M0012169

# SANMOTION

## AC SERVO SYSTEMS

# R

## 3E Model

## TYPE S

Analog / Pulse Input Type

For Rotary Motor / 400V AC Input / 800 A

**Instruction Manual**

SANYO DENKI

# Safety Precautions

Please read this User Manual and its appendix carefully prior to installation, operation, maintenance or inspection and perform all tasks according to the instructions provided here. A good understanding of this equipment, its safety information as well as all Warnings / Cautions is also necessary before using.
Matters that require attention are ranked as “Danger” “Warning” and “Caution” in this document.

■ Warning Symbol

| | |
|---|---|
| | Denotes immediate hazards that will probably cause severe bodily injury or death as a result of incorrect operation. |
| | Denotes immediate hazards which will probably cause severe bodily injury or death as a result of incorrect operation. |
| | Denotes hazards which could cause bodily injury and product or property damage as a result of incorrect operation. |

⚠Caution Even those hazards denoted by this symbol could lead to a serious accident. Make sure to strictly follow these safety precautions.

■ Prohibited, Mandatory Symbols

| | |
|---|---|
| | Indicates actions that must not be allowed to occur / prohibited actions. |
| | Indicates actions that must be carried out / mandatory actions. |

# Safety Precautions

■ Attention in use

## ⚠ Warning

- ◆ Do not use this device in explosive environment.
  Injury or fire could otherwise result.
- ◆ Do not perform any wiring, maintenance or inspection when the device is hot-wired. After switching the power off, wait at least 15 minutes before performing these tasks.
  Electric shock or damage could otherwise result.
- ◆ The protective ground terminal ( ⏚ ) should always be grounded to the unit or control board. The ground terminal of the motor should always be connected to the protective ground terminal ( ⏚ ) of the amplifier.
  Electric shock could otherwise result.
- ◆ Do not touch the inside of the amplifier.
  Electric shock could otherwise result.
- ◆ Do not damage the cable, do not apply unreasonable stress to it, do not place heavy items on it, and do not insert it in between objects.
  Electric shock could otherwise result.
- ◆ Do not touch the rotating part of the motor during operation.
  Bodily injury could otherwise result.

## Caution

- Use the amplifier and motor together in the specified combination.
  Fire or damage to the device could otherwise result.
- Only technically qualified personnel should transport, install, wire, operate, or perform maintenance and inspection on this device.
  Electric shock, injury or fire could otherwise result.
- Do not expose the device to water, corrosive or flammable gases, or any flammable material.
  Fire or damage to the device could otherwise result.
- Be careful of the high temperatures generated by the amplifier/motor and the peripherals.
  Burn could otherwise result.
- Do not touch the radiation fin of the amplifier, the regenerative resistor, or the motor while the device is powered up, or immediately after switching the power off, as these parts generate excessive heat.
  Burn could otherwise result.
- In terms of designing safety systems using the Safe Torque Off function, personnel who have expertise of relevant safety standard are supposed to do that job with good understanding of this instruction manual.
  Injury or damage to the device could otherwise result.
- Please read the User Manual carefully before installation, operation, maintenance or inspection, and perform these tasks according to the instructions.
  Electric shock, injury or fire could otherwise result.
- Do not use the amplifier or the motor outside their specifications.
  Electric shock, injury or damage to the device could otherwise result.
- Regenerative resistor has instantaneous capacity. Contact our offices if the instantaneous regenerative power could be high as the result of high-inertia moment or high-velocity rotation.

■ Storage

## Prohibited

- Do not store the device where it could be exposed to rain, water, toxic gases or other liquids.
  Damage to the device could otherwise result.

# Safety Precautions

## Mandatory

- Store the device where it is not exposed to direct sunlight, and within the specified temperature and humidity ranges {- 20°C to + 65°C, below 90% RH (non-condensing)}.
  Damage to the device could otherwise result.
- Please contact our office if the amplifier is to be stored for a period of 3 years or longer. The capacity of the electrolytic capacitors decreases during long-term storage, and could cause damage to the device.
  Damage to the device could otherwise result.
- Please contact our office if the amplifier is to be stored for a period of 3 years or longer.
  Confirmations such as bearings and the brakes are necessary.

■ Transportation

## Caution

- When handling or moving this equipment, do not hold the device by the cables, the motor shaft or detector portion.
  Damage to the device or bodily injury could otherwise result.
- Keep in mind that it is dangerous at the time of conveyance if it falls and overturns.
  Bodily injury could otherwise result.

## Mandatory

- Follow the directions written on the outside box. Excess stacking could result in collapse.
  Bodily injury could otherwise result.
- Use eyebolt of the motor only for transporting itself. Do not use for transportation of machinery combined with the motor.
  Damage to the device or bodily injury could otherwise result.

■ Installation

## ⚠ Caution

- ◆ Do not stand on the device or place heavy objects on top of it.
  Bodily injury could otherwise result.
- ◆ Make sure the mounting orientation is correct.
  Fire or damage to the device could otherwise result.
- ◆ Do not drop this device or subject it to excessive shock of any kind.
  Damage to the device could otherwise result.
- ◆ Do not obstruct the air intake and exhaust vents, and keep them free of debris and foreign matter.
  Fire could otherwise result.
- ◆ Consult the User Manual regarding the required distance inside the amplifier disposition.
  Fire or damage to the device could otherwise result.
- ◆ Open the box only after checking its top and bottom location.
  Bodily injury could otherwise result.
- ◆ Verify that the products correspond to the order sheet/packing list.
  Injury or damage could result.
- ◆ Take care of falling or overturning of the device during installation.
  Use eyebolts of the motor if supplied.
  Bodily injury could otherwise result.
- ◆ Install the device on a metal or other non-flammable support.
  Fire could otherwise result.
- ◆ Make the collision safety device strong enough to resist the maximum output of the system.
  Bodily injury could otherwise result.

# Safety Precautions

■ Wiring

## ⚠ Caution

- ◆ Wiring connections must be secure.
  Bodily injury could otherwise result.
- ◆ Wiring should be completed based on the Wiring Diagram or the User Manual.
  Electric shock or fire could otherwise result.
- ◆ Wiring should follow electric equipment technical standards and indoor wiring regulations.
  An electrical short or fire could otherwise result.
- ◆ Do not connect a commercial power supply to the U, V or W terminals of the servo motor.
  Fire or damage to the device could otherwise result.
- ◆ Install a safety device such as a breaker to prevent external wiring short-circuits.
  Fire could otherwise result.
- ◆ Do not bind or band the power cable, input/output signal cable and/or encoder cable together or pass through the same duct or conduit.
  This action will cause faulty operation.
- ◆ Must connect a polarity of control power 24 VDC of servo amplifier, correctly.
- ◆ Must add the surge absorbing diode if inductive load as relay connect to the control signal output of the amplifier. Please take care of polarity of the diode that will be cause of failure.
- ◆ Do not connect 90 VDC or AC power to the 24 VDC Brake of the servo motor. Also, do not connect 400 VAC to the 200 VAC Fan of the servo motor.
  An electrical short or fire could otherwise result.
- ◆ Please design a sequence that included braking delay time because the surge-absorbing component for the relay of holding brake of the servo motor gives braking delay time.
  Injury or load falling could otherwise result.

## Mandatory

- ◆ Install an external emergency stop circuit that can stop the device and cut off the power instantaneously. Install an external protective circuit to the amplifier to cut off the power from the main circuit in the case of an alarm.
  Motor runaway, bodily injury, burnout, fire and secondary damages could otherwise result.

■ Operation

## ⚠ Caution

- Do not perform extensive adjustments to the device as they may result in unstable operation.
  Bodily injury could otherwise result.
- Trial runs should be performed with the motor in a fixed position, separated from the mechanism. After verifying successful operation, install the motor on the mechanism.
  Bodily injury could otherwise result.
- The holding brake is not to be used as a safety stop for the mechanism. Install a safety stop device on the mechanism.
  Bodily injury could otherwise result.
- In the case of an alarm, first remove the cause of the alarm, and then verify safety. Next, reset the alarm and restart the device.
  Bodily injury could otherwise result.
- Check that input power supply voltage is keeping a specification range.
  Damage to the device could otherwise result.
- Avoid getting close to the device, as a momentary power outage could cause it to suddenly restart (although it is designed to be safe even in the case of a sudden restart).
  Bodily injury could otherwise result.
- Do not use motor or amplifier which is defective or failed and damaged by fire.
  Injury or fire could otherwise result.
- In the case of any irregular operation, stop the device immediately.
  Electric shock, injury or fire could otherwise result.
- When using the servo motor in vertical axis, provide safety devices to prevent falls during the work that will cause an alarm condition.
  Injury or damage could result.

# Safety Precautions

## Prohibited

- The built-in brake is intended to secure the motor; do not use it for regular control. Damage to the brake could otherwise result.
  Damage to the device could otherwise result.
- Keep the motor's encoder cables away from static electricity and high voltage.
  Damage to the device could otherwise result.
- Standard specification servo amplifiers have a dynamic brake resistor. Do not rotate the motor continuously from the outside when the amplifier is not powered on, because the dynamic brake resistor will heat up, and can be dangerous.
  Fire or burn could otherwise result.
- Absolutely do not apply voltage more than the spec to the amplifier because overvoltage will be cause of part failure.
  Damage to the device or bodily injury could otherwise result.
- Avoid frequent on and off power supply.
  Inner parts might get premature failure in case of repeating ON/OFF of power supply 30 times or more per day, otherwise 5 times or more per hour.

## Mandatory

- Install an external emergency stop circuit that can stop the device and cut off the power instantaneously. Install an external protective circuit to the amplifier to cut off the power from the main circuit in the case of an alarm.
  Motor runaway, bodily injury, burnout, fire and secondary damages could otherwise result.
- There is no safeguard on the motor. Use an over-voltage safeguard, short-circuit breaker, overheating safeguard, and emergency stop to ensure safe operation.
  Injury or fire could otherwise result.
- Operate within the specified temperature and humidity range.
  Servo Amplifier
  Temperature 0°C to 55°C
  Humidity below 90% RH (non-condensing).
  Servo Motor
  Temperature 0°C to 40°C
  Humidity below 90% RH (non-condensing).}
  Burnout or damage to the device could otherwise result.

■ Maintenance・Inspection

## Caution

- Some parts of the servo amplifier (electrolytic capacitor, cooling fan, lithium battery for encoder, fuse and relay kinds) can deteriorate with long-term use. Please contact our offices for replacements.
  Damage to the device could otherwise result.
- Do not touch or get close to the terminal while the device is powered up.
  Electric shock could otherwise result.
- Be careful during maintenance and inspection, as the body of the amplifier becomes hot.
  Burn could otherwise result.
- Please contact your distributor or sales office if repairs are necessary. Disassembly could render the device inoperative.
  Damage to the device could otherwise result.

## Prohibited

- Do not overhaul the device.
  Fire or electric shock could otherwise result.
- Do not measure the insulation resistance and the pressure resistance.
  Damage to the device could otherwise result.
- Absolutely do not unplug the connector while the device is powered up because hot plug will give damaged by surge to component.
  Electric shock or damage could otherwise result.
- Do not remove the nameplate cover attached to the device.

■ Disposal

## Mandatory

- If the amplifier or the motor is no longer in use, it should be discarded as industrial waste.

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# 1 Preface

In this chapter, Introduction, Instruction manual, Illustration of system components, Model number structure and Part names of servo amplifier/motor are explained.


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# 1. Preface

## 1.1 Introduction

### 1.1.1 Product overview

Thank you for purchasing the AC servo system, “SANMOTION R” 3E Model. This instruction manual describes important things to notice to ensure your safety, such as specifications, installation, wiring, operation, functions and maintenance of the system. Please make sure to read this instruction manual before use to operate this AC servo system correctly. After reading, please keep it handy to refer as needed.

The AC Servo amplifier “SANMOTION R” 3E Model 400V AC input type with 800A is power unit separating servo amplifier combinating with 55kW power unit for use. This construction reduces work load of installation.
This product is corresponded the Rotary Motor R series, and allows using an absolute encoder and incremental encoder as motor encoder. Furthermore, this product is able to correspond to an external incremental encoder for a full-closed control system.
Communication with setup software (in PC) is corresponding USB (Full speed).

## 1.1.2 Features of "SANMOTION R" 3E Model

"SANMOTION R" 3E Model servo amplifier is having concepts of "Evolved", "Eco-Efficient" and "Easy to use", as below.

### (1) Evolved

- Shortening of positioning settle time
  Positioning settle time can shorten by higher response of velocity loop and evolution of model following vibration suppression control.

- Higher control accuracy
  Control gain will be 1.2 times of previous model by equipping phase characteristic compensation function. Resist disturbance strongly, and realize high accurate process.

- Shortening of tact time of process machinery
  Tact time of process machinery is shortened drastically by real time switching function of trajectory control and positioning control.

- Enhancing adaptive function
  Adaptive notch filter that realize adaptive vibration suppression of machine vibration is equipped.
  Realize stable operation by suppressing fluctuation and variation of machinery resonance frequency.
- Safety performance improvement of Safe Torque Off
  Improves Safety performance of Safe Torque Off by conforming of "SIL3/IEC 61508", "PL=e/ISO 13849-1". The product can use for the application which requires high safe performance.

### (2) Eco-Efficient

- Lower power consumption
  Up to 10% loss reduction by equipping new generation power device. And decreasing waste of energy by controlling speed of fan that cools depending on load condition and environment temperature.

  Especially standby power requirement (at servo off) is decreased 10% maximum, and fan noise decreased, also.

- Power consumption visualization
  Power consumption monitor function is equipped, so power consumption visualization of machine is available.
  * Power consumption monitor function is available with R2 series, 200VAC motor written on this manual. The other motors can not use that function.

### (3) Easy to use

- Easy startup
  Easy startup is available by Virtual motor operation function that simulates operation of motor and amplifier without actual motion and Visualized functional parameter editor (in Setup software).

- Easy servo tuning
  Servo adjustment support function is enhanced by functions of setup software "SANMOTION motor setup", such as the auto selection function of optimum tuning mode by machine/load condition, the basic adjustment mode which allows maximum two parameters and the advanced adjustment mode for decided purpose.

- Easy troubleshooting
  Easy troubleshooting is available by the 1 ms each timestamp and the drive-recorder function which records operation state of motor and amplifier, and they will show trouble status later.

# 1. Preface

## 1.2 Instruction manual

This manual outlines the specifications, installation, wiring, operations, functions, maintenance, etc. of the AC servo amplifier “SANMOTION R” 3E Model "Power unit", "Amplifier unit" and "Servo motor" as follows:

### 1.2.1 Contents

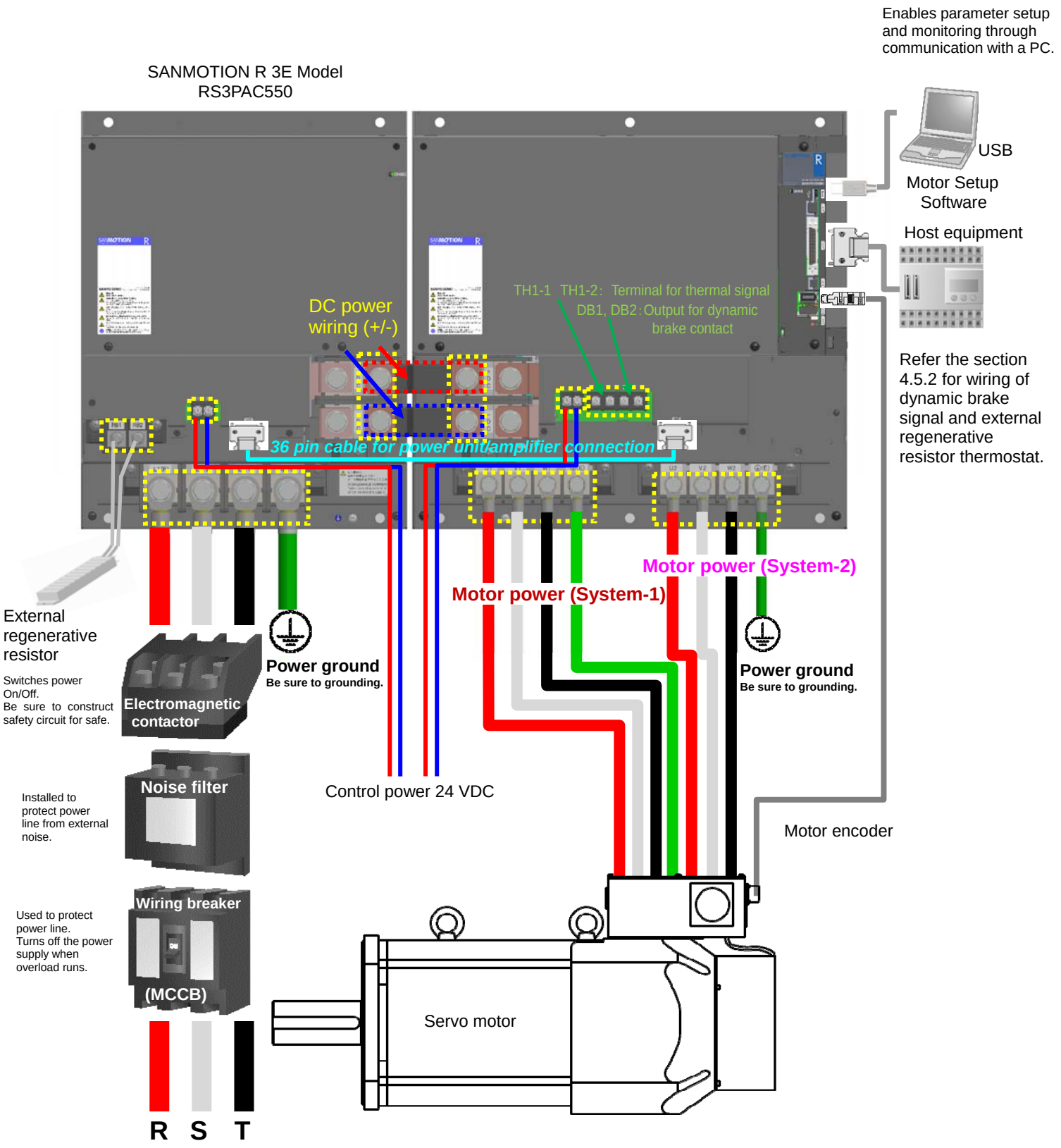
- Chapter 1 Preface
  Product outline, model number, names of components
- Chapter 2 Specifications
  Detailed specifications for Servo Motor, Motor Encoder, Power unit and Amplifier unit
- Chapter 3 Installation
  Explanation of installation procedure
- Chapter 4 Wiring
  Illustrations and explanations of wiring
- Chapter 5 Operation
  Explanation of operation sequence, test operations and parameters
- Chapter 6 Servo Tuning
  Explanation of servo adjustment as auto-tuning, manual tuning
- Chapter 7 Digital Operator
  Explanation of the LED display and use of the digital operator
- Chapter 8 Maintenance
  Explanation of troubleshooting when alarms occur and inspection
- Chapter 9 Dedicated function
  Explanation of full-closed control, tandem operation function and its how to use
- Chapter 10 Safe Torque Off function
  Explanation of Safe Torque Off function and its how to use
- Chapter 11 Selection
  Explanation of selection method for the servo motor and regenerative resistor capacity
- Chapter 12 Appendix
  Explanation of international standards, servo motor data sheets, dimensions and options

## 1.2.2 Precautions related to these instructions

In order to fully understand the functions of this product, please read this instruction manual thoroughly before using the product. After thoroughly reading the manual, keep it handy for reference.
Carefully and completely follow the safety instructions outlined in this manual.
Note that safety is not guaranteed for usage methods other than those specified in this manual or those methods intended for the original product.
Permission is granted to reproduce or omit a portion of the attached figures (as abstracts) for use.
The contents of this manual may be modified without prior notice as revisions or additions are created regarding the usage method of the product. Modifications are performed as per the revisions of this manual.
Although the manufacturer has taken all possible measures to ensure the veracity of the contents of this manual, should you notice any error or omission, please notify the nearest branch office or head office written in back cover.

Moreover, original text of this instruction manual is Japanese. Original text writing has priority if there is difference between original text and the other language writing.

## 1.3 Illustration of system components



# 1.4 Model number structure

## 1.4.1 Servo Motor Model Number

■ R motor

R 2 CA 32 55K B X S 00

**Servo motor series**
R･･･R series

**Servo motor type**
2･･･R2 motor

**Voltage**
CA･･･400 VAC

**Flange dimensions**
32･･･320 mm

**Rated output**
55K･･･55 kW

**Maximum rotation speed**
B･･･2000 $min^{-1}$

**Existence and spec for securing brake**
X･･･No brake

**Encoder type**
S･･･Wire-saving incremental encoder

**Specification identification**
00･･･Standard

◆ Incremental encoder (Standard)

| Name (Code) | Motor model number encoder code | Number of pulse (Division number) |
|---|---|---|
| Wire-saving incremental encoder (PP062H) | S | 5,000 P/R (20,000) |

* Please contact us for the motor model number with the other incremental encoder except above.

# 1. Preface

## 1.4.2 Power Unit Model Number

RS3 PA C □□□ XX

**Series name**
RS3･･･"SANMOTION R"3E Model series

**Unit type**
PA･･･Power unit (No built-in regenerative resistor)

**Input power voltage**
C･･･Main circuit /400 VAC,
Control /24 VDC

**Power capacity**
550･･･55 kW
It shall be used dedicated power unit matching with combination servo motor rated output.

**Specification identification**
None･･･Standard
2 digits indication･･･Special specifications

* Model numbers above are standard spec. Model number which is not listed spec in this manual will differ.
Please contact us for the detail.
* Refer Section 10 for detail of Safe-Torque-Off function.

## 1.4.3 Amplifier Unit Model Number

RS3 D ○○ A □ ◇ △ 0

**Series name**
RS3･･･"SANMOTION R"3E Model series

**Input power voltage**
C･･･Main circuit /560 VDC,
Control /24 VDC

**Servo amplifier capacity**
80･･･800A
* Refer page 1-13 for amplifier unit capacity and combination motor.

**Servo motor type**
A･･･Rotary motor

**Motor enclder type**

| | EN1 (for motor encoder only) | EN2 (for motor encoder or external encoder) |
|---|---|---|
| 8 | Incremental encoder | – |
| 9 | Incremental encoder | Absolute encoder |
| A | Incremental encoder | Incremental encoder |

**Interface type**
A･･･Analog pulse control, sink type general output
B･･･Analog pulse control, source type general output
* Refer page 1-9 for the detail of sink and source type general output.

**Option 1**
M･･･Without regenerative resistor/ Without DB resistor

**Option 2**

| | With Velocity/ Torque command input | Safe Torque Off function | Tandem operation function | Functional safety module |
|---|---|---|---|---|
| 0 | Available | None | None | None |
| 2 | Available | Available (without delay circuit) | Available | None |
| 4 | Available | Available (with delay circuit) | Available | None |
| C | Available | Available (without delay circuit) | Available | Available |
| E | Available | Available (with delay circuit) | Available | Available |

* Refer "Instruction manual of SANMOTION R3E Model Safety, M0011778" for the functional safety module.

* Model numbers above are standard spec. Model number which is not listed spec in this manual will differ.
Please contact us for the detail.

* Setup values of amplifier unit are "default values" at the time of shipment from our factory.
Adjustments for System Parameters and General Parameters according to your equipment specifications, etc., as well as for Combination of amplifier unit and Servo motor are necessary. Make certain to follow the appropriate set-up procedure to operate your system by referring to the following chapters:
◆ 5.1 Basic setting of the system ◆ 5.8 Parameter functions

* Motor encoder types, "0" or "8" are used exclusively for "Semi-closed" system and cannot be used for "Full-closed" systems.
However, the amplifier unit for the "Full-closed" system can be used for the "Semi-closed" system.

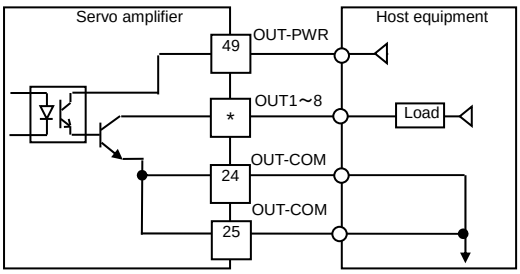
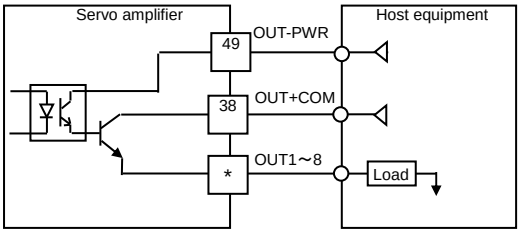
* Refer "10. Safe Torque Off function" for detail of Safe Torque Off function.

# 1. Preface

■ Power unit, amplifier unit and combination motor (400 VAC)
*: Factory setting value of shortened model number

| Input voltage | Power unit model number | Amplifier unit model number | Servo motor model number |
|---|---|---|---|
| 400 VAC | RS3PAC550 | RS3D80# | R2CA3255KB |

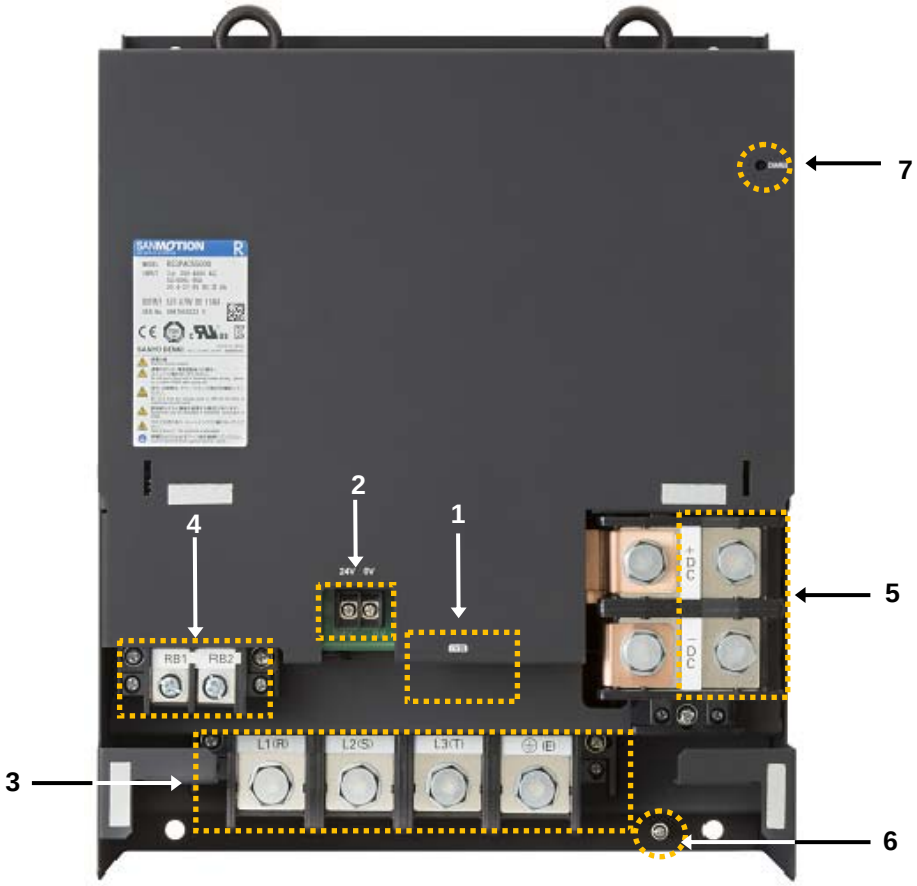
■ Sink type general output, Source type general output

| Interface type code | General output circuit type | Output current | Circuit |
|---|---|---|---|
| A | Sink type general output | Current flows to output terminal from a load at output signal ON. |  *:39-46 |
| B | Source type general output | Current flows to a load from output terminal at output signal ON. |  *:39-46 |

# 1.5 Part names

## 1.5.1 Power unit

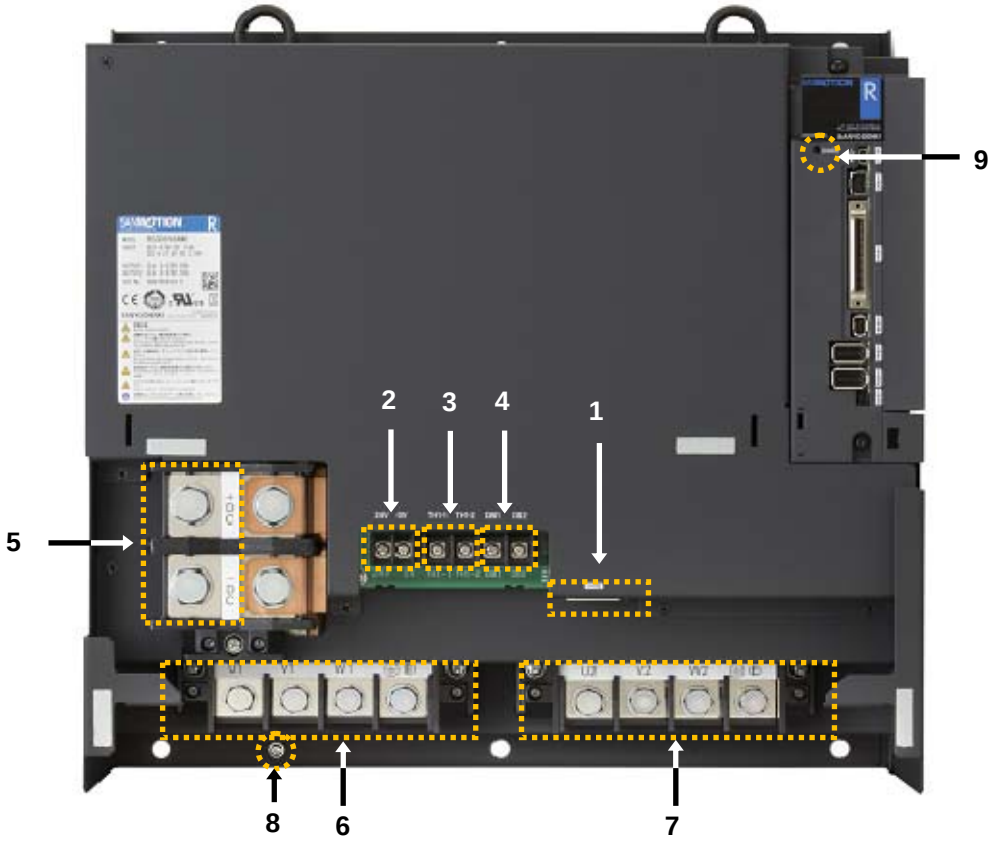
■ RS3PAC550




| No. | Name/Use |
|---|---|
| 1 | Amplifier unit connection connector(CN10)/<br>Connect to CN10 of the amplifier unit with optional cable which connects units each other. |
| 2 | Control power input (24V･0V)/<br>For input terminal of control power |
| 3 | Main circuit power input(R･S･T･E)/<br>For input terminal of main circuit power<br>Make sure to connect power grounding cable to terminal E. |
| 4 | Regenerative resistor terminal(RB1･RB2)/<br>Connect the resistor between RB1 and RB2. |
| 5 | DC output terminal for main circuit（+DC･-DC）<br>Connect to +DC/-DC of the amplifier unit. |
| 6 | Frame ground<br>Connect to the frame ground of amplifier unit. |
| 7 | Main circuit power LED (Red)/<br>Lighting on when main circuit power is ON. Continue lighting during internal capacitor has charge, even if power is OFF. Do not touch power terminal during lighting.<br>There is a risk of electric shock. |

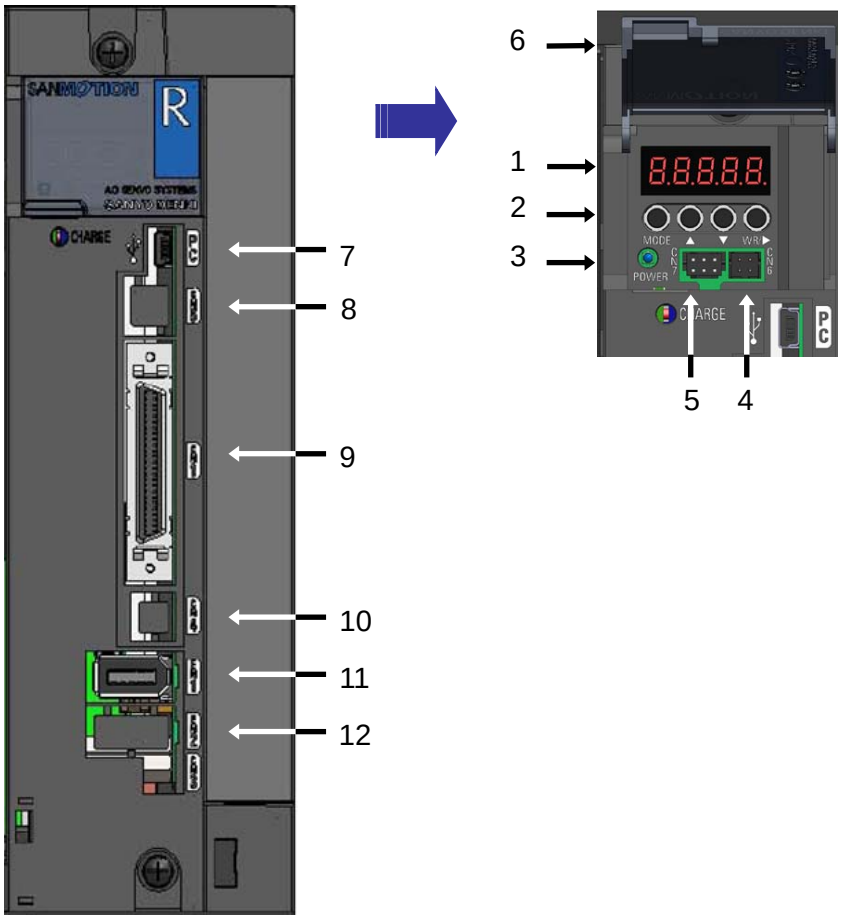
## 1.5.2 Amplifier unit

■ RS3D80# Terminal block, connectors and main body indication part




| No. | Name/Use |
|---|---|
| 1 | Power unit connection connector(CN10)/<br>Connect to CN10 of the power unit with optional cable which connects units each other. |
| 2 | Control power input (24V・0V)/<br>For input terminal of control power |
| 3 | Terminal for thermal signal connection of dynamic brake (TH1-1・TH1-2)/<br>Use as dynamic brake overheat detection.<br>Note) If not used, be sure to make short circuit between terminals. |
| 4 | Terminal for dynamic brake signal (DB1・DB2)/<br>Terminal for dynamic brake signal timing output contact (24 VDC output). Use for construction of dynamic brake circuit externally. |
| 5 | DC input terminal for main circuit（+DC・-DC）<br>Connect to +DC/-DC of the power unit. |
| 6 | Motor power line (U1・V1・W1・E)<br>Connect to motor terminal block (U1・V1・W1). Be sure to connect motor grounding cable to terminal E. |
| 7 | Motor power line (U2・V2・W2・E)<br>Connect to motor terminal block (U2・V2・W2). Be sure to connect motor grounding cable to terminal E. |
| 8 | Frame ground<br>Connect to the frame ground of power unit. |
| 9 | Main circuit power LED (Red)/<br>Lighting on when main circuit power is ON. Continue lighting during internal capacitor has charge, even if power is OFF. Do not touch power terminal during lighting.<br>There is a risk of electric shock. |

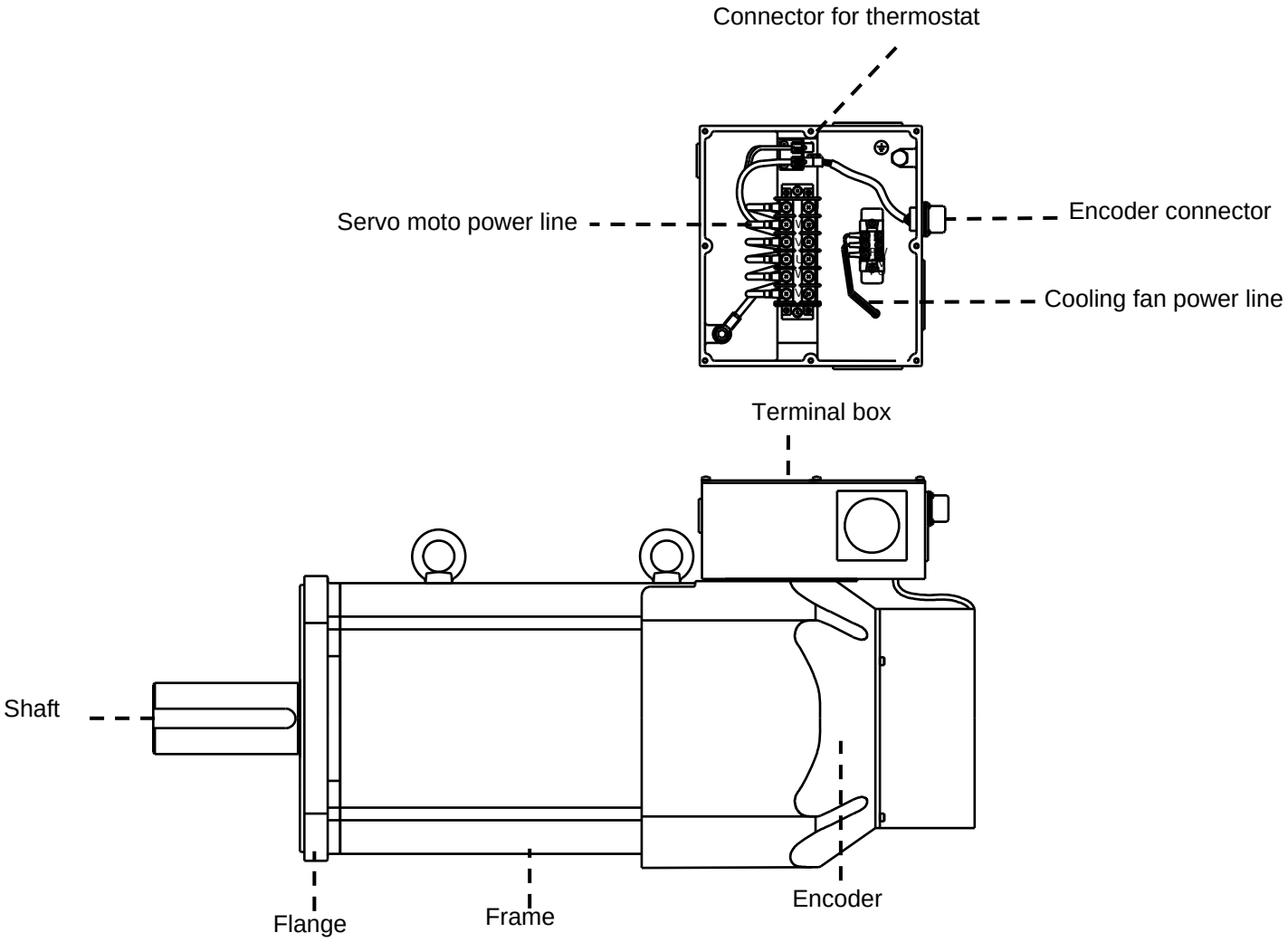
■ RS3D80# Interface part with upper device




| No. | Name/Use |
|---|---|
| 1 | Digital operator display/<br>For servo amplifier status, alarm code and data display for parameter input |
| 2 | Digital operator key/<br>For parameter setting |
| 3 | Control power status LED (Blue)/<br>Lighting on when control power inputted and control circuit is working. |
| 4 | Analog monitor connector (CN6)/<br>For measuring analog signal such as velocity or current with dedicated cable. |
| 5 | (CN7)/ For maintenance |
| 6 | Front panel cover/ |
| 7 | USB connector for PC communication (PC)/ |
| 8 | Amplifier communication connector for axes sync (CN5)/<br>* It may not have the connecter depending on the amplifier unit spec. |
| 9 | For I/O signal connector with host equipment (CN1)/ |
| 10 | For safety features connector (CN4)/<br>* It may not have the connecter depending on the amplifier unit spec. |
| 11 | For motor encoder (EN1)/ |
| 12 | For motor encoder or external encoder (CN2)/<br>* It may not have the connecter depending on the amplifier unit spec. |

## 1.5.3 Servo motor

■ R2 servo motor 320 mm sq. 55 kW
R2CA3255KB△□◇



# 2

# Specifications

In this chapter, specifications of servo amplifier, servo motor and regenerative resistor are explained.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# 2. Specifications

## 2.1 Servo motor

### 2.1.1 General specifications

| Series name | R1, R2 |
|---|---|
| Heat resistance class | Class F |
| Voltage/Dielectric strength | AC2000V 1 minute |
| Insulation resistance | DC500V, greater than 10MΩ |
| Cooling method | Totally Enclosed Air Over (TEAO) |
| Protection level | IP65<br>Excepts cooling fan and terminal box (customer working part). |
| Oil Sealing | Yes |
| Ambient temperature | 0 to +40°C |
| Storage temperature | -20 to +65°C |
| Ambient humidity | 20 to 90% (without condensation) |
| Elevation | Altitude 1,000 m or less |
| Vibration classification | V15 |
| Excitation method | Permanent magnet type |
| Installation method | Flange mount |

### 2.1.2 Exterior dimensions/ specifications/ mass

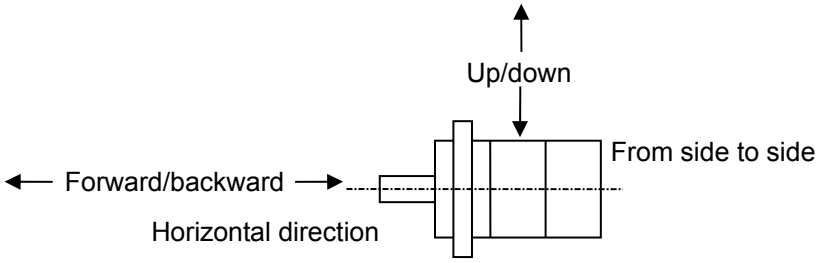
Refer to “12.3 Servo Motor Dimension”.
Refer to “12.4 Servo Motor Data Sheet”.

### 2.1.3 Cooling fan specifications

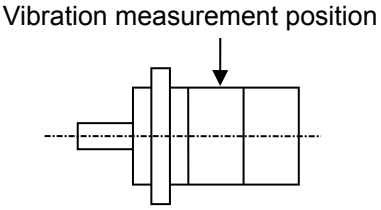
| Item | Unit | Constant value |
|---|---|---|
| Power supply voltage | V | 200 VAC±10 % (180 to 220 VAC) |
| Frequency | Hz | 50/60 (Nominal) |
| Phase number | - | 3-phase |
| Input | W | 150/195 (Nominal) |
| Current | A | 0.9/0.9 (Nominal) |

## 2.1.4 Mechanical specifications/ mechanical strength/ working accuracy

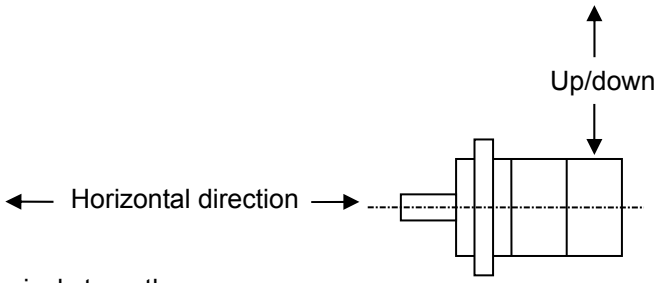
■ Vibration resistance
Install the servo motor horizontally (shown in the figure below), so when vibration occurs in any of three (3) directions (up/down, backward/forward, left/right) the motor will withstand vibration acceleration up to 24.5m/s2.
Exceptionally for 100 and 130mm flange size R1 motor, 49m/s2 in rotating and 24.5m/s2 at stop.




■ Vibration classification
The vibration classification of the servo motor is V15 or less at maximum rotation speed for a single servo motor unit and is measured as indicated in the figure below.

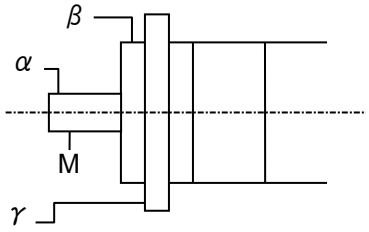



■ Shock resistance
Install the shaft of servo motor in a horizontal direction (shown in the figure below). This shaft should withstand shock acceleration up to 98m/s$^2$ (when shock is applied in an upward/downward direction) for two (2) times. However, since a precision motor encoder is fixed to the counter-load side of the flange, any shock applied to the shaft may cause damage to the motor encoder. Therefore, try to avoid shock to the shaft under any circumstances.




■ Mechanical strength
The axis strength of the servo motor can withstand peak torque at stall.

■ Working accuracy
The following table shows the accuracy and precision of the servo motor output shaft (Total Indicator Reading) of the parts surrounding the shaft.

| Items | T. I. R. | Reference Figure |
|---|---|---|
| Vibration of output shaft terminal: α | 0.04 |  |
| Eccentricity of external diameter of flange on output shaft M: β | 0.10 | |
| Perpendicularity of flange face to output shaft M: γ | 0.10 | |

# 2. Specifications

## 2.1.5 Oil seal type

S-Type oil seal (as shown in the table below) is fixed to the output shaft of the servo motor.
This oil seal is produced by NOK Corporation.
Please contact us for replacement of this oil seal.

| Servo motor model number | Oil seal type |
|---|---|
| R2CA3255KB | Standard: With oil seal, S-Type |

* Please contact us for specifications of the other model number above.

## 2.1.6 Holding brake

For servo motor R2CA3255KB, there is no specification with brake.

# 2.2 Motor encoder



## 2.2.1 Incremental encoder specifications

■ Wire-saving incremental encoder

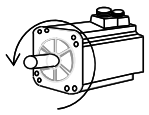
| Model | Motor model number encoder code | Number of pulse (Resolution) |
|---|---|---|
| PP062H | S | 5,000P/R (20,000) |

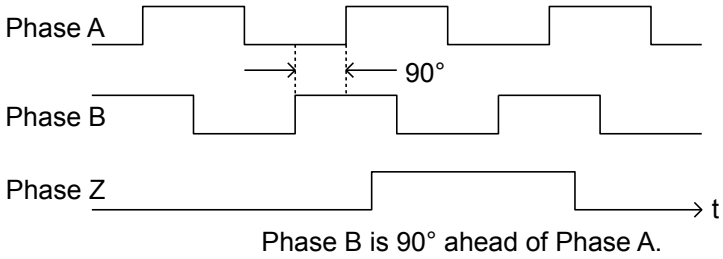
Model number example: R2CA3255KBXS00

* Please contact us for the motor model number with the other incremental encoder except above.

■ Servo motor rotation direction and encoder signal phase
Motor rotation direction and motor encoder signal phases are related as follows:

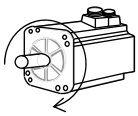
Servo motor rotation direction-Normal

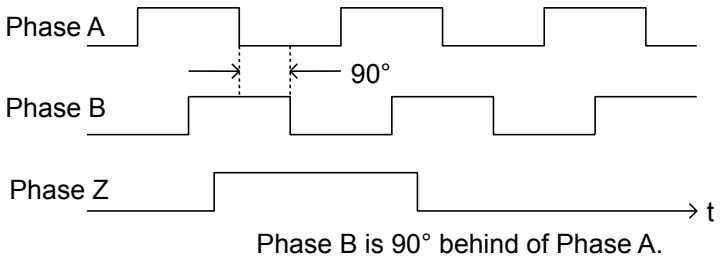





Phase B is 90° ahead of Phase A.

Servo motor rotation direction- Reverse






Phase B is 90° behind of Phase A.

* When Z-Phase is at high level, both Phases A and B cross the low level once every rotation.
* Forward (normal) rotation is Counterclockwise (CCW) seeing from load side.

# 2. Specifications

## 2.3 Power unit/Amplifier unit

### 2.3.1 Common specifications

■ General specifications (Power unit/Amplifier unit combination)

| | | | |
|---|---|---|---|
| Control function | | Speed control/Torque control/Position control (Changed by parameter) | |
| Control method | | IGBT: PWM control Sinusoidal drive | |
| Main Circuit Power Note 1) | | Three-phase: 380 to 480 VAC+10,-15 % , 50/6 0Hz±3 Hz | |
| Control power Note 1) | | 24 VDC±10 % | |
| Protection level | | IP00 | |
| Environment | Ambient temperature | 0 to 55℃ | |
| | Storage temperature | -20 to +65℃ | |
| | Operation/ Storage humidity | Below 90%RH (no condensation) | |
| | Elevation | Below 1000m | |
| | Vibration | 4.9m/s$^2$ | |
| | Shock | 19.6m/s$^2$ | |
| Structure | | Wall-mounted type power unit | Wall-mounted type amplifier unit |
| Unit model number | | RS3PAC550 | RS3D80# |
| External dimensions (H×W×D) | | 380 | 380 |
| | | 300 | 400 |
| | | 315 | 315 |
| Mass (kg) | | 22.4 | 32.5 |

Note 1) Power source voltage should be within the specified range.
Specified power supply range Main circuit power: 323 to 528 VAC
Control power: 20.4 to 27.6 VDC
Moreover, Overvoltage Category of Power unit and Amplifier unit are III (EN61800-5-1).
So, use a DC power supply with reinforced insulation, for 24VDC control power and DC power of interface.

■ Performances

| | |
|---|---|
| Speed control range | 1: 5000 Note 2) |
| Allowable load inertia moment | 10 times motor rotor inertia moment Note 3) |

Note 2) Internal speed command
Note 3) When the value exceeds the above allowable load inertia moment, please contact us.

■ Built-in functions

| | | |
|---|---|---|
| Protection functions | Over current, Current detection error, Overload, Regeneration error, Overheat error, External overheating, Over voltage, Main circuit power low voltage, Main circuit power supply open phase, Control power supply low voltage, Encoder error, Over speed, Speed control error, Speed feedback error, Excessive position, Position command pulse error, Built-in memory error, Parameter error, Cooling fan error | |
| Digital operator | Status display, Monitor display, Alarm display, Parameter setting, Test operation, Adjustment mode | |
| Dynamic brake circuit | Not included Note 4) | |
| Regeneration process circuit | Included Note 5) | |
| Monitor | Speed monitor (VMON) | 2.0 V±10 % (at 1000 min$^{-1}$) |
| | Torque (Thrust) (TCMON) | 2.0 V±10 % (at 100 %) |

Note 4) Only dynamic brake timing signal output circuit is included.
Note 5) Regenerative resistor is attached external.

## 2.3.2 Input command, position signal output, general input, general output

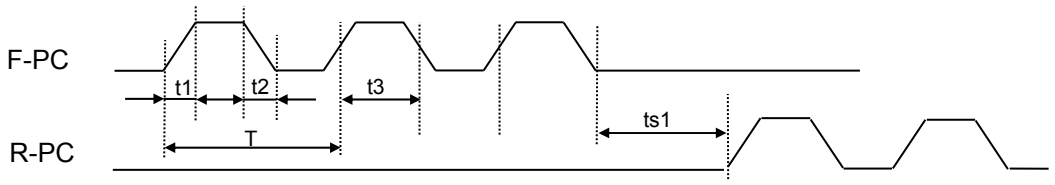
■ Input command

◆ Position command

| | | |
|---|---|---|
| Position command | Maximum input pulse frequency | 4M Pulse/s (Reverse + Forward pulse, Code +Pulse)<br>1M Pulse/s (90°-phase difference two-phase pulse) |
| | Input pulse form | Forward + Reverse command pulse,<br>Code + Pulse train command or<br>90°-phase difference two-phase pulse train command |
| | Electronic gear | N/D(N=1 to 2097152, D=1 to 2097152)<br>However, 1/2097152 ≦ N/D ≦ 2097152 |

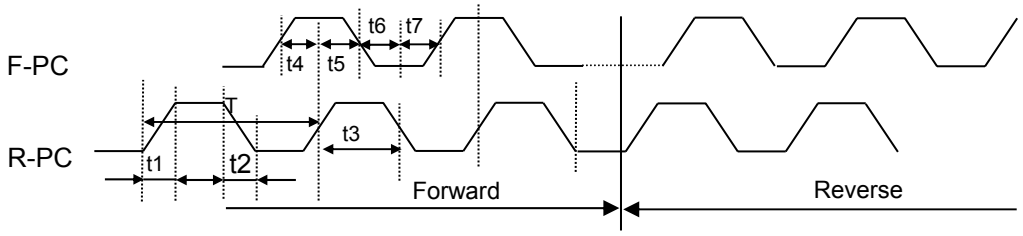
◆ Position command timing

Positive move pulse train + Negative move pulse train



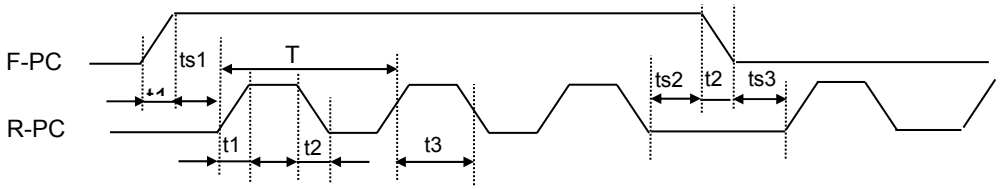

| | |
|---|---|
| Stage up time (t1): ≦0.1μs | Stage down time (t2): ≦0.1μs |
| Duty[(t3/T)x100]: 50% | Change of pulse time: ts1 > 2μs |

Pulse trains with 90°phase difference




| | |
|---|---|
| Stage up time (t1): ≦0.1μs | Stage down time (t2): ≦0.1μs |
| Duty[(t3/T)x100]: 50% | |
| Minimum phase difference between pulse edges (t4, t5, t6, t7): >250nsec | |

Code + Pulse train




| | |
|---|---|
| Stage up time (t1): ≦0.1μs | Stage down time (t2): ≦0.1μs |
| Duty[(t3/T)x100]: 50% | Change of pulse time: ts1,ts2,ts3> 2μs |

◆ Speed command

| | | |
|---|---|---|
| Speed command | Voltage command | DC±2.0V<br>at 1000min-1 command, Plus command (forward)<br>motor rotation Maximum input voltage ±10V |
| | Input impedance | Approximately10kΩ |

# 2. Specifications

◆ Torque command

| | | |
|---|---|---|
| Torque command | Voltage command | ±2.0 VDC<br>at 100% torque, Plus command (forward) rotation<br>Maximum input voltage ±10kΩ |
| | Input impedance | Approximately 10kΩ |

■ Position signal output

| | |
|---|---|
| Encoder output Pulse signal | N/32768 (N=1 to 32767), 1/N (N=1 to 64) or 2/N (N=2 to 64) |
| Encoder output serial signal | Binary code output, decimal ASCII output |

■ General input

| | |
|---|---|
| Sequence input | Interactive photo coupler (sink, source connection): ×8 input |
| | Input power voltage range: 5 VDC±5 % / 12 to 24 VDC±10 %,<br>100 mA or over (24 VDC) |
| | Servo ON, Alarm reset, Torque limit, Encoder clear, Forward rotation prohibit, Command prohibit, Reverse rotation prohibit, Command prohibit, External trip, Forced discharge, Emergency stop, Gain switching, Internal speed setting, etc.<br>Refer to “Group9 Condition settings for enabling function (5-102)” for details. |

■ General output [Sink type general output, Source type general output]

| | |
|---|---|
| Sequence output | Open collector output: x 8 outputs |
| | Power supply for general output circuit (CN1-49,OUT-PWR):<br>5 VDC±5 % / 12 to 24 VDC±10 %, 20 mA or over |
| | Specification of Power supply for general output circuit<br>·5 VDC±5 % , Maximum current value 10 mA (per 1 output )<br>·12 to 15 VDC±10 % , Maximum current value 30 mA (per 1 output)<br>·24 VDC±10 % , Maximum current value 50 mA (per 1 output) |
| | Servo ready, Power ON, Servo ON, Holding brake timing, Torque limiting, Low speed, Velocity attainment, Matching speed, Zero speed, Command acceptable, Status of gain switch, Velocity loop proportional control status, Control mode switchover status, Forward OT, Reverse OT, Reverse OT, Warning, Alarm code (3bits), etc.<br>Refer to “GroupA Settings for Generic Output Outputting Condition/Monitor Output selection/ Serial Communications (5-113)” for details. |

## 2.3.3 Torque limit input

| | |
|---|---|
| Torque limit input | DC±2.0V±15% (at rated torque)<br>Input impedance: approximately 10kΩ |

## 2.4 Power supply, calorific value



### 2.4.1 Main circuit power supply capacity, control power supply capacity

■ 400 VAC input

| Input Voltage | Servo motor model number | Rated output (kW) | Unit model number | Main circuit power capacity (kVA) | Control power capacity (VA) |
|---|---|---|---|---|---|
| 400 VAC | R2CA3255KB | 55 | RS3PAC550 | 90 | 61 |
| | | | RS3D80# | | 83 |

* # = Optional alphabetical letter
* Values of power capacity above are of motor rated output operation.
* Values of control power capacity are in a holding brake operation and at a maximum rotation of fan.
* Main circuit power capacity is the value with the condition of rated output calculated by power factor 75 %.

## 2.4.2 Inrush current, leakage current

■ Inrush current

| Input Voltage | Servo amplifier capacity | Control power (Maximum value between 1ms after input) | Main circuit power (Maximum value between 1.2 seconds after input) |
|---|---|---|---|
| 400 VAC | RS3PAC550 | 56 A(0-P) | 135.8 A(0-P) |
| | RS3D80# | | |

* # = Optional alphabetical letter
* Inrush current values above are at the condition of ordinary temperature and 480VAC input voltage.

■ Leakage current

| Servo amplifier capacity | Electric leakage current per motor |
|---|---|
| RS3PAC550 | 13 mA or less |
| RS3D80# | |

* # = Optional alphabetical letter
* Leakage current value above is measured with star-connection three-phase four-wire system, by leak checker which has set 700 Hz filter.
* While using two (2) or more motors, leakage current from each motor should be added.
* These values are applicable when a tough rubber sheath cable of 2M is used as a power line. In the case of a shorter or longer cable length, values of the above table should be selected as closely as possible.
* The machine should be grounded so that dangerous voltage does not occur at the main part of the machine, such as the operation panel, etc., during a period of emergency leakage current. (C-class or greater grounding is recommended.)
* Please use an earth leakage circuit breaker which is allowing high harmonics because normal earth leakage circuit breaker or earth leakage protection relay might malfunction by flow of a high harmonics leakage current of ground floating capacitance of servo motor winding, power cable or power unit/amplifier unit.
* This product has touch current 3.5 mA or more so make sure to connect grounding with the copper wire having cross section 10 mm2 or more, determined in IEC/EN 61800-5-1.

# 2.4 Power supply calorific value

## 2.4.3 Calorific value

| Input voltage | Servo amplifier capacity | Servo motor model number | Power unit/Amplifier unit total calorific value (W) |
|---|---|---|---|
| 400 VAC | RS3PAC550<br>RS3D80# | R2CA3255KB | 1,600 or less |

* # = Optional alphabetical letter
* Calorific values above are the condition of rated motor output operation. Calorific value of regenerative resistor is not included.

# 2. Specifications

## 2.5 Operation pattern

### 2.5.1 Time of acceleration and deceleration, permitted repetition, loading precaution

The motor's acceleration time (ta), and deceleration time (tb) when under constant load is calculated using the following method:

■ Acceleration time: $t_a=(J_M+J_L)\cdot(2\pi/60)\cdot\{(N_2-N_1)/(0.8\times T_P-T_L)\}$ [s]

■ Deceleration time: $t_b=(J_M+J_L)\cdot(2\pi/60)\cdot[(N_2-N_1)/(0.8\times T_P+T_L)]$[s]

- ◆ $t_a$: Acceleration time (s)
- ◆ $t_b$: Deceleration time (s)
- ◆ $J_M$: Motor inertia moment ($kg\cdot m^2$)
- ◆ $J_L$: Load inertia moment ($kg\cdot m^2$)
- ◆ $N_1$, $N_2$:Rotational speed of motor ($min^{-1}$)
- ◆ $T_P$: Instantaneous maximum stall torque ($N\cdot m$)
- ◆ $T_L$: Load torque ($N\cdot m$)

* These expressions are for the rated speed values but exclude the viscous torque and friction of the motor.

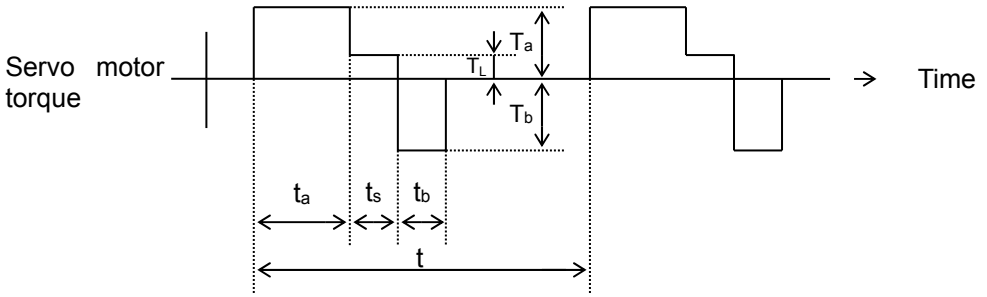
■ Loading precaution
There are separate limitations on repetitive operations for both the servo motor and amplifier unit, and the conditions of both must be met simultaneously.

■ Frequency of permitted repetitions for the amplifier unit
When Start/Stop sequences are repeated frequently, confirm in advance that the frequency of repetitions are within tolerance range. Allowed repetitions differ depending on the type, capacity, load inertia moment, accel/decel torque and motor rotation speed of the motor in use. If the load inertia moment = motor inertia moment X m-times, and when the permitted Start/Stop repetitions (up to the maximum rotation speed) exceed the following value, please contact us for assistance, as precise calculation of effective torque and regenerating power is critical.

$$\text{Frequency of repetitions} = \frac{20}{m+1} \quad \text{times / min}$$

■ Frequency of permitted repetitions for the servo motor
Permitted Start/Stop repetitions differ according to the motor usage conditions, such as load condition and operating time.

■ When the motor repeats continuous speed status and stop status
In operating status (shown below) the motor should be used at a frequency in which its effective torque is less than the rated torque $T_R$.




◆ If the operating cycle is considered as "t", the usable range can be determined as follows:

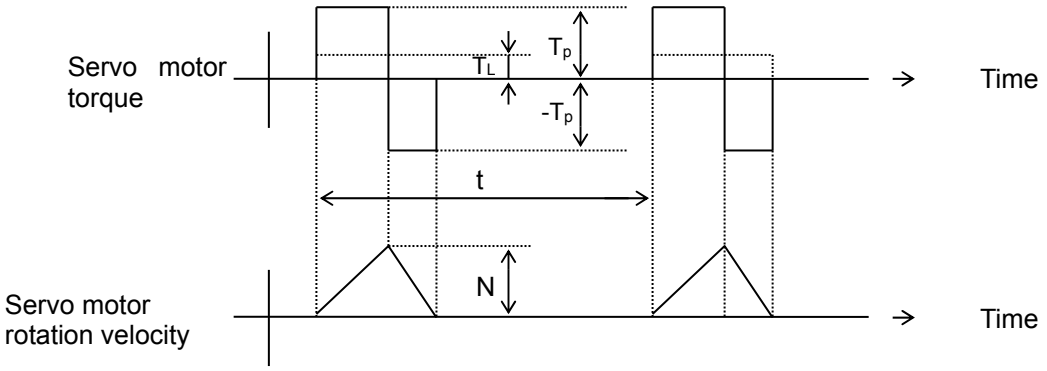
$$t \geqq \frac{T_a^2 t_a + T_L^2 t_s + T_b^2 t_b}{T_R^2} \quad [s]$$

Ta: Acceleration torque
Tb: Deceleration torque
TL: Load torque
Trms: Effective torque
TR: Rated torque
ts: constant speed time(s)

◆ When the cycle time (t) is predetermined Ta, Tb, ta, and tb appropriate in the above formula are required.

* When actually determining the system drive mode, it is recommended to calculate the load margin and suppress it to Trms< $0.8T_R$.

■ When the motor repeats acceleration, deceleration and stop status
In operating status (shown below) the value of permitted repetitions n (times/minutes) is found with the following equation:

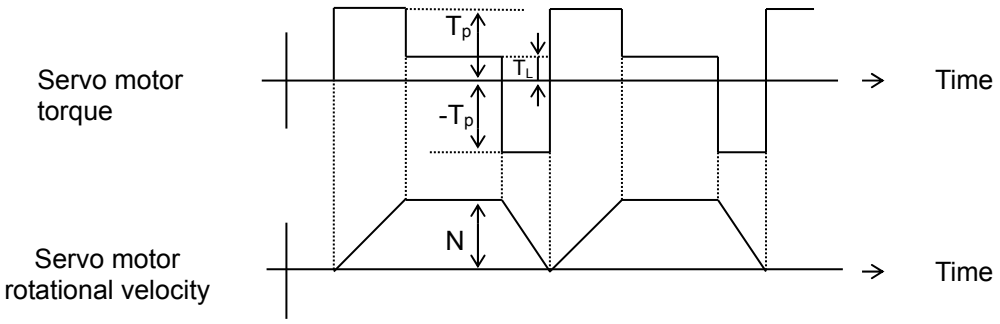



$$n = 2.86 \times 10^2 \times \frac{1}{N(J_M + J_L)} \times \frac{T_P^2 - T_L^2}{T_P^3} \times T_R^2 \quad [\text{times/ min}]$$

$T_P$: Peak Torque at stall (N･m)
$T_R$: Rated torque
N: Motor rotation speed ($min^{-1}$)
$J_M$: Servo motor inertia moment ($kg･m^2$)
$J_L$: Load inertia moment ($kg･m^2$)

# 2. Specifications

■ When the motor repeats acceleration − constant speed operation − deceleration status
For the operating status shown below, the value of permitted repetitions n (times/min) is found in the following equation:




$$n = 2.86 \times 10^2 \times \frac{1}{N(J_M + J_L)} \times \frac{T_R^2 - T_L^2}{T_P} \quad [\text{times/ min}]$$

■ Negative load
Amplifier unit cannot perform continuous operation with a negative load from the servo motor. Please contact us when using the amplifier with a negative load.

Example

- Motor drive downward (when there is no center weight).
- Using like a generator, such as the wind-out spindle of a winder.

■ Load inertia moment (JL)
When the servo amplifier is used with a load inertia moment exceeding the allowable load inertia moment calculated in terms of the motor shaft, “main circuit power over voltage detection” or “regenerative error function” may be issued at the time of the operation.

- ◆ Reduce the torque limit
- ◆ Extend the acceleration and deceleration times (slow down)
- ◆ Reduce the maximum rotation speed
- ◆ Re-examine regenerative resistance

# 2.6 Position signal output

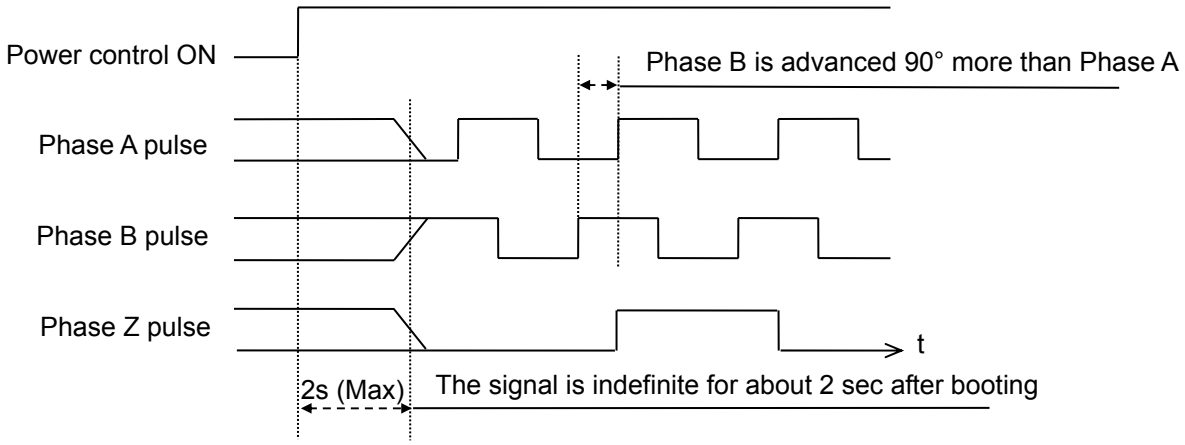
The amplifier unit outputs a pulse signal as position signal.

## 2.6.1 Position signal output from pulse signal

■ Amplifier unit outputs "90° -phase difference two-phase pulse (phase A, phase B) and original phase (phase Z)". Pulse output can change the division ratio by parameter. Set the general parameter "GroupC ID04 Encoder Output Pulse Division [ENRAT]".

* Output signal “A phase pulse output (AO/$\overline{A0}$)” outputs from “CN1-3 pin, 4 pin.”
* Output signal “B phase pulse output (BO/$\overline{B0}$)” outputs from “CN1-5 pin, 6 pin.”
* Output signal “Z phase output (ZO/$\overline{ZO}$)” outputs from “CN1-7 pin, 8 pin.” Also output from CN1-11 pin with open-collector.

■ Output signal under forward rotation




* EnDat (angle encoder, rotary encoder)
  Division ratio will be limited in such a way that a resolution becomes 32,768pulse/rev or more, if into the relation as follows: Single turn resolution x (1/N) < 32,768pulse/rev.

  EnDat (linear encoder)
  Use it in the range as follows: "231 x Resolution/((1/N)x4)" based on position 0.
  (When it move to out of range from in a range and perform cycle power, phase Z output may misaligned.)

  1/N: Selection value in the GroupC ID0C "External encoder output pulse division ratio selection".

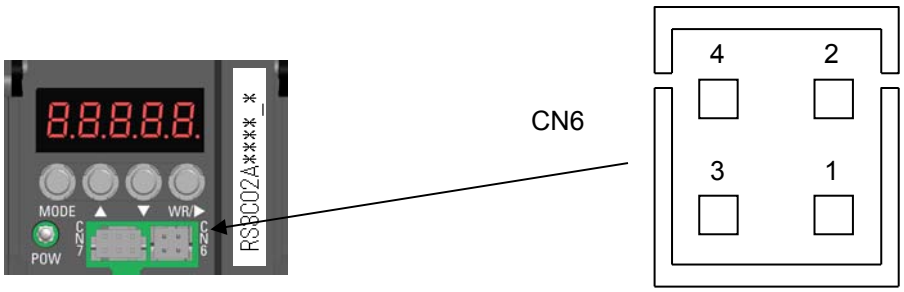
  It is indefinite between 3 seconds from control power establishment.

# 2. Specifications

## 2.7 Specifications for analog monitor

### 2.7.1 Specifications for analog monitor

■ Monitor output




Connector model number on board: DF11-4DP-2DSA(01)
Housing model number on receiving equipment: DF11-4DS-2C
Connector model number on receiving equipment: DF11-2428SCA

| | General input/output connector CN1 | CN6 |
|---|---|---|
| Analog monitor output 1(MON1) | CN1-30 | CN6-3 |
| Analog monitor output 2(MON2) | Disabled | CN6-4 |
| Digital monitor output (DMON) | Disabled | CN6-2 |
| GND | CN1-31 | CN6-1 |

# 2.7 Specifications for analog monitor

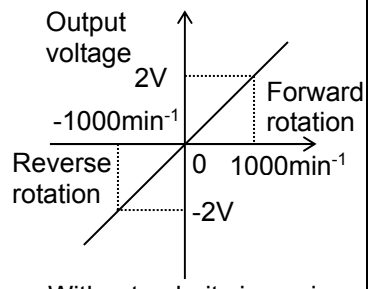
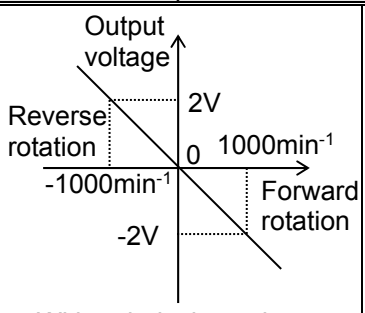
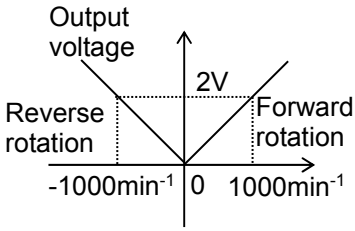
## 2.7.2 Monitor for velocity, torque, and position deviation

■ Electrical specifications
- ◆ Output voltage range: DC±8V
- ◆ Output resistance: 1kΩ
- ◆ Load: less than 2mA

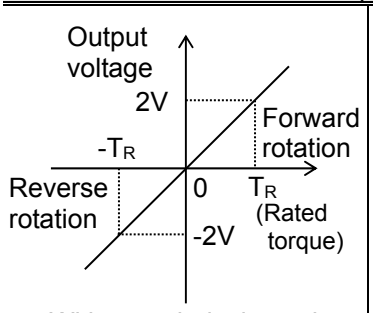
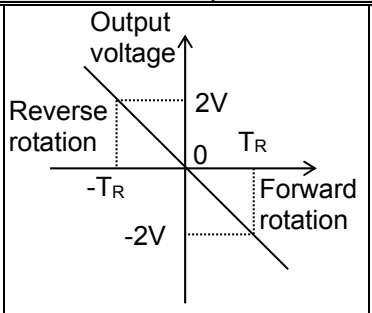
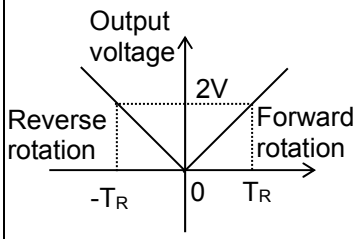
* Monitor output is indefinite at the time of power ON/OFF and may output DC12V+/- around 10%.

* Monitor output polarity can be selected from "+, Without polarity inversion", "-, With polarity inversion", "ABS, Absolute value output". Select from the GroupA ID13: Analog monitor output polarity [MONPOL].

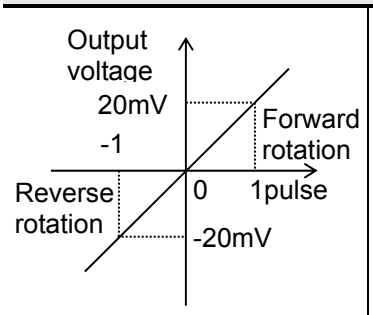
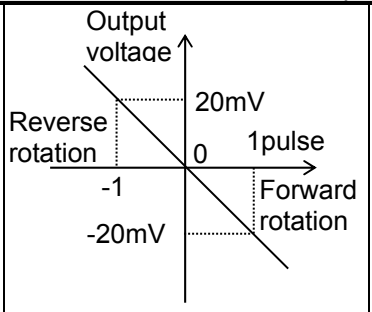
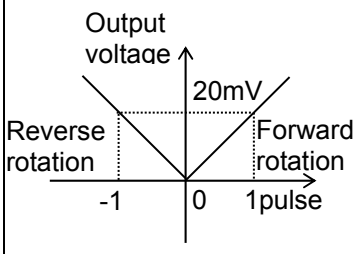
■ Velocity command, velocity monitor

| Speed command, speed monitor output | | |
|---|---|---|
|  |  |  |
| +, Without polarity inversion | -, With polarity inversion | ABS, Absolute value output |

■ Torque command, torque monitor

| Torque command, torque monitor output | | |
|---|---|---|
|  |  |  |
| +, Without polarity inversion | -, With polarity inversion | ABS, Absolute value output |

■ Position deviation monitor

| Position deviation monitor output | | |
|---|---|---|
|  |  |  |
| +, Without polarity inversion | -, With polarity inversion | ABS, Absolute value output |

# 2. Specifications

## 2.8 Specifications for dynamic brake

### 2.8.1 Dynamic brake

- Dynamic brake circuit is not included to amplifier unit RS3D80#.
  Please contact us for external dynamic brake resistor selection.

# 2.9 Regeneration process



Allowable minimum values of external regenerative resistor and allowable regenerative power of regenerative circuit of power unit are shown below. See "11.2 Selection of regenerative resistor" for selection method of regenerative resistor.

## 2.9.1 Minimum values of Built-in/ external regenerative resistor

| Power unit model number | External regenerative resistor |
|---|---|
| RS3PAC550 | 2.4Ω |

* "#" is optional number or alphabetical letter.

## 2.9.2 Allowable regenerative power

| Power unit model number | External regenerative resistor use [PR0] |
|---|---|
| RS3PAC550 | 5000W |

* "#" is optional number or alphabetical letter.

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# 3 Installation

In this chapter, installation of servo amplifier and servo motor are explained.


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# 3. Installation

## 3.1 Amplifier unit

### 3.1.1 Precautions

When installing, please be sure to protect the following precautions.

■ Various precautions

| |
|---|
| The device should be installed on non-flammable surfaces only. Installation on or near flammable materials can cause fire. |
| Do not stand on, or put heavy items on the servo amplifier. |
| Operate the device within the specified environmental conditions. |
| Do not drop the device or subject it to excessive shock. |
| Make sure no screws or other conductive or flammable materials get inside the power unit and amplifier unit. |
| Do not obstruct the air intake and exhaust vents. The mounting direction should be observed strictly. |
| Please contact our office if the power unit and amplifier unit. are to be stored for a period of 3 years or longer. The capacity of the electrolytic capacitors decreases during long-term storage. |
| Any damaged parts or the products which have damaged parts shall be repaired by returning it to our company immediately. |

■ If enclosed in a cabinet

| |
|---|
| The temperature inside the cabinet might exceed the external temperature depending on the power consumption of the device and the size of the cabinet. Consider the cabinet size, cooling, and placement, and make sure the temperature around the power unit/amplifier unit does not exceed 55°C. For longevity and reliability purposes it is recommended to keep the temperature below 40°C. |

■ If there is a vibration source nearby

| |
|---|
| Protect the power unit and amplifier unit from vibration by installing it on a base with a shock absorber. |

■ If there is a heat generator nearby

| |
|---|
| If the ambient temperature might increase by convection or radiation, make sure the temperature near the power unit/amplifier unit does not exceed 55°C. |

■ If corrosive gas is present

| |
|---|
| Long-term use may cause contact failure on the connectors and connecting parts. Never use the device where it may be exposed to corrosive gas. |

■ If explosive or combustible gas is present

| |
|---|
| Never use the device where explosive or combustible gas is present.<br>The device's relays and contactors, regenerative resistors and other parts can generate arc (spark) and can cause fire or explosion. |

■ If dust or oil mist is present

| |
|---|
| The device cannot be used where dust or oil mist is present. If dust or oil mist accumulates on the device, it can cause insulation deterioration or leakage between the conductive parts, and damage the power unit/amplifier unit. |

■ If a large noise source is present

| |
|---|
| If inductive noise enters the input signals or the power circuit, it can cause a malfunction. If there is a possibility of noise, inspect the line wiring and take appropriate noise prevention measures. A noise filter should be installed before the power unit. |

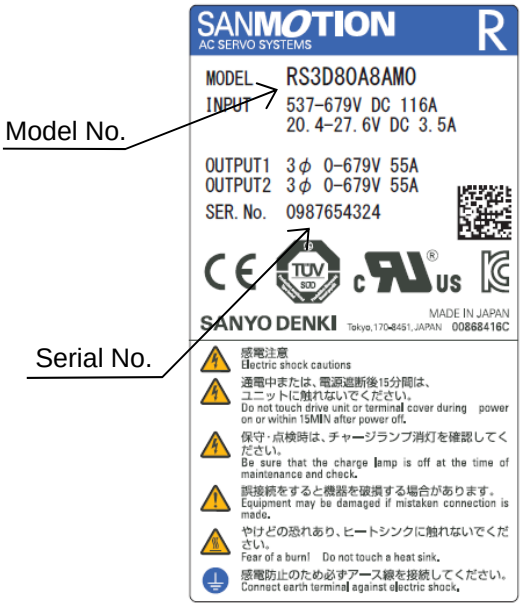
## 3.1.2 Unpacking

Verify the followings when the product arrives. If you find any discrepancy, contact your distributor or sales office.

- Verify that the model number of the power unit and amplifier unit are the same as ordered. The model number is located on the main nameplate, following the word “MODEL”.
- Verify that there is no problem in the appearance of power unit and amplifier unit.
- Verify that there are no loose screws on the power unit and amplifier unit.



Example of amplifier unit main nameplate



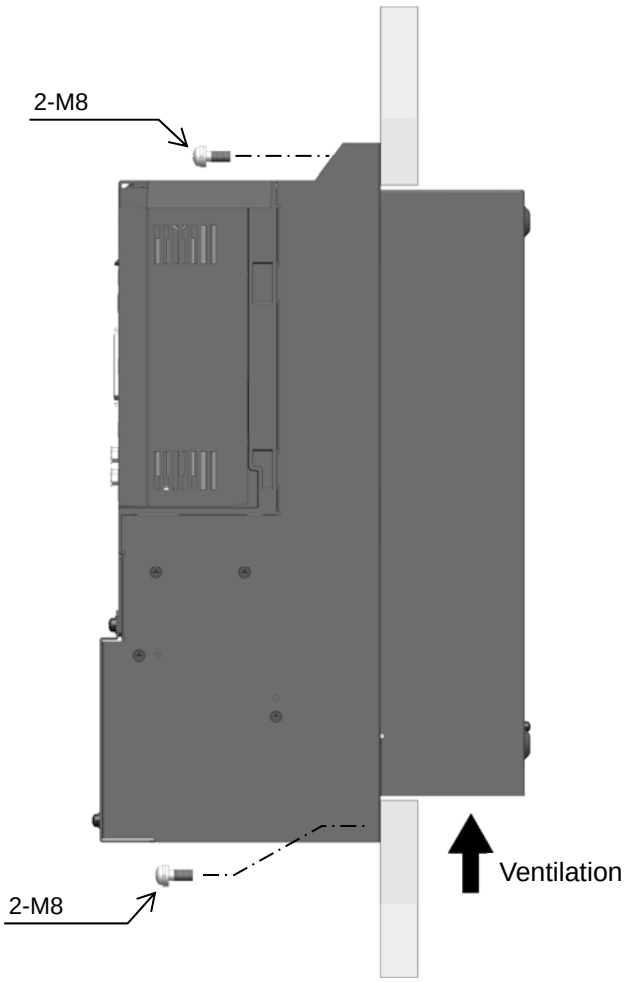

Amplifier unit

Interpretation of the serial number
Month (2-digit) + Year (2-digit) + Day (2-digit) + Serial number (4-digit) + Revision ("A" abbreviated)

# 3. Installation

## 3.1.3 Mounting direction and location

RS3PAC550
RS3D80#

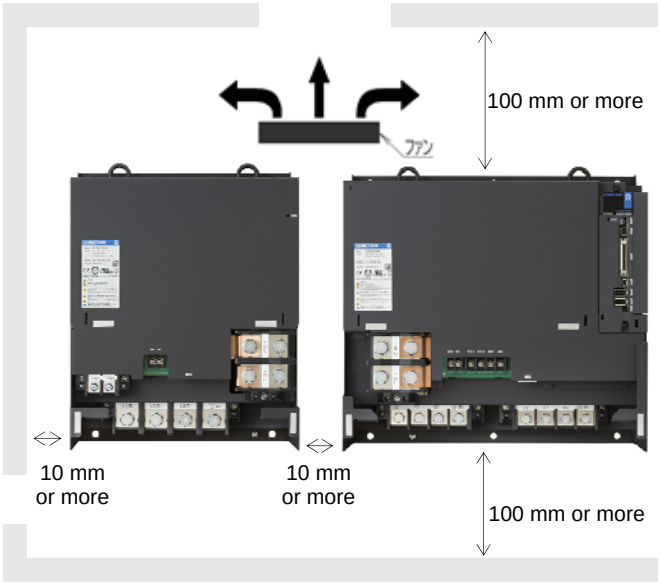


### 3.1.4 Arrangement within the cabinet

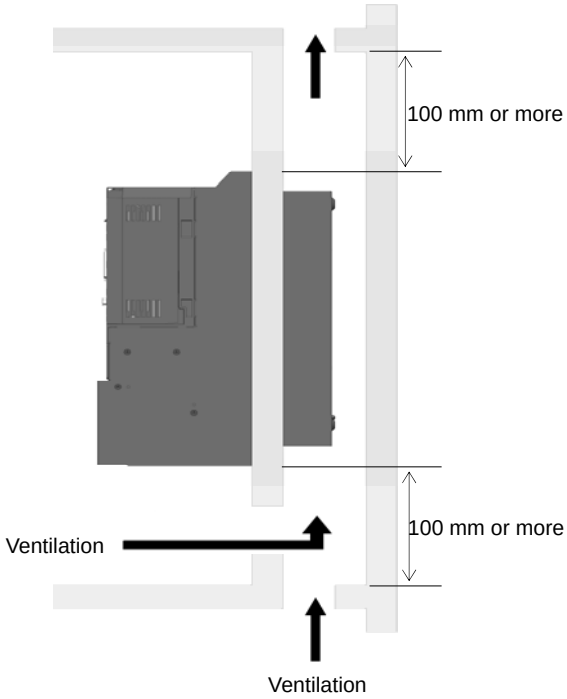
- Leave at least 100 mm space above and below the power unit/amplifier unit to ensure unobstructed airflow from the inside of the power unit/amplifier unit and the radiator. If heat gets trapped around the power unit/amplifier unit, use a cooling fan to create airflow.
- Make sure the temperature around the power unit/amplifier unit does not exceed 55°C. For longevity and reliability purposes it is recommended to keep the temperature below 40°C.
- Leave at least 10 mm space on both sides of the power unit/amplifier unit to ensure unobstructed airflow from the heat sinks on the side and from the inside of the power unit/amplifier unit.



Front view




Side view




* Arrangement above is order of RS3PAC550 and RS3D80# from left side.

# 3. Installation

## 3.2 Servo motor

### 3.2.1 Precautions

■ Various precautions

| |
|---|
| The device should be installed on non-flammable surfaces only. Installation on or near flammable materials can cause fire. |
| Do not stand on, or put heavy items on the servo amplifier. |
| Operate the device within the specified environmental conditions. |
| Do not drop the device or subject it to excessive shock. |
| The mounting instruction should be followed strictly. |
| Any damaged parts or the products which have damaged parts shall be repaired by returning it to our company immediately. |
| Please contact us for long-term period storage (for 3 years or more). |

### 3.2.2 Unpacking

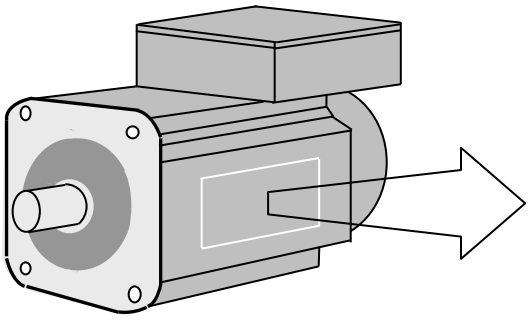
Verify the followings when the product arrives. If you find any discrepancy, contact your distributor or sales office.

■ Verify that the model number of the servo motor is the same as ordered.
The model number is located on the main nameplate, following the word “MODEL”.

■ Verify that there is no problem in the appearance of servo motor.

■ Verify that there are no loose screws on the servo motor.

Servo motor



Servo motor main nameplate

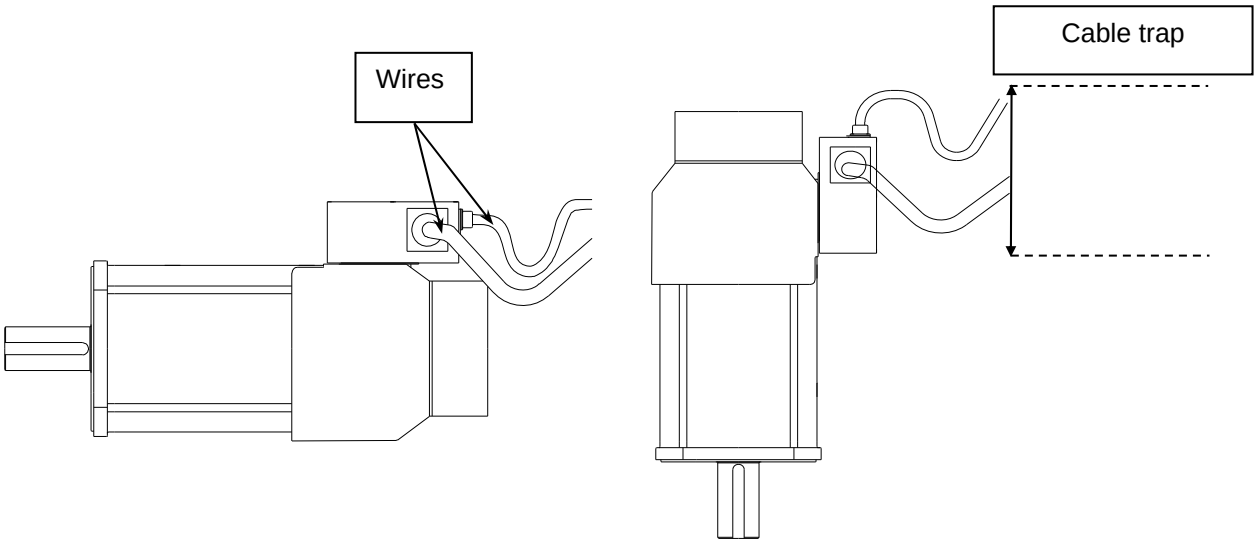
### 3.2.3 Installation

Please note the following regarding the installation location and mounting method.

| | |
|---|---|
| The servo motor is designed for indoor use. Make sure to Install it indoors. | |
| Do not use the device in locations where the oil seal lip is continuously exposed to oil, or where the device is exposed to large quantities of water, oil drops, or cutting fluid. The motor is designed to withstand only small amounts of moisture spray. | |
| Ambient temperature: 0 to 40°C<br>Storage temperature: -20 to 65°C<br>Ambient humidity: 20 to 90% | Good ventilation, no corrosive or explosive gases present.<br>No dust or dirt accumulation in the environment.<br>Easy access for inspection and cleaning. |

## 3.2.4 Mounting method

- Mounting in several orientations are acceptable as horizontal, or upper side/bottom side of the shaft end.
- If the output shaft is used in reduction devices that use grease, oil, or other lubricants, or in mechanisms exposed to liquids, the motor shaft should be installed in a perfectly horizontal or downward position. There is an oil-seal attached to the output shaft. If the shaft is facing upwards and the seal lip is continuously exposed to oil, oil can enter inside the motor and cause damage, as a result of wear and degradation of the oil seal. In such cases an oil seal should be used on the load-side as well. Contact your distributor or sales office if the device is to be used in such conditions.
- At an installation, create a cable trap to prevent oily water from getting into the motor.



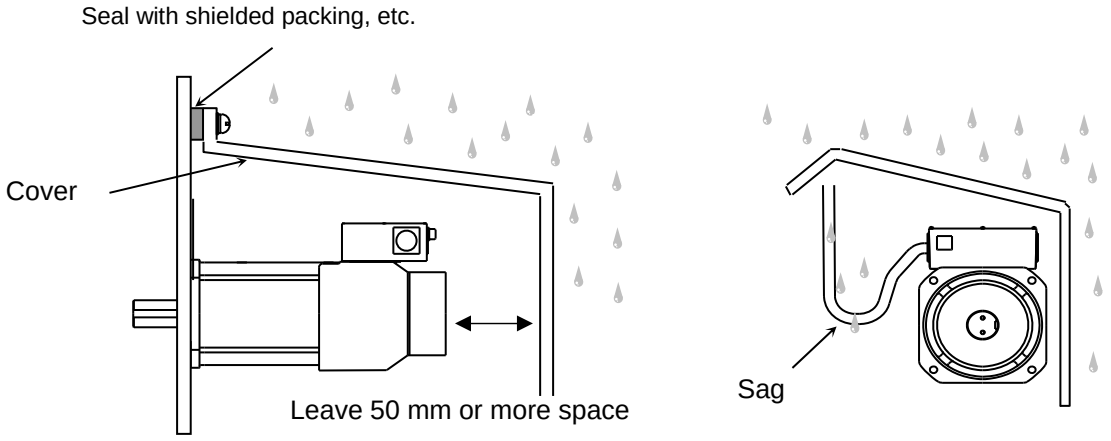

## 3.2.5 Waterproofing and dust proofing

- The protection inside the motor conforms to IEC standards (IEC60034-5). However, such protection is suitable only for short-term use. For regular use, additional sealing measures are required. Be sure to handle the connector carefully, as damage to the exterior of the connector (painted surface) can reduce its waterproofing capability.
- For terminal box working part, add waterproof/dustproof item by customer, if required.
- Install a protective cover to prevent corrosion of the coating and the sealing material, which can be caused by certain types of coolants (especially water soluble types).

# 3. Installation

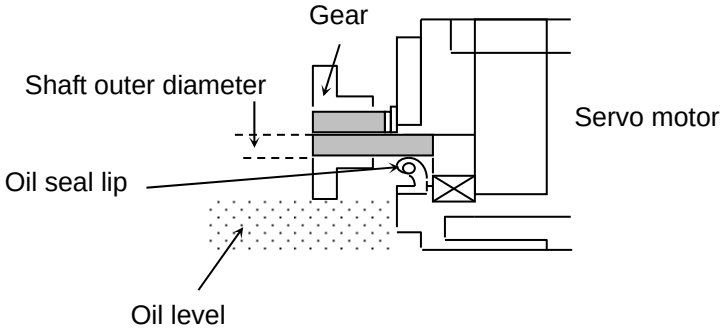
## 3.2.6 Protective cover installation

- Install a protective cover (as described below) for motors continuously subjected to liquids.
- Install the cover on the side where the water or oil would drip.
- Install the cover with slant (for runoff), to prevent water or oil from collecting.
- Make sure that the cable does not get soaked in water or oil.
- Create a sag in the cable outside the cover, to make sure water or oil does not penetrate to the motor.
- In case that lead outlet directs to up or side, create a sag with cables to prevent intrusion of water/oil.
- Cover shall be left 50 mm or more from fan motor.



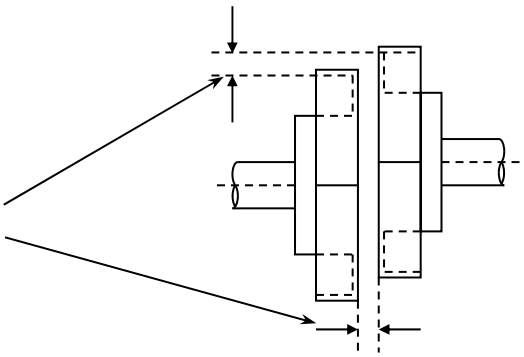

## 3.2.7 Gear installation and Integration with the target machinery

- The oil level of the gear box should be below the oil seal lip, for a slight spraying effect on the lip.
- Create a hole to prevent pressure build-up inside the gear box, as pressure can cause water or oil to penetrate the oil seal and enter inside the motor.
- If the motor is used with the shaft facing upwards, an oil seal should be used on the opposite side of the mechanism as well. In addition, install a drain to expel the water or oil that may penetrate through this oil seal.

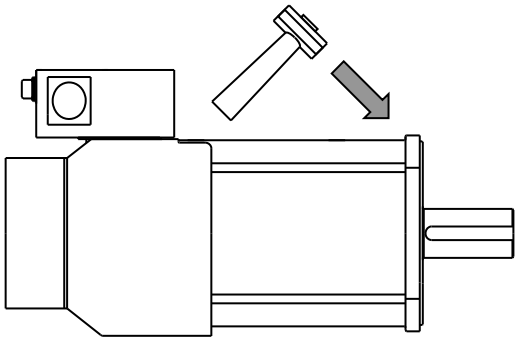


■ Refer to the drawing below for correct centering of the motor shaft and the target machinery. Please note when using a rigid coupling that even a slight mistake in centering can damage the output shaft.

Measured at all 4 locations, the difference between the maximum and the minimum should not exceed 3/100mm.
(coupling rotates jointly)

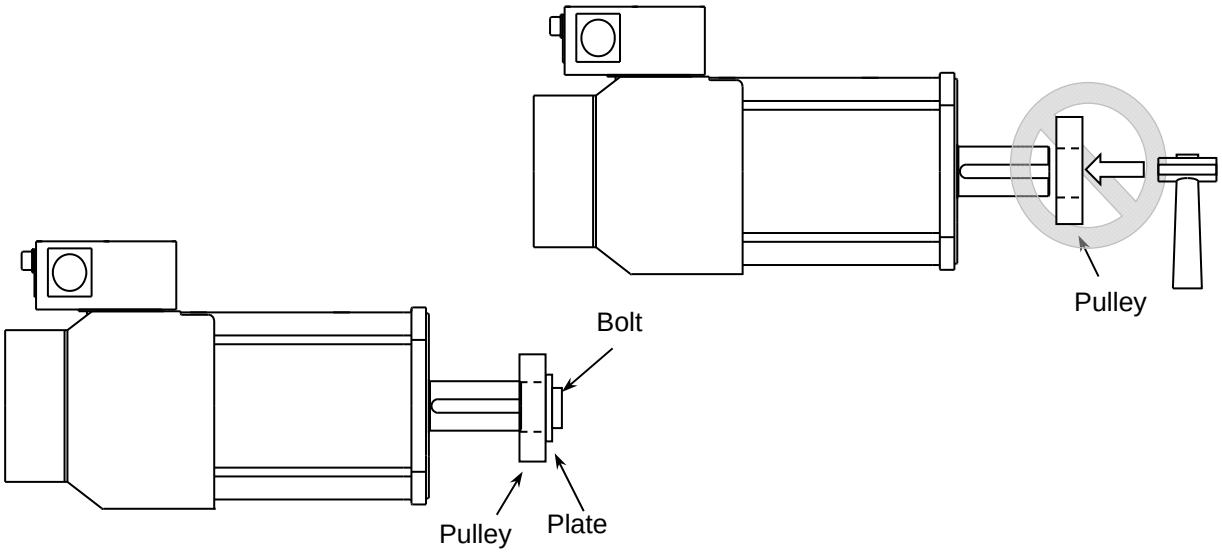


■ Do not apply any shocks on the servo motor shaft because precision equipment, encoder is directly connected to it. If it is absolutely necessary to hit the motor for position adjustment or other reasons, use a rubber or plastic hammer and hit the front flange area.

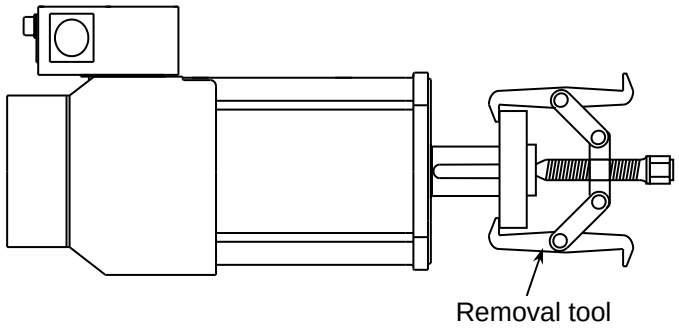


■ For mounting to a machine, create accurate enough mounting holes for smooth coupling of the motor flange rabbet. The mounting surface should be flat, otherwise damage to the shaft or the load may occur.

■ Use the screw at the end of the shaft for installing parts such as the gear, pulley, or coupling, to avoid shock.



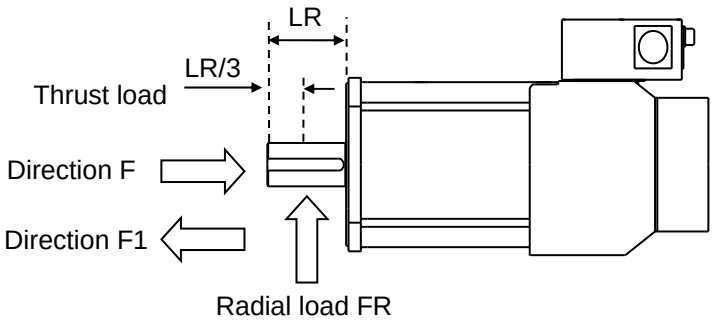
■ Use a special tool for removing the gear, pulley, etc.




## 3.2.8 Allowable bearing load

■ The table below shows the allowable bearing load of the servo motors. Do not apply excessive thrust load or radial load. In case of belt driving, make sure that the shaft converted value of belt tension does not exceed the allowable values shown below. The thrust load and radial load tolerance values assume individual application to the shaft.

The radial load tolerance value is the maximum load that can be applied at the point measured 1/3 of the distance from the tip of the output shaft.




| Servo motor model number | Assembly | | | Operation | | |
|---|---|---|---|---|---|---|
| | Radial load (N) | Thrust load (N) | | Radial load (N) | Thrust load (N) | |
| | FR | Direction F | Direction F1 | FR | Direction F | Direction F1 |
| R2CA3255KB | 8,500 | 3,400 | 3,400 | 5,900 | 2,000 | 2,000 |

## 3.2.9 Cable installation considerations

■ Be careful not to apply excessive stress and damages onto cables.

■ When installing cables in the place servo motor can move, take sufficient inflective radius so as not to apply excessive stress onto cables.

■ Pass cables through the areas where cable insulators shall not be scratched by sharp cutting debris. Do not pass cables through the areas having possibility that machine corner scrapes against cables, or personnel/machines may tread on cables.

■ Take measures such as clamp to machines so as not to apply flexion stress and own weight stress onto each connecting point of cables. When motor and cables need to be transferred with cableveyor (cable carrier), bending radius of cable shall be determined by referring required flexion life and wire type.

■ Periodic replaceable structure for movable part of cable is recommended. Please contact us when you would like to use recommended cables for movable parts.

# 4 Wiring

In this chapter, wiring between the servo amplifier, servo motor and peripherals are explained.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# 4. Wiring

## 4.1 Wiring for the terminal of high voltage and grounding

### 4.1.1 Part name and function

| Terminal name | Terminal marking | Equipping unit | Remarks |
|---|---|---|---|
| 3-phase main circuit power input terminal | R･S･T | Power unit | 3-phase 380 to 480 VAC +10 %, -15 %, 50/60Hz±3 % |
| Direct current main circuit power terminal | +DC･-DC | Power unit<br>Amplifier unit | 457 to 747 VDC<br>Connects a power unit output to amplifier unit. |
| Servo motor connector | U1･V1･W1<br>U2･V2･W2 | Amplifier unit | Connects 2 systems output to servo motor. |
| Protective grounding terminal | ⏚ | Power unit<br>Amplifier unit | Connected with grounding wire of power supply and of servo motor. |
| Regenerative resistor connector | RB1･RB2 | Power unit | Connects an external regenerative resistor to RB1 and RB2 terminals. |
| Control power terminal | 24V･0V | Power unit<br>Amplifier unit | DC24V ±15% |
| Thermostat connecting terminal | TH1-1･<br>TH1-2 | Amplifier unit | Connects a thermostat (normally-close, b-contact) of external dynamic brake resistor. |
| Dynamic brake contact output terminal | DB1･DB2 | Amplifier unit | The terminal for outputting a contact of magnet switch for external dynamic brake.<br>Contact rating: 5 A, 250 VAC/ 30 VDC (resistance load)<br>Mechanical life: 2 million times<br>Electrical life: Hundred thousand times<br>(Contact rating load, resistance load) |

* When wires are bundled or put into a wire-duct, such as a hardening vinyl pipe or a metallic conduit, take the allowable current reduction ratio into account.

* At high ambient temperature, service life of the wires becomes shorter by heat-related deterioration.
In this case, we recommend using heat-resistant vinyl wires (HIV).

## 4.1.2 Wire

■ Electric wires for use in power unit and amplifier unit main circuit power are shown below.
Wire type

| Kinds of wires | | Conductor allowable temperature [°C] |
|---|---|---|
| Code | Name | |
| PVC | Common vinyl electric wire | – |
| IV | 600V electric wire | 60 |
| HIV | Special heat-resistant vinyl wire | 75 |

* The information in this table is based on rated armature current running through three bundled lead wires at ambient temperature of 40°C.
Use the electric wire beyond voltage resistance 600V.

## 4.1.3 Wire size - allowable current

| Nominal cross-sectional area [$mm^2$] | AWG size | Allowable current over ambient temperature [A] | | |
|---|---|---|---|---|
| | | 30°C | 40°C | 55°C |
| 14.0 | AWG6 | 79.0 | 70.0 | 52.5 |
| 22.0 | AWG4 | 98.0 | 86.2 | 65.7 |
| 38.0 | AWG1 | 138.0 | 121.4 | 92.5 |
| 60.0 | AWG2/0 | 185.0 | 162.8 | 124.0 |

* This is reference value in the case of a special heat-resistant vinyl wire (HIV).
* Electric wire size and allowable current shows in case of a three electric wires bundled.
* Use wire at less than above-mentioned allowable current.

## 4.1.4 Recommended wire size

■ The recommendation electric wire size used for power unit, amplifier unit and servo motors are shown below.

| Servo motor model No. | Motor power (U･V･W･ ⏚ ) | | Combination servo amplifier | Main circuit power supply (R･S･T) | | Control power supply | | Regenerative resistance | | ⏚ | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | $mm^2$ | AWG No | | $mm^2$ | AWG No | $mm^2$ | AWG No | $mm^2$ | AWG No | $mm^2$ | AWG No |
| R2CA3255KB | 22 | 4 | RS3PAC550 RS3D80# | 60 | 2/0 | 1.25 | 16 | 22 | 4 | 50 | 0 |

* The information in this table is based on rated armature current flowing through three bundled lead wires at ambient temperature of 40°C.
* When wires are bundled or put into a wire-duct, take the allowable current reduction ratio into account.
* At high ambient temperature, service life of the wires becomes shorter by heat-related deterioration. In this case, we recommend using heat-resistant vinyl wires (HIV).
* Depending on the servo motor capacity, thinner electric wires than indicated in the above table can be used for the main circuit power terminal.

## 4.1.5 Wiring for servo motor

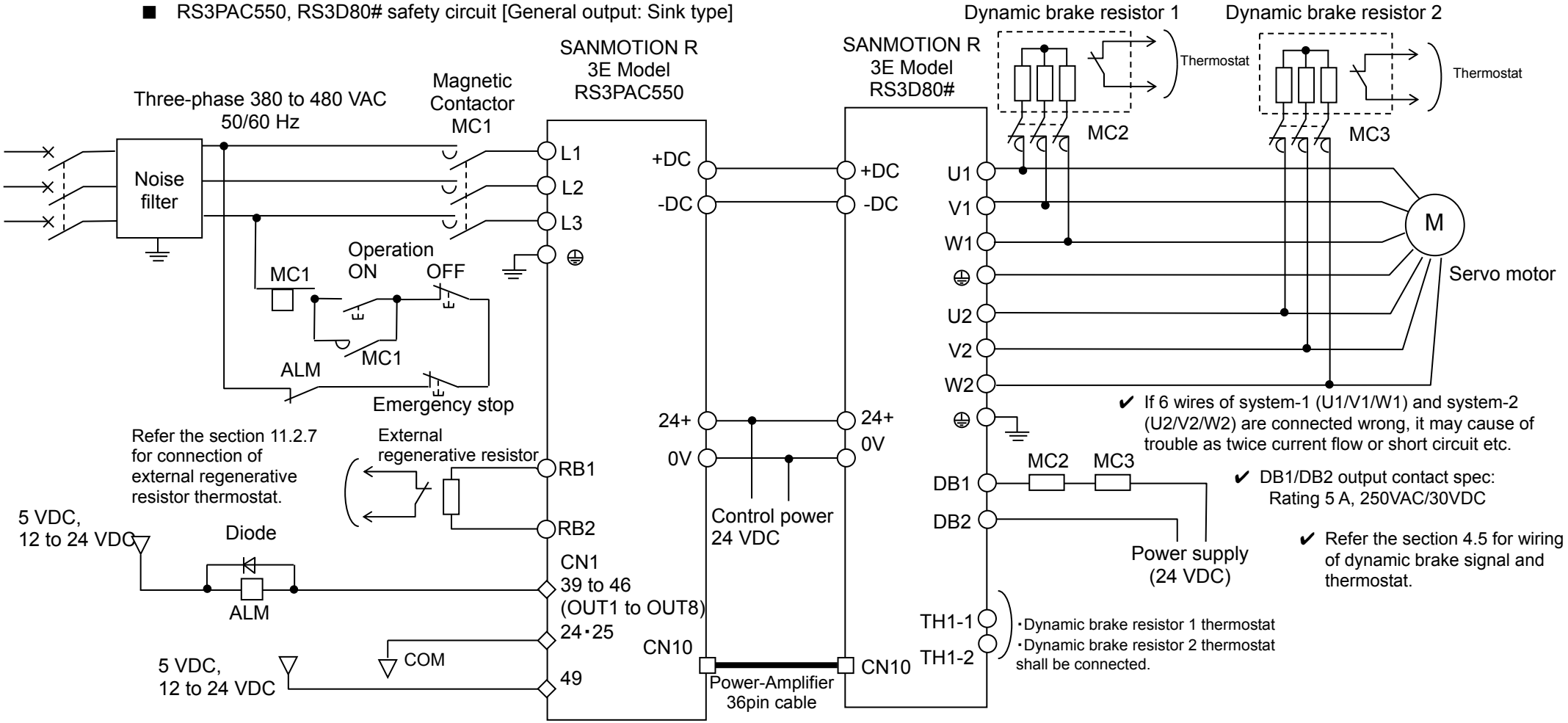
■ For R2CA3255KB, terminal block is used for power cable connection.
Note) There is no specification with brake.

* 200 VAC shall be used to cooling fan power supply.
Recommended wire size for cooling fan is 1.25mm$^2$ (AWG16).
* Contact our sales representative for fan motor power supply except 200 VAC.

## 4.1.6 Example of wiring

Even if it turns off power supply, high-pressure voltage may remain in power unit/amplifier unit. Therefore, do not touch a power supply terminal for 15 minutes for the prevention from an electric shock. Completion of electric discharge turns off the CHARGE LED. Please perform connection check work after checking that the CHARGE LED goes dark.

■ RS3PAC550, RS3D80# safety circuit [General output: Sink type]

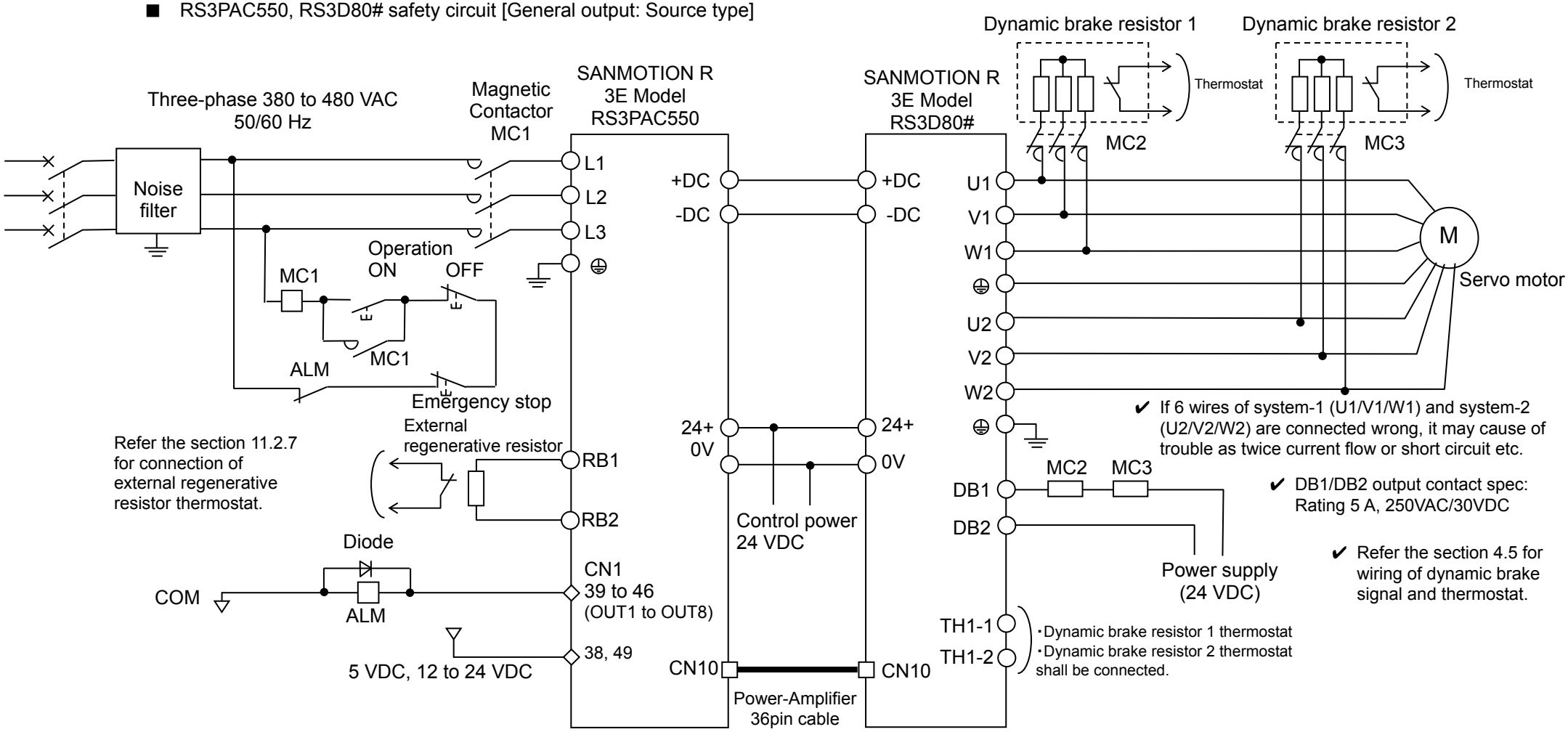



* For ALM contact of safety circuit, use one of the outputs from CN1- 39 to 46 (OUT1 to OUT8) as alarm signal by setting either During ALM status output ON or During ALM status output OFF at the selection setting of Group A “General output terminal output condition" (5-113).

* Must add the surge absorbing diode to if inductive load as relay connect to CN1- 39 to 46 (OUT1 to OUT8).
Please take care of polarity of the diode that will be cause of each unit failure.

# 4. Wiring

■ RS3PAC550, RS3D80# safety circuit [General output: Source type]

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* Must add the surge absorbing diode to if inductive load as relay connect to CN1- 39 to 46 (OUT1 to OUT8).
Please take care of polarity of the diode that will be cause of each unit failure.

## 4.1.7 Tightening torque

| | Terminal marking | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Unit model number | U1 | V1 | W1 | U2 | V2 | W2 | ⏚ | FU | FV | FW |
| R2CA3255KB | Motor terminal block [4.9N·m] M6 (screw size) | | | | | | Ground [23N·m] M10 (screw size) | Fan terminal block [1.2 N·m] M4 (screw size) | | |

| | Terminal marking | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Unit model number | R | S | T | ⏚ | RB1 | RB2 | 24V | 0V |
| RS3PAC550 | [12.0 N·m] M10 (screw size) | | | | [3.0 N·m] M6 (screw size) | | [1.2 N·m] M4 (screw size) | |

| | Terminal marking | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Unit model number | U1 | V1 | W1 | ⏚ | U2 | V2 | W2 | ⏚ | 24V | 0V | TH1-1 | TH1-2 | DB1 | DB2 |
| RS3D80# | [9.0 N·m] M8 (screw size) | | | | | | | [1.2 N·m] M4 (screw size) | | | | | | |

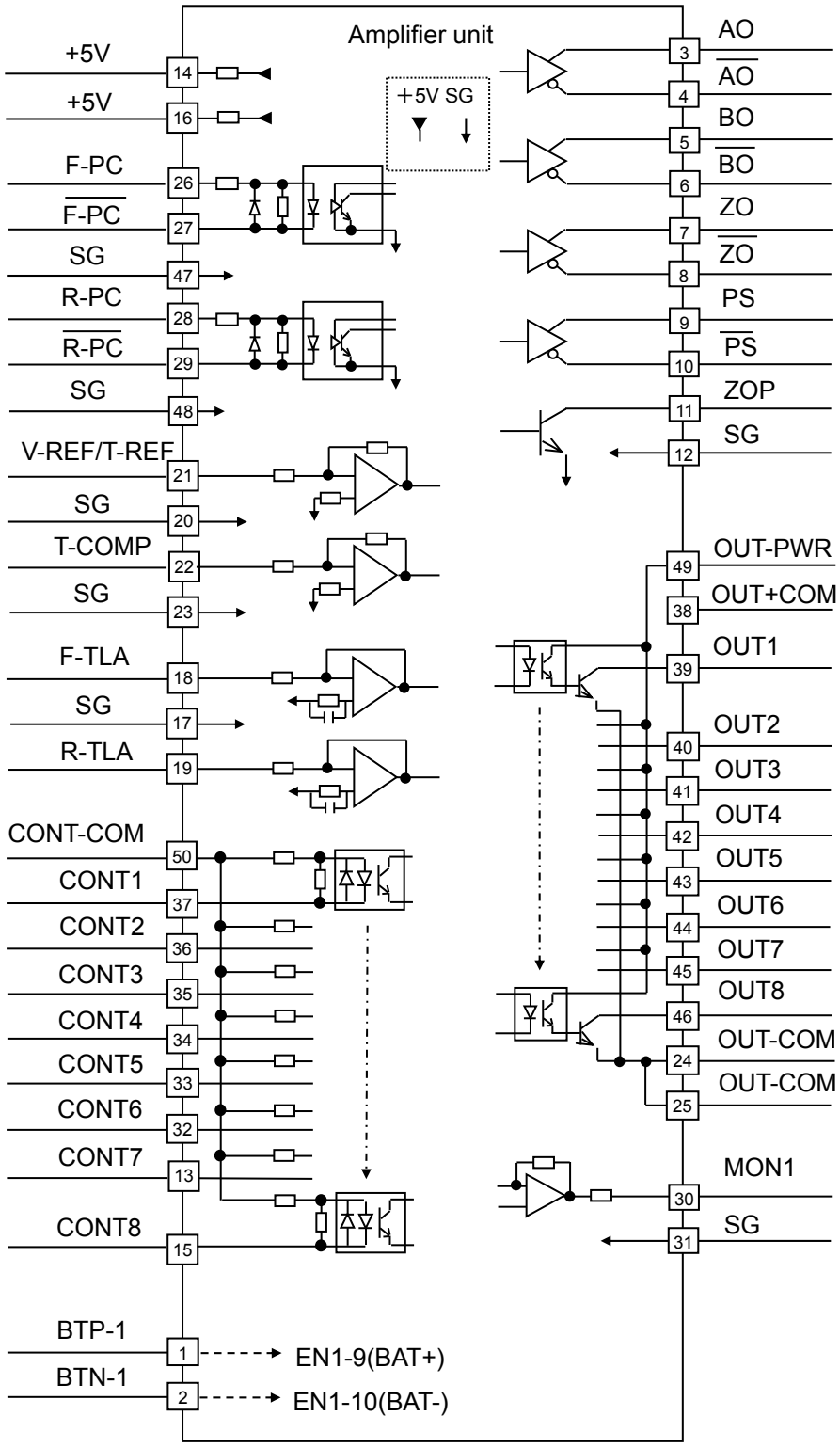
* " # " will be any number or alphabet.

# 4. Wiring

## 4.2 Wiring with Host Unit

### 4.2.1 CN1 signal name and pin number (wiring with host unit)

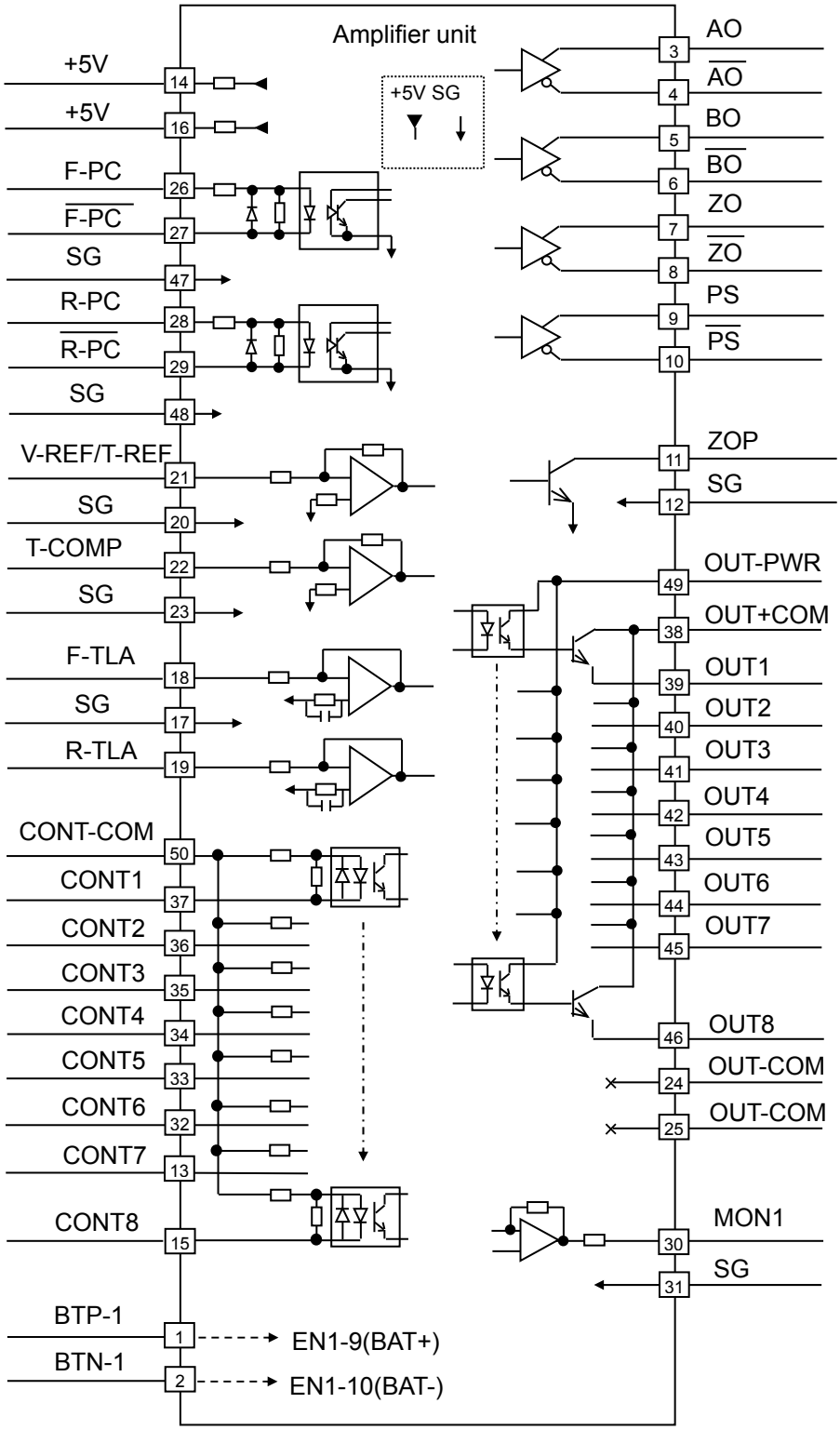
■ CN1 terminal sequence [General output: Sink type output]




* Please check "1.1.3 Cautions for replacement from "SANMOTION R" for replacement from previous product (RS1).

* The wiring of CN1 use a twisted pair shield cable.

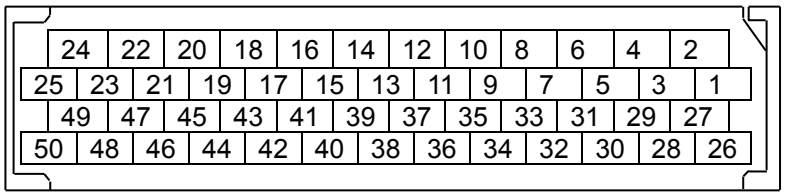
■ CN1 terminal sequence [General output: Source type output]




* Please check "1.1.3 Cautions for replacement from "SANMOTION R" for replacement from previous product (RS1).
* The wiring of CN1 use a twisted pair shield cable.
* ZOP signal is sink type output even if general outputs are used as source type.

## 4.2.2 CN1 pin assignment

■ CN1 10150-3000PE (Soldered side)




## 4.2.3 Signal name and its function

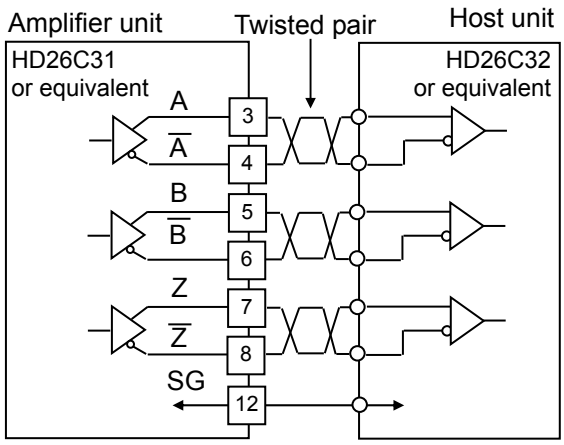
| Terminal number | Signal name | Description |
|---|---|---|
| 1 | BTP-1 | Battery plus |
| 2 | BTN-1 | Battery minus |
| 3 | AO | A phase pulse output |
| 4 | $\overline{AO}$ | /A phase pulse output |
| 5 | BO | B phase pulse output |
| 6 | $\overline{BO}$ | /B phase pulse output |
| 7 | ZO | Z phase pulse output |
| 8 | $\overline{ZO}$ | /Z phase pulse output |
| 9 | PS | Encoder signal output |
| 10 | $\overline{PS}$ | /Encoder signal output |
| 11 | ZOP | Z phase pulse output |
| 12 | SG | Common for pins 3 to 11 |
| 17 | SG | Common for pins 18, 19 |
| 18 | F-TLA | Forward side torque limitation input |
| 19 | R-TLA | Reverse side torque limitation input |
| 20 | SG | Common for pin 21 |
| 21 | V-REF | Velocity command input |
| | T-REF | Torque command input |
| 22 | T-COMP | Torque compensation input |
| 23 | SG | Common for pin 22 |
| 14 | PC-PWR | Internal power for command pulse |
| 16 | PC-PWR | Internal power for command pulse |
| 26 | F-PC | Command pulse input |
| 27 | $\overline{F\text{-}PC}$ | Command pulse input |
| 28 | R-PC | Command pulse input |
| 29 | $\overline{R\text{-}PC}$ | Command pulse input |
| 47 | SG | Common for pins 26, 27 |
| 48 | SG | Common for pins 28, 29 |

| Terminal number | Signal name | Description |
|---|---|---|
| 30 | MON1 | Analog monitor output |
| 31 | SG | Common for pin 30 |
| 15 | CONT8 | General input |
| 13 | CONT7 | General input |
| 32 | CONT6 | General input |
| 33 | CONT5 | General input |
| 34 | CONT4 | General input |
| 35 | CONT3 | General input |
| 36 | CONT2 | General input |
| 37 | CONT1 | General input |
| 50 | CONT-COM | For general input power supply |
| 39 | OUT1 | General output |
| 40 | OUT2 | General output |
| 41 | OUT3 | General output |
| 42 | OUT4 | General output |
| 43 | OUT5 | General output |
| 44 | OUT6 | General output |
| 45 | OUT7 | General output |
| 46 | OUT8 | General output |
| 49 | OUT-PWR | Power supply for general output circuit |
| 38 Note 1) | OUT+COM | Common for general output plus |
| 24 Note 2) | OUT-COM | Common for general output minus |
| 25 Note 2) | OUT-COM | Common for general output minus |

Note 1) 38: OUT+COM will be NC in case of sink type, general output.
Note 2) 24 and 25: OUT-COM will be NC in case of source type, general output.

## 4.2.4 Terminal connection circuit

■ Encoder signal output: A, B, Z
Outputting Signal: A, B and origin Z of motor or external encoder. Connect with a line receiver.

| Terminal No. | Symbol | Name | Description |
|---|---|---|---|
| 3 | AO | A phase pulse output |  |
| 4 | $\overline{AO}$ | /A phase pulse output | |
| 5 | BO | B phase pulse output | |
| 6 | $\overline{BO}$ | /B phase pulse output | |
| 7 | ZO | Z phase pulse output | |
| 8 | $\overline{ZO}$ | /Z phase pulse output | |
| 12 | SG | Common for pins 3 to 11 | |

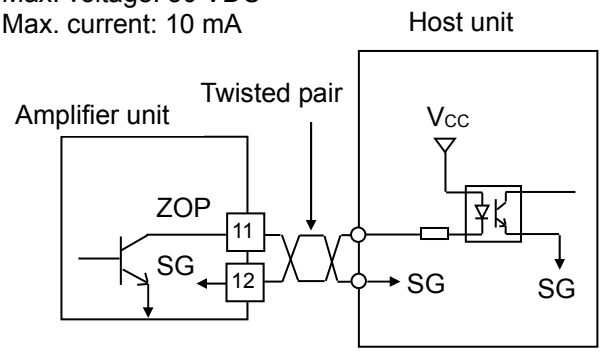


* Make sure to connect SG.

# 4. Wiring

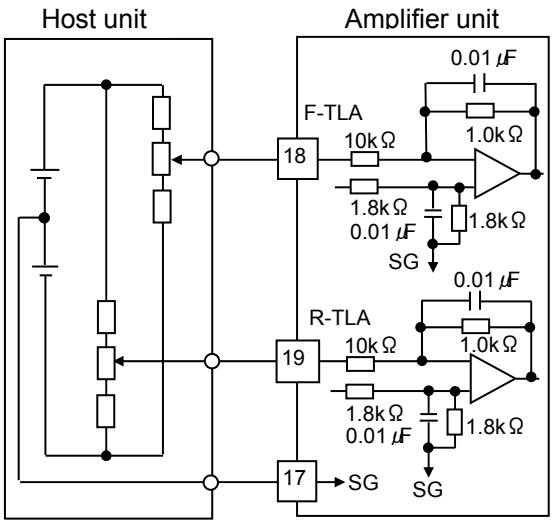
■ Encoder signal output: Z phase pulse, open collector
The origin Z phase pulse of a motor encoder is output by open collector.

◆ Sink type open collector output

| Terminal No. | Symbol | Name | Description |
|---|---|---|---|
| 11 | ZOP | Z phase pulse output | [Circuit spec.]<br>Max. voltage: 30 VDC<br>Max. current: 10 mA<br>  |
| 12 | SG | Common for pins 3 to 11 | |

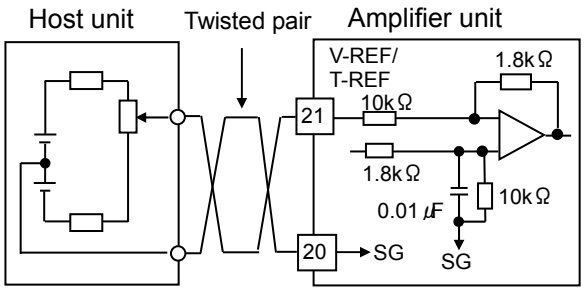
* Make sure to connect SG.
* Source type open collector output is not available.

■ Torque limit input
Forward and reverse side torque is restricted on external analog voltage.

| Terminal No. | Symbol | Name | Description |
|---|---|---|---|
| 18 | F-TLA | Forward side torque limit input | [Circuit spec.]<br>Input voltage range -10 V to +10 V<br>Input impedance: about 10k Ω<br>  |
| 19 | R-TLA | Reverse side torque limit input | |
| 17 | SG | Common for pins 18, 19 | |

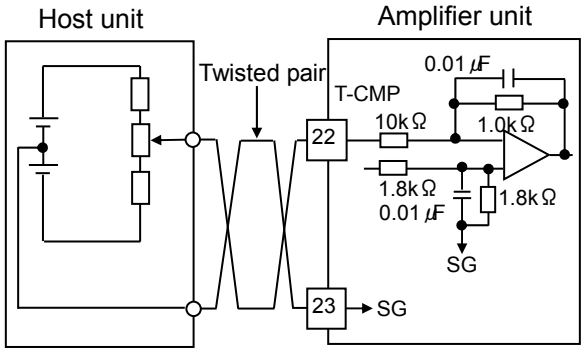
* Make sure to connect SG.

■ Analog command input
Inputting velocity addition command of position control, velocity command of velocity control and torque command of torque control, by analog voltage.

| Terminal No. | Control type | Symbol | Name | Description |
|---|---|---|---|---|
| 21 | Position | V-REF | Velocity addition command input | [Circuit spec.]<br>Maximum allowable input voltage is ±10 V.<br>Input impedance is about 10k Ω<br>  |
| | Velocity | V-REF | Velocity command input | |
| | Torque | T-REF | Torque command input | |
| 20 | Velocity, Torque | SG | Common for pins 21 | |

* Make sure to connect SG.

■ Torque compensation input
Inputting torque compensation value (position or velocity control only) by analog voltage.

<table>
<tr><th>Terminal No.</th><th>Symbol</th><th>Name</th><th>Description</th></tr>
<tr><td>22</td><td>T-COMP</td><td>Torque compensation input</td><td rowspan="2">[Circuit spec.]<br>Maximum allowable input voltage is ±10 V.<br>Input impedance is about 10k Ω<br> 
</td></tr>
<tr><td>23</td><td>SG</td><td>Common for pins 22</td></tr>
</table>

* Make sure to connect SG.

■ Command pulse input
For inputting position command pulse of position control.

[Command pulse input type]
Command pulse input type is able to choose from 3 types below.

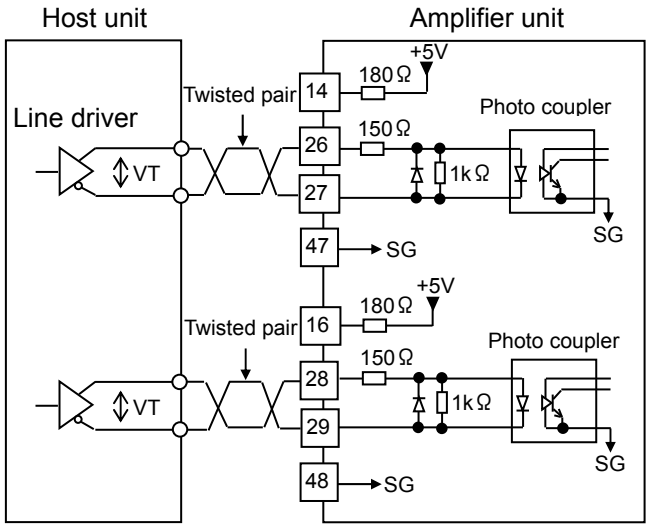
| Command pulse input type | Maximum frequency of input pulse |
|---|---|
| Forward pulse and Reverse pulse | 4 M Pulse/s |
| Pulse and Direction code | 4 M Pulse/s |
| 90 degree phase difference pulses | 1 M Pulse/s |

* When used in the Pulse and Direction code, connect the code to F-PC, and the pulse to R-PC. Refer the section 2.3.2, for detail of command pulse input.

[Command pulse output circuit]
Command pulse which outputted from host unit is able to choose from 3 types, Differential line driver, Sink type open collector and Source type open collector.

◆ For Differential line driver

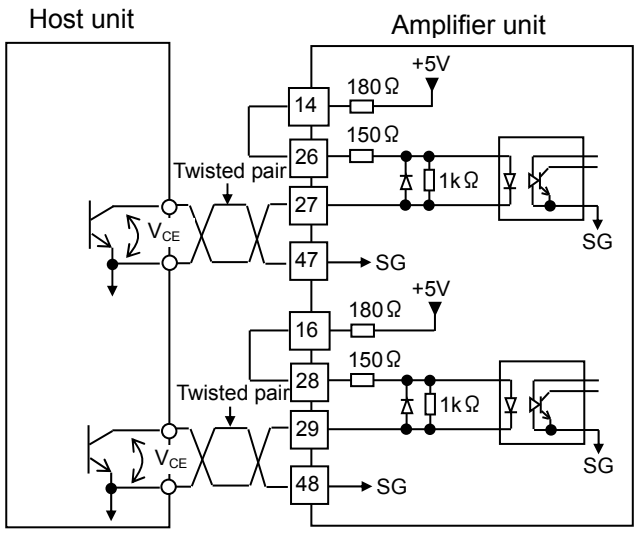
| Terminal No. | Symbol | Name | Description |
|---|---|---|---|
| 26 | F-PC | Command pulse input | [Differential line driver spec.]<br>Choose host unit side line driver which has differential output voltage(VT) range: 2.5 to 3.8 V. |
| 27 | $\overline{\text{F-PC}}$ | Command pulse input | |
| 47 | SG | Common for pins 26, 27 | |
| 28 | R-PC | Command pulse input | |
| 29 | $\overline{\text{R-PC}}$ | Command pulse input | |
| 48 | SG | Common for pins 28, 29 | |




* It will be cause of wrong operation by pulse missing or circuit failure when differential output voltage (VT) is less than 2.5 V or more than 3.8 V.

# 4. Wiring

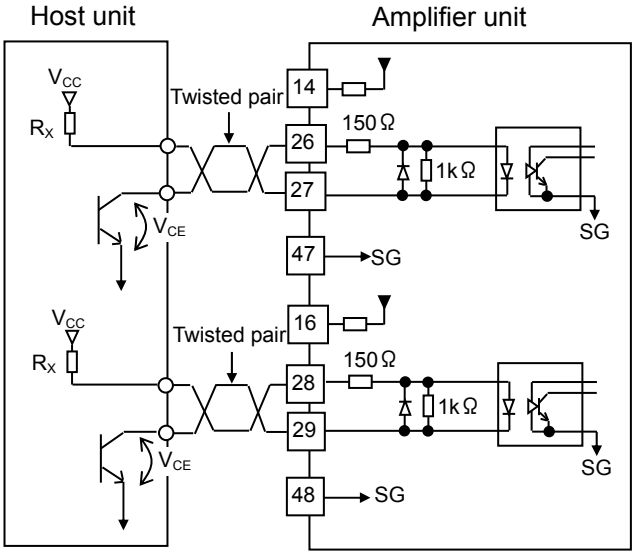
◆ For Sink type open collector (Internal power source is used)

| Terminal No. | Symbol | Name | Description |
|---|---|---|---|
| 26 | F-PC | Command pulse input | [Output transistor spec.]<br>Choose host unit side transistor which has collector-emitter voltage ($V_{CE}$) range: less than 1.5 V.<br>  |
| 27 | $\overline{\text{F-PC}}$ | Command pulse input | |
| 14 | PC-PWR | Internal power for command pulse | |
| 47 | SG | Common for pins 26, 27 | |
| 28 | R-PC | Command pulse input | |
| 29 | $\overline{\text{R-PC}}$ | Command pulse input | |
| 16 | PC-PWR | Internal power for command pulse | |
| 48 | SG | Common for pins 28, 29 | |

* It will be cause of wrong operation by pulse missing or circuit failure when collector-emitter voltage ($V_{CE}$) of a transistor in host unit is more than 1.5 V.

* Make sure to connect SG.

◆ For Sink type open collector (External power source is used)

| Terminal No. | Symbol | Name | Description |
|---|---|---|---|
| 26 | F-PC | Command pulse input | [Pull up resistance spec.]<br>Choose pull up resistance ($R_X$) from table below with depending to power supply voltage ($V_{CC}$) to keep range of input current to amplifier unit: 3.8 to 15 mA.<br>External power($V_{CC}$) / Pull up resistance ($R_X$)<br>5 V±5 % / 100 to 180 Ω<br>12 V±5 % / 590 to 1.5k Ω<br>24 V±5 % / 1.8k to 3.9k Ω<br><br>[Output transistor spec.]<br>Choose host unit side transistor which has collector-emitter voltage ($V_{CE}$) range: less than 1.5 V.<br>  |
| 27 | $\overline{\text{F-PC}}$ | Command pulse input | |
| 47 | SG | Common for pins 26, 27 | |
| 28 | R-PC | Command pulse input | |
| 29 | $\overline{\text{R-PC}}$ | Command pulse input | |
| 48 | SG | Common for pins 28, 29 | |

* It will be cause of wrong operation by pulse missing or circuit failure when input current to amplifier unit is less than 3.8 mA or more than 15 mA.

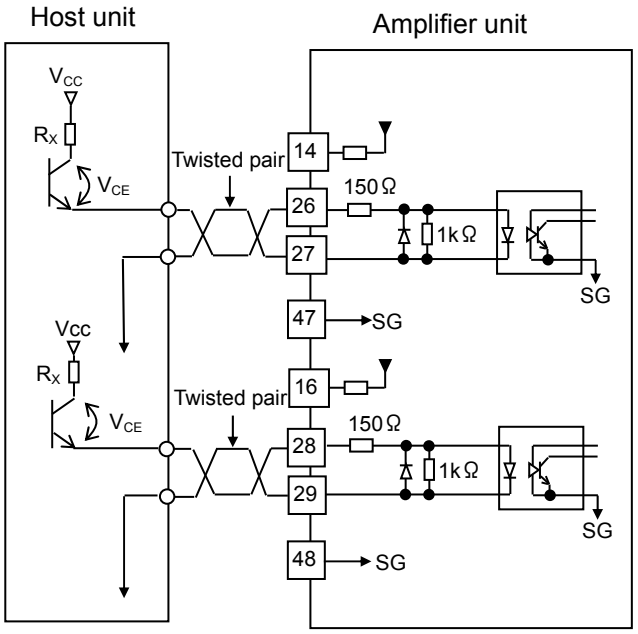
* It will be cause of wrong operation by pulse missing or circuit failure when collector-emitter voltage ($V_{CE}$) of a transistor in host unit is more than 1.5 V.

# 4. Wiring

◆ For Source type open collector (External power source only)

| Terminal No. | Symbol | Name | Description |
|---|---|---|---|
| 26 | F-PC | Command pulse input | [Pull up resistance spec.]<br>Choose pull up resistance ($R_X$) from table below with depending to power supply voltage ($V_{CC}$) to keep range of input current to amplifier unit: 3.8 to 15 mA |
| 27 | $\overline{\text{F-PC}}$ | Command pulse input | |
| 47 | SG | Common for pins 26, 27 | [Output transistor spec.]<br>Choose host unit side transistor which has collector-emitter voltage ($V_{CE}$) range: less than 1.5 V. |
| 28 | R-PC | Command pulse input | |
| 29 | $\overline{\text{R-PC}}$ | Command pulse input | |
| 48 | SG | Common for pins 28, 29 | |

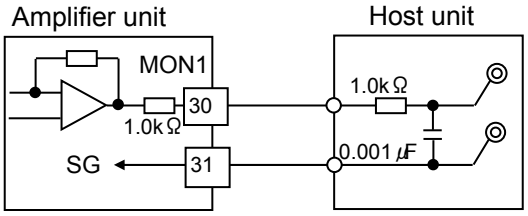
| External power ($V_{CC}$) | Pull up resistance ($R_X$) |
|---|---|
| 5 V±5 % | 100 to 180 Ω |
| 12 V±5 % | 590 to 1.5k Ω |
| 24 V±5 % | 1.8k to 3.9k Ω |



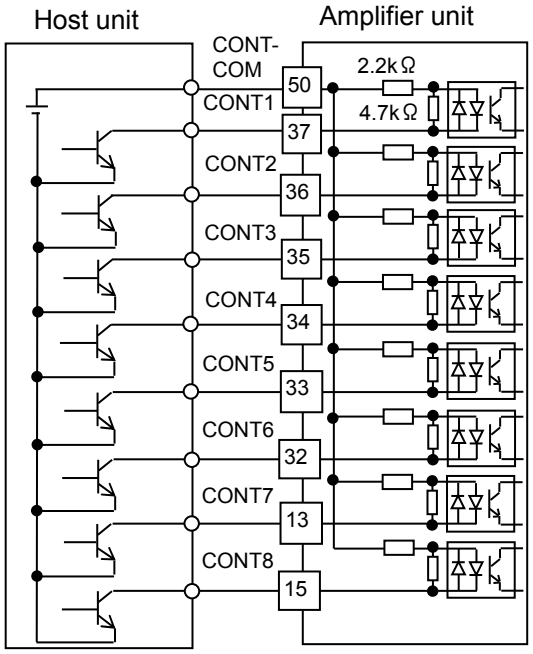

* It will be cause of wrong operation by pulse missing or circuit failure when input current to amplifier unit is less than 3.8 mA or more than 15 mA.

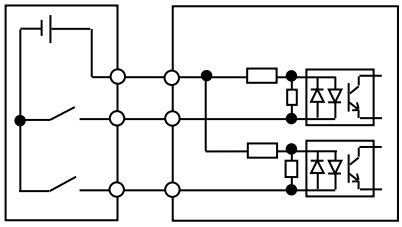
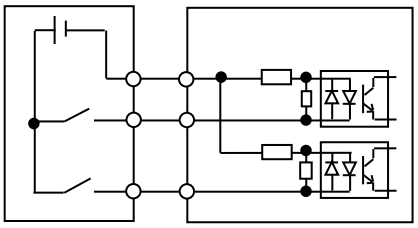
* It will be cause of wrong operation by pulse missing or circuit failure when collector-emitter voltage ($V_{CE}$) of a transistor in host unit is more than 1.5 V.

■ Analog monitor output
Outputs the selection of analog monitor output 1.

| Terminal No. | Symbol | Name | Description |
|---|---|---|---|
| 30 | MON1 | Analog monitor output | [Circuit spec.]<br>Load shall be less than 2 mA.<br>Output resistance shall be 1k Ω.<br>Output voltage range shall be ±8 V.<br>  |
| 31 | SG | Common for pin 30 | |

■ General input
Inputting signals from relay switch, open collector type transistor (sink type, source type) output, etc.

| Terminal No. | Symbol | Name | Description |
|---|---|---|---|
| 37 | CONT1 | General input | [External power supply spec.]<br>Power supply voltage range:<br>5 VDC±5 %, 12 to 24 VDC±10 %<br>Current capacity: 100 mA or more (at 24 VDC)<br><br>[Sink type circuit example]<br>  |
| 36 | CONT2 | General input | |
| 35 | CONT3 | General input | |
| 34 | CONT4 | General input | |
| 33 | CONT5 | General input | |
| 32 | CONT6 | General input | |
| 13 | CONT7 | General input | |
| 15 | CONT8 | General input | |
| 50 | CONT-COM | For power supply to general input | |

| Sink type circuit | Source type circuit |
|---|---|
|  |  |

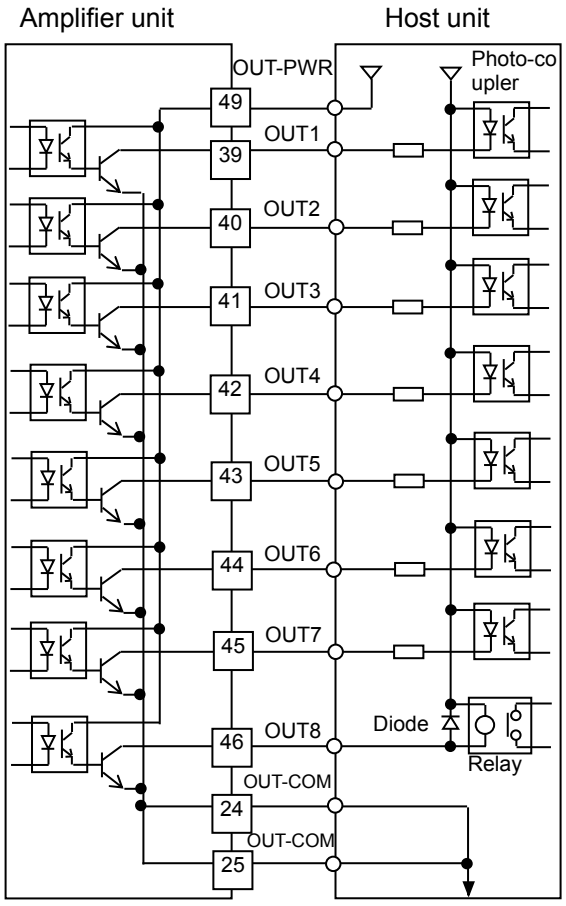
# 4. Wiring

■ General output
Driving electric loads like relay switch or photo-coupler.

◆ For sink type general output
These outputs pull current from electric load when output state is ON.

| Terminal No. | Symbol | Name | Description |
|---|---|---|---|
| 39 | OUT1 | General output | [Internal power supply spec. for general output(OUT-PWR] Power supply voltage range: 5 VDC±5 %, 12 to 24 VDC±10 % Current capacity: 20mA or more<br><br>[General output (OUT-1 to OUT-8) spec.] |
| 40 | OUT2 | General output | |
| 41 | OUT3 | General output | |
| 42 | OUT4 | General output | |
| 43 | OUT5 | General output | |
| 44 | OUT6 | General output | |
| 45 | OUT7 | General output | |
| 46 | OUT8 | General output | |
| 49 | OUT-PWR | For power supply to general output | |
| 24 | OUT-COM | Minus common for general output | |
| 25 | OUT-COM | Minus common for general output | |

| Power supply voltage range | Maximum output current (Each port) |
|---|---|
| 5 V±5 % | 10 mA |
| 12 to 15 VDC±10 % | 30 mA |
| 24 VDC±10 % | 50 mA |

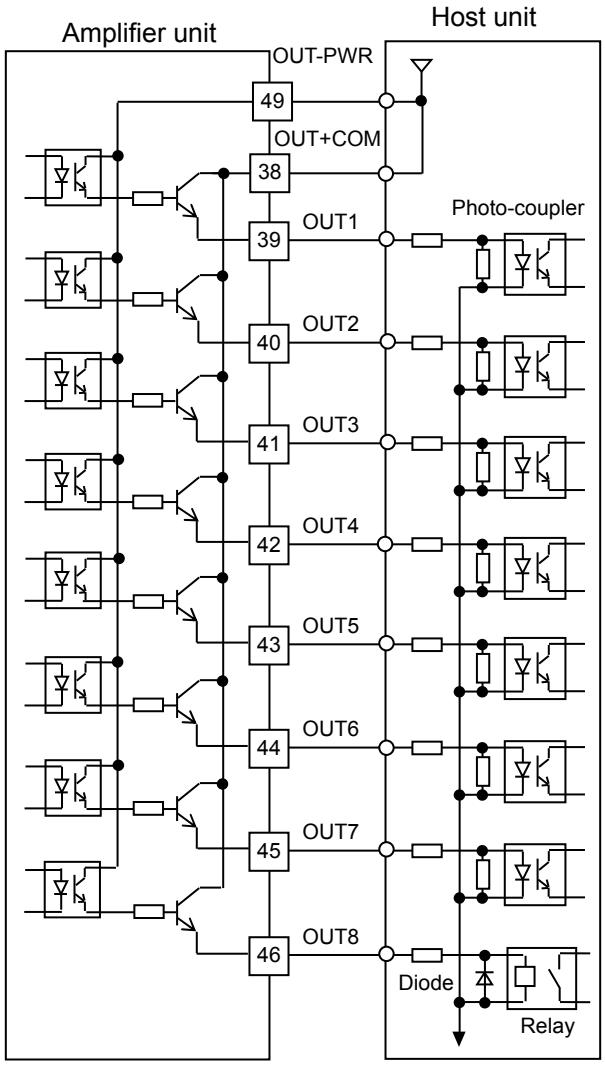



* Must add the surge absorbing diode if inductive load as relay connect to the control signal output of the amplifier. Please take care of polarity of the diode that will be cause of amplifier unit failure.

◆ For source type general output
These outputs flow current to electric load from terminal when output state is ON.

| Terminal No. | Symbol | Name | Description |
|---|---|---|---|
| 39 | OUT1 | General output | [Internal power supply spec. for general output(OUT-PWR] Power supply voltage range: DC5V±5%, DC12V to DC24V±10% Current capacity: 20mA or more<br><br>[General output (OUT-1 to OUT-8) spec.] |
| 40 | OUT2 | General output | |
| 41 | OUT3 | General output | |
| 42 | OUT4 | General output | |
| 43 | OUT5 | General output | |
| 44 | OUT6 | General output | |
| 45 | OUT7 | General output | |
| 46 | OUT8 | General output | |
| 49 | OUT-PWR | For power supply to general output | |
| 38 | COT+COM | Plus common for general output | |

| Power supply voltage range | Maximum output current (Each port) |
|---|---|
| DC5V±5% | 10mA |
| DC12 to 15V±10% | 30mA |
| DC24V±10% | 50mA |



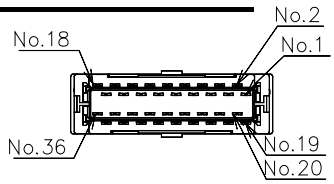

* Must add the surge absorbing diode if inductive load as relay connect to the control signal output of the amplifier. Please take care of polarity of the diode that will be cause of amplifier unit failure.

# 4. Wiring

## 4.3 Wiring for motor encoder and unit connection cable

### 4.3.1 CN10 signal names and its pin numbers

| Power unit CN10 Terminal No. | Signal name | Amplifier unit CN10 Terminal No. | Remarks |
|---|---|---|---|
| 1 | PON/FP+ | 1 | Twisted pair (Recommended) |
| 2 | PON/FP- | 2 | |
| 3 | REGMON+ | 3 | Twisted pair (Recommended) |
| 4 | REGMON- | 4 | |
| 5 | 0V+ | 5 | Twisted pair (Recommended) |
| 6 | 0V- | 6 | |
| 7 | CPE_PS+ | 7 | Twisted pair (Recommended) |
| 8 | CPE_PS- | 8 | |
| 9 | FANMON_PS+ | 9 | Twisted pair (Recommended) |
| 10 | FANMON_PS- | 10 | |
| 11 | RSRYON+ | 11 | Twisted pair (Recommended) |
| 12 | RSRYON- | 12 | |
| 13 | REGTRON+ | 13 | Twisted pair (Recommended) |
| 14 | REGTRON- | 14 | |
| 15 | FANCONT+ | 15 | Twisted pair (Recommended) |
| 16 | FANCONT- | 16 | |
| 17 | 5G | 17 | Twisted pair (Recommended) |
| 18 | 5G | 18 | |
| 19 | RRSOH | 19 | Twisted pair (Recommended) |
| 20 | PSOH | 20 | |
| 21 | 5G | 21 | Twisted pair (Recommended) |
| 22 | +5V | 22 | |
| 23 | +5V | 23 | Twisted pair (Recommended) |
| 24 | +5V | 24 | |
| 25 | +5V | 25 | Twisted pair (Recommended) |
| 26 | +5V | 26 | |
| 27 | +5V | 27 | Twisted pair (Recommended) |
| 28 | +5V | 28 | |
| 29 | +3.3V | 29 | Twisted pair (Recommended) |
| 30 | 5G | 30 | |
| 31 | 5G | 31 | Twisted pair (Recommended) |
| 32 | 5G | 32 | |
| 33 | 5G | 33 | Twisted pair (Recommended) |
| 34 | 5G | 34 | |
| 35 | +12V | 35 | Twisted pair (Recommended) |
| 36 | -12V | 36 | |
| Shell(shielded) | Ground | Shell (shielded) | — |




### 4.3.2 CN10 connector pin arrangement

■ Connector model number(Products of Japan Aviation Electronics Industry, Ltd.)

| | Model number | Applicable wire size | Applicable cable diameter |
|---|---|---|---|
| Connector | DF02D036A22 | AWG22 to 30 | $\phi$15.0 to 16.0 |
| Shell kit | DF02P036F22A1 | | |

# 4.3 Wiring for motor encoder and unit connection cable

## 4.3.3 EN1, EN2 signal names and its pin numbers

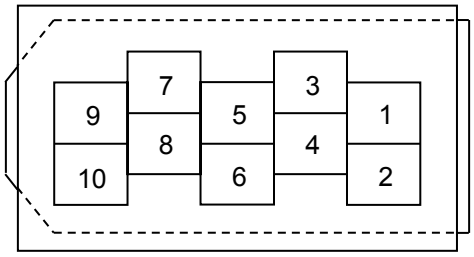
■ Battery backup absolute encoder (Encoder code: S)

| Amplifier unit EN1 Terminal No. | Signal name | Servo motor plug pin number | Description | Remarks Note 1) |
|---|---|---|---|---|
| 1 | 5V | 7 (Red) | Power supply | Twisted pair (Recommended) |
| 2 | SG | 8 (Black) | Power supply common | |
| 3 | 5V | - | NC Note 3) | - |
| 4 | SG | - | NC Note 3) | - |
| 5 | B | 3 (Green) | Phase B pulse output | Twisted pair |
| 6 | /B | 4 (Purple) | | |
| 7 | A | 1 (Blue) | Phase A pulse output | Twisted pair |
| 8 | /A | 2 (Brown) | | |
| 9 | Z | 5 (White) | Phase Z pulse output | Twisted pair |
| 10 | /Z | 6 (Yellow) | | |
| Note 1) | Earth | 10(Shield) | Shield | - |

Note 1) Use an exterior covering shielded cable and perform twisted-pair wiring.
Note 2) Connect outer-shielded wires of encoder cable to metallic case (ground) of encoder connector (EN1) for amplifier unit Outer-shielded wire should connect to outer-shielded wire of encoder at the servomotor with leads, or connect up to the edge of cannon plug at the servo motor with cannon plug. This encoder does not connect outer-shields to somewhere inside of the servo motor equipped with this encoder.
Note 3) Do not connect anything to 3 to 4 pins.

## 4.3.4 EN1, EN2 pin assignment

■ EN1, EN2 36210-0100PL (soldered side)




* Wirings vary depending on encoders to be connected, so please carefully perform wiring.

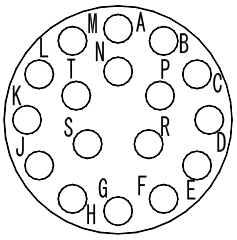
■ Connector model number (3M Japan Limited)

| | Model Number | Applicable wire size | Applicable cable diameter |
|---|---|---|---|
| Connector | 36210-0100PL | AWG30 to AWG18 | — |
| Shell kit | 36310-3200-008 | — | $\phi$7 to $\phi$9 |

## 4.3.5 Connector model number for motor encoder

■ Encoder of R2CA3255KBXS00 (for wire-saving incremental system)
Connector model numbers (Products of Japan Aviation Electronics Industry, Ltd.)

| Motor model number | Motor encoder plug model number | Connector type | Applicable cable diameter |
|---|---|---|---|
| R2CA3255KB | N/MS3106B20-29S | Straight | — |




Encoder cannon plug
pin assignment
(Viewed from motor)

## 4.3.6 Recommended encoder cable specification

Shielded cables with multiple twisted pairs

| | |
|---|---|
| Cable Ratings | 80°C, 30V |
| Conductor resistance value | 1Ω or less |
| Conductor size | AWG26 to AWG18 |
| | SQ ($mm^{2)}$ 0.15 to 0.75 |

The conductor resistance value is recommended with the cable length actually used.

## 4.3.7 Encoder cable length

Maximum cable lengths by conductor sizes of power supply cable (5V, SG).

| Conductor size | | Conductor resistance Ω/km (20℃) | Length (m) |
|---|---|---|---|
| AWG | 26 | 150 or less | 5 |
| | 24 | 100 or less | 10 |
| | 22 | 60 or less | 15 |
| | 20 | 40 or less | 25 |
| | 18 | 25 or less | 40 |
| $SQ(mm^2)$ | 0.15 | 150 or less | 5 |
| | 0.2 | 100 or less | 10 |
| | 0.3 | 65 or less | 15 |
| | 0.5 | 40 or less | 25 |
| | 0.75 | 28 or less | 35 |

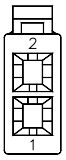
* The values above are for the case power supply (5V, SG) line is wired in a pair.
* Conductor resistance varies depending on conductor specifications.

# 4.4 Wiring for thermostat

## 4.4.1 Connector model number for thermostat

■ Connector model number (Molex Japan LLC)

| Motor model number | Model number | Applicable wire size |
|---|---|---|
| R2CA3255K | 5557-02R | AWG22 to AWG28 |




Flange size 320mm thermostat connector of servo motor FAN pin assignment (Viewed from motor)

■ Contact model number (Molex Japan LLC)

| Type | Model number | Applicable wire size |
|---|---|---|
| Manual crimping type | 5556T2L | AWG22 to AWG28 |

# 4. Wiring

## 4.5 Wiring for dynamic brake signal and thermostat

### 4.5.1 Terminal block pin assignment for dynamic brake signal/ thermostat

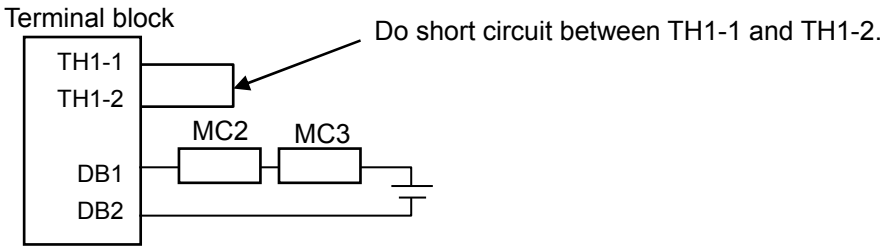
| Terminal name | Signal name |
|---|---|
| TH1-1 | Terminal of external dynamic brake resistor thermostat signal |
| TH1-2 | |
| DB1 | Control terminal (+) for contact of external dynamic brake resistor |
| DB2 | Control terminal (-) for contact of external dynamic brake resistor |

* "Terminal of external dynamic brake resistor thermostat signal" can use for motor thermostat, if required.

### 4.5.2 Wiring of dynamic brake signal/ external resistor thermostat

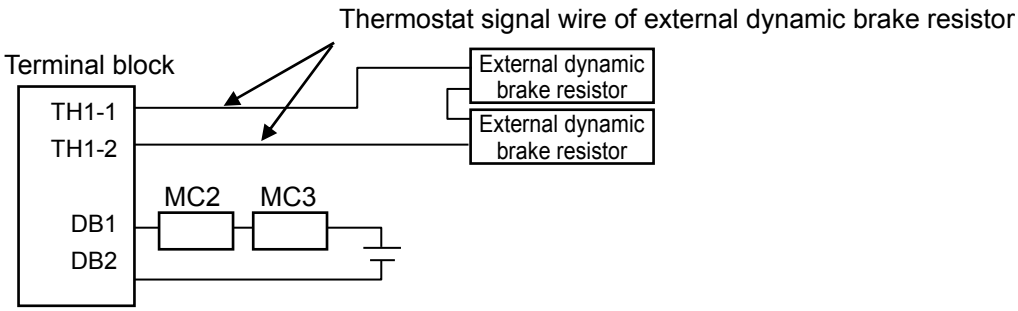
Below shows a wiring example. Consult our sales representative for the other usage.

■ Wiring of dynamic brake signal only



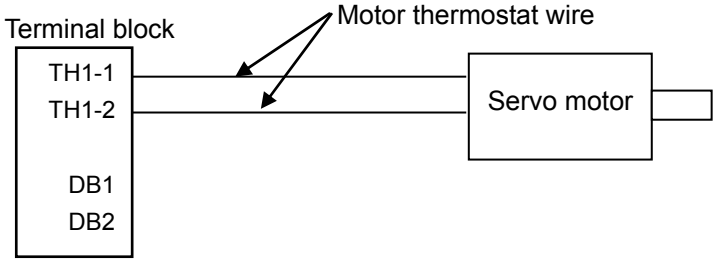

* Use Form b-contact (Normally Close) to magnetic contact (MC) of external dynamic brake circuit.

■ Wiring of dynamic brake signal and dynamic brake resistor thermostat.




* Use Form b-contact (Normally Close) to magnetic contact (MC) of external dynamic brake circuit.

■ Wiring of servo motor thermostat.




■ In case of using nothing

* Do short circuit between TH1-1 and TH1-2.

# 4.6 Peripheral equipments

## 4.6.1 Power supply capacity and peripherals list

■ 400 VAC input

| Input voltage | Power unit/Amplifier unit model number | Servo motor model number | Main circuit power supply rating (kVA) | Molded Case Circuit Breaker (MCCB) | Noise filter | Magnetic contact | Surge absorber |
|---|---|---|---|---|---|---|---|
| 400 VAC | RS3PAC550<br>RS3D80# | R2CA3255KB | 90 | EW400EAG-3P250 (30mA)100/200/500/ 1000mA, Operating time 0.1/0.2/0.4/1/2s switching<br>Fuji Electric Co., Ltd. | HF3200C-SZB<br>SOSHIN ELECTRIC Co., Ltd. | H400C<br>Hitachi Industrial Equipment Systems Co., Ltd. | LV480DI-U4<br>OKAYA ELECTRIC INDUSTRIES CO.,LTD. |

* "#" will be any number or alphabet.
* Add surge absorber to power line input of power unit if overvoltage like lightning surge may be given to power unit/amplifier unit.
* For Molded Case Circuit Breaker (MCCB)/Noise filter/Magnetic contact, the model required to single axis is shown.

No Text on This Page.

# 5

# Operation

In this chapter, each items for motor operations are explained.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# 5. Operation

## 5.1 Basic setting of the system

Basic settings of the system that needed to the operation are explained.

### 5.1.1 Specification check

Check the specification of amplifier unit through the setup software "SANMOTION MOTOR SETUP (hereinafter referred to as setup software)" or digital operator.

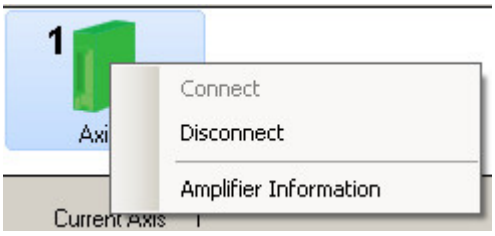
**[Step 1: Check for the amplifier unit spec]**

Check by 4 items below whether purchased amplifier unit is fit to the target system spec.

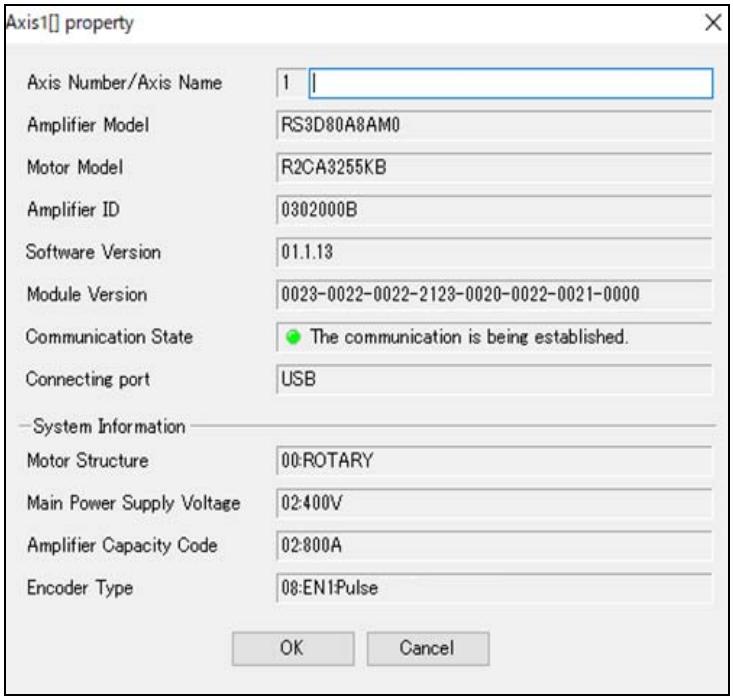
- Motor structure
- Main power supply voltage
- Amplifier capacity code
- Control circuit type

1) Check by the setup software

- Connect the amplifier unit by USB cable to a PC which installed setup software, and then turn on control power (r, t).
- Run the setup software and start communication with the amplifier unit.
- Select the target axis from upper side of main window, and then show the popup menu by right click.



■ Property window for the axis will open when Amplifier information in the popup menu is selected.
The codes of "Motor structure", "Main power supply voltage", "Amplifier capacity" and "Control circuit type" are shown in System Information area. (See below)




■ Check each item above by following description of step 2 or later.

* See the manual: M0010842 for detail of the setup software operation.

2) Check by the digital operator

■ Use amplifier unit info code display function (InFo.1 to 3).

* See "7.4.7 How to check the amplifier unit infomation 1 to 3" for detail of the function use.

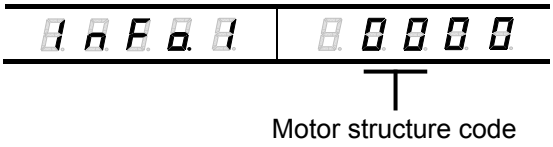
**[Step 2: Check for motor structure]**

This shows available motor structure with the amplifier unit. Please confirm that motor structure code is 00 (rotary motor).

| motor structure code | Description |
|---|---|
| 00 | Rotary |

1) By the setup software
Motor structure code is shown in System Information area of Axis property window.

2) By the digital operator
Motor structure code is shown at an upper byte of InFo.1.



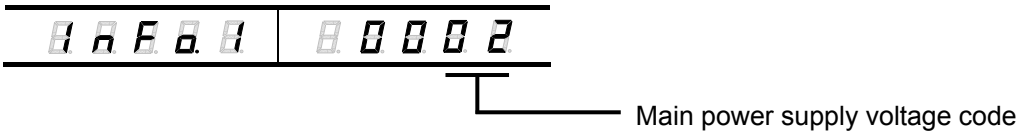

**[Step 3: Check for main power supply voltage]**

This shows applicable input voltage (into R/S/T terminals of terminal block) with the amplifier unit. Please confirm that main power supply voltage code is match to your system.

| Main power supply voltage code | Description |
|---|---|
| 02 | 400V |

1) By the setup software
Main power supply voltage code is shown in System Information area of Axis property window.

2) By the digital operator
Main power supply voltage code is shown at a lower byte of InFo.1.



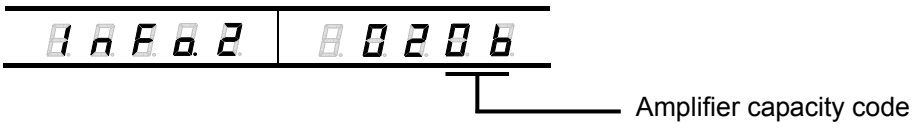

**[Step 4: Check for amplifier capacity]**

This shows amplifier unit capacity of output current.
Please confirm that the amplifier capacity code is match to combined motor.

| Amplifier capacity code | Description | Amplifier unit model number |
|---|---|---|
| 02 | 800A | RS3D80A#### |

1) By the setup software
Amplifier capacity code is shown in System Information area of Axis property window.

2) By the digital operator
Amplifier capacity code is shown at a lower byte of InFo.2.



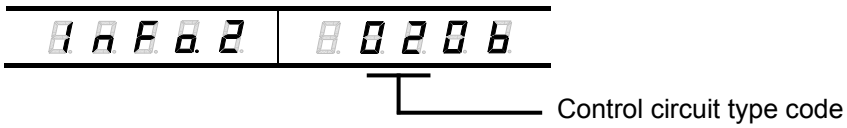
**[Step 5: Check for control circuit type]**

This shows the allowable encoder for the amplifier unit. Please confirm that combined motor encoder and external encoder you use are available.

| Amplifier unit model number | Control circuit type code | The motor encoder allowed by EN1 | The external encoder allowed by EN2 |
|---|---|---|---|
| RS3###A8## | 08 | Incremental encoder | N/A |
| RS3###A9## | 09 | Incremental encoder | Absolute encoder |
| RS3###AA## | 0A | Incremental encoder | Incremental encoder |

1) By the setup software
   Control circuit type code is shown in System Information area of Axis property window.

2) By the digital operator
   Control circuit type code is shown at an upper byte of InFo.2.



## 5.1.2 System parameters

System parameters decide basic specs and functions such as servo motor setting, selection of motor encoder, main power supply and control method.
See details of each parameter through page reference table below.

1) System parameter list

| ID | Parameter name | Description | Page |
|---|---|---|---|
| 00 | Control cycle | Changing control cycle of velocity/torque control. | 5-16 |
| 01 | Main circuit power input type | Selecting input spec of main circuit power. | 5-15 |
| 02 | Virtual mode | Selecting mode of motor operation. | 5-138 |
| 03 | Regenerative resistor selection | Selecting regenerative resistor. | 5-6, 5-15 |
| 04 | Main power discharge selection | Selecting about electric discharge of main circuit power. | 5-6, 5-15 |
| 06 | Control mode selection | Selecting control mode. | 5-16 |
| 07 | Position control selection | Selecting position control method. | 5-17 |
| 08 | Amplifier communication function | Selecting the target of RS422 communication function (CN5 connector). | 9-22 |
| 09 | Motor parameter automatic set function selection | Selecting valid/invalid of motor parameter automatic set function. | 5-8 |
| 0B | External regenerative resistor value | Setting regenerative resistor value. | 5-15 |
| 10 | Motor encoder input selection | Selecting connector of motor encoder to use. | 5-11, 5-13 |
| 11 | EN1 encoder type | Selecting encoder type of EN1 connection. | 5-11, 5-13 |
| 12 | EN2 encoder type | Selecting encoder type of EN2 connection. | 5-13 |
| 13 | EN1 absolute encoder baud rate selection | Selecting communication speed of absolute encoder of EN1 connection. | 5-11 |
| 14 | Battery backup absolute encoder function selection | Selecting function of battery backup absolute encoder. | 5-12 |
| 15 | Absolute encoder resolution | Selecting resolution of absolute encoder. | 5-12 |
| 16 | Absolute encoder multi turn count | Selecting multi turn count of absolute encoder. | 5-12 |
| 17 | Incremental encoder resolution | Selecting resolution of incremental encoder. | 5-13 |
| 20 | Position loop control, position loop encoder selection | Selecting encoder for position control. | 9-7 |
| 21 | EN2 absolute encoder baud rate selection | Selecting the communication speed of absolute encoder which connect to EN2. | 9-8 |
| 22 | External pulse encoder resolution | Selecting resolution of external encoder. | 9-9 |
| 24 | Feedback pulse electronic gear ratio numerator | Setting the electronic gear ratio for converting a motor encoder resolution to an external encoder resolution. | 9-11 |
| 25 | Feedback pulse electronic gear ratio denominator | | |
| 26 | External absolute encoder resolution | Setting the external absolute encoder resolution. | 9-10 |

2) Factory set value of parameters
Part of system parameters at factory setting are different depending on product model number.

RS3 D 80 A □ # M #

**Input power voltage**
D・・・Main circuit, 560 VDC
/Control, 24 VDC

**Option 1**
M・・Without regenerative resistor/Without DB reisitor

**Encoder type**

| | EN1 (for motor encoder only) | EN2 (for motor encoder or external encoder) |
|---|---|---|
| 8 | Incremental encoder | — |
| 9 | Incremental encoder | Absolute encoder |
| A | Incremental encoder | Incremental encoder |

* "#" will be any number or alphabet.

* Parameter backup function is able to save "system parameter", "general parameter" and "motor parameter" into the backup memory area in amplifier unit, and the saved data can be restored when needed it.



■ The system parameter shared to all model number
The system parameters shown in below table are shared to all model number

| ID | Parameter name | Common item |
|---|---|---|
| 00 | Control cycle | 00:Standard_Sampling |
| 02 | Operation mode | 00:Normal |
| 06 | Control mode selection | 02:Position |
| 07 | Position control selection | 00:Standard |
| 10 | Motor encoder input selection | 00:EN1 |

■ Main circuit power input type
Set value of main circuit power input type depends on its voltage.

| ID | Parameter name | Symbol of input power voltage |
|---|---|---|
| | | D |
| 01 | Main circuit power input type | 00:AC_3-phase |

■ Regenerative resistor selection
Set value of regenerative resistor selection depends on option 1.

| ID | Parameter name | Symbol of option 1 |
|---|---|---|
| | | M |
| 03 | Regenerative resistor selection | 00:Not_conect |

■ Main circuit power electric discharge selection
Set value of main circuit power electric discharge selection depends on option 1.

| ID | Parameter name | Symbol of option 1 |
|---|---|---|
| | | L |
| 04 | Main circuit power electric discharge selection | 00:Not_Discharge |

■ System parameter related to encoder
Set value of system parameter related to encoder depends on encoder type.

| ID | Parameter name | Symbol at "□" part that shows encoder type | | |
|---|---|---|---|---|
| | | 8 | 9 | A |
| 09 | Motor parameter automatic set function selection | - | | |
| 11 | EN1 encoder type | 80:Pulse | | |
| 12 | EN2 encoder type | - | 22:EnDat_ABS | 82:Pulse_without_CS |
| 13 | EN1 absolute encoder baud rate selection | - | | |
| 14 | Battery backup absolute encoder function selection | - | | |
| 15 | Absolute encoder resolution | - | | |
| 16 | Absolute encoder multi turn value | - | | |
| 17 | Incremental encoder resolution | 5,000 | | |
| 20 | Position loop control, position loop encoder selection | - | 01:External_Enc | |
| 21 | EN2 absolute encoder baud rate selection | - | 01:2Mbps | - |
| 22 | External pulse encoder resolution | - | - | 2,000 |
| 24 | Feedback pulse electronic gear ratio numerator | - | 1/1 | 1/1 |
| 25 | Feedback pulse electronic gear ratio denominator | | | |
| 26 | External absolute encoder resolution | - | 10,000 | - |

* "-" in table means "not applicable for the product", so these parameters don't show at the setup software and the digital operator.

## 5.1.3 Servo motor setting

Combination servo motor can set by three ways below.

- ◆ Connected servo motor set automatically at power on. (Motor automatic set)
- ◆ Setting by the digital operator for the servo motor in use.
- ◆ Setting by the setup software for the servo motor in use.

■ Servo motor setting availability

Allowable setting method differs like as below table depending on the specs of servo motor and motor encoder.
Please select applicable method for the product in use.

| Servo motor | Motor encoder | Setting method | | |
|---|---|---|---|---|
| | | Motor automatic set | Setting by the digital operator | Setting by the setup software |
| Applicable motor | Absolute encoder | ○ | ○ | ○ |
| | Incremental encoder | × | ○ | ○ |
| Except above | Absolute encoder | × | × | ○ |
| | Incremental encoder | × | × | ○ |

* ○: Available, ×: Not abailable
* For applicable motor, see next "Applicable motor list".
* Even if your servo motor or motor encoder is on the list, motor automatic set is disabled to some product by production date. In this case, please use the digital operator or the setup software to set the motor.

■ Applicable motor list

This is the list of servo motor model number and motor code that are able to set by the motor automatic set or the digital operator.

| Combination servo amplifier | Servo motor model number | Motor code |
|---|---|---|
| RS3D80# | R2CA3255KB | 056B |

1) How to use motor automatic set function

**[Step 1: Connecting motor encoder]**

Connect the motor encoder to amplifier unit, and then turn control power on.

**[Step 2: Enabling the motor parameter automatic set function]**

Check the system parameter ID09 through the setup software or the digital operator that is set to "00: Enabled" or not.

- ◆ Go Step 3, if "00: Enabled" is set to the system parameter ID09.
- ◆ If "01: Disabled" is set, change to "00: Enabled", and then power-cycle and go Step 3.

| Group | ID | Name | Value | Description |
|---|---|---|---|---|
| System | 09 | Motor parameter automatic set function selection | 00:Enabled | Motor automatic set function is available. |

* For R2CA3255KB, motor encoder is incremental encoder so "01: Disabled" shall be selected for this parameter.

**[Step 3: Checking alarm]**

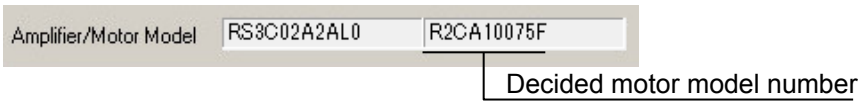
Check alarm of AL.EE (Motor Parameter Automatic Setting Error 1) and AL.EF(Motor Parameter Automatic Setting Error 2).
If these alarms are there, please follow the way below.

| Alarm | Reason | Motor setting method |
|---|---|---|
| Motor Parameter Automatic Setting Error 1 (AL.EE) | Connected servo motor does not support to motor automatic set function. | Setting by the digital operator or the setup software. |
| Motor Parameter Automatic Setting Error 2 (AL.EF) | The amplifier unit does not support connected servo motor. | Setting by the setup software. |
| | Wrong combination of amplifier unit and servo motor. | Confirm model number of amplifier unit and servo motor, and then correct a combination. |

**[Step 4: Rechecking the motor set by automatic set]**

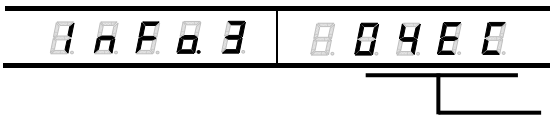
Double check the motor through the setup software or the digital operator.

■ Check through the setup software
Decided motor model number is shown in upper of each function window.




* See another manual: M0010842 for the setup software operation.

■ Check through the digital operator
Decided servo motor code is shown at InFo.3 display.




* See "7.4.7 How to check the amplifier unit infomation 1 to 3" to show the InFo.3 display.

2) How to set motor through the digital operator

**[Step 1: Disabling motor automatic set function]**

For setting by the digital operator, please check the system parameter ID09 that is set to "01: Disabled" or not. If "00: Enabled" is set, change to "01: Disabled", and then power-cycle and go Step 2.

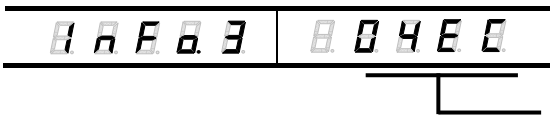
**[Step 2: Selecting motor]**

Set the motor code that will be used by following the steps of "7.18 How to set the motor code". Please have a control power-cycle after setting.

* For checking the motor code of servo motor, see "Applicable motor list (page 5-8)".
* For the servo motor which is not listed on Applicable motor list, please set by the setup software.

**[Step 3: Rechecking the motor setting]**

After power-cycling, please check whether motor code is correct through InFo.3 display.




* See "7.4.7 How to check the amplifier unit infomation 1 to 3" to show the InFo.3 display.

3) How to set motor through the setup software

**[Step 1: Disabling motor automatic set function]**

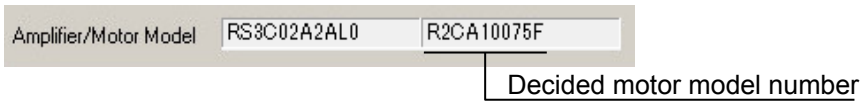
For setting by the Setup software, please check the system parameter ID09 that is set to "01: Disabled" or not. If "00: Enabled" is set, change to "01: Disabled", and then power-cycle and go Step 2.

**[Step 2: Selecting motor]**

Select the servo motor that will be used by following the steps of "4.2.3 How to set motor parameters - (B) When manually setting a motor", the setup software manual: M0010842.
Please have a control power-cycle after setting.

**[Step 3: Rechecking the motor setting]**

After power-cycling, please check whether motor model number is correct through the setup software, upper of each function window.



## 5.1.4 Motor encoder setting

The motor encoder that will be used is set. Available encoder differs by encoder type of the amplifier unit. Please set the system parameter concerned with motor encoder by following table reference below.

| Target motor encoder | Applicable encoder type by amplifier unit model number | | | | Reference |
|---|---|---|---|---|---|
| | RS3xxxx0xxx | RS3xxxx2xxx | RS3xxxx8xxx | RS3xxxxAxxx | |
| Absolute encoder | ○ | ○ | × | × | 1) |
| Incremental encoder | × | ○ | ○ | ○ | 2) |

* ○: Combination available, ×: Combination not available

1) Absolute encoder (Applicable amplifier model number: RS3xxxx0xxx, RS3xxxx2xxx)

■ Motor encoder connector selection
Select the connector for connecting motor encoder. Must set "00: EN1".

| Group | ID | Selection | | Description |
|---|---|---|---|---|
| System | 10 | 00 | EN1 | Uses EN1 for connecting motor encoder. |
| | | 01 | EN2 | Uses EN2 for connecting motor encoder. |

* RS3xxxx0xxx allows "00:EN1" only.

■ EN1 encoder type
Select the encoder type that will be connected to EN1.
Please select Absolute encoder type that will be used.

| Group | ID | Selection | | Description |
|---|---|---|---|---|
| System | 11 | 10 | PA S-ABS | Single-turn absolute encoder (Encoder code: H) |
| | | 11 | PA C-ABS | Battery backup absolute encoder (Encoder code: P) |
| | | 12 | RA C-ABS | Battery-less absolute encoder (Encoder code: R,W) |

* It will be set automatically if motor automatic set function is effective.

■ EN1 absolute encoder baud rate selection
Select the baud rate of abusolute encoder that will be used.

| Group | ID | Selection | | Description |
|---|---|---|---|---|
| System | 13 | 02 | 2.5Mbps | 2.5Mbps |
| | | 03 | 4Mbps | 4Mbps |

* It will be set automatically if motor automatic set function is effective.

■ Battery backup abusolute encoder function selection
Select a use of battery backup abusolute encoder as an absolute system with multi turn value or as an incremental system without multi turn value.
- ◆ Must connect battery if use as an absolute system.
- ◆ Battery is not necessary if use as an incremental system. As note, multi turn value does not back up.

| Group | ID | Selection | | Description |
|---|---|---|---|---|
| System | 14 | 00 | Absolute_System | Use as absolute system |
| | | 01 | Incremental_System | Use as incremental system |

■ Abusolute encoder resolution
Select the resolution of single turn of motor.

| Group | ID | Selection | | Description | Selection | | Description |
|---|---|---|---|---|---|---|---|
| System | 15 | 00 | 2048_FMT | 2048 division | 07 | 262144_FMT | 262144 division |
| | | 01 | 4096_FMT | 4096 division | 08 | 524288_FMT | 524288 division |
| | | 02 | 8192_FMT | 8192 division | 09 | 1048576_FMT | 1048576 division |
| | | 03 | 16384_FMT | 16384 division | 0A | 2097152_FMT | 2097152 division |
| | | 04 | 32768_FMT | 32768 division | 0B | 4194304_FMT | 4194304 division |
| | | 05 | 65536_FMT | 65536 division | 0C | 8388608_FMT | 8388608 division |
| | | 06 | 131072_FMT | 131072 division | | | |

* It will be set automatically if motor automatic set function is effective.

■ Abusolute encoder multi turn value
Select the multi turn value of abusolute encoder.

| Group | ID | Selection | | Description | Selection | | Description |
|---|---|---|---|---|---|---|---|
| System | 16 | 00 | 1_ROT | 1 turn | 07 | 131072_ROT | 131072 turns |
| | | 01 | 2048_ROT | 2048 turns | 08 | 262144_ROT | 262144 turns |
| | | 02 | 4096_ROT | 4096 turns | 09 | 524288_ROT | 524288 turns |
| | | 03 | 8192_ROT | 8192 turns | 0A | 1048576_ROT | 1048576 turns |
| | | 04 | 16384_ROT | 16384 turns | 0B | 2097152_ROT | 2097152 turns |
| | | 05 | 32768_ROT | 32768 turns | 0C | 4194304_ROT | 4194304 turns |
| | | 06 | 65536_ROT | 65536 turns | | | |

* It will be set automatically if motor automatic set function is effective.

2) Incremental encoder
(Applicable amplifier model number: RS3xxxx2xxx, RS3xxxx8xxx, RS3xxxxAxxx)

■ Motor encoder connector selection
Select the connector for connecting motor encoder. Must set "00: EN1".
- ◆ Select "01:EN2" if "RS3xxxx2xxx" is used.
- ◆ Select "00:EN1" if "RS3xxxx8xxx or RS3xxxxAxxx" is used.

| Group | ID | Selection | | Description |
|---|---|---|---|---|
| System | 10 | 00 | EN1 | Uses EN1 for connecting motor encoder. |
| | | 01 | EN2 | Uses EN2 for connecting motor encoder. |

* RS3xxxx8xxx and RS3xxxxAxxx allow "00:EN1" only.

■ EN1 encoder type
Select the encoder type that will be connected to EN1.
Please select incremental encoder type that will be used.
- ◆ For RS3xxxx2xxx, select encoder type at "EN2 encoder type".
- ◆ For RS3xxxx8xxx and RS3xxxxAxxx, select encoder type at this parameter.

| Group | ID | Selection | | Description |
|---|---|---|---|---|
| System | 11 | 80 | Pulse | Wire-saving incremental encoder |

■ EN2 encoder type
Select the encoder type that will be connected to EN2.
Please select incremental encoder type that will be used.
- ◆ For RS3xxxx2xxx, select encoder type at this parameter.
- ◆ For RS3xxxx8xxx and RS3xxxxAxxx, this parameter is not shown because it is not necessary.

| Group | ID | Selection | | Description |
|---|---|---|---|---|
| System | 12 | 80 | Pulse | Wire-saving incremental encoder |

■ Incremental encoder resolution
Set the motor encoder resolution that will be used. Please set one-multiplied value.

| Group | ID | Setting range | Unit |
|---|---|---|---|
| System | 17 | 500 to 65,535 (one-multiplied) | P/R |

3) System parameters setting list related to motor encoder due to encoder types each

| ID | System paramer | Motor model number | | | |
|---|---|---|---|---|---|
| | | RxxxxxxxxxHxx | RxxxxxxxxxPxx | RxxxxxxxxxRxx | RxxxxxxxxxSxx |
| 10 | Motor encoder input selection | 00: EN1 | 00: EN1 | 00: EN1 | 00: EN1 or 01: EN2 Note 1) |
| 11 | EN1 encoder type | 10: PA S-ABS | 11: PA C-ABS | 12: RA C-ABS | 80: Pulse Note 2) |
| 12 | EN2 encoder type | Setting is just required for full-closed system use. | | | 80:Pulse Note 2) Note 3) |
| 13 | EN1 absolute encoder baud rate selection | Set according to encoder spec in use. | | | Setting not required |
| 14 | Battery backup absolute encoder function selection | Setting not required | 00: Absolute_System or 01: Incremental_System Note 4) | Setting not required | Setting not required |
| 15 | Absolute encoder resolution | Set according to encoder spec in use. | | | Setting not required |
| 16 | Absolute encoder multi turn count | Set according to encoder spec in use. | | | Setting not required |
| 17 | Incremental encoder resolution | Setting not required | | | Set according to encoder spec in use. |

Note 1) Motor encoder input connector is able to select from EN1 or EN2 when amplifier unit model number is RS3□□□A2□□□ (eighth digit from left is "2").
Set "00：EN1" for a use of absolute encoder, "01：EN2" for a use of incremental encoder.

Note 2) Set "80:Pulse" to "EN1 encoder type" when amplifier unit model number is RS3□□□A8□□□ (eighth digit from left is "8").
Set "80:Pulse" to "EN2 encoder type", when amplifier unit model number is RS3□□□A2□□□ (eighth digit from left is "2") and "01:EN1" is set to the motor encoder input selection.

Note 3) It is not shown because the setting is not required when amplifier unit model number is RS3□□□A8□□□ (eighth digit from left is "8" or "A").

Note 4) For a use of battery backup absolute encoder as incremental system without multi-turn data, select "01:Incremental_System". In this case, battery connection is not required.

## 5.1.5 Main circuit power setting

Set the parameters about main circuit power.

■ Main circuit power input type selection
Sets the type of power that will connect to main circuit power terminal (R/S/T) of power unit.

| Group | ID | Selection | | Description |
|---|---|---|---|---|
| System | 01 | 00 | AC_3-phase | Provides the power from power unit DC output terminal to main circuit. |

■ Main power discharge selection
When cutting off the main power supply, select whether discharging or not a energy of DC bus capacitor through regenerative resistor.

| Group | ID | Selection | | Description |
|---|---|---|---|---|
| System | 04 | 00 | Not_Discharge | No discharge. |
| | | 01 | Discharge | Will discharge. |

* When regenerative resistor is not connected, discharge will be not occur even if "01:Discharge" is selected.
* When cut off the control power, discharge will be occur even if "00:Not_Discharge" is selected.

## 5.1.6 Regenerative resistor setting

Sets about a regenerative resistor.

■ Regenerative resistor selection
Select the regenerative resistor that will connect to the terminal (RB1/RB2) of power unit.

| Group | ID | Selection | | Description |
|---|---|---|---|---|
| System | 03 | 00 | Not_Connect | No regenerative resistor connection. |
| | | 01 | Built-in_R | Using internal regenerative resistor. |
| | | 02 | External_R | Using external regenerative resistor. |

* Built-in regenerative resistor is not exist so do not set "01 : Built-in_R".

■ External regenerative resistor value

| Group | ID | Setting range | Unit |
|---|---|---|---|
| System | 0B | 1.0 to 100.0 | ohm |

* Minimum value of external regenerative resistor is 2.4 Ω. Make sure to set 2.4 Ω or more when external regenerative resistor is connected.

* The value of regenerative resistor shall be set when selecting "02: External R (use external regenerative resistor)". This setting will invalid when selecting except "02: External R (use external regenerative resistor)".

* Accurate value is not able to calculate in the average power monitor, if wrong value is set to regenerative resistor.

## 5.1.7 Control method selection

Set the basic control method to use.

■ Control cycle
Select the control cycle of velocity control and torque control.
Velocity control type response frequency is able to set high by setting "01:High-freq_Sampling".
Please select "00:Standard_Sampling", normally.

| Group | ID | Selection | | Description |
|---|---|---|---|---|
| System | 00 | 00 | Standard_Sampling | Doing standard sampling mode. |
| | | 01 | High-freq_Sampling | Doing high frequency sampling mode. |

When "01:High-freq_Sampling" is selected, the functions in table below can not use.
When high frequency sampling is used, must use the parameter setting value of table below to the limiting functions.

| Limiting functions | Parameter for limiting function | | | |
|---|---|---|---|---|
| | Group | ID | Name | Selection |
| Model-following (vibration suppression) control | System | 07 | Position control selection | 00:Standard |
| Full closed control | System | 20 | Position loop control, position loop encoder selection | 00:Motor_Enc |

* When used in full-closed system, select "00:Standard_sampling" (Standard sampling mode).

■ Control mode selection
Sets the control mode of the servo system.

| Group | ID | Selection | | Type | Description |
|---|---|---|---|---|---|
| System | 06 | 00 | Torque | Torque control type | Control the motor torque.<br>Operate by analog voltage as torque command from a host unit. |
| | | 01 | Velocity | Velocity control type | Control the motor speed.<br>Operate by the analog voltage as velocity command from a host unit, or by the internal velocity command that set in the amplifier unit. |
| | | 02 | Position | Position control type | Control the motor position.<br>Operate by pulse type position command from a host unit. |
| | | 03 | Velo-Torq | Velocity / Torque control switching type | Operate with switching velocity control and torque control.<br>The switching condition is set to the control mode switching function at Group9, ID10. |
| | | 04 | Posi-Torq | Position / Torque control switching type | Operate with switching position control and torque control.<br>The switching condition is set to the control mode switching function at Group9, ID10. |
| | | 05 | Posi-Velo | Position / Velocity control switching type | Operate with switching position control and velocity control.<br>The switching condition is set to the control mode switching function at Group9, ID10. |

■ Position control selection
Select the type of position control.

| Group | ID | Selection | | Type |
|---|---|---|---|---|
| System | 07 | 00 | Standard | Standard position control |
| | | 01 | Model1 | Model-following control |
| | | 02 | Model2 | Model-following vibration suppression control |
| | | 03 | Model3 | Model-following / standard position control switching |
| | | 04 | Model4 | Model-following vibration suppression / standard position control switching |

* When "01:High-freq_Sampling" (Control cycle:High speed sampling mode) is set to System parameter, ID00, only "00:Standard" (Standard position control) is effective for this parameter.

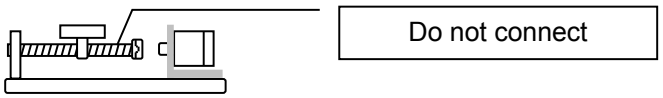
# 5.2 Test operation

## 5.2.1 Check of installation and wiring

Check the installation and wiring of amplifier unit and servo motor.

**[Step 1: installation]**

- Set the power unit, amplifier unit and servo motor by following "3. Installation".
- Do not connect servo motor shaft to any mechanism, keep free from a load.




**[Step 2: Wiring/Connection --> Turn power on]**

- Please wire the servo amplifier, motor and host unit by following "4. Wiring".
  As note, do not connect CN1 to the amplifier unit.
- Supply power. Check that the display of upper of amplifier unit front face does not show alarm code. If alarm code is shown, please take corrective action by following "8.3 Trouble shooting when alarm activated".
- If "☰" is not shown at 7-segment LED even if main power turns on, please take corrective action by following " 8.1 Trouble shooting".
- "Absolute encoder Internal Error 1 (AL.A1)" may blink when turning power on at the first time with amplifier unit and servo motor that has battery backup absolute encoder.
  The reason why alarm occurs is the data loss of absolute position in encoder by running out of battery.

## 5.2.2 Check of operation

**[Step 1: JOG operation]**

- Run the JOG operation without connection of a load to servo motor shaft.
- Check whether the servo motor shaft is able to rotate to positive and negative direction.
  - How to operate through the setup software
    Select JOG operation at the menu of Test Operation. See the manual: M0010842, "7.1 JOG operation" for detail of the setup software operation.
  - How to operate through the digital operator
    See "7.10 Velocity-controlled JOG Operation" for detail of the digital operator operation.

## 5.2.3 Check of I/O signal

Do the I/O signal setting, and then operation check by command from host controller.

**[Step 1: Input signal setting]**

■ Select the function to be used from parameter Group9, and then set it to CONT1 to CONT8. Factory settings are written in table below.

| Input signal | CN1 pin number | Factory settings | |
|---|---|---|---|
| | | The function in general parameter Group9 | Setting value |
| CONT1 | 37 | Servo-ON Function | 02:CONT1_ON |
| CONT2 | 36 | Velocity Loop Proportional Control Switching Function | 04:CONT2_ON |
| CONT3 | 35 | Encoder Clear Function | 06:CONT3_ON |
| CONT4 | 34 | Deviation Clear Function | 08:CONT4_ON |
| CONT5 | 33 | Negative Over Travel Function | 0B:CONT5_OFF |
| CONT6 | 32 | Positive Over Travel Function | 0D:CONT6_OFF |
| CONT7 | 13 | Torque Limit Function | 0E:CONT7_ON |
| CONT8 | 15 | Alarm Reset Function | 10:CONT8_ON |

**[Step 2: Output signal setting]**

■ Select the function to be used from parameter GroupA, and then set it to OUT1 to OUT8. Factory settings are written in table below.

| Output signal | CN1 pin number | Factory settings |
|---|---|---|
| OUT1 | 39 | 18:INP_ON |
| OUT 2 | 40 | 0C:TLC_ON |
| OUT 3 | 41 | 02:S-RDY_ON |
| OUT 4 | 42 | 0A:MBR-ON_ON |
| OUT 5 | 43 | 33:ALM5_OFF |
| OUT 6 | 44 | 35:ALM6_OFF |
| OUT 7 | 45 | 37:ALM7_OFF |
| OUT 8 | 46 | 39:ALM_OFF |

**[Step 3: Double check of I/O signal setting]**

■ Through monitor function, check that the I/O signal that has set works correctly. See "5.5 Monitor function" for detail of the monitor.

◆ How to check through the setup software
Select Monitor function at the menu and check.

◆ How to check through the digital operator
See "7.17 Monitor display" for detail of the digital operator operation.

**[Step 4: Input servo ON signal]**

Input servo ON signal. Confirm that the servo motor is excited and the digital operator display on the amplifier unit front is drawing the character “8”.

■ When the digital operator shows as below, it means over travel status.
In case of no use of over travel function, set "00:Always_Disable" to parameter Group9 ID00, ID01.

| | |
|---|---|
| | Positive direction over-travel status.<br>Positive direction over-travel has occured at position/velocity control. |
| | Negative direction over-travel status.<br>Negative direction over-travel has occured at position/velocity control. |

**[Step 5: Inputting the command]**

■ Inputting the command suitable for the control mode in use, by host unit. (see in system parameter ID06)
- ◆ “Position control mode”‥‥Position command pulse
- ◆ “Velocity control mode”‥‥Analog voltage
- ◆ “Torque control mode” ‥‥Analog voltage

* When operating by torque control without load, motor might rotate up to high speed. Please avoid risk watching a velocity or position by host unit.

■ Confirm that the shaft of the servo motor rotates to commanded direction.

■ If servo motor shaft does not rotate even if host unit gives command, please confirm command reception by monitor function.

| Control mode | Input command type | Monitor | | |
|---|---|---|---|---|
| | | ID | Name | Description |
| Position control | Position command pulse | 30 | Position command pulse frequency monitor 1 | Frequency of inputted command pulse is displayed. |
| Velocity control | Analog velocity command | 31 | Analog velocity command/Analog torque command input voltage monitor | Voltage of inputted command is displayed. |
| Torque control | Analog torque command | | | |

■ If the amplifier unit does not receive the command from the upper device, the value displayed on the monitor does not change.
Any of these cases could be the result of wrong wiring. Please double check the wiring.

■ Give command after receiving command acceptance permission signal from amplifier unit.
See “5.4 Operation sequence” for the details.

**[Step 6: Power shut off]**

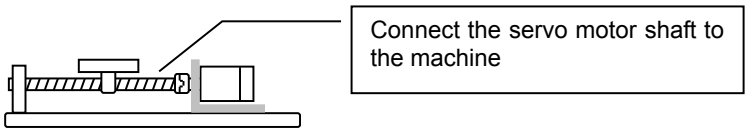
■ Turn off the servo-on signal. Then turn off the power supply.

## 5.2.4 Check of device operation

Connect the servo motor shaft with the machine and check the operation.

**[Step 1: Connection to the machine]**

■ Connect the servo motor shaft with the machine and check the operation.




■ Input the command (low speed); check the operation direction, distance, emergency stop and over-travel (F-OT·R-OT) to make sure they are operating properly.

■ Prepare to stop soon in the event of something abnormal operation.

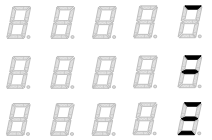
**[Step 2: Operation]**

■ Input the command for the actual operation and start the machine.

■ At the time of shipment, Auto-tuning (auto-adjustment for servo gain and filter, etc.) is valid. If there is nothing wrong with operation and the characteristic, manual tuning is not necessary. See "6. Servo tuning" for the Servo Tuning.

# 5.3 Amplifier unit status display

## 5.3.1 Normal display

| Marking | Description | Status code |
|---|---|---|
| | Control power supply established.<br>Control power supply (r, t) is established and amplifier (RDY) is on. | 1 |
| | Main circuit power supply established.<br>Main power supply (R, S and T) is established, but operation preparation completion signal is off. | 2 |
|  | Safe torque off working status.<br>Main circuit power supply (R, S and T) is established and either safe torque off input 1 or 2 is “off”.<br>“ --> --> ” are shown sequentially. | 2 |
| | Operation setup is completed.<br>Main power supply (R, S and T) is established and operation setup completion signal is on. | 3 |
| | Servo is on.<br>Continue drawing of character "8", sequentially. | 4 |

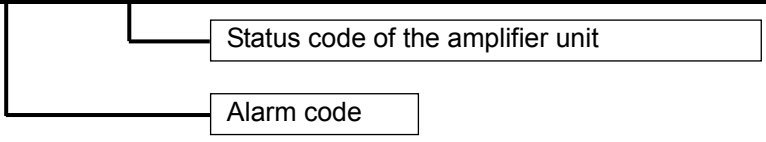
| Marking | Description |
|---|---|
| | Positive direction over-travel status.<br>Positive direction over-travel has occured at position/velocity control. |
| | Negative direction over-travel status.<br>Negative direction over-travel has occured at position/velocity control. |

* See "7.4.3 Warning status display" about display of warning status.

## 5.3.2 Alarm display

When an alarm occurs, the display shows the alarm code and the status code of the amplifier unit.

| Marking | Description |
|---|---|
| | When an alarm occurs, take corrective actions as instructed in "8. Maintenance". |



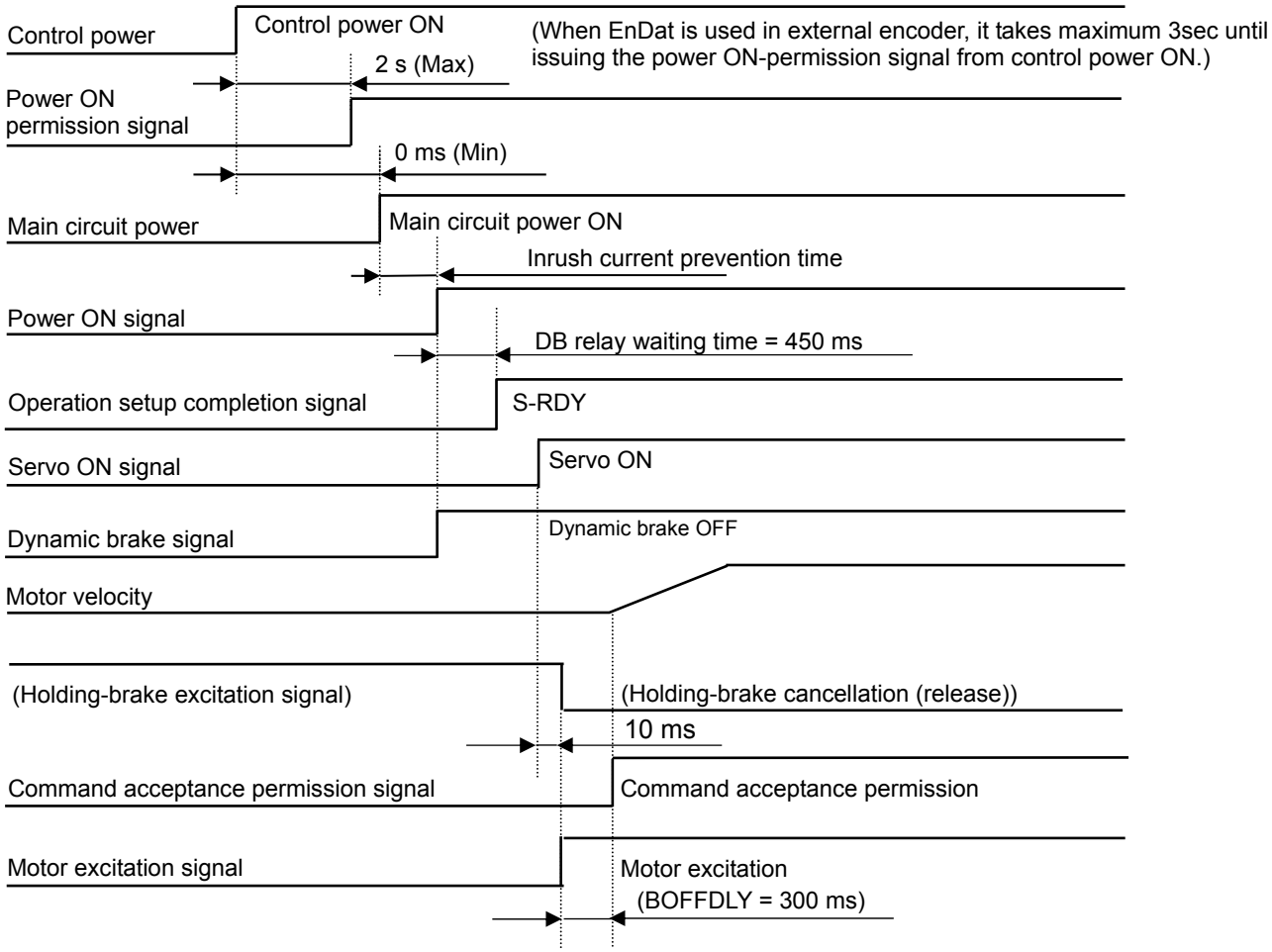

| Code | Status | |
|---|---|---|
| 1 | Power OFF status | (P-OFF) |
| 2 | Power ON status | (P-ON) |
| 3 | Servo ready status | (S-RDY) |
| 4 | Servo ON status | (S-ON) |
| 5 | Servo OFF and stop status | (S-OFF) |
| 6 | Emergency stop status | (EMR) |
| F | Initial status | |

# 5. Operation

## 5.4 Operation sequence

### 5.4.1 The operation sequence with factory setting from "turn power on" to "turn power off"

Power ON --> Servo ON

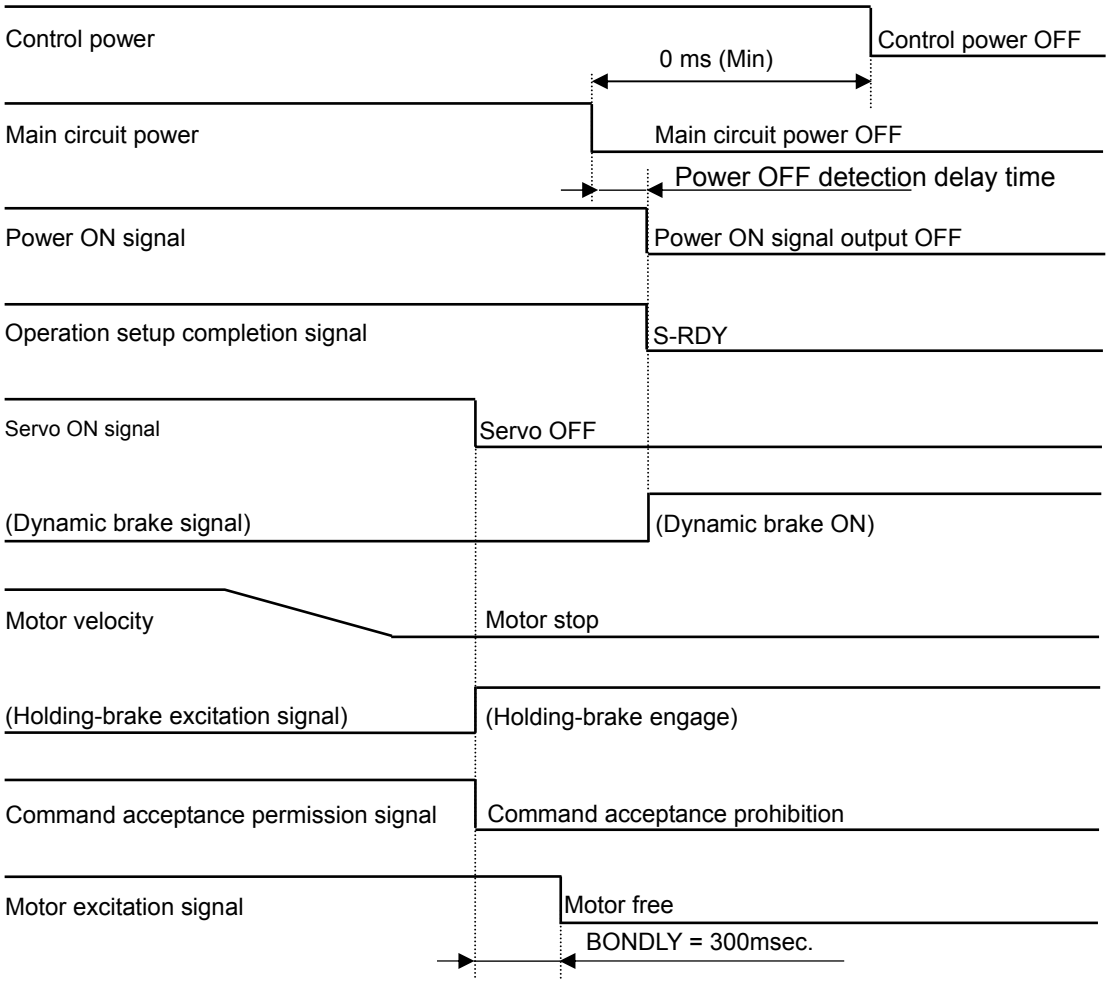



* Turn on power to an external encoder at same time or before of amplifier unit control power.
* The frequency of the power ON/OFF of the amplifier unit shall be 5 times/hour or less and 30 times/day or less. Please set 10 minutes or more to power ON/OFF interval.
* Inrush current prevention time of power unit and amplifier unit is shown below.

| Servo amplifier capacity | Inrush current prevention time |
|---|---|
| | 3-phase |
| RS3PAC550, RS3D80# | 1,200 [ms] |

* For servo motor R2CA3255KB, there is no specification with brake.
* For amplifier unit RS3D80#, dynamic brake circuit is not included. Just provides a contact output.

Servo OFF --> Power OFF

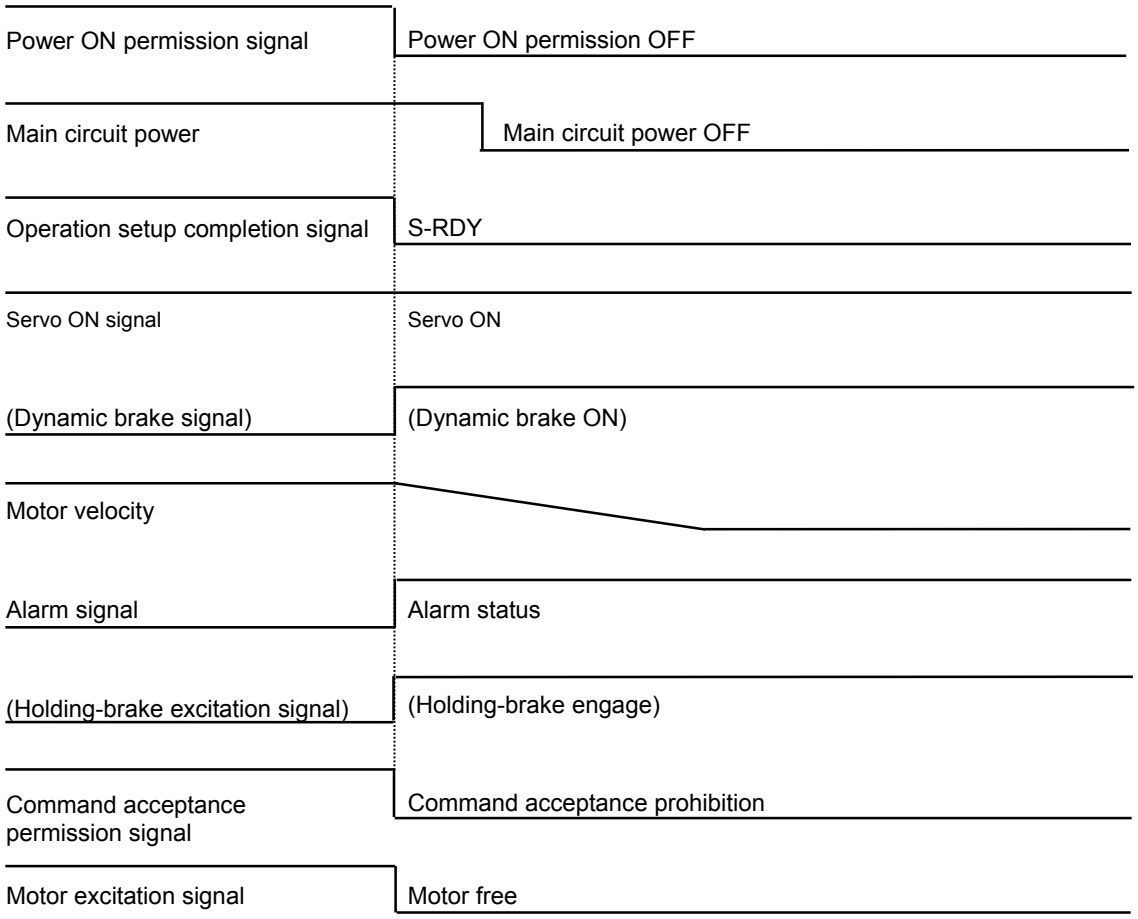



* For servo motor R2CA3255KB, there is no specification with brake.
* For amplifier unit RS3D80#, dynamic brake circuit is not included. Just provides a contact output.

## 5.4.2 Stop sequence at alarm

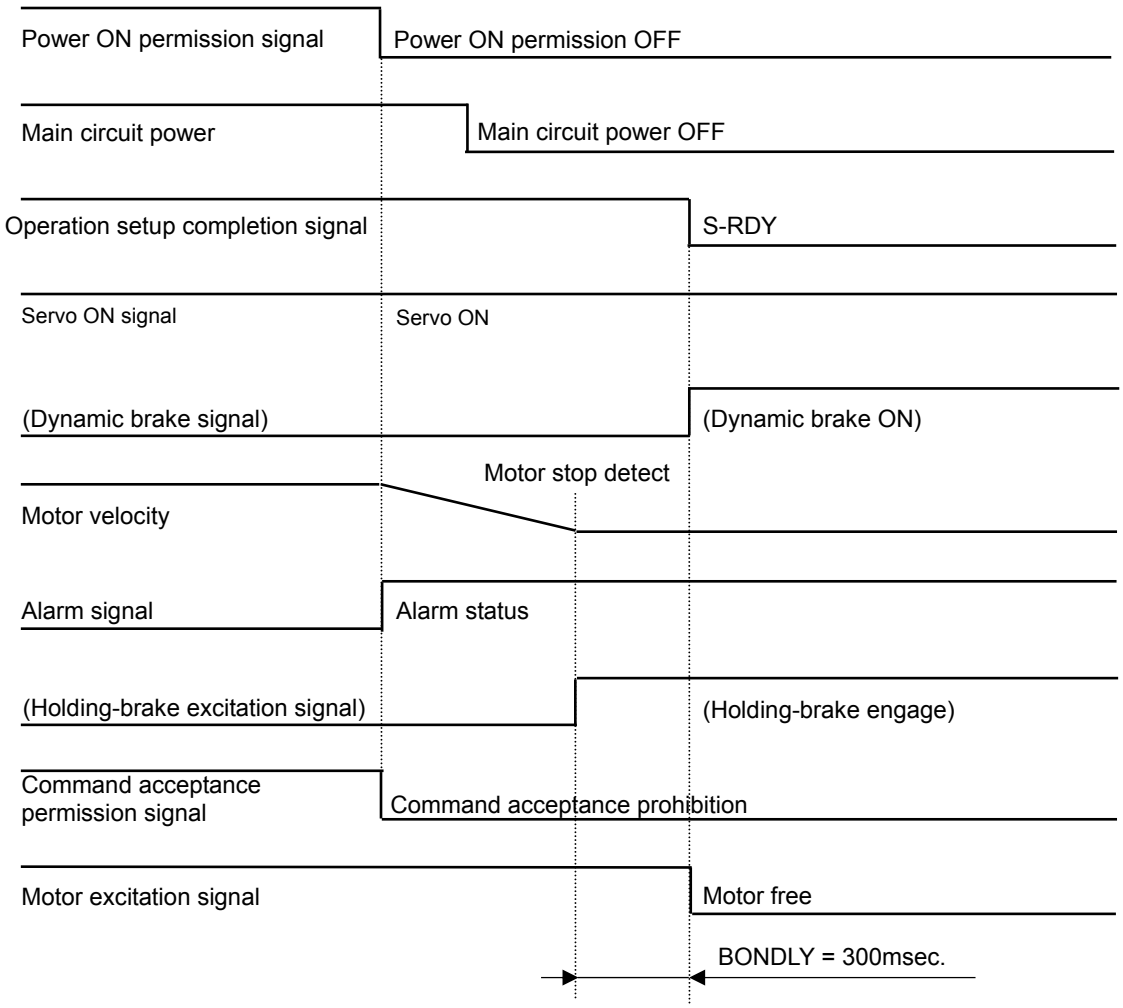
When an alarm occurs, the servo motor is stopped by either dynamic brake or servo brake. Which brake to be used is depending on alarm. See "8.2 List of warning and alarm".

Stop by dynamic brake at alarm




* For servo motor R2CA3255KB, there is no specification with brake.
* For amplifier unit RS3D80#, dynamic brake circuit is not included. Just provides a contact output.

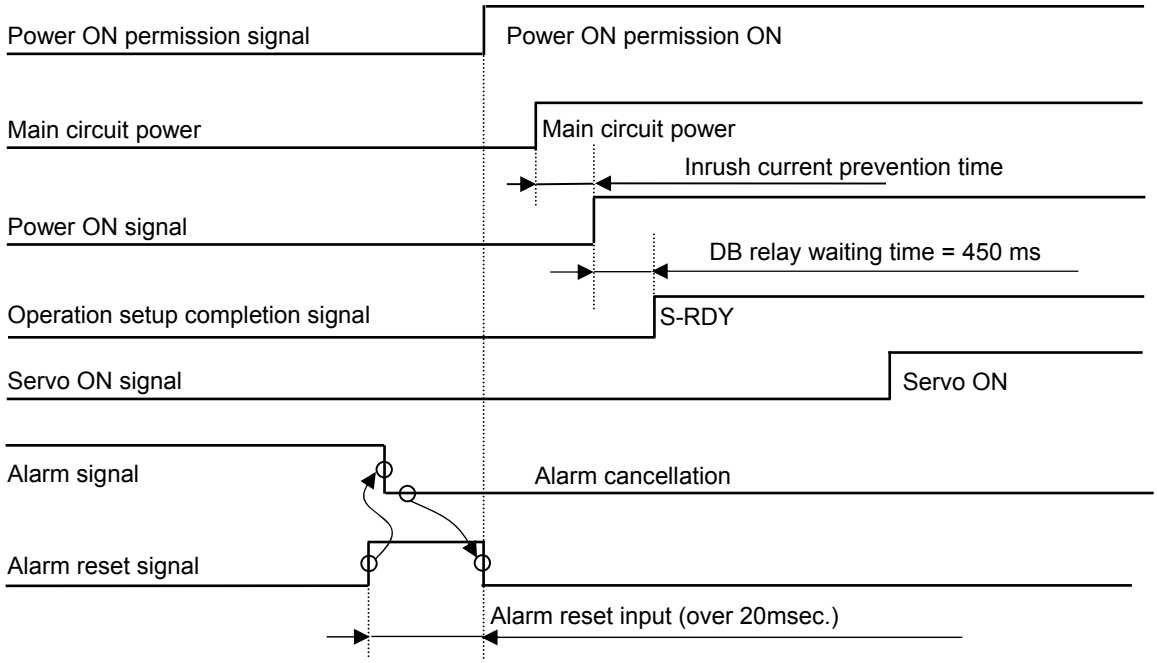
Stop by servo brake at alarm




* The above sequence is the one when protective circuit is installed. Install a protective circuit seeing "4.1.6 Wiring example".
* For servo motor R2CA3255KB, there is no specification with brake.
* For amplifier unit RS3D80#, dynamic brake circuit is not included. Just provides a contact output.

## 5.4.3 Sequence of alarm reset

Inputting alarm reset signal from general input signal can reset alarms.

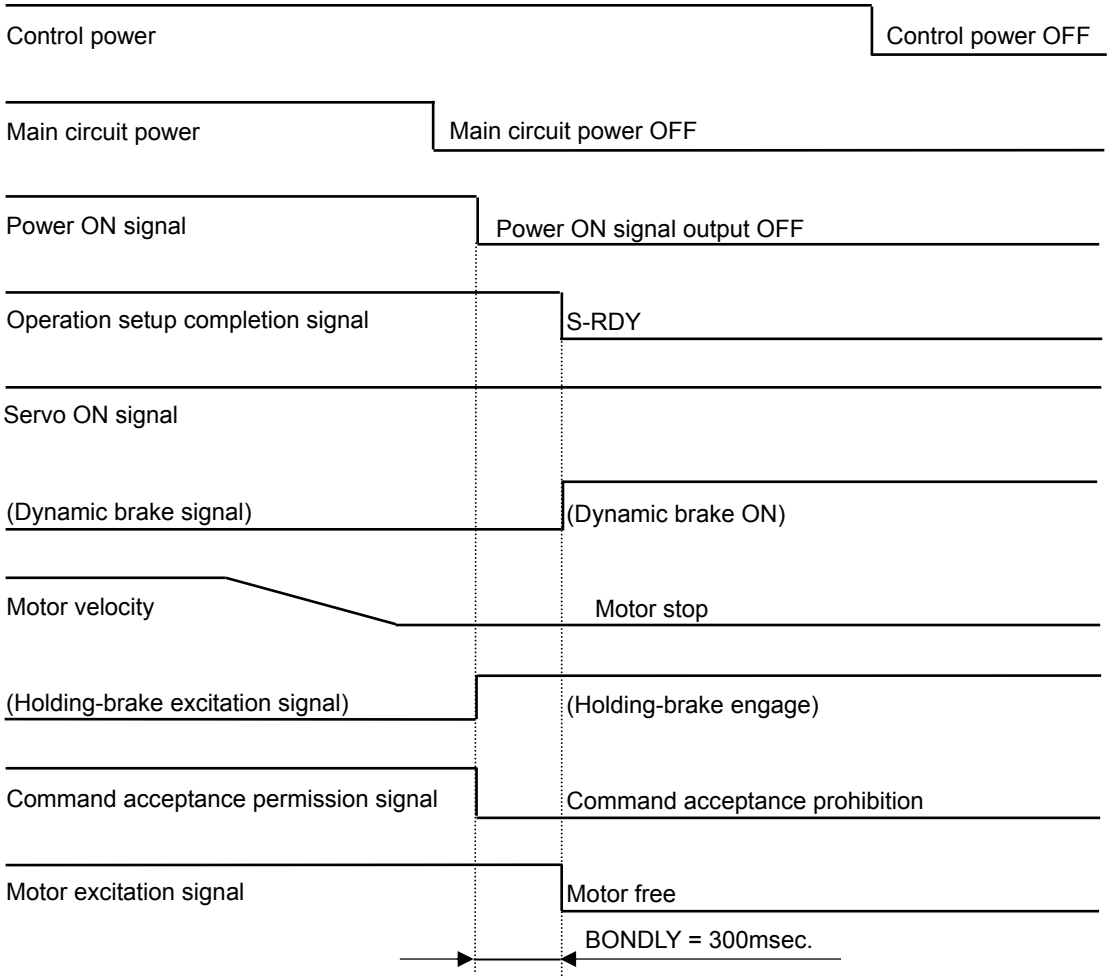



* Some alarms cannot be reset unless the power is reset (control power is turned OFF and ON again), or encoder is cleared.
See "8.2 List of warning and alarm".

* Turn the alarm reset signal off after checking if the alarm signal is cleared. The alarm signal cannot be cleared when the alarm condition is continued, therefore, set a timeout period of 20ms or more to clear “alarm reset signal”.
Also, it is necessary to input the time of 20 ms or more when the alarm reset signal is input without checking for the alarm signal output.

### 5.4.4 Sequence when power is turned OFF during operation (During servo ON)

Stop by servo brake




* This is the sequence when "00: SERVO-BRAKE" is selected at GroupB ID02 "Emergency Stop Operation".
* For servo motor R2CA3255KB, there is no specification with brake.
* For amplifier unit RS3D80#, dynamic brake circuit is not included. Just provides a contact output.

# 5. Operation

## 5.5 Monitor function

### 5.5.1 Monitor list

| ID | Symbol | Name | | Unit |
|---|---|---|---|---|
| 00 | STATUS | Amplifier unit status monitor | | --- |
| 01 | WARNING1 | Warning status 1 monitor | | --- |
| 02 | WARNING2 | Warning status 2 monitor | | --- |
| 03 | WARNING3 | Warning status 3 monitor | | --- |
| 04 | WARNING4 | Warning status 4 monitor | | --- |
| 05 | CONT8-1 | General Purpose Input CONT8 to 1 monitor | | --- |
| 06 | OUT8-1 | General Purpose Output OUT8 to 1 monitor | | --- |
| 07 | INC-E MON | Incremental encoder signal monitor | | --- |
| 10 | APMON | Present position monitor (Motor encoder) | Digital operator: Displays upper data | $\times 2^{32}$ Pulse |
| 11 | | | Digital operator: Displays lower data | Pulse |
| 12 | CPMON | Command position monitor | Digital operator: Displays upper data | $\times 2^{32}$ Pulse |
| 13 | | | Digital operator: Displays lower data | Pulse |
| 14 | PMON | Position deviation monitor | | Pulse |
| 15 | VMON | Velocity monitor | | $min^{-1}$ |
| 16 | VCMON | Velocity command monitor | | $min^{-1}$ |
| 17 | TMON | Torque monitor | | % |
| 18 | TCMON | Torque command monitor | | % |
| 19 | ACCMON | Acceleration monitor | | $rad/s^2$ |
| 1A | MTLMON-EST | Load Torque monitor (Estimate value) | | % |
| 30 | FMON1 | Position command pulse frequency monitor | | k Pulse/s |
| 31 | VC/TC-IN | Analog velocity command/Analog torque command input voltage monitor | | mV |
| 32 | MTCOMP | Analog torque addition command input voltage monitor | | mV |
| 33 | ABSPS | Absolute encoder PS data monitor | Digital operator: Displays upper data | $\times 2^{32}$ Pulse |
| 34 | | | Digital operator: Displays lower data | Pulse |
| 35 | MMOENCF | Motor Encoder frequency monitor | | kPulse/s |
| 36 | CSU | U-phase electric angle monitor | | degree |
| 40 | RegP | Regenerative resistor operation percentage monitor | | % |
| 41 | TRMS | Effective torque monitor | | % |
| 42 | ETRMS | Effective torque monitor (Estimated value) | | % |
| 44 | VBUS | Vbus monitor | | V |
| 45 | ENTMP | Encoder temperature monitor | | degreeC |
| 46 | MATEMP | Amplifier temperature monitor | | degreeC |
| 47 | RUNTIM | Amplifier Operation Time | | h:mm:ss.ms |
| 4A | MAVEPOW1 | Average electric power monitor | | W |
| 4B | MAVEPOW2 | Average electric power monitor | | kW |
| 4C | RegPOW | Regenerative power monitor | | W |
| 4D | PSTMP | Power unit internal temperature monitor | | Degree C |
| 50 | JRAT MON | Load Inertia Moment Ratio monitor | | % |
| 51 | MKP MON | Model Control Gain monitor | | 1/s |
| 52 | KP MON | Position Loop Proportional Gain monitor | | 1/s |
| 53 | TPI MON | Position Loop Integral Time Constant monitor | | ms |
| 54 | KVP MON | Velocity Loop Proportional Gain monitor | | Hz |
| 55 | TVI MON | Velocity Loop Integral Time Constant monitor | | ms |
| 56 | TCFIL MON | Torque Command Filter monitor | | Hz |
| 58 | ADNFE MON | Frequency monitor E for adaptive notch filter | | Hz |
| 60 | DFERR-MON | Dual position error monitor | | Pulse |
| 61 | EX-APMON | Present position monitor (External encoder) | Digital operator: Displays upper data | $\times 2^{32}$ Pulse |
| 62 | | | Digital operator: Displays lower data | Pulse |
| 63 | EX-ABSPS | External absolute encoder PS data monitor | Digital operator: Displays upper data | $\times 2^{32}$ Pulse |
| 64 | | | Digital operator: Displays lower data | Pulse |
| 65 | MEXENCF | Ext. Encoder frequency monitor | | kPulse/s |
| 66 | SYNERR | Axes-sync error monitor | | Pulse |
| 70 | RSRLYLF | Remaining life of relay for an inrush current prevention | | % |
| 73 | MOTE-ERRAT | Error rate of motor encoder communication | | --- |
| 74 | EXTE-ERRAT | Error rate of external encoder communication | | --- |
| 77 | HBLF | Remaining life of a holding brake | | % |
| 78 | IPMEL | Power module error occurred system | | --- |

## 5.5.2 Descriptions of each monitor

<table>
<tr><th>ID</th><th>Description</th></tr>
<tr><td>00</td><td>Amplifier unit status monitor [STATUS]
<table>
<tr><th>Code</th><th colspan="2">Status</th></tr>
<tr><td>1</td><td>Power OFF state</td><td>(P-OFF)</td></tr>
<tr><td>2</td><td>Power ON state</td><td>(P-ON)</td></tr>
<tr><td>3</td><td>Servo ready state</td><td>(S-RDY)</td></tr>
<tr><td>4</td><td>Servo ON state</td><td>(S-ON)</td></tr>
<tr><td>5</td><td>Servo OFF and stop status</td><td>(S-OFF)</td></tr>
<tr><td>6</td><td>Emergency stop state</td><td>(EMR)</td></tr>
<tr><td>11</td><td>Alarm and power OFF state</td><td>(ALARM_P-OFF)</td></tr>
<tr><td>12</td><td>Alarm and power ON state</td><td>(ALARM_P-ON)</td></tr>
<tr><td>16</td><td>Alarm and emergency stop state</td><td>(ALARM_EMR)</td></tr>
<tr><td>22</td><td>Gate off and power-on state</td><td>(GATE OFF_P-ON)</td></tr>
</table></td></tr>
<tr><td>01</td><td>Warning status 1 monitor [WARNING1]<br>■ Displays warning status. "1" or "ON" shows that the warning is active.
<table>
<tr><th>Bit</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td>Function</td><td>Regenerative overload</td><td>Overload</td><td>---</td><td>Power/Amplifier unit temperature</td></tr>
</table>
<table>
<tr><th>Bit</th><th>7</th><th>6</th><th>5</th><th>4</th></tr>
<tr><td>Function</td><td>Excessive deviation</td><td>---</td><td>Velocity command under limit</td><td>Torque command under limit</td></tr>
</table></td></tr>
<tr><td>02</td><td>Warning status 2 monitor [WARNING2]<br>■ Displays warning status. "1" or "ON" shows that the warning is active.
<table>
<tr><th>Bit</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td>Function</td><td>Negative direction Over-travel</td><td>Positive direction Over-travel</td><td>---</td><td>Main circuit power being charged</td></tr>
</table>
<table>
<tr><th>Bit</th><th>7</th><th>6</th><th>5</th><th>4</th></tr>
<tr><td>Function</td><td>---</td><td>Absolute encoder warning</td><td>---</td><td>---</td></tr>
</table></td></tr>
<tr><td>03</td><td>Warning status 3 monitor [WARNING3]<br>■ Displays warning status. "1" or "ON" shows that the warning is active.
<table>
<tr><th>Bit</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td>Function</td><td>Adaptive notch filter E frequency</td><td>---</td><td>Dual position error excess</td><td>Axes-sync error excess</td></tr>
</table>
<table>
<tr><th>Bit</th><th>7</th><th>6</th><th>5</th><th>4</th></tr>
<tr><td>Function</td><td>---</td><td>---</td><td>External encoder warning</td><td>---</td></tr>
</table></td></tr>
<tr><td>04</td><td>Warning status 4 monitor [WARNING4]<br>■ Displays warning status. "1" or "ON" shows that the warning is active.
<table>
<tr><th>Bit</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td>Function</td><td>---</td><td>---</td><td>---</td><td>---</td></tr>
</table>
<table>
<tr><th>Bit</th><th>7</th><th>6</th><th>5</th><th>4</th></tr>
<tr><td>Function</td><td>---</td><td>---</td><td>---</td><td>---</td></tr>
</table></td></tr>
</table>

# 5. Operation

<table>
<tr><th>ID</th><th>Description</th></tr>
<tr><td>05</td><td>
General input CONT8 to 1 monitor [CONT8-1]<br>
■ Displays generic input terminal status. It will be in a photo coupler excitation state by "1" or "ON".
<table>
<tr><td>Bit</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
<tr><td>Function</td><td>CONT4</td><td>CONT3</td><td>CONT2</td><td>CONT1</td></tr>
</table>
<table>
<tr><td>Bit</td><td>7</td><td>6</td><td>5</td><td>4</td></tr>
<tr><td>Function</td><td>CONT8</td><td>CONT7</td><td>CONT6</td><td>CONT5</td></tr>
</table>
</td></tr>
<tr><td>06</td><td>
General output OUT8 to 1 monitor [OUT8-1]<br>
■ Displays generic output terminal status. It will be in a photo coupler excitation state by "1" or "ON".
<table>
<tr><td>Bit</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
<tr><td>Function</td><td>OUT4</td><td>OUT3</td><td>OUT2</td><td>OUT1</td></tr>
</table>
<table>
<tr><td>Bit</td><td>7</td><td>6</td><td>5</td><td>4</td></tr>
<tr><td>Function</td><td>OUT8</td><td>OUT7</td><td>OUT6</td><td>OUT5</td></tr>
</table>
</td></tr>
<tr><td>07</td><td>
Incremental encoder signal monitor [INC-E MON]<br>
■ Displays incremental encoder signal status. "1" or "ON" shows an incoming signal level “H” state.
<table>
<tr><td>Bit</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
<tr><td>Function</td><td>---</td><td>EN1 encoder Z-phase signal</td><td>EN1 encoder B-phase signal</td><td>EN1 encoder A-phase signal</td></tr>
</table>
<table>
<tr><td>Bit</td><td>7</td><td>6</td><td>5</td><td>4</td></tr>
<tr><td>Function</td><td>---</td><td>EN2 encoder Z-phase signal</td><td>EN2 encoder B-phase signal</td><td>EN2 encoder A-phase signal</td></tr>
</table>
</td></tr>
</table>

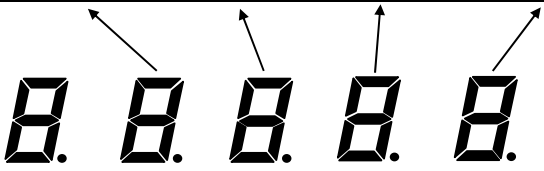
See tables below because display format of ID01 to 07 is different at the setup software and the digital operator.

■ Display of the setup software

| Bit | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| 0 or 1 | 0/1 | 0/1 | 0/1 | 0/1 | 0/1 | 0/1 | 0/1 | 0/1 |

■ Display of the Digital operator

| Bit | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| ON | | | | | | | | |
| OFF | | | | | | | | |
| - | LED4 | | LED3 | | LED2 | | LED1 | |



Digital operator at the front of amplifier unit

<table>
<tr><th>ID</th><th>Description</th></tr>
<tr><td>10<br>11</td><td>
Actual position monitor (Motor encoder) [APMON]<br>
■ Displays the current position of the motor encoder that has the origin as the position at the time the control power was turned ON.<br>
As this is a free run counter, if the current position exceeds the displayed range, the maximum reverse polarity value will be displayed.<br>
◆ Setup software displays the data to ID10.
<table>
<tr><th>Display range</th><th>Unit</th></tr>
<tr><td>-9223372036854775808 to 9223372036854775807</td><td>Pulse</td></tr>
</table>
◆ Digital operator displays the data to ID10, ID11 by hexadecimal notation (32-bit data).
<table>
<tr><th>ID</th><th>Data range</th><th>Display range</th><th>Unit</th></tr>
<tr><td>10</td><td>Bit63 to Bit32</td><td>H.8000 L.0000 to H.7FFF L.FFFF</td><td>×$2^{32}$ Pulse</td></tr>
<tr><td>11</td><td>Bit31 to Bit0</td><td>H.0000 L.0000 to H.FFFF L.FFFF</td><td>Pulse</td></tr>
</table>
</td></tr>
<tr><td>12<br>13</td><td>
Command position monitor [CPMON]<br>
■ Displays the current position of the pulse command that has the origin as the position at the time the control power was turned ON.<br>
As this is a free run counter, if the current position exceeds the displayed range, the maximum reverse polarity value will be displayed.<br>
◆ Setup software displays the data to ID12.
<table>
<tr><th>Display range</th><th>Unit</th></tr>
<tr><td>-9223372036854775808 to 9223372036854775807</td><td>Pulse</td></tr>
</table>
◆ Digital operator displays the data to ID12, ID13 by hexadecimal notation (32-bit data).
<table>
<tr><th>ID</th><th>Data range</th><th>Display range</th><th>Unit</th></tr>
<tr><td>12</td><td>Bit63 to Bit32</td><td>H.8000 L.0000 to H.7FFF L.FFFF</td><td>×$2^{32}$ Pulse</td></tr>
<tr><td>13</td><td>Bit31 to Bit0</td><td>H.0000 L.0000 to H.FFFF L.FFFF</td><td>Pulse</td></tr>
</table>
</td></tr>
<tr><td>14</td><td>
Position deviation monitor [PMON]<br>
■ Displays the position deviation value.<br>
◆ Setup software displays values in decimal notation.
<table>
<tr><th>Display range</th><th>Unit</th></tr>
<tr><td>-2147483648 to 2147483647</td><td>Pulse</td></tr>
</table>
◆ Digital operator displays values in hexadecimal notation.
<table>
<tr><th>ID</th><th>Data range</th><th>Display range</th><th>Unit</th></tr>
<tr><td>14</td><td>Bit31 to Bit0</td><td>H.8000 L.0000 to H.7FFF L.FFFF</td><td>Pulse</td></tr>
</table>
</td></tr>
</table>

<table>
<tr><th>ID</th><th>Description</th></tr>
<tr><td>15</td><td>
Velocity monitor [VMON]<br>
■ Displays the rotation speed of the servo motor.<br>
◆ Setup software displays values in decimal notation.
<table>
<tr><th>Display range</th><th>Unit</th></tr>
<tr><td>-2147483648 to 2147483647</td><td>$min^{-1}$</td></tr>
</table>
◆ Digital operator displays values in hexadecimal notation.
<table>
<tr><th>ID</th><th>Data range</th><th>Display range</th><th>Unit</th></tr>
<tr><td>15</td><td>Bit31 to Bit0</td><td>H.8000 L.0000 to H.7FFF L.FFFF</td><td>$min^{-1}$</td></tr>
</table>
</td></tr>
<tr><td>16</td><td>
Velocity command monitor [VCMON]<br>
■ Displays the velocity command value.<br>
◆ Setup software displays values in decimal notation.
<table>
<tr><th>Display range</th><th>Unit</th></tr>
<tr><td>-2147483648 to 2147483647</td><td>$min^{-1}$</td></tr>
</table>
◆ Digital operator displays values in hexadecimal notation.
<table>
<tr><th>ID</th><th>Data range</th><th>Display range</th><th>Unit</th></tr>
<tr><td>16</td><td>Bit31 to Bit0</td><td>H.8000 L.0000 to H.7FFF L.FFFF</td><td>$min^{-1}$</td></tr>
</table>
</td></tr>
<tr><td>17</td><td>
Torque monitor [TMON]<br>
■ Displays the output torque of servo motor.
<table>
<tr><th>Display range</th><th>Unit</th></tr>
<tr><td>-499.9 to 499.9</td><td>%</td></tr>
</table>
</td></tr>
<tr><td>18</td><td>
Torque command monitor [TCMON]<br>
■ Displays the torque command value.
<table>
<tr><th>Display range</th><th>Unit</th></tr>
<tr><td>-499.9 to 499.9</td><td>%</td></tr>
</table>
</td></tr>
<tr><td>19</td><td>
Acceleration monitor [ACCMON]<br>
■ Displays the servo motor acceleration.<br>
◆ Setup software displays values in decimal notation.
<table>
<tr><th>Display range</th><th>Unit</th></tr>
<tr><td>-2147483648 to 2147483647</td><td>$rad/s^2$</td></tr>
</table>
◆ Digital operator displays values in hexadecimal notation.
<table>
<tr><th>ID</th><th>Data range</th><th>Display range</th><th>Unit</th></tr>
<tr><td>19</td><td>Bit31 to Bit0</td><td>H.8000 L.0000 to H.7FFF L.FFFF</td><td>$rad/s^2$</td></tr>
</table>
</td></tr>
</table>

<table>
<tr><th>ID</th><th>Description</th></tr>
<tr><td>1A</td><td>Load Torque monitor (Estimate value) [MTLMON-EST]<br>■ Displays the estimated value of load torque.
<table>
<tr><th>Display range</th><th>Unit</th></tr>
<tr><td>-499.9 to 499.9</td><td>%</td></tr>
</table></td></tr>
<tr><td>30</td><td>Position command pulse frequency monitor [FMON1]<br>■ Displays the entered command pulse frequency.<br>◆ Setup software displays values in decimal notation.
<table>
<tr><th>Display range</th><th>Unit</th></tr>
<tr><td>-2147483648 to 2147483647</td><td>kPulse/s</td></tr>
</table>
◆ Digital operator displays values in hexadecimal notation.
<table>
<tr><th>ID</th><th>Data range</th><th>Display range</th><th>Unit</th></tr>
<tr><td>30</td><td>Bit31 to Bit0</td><td>H.8000 L.0000 to H.7FFF L.FFFF</td><td>kPulse/s</td></tr>
</table></td></tr>
<tr><td>31</td><td>Analog velocity command/Analog torque command input voltage monitor [VC/TC-IN]<br>■ Displays the entered command voltage.<br>◆ Displays with mV unit at the setup software.
<table>
<tr><th>Display range</th><th>Unit</th></tr>
<tr><td>-12000 to 12000</td><td>mV</td></tr>
</table>
◆ Displays with 10mV unit at the digital operator.
<table>
<tr><th>Display range</th><th>Unit</th></tr>
<tr><td>-1200 to 1200</td><td>x10mV</td></tr>
</table></td></tr>
<tr><td>32</td><td>Analog torque addition command input voltage monitor [MTCOMP]<br>■ Displays the entered command voltage.<br>◆ Displays with mV unit at the setup software.
<table>
<tr><th>Display range</th><th>Unit</th></tr>
<tr><td>-12000 to 12000</td><td>mV</td></tr>
</table>
◆ Displays with 10mV unit at the digital operator.
<table>
<tr><th>Display range</th><th>Unit</th></tr>
<tr><td>-1200 to 1200</td><td>x10mV</td></tr>
</table></td></tr>
<tr><td>33<br>34</td><td>Absolute encoder PS data monitor (motor encoder) [ABSPS]<br>■ Displays position data of absolute encoder.<br>◆ Setup software displays the data to ID33.
<table>
<tr><th>Display range</th><th>Unit</th></tr>
<tr><td>0 to FFFFFFFFFFFFFFFF</td><td>Pulse</td></tr>
</table>
(Actual display range varies depending on the encoder specifications.)<br>◆ Digital operator displays the data to ID33, ID34 by hexadecimal notation (32-bit data).
<table>
<tr><th>ID</th><th>Data range</th><th>Display range</th><th>Unit</th></tr>
<tr><td>33</td><td>Bit63 to Bit32</td><td>H.0000 L.0000 to H.FFFF L.FFFF</td><td>×$2^{32}$ Pulse</td></tr>
<tr><td>34</td><td>Bit31 to Bit0</td><td>H.0000 L.0000 to H.FFFF L.FFFF</td><td>Pulse</td></tr>
</table></td></tr>
</table>

<table>
<tr><th>ID</th><th>Description</th></tr>
<tr><td>35</td><td>
Motor Encoder frequency monitor [MMOENCF]<br>
■ Displays the motor encoder frequency of incremental encoder.<br>
◆ Setup software displays values in decimal notation.
<table>
<tr><th>Display range</th><th>Unit</th></tr>
<tr><td>-2147483648 to 2147483647</td><td>kPulse/s</td></tr>
</table>
◆ Digital operator displays values in hexadecimal notation.
<table>
<tr><th>ID</th><th>Data range</th><th>Display range</th><th>Unit</th></tr>
<tr><td>35</td><td>Bit31 to Bit0</td><td>H.8000 L.0000 to H.7FFF L.FFFF</td><td>kPulse/s</td></tr>
</table>
</td></tr>
<tr><td>36</td><td>
U-phase electric angle monitor [CSU]<br>
■ Displays U-phase electric angle. Always displayed except when encoder errors.
<table>
<tr><th>Display range</th><th>Unit</th></tr>
<tr><td>0 to 359</td><td>deg</td></tr>
</table>
</td></tr>
<tr><td>40</td><td>
Regenerative resistor operation percentage monitor [RegP]<br>
■ Displays the working ratio of regenerative resistor.
<table>
<tr><th>Display range</th><th>Unit</th></tr>
<tr><td>0.00 to 99.99</td><td>%</td></tr>
</table>
</td></tr>
<tr><td>41</td><td>
Effective torque monitor [TRMS]<br>
■ Displays effective torque. Depending on the operation pattern, it may take some hours to become stable.
<table>
<tr><th>Display range</th><th>Unit</th></tr>
<tr><td>0 to 499</td><td>%</td></tr>
</table>
</td></tr>
<tr><td>42</td><td>
Effective torque monitor (Estimated value) [ETRMS]<br>
■ Displays the effective torque estimation value. Estimates from short time operation. This can be confirmed shortly if the same operation pattern is repeated.
<table>
<tr><th>Display range</th><th>Unit</th></tr>
<tr><td>0 to 499</td><td>%</td></tr>
</table>
</td></tr>
<tr><td>44</td><td>
Vbus monitor [VBUS]<br>
■ Displays the dc value at main circuit.
<table>
<tr><th>Display range</th><th>Unit</th></tr>
<tr><td>0 to 1000</td><td>V</td></tr>
</table>
</td></tr>
<tr><td>45</td><td>
Encoder temperature monitor [ENTMP]<br>
■ Displays internal temperature of encoder.
<table>
<tr><th>Display range</th><th>Unit</th></tr>
<tr><td>-40 to 127</td><td>degree C</td></tr>
</table>
* Not shown with incremental encoder.
</td></tr>
</table>

* Please use following conversion to convert "Effective torque monitor" or "Effective torque monitor (Estimated value)" to Motor Operating Rate Monitor which used for RS1 amplifier.

Motor Operating Rate Monitor [%] = (Effective torque monitor display value [%] / 100)$^2$ x 100

<table>
<tr><th>ID</th><th>Description</th></tr>
<tr><td>46</td><td>Amplifier unit temperature monitor [MATEMP]<br>■ Displays internal temperature of servo amplifier.<br><table><tr><th>Display range</th><th>Unit</th></tr><tr><td>-15 to 150</td><td>degree C</td></tr></table>◆ Internal temperature of amplifier unit is the point near to power device.</td></tr>
<tr><td>47</td><td>Amplifier Operation Time [RUNTIM]<br>■ Displays the total time of control power ON.<br><table><tr><th>Display format</th></tr><tr><td>Hour (h) : Minute (mm) : Second (ss) . Millisecond (ms)</td></tr></table>◆ See "7.3 Setting and display range" for the digital operator display.</td></tr>
<tr><td>4A</td><td>Average electric power monitor [MAVEPOW1]<br>■ Average electric power monitor shows a measurement result every 1 minute.<br><table><tr><th>Display range</th><th>Unit</th></tr><tr><td>-999,999.9 to 999,999.9</td><td>[W]</td></tr></table>◆ Refer to "7.3 Setting and display range" for the display of the digital operator.<br>* Not shown with the motor except standard spec R series.<br>* For the 400V AC input type, accuracy will be ±30% (at the accel/decel operation with 100% effective torque).<br>* For external regenerative resistor use, must set regenerative resistor value correctly to the system parameter ID_0B.<br>* (Accuracy may be worse when it is used at the instantaneous area of Velocity-torque characteristics.)</td></tr>
<tr><td>4B</td><td>Average electric power monitor [MAVEPOW2]<br>■ Average electric power monitor shows a measurement result every 1 minute.<br><table><tr><th>Display range</th><th>Unit</th></tr><tr><td>-999.9 to 999.9</td><td>[kW]</td></tr></table>* Not shown with the motor except R series.<br>* For 400V AC input type, accuracy will be ±30% (at the accel/decel operation with 100% effective torque).<br>* For external regenerative resistor use, must set regenerative resistor value correctly to the system parameter ID_0B.<br>* (Accuracy may be worse when it is used at the instantaneous area of Velocity-torque characteristics.)</td></tr>
<tr><td>4C</td><td>Regenerative power monitor [RegPOW]<br>■ Displays the consumption power of regenerative resistor.<br><table><tr><th>Display range</th><th>Unit</th></tr><tr><td>0 to 4294967.295</td><td>W</td></tr></table></td></tr>
<tr><td>4D</td><td>Power unit internal temperature monitor [PSTMP]<br>■ Displays the power unit internal temperature.<br><table><tr><th>Display range</th><th>Unit</th></tr><tr><td>-15 to 150</td><td>Degree C</td></tr></table>◆ It shows the temperature near power device IC.</td></tr>
</table>

<table>
<tr><th>ID</th><th>Description</th></tr>
<tr><td>50</td><td>Load inertia moment ratio monitor [JRAT MON]<br>■ Displays the present load inertia moment ratio.<br>Value can check when using gain switching and auto-tuning function.</td></tr>
<tr><td>51</td><td>Model Control Gain monitor [MKP MON]<br>■ Displays the present Model Control Gain.<br>Value can check when using gain switching and auto-tuning function.</td></tr>
<tr><td>52</td><td>Position Loop Proportional Gain monitor [KP MON]<br>■ Displays the present Position Loop Proportional Gain.<br>Value can check when using gain switching and auto-tuning function.</td></tr>
<tr><td>53</td><td>Position Loop Integral Time Constant monitor [TPI MON]<br>■ Displays the present Position Loop Integral Time Constant.<br>Value can check when using gain switchinga function.</td></tr>
<tr><td>54</td><td>Velocity Loop Proportional Gain monitor [KVP MON]<br>■ Displays the present Velocity Loop Proportional Gain.<br>Value can check when using gain switching and auto-tuning function.</td></tr>
<tr><td>55</td><td>Velocity Loop Integral Time Constant monitor [TVI MON]<br>■ Displays the present Velocity Loop Integral Time Constant.<br>Value can check when using gain switching and auto-tuning function.</td></tr>
<tr><td>56</td><td>Torque Command Filter monitor [TCFIL MON]<br>■ Displays the present Torque Command Filter.<br>Value can check when using gain switching and auto-tuning function.</td></tr>
<tr><td>58</td><td>Frequency monitor E for adaptive notch filter [ADNFE MON]<br>■ Displays the adaptive notch filter frequency.
<table>
<tr><th>Display range</th><th>Unit</th></tr>
<tr><td>100 to 1000, 4000</td><td>Hz</td></tr>
</table>
</td></tr>
<tr><td>60</td><td>Dual position error monitor [DFERR-MON]<br>■ Displays the difference of current position between an external encoder and a motor encoder of after feedback pulse electronic gear.<br>This value can check in use of full-closed control.<br>◆ Setup software displays values in decimal notation.
<table>
<tr><th>Display range</th><th>Unit</th></tr>
<tr><td>-2147483648 to 2147483647</td><td>Pulse</td></tr>
</table>
◆ Digital operator displays values in hexadecimal notation.
<table>
<tr><th>ID</th><th>Data range</th><th>Display range</th><th>Unit</th></tr>
<tr><td>60</td><td>Bit31 to Bit0</td><td>H.8000 L.0000 to H.7FFF L.FFFF</td><td>Pulse</td></tr>
</table>
</td></tr>
</table>

| ID | Description |
|---|---|
| 61<br>62 | Present position monitor (External encoder) [EX-APMON]<br>■ Displays the current position of the external encoder that has the origin as the position at the time the control power was turned ON.<br>As this is a free run counter, if the current position exceeds the displayed range, the maximum reverse polarity value will be displayed.<br>◆ Setup software displays the data to ID61.<br>Display range: -9223372036854775808 to 9223372036854775807 / Unit: Pulse<br>◆ Digital operator displays the data to ID61, ID62 by hexadecimal notation (32-bit data).<br>ID 61: Data range Bit63 to Bit32 / Display range H.8000 L.0000 to H.7FFF L.FFFF / Unit ×$2^{32}$ Pulse<br>ID 62: Data range Bit31 to Bit0 / Display range H.0000 L.0000 to H.FFFF L.FFFF / Unit Pulse |
| 63<br>64 | External absolute encoder PS data monitor [EX-ABSPS]<br>■ Displays position data of external absolute encoder.<br>◆ Setup software displays the data to ID63.<br>Display range: 0 to FFFFFFFFFFFFFFFF / Unit: Pulse<br>(Actual display range varies depending on the encoder specifications.)<br>◆ Digital operator displays the data to ID63, ID64 by hexadecimal notation (32-bit data).<br>ID 63: Data range Bit63 ～ Bit32 / Display range H.0000 L.0000 to H.FFFF L.FFFF / Unit × $2^{32}$ Pulse<br>ID 64: Data range Bit31 ～ Bit0 / Display range H.0000 L.0000 to H.FFFF L.FFFF / Unit Pulse |
| 65 | Ext. Encoder frequency monitor [MEXENCF]<br>■ Displays the external encoder frequency of incremental encoder.<br>◆ Setup software displays values in decimal notation.<br>Display range: -2147483648 to 2147483647 / Unit: kPulse/s<br>◆ Digital operator displays values in hexadecimal notation (32-bit data).<br>ID 65: Data range Bit31 to Bit0 / Display range H.8000 L.0000 to H.7FFF L.FFFF / Unit kPulse/s |
| 66 | Axes-sync error monitor [SYNERR]<br>■ Displays position deviation error between own axis and counterpart axis.<br>◆ Setup software displays values in decimal notation.<br>Display range: -2147483648 to 2147483647 / Unit: Pulse<br>◆ Digital operator displays values in hexadecimal notation.<br>ID 66: Data range Bit31 to Bit0 / Display range H.8000 L.0000 to H.7FFF L.FFFF / Unit Pulse |

<table>
<tr><th>ID</th><th>Description</th></tr>
<tr><td>70</td><td>Remaining life of relay for an inrush current prevention [RSRLYLF]<br>■ Displays the remaining life of relay for an inrush current prevention.<br><table><tr><th>Display range</th><th>Unit</th></tr><tr><td>0 to 100.00</td><td>%</td></tr></table>* RS3D80# does not support this function.</td></tr>
<tr><td>73</td><td>Error rate of motor encoder communication [MOTE-ERRAT]<br>■ Displays the error rate of motor encoder communication.<br>It shows error count ratio against communication count per second.<br><table><tr><th>Display range</th><th>Unit</th></tr><tr><td>0.000000 to 1.000000</td><td>-</td></tr></table></td></tr>
<tr><td>74</td><td>Error rate of external encoder communication [EXTE-ERRAT]<br>■ Displays the Error rate of external encoder communication.<br>It shows error count ratio against communication count per second.<br><table><tr><th>Display range</th><th>Unit</th></tr><tr><td>0.000000 to 1.000000</td><td>-</td></tr></table></td></tr>
<tr><td>77</td><td>Remaining life of a holding brake [HBLF]<br>■ Displays the remaining life of a holding brake.<br><table><tr><th>Display range</th><th>Unit</th></tr><tr><td>0 to 100.00</td><td>%</td></tr></table>* Displays just when the servo motor with holding brake is used.<br>* It doesn't display if combining the servo motor which is not support this function.</td></tr>
<tr><td>78</td><td>Power module error occurred system [IPMEL]<br>■ Displays information of power module error occurred system. "1" or "ON" means into error occurrence.<br><table><tr><th>Bit</th><th>3</th><th>2</th><th>1</th><th>0</th></tr><tr><td>System</td><td>---</td><td>System 2,<br>U-phase</td><td>System 2,<br>V-phase</td><td>System 2,<br>W-phase</td></tr></table><table><tr><th>Bit</th><th>7</th><th>6</th><th>5</th><th>4</th></tr><tr><td>System</td><td>---</td><td>System 1,<br>U-phase</td><td>System 1,<br>V-phase</td><td>System 1,<br>W-phase</td></tr></table></td></tr>
</table>

## 5.6 Analog monitor and digital monitor

All signals and internal status of the amplifier unit can be monitored by using the dedicated Monitor Box and cable. See "12.6 Optional parts" for the details of monitor box and dedicated cable.
Analog monitor output 1 is output also from “CN1-pin30”.

■ Selection of output signal
Selecting and changing the output signal to be used from the parameters list below.

| | |
|---|---|
| General parameters GroupA ID10 | DMON: Digital Monitor Output Signal Selection |
| General parameters GroupA ID11 | Analog Monitor Selection for Output 1 |
| General parameters GroupA ID12 | Analog Monitor Selection for Output 2 |

# 5. Operation

## 5.7 Setting parameters

### 5.7.1 Parameters list

Below is the parameters list that classified to each Group and put in ID order. “System parameters”, “General parameters” and “Motor parameters” are retained in the amplifier unit by running the parameter back-up function, and they can reload as needed.
See another manual: M0010842 for the setup software operation.

■ General parameters group list

| Group | Classification of the parameters in the group |
|---|---|
| Group0 | Auto-tuning settings |
| Group1 | Basic control parameter settings |
| Group2 | FF (feed forward) vibration suppression control/ Notch filter/ Disturbance observer settings |
| Group3 | Model following control settings |
| Group4 | Gain switching control/ Vibration suppression frequency switching settings |
| Group5 | Higher settling control settings |
| Group8 | Control system settings |
| Group9 | Function enabling condition settings |
| GroupA | General output terminal output condition/ Monitor output selection |
| GroupB | Sequence/alarm related settings |
| GroupC | Encoder related settings |
| GroupD | Support function related settings |

* Parameters vary depending on the amplifier unit to be used.
* Setup software does not display invalid parameters.
The Digital Operator cannot change the setting value.

■ General parameters Group0 "Auto-tuning settings"

| ID | Symbol | Name | Control mode | Default value | Unit | Setting range |
|---|---|---|---|---|---|---|
| 00 | TUNMODE | Tuning Mode | M,P,V,T | 00:AutoTun | — | 00 to 02 |
| 01 | ATCHA | Auto-Tuning Characteristic | M,P,V,T | 00:Positioning1 | — | 00 to 06 |
| 02 | ATRES | Auto-Tuning Response | M,P,V,T | 5 | — | 1 to 40 |
| 03 | ATSAVE | Auto-Tuning Automatic Parameter Saving | M,P,V,T | 00:Auto_Saving | — | 00 to 01 |
| 04 | ATCSEL | Auto-Tuning characteristic compatible mode | M,P,V,T | 00:Disable | — | 00 to 01 |
| 10 | ANFILTC | Auto-Notch Filter Tuning Torque Command | M,P,V,T | 50.0 | % | 10.0 to 100.0 |
| 20 | ASUPTC | Auto-FF Vibration Suppression Frequency Tuning Torque Command | M,P | 25.0 | % | 10.0 to 100.0 |
| 21 | ASUPFC | Auto-FF Vibration Suppression Frequency Tuning Friction Compensation Value | M,P | 5.0 | % | 0.0 to 50.0 |
| 34 | ADNFE | Adaptive notch filter function E | M,P,V | 00:Adp_Filter Disable | — | 00 to 01 |
| 35 | ADNFUE | Adaptive notch filter frequency upper limit E | M,P,V | 1000 | Hz | 100 to 1000 |
| 36 | ADNFLE | Adaptive notch filter frequency lower limit E | M,P,V | 100 | Hz | 100 to 1000 |
| 37 | ADNSVE | Adaptive notch filter E auto saving | M,P,V | 00:Auto_Saving | — | 00 to 01 |

* M = Model following control type, P = Position control type, V = Velocity control type, T = Torque control type

■ General parameters Group1 "Basic control parameter settings"

| ID | Symbol | Name | Control mode | Default value | Unit | Setting range |
|---|---|---|---|---|---|---|
| 00 | PCSMT | Position Command Smoothing Constant | M,P | 0.0 | ms | 0.0 to 500.0 |
| 01 | PCFIL | Position Command Filter | M,P | 0.0 | ms | 0.0 to 2000.0 |
| 02 | KP1 | Position Loop Proportional Gain 1 | M,P | 30 | 1/s | 1 to 3000 |
| 03 | TPI1 | Position Loop Integral Time Constant 1 | M,P | 1000.0 | ms | 0.3 to 1000.0 |
| 04 | PLPHLK | Position loop phase lead compensation gain | M,P | 0 | % | 0 to 100 |
| 05 | PLPHLF | Position loop phase lead compensation frequency | M,P | 500 | Hz | 10 to 4000 |
| 06 | FFGN | Velocity Feed Forward Gain | P | 0 | % | 0 to 100 |
| 07 | FFFIL | Velocity Feed Forward Filter | P | 4000 | Hz | 1 to 4000 |
| 08 | TRCPGN | Higher Tracking Control Position Compensation Gain | M (*1), P | 0 | % | 0 to 100 |
| 10 | VCFIL | Velocity Command Filter | M,P,V | 4000 | Hz | 1 to 4000 |
| 11 | VDFIL | Velocity Detection Filter | M,P,V | 1500 | Hz | 1 to 4000 |
| 12 | KVP1 | Velocity Loop Proportional Gain 1 | M,P,V | 50 | Hz | 1 to 2000 |
| 13 | TVI1 | Velocity Loop Integral Time Constant 1 | M,P,V | 20.0 | ms | 0.3 to 1000.0 |
| 14 | JRAT1 | Load Inertia Moment Ratio 1 | M,P,V | 100 | % | 0 to 15000 |
| 15 | VLPHLK | Velocity loop phase lead compensation gain | M,P,V | 0 | % | 0 to 100 |
| 16 | VLPHLF | Velocity loop phase lead compensation frequency | M,P,V | 500 | Hz | 10 to 4000 |
| 17 | HKVIK | High order integral control gain | M,P,V | 0 | % | 0 to 100 |
| 18 | HKVIF | High order integral control frequency | M,P,V | 500 | Hz | 10 to 4000 |
| 19 | TFFK | Torque feedforward gain | P,V | 0 | % | 0 to 100 |
| 1A | TFFAVE | Torque feedforward averaging | P,V | 01:4timesAverage | — | 00 to 01 |
| 1B | TFFOUT | Torque feedforward output selection | P,V | 00:Before_Filter | — | 00 to 01 |
| 1C | AFBK | Acceleration Feedback Gain | M,P,V | 0.0 | % | -100.0 to 100.0 |
| 1D | AFBFIL | Acceleration Feedback Filter | M,P,V | 500 | Hz | 1 to 4000 |
| 1E | TRCVGN | Higher Tracking Control Velocity Compensation Gain | P,V | 0 | % | 0 to 100 |
| 20 | TCFIL1 | Torque Command Filter 1 | M,P,V,T | 600 | Hz | 1 to 4000 |
| 21 | TCFILOR | Torque Command Filter Order | M,P,V,T | 2 | Order | 1 to 3 |
| 30 | DFBCG | Dual position feedback gain | M,P | 0 | % | 0 to 100 |
| 31 | DFBFIL | Dual position feedback filter | M,P | 0.0 | ms | 0.0 to 2000.0 |
| 80 | KSCPGN | Axes-sync compensation proportional gain | P | 0 | % | 0 to 1000 |
| 81 | TSCIGN | Axes-sync compensation integral time constant | P | 1000.0 | ms | 0.5 to 1000.0 |
| 82 | SCFIL | Axes-sync compensation filter | P | 0.0 | ms | 0.0 to 1000.0 |

* M = Model following control type, P = Position control type, V = Velocity control type, T = Torque control type

*1: It can not use when "03:Model1/Standard" or "04:Model2/Standard" are selected to the system parameter ID07.

■ General parameters Group2 "FF (Feed forward) vibration suppression control/ Notch filter/ Disturbance observer settings"

| ID | Symbol | Name | Control mode | Default value | Unit | Setting range |
|---|---|---|---|---|---|---|
| 00 | SUPFRQA1 | FF Vibration Suppression Frequency A1 | M,P | 500.0 | Hz | 1.0 to 500.0 |
| 01 | SUPLVA | FF Vibration Suppression Level Selection A | M,P | 00 | - | 00 to 03 |
| 02 | SUPFRQB1 | FF Vibration Suppression Frequency B1 | M,P | 500.0 | Hz | 1.0 to 500.0 |
| 03 | SUPCRB | FF Vibration Suppression Level Selection B | M,P | 00 | - | 00 to 01 |
| 10 | VCNFIL | Velocity Command Notch Filter | M,P,V | 1000 | Hz | 50 to 1000 |
| 20 | TCNFILA | Torque Command Notch Filter A | M,P,V,T | 4000 | Hz | 100 to 4000 |
| 21 | TCNFPA | TCNFILA, Low Frequency Phase Delay Improvement | M,P,V,T | 0 | - | 0 to 2 |
| 22 | TCNFILB | Torque Command Notch Filter B | M,P,V,T | 4000 | Hz | 100 to 4000 |
| 23 | TCNFDB | TCNFILB, Depth Selection | M,P,V,T | 0 | - | 0 to 15 |
| 24 | TCNFILC | Torque Command Notch Filter C | M,P,V,T | 4000 | Hz | 100 to 4000 |
| 25 | TCNFDC | TCNFILC, Depth Selection | M,P,V,T | 0 | - | 0 to 15 |
| 26 | TCNFILD | Torque Command Notch Filter D | M,P,V,T | 4000 | Hz | 100 to 4000 |
| 27 | TCNFDD | TCNFILD, Depth Selection | M,P,V,T | 0 | - | 0 to 15 |
| 28 | TCNFILE | Torque Command Notch Filter E | M,P,V,T | 4000 | Hz | 100 to 4000 |
| 29 | TCNFDE | TCNFILE, Depth Selection | M,P,V,T | 0 | - | 0 to 15 |
| 30 | OBCHA | Observer Characteristic | M,P,V | 00:Low | - | 00 to 02 |
| 31 | OBG | Observer Compensation Gain | M,P,V | 0 | % | 0 to 100 |
| 32 | OBLPF | Observer Output Low-pass Filter | M,P,V | 50 | Hz | 1 to 4000 |
| 33 | OBNFIL | Observer Output Notch Filter | M,P,V | 4000 | Hz | 100 to 4000 |
| 40 | STV | Effective velocity for compensating stick-slip behavior | M,P,V,T | 10.0 | $min^{-1}$ | 0.1 to 128.0 |
| 41 | STHLD | Retention time for compensating stick-slip behavior | M,P,V,T | 20 | ms | 1 to 500 |
| 42 | STTVI | Velocity loop integral time constant for stick-slip behavior compensation | M,P,V,T | 3.0 | ms | 0.3 to 1000 |
| 50 | CPVSFQ | CP vibration suppression control frequency | P,V | 100.0 | Hz | 10.0 to 100.0 |
| 51 | CPVSLV | CP vibration suppression control level | P,V | 00 | - | 00 to 03 |
| 52 | CPVSCR | CP vibration suppression control characteristics selection | P,V | 01 | - | 00 to 02 |
| 60 | FBHPLS | Minor vibration suppression pulse compensation value | M,P,V,T | 1 | Pulse | 1 to 100 |
| 61 | FBHTIM | Minor vibration suppression pulse compensation frequency | M,P,V,T | 1 | times | 1 to 100 |

* M = Model following control type, P = Position control type, V = Velocity control type, T = Torque control type

■ General parameters Group3 "Model following control settings"

| ID | Symbol | Name | Control mode | Default value | Unit | Setting range |
|---|---|---|---|---|---|---|
| 00 | KM1 | Model Control Gain 1 | M | 30 | 1/s | 1 to 3000 |
| 01 | MZETA | Model control damping coefficient | M | 100 | % | 0 to 100 |
| 02 | MFFGN | Model velocity feedforward gain | M | 0 | % | 0 to 100 |
| 03 | MTFFD | Model velocity feedforward differential time constant | M | 0.00 | ms | 0.00 to 10.00 |
| 04 | MFFFIL | Model velocity feedforward filter | M | 4000 | Hz | 1 to 4000 |
| 05 | OSSFIL | Overshoot Suppression Filter | M | 1500 | Hz | 1 to 4000 |
| 06 | ANRFRQ1 | Model Control Antiresonance Frequency 1 | M | 80.0 | Hz | 10.0 to 80.0 |
| 07 | RESFRQ1 | Model Control Resonance Frequency 1 | M | 80.0 | Hz | 10.0 to 80.0 |

* M = Model following control type, P = Position control type, V = Velocity control type, T = Torque control type

■ General parameters Group4 "Gain switching control/ Vibration suppression frequency switching settings"

| ID | Symbol | Name | Control mode | Default value | Unit | Setting range |
|---|---|---|---|---|---|---|
| 00 | KM2 | Model Control Gain 2 | M | 30 | 1/s | 1 to 3000 |
| 01 | KP2 | Position Loop Proportional Gain 2 | M,P | 30 | 1/s | 1 to 3000 |
| 02 | TPI2 | Position Loop Integral Time Constant 2 | M,P | 1000.0 | ms | 0.3 to 1000.0 |
| 03 | KVP2 | Velocity Loop Proportional Gain 2 | M,P,V | 50 | Hz | 1 to 2000 |
| 04 | TVI2 | Velocity Loop Integral Time Constant 2 | M,P,V | 20.0 | ms | 0.3 to 1000.0 |
| 05 | JRAT2 | Load Inertia Moment Ratio 2 | M,P,V | 100 | % | 0 to 15000 |
| 06 | TCFIL2 | Torque Command Filter 2 | M,P,V,T | 600 | Hz | 1 to 4000 |
| 10 | KM3 | Model Control Gain 3 | M | 30 | 1/s | 1 to 3000 |
| 11 | KP3 | Position Loop Proportional Gain 3 | M,P | 30 | 1/s | 1 to 3000 |
| 12 | TPI3 | Position Loop Integral Time Constant 3 | M,P | 1000.0 | ms | 0.3 to 1000.0 |
| 13 | KVP3 | Velocity Loop Proportional Gain 3 | M,P,V | 50 | Hz | 1 to 2000 |
| 14 | TVI3 | Velocity Loop Integral Time Constant 3 | M,P,V | 20.0 | ms | 0.3 to 1000.0 |
| 15 | JRAT3 | Load Inertia Moment Ratio 3 | M,P,V | 100 | % | 0 to 15000 |
| 16 | TCFIL3 | Torque Command Filter 3 | M,P,V,T | 600 | Hz | 1 to 4000 |
| 20 | KM4 | Model Control Gain 4 | M | 30 | 1/s | 1 to 3000 |
| 21 | KP4 | Position Loop Proportional Gain 4 | M,P | 30 | 1/s | 1 to 3000 |
| 22 | TPI4 | Position Loop Integral Time Constant 4 | M,P | 1000.0 | ms | 0.3 to 1000.0 |
| 23 | KVP4 | Velocity Loop Proportional Gain 4 | M,P,V | 50 | Hz | 1 to 2000 |
| 24 | TVI4 | Velocity Loop Integral Time Constant 4 | M,P,V | 20.0 | ms | 0.3 to 1000.0 |
| 25 | JRAT4 | Load Inertia Moment Ratio 4 | M,P,V | 100 | % | 0 to 15000 |
| 26 | TCFIL4 | Torque Command Filter 4 | M,P,V,T | 600 | Hz | 1 to 4000 |
| 30 | GCFIL | Gain Switching Filter | M,P,V | 0 | ms | 0 to 100 |
| 40 | SUPFRQA2 | FF Vibration Suppression Frequency A2 | M,P | 500.0 | Hz | 1.0 to 500.0 |
| 41 | SUPFRQA3 | FF Vibration Suppression Frequency A3 | M,P | 500.0 | Hz | 1.0 to 500.0 |
| 42 | SUPFRQA4 | FF Vibration Suppression Frequency A4 | M,P | 500.0 | Hz | 1.0 to 500.0 |
| 43 | SUPFRQB2 | FF Vibration Suppression Frequency B2 | M,P | 500.0 | Hz | 1.0 to 500.0 |
| 44 | SUPFRQB3 | FF Vibration Suppression Frequency B3 | M,P | 500.0 | Hz | 1.0 to 500.0 |
| 45 | SUPFRQB4 | FF Vibration Suppression Frequency B4 | M,P | 500.0 | Hz | 1.0 to 500.0 |
| 50 | ANRFRQ2 | Model Control Antiresonance Frequency 2 | M | 80.0 | Hz | 10.0 to 80.0 |
| 51 | RESFRQ2 | Model Control Resonance Frequency 2 | M | 80.0 | Hz | 10.0 to 80.0 |
| 52 | ANRFRQ3 | Model Control Antiresonance Frequency 3 | M | 80.0 | Hz | 10.0 to 80.0 |
| 53 | RESFRQ3 | Model Control Resonance Frequency 3 | M | 80.0 | Hz | 10.0 to 80.0 |
| 54 | ANRFRQ4 | Model Control Antiresonance Frequency 4 | M | 80.0 | Hz | 10.0 to 80.0 |
| 55 | RESFRQ4 | Model Control Resonance Frequency 4 | M | 80.0 | Hz | 10.0 to 80.0 |

* M = Model following control type, P = Position control type, V = Velocity control type, T = Torque control type

■ General parameters Group5 "High settling control settings"

| ID | Symbol | Name | Control mode | Default value | Unit | Setting range |
|---|---|---|---|---|---|---|
| 00 | CVFIL | Command Velocity Low-pass Filter | P | 1000 | Hz | 1 to 4000 |
| 01 | CVTH | Command Velocity Threshold | P | 20 | $min^{-1}$ | 0 to 65535 |
| 02 | ACCCO | Acceleration Compensation | P | 0 | ×50 Pulse | -9999 to 9999 |
| 03 | DECCO | Deceleration Compensation | P | 0 | ×50 Pulse | -9999 to 9999 |

* P = Position control type

■ General parameters Group8 "Control system settings"

| ID | Symbol | Name | Control mode | Default value | Unit | Setting range |
|---|---|---|---|---|---|---|
| 00 | CMDPOL | Position, Velocity, Torque Command Input Polarity | M,P,V,T | 00:PC+_VC+_TC+ | — | 00 to 07 |
| 01 | VC/TC-DW | Analog Velocity, Torque Command Input Dead Band Width | P,V,T | 0.0 | mV | 0.0 to 6553.5 |
| 10 | PMOD | Position Command Pulse Selection | M,P | 00:F-PC_R-PC | — | 00 to 02 |
| 11 | PCPPOL | Position Command Pulse Count Polarity | M,P | 00:Type1 | — | 00 to 03 |
| 12 | PCPFIL | Position Command Pulse Digital Filter | M,P | 00:850ns | — | 00 to 07 |
| 13 | B-GER1 | Electronic Gear 1 Numerator | M,P | 1 | — | 1 to 2097152 |
| 14 | A-GER1 | Electronic Gear 1 Denominator | M,P | 1 | — | 1 to 2097152 |
| 15 | B-GER2 | Electronic Gear 2 Numerator | M,P | 1 | — | 1 to 2097152 |
| 16 | A-GER2 | Electronic Gear 2 Denominator | M,P | 1 | — | 1 to 2097152 |
| 17 | EDGEPOS | Positioning Methods | M,P | 00:Pulse_Interval | — | 00 to 01 |
| 18 | PDEVMON | In-Position Signal/ Position Deviation Monitor | P | 00:After_Filter | — | 00 to 01 |
| 19 | CLR | Deviation Clear Selection | M,P | 00:Type1 | — | 00 to 03 |
| 1A | PCDLY | Time to judge position command distribution completion | M,P | 0.0 | ms | 0.0 to 1000.0 |
| 20 | VC1 | Preset Velocity Command 1 | V | 100 | $min^{-1}$ | 0 to 32767 |
| 21 | VC2 | Preset Velocity Command 2 | V | 200 | $min^{-1}$ | 0 to 32767 |
| 22 | VC3 | Preset Velocity Command 3 | V | 300 | $min^{-1}$ | 0 to 32767 |
| 23 | VC4 | Preset Velocity Command 4 | V | 400 | $min^{-1}$ | 0 to 32767 |
| 24 | VC5 | Preset Velocity Command 5 | V | 500 | $min^{-1}$ | 0 to 32767 |
| 25 | VC6 | Preset Velocity Command 6 | V | 600 | $min^{-1}$ | 0 to 32767 |
| 26 | VC7 | Preset Velocity Command 7 | V | 700 | $min^{-1}$ | 0 to 32767 |
| 27 | VCOMSEL | Velocity Compensation Command Input Selection | P | 02:V-COMP | — | 01 to 02 |
| 28 | V-COMP | Preset Velocity Compensation Command | P | 0 | $min^{-1}$ | -9999 to 9999 |
| 29 | VCGN | Analog Velocity (Compensation) Command Scaling | P,V | 500 | $min^{-1}$/V | 0 to 4000 |
| 2A | EX-VCFIL | External Velocity Command Filter | P,V | 4000 | Hz | 1 to 4000 |
| 2B | TVCACC | Velocity Command Acceleration Time Constant | V | 0 | ms | 0 to 16000 |
| 2C | TVCDEC | Velocity Command Deceleration Time Constant | V | 0 | ms | 0 to 16000 |
| 2D | VCLM | Velocity Limit Command | P,V | 65535 | $min^{-1}$ | 1 to 65535 |
| 30 | TCOMSEL | Torque Compensation Command Input Selection | P,V | 02:T-COMP | — | 01 to 02 |
| 31 | T-COMP1 | Preset Torque Compensation Command 1 | P,V | 0.0 | % | -500.0 to 500.0 |
| 32 | T-COMP2 | Preset Torque Compensation Command 2 | P,V | 0.0 | % | -500.0 to 500.0 |
| 33 | TCGN | Analog Torque Command Scaling | T | 50.0 | %/V | 0.0 to 500.0 |
| 34 | T-COMPGN | Analog Torque Compensation Command Scaling | P,V | 50.0 | %/V | 0.0 to 500.0 |
| 35 | EX-TCFIL | External Torque Command Filter | P,V,T | 4000 | Hz | 1 to 4000 |
| 36 | TLSEL | Torque Limit Input Selection | M,P,V,T | 00:TCLM | — | 00 to 02 |
| 37 | TCLM-F | Forward Direction Internal Torque Limit Value | M,P,V,T | 100.0 | % | 10.0 to 500.0 |
| 38 | TCLM-R | Reverse Direction Internal Torque Limit Value | M,P,V,T | 100.0 | % | 10.0 to 500.0 |
| 39 | SQTCLM | Sequence Operation Torque Limit Value | M,P,V,T | 120.0 | % | 10.0 to 500.0 |
| 3B | TASEL | Torque Attainment function select | M,P,V,T | 00:TA/TR | — | 00 to 01 |
| 3C | TA | Torque attainment setting | M,P,V,T | 100.0 | % | 0.0 to 500.0 |
| 3E | BDLY_TCMP | Torque compensation command at holding brake operation cancellation delay | M,P,V | 0.0 | % | -100.0 to 100.0 |
| 40 | NEAR | Near Range | M,P | 500 | Pulse | 1 to 2147483647 |
| 41 | INP | In-Position Window | M,P | 100 | Pulse | 1 to 2147483647 |
| 42 | ZV | Speed Zero Range | M,P,V,T | 50 | $min^{-1}$ | 50 to 500 |
| 43 | LOWV | Low Speed Range | M,P,V,T | 50 | $min^{-1}$ | 0 to 65535 |
| 44 | VA | Speed Attainment Setting (High Speed Range) | M,P,V,T | 1000 | $min^{-1}$ | 0 to 65535 |
| 45 | VCMPUS | Speed Matching Unit Selection | M,P,V | 00:$min^{-1}$ | — | 00 to 01 |
| 46 | VCMP | Speed Matching Range | M,P,V | 50 | $min^{-1}$ | 0 to 65535 |
| 47 | VCMPR | Speed Matching Range Ratio | M,P,V | 5.0 | % | 0.0 to 100.0 |
| 80 | SYNCDIR | Polarity selection of axes-sync compensation input | P | 00:Not_Reversed | — | 00 to 01 |

* M = Model following control type, P = Position control type, V = Velocity control type, T = Torque control type

■ General parameters Group9 "Function enabling condition settings"

| ID | Symbol | Name | Control mode | Default value | Setting range |
|---|---|---|---|---|---|
| 00 | F-OT | Positive Over Travel Function | M,P,V,T | 0D:CONT6_OFF | 00 to 29 |
| 01 | R-OT | Negative Over Travel Function | M,P,V,T | 0B:CONT5_OFF | 00 to 29 |
| 02 | AL-RST | Alarm Reset Function | M,P,V,T | 10:CONT8_ON | 00 to 29 |
| 03 | ECLR | Encoder Clear Function | M,P,V,T | 06:CONT3_ON | 00 to 29 |
| 04 | CLR | Deviation Clear Function | M,P | 08:CONT4_ON | 00 to 29 |
| 05 | S-ON | Servo-ON Function | M,P,V,T | 02:CONT1_ON | 00 to 29 |
| 10 | MS | Control Mode Switching Function | P,V,T | 00:Always_Disable | 00 to 29 |
| 11 | INH/Z-STP | Position Command Pulse Inhibit Function, Velocity Command Zero Clamp Function | M,P,V | 00:Always_Disable | 00 to 29 |
| 12 | GERS | Electronic Gear Switching Function | M,P | 00:Always_Disable | 00 to 29 |
| 13 | GC1 | Gain Switching Condition 1 | M,P,V,T | 00:Always_Disable | 00 to 29 |
| 14 | GC2 | Gain Switching Condition 2 | M,P,V,T | 00:Always_Disable | 00 to 29 |
| 15 | SUPFSELA1 | FF Vibration Suppression Frequency Select Input A1 | M,P | 00:Always_Disable | 00 to 29 |
| 16 | SUPFSELA2 | FF Vibration Suppression Frequency Select Input A2 | M,P | 00:Always_Disable | 00 to 29 |
| 17 | SUPFSELB1 | FF Vibration Suppression Frequency Select Input B1 | M,P | 00:Always_Disable | 00 to 29 |
| 18 | SUPFSELB2 | FF Vibration Suppression Frequency Select Input B2 | M,P | 00:Always_Disable | 00 to 29 |
| 19 | PLPCON | Position Loop Proportional Control Switching Function | P | 01:Always_Enable | 00 to 29 |
| 1A | MODEL | Model following (vibration suppression) control/ standard position control switching function | M | 00:Always_Disable | 00 to 11 |
| 1B | MDLFSEL1 | Model Vibration Suppression Frequency Select Input 1 | M | 00:Always_Disable | 00 to 29 |
| 1C | MDLFSEL2 | Model Vibration Suppression Frequency Select Input 2 | M | 00:Always_Disable | 00 to 29 |
| 20 | SP1 | Preset Velocity Command Select Input 1 | V | 00:Always_Disable | 00 to 29 |
| 21 | SP2 | Preset Velocity Command Select Input 2 | V | 00:Always_Disable | 00 to 29 |
| 22 | SP3 | Preset Velocity Command Select Input 3 | V | 00:Always_Disable | 00 to 29 |
| 23 | DIR | Preset Velocity Command Operation Direction Select Input | V | 00:Always_Disable | 00 to 29 |
| 24 | RUN | Preset Velocity Command Operation Start Signal Input | V | 00:Always_Disable | 00 to 29 |
| 25 | RUN-F | Preset Velocity Command Positive (direction) Move Start Signal Input | V | 00:Always_Disable | 00 to 29 |
| 26 | RUN-R | Preset Velocity Command Negative (direction) Move Start Signal Input | V | 00:Always_Disable | 00 to 29 |
| 27 | VLPCON | Velocity Loop Proportional Control Switching Function | P,V | 04:CONT2_ON | 00 to 29 |
| 28 | V-COMPS | Velocity Compensation Function | P | 00:Always_Disable | 00 to 29 |
| 30 | T-COMPS1 | Torque Compensation Function 1 | P,V | 00:Always_Disable | 00 to 29 |
| 31 | T-COMPS2 | Torque Compensation Function 2 | P,V | 00:Always_Disable | 00 to 29 |
| 32 | TL | Torque Limit Function | M,P,V,T | 0E:CONT7_ON | 00 to 29 |
| 33 | OBS | Disturbance Observer Function | M,P,V | 00:Always_Disable | 00 to 29 |
| 34 | STC | Stick-slip behavior compensation function | M,P,V,T | 00:Always_Disable | 00 to 29 |
| 35 | FBHYST | Minor vibration (oscillation) suppression function | M,P,V,T | 00:Always_Disable | 00 to 29 |
| 40 | EXT-E | External Trip Input Function | M,P,V,T | 00:Always_Disable | 00 to 29 |
| 41 | EMR | Emergency Stop Function | M,P,V,T | 00:Always_Disable | 00 to 29 |
| 80 | SYNCEN | Axes-sync compensation function | P | 00:Always_Disable | 00 to 11 |
| 81 | SYNPCNEN | Axes-sync compensation proportional control switching function | P | 00:Always_Disable | 00 to 29 |

* M = Model following control type, P = Position control type, V = Velocity control type, T = Torque control type

■ General parameters GroupA "General output terminal output condition/ Monitor output selection"

| ID | Symbol | Name | Control mode | Default value | Unit | Setting range |
|---|---|---|---|---|---|---|
| 00 | OUT1 | General Output 1 | M,P,V,T | 18:INP_ON | — | 00 to 81 |
| 01 | OUT2 | General Output 2 | M,P,V,T | 0C:TLC_ON | — | 00 to 81 |
| 02 | OUT3 | General Output 3 | M,P,V,T | 02:S-RDY_ON | — | 00 to 81 |
| 03 | OUT4 | General Output 4 | M,P,V,T | 0A:MBR-ON_ON | — | 00 to 81 |
| 04 | OUT5 | General Output 5 | M,P,V,T | 33:ALM5_OFF | — | 00 to 81 |
| 05 | OUT6 | General Output 6 | M,P,V,T | 35:ALM6_OFF | — | 00 to 81 |
| 06 | OUT7 | General Output 7 | M,P,V,T | 37:ALM7_OFF | — | 00 to 81 |
| 07 | OUT8 | General Output 8 | M,P,V,T | 39:ALM_OFF | — | 00 to 81 |
| 10 | DMON | Digital Monitor Output Signal Selection | M,P,V,T | 00:Always_OFF | — | 00 to 81 |
| 11 | MON1 | Analog Monitor Select Output 1 | M,P,V,T | 05:VMON_2mV/min$^{-1}$ | — | 00 to 36 |
| 12 | MON2 | Analog Monitor Select Output 2 | M,P,V,T | 02:TCMON_2V/TR | — | 00 to 36 |
| 13 | MONPOL | Analog Monitor Output Polarity | M,P,V,T | 00:MON1+_MON2+ | — | 00 to 08 |

* M = Model following control type, P = Position control type, V = Velocity control type, T = Torque control type

■ General parameters GroupB "Sequence/Alarm related settings"

| ID | Symbol | Name | Control mode | Default value | Unit | Setting range |
|---|---|---|---|---|---|---|
| 00 | DBOPE | Servo-OFF stop behavior | M,P,V,T | 04:SB_Free | — | 00 to 07 |
| 01 | ACTOT | Over-Travel Action | M,P,V,T | 00:CMDINH_ SB_SON | — | 00 to 08 |
| 02 | ACTEMR | Emergency Stop Operation | M,P,V | 00:SERVO-BRAKE | — | 00 to 02 |
| 03 | BONDLY | Delay Time of Engaging Holding Brake (Holding Brake Holding Delay Time) | M,P,V,T | 300 | ms | 0 to 1000 |
| 04 | BOFFDLY | Delay Time of Releasing Holding Brake (Holding Brake Release Delay Time) | M,P,V,T | 300 | ms | 0 to 1000 |
| 05 | BONBGN | Brake Operation Beginning Time | M,P,V,T | 10000 | ms | 0 to 65535 |
| 06 | PFDDLY | Power Failure Detection Delay Time | M,P,V,T | 10 | ms | 10 to 1000 |
| 07 | INTTIM | Initial timeout wait time | M,P,V,T | 00:Disabled | — | 00 to 07 |
| 10 | OFWLV | Excessive Deviation Warning Level | M,P | 2147483647 | Pulse | 1 to 2147483647 |
| 11 | OFLV | Deviation Counter Overflow Value | M,P | 5000000 | Pulse | 1 to 2147483647 |
| 12 | OLWLV | Overload Warning Level | M,P,V,T | 90 | % | 20 to 100 |
| 13 | VFBALM | Velocity Feedback Alarm (ALM_C3) Detection | M,P,V,T | 01:Enabled | — | 00 to 01 |
| 14 | VCALM | Velocity Control Alarm (ALM_C2) Detection | M,P,V,T | 00:Disabled | — | 00 to 01 |
| 15 | SOFDEC | Deceleration Time Constant at Servo off Stopping | M,P,V,T | 0 | ms | 0 to 16000 |
| 16 | EMRDEC | Deceleration Time Constant at Emergency Stopping | M,P,V,T | 0 | ms | 0 to 16000 |
| 17 | SONFALL | External command effectivity selection at holding brake operation cancellation delay time | M,P,V | 00:Disabled | — | 00 to 01 |
| 18 | SOFFFALL | External command effectivity selection at holding brake operation delay time | M,P,V | 00:Disabled | — | 00 to 01 |
| 19 | DFOFWLV | Dual position error warning level | M,P | 2147483647 | Pulse | 0 to 2147483647 |
| 1A | DFOFLV | Dual position error excess value | M,P | 5000000 | Pulse | 0 to 2147483647 |
| 80 | PSDEVW | Axes-sync error warning level | P | 2147483647 | Pulse | 1 to 2147483647 |
| 81 | PSDEVA | Axes-sync error excess value | P | 5000000 | Pulse | 1 to 2147483647 |

* M = Model following control type, P = Position control type, V = Velocity control type, T = Torque control type

■ General parameters GroupC "Encoder related settings"

| ID | Symbol | Name | Control mode | Default value | Unit | Setting range |
|---|---|---|---|---|---|---|
| 00 | ENFIL | Motor Incremental Encoder Digital Filter | M,P,V,T | 01:220ns | — | 00 to 07 |
| 01 | EX-ENFIL | External Incremental Encoder Digital Filter | M,P,V,T | 01:220ns | — | 00 to 07 |
| 02 | EX-ENPOL | External Pulse Encoder Polarity Selection | M,P,V,T | 00:Type1 | — | 00 to 07 |
| 03 | PULOUTSEL | Encoder Output Pulse Divide Selection | M,P,V,T | 00:Motor_Enc | — | 00 to 01 |
| 04 | ENRAT | Encoder Output Pulse Division | M,P,V,T | 1/1 | — | 1/32768 to 1/1 |
| 05 | PULOUTPOL | Encoder Output Pulse Divide Polarity | M,P,V,T | 00:Type1 | — | 00 to 03 |
| 06 | PULOUTRES | Encoder Output Pulse Divide Resolution Selection | M,P,V,T | 00:32768P/R | — | 00 to 01 |
| 07 | PSOFORM | Encoder Signal Output (PS) Format | M,P,V,T | 00:MOT_Binary | — | 00 to 04 |
| 08 | ECLRFUNC | Encoder Clear Function Selection | M,P,V,T | 00:Status_ MultiTurn | — | 00 to 01 |
| 0B | EX-SENPOL | External Absolute Encoder polarity selection | M,P,V,T | 00:Standard | — | 00 to 01 |
| 0C | EX-PULDIV | External encoder output pulse divide ratio selection | M,P,V,T | 00:1/4(R)_1/4(L) | — | 00 to 0B |
| 10 | DE1MSKLVL | Broken wire mask level at Encoder connector 1 | M,P,V,T | 0 | kHz | 0 to 65535 |
| 11 | DE3MSKLVL | Broken wire mask level at Encoder connector 2 | M,P,V,T | 0 | kHz | 0 to 65535 |

* M = Model following control type, P = Position control type, V = Velocity control type, T = Torque control type

■ General parameters GroupD "Support function related settings"

| ID | Symbol | Name | Control mode | Default value | Unit | Setting range |
|---|---|---|---|---|---|---|
| 00 | JOGVC | JOG Velocity Command | M,P,V,T | 50 | $min^{-1}$ | 0 to 32767 |
| 02 | TSTTCLM | Support function torque limit value | M,P,V,T | 120.0 | % | 10.0 to 500.0 |
| 10 | COMAXIS | Serial Communication Axis Number | M,P,V,T | 01:#1 | — | 01 to 0F |
| 11 | MONDISP | Monitor Display Selection | M,P,V,T | 00:STATUS | — | 00 to 77 |
| 20 | SAMPDIV | Drec. sampling rate | M,P,V,T | 20 | — | 0 to 65535 |
| 21 | SAMPNUM | Drec. sampling mode | M,P,V,T | 00:256point | — | 00 to 02 |
| 22 | TRGCHSEL | Drec. Trigger Channel | M,P,V,T | 83:DIGITAL_4 | — | 00 to 83 |
| 23 | TRGEDGSEL | Drec. Trigger Slope | M,P,V,T | 00:POS_EDGE | — | 00 to 02 |
| 24 | TRGHPOS | Drec. Trigger Horizontal Position | M,P,V,T | 80 | % | 0 to 100 |
| 25 | TRGLVL | Drec. Trigger Level | M,P,V,T | 1 | — | -9223372036854775808 to 9223372036854775807 |
| 31 | CH1SEL | Drec. Analog CH1 selection | M,P,V,T | 08:PCMDF1 | — | 00 to 23, FF |
| 32 | CH2SEL | Drec. Analog CH2 selection | M,P,V,T | 01:VCMON | — | 00 to 23, FF |
| 33 | CH3SEL | Drec. Analog CH3 selection | M,P,V,T | 03:TCMON | — | 00 to 23, FF |
| 34 | CH4SEL | Drec. Analog CH4 selection | M,P,V,T | 15:VBUS | — | 00 to 23, FF |
| 35 | CH5SEL | Drec. Analog CH5 selection | M,P,V,T | 05:POSITION | — | 00 to 23, FF |
| 36 | CH6SEL | Drec. Analog CH6 selection | M,P,V,T | 00:VMON | — | 00 to 23, FF |
| 37 | DCH1SEL | Drec. Digital CH1 selection | M,P,V,T | 16:SRDY | — | 00 to 20, FF |
| 38 | DCH2SEL | Drec. Digital CH2 selection | M,P,V,T | 15:SACT | — | 00 to 20, FF |
| 39 | DCH3SEL | Drec. Digital CH3 selection | M,P,V,T | 1B:WRG-DF | — | 00 to 20, FF |
| 3A | DCH4SEL | Drec. Digital CH4 selection | M,P,V,T | 1C:ALM | — | 00 to 20, FF |

* M = Model following control type, P = Position control type, V = Velocity control type, T = Torque control type

■ Basic parameters

| ID | Symbol | Name | Control mode | Remarks | |
|---|---|---|---|---|---|
| 00 | COMAXIS | Serial Communication Axis Number | M,P,V,T | This is common with GroupD ID11 | |
| 01 | TUNMODE | Tuning Mode | M,P,V,T | This is common with Group0 ID00 | |
| 02 | ATRES | Auto-Tuning Response | M,P,V,T | This is common with Group0 ID02 | |
| 03 | PCSMT | Position Command Smoothing Constant | M,P | This is common with Group1 ID00 | |
| 04 | PCFIL | Position Command Filter | M,P | This is common with Group1 ID01 | |
| 05 | B-GER1 | Electronic Gear 1 Numerator | M,P | This is common with Group8 ID13 | |
| 06 | A-GER1 | Electronic Gear 1 Denominator | M,P | This is common with Group8 ID14 | |
| 07 | INP | In-Position Window | M,P | This is common with Group8 ID41 | |
| 08 | F-OT | Positive Over Travel Function | M,P,V,T | This is common with Group9 ID00 | |
| 09 | R-OT | Negative Over Travel Function | M,P,V,T | This is common with Group9 ID01 | |
| 0A | AL-RST | Alarm Reset Function | M,P,V,T | This is common with Group9 ID02 | |
| 0B | ECLR | Encoder Clear Function | M,P,V,T | This is common with Group9 ID03 | |
| 0C | CLR | Deviation Clear Function | M,P | This is common with Group9 ID04 | |
| 0D | S-ON | Servo-ON Function | M,P,V,T | This is common with Group9 ID05 | |
| 0E | TL | Torque Limit Function | M,P,V,T | This is common with Group9 ID32 | |
| 0F | JOGVC | JOG Velocity Command | M,P,V,T | This is common with GroupD ID00 | |
| 10 | ENRAT | Encoder output frequency pulse dividing | M,P,V,T | This is common with GroupC ID04 | |
| 11 | | Offset Adjustment of Velocity/Torque Command | P,V,T | Setting range | -9999 to 9999 |
| 12 | | Offset Adjustment of Analog Torque Compensation Command | P,V | Setting range | -9999 to 9999 |

* "Basic parameters" is able to set by the Digital operator.

* M = Model following control type, P = Position control type, V = Velocity control type, T = Torque control type

## 5.8 Parameter functions

Each parameter function is explained below.

■ Group0 "Auto-tuning settings"

<table>
<tr><th>ID</th><th colspan="4">Contents</th></tr>
<tr><td rowspan="3">00</td><td rowspan="2">Tuning mode<br>[TUNMODE]</td><td>Setting range</td><td>Unit</td><td>Default</td></tr>
<tr><td>00 to 02</td><td>-</td><td>00:AutoTun</td></tr>
<tr><td colspan="4">■ Set the validity/ invalidity of Auto-tuning and Load inertia moment rate estimation.
<table>
<tr><th colspan="2">Selection</th><th>Contents</th></tr>
<tr><td>00</td><td>AutoTun</td><td>Automatic Tuning</td></tr>
<tr><td>01</td><td>AutoTun_JRAT-Fix</td><td>Automatic Tuning (JRAT Manual Setting)</td></tr>
<tr><td>02</td><td>ManualTun</td><td>Manual Tuning</td></tr>
</table>
◆ Under the following operating conditions, Load inertia rate is not estimated properly: at low velocity, at low acceleration and at low acceleration/deceleration torque.<br>In these cases, please set “Automatic Tuning (JRAT Manual Setting)” and set proper value to JRAT 1.<br><br>◆ In addition, under the following machine operating conditions, Load inertia rate is not estimated properly: machine with large disturbance torque, with big backlash and with a machine in which movable parts vibrate.<br>In these cases, set at “Automatic Tuning (JRAT Manual Setting)” and set proper value to JRAT1.<br><br>* When “Model following vibration suppression control” is set to “ID07 Position Control Selection“ of system parameter, set “02: Manual tuning”.</td></tr>
</table>

－Group0－

| ID | Contents | | | |
|---|---|---|---|---|
| 01 | Auto-Tuning Characteristic [ATCHA] | Setting range | Unit | Default |
| | | 00 to 06 | - | 00:Positioning1 |

■ Set the suitable parameters for each control method.

| Selection | | Contents |
|---|---|---|
| 00 | Positioning1 | Positioning Control 1 (General Purpose) |
| 01 | Positioning2 | Positioning Control 2 (High Response) |
| 02 | Positioning3 | Positioning Control 3 (High Response, FFGN Manual Setting) |
| 03 | Positioning4 | Positioning Control 4 (High Response, Horizontal Axis Limited) |
| 04 | Positioning5 | Positioning Control 5 (High Response, Horizontal Axis Limited, FFGN Manual Setting) |
| 05 | Trajectory1 | Trajectory Control 1 |
| 06 | Trajectory2 | Trajectory Control 2 (KP,FFGN Manual Setting) |

◆ “Positioning Control 1”
- Select for general purpose positioning.
- Use this parameter at Velocity control mode or Torque control mode.
- Can be used for an axis which affected by gravity or external forces.

◆ “Positioning Control 2”
- Use this parameter at Position control mode.
- Can be suppressed overshoot at positioning use, it will shorten positioning settling time.
- Can be used for an axis which affected by gravity or external forces.

◆ “Positioning Control 3”
- Select for the purpose of manual tuning of FFGN.

◆ “Positioning Control 4”
- Select this mode when the machine movement is in horizontal axis and receives no impacts from external force.
- Positioning-settling time may shorten compared to “Positioning Control 2”.
- Use this parameter at Position control mode.
- Do not use for an axis which affected by gravity or external forces.
- This parameter may give shock to the application.

◆ “Positioning Control 5”
- Select for the purpose of manual tuning of FFGN when the machine movement is in horizontal axis and receives no impacts from external force.
- Positioning-settling time may shorten compared to “Positioning Control 3”.
- This parameter may give shock to the application.

◆ “Trajectory Control 1”
- This is the setting for tracking a position command from host unit as machining.
- Use this parameter at Position control mode.
- Can be used for an axis which affected by gravity or external forces.
- Select this parameter for single axis or asynchronous use.
- Select "Trajectory Control 2" when cooperating with other axes.
- The positioning characteristics will change when the “Position Loop Gain” is altered with fluctuation of the estimated inertia moment. If you want to avoid this change, please adopt “Trajectory Control 2” or use manual tuning.

◆ “Trajectory Control 2”
- This is the setting for syncing a response of each axis position loop as cooperation with the other axes.
- Use this parameter at Position control mode.
- Can be used for an axis which affected by gravity or external forces.

* When "Trajectory control" is used, do not set "Model following vibration suppression control" to “ID07 Position Control Selection”. By setting "Model following vibration suppression control", trajectory will get deviation.

<table>
<tr><th>ID</th><th>Contents</th></tr>
<tr><td>02</td><td>
<table>
<tr><td>Auto-Tuning Response [ATRES]</td><td>Setting range<br>1 to 40</td><td>Unit<br>-</td><td>Default<br>5</td></tr>
</table>
■ Sets the Auto-Tuning Response.<br>
◆ The larger the set value, the higher the response.<br>
◆ Caution, if the response is set too high, the machine may oscillate.<br>
◆ Make the setting suited to rigidity of the device.<br>
■ In case of following, set value will be 30 even if 31 to 40 are set.<br>
◆ When "00: Positioning1" is set to Group0 ID01 Auto-Tuning Characteristic [ATCHA].<br>
◆ When "01: Enable" is set to Group0 ID04 Auto-Tuning characteristic compatible mode [ATCSEL].
</td></tr>
<tr><td>03</td><td>
<table>
<tr><td>Auto-Tuning Automatic Parameter Saving [ATSAVE]</td><td>Setting range<br>00 to 01</td><td>Unit<br>-</td><td>Default<br>00:Auto_Saving</td></tr>
</table>
■ Select if the automatic parameter saving function is valid to save the Load inertia moment ratio estimated by auto-tuning function of amplifier unit in the Group1 ID14 Load Inertia Moment Ratio 1 [JRAT1].<br>
◆ This setting is valid when Group0 ID00 Tuning Mode is at "00: AutoTun Auto-tuning".<br>
◆ Automatic save is done in every 30 minutes.
<table>
<tr><th colspan="2">Selection</th><th>Contents</th></tr>
<tr><td>00</td><td>Auto_Saving</td><td>Automatically Saves in JRAT1</td></tr>
<tr><td>01</td><td>No_Saving</td><td>Automatic Saving is Invalid</td></tr>
</table>
</td></tr>
<tr><td>04</td><td>
<table>
<tr><td>Auto-Tuning characteristic compatible mode [ATCSEL]</td><td>Setting range<br>00 to 01</td><td>Unit<br>-</td><td>Default<br>00:Disable</td></tr>
</table>
■ Set "01: Enable Valid (RS2 compatible)" to set auto-tuning characteristic compatible with RS1/RS2 amplifier. In this case, gain set value will be 30 even if 31 to 40 are set.
<table>
<tr><th colspan="2">Selection</th><th>Contents</th></tr>
<tr><td>00</td><td>Disable</td><td>Invalid</td></tr>
<tr><td>01</td><td>Enable</td><td>Valid (RS2 compatible)</td></tr>
</table>
</td></tr>
<tr><td>10</td><td>
<table>
<tr><td>Auto-Notch Filter Tuning Torque Command [ANFILTC]</td><td>Setting range<br>10.0 to 100.0</td><td>Unit<br>%</td><td>Default<br>50.0</td></tr>
</table>
■ Sets the torque value for excite the mechanical system during operation under "Auto-Notch Filter Tuning".<br>
* Larger value makes the tuning more accurate; however, note that it also makes the movement of the machine greater.
</td></tr>
<tr><td>20</td><td>
<table>
<tr><td>Auto-FF Vibration Suppression Frequency Tuning Torque Command [ASUPTC]</td><td>Setting range<br>10.0 to 100.0</td><td>Unit<br>%</td><td>Default<br>25.0</td></tr>
</table>
■ Sets the torque value for excite the mechanical system during operation under "Auto-FF Vibration Suppression Frequency Tuning".<br>
* Larger value makes the tuning more accurate; however, note that it also makes the movement of the machine greater.
</td></tr>
<tr><td>21</td><td>
<table>
<tr><td>Auto-FF Vibration Suppression Frequency Tuning Friction Compensation Value [ASUPFC]</td><td>Setting range<br>0.0 to 50.0</td><td>Unit<br>%</td><td>Default<br>5.0</td></tr>
</table>
■ Sets the friction torque compensation added to the motor torque to excite the mechanical system at the time of Auto-FF Vibration Suppression Frequency Tuning.<br>
◆ By setting this value close to actual friction torque, Auto-FF vibration suppression frequency tuning will be more accurate.<br>
* When the set value is low, there may be cases that the vibration frequency of the mechanical system cannot be detected, or the wrong value is detected. Raise the value until the detected value settles.
</td></tr>
</table>

－Group0－

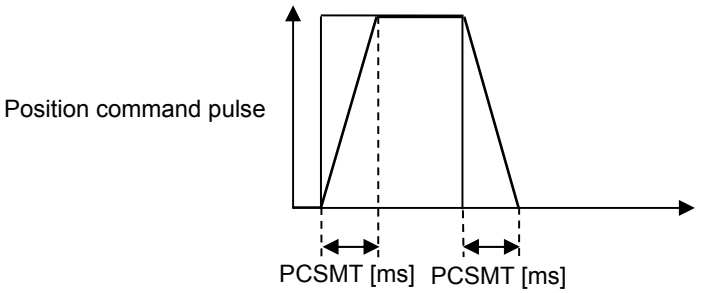
<table>
<tr><th>ID</th><th>Contents</th></tr>
<tr><td>34</td><td>
Adaptive notch filter function E [ADNFE]
<table>
<tr><th>Setting range</th><th>Unit</th><th>Default</th></tr>
<tr><td>00 to 01</td><td>-</td><td>00: Adp_Filter Disable</td></tr>
</table>
■ This is the parameter which selects function of torque command notch filter E.<br>
By setting "01: Adp_Filter Enable Adaptation at all times", notch filter E will be adjusted to mechanical resonant frequency.<br>
When adaptive notch filter function is valid, Group2 ID29 will be fixed to 0. Group2 ID28 will work as initial value of adaptive notch filter.
<table>
<tr><th colspan="2">Selection</th><th>Contents</th></tr>
<tr><td>00</td><td>Adp_Filter Disable</td><td>Adaptation invalid (TCNFILE manual setting)</td></tr>
<tr><td>01</td><td>Adp_Filter Enable</td><td>Adaptation at all times</td></tr>
</table>
</td></tr>
<tr><td>35</td><td>
Adaptive notch filter frequency upper limit E [ADNFUE]
<table>
<tr><th>Setting range</th><th>Unit</th><th>Default</th></tr>
<tr><td>100 to 1000</td><td>Hz</td><td>1000</td></tr>
</table>
■ Sets adaptive notch filter frequency upper limit.<br>
Sets upper limit of mechanical variation.<br>
Please set higher value than ADNFLE.
</td></tr>
<tr><td>36</td><td>
Adaptive notch filter frequency lower limit E [ADNFLE]
<table>
<tr><th>Setting range</th><th>Unit</th><th>Default</th></tr>
<tr><td>100 to 1000</td><td>Hz</td><td>100</td></tr>
</table>
■ Sets adaptive notch filter frequency lower limit.<br>
Sets lower limit of mechanical variation.<br>
Please set lower value than ADNFUE.
</td></tr>
<tr><td>37</td><td>
Adaptive notch filter E auto saving [ADNSVE]
<table>
<tr><th>Setting range</th><th>Unit</th><th>Default</th></tr>
<tr><td>00 to 01</td><td>-</td><td>00:Auto_Saving</td></tr>
</table>
■ Selects valid/invalid of the function that saves mechanical resonant frequency automatically which is estimated by the amplifier unit to torque command notch filter E set value.<br>
◆ This setting is valid when "01: Adp_Filter_Enable" is set to Group0 ID34.<br>
◆ Estimation result is automatically saved in torque command notch filter E in every 30 minutes.
<table>
<tr><th colspan="2">Selection</th><th>Contents</th></tr>
<tr><td>00</td><td>Auto_Saving</td><td>Save automatically</td></tr>
<tr><td>01</td><td>No_Saving</td><td>Without save</td></tr>
</table>
</td></tr>
</table>

■ Group1 "Basic control parameter settings"

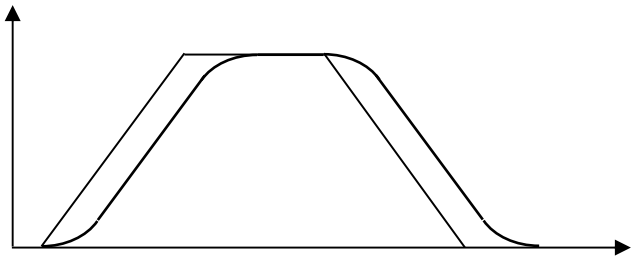
| ID | Contents | | | |
|---|---|---|---|---|
| 00 | Position Command Smoothing Constant [PCSMT] | Setting range | Unit | Default |
| | | 0.0 to 500.0 | ms | 0.0 |

■ This is the moving-average filter which makes smooth the position command pulse.
- ◆ Sets time constants.
- ◆ Applies ramp to the step form position command pulse.
- ◆ Applies S curve to the ramp form position command pulse.
- ◆ Smoothes the position command pulse when the electronic gear ratio is greater or the position command pulse is coarse. (This may decrease the operating noise from servo motor.)
- ◆ Set the value 0.3 ms or more.
- ◆ When the set value is “0.0 to 0.2 ms”, this filter is invalid.
- ◆ Set in increments of 0.5ms. (Under the set value “0.4ms and less”, there may be cases where the set value cannot be applied to the operation.)

● Position command pulse applied as step form

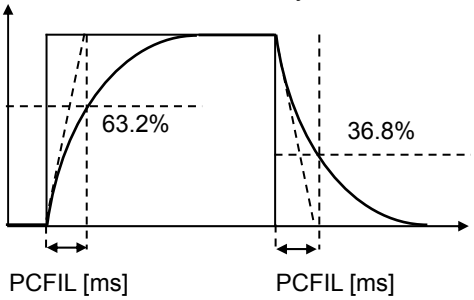



● Position command pulse applied as ramp form



# 5. Operation

－Group1－

<table>
<tr><th>ID</th><th>Contents</th></tr>
<tr><td>01</td><td>
<table>
<tr><td>Position Command Filter<br>[PCFIL]</td><td>Setting range<br>0.0 to 2000.0</td><td>Unit<br>ms</td><td>Default<br>0.0</td></tr>
</table>
■ This primary low-pass filter suppresses any sudden change of the position control pulse.<br>
Sets time constants.<br>
◆ This parameter setting is valid when the value of Group1 ID08 Higher Tracking Control Position Compensation Gain is set at 0%.<br>
◆ When Higher Tracking Control Position Compensation Gain is 0%, and this value is set at 0.0ms, the filter becomes invalid.<br>
◆ This filter can suppress overshoot caused by the rise of the feed forward compensation gain.<br>


</td></tr>
<tr><td>02</td><td>
<table>
<tr><td>Position Loop Proportional Gain 1<br>[KP1]</td><td>Setting range<br>1 to 3000</td><td>Unit<br>1/s</td><td>Default<br>30</td></tr>
</table>
■ Proportional gain for position controller.<br>
◆ Automatically overwrite by Auto-tuning result saving.<br>
◆ When Auto-tuning function is valid, this setting value is not applied.<br>
◆ When Gain switching function is valid, this setting value is applied by selecting gain 1.<br>
◆ When Gain switching function is invalid, this setting value is applied.
</td></tr>
<tr><td>03</td><td>
<table>
<tr><td>Position Loop Integral Time Constant 1<br>[TPI1]</td><td>Setting range<br>0.3 to 1000.0</td><td>Unit<br>ms</td><td>Default<br>1000.0</td></tr>
</table>
■ Integral time constant for position controller.<br>
This setting is valid when the Position Loop Proportional Control Switching Function is invalid.<br>
◆ Integral term is invalid (proportional control) at the setting value 1000.0ms.<br>
◆ When Gain switching function is valid, this setting value is applied by selecting gain 1.<br>
◆ When Gain switching function is invalid, this setting value is applied.
</td></tr>
<tr><td>04</td><td>
<table>
<tr><td>Position loop phase lead compensation gain<br>[PLPHLK]</td><td>Setting range<br>0 to 100</td><td>Unit<br>%</td><td>Default<br>0</td></tr>
</table>
■ Sets the phase improving value of Position loop phase lead compensation.<br>
◆ For position loop, adds the function that shifts phase on phase lead compensation frequency (PLPHLF) as 17deg by 50% and 35deg by 100%. Pay attention for gain increment after PLPHLF.<br>
◆ This parameter will be disabled when 0% is set.
</td></tr>
<tr><td>05</td><td>
<table>
<tr><td>Position loop phase lead compensation frequency<br>[PLPHLF]</td><td>Setting range<br>10 to 4000</td><td>Unit<br>Hz</td><td>Default<br>500</td></tr>
</table>
■ Sets the frequency that is wanted to improve the phase of position loop.<br>
◆ Set value will limit 1,000Hz even if 1,000Hz or more is set.<br>
◆ This parameter can set in 1 Hz unit, but it will be rounded down to the 10 Hz internally.<br>
* Please stop servo motor if change this value.
</td></tr>
</table>

## ID 06

| Velocity Feed Forward Gain [FFGN] | Setting range | Unit | Default |
|---|---|---|---|
| | 0 to 100 | % | 0 |

■ Sets the feed forward compensation gain to position control system.

■ When "Model following control" is enabling, model velocity feed forward gain will be enabled and this parameter value will be disabled.

◆ This parameter will be valid when "Higher Tracking Control Position Compensation Gain" is set to 0%.

◆ Automatically overwrite by Auto-tuning result saving.

◆ The setting value is not applied when using the Auto-Tuning Characteristics listed below.

| | |
|---|---|
| Positioning1 | Positioning Control 1 (General Purpose) |
| Positioning2 | Positioning Control 2 (High Response) |
| Positioning4 | Positioning Control 4 (High Response, Horizontal Axis Limited) |
| Trajectory1 | Trajectory Control 1 |

## ID 07

| Velocity Feed Forward Filter [FFFIL] | Setting range | Unit | Default |
|---|---|---|---|
| | 1 to 4000 | Hz | 4000 |

■ This is primary low-pass filter to eliminate pulsed ripple caused by the position command pulse included in the feed forward command. Sets the cutoff frequency.

■ When "Model following control" is enabling, model velocity feed forward will be enabled and this parameter value will be disabled.

| Control cycle | | Setting value | Valid/ Invalid |
|---|---|---|---|
| 00 | Standard_Sampling | 1 to 1999Hz | Set value valid |
| | | 2000 to 4000Hz | Filter invalid |
| 01 | High-freq_Sampling | 1 to 1999Hz | Set value valid |
| | | 2000 to 4000Hz | Filter invalid |

## ID 08

| Higher Tracking Control Position Compensation Gain [TRCPGN] | Setting range | Unit | Default |
|---|---|---|---|
| | 0 to 100 | % | 0 |

■ Adjusts command tracking performance of position control system.
The larger value can raise command tracking performance higher.

◆ When set the value except 0%, "Position command filter" and "Velocity Feed forward gain" are set automatically in the amplifier unit.

◆ Automatically overwrite by Auto-tuning result saving.

◆ When Auto-tuning function is valid, this setting value not applied.

## ID 10

| Velocity Command Filter [VCFIL] | Setting range | Unit | Default |
|---|---|---|---|
| | 1 to 4000 | Hz | 4000 |

■ This is primary low-pass filter to suppress sudden change of velocity command.
Sets the cutoff frequency.
Use External Velocity Command Filter when eliminating Analog velocity command noise.

◆ Setting range varies depending on the setting of the system parameter ID00 Control Cycle.

| Control cycle | | Setting value | Valid/ Invalid |
|---|---|---|---|
| 00 | Standard_Sampling | 1 to 1999Hz | Set value valid |
| | | 2000 to 4000Hz | Filter invalid |
| 01 | High-freq_Sampling | 1 to 3999Hz | Set value valid |
| | | 4000Hz | Filter invalid |

－Group1－

<table>
<tr><th>ID</th><th>Contents</th></tr>
<tr><td>11</td><td>
Velocity Feedback Filter [VDFIL]<br>
Setting range: 1 to 4000 | Unit: Hz | Default: 1500<br>
■ This is primary low-pass filter to eliminate ripples caused by encoder pulse included in the velocity control system feedback. Sets the cutoff frequency.<br>
◆ When the encoder resolution is low, lowering the setting value and suppressing the ripples may suppress motor drive noise. In addition, when the encoder resolution is high, raising the setting value may improve the response of the velocity control system. For general use, set at the Standard value.<br>
◆ Setting range varies depending on the setting of the system parameter ID00 Control Cycle.
<table>
<tr><th colspan="2">Control cycle</th><th>Setting value</th><th>Valid/ Invalid</th></tr>
<tr><td rowspan="2">00</td><td rowspan="2">Standard_Sampling</td><td>1 to 1999Hz</td><td>Set value valid</td></tr>
<tr><td>2000 to 4000Hz</td><td>Filter invalid</td></tr>
<tr><td rowspan="2">01</td><td rowspan="2">High-freq_Sampling</td><td>1 to 3999Hz</td><td>Set value valid</td></tr>
<tr><td>4000Hz</td><td>Filter invalid</td></tr>
</table>
</td></tr>
<tr><td>12</td><td>
Velocity Loop Proportional Gain 1 [KVP1]<br>
Setting range: 1 to 2000 | Unit: Hz | Default: 50<br>
■ Proportional gain of velocity controller.<br>
When Load Inertia Moment Ratio 1 is same as the actual load inertia moment, this setting value response is performed.<br>
◆ Automatically overwrite by Auto-tuning result saving.<br>
◆ When Auto-tuning function is valid, this setting value is not applied.<br>
◆ When Gain switching function is valid, this setting value is applied by selecting gain 1.<br>
◆ While system analysis function is active, this value is applied even if Auto-tuning is valid.
</td></tr>
<tr><td>13</td><td>
Velocity Loop Integral Time Constant 1 [TVI1]<br>
Setting range: 0.3 to 1000.0 | Unit: ms | Default: 20.0<br>
■ Integral time constant of velocity controller.<br>
This setting value is valid when Velocity Loop Proportional Control Switching Function is invalid.<br>
◆ Integral term is invalid (proportional control) with the setting value of 1000.0ms.<br>
◆ Automatically overwrite by Auto-tuning result saving.<br>
◆ When Auto-tuning function is valid, this setting value is not applied.<br>
◆ When Gain switching function is valid, this setting value is applied by selecting gain 1.<br>
◆ While system analysis function is active, this value is applied even if Auto-tuning is valid.
</td></tr>
</table>

－Group1－

<table>
<tr><th>ID</th><th>Contents</th></tr>
<tr><td>14</td><td>
Load Inertia Moment Ratio 1 [JRAT1]<br>
Setting range: 0 to 15000 | Unit: % | Default: 100<br>
■ Sets the inertia moment of the loading device to the servo motor inertia moment.<br>
◆ Setting value=$J_L/J_M \times 100\%$<br>
● $J_L$ : Load inertia moment<br>
● $J_M$ : Motor inertia moment<br>
◆ Automatically overwrite by Auto-tuning result saving.<br>
◆ If this value matches the actual mechanical system, setting value of KVP will be the response frequency of the velocity control system.<br>
◆ When Auto-Tuning Automatic Parameter Saving function is valid, this parameter is overwriting with an estimated result.<br>
◆ When Auto-tuning Function is valid, this value is not applied.<br>
◆ Use between the range of 100 to 3000% when driven with Model following vibration suppression control.<br>
◆ When Gain switching function is valid, this setting value is applied by selecting gain 1.<br>
◆ While system analysis function is active, this value is applied even if Auto-tuning is valid.
</td></tr>
<tr><td>15</td><td>
Velocity loop phase lead compensation gain [VLPHLK]<br>
Setting range: 0 to 100 | Unit: % | Default: 0<br>
■ Sets the phase improving value of Velocity loop phase lead compensation.<br>
◆ For velocity loop, adds the function that shifts phase on phase lead compensation frequency as 17deg by 50% and 35deg by 100%. Pay attention for gain increment after VLPHLF.<br>
◆ This parameter will be disabled when 0% is set.
</td></tr>
<tr><td>16</td><td>
Velocity loop phase lead compensation frequency [VLPHLF]<br>
Setting range: 10 to 4000 | Unit: Hz | Default: 500<br>
■ Sets the frequency that is wanted to improve the phase of velocity loop.<br>
◆ This parameter can set in 1 Hz unit, but it will be rounded down to the 10 Hz internally.<br>
* Please stop servo motor if change this value.
<table>
<tr><th colspan="2">Control cycle</th><th>Setting value</th><th>Compensation frequency</th></tr>
<tr><td rowspan="2">00</td><td rowspan="2">Standard_Sampling<br>Standard sampling mode</td><td>1 to 1000Hz</td><td>Set value valid</td></tr>
<tr><td>1001 to 4000Hz</td><td>1000Hz</td></tr>
<tr><td rowspan="2">01</td><td rowspan="2">High-freq_Sampling<br>Hi-speed sampling mode</td><td>1 to 2000Hz</td><td>Set value valid</td></tr>
<tr><td>2001 to 4000Hz</td><td>2000Hz</td></tr>
</table>
</td></tr>
<tr><td>17</td><td>
High order integral control gain [HKVIK]<br>
Setting range: 0 to 100 | Unit: % | Default: 0<br>
■ Sets the phase improving value of Velocity loop phase lead compensation.<br>
◆ The larger value can change shorter velocity loop integral time constant.<br>
◆ This parameter will be disabled when 0% is set.
</td></tr>
<tr><td>18</td><td>
High order integral control frequency [HKVIF]<br>
Setting range: 10 to 4000 | Unit: Hz | Default: 500<br>
■ Sets when velocity loop integral time constant wants to be shorter. Sets the frequency that is wanted to improve the phase.<br>
* This parameter can set in 1 Hz unit, but it will be rounded down to the 10 Hz internally.<br>
* Please stop servo motor if change this value.
<table>
<tr><th colspan="2">Control cycle</th><th>Setting value</th><th>Compensation frequency</th></tr>
<tr><td rowspan="2">00</td><td rowspan="2">Standard_Sampling<br>Standard sampling mode</td><td>1 to 1000Hz</td><td>Set value valid</td></tr>
<tr><td>1001 to 4000Hz</td><td>1000Hz</td></tr>
<tr><td rowspan="2">01</td><td rowspan="2">High-freq_Sampling<br>Hi-speed sampling mode</td><td>1 to 2000Hz</td><td>Set value valid</td></tr>
<tr><td>2001 to 4000Hz</td><td>2000Hz</td></tr>
</table>
</td></tr>
</table>

－Group1－

<table>
<tr><th>ID</th><th colspan="4">Contents</th></tr>
<tr><td rowspan="2">19</td><td>Torque Feed Forward Gain<br>[TFFK]</td><td>Setting range<br>0 to 100</td><td>Unit<br>%</td><td>Default<br>0</td></tr>
<tr><td colspan="4">■ Sets feed forward compensation gain to velocity control system.<br>◆ The setting value is not applied when "Position control selection " is "Model following control".</td></tr>
<tr><td rowspan="2">1A</td><td>Torque feedforward averaging<br>[TFFAVE]</td><td>Setting range<br>00 to 01</td><td>Unit<br>-</td><td>Default<br>01: 4timesAverage</td></tr>
<tr><td colspan="4">■ Selects the average count of torque feedforward compensation.
<table>
<tr><th colspan="2">Selection</th><th>Contents</th></tr>
<tr><td>00</td><td>2timesAverage</td><td>2 times</td></tr>
<tr><td>01</td><td>4timesAverage</td><td>4 times</td></tr>
</table></td></tr>
<tr><td rowspan="2">1B</td><td>Torque feedforward output selection<br>[TFFOUT]</td><td>Setting range<br>00 to 01</td><td>Unit<br>-</td><td>Default<br>00:Before_filter</td></tr>
<tr><td colspan="4">■ Select the point that is to be added torque feed forward compensation.
<table>
<tr><th colspan="2">Selection</th><th>Contents</th></tr>
<tr><td>00</td><td>Before_filter</td><td>Before torque command filter</td></tr>
<tr><td>01</td><td>After_filter</td><td>After torque command filter</td></tr>
</table></td></tr>
</table>

－Group1－

<table>
<tr><th>ID</th><th>Contents</th></tr>
<tr><td>1C</td><td>
<table>
<tr><td>Acceleration Feedback Gain<br>[AFBK]</td><td>Setting range<br>-100.0 to 100.0</td><td>Unit<br>%</td><td>Default<br>0.0</td></tr>
</table>
■ Sets acceleration feedback compensation gain to make the velocity loop stable.<br>
Multiply this gain with the detected acceleration to compensate torque command.<br>
◆ Automatically overwrite by Auto-tuning result saving.<br>
◆ When Auto-tuning function is valid, this setting value not applied.<br>
◆ If the value is too large, the motor may oscillate. Sets within range ±15.0% for general use.
</td></tr>
<tr><td>1D</td><td>
<table>
<tr><td>Acceleration Feedback Filter<br>[AFBFIL]</td><td>Setting range<br>1 to 4000</td><td>Unit<br>Hz</td><td>Default<br>500</td></tr>
</table>
■ This is primary low-pass filter to eliminate ripples caused by encoder pulse included in acceleration feedback compensation. Sets the cutoff frequency.<br>
◆ Lower this setting value when the encoder resolution is low.<br>
◆ Setting range varies depending on the setting of the system parameter ID00 Control Cycle.
<table>
<tr><th colspan="2">Control cycle</th><th>Setting value</th><th>Valid/ Invalid</th></tr>
<tr><td rowspan="2">00</td><td rowspan="2">Standard_Sampling<br>Standard sampling mode</td><td>1 to 1999Hz</td><td>Set value valid</td></tr>
<tr><td>2000 to 4000Hz</td><td>Filter invalid</td></tr>
<tr><td rowspan="2">01</td><td rowspan="2">High-freq_Sampling<br>Hi-speed sampling mode</td><td>1 to 3999Hz</td><td>Set value valid</td></tr>
<tr><td>4000Hz</td><td>Filter invalid</td></tr>
</table>
</td></tr>
<tr><td>1E</td><td>
<table>
<tr><td>Higher Tracking Control Velocity Compensation Gain<br>[TRCVGN]</td><td>Setting range<br>0 to 100</td><td>Unit<br>%</td><td>Default<br>0</td></tr>
</table>
■ Adjusts command tracking performance of velocity control system.<br>
◆ The larger value can raise command tracking performance higher.<br>
◆ When using Velocity Loop Proportional Control Switching Function, set 0%.<br>
◆ When synchronizing with other axes, set 0%.<br>
◆ When corresponding with Q series amplifier unit, set 100%.<br>
◆ Automatically overwrite by Auto-tuning result saving.<br>
◆ When Auto-tuning function is valid, this setting value not applied.<br>
◆ The setting value is invalid with "Model following control" or "Model following vibration suppression control".
</td></tr>
</table>

－Group1－

<table>
<tr><th>ID</th><th>Contents</th></tr>
<tr><td>20</td><td>
<table>
<tr><td>Torque Command Filter 1<br>[TCFIL1]</td><td>Setting range<br>1 to 4000</td><td>Unit<br>Hz</td><td>Default<br>600</td></tr>
</table>
■ This is Low-pass filter to eliminate high frequency component included in the torque command. Sets cutoff frequency.<br>
◆ Automatically overwrite by Auto-tuning result saving.<br>
◆ When Auto-tuning function is valid, this setting value is not applied.<br>
◆ When Gain switching function is valid, this setting value is applied by selecting gain 1.<br>
◆ While system analysis function is active, this value is applied even if Auto-tuning is valid.<br>
◆ Setting range varies depending on the setting of the system parameter ID00 Control Cycle.<br>
(Torque command filter cannot be disabled)
<table>
<tr><th colspan="2">Control cycle</th><th>Setting value</th><th>Cutoff frequency</th></tr>
<tr><td rowspan="2">00</td><td rowspan="2">Standard_Sampling<br>Standard sampling mode</td><td>1 to 1999Hz</td><td>Set value valid</td></tr>
<tr><td>2000 to 4000Hz</td><td>2000Hz</td></tr>
<tr><td>01</td><td>High-freq_Sampling<br>Hi-speed sampling mode</td><td>1 to 4000Hz</td><td>Set value valid</td></tr>
</table>
Use within 1 to 1,000Hz with Model following control.<br>
Use within 100 to 1,000Hz with Model following vibration suppression control.
</td></tr>
<tr><td>21</td><td>
<table>
<tr><td>Torque Command Filter Order<br>[TCFILOR]</td><td>Setting range<br>1 to 3</td><td>Unit<br>Order</td><td>Default<br>2</td></tr>
</table>
■ Sets order of the torque command filter.<br>
The order will be fixed with the set value even if the cut off frequency of torque command filter is changed by Gain switching.
</td></tr>
</table>

－Group1－

| ID | Contents | | | |
|---|---|---|---|---|
| 30 | Dual position feedback gain [DFBCG] | Setting range | Unit | Default |
| | | 0 to 100 | % | 0 |
| | ■ Sets the dual position feedback compensation gain. The larger value, the higher influence of the dual position feedback compensation.<br>◆ Become Invalid the dual position feedback gain compensation function when 0% is set. | | | |
| 31 | Dual position feedback filter [DFBFIL ] | Setting range | Unit | Default |
| | | 0.0 to 2000.0 | ms | 0.0 |
| | ■ Sets a band of the dual position feedback gain compensation. At transient responsiveness, the larger value, the nearer to a semi-closed control.<br>◆ Become Invalid the dual position feedback gain compensation function when 0% is set. | | | |
| 80 | Axes-sync compensation proportional gain [KSCPGN] | Setting range | Unit | Default |
| | | 0 to 1000 | % | 0 |
| | ■ Sets a rate of the axes-sync compensation value.<br>◆ When 100% is set, adds the axes-sync compensation pulse value to the position deviation without change.<br>◆ Vibration might occur if set value is too large. | | | |
| 81 | Axes-sync compensation integral time constant [TSCIGN] | Setting range | Unit | Default |
| | | 0.5 to 1000.0 | ms | 1000.0 |
| | ■ Sets an integral time constant for the axes-sync compensation.<br>◆ This set value will be valid when axes-sync compensation proportional control function is invalid.<br>◆ Integral term will be invalid (proportional control) when 1000.0ms is set. | | | |
| 82 | Axes-sync compensation filter [SCFIL] | Setting range | Unit | Default |
| | | 0.0 to 1000.0 | ms | 0.0 |
| | ■ Primary low pass filter that suppress sudden variation of axes-sync compensation value.<br>◆ Filter will be invalid when 0.0ms is set. | | | |

■ Group2 "FF (Feed Forward) vibration suppression control/ Notch filter/ Disturbance observer settings"

<table>
<tr><th>ID</th><th colspan="4">Contents</th></tr>
<tr><td rowspan="2">00</td><td>FF Vibration Suppression Frequency A1<br>[SUPFRQA1]</td><td>Setting range<br>1.0 to 500.0</td><td>Unit<br>0.1Hz</td><td>Default<br>500.0</td></tr>
<tr><td colspan="4">■ Sets the frequency of the machine vibration to be suppressed by FF vibration suppressor function.<br>Please stop servo motor if change this value.<br>This parameter will be overwritten by executing Auto-FF Vibration Suppression Frequency Tuning.<br>◆ Tuning result will be saved to this parameter automatically.<br>◆ This setting value works when "FF Vibration Suppression Frequency Select Input A1" is enabled.<br>◆ Do not use while synchronizing with other axis such as controlling XY table trajectory for cutting operation.
<table>
<tr><th>Setting range</th><th>Unit and process inside amplifier unit</th></tr>
<tr><td>1.0 to 9.9Hz</td><td>Valid by 0.1Hz</td></tr>
<tr><td>10.0 to 99.9Hz</td><td>Valid by 0.5Hz and drop less than 0.5</td></tr>
<tr><td>100.0 to 499.9Hz</td><td>Valid by 5Hz and drop less than 5</td></tr>
<tr><td>500.0Hz</td><td>FF vibration suppression control is invalid</td></tr>
</table>
* FF vibration suppression control will be invalid during this parameter change, and servo motor will rotate until rest of internal position command of FF vibration suppression control has outputted.<br>* If FF vibration suppression frequency is changed, the time which will be valid of changed value varies depending on the frequency before change.
<table>
<tr><th>The frequency before change</th><th>The time which will be valid of changed value</th></tr>
<tr><td>5.0Hz or more</td><td>1 sec.</td></tr>
<tr><td>3.0Hz</td><td>3 sec.</td></tr>
<tr><td>1.0Hz</td><td>7 sec.</td></tr>
</table></td></tr>
<tr><td rowspan="2">01</td><td>FF Vibration Suppression Level Selection A<br>[SUPLVA]</td><td>Setting range<br>00 to 03</td><td>Unit<br>—</td><td>Default<br>00</td></tr>
<tr><td colspan="4">■ Sets the FF vibration suppression control effect level.<br>◆ Please stop servo motor if change this value.<br>◆ The delay for position command will be improved by enlarging this parameter value but vibration suppression effects become weak.<br>◆ FF vibration suppressor frequency switching function does not affect this.</td></tr>
<tr><td rowspan="2">02</td><td>FF Vibration Suppression Frequency B1<br>[SUPFRQB1]</td><td>Setting range<br>1.0 to 500.0</td><td>Unit<br>0.1Hz</td><td>Default<br>500.0</td></tr>
<tr><td colspan="4">■ See FF Vibration Suppression Frequency A1.<br>* It is not set automatically by Auto-FF Vibration Suppression Frequency Tuning.</td></tr>
<tr><td rowspan="2">03</td><td>FF Vibration Suppression Level Selection B<br>[SUPCRB ]</td><td>Setting range<br>00 to 01</td><td>Unit<br>—</td><td>Default<br>00</td></tr>
<tr><td colspan="4">■ Vibration suppression frequency range will be narrow at set frequency when 01 is set.</td></tr>
</table>

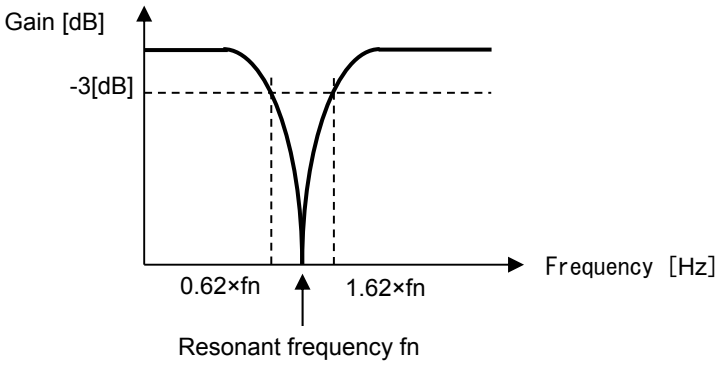
－Group2－

| ID | Contents | | | |
|---|---|---|---|---|
| 10 | Velocity Command Notch Filter [VCNFIL] | Setting range | Unit | Default |
| | | 50 to 1000 | Hz | 1000 |

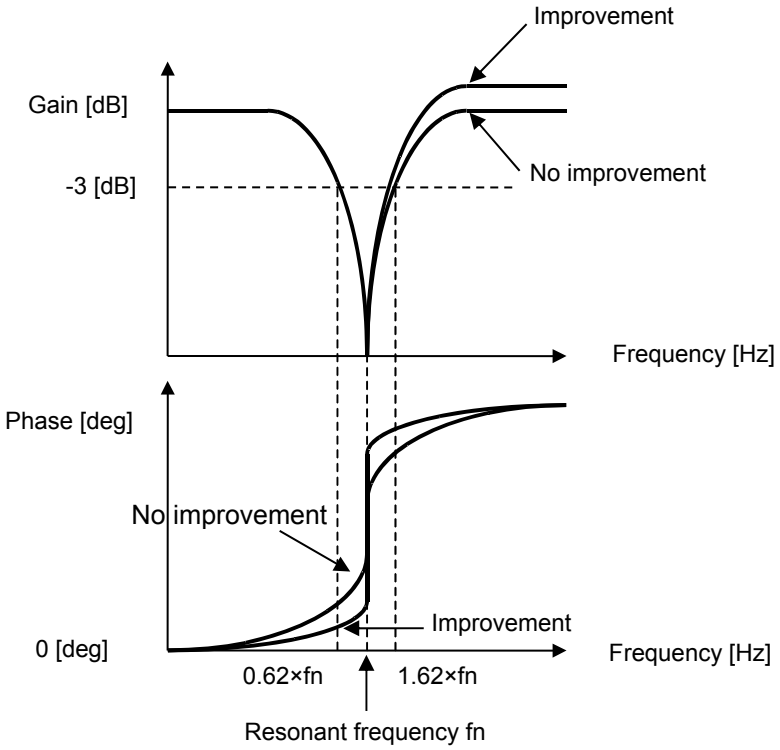
■ This is notch filter to eliminate frequency element arbitrarily set from velocity command.
Sets the resonant frequency.

- ◆ When sympathetic vibration occurs in velocity control system, the gain will be able to raise by setting the resonance frequency.
- ◆ Do not use while synchronizing with other axis such as controlling XY table trajectory for cutting operation.
- ◆ Invalid setting value varies depending on the setting of the system parameter ID00 Control Cycle. This parameter can set in 1 Hz unit, but the units listed below are applied internally.

| Control cycle | | Setting value | Unit and process inside amplifier unit |
|---|---|---|---|
| 00 | Standard_Sampling Standard sampling mode | 50 to 99Hz | Valid by 1Hz |
| | | 100 to 499Hz | Valid by 5Hz and drop less than 5 |
| | | 500 to 1000Hz | Filter invalid |
| 01 | High-freq_Sampling Hi-speed sampling mode | 50 to 199Hz | Valid by 1Hz |
| | | 200 to 999Hz | Valid by 10Hz and drop less than 10 |
| | | 1000Hz | Filter invalid |



－Group2－

<table>
<tr><th>ID</th><th>Contents</th></tr>
<tr><td>20</td><td>
<table>
<tr><td>Torque Command Notch Filter A<br>[TCNFILA]</td><td>Setting range<br>100 to 4000</td><td>Unit<br>Hz</td><td>Default<br>4000</td></tr>
</table>
■ This is notch filter to eliminate sympathetic vibration element included in torque command. Sets the resonant frequency.<br>
◆ Invalid setting value varies depending on the setting of the system parameter ID00 Control Cycle.
<table>
<tr><th colspan="2">Control cycle</th><th>Setting value</th><th>Unit and process inside amplifier unit</th></tr>
<tr><td rowspan="2">00</td><td rowspan="2">Standard_Sampling<br>Standard sampling mode</td><td>100 to 1999Hz</td><td>Valid by 1Hz</td></tr>
<tr><td>2000 to 4000Hz</td><td>Filter invalid</td></tr>
<tr><td rowspan="2">01</td><td rowspan="2">High-freq_Sampling<br>Hi-speed sampling mode</td><td>100 to 3999Hz</td><td>Valid by 1Hz</td></tr>
<tr><td>4000Hz</td><td>Filter invalid</td></tr>
</table>
This parameter is automatically saved by executing Notch filter tuning.
</td></tr>
<tr><td>21</td><td>
<table>
<tr><td>TCNFILA, Low Frequency Phase Delay Improvement<br>[TCNFPA]</td><td>Setting range<br>00 to 02</td><td>Unit<br>-</td><td>Default<br>00</td></tr>
</table>
■ Improves phase delay at lower frequency than resonant frequency of the Torque Command Notch Filter A.<br>
◆ The larger the value is, the greater the improvement.<br>
◆ Characteristic is same as the standard notch filter when the setting value is 0.<br>
◆ Caution, other than the setting value 0, higher frequencies than the resonant frequency will be amplified.


</td></tr>
</table>

－Group2－

| ID | Contents | | | |
|---|---|---|---|---|
| 22 | Torque Command Notch Filter B [TCNFILB] | Setting range | Unit | Default |
| | | 100 to 4000 | Hz | 4000 |
| 24 | Torque Command Notch Filter C [TCNFILC] | Setting range | Unit | Default |
| | | 100 to 4000 | Hz | 4000 |
| 26 | Torque Command Notch Filter D [TCNFILD] | Setting range | Unit | Default |
| | | 100 to 4000 | Hz | 4000 |
| 28 | Torque Command Notch Filter E [TCNFILE] | Setting range | Unit | Default |
| | | 100 to 4000 | Hz | 4000 |

■ This is notch filter to eliminate sympathetic vibration element included in torque command. Sets the resonant frequency.

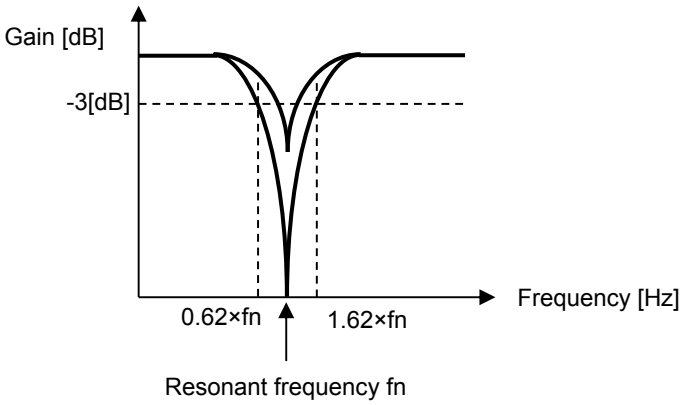
◆ Invalid "Torque command notch filter" setting value varies depending on the setting of the system parameter ID00 Control Cycle.

| Control cycle | | Setting value | Unit and process inside amplifier unit |
|---|---|---|---|
| 00 | Standard_Sampling | 100 to 1999Hz | Valid by 1Hz |
| | | 2000 to 4000Hz | Filter invalid |
| 01 | High-freq_Sampling | 100 to 3999Hz | Valid by 1Hz |
| | | 4000Hz | Filter invalid |

◆ The value set to Torque Command Notch Filter E will be valid when “00: Adp_Filter Disable Adaptation invalid” is set to Group0 ID34 “Adaptive notch filter function E”.

| ID | Contents | | | |
|---|---|---|---|---|
| 23 | TCNFILB, Depth Selection [TCNFDB] | Setting range | Unit | Default |
| | | 0 to 15 | - | 0 |
| 25 | TCNFILC, Depth Selection [TCNFDC] | Setting range | Unit | Default |
| | | 0 to 15 | - | 0 |
| 27 | TCNFILD, Depth Selection [TCNFDD] | Setting range | Unit | Default |
| | | 0 to 15 | - | 0 |
| 29 | TCNFILE, Depth Selection [TCNFDE] | Setting range | Unit | Default |
| | | 0 to 15 | - | 0 |

■ Parameters to set the depth of each Torque Command Notch Filter (TCNFILB to E). The larger the value is, the shallower the depth.

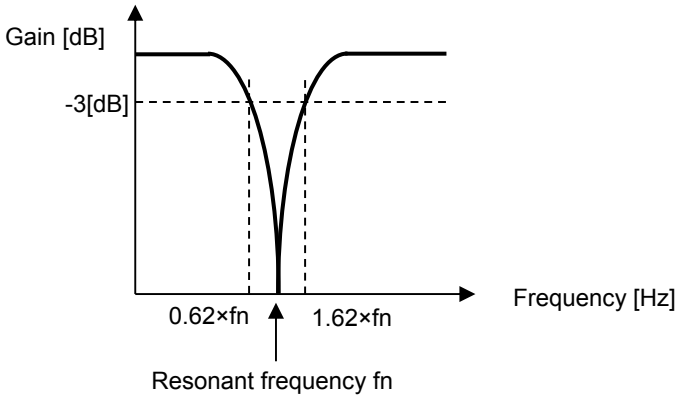



◆ The value set to TCNFILE, Depth Selection will be valid when “00: Adp_Filter Disable Adaptation invalid” is set to Group0 ID34 “Adaptive notch filter function E”.

－Group2－

<table>
<tr><th>ID</th><th colspan="4">Contents</th></tr>
<tr><td rowspan="2">30</td><td>Observer Characteristic<br>[OBCHA]</td><td>Setting range<br>00 to 02</td><td>Unit<br>—</td><td>Default<br>00:Low</td></tr>
<tr><td colspan="4">■ Selects frequency characteristic of the disturbance observer.
<table>
<tr><th colspan="2">Selection</th><th>Contents</th></tr>
<tr><td>00</td><td>Low</td><td>For Low Frequency</td></tr>
<tr><td>01</td><td>Middle</td><td>For Middle Frequency</td></tr>
<tr><td>02</td><td>High</td><td>For High Frequency</td></tr>
</table>
◆ Select “00: Low, Low Frequency Disturbance Observer Suppressor” for Load torque monitor (estimate value).<br>◆ Select 02: High, High Frequency Disturbance Observer Suppressor, when the encoder resolution is over 1048576P/R.</td></tr>
<tr><td rowspan="2">31</td><td>Observer Compensation Gain<br>[OBG]</td><td>Setting range<br>0 to 100</td><td>Unit<br>%</td><td>Default<br>0</td></tr>
<tr><td colspan="4">■ This is Compensation gain for Disturbance Observer.<br>The larger the value is, the higher the suppression performance. However, if the value is too large, oscillation may sometimes occur.</td></tr>
<tr><td rowspan="2">32</td><td>Observer Output Low-pass Filter<br>[OBLPF]</td><td>Setting range<br>1 to 4000</td><td>Unit<br>Hz</td><td>Default<br>50</td></tr>
<tr><td colspan="4">■ This is primary low-pass filter to eliminate high frequency elements included in the observer compensation.<br>Sets the cutoff frequency.<br>◆ The larger the value is, the faster the response of disturbance observer suppression. However, it may cause a louder driving sound depending on the ripple components included in disturbance observer output.<br>◆ Filter is invalid at the setting value more than 2,000Hz.<br>◆ Filter is invalid when observer characteristic is set to “01: Middle, For Middle Frequency”, or “02: High, For High Frequency”.</td></tr>
</table>

－Group2－

<table>
<tr><th>ID</th><th colspan="4">Contents</th></tr>
<tr><td rowspan="3">33</td><td>Observer Output Notch Filter<br>[OBNFIL]</td><td>Setting range<br>100 to 4000</td><td>Unit<br>Hz</td><td>Default<br>4000</td></tr>
<tr><td colspan="4">■ This is notch filter to eliminate arbitrarily selected frequency from observer compensation.<br>Sets the resonant frequency.<br>When resonance appears in disturbance observer output, such as sympathetic vibration with the mechanical system, this notch filter sometimes suppresses the vibration.<br>◆ This parameter can set in 1 Hz unit, but the units listed below are applied internally.<br><table><tr><th>Setting value</th><th>Unit and process inside amplifier unit</th></tr><tr><td>100 to 1999Hz</td><td>Valid by 10Hz and drop less than 10</td></tr><tr><td>2000 to 4000Hz</td><td>Filter invalid</td></tr></table> 
</td></tr>
<tr><td rowspan="2">40</td><td>Effective velocity for compensating stick-slip behavior<br>[STV]</td><td>Setting range<br>0.1 to 128.0</td><td>Unit<br>$min^{-1}$</td><td>Default<br>10.0</td></tr>
<tr><td colspan="4">■ Sets the velocity at which stick-slip behavior compensatory function works.<br>◆ Stick-slip behavior compensatory function works when the velocity command inside of amplifier unit is the set value or less.<br>◆ Stick-slip behavior compensation is effective when the valid condition of stick-slip behavior compensatory function (Group9 ID34) is satisfied.</td></tr>
<tr><td rowspan="2">41</td><td>Retention time for compensating stick-slip behavior<br>[STHLD]</td><td>Setting range<br>1 to 500</td><td>Unit<br>ms</td><td>Default<br>20</td></tr>
<tr><td colspan="4">■ Sets the time to retain stick-slip behavior compensation.<br>◆ Stick-slip behavior compensation continues till the above set time elapses even if the velocity command inside of amplifier unit exceeds the effective velocity for compensating stick-slip behavior.<br>◆ Increase the value of the time if velocity loop responsiveness is low.<br>◆ Stick-slip behavior compensation is effective when the valid condition of stick-slip behavior compensatory function (Group9 ID34) is satisfied.</td></tr>
<tr><td rowspan="2">42</td><td>Velocity loop integral time constant for stick-slip behavior compensation<br>[STTVI]</td><td>Setting range<br>0.3 to 1000</td><td>Unit<br>ms</td><td>Default<br>3.0</td></tr>
<tr><td colspan="4">■ Sets the Velocity loop integral time constant for stick-slip behavior compensation.<br>◆ The above set value applies to velocity loop integral time constant while stick-slip behavior compensation is being performed.<br>◆ This velocity loop integral time constant for stick-slip behavior compensation sets smaller velocity loop integral time constant values than the ones normally used. If you set the value larger than the above, stick-slip behavior compensation doesn't work.<br>◆ Stick-slip behavior compensation doesn't work when velocity loop is in proportional control. Please carefully set the effective condition of "Velocity loop proportional control switching function" (Group9 ID27) when applying P-PI control switching to velocity control system.<br>◆ Stick-slip behavior compensation is effective when the valid condition of stick-slip behavior compensatory function (Group9 ID34) is satisfied.</td></tr>
</table>

－Group2－

<table>
<tr><th>ID</th><th colspan="4">Contents</th></tr>
<tr><td rowspan="2">50</td><td>CP vibration suppression control frequency<br>[CPVSFQ]</td><td>Setting range<br>10.0 to 100.0</td><td>Unit<br>0.1Hz</td><td>Default<br>100.0</td></tr>
<tr><td colspan="4">■ Sets the vibration frequency of Machine stand.<br>◆ The filter will invalid if set value is 100.0 Hz or more.<br>◆ This function will valid if in conditions below.<br>・In case of standard position control.<br>・In case of "Model-following / standard position control switching (Model 3)" is set and Standard position control is valid.<br>・In case of "Model-following vibration suppression / standard position control switching (Model 4)" is set and Standard position control is valid.<br>* Please stop servo motor if change this value.</td></tr>
<tr><td rowspan="2">51</td><td>CP vibration suppression control level<br>[CPVSLV]</td><td>Setting range<br>00 to 03</td><td>Unit<br>-</td><td>Default<br>00</td></tr>
<tr><td colspan="4">■ This is the parameter which sets impact of CP vibration suppression control.<br>◆ The larger value can be impact of CP vibration suppression control big.<br>* Please stop servo motor if change this value.</td></tr>
<tr><td rowspan="2">52</td><td>CP vibration suppression control characteristics selection<br>[CPVSCR]</td><td>Setting range<br>00 to 02</td><td>Unit<br>-</td><td>Default<br>01</td></tr>
<tr><td colspan="4">■ Sets the effective frequency range of CP vibration suppression control.<br>◆ The larger value will be narrower the effective frequency range of CP vibration suppression control.<br>* Please stop servo motor if change this value.</td></tr>
<tr><td rowspan="2">60</td><td>Minor vibration suppression pulse compensation value<br>[FBHPLS]</td><td>Setting range<br>1 to 100</td><td>Unit<br>Pulse</td><td>Default<br>1</td></tr>
<tr><td colspan="4">■ Sets the compensation amount of Minor vibration suppression function for velocity feedback.<br>Unit of set value is 1 pulse of encoder.<br>* Sets by multiple of FBHTIM. If not multiple of FBHTIM, the actual Minor vibration suppression pulse compensation frequency will have deviation with FBHTIM.</td></tr>
<tr><td rowspan="2">61</td><td>Minor vibration suppression pulse compensation frequency<br>[FBHTIM]</td><td>Setting range<br>1 to 100</td><td>Unit<br>times</td><td>Default<br>1</td></tr>
<tr><td colspan="4">■ Sets the number of Minor vibration suppression.<br>* This value will be valid if Minor vibration suppression function is valid.</td></tr>
</table>

■ Group3 "Model following control settings"

<table>
<tr><th>ID</th><th colspan="4">Contents</th></tr>
<tr><td rowspan="3">00</td><td>Model Control Gain 1<br>[KM1]</td><td>Setting range<br>1 to 3000</td><td>Unit<br>1/s</td><td>Default<br>30</td></tr>
<tr><td colspan="4">■ Proportional gain for model position controller.<br>◆ Use within the range of 15 to 315 (1/s) if operate with Model-following vibration suppression control.<br>◆ Automatically overwrite by Auto-tuning result saving.<br>◆ When Auto-tuning function is valid, this setting value is not applied.<br>◆ When Gain switching function is valid, this setting value is applied by selecting gain 1.<br>◆ Please stop servo motor if change this value.</td></tr>
<tr><td></td></tr>
<tr><td rowspan="3">01</td><td>Model control damping coefficient<br>[MZETA]</td><td>Setting range<br>0 to 100</td><td>Unit<br>%</td><td>Default<br>100</td></tr>
<tr><td colspan="4">■ This is parameter which changes velocity proportional gain of Model following control.<br>◆ The parameter value will be ζ=0.866 by the set value 0% and ζ=1.0 by 100%.</td></tr>
<tr><td></td></tr>
<tr><td rowspan="3">02</td><td>Model velocity feedforward gain<br>[MFFGN]</td><td>Setting range<br>0 to 100</td><td>Unit<br>%</td><td>Default<br>0</td></tr>
<tr><td colspan="4">■ This is FF compensation gain for Model position control system.<br>◆ Automatically overwrite by Auto-tuning result saving.<br>◆ When Auto-tuning function is valid, this setting value is not applied.</td></tr>
<tr><td></td></tr>
<tr><td rowspan="3">03</td><td>Model velocity feedforward differential time constant<br>[MTFFD]</td><td>Setting range<br>0.00 to 10.00</td><td>Unit<br>ms</td><td>Default<br>0.00</td></tr>
<tr><td colspan="4">■ This is the parameter which improves command-following capability of Model position control system.<br>The function is invalid when set value is 0.00msec.</td></tr>
<tr><td></td></tr>
<tr><td rowspan="3">04</td><td>Model velocity feedforward filter<br>[MFFFIL]</td><td>Setting range<br>1 to 4000</td><td>Unit<br>Hz</td><td>Default<br>4000</td></tr>
<tr><td colspan="4">■ This is primary low-pass filter to eliminate pulsed ripple caused by the position command pulse included in the feed forward command. Sets the cutoff frequency.<br>◆ The function is Invalid at 1,000Hz or more.</td></tr>
<tr><td></td></tr>
</table>

* Please stop the servo motor when Gain switching function is acting.
* Please stop the servo motor if Model vibration suppression frequency switching is used.
* When alarm "Model Following Vibration Suppression Control Error (AL.C5)" occurs while working, please make accel/ decel gently by reducing "Model control gain (KM)" or changing operation pattern.
* Model Following Vibration Suppression Control function does not work at JOG operation.

－Group3－

<table>
<tr><th>ID</th><th>Contents</th></tr>
<tr><td>05</td><td>
<table>
<tr><td>Overshoot Suppression Filter<br>[OSSFIL]</td><td>Setting range<br>1 to 4000</td><td>Unit<br>Hz</td><td>Default<br>1500</td></tr>
</table>
■ Filter to suppress overshoot with Model following control or Model following vibration suppression control.<br>Sets cutoff frequency.<br>◆ Lower the setting value when overshoot on position deviation occurs.<br>◆ Filter is invalid at the setting value of 2,000Hz or more.
</td></tr>
<tr><td>06</td><td>
<table>
<tr><td>Model Control Antiresonance Frequency 1<br>[ANRFRQ1]</td><td>Setting range<br>10.0 to 80.0</td><td>Unit<br>Hz</td><td>Default<br>80.0</td></tr>
</table>
■ Sets the antiresonance frequency of the mechanical model in Model following vibration suppression control.<br>Actual measurement antiresonance frequency value of the mechanical system is able to set by using System Analysis function of the setup software.<br>◆ This value does not apply with “Model following control”.<br>◆ Vibration suppression control is invalid if larger value than "Model Control Resonance Frequency" has set.<br>◆ Please stop servo motor if change this value.
</td></tr>
<tr><td>07</td><td>
<table>
<tr><td>Model Control Resonance Frequency 1<br>[RESFRQ1]</td><td>Setting range<br>10.0 to 80.0</td><td>Unit<br>Hz</td><td>Default<br>80.0</td></tr>
</table>
■ Sets the resonance frequency of the mechanical model in Model-following vibration suppression control.<br>Actual measurement resonance frequency value of the mechanical system is able to set by using System Analysis function of the setup software.<br>◆ This value does not apply with “Model following control”.<br>◆ Vibration suppression control is invalid if smaller value than "Model Control Antiresonance Frequency" has set, or if 80 Hz is set.<br>◆ Please stop servo motor if change this value.
</td></tr>
</table>

* Please stop the servo motor when Gain switching function is acting.
* Please stop the servo motor if Model vibration suppression frequency switching is used.
* When alarm "Model Following Vibration Suppression Control Error (AL.C5)" occurs while working, please make accel/ decel gently by reducing "Model control gain (KM)" or changing operation pattern.
* Model Following Vibration Suppression Control function does not work at JOG operation.

■ Group4 "Gain switching control/ vibration suppression frequency switching settings"

| ID | Contents | | | |
|---|---|---|---|---|
| 00 | Model Control Gain 2 [KM2] | Setting range | Unit | Default |
| | | 1 to 3000 | 1/s | 30 |
| 10 | Model Control Gain 3 [KM3] | Setting range | Unit | Default |
| | | 1 to 3000 | 1/s | 30 |
| 20 | Model Control Gain 4 [KM4] | Setting range | Unit | Default |
| | | 1 to 3000 | 1/s | 30 |
| | ■ Proportional gain for Model position controller which is selected in the Gain switching function 1 or 2.<br>◆ This parameter is excepted from Auto-tuning result saving.<br>◆ Please stop servo motor if change this value. | | | |
| 01 | Position Loop Proportional Gain 2 [KP2] | Setting range | Unit | Default |
| | | 1 to 3000 | 1/s | 30 |
| 11 | Position Loop Proportional Gain 3 [KP3] | Setting range | Unit | Default |
| | | 1 to 3000 | 1/s | 30 |
| 21 | Position Loop Proportional Gain 4 [KP4] | Setting range | Unit | Default |
| | | 1 to 3000 | 1/s | 30 |
| | ■ Proportional gain for Position controller which is selected in the Gain switching function 1 or 2.<br>◆ This parameter is excepted from Auto-tuning result saving. | | | |
| 02 | Position Loop Integral Time Constant 2 [TPI2] | Setting range | Unit | Default |
| | | 0.3 to 1000.0 | ms | 1000.0 |
| 12 | Position Loop Integral Time Constant 3 [TPI3] | Setting range | Unit | Default |
| | | 0.3 to 1000.0 | ms | 1000.0 |
| 22 | Position Loop Integral Time Constant 4 [TPI4] | Setting range | Unit | Default |
| | | 0.3 to 1000.0 | ms | 1000.0 |
| | ■ Integral time constant for Position controller which is selected in the Gain switching function 1 or 2.<br>◆ This parameter is excepted from Auto-tuning result saving.<br>◆ Integral term will be invalid (Proportional control) at 1,000.0 ms.<br>◆ This setting will be valid if Position loop proportional control switching function is invalid. | | | |
| 03 | Velocity Loop Proportional Gain 2 [KVP2] | Setting range | Unit | Default |
| | | 1 to 2000 | Hz | 50 |
| 13 | Velocity Loop Proportional Gain 3 [KVP3] | Setting range | Unit | Default |
| | | 1 to 2000 | Hz | 50 |
| 23 | Velocity Loop Proportional Gain 4 [KVP4] | Setting range | Unit | Default |
| | | 1 to 2000 | Hz | 50 |
| | ■ Proportional gain for Velocity controller which is selected in the Gain switching function 1 or 2.<br>◆ This parameter is excepted from Auto-tuning result saving.<br>◆ This value will be response frequency if corresponding Load inertia moment ratio (JRAT2, JRAT3 and JRAT4) matches actual Load inertia moment ratio. | | | |

－Group4－

| ID | Contents | | | |
|---|---|---|---|---|
| 04 | Velocity Loop Integral Time Constant 2 [TVI2] | Setting range | Unit | Default |
| | | 0.3 to 1000.0 | ms | 20.0 |
| 14 | Velocity Loop Integral Time Constant 3 [TVI3] | Setting range | Unit | Default |
| | | 0.3 to 1000.0 | ms | 20.0 |
| 24 | Velocity Loop Integral Time Constant 4 [TVI4] | Setting range | Unit | Default |
| | | 0.3 to 1000.0 | ms | 20.0 |
| | ■ Integral time constant for Velocity controller which is selected in the Gain switching function 1 or 2.<br>◆ This parameter is excepted from Auto-tuning result saving.<br>◆ This setting is valid when Velocity Loop Proportional Control Switching Function is invalid.<br>◆ Integral term will be invalid (Proportional control) at 1,000.0 ms. | | | |
| 05 | Load Inertia Moment Ratio 2 [JRAT2] | Setting range | Unit | Default |
| | | 0 to 15000 | % | 100 |
| 15 | Load Inertia Moment Ratio 3 [JRAT3] | Setting range | Unit | Default |
| | | 0 to 15000 | % | 100 |
| 25 | Load Inertia Moment Ratio 4 [JRAT4] | Setting range | Unit | Default |
| | | 0 to 15000 | % | 100 |
| | ■ Load inertia ratio for rotor inertia of servo motor which is selected in the Gain switching function 1 or 2.<br>◆ If this value matches the actual mechanical system, the corresponding value of Velocity Loop Proportional Gain (KVP2, KVP3, or KVP4) will be response frequency of the velocity control system.<br>◆ This parameter is excepted from Auto-tuning result saving.<br>◆ Setting value=$J_L/J_M$×100%<br>● $J_L$: Load inertia moment<br>● $J_M$: Motor inertia moment | | | |
| 06 | Torque Command Filter 2 [TCFIL2] | Setting range | Unit | Default |
| | | 1 to 4000 | Hz | 600 |
| 16 | Torque Command Filter 3 [TCFIL3] | Setting range | Unit | Default |
| | | 1 to 4000 | Hz | 600 |
| 26 | Torque Command Filter 4 [TCFIL4] | Setting range | Unit | Default |
| | | 1 to 4000 | Hz | 600 |

■ This is low-pass filter to eliminate high frequency component in torque command which is selected in the Gain switching function 1 or 2. Sets the cutoff frequency.

◆ This parameter is excepted from Auto-tuning result saving.

◆ Setting range varies depending on the setting of the system parameter ID00 Control Cycle.
(Torque command filter cannot be disabled)

| Control cycle | | Setting value | Cutoff frequency |
|---|---|---|---|
| 00 | Standard_Sampling<br>Standard sampling mode | 1 to 2000Hz | Set value valid |
| | | 2001 to 4000Hz | 2000Hz |
| 01 | High-freq_Sampling<br>Hi-speed sampling mode | 1 to 4000Hz | Set value valid |

－Group4－

| ID | Contents | | | |
|---|---|---|---|---|
| 30 | Gain Switching Filter [GCFIL] | Setting range | Unit | Default |
| | | 0 to 100 | ms | 0 |
| | ■ This is primary Low-pass filter which makes gain change gently at Gain switching. Sets time constant.<br>◆ When the mechanical system is shocked by the change of gain resulted from gain switching, making a gentle gain change will soften the shock.<br>◆ The larger the value, the gentler the gain changes. | | | |
| 40 | FF Vibration Suppression Frequency A2 [SUPFRQA2] | Setting range | Unit | Default |
| | | 1.0 to 500.0 | Hz | 500.0 |
| 41 | FF Vibration Suppression Frequency A3 [SUPFRQA3] | Setting range | Unit | Default |
| | | 1.0 to 500.0 | Hz | 500.0 |
| 42 | FF Vibration Suppression Frequency A4 [SUPFRQA4] | Setting range | Unit | Default |
| | | 1.0 to 500.0 | Hz | 500.0 |

■ Sets the mechanical vibration frequency which is wanted to suppress by FF vibration suppression function. Selects in FF vibration suppression frequency selection 1 or 2.

◆ Please stop servo motor if change this value.
◆ This parameter is excepted from Auto-tuning result saving.
◆ This parameter can set in 0.1 Hz unit, but the units listed below are applied internally.

| Setting range | Unit and process inside amplifier unit |
|---|---|
| 1.0 to 9.9Hz | Valid by 0.1Hz |
| 10.0 to 99.9Hz | Valid by 0.5Hz and drop less than 0.5 |
| 100.0 to 499.9Hz | Valid by 5Hz and drop less than 5 |
| 500.0Hz | FF vibration suppression control is invalid |

* FF vibration suppression control will be invalid when this parameter is changed. After outputting rest of internal position command, FF vibration suppression control will be valid with the frequency changed after.

* The time which will be valid of changed value varies depending on the frequency before change as follows.

| The frequency before change | The time which will be valid of changed value |
|---|---|
| 5.0Hz or more | 1 sec. |
| 3.0Hz | 3 sec. |
| 1.0Hz | 7 sec. |

| | | | | |
|---|---|---|---|---|
| 43 | FF Vibration Suppression Frequency B2 [SUPFRQB2] | Setting range | Unit | Default |
| | | 1.0 to 500.0 | Hz | 500.0 |
| 44 | FF Vibration Suppression Frequency B3 [SUPFRQB3] | Setting range | Unit | Default |
| | | 1.0 to 500.0 | Hz | 500.0 |
| 45 | FF Vibration Suppression Frequency B4 [SUPFRQB4] | Setting range | Unit | Default |
| | | 1.0 to 500.0 | Hz | 500.0 |
| | ■ See FF Vibration Suppression Frequency A2 to A4. Selects these in FF Vibration Suppression Frequency Select Input B1/ B2. | | | |

－Group4－

<table>
<tr><th>ID</th><th colspan="4">Contents</th></tr>
<tr><td rowspan="2">50</td><td rowspan="2">Model Control Antiresonance Frequency 2<br>[ANRFRQ2]</td><td>Setting range</td><td>Unit</td><td>Default</td></tr>
<tr><td>10.0 to 80.0</td><td>Hz</td><td>80.0</td></tr>
<tr><td rowspan="2">52</td><td rowspan="2">Model Control Antiresonance Frequency 3<br>[ANRFRQ3]</td><td>Setting range</td><td>Unit</td><td>Default</td></tr>
<tr><td>10.0 to 80.0</td><td>Hz</td><td>80.0</td></tr>
<tr><td rowspan="2">54</td><td rowspan="2">Model Control Antiresonance Frequency 4<br>[ANRFRQ4]</td><td>Setting range</td><td>Unit</td><td>Default</td></tr>
<tr><td>10.0 to 80.0</td><td>Hz</td><td>80.0</td></tr>
<tr><td></td><td colspan="4">■ Sets the antiresonance frequency of the mechanical device at Model-following vibration suppression control. Selects in Model Vibration Suppression Frequency Select Input 1 or 2.<br>◆ This value does not apply with Model following control.<br>◆ Vibration suppression control is invalid if larger value than "Model Control Resonance Frequency" has set.<br>◆ Setting by using “system analysis” function cannot be performed.<br>◆ Please stop servo motor if change this value.</td></tr>
<tr><td rowspan="2">51</td><td rowspan="2">Model Control Resonance Frequency 2<br>[RESFRQ2]</td><td>Setting range</td><td>Unit</td><td>Default</td></tr>
<tr><td>10.0 to 80.0</td><td>Hz</td><td>80.0</td></tr>
<tr><td rowspan="2">53</td><td rowspan="2">Model Control Resonance Frequency 3<br>[RESFRQ3]</td><td>Setting range</td><td>Unit</td><td>Default</td></tr>
<tr><td>10.0 to 80.0</td><td>Hz</td><td>80.0</td></tr>
<tr><td rowspan="2">55</td><td rowspan="2">Model Control Resonance Frequency 4<br>[RESFRQ4]</td><td>Setting range</td><td>Unit</td><td>Default</td></tr>
<tr><td>10.0 to 80.0</td><td>Hz</td><td>80.0</td></tr>
<tr><td></td><td colspan="4">■ Sets the resonance frequency of the mechanical device at Model-following vibration suppression control. Selects in Model Vibration Suppression Frequency Select Input 1 or 2.<br>◆ This value does not apply with Model following control.<br>◆ Vibration suppression control is invalid if smaller value than "Model Control Antiresonance Frequency" has set, or if 80 Hz is set.<br>◆ Setting by using “system analysis” function cannot be performed.<br>◆ Please stop servo motor if change this value.</td></tr>
</table>

■ Group5 " Fast-settling control settings"

<table>
<tr><th>ID</th><th colspan="4">Contents</th></tr>
<tr><td rowspan="3">00</td><td rowspan="2">Command Velocity Low-pass Filter<br>[CVFIL]</td><td>Setting range</td><td>Unit</td><td>Default</td></tr>
<tr><td>1 to 4000</td><td>Hz</td><td>1000</td></tr>
<tr><td colspan="4">■ This is primary low-pass filter to eliminate high frequency component such as ripples included in the velocity (command velocity) calculated from position command pulse inside of fast-settling control.<br>◆ Lower this setting value when the encoder resolution is low.<br>◆ Filter is invalid at the setting value of 2,000Hz or more.</td></tr>
<tr><td rowspan="3">01</td><td rowspan="2">Command Velocity Threshold<br>[CVTH]</td><td>Setting range</td><td>Unit</td><td>Default</td></tr>
<tr><td>0 to 65535</td><td>min$^{-1}$</td><td>20</td></tr>
<tr><td colspan="4">■ Sets the velocity threshold value that activates fast-settling control compensation (Acceleration Compensation and Deceleration Compensation).<br>◆ Acceleration Compensation or Deceleration Compensation will be done when velocity (command velocity) calculated from the position command pulse is larger than this value.</td></tr>
<tr><td rowspan="3">02</td><td rowspan="2">Acceleration Compensation<br>[ACCCO]</td><td>Setting range</td><td>Unit</td><td>Default</td></tr>
<tr><td>-9999 to 9999</td><td>×50 Pulse</td><td>0</td></tr>
<tr><td colspan="4">■ Sets the Acceleration Compensation value in fast-settling control.<br>◆ Sets in units of position deviation pulse (In case of icremental encoder, four-multiplied to encoder resolution is it).<br>◆ Compensation will be done to a position deviation.<br>◆ The larger the setting value, the greater the compensation value.<br>◆ The larger the acceleration value calculated from position command pulse, compensation value increases.<br>◆ The larger the Load inertia moment, the greater the compensation value is.<br>◆ Position deviation decreases by fast-settling control.<br>◆ The setting value is invalid with "Model following control" or "Model following vibration suppression control".</td></tr>
<tr><td rowspan="3">03</td><td rowspan="2">Deceleration Compensation<br>[DECCO]</td><td>Setting range</td><td>Unit</td><td>Default</td></tr>
<tr><td>-9999 to 9999</td><td>×50 Pulse</td><td>0</td></tr>
<tr><td colspan="4">■ Sets the Deceleration Compensation value in fast-settling control.<br>◆ Sets in units of position deviation pulse (In case of incremental encoder, four-multiplied to encoder resolution is it).<br>◆ Compensation will be done to a position deviation.<br>◆ The larger the setting value, the greater the compensation value.<br>◆ The larger the acceleration value calculated from position command pulse, compensation value increases.<br>◆ The larger the Load inertia moment, the greater the compensation value is.<br>◆ Position deviation decreases by fast-settling control.<br>◆ The setting value is invalid with "Model following control" or "Model following vibration suppression control".</td></tr>
</table>

■ Group8 "Control system settings"

| ID | Contents | | | |
|---|---|---|---|---|
| 00 | Position, Velocity, Torque Command Input Polarity [CMDPOL] | Setting range | Unit | Default |
| | | 00 to 07 | - | 00:PC+_VC+_TC+ |

■ Selects the combination of each command polarity for position command pulse, Analog velocity command and Analog torque command input from the list below.

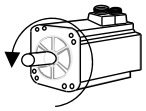
◆ Rotating direction of the servo motor can be reversed without changing the command wiring.

◆ Rotating direction which depends on the selection value will be shown below in case positive (+) polarity command is given.

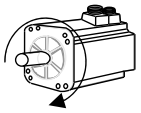
| Selection | | Polarity | Position Command Pulse (PCMD) | Analog Velocity Command (VCMD) | Analog Torque Command (TCMD) |
|---|---|---|---|---|---|
| 00 | PC+_VC+_TC+ | + | Forward | Forward | Forward |
| 01 | PC+_VC+_TC- | + | Forward | Forward | Reverse |
| 02 | PC+_VC-_TC+ | + | Forward | Reverse | Forward |
| 03 | PC+_VC-_TC- | + | Forward | Reverse | Reverse |
| 04 | PC-_VC+_TC+ | + | Reverse | Forward | Forward |
| 05 | PC-_VC+_TC- | + | Reverse | Forward | Reverse |
| 06 | PC-_VC-_TC+ | + | Reverse | Reverse | Forward |
| 07 | PC-_VC-_TC- | + | Reverse | Reverse | Reverse |

◆ Command input polarity is at standard setting value “00: PC+_VC+_TC+”

Forward rotation (CCW) with (+) polarity command

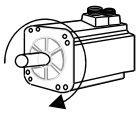


Reverse rotation (CW) with (-) polarity command

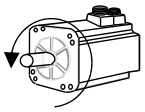


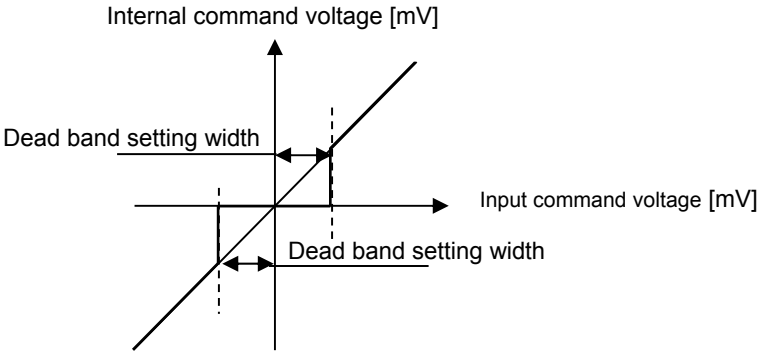
◆ Command input polarity change “07:PC-_VC-_TC-“

Reverse rotation (CW) with (+) polarity command



Forward rotation (CCW) with (-) polarity command



<table>
<tr><th>ID</th><th>Contents</th></tr>
<tr><td>01</td><td>
<table>
<tr><td rowspan="2">Analog Velocity/Torque Command Input Dead Band Width [VC/TC-DW]</td><td>Setting range</td><td>Unit</td><td>Default</td></tr>
<tr><td>0.0 to 6553.5</td><td>mV</td><td>0.0</td></tr>
</table>
■ Sets the voltage as dead band for Analog velocity command input and Analog torque command input.<br>
◆ Command voltage within the dead band setting range is treated as 0V at internal of amplifier unit.<br>
◆ It improves influences as noise and drift for Analog velocity command input and Analog torque command input.<br>


</td></tr>
<tr><td>10</td><td>
<table>
<tr><td rowspan="2">Position Command Pulse Selection [PMOD] “Power cycle for control after setting”</td><td>Setting range</td><td>Unit</td><td>Default</td></tr>
<tr><td>00 to 02</td><td>-</td><td>00: F-PC_R-PC</td></tr>
</table>
■ Sets the Position control command pulse type.<br>
◆ Select from below to match with the upper device specifications.
<table>
<tr><th colspan="2">Selection</th><th>Contents</th></tr>
<tr><td>00</td><td>F-PC_R-PC</td><td>Forward Rotation (Positive) Pulse<br>+ Reverse Rotation (Negative) Pulse</td></tr>
<tr><td>01</td><td>PC-A_PC-B</td><td>Two-phase Pulse Train of 90°-Phase Difference</td></tr>
<tr><td>02</td><td>SIGN_PULS</td><td>Code + Pulse Train</td></tr>
</table>
◆ Connect position command pulse to CN1 pin listed below.
<table>
<tr><th>Forward rotation</th><th>Reverse rotation</th></tr>
<tr><td>Forward pulse (F-PC): CN1-26</td><td>Reverse pulse (R-PC): CN1-28</td></tr>
<tr><td>Forward pulse ($\overline{\text{F-PC}}$): CN1-27</td><td>Reverse pulse ($\overline{\text{R-PC}}$): CN1-29</td></tr>
<tr><td>Forward pulse SG: CN1-47</td><td>Reverse pulse SG: CN1-48</td></tr>
</table>
◆ These output types of the upper device are allowed: Line driver output and Open collector output. Be sure to connect SG.
</td></tr>
</table>

－Group8－

| ID | Contents | | | |
|---|---|---|---|---|
| 11 | Position Command Pulse Count Polarity<br>[PCPPOL] "Power cycle for control after setting" | Setting range | Unit | Default |
| | | 00 to 03 | - | 00:Type1 |

■ Selects the Position Command Pulse Count Polarity from the list below.

◆ Select according to host equipment.

| Selection | | Contents |
|---|---|---|
| 00 | Type1 | F-PC: Not inverted.<br>R-PC: Not inverted. |
| 01 | Type2 | F-PC: Inverted.<br>R-PC: Not inverted. |
| 02 | Type3 | F-PC: Not inverted.<br>R-PC: Inverted. |
| 03 | Type4 | F-PC: Inverted.<br>R-PC: Inverted. |

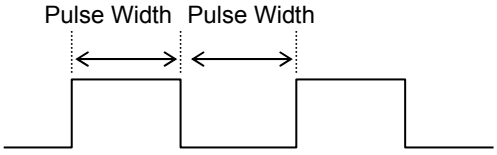
| ID | Position Command Pulse Digital Filter<br>[PCPFIL] | Setting range | Unit | Default |
|---|---|---|---|---|
| 12 | | 00 to 07 | - | 00:850ns |

■ This is filter to eliminate noise elements included in the Position command pulse.

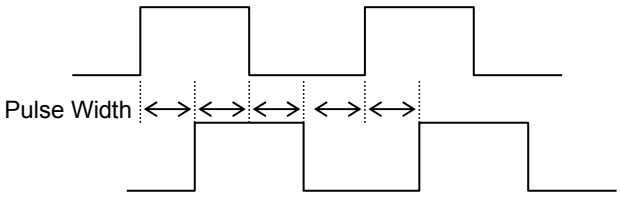
◆ Select from below depending on pulse command condition.

| Selection | | Contents |
|---|---|---|
| 00 | 850nsec. | Minimum Pulse Width =850nsec. |
| 01 | 250nsec. | Minimum Pulse Width =250nsec. |
| 02 | 500nsec. | Minimum Pulse Width =500nsec. |
| 03 | 1.8µsec. | Minimum Pulse Width =1.8µsec. |
| 04 | 3.6µsec. | Minimum Pulse Width =3.6µsec. |
| 05 | 7.2µsec. | Minimum Pulse Width =7.2µsec. |
| 06 | 200nsec. | Minimum Pulse Width =200nsec. |
| 07 | 125nsec. | Minimum Pulse Width =125nsec. |

Forward/Reverse Rotation pulse train method
or Code + Pulse train method




90°-Phase difference pulse method




■ When the Position command pulse width becomes less that the setting values of the Digital filter, the status may become Alarm Code D2 (Position command pulse frequency error 1).
Set Digital filter setting value smaller than that of Pulse width at maximum command frequency.

■ Refer to "2.3.2 Input command, Position signal output, General input, General output" for the specification of the command pulse.

| ID | Contents | | | |
|---|---|---|---|---|
| 13 | Electronic Gear 1 Numerator [B-GER1] | Setting range | Unit | Default |
| | | 1 to 2097152 | - | 1 |
| 14 | Electronic Gear 1 Denominator [A-GER1] | Setting range | Unit | Default |
| | | 1 to 2097152 | - | 1 |
| 15 | Electronic Gear 2 Numerator [B-GER2] | Setting range | Unit | Default |
| | | 1 to 2097152 | - | 1 |
| 16 | Electronic Gear 2 Denominator [A-GER2] | Setting range | Unit | Default |
| | | 1 to 2097152 | - | 1 |

■ Sets the Electronic gear ratio to position command pulse.

◆ Two settings for Electronic gear ratio are available. Set gear 1 or gear 2 by switching.

* Switching of Electronic gear ratio should done at state without position command input.

◆ If the position command pulse is the same, by switching the Electronic gear, rotating velocity and distance are changed.

$$f1 \longrightarrow \boxed{\frac{B\ (1 \text{ to } 2097152)}{A\ (1 \text{ to } 2097152)} \quad 1/2^{21} \leqq B/A \leqq 2^{21}} \longrightarrow f2\ (f2 = f1 \times B/A)$$

■ Example 1. Changing the unit of Position command pulse on the feed shaft with ball screw.
Use absolute encoder which has 131072[P/R] resolutions, decide the position of the lead 10[mm] ball screw. To calculate by 1 $\mu$m unit, use the calculation formula below and calculate the Electronic gear ratio numerator and denominator.

◆ Encoder position resolution = $\dfrac{131072[P/R]}{10 \times 10^{-3}\ [m]}$ = 13107200[P/m]

◆ Position resolution of upper controller = 1000000[P/m]

● Electronic gear ratio = $\dfrac{13107200[P/m]}{1000000[P/m]} = \dfrac{131072}{10000} = \dfrac{8192}{625}$

Thus, Electronic gear numerator = 8192, Electronic gear denominator = 625 are gotten.
(Setting value of numerator = 131072, denominator = 10000 are fine because they are within the setting range of Electronic gear.)

■ Example 2. In case of that the encoder resolution is changed by the motor exchange.
To change a servo motor with 2000[P/R] incremental encoder, to a servo motor with 8576[P/R] absolute encoder without changing upper controller position resolution. Use the calculation formula below and calculate Electronic gear numerator and denominator.

◆ Resolution before the motor exchange = 2000[P/R]×4 = 8000[P/R]
(At an incremental encoder, the position control resolution is 4-multiplied to the encoder resolution)

● Electronic gear ratio = $\frac{1048576[P/m]}{8000[P/m]} = \frac{16384}{125}$

Thus, Electronic gear numerator = 16384, Electronic gear denominator = 125 are gotten.
(Setting value of numerator = 1048576, denominator = 8000 are fine because they are within the setting range of Electronic gear.)
(If the Electronic gear value has set at the motor before exchanging, multiply the value of the Electronic gear ratio given here.)

■ Example 3. To avoid the constraint of Position command pulse frequency.
In case you operate a servo motor which has 131072 [P/R] resolution absolute encoder at 6000 [$min^{-1}$] using a controller having maximum frequency of 600 [kpps] (six hundred thousand pulse per sec.), use the following formula to get the value of the numerator and the denominator of the electric gearing.

◆ Position command pulse frequency at the encoder resolution
= 131072[P/R]×6000[$min^{-1}$]/60 = 13107.2[kpps]

● Electronic gear ratio = $\frac{13107.2\ [kpps]}{600[kpps]} = \frac{8192}{375}$

Thus, Electronic gear numerator = 8192, Electronic gear denominator = 375 are gotten.
(Setting value of numerator = 131072, denominator = 6000 are fine because they are within the setting range of Electronic gear.)
By setting this Electronic gear numerator and denominator, the motor rotation velocity is 6000[$min^{-1}$], when the Position command pulse frequency is 600[kpps].

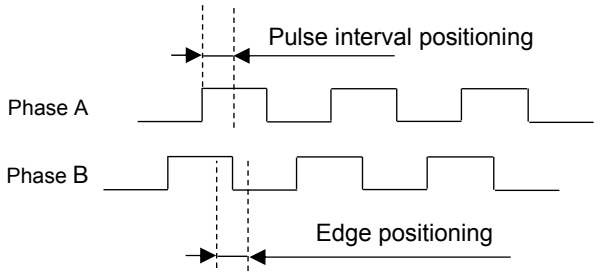
| ID | Contents | | | |
|---|---|---|---|---|
| 17 | Positioning Methods<br>[EDGEPOS] “Power cycle for control after setting” | Setting range | Unit | Default |
| | | 00 to 01 | - | 00:Pulse_Interval |

■ Selects the Encoder pulse positioning.

◆ Positioning accuracy may improved by selecting Edge positioning when the encoder resolution is coarse. However, this may cause the driving sound of the mechanical system to increase as this edge is always the center of vibration.

◆ Select standard value in usual operation.

| Selection | | Contents |
|---|---|---|
| 00 | Pulse_Interval | Specify Pulse Interval |
| 01 | Pulse_Edge | Specify Pulse Edge |




| ID | Contents | | | |
|---|---|---|---|---|
| 18 | In-Position Signal/ Position Deviation Monitor<br>[PDEVMON] | Setting range | Unit | Default |
| | | 00 to 01 | - | 00:After_Filter |

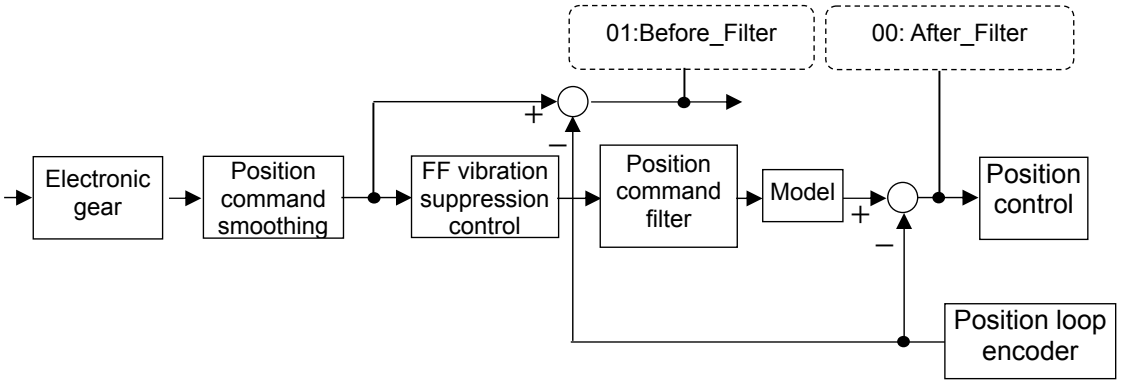
■ Selects in-position signal (INP) and Position deviation monitor output before or after passing through the Position Command Filter.

◆ For "00: After_Filter", use the Position deviation value of the Position controller.

◆ For "01: Before_Filter", use the Position deviation value based on Position command before FF vibration suppression control.

◆ This parameter works as "01: Before_Filter" even if the other value is selected when "01: Model 1 Model Following Control" or "02: Model 2 Model Following Vibration Suppression Control" is set to the system parameter ID07 Position Control Selection.

| Selection | | Contents |
|---|---|---|
| 00 | After_Filter | Compare Position command value with Feedback value after passing through the filter. |
| 01 | Before_Filter | Compare Position command value with Feedback value before passing through the filter. |



－Group8－

| ID | Contents | | | |
|---|---|---|---|---|
| 19 | Deviation Clear Selection [CLR] | Setting range | Unit | Default |
| | | 00 to 03 | - | 00:Type1 |

■ Sets whether a position deviation will be cleared or not during servo OFF, and how to treat deviation clear signal.

- ◆ Selects operation during servo OFF. Deviation cleared/ Deviation not cleared
- ◆ Selects deviation clear signal treatment. Level detection/ Edge detection
- ◆ Select proper setting corresponding to above combination from the list below.

| Selection | | Contents | |
|---|---|---|---|
| 00 | Type1 | At servo OFF → Deviation cleared<br>Clear input = Level detection | Deviation clear is continuing during servo OFF.<br>Deviation clear is continuing during Clear input is ON. |
| 01 | Type2 | At servo OFF → Deviation cleared<br>Clear input = Edge detection | At the edge of OFF to ON of Deviation clear input, Deviation clear is executed. |
| 02 | Type3 | At servo OFF → Deviation not cleared<br>Clear input = Level detection | During servo OFF, Deviation clear is not executed.<br>(After servo ON, the motor might operate suddenly.) |
| 03 | Type4 | At servo OFF → Deviation not cleared<br>Clear input = Edge detection | During servo OFF, Deviation clear is not executed.<br>(After servo ON, the motor might operate suddenly.) |

| ID | Contents | | | |
|---|---|---|---|---|
| 1A | Time to judge position command distribution completion [PCDLY] | Setting range | Unit | Default |
| | | 0.0 to 1000.0 | ms | 0.0 |

■ Sets the time till judging position command distribution completion.

- ◆ Distribution completion is judged if command position does not change (means previous and present command position are same) even if spending this setting time.
- ◆ State will change to "during position command distribution" instantly with no matter to this setting time, when new position command is input during count of position command distribution completion.

| ID | Contents | | | |
|---|---|---|---|---|
| 20 | Preset Velocity Command 1 [VC1] | Setting range | Unit | Default |
| | | 0 to 32767 | $min^{-1}$ | 100 |
| 21 | Preset Velocity Command 2 [VC2] | Setting range | Unit | Default |
| | | 0 to 32767 | $min^{-1}$ | 200 |
| 22 | Preset Velocity Command 3 [VC3] | Setting range | Unit | Default |
| | | 0 to 32767 | $min^{-1}$ | 300 |
| 23 | Preset Velocity Command 4 [VC4] | Setting range | Unit | Default |
| | | 0 to 32767 | $min^{-1}$ | 400 |
| 24 | Preset Velocity Command 5 [VC5] | Setting range | Unit | Default |
| | | 0 to 32767 | $min^{-1}$ | 500 |
| 25 | Preset Velocity Command 6 [VC6] | Setting range | Unit | Default |
| | | 0 to 32767 | $min^{-1}$ | 600 |
| 26 | Preset Velocity Command 7 [VC7] | Setting range | Unit | Default |
| | | 0 to 32767 | $min^{-1}$ | 700 |

■ Sets Velocity command for internal velocity operation.

◆ Preset velocities are able to set upto seven.

◆ Use the following General parameters Group9 ID20-26 to activate the Preset velocities.

| ID | Symbol | Contents |
|---|---|---|
| 20 | SP1 | Preset Velocity Command Select Input 1 |
| 21 | SP2 | Preset Velocity Command Select Input 2 |
| 22 | SP3 | Preset Velocity Command Select Input 3 |
| 23 | DIR | Preset Velocity Command Operation Direction Select Input |
| 24 | RUN | Preset Velocity Command Operation Start Signal Input |
| 25 | RUN-F | Preset Velocity Command Positive (direction) Move Start Signal Input |
| 26 | RUN-R | Preset Velocity Command Negative (direction) Move Start Signal Input |

◆ Select Preset velocity command by Preset velocity selection.

| | VC1 | VC2 | VC3 | VC4 | VC5 | VC6 | VC7 | Analog velocity command |
|---|---|---|---|---|---|---|---|---|
| SP3 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 |
| SP2 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 |
| SP1 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 |

0=OFF, 1=ON
Example: VC2 is valid when SP1=OFF, SP2=ON, SP3=OFF

◆ Drives the servo motor

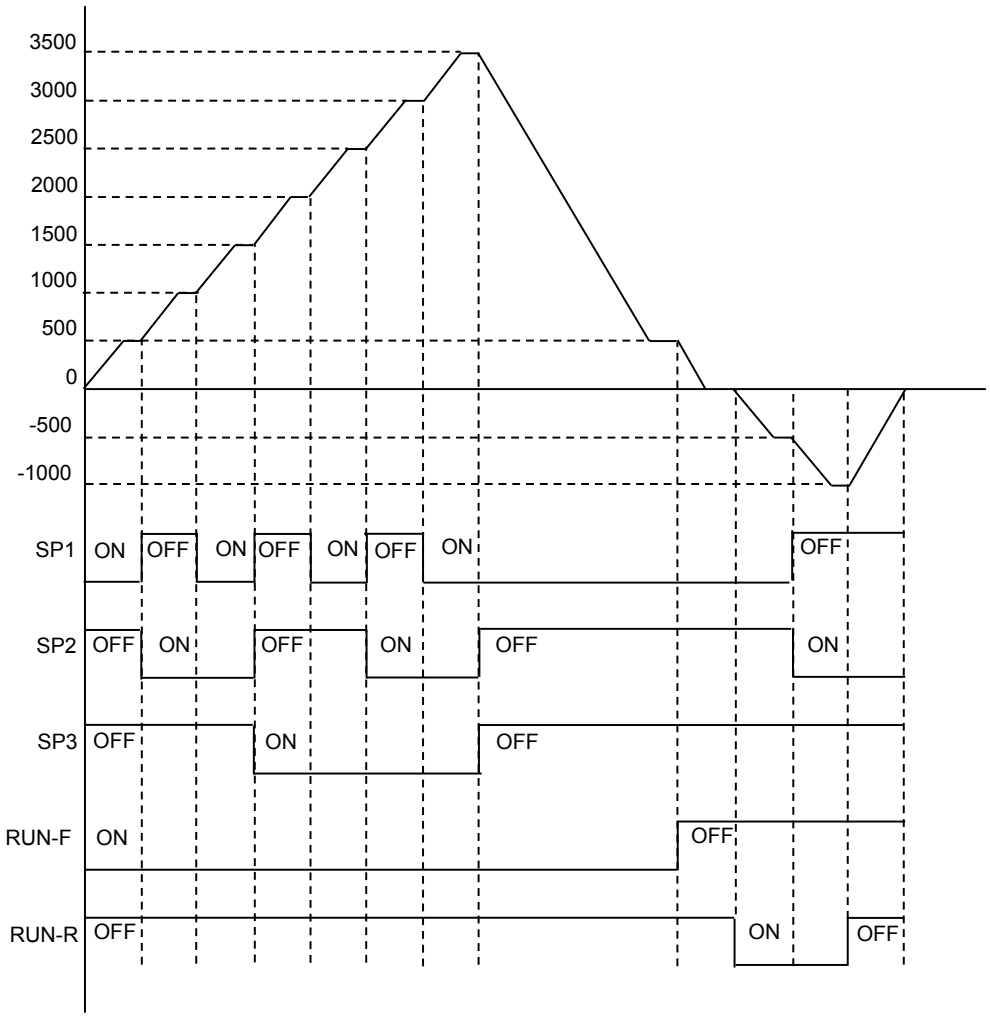
| | | |
|---|---|---|
| RUN: Preset Velocity Command Operation Start Signal Input | ON | Servo motor rotates forward |
| DIR: Preset Velocity Command Operation Direction Select Input | OFF | |
| RUN: Preset Velocity Command Operation Start Signal Input | ON | Servo motor rotates reverse |
| DIR: Preset Velocity Command Operation Direction Select Input | ON | |

| | | |
|---|---|---|
| RUN-F: Preset Velocity Command Positive (direction) Move Start Signal Input | ON | Servo motor rotates forward |
| RUN-R: Preset Velocity Command Negative (direction) Move Start Signal Input | ON | Servo motor rotates reverse |

| ID | Contents |
|---|---|

■ Examples of setting and operation pattern at Preset Velocity Command Operation

| | |
|---|---|
| VC1 Preset Velocity Command 1 | 500[min$^{-1}$] |
| VC2 Preset Velocity Command 2 | 1000[min$^{-1}$] |
| VC3 Preset Velocity Command 3 | 1500[min$^{-1}$] |
| VC4 Preset Velocity Command 4 | 2000[min$^{-1}$] |
| VC5 Preset Velocity Command 5 | 2500[min$^{-1}$] |
| VC6 Preset Velocity Command 6 | 3000[min$^{-1}$] |
| VC7 Preset Velocity Command 7 | 3500[min$^{-1}$] |




◆ To change the Preset velocity using external contact input, set them so that SP1, SP2 and SP3 are changed at the same timing.

◆ When RUN-F and RUN-R are ON at the same time, it is treated as Velocity command 0.

<table>
<tr><th>ID</th><th colspan="4">Contents</th></tr>
<tr><td rowspan="2">27</td><td>Velocity Compensation Command Input Selection [VCOMSEL]</td><td>Setting range</td><td>Unit</td><td>Default</td></tr>
<tr><td></td><td>01 to 02</td><td>-</td><td>02:V-COMP</td></tr>
<tr><td colspan="4">■ Selects Velocity compensation command input.
<table>
<tr><th colspan="2">Selection</th><th>Contents</th></tr>
<tr><td>01</td><td>Analog_Input</td><td>Analog velocity compensation command value is used when velocity compensation function is valid.</td></tr>
<tr><td>02</td><td>V-COMP</td><td>Preset velocity compensation command is used when velocity compensation function is valid.</td></tr>
</table></td></tr>
<tr><td rowspan="2">28</td><td>Preset Velocity Compensation Command [V-COMP]</td><td>Setting range</td><td>Unit</td><td>Default</td></tr>
<tr><td></td><td>-9999 to 9999</td><td>min$^{-1}$</td><td>0</td></tr>
<tr><td colspan="4">■ Sets the Velocity if the velocity compensation command is used as fixed value in Velocity Compensation Function.</td></tr>
<tr><td rowspan="2">29</td><td>Analog Velocity (Compensation) Command Scaling [VCGN]</td><td>Setting range</td><td>Unit</td><td>Default</td></tr>
<tr><td></td><td>0 to 4000</td><td>min$^{-1}$/V</td><td>500</td></tr>
<tr><td colspan="4">■ Sets Analog Velocity (Compensation) Command scaling.<br>◆ Sets the velocity value per 1 volt of Analog velocity (compensation) command input signal.</td></tr>
<tr><td rowspan="2">2A</td><td>External Velocity Command Filter [EX-VCFIL]</td><td>Setting range</td><td>Unit</td><td>Default</td></tr>
<tr><td></td><td>1 to 4000</td><td>Hz</td><td>4000</td></tr>
<tr><td colspan="4">■ This is primary low-pass filter to eliminate noise component from Analog velocity (compensation) command.<br>◆ Sets cutoff frequency.<br>◆ This filter also works with Preset velocity command.<br>◆ Setting range varies depending on the setting of the system parameter ID00 Control Cycle.
<table>
<tr><th colspan="2">Control cycle</th><th>Setting value</th><th>Valid/ Invalid</th></tr>
<tr><td rowspan="2">00</td><td rowspan="2">Standard_Sampling</td><td>1 to 1999Hz</td><td>Set value valid</td></tr>
<tr><td>2000 to 4000Hz</td><td>Filter invalid</td></tr>
<tr><td rowspan="2">01</td><td rowspan="2">High-freq_Sampling</td><td>1 to 3999Hz</td><td>Set value valid</td></tr>
<tr><td>4000Hz</td><td>Filter invalid</td></tr>
</table></td></tr>
</table>

－Group8－

| ID | Contents |
|---|---|

■ About Velocity Compensation Function

Velocity Compensation Function is a Feed forward function for the Velocity control system.
There are two settings for the Velocity compensation command input function:
Preset velocity compensation command and Analog velocity compensation command.
Use preset velocity compensation command to keep the Velocity compensation command fixed.
Analog velocity compensation command is used when setting the Velocity compensation command input value from upper device.

◆ Sets preset velocity compensation command value

| Group | ID | Symbol | Contents |
|---|---|---|---|
| 8 | 28 | V-COMP | Preset Velocity Compensation Command |

◆ Selects velocity compensation command input method

| Group | ID | Symbol | Contents |
|---|---|---|---|
| 8 | 27 | VCOMSEL | Velocity Compensation Command Input Selection |

◆ Selects and sets the condition to set Velocity Compensation Function valid

| Group | ID | Symbol | Contents |
|---|---|---|---|
| 9 | 28 | VCOMPS | Velocity Compensation Function |

◆ Sets Analog velocity compensation scaling

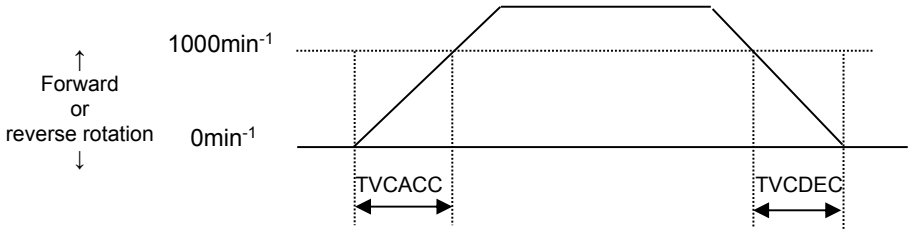
| Group | ID | Symbol | Contents |
|---|---|---|---|
| 8 | 29 | VCGN | Analog Velocity Command Scaling |

◆ Input for Analog velocity compensation command is shared with Analog velocity command/Analog torque command Input.
CN1-21: Input Voltage range -10V to +10V

| ID | Contents | | | |
|---|---|---|---|---|
| 2B | Velocity Command Acceleration Time Constant [TVCACC] | Setting range | Unit | Default |
| | | 0～16000 | ms | 0 |
| 2C | Velocity Command Deceleration Time Constant [TVCDEC] | Setting range | Unit | Default |
| | | 0 to 16000 | ms | 0 |

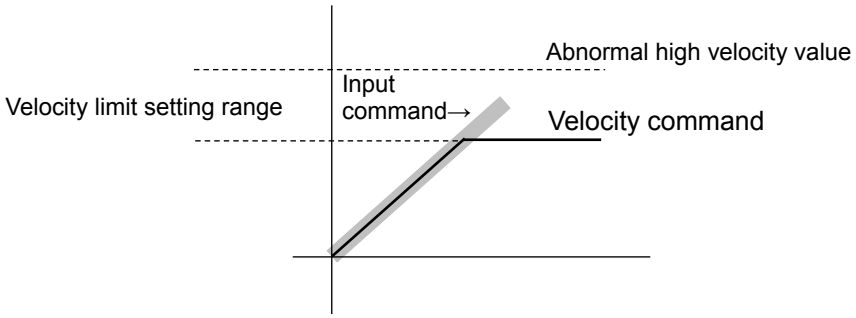
■ These are parameters to restrict Acceleration and Deceleration commands of the Analog velocity command input, Preset velocity command, Analog velocity compensation input, Preset compensation, and JOG operation.
Acceleration: 0 $min^{-1}$ --> forward, reverse rotation
Deceleration: forward, reverse rotation --> 0 $min^{-1}$
Sets the acceleration, deceleration per 1000 $min^{-1}$.

■ These parameters can give accel/decel to a step type velocity command input.




| 2D | Velocity Limit Command [VCLM] | Setting range | Unit | Default |
|---|---|---|---|---|
| | | 1 to 65535 | $min^{-1}$ | 65535 |

■ Set to restrict Velocity command.
- ◆ Sets the maximum value of Velocity command.
- ◆ Restricts Velocity command at the setting range with position control mode or Velocity control mode.
- ◆ If the setting value is 50000 or more, Velocity command limit will be set to 1.1 times of maximum speed of the combination motor.
  Set this parameter to limit motor rotational velocity to the value lower than 1.1 times the maximum rotational velocity. Use the standard value for normal use.



－Group8－

**ID 30**

| Torque Compensation Command Input Selection [TCOMSEL] | Setting range | Unit | Default |
|---|---|---|---|
| | 01 to 02 | - | 02:T-COMP |

■ Select Torque compensation command input from the list below.

| Selection | | Contents |
|---|---|---|
| 01 | Analog_Input | Analog torque compensation command value is used when torque compensation function is valid. |
| 02 | T-COMP | Preset torque compensation command 1, 2 are used when torque compensation function is valid. |

**ID 31**

| Preset Torque Compensation Command 1 [T-COMP1] | Setting range | Unit | Default |
|---|---|---|---|
| | -500.0 to +500.0 | % | 0.0 |

■ This is parameter for using torque compensation command with fixed value if T-COMPS1 is activated.

◆ This value will be added to the Torque command When Torque Compensation Command Input Selection is set at 02: T-COMP.

**ID 32**

| Preset Torque Compensation Command 2 [T-COMP2] | Setting range | Unit | Default |
|---|---|---|---|
| | -500.0 to +500.0 | % | 0.0 |

■ This is parameter for using torque compensation command with fixed value if T-COMPS2 is activated.

◆ This value will be added to the Torque command When Torque Compensation Command Input Selection is set at 02: T-COMP.

**ID 33**

| Analog Torque Command Scaling [TCGN] | Setting range | Unit | Default |
|---|---|---|---|
| | 0.0 to 500.0 | %/V | 50.0 |

■ Sets Analog Torque Command Scaling.

◆ Sets the torque value per 1 volt of Analog torque command input signal.

**ID 34**

| Analog Torque Compensation Command Scaling [T-COMPGN] | Setting range | Unit | Default |
|---|---|---|---|
| | 0.0 to 500.0 | %/V | 50.0 |

■ Sets Analog Torque Compensation Command Scaling.

◆ Sets the torque value per 1 volt of Analog torque compensation command input signal.

**ID 35**

| External Torque Command Filter [EX-TCFIL] | Setting range | Unit | Default |
|---|---|---|---|
| | 1 to 4000 | Hz | 4000 |

■ This is primary Low-pass filter to eliminate noise component from Analog torque (compensation) command.

◆ Sets Cutoff frequency.

◆ Setting range varies depending on the setting of the system parameter ID00 Control Cycle.

| Control cycle | | Setting value | Valid/ Invalid |
|---|---|---|---|
| 00 | Standard_Sampling | 1 to 1999Hz | Set value valid |
| | | 2000 to 4000Hz | Filter invalid |
| 01 | High-freq_Sampling | 1 to 1999Hz | Set value valid |
| | | 2000 to 4000Hz | Filter invalid |

| ID | Contents |
|---|---|

■ About Torque Compensation Function

The Torque Compensation Function is a feed forward function for the Torque control system.
There are two settings for Torque compensation command input function:
Preset torque compensation command and Analog torque compensation command.
Use preset torque compensation command to keep the Torque compensation command fixed.
Analog torque compensation command is used when setting the Torque compensation command input value from upper device.

◆ Sets Preset Torque Compensation Command Value

| Group | ID | Symbol | Contents |
|---|---|---|---|
| 8 | 31 | T-COMP1 | Preset Torque Compensation Command 1 |
| 8 | 32 | T-COMP2 | Preset Torque Compensation Command 2 |

◆ Selects Torque Compensation Command Input Method.

| Group | ID | Symbol | Contents |
|---|---|---|---|
| 8 | 30 | TCOMSEL | Torque Compensation Command Input Selection |

◆ Sets the condition of Torque Compensation Function being Valid

| Group | ID | Symbol | Contents |
|---|---|---|---|
| 9 | 30 | T-COMPS1 | Torque Compensation Function 1 |
| 9 | 31 | T-COMPS2 | Torque Compensation Function 2 |

◆ Sets Analog Torque Compensation Command Scaling

| Group | ID | Symbol | Contents |
|---|---|---|---|
| 8 | 34 | T-COMPGN | Analog Torque Compensation Command Scaling |

◆ Analog torque compensation command input
CN1-22: Input Voltage range -10V to +10V

36

| Torque Limit Input Selection [TLSEL] | Setting range | Unit | Default |
|---|---|---|---|
| | 00 to 02 | - | 00:TCLM |

■ Selects input system to limit Torque command limit function from listed below.

| Selection | | Contents | |
|---|---|---|---|
| 00 | TCLM | Use internal torque limit value<br>Forward side/TCLM-F<br>Reverse side/TCLM-R | Forward side (forward direction):<br>Limited at Forward Direction Internal Torque Limit Value.<br>Reverse side (reverse direction):<br>Limited at Reverse Direction Internal Torque Limit Value. |
| 01 | Analog_1 | Use external torque limit input<br>Forward side/F-TLA<br>Reverse side/R-TLA | Forward side (forward direction):<br>Limited at the voltage input to F-TLA.<br>Reverse side (reverse direction):<br>Limited at the voltage input to R-TLA. |
| 02 | Analog_2 | Use external torque limit input<br>Forward side/F-TLA<br>Reverse side/F-TLA | Forward side (forward direction):<br>Limited at the voltage input to F-TLA.<br>Reverse side (reverse direction):<br>Limited at the voltage input to F-TLA. |

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| ID | Contents | | | |
|---|---|---|---|---|
| 37 | Forward Direction Internal Torque Limit Value [TCLM-F] | Setting range | Unit | Default |
| | | 10.0 to 500.0 | % | 100.0 |
| 38 | Reverse Direction Internal Torque Limit Value [TCLM-R] | Setting range | Unit | Default |
| | | 10.0 to 500.0 | % | 100.0 |

■ Limits the Torque output at this setting value when Preset torque limit value is valid.

◆ Limits the torque by the ratio for the torque rating (100.0%= torque rating)

◆ When the Torque Limit Function (TL) is valid, the torque output is limited by the Preset torque limit setting value appropriate to the polarity of the Torque command.

◆ When the following conditions are set, the torque output is limited by a rate of "Peak armature current at stall (IP) / Rated armature current (IR)".
- In case of exceeding Peak torque at stall (Tp) of combination motor.
- In case of setting of exceeding a rate of "Peak armature current at stall (IP) / Rated armature current (IR)".

■ About Torque limit function

There are two input systems of restricting Torque function:
Preset torque limit and External torque limit.

◆ To use preset torque limit

- Restricts the maximum output torque by using preset torque limit.

| Group | ID | Symbol | Contents |
|---|---|---|---|
| 8 | 36 | TLSEL | Torque Limit Input Selection |

| Selection | | Contents |
|---|---|---|
| 00 | TCLM | Use preset torque limit value<br>Forward side/TCLM-F<br>Reverse side/TCLM-R |

- Sets torque limit value.

| Group | ID | Symbol | Contents |
|---|---|---|---|
| 8 | 37 | TCLM-F | Forward Direction Internal Torque Limit Value |
| 8 | 38 | TCLM-R | Reverse Direction Internal Torque Limit Value |

- Sets torque limit function ON

| Group | ID | Symbol | Contents |
|---|---|---|---|
| 9 | 32 | TL | Torque Limit Function |

Selects to set the Torque function being valid.
While the Torque limit function is valid, restricts torque.

* When setting, be cautious about acceleration/deceleration time. If the setting value is too small, enough Acceleration/Deceleration torque can not get, and normal operation can not get.

* Set at: Preset torque limit value > Acceleration/Deceleration torque.

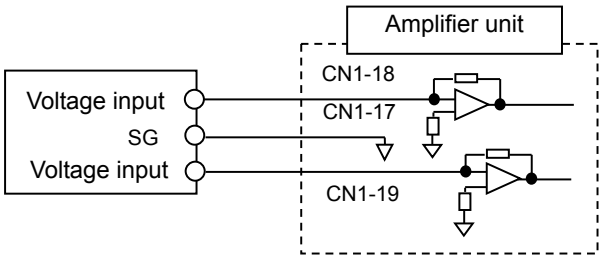
* Preset torque limit can set individually to Forward and Reverse direction.

| ID | Contents |
|---|---|

◆ To use External torque limit

- Restricts forward and reverse rotation torque by inputting External analog voltage to CN1.

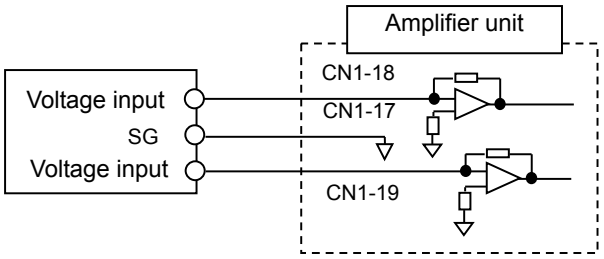
* Forward side torque limit input (F-TLA): CN1-18 input voltage range -10V to +10V
* Reverse side torque limit input (R-TLA): CN1-19 input voltage range -10V to +10V



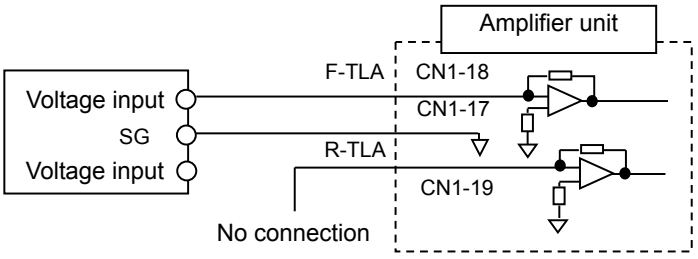

- Input signal specification has two ways.

| Group | ID | Symbol | Contents |
|---|---|---|---|
| 8 | 36 | TLSEL | Torque Limit Input Selection |

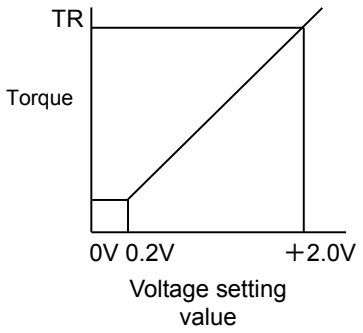
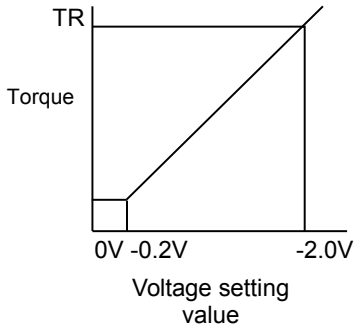
| Selection | | Contents |
|---|---|---|
| 00 | Analog_1 | Use external torque limit input<br>Forward side/ F-TLA<br>Reverse side/ R-TLA |




| Selection | | Contents |
|---|---|---|
| 00 | Analog_2 | Use external torque limit input<br>Forward side/ F-TLA<br>Reverse side/ F-TLA |



－Group8－

| ID | Contents |
|---|---|
| | ◆ Inputs the voltage corresponding to the Torque limit.<br>  <br>  <br>● Enables the Torque limit function<br><br>Group \| ID \| Symbol \| Contents<br>9 \| 32 \| TL \| Torque Limit Function<br><br>● Selects the condition to enable the Torque limit function.<br>● Restricts torque while Torque limit function is valid. |
| 39 | Sequence Operation Torque Limit Value [SQTCLM] — Setting range: 10.0 to 500.0 \| Unit: % \| Default: 120.0<br>■ Limits the output torque at sequence operation.<br>◆ Sets the limiting torque by the ratio of rated output torque. (100.0%=rated torque)<br>◆ When the following conditions are set, the torque output is limited by a rate of "Peak armature current at stall (IP) / Rated armature current (IR)".<br>- In case of exceeding Peak torque at stall (Tp) of combination motor.<br>- In case of setting of exceeding a rate of "Peak armature current at stall (IP) / Rated armature current (IR)".<br>◆ This parameter corresponds to JOG Operation, Over-Travel Action, Holding brake stand-by time, and Servo brake action. |

| ID | Contents | | | |
|---|---|---|---|---|
| 3B | Torque Attainment select [TASEL] | Setting range | Unit | Default |
| | | 00 to 01 | - | 00 |

■ To select a setting rate type of attaining torque

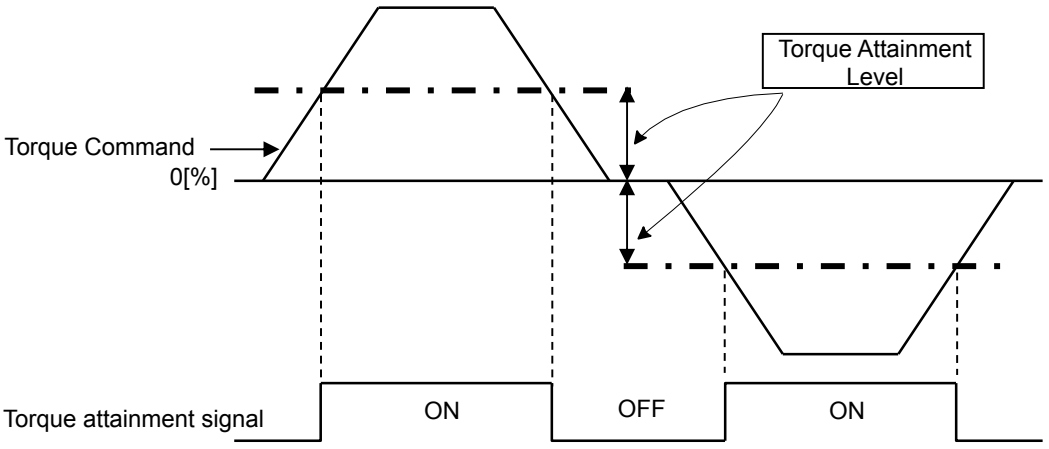
| Selection | | Contents |
|---|---|---|
| 00 | TA/TR | Sets the rate against rated torque. (Rated torque is 100%) |
| 01 | TA/TCLM | Sets the rate against Torque limit value. |

| 3C | Torque Attainment Setting [TA] | Setting range | Unit | Default |
|---|---|---|---|---|
| | | 0.0 to 500.0 | % | 100.0 |

■ Sets the rate of Torque attainment.
Target data of the ratio set in this parameter varies depending on Group8 3B "Torque attainment function selection".

◆ ["Torque attainment function selection": 00]

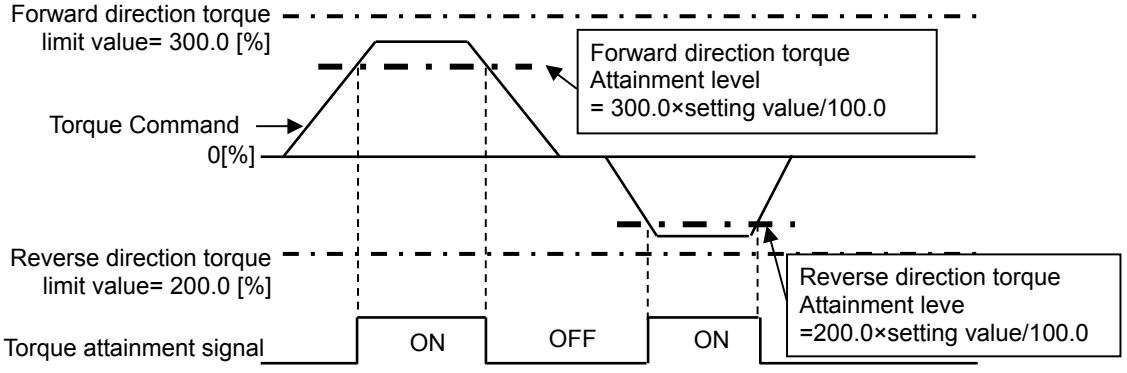
- Sets the rate against rated torque: 100%.
  Therefore, once the commanded torque exceeds the setting value, Torque attainment signal is output.




◆ ["Torque attainment function selection": 01]

- Sets the rate against Torque limit value.
  The level of attaining torque is calculated from the following formula.
  Torque attainment level = Torque limit value x setting value / 100.0 [%]

  Therefore, once the commanded torque exceeds the level of attaining torque that is calculated from the above formula, torque attainment signal is output.
  Even if the setting value is set more than 100.0 [%], that is limited to 100.0[%].
  If forward direction and reverse direction torque limit value are different, torque attainment level will be setup based on values of each of limited torque.



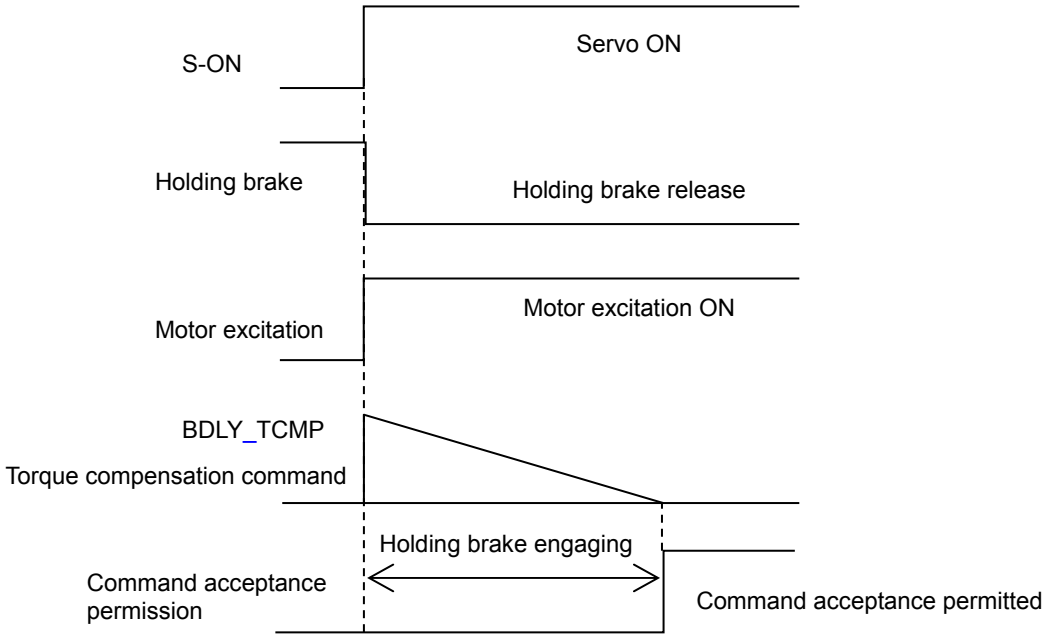
－Group8－

| ID | Contents | | | |
|---|---|---|---|---|
| 3E | Torque compensation command at holding brake operation cancellation delay [BDLY_TCMP] | Setting range | Unit | Default |
| | | -100 to 100 | % | 0.0 |

■ Sets the Torque compensation command at holding-brake operation cancellation delay to avoid self weight fall at the time of servo OFF to ON.

◆ Self weight fall at servo ON is able to suppress by setting the torque compensation value which is correspond to gravity load or external load.

◆ Torque compensation command will be linear-interpolated as to be zero after spending the time of GroupB ID04 "Delay Time of Releasing Holding Brake (Holding Brake Release Delay Time)".



| ID | Contents | | | |
|---|---|---|---|---|
| 40 | Near Range [NEAR] | Setting range | Unit | Default |
| | | 1 to 2147483647 | Pulse | 500 |

■ Sets the output range of near range (near in-position) signal.

◆ Outputs the Near range signal if the Position deviation counter is lower than this set value.

◆ Sets at the encoder pulse resolution without relation to Electronic gear ratio. (Not the Position command pulse resolution.)

■ Generally, near range signal is used as auxiliary of In-position signal. For example, by setting this value larger than the range of In-position, the upper device receives the NEAR signal before the In-position signal (INP), and then necessary action can smoothly be accomplished when In-position completed.

◆ Sets Near Range signal output

| Group | ID | Symbol | Contents |
|---|---|---|---|
| A | 0* | OUT* | Generic Purpose output* |

| Selection | | Contents |
|---|---|---|
| 1A | NEAR_ON | Near Range Status, Output ON |
| 1B | NEAR _OFF | Near Range Status, Output OFF |

| ID | Contents | | | |
|---|---|---|---|---|
| 41 | In-Position Window [INP] | Setting range | Unit | Default |
| | | 1 to 2147483647 | Pulse | 100 |

■ Sets output range of In-Position signal.

◆ Outputs the positioning completion signal when position deviation counter value is this setting value or less.

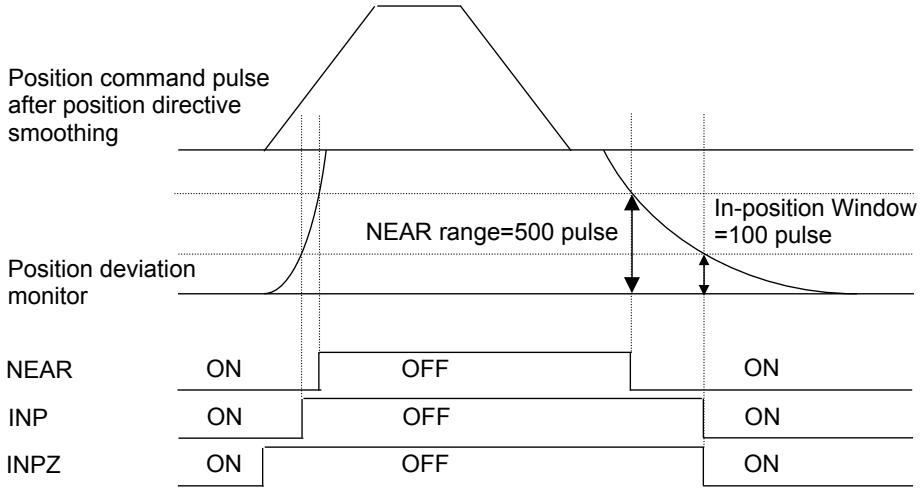
◆ Sets at the encoder pulse resolution without relation to Electronic gear ratio. (Not the Position command pulse resolution.)

◆ In-Position completion signal will output from selected output terminal if the position deviation of a servo motor changes to less than this setting value.

◆ Sets In-Position signal output

| Group | ID | Symbol | Contents |
|---|---|---|---|
| A | 0* | OUT* | Generic Purpose output* |

| Selection | | Contents |
|---|---|---|
| 18 | INP_ON | In-Position Status,Output ON |
| 19 | INP_OFF | In-Position Status,Output OFF |




◆ INPZ is a state signal turned on when the position directive pulse after position directive smoothing is 0 and a position deviation counter value is below setting of the completion range of positioning.

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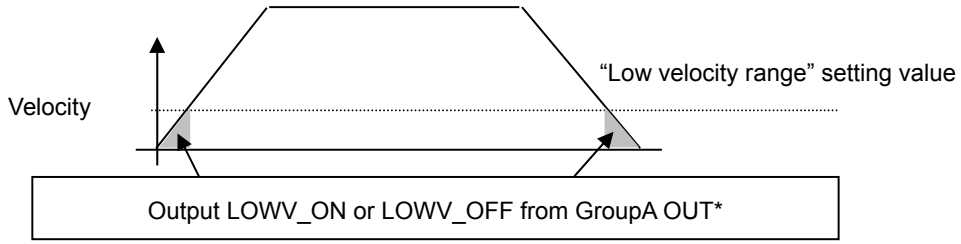
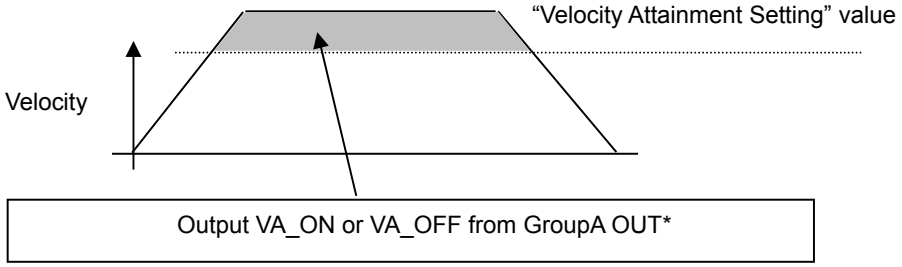
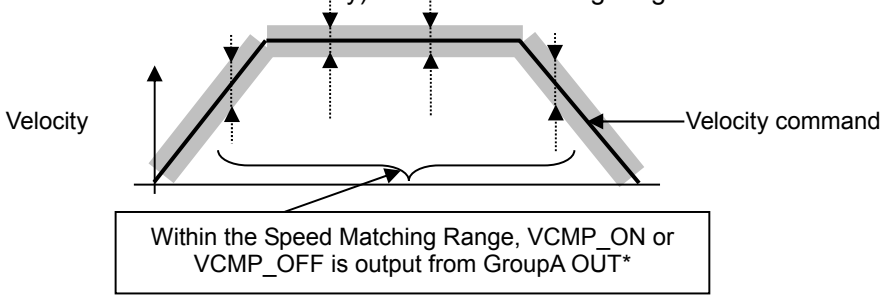
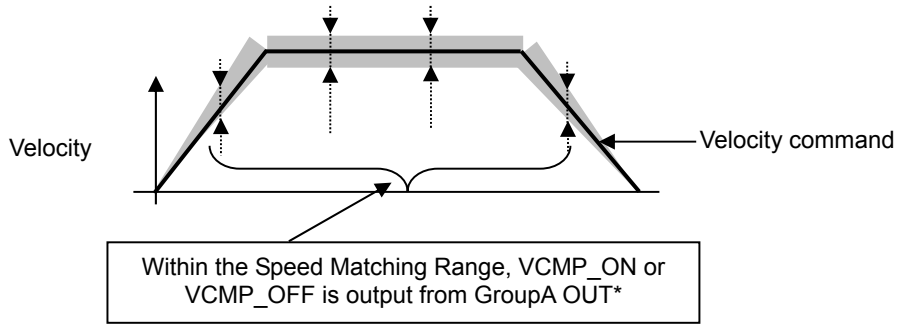
<table>
<tr><th>ID</th><th colspan="4">Contents</th></tr>
<tr><td rowspan="3">42</td><td rowspan="2">Speed Zero Range<br>[ZV]</td><td>Setting range</td><td>Unit</td><td>Default</td></tr>
<tr><td>50 to 500</td><td>min$^{-1}$</td><td>50</td></tr>
<tr><td colspan="4">■ Setting value for detecting Zero-speed status (motor stop).<br>◆ When the speed becomes lower than this value, Zero-speed status is out.</td></tr>
<tr><td rowspan="3">43</td><td rowspan="2">Low Speed Range<br>[LOWV]</td><td>Setting range</td><td>Unit</td><td>Default</td></tr>
<tr><td>0 to 65535</td><td>min$^{-1}$</td><td>50</td></tr>
<tr><td colspan="4">■ Parameter for setting Low speed output range.<br>◆ When the speed is lower than this value, Low speed status is output.<br>  <br><br>◆ Automatically overwrite by Auto-tuning result saving.<br>◆ When Auto-tuning function is valid, this setting value is not applied.</td></tr>
<tr><td rowspan="3">44</td><td rowspan="2">Speed Attainment Setting (High Speed Range)<br>[VA]</td><td>Setting range</td><td>Unit</td><td>Default</td></tr>
<tr><td>0 to 65535</td><td>min$^{-1}$</td><td>1000</td></tr>
<tr><td colspan="4">■ Parameters for setting speed attainment output range.<br>◆ When the speed exceeds this setting value, Speed attainment is output.<br>◆ When the operation is switched to torque control mode by using control mode switching function, in other words, when enabling “control model switching function (MS)” after setting ”03:Velo-Torq” or “04:Posi-Torq” of system parameter ID06 ”control mode selection”,simplified velocity limitation is controlled by this parameter. However, this method can not control with constant speed because a torque is forced to be zero when Motor speed exceeds this setting value. Avoid the use of such status to continue.<br>  <br></td></tr>
</table>

<table>
<tr><th>ID</th><th>Contents</th></tr>
<tr><td>45</td><td>
<table>
<tr><td colspan="2">Speed Matching Unit Selection<br>[VCMPUS] “Power cycle for control after setting”</td><td>Setting range<br>00 to 01</td><td>Unit<br>—</td><td>Default<br>00:min$^{-1}$</td></tr>
</table>
■ Selects Speed Matching Unit setting method.
<table>
<tr><th colspan="2">Selection</th><th>Contents</th></tr>
<tr><td>00</td><td>min$^{-1}$</td><td>Sets by [min$^{-1}$] unit.<br>Uses the setting value of ID46 [VCMP] Speed Matching Range</td></tr>
<tr><td>01</td><td>Percent</td><td>Sets the ratio to velocity command by [%] unit.<br>Uses the setting value of ID47 [VCMPR] Speed Matching Range Ratio.</td></tr>
</table>
</td></tr>
<tr><td>46</td><td>
<table>
<tr><td>Speed Matching Range<br>[VCMP]</td><td>Setting range<br>0 to 65535</td><td>Unit<br>min$^{-1}$</td><td>Default<br>50</td></tr>
</table>
■ Sets the range regarded as Speed matching by the [min$^{-1}$] unit.<br>
◆ Use this setting value when ID45 [VCMPUS] Speed Matching Unit Selection is ”00:min$^{-1}$”.<br>
◆ Velocity matching is output when the Velocity deviation (difference between the velocity command and actual velocity) is within this setting range.<br>


</td></tr>
<tr><td>47</td><td>
<table>
<tr><td>Speed Matching Range Ratio<br>[VCMPR]</td><td>Setting range<br>0.0 to 100.0</td><td>Unit<br>%</td><td>Default<br>5.0</td></tr>
</table>
■ Sets the range regarded as Speed matching ratio to Velocity command by the [%] unit.<br>
◆ This setting is used when “01: Percent” is set to ID45 ”[VCMPUS] Speed Matching Unit Selection”.<br>
◆ The value that multiplied the velocity command by this setting value is a Speed matching range.<br>
◆ Speed matching is outputted when a velocity deviation (difference of commanded velocity and real one) is in this setting range.<br>
◆ When this value is less than 1[min$^{-1}$], the Speed matching range is treated as 1[min$^{-1}$].<br>


</td></tr>
</table>

－Group8－

| ID | Contents |
|---|---|

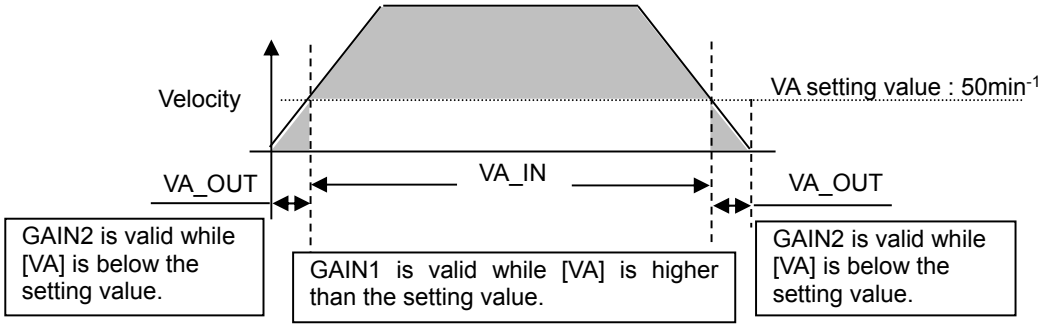
■ By combining with Group9 "Condition Settings for Enabling Functions", ID42 to ID47 will make the functions of Group9 valid.

| Selection | | Contents |
|---|---|---|
| 12 | LOWV_IN | Function is valid while in low speed status (speed is lower than the LOWV Setting Value). |
| 13 | LOWV_OUT | Function is valid while not in low speed status (speed is lower than the LOWV Setting Value). |
| 14 | VA_IN | Function is valid while in speed attainment status (speed is higher than the VA Setting Value). |
| 15 | VA_OUT | Function is valid while not in speed attainment status (speed is higher than the VA Setting Value). |
| 16 | VCMP_IN | Function is valid while in speed matching status (within command-actual velocity consistent range). |
| 17 | VCMP_OUT | Function is valid while not in speed matching status (within command-actual velocity consistent range). |
| 18 | ZV_IN | Function is valid while in zero speed status (speed is lower than the ZV Setting Value) |
| 19 | ZV_OUT | Function is valid while not in zero speed status (speed is lower than the ZV Setting Value) |

* Speed Matched Range is depending on “Group8 ID45 to ID47” setting.

◆ Example: The amplifier unit sets the GAIN1 and GAIN2 switching without using input signal from the host unit.

- Sets 15: VA_OUT to Group9 ID13 Gain Switching Condition 1 [GC1].
- Sets 00: Always_Disable to Group9 ID14 Gain Switching Condition 2 [GC2].
- Sets 50min$^{-1}$ (arbitrary value) to Group8 ID44 Speed Attainment
- (High Speed setting) [VA].




80

| Polarity selection of axes-sync compensation input [SYNCDIR] | Setting range | Unit | Default |
|---|---|---|---|
| | 00 to 01 | - | 00: Not_Reversed |

■ Fit a polarity of position deviation each other.

◆ Set "01: Reversed" to one axis if rotation directions of combination axes are different.

| Selection | | Contents |
|---|---|---|
| 00 | Not_Reversed | Without reversing |
| 01 | Reversed | With reversing |

■ General parameters Group9 "Function enabling condition settings"

| ID | Name | Setting range | Default value | Functions-enabled input time |
|---|---|---|---|---|
| 00 | Positive Over Travel Function [F-OT] | 00 to 29 | 0D:CONT6_OFF | 20ms |
| 01 | Negative Over Travel Function [R-OT] | 00 to 29 | 0B:CONT5_OFF | 20ms |
| 02 | Alarm Reset Function [AL-RST] | 00 to 29 | 10:CONT8_ON | 20ms |
| 03 | Encoder Clear Function [ECLR] | 00 to 29 | 06:CONT3_ON | 200ms |
| 04 | Deviation Clear Function [CLR] | 00 to 29 | 08:CONT4_ON | 2ms |
| 05 | Servo-ON Function [S-ON] | 00 to 29 | 02:CONT1_ON | 20ms |
| 10 | Control Mode Switching Function [MS] | 00 to 29 | 00:Always_Disable | 5ms |
| 11 | Position Command Pulse Inhibit Function, Velocity Command Zero Clamp Function [INH/Z-STP] | 00 to 29 | 00:Always_Disable | 20ms |
| 12 | Electronic Gear Switching Function [GERS] | 00 to 29 | 00:Always_Disable | 20ms |
| 13 | Gain Switching Condition 1 [GC1] | 00 to 29 | 00:Always_Disable | 2ms |
| 14 | Gain Switching Condition 2 [GC2] | 00 to 29 | 00:Always_Disable | 2ms |
| 15 | FF Vibration Suppressor Frequency Select Input A1 [SUPFSELA1] | 00 to 29 | 00:Always_Disable | 20ms |
| 16 | FF Vibration Suppressor Frequency Select Input A2 [SUPFSELA2] | 00 to 29 | 00:Always_Disable | 20ms |
| 17 | FF Vibration Suppressor Frequency Select Input B1 [SUPFSELB1] | 00 to 29 | 00:Always_Disable | 20ms |
| 18 | FF Vibration Suppressor Frequency Select Input B2 [SUPFSELB2] | 00 to 29 | 00:Always_Disable | 20ms |
| 19 | Position Loop Proportional Control Switching Function [PLPCON] | 00 to 29 | 01:Always_Enable | 20ms |
| 1A | Model following (vibration suppression) control/ standard position control switching function [MODEL] | 00 to 11 | 00:Always_Disable | 2ms |
| 1B | Model Vibration Suppressor Frequency Select Input 1 [MDLFSEL1] | 00 to 29 | 00:Always_Disable | 20ms |
| 1C | Model Vibration Suppressor Frequency Select Input 2 [MDLFSEL2] | 00 to 29 | 00:Always_Disable | 20ms |
| 20 | Preset Velocity Command Select Input 1 [SP1] | 00 to 29 | 00:Always_Disable | 20ms |
| 21 | Preset Velocity Command Select Input 2 [SP2] | 00 to 29 | 00:Always_Disable | 20ms |
| 22 | Preset Velocity Command Select Input 3 [SP3] | 00 to 29 | 00:Always_Disable | 20ms |
| 23 | Preset Velocity Command Input Direction of Movement [DIR] | 00 to 29 | 00:Always_Disable | 20ms |
| 24 | Preset Velocity Command Operation Start Signal Input [RUN] | 00 to 29 | 00:Always_Disable | 20ms |
| 25 | Preset Velocity Command Positive (direction) Move Start Signal Input [RUN-F] | 00 to 29 | 00:Always_Disable | 20ms |
| 26 | Preset Velocity Command Negative (direction) Move Start Signal Input [RUN-F] | 00 to 29 | 00:Always_Disable | 20ms |
| 27 | Velocity Loop Proportional Control Switching Function [VLPCON] | 00 to 29 | 04:CONT2_ON | 2ms |
| 28 | Velocity Compensation Function [V-COMPS] | 00 to 29 | 00:Always_Disable | 2ms |
| 30 | Torque Compensation Function 1 [T-COMPS1] | 00 to 29 | 00:Always_Disable | 2ms |
| 31 | Torque Compensation Function 2 [T-COMPS2] | 00 to 29 | 00:Always_Disable | 2ms |
| 32 | Torque Limit Function [TL] | 00 to 29 | 0E:CONT7_ON | 20ms |
| 33 | Disturbance Observer Function [OBS] | 00 to 29 | 00:Always_Disable | 20ms |
| 34 | Compensatory function for stick-slip behavior [STC] | 00 to 29 | 00:Always_Disable | 20ms |
| 35 | Minor vibration (oscillation) suppression function [FBHYST] | 00 to 29 | 00:Always_Disable | 20ms |
| 40 | External Trip Input Function [EXT-E] | 00 to 29 | 00:Always_Disable | 20ms |
| 41 | Emergency Stop Function [EMR] | 00 to 29 | 00:Always_Disable | 20ms |
| 80 | Axes-sync compensation function [SYNCEN] | 00 to 11 | 00:Always_Disable | 20ms |
| 81 | Axes-sync compensation proportional control switching function [SYNPCNEN] | 00 to 29 | 00:Always_Disable | 20ms |

Group9 List of selection contents

■ Keeping the function always valid or invalid

| Selection | | Contents |
|---|---|---|
| 00 | Always_Disable | Function is always invalid |
| 01 | Always_Enable | Function is always valid |

■ Using function with the generic input signals

| Selection | | Contents |
|---|---|---|
| 02 | CONT1_ON | Function is valid when generic input, CONT1, is ON |
| 03 | CONT1_OFF | Function is valid when generic input, CONT1, is OFF |
| 04 | CONT2_ON | Function is valid when generic input, CONT2, is ON |
| 05 | CONT2_OFF | Function is valid when generic input, CONT2, is OFF |
| 06 | CONT3_ON | Function is valid when generic input, CONT3, is ON |
| 07 | CONT3_OFF | Function is valid when generic input, CONT3, is OFF |
| 08 | CONT4_ON | Function is valid when generic input, CONT4, is ON |
| 09 | CONT4_OFF | Function is valid when generic input, CONT4, is OFF |
| 0A | CONT5_ON | Function is valid when generic input, CONT5, is ON |
| 0B | CONT5_OFF | Function is valid when generic input, CONT5, is OFF |
| 0C | CONT6_ON | Function is valid when generic input, CONT6, is ON |
| 0D | CONT6_OFF | Function is valid when generic input, CONT6, is OFF |
| 0E | CONT7_ON | Function is valid when generic input, CONT7, is ON |
| 0F | CONT7_OFF | Function is valid when generic input, CONT7, is OFF |
| 10 | CONT8_ON | Function is valid when generic input, CONT8, is ON |
| 11 | CONT8_OFF | Function is valid when generic input, CONT8, is OFF |

■ Activating the functions conditioning the rotational speed of servomotor

| Selection | | Contents |
|---|---|---|
| 12 | LOWV_IN | Function is valid while in low speed status<br>(speed is lower than the LOWV Setting Value). |
| 13 | LOWV_OUT | Function is valid while not in low speed status<br>(speed is lower than the LOWV Setting Value). |
| 14 | VA_IN | Function is valid while in speed attainment status<br>(speed is higher than the VA Setting Value). |
| 15 | VA_OUT | Function is valid while not in speed attainment status<br>(speed is higher than the VA Setting Value). |
| 16 | VCMP_IN | Function is valid while in speed matching status<br>(within command-actual velocity consistent range). |
| 17 | VCMP_OUT | Function is valid while not in speed matching status<br>(within command-actual velocity consistent range). |
| 18 | ZV_IN | Function is valid while in zero speed status<br>(speed is lower than the ZV Setting Value). |
| 19 | ZV_OUT | Function is valid while not in zero speed status<br>(speed is lower than the ZV Setting Value). |

■ Activating the functions using the positioning signals

| Selection | | Contents |
|---|---|---|
| 20 | NEAR_IN | Function is valid while in Near range status |
| 21 | NEAR_OUT | Function is valid while not in Near range status |
| 1A | INP_IN | Function is valid while in In-Position status (position deviation < INP) |
| 1B | INP_OUT | Function is valid while not in In-Position status (position deviation < INP) |
| 26 | INPZ_IN | Function is valid while in Position command 0 and In-Position status (position deviation < INP) |
| 27 | INPZ_OUT | Function is valid while not in Position command 0 and In-Position status (position deviation < INP) |
| 28 | TRJCMP_IN | Function is valid while in Position command distribution completion (including delay time) |
| 29 | TRJCMP_OUT | Function is valid while not in Position command distribution completion (including delay time) |

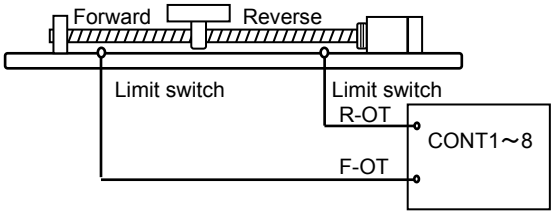
■ Activating the functions using the torque / speed limit

| Selection | | Contents |
|---|---|---|
| 1C | TLC_IN | Function is valid while in torque limit status |
| 1D | TLC_OUT | Function is valid while not in torque limit status |
| 1E | VLC_IN | Function is valid while in velocity limit status |
| 1F | VLC_OUT | Function is valid while not in velocity limit status |

■ Activating the functions by the rotating direction or zero-speed state of servo motor

| Selection | | Contents |
|---|---|---|
| 22 | VMON_>_+LV | Function is valid while rotation direction is forward (VMON>+LOWV) |
| 23 | VMON_<=_+LV | Function is valid while rotation direction is not forward (VMON≦+LOWV) |
| 24 | VMON_<_-LV | Function is valid while rotation direction is reverse (VMON<-LOWV) |
| 25 | VMON_>=_-LV | Function is valid while rotation direction is not reverse (VMON≧-LOWV) |

－Group9－

| ID | Contents |
|---|---|
| 00<br>01 | Forward Over-Travel Function [F-OT]<br>Reverse Over-Travel Function [R-OT]<br>■ The over travel function uses limit switch to prevent damage to the unit. This function forcedly stops the unit when the movement range of the moving part is exceeded.<br>◆ Allocating over-travel input signal to CONT1 to CONT8.<br>  <br><br>◆ To use over-travel function, select the operating conditions of “position command input, servo motor stop operation and servo-on signal” when over-travel occurs. |

| Group | ID | Symbol | Contents |
|---|---|---|---|
| B | 01 | ACTOT | Over-Travel operation |

00
01

| Selection | | Contents |
|---|---|---|
| 00 | CMDINH_SB_SON | Command input is disabled, and motor is stopped by servo-braking (with peak torque) when OT occurs. Servo is turned on after motor stops.<br>(Command from either positive or negative direction in which OT occurs, command disabled = velocity limit command = 0)<br>(Torque command for OT side is limited by the sequence torque limit.) |
| 01 | CMDINH_DB_SON | Command input is disabled, and motor is stopped by dynamic-braking when OT occurs. Servo is turned on after motor stops.<br>(Command from either positive or negative direction in which OT occurs, command disabled = velocity limit command = 0) |
| 02 | CMDINH_Free_SON | Command input is disabled, and motor is free-running when OT occurs. Servo is turned on after motor stops.<br>(Command from either positive or negative direction in which OT occurs, command disabled = velocity limit command = 0) |
| 03 | CMDINH_SB_SOFF | Command input is disabled, and motor is stopped by servo-braking when OT occurs. Servo is turned off after motor stops.<br>(Torque command for both side is limited by the sequence torque limit.) |
| 04 | CMDINH_DB_SOFF | Command input is disabled, and motor is stopped by dynamic-braking when OT occurs. Servo is turned off after motor stops. |
| 05 | CMDINH_Free_SOFF | Command input is disabled, and motor is free-running when OT occurs. Servo is turned off after motor stops. |
| 06 | CMDACK_VCLM=0 | Velocity limit command for the direction on which OT occured becomes zero when OT occurs. |
| 08 | CMDINH_SB_SON2 | Command input is disabled, and motor is stopped by servo-brake operation (with sequence torque limit) when OT occurs.<br>Servo is turned on after motor stops.<br>(Command from either positive or negative direction in which OT occurs, command disabled = velocity limit command = 0)<br>(Torque command for both side is limited by the sequence torque limit.) |

◆ Torque limit value differs depending on selection code, when stopping a servo motor by servo-brake.

00: Peak torque
03, 08: Sequence torque limit

◆ For the velocityt control mode, select from 00 to 05 or 08.

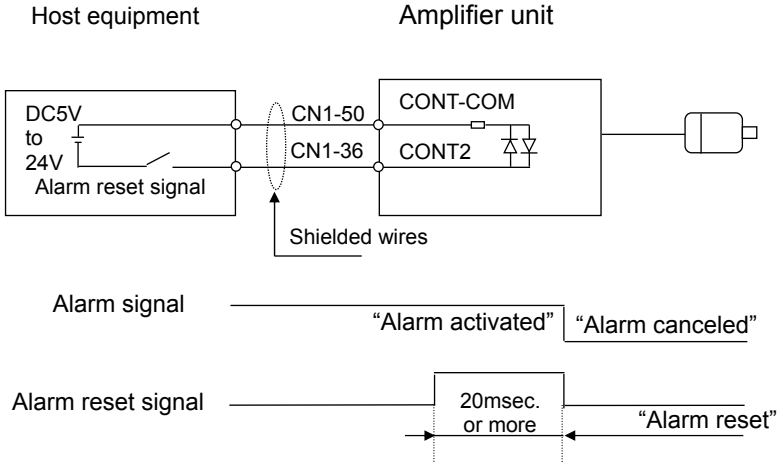
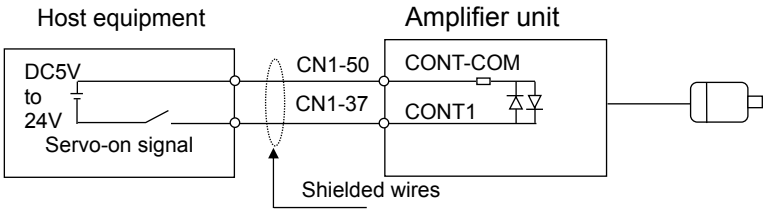
◆ For the torque control mode, operates as follows:

- For 00 to 02 or 08, keeps servo-on state with torque command limitation by sequence torque limit.
- For 03 or 04, shift to servo-off state and stop with dynamic brake. Also keeps servo-off state after motor stop.
- For 05, shift to servo-off state and becobe freerun operation. Also keeps servo-off state after motor stop.

◆ “Stop motor by servo-braking” when OT occurs.
When selecting [08:_CMDINH_SB_SON2], torque value when servo-brake is working can be set by sequence operation torque limit value.

| Group | ID | Symbol | Contents |
|---|---|---|---|
| 8 | 39 | SQTCLM | Sequence operation torque limit value |

－Group9－

| ID | Contents |
|---|---|
| 02 | Alarm reset function<br>[AL-RST]<br>■ This function enables inputting alarm reset signal from host equipment. Alarm is cleared by enabling alarm reset function (AL-RST).<br>◆ Allocating conditions to enable alarm reset function. When AL-RST signal enabled, this function clears alarms.<br>* Please note that the alarms which needs control power-cycle for alarm reset are not able to clear by alarm reset signal.<br>◆ The wiring is as follows when enabling conditions allocation is set to CONT2. Logic can be changed by selecting options of enabling conditions allocation.<br>  |
| 05 | Servo-on function [S-ON]<br>[S-ON]<br>■ This function is to input servo-on signal from host equipment. Enabling servo-on function (SON) can put servo motor into current-applied state.<br>◆ Allocating conditions to enable servo-on function. When SON signal is enabled, the servo motor will be into current-applied state.<br>◆ The wiring is as follows when enabling conditions allocation is set to CONT1. Logic can be changed by selecting options of enabling conditions allocation.<br>  |

<table>
<tr><th>ID</th><th>Contents</th></tr>
<tr><td>10</td><td>
Control mode switching function<br>[MS]<br>
■ 2 types of control mode can be switched and used.<br>
The control mode combination is selected by system parameter and can be switched with control mode switching function.<br>
◆ Selecting control modes from system parameters ID06.<br>
<table>
<tr><th>ID</th><th>Name</th><th>Setting range</th></tr>
<tr><td>06</td><td>Control mode</td><td>6 methods</td></tr>
</table>
<table>
<tr><th>Setting</th><th>Contents</th></tr>
<tr><td>03: Velo－Torq</td><td>Velocity control - torque control switching type</td></tr>
<tr><td>04: Posi－Torq</td><td>Position control - torque control switching type</td></tr>
<tr><td>05: Posi－Velo</td><td>Position control - velocity control switching type</td></tr>
</table>
* After setting changed --> The setting is enabled by re-turning on control power supply.<br>
◆ Allocating conditions to enable control mode switching function. When MS signal is valid, control mode is switched.<br>
◆ When using control mode switching type, “Auto-notch frequency tuning”, “Auto-vibration suppression frequency tuning”, and “JOG-operation” may not be used. Please use “Auto-notch frequency tuning”, “Auto-vibration suppression frequency tuning,” and “JOG-operation” after changing control mode to primary side (turning off “input signal”).
</td></tr>
<tr><td>11</td><td>
Position command pulse inhibiting function･velocity-zero stop function<br>[INH/Z-STP]<br>
■ When operating in position control mode, you use position command pulse inhibiting function (INHIBIT function), when in velocity control mode, you use velocity-zero stop function.<br>
◆ Enabling the function during servo motor operation inhibits input command, and then servo motor stops with the state servo motor being excited.<br>
* When operating in position control mode, input pulse is not counted inside of the amplifier unit even if position command pulse is input.<br>
◆ Allocating conditions to enable position command pulse inhibiting function/ velocity-zero stop function. This functions when INH/Z-STP signal is enabled.
</td></tr>
<tr><td>13<br>14</td><td>
Gain switching condition 1 [GC1]<br>Gain switching condition 2 [GC2]<br>
■ 4 types of gain can be used by switching them.<br>
◆ Allocating conditions to enable gain switching condition. You can switch GAIN 1 to 4 by combination of GC1 and GC2 setting.<br>
<table>
<tr><td>GC1 : Gain switching condition 1</td><td>Invalid</td><td>Valid</td><td>Invalid</td><td>Valid</td></tr>
<tr><td>GC2 : Gain switching condition 2</td><td>Invalid</td><td>Invalid</td><td>Valid</td><td>Valid</td></tr>
<tr><td></td><td>↓</td><td>↓</td><td>↓</td><td>↓</td></tr>
<tr><td>Gain becoming valid</td><td>GAIN1</td><td>GAIN2</td><td>GAIN3</td><td>GAIN4</td></tr>
</table>
</td></tr>
</table>

－Group9－

<table>
<tr><th>ID</th><th>Contents</th></tr>
<tr><td>15<br>16</td><td>
FF vibration suppression frequency selecting input A1 [SUPFSELA1]<br>
FF vibration suppression frequency selecting input A2 [SUPFSELA2]<br>
■ 4 types of FF vibration suppression frequency can be used by switching them.<br><br>
◆ Allocating conditions to enable FF vibration suppression frequency selecting input. You can switch FF vibration suppression frequency A1 to A4 by combination of SUPFSELA1 and SUPFSELA2 setting.
<table>
<tr><td>SUPFSELA1: FF vibration suppression frequency selecting input A1</td><td>Invalid</td><td>Valid</td><td>Invalid</td><td>Valid</td></tr>
<tr><td>SUPFSELA2: FF vibration suppression frequency selecting input A2</td><td>Invalid</td><td>Invalid</td><td>Valid</td><td>Valid</td></tr>
<tr><td></td><td>↓</td><td>↓</td><td>↓</td><td>↓</td></tr>
<tr><td>Vibration suppression becoming valid</td><td>FF vibration suppression frequency A1<br>Group 2<br>ID00</td><td>FF vibration suppression frequency A2<br>Group 4<br>ID40</td><td>FF vibration suppression frequency A3<br>Group 4<br>ID41</td><td>FF vibration suppression frequency A4<br>Group 4<br>ID42</td></tr>
</table>
</td></tr>
<tr><td>17<br>18</td><td>
FF vibration suppression frequency selecting input B1 [SUPFSELB1]<br>
FF vibration suppression frequency selecting input B2 [SUPFSELB2]<br>
■ 4 types of FF vibration suppression frequency can be used by switching them.<br><br>
◆ Allocating conditions to enable FF vibration suppression frequency selecting input. You can switch FF vibration suppression frequency B1 to B4 by combination of SUPFSELB1 and SUPFSELB2 setting.
<table>
<tr><td>SUPFSELB1: FF vibration suppression frequency selecting input B1</td><td>Invalid</td><td>Valid</td><td>Invalid</td><td>Valid</td></tr>
<tr><td>SUPFSELB2: FF vibration suppression frequency selecting input B2</td><td>Invalid</td><td>Invalid</td><td>Valid</td><td>Valid</td></tr>
<tr><td></td><td>↓</td><td>↓</td><td>↓</td><td>↓</td></tr>
<tr><td>Vibration suppression becoming valid</td><td>FF vibration suppression frequency B1<br>Group 2<br>ID02</td><td>FF vibration suppression frequency B2<br>Group 4<br>ID43</td><td>FF vibration suppression frequency B3<br>Group 4<br>ID44</td><td>FF vibration suppression frequency B4<br>Group 4<br>ID45</td></tr>
</table>
</td></tr>
</table>

<table>
<tr><th>ID</th><th>Contents</th></tr>
<tr><td>19</td><td>
Position loop proportional control switching function<br>[PLPCON]<br>
■ You can switch between position loop PI control and P control. Enabling position loop proportional control switching function (PLPCON) enable switching.<br><br>
◆ Allocating conditions to enable position loop proportional control switching function. When PLPCON signal enabled, the control is switched to proportional control.<br><br>
● PI control (proportional･integral control)･･Position loop proportional gain (KP)/ integral time constant (TPI)<br>
● P control (proportional control)･･････ Position loop proportional gain (KP)<br><br>
* In the standard setting, position loop integral time constant (TPI) is 1000.0ms, so integration function is disabled.<br><br>
◆ Automatically overwrite by Auto-tuning result saving.<br>
◆ When Auto-tuning function is valid, this setting value is not applied.
</td></tr>
<tr><td>1A</td><td>
Model following (vibration suppression) control/ standard position control switching function<br>[MODEL]<br>
■ Enabling Model following (vibration suppression) control.<br>
◆ This setting value is valid only when Control mode selection is "03: Velocity / Torque control switching type" or "04: Position / Torque control switching type".<br>
* Valid condition is limited to 00 to 11.<br>
* Do not perform switching of the model following (vibration suppression) control and the standard position control, during servo motor operation. Alarm (Model Following Vibration Suppression Control Error (AL.C5)) may occur.
</td></tr>
<tr><td>1B<br>1C</td><td>
Model vibration suppression frequency selecting input 1 [MDLFSEL1]<br>Model vibration suppression frequency selecting input 2 [MDLFSEL2]<br>
■ 4 types of model vibration suppression frequency can be used by switching them.<br><br>
◆ Allocating conditions to enable model control antiresonant frequency selecting input. You can switch model control antiresonant frequency 1 to 4/ model control antiresonant frequency 1 to 4 by combination of MDLFSEL1 with MDLFSEL2.<br><br>
<table>
<tr><td>MDLFSEL1: Model vibration suppression frequency selecting input 1</td><td>Invalid</td><td>Valid</td><td>Invalid</td><td>Valid</td></tr>
<tr><td>MDLFSEL2: Model vibration suppression frequency selecting input 2</td><td>Invalid</td><td>Invalid</td><td>Valid</td><td>Valid</td></tr>
<tr><td></td><td>↓</td><td>↓</td><td>↓</td><td>↓</td></tr>
<tr><td>Vibration suppression frequency becoming valid</td><td>Model control antiresonant frequency 1 Group 3 ID06<br>Model control resonant frequency 1 Group 3 ID07</td><td>Model control antiresonant frequency 2 Group 4 ID50<br>Model control resonant frequency 2 Group 4 ID51</td><td>Model control antiresonant frequency 3 Group 4 ID52<br>Model control resonant frequency 3 Group 4 ID53</td><td>Model control antiresonant frequency 4 Group 4 ID54<br>Model control resonant frequency 4 Group 4 ID55</td></tr>
</table>
</td></tr>
</table>

－Group9－

| ID | Contents |
|---|---|
| 27 | Velocity loop proportional control switching function<br>[VLPCON]<br>■ You can switch between velocity loop PI control and P control.<br>◆ Enabling velocity loop proportional control switching function (VLPCON) enables switching.<br>◆ Allocating conditions to enable velocity loop proportional control switching function. When VLPCON signal is enabled, the control is switched to proportional control.<br>● PI control (proportional･integral control)･･Velocity loop proportional gain (KVP)/ integral time constant (TVI)<br>● P control (proportional control)･･････ Velocity loop proportional gain (KVP)<br>* Switching to proportional control decreases servo gain, and servo system becomes easy to stable.<br>* In the default setting, the velocity loop integral time constant (TVI) is 1000.0ms, so the integral function is invalid.<br>◆ Automatically overwrite by Auto-tuning result saving.<br>◆ When Auto-tuning function is valid, this setting value is not applied. |
| 34 | Stick-slip behavior compensation function<br>[STC]<br>■ This enables stick motion compensation function in quadrant to compensate trajectory error occurred due to quadrant switching, for use in applications for arc-shape or curved surface process, such as NC machining equipments.<br>◆ The conditions for enabling compensatory function for stick-slip behavior are assigned. The compensatory function for stick-slip behavior becomes enabled If the STC signal is valid. |
| 35 | Minor vibration suppression function<br>[FBHYST]<br>■ Minor vibration suppression function to suppress mechanical system-induced vibration caused by encoder pulse modulation is enabled when motor stops.<br>◆ The conditions for enabling minor vibration suppression function are assigned. The minor vibration suppression function becomes enabled if the FBHYST signal is valid. |
| 40 | External trip input function<br>[EXT-E]<br>■ Contact input such as external thermal device can be taken in amplifier unit, and then output as an alarm (AL.55).<br>◆ Allocating conditions to enable external trip function. When EXT-E signal is enabled, this becomes alarm (AL.55). |
| 41 | Emergency stop function<br>[EMR]<br>■ This can urgently stop servo motor by taking unit emergency signal into amplifier unit.<br>◆ Allocating conditions to enable unit emergency signal. When EMR signal is enabled, motor urgently stops. |

| ID | Contents |
|---|---|
| 80 | Axes-sync compensation function<br>[SYNCEN]<br>■ Tandem operation function will work when "01: Tandem" is set to system parameter ID08 "Amplifier communication function", and this parameter is valid.<br>* Valid condition is limited to 00 to 11. |
| 81 | Axes-sync compensation proportional control switching function<br>[SYNPCNEN]<br>■ Able to switch PI control and P control, in the axes-sync compensation function.<br>◆ Able to switch when this parameter (SYNPCNEN) is valid.<br>◆ Assign conditions of becoming valid the axes-sync compensation proportional control switching function. Change to proportional control when SYNPCNEN signal is valid.<br>● PI (Proportional-Integral) control<br>Axes-sync compensation proportional gain (KSCPGN),<br>Axes-sync compensation integral time constant (TSCIGN)<br>● P (Proportional) control<br>Axes-sync compensation proportional gain (KSCPGN)<br>* Servo system will ease to stable when changing to proportional control by reducing axes-sync compensation value.<br>* In the default setting, the axes-sync compensation integral time constant (TSCIGN) is 1000.0ms, so the integral function is invalid. |

■ GroupA "General output terminal output condition/ Monitor output selection"

| ID | Contents | Setting range | Unit | Default value |
|---|---|---|---|---|
| 00 | General Purpose Output 1 [OUT1] | 00 to 81 | - | 18:INP_ON |
| 01 | General Purpose Output 2 [OUT2] | 00 to 81 | - | OC:TLC_ON |
| 02 | General Purpose Output 3 [OUT3] | 00 to 81 | - | 02:S-RDY_ON |
| 03 | General Purpose Output 4 [OUT4] | 00 to 81 | - | 0A:MBR-ON_ON |
| 04 | General Purpose Output 5 [OUT5] | 00 to 81 | - | 33:ALM5_OFF |
| 05 | General Purpose Output 6 [OUT6] | 00 to 81 | - | 35:ALM6_OFF |
| 06 | General Purpose Output 7 [OUT7] | 00 to 81 | - | 37:ALM7_OFF |
| 07 | General Purpose Output 8 [OUT8] | 00 to 81 | - | 39:ALM_OFF |
| 10 | Digital Monitor Output Signal Selection [DMON] | 00 to 81 | - | 00:Always_OFF |

■ Selects output signal for Output digital monitor.
- ◆ The logic is reversed with the Digital monitor.
- ◆ Output voltage is approximately 5V when OFF, and 0V when ON.

■ Selection Contents list for General Purpose Output OUT1 to General Purpose Output OUT8 /Digital monitor output selection

◆ Fix Output to either selection.

| | |
|---|---|
| 01:Always_ON | 00:Always_OFF |

◆ When Generic input signal status is to be Output

| | | |
|---|---|---|
| General Input, CONT1 is ON | 3A:CONT1_ON | 3B:CONT1_OFF |
| General Input, CONT2 is ON | 3C:CONT2_ON | 3D:CONT2_OFF |
| General Input, CONT3 is ON | 3E:CONT3_ON | 3F:CONT3_OFF |
| General Input, CONT4 is ON | 40:CONT4_ON | 41:CONT4_OFF |
| General Input, CONT5 is ON | 42:CONT5_ON | 43:CONT5_OFF |
| General Input, CONT6 is ON | 44:CONT6_ON | 45:CONT6_OFF |
| General Input, CONT7 is ON | 46:CONT7_ON | 47:CONT7_OFF |
| General Input, CONT8 is ON | 48:CONT8_ON | 49:CONT8_OFF |

◆ When Amplifier unit Preset status is to be output.

| | | |
|---|---|---|
| While Servo Ready Complete | 02:S-RDY_ON | 03:S-RDY_OFF |
| While Power Supply ON | 04:P-ON_ON | 05:P-ON_OFF |
| While Power Supply ON Permission | 06:A-RDY_ON | 07:A-RDY_OFF |
| While Motor Excitation | 08:S-ON_ON | 09:S-ON_OFF |
| While Holding Brake Excitation Signal Output | 0A:MBR-ON_ON | 0B:MBR-ON_OFF |
| While Torque Limiting | 0C:TLC_ON | 0D:TLC_OFF |
| While Velocity Limiting | 0E:VLC_ON | 0F:VLC_OFF |
| While Low Speed Status | 10:LOWV_ON | 11:LOWV_OFF |
| While Speed Attainment Status | 12:VA_ON | 13:VA_OFF |
| While Speed Matching Status | 14:VCMP_ON | 15:VCMP_OFF |
| While Speed Zero Status | 16:ZV_ON | 17:ZV_OFF |
| While Command Acceptance Permission Status | 1C:CMD-ACK_ON | 1D:CMD-ACK_OFF |
| While Gain Switching Status | 1E:GC-ACK_ON | 1F:GC-ACK_OFF |
| While Velocity Loop Proportional Control Switching Status | 20:PCON-ACK_ON | 21:PCON-ACK_OFF |
| While Electronic Gear Switching Status | 22:GERS-ACK_ON | 23:GERS-ACK_OFF |
| While Control Mode Switching Status | 24:MS-ACK_ON | 25:MS-ACK_OFF |
| While Forward Over-Travel Status | 26:F-OT_ON | 27:F-OT_OFF |
| While Reverse Over-travel Status | 28:R-OT_ON | 29:R-OT_OFF |
| While Main Circuit Power Supply Charging | 4A:CHARGE_ON | 4B:CHARGE_OFF |
| While Dynamic Braking | 4C:DB_OFF | 4D:DB_ON |
| While Torque Attainment Status | 5E:TA_ON | 5F:TA_OFF |
| While Model control/ Model vibration suppression control Status | 68:MODLCH_ON | 69:MODLCH_OFF |
| While Velocity command zero status | 6A:VCZV_ON | 6B:VCZV_OFF |

◆ When Positioning signal is to be output

| | | |
|---|---|---|
| While In-Position Status | 18:INP_ON | 19:INP_OFF |
| While Near Range Status | 1A:NEAR_ON | 1B:NEAR_OFF |
| While In-Position with Position Command 0 Status | 5A:INPZ_ON | 5B:INPZ_OFF |
| While position command distribution completion status | 60:TRJCMP_ON | 61: TRJCMP_OFF |

◆ When Warning signal is to be output

| | | |
|---|---|---|
| While Position Deviation Excess Warning Status | 2A:WNG-OFW_ON | 2B:WNG-OFW_OFF |
| While Overload Warning Status | 2C:WNG-OLW_ON | 2D:WNG-OLW_OFF |
| While Regenerative Overload Warning Status | 2E:WNG-ROLW_ON | 2F:WNG-ROLW_OFF |
| While Encoder Warning status | 30:WNG-BAT_ON | 31:WNG-BAT_OFF |
| While Voltage Sag Warning Status | 5C:PEWNG_ON | 5D:PEWNG_OFF |
| While dual position error excess warning status | 66:DFWNG_ON | 67:DFWNG_OFF |
| While adaptive notch filter E frequency warning status | 6E:ANFEWNG_ON | 6F:ANFEWNG_OFF |
| While axes-sync error warning status | 80:SYNCEWNG_ON | 81:SYNCEWNG_OFF |

◆ When Alarm signals are to be output

| | | |
|---|---|---|
| Alarm Code Bit 5 | 32:ALM5_ON | 33:ALM5_OFF |
| Alarm Code Bit 6 | 34:ALM6_ON | 35:ALM6_OFF |
| Alarm Code Bit 7 | 36:ALM7_ON | 37:ALM7_OFF |
| While Alarm Status | 38:ALM_ON | 39:ALM_OFF |

◆ When PY compatible alarm signals are to be output

| | | |
|---|---|---|
| PY Compatible Alarm Code 1 | 50:PYALM1_ON | 51:PYALM1_OFF |
| PY Compatible Alarm Code 2 | 52:PYALM2_ON | 53:PYALM2_OFF |
| PY Compatible Alarm Code 4 | 54:PYALM4_ON | 55:PYALM4_OFF |
| PY Compatible Alarm Code 8 | 56:PYALM8_ON | 57:PYALM8_OFF |

* For RS3 amplifier unit, "Torque limiting" is performed at "before torque limit filter" and "after torque command filter/torque FF compensation", by equipping the torque FF compensation function. "While Torque Limiting" is output when either condition is established. Therefore, confirm each state of the torque command monitor and the torque command monitor (before filter), for "Torque limiting".

# 5. Operation

－GroupA－

| ID | Contents | Setting range | Unit | Default value |
|---|---|---|---|---|
| 11 | Analog Monitor Select Output 1 [MON1] | 00 to 36 | - | 05:VMON_2mV/min$^{-1}$ |
| 12 | Analog Monitor Select Output 2 [MON2] | 00 to 36 | - | 02:TCMON_2V/TR |

■ Selects output signals to output to Analog monitor 1 and 2 from the list below.

| | | |
|---|---|---|
| 00:RESERVE | Monitor mode for manufacturer only | - |
| 01:TMON_2V/TR | Torque Monitor | 2V/Rated torque |
| 02:TCMON_2V/TR | Torque Command Monitor | 2V/Rated torque |
| 03:VMON_0.2mV/ min$^{-1}$ | Velocity Monitor | 0.2mV/min$^{-1}$ |
| 04:VMON_1mV/ min$^{-1}$ | Velocity Monitor | 1mV/min$^{-1}$ |
| 05:VMON_2mV/ min$^{-1}$ | Velocity Monitor | 2mV/min$^{-1}$ |
| 06:VMON_3mV/ min$^{-1}$ | Velocity Monitor | 3mV/min$^{-1}$ |
| 07:VCMON_0.2mV/ min$^{-1}$ | Velocity Command Monitor | 0.2mV/min$^{-1}$ |
| 08:VCMON_1mV/ min$^{-1}$ | Velocity Command Monitor | 1mV/min$^{-1}$ |
| 09:VCMON_2mV/ min$^{-1}$ | Velocity Command Monitor | 2mV/min$^{-1}$ |
| 0A:VCMON_3mV/ min$^{-1}$ | Velocity Command Monitor | 3mV/min$^{-1}$ |
| 0B:PMON_0.01mV/P | Position Deviation Counter Monitor | 0.01mV/Pulse |
| 0C:PMON_0.1mV/P | Position Deviation Counter Monitor | 0.1mV/Pulse |
| 0D:PMON_1mV/P | Position Deviation Counter Monitor | 1mV/Pulse |
| 0E:PMON_10mV/P | Position Deviation Counter Monitor | 10mV/Pulse |
| 0F:PMON_20mV/P | Position Deviation Counter Monitor | 20mV/Pulse |
| 10:PMON_50mV/P | Position Deviation Counter Monitor | 50mV/Pulse |
| 11:FMON1_2mV/kP/s | Position Command Pulse Frequency Monitor 1 (Position Command Pulse Input Frequency) | 2mV/kPulse/s |
| 12:FMON1_10mV/kP/s | Position Command Pulse Frequency Monitor 1 (Position Command Pulse Input Frequency) | 10mV/kPulse/s |
| 13:FMON2_0.05mV/kP/s | Position Command Pulse Frequency Monitor 2 (Position Command Pulse Frequency for Position Controller) | 0.05mV/kPulse/s |
| 14:FMON2_0.5mV/kP/s | Position Command Pulse Frequency Monitor 2 (Position Command Pulse Frequency for Position Controller) | 0.5mV/kPulse/s |
| 15:FMON2_2mV/kP/s | Position Command Pulse Frequency Monitor 2 (Position Command Pulse Frequency for Position Controller) | 2mV/kPulse/s |
| 16:FMON2_10mV/kP/s | Position Command Pulse Frequency Monitor 2 (Position Command Pulse Frequency for Position Controller) | 10mV/kPulse/s |
| 17:TLMON_EST_2V/TR | Load Torque Monitor (Estimated Value) | 2V/Rated torque |
| 18:Sine-U | U Phase Electronic Angle Sine | 8Vpeak |
| 19:ACMON_0.01mV/rad/s$^2$ | Acceleration monitor | 0.01mV/rad/s$^2$ |

| | | |
|---|---|---|
| 1A:ACMON_0.1mV/rad/s$^2$ | Acceleration monitor | 0.1mV/rad/s$^2$ |
| 1B:ACMON_1mV/rad/s$^2$ | Acceleration monitor | 1mV/rad/s$^2$ |
| 1C:ACMON_10mV/rad/s$^2$ | Acceleration monitor | 10mV/rad/s$^2$ |
| 1D: VBUS_ 1V/DC100V | Bus voltage monitor | 1V/DC100V |
| 1E: VBUS_ 1V/DC10V | Bus voltage monitor | 1V/DC10V |
| 1F:DFERR_10mV/P | Dual position error monitor | 10mV/Pulse |
| 20:DFERR_0.1mV/P | Dual position error monitor | 0.1mV/Pulse |
| 21:SYNERR_10mV/P | Axes-sync error monitor | 10mV/Pulse |
| 22:SYNERR_0.1mV/P | Axes-sync error monitor | 0.1mV/Pulse |
| 23:OLRAT_0.5V/% | Overload detection temperature reach rate monitor | 0.5V/% |
| 24:FMON1_0.01mV/kP/s | Position command pulse frequency monitor 1 (Position command pulse input frequency) | 0.01mV/kPulse/s |
| 25:FMON1_0.05mV/kP/s | Position command pulse frequency monitor 1 (Position command pulse input frequency) | 0.05mV/kPulse/s |
| 26:FMON1_0.5mV/kP/s | Position command pulse frequency monitor 1 (Position command pulse input frequency) | 0.5mV/kPulse/s |
| 27:FMON2_0.01mV/kP/s | Position command pulse frequency monitor 2 (Position command pulse input frequency) | 0.01mV/kPulse/s |
| 28：MAVEPOW_1V/ 10W | Average power monitor | 1V/ 10W |
| 29：MAVEPOW _1V/ 100W | Average power monitor | 1V/ 100W |
| 2A：MAVEPOW _1V/ 1kW | Average power monitor | 1V/ 1kW |
| 2B：MAVEPOW _1V/ 10kW | Average power monitor | 1V/ 10kW |
| 2C：MAVEPOW _1V/ 100kW | Average power monitor | 1V/ 100kW |
| 2D：TMON2_2V/TR | Torque Command Monitor (before filter) | 2V/Rated torque |
| 34:JRAT_10mV/% | Load inertia moment ratio monitor | 10mV/% |
| 35:JRAT_5mV/% | Load inertia moment ratio monitor | 5mV/% |
| 36:JRAT_0.5mV/% | Load inertia moment ratio monitor | 0.5mV/% |

- Position command pulse frequency monitor 1 monitors Position command pulse before the Electronic gear.
- Position command pulse frequency monitor 2 monitors Position command pulse after passing through the Electronic gear and Position command smoothing.

* Position command pulse frequency monitor 1, 2 will be generated in pulse-state when the position command pulse is 10 kHz or less. When converting it to position command frequency, use it after averaging.

- The following low-pass filters are placed into torque monitor, acceleration monitor, and load torque monitor.

| | |
|---|---|
| Torque monitor | 250Hz |
| Velocity monitor | 250Hz |
| Load torque monitor | 50Hz |

- Torque Command Monitor (before filter) outputs the state before filter, so torque command is shown with ripple. However, motor is driven by the torque command after filter. Therefore, it differs from motor behavior.

－GroupA－

| ID | Contents | | | |
|---|---|---|---|---|
| 13 | Analog Monitor Output Polarity [MONPOL] | Setting range | Unit | Default value |
| | | 00 to 08 | - | 00:MON1+_MON2+ |

■ Selects Output polarity of Analog monitor output, MON1and MON2 from below.

◆ For both MON1 and MON2, set from any of the followings:
+ No Polarity Rotation, - Polarity Rotation, ABS Absolute Value Output

| Selection | Contents |
|---|---|
| 00:MON1+_MON2+ | MON1: Output positive voltage at Forward (Positive) Rotation. Output positive/negative voltage.<br>MON2: Output positive voltage at Forward (Positive) Rotation. Output positive/negative voltage. |
| 01:MON1-_MON2+ | MON1: Output negative voltage at Forward (Positive) Rotation. Output positive/negative voltage.<br>MON2: Output positive voltage at Forward (Positive) Rotation. Output positive/negative voltage. |
| 02:MON1+_MON2- | MON1: Output positive voltage at Forward (Positive) Rotation. Output positive/negative voltage.<br>MON2: Output negative voltage at Forward (Positive) Rotation. Output positive/negative voltage. |
| 03:MON1-_MON2- | MON1: Output negative voltage at Forward (Positive) Rotation. Output positive/negative voltage.<br>MON2: Output negative voltage at Forward (Positive) Rotation. Output positive/negative voltage. |
| 04:MON1ABS_MON2+ | MON1: Output positive voltage at Forward (Positive) and Reverse (Negative) Rotation.<br>MON2: Output negative voltage at Forward (Positive) Rotation. Output positive/negative voltage. |
| 05:MON1ABS_MON2- | MON1: Output positive voltage at Forward (Positive) and Reverse (Negative) Rotation.<br>MON2: Output negative voltage at Forward (Positive) Rotation. Output positive/negative voltage. |
| 06:MON1+_MON2ABS | MON1: Output positive voltage at Forward (Positive) Rotation. Output positive/negative voltage.<br>MON2: Output positive voltage at Forward (Positive) and Reverse (Negative) Rotation. |
| 07:MON1-_MON2ABS | MON1: Output negative voltage at Forward (Positive) Rotation. Output positive/negative voltage.<br>MON2: Output positive voltage at Forward (Positive) and Reverse (Negative) Rotation. |
| 08:MON1ABS_MON2ABS | MON1: Output positive voltage at Forward (Positive) and Reverse (Negative) Rotation.<br>MON2: Output positive voltage at Forward (Positive) and Reverse (Negative) Rotation. |

■ GroupB "Sequence/Alarm related settings"

| ID | Contents | | | |
|---|---|---|---|---|
| 00 | Servo-OFF stop behavior [DBOPE] | Setting range | Unit | Default value |
| | | 00 to 07 | - | 04:SB_Free |

■ Sets the stop behavior when state changed to servo OFF from servo ON, and the dynamic brake operation during servo OFF.

| Selection | | Contents |
|---|---|---|
| 00 | Free_Free | Free run works, at servo OFF.<br>Motor gets free state, after motor stop. |
| 01 | Free_DB | Free run works, at servo OFF.<br>Dynamic brake works, after motor stop. |
| 02 | DB_Free | Dynamic brake works, at servo OFF.<br>Motor gets free state, after motor stop. |
| 03 | DB_DB | Dynamic brake works, at servo OFF.<br>Dynamic brake works, after motor stop. |
| 04 | SB_Free | Servo brake works, at servo OFF.<br>Motor gets free state, after motor stop. |
| 05 | SB_DB | Servo brake works, at servo OFF.<br>Dynamic brake works, after motor stop. |
| 06 | Dec_Free | Stop after deceleration, at servo OFF.<br>Motor gets free state, after motor stop. |
| 07 | Dec_DB | Stop after deceleration, at servo OFF.<br>Dynamic brake works, after motor stop. |

◆ Set the deceleration time constant of decelerate stop, into GroupB ID15.

* Motor stops by the action which set in GroupB ID02 "Emergency Stop Operation" if Main circuit power is shut down, and dynamic brake will work after stop. However if "Main Circuit Under-voltage" or "BONBGN passing" are detected during stopping, motor stops by dynamic brake operation.

－GroupB－

| ID | Contents | | | |
|---|---|---|---|---|
| 01 | Over-Travel Action [ACTOT] | Setting range | Unit | Default value |
| | | 00 to 08 | - | 00:CMDINH_SB_SON |

■ Selects operations at over-travel action.

| Selection | | Contents |
|---|---|---|
| 00 | CMDINH_SB_SON | Command input is disabled, and motor is stopped by servo-braking (with peak torque) when OT occurs. Servo is turned on after motor stops.<br>(Command from either positive or negative direction in which OT occurs, command disabled = velocity limit command = 0)<br>(Torque command for OT side is limited by the sequence torque limit.) |
| 01 | CMDINH_DB_SON | Command input is disabled, and motor is stopped by dynamic-braking when OT occurs. Servo is turned on after motor stops.<br>(Command from either positive or negative direction in which OT occurs, command disabled = velocity limit command = 0) |
| 02 | CMDINH_Free_SON | Command input is disabled, and motor is free-running when OT occurs. Servo is turned on after motor stops.<br>(Command from either positive or negative direction in which OT occurs, command disabled = velocity limit command = 0) |
| 03 | CMDINH_SB_SOFF | Command input is disabled, and motor is stopped by servo-braking when OT occurs. Servo is turned off after motor stops.<br>(Torque command for both side is limited by the sequence torque limit.) |
| 04 | CMDINH_DB_SOFF | Command input is disabled, and motor is stopped by dynamic-braking when OT occurs. Servo is turned off after motor stops. |
| 05 | CMDINH_Free_SOFF | Command input is disabled, and motor is free-running when OT occurs. Servo is turned off after motor stops. |
| 06 | CMDACK_VCLM=0 | Velocity limit command for the direction on which OT occured becomes zero when OT occurs. |
| 08 | CMDINH_SB_SON2 | Command input is disabled, and motor is stopped by servo-brake operation (with sequence torque limit) when OT occurs.<br>Servo is turned on after motor stops.<br>(Command from either positive or negative direction in which OT occurs, command disabled = velocity limit command = 0)<br>(Torque command for both side is limited by the sequence torque limit.) |

◆ Torque limit value differs depending on selection code, when stopping a servo motor by servo-brake.

00: Peak torque
03, 08: Sequence torque limit

◆ For the velocityt control mode, select from 00 to 05 or 08.

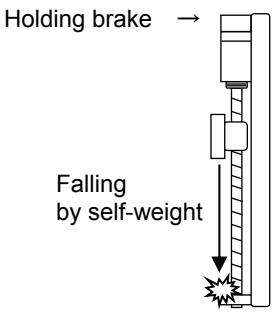
◆ For the torque control mode, operates as follows:

- For 00 to 02 or 08, keeps servo-on state with torque command limitation by sequence torque limit.
- For 03 or 04, shift to servo-off state and stop with dynamic brake. Also keeps servo-off state after motor stop.
- For 05, shift to servo-off state and becobe freerun operation. Also keeps servo-off state after motor stop.

<table>
<tr><th>ID</th><th colspan="4">Contents</th></tr>
<tr><td rowspan="3">02</td><td rowspan="2">Emergency Stop Operation<br>[ACTEMR]</td><td>Setting range</td><td>Unit</td><td>Default value</td></tr>
<tr><td>00 to 02</td><td>-</td><td>00:SERVO-BRAKE</td></tr>
<tr><td colspan="4">■ Sets operation at Emergency Stop<br>◆ Selects operation at the time of emergency stop.<br>In case of vertical axis use, please use it with default setting (00: SERVO-BRAKE).<br><br>
<table>
<tr><th colspan="2">Selection</th><th>Contents</th></tr>
<tr><td>00</td><td>SERVO-BRAKE</td><td>Stops servo motor by operating servo brake at Emergency stop.</td></tr>
<tr><td>01</td><td>DYNAMIC-BRAKE</td><td>Stops servo motor by operating dynamic brake at Emergency stop.</td></tr>
<tr><td>02</td><td>DEC-STOP</td><td>Stops servo motor after deceleration at Emergency stop.</td></tr>
</table>
◆ Under Torque control mode, dynamic brake stops servo motor regardless of the setting value.<br>◆ If the alarm that has DB in "Detection operations" at 8.2.2 Alarm list occurs, and no Safe Torque Off function (servo amplifier model number option 2 is 0), stops servo motor by dynamic brake regardless of this setting.<br>◆ Sets the deceleration time constant of deceleration stop at GroupB ID16.<br><br>* Forced stop operation means “emergency stop function enabled”, “main circuit power shutoff“, ”alarm activated” and “safe-torque-off operation”.</td></tr>
<tr><td rowspan="3">03</td><td rowspan="2">Delay Time of Engaging Holding Brake<br>(Holding Brake Holding Delay time) [BONDLY]</td><td>Setting range</td><td>Unit</td><td>Default value</td></tr>
<tr><td>0 to 1000</td><td>ms</td><td>300</td></tr>
<tr><td colspan="4">■ Sets the holding-brake-activation delay time from when power distribution to holding brake stopped till when holding torque generated.<br>◆ While shifting from servo ON to servo OFF, during the setting time, Excitation command 0 is given to servo motor. (Even when servo is turned OFF, power is supplied to the motor until the setting time is over).<br>By this, until Holding brake functions, servo motor generates Holding torque.<br>◆ Setting unit is 4ms. When the setting value is 0ms, after servo OFF, command is invalid (command 0) for approximately 4ms.<br>◆ At the setting, GroupB ID00 [DBOPR] Servo-OFF stop behavior, when servo brake is ON at servo OFF, (04 SB_Free or 05 SB_DB), this is valid.<br>(This function is invalid in Dynamic brake operation and Free-run operation.)</td></tr>
<tr><td rowspan="3">04</td><td rowspan="2">Delay Time of Releasing Holding Brake<br>(Holding Brake Releasing Delay time) [BOFFDLY]</td><td>Setting range</td><td>Unit</td><td>Default value</td></tr>
<tr><td>0 to 1000</td><td>ms</td><td>300</td></tr>
<tr><td colspan="4">■ Sets the holding-brake-release delay time from when power distribution to holding brake started till when holding torque disappeared.<br>◆ While shifting from servo OFF to servo ON, during the setting time, Excitation command 0 is given to servo motor. (Even when servo is turned ON, command is not accepted until the setting time is complete.)<br>Therefore, until Holding brake is released, servo motor does not operate.<br>◆ Setting unit is 4ms. When the setting value is 0ms, after servo ON, command is invalid (command 0) for approximately 4ms.</td></tr>
<tr><td rowspan="3">05</td><td rowspan="2">Brake Operation Beginning Time<br>[BONBGN]</td><td>Setting range</td><td>Unit</td><td>Default value</td></tr>
<tr><td>0 to 65535</td><td>ms</td><td>10000</td></tr>
<tr><td colspan="4">■ Sets permissible time from servo OFF until servo motor stop.<br>◆ While shifting servo ON to servo OFF, even after the selected time passed and the servo motor does not stop. Servo motor is forced to stop with Holding brake and Dynamic brake.<br>◆ When the servo motor stops this setting does not function.<br>◆ When servo motor does not stop after servo OFF at gravity axis, set this parameter.<br>◆ When forced to stop by holding brake, the Holding brake may possibly be broken.<br>Be cautious about device specifications and sequence when using this function.</td></tr>
</table>

■ About Holding Brake

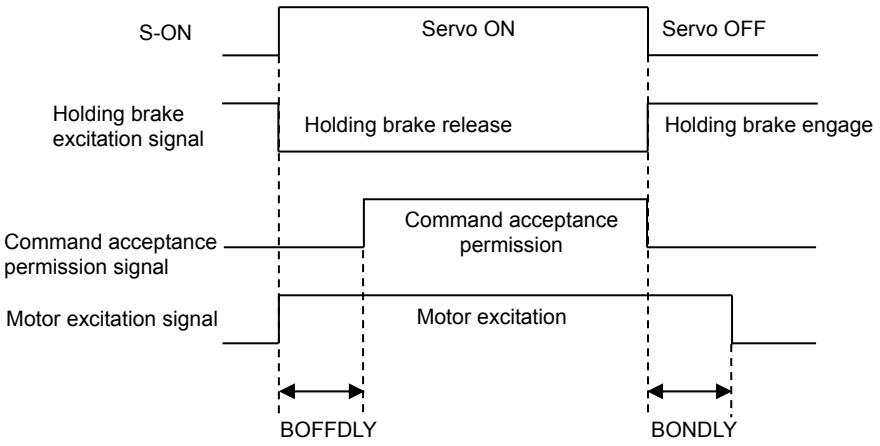
Servo motor with Holding brake function is usually used with an axis that is always affected by gravity and external forces in order to avoid movable parts falling off from its position when main circuit power is OFF, or servo OFF. Holding brake is to support the movable parts against gravity and other external force when at rest.
Do not use it to stop a moving machine.




◆ Setting for Holding brake excitation signal output

| Group | ID | Symbol | Contents |
|---|---|---|---|
| A | 0* | OUT* | Generic Output* |

| Selection | | Contents |
|---|---|---|
| 0A | MBR-ON_ON | While Holding brake excitation signal output, output ON. |
| 0B | MBR-ON_OFF | While Holding brake excitation signal output, output OFF. |



<table>
<tr><th>ID</th><th>Contents</th></tr>
<tr><td>06</td><td>
<table>
<tr><td>Power Failure Detection Delay Time<br>[PFDDLY] “Power cycle for control after setting”</td><td>Setting range<br>20 to 1000</td><td>Unit<br>ms</td><td>Default value<br>32</td></tr>
</table>
■ Sets the delay time from Control power OFF to Control power error detection.<br>
The larger value makes the detection of Instantaneous stop slower.<br>
(Control power holding time is about 23.4msec. Larger set value will only result in slower detections of errors. In case of power failure of internal logic circuit, operation is same as when Control power is turned ON again. In case of energy shortage of Main circuit power, other errors such as Main circuit power loss may be detected.)<br>
In this setting, actual detection delay time varies by -12ms to +6ms.
</td></tr>
<tr><td>07</td><td>
<table>
<tr><td>Initial timeout wait time<br>[INTTIM] “Power cycle for control after setting”</td><td>Setting range<br>00 to 07</td><td>Unit<br>-</td><td>Default value<br>00:Disabled</td></tr>
</table>
■ Selects the time till initialization completion.
<table>
<tr><th colspan="2">Selection</th><th>Contents</th></tr>
<tr><td>00</td><td>Disabled</td><td>Without wait time</td></tr>
<tr><td>01</td><td>1000ms</td><td>Insert 1000ms wait</td></tr>
<tr><td>02</td><td>1400ms</td><td>Insert 1400ms wait</td></tr>
<tr><td>03</td><td>1800ms</td><td>Insert 1800ms wait</td></tr>
<tr><td>04</td><td>2000ms</td><td>Insert 2000ms wait</td></tr>
<tr><td>05</td><td>3000ms</td><td>Insert 3000ms wait</td></tr>
<tr><td>06</td><td>5000ms</td><td>Insert 5000ms wait</td></tr>
<tr><td>07</td><td>10000ms</td><td>Insert 10000ms wait</td></tr>
</table>
</td></tr>
<tr><td>10</td><td>
<table>
<tr><td>Excessive Deviation Warning Level<br>[OFWLV]</td><td>Setting range<br>1 to 2147483647</td><td>Unit<br>Pulse</td><td>Default value<br>2147483647</td></tr>
</table>
■ Sets Warning output level before Excessive position deviation alarm is output.<br>
◆ Sets at Encoder pulse resolution regardless of Electronic gear.<br>
* It will be limited to 1073741823 [Pulse] if the value is set exceeding 1073741823[Pulse].
</td></tr>
<tr><td>11</td><td>
<table>
<tr><td>Deviation Counter Overflow Value<br>[OFLV]</td><td>Setting range<br>1 to 2147483647</td><td>Unit<br>Pulse</td><td>Default value<br>5000000</td></tr>
</table>
■ Sets Position deviation value regarded as Excessive position deviation alarm.<br>
◆ Sets at Encoder pulse resolution regardless of Electronic gear.<br>
* It will be limited to 1073741823 [Pulse] if the value is set exceeding 1073741823[Pulse].
</td></tr>
<tr><td>12</td><td>
<table>
<tr><td>Overload Warning Level<br>[OLWLV] “Power cycle for control after setting”</td><td>Setting range<br>20 to 100</td><td>Unit<br>%</td><td>Default value<br>90</td></tr>
</table>
■ Sets the Warning output level before Overload alarm output.<br>
◆ The possible level to be set is from 20%-99%, assuming that the Overload Warning Level is 100%. When set to 100%, Overload warning and Overload alarm are output at one time.<br>
◆ Overload detection is assumed and set as 75%, of a rated load when Control power is turned ON (hot start). Therefore, Overload warning may be output when Control power is turned ON.
</td></tr>
<tr><td>13</td><td>
<table>
<tr><td>Velocity Feedback Alarm (ALM_C3) Detection<br>[VFBALM]</td><td>Setting range<br>00 to 01</td><td>Unit<br>-</td><td>Default value<br>01:Enabled</td></tr>
</table>
■ Selects Valid/Invalid Velocity feedback error detection.
<table>
<tr><th colspan="2">Selection</th><th>Contents</th></tr>
<tr><td>00</td><td>Disabled</td><td>Invalid</td></tr>
<tr><td>01</td><td>Enabled</td><td>Valid</td></tr>
</table>
</td></tr>
</table>

－GroupB－

<table>
<tr><th>ID</th><th>Contents</th></tr>
<tr><td>14</td><td>
<table>
<tr><td>Velocity Control Alarm (ALM_C2) Detection [VCALM]</td><td>Setting range</td><td>Unit</td><td>Default value</td></tr>
<tr><td></td><td>00 to 01</td><td>-</td><td>00:Disabled</td></tr>
</table>
■ Selects Valid/Invalid Velocity control error detection.
<table>
<tr><th colspan="2">Selection</th><th>Contents</th></tr>
<tr><td>00</td><td>Disabled</td><td>Invalid</td></tr>
<tr><td>01</td><td>Enabled</td><td>Valid</td></tr>
</table>
In such an operation pattern as causing a servo motor overshoot to the command, Velocity control error may be detected by mistake. For this, set this parameter to invalid.
</td></tr>
<tr><td>15</td><td>
<table>
<tr><td>Deceleration Time Constant at Servo off Stopping [SOFDEC]</td><td>Setting range</td><td>Unit</td><td>Default value</td></tr>
<tr><td></td><td>0 to 16000</td><td>ms</td><td>0</td></tr>
</table>
■ This is the parameter which sets the deceleration time constant in case of servo OFF during servo motor rotation.<br>Sets deceleration time per 1000 $min^{-1}$.<br>Will be valid when 06 or 07 is set to GroupB ID00.
</td></tr>
<tr><td>16</td><td>
<table>
<tr><td>Deceleration Time Constant at Emergency Stopping [EMRDEC]</td><td>Setting range</td><td>Unit</td><td>Default value</td></tr>
<tr><td></td><td>0 to 16000</td><td>ms</td><td>0</td></tr>
</table>
■ This is the parameter which sets the deceleration time constant in case of Emergency stop (Status of "emergency stop function enabled", "main circuit power shutoff", "alarm activated" and "safe-torque-off operation") during servo motor rotation.<br>Sets deceleration time per 1000 $min^{-1}$.<br>Will be valid when 02 is set to GroupB ID02.<br><br>◆ Operation will shift to dynamic brake stop sequence when main circuit power falls lower or safe torque-off time has passed during deceleration stop.
</td></tr>
<tr><td>17</td><td>
<table>
<tr><td>External command effectivity selection at holding brake operation cancellation delay time [SONFALL]</td><td>Setting range</td><td>Unit</td><td>Default value</td></tr>
<tr><td></td><td>00 to 01</td><td>-</td><td>00:Disabled</td></tr>
</table>
■ Selects valid/invalid of external position/velocity command during the holding-brake-release delay time.<br>Self weight fall can suppress at servo ON by setting of position/velocity command that corresponded to gravity load or external load.
<table>
<tr><th colspan="2">Selection</th><th>Contents</th></tr>
<tr><td>00</td><td>Disabled</td><td>Invalid</td></tr>
<tr><td>01</td><td>Enabled</td><td>Valid</td></tr>
</table>
◆ As notes, when the command that exceeds gravity load or external load is given, servo motor will rotate and it may cause of holding-brake failure.
</td></tr>
<tr><td>18</td><td>
<table>
<tr><td>External command effectivity selection at holding brake operation delay time [SOFFFALL]</td><td>Setting range</td><td>Unit</td><td>Default value</td></tr>
<tr><td></td><td>00 to 01</td><td>-</td><td>00:Disabled</td></tr>
</table>
■ Selects valid/invalid of external position/velocity command during the holding-brake-activation delay time.<br>Self weight fall can suppress at servo OFF by setting of position/velocity command that corresponded to gravity load or external load.
<table>
<tr><th colspan="2">Selection</th><th>Contents</th></tr>
<tr><td>00</td><td>Disabled</td><td>Invalid</td></tr>
<tr><td>01</td><td>Enabled</td><td>Valid</td></tr>
</table>
◆ As notes, when the command that exceeds gravity load or external load is given, servo motor will rotate and it may cause of holding-brake failure.
</td></tr>
</table>

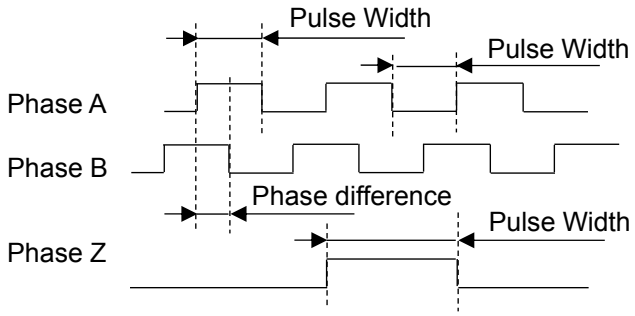
<table>
<tr><th>ID</th><th colspan="4">Contents</th></tr>
<tr><td rowspan="3">19</td><td>Dual position error warning level<br>[DFOFWLV]</td><td>Setting range<br>0 to 2147483647</td><td>Unit<br>Pulse</td><td>Default value<br>2147483647</td></tr>
<tr><td colspan="4">■ Warning is output when current position difference between external encoder and motor encoder exceeds this value. Using as warning output before the Dual position error excess alarm occurs.<br><br>* Sets 4 multiples of external encoder resolution as standards.<br>* Dual position error excess alarm does not detect when set value is 0.</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td rowspan="3">1A</td><td>Dual position error excess value<br>[DFOFLV]</td><td>Setting range<br>0 to 2147483647</td><td>Unit<br>Pulse</td><td>Default value<br>5000000</td></tr>
<tr><td colspan="4">■ Outputs the dual position error excess alarm when current position difference between external encoder and motor encoder exceeds this value.<br><br>* Sets 4 multiples of external encoder resolution as standards.<br>* Dual position error excess alarm does not detect when set value is 0.</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td rowspan="3">80</td><td>Axes-sync error warning level<br>[PSDEVW]</td><td>Setting range<br>1 to 2147483647</td><td>Unit<br>Pulse</td><td>Default value<br>2147483647</td></tr>
<tr><td colspan="4">■ Warning occurs when position deviation error between own axis and counterpart axis exceeds this set value.<br>Uses as warning output before outputting the axes-sync error excess alarm.</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td rowspan="3">81</td><td>Axes-sync error excess value<br>[PSDEVA]</td><td>Setting range<br>1 to 2147483647</td><td>Unit<br>Pulse</td><td>Default value<br>5000000</td></tr>
<tr><td colspan="4">■ Will be the axes-sync error excess when position deviation error between own axis and counterpart axis exceeds this set value.</td></tr>
<tr><td colspan="4"></td></tr>
</table>

■ GroupC "Encoder related settings"

| ID | Contents | | | |
|---|---|---|---|---|
| 00 | Motor Incremental Encoder Digital Filter [ENFIL] | Setting range | Unit | Default value |
| | | 00 to 07 | - | 01:220ns |

■ This parameter is settable only when using incremental encoder.
Sets Digital filter to motor incremental encoder.
Pulse lower than the set value is eliminated as noise when noise superposition occurs in encoder signals. Consider Encoder resolution and Maximum rotation velocity of the servo motor in operation when selecting value. Set the value roughly less than 1/4 of the Encoder pulse width at Maximum rotation velocity.

| Selection | | Contents |
|---|---|---|
| 00 | 110nsec | Minimum Pulse Width =110nsec<br>(Minimum pulse Phase Difference = 37.5nsec) |
| 01 | 220nsec | Minimum Pulse Width = 220nsec |
| 02 | 440nsec | Minimum Pulse Width = 440nsec |
| 03 | 880nsec | Minimum Pulse Width = 880nsec |
| 04 | 75nsec | Minimum Pulse Width = 75nsec<br>(Minimum pulse Phase Difference = 37.5nsec) |
| 05 | 150nsec | Minimum Pulse Width = 150nsec |
| 06 | 300nsec | Minimum Pulse Width = 300nsec |
| 07 | 600nsec | Minimum Pulse Width = 600nsec |




| ID | External Incremental Encoder Digital Filter [EX-ENFIL] | Setting range | Unit | Default value |
|---|---|---|---|---|
| 01 | | 00 to 07 | - | 01:220ns |

■ This parameter is settable only when using fully closed control function.
Sets Digital filter to External Incremental Encoder.
Pulse lower than the set value is eliminated as noise when noise superposition occurred in encoder signals. Consider Encoder resolution and Maximum rotation velocity of the servo motor in operation when selecting value. Set the value roughly less than 1/4 of the Encoder pulse width at Maximum rotation velocity.

| Selection | | Contents |
|---|---|---|
| 00 | 110nsec | Minimum Pulse Width =110nsec<br>(Minimum pulse Phase Difference = 37.5nsec) |
| 01 | 220nsec | Minimum Pulse Width = 220nsec |
| 02 | 440nsec | Minimum Pulse Width = 440nsec |
| 03 | 880nsec | Minimum Pulse Width = 880nsec |
| 04 | 75nsec | Minimum Pulse Width = 75nsec<br>(Minimum pulse Phase Difference = 37.5nsec) |
| 05 | 150nsec | Minimum Pulse Width = 150nsec |
| 06 | 300nsec | Minimum Pulse Width = 300nsec |
| 07 | 600nsec | Minimum Pulse Width = 600nsec |

－GroupC－

| ID | Contents | | | |
|---|---|---|---|---|
| 02 | External Pulse Encoder Polarity Selection<br>[EX-ENPOL] “Power cycle for control after setting” | Setting range | Unit | Default value |
| | | 00 to 07 | - | 00:Type1 |

■ This parameter is settable only when using fully closed control function.

◆ Select External pulse encoder signal polarity.

| Selection | | Contents | | |
|---|---|---|---|---|
| 00 | Type1 | EX-Z/Not Reversed | EX-B/ Not Reversed | EX-A/ Not Reversed |
| 01 | Type2 | EX-Z/Not Reversed | EX-B/ Not Reversed | EX-A/ Reversed |
| 02 | Type3 | EX-Z/Not Reversed | EX-B/ Reversed | EX-A/ Not Reversed |
| 03 | Type4 | EX-Z/Not Reversed | EX-B/ Reversed | EX-A/ Reversed |
| 04 | Type5 | EX-Z/Reversed | EX-B/ Not Reversed | EX-A/ Not Reversed |
| 05 | Type6 | EX-Z/Reversed | EX-B/ Not Reversed | EX-A/ Reversed |
| 06 | Type7 | EX-Z/Reversed | EX-B/ Reversed | EX-A/ Not Reversed |
| 07 | Type8 | EX-Z/Reversed | EX-B/ Reversed | EX-A/ Reversed |

| ID | Encoder Output Pulse Divide Selection<br>[PULOUTSEL] “Power cycle for control after setting” | Setting range | Unit | Default value |
|---|---|---|---|---|
| 03 | | 00 to 01 | - | 00:Motor_Enc. |

■ Sets Encoder output pulse division signal.
Select Motor encoder or External encoder to load Encoder pulse to upper device.

| Selection | | |
|---|---|---|
| 00 | Motor_Enc | Motor Encoder |
| 01 | External_Enc | External Encoder |

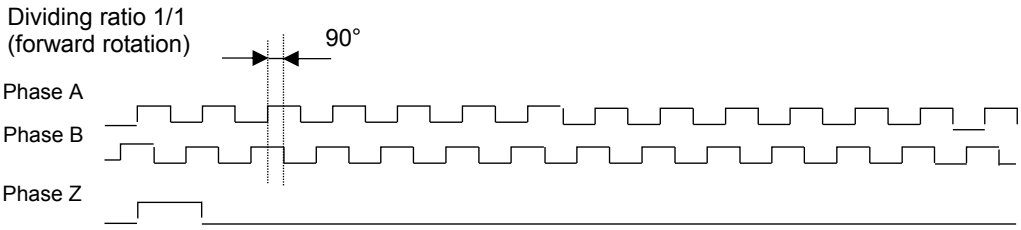
* When "00：Motor_Enc" is selected in the system parameter ID20 "Position loop control, position loop encoder selection", motor encoder side is output regardless with the set value.

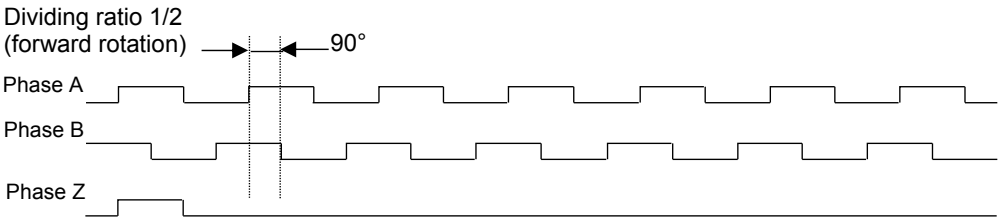
－GroupC－

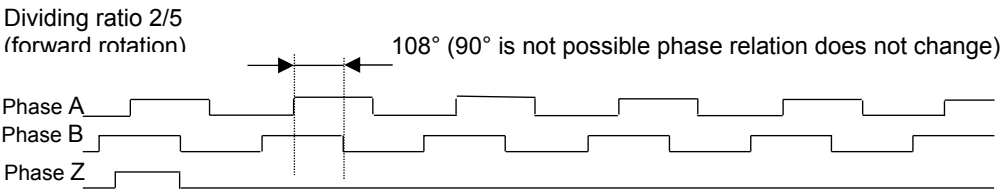
| ID | Contents | | | |
|---|---|---|---|---|
| 04 | Encoder Output Pulse Division [ENRAT] | Setting range | Unit | Default value |
| | | 1/1 to 1/64<br>2/3 to 2/64<br>1/32768 to 32767/32768 | - | 1/1 |

■ Sets ratio of Encoder output pulse division.

- ◆ When the numerator of the dividing ratio is 1, setting range of the denominator is 1 (not divide), 2-64 or 32768.
- ◆ When the numerator of the dividing ratio is 2, setting range of the denominator is 3-64 or 32768.
- ◆ When the denominator of the dividing ratio is 32768, setting range of the numerator is 1-32767.
- ◆ Z phase output is not divided.
- ◆ After Control power ON, for 2s at maximum, the ratio is unstable.




| 05 | Encoder Output Pulse Divide Polarity [PULOUTPOL] | Setting range | Unit | Default value |
|---|---|---|---|---|
| | | 00 to 03 | - | 00:Type1 |

■ Sets division polarity of Encoder output pulse.

| Selection | | Contents |
|---|---|---|
| 00 | Type1 | A Phase Signal/Not Reversed<br>Z Phase Signal Logic/High Active |
| 01 | Type2 | A Phase Signal/Reversed<br>Z Phase Signal Logic/High Active |
| 02 | Type3 | A Phase Signal/Not Reversed<br>Z Phase Signal Logic/Low Active |
| 03 | Type4 | A Phase Signal/Reversed<br>Z Phase Signal Logic/Low Active |

<table>
<tr><th>ID</th><th>Contents</th></tr>
<tr><td>06</td><td>
<table>
<tr><td>Encoder Output Pulse Divide Resolution Selection<br>[PULOUTRES] “Power cycle for control after setting”</td><td>Setting range<br>00 to 01</td><td>Unit<br>-</td><td>Default value<br>00:32768P/R</td></tr>
</table>
■ This parameter is settable only when using absolute encoder.<br>
◆ Sets resolution of Encoder output pulse divide.<br>
◆ Set at 8192P/R to make the Output pulse same as that of RS1 series amplifier unit.<br>
◆ Set at 8192P/R when Output pulse frequency exceeds the specification of the upper controller.<br>
◆ Set at 8192P/R when using servomotor at motor revolution speed of over 4000min$^{-1}$.<br>
◆ Outputs divided pulse by setting resolution to ID04 Encoder output divide.
<table>
<tr><th colspan="2">Selection</th><th>Contents</th></tr>
<tr><td>00</td><td>32768P/R</td><td>32768 Pulse per 1 Motor Rotation</td></tr>
<tr><td>01</td><td>8192P/R</td><td>8192 Pulse per 1 Motor Rotation</td></tr>
</table>
</td></tr>
<tr><td>07</td><td>
<table>
<tr><td>Encoder Signal Output(PS) Format<br>[PSOFORM] “Power cycle for control after setting”</td><td>Setting range<br>00 to 04</td><td>Unit<br>-</td><td>Default value<br>00:MOT_Binary</td></tr>
</table>
■ Sets signal format of Encoder signal output (PS).
<table>
<tr><th colspan="2">Selection</th><th>Contents</th></tr>
<tr><td>00</td><td>MOT_Binary</td><td>Encoder Binary Code Output</td></tr>
<tr><td>01</td><td>MOT_ASCII</td><td>Motor Encoder Decimal ASCII Code Output</td></tr>
<tr><td>02</td><td>MOT_Direct</td><td>Motor Encoder Signal Direct Output</td></tr>
<tr><td>03</td><td>EXT_Binary</td><td>External Encoder Binary Code Output</td></tr>
<tr><td>04</td><td>EXT_Direct</td><td>External Encoder Signal Direct Output</td></tr>
</table>
◆ The dedicated receiving circuit is needed if “02: Mot_Direct” is selected.<br>
◆ “03: EXT_Binary” and “04: EXT_Direct” are able to select when Full-closed control valid.
</td></tr>
<tr><td>08</td><td>
<table>
<tr><td>Encoder Clear Function Selection<br>[ECLRFUNC]</td><td>Setting range<br>00 to 01</td><td>Unit<br>-</td><td>Default value<br>00:Status_MultiTurn</td></tr>
</table>
■ This parameter is settable only when using absolute encoder.<br>
◆ This is effective when using battery backup absolute encoder (encoder code: p) and battery-less absolute encoder.<br>
◆ When using single-turn absolute encoder (encoder code: H) for incremental system, “clear only encoder status” is set even if “00: Status_MultiTurn” is selected.<br>
◆ For the case an absolute encoder with multi turn is used, clearing the encoder cannot clear the single turn part of the absolute encoder.
<table>
<tr><th colspan="2">Selection</th><th>Contents</th></tr>
<tr><td>00</td><td>Status_MultiTurn</td><td>Clear Encoder Status (Alarm and Warning) and Multi Turn Data</td></tr>
<tr><td>01</td><td>Status</td><td>Clear Only Encoder Status (Alarm and Warning)</td></tr>
</table>
</td></tr>
</table>

－GroupC－

<table>
<tr><th>ID</th><th colspan="4">Contents</th></tr>
<tr><td rowspan="2">0B</td><td>External absolute encoder polarity selection<br>[EX-SENPOL] “Power cycle for control after setting”</td><td>Setting range</td><td>Unit</td><td>Default value</td></tr>
<tr><td></td><td>00 to 01</td><td>-</td><td>00:Standard</td></tr>
<tr><td></td><td colspan="4">■ Selects the count polarity of external encoder against motor rotation direction.<br>◆ Select the polarity to match between the increment/decrement of monitor of ID61/62 (EX-APMON) and the ID10/11 (APMON).<br>It becomes valid after control power cycle.<br>◆ It is valid when an absolute encoder is used as external encoder.<br><br><table><tr><th colspan="2">Selection</th><th>Contents</th></tr><tr><td>00</td><td>Standard</td><td>Inverts not an encoder operation direction.</td></tr><tr><td>01</td><td>Reversed</td><td>Inverts an encoder operation direction.</td></tr></table></td></tr>
<tr><td rowspan="2">0C</td><td>External encoder output pulse divide ratio selection<br>[EX-PULDIV] “Power cycle for control after setting”</td><td>Setting range</td><td>Unit</td><td>Default value</td></tr>
<tr><td></td><td>00 to 0B</td><td>-</td><td>00: 1/4(R)_1/4(L)</td></tr>
<tr><td></td><td colspan="4">■ Selects the external encoder output pulse divide ratio when an absolute encoder is used as external encoder.<br>◆ Selects the external encoder output pulse divide ratio (1/N) when EnDat is used to external encoder.<br>◆ When the external encoder is angle encoder or rotary encoder, select from the range of 1/4(R) to 1/8192(R).<br>◆ When the external encoder is linear encoder, select from the range of 1/4(L) to 1/2000(L).<br><br><table><tr><th colspan="2">Selection</th><th>Contents</th></tr><tr><td>00</td><td>1/4(R)_1/4(L)</td><td>Outputs by following calculation according to encoder type.</td></tr><tr><td>01</td><td>1/8(R)_1/20(L)</td><td rowspan="11">For angle encoder or rotary encoder,<br>outputs the pulse as follows:<br>"Single turn resolution" x (1/N).<br>(Use 1/4(R) to 1/8192(R))<br><br>For linear encoder,<br>outputs the pulse as follows:<br>"Resolution" / (1/N).<br>(Use 1/4(L) to 1/2000(L))</td></tr><tr><td>02</td><td>1/16(R)_1/40(L)</td></tr><tr><td>03</td><td>1/32(R)_1/80(L)</td></tr><tr><td>04</td><td>1/64(R)_1/120(L)</td></tr><tr><td>05</td><td>1/128(R)_1/160(L)</td></tr><tr><td>06</td><td>1/256(R)_1/200(L)</td></tr><tr><td>07</td><td>1/512(R)_1/400(L)</td></tr><tr><td>08</td><td>1/1024(R)_1/800(L)</td></tr><tr><td>09</td><td>1/2048(R)_1/1200(L)</td></tr><tr><td>0A</td><td>1/4096(R)_1/1600(L)</td></tr><tr><td>0B</td><td>1/8192(R)_1/2000(L)</td></tr></table><br>* Output is available up to the frequency of 2Mpulse/sec (multiply 1).<br>Select the divide ratio in the range less than the frequency above.<br><br>EnDat (Angle encoder, Rotary encoder)<br>Divide ratio is limited to be 32768 pulse/rev or more when ""Single turn resolution" x (1/N) < 32768 pulse/rev." is established.<br><br>EnDat (Linear encoder)<br>Use in the range as follows: $2^{31}$ x Resolution / ((1/N)x4), based on zero position.<br>(Z-phase output position might shift if a power cycle is performed after moving to out of the range.)</td></tr>
</table>

－GroupC－

<table>
<tr><th>ID</th><th colspan="4">Contents</th></tr>
<tr><td rowspan="3">10</td><td>Broken wire mask level at Encoder connector 1<br>[DE1MSKLVL]</td><td>Setting range</td><td>Unit</td><td>Default value</td></tr>
<tr><td></td><td>0 to 65535</td><td>kHz</td><td>0</td></tr>
<tr><td colspan="4">■ Sets the encoder pulse frequency (1-multiplied) which masks the detection of "Encoder Connector Disconnection 1 (AL.81)" if the motor encoder is incremental type and connect to encoder connector 1 (EN1).<br>◆ For high resolution incremental encoder, "Encoder Connector Disconnection 1 (AL.81)" might detect at high frequency range depending on its specs. In that case, please change this setting value.<br>◆ "Encoder Connector Disconnection 1 (AL.81)" does not detect while encoder frequency exceeds this setting value.<br>◆ "Encoder Connector Disconnection 1 (AL.81)" is detected at all frequency if 0 [kHz] is set.</td></tr>
<tr><td rowspan="3">11</td><td>Broken wire mask level at Encoder connector 2<br>[DE3MSKLVL]</td><td>Setting range</td><td>Unit</td><td>Default value</td></tr>
<tr><td></td><td>0 to 65535</td><td>kHz</td><td>0</td></tr>
<tr><td colspan="4">■ Sets the encoder pulse frequency (1-multiplied) which masks the detection of "Encoder Connector Disconnection 2 (AL.83)" if the encoder is incremental type or external type and connect to encoder connector 2 (EN2).<br>◆ For high resolution incremental encoder, "Encoder Connector Disconnection 2 (AL.83)" might detected at high frequency range depending on its specs. In that case, please change this setting value.<br>◆ "Encoder Connector Disconnection 2 (AL.83)" does not detect while encoder frequency exceeds this setting value.<br>◆ "Encoder Connector Disconnection 2 (AL.83)" is detected at all frequency if 0 [kHz] is set.</td></tr>
</table>

■ GroupD "Supporting function related settings"

<table>
<tr><th>ID</th><th>Contents</th></tr>
<tr><td>00</td><td>
<table>
<tr><td>JOG velocity command<br>[JOGVC]</td><td>Setting range<br>0 to 32767</td><td>Unit<br>min$^{-1}$</td><td>Default value<br>50</td></tr>
</table>
■ Sets the velocity command value for JOG operation.<br>◆ This value will be initial setting value of JOG velocity command in the Setup software.
</td></tr>
<tr><td>02</td><td>
<table>
<tr><td>Support function torque limit<br>[TSTTCLM]</td><td>Setting range<br>10.0 to 500.0</td><td>Unit<br>%</td><td>Default value<br>120.0</td></tr>
</table>
■ Sets the limit value of torque command at the support function (JOG, positioning and homing) operation.<br>◆ This value will be initial setting value of torque command limit for the support function operation in the Setup software.
</td></tr>
<tr><td>10</td><td>
<table>
<tr><td>Serial Communication Axis Number<br>[COMAXIS] “Power cycle for control after setting”</td><td>Setting range<br>01 to 0F</td><td>Unit<br>-</td><td>Default value<br>01:#1</td></tr>
</table>
■ Selects axis number when communicating with the setup software.<br>◆ Please set different number for each axis when multi axes are connecting at once because the setup software identifies amplifier unit by this number.
<table>
<tr><th colspan="2">Selection</th><th colspan="2">Selection</th><th colspan="2">Selection</th><th colspan="2">Selection</th><th colspan="2">Selection</th></tr>
<tr><td>01</td><td>#1</td><td>04</td><td>#4</td><td>07</td><td>#7</td><td>0A</td><td>#A</td><td>0D</td><td>#D</td></tr>
<tr><td>02</td><td>#2</td><td>05</td><td>#5</td><td>08</td><td>#8</td><td>0B</td><td>#B</td><td>0E</td><td>#E</td></tr>
<tr><td>03</td><td>#3</td><td>06</td><td>#6</td><td>09</td><td>#9</td><td>0C</td><td>#C</td><td>0F</td><td>#F</td></tr>
</table>
</td></tr>
<tr><td>11</td><td>
<table>
<tr><td>Monitor Display Selection<br>[MONDISP]</td><td>Setting range<br>00 to 77</td><td>Unit<br>-</td><td>Default value<br>00:STATUS</td></tr>
</table>
■ Selects the contents of status display of the digital operator.
<table>
<tr><th colspan="2">Selection</th><th>Contents</th></tr>
<tr><td>00</td><td>STATUS</td><td>Shows the status of amplifier unit.<br>See "5.3 Amplifier unit status display" for details.</td></tr>
<tr><td>01<br>to<br>77</td><td>WARNING1<br>to<br>HBLF</td><td>Selects the monitor data showing at monitor function.<br>See "5.5 Monitor function" for details.</td></tr>
</table>
</td></tr>
</table>

## ID 20

Drec. sampling rate [SAMPDIV]

| Setting range | Unit | Default value |
|---|---|---|
| 0 to 65535 | - | 20 |

■ Sets the sampling rate of the Drive recorder.
- ◆ Minimum sampling rate (Ts) is fixed to 112 µs.
- ◆ Sampling timing (T) is shown by T=Ts*n, and this parameter sets "n".
- ◆ Drive recorder will stop if 0 is set.

## ID 21

Drec. sampling mode [SAMPNUM]

| Setting range | Unit | Default value |
|---|---|---|
| 00 to 02 | - | 00:256point |

■ Selects total data points per channel that will record by the Drive recorder.
- ◆ Recordable channel numbers will limit if larger data point is selected.

| Selection | | Maximum recordable channel at once |
|---|---|---|
| 00 | 256point | 6 channels |
| 01 | 512point | 3 channels |
| 02 | 1024point | 1 channel |

## ID 22

Drec. Trigger Channel [TRGCHSEL]

| Setting range | Unit | Default value |
|---|---|---|
| 00 to 83 | - | 83:DIGITAL_4 |

■ Selects the channel for trigger on the Drive recorder.
- ◆ Digital ch. and analog ch. can set.

| Selection | | Setting value | Selection | | Setting value |
|---|---|---|---|---|---|
| 00 | ANALOG_1 | Analog CH1 | 05 | ANALOG_6 | Analog CH6 |
| 01 | ANALOG_2 | Analog CH2 | 80 | DIGITAL_1 | Digital CH1 |
| 02 | ANALOG_3 | Analog CH3 | 81 | DIGITAL_2 | Digital CH2 |
| 03 | ANALOG_4 | Analog CH4 | 82 | DIGITAL_3 | Digital CH3 |
| 04 | ANALOG_5 | Analog CH5 | 83 | DIGITAL_4 | Digital CH4 |

## ID 23

Drec. Trigger Slope [TRGEDGSEL]

| Setting range | Unit | Default value |
|---|---|---|
| 00 to 02 | - | 00:POS_EDGE |

■ Sets the trigger edge condition on the Drive recorder.

| Selection | | Setting value |
|---|---|---|
| 00 | POS_EDGE | ↑ edge |
| 01 | NEG_EDGE | ↓ edge |
| 02 | BOTH_EDGE | ↑ edge or ↓ edge |

## ID 24

Drec. Trigger Horizontal Position [TRGHPOS]

| Setting range | Unit | Default value |
|---|---|---|
| 0 to 100 | % | 80 |

■ Sets the horizontal position of trigger on the Drive recorder.
- ◆ Set the rate of the total sampling time and the trigger position from sampling start by [0 -100%].

## ID 25

Drec. Trigger Level [TRGLVL]

| Setting range | Unit | Default value |
|---|---|---|
| -9223372036854775808 to 9223372036854775807 | - | 1 |

■ Set the trigger level on the Drive recorder.
- ◆ Shows by hexadecimal (32 bit data) at ID25 and ID26 of the Digital operator.

| ID | Data range | Display range |
|---|---|---|
| 25 | Bit63 to Bit32 | H.8000 L.0000 to H.7FFF L.FFFF |
| 26 | Bit31 to Bit0 | H.0000 L.0000 to H.FFFF L.FFFF |

－GroupD－

| ID | Contents | | | |
|---|---|---|---|---|
| 31 | Drec. Analog CH1 selection [CH1SEL] | Setting range | Unit | Default value |
| | | 00 to 23 FF | - | 08:PCMDF1 |
| 32 | Drec. Analog CH2 selection [CH2SEL] | Setting range | Unit | Default value |
| | | 00 to 23 FF | - | 01:VCMON |
| 33 | Drec. Analog CH3 selection [CH3SEL] | Setting range | Unit | Default value |
| | | 00 to 23 FF | - | 03:TCMON |
| 34 | Drec. Analog CH4 selection [CH4SEL] | Setting range | Unit | Default value |
| | | 00 to 23 FF | - | 15:VBUS |
| 35 | Drec. Analog CH5 selection [CH5SEL] | Setting range | Unit | Default value |
| | | 00 to 23 FF | - | 05:POSITION |
| 36 | Drec. Analog CH6 selection [CH6SEL] | Setting range | Unit | Default value |
| | | 00 to 23 FF | - | 00:VMON |

■ Selects the data which is measured as Analog channel on the Drive recorder.

◆ The datas below will need 2 ch data capacity when it set.

- Present position monitor (Motor encoder/ External encoder)
- Command position monitor
- PS data monitor (Motor encoder/ External encoder)

* For example, ch.2 setting will invalid if encoder PS data is set to ch.1.
Above channels will be invalid if sampling point: 1024 is selected.

◆ Do not set FF because it is for Manufacturer only.

| ID | | Setting value | ID | | Setting value |
|---|---|---|---|---|---|
| 00 | VMON | Velocity monitor | 0F | JRAT | Load Inertia Moment Ratio monitor |
| 01 | VCMON | Velocity command monitor | 10 | MTL-EST | Load Torque monitor (Estimate value) |
| 02 | TMON | Torque monitor | 11 | SINEU | U-phase electric angle monitor |
| 03 | TCMON | Torque command monitor | 12 | DFERR | Dual position error monitor |
| 04 | PMON | Position deviation monitor | 13 | ACCMON | Acceleration monitor |
| 05 | POSITION | Present position monitor (Motor encoder) | 14 | ENTEMP | Encoder temperature monitor |
| 06 | POSITION-EXT | Present position monitor (External encoder) | 15 | VBUS | Main circuit bus voltage monitor |
| 07 | PCMDSUM | Command position integration value | 16 | OLRAT | Reaching rate of OL detection level of motor temperature rise estimation value |
| 08 | PCMDF1 | Position command pulse frequency monitor 1 | 17 | MAVEPOW1 | Average power monitor |
| 09 | PCMDF2 | Position command pulse frequency monitor 2 | 18 | TCMON2 | Torque command filter (before filter) |
| 0A | PS_MOT | Absolute encoder PS data monitor (Motor encoder) | 19 | SYNERR | Axes-sync error monitor |
| 0B | PS_EXT | External absolute encoder PS data monitor | 21 | RegPOW | Regenerative power monitor |
| 0C | RegR | Regenerative resistor operation percentage monitor | 22 | MOTE-ERRAT | Error rate of motor encoder communication |
| 0D | TRMS | Effective torque monitor | 23 | EXTE-ERRAT | Error rate of external encoder communication |
| 0E | ETRMS | Effective torque monitor (Estimated value) | FF | RESERVE | Monitor mode, for manufacturer only |

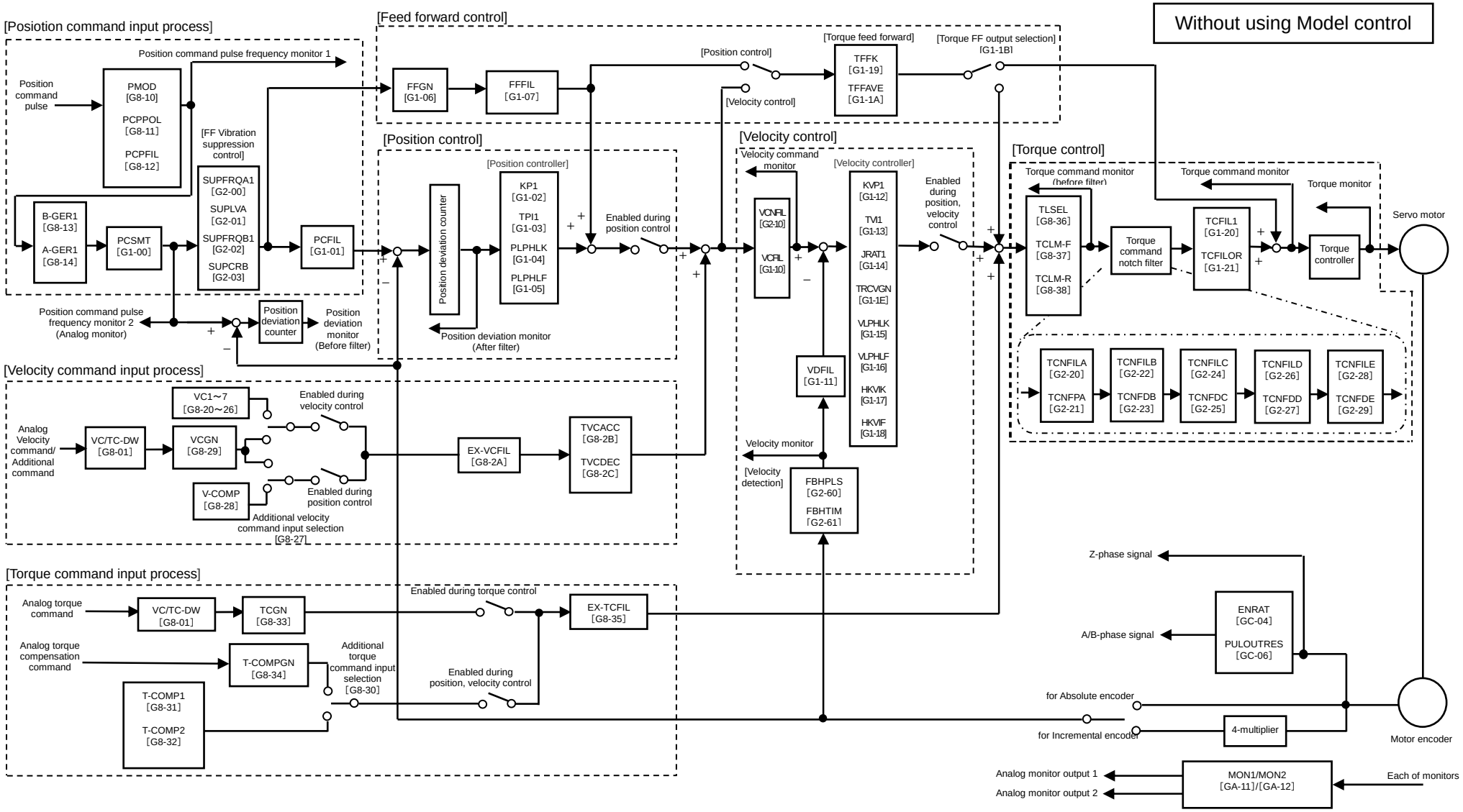
| ID | Contents | | | |
|---|---|---|---|---|
| 37 | Drec. Digital CH1 selection [DCH1SEL] | Setting range | Unit | Default value |
| | | 00 to 20, FF | - | 16:SRDY |
| 38 | Drec. Digital CH2 selection [DCH2SEL] | Setting range | Unit | Default value |
| | | 00 to 20, FF | - | 15:SACT |
| 39 | Drec. Digital CH3 selection [DCH3SEL] | Setting range | Unit | Default value |
| | | 00 to 20, FF | - | 1B:WRG-OL |
| 3A | Drec. Digital CH4 selection [DCH4SEL] | Setting range | Unit | Default value |
| | | 00 to 20, FF | - | 1C:ALM |

■ Selects the data which is measured as Digital channel on the Drive recorder.

◆ Do not set FF because it is for Manufacturer only.

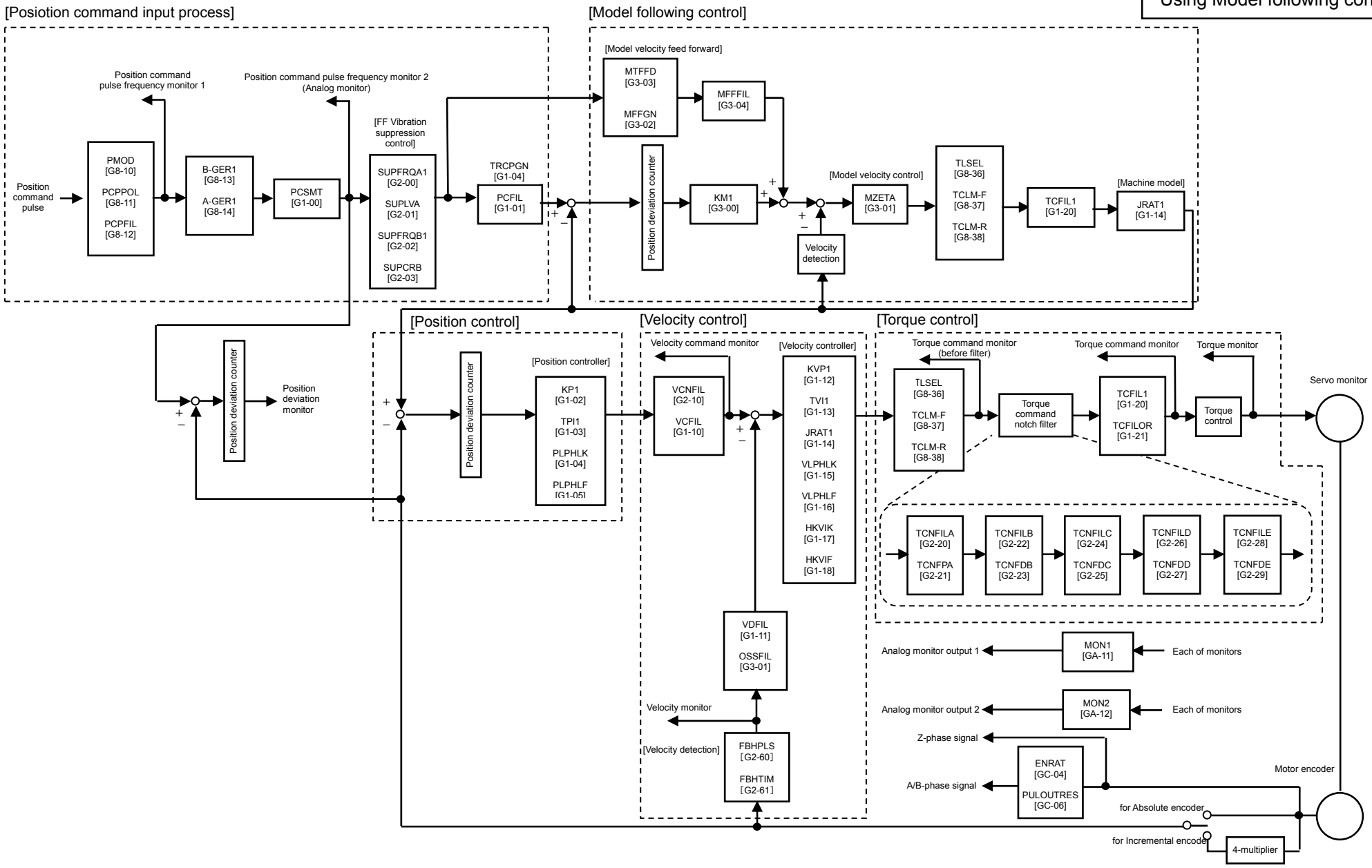
| ID | | Setting value | ID | | Setting value |
|---|---|---|---|---|---|
| 00 | GIN1 | General input 1 | 10 | INP | While In-Position Status |
| 01 | GIN2 | General input 2 | 11 | NEAR | While Near Range Status |
| 02 | GIN3 | General input 3 | 12 | VCMP | While Speed Matching Status |
| 03 | GIN4 | General input 4 | 13 | TLIM | While Torque Limiting |
| 04 | GIN5 | General input 5 | 14 | VLIM | While Velocity Limiting |
| 05 | GIN6 | General input 6 | 15 | SACT | While Motor Excitation |
| 06 | GIN7 | General input 7 | 16 | SRDY | While Servo Ready Status |
| 07 | GIN8 | General input 8 | 17 | CMD-ACK | While Command Acceptance Permission Status |
| 08 | GOUT1 | General output 1 | 18 | PCON-ACK | While Velocity Loop Proportional Control Switching Status |
| 09 | GOUT2 | General output 2 | 19 | GC-ACK | While Electronic Gear Switching Status |
| 0A | GOUT3 | General output 3 | 1A | WRG-OVF | While Excessive Deviation Warning Status |
| 0B | GOUT4 | General output 4 | 1B | WRG-OL | While Overload Warning Status |
| 0C | GOUT5 | General output 5 | 1C | ALM | While Alarm Status |
| 0D | GOUT6 | General output 6 | 1D | WRG-DF | While dual position error excess warning |
| 0E | GOUT7 | General output 7 | 1E | TRJCMP | While position command distribution completion status (Delay time included) |
| 0F | GOUT8 | General output 8 | 20 | WRG-SY | While Axes-sync Error Excess Warning |
| | | | FF | RESERVE | Monitor mode, for manufacturer only |

## 5.9 Control block diagram

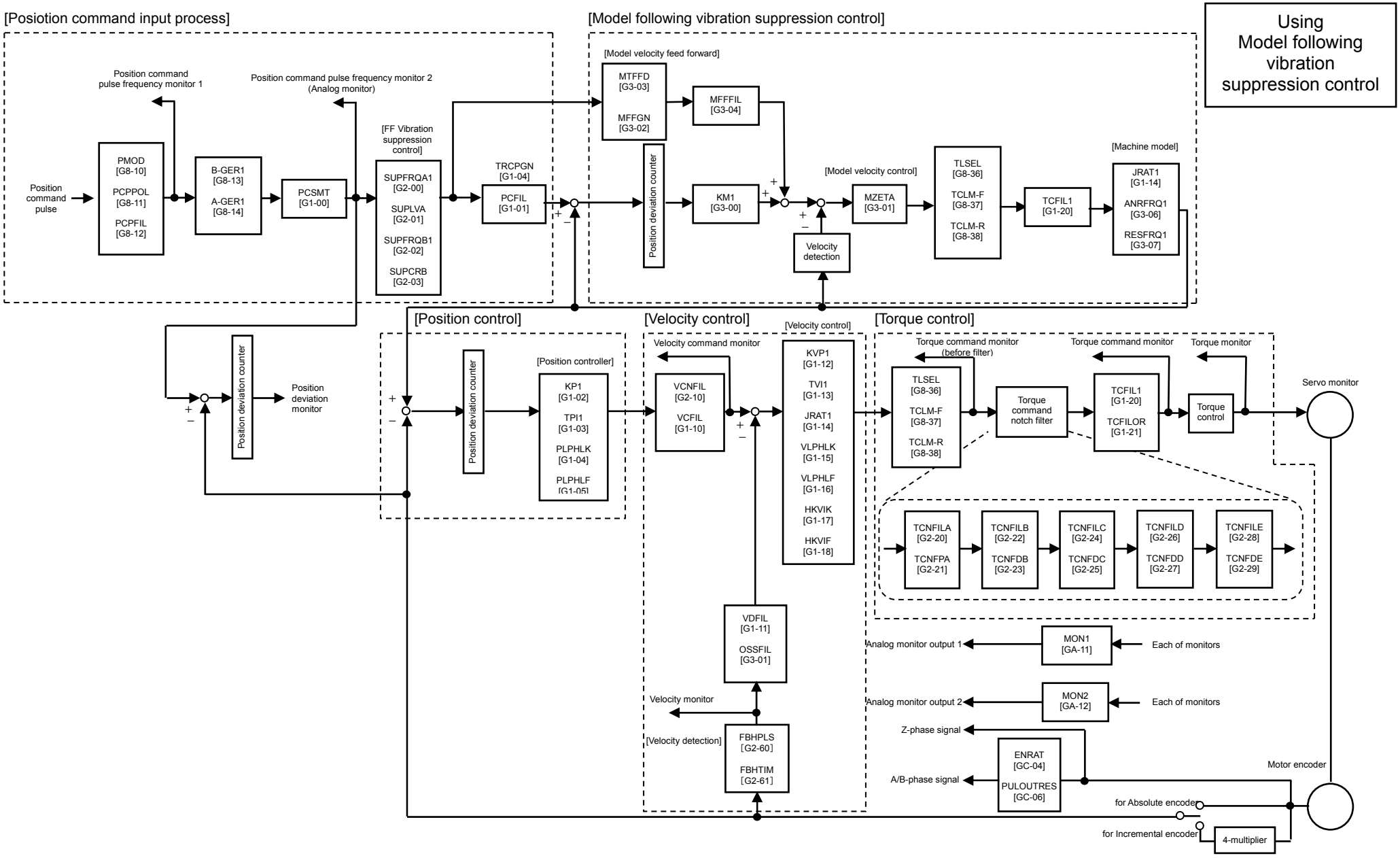


# 5.9 Control block diagram

Using Model following control



# 5. Operation


[Posiotion command input process]
[Model following vibration suppression control]
Using Model following vibration suppression control
Position command pulse frequency monitor 1
Position command pulse frequency monitor 2 (Analog monitor)
[FF Vibration suppression control]
[Model velocity feed forward]
Position command pulse
PMOD [G8-10]
PCPPOL [G8-11]
PCPFIL [G8-12]
B-GER1 [G8-13]
A-GER1 [G8-14]
PCSMT [G1-00]
SUPFRQA1 [G2-00]
SUPLVA [G2-01]
SUPFRQB1 [G2-02]
SUPCRB [G2-03]
TRCPGN [G1-04]
PCFIL [G1-01]
MTFFD [G3-03]
MFFGN [G3-02]
MFFFIL [G3-04]
Position deviation counter
KM1 [G3-00]
[Model velocity control]
MZETA [G3-01]
Velocity detection
TLSEL [G8-36]
TCLM-F [G8-37]
TCLM-R [G8-38]
TCFIL1 [G1-20]
[Machine model]
JRAT1 [G1-14]
ANRFRQ1 [G3-06]
RESFRQ1 [G3-07]
[Position control]
[Velocity control]
[Torque control]
Position deviation counter
Position deviation monitor
[Position controller]
KP1 [G1-02]
TPI1 [G1-03]
PLPHLK [G1-04]
PLPHLF [G1-05]
Velocity command monitor
VCNFIL [G2-10]
VCFIL [G1-10]
[Velocity control]
KVP1 [G1-12]
TVI1 [G1-13]
JRAT1 [G1-14]
VLPHLK [G1-15]
VLPHLF [G1-16]
HKVIK [G1-17]
HKVIF [G1-18]
VDFIL [G1-11]
OSSFIL [G3-01]
Velocity monitor
[Velocity detection]
FBHPLS [G2-60]
FBHTIM [G2-61]
Torque command monitor (before filter)
Torque command monitor
Torque monitor
TLSEL [G8-36]
TCLM-F [G8-37]
TCLM-R [G8-38]
Torque command notch filter
TCFIL1 [G1-20]
TCFILOR [G1-21]
Torque control
Servo monitor
TCNFILA [G2-20]
TCNFPA [G2-21]
TCNFILB [G2-22]
TCNFDB [G2-23]
TCNFILC [G2-24]
TCNFDC [G2-25]
TCNFILD [G2-26]
TCNFDD [G2-27]
TCNFILE [G2-28]
TCNFDE [G2-29]
Analog monitor output 1
MON1 [GA-11]
Each of monitors
Analog monitor output 2
MON2 [GA-12]
Each of monitors
Z-phase signal
A/B-phase signal
ENRAT [GC-04]
PULOUTRES [GC-06]
Motor encoder
for Absolute encoder
for Incremental encoder
4-multiplier

# 5.10 Virtual motor operation function

This is the function which simulates servo motor behavior and amplifier unit status at internal of the amplifier unit. This function is able to check a sequence with output signal and check a wiring with upper controller, without actual motor operation. Thus, safer and faster start-up of a system is available by this function.
As note, servo motor and encoder connection is not necessary for this function use.

## 5.10.1 Setting

Sets the system parameter below for this function use.

<table>
<tr><th>ID</th><th>Contents</th></tr>
<tr><td>02</td><td>
Operation mode selection<br>
■ Selects the operation mode.
<table>
<tr><th colspan="2">Selection</th><th>Contents</th></tr>
<tr><td>00</td><td>Normal</td><td>Normal operation mode</td></tr>
<tr><td>01</td><td>Virtual1</td><td>Virtual operation mode (virtual P_ON valid)</td></tr>
<tr><td>02</td><td>Virtual2</td><td>Virtual operation mode (virtual P_ON invalid)</td></tr>
</table>
* “Power cycle for control after setting”<br><br>
■ Operation mode action<br><br>
◆ 01：Virtual1 Virtual operation mode (virtual P_ON valid)<br>
In this mode, servo motor operation can simulate by control power supply only.<br>
Automatically change state to main power ON, after control power supplied.<br><br>
◆ 02：Virtual2 Virtual operation mode (virtual P_ON invalid)<br>
In this mode, servo motor operation can simulate after main circuit power supplied.<br>
Main circuit power supply is necessary, after control power supplied.
</td></tr>
</table>

## 5.10.2 Restrictions

There are restrictions below for this function.

■ Load model for virtual motor operation is rigid body sysytem by load inertia moment.

| Item | Conditions |
|---|---|
| Load torque | 0 [N・m] |
| Load inertia moment | Load inertia moment ratio × Servo motor inertia moment |
| Mechanical stiffness | Rigid body |

* Load inertia moment ratio is used from Group1 ID14.
The value set by the parameter below is used depending on gain switching condition if gain switching function is used.

| Selection | Used Load inertia moment ratio | | |
|---|---|---|---|
| | Group | ID | Name |
| 1 | 1 | 14 | Load inertia moment ratio 1 |
| 2 | 4 | 05 | Load inertia moment ratio 2 |
| 3 | 4 | 15 | Load inertia moment ratio 3 |
| 4 | 4 | 25 | Load inertia moment ratio 4 |

■ Encoder position data does not backuped. Position data is zero when power is on.

■ Multi-turn part of encoder position data does not clear even if encoder clear function is executed.

■ Detection of alarm and warning for encoder does not work.

■ In use of incremental encoder, output pulse resolution from amplifier unit will be 8192 [P/R] regardless of the encoder resolution setting.
Dividing is available for this resolution by the setting of GroupC ID04 Encoder Output Pulse Division.

■ U-phase electric angle monitor might show wrong value if incremental encoder is used.

■ Position, velocity and torque of servo motor is simulated to response of control system against virtual motor operation load model.

■ Action of servo motor and load model is stop at servo OFF. Free-run operation at servo OFF can not simulate.

■ When "01: Virtual" is set to Operation mode selection, main circuit power is supplied virtually, and regard as supplying rated power. As note, Alarm and regenerative operation for main power can not simulate.

■ Dynamic brake does not work. Stop operation by servo OFF or dynamic brake of emergency stop can not simulate. However, the signal of While Dynamic Braking is output from general purpose output.

■ When external encoder is absolute encoder (EnDat), it works as angle encoder (resolution 28bit).

## 5.10.3 Digital operator display

Digital operator display will change during virtual motor operation.

| Display | Description |
|---|---|
| | Alphabet "t" shows at second LED from right, during virtual motor operation.<br>The other LEDs show same as normal status display.<br>In case except status display mode, also the same as normal. |

## 5.10.4 Operating precautions

■ Holding-brake release signal outputs same as normal operation even if virtual motor operation is executed. At vertical axis use, avoid holding-brake release as follows: Cancel the allocation of holding-brake release signal for general output. Shut off the holding-brake power. etc.

No Text on This Page.

# 6

# Servo Tuning

In this chapter, tuning of servo amplifier are explained.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# 6. Servo Tuning

## 6.1 Servo tuning functions and basic adjustment procedure

To operate the servo motor (and machine) using amplifier unit, adjustments of the servo gain and its control system is necessary. Generally, the higher setting value of the servo gain increases the machine response. However, if the servo gain is too high, in a lower rigidity machine, vibration may result and the machine response will not increase. The servo gain and its control system need to be appropriately adjusted according to the operating servo motor and the mechanical system, and this adjustment method is called Servo tuning.
Following is an explanation of the Servo tuning procedure:

### 6.1.1 Servo tuning functions

■ Adaptive notch filter function
Realizing vibration suppression operation of machine vibration by estimating resonant frequency of machine system during servo motor operation and making feedback it to the control system.

■ Automatic Tuning function
- ◆ Automatic Tuning
  Amplifier unit estimates load inertia moment ratio during operation, and then automatically adjusts servo gain and filter frequency on a real-time basis. This is the most basic tuning method.

- ◆ Automatic Tuning [JRAT Manual Setting]
  The servo amplifier does not estimate the Load inertia moment ratio. Servo gain and filter frequency are adjusted automatically corresponding to the load inertia moment ratio and the responses that are already set. This method is used when the Load inertia moment ratio could not be estimated correctly with auto-tuning.

■ Manual Tuning
Set all parameters, such as Load inertia moment ratio, servo gain, filter frequency, etc. manually. This method is used when characteristics during auto-tuning are insufficient.

■ The function of making servo gain higher
- ◆ Velocity loop phase lead compensation
  This is the function which compensate phase delay of velocity control system, to get higher velocity loop proportional gain.

- ◆ Position loop phase lead compensation
  This is the function which compensate phase delay of position control system, to get higher position loop proportional gain.

- ◆ Torque feed forward compensation
  This is the function which improve response for the command of control system by applying feed forward compensation to torque control system.

■ Model following control
Model following control is a control method that ensures a higher response by composing a model control system including the mechanical system in amplifier unit to operate the actual servo motor in order to follow the model control system.

■ Auto notch filter tuning function
Notch filter is able to suppress high frequency resonance depends on a mechanical system coupling or stiffness. "Auto notch filter tuning" is able to search mechanical system resonant frequency easily by rotating servo motor in a short time.

# 6.1 Servo tuning functions and basic adjustment procedure

■ Vibration suppression function

◆ Model-following vibration suppression
Positioning settle time and response of machine are able to improve by using model control system to suppress machine stand vibration.

◆ Auto FF Vibration Suppression Frequency Tuning, FF vibration suppression control
FF Vibration Suppression control is able to suppress low frequency resonance like machine end vibration. "Auto FF Vibration Suppression Frequency Tuning" is able to set FF Vibration Suppression Frequency easily by rotating servo motor in a short time.

◆ CP vibration suppression control
This function is suppressing machine stand vibration though at the CP (Continuous Path) control like cutting work of machine tool.

◆ Minor vibration suppression
This function is suppressing minor vibration against velocity feedback during servo motor stop.

■ Disturbance impact suppression function

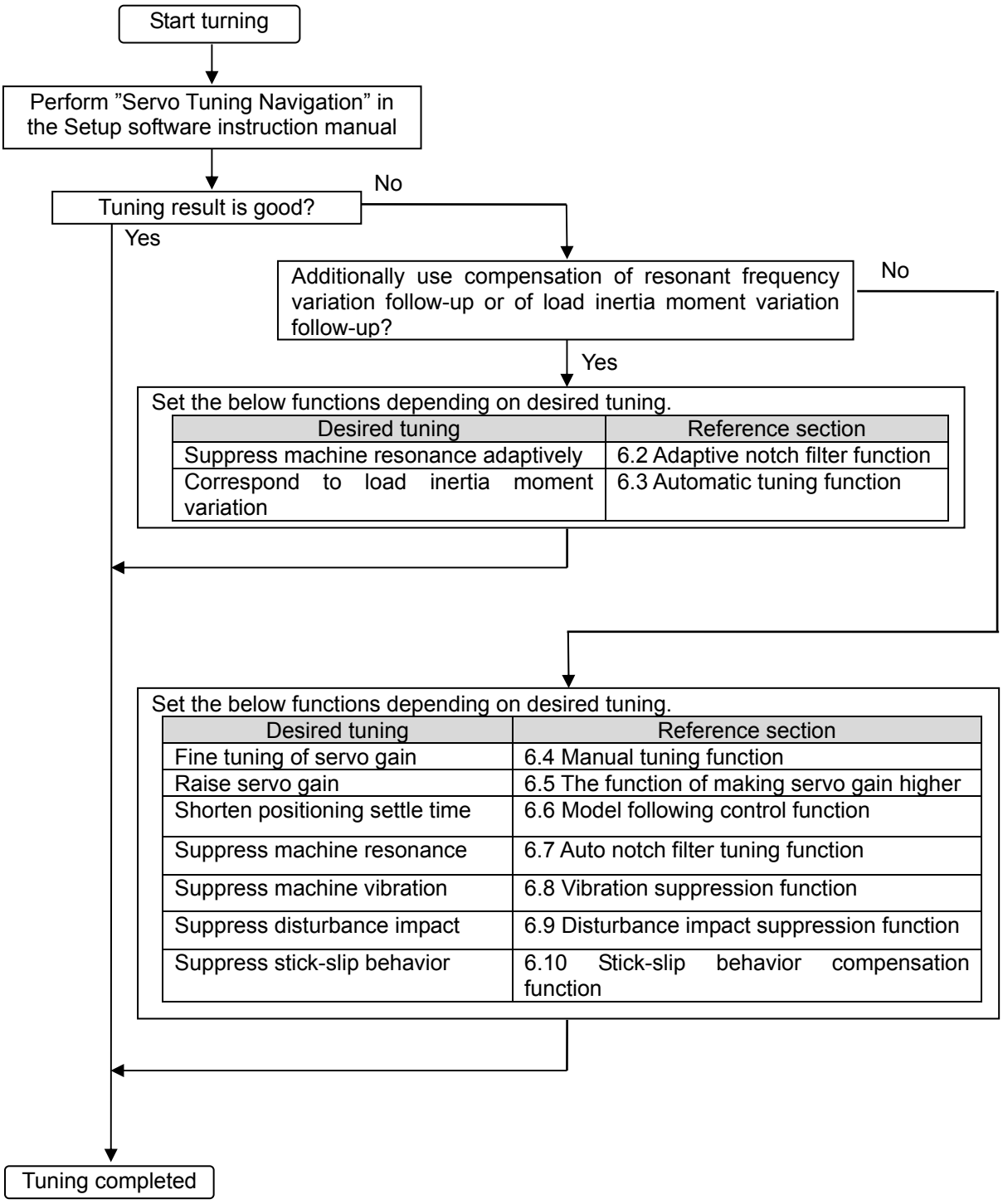
◆ High order integral control
Uses when desired to suppress disturbance impact into control system, by decreasing the velocity loop integral time constant. This function compensates phase delay against feedback of velocity integral control system.

◆ Disturbance observer function
This function is suppressing impact of load torque by estimating the load torque at amplifier unit internally and adding compensation against load torque to a torque command, if external load torque is applied to a servo motor.

■ Stick-slip behavior compensation function
This function is suppressing stick-slip behavior occurring by machine system friction etc.

## 6.1.2 Tuning method selection procedure

The selection procedure is displayed in the following chart:




* Combinations of some functions are not allowed.

## 6.2 Adaptive notch filter function

Vibration suppression operation which adapt to frequency variation of mechanical vibration is realized by estimating mechanical resonant frequency in motor operation and reflecting to the control system.
It can suppress dispersion and variation of mechanical resonance frequency.

■ How to use

- ◆ Check a resonant frequency of mechanical system. (For use of the system analysis, see "10.3 System analysis" in setup software instruction manual: M0010842.)
- ◆ Set the value which have margin and consider dispersion and variation of mechanical resonance frequency from system analysis result, into "Adaptive notch filter frequency upper limit E", "Adaptive notch filter frequency lower limit E", Group0 ID35, 36. Adaptive notch filter will work between upper/lower limit which set.
- ◆ This function will be valid when "01_Adp_Filter_Enable" is set to "Group0 ID34: Adaptive notch filter function E [ADNFE]".
- ◆ Adaptive notch filter starts a operation with getting the value of "Group2 ID28: Torque Command Notch Filter E [TCNFILE]" as the initial value.
- ◆ Tuning result of Adaptive notch filter is saved to "Torque Command Notch Filter E [TCNFILE]" every 30 minutes automatically.
- ◆ Set "01_No_Saving" to "Group0 ID37: Adaptive notch filter E auto saving [ADNSVE]" if auto-save is not desired.

* This function is not able to estimate resonant frequency at below conditions.
(Corrective action: Adaptive notch filter is not able to use, so use notch filter with fixed value.)

- ◆ Resonance frequency is 3 times or less of “velocity loop proportional gain [KVP]".
- ◆ Resonance amplitude is small, or there is no impact of resonance to motor speed caused by low “velocity loop proportional gain [KVP]".
- ◆ Mechanical system has multiple resonance frequency.
- ◆ Position command resolution is low.
(Corrective action: Set "Group1 ID00: Position Command Smoothing Constant [PCSMT]".)

* This function cannot use with the tandem operation.

# 6. Servo Tuning

## 6.3 Auto-tuning function

### 6.3.1 Selection of tuning method

■ Parameter list
Using parameters below for auto-tuning mode.

◆ Tuning mode

| Group | ID | Selection | | Contents |
|---|---|---|---|---|
| 0 | 00 | 00 | AutoTun | Auto-tuning |
| | | 01 | AutoTun_JRAT-Fix | Auto-tuning [JRAT manual setting ] |
| | | 02 | ManualTun | Manual Tuning |

◆ Auto-Tuning characteristic

| Group | ID | Selection | | Contents |
|---|---|---|---|---|
| 0 | 01 | 00 | Positioning1 | Positioning Control 1 (General Purpose) |
| | | 01 | Positioning2 | Positioning Control 2 (High Response) |
| | | 02 | Positioning3 | Positioning Control 3 (High Response, FFGN Manual Setting) |
| | | 03 | Positioning4 | Positioning Control 4 (High Response, Horizontal Axis Limited) |
| | | 04 | Positioning5 | Positioning Control 5 (High Response, Horizontal Axis Limited, FFGN Manual Setting) |
| | | 05 | Trajectory1 | Trajectory Control 1 |
| | | 06 | Trajectory2 | Trajectory Control 2 (KP, FFGN Manual Setting) |

◆ Auto-Tuning Response

| Group | ID | Setting range | Unit |
|---|---|---|---|
| 0 | 02 | 1 to 40 | – |

◆ Auto-Tuning Automatic Parameter Saving

| Group | ID | Selection | | Contents |
|---|---|---|---|---|
| 0 | 03 | 00 | Auto_Saving | Automatically Saves in JRAT1 |
| | | 01 | No_Saving | Automatic Saving is Invalid |

◆ Auto-Tuning characteristic compatible mode

| Group | ID | Selection | | Contents |
|---|---|---|---|---|
| 0 | 04 | 00 | Disable | Invalid |
| | | 01 | Enable | Valid (RS2 Compatible) |

■ Explanation for each parameter
Details of each parameter are shown below.

◆ General Parameter Group0 Auto-Tuning

| ID | Contents |
|---|---|
| 00 | Tuning Mode [TUNMODE] |

| Selection | Contents |
|---|---|
| 00: AutoTun | Auto-Tuning |

- ◆ Amplifier unit estimates Load inertia moment ratio of the machine or equipment during real time and automatically tunes the servo gain.
- ◆ Parameters which is tuned automatically by amplifier unit, is vary depends on selection of Group0 ID00 "Auto-Tuning Characteristic [ATCHA]".
- ◆ Amplifier unit estimates the Load inertia moment ratio at the time of acceleration/deceleration. Therefore, for operations only with excessively long acceleration/deceleration time constants or with only low torque in low velocity, this mode cannot be used. Also, for operations with high disturbance torque or with major mechanical clearance, this mode cannot be used. Use in [01:_AutoTun_JRAT-Fix Automatic Tuning [JRAT Manual Setting].

| Selection | Contents |
|---|---|
| 01: AutoTun_JRAT-Fix | Auto-Tuning [JRAT manual setting ] |

- ◆ Based on Group1 ID14 "Load inertia moment ratio 1 [JRAT1], which has to be set, the amplifier unit automatically tunes to the best servo gain.
- ◆ Parameters for the amplifier unit to automatically tune will vary depending on "Auto-Tuning characteristic [ATCHA]".

| Selection | Contents |
|---|---|
| 02: ManualTun | Manual Tuning |

- ◆ This mode is used in order to adjust the servo gain to the machine or equipment to ensure maximum response as well as when characteristics in auto-tuning are insufficient.

| ID | Contents |
|---|---|
| 01 | Auto-Tuning Characteristic [ATCHA] |

■ Auto-Tuning Characteristic to fit the mechanical requirements and movements are provided. Parameters that can be adjusted vary depending on each auto-tuning characteristic. Select the parameters based on the situation.

■ [Positioning control (Positioning)]
Positioning control is a control method used to reach the servo motor quickly to target a position from the present position by disregarding the trajectory between the positions. Select this mode when positioning PTP (point to point) is necessary.

■ [Trajectory control (Trajectory)]
Trajectory control is a method used to move the servo motor to the target position from the present position while considering the trajectory between the positions. Select this mode when the Position command corresponding trajectory control is needed such as in processing work.

| Selection | | Contents |
|---|---|---|
| 00 | Positioning1 | Positioning Control 1 (General Purpose) |

◆ Select for general positioning purposes.
◆ Parameters shown in table at section 6.3.2 cannot be adjusted manually.

| Selection | | Contents |
|---|---|---|
| 01 | Positioning2 | Positioning Control 2 (High Response) |

◆ Select for high response positioning.
◆ Parameters shown in table at section 6.3.2 cannot be adjusted manually.

| Selection | | Contents |
|---|---|---|
| 02 | Positioning3 | Positioning control 3<br>(High Response, FFGN Manual Setting) |

◆ Select this mode to adjust Group1 ID06 "Velocity Feed Forward Gain [FFGN]" manually.
◆ The following parameter is able to adjust manually, if not use model following (vibration suppression) control:

| Group | ID | Symbol | Contents |
|---|---|---|---|
| 1 | 06 | FFGN | Velocity Feed Forward Gain |

◆ The following parameter is able to adjust manually, if using model following (vibration suppression) control:

| Group | ID | Symbol | Contents |
|---|---|---|---|
| 3 | 02 | MFFGN | Model velocity feed forward gain |

| Selection | | Contents |
|---|---|---|
| 03 | Positioning4 | Positioning control 4<br>(High Response, Horizontal Axis Limited) |

◆ Select this mode when the machine movement is on a horizontal axis and receives no disturbing influence from external sources.
◆ Positioning time may be shortened compared to “Positioning Control 2”.
◆ Parameters shown in table at section 6.3.2 cannot be adjusted manually.

| ID | Contents |
|---|---|
| 01 | Auto-Tuning Characteristic [ATCHA] |

| Selection | | Contents |
|---|---|---|
| 04 | Positioning5 | Positioning control 5 (for high response, horizontal axis only, FFGN manual setting) |

- Select this mode when the machine movement is on a horizontal axis and receives no disturbing influence from external sources and when you want to adjust Group1 id06 "Velocity Feed Forward Gain [FFGN]" manually.
- Positioning time may be shortened compared to “Positioning control 3”.
- The following parameter is able to adjust manually, if not use model following (vibration suppression) control:

| Group | ID | Symbol | Contents |
|---|---|---|---|
| 1 | 06 | FFGN | Velocity Feed Forward Gain |

- The following parameter is able to adjust manually, if using model following (vibration suppression) control:

| Group | ID | Symbol | Contents |
|---|---|---|---|
| 3 | 02 | MFFGN | Model velocity feed forward gain |

| Selection | | Contents |
|---|---|---|
| 05 | Trajectory1 | Trajectory Control 1 |

- Select this mode for single axis use. The response of each axis can be different.
- Parameters shown in table 6.3.2 cannot be adjusted manually.

| Selection | | Contents |
|---|---|---|
| 06 | Trajectory2 | Trajectory Control 2 (KP, FFGN Manual Setting) |

- Select this mode when you need equal responses from multiple axes, respectively. Adjust Group1 ID02 "Position Loop Proportional Gain 1 [KP1]”, Group1 ID06 “Velocity Feed Forward Gain [FFGN]".
- The following parameter is able to adjust manually, if not use model following (vibration suppression) control:

| Group | ID | Symbol | Contents |
|---|---|---|---|
| 1 | 02 | KP1 | Position Loop Proportional Gain 1 |
| 1 | 06 | FFGN | Velocity Feed Forward Gain |

- The following parameter is able to adjust manually, if using model following (vibration suppression) control:

| Group | ID | Symbol | Contents |
|---|---|---|---|
| 1 | 02 | KP1 | Position Loop Proportional Gain 1 |
| 3 | 02 | MFFGN | Model velocity feed forward gain |

| ID | Contents |
|---|---|
| 02 | Auto-Tuning Response [ATRES]<br>■ Set this parameter when "00: Auto Tun" or "01: AutoTun_JRAT-Fix" in Group0 ID00 are used.<br>■ As the setting value rises, the response increases. Set the value suitable for equipment rigidity.<br>■ This does not function when "02: ManualTun" of the Tuning mode is selected. |
| 03 | Auto-Tuning Automatic Parameter Saving [ATSAVE]<br>■ "Load inertia moment ratio" obtained from the result of auto-tuning is automatically saved in Group1 ID14 "Load Inertia Moment Ratio 1 [JRAT1]" every 30 minutes.<br>■ The select value is effective when auto-tuning is used.<br>This does not function when "01: AutoTun_JRAT-Fix" of the Tuning mode is selected. |

## 6.3.2 Automatically adjusted parameters in auto-tuning

These parameters will not reflect on servo motor movements by changing or overriding those values.
However, some of them can be adjusted manually depending on selected Group0 ID00 "Tuning mode [TUNMODE]" and Group0 ID01 "Auto-Tuning Characteristic [ATCHA].

■ At the standard position control, below parameters are adjusted automatically.

◆ General parameters Group1 “Basic control parameter settings”

| ID | Symbol | Name | Remarks |
|---|---|---|---|
| 02 | KP1 | Position Loop Proportional Gain 1 | Note 1) |
| 06 | FFGN | Velocity Feed Forward Gain | Note 1), Note 2) |
| 08 | TRCPGN | Higher Tracking Control Position Compensation Gain | |
| 12 | KVP1 | Velocity Loop Proportional Gain 1 | |
| 13 | TVI1 | Velocity Loop Integral Time Constant 1 | |
| 14 | JRAT1 | Load Inertia Moment Ratio 1 | Note 3) |
| 1C | AFBK | Acceleration Feedback Gain | |
| 1E | TRCVGN | Higher Tracking Control Velocity Compensation Gain | |
| 20 | TCFIL1 | Torque Command Filter 1 | |

◆ General parameters Group8 "Control system settings"

| ID | Symbol | Name | Remarks |
|---|---|---|---|
| 43 | LOWV | Low Speed Range | Note 4) |

◆ General parameters Group9 "Function enabling condition settings"

| ID | Symbol | Name |
|---|---|---|
| 19 | PLPCON | Position Loop Proportional Control Switching Function |
| 27 | VLPCON | Velocity Loop Proportional Control Switching Function |

Note 1) Manual setting is available on "06: Trajectory Control 2 (KP,FFGN Manual Setting)" is selected at the Auto-Tuning Characteristic [ATCHA].
Note 2) Manual setting is available on "02: Positioning Control 3 (High Response, FFGN Manual Setting)" or "04: Positioning Control 5 (High Response, Horizontal Axis Limited, FFGN Manual Setting)" are selected at the Auto-Tuning Characteristic [ATCHA].
Note 3) Manual setting is available on "01: Positioning Control 2 (High Response)" is selected at the Auto-Tuning Characteristic [ATCHA].
Note 4) Manual setting is available on "00: Positioning Control 1 (General Purpose)", "01: Positioning Control 2 (High Response)", "02: Positioning Control 3 (High Response, FFGN Manual Setting)", "05: Trajectory Control 1" or "06: Trajectory Control 2 (KP,FFGN Manual Setting)" are selected at the Auto-Tuning Characteristic [ATCHA].

# 6. Servo Tuning

■ At the model following control, below parameters are adjusted automatically.

◆ General parameters Group1 “Basic control parameter settings”

| ID | Symbol | Name | Remarks |
|---|---|---|---|
| 02 | KP1 | Position Loop Proportional Gain 1 | Note 1) |
| 08 | TRCPGN | Higher Tracking Control Position Compensation Gain | |
| 12 | KVP1 | Velocity Loop Proportional Gain 1 | |
| 13 | TVI1 | Velocity Loop Integral Time Constant 1 | |
| 14 | JRAT1 | Load Inertia Moment Ratio 1 | Note 3) |
| 1C | AFBK | Acceleration Feedback Gain | |
| 1E | TRCVGN | Higher Tracking Control Velocity Compensation Gain | |
| 20 | TCFIL1 | Torque Command Filter 1 | |

◆ General parameters Group3 "Model following control settings"

| ID | Symbol | Name | Remarks |
|---|---|---|---|
| 00 | KM1 | Model Control Gain 1 | |
| 02 | MFFGN | Model velocity feed forward gain | Note 1), Note 2) |

◆ General parameters Group8 "Control system settings"

| ID | Symbol | Name | Remarks |
|---|---|---|---|
| 43 | LOWV | Low Speed Range | Note 4) |

◆ General parameters Group9 "Function enabling condition settings"

| ID | Symbol | Name |
|---|---|---|
| 19 | PLPCON | Position Loop Proportional Control Switching Function |
| 27 | VLPCON | Velocity Loop Proportional Control Switching Function |

Note 1) Manual setting is available on "06: Trajectory2 (KP,FFGN Manual Setting)" is selected at the Auto-Tuning Characteristic [ATCHA].
Note 2) Manual setting is available on "00: Positioning1 (General Purpose)", "02: Positioning3 (High Response, FFGN Manual Setting)" or "04: Positioning5 (High Response, Horizontal Axis Limited, FFGN Manual Setting)" are selected at the Auto-Tuning Characteristic [ATCHA].
Note 3) Manual setting is available on "01: Positioning2 (High Response)" is selected at the Auto-Tuning Characteristic [ATCHA].
Note 4) Manual setting is available on "00: Positioning1 (General Purpose)", "01: Positioning2 (High Response)", "02: Positioning3 (High Response, FFGN Manual Setting)", "05: Trajectory1" or "06: Trajectory2 (KP,FFGN Manual Setting)" are selected at the Auto-Tuning Characteristic [ATCHA].

### 6.3.3 Adjustable main parameters during auto-tuning

■ The following main parameters are adjustable during auto-tuning:

◆ General parameters Group1 “Basic control parameter settings”

| ID | Symbol | Name |
|---|---|---|
| 00 | PCSMT | Position Command Smoothing Constant |
| 01 | PCFIL | Position Command Filter |
| 07 | FFFIL | Velocity Feed Forward Filter |
| 10 | VCFIL | Velocity Command Filter |
| 11 | VDFIL | Velocity Feedback Filter |
| 19 | TFFK | Torque Feed Forward Gain |
| 1A | TFFAVE | Torque feed forward averaging |
| 1B | TFFOUT | Torque Feed Forward output selection |
| 21 | TCFILOR | Torque Command Filter Order |
| 30 | DFBCG | Dual position feedback gain |
| 31 | DFBFIL | Dual position feedback filter |

◆ General parameters Group2 "FF vibration suppression control/ Notch filter/ Disturbance observer settings"

| ID | Symbol | Name |
|---|---|---|
| 00 | SUPFRQA1 | FF Vibration Suppression Frequency 1 |
| 01 | SUPLVA | FF Vibration Suppression Level Selection A |
| 02 | SUPFREQB1 | FF Vibration Suppression Frequency B1 |
| 03 | SUPCRB | FF Vibration Suppression Level Selection B |
| 10 | VCNFIL | Velocity Command Notch Filter |
| 20 | TCNFILA | Torque Command Notch Filter A |
| 21 | TCNFPA | TCNFILA, Low Frequency Phase Delay Improvement |
| 22 | TCNFILB | Torque Command Notch Filter B |
| 23 | TCNFDB | TCNFILB, Depth Selection |
| 24 | TCNFILC | Torque Command Notch Filter C |
| 25 | TCNFDC | TCNFILC, Depth Selection |
| 26 | TCNFILD | Torque Command Notch Filter D |
| 27 | TCNFDD | TCNFILD, Depth Selection |
| 28 | TCNFILE | Torque Command Notch Filter E |
| 29 | TCNFDE | TCNFILE, Depth Selection |
| 50 | CPVSFQ | CP vibration suppression control frequency |
| 51 | CPVSLV | CP vibration suppression control level |
| 52 | CPVSSH | CP vibration suppression control characteristics selection |
| 60 | FBHPLS | Minor vibration suppression pulse compensation value |
| 61 | FBHTIM | Minor vibration suppression pulse compensation frequency |

◆ General parameters Group4 “Gain switching control/Vibration suppression frequency switching settings”

| ID | Symbol | Name |
|---|---|---|
| 40 | SUPFRQA2 | FF Vibration Suppression Frequency A2 |
| 41 | SUPFRQA3 | FF Vibration Suppression Frequency A3 |
| 42 | SUPFRQA4 | FF Vibration Suppression Frequency A4 |
| 43 | SUPFRQB2 | FF Vibration Suppression Frequency B2 |
| 44 | SUPFRQB3 | FF Vibration Suppression Frequency B3 |
| 45 | SUPFRQB4 | FF Vibration Suppression Frequency B4 |

◆ General parameters Group5 “High setting control setting”

| ID | Symbol | Name |
|---|---|---|
| 00 | CVFIL | Command Velocity Low-pass Filter |
| 01 | CVTH | Command Velocity Threshold |
| 02 | ACCCO | Acceleration Compensation |
| 03 | DECCO | Deceleration Compensation |

## 6.3.4 Unavailable functions during auto-tuning

■ The following functions CANNOT be used during auto-tuning:

◆ General parameters Group9 “Function enabling condition settings”

| ID | Symbol | Name |
|---|---|---|
| 13 | GC1 | Gain Switching Condition 1 |
| 14 | GC2 | Gain Switching Condition 2 |
| 19 | PLPCON | Position Loop Proportional Control Switching Function |
| 27 | VLPCON | Velocity Loop Proportional Control Switching Function |
| 33 | OBS | Disturbance Observer Function |
| 80 | SYNCEN | Axes-sync compensation function |
| 81 | SYNPCNEN | Axes-sync compensation proportional control switching function |

* "Disturbance Observer" is not able to use together with Auto-Tuning. If desired to use Auto-Tuning, make Group9 ID33 "Disturbance Observer Function [OBS]" invalid.
* SYNCEN and SYNPCNEN are able to use when "01: AutoTun_JRAT-Fix" is set to Group0 ID00 "Tuning mode". If "00: AutoTun" is set, disable Group9 ID80 [SYNCEN] and Group9 ID81 [SYNPCNEN].

◆ General parameters Group1 “Basic control parameter settings”

| ID | Symbol | Name |
|---|---|---|
| 08 | TRCPGN | Higher Tracking Control Position Compensation Gain |
| 1C | AFBK | Acceleration Feedback Gain |
| 1E | TRCVGN | Higher Tracking Control Velocity Compensation Gain |

◆ General parameters Group8 "Control system settings"

| ID | Symbol | Name |
|---|---|---|
| 43 | LOWV | Low Speed Range |

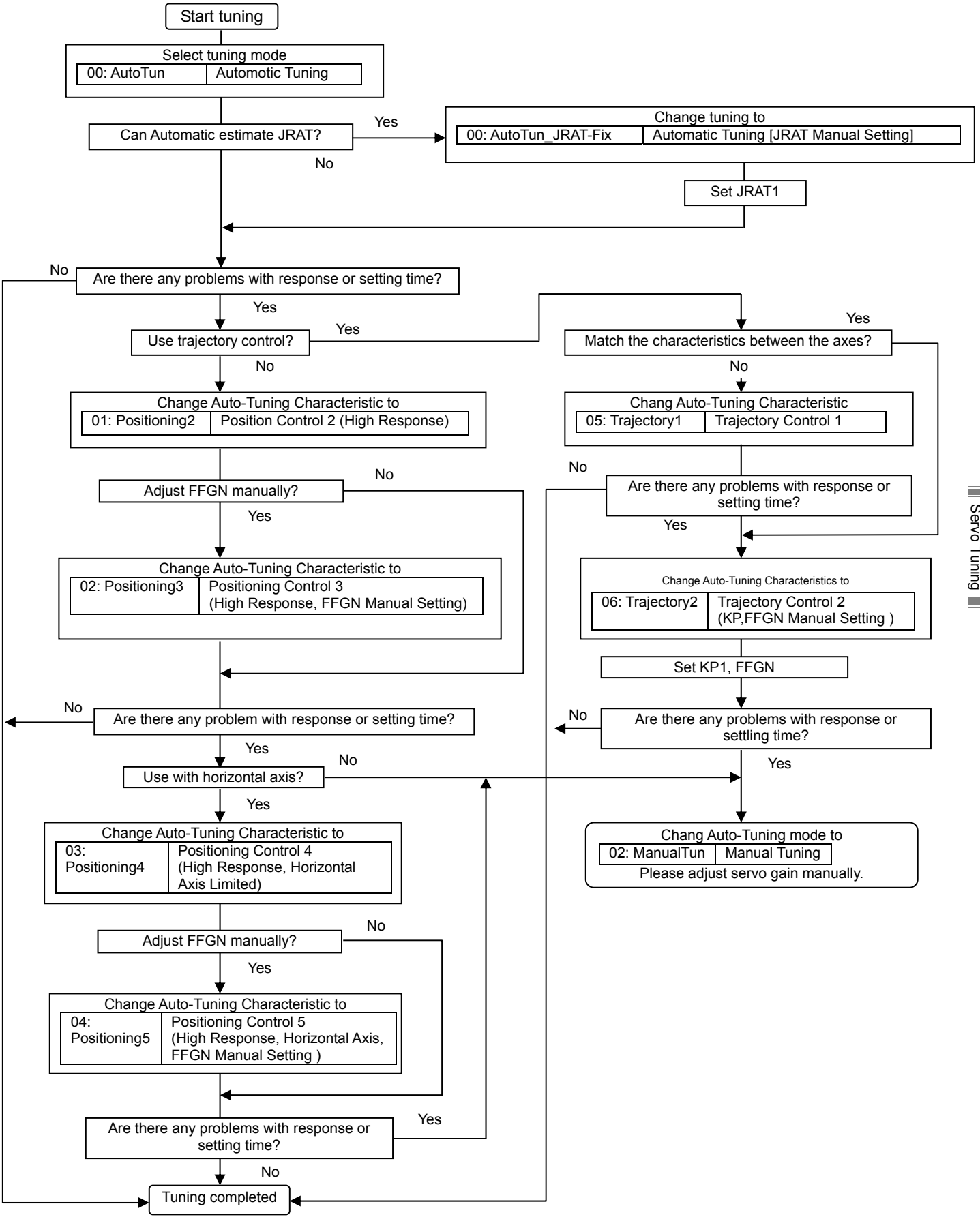
* "Low Speed Range [LOWV]" is able to use when "00: Positioning Control 1 (General Purpose)", "01: Positioning Control 2 (High Response)", "02: Positioning Control 3 (High Response, FFGN Manual Setting)", "05: Trajectory Control 1" or "06: Trajectory Control 2 (KP,FFGN Manual Setting)" are selected at the Auto-Tuning Characteristic [ATCHA].

◆ General parameters Group3 “Model following control settings”

| ID | Symbol | Name |
|---|---|---|
| 06 | ANRFRQ1 | Model Control Antiresonance Frequency 1 |
| 07 | RESFRQ1 | Model Control Resonance Frequency 1 |

* “Model following control” is able to use when "01: AutoTun_JRAT-Fix" is set to Group0 ID00 "Tuning mode". If "00: AutoTun" is set, select"00: Standard" or "01: Model1" to sytem parameter ID07 "Position control selection".

## 6.3.5 Auto-tuning characteristic selection



## 6.3.6 Adjustment method for auto-tuning

Auto-tuning is a function where the amplifier unit automatically tunes to the best servo gain in real time.

| | |
|---|---|
| Procedure 1 | ■ Select "00: AutoTun Auto-Tuning" at Group0 ID00 "Tuning mode [TUNMODE]" to estimate load inertia moment ratio by amplifier unit on a real-time basis, and then automatically adjust servo gain.<br>Select "01:AutoTun_JRAT-Fix Automatic Tuning (JRAT Manual Setting)" to automatically adjust optimum servo gain based on manually set value of Group1 ID14 "Load Inertia Moment Ratio 1 [JRAT1]". |
| Procedure 2 | ■ After setting "Tuning mode [TUNMODE]", select Group0 ID00 "Auto-Tuning Characteristic [ATCHA]" for the machine or equipment. |
| Procedure 3 | ■ Next, boot the servo motor and adjust Group0 ID02 "Auto-Tuning Response [ATRES]" according to equipment rigidity.<br>◆ Set "Auto-Tuning Response [ATRES]" at a low value initially and allow the machine to work about 10 times or more by commanding from upper controller.<br>◆ When response is low and the positioning settling time is slow, after machine movement, try to improve the response and settling times by increasing "Auto-Tuning Response [ATRES]" gradually.<br>◆ If increasing the response has caused the machine to get vibration, lower the value of the "Auto-Tuning Response [ATRES]" slightly.<br>* If the machine has not developed vibration, enable the Vibration suppression by setting the Notch filter and /or FF Vibration suppression frequency. Set the filter frequency to suppress mechanical vibration by using "6.7 Auto notch filter tuning function" and/or "6.8.2 Auto FF Vibration Suppression Frequency Tuning".<br>* Tuning methods are the same in "01:AutoTun_JRAT-Fix Automatic Tuning (JRAT Manual Setting)". |

## 6.3.7 Monitoring servo gain adjustment parameters

Parameters automatically adjusted when using auto-tuning can be monitored with the Digital Operator and the Setup software. Refer to "7. Digital operator" for use of the Digital Operator.

| ID | Symbol | Name | Unit |
|---|---|---|---|
| 50 | JRAT MON | Load Inertia Moment Ratio monitor | % |
| 51 | MKP MON | Model Control Gain monitor | 1/s |
| 52 | KP MON | Position Loop Proportional Gain monitor | 1/s |
| 54 | KVP MON | Velocity Loop Proportional Gain monitor | Hz |
| 55 | TVI MON | Velocity Loop Integral Time Constant monitor | ms |
| 56 | TCFIL MON | Torque Command Filter monitor | Hz |

## 6.3.8 Manual tuning method using auto-tuning results

Result of auto-tuning can be stored in block and used to perform auto-tuning.
Refer to "7. Digital operator" for use of the Digital Operator.
For the Setup software, perform "Auto-tuning >> Auto-tuning result saving".

■ Saving parameters

◆ General parameters Group1 “Basic control parameter setting”

| ID | Symbol | Name | Unit |
|---|---|---|---|
| 02 | KP1 | Position Loop Proportional Gain 1 | 1/s |
| 06 | FFGN | Velocity Feed Forward Gain | % |
| 08 | TRCPGN | Higher Tracking Control Position Compensation Gain | % |
| 12 | KVP1 | Velocity Loop Proportional Gain 1 | Hz |
| 13 | TVI1 | Velocity Loop Integral Time Constant 1 | ms |
| 14 | JRAT1 | Load Inertia Moment Ratio 1 | % |
| 1C | AFBK | Acceleration Feedback Gain | % |
| 1E | TRCVGN | Higher Tracking Control Velocity Compensation Gain | % |
| 20 | TCFIL1 | Torque Command Filter 1 | Hz |

◆ General parameters Group3 “Model following control settings”

| ID | Symbol | Name | Unit |
|---|---|---|---|
| 00 | KM1 | Model Control Gain 1 | 1/s |
| 02 | MFFGN | Model velocity feed forward gain | % |

◆ General parameters Group8 "Control system settings"

| ID | Symbol | Name | Unit |
|---|---|---|---|
| 43 | LOWV | Low Speed Range | $min^{-1}$ |

◆ General parameters Group9 "Function enabling condition settings"

| ID | Symbol | Name | Unit |
|---|---|---|---|
| 19 | PLPCON | Position Loop Proportional Control Switching Function | — |
| 27 | VLPCON | Velocity Loop Proportional Control Switching Function | — |

# 6. Servo Tuning

## 6.4 Manual tuning function

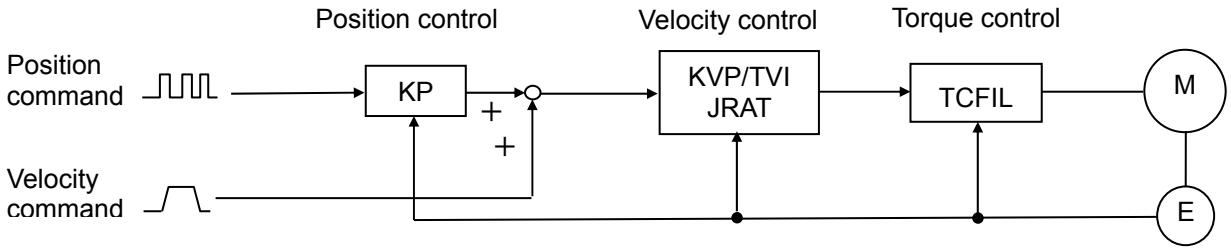
All gain is adjustable manually using manual tuning mode when characteristics in auto-tuning are insufficient. Select "02: ManualTun Manual Tuning" at Group0 ID00 "Tuning mode [TUNMODE]".

■ Setting parameters
  ◆ General parameters Group0 ID00 “Tuning Mode [TUNMODE]”

| Selection | | Contents |
|---|---|---|
| 02 | ManualTun | Manual Tuning |

### 6.4.1 Servo system configuration and servo adjustment parameters

The servo system is consist from "Position, Velocity and Torque control", and the control system response should be "Position control < Velocity control < Torque control". If this structure is compromised, the system will be unstable and it might result in low response, vibration or oscillation.




See below explanation for each servo parameter

■ Group1 ID00 "Position Command Smoothing Constant [PCSMT]"
This moving low-pass filter smoothes the position command pulse. Sets time constants. The position command pulse will become smoother by setting this parameter when the electronic gear ratio is high or position command pulse is coarse.

■ Group1 ID01 "Position Command Filter [PCFIL]"
When the position command resolution is low, set this parameter to suppress the ripples contained in the position command. A larger value of this parameter will cause a greater ripple suppressing effect; however, delay will be increased.

  ◆ When Group1 ID1E "Higher Tracking Control Position Compensation Gain [TRCPGN]" is set to other than 0%, this parameter is automatically set.

■ Group1 ID02 "Position Loop Proportional Gain 1 [KP1]"
Sets the response of Position control. Set this to: KP1 [1/S]=KVP1 [Hz]/4・2π as a rough indication.

■ Group1 ID06 "Velocity Feed Forward Gain [FFGN]"
The tracking effect of position command can be improved by increasing this gain. Under positioning control, set this to approximately 30-40% as the standard.

◆ When Group1 ID1E "Higher Tracking Control Position Compensation Gain [TRCPGN]" is set to other than 0%, this parameter is automatically set.

■ Group1 ID07 "Velocity Feed Forward Filter [FFFIL]"
When position command resolution is low, set this parameter to suppress ripples.

■ Group1 ID08 "Higher Tracking Control Position Compensation Gain [TRCPGN]"
When the tracking effect needs to be improved under high resolution of position command, increase this parameter after adjustment of Higher Tracking Control Velocity Compensation Gain.

■ Group1 ID12 "Velocity Loop Proportional Gain 1 [KVP1]"
Set the value as high as possible in stable range that machine system does not vibrate and oscillate. If Group1 ID14 "Load Inertia Moment Ratio 1 [JRAT1]" is properly set, the set value as "Velocity Loop Proportional Gain 1 [KVP1]" becomes velocity control responsive band.

■ Group1 ID13 "Velocity Loop Integral Time Constant 1 [TVI1]"
Set this to: TVI1 [ms] = 1000/(KVP1 [Hz]), as a rough indication.

■ Group1 ID14 "Load inertia moment ratio 1 [JRAT1]"
Set this value to the calculation shown below:

$$JRAT = \frac{\text{Motor axis converted load inertia moment (JL)}}{\text{Servo motor rotor inertia moment (JM)}} \times 100\%$$

■ Group1 ID1E "Higher Tracking Control Velocity Compensation Gain [TRCVGN]"
Tracking effect can be improved by increasing compensation gain.
Adjust this to shorten the position setting time.

◆ Set the value of "Load Inertia Moment Ratio 1 [JRAT1]" properly to use this function.

◆ Set 0% when you use Group9 ID27 "Velocity Loop Proportional Control Switching Function [VLPCON]" during operation.

◆ Set at 100% to equal Q-series servo amplifier.

■ Group1 ID20 "Torque Command Filter 1 [TCFIL1]"
When rigidity of the mechanical device is high, set this value high and the "Velocity Loop Proportional Gain1 [KVP1]" can also be set higher. When the rigidity of the mechanical device is low, set this value low and resonance in the high frequency zone as well as abnormal sound can be suppressed. For normal usage, set this below 1200Hz.

## 6.4.2 Basic manual tuning method for velocity control

- Set value of Group1 ID12 "Velocity Loop Proportional Gain 1 [KVP1]" as high as possible within the range that mechanical system can stably work without any vibration or oscillation. If vibration increases, lower the value.

- Set value of Group 1 ID13 "Velocity Loop Integral Time Constant 1[TVI1]" by referring to "TVI1 [ms] = 1000/ KVP1 [Hz]", as a rough indication.

  - When you cannot increase the gain because of mechanical resonance, etc., and the response is insufficient, (after using the Torque notch filter and/or FF vibration suppression frequency to suppress resonance) try the procedure again.

## 6.4.3 Basic manual tuning method for position control

- Set value of Group1 ID12 "Velocity Loop Proportional Gain 1 [KVP1]" as high as possible within the range that mechanical system can stably work without any vibration or oscillation. If vibration increases, lower the value.

- Set value of Group1 ID13 "Velocity Loop Integral Time Constant 1 [TVI1]" by referring to "TVI1 [ms] = 1000/ KVP1 [Hz]", as a rough indication.

- Set value of Group1 ID02 "Position Loop Proportional Gain 1 [KP1]" by referring to "KP1 [1/s] = KVP1 [Hz]/ 4・2π", as a rough indication. When vibration occurs, lower the value.

  - When you cannot increase the gain because of mechanical resonance, etc., and the response is insufficient (after using the Torque notch filter and/or FF vibration suppression frequency to suppress resonance) try the procedure again.

# 6.5 The function of making servo gain higher

There are explanations of the function for improving response, for position/ velocity/ torque control system each.

## 6.5.1 Velocity loop phase lead compensation

This is the function to compensate phase delay of Velocity control system, and helps Group1 ID12 "Velocity loop proportional gain 1 [KVP1]" change higher.
Use this when "Velocity loop proportional gain 1 [KVP1]" is not able to increase because there is no gain margin, phase margin.

■ How to use

◆ Please get a frequency characteristic of machine. (In case use of the System Analysis, see "10.3 System Analysis" in M0010842.)

◆ Set 3 times of "Velocity Loop Proportional Gain 1 [KVP1]" to Group1 ID16 "Velocity loop phase lead compensation frequency [VLPHLF]", and set near 30% to Group1 ID15 "Velocity loop phase lead compensation gain [VLPHLK]", and then confirm increase of phase margin at higher frequency.

◆ Group1 ID15 "Velocity loop phase lead compensation gain [VLPHLK]" is able to increase up to the value of allowed phase margin at higher frequency.

◆ "Velocity Loop Proportional Gain 1 [KVP1]" is able to increase up to the value of allowed phase margin at around of "Velocity Loop Proportional Gain 1 [KVP1]".

■ Velocity loop phase lead compensation gain
Sets the compensation value of Velocity loop phase lead compensation.

◆ General parameters Group1 “Basic Control parameter settings”

| ID | Symbol | Name | Unit | Setting range |
|---|---|---|---|---|
| 15 | VLPHLK | Velocity loop phase lead compensation gain | % | 0 to 100 |

* This function will be disabled when 0% is set.

■ Velocity loop phase lead compensation frequency
Sets the frequency of Velocity loop phase lead compensation.

◆ General parameters Group1 “Basic Control parameter settings”

| ID | Symbol | Name | Unit | Setting range |
|---|---|---|---|---|
| 16 | VLPHLF | Velocity loop phase lead compensation frequency | Hz | 10 to 4000 |

* Up to 1000Hz setting is valid at normal sampling mode.
* Up to 2000Hz setting is valid at high rate sampling mode.

## 6.5.2 Position loop phase lead compensation

This is the function to compensate phase delay of Position control system, and helps Group1 ID02 "Velocity Loop Proportional Gain 1 [KVP1]" change higher.
Use when "Velocity Loop Proportional Gain 1 [KVP1]" is not able to change higher by overshoot occurring.

■ How to use

◆ Set 4 times of "Position Loop Proportional Gain 1 [KP1]" (KP1 [1/s]/2π×4 [Hz]) to Group1 ID05 "Position loop phase lead compensation frequency [PLPHLF]", and set near 30% to Group1 ID04 "Position loop phase lead compensation gain [PLPHLK]", and operate a servo motor.

◆ Increase "Position loop phase lead compensation gain [PLPHLK]" up to eliminating overshoot.

◆ Able to increase "Position Loop Proportional Gain 1 [KP1]" up to the value that allowed overshoot.

■ Position loop phase lead compensation gain
Sets the compensation value of Position loop phase lead compensation.

◆ General parameters Group1 “Basic Control parameter settings”

| ID | Symbol | Name | Unit | Setting range |
|---|---|---|---|---|
| 04 | PLPHLK | Position loop phase lead compensation gain | % | 0 to 100 |

* This function will be disabled when 0% is set.

■ Position loop phase lead compensation frequency
Sets the compensation frequency of Position loop phase lead compensation.

◆ General parameters Group1 “Basic Control parameter settings”

| ID | Symbol | Name | Unit | Setting range |
|---|---|---|---|---|
| 05 | PLPHLF | Position loop phase lead compensation frequency | Hz | 10 to 4000 |

* Up to 1000Hz setting is valid at normal sampling mode.

# 6.5 The function of making servo gain higher

## 6.5.3 Torque feed forward compensation

There is explanation of function which improving response against a command of control system and applying feed forward compensation to the torque control system. Use when response is not good against command during circular machining etc.

■ How to use

◆ Improve response by increasing Group1 ID19 "Torque feed forward gain [TFFK]", at condition of setting value except 0% to Group1 ID06 "Feed Forward Gain [FFGN]".

◆ When there is no Improvement even if increasing "Torque feed forward gain [TFFK]", please change value of Group1 ID1A "Torque feed forward averaging [TFFAVE]" or Group1 ID1B "Torque feed forward output selection [TFFOUT]", and then confirm impact.

■ Torque Feed Forward Gain
Sets the compensation value of Torque-Feed Forward.

◆ General parameters Group1 “Basic Control parameter settings”

| ID | Symbol | Name | Unit | Setting range |
|---|---|---|---|---|
| 19 | TFFK | Torque feed forward gain | % | 0 to 100 |

* This function will be disabled when 0% is set.
* Able to use at the position control type and velocity control type.
* At the position control type, this function will be disabled when 0% is set to Group1 ID06 "Feed Forward Gain [FFGN]".
* This function will be disabled at torque control type.
* This function will be disabled at model following (vibration suppression) control.
* Able to use the function along with the auto-tuning, except when "00: Positioning1 Positioning Control 1 (General Purpose)" is set to Gropu0 ID01 "Auto-Tuning Characteristic [ATCHA]".

■ Torque feed forward gain averaging
Selects the average count of torque feed forward compensation.

◆ General parameters Group1 “Basic Control parameter settings”

| ID | Symbol | Name | Unit | Setting range |
|---|---|---|---|---|
| 1A | TFFAVE | Torque feed forward gain averaging | - | 00 to 01 |

| Selection | | Contents |
|---|---|---|
| 00 | 2timesAverage | 2 times |
| 01 | 4timesAverage | 4 times |

■ Torque feed forward output selection
Select the point that is to be added torque feed forward compensation.

◆ General parameters Group1 “Basic Control parameter settings”

| ID | Symbol | Name | Unit | Setting range |
|---|---|---|---|---|
| 1B | TFFOUT | Torque feed  forward output selection | - | 00 to 01 |

| Selection | | Contents |
|---|---|---|
| 00 | Before_Filter | Before torque command filter |
| 01 | After_Filter | After torque command filter |

## 6.6 Model following control function

Model following control is a method used to obtain a higher response. Model control systems include mechanical devices in amplifier unit and drive a servo motor in order to track the Model control system.
Select "02: Position, position control type" at the system parameter ID06 "Control mode selection", and "01: Model1 Model-following control" at the system parameter ID07 "Position control selection".

■ How to use

◆ See "6.3.6 Adjustment method for auto-tuning" when using this function together with the auto-tuning.

◆ See "6.6.1 Manual tuning method for model following control" when setting the parameter manually without the auto-tuning.

◆ See "6.6.3 Model velocity feed forward differential compensation", for command-following improvement after the auto-tuning or the manual tuning.

■ Setting parameters
◆ System parameters

<table>
<tr><th>ID</th><th>Content</th></tr>
<tr><td>06</td><td>Control Mode Selection<br><table><tr><th colspan="2">Select value</th><th>Content</th></tr><tr><td>02</td><td>Position</td><td>Position control type</td></tr></table></td></tr>
<tr><td>07</td><td>Position Control Selection<br><table><tr><th colspan="2">Select value</th><th>Content</th></tr><tr><td>01</td><td>Model1</td><td>Model following control</td></tr></table></td></tr>
</table>

* Model following control cannot be used when in velocity control type or torque control type.

* Model following control can be used with auto-tuning at the same time.

* Model following control can be used with full-closed control at the same time.

# 6.6 Model following control function

## 6.6.1 Manual tuning method for model following control

■ Set value of Group1 ID12 "Velocity Loop Proportional Gain 1 [KVP1]" as high a value as possible within the range that mechanical system stably works without any oscillation. If vibration occurs, lower the value.

■ Set value of Group1 ID13 "Velocity Loop Integral Time Constant 1 [TVI1]" by referring "TVI1 [ms] = 1000/ KVP1 [Hz]", as a rough indication.

■ Set value of Group1 ID12 "Position Loop Proportional Gain 1 [KP1]" by referring to "KP1 [1/s] = KVP1 [Hz]/ 4・2π", as a rough indication.

■ Set value of Group3 ID03 "Model control gain 1 [KM1]" by referring to "KM1 ≒KP1", as a rough indication. When vibration occurs, lower the set value.

■ When responsiveness is low, change the value of "Model control gain 1 [KM1]" to the value approximately 1.1 to 1.2 times the value.

◆ When the gain cannot rise because of mechanical vibration, etc., and the response time is insufficient, use Torque notch filter and/or FF Vibration suppression frequency to suppress resonance and attempt it again.

■ Adjustable parameters in Model following control
In addition to the parameters in Standard position control, the following parameters are also adjustable:

◆ General Parameters Group3 "Model following control settings"

| ID | Symbol | Name |
|---|---|---|
| 00 | KM1 | Model Control Gain 1 |
| 01 | MZETA | Model control damping coefficient |
| 05 | OSSFIL | Overshoot Suppression Filter |

◆ Model Control Gain 1 [KM1]
Proportional gain fro Model following control position controller.
Adjust this to: KM1 ≒ KP1, as a rough indication.

◆ Model control damping coefficient [MZETR]
This is parameter which changes velocity proportional gain of Model following control.
The parameter value will be ζ=0.866 by 0% and ζ=1.0 by 100%.

◆ Overshoot Suppression Filter [OSSFIL]
Set cutoff frequency of overshoot suppression filter in Model following control.
If overshoot occurs, lower the setting value. When overshoot occurs on position deviation, lower the set value.

## 6.6.2 Switching of the Feedback control and the Model-following (vibration suppression) control

Explains the function which switches standard position control, model-following control and model-following vibration suppression control, on real-time.
Select "02: Position Position control type" at the system parameter ID06 "Control mode selection", and select "03: Model3 Model-following / standard position control switching" or "04: Model4 Model-following vibration suppression / standard position control switching" at the system parameter ID07 "Position control selection".

■ How to use

◆ The function is valid when condition that is selected in Group9 ID1A "Model following (vibration suppression) control/ standard position control switching function" is satisfied.

◆ "Model following (vibration suppression) control/ standard position control switching function" supports "00: Always_Disable", "01: Always_Enable" and "General input signal (CONT1 to CONT8)".

■ Setting parameters
◆ System parameters

<table>
<tr><th>ID</th><th>Content</th></tr>
<tr><td>06</td><td>Control Mode Selection<br><table><tr><th colspan="2">Select value</th><th>Content</th></tr><tr><td>02</td><td>Position</td><td>Position control type</td></tr></table></td></tr>
<tr><td>07</td><td>Position Control Selection<br><table><tr><th colspan="2">Select value</th><th>Content</th></tr><tr><td>03</td><td>Model3</td><td>Model-following / standard position control switching</td></tr><tr><td>04</td><td>Model4</td><td>Model-following vibration suppression / standard position control switching</td></tr></table></td></tr>
</table>

* Model following control cannot be used when in velocity control type or torque control type.
* Model following control can be used with auto-tuning at the same time.
* Model following control / Model-following vibration suppression control can be used with full-closed control at the same time.

■ Model following (vibration suppression) control/ standard position control switching function
Sets the valid condition for Model-following (vibration suppression) control.

◆ General parameters Group9 "Function enabling condition settings"

| ID | Symbol | Name | Unit | Setting range |
|---|---|---|---|---|
| 1A | MODEL | Model following (vibration suppression) control/ standard position control switching function | - | 00 to 11 |

* Control mode will be Model-following (vibration suppression) control when this function is valid.
* This setting value is valid only when Control mode selection is "03: Model3 Model-following / standard position control switching" or "04: Model4 Model-following vibration suppression / standard position control switching".
* Do not perform switching of the model following (vibration suppression) control and the standard position control, during servo motor operation. Alarm (Model Following Vibration Suppression Control Error (AL.C5)) may occur.

### 6.6.3 Model velocity feed forward differential compensation

This is the function to improve command response of model control system by differential compensation for feed forward of model control system.

■ How to use

◆ Able to improve a command-following by increasing Group3 ID02 "Model velocity feed forward gain [MFFGN]", at the model following control mode and the model following vibration suppression control mode.

◆ Able to improve more a command-following by increasing Group3 ID03 "Model velocity feed forward differential time constant [MTFFD]".

■ Model velocity feed forward gain
Sets the compensation value of Model velocity feed forward.

◆ General parameters Group3 “Model following control”

| ID | Symbol | Name | Unit | Setting range |
|---|---|---|---|---|
| 02 | MFFGN | Model velocity feed forward gain | % | 0 to 100 |

* This function will be disabled when 0% is set.

■ Model velocity feed forward differential time constant
Sets the time constant of Model velocity feed forward differential compensation.

◆ General parameters Group3 “Model following control”

| ID | Symbol | Name | Unit | Setting range |
|---|---|---|---|---|
| 03 | MTFFD | Model velocity feed forward differential time constant | ms | 0.00 to 10.00 |

* This function will be disabled when 0.00ms is set.
* This function will be enabled when the value except 0% is set to "Model velocity feed forward gain [MFFGN]".

■ Model velocity feed forward filter
Sets the cutoff frequency of Model velocity feed forward filter.

◆ General parameters Group3 “Model following control”

| ID | Symbol | Name | Unit | Setting range |
|---|---|---|---|---|
| 04 | MFFFIL | Model velocity feed forward filter | Hz | 1 to 4000 |

* The function is Invalid at 1,000Hz or more.

## 6.7 Auto notch filter tuning function

Notch filter is able to suppress high frequency resonance depends on a mechanical system coupling or stiffness. "Auto notch filter tuning" is able to search mechanical system resonant frequency easily by rotating servo motor in a short time.

■ How to use

◆ Able to operate from "Auto-tuning mode" in the Setup Software or the Digital Operator.

◆ The tuning results are saved automatically in Group2 ID20 “Torque Command Notch Filter A [TCNFILA]”.

◆ When resonance of the device does not stop even after using Automatic Tuning of notch filter, there may be two or more resonance points. In this case, inquire about the resonance frequency using the system analysis function and insert Notch filter B, C, D (Manual setting) to suppress each resonance. If resonance is still not suppressed, there is a possibility that Group0 ID02 "Auto-tuning response [ATRES]" or Group1 ID12 "Velocity loop proportional gain 1 [KVP1]" is too high. Lower the "Auto-tuning response [ATRES]" or "Velocity loop proportional gain 1 [KVP1]".

* Torque command notch filter function can be used together with Auto-tuning at the same time.

* Holding torque falls while auto notch filter is running. Do not use as a gravity axis.

■ Torque command value for auto notch filter tuning
Setting the Torque command value to the servo motor at the time of auto notch filter tuning :

◆ General parameters Group0 “Auto-Tuning settings”

| ID | Symbol | Name | Unit | Setting range |
|---|---|---|---|---|
| 10 | ANFILTC | Auto-Notch Filter Tuning Torque Command | % | 10.0 to 100.0 |

* As the value increases so does tuning accuracy. However, machine movement will increase as well. Please monitor it closely.

■ Automatically saving parameters with Automatic tuning of notch filter

◆ General parameters Group2
“FF vibration suppression control / Notch filter Disturbance observer settings”

| ID | Symbol | Name | Unit | Setting range |
|---|---|---|---|---|
| 20 | TCNFILA | Torque Command Notch Filter A | Hz | 100 to 4000 |

* The above parameter is saved automatically with auto notch filter tuning.

■ Adaptive notch filter function E
Selects the valid/invalid of the Adaptive notch filter.

◆ General parameters Group0 “Auto-Tuning”

| ID | Symbol | Name | Unit | Setting range |
|---|---|---|---|---|
| 34 | ADNFE | Adaptive notch filter function E | - | 00 to 01 |

| Select value | | Content |
|---|---|---|
| 00 | Adp_Filter Disable | Adaptation invalid (TCNFILE manual setting) |
| 01 | Adp_Filter Enable | Adaptation at all times |

* When adaptive notch filter function is valid, Group2 ID29 "TCNFILE, Depth Selection" will be fixed to 0.

■ Adaptive notch filter frequency upper limit E
Sets the upper limit value of adaptive notch filter frequency.

◆ General parameters Group0 “Auto-Tuning”

| ID | Symbol | Name | Unit | Setting range |
|---|---|---|---|---|
| 35 | ADNFUE | Adaptive notch filter frequency upper limit E | Hz | 100 to 1000 |

* Sets the upper limit value of adaptive notch filter frequency for mechanical dispersion.
* Please set higher value than ADNFLE.

■ Adaptive notch filter frequency lower limit E
Sets the lower limit value of adaptive notch filter frequency.

◆ General parameters Group0 “Auto-Tuning”

| ID | Symbol | Name | Unit | Setting range |
|---|---|---|---|---|
| 36 | ADNFLE | Adaptive notch filter frequency lower limit E | Hz | 100 to 1000 |

* Sets the lower limit value of adaptive notch filter frequency for mechanical dispersion.
* Please set lower value than ADNFLE.

■ Adaptive notch filter E auto saving
Selects valid/invalid of the function that saves mechanical resonant frequency automatically.

◆ General parameters Group0 “Auto-Tuning”

| ID | Symbol | Name | Unit | Setting range |
|---|---|---|---|---|
| 37 | ADNSVE | Adaptive notch filter E auto saving | - | 00 to 01 |

| Select value | | Content |
|---|---|---|
| 00 | Auto_Saving | Automatically Saves |
| 01 | No_Saving | Automatic Saving is Invalid |

# 6. Servo Tuning

## 6.8 Vibration suppression function

### 6.8.1 Model following vibration suppression control

When you use the servo motor to drive tables on a machine stand, the stand itself may vibrate as a reciprocal reactor of the motor.
When the machine stand vibrates, the vibration may cause a reaction with the Positioning stabilizing time of the table working on the stand.
Model following vibration suppression control suppresses this type of machine stand vibration and improves Position stabilization time and response.

■ How to use

◆ First, select “01: Model1 model following control” at the system parameter ID07 "Position control selection”, and then perform auto-tuning to adjust the machine to optimum servo gain. Refer to "6.3.6 Adjustment method for auto-tuning" for instructions on tuning.

◆ When servo gain tuning is completed, switch Group0 ID00 “Tuning mode” to “02: ManualTun manual tuning“ after performing auto tuning result saving function.

◆ Set “02: Model2 model following vibration suppression control” at the "Position control selection”, and then set mechanical anti-resonance frequency and resonance frequency. When anti-resonance frequency and resonance frequency are already known, set the values. If anti-resonance frequency and resonance frequency are not known, you can set by measuring anti-resonance frequency and resonance frequency by system analysis.

- When you measure the anti-resonance and resonance frequencies using System analysis, set the "Frequency range selection" in the low range. If you set the range in a high range, the ant-resonance and resonance frequencies in suppressible ranges created by the Model following vibration suppression control may not be measured.
  1 - 125Hz for "Frequency range selection" is recommended.
  (For use of the system analysis, see "10.3 System analysis" in another document: M0010842.)

- When the mass of the servo motor is smaller than the machine stand mass, the anti-resonance and resonance frequencies may not be measured in system analysis. And, system analysis cannot use during tandem operation. In this case, obtain the vibration frequency (Model anti-resonance frequency) by calculating the machine vibration period of the vibrating point at positioning and its reciprocal and set the model resonance frequency 1.05-1.2 times the anti-resonance frequency.

◆ Set value of Group1 ID12 "Velocity Loop Proportional Gain 1 [KVP1]" as high as possible within the range that mechanical system can stably work without any oscillation. If vibration occurs, lower the set value.

◆ Set value of Group1 ID13 "Velocity Loop Integral Time Constant 1 [TVI1]" by referring to “TVI1 [ms] = 1000/KVP1 [Hz]”, as a rough indication.

◆ Set value of Group1 ID02 "Position Loop Proportional Gain 1 [KP1] by referring to “KP1 [1/s] = KVP1 [Hz]/ 4・2π, as a rough indication.

◆ Set value of Group3 ID00 "Model Control Gain 1 [KM1]" by referring to “KM1 ≒KP1”, as a rough indication.
If vibration increases, lower the value.

- ◆ When responsiveness is low, change the value of "Model control gain 1 [KM1]" to the value approximately 1.1 to 1.2 times the value.

- ◆ Depending on the mechanical system, there may be two or more frequency vibrations aside from anti-resonance and resonance frequencies that have already been set. In this case, the vibration can be suppressed using FF vibration suppression controls together. Set the vibration frequency to Group02 ID00 "FF vibration suppression frequency A1 [SUPFRQA1]" by calculating the frequency from the vibration period.

- ◆ In case you cannot increase the gain because of mechanical resonance, etc., and response is insufficient, use Torque command notch filter and FF vibration suppression frequency to suppress the resonance, and then try again.

* Auto-tuning function is able to use only "Auto-tuning [JRAT manual setting]".

* Full-closed control is able to use in Model-following vibration suppression control, also.

* Model following (vibration suppression) control cannot be used when in Velocity control type or Torque control type.

■ Setting parameters

- ◆ General parameters Group3 “Model following control settings”

| ID | Symbol | Name | Unit | Setting range |
|---|---|---|---|---|
| 00 | KM1 | Model Control Gain 1 | 1/s | 15 to 315 |
| 01 | MZETA | Model control damping coefficient | % | 0 to 100 |
| 05 | OSSFIL | Overshoot Suppression Filter | Hz | 1 to 4000 |
| 06 | ANRFRQ1 | Model Control Antiresonance Frequency 1 | Hz | 10.0 to 80.0 |
| 07 | RESFRQ1 | Model Control Resonance Frequency 1 | Hz | 10.0 to 80.0 |



* Do not change the setting value when the servo motor is running.

■ Model Control Gain 1 [KM1]
This is the proportional gain of the Model following controlling position controller and set response for Model control system. Adjust by referring to “KM1 ≒KP1”, as a rough indication.

■ Model control damping coefficient [MZETA]
This is parameter which changes velocity proportional gain of Model following control. The parameter value will be ≦0.866 by 0% and ≦1.0 by 100%.

■ Overshoot Suppression Filter [OSSFIL]
This parameter is to set the cutoff frequency of the Overshoot suppression filter in Model following vibration suppression control. When overshoot occurs on position deviation, lower the set value.

■ Model Control Antiresonance Frequency 1 [ANRFRQ1]
This is to set the Anti-resonance frequency of the machine using Model following vibration suppression control.
When the value is set higher than Model Control Resonance Frequency, vibration suppression control will be invalid.

■ Model Control Resonance Frequency 1 [RESFRQ1]
This is to set the Resonance frequency of the machine model using Model following vibration suppression control.
Vibration suppression control will be invalid at 80.0Hz.

■ Parameter setting range for model following vibration suppression control
Setting ranges for the following parameters are restricted:

◆ General parameters Group1 “Basic control parameter settings”

| ID | Symbol | Name | Unit | Setting range |
|---|---|---|---|---|
| 14 | JRAT1 | Load Inertia Moment Ratio 1 | % | 100 to 3000 |
| 20 | TCFIL1 | Torque Command Filter 1 | Hz | 100 to 1000 |

◆ General parameters Group3 “Model following control settings”

| ID | Symbol | Name | Unit | Setting range |
|---|---|---|---|---|
| 00 | KM1 | Model Control Gain 1 | 1/s | 15 to 315 |

## 6.8.2 Auto FF Vibration Suppression Frequency Tuning

FF Vibration Suppression control is able to suppress low frequency resonance like machine end vibration. "Auto FF Vibration Suppression Frequency Tuning" is able to set FF Vibration Suppression Frequency easily by rotating servo motor in a short time.

■ How to use

◆ Able to operate from "Auto-tuning mode" in the Setup Software or the Digital Operator. For use of the setup software, see "9.2 Auto FF Vibration Suppression Frequency Tuning" in another document: M0010842. For use of the digital operator, see "7.7 Auto FF vibration suppression frequency tuning".

◆ The tuning result is automatically saved in Group2 ID00 "FF vibration suppression frequency A1 [SUPFREQA1]".

◆ FF vibration suppression frequency is obtained by executing auto-tuning of vibration suppression frequency or by calculating vibration frequency from the mechanical vibration period at the time of positioning, and it is able to set.

* When the vibration is not able to suppress by setting of FF vibration suppression frequency, there is a possibility that Group1 ID02 "Position Loop Proportional Gain 1 [KP1]" or Group1 ID12 "Velocity Loop Proportional Gain 1 [KVP1]" may be too high. In this case, lower "Position Loop Proportional Gain 1 [KP1]" or "Velocity Loop Proportional Gain 1 [KVP1]".

* When used together with Group1 ID1E "Higher Tracking Control Velocity Compensation Gain [TRCVGN]", vibration suppression effect may be improved.

* FF vibration suppression control function can be used with auto-tuning at the same time.

* Holding torque falls while Auto FF Vibration Suppression Frequency tuning is executing. Do not use as gravity axis.

■ Torque command value of Auto FF vibration suppression frequency tuning
Sets torque command value giving to servo motor at the time of performing the Auto FF vibration suppression frequency tuning

◆ General parameters Group0 “Auto-Tuning”

| ID | Symbol | Name | Unit | Setting range |
|---|---|---|---|---|
| 20 | ASUPTC | Auto-FF Vibration Suppression Frequency Tuning Torque Command | % | 10.0 to 100.0 |

* As the value increases so does tuning accuracy. However, machine movement will increase as well. Please monitor it closely.

■ Auto-FF Vibration Suppression Frequency Tuning Friction Compensation Value
Sets additional frictional torque compensation amount when Auto FF Vibration Suppression Frequency Tuning is executed. By setting the value close to the actual friction torque, the accuracy of Auto FF Vibration Suppression Frequency Tuning can be improved.

◆ General parameters Group0 “Auto-Tuning”

| ID | Symbol | Name | Unit | Setting range |
|---|---|---|---|---|
| 21 | ASUPFC | Auto-FF Vibration Suppression Frequency Tuning Friction Compensation Value | % | 0.0 to 50.0 |

■ The parameter saved automatically by the Auto FF Vibration Suppression Frequency Tuning

◆ General parameters Group2 "FF (Feed forward) vibration suppression control/ Notch filter/ Disturbance observer settings"

| ID | Symbol | Name | Unit | Setting range |
|---|---|---|---|---|
| 00 | SUPFRQA1 | FF Vibration Suppression Frequency A1 | Hz | 1.0 to 500.0 |

## 6.8.3 FF vibration suppression control

FF vibration suppression control can be used as a method of suppressing the vibration of the mechanical tip.
There are two kinds of FF vibration suppression controls which have different characteristics.

| Name | Adjustable characteristics |
|---|---|
| FF vibration suppression control A | Vibration suppression effect |
| FF vibration suppression control B | Responsiveness of position control |

■ How to use

◆ Find out vibration frequencies of machine. (For use of the system analysis, see "10.3 System analysis" in another document: M0010842.)

◆ In case of having a single vibration frequency, use either FF vibration suppression control A or B. (The vibration frequency will be set to FF vibration suppression control A (Group2 ID00 "FF vibration suppression frequency A1 [SUPFRQA1]") by performing "Auto FF vibration suppression frequency tuning".)

◆ In case of having 2 vibration frequencies, use FF vibration suppression control A ("FF vibration suppression frequency A1 [SUPFRQA1]") with lower frequency, and use B (Group2 ID00 "FF vibration suppression frequency B1 [SUPFRQB1]") with higher frequency.

* When the vibration is not able to suppress the vibration of the mechanical tip by procedure above, there is a possibility that Group1 ID02 "Position Loop Proportional Gain 1 [KP1]" or Group1 ID12 "Velocity Loop Proportional Gain 1 [KVP1]" may be too high. In this case, lower "Position Loop Proportional Gain 1 [KP1]" or "Velocity Loop Proportional Gain 1 [KVP1]".

■ Setting parameter

◆ General parameters Group2
"FF vibration suppression control / Notch filter Disturbance observer settings"

| ID | Symbol | Name | Unit | Setting range |
|---|---|---|---|---|
| 00 | SUPFRQA1 | FF Vibration Suppression Frequency A1 | Hz | 1.0～500.0 |
| 01 | SUPLVA | FF Vibration Suppression Level Selection A | — | 00～03 |
| 02 | SUPFRQB1 | FF Vibration Suppression Frequency B1 | Hz | 1.0～500.0 |
| 03 | SUPCRB | FF Vibration Suppression Level Selection B | — | 00～01 |

* Do not change the setting value when the servo motor is running.

■ General parameters Group4 "Gain switching control/ Vibration suppression frequency switching settings"

| ID | Symbol | Name |
|---|---|---|
| 40 | SUPFRQA2 | FF Vibration Suppression Frequency A2 |
| 41 | SUPFRQA3 | FF Vibration Suppression Frequency A3 |
| 42 | SUPFRQA4 | FF Vibration Suppression Frequency A4 |
| 43 | SUPFRQB2 | FF Vibration Suppression Frequency B2 |
| 44 | SUPFRQB3 | FF Vibration Suppression Frequency B3 |
| 45 | SUPFRQB4 | FF Vibration Suppression Frequency B4 |

◆ General parameters Group9 "Function enabling condition settings"

| ID | Symbol | Name | Unit | Setting range |
|---|---|---|---|---|
| 15 | SUPFSELA1 | FF Vibration Suppression Frequency Select Input A1 | - | 00 to 29 |
| 16 | SUPFSELA2 | FF Vibration Suppression Frequency Select Input A2 | - | 00 to 29 |
| 17 | SUPFSELB1 | FF Vibration Suppression Frequency Select Input B1 | - | 00 to 29 |
| 18 | SUPFSELB2 | FF Vibration Suppression Frequency Select Input B2 | - | 00 to 29 |

* When the vibration suppression frequency is changed, FF vibration suppression control will be invalid and servo motor will rotate till outputting a rest of position command pulse in the FF vibration suppression function.
* Do not change the vibration suppression frequency when the servo motor is running.

## 6.8.4 CP vibration suppression control

This is the function which suppress a vibration of machine stand, even if perform CP control like as during machine cutting.

■ How to use

◆ If a vibration occur by low rigidity of machine, calculate and find out vibration frequency from position deviation monitor, and set it to Group2 ID50 "CP vibration suppression control frequency [CPVSFQ]".

◆ If effect of CP vibration suppression is weak, it is able to make strong by increasing value of Group2 ID51 "CP vibration suppression control level [CPVSLV]".

■ CP vibration suppression control frequency
Sets the vibration frequency of Machine stand.

◆ General parameters Group2
"FF (Feed Forward) vibration suppression control/ Notch filter/ Disturbance observer settings"

| ID | Symbol | Name | Unit | Setting range |
|---|---|---|---|---|
| 50 | CPVSFQ | CP vibration suppression control frequency | Hz | 10.0 to 100.0 |

* Please stop servo motor when setting this value.
* This function will be valid when performing at standard position control mode.

■ CP vibration suppression control level
This is the parameter which sets impact of CP vibration suppression control.

◆ General parameters Group2
"FF (Feed Forward) vibration suppression control/ Notch filter/ Disturbance observer settings"

| ID | Symbol | Name | Unit | Setting range |
|---|---|---|---|---|
| 51 | CPVSLV | CP vibration suppression control level | - | 00 to 03 |

* Effect of CP vibration control will be larger when increasing this value.
* Please stop servo motor when selecting this value.

■ CP vibration suppression control characteristics selection
Sets the effective frequency range of CP vibration suppression control.

◆ General parameters Group2
"FF (Feed Forward) vibration suppression control/ Notch filter/ Disturbance observer settings"

| ID | Symbol | Name | Unit | Setting range |
|---|---|---|---|---|
| 52 | CPVSSH | CP vibration suppression control characteristics selection | - | 00 to 03 |

* Frequency range of CP vibration control will be narrow when increasing this value.
* Please stop servo motor when selecting this value.

## 6.8.5 Minor vibration suppression

Explains the function which suppresses a minor vibration against velocity feedback during servo motor stop.

■ How to use

- ◆ The function is valid when condition that is selected in Group9 ID35 "Minor vibration suppression function" is filled.
  Example: Always valid when "01: Always_Enable" is selected.
- ◆ If minor vibration is there in velocity feedback at conditions of servo ON and servo motor stopping, activate FBHYST and set FBHPLS, FBHTIM.
- ◆ Set FBHPLS as multiple of FBHTIM as follows. If not multiple of FBHTIM, the actual Minor vibration suppression pulse compensation frequency will have deviation with FBHTIM.
- ◆ Sample combinations of Minor vibration suppression pulse compensation value and Minor vibration suppression pulse compensation frequency

| Minor vibration suppression pulse compensation value | Minor vibration suppression pulse compensation frequency |
|---|---|
| 10 | 1 |
| 10 | 10 |
| 50 | 1 |
| 50 | 10 |
| 50 | 50 |

■ Minor vibration suppression function
Select the condition which will be valid/invalid of this function.

- ◆ General parameters Group9 "Function enabling condition settings"

| ID | Symbol | Name | Unit | Setting range |
|---|---|---|---|---|
| 35 | FBHYST | Minor vibration suppression function | - | 00 to 29 |

■ Minor vibration suppression pulse compensation value
Sets the compensation amount of Minor vibration suppression function for velocity feedback.

- ◆ General parameters Group2
  "FF (Feed Forward) vibration suppression control/ Notch filter/ Disturbance observer settings"

| ID | Symbol | Name | Unit | Setting range |
|---|---|---|---|---|
| 60 | FBHPLS | Minor vibration suppression pulse compensation value | pulse | 1 to 100 |

* Sets by multiple of FBHTIM.

■ Minor vibration suppression pulse compensation frequency
Sets the number of Minor vibration suppression.

- ◆ General parameters Group2
  "FF (Feed Forward) vibration suppression control/ Notch filter/ Disturbance observer settings"

| ID | Symbol | Name | Unit | Setting range |
|---|---|---|---|---|
| 61 | FBHTIM | Minor vibration suppression pulse compensation frequency | times | 1 to 100 |

* The larger the set value, longer the minor vibration suppression period.
* Set the value which is smaller than FBHPLS.

# 6. Servo Tuning

## 6.9 Disturbance impact suppression function

When a force is given to a servo motor externally, bad impact might be given to the control system. Follows are explaining the function of suppressing disturbance impact.

### 6.9.1 High order integral control

Use for suppression of disturbance impact for control system by decreasing Group1 ID13 "Velocity Loop Integral Time Constant 1 [TVI1]" more. This is the function to compensate phase delay of Velocity integral control system feedback. Use when oscillation or overshoot occurs by decreasing "Velocity Loop Integral Time Constant 1 [TVI1]".

■ How to use

◆ Set 1 or 2 times of Group1 ID12 "Velocity Loop Proportional Gain 1 [KVP1]" to Group1 ID18 "High order integral control frequency [HKVIF]".

◆ Set 30% to Group1 ID17 "High order integral control gain [HKVIK]", and then confirm the things that phase margin near to "Velocity Loop Proportional Gain 1 [KVP1]" became large.

◆ "High order integral control gain [HKVIK]" is able to increase up to phase margin will be allowed value at high frequency range.

◆ "Velocity Loop Integral Time Constant 1 [TVI1]" is able to decrease till phase margin will be allowed value at near of "Velocity Loop Proportional Gain 1 [KVP1]".

* High order integral control cannot use along with higher tracking control. For use of High order integral control, set 0% to Group1 ID1E "Higher Tracking Control Velocity Compensation Gain [TRCVGN]".

■ High order integral control gain

◆ General parameters Group1 "Basic control parameter settings"

| ID | Symbol | Name | Unit | Setting range |
|---|---|---|---|---|
| 17 | HKVIK | High order integral control gain | % | 0 to 100 |

* This function will be disabled when 0% is set.

■ High order integral control frequency

◆ General parameters Group1 "Basic control parameter settings"

| ID | Symbol | Name | Unit | Setting range |
|---|---|---|---|---|
| 18 | HKVIF | High order integral control frequency | Hz | 10 to 4000 |

* Up to 1000Hz setting is valid at normal sampling mode.
* Up to 2000Hz setting is valid at high rate sampling mode.

# 6.9 Disturbance impact suppression function

## 6.9.2 Disturbance Observer Function

The Disturbance Observer is a function to suppress the influence of external load torque by estimating the load torque inside the amplifier unit and adding the load torque compensation to the torque command.

■ How to use

◆ The function will be valid when the condition which is selected at Group9 ID33 "Disturbance Observer Function" is filled.
Example: The function will be always valid when "01: Always_Enable" is selected.

◆ Select appropriate observer characteristic depending on disturbance frequency which is desired to suppress.

◆ Increase the value of Group2 ID31 "Observer Compensation Gain [OBG]" by little, and do not start from large value. Disturbance suppression characteristic will improve by increasing "Observer Compensation Gain [OBG]". However, oscillation might occur by too large of set value. Please use in range of no oscillation.

◆ Group2 ID32 "Observer Output Low-pass Filter [OBLPF]" is able to improve observer characteristic by setting frequency higher at high encoder resolution or low load inertia moment ratio etc.

◆ Use "Observer Output Notch Filter" to suppress vibration when resonance is changed at high frequency range.

■ Parameters for using the Disturbance Observer

◆ Group9 “Functions enabling conditions settings”

| ID | Symbol | Name | Setting range |
|---|---|---|---|
| 33 | OBS | Disturbance Observer Function | 00 to 29 |

◆ General parameters Group2
"FF (Feed Forward) vibration suppression control/ Notch filter/ Disturbance observer settings"

| ID | Symbol | Name | Unit | Setting range |
|---|---|---|---|---|
| 30 | OBCHA | Observer Characteristic | — | 00 to 02 |
| 31 | OBG | Observer Compensation Gain | % | 0 to 100 |
| 32 | OBLPF | Observer Output Low-pass Filter | Hz | 1 to 4000 |
| 33 | OBNFIL | Observer Output Notch Filter | Hz | 100 to 4000 |

◆ Disturbance observer characteristics are prepared as "00_Low: Low frequency disturbance suppression", "01_Middle: Mid-frequency disturbance suppression" and "02_High: High frequency disturbance suppression".

| Frequency | Selection | | Description |
|---|---|---|---|
| 10 to 40 Hz | 00 | Low | Low frequency disturbance suppression |
| 40 to 80 Hz | 01 | Middle | Mid-frequency disturbance suppression |
| 80 to 200 Hz | 02 | High | High frequency disturbance suppression |

* Disturbance Observer cannot be used with Auto-tuning at the same time.

* Use “02_High for High frequency disturbance suppression” when encoder resolution is above 1048576 division.

* Torque command might have variation if switches a valid/ invalid of Group9 ID33 "Disturbance Observer Function [OBS]" when cutoff frequency of OBLPF is set higher.

# 6. Servo Tuning

## 6.10 Stick-slip behavior compensation function

Explains the compensation function of stick-slip behavior which occurs by machine system friction etc.

■ How to use

◆ The function will be valid when the condition which is selected at Group9 ID34 "Stick-slip behavior compensation function" is filled.
Example: The function will be always valid when "01: Always_Enable" is selected.

◆ Set 70% of Group1 ID13 "Velocity Loop Integral Time Constant 1 [TVI1]" to Group1 ID42 "Velocity loop integral time constant for stick-slip behavior compensation [STTVI]", and then confirm the things that stick-slip behavior has reduced.

◆ "Velocity loop integral time constant for stick-slip behavior compensation [STTVI]" is able to decrease when oscillation does not occur. Increase "Velocity loop integral time constant for stick-slip behavior compensation [STTVI]" up to the value which has margin against oscillation, when oscillation occurs.

■ Parameters for using the stick-slip behavior compensation function.

◆ Group9 “Functions enabling conditions settings”

| ID | Symbol | Name | Unit | Setting range |
|---|---|---|---|---|
| 34 | STC | Stick-slip behavior compensation function | - | 00 to 29 |

◆ General parameters Group2
"FF (Feed Forward) vibration suppression control/ Notch filter/ Disturbance observer settings"

| ID | Symbol | Name | Unit | Setting range |
|---|---|---|---|---|
| 40 | STV | Effective velocity for compensating stick-slip behavior | $min^{-1}$ | 0.1 to 128.0 |
| 41 | STHLD | Retention time for compensating stick-slip behavior | ms | 1 to 500 |
| 42 | STTVI | Velocity loop integral time constant for stick-slip behavior compensation | ms | 0.3 to 1000.0 |

◆ Effective velocity for compensating stick-slip behavior [STV]
Stick-slip behavior compensation will work when internal velocity command of amplifier unit is below of this value.

◆ Retention time for compensating stick-slip behavior [STHLD]
Stick-slip behavior compensation will be kept till over the set time, when internal velocity command of amplifier unit exceeds STV. Increase this value when response of velocity control is low.

◆ Velocity loop integral time constant for stick-slip behavior compensation [STTVI]
This set value will apply to velocity integral control system while stick-slip behavior compensation is performing.

# 7 Digital Operator

In this chapter, details of the Digital operator are explained.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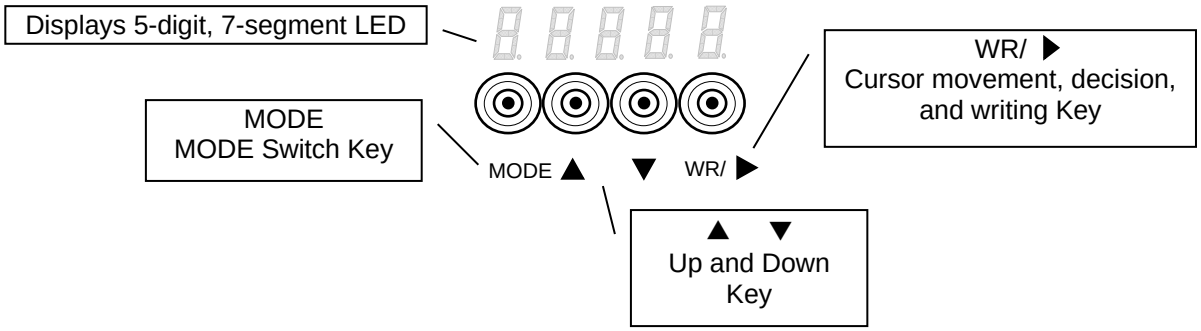
# 7. Digital Operator

## 7.1 Digital Operator names and functions

It is possible to change or set the parameters and to confirm the status display, monitor display, test operation and alarm history with the built-in digital operator.

■ Names




◆ Functions

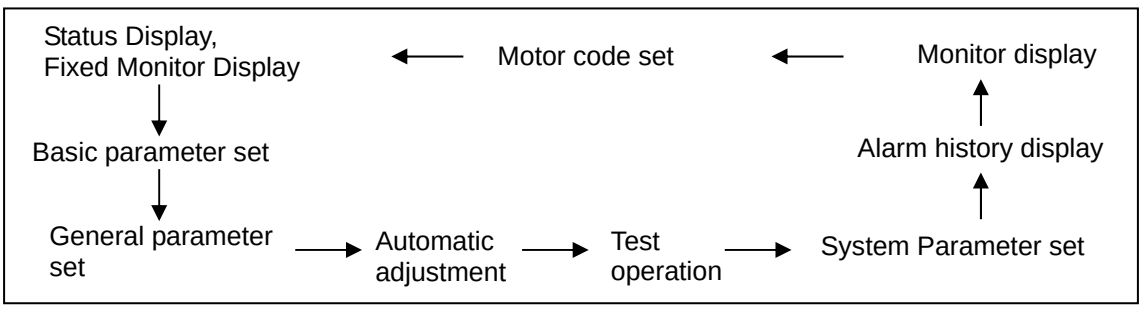
| Displayed marks | Functions | Input time |
|---|---|---|
| WR | To input selections and write edited data. | More than 1 second |
| MODE | Changes the Mode. | Less than 1 second |
| ▶ | Cursor Key Changes the cursor position when editing | Less than 1 second |
| ▲ ▼ | Up/ Down key. Changes the numeric value. | Less than 1 second |
| 7 segment LED | Displays monitor value or parameter setting value in five digits. | – |

## 7.2 Modes

It is possible to display the status, to change or set the parameters, to automatically set the notch filter, to change servo motor, and to confirm test operation, alarm history and monitor display with the built-in digital operator.

### 7.2.1 Changing modes

Change in the mode presses the "MODE key." The mode switches in order of the following figure.



## 7.2.2 Mode contents

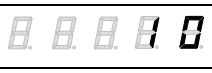
| Mode | Contents |
|---|---|
| Status Display | ■ Displays the establishment of control or main power supply, Servo ON, over-travel, warning and alarm status.<br>■ |
| Basic parameter<br>bA.00 | Parameters necessary for test operations by JOG and auto-tuning. Can be set at general parameter mode. |
| General parameter<br>Gr.00 | Settings can be made suitable for machines and equipment.<br>Parameters for adjusting servo gain can be changed.<br>Classified into 12 groups according to the functions.<br><br>Group / Description of Group<br>Group0 — Settings of automatic tuning.<br>Group1 — Settings of basic control parameters.<br>Group2 — Settings of damping control/notch filter/disturbance observer.<br>Group3 — Settings of model following control.<br>Group4 — Settings of gain switching control/damping frequency switching.<br>Group5 — To set high setting control.<br>Group8 — Settings of control system.<br>Group9 — Settings of various functional effective conditions.<br>GroupA — Setting of general output terminal output condition / monitor output selection<br>GroupB — Setting related to sequence / alarm.<br>GroupC — Settings related to encoder.<br>GroupD — Settings related to supporting function.<br>■ |
| Automatic adjustment<br>AJ.00 | Enables Adjustment for Torque Command Notch Filter A, Vibration Suppression frequency 1 and Offset of Analog Velocity/Torque/Torque Addition Command. |
| Test operation<br>Ad.00 | JOG operation, encoder clear, auto tuning result writing and motor origin search are available. |
| System parameter<br>SY.00 | Sets the parameters related to power unit, amplifier unit and motor encoder. |
| Alarm history<br>AL.H.1 | Displays the latest 15 alarm events. |
| Monitor<br>Mb.00 | Displays the amplifier unit status such as Velocity, Velocity Command, Torque, Torque command, Position Deviation and Servo Adjustment Gain when using auto-tuning.<br>■ |
| Motor code set<br>CoSEt | Sets the motor cord corresponding to servo motor, and changes the servo motor to be used. |

# 7. Digital Operator

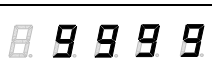
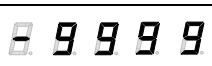
## 7.3 Setting and display range

Digital operator displays data becomes the following form.

■ Data of 0 to +65535

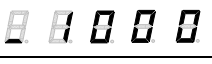
| Symbol | Digital operator display | Range of a digit display | |
|---|---|---|---|
| Plus | | Position of 1 display | 0 to 9 |
| Plus |  | Position of 10 display | 10 to 99 |
| Plus | | Position of 100 display | 100 to 999 |
| Plus | | Position of 1000 display | 1000 to 9999 |
| Plus | | Position of 10000 display | 10000 to 99999 |

■ Data of -9999 to +9999

| Symbol | Digital operator display | Range of a digit display | |
|---|---|---|---|
| Plus | | Position of 1 display | 0 to 9 |
| Plus | | Position of 10 display | 10 to 99 |
| Plus | | Position of 100 display | 100 to 999 |
| Plus |  | Position of 1000 display | 1000 to 9999 |
| Minus |  | Position of 10000 display | 1000 to 9999 |

* Left end – expresses minus.

■ Data of 0 to +4199999999

| Symbol | Digital operator display | Range of a digit display | |
|---|---|---|---|
| Plus |  | Low position of 1 to 1000 display | 0 to 9999 |
| Plus | | Middle position of 10000 to 10000000 display | 0 to 9999 |
| Plus | | High position of 100000000 to 1000000000 display | 0 to 41 |

* Left end LED expresses low position, middle position, and high position.
Press and hold MODE for 1 sec or more to switch.

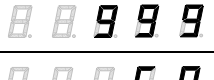
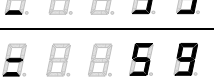
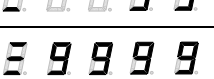
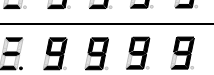
■ Hexadecimal data

| Data size | Digital operator display | Range of a digit display |
|---|---|---|
| 1 byte | | 00 to FF |
| 2 byte | | 0000 to FFFF |
| 4 byte Low | | 0000 to FFFF (Bit15 to Bit0) display |
| 4 byte High | | 0000 to FFFF (Bit31 to Bit16) display |

■ Example display of decimal point data

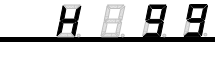
| | |
|---|---|
| First position of a decimal point | |
| Second position of a decimal point | |

■ The data of servo amplifier operating time

| Digits of the data | Digital operator display | Range of a digit display |
|---|---|---|
| Digits of millisec unit |  | 0 to 999 |
| Digits of sec unit |  | 0 to 59 |
| Digits of minute unit |  | 0 to 59 |
| Lower 4 digits of hour unit |  | 0 to 9999 |
| Upper 4 digits of hour unit | | 0 to 9999 |

* Left end LED expresses digits of the data. Press and hold MODE for 1 sec or more to switch.

■ Average power monitor display (Monitor ID: 4A)
Display range of average power is automatically changed depending on the value, to indicate optimum range.
When average power exceed 1000W, "H" is indicated to highest digit and unit is changed to [kW].
Also, decimal point moves a position depending on average power.

| Average power range | | Example display | Unit |
|---|---|---|---|
| -999999.9 W | < Average power ≦-99950.0 W | | kW |
| -99950.0 W | < Average power ≦-9995.0 W | | kW |
| -9995.0 W | < Average power ≦-1000.0 W | | kW |
| -999.9 W | ≦ Average power ≦+999.9 W | <br> | W |
| 1000.0 W | ≦ Average power <+9995.0 W | | kW |
| 9995.0 W | ≦ Average power <+99950.0 W |  | kW |
| 99950.0 W | ≦ Average power <+999999.9 W |  | kW |

■ Regenerative power monitor display (Monitor ID: 4C)
Display range of regenerative power is automatically changed depending on the value, to indicate optimum range.

| Regenerative power range | | | Example display | Unit |
|---|---|---|---|---|
| 0.000 W | ≦ Regenerative power ≦ | 99.999 W | 9 9.9 9 9 | [W] |
| 100.000 W | ≦ Regenerative power < | 999.995 W | 9 9 9.9 9 | [W] |
| 999.995 W | ≦ Regenerative power < | 9,999.950 W | 9 9 9 9.9 | [W] |
| 9,999.950 W | ≦ Regenerative power | | 9 9 9 9 9 | [W] |

# 7.4 Status display mode

In this mode, the state of amplifier unit and the display of the alarm number when alarm occurring can be checked. In addition to these, reset of alarm, the software version check of amplifier unit, and setup of a password can be performed at the time of an alarm number display.

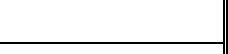
## 7.4.1 Amplifier unit status display

| Marking | Description | Status code |
|---|---|---|
| | Control power supply established.<br>Control power supply is established and amplifier (RDY) is ON. | 1 |
| | Main circuit power supply established.<br>Main power supply (R, S, and T) is established, but operation preparation completion signal is OFF. | 2 |
| <br> <br> | Safe Torque Off working status.<br>Main circuit power supply (R, S, and T) is established and either safe torque off input 1 or 2 is “OFF”.<br>“ ” are shown sequentially. | 2 |
| | Operation preparation completion signal established.<br>Main power supply (R, S, T) is established and operation preparation completion signal is ON. | 3 |
| | Servo is ON.<br>Rotates after displaying the character“8”. | 4 |

## 7.4.2 Over-travel status display

| Marking | Description |
|---|---|
| | Over-travel status at normal rotation.<br>Forward rotation is in ‘Over-Travel’ status in position and speed control type. |
| | Over-travel status at reverse rotation.<br>Reverse rotation is in ‘Over-Travel’ status in position and speed control type. |

## 7.4.3 Status display of warning

| Marking | Description |
|---|---|
| | Encoder system warning status<br>Occurred warning below<br>■ Battery voltage sag |
| | Load system warning status<br>Occurred one of warnings below<br>■ Regeneration overload<br>■ Overload<br>■ Amplifier internal temperature Note1) |
|  | Power system warning status<br>Occurred warning below<br>■ Battery voltage sag |
| | Control system warning status<br>Occurred one of warnings below<br>■ Restricting torque command<br>■ Restricting velocity command<br>■ Excessive position deviation<br>■ Dual position error excess<br>■ Sync error excess<br>■ Adaptive notch filter E frequency |

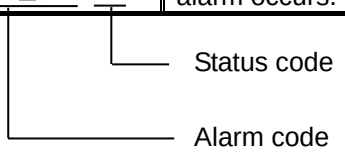
* Descriptions of each warning are shown at "8.2.1 Warning List".

* Confirm occurring warning by the digital operator referring "7.17 Monitor display" or by warning information of the setup software. For operation of the setup software, see another document: M0010842.

* It shows when either of power unit or amplifier unit into warning status.

## 7.4.4 Alarm code and amplifier unit status code when alarm occurs

| Marking | Description |
|---|---|
| AL.85.F | Please take a measure according to the contents of "Maintenance" when alarm occurs. |




## 7.4.5 Alarm reset when alarm activated

Alarm can be reset from the digital operator. However, the alarm that needs to perform power supply reset cannot be reset from the digital operator. About the alarm that performs power supply reset, can check by [8.2 Warning and Alarm List]

| Step | Displayed Character, number, code | Input button | | | | How to operate |
|---|---|---|---|---|---|---|
| 1 | AL.85.4 | | | | | Make the state where the alarm number is displayed. |
| 2 | | ● MODE | ▲ | ▼ | WR/► | Push MODE for more than 1 second. |
| 3 | AL.rSt | | | | | Display changes as the left. |
| 4 | | MODE | ▲ | ▼ | ● WR/► | Push WR for more than 1 second. |
| 5 | .r.u.n. | | | | | Display changes as the left for 2 seconds. |
| 6 | 0.0.0.0.3 | | | | | When the cause of alarm is removed, the state of amplifier unit is displayed. |

## 7.4.6 How to check the software version of amplifier unit

The software version of amplifier unit can be checked from the digital operator.

| Step | Displayed Character, number, code | Input button | | | | How to operate |
|---|---|---|---|---|---|---|
| 1 | 0.0.0.0.3 | | | | | Make the state of amplifier unit, or the state where alarm is displayed. |
| 2 | | MODE | ▲ | ● ▼ | WR/► | Push the subtraction button for more than 1 second. |
| 3 | C.P.u.n.0 | | | | | Display changes as the left. |
| 4 | | MODE | ▲ | ▼ | ● WR/► | Push WR for more than 1 second. |
| 5 | 0.0.0.0.0 | | | | | The present software version is displayed. |
| 6 | | ● MODE | ▲ | ▼ | WR/► | Push MODE once. |
| 7 | C.P.u.n.0 | | | | | Display changes as the left. |
| 8 | | ● MODE | ▲ | ▼ | WR/► | Push MODE once. |
| 9 | 0.0.0.0.3 | | | | | Returns to Process 1. |

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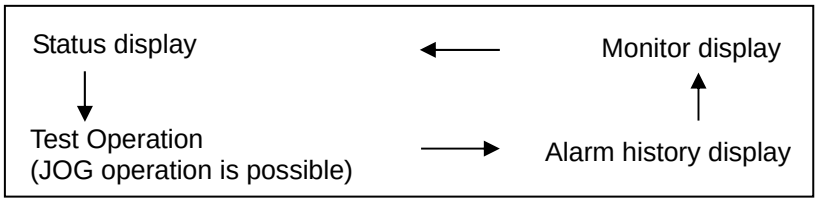
## 7.4.7 How to check the amplifier unit information 1 to 3

| Step | Displayed Character, number code | Input button | | | | How to operate |
|---|---|---|---|---|---|---|
| 1 | | | | | | Make the state of amplifier unit, or the state where alarm is displayed. |
| 2 | | ○ MODE | ○ ▲ | ● ▼ | ○ WR/► | Push the subtraction button for more than 1 second. |
| 3 | | | | | | Display changes as the left. |
| 4 | | ○ MODE | ● ▲ | ● ▼ | ○ WR/► | Push addition and subtraction button. |
| 5 | | | | | | Display changes as the left. |
| 6 | | ○ MODE | ○ ▲ | ○ ▼ | ● WR/► | Push WR for more than 1 second. |
| 7 | | | | | | The selected information is displayed. |
| 8 | | ● MODE | ○ ▲ | ○ ▼ | ○ WR/► | Push MODE once. |
| 9 | | | | | | Returns to Process 5. |
| 10 | | ● MODE | ○ ▲ | ○ ▼ | ○ WR/► | Push MODE once. |
| 11 | | | | | | Returns to Process 1. |

* The contents of display information 1, information 2, and information 3 are described to “5.1.1 Specification check”.

### 7.4.8 How to set pass ward

The function that can be used by setting up a password from digital operator can be restricted, and change of a parameter etc. can be forbidden. The function and the setting method can be used is the following.




| Step | Displayed character, number, code | Input button | | | | How to operate |
|---|---|---|---|---|---|---|
| 1 | | | | | | Make the state of amplifier unit, or the state where alarm is displayed. |
| 2 | | MODE | ▲ | ▼ | WR/► | Push addition button for more than 1 second. |
| 3 | -PASS- | | | | | Display switches as the left and the whole display blinks.<br>When setup of the password has ended, display does not blink. |
| 4 | 0000 | MODE | ▲ | ▼ | WR/► | Push WR for more than 1 second. |
| 5 | | | | | | Display changes as the left and right end LED blinks. |
| 6 | 1234 | MODE | ▲ | ▼ | WR/► | Display arbitrary numerical values with addition and subtraction and the cursor button.<br>0000 and FFFF cannot be set up. |
| 7 | | MODE | ▲ | ▼ | WR/► | Push WR for more than 1 second. |
| 8 | 1234 | | | | | Display blinks 3 times, and setup will be completed if blink stops. |
| 9 | | MODE | ▲ | ▼ | WR/► | Push MODE once. |
| 10 | | | | | | Returns to process 1. |
| 11 | | | | | | Password will become effective if power supply is turned on again. |

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## 7.4.9 How to cancel password

| Step | Displayed character, number, code | Input button | | | | How to operate |
|---|---|---|---|---|---|---|
| 3 | -PAS- | | | | | Display switches as the left and the whole display lights up.<br>Password is not set up when the display is blinking. |
| 4 | 0000 | MODE | ▲ | ▼ | WR/▶ | Push WR for more than 1 second. |
| 5 | | | | | | Display switches as the left and right end LED blinks. |
| 6 | 1234 | MODE | ▲ | ▼ | WR/▶ | Set up password is displayed with addition and subtraction and the cursor button. |
| 7 | | MODE | ▲ | ▼ | WR/▶ | Push WR for more than 1 second. |
| 8 | 1234 | | | | | Display blinks 3 times, and cancel will be completed if blink stops. |
| 9 | | MODE | ▲ | ▼ | WR/▶ | Push MODE once. Then returns to Process 1. |
| 10 | | | | | | After cancel does not need to turn on power supply again. |

## 7.5 Editing parameters

The parameter inside amplifier unit can be changed into a setup put together with equipment and the machine of usage in fundamental parameter edit mode, general parameter edit mode, and system-parameter edit mode.
Here, the setting method is explained to an example for fundamental parameter edit mode.

### 7.5.1 Basic parameters, editing system parameters

| Step | Displayed character, number, code | Input button | | | | How to operate |
|---|---|---|---|---|---|---|
| 1 | bA | ● MODE | ○ ▲ | ○ ▼ | ○ WR/► | Push MODE until it displays the left. |
| 2 | bA 00 | | | | | Display changes as left, and right end LED blinks. |
| 3 | bA 10 | ○ MODE | ● ▲ | ● ▼ | ● WR/► | Display ID of the parameter changed with addition and subtraction and the cursor button. |
| 4 | | ○ MODE | ○ ▲ | ○ ▼ | ● WR/► | Push WR for more than 1 second. |
| 5 | 0E | | | | | The data set up is displayed. |
| 6 | 0A | ○ MODE | ● ▲ | ● ▼ | ● WR/► | Display a value to set up with addition and subtraction and the cursor button. |
| 7 | | ○ MODE | ○ ▲ | ○ ▼ | ● WR/► | Push WR for more than 1 second. |
| 8 | 0A | | | | | Setup is completion when blink stops, after a display blinks 3 times.<br>When the set-up value is outside a setting range, setting of Process 5 is display without a display blinking 3 times. |
| 9 | | ● MODE | ○ ▲ | ○ ▼ | ○ WR/► | Push MODE. |
| 10 | bA 10 | | | | | Display switches ad the left. When you set other parameters continuously, repeat from Process 3. |
| 11 | | ● MODE | ○ ▲ | ○ ▼ | ○ WR/► | Push MODE. |
| 12 | Cr | | | | | Changes to the left display. |

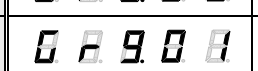
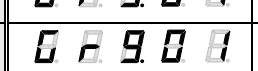
| | | |
|---|---|---|
| 5 | noA | When reservation parameter cannot be set, the left is displayed in Process 5. |

* When operating in system parameter editing mode, the displayed character in step 1 shall be “SY.”

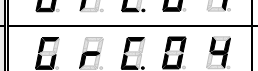
# 7. Digital Operator

## 7.5.2 Editing general parameters

For example, method of changing Group9 ID01 “Negative Over Travel Function [R-OT]” from “0B” to ”00“ is as follows. Also, see next example for GroupC ID04 “Encoder Output Pulse Division [ENRAT]”.

| Step | Displayed character, number, code | Input button | | | | How to operate |
|---|---|---|---|---|---|---|
| 1 | | ● MODE | ○ ▲ | ○ ▼ | ○ WR/► | Hold down MODE until the figure left is displayed. |
| 2 | | | | | | Display changes as left, and right end LED blinks. |
| 3 |  | ○ MODE | ● ▲ | ● ▼ | ● WR/► | Display ID of parameter to be changed by addition/ subtraction, cursor button. |
| 4 |  | ○ MODE | ○ ▲ | ○ ▼ | ● WR/► | Hold down WR for over a second. |
| 5 | | | | | | “0b” is displayed. |
| 6 | | ○ MODE | ● ▲ | ● ▼ | ● WR/► | Set figure “00” by addition/ subtraction, cursor button. |
| 7 | | ○ MODE | ○ ▲ | ○ ▼ | ● WR/► | Hold down WR for over a second. |
| 8 | | ● MODE | ○ ▲ | ○ ▼ | ○ WR/► | Press MODE. |
| 9 | | | | | | Display to be switched to the display left. |

Editing general parameter GroupC ID04 “Encoder Output Pulse Division [ENRAT]”
For example, method to change from 1/1 to 2/64 is as follows.

| Step | Displayed character, number, code | Input button | | | | How to operate |
|---|---|---|---|---|---|---|
| 1 | | ● MODE | ○ ▲ | ○ ▼ | ○ WR/► | Hold down MODE until the figure left is displayed. |
| 2 | | | | | | Display changes as left, and right end LED blinks. |
| 3 | | ○ MODE | ● ▲ | ● ▼ | ● WR/► | Display ID of parameter to be changed by addition/ subtraction, cursor button. |
| 4 |  | ○ MODE | ○ ▲ | ○ ▼ | ● WR/► | Hold down WR for over a second. |
| 5 | | | | | | “Gr nu” is displayed. |
| 6 | | ● MODE | ○ ▲ | ○ ▼ | ○ WR/► | Hold down MODE for over a second to change the display to Gr dE. “nu” stands for numerator, “dE” stands for denominator. Hold down MODE for over a second to switch between “nu” and “dE.” Set “Gr dE (denominator)” first. |
| 7 | | ○ MODE | ○ ▲ | ○ ▼ | ● WR/► | Hold down WR for over a second. |
| 8 | | | | | | Display to be switched, and then rightmost LED flashes.<br>When setting dE first, holding down WR displays the denominator.<br>The display left shows “1” as dE is set first.<br>When you set nu first, holding down WR displays numerator. |
| 9 | | ○ MODE | ● ▲ | ● ▼ | ● WR/► | Set figure “64” (denominator) by addition/ subtraction, cursor button. |
| 10 | | ○ MODE | ○ ▲ | ○ ▼ | ● WR/► | Hold down WR for over a second. |

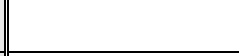
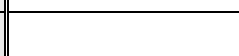
| Step | Displayed character, number, code | Input button | | | | How to operate |
|---|---|---|---|---|---|---|
| 11 | 64 | | | | | When display flashes 3 times, and then the flashing stops, the setting of denominator is completed. If the set value is out of the setting range, the set value in the step 6 is displayed without flashing 3 times. When the numerator is "1," "1 to 64" or "32768" is settable as the denominator. |
| 12 | | ● MODE | ○ ▲ | ○ ▼ | ○ WR/► | Push MODE. |
| 13 | GrC.04 | | | | | "GrC.04" is displayed. |
| 14 | | ○ MODE | ○ ▲ | ○ ▼ | ● WR/► | Hold down WR for over a second. |
| 15 | Gr nu | ● MODE | ○ ▲ | ○ ▼ | ○ WR/► | "Gr nu" is displayed. |
| 16 | | ○ MODE | ○ ▲ | ○ ▼ | ● WR/► | Hold down WR for over a second. |
| 17 | 1 | | | | | Display to be switched, and then rightmost LED flashes.<br>The set data are displayed. The display left shows "1" as nu is set first. |
| 18 | 2 | ○ MODE | ● ▲ | ● ▼ | ● WR/► | Display the figure "2 (numerator)" you want to set by addition/ subtraction, cursor button. |
| 19 | | ○ MODE | ○ ▲ | ○ ▼ | ● WR/► | Hold down WR for over a second. |
| 20 | 2 | | | | | When display flashes 3 times, and then the flashing stops, the setting is completed.<br>If the set value is out of the setting range, the set value in the step 13 is displayed without flashing 3 times. |
| 21 | GrC.04 | ● MODE | ○ ▲ | ○ ▼ | ○ WR/► | Press MODE. |
| 22 | | | | | | Display to be switched to the display left. |

* There are three setting ranges of pulse frequency dividing, "1/1 to 1/64," "2/3 to 2/64," and "1/32768 to 32767/32768."
If you set the figure out of the ranges, the figure is not displayed, the figure before the setting flashes.
When setting numerator, the figure of denominator is applicable to the figure presently established.
For example, to change from 1/1 to 2/64, you need to set the denominator first, as the numerator is already fixed to "1," and "2/1" is out of the ranges.

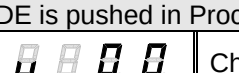
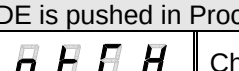
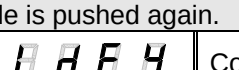
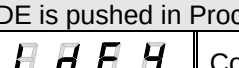
* "nu" stands for numerator, "dE" stands for denominator.

# 7. Digital Operator

## 7.6 How to tune automatic notch frequency

| Step | Displayed character, number, code | Input button | | | | How to operate |
|---|---|---|---|---|---|---|
| 1 | | ● MODE | ▲ | ▼ | WR/► | Push MODE until it displays the left. |
| 2 | | | | | | Display changes and right end LED blinks. |
| 3 | | MODE | ● ▲ | ● ▼ | ● WR/► | Make as the left display with addition and subtraction and the cursor button. |
| 4 | | MODE | ▲ | ▼ | ● WR/► | Push WR for more than 1 second. |
| 5 | | | | | | Changes to the left display. |
| 6 | | MODE | ▲ | ▼ | ● WR/► | Push WR for more than 1 second. |
| 7 |  | | | | | The character of 8 is drawn and servo is on. |
| 8 | | MODE | ▲ | ▼ | ● WR/► | Push WR for more than 1 second. |
| 9 |  | | | | | A display change as the left and it performs. |
| 10 | | | | | | Changes to the display of the left after a normal end. |
| 11 | | ● MODE | ▲ | ▼ | WR/► | Push MODE. |
| 12 | | | | | | Servo is off and changes to the left display. |
| 13 | | ● MODE | ▲ | ▼ | WR/► | Push MODE. |
| 14 | | | | | | Completes and changes to the left display. |

■ For stopping during operation, please push the MODE button.

| | |
|---|---|
| MODE is pushed in Process 2. | |
| | Changes to the left display. |
| MODE is pushed in Process 5. | |
|  | Changes to the left display and return to Process 2. |
| MODE is pushed in Process 7. | |
|  | Changes to the left display and return to Process 5. |
| Mode is pushed again. | |
|  | Complete and changes to the left display. |
| MODE is pushed in Process 9. | |
|  | Complete and changes to the left display. |

■ Error is displayed when cannot end normally.

| | |
|---|---|
| | Changes to the left display. |
| Will end, if MODE is pushed. | |
| | Complete to the left display. |

# 7.7 Auto FF vibration suppression frequency tuning

## 7.7 Auto FF vibration suppression frequency tuning

| Step | Displayed character, number, code | Input button | | | | How to operate |
|---|---|---|---|---|---|---|
| 1 | AU | ● MODE | ○ ▲ | ○ ▼ | ○ WR/► | Push MODE until it displays the left. |
| 2 | AU 00 | | | | | Display changes and right end LED blinks. |
| 3 | AU 01 | ○ MODE | ● ▲ | ● ▼ | ● WR/► | Make as the left display with addition and subtraction and the cursor button. |
| 4 | | ○ MODE | ○ ▲ | ○ ▼ | ● WR/► | Push WR for more than 1 second. |
| 5 | SUPr | | | | | Changes to the left display. |
| 6 | | ○ MODE | ○ ▲ | ○ ▼ | ● WR/► | Push WR for more than 1 second. |
| 7 | 8 | | | | | The character of 8 is drawn and servo is on. |
| 8 | | ○ MODE | ○ ▲ | ○ ▼ | ● WR/► | Push WR for more than 1 second. |
| 9 | run. | | | | | A display change as the left and it performs. |
| 10 | 8 | | | | | Changes to the display of the left after a normal end. |
| 11 | | ● MODE | ○ ▲ | ○ ▼ | ○ WR/► | Push MODE. |
| 12 | SUPr | | | | | Servo is off and changes to the left display. |
| 13 | | ● MODE | ○ ▲ | ○ ▼ | ○ WR/► | Push MODE. |
| 14 | ALdF.4 | | | | | Completes and changes to the left display. |

■ For stopping during operation, please push the MODE button.

| | |
|---|---|
| MODE is pushed in Process 2. | |
| Ad | Changes to the left display. |
| MODE is pushed in Process 5. | |
| AU 01 | Changes to the left display and return to Process 2. |
| MODE is pushed in Process 7. | |
| SUPr | Changes to the left display and return to Process 5. |
| MODE is pushed again. | |
| ALdF.4 | Complete and changes to the left display. |
| MODE is pushed in Process 9. | |
| ALdF.4 | Complete and changes to the left display. |

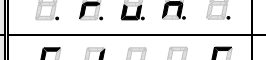
■ Error is displayed when cannot end normally.

| | |
|---|---|
| Err | Changes to the left display. |
| Will end, if MODE is pushed. | |
| ALdF.4 | Completes and changes to the left display. |

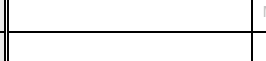
# 7. Digital Operator

## 7.8 Offset adjustment of velocity/ torque command

■ Method of auto offset

| Step | Displayed character, number, code | Input button | | | | How to operate |
|---|---|---|---|---|---|---|
| 1 | | ● MODE | ○ ▲ | ○ ▼ | ○ WR/► | Push MODE until it displays the left. |
| 2 | | | | | | Display changes and right end LED blinks. |
| 3 | | ○ MODE | ● ▲ | ● ▼ | ● WR/► | Make as the left display with addition and subtraction and the cursor button. |
| 4 | | ○ MODE | ○ ▲ | ○ ▼ | ● WR/► | Push WR for more than 1 second. |
| 5 | | | | | | Changes to the left display. |
| 6 | | ○ MODE | ○ ▲ | ○ ▼ | ● WR/► | Push WR for more than 1 second. |
| 7 | | | | | | Changes to the left display. |
| 8 | | ○ MODE | ○ ▲ | ○ ▼ | ● WR/► | Push WR for more than 1 second. |
| 9 | | | | | | A display change as the left and it performs. |
| 10 |  | | | | | Changes to the display of the left after a normal end. |
| | | | | | | Error is displayed when cannot end normally. |
| 11 | | ● MODE | ○ ▲ | ○ ▼ | ○ WR/► | Push MODE and finish. |
| 12 | | | | | | Changes to the left display. |
| 13 | | ● MODE | ○ ▲ | ○ ▼ | ○ WR/► | Push MODE. |
| 14 | | | | | | Changes to the left display. |

■ The method of manual offset

| From Process 1 to 7 are the same as auto offset. | | | | | | |
|---|---|---|---|---|---|---|
| 7 | | | | | | Changes to the left display. |
| 8 | | ○ MODE | ○ ▲ | ● ▼ | ○ WR/► | Push subtraction button. |
| 9 | | | | | | Changes to the left display. |
| 10 | | ○ MODE | ○ ▲ | ○ ▼ | ● WR/► | Push WR for more than 1 second. |
| 11 | | | | | | The data setup is displayed. |
| 12 | | ○ MODE | ● ▲ | ● ▼ | ○ WR/► | Adjust offset value with the addition-and-subtraction button. |
| 13 | | ● MODE | ○ ▲ | ○ ▼ | ○ WR/► | Push MODE. |
| 14 |  | | | | | Changes to the left display. |
| 15 | | ● MODE | ○ ▲ | ○ ▼ | ○ WR/► | Push MODE and finish. |
| 16 | | | | | | Changes to the left display. |
| 17 | | ● MODE | ○ ▲ | ○ ▼ | ○ WR/► | Push MODE. |
| 18 | | | | | | Changes to the left display. |

# 7.9 Offset adjustment of analog torque compensation command

■ Method of auto offset

| Step | Displayed character, number, code | Input button | | | | How to operate |
|---|---|---|---|---|---|---|
| 1 | AU | ● MODE | ○ ▲ | ○ ▼ | ○ WR/► | Push MODE until it displays the left. |
| 2 | AU00 | | | | | Display changes and right end LED blinks. |
| 3 | AU03 | ○ MODE | ● ▲ | ● ▼ | ● WR/► | Make as the left display with addition and subtraction and the cursor button. |
| 4 | | ○ MODE | ○ ▲ | ○ ▼ | ● WR/► | Push WR for more than 1 second. |
| 5 | AddoF | | | | | Changes to the left display. |
| 6 | | ○ MODE | ○ ▲ | ○ ▼ | ● WR/► | Push WR for more than 1 second. |
| 7 | AUtoB | | | | | Changes to the left display. |
| 8 | | ○ MODE | ○ ▲ | ○ ▼ | ● WR/► | Push WR for more than 1 second. |
| 9 | .run. | | | | | A display change as the left and it performs. |
| 10 | AddoF | | | | | Changes to the display of the left after a normal end. |
| | Err | | | | | Error is displayed when cannot end normally. |
| 11 | | ● MODE | ○ ▲ | ○ ▼ | ○ WR/► | Push MODE and finish. |
| 12 | AU03 | | | | | Changes to the left display. |
| 13 | | ● MODE | ○ ▲ | ○ ▼ | ○ WR/► | Push MODE. |
| 14 | Ad | | | | | Changes to the left display. |

■ The method of manual offset

| From Process 1 to 7 are same as auto offset. | | | | | | |
|---|---|---|---|---|---|---|
| 7 | AUtoB | | | | | Changes to the left display. |
| 8 | | ○ MODE | ○ ▲ | ● ▼ | ○ WR/► | Push subtraction button. |
| 9 | HAnd | | | | | Changes to the left display. |
| 10 | | ○ MODE | ○ ▲ | ○ ▼ | ● WR/► | Push WR for more than 1 second. |
| 11 | -004 | | | | | The data set up is displayed. |
| 12 | | ○ MODE | ● ▲ | ● ▼ | ○ WR/► | Adjust offset value with an addition-and-subtraction button. |
| 13 | | ● MODE | ○ ▲ | ○ ▼ | ○ WR/► | Push MODE. |
| 14 | AddoF | | | | | Changes to the left display. |
| 15 | | ● MODE | ○ ▲ | ○ ▼ | ○ WR/► | Push MODE and finish. |
| 16 | AU03 | | | | | Changes to the left display. |
| 17 | | ● MODE | ○ ▲ | ○ ▼ | ○ WR/► | Push MODE. |
| 18 | Ad | | | | | Changes to the left display. |

# 7. Digital Operator

## 7.10 Velocity-controlled JOG Operation

| Step | Displayed character, number, code | Input button | | | | How to operate |
|---|---|---|---|---|---|---|
| 1 | Ad | ● MODE | ○ ▲ | ○ ▼ | ○ WR/► | Push MODE until it displays the left. |
| 2 | Ad 00 | | | | | Display changes and right end LED blinks. |
| 3 | Ad 00 | ○ MODE | ● ▲ | ● ▼ | ● WR/► | Make as the left display with addition and subtraction and the cursor button. |
| 4 | | ○ MODE | ○ ▲ | ○ ▼ | ● WR/► | Push WR for more than 1 second. |
| 5 | JoG | | | | | Changes to the left display. |
| 6 | | ○ MODE | ○ ▲ | ○ ▼ | ● WR/► | Push WR for more than 1 second. |
| 7 | 8 | | | | | The character of 8 is drawn and servo is on. |
| 8 | 8 | ○ MODE | ● ▲ | ○ ▼ | ○ WR/► | If it continues pushing an addition button, a motor shaft will rotate in the CCW direction. Will stop when an addition button is detached. |
| 9 | 8 | ○ MODE | ○ ▲ | ● ▼ | ○ WR/► | If it continues pushing an addition button, a motor shaft will rotate in the CW direction. Will stop when a subtraction button is detached. |
| 10 | | ● MODE | ○ ▲ | ○ ▼ | ○ WR/► | Push MODE. |
| 11 | JoG | | | | | Servo is off and it changes to the left display. |
| 12 | | ● MODE | ○ ▲ | ○ ▼ | ○ WR/► | Push MODE. |
| 13 | AL.dF.4 | | | | | Completes and changes to the left display. |

■ For stopping during operation, please push the MODE button.

| | |
|---|---|
| MODE is pushed in Process 2. | |
| SY | Changes to the left display and shifts to system parameter. |
| MODE is pushed in Process 5. | |
| Ad 00 | Changes to the left display and returns to step 2. |
| MODE is pushed in Process 7. | |
| JoG | Changes to the left display and returns to step 5. |
| Mode is pushed again. | |
| AL.dF.4 | Completes and changes to the left display. |

+

■ Display below is state of over travel.

| | |
|---|---|
| 4 | Positive direction over-travel status.<br>Positive direction over-travel has occurred at position/velocity control. |
| F | Negative direction over-travel status.<br>Negative direction over-travel has occurred at position/velocity control. |

* Over-travel functions are set at general parameter Group9 ID00 “Positive Over Travel Function [F-OT]”, ID01 “Negative Over Travel Function [R-OT]”.
See detail in "5.8 Parameter functions", Group9 "Function enabling condition settings".

## 7.11 Encoder Clear

| Step | Displayed character, number, code | Input button | | | | How to operate |
|---|---|---|---|---|---|---|
| 1 | Ad | ● MODE | ○ ▲ | ○ ▼ | ○ WR/► | Push MODE until it displays the left. |
| 2 | | | | | | Display changes and right end LED blinks. |
| 3 | Ad00 | ○ MODE | ● ▲ | ● ▼ | ● WR/► | Make as the left display with addition and subtraction and the cursor button. |
| 4 | Ad01 | ○ MODE | ○ ▲ | ○ ▼ | ● WR/► | Push WR for more than 1 second. |
| 5 | EnCLr | | | | | Changes to the left display. |
| 8 | | ○ MODE | ○ ▲ | ○ ▼ | ● WR/► | Push WR for more than 1 second. |
| 9 | .r.un. | | | | | A display change as the left and it performs. |
| 10 | EnCLr | | | | | Changes to the display of the left after a normal end. |
| 11 | | ● MODE | ○ ▲ | ○ ▼ | ○ WR/► | Push MODE. |
| 12 | Ad01 | | | | | Changes to the left display. |
| 13 | | ● MODE | ○ ▲ | ○ ▼ | ○ WR/► | Push MODE. |
| 14 | Sy | | | | | Changes to the left display. |

## 7.12 Automatic tuning result writing

| Step | Displayed character, number, code | Input button | | | | How to operate |
|---|---|---|---|---|---|---|
| 1 | Ad | ● MODE | ○ ▲ | ○ ▼ | ○ WR/► | Push MODE until it displays the left. |
| 2 | Ad00 | | | | | Display changes and right end LED blinks. |
| 3 | Ad02 | ○ MODE | ● ▲ | ● ▼ | ● WR/► | Make as the left display with addition and subtraction and the cursor button. |
| 4 | | ○ MODE | ○ ▲ | ○ ▼ | ● WR/► | Push WR for more than 1 second. |
| 5 | tunSL | | | | | Changes to the left display. |
| 8 | | ○ MODE | ○ ▲ | ○ ▼ | ● WR/► | Push WR for more than 1 second. |
| 9 | .r.un. | | | | | A display change as the left and it performs. |
| 10 | tunSL | | | | | Changes to the display of the left after a normal end. |
| 11 | | ● MODE | ○ ▲ | ○ ▼ | ○ WR/► | Push MODE. |
| 12 | Ad02 | | | | | Changes to the left display. |
| 13 | | ● MODE | ○ ▲ | ○ ▼ | ○ WR/► | Push MODE. |
| 14 | Sy | | | | | Changes to the left display. |

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## 7.13 Motor origin search

| Step | Displayed character, number, code | Input button | | | | How to operate |
|---|---|---|---|---|---|---|
| 1 | Ad | ● MODE | ○ ▲ | ○ ▼ | ○ WR/▶ | Push MODE until it displays the left. |
| 2 | Ad 00 | | | | | Display changes and right end LED blinks. |
| 3 | Ad 03 | ○ MODE | ● ▲ | ● ▼ | ● WR/▶ | Make as the left display with addition and subtraction and the cursor button. |
| 4 | | ○ MODE | ○ ▲ | ○ ▼ | ● WR/▶ | Push WR for more than 1 second. |
| 5 | orGPo | | | | | Changes to the left display. |
| 6 | | ○ MODE | ○ ▲ | ○ ▼ | ● WR/▶ | Push WR for more than 1 second. |
| 7 | 8 | | | | | The character of 8 is drawn and servo is on. |
| 8 | .run. | ○ MODE | ● ▲ | ● ▼ | ○ WR/▶ | Origin search starts to CCW when pushing addition button 1 sec or more, to CW when pushing subtraction button 1 sec or more.<br>Display changes as the left at origin search starting. |
| 9 | orGPo | | | | | A display change as the left and it performs. |
| 10 | | | | | | Changes to the display of the left after a normal end. |
| 11 | ALdF4 | ● MODE | ○ ▲ | ○ ▼ | ○ WR/▶ | Completes and changes to the left display. |

■ For stopping during operation, please push the MODE button.

| | |
|---|---|
| MODE is pushed in Process 2. | |
| SY | Changes to the left display and shifts to system parameter. |
| MODE is pushed in Process 5. | |
| Ad 00 | Changes to the left display and returns to step 2. |
| MODE is pushed in Process 7. | |
| orGPo | Changes to the left display and returns to step 5. |
| Mode is pushed again. | |
| ALdF4 | Completes and changes to the left display. |

■ Display below is state of over travel.

| | |
|---|---|
| 4 | Positive direction over-travel status.<br>Positive direction over-travel has occurred at position/velocity control. |
| F | Negative direction over-travel status.<br>Negative direction over-travel has occurred at position/velocity control. |

* Over-travel functions are set at general parameter Group9 ID00 “Positive Over Travel Function [F-OT]”, ID01 “Negative Over Travel Function [R-OT]”.
See detail in "5.8 Parameter functions", Group9 "Function enabling condition settings".

## 7.14 Holding brake control (disabled)

* For servo motor R2CA3255KB, there is no specification with brake.
* For amplifier unit RS3D80#, there is no output of holding brake excitation.

# 7. Digital Operator

## 7.15 Alarm history display

| Step | Displayed character, number, code | Input button | | | | How to operate |
|---|---|---|---|---|---|---|
| 1 | AL.H | ● MODE | ▲ | ▼ | WR/► | Push MODE until it displays the left. |
| 2 | AL.H.1 | | | | | Display changes and right end LED blinks. |
| 3 | AL.H.3 | MODE | ● ▲ | ● ▼ | WR/► | Display the number of an alarm history to check with an addition-and-subtraction button. The history of 15 times past before can be displayed. |
| 4 | | MODE | ▲ | ▼ | ● WR/► | Push WR for more than 1 second. |
| 5 | AL.85.F | | | | | The alarm of 3 times ago is displayed. |
| 6 | | MODE | ▲ | ▼ | ● WR/► | Push WR for more than 1 second. |
| 7 | ..802 | | | | | The passed time of alarm generating is displayed. Digits of millisec unit. |
| 8 | | ● MODE | ▲ | ▼ | WR/► | Press and hold MODE for more than 1 second. |
| 9 | ...29 | | | | | The passed time of alarm generating is displayed. Digits of sec unit. |
| 10 | | ● MODE | ▲ | ▼ | WR/► | Press and hold MODE for more than 1 second. |
| 11 | -....1 | | | | | The passed time of alarm generating is displayed. Digits of minute unit |
| 12 | | ● MODE | ▲ | ▼ | WR/► | Press and hold MODE for more than 1 second. |
| 13 | -....0 | | | | | The passed time of alarm generating is displayed. Lower 4 digits of hour unit |
| 14 | | ● MODE | ▲ | ▼ | WR/► | Press and hold MODE for more than 1 second. |
| 15 | -....0 | | | | | The passed time of alarm generating is displayed. Upper 4 digits of hour unit |
| 16 | | ● MODE | ▲ | ▼ | WR/► | Push MODE. |
| 17 | AL.85.F | | | | | Returns to Process 5. |
| 18 | | ● MODE | ▲ | ▼ | WR/► | Push MODE. |
| 19 | AL.H.3 | | | | | Returns to Process 3. |
| 20 | ob | | | | | Changes to the left display. |

## 7.16 How to clear alarm history

| Step | Displayed character, number, code | Input button | | | | How to operate |
|---|---|---|---|---|---|---|
| 1 | | ● MODE | ▲ | ▼ | WR/► | Push MODE until it displays the left. |
| 2 | | | | | | Display changes and right end LED blinks. |
| 3 | | MODE | ● ▲ | ● ▼ | WR/► | Display the left with the addition-and-subtraction button. |
| 4 | | MODE | ▲ | ▼ | ● WR/► | Push WR for more than 1 second. |
| 5 | | | | | | Changes to the left display and it blinks. |
| 7 | | MODE | ▲ | ▼ | ● WR/► | Push WR for more than 1 second. |
| 8 | | | | | | A display change as the left and it performs. |
| 9 | | | | | | Changes to the display of the left after a normal end. |
| 10 | | ● MODE | ▲ | ▼ | WR/► | Push MODE. |
| 11 | | | | | | Changes to the left display. |

## 7.17 Monitor display

| Step | Displayed character, number, code | Input button | | | | How to operate |
|---|---|---|---|---|---|---|
| 1 | | ● MODE | ▲ | ▼ | WR/► | Push MODE until it displays the left. |
| 2 | | | | | | Display changes and right end LED blinks. |
| 3 | | MODE | ● ▲ | ● ▼ | ● WR/► | Display ID of the monitor with addition and subtraction and the cursor button. |
| 4 | | MODE | ▲ | ▼ | ● WR/► | Push WR for more than 1 second. |
| 5 | | | | | | The data is displayed. |
| 6 | | ● MODE | ▲ | ▼ | WR/► | Push MODE. |
| 7 | | | | | | Changes to the left display. When you monitor other data continuously, repeat from Process 3. |
| 8 | | ● MODE | ▲ | ▼ | WR/► | Push MODE. |
| 9 | | | | | | Changes to the left display. |

| | | |
|---|---|---|
| Note) | | When it is a monitor that cannot be displayed, the left is displayed in Process 5. |

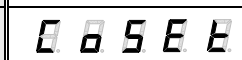
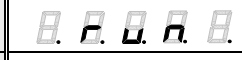
* See "5.5.1 Monitor list" for ID of monitor items.

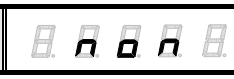
# 7. Digital Operator

## 7.18 Fixed monitor display

The display shows monitoring value in 2 seconds after powering up.
It shows monitoring value set at Group D ID11 “Monitor Display Selection [MONDISP]” in status display mode.
“Monitor” to be displayed is the same as parameter ID in monitor display mode, but in the setting value “00 STATUS amplifier unit status monitor”, the display will be different from the code display in the monitor mode and will show the amplifier status in the status display mode (- or Ξ).
In the state of alarm occurring, requiring safety function input, requiring motor magnetic pole detection or detecting the poles, the monitor display prioritize these status over the fixed display.

## 7.19 Motor code-setting of servo motor used

| Step | Displayed character, number, code | Input button | | | | How to operate |
|---|---|---|---|---|---|---|
| 1 | | ● MODE | ▲ | ▼ | WR/► | Push MODE until it displays the left. |
| 2 |  | | | | | Display changes and right end LED blinks. |
| 3 | | MODE | ▲ | ▼ | ● WR/► | Push WR for more than 1 second. |
| 4 | | MODE | ● ▲ | ● ▼ | ● WR/► | Display the motor cord of the servo motor used with addition and subtraction and the cursor button. |
| 5 | | MODE | ▲ | ▼ | ● WR/► | Push WR for more than 1 second. |
| 6 |  | | | | | A display changes as the left and it performs. |
| 7 | | | | | | Changes to the display of the left after a normal end. |
| 8 | | | | | | Turn on the power supply again. |

| Note) |  | The servomotor that cannot be combined or used displays the left in Process 5. In this display, please set up by “Setup Software”. |
|---|---|---|

* Check the Applicable motor list at "5.1.3 Servo motor setting" about applicable servo motor and motor code.

# 8 Maintenance

In this chapter, trouble shooting, inspection and service parts are explained.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# 8. Maintenance

## 8.1 Trouble shooting

When troubles occurred without any alarm displayed, check and take corrective actions for them by referring to the description below. When alarm occurs, take corrective measures referring to “8.3 Trouble shooting when alarm is activated “.

■ “≡“ does not blink in 7-segment LED even if main power is ON.

| Investigation | Assumed causes and corrective actions |
|---|---|
| Check the voltage at the power input terminal. | ■ If voltage is low, check the power supply.<br>■ Check that wires and screws are fastened properly. |
| Red “CHARGE“ LED goes out. | ■ Internal power circuit of power unit or amplifier unit is defective, so replace unit. |
| Over-travel status.<br>Emergency Stop status. | ■ Stop the input of Over-travel or the input of Emergency Stop.<br>■ Check of “Functions enabling condition settings “. |
| Safe Torque Off working status | ■ Turn on /HWGOFF1 and /HWGOFF2 inputs. |

■ The motor does not rotate although 7-segment LED is drawing a character “8 “.

| Investigation | Assumed causes and corrective actions |
|---|---|
| Check a inputting command by using digital operator monitor.<br>Page16: Velocity command monitor<br>Page18: Torque command monitor<br>Page30: Position command pulse frequency monitor | ■ Inputting a command if the monitor value is zero. |
| Check the servo motor is locked or not. | ■ Check that the power line of a servo motor is connected. |
| Check if torque limit is input. | ■ When torque restriction is inputted, a servo motor cannot output the torque beyond the load torque.<br>■ Check of “Functions enabling condition settings “ |
| Check the deviation clear input status. | ■ Stop the input of deviation clear if the signal is in.<br>■ Check of “Functions enabling condition settings “ |
| Check the encoder clear input status. | ■ Stop the input of encoder clear if the signal is in.<br>■ Check of “Functions enabling condition settings “ |

* When performing the work for correction and investigation processing about wiring, be sure to intercept power supply.

■ Servo motor operation is unstable or lower speed than the specified velocity command.

| Investigation | Assumed causes and corrective actions |
|---|---|
| Check the status of proportional control input signal. | ■ Stop the input of proportional control if the signal is in.<br>■ Check of "Functions enabling condition settings " |
| Check the status of torque limit input signal. | ■ Stop the input of torque limit if the signal is in.<br>■ Check of "Functions enabling condition settings " |

■ Servo motor rotates only moment, and stops.

| Investigation | Assumed causes and corrective actions |
|---|---|
| Check the servo motor power line. | ■ Some of the servo motor power line is not connected. |
| Check a setup of combination motor. | ■ Change the settings and turn ON the power again. |
| Check a setup of encoder resolution. (in System parameter) | |

* When performing the work for correction and investigation processing about wiring, be sure to intercept power supply.

■ Servo motor runs away.

| Investigation | Assumed causes and corrective actions |
|---|---|
| Check the servo motor power line. | ■ Phase order of servo motor power line is wrong. |
| Check the wiring of encoder cable. | ■ Wiring of the encoder is incorrect. |

* When performing the work for correction and investigation processing about wiring, be sure to intercept power supply.

■ Servo motor is vibrating.

| Investigation | Assumed causes and corrective actions |
|---|---|
| Check that motor is vibrating over 200Hz. | ■ Reduce the loop gain speed, or set the torque command low-pass filter / torque command notch filter. |

■ Occurs over shoot/ under shoot when starting / stopping.

| Assumed causes and corrective actions |
|---|
| ■ Adjust the auto tuning "response ". |
| ■ Reduce the velocity loop gain. |
| ■ Increase the velocity integral time constant. |
| ■ Loose the slope of acceleration / deceleration command. |
| ■ Use position command low-pass filter |

# 8. Maintenance

■ Abnormal sound occurs

| Investigation | Assumed causes and corrective actions |
|---|---|
| Check whether there is any problem in mechanical attachment. | ■ Observe by operating servo motor by stand alone.<br>■ Check that the coupling does not have core shift or unbalance. |
| Operate at a low speed and check whether abnormal sound has periodicity. | ■ Confirm that the twisted pair and shield processing of motor encoder signal line are correct.<br>■ Confirm that the wiring for motor encoder line and servo motor power line are not installed in the same duct.<br>■ Confirm that the power supply voltage is sufficient. |

# 8.2 List of warning and alarm

Names, contents and stopping operation of warning/ alarm, and alarm-reset methods are listed below.

## 8.2.1 Warning List

| | Name | Contents |
|---|---|---|
| Load system | Overload Warning | ■ When the effective torque exceeds the Overload Warning Level |
| | Regeneration Overload Warning | ■ In case of overload of regenerative resistance |
| | Power unit/Amplifier unit Temperature Warning | ■ Ambient temperature of the power unit or amplifier unit is out of range of the operation temperature |
| External input system | Forward over travel | ■ While entering forward over travel |
| | Reverse over travel | ■ While entering reverse over travel |
| Encoder system | Absolute encoder warning | ■ Battery voltage is below 3.2 V (typ.) (with battery backup)<br>■ State of detecting LED deterioration (battery-less) |
| | External absolute encoder warning | ■ While occurring the external absolute encoder (EnDat) warning |
| Control system | Restricting torque command | ■ While restricting the torque command by torque restriction value |
| | Restricting velocity command | ■ While restricting the velocity command by velocity restriction value |
| | Excessive position deviation | ■ While position deviation exceeds warning setting value. |
| | Dual position error excess | ■ The difference between servo motor position and load position is exceeding the warning set value. |
| | Adaptive notch filter E frequency warning | ■ Estimated frequency of the adaptive notch filter E is out of setting range. |
| | Axes-sync error excess | ■ While position deviation error between own axis and counterpart axis exceeds warning setting value. |

# 8. Maintenance

## 8.2.2 Alarm list

Operation at detecting: “DB“ performs the slowdown stop of the servo motor by dynamic brake operation at the alarm generating.
Operation at detecting: “SB“ performs the slowdown stop of the servo motor with sequence current limiting value.
When dynamic brake is selected by Emergency Stop Operation selection, the servo motor is decelerating stopped for the dynamic brake operation regardless of the operation when detecting it. (However, it stops in servo brake operation at the time of alarm 53H (DB resistor overheating) detection.)

| | Alarm code | | | | | | | | Alarm name | Alarm contents | Detection Operations | Alarm reset |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Display | 3bits output | | | PY compatible code | | | | | | | |
| | | Bit7 | Bit6 | Bit5 | ALM8 | ALM4 | ALM2 | ALM1 | | | | |
| Abnormality related to drive | 21 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | Main Circuit Power Device Error (Over current) | ■ Over current of drive module<br>■ Abnormality in drive power supply<br>■ Overheating of drive module | DB | Yes |
| | 22 | | | | 0 | 0 | 0 | 1 | Current Detection Error 0 | ■ Abnormality of electric current detection value | DB | Yes |
| | 23 | | | | 0 | 0 | 0 | 1 | Current Detection Error 1 | ■ Abnormality of Electric current detection circuit | DB | Yes |
| | 24 | | | | 0 | 0 | 0 | 1 | Current Detection Error 2 | ■ Abnormality in communication with Electric current detection circuit | DB | Yes |
| | 25 | | | | 1 | 1 | 1 | 0 | Safe Torque Off Error 1 | ■ Logic unmatched in safe torque off input | DB | No |
| | 26 | | | | 1 | 1 | 1 | 0 | Safe Torque Off Error 2 | ■ Failure of safe torque off circuit | DB | No |
| | 27 | | | | 0 | 0 | 0 | 1 | Fan stop | ■ Speed reduction of fan | DB | No |
| Abnormality related to load | 41 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | Overload 1 | ■ Excessive effective torque | SB | Yes |
| | 43 | | | | 0 | 1 | 0 | 1 | Regenerative Overload | ■ Regeneration load ratio exorbitance | DB | Yes |
| | 45 | | | | 0 | 0 | 1 | 0 | Average continuous over speed | ■ Over speed in average rotational speed | SB | Yes |
| | 52 | | | | 0 | 0 | 1 | 1 | RS Overheat | ■ Detection of in-rush prevention resistance overheating | SB | Yes |
| | 53 | | | | 0 | 0 | 1 | 1 | Dynamic Brake Resistance Overheat | ■ Overheating detection of dynamic brake resistor<br>■ External thermostat operated | SB | Yes |
| | 54 | | | | 0 | 1 | 0 | 1 | Internal Regenerative Resister Overheat | ■ Overheating detection of Internal regenerative resistor | DB | Yes |
| | 55 | | | | 0 | 0 | 1 | 1 | External Error | ■ Overheating detection of External regenerative resistor | DB | Yes |
| | 56 | | | | 0 | 0 | 1 | 1 | Servo Amplifier Temperature Error | ■ Overheat of power unit or amplifier unit | DB | Yes |
| Abnormality in power supply | 61 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | Over-voltage | ■ DC Excess voltage of main circuit | DB | Yes |
| | 62 | | | | 1 | 0 | 0 | 1 | Main Circuit Under-voltage Note1) | ■ DC Main circuit low voltage | DB | Yes |
| | 63 | | | | 1 | 0 | 1 | 0 | Main Power Supply Fail Phase Note1) | ■ 1 phase of the 3 phase main circuit power supply disconnected | SB | Yes |
| | 68 | | | | 0 | 1 | 0 | 1 | Main circuit voltage detection error | ■ Failure of VBUS detection circuit | DB | No |
| | 71 | | | | 0 | 1 | 1 | 1 | Control Power voltage abnormality Note2) | ■ Control power supply low voltage | DB | Yes Note 3) |
| | 72 | | | | 0 | 1 | 1 | 1 | Control Circuit Under-voltage 1 | ■ Under voltage of ±12V | SB | Yes |
| | 73 | | | | 0 | 1 | 1 | 1 | Control Circuit Under-voltage 2 | ■ Under voltage of +5V | DB | No |

| | Alarm code | | | | | | | | Alarm name | Alarm contents | Detection Operations | Alarm reset |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Display | 3bits output | | | PY compatible code | | | | | | | |
| | | Bit7 | Bit6 | Bit5 | ALM8 | ALM4 | ALM2 | ALM1 | | | | |
| Abnormality related to encoder wiring | 81 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | Encoder Connector 1 Disconnection | ■ Incremental encoder (A, B, Z) signal line break<br>■ Power supply break | DB | No |
| | 83 | | | | 1 | 0 | 0 | 0 | Encoder Connector 2 Disconnection Note 7) | ■ Incremental encoder (A, B, Z) signal line break<br>■ Power supply break | DB | No/Yes |
| | 84 | | | | 1 | 0 | 0 | 0 | Absolute encoder Communication Error | ■ Encoder serial signal time out<br>■ Serial communication data error | DB | No |
| | 85 | | | | 1 | 0 | 0 | 0 | Encoder Initial Process Error | ■ Failed to read CS data of incremental encoder.<br>■ Abnormality in initial process of absolute encoder | – | No |
| | 87 | | | | 1 | 0 | 0 | 0 | CS Signal Disconnection | ■ CS signal line break | DB | No |
| | 88 | | | | 1 | 0 | 0 | 0 | External absolute encoder Communication Error | ■ Encoder serial signal time out<br>■ Serial communication data error | DB | No |
| | 89 | | | | 1 | 0 | 0 | 0 | External Encoder Initial Process Error | ■ Abnormality in initial process of absolute encoder | - | No |
| | 8D | | | | 1 | 0 | 0 | 0 | External encoder (EnDat) combination error | ■ External encoder (EnDat) is out of applicable range. | - | No |
| Abnormality in encoder main body | A0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | Absolute encoder Internal Error 0 | ■ Encoder failure | DB | No |
| | A1 | | | | 1 | 0 | 0 | 0 | Absolute encoder Internal Error 1 | ■ Encoder internal error | DB | Note 4) |
| | A2 | | | | 1 | 0 | 0 | 0 | Absolute encoder Internal Error 2 | ■ Encoder internal error | DB | Note 4) |
| | A3 | | | | 1 | 0 | 0 | 0 | Absolute encoder Internal Error 3 | ■ Encoder internal error | DB | Note 4) |
| | A4 | | | | 1 | 0 | 0 | 0 | Absolute encoder Internal Error 4 | ■ Encoder internal error | DB | Note 4) |
| | A5 | | | | 1 | 0 | 0 | 0 | Absolute encoder Internal Error 5 | ■ Encoder internal error | DB | Note 4) |
| | A6 | | | | 1 | 0 | 0 | 0 | Absolute encoder Internal Error 6 | ■ Encoder internal error | DB | Note 4) |
| | A9 | | | | 1 | 0 | 0 | 0 | Absolute encoder Internal Error 9 | ■ Encoder internal error | DB | Note 4) |
| | AA | | | | 1 | 0 | 0 | 0 | Absolute encoder Internal Error 10 | ■ Encoder internal error | DB | Note 4) |
| | AC | | | | 1 | 0 | 0 | 0 | Absolute encoder Internal Error 12 | ■ Encoder internal error | DB | Note 4) |
| | AD | | | | 1 | 0 | 0 | 0 | Absolute encoder Internal Error 13 | ■ Encoder internal error | DB | Note 4) |
| | AF | | | | 1 | 0 | 0 | 0 | Absolute encoder Internal Error 15 | ■ Encoder internal error | DB | Note 4) |

# 8. Maintenance

| | Alarm code | | | | | | | Alarm name | Alarm contents | Detection Operations | Alarm reset |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Display | 3bits output | | | PY compatible code | | | | | | |
| | | Bit7 | Bit6 | Bit5 | ALM8 | ALM4 | ALM2 | ALM1 | | | | |
| Abnormality in external encoder main body | B0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | External Absolute encoder Internal Error 0 | ■ Encoder failure | DB | No |
| | B1 | | | | 1 | 0 | 0 | 0 | External Absolute encoder Internal Error 1 | ■ Encoder internal error | DB | Note 4) |
| | B2 | | | | 1 | 0 | 0 | 0 | External Absolute encoder Internal Error 2 | ■ Encoder internal error | DB | Note 4) |
| | B3 | | | | 1 | 0 | 0 | 0 | External Absolute encoder Internal Error 3 | ■ Encoder internal error | DB | Note 4) |
| | B4 | | | | 1 | 0 | 0 | 0 | External Absolute encoder Internal Error 4 | ■ Encoder internal error | DB | Note 4) |
| | B5 | | | | 1 | 0 | 0 | 0 | External Absolute encoder Internal Error 5 | ■ Encoder internal error | DB | Note 4) |
| | B6 | | | | 1 | 0 | 0 | 0 | External Absolute encoder Internal Error 6 | ■ Encoder internal error | DB | Note 4) |
| | B7 | | | | 1 | 0 | 0 | 0 | External Absolute encoder Internal Error 7 | ■ Encoder internal error | DB | Note 4) |
| | B8 | | | | 1 | 0 | 0 | 0 | External Absolute encoder Internal Error 8 | ■ Encoder internal error | DB | Note 4) |
| | B9 | | | | 1 | 0 | 0 | 0 | External Absolute encoder Internal Error 9 | ■ Encoder internal error | DB | Note 4) |
| | BA | | | | 1 | 0 | 0 | 0 | External Absolute encoder Internal Error 10 | ■ Encoder internal error | DB | Note 4) |
| | BB | | | | 1 | 0 | 0 | 0 | External Absolute encoder Internal Error 11 | ■ Encoder internal error | DB | Note 4) |
| | BC | | | | 1 | 0 | 0 | 0 | External Absolute encoder Internal Error 12 | ■ Encoder internal error | DB | Note 4) |
| | BD | | | | 1 | 0 | 0 | 0 | External Absolute encoder Internal Error 13 | ■ Encoder internal error | DB | Note 4) |
| | BE | | | | 1 | 0 | 0 | 0 | External Absolute encoder Internal Error 14 | ■ Encoder internal error | DB | Note 4) |
| | BF | | | | 1 | 0 | 0 | 0 | External Absolute encoder Internal Error 15 | ■ Encoder internal error | DB | Note 4) |

| | Alarm code | | | | | | | Alarm name | Alarm contents | Detection Operations | Alarm reset |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Display | 3bits output | | | PY compatible code | | | | | | |
| | | Bit7 | Bit6 | Bit5 | ALM8 | ALM4 | ALM2 | ALM1 | | | | |
| Control system abnormality | C1 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | Over-speed | ■ Motor rotation speed reaches 120 % of the highest speed limit. | DB | Yes |
| | C2 | | | | 1 | 1 | 0 | 0 | Velocity Control Error | ■ Torque command and acceleration direction are not matching. | DB | Yes |
| | C3 | | | | 1 | 1 | 0 | 0 | Velocity Feedback Error | ■ Servo motor power disconnection Note 5) | DB | Yes |
| | C5 | | | | 1 | 1 | 0 | 0 | Model tracking vibration suppression control error | ■ Operation pattern is not mach with model tracking vibration suppression control. | DB | Yes |
| | D1 | | | | 1 | 1 | 0 | 1 | Excessive Position Deviation | ■ Position Deviation exceeds setup value. | DB | Yes |
| | D2 | | | | 1 | 1 | 0 | 1 | Faulty Position Command Pulse Frequency 1 | ■ Frequency of entered position command pulse is excessive | SB | Yes |
| | D3 | | | | 1 | 1 | 0 | 1 | Faulty Position Command Pulse Frequency 2 | ■ Position command frequency after electronic gear is high. | SB | Yes |
| | D4 | | | | 1 | 1 | 0 | 1 | Axes-sync error excess | ■ Position deviation error between own axis and counterpart axis exceeds setting value. | DB | Yes |
| | D5 | | | | 1 | 1 | 0 | 1 | Dual position error excess | ■ The difference of servo motor position and load position exceeds the setting value. | DB | Yes |
| | D6 | | | | 1 | 1 | 0 | 1 | Dual position error feedback error | ■ The motor encoder frequency after feedback electronic gear is too high. | DB | Yes |
| | D7 | | | | 1 | 1 | 0 | 1 | Amplifier communication error | ■ Amplifier communication error during axes-sync operation | DB | No |
| | DF | | | | 1 | 1 | 0 | 1 | Test Run Close Note6) | ■ Detection in ‘Test mode end’ status | DB | Yes |
| Control system/Memory system abnormality | E1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | Memory Error 1 | ■ Abnormality of amplifier unit with built-in EEPROM | DB | No |
| | E2 | | | | 1 | 1 | 1 | 1 | Memory Error 2 | ■ Error in check sum of EEPROM (entire area) | — | No |
| | E3 | | | | 1 | 1 | 1 | 1 | CPU error 1 | ■ Access error in CPU built in RAM | — | No |
| | E4 | | | | 1 | 1 | 1 | 1 | CPU error 2 | ■ Checksum error of FLASH memory with built in CPU | — | No |
| | E5 | | | | 1 | 1 | 1 | 1 | System Parameter Error 1 | ■ System parameter is outside a setting range. | — | No |
| | E6 | | | | 1 | 1 | 1 | 1 | System Parameter Error 2 | ■ The combination of a system parameter is abnormal. | — | No |
| | E7 | | | | 1 | 1 | 1 | 1 | Motor Parameter Error | ■ Setup of a motor parameter is abnormal. | — | No |
| | E8 | | | | 1 | 1 | 1 | 1 | Control circuit error 1 | ■ Access abnormality in CPU to ASIC | — | No |
| | E9 | | | | 1 | 1 | 1 | 1 | Control circuit error 2 | ■ Abnormalities of control circuit. | — | No |
| | EA | | | | 1 | 1 | 1 | 1 | Memory Error 3 | ■ Abnormality of FLASH memory in amplifier unit. | SB | No |
| | EB | | | | 1 | 1 | 1 | 1 | Control circuit error 3 | ■ Abnormalities of control circuit. | — | No |
| | EE | | | | 1 | 1 | 1 | 1 | Motor Parameter Automatic Setting Error 1 | ■ Motor parameter automatic setting function cannot be performed. | — | No |
| | EF | | | | 1 | 1 | 1 | 1 | Motor Parameter Automatic Setting Error 2 | ■ The result of motor parameter automatic setting is abnormal. | — | No |
| | F1 | | | | 1 | 1 | 1 | 1 | Task Process Error | ■ Error in interruption process of CPU | DB | No |
| | F2 | | | | 1 | 1 | 1 | 1 | Initial Process Time-Out | ■ Initial process does not end within initial process time | — | No |
| | F3 | | | | 1 | 1 | 1 | 1 | CPU error 3 | ■ Abnormality of CPU setting | — | No |

Note 1) When the main power voltage increases or decreases gradually or is suspended, main circuit low voltage or main power failed phase may be detected.

Note 2) When moment cutting of a control power source is long, it regards in power supply interception and re-input, and does not leave detected control power supply under-voltage to an alarm history. (If cutting exceeds 1 second at the moment, it will be certainly judged as power supply interception.)

Note 3) Due to abnormality in encoder main body, encoder clear may sometimes be needed. “An encoder clear and the alarm reset method“ change with motor encoders in use. Please refer to “8.4 Encoder clear and the alarm reset method. “

Note 4) When there is a rapid motor slow down simultaneous with servo ON, there is a possibility that a break in the motor’s power line cannot be detected.

Note 5) Alarm that occurs in ‘Test mode end’ status is not recorded in the alarm history.

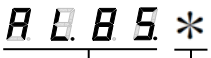
Note 6) When encoder connector EN2 is used as motor encoder input, "Alarm reset" is "No". When encoder connector EN2 is used as external encoder input, "Alarm reset" is "Yes".

Note 7) For the amplifier unit with functional safety module, all alarms are treated as diagnosis function, so Safe Torque Off function is performed simultaneously with alarm occurring. That is reason why Safe Torque Off state continues after alarm resetting. To start operation again, turn off the servo ON input and return to servo ready state.

# 8.3 Trouble shooting when alarm activated

## 8.3.1 Alarm display

When an alarm occurs, the display shows the alarm code and the amplifier unit status code.

| Display | Description |
|---|---|
|  | Take appropriate action based on "8.3.2 Corrective action for alarm". |



■ Status code

| Code | Status | |
|---|---|---|
| 1 | Power OFF status | (P-OFF) |
| 2 | Power ON status | (P-ON) |
| 3 | Servo ready status | (S-RDY) |
| 4 | Servo ON status | (S-ON) |
| 5 | Servo OFF status | (S-OFF) |
| 6 | Emergency stop status | (EMR) |
| F | Initial status | |

# 8. Maintenance

## 8.3.2 Corrective action for alarm

■ Alarm code 21 (Main Circuit Power Device Error)

- Over current of drive module
- Abnormality in drive power supply
- Overheating of drive module

| Status at the time of alarm | Cause | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| Issued when control power is turned ON. | ✔ | | ✔ | ✔ |
| Issued at input of servo ON. | ✔ | ✔ | ✔ | |
| Issued while starting and stopping the servo motor. | ✔ | ✔ | ✔ | |
| Issued after operation for some time. | ✔ | ✔ | ✔ | ✔ |

◆ Corrective actions

| | Cause | Investigation and corrective actions |
|---|---|---|
| 1 | ■ Short circuit is there at amplifier side of U1/V1/W1/U2/V2/W2-phases wiring between amplifier unit and motor. Otherwise, U1/V1/W1/U2/V2/W2-phases are grounded. | ■ Check the wiring conditions and correct it if improper. |
| 2 | ■ Short circuit or grounding fault in U1/V1/W1/U2/V2/W2-phases on servo motor side. | ■ Replace the servo motor. |
| 3 | ■ Defect in internal circuit of amplifier unit. | ■ Replace the amplifier unit. |
| 4 | ■ Overheating detection of the main circuit power device functioned. | ■ Confirm temperature in cabinet (or ambient of the amplifier unit), then refine installation method of the amplifier unit and ventilation of the cabinet so as to keep 55℃ or less. |
| 5 | ■ Either of system 1 (U1/V1/W1) or system 2 (U2/V2/W2) wiring becomes open state and the other flows twice of current. | ■ Check the wiring conditions and correct it if improper. |

# 8.3 Trouble shooting when alarm activated

■ Alarm code 22 (Current Detection Error 0)

● Abnormality of electric current detection value

| Status at the time of alarm | Cause | |
|---|---|---|
| | 1 | 2 |
| Issued at input of servo ON. | ✔ | ✔ |

◆ Corrective actions

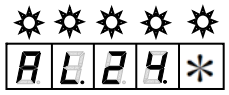
| | Cause | Investigation and corrective actions |
|---|---|---|
| 1 | ■ Defect in internal circuit of amplifier unit. | ■ Replace the amplifier unit. |
| 2 | ■ Amplifier unit and motor are not combined properly. | ■ Check that the servo motor is fit to the motor code, if not, change motor correctly. |

■ Alarm code 23 (Current Detection Error 1)

● Abnormality of Electric current detection circuit

■ Alarm code 24 (Current Detection Error 2)

● Abnormality in communication with Electric current detection circuit




| Status at the time of alarm | Cause | |
|---|---|---|
| | 1 | 2 |
| Issued during operation. | ✔ | ✔ |

◆ Corrective actions

| | Cause | Investigation and corrective actions |
|---|---|---|
| 1 | ■ Defect in internal circuit of amplifier unit. | ■ Replace the amplifier unit. |
| 2 | ■ Malfunction due to noise. | ■ Confirm proper grounding of the amplifier unit.<br>■ Add ferrite core or similar countermeasures to against noise. |

■ Alarm code 25 (Safe Torque Off error 1)

● Logic unmatched in safe torque off input

| Status at the time of alarm | Cause | |
|---|---|---|
| | 1 | 2 |
| Occurred in about 10 sec. after control power turned on. | ✔ | ✔ |
| Occurred during operation. | ✔ | |

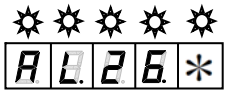
◆ Corrective actions

| | Cause | Investigation and corrective actions |
|---|---|---|
| 1 | ■ Discrepancy of the input logic level between /HWGOFF1 and /HWGOFF2. | ■ Match the input logic level of /HWGOFF1 and /HWGOFF2.<br>■ Check the wiring of both the HWGOFF1 and /HWGOFF2 signals, and correct the wiring if needed.<br>■ After switching the logic level of either /HWGOFF1 or /HWGOFF2 signal, make sure to switch the logic of the other signal also within 10 seconds. |
| 2 | ■ Defect in internal circuit of amplifier unit. | ■ Replace the amplifier unit. |

# 8. Maintenance

■ Alarm code 26 (Safe Torque Off error 2)

● Failure of safe torque off circuit




| Status at the time of alarm | Cause | |
|---|---|---|
| | 1 | 2 |
| Occurred when control power is turned on. | ✔ | ✔ |
| Occurred during the operation. | | ✔ |

◆ Corrective actions

| | Cause | Investigation and corrective actions |
|---|---|---|
| 1 | ■ Defect in internal circuit of amplifier unit. | ■ Replace the amplifier unit. |
| 2 | ■ Malfunction due to noise. | ■ Check grounding of the amplifier unit.<br>■ Take care of noise by adding ferrite core etc. |

■ Alarm code 27 (Fan stop)

● Speed reduction of fan

| Status at the time of alarm | Cause | | |
|---|---|---|---|
| | 1 | 2 | 3 |
| Occurred during the operation. | ✔ | ✔ | ✔ |

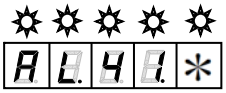
◆ Corrective actions

| | Cause | Investigation and corrective actions |
|---|---|---|
| 1 | ■ Defect in internal circuit of power unit or amplifier unit. | ■ Replace the power unit or amplifier unit. |
| 2 | ■ The end of fan life. | ■ Replace the cooling fan. |
| 3 | ■ Connection cable between power unit/amplifier unit has disconnection. | ■ Replace the connection cable between power unit/amplifier unit. |

# 8.3 Trouble shooting when alarm activated

■ Alarm code 41 (Overload 1)

● Excessive effective torque




| Status at the time of alarm | Cause | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| Issued at input of servo ON. | ✔ | ✔ | | | | | | | ✔ |
| After command input, issued without rotating the motor. | | ✔ | | | ✔ | ✔ | ✔ | | ✔ |
| After command input, brief motor rotation | | | ✔ | ✔ | ✔ | | ✔ | ✔ | |

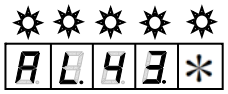
◆ Corrective actions

| | Cause | Investigation and corrective actions |
|---|---|---|
| 1 | ■ Defect in internal circuit of amplifier unit. | ■ Replace the amplifier unit. |
| 2 | ■ Defect in internal circuit of motor encoder. | ■ Replace the servo motor. |
| 3 | ■ Effective torque exceeds the rated torque. | ■ Monitor the load status using the monitor function ID41 Effective torque monitor [TRMS]", and check if effective torque exceeds the rated value. Or, calculate the motor effective torque from load conditions and operation conditions. If the effective torque is excessive, check the operation or load condition, or replace to the capacity of the large motor. |
| 4 | ■ Defect in servo motor and amplifier unit combination. | ■ Check if the motor in use matches with the recommended type, and replace if it is improper. |
| 5 | ■ Holding brake of servo motor has not released. | ■ Check that the wiring and voltage of the holding brake are correct; if not, correct it. If the above are OK, replace the servo motor. |
| 6 | ■ Wiring of U/V/W −phase between amplifier unit and motor is wrong. | ■ Check the wiring conditions and correct it if improper. |
| 7 | ■ One or all connections of U/V/W -phase wiring of amplifier unit / motor is disconnected. | ■ Check the wiring conditions and correct it if improper. |
| 8 | ■ Application collided to something. | ■ Check the operating conditions and limit switch. |
| 9 | ■ Motor encoder resolution setting does not match with the servo motor. | ■ Set correct value depending on actual motor encoder to the System parameter ID15 "Absolute encoder resolution" or the System parameter ID17 "Incremental encoder resolution". |

* In case of the alarm caused by conditions in #3 (above), there is a risk of burning out the servo motor if OFF and ON of control power supply is repeated. Wait for longer than 30 min for cooling purposes after power shut OFF, and resume operations.

■ Alarm code 43 (Regenerative Overload)

● Regeneration load ratio exorbitance




| Status at the time of alarm | Cause | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| Issued when control power supply is turned ON. | | | | | | ✔ | | |
| Issued when main circuit power supply is turned ON. | | ✔ | ✔ | | ✔ | ✔ | ✔ | ✔ |
| Issued during operation. | ✔ | | ✔ | ✔ | | ✔ | | ✔ |

◆ Corrective actions

| | Cause | Investigation and corrective actions |
|---|---|---|
| 1 | ■ Exceeds a permitted value of the regenerative power.<br>■ Excessive load inertia moment, or tact time is short. | ■ Check the load and operating conditions.<br>■ Set to be the load inertia moment within the specified range.<br>■ Increase the deceleration time.<br>■ Increase the tact time. |
| 2 | ■ Regenerative resistor is connected to the model without regenerative resistor. | ■ Remove regenerative resistor. |
| 3 | ■ Regenerative resistor wire breaks. | ■ Replace the regenerative resistor. |
| 4 | ■ Resistance value of external regenerative resistor is excessive. | ■ Replace to the resister that matching the specifications. |
| 5 | ■ Input power supply voltage exceeds the specified range. | ■ Check the input power supply voltage level. |
| 6 | ■ Defect in internal circuit of power unit or amplifier unit. | ■ Replace the power unit or amplifier unit. |
| 7 | ■ External regenerative resistor does not connect although "02: External_R" is set in the system parameter ID03 "Regenerative resistor selection". | ■ Connect external regenerative resistor.<br>■ Set "00: Not_connect" in the system parameter ID03 "Regenerative resistor selection". |
| 8 | ■ Connection cable between power unit/amplifier unit has disconnection. | ■ Replace the connection cable between power unit/amplifier unit. |

* If the setting of system parameter ID03 “Regenerative Resistor Selection” is incorrect, regeneration overload is not detected properly, and the amplifier unit and surrounding circuit may be damaged or burnt.

■ Alarm code 45 (Average continuous over speed)

● Over speed in average rotational speed

| Status at the time of alarm | Cause |
|---|---|
| | 1 |
| Occurred during operation. | ✔ |

◆ Corrective actions

| | Cause | Investigation and corrective actions |
|---|---|---|
| 1 | ■ The average speed exceeds the maximum speed of continuous rotation speed range. | ■ Review the operating conditions.<br>■ Resize the servo motor. |

# 8.3 Trouble shooting when alarm activated

■ Alarm Code 52 (In-rush prevention resistance Overheat)

● Detection of in-rush prevention resistance overheating

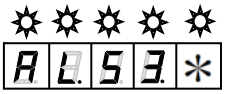
| Status at the time of alarm | Cause | | |
|---|---|---|---|
| | 1 | 2 | 3 |
| Issued when control power supply is turned ON. | ✔ | | |
| Issued when main circuit power supply is turned ON. | | ✔ | |
| Issued during operation. | | | ✔ |

◆ Corrective actions

| | Cause | Investigation and corrective actions |
|---|---|---|
| 1 | ■ Defect in internal circuit of power unit or amplifier unit. | ■ Replace the power unit or amplifier unit. |
| 2 | ■ Power turning ON is repeated too frequently. | ■ Turn ON/OFF the power less frequently. |
| 3 | ■ Ambient temperature is high. | ■ Confirm temperature in cabinet (or ambient of the power unit), then refine installation method of the amplifier unit and ventilation of the cabinet so as to keep 55℃ or less. |

■ Alarm Code 53 (Dynamic Brake Resistor Overheat)

● Overheating detection of dynamic brake resistor




| Status at the time of alarm | Cause | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| Issued when control power supply is turned ON. | ✔ | | ✔ | | ✔ |
| Issued during operation. | ✔ | ✔ | | ✔ | ✔ |

◆ Corrective actions

| | Cause | Investigation and corrective actions |
|---|---|---|
| 1 | ■ Defect in internal circuit of servo amplifier. | ■ Replace the servo amplifier. |
| 2 | ■ Dynamic Brake operation is repeated too frequently. | ■ Use the dynamic brake so as not to exceed the permissive frequency. |
| 3 | ■ There is no wiring to TH1-1 and TH1-2, for dynamic brake thermostat wiring. | ■ Wire to TH1-1 and TH1-2. (Refer the section 4.5.) |
| 4 | ■ Ambient temperature of servo motor is high. Note 1) | ■ Confirm ambient temperature of servo motor, then refine installation method of the servo motor so as to keep 40℃ or less |
| 5 | ■ Fan motor failure. Note 1) | ■ Replace the servo motor. |

Note 1) In case that servo motor thermostat is connected to TH1-1 and TH1-2.

* Amplifier unit does not include dynamic brake resistor.

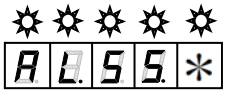
# 8. Maintenance

■ Alarm Code 55 (External Error)

● Overheating detection of External regenerative resistor

When host device or thermal output signal of external regenerative resistor are not connected

| Status at the time of alarm | Cause | |
|---|---|---|
| | 1 | 2 |
| Issued when control power is turned ON. | ✔ | ✔ |




◆ Corrective actions

| | Cause | Investigation and corrective actions |
|---|---|---|
| 1 | ■ Validity condition for external trip function is set to ‘Valid’. | ■ When not used, set ”00:_Always_Disable” at Group9 ID40 " External Trip Input Function [EXT-E]". |
| 2 | ■ Defect in internal circuit of amplifier unit. | ■ Replace the amplifier unit. |

When thermal signal of the external regenerative resistor is connected

| Status at the time of alarm | Cause | | |
|---|---|---|---|
| | 1 | 2 | 3 |
| Issued when control power is turned ON. | ✔ | | ✔ |
| Issued after operation for some time. | | ✔ | ✔ |

◆ Corrective actions

| | Cause | Investigation and corrective actions |
|---|---|---|
| 1 | ■ Improper wiring of external regenerative resistance. | ■ Check the wiring conditions and correct it if improper. |
| 2 | ■ External regenerative resistor is operating. | ■ Check the operating conditions.<br>■ Increase the capacity of the external regeneration resistor. |
| 3 | ■ Defect in internal circuit of amplifier unit. | ■ Replace the amplifier unit. |

* When output terminal of upper level device is connected, eliminate the alarm trigger of the host level device.

# 8.3 Trouble shooting when alarm activated

■ Alarm Code 56 (Servo Amplifier Temperature Error)

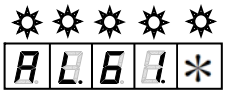
● Overheat of internal power module of power unit or amplifier unit

| Status at the time of alarm | Cause | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| Issued when control power is turned ON. | ✔ | | ✔ | ✔ |
| Issued at input of servo ON. | ✔ | ✔ | ✔ | |
| Issued while starting and stopping the servo motor. | ✔ | ✔ | ✔ | |
| Issued after operation for some time. | ✔ | ✔ | ✔ | ✔ |

◆ Corrective actions

| | Cause | Investigation and corrective actions |
|---|---|---|
| 1 | ■ Defect in temperature detection element of power unit or amplifier unit. | ■ Replace the power unit or amplifier unit. |
| 2 | ■ Overheat of internal power module of power unit or amplifier unit. | |
| 3 | ■ Defect in internal circuit of power unit or amplifier unit. | |
| 4 | ■ Ambient temperature of power unit or amplifier unit is high. | ■ Confirm temperature in cabinet (or ambient of the power unit/amplifier unit), then refine installation method of the power unit/amplifier unit and ventilation of the cabinet to keep 55℃ or lower of ambient temperature. |

■ Alarm Code 61 (Over-Voltage)




● DC Excess voltage of main circuit

| Status at the time of alarm | Cause | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| Issued when control power is turned ON. | ✔ | | | | |
| Issued when main circuit power supply is turned ON. | ✔ | ✔ | | | |
| Issued while starting and stopping the servo motor. | | ✔ | ✔ | ✔ | ✔ |

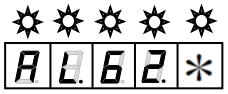
◆ Corrective actions

| | Cause | Investigation and corrective actions |
|---|---|---|
| 1 | ■ Defect in internal circuit of power unit or amplifier unit. | ■ Replace the power unit or amplifier unit. |
| 2 | ■ The power supply voltage of main circuit is out of the specification. | ■ Reduce the power supply voltage to within the specified range. |
| 3 | ■ Excessive load inertia moment. | ■ Reduce the load inertia moment to within the specified range. |
| 4 | ■ Incorrect wiring of regenerative resistor.<br>■ Built-in regenerative circuit is not functioning. | ■ Wire the regenerative resistor correctly.<br>■ Check the wiring and resistance value if using the external regenerative resistor.<br>■ Replace the power unit or amplifier unit if any abnormality occurs after countermeasure above. |
| 5 | ■ Connection cable between power unit/amplifier unit has disconnection. | ■ Replace the connection cable between power unit/amplifier unit. |

# 8. Maintenance

■ Alarm Code 62 (Main Circuit Under-voltage)

● DC Main circuit low voltage



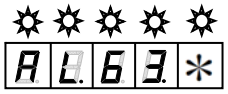

| Status at the time of alarm | Cause | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| Issued when control power is turned ON. | | | | ✔ | ✔ |
| Issued when main circuit power supply is turned ON. | ✔ | ✔ | ✔ | | |
| Issued during operation. | | ✔ | ✔ | | |

◆ Corrective actions

| | Cause | Investigation and corrective actions |
|---|---|---|
| 1 | ■ Input power supply voltage is below the specified range. | ■ Check the power supply and set it within the specified range. |
| 2 | ■ Rectifier of main circuit is broken. | ■ Replace the power unit. |
| 3 | ■ Input power supply voltage is reduced, or instantaneous power interruption is occurred. | ■ Check the power supply, and confirm that there is no instantaneous power interruption or low voltage. |
| 4 | ■ Low voltage outside of the specified range is supplied to the main circuit (R/S/T). | ■ Check the main circuit voltage. Confirm that there is no external power supply to R/S/T when the main circuit is OFF. |
| 5 | ■ Defect in internal circuit of power unit or amplifier unit. | ■ Replace the power unit or amplifier unit. |

■ Alarm Code 63 (Main Power Supply phase loss)

● 1 phase of the 3 phase main circuit power supply disconnected




| Status at the time of alarm | Cause | | |
|---|---|---|---|
| | 1 | 2 | 3 |
| Issued when control power is turned ON. | | ✔ | |
| Issued when main circuit power supply is turned ON | ✔ | ✔ | ✔ |
| Issued during operation. | ✔ | ✔ | |

◆ Corrective actions

| | Cause | Investigation and corrective actions |
|---|---|---|
| 1 | ■ One of 3 phases (R/S/T) is not connected. | ■ Check the wiring conditions and correct it if improper. |
| 2 | ■ Defect in internal circuit of s power unit or amplifier unit. | ■ Replace the power unit or amplifier unit. |
| 3 | ■ Connection cable between power unit/amplifier unit has disconnection. | ■ Replace the connection cable between power unit/amplifier unit. |

# 8.3 Trouble shooting when alarm activated

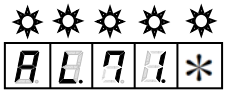
■ Alarm Code 68 (Main circuit voltage detection error)
- Failure of VBUS detection circuit

| Status at the time of alarm | Cause |
|---|---|
| | 1 |
| Issued when control power is turned ON. | ✔ |

◆ Corrective actions

| | Cause | Investigation and corrective actions |
|---|---|---|
| 1 | ■ Defect in internal circuit of power unit or amplifier unit. | ■ Replace the power unit or amplifier unit |

■ Alarm Code 71 (Control Power voltage abnormality)
- Control power supply low voltage

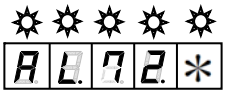



| Status at the time of alarm | Cause | | |
|---|---|---|---|
| | 1 | 2 | 3 |
| Issued when control power is turned ON. | ✔ | ✔ | |
| Issued during operation. | ✔ | | ✔ |

◆ Corrective actions

| | Cause | Investigation and corrective actions |
|---|---|---|
| 1 | ■ Defect in internal circuit of power unit or amplifier unit. | ■ Replace the power unit or amplifier unit. |
| 2 | ■ Input power supply voltage is below the specified range. | ■ Confirm that the power supply is set within the specified range of 20.4 to 27.6 VDC. |
| 3 | ■ Input power supply voltage is fluctuating or having phase loss. | ■ Confirm power supply to avoid phase loss or voltage reduction. |

■ Alarm Code 72 (Control Circuit voltage reduction 1)
- Under voltage of ±12V



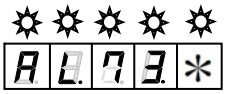

| Status at the time of alarm | Cause | | |
|---|---|---|---|
| | 1 | 2 | 3 |
| Issued when control power is turned ON. | ✔ | ✔ | ✔ |

◆ Corrective actions

| | Cause | Investigation and corrective actions |
|---|---|---|
| 1 | ■ Defect in internal circuit of power unit or amplifier unit. | ■ Replace the power unit or amplifier unit. |
| 2 | ■ Defect in external circuit. | ■ Restart the power supply after removing the connector: CN1. Check the external circuit if alarm is not issued. |
| 3 | ■ Connection cable between power unit/amplifier unit has disconnection. | ■ Replace the connection cable between power unit/amplifier unit. |

# 8. Maintenance

■ Alarm Code 73 (Control Circuit voltage reduction 2)
● Under voltage of +5V



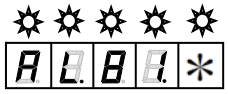

| Status at the time of alarm | Cause | |
|---|---|---|
| | 1 | 2 |
| Issued when control power is turned ON. | ✔ | ✔ |

◆ Corrective actions

| | Cause | Investigation and corrective actions |
|---|---|---|
| 1 | ■ Defect in internal circuit of power unit and amplifier unit. | ■ Replace the power unit and amplifier unit. |
| 2 | ■ Defect in external circuit. | ■ Restart the power supply after removing the connector: CN1. Check the external circuit if alarm is not issued.<br>■ Restart the power supply after replacing the servo motor; if alarm is not issued, there is defect in internal circuit of motor encoder. Replace the servo motor. |

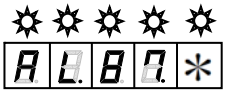
# 8.3 Trouble shooting when alarm activated

■ Alarm Code 81 (Encoder Connector 1 Disconnection)
- Incremental encoder (A, B, Z) signal line break
- Power supply break




■ Alarm Code 87 (CS Signal Disconnection)
- CS signal line break

| Status at the time of alarm | Cause | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| Issued when control power is turned ON. | ✔ | ✔ | ✔ | ✔ |
| Issued during operation. | ✔ | | ✔ | ✔ |




◆ Corrective actions

| | Cause | Investigation and corrective actions |
|---|---|---|
| 1 | ■ For motor encoder wiring:<br>◆ Improper wiring.<br>◆ Connector is removed.<br>◆ Loose connection.<br>◆ Encoder cable is too long.<br>◆ Encoder cable is too thin. | ■ Check the wiring conditions and correct it if improper.<br>■ Confirm that the encoder power supply voltage at the motor side is above 4.75 V, correct it if improper. |
| 2 | ■ Amplifier unit and motor encoder are not combined properly. | ■ Replace with servo motor equipped with proper encoder. |
| 3 | ■ Defect in internal circuit of amplifier unit. | ■ Replace the amplifier unit. |
| 4 | ■ Defect in internal circuit of motor encoder. | ■ Replace the servo motor. |

■ Alarm Code 83 (Encoder Connector 2 Disconnection)
- Incremental encoder (A, B, Z) signal line break
- Power supply break

[Use of EN1 with motor encoder in the semi-closed system]

| Status at the time of alarm | Cause | |
|---|---|---|
| | 1 | 2 |
| Issued when control power is turned ON. | ✔ | ✔ |

◆ Corrective actions

| | Cause | Investigation and corrective actions |
|---|---|---|
| 1 | ■ Parameter setting is for full-closed system. | ■ Change the system parameter ID20 to "00:Motor_Enc". |
| 2 | ■ EN2 is selected as encoder connector. (In case of that the 8th digit of amplifier unit model number (encoder type) is "2".) | ■ Change the system parameter ID10 to "00:EN1". |

[Use of EN2 with motor encoder in the semi-closed system]

| Status at the time of alarm | Cause | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| Issued when control power is turned ON. | ✔ | ✔ | ✔ | ✔ |
| Issued during operation. | ✔ | | ✔ | ✔ |

◆ Corrective actions

| | Cause | Investigation and corrective actions |
|---|---|---|
| 1 | ■ For motor encoder wiring:<br>◆ Improper wiring.<br>◆ Connector is removed.<br>◆ Loose connection.<br>◆ Encoder cable is too long.<br>◆ Encoder cable is too thin. | ■ Check the wiring conditions and correct it if improper.<br>■ Confirm that the encoder power supply voltage at the motor side is above 4.75 V, correct it if improper. |
| 2 | ■ Amplifier unit and motor encoder are not combined properly. | ■ Replace with servo motor equipped with proper encoder. |
| 3 | ■ Defect in internal circuit of amplifier unit. | ■ Replace the amplifier unit. |
| 4 | ■ Defect in internal circuit of motor encoder. | ■ Replace the servo motor. |

[Use of EN2 with external encoder]

| Status at the time of alarm | Cause | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| Issued when control power is turned ON. | ✔ | ✔ | ✔ | ✔ |
| Issued during operation. | ✔ | | ✔ | ✔ |

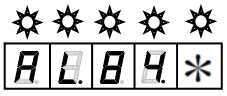
◆ Corrective actions

| | Cause | Investigation and corrective actions |
|---|---|---|
| 1 | ■ For external encoder wiring,<br>◆ Improper wiring.<br>◆ Connector is removed.<br>◆ Loose connection.<br>◆ Encoder cable is too long.<br>◆ Encoder cable is too thin. | ■ Check the wiring conditions and correct it if improper.<br>■ Confirm that the power supply voltage for the external encoder is above 4.75 V, and correct it if improper. |
| 2 | ■ Turn-on timing of external encoder power is delayed. | ■ Confirm that the power supply voltage for the external encoder soon after turning on control power, and bring forward the timing of turning on the power for external encoder if it is not established. |
| 3 | ■ Defect in internal circuit of amplifier unit. | ■ Replace the amplifier unit. |
| 4 | ■ Defect in internal circuit of motor encoder. | ■ Replace the servo motor. |

# 8.3 Trouble shooting when alarm activated

■ Alarm Code 84 (Absolute Encoder Communication Error)

- Encoder serial signal time out
- Serial communication data error



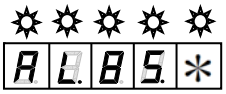

| Status at the time of alarm | Cause | | |
|---|---|---|---|
| | 1 | 2 | 3 |
| Issued when control power is turned ON. | ✔ | ✔ | ✔ |
| Issued during operation. | | ✔ | |

◆ Corrective actions

| | Cause | Investigation and corrective actions |
|---|---|---|
| 1 | ■ Defect in internal circuit of motor encoder. | ■ Replace the servo motor. |
| 2 | ■ Malfunction due to noise. | ■ Confirm proper grounding of the power unit and amplifier unit.<br>■ Check the shielding of the encoder cable.<br>■ Add ferrite core or similar countermeasures to against noise. |
| 3 | ■ Motor encoder wiring has abnormalities. | ■ Check the wiring conditions and correct it if improper. |

■ Alarm Code 85 (Encoder Initial Process Error)

- Failed to read CS data of incremental encoder
- Abnormality in initial process of absolute encoder



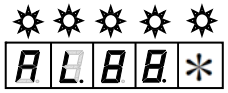

| Status at the time of alarm | Cause | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| Issued when control power is turned ON. | ✔ | ✔ | ✔ | ✔ | ✔ |

◆ Corrective actions

| | Cause | Investigation and corrective actions |
|---|---|---|
| 1 | ■ For motor encoder wiring:<br>◆ Improper wiring.<br>◆ Connector is removed.<br>◆ Loose connection.<br>◆ Encoder cable is too long.<br>◆ Encoder cable is too thin. | ■ Check the wiring conditions and correct it if improper.<br>■ Confirm that the encoder power supply voltage at the motor side is above 4.75 V, and correct it if improper. |
| 2 | ■ Amplifier unit and motor encoder are not combined properly. | ■ Replace with servo motor equipped with proper encoder. |
| 3 | ■ Defect in internal circuit of amplifier unit. | ■ Replace the amplifier unit. |
| 4 | ■ Defect in internal circuit of motor encoder. | ■ Replace the servo motor. |
| 5 | ■ Initial position data could not be set because the number of rotations of the motor is more than 250 $min^{-1}$ when power has been supplied. | ■ Restart the power supply after motor is stopped. (Only when absolute encoder is used.) |

# 8. Maintenance

■ Alarm Code 88 (External Absolute Encoder Communication Error)
- Encoder serial signal time out
- Serial communication data error

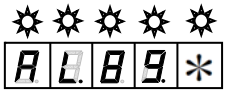



| Status at the time of alarm | Cause | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| Issued when control power is turned ON. | ✔ | ✔ | ✔ | |
| Issued during operation. | | ✔ | | ✔ |

◆ Corrective actions

| | Cause | Investigation and corrective actions |
|---|---|---|
| 1 | ■ Defect in internal circuit of external encoder. | ■ Replace the external encoder. |
| 2 | ■ Malfunction due to noise. | ■ Confirm proper grounding of the power unit/amplifier unit.<br>■ Check the shielding of the encoder cable.<br>■ Add ferrite core or similar countermeasures to against noise. |
| 3 | ■ External encoder wiring has abnormalities. | ■ Check the wiring conditions and correct it if improper. |
| 4 | ■ External encoder power supply voltage reduction. | ■ Confirm that the external encoder power supply voltage is above 4.75 V, and correct it if improper. |

■ Alarm Code 89 (External Encoder Initial Process Error)
- Abnormality in initial process of absolute encoder



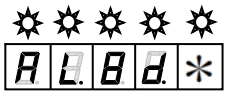

| Status at the time of alarm | Cause | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| Issued during operation. | ✔ | ✔ | ✔ | ✔ |

◆ Corrective actions

| | Cause | Investigation and corrective actions |
|---|---|---|
| 1 | ■ For external encoder wiring:<br>◆ Improper wiring.<br>◆ Connector is removed.<br>◆ Loose connection.<br>◆ Encoder cable is too long.<br>◆ Encoder cable is too thin. | ■ Check the wiring conditions and correct it if improper.<br>■ Confirm that the encoder power supply voltage at the motor side is above 4.75 V, and correct it if improper. |
| 2 | ■ Turn-on timing of external encoder power is delayed. | ■ Confirm that the power supply voltage for the external encoder soon after turning on control power, and bring forward the timing of turning on the power for external encoder if it is not established. |
| 3 | ■ Defect in internal circuit of amplifier unit. | ■ Replace the amplifier unit. |
| 4 | ■ Defect in internal circuit of external encoder. | ■ Replace the external encoder. |

# 8.3 Trouble shooting when alarm activated

■ Alarm Code BD (External encoder (EnDat) combination error)
- External encoder (EnDat) is out of applicable range.

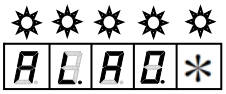



| Status at the time of alarm | Cause |
|---|---|
| | 1 |
| Issued when control power is turned ON. | ✔ |

◆ Corrective actions

| | Cause | Investigation and corrective actions |
|---|---|---|
| 1 | ■ Combined external encoder is not apply to amplifier unit. | ■ Replace to our recommended encoder. (Refer the section 9.1.3) |

■ Alarm Code A0 (Absolute Encoder Internal Error 0)
- Encoder failure




| Status at the time of alarm | Cause | |
|---|---|---|
| | 1 | 2 |
| Issued when control power is turned ON. | ✔ | ✔ |
| Issued during operation. | ✔ | ✔ |

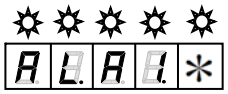
◆ Corrective actions

| | Cause | Investigation and corrective actions |
|---|---|---|
| 1 | ■ Defect in internal circuit of motor encoder. | ■ Turn ON the power supplies again, if not corrected, replace the servo motor. |
| 2 | ■ Malfunction due to noise. | ■ Confirm proper grounding of the power unit/amplifier unit.<br>■ Check the shielding of the encoder cable.<br>■ Add ferrite core or similar countermeasures to against noise. |

# 8. Maintenance

■ Alarm Code A1 (Absolute Encoder Internal Error 1)

● Encoder internal error




| Status at the time of alarm | Cause | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| Issued when control power is turned ON. | ✔ | ✔ | | |
| Issued during operation. | | | ✔ | ✔ |

◆ Corrective actions

| | Cause | Investigation and corrective actions |
|---|---|---|
| 1 | ■ Loose connection of battery cable. | ■ Check the battery connector of encoder cable attachment. |
| 2 | ■ Battery voltage reduction. | ■ Check the voltage of battery. |
| 3 | ■ Loose connection of encoder connector. | ■ Check the wiring conditions and correct it if improper. |
| 4 | ■ Defect in internal circuit of motor encoder. | ■ Turn ON the power supplies again, if not corrected, replace the servo motor. |

* "Encoder clear and alarm reset methods" vary depending on the motor encoder in use. Please refer to "8.4 Encoder Clear and Alarm Reset Methods".

■ Alarm Code A2 (Absolute Encoder Internal Error 2)

| Status at the time of alarm | Cause | | |
|---|---|---|---|
| | 1 | 2 | 3 |
| Issued while stopping the servo motor. | ✔ | ✔ | |
| Issued while rotating the servo motor. | ✔ | ✔ | ✔ |

◆ Corrective actions

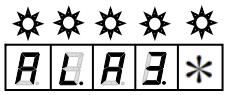
| | Cause | Investigation and corrective actions |
|---|---|---|
| 1 | ■ Defect in internal circuit of motor encoder. | ■ Turn ON the power supplies again, if not corrected, replace the servo motor. |
| 2 | ■ Malfunction due to noise. | ■ Confirm proper grounding of the power unit , amplifier unit.<br>■ Check the shielding of the encoder cable.<br>■ Take care of noise by adding ferrite core etc. |
| 3 | ■ Motor acceleration exceeds the permitted value. | ■ Check the operation condition and increase the accel/decel time. |

* "Encoder clear and alarm reset methods" vary depending on the motor encoder in use. Please refer to "8.4 Encoder Clear and Alarm Reset Methods".

# 8.3 Trouble shooting when alarm activated

■ Alarm Code A3 (Absolute Encoder Internal Error 3)

● Encoder internal error




| Status at the time of alarm | Cause | | |
|---|---|---|---|
| | 1 | 2 | 3 |
| Issued when control power is turned ON. | ✔ | | ✔ |
| Issued while stopping the servo motor. | ✔ | ✔ | |
| Issued while rotating the servo motor. | ✔ | ✔ | ✔ |

◆ Corrective actions

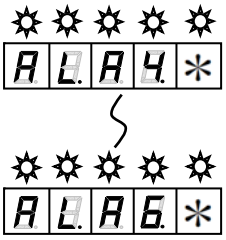
| | Cause | Investigation and corrective actions |
|---|---|---|
| 1 | ■ Defect in internal circuit of motor encoder. | ■ Turn ON the power supplies again, if not corrected, replace the servo motor. |
| 2 | ■ Malfunction due to noise | ■ Confirm proper grounding of the power unit/amplifier unit.<br>■ Check the shielding of the encoder cable.<br>■ Add ferrite core or similar countermeasures to against noise. |
| 3 | ■ Motor rotation speed exceeds the permitted velocity. | ■ Check the operation condition and reduce the maximum rotation speed. |

* “Encoder clear and alarm reset methods“ vary depending on the motor encoder in use. Please refer to "8.4 Encoder Clear and Alarm Reset Methods".

# 8. Maintenance

■ Alarm Code A4 to A6 (Absolute Encoder Internal Error 4 to 6)

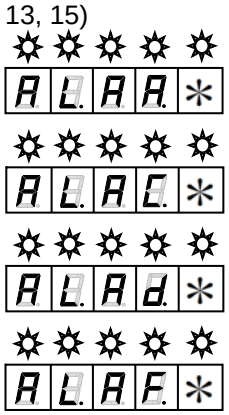
● Encoder internal error




■ Alarm Code AA, AC, AD, AF (Absolute Encoder Internal Error 10, 12, 13, 15)

● Encoder internal error

| Status at the time of alarm | Cause | |
|---|---|---|
| | 1 | 2 |
| Issued when control power is turned ON. | ✔ | |
| Issued during operation. | ✔ | ✔ |



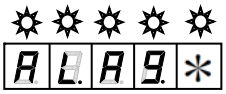

◆ Corrective actions

| | Cause | Investigation and corrective actions |
|---|---|---|
| 1 | ■ Defect in internal circuit of motor encoder. | ■ Turn ON the power supplies again, if not corrected, replace the servo motor. |
| 2 | ■ Malfunction due to noise | ■ Confirm proper grounding between power unit/amplifier unit and servo motor.<br>■ Check the shielding of the encoder cable.<br>■ Add ferrite core or similar countermeasures to against noise. |

* "Encoder clear and alarm reset methods" vary depending on the motor encoder in use. Please refer to "8.4 Encoder Clear and Alarm Reset Methods".

■ Alarm Code A9 (Absolute Encoder Internal Error 9)

● Encoder internal error




| Status at the time of alarm | Cause | | |
|---|---|---|---|
| | 1 | 2 | 3 |
| Issued when control power is turned ON. | ✔ | ✔ | |
| Issued while stopping the servo motor. | ✔ | ✔ | |
| Issued while rotating the servo motor. | | ✔ | ✔ |

◆ Corrective actions

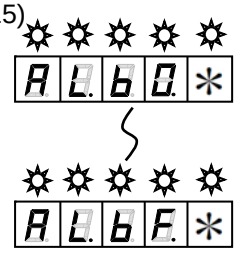
| | Cause | Investigation and corrective actions |
|---|---|---|
| 1 | ■ Defect in internal circuit of motor encoder. | ■ Turn ON the power supplies again, if not corrected, replace the servo motor. |
| 2 | ■ Servo motor is not generating heat, but encoder ambient temperature is too high. | ■ Confirm that the cooling method keeps the motor encoder ambient temperature as below 80℃. |
| 3 | ■ Servo motor is overheated. | ■ Confirm the cooling procedure of the servo motor. |

* "Encoder clear and alarm reset methods" vary depending on the motor encoder in use. Please refer to "8.4 Encoder Clear and Alarm Reset Methods".

# 8.3 Trouble shooting when alarm activated

■ Alarm Code B0 to BF (External Absolute Encoder Internal Error 0 to 15)

| Status at the time of alarm | Cause | |
|---|---|---|
| | 1 | 2 |
| Issued when control power is turned ON. | ✔ | |
| Issued during operation. | ✔ | ✔ |



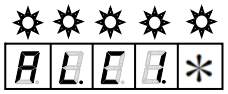

◆ Corrective actions

| | Cause | Investigation and corrective actions |
|---|---|---|
| 1 | ■ Defect in internal circuit of external encoder. | ■ Turn ON the power supplies again, if not corrected, replace the external encoder. |
| 2 | ■ Malfunction due to noise | ■ Confirm proper grounding between power unit/amplifier unit and servo motor.<br>■ Check the shielding of the encoder cable.<br>■ Add ferrite core or similar countermeasures to against noise. |

# 8. Maintenance

■ Alarm Code C1 (Over-speed)

● Motor rotation speed reaches 120 % of the highest speed limit.



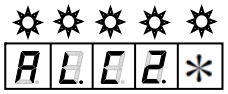
| Status at the time of alarm | Cause | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| Issued when command is entered after Servo ON. | ✔ | ✔ | | | |
| Issued when the servo motor is started. | | | ✔ | ✔ | ✔ |
| Issued other than operating and starting the motor. | | ✔ | ✔ | | |

◆ Corrective actions

| | Cause | Investigation and corrective actions |
|---|---|---|
| 1 | ■ Defect in internal circuit of amplifier unit. | ■ Replace the amplifier unit. |
| 2 | ■ Defect in internal circuit of motor encoder. | ■ Replace the servo motor. |
| 3 | ■ Excessive overshoot while starting. | ■ Adjust the servo parameters.<br>■ Loose the slope of acceleration / deceleration command.<br>■ Reduce the load inertia moment, or change motor capacity. |
| 4 | ■ Wiring of U/V/W −phase between amplifier unit and motor is wrong. | ■ Check the wiring conditions and correct it if improper. |
| 5 | ■ Wiring of A and B phase of incremental encoder is wrong. | ■ Check the wiring conditions and correct it if improper. |

■ Alarm Code C2 (Velocity Control Error)

● Torque command and acceleration direction are not matching.



| Status at the time of alarm | Cause | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| Issued while due to input of Servo ON. | ✔ | | ✔ | |
| Issued when command has entered. | ✔ | ✔ | ✔ | |
| Issued while starting and stopping the servo motor. | | | | ✔ |

◆ Corrective actions

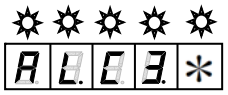
| | Cause | Investigation and corrective actions |
|---|---|---|
| 1 | ■ Wiring of U/V/W −phase between amplifier unit and motor is wrong. | ■ Check the wiring conditions and correct it if improper. |
| 2 | ■ Wiring of A and B phase of incremental encoder is wrong. | ■ Check the wiring conditions and correct it if improper. |
| 3 | ■ The servo motor is vibrating (oscillating). | ■ Adjust the servo parameters so that servo motor will not vibrate (oscillate). |
| 4 | ■ Excessive overshoot and undershoot. | ■ Adjust the servo parameters to reduce overshoot and undershoot.<br>■ Loose the slope of acceleration / deceleration command.<br>■ Change Group B ID14 "Velocity Control Alarm (ALM_C2) Detection " to "00: Disabled". |

* Velocity control error alarm is set to "00:Disabled" as default because the alarm may be detected if it is available in case of accel/decel with large load inertia or vertical application. If its detection is needed, consult our representatives.

# 8.3 Trouble shooting when alarm activated

■ Alarm Code C3 (Velocity Feedback Error)

● Servo motor power disconnection




| Status at the time of alarm | Cause | | |
|---|---|---|---|
| | 1 | 2 | 3 |
| Issued when command has entered. | ✔ | ✔ | ✔ |
| Issued when control power is turned ON. | | ✔ | |

◆ Corrective actions

| | Cause | Investigation and corrective actions |
|---|---|---|
| 1 | ■ Motor is not rotating. | ■ Check the wiring conditions of servo motor power line and correct it if improper.<br>■ Replace the servo motor. |
| 2 | ■ Defect in internal circuit of amplifier unit. | ■ Replace the amplifier unit. |
| 3 | ■ The servo motor is vibrating (oscillating). | ■ Adjust the servo parameters so that servo motor will not vibrate (oscillate). |

■ Alarm Code C5 (Model Following Vibration Suppression Control Error)

● Operation pattern is not match with model tracking vibration suppression control.

| Status at the time of alarm | Cause | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| Issued when position command pulse is entered. | ✔ | ✔ | ✔ | ✔ |

◆ Corrective actions

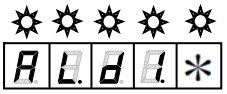
| | Cause | Investigation and corrective actions |
|---|---|---|
| 1 | ■ Setup of model control gain is high. | ■ Lower model control gain. |
| 2 | ■ The accel/decel time of a position command is short. | ■ Loose the slope of acceleration / deceleration command. |
| 3 | ■ Torque limiting value is low. | ■ Enlarge a torque limit value, or disable a torque limitation. |
| 4 | ■ Switched from the standard position control to the model following vibration suppression control. | ■ Switch it at the state of servo motor stop. |

* Other alarms are generated, and this alarm might be generated if a servo brake performs alarm reset during a slowdown.

# 8. Maintenance

■ Alarm Code D1 (Excessive Position Deviation)

● Position Deviation exceeds setup value.




| Status at the time of alarm | Cause | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| Issued when control power is turned ON. | | | | | | | | | | | | ✔ | | |
| Issued when servo ON and while motor stopping. | | | | | | ✔ | | | | | | | ✔ | |
| Issued immediately after entering the command. | ✔ | ✔ | ✔ | ✔ | ✔ | | ✔ | ✔ | ✔ | ✔ | ✔ | | ✔ | |
| Issued during starting / stopping at high speed. | ✔ | ✔ | | | | | ✔ | ✔ | ✔ | | | | ✔ | ✔ |
| Issued during the operations by lengthy command. | | ✔ | | | | | ✔ | ✔ | | | | | ✔ | |

◆ Corrective actions

| | Cause | Investigation and corrective actions |
|---|---|---|
| 1 | ■ Position command frequency is too high. | ■ Correct the position command of the controller. |
| 2 | ■ Excessive load inertia moment or low motor capacity. | ■ Correct the load condition or increase the motor capacity. |
| 3 | ■ Holding brake is not released. | ■ Check the wiring conditions and correct it if improper. Replace the servo motor even brake is not released if brake is excited with proper voltage. |
| 4 | ■ Application collided to something or locked mechanically. | ■ Refine application system. |
| 5 | ■ One or all phases of U/V/W -phase of the amplifier unit and motor has disconnected. | ■ Check the wiring conditions and correct it if improper. |
| 6 | ■ Motor is being rotated by an external force (Gravity, etc.) during stopping (positioning completion). | ■ Check the load, or increase the servo motor capacity. |
| 7 | ■ Valid torque limit command is entered by the controller, and its setting is too small.<br>■ Setting of a velocity limit command is too small.<br>■ Motor encoder pulse setting is not match with actual servo motor. | ■ Enlarge a torque limit value, or disable a torque limitation.<br>■ Enlarge setting value of velocity limit command.<br>■ Sets a correct value to the system parameter ID15 "Absolute encoder resolution" or the system parameter ID17 "Incremental encoder resolution", for matching with servo motor encoder. |
| 8 | ■ Settings of servo parameters (Position Loop Gain, etc.) are not appropriate. | ■ Adjust the servo parameter settings (Raise the position loop gain, etc.). |
| 9 | ■ Setting of a excessive position deviation is too small. | ■ Set a value larger of GroupB ID11 "Deviation Counter Overflow Value". |
| 10 | ■ Rotation directions of 2 axes are different, in the tandem operation. | ■ Set "04: PC-_VC+_TC+" to Group8 ID00 "Position, Velocity, Torque Command Input Polarity". Change to "01: Reversed ", in Group8 ID80. |
| 11 | ■ Wiring of servo motor and encoder is wrong, in the tandem operation. | ■ Check the wiring and fix if wrong. |
| 12 | ■ Defect in internal circuit of amplifier unit. | ■ Replace the amplifier unit. |
| 13 | ■ Defect in internal circuit of motor encoder. | ■ Replace the servo motor. |
| 14 | ■ Power supply voltage is low. | ■ Check the power supply voltage. |

# 8.3 Trouble shooting when alarm activated

■ Alarm Code D2 (Faulty Position Command Pulse Frequency 1)

● Frequency of entered position command pulse is excessive

| Status at the time of alarm | Cause |
|---|---|
| | 1 |
| Issued after entering position command pulse. | ✔ |

◆ Corrective actions

| | Cause | Investigation and corrective actions |
|---|---|---|
| 1 | ■ The command that exceeded digital filter setting for command pulse is entered. | ■ Decrease the frequency of the command pulse.<br>■ Decrease minimum pulse width of digital filter setting in Group 8 ID12 "Position command pulse digital filter [PCPFIL]". |

■ Alarm Code D3 (Faulty Position Command Pulse Frequency 2)

● Position command frequency after electronic gear is high.

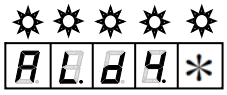
| Status at the time of alarm | Cause | |
|---|---|---|
| | 1 | 2 |
| Issued after entering position command pulse. | ✔ | ✔ |

◆ Corrective actions

| | Cause | Investigation and corrective actions |
|---|---|---|
| 1 | ■ Frequency of command pulse input is too high. | ■ Reduce the frequency of command pulse input. |
| 2 | ■ Setting value of electronic gear is excessive. | ■ Decrease the electronic gear setting value in ID 13 to 16: Electric gear, Group 8 parameter. |

■ Alarm Code D4 (Axes-sync error excess)

● Position deviation error between own axis and counterpart axis exceeds setting value.




| Status at the time of alarm | Cause | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| Issued immediately after entering the command. | ✔ | ✔ | ✔ | ✔ | ✔ |
| Issued during starting / stopping at high speed. | ✔ | | ✔ | ✔ | ✔ |

◆ Corrective actions

| | Cause | Investigation and corrective actions |
|---|---|---|
| 1 | ■ Parameter settings of 2 axes are different. | ■ Sets the parameters follow 9.2.5. |
| 2 | ■ Same command is not entered to both axes. | ■ Check the wiring and fix if wrong. |
| 3 | ■ Axes-sync error set value is too small. | ■ Increase setting of GroupB ID81 "Axes-sync error warning level". |
| 4 | ■ Defect in internal circuit of amplifier unit. | ■ Replace the amplifier unit. |
| 5 | ■ Defect in internal circuit of motor encoder. | ■ Replace the servo motor. |

■ Alarm Code D5 (Dual position error excess)

● The difference of servo motor position and load position exceeds the setting value.

| Status at the time of alarm | Cause | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| Issued immediately after entering the command. | ✔ | | ✔ | ✔ | ✔ | | ✔ | ✔ | ✔ | ✔ |
| Issued during starting / stopping at high speed. | ✔ | ✔ | | | | | ✔ | ✔ | ✔ | ✔ |
| Issued during the operations by lengthy command. | | | | | | ✔ | | | | |

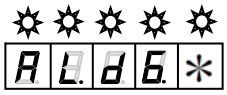
◆ Corrective actions

| | Cause | Investigation and corrective actions |
|---|---|---|
| 1 | ■ Servo motor and load (external encoder) are not connected mechanically. Or the connection is not rigid. | ■ Review the mechanical connection status. |
| 2 | ■ Servo parameters are not correct. (Position loop gain, Position feedback gain, etc) | ■ Adjust the servo parameter according to "9.1.5.7 Dual position feedback compensation". |
| 3 | ■ Motor encoder pulse setting does not match with the servo motor. | ■ Fit to the motor encoder pulse number of the servo motor. |
| 4 | ■ External encoder resolution does not match to servo motor encoder resolution after feedback electronic gear. | ■ Review the system parameter ID22 "External pulse encoder resolution", ID24/ 25 "Feedback electronic gear numerator/ denominator", according to "9.1.5.4 Feedback pulse setting". |
| 5 | ■ The polarity of external encoder does not match to the motor encoder. | ■ Check the wiring conditions of external encoder and correct it if improper.<br>■ Set the parameter GroupC ID02 "External Pulse Encoder Polarity Selection", according to "9.1.5.5 Servo motor rotation direction setting". |
| 6 | ■ Rounded off a rest, at the setting of ID24/ 25 "Feedback electronic gear numerator/ denominator". | ■ Invalid the alarm by setting 0 pulse to GroupB ID1A "Dual position error excess value". |
| 7 | ■ Setting value of Dual position error excess error is too small. | ■ Larger the setting of GroupB ID1A "Dual position error excess value". |
| 8 | ■ Defect in internal circuit of amplifier unit. | ■ Replace the amplifier unit. |
| 9 | ■ Defect in internal circuit of motor encoder. | ■ Replace the servo motor. |
| 10 | ■ Defect in internal circuit of external encoder. | ■ Replace the external encoder. |

# 8.3 Trouble shooting when alarm activated

■ Alarm Code D6 (Dual position error feedback error)

● The motor encoder frequency after feedback electronic gear is too high.




| Status at the time of alarm | Cause | | |
|---|---|---|---|
| | 1 | 2 | 3 |
| Issued after entering position command pulse. | ✔ | ✔ | ✔ |

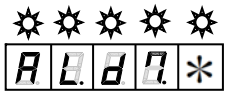
◆ Corrective actions

| | Cause | Investigation and corrective actions |
|---|---|---|
| 1 | ■ Motor rotation speed is too high. | ■ Lower a frequency of command pulse input. |
| 2 | ■ Motor encoder pulse setting does not match with the servo motor. | ■ Fit to the motor encoder pulse number of the servo motor. |
| 3 | ■ Feedback electronic gear ratio is too large. | ■ Review the setting value of system parameter ID24/ 25 "Feedback electronic gear numerator/ denominator". |

* Maximum velocity of servo motor will be limited at the system which has larger motor encoder resolution and feedback electronic gear ratio.

■ Alarm Code D7 (Amplifier communication error)

● Amplifier communication error during axes-sync operation



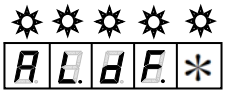

| Status at the time of alarm | Cause | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| Issued when control power is turned ON. | ✔ | ✔ | ✔ | ✔ | |
| Issued during operation. | | | | | ✔ |

◆ Corrective actions

| | Cause | Investigation and corrective actions |
|---|---|---|
| 1 | ■ Wiring between amplifiers<br>◆ wrong wiring<br>◆ connector is unplugged<br>◆ connector has contact failure<br>◆ cable is too long | ■ Check the wiring and fix if wrong.<br>■ Use our recommendation cables. |
| 2 | ■ With tandem operation<br>Tandem operation is not set to the parameter of counterpart axis. | ■ Change to "01: Tandem operation" in counterpart axis system parameter ID08 "Amplifier communication function". |
| 3 | ■ Without tandem operation<br>Tandem operation is set to the parameter of own axis. | ■ Change to "00: Invalid" in own axis system parameter ID08 "Amplifier communication function". |
| 4 | ■ Defect in internal circuit of amplifier unit. | ■ Replace the amplifier unit. |
| 5 | ■ Malfunction due to noise. | ■ Confirm proper grounding of the power unit/amplifier unit.<br>■ Add ferrite core or similar countermeasures to against noise. |

■ Alarm Code DF (Test mode has closed)

● Detection in 'Test mode end' status




| Status at the time of alarm | Cause |
|---|---|
| | 1 |
| Occurred after execution of test mode. | ✔ |

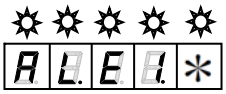
◆ Corrective actions

| | Cause | Investigation and corrective actions |
|---|---|---|
| 1 | ■ Normal operation. | ■ Return to normal operation by alarm clear. (This is caution because test mode might have some deviation in control side after finish.) |

# 8. Maintenance

■ Alarm Code E1 (Memory Error 1)

● Abnormality of amplifier unit with built-in EEPROM



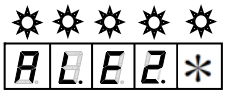

| Status at the time of alarm | Cause |
|---|---|
| | 1 |
| Issued during display key operation or setup software operation. | ✔ |

◆ Corrective actions

| | Cause | Investigation and corrective actions |
|---|---|---|
| 1 | ■ Defect in internal circuit of amplifier unit. | ■ Replace the amplifier unit. |

■ Alarm Code E2 (Memory Error 2)

● Error in check sum of EEPROM (entire area)




| Status at the time of alarm | Cause | |
|---|---|---|
| | 1 | 2 |
| Issued when control power is turned ON. | ✔ | ✔ |

◆ Corrective actions

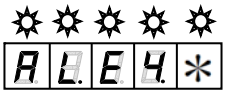
| | Cause | Investigation and corrective actions |
|---|---|---|
| 1 | ■ Correct value did not read to CPU from EEPROM of amplifier unit. | ■ Replace the amplifier unit. |
| 2 | ■ Failed to write into the EEPROM during last power supply cutoff. | ■ Replace the amplifier unit. |

■ Alarm Code E3 (CPU error 1)

● Access error in CPU built in RAM

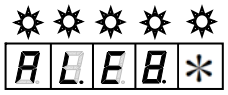
■ Alarm Code E4 (CPU error 2)

● Checksum error of FLASH memory with built in CPU



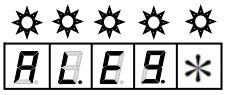

■ Alarm Code E8 (Control power circuit error 1)

● Access abnormality in CPU to ASIC



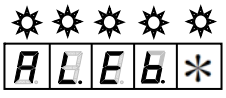

■ Alarm Code E9 (Control power circuit error 2)

● Abnormalities of control circuit.




■ Alarm Code EB (Control power circuit error 3)

● Abnormalities of control circuit.




| Status at the time of alarm | Cause |
|---|---|
| | 1 |
| Issued when control power is turned ON. | ✔ |

◆ Corrective actions

| | Cause | Investigation and corrective actions |
|---|---|---|
| 1 | ■ Defect in internal circuit of amplifier unit. | ■ Replace the amplifier unit. |

# 8.3 Trouble shooting when alarm activated

■ Alarm Code E5 (System Parameter Error 1)

● System parameter is outside a setting range.

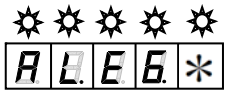
| Status at the time of alarm | Cause | |
|---|---|---|
| | 1 | 2 |
| Issued when control power is turned ON. | ✔ | ✔ |

◆ Corrective actions

| | Cause | Investigation and corrective actions |
|---|---|---|
| 1 | ■ The data out of setting range was given to system parameter. | ■ Confirm the model number of the amplifier unit. Check and correct the setting value of system parameter. Turn ON the control power again and confirm that alarm is cleared. |
| 2 | ■ Defect in internal circuit of amplifier unit. | ■ Replace the amplifier unit. |

■ Alarm Code E6 (System Parameter Error 2)

● The combination of a system parameter is abnormal.



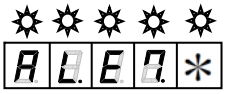

| Status at the time of alarm | Cause | |
|---|---|---|
| | 1 | 2 |
| Issued when control power is turned ON. | ✔ | ✔ |

◆ Corrective actions

| | Cause | Investigation and corrective actions |
|---|---|---|
| 1 | ■ Wrong combination of system parameter setting value and actual hardware.<br>■ Wrong combination of motor parameter and amplifier unit parameter.<br>■ Wrong combination between system parameters. | ■ Confirm the model number of the amplifier unit.<br>■ Set a correct parameter applying to amplifier unit capacity.<br>■ Check and correct the setting value of system parameter. Turn ON the control power again and confirm that alarm is cleared. |
| 2 | ■ Defect in internal circuit of amplifier unit. | ■ Replace the amplifier unit. |

■ Alarm Code E7 (Motor Parameter Error)

● Setup of a motor parameter is abnormal.



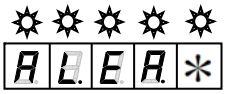

| Status at the time of alarm | Cause | |
|---|---|---|
| | 1 | 2 |
| Issued when control power is turned ON. | ✔ | ✔ |

◆ Corrective actions

| | Cause | Investigation and corrective actions |
|---|---|---|
| 1 | ■ Correct value did not read to CPU from non-volatile memory of amplifier unit. | ■ If alarm recurs by control power cycle after re-setting the motor parameter, replace amplifier unit. |
| 2 | ■ Failed to write into the non-volatile memory when changing motor parameter. | ■ If alarm recurs by control power cycle after re-setting the motor parameter, replace amplifier unit. |

■ Alarm Code EA (Memory Error 3)

● Abnormality of FLASH memory in amplifier unit.



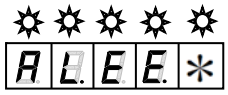

| Status at the time of alarm | Cause |
|---|---|
| | 1 |
| Issued during display key operation or setup software operation. | ✔ |

◆ Corrective actions

| | Cause | Investigation and corrective actions |
|---|---|---|
| 1 | ■ Defect in internal circuit of amplifier unit. | ■ Replace the amplifier unit. |

■ Alarm Code EE (Motor Parameter Automatic Setting Error 1)

● Motor parameter automatic setting function cannot be performed.



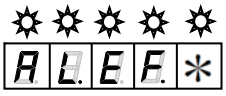

| Status at the time of alarm | Cause | | |
|---|---|---|---|
| | 1 | 2 | 3 |
| Issued when control power is turned ON. | ✔ | ✔ | ✔ |

◆ Corrective actions

| | Cause | Investigation and corrective actions |
|---|---|---|
| 1 | ■ The connected encoder is not supported by the amplifier unit. | ■ Replace with the supported servo motor. |
| 2 | ■ The connected encoder does not support a motor parameter automatic setting function. | ■ Change the system parameter ID09 "Motor parameter automatic set function selection" to "01:Disabled". Then download a motor parameter from setup software. |
| 3 | ■ Defect in internal circuit of motor encoder. | ■ Replace the servo motor. |

■ Alarm Code EF (Motor Parameter Automatic Setting Error 2)

● The result of motor parameter automatic setting is abnormal.




| Status at the time of alarm | Cause | | |
|---|---|---|---|
| | 1 | 2 | 3 |
| Issued when control power is turned ON. | ✔ | ✔ | ✔ |

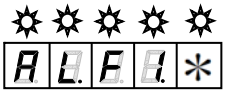
◆ Corrective actions

| | Cause | Investigation and corrective actions |
|---|---|---|
| 1 | ■ Combination of amplifier unit and servo motor is wrong. | ■ Please correct combination by checking the model number of amplifier unit and servo motor. |
| 2 | ■ The connected amplifier unit does not support a motor parameter automatic setting function. | ■ Change ID09 of system parameter to "01:Disabled". Then download a motor parameter from setup software. |
| 3 | ■ Defect in internal circuit of motor encoder. | ■ Replace the servo motor. |

# 8.3 Trouble shooting when alarm activated

■ Alarm Code F1 (Task Process Error)

● Error in interruption process of CPU



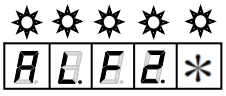

| Status at the time of alarm | Cause |
|---|---|
| | 1 |
| Issued during operation. | ✔ |

◆ Corrective actions

| | Cause | Investigation and corrective actions |
|---|---|---|
| 1 | ■ Defect in internal circuit of amplifier unit. | ■ Replace the amplifier unit. |

■ Alarm Code F2 (Initial Process Time-Out)

● Initial process does not end within initial process time



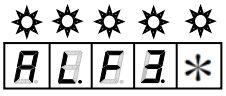

| Status at the time of alarm | Cause | |
|---|---|---|
| | 1 | 2 |
| Issued when control power is turned ON. | ✔ | ✔ |

◆ Corrective actions

| | Cause | Investigation and corrective actions |
|---|---|---|
| 1 | ■ Defect in internal circuit of amplifier unit. | ■ Replace the amplifier unit. |
| 2 | ■ Malfunction due to noise. | ■ Confirm proper grounding of the power unit/amplifier unit.<br>■ Add ferrite core or similar countermeasures to against noise. |

■ Alarm Code F3 (CPU error 3)

● Abnormality of CPU setting




| Status at the time of alarm | Cause |
|---|---|
| | 1 |
| Issued after firmware updating. | ✔ |

◆ Corrective actions

| | Cause | Investigation and corrective actions |
|---|---|---|
| 1 | ■ CPU setting was wrong at firmware updating. | ■ Correcting CPU setting of firmware updating tool. |

## 8.3.3 Correspondence table for EnDat Error message and alarm code

| EnDat Error message | | RS3 Servo Amplifier | |
|---|---|---|---|
| Bit | | Alarm Code | Priority |
| 0 | Light Source | B0 | 1 |
| 1 | Signal amplitude | B1 | 2 |
| 2 | Position | B2 | 3 |
| 3 | Overvoltage | B3 | 4 |
| 4 | Undervoltage | B4 | 5 |
| 5 | Overcurrent | B5 | 6 |
| 6 | Battery | B6 | 7 |
| 7 | Currently not allocated Extension planned | B7 | 8 |
| 8 | | B8 | 9 |
| 9 | | B9 | 10 |
| 10 | | B10 | 11 |
| 11 | | B11 | 12 |
| 12 | | B12 | 13 |
| 13 | | B13 | 14 |
| 14 | | B14 | 15 |
| 15 | | B15 | 16 |

* "Error message" means Operation Status Word0 of EnDat.

* "Alarm Code" means the alarm code output from amplifier unit against applicable Error Message.

* "Priority" is given to alarm codes to be output when Error Messages are received simultaneously. Alarm Code output from amplifier unit is only one (which has higher priority) even if Error Messages are received multiple.

## 8.4 Inspection

For maintenance purposes, a daily inspection is typically sufficient because worn-parts are not used with power unit, amplifier unit and servo motor. Upon inspection, refer to the following description.

| Inspection target | Conditions | | | Items | Methods | Solution if abnormal |
|---|---|---|---|---|---|---|
| | Time | During operation | While stopping | | | |
| Servo motor | Daily | ✔ | | Vibration | Check for excessive vibration than usual. | Contact dealer or sales office. |
| | Daily | ✔ | | Sound | Check for abnormal sound than usual. | |
| | Daily | ✔ | | Cooling fan behavior | Check for abnormal behavior compare to usual. | |
| | Periodic | | ✔ | Cleaning | Check for dust/waste accumulated in exterior. | Clean with air or cloth. Note 1) |
| | Yearly | | ✔ | Measure a insulation resistance | Contact dealer or sales office. | |
| | 5000 hours Note 2) | | ✔ | Replacement of oil seal | | |
| Power unit, Amplifier unit | Periodic | | ✔ | Cleaning | Check for dust accumulated in the accessories. | Clean with air. Note 1) |
| | Yearly | | ✔ | Loose screws | Check for loose connections. | Fasten the screws properly. |
| Temperature | Periodic | ✔ | | Measure temperature | Ambient temperature Motor frame temperature | Set the ambient temperature within the specified range. Check the load condition. |

Note 1) Before cleaning, confirm that there is no oil content and/or moisture in compression air.

Note 2) This inspection and replacement period is when water- or oil-proof functions are required.

Note 3) The life expectancy of the battery is approximately 3 years at continuous backup of encoder. For replacement, a lithium battery (ER3VLY: 3.6V, 1000mAh) manufactured by Toshiba Lifestyle Products & Services Corporation is recommended.

# 8. Maintenance

## 8.5 Service parts

### 8.5.1 The parts requiring Inspection

Some parts have aging degradation.
Please request us an overhaul by referring to the periods below for preventive maintenance.

| No. | Part name | Number of average replacement periods | Corrective measures / usage conditions |
|---|---|---|---|
| 1 | Aluminum electrolytic capacitor for smoothing main circuit | 5 Years | Replacement with new part is necessary.<br>Load ratio: 50% of rated output current of amplifier.<br>Usage condition: Yearly average 40°C |
| 2 | Cooling Fan motor | 5 Years | Replacement with new part is necessary.<br>Usage condition: Yearly average 40°C |
| 3 | Aluminum electrolytic capacitor (other than capacitor for smoothing main circuit) | 5 Years | Replacement with new part is necessary.<br>Usage condition: Yearly average 40°C<br>Annual total usage time is 4800 hours. |
| 4 | Fuse | 10 Years | Replacement with new part is necessary. |
| 5 | Relays | (Power-cycle: a hundred thousand times) | Replacement with new part is necessary. |

■ Capacitor for smoothing the main circuit, and relays

- ◆ Inspection is needed if the power unit/amplifier unit have stored for more than 3 years. Contact the dealer or sales office.
- ◆ It is necessary to replace the capacitor that is earlier than 5 years when it is used to exceed yearly average 40°C or exceed more than 50% of the rated output current of amplifier unit.
- ◆ It is necessary to replace the capacitor or relays that are earlier than periods above where the main power-cycle is repeated more than 30 times per day or 5 times per hour. Capacity reduction or early failure of relays is considered.

■ Cooling Fan motor

◆ The power unit/amplifier unit are designed corresponding to the pollution degree specified in EN61800-5-1 or IEC 664-1. It is not for dust proof or oil proof, so use it in an environment at Pollution Level 2 or less (i.e., Pollution Level 1, 2).

◆ Power unit/amplifier unit have a built-in cooling fan; therefore be sure to maintain a space of 100 mm on the upper and lower side of the power unit/amplifier unit for airflow. Installation in a narrow space may cause failure due to a wind pressure reduction of the cooling fan and/or electronic parts degradation. Replacement is necessary if abnormal noise occurs or oil / dust are observed on the parts. Also, at an average temperature of 40°C year-round, the life expectancy is 5 years.

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# 9

# Dedicated function

In this chapter, the things concerning dedicated function are explained.


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9.1.2 Amplifier unit Internal block diagram ..... 9-2
9.1.3 Combination encoder ..... 9-3
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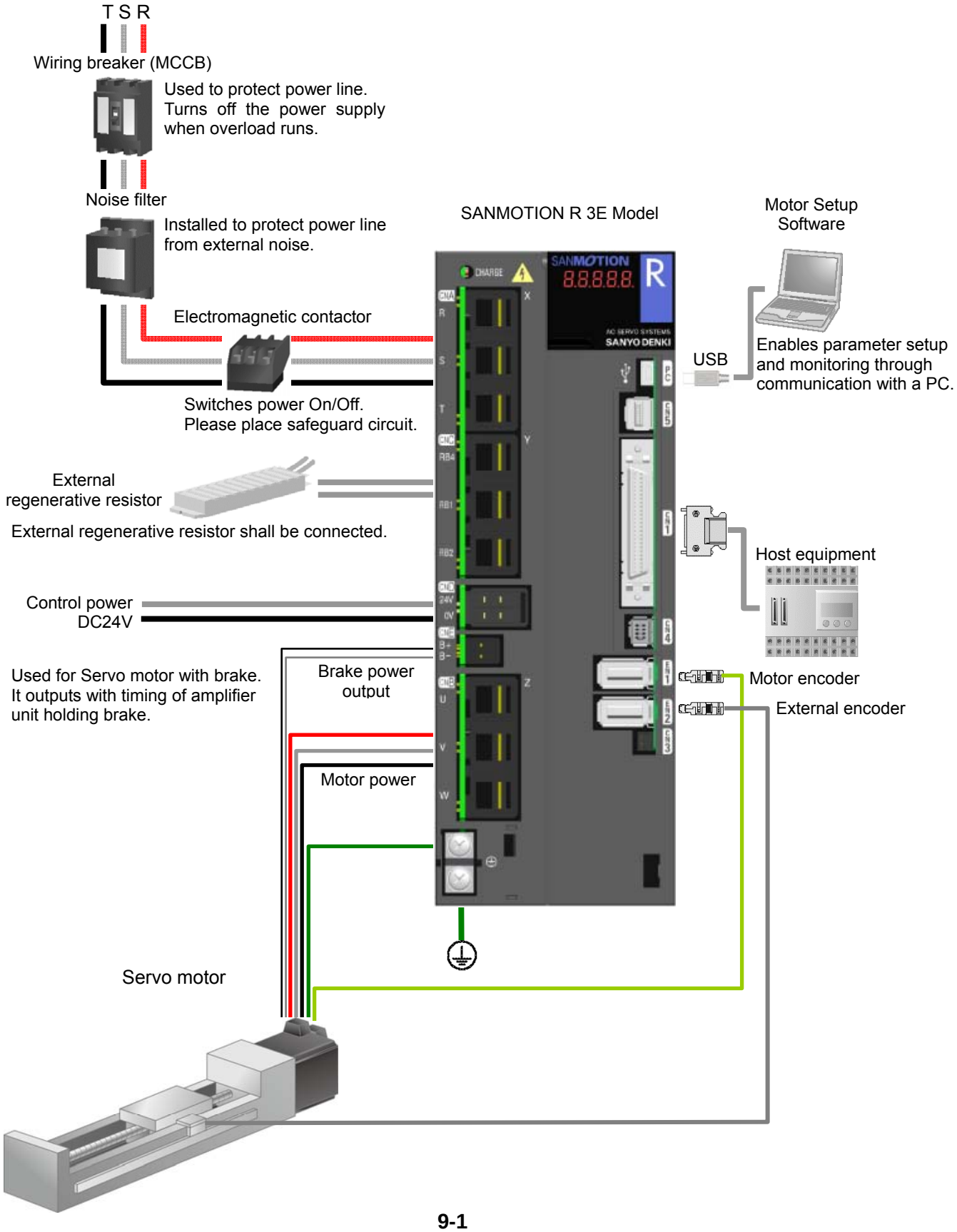
# 9. Dedicated function

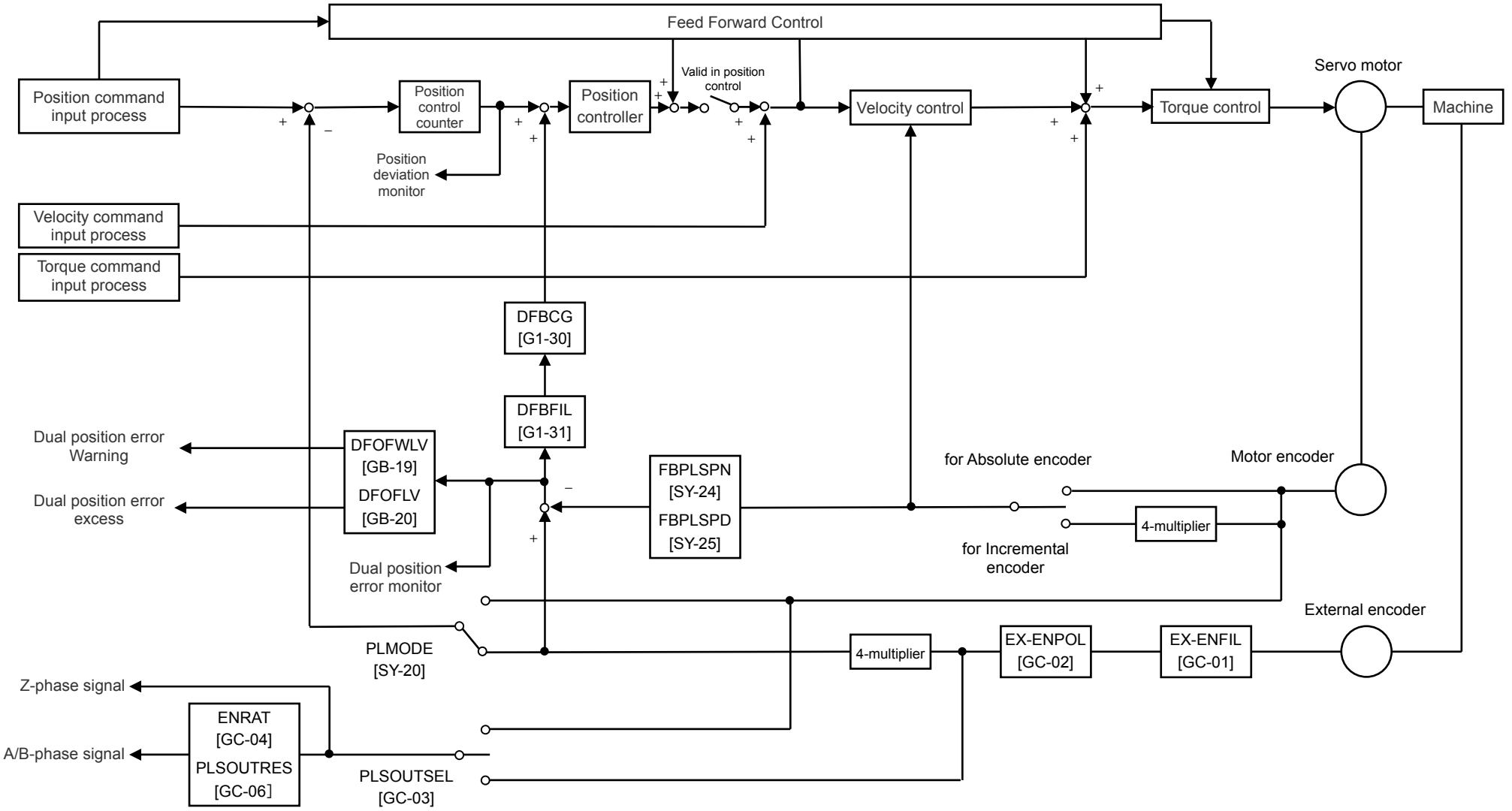
## 9.1 Full-closed system

### 9.1.1 Illustration of system components

■ RS3C02 is used for description below.



## 9.1.2 Amplifier unit Internal block diagram



# 9. Dedicated function

## 9.1.3 Combination encoder

Apply to the product below as external combination encoder.

■ Incremental encoder

| Manufacturer | Series name | Output signal | Power supply | Minimum resolution |
|---|---|---|---|---|
| Renishaw plc | RGH22 | RS422 compliant, 90 degree phase shift pulse train | 5V±5% | 0.1 to 5μm |
| HEIDENHAIN K.K. | LIDA400 | | | 0.05 to 1μm |
| | LIDA200 | | | 0.5 to 5μm |

* Applicable output signal is RS422 compliant 90 degree phase shift pulse train only. (LIDA47, LIDA27)
Analog sine wave output (LIDA48, LIDA28) and serial signal output are not applicable.

* For detail of linear encoder performance/spec/guarantee/mounting/etc, inquire to manufacturer of each linear encoder.

* Contact us if combine with the encoder except recommendation encoder above.

■ Absolute encoder
Only EnDat2.2 is apply to the interface.

| Manufacturer | Type | Series name | Power supply | Resolution |
|---|---|---|---|---|
| HEIDENHAIN K.K. | Linear encoder | LIC4100 | 5V±5% | 0.01μm<br>0.005μm<br>0.001μm |
| | | LIC2100 | | 0.1μm<br>0.05μm |
| | | LC400 | | 0.01μm<br>0.001μm |
| | Angle encoder | RCN2000 | | 26,28bit |
| | | RCN5000 | | 26,28bit |
| | | RCN8000 | | 29bit |
| | Rotary encoder | ECN/ENQ1100 | | Single-turn resolution: 23bit<br>Multi-turn total rotation number:<br>－/12bit |
| | | ECN/ENQ1300 | | Single-turn resolution: 25bit<br>Multi-turn total rotation number:<br>－/12bit |

* This table is combination spec with our amplifier unit.
It may differ from manufacturer spec.

* For detail of each encoder performance/spec/guarantee/mounting/etc,
inquire to the encoder manufacturer.

* It is not applicable except EnDat2.2 interface (Ordering designation: EnDat22).

* Contact us if combine with the encoder except recommendation encoder above.

* It cannot use if the resolution which converted to motor single-turn exceeds 23 bit (8,388,608).

## 9.1.4 Wiring

Connect external encoder to EN2 when using as full-closed system. See "4.3 Wiring for motor encoder" for motor encoder wiring (EN1 connector).

### 9.1.4.1 Signal names and its pin numbers for external encoder (EN2)

■ Incremental encoder

| EN2 Terminal No. | Signal name | Description | Remarks Note 1) |
|---|---|---|---|
| 1 | - | Note 3) | — |
| 2 | SG | Power supply common Note 4) | |
| 3 | - | Note 3) | — |
| 4 | SG | Power supply common Note 4) | |
| 5 | B | Phase B pulse output | Twisted pair |
| 6 | /B | | |
| 7 | A | Phase A pulse output | Twisted pair |
| 8 | /A | | |
| 9 | Z | Phase Z pulse output | Twisted pair |
| 10 | /Z | | |
| Note 2) | Earth | Shield | — |

Note 1) Use an exterior covering shielded cable and perform twisted-pair wiring.
Note 2) Connect exterior covering shielded cable to metal case of EN2 side, and to earth of external encoder side.
Note 3) Please prepare power supply for external encoder by yourself.
Do not connect power supply for external encoder to 1 and 3 pins.
Note 4) Power supply common shall be connected.

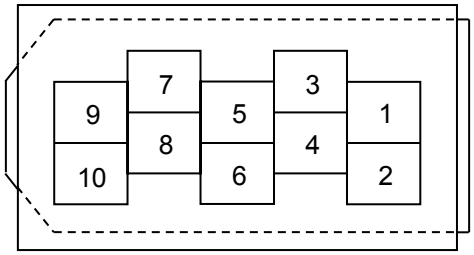
■ Absolute encoder (EnDat2.2)

| EN2 Terminal No. | Signal name | Description | Remarks Note 1) |
|---|---|---|---|
| 1 | - | Note 3) | — |
| 2 | SG | Power supply common Note 4) | |
| 3 | - | Note 3) | — |
| 4 | SG | Power supply common Note 4) | |
| 5 | CLOCK+ | Serial clock signal | Twisted pair |
| 6 | CLOCK- | | |
| 7 | DATA+ | Serial data signal | Twisted pair |
| 8 | DATA- | | |
| 9 | — | — | — |
| 10 | — | | |
| Note 2) | Earth | Shield | — |

Note 1) Use an exterior covering shielded cable and perform twisted-pair wiring.
Note 2) Connect exterior covering shielded cable to metal case of EN2 side, and to earth of external encoder side.
Note 3) Please prepare power supply for external encoder by yourself.
Do not connect power supply for external encoder to 1 and 3 pins.
Note 4) Power supply common shall be connected.

### 9.1.4.2 EN2 pin assignment

■ EN2 36210-0100PL (soldered side)




■ Connector model number (3M Japan Limited )

| | Model Number | Applicable wire size | Applicable cable diameter |
|---|---|---|---|
| Connector | 36210-0100PL | AWG30 to AWG18 | — |

## 9.1.5 Basic setting of full-closed system

Explains basic setting of the system for full-closed system operation.

### 9.1.5.1 Specification confirmation

Confirm specifications of amplifier unit through the setup software or the digital operator.

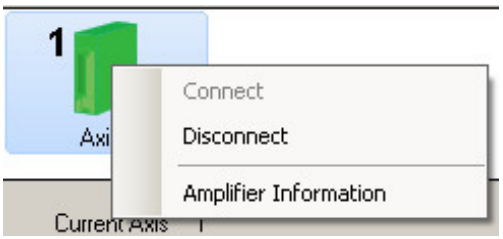
**[Step 1: How to confirm specifications of amplifier unit]**

Confirm that purchased amplifier unit is fit to full-closed system or not by the information below.

- ◆ Encoder type

1) Confirmation through the setup software

- ■ Connect the amplifier unit and PC (with USB cable) which installed the setup software, and then supply control power (to r and t terminal).
- ■ Run the setup software and start communication with the amplifier unit.
- ■ Select a desired axis from main window upper side axis icon, and then display popup menu (by right click).




**[Step 2: Encoder type confirmation]**

See below for allowable encoder of this amplifier unit. Please confirm that your external encoder is allowed.

| Amplifier unit model number | Encoder type code | Motor encoder allowed by EN1 | External encoder allowed by EN2 |
|---|---|---|---|
| RS3###A9## | 09 | Incremental encoder | Absolute encoder |
| RS3###AA## | 0A | Incremental encoder | Incremental encoder |

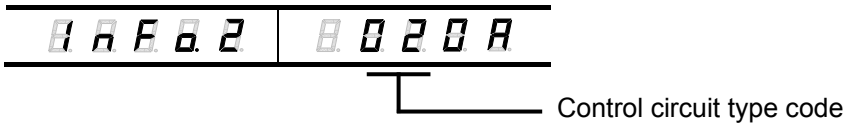
* Full-closed system is not allowed when encoder type code is the other of 01, 02, 09 or 0A.

1) Through the setup software

Encoder type code is shown in Control Circuit Type of System information.

2) Through the digital operator

Encoder type code is shown at an upper byte of InFo.2.



### 9.1.5.2 System parameter setting

Set the parameters as follows for use of full-closed control.

■ Control cycle
Select a control cycle of velocity control and torque control. "00: Standard_Sampling" shall be selected for use of full-closed control.

| Group | ID | Selection | | Description |
|---|---|---|---|---|
| System | 00 | 00 | Standard_Sampling | Standard sampling mode |

■ Control mode selection
Selects the control mode. "02: Position" shall be selected for use of full-closed control.

| Group | ID | Selection | | Description |
|---|---|---|---|---|
| System | 06 | 02 | Position | Position control type |

■ Motor encoder connector selection
Selects the connector used as motor encoder. "00: EN1" shall be selected for use of full-closed control.

| Group | ID | Selection | | Description |
|---|---|---|---|---|
| System | 10 | 00 | EN1 | Uses EN1 for connecting motor encoder. |

■ Position loop control, position loop encoder selection
Select the encoder for use of control method of position loop and position control. "01: External_Enc" shall be selected for use of full-closed control.

| Group | ID | Selection | | Description |
|---|---|---|---|---|
| System | 20 | 01 | External_Enc | Full-closed control/ External encoder |

# 9.1.5 Basic setting of full-closed system

## 9.1.5.3 Full-closed encoder selection

■ EN2encoder type
Selects the external encoder type connected to EN2. Select depending on encoder type as below:
8th digit of amplifier unit model number is 1 or 9 (Absolute encoder): "22: EnDat_ABS"
8th digit of amplifier unit model number is 2 or A (Incremental encoder): "82: Pulse_without_CS"

| Group | ID | Selection | | Selection |
|---|---|---|---|---|
| System | 12 | 22 | EnDat_ABS | EnDat2.2 |
| | | 80 | Pulse | Wire-saving incremental encoder |
| | | 82 | Pulse_without_CS | Incremental encoder (without CS) |

■ EN2 absolute encoder baud rate selection
Set it when "22：EnDat_ABS" is selected to EN2.

| Group | ID | Selection | | Selection |
|---|---|---|---|---|
| System | 21 | 01 | 2Mbps | 2Mbps |
| | | 03 | 4Mbps | 4Mbps |

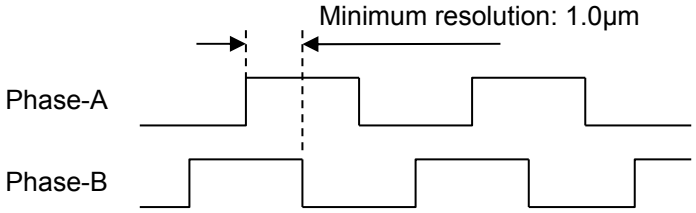
* Use with the initial setting (01:2Mbps), normally.

## 9.1.5.4 Feedback pulse setting

■ External encoder resolution (for incremental encoder)
Sets pulse amount (multiply 1) of external encoder per 1 turn of motor axis.
Be valid after control power cycle.

| Group | ID | Setting range | Unit |
|---|---|---|---|
| System | 22 | 500 to 500,000 (multiplied 1) | P/R |

◆ Setting sample
[Use condition]
- Move distance of work per 1 turn of motor axis: 10mm
- Minimum resolution of external encoder (multiplied 4): $1.0\times10^{-3}$ mm (=1.0μm)




[Setting value]
Move distance of work per 1 turn of motor axis is 10mm, and Minimum resolution of external encoder is 1.0μm, so,

Pulse amount of external encoder per 1 turn of motor axis

$$= \frac{\text{Move distance of work per 1 turn of motor axis [mm]}}{\text{Minimum resolution of external encoder [mm]}}$$

$= 10\text{mm} / (1.0 \times 10^{-3}\text{ mm})$
= 10000 P/R (multiplied 4)

System parameter ID22 "External pulse encoder resolution" is "multiplied 1" value (amount of phase-A or phase-B), so,

External pulse encoder resolution = 10000/4 = 2500 P/R

set this value.

* Round off the value to the whole number.

# 9.1.5 Basic setting of full-closed system

■ External absolute encoder resolution (for absolute encoder)
Sets the external encoder resolution per equal to motor single-turn.
Be valid after control power cycle.

| Group | ID | Setting range | Unit |
|---|---|---|---|
| System | 26 | 2048 to 8388608 | P/R |

◆ Setting sample
[Use condition]
- Move distance of work per 1 turn of motor axis: 10mm
- Minimum resolution of external encoder (linear encoder): $0.01\times10^{-3}$ mm (=0.01μm)

[Setting value]
Move distance of work per 1 turn of motor axis is 10mm, and Minimum resolution of external encoder is 1.0μm, so,

Pulse amount of external encoder per 1 turn of motor axis

$$= \frac{\text{Move distance of work per 1 turn of motor axis [mm]}}{\text{Minimum resolution of external encoder [mm]}}$$

$= 10\text{mm} / (0.01\times10^{-3}\text{ mm})$
$= 1000000\text{P/R}$

◆ Setting sample
[Use condition]
- Rotation of work per 1 turn of motor axis : 1/32 rotation
- Resolution of external encoder (angle encoder): 26bit (67,108,864 division)

[Setting value]
Rotation of work per 1 turn of motor axis is 1/32 rotation, and Resolution of external encoder is 67,108,864 division, so,

Pulse amount of external encoder per 1 turn of motor axis
= Rotation of work per 1 turn of motor axis [rotation]
x Resolution of external encoder [division]
= (1/32 rotation) x (67,108,864 division)
= 2,097,152P/R

* Round off the value to the whole number.

■ Feedback pulse electronic gear
Sets the electronic gear ratio for converting motor encoder resolution to external encoder resolution.
This parameter is used for calculation of dual position error (position error between motor encoder and external encoder).
Be valid after control power cycle.

| Group | ID | Symbol | Name | Setting range | Unit |
|---|---|---|---|---|---|
| System | 24 | FBPLSPN | Numerator of feedback pulse electronic gear | 1 to 2,097,152 | Pulse |
| System | 25 | FBPLSPD | Denominator of feedback pulse electronic gear | 1 to 2,097,152 | Pulse |

Relation equation of electronic gear ratio is follows.

$$\frac{\text{FBPLSPN [SY-24]}}{\text{FBPLSPD [SY-25]}} = \frac{\text{Feedback encoder pulse amount per 1 turn of motor}}{\text{Motor encoder resolution}}$$

* Multiplied 4 to encoder resolution, in case of incremental encoder.

◆ Setting sample 1 (Motor encoder is absolute encoder)
[Use condition]
- Move distance of work per 1 turn of motor axis: 10mm
- Minimum resolution of external encoder: $1.0\times10^{-3}$mm ( =1.0μm)
- System parameter ID15 “Absolute encoder resolution”: 131072 division

[Setting value]
- FBPLSPN = 10mm/($1.0\times10^{-3}$) = 10000 Pulse
- FBPLSPD = Absolute encoder resolution = 131072 Pulse

◆ Setting sample 2 (Motor encoder is incremental encoder)
[Use condition]
- Move distance of work per 1 turn of motor axis: 10mm
- Minimum resolution of external encoder: $1.0\times10^{-3}$mm ( =1.0μm)
- System parameter ID17 “Incremental encoder resolution”: 2000 P/R

[Setting value]
- FBPLSPN = 10mm/($1.0\times10^{-3}$) = 10000 = 10000 Pulse
- FBPLSPD = Incremental encoderresolution×4 = 2000×4 = 8000 Pulse

◆ Setting sample 3 (Motor encoder is absolute encoder)
[Use condition]
- Move distance of work per 1 turn of motor axis: 10/3 mm
  (Work moves 10 mm by 3 turns of motor.)
- Minimum resolution of external encoder: $1.0\times10^{-3}$mm ( =1.0μm)
- System parameter ID15 “Absolute encoder resolution”: 131072 division

[Setting value]
- FBPLSPN = (10/3) /($1.0\times10^{-3}$) = 10000 / 3 = 3333 .333･･･ = 3333 Pulse
  Indivisible. So, set the value as follows in this case.

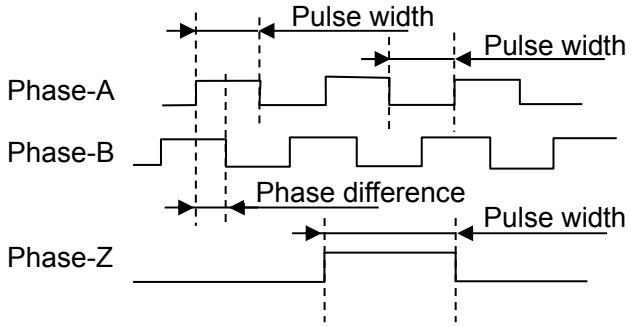
- FBPLSPN = 10/($1.0\times10^{-3}$) = 10000 Pulse
- FBPLSPD = Absolute encoder resolution×3 = 131072×3 = 393216 Pulse

* When calculation values of FBPLSPN or FBPLSPD have decimal part, round off the value to the whole number. However, dual position error is not able to calculate accurate by round off, and it might detect “Dual position error excess (AL.D5).
So, in this case, set 0 to GroupB ID19 "Dual position error warning level" and GroupB ID1A "Dual position error excess value", for excepting warning and alarm detection.

# 9.1.5 Basic setting of full-closed system

■ External Encoder Digital Filter
Sets the digital filter for external encoder.
Even if noise is given to external incremental encoder, eliminate pulses below set value, as noise. Considering encoder resolution and maximum operation speed of servo motor, and set a quarter of maximum speed pulse width as a rough indication.

| Group | ID | Selection | | Description |
|---|---|---|---|---|
| C | 01 | 00 | 110nsec | Minimum Pulse Width =110nsec<br>(Minimum pulse Phase Difference = 37.5nsec) |
| | | 01 | 220nsec | Minimum Pulse Width = 220nsec |
| | | 02 | 440nsec | Minimum Pulse Width = 440nsec |
| | | 03 | 880nsec | Minimum Pulse Width = 880nsec |
| | | 04 | 75nsec | Minimum Pulse Width = 75nsec<br>(Minimum pulse Phase Difference = 37.5nsec) |
| | | 05 | 150nsec | Minimum Pulse Width = 150nsec |
| | | 06 | 300nsec | Minimum Pulse Width = 300nsec |
| | | 07 | 600nsec | Minimum Pulse Width = 600nsec |

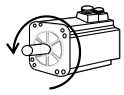
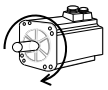
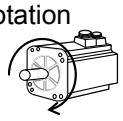
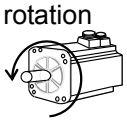



* Be valid when external incremental encoder is used.

## 9.1.5.5 Rotation direction setting for servo motor

At full-closed control, servo motor rotation direction is decided by command polarity and external incremental encoder polarity.

■ Position, Velocity, Torque Command Input Polarity
Selects command polarity of position command pulse.
Rotation direction of servo motor is able to invert without changing command wiring.
Be valid after control power cycle.

| Group | ID | Selection | | Position Command Pulse (PCMD) Plus | Position Command Pulse (PCMD) Minus |
|---|---|---|---|---|---|
| 8 | 00 | 00 | PC+_VC+_TC+ | CCW rotation  | CW rotation  |
| | | 01 | PC+_VC+_TC- | | |
| | | 02 | PC+_VC-_TC+ | | |
| | | 03 | PC+_VC-_TC- | | |
| | | 04 | PC-_VC+_TC+ | CW rotation  | CCW rotation  |
| | | 05 | PC-_VC+_TC- | | |
| | | 06 | PC-_VC-_TC+ | | |
| | | 07 | PC-_VC-_TC- | | |

■ External Encoder Polarity Selection
Selects signal polarity of external incremental encoder.
Select polarity to get matching with increase/decrease of Monitor ID 61/62 "Present position monitor (External encoder) [EX-APMON]" and Monitor ID 10/11 "Present position monitor (Motor encoder) [APMON]".
Be valid after control power cycle.

| Group | ID | Selection | | Description | | |
|---|---|---|---|---|---|---|
| C | 02 | 00 | Type1 | EX-Z /without inversion | EX-B /without inversion | EX-A /without inversion |
| | | 01 | Type2 | EX-Z /without inversion | EX-B /without inversion | EX-A /with inversion |

* When count direction (increase/decrease) of external incremental encoder and motor encoder are not match, it might get runaway.

■ External Absolute encoder Polarity Selection
Selects counting polarity of external absolute encoder.
Select polarity to get matching with increase/decrease of Monitor ID 61/62 "Present position monitor (External encoder) [EX-APMON]" and Monitor ID 10/11 "Present position monitor (Motor encoder) [APMON]".
Be valid after control power cycle.

| Group | ID | Selection | | Description |
|---|---|---|---|---|
| C | 0B | 00 | Standard | Inverts not an encoder operation direction. |
| | | 01 | Reversed | Inverts an encoder operation direction. |

* It may become out of control if a counting direction (increase/decrease) of motor encoder and external absolute encoder are not matched.

## 9.1.5.6 Encoder output pulse signal setting

■ Encoder Output Pulse Divide Selection
Selects encoder output pulse divide signal.
Select desired signal when upper controller requires encoder pulse signal.
Be valid after control power cycle.

| Group | ID | Selection | | Description |
|---|---|---|---|---|
| C | 03 | 00 | Motor_Enc | Motor encoder |
| | | 01 | External_Enc | External encoder |

■ External encoder output pulse divide ratio selection
Selects the external encoder output pulse divide ratio (1/N) when EnDat is used to external encoder.
When the external encoder is angle encoder or rotary encoder, select from the range of 1/4(R) to 1/8192(R).
When the external encoder is linear encoder, select from the range of 1/4(L) to 1/2000(L).

Be valid after control power cycle.

| Selection | | Contents |
|---|---|---|
| 00 | 1/4(R)_1/4(L) | Outputs by following calculation according to encoder type. |
| 01 | 1/8(R)_1/20(L) | For angle encoder or rotary encoder, outputs the pulse as follows: "Single turn resolution" x (1/N). (Use 1/4(R) to 1/8192(R))<br><br>For linear encoder, outputs the pulse as follows: "Resolution" / (1/N). (Use 1/4(L) to 1/2000(L)) |
| 02 | 1/16(R)_1/40(L) | |
| 03 | 1/32(R)_1/80(L) | |
| 04 | 1/64(R)_1/120(L) | |
| 05 | 1/128(R)_1/160(L) | |
| 06 | 1/256(R)_1/200(L) | |
| 07 | 1/512(R)_1/400(L) | |
| 08 | 1/1024(R)_1/800(L) | |
| 09 | 1/2048(R)_1/1200(L) | |
| 0A | 1/4096(R)_1/1600(L) | |
| 0B | 1/8192(R)_1/2000(L) | |

* Output is available up to the frequency of 2Mpulse/sec (multiply 1).
Select the divide ratio in the range less than the frequency above.

EnDat (Angle encoder, Rotary encoder)
Divide ratio is limited to be 32768 pulse/rev or more when ""Single turn resolution" x (1/N) < 32768 pulse/rev." is established.

EnDat (Linear encoder)
Use in the range as follows: 231 x Resolution / ((1/N)x4), based on zero position.
(Z-phase output position might shift if a power cycle is performed after moving to out of the range.)

## 9.1.5.7 Dual position feedback compensation setting

Dual position feedback compensation performs full-closed control using along with external encoder feedback and motor encoder feedback, by setting dual position feedback filter. From above, it can use full-closed control at motor stop or constant rotation, and use semi-closed control at accel/decel, so accuracy of full-closed control and response of semi-closed control are able to go together.

■ Dual position feedback gain
Sets the ratio of semi-closed control (motor encoder feedback). Larger the value, higher the compensation impact.
Dual position feedback compensation function will be invalid when 0% is set.

| Group | ID | Setting range | Unit |
|---|---|---|---|
| 1 | 30 | 0 to 100 | % |

■ Dual position feedback filter
Sets the band of dual position feedback compensation. Larger the value, nearer responsiveness of transient response to semi-closed control.
Dual position feedback compensation function will be invalid when 0ms is set.

| Group | ID | Setting range | Unit |
|---|---|---|---|
| 1 | 31 | 0.0 to 2000.0 | ms |

■ How to use
- ◆ Set 100% to "Dual position feedback gain", and set the value of "Dual position feedback filter" with referring calculation below as a rough indication.
  Dual position feedback filter [ms]=3÷KP [1/s]×1000
- ◆ Increase position loop proportional gain until position deviation is getting vibration exceeding positioning completion range.
- ◆ Increase Dual position feedback filter value up to the value that makes position deviation vibration stable.
- ◆ When the vibration is not fit into positioning completion range, decrease position loop proportional gain and try adjustment again.

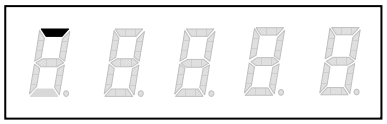
## 9.1.5.8 Alarm detection setting

Warning and alarm are able to output by detecting position difference between external encoder and motor encoder. It is able to avoid that continuous rotation of motor when abnormal issue is occurred like as external encoder signal does not change by something or change to opposite direction of motor encoder.

■ Dual position error warning level
Warning will be output when exceeding this setting value by difference between external encoder and current position of motor encoder which is applied feedback pulse electronic gear. Set the value of multiply 4 to external encoder resolution, as a base.
Dual position error warning does not output when 0 pulse is set.

| Group | ID | Setting range | Unit |
|---|---|---|---|
| B | 19 | 0 to 2147483647 | Pulse |

* Warning status is able to check on monitor display and front panel LED. Also, able to output from general output port.



■ Dual position error excess value
"Dual position error excess alarm (AL.D5)" will be output when exceeding this setting value by difference between external encoder and current position of motor encoder which is applied feedback pulse electronic gear. Set the value of multiply 4 to external encoder resolution, as a base.
Dual position error excess alarm does not detect when 0 pulse is set.

| Group | ID | Setting range | Unit |
|---|---|---|---|
| B | 1A | 0 to 2147483647 | Pulse |

* Dual position error (difference between external encoder and current position of motor encoder) is able to check by Monitor ID60 "Dual position error monitor [DFERR-MON]".
* Dual position error will be cleared by the Deviation Clear.

## 9.1.5.9 External encoder signal output waiting function setting

If there is delay from supplying power to outputting encoder signal depending on external encoder specification, this function is able to delay boot time of amplifier unit along with encoder signal start time.

■ Initial timeout waiting time
Set the time of "from Supplying power to external encoder to Starting encoder signal output + α".

| Group | ID | Selection | Description |
|---|---|---|---|
| B | 0B | 0 | Invalid |
| | | 1 | 1000ms |
| | | 2 | 1400ms |
| | | 3 | 1800ms |
| | | 4 | 2000ms |
| | | 5 | 3000ms |
| | | 6 | 5000ms |
| | | 7 | 10000ms |

* Supply power to external encoder at same timing for control power of power unit/amplifier unit or earlier.
* "Encoder Connector 2 Disconnection (AL.83)" will be output when setting value is shorter than the time from supplying power to outputting encoder signal.
* When EnDat is used to external encoder, it takes 1.3sec to start serial communication access from power establishment of external encoder. Therefore, 1.3sec or more is required to a booting time also when set value is 1 or 3.

## 9.1.6 Precautions

### 9.1.6.1 Power supply for external encoder

■ Please prepare power supply for external encoder by yourself.

* Power supply to external encoder shall be start at before or same timing of power unit/amplifier unit control power.

### 9.1.6.2 External encoder operation

■ Please check that external encoder has no problem before servo ON (exciting servomotor).

◆ When count directions (increase/decrease) of Monitor ID10/11 "Present position monitor (Motor encoder) [APMON]" and Monitor ID 61/62 "Present position monitor (External encoder) [EX-APMON]" are opposite, change GroupC ID02 "External Incremental encoder Polarity Selection" for external incremental encoder or change GroupC ID0B "External Absolute encoder Polarity Selection" for external absolute encoder, and adjust count directions (increase/decrease).

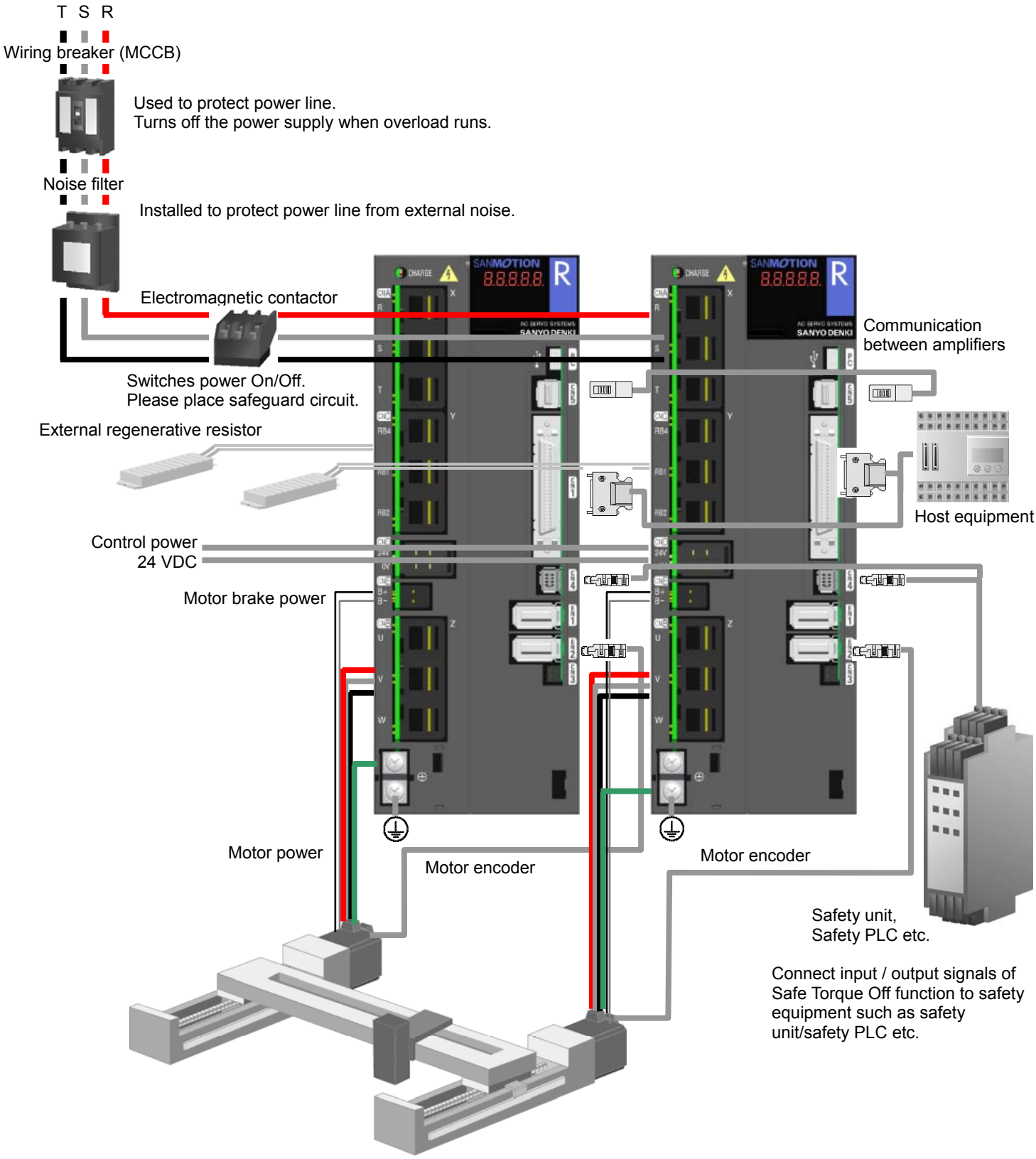
◆ When external pulse encoder operation is removed
Use at the condition that external pulse encoder is connecting mechanically.

# 9. Dedicated function

## 9.2 Tandem operation

This is the function that operates 2 axes with checking position error each other and compensating difference, through local communication function built in an amplifier unit.
(RS3C02 is used for description below.)

### 9.2.1 Illustration of system components

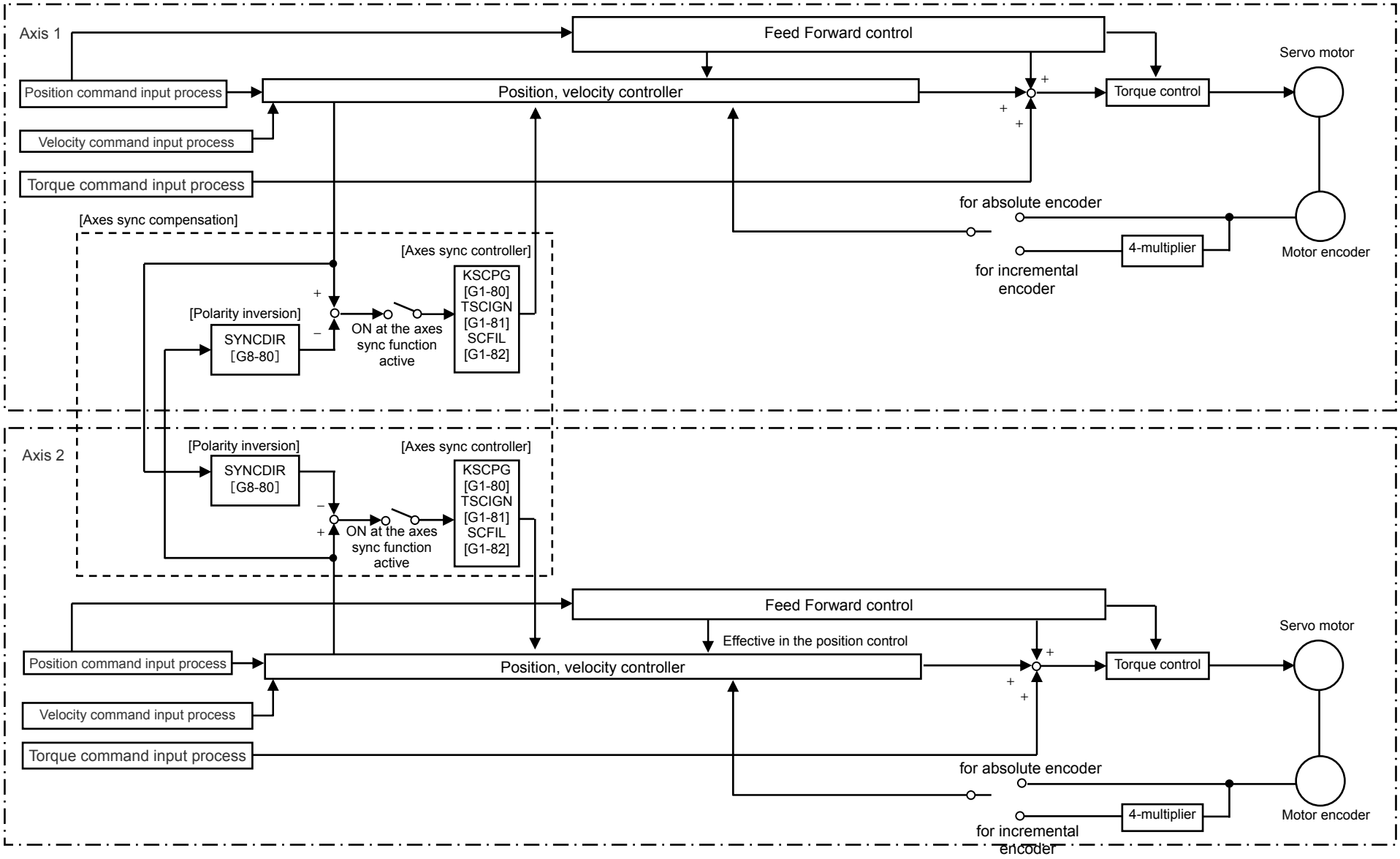


■ Precaution for system construction

* Construct system as balance of machine system (load inertia moment, friction, load torque) will be same in 2 axes. When that balance differs in 2 axes, overload alarm might occur only in 1 axis.
* At the tandem operation, please use servo motors and amplifier units with a same model number, in 2 axes.
* Please place safeguard circuit that is able to stop both axes by single axis alarm (like as power supply breaker).
* When overtravel function is used, construct system as inputting an overtravel status to both axes with same timing, after sending individual overtravel signal to a host equipment.
* In case that emergency stop function is assigned to general input signal and used, system shall be constructed so as to input emergency stop signal to both axes.

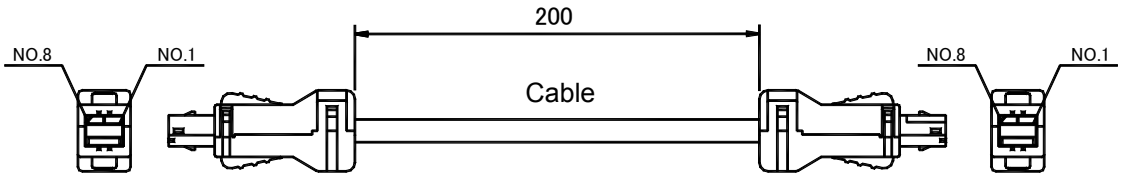
# 9. Dedicated function

## 9.2.2 Amplifier unit internal block diagram



## 9.2.3 Wiring

For use of the tandem operation, connect the communication cable to CN5.




* For use of the Safe Torque Off function, connect the wiring of CN4 (connector for safety device connection), between 2 axes.
* See "12.6.6 Communication cable of tandem operation between servo amplifiers" for detail of the communication cable.

## 9.2.4 Setting for the tandem operation function

For use of the Safe Torque Off function, set the parameters below.

■ Amplifier communication function selection
Select use of the RS422 communication function (at CN5 connector).
It will activate after power cycle for control.

| Group | ID | Selection | | Contents |
|---|---|---|---|---|
| System | 08 | 01 | Tandem | Uses as for the tandem operation. |

* Select "01: Tandem" in both axes.
If it is not selected at one side, "AL.D7(Amplifier communication error)" will occur.

■ Axes-sync compensation proportional gain
Sets a rate of the axes-sync compensation value.
When 100% is set, adds the axes-sync compensation pulse value to the position deviation without change.
Vibration might occur if set value is too large.

| Group | ID | Setting range | Default | Unit |
|---|---|---|---|---|
| 1 | 80 | 0 to 300 | 0 | % |

■ Axes-sync compensation integral time constant
Sets an integral time constant for the axes-sync compensation.
This set value will be valid when axes-sync compensation proportional control function is invalid.
Integral term will be invalid (proportional control) when 1000.0ms is set.

| Group | ID | Setting range | Default | Unit |
|---|---|---|---|---|
| 1 | 81 | 0.5 to 1000.0 | 1000.0 | ms |

■ Axes-sync compensation filter
Primary low pass filter that suppress sudden variation of axes-sync compensation value.
Filter will be invalid when 0.0ms is set.

| Group | ID | Setting range | Default | Unit |
|---|---|---|---|---|
| 1 | 82 | 0.0 to 1000.0 | 0.0 | ms |

■ Polarity selection of axes-sync compensation input
Fit a polarity of position deviation each other.
Set "01: Reversed" to one axis if rotation directions of combination axes are different.

| Group | ID | Setting range | Default | Contents |
|---|---|---|---|---|
| 8 | 80 | 00:Not_reversed | 00: Not_reversed | Without reversing |
| | | 01:Reversed | | Reversing |

■ Axes-sync compensation function
Selects an input condition to activate the axes-sync compensation function.
Tandem operation function will work when "01: Tandem" is set to system parameter ID08 "Amplifier communication function", and this parameter is valid.

| Group | ID | Setting range | Default | Unit |
|---|---|---|---|---|
| 9 | 80 | 00 to 11 | 00 | -- |

* See "Group9 Function enabling condition settings" in "5.8 Parameter functions", for detail of the selection.

■ Axes-sync compensation proportional control switching function
Selects an input condition to activate the axes-sync compensation proportional control switching function.

| Group | ID | Setting range | Default | Unit |
|---|---|---|---|---|
| 9 | 81 | 00 to 29 | 00 | -- |

* See "Group9 Function enabling condition settings" in "5.8 Parameter functions", for detail of the selection.

## 9.2.5 How to use

■ Tandem operation has the mutual compensating method and the Master-Slave method.
- ◆ Mutual compensating method: This is the method that 2 axes are checking position error each other and compensating difference, through local communication function built in the servo amplifier. Use this method if same motion is required to both axes.
- ◆ Master-Slave method: This is the method that one side (Slave) checks position deviation with the other side (Master) and compensates difference. Use this method if a follow-up motion against the Master axis is required to the Slave axis.

■ For the mutual compensating method
- ◆ If rotation directions of 2 axes are same, set all parameters same in 2 axes.
- ◆ If rotation directions of 2 axes are different, set "04: PC-_VC+_TC+" to Group8 ID00 "Position, Velocity, Torque Command Input Polarity", at one axis. And, set "01: Reversed" to Group8 ID80 "Polarity selection of axes-sync compensation", at both axes. For the other parameters, set same parameters, at both axes.
- ◆ Recommends parameters below, at adjustment starting.
  Axes-sync compensation proportional gain: 30%, Axes-sync compensation integral time constant: 1000ms (equal to invalid), Axes-sync compensation filter: 0.0ms
- ◆ Adjust the value of the axes-sync compensation proportional gain and the axes-sync compensation filter for minimizing deviation, with checking the axes-sync error monitor.
- ◆ Make tune of servo gain. See "6. Servo tuning" for tuning procedure. However, some of functions are not able to use. See "9.2.7 Precautions" for the functions which are not able to use.

■ For the Master-Slave method
- ◆ When Master-Slave method is used, the axes-sync compensation function is set as invalid at Master axis, and set as valid at Slave axis.
- ◆ If rotation directions of 2 axes are same, set same parameter to Group8 ID00 "Position, Velocity, Torque Command Input Polarity", in 2 axes. And, set " 00:Not_Reversed " to Group8 ID80 "Polarity selection of axes-sync compensation", at Slave axis.
- ◆ If rotation directions of 2 axes are different, set "04: PC-_VC+_TC+" to Group8 ID00 "Position, Velocity, Torque Command Input Polarity" and set " 01:Reversed " to Group1 ID83 "Polarity selection of axes-sync compensation", at Slave axis.
- ◆ Set Master side parameters as below.
  Axes-sync compensation proportional gain: 0% (equal to invalid), Axes-sync compensation integral time constant: 1000ms (equal to invalid), Axes-sync compensation filter: 0.0ms
- ◆ Slave side parameters are recommended as below.
  Axes-sync compensation proportional gain: 30%, Axes-sync compensation integral time constant: 1000ms (equal to invalid), Axes-sync compensation filter: 0.0ms
- ◆ Adjust the value of the axes-sync compensation proportional gain, the axes-sync compensation integral time constant and the axes-sync compensation filter for minimizing deviation, with checking the axes-sync error monitor.
- ◆ Make tune of servo gain. See "6. Servo tuning" for tuning procedure. However, some of functions are not able to use. See "9.2.7 Precautions" for the functions which are not able to use.
- ◆ The other parameters of above shall be set same value, basically.

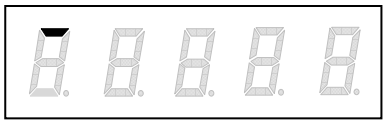
## 9.2.6 Error detection

Warnings or alarms are able to output by detecting position deviation error of own axis and counterpart axis. Avoids continuance of servo motor rotation if motions between 2 axes have gap by something cause.

■ Axes-sync error warning level
Warning outputs when position deviation error between own axis and counterpart axis exceeds this set value.

| Group | ID | Setting range | Unit |
|---|---|---|---|
| B | 80 | 1 to 2147483647 | Pulse |

* Warning status is able to check by the monitor indication and the front LED.



■ Axes-sync error excess value
Outputs the axes-sync error excess (alarm code: D4) when position deviation error between own axis and counterpart axis exceeds this set value.

| Group | ID | Setting range | Unit |
|---|---|---|---|
| B | 81 | 1 to 2147483647 | Pulse |

* Axes-sync error pulse is able to check by the monitor indication: ID66 Axes-sync error monitor.
* Axes-sync error pulse is able to reset by the position deviation clear.

## 9.2.7 Precaution

◆ At the tandem operation, different load inertia moment ratios can not use in 2 axes. (Please set same load inertia moment ratio in 2 axes if using the value estimated by the load inertia moment ratio estimation.)

◆ Do not use functions below, in the tandem operation.

* Adaptive notch filter function
* Model control switching function
* Model vibration suppression control switching function
* Auto tuning function (Auto tuning [JRAT manual setting] is available)
* Auto notch filter tuning function
* Auto FF vibration suppression frequency tuning
* CP vibration suppression control
* Minor vibration suppression
* Disturbance observer function
* Gain switching function (In case of "always valid" and "operating by using general input signal", function is available.)
* Full-closed function
* System analysis function
* Servo tuning navigation

◆ In use of mutual compensating method, please operate at same timing in 2 axes for active status control of each function which assigned to general input.

◆ When alarm is occurred, 2 axes might have position deviation.
In that case, please adjust machine positions of 2 axes.

◆ For one side axis operation, disable Group9 ID80 "Axes-sync compensation function" and make counterpart axis servo off.

* Avoid high speed operation. (Dynamic brake of counterpart axis might burn out.)

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# 10

# Safe-Torque-Off (STO) function

In this chapter, details of Safe-Torque-Off (STO) function are explained.


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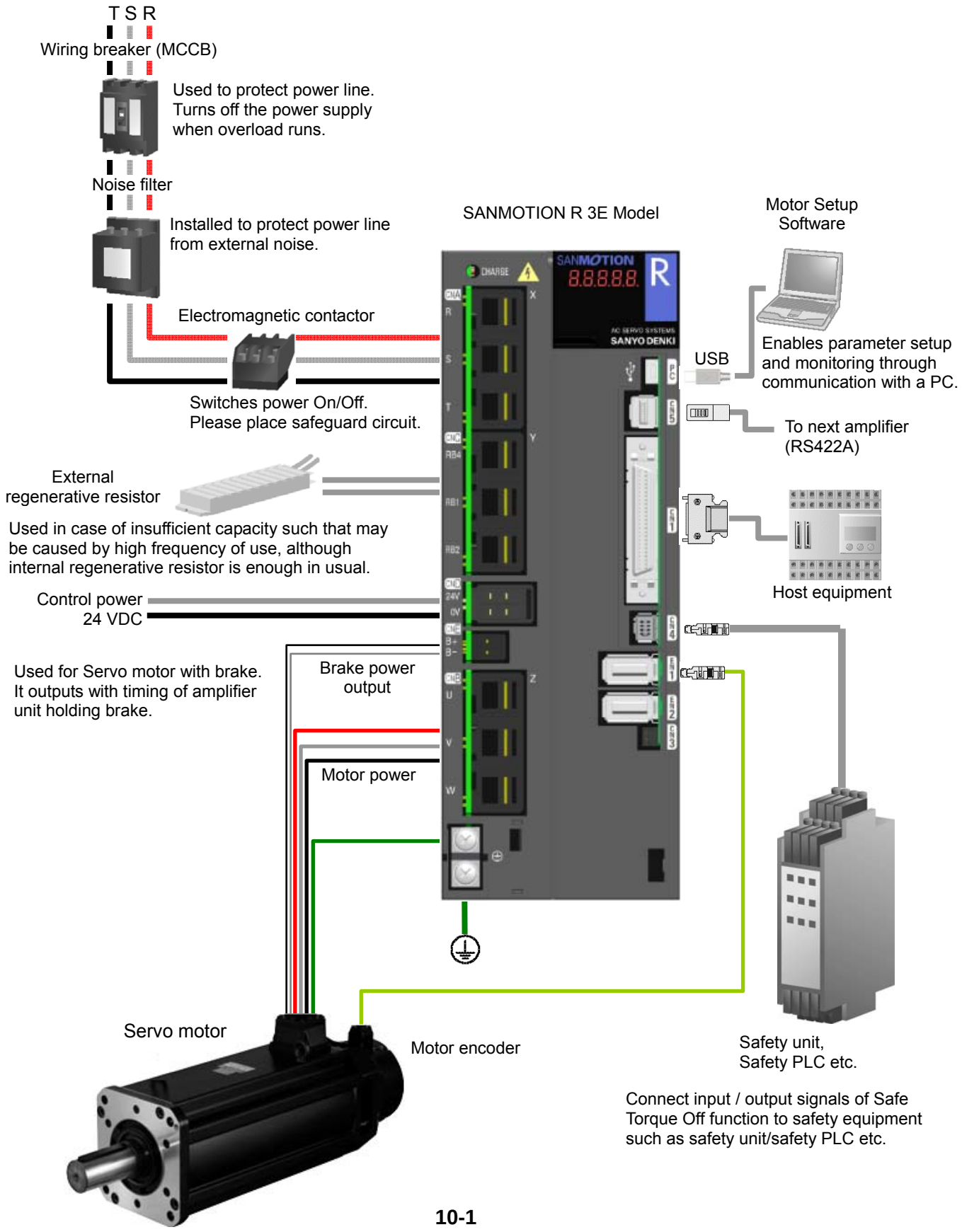
# 10. Safe Torque Off function

## 10.1 Illustration of system configuration

RS3C02 is used for description below.

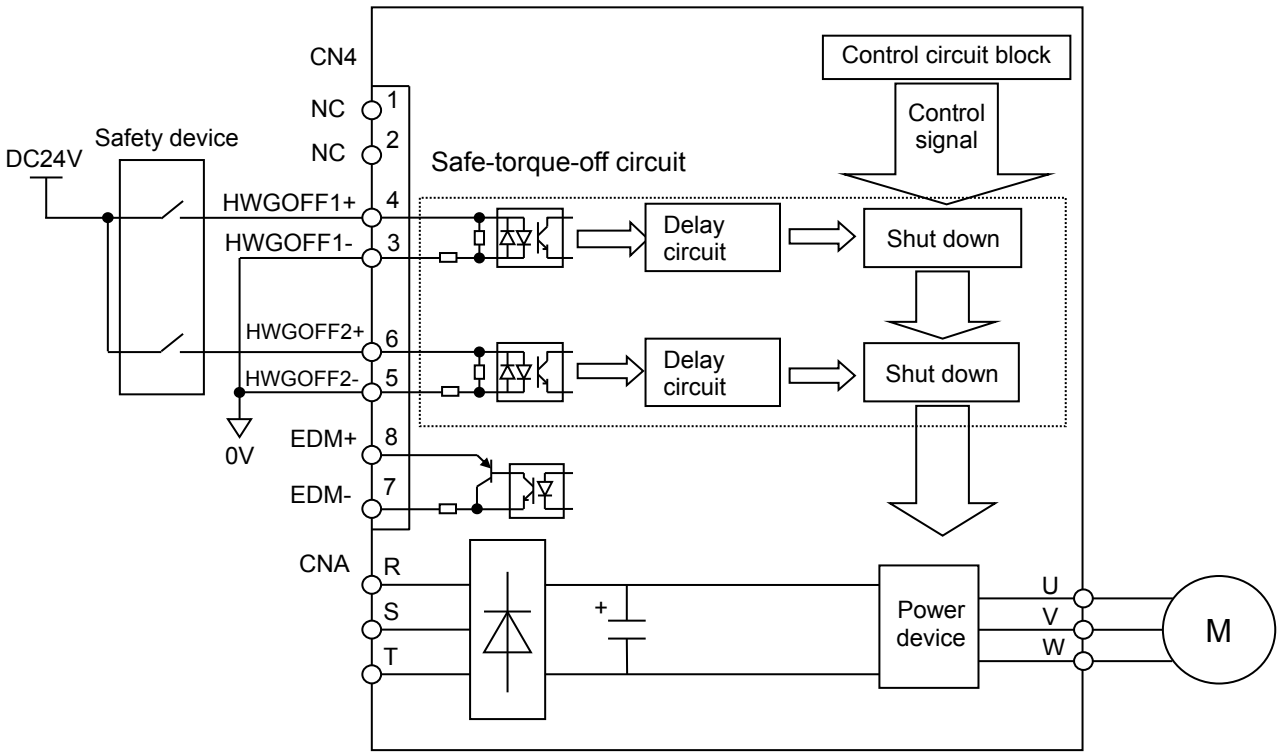


## 10.2 Safe-Torque-Off function

Safe-torque-off function reduces injury risks and ensures the safety for those who work near moving parts of equipment. This function employs 2-channel input signal to block current to servo motor. Previously we ensure machine safety by blocking current to power unit/amplifier unit with use of electromagnetic contactor. This safe-torque-off function allows keeping machine safety without shutting down power supply even when you need to perform tasks such as machine maintenance in dangerous areas. Maintenance without shutting down power supply can help you improve your work efficiency.

### 10.2.1 Outline

This function stops current control signal of servo motor, which is generated control circuit, by any of each path connected to 2-channel safety input signals (HWGOFF1 and HWGOFF2), and then blocks current from power device to servo motor.



# 10. Safe Torque Off function

## 10.2.2 Standards conformity

This function meets the following safety functions, safety standards, and safety parameters.

| Item | Standard |
|---|---|
| Safety functions | ■ IEC61800-5-2, safe-torque-off (STO) / EN61800-5-2 |
| Safety Standards | ■ IEC61508(2nd), SIL3, HFT=1, type B / EN61508<br>■ IEC62061, SILCL3, HFT=1, type B / EN62061<br>■ ISO13849-1:2015, Cat3, PL = e (When error detection performed by using EDM) / EN ISO 13849-1 / 2015<br>■ ISO13849-1:2015, PL = c (When error detection not performed.) / EN ISO 13849-1 / 2015 |

* Probability of a dangerous Failure per Hour (PFH) of this function (Safe Torque Off circuit) achieves less than 25% of required level of SIL3 and 2% of required level of SIL2.

* To suffice ISO13849-1:2015, Cat3, PL=e, you need to design machine safety system so as to detect failure of STO circuit by surely using Error Detection Monitor (EDM).

* The Mean Time to Dangerous Failure (MTTFd) for this function is a hundred year. The Diagnostic Coverage (DC) for this function with use of Error Detection Monitor (EDM) is 92%.

* For another standards conformity of Safety Function and Safety Standard, refer to Chapter 12.

* Please contact us if error detection by EDM is not used.

## 10.2.3 Risk assessment

This amplifier unit meets the requirements of the above functional safety standards. However, before activating this safety function, make sure to assess the risks associated with the overall equipment to ensure safety.

## 10.2.4 Residual risk

Even if this function activated, the following risks remain. Please ensure the safety is maintained even if these risks occur, by performing risk assessments.

■ When this function is activated while servo motor is running, the power supply to the motor is shut down, however, the motor continues to run a while because of inertia. Please make sure to design the safety system to prevent any danger until the motor stops completely.

■ When servo motor used in vertical axes, the motor rotates by gravity. Please be advised that preparing means for stopping such as mechanical brake at your end is needed. Moreover, please note that servo brake circuit/dynamic brake circuit/holding brake excitation signal of amplifier unit and servo motor holding brake are not safety related devices.

■ If the power device malfunctions and causes inter-phase shorting, the servo motor may move within a range of up to 180 degrees in electrical angle and remain in the excited state. For your information, the travel distance of R motor in this occasion is as follows;
R-motor travel distance: 1/10 turns (rotation angle at the motor shaft).

■ Be sure to check if this function works properly when the machine is operated for the first time or power unit/amplifier unit is replaced. If the servo amplifier is incorrectly used due to miswiring of input / output signals, this function will not work properly, which may incur danger.

■ Even when this function is working, power supply to power unit/amplifier unit is not shut down. Be sure to shut down power supply before you perform maintenance or checkup of each unit, in which you may be exposed to electric shock.

### 10.2.5 Delay circuit

We offer two paths, with or without delay circuit between safety input 1(HGWOFF1)/safety input 2 (HWGOFF2) input circuit and servo motor current control signal blocking circuit. When using in vertical axis, please use path with delay circuit to prevent motor shaft falling due to holding brake operation delay during safe torque off function operation.

| Amplifier unit model number | Delay circuit (Max. delay time) |
|---|---|
| RS3#######2 | No delay circuit (Max.20ms) |
| RS3#######4 | With delay circuit (Max.700ms) |

* Even the hardware without delay circuit, there are still max. 20ms of delay until the safe torque off function works due to the delay in the input circuit.

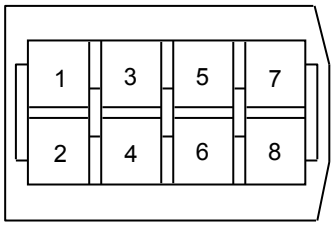
* Holding brake excitation signal and servo motor holding brake are not safety related parts.

# 10. Safe Torque Off function

## 10.3 Wiring

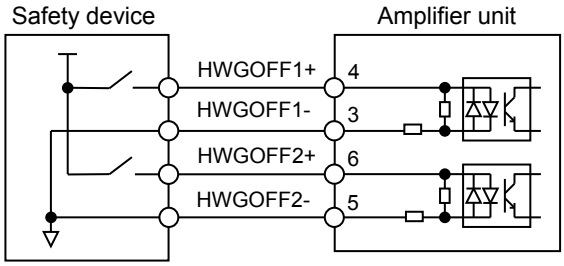
### 10.3.1 CN4 connector layout

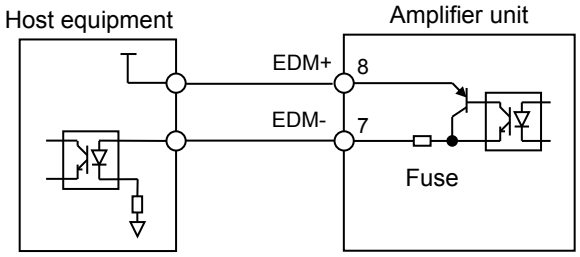
■ CN4 2013595-3 (soldered side)




### 10.3.2 Connection diagram of CN4-terminals

Functions and connection circuit of each CN4-teminals are as shown below.

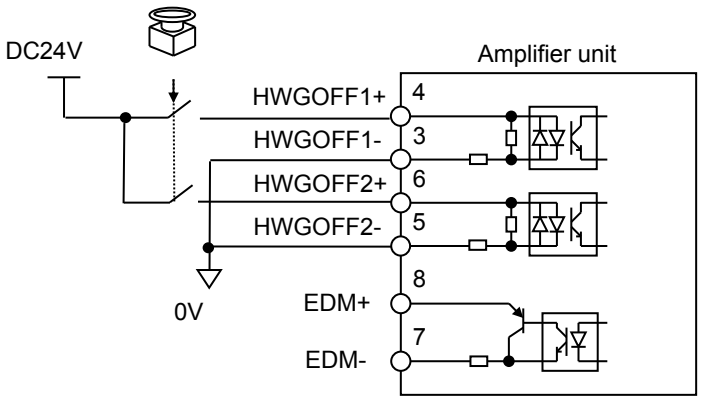
| Signal | Terminal No. | Code | Description |
|---|---|---|---|
| | 1 | | These are connecting terminals when the function is not used.<br>Do not use these terminals. |
| | 2 | | |
| Safety input 1 | 3 | HWGOFF1- | This is an input signal to control safe-torque-off state.<br><br>Connection circuit<br>Connects to relay or transistor circuit of open collector.<br>Power supply voltage range: DC24V±10%<br>Internal impedance: 2.2kΩ<br><br>  |
| | 4 | HWGOFF1+ | |
| Safety input 2 | 5 | HWGOFF2- | |
| | 6 | HWGOFF2+ | |

| Signal | Terminal No. | Code | Description |
|---|---|---|---|
| Error detection monitor | 7 | EDM- | This is a signal to monitor safe-torque-off functions faults.<br><br>Connection circuit:<br>Connects to photo coupler or relay circuit.<br>Power supply voltage range (Uext): 24 VDC±10 %<br>Maximum current value: 50 mA<br>Output voltage: Uext-0.5 to Uext<br><br>  <br> |
| | 8 | EDM+ | |

* When you do not use this function, connect terminal 1 and 3, 5, and also connect terminal 2 and 4, 6 (short-circuit). A connector for short-circuit, PN# AL-00718251-01, is available as an option.

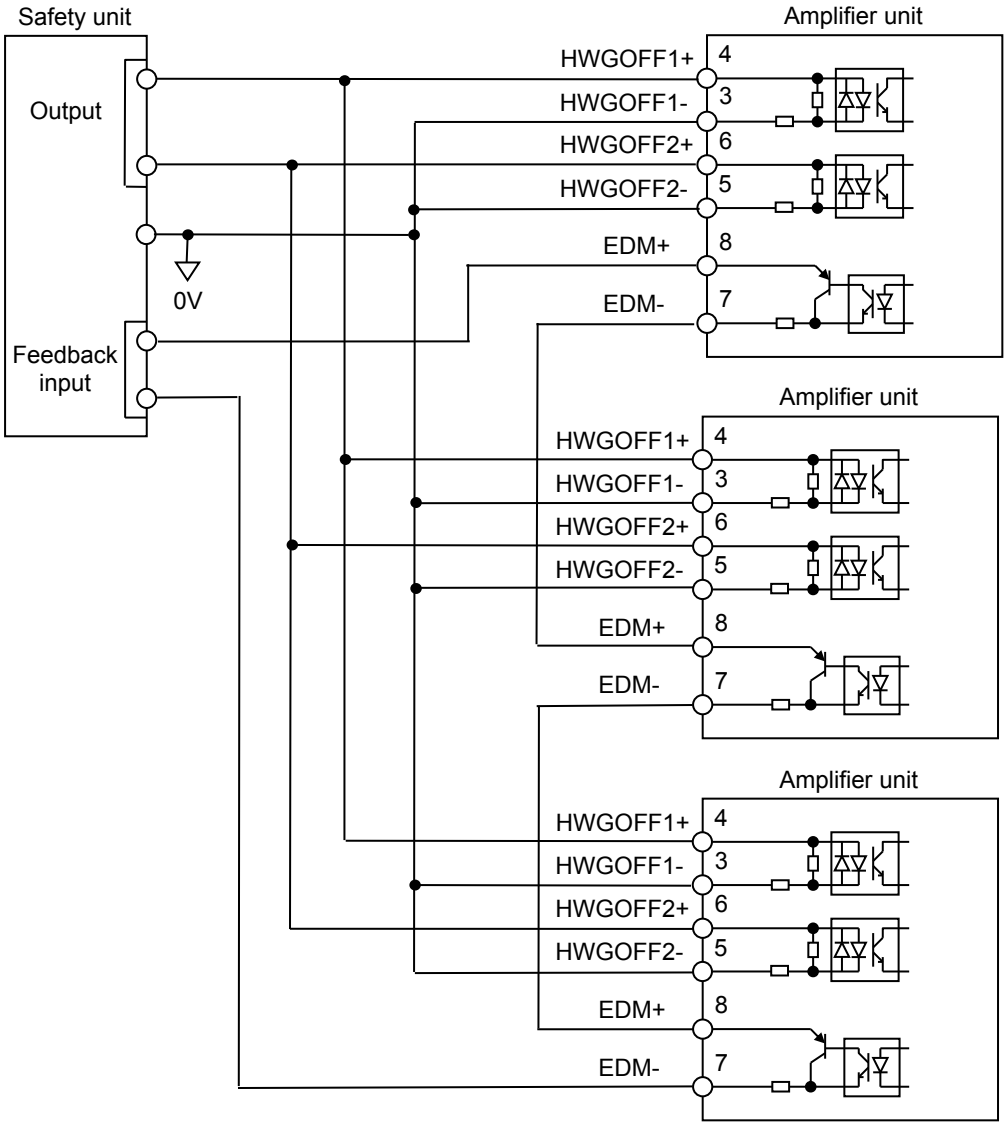
## 10.3.3 Example of wiring

Example of wiring to safety switch (single servo amplifier connected)



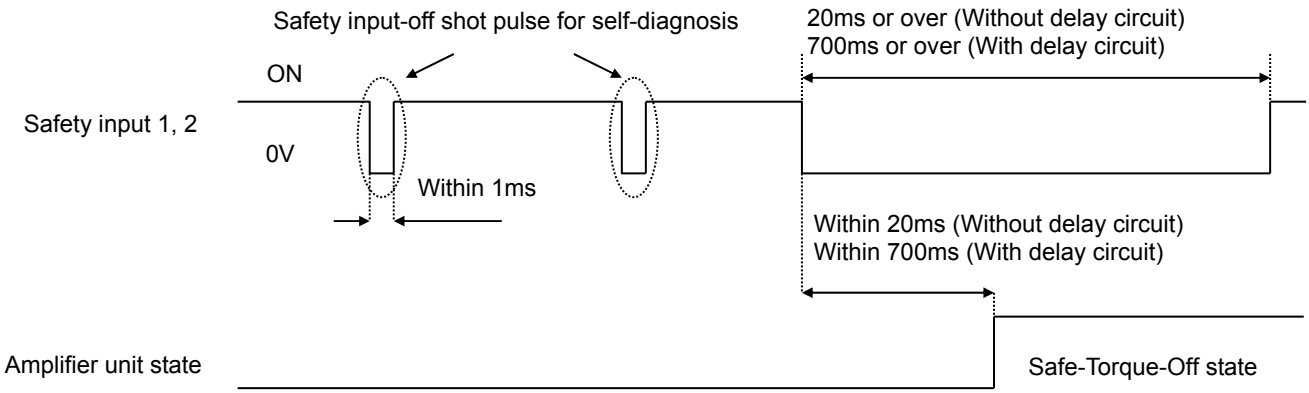
# 10. Safe Torque Off function

Example of wiring to safety unit (multiple-servo amplifier connected)



## 10.3.4 Safety input-off shot pulse for safety device self-diagnosis

When you connect safety device supplied with safety input-off shot pulse signal for self-diagnosis added to safety output signal, such as safety unit or safety sensor, use safety device whose safety input-off shot pulse signal is 1ms or less. Safe-torque-off function is not activated when the period of safety input signal (HWGOFF1, HWGOFF2)-OFF is 1ms or less.
In order to surely fulfill safe-torque-off function, turn off safety input signal for 20ms or more (without delay circuit) or 700ms or more (with delay circuit).




* Torque may turn off for a moment if the pulse of 1ms over to less than 8ms is input.

# 10. Safe Torque Off function

## 10.4 Safe-Torque-Off operation

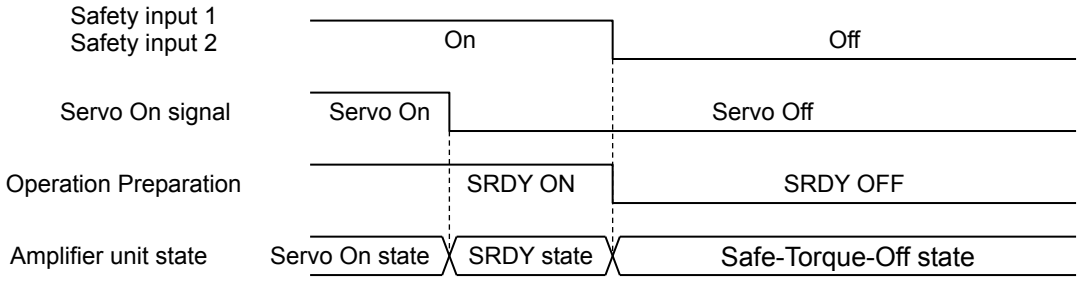
### 10.4.1 Safe-torque-off state

When safety input 1(HWGOFF1) or safety input 2 (HWGOFF2) signal is off (as shown the table below), the state becomes safe-torque-off state.
In this state, servo-ready signal is turned off, and servo-on signal reception is prohibited.

| Signal | Input condition | Amplifier unit state |
|---|---|---|
| Safety input 1 (HWGOFF1) | On | Normal state |
| | Off | Safe-torque-off state |
| Safety input 2 (HWGOFF2) | On | Normal state |
| | Off | Safe-torque-off state |

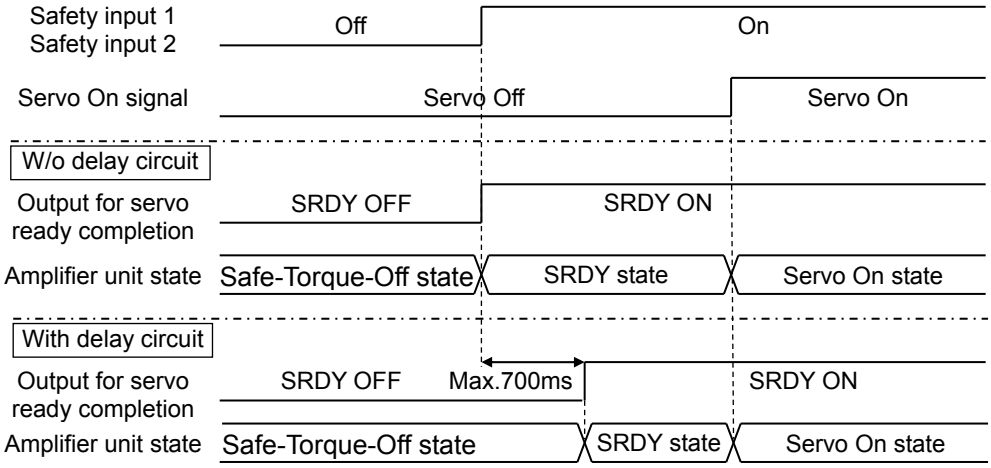
* Off: Electric current will not flow (contact open).

* On: Electric current will flow (contact closed).

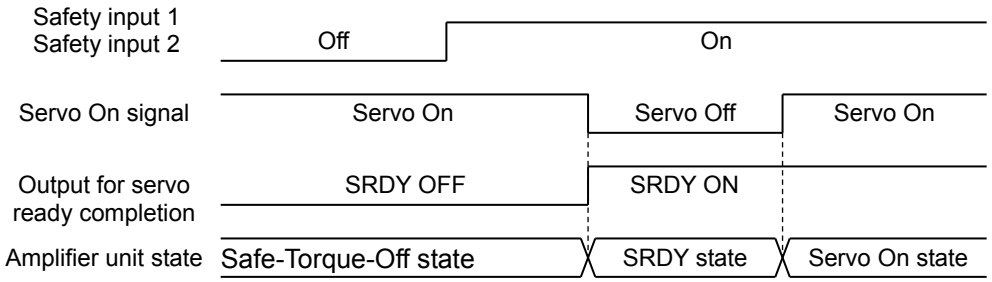


## 10.4.2 Restoration from safe-torque-off state

In the state servo-on signal is not input as described in 10.4.1, turning on safety input 1 or 2 activates SRDY state. Operation is restarted on inputting servo-on signal. (For delay circuit equipped hardware, it takes maximum 700ms to become SRDY state.)




In the state servo-on signal is input, safe-torque-off activated state remains even if safety input 1 or 2 is turned on. To restart operation, turn off servo-on signal to activate SRDY state, then input servo-on signal.



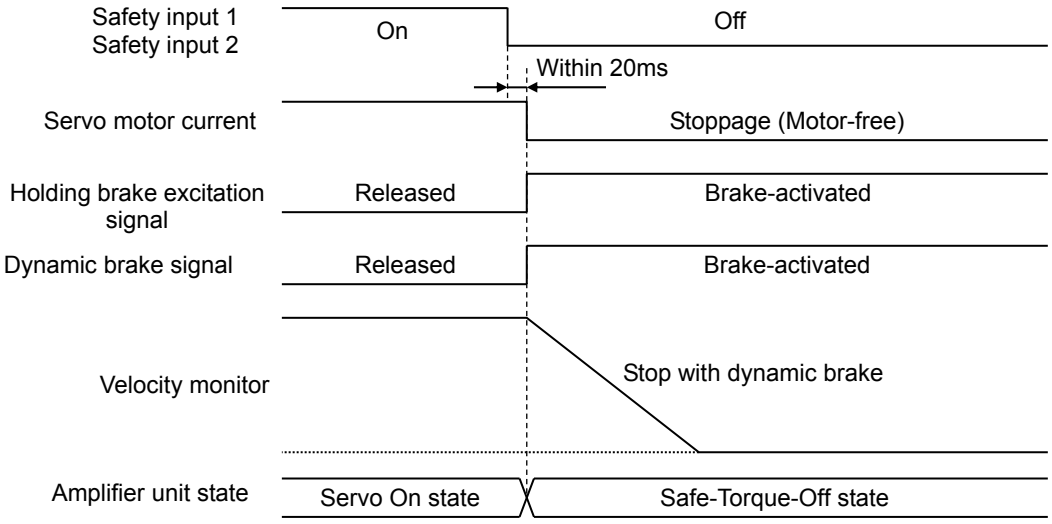

* Group9 ID05: Setting the Servo-ON Function parameter to "01: Always On" disables resets from the safe torque off state. Avoid this setting when using the safe torque off function.

## 10.4.3 Safe-Torque-Off during servo motor running

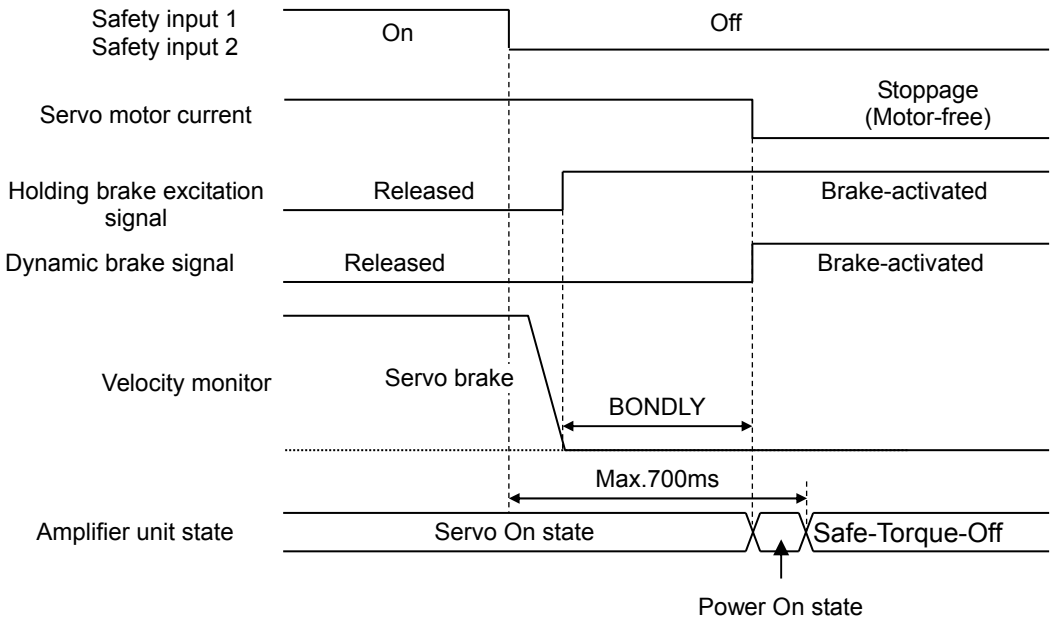
Stoppage behavior varies depending on forced outage operation settings (ACTEMR Group B ID02).

■ In case of setting "00: SERVO-BRAKE" at GroupB ID02 "Emergency Stop Operation [ACTEMR]".
Stoppage behavior varies depending on amplifier model numbers.

◆ RS3#######2 (without safe-torque-off delay circuit)
Motor cannot stop with servo brake when safety input 1 or 2 is turned off because servo motor current is blocked. So motor shall be stopped with dynamic brake or holding brake.



◆ RS3#######4 (with safe-torque-off delay circuit)
Motor stops with servo brake when safety input 1 or 2 is turned off.




* When set value of GroupB ID03 “Holding brake activation delay time [BONDLY]” is more than safe-torque-off delay time (700ms max.), the state becomes motor-free after period of safe-torque-off delay time. Please note that recommended set value for BONDLY is less than 300ms.

* Servo brake circuit, dynamic brake circuit, and holding brake excitation signal are not safety-related sections.

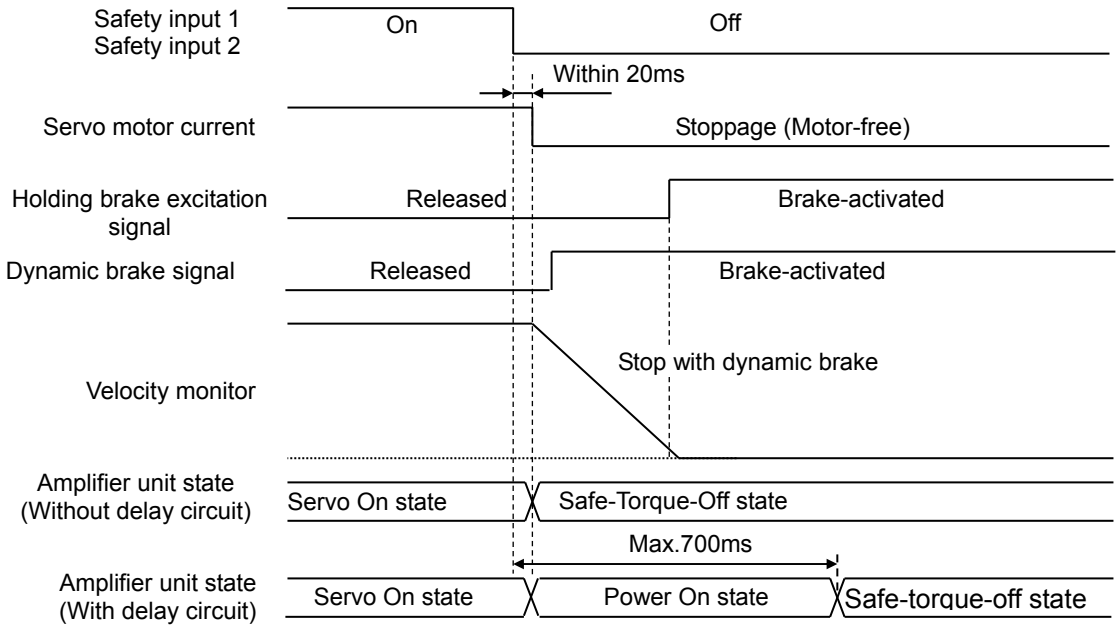
# 10. Safe Torque Off function

■ In case of setting "01: DYNAMIC-BRAKE" at GroupB ID02 "Emergency Stop Operation [ACTEMR]".

When safety input 1 or 2 is turned off, this setting blocks servo motor current, and then stops servo motor with dynamic brake after. Transition behavior to safe-torque-off state varies depending on amplifier model numbers.

◆ RS3#######2 (without safe-torque-off delay circuit)
Safety input is turned off and then the status comes to safe-torque-off state at the same time dynamic brake applied.

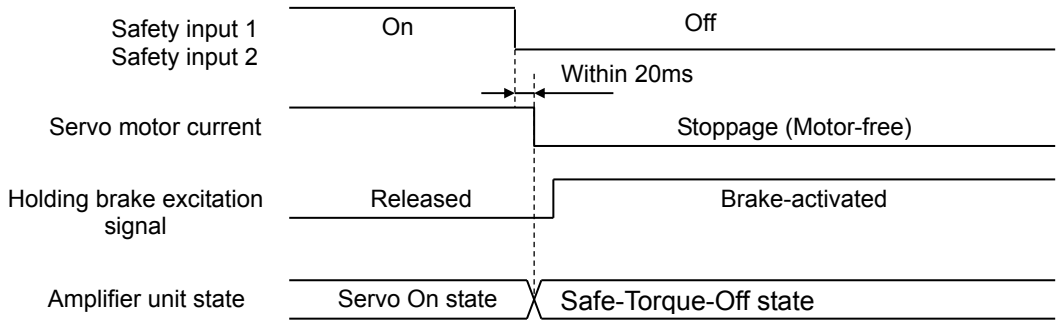
◆ RS3#######4 (with safe-torque-off delay circuit)
The state moves to safe-torque-off state after period of delay time (500ms max.) from turning off safety input. Dynamic brake is activated on turning off safety input.



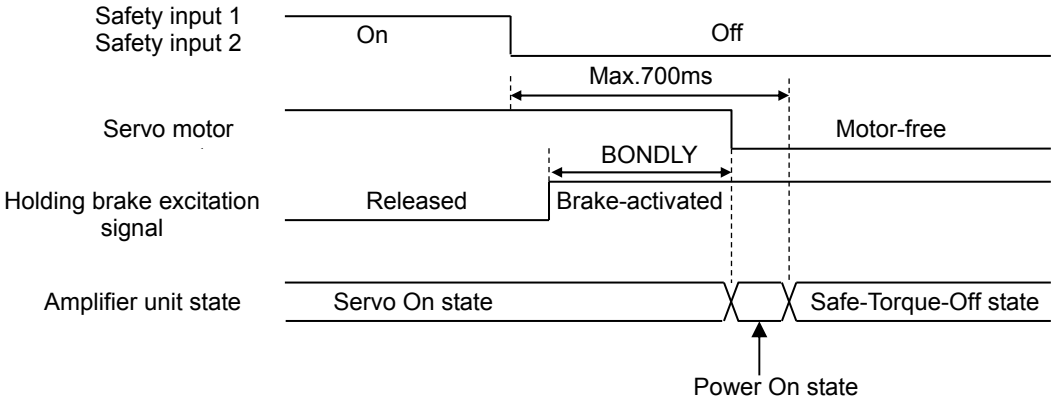

* Dynamic brake circuit and holding brake excitation signal are not safety-related sections.

### 10.4.4 Safe-Torque-Off during servo motor stoppage

When safety input 1 or safety input 2 is turned off, holding brake signal outputs brake-activated state, however this blocks servo motor current, so "holding brake activation delay time" becomes invalid. In line with this, servo motor may run by an external force during the period from the time holding brake signal activation state output to the time holding brake being activated.




When you use amplifier model number RS3#######4 (with safe-torque-off delay circuit), you can ensure the time to activate holding brake because of maximum 700ms of delay time by the time safe-torque-off function activated after safety input 1 or 2 is input.
Select amplifier model number RS3#######4 for use in gravity axes.




* Set GroupB ID03 "Holding brake activation delay time [BONDLY]" to the value less than 700ms.

* Set GroupB ID02 "Emergency Stop Operation [Emergency Stop Operation]" to "00: SERVO-BRAKE".

## 10.4.5 Deviation clear

When selecting 02:Type3 or 03:Type4 (not to clear deviations at servo-off state) on Group8 ID19 "Deviation Clear Selection [CLR]", please pay careful attention to the followings.
When safe-torque-off function activated under the condition that position command is input at the time of position control, position deviation accumulates and this causes alarm (excess position deviation: alarm D1) activated. Furthermore, when servo-on re-performed before alarm activated, servo motor moves by the accumulated partial position deviation. When you activated safe-torque-off function to avoid this state, stop position command and clear position deviation at the same time.
When selecting 00:Type1 or 01:Type2 (to clear deviation at servo-off state) on Group8 ID19 "Deviation Clear Selection [CLR]", position deviation is automatically cleared at servo-off.

## 10.4.6 Safety input signal failure detection

- Safe-Torque-Off malfunction 1 (Alarm 25)
  This alarm is activated when either safety input 1 or safety input 2 turned off, and after that the other is not turned off within 10 seconds. This allows detecting errors such as safety input signal disconnection.
  If internal circuits fail, the alarm is detected after 10 seconds. However it doesn't affect the safety circuit.

- Safe-Torque-Off malfunction 2 (Alarm 26)
  This alarm is activated when detecting internal circuit errors by judging from safety input and internal status. This allows detecting errors occurred in the circuit that stops control signal from safety input to power module.

# 10.5 Error Detection Monitor (EDM)

## 10.5.1 Specifications

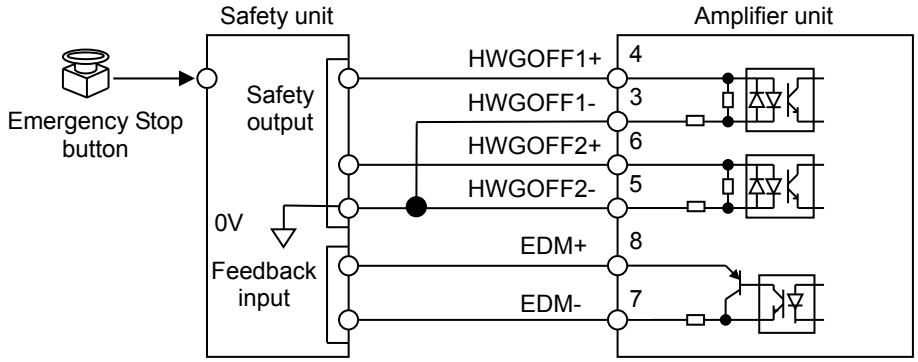
Error detection monitor (EDM) output is a signal to monitor wiring errors in safe-torque-off circuit or between safety equipment and safety input. The following table shows connections between safety input (HWGOFF1 and HWGOFF2) and error detection monitor (EDM) output.

| Signal | State | | | |
|---|---|---|---|---|
| Safety input 1 (HWGOFF1) | On | On | Off | Off |
| Safety input 2 (HWGOFF2) | On | Off | On | Off |
| Error detection monitor (EDM) | Off | Off | Off | On |

* If the above connections are not satisfied, the safe-torque-off circuit or EDM output circuit is malfunctioning.

## 10.5.2 Connection example

The following is connection example that allows activating safe-torque-off function on pressing emergency button by using safety unit.




Connect safety output signals of safety unit to safety input 1 (HWGOFF1) and safety input 2 (HWGOFF2) respectively, and then failure detection monitor output signal (EDM) from amplifier unit to feedback input of safety unit. Under normal conditions, pressing emergency stop button turns off both of safety inputs and on EDM output. Once emergency stop button is cancelled, feedback circuit of safety unit is reset and 2 safety inputs are turned on at the same time because EDM output is on. This allows restarting operation.

* In case such a malfunction occurs that EDM will not be turned on despite both the /HWGOFF1 and /HWGOFF2 being off, even if the emergency stop button is cancelled, the operation will not resume as the feedback circuit has not been reset yet. (The amplifier keeps safe-torque-off state).

### 10.5.3 Error detection method

EDM output will not on and EDM-signal remains off even if emergency stop button is pressed, in the case of an error such as either of safety input remains on inside of amplifier unit. In line with this, errors like this can be detected by developing system with use of safety unit enabling to detect any failures in the connections in the above table.

* In case you need to suffice requirement of ISO13849-1, PL=e, be sure to do testing of failure detection using EDM output once a month or more frequently.

* For discussions on connecting and operating the safety unit, please refer to the manual provided with your safety unit.

* The EDM signal is not a safety output. Do not use the EDM signal for any purpose other than malfunction monitoring.

# 10.6 Verification test

For use of the Safe Torque Off function, you must confirm that the safe torque off operations correctly during machine startup, power unit/amplifier unit replacement and test operation.
Even if it is not fit to the case above, strongly recommended that confirmation of function operation at least once every three months.

## 10.6.1 Preparation

Please perform test operation prior to performing verification test to verify no problems with amplifier unit and motor installation and wiring, and with servo amplifier and motor properly operate. Refer to “3. Installation” through “5.2 Test Operation” for installation, wiring, and test operation.

## 10.6.2 Confirmation procedure

Perform verification test for safe-torque-off in accordance with the follow the procedures:

Procedure 1. Supply control power and main circuit power.
Procedure 2. Turn on both safety input 1and 2.
Procedure 3. Input servo-on signal to excite servo motor.
Procedure 4. Turn off both safety input 1and 2.

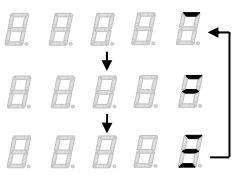
## 10.6.3 Acceptance criteria

In steps 2 to 4, verify the states listed below.

Procedure 1. In step 2, make sure that EDM output and LED indication are as follows:

| Confirmation item | State |
|---|---|
| EDM output | Off |
| LED indication | |

Procedure 2. In step 3, verify that servo motor is excited.
Procedure 3. In step 4, verify that EDM output and LED indication are as follows:
Also, verify that servo motor excitation is cancelled.

| Confirmation item | State |
|---|---|
| EDM output | On |
| LED indication |  |

# 10. Safe Torque Off function

## 10.7 Safety precautions

Please thoroughly observe the following safety precautions to use safe-torque-off functions. Incorrect use of the functions can lead to personal injury or death.

* Safety system with safe-torque-off function shall be designed by the person with expertise of related safety standards and through understanding of the descriptions specified in this manual.

* Surely perform system risk assessment when you design safety system by using this function.

* When safe-torque-off function activated during servo motor running, power supply to servo motor is blocked but servo motor remains running through inertia. Please design your safety system so that no risks occur until servo motor comes to a complete stop.

* When used in vertical axes, servo motor runs by gravity. So please prepare means for stopping such as mechanical brake. Amplifier unit servo brake circuit, dynamic brake circuit, holding brake excitation signal, and servo motor holding brake are not safety-related sections.

* There is a possibility that servo motor runs in the range of maximum 180 electrical degree and servo motor-excited state continues, due to servo motor inter-phase short-circuit caused by power device failure. Please use this function only for usage you can judge that this behavior causes no risk conditions.

* Please perform verification test for this function at every machine start-up and power unit/amplifier unit replacement. Incorrect usage such as faulty wiring of input-output signals can lead to improper functioning and a risk condition.

* For the time of Safe Torque Off function working and the cause concerning information, recommended that recording as error log at user device.

* At inspection and maintenance for power unit/amplifier unit, strongly recommended that recording and storing a detail of inspection and maintenance.

# 11 Selection

In this chapter, each kind of selections are explained.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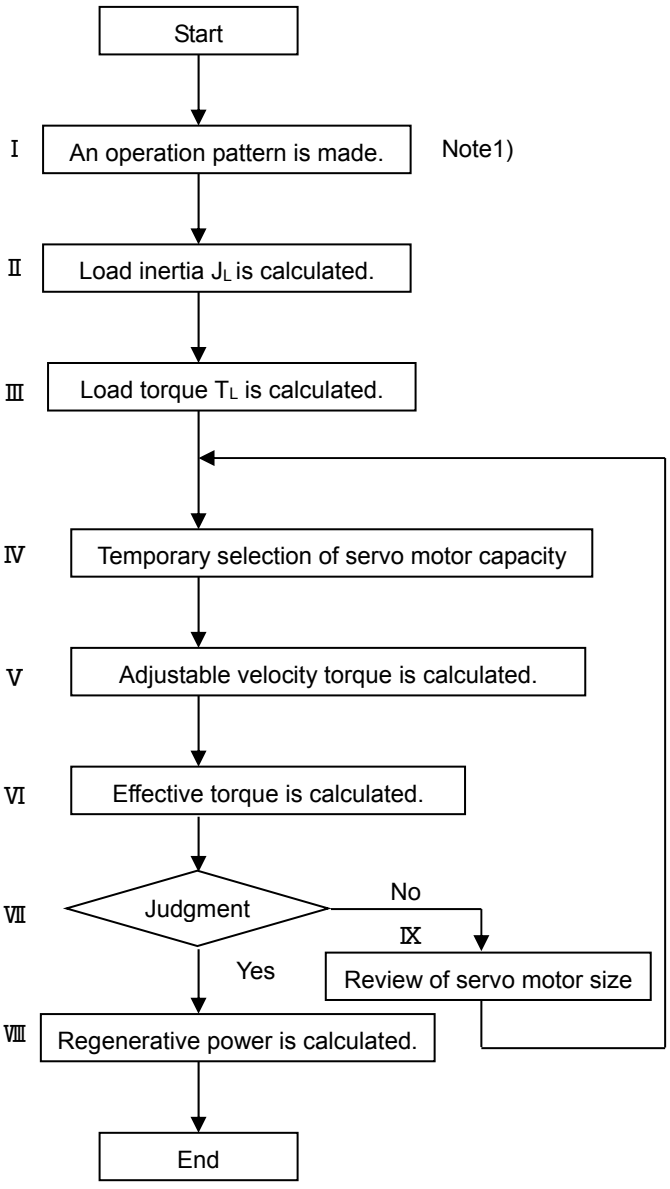
# 11. Selection

## 11.1 Servo motor sizing

It is estimated that selection of servo motor capacity computes required servo motor capacity from machine specification (composition). In addition, since the capacity selection of a servo motor can download "the capacity selection software of a servo motor" for free from our company "website", please use it here. Here, the fundamental formula is described.

### 11.1.1 Flowchart of servo motor sizing

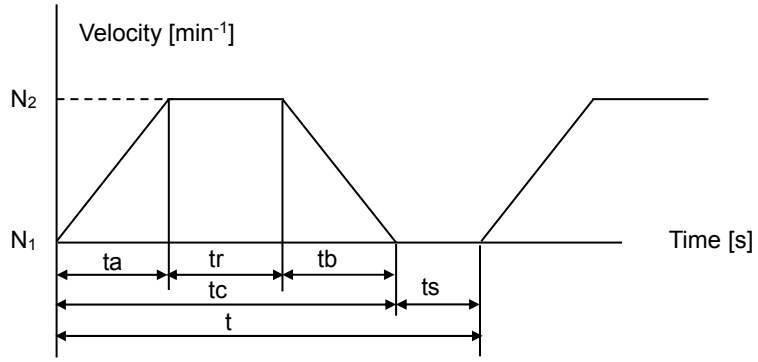



Ⅰ. Create operation pattern.
Ⅱ. Calculate load moment of inertia from a machine configuration.
Ⅲ. Calculate load torque from a machine configuration.
Ⅳ. Select the following motor:
- Load moment of inertia ($J_L$) is 10 times or less of servo motor rotor moment of inertia ($J_M$).
- The load torque ($T_L$) is 80% ($T_R$×0.8) of the motor rated torque or less.
  $J_L \leqq J_M \times 10$
  $T_L \leqq T_R \times 0.8$

Ⅴ. Calculate the required adjustable velocity torque from an operation pattern.
Ⅵ. Calculate the effective torque from a torque pattern.
Ⅶ. Judge whether the followings have been established. Adjustable velocity torque ($T_a$, $T_b$) is 80% ($T_p$×0.8) or less of the peak torque at stall ($T_p$) of servo motor
The effective torque (Trms) is 80% ($T_R$×0.8) or less of the rated torque ($T_R$) of servo motor
$T_a \leqq T_p \times 0.8$
$T_b \leqq T_p \times 0.8$
$Trms \leqq T_R \times 0.8$
Ⅷ. Calculate regeneration electric power, and if required, select an external regeneration resistor.
Ⅸ. Improve servo motor capacity, such as raising the capacity of a servo motor.

Note1) For making operation pattern, Must not exceed continuous maximum rotation speed by average rotation speed of motor.

## 11.1.2 Make an operation pattern




ta=Acceleration time
tb=Deceleration time
tr=Constant velocity time
ts=Stop time
t=1cycle

## 11.1.3 Calculate motor shaft conversion load moment of inertia ($J_L$)

■ The inertia moment of a moving part.

$$J_L = \left(\frac{1}{G}\right)^2 \times \frac{\pi \times \rho \times D^4 \times L}{32} \quad [kg \cdot m^2]$$

G: Reduction ratio
$\rho$ Moving part specific gravity [kg/m$^3$]
D: Moving part diameter [m]
L: Moving part length [m]

■ Work inertia moment

$$J_L = \left(\frac{1}{G}\right)^2 \times W \times \left(\frac{P}{2\pi}\right)^2 \quad [kg \cdot m^2]$$

G: Reduction ratio
W: Moving part mass [kg]
P: In the case of a ball screw, is the lead of a ball screw [m]
In the case of a belt pulley, is an outside diameter of a pulley. [m]
($P = \pi D$)

### 11.1.4 Calculate motor shaft conversion load torque ($T_L$)

■ Ball screw (in horizontal axis)

$$T_L = \frac{(F + \mu W)}{\eta} \times \frac{P}{2\pi} \times \frac{1}{G} \times 9.8 \quad [N \cdot m]$$

■ Ball screw (in vertical axis)

When motor drives upward

$$T_L = \frac{(F + (\mu + 1)W)}{\eta} \times \frac{P}{2\pi} \times \frac{1}{G} \times 9.8 \quad [N \cdot m]$$

When motor drives downward

$$T_L = \frac{(F + (\mu - 1)W)}{\eta} \times \frac{P}{2\pi} \times \frac{1}{G} \times 9.8 \quad [N \cdot m]$$

■ When ball screw stops (in horizontal axis)

$$T_L = \frac{F}{\eta} \times \frac{P}{2\pi} \times \frac{1}{G} \times 9.8 \quad [N \cdot m]$$

■ When ball screw stops (in vertical axis)

$$T_L = \frac{(F+W)}{\eta} \times \frac{P}{2\pi} \times \frac{1}{G} \times 9.8 \quad [N \cdot m]$$

F: External force [kg]
$\eta$ : Transmission efficiency
μ: Coefficient of friction
W: Moving part mass [kg]
P: Ball screw lead [m]
G: Reduction ratio

■ Belt pulley (in vertical axis)

$$T_L = \frac{(F+\mu W)}{\eta} \times \frac{D}{2} \times \frac{1}{G} \times 9.8 \quad [N \cdot m]$$

■ Belt pulley (in vertical axis)

Belt pulley (in vertical axis)

$$T_L = \frac{(F+(\mu+1)W)}{\eta} \times \frac{D}{2} \times \frac{1}{G} \times 9.8 \quad [N \cdot m]$$

When motor drives downward

$$T_L = \frac{(F+(\mu-1)W)}{\eta} \times \frac{D}{2} \times \frac{1}{G} \times 9.8 \quad [N \cdot m]$$

■ When belt pulley stops (in horizontal axis)

$$T_L = \frac{F}{\eta} \times \frac{D}{2} \times \frac{1}{G} \times 9.8 \quad [N \cdot m]$$

■ When belt pulley stops (in vertical axis)

$$T_L = \frac{(F+W)}{\eta} \times \frac{D}{2} \times \frac{1}{G} \times 9.8 \quad [N \cdot m]$$

F: External force [kg]
$\eta$ : Transmission efficiency
μ: Coefficient of friction
W: Moving part mass [kg]
P: Diameter of a pulley [m]
G: Reduction ratio

### 11.1.5 Calculate acceleration torque ($T_a$)

$$T_a = \frac{2\pi (N_2-N_1) \times (J_L+J_M)}{60 \times ta} + T_L \quad [N \cdot m]$$

$N_2$: Servo motor rotation velocity after acceleration [$min^{-1}$]
$N_1$: Servo motor rotation velocity before acceleration [$min^{-1}$]
$J_L$: Load inertia moment [$kg \cdot m^2$]
$J_M$: Rotor inertia moment of servo motor [$kg \cdot m^2$]

### 11.1.6 Calculate deceleration torque ($T_b$)

$$T_b = \frac{2\pi (N_2-N_1) \times (J_L+J_M)}{60 \times tb} - T_L \quad [N \cdot m]$$

$N_2$: Servo motor rotation velocity before deceleration [$min^{-1}$]
$N_1$: Servo motor rotation velocity after deceleration [$min^{-1}$]
$J_L$: Load inertia moment [$kg \cdot m^2$]
$J_M$: Rotor inertia moment of servo motor [$kg \cdot m^2$]

### 11.1.7 Calculate effective torque (Trms)

$$Trms = \sqrt{\frac{(T_a^2 \times ta) + (T_L^2 \times tr) + (T_b^2 \times tb)}{t}} \quad [N \cdot m]$$

### 11.1.8 Judgment condition

■ We consider the followings as the standard of the judgment.

◆ Load torque load ratio $T_L \leqq T_R \times 0.8$ (Load torque is 80% or less of rated torque)

◆ Acceleration torque load ratio $T_a \leqq T_P \times 0.8$ (Acceleration torque is 80% or less of peak torque at stall )
* $T_P$: peak torque at stall

◆ Deceleration torque load ratio $T_b \leqq T_P \times 0.8$ (Deceleration torque is 80% or less of peak torque at stall)
* $T_P$: peak torque at stall

◆ Effective torque load ratio $Trms \leqq T_R \times 0.8$ (The effective torque is 80% or less of rated torque)

◆ Inertia moment ratio $J_L \leqq J_M \times 10$(Load moment of inertia is 10 times or less of the motor rotor moment of inertia)

In addition, the rise in heat of motor can be suppressed by taking the large degree of margin at torque load ratio. Moreover, when rotating a table mechanism slowly depending on inertia moment ratio, it may be able to control 10 or more times. We recommend you the check by the real machine.

## 11.2 Selection of regenerative resistor

Calculate "regeneration effective power (PM)," and determine the capacity of the regeneration resistance to be used. Judge whether usage of an internal regenerative register machine is possible by this calculation result.

### 11.2.1 How to find "regeneration effective power (PM)" of the horizontal axis drive by a formula

■ Calculate regeneration energy.

$$EM = Ehb = \frac{1}{2} \times N \times 3 \times Ke\phi \times \frac{Tb}{KT} \times tb - \left[\frac{Tb}{KT}\right]^2 \times 3 \times R\phi \times tb$$

EM : EM: Regeneration energy during operations along horizontal axis [J]
Ehb : Regeneration energy during deceleration [J]
Keϕ : Voltage constant per phase [Vrms/min$^{-1}$] (Motor constant)
KT : Torque constant [N・m/Arms] (Motor constant)
N : Motor rotation speed [min$^{-1}$]
Rϕ : Phase resistance [Ω] (Motor constant)
tb : Deceleration time [s]
Tb : Torque during deceleration [N・m]

■ Calculate "regeneration effective power" from regeneration energy.

$$PM = \frac{EM}{to}$$

PM : Effective regeneration power [W]
EM : Regeneration energy [J]
to :Cycle time [s]

### 11.2.2 How to find "regeneration effective power (PM)" of the vertical axis drive by a formula

■ Calculate regeneration energy.

$$EM = EVUb + EVD + EVDb$$

$$= \frac{1}{2} \times N \times 3 \cdot Ke\phi \times \frac{TUb}{KT} \times tUb - \left[\frac{TUb}{KT}\right]^2 \times 3 \cdot R\phi \times tUb$$

$$+ N \times 3 \cdot Ke\phi \times \frac{TD}{KT} \times tD - \left[\frac{TD}{KT}\right]^2 \times 3 \cdot R\phi \times tD$$

$$+ \frac{1}{2} \times N \times 3 \cdot Ke\phi \times \frac{TDb}{KT} \times tDb - \left[\frac{TDb}{KT}\right]^2 \times 3 \cdot R\phi \times tDb$$

EM : Regeneration energy during operation in horizontal axis [J]
EVUb : Regeneration energy while motor drives upward during deceleration [J]
EVD : Regeneration energy while motor drives downward [J]
EVDb : Regeneration energy while motor drives downward during deceleration [J]
$Ke\phi$ : Voltage constant per phase [Vrms/min$^{-1}$] (Motor constant)
KT : Torque constant [N・m/Arms] (Motor constant)
N : Motor rotational velocity [min$^{-1}$]
$R\phi$ : Phase resistance [Ω ] (Motor constant)
Tub : Torque while motor drives upward during deceleration [N・m]
tUb : Period of time motor drives upward during deceleration [s]
TD : Torque while motor drives downward [N・m]
tD : Period of time motor drives downward [s]
TDb : Torque while motor drives downward during deceleration [N・m]
tDb : Period of time motor drives downward during deceleration [s]

* When the calculation result of either of EVUb, EVD, or EVDb is negative, calculate EM by considering the value of those variabkes as 0.

■ Calculate "regeneration effective power" from regeneration energy.

$$PM = \frac{EM}{to}$$

PM : Effective regeneration power [W]
EM : Regeneration energy during deceleration [J]
to : Cycle time [s]

### 11.2.3 Selection of regenerative resistor

Regenerative resistor is not included to power unit RS3PAC550 so connect an external regenerative resistor for use.

■ Allowable power of an external regenerative resistor
The optional external regenerative resistor which is shown at the section 11.2.4 can be connected and operated. Allowable regenerative power and minimum resistance value of regenerative resistor are shown in below table.

| Power unit model number | Allowable regeneration resistance power to be used with an external regenerative resistor [PR0] | Allowable minimum resistance value of external regenerative resistor |
|---|---|---|
| RS3PAC550 | 5,000 W or less | 2.4 Ω |

* When regeneration effective power PM exceeds the maximum permitted power [PR0] of the external regeneration resistor, reconsider the acceleration constant, load inertia, etc.
* For external regenerative resistor use, must set regenerative resistor value correctly to the system parameter ID_0B.

### 11.2.4 Selection of external regenerative resistor

With the regeneration effective power "PM" found from calculation, choose the external regeneration resistor to be used from the following table.

| Unit model number | [PM] | 250W or less | 500W or less | 1kW or less | 2kW or less | 4kW or less |
|---|---|---|---|---|---|---|
| RS3PAC550 | Resistor Sign | A × 2 | B × 4 | C × 8 | D × 16 | E × 32 |
| | Connection Number | Ⅰ | Ⅱ | Ⅲ | Ⅳ | Ⅴ |
| | Connection type | 2-parallel connection | 4-parallel connection | 8-parallel connection | 16-parallel connection | 32-parallel connection |
| | Resultant resistance value | 2.5Ω | 2.5Ω | 2.5Ω | 2.5Ω | 2.5Ω |

* The resistor sign of an external regeneration resistor and the connection number correspond with the following page.

* The permissible effective power of external regenerative resistor is maximum 25% of the rated power under natural air cooling.

* The permissible effective power of external regenerative resistor is maximum 50% of the rated power under forced air cooling by fan.

### 11.2.5 Specification of external regenerative resistor

The resistor model name corresponds with the sign of the external regeneration resistor selected for the preceding clause.

| Resistor Sign | Resistor Model Number | Rated power [PR] | Resistance Value | Permissible Effective Power [PM] | Allowable instantaneous capacity [JI] | Thermostat Detection temperature (Contact specification) | Mass |
|---|---|---|---|---|---|---|---|
| A | REGIST-500CW5B | 500 W | 5 Ω | 125 W | 8,000 J | 100 °C±5° C (Contact-b, normally close) | 1.4 kg |
| B | REGIST-500CW10B | 500 W | 10 Ω | 125 W | 9,300 J | | |
| C | REGIST-500CW20B | 500 W | 20 Ω | 125 W | 9,700 J | | |
| D | REGIST-500CW40B | 500 W | 40 Ω | 125 W | 6,400 J | | |
| E | REGIST-500CW80B | 500 W | 80 Ω | 125 W | 4,200 J | | |

* See "12.7.11 Outline drawing of regenerative resistor" for external dimension of regenerative resistor.
* Permissible Effective Power value is at condition of natural air cooling.
* Equip an external regenerative resistor and measure that temperature, then confirm no alarm occurrence in operation with the condition of maximum regenerative power.

# 11.2 Selection of regenerative resistor

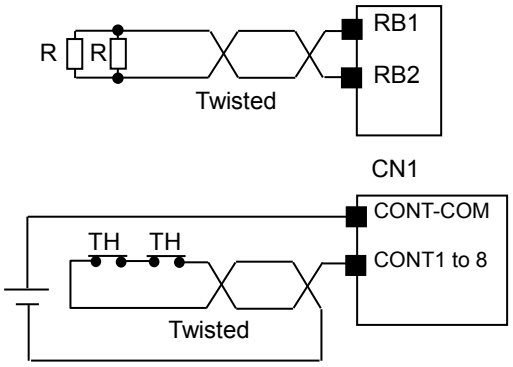
## 11.2.6 Connection of regenerative resistor

The connection method of a resistor corresponds with the connection number of the external regeneration resistor selected by the section 11.2.4.

■ Connection of external regenerative resistor

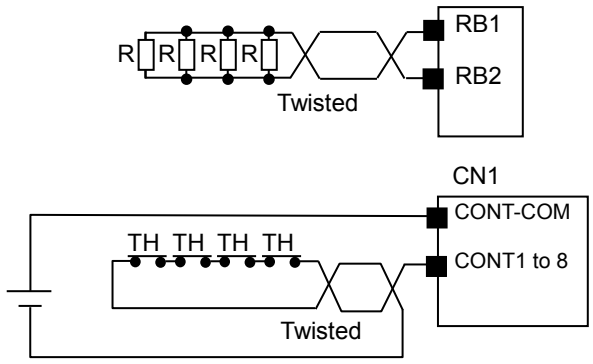
Connection Number I

■ 2 resistors A connected parallel.



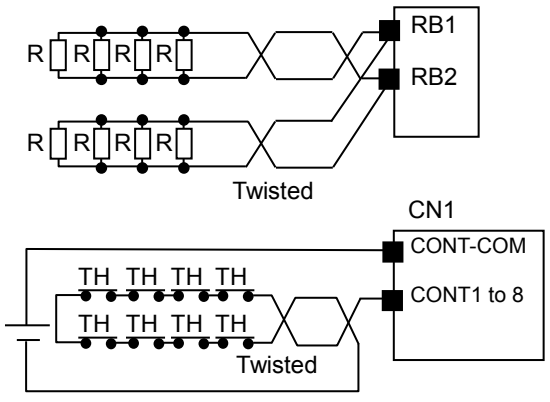

Connection Number II

■ 4 resistors B connected parallel.




Connection Number III

■ 8 resistors C connected parallel.

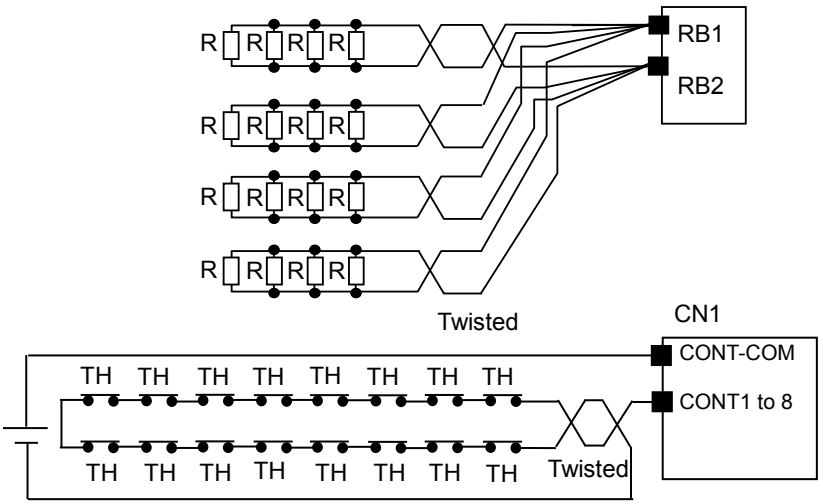



* Thermostat shall be connected to general input in CN1 of amplifier unit.
* Do not connect shorting wire between RB1 and RB2.

# 11. Selection

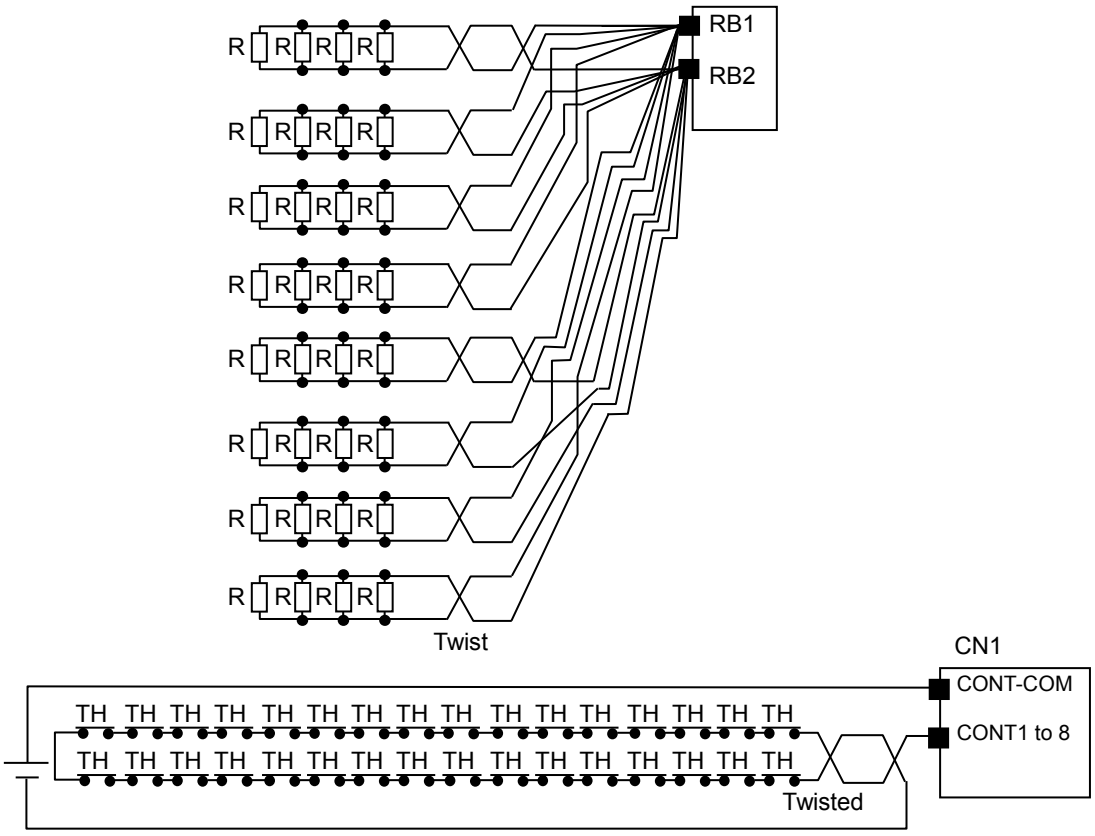
## Connection Number IV

16 resistors D connected parallel.




## Connection Number V

■ 32 resistors E connected parallel.




* Thermostat shall be connected to general input in CN1 of amplifier unit.
* Do not connect shorting wire between RB1 and RB2.

## 11.2.7 Thermostat connection of external regenerative resistor

Connect a thermostat to either of "General inputs CONT1 to CONT8" of amplifier unit. Depending on the connected general input signal terminal, please set Group9 ID40 "External Trip Input Function [EXT-E]".

■ Example: when connecting the thermostat to CONT6
The external trip function will be valid when "0DH:CONT6_OFF" is set to Grop9 ID40 "External Trip Input Function" and CONT6 is turned off. Alarm AL.55 will be output from the amplifier unit when the thermostat of a generative resistor trips (the contact point comes off) because of heating. Refer to "4.2 Wiring with host unit for the wiring method".

## 11.2.8 Protection function of regenerative resistor

The regenerative resistor protection function is specified by parameter selections. Appropriate protection for regenerative resistor is applied by setting parameters according to the type of regenerative resistor to be connected. Set the appropriate parameters by following the instructions given below.

■ The two parameters requiring settings are given below.

◆ System parameter ID03 “Regenerative resistor selection”
- Must set "02: External_R" when external regenerative resistor is used.

◆ Group9 ID40 “External Trip Input Function”
- When thermostat is connected to the amplifier unit, please set Group9 ID40 "External Trip Input Function [EXT-E]" depending on the connected general-purpose input signal terminal.

■ The protection functions are classified as below:

◆ Protection for a short-time, high load factor (using external regenerative resistor):
An error is detected when the power absorption of regenerative resistor is extremely high over a short time period (100 ms to several tens of seconds). A ‘Regenerative Error’ alarm “AL.43” is issued when this error is detected.

◆ Protection during thermostat operation of the external regenerative resistor:
An error will be detected when External Trip Function works. An ’External Error’ alarm “AL.55” is issued when this error is detected.

## 11.2.9 Confirmation method of regeneration power PM in actual operation

Regeneration power PM can be easily confirmed in the digital operator or by R ADVANCED MODEL setup software.

■ Digital operator: Monitor mode ID40 "Regenerative Resistor Operation Percentage monitor"

■ Setup software: Monitor display ID40 "Regenerative Resistor Operation Percentage monitor"

* The monitor value of the regenerative resistor operation percentage shows the operating rate of regeneration circuit.

* The display range is 0.00% - 99.9%.

■ The actual regeneration effective power PM can be calculated from this monitor value by following equation.

◆ Input Supply Voltage: In case of 400 VAC specification

$$\text{Regeneration effective power [PM](W)} = \frac{800(\text{V}) \times 800(\text{V})}{\text{Regeneration resistance}(\Omega)} \times \frac{\text{Regenerative Resistor Operation Percentage (\%)}}{100(\%)}$$

■ Calculation Example
Input Supply Voltage: [200 VAC Specification]
Regeneration resistance value: 50 Ω[Built-in Regenerative Resistor]
Monitor Value (RegP): 0.12%

$$\text{Regeneration effective power [PM](W)} = \frac{800(\text{V}) \times 800(\text{V})}{\text{Regeneration resistance}(\Omega)} \times \frac{0.12(\%)}{100(\%)} = 9.6\ (\text{W})$$

* The regeneration power calculated from this monitor value continues to be the target until the end of operations. Regeneration power varies with the voltage fluctuation of the input power supply and changes across the ages of the power unit/amplifier unit and the loading device.

* Be sure to opt for selection of regeneration resistance based on the regeneration effective power "PM" found from calculation of a pattern of operation and regeneration power.

* Install the external regeneration resistor on equipment, and measure the temperature of the external regeneration resistor by the operating condition that the regeneration effective power “PM” becomes the maximum. Then do sufficient mounting check of alarm not being generated. In addition, it takes 1 to 2 hours until the temperature of the external regeneration resistor is saturated.

* Monitor ID4C Regenerative power monitor can substitute of calculated value above.

# 11.2 Selection of regenerative resistor

## 11.2.10 Precautions for external regenerative resistor use

- The place where corrosive gas has occurred, and when there is much dust, insulated degradation, corrosion, etc .may arise. There fore be careful of an attachment place.
- External regeneration resistor should be placed by keeping enough distance from the other parts so as not to be affected by the other parts-generated heat.
- Must wiring by twisted lines to external regenerative resistor. Wiring length keeps 5 m or less, and aims as short as it can.
- Wiring should keep no contact with regenerative resister, and using flame-retardant cable or giving flame-retardant by silicon tube.

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# 12
# Appendix

In this chapter, servo motor outline drawing and datasheet, servo amplifier outline drawing and option parts are explained.


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# 12.1 Standards Conformity

In our company, compatibility examinations of overseas standards are carried out in certificate authorities, and attestation markings are done based on the published certificate of attestation.

## 12.1.1 Standards Conformity

■ This power unit/amplifier unit implements the standards examinations below.

| Product model NO. | Applicable laws and Regulations | | Standard code | Certificate authorities |
|---|---|---|---|---|
| | Class | Detailed class | | |
| RS3#02A### #<br>RS3#05A### #<br>RS3#10A### #<br>RS3#15A### #<br>RS3#30A### # | UL/c-UL standards | --- | UL61800-5-1 | UL<br>(Underwriters Laboratories inc.) |
| RS3###A### **0**<br><br>(Safe Torque Off function Unequipped model) | Electrical safety | Low Voltage Directive: LVD (2014/35/EU) | IEC61800-5-1<br>EN61800-5-1 | TÜV<br>(TÜV SÜD Japan, Ltd.) |
| | EMC | EMC directive: EMC (2014/30/EU) | EN61000-6-2<br>IEC61800-3 (Note 1)<br>EN61800-3 (Note 1) | TÜV<br>(TÜV SÜD Japan, Ltd.) |
| RS3###A### **2**<br>RS3###A### **4**<br><br>(Safe Torque Off function equipped model) | Electrical safety | Low Voltage Directive: LVD (2014/35/EU) | IEC61800-5-1/<br>EN61800-5-1 | TÜV<br>(TÜV SÜD Japan, Ltd.)<br><br>(Blue octagon) |
| | Functional Safety | Generic Functional safety | IEC61508<br>EN61508 (SIL3) | |
| | | Functional safety standards: FS (2006/42/EC) | IEC62061<br>EN62061(SILCL3) | |
| | | Functional safety standards: FS (2006/42/EC) | EN ISO13849-1/<br>2015 (Cat.3, PL=e) | |
| | | Functional safety standards: FS (2006/42/EC) | IEC61800-5-2<br>EN61800-5-2 | |
| | EMC | EMC Directive: EMC (2014/30/EU) | IEC61800-3 (Note 1)<br>EN61800-3 (Note 1) | |
| | | Functional safety EMC | IEC61326-3-1<br>EN61326-3-1 | |
| RS3###A### # | KC Mark | | KN61000-6-2<br>KN61000-6-4 | Ministry of Science, ICT & Future Planning |

Note 1) Category of this standard is C2.

Warning: In a domestic environment, this product may cause radio interference, in which case supplementary mitigation measures may be required.

# 12. Appendix

## 12.1.2 Over-voltage Category, Protection Grade, Pollution Level

- The "over-voltage category" of power unit/amplifier unit is "III" (EN61800-5-1). For the control power 24VDC and interface, use a DC power supply with reinforced and insulated input and outputs.

- Make sure to install the power unit/amplifier unit in your control panel in an environment where the pollution level specified in EN61800-5-1 and IEC664 is no less than 2 (pollution level 1, 2). The protection grade of power unit/amplifier unit is IP00. Make sure to install them into the cabinet having structure preventing water, oil, carbon, dust, etc (IP54).

## 12.1.3 Connection and installation

Be careful of connection and installation as follows.

- ✔ Always ground the protective grounding terminals of the power unit/amplifier unit to the power supply earth.

- ✔ When connecting grounding wire to the protective earth terminal, always connect one wire in one terminal; never connect jointly with multiple wires or terminals.

- ✔ When connecting the leakage stopper, make sure to connect the protective grounding terminal to the power supply ground.

- ✔ Connect wires for power unit/amplifier unit by using a crimping terminal with insulated tube, so that the connected wire will not touch the neighboring terminals.

- ✔ For relaying wires, use a fixed terminal block to connect wires; never connect wires directly.

- ✔ Connect an EMC filter to the input at the stage before power unit power line.

- ✔ Use an EN/ IEC-standard compatible no-fuse Circuit breaker and electromagnetic contactor.

- ✔ Wiring for main circuit power shall be done as with the circuit shown in the section "4.1.6 Example of wiring", to break power at alarm.

# 12.2.3 Precautions for noise filter connection

## 12.2 Compliance with EN Directives

We implement the conformity verification test of "Low Voltage Directive" and "an EMC Directive" in a certificate authority so that a user's CE Marking acquisition can be performed easily, and servo amplifier CE Marking is done based on the published certificate of attestation.

### 12.2.1 Conformity verification test

The following conformity verification tests are implemented.

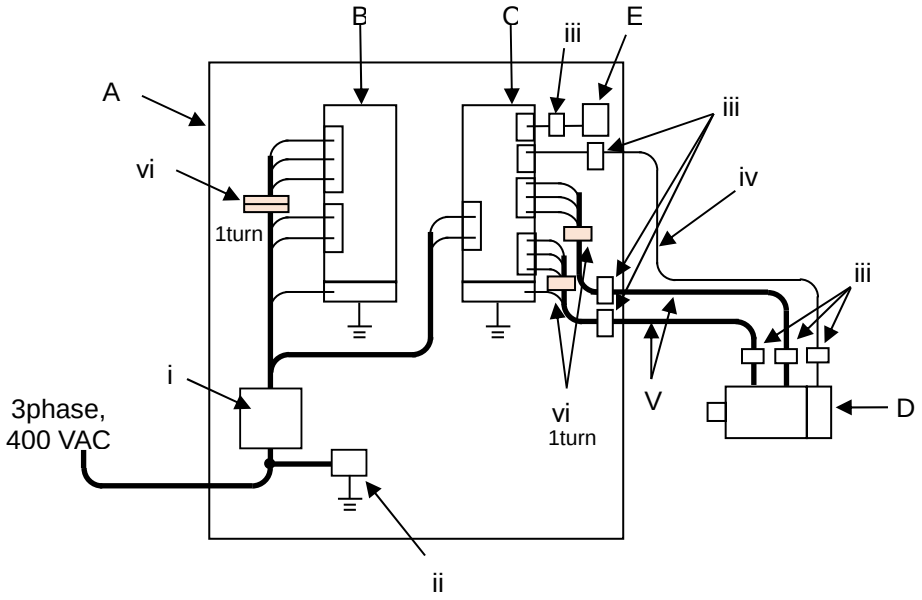
| Directive classification | Classification | Test | Test standard |
|---|---|---|---|
| Low voltage Directive (power unit/ amplifier unit) | — | — | EN61800-5-1 |
| Low voltage Directive (Servo motor) | — | Rotating electrical machines-Part1: Rating and performance | EN60034-1 |
| | | Rotating electrical machines-Part5: Classification of degrees of protection provided by enclosures of rotating electrical machines (IP code) | EN60034-5 |
| EMC Directive (power unit/ amplifier unit/ servo motor) | Emission | Conducted emission | EN61800-3 |
| | | Radiated emission | EN61800-3 |
| | Immunity | Electrostatic discharge immunity | EN61000-4-2 |
| | | Radiated electromagnetic field immunity | EN61000-4-3 |
| | | Electrical first transient/ burst immunity | EN61000-4-4 |
| | | Conducted disturbance immunity | EN61000-4-6 |
| | | Surge immunity | EN61000-4-5 |
| | | Voltage Dips & Interruptions immunity | EN61000-4-11 |
| | | Adjustable speed electrical power drive system | EN61800-3 |
| | | Safety of machinery | EN62061 (Annex E) Note 1) |

Note 1) Standards applicable only to Safe Torque Off function equipped models.

# 12. Appendix

## 12.2.2 EMC Installation Requirements

For the installation requirements, in our company the verification test is implemented by the following installations and measures methods, as machines and configurations differ depending on customers' needs. This power unit/amplifier unit has been authorized to display CE marking based on the recognition certificate issued by a certifying authority. Customers are instructed to perform the final conformity tests for all instruments and devices in use.



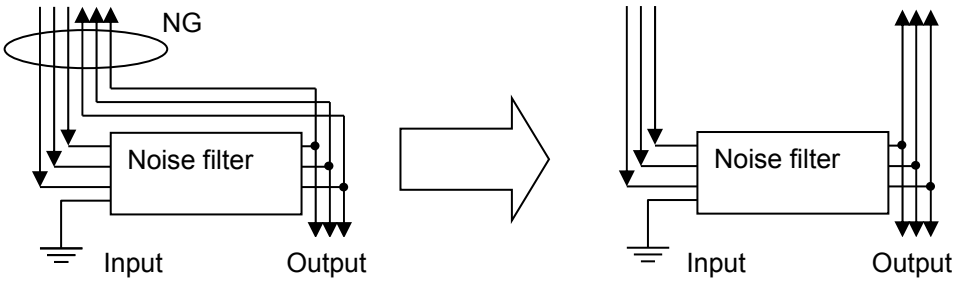

| No. | Name | Remarks |
|---|---|---|
| A | Control panel | - |
| B | Servo amplifier | - |
| C | Servo motor | - |
| D | Host device | - |
| i | Noise filter (Recommended prevention components) | HF3200C-SZB-4DEDE: SOSHIN ELECTRIC Co. Ltd.<br>Rated voltage/rated current: Line-Line 500 VAC / 200A |
| ii | Surge-absorber (Recommended prevention components) | LV480DI-U4: OKAYA ELECTRIC INDUSTRIES CO.,LTD. |
| iii | Clamp grounding | - |
| iv | Encoder cable | Shield cable |
| v | Servo motor power cable | Shield cable |
| vi | Sleeve Ferrite Clamp | RC1100Y: SOSHIN ELECTRIC Co. Ltd. |
| vii | Split Ferrite Core | E04SR401938: SEIWA ELECTRIC MFG CO. Ltd. |

- ✔ Use metallic materials for the door and main body of control panel.
- ✔ Use EMI gasket so that there is zero clearance between the door and control panel. Install EMI gasket uniformly to the contact points between door and main body of control panel to confirm their conductivity.
- ✔ Ground the noise filter frame to the control panel.
- ✔ Use shield cables for motor power line and encoder cable. Clamp grounding of shield at the frame of control panel and equipment.
- ✔ Use conducting metal P-clip or U-clip to ground and clamp shielded wire, and fix it directly with metal screws. Do not ground by soldering electric wire to shielded wire.
- ✔ Wire a power unit at a short distance from the secondary side of noise filter, and wire the primary side and secondary side of noise filter separately.
- ✔ Avoid putting each cables redundant at cabinet inside.

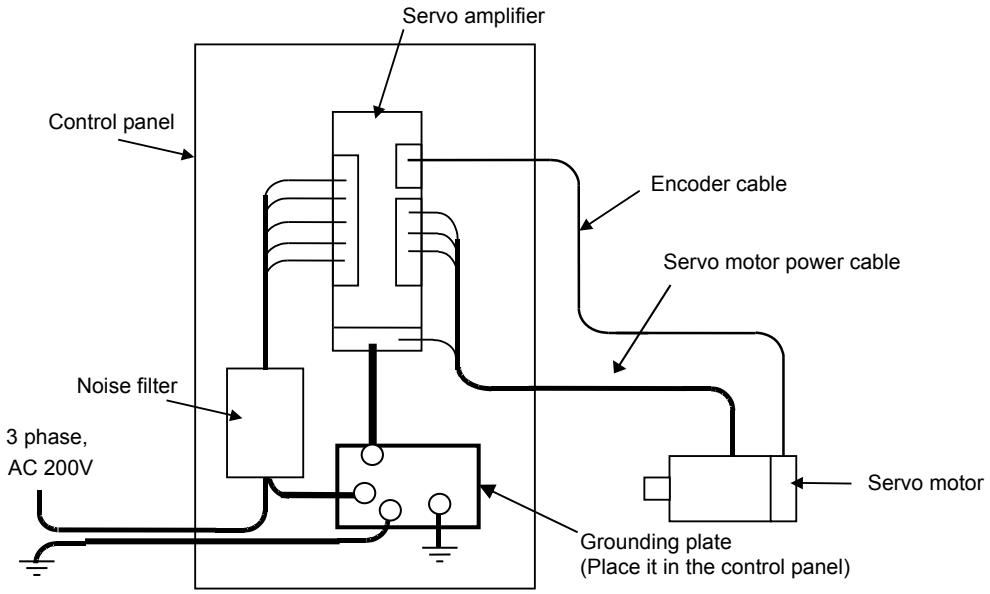
## 12.2.3 Precautions for noise filter connection

Precautions for noise filter mounting and wiring
See below precautions for mounting and wiring when noise filter is used.

■ Do not bundle with input line and output line of noise filter. (Earth line also.)
Avoid that go through a same duct. (It might reduce effect of filter, and noise might come around through that point.)




■ Each of earth line shall be connected to grounding plate in a control panel by single-point.
Also in case of multi axes construction in same control panel, grounding by single-point.



# 12. Appendix

## 12.2.4 Ground fault test

RS3E series power unit/amplifier unit have conformity with IEC 60364-4-41: 2005/AMD1: 2016 (HD 60364-4-41: 2007), Clause 411, with conditions below.

■ Precautions

✔ TN grounding system
It shall be set that input wiring is within specified diameter and length, and within the Fault Loop Impedance value shown in table 12-1.

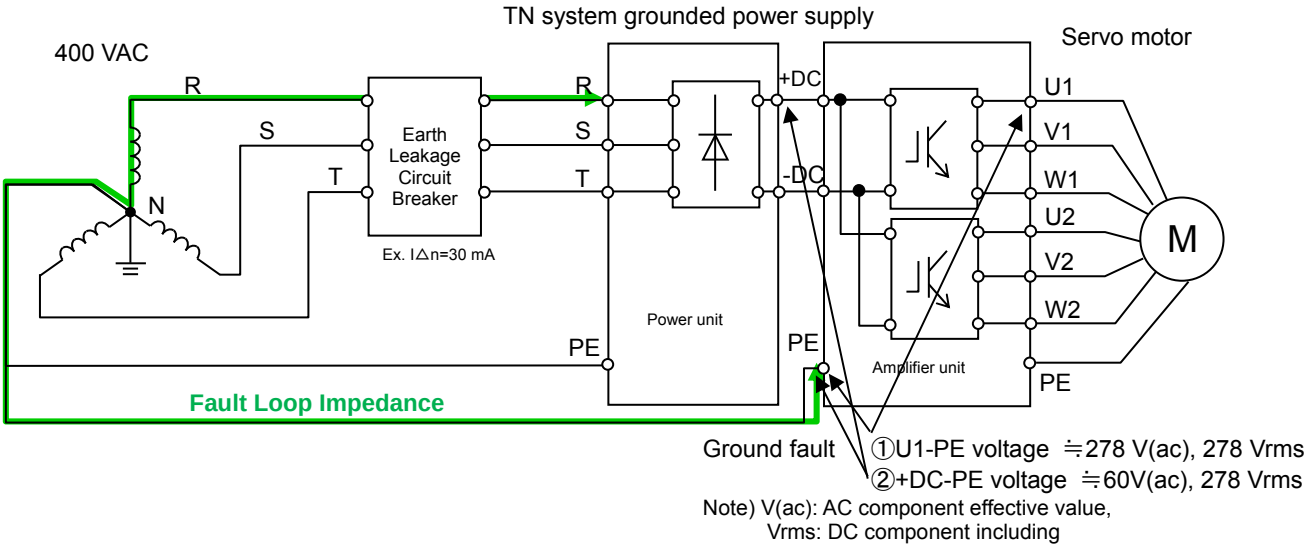
✔ TT grounding system
It shall be set that input wiring is connected to Earth Leakage Circuit Breaker (30 mA) and is within specified diameter and length, and within the Fault Loop Impedance value shown in table 12-1.

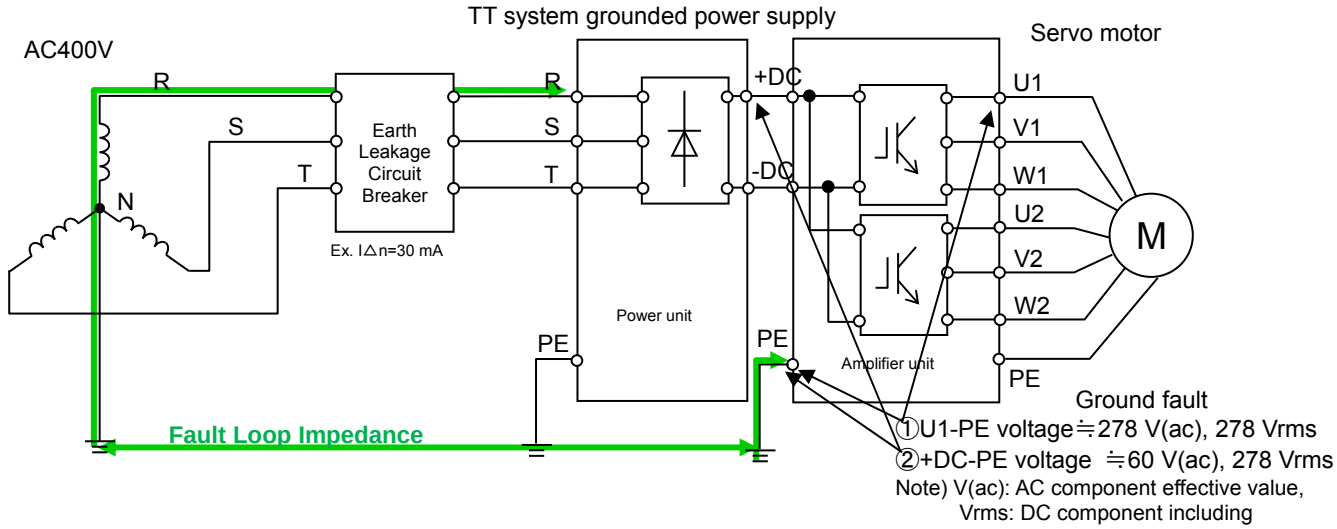
✔ How to shut-off with 40 ms at ground fault
To shut-off with 40 ms, shown in table 41.1 in IEC60364-4-41, or less, TT power system shall be used and Earth Leakage Circuit Breaker is selected with 30 mA sensed current. And Fault Loop Impedance shall be the value shown in table 12-1 or less.

✔ IT grounding system
Our servo amplifier cannot detect ground fault with IT system so it doesn't supporsed.

✔ Peripheral equipment (including Earth Leakage Circuit Breaker) and wire size shall be used depending on Power supply capacity and peripherals list and Recommended wire size.

■ Wiring for ground fault test (with 400 VAC input type)



# 12.2.3 Precautions for noise filter connection

■ Fault Loop Impedance and servo system internal impedance

FLI: Fault Loop Impedance
SSI: Servo System Impedance

Table 12-1

| Model number | Power voltage | Rated current | Power system | Shut-off time | Shut-off method | Voltage to ground, AC component | Shut-off current | SSI | FLI |
|---|---|---|---|---|---|---|---|---|---|
| RS3PAC550 RS3D80 | 400 VAC | 95 A | TN | 5 s | Fuse at power unit input | 278 V(ac) | 900 A | 1.55 mΩ | 0.3 Ω |
| | | | TT | 1 s | 30 mA ELCB | 60 V(ac) | 0.03 A | 1.55 mΩ | 2000 Ω |

■ Fault Loop Impedance of each servo amplifier with performing shut-off 40 ms or less

To shut-off with 40 ms, shown in table 41.1 in IEC60364-4-41, or less, use TT power system and set FLI which ables to flow 5-multiplied sensed current of Earth Leakage Circuit Breaker.
Below shows calculation result of FLI wired with recommended cable and used ELCB having a sensed current I⊿n=30 mA.

FLI: Fault Loop Impedance
SSI: Servo System Impedance

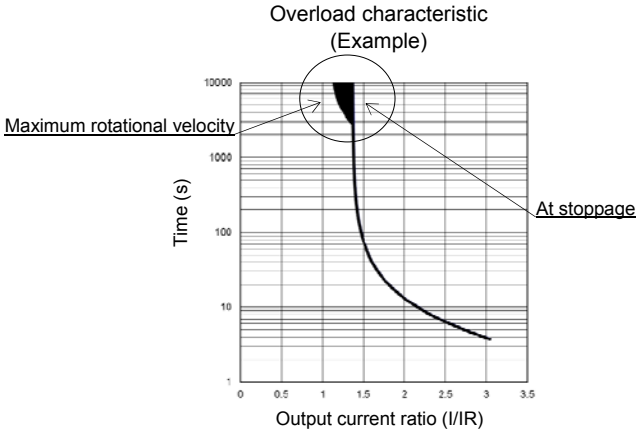
Table 12-2

| Model number | Power voltage | Rated current | Power system | Shut-off time | Shut-off method | Voltage to ground, AC component | Shut-off current | SSI | FLI |
|---|---|---|---|---|---|---|---|---|---|
| RS3PAC550 RS3D80 | 400 VAC | 95 A | TT | 40 ms | 30 mA ELCB | 60 V(ac) | 0.15 A | 1.55 mΩ | 400 Ω |

# 12. Appendix

## 12.2.5 About motor overload characteristics

■ Overload characteristic




✔ Some motor has the overload characteristic such as above. Characteristic curve becomes broad at maximum rotational velocity around and it means overload detection time varies dending on motor rotational velocity. (at circle internal of above graph)

✔ When rotating with maximum velocity, overload alarm is detected by the time according to output current ratio shown left end line. (※1)

✔ Output current ratio shown right end line shows overload alarm detection time when motor is is locked completely (motor stops with torque limit setting). (※2)

■ Thermal memory function

For thermal memory function in our amplifier unit, thermal memory (shut down) is exist but thermal memory (loss of power) function and speed sensitivity function are not exist.

✔ Overload alarm is detected by using the time shown in overload characteristic after calculating output current ratio at amplifier unit internal. Detection time may become shorten when alarm is cleared soon after overload detection because output current ratio calculation at amplifier unit internal is still high.

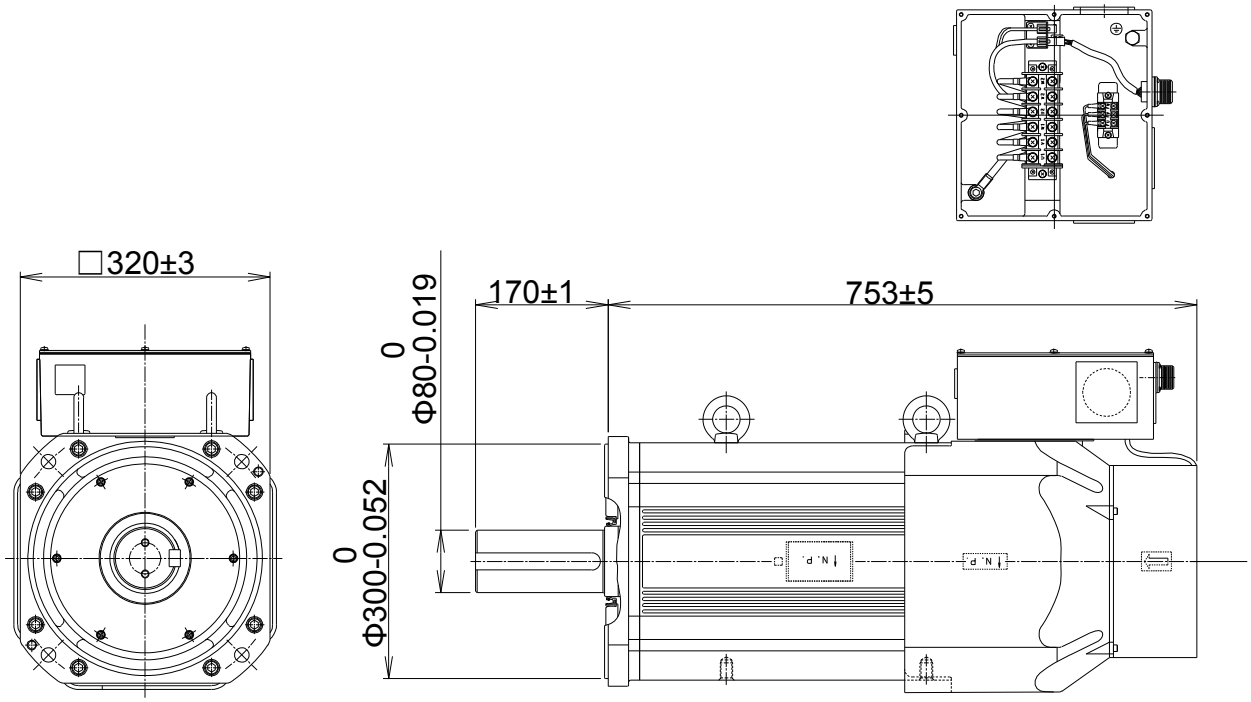
✔ There is no thermal memory function at power OFF because output current ratio calculation at amplifier unit internal returns to initial state by control power ON/OFF.

✔ For motor overload characteristic of R2CA3255KB, refer the section 12.4.3.

## 12.3 Servo motor dimensions

Below shows outline drawing and each dimensions of the motor

### 12.3.1 R2 motor, flange size 320 mm, 55 kW



# 12. Appendix

## 12.4 Servo motor data sheet

### 12.4.1 Characteristics table

■ Specification of R2 motor, 400 VAC

| Servo motor model number R2CA | | | 3255KB |
|---|---|---|---|
| Amplifier unit size combined | | | RS3D80 |
| *Rated output | $P_R$ | kW | 55 |
| *Rated velocity | $N_R$ | $min^{-1}$ | 1500 |
| *Maximum velocity | $N_{max}$ | $min^{-1}$ | 2000 |
| *Rated torque | $T_R$ | N·m | 350 |
| *Continuous Torque at stall | $T_S$ | N·m | 385 |
| *Peak Torque at stall | $T_P$ | N·m | 980 |
| *Rated armature current | $I_R$ | Arms | 110 <55> |
| *Armature current at stall | $I_S$ | Arms | 118 <59> |
| *Peak armature current at stall | $I_P$ | Arms | 330 <165> |
| *Torque constant | $K_T$ | N·m/ Arms | 3.3±10% |
| Voltage constant for each phase | $K_{E\phi}$ | $mV/min^{-1}$ | 105±10% |
| Phase resistance | $R_\phi$ | Ω | 0.022 <0.044> |
| *Rated power rate | $Q_R$ | kW/s | 692 |
| Moment of inertia | $J_M$ | $Kg·m^2(GD^2/4) \times 10^{-4}$ | 1770 |
| Mass | WE | kg | 245 |
| Brake mass | W | kg | - |
| Aluminum plate | | mm | t40 × 690 |

✔ Constant in the table above is the value when motor is installed on heat releasing aluminum plate, indicates “thickness” x “length of a side of square.

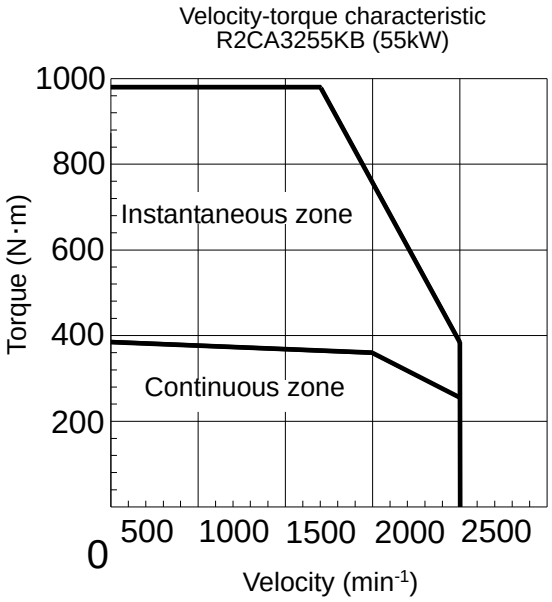
✔ Items marked with * and Velocity-Torque Characteristics indicate values after temperature rise saturation. The others indicate values at 20°C.

✔ Each value indicates TYP.

✔ Value in <> shows single-system value.

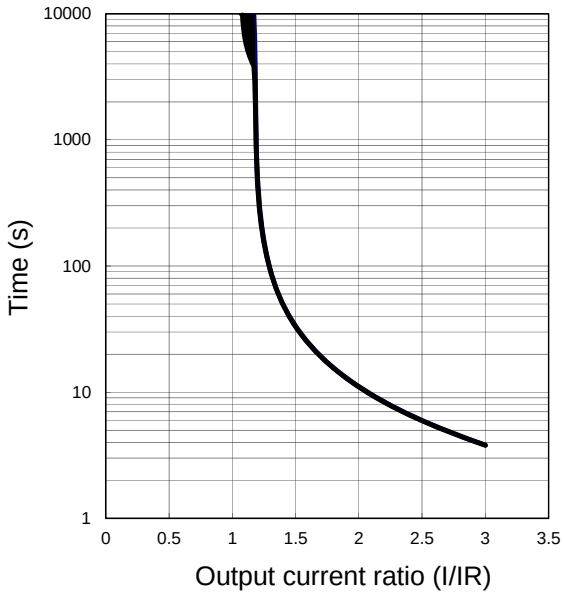
## 12.4.2 Velocity-torque characteristics

R2CA motor velocity-torque characteristics charts show the values when 400 VAC is used as input power supply. When power supply voltage is less than 400V, instantaneous zone decreases.




## 12.4.3 Overload characteristics

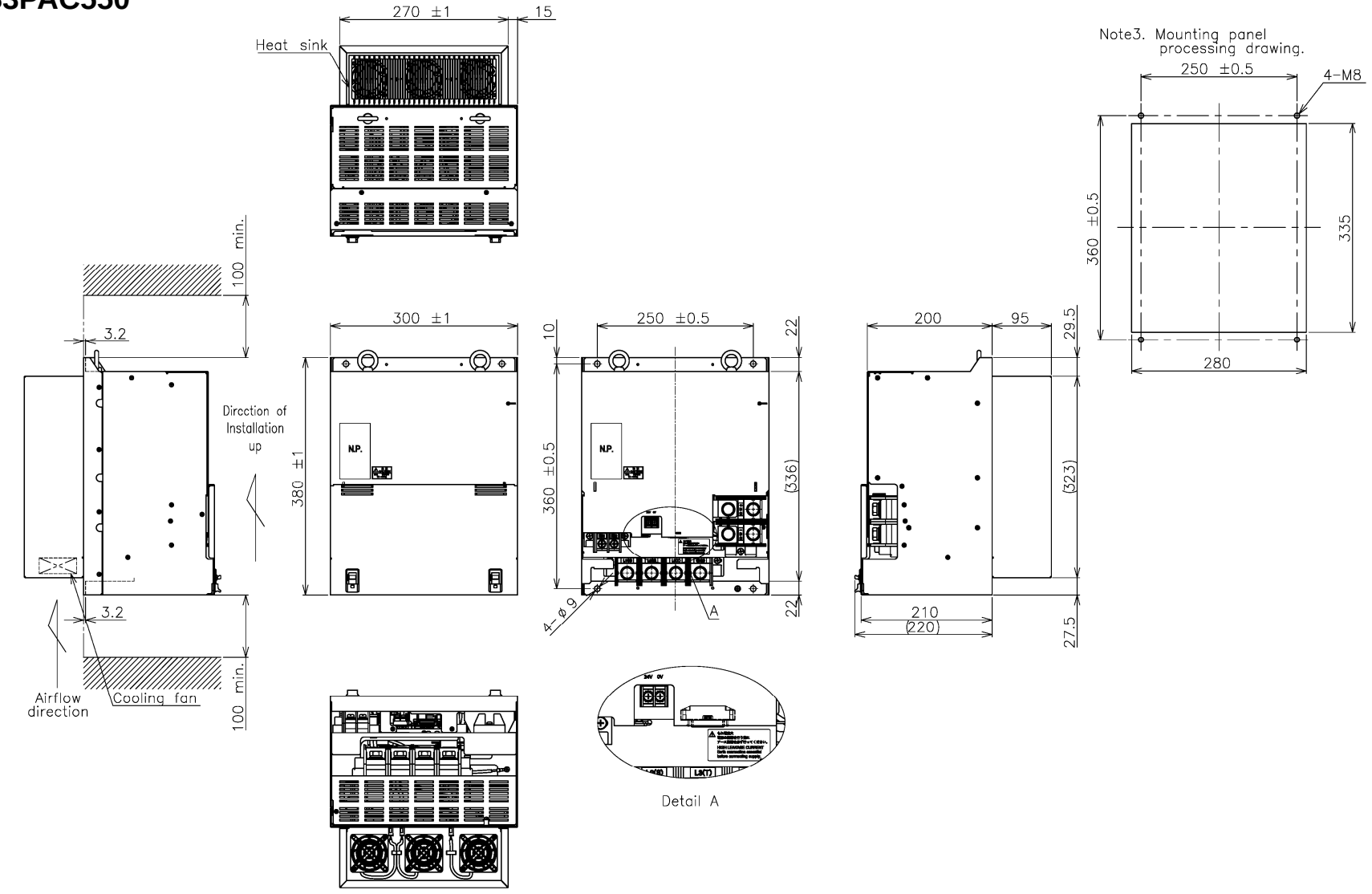
The following show overload characteristic of R2CA3255KB motor.



# 12. Appendix

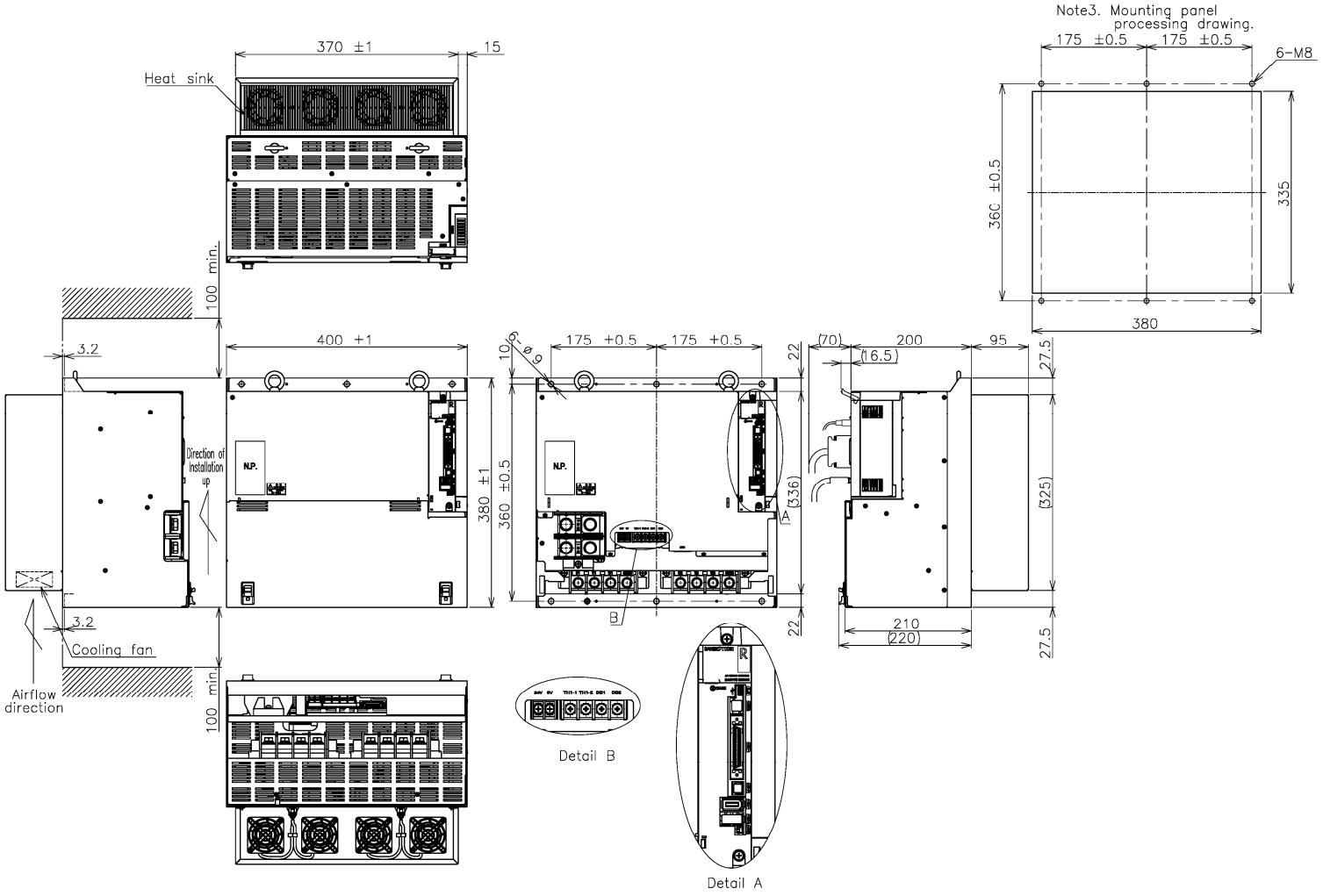
## 12.5 Power unit dimensions

### 12.5.1 RS3PAC550



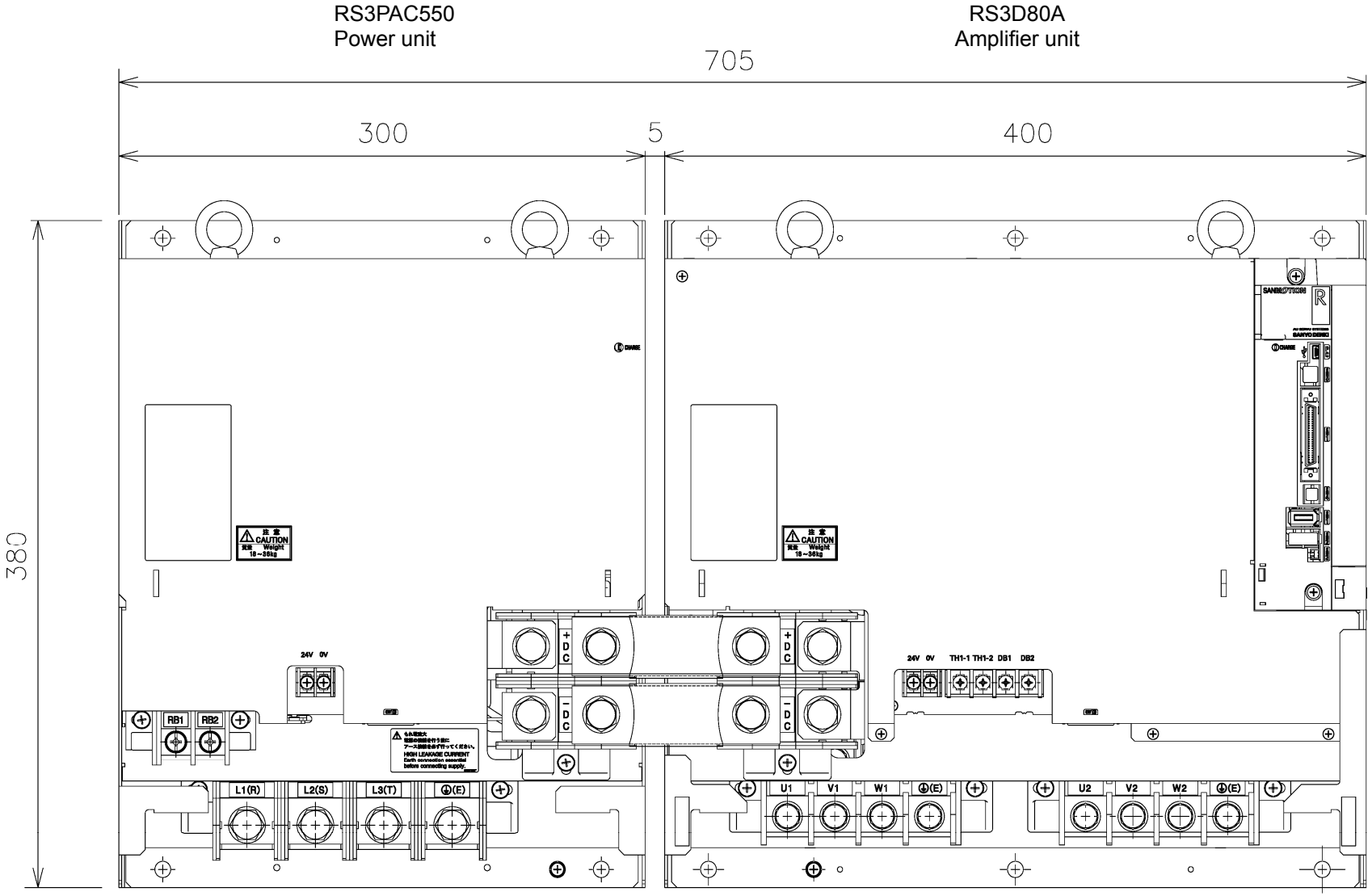
## 12.6 Amplifier unit dimensions

### 12.6.1 RS3D80A□□M□



# 12. Appendix

## 12.7 Unit innstallation dimensions



# 12.8 Optional parts

SANYO DENKI offers the following optional parts.

## 12.8.1 Connectors for amplifier unit

■ Model numbers of single connectors for RS3D80A

| Connector No. | Item | SANYO DENKI model No. | Manufacturer's model No. | Manufacturer |
|---|---|---|---|---|
| CN1 | For host unit connection | AL-00385594 | 10150-3000PE and 10350-52A0-008 | 3M Japan Limited |
| EN1, EN2 | For encoder connection | AL-00632607 | 36210-0100PL and 36310-3200-008 | |
| CN4 Note1) | For safety device connection (For short circuit) | AL-00718251-01 | 2040978-1 | Tyco Electronics Japan G.K. |
| CN4 | For safety device connection (For wiring) | AL-00718252-01 | 2013595-3 | |
| CN10 | For power unit connection Note 2) | AL-01017659 | DF02P036F22A1 and DF02D036A22 | Japan Aviation Electronics Industry, Ltd. |

Note1) If CN4 is unused (open), be sure to insert connecter for safety device (for short circuit) to CN4 of amplifier unit.
Note2) CN10 connector includes 2 pieces: for power unit side and for amplifier unit side.

■ Model numbers of connector-kits for RS3D80A
(No safe-torque-off function)

| Connector No. | Item | SANYO DENKI model No. | Applicable amplifier unit model number |
|---|---|---|---|
| CN1,EN1 | Standard | AL-00723290 | RS3D80A8#M0 |
| CN1,EN1 CNE and open tool | For full-closed control system | AL-00966993 | RS3D80AA#M0 |

✔ Mark "#" shows arbitrary numerical values or alphabets.

■ Model numbers of connector-kits for RS3D80A
(With Safe-torque-off function)

| Connector No. | Item | SANYO DENKI model No. | Applicable servo amplifier model number | Remarks |
|---|---|---|---|---|
| CN1,EN1,CN4 | Standard | AL-00723159 | RS3D80A8#M2(4) | For holding brake Without connector |
| CN1,EN1,EN2,CN4 | For full-closed control system | AL-00967015 | RS3D80AA#M2(4) | For holding brake Without connector |

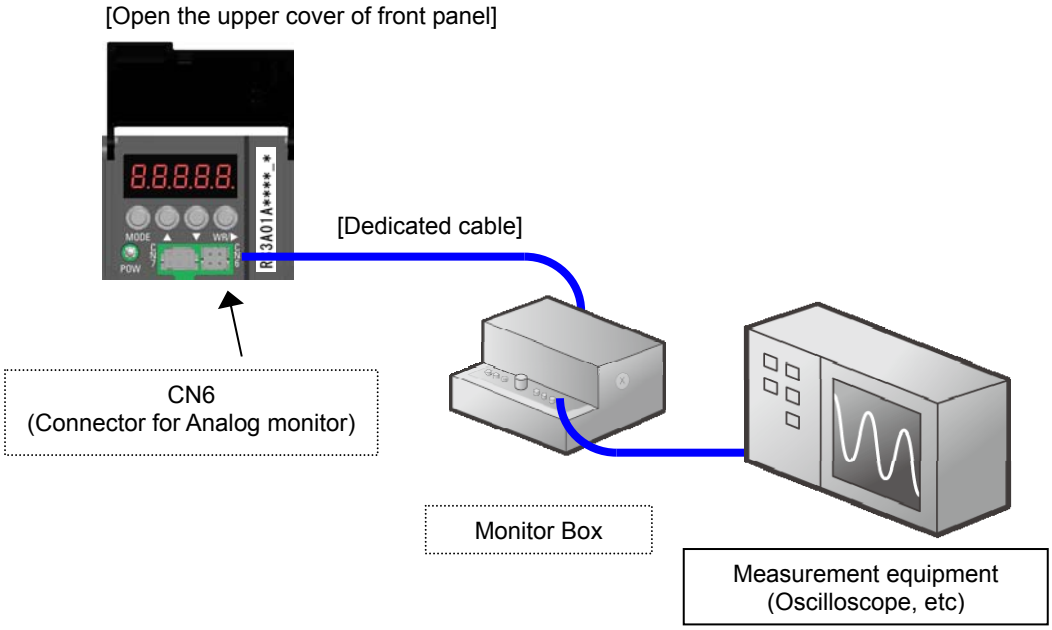
✔ Mark "#" shows arbitrary numerical values or alphabets.
✔ CN4 of the connecter kit is for connection with safety devices (for wiring), part number: AL-00718252-01.

# 12. Appendix

RS3D80A8AM0

## 12.8.2 Analog monitor related item

| Name | Details | SANYO DENKI model No. |
|---|---|---|
| Monitor Box | Monitor box body<br>2 dedicated cables | Q-MON-3 |
| Dedicated cable | 1 dedicated cables | AL-00690525-01 |



# 12. Appendix

## 12.8.3 USB communication cable

| Name | Details | SANYO DENKI model No. |
|---|---|---|
| USB communication cable (1.0 m) | Standard-A plug⇔Mini-B plug | AL-00896515-01 |
| USB communication cable (2.0 m) | | AL-00896515-02 |

## 12.8.4 Communication cable of tandem operation between amplifiers

| Name | Details | SANYO DENKI model No. |
|---|---|---|
| Communication cable between amplifiers (3.0 m) | Amplifier unit (CN10) ⇔ Amplifier unit (CN10) | AL-00911582-02 |

## 12.8.5 Unit connection cable (0.5 m)

| Name | Details | SANYO DENKI model No. |
|---|---|---|
| Unit connection cable (0.5 m) | power unit (CN10)⇔Amplifier unit (CN10) | AL-01018354-01 |

## 12.8.6 Copper bar

| Application | Details | SANYO DENKI model No. |
|---|---|---|
| +DC, -DC 接続用 | 2 pieces included | AL-01020858-01 |

## 12.8.7 Servo motor encoder cable

| Item | Connector model number | Remarks |
|---|---|---|
| Motor encoder connector | Plug: MS3106B20-29S | Japan Aviation Electronics Industry, Ltd. |
| Motoer thermostat connector | Straight plug: 5557-02R_NARUEAL<br>Contact: 5556T2L_ | Molex Japan LLC |

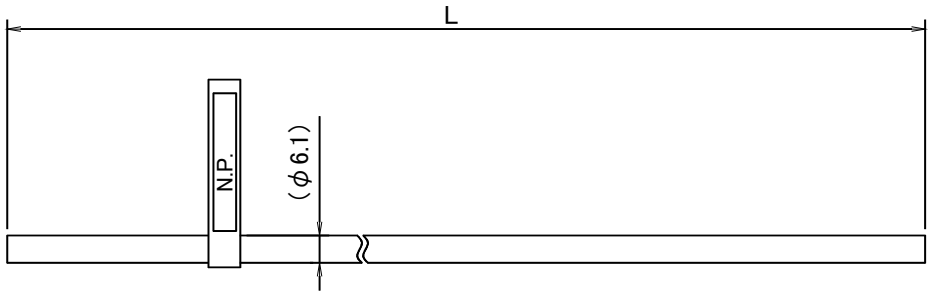
## 12.8.8 Servo motor FAN power cable

| Model number<br>For encoder | Cable length:<br>L (mm) | Applicable motor |
|---|---|---|
| AL-00999241-01 | 1,000 | R2CA3255KB |
| AL-00999241-02 | 2,000 | |
| AL-00999241-03 | 3,000 | |
| AL-00999241-05 | 5,000 | |
| AL-00999241-10 | 10,000 | |

| Item | Connector model number | Remarks |
|---|---|---|
| Motor side crimp terminal | — | No work with both side crimp terminal. |

■ Cable specifications

| (NISSEI ELECTRIC CO., LTD.) (Operating temperature range: Up to 105 ℃) |
|---|
| 2103_PVC_AWG#19X4C |
| AL-00999241 -01 to 10; 1 to 10 m specifications |
| 19AWG × 4C<br>Sheath thickness: 0.5 mm<br>Cable diameter: Around 6.1 mm |
| Individual wire specification<br>19 AWG Conductor diameter: Around 1.24 mm, Insulator thickness: 0.23 mm, Overall diameter: 1.7 mm |




L (mm): 1,000/2,000/3,000/5,000/10,000

## 12.8.9 External regenerative resistor

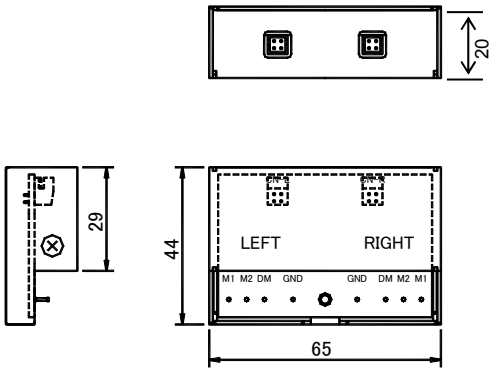
| Resistor Model Number | Rated power [PR] | Resistance value | Thermostat Detection temperature (Contact specification) | Mass |
|---|---|---|---|---|
| REGIST-500CW5B | 500W | 5Ω | 100 °C±5 °C (Switching contact b, normally close) | 1.4 kg |
| REGIST-500CW10B | 500W | 10Ω | | |
| REGIST-500CW20B | 500W | 20Ω | | |
| REGIST-500CW40B | 500W | 40Ω | | |
| REGIST-500CW80B | 500W | 80Ω | | |

# 12. Appendix

## 12.9 Optional parts dimensions

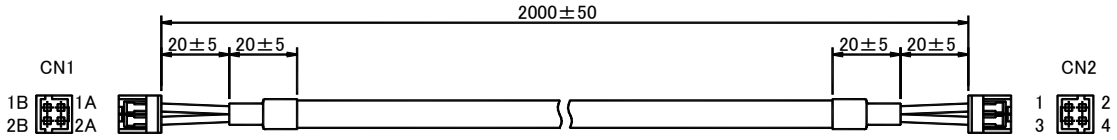
### 12.9.1 Monitor box outline drawing

■ Monitor Box (Model No.: Q-MON-3)




### 12.9.2 Dedicated Cable outline drawing

■ Dedicated Cable (Model No.: AL-00690525-01)




Note 1) A pair of the dedicated cable shown above (model number: AL-00690525-01) are supplied with the Monitor Box (model number: Q-MON-3).

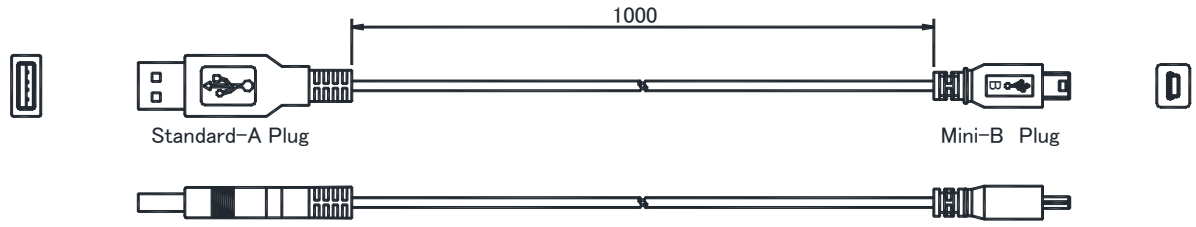
| Terminal No. on CN1 | Signal name | Terminal No. on CN2 |
|---|---|---|
| 1A | Analog monitor 1 | 3 |
| 1B | Analog monitor 2 | 4 |
| 2A | GND | 1 |
| 2B | Digital monitor | 2 |

| CN1 | Manufacturer model No. | Manufacturer |
|---|---|---|
| Connector | LY10-DC4BR | Japan Aviation Electronics Industry, Limited |
| Contact | LY10-C1-A1-1000 | Japan Aviation Electronics Industry, Limited |

| CN2 | Manufacturer model No. | Manufacturer |
|---|---|---|
| Connector | DF11-4DS-2C | HIROSE ELECTRIC CO., LTD. |
| Contact | DF11-2428SCA | HIROSE ELECTRIC CO., LTD. |

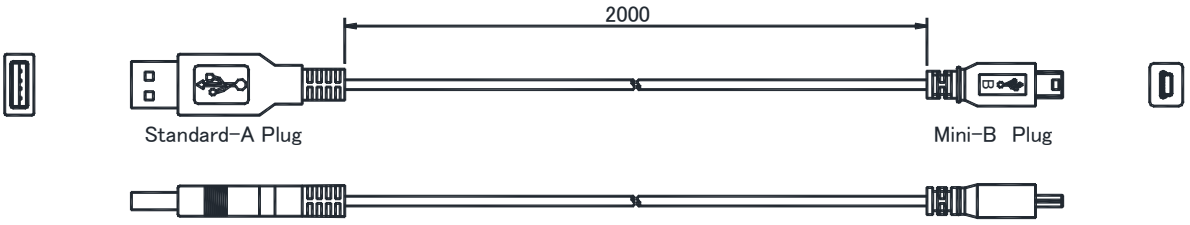
## 12.9.3 Outline drawing of USB communication cable

■ USB communication cable (1.0 m) (Model number: AL-00896515-01)




✔ Appearance and spec may change without prior notice.

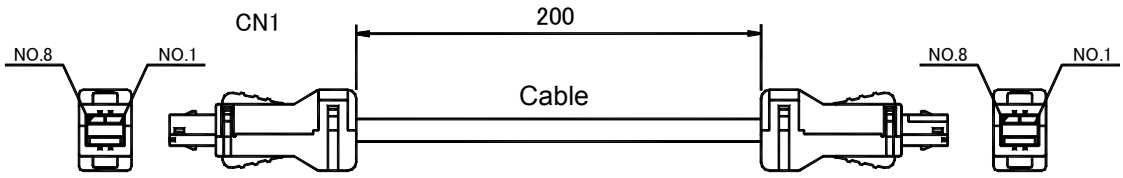
■ USB communication cable (2.0 m) (Model number: AL-00896515-02)



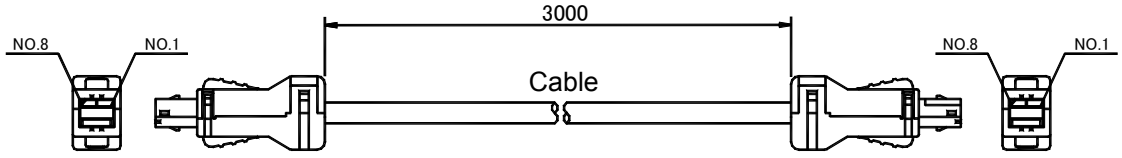

✔ Appearance and spec may change without prior notice.

## 12.9.4 Outline drawing of communication cable of tandem operation between amplifiers

■ Communication cable of tandem operation between amplifiers (0.2 m)
(Model number: AL-00911582-01)




■ Communication cable of tandem operation between amplifiers (3.0 m)
(Model number: AL-00911582-02)

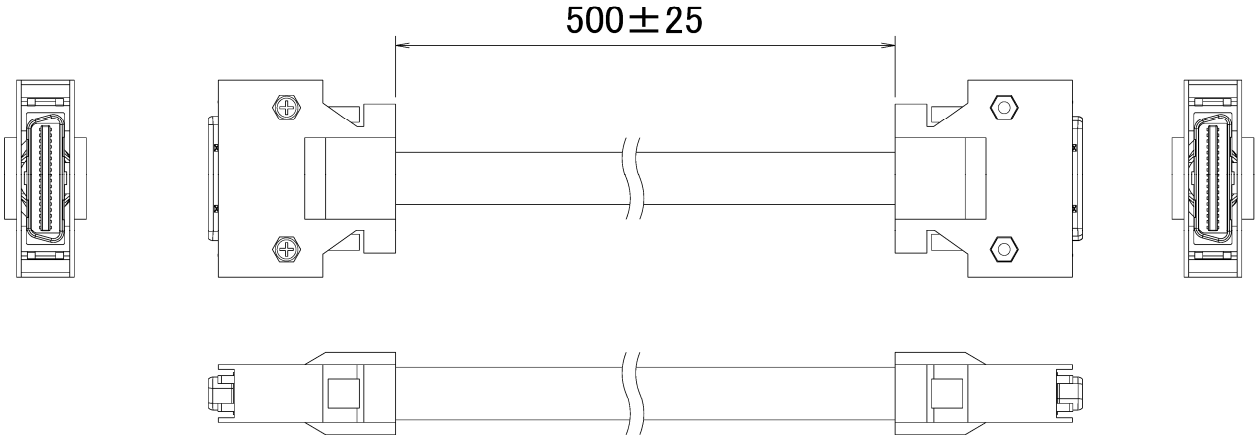



✔ As note, the wiring differs from the communication cable between amplifiers for R ADVANCED MODEL (Model number: AL-00695974-**).

# 12. Appendix

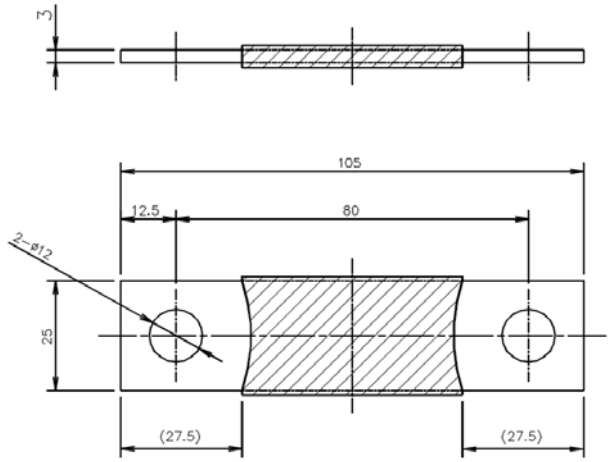
## 12.9.5 Unit connection cable (0.5 m)

■ AL-01018354-01



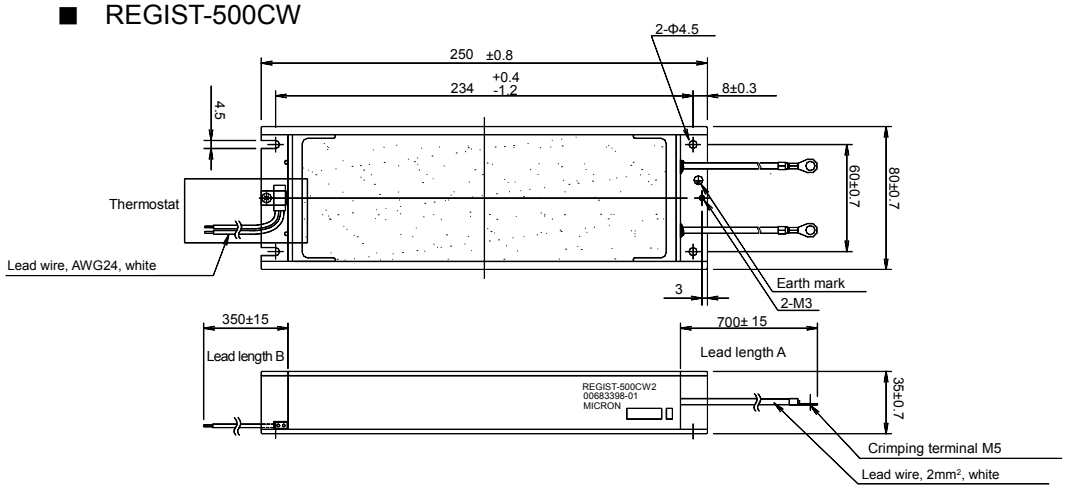

## 12.9.6 Outline drawing of copper bar

■ +DC, -DC (Model number: AL-01020858-01)




## 12.9.7 Outline drawing of regenerative resistor

■ REGIST-500CW



Release
Revision A Apr. 2019

ECO PRODUCTS

■ECO PRODUCTS
Sanyo Denki's ECO PRODUCTS are designed with the concept of lessening impact on the environment in the process from product development to waste. The product units and packaging materials are designed for reduced environmental impact.
We have established our own assessment criteria on the environmental impacts applicable to all processes, ranging from design to manufacture.

■Precautions For Adoption

Failure to follow the precautions on the right may cause moderate injury and property damage, or in some circumstances, could lead to a serious accident.
Always follow all listed precautions.

⚠ Cautions

- Read the accompanying Instruction Manual carefully prior to using the product.
- If applying to medical devices and other equipment affecting people's lives please contact us beforehand and take appropriate safety measures.
- If applying to equipment that can have significant effects on society and the general public, please contact us beforehand.
- Do not use this product in an environment where vibration is present, such as in a moving vehicle or shipping vessel.
- Do not perform any retrofitting, re-engineering, or modification to this equipment.
- The Products presented in this Instruction Manual are meant to be used for general industrial applications. If using for special applications related to aviation and space, nuclear power, electric power, submarine repeaters, etc., please contact us beforehand.

* For any question or inquiry regarding the above, contact our Sales Department.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*Specifications are subject to change without notice.

Translated version of the original instructions