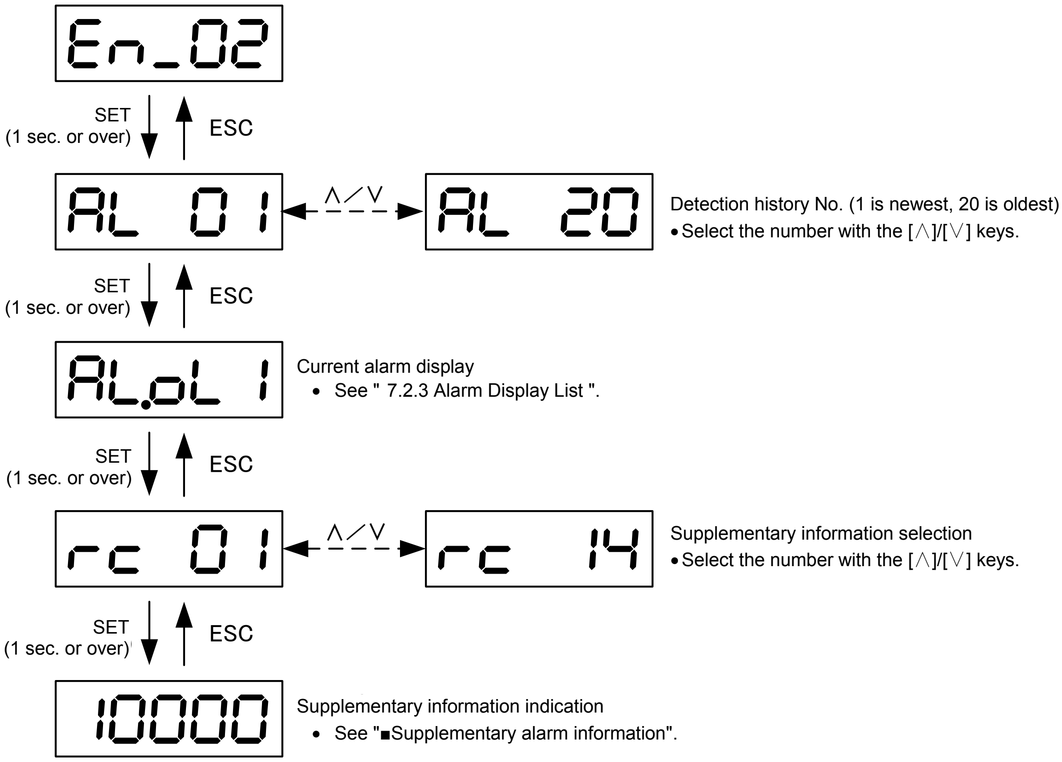
- The alarm is automatically displayed upon detection.
- If an alarm is detected, indication blinks quickly (at 0.5-second intervals) when compared with regular blinks (at 1-second intervals).
- The alarm can be reset even in the test operation mode.
- When an alarm is displayed, press and hold the [∧] and [∨] keys simultaneously for at least one second to reset the alarm.
- After an alarm reset, indication changes to AL.--- .
  Next, initial display is automatically restored.

■ Supplementary alarm information

Supplementary information No.	Name	Display example	Display content
rc_01	Total time - main power supply	10000	See item En_04.
rc_02	Total time - control power supply	10000	See item En_05.
rc_03	Motor running time	.05.30	See item En_06.
rc_04	Feedback speed	-6000	See item on_01.
rc_05	Feedback speed, 5 [ms] before	-6000	See item on_01.
rc_06	Command speed	-6000	See item on_02.
rc_07	Command torque	- 300	See item on_03.
rc_08	Motor current	- 300	See item on_04.
rc_09	Effective torque	300	See item on_06.
rc_10	DC link voltage	300	DC link voltage [V]
rc_11	EC error count	10	Encoder communication error count
rc_12	Command current position	H 12	See item on_08.
rc_13	Operation mode	PPi n	See item Sn_01. * There is no status display.
rc_14	Sub-code	0001	Sub-code*1

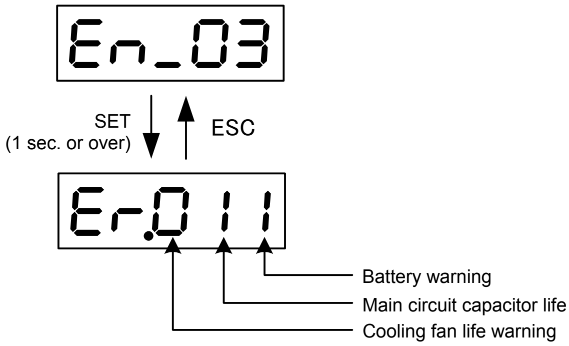
*1: This is displayed only if a safety function fault alarm occurs.
Refer to the “ALPHA7 Series Function Safety Module User's Manual” for details on sub-codes.

(2) Alarm history
Up to 20 past alarms can be displayed.
Press the [∧] or [∨] key to scroll in the history.

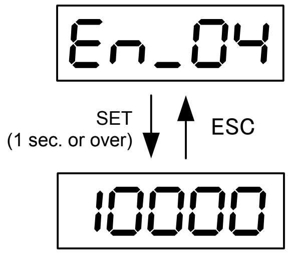


Hint	The history can be cleared in the test operation mode [Fn_06].

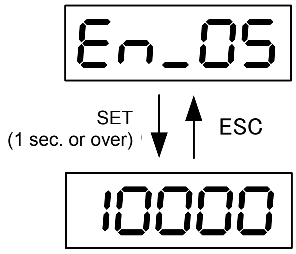
(3) Warning at present
Warnings in the ABS battery, main circuit capacitors and cooling fan are displayed.
"0" indicates no warning, and "1" indicates a warning.



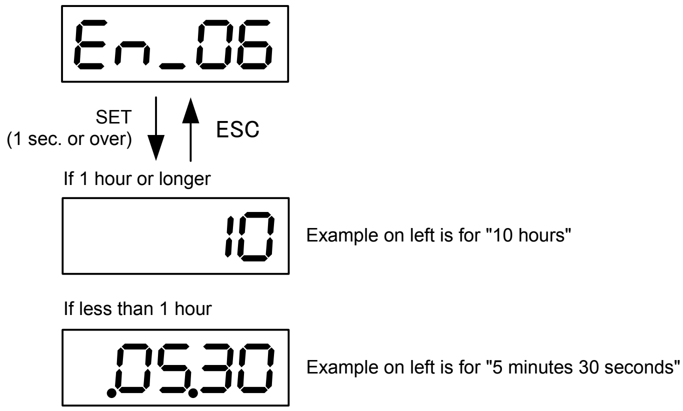
(4) Total time - main power supply
The cumulative time of turning the main power (L1, L2 and L3) on is displayed.
The displaying range is from 0 [h] to 99999 [h].
(The display range of supplementary alarm information is from 0[h] to 65535[h].)



(5) Total time - control power supply
The cumulative time of turning the control power (L1C and L2C) on is displayed.
The displaying range is from 0 [h] to 99999 [h].
(The display range of supplementary alarm information is from 0[h] to 65535[h].)



(6) Motor running time
The time of turning the servomotor on is displayed.
The displaying range is from 0 [h] to 32767 [h].
The time is cleared to 0[h] at the time when the power of servo motor is turned off.



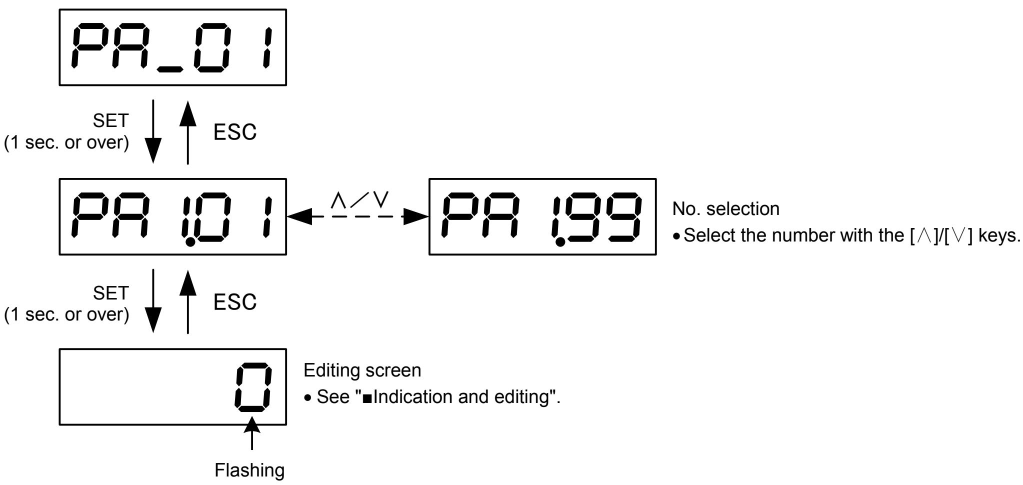
6.7 Parameter Edit Mode

Parameters can be edited in the parameter edit mode.
Press the [MODE/ESC] key until [PA_On] is displayed and press and hold the [SET/SHIFT] key for at least one second to select parameter editing.
After selecting parameter editing, press the [∧] or [∨] key to select the number of the desired parameter to be edited.

Press and hold the [SET/SHIFT] key for at least one second to edit the data.
PA_01: Parameter page 1
PA_02: Parameter page 2
PA_03: Parameter page 3
PA_04: Parameter page 4

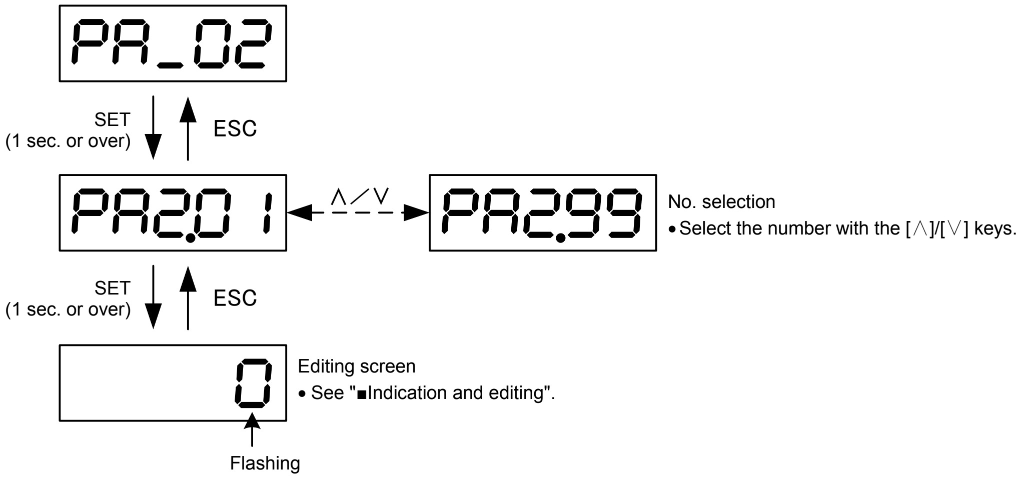
There are parameters that are reflected in operation when settings are changed, and parameters that are enabled following changes after turning the power off then on again.
If parameters that are enabled after turning the power off then on again are changed, all digits on the 7-segment LED flash twice every 2 seconds to notify the operator.

(1) Parameter page 1
On parameter page 1, relatively frequently used parameters are registered. Changes in most parameters are reflected on the servo amplifier and servomotor operation immediately.



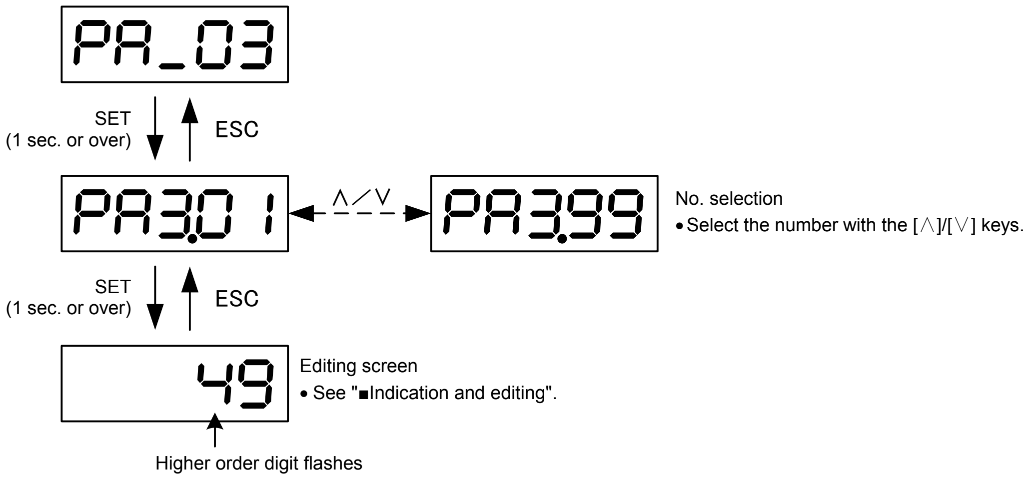
(2) Parameter page 2

On parameter page 2, parameters related to system setting such as the homing functions are registered. Changes in parameters become enabled after the power is turned off then on again.



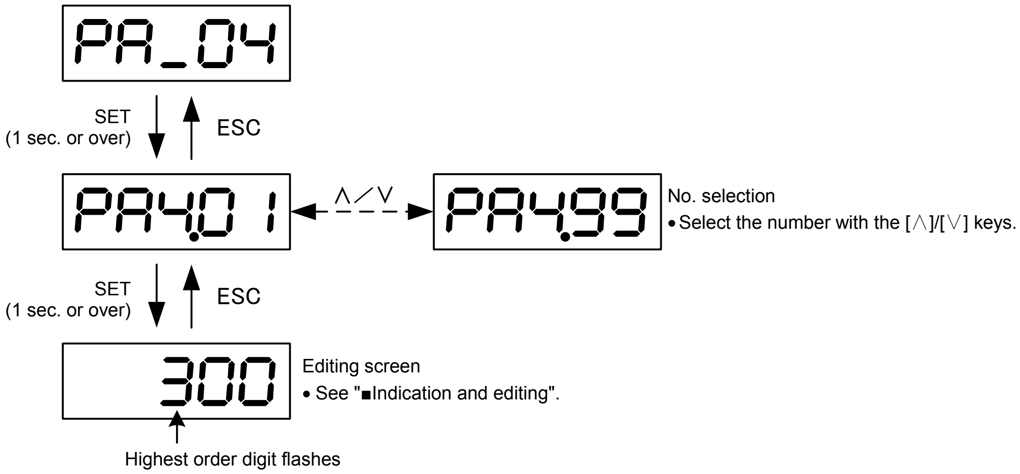
(3) Parameter page 3

On parameter page 3, parameters related to system setting such as sequence I/O terminals are registered. Changes in parameters become enabled after the power is turned off then on again.



(4) Parameter page 4

Content relating to new functions introduced from the ALPHA7 Series are registered on parameter page 4.



■ Display and editing

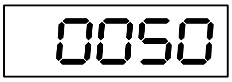
The parameter setting display and editing methods are as follows.

Displaying values

<Parameters with no symbol and 5 or fewer digits>

Values are displayed on a single screen.

If 4 digits with no symbol



In order to clarify the number of digits, 0 is displayed even for high order digits with no value. The example on the left illustrates that the value that can be set has 4 digits.

<Parameters with symbol and 4 or fewer digits>

A symbol setting digit and values are displayed on a single screen.

If 4 digits with symbol

↑ Symbol setting digit
(if positive)

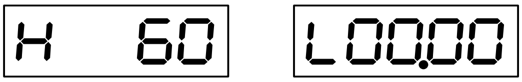
The example on the left indicates "+7.0".

↑ Symbol setting digit
(if negative)

The example on the left indicates "-7.0".

<Parameters with no symbol and 6 digits or more/with symbol and 5 digits or more>
Parameters with 6 digits or more including symbol setting digit and value digits are displayed on multiple screens.
Characters H/C/L used to identify high order/middle order/low order digits, and 4 value digits are displayed on one screen.

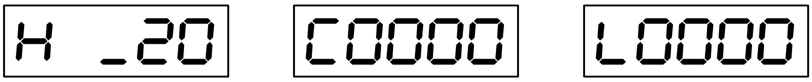
If 6 digits with no symbol



The example on the left indicates "6000.00".

↑ Identifying character (high order)
↑ Identifying character (low order)

If 10 digits with symbol



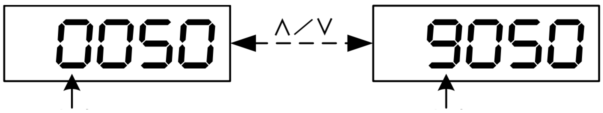
The example on the left indicates "+2000000000".

↑ Identifying character (high order)
↑ Identifying character (middle order)
↑ Identifying character (low order)

Editing values

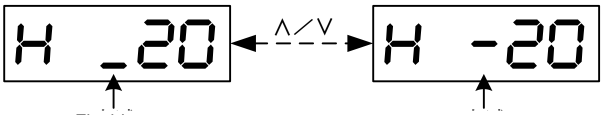
The screen with highest order digit appears first on the parameter editing screen, and the highest order digit flashes (1 second cycle).
The value (or symbol setting) for the flashing digit can be changed with the ∧/∨ keys.

If 4 digits with no symbol



Flashing
Flashing

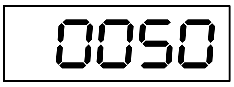
If 10 digits with no symbol



Flashing
Flashing

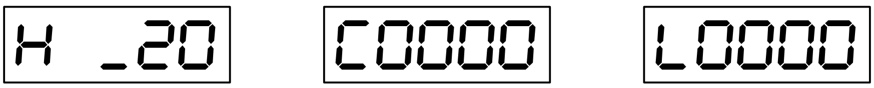
The digit (flashing digit) being edited moves to the right each time the [SHIFT] key is pressed.
As shown below, the digit being edited moves from the highest order digit (1) → (2) → (3) → ..., and then returns to (1) when the lowest order digit is reached.

If 4 digits with no symbol



(1) (2) (3) (4) → Returns to (1)

If 10 digits with no symbol



(1) (2) (3)
(4) (5) (6) (7)
(8) (9) (10) (11) → Returns to (1)

Setting values

Press and hold the [SET/SHIFT] key for 1 second or longer to write the edited value to the parameters.
When the value has been written successfully, all digits flash six times to notify the operator (3 seconds in 0.5 second cycles).
Press the [MODE/ESC] key to return to the parameter No. selection screen.

Values outside the range

Edited values are not written if they lie outside the parameter range.
[Example] The parameter PA1_07 value can be edited from 0 to 99999999 (max. 8 digits), however, the value will not be written if it does not lie within the 1 to 67108864 setting range.

NG is displayed if unable to write the value.

nG3	The write data lies outside the range.
nG4	Writing is prohibited.

■ Edit operation example

The parameter PA1_7 electronic gear denominator is changed to 100000.

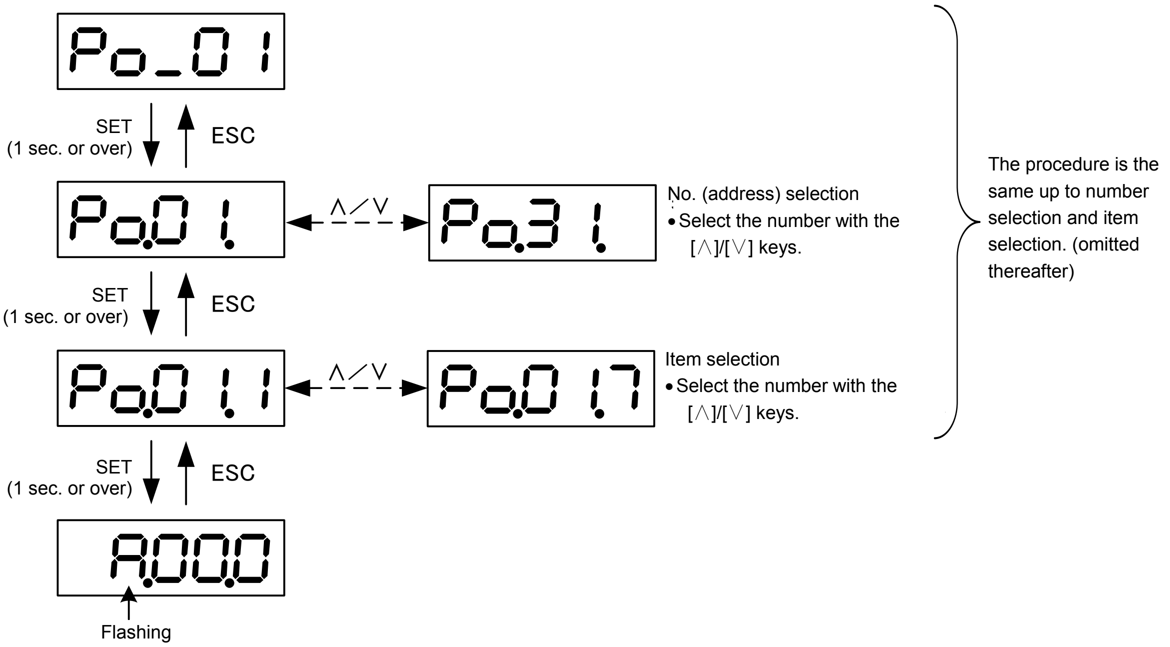
Key operation	Display	Description
	=PSoF	This is a sequence mode display example.
[MODE]	Sn_01	Returns to mode selection.
[MODE]	PA_01	Selects parameter edit mode.
[SET] (1 sec. or longer)	PA1.01	Displays the parameter No.
[∧]	PA1.07	Selects parameter PA1_7.
[SET] (1 sec. or longer)	H0000 (Flashing)	The PA1_7 setting content is displayed. The H (high order) side screen is displayed, and the highest order digit flashes.
[SET]	H0000 (Flashing)	Shifts to the digit to be edited.
[∧]	H0001 (Flashing)	Increases the value to 1.
[SET]	L0001 (Flashing)	Jumps to the L (low order) side screen.
[SET]	L0001 (Flashing)	Shifts to the digit to be edited.
[∨]	L0000 (Flashing)	Changes the value to 0.
[SET] (1 sec. or longer)	L0000	Sets the changed value.
	L0000	The display remains unchanged when set.

6.8 Positioning Data Edit Mode

Positioning data can be edited in positioning data edit mode.
Each piece of positioning data contains the following seven items.

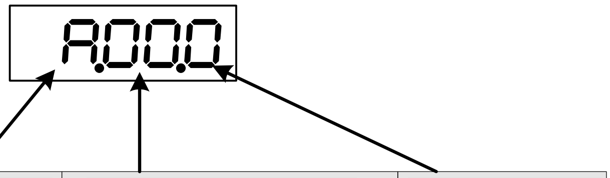
Po.01.1: Positioning status
Po.01.2: Target position
Po.01.3: Rotation speed
Po.01.4: Stand still timer
Po.01.5: M code
Po.nn.6: Acceleration time
Po.nn.7: Deceleration time
(nn is the positioning data No. (address).)

(1) Positioning status
Set data relevant to the positioning data.



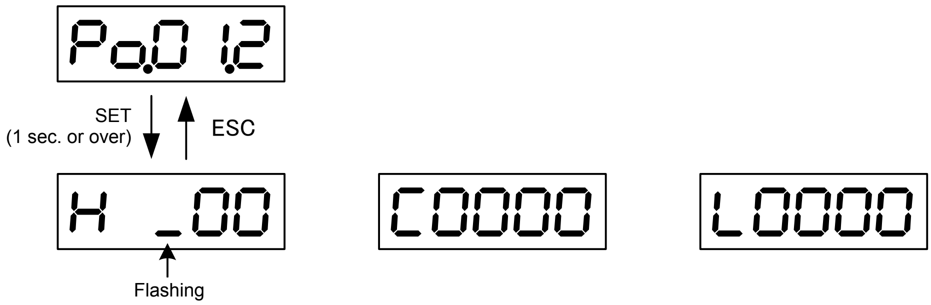
Editing screen
- Refer to "■ Display and editing" in "6.7 Parameter Edit Mode".

• Positioning status contains the following setting items.



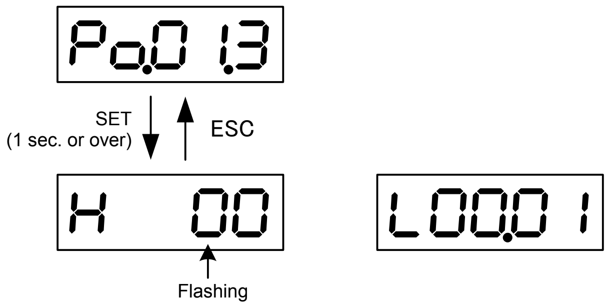
Command method		Step mode			M code setting	
A	ABS	0	0	Not specified	0	Disabled
i	INC	c	o	Continuous	1	Output at startup
		c	E	Cycle end	2	Output at completion

(2) Target position
Set the target position of the motor. The setting value range is from -2,000,000,000 to 2,000,000,000 in increments of 1.
Set the target position of the servomotor for ABS command method, and set the incremental value for INC.



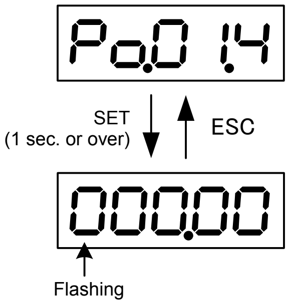
Editing screen
• Refer to "■ Display and editing" in "6.7 Parameter Edit Mode".

(3) Rotation speed
Set the travel speed to the motor target position. Use the motor shaft rotation speed for the setting value. The setting value range is from 0.01 to 6000 [r/min] in increments of 0.01.
Note that the setting speed is not the machine travel speed.



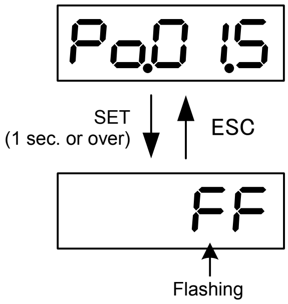
Editing screen
• Refer to "■ Display and editing" in "6.7 Parameter Edit Mode".

(4) Stand still timer
Set the stop time after the motor has reached the target position. The setting value range is from 0.00 to 655.35 [s] in increments of 0.01.
After the stop time has elapsed, the sequence output signal (in-position signal [INP]) turns on.
The decimal point position can be changed in the parameter PA2-42 (timer data decimal point position).



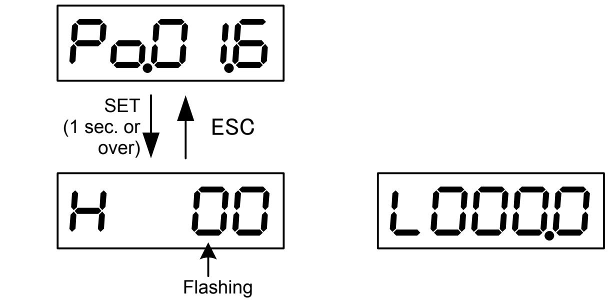
Editing screen
• Refer to "■ Display and editing" in "6.7 Parameter Edit Mode".

(5) M code
The M code output by executing positioning data can be edited. The setting range is from 00 to FF in hexadecimal. The minimum increment is 1.
The default value is [FF].



Editing screen
• Refer to "■ Display and editing" in "6.7 Parameter Edit Mode".

(6) Acceleration time
Sets the motor acceleration time. The setting value can be specified in the 0.0 [ms] to 99999.9 [ms] range in 0.1 [ms] increments.
The setting value is the time taken for the motor rotation speed to go from 0 to 2000 [r/min].

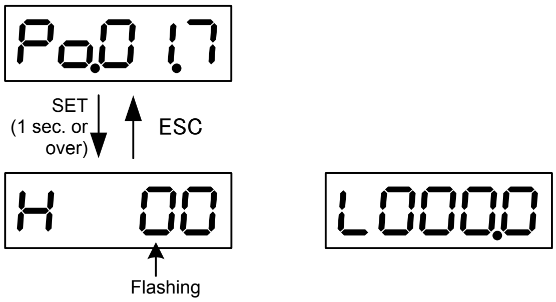


Editing screen
• Refer to "■ Display and editing" in "6.7 Parameter Edit Mode".

(7) Deceleration time

Sets the motor deceleration time. The setting value can be specified in the 0.0 [ms] to 99999.9 [ms] range in 0.1 [ms] increments.

The setting value is the time taken for the motor rotation speed to go from 2000 to 0 [r/min].



Editing screen

- Refer to "■ Display and editing" in "6.7 Parameter Edit Mode".

6.9 Test Operation Mode

In the test operation mode, you can operate keypad keys to rotate the servo amplifier or reset various data. Press the [MODE/SET] key until [Fn_0n] is displayed, and press and hold the [SET/SHIFT] key for at least one second to execute test operation.

Fn_01	: Manual operation	Fn_09	: Auto offset adjustment
Fn_02	: Position preset	Fn_10	: Z-phase position adjustment
Fn_03	: Homing	Fn_11	: Auto tuning gain
Fn_04	: Automatic operation	Fn_12	: Easy tuning
Fn_05	: Alarm reset	Fn_13	: Profile operation
Fn_06	: Alarm history initialization	Fn_14	: Sequence mode
Fn_07	: Parameter initialization	Fn_15	: Teaching
Fn_08	: Positioning data initialization		

■ NG display (common)

NG is displayed if unable to perform test operation.
Press the [ESC] key to return to the test operation name display.

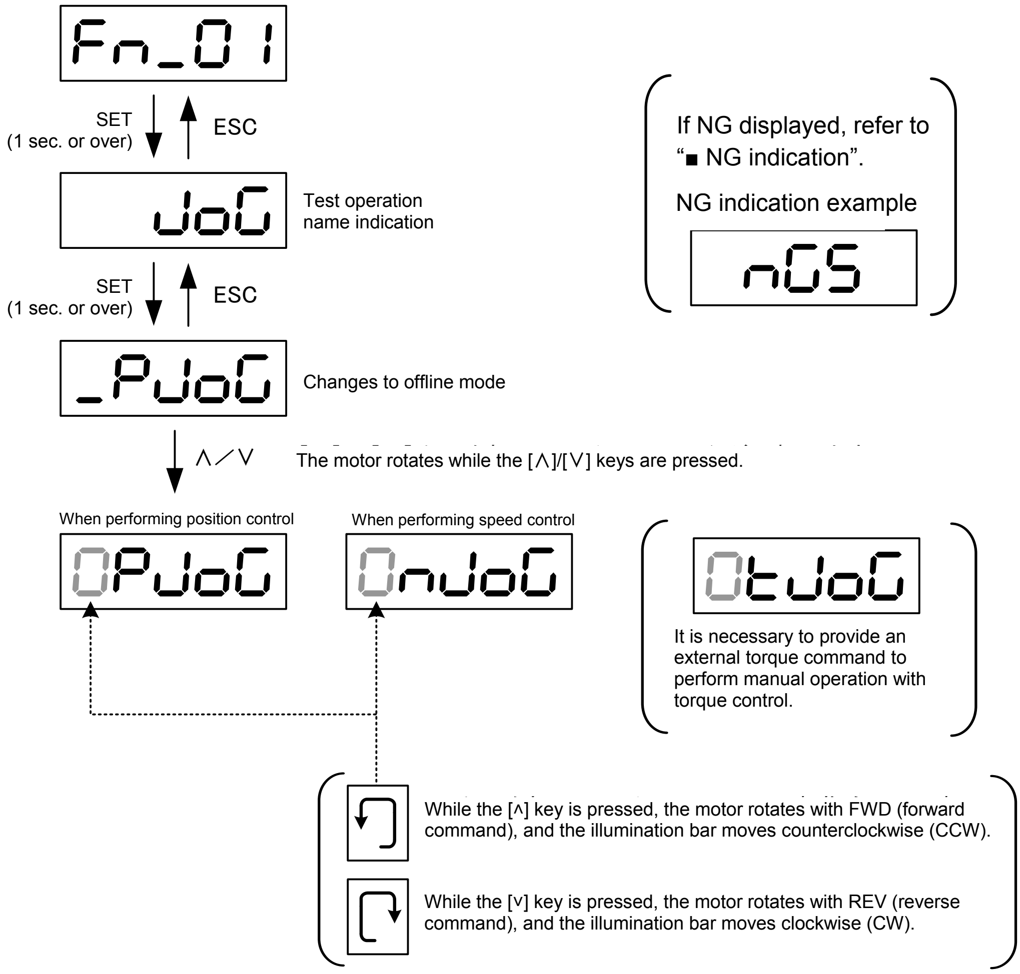
NG No.	NG details
nG1	Unable to perform test operation. • Fn_02: Position preset is not possible while the motor is rotating. → Perform position preset after stopping the motor. • Fn_03: Homing is not possible in other than position control mode. → Perform homing in position control mode. • Fn_05: It was not possible to reset by resetting the alarm. → Refer to the “Troubleshooting Method” section in “CHAPTER 7 MAINTENANCE AND INSPECTION”. • Fn_06, Fn_07, Fn_08: Initialization is not possible with the servo ON. → Perform initialization after turning the servo OFF. • Fn_10: Z-phase offset adjustment is not possible with the encoder not connected. → Perform Z-phase offset adjustment after connecting the encoder (with no encoder related alarm occurring). • Fn_11: Auto tuning gain cannot be applied when the tuningless function is enabled. → Tuningless function is disabled. • Fn_12: Easy tuning cannot be performed when the parameter setting, etc. does not match the startup conditions. → Refer to "Easy Tuning" in the "SERVO ADJUSTMENT" chapter. • Fn_14: Sequence test mode is not possible with the servo ON. → Change to sequence test mode after turning the servo OFF.
nG2	Test operation was aborted. • The motor is unable to rotate (due to alarm, forced stop, STO, ±OT detection, etc.) → Eliminate the cause and perform test operation again.

NG No.	NG details
nG3	The parameter, or the data being written to the positioning data lies outside the range. • Fn_09: As a result of auto offset adjustment, the PA3_32, 34 setting range has been exceeded. • The motor is resonating even with gain of 4 or less after performing Fn_12: Easy tuning. → Refer to "Easy Tuning" in the "SERVO ADJUSTMENT" chapter. • The position exceeds the position (±2000000000) that can be set in the positioning data when performing Fn_15: Teaching. → Perform teaching at a position within the setting range.
nG4	The rewriting of parameters or positioning data is prohibited. • PA2_74: Parameter write protection is set to "1: Write protect". • PA2_75: Positioning data write protection is set to "1: Write protect". • An edit permission signal is assigned to sequence input signal CONTn, and the signal is OFF (editing prohibited). → Write parameters and positioning data when writing is enabled.
nG5	It was not possible to change to offline. • The motor is already running (performing pulse train operation, manual feed, homing, automatic operation, etc.) → Change to offline after stopping operation (turns FWD, REV signals OFF, etc.) • Test operation is already being performed from PC Loader. → Change to offline after closing all PC Loader test operation screens.
nG6	It was not possible to turn the servo ON. • The motor is unable to rotate (due to alarm, forced stop, STO, etc.) → Eliminate the cause and turn the servo ON.

(1) Manual operation

The servomotor rotates while a keypad key is held down.

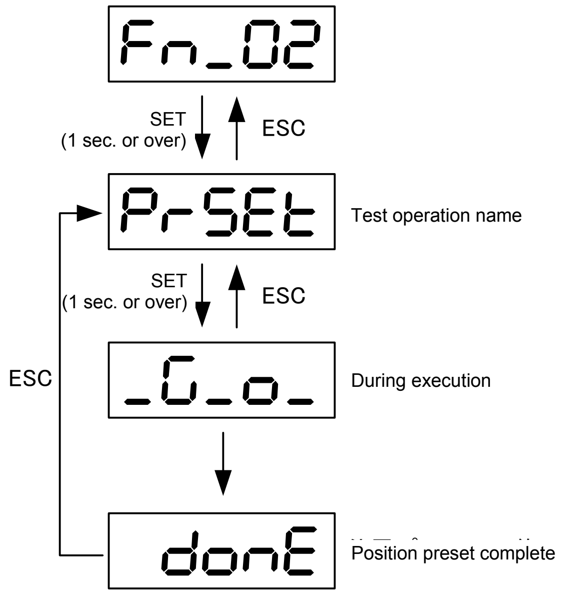
The rotation speed of the servomotor depends on the setting of parameter PA1_41.

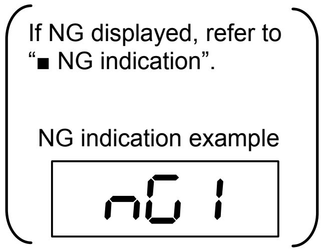

Fn_01
SET
(1 sec. or over)
ESC
JoG
Test operation
name indication
SET
(1 sec. or over)
ESC
_PJoG
Changes to offline mode
∧／∨
The motor rotates while the [∧]/[∨] keys are pressed.
When performing position control
0PJoG
When performing speed control
0nJoG
0tJoG
It is necessary to provide an external torque command to perform manual operation with torque control.
If NG displayed, refer to "■ NG indication".
NG indication example
nGS
While the [^] key is pressed, the motor rotates with FWD (forward command), and the illumination bar moves counterclockwise (CCW).
While the [v] key is pressed, the motor rotates with REV (reverse command), and the illumination bar moves clockwise (CW).

6

(2) Position preset

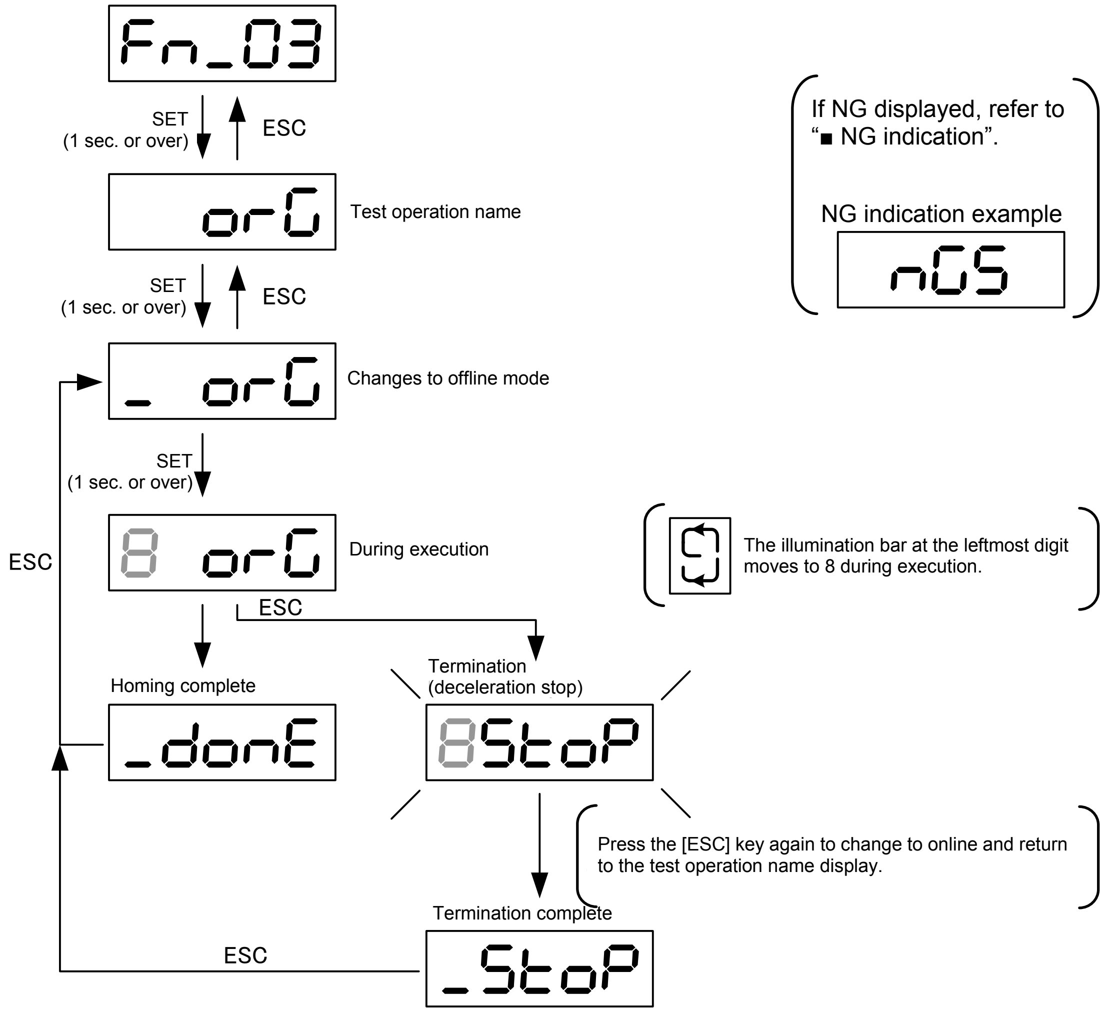
Reset the command current position and feedback current position to the parameter PA2_19 (preset position) setting value.





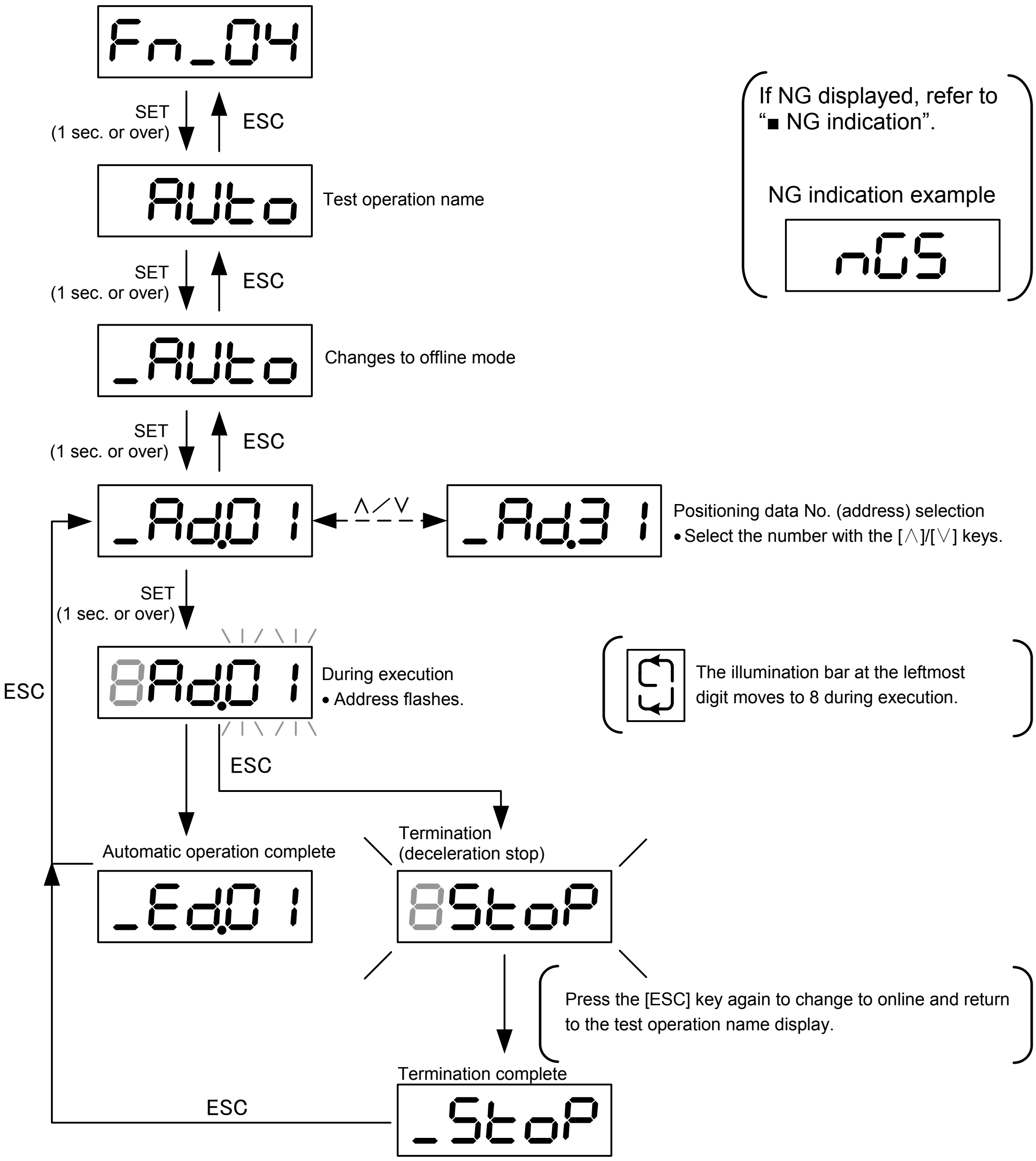
(3) Homing

Perform homing with keypad key operation. The homing operation is based on the settings in parameters PA2_6 to PA2_18, and PA2_22 to PA2_23.



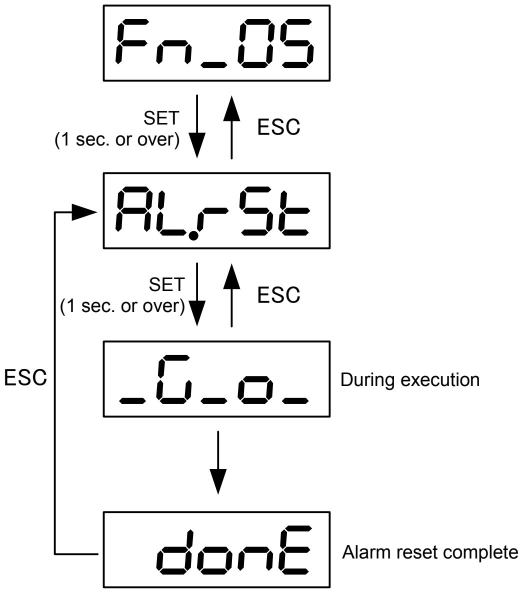
6

(4) Automatic operation
This signal is enabled only when parameter PA1_01 is set to "7" (positioning function).
Operate keypad keys to perform automatic operation.
Positioning is executed according to registered positioning data.



(5) Alarm reset

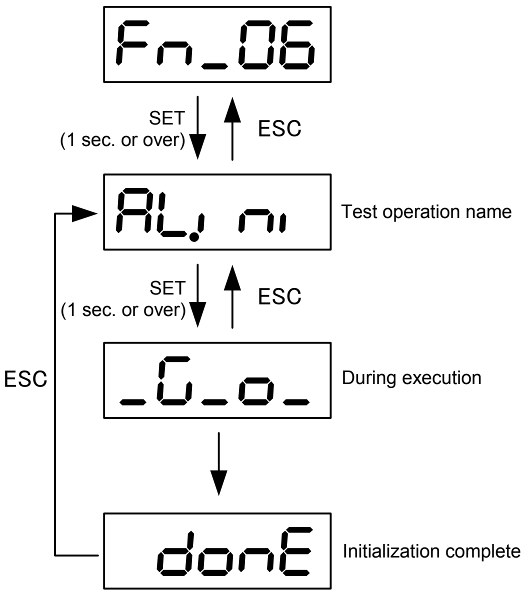
The alarm currently detected in the servo amplifier is reset.

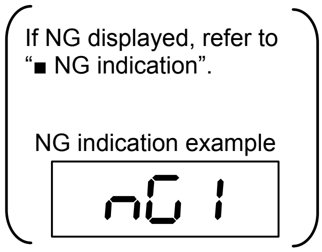


・The servo amplifier is not reset from some alarms through alarm resetting. Refer to "■ Alarm reset" in "7.2.3 Alarm Display List".

(6) Alarm history initialization

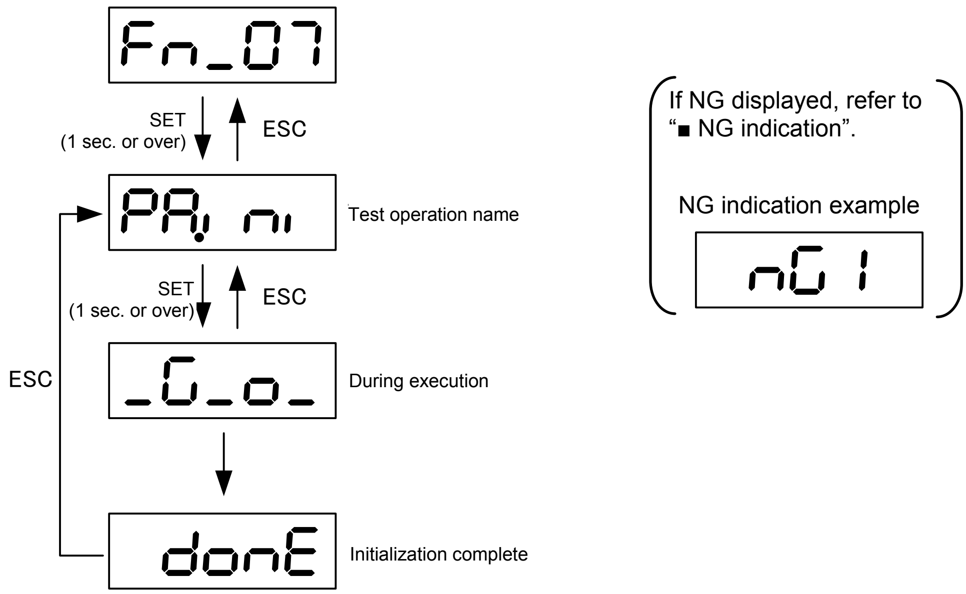
The history of detected alarms recorded in the servo amplifier is deleted. The alarm detection history (alarm history) can be monitored with [En_02] in the sequence mode.



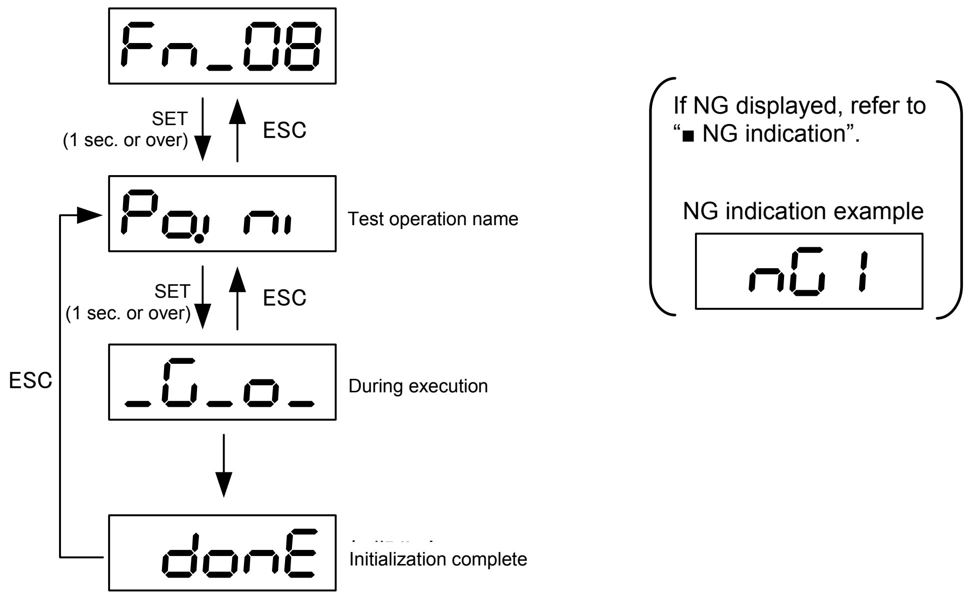


・The alarm history is retained even after the power is turned off.

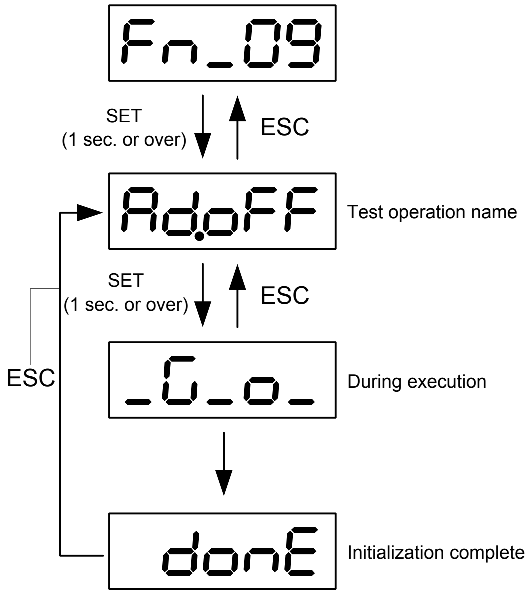
(7) Parameter initialization
Parameters are initialized.
After initializing parameters, be sure to turn the power off then on again.

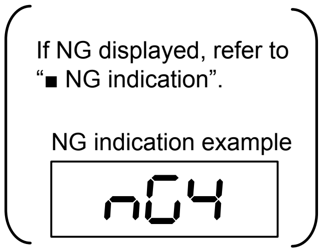


(8) Positioning data initialization
All positioning data is reset to initial values.
・After initializing, turn the power off then on again.



(9) Auto offset adjustment
The input voltage at the input terminals by analog command voltage [VREF]/[TREF] is set to 0[V].





In speed control mode, when multi-step speed selection X1 and X2 terminals are all turned off by the FWD (REV) signal, the output shaft of the servo motor rotates by following the analog speed command voltage.
The output shaft of the servomotor may rotate at a small speed even if the speed command voltage is 0 [V].
Use the "Zero clamp level (parameter PA3_35)" when necessary.

Follow the procedure below to adjust the offset voltage.

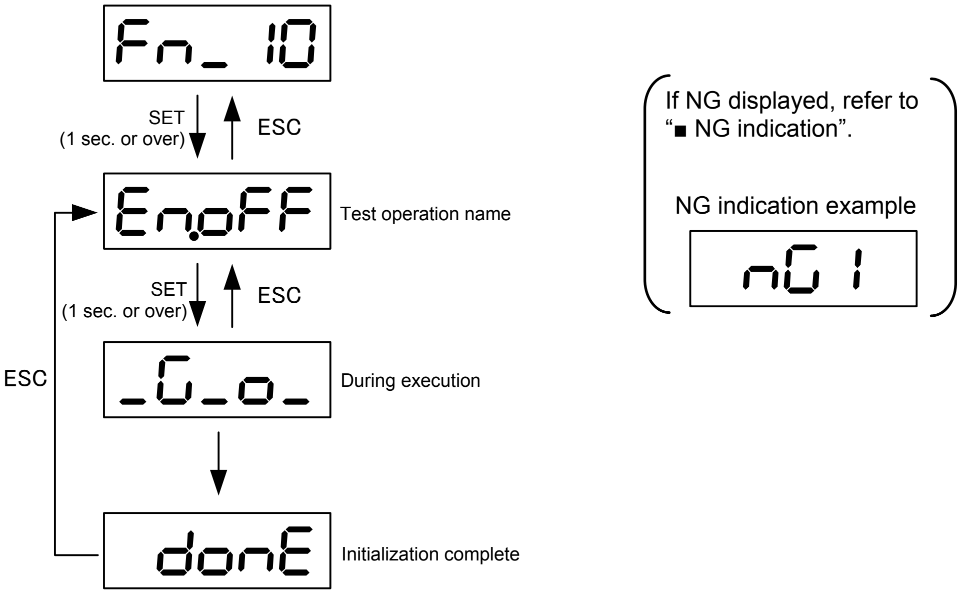
[1] Supply voltage 0 [V] to the [VREF] and [TREF] terminals. The operation command is not necessary.
[2] Select [Fn_009] at the keypad and press the [SET/SHIFT] key to automatically adjust the offset.
[3] Turn the operation command [S-ON] signal on and check that the output shaft of the servomotor does not rotate.

*1) Cause of NG indication
・Parameter PA2_75 (positioning data write protection) is set at 1 (write protected).

Hint	• The adjusted result is stored in parameters PA3_32 and PA3_34. • According to variation in the ambient environment of the servo amplifier, offset adjustment may become necessary. However, do not select if the host controller uses the command voltage and division output pulse (feedback) to control the servo amplifier.

(10) Z-phase position offset

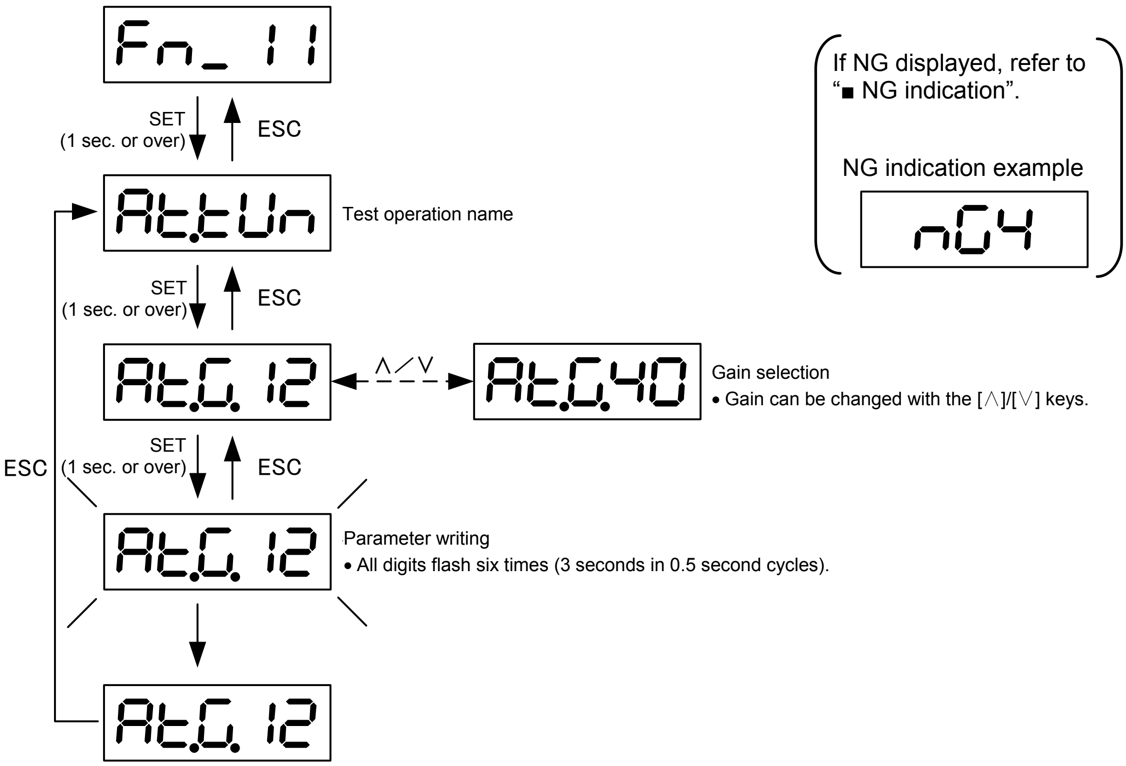
The current position is defined to be the Z-phase position. After the Z-phase offset is defined, the distance between the current position and Z-phase is automatically entered in parameter PA1_12 (Z-phase offset).



(11) Auto tuning gain

Parameter PA1_15 (auto tuning gain 1) is updated at real time.

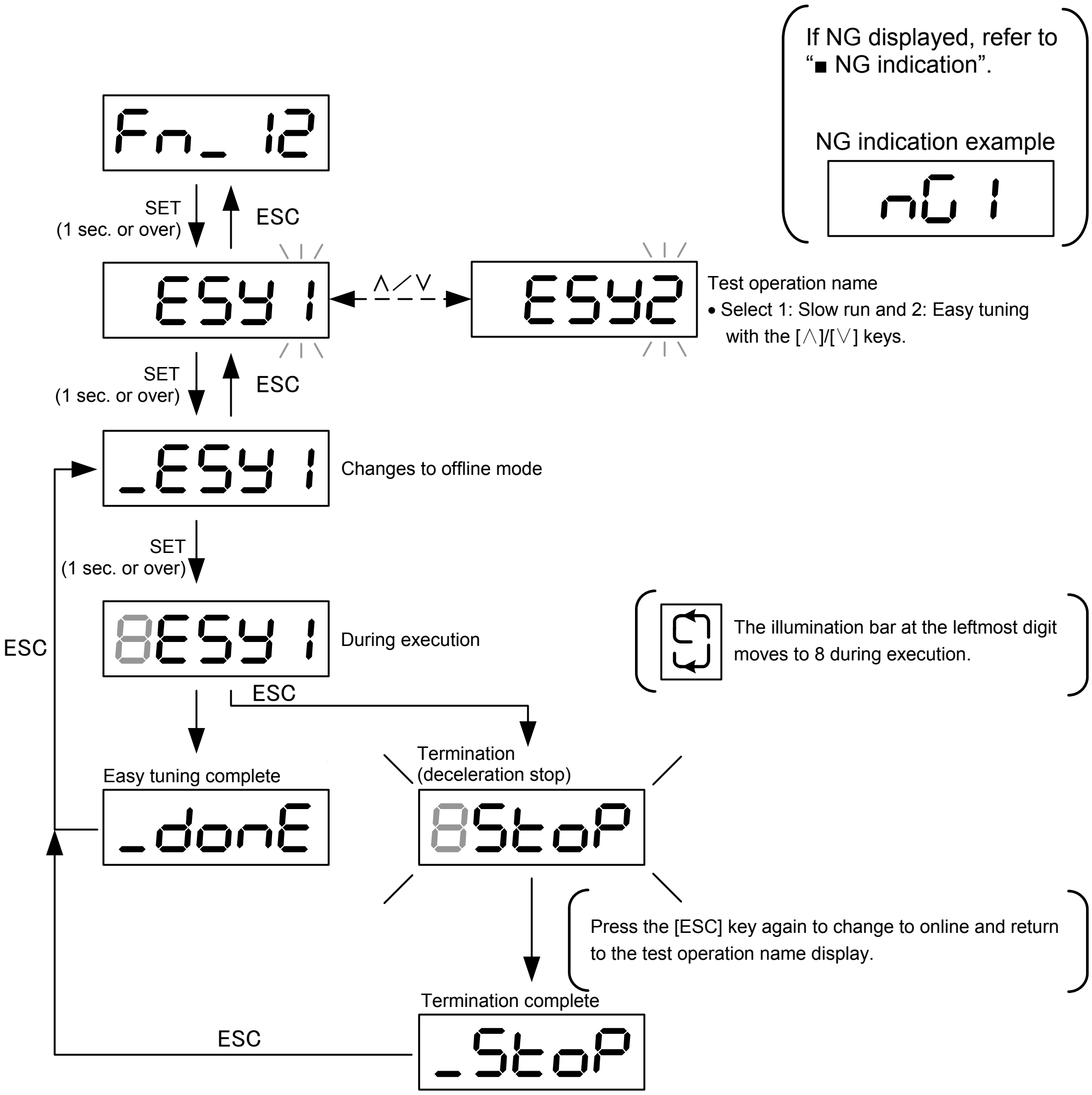
The data is reflected at real time merely through increase/decrease of data, different from regular parameter entry (parameter PA1_15 is not updated if no operation is made; press the [SET/SHIFT] key to register parameter PA1_15).



(12) Easy tuning

Operate the servomotor automatically and adjust the auto tuning gains automatically.
Best adjustment can be obtained according to the machine even if cables to the host control unit are not connected.
The operation pattern includes two variations: slow running and easy tuning.
For details, refer to "CHAPTER 5 SERVO ADJUSTMENT."

Operation pattern name	Travel distance	Operation frequency	Acceleration time	Deceleration time	Rotation speed	Timer	Direction of rotation	
							Go path	Return path
Slow running	PA1_20	Once	PA1_37	PA1_38	10r/min	PA1_22	PA1_23	
Easy tuning	PA1_20	Max. 50 times	Automatically calculated	Automatically calculated	PA1_21	PA1_22	PA1_23	

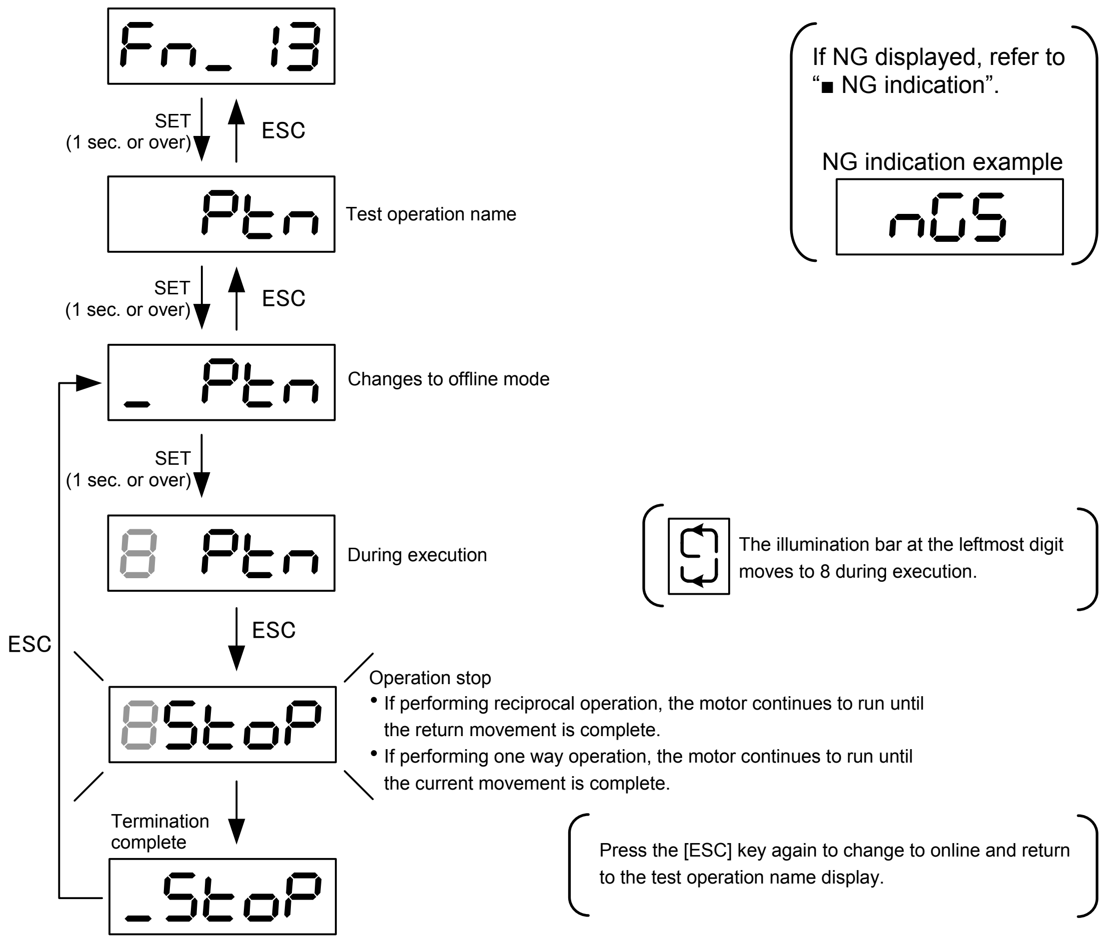


(13) Profile operation

Operate the servomotor continuously. Once started, reciprocal operation (depending on parameter PA1_23) continues until operation is stopped.

Continuous operation is possible even if cables to the host control unit are not connected. Use this mode to check the effective torque or for other purposes.

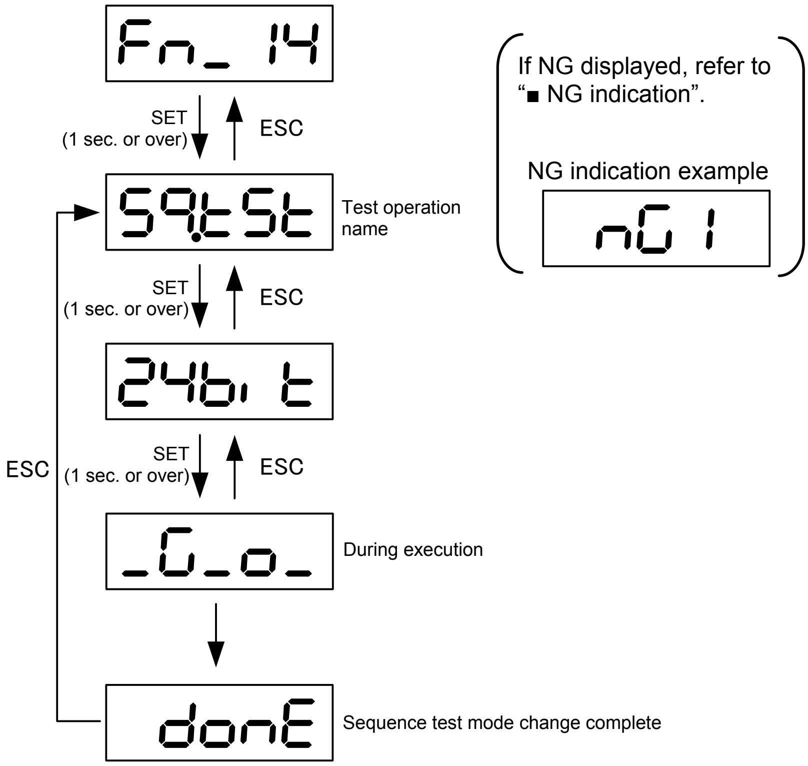
Operation pattern name	Travel distance	Operation frequency	Acceleration time	Deceleration time	Rotation speed	Timer	Direction of rotation	
							Go path	Return path
Profile operation	PA1_20	Endless	PA1_37	PA1_38	PA1_21	PA1_22	PA1_23	



(14) Sequence test mode

You can issue sequence output signals and show statuses without connecting the servomotor as if the servomotor actually operates in response to sequence input signals.

Use this mode to check the program (sequence) of the host controller or similar.

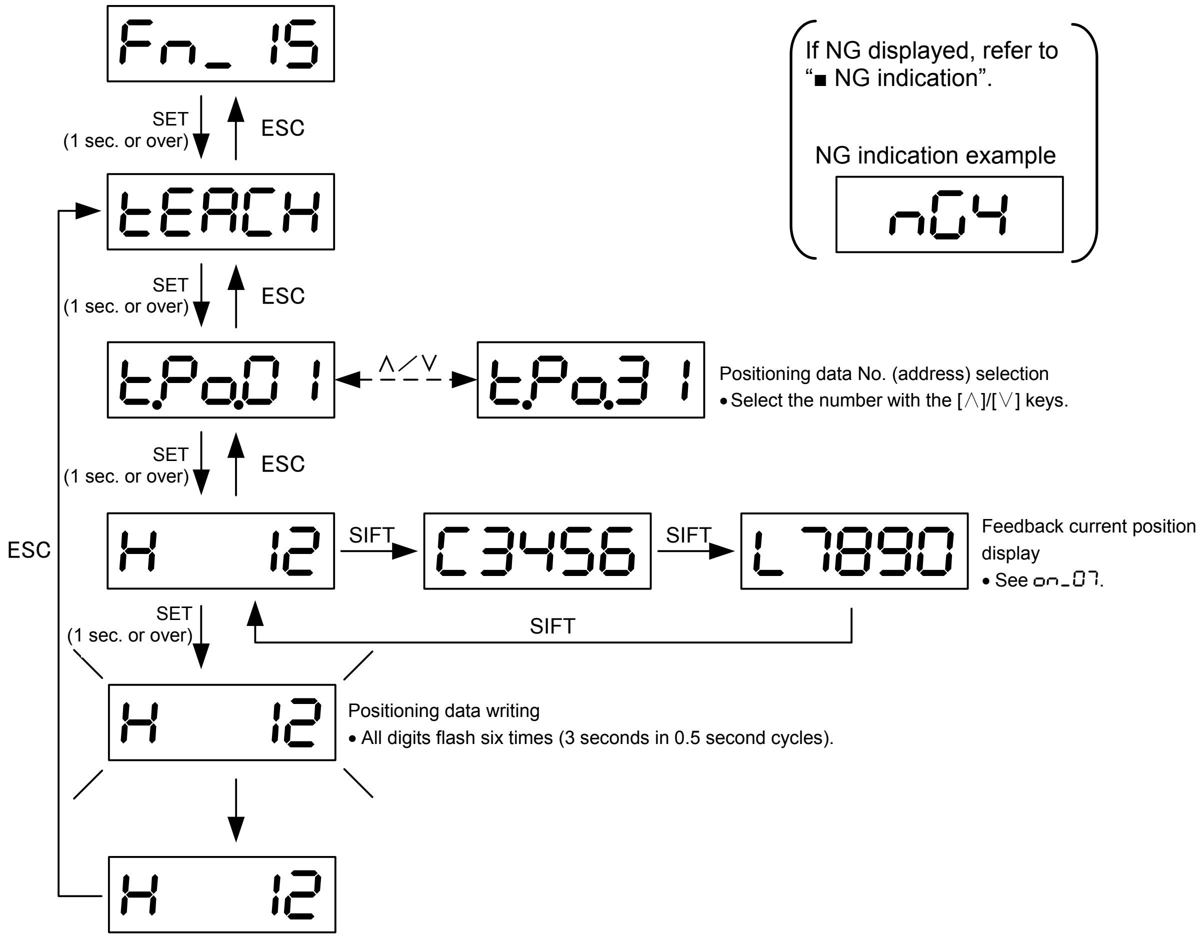


Hint	• All digits on the 7-segment LED flash every two seconds while in sequence test mode. (Digits do not flash when performing key operation while values are being edited.) • Sequence test mode cannot be exited even by changing to another mode after "Fn_ 14" appears. To end operation, turn the servo amplifier power off and then on again. When parameter PA2_89 is set to 1, turn the servo amplifier power off and then on again after changing the setting value to 0.

(15) Teaching mode

After operating the servomotor in the manual operation or pulse train operation or similar, the target position can be written to the specified address as the positioning data.

・Only the target position can be written and other data need to be set separately.
(Positioning status, rotation speed, stand still timer)
If the initial positioning data is selected for teaching, the command method of positioning status is set to [ABS].



CHAPTER 7 MAINTENANCE AND INSPECTION

7

7.1 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.

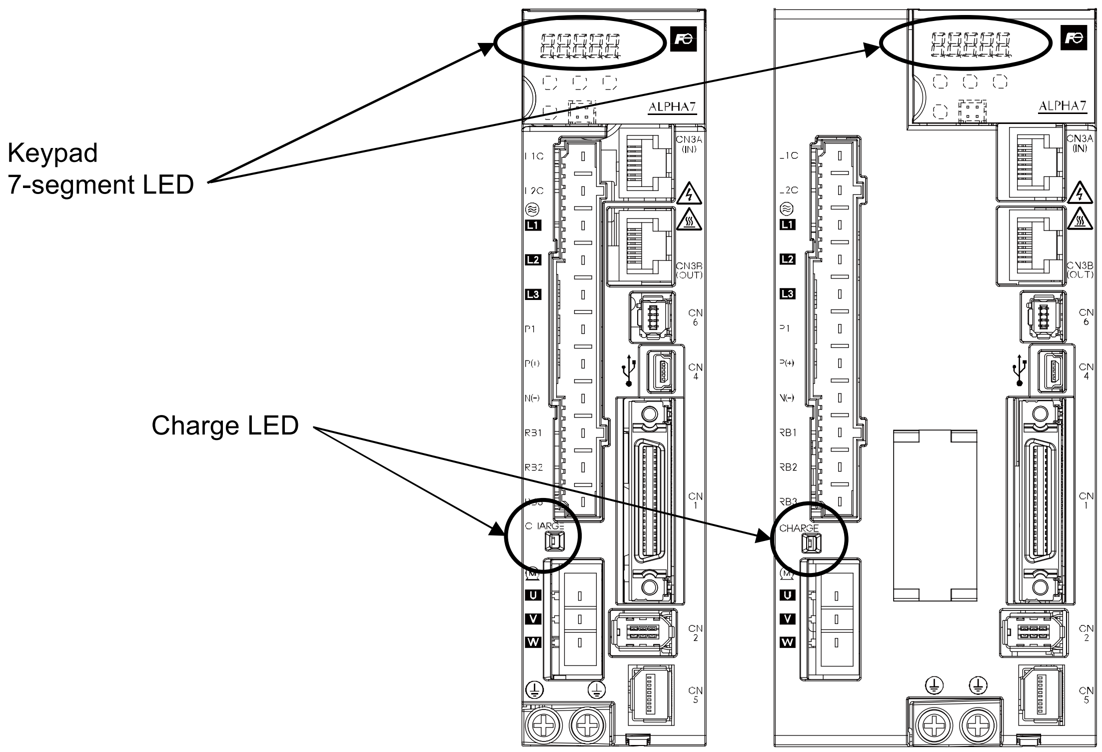
7.2 Status Display

7.2.1 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 "14.5.8 Diagnosis to be Made if the Servomotor Fails to Start", or contact us.

Front view of servo amplifier



7.2.2 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 1 second intervals.)

Be sure to check the alarm code to clarify the cause of the alarm.

7.2.3 Alarm Display List

When an alarm is detected, the keypad of the servo amplifier automatically shows alarm data.

Order of description	Indication	Name (in English)	Type
1	AL.oc 1	Over Current 1	Serious failure
	AL.oc2	Over Current 2	
2	AL.oS	Over Speed	
3	AL.Luc	Circuit Low voltage	
4	AL.Hu	High voltage	
5	AL.Et 1	Encoder trouble1	
	AL.Et2	Encoder trouble2	
6	AL.dE	Data Error	
7	AL.cE	Combination Error	
8	AL.Ec	Encoder Communication error	
9	AL.ctE	CONT (Control signal) Error	
10	AL.oL 1	Over Load 1	
	AL.oL2	Over Load 2	
11	AL.rH4	Inrush Current Suppression Circuit Trouble	
12	AL.EcF	Safety Function Error	
13	AL.LuP	Power Low voltage	Minor failure
14	AL.rH 1	Internal resistor Heat	
15	AL.rH2	External resistor Heat	
16	AL.rH3	Resistor Tr Error	

Order of description	Indication	Name (in English)	Type
17	AL.oF	Over Flow	Minor failure
18	AL.AH	Amp Heat	
19	AL.EH	Encoder Heat	
20	AL.dL 1	Absolute data Lost 1	
	AL.dL2	Absolute data Lost 2	
	AL.dL 3	Absolute data Lost 3	
21	AL.AF	Absolute data over Flow	
22	AL.i E	Initial Error	
23	AL.HF	Pulse Frequency Error	
24	AL.oL 3	Over Load 3	

To reset the alarm, perform one of the following methods.

- Turn alarm reset (RST: sequence input signal) on temporarily and then turn it off.
- From the keypad, select the test operation mode [Fn_05] and execute alarm reset.
- On the alarm screen, press and hold the [∧] and [∨] keys of the keypad simultaneously for at least one second.
- From the PC Loader, use alarm reset in the "monitor" command.
  After an alarm reset, the data specified with parameter "PA2_77 (initial display of the keypad)" is displayed.
- Turn OFF the input power supply and then turn it back ON.

■ Alarm reset

Some alarms cannot be canceled through alarm resetting. To remove the alarm that is not canceled through alarm resetting, reset it by turning the power off then on again.

Alarms that can be canceled through alarm resetting

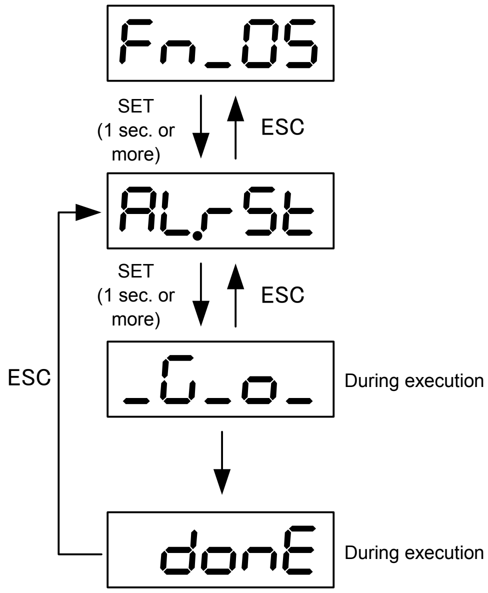
Display	Name	Display	Name
AL.oc 1	Overcurrent 1	AL.oL3	Overload 3
AL.oc2	Overcurrent 2	AL.LuP	Main circuit undervoltage
AL.oS	Overspeed	AL.rH 1	Internal regenerative resistor overheat
AL.Luc	Control power undervoltage	AL.rH2	External regenerative resistor overheat
AL.Hu	Overvoltage	AL.oF	Deviation overflow
AL.Ec	Encoder communication error	AL.AH	Amplifier overheat
AL.oL 1	Overload 1	AL.EH	Encoder overheat
AL.oL2	Overload 2	AL.HF	Command pulse frequency error

Alarms that cannot be canceled through alarm resetting

Display	Name	Display	Name
AL.Et 1	Encoder error 1	AL.dL 1	Absolute data loss 1
AL.Et2	Encoder error 2	AL.dL2	Absolute data loss 2
AL.dE	Memory error	AL.dL3	Absolute data loss 3
AL.cE	Motor combination error	AL.AF	Multi-turn overflow
AL.ctE	CONT overlap	AL.i E	Initial error
AL.rH3	Regenerative transistor error	AL.EcF	Safety function error
AL.rH4	Inrush current suppression circuit trouble		

Alarm reset at keypad

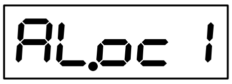
The alarm currently detected at the servo amplifier is reset.

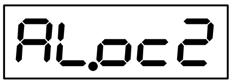


7.3 Troubleshooting Method

1. Overcurrent

[Display]





[Description of detected alarm]

The output current of the servo amplifier exceeds the rated value.

OC1: Direct detection by internal transistor of servo amplifier

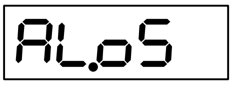
OC2: Indirect detection with software of servo amplifier

[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 regenerative resistor	• Replace with the regenerative resistor within the rating.
Current imbalance caused by an encoder fault	• Replace the servomotor.
Unconnected grounding cable	• Connect the grounding cable.

2. Overspeed

[Display]

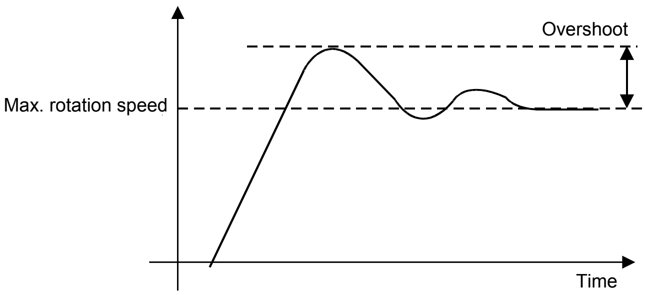


[Description of detected alarm]

The rotation speed of the servomotor exceeds 1.1 times the maximum speed.

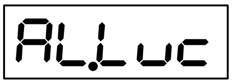
[Cause and remedy]

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.
DC input is under execution.	• Set PA2_68 (main power shutoff detection time) at 1000 [ms].

4. Overvoltage

[Display]

AL.Hu

[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 regenerative resistor or wrong wiring	• Connect the external regenerative resistor. • Correct the wiring of the external regenerative resistor.
Broken braking transistor	• Replace the servo amplifier.

The internal DC voltage can be checked in the monitor mode of the keypad.
[on_ 15]: Internal DC link voltage (max. value)
Approximately over 420 [V], overvoltage is detected.

5. Encoder Trouble

[Display]

AL.Et1

AL.Et2

[Description of detected alarm]

There is a fault in the encoder built in the servomotor.
(Communications are normal.)

- Et1: Single revolution position detection fault of encoder
- Et2: 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]

AL.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]

AL.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]

AL.Ec

[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]

AL.ctE

[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]

AL.oL 1

AL.oL2

[Description of detected alarm]

- OL1: Instantaneous alarm such as a locked shaft.
- OL2: The effective torque exceeds the allowable limit of the servomotor. (Detection at electronic thermal relay built in servo amplifier)
- Overload level: See "9.2 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 OL2 alarm is caused but no damaged servo amplifier or incorrect wiring is found, the servomotor capacity must be examined.
Check the OL thermal value with the PC Loader or monitor mode of the keypad in both cases.

11. Inrush Current Suppression Circuit Trouble

[Display]

AL.rH4

[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]

AL.EcF

[Description of detected alarm]

- Safety input signal mismatch
- Internal circuit error
- The function safety module (WSU-ST1) output an alarm.

[Cause and remedy]

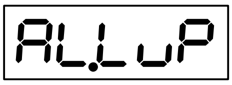
Cause	Remedy
The [EN1+], [EN2+] terminal input mismatch continued for 50 ms or longer.	• Check for wiring abnormalities such as disconnection or shorting in the [EN1+], [EN2+] terminal wiring. • Reduce the [EN1+], [EN2+] terminal input mismatch time to 50 ms or less.
The function safety module (WSU-ST1) 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]



[Description of detected alarm]

The power supplied to the servo amplifier falls below the minimum specification voltage limit.

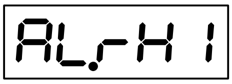
[Cause and remedy]

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 Regenerative Resistor Overheat

[Display]



[Description of detected alarm]

The power consumption of the regenerative 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 regenerative resistor. • Install a counterweight.

15. External Regenerative Resistor Overheat

[Display]

AL.rH2

[Description of detected alarm]

The external regenerative 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 regenerative resistor. • Install a counterweight.
Wrong wiring of external regenerative resistor overheat signal	• Connect correctly.

16. Braking Transistor Error

[Display]

AL.rH3

[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]

AL.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.

[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, _28 (torque limit).
The deviation detection width is small.	• Increase PA2_69 (deviation detection overflow 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 acute.	• Increase the acceleration/deceleration time.

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]

AL.AH

[Description of detected alarm]

The temperature of the servo amplifier has exceeded the allowable limit.

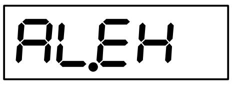
[Cause and remedy]

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]



[Description of detected alarm]

The encoder inside the servomotor may be overheated.

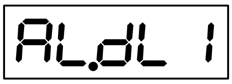
[Cause and remedy]

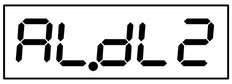
Cause	Remedy
Excessive ambient temperature	• Reduce the ambient temperature of the servomotor to 40 [°C] or lower. • Remove shields interrupting heat radiation, if there are any.
The effective torque exceeds the rating.	• Increase the cycle time and reduce the operation frequency.

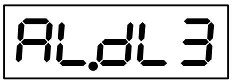
The main body of the encoder detects this alarm according to results of self-diagnosis.

20. Absolute Data Lost

[Display]







[Description of detected alarm]

The absolute data of the encoder is lost.

- dL1: Battery voltage drop, broken encoder cable, loss of multi-rotation data
- dL2: Multi-turn data fault in encoder
- dL3: Detection at power-on after an ET alarm

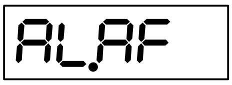
[Cause and remedy]

Cause	Remedy
dL1 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)
dL2 alarm	• Perform position preset. If the alarm persists, replace the servomotor.
dL3 alarm	• After position preset, dL3 is canceled but the ET alarm persists. • If the ET alarm is not canceled, replace the servomotor.

For details, refer to "CHAPTER 11 ABSOLUTE POSITION SYSTEM."

21. Multi-turn Data Overflow

[Display]



[Description of detected alarm]

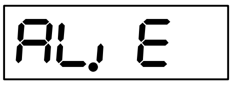
Rotation of the output shaft of the servomotor exceeds the range between -32766 and +32765.

[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]



[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]

AL.HF

[Description of detected alarm]

- The input frequency for pulse train input exceeds the maximum input specification.
- The output frequency for pulse train output exceeds the maximum output specification.

2000 [MHz] or a higher frequency is detected at the inlet of the position deviation counter inside the servo amplifier.

[Cause and remedy]

Cause	Remedy
The command pulse frequency is high.	• Reduce the command pulse frequency.
The pulse reference value such as the input electronic gear setting is high.	• Change the pulse ratio setting to a correct reference value.
The pulse train output frequency is high.	• Review the output pulse division. • Set “0” (Disable) for the output pulse frequency error (PA3_90) setting.

24. Overload 3

[Display]

AL.oL3

[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.

7.4 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] RYT201D7-VV2
Device configuration	Host control unit, external regenerative resistor, etc. [Example] External regenerative 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 (pulse operation, 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

7.5 Maintenance and Discarding

7.5.1 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 10 PERIPHERAL EQUIPMENT."

7.5.2 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 14 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 14 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.

7.5.3 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.

7.6 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 8 SPECIFICATIONS

8

8.1 Specifications of Servomotor

8.1.1 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～+40°C, 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

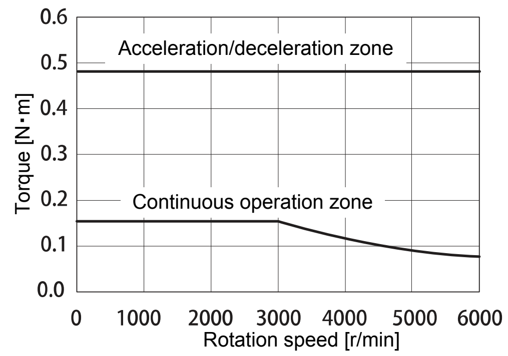
Motor type	GYS102D7 -□□2	GYS152D7 -□□2
Rated output [kW]	1.0	1.5
Rated torque [N·m]	3.18	4.78
Rated speed [r/min]	3000	
Max. speed [r/min]	5000	
Max. torque [N·m]	9.55	14.3
Max. torque [kg·m^2]	1.73×10^{-4}	2.37×10^{-4}
Rated current [A]	7.1	9.6
Max. current [A]	21.3	28.8
Insulation class	Class F	
Degree 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～+40°C, within 90%RH max. (without condensation)	
Vibration resistance [m/s2]	24.5	
Mass [kg]	4.4	5.2
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).

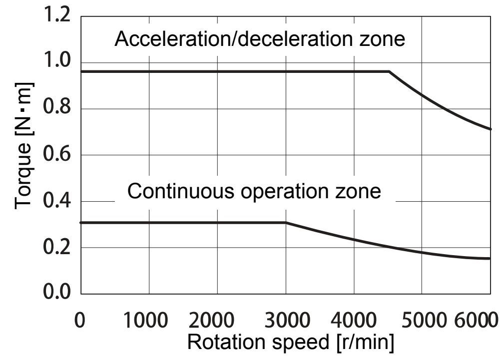
Motor type	GYS102D7 -□□2-B	GYS152D7 -□□2-B
Rated output [kW]	1.0	1.5
Rated torque [N·m]	3.18	4.78
Max. torque [kg·m^2]	2.03×10^{-4}	2.67×10^{-4}
Static friction torque [N·m]	6.86	
Rated voltage [V]	DC24 ±10%	
Attraction time [ms]	100	
Release time [ms]	40	
Power consumption [W]	17.7 (at 20°C)	
Mass [kg]	5.9	6.8

■ Torque characteristics drawing
(at 3-phase 200 [V] or single-phase 230 [V] source voltage*)

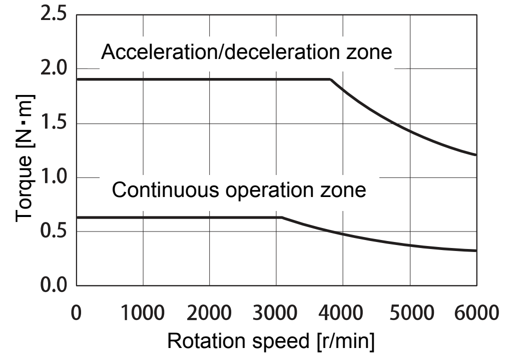
GYS500D7-□□2 (0.05 [kW])



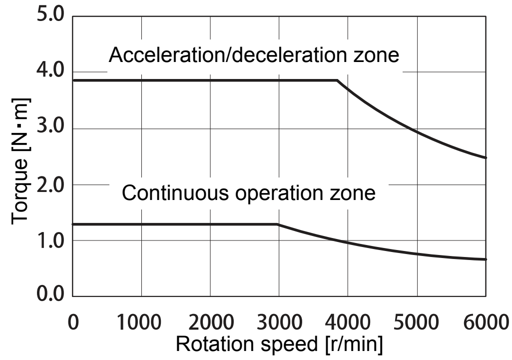
GYS101D7-□□2 (0.1 [kW])



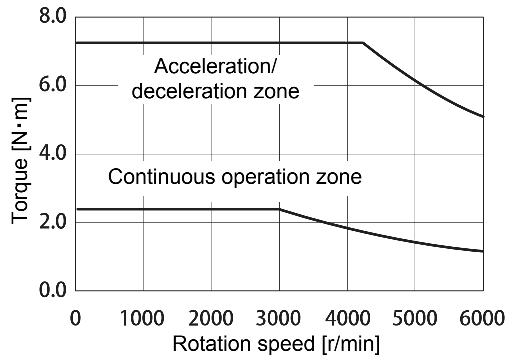
GYS201D7-□□2 (0.2 [kW])



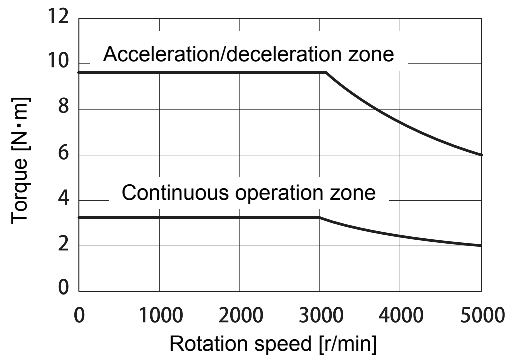
GYS401D7-□□2 (0.4 [kW])



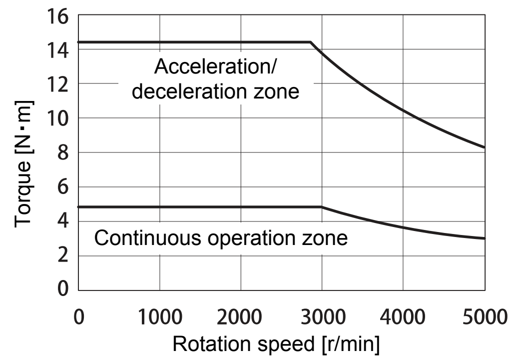
GYS751D7-□□2 (0.75 [kW])



GYS102D7-□□2 (1.0 [kW])



GYS152D7-□□2 (1.5 [kW])



*: 0.75 [kW] or less for single-phase 230 [V]

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 : 350 × 350 × 8 [mm]

8

8.1.2 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 (locations not 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.

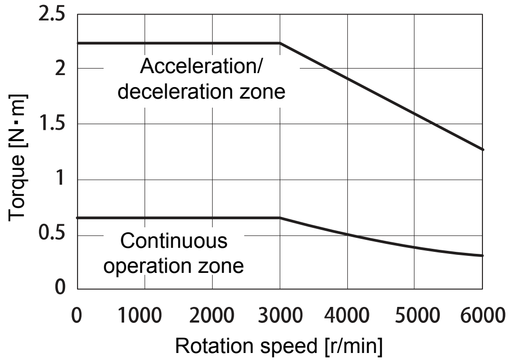
*2: The vibration value is a characteristic when fitted with flange mounting IMV1 (L52).

■ Brake specifications (motor equipped with a brake)

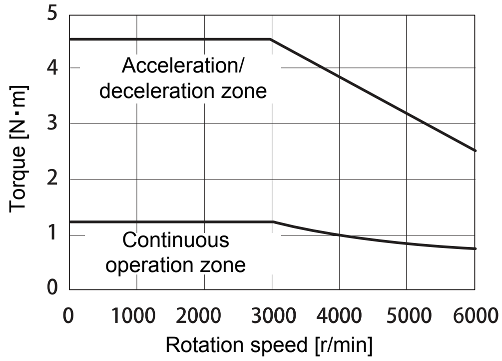
Motor type	GYB201D7-□□2-□	GYB401D7-□□2-□	GYB751D7-□□2-□
Rated output [kW]	0.2	0.4	0.75
Rated torque [N·m]	0.637	1.27	2.39
Max. torque [kg·m^2]	0.37×10^{-4}	0.62×10^{-4}	1.71×10^{-4}
Static friction torque [N·m]	1.3		3.0
Rated voltage [V]	DC24 ±10%		
Attraction time [ms]	40		60
Release time [ms]	20		20
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)

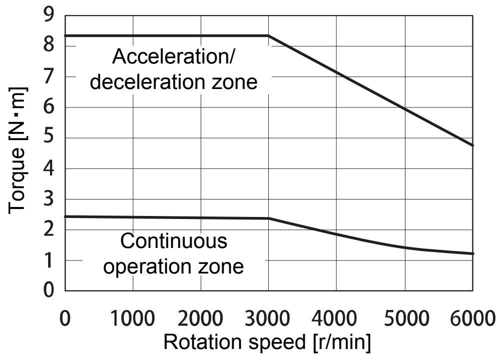
GYB201D7-□□2-□ (0.2 [kW])



GYB401D7-□□2-□ (0.4 [kW])



GYB751D7-□□2-□ (0.75 [kW])



These characteristics indicate typical values of each servomotor combined with the corresponding RYT-7 type 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]

8

8.1.3 GYG Motor

■ Standard specifications

Motor type	GYG102C7-□□2	GYG851B7-□□2
Rated output [kW]	1.0	0.85
Rated torque [N･m]	4.77	5.41
Rated speed [r/min]	2000	1500
Max. speed [r/min]	3000	
Max. torque [N･m]	14.3	16.2
Max. torque [kg･m^2]	11.8×10^{-4}	11.8×10^{-4}
Rated current [A]	4.7	5.4
Max. current [A]	18.0	22.0
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	V10 or below	
Installation place, environment	For indoor use (locations not 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, within 90%RH max. (without condensation)	
Vibration resistance [m/s^2]	24.5	
Mass [kg]	5.6	5.6
Standards	UL/cUL (UL1004), CE marking (EN60034-1, EN60034-6), RoHS directive	

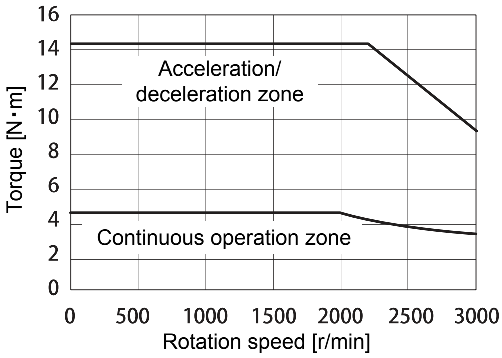
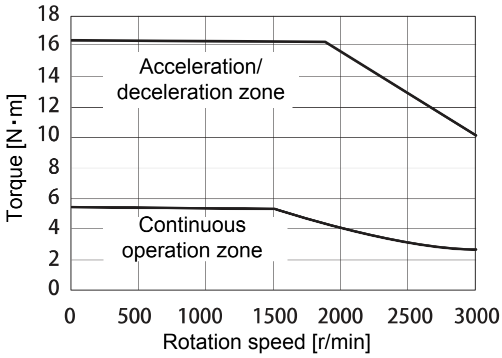
*1: When using the product under such an environment as specified by IP67, make sure that the connector for wiring is also compatible with IP67.

*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	GYG851B7-□□2-B
Rated output [kW]	1.0	0.85
Rated torque [N･m]	4.77	5.41
Max. torque [kg･m^2]	13.8×10^{-4}	13.8×10^{-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	7.8

■ Torque characteristics drawing (servo amplifier power supply voltage: 3-phase 200 [V])

GYG102C7-□□2 (1.0 [kW])	GYG851B7-□□2 (0.85 [kW])
	

These characteristics indicate typical values of each servomotor combined with the corresponding RYT-7 type 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]

8

8.2 Specifications of Servo Amplifier

8.2.1 Common Specifications

Applicable motor rated speed			3000r/min (6000r/min Max.)							2000r/min (3000r/min Max.)	1500r/min (3000r/min Max.)
Applicable motor output [kW]			0.05	0.1	0.2	0.4	0.75	1.0	1.5	1.0	0.85
Amplifier type RYT □□□	F7-△△2		500	101	201	401	751	102	152	102	851
Outer frame number			Frame 1				Frame 2				
Mass [kg]			0.9	0.9	0.9	0.9	1.5	1.5	1.5	1.5	1.5
Protective construction/cooling			Open/natural cooling				Open/mechanical cooling				
Power supply	Main power supply	Phases	Single-phase, 3-phase					3-phase			
		Voltage/frequency	AC200 to 240 [V], 50/60 [Hz]								
		Allowable voltage fluctuation	3-phase: AC170 to 264 [V], Single-phase: AC190 to 264V								
	Control power supply	Phases	Single-phase								
		Voltage/frequency	AC200 to 240 [V], 50/60 [Hz]								
		Allowable voltage fluctuation	AC170 to 264V								
Control system			Fully-digital sinusoidal PWM drive								
Carrier frequency			10 [kHz]								
Overload capability			Overload capability varies from motor to motor								
Max voltage for regenerative resistance [W]	Built-in resistor		-	-	-	8	20	20	20		
	External resistor *1		17	17	17	17	50	50	50		
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)								
	Power supply fluctuation		0% (power supply fluctuation -10% to +10% at rated speed)								
	Temperature fluctuation		±0.2% or less (25°C±10°C, at rated speed with analog voltage directive)								
Performance and functionality	VV type	Speed control	Closed-loop control by speed adjuster, acceleration/deceleration time setting, manual feed speed/max. speed, speed command zero clamp, etc.								
		No. of positioning data points	31 points (position, speed, acceleration time, deceleration time, stand still timer, M code output, and various statuses)								
		Position control	Closed-loop control by position adjuster, electronic gear, output pulse setting, feed-forward, homing, interrupt positioning, start positioning, etc.								
		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.								
		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)			Over Current (OC1, OC2), Over Speed (OS), Low Control Voltage (LvC), Overvoltage (Hv), Encoder Trouble (Et1, Et2), Memory Error (dE), Motor Combination Error (CE), Encoder Communication Error (EC), CONT (Control signal) Error (CtE), Over Load (OL1, OL2, OL3), Power Low Voltage (LvP), Regenerative Resistor Overheat (rH1, rH2, rH3), Deviation Overflow (oF), Amplifier Overheat (AH), Encoder Overheat (EH), Absolute Data Lost (dL1, dL2, dL3), Multi-turn Data Over Flow (AF), Initial Error (IE), Command Pulse Frequency Error (HF), Functional Safety Error (EcF)								
Operation and display section of main body			5-digit alphanumeric display with 7-segment LED 4 push-switches (MODE, UP, DOWN, and SET)								
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								
	Temperature/humidity/atmospheric pressure		-10 to 55°C/10 to 90%RH (without condensation)/70 to 106kPa								
	Vibration/shock resistance		$4.9m/s^2$/$19.6m/s^2$								

<table>
<tr><td colspan="2">Applicable motor rated speed</td><td>3000r/min
(6000r/min Max.)</td><td>2000r/min
(3000r/min Max.)</td><td>1500r/min
(3000r/min Max.)</td></tr>
<tr><td colspan="2">Standards</td><td colspan="3">UL standard : UL61800-5-1
CE marking Low voltage directive : EN61800-5-1
EMC directive : EN61800-3
Machine directive: EN ISO13849-1
EN61508 SIL3
EN61800-5-2 SIL3 (STO)
EN62061 SIL CL3</td></tr>
<tr><td rowspan="6">Control function</td><td>Frequency response</td><td colspan="3">3, 200Hz</td></tr>
<tr><td>Tuning features</td><td colspan="3">Auto tuning, semi-auto tuning, interpolation control mode, manual tuning</td></tr>
<tr><td>Auto adjustment features</td><td colspan="3">Tuningless features, easy tuning, fine tuning</td></tr>
<tr><td>Notch filter</td><td colspan="3">5-step</td></tr>
<tr><td>Vibration suppression control</td><td colspan="3">2-step (number of steps that can be configured at the same time)</td></tr>
<tr><td>Compensation features</td><td colspan="3">Friction compensation, interference detection, cogging torque compensation</td></tr>
</table>

*1: This value assumes that the external resistor dedicated to each amplifier is connected.

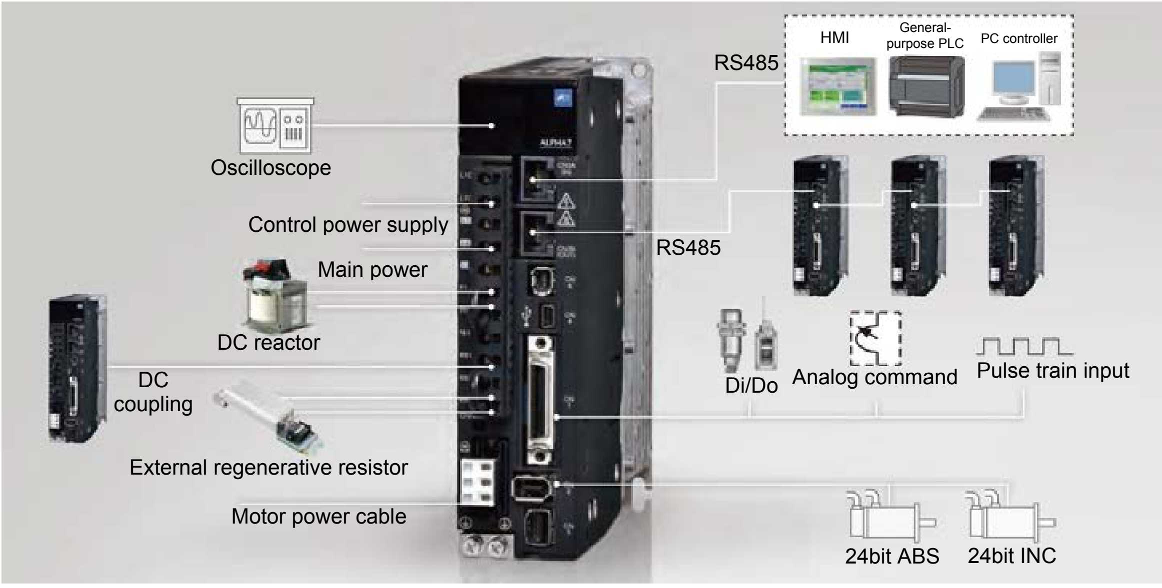
*2: We will accept custom orders for models without a dynamic brake.

*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.

8

8.2.2 VV Type Specifications

■ Outline of system configuration



■ Interface specifications

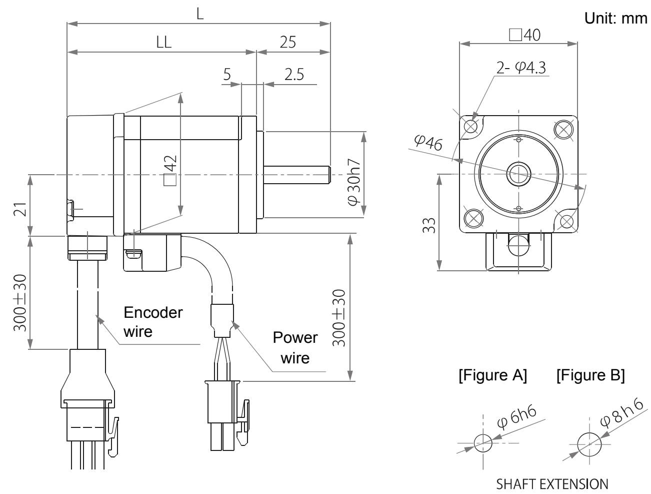
Interface type		Specifications
Command interface	Positioning function	RS-485 (Modbus-RTU), Di/Do
	Position control	Pulse input
	Speed control	Analog voltage input
	Torque control	Analog voltage input
Communication interface		RS-485 2 ports (for parameter editing and monitoring)
		Our original protocol, Modbus-RTU
		9600/19200/38400/115200 bps, connection of max. 31 axes

Terminal name	Symbol	Specifications
Pulse input shared with CONT signal	CA, *CA CB, *CB	Differential input: Max. input frequency ≤ 4.0MHz Open collector input: Max. input frequency ≤ 200kHz (In case of signals at 90-degree phase difference, the above relationship is true for the four-fold frequency.) Pulse format { Command pulse/Command direction Forward/Reverse pulse Two signals at 90-degree phase difference } Select one of these formats with a parameter setting
		CA, *CA: CONT9 signal, CB, *CB: CONT10 signal, compatible with both sink and source input methods
	PPI	Pull-up power input at open collector input (24VDC ± 10%)
Pulse output shared with OUT signal	FFA, *FFA FFB, *FFB	Differential output: Max. output frequency ≤ 500kHz Two signals at 90-degree phase difference Pulse output count setting (n pulses/rev): 16 ≤ n ≤ 262144
	FFZ, *FFZ	Differential output: 1 pulse/rev
	FZ	Open collector output: 1pulse/rev, FZ: OUT6 signal
	M5	Reference potential (0V)
Analog monitor voltage output	MON1 MON2	0V to ±10VDC Resolution: 14 bits / ±full scale The output data depends on the internal parameter
	M5	Reference potential (0V)
Common for sequence I/O	COMIN	Common for sequence input signal
	COMOUT	Common for sequence output signal
Sequence input signal	CONT1 to CONT8	ON upon short circuit across contacts, OFF upon open circuit 12VDC-10% to 24VDC+10% Current consumption 8mA (per contact; used at circuit voltage 24 VDC) Function of each signal depends on parameter setting Compatible with both sink and source input methods
Sequence output signal	OUT1 to OUT5	Short circuit upon ON, open circuit upon OFF 30VDC / 50mA (max.) Function of each signal depends on parameter setting Compatible with both sink and source output methods

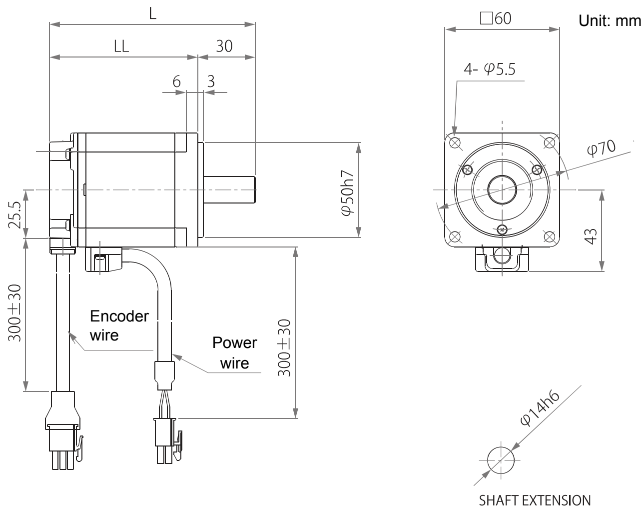
Analog voltage input	VREF	Speed command input at speed control Input range: -10V to 0 to +10V, input impedance: 20kΩ Resolution: 16 bit/±full-scale
	TREF	Torque command input at torque control Input range: -10V to 0 to +10V, input impedance: 20kΩ Resolution: 16 bit/±full-scale
	P10	Analog command power output (+10VDC), output capacity: 30mA
	M5	Reference potential (0V)

8.3 Dimensions of Servomotor

8.3.1 GYS Motor (With no Brake)

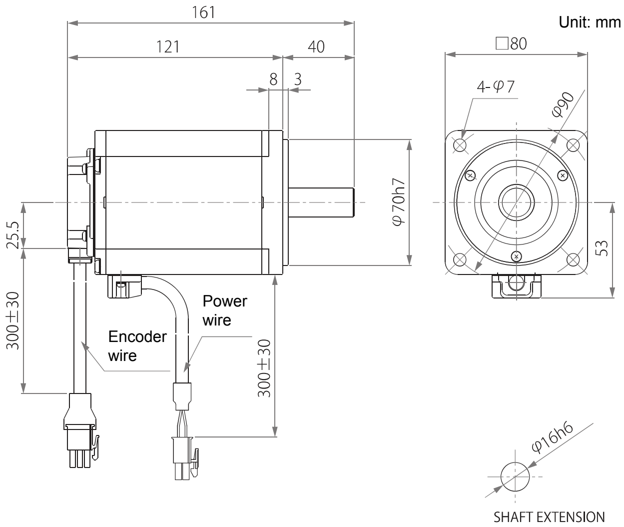


Power supply	Rated speed	Rated output	Type	Shaft shape	Overall length	Dimensions (Flange)	Mass [kg]
					L	LL	
200V series	3000r/min	0.05kW	GYS500D7-□B2	Figure A	89	64	0.45
		0.1kW	GYS101D7-□B2	Figure B	107	82	0.55

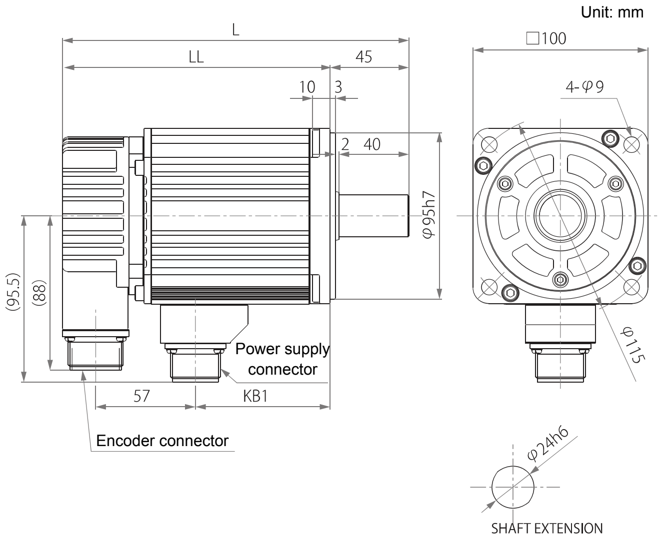


Power supply	Rated speed	Rated output	Type	Overall length	Dimensions (Flange)	Mass [kg]
				L	LL	
200V series	3000r/min	0.2kW	GYS201D7-□B2	107.5	77.5	1.2
		0.4kW	GYS401D7-□B2	135.5	105.5	1.8

* See “8.5 Optional Specification of Shaft Extension [With a Key, Tapped]” for the shaft extension specifications of the motor with a key.



Power supply	Rated speed	Rated output	Type	Mass [kg]
200V series	3000r/min	0.75kW	GYS751D7-□B2	3.4

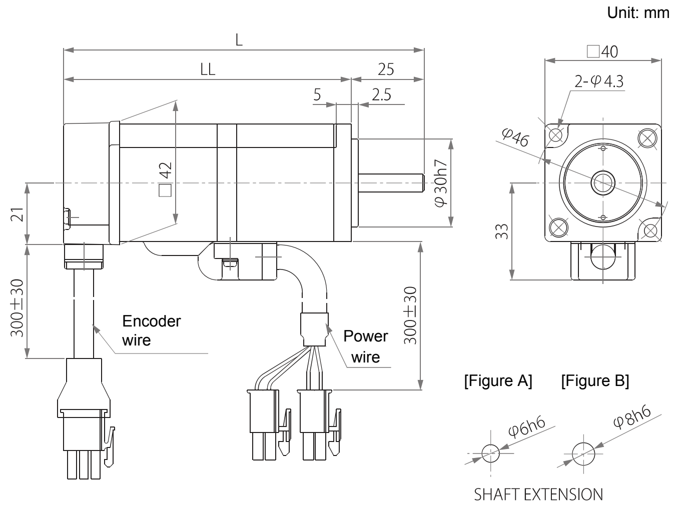


Power supply	Rated speed	Rated output	Type	Overall length	Dimensions (Flange)	Terminal portion	Mass [kg]
				L	LL	KB1	
200V series	3000r/min	1.0kW	GYS102D7-□B2	198	153	77	4.4
		1.5kW	GYS152D7-□B2	220.5	175.5	99.5	5.2

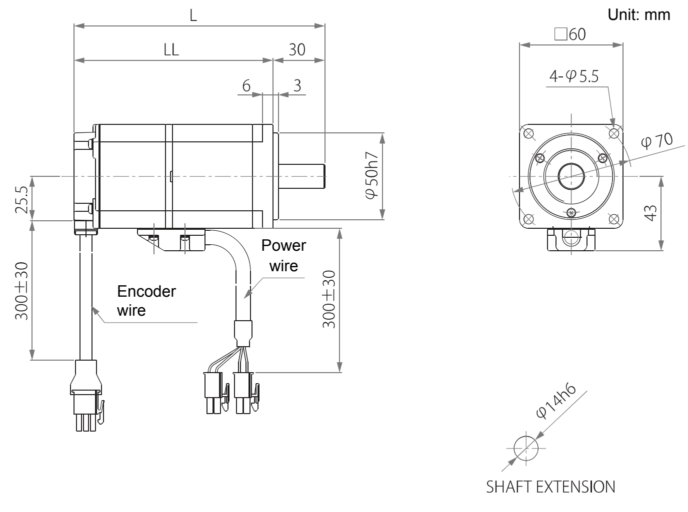
* See “8.5 Optional Specification of Shaft Extension [With a Key, Tapped]” for the shaft extension specifications of the motor with a key.

8

8.3.2 GYS Motor (With a Brake)

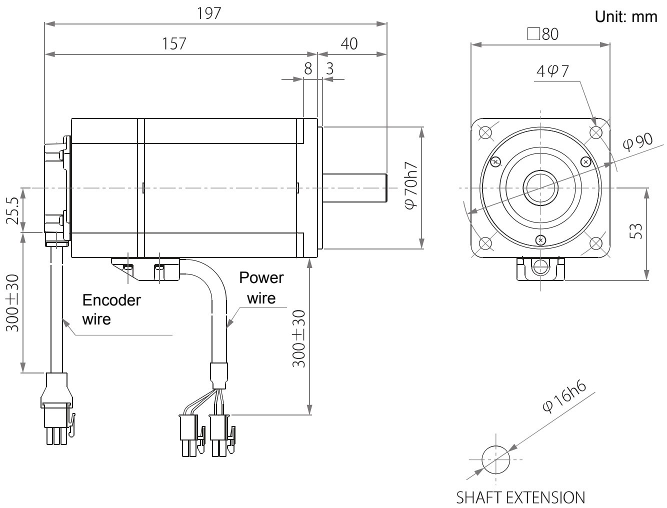


Power supply	Rated speed	Rated output	Type	Shaft shape	Overall length	Dimensions (Flange)	Mass [kg]
					L	LL	
200V series	3000r/min	0.05kW	GYS500D7-□B2-B	Figure A	123.5	98.5	0.62
		0.1kW	GYS101D7-□B2-B	Figure B	141.5	116.5	0.72

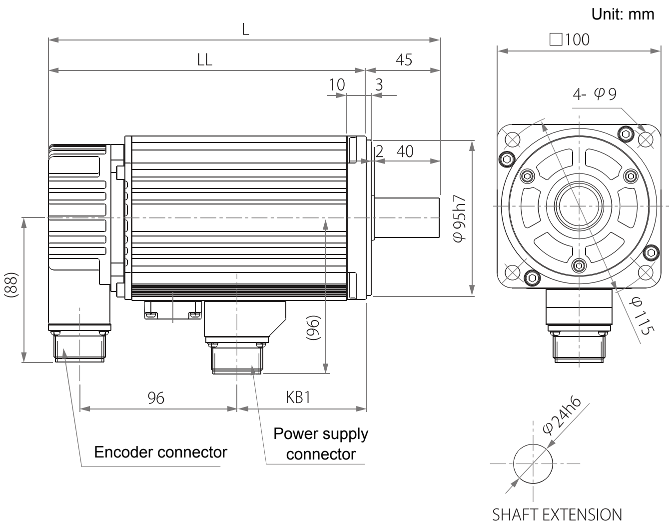


Power supply	Rated speed	Rated output	Type	Overall length	Dimensions (Flange)	Mass [kg]
				L	LL	
200V series	3000r/min	0.2kW	GYS201D7-□B2-B	145.5	115.5	1.7
		0.4kW	GYS401D7-□B2-B	173.5	143.5	2.3

* See “8.5 Optional Specification of Shaft Extension [With a Key, Tapped]” for the shaft extension specifications of the motor with a key.



Power supply	Rated speed	Rated output	Type	Mass [kg]
200V series	3000r/min	0.75kW	GYS751D7-□B2-B	4.2

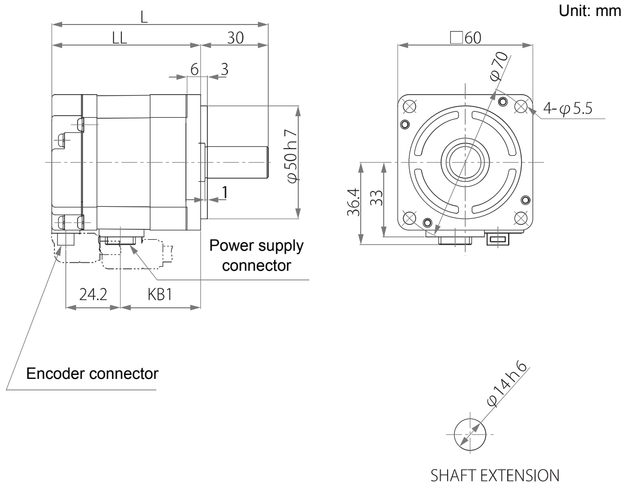


Power supply	Rated speed	Rated output	Type	Overall length	Dimensions (Flange)	Terminal portion	Mass [kg]
				L	LL	KB1	
200V series	3000r/min	1.0kW	GYS102D7-□B2-B	239	194	79	5.9
		1.5kW	GYS152D7-□B2-B	261.5	216.5	101.5	6.8

* See “8.5 Optional Specification of Shaft Extension [With a Key, Tapped]” for the shaft extension specifications of the motor with a key.

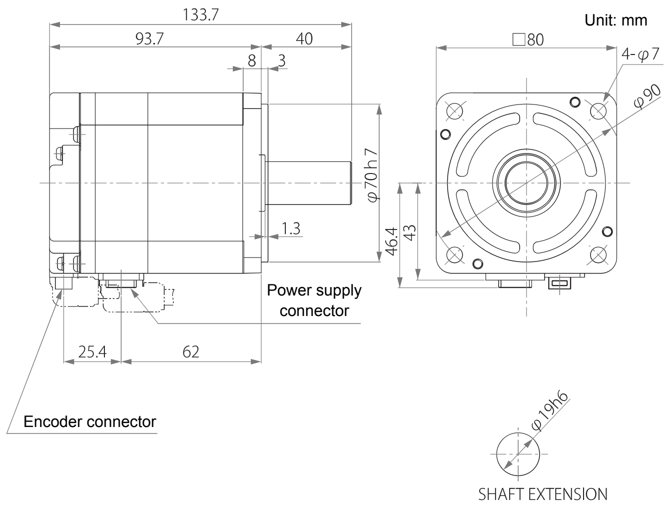
8

8.3.3 GYB Motor (Connector Type)



Power supply	Rated speed	Rated output	Type	Overall length	Dimensions (Flange)	Terminal portion	Mass [kg]
				L	LL	KB1	
200V series	3000r/min	0.2kW	GYB201D7-□□2-C	96.2	66.2	35.7	0.9
		0.4kW	GYB401D7-□□2-C	114	84	53.5	1.2

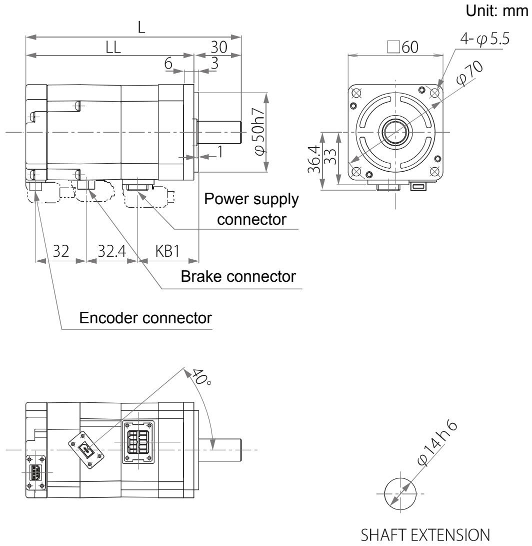
8



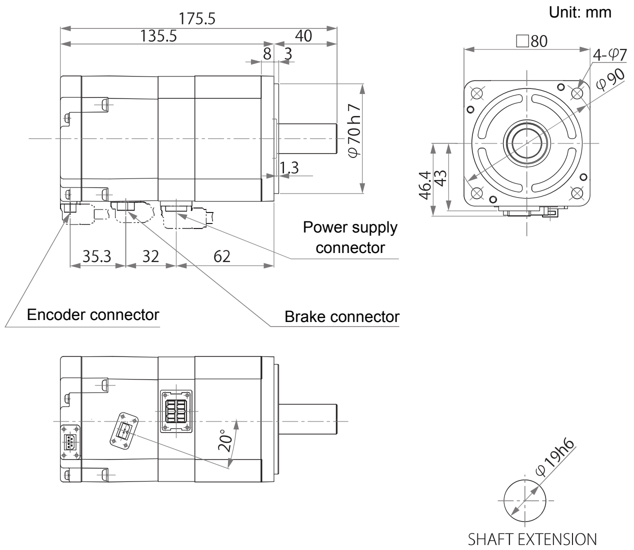
Power supply	Rated speed	Rated output	Type	Mass [kg]
200V series	3000r/min	0.75kW	GYB751D7-□□2-C	2.3

* See “8.5 Optional Specification of Shaft Extension [With a Key, Tapped]” for the shaft extension specifications of the motor with a key.

8.3.4 GYB Motor (Connector Type) (With a Brake)



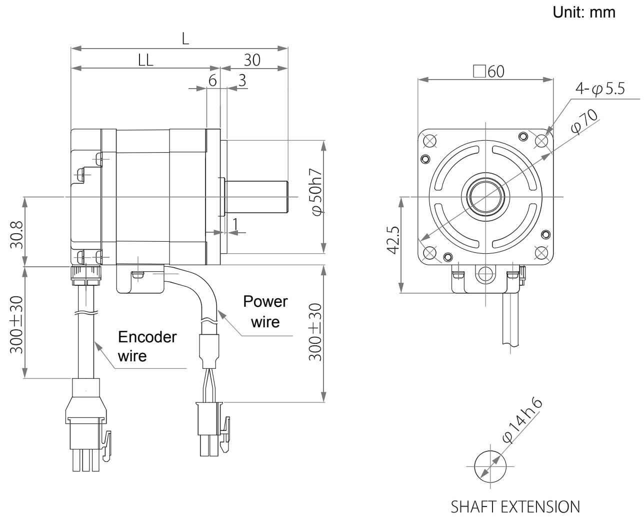
Power supply	Rated speed	Rated output	Type	Overall length	Dimensions (Flange)	Terminal portion	Mass [kg]
				L	LL	KB1	
200V series	3000r/min	0.2kW	GYB201D7-□□2-D	136.25	106.25	35.7	1.3
		0.4kW	GYB401D7-□□2-D	154.1	124.1	53.5	1.8



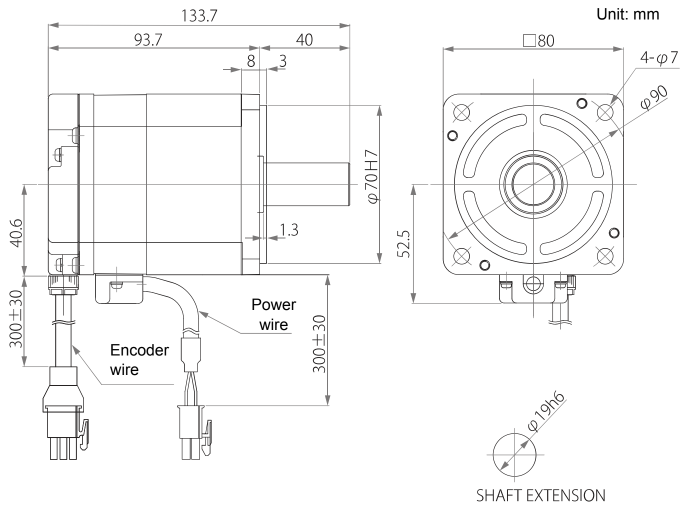
Power supply	Rated speed	Rated output	Type	Mass [kg]
200V series	3000r/min	0.75kW	GYB751D7-□□2-D	3.2

* See “8.5 Optional Specification of Shaft Extension [With a Key, Tapped]” for the shaft extension specifications of the motor with a key.

8.3.5 GYB Motor (Lead Wire Type)



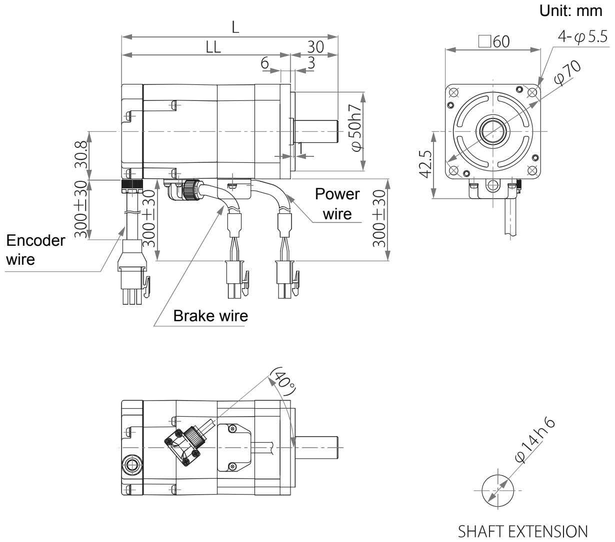
Power supply	Rated speed	Rated output	Type	Overall length	Dimensions (Flange)	Mass [kg]
				L	LL	
200V series	3000r/min	0.2kW	GYB201D7-□□2	96.2	66.2	0.9
		0.4kW	GYB401D7-□□2	114	84	1.2



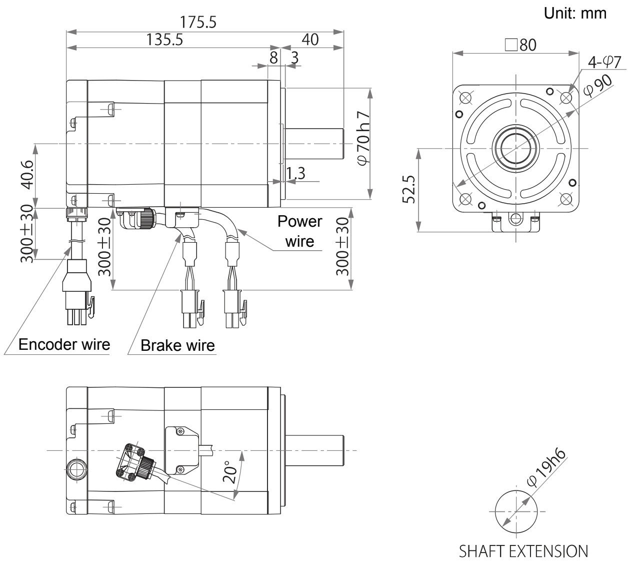
Power supply	Rated speed	Rated output	Type	Mass [kg]
200V series	3000r/min	0.75kW	GYB751D7-□□2	2.3

* See “8.5 Optional Specification of Shaft Extension [With a Key, Tapped]” for the shaft extension specifications of the motor with a key.

8.3.6 GYB Motor (Lead Wire Type) (With a Brake)



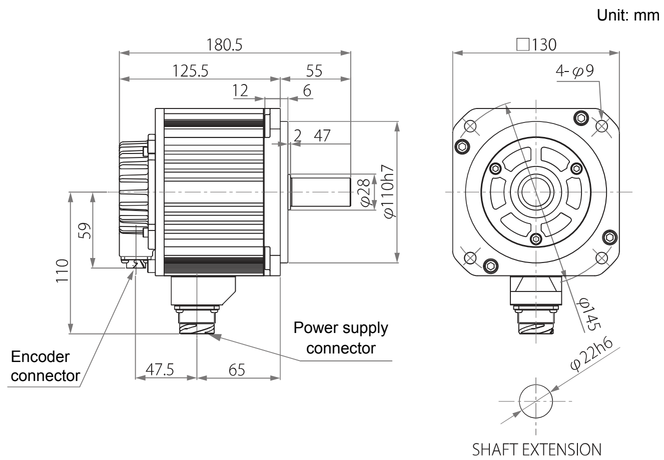
Power supply	Rated speed	Rated output	Type	Overall length	Dimensions (Flange)	Mass [kg]
				L	LL	
200V series	3000r/min	0.2kW	GYB201D7-□□2-B	136.25	106.25	1.3
		0.4kW	GYB401D7-□□2-B	154.1	124.1	1.8



Power supply	Rated speed	Rated output	Type	Mass [kg]
200V series	3000r/min	0.75kW	GYB751D7-□□2-B	3.2

* See “8.5 Optional Specification of Shaft Extension [With a Key, Tapped]” for the shaft extension specifications of the motor with a key.

8.3.7 GYG Motor (2000 [r/min])

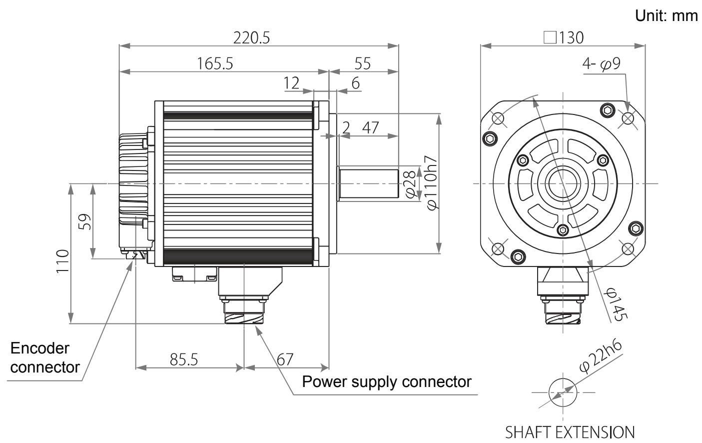


Power supply	Rated speed	Rated output	Type	Mass [kg]
200V series	2000r/min	1.0kW	GYG102C7-□□2	5.6

* See “8.5 Optional Specification of Shaft Extension [With a Key, Tapped]” for the shaft extension specifications of the motor with a key.

8

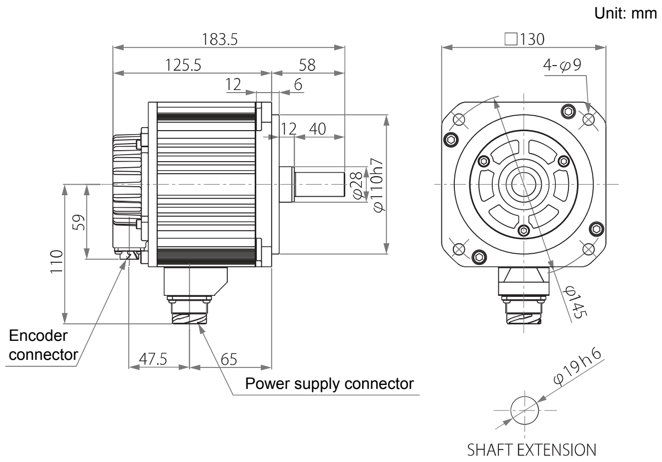
8.3.8 GYG Motor (2000 [r/min]) (With a Brake)



Power supply	Rated speed	Rated output	Type	Mass [kg]
200V series	2000r/min	1.0kW	GYG102C7-□□2-B	7.8

* See “8.5 Optional Specification of Shaft Extension [With a Key, Tapped]” for the shaft extension specifications of the motor with a key.

8.3.9 GYG Motor (1500 [r/min])

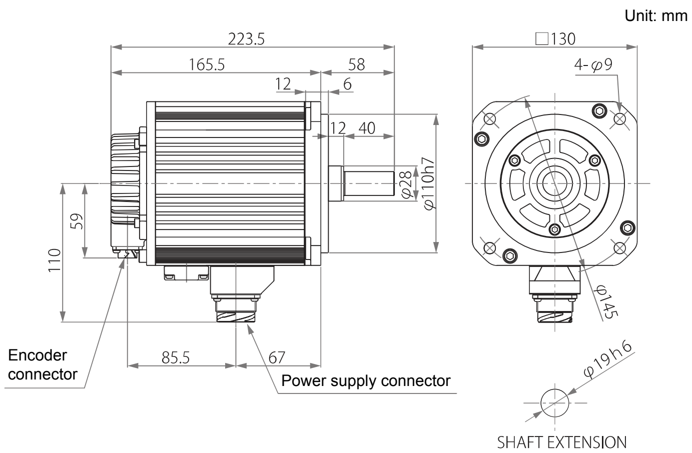


Power supply	Rated speed	Rated output	Type	Mass [kg]
200V series	1500r/min	0.85kW	GYG851B7-□□2	5.6

* See “8.5 Optional Specification of Shaft Extension [With a Key, Tapped]” for the shaft extension specifications of the motor with a key.

8

8.3.10 GYG Motor (1500 [r/min]) (With a Brake)

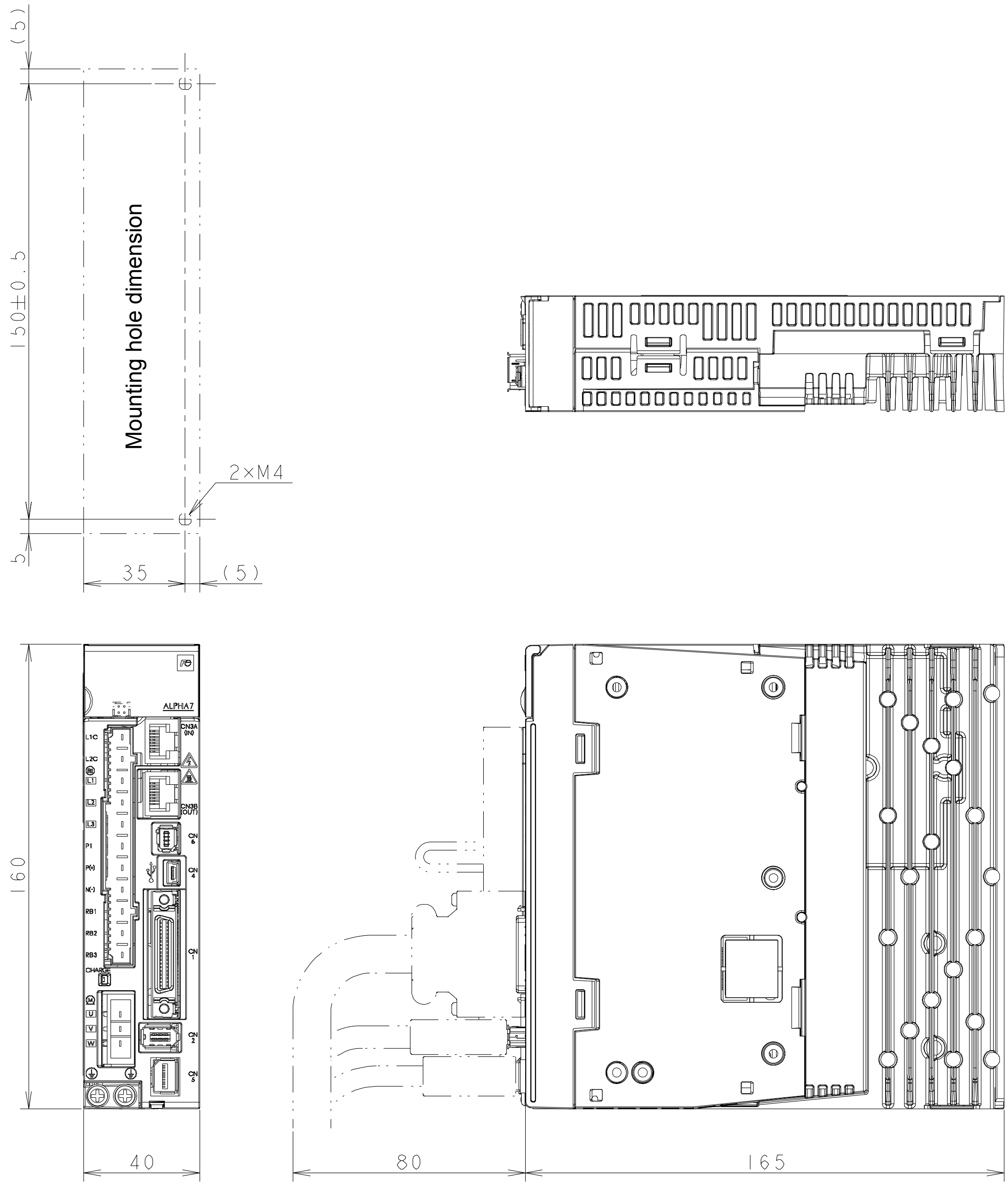


Power supply	Rated speed	Rated output	Type	Mass [kg]
200V series	1500r/min	0.85kW	GYG851B7-□□2-B	7.8

* See “8.5 Optional Specification of Shaft Extension [With a Key, Tapped]” for the shaft extension specifications of the motor with a key.

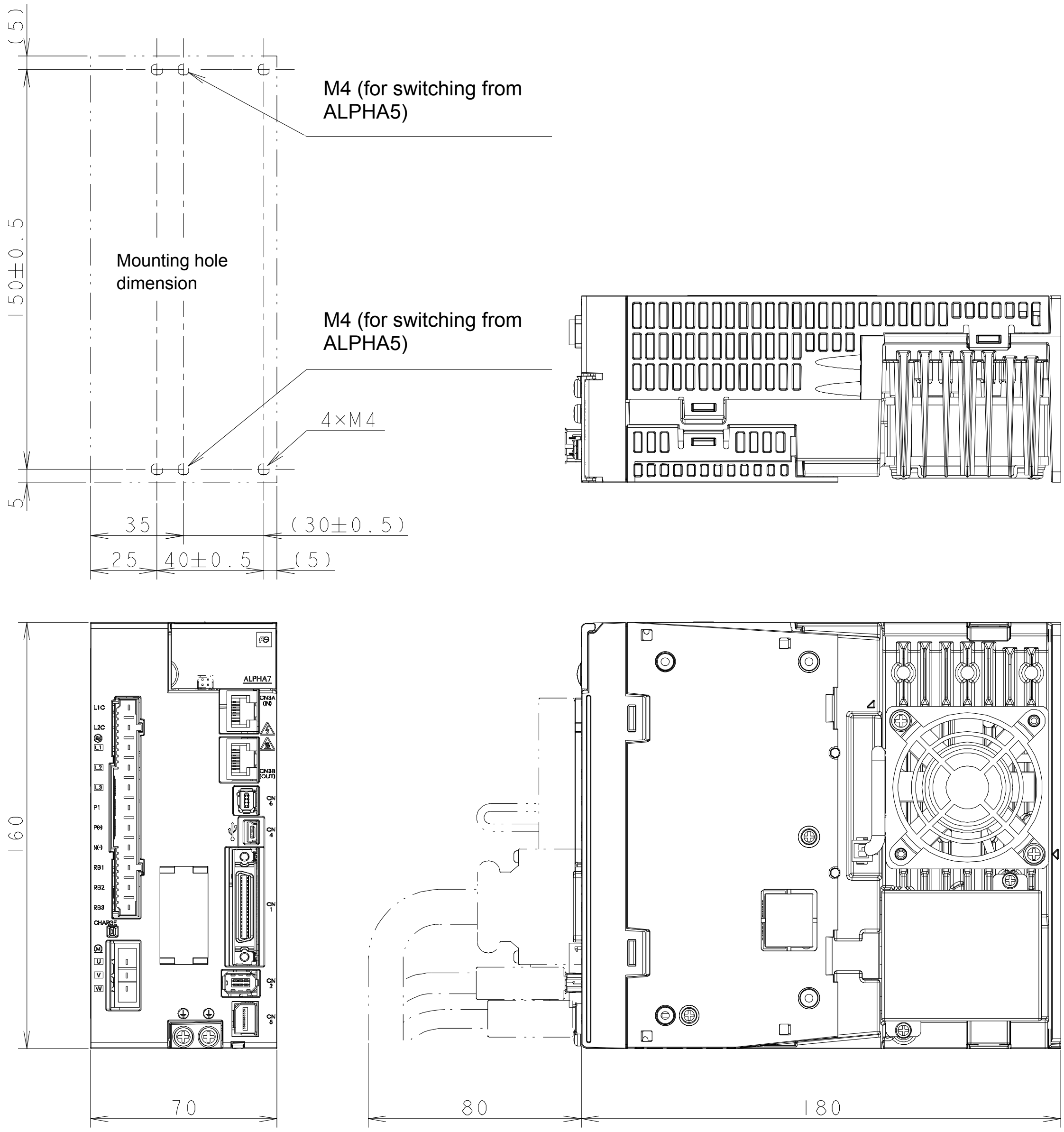
8.4 Dimensions of Servo Amplifier

Frame 1



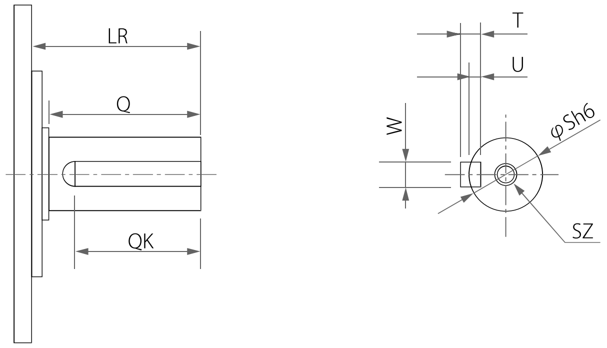
Power supply	Type	Mass [kg]
200V series	RYT500F7-☐S2	0.9
	RYT101F7-☐S2	
	RYT201F7-☐S2	
	RYT401F7-☐S2	

Frame 2



Power supply	Type	Mass [kg]
200V series	RYT751F7-□S2	1.5
	RYT102F7-□S2	
	RYT152F7-□S2	
	RYT102F7-□S2	
	RYT102F7-□S2	

8.5 Optional Specification of Shaft Extension [With a Key, Tapped]



Unit: mm

Motor type	LR	Q	QK	S	T	U	W	SZ
GYS motor 3000r/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
GYB motor 3000r/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 2000r/min								
GYG102C7-□C2-□	55	47	35	22	7	4	8	M8 depth: 16
GYG motor 1500r/min								
GYG851B7-□C2-□	58	40	30	19	6	3.5	6	M6 depth: 12

* The shaft extension of the GYS motors of 0.1kW or less is not tapped.

8

CHAPTER 9 CHARACTERISTICS

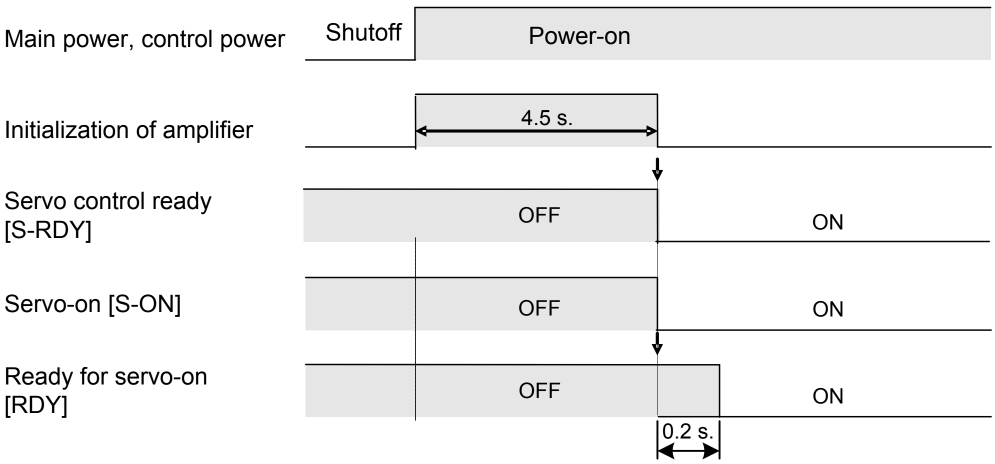
9

9.1 Timing Chart

9.1.1 Power-On Timing

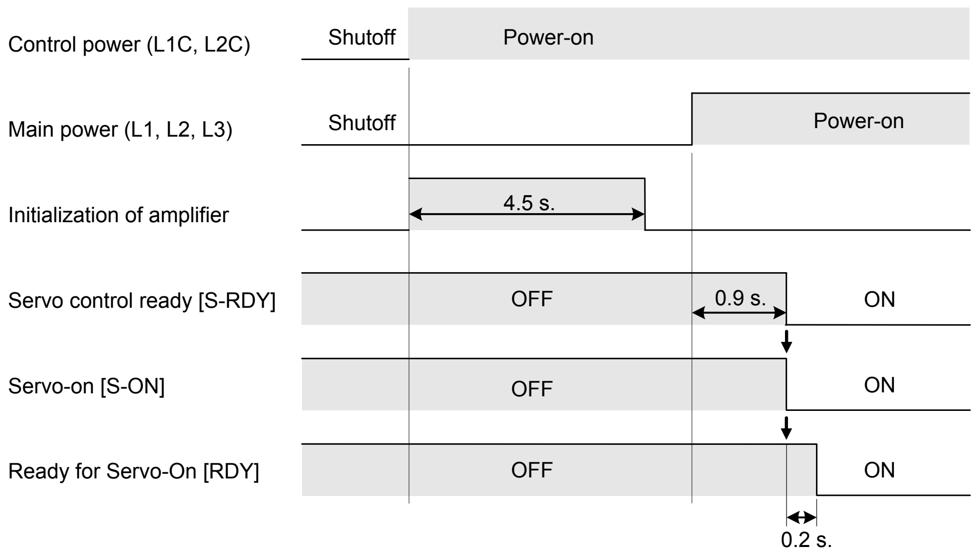
■ If the motor power and control power are turned on simultaneously

(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) After (2) is verified, the servo-on [S-ON] signal is turned on.
(4) After ready for servo-on [RDY] is turned on, the servo amplifier is ready to operate.



■ 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) After (2) is verified, the motor power is turned on and the servo-on [S-ON] signal is turned on.
(4) After ready for servo-on [RDY] is turned on, the servo amplifier is ready to operate.

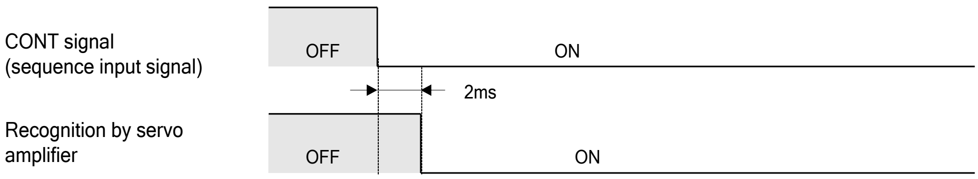


9

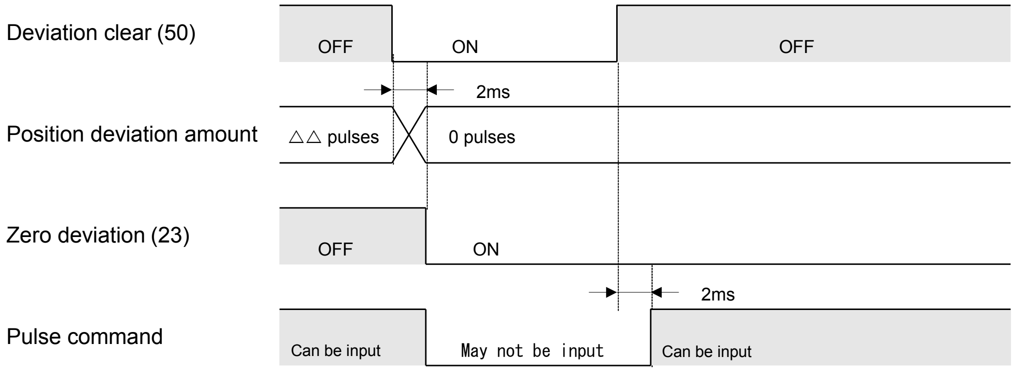
9.1.2 Each Signal Timing

■ 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.



[Example] Deviation clear signal



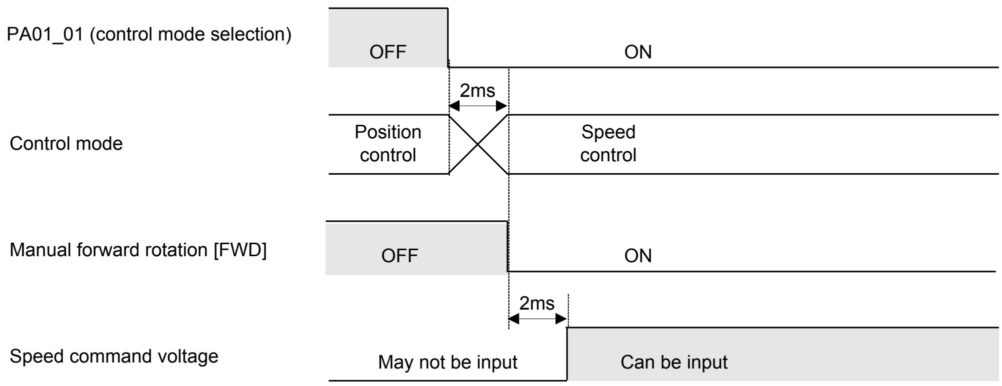
9

9.1.3 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.

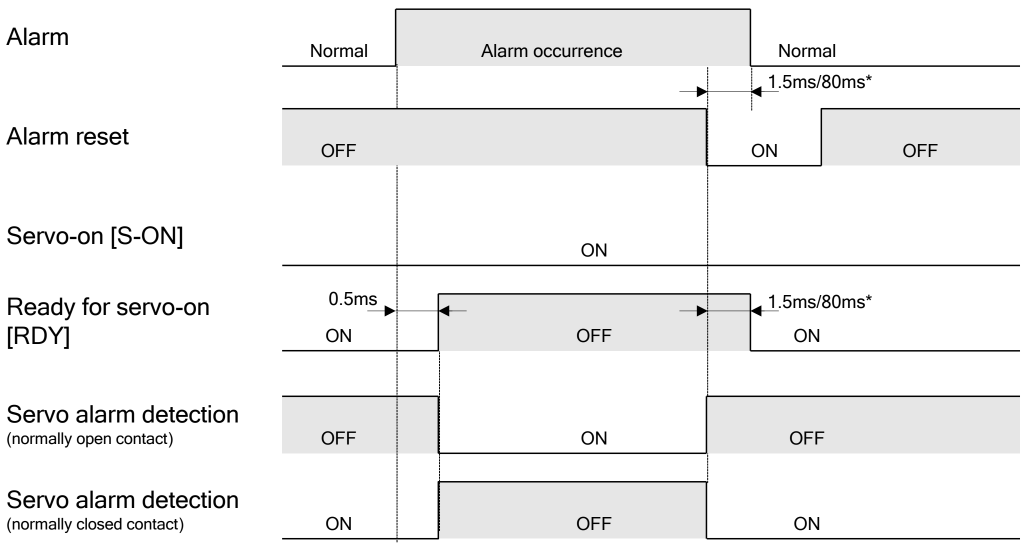
[Example] Switching from position control to speed control



9.1.4 Alarm Reset Timing

After an alarm occurs, it takes about 0.5 [ms] until alarm detection output.

It takes about 1.5 [ms] or 80 [ms]* after an alarm reset signal is issued until the alarm is actually removed.



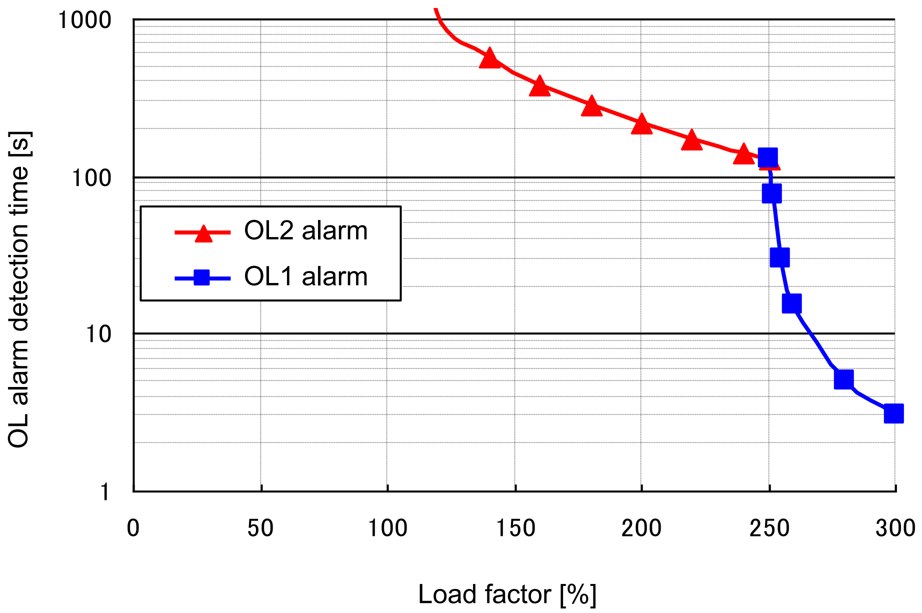
* The time varies according to the setting of PA2_62 (Action sequence at alarm).
If the action at stop is free-run (reference value: 1, 3 or 5): 1.5 [ms]
If the action at stop is DB (dynamic brake) (reference value: 0, 2 or 4): 80 [ms]

9.2 Overload Characteristic

The detection time and load factor characteristics until an overload alarm (OL1/OL2) occurs are indicated by rotation speed.

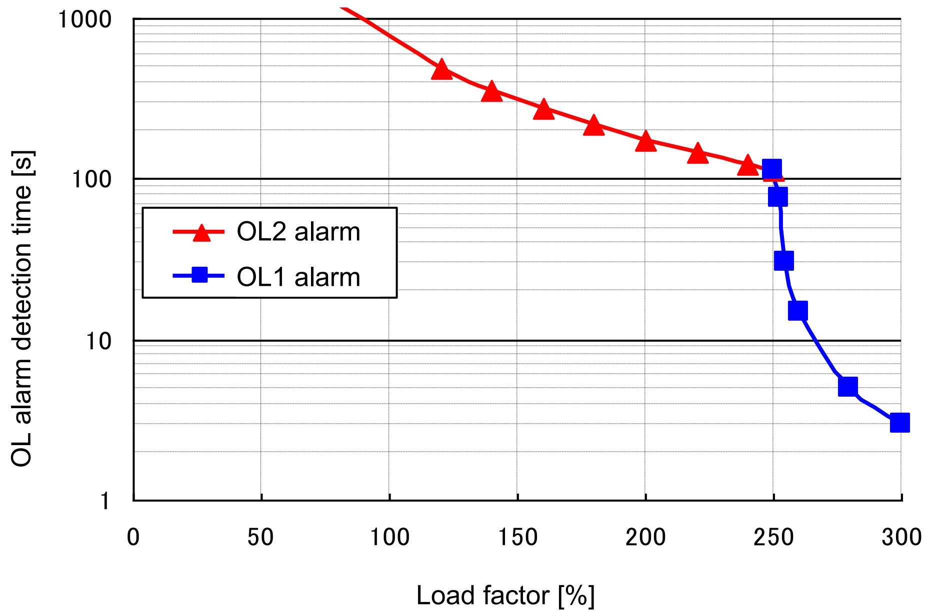
9.2.1 GYS Motor

(1) In case of operation at rated rotation speed (3000 [r/min])

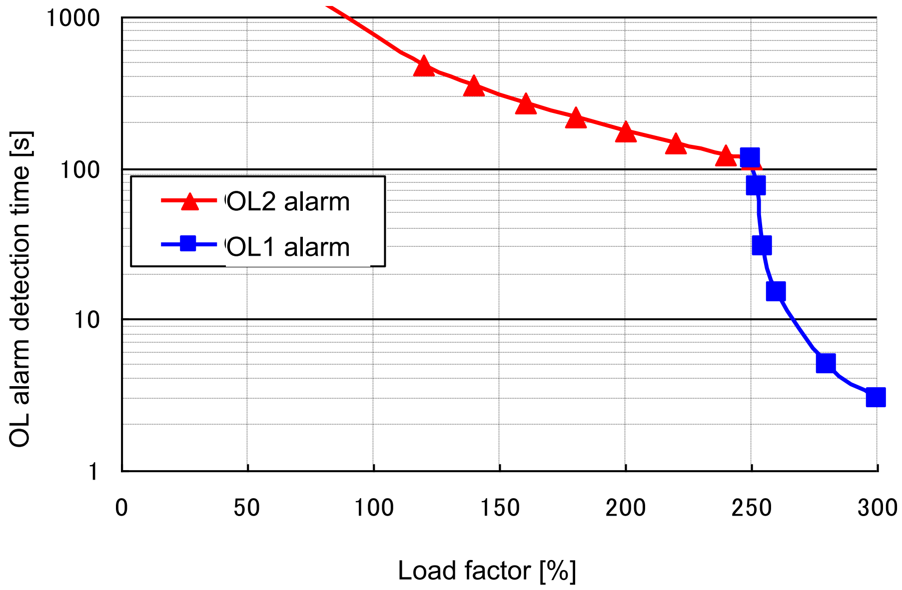


9

(2) In case of operation at maximum rotation speed (6000 [r/min])

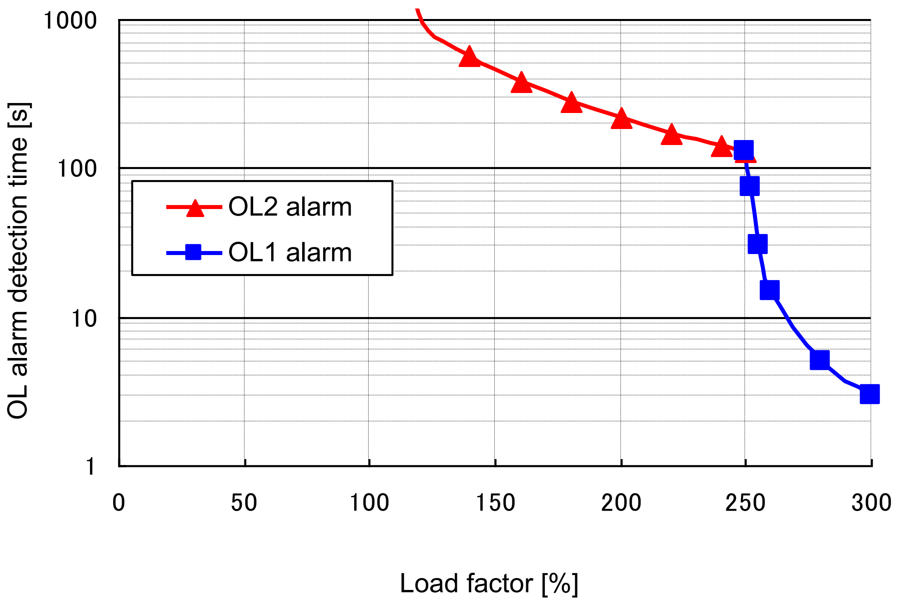


(3) In case of operation at max. rotation speed (5000 [r/min])
Target capacity: 1.0 [kW]

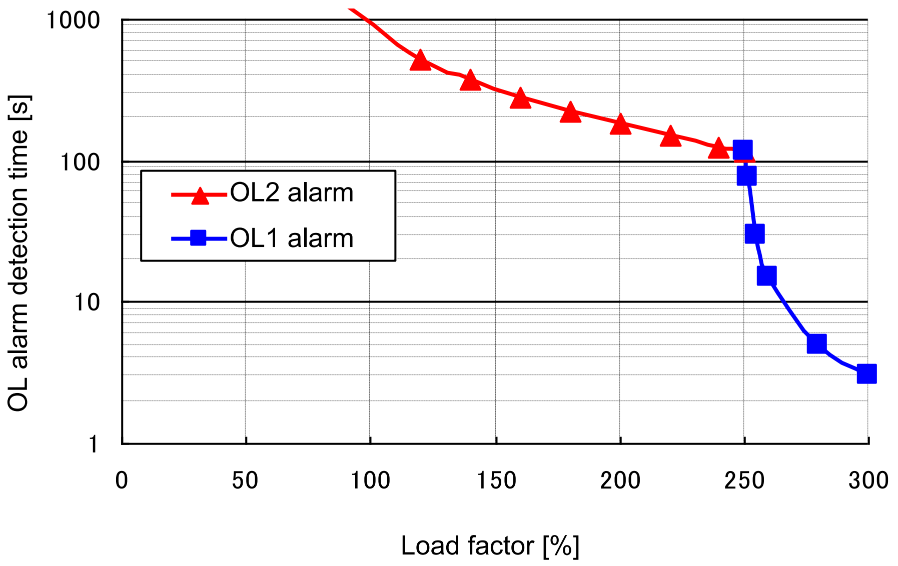


9.2.2 GYG Motor

(1) In case of operation at rated rotation speed (1500/2000 [r/min])

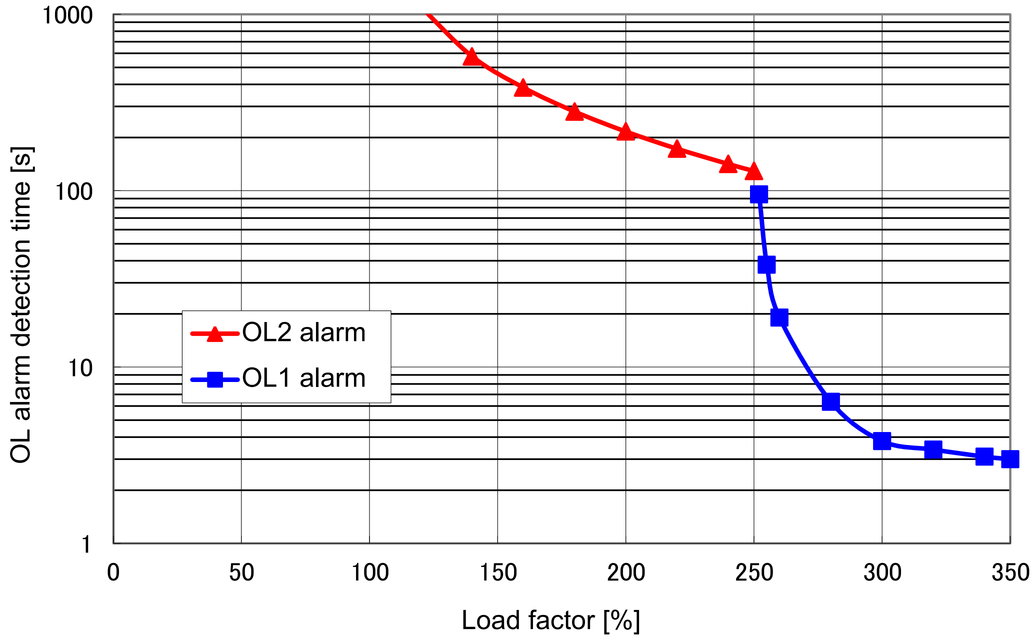


(2) In case of operation at max. rotation speed (3000 [r/min])

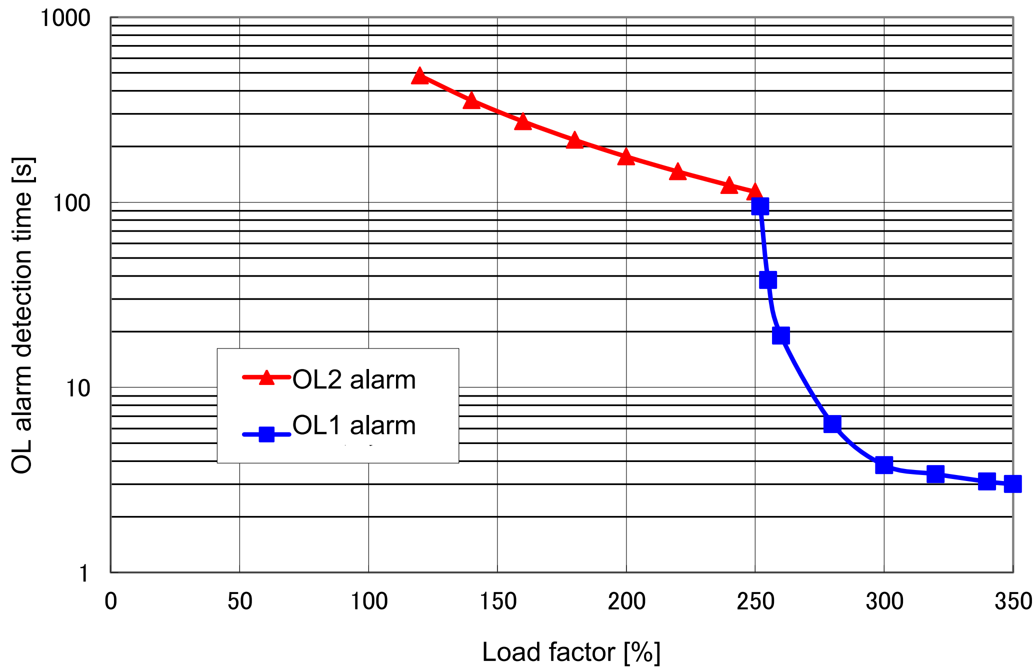


9.2.3 GYB Motor

(1) 3000 [r/min] or less

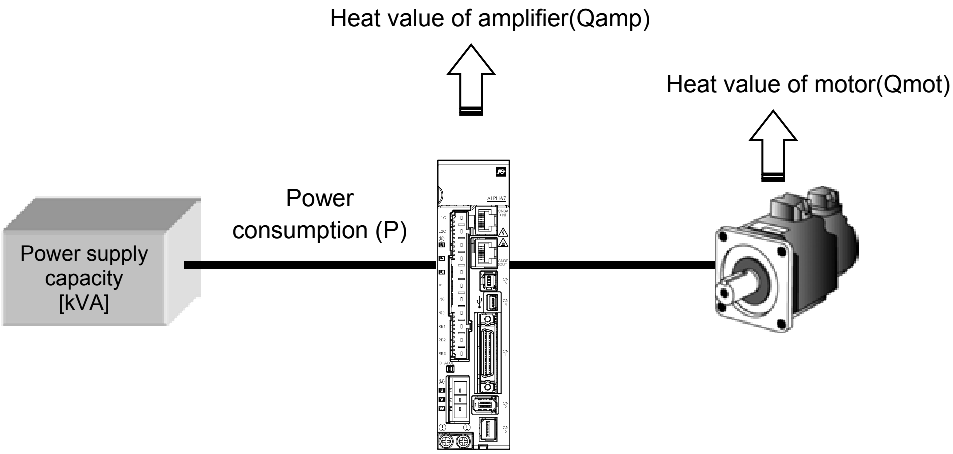


(2) 6000 [r/min] or less



9

9.3 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-□□2	GY□500D7-□□2	0.05	0.1	0.074	0.018	0.006
	RYT101F7-□□2	GY□101D7-□□2	0.1	0.2	0.13	0.021	0.011
	RYT201F7-□□2	GY□201D7-□□2	0.2	0.4	0.25	0.027	0.022
	RYT401F7-□□2	GY□401D7-□□2	0.4	0.8	0.48	0.038	0.044
	RYT751F7-□□2	GY□751D7-□□2	0.75	1.5	0.89	0.059	0.083
	RYT102F7-□□2	GY□102D7-□□2	1.0	2.0	1.2	0.073	0.11
	RYT152F7-□□2	GY□152D7-□□2	1.5	2.9	1.8	0.103	0.17
2000 [r/min]	RYT102F7-□□2	GY□102C7-□□2	1.0	2.0	1.20	0.073	0.11
1500 [r/min]	RYT851F7-□□2	GY□851B7-□□2	0.85	1.7	1.0	0.065	0.094

9.4 Inrush Current

The allowable inrush current of the servo amplifier is specified below.

Servo amplifier model	Inrush current [A]
RYT500F7-□□2	5.1
RYT101F7-□□2	
RYT201F7-□□2	
RYT401F7-□□2	
RYT751F7-□□2	
RYT102F7-□□2	
RYT152F7-□□2	

・Input voltage = 200 [V] AC

・The inrush current indicates the maximum peak current.

9

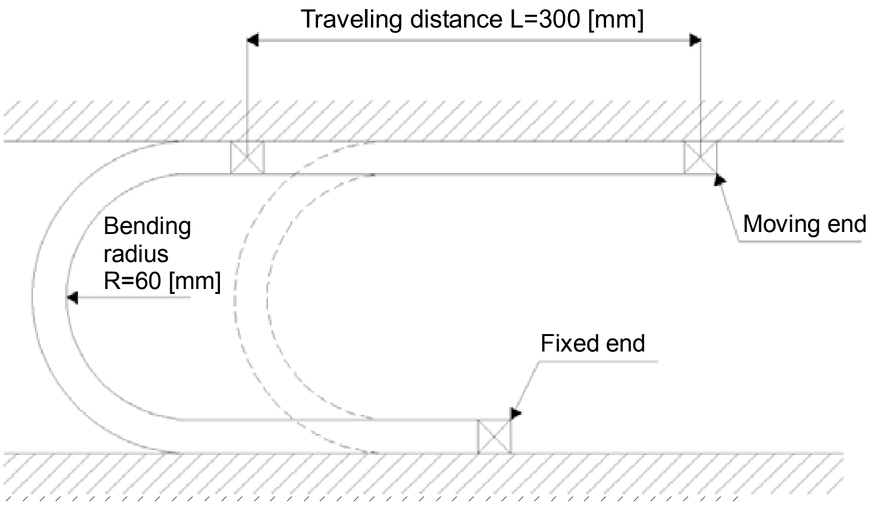
9.5 Bending Strength of Cable

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.

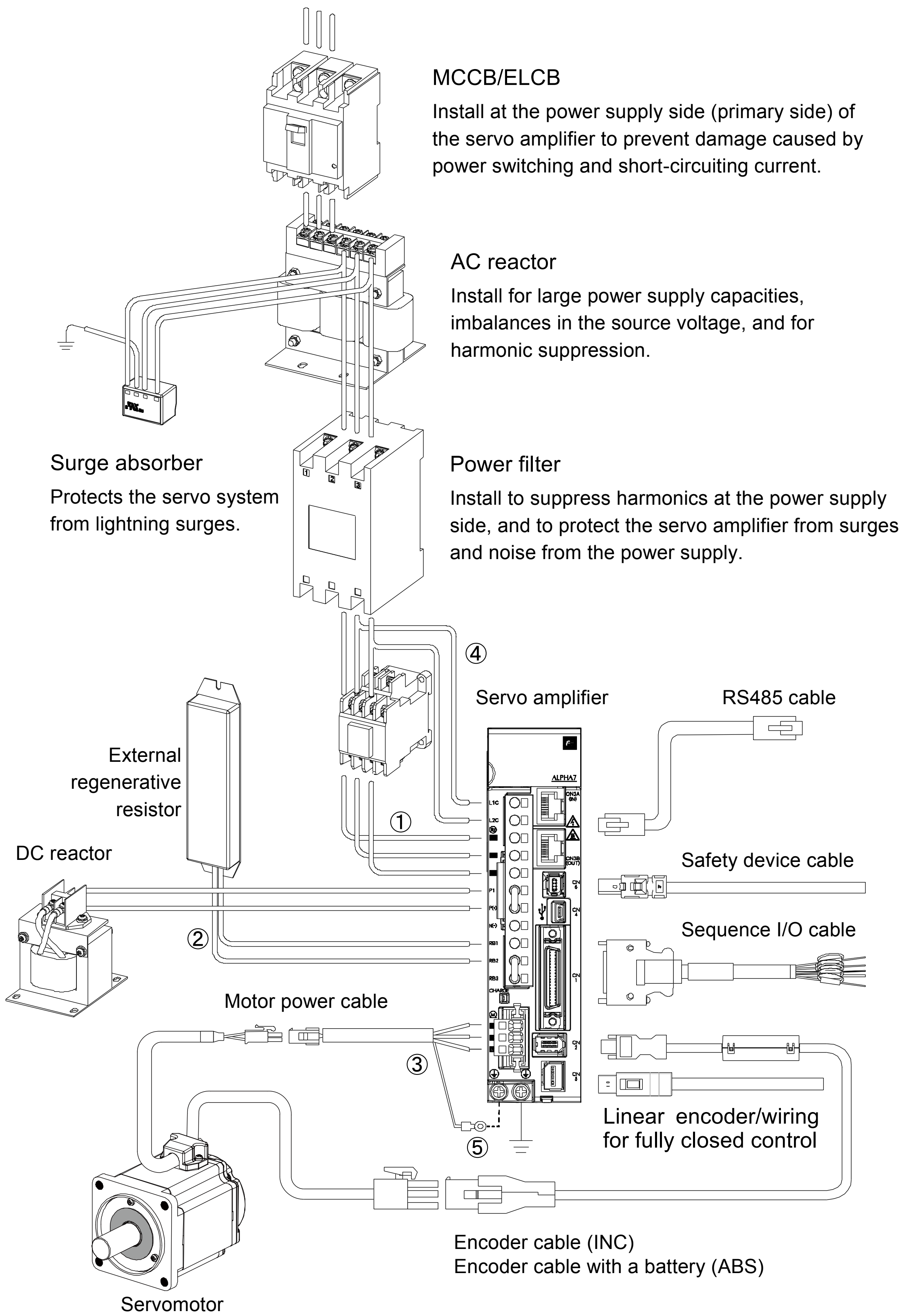


Note	The cable life depends largely on the handling method. The bending life is a reference value for the testing conditions specified above.

9

CHAPTER 10 PERIPHERAL EQUIPMENT

10.1 Overall Configuration of Peripheral Equipment



Recommended cable sizes for cables (1) to (5) above are listed in "10.2.1 Main Circuit Section Cable Size".

10

10.2 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.

10.2.1 Main Circuit Section Cable Size

The following cable sizes are recommended for parts (1), (2), (3), (4) and (5) specified “10.1 Overall Configuration of Peripheral Equipment”.

■ Single-phase 200V

Servo amplifier capacity [W]	Recommended cable size [mm^2]				
	(1) Power supply (L1,L2,L3) (3) Motor power (U,V,W) (5) Earthing (E)		(2) Regenerative resistor (RB1, RB2, RB3)		(4) Control power (L1C,L2C)
	75 [℃] (HIV)	90 [℃] (CV)	75 [℃] (HIV)	90 [℃] (CV)	Common
50 to 750	1.25	0.75	1.25	1.25	0.75

■ 3-phase 200V

Servo amplifier capacity [W]	Recommended cable size [mm^2]				
	(1) Power supply (L1,L2,L3) (3) Motor power (U,V,W) (5) Earthing (E)		(2) Regenerative resistor (RB1, RB2, RB3)		(4) Control power (L1C,L2C)
	75 [℃] (HIV)	90 [℃] (CV)	75 [℃] (HIV)	90 [℃] (CV)	Common
50 to 1000	1.25	0.75	1.25	1.25	0.75
1500	2.0				

If the servo system requires to fit the overseas standard, use the following cable size.
(Cable: 75 [℃] (HIV))

<Power supply and motor power>
(1) 1kW or less = 1.25mm^2
(2) 1.5kW = 2.0mm^2

<Regenerative resistor, control power supply, etc.>
Same as above table.

10.2.2 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

10.2.3 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]): $Iin = (Po + Pi) / (Vac \times 1.35 \times \eta amp \times \eta mot) \times 1.27 \times \sqrt{3}$

Input current (3-phase 200 [V]): $Iin = (Po + Pi) / (Vac \times 1.35 \times \eta amp \times \eta mot) \times 1.27$

ηamp (amplifier efficiency) = 0.95 and ηmot (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			0.7	1.0
100			1.2	1.7
200	190*	15	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			0.4	0.6
100			0.7	1.1
200			1.4	2.1
400	170*	15	2.7	4.0
750			5.0	7.4
1000			6.6	9.8
1500			9.8	14.7

*-15% of 200V

10.2.4 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.

10.3 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

10.4 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

<table>
<tr><th>Servo amplifier capacity [kW]</th><th>MC</th></tr>
<tr><td>0.05</td><td rowspan="4">SC-03</td></tr>
<tr><td>0.1</td></tr>
<tr><td>0.2</td></tr>
<tr><td>0.4</td></tr>
<tr><td>0.75</td><td>SC-0</td></tr>
</table>

■ In case of 3-phase 200V

<table>
<tr><th>Servo amplifier capacity [kW]</th><th>MC</th></tr>
<tr><td>0.05</td><td rowspan="6">SC-03</td></tr>
<tr><td>0.1</td></tr>
<tr><td>0.2</td></tr>
<tr><td>0.4</td></tr>
<tr><td>0.75</td></tr>
<tr><td>1.0</td></tr>
<tr><td>1.5</td><td>SC-4-1</td></tr>
</table>

10.5 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.

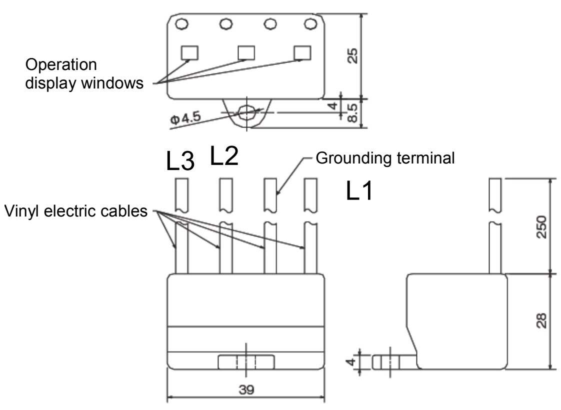
Recommendation [Soshin Electric product]

Single phase: LT-C12G801WS *

Three-phase: LT-C32G801WS

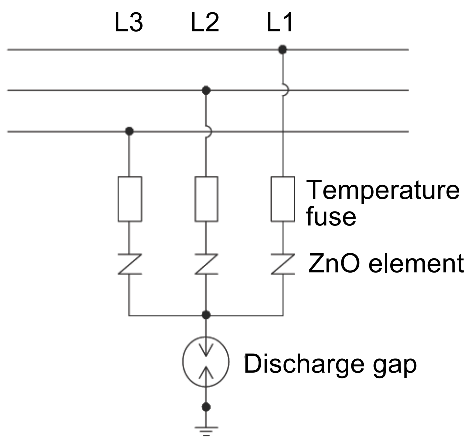
* The product for single phase has no L2 terminals.

<External dimensions>



(Unit: mm)

<Internal connection diagram>



■ For protection from open/close surge of peripheral equipment

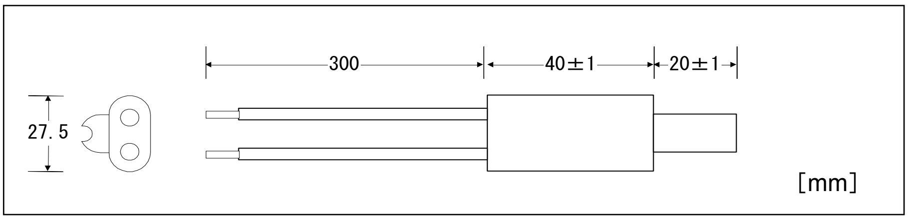
To install a surge absorber to peripheral equipment (electromagnetic contactor, solenoid, electromagnetic brake, etc.) of the servo amplifier, use the following one.

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.

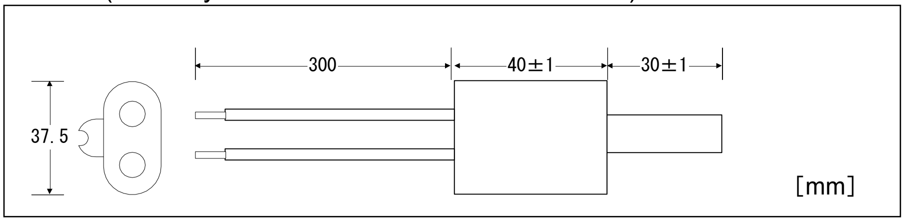
Control relay, etc.

Model: S1-B-0 (made by OKAYA ELECTRIC INDUSTRIES)



Electromagnetic contactor, etc.

Model: S2-A-0 (made by OKAYA ELECTRIC INDUSTRIES)

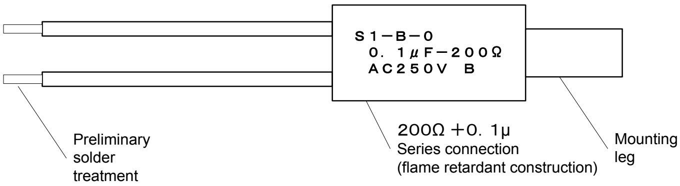


Applicable to 250 [V] AC or less voltages

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]

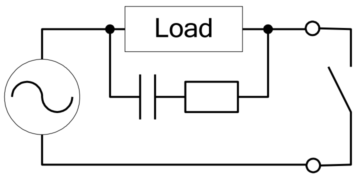


The purpose of the surge absorber is suppression of the surge voltage.

・Protection in AC circuit

C-R circuit

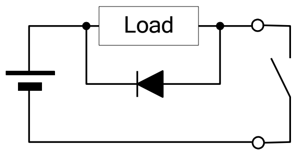
(Protection of the DC circuit is also provided.)



・Protection in DC circuit

Diode

(Be aware of the orientation of the diode.)

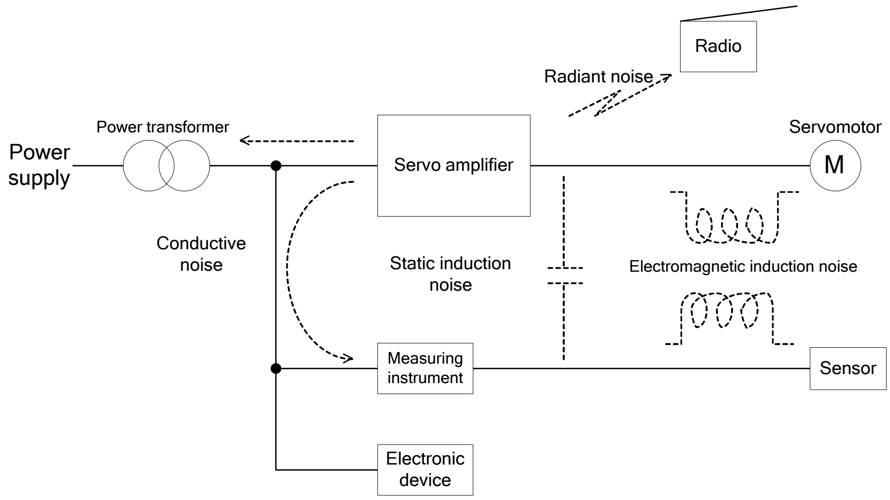


10

10.6 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).

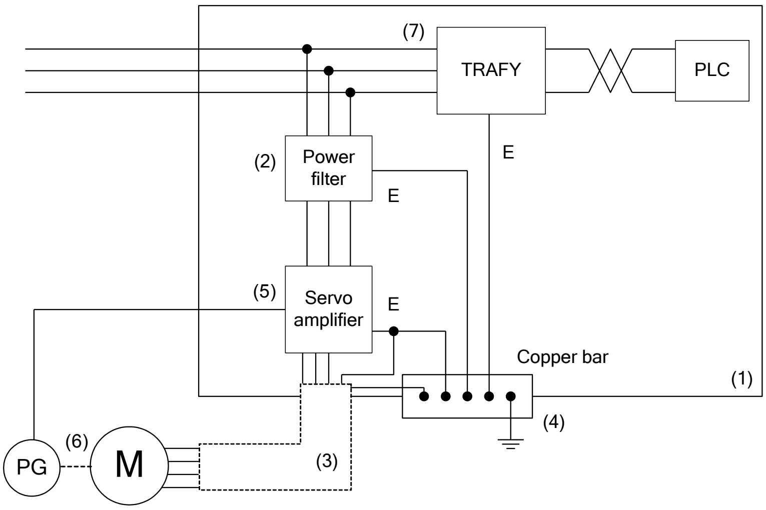
(4) Use a grounding cable as thick and short as possible.
Connect the grounding cable directly from the copper bar to individual device (do not use a jumper cable). A twisted or net cable has a larger effect.

(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	RNFTD06-20
0.1	
0.2	
0.4	
0.75	RNFTD10-20
1.0	
1.5	RNFTD20-20

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.

10.7 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.

Model of AC/DC reactor

■ In case of single-phase 200V

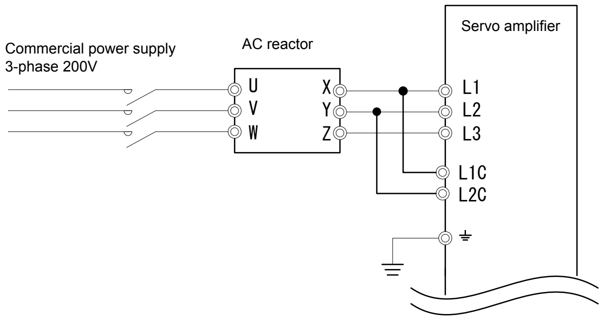
Servo amplifier capacity [kW]	AC reactor	DC reactor
0.05	ACR2-0.4A	DCR2-0.2
0.1		DCR2-0.4
0.2	ACR2-0.75A	DCR2-0.75
0.4	ACR2-1.5A	DCR2-1.5
0.75	ACR2-2.2A	DCR2-2.2

■ 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		

- How to connect the AC reactor

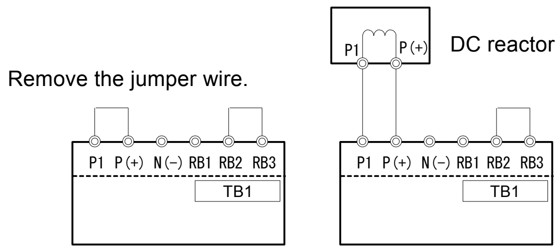
  Connect in the primary circuit of the servo amplifier as shown in the figure below.



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

10.8 External Regenerative Resistor

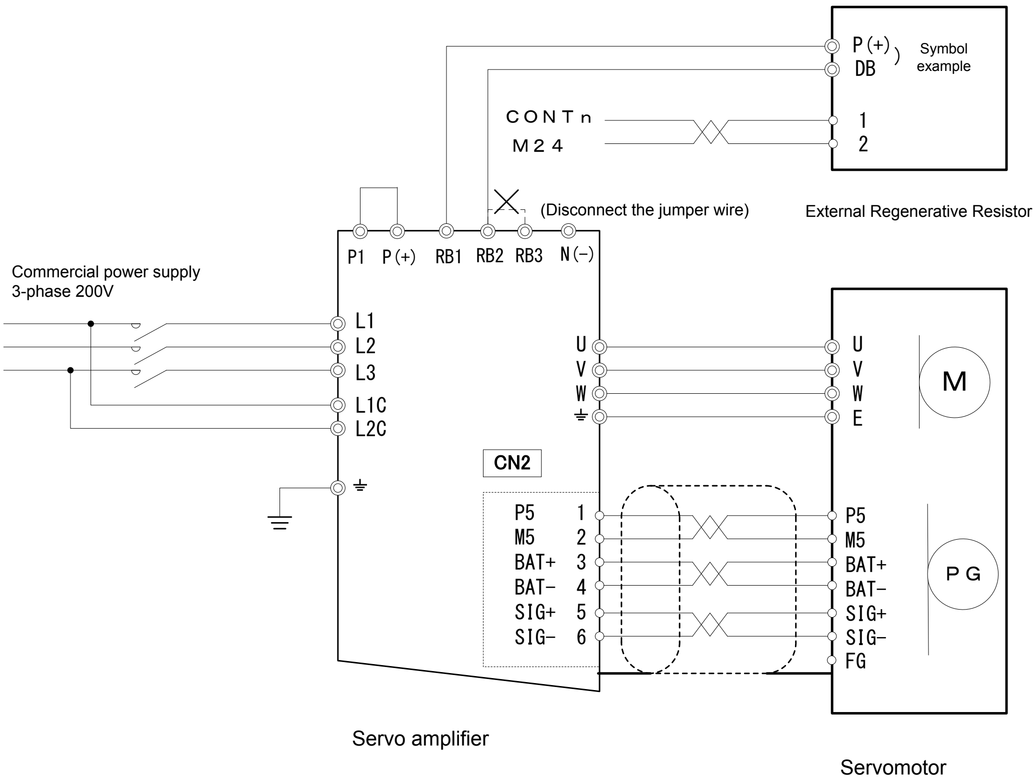
The external regenerative resistor consumes regenerative power generated by the servomotor.

Use an external regenerative resistor if the elevating load is large and the operation frequency is high.

Servo amplifier model	Capacity [kW]	Built-in resistor*	External Regenerative Resistor	Applicable resistance [Ω]
RYT500F7-□□2	0.05	－	WSR-401 (68Ω,17W)	39～160
RYT101F7-□□2	0.1	－		
RYT201F7-□□2	0.2	－		
RYT401F7-□□2	0.4	8W/40Ω		39～80
RYT751F7-□□2	0.75	20W/15Ω	WSR-152 (15Ω, 50W)	15～40
RYT102F7-□□2	1.0			12～27
RYT152F7-□□2	1.5			

* The allowable wattage of the built-in regenerative resistor varies according to the ambient temperature.

■ To connect the optional external regenerative resistor



To use an external regenerative resistor, wiring and parameter setting are necessary.

- Wiring of thermistor output of external regenerative resistor
  - Be sure to connect to the host device, turn on the thermistor, and turn off the servo amplifier main power.*
  - Allocate external regenerative resistor overheat (34) to a CONT input terminal.
- Parameter setting
  - Set PA2_65 (regenerative resistor selection) at 2 (external resistor).

Note	* The external regenerative resistor will become excessively hot in the event of failure of the braking transistor, possibly causing fire.

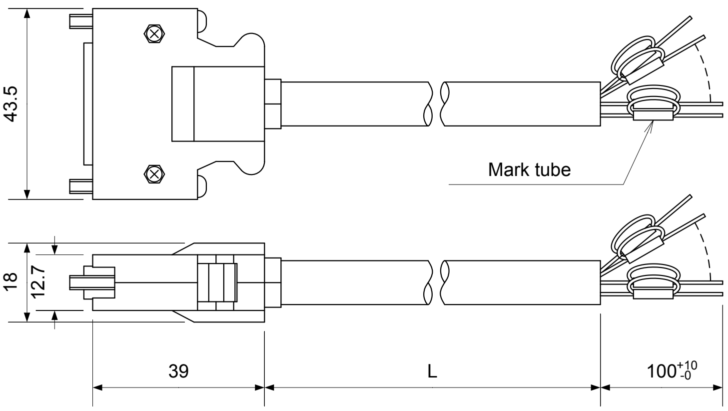
10

10.9 Optional Equipment

Sequence I/O cable

Model: WSC-D36P03

Applicable range: All models (for CN1)



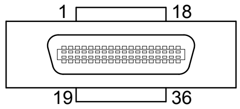
■ Model/manufacturer

Connector 1

Plug	10136-3000PE
Shell	10336-52A0-008

Sumitomo 3M Limited

■ Terminal layout



■ Wire color

Connector 1		1	2	3	4	5	6	7	8	9	11*	10*	12	13	15*	14*	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
Mark tube		1	2	3	4	5	6	7	8	9	11	10	12	13	15	14	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
Wire color	Color	Orange		Gray		White		Yellow		Pink		Orange		Gray		White		Yellow		Pink		Orange		Gray		White		Yellow		Pink		Orange		Gray		White	
	Mark	Red 1	Black 1	Red 1	Black 1	Red 1	Black 1	Red 1	Black 1	Red 1	Black 1	Red 2	Black 2	Red 2	Black 2	Red 2	Black 2	Red 2	Black 2	Red 2	Black 2	Red 3	Black 3	Red 3	Black 3	Red 3	Black 3	Red 3	Black 3	Red 3	Black 3	Red 4	Black 4	Red 4	Black 4	Red 4	Black 4

* Pay close attention to pin numbers.

■ Length

Model	L [mm]
WSC-D36P03	3000^{+30}_{0}

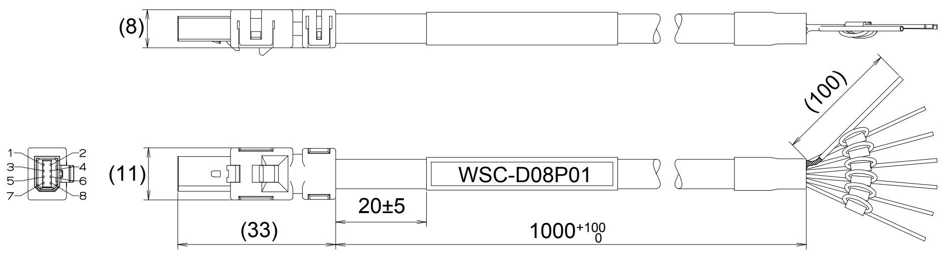
* Please contact Fuji if cables of length other than 3 [m] are required.

- The connector manufacturer may be changed without prior notice.

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

■ 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+	-

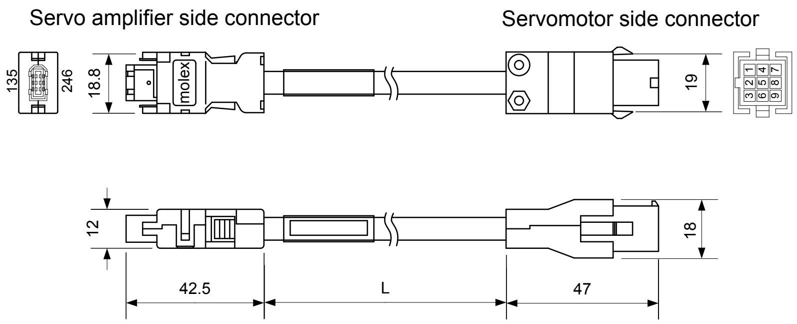
- The connector manufacturer may be changed without prior notice.
- Movable cables are used for cables.

10

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

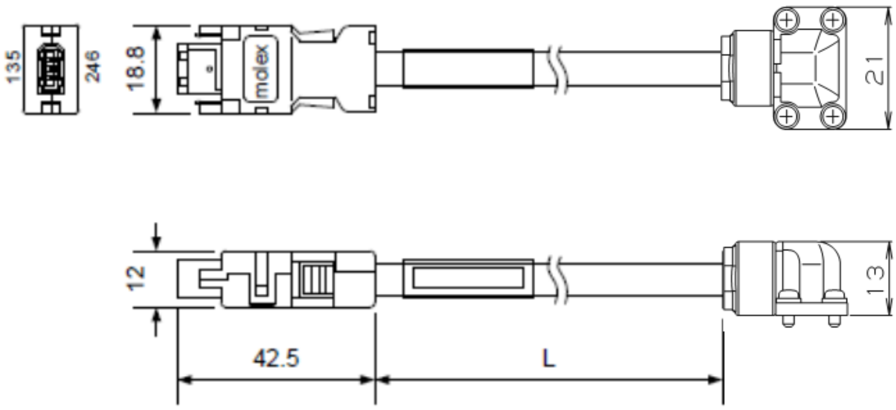
Connect two or more encoder cables, and do not extend the wiring distance.
A sudden stoppage may occur due to a voltage drop resulting from connector contact resistance.

Encoder cable (2)

Model: WSC-P06P02-K to WSC-P06P20-K

Application range: GYB (connector connection specification) model ..... 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

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.

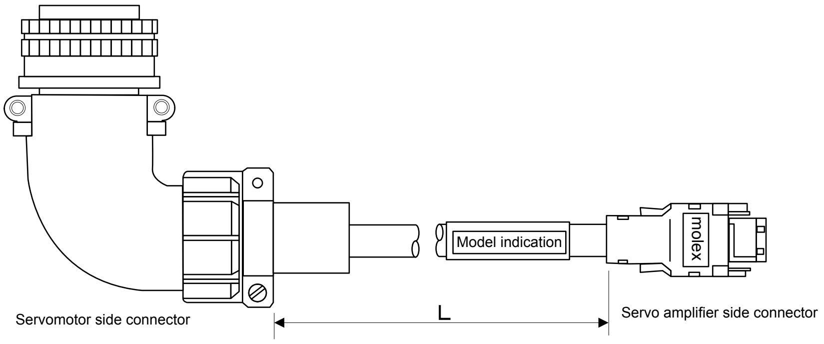
⚠ Caution

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 1.5 [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.

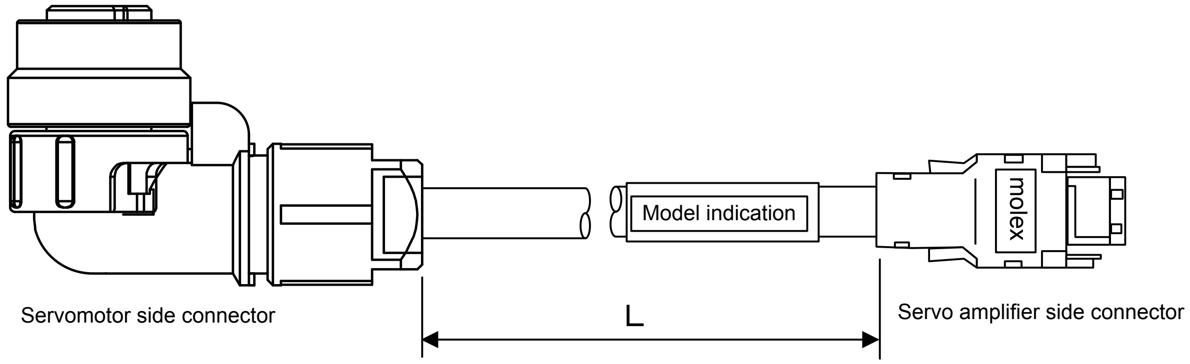
⚠ Caution

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 ..... 0.85 to 1.0 [kW] (for CN2)



■ Model/manufacturer

Servomotor side connector

Plug (L = 500 and 10000)	JN2FS10SL1-R
Plug (L = 20000)	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

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

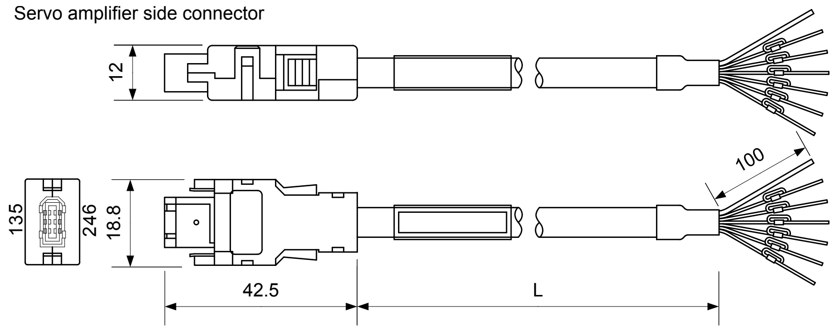
Connect two or more encoder cables, and do not extend the wiring distance.
A sudden stoppage may occur due to a voltage drop resulting from connector contact resistance.

10

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).

10

■ 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.

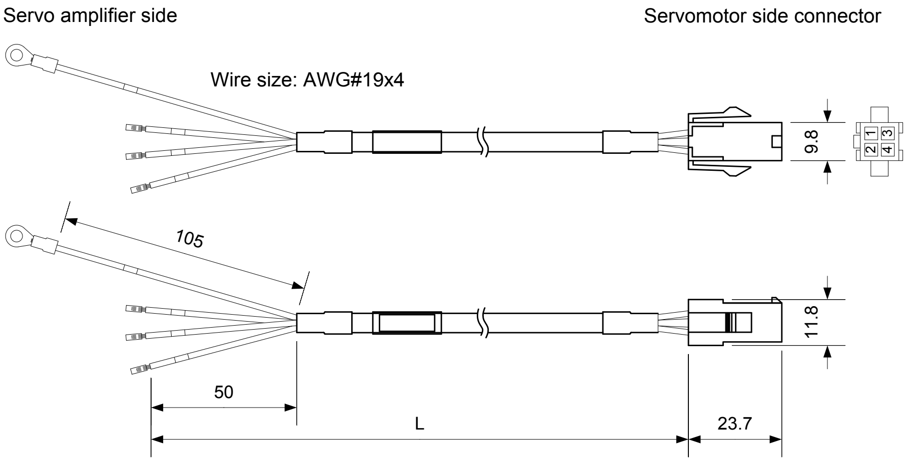
⚠ Caution

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.

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}

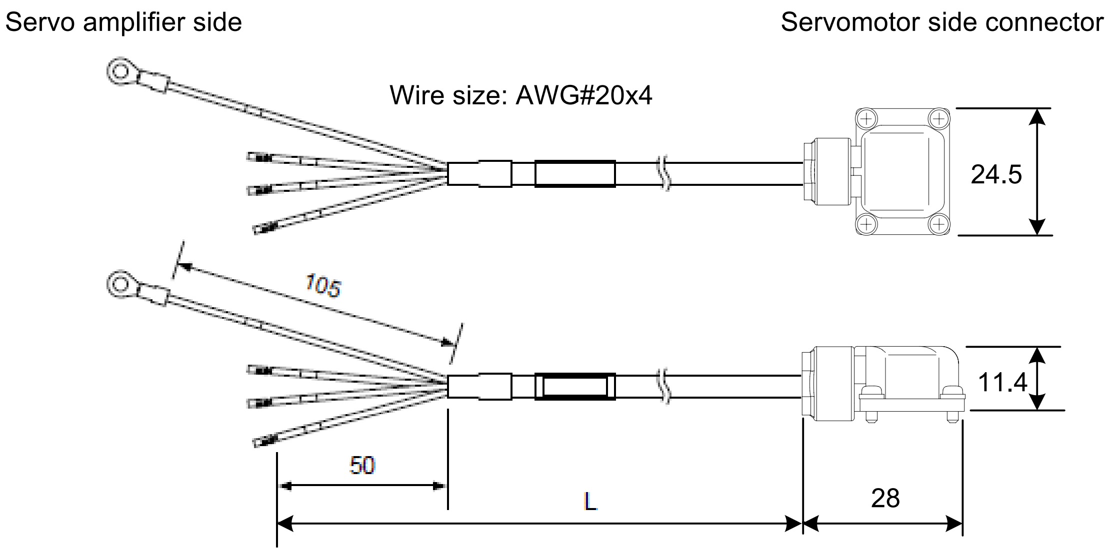
- The connector manufacturer may be changed without prior notice.
- Movable cables are used for cables.

10

Motor power cable (2)

Model: WSC-M04P02-K to WSC-M04P20-K

Application range: GYB (connector connection specification) model ..... 0.75 [kW] or less



■ 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

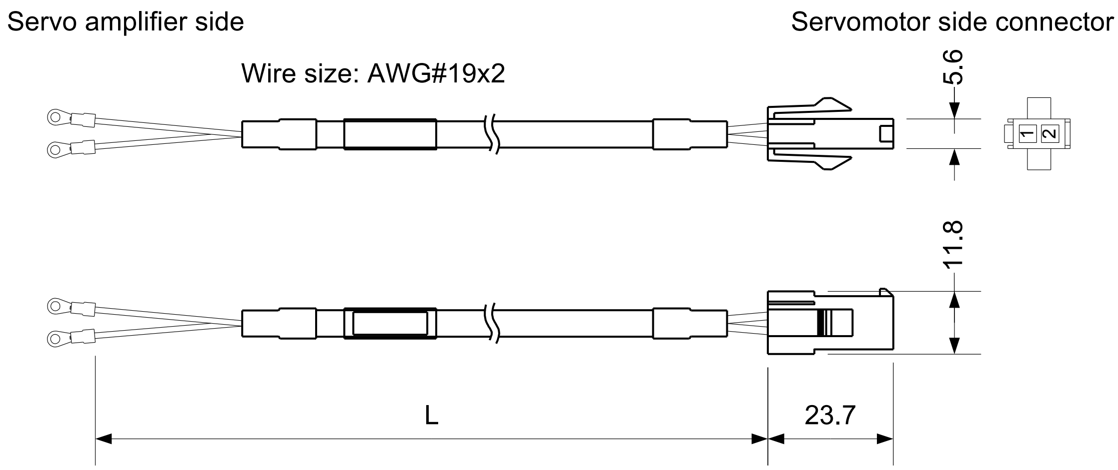
Model	L [mm]
WSC-M04P02-K	2000^{+200}_{0}
WSC-M04P05-K	5000^{+500}_{0}
WSC-M04P10-K	10000^{+1000}_{0}
WSC-M04P20-K	20000^{+2000}_{0}

- The connector manufacturer may be changed without prior notice.
- Movable cables are used for cables.

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}

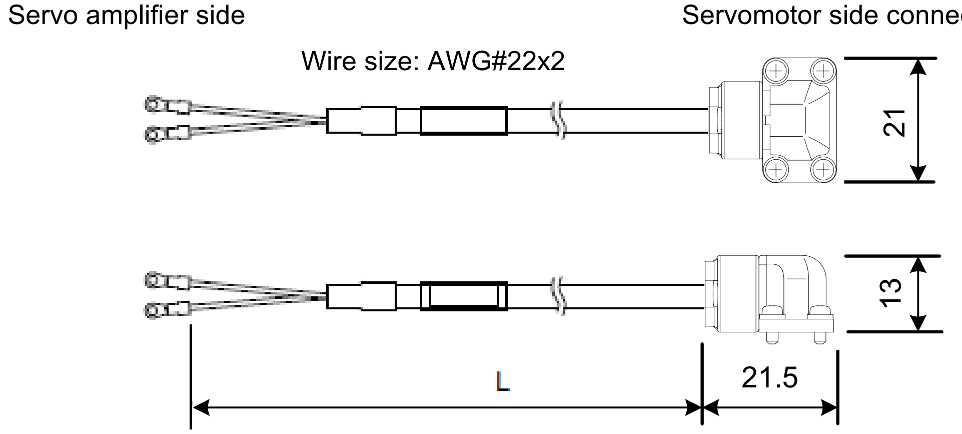
- The connector manufacturer may be changed without prior notice.
- Movable cables are used for cables.

10

Brake cable (2)

Model: WSC-M02P02-K to WSC-M02P20-K

Application range: GYB (connector connection specification) model ..... 0.75 [kW] or less (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}

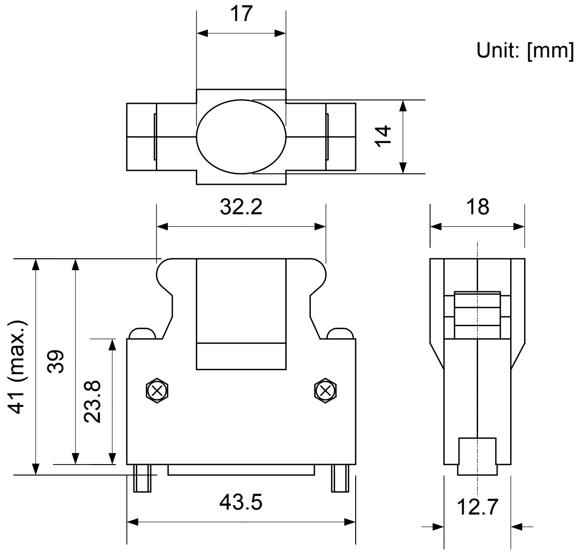
- The connector manufacturer may be changed without prior notice.
- Movable cables are used for cables.

Sequence I/O connector kit

Model: WSK-D36P

Application range: Common to all models

■ External dimensions

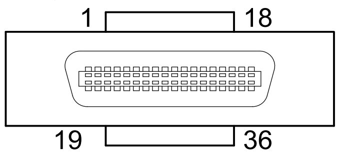


■ Model/manufacturer

Solder plug	10136-3000PE
Shell kit	10336-52A0-008

Sumitomo 3M Limited

■ Terminal layout



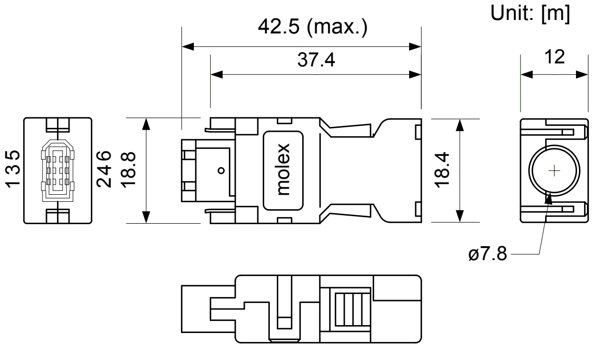
- The connector kit model differs from the optional cable.
- The connector manufacturer may be changed without prior notice.

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.

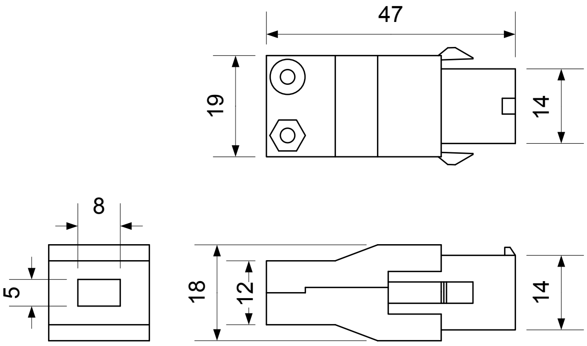
Encoder connector kit (motor side) (1)

Model: WSK-P09P-D

Applicable range: GYS/GYB (lead wire specification) model ..... 0.75 [kW] or less

■ External dimensions

Unit: [mm]

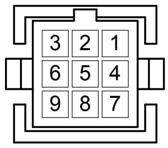


■ Model/manufacturer

Cap	172161-9
Cap cover	316455-1
Socket (SIG+, SIG-, FG)	170365-1 (Loose Piece) 170361-1 (Strip)
Socket (P5, M5)	170366-1 (Loose Piece) 170362-1 (Strip)

TE Connectivity Corporation

■ Terminal layout



- The connector model differs from the optional cable.
- The connector manufacturer may be changed without prior notice.

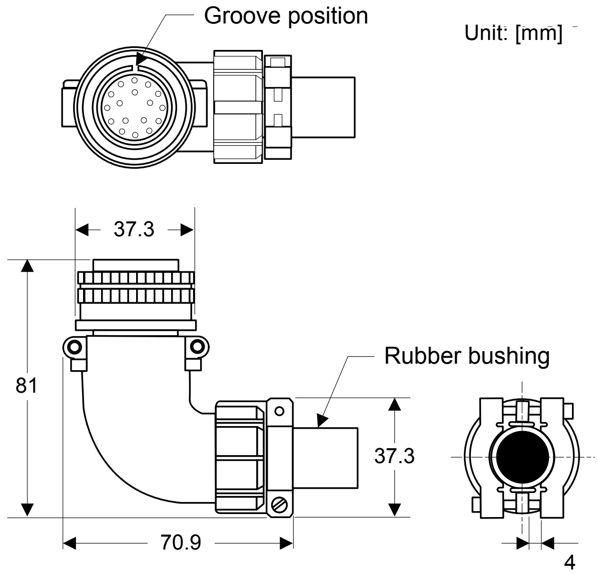
Encoder connector kit (motor side) (2)

Model: WSK-P06P-C

Application range: GYS model ..... 1.0 to 1.5 [kW]

■ External dimensions

Unit: [mm]

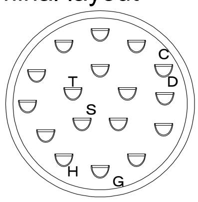


■ Model/manufacturer

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-

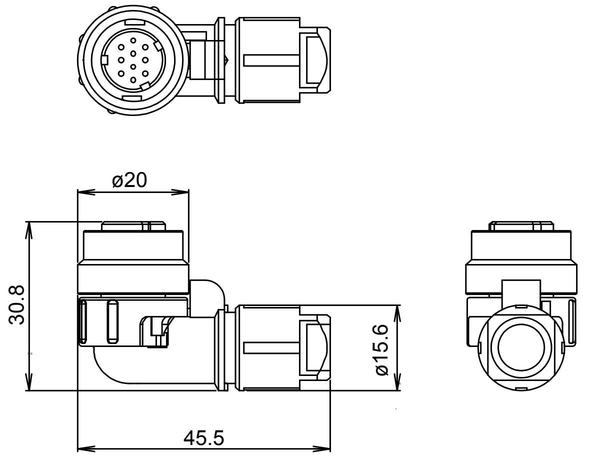
- The connector model differs from the optional cable.
- The connector manufacturer may be changed without prior notice.

Connector kit for encoder (motor side) (3)

Model: WSK-P10P-J

Application range: GYG model ..... 0.85 to 1.0 [kW]

■ External dimensions

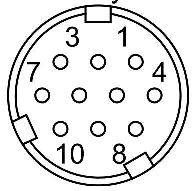


■ Model/manufacturer

Plug	JN2FS10SL2-R (Applicable wire diameter: φ6.5 to φ8.0 [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.

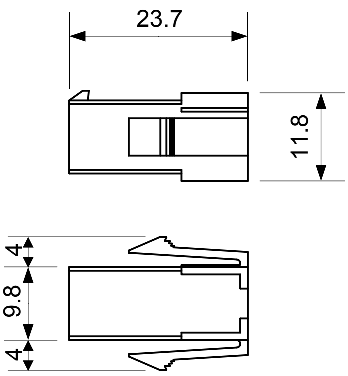
Motor power connector kit (motor side) (1)

Model: WSK-M04P-E

Applicable range: GYS/GYB (lead wire specification) model ..... 0.75 [kW] or less

■ External dimensions

Unit: [mm]

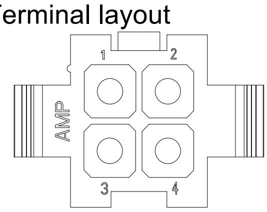


■ Model/manufacturer

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

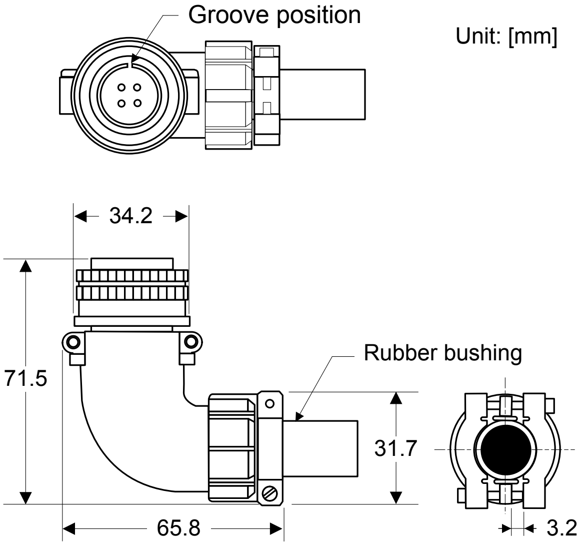
- The connector model differs from the optional cable.
- The connector manufacturer may be changed without prior notice.

Connector kit for motor power (motor side) (2)

Model: WSK-M04P-CA

Application range: GYS model ..... 1.0 to 1.5 [kW]

■ External dimensions

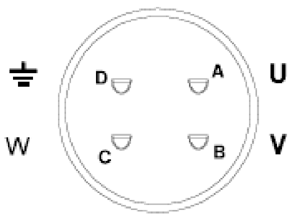


■ Model/manufacturer

L-type clamp	MS3108B18-10S
Cable clamp	MS3057-10A

DDK Ltd.

■ Terminal layout



A	U
B	V
C	W
D	⏚

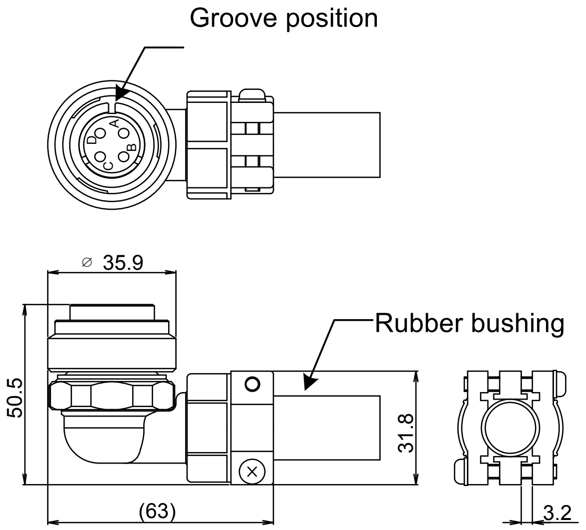
- The connector manufacturer may be changed without prior notice.

Connector kit for motor power (motor side) (3)

Model: WSK-M04P-CC

Application range: GYG model ..... 0.85 to 1.0 [kW]

■ External dimensions

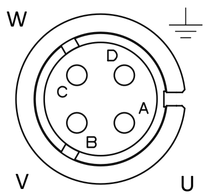


■ Model/manufacturer

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 manufacturer may be changed without prior notice.

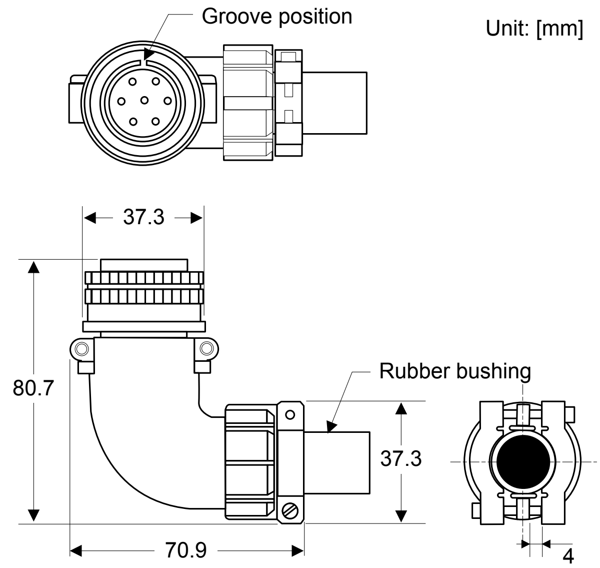
Connector kit for motor power (motor side: with brake) (1)

Model: WSK-M06P-CA

Application range: GYS model ..... 1.0 to 1.5 [kW] (with brake)

■ External dimensions

Unit: [mm]

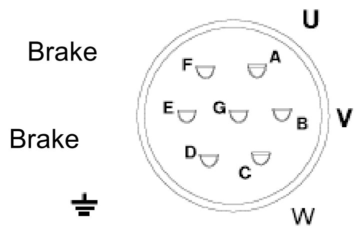


■ Model/manufacturer

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	-

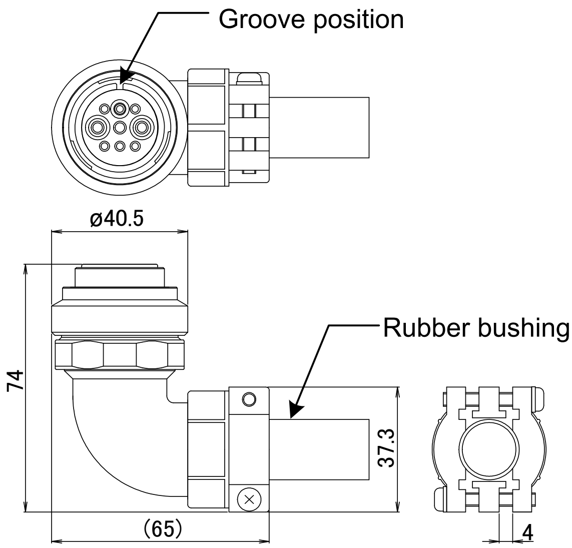
- The connector manufacturer may be changed without prior notice.

Connector kit for motor power (motor side: with brake) (2)

Model: WSK-M06P-CC

Application range: GYG model ..... 0.85 to 1.0 [kW]

■ External dimensions

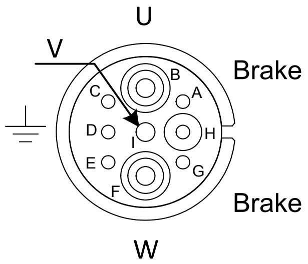


■ Model/manufacturer

Plug	JL10-8A20-18SE-EB
Cable clamp	JL04-2022CK(14)-R (Applicable wire diameter: φ12.9 to φ16 [mm])

Japan Aviation Electronics Industry, Limited

■ Terminal layout



A	Br
B	U
D	⏚
F	W
G	Br
I	V

- The connector manufacturer may be changed without prior notice.

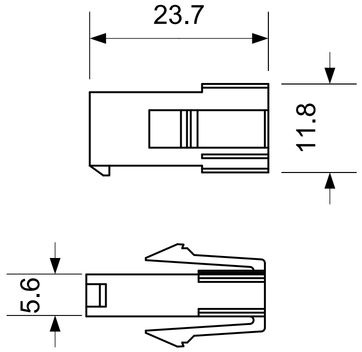
Brake connector kit (motor side) (1)

Model: WSK-M02P-E

Applicable range: GYS/GYB (lead wire specification) model ..... 0.75 [kW] or less (with brake)

■ External dimensions

Unit: [mm]

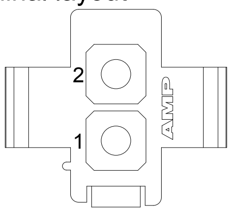


■ Model/manufacturer

Cap housing	172157-9
Socket	170362-1

TE Connectivity Corporation

■ Terminal layout



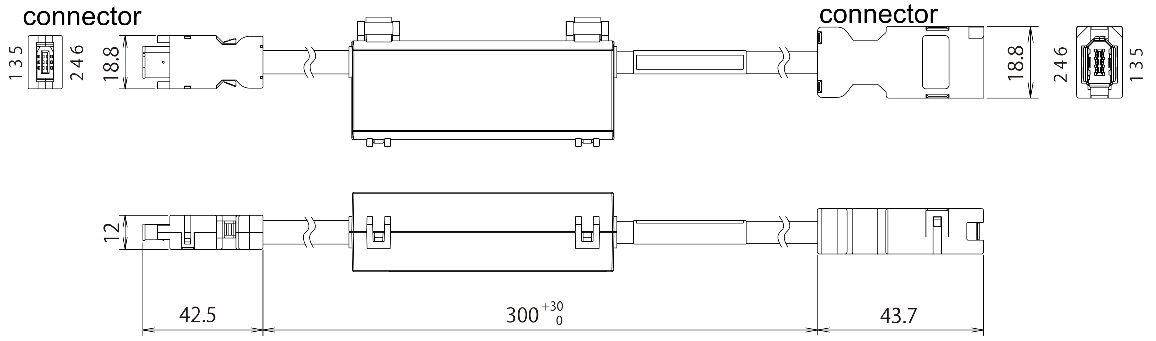
1	B
2	B

- The connector 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.

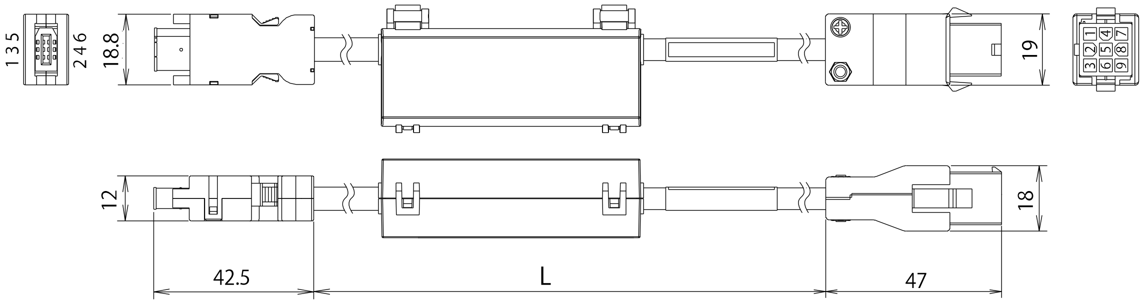
Encoder cable with battery (1)

Model: WSC-P06P02-BE to WSC-P06P20-BE

Applicable range: GYS/GYB model: 0.75kW 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	$2,000^{+200}_{0}$
WSC-P06P05-BE	$5,000^{+500}_{0}$
WSC-P06P10-BE	$10,000^{+1,000}_{0}$
WSC-P06P20-BE	$20,000^{+2,000}_{0}$

- 1 battery is provided.
- The connector manufacturer may be changed without prior notice
- Movable cables are used for cables.

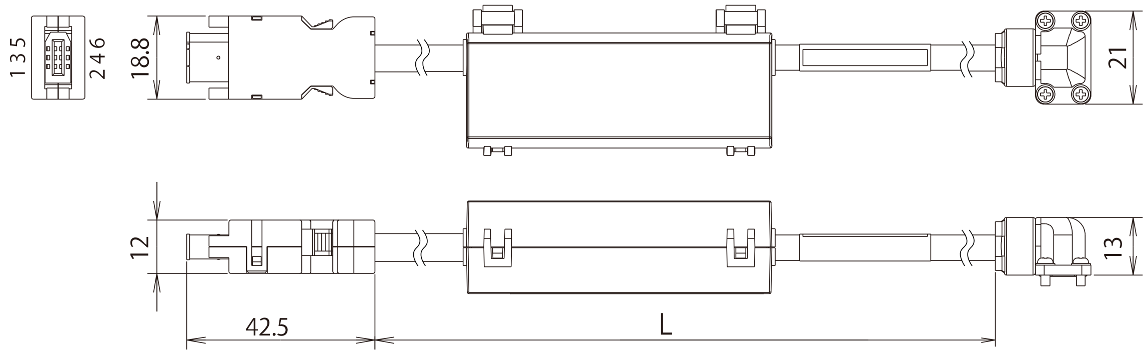
⚠ CAUTION

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 ..... 0.75kW 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

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	$2{,}000\,^{+200}_{0}$
WSC-P06P05-BK	$5{,}000\,^{+500}_{0}$
WSC-P06P10-BK	$10{,}000\,^{+1{,}000}_{0}$
WSC-P06P20-BK	$20{,}000\,^{+2{,}000}_{0}$

- 1 battery is provided.
- The connector manufacturer may be changed without prior notice
- Movable cables are used for cables.

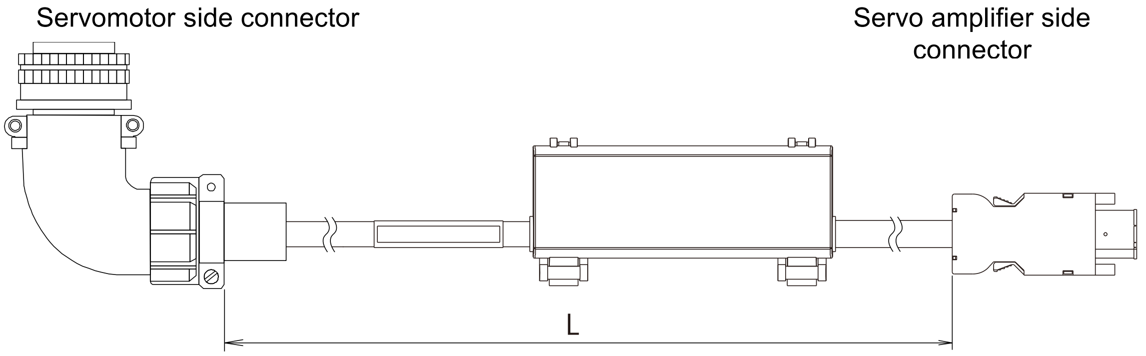
⚠ CAUTION

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 (3)

Model: WSC-P06P02-BC to WSC-P06P20-BC

Application range: GYS model ..... 1.0 to 1.5kW (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

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	$2{,}000^{+200}_{0}$
WSC-P06P05-BC	$5{,}000^{+500}_{0}$
WSC-P06P10-BC	$10{,}000^{+1{,}000}_{0}$
WSC-P06P20-BC	$20{,}000^{+2{,}000}_{0}$

- 1 battery is provided.
- The connector manufacturer may be changed without prior notice
- Movable cables are used for cables.

⚠ CAUTION

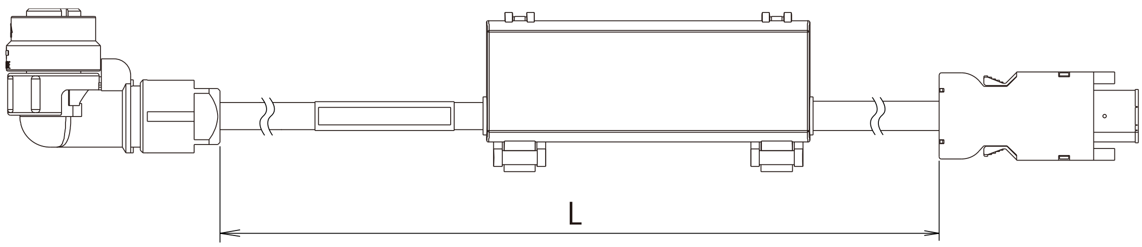
Connect two or more encoder cables, and do not extend the wiring distance.
A sudden stoppage may occur due to a voltage drop resulting from connector contact resistance.

Encoder cable with battery (4)

Model: WSC-P06P02-BJ to WSC-P20P20-BJ

Application range: GYG model ..... 0.85 to 1.0kW (for CN2)

Servomotor side connector   Servo amplifier side connector



■ Model/manufacturer

Servomotor side connector

Plug (L = 500 and 10,000)	JN2FS10SL1-R
Plug (L = 20,000)	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 $^{+200}_{0}$
WSC-P06P05-BJ	5,000 $^{+500}_{0}$
WSC-P06P10-BJ	10,000 $^{+1,000}_{0}$
WSC-P06P20-BJ	20,000 $^{+2,000}_{0}$

- 1 battery is provided.
- The connector manufacturer may be changed without prior notice
- Movable cables are used for cables.

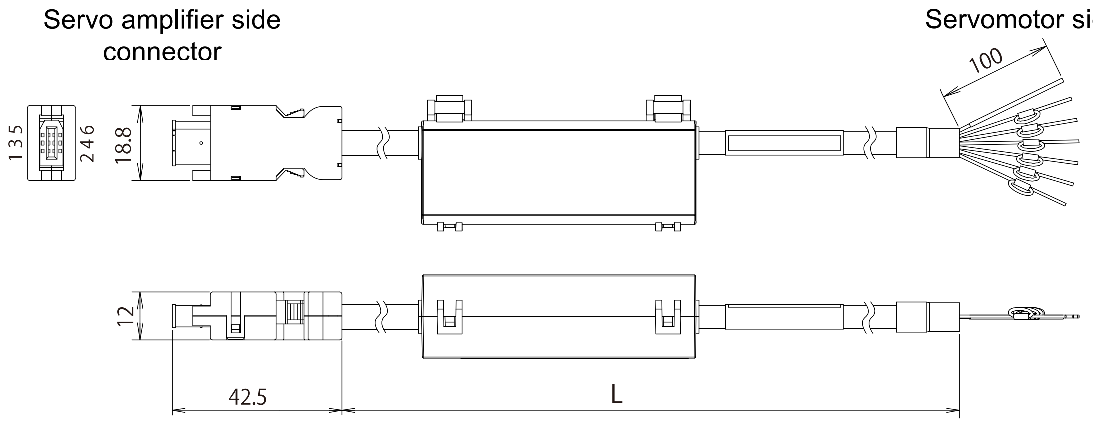
⚠ CAUTION

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	$2{,}000^{+200}_{0}$
WSC-P06P05-BW	$5{,}000^{+500}_{0}$
WSC-P06P10-BW	$10{,}000^{+1{,}000}_{0}$
WSC-P06P20-BW	$20{,}000^{+2{,}000}_{0}$

- 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.

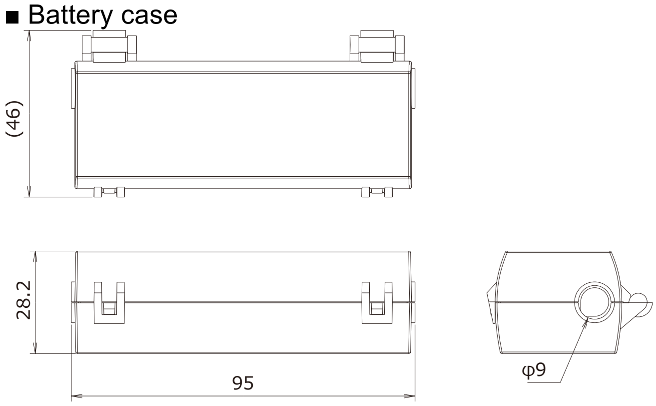
Battery case kit for encoder cable

Model: WSB-BC

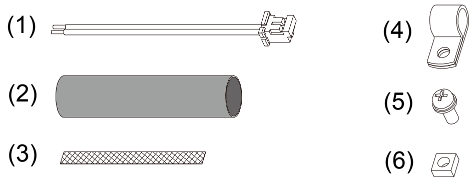
Application range: Common to all models (for CN2)

Use if fabricating your own encoder cable with battery.

■ Battery case



■ Accessories



(1) Battery wiring
(2) Contraction tube
(3) Copper foil tape
(4) Nylon clip
(5) Screw
(6) Nut

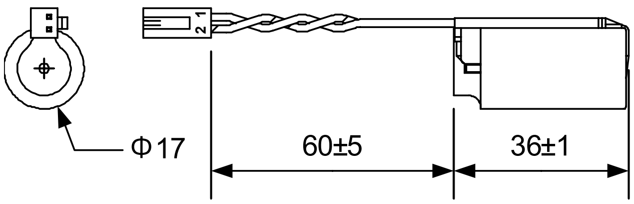
- The connector manufacturer may be changed without prior notice
- Refer to “2.4.2.2 Encoder Cable With Battery Fabrication Method” for details on the wiring processing method.
- Replacement battery: WBS-S is sold separately.

Replacement battery

Model: WSB-S

Application range: All models

■ External dimensions



■ Model/manufacturer

Battery	ER17/33WK41 1PP

Hitachi Maxell, Ltd.

Safety device connection connector (CN6)

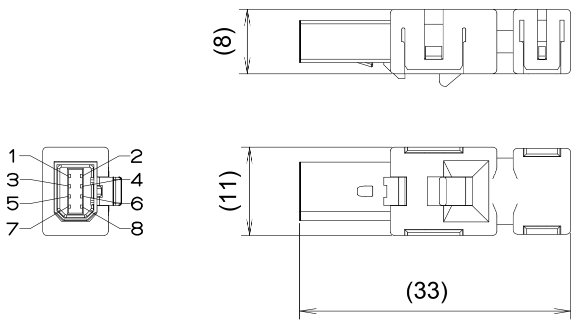
This connector is not available as an option.

Product name: INDUSTRIAL MINI I/O D-SHAPE TYPE 1

Model: 2013595-1

Manufacturer: TE Connectivity Corporation

* The cable is not provided.



Monitor (CN7)

Connect a measuring instrument, etc. to servo amplifier connector 7 (CN7).

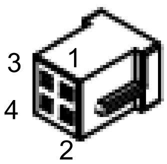
This is an analog output voltage signal for measuring instruments, and is not required for servo amplifier operation.

This connector is not available as an option.

■ Model/manufacturer

Crimp socket	DF11-4DS-2C
Crimp terminal	DF11-2428SC

HIROSE ELECTRIC CO., LTD.

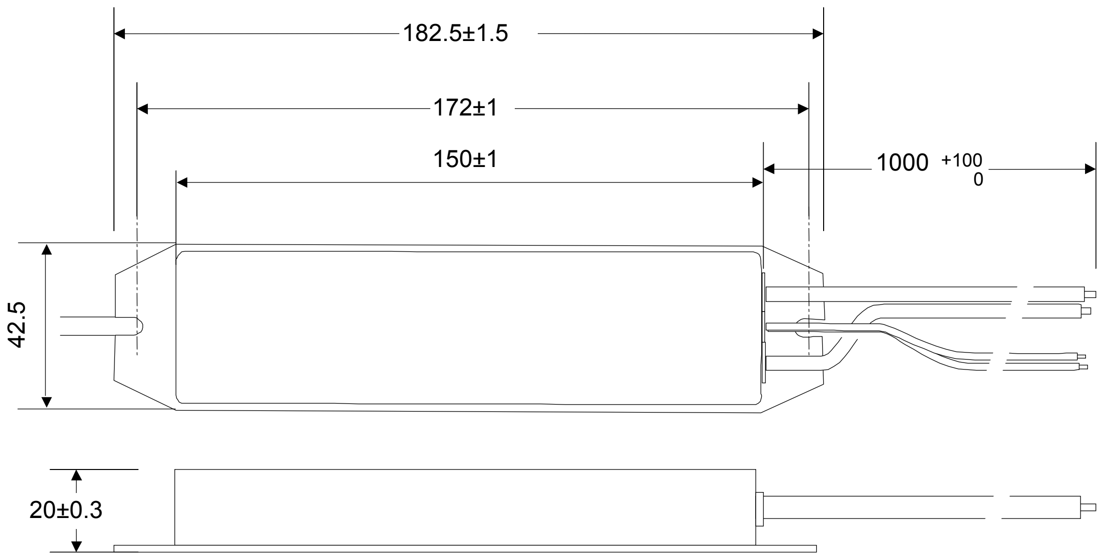


1	MON1	3	M5(0V)
2	MON2	4	M5(0V)

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

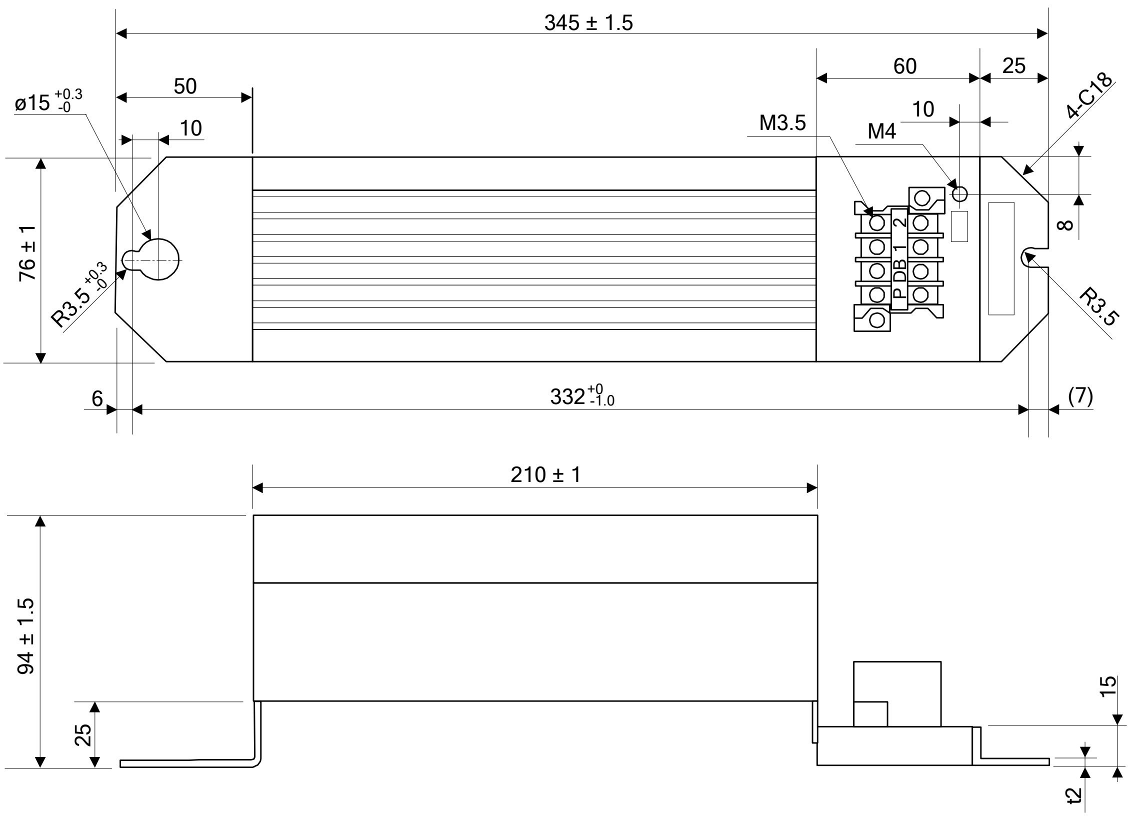
- Connect the external regenerative resistor to the servo amplifier with a 10 [m] or shorter cable.
- The external regenerative resistor becomes hot. Do not install flammable objects in the vicinity.
- Refer to "10.8 External Regenerative Resistor" for details on external regenerative resistors.

10

External regenerative resistor (2)

Model: WSR-152

Application range: Amplifier models RYT751F7 to RYT152F7



10

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 "10.8 External Regenerative Resistor" for details on external regenerative resistors.

CHAPTER 11 ABSOLUTE POSITION SYSTEM

11

11.1 Specifications

11.1.1 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.

11.1.2 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.

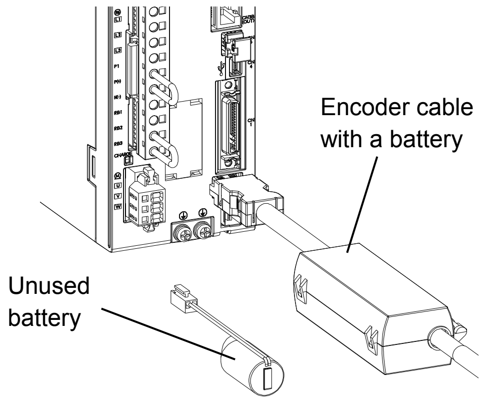
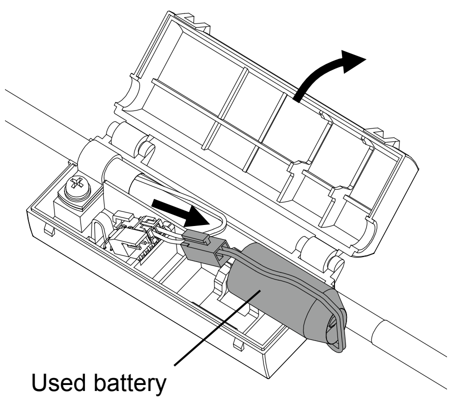
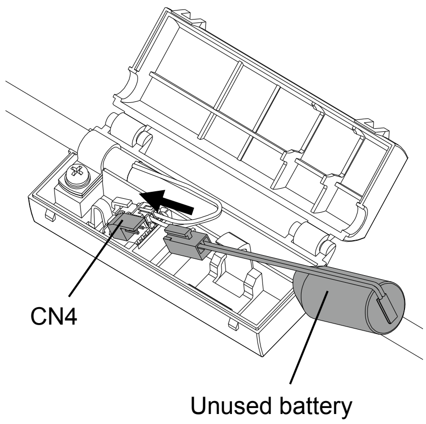
■ Encoder cable

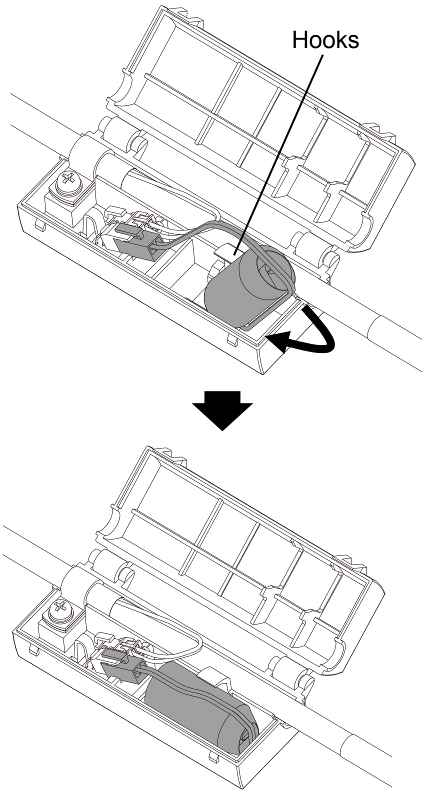
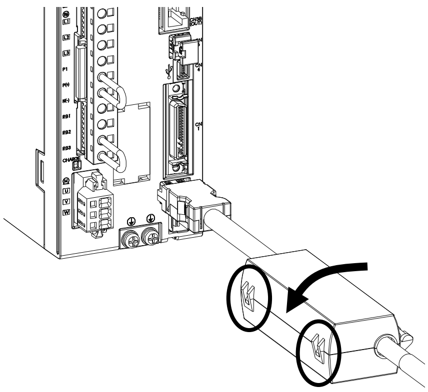
Use an encoder cable with battery (model: xxxxxxxxx).

11.2 Battery Installation and Replacement Procedures

11.2.1 Battery Installation Procedure (Amplifier models: RYT□□□□7-VV2)

Install the battery using the following procedure.

[1]		Prepare an unused battery.
[2]		Open the battery case of the encoder cable and remove the old battery from the connector if it’s inside.
[3]		Connect the unused battery to connector CN4.

[4]		Secure the battery with the case hook as shown in the diagram.
[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.

11.3 Starting Up Procedure

Follow the procedure below to start up the absolute position system.

[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.
	AL.dL 1	
[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].

11.4 Battery Warning

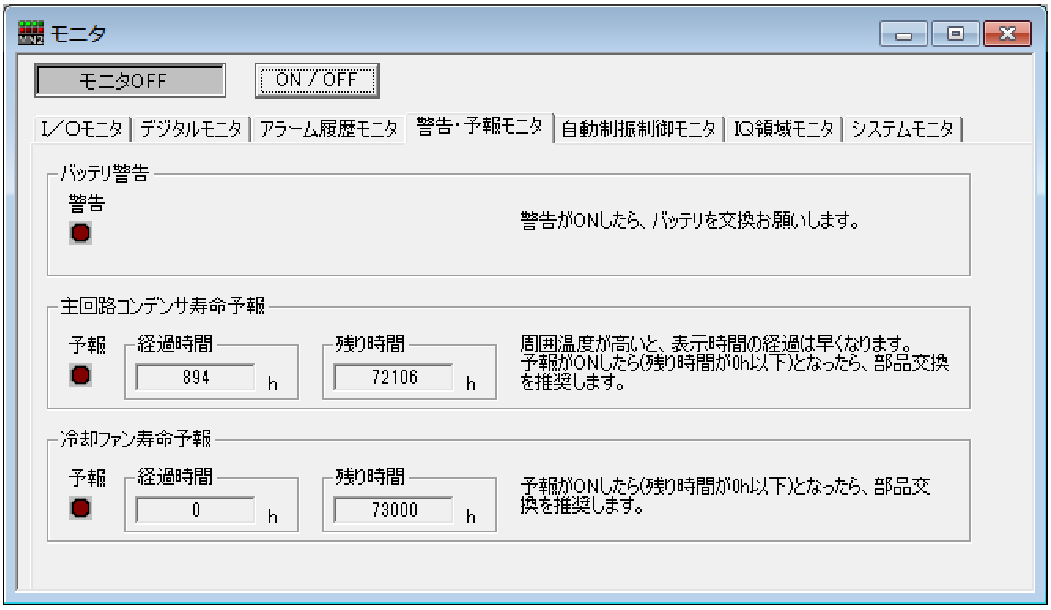
A battery warning is issued if the battery voltage is lower than the value preset in the servo amplifier.
If this warning* is issued, replace the battery immediately.

*: 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.

There are the following four ways to check the battery warning.

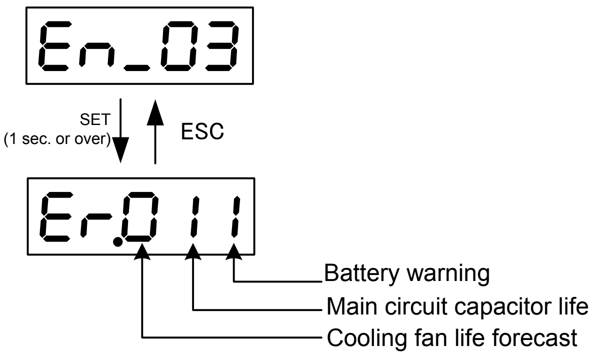
(1) OUT signal (assignment number: 45)

(2) [Monitor] - [Warning/Forecast monitor] of PC Loader



(3) Maintenance mode of keypad

The battery warning can be checked in the maintenance mode of the keypad.



* Set PA2_78 (display transition at warning detection) at 1 (transition to warning display) to automatically show (3) at the keypad.

11.5 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.

CHAPTER 12 POSITIONING DATA

12

12.1 Operation Modes

12.1.1 Operation Method

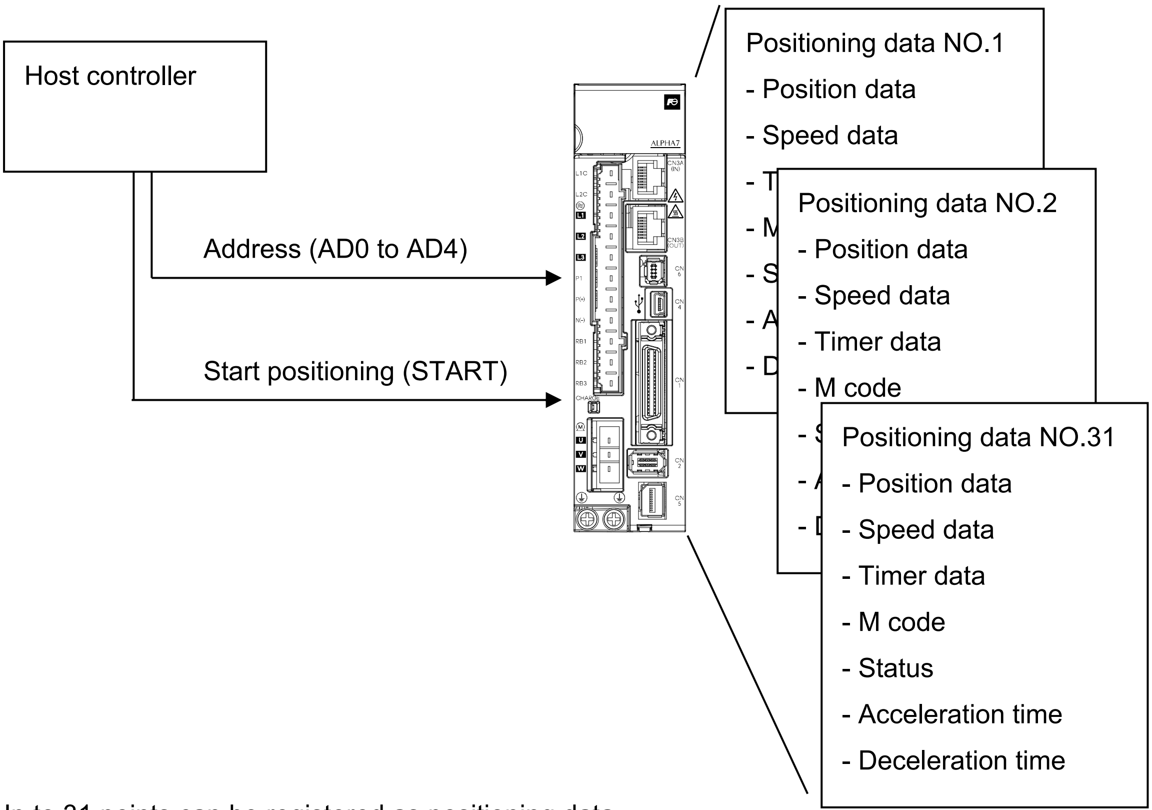
Positioning operation based on positioning data and immediate value data can be conducted with this servo amplifier.

(1) Positioning data operation

Set data items to positioning data inside the servo amplifier in advance and designate the address (data number) of the desired operation data among AD0 to AD4 at the host controller, etc.

Turn on the start positioning (START) to execute the positioning operation according to the preset data.

Interface: Di / Do signal or RS-485 communications (Modbus-RTU)



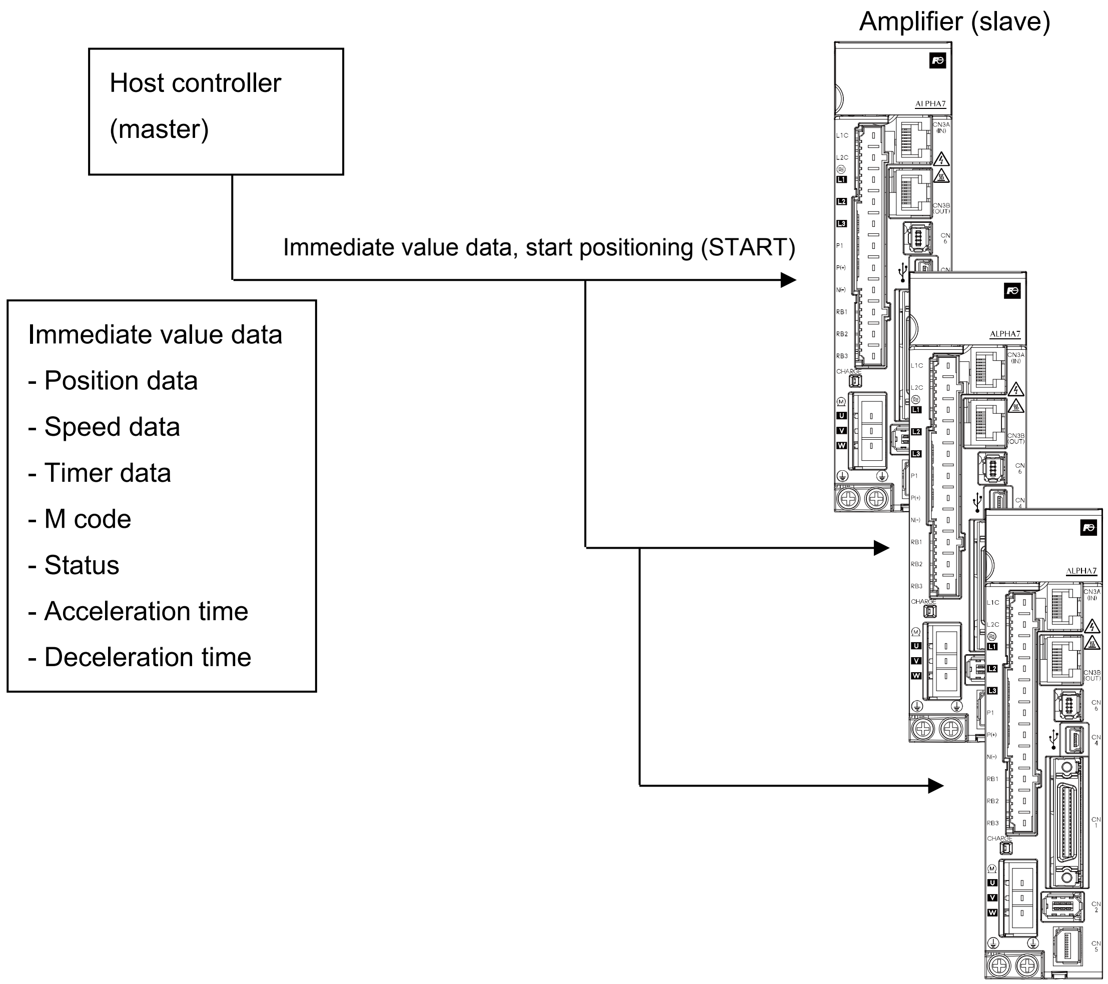
Up to 31 points can be registered as positioning data.

Register data, using PC Loader or at the keypad.

(2) Immediate value data operation

Designate position data, speed data and so on at the host controller directly to execute positioning operation.

Interface: RS-485 communications (Modbus-RTU)



<Message>

- Messages are sent from the master to the slave in the uni-cast method where the immediate value data, monitor data and so on are sent with the station number of the slave and then a response message is sent.
- To start two or more axes simultaneously, you can use the broadcasting method where transmission is made to all slaves through designation of station number 0.
  In the broadcasting method, no response message is sent. For this reason, you can send the start positioning signal in a broadcasting message to execute motions under pseudo interpolation control.

<Message>

The following parameters must be entered for operation based on immediate data.

- PA1_01: control mode selection = 7 (positioning operation)
- PA2_40: internal positioning data selection = 0 (disable)
- PA2_97: communication protocol = 1 (Modbus-RTU)

12.1.2 Operation Mode Selection

Positioning operation based on positioning data and immediate value data can be conducted with this servo amplifier.

To change the operation mode, enter parameters shown in the table below and supply an input signal. The setting in operation mode (1) is enabled if “77” (positioning data selection) is not specified with the CONT signal.

<Operation mode (1)>

Control mode selection: PA1_01	Internal positioning data selection: PA2_40	Sequential start selection: PA2_41	AD4	AD3	AD2	AD1	AD0	Operation
7: Positioning operation	1: Enable	0: Disable	OFF	OFF	OFF	OFF	OFF	Address error
		1: Enable						Sequential start
		2: Homing						Homing
		3: Operation with immediate value data						Operation with immediate value data
			OFF	OFF	OFF	OFF	ON	Operation with positioning data No. 1
					≀			≀
			ON	ON	ON	ON	ON	Operation with positioning data 31
	0: Disable	PA2_97: Communication protocol selection = 1 *						Operation with immediate value data

Immediate value data operation is impossible with the PC Loader protocol.

If “77” (positioning data selection) is specified with the CONT signal, the setting in operation mode (2) is enabled.

＜Operation mode (2)＞

Control mode selection: PA1_01	Internal positioning data selection: CONT signal: 77	Sequential start selection: PA2_41	AD4	AD3	AD2	AD1	AD0	Operation
7: Positioning operation	ON	0: Disable	OFF	OFF	OFF	OFF	OFF	Address error
		1: Enable						Sequential start
		2: Homing						Homing
		3: Operation with immediate value data						Operation with immediate value data
			OFF	OFF	OFF	OFF	ON	Operation with positioning data No. 1
			~					~
			ON	ON	ON	ON	ON	Operation with positioning data 31
	OFF	PA2_97: Communication protocol selection = 1						Operation with immediate value data

12

12.2 Settings

12.2.1 Positioning Data Specifications

By providing a start positioning signal as assigned from an external address (AD4-AD0), positioning operation is started according to the settings.

The content of the internal positioning data is as follows:

Item		Setting range	Default value
No. of positioning data addresses		31 (addresses 1-F)	
Positioning data setting	Status (ABS/INC)	ABS, INC, CO, CEND, and M code enable/disable M code output during positioning/after positioning completion	INC and M code disable
	Position (stop position)	-2000000000 to +2000000000 [unit amount] (in increments of 1)	0
	Speed (rotation speed)	0.01 to max. rotation speed [r/min] (in increments of 0.01)	0.01
	Stand still timer	0.00-655.35 [sec] (by 0.01s) or 0.000-65.535 [sec] (by 0.001s) (Note 1)	0.00
	Acceleration time	0.0-99999.9 [ms] (in increments of 0.1) However, when 0.0 is set, the amplifier follows the acceleration time 1 (PA1_37) or 2 (PA1_39) (Note 2) selected by ACC0.	0.0
	Deceleration time	0.0-99999.9 [ms] (in increments of 0.1) However, when 0.0 is set, the amplifier follows the deceleration time 1 (PA1_38) or 2 (PA1_40) (Note 2) selected by ACC0.	0.0
	M code	0 to 0xFF	0xFF

Note 1: Set by the decimal point position of stand still timer (PA2_42).
Note 2: If ACC0 (set to 14) has not been assigned to the CONT signal, acceleration/deceleration time values follow acceleration time 1 (PA1_37) and deceleration time 1 (PA1_38).

12

12.2.1.1 Position data (stop position)

Specify a position at which the servo motor stops when the status is ABS. Specify an increment when the status is INC.

To travel the mechanical system for the same amount (20.00 [mm]) as the setting of positioning data (ex. 20.00), the following parameter setting is necessary.

For the details of setting, refer to “PA1_06 Numerator 0 of electronic gear, PA1_07 Denominator of electronic gear” and “PA2_01 Decimal point position of positioning data.”

PA1_06 Numerator 0 of electronic gear, PA1_07 Denominator of electronic gear

No.	Name	Setting range	Default value	Change
06	Numerator 0 of electronic gear	1-4194304 (in increments of 1)	16	Always
07	Denominator of electronic gear	1-4194304 (in increments of 1)	1	Always

PA2_01 Decimal point position of positioning data

No.	Name	Setting range	Default value	Change
01	Decimal point position of positioning data	0:0 1:0.1 2:0.01 3:0.001 4:0.0001 5:0.00001	0	Always

12.2.1.2 Speed data (motor axis rotation speed)

Set a rotation speed at which the servo motor rotates up to a specified position of positioning data.

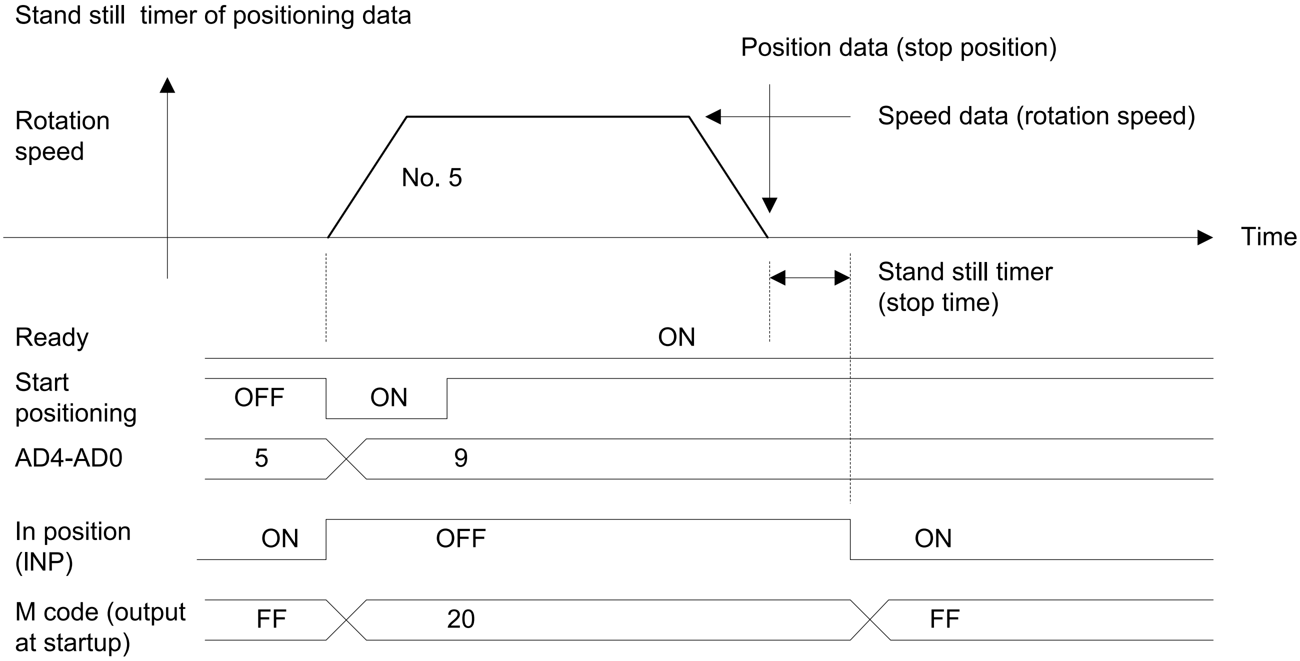
This setting is not a traveling speed of the mechanical system but a rotation speed of the servo motor axis [r/min].

Speed data can be set from the minimum value, 0.01, to the maximum rotation speed of the servo motor by 0.01 [r/min].

12

12.2.1.3 Stand still timer (stop time)

After the motor has reached a specified position of the positioning data, when the set time of the stand still timer has passed, the in position [INP] signal is output outside. (It is impossible to set the stand still timer on immediate value data.)
This timer can be set from 0.00 to 655.35 [s] in increments of 0.01 [s].
By changing the setting of the PA2_42 decimal point position of stand still timer, it is also allowed to set from 0.000 to 65.535 [s].



・Positioning data are regarded as being executed while the timer is measured.
・The default value of the M code is "FF" (changeable into "00" by PA2_43).

12.2.1.4 Acceleration time and deceleration time

Set an acceleration/deceleration time of the servo motor.
Setting value of the acceleration/deceleration time is a time setting before reaching 0 to 2000 [r/min]. However, if the setting is 0.0 (default value), as shown in the table below, the motor follows the acceleration/deceleration time is set by parameters by turning ON/OFF ACC0.

ACC0 (14)	Acceleration time	Deceleration time
OFF	PA1_37	PA1_38
ON	PA1_39	PA1_40

For details of acceleration time and deceleration time, refer to “PA1_36 to 40 Acceleration / deceleration selection at speed control, Acceleration time and deceleration time settings” in CHAPTER 4 on page 4-27.

12

12.2.1.5 Status (command system, step mode)

To set status, ABS/INC, CO, CEND, and M code enable/disable are usable.
It is also allowed not to specify CO or CEND.
Use CO when operate data continuously.
Use CEND when starting up the motor in series.

■ Absolute (ABS) / Incremental (INC)

When ABS specification is applied, the current position of the motor moves up to the setting of the positioning data.
When positioning data is set to 0 and the motor is started up by the positioning data of ABS, the motor moves up to the zero point from any position.

When INC specification is applied, the servo motor moves from the current position by the setting of the positioning data.
When positioning data is set to 100.0, the servo motor moves from the current position by 100.0 in the positive direction.

■ Data continuation (CO)

When the motor is started up by positioning data with data continuation specified, positioning is completed by the data, and then the motor moves according to the setting of the next positioning data.

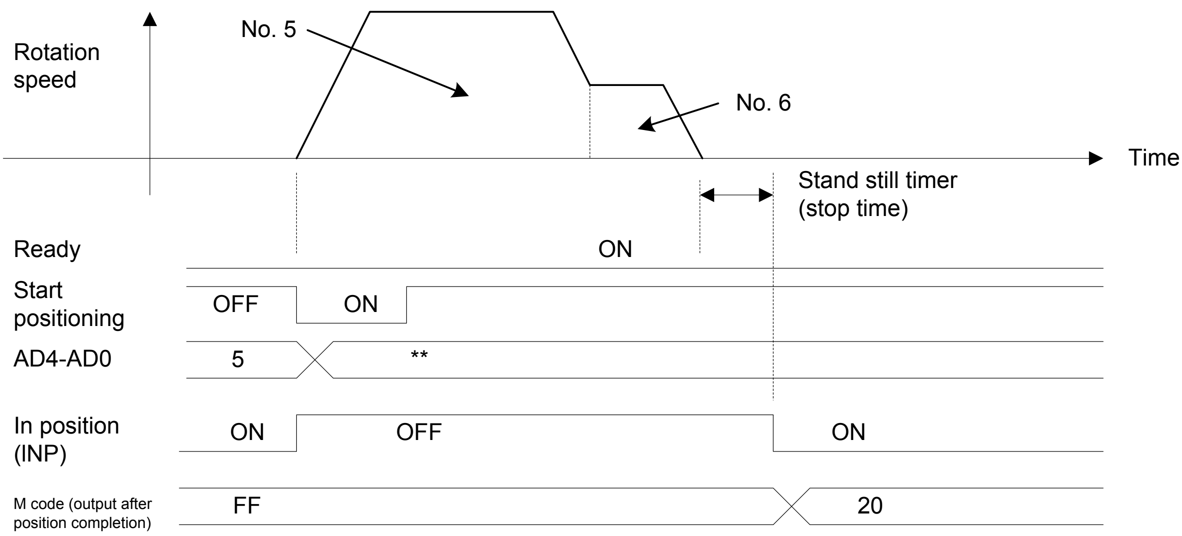
If data continuation is specified on positioning data 5, the motor moves according to positioning data 6.

In the same way, if data continuation is specified on positioning data 6, the motor moves according to positioning data 7.

If the stop timer is set to 0.00 [s], traveling speed varies continuously.

If the stop timer is set to 0.00 [s], speed varies depending on the setting of positioning data.

Data continuation of positioning data



・Positioning data are regarded as being executed while timer is measured.
・The default value of the M code is "FF" (changeable into "00" by PA2_43).

(1) When data with a high speed is continued to data with a low speed, speed has already been reduced to the next speed data at the specified position of the positioning data.

(2) When data with a low speed is continued to data with a high speed, acceleration is started from the specified position of the positioning data.

Data continuation is executed in the order of positioning data numbers (addresses).

When the motor is started up at positioning data while data continuation is executed, the positioning data before the start up are ignored.

(Data continuation is not executed as tracing back positioning data.)

When the motor is started up from No.7 using the following positioning data, the setting of No.6 is ignored.

Data continuation of positioning data

No.	Command style	Step mode	Stop position	Rotation speed	＊＊	＊＊
6	ABS	CO	0.00	0.00		
7	ABS	CO	5000.00	5000.00		
8	ABS	CO	5200.00	500.00		
9	ABS		5400.00	50.00		

■ Cycle end (CEND)

After the motor has been moved completely by positioning data with cycle end specified, the cycle end signal assigned to OUT is output.

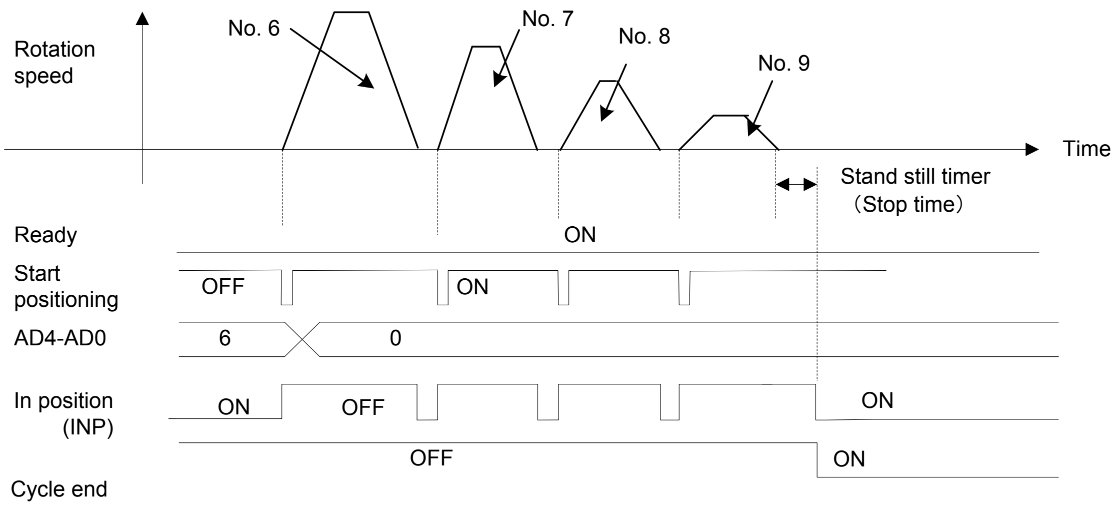
It is not allowed to specify data continuation and cycle end on a set of positioning data simultaneously.

Cycle end is used when performing sequential start operation.

Operation by sequential start can be selected by PA2_41: sequential start selection.

After an address at which you wish to start up is set, if start positioning is turned on, operation will be started up. When the address is changed to 0 afterward, positioning operation is automatically continued up to the positioning data on which cycle end is specified.

Data continuation of positioning data



・Positioning data are regarded as being executed while timer is measured.

Sample setting of positioning data

No.	Command style	Step mode	Stop position	Rotation speed	＊＊	＊＊
6	ABS		500.00	3000.00		
7	ABS		1000.00	2000.00		
8	ABS		1500.00	1000.00		
9	ABS	CEND	2000.00	500.00		

12

■ M code

By specifying an M code on positioning data, it is able to output an arbitrary numerical value outside while positioning is executed (output at startup) or after positioning has been complete (output at completion).

The figure above shows an output of M code after positioning has been complete.

12.2.2 Immediate Value Data Specifications

After immediate value data are set by the RS-485 communications, when the start positioning signal is set, positioning is started according to the setting.

The content of immediate value data is as follows:

Item	Setting range	Default value
Status (ABS/INC)	ABS, INC, and M code enable/disable M code output during positioning/after positioning completion	INC and M code disable
Position (stop position)	-2000000000 to +2000000000 [unit amount] (in increments of 1)	0
Speed (rotation speed)	0.01 to max. rotation speed [r/min] (in increments of 0.01)	0.01
Acceleration time	0.0-99999.9 [ms] (in increments of 0.1) However, when 0.0 is set, the amplifier follows the acceleration time 1 (PA1_37) or 2 (PA1_39) (Note 1) selected by ACC0.	0.0
Deceleration time	0.0-99999.9 [ms] (in increments of 0.1) However, when 0.0 is set, the amplifier follows the deceleration time 1 (PA1_38) or 2 (PA1_40) (Note 1) selected by ACC0.	0.0
M code	0 to 0xFF	0xFF(Note 2)

Note 1: If ACC0 (setting 14) is not assigned to the CONT signal, the motor follows acceleration time 1 (PA1_37) and deceleration time 1 (PA1_38), respectively.

Note 2: The OUT signals (MD0 to MD7) of the M code follow the selection of output when PA2_43: output when M code off.

Immediate value data are different from positioning data in the continuing function of status setting (CO and CEND) and setting of the stand still timer.

For details of each data, refer to sections 12.2.1.1 to 12.2.1.5.

12.3 Startup

■ Operation with positioning data

It is able to register 31 sets of positioning data in the servo amplifier.

Register the positioning data described in section 12.2.1 from the PC Loader or keypad, and set address numbers according to the table below:

Positioning is started at the ON edge of the start positioning [START] signal.

Even if homing or position presetting has not been complete, the start positioning signal is enabled.

Address No. selection table

Address No.	AD4	AD3	AD2	AD1	AD0	Sequential start selection: PA2_41	Operation mode
0	OFF	OFF	OFF	OFF	OFF	0: Disable	Address error
						1: Enable	Sequential startup
						2: Homing	Homing
						3: Operation with immediate value data	Operation with immediate value data
1	OFF	OFF	OFF	OFF	ON	—	Operation with positioning data 1
2	OFF	OFF	OFF	ON	OFF	—	Operation with positioning data 2
3	OFF	OFF	OFF	ON	ON	—	Operation with positioning data 3
4	OFF	OFF	ON	OFF	OFF	—	Operation with positioning data 4
5	OFF	OFF	ON	OFF	ON	—	Operation with positioning data 5
6	OFF	OFF	ON	ON	OFF	—	Operation with positioning data 6
7	OFF	OFF	ON	ON	ON	—	Operation with positioning data 7
8	OFF	ON	OFF	OFF	OFF	—	Operation with positioning data 8
9	OFF	ON	OFF	OFF	ON	—	Operation with positioning data 9
10	OFF	ON	OFF	ON	OFF	—	Operation with positioning data 10
11	OFF	ON	OFF	ON	ON	—	Operation with positioning data 11
12	OFF	ON	ON	OFF	OFF	—	Operation with positioning data 12
13	OFF	ON	ON	OFF	ON	—	Operation with positioning data 13
14	OFF	ON	ON	ON	OFF	—	Operation with positioning data 14
15	OFF	ON	ON	ON	ON	—	Operation with positioning data 15

Address No.	AD4	AD3	AD2	AD1	AD0	Sequential start selection: PA2_41	Operation mode
16	ON	OFF	OFF	OFF	OFF	—	Operation with positioning data 16
17	ON	OFF	OFF	OFF	ON	—	Operation with positioning data 17
18	ON	OFF	OFF	ON	OFF	—	Operation with positioning data 18
19	ON	OFF	OFF	ON	ON	—	Operation with positioning data 19
20	ON	OFF	ON	OFF	OFF	—	Operation with positioning data 20
21	ON	OFF	ON	OFF	ON	—	Operation with positioning data 21
22	ON	OFF	ON	ON	OFF	—	Operation with positioning data 22
23	ON	OFF	ON	ON	ON	—	Operation with positioning data 23
24	ON	ON	OFF	OFF	OFF	—	Operation with positioning data 24
25	ON	ON	OFF	OFF	ON	—	Operation with positioning data 25
26	ON	ON	OFF	ON	OFF	—	Operation with positioning data 26
27	ON	ON	OFF	ON	ON	—	Operation with positioning data 27
28	ON	ON	ON	OFF	OFF	—	Operation with positioning data 28
29	ON	ON	ON	OFF	ON	—	Operation with positioning data 29
30	ON	ON	ON	ON	OFF	—	Operation with positioning data 30
31	ON	ON	ON	ON	ON	—	Operation with positioning data 31

■ Operation with immediate value data

When immediate value data are directly set by the RS-485 communications, if the start positioning signal is set, positioning is started according to the setting.

This operation differs from the operation with positioning data in the continuation function and setup of the stand still timer.
For the continuation function, a similar function can be realized by assigning the immediate value continuation to the CONT signal.
In addition, if you wish to change data immediately during operation, the function of the immediate value change is usable.
For the function of the stand still timer, adjust timing using the host controller.
For details, refer to “CHAPTER 13　MODBUS RTU COMMUNICATION”.

12

■ Stop method

The servo motor is decelerated before the specified position set by positioning data, and stopped automatically at that position.

The method for stopping the motor forcibly after moving has started is as follows:

- Turn off the operation command [RUN].
- Turn off the forced stop [EMG].
- Turn on the positioning cancel.
- Turn off the external error input.
- Turn on the pause (By turning it off, the remaining operation is executed).
- Turn on free run.

After the motor has started moving, if one of the signals below is detected, the specified position of positioning data might not be reached.

- Software OT (overtravel), +OT, and -OT signals
- Limiter detection

12.4 Setting Change

The setting of positioning data can be edited by the following method.

- Edit on the keypad of the servo amplifier
- Edit using the PC loader
- Change positioning data by the teaching signal assigned to control
- Edit positioning data using the RS-485 communications

Editing positioning data by the PC Loader or keypad can be restricted by setting PA2_75: positioning data write protection.
Editing can be limited by the external control input signal using the editing permission signal assigned to the CONT signal.

After positioning data are set, if PA2_01: decimal point position of positioning data is changed, the setting might be increased (or decreased). The significant figure 10 digits long is not changed.

12.5 Response Time

The response time of start positioning (operation according to positioning data) is as follows:

■ Starting up by the CONT signal

Start positioning [START] terminal sampling time	Approx. 1.0 [ms]
Automatic startup software processing time	Approx. 0.5 [ms]
Total	Approx. 1.5 [ms]

CHAPTER 13 MODBUS RTU COMMUNICATION

13

13.1 Settings for Servo Amplifier

Set up the parameters of the servo amplifier (hereinafter called amplifier) to perform the Modbus communications.

(1) Protocol selection

No.	Parameter name	Setting range	Default value	Change
PA2_97	Communication protocol selection	0: PC Loader protocol 1: Modbus RTU	0	Power

Set to 1 (Modbus RTU).

<u>Since this parameter is set to 0 (PC Loader protocol) at factory shipment, be sure to change it to 1.</u>

(2) Station number/communication baud rate

No.	Parameter name	Setting range	Default value	Change
PA2_72	Station number	1 to 31	1	Power
PA2_73	Communication baud rate	0・・・ 38400 [bps] 1・・・ 19200 [bps] 2・・・ 9600 [bps] 3・・・115200 [bps]	0	Power

Set an amplifier’s station number (slave’s station number) and a communication baud rate.

(3) Character configuration

No.	Parameter name	Setting range	Default value	Change
PA2_93	Selection of parity/stop bit	0: Even parity with 1 stop bit 1: Odd parity with 1 stop bit 2: No parity with 1 stop bit 3: Even parity with 2 stop bits 4: Odd parity with 2 stop bits 5: No parity with 2 stop bits	0	Power

13

Set existence and logic of a parity and a stop bit length.
Characters are organized for each setting as follows:

PA2_93	0 (LSB)	1	2	3	4	5	6	7	8	9	10	11 (MSB)
0, 1	Start	Data (8 bits)								Parity	Stop	
2	Start	Data (8 bits)								Stop		
3, 4	Start	Data (8 bits)								Parity	Stop (2 bits)	
5	Start	Data (8 bits)								Stop (2 bits)		

(4) Response time and communication time over

No.	Parameter name	Setting range	Default value	Change
PA2_94	Response time	0.00 to 1.00 [s]	0.00	Always
PA2_95	Communication time over	0.00 [s]: No detection 0.01 to 9.99 [s]	0.00	Always

Set the response time and communication time over parameters if needed.
For details, refer to pages 13-34 (response time) and 13-36 (communication time over).

13

(5) Parameter assignment No.: ○ Supported X: Not supported

Data type	Assigned parameter No.	Name	FC：17H Read	FC：17H Write	FC：03H (Read)	FC：10H (Write)
Communication CONT/OUT signals	79	Communication CONT signal	○	○	○	○
	39	Communication OUT signal	○	×	○	×
Monitor	00	Feedback speed	○	×	○	×
	01	Command speed	○	×	○	×
	02	Command torque	○	×	○	×
	03	Peak current	○	×	○	×
	04	Motor current	○	×	○	×
	05	Effective torque	○	×	○	×
	06	Feedback position	○	×	○	×
	07	Command position	○	×	○	×
	08	Position deviation	○	×	○	×
	09	Command pulse frequency	○	×	○	×
	10	Feedback cumulative pulses	○	×	○	×
	11	Cumulative input pulses	○	×	○	×
	12	LS-Z pulse	○	×	○	×
	13	Load inertia ratio	○	×	○	×
	14	DC link voltage (max.)	○	×	○	×
	15	DC link voltage (min.)	○	×	○	×
	16	VREF input voltage	○	×	○	×
	17	TREF input voltage	○	×	○	×
	18	OL thermal value	○	×	○	×
	19	Regenerative resistor thermal value	○	×	○	×
	20	Power (W)	○	×	○	×
	21	Motor temperature	○	×	○	×
	22	Overshoot unit amount	○	×	○	×
	23	Settling time	○	×	○	×
	24	Resonance frequency 1	○	×	○	×

13

Data type	Assigned parameter No.	Name	FC：17H		FC：03H (Read)	FC：10H (Write)
			Read	Write		
Monitor	25	Resonance frequency 2	○	×	○	×
Sequence monitor	40	Hardware CONT signal	○	×	○	×
	41	Hardware OUT signal	○	×	○	×
	42	Control mode	○	×	○	×
	43	Sequence mode	○	×	○	×
	50	Alarm at present	○	×	○	×
	51-70	Alarm history 1-20	○	×	○	×
Various commands	82	Anti resonance frequency	○	○	○	○
	83	Workpiece inertia ratio	○	○	○	○
Immediate value data	90	Immediate value status	○	○	○	○
	91	Immediate value position	○	○	○	○
	92	Immediate value speed	○	○	○	○
	93	Immediate value acceleration time	○	○	○	○
	94	Immediate value deceleration time	○	○	○	○

13.2 Communication Specifications

Item		Specifications	Remarks (PA is a parameter No.)
Communication	Electric I/F	Modbus RTU	
	Communication speed	38400／19200／9600／115200 bps	Set by parameter PA2_73
	Synchronization method	Asynchronous (UART)	
	Communication method	Semi-duplex communication	
	Transmission format	Master-slave (servo amplifier) = 1:N ($1 \leq N \leq 31$)	Max. 31 units connected simultaneously
	Connection cable	LAN cable (straight) or equivalent	
	Cable length (recommneded)	Entire extended length: 100 m or less (up to 38400 bps) 40 m or less (115200 bps) Length between stations: 20 m or less	
	Terminator treatment	Master side :100 Ω recommended Slave side : Unnecessary	
	Character configuration	Start bit : 1 bit Data length : 8 bits Parity : Even/Odd/None Stop bit : 1 or 2 bits	Set by parameter PA2_93
Protocol	Communications protocol	Compliant with Modbus RTU protocol	
	Communications mode	RTU mode	The ASCII mode is not supported.
	Station number	0: Broadcast 1-31: Slave station No.	Set by parameter PA2_72
	Function code (FC)	1(01h): Read out coil data 3(03h): Read out various data 5(05h): Write in single coil data 8(08h): Maintenance (echo back) 15(0Fh): Write in coil data 16(10h): Write in various data 23(17h): Read out/write in various data	Responses other than those in the left cell are exceptional responses (improper FC).
	Error check method	CRC-16 method	
	Message length	Variable length	Max. 200 bytes
	Frame synchronization method	Timing synchronization	Frames are initialized if time data for three characters are absent.

It is recommended to use the RS-232C - RS-422 converter (model: NW0H-CNV) for the use of 1:1 communications between the master and the slave (servo amplifier). Do not use it for multiple unit connection.

13.3 Transmission Protocol

13.3.1 Message types

Communications are configured as the single master and multiple slaves method. The amplifier operates as a slave.
The messages sent/received between the master and amplifier are classified into the two types below:

- Query: Messages transferred from the master to the amplifier
- Response message: Messages transferred from the amplifier to the master

Communications are started by a query from the master. Communications are not performed between the amplifiers.

13.3.2 Message fields

The message frame is as follows for both the query from the master and the response message from the amplifier.

<table>
<tr><td>Station No.</td><td colspan="2">1 byte</td><td>・ 0: Broadcast query to all amplifiers.
(No response message is issued.)
・ 1-31: Query for each station number.
Self station numbers 1-31 are responded in the response messages from the amplifiers.</td></tr>
<tr><td>FC (function code)</td><td colspan="2">1 byte</td><td>・ Master: Specify an FC according to the processing that you wish to execute.
・ Amplifier: Returns the specified FC.
(If the amplifier has not finished processing successfully, the message is returned with the MSB of the FC set to 1.)
...Exceptional response</td></tr>
<tr><td>Information</td><td colspan="2">Variable length</td><td>・ Query/response message: Data are set according to the FC.
・ An exceptional code (1 byte) is returned in the exceptional response from the amplifier.</td></tr>
<tr><td rowspan="2">CRC check</td><td rowspan="2">16 bits
(2 bytes)</td><td>(L)</td><td rowspan="2">・ Query/response message: CRC-16 is added to the bottom of the frame.
・ The sender calculates CRC-16 for the data sent, add it to the bottom of the frame, and send the frame.
・ The receiver calculates CRC-16 of the received data. If the calculation results are not equal to the received CRC-16, an error occurs.
If an error is detected, no response message is returned.</td></tr>
<tr><td>(H)</td></tr>
</table>

13.3.3 Function codes (FC)

The six types of FC below are supported:

Category	FC	Function	Broadcasting
Data manipulation	03h (3)	Read out various data	Disabled
	10h (16)	Write in various data	Enabled
	17h (23)	Read out/write in various data	Enabled*
Coil data manipulation	01h (1)	Read out coil data	Disabled
	05h (5)	Write in single coil data	Enabled
	0Fh (15)	Write in coil data	Enabled
Maintenance	08h (8)	Echo back	Disabled

*Queries from master are accepted, and response messages are not returned.

■ FC 03h (Readout of various data)

(1) Query from the master

Station No.		1 byte		
FC		1 byte		··· **03h**
Information	Address	2 bytes	(H)	··· Specify the data address. * For the addresses, refer to the table 13-1.
			(L)	
	No. of registers	2 bytes	(H)	··· Specify the number of sets of data **n × 2**. * Specify **n × 10** on the positioning data. * The max number of positioning data is 9, and 45 for others.
			(L)	
CRC check		16 bits (2 bytes)	(L)	
			(H)	

(2) Response message from the amplifier

Station No.		1 byte		
FC		1 byte		··· **03h**
Information	No. of data bytes	1 byte		··· **n × 4** * The positioning data are **n × 20**.
	Data 1	4 bytes	(HH)	··· Readout data for n sets from the specified address * The positioning data are 20 bytes per data. * For the data format, refer to [Table 13-1]. * "0" is returned to nonexistent data.
			(HL)	
			(LH)	
			(LL)	
	~	~		
	Data n	4 bytes	(HH)	
			(HL)	
			(LH)	
			(LL)	
CRC check		16 bits (2 bytes)	(L)	
			(H)	

(3) Message examples

Monitor data: shows a message example to read out a feedback position.

<Query example>

Station No.		1 byte	**01**	・・・ When the amplifier station no. is "1".
FC		1 byte	**03**	
Information	Address	2 bytes	**10**	・・・ Specify **1006h** as the address of a feedback position.
			06	
	No. of registers	2 bytes	**00**	・・・ Specify **0002h** as the number of data 1×2.
			02	
CRC check		16 bits (2 bytes)	**20**	
			CA	

<Response message example>

Station No.		1 byte	**01**	
FC		1 byte	**03**	
Information	No. of data bytes	1 byte	**04**	・・・ 1×4 = **04h**
	Data 1	4 bytes	**00**	・・・ **000186A0h** = 100000 units Data 1 will be **FFFE7960h** with -100000 units.
			01	
			86	
			A0	
CRC check		16 bits (2 bytes)	**C9**	
			EB	

■ FC 10h (Write of various data)

(1) Query from the master

Station No.		1 byte		
FC		1 byte		・・・ **10h**
Information	Address	2 bytes	(H)	・・・ Specify the data address. * For the addresses, refer to the table 13-1.
			(L)	
	No. of registers	2 bytes	(H)	・・・ Specify the number of sets of data **n × 2**. * Specify **n × 10** on the positioning data. * The max number of parameters and positioning data is 9, and 45 for others.
			(L)	
	No. of data bytes	1 byte		・・・ **n × 4** * The positioning data are **n × 20**.
	Data 1	4 bytes	(HH)	・・・ Write data for n sets from the specified address * The positioning data are 20 bytes per data. * For the data format, refer to the table 13-1.
			(HL)	
			(LH)	
			(LL)	
	~	~		
	Data n	4 bytes	(HH)	
			(HL)	
			(LH)	
			(LL)	
CRC check		16 bits (2 bytes)	(L)	
			(H)	

13

(2) Response message from the amplifier

Station No.		1 byte		
FC		1 byte		··· **10h**
Information	Address	2 bytes	(H)	··· Specified address
			(L)	
	No. of registers	2 bytes	(H)	··· Number of sets of actually written data, **m × 2** * The positioning data are **m × 10**. * Cannot write in to nonexistent data.
			(L)	
CRC check		16 bits (2 bytes)	(L)	
			(H)	

(3) Message examples

PA2_19: shows a message example to enter 200000 to a preset position.

<Query example>

Station No.		1 byte	**01**	··· When the amplifier station no. is "1".
FC		1 byte	**10**	
Information	Address	2 bytes	**41**	··· Specify **4112h** as the address of PA2_19.
			12	
	No. of registers	2 bytes	**00**	··· Specify **0002h** as the number of data 1×2.
			02	
	No. of data bytes	1 byte	**04**	··· 1×4 = **04h**
	Data 1	4 bytes	**00**	··· Specify 200000 = **00030D40h**.
			03	Specify data 1 = **FFFCF2C0h** for -20000.
			0D	
			40	
CRC check		16 bits (2 bytes)	**BA**	
			49	

<Response message example>

Station No.		1 byte	**01**
FC		1 byte	**10**
Information	Address	2 bytes	**41**
			12
	No. of registers	2 bytes	**00**
			02
CRC check		16 bits (2 bytes)	**F5**
			F1

■ FC 01h (Read out coil data)

(1) Query from the master

Station No.		1 byte	
FC		1 byte	
Information	Address	2 bytes	(H)
			(L)
	No. of coil data	2 bytes	(H)
			(L)
CRC check		16 bits (2 bytes)	(L)
			(H)

FC: ・・・ **01h**

Address: ・・・ Specify the coil address.
 * For the addresses, refer to the table 13-2.

No. of coil data: ・・・ Specify the number of coils n.
 * Up to 16 pcs.

(2) Response message form the amplifier

Station No.		1 byte	
FC		1 byte	
Information	No. of data bytes	1 byte	
	Data 1	1 byte	(8 bits)
	~	~	
	Data N	1 byte	(8 bits)
CRC check		16 bits (2 bytes)	(L)
			(H)

FC: ・・・ **01h**

No. of data bytes: ・・・ The value (N) obtained from n/8 and by rounding up decimal

Data 1: ・・・ n pcs data read out from a specified address.
 * 1 pcs = 1 bit (1 byte by 8 pcs)
 * Allocated from LSB in order.

(3) Message examples

Shows a message example to read out ten pieces of coil data from OUT6 signal.

<Query example>

Station No.		1 byte	**01**
FC		1 byte	**01**
Information	Address	2 bytes	**03**
			05
	No. of coil data	2 bytes	**00**
			0A
CRC check		16 bits (2 bytes)	**AC**
			48

Station No.: ・・・ When the amplifier station no. is "1".

Address: ・・・ Specify **0305h** as the OUT6 signal address.

No. of coil data: ・・・ Specify 10 = **000Ah** as the number of coils.

<Response message example>

Station No.		1 byte	**01**
FC		1 byte	**01**
Information	No. of data bytes	1 byte	**02**
	Data 1	1 byte	**A5**
	Data 2	1 byte	**02**
CRC check		16 bits (2 bytes)	**43**
			6D

No. of data bytes: ・・・ The value obtained from 10 pcs/8 and by rounding up decimal

Data 1: ・・・ See below.

Data are allocated from LSB in order starting from the smaller address.

The corresponding bit indicates ON with "1" and OFF with "0". The rest of bits are all fixed to "0."

Data1 (=A5h)	OUT13 1 (ON)	OUT12 0 (OFF)	OUT11 1 (ON)	OUT10 0 (OFF)	OUT9 0 (OFF)	OUT8 1 (ON)	OUT7 0 (OFF)	OUT6 1 (ON)
Data2 (=02h)	0	0	0	0	0	0	OUT15 1 (ON)	OUT14 0 (OFF)

■ FC 05h (Write in single coil data)

(1) Query from the master

Station No.		1 byte		
FC		1 byte		. . . **05h**
Information	Address	2 bytes	(H)	. . . Specify the coil address. * For the addresses, refer to the table 13-2.
			(L)	
	Coil data	2 bytes	(H)	. . . Specify **000h** for OFF and **FF00h** for ON.
			(L)	
CRC check		16 bits (2 bytes)	(L)	
			(H)	

(2) Response message form the amplifier

Station No.		1 byte		
FC		1 byte		. . . **05h**
Information	Address	2 bytes	(H)	. . . Specified address.
			(L)	
	Coil data	2 bytes	(H)	. . . Specified data.
			(L)	
CRC check		16 bits (2 bytes)	(L)	
			(H)	

(3) Message examples

Shows a message example to write in ON to OUT9 signal.

<Query example>

Station No.		1 byte	**01**	. . . When the amplifier station no. is "1".
FC		1 byte	**05**	
Information	Address	2 bytes	**02**	. . . Specify **0208h** as the CONT9 signal address.
			08	
	No. of coil data	2 bytes	**FF**	. . . Specify ON = **FF00h**.
			00	
CRC check		16 bits (2 bytes)	**0C**	
			40	

13

<Response message example>

Station No.		1 byte	**01**
FC		1 byte	**05**
Information	Address	2 bytes	**02**
			08
	No. of coil data	2 bytes	**FF**
			00
CRC check		16 bits (2 bytes)	**0C**
			40

■ FC 0Fh (Write in coil data)

(1) Query from the master

Station No.		1 byte		
FC		1 byte		· · · **0Fh**
Information	Address	2 bytes	(H)	· · · Specify the coil address. * For the addresses, refer to the table 13-2.
			(L)	
	No. of coil data	2 bytes	(H)	· · · Specify the number of coils n. * Up to 16 pcs.
			(L)	
	No. of data bytes	1 byte		· · · The value (N) obtained from n/8 and by rounding up decimal
	Data 1	1 byte	(8 bits)	· · · n pcs of data read out from a specified address. * 1 pcs = 1 bit (1 byte by 8 pcs) * Allocated from LSB in order.
	~	~		
	Data N	1 byte	(8 bits)	
CRC check		16 bits (2 bytes)	(L)	
			(H)	

(2) Response message from the amplifier

Station No.		1 byte		
FC		1 byte		· · · **05h**
Information	Address	2 bytes	(H)	· · · Specified address.
			(L)	
	No. of coil data	2 bytes	(H)	· · · The number of coils actually written in is m pcs. * Cannot write in to nonexistent coil data.
			(L)	
CRC check		16 bits (2 bytes)	(L)	
			(H)	

13

(3) Message examples

Shows a message example to write in three pieces of coil data from CONT22 signal.

<Query example>

Station No.		1 byte	**01**	. . . When the amplifier station no. is "1".
FC		1 byte	**0F**	. . . **0Fh**
Information	Address	2 bytes	**02**	. . . Specify **0215h** as the CONT22 signal address.
			15	
	No. of coil data	2 bytes	**00**	. . . Specify 3 = **0003h** as the number of coils.
			03	
	No. of data bytes	1 byte	**01**	. . . The value obtained from 3 pcs/8 and by rounding up decimal
	Data 1	1 byte	**06**	. . . See below.
CRC check		16 bits (2 bytes)	**03**	
			74	

Data are allocated from LSB in order starting from the smaller address.

The corresponding bit indicates ON with "1" and OFF with "0". The rest of bits are all fixed to "0."

Data1 (=06h)	0	0	0	0	0	CONT24 1 (ON)	CONT23 1 (ON)	CONT22 0 (OFF)

<Response message example>

Station No.		1 byte	**01**
FC		1 byte	**0F**
Information	Address	2 bytes	**02**
			15
	No. of coil data	2 bytes	**00**
			03
CRC check		16 bits (2 bytes)	**05**
			B6

13

■ FC 17h (Read out/write in various data)

Only addresses 6000H to 600FH are applicable.

An exception response (exception code: 02H) is returned if an address outside this range is specified.

(1) Query from the master

Station No.		1 byte		
FC		1 byte		· · · **17h**
Information	Read out start address	2 bytes	(H)	· · · Specifies the data address. * Addresses from **6000H to 600FH** can be set.
			(L)	
	No. of registers	2 bytes	(H)	· · · Specify the number of sets of data **n x 2**. * Up to setting range **1 to 16** for number of sets of data n
			(L)	
	Write in start address	2 byte	(H)	· · · Specify the data address. * Addresses from **6000H to 6007H** can be set.
			(L)	
	No. of registers	2 byte	(H)	· · · Specify the number of sets of data **n x 2**. * Up to setting range **1 to 8** for number of sets of data n
			(L)	
	No. of data bytes	1 byte		· · · **n x 4**
	Data 1	4 bytes	(HH)	
			(HL)	
			(LH)	
			(LL)	
	~	~		
	Data n	4 bytes	(HH)	
			(HL)	
			(LH)	
			(LL)	
CRC check		16 bits (2 bytes)	(L)	
			(H)	

(2) Response message from slave

Station No.		1 byte		
FC		1 byte		· · · **17h**
Information	No. of data bytes	1 byte		· · · **n x 4**
	Data 1	4 bytes	(HH)	· · · Read out data for n sets from the specified Address ** Data read out range: **1 to 16**
			(HL)	
			(LH)	
			(LL)	
	~	~		
	Data n	4 bytes	(HH)	
			(HL)	
			(LH)	
			(LL)	
CRC check		16 bits (2 bytes)	(L)	
			(H)	

(3) Message examples

Shows a message example to write in immediate speed, immediate acceleration time and communication CONT signal, and read out feedback speed, effective torque, and motor current. The write in start address is 6000H, and the read out start address is 6008H.

First, set parameter Nos. for the free assignment of addresses for parameters PA3_41 to PA3_44. After setting, reboot to enable the settings.

PA3_41: 007993292
PA3_42: 00000000 (default)

PA3_43: 00040500
PA3_44: Set 00000000 (default)

<Query example>

Station No.		1 byte	**01**	・ When the amplifier station no. is "**1**".
FC		1 byte	**17**	
Information	Read out start address	2 bytes	**60**	・・・ Specify the read out first address.
			08	
	No. of registers	2 bytes	**00**	・・・ Specify **0006h** as the number of data 3×2.
			06	
	Write in start address	2 bytes	**60**	・・・ Specify the write in first address.
			00	
	No. of registers	2 bytes	**00**	・・・ Specify **0006h** as the number of data 3×2.
			06	
	No. of data bytes	1 byte	**0C**	・・・ Specify 3×4 = **0Ch**.
	Data 1	4 byte	**00**	・・・ Specify immediate speed: **186A0h (1000 r/min)**.
			01	
			86	
			A0	
	Data 2	4 byte	**00**	・・・ Specify immediate acceleration time: **3E8h (100 ms)**.
			00	
			03	
			E8	
	Data 3	4 byte	**00**	・・・ Specify communication CONT signal: servo ON and FWD.
			00	
			00	
			03	
CRC check		16 bits (2 bytes)	**CC**	
			17	

<Response message example>

Station No.		1byte	01	
FC		1byte	17	
Information	No. of data bytes	1byte	0C	
	Data 1	4byte	00	··· Feedback speed: 1000 [r/min] (3E8h)
			00	
			03	
			E8	
	Data 2	4byte	00	··· Effective torque: 80 [%] (50h)
			00	
			00	
			50	
	Data 3	4byte	00	··· Motor current: 80 [%] (50h)
			00	
			00	
			50	
CRC check		16 bits (2 bytes)	19	
			5F	

■ FC 08h (Echo back maintenance)

(1) Query from the master

Station No.		1 byte		
FC		1 byte		··· **08h**
Information	Sub code	2 bytes	(H)	··· Specify **0000h** as the sub code of echo back.
			(L)	
	Data	2 bytes	(H)	··· Specify an arbitrary data.
			(L)	
CRC check		16 bits (2 bytes)	(L)	
			(H)	

(2) Response message from the amplifier

Station No.		1 byte		
FC		1 byte		··· **08h**
Information	Sub code	2 bytes	(H)	··· **0000h**
			(L)	
	Data	2 bytes	(H)	··· Echo back the specified data.
			(L)	
CRC check		16 bits (2 bytes)	(L)	
			(H)	

13

13.3.4 Addresses

The addresses of various data are as follows:

■ Data addresses

[Table 13-1] Data address list

Data type	Data name	Address (hex.)	Applicable FC 03h	Applicable FC 10h	Format (with a sign)	Setting range (default value)
Communication CONT/OUT signals	Communication CONT signal	0000	○	○	Refer to [■ Communication CONT/OUT signals]	0-FFFFh (0: OFF all)
	Communication OUT signal	0100	○	×		—
Monitor	Feedback speed	1000	○	×	1h=1 [r/min] (Yes)	—
	Command speed	1001	○	×	1h=1 [r/min] (Yes)	—
	Command torque	1002	○	×	1h=1[%] (Yes)	—
	Peak current	1003	○	×	1h=1[%] (Yes)	—
	Motor current	1004	○	×	1h=1[%] (Yes)	—
	Effective torque	1005	○	×	1h=1[%] (No)	—
	Feedback position	1006	○	×	1h=1 [unit] (Yes)	—
	Command position	1007	○	×	1h=1 [unit] (Yes)	—
	Position deviation	1008	○	×	1h=1 [(*1)] (Yes)	—
	Command pulse frequency	1009	○	×	1h=0.1 [kHz] (No)	—
	Feedback cumulative pulses	100A	○	×	1h=1 [pulse] (Yes)	—
	Cumulative input pulses	100B	○	×	1h=1 [pulse] (Yes)	—
	LS-Z pulse	100C	○	×	1h=1 [pulse] (No)	—
	Load inertia ratio	100D	○	×	1h=0.1 [times] (No)	—
	DC link voltage (max.)	100E	○	×	1h=1 [V] (No)	—
	DC link voltage (min.)	100F	○	×	1h=1 [V] (No)	—
	VREF input voltage	1010	○	×	1h=0.01 [V] (Yes)	—
	TREF input voltage	1011	○	×	1h=0.01 [V] (Yes)	—
	OL thermal value	1012	○	×	1h=1[%] (No)	—

13

Data type	Data name	Address (hex.)	Applicable FC 03h	Applicable FC 10h	Format (with a sign)	Setting range (default value)
Monitor	Regenerative resistor thermal value	1013	○	×	1h=1[%] (No)	—
	Power (W)	1014	○	×	1h=1[%] (Yes)	—
	Motor temperature	1015	○	×	1h=1[°C] (No)	—
	Overshoot unit amount	1016	○	×	1h=1 [(*1)] (Yes)	—
	Settling time	1017	○	×	1h=0.1 [ms] (No)	—
	Resonance frequency 1	1018	○	×	1h=1 [Hz] (No)	—
	Resonance frequency 2	1019	○	×	1h=1 [Hz] (No)	—
Sequence monitor	Hardware CONT signal	2000	○	×	Refer to [■Sequence monitor]	—
	Hardware OUT signal	2001	○	×		—
	Control mode	2100	○	×		—
	Sequence mode	2101	○	×		—
	Alarm at present	2200	○	×		—
	Alarm history 1-20	2201-2214	○	×		
Various commands	Anti resonance frequency	3002	○	○	1h=0.1 [Hz] (No)	0.0, 1.0-300.0 (0.0: The vibration suppressing control function is disabled.)
	Workpiece inertia ratio	3003	○	○	1h=1[%] (No)	0-80 (0)
Parameter	PA1_1-99	4000-4062	○	○	The parameter is followed.	The parameter is followed.
	PA2_1-99	4100-4162	○	○		
	PA3_1-99	4200-4262	○	○		
	PA4_1-99	4300-4362	○	○		
Immediate value data	Immediate value status	5100	○	○	Refer to [■Immediate value data]	—
	Immediate value position	5101	○	○	1h=1 [unit] (Yes)	0-±2000000000 (0)
	Immediate value speed	5102	○	○	1h=0.01 [r/min] (No)	0.01-Max. rotation speed (0.01)
	Immediate value acceleration time	5103	○	○	1h=0.1 [ms] (No)	0.0-99999.9 (0.0)
	Immediate value deceleration time	5104	○	○	1h=0.1 [ms] (No)	0.0-99999.9 (0.0)

13

Data type	Data name		Address (hex.)	Applicable FC 03h	Applicable FC 10h	Format (with a sign)		Setting range (default value)
Positioning data (divided)	Data 1	Positioning status + M code	5200	○	○	Positioning status: Refer to [Table 13-4].	(No)	M code: 0-FFh (FFh)
		Stop timer	5201	○	○	1h=0.01[s] *2	(No)	0.00-655.35 (0.00)
		Stop position	5202	○	○	1h=1 [unit]	(Yes)	0-±2000000000 (0)
		Rotation speed	5203	○	○	1h=0.01 [r/min]	(No)	0.01-Max. rotation speed (0.01)
		Acceleration time	5204	○	○	1h=0.1 [ms]	(No)	0.0-99999.9 (0.0)
		Deceleration time	5205	○	○			
		・・・	・・・	・・・	・・・			
		Positioning status + M code	52E0	○	○	Positioning status: Refer to [Table 13-4].	(Yes)	M code: 0-FFh (FFh)
		Stop timer	52E1	○	○	1h=0.01[s] *2	(No)	0.00-655.35 (0.00)
		Stop position	52E2	○	○	1h=1 [unit]	(Yes)	0-±2000000000 (0)
		Rotation speed	52E3	○	○	1h=0.01 [r/min]	(No)	0.01-Max. rotation speed (0.01)
		Acceleration time	52E4	○	○	1h=0.1 [ms]	(No)	0.0-99999.9 (0.0)
		Deceleration time	52E5	○	○			
Positioning data (Batch)	Positioning data 1-15		D000-D00E	○	○	Refer to [■Positioning data (Batch)].		—

(*1) By setting PA1_31 (selection of deviation unit), 0 and 1 are defined as unit amount and pulse, respectively.
(*2) By setting PA2_42 (stop timer decimal position), 0 represents 0.01 sec, and 1 represents 0.001 sec.

13

■ Coil addresses

[Table 13-2] Coil address list

Coil type	Coil name	Address (hex.)	Applicable FC 01h	05h	0Fh
Communication CONT signal	CONT9 signal	0208	○	○	○
	CONT10 signal	0209			
	CONT11 signal	020A			
	CONT12 signal	020B			
	CONT13 signal	020C			
	CONT14 signal	020D			
	CONT15 signal	020E			
	CONT16 signal	020F			
	CONT17 signal	0210			
	CONT18 signal	0211			
	CONT19 signal	0212			
	CONT20 signal	0213			
	CONT21 signal	0214			
	CONT22 signal	0215			
	CONT23 signal	0216			
	CONT24 signal	0217			
Communication OUT signal	OUT6 signal	0305	○	×	×
	OUT7 signal	0306			
	OUT8 signal	0307			
	OUT9 signal	0308			
	OUT10 signal	0309			
	OUT11 signal	030A			
	OUT12 signal	030B			
	OUT13 signal	030C			
	OUT14 signal	030D			
	OUT15 signal	030E			
	OUT16 signal	030F			
	OUT17 signal	0310			
	OUT18 signal	0311			
	OUT19 signal	0312			
	OUT20 signal	0313			
	OUT21 signal	0314			
Hardware CONT signal	CONT1 signal	0400	○	×	×
	CONT2 signal	0401			
	CONT3 signal	0402			
	CONT4 signal	0403			
	CONT5 signal	0404			
	CONT6 signal	0405			
	CONT7 signal	0406			
	CONT8 signal	0407			
Hardware OUT signal	OUT1 signal	0500	○	×	×
	OUT2 signal	0501			
	OUT3 signal	0502			
	OUT4 signal	0503			
	OUT5 signal	0504			

13

■ Communication CONT/OUT signal

The CONT/OUT signal is divided into two types: the hardware signal (sequence I/O terminal) and the communications signal (Modbus communications) depending on the I/O form as shown in the table below. For the hardware CONT/OUT signals, refer to the page of the sequence monitor.

	Hardware signal	Communications signal
CONT signal	CONT1-8 (8 bits)	CONT9-24 (16 bits)
OUT signal	OUT1-5 (5 bits)	OUT6-21 (16 bits)

It is possible to write and read the CONT signals via Modbus RTU communications. In reading and writing, the same type of signals (5 to 16 bits) are handled in a batch data.
The following shows the signal arrangement in the data. The signal turns on with the corresponding bit "1" and off with bit "0".

a) Communication CONT signal (CONT9 - 24)

<table>
<tr><td rowspan="4">Data</td><td rowspan="4">4bytes</td><td colspan="8">00h</td></tr>
<tr><td colspan="8">00h</td></tr>
<tr><td>CONT24</td><td>CONT23</td><td>CONT22</td><td>CONT21</td><td>CONT20</td><td>CONT19</td><td>CONT18</td><td>CONT17</td></tr>
<tr><td>CONT16</td><td>CONT15</td><td>CONT14</td><td>CONT13</td><td>CONT12</td><td>CONT11</td><td>CONT10</td><td>CONT9</td></tr>
</table>

b) Communication OUT signal (OUT6 - 21)

<table>
<tr><td rowspan="4">Data</td><td rowspan="4">4bytes</td><td colspan="8">00h</td></tr>
<tr><td colspan="8">00h</td></tr>
<tr><td>OUT21</td><td>OUT20</td><td>OUT19</td><td>OUT18</td><td>OUT17</td><td>OUT16</td><td>OUT15</td><td>OUT14</td></tr>
<tr><td>OUT13</td><td>OUT12</td><td>OUT11</td><td>OUT10</td><td>OUT9</td><td>OUT8</td><td>OUT7</td><td>OUT6</td></tr>
</table>

Relation with coil data manipulation

Manipulating CONT/OUT signals can be performed in the following two ways: a batch data operation (FC 03h, and 10h) by specifying data addresses and individual operation per bit (FC 01h, 05h, and 0Fh) by specifying each coil address. Among these, the signal statuses will follow the latest manipulation regardless of method of batch data operation or coil address specification for communication CONT signals 9 to 24 to which data can be written (FC 05h, 0Fh, and 10h).

■ Sequence monitor

(1) Hardware CONT signal and hardware OUT signal

The CONT signal and the OUT signal of sequence I/O can be loaded.

a) Hardware CONT signal (CONT1 - 8)

Data	4bytes	00h							
		00h							
		00h							
		CONT8	CONT7	CONT6	CONT5	CONT4	CONT3	CONT2	CONT1

b) Hardware OUT signal (OUT1 - 5)

Data	4bytes	00h							
		00h							
		00h							
		0	0	0	OUT5	OUT4	OUT3	OUT2	OUT1

(2) Control mode, Sequence mode, Alarm at present, Alarm history

Each piece of data in the control mode, sequence mode, alarm at present, and alarm history is the code data of 1 byte.

DATA	4bytes	00h
		00h
		00h
		Code

The content of the code varies depending on the data. For the detail, refer to the corresponding tables below.

Control mode

Code	Control mode
00h	Position control
01h	Speed control
02h	Torque control

Sequence mode

Code	Sequence mode
00h	Servo off
01h	Servo on
02h	Zero speed stop
03h	Manual feed (JOG)
04h	Pulse operation
05h	＋OT
06h	－OT
07h	In LV (under voltage)
08h	Positioning
09h	Homing
0Ah	Interrupt positioning
0Bh	In safe stop (STO)

Alarms at present and alarm histories

Code	Alarm	Symbol (*)	Code	Alarm	Symbol (*)
00h	None	---			
01h	Overcurrent 1	oc1	0Dh	Encoder Communication Error	Ec
02h	Overcurrent 2	oc2	0Eh	CONT (Control signal) Error	ctE
03h	Overspeed	oS	0Fh	Overload 1	oL1
04h	Undervoltage of Control power	LUc	10h	Overload 2	oL2
05h	Overvoltage	HU	11h	Inrush Current Suppression Circuit Trouble	rH4
06h	Encoder Trouble 1	Et1	12h	Safety function trouble	EcF
07h	Encoder Trouble 2	Et2	21h	Main Power Undervoltage	LUP
09h	Memory Error	dE	22h	Internal Breaking Resistor Overheat	rH1
0Bh	Motor Combination Error	cE	23h	External Breaking Resistor Overheat	rH2
24h	Breaking Transistor Error	rH3	2Ah	Absolute Data Lost 3	dL3
25h	Deviation Overflow	oF	2Bh	Multi-turn Data Over Flow	AF
26h	Amplifier Overheat	AH	2Ch	Initial Error	iE
27h	Encoder Overheat	EH	2Dh	Command pulse frequency error	HF
28h	Absolute Data Lost 1	dL1	2Eh	Overload 3	oL3
29h	Absolute Data Lost 2	dL2			

(*) Displayed on the amplifier.

■ Immediate value data

The immediate value status of immediate data is configured as follows:

	Configuration			Format (default value)
Data	4 bytes	Immediate value status	1 byte	Refer to [Table 13-3].
		Immediate value M code	1 byte	0-FFh (FFh)
		Not used	2 bytes	00h fixed

[Table 13-3] Immediate value status

Bit	Item	Description		Default value
5	M code output timing	0: Output during start up	1: Output after positioning completion	0
4	M code selection	0: Disable	1: Enable	0
0	Command method	0: ABS	1: INC	1
Others	Not used	0 fixed		0

■ Positioning data(batch)

Positioning data are 20 bytes long for each set, organized as follows:

	Configuration				Format, setting range (default value)
Data	20 bytes	Positioning status	1 byte		Refer to [Table 13-4].
		M code	1 byte		0-FFh (FFh)
		Stop timer	2 bytes	(H)	1h = 0.01 [s] (*)
				(L)	0.00-655.35 (0.00)
		Stop position	4 bytes	(HH)	1h = 1 [unit]
				(HL)	0 - ±2000000000 (0)
				(LH)	
				(LL)	
		Rotation speed	4 bytes	(HH)	1h = 0.01 [r/min]
				(HL)	0.01 - Max. rotation speed (0.01)
				(LH)	
				(LL)	
		Acceleration time	4 bytes	(HH)	1h = 0.1 [ms]
				(HL)	0.0 - 99999.9 (0.0)
				(LH)	
				(LL)	
		Deceleration time	4 bytes	(HH)	
				(HL)	
				(LH)	
				(LL)	

(*) By setting PA2_42 (stop timer decimal point position), 0 and 1 indicate 0.01 [s] and 0.001 [s], respectively.

[Table 13-4] Positioning status

Bit	Item	Description		Default value
5	M code output timing	0: Output during startup	1: Output after positioning completion	0
4	M code Selection	0: Disable	1: Enable	0
2,1	Step mode	0,0: No specification 0,1: Data continuation (CO) 1,0: Cycle end (CEND) 1,1: Setup impossible		0,0
0	Command method	0: ABS	1: INC	1
Others	Not used	fixed to 0		0

■ Positioning data (divided)

Positioning data are 4 bytes long for each set. The positioning status, M code, and the stop timer are configured as follows. All other items are configured in the same way as positioning data (batch).

DATA	4bytes	00h
		00h
		Positioning status
		M code

DATA	4bytes	00h
		00h
		Stop timer (H)
		Stop timer (L)

13

13.3.5 Exceptional responses

The amplifier returns an exceptional response if it has not succeed the process specified by a query.
The message frame is as follows. This is common to all FC values.

Station No.	1 byte	
FC	1 byte	
Exceptional code	1 byte	
CRC check	16 bits (2 bytes)	(L)
		(H)

(1) Function code (FC) field
Exceptional responses from slaves are returned as one is set on the MSB of the FC specified by the query.

Query	Exceptional response
01h	81h
03h	83h
05h	85h
08h	88h
0Fh	8Fh
10h	90h
17h	97h

(2) Exceptional code field
Exceptional responses from slaves are returned as exceptional response which indicates exceptional content with the query.

Exceptional code	Description and sample queries
01h	Incorrect FC (An incorrect FC is specified.) ・An FC other than 01h, 03h, 05h, 08h, 0Fh, and 10h, which are supported, is specified.

13

02h	Incorrect address (An incorrect address is specified) When FC 03h or 10h is specified ・An address not listed in [Table 13-1] data addresses list is specified. ・The address that is listed only for FC 03h in [Table 13-1] is specified for FC 10h. When FC 01h, 05h or 0Fh is specified ・An address not listed in [Table 13-2] coil data addresses list is specified. ・The address that is listed only for FC 01h in [Table 13-2] is specified for FC 05h or 0Fh. When FC 17h is specified ・The write data specified address is other than 6000h to 6007h, and the read data specified address is other than 6000h to 600Fh. When corresponding address in 6000s is specified with FC 03h or 10h ・The read data address specified with FC 03h is other than 6000h to 600Fh. ・The write data address specified with FC 10h is other than 6000h to 6007h.
03h	Incorrect data (An abnormal value is specified in the information field.) When FC 03h or 10h is specified ・The following value is specified as the no. of registers: zero, odd number, or a value exceeding the maximum value. ・A value different from the no. of registers is specified to the no. of data bytes. ・A value out of range is specified to a write data. When FC 01h, 05h or 0Fh is specified ・The following value is specified as the no. of coil data: zero, or a value exceeding the maximum value. ・A value different from the no. of coil data is specified to the no. of data bytes. ・A value not specified as ON/OFF values is specified to a coil data in FC 05h. When address in 6000s is specified with FC 17h ・The number of registers is 0 or an odd number, or a value that exceeds the maximum value is specified. ・The value specified for the number of data bytes is in disagreement with the number of registers. ・A value outside the following ranges is specified for read and write data. ・The number of read data items exceeds 16. ・The number of write data items exceeds 8.

13.3.6 CRC-16

(1) Outline of CRC

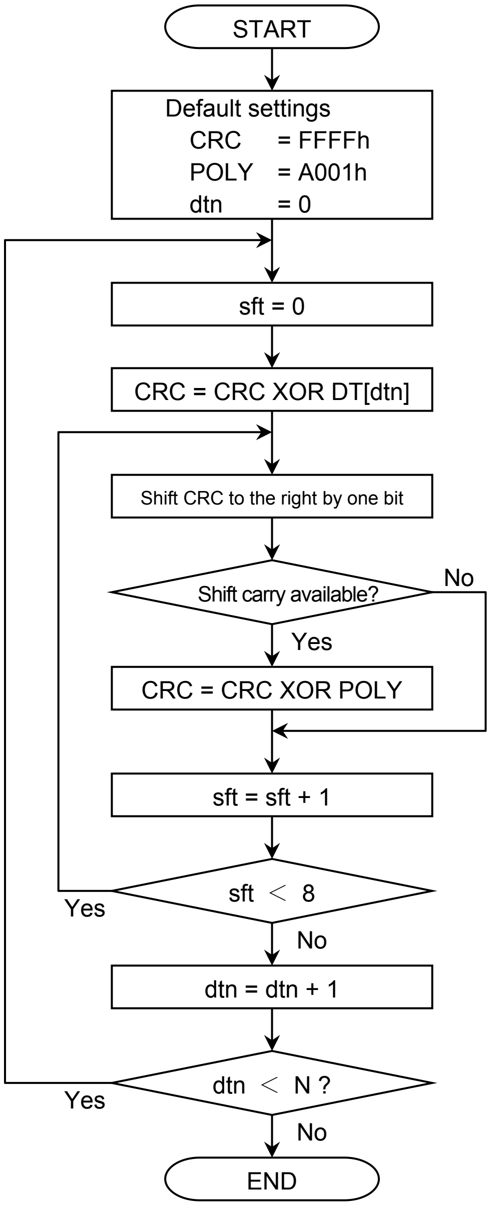
CRC (Cyclic Redundancy Check) is a system to check if communications data are correct.

In the CRC calculation, data expressed as a polynomial are divided by a generating polynomial, and the residue is used as CRC data.

Modbus RTU uses the CRC-16 which performs calculation using $X^{16} + X^{15} + X^{2} + 1$ as the generating polynomial.

(2) CRC-16 calculation algorithm

The algorism for calculating CRC-16 on the data (N bytes) from the station number field to the information field is as follows:



CRC ··· Calculated value of CRC-16
POLY ··· Generating polynomial
dtn ··· Data counter
sft ··· Shift counter
DT[dtn] ··· Nth data (one byte)
N ··· Number of data bytes
XOR ··· exclusive OR

DT[0] is station number, DT[1] is FC, and DT[2]-DT[N-1] are data in the information field.

(3) CRC-16 calculation example

The [Table 13-5] is the result obtained from CRC-16 calculated according to its algorithm using the query to read parameters PA1_41 to 47 (7 pcs). The last data No.52: C651h will be added to the end of the frame in order of digits from lower to upper.

Station No.	FC	Address		No. of registers		CRC check	
01h	03h	40h	28h	00h	0Eh	51h	C6h

[Table 13-5] calculation examples

No.	Calculations	bit																Shift carry
		15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
1	**CRC** (initial value)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
2	**POLY** (initial value)	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	
3	**DT[0]** (station no.)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	
4	**CRC** = No.1 XOR No.3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	
5	Shift **CRC** by 2 bits to the right (until shift-carry occurs.)	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
6	**CRC** = No.5 XOR No.2	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	0	
7	Shift **CRC** by 2 bits to the right	0	0	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1
8	**CRC** = No.7 XOR No.2	1	0	0	0	0	1	1	1	1	1	1	1	1	1	1	0	
9	Shift **CRC** by 2 bits to the right	0	0	1	0	0	0	0	1	1	1	1	1	1	1	1	1	1
10	**CRC** = No.9 XOR No.2	1	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	
11	Shift **CRC** by 2 bits to the right (Finished with **sht** =8.)	0	0	1	0	0	0	0	0	0	1	1	1	1	1	1	1	1
12	**CRC** = No.11 XOR No.2	1	0	0	0	0	0	0	0	0	1	1	1	1	1	1	0	
13	**DT[1]** (FC)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	
14	**CRC** = No.12 XOR No.13	1	0	0	0	0	0	0	0	0	1	1	1	1	1	0	1	
15	Shift **CRC** by 1 bit to the right	0	1	0	0	0	0	0	0	0	0	1	1	1	1	1	0	1
16	**CRC** = No.15 XOR No.2	1	1	1	0	0	0	0	0	0	0	1	1	1	1	1	1	
17	Shift **CRC** by 1 bit to the right	0	1	1	1	0	0	0	0	0	0	0	1	1	1	1	1	1
18	**CRC** = No.17 XOR No.2	1	1	0	1	0	0	0	0	0	0	0	1	1	1	1	0	
19	Shift **CRC** by 2 bits to the right	0	0	1	1	0	1	0	0	0	0	0	0	0	1	1	1	1
20	**CRC** = No.19 XOR No.2	1	0	0	1	0	1	0	0	0	0	0	0	0	1	1	0	
21	Shift **CRC** by 2 bits to the right	0	0	1	0	0	1	0	1	0	0	0	0	0	0	0	1	1
22	**CRC** = No.21 XOR No.2	1	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	
23	Shift **CRC** by 2 bits to the right	0	0	1	0	0	0	0	1	0	1	0	0	0	0	0	0	
24	**DT[2]** (Address (H))	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	
25	**CRC** = No.23 XOR No.24	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	
26	Shift **CRC** by 8 bits to the right	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	
27	**DT[3]** (Address (L))	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	
28	**CRC** = No.26 XOR No.27	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	
29	Shift **CRC** by 1 bit to the right	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
30	**CRC** = No.29 XOR No.2	1	0	1	0	0	0	0	0	0	0	0	0	0	1	0	1	
31	Shift **CRC** by 1 bit to the right	0	1	0	1	0	0	0	0	0	0	0	0	0	0	1	0	1
32	**CRC** = No.31 XOR No.2	1	1	1	1	0	0	0	0	0	0	0	0	0	0	1	1	
33	Shift **CRC** by 1 bit to the right	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	1	1
34	**CRC** = No.33 XOR No.2	1	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	
35	Shift **CRC** by 5 bits to the right	0	0	0	0	0	1	1	0	1	1	0	0	0	0	0	0	
36	**DT[4]** (No. of registers (H))	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
37	**CRC** = No.35 XOR No.36	0	0	0	0	0	1	1	0	1	1	0	0	0	0	0	0	
38	Shift **CRC** by 7 bits to the right	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	1
39	**CRC** = No.38 XOR No.2	1	0	1	0	0	0	0	0	0	0	0	0	1	1	0	0	
40	Shift **CRC** by 1 bit to the right	0	1	0	1	0	0	0	0	0	0	0	0	0	1	1	0	

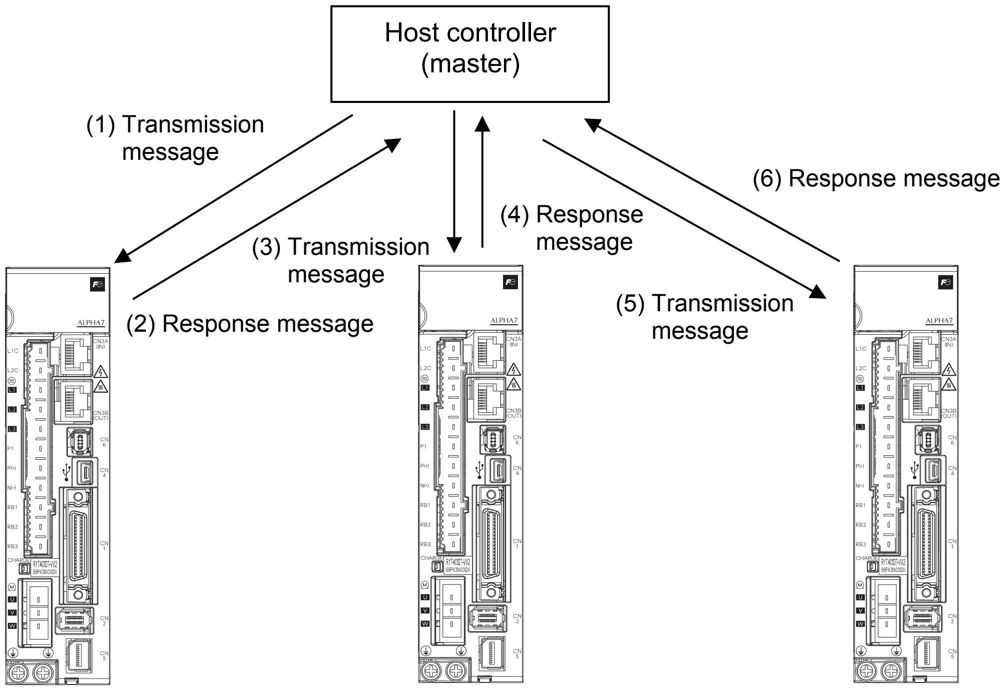
13

No.	Calculations	bit																Shift carry
		15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
41	**DT[5]** (No. of registers (L))	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	
42	**CRC** = No.40 XOR No.41	0	1	0	1	0	0	0	0	0	0	0	0	1	0	0	0	
43	Shift **CRC** by 4 bits to the right	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	1
44	**CRC** = No.43 XOR No.2	1	0	1	0	0	1	0	1	0	0	0	0	0	0	0	1	
45	Shift **CRC** by 1 bit to the right	0	1	0	1	0	0	1	0	1	0	0	0	0	0	0	0	1
46	**CRC** = No.45 XOR No.2	1	1	1	1	0	0	1	0	1	0	0	0	0	0	0	1	
47	Shift **CRC** by 1 bit to the right	0	1	1	1	1	0	0	1	0	1	0	0	0	0	0	0	1
48	**CRC** = No.47 XOR No.2	1	1	0	1	1	0	0	1	0	1	0	0	0	0	0	1	
49	Shift **CRC** by 1 bit to the right	0	1	1	0	1	1	0	0	1	0	1	0	0	0	0	0	1
50	**CRC** = No.49 XOR No.2	1	1	0	0	1	1	0	0	1	0	1	0	0	0	0	1	
51	Shift **CRC** by 1 bit to the right	0	1	1	0	0	1	1	0	0	1	0	1	0	0	0	0	1
52	**CRC** = No.51 XOR No.2	**1**	**1**	**0**	**0**	**0**	**1**	**1**	**0**	**0**	**1**	**0**	**1**	**0**	**0**	**0**	**1**	

13.3.7 Communication operating method

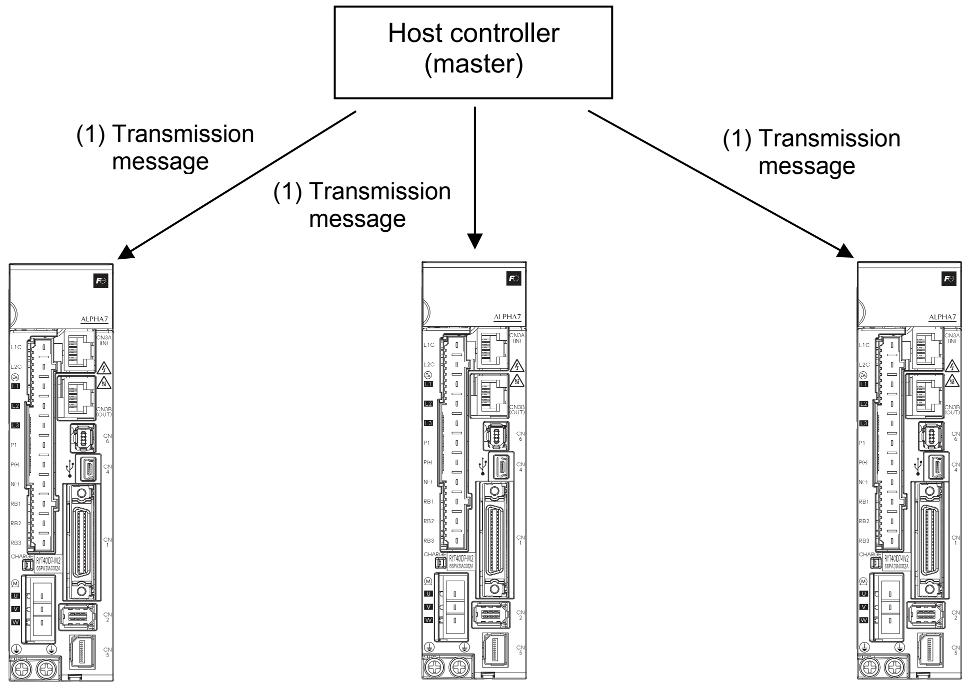
<Unicast method>

Messages are sent in the following order in this method: (1) → (2) → (3) → (4) → (5) → (6).



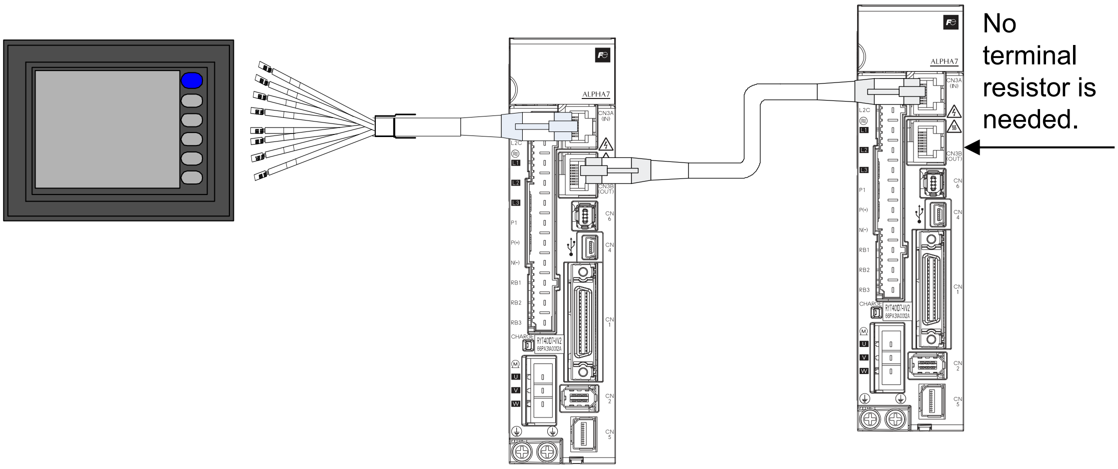
<Broadcasting method>

A transmission message is sent to slaves simultaneously in this method. No response message is sent back.



13.4 Sample Wiring with Host Controller

Operation display (host controller)



In case of using Fuji's MONITOUCH

MONITOUCH （MJ1/MJ2）

Signal name	Pin.NO
-RD/-SD	2
+RD/+SD	1
SG	5
FG	Shell

ALPHA7 （CN3A）

Pin.NO	Signal name
8	P5
7	M5 (0 V)
6	*TXD
5	RXD
4	*RXD
3	TXD
2	M5 (0 V)
1	P5

RJ45 connector

・Connect between ALPHA7 and ALPHA7 with a commercial LAN cable (straight).

13.5 Communications Procedures

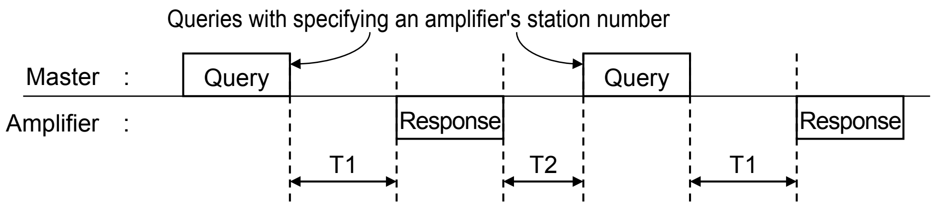
13.5.1 Start of communications

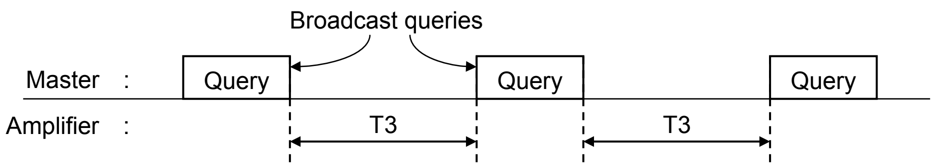
The amplifier cannot perform communications after the power supply is turned on until the internal initialization has been complete. When turning on the amplifier, perform the procedure below, and then start normal communications.

1. Turn on the power supply, and wait for approximately 4.5 s.
2. Send an FC 08h (maintenance echo back) query from the master.
3. Confirm that a response message (echo back) is returned from the amplifier.

13.5.2 Communications timings

Communications timings are as follows:





(1) Amplifier’s response time (T1)

This is the time passing after a query is sent from the master until the amplifier starts sending a response message. When communication timeout is monitored by the master, time around T1 + 100 ms is recommended.

(2) Sending/receiving switching time (T2)

This is the time passing after a response message is sent by an amplifier until the amplifier becomes able to receive the next query.

When the master has received a response message from the amplifier, it must wait for T2 or more before sending the next query.

13

(3) Waiting time after a broadcast query is sent (T3)

This is the time passing after a broadcast query is sent by the master until the amplifier becomes able to receive the next query. When the master has sent a broadcast query, it must wait for T3 or more before sending the next query.

(4) Definition of amplifier's timings

Timings on the amplifier side are defined as follows:

<table>
<tr><th>FC</th><th>Information field</th><th>T1</th><th>T2</th><th>T3</th><th>Recommended timeout setting</th></tr>
<tr><td>Other than 10h</td><td>-</td><td rowspan="2">115200 [bps] :
within 1.7 [ms]
38400 [bps] :
within 5 [ms]
19200 [bps] :
within 10 [ms]
9600 [bps] :
within 10 [ms]</td><td rowspan="3">115200 [bps] :
within 1.7 [ms]
38400 [bps] :
within 5 [ms]
19200 [bps] :
within 10 [ms]
9600 [bps] :
within 10 [ms]</td><td rowspan="3">Same as T1</td><td rowspan="2">100 [ms]</td></tr>
<tr><td rowspan="2">10h</td><td>Other than below</td></tr>
<tr><td>Specify that n sets of parameters or positioning data are written in</td><td>Within (n+2)×10 [ms]</td><td>250 [ms]</td></tr>
</table>

■ Response time

It is posssible to delay a response time of the amplifier by using PA2_94(response time).
If PA2_94 is set to other than 0.00[s], the response time of the amplifier is T1 + PA2_94.
However, if the parameter or positioning data is written with FC=10h, the longer time is employed between T1 and PA2_94.
After the master has sent a query, if it takes a long time until the master switches into the receiving state, set PA2_94 (response time) as needed because responses from the amplifiers might not be received correctly.

13

13.5.3 Error processing

Errors are classified into the following:

(a) Physical/character-level errors	: Parity error, framing error, and so on
(b) Protocol level error (1)	: CRC error
(c) Protocol level error (2)	: Incorrect FC/address/data

(1) Amplifier's operation when an error is detected

An amplifier operates as follows when it has detected one of various errors while receiving a query from the master:

If an error of type (a) or (b) is detected:

The amplifier discards the data which have been received up to that time, and returns to the reception waiting state. No response message is returned.

It is recommended that the master monitors timeout after sending a query.

If an error of type (c) is detected:

The amplifier returns an exceptional response. It must confirm the content of the query according to the exceptional code.

(2) Master's operation when an error is detected (recommended)

While the master is receiving a response message from an amplifier, if it has detected one of the various errors, it is recommended to send the same query again (retry processing) after waiting for T2 after the reception has been complete.

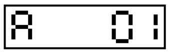
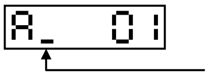
13

13.5.4 Communication time over

Communication time over is detected if any time other than 0.00 s is set on PA2_95 (communication time over).

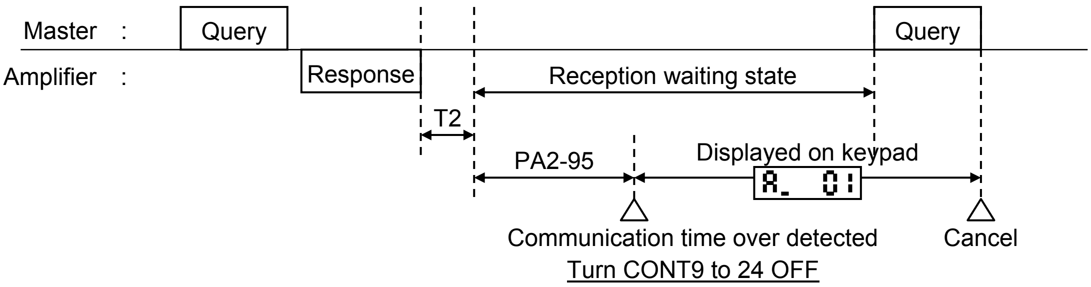
If an amplifier has been in the state of waiting for receiving a message over the time specified by PA2_95, a communication time over has occurred, and <u>all the communication CONT signals (CONT9-24) operated by the Modbus communications are set off.</u>

When communication time over has occurred, the station number mode of the keypad is displayed as follows (an example of station number 01):

- Normal display of station number 
- Communication time over 

Communication time over detected
("_" is displayed at the second leftmost digit.)

Even if communication time over has occurred, communications can be performed as usual. When the amplifier receives a query from the master to the self station number or a broadcast query, communication time over is cleared, and it returns to the normal display.



If PA2_95 is set to 0.00 s, communication time over is not detected. Use this setting as needed, for example, if the system communicates periodically and you wish to detect discontinuation of the communications.

13

13.5.5 Communications example

1. Immediate value data operation

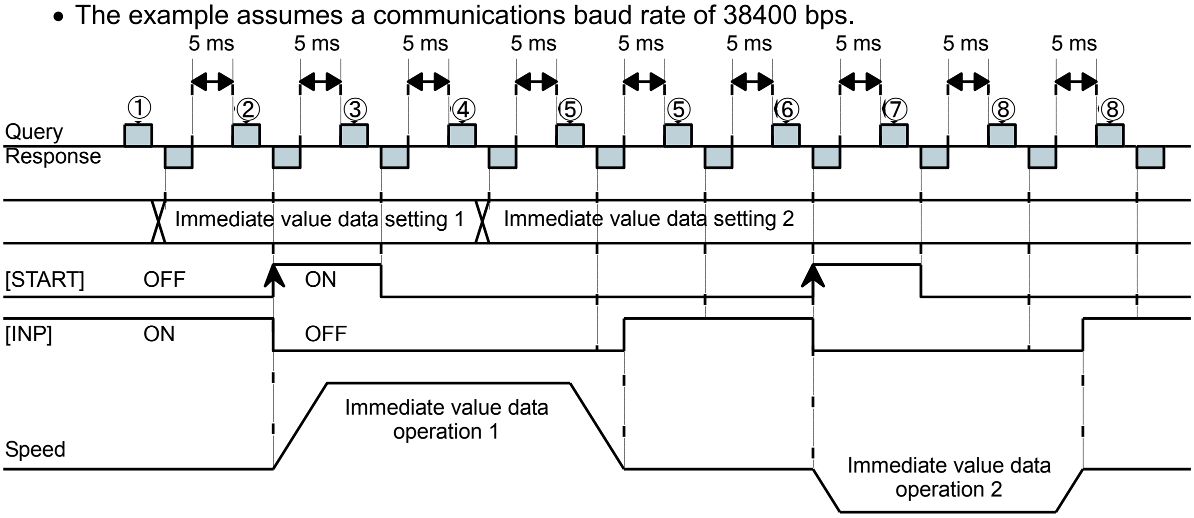
A Communications example for conducting positioning operation with immediate value data is described.

■ Preparation

- Select the positioning operation control mode.
  ・・・ PA1_01: Control mode selection =7: Positioning operation
- Assign [START] to CONT9.・・・ PA3_09: CONT9 signal assignment =4: [START]
- Assign [INP] to OUT6. ・・・ PA3_56: OUT6 signal assignment =2: [INP]

■ Communications example

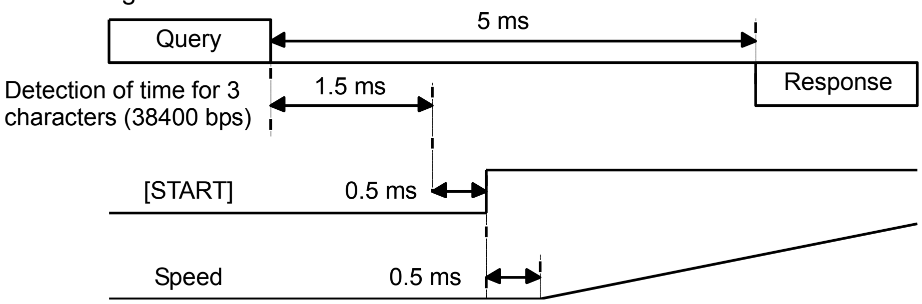
- Turn on [S-ON] assigned to CONT1 to arrange the operation state, and perform communications as shown below.
- The example assumes a communications baud rate of 38400 bps.



(1) Write immediate value data setting 1 as immediate value data.
Setting 1: Designation method = ABS. Immediate value position = 500000 units.
Immediate value speed = 500.00 r/min
Query: 01 10 5100 0006 0C 00000000 0007A120 0000C350 D9EC (21 bytes)
Response: 01 10 5100 0006 50F7 (8 bytes)

(2) Write “1” (ON) to [START] to start positioning operation. (Immediate value data operation 1 based on immediate value data setting 1 starts.)
Query: 01 10 0000 0002 04 00000001 326F (13 bytes)
Response: 01 10 0000 0002 41C8 (8 bytes)

The detail timing at this time is shown below.



(3) Write “0” (OFF) to [START]. (This is to generate a rising edge in the next start.)

Query: 01 10 0000 0002 04 00000000 F3AF (13 bytes)

Response: 01 10 0000 0002 41C8 (8 bytes)

(4) Write immediate value data setting 2, which is for the next operation, as immediate value data. The immediate value data operation follows the immediate value data read at the start (rising edge of [START]). After operation is started, you can write the following setting as immediate value data.

Setting 2: Immediate value position = -100000 units.
Immediate value speed = 200.00 r/min

Query: 01 10 5101 0004 08 FFFE7960 00004E20 667A (17 bytes)

Response: 01 10 5101 0004 80F6 (8 bytes)

(5) Read [INP] and check that immediate value data operation 1 is finished.
If [INP] is turned off, immediate value data operation 1 is in progress. (5) is repeated until [INP] is turned on.

Query: 01 03 0100 0002 C5F7 (8 bytes)

Response: 01 03 04 0000 000**0** FA33 (9 bytes)

↑ If “**1**”, [INP] is turned on.
Because immediate value data operation 1 is finished, the process proceeds to step (6).

(6) Write “1” (ON) at [START] to start positioning operation. (Immediate value data operation 2 based on immediate value data setting 2 starts.)

Query: 01 10 0000 0002 04 00000001 326F (13 bytes)

Response: 01 10 0000 0002 41C8 (8 bytes)

(7) Write “0” (OFF) at [START]. (This is to generate a rising edge at the next start.)

Query: 01 10 0000 0002 04 00000000 F3AF (13 bytes)

Response: 01 10 0000 0002 41C8 (8 bytes)

(8) Read [INP] and check that immediate value data operation 2 is finished.
If [INP] is OFF, immediate value data operation 2 is in progress. Repeat step (8) until [INP] is turned on.

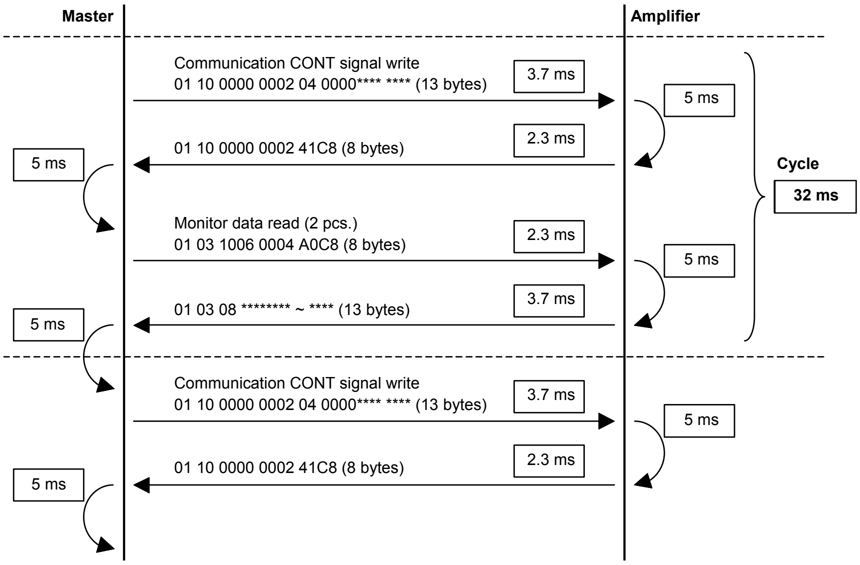
Query: 01 03 0100 0002 C5F7 (8 bytes)

Response: 01 03 04 0000 000**0** FA33 (9 bytes)

↑ If “**1**”, [INP] is turned on.
Immediate value data operation 2 is finished.

2. Monitoring cycle

A communications cycle example for writing the CONT signal to read monitored data is shown as a communication method for starting operation and monitoring the state. The example assumes a communications baud rate of 38400 bps and 11-bit characters.



13

CHAPTER 14 PC LOADER

14

14.1 Operating Environment

A PC with the following environment is required to use PC Loader.

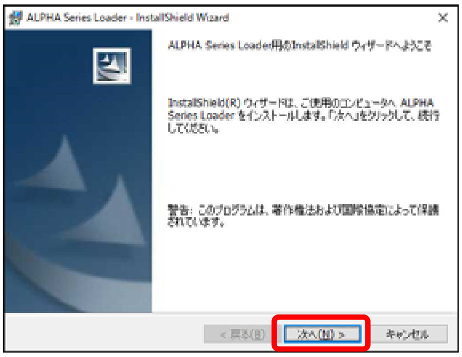
- Operating system
  Windows 10
  Windows 8.1
  Windows 7
- CPU
  1[GHz] or higher
- Memory environment
  2 [GB] or more (1 [GB] or more for 32-bit system)
- Display
  Windows compatible display with XGA (1024 × 768 [pixels]) resolution or higher
- Available hard disk capacity
  200 [MB] or more

14.2 Installation Method

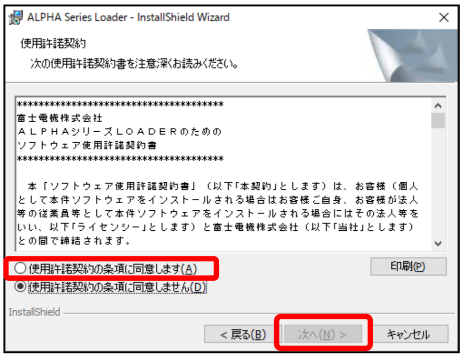
Exit Message Manager (MM) prior to installation.

[1] Start the ALPHA7 Series PC Loader setup program.
Click “setup.exe”.

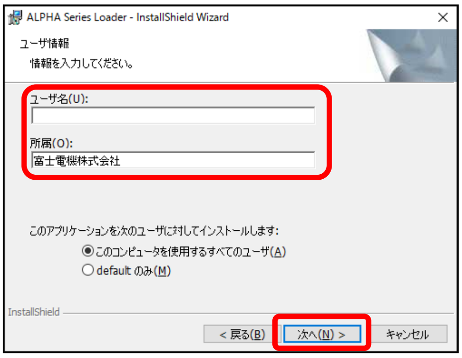
[2] The installation preparation screen is displayed.
Click [Next].



[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].



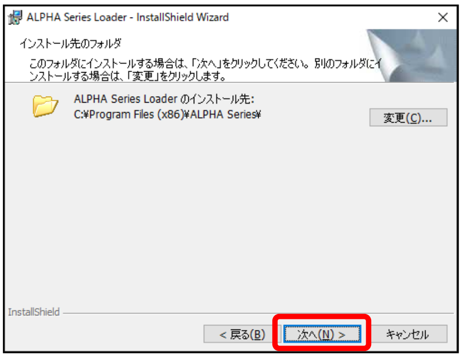
[4] Enter user information.
Enter your user name and the division you belong to.
Furthermore, specify the user(s) who will be using PC Loader.
After entering information and selecting the applicable user(s), click [Next].



14

[5] Select the installation folder.

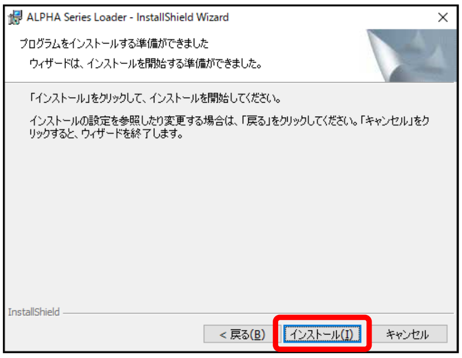
Select the folder in which PC Loader is to be installed, and click [Next].



[6] The installation preparation start screen is displayed.

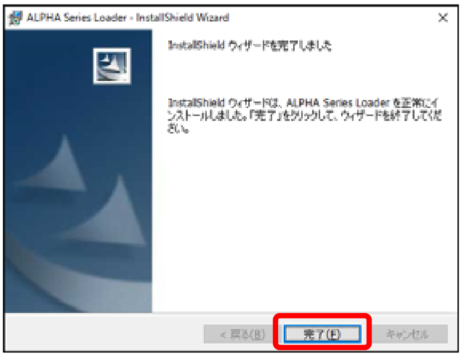
Click [Install].

File copying is started.



[7] The installation complete screen is displayed.

Click [Finish] to complete the installation.



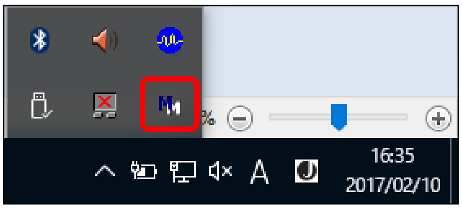
■ Message Manager (MM)

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.

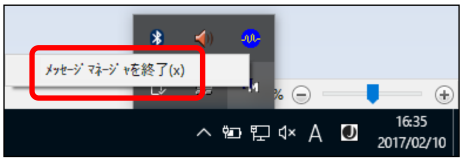
Applicable device	Applicable model	Loader name/model
Fuji integrated controllers	MICREX-SX	SX Programmer Expert (D300winVer2) / NP4H-SEDBV2
		SX Programmer Expert (D300winVer3) / NP4H-SEDBV3
		SX Programmer Standard / NP4H-SWN
		SX communication middleware / NP4N-MDLW
Fuji inverters	FRENIC-Mini FRENIC-Eco	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.

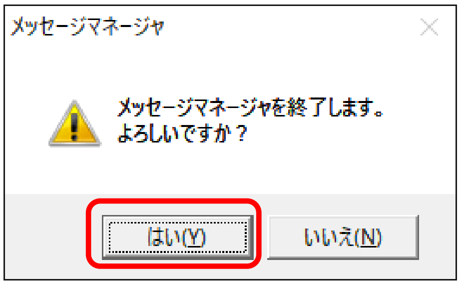


The following procedure can be used to exit MM (explanation based on use of right-hand mouse).

[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.

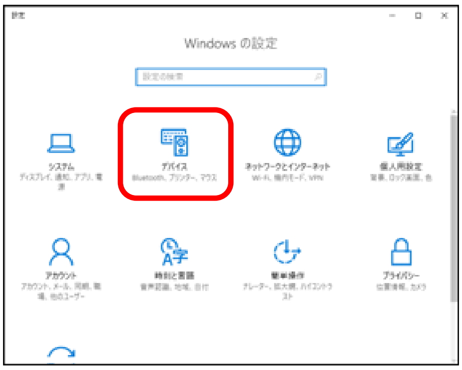


[3]　MM is exited (the  icon disappears from the task bar).

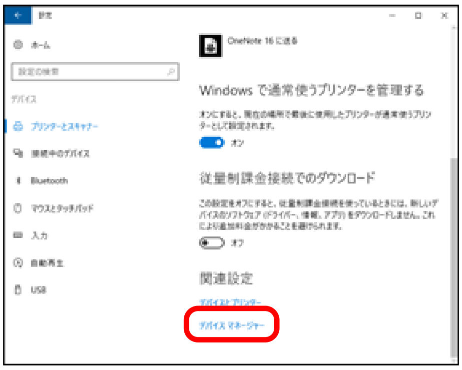
■　USB hardware search wizard procedure

Windows 10 edition

[1]　Connect the computer and servo amplifier with a USB cable, and select [Control Panel] - [Devices].

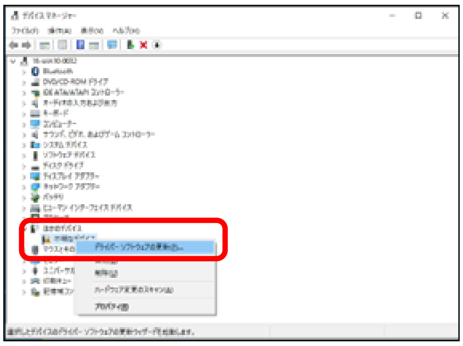


[2]　Select Device Manager.



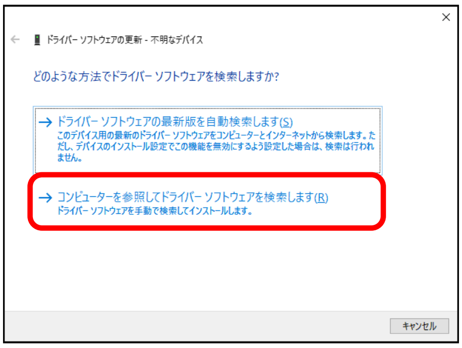
14

[3] Right-click "Unknown device", and then left-click "Update Driver Software...".

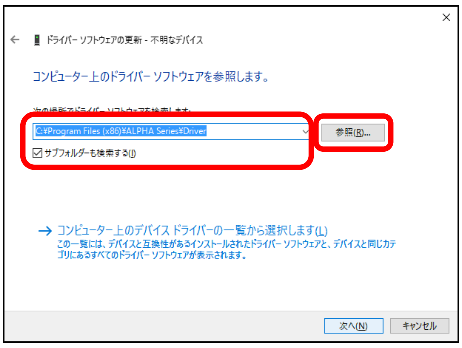


[4] Select the USB driver file.
Click [Browse].

[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.

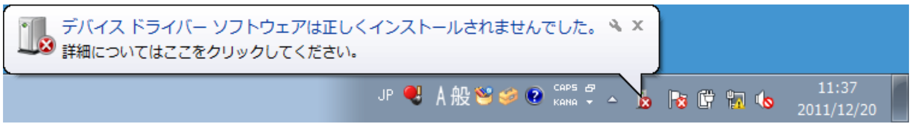


[7] The file is copied, and the completion screen is displayed.
Click [Close] to complete the driver installation.

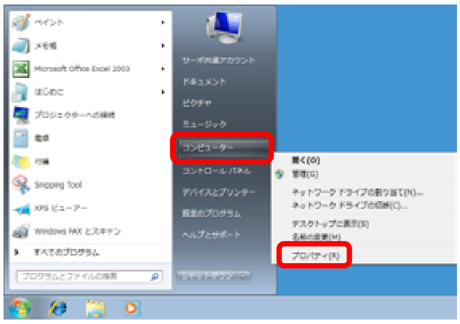
14

Windows 7 edition

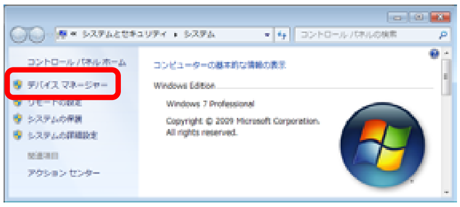
[1]　Connect the computer and servo amplifier with a USB cable. By connecting, the computer recognizes the USB device, and a message is displayed.



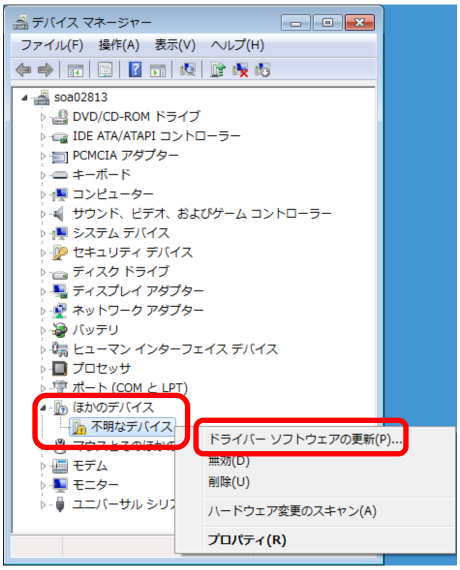
[2]　The wizard used to install the USB driver does not start automatically, and therefore the following procedure should be used to install the driver. Click the Start button, right-click "Computer", and then select "Properties" from the list that appears.



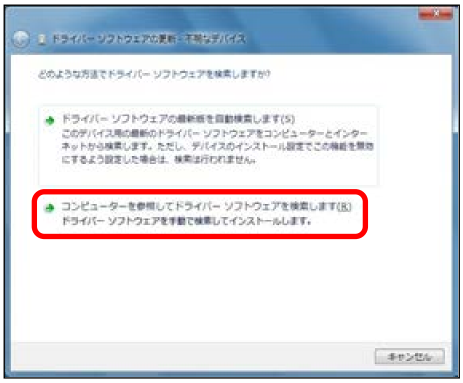
[3]　Click "Device Manager".



[4]　Right-click "Unknown device", and then left-click "Update Driver Software...".

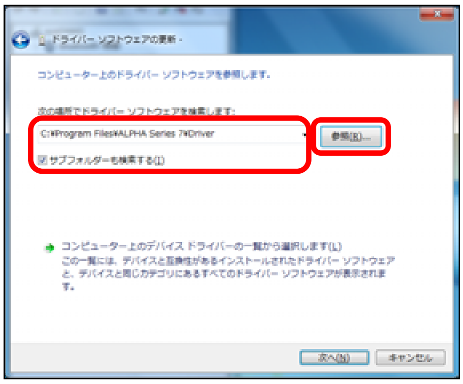


[5] Select "Browse my computer for driver software".



[6] Select the USB driver file.

Click [Browse].

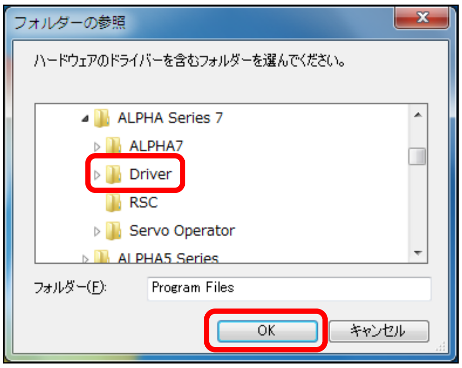


[7] Select the folder which contains the driver file.

The USB driver is copied to the folder * on which PC Loader is installed.

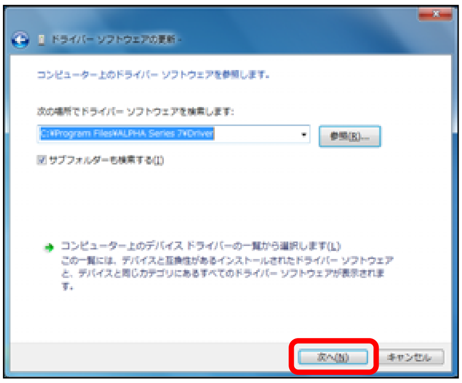
* ALPHA Series PC Loader example

Select the "C:¥Program Files¥ALPHA Series 7¥Driver" folder and click [OK].



[8] The folder is specified.

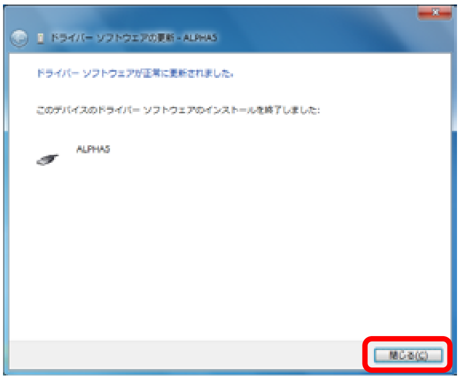
Click [Next].



[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.



14

14.3 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

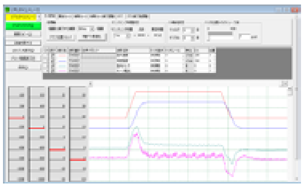
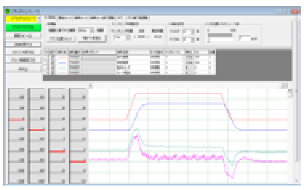
  Safety parameters can be edited and transferred, etc.

  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.

14.4 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)

14.5 Detailed Function Description

14.5.1 Real-time Trace

This function draws the servomotor operation waveform. Data for approximately 60,000 points is acquired continuously.

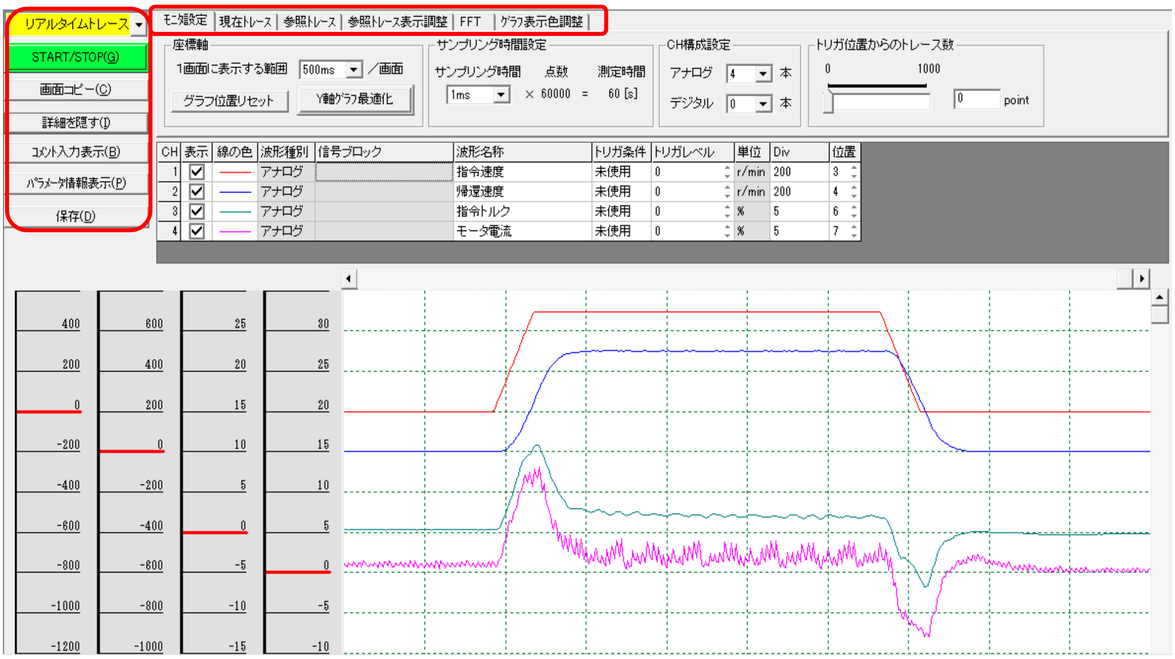
The trace ends automatically when 60,000 points are exceeded.

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

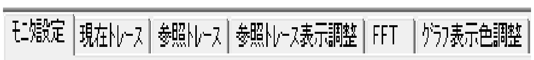
[Real-time Trace screen example]



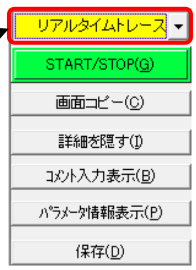
Functions such as displaying between two cursors, superimposing waveforms, FFT analysis, copying screens, acquired waveform parameter information, and waveform saving (CSV format supported) are available at this screen.

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.

14

■ 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]

14

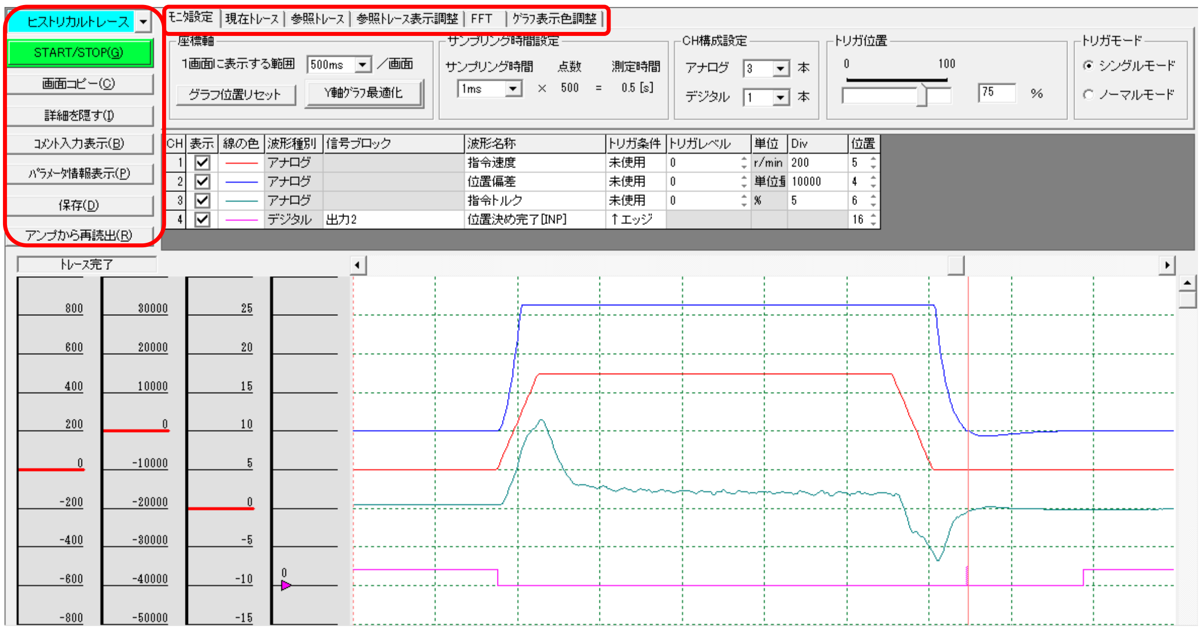
14.5.2 Historical Trace

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

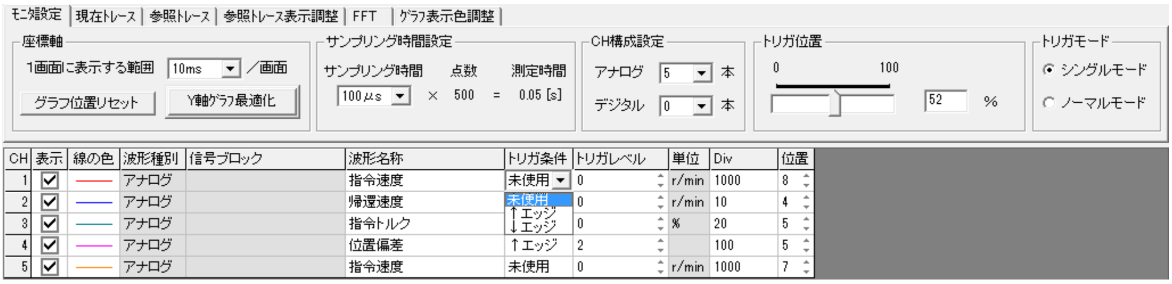
The waveforms that can be acquired are the same as those for real-time trace.

■ Trigger settings

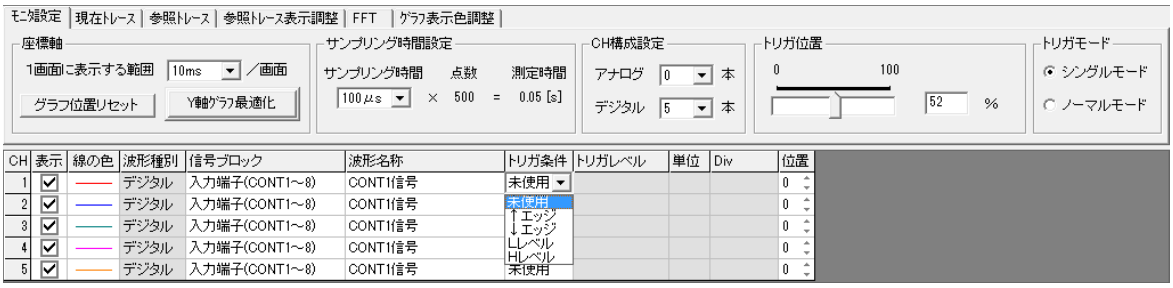
Trigger settings * can be specified for either analog waveforms or digital waveforms.

* Analog trigger setting: 1 channel only Digital trigger setting: Multiple channels are available

[Analog trigger settings]



[Digital trigger settings]



14

■ Setting method example if waveform measured during stoppage

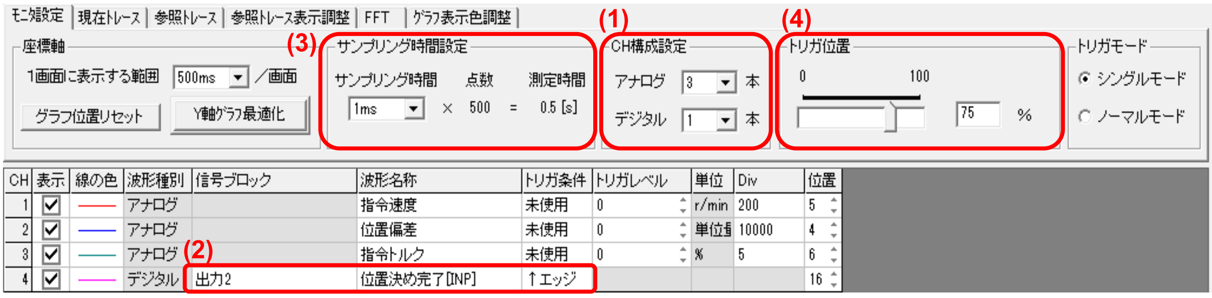
(1) Set analog waveform x 3 (command speed, position deviation, command torque), and digital waveform x 1 (positioning complete (INP)).

(2) Set the digital trigger signal for the digital waveform (positioning complete (INP)) to “Use with ↑ edge”.

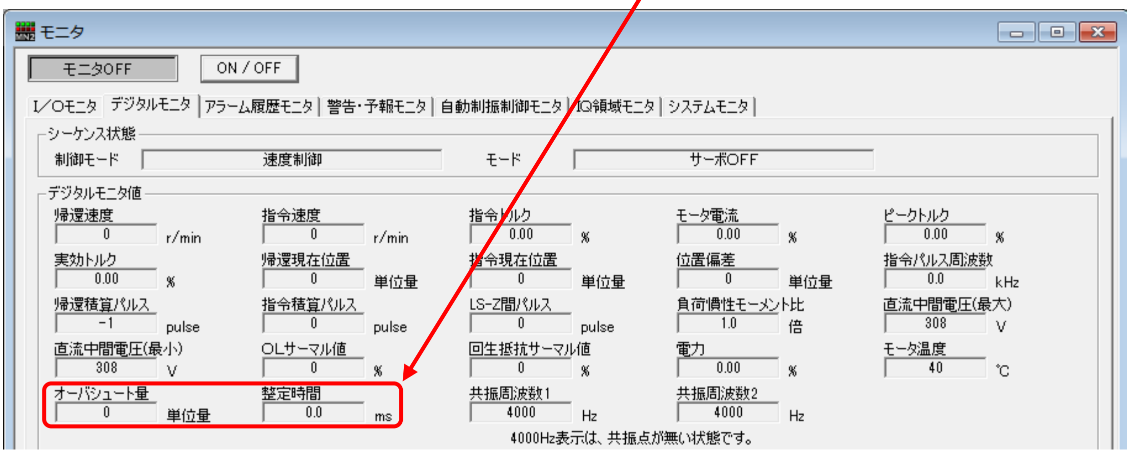
(3) Set the sampling time to “1 ms”.

(4) Set the trigger position to 75%.

After specifying the above settings, press the [START/STOP] button to start the trace.

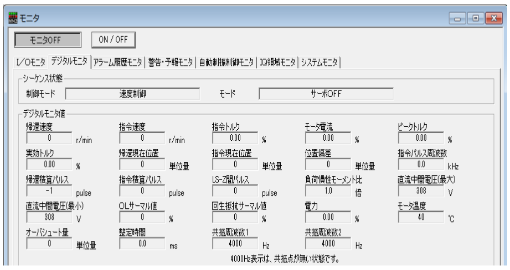


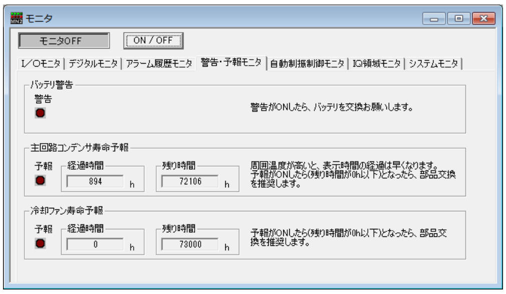
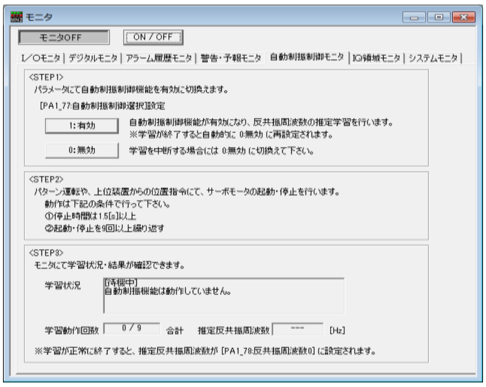
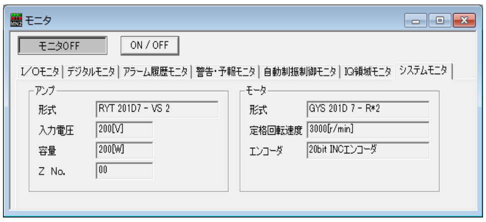
Hint	By selecting [Monitor] → [Digital Monitor], the amount of overshoot and settling time are displayed in real time.



14.5.3 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.	

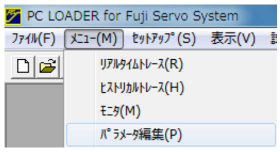
Warning, forecast monitor	Displays the warning and forecast status occurring at the servo amplifier. Displays such information as battery warnings, remaining main circuit capacitor time, and remaining cooling fin time.	
Automatic vibration suppression monitor	Displays the automatic vibration suppression learning state.	
System monitor	Displays such information as the model and capacity of connected servo amplifiers and servomotors.	

14

14.5.4 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.

14

(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.

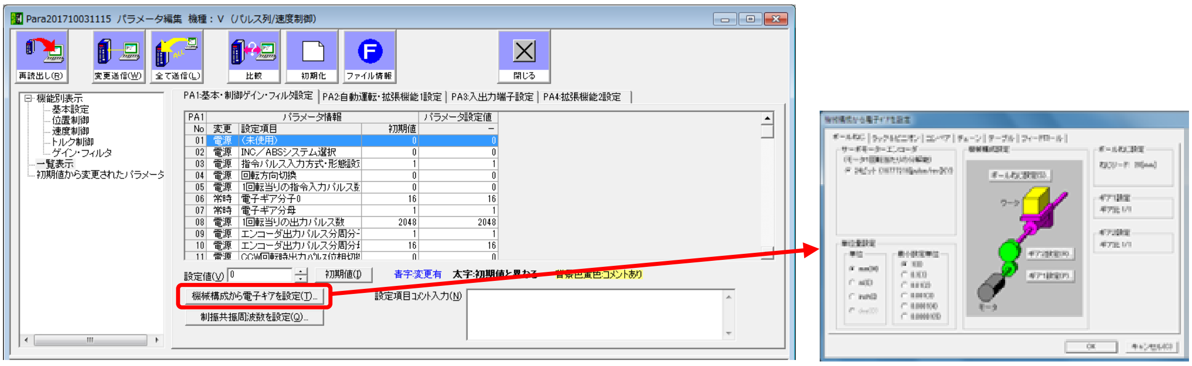
(7) Function based display function

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.

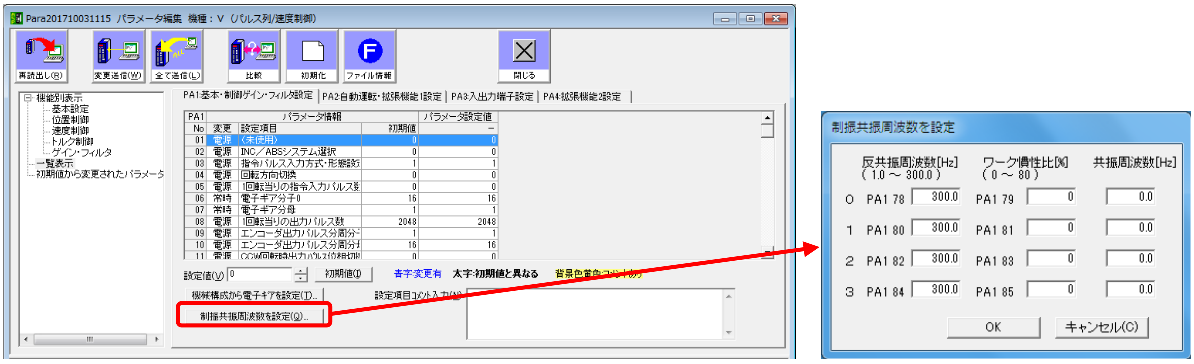
■ Automatic electronic gear calculation

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.



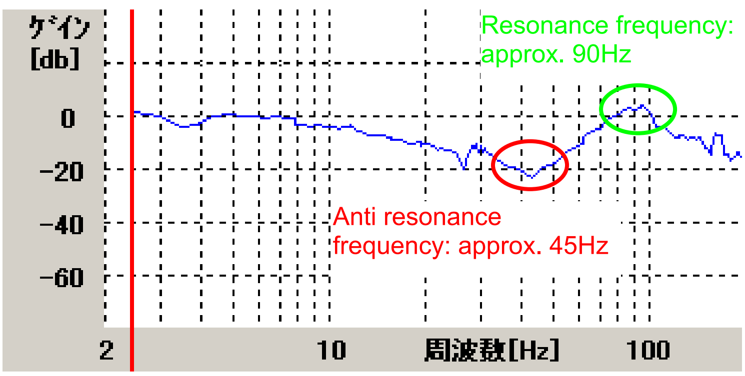
■ Automatic workpiece inertia ratio calculation

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 *.



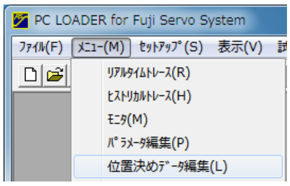
* Resonance frequency is not the resonance frequency suppressed with the notch filter.
This resonance frequency can be checked with the Servo Analyze function.
This resonance frequency is produced as the counterpart to anti resonance frequency, and the value is approximately twice the anti resonance frequency.

[Resonance frequency example]



14.5.5 Positioning Data Editing

This screen is used to register positioning data in the servo amplifier. and is run by selecting [Menu] - [Edit Positioning Data].



The functions of each button on this screen are as follows.

(1) Re-read

Reads positioning data from the connected servo amplifier.

(2) Send Changes

Sends changed positioning data to the connected servo amplifier.

(3) Send All

Sends all positioning data 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.

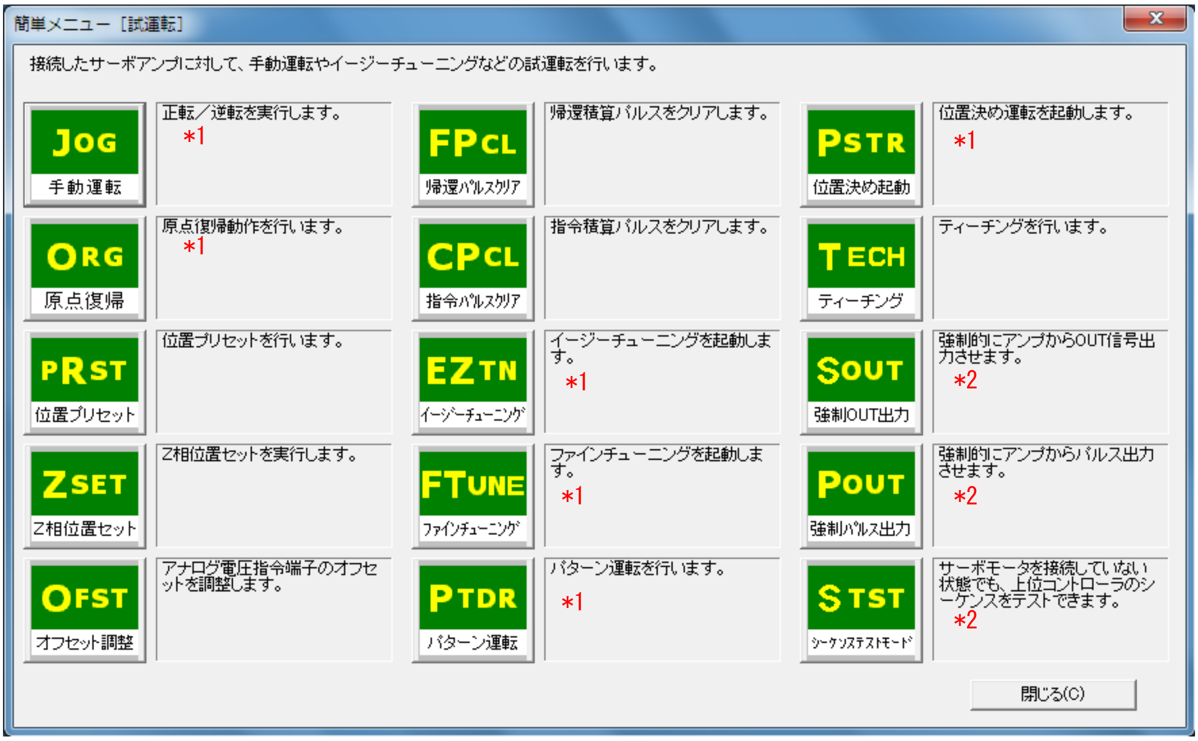
(6) File Info.

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.

- Refer to PC Loader Help for a description of other buttons.

14.5.6 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.



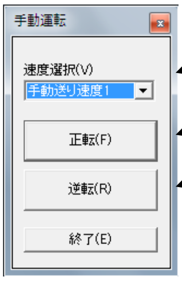
*1 The servo turns on automatically, and the motor rotates. Caution is advised.

*2 The system will not return to normal mode until the servo amplifier power supply is turned off. Caution is advised.

14

■ Test operation screens

(1) Manual Operation

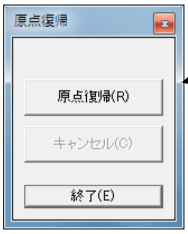


Selects the speed (parameters PA1_41 to 47).

The motor rotates in the forward direction while clicked.

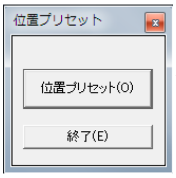
The motor rotates in the backward direction while clicked.

(2) Origin Return



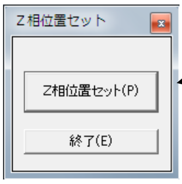
By pressing the [Origin Return] button, the motor rotates based on the origin return related parameter settings in PA2_06 to 14.
Operation then ends when the specified origin return operation is complete.

(3) Position Preset



By pressing the [Position Preset] button, the current position is rewritten to the PA2_19 (preset position) parameter value.

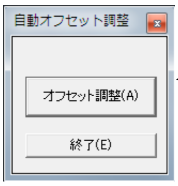
(4) Set Z-phase Position



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).

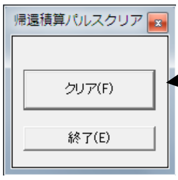
* The Z-phase position cannot be set under the following conditions.
  - When PA2_74 (parameter write protection) is set to "1: Write protect".
  - When the encoder origin position (Z-phase) is not set.
    At such times, rotate the motor shaft twice or more.

(5) Offset Adjust



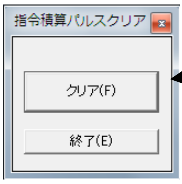
By pressing the [Offset Adjust] button, the analog input VREF terminal and TREF terminal offsets are adjusted (The PA3_32 (speed command offset) and PA3_34 (torque command offset) parameters are automatically rewritten). Please note that offset adjustment is not possible when PA2_74 (parameter write protection) is set to "1: Write disable".

(6) Feedback Cumulative Pulse Clear



By pressing the [Clear] button, the feedback cumulative pulse count is set to “0”.

(7) Command Cumulative Pulse Clear

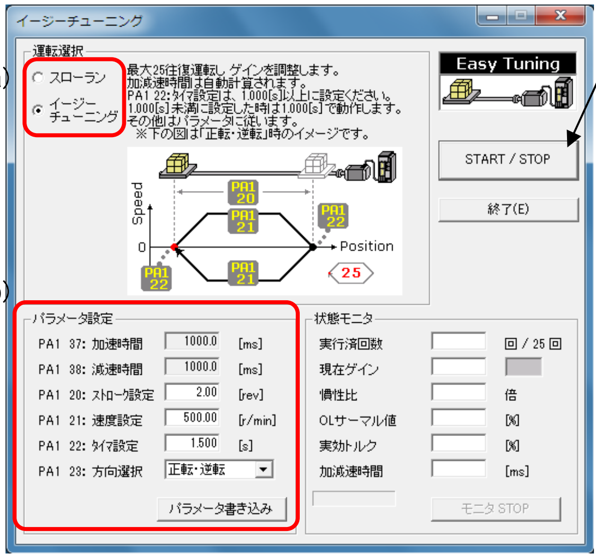


By pressing the [Clear] button, the command cumulative pulse count is set to “0”.

(8) Easy Tuning

(a)

(b)



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].

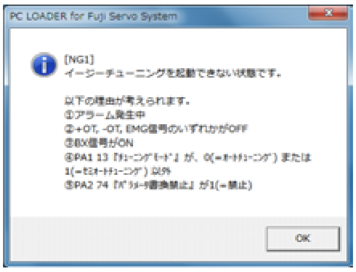
  This is for checking the travel amount and direction.

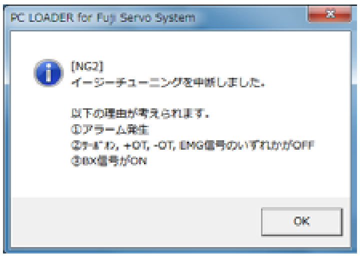
- Easy tuning

  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]

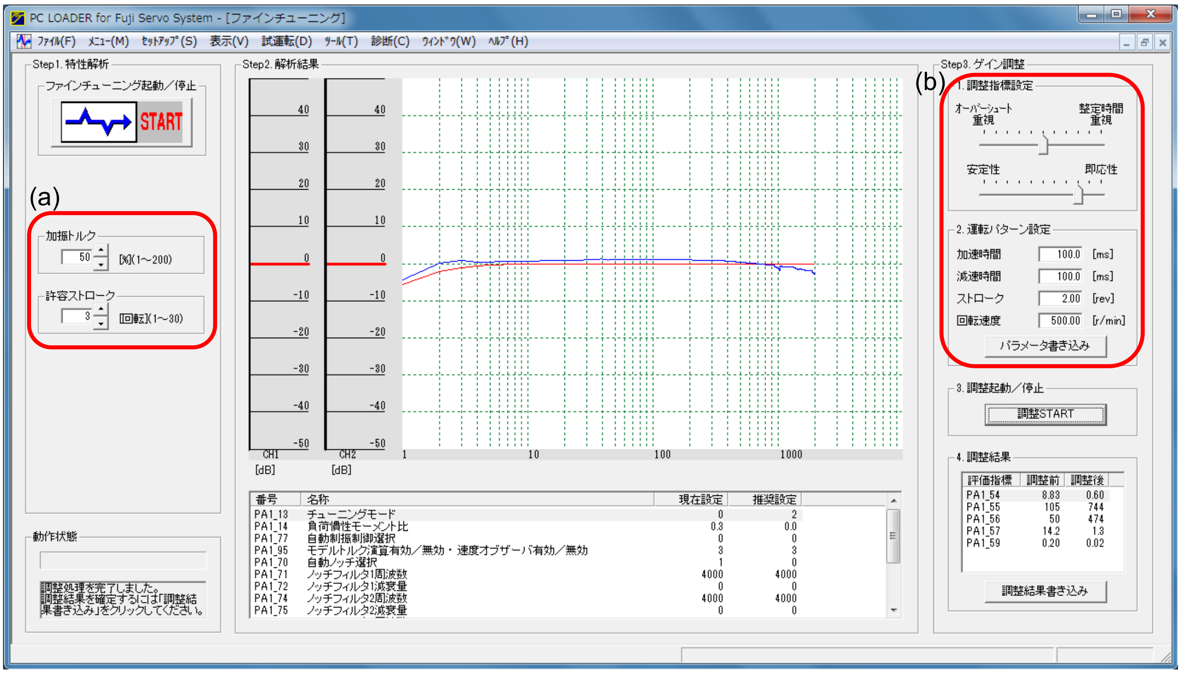
[Easy tuning NG screen]





14

(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.

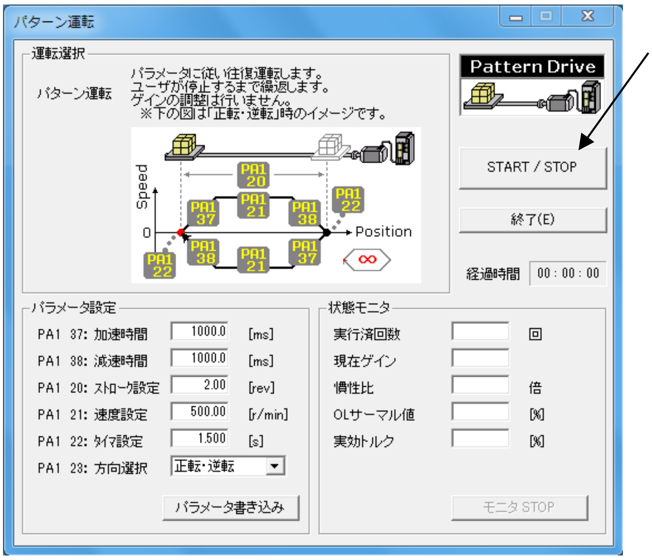
Step 3.

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 "5.5 Fine Tuning" for details.

14

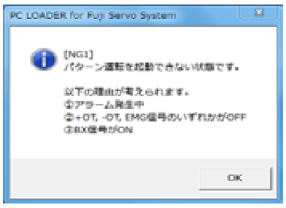
(10) Pattern operation

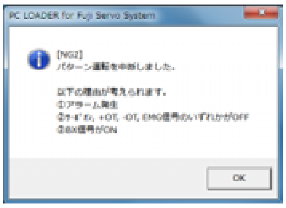


By pressing the [START/STOP] button, pattern operation starts.

Furthermore, by pressing the [START/STOP] button during operation,

[Pattern operation NG screen]





(11) Forced OUT Signal Output

(a)

(b)

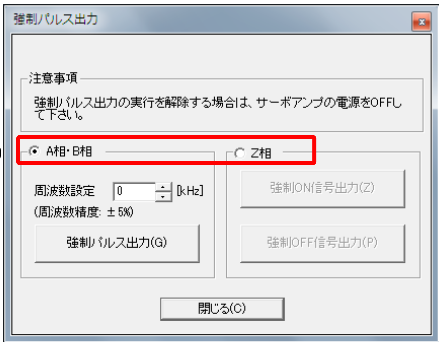
Select the OUT signal to be operated at (a), and turn the OUT signal ON or OFF with the (b) [ON] or [OFF] buttons.

Turn off the power to cancel this mode.

14

(12) Forced Pulse Output

(a)



Select the pulse signal to be output at (a).

A-phase, B-phase

By setting the frequency and pressing the [Forced Pulse Output] button, a pulse is output.

Frequency setting range: 0 to ±1,000[kHz], 1[kHz] increments

Z-phase

The Z-phase signal changes each time the [Forced H Signal Output]/[Forced L Signal Output] buttons are pressed.

Turn off the power to cancel this mode.

(12) 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.

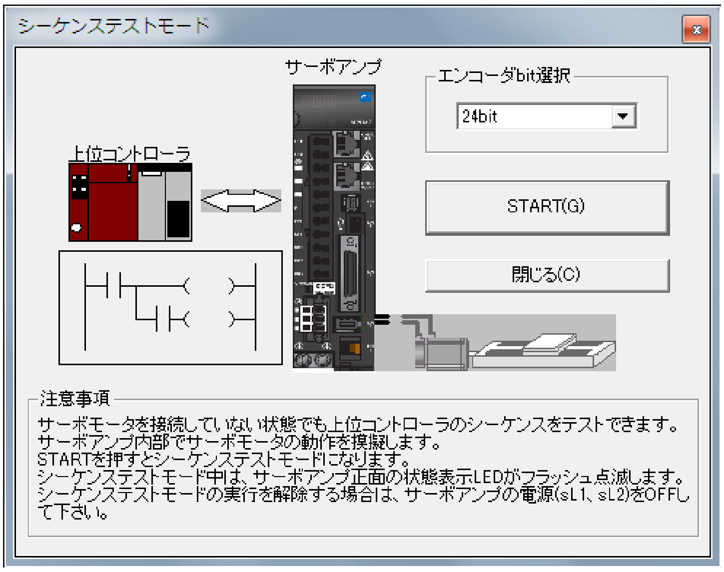
Precautions

- 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.)

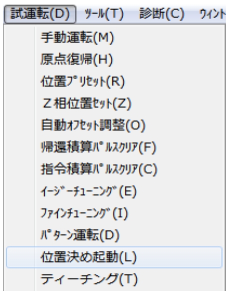
Startup screen



14

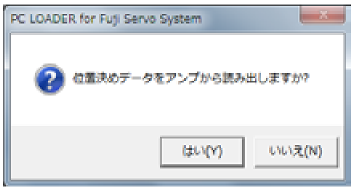
(13) Positioning startup

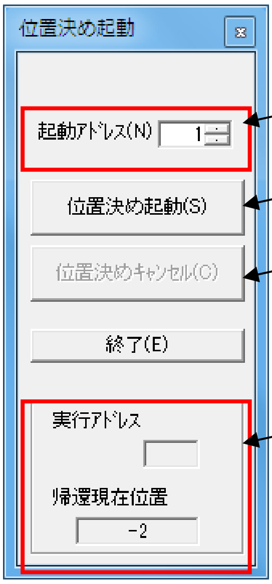
Select [Test Operation] - [Positioning Start] to start positioning.



The following window is displayed when positioning starts.

(A positioning data editing screen can be started at the same time in order to check positioning data.)





Selects the data for which positioning is to be started.

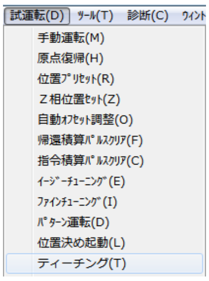
Automatic operation starts based on the selected positioning data.

When pressed during operation, positioning is canceled.

Monitors the positioning data address currently being executed, as well as the current feedback position.

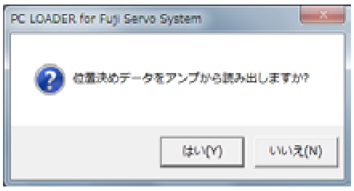
(14) Teaching

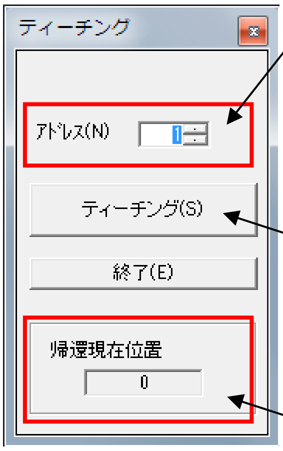
Select [Test Operation] → [Teaching] to start teaching.



The following window is displayed when teaching starts.

(A positioning data editing screen can be started at the same time in order to check positioning data.)





Selects the positioning data to be written.

Performs teaching.

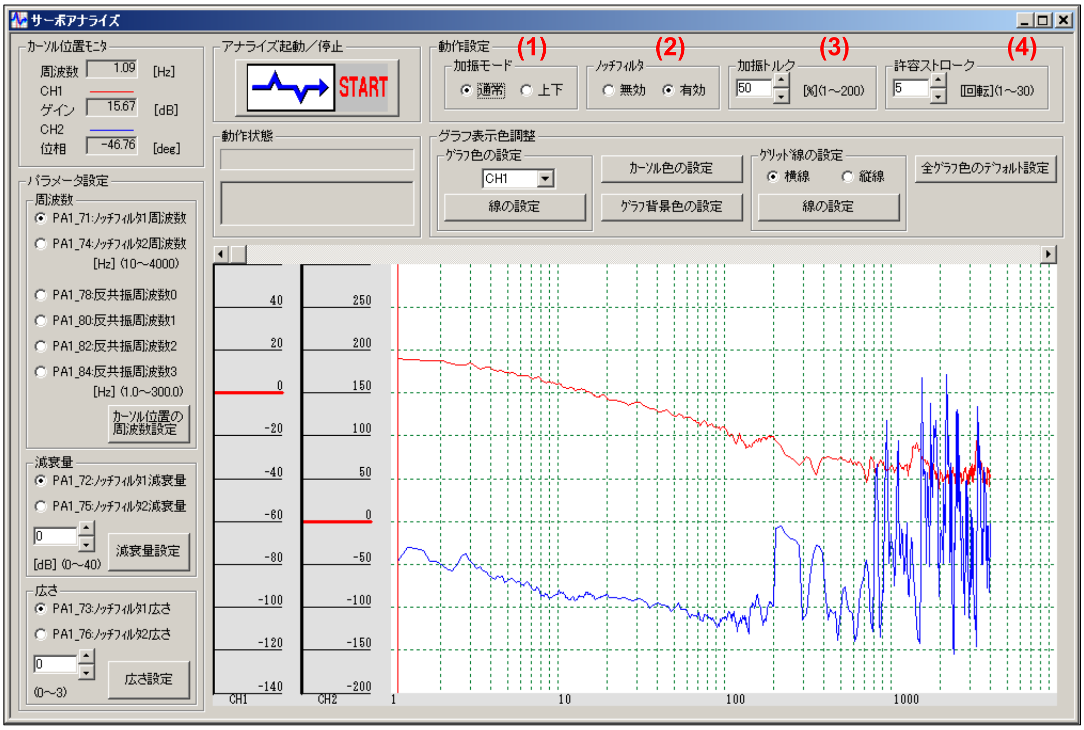
Writes this current feedback position to the selected address.

* The taught address command system is ABS system.
No other settings will change.

14.5.7 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.

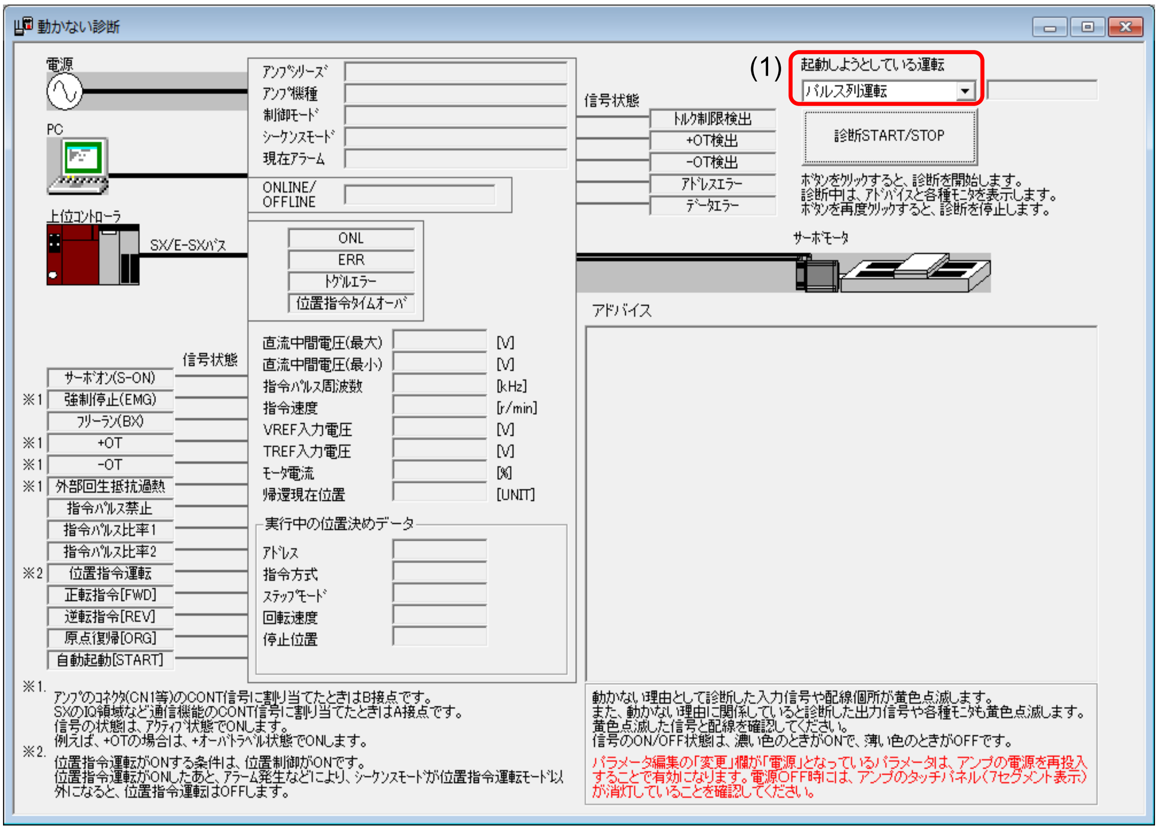
14.5.8 Diagnosis to be Made if the Servomotor Fails to Start

When the servomotor fails to start, or when an unexpected display appears, the assumed cause of the problem can be analyzed in real time by running [Failure Diagnosis].

■ Startup method

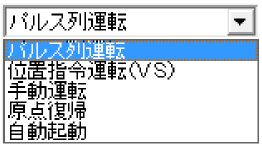
Select [Diagnosis] - [Failure Diagnosis] from the menu, or run using the icon.

■ Reference screen



■ Operation method

Select from the “Operation to be started” list at (1) in the screen above.



By pressing the [START/STOP Diagnosis] button, the servo amplifier status is displayed, and the reason why the servomotor does not move is assumed.

14.5.9 Changing the Language

This PC Loader supports Japanese only.

CHAPTER 15 STANDARDS COMPLIANCE

15.1 European Standards Compatibility (CE)

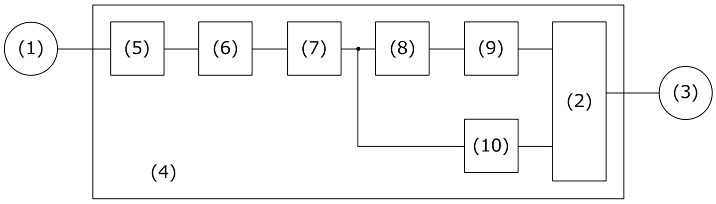
The CE marking on Fuji products indicates that they comply with the essential requirements of European Council of Ministers Directive (EMC Directive) 2014/30/EU, Low Voltage Directive 2014/35/EU, and Machinery Directive 2006/42/EC relating to electromagnetic compatibility (EMC).

Table15.1-1 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)

15

15.1.1 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.

15.1.2 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

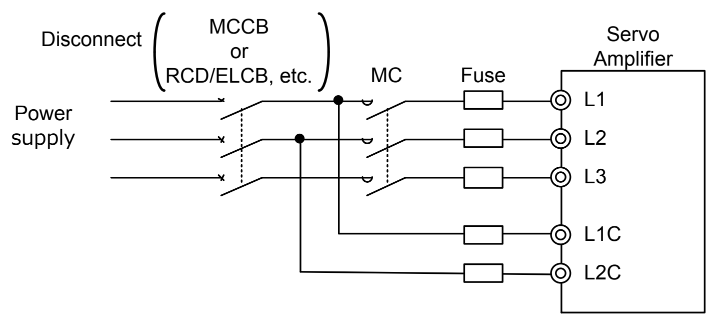
Compatibility with European Low Voltage Directive

⚠ 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

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

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. If using servo amplifiers in locations with altitude greater than 1,000 m, use basic insulation for control circuit insulation. Servo amplifiers cannot be used in locations with altitude greater than 3,000 m.
10. Use an interface power supply with reinforced insulation across inputs and outputs.
11. 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.

15.2 UL Standards and Canadian Standards (cUL Certification) Compliance

15.2.1 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.

15.2.2 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℃
   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。

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。

Power supply voltage 電源系列	Servo Amplifier type サーボアンプ形式	Class J fuse size (A) ヒューズ定格 [A]	Required torque 締め付けトルク Ib-in (N・m)	Wire size AWG (mm^2) *1 電線サイズ		
			接地端子 Grounding terminal	L1, L2, L3, U, V, W	L1C, L2C	接地線 Grounding wire
200V	RYT500F7-■■2	10	15.9 (1.8)	16 (1.25)	18 (0.75)	16 (1.25)
	RYT101F7-■■2	10				
	RYT201F7-■■2	10				
	RYT401F7-■■2	10				
	RYT751F7-■■2	15				
	RYT102F7-■■2	30				
	RYT152F7-■■2	30		14 (2.0)		14 (2.0)

*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。

15.3 Radio Waves Act (South Korea)

■ 韓国電波法への対応

本製品は韓国電波法に適合しています。韓国では下記に注意して使用してください。
（本製品は業務用（A 級）電磁波適合機器であり，販売者あるいは使用者はこの点にご注意ください。
尚，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

본제품은 한국전파법에 적합한 제품입니다.
한국에서 사용시는 아래에 주의하여 주시길 바랍니다.
“이　기기는 업무용(A 급) 전자파 적합기기로서 판매자 또는 사용자는
이점을 주의하시기 바라며, 가정외의 지역에서 사용하는 것을 목적
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)

This product complies with the Radio Waves Act (South Korea)
Note the following when using the product in south korea
(The product is for business-use (Class A) and meets the electromagnetic compatibility requirement. The seller and the user must note the above point, and use the product in a place except for 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.)

15.4 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".

15.4.1 Servo Amplifier Application

15.4.1.1 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.

15.4.1.2 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 "15.4.2.1 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 15.4-1.

If calculating "harmonic current" in accordance with the guidelines, a supplementary description is provided in "15.4.2 Complying with "Guideline for Suppressing Harmonics by Customers Receiving High Voltage or Special High Voltage".

Table 15.4-1 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

15.4.2 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.

15.4.2.1 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.

(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:

15

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.

Table15.4-2 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) 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 Table15.4-3.

Table15.4-3 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.

$$I_{\mathrm{H}} = I_{\mathrm{l}} \times \frac{V_i}{V_{\mathrm{H}}} \times 10^3$$

I_{H}: Rated input current (receiving voltage conversion value) (mA)
I_{l}: 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.15.4-1, 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)

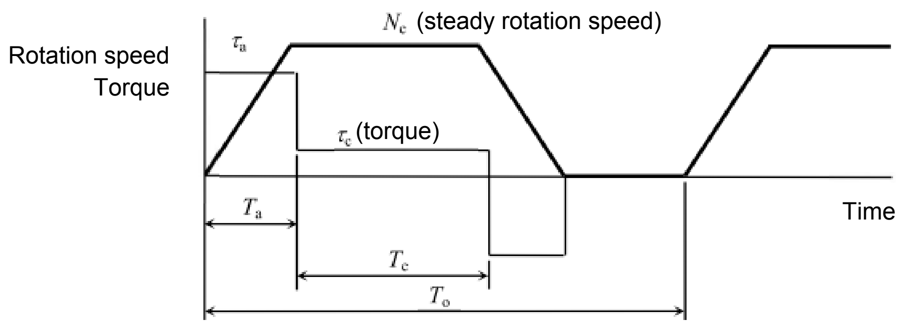


Fig.15.4-1 Servomotor operation pattern

15.4.2.2 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 Table15.4-4 for the guidelines appendices.

Table15.4-4 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

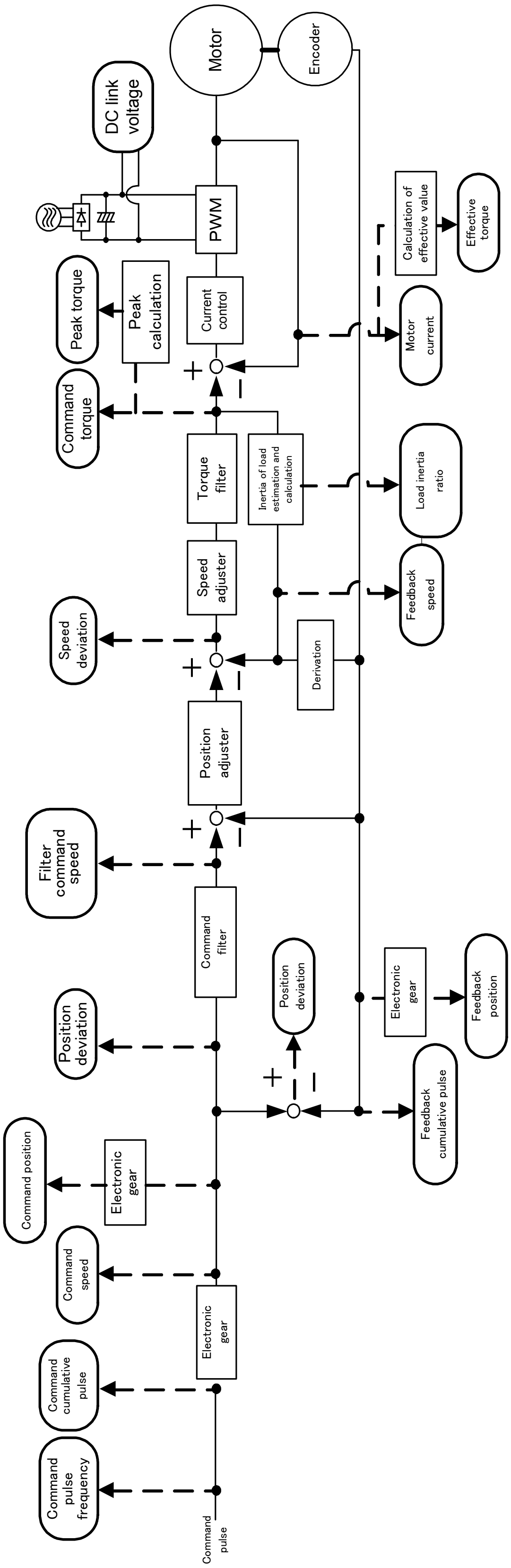
- AC side reactor: 3%
- DC side reactor: Stored energy is equivalent to 0.08 to 0.15 ms (100% load conversion)
- Smoothing capacitor: Stored energy is equivalent to 15 to 30 ms (100% load conversion)
- Load: 100%

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 16 APPENDIXES

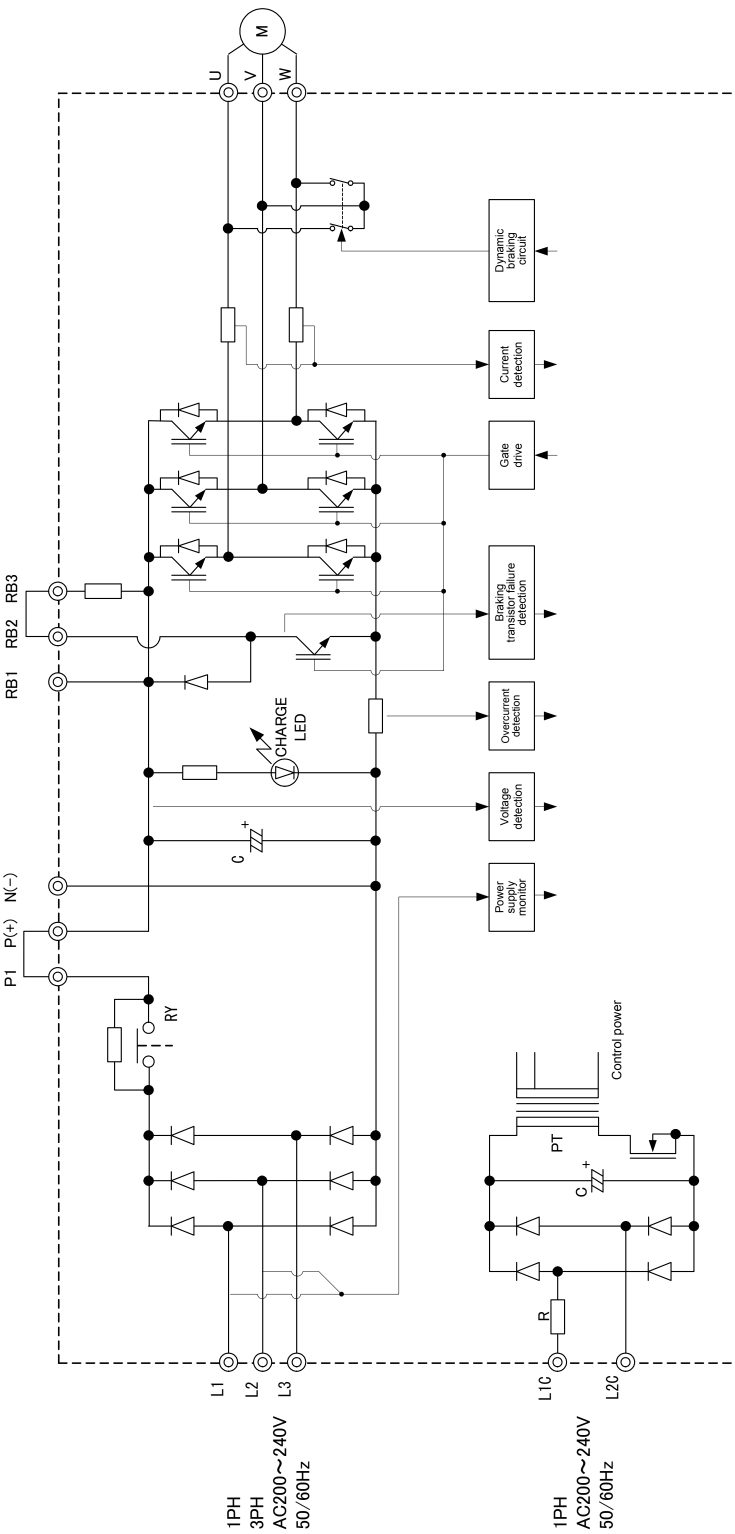
16.1 Status Indication Block Diagram



16.2 Main Circuit Block Diagram

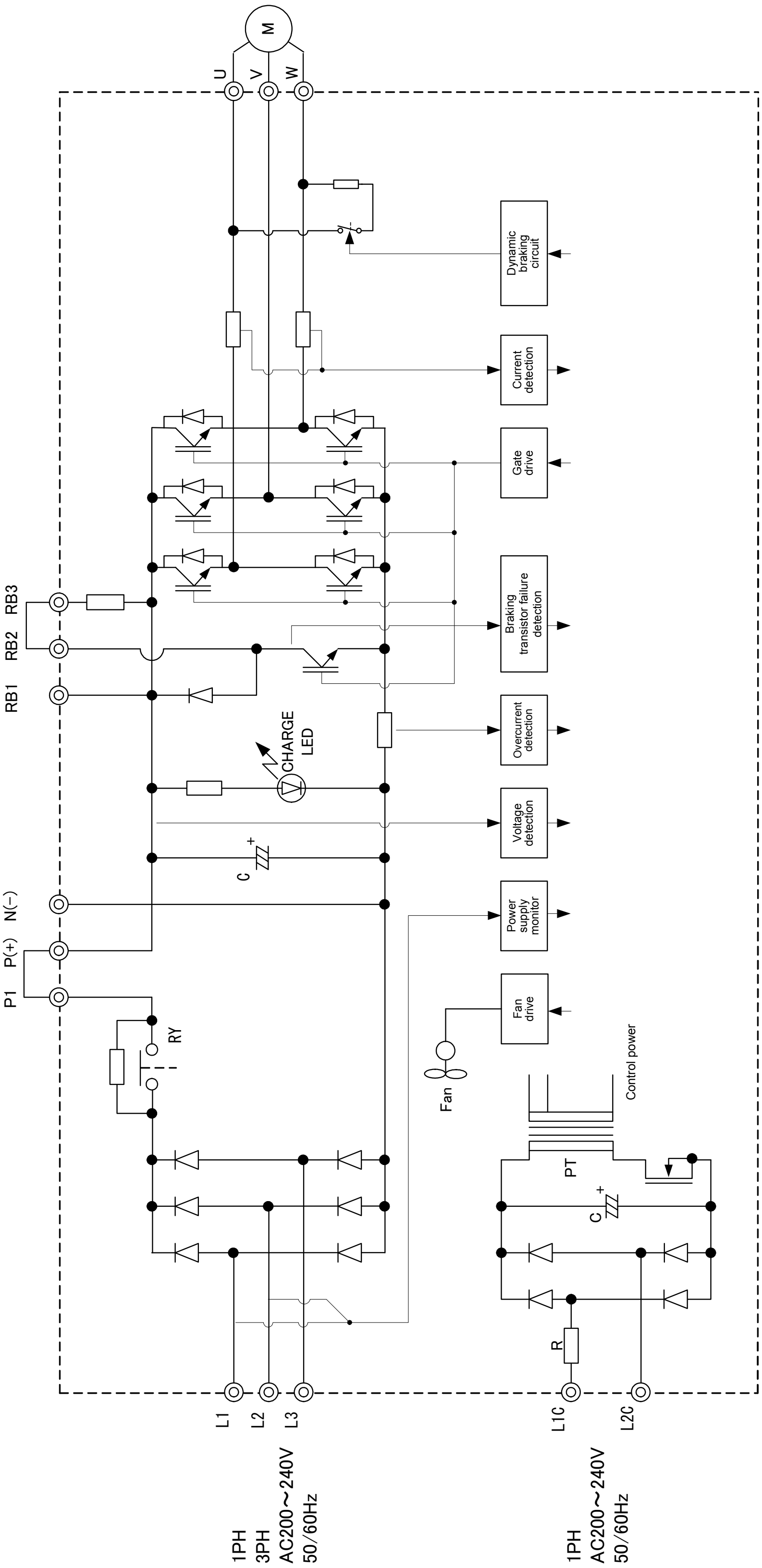
Applicable models:

RYT500F7～RYT401F7



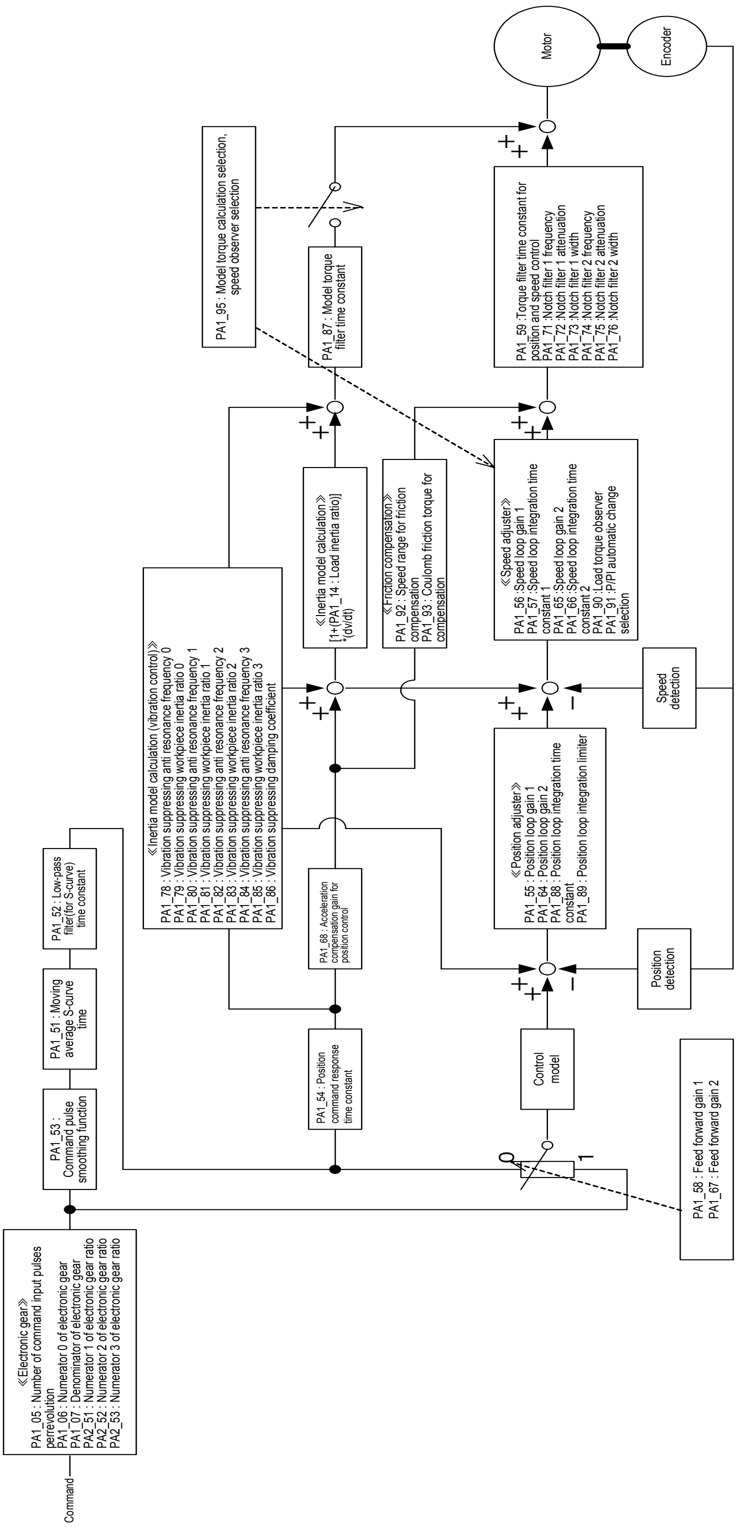
Applicable models:

RYT751F7～RYT152F7



4　Main Circuit Block Diagram

16.3 Control Circuit Block Diagram



16.4 Parameter List

■ PA1_: Basic setting parameter

No.	Name	Power	Control mode			Record of reference value
			Position	Speed	Torque	
01	Control mode selection	○	○	○	○	
02	INC/ABS system selection	○	○	○	○	
03	Command pulse frequency/form setting	○	○	—	—	
04	Rotation direction selection	○	○	○	○	
05	Number of command input pulses per revolution	○	○	—	—	
06	Numerator 0 of electronic gear	—	○	—	—	
07	Denominator of electronic gear	—	○	—	—	
08	Number of output pulses per revolution	○	○	○	○	
09	Numerator of electric gear for output pulses	○	○	○	○	
10	Denominator of electric gear for output pulses	○	○	○	○	
11	Output pulse phase selection at CCW rotation	○	○	○	○	
12	Z-phase offset	○	○	○	○	
13	Tuning mode selection	—	○	○	○	
14	Load 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	—	○	○	—	

No.	Name	Power	Control mode			Record of reference value
			Position	Speed	Torque	
30	Zero speed range	—	○	○	○	
31	Deviation unit selection	—	○	—	—	
32	Zero deviation range/In-position range	—	○	—	—	
33	In-position output format	○	○	—	—	
34	In-position minimum OFF time/ Single shot ON time	—	○	—	—	
35	In-position judgment time	—	○	—	—	
36	Acceleration / deceleration selection at speed control	—	—	○	—	
37	Acceleration time 1	—	○	○	○	
38	Deceleration time 1	—	○	○	○	
39	Acceleration time 2	—	○	○	○	
40	Deceleration time 2	—	○	○	○	
41	Manual feed speed 1/speed limit 1 at torque control	—	○	○	○	
42	Manual feed speed 2/speed limit 2 at torque control	—	○	○	○	
43	Manual feed speed 3/speed limit 3 at torque control	—	○	○	○	
44	Manual feed speed 4/speed limit 4 at torque control	—	○	○	○	
45	Manual feed speed 5/speed limit 5 at torque control	—	○	○	○	
46	Manual feed speed 6/speed limit 6 at torque control	—	○	○	○	
47	Manual feed speed 7/speed limit 7 at torque control	—	○	○	○	

■ PA1_: Control gain and filter setting parameter

No.	Name	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	—	○	○	—	
53	Command pulse smoothing function	—	○	—	—	
54	Position command response time constant	—	○	—	—	
55	Position loop gain 1	—	○	—	—	

No.	Name	Power	Control mode			Record of reference value
			Position	Speed	Torque	
56	Speed loop gain 1	—	○	○	○	
57	Speed loop integration time constant 1	—	○	○	○	
58	Feed forward gain 1	—	○	—	—	
59	Torque filter time constant	—	○	○	—	
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	Automatic vibration control selection	—	○	—	—	
78	Vibration suppressing anti resonance frequency 0	—	○	—	—	
79	Vibration suppressing workpiece inertia ratio (vibration suppressing resonance frequency) 0	—	○	—	—	
80	Vibration suppressing anti resonance frequency 1	—	○	—	—	
81	Vibration suppressing workpiece inertia ratio (vibration suppressing resonance frequency) 1	—	○	—	—	
82	Vibration suppressing anti resonance frequency 2	—	○	—	—	

No.	Name	Power	Control mode			Record of reference value
			Position	Speed	Torque	
83	Vibration suppressing workpiece inertia ratio (vibration suppressing resonance frequency) 2	—	○	—	—	
84	Vibration suppressing anti resonance frequency 3	—	○	—	—	
85	Vibration suppressing workpiece inertia ratio (vibration suppressing resonance frequency) 3	—	○	—	—	
86	Vibration suppressing control 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	Speed range for friction compensation	—	○	○	—	
93	Coulomb friction torque for friction compensation	—	○	○	—	
94	Torque filter setting mode	—	○	○	—	
95	Model torque calculation selection, speed observer selection	—	○	○	—	
96	Speed limit gain for torque control	—	—	—	○	

■ PA2_: Automatic operation setting parameter

No.	Name	Power	Control mode			Record of reference value
			Position	Speed	Torque	
01	Decimal point position of positioning data	—	○	○	○	
06	Homing speed	—	○	—	—	
07	Creep speed for homing	—	○	—	—	

16

No.	Name	Power	Control mode			Record of reference value
			Position	Speed	Torque	
08	Starting direction for homing	○	○	—	—	
09	Reverse traveling unit amount for homing	—	○	—	—	
10	Homing direction after reference signal detection	○	○	—	—	
11	Reference signal for shift operation	○	○	—	—	
12	Reference signal for homing	○	○	—	—	
13	Home position LS signal edge selection	○	○	—	—	
14	Home position shift unit amount	—	○	—	—	
15	Deceleration operation for creep speed	○	○	—	—	
16	Home position after homing completion	—	○	—	—	
17	Home position detection range	—	○	—	—	
18	Selection of operation at OT during homing	—	○	—	—	
19	Preset position	—	○	—	—	
20	Interrupt traveling unit amount	—	○	—	—	
22	Detection time for contact-stopper	—	○	—	—	
23	Torque limit for contact-stopper	—	○	—	—	
24	Reverse motion selection at homing OT	○	○	—	—	
25	Software OT selection/position command form	○	○	○	—	
26	+software OT detection position	—	○	○	—	
27	-software OT detection position	—	○	○	—	
28	+limiter detection position	—	○	—	—	
29	-limiter detection position	—	○	—	—	
31	Point detection, area detection	—	○	○	○	
32	Point detection, area detection: position 1	—	○	○	○	
33	Point detection, area detection: position 2	—	○	○	○	
34	Point detection range	—	○	○	○	
36	Override 1	—	○	○	—	

No.	Name	Power	Control mode			Record of reference value
			Position	Speed	Torque	
37	Override 2	—	○	○	—	
38	Override 4	—	○	○	—	
39	Override 8	—	○	○	—	
40	Positioning data selection	○	○	—	—	
41	data selection	○	○	—	—	
42	Decimal point position of stand still timer	—	○	—	—	
43	Output selection at M code OFF	○	○	—	—	

■ PA2_: Extended function setting parameter

No.	Name	Power	Control mode			Record of reference value
			Position	Speed	Torque	
51	Numerator 1 of electronic gear ratio	—	○	—	—	
52	Numerator 2 of electronic gear ratio	—	○	—	—	
53	Numerator 3 of electronic gear ratio	—	○	—	—	
54	Command pulse ratio 1	—	○	—	—	
55	Command pulse ratio 2	—	○	—	—	
56	Speed limit selection at torque control	○	—	—	○	
57	Torque limit selection	○	○	○	—	
58	Second torque limit	—	○	○	—	
59	Deviation hold selection at torque limit	○	○	—	—	
60	Third torque limit	—	○	○	—	
61	Action sequence at servo-on OFF and forced stop	○	○	○	○	
62	Action sequence at alarm	○	○	○	○	
63	Action sequence at main power shutoff and OT detection	○	○	○	○	
64	Torque keeping time to holding brake	—	○	○	○	
65	Regenerative resistor selection	○	○	○	○	
66	Flying start at speed control	○	—	○	—	
67	Alarm detection at undervoltage	○	○	○	○	
68	Main power shutoff detection time	○	○	○	○	

No.	Name	Power	Control mode			Record of reference value
			Position	Speed	Torque	
69	Deviation detection overflow value	—	○	—	—	
70	Overload warning value	—	○	○	○	
72	Station number	○	○	○	○	
73	Communication baud rate	○	○	○	○	
74	Parameter write protection	—	○	○	○	
75	Positioning data write protection	—	○	—	—	
76	3rd deceleration time	—	○	○	○	
77	Initial display of the keypad	○	○	○	○	
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	○	○	○	○	
86	Positioning data in RAM 1	○	○	—	—	
87	Positioning data in RAM 2	○	○	—	—	
88	Positioning data in RAM 3	○	○	—	—	
89	Sequence test mode: mode selection	○	○	○	○	
90	Sequence test mode: encoder bit selection	○	○	○	○	
93	Parity/stop bit selection	○	○	○	○	
94	Response time (for Modbus)	—	○	○	○	
95	Communication time over time (for Modbus)	—	○	○	○	
97	Communication protocol selection	—	○	○	○	

■ PA3_: Input terminal function setting parameter

No.	Name	Power	Control mode			Record of reference value
			Position	Speed	Torque	
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	○	○	○	○	
09	CONT9 signal assignment	○	○	○	○	
10	CONT10 signal assignment	○	○	○	○	
11	CONT11 signal assignment	○	○	○	○	
12	CONT12 signal assignment	○	○	○	○	
13	CONT13 signal assignment	○	○	○	○	
14	CONT14 signal assignment	○	○	○	○	
15	CONT15 signal assignment	○	○	○	○	
16	CONT16 signal assignment	○	○	○	○	
17	CONT17 signal assignment	○	○	○	○	
18	CONT18 signal assignment	○	○	○	○	
19	CONT19 signal assignment	○	○	○	○	
20	CONT20 signal assignment	○	○	○	○	
21	CONT21 signal assignment	○	○	○	○	
22	CONT22 signal assignment	○	○	○	○	
23	CONT23 signal assignment	○	○	○	○	
24	CONT24 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	○	○	○	○	
31	Speed command scale	—	○	○	○	

No.	Name	Power	Control mode			Record of reference value
			Position	Speed	Torque	
32	Speed command offset	—	○	○	○	
33	Torque command scale	—	○	○	○	
34	Torque command offset	—	○	○	○	
35	Zero clamp level	—	○	○	—	
36	Deviation clear input form	○	○	—	—	
39	Speed command fine adjustment gain	—	○	○	○	
40	torque command fine adjustment gain	—	○	○	○	
41	Address free assignment 1 (for Modbus)	○	○	○	○	
42	Address free assignment 2 (for Modbus)	○	○	○	○	
43	Address free assignment 3 (for Modbus)	○	○	○	○	
44	Address free assignment 4 (for Modbus)	○	○	○	○	
48	CONT CA signal assignment	○	○	○	○	
49	CONT CB signal assignment	○	○	○	○	
50	CONTCA/CB signal inversion	○	○	○	○	

■ PA3_: Output terminal function setting parameter

No.	Name	Power	Control mode			Record of reference value
			Position	Speed	Torque	
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	○	○	○	○	

No.	Name	Power	Control mode			Record of reference value
			Position	Speed	Torque	
63	OUT13 signal assignment	○	○	○	○	
64	OUT14 signal assignment	○	○	○	○	
65	OUT15 signal assignment	○	○	○	○	
66	OUT16 signal assignment	○	○	○	○	
67	OUT17 signal assignment	○	○	○	○	
68	OUT18 signal assignment	○	○	○	○	
69	OUT19 signal assignment	○	○	○	○	
70	OUT20 signal assignment	○	○	○	○	
71	OUT21 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	—	○	○	○	
88	Command pulse frequency sampling time for monitor	—	○	—	—	
89	Feedback speed sampling time for monitor	—	○	○	○	
90	Output pulse frequency error	—	○	○	○	
92	Range 1 of position: Setting 1	—	○	—	—	
93	Range 1 of position: Setting 2	—	○	—	—	
94	Range 2 of position: Setting 1	—	○	—	—	
95	Range 2 of position: Setting 2	—	○	—	—	
98	OUT FZ signal assignment	—	○	○	○	
99	OUT FZ signal inversion	—	○	○	○	

16

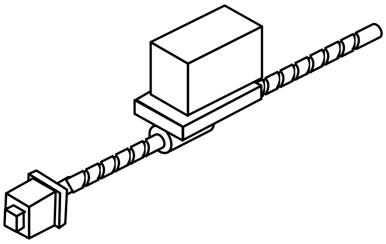
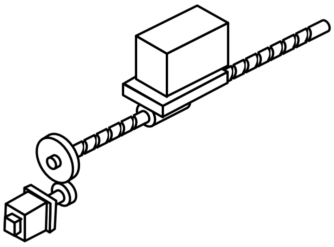
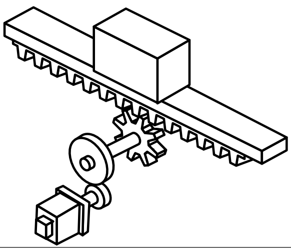
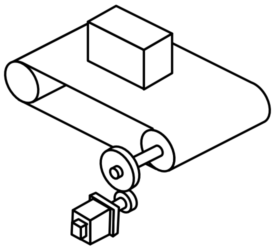
■ PA4_: Extended function setting parameter

No.	Name	Power	Control mode			Record of reference value
			Position	Speed	Torque	
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 method	○	—	—	○	
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 ON/OFF	○	○	○	—	
62	Tuningless level	—	○	○	—	
63	Tuningless load level	—	○	○	—	
64	New vibration suppressing control damping coefficient	—	○	—	—	
65	New vibration suppressing control workpiece inertia ratio	—	○	—	—	

16.5 Capacity Selection Calculation

16.5.1 Type of Mechanical System

The mechanical system driven by a variable speed motor includes the following types.

Mechanism	Features
	Ball screw (direct coupling) Used for a relatively short distance and accurate positioning. The motor is connected with the ball screw via a coupling and no play is included.
	Ball screw (geared) A reduction gear is included so that the torque transmitted to the mechanical system becomes large. Because of a gear backlash, compensation measures are necessary.
	Rack & Pinion Used for positioning of a relatively long distance (such as carrier drive). Because a π value is included in each pinion rotation, compensation measures are necessary.
	Timing belt (conveyor) Has a relatively large degree of freedom when compared with chain. Mainly for small loads. Because a π value is included in the traveling distance of each pulley rotation, compensation measures are necessary.

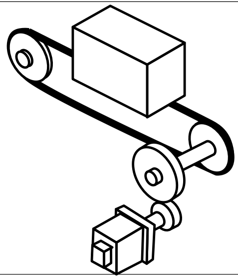
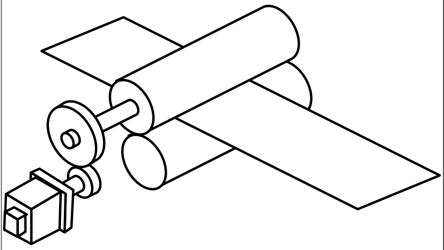
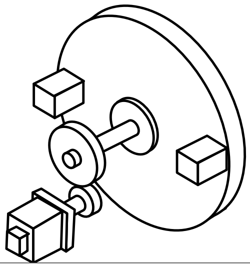
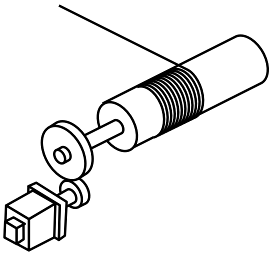
When applying the servo system to a mechanical system, take care of the following points.

(1) Reduction ratio
Use nearly at the rated speed (maximum rotation speed) of the motor to take advantage of the servomotor power. The continuous output torque at the maximum rotation speed is smaller than the rated torque.

(2) Preload torque
The load torque of a preloaded screw is large while the rigidity is increased. For the friction torque caused by the preload, refer to the specifications of the ball screw.

(3) Retention torque
The servomotor keeps outputting the retention force in the stopping state of a hoisting machine. Use of a retention brake is recommended if the time allows.

16

Mechanism	Features
	**Chain drive** Mainly used for the transfer line. Countermeasures against elongation of the chain itself are necessary. Used mainly for relatively large reduction ratios; the traveling speed of the mechanical system is small.
	**Feed roll** The material on a plate (band) is sandwiched between rolls and fed. Because the roll diameter is not obtained accurately, there is an error in a long distance. π compensation is necessary. Sudden acceleration causes slippage, resulting in shortage in the feeding amount.
	**Table indexing** Because the moment of inertia of the table is large, a sufficiently large reduction ratio is necessary. The table rotation speed is low and a worm gear is usually used.
	**Spindle drive** Because winding of a wire material results in a larger moment of inertia, a sufficiently large reduction ratio is necessary. To achieve a constant surface speed, examination must be made, including peripheral equipment.

■ Approximate machine constants

Approximate friction coefficient μ

Mechanism	Friction coefficient
Rail and iron wheel (Carrier and crane)	0.05
Linear guide	0.05～0.2
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 efficiency η

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

$$\text{(Module)} = \frac{\text{(Pitch circle diameter of gear)}}{\text{(Number of teeth)}}$$

* Metric gear

* Module
0.5 0.75 0.8 1 1.5 2 2.5 3 4 5 6 7

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

16.5.2 Capacity Selection Calculation

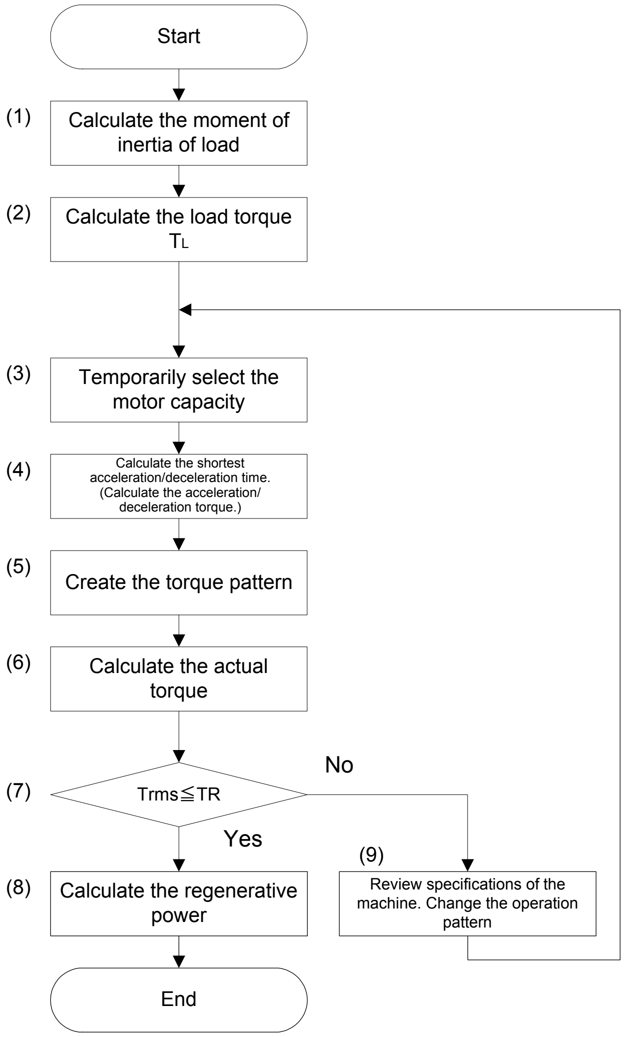
Perform capacity selection calculation to obtain the servomotor capacity necessary for machine specifications (configuration).
Items necessary for capacity selection calculation include the following.

- Load inertia (moment of inertia of mechanical system)
- Load torque (torque necessary to move the machine)
- Acceleration/Deceleration time
- Operation profile

In general, there is no way to measure the inertia of the mechanical system and load torque, calculate approximate values according to the configuration of the machine.

Follow the procedure below to perform capacity selection calculation.

Capacity selection flow chart



(1) Calculate the load inertia according to the configuration of the machine.

(2) Calculate the load torque according to the configuration of the machine.

(3) Temporarily select the motor capacity.

(4) Check the shortest acceleration/deceleration time. If the time is designated, calculate the necessary acceleration/deceleration torque.

(5) Create the torque pattern according to the operation pattern.

(6) Calculate the effective torque according to the torque pattern.

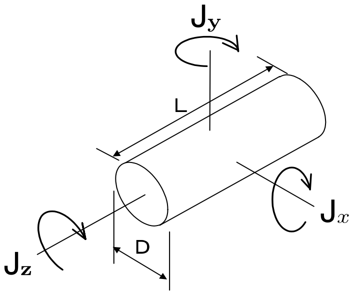
(7) If the effective torque (T_{rms}) is smaller than the rated torque (T_R), operation can be made with the designated operation pattern.

(8) Calculate the regenerative power and, if necessary, select the regenerative resistor.

(9) Review the specifications of the machine if possible.

■ Calculation of inertia

Shape

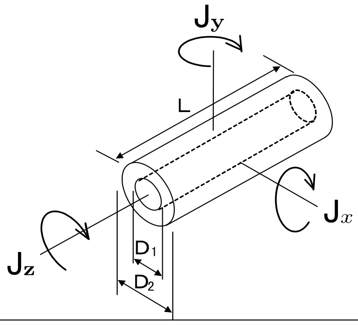


$$J_z = \frac{W}{8}\left(\frac{D}{10^3}\right)^2 = \frac{\pi\rho}{32}\left(\frac{L}{10^3}\right)\left(\frac{D}{10^3}\right)^4$$

$$J_x = J_y = \frac{W}{16}\left(\frac{D}{10^3}\right)^2 + \frac{W}{12}\left(\frac{L}{10^3}\right)^2$$

$$W = \frac{\pi\rho}{4}\left(\frac{L}{10^3}\right)\left(\frac{D}{10^3}\right)^2$$

W : [kg]
D : [mm]
L : [mm]
ρ : [kg/m^3]

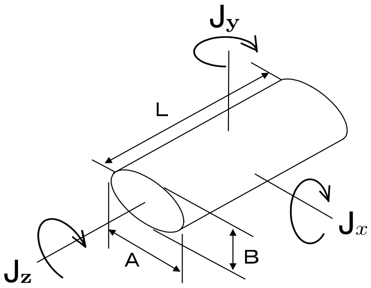


$$J_z = \frac{W}{8}\left\{\left(\frac{D_2}{10^3}\right)^2 + \left(\frac{D_1}{10^3}\right)^2\right\} = \frac{\pi\rho}{32}\left(\frac{L}{10^3}\right)\left\{\left(\frac{D_2}{10^3}\right)^4 - \left(\frac{D_1}{10^3}\right)^4\right\}$$

$$J_x = J_y = \frac{W}{16}\left\{\left(\frac{D_2}{10^3}\right)^2 + \left(\frac{D_1}{10^3}\right)^2\right\} + \frac{W}{12}\left(\frac{L}{10^3}\right)^2$$

$$W = \frac{\pi\rho}{4}\left(\frac{L}{10^3}\right)\left\{\left(\frac{D_2}{10^3}\right)^2 - \left(\frac{D_1}{10^3}\right)^2\right\}$$

W : [kg]
D : [mm]
L : [mm]
ρ : [kg/m^3]



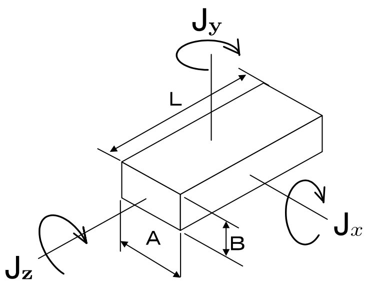
$$J_z = \frac{W}{16}\left\{\left(\frac{A}{10^3}\right)^2 + \left(\frac{B}{10^3}\right)^2\right\}$$

$$J_x = \frac{W}{16}\left(\frac{B}{10^3}\right)^2 + \frac{W}{12}\left(\frac{L}{10^3}\right)^2$$

$$J_y = \frac{W}{16}\left(\frac{A}{10^3}\right)^2 + \frac{W}{12}\left(\frac{L}{10^3}\right)^2$$

$$W = \frac{\pi\rho}{4}\left(\frac{A}{10^3}\right)\left(\frac{B}{10^3}\right)\left(\frac{L}{10^3}\right)$$

W : [kg]
L : [mm]
A : [mm]
B : [mm]
ρ : [kg/m^3]



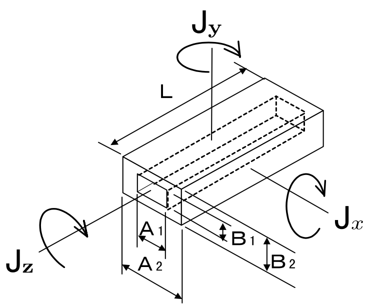
$$J_x = \frac{W}{12}\left\{\left(\frac{B}{10^3}\right)^2 + \left(\frac{L}{10^3}\right)^2\right\}$$

$$J_y = \frac{W}{12}\left\{\left(\frac{L}{10^3}\right)^2 + \left(\frac{A}{10^3}\right)^2\right\}$$

$$J_z = \frac{W}{12}\left\{\left(\frac{A}{10^3}\right)^2 + \left(\frac{B}{10^3}\right)^2\right\}$$

$$W = \rho\left(\frac{A}{10^3}\right)\left(\frac{B}{10^3}\right)\left(\frac{L}{10^3}\right)$$

W : [kg]
L : [mm]
A : [mm]
B : [mm]
ρ : [kg/m^3]



$$J_x = \frac{W_2}{12}\left\{\left(\frac{B_2}{10^3}\right)^2 + \left(\frac{L}{10^3}\right)^2\right\} - \frac{W_1}{12}\left\{\left(\frac{B_1}{10^3}\right)^2 + \left(\frac{L}{10^3}\right)^2\right\}$$

$$J_y = \frac{W_2}{12}\left\{\left(\frac{A_2}{10^3}\right)^2 + \left(\frac{L}{10^3}\right)^2\right\} - \frac{W_1}{12}\left\{\left(\frac{A_1}{10^3}\right)^2 + \left(\frac{L}{10^3}\right)^2\right\}$$

$$J_z = \frac{W_2}{12}\left\{\left(\frac{A_2}{10^3}\right)^2 + \left(\frac{B_2}{10^3}\right)^2\right\} - \frac{W_1}{12}\left\{\left(\frac{A_1}{10^3}\right)^2 + \left(\frac{B_1}{10^3}\right)^2\right\}$$

$$W = \rho\left\{\left(\frac{A_2}{10^3}\right)\left(\frac{B_2}{10^3}\right) - \left(\frac{A_1}{10^3}\right)\left(\frac{B_1}{10^3}\right)\right\}\left(\frac{L}{10^3}\right)$$

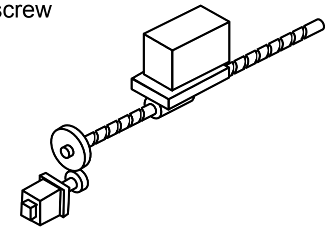
$$W_2 = \rho\left(\frac{A_2}{10^3}\right)\left(\frac{B_2}{10^3}\right)\left(\frac{L}{10^3}\right) \qquad W_1 = \rho\left(\frac{A_1}{10^3}\right)\left(\frac{B_1}{10^3}\right)\left(\frac{L}{10^3}\right)$$

W : [kg]
L : [mm]
A : [mm]
B : [mm]
ρ : [kg/m^3]

16

Conversion

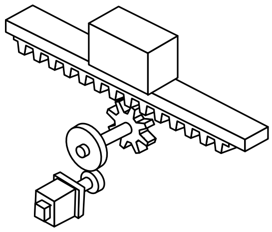
Ball screw



$$J_1 = W\left(\frac{1}{2\pi} \times \frac{BP}{10^3}\right)^2 \times GL^2$$

W:　Total mass of moving parts [kg]
BP:　Thread lead [mm]
GL:　Reduction ratio (no unit)

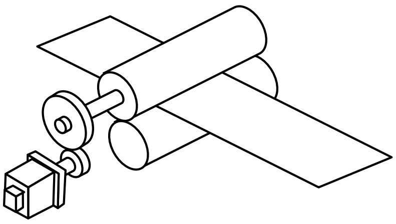
Rack & Pinion, conveyor and chain drive



$$J_2 = \frac{W}{4}\left(\frac{D}{10^3}\right)^2 \times GL^2$$

W:　Total mass of moving parts [kg]
D:　Diameter of pinion [mm]
　　Diameter of sprocket [mm]
GL:　Reduction ratio (no unit)

Feed roll

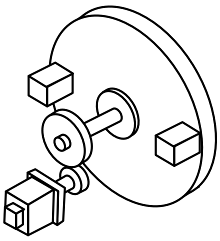


$$J_3 = \frac{W}{4}\left(\frac{D}{10^3}\right)^2 \times GL^2$$

W:　Total mass of moving parts [kg]
D:　Roll diameter [mm]
GL:　Reduction ratio (no unit)

Rotating body and table drive

Obtain the sum of inertia of each shape.
Inertia of body located at a distance from the axis of rotation (J_4)

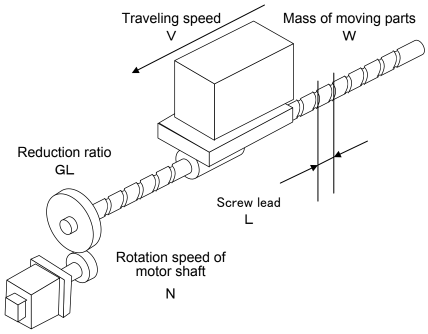


$$J_4 = \left(J + W\left(\frac{L}{10^3}\right)^2\right) \times GL^2$$

J:　Inertia around the center of gravity of body
W:　Mass of body [kg]
L:　Distance between body and axis of rotation [mm]
GL:　Reduction ratio (no unit)

■ Calculation of load torque (T_L)

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, W1: Mass of moving parts [kg]
W_1: Mass of moving parts [kg]
W_2: Mass of counterweight [kg]
GL : Reduction ratio (no unit) F: Thrust [kg]

・Hoisting (vertically)

$$T_L = \frac{((\mu + 1)W_1 - W_2) \times 9.81}{2\pi\eta} \left(\frac{BP}{10^3}\right) \times GL$$

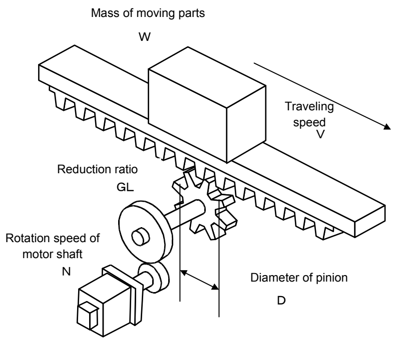
・Descending (vertically)

$$T_L = \frac{((\mu - 1)W_1 - W_2) \times 9.81}{2\pi\eta} \left(\frac{BP}{10^3}\right) \times GL$$

・At a stop (vertically)

$$T_L = \frac{(W_1 - W_2) \times 9.81}{2\pi\eta} \left(\frac{BP}{10^3}\right) \times GL$$

Conveyor and 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, W1: Mass of moving parts [kg]

W2: Mass of counterweight [kg]

GL: Reduction ratio (no unit)

・Hoisting (vertically)

$$T_L = \frac{((\mu + 1)W_1 - W_2) \times 9.81}{\eta} \left(\frac{D}{2} \times \frac{1}{10^3}\right) \times GL$$

・Descending (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 a stop (vertically)

$$T_L = \frac{(W_1 - W_2) \times 9.81}{\eta} \left(\frac{D}{2} \times \frac{1}{10^3}\right) \times GL$$

16

(1) Calculating the load inertia (J_L)
Calculate the inertia (J_L) of the load of the mechanical system converted to the motor axis.
Calculate the inertia of the parts rotating (moving) along with motor rotation, and obtain the sum of all.

(2) Calculating the load torque (T_L)
Calculate the load torque converted to the motor axis.

(3) Temporarily select the motor capacity
Select the motor capacity satisfying the following two conditions.

- Allowable load inertia
  $J_L \le J_M \times 100$ (30) ………………… In case of slow travel under speed control
  $J_L \le J_M \times 30$ (10) ………………… In case of positioning under position control
  $J_L \le J_M \times 10$ (-) ………………… In case of frequent positioning
  (Approximate measure: Starting and stopping at every 0.5 seconds or more frequently)
  Values in parentheses indicate operation with the GYG motor.
- Load torque
  $T_L \le T_R \times 0.9$ ………………… 0.9 indicates a typical margin of safety.

(4) Calculating the shortest acceleration/deceleration time (calculating the accelerating/decelerating torque)
Check the shortest acceleration/deceleration under consideration of load conditions. If the acceleration/deceleration time is designated, calculate the acceleration/deceleration torque.

- Shortest acceleration/Deceleration time

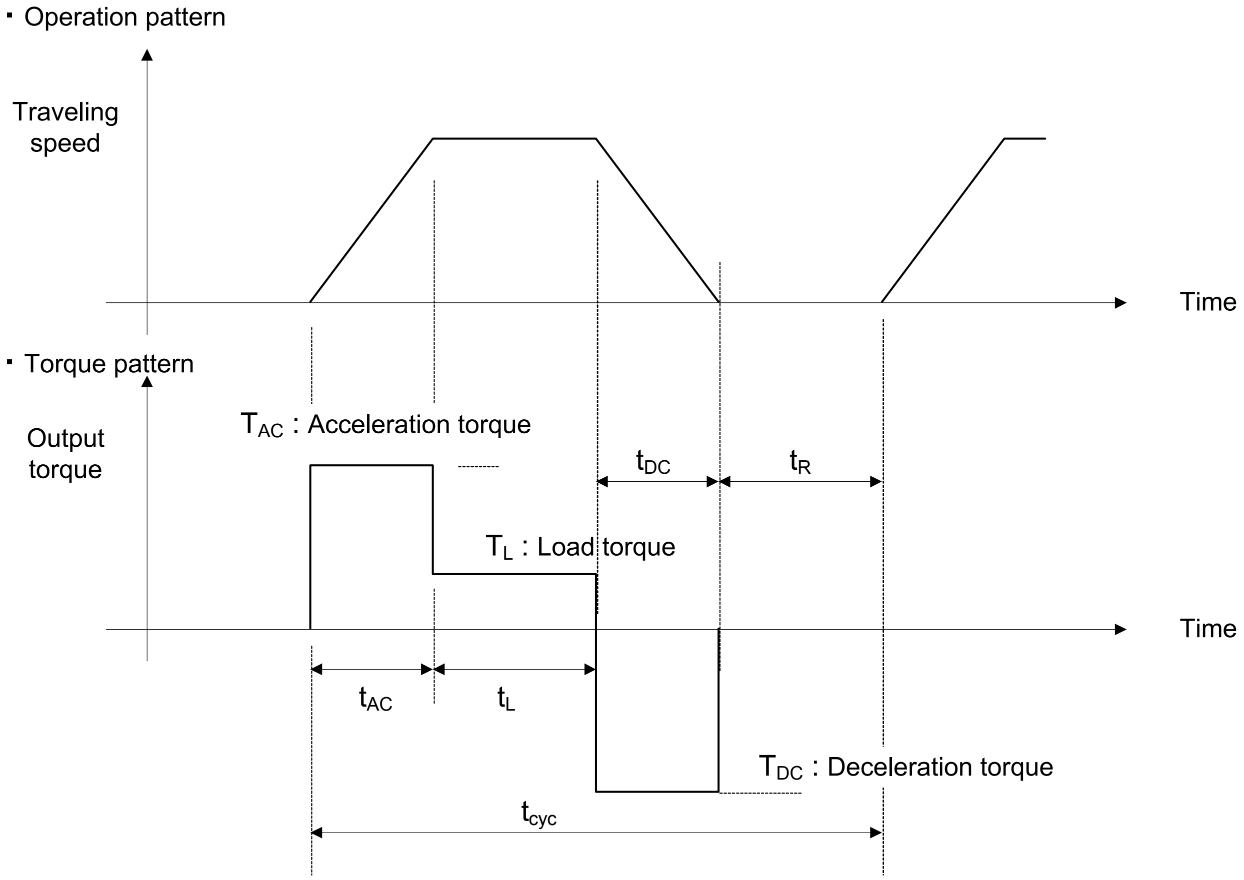
$$t_{AC} = \frac{(J_M + J_L) \times 2\pi \times (N_1 - N_0)}{60\,(T_{AC} - T_L)}$$

- 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 : Inertia of servomotor [kgm^2]
J_L : Inertia of load converted to motor shaft [kgm^2]
T_L : Load torque converted to motor shaft [Nm]
T_{AC} : Acceleration/Deceleration torque [Nm]
N_1 : Rotation speed after speed change [r/min]
N_0 : Rotation speed before speed change [r/min]

(5) Creating the torque pattern
Create the pattern of the output torque according to the operation pattern.



(6) Calculating the effective torque (T_{rms})
Calculate the effective torque of each cycle of the operation pattern.

$$T_{rms} = \sqrt{\frac{(T_{AC}^2 \times t_{AC}) + (T_L^2 \times t_L) + (T_{DC}^2 \times t_{DC})}{t_{CYC}}}$$

Obtain the sum of each of the product of the squared output torque multiplied by the output time and divide the sum by the cycle time, and obtain the square root of the result.

(7) $T_{rms} \leq T_R$
If the effective torque is equal to or smaller than the rated torque, continuous operation in the designated operation pattern is possible.

(8) Calculating the regenerative power
Regenerative operation is caused in general in the following state.
Horizontal feed: During deceleration
Vertical feed: During constant speed feed in the lowering cycle and during deceleration

Regenerative power during deceleration (P_1)

$$P_1[W] = (2\pi/60) \times T_{DC}[Nm] \times N_1[r/min] \times (1/2)$$

Constant speed feed in lowering cycle (P_2)

$$P_2[W] = (2\pi/60) \times T_{DC}[Nm] \times N_1[r/min]$$

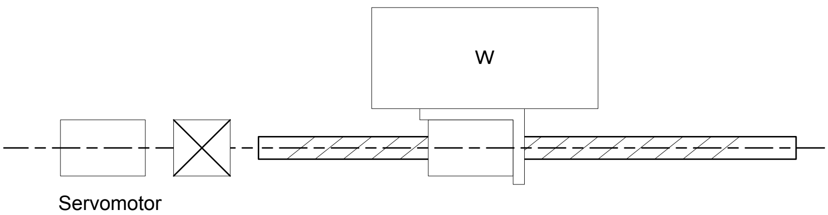
Calculate the average regenerative power (P) of each cycle of the operation pattern to check if P is within the regenerative resistor capacity. If it is not, an external regenerative resistor is necessary.

(9) Reviewing the operation pattern and mechanical configuration
If T_{rms} exceeds TR, review the following items.
- Increase the acceleration/deceleration time a little in the allowable range.
- Reduce the operation frequency (increase the cycle time).
- If the rotation speed allows, increase the reduction ratio.
- Increase the motor capacity.
- If the stopping time of a hoisting machine is too long, adopt a mechanical brake.
- In case of operation at a high frequency, increase the reduction ratio and reduce the inertia.

16.5.3 Capacity Selection Calculation Example

■ Mechanical configuration

Reduction ratio 1/1 (direct coupling)



Screw pitch 10 [mm], transfer mass 20 [kg], thrust 0 [kg] (absent)

(1) Max. traveling speed (v)
If the reduction ratio is 1/1 and the rotation speed of the motor shaft is 3000 [r/min]

v = (3000/60) × 10×(1/1) = 500 [mm/s]

(2) Load inertia converted to motor axis (J_L)

- Screw (J_1) Suppose Ø20 and 500 [mm] in length.

$$J_1 = \frac{\pi\rho}{32}\left[\frac{L}{1000}\right]\left[\frac{D_1}{1000}\right]^4 \times GL^2$$

$$= \frac{\pi \times 7.85 \times 10^3}{32}\left[\frac{500}{1000}\right]\left[\frac{20}{1000}\right]^4 \times (1/1)^2$$

$$= 0.6 \times 10^{-4}\ [\text{kg m}^2]$$

- Moving parts (J2) Suppose a transfer mass of 20 [kg].

$$J_2 = W\left[\frac{1}{2\pi}\ \frac{BP}{1000}\right]^2 \times (GL)^2$$

$$= 20\left[\frac{1}{2\pi}\ \frac{10}{1000}\right]^2 \times (1/1)^2$$

$$= 0.5 \times 10^{-4}\ [\text{kg m}^2]$$

$$J_L = 1.1 \times 10^{-4}\ [\text{kg m}^2]$$

(3) Load torque converted to motor axis (TL)
Suppose a transfer mass of 20 kg, friction coefficient (μ) of 0.1 and machine efficiency (η) of 0.9.

$$T_L = \frac{(\mu W + F) \times 9.81}{2\pi\eta}\left[\frac{BP}{1000}\right] \times GL$$

$$= \frac{(0.1 \times 20 + 0) \times 9.81}{2\pi \times 0.9}\left[\frac{10}{1000}\right] \times (1/1)$$

$$= 0.03\ [\text{Nm}]$$

16

(4) Capacity selection condition

$T_L \leq T_R \times 0.9$
$J_L \leq J_M \times 5$ (Frequent feed)

$T_L = 0.03$ Nm
$J_L = 1.1 \times 10^{-4}$ [kg m^2]

(5) Temporary selection
According to the capacity selection condition, GYS201D7-□□2 (0.2 [kW]) is found.
($J_M = 0.135 \times 10^{-4}$ [kgm^2], $T_R = 0.637$ [Nm], $T_{AC} = 1.91$ [Nm])

(6) Shortest acceleration/deceleration time (t_{AC})

$$t_{AC} = \frac{(J_M + J_L) \times 2\pi \times N}{60\,(T_{AC} - T_L)}$$

$$= \frac{(0.135 \times 10^{-4} + 1.1 \times 10^{-4}) \times 2\pi \times 3000}{60\,(1.91 - 0.03)}$$

$$= 0.021 \quad [\mathrm{s}]$$

Acceleration/Deceleration torque at an acceleration/Deceleration time of 0.05 seconds

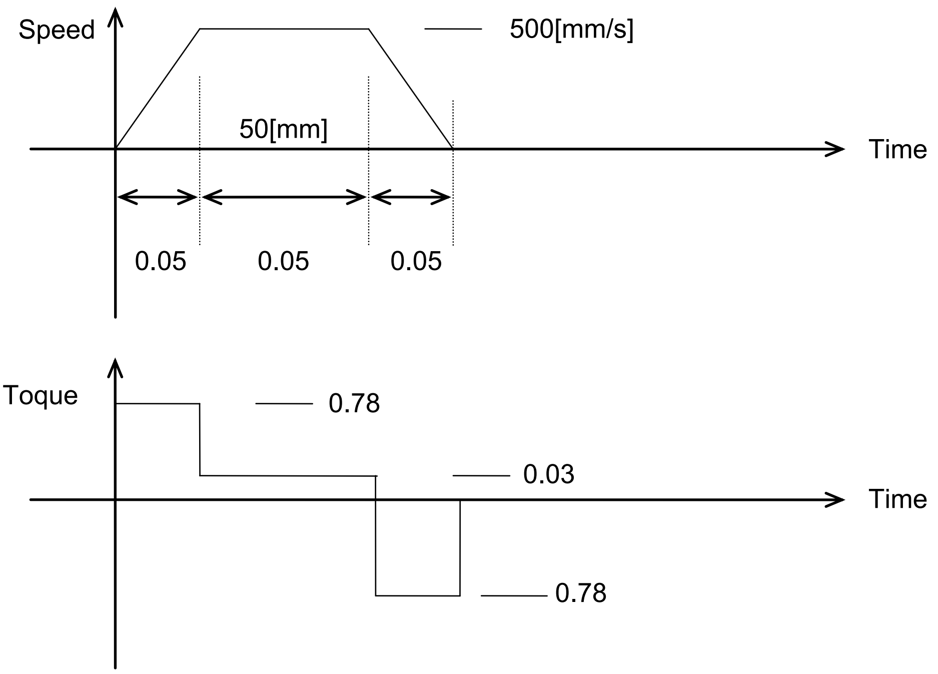
$$T_{AC} = \frac{(J_M + J_L) \times 2\pi \times N}{60\,(t_{AC})} + T_L$$

$$= \frac{(0.135 \times 10^{-4} + 1.1 \times 10^{-4}) \times 2\pi \times 3000}{60 \times 0.05} + 0.03$$

$$= 0.78 \quad [\mathrm{Nm}]$$

16

(7) Operation profile



This profile is based on calculation selection. The operation cycle time supposes 0.5 sec.

(8) Effective torque (T_{rms})

Time-average output torque

$$T_{rms} = \sqrt{\frac{T_{AC}{}^2 \times t_a + T_L{}^2 \times t_L + T_{DC}{}^2 \times t_d}{t_{cyc}}}$$

$$= \sqrt{\frac{(0.78^2 \times 0.05) \times 2 + (0.03^2 \times 0.05) \times 1}{0.5}}$$

$$= 0.25 \quad [\mathrm{Nm}]$$

Because the result is smaller than rated torque (0.637 [Nm]) of the GYS201D7-□□2 type, continuous operation can be made in the designated profile.

(9) Result of selection

Servomotor: GYS201D7-□□2 (0.2 [kW])

16

(10) Regenerative power

Regenerative power is caused during deceleration.

$$P_1[\mathrm{W}] = (2\pi/60) \times T\ [\mathrm{Nm}] \times N[\mathrm{r/min}] \times (1/2)$$

$$= (2\pi/60) \times 0.78 \times 3000 \times (1/2)$$

$$\approx 123\ [\mathrm{W}]$$

Average regenerative power of cycle operation

$$P = (123 \times 0.05)/0.5$$

$$\approx 12.3\ [\mathrm{W}]$$

The RYT201F7 type servo amplifier is not equipped with a built-in regenerative resistor.

Follow the procedure below to check if the regenerative resistor is necessary or not.

[1] Obtain the energy (E_G) of the mechanical system in the deceleration cycle.

$$E_G = \frac{1}{2}(J_M + J_L) \cdot (2\pi N/60)^2$$

$$= \frac{1}{2}(0.135\times 10^{-4} + 1.1\times 10^{-4}) \times \left(\frac{2\pi\times 3000}{60}\right)^2$$

$$= 6.1[\mathrm{J}]$$

[2] Calculate the energy (E_L) consumed by the load torque.

$$E_L = (2\pi/60) \times T_L \times N \times t_{DC} \times (1/2)$$

$$= (2\pi/60) \times 0.03 \times 3000 \times 0.05 \times (1/2)$$

$$= 0.24\ [\mathrm{J}]$$

[3] Calculate the energy (E_M) consumed by the coil of the servomotor.

$$E_M = 3\times (R \times I^2) \times t_{DC}$$

$$= 3\times R \times ((T_{DC}/T_R \times I_R)^2) \times t_{DC}$$

$$= 3\times 2.3\times ((0.78/0.637\times 1.5)^2) \times 0.05$$

$$= 1.2[\mathrm{J}]$$

Phase resistance of GYS201D7-□□2 type: 2.3 [Ω]

[4] Calculate the energy (E_S) that can be absorbed by the servo amplifier.

$$E_S = \frac{1}{2} C\left(V_{DB}{}^2 - V_{DC}{}^2\right)$$

$$= \frac{1}{2} (440 \times 10^{-6}) \times (390^2 - (200 \times \sqrt{2})^2)$$

$$= 15.86 \text{ [J]}$$

・ DC link capacity (RYT201): 440 [μF], source voltage 200 [V] (actual value)
・ The capacitor of 0.2 [kW] or smaller capacity servo amplifiers is 440 [μF].
・ V_{DB}: DB transistor activation level (390 [V]). V_{DC}: DC link voltage (200 x √2 [V])

The energy that can be processed by the mechanical system, servo amplifier and servomotor is:
$E_L + E_M + E_S = 0.24 + 1.2 + 15.86 \approx 17.3$ [J]
Because $E_G = 6.1$ [J], no external regenerative resistor is necessary.

■ Constants

■ 200 V series

Series	Capacity [kW]	Rated current [A]	Phase resistance [Ω]	Inertia 10^{-4}[kg·m^2]	Capacity of capacitor [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	

Series	Capacity [kW]	Rated current [A]	Phase resistance [Ω]	Inertia 10^{-4}[kg·m^2]	Capacity of capacitor [μF]
GYG 2000r/min	1.0	4.7	0.54	11.8	940
GYG 1500r/min	0.85	5.4	0.54	11.8	940

Series	Capacity [kW]	Rated current [A]	Phase resistance [Ω]	Inertia 10^{-4}[kg·m^2]	Capacity of capacitor [μF]
GYB	0.2	1.4	3.5	0.33	440
	0.4	2.7	1.8	0.57	720
	0.75	4.9	0.5	1.53	940

16.6 Revision History

Date of printing	Index	Description of revision
July, 2018	None	First version

16.7 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. 2018-09 (I18/I18) CM00FOLS