SANMOTION

AC SERVO SYSTEMS

R

3E Model

TYPE S

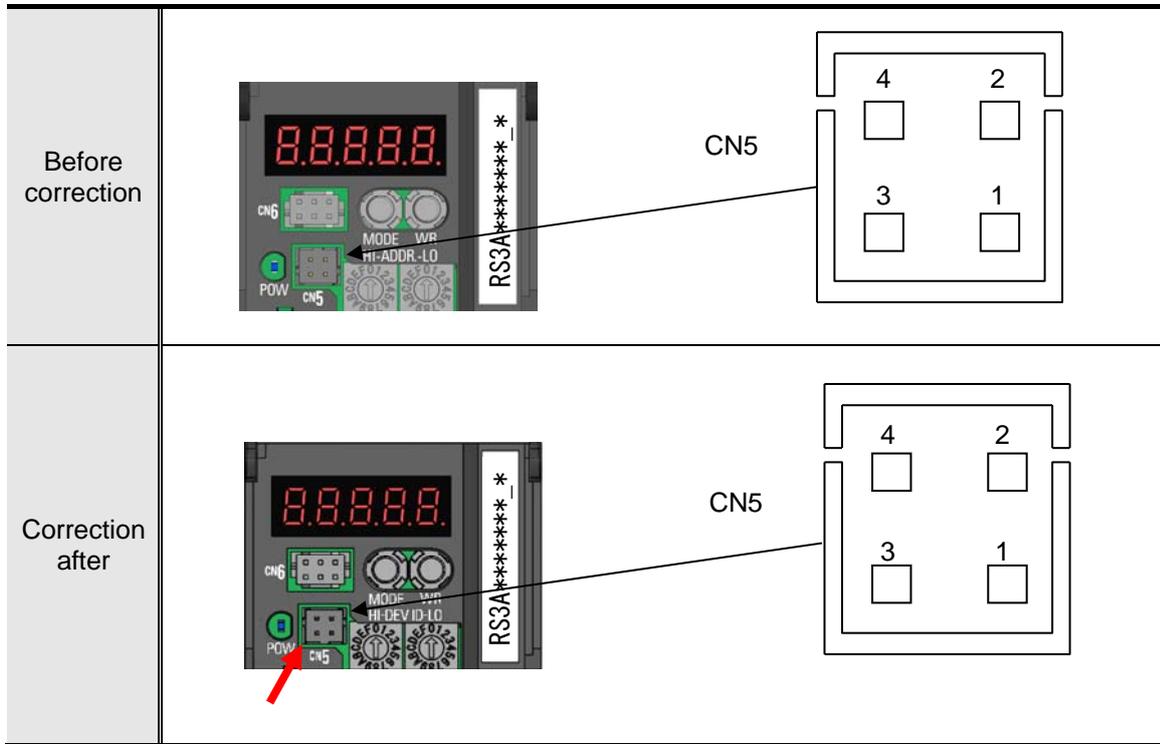EtherCAT Interface

For Rotary Motor, Linear Motor

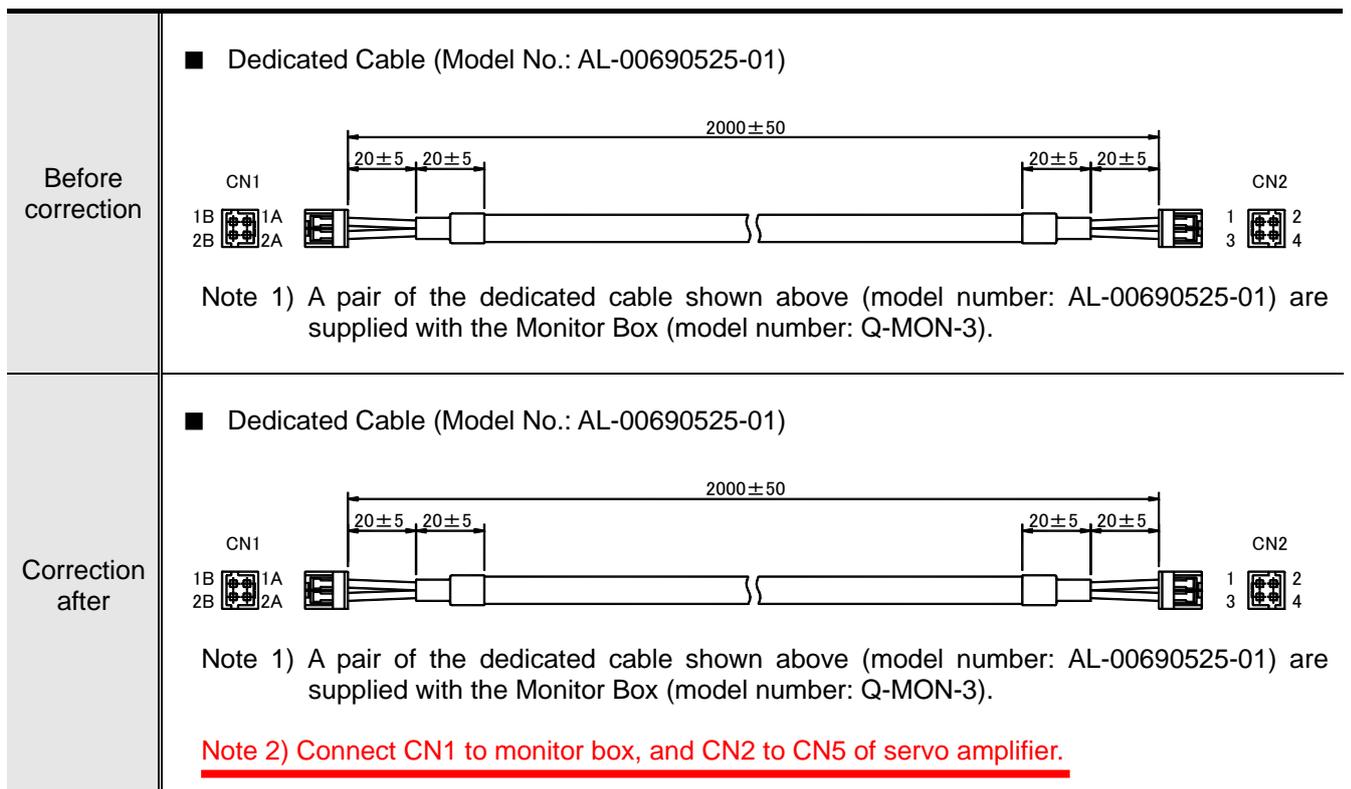**Instruction Manual**

SANYO DENKI

There are wrong descriptions in the instruction manual for RS3 EtherCAT. Please correct them as follows.

RS3 EtherCAT instruction manual (M0011696D) error correction list

Page : 2-31
Item : 2.Specifications
2.8.1 Specifications for analog monitor

Before correction	
Correction after	

Page : 12-63
Item : 12. Appendix
12.9.3 Dedicated Cable outline drawing

Before correction	■ 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).
Correction after	■ 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). Note 2) Connect CN1 to monitor box, and CN2 to CN5 of servo amplifier.

The fourth edition (D)

- ■ Overall
  - 400V/800A type is added.
  - R1 motors are added.

- ■ p.1-12, 1-13, 1-32, 1-33

  12-17, 12-18, 12-32
  - Outline drawings are updated due to change of RS3 400 VAC 150A/300A main body.

- ■ p.2-22
  - Description for inrush current of 400 VAC input model is corrected.

- ■ p.2-31

  CN6 expansion drawing is corrected.

- ■ p.3-6
  - Motor and IEC standards number are updated.

- ■ p.4-6
  - Recommended wire size for R1AA10200F and R1AA10250F is corrected.

- ■ p.7-5
  - Alarm history amount is corrected to 15.

- ■ p.7-28
  - Description is corrected because fixed monitor display can change initialization completion time.

- ■ p.7-28
  - Description is changed as below:
    in 2 seconds after powering up. ⇒ after initialization completion.

- ■ p.8-1, 8-3
  - Description for analog interface is changed for EtherCAT interface.

- ■ p.8-4
  - Communication system warnings are added.

- ■ p.9-8
  - Description for full-closed encoder selection is corrected.

- ■ p.9-24
  - Description of torque assisting function is added to tandem operation.

- ■ p.12-35
  - Optional connector-kits for 400V is added.

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

⚠**Danger**	Denotes immediate hazards that will probably cause severe bodily injury or death as a result of incorrect operation.
⚠**Warning**	Denotes immediate hazards which will probably cause severe bodily injury or death as a result of incorrect operation.
⚠**Caution**	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 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

<table>
<tr><td align="center">⚠ Caution</td></tr>
<tr><td>

◆ 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.

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

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.

Table of contents

Table of contents

3. Installation

1 Preface

2 Specifications

3 Installation

4 Wiring

5 Linear motor

6 Servo Tuning

7 Digital Operator

8 Maintenance

9 Dedicated function

10 Safe-Torque-Off function

11 Selection

12 Appendix

Table of contents

Table of contents

1 Preface

2 Specifications

3 Installation

4 Wiring

5 Linear motor

6 Servo Tuning

7 Digital Operator

8 Maintenance

9 Dedicated function

10 Safe-Torque-Off function

11 Selection

12 Appendix

Table of contents

7. Digital Operator

Table of contents

1 Preface

2 Specifications

3 Installation

4 Wiring

5 Linear motor

6 Servo Tuning

7 Digital Operator

8 Maintenance

9 Dedicated function

10 Safe-Torque-Off function

11 Selection

12 Appendix

Table of contents

Table of contents

12. Appendix

Table of contents

1

Preface

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

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 has lineup of eight (8) models of consolidated power supply single-axis type and two (2) models of separated power supply model, ten (10) types capacity totally.
This product is corresponded the Rotary Motor R series, and allows using an absolute encoder and incremental encoder as motor encoder. It is also allows using an incremental encoder and Heidenhain-made absolute encoder (Endat 2.2) as external encoder of full-closed system. Battery for the motor encoder is able to mount by battery holder (provided optionally). Battery holder is two types such as attaching to the amplifier and attaching to the encoder cable.
Outer shape and mounting dimensions and each connector is compatible with "SANMOTION R" ADVANCED MODEL. And, communication with setup software (in PC) is corresponding USB (Full speed).

1.1.2 Features of "SANMOTION R" 3E Model

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

(1) Evolved

■ Shortening of positioning settle time
Positioning settle time is shortened to 1/3 of previous model by higher response of velocity loop (2.2 kHz) 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

1.1.3 Cautions for replacement from "SANMOTION R" ADVANCED MODEL

Please check contents below for replacement from "SANMOTION R" ADVANCED MODEL.

■ Servo amplifier capacity
The lineup under 100A are refining to 6 types (10A, 20A, 30A, 50A,75A,100A) from 4 types (15A, 30A, 50A,100A). Therefore relationship between servo amplifier capacity and combined motor has changed.
See detail in "1.4.2 Servo amplifier model number".

■ The setup software
The setup software for AC servo amplifier "SANMOTION R" 3E Model is "SANMOTION MOTOR SETUP SOFTWARE". "SANMOTION R ADVANCED MODEL SETUP SOFTWARE" is not able to use.
Please download "SANMOTION MOTOR SETUP SOFTWARE" from our Website.
And prepare commercial USB cable (Amplifier side is mini USB) as communication cable between the setup software and amplifier.

1.2 Instruction manual

This manual outlines the specifications, installation, wiring, operations, functions, maintenance, etc. of the AC servo amplifier "SANMOTION R" 3E Model as follows.
Descriptions against servo amplifier are applied to power unit/amplifier unit also, when there is no specification.

1.2.1 Contents

■ Chapter 1 Preface
Product outline, model number, names of components

■ Chapter 2 Specifications
Detailed specifications for Servo Motor, Servo Amplifier and Motor Encoder

■ Chapter 3 Installation
Explanation of installation procedure

■ Chapter 4 Wiring
Illustrations and explanations of wiring

■ Chapter 5 Linear motor
Explanation of how to use with linear motor combination

■ 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. Preface

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

■ RS3□01/02/03/05 (rotary motor)

T S R

Wiring breaker (MCCB)

Used to protect power line.
Turns off the power supply
when overload runs.

Noise filter

Installed to protect power line
from external noise.

Electromagnetic contactor
Switches power On/Off.
Please place safeguard circuit.

External regenerative resistor

Used in case of insufficient capacity such
that may be caused by high frequency of
use, although internal regenerative resistor
is enough in usual.

Motor power

Brake power source

Used for Servo motor with brake

Servo motor

SANMOTION R 3E Model
With **EtherCAT** Interface

SANMOTION R

EtherCAT
Conformance tested

SANYO DENKI

CHARGE

CNA
R
S
T
r
t
⊖
RB1
RB2

CNB
U
V
W

PC

OUT
L/A
RUN
IN
L/A
ERR

CN2

CN4

EN1

EN2

CN3

Enables parameter setup
and monitoring through
communication with a PC.

USB

Setup software

To next amplifier

Host equipment

General I/O connector
Connects homing,
probing and general
signals.

Motor encoder

Safety unit, safety PLC etc.

Connects I/O signal of
Safe Torque Off function
to safety devices as
safety unit, safety PLC.

1. Preface

■ RS3□07 (rotary motor)

T S R

Wiring breaker (MCCB)

Used to protect power line. Turns off the power supply when overload runs.

Noise filter

Installed to protect power line from external noise.

SANMOTION R 3E Model
With **EtherCAT** Interface

Electromagnetic contactor

Switches power On/Off. Please place safeguard circuit.

External regenerative resistor

【Built-in regenerative resistor】
Short-circuits RB4-RB1.
【External regenerative resistor】
Remove short bar RB4-RB1.
Connect the register to RB1-RB2.

Normally built-in regenerative resistor of servo amplifier is used for operation. An external regenerative resistor is used in case of insufficient capacity such as may be caused by high frequency of use.

CHARGE

CNA
R
S
T
⊖
RB4
RB1
RB2

CNB
U
V
W

CNC
r
t

SAN**MOTION** R
8.8.8.8.8.
EtherCAT.
SANYO DENKI

Enables parameter setup and monitoring through communication with a PC.

USB

Setup software

To next amplifier

Host equipment

General I/O connector
Connects homing, probing and general signals.

Motor encoder

Brake power source

Used for Servo motor with brake

Motor power

Safety unit, safety PLC etc.

Servo motor

Connects I/O signal of Safe Torque Off function to safety devices as safety unit, safety PLC.

1.3 Illustration of system components

■ RS3□10/15 (rotary motor)

T S R

Wiring breaker (MCCB)

Used to protect power line. Turns off the power supply when overload runs.

Noise filter

Installed to protect power line from external noise.

Electromagnetic contactor

Switches power On/Off. Please place safeguard circuit.

External regenerative resistor

【Built-in regenerative resistor】
Short-circuits RB4-RB1.
【External regenerative resistor】
Remove short bar RB4-RB1.
Connect the register to RB1-RB2.

Normally built-in regenerative resistor of servo amplifier is used for operation. An external regenerative resistor is used in case of insufficient capacity such as may be caused by high frequency of use.

Brake power source

Used for Servo motor with brake

SANMOTION R 3E Model
With **EtherCAT** Interface

Enables parameter setup and monitoring through communication with a PC.

USB

Setup software

To next amplifier

Host equipment

General I/O connector
Connects homing, probing and general signals.

Motor encoder

Safety unit, safety PLC etc.

Motor power

Servo motor

Connects I/O signal of Safe Torque Off function to safety devices as safety unit, safety PLC.

SANMOTION R
EtherCAT
SANYO DENKI

R

CHARGE

R
S
T
⊖
RB4
RB1
RB2
U
V
W

CNA

1-8

1. Preface

■ RS3□30 (rotary motor)

T S R

Wiring breaker (MCCB)
Used to protect power line.
Turns off the power supply
when overload runs.

Noise filter
Installed to protect
power line from
external noise.

SANMOTION R 3E Model
With **EtherCAT** Interface

Enables parameter setup
and monitoring through
communication with a PC.

USB

Setup software

CHARGE

SANMOTION R
EtherCAT
SANYO DENKI

Electromagnetic contactor

Switches power On/Off.
Please place safeguard
circuit.

External regenerative resistor
Connect the register to RB1-RB2.

To next amplifier

Host equipment

General I/O connector
Connects homing, probing
and general signals.

R
S
T
⊖
P

RB1
RB2

Motor power

U
V
W

Safety unit, safety PLC etc.
Connects I/O signal of
Safe Torque Off function
to safety devices as
safety unit, safety PLC.

Brake power source

Used for Servo motor with brake

Used in case of insufficient capacity
such that may be caused by high
frequency of use, although internal
regenerative resistor is enough in usual.

Servo motor

Motor encoder

1.3 Illustration Of System Components

■ RS3W60 (rotary motor)

SANMOTION R 3E Model
With **EtherCAT** Interface

Enables parameter setup
and monitoring through
communication with a PC.

T S R

Wiring breaker (MCCB)

Used to protect
power line.
Turns off the power
supply when
overload runs.

Noise filter

Installed to protect
power line from
external noise.

RS3PAA270
Power unit

RS3W60
Amplifier unit

USB

Setup
software

To next
amplifier

Host
equipment

General I/O connector
Connects homing,
probing and general
signals.

r   t
Control
power

External
regenerative
resistor

RB1 RB2

+DC   -DC

+DC   -DC

L1(R) L2(S) L3(T) ⏚(E)

U   V   W   ⏚(E)

Electromagnetic
contactor

Switches power On/Off.
Please place safeguard circuit.

r   t
Control
power

Brake power source

Used for Servo motor with brake

Safety unit,
safety PLC
etc.

Servo motor

Motor encoder

Connects I/O signal of
Safe Torque Off function
to safety devices as
safety unit, safety PLC.

1. Preface

■ RS3C02/05/10

T S R

Wiring breaker (MCCB)

Used to protect power line.
Turns off the power supply
when overload runs.

Noise filter

Installed to protect power line
from external noise.

Electromagnetic contactor

Switches power On/Off.
Please place safeguard circuit.

External
regenerative
resistor

Normally built-in regenerative resistor of servo amplifier is used for
operation. An external regenerative resistor is used in case of
insufficient capacity such as may be caused by high frequency of use.

Control power
24VDC

Used for Servo motor with brake
It outputs with the timing of a holding
brake activation of servo amplifier.

Brake power output

Motor power

Servo motor

Motor encoder

SANMOTION R 3E Model
With **EtherCAT** Interface

CHARGE

CNA
R
S
T
X

CNC
RB4
Y

RB1

RB2

CND
24V
0V

CNE
B+
B−

CNB
U

V

W

Z

Motor Setup
Software

USB

Enables parameter setup
and monitoring through
communication with a PC.

To next amplifier

Host equipment

General I/O connector
Connects homing,
probing and general
signals.

Safety unit,
safety PLC etc.

Connects I/O signal of
Safe Torque Off function
to safety devices as
safety unit, safety PLC.

1.3 Illustration Of System Components

■ RS3C15

SANMOTION R 3E Model
With **EtherCAT** Interface

T S R

Wiring breaker (MCCB)

Used to protect power line.
Turns off the power supply
when overload runs.

Noise filter

Installed to protect power
line from external noise.

Enables parameter
setup and monitoring
through communication
with a PC.

USB

Motor Setup
Software

To next amplifier

Host
equipment

General I/O connector
Connects homing,
probing and general
signals.

Motor
encoder

Brake power output

24V 0V B+ B−

R S T   RB1 RB2 U V W

Electromagnetic contactor

Switches power On/Off.
Please place safeguard circuit.

Control power supply
24V DC

External regenerative resistor

Safety unit,
safety PLC,
etc.

Connects I/O signal of
Safe Torque Off function
to safety devices as
safety unit, safety PLC.

1-12   Servo motor

1. Preface

■ RS3C30

SANMOTION R 3E Model
With **EtherCAT** Interface

T S R

Wiring breaker (MCCB)
Used to protect power line. Turns off the power supply when overload runs.

Noise filter
Installed to protect power line from external noise.

Enables parameter setup and monitoring through communication with a PC.

USB

Motor Setup Software

To next amplifier

Host equipment

General I/O connector
Connects homing, probing and general signals.

Motor encoder

Refer the section 4.5.4 for wiring of dynamic brake signal.

TH1-1 TH1-2 DB1 DB2

24V 0V B+ B-

Brake power output

Electromagnetic contactor

R S T

RB1 RB2 U V W

Switches power On/Off. Please place safeguard circuit.

Control power supply 24V DC

External regenerative resistor

Safety unit, safety PLC, etc.

Connects I/O signal of Safe Torque Off function to safety devices as safety unit, safety PLC.

Servo motor

1-13

1.3 Illustration Of System Components

■ Power unit: RS3PAC550, Amplifier unit: RS3D80

SANMOTION R 3E Model
RS3PAC550

SANMOTION R 3E Model
RS3D80#

Enables parameter setup
and monitoring through
communication with a PC.

USB

Motor Setup
Software

To next amplifier

Host equipment

General I/O connector
Connects homing,
probing and general
signals.

DC power
wiring (+/-)

TH1-1 TH1-2 : Terminal for thermal signal
DB1, DB2 : Output for dynamic
                      brake contact

Refer the section
4.5.5 for wiring of
dynamic brake
signal and external
regenerative
resistor thermostat.

36 pin cable for power unit/amplifier connection

Motor power (System-2)

Motor power (System-1)

External regenerative
resistor

Switches power
On/Off.
Be sure to construct
safety circuit for safe.

Power ground
Be sure to grounding.

Power ground
Be sure to grounding.

Electromagnet
ic contactor

Control Power
DC24V

Installed to
protect power
line from external
noise.

Noise filter

Motor encoder

Used to protect
power line.
Turns off the power
supply when
overload runs.

Wiring breaker

(MCCB)

R S T

Servo motor

1. Preface

1.4 Model number structure

1.4.1 Servo Motor Model Number

■ R motor

R 2 AA OO OOO △ □ ◇ OO △ □

Servo motor series
R・・・R series

Servo motor type
1・・・R1 motor　　2・・・R2 motor　　5・・・R5 motor

Voltage
AA・・・200V AC　　　EA・・・100V AC

Flange dimensions

04・・・40mm	06・・・60mm	08・・・80mm
B8・・・86mm	10・・・100mm	13・・・130mm
18・・・180mm	22・・・220mm	32・・・320mm

Rated output

003・・・30W	005・・・50W	008・・・80W	010・・・100W
020・・・200W	040・・・400W	050・・・500/550W	075・・・750W
100・・・1.0kW	120・・・1.2kW	150・・・1.5kW	180・・・1.8kW
200・・・2.0kW	250・・・2.5kW	300・・・3.0kW	350・・・3.5kW
400・・・4.0kW	450・・・4.5kW	500・・・5.0kW	550・・・5.5kW
700・・・7.0kW	750・・・7.5kW	11K・・・11kW	15K・・・15kW
20K・・・20k/21kW	30K・・・30kW	55K・・・55kW	

Maximum rotation speed

S・・・1000 min^{-1}	B・・・2000min^{-1}	R・・・2500/3000min^{-1}
L・・・3000/4000min^{-1}	H・・・3000/3500min^{-1}	V・・・2500/3000min^{-1}
D・・・4000/4500/5000min^{-1}	F・・・6000min^{-1}	

Existence and spec for securing brake
X・・・No brake　　　B・・・With brake (90V DC)　　　C・・・With brake (24V DC)

Encoder type

H・・・Single-turn absolute encoder
P・・・Battery backup absolute encoder
R・・・Battery-less absolute encoder
W・・・Resolver type battery-less absolute encoder
S・・・Wire-saving incremental encoder
　　*　See page 1-15, for kind of applicable motor encoder.

Specification identification
00・・・Standard

Additional specification
M・・・CE mark + UL supported　0・・・With decelerator without standards

Additional specification
for the motor with gear

Symbol	Reducer type	Reduction ratio
A		1/3
B		1/5
C	Planet gear	1/9
D		1/15
E		1/33

Symbol	Reducer type	Reduction ratio
S		1/5
T	Backlash-less	1/11
U	planet gear	1/21
V		1/33

　　*　Applicable to the flange size of 86mm or less.

1.4 Model number structure

◆ Absolute encoder (Standard)

Name (Code)	Motor model number Encoder code	Resolution per rotation	Multi turn amount	Transfer method
Single-turn absolute encoder (PA035S)	H	131072(17bit)	—	Half-duplex asynchronous 2.5Mbps
Battery backup absolute encoder (PA035C)	P	131072(17bit)	65536(16bit)	Half-duplex asynchronous 2.5Mbps
Battery-less absolute encoder (HA035)	R	131072(17bit)	65536(16bit)	Half-duplex asynchronous 2.5Mbps
Resolver type battery-less absolute encoder (RA035C)	W	131072(17bit)	65536(16bit)	Half-duplex asynchronous 2.5Mbps

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

◆ Incremental encoder (Standard)

Name (Code)	Motor model number Encoder code	Division number (Number of pulse)
Wire-saving incremental encoder (PP031H, PP031T, PP062)	S	8000 (2000P/R) Note 1)

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

Note 1) Pay attention to R2CA3255KB motor encoder because that resolution (pulse number) is 20,000 (5,000 P/R).

1. Preface

1.4.2 Linear Motor Model Number (DS, DD series)

■ Coil model number

DS 030 C 1 N2 E C 1 00

Linear motor series
DS･･･Flat type, with core   DD･･･Twin type, with core

Magnet width
030･･･30mm   050･･･50mm   075･･･75mm
100･･･100mm   150･･･150mm

Type
C･･･Coil

Coil length

	Flat type, with core (DS)	Twin type, with core (DD)
1	200mm	226mm
2	376mm	402mm
3	552mm	578mm
4	-	754mm (DD075 only)

Cooling options
N2･･･Standard winding   Y2･･･Standard winding(DD050, DD075)
Y4･･･Standard winding (DD030)

Hall effect sensor specification
E･･･Line drive (Standard)   B･･･Open-collector   A･･･None

Thermal protection
A･･･None   C･･･With thermal protector

Cable length
1･･･300mm   2･･･600mm

Specification identification
00･･･DS standard   02･･･DD standard

■ Magnet rail model number

DS 030 M 512 A 00

Linear motor series
DS･･･Flat type, with core   DD･･･Twin type, with core

Magnet width
030･･･30mm   050･･･50mm   075･･･75mm
100･･･100mm   150･･･150mm

Type
M･･Magnet rail

Magnet rail length
064･･･64mm   128･･･128mm   256･･･256mm   512･･･512mm

Cover
A･･･Without cover   B･･･With cover

Hall effect sensor specification
00･･･DS standard   02･･･DD standard

1.4.3 Linear Motor Model Number (DS/DD series, Small type)

■ Coil Model Number

DS 045 C C1 A N E A 1 00

Linear motor series
DS···Flat type, with core　　　DD···Twin type, with core

Magnet width
045···45mm (for DS type, and DD type (coil length B4 only))
035···35mm (for DD type (coil length C2 only))

Type
C···Coil

Coil length

	Flat type, with core (DS)	Twin type, with core (DD)
C1	130mm	-
B4	-	349mm
C2	-	253mm

Power supply voltage
A··200 VAC

Winding specification
N··Standard winding

Hall effect sensor specification
E···Line driver (Standard)　　　A···None

Thermal specification
A···No thermal

Cable length
1···300mm　　　2···600mm

Specification identification
00···Standard

■ Magnet rail model number

DS 045 M C512 A 00

Linear motor series
DS···Flat type, with core　　　DD···Twin type, with core

Magnet width
045···45mm　　　035···35mm

Type
M··Magnet rail

Magnet rail length
DS type　　C064···64mm　　C128···128mm　　C256···256mm　　C288···288mm
　　　　　　C512···512mm
DD type　　B064···64mm　　B128···128mm　　B256···256mm　　B512···512mm

Cover
A···Without cover　　　B···With cover

Specification identification
00···Standard

1. Preface

1.4.4 Linear Motor Model Number (DT series)

■ Coil Model Number

DT 030 C D1 A N E A 1 00

Linear motor series
DT···Center magnet type

Magnet width
030···30mm

Type
C···Coil

Coil length
D1···145mm

Power supply voltage
A··200 VAC

Winding specification
N··Standard winding

Hall effect sensor specification
E···Line driver (Standard)   A···None

Thermal specification
A···No thermal

Cable length
1···300mm   2···600mm

Specification identification
00···Standard

■ Magnet rail model number

DT 030 M 512 B 00

Linear motor series
DT···Center magnet type

Magnet width
030···30mm

Type
M··Magnet rail

Magnet rail length
128···128mm   256···256mm   288···288mm   512···512mm

Cover
A···Without cover   B···With cover

Individual specification
00···Standard

1.4.5 Power Unit Model Number

RS3 PA △ □□□ XX

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

Unit type
PA・・・Power unit (with external generative resistor)

Input power voltage
A・・・Main circuit 200 VAC / Control 200 VAC
C・・・Main circuit 400 VAC / Control 24 VDC

Power unit capacity
270・・・27 kW, 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. Preface

1.4.6 Servo Amplifier Model Number

RS3 △ ○○ A □ ◇ △ 0

Servo amplifier series
RS3···"SANMOTION R" 3E Model series

Input voltage
A···Main circuit 200 VAC / Control 200 VAC
E···Main circuit 100 VAC / Control 200 VAC
C···Main circuit 400 VAC / Control 24 VDC
D···Main circuit 560 VDC / Control 24 VDC
W···Main circuit 280 VDC / Control 200 VAC

Servo Amplifier capacity
01···10A   02···20A(100,200V AC), 25A(400V AC)   03···30A   05···50A
07···75A   10···100A   15···150A   30···300A   60···600A   80···800A
 ✓ See page 1-20 for servo amplifier capacity and combination motor.

Servo Motor type
A···Rotary motor/Linear motor/Direct drive motor

Motor Encoder Type (for rotary motor)

	EN1 (for motor encoder only)	EN2 (for motor encoder or external encoder)
1	Absolute encoder	Absolute encoder
2	Absolute encoder	Incremental encoder
9	Incremental encoder	Absolute encoder
A	Incremental encoder	Incremental encoder

Motor Encoder Type (for linear motor)

	EN1 (for Linear encoder)	EN2 (for Hall sensor)
A	Incremental encoder	Line driver
B	Incremental encoder	Open collector

Interface type
H···EtherCAT

Option 1
A···With built-in regenerative resistance/ with DB resistance
L···Without built-in regenerative resistance/ with DB resistance
M···Without built-in regenerative resistance/ without DB resistance

Option 2

	Safe Torque Off function	Functional safety module
4	Available (with delay circuit)	None
E	Available (with delay circuit)	Available

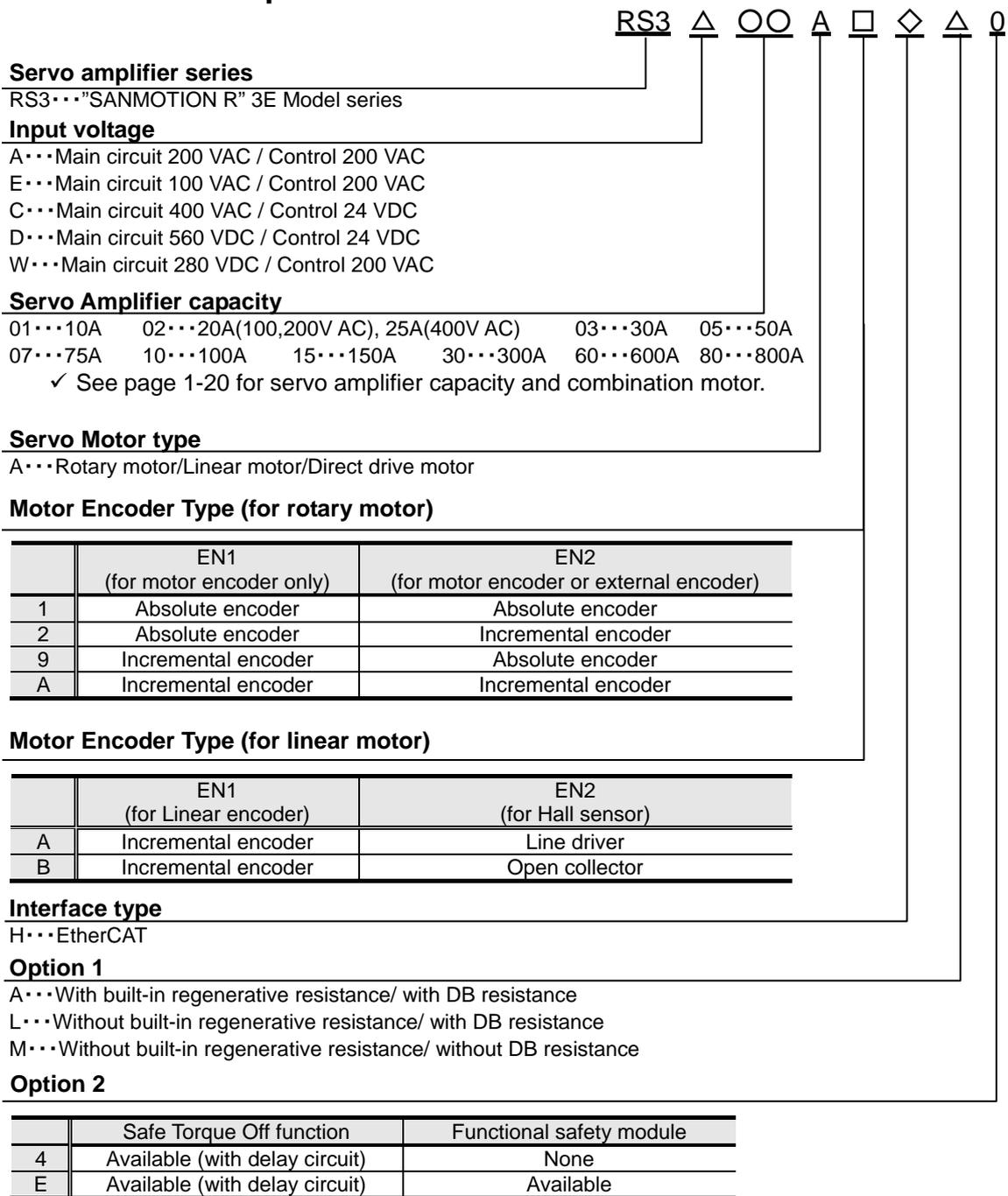* See "Instruction manual of SANMOTION R3E Model Safety: M0011778" for detail of Functional safety module.
* Model numbers above are standard spec. Model number which is not listed spec in this manual will differ.
  Please contact us for the detail.
* Setup values of servo amplifier are "default values" 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 Servo amplifier and Servo motor are necessary. Make sure to perform setup fit to the system to be used by referring another document M0011697 (EtherCAT communication).
* Servo amplifier for the "Full-closed" system can be used for the "Semi-closed" system.
* Motor encoder type "2" is able to use for both of absolute encoder and incremental encoder, as motor encoder. Connect absolute encoder to EN1, and connect incremental encoder to EN2.
* See "10. Safe Torque Off function" for detail of Safe Torque Off function.

1.4 Model number structure

■ Servo amplifier capacity and combination servo motor (200V AC)

Input voltage	Servo amplifier model number	Servo motor model number	Input voltage	Servo amplifier model number	Servo motor model number
200V AC	RS3A01#	R1AA04005F	200V AC	RS3A10#	R1AA13300F
		R1AA04010F			R1AA13400H
		R2AA04003F			R1AA13500H
		R2AA04005F			R2AA13180D
		R2AA04010F			R2AA13200D
		R2AA06010F			R2AA18350L
		R5AA06020H		RS3A15#	R1AA13400F
	RS3A02#	R1AA06020F			R1AA13500F
		R1AA06040F			R2AA18350D
		R2AA06020F			R2AA18450H
		R2AA06040F			R2AA18550R
		R2AA06040H			R2AA22500L
		R2AA08020F			R2AA22700S
		R2AA08040F		RS3A30#	R1AA18550H
		R5AA06020F			R1AA18750L
		R5AA06040F			R1AA1811KR
		R5AA06040H			R1AA1815KB
	RS3A03#	R1AA08075V			R2AA18550H
		R1AA10100H			R2AA18750H
		R1AA10150H			R2AA1811KR
		R2AA08075F			R2AA2211KB
		R2AAB8100H			R2AA2215KB
		R2AA10075F		RS3W60#	R1AA2220KV
		R2AA13050D			R2AA2220KB
		R2AA13050H			R2AA2225KB
		R2AA13120B			R2AA2830KV
		R5AA08075D			
		R5AA08075F			
	RS3A05#	R1AA08075F			
		R1AA10100F			
		R1AA10150F			
		R1AA10200H			
		R1AA10250H			
		R2AAB8075F			
		R2AAB8100F			
		R2AA10100F			
		R2AA13120D			
		R2AA13120L			
		R2AA13180H			
		R2AA13200L			
	RS3A07#	R1AA10200F			
		R1AA10250F			
		R1AA13300H			
		R2AA13180D			
		R2AA13200D			
		R2AA18350V			

* R2AA13180D and R2AA13200D are able to combine with either of RS3A07 or RS3A10.

■ Servo amplifier capacity and combination servo motor (100V AC)

Input voltage	Servo amplifier model number	Servo motor model number
100V AC	RS3E01#	R2EA04003F
	RS3E02#	R1EA04005F
		R1EA04010F
		R2EA04005F
		R2EA04008F
		R2EA06010F
	RS3E03#	R1EA06020F
		R2EA06020F

1. Preface

■ Servo amplifier capacity and combination servo motor (400V AC)

Input voltage	Servo amplifier model number	Servo motor model number
400V AC	RS3C02#	R1CA10150V
		R2CA10075F
		R2CA13050D
		R2CA13120R
		R2CA13180H
		R2CA13200L
	RS3C05#	R1CA10200V
		R1CA13300V
		R2CA10100F
		R2CA13120F
		R2CA13180D
		R2CA13200H
		R2CA18350L
	RS3C10#	R2CA18350D
		R2CA18450H
		R2CA18550R
	RS3C15#	R1CA18550H
		R1CA18750L
		R1CA1811KR
		R1CA1815KB
		R2CA18550H
		R2CA18750H
		R2CA2211KB
		R2CA2215KV
	RS3C30#	R1CA2220KV
		R2CA2220KV
		R2CA2830KV

■ Amplifier unit capacity and combination servo motor (400V AC)
  * : 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

■ Servo amplifier capacity and combination linear motor (200V AC)

Input voltage	Servo amplifier model number	Linear motor model number	Input voltage	Servo amplifier model number	Linear motor model number
200V	RS3A03#	DS030C1N2*	200V	RS3A10#	DS030C3N2*
		DS050C1N2			DS050C3N2
		DS075C1N2			DS075C3N2
		DS045CC1AN			DS100C2N2
		DT030CD1AN			DS150C2N2
	RS3A05#	DS030C2N2*			DD030C2Y4
		DS050C2N2			DD030C3Y4
		DS075C2N2			DD050C1Y2
		DS100C1N2			DD075C1Y2
		DS150C1N2			DD045CB4AN
		DD030C1Y4		RS3A15#	DS100C3N2*
	RS3A07#	DS030C3N2*			DS150C3N2
		DS050C3N2			DD050C2Y2
		DS075C3N2			DD075C2Y2
		DD030C2Y4		RS3A30#	DD050C3Y2*
		DD050C1Y2			DD075C3Y2
		DD075C1Y2			DD075C4Y2
		DD045CB4AN			
		DD035CC2AN			

* DS030C3N2, DS050C3N2, DS075C3N2, DD030C2Y4, DD050C1Y2, DD075C1Y2 and DD045CB4AN are able to combine with either RS3A07 or RS3A10.
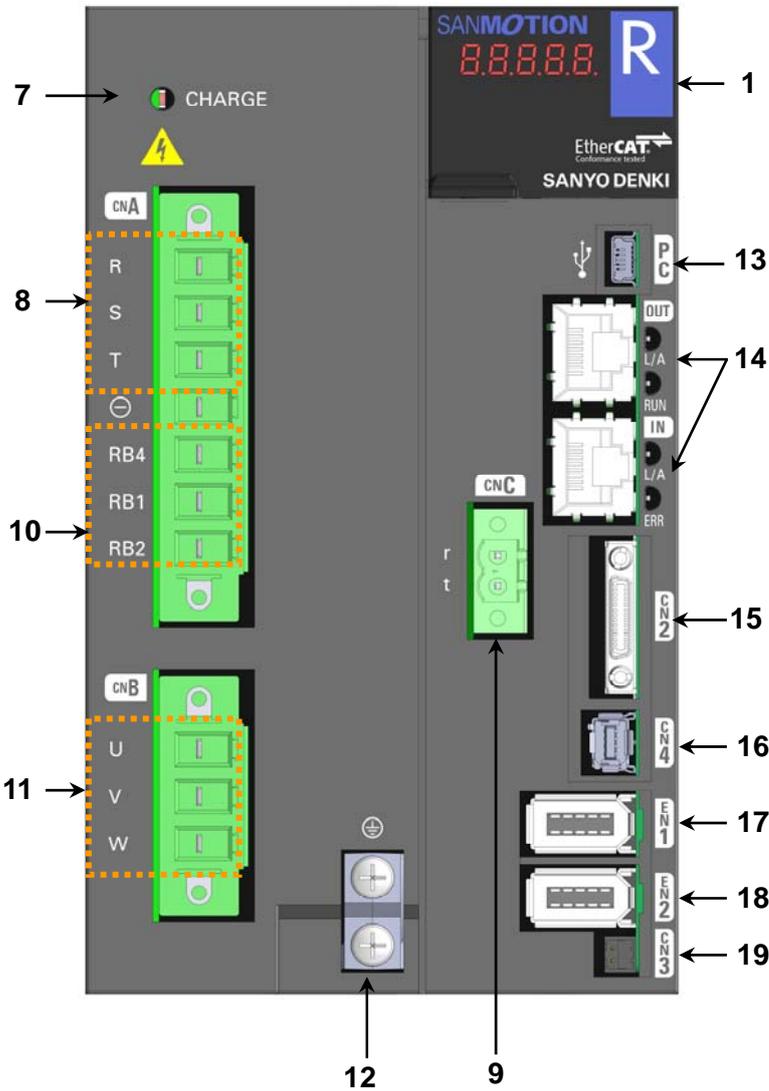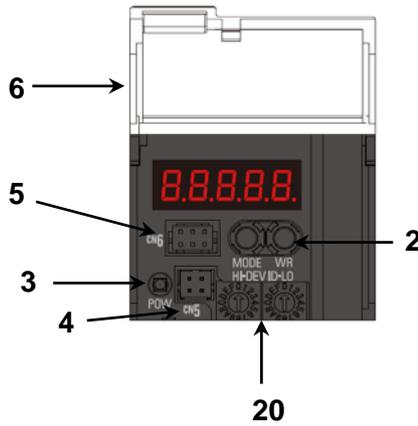
1-23

1.5 Part names

1.5.1 Servo amplifier

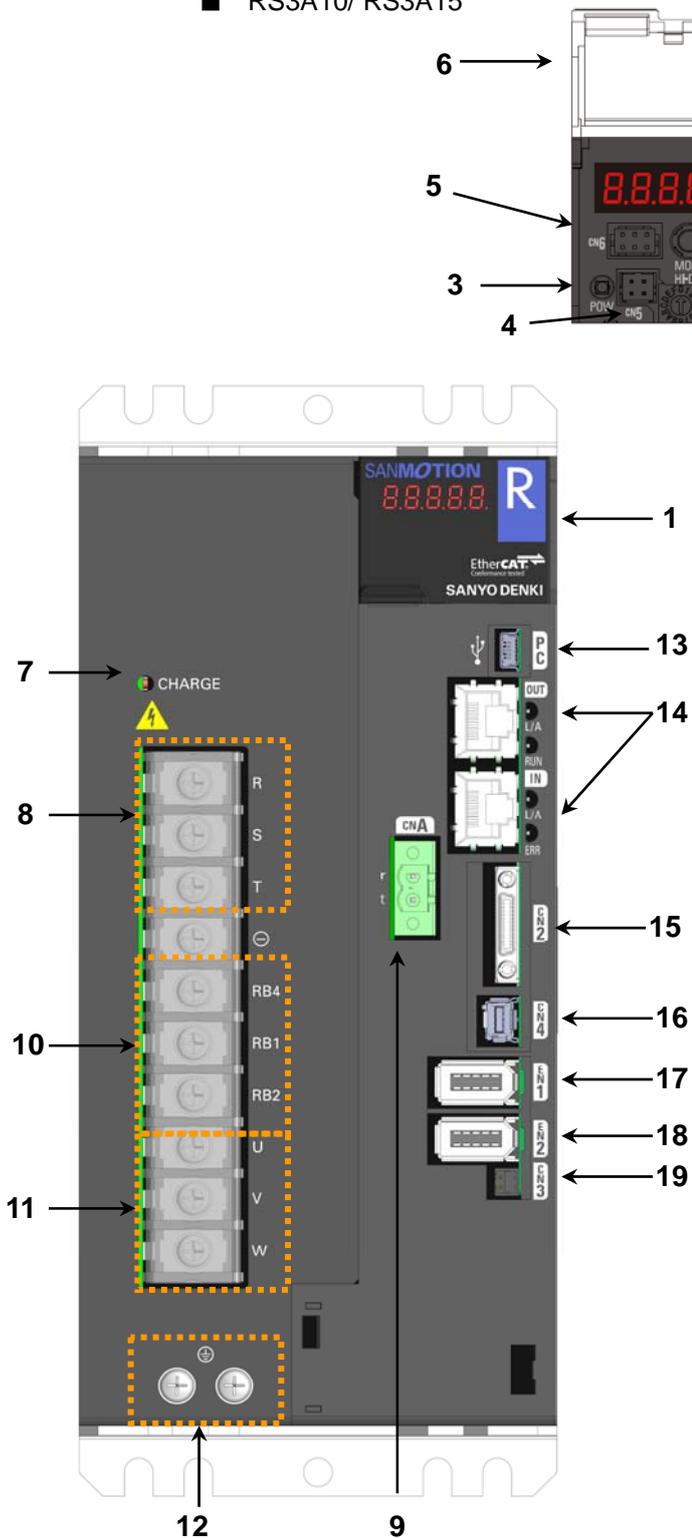■ RS3□01/ RS3□02/ RS3□03/ RS3□05

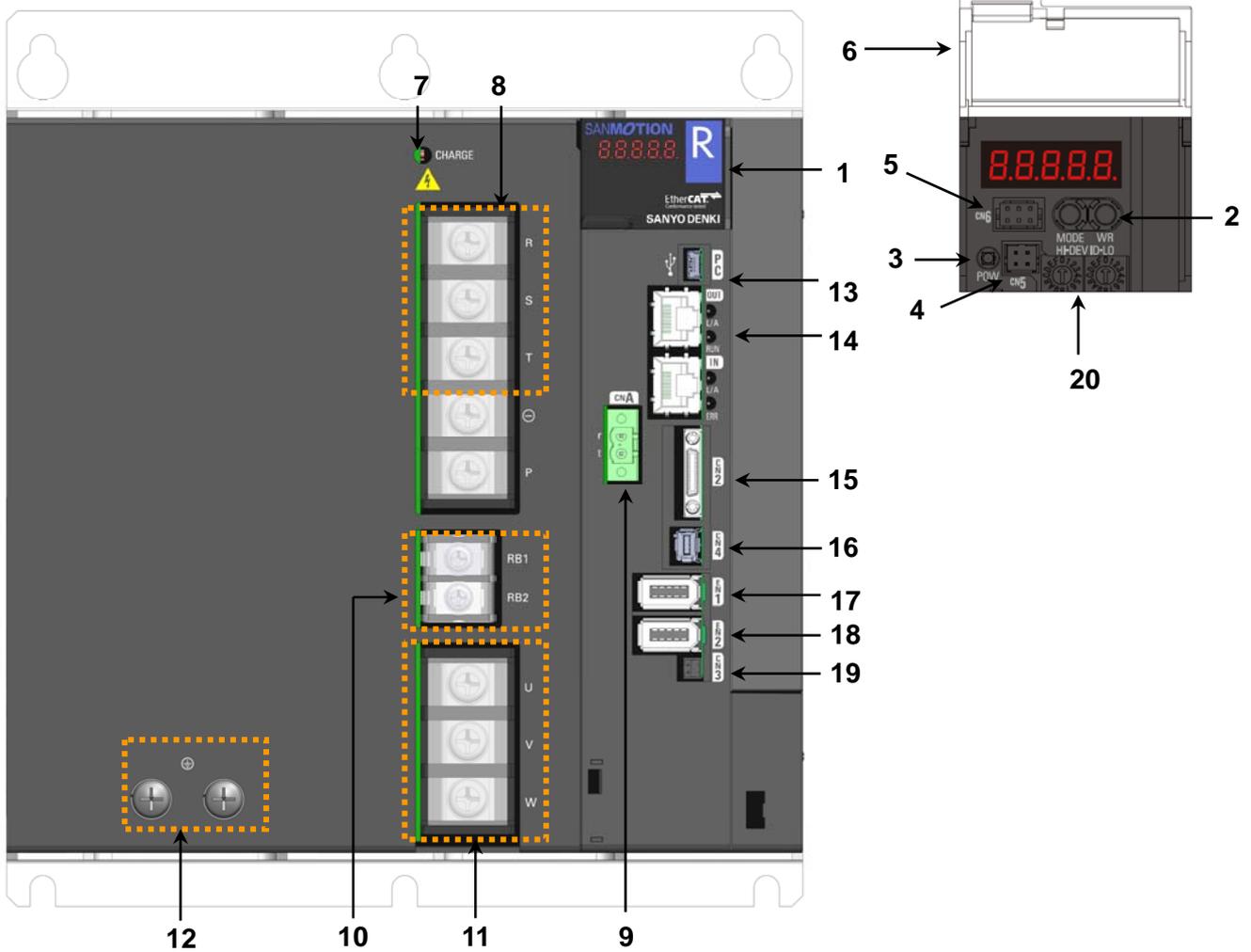| No.	Name/ Use
1	Digital operator display/ For servo amplifier status, alarm code and data display for parameter input
2	Digital operator key/ For parameter setting, test operation etc.
3	Control power status LED (Blue)/ Lighting on when control power inputted and control circuit is working.
4	Analog monitor connector (CN5)/ For measuring analog signal such as velocity or current with dedicated cable.
5	(CN6)/ For maintenance
6	Front panel cover/
7	Main circuit power LED (Red)/ 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. There is a risk of electric shock.
8	Main circuit power input (CNA)/ For input terminal of main circuit power
9	Control power input (CNA)/ For input terminal of control power
10	Regenerative resistor terminal (CNA)/ Connect the resistor between RB1 and RB2. There are two kind of regenerative resistor, internal and external.
11	Motor power terminal (CNB)/
12	Grounding terminal/
13	USB connector for PC communication (PC)/
14	For EtherCAT communication connector (IN/OUT)/
15	For general I/O signal connector (CN2)/
16	For safety device connecting connector (CN4)/
17	For motor encoder (EN1)/
18	For motor encoder or external encoder (EN2)/
19	For battery connection (CN3)/
20	Rotary switch for station alias setting/

1. Preface

■ RS3A07

No.	Name/ Use
1	Digital operator display/ For servo amplifier status, alarm code and data display for parameter input
2	Digital operator key/ For parameter setting, test operation etc.
3	Control power status LED (Blue)/ Lighting on when control power inputted and control circuit is working.
4	Analog monitor connector (CN5)/ For measuring analog signal such as velocity or current with dedicated cable.
5	(CN6)/ For maintenance
6	Front panel cover/
7	Main circuit power LED (Red)/ 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. There is a risk of electric shock.
8	Main circuit power input (CNA)/ For input terminal of main circuit power
9	Control power input (CNC)/ For input terminal of control power
10	Regenerative resistor terminal (CNA)/ Connect the resistor between RB1 and RB2. There are two kind of regenerative resistor, internal and external.
11	Motor power terminal (CNB)/
12	Grounding terminal/
13	USB connector for PC communication (PC)/
14	For EtherCAT communication connector (IN/OUT)/
15	For general I/O signal connector (CN2)/
16	For safety device connecting connector (CN4)/
17	For motor encoder (EN1)/
18	For motor encoder or external encoder (EN2)/
19	For battery connection (CN3)/
20	Rotary switch for station alias setting/

■ RS3A10/ RS3A15

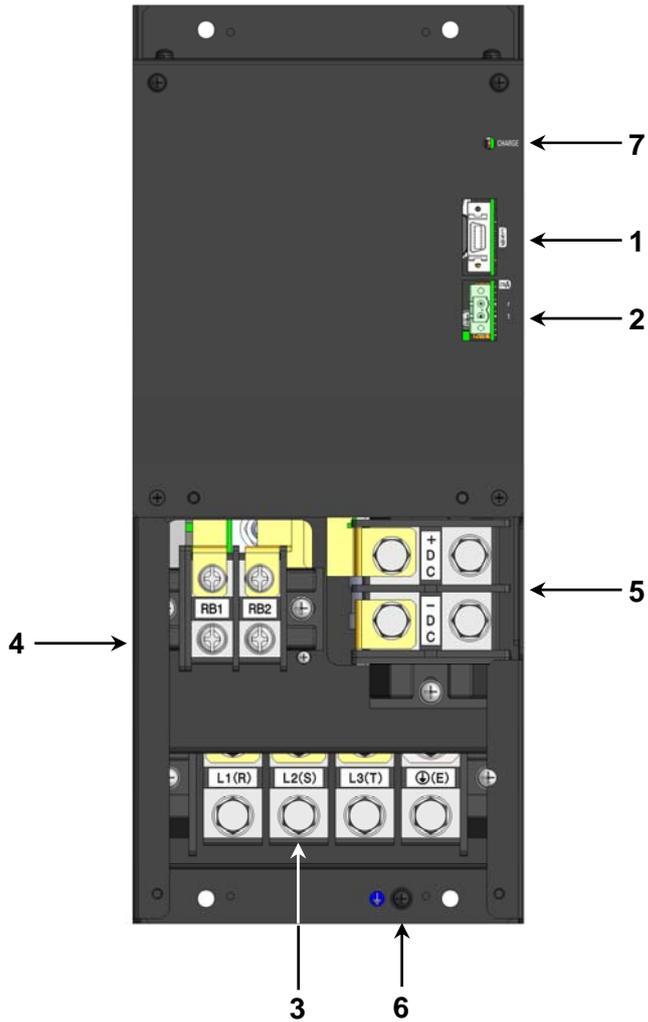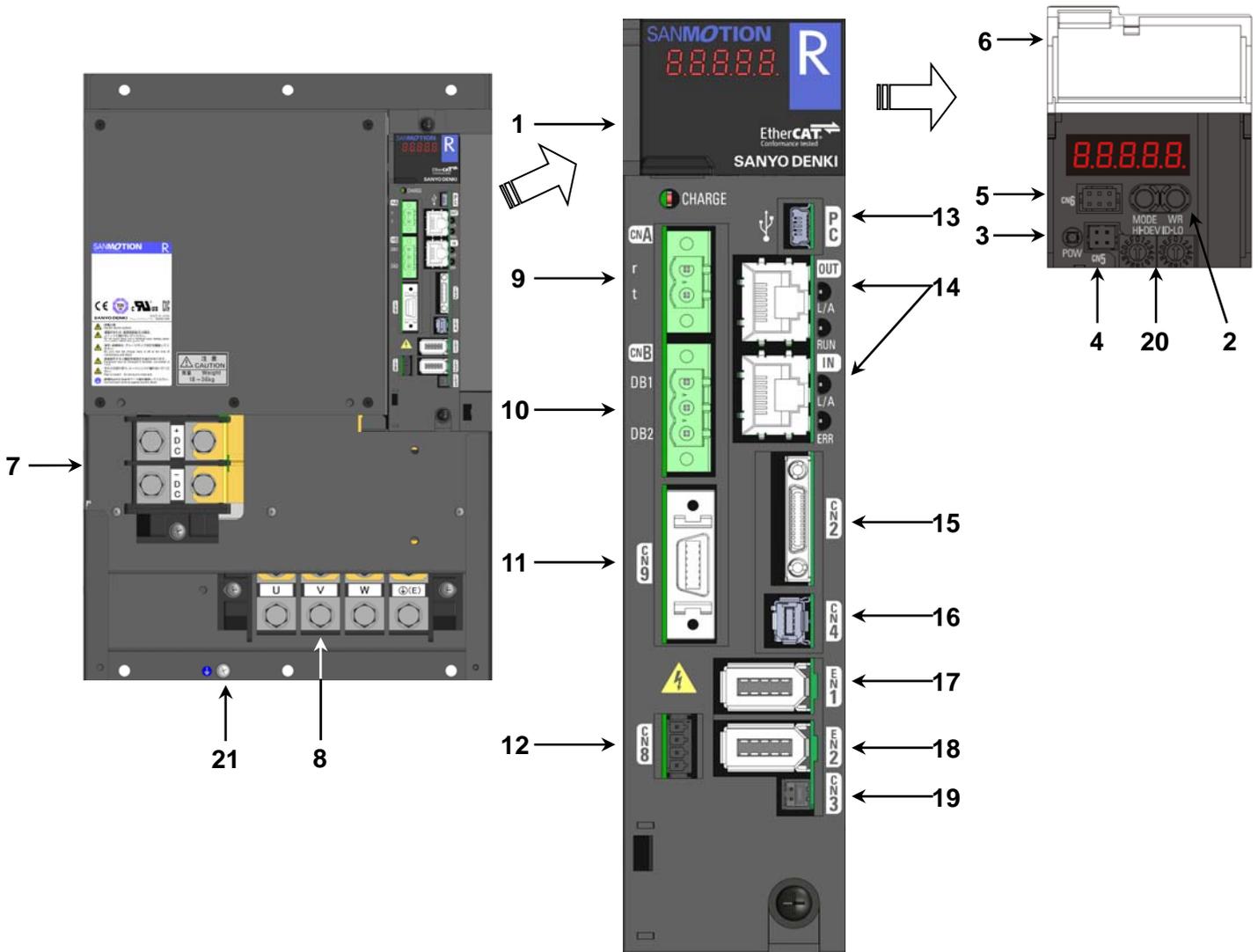| No.	Name/ Use
1	Digital operator display/ For servo amplifier status, alarm code and data display for parameter input
2	Digital operator key/ For parameter setting, test operation etc.
3	Control power status LED (Blue)/ Lighting on when control power inputted and control circuit is working.
4	Analog monitor connector (CN5)/ For measuring analog signal such as velocity or current with dedicated cable.
5	(CN6)/ For maintenance
6	Front panel cover/
7	Main circuit power LED (Red)/ 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. There is a risk of electric shock.
8	Main circuit power input terminal/ For input terminal of main circuit power
9	Control power input (CNA)/ For input terminal of control power
10	Regenerative resistor terminal/ Connect the resistor between RB1 and RB2. There are two kind of regenerative resistor, internal and external.
11	Motor power terminal/
12	Grounding terminal/
13	USB connector for PC communication (PC)/
14	For EtherCAT communication connector (IN/OUT)/
15	For general I/O signal connector (CN2)/
16	For safety device connecting connector (CN4)/
17	For motor encoder (EN1)/
18	For motor encoder or external encoder (EN2)/
19	For battery connection (CN3)/
20	Rotary switch for station alias setting/

1. Preface

■ RS3A30

No.	Name/ Use
1	Digital operator display/ For servo amplifier status, alarm code and data display for parameter input
2	Digital operator key/ For parameter setting, test operation etc.
3	Control power status LED (Blue)/ Lighting on when control power inputted and control circuit is working.
4	Analog monitor connector (CN5)/ For measuring analog signal such as velocity or current with dedicated cable.
5	(CN6)/ For maintenance
6	Front panel cover/
7	Main circuit power LED (Red)/ 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. There is a risk of electric shock.

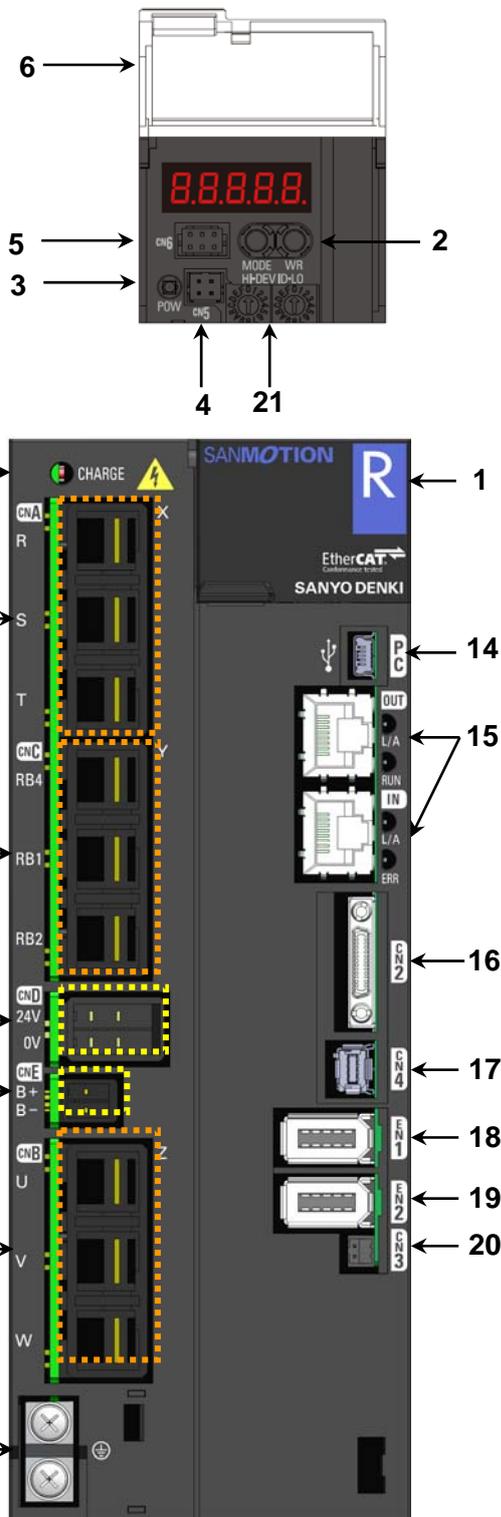| No.	Name/ Use
8	Main circuit power input terminal/ For input terminal of main circuit power
9	Control power input (CNA)/ For input terminal of control power
10	Regenerative resistor terminal/ Connect the resistor between RB1 and RB2.
11	Motor power terminal/
12	Grounding terminal/
13	USB connector for PC communication (PC)/
14	For EtherCAT communication connector (IN/OUT)/
15	For general I/O signal connector (CN2)/
16	For safety device connecting connector (CN4)/
17	For motor encoder (EN1)/
18	For motor encoder or external encoder (EN2)/
19	For battery connection (CN3)/
20	Rotary switch for station alias setting/

1-27

■ RS3PAA270

No.	Name/ Use
1	Amplifier unit connection connector Connect to CN9 of the amplifier unit.
2	Control power input (CNA)/ For input terminal of control power
3	Main circuit power input For input terminal of main circuit power Also, grounding a power unit.
4	Regenerative resistor terminal Connect the resistor between RB1 and RB2.
5	DC output terminal for main circuit Connect to +DC/-DC of the amplifier unit.
6	Frame ground Connect to the frame ground of amplifier unit and upper controller.
7	Main circuit power LED (Red)/ 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. There is a risk of electric shock.

1. Preface

■ RS3W60

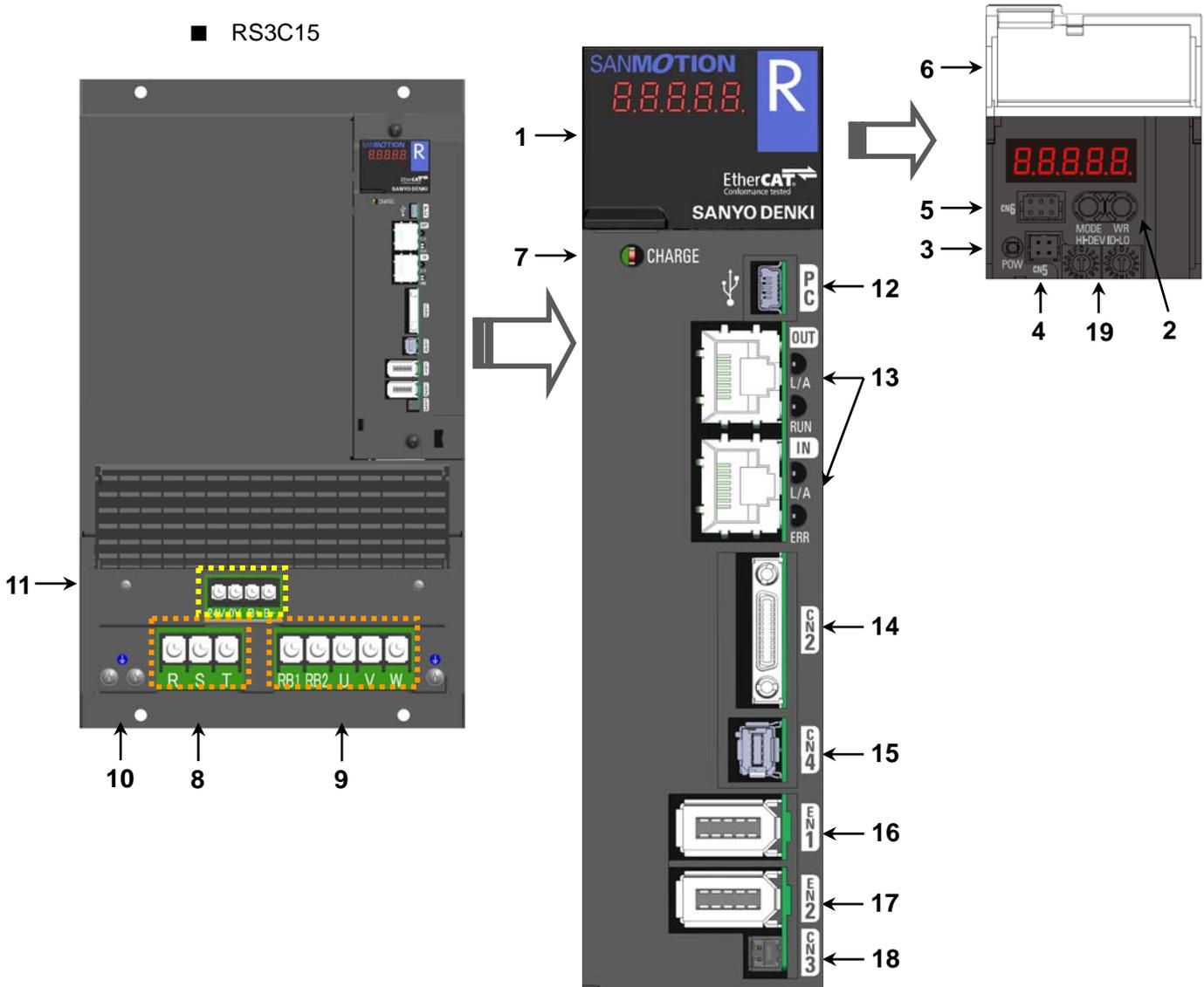| No.	Name/ Use
1	Digital operator display/ For servo amplifier status, alarm code and data display for parameter input
2	Digital operator key/ For parameter setting, test operation etc.
3	Control power status LED (Blue)/ Lighting on when control power inputted and control circuit is working.
4	Analog monitor connector (CN5)/ For measuring analog signal such as velocity or current with dedicated cable.
5	(CN6)/ For maintenance
6	Front panel cover/
7	Main circuit power DC input/ For connection with +DC/-DC of power unit.
8	Motor power line/

No.	Name/ Use
9	Control power input (CNA)/ For input terminal of control power
10	For dynamic brake signal connector (CNB)/
11	For power unit signal connector (CN9)/ Connect with CN9 of power unit.
12	For external alarm input (CN8)/
13	USB connector for PC communication (PC)/
14	For EtherCAT communication connector (IN/OUT)/
15	For general I/O signal connector (CN2)/
16	For safety device connecting connector (CN4)/
17	For motor encoder (EN1)/
18	For motor encoder or external encoder (EN2)/
19	For battery connection (CN3)/
20	Rotary switch for station alias setting/
21	Frame grounding/ Connect to frame grounding of power unit.

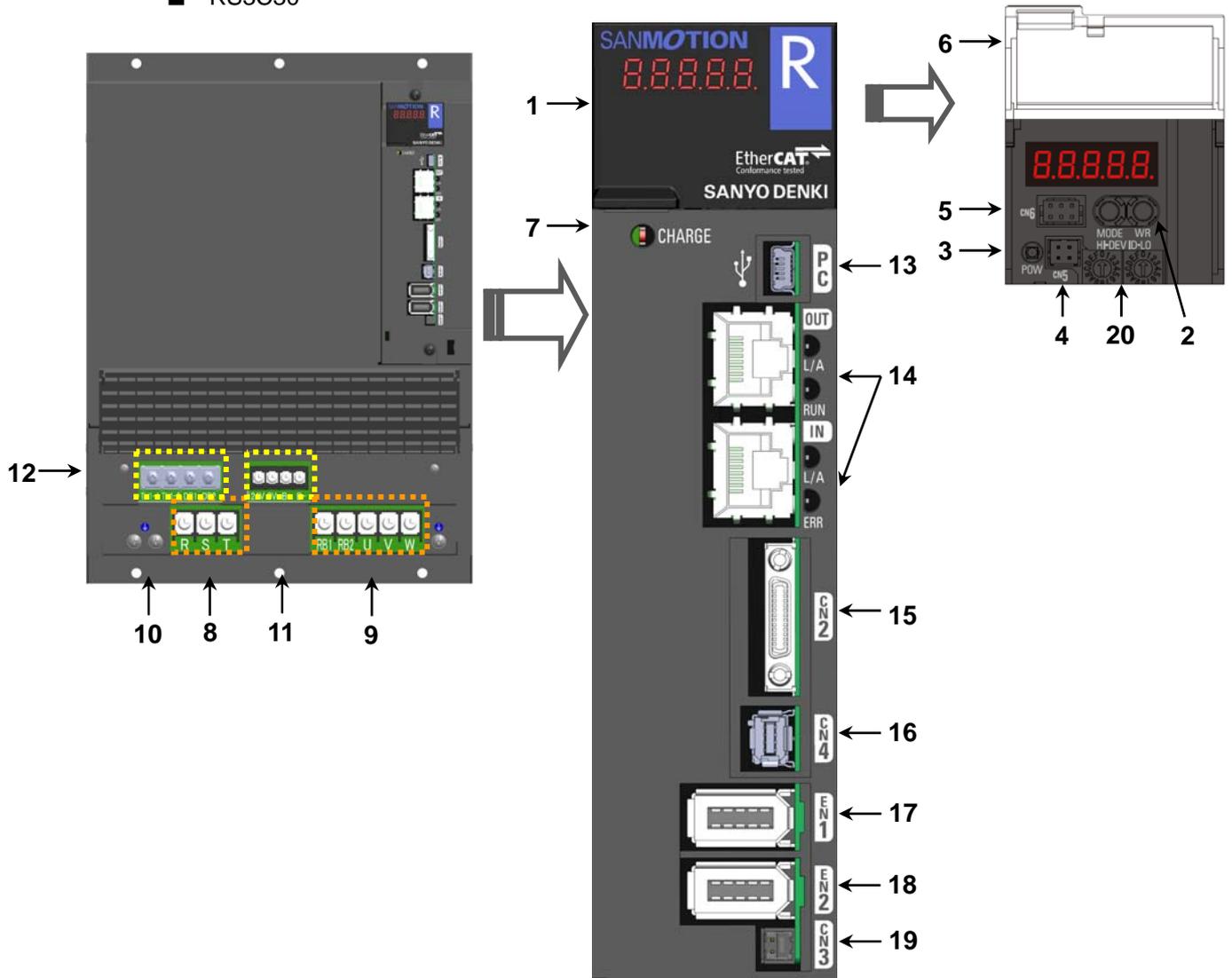■ RS3C02/05/10

No.	Name/ Use
1	Digital operator display/ For servo amplifier status, alarm code and data display for parameter input
2	Digital operator key/ For parameter setting, test operation etc.
3	Control power status LED (Blue)/ Lighting on when control power inputted and control circuit is working.
4	Analog monitor connector (CN5)/ For measuring analog signal such as velocity or current with dedicated cable.
5	(CN6)/ For maintenance
6	Front panel cover/
7	Main circuit power LED (Red)/ 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. There is a risk of electric shock.
8	Main circuit power input (CNA)/ For input terminal of main circuit power
9	Regenerative resistor connector (CNC) For built-in regenerative resistor, make short-circuit of RB4-RB1. For external regenerative resistor, remove short bar RB4-RB1 and connect the register to RB1-RB2. 　Note) Do not connect short wire to RB1-RB2.
10	Control power input (CND) or input terminal of control power
11	Holding brake power output (CNE)/ For output terminal of motor holding brake power
12	Motor power output (CNB)/
13	Grounding terminal/
14	USB connector for PC communication (PC)/
15	For EtherCAT communication connector (IN/OUT)/
16	For general I/O signal connector (CN2)/
17	For safety device connecting connector (CN4)/
18	For motor encoder (EN1)/
19	For motor encoder or external encoder (EN2)/
20	For battery connection (CN3)/
21	Rotary switch for station alias setting/

1. Preface

■ RS3C15

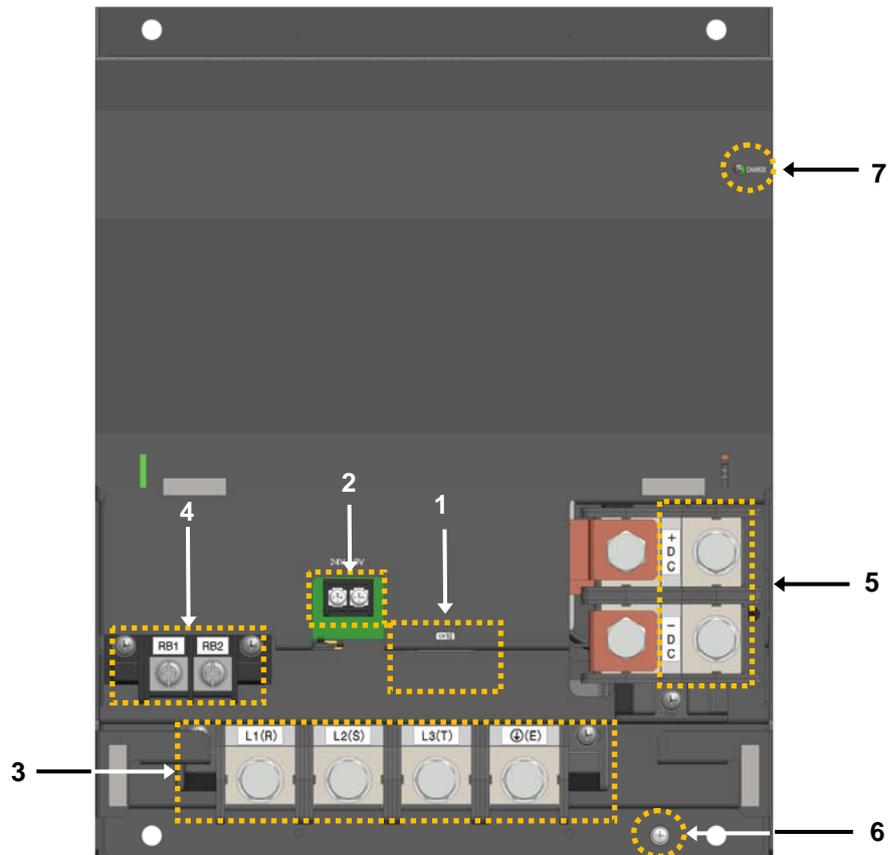| No.	Name/ Use
1	Digital operator display/ For servo amplifier status, alarm code and data display for parameter input
2	Digital operator key/ For parameter setting, test operation etc.
3	Control power status LED (Blue)/ Lighting on when control power inputted and control circuit is working.
4	Analog monitor connector (CN5)/ For measuring analog signal such as velocity or current with dedicated cable.
5	(CN6)/ For maintenance
6	Front panel cover/
7	Main circuit power LED (Red)/ 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. There is a risk of electric shock.

No.	Name/ Use
8	Main circuit power input terminal/ For input terminal of main circuit power
9	Terminal block for external regenerative resistor and motor power
10	Grounding terminal/
11	Control power input and holding brake power output/ Terminal block for control power input and holding brake power output.
12	USB connector for PC communication (PC)/
13	For EtherCAT communication connector (IN/OUT)/
14	For general I/O signal connector (CN2)/
15	For safety device connecting connector (CN4)/
16	For motor encoder (EN1)/
17	For motor encoder or external encoder (EN2)/
18	For battery connection (CN3)/
19	Rotary switch for station alias setting/

■ RS3C30

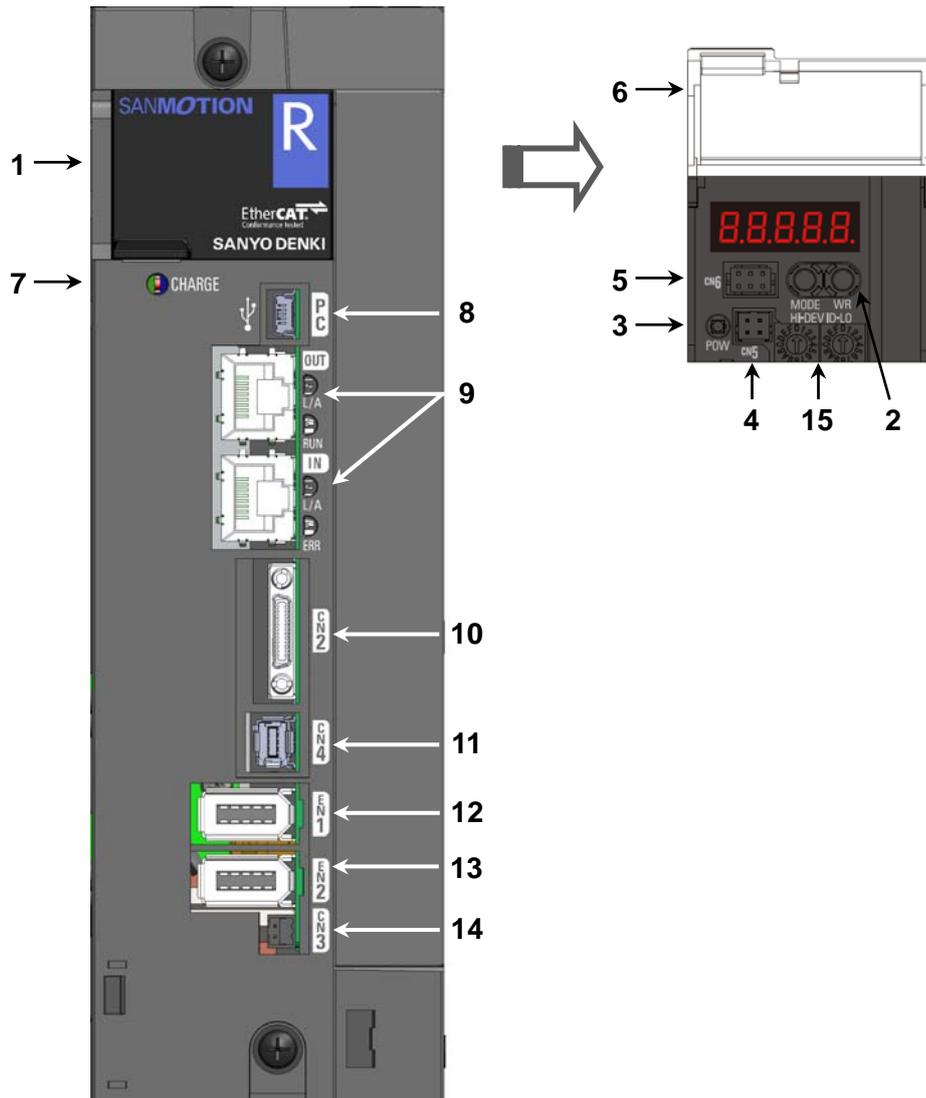| No.	Name/ Use
1	Digital operator display/ For servo amplifier status, alarm code and data display for parameter input
2	Digital operator key/ For parameter setting, test operation etc.
3	Control power status LED (Blue)/ Lighting on when control power inputted and control circuit is working.
4	Analog monitor connector (CN5)/ For measuring analog signal such as velocity or current with dedicated cable.
5	(CN6)/ For maintenance
6	Front panel cover/
7	Main circuit power LED (Red)/ 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. There is a risk of electric shock.

No.	Name/ Use
8	Main circuit power input terminal/ For input terminal of main circuit power
9	Terminal block for external regenerative resistor and motor power
10	Grounding terminal/
11	Control power input and holding brake power output/ Terminal block for control power input and holding brake power output.
12	Terminal block for dynamic brake signal and thermal signal connection
13	USB connector for PC communication (PC)/
14	For EtherCAT communication connector (IN/OUT)/
15	For general I/O signal connector (CN2)/
16	For safety device connecting connector (CN4)/
17	For motor encoder (EN1)/
18	For motor encoder or external encoder (EN2)/
19	For battery connection (CN3)/
20	Rotary switch for station alias setting/

1. Preface

1.5.2 Power unit

■ RS3PAC550

No.	Name/ Use
1	Amplifier unit connection connector(CN10)/ Connect to CN10 of the amplifier unit with optional cable which connects units each other.
2	Control power input (24V・0V)/ For input terminal of control power
3	Main circuit power input(R・S・T・E)/ For input terminal of main circuit power Make sure to connect power grounding cable to terminal E.
4	Regenerative resistor terminal(RB1・RB2)/ Connect the resistor between RB1 and RB2.
5	DC output terminal for main circuit（+DC・-DC） Connect to +DC/-DC of the amplifier unit.
6	Frame ground Connect to the frame ground of amplifier unit.
7	Main circuit power LED (Red)/ 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. There is a risk of electric shock.

1.5.3 Amplifier unit

■ RS3D80#　Terminal block, connectors and main body indication part
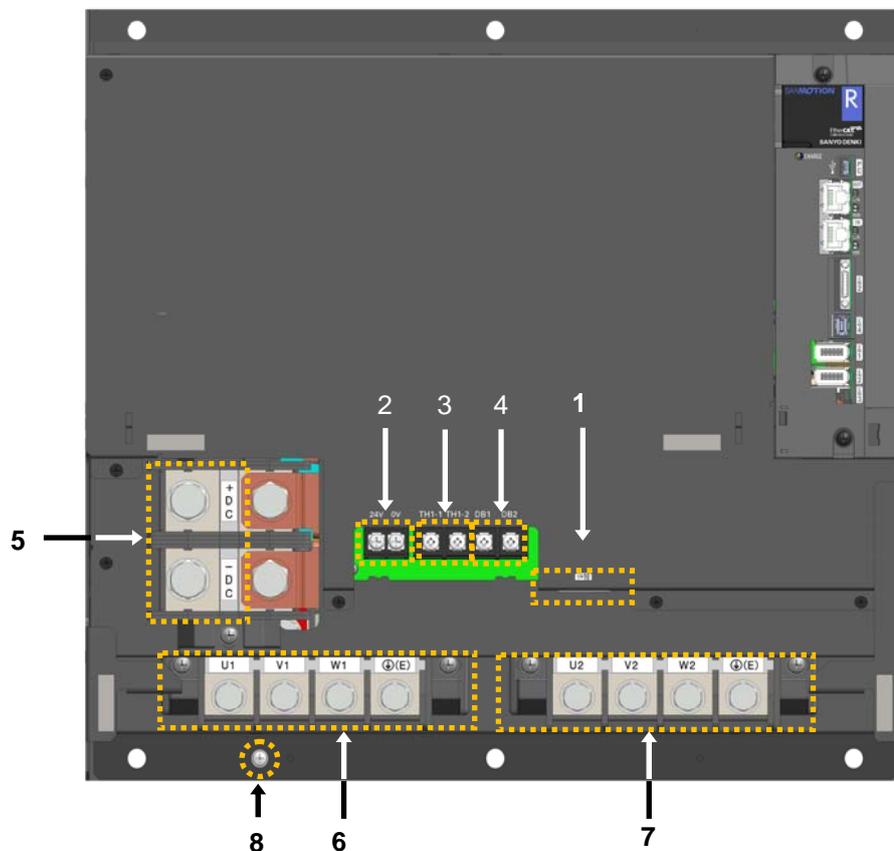
No.	Name/ Use
1	Power unit connection connector(CN10)/ Connect to CN10 of the power unit with optional cable which connects units each other.
2	Control power input (24V・0V)/ For input terminal of control power
3	Terminal for thermal signal connection of dynamic brake (TH1-1・TH1-2)/ Use as dynamic brake overheat detection. Note) If not used, be sure to make short circuit between terminals.
4	Terminal for dynamic brake signal (DB1・DB2)/ 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） Connect to +DC/-DC of the power unit.
6	Motor power line (U1・V1・W1・E) 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) Connect to motor terminal block (U2・V2・W2). Be sure to connect motor grounding cable to terminal E.
8	Frame ground Connect to the frame ground of power unit.

1. Preface

■ RS3D80# Interface part with upper device

No.	Name/ Use
1	Digital operator display/ For servo amplifier status, alarm code and data display for parameter input
2	Digital operator key/ For performing a parameter setting and test operation etc.
3	Control power status LED (Blue)/ Lighting on when control power inputted and control circuit is working.
4	Analog monitor connector (CN5)/ For measuring analog signal such as velocity or current with dedicated cable.
5	(CN6)/ For maintenance
6	Front panel cover/
7	Main circuit power LED (Red)/ 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. There is a risk of electric shock.

No.	Name/ Use
8	USB connector for PC communication (PC)/
9	For EtherCAT communication connector (IN/OUT)/
10	For general I/O signal connector (CN2)/
11	For safety device connecting connector (CN4)/
12	For motor encoder (EN1)/
13	For motor encoder or external encoder (EN2)/
14	For battery connection (CN3)/
15	Rotary switch for station alias setting/

1.5.4 Servo motor

■ R1 servo motor, 180 mm sq./5.5 to 15 kW
R1AA18550△□◇
R1AA18750△□◇
R1AA1811K△□◇
R1AA1815K△□◇

Frame   Brake   Fan motor   Encoder

Shaft

Flange

Servo motor power and ground connector   Brake connector   Encoder connector   Fan connector
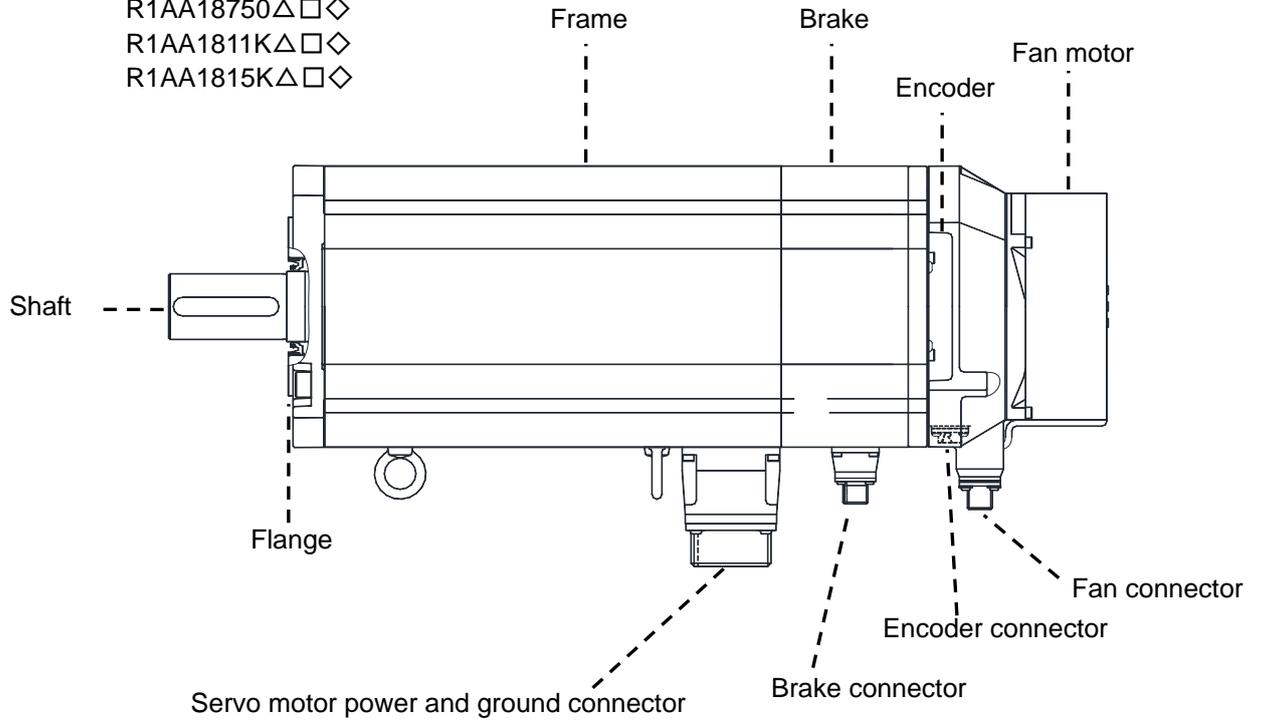
■ R1 servo motor, 40 to 80 mm sq.
R1□A04○○○△□◇
R1□A06○○○△□◇
R1AA08○○○△□◇

Frame   Brake   Encoder

Shaft

Flange

Servo motor power cable   Brake cable   Encoder cable

1-36
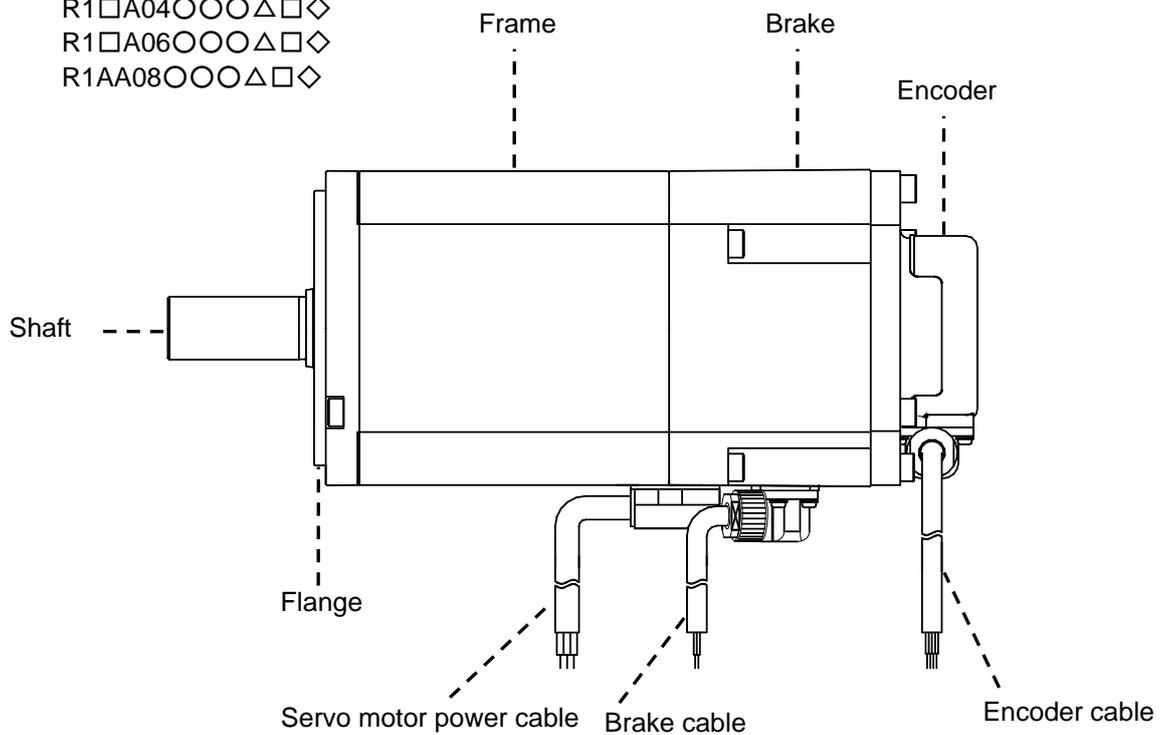
1. Preface

■ R2,R5 servo motor, 40 to 100 mm sq./30 W to 1.0 kW
    R2□A04○○○△□◇
    R2□A06○○○△□◇
    R2□A08○○○△□◇
    R2□AB8○○○△□◇
    R2AA10○○○△□◇
    R5AA06○○○△□◇
    R5AA08○○○△□◇

Frame   Brake   Encoder

Shaft

Flange

Servo motor power cable   Brake cable   Encoder cable
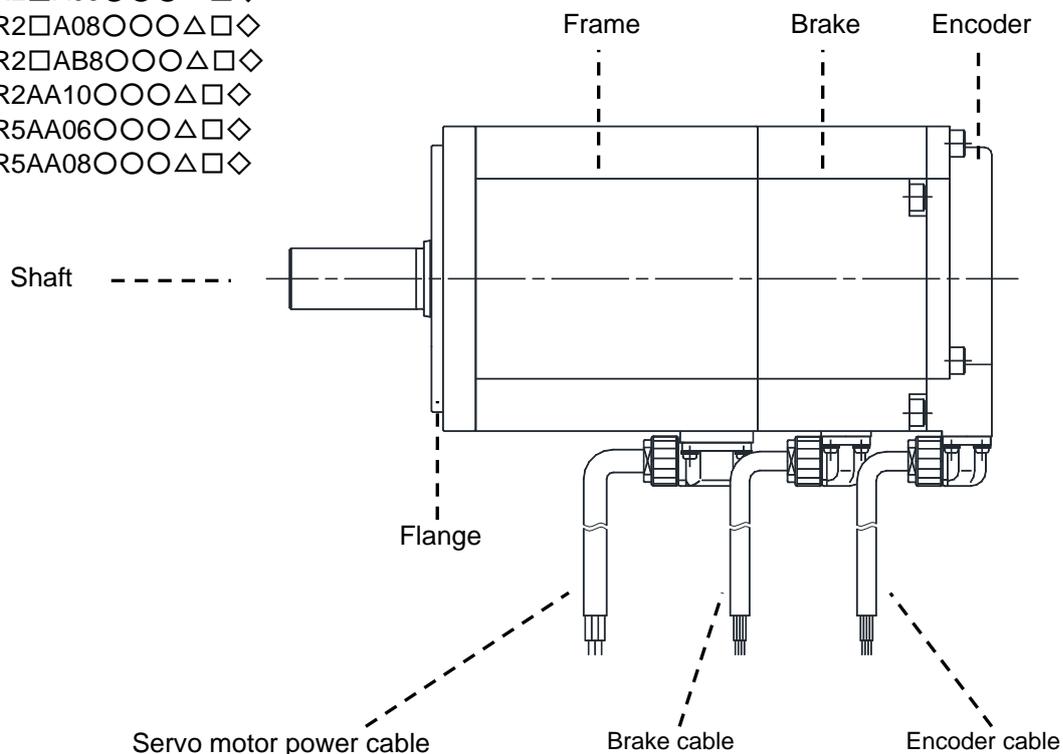
■ R1 servo motor, 100 mm sq./1.0 to 2.5 kW, 130 mm sq./3 to 5 kW
  R2 servo motor, 130 mm sq./0.5 to 2 kW, 180 mm sq./3.5 to 4.5 kW
    R1AA10100△□◇
    R1AA10150△□◇
    R1AA10200△□◇
    R1AA10250△□◇
    R1AA13300△□◇
    R1AA13400△□◇
    R1AA13500△□◇
    R2AA13○○○△□◇
    R2AA18350△□◇
    R2AA18450△□◇

Frame   Brake

Encoder

Shaft

Encoder connector

Flange

Servo motor power, brake and ground connector

1-37
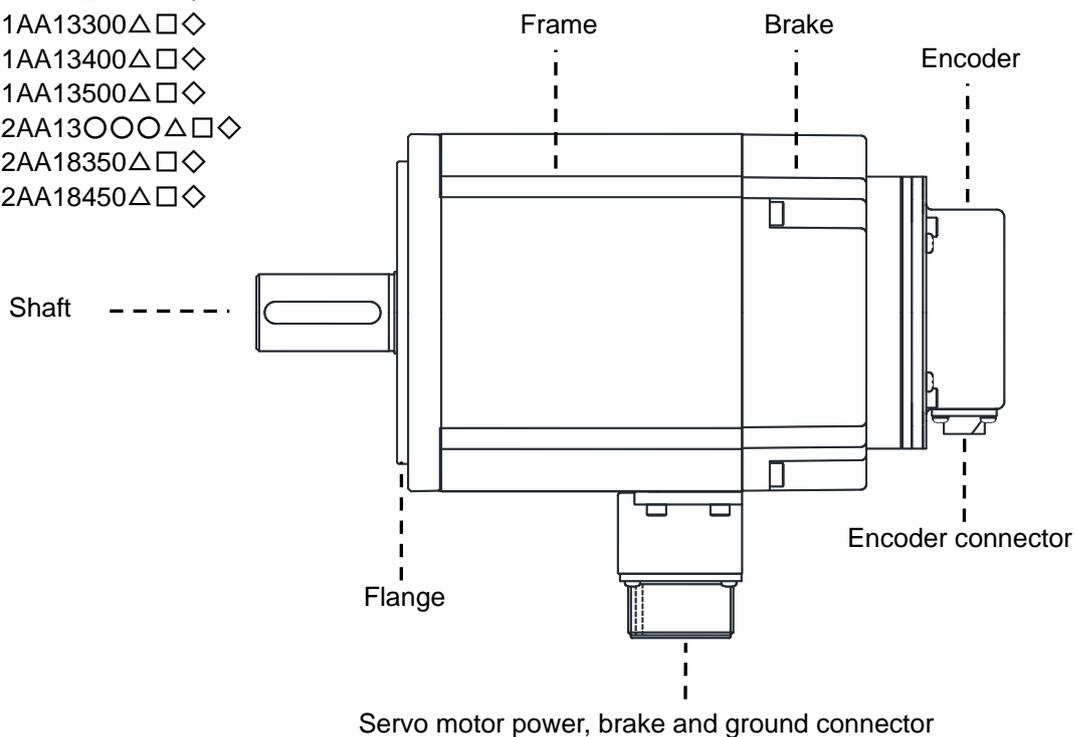
■ R2 servo motor, 180 mm sq./5.5 to 7.5 kW
    R2AA18550△□◇
    R2AA18750△□◇
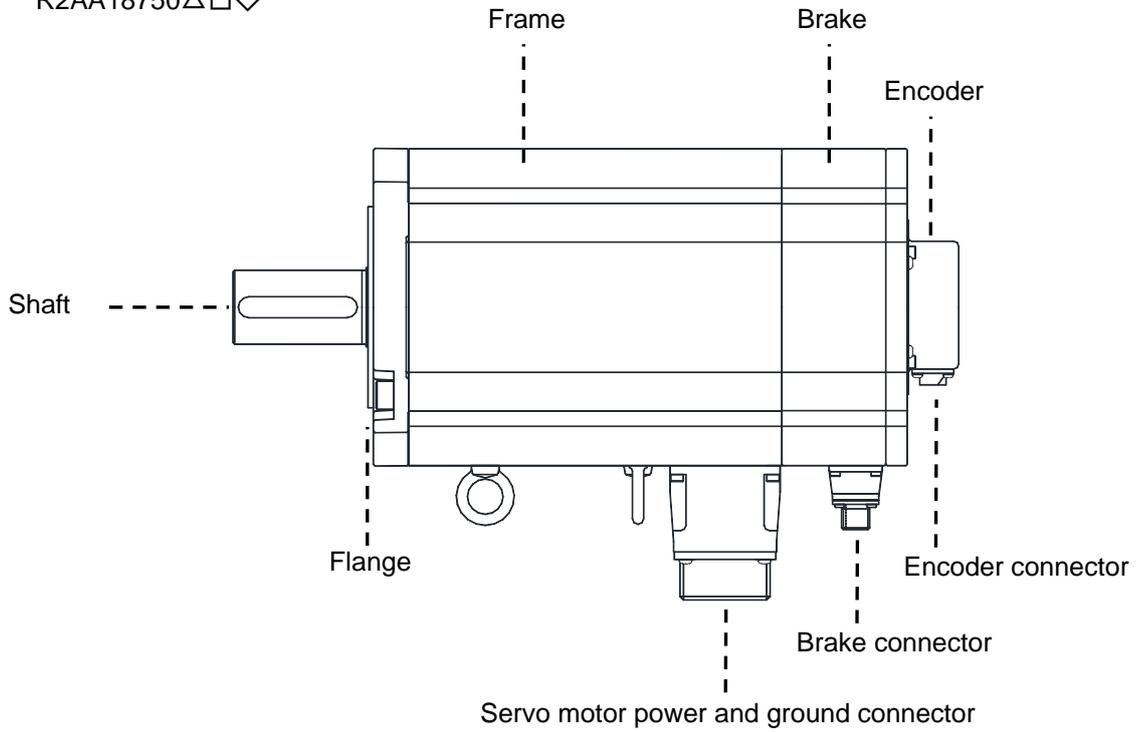
■ R2 servo motor, 180 mm sq./11 kW
    R2AA1811K△□◇
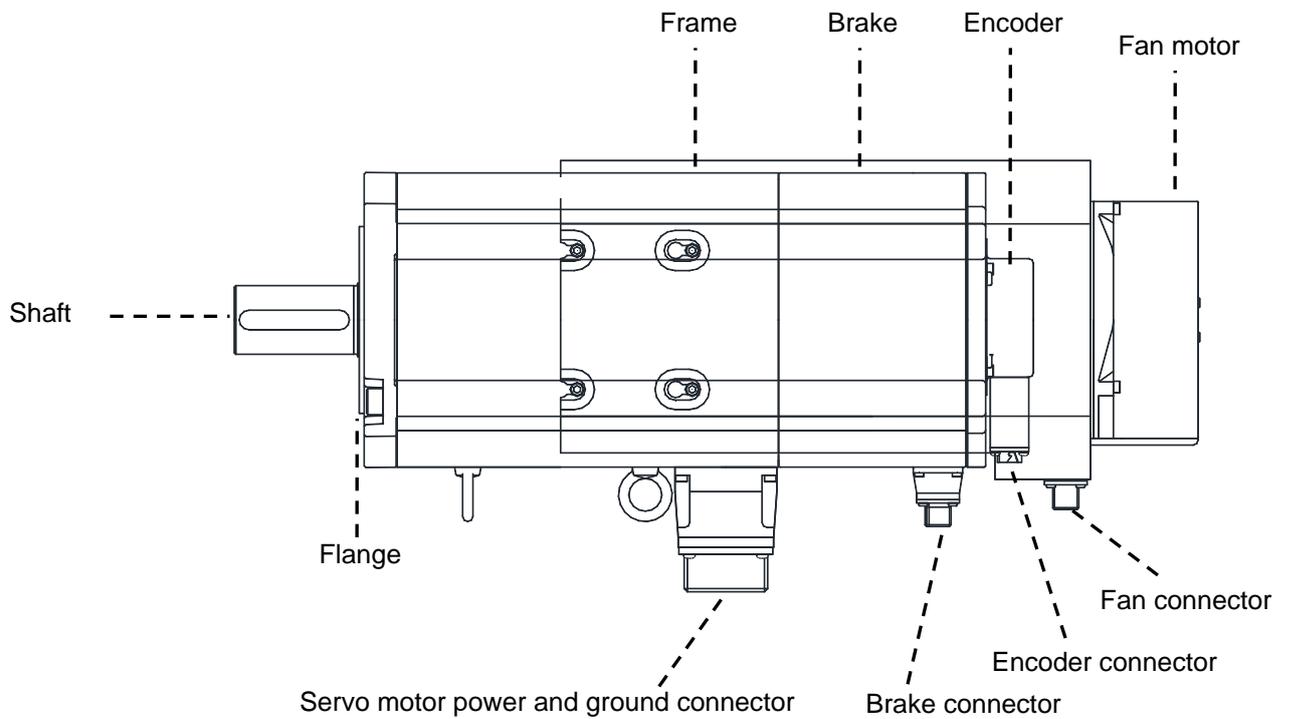
1. Preface

■ R2 servo motor, 220 mm sq./5 kW
　R2AA22500△□◇

Frame　　Brake

Encoder

Shaft

Encoder connector

Flange

Servo motor power, ground and brake connector
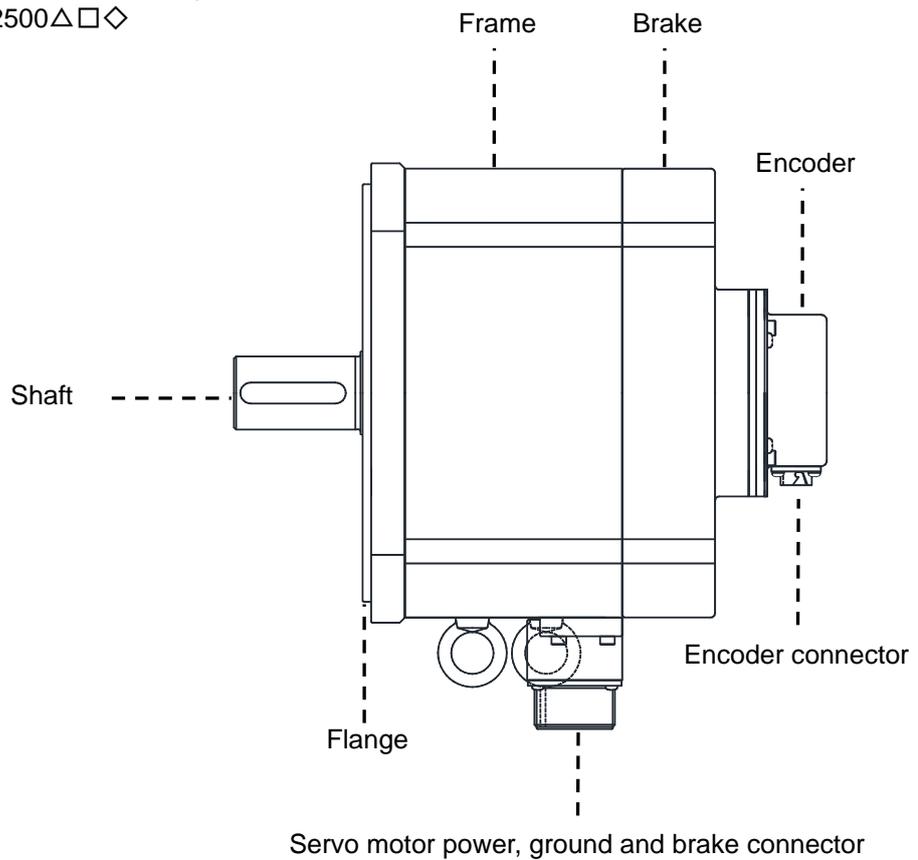
■ R2 servo motor, 220 mm sq./7 to 15 kW
　　R2AA22700△□◇
　　R2AA2211K△□◇
　　R2AA2215K△□◇

Frame　　Brake

Encoder

Shaft

Flange

Encoder connector

Brake connector

Servo motor power and ground connector

1-39
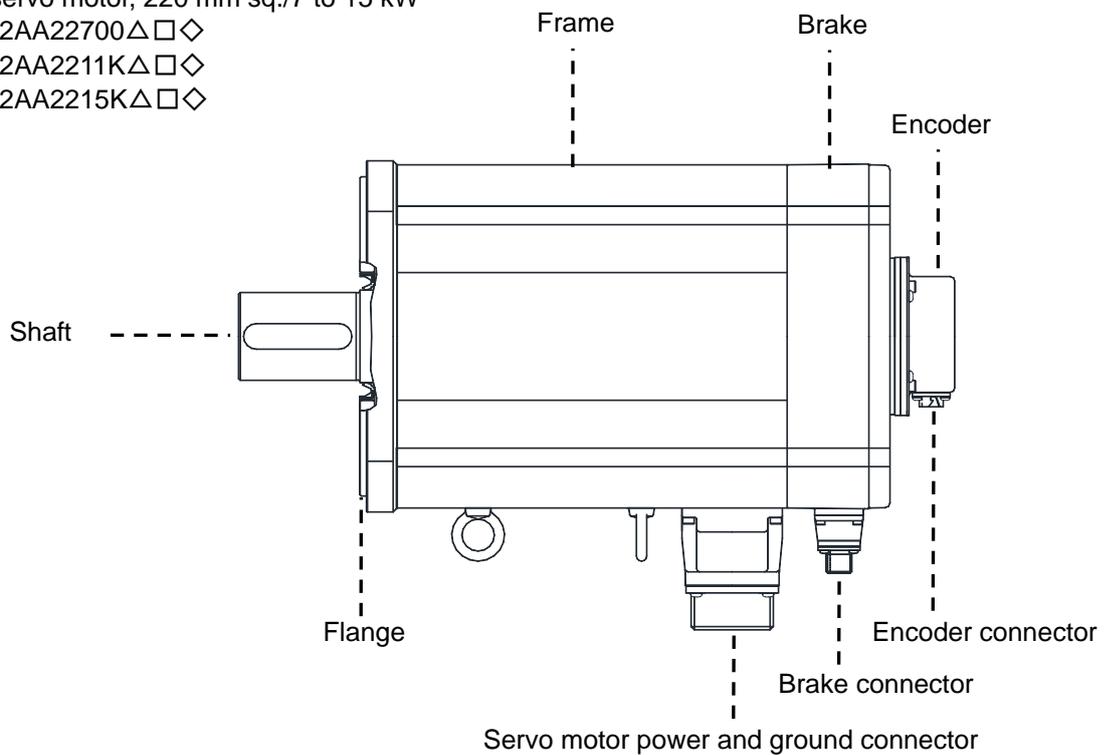
■ R1 servo motor, 100 mm sq./1.5 to 2.0 kW, 130 mm sq./3.0kW
R2 servo motor, 100 mm sq./0.75 to 1.0 kW, 130 mm sq./0.5 to 2.0kW, 180mm sq./5.5kW

R1CA10150△□◇
R1CA10200△□◇
R1CA13300△□◇
R2CA10075△□◇
R2CA10100△□◇
R2CA13050△□◇
R2CA13120△□◇
R2CA13180△□◇
R2CA13200△□◇
R2CA13350△□◇
R2CA18450△□◇
R2CA18550△□◇
R2CA13050△□◇

Frame   Brake   Encoder

Shaft

Flange

Encoder connector

Servo motor power, brake and ground connector
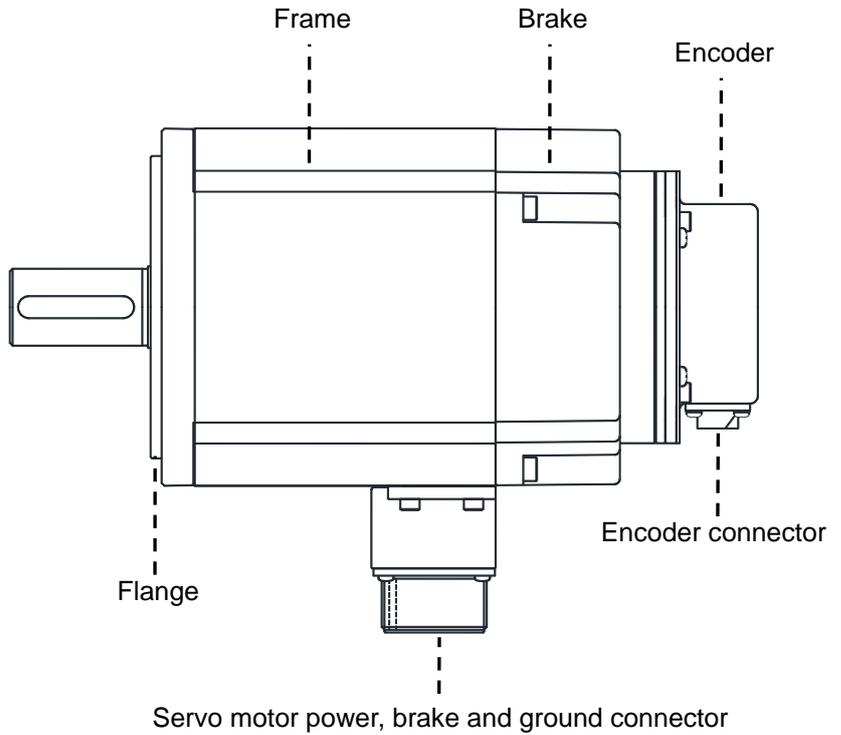
■ R1 servo motor 180mm sq./5.5 to 15kW

R1CA18550△□◇
R1CA18750△□◇
R1CA1811K△□◇
R1CA1815K△□◇

Frame   Brake   Fan motor

Encoder

Shaft

Flange

Servo motor power and ground connector

Brake connector

Encoder connector

Fan connector

1-40
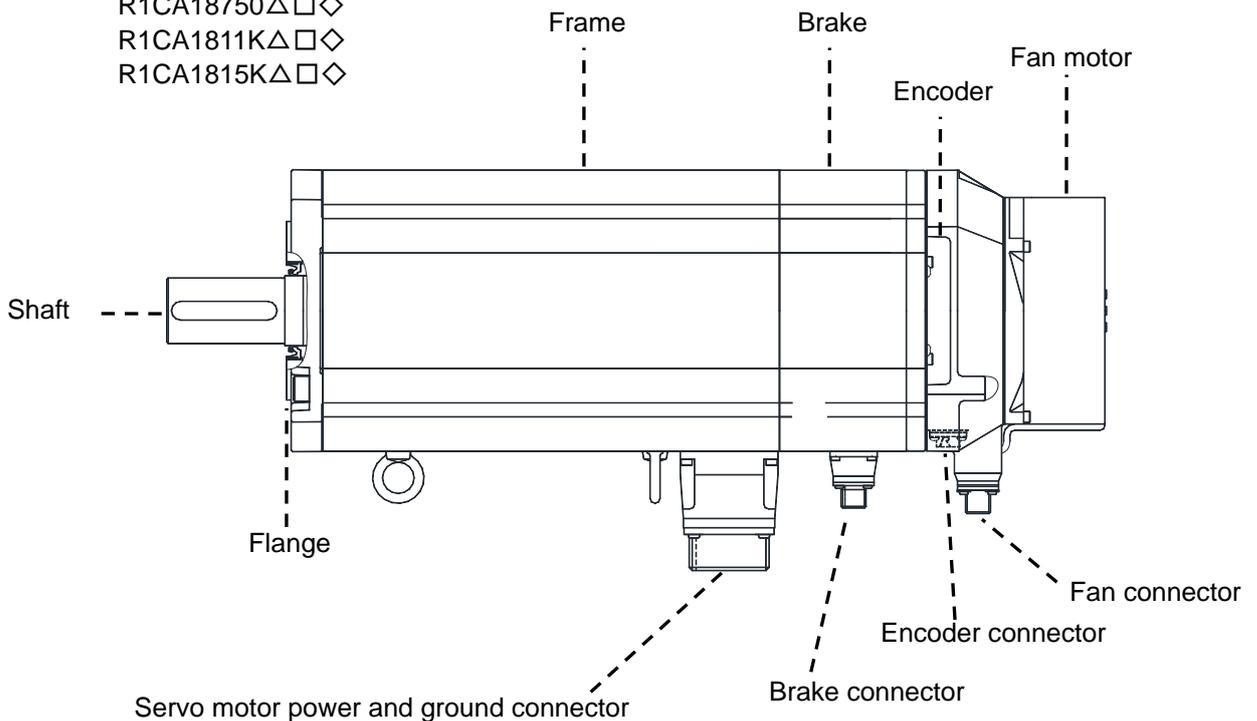
1. Preface

■ R2 servo motor 180mm sq./7.5kW, 220mm sq./11 to 15kW
R2CA18750△□◇
R2CA2211K△□◇
R2CA2215K△□◇

Frame

Brake

Encoder

Shaft

Flange

Encoder connector

Brake connector

Servo motor power and ground connector
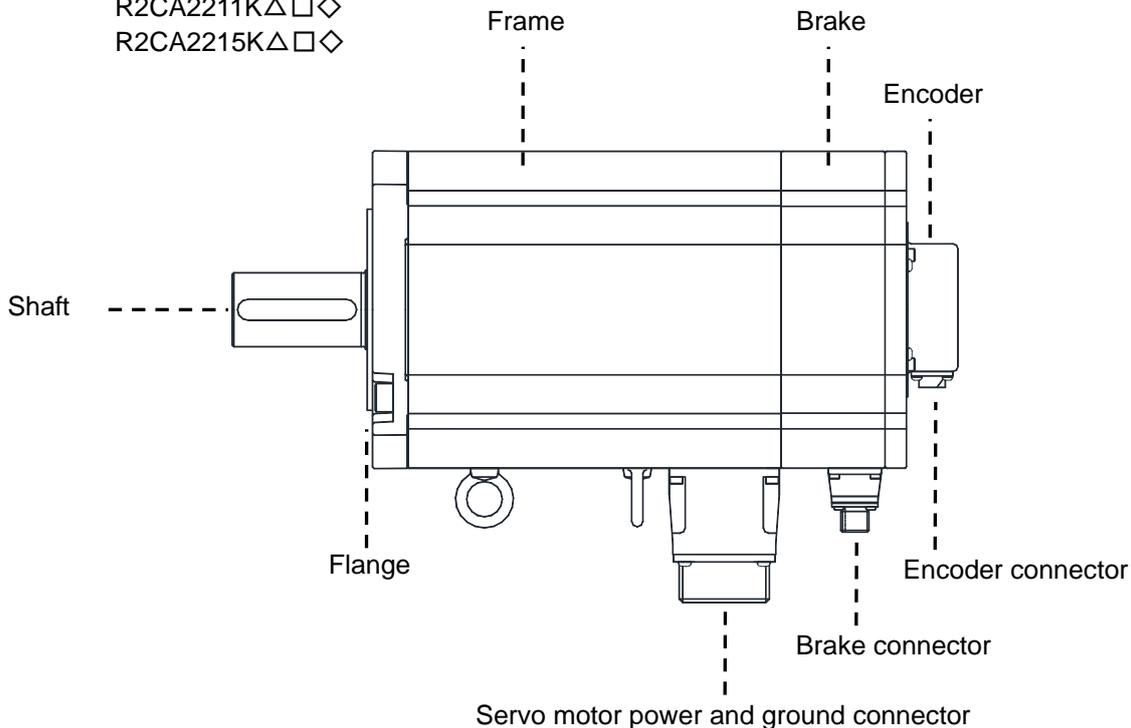
■ R1 servo motor 220mm sq./21kW
R2 servo motor 220mm sq./20kW, 275mm sq./30kW
R1CA2220K△□◇
R2CA2220K△□◇
R2CA2830K△□◇

Terminal block
(Servo motor power terminal, encoder connector)

Frame

Shaft

Air intake

Flange

Exhaust

Cooling fan

1-41
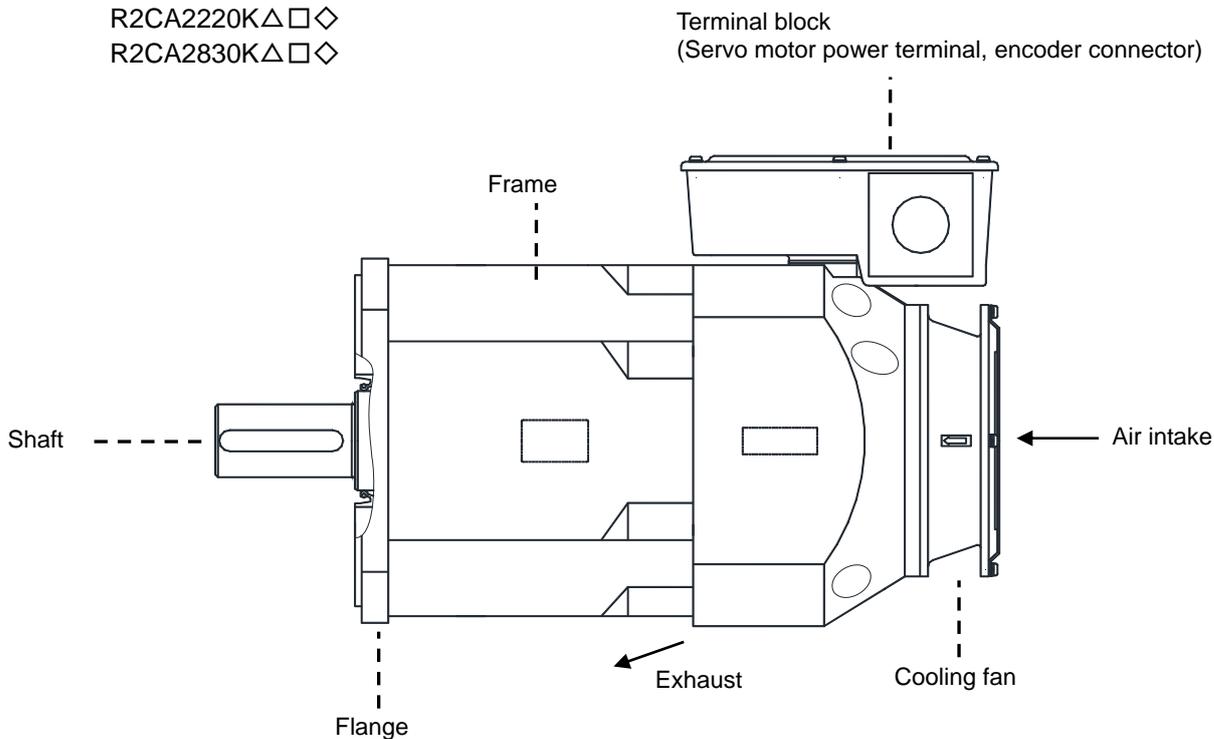
■ R2 sevo motor, 320 mm sq./55 kW
  R2CA3255K△□◇

Connector for thermostat

Motor power wire

Encoder connector

Cooling fan power line

Terminal box

Shaft

Flange

Flame

Encoder
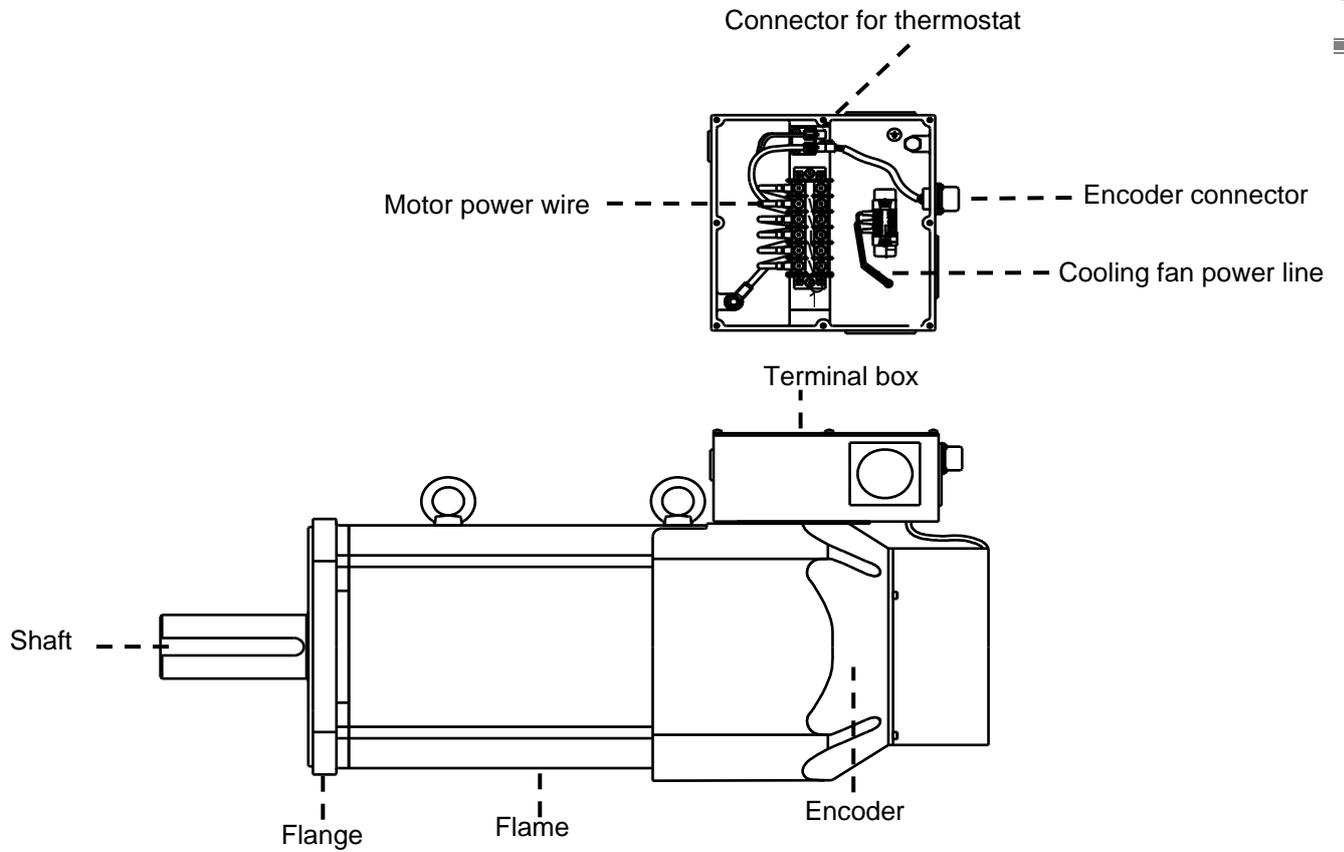
1. Preface

1.5.5 Linear motor

■ Flat type with core
DS030□△○○
DS045□△△○◇
DS050□△○○
DS075□△○○
DS100□△○○
DS150□△○○
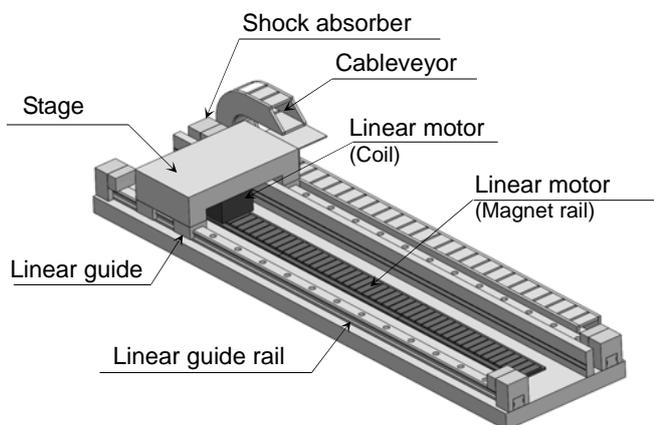
■ Twin type with core
DD030□△○○
DD035□△△○◇
DD045□△△○◇
DD050□△○○
DD075□△○○
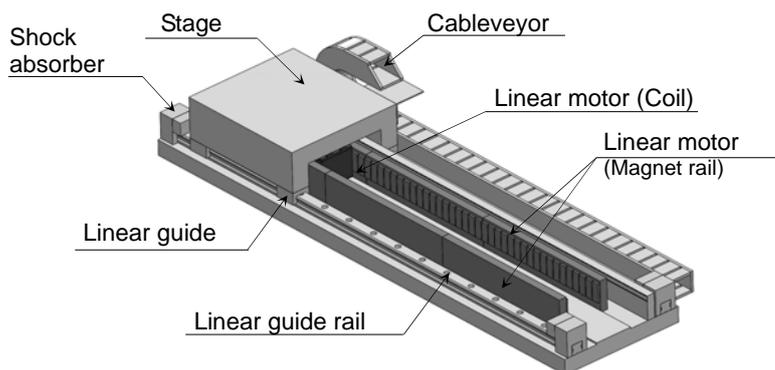
■ Center magnet type with core
DT030□△○○

2
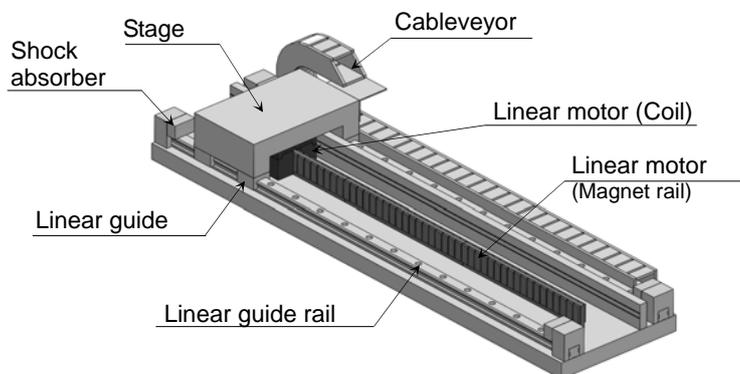
Specifications

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

2. Specifications

2.1 Servo motor

2.1.1 General specifications

Series name	R1, R2, R5	R2CA3255KB
Time rating	Continuous	
Insulation classification	Type F	
Voltage/Dielectric strength	1500V AC (2000V AC), 1 minute. Note) Value in parentheses is for 400V AC R2 motor.	
Insulation resistance	500V DC, greater than 10MΩ	
Protection method	Totally Enclosed, Non-Ventilated	Totally Enclosed Air Over
	Motor flange size 100 or less: IP65, 67 Motor flange size 130 or over: IP65 However, except for axial penetration part and cable tip part	IP55 However except terminal box working part by customer, and fan motor.

Oil Sealing	Motor flange size 100 or less: No oil seal
	    (but optionally available.
	    Exceptionally, motor flange size 100 of R1 motor: With oil seal.)
	Motor flange size 130 or over: With oil seal	

Ambient temperature	0 to +40°C	
Storage temperature	-20 to +65°C	
Ambient humidity	20 to 90% (without condensation)	
Vibration classification	V15	
Excitation method	Permanent magnet type	
Installation method	Flange mount	

2.1.2 Exterior dimensions/ specifications/ mass

Described on another document: M0011792.

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 $24.5 m/s^2$.
Exceptionally for 100 and 130mm flange size R1 motor, 49m/s2 in rotating and $24.5 m/s^2$ at stop.

Up/down

From side to side

← Forward/backward →

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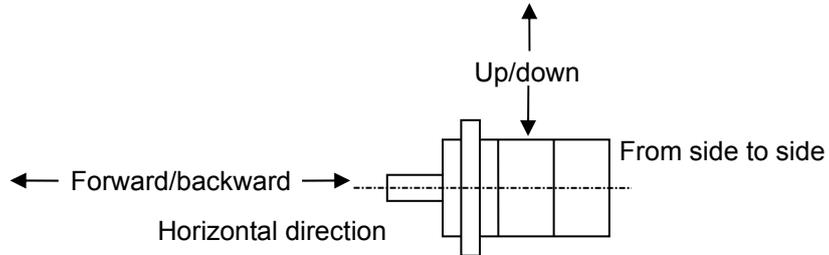
■ Vibration classification
The vibration classification of the servo motor is V15 or less at maximum rotation speed for a single servo motor unit and is measured as indicated in the figure below.

Vibration measurement position
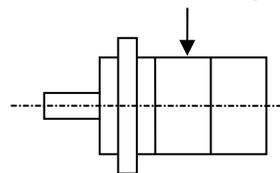
■ Shock resistance
Install the shaft of servo motor in a horizontal direction (shown in the figure below). This shaft should withstand shock acceleration up to 98m/s2 (when shock is applied in an upward/downward direction) for two (2) times. However, since a precision motor encoder is fixed to the counter-load 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.

Up/down

← Horizontal direction →
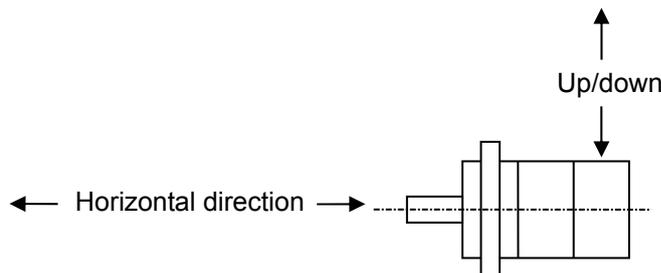
2. Specifications

■ 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	0.02 0.03 (220) 0.04 (280, 320)	
Eccentricity of external diameter of flange on output shaft M: β	0.06 (80 or less)	
	0.08 (100 or over) 0.10 (280, 320)	
Perpendicularity of flange face to output shaft M: γ	0.07 (80 or less)	
	0.08 (100 or over) 0.10 (220 or over)	

* Figures in parentheses indicate square flange dimensions in millimeters.

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.
Please contact us for oil seal replacement.

Servo motor model number	Oil seal type
R1□A04○○○□	Standard: N/A, Optional: G-Type
R1□A06○○○□	Standard: N/A, Optional: S-Type
R1□A08○○○□	Standard: N/A, Optional: S-Type
R1AA10○○○□	Standard: Double Lip seal type
R1AA13○○○□	Standard: S-Type
R1AA18○○○□	Standard: S-Type
R2□A04○○○□	Standard: N/A, Optional: S-Type
R2□A06○○○□/R2□A□8○○○□	Standard: N/A, Optional: S-Type
R2□A10○○○□	Standard: N/A, Optional: S-Type
R2AA13○○○□/R2AA22500L	Standard: Double Lip seal type
R2AA18○○○□/R2AA22○○○□	Standard: S-Type
R5AA06○○○□	Standard: N/A, Optional: S-Type
R5AA08○○○□	Standard: N/A, Optional: S-Type

Servo motor model number	Oil seal type
R1AA2220KV	Standard: With oil seal, S-Type
R2AA2220KB	Standard: With oil seal, S-Type
R2AA2225KB	Standard: With oil seal, S-Type
R2AA2830KV	Standard: With oil seal, S-Type
R1CA10○○○□	Standard: Double Lip seal type
R1CA13○○○□	Standard: S-Type
R1CA18○○○□	Standard: S-Type
R1CA22○○○□	Standard: With oil seal, S-Type
R2CA10○○○□	Standard: N/A, Optional: S-Type
R2CA13○○○□	Standard: Double Lip seal type
R2CA18○○○□	Standard: S-Type
R2CA22○○○□	Standard: S-Type
R2CA28○○○□	Standard: With oil seal, S-Type
R2CA3255KB	Standard: With oil seal, S-Type

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

Specifications 2

2. Specifications

2.1.6 Holding brake

An optional Holding Brake is available for the servo motor. Since the primary use of this brake is for holding, it should never be used for braking, except in emergency situations.

■ Surge-absorbing element

Must connect surge-absorbing element such as varistor or diode, to between holding brake terminals, for suppressing surge noise which occurs at holding brake excitation turn off. Please note, the braking delay time will differ depending on used servo motor and surge-absorbing element, as see table below.

■ Holding brake control

Please control by using holding brake excitation signal from servo amplifier. In use of this signal, set suitable value to "Index 0x2025 Delay Time of Releasing Holding Brake [BOFFDLY]" and "Index 0x2024 Delay Time of Engaging Holding Brake [BONDLY]" by seeing the time in the table below as reference.

In use of the signal from other device for holding brake excitation control, also refer the time in the table below.

Release delay time is same for varistor and diode.

Servo motor model number		Static friction torque N·m	Release delay time msec	Braking delay time msec	
				Varistor	Diode
R1	R1AA04005□	0.32	25	15	100
	R1AA04010□				
	R1AA06020□	1.37	30	20	120
	R1AA06040□				
	R1AA08075□	2.55	40	20	200
	R1AA10100□	9.3	100	30	140
	R1AA10150□				
	R1AA10200□				
	R1AA10250□				
	R1AA13300□	12	100	30	140
	R1AA13400□	16	150	50	300
	R1AA13500□				
	R1AA18550H	54.9	300	140	400
	R1AA18750L				
	R1AA1811KR	75			
	R1AA1815KB	120		60	600
	R1AA2220KV	170	250	-	350
	R1EA04005□	0.32	25	15	100
	R1EA04010□				
	R1EA06020□	1.37	30	20	120

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

Servo motor model number		Static friction torque N·m	Release delay time msec	Braking delay time msec	
				Varistor	Diode
R2	R2AA04003F	0.32	25	15	100
	R2AA04005F				
	R2AA04010F				
	R2AA06010F	0.36	30		120
	R2AA06020F	1.37			
	R2AA06040□	1.37			
	R2AA08020F	2.55	40	20	200
	R2AA08040F				
	R2AA08075F				
	R2AAB8075F	3.92			
	R2AAB8100□				
	R2AA10075F				
	R2AA10100F				
	R2AA13050□	3.50			120
	R2AA13120□	9.0	100	30	130
	R2AA13180□				
	R2AA13200□	12.0			140
	R2AA18350□	22.0	120	50	150
	R2AA18450H	32.0	150	60	250
	R2AA18550□	42.0	150	60	250
	R2AA18750H	54.9	300	140	400
	R2AA1811KR	100	300	140	400
	R2AA22500L	42	150	60	250
	R2AA22700S	90	300	140	400
	R2AA2211KB				
	R2AA2215KB				
	R2AA2220KB	170	250	-	350
	R2AA2225KB	-	-	-	-
	R2AA2830KV	-	-	-	-
	R2EA04003F	0.32	25	15	100
	R2EA04005F				
	R2EA04008F				
	R2EA06010F	0.36	30	20	120
	R2EA06020F				
R5	R5AA06020□	1.37			
	R5AA06040□				
	R5AA08075□	2.55	40		200

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

2. Specifications

Delay times below are not including the delay time by acting relay etc.
The value in parentheses shows the time including delay of internal action when using CNE brake output of servo amplifier.
Release delay time is same even if using either of varistor or diode.

| Servo motor model number		Static friction torque N·m	Release delay time msec	Braking delay time msec	
				Varistor	Diode
R1	R1CA10150V	9.3	100 (125)	30 (55)	140 (165)
	R1CA10200V				
	R1CA13300V	12			
	R1CA18550H	54.9	300 (325)	140 (165)	400 (425)
	R1CA18750L				
	R1CA1811KR	75			
	R1CA1815KB	120		60 (85)	600 (625)
	R1CA2220KV	There is no model with brake.			
R2	R2CA10075F	3.92	40 (65)	20 (45)	200 (225)
	R2CA10100F				
	R2CA13050□	3.50			120 (145)
	R2CA13120□	9.0	100 (125)	30 (55)	130 (155)
	R2CA13180□				
	R2CA13200□	12.0			140 (165)
	R2CA18350□	22.0	120 (145)	50 (75)	150 (175)
	R2CA18450H	32.0	150 (175)	60 (85)	250 (275)
	R2CA18550□	42.0	150 (175)	60 (85)	250 (275)
	R2CA18750□	54.9	300 (325)	140 (165)	400 (425)
	R2CA2211K□	90	300 (325)	140 (165)	400 (425)
	R2CA2215K□				
	R2CA2220K□	170	250 (275)	-	350 (375)
	R2CA2830K□	191.2	600 (625)	-	600 (625)

*   Please contact us for specifications of the other model number above.
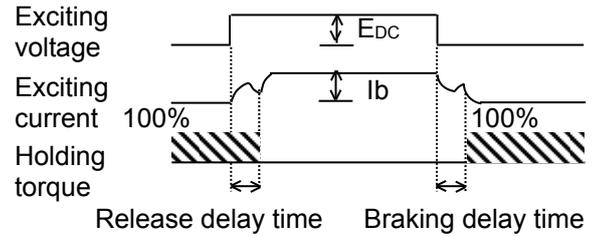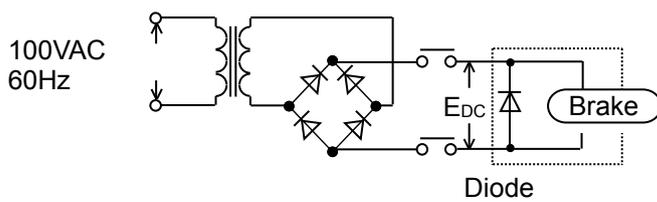*   For servo motor R2CA3255KB, there is no specification with brake.

■ Measurement of release delay time and braking delay time
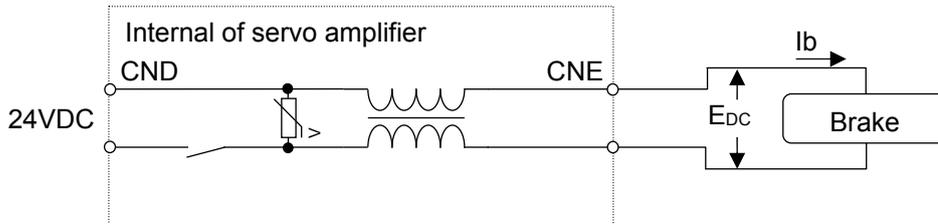The value of release delay time and braking delay time are measured by the circuit below.

◆ Varistor used circuit
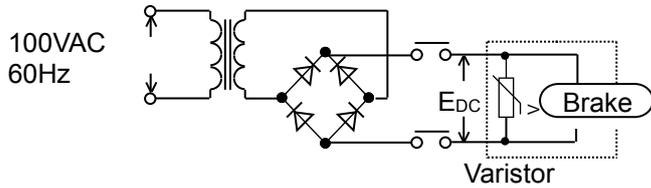
◆ Diode used circuit

◆ When using CNE holding brake output which is built in servo amplifier (400VAC)

* For use of holding brake power supply built in servo amplifier, brake power voltage may drop by influence of cable impedance. Make sure the voltage at power plug of motor is 21.6 VDC or more. If it is less than 21.6 VDC, adjust control power voltage up to 26.4 VDC and check the voltage again.

2.1.7 Degree of decrease rating for R1□A / R2□A motor, with oil seal and brake

In terms of servomotors with oil-seal and/or brake, the following de-rating ratio has to be applied to the torque characteristic in the continuous speed range.

Oil seal / Brake	Without oil seal	With oil seal
With no brake	-	Degree of decrease rating 2
With brake	Degree of decrease rating 1	Degree of decrease rating 2

	R1AA06040F	R1AA08075□	R1EA04005F	R1EA04010F	R1EA06020F
Degree of decrease rating 1	90%	-	-	80%	-
Degree of decrease rating 2	80%	90%	90%	80%	90%

	R2AA04005F	R2AA04010F	R2AA06040□	R2AA08075F	R2EA04005F
Degree of decrease rating 1	-	90%	90%	-	-
Degree of decrease rating 2	90%	85%	80%	90%	90%

2. Specifications

2.2 Linear motor

2.2.1 General specifications

Series name	DS, DD, DT
Time rating	Continuous
Insulation classification	Type F
Voltage/Dielectric strength	1500V AC, 1 minute.
Insulation resistance	500V DC, greater than 10MΩ
Protection method	Self-cooling type or Water cooling type (IP00)
Ambient temperature	0 to +40°C
Storage temperature	-20 to +65°C
Ambient humidity	20 to 90% (without condensation)
Excitation method	Permanent magnet type
Elevation	Less than 1000m

2.2.2 Exterior dimensions/ specifications/ mass

Described on another document: M0011791.

2.2.3 Mechanical specifications

■   Vibration resistance
Install the linear 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/s^2.
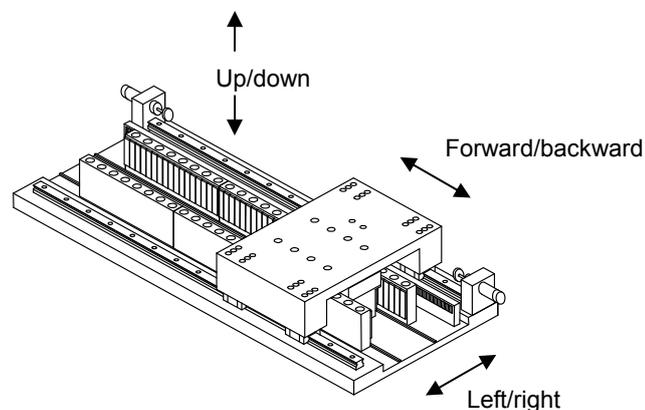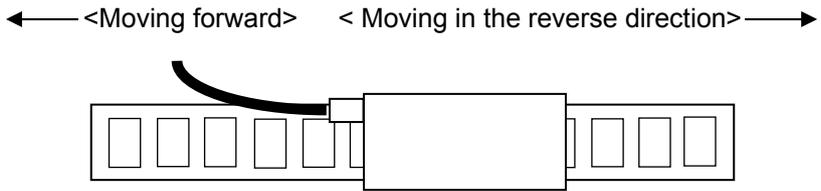
■ Shock resistance
Install the linear motor in a horizontal direction (shown in the figure below) and add shock to vertical direction. The motor should withstand shock acceleration up to 98m/s^2 (when shock is applied in an upward/downward direction) for two (2) times.
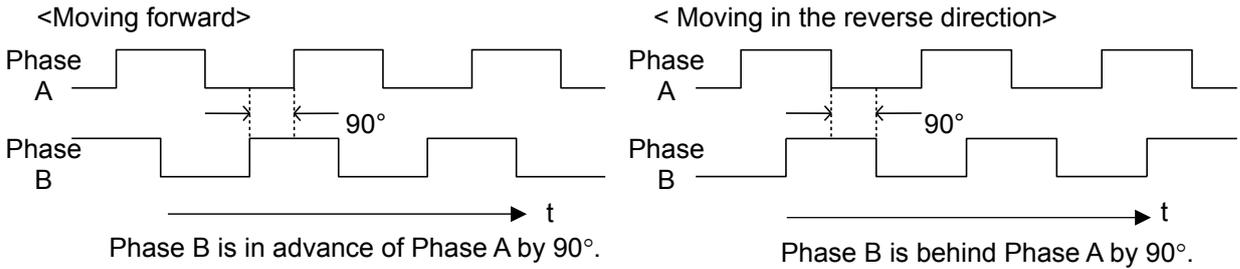
Up/down

Horizontal direction
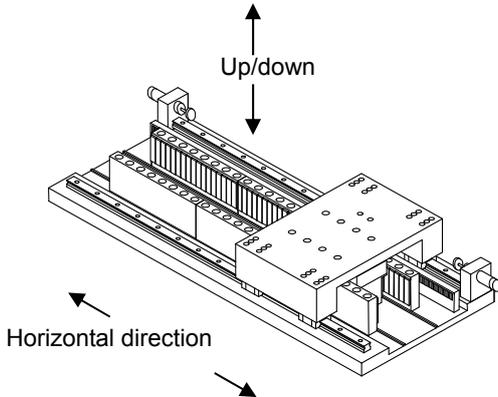
2.2.4 Moving direction of linear motor (DD/DS/DT series)

■ Forward moving direction of linear motor is defined as the direction to where power line lead pulled out when position command inputs a command to increase.
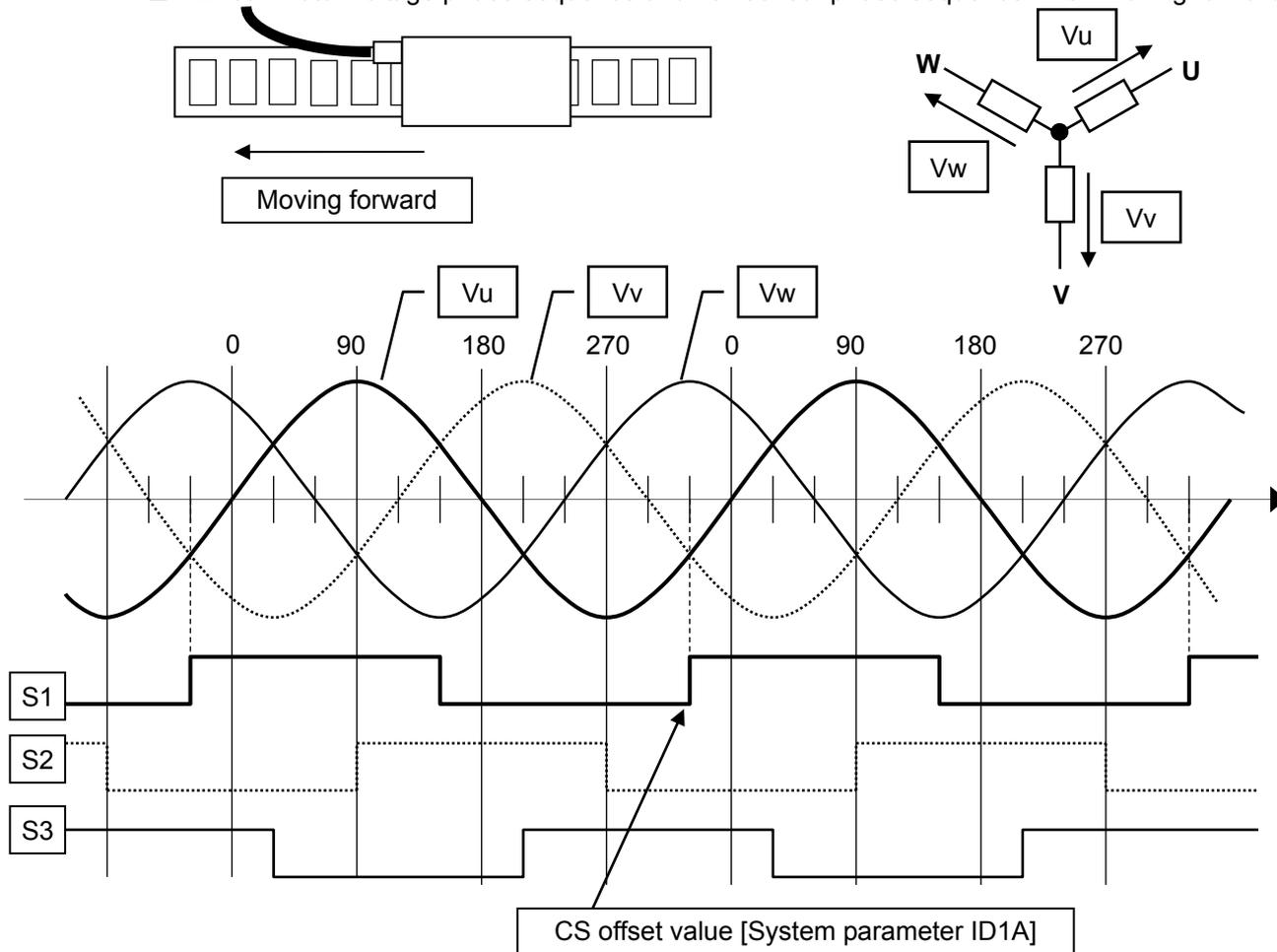
◄——— <Moving forward>   < Moving in the reverse direction>———►

■ Linear encoder signal phase

<Moving forward>

Phase A

Phase B

90°

t

Phase B is in advance of Phase A by 90°.

< Moving in the reverse direction>

Phase A

Phase B

90°

t

Phase B is behind Phase A by 90°.

2-10

2. Specifications

■ Linear motor voltage phase sequence and hall sensor phase sequence when moving forward

CS offset value [System parameter ID1A]

* CS offset value of each linear motor is shown in table below.
In case of using our recommendation Hall effect sensor, CS-offset value shall be set depending on table below, before operation.

Combination amplifier	Linear motor model number	CS offset value	Combination amplifier	Linear motor model number	CS offset value
RS3A03	DS030C1N2	330	RS3A10	DS030C3N2	330
	DS050C1N2	330		DS050C3N2	330
	DS075C1N2	330		DS075C3N2	330
	DS045CC1AN	155		DS100C2N2	330
	DT030C01AN	240		DS150C2N2	330
RS3A05	DS030C2N2	330		DD030C2Y4	330
	DS050C2N2	330		DD030C3Y4	330
	DS075C2N2	330		DD050C1Y2	330
	DS100C1N2	330		DD075C1Y2	330
	DS150C1N2	330		DD045CB4AN	290
	DD030C1Y4	330	RS3A15	DS100C3N2	330
RS3A07	DS030C3N2	330		DS150C3N2	330
	DS050C3N2	330		DD050C2Y2	330
	DS075C3N2	330		DD075C2Y2	330
	DD030C2Y4	330	RS3A30	DD050C3Y2	330
	DD050C1Y2	330		DD075C3Y2	330
	DD075C1Y2	330		DD075C4Y2	330
	DD045CB4AN	290			
	DD035CC2AN	230			

2-11

## 2.3 Motor encoder

2-12

### 2.3.1 Absolute encoder

■ Absolute encoder specifications

Name (code)	Motor model number encoder code	Resolution per rotation (Single turn)	Multi turn part amount (Multi turn)	Transfer method
Battery less absolute encoder (HA035)	R	131,072 (17bit) 1,048,576 (20bit) 8,388,608 (23bit)	65536 (16bit)	Half duplex asynchronous 2.5Mbps / 4Mbps
Single-turn absolute encoder (PA035S)	H	131,072 (17bit) 1,048,576 (20bit)	-	Half duplex asynchronous 2.5Mbps / 4Mbps
Battery backup absolute encoder (PA035C)	P	131,072 (17bit) 1,048,576 (20bit)	65536 (16bit)	Half duplex asynchronous 2.5Mbps / 4Mbps
Resolver type battery-less absolute encoder (RA035C)	W	131,072(17bit)	65536(16bit)	Half duplex asynchronous 2.5Mbps / 4Mbps

■ Relation between servo motor rotation direction and absolute position data (PS data)
See below the relation between servo motor rotation direction and absolute position data (PS data).

Servo motor rotation direction (Normal rotation) Position signal output (PS data): Increase
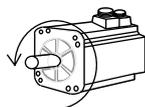
Servo motor rotation direction (Reverse rotation) Position signal output (PS data): Decrease
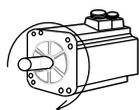
* PS data can be confirmed by ABSPS in "7.8 Monitor display mode".

2. Specifications

2.3.2 Incremental encoder specifications

■ Wire-saving incremental encoder

Model	Motor model number encoder code	Resolution	Applicable motor flange size
PP031H PP031T	S	1000/2000/2048/4096/5000/6000/8192/10000 P/R	40 mm sq. or more
PP062	S	1000/2000/2048/4096/5000/6000/8192/10000 P/R	80 mm sq. or more
PP062H	S	5,000P/R Note 1)	320 mm sq. or more

Model number example: R2-series, 60mm sq., 200W-model
R2AA06020FCS00

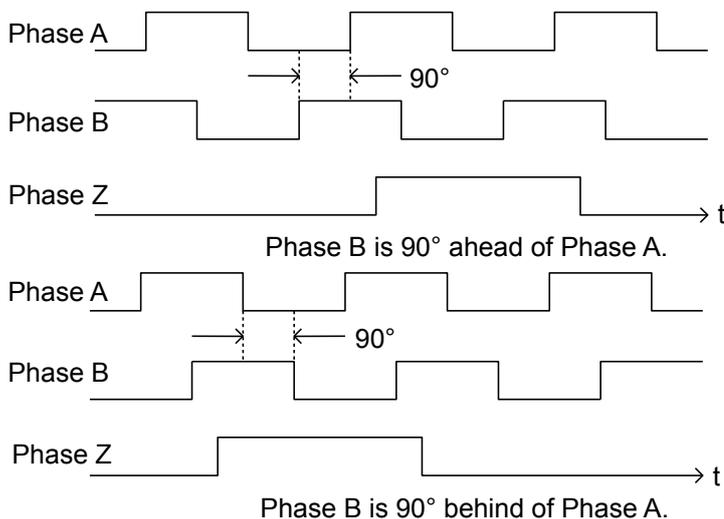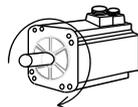Note 1) Please contact us for the motor model number with the other incremental encoder except above.

■ 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 A

90°

Phase B

Phase Z
t

Phase B is 90° ahead of Phase A.

Servo motor rotation direction- Reverse

Phase A

90°

Phase B

Phase Z
t

Phase B is 90° behind of Phase A.
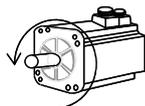
* When Z-Phase is at high level, both Phases A and B cross the low level once every rotation.

2.3.3 Battery specification

Model: ER3VLY (produced by Toshiba Lifestyle Products & Services Corporation)
Voltage: 3.6V

2.4 Linear encoder

2.4.1 Applicable linear encoder

The products below are applicable as combination linear encoder.

■ Incremental encoder

Manufacturer	Series name	Output signal	Power supply voltage	Minimum resolution
Renishaw Inc	RGH22	RS422-compliant, 90 degree phase shift pulse train	5V±5%	0.1 to 5μm
Heidenhain Corporation	LIDA400			0.05 to 1μm
	LIDA200			0.5 to 5μm

* Output signal is applicable to only RS422-compliant 90 degree phase shift pulse train (LIDA47 and LIDA27). Analog sinusoidal output (LIDA47 and LIDA27) or serial signal output is not available.
* Please contact each linear encoder manufacturer for the details of performance, specification, warranty, and installation.

■ Absolute encoder
EnDAT2.2 interface is only applicable.

Manufacturer	Series name	Power supply voltage	Resolution	Maximum speed	Effective measurement distance (Maximum)
Heidenhain Corporation	LIC4100	5V±5%	0.01μm 0.005μm 0.001μm	6m/s	28,440mm
	LIC2100		0.1μm 0.05μm	6m/s	6,020mm
	LC400		0.01μm 0.001μm	3m/s	2,040mm

* Above table spec is depending on our servo amplifier combination.
 Something may differ from manufacturer spec.
* Effective measurement distance is manufacturer spec.
* Please contact each linear encoder manufacturer for the details of performance, specification, warranty, and installation.
* It is not applicable except EnDat2.2 interface (Ordering designation: EnDat22).
* Please contact us if combined with the other of above recommendation encoder.

2. Specifications

2.5 Servo amplifier

2.5.1 General specifications

■ General specifications (100/200 VAC)

Control function	Speed control/Torque control/Position control (Parameter changeover)							
Control system	IGBT: PWM control Sinusoidal drive							
Main Circuit Power Note 1)	Three-phase: 200 to 240 VAC +10,-15%, 50/60Hz±3Hz Single-phrase: 200 to 240 VAC +10,-15%, 50/60Hz±3Hz Note 2) Single-phrase: 100 to 120 VAC +10,-15%, 50/60Hz±3Hz Note 3)							
Control power Note 1)	Single-phrase: 200 to 240 VAC +10,-15%, 50/60Hz±3Hz Single-phrase: 100 to 120 VAC +10,-15%, 50/60Hz±3Hz Note 3)							
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	Built-in tray type power supply							
Servo amplifier model number	RS3#01A#HA# RS3#01A#HL#	RS3#02A#HA# RS3#02A#HL#	RS3#03A#HA# RS3#03A#HL#	RS3A05A#HA# RS3A05A#HL#	RS3A07A#HA# RS3A07A#HL#	RS3A10A#HA# RS3A10A#HL#	RS3A15A#HA# RS3A15A#HL#	RS3A30A#HL#
External dimensions (H×W×D)	160×40×130	160×40×130	160×50×130	160×85×130	160×95×190	205(235)×100×220	205(235)×120×220	205(235)×220×220
Weight (kg) — Without internal regenerative resistor	0.7	0.7	0.8	1.5	2.3	4.2	4.8	9.8
Weight (kg) — With internal regenerative resistor	0.8	0.8	0.9	1.6	2.5	4.2	5.0	None

Note 1) Power source voltage should be within the specified range.
   200 VAC Power input type: Specified power supply range = 170 to 264 VAC
   100 VAC Power input type: Specified power supply range = 85 to 132 VAC
Note 2) 200 VAC -single-phase input type corresponds only to RS3□01/RS3□02/RS3□03/ RS3□05.
Note 3) 100 VAC -single-phase input type corresponds only to RS3□01/ RS3□02/RS3□03.

■ General specifications (100 VAC, 600 A power unit and amplifier unit combination)

Control function		Position control/ Velocity control/ Force control/ (Parameter changeover)
Control system		IGBT: PWM control Sinusoidal drive
Main Circuit Power Note 1)		Three-phase: 200 to 240 VAC +10,-15%, 50/60Hz±3Hz
Control power Note 1)		Single-phase: 200 to 240 VAC +10,-15%, 50/60Hz±3Hz
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 supply part is separating
Power unit model number/ Amplifier unit model number		RS3PAA270# / RS3W60#
External dimensions (H×W×D)		380x160x292 / 380x250x292
Mass (kg)		12 / 18

Note 1) Power source voltage should be within the specified range.
   Specified power supply range for 200V AC power input type: 170 to 264 V AC

2.5 Servo amplifier

■ General specifications (400V AC)

Control function	Position control/ Velocity control/ Force control/ (Parameter changeover)				
Control system	IGBT: PWM control Sinusoidal drive				
Main Circuit Power Note 1)	Three-phase: 380 to 480V AC +10,-15%, 50/60Hz±3Hz				
Control power Note 1)	24V DC ±10%				
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/s²				
	Shock	19.6m/s²				
Structure		Built-in tray type power supply			Built-in wall mount type power supply	
Servo amplifier model number		RS3C02A##A#	RS3C05A##A#	RS3C10A##A#	RS3C15A##L#	RS3C30A##M#
External dimensions: H		205mm	205mm	205mm	375mm	375mm
W		75mm	100mm	175mm	220mm	270mm
D		235mm	235mm	235mm	230mm	235mm
Mass		2.5 kg	4.7 kg	8.5 kg	11.0 kg	18.0 kg

Note 1) Power source voltage should be within the specified range.
　　　Spec of power supply range: 323 to 528V AC for main power,
　　　　　　　　　　　　　　　21.6 to 26.4V DC for control power
　Moreover, the "over-voltage category" of servo amplifier is "III" (EN61800-5-1). For a control power 24V DC and interface DC power, use a DC power supply with reinforced insulation of input/output.

■ General specifications (Power unit/Amplifier unit combination of 400 VAC-800 A)

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/s²	
	Shock	19.6m/s²	
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.

Specifications 2

2-16

2. Specifications

■ Specifications

Speed control range	1: 5000　Note 2)
Frequency characteristics	2200Hz　Note 3)
Allowable load inertia moment	10 times motor rotor inertia moment　Note 4)

Note 2) Internal speed command
Note 3) In case of high-velocity sampling mode
Note 4) When the value exceeds the above allowable load inertia moment, please contact us.

■ Built-in functions (100/200 VAC, 400 VAC)

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 deviation, Position command pulse error, Built-in memory error, Parameter error, Cooling fan error	
Digital operator	Status display, Monitor display, Alarm display, Test operation	
Dynamic brake circuit	Built-in　Note 5)	
Regeneration process circuit	Built-in　Note 6)	
Monitor	Speed monitor (VMON)	2.0 V±10 % (at 1,000 min^{-1})
	Torque (Thrust) (TCMON)	2.0 V±10 % (at 100 %)

Note 5) For RS3C30, just DB signal output circuit is built in.
Note 6) For RS3C15/30, regenerative resistor is external type only.

■ Built-in functions (Power unit/Amplifier unit combination of 200 VAC-600 A, 400 VAC-800 A)

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 deviation, 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 7)	
Regeneration process circuit	Included　Note 8)	
Monitor	Speed monitor (VMON)	2.0 V±10 % (at 1,000 min^{-1})
	Torque (Thrust) (TCMON)	2.0 V±10 % (at 100 %)

Note 7) Only dynamic brake timing signal output circuit is included.
Note 8) Regenerative resistor is attached external.

2.5.2 General Input/Output

■　General input signals

Sequence input signals	Interactive photo coupler (sink, source connection): ×7 input
	External power supply: 5V DC±5% / 12 to 24V DC±10%,100mA or over (24V DC)
	Forward direction limit switch, Reverse direction limit switch, External trip, Forced discharge, Emergency stop. Refer to [Index:0x20F8 General input function selection (M0011695)]

(PC OFF) T_H　　(PC ON) T_L
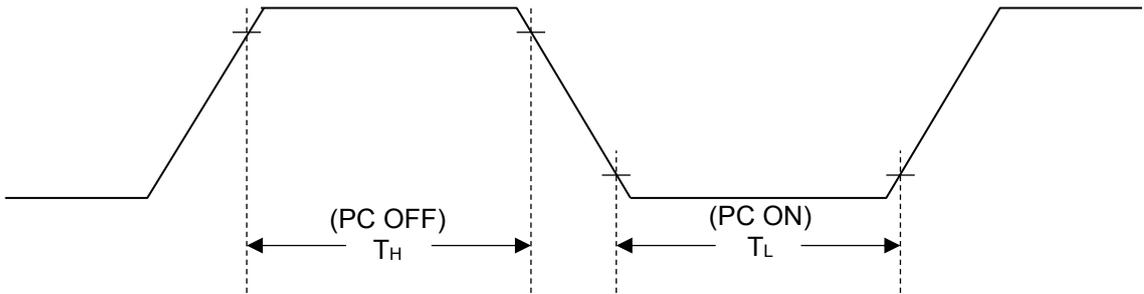
*　T_H denotes the minimum time that H-level input signal must be held and T_L denotes the minimum time that L-level input signals must be held.
*　Generic input signals will be set depending on the selection of each function. Validity conditions and AC characteristics differ depending on set functions.
*　Shows AC characteristics in respective functions.

General input functions	Photo coupler ON Hold time (T_L)	Photo coupler OFF Hold time (T_H)
Emergency stop function (Emergency Stop)	Min. 250 µsec	Min. 250 µsec
Forward direction limit switch Reverse direction limit switch Forced discharge input External trip input	Min. 8 msec	Min. 8 msec

*　Generic output is transmitted when the set function has held longer than 125µsec inside the servo amplifier.

■　General output signals

Sequence output signals	Photorelay output (SYNC, Source connection) x 2 outputs
	External power supply: 5V DC±5% / 12 to 24V DC±10%, 20mA or over
	Circuit power for output signal: 5V DC±5% / Max. current value 50mA (per 1 output) Circuit power for output signal: 12 to 15V DC±10% / Max. current value 50mA (per 1 output) Circuit power for output signal: 24V DC±10% / Max. current value 50mA (per 1 output)
	Servo ready, Power ON, Servo ON, Holding brake timing, Torque limiting, Velocity 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/Reverse direction limit, Warning, Alarm code (3bits), etc. Refer to [Index: 0x20F9 (M0011697)], for all signal names.

2. Specifications

2.6 Power supply, calorific value

2.6.1 Main circuit power supply capacity, control power supply capacity

■ 200 VAC input

Input Voltage	Servo amplifier capacity	Servo motor model number	Rated output (W)	Main circuit power supply capacity (kVA)	Control power supply capacity (VA)
200V AC	RS3A01#	R1AA04005F	50	0.2	40
		R1AA04010F	100	0.3	
		R2AA04003F	30	0.2	
		R2AA04005F	50	0.2	
		R2AA04010F	100	0.3	
		R2AA06010F	100	0.3	
		R5AA06020H	200	0.6	
	RS3A02#	R1AA06020F	200	0.6	
		R1AA06040F	400	1.0	
		R2AA06020F	200	0.6	
		R2AA06040F	400	1.0	
		R2AA06040H	400	1.0	
		R2AA08020F	200	0.6	
		R2AA08040F	400	1.0	
		R5AA06020F	200	0.6	
		R5AA06040F	400	1.0	
		R5AA06040H	400	1.0	
	RS3A03#	R1AA08075V	750	1.6	
		R1AA10100H	1,000	2.3	
		R1AA10150H	1,500	3.0	
		R2AA08075F	750	1.6	
		R2AAB8100H	1,000	2.0	
		R2AA10075F	750	1.7	
		R2AA13050D	550	1.2	
		R2AA13050H	550	1.2	
		R2AA13120B	1,200	2.2	
		R5AA08075D	750	1.6	
		R5AA08075F	750	1.6	
	RS3A05#	R1AA08075F	750	1.6	
		R1AA10100F	1,000	2.3	
		R1AA10150F	1,500	3.0	
		R1AA10200H	2,000	4.0	
		R1AA10250H	2,500	5.0	
		R2AAB8075F	750	1.6	
		R2AAB8100F	1,000	2.3	
		R2AA10100F	1,000	2.3	
		R2AA13120D	1,200	2.8	
		R2AA13120L	1,200	2.8	
		R2AA13180H	1,800	3.6	
		R2AA13200L	2,000	4.0	
	RS3A07#	R1AA10200F	2,000	4.0	
		R1AA10250F	2,500	5.0	
		R1AA13300H	3,000	6.0	
		R2AA13180D	1,800	4.0	
		R2AA13200D	2,000	4.0	
		R2AA18350V	3,500	6.0	

* # = Optional alphabetical letter
* Power supply capacity above is the value with motor rated output operation.

■   200 VAC input

Input Voltage	Servo amplifier capacity	Servo motor model number	Rated output (W)	Main circuit power supply capacity (kVA)	Control power supply capacity (VA)
200V AC	RS3A10#	R1AA13300F	3,000	6.0	40
		R1AA13400H	4,000	6.7	
		R1AA13500H	5,000	8.3	
		R2AA13180D	1,800	4.0	
		R2AA13200D	2,000	5.0	
		R2AA18350L	3,500	6.0	
	RS3A15#	R1AA10200F	4,000	6.7	
		R1AA10250F	5,000	8.3	
		R2AA18350D	3,500	7.0	
		R2AA18450H	4,500	7.4	
		R2AA18550R	5,500	8.4	
		R2AA22500L	5,000	9.6	
		R2AA22700S	7,000	12.2	
	RS3A30#	R1AA18550H	5,500	9.3	
		R1AA18750L	7,500	11.6	
		R1AA1811KR	11,000	16.0	
		R1AA1815KB	15,000	21.4	
		R2AA18550H	5,500	9.3	
		R2AA18750H	7,500	11.6	
		R2AA1811KR	11,000	16.0	
		R2AA2211KB	11,000	16.0	
		R2AA2215KB	15,000	21.4	
	RS3PAA270 RS3W60#	R1AA2220KV	21K	28	80 Note 1)
		R2AA2220KB	20K	28	
		R2AA2830KV	30K	42	

*   # = Optional alphabetical letter
*   Power supply capacity above is the value with motor rated output operation.

Note 1) Control power supply capacity is total of power unit (40VA) and amplifier (40VA).

2. Specifications

■ 100 VAC Input

Input Voltage	Servo amplifier capacity	Servo motor model number	Rated output (W)	Main circuit power supply capacity (kVA)	Control power supply capacity (VA)
100V AC	RS3E01#	R2EA04003F	30	0.2	40
	RS3E02#	R1EA04005F	50	0.2	
		R1EA04010F	100	0.4	
		R2EA04005F	50	0.2	
		R2EA04008F	80	0.4	
		R2EA06010F	100	0.5	
	RS3E03#	R1EA06020F	200	0.6	
		R2EA06020F	200	0.6	

* # = Optional alphabetical letter
* Power supply capacity above is the value with motor rated output operation.

■ 400 VAC Input

Input Voltage	Servo amplifier capacity	Servo motor model number	Rated output (W)	Main circuit power supply capacity (kVA)	Control power supply capacity (VA)
400V AC	RS3C02#	R1CA10150V	1,500	2.5	55
		R2CA10075F	750	1.3	45
		R2CA13050D	550	1.0	48
		R2CA13120R	1,200	2.0	50
		R2CA13180H	1,800	2.9	50
		R2CA13200L	2,000	3.3	54
	RS3C05#	R1CA10200V	2,000	3.7	59
		R1CA13300V	3,000	5.2	58
		R2CA10100F	1,000	1.8	49
		R2CA13120F	1,200	2.3	54
		R2CA13180D	1,800	3.3	54
		R2CA13200H	2,000	3.7	58
		R2CA18350L	3,500	6.0	71
	RS3C10#	R2CA18350D	3,500	6.0	77
		R2CA18450H	4,500	7.6	72
		R2CA18550R	5,500	9.5	72
	RS3C15#	R1CA18550H	5,500	7.0	98
		R1CA18750L	7,500	9.5	98
		R1CA1811KR	11,000	13.8	100
		R1CA1815KB	15,000	18.2	110
		R2CA18550H	5,500	7.0	88
		R2CA18750H	7,500	9.4	96
		R2CA2211KB	11,000	13.6	105
		R2CA2215KV	15,000	18.4	105
	RS3C30#	R1CA2220KV	21,000	24.2	120
		R2CA2220KV	20,000	27.5	120
		R2CA2830KV	30,000	36.2	147
	RS3PAC550	R2CA3255KB	55,000	90	61
	RS3D80#				83

* # = Optional alphabetical letter
* Power supply capacity above is the value with motor rated output operation.
* Control power supply capacity is the value with using holding brake output and maximum fan motor rotation.
* For RS3D80#, control power supply capacity is the value with using holding brake output and maximum fan motor rotation. Moreover, Main circuit power capacity is the value with the condition of rated output calculated by power factor 75 %.

2.6.2 Inrush current, leakage current

■ Inrush current (100/200 VAC input)

Input Voltage	Servo amplifier capacity	Control power (Maximum value between1ms after input)	Main circuit power (Maximum value between 1.2 seconds after input)
200V AC	RS3A01#	40A(0-P)	22A(0-P)
	RS3A02#		
	RS3A03#		
	RS3A05#		
	RS3A07#		17A(0-P)
	RS3A10#		
	RS3A15#		
	RS3A30#		
100V AC	RS3E01#	20A(0-P)	11A(0-P)
	RS3E02#		
	RS3E03#		

■ Inrush current for control circuit of RS3W60#

Input voltage	Unit name	Model number	Control power (Maximum value between1ms after input)
200V AC	Power unit	RS3PAA270#	80A(0-P)
	Amplifier unit	RS3W60#	

■ Inrush current for main circuit of RS3W60#

Input voltage	Power unit	Main circuit power (Maximum value between 1.2 seconds after input)
200V AC	RS3PAA270#	80A(0-P)

* # = Optional alphabetical letter
* Inrush current values above are at the condition of ordinary temperatures, 240 VAC input.
* Using thermistor for inrush prevention circuit of control power supply. Inrush current which exceed value above might flow if power-cycled frequently in short time or ambient temperature is higher.

■ Inrush current (400V AC input)

Input Voltage	Servo amplifier capacity	Control power (Maximum value between1ms after input)	Main circuit power (Maximum value between 1.2 seconds after input)
400V AC	RS3C02#	56A(0-P)	22.6A(0-P)
	RS3C05#		
	RS3C10#		
	RS3C15#		
	RS3C30#		45.3A(0-P)

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

■ Inrush current for control circuit/main circuit of RS3D80#

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 480 VAC input voltage.

2. Specifications

■ Leakage current

Servo amplifier capacity	Electric leakage current per motor
RS3#01#	0.8 mA or less
RS3#02#	0.8 mA or less
RS3#03#	0.8 mA or less
RS3#05#	1.5 mA or less
RS3#07#	3.0mA or less
RS3#10#	3.0mA or less
RS3#15#	3.0mA or less
RS3#30#	3.0mA or less
RS3PAA270+RS3W60A#	3.5 mA or less
RS3C02#	1.0 mA or less
RS3C05#	1.0 mA or less
RS3C10#	3.0 mA or less
RS3C15#	3.0 mA or less
RS3C30#	3.0 mA or less
RS3PAC550+RS3D80#	13.0mA or less

* # = Optional alphabetical letter
* Leakage current value above is measured 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 2 meter 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.
* 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, servo amplifier, power unit or amplifier unit.

2.6.3 Calorific value

■ 200V AC

Input voltage	Servo amplifier capacity	Servo motor model number	Servo amplifier total calorific value (W)
200V AC	RS3A01#	R1AA04005F	14
		R1AA04010F	15
		R2AA04003F	13
		R2AA04005F	14
		R2AA04010F	15
		R2AA06010F	15
		R5AA06020H	20
	RS3A02#	R1AA06020F	20
		R1AA06040F	32
		R2AA06020F	20
		R2AA06040F	31
		R2AA06040H	22
		R2AA08020F	20
		R2AA08040F	30
		R5AA06020F	20
		R5AA06040F	31
		R5AA06040H	22
	RS3A03#	R1AA08075V	43
		R1AA10100H	45
		R1AA10150H	60
		R2AA08075F	43
		R2AAB8100H	45
		R2AA10075F	43
		R2AA13050D	44
		R2AA13050H	40
		R2AA13120B	50
		R5AA08075D	43
		R5AA08075F	43
	RS3A05#	R1AA08075F	45
		R1AA10100F	60
		R1AA10150F	70
		R1AA10200H	70
		R1AA10250H	80
		R2AAB8075F	45
		R2AAB8100F	52
		R2AA10100F	50
		R2AA13120D	68
		R2AA13120L	60
		R2AA13180H	87
		R2AA13200L	87
	RS3A07#	R1AA10200F	100
		R1AA10250F	115
		R1AA13300H	120
		R2AA13180D	110
		R2AA13200D	100
		R2AA18350V	135

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

2. Specifications

■ 200V AC (continued)

Input voltage	Servo amplifier capacity	Servo motor model number	Servo amplifier total calorific value (W)
200V AC	RS3A10#	R1AA13300F	135
		R1AA13400H	157
		R1AA13500H	170
		R2AA13180D	110
		R2AA13200D	100
		R2AA18350L	148
	RS3A15#	R1AA13400F	157
		R1AA13500F	180
		R2AA18350D	148
		R2AA18450H	163
		R2AA18550R	213
		R2AA22500L	164
		R2AA22700S	235
	RS3A30#	R1AA18550H	315
		R1AA18750L	365
		R1AA1811KR	430
		R1AA1815KB	450
		R2AA18550H	315
		R2AA18750H	365
		R2AA1811KR	430
		R2AA2211KB	440
		R2AA2215KB	450

■ RS3W60#

Input voltage	Power unit/ Amplifier unit	Servo motor model number	Power unit/Amplifier unit total calorific value (W)
200V AC	RS3PAA270#/ RS3W60#	R1AA2220KV	890
		R2AA2220KB	890
		R2AA2830KV	960

■ 100V AC

Input voltage	Servo amplifier capacity	Servo motor model number	Servo amplifier total calorific value (W)
100V AC	RS3E01#	R2EA04003F	13
	RS3E02#	R1EA04005F	15
		R1EA04010F	17
		R2EA04005F	15
		R2EA04008F	16
		R2EA06010F	17
	RS3E03#	R1EA06020F	26
		R2EA06020F	26

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

■ 400V AC

Input voltage	Servo amplifier capacity	Servo motor model number	Servo amplifier total calorific value (W)
400 VAC	RS3C02#	R1CA10150V	96
		R2CA10075F	78
		R2CA13050D	76
		R2CA13120R	84
		R2CA13180H	102
		R2CA13200L	98
	RS3C05#	R1CA10200V	116
		R1CA13300V	142
		R2CA10100F	102
		R2CA13120F	114
		R2CA13180D	152
		R2CA13200H	134
		R2CA18350L	152
	RS3C10#	R2CA18350D	228
		R2CA18450H	208
		R2CA18550R	280
	RS3C15#	R1CA18550H	288
		R1CA18750L	333
		R1CA1811KR	385
		R1CA1815KB	450
		R2CA18550H	293
		R2CA18750H	344
		R2CA2211KB	423
		R2CA2215KV	475
	RS3C30#	R1CA2220KV	536
		R2CA2220KV	643
		R2CA2830KV	700

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

■ RS3D80#

Input voltage	Servo amplifier capacity	Servo motor model number	Power unit/Amplifier unit total calorific value (W)
400 VAC	RS3PAC550 RS3D80#	R2CA3255KB	2,500 or less

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

Specifications 2

2. Specifications

■ Linear motor

Input voltage	Servo amplifier capacity	Linear motor model number	Servo amplifier total calorific value (W)
200V AC	RS3A03#	DS030C1N2	41
		DS050C1N2	41
		DS075C1N2	42
		DS045CC1AN	41
		DT030CD1AN	41
	RS3A05#	DS030C2N2	68
		DS050C2N2	68
		DS075C2N2	69
		DS100C1N2	70
		DS150C1N2	70
		DD030C1Y4	65
	RS3A07#	DS030C3N2	91
		DS050C3N2	91
		DS075C3N2	93
		DD030C2Y4	110
		DD050C1Y2	110
		DD075C1Y2	110
		DD045CB4AN	75
		DD035CC2AN	70
	RS3A10#	DS030C3N2	91
		DS050C3N2	91
		DS075C3N2	93
		DS100C2N2	135
		DS150C2N2	135
		DD030C2Y4	110
		DD030C3Y4	138
		DD050C1Y2	110
		DD075C1Y2	110
		DD045CB4AN	75
	RS3A15#	DS100C3N2	185
		DS150C3N2	185
		DD050C2Y2	210
		DD075C2Y2	210
	RS3A30#	DD050C3Y2	270
		DD075C3Y2	275
		DD075C4Y2	380

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

2.7 Operation pattern

2.7.1 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・m^2)
◆ J_L: Load inertia moment (kg・m^2)
◆ N_1, N_2: Rotational speed of motor (min^{-1})
◆ T_P: Instantaneous maximum stall torque (N・m)
◆ T_L: Load torque (N・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 servo amplifier, and the conditions of both must be met simultaneously.

■ Frequency of permitted repetitions for the servo amplifier
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.

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

■ 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.

2. Specifications

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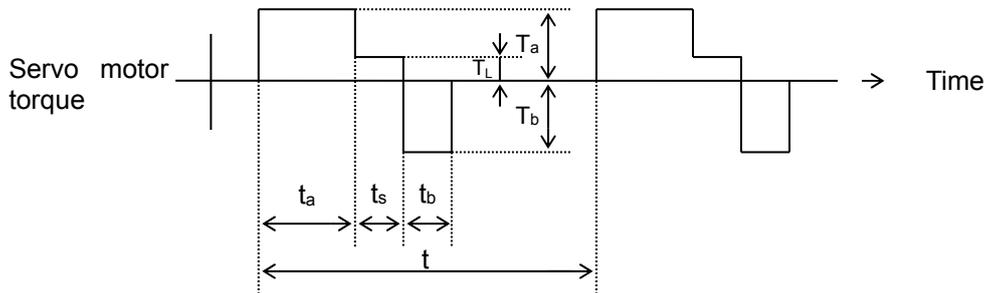
◆ If the operating cycle is considered as "t", the usable range can be determined as follows:

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

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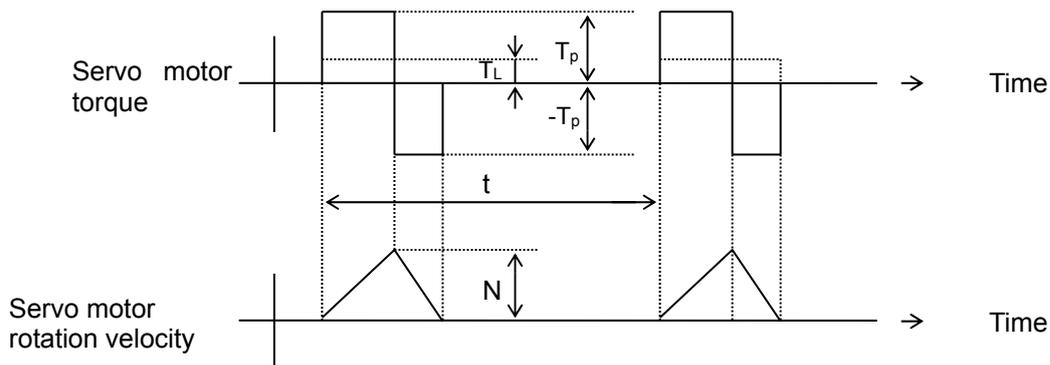
$$n = 2.86 \times 10^2 \times \frac{1}{N(J_M + J_L)} \times \frac{T_P^2 - T_L^2}{T_P^3} \times T_R^2 \quad [times/\ min]$$

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)

■ 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:

Servo motor torque → Time

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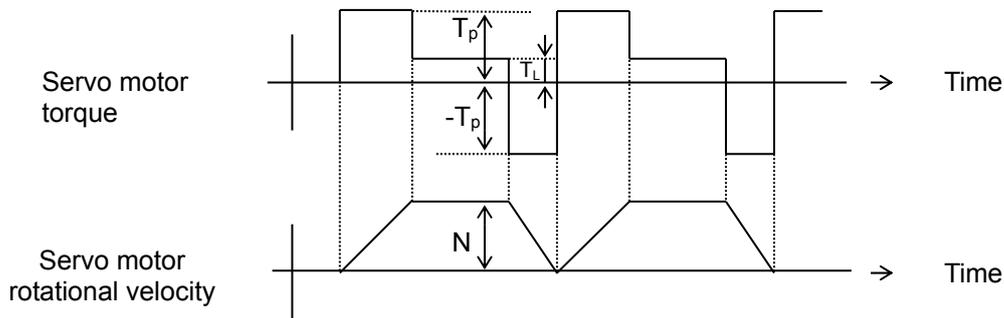
$$n = 2.86 \times 10^2 \times \frac{1}{N(J_M + J_L)} \times \frac{T_R^2 - T_L^2}{T_P} \quad [\text{times/ min}]$$

■ Negative load
   Servo amplifier 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. Specifications

2.8 Specifications for analog monitor

2.8.1 Specifications for analog monitor

■ Monitor output

CN5
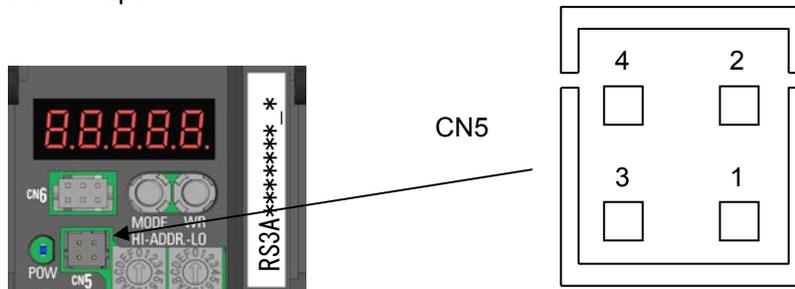
Connector model number on board: DF11-4DP-2DSA(01)
Housing model number on receiving equipment: DF11-4DS-2C
Connector model number on receiving equipment: DF11-2428SCA

	Analog monitor connector CN5
Analog monitor output 1(MON1)	CN5-3
Analog monitor output 2(MON2)	CN5-4
GND	CN5-1

2.8.2 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 Index 0x2023-3: 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
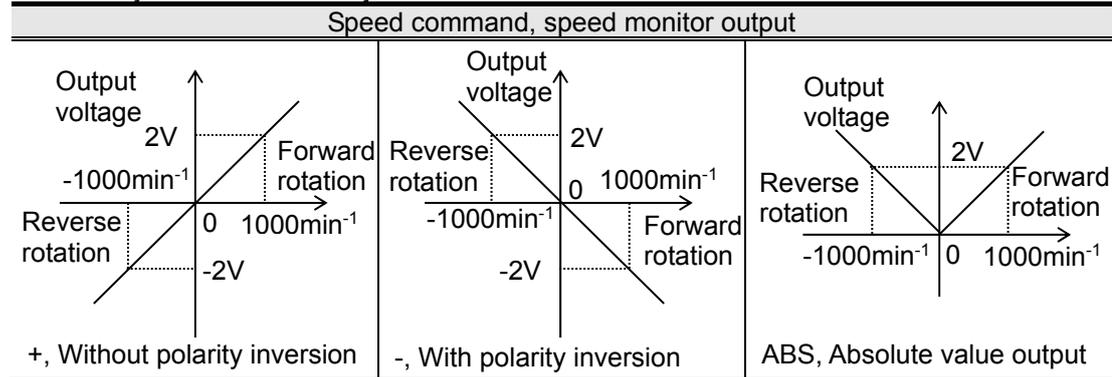
■ Position deviation monitor

Position deviation monitor output		
+, Without polarity inversion	-, With polarity inversion	ABS, Absolute value output
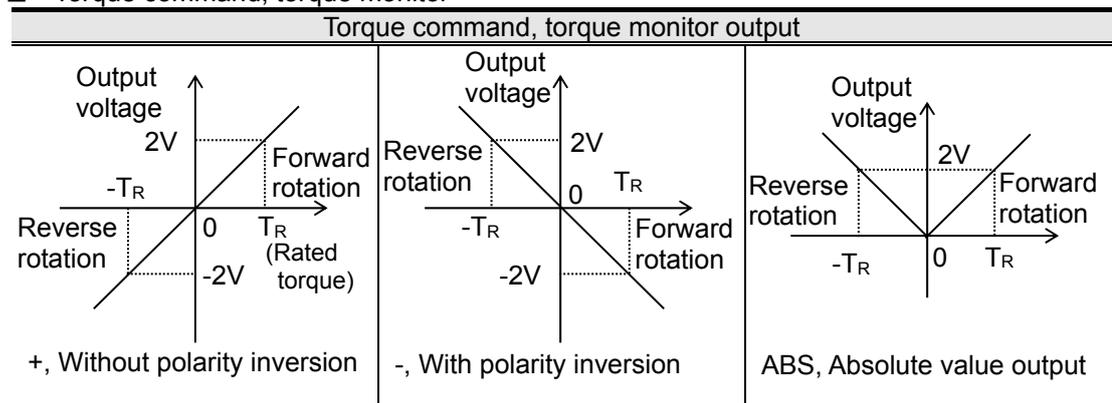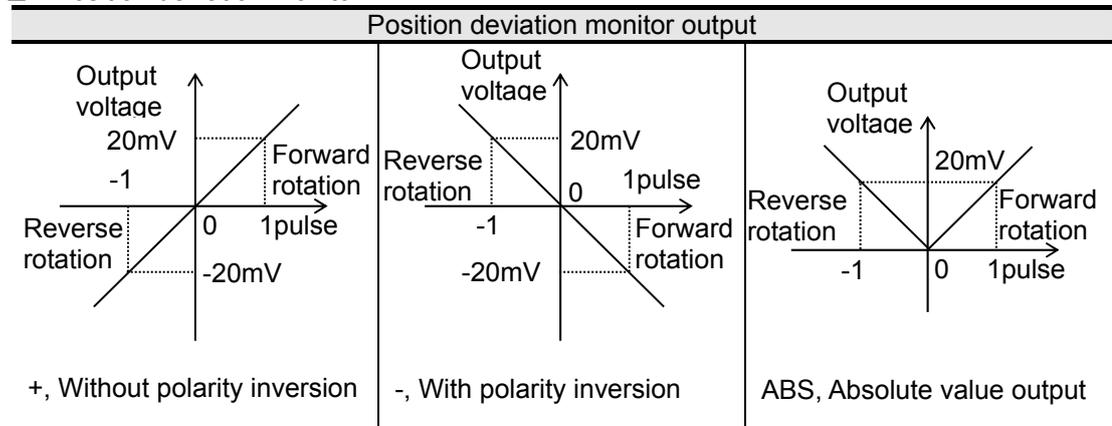
2. Specifications

2.9 Specifications for dynamic brake

2.9.1 Allowable frequency, instantaneous tolerance, decreasing the rotation angle of the dynamic brake

■ Allowable frequency of the dynamic brake
Less than 10 times per hour and 30 times per day at maximum speed within allowable load inertia moment.

■ Operation intervals
In basic terms, operation of the dynamic brake in six (6) minutes intervals is acceptable. If the brake is to be operated more frequently, the motor speed must be reduced sufficiently.
Refer to the following expression to find a standard of operation:

$$\frac{6 \text{ minutes}}{(\text{Rated rotation speed/maximum rotation speed in use})^2}$$

■ If/When load inertia moment (J_L) substantially exceeds allowable load inertia moment, abnormal heat can generate due to dynamic brake resistance. Take precautions against (Overheat alarm of the dynamic break) or (failure of dynamic brake resistance). Please consult us if such a situation is evident.
Dynamic brake circuit is not included to servo amplifier RS3C30# and amplifier unit RS3D80#. Please contact us for external dynamic brake resistor selection.

■ Instantaneous tolerance of dynamic brake

Servo amplifier model number	E_{RD} (J)
RS3#02A##A#/RS3#02A##L#	218
RS3#03A##A#/RS3#03A##L#	
RS3#05A##A#/RS3#05A##L#	912
RS3#07A##A#/RS3#07A##L#	2000
RS3#10A##A#/RS3#10A##L#	2450
RS3#15A##A#/RS3#15A##L#	
RS3#30A##L#	9384
RS3C02A##A#	1100
RS3C05A##A#	2100
RS3C10A##A#	13000
RS3C15A##L#	13000

* # = Optional number or alphabetical letter.
* RS3#01A does not have dynamic brake resistor. Shorting between motor phases as dynamic brake.

2.9 Specifications for dynamic brake

■ Rotary motor

◆ The consumption of energy E_{RD} by dynamic brake resistance in one dynamic brake operation is as follows:

$$E_{RD}= \frac{2.5}{R\phi+2.5} \times \left\{ \frac{1}{2}(J_M+J_L) \times \left[\frac{2\pi}{60} N \right]^2 - I \times T_L \right\}$$

Rϕ: Servo motor phase winding resistance(Ω)
J_M: Inertia moment of servo motor (kg·m^2)
J_L: Load inertia moment (motor axis conversion)(kg·m$^{2)}$)
N: Servo motor rotation speed in feed rate V(min^{-1})
I: Integrated stage-down rotation angle (rad)
T_L: Load torque (N·m)

■ Linear motor

◆ The consumption of energy E_{RD} by dynamic brake resistance in one dynamic brake operation is as follows:

$$E_{RD}= \frac{2.5}{R\phi+2.5} \times \frac{1}{2} M \times V^2 \quad [J]$$

Rϕ: Linear motor phase winding resistance [Ω]
M: Movable part [kg]
Movable part $M = M_C + M_L$
(M_C: Mover mass [kg], M_L: Load mass [kg])
V: Last-minute velocity before deceleration [m/s]

2. Specifications

- ■ Staging down the rotation angle using the dynamic brake is show as follows:

  - ◆ Rotary motor

$$I = I_1 + I_2 = \frac{2\pi N \times t_D}{60} + (J_M + J_L) \times (\alpha N + \beta N^3)$$

J_M: Inertia of servo motor (kg·m^2)
J_L: Load inertia (motor axis conversion) (kg·m^2)
N: Servo motor rotation speed (min^{-1})
I_1: Stage down rotation angle (rad) using amplifier internal process t_D
I_2: Stage down rotation angle (rad) using dynamic brake operation
t_D: 10×10^{-3}(s)
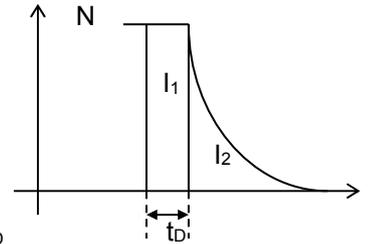
α, β: See below.

  - ◆ 100/200V AC input

Servo amplifier capacity	Servo motor model number	α	β	J_M (kg·m^2)
RS3A01	R1AA04005F	111	6.15×10^{-6}	0.0146×10^{-4}
	R1AA04010F	49.4	3.88×10^{-6}	0.0242×10^{-4}
	R2AA04003F	187	5.18×10^{-6}	0.0247×10^{-4}
	R2AA04005F	93.2	3.78×10^{-6}	0.0376×10^{-4}
	R2AA04010F	32.5	1.98×10^{-6}	0.0627×10^{-4}
	R2AA06010F	21.4	7.67×10^{-6}	0.117×10^{-4}
	R5AA06020H	11.7	3.76×10^{-6}	0.2×10^{-4}
RS3A02	R1AA06020F	14.7	3.39×10^{-6}	0.122×10^{-4}
	R1AA06040F	9.25	1.37×10^{-6}	0.203×10^{-4}
	R2AA06020F	14.5	2.46×10^{-6}	0.219×10^{-4}
	R2AA06040F	8.82	1.00×10^{-6}	0.412×10^{-4}
	R2AA06040H	5.47	1.61×10^{-6}	0.412×10^{-4}
	R2AA08020F	11.3	1.13×10^{-6}	0.52×10^{-4}
	R2AA08040F	6.91	4.25×10^{-6}	1.04×10^{-4}
	R5AA06020F	15.36	2.92×10^{-6}	0.2×10^{-4}
	R5AA06040F	10.11	1.55×10^{-6}	0.416×10^{-4}
	R5AA06040H	6.09	2.3×10^{-6}	0.416×10^{-4}
RS3A03	R1AA08075V	4.35	6.57×10^{-7}	0.719×10^{-4}
	R1AA10100H	2.6	1.21×10^{-6}	1.4×10^{-4}
	R1AA10150H	1.31	6.87×10^{-7}	2.0×10^{-4}
	R2AA08075F	5.84	9.10×10^{-8}	1.82×10^{-4}
	R2AAB8100H	3.09	3.83×10^{-7}	2.38×10^{-4}
	R2AA10075F	6.04	1.2×10^{-6}	2.0×10^{-4}
	R2AA13050D	6.46	2.14×10^{-6}	3.1×10^{-4}
	R2AA13050H	4.37	3.55×10^{-6}	3.1×10^{-4}
	R2AA13120B	1.68	1.56×10^{-6}	6×10^{-4}
	R5AA08075D	4.67	1.67×10^{-6}	1.65×10^{-4}
	R5AA08075F	6.45	2.75×10^{-6}	1.65×10^{-4}
RS3A05	R1AA08075F	7.44	3.75×10^{-7}	0.719×10^{-4}
	R1AA10100F	8.39	3.24×10^{-7}	1.4×10^{-4}
	R1AA10150F	4.21	1.82×10^{-7}	2.0×10^{-4}
	R1AA10200H	1.71	3.88×10^{-7}	2.3×10^{-4}
	R1AA10250H	1.26	2.80×10^{-7}	2.8×10^{-4}
	R2AAB8075F	6.55	4.16×10^{-7}	1.64×10^{-4}
	R2AAB8100F	5.46	2.08×10^{-7}	2.38×10^{-4}
	R2AA10100F	5.35	4.86×10^{-7}	3.5×10^{-4}
	R2AA13120D	4.06	6.45×10^{-7}	6.3×10^{-4}
	R2AA13120L	2.99	1.21×10^{-6}	6×10^{-4}
	R2AA13180H	2.17	4.66×10^{-7}	9.0×10^{-4}
	R2AA13200L	1.83	3.1×10^{-7}	12.2×10^{-4}

* The values for α, β are reached based on an assumed resistance value of the power line being 0Ω. Contact us when the combination with an amplifier is different than those shown above (invariably values are different).

2.9 Specifications for dynamic brake

Servo amplifier capacity	Servo motor model number	α	β	J_M (kg·m^2)
RS3A07	R1AA10200F	3.17	5.00×10^{-8}	2.3×10^{-4}
	R1AA10250F	2.15	4.70×10^{-8}	2.8×10^{-4}
	R1AA13300H	1.00	5.60×10^{-8}	7.0×10^{-4}
	R2AA13180D	2.12	1.23×10^{-7}	9.0×10^{-4}
	R2AA13200D	1.69	0.91×10^{-7}	12.2×10^{-4}
	R2AA18350V	0.56	2.5×10^{-8}	40×10^{-4}
RS3A10	R1AA13300F	3.08	4.20×10^{-8}	7.0×10^{-4}
	R1AA13400H	0.8	3.40×10^{-8}	8.8×10^{-4}
	R1AA13500H	0.57	3.00×10^{-8}	10.6×10^{-4}
	R2AA13180D	2.12	1.23×10^{-7}	9.0×10^{-4}
	R2AA13200D	1.69	0.91×10^{-7}	12.2×10^{-4}
	R2AA18350L	0.82	1.6×10^{-8}	40×10^{-4}
RS3A15	R1AA13400F	2.06	1.40×10^{-8}	8.8×10^{-4}
	R1AA13500F	1.88	9.00×10^{-9}	10.6×10^{-4}
	R2AA18350D	1.05	1.3×10^{-8}	40×10^{-4}
	R2AA18450H	0.67	1.2×10^{-8}	50×10^{-4}
	R2AA18550R	0.53	7×10^{-9}	68×10^{-4}
	R2AA22500L	0.8	0.41×10^{-7}	55×10^{-4}
	R2AA22700S	0.16	7×10^{-9}	136×10^{-4}
RS3A30	R1AA18550H	1.08	4×10^{-9}	33×10^{-4}
	R1AA18750L	0.67	2×10^{-9}	42×10^{-4}
	R1AA1811KR	0.41	2×10^{-9}	64×10^{-4}
	R1AA1815KB	0.26	2×10^{-9}	86×10^{-4}
	R2AA18550H	1.13	4×10^{-9}	68×10^{-4}
	R2AA18750H	0.72	2×10^{-9}	98×10^{-4}
	R2AA1811KR	0.51	3×10^{-9}	110×10^{-4}
	R2AA2211KB	0.42	1×10^{-9}	178×10^{-4}
	R2AA2215KB	0.35	1×10^{-9}	237×10^{-4}
RS3E01	R2EA04003F	187	5.18×10^{-6}	0.0247×10^{-4}
RS3E02	R1EA04005F	166	4.03×10^{-6}	0.0146×10^{-4}
	R1EA04010F	75.1	2.56×10^{-6}	0.0242×10^{-4}
	R2EA04005F	171	2.06×10^{-6}	0.0376×10^{-4}
	R2EA04008F	69.7	1.06×10^{-6}	0.0627×10^{-4}
	R2EA06010F	59.1	2.84×10^{-6}	0.117×10^{-4}
RS3E03	R1EA06020F	47.8	1.3×10^{-6}	0.122×10^{-4}
	R2EA06020F	38.8	9.10×10^{-7}	0.219×10^{-4}

* The values for α, β are reached based on an assumed resistance value of the power line being 0Ω. Contact us when the combination with an amplifier is different than those shown above (invariably values are different).

2. Specifications

◆ 400V AC input

Servo amplifier capacity	Servo motor model number	α	β	$J_M(kg \cdot m^2)$
RS3C02	R1CA10150V	1.26	8.37×10^{-7}	2.1×10^{-4}
	R2CA10075F	2.54	2.86×10^{-6}	2.5×10^{-4}
	R2CA13050D	2.15	6.23×10^{-6}	3.1×10^{-4}
	R2CA13120R	0.66	2.54×10^{-6}	6.0×10^{-4}
	R2CA13180H	0.41	1.93×10^{-6}	9.0×10^{-4}
	R2CA13200L	0.25	1.38×10^{-6}	12.2×10^{-4}
RS3C05	R1CA10200V	1.17	6.39×10^{-7}	2.4×10^{-4}
	R1CA13300V	0.78	3.12×10^{-7}	6.8×10^{-4}
	R2CA10100F	3.40	7.64×10^{-7}	3.9×10^{-4}
	R2CA13120F	1.97	1.13×10^{-6}	6.0×10^{-4}
	R2CA13180D	1.26	5.88×10^{-7}	9.0×10^{-4}
	R2CA13200H	0.68	1.05×10^{-6}	12.2×10^{-4}
	R2CA18350L	0.30	2.19×10^{-7}	40×10^{-4}
RS3C10	R2CA18350D	0.26	5.20×10^{-8}	40×10^{-4}
	R2CA18450H	0.15	5.30×10^{-8}	50×10^{-4}
	R2CA18550R	0.13	3.10×10^{-8}	68×10^{-4}
RS3C15	R1CA18550H	0.17	2.70×10^{-8}	33×10^{-4}
	R1CA18750L	0.12	2.20×10^{-8}	42×10^{-4}
	R1CA1811KR	0.06	1.50×10^{-8}	64×10^{-4}
	R1CA1815KB	0.05	1.30×10^{-8}	86×10^{-4}
	R2CA18550H	0.18	2.30×10^{-8}	68×10^{-4}
	R2CA18750H	0.13	1.70×10^{-8}	98×10^{-4}
	R2CA2211KB	0.07	8.00×10^{-9}	178×10^{-4}
	R2CA2215KV	0.05	5.00×10^{-9}	288×10^{-4}

* The values for α, β are reached based on an assumed resistance value of the power line being 0Ω. Contact us when the combination with an amplifier is different than those shown above (invariably values are different).
* About the values for α, β of R2CA3255KB, please consult us.

2.9 Specifications for dynamic brake

◆ Linear motor

■ Coasting distance of movable stage is calculated roughly as follows, when dynamic brake is worked at horizontal axis without friction consideration:

$$\text{Coasting distance} = V \cdot t_D + M \cdot (\alpha V + \beta V^3) \ [m]$$

V: Linear motor velocity [m/s]
t_D : 10×10^{-3} [s]
M: Movable part [kg]
Movable part $M = M_C + M_L$
(M_C: Mover mass [kg], M_L: Load mass [kg])
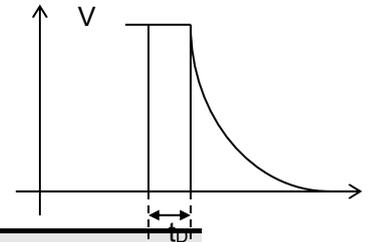
α·β: See below.

Servo amplifier capacity	Servo motor model number	α	β	M_C[kg]
RS3A03	DS030C1N2	6.88E-3	1.59E-3	2.8
	DS050C1N2	3.05E-3	1.27E-3	3.8
	DS075C1N2	1.75E-3	1.03E-3	5.2
	DS045CC1AN	4.16E-3	3.62E-3	1.8
	DT030CD1AN	2.85E-3	1.06E-3	2.4
RS3A05	DS030C2N2	5.42E-3	5.04E-4	5.4
	DS050C2N2	2.27E-3	4.26E-4	7.4
	DS075C2N2	1.23E-3	3.64E-4	10
	DS100C1N2	2.65E-3	4.05E-4	6.6
	DS150C1N2	1.30E-3	3.49E-4	9.4
	DD030C1Y4	3.98E-3	1.08E-3	8.3
RS3A07	DS030C3N2	4.46E-3	6.83E-5	7.8
	DS050C3N2	1.74E-3	6.15E-5	10.9
	DS075C3N2	8.91E-4	5.59E-5	14.8
	DD030C2Y4	2.21E-3	1.22E-4	15.0
	DD050C1Y2	3.25E-3	1.09E-4	11.2
	DD075C1Y2	1.63E-3	9.95E-5	14.7
	DD045CB4AN	2.30E-3	1.62E-4	8.6
	DD035CC2AN	2.30E-3	1.62E-4	5.0
RS3A10	DS030C3N2	4.46E-3	6.83E-5	7.8
	DS050C3N2	1.74E-3	6.15E-5	10.9
	DS075C3N2	8.91E-4	5.59E-5	14.8
	DS100C2N2	2.09E-3	3.21E-5	12.6
	DS150C2N2	9.60E-4	2.96E-5	17.8
	DD030C2Y4	2.21E-3	1.22E-4	15.0
	DD030C3Y4	2.02E-3	5.92E-5	21.6
	DD050C1Y2	3.25E-3	1.09E-4	11.2
	DD075C1Y2	1.63E-3	9.95E-5	14.7
	DD045CB4AN	2.30E-3	1.62E-4	8.6
RS3A15	DS100C3N2	2.03E-3	1.47E-5	18.6
	DS150C3N2	9.23E-4	1.37E-5	26.2
	DD050C2Y2	2.93E-3	3.01E-5	21.2
	DD075C2Y2	1.43E-3	2.83E-5	26.5
RS3A30	DD050C3Y2	2.83E-3	1.39E-5	29.0
	DD075C3Y2	1.37E-3	1.32E-5	38.1
	DD075C4Y2	1.33E-3	7.60E-6	49.5

* The values for α, β are reached based on an assumed resistance value of the power line being 0Ω. Contact us when the combination with an amplifier is different than those shown above (invariably values are different).

2. Specifications

2.10 Regeneration process

Allowable minimum values of Built-in/ external regenerative resistor and allowable regenerative power of regenerative circuit of servo amplifier are shown below. See "11.3 Selection of regenerative resistor" for selection method of regenerative resistor.

2.10.1 Minimum values of Built-in/ external regenerative resistor

Servo amplifier model	Built-in regenerative resistor	External regenerative resistor
RS3#01A##A#	50Ω	35Ω
RS3#02A##A#	50Ω	35Ω
RS3#03A##A#	50Ω	35Ω
RS3#05A##A#	17Ω	17Ω
RS3A07A##A#/RS3A07A##L#	10Ω	10Ω
RS3A10A##A#/RS3A10A##L#	10Ω	10Ω
RS3A15A##A#/RS3A15A##L#	6Ω	6Ω
RS3A30A##L#	Without built-in regenerative resistor	2.5Ω
RS3PAA270#	Without built-in regenerative resistor	2.5Ω

■ Input voltage 400V AC

Servo amplifier model	Built-in regenerative resistor	External regenerative resistor
RS3C02A##A#	80Ω	80Ω
RS3C05A##A#	40Ω	40Ω
RS3C10A##A#	20Ω	20Ω
RS3C15A##L#	Without built-in regenerative resistor	13Ω
RS3C30A##M#	Without built-in regenerative resistor	6.5Ω
RS3PAC550	Without built-in regenerative resistor	2.4Ω

* "#" is optional number or alphabetical letter.

2.10.2 Allowable regenerative power

Servo amplifier model	Built-in regenerative resistor use [PRI]	External regenerative resistor use [PR0]
RS3#01A##A#/RS3#01A##L#	5W	125W
RS3#02A##A#/RS3#02A##L#	5W	125W
RS3#03A##A#/RS3#03A##L#	5W	125W
RS3#05A##A#/RS3#05A##L#	20W	250W
RS3A07A##A#/RS3A07A##L#	60W	500W
RS3A10A##A#/RS3A10A##L#	90W	500W
RS3A15A##A#/RS3A15A##L#	120W	500W
RS3A30A##L#	-	500W

■ Input voltage 400V AC

Servo amplifier model	Built-in regenerative resistor use [PRI]	External regenerative resistor use [PR0]
RS3C02A##A#	15W	125W
RS3C05A##A#	28W	250W
RS3C10A##A#	40W	500W
RS3C15A##L#	Without built-in regenerative resistor	1000W
RS3C30A##M#	Without built-in regenerative resistor	2000W
RS3PAC550	Without built-in regenerative resistor	5000W

* "#" is optional number or alphabetical letter.

3

Installation

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

3. Installation

3.1 Servo amplifier

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 servo amplifier.
Do not obstruct the air intake and exhaust vents. The mounting direction should be observed strictly.
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.
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 servo amplifier 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 servo amplifier 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 servo amplifier 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. 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 servo amplifier.

■　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 servo amplifier.

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 servo motor or servo amplifier 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 amplifier.

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

Servo amplifier   Servo amplifier main nameplate

Model No.
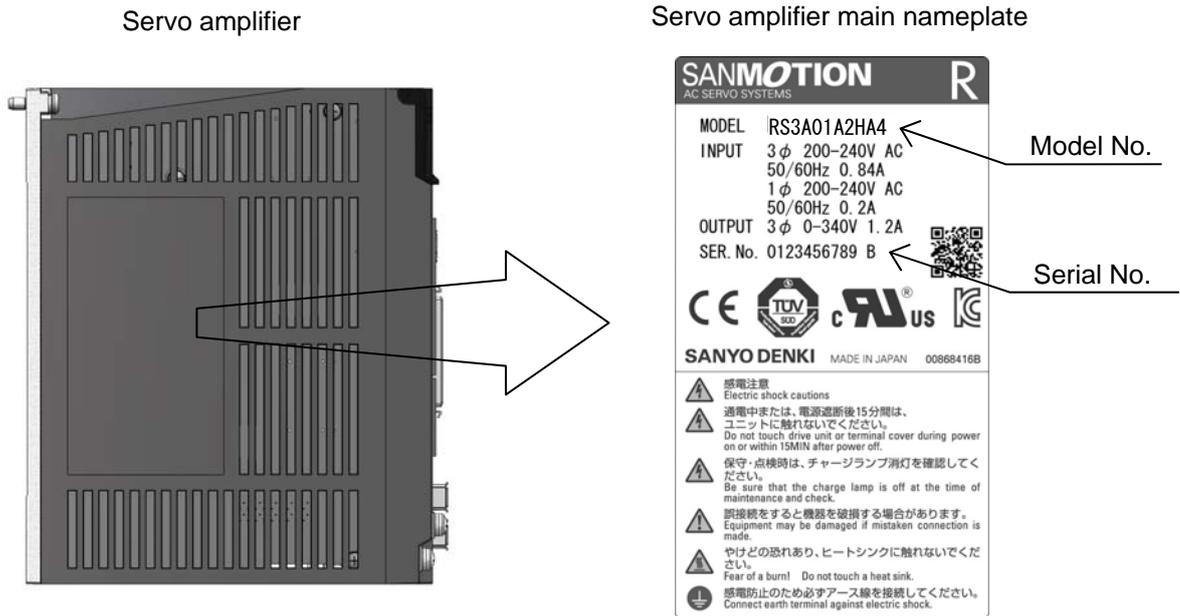
Serial No.

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

Rear-mounting

Front-mounting

M4
(Attached to servo amplifier)

2-M4

M4

2-M4

Ventilation
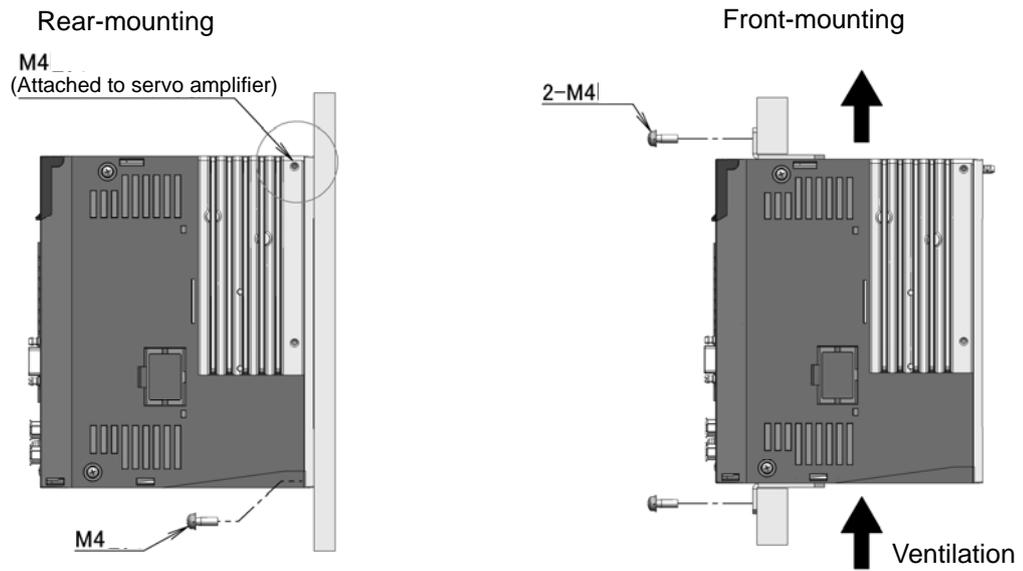
* For metal fittings of front mounting, see "12.6 Optional parts".

RS3PAC550
RS3D80#

2-M8

2-M8

Ventilation
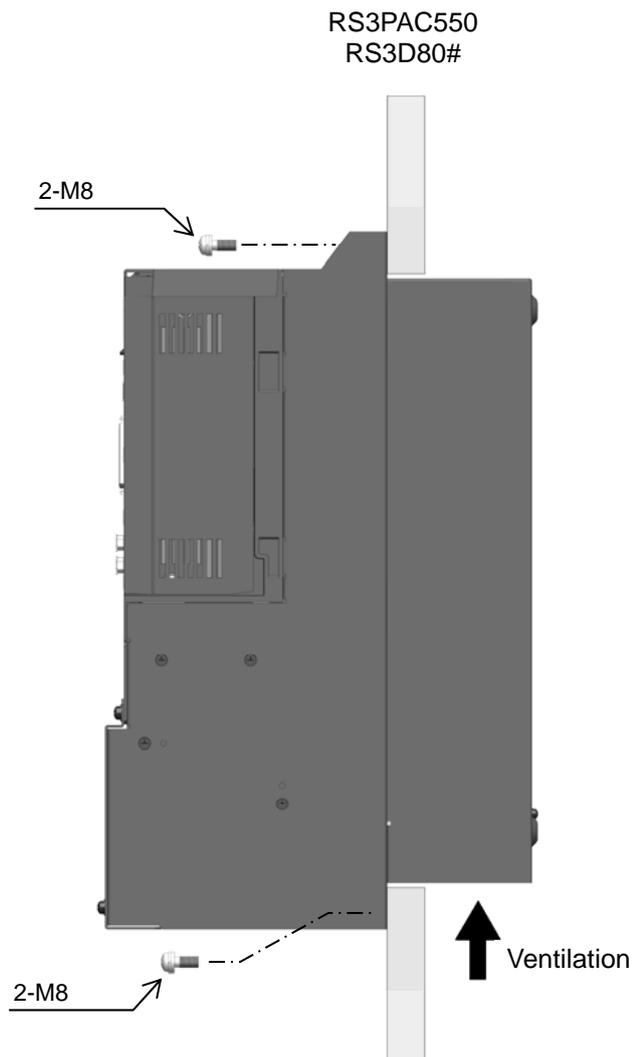
3.1.4 Arrangement within the cabinet

■ Leave at least 50 mm (100 mm for RS3D80#) space above and below the servo amplifier to ensure unobstructed airflow from the inside of the servo amplifier and the radiator. If heat gets trapped around the servo amplifier, use a cooling fan to create airflow.

■ Make sure the temperature around the servo amplifier 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 servo amplifier to ensure unobstructed airflow from the heat sinks on the side and from the inside of the servo amplifier.

■ For RS3□02·RS3□03·RS3□05, a cooling fan is attached at the side. Therefore, it is recommended that the servo amplifier be mounted in an arrangement as shown below.

Front view   Side view
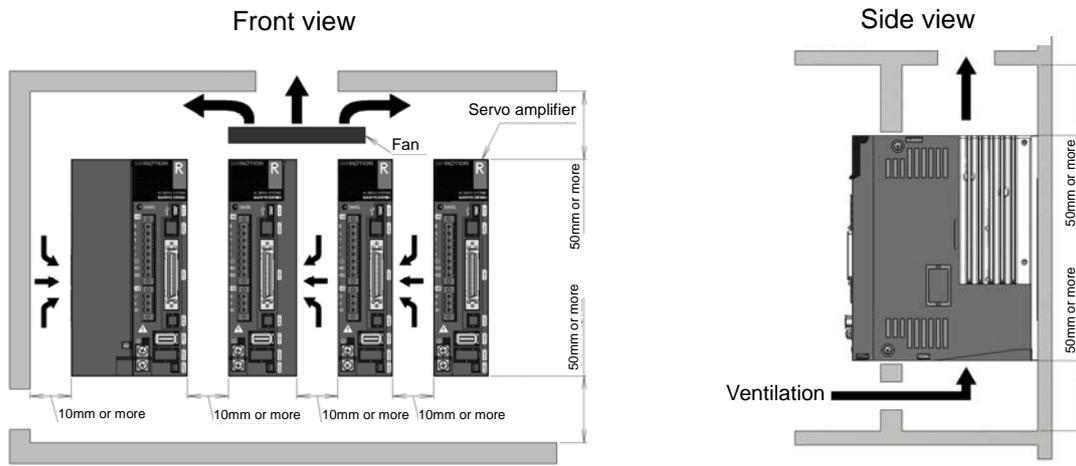
* Arrangement above is order of RS3□05, RS3□03, RS3□02 and RS3□01 from left side.

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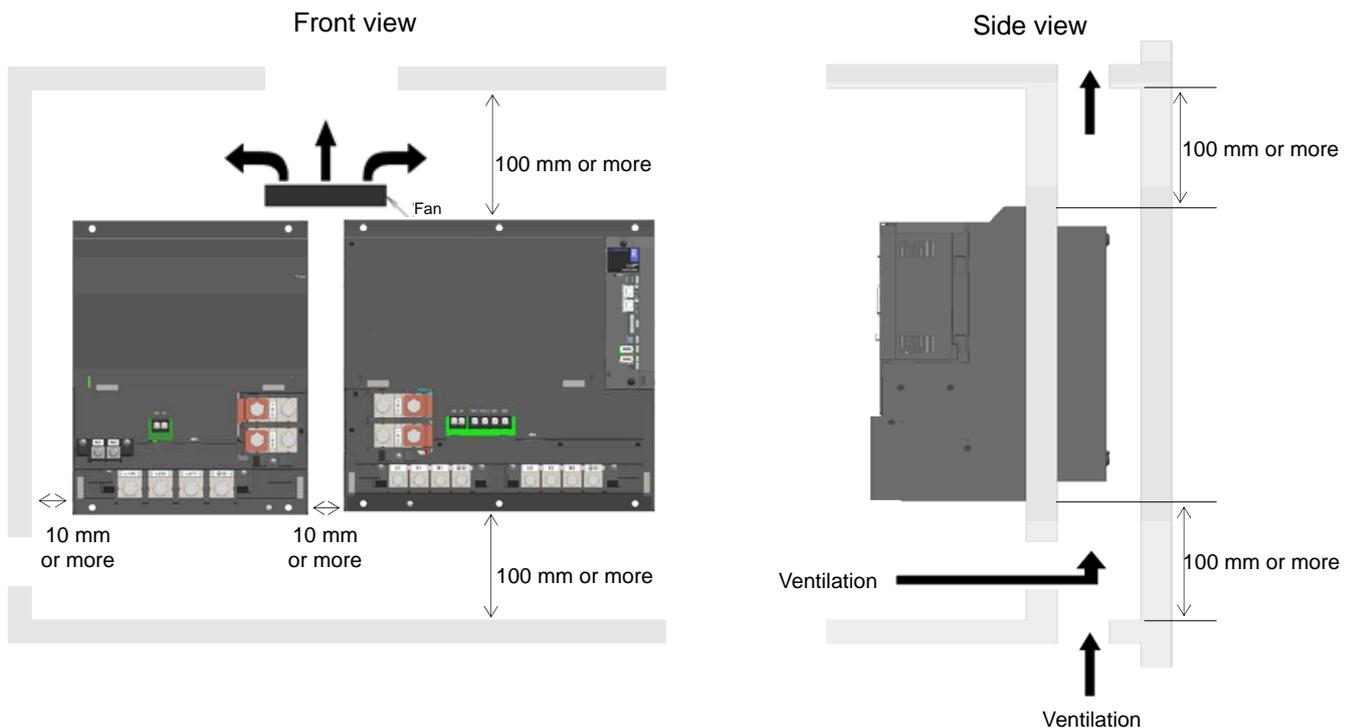
* Arrangement above is order of RS3PAC550 and RS3D80# from left side.

3-4

3. Installation

3.2 Rotary 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

SANMOTION R
AC SERVO SYSTEMS

MODEL R2AA06010FXPA0 — Model　No.
100W AC200V 0.86A
3000 min⁻¹ 3Ø-人 CI.F IP67
SER. NO. 01680386452 — Serial No.
SANYO DENKI MADE IN JAPAN 0011B/13.01
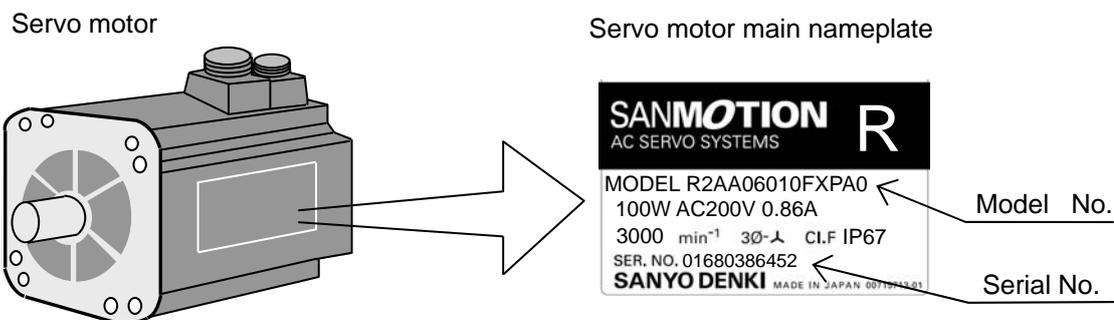
3.2.3 Installation

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 Storage temperature: -20 to 65°C Ambient humidity: 20 to 90%	Good ventilation, no corrosive or explosive gases present. No dust or dirt accumulation in the environment. 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. In some models, 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.

■ The motor connector and cable outlet should be installed facing downwards, as nearly vertical as possible.

■ In vertical installation, create a cable trap to prevent oily water from getting into the motor.

Cable trap

Wires
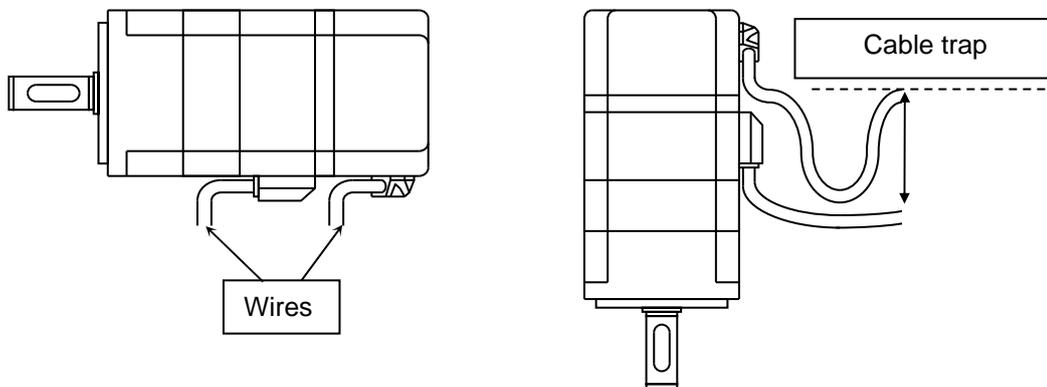
3.2.5 Waterproofing and dust proofing

■ 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.

■ The motor waterproofing is of IPX 7 class level, but still requires careful handling. If the motor is continuously wet, due to the respiratory effect of the motor, liquid might penetrate inside the motor.

■ 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).

■ In case of a cannon plug type motor, please use a waterproofed type plug.

3. Installation

3.2.6 Protective cover installation

■ Install a protective cover (as described below) for motors continuously subjected to liquids.

■ Turn the connectors (lead outlets) downwards within the angle range shown in the picture below.

■ 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.

■ If it is not possible to install the connectors (lead outlets) facing downwards, create a sag in the cable to prevent water or oil from entering the motor.
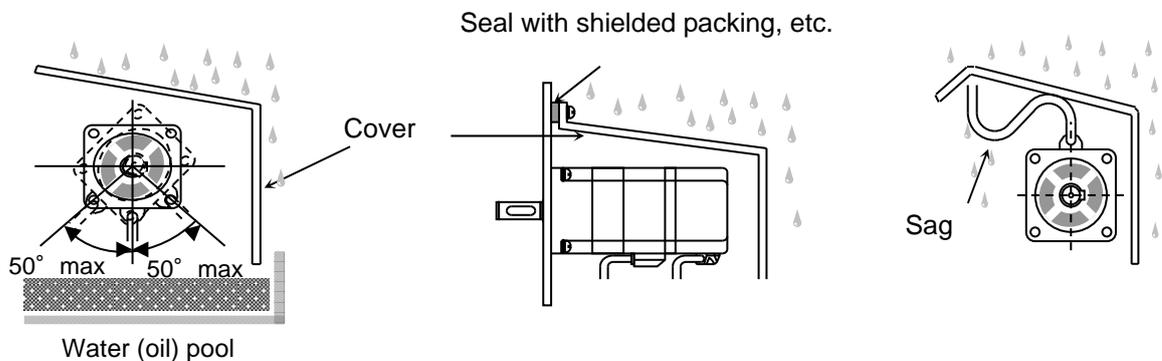
3.2.7 Gear installation and Integration with the target machinery

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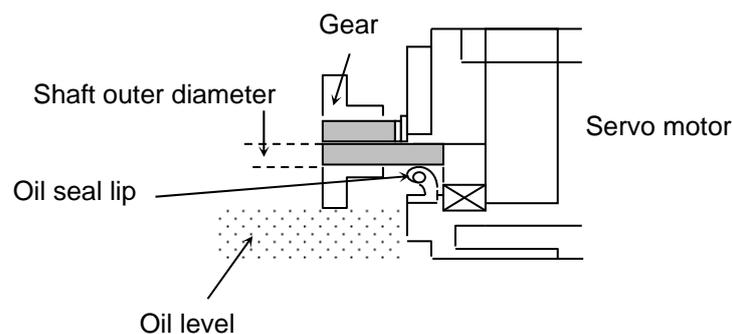
■ Refer to the drawing below for correct centering of the motor shaft and the target machinery. Please note when using a rigid coupling that even a slight mistake in centering can damage the output shaft.

Measured at all 4 locations, the difference between the maximum and the minimum should not exceed 3/100mm.
(coupling rotates jointly)
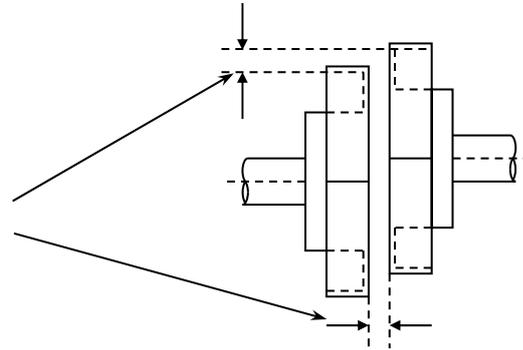
■ Do not apply any shocks on the servo motor shaft because precision equipment, encoder is directly connected to it. If it is absolutely necessary to hit the motor for position adjustment or other reasons, use a rubber or plastic hammer and hit the front flange area.
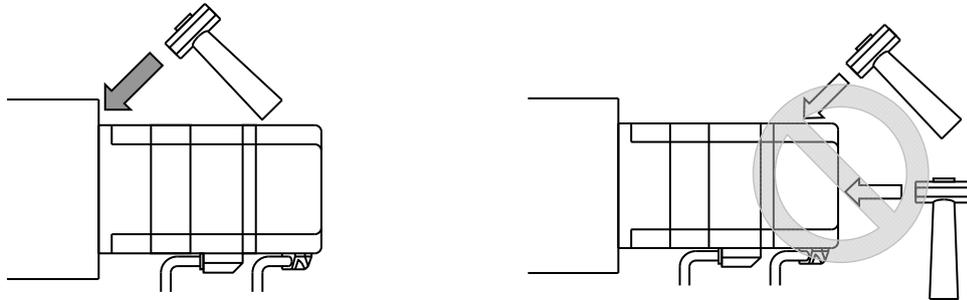
■ For mounting to a machine, create accurate enough mounting holes for smooth coupling of the motor flange rabbet. The mounting surface should be flat, otherwise damage to the shaft or the load may occur.

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

Bolt

Pulley   Plate
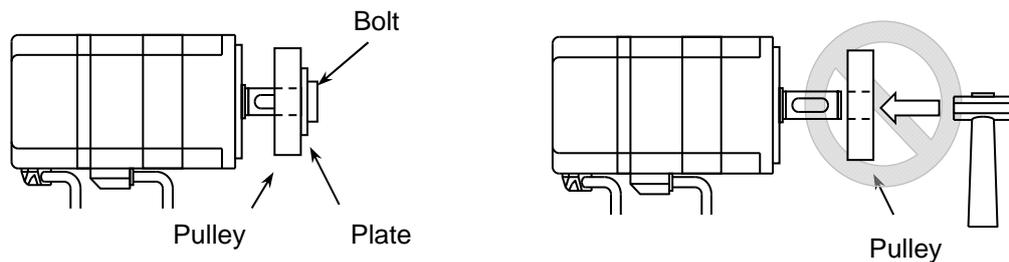
Pulley

■ Tapered servo motor shafts transmit the torque via the tapered surface. Make sure the key fits without rattling. The tapered surface contact should be no less than 70%.

Installation 3

3. Installation

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

Removal tool

Tapered
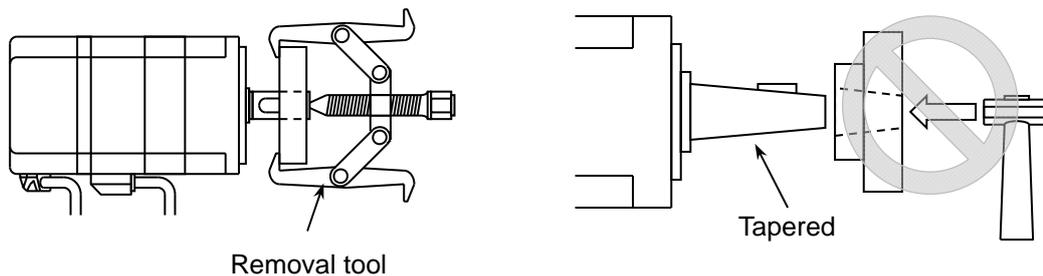
3.2.8 Allowable bearing load

■ 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.

LR

LR/3

Thrust load

Direction F

Direction F1
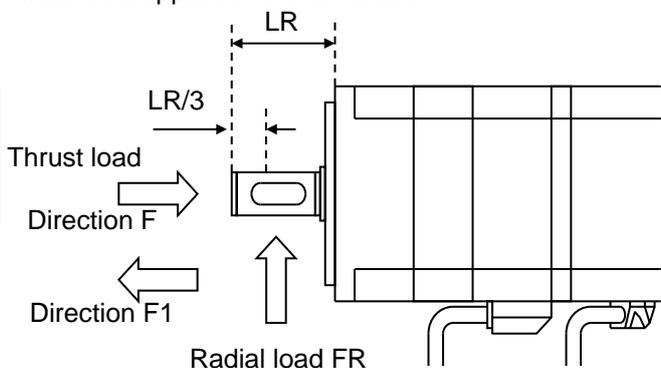
Radial load FR

■ Input voltage 100, 200V AC (10 to 300A)

	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
R1	R1□A04005	150	98	98	98	29	29
	R1□A04010	150	98	98	98	29	29
	R1□A06020	390	200	200	200	68	68
	R1AA06040	390	200	200	200	68	68
	R1AA08075	590	390	390	340	200	200
	R1AA10100	980	290	290	690	290	290
	R1AA10150	980	290	290	690	290	290
	R1AA10200	980	290	290	690	290	290
	R1AA10250	980	290	290	690	290	290
	R1AA13300	2000	390	390	980	390	390
	R1AA13400	2000	390	390	980	390	390
	R1AA13500	2000	390	390	1200	390	390
	R1AA18550	3900	2000	2000	1800	590	590
	R1AA18750	3900	2000	2000	1800	590	590
	R1AA1811K	3900	2000	2000	1800	590	590
	R1AA1815K	3900	2000	2000	2700	1500	1500

■ Input voltage 100, 200V AC (10 to 300A, continued)

	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
R2	R2□A04003	98	78	78	49	29	29
	R2□A04005	150	98	98	98	29	29
	R2EA04008	150	98	98	98	29	29
	R2AA04010	150	98	98	98	29	29
	R2□A06010	150	98	98	98	29	29
	R2□A06020	390	200	200	200	68	68
	R2AA06040	390	200	200	250	68	68
	R2AA08020	390	200	200	200	98	98
	R2AA08040	390	200	200	250	98	98
	R2AA08075	590	390	390	340	200	200
	R2AAB8075	590	780	290	340	200	200
	R2AAB8100	590	780	290	340	200	200
	R2AA10075	590	780	290	340	200	200
	R2AA10100	590	780	290	340	200	200
	R2AA13050	980	1400	1400	640	490	490
	R2AA13120	1700	1900	1900	640	490	490
	R2AA13180	1700	1900	1900	640	490	490
	R2AA13200	1700	1900	1900	640	490	490
	R2AA18350	2300	1900	1900	1500	290	290
	R2AA18450	2300	1900	1900	1500	290	290
	R2AA18550	3900	2000	2000	1800	590	590
	R2AA18750	3900	2000	2000	1800	590	590
	R2AA1811K	3900	2000	2000	1800	590	590
	R2AA22500	2300	1900	1900	1500	490	490
	R2AA22700	3900	2000	2000	2500	1100	1100
	R2AA2211K	3900	2000	2000	2700	1500	1500
	R2AA2215K	3900	2000	2000	2700	1500	1500
R5	R5AA06020	390	200	200	200	68	68
	R5AA06040	390	200	200	250	68	68
	R5AA08075	390	390	390	340	200	200

Installation 3

3. Installation

■ Input voltage 100, 200V AC (600A)

	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
R1	R1AA2220KV	3900	2000	2000	2700	1500	1500
R2	R2AA2220KB	3900	2000	2000	2700	1500	1500
	R2AA2225KB						
	R2AA2830KV	4700	2000	2000	3300	1500	1500

■ Input voltage 400V AC

	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
R1	R1CA10150	980	290	290	690	290	290
	R1CA10200	980	290	290	690	290	290
	R1CA13300	2000	390	390	980	390	390
	R1CA18550	3900	2000	2000	1800	590	590
	R1CA18750	3900	2000	2000	1800	590	590
	R1CA1811K	3900	2000	2000	1800	590	590
	R1CA1815K	3900	2000	2000	2700	1500	1500
	R1CA2220K	3900	2000	2000	2700	1500	1500
R2	R2CA10075	590	780	290	340	200	200
	R2CA10100	590	780	290	340	200	200
	R2CA13050	980	1400	1400	640	490	490
	R2CA13120	1700	1900	1900	640	490	490
	R2CA13180	1700	1900	1900	640	490	490
	R2CA13200	1700	1900	1900	640	490	490
	R2CA18350	2300	1900	1900	1500	290	290
	R2CA18450	2300	1900	1900	1500	290	290
	R2CA18550	3900	2000	2000	1800	590	590
	R2CA18750	3900	2000	2000	1800	590	590
	R2CA2211K	3900	2000	2000	2700	1500	1500
	R2CA2215K	3900	2000	2000	2700	1500	1500
	R2CA2220K	3900	2000	2000	2700	1500	1500
	R2CA2830K	4700	2000	2000	3300	1500	1500
	R2CA3255KB	8500	3400	3400	5900	2000	2000

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.

Installation   3

3. Installation

3.3 Linear motor

3.3.1 Precautions on linear motor installation

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

■ Prevention of impairment

Strong magnet is mounted in magnet rail, so those who is wearing medical equipment, such as pacemakers, or being implanted magnetic metal into the body, make sure to keep 0.5m or over away from linear motor, and do not perform unpacking. Severe physical impairment can occur due to equipment failure or strong magnetic attraction of magnetic metal. So pay careful attention to not only operators but also people around work area.

Magnet rail structure is such that magnet is adhered on the surface of back iron which has magnetic body.
There is almost no magnetic field on the mounting surface of back iron, and magnetic attraction is weak. (Less than one tenth the own weight)
However, please also be aware that powerful magnetic field generates on the surface of magnet, and strong magnetic attractive force generates between magnetic bodies. Coil is not mounting magnet in, however, consisting of magnetic substances.

Magnet
Magnetic attraction is strong on the surface

Back iron (magnetic substances)
Magnetic attraction is weak on the mounting surface

Coil
Consisting of magnetic substances
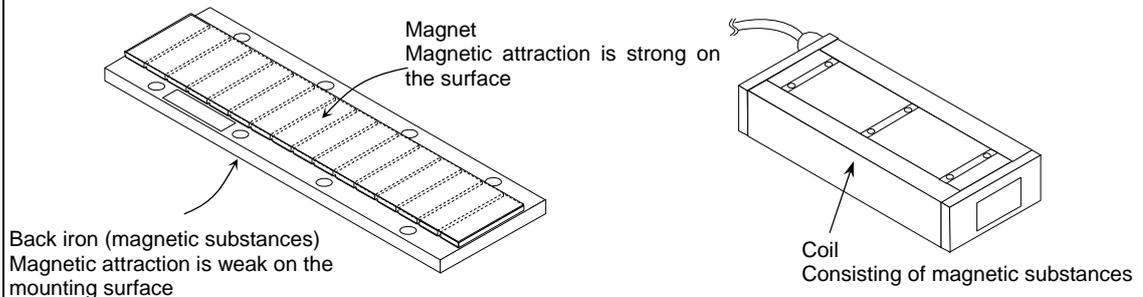
Magnet rail body is wrapped in plastic bag, and protection material (styrene foam) whose thickness is approximately 20mm is enclosed on the surface of magnet to reduce magnetic attraction.
Do not remove the protection material until just before mounting process.

Protection material enclosed on the surface of magnet.

Plastic bag

Magnet rail

Packing of single magnet rail
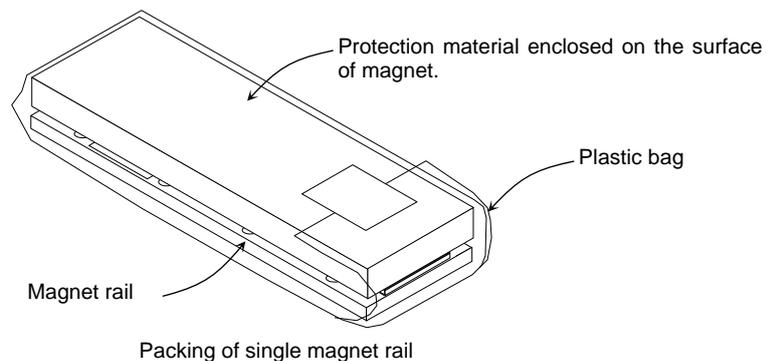
Operators shall not wear any rings, watches, or magnetic cards.
Putting magnetic storage media, such as magnetic card or floppy disk, and PC close to magnet rail can result in damages to the data or equipment failures.

Never touch edge of magnet rail stainless-steel cover or coil with bare hands. Failure to do so can result in injuries. Make sure to protect your hands with gloves to perform installation. However, please also make sure not to use gloves when operating motor to prevent operators being caught in.

Stainless-steel cover
Magnet rail
Edge
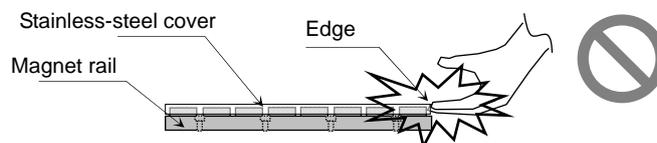
3.3 Linear motor

Take care to keep the magnetic substances other than tools needed away from magnet rail.
Strong magnet is mounted in magnet rail, so strong attraction generates between a piece of iron, steel tool, or magnet, and your hand may be gotten stuck in, and this can cause severe physical impairment. The smaller the gap is, the more sharply-increased the magnetic attraction between magnet surface and magnet body is, and the magnetic attraction is proportional to the opposing area. It is dangerous as extremely great force up to approximately 4000N (400kgf) per 100cm^2 (10cm square) of the opposing area generates.

Magnetic material

Magnet rail

Magnet surface + magnetic body

Magnet rail

Magnet surface + back iron surface

Magnet rail

Magnet surface + magnet surface

Up to approximately 4000N (400kgf) per 100cm^2 (10cm square) of the opposing area generates.
The magnetic attraction is proportional to the opposing area.

Gap

Magnetic attraction per 100cm^2 of the opposing area

Magnetic attraction per 100cm^2 of the opposing area (N) vs Gap (mm)
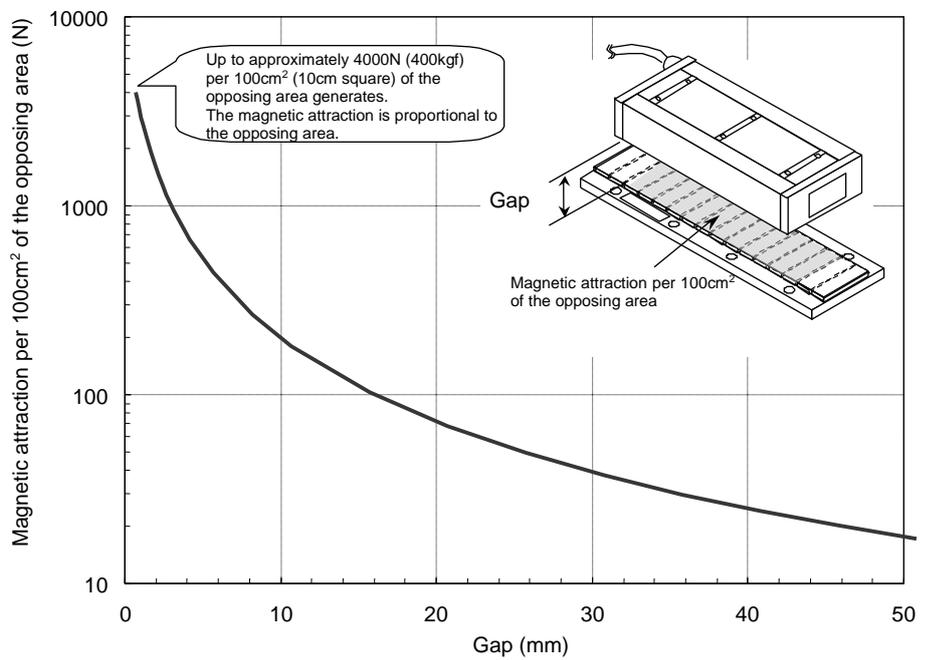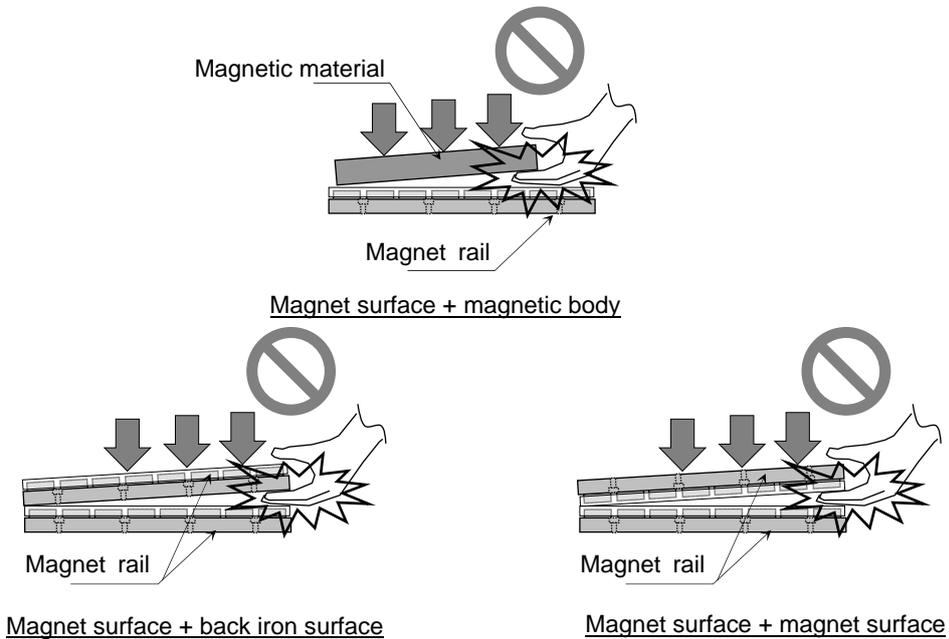
If you suspend unpacking, return the unpacked items to the original packing state.
If you leave the magnet rail as it is, strong attraction generates between magnetic bodies, your hand may be gotten stuck in, and this can cause severe physical impairment.

3-14

3. Installation

■　Prevention of system damage

Take care not to have a hand on edge of magnet stainless-steel cover. Applying stress to the edge can cause deformation or removal, and then damages to the product.

Edge

Stainless-steel cover
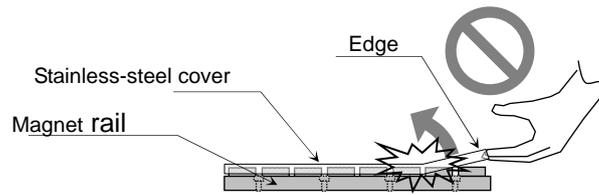
Magnet rail

Take care not to drop items such as tools, bolts (especially magnetic materials) onto magnet rail surface. This can cause deformation and damage of cover, crack and chip on magnet, and then damages to the product.

Any tools

Bolt, washer

Any tools

Magnet rail
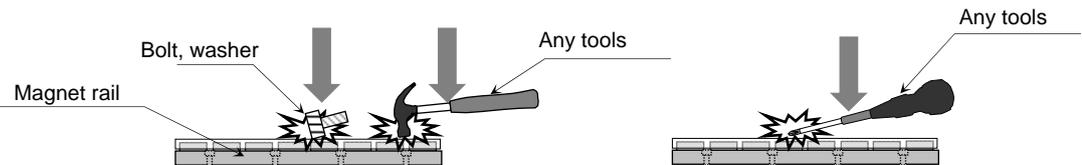
3.3.2 Unpacking

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

■ Unpack after checking upside and downside. Failure to do this can result in injuries.
■ Check servo motor model number to see if any discrepancies between ordered item and delivered item. Model number is marked after each product nameplate "MODEL."
  Nameplate is placed onto coil and magnet rail respectively.
  Position to which nameplate placed varies depending on linear motor models.
  Installing incorrect model number product can result in injuries or damages.
■ Check servo motor exterior to see if any problems.
■ Check servo motor screws to see if any looseness.

Example of linear motor main nameplate

SANMOTION
LINEAR AC SERVO SYSTEMS

MODEL [-------------------]
[----------]N   AC200V   [--------]A
       mm   3Ø-λ   WDG.F
SER. NO. [-------------------]
SANYO DENKI   MADE IN JAPAN   DD5D6D24-D1

Model number

Serial number

Nameplate is placed here.
(Coil)

Nameplate is placed here.
(Magnet rail)

Nameplate is placed here.
(Coil)

Nameplate is placed here.
(Cylinder-type linear motor)
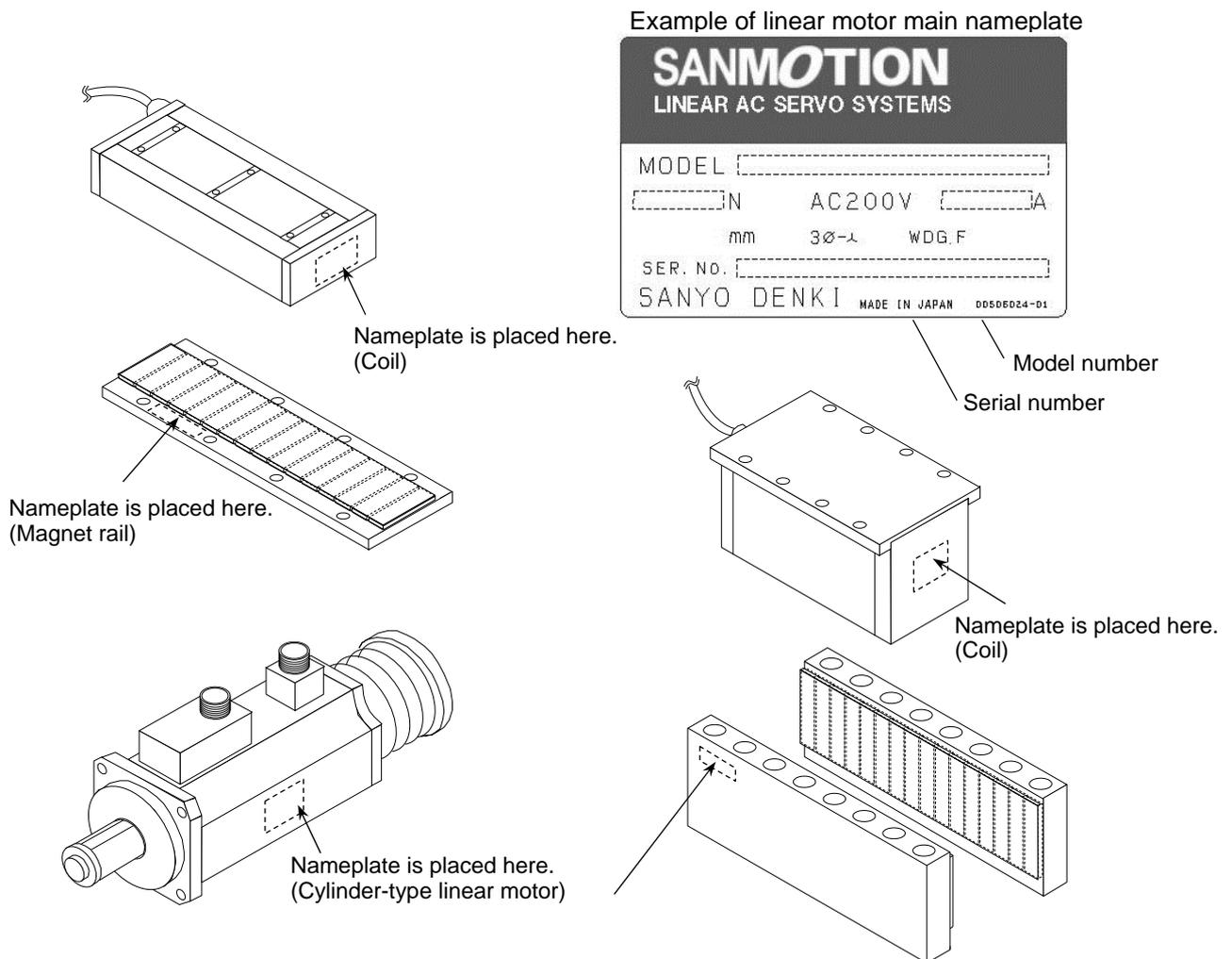
3 Installation

3. Installation

3.3.3 Installation of flat-type linear motor with core

■ Mounting magnet rail

Step	Description
1	Strong magnet is mounted on the surface of magnet rail. Strong magnetic attraction works when putting magnetic substances such as motor coil, steel tools or other magnet rail closer to the magnet rail. Take great care not to get your hand stuck in.
2	Magnetic attraction works between magnet rail and motor coil. This force always stays constant, and works even if motor power supply not tuned on. So the system structure needs to have sufficient rigidity enough to support magnetic attraction and maintain the accuracy.
3	Driving motor with foreign substances, such as magnetic powder, magnetic metal, or dirt, adsorbed onto the surface of magnet rail, the foreign substances can be gotten caught in the moving part, and then this causes failures. Place bellows or sliding cover to prevent adhesion of foreign substances, depending on the operating environments. Always keep magnet rail surface clean.
4	Face all the nameplates on magnet rail in the same direction.
5	Make sure that mounting front surface is the back surface (even surface) to install magnet rail. Closing the front surface to the mounting surface generates magnetic attraction, this can cause injuries or damages.
6	Place magnet rails with all their positioning pin hole placed in the same direction on the same side. Please be aware of that mounting magnet rails with their positioning holes placed upside down makes magnet polarity incorrect, and this can cause going out of control.
7	Secure the magnet rails one by one with all the mounting screws. Tightening torque, mating length and screw strength class of mounting screw depends on the values written in the outline drawing of magnet rail. Also, use a thread locker. Magnet rail not fastened with screw can generate attraction when bringing other magnet rails or magnetic metal close to the magnet rail, this can cause injuries and damages.
8	Place magnet rails from the end in order. When mounting a magnet rail next to the already fixed magnet rail, put the magnet rail from the side not from the top. Magnetic attraction can generate, and this can cause injuries and damages.

■ Installation of coil <Mounting coil where magnet rail not mounted. >

Step	Description
1	First mount one-half of the entire length of magnet rail. Make sure that both the magnet rail length and the length magnet rail not yet mounted shall be more than 50mm longer than coil length. Shock absorber Linear encoder (Scale tape) Linear guide Linear motor (Magnet rail) Linear guide rail
2	Place the coil via spacer to the base where magnet rail not yet mounted. Use the material avoiding base or coil being damaged for spacer. Take care not to get your fingers stuck between coil and base. Please use the spacer thinner than magnet rail in some degree. Stage Linear encoder (Read head) Spacer Linear motor (Coil) Linear motor (Magnet rail)
3	Secure the coil with all the mounting screws. Use screw strength class: more than 10.9, and use thread locker. And, tightening torque and mating length of mounting screw depends on the values written in the outline drawing of coil. Assembly dimension between magnet rail and coil depends on the values written in the outline drawing of coil. Stage (Supported by linear guide.) Coil Magnet rail Assembly dimension Base
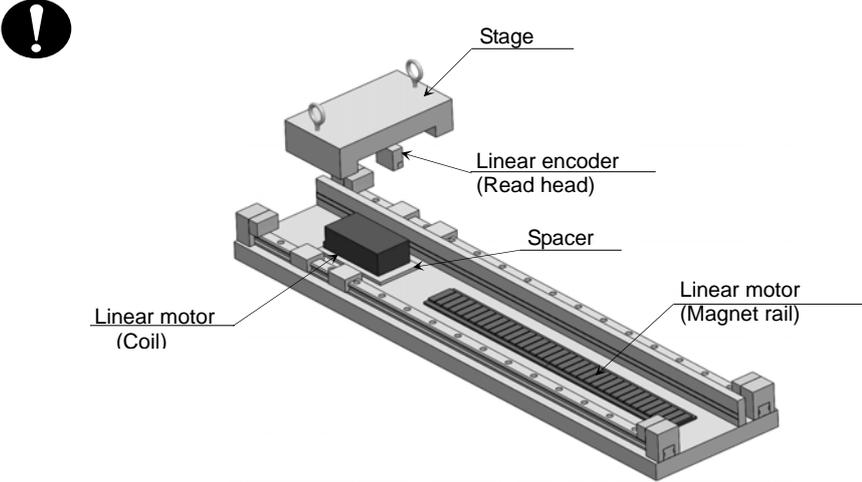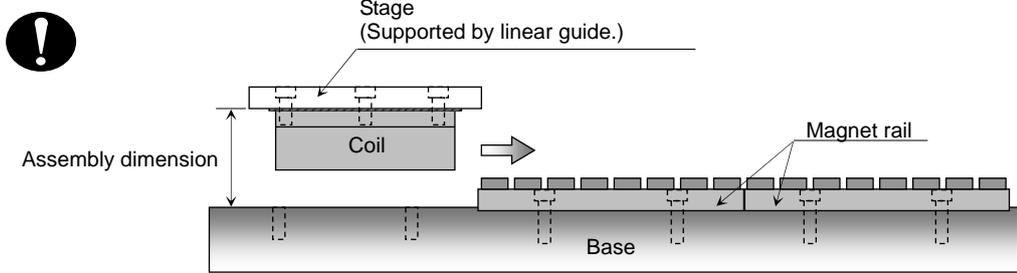
3. Installation

Step	Description
4	Slide the moving stage with coil mounted across the magnet rail fasten with screw. The attraction that coil drawn to the magnet surface at this time is as indicated in the table below. The attraction goes off when the entire coil is over the magnet rail. The attraction when mounting: generates value ± in cycle of approximately 16mm _(see table below)_
5	Mount the last half of the magnet rail.
6	The installation is completed when motor mounting completed. Perform wirings.

Step 4 attraction table:

Series	Attraction
DS030C####	Approx. ±60N
DS045C####	Approx. ±100N
DS050C####	Approx. ±100N
DS075C####	Approx. ±150N
DS100C####	Approx. ±200N
DS150C####	Approx. ±300N

Step 6 labels:
Shock absorber, Cableveyor, Stage, Linear motor (Coil), Linear motor (Magnet rail), Linear guide, Linear guide rail

■   Installation of coil <Mounting coil where magnet rail mounted. >

Step	Description
1	After installing the entire magnet rail, place coil via nonmagnetic spacer whose thickness is more than 50mm to the magnet rail surface. Use the nonmagnetic spacer whose materials are not being compressed by coil weight.
2	Place removal tap so that stage can be moved up and down in a horizontal direction with bolts. Stage can be lifted up by contacting with the tip of removal bolt. Use resin spacer so as not to scratch base even if removal bolt hits the base. Determine tap shape, the number of tap, and spacer in consideration of magnetic attraction.
3	Place stage onto coil, fasten the coil and stage, lift the coil including stage by using removal bolts with removal taps placed in the stage, separate coil from nonmagnetic spacer, and then remove the nonmagnetic spacer.
4	Move the stage down to be locked with guide block in a parallel fashion by pushing removal screw down in order. After that, remove the removal bolts. Stage positioning shall be performed where the space between coil and magnet is wide and magnetic attraction is small.
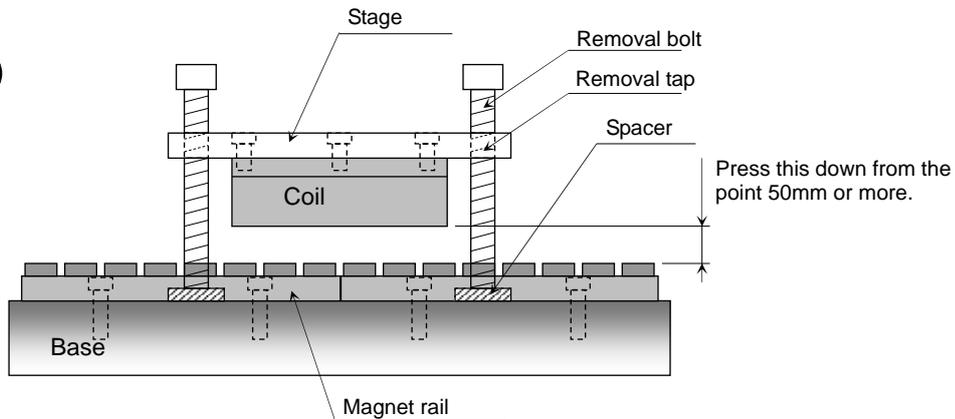
Magnetic attraction vs Clearance characteristic
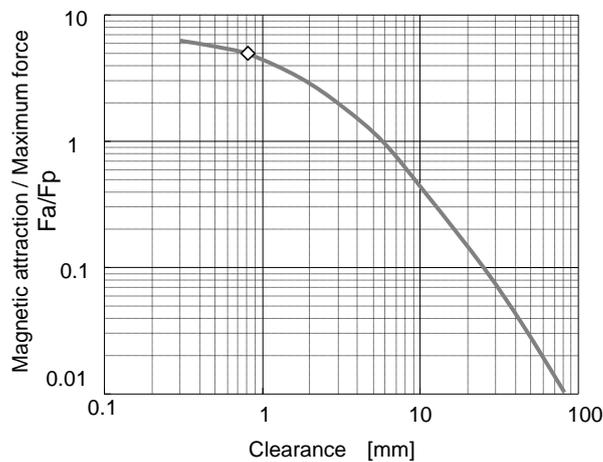
Keep clearance 50mm or more between coil and magnet rail while installing, for the safety.
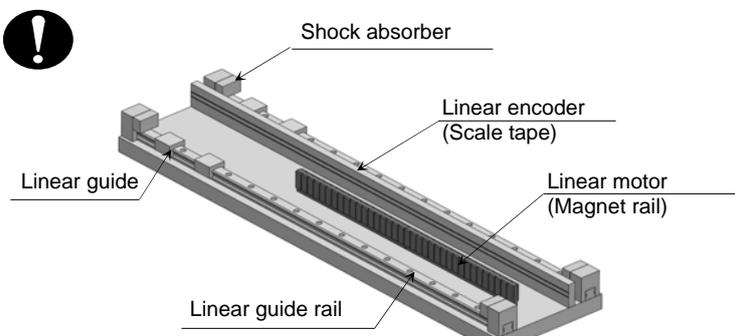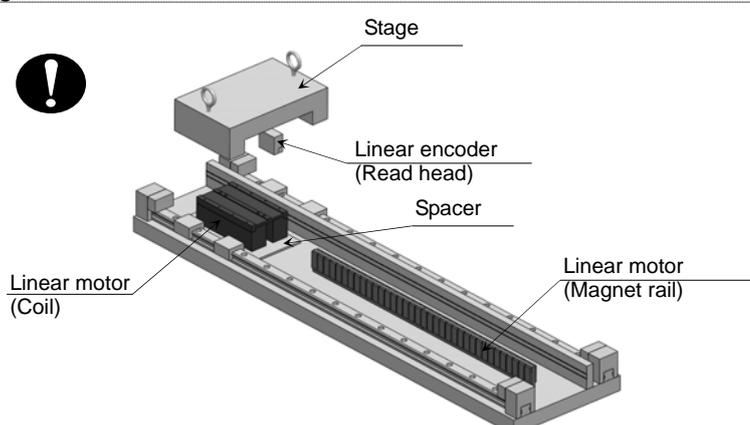
3. Installation

3.3.4 Installation of twin-type linear motor with core

■ Mounting magnet rail and the precautions

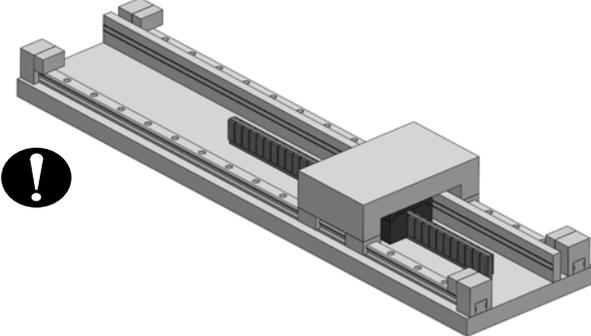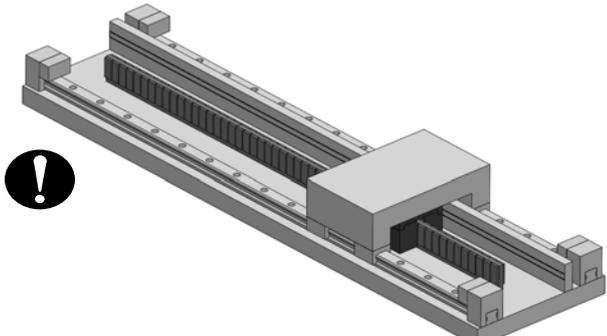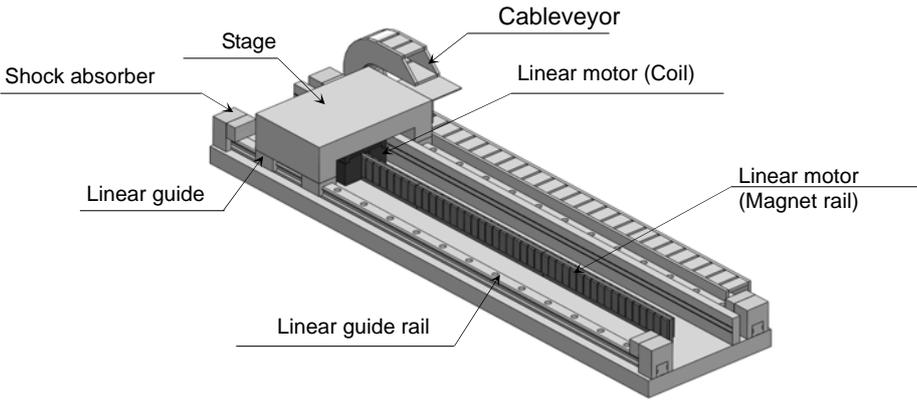| Step	Description
1	Strong magnet is mounted on the surface of magnet rail. Strong magnetic attraction works when putting magnetic substances such as motor coil, steel tools, or other magnet rail closer to the magnet rail. Take great care not to get your hand stuck in.
2	Magnetic attraction works between magnet rail and motor coil. This force always stays constant, and works even if motor power supply not tuned on. So the system structure needs to have sufficient rigidity enough to support magnetic attraction and maintain the accuracy.
3	Driving motor with foreign substances, such as magnetic powder, magnetic metal, or dirt, adsorbed onto the surface of magnet rail, the foreign substances can be gotten caught in the moving part, and then this causes failures. Place bellows or sliding cover to prevent adhesion of foreign substances, depending on the operating environments. Always keep magnet rail surface clean.
4	Install magnet rails so that two magnet surfaces (convex side) of both magnet rails face each other. Make sure not to let the both magnet rails being attracted each other by inserting nonmagnetic spacer (Width: 30 to 80mm, height: more than 100mm) between the magnet rails facing each other for your safety. Nonmagnetic space (Aluminum, wood) Magnet rail
5	To place magnet rail, the surface with counterbore in its mounting hole is the upper side. Mounting magnet rail upside down makes mounting bolt head interfere with motor coil, and this can cause damages.
6	Secure the magnet rails one by one with all the mounting screws. Tightening torque, mating length and screw strength class of mounting screw depends on the values written in the outline drawing of magnet rail. Also, use a thread locker. Magnet rail not fastened with screw can generate attraction when bringing other magnet rails or magnetic metal close to the magnet rail, this can cause injuries and damages. Magnet rail: fixed — Nonmagnetic spacer Magnet rail: not fixed — Magnet rail: fixed Magnet rail: fixed — Nonmagnetic spacer — Magnet rail: not fixed
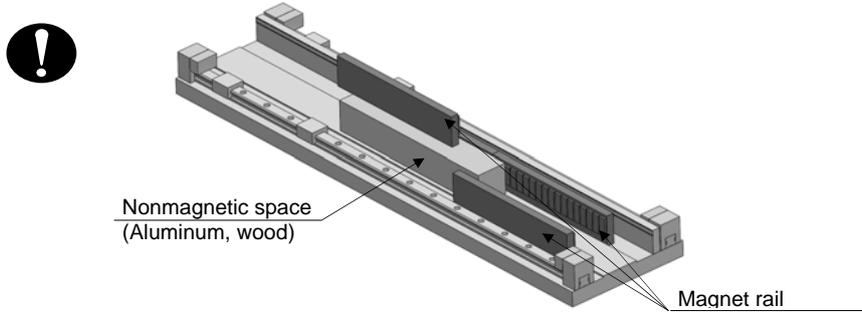
7	Place magnet rails from the end in order. When mounting a magnet rail next to the already fixed magnet rail, put the magnet rail from the stroke direction not from the orthogonal (facing magnet surface). Magnetic attraction can generate, and this can cause injuries and damages.

■   Mounting coil

Step	Description
1	First mount one-half of the entire length of magnet rail. Make sure that both the magnet rail length and the length magnet rail not yet mounted shall be more than 50mm longer than coil length.
2	Mount dummy magnet rail on the stroke area magnet rail not mounted, insert motor coil into the area dummy magnet rail mounted. Take care not to get your fingers stuck between motor coil and base. (Prepare the dummy magnet rail for D###C1-4 only. Refer to the outline drawing, for shape.)

3-22

3. Installation

	3	Temporary fasten motor coil and stage with bolts, and adjust the gap length between dummy magnet rail and coil so as to be appropriate value (gap length refer the outline drawing of coil). 0.2mm or less is recommended for the difference between two points of the gap between dummy magnet rail and motor coil. After adjusting gap, tighten the bolts for fastening motor coil and stage. Use all the mounting screws for motor coil. Use screw strength class: more than 10.9, and use thread locker. And, tightening torque and mating length of mounting screw depends on the values written in the outline drawing of coil.

Stage
Dummy magnet rail
Linear motor (Magnet rail)
Linear motor (Coil)
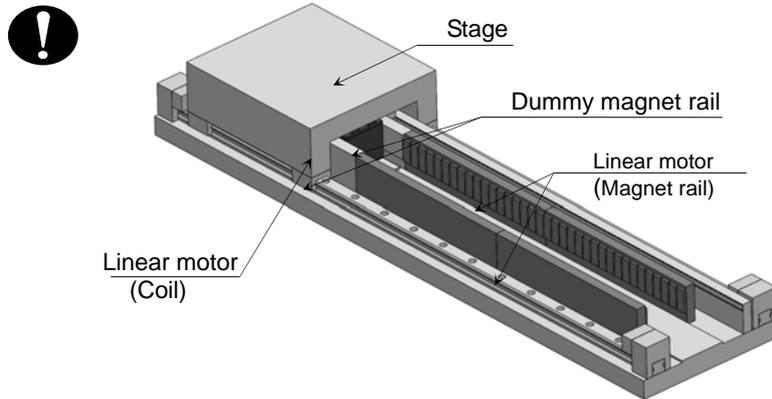
[Adjusting gap]

Make sure to perform gap adjustment only within the area motor coil faces dummy magnet rail. Strong magnetic attraction is acting on motor coil within the area magnet rails face each other, so this can cause injuries and damages. Never perform gap adjustment within the area magnet rails face each other.

By using off-centric pin (DD###C1-4)

When using off-centric pin, perform gap adjustment from the upper side of the stage.

Place more than four off-centric pin holes on the stage. These hole positions shall be located on the points of motor coil top board with which off-centric pin ends contact. If stress of off-centric pin is applied to the area other than top board, motor coil can be damaged. For hole position of off-centric pin, refer to the recommended values indicated below. For recommended shape of off-centric pin, refer to outline drawing. Gap adjustment is performed by inserting off-centric pin into off-centric pin hole on the stage, and then turning this pin side to side. 0.2mm or less is recommended for the difference between two points of the gap between dummy magnet rail and motor coil.

Off-centric pin for gap adjustment (4 points)
Stage
Motor coil
Dummy magnet rail
124±0.1
L
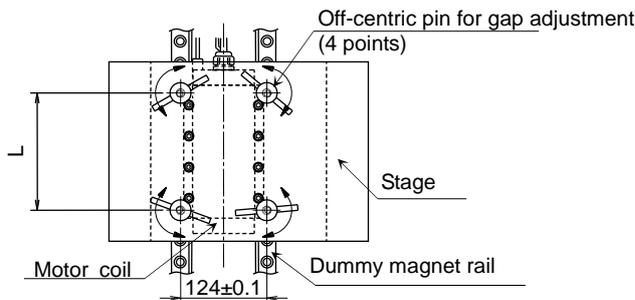
Coil model number	L [mm]
DD###C1	170±5
DD###C2	345±5
DD###C3	520±5
DD###C4	670±5
DD###CB4	300±5

(Position of off-centric pin hole for gap adjustment: dimensions recommended)

Off-centric pin for gap adjustment (4 points)
Stage
Motor coil
Dummy magnet rail
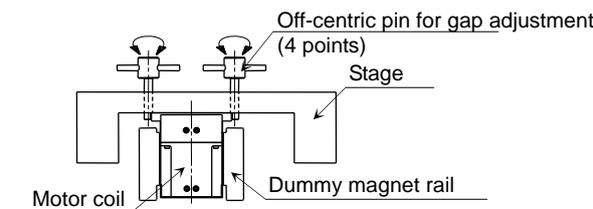
By using bolt (DD###C1-4)

When using bolts, gap adjustment shall be performed from the side of stage.
Place 4 taps for gap adjusting bolt on the side of stage.
This hole position shall be the place where gap adjusting bolt end contacts top panel of motor coil.
Applying bolt stress to the area other than the top board can damage the motor coil.
For bolt tap position, refer to the recommended values indicated in the figure below. M8 or M10 is recommended for tap diameter.
Gap adjustment is performed by installing bolts for gap adjustment in the taps on the side of stage, and then turning the bolts side to side. If the bolts are too short to reach the top board of coil, insert spacer between the end of bolt and top board. 0.2 mm or less is recommended for the difference between two points of the gap between dummy magnet rail and motor coil.
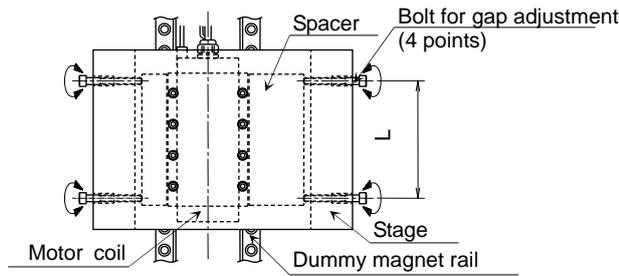
Coil model number	L [mm]
DD###C1	170±5
DD###C2	345±5
DD###C3	520±5
DD###C4	670±5
DD###CB4	300±5

3
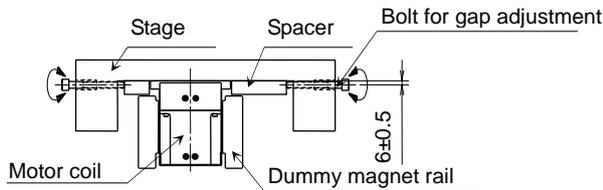
By using positioning pin (DD###CB, DD###CC)

DD###CB and DD###CC have pin holes for positioning on the coil-mounting side.
Prepare the positioning pins to machine side stage, for use. Refer to outline drawing of coil, for diameter, length, position and quantity of positioning pin.
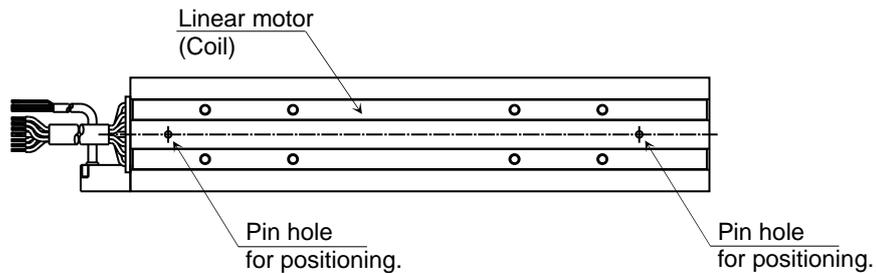
Installation 3

3. Installation

4	Slide the moving stage with coil mounted to the magnet rail fasten with screw. The attraction that coil drawn to the magnet surface at this time is as indicated in the table below. The attraction goes off when the entire coil is over the magnet rail. The attraction when mounting: generates value ± in cycle of approximately 16mm	
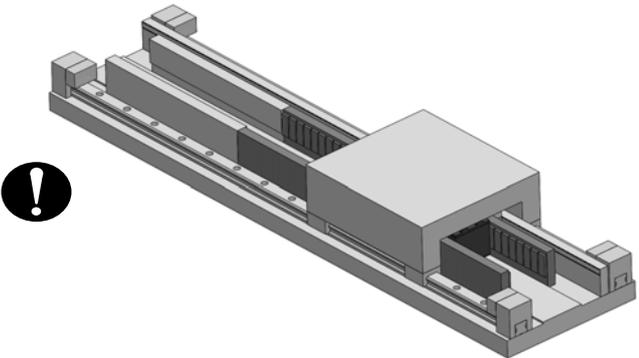
Series	Attraction
DD030C####	Approx.±120N
DD035C####	Approx.±160N
DD045C####	Approx.±200N
DD050C####	Approx.±200N
DD075C####	Approx.±300N

5	Remove dummy magnet rail and mount the last half of the magnet rail.

6	Perform wirings after completing motor installation.

Stage

Cableveyor

Shock absorber

Linear motor (Coil)

Linear guide

Linear motor (Magnet rail)

Linear guide rail

3.2.5 Installation of center magnet type linear motor with core

■　Mounting magnet rail, and caution

Step	Description
1	Strong magnet is mounted on the surface of magnet rail. Strong magnetic attraction works when putting magnetic substances such as motor coil, steel tools or other magnet rail closer to the magnet rail. Take great care not to get your hand stuck in.
2	Magnetic attraction works between magnet rail and motor coil. This force always stays constant, and works even if motor power supply not tuned on. So the system structure needs to have sufficient rigidity enough to support magnetic attraction and maintain the accuracy.
3	Driving motor with foreign substances, such as magnetic powder, magnetic metal, or dirt, adsorbed onto the surface of magnet rail, the foreign substances can be gotten caught in the moving part, and then this causes failures. Place bellows or sliding cover to prevent adhesion of foreign substances, depending on the operating environments. Always keep magnet rail surface clean.
4	Face all the nameplates on magnet rail in the same direction. Magnet rail Nameplate
5	Make sure that nameplate is lower side (mounting side) to install magnet rail. If it is to be mounted upside down, strong magnetic attraction is generated and this can cause injuries or damages. Moreover, this can cause a motor force reduction, driving-characteristic reduction and abnormal heat generation.
6	Secure the magnet rails one by one with all the mounting screws. Tightening torque and mating length of mounting screw depends on the values written in the outline drawing of magnet rail. Also, use screw strength class: more than 10.9, and use thread locker. Magnet rail not fastened with screw can generate attraction when bringing other magnet rails or magnetic metal close to the magnet rail, this can cause injuries and damages.
7	Place magnet rails from the end in order. When mounting a magnet rail next to the already fixed magnet rail, put the magnet rail from the side not from the top. Magnetic attraction can generate, and this can cause injuries and damages.

3. Installation

■ Mounting coil

Step	Description
1	First mount one-half of the entire length of magnet rail. Make sure that both the magnet rail length and the length magnet rail not yet mounted shall be more than 50mm longer than coil length.
	Shock absorber Linear encoder (Scale tape) Linear guide Linear motor (Magnet rail) Linear guide rail
2	Put a coil along with spacer on the stroke area without magnet rail. For spacer, use the material which does not scar a base or coil. Pay attention to avoid pinching fingers, between base and coil.
	Stage Linear encoder (Read head) Spacer Linear motor (Coil) Linear motor (Magnet rail)
3	Secure the coil with all the mounting screws. Use screw strength class: more than 10.9, and use thread locker. And, tightening torque and mating length of mounting screw depends on the values written in the outline drawing of coil. Assembly dimension between magnet rail and coil depends on the values written in the outline drawing of coil.
	[Adjusting gap]
	Make sure to perform gap adjustment only within the area motor coil faces dummy magnet rail. Strong magnetic attraction is acting on motor coil within the area magnet rails face each other, so this can cause injuries and damages. DT###C has pin holes for positioning on the coil-mounting side. Prepare the positioning pins to machine side stage, for use. Refer to outline drawing of coil, for diameter, length, position and quantity of positioning pin.
	Linear motor (Coil) Pin hole for positioning
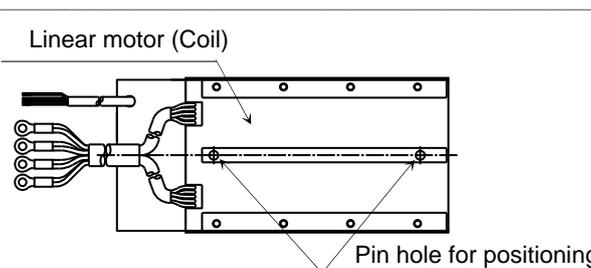
4	Slide the moving stage with coil mounted across the magnet rail fasten with screw. The attraction that coil drawn to the magnet surface at this time is as indicated in the table below. The attraction goes off when the entire coil is over the magnet rail. The attraction when mounting: generates value ± in cycle of approximately 16mm Series / Attraction table: <table><tr><td>Series</td><td>Attraction</td></tr><tr><td>DT030CD###</td><td>Approx.±250N</td></tr></table>
5	Mount the last half of the magnet rail.
6	The installation is completed when motor mounting completed. Perform wirings. Cableveyor Stage Shock absorber Linear motor (Coil) Linear guide Linear motor (Magnet rail) Linear guide rail

Installation 3

3-28

3. Installation

3.2.6 Installation of cylinder-type motor

Step	Description
1	The rotational moment acting on load mounting plate on the output shaft is received by the rotation stopper on the counter-output shaft side alone. Therefore if excessive rotational moment load is acting on, this can cause motor damage or reduce the motor lifetime. Fix the mover to install load so as not to apply rotational moment to output shaft, and not to exceed the allowable load indicated in the table below. Maximum allowable moment load — Direction M — 0.8 (N·m) Maximum allowable radial load — Direction F_{R1} — 70 (N) Maximum allowable radial load — Direction F_{R2} — 70 (N)
2	Four screw taps for M5-screw provided on the top surface to dust prevention. An opening on the flange surface is passing completely through the interior of the motor. So using in the environment such as exposing to dust needs to perform air blower to prevent dust from entering the inside of the motor and to apply internal pressure. Perform piping to screw taps in which air is injected, to perform air blower. Plug the screw taps not used with M5-screw. The mating depth shall be 8mm or less.
3	This motor needs periodical grease refilling to avoid running out of oil film for the bearing. The recommend interval of grease refilling is either every 1500 to 1700km of mileage or every 8 to 10 months, whichever is shorter. Grease refilling shall be performed as follows: Refill grease into grease refilling hole of PT 1/8 on counter-output shaft side until grease overflows from grease check hole on output shaft side. Rub the grease overflowed off thoroughly. Recommended single grease refilling amount is less than the amount of two discharges of grease gun (0.7cc/ time-discharge). For motor mover position when refilling grease, the output shaft shall be moved further than the center of all the movable range. AFC grease (product of THK Co., Ltd.) is filled in the motor at the factory, so AFC grease is recommended for refilling. Grease check hole — For air blower of 4-M5 — PT1/8 Grease refilled
4	As return-to-origin operation after control power supply turned on, drive the motor coming across phase Z signal at least 1 time. If use the motor without coming across phase Z signal, the force to be generated can decrease to approximately one-half of the specified value.
5	If drive stroke is always shorter than 10mm, grease cannot be applied to ball bearing. This cause fretting damage due to lack of oil film. So you need devices to add whole stroke operation during continuous drive pattern when operating with a short stroke. Please contact us for further detailed setting of drive patterns.
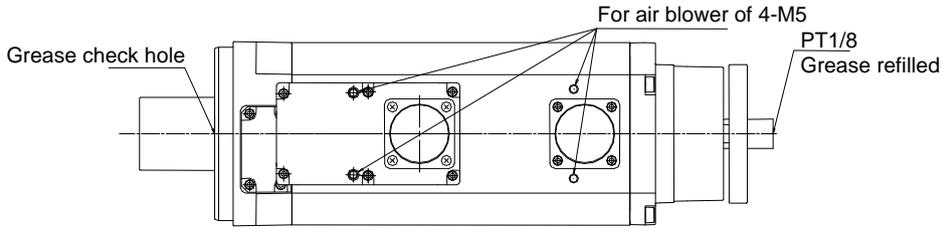
4

Wiring

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

4. Wiring

4.1 Wiring for the terminal of high voltage and grounding

4.1.1 Part name and function

■ Input voltage 200V AC

Terminal name	Connector marking	Remarks	
Main circuit power supply	R·T or R·S·T	Single phase 100 to 120 VAC +10%, -15% 50/60Hz±3%	
		Single phase 200 to 240 VAC +10%, -15% 50/60Hz±3%	
		Three-phase 200 to 240 VAC +10%, -15% 50/60Hz±3%	
Control power supply	r·t	Single phase 100 to 120 VAC +10%, -15% 50/60Hz±3%	
		Single phase 200 to 240 VAC +10%, -15% 50/60Hz±3%	
Servo motor connector	U·V·W	Connected with servo motor	
Protective grounding terminal	⏚	Connected with grounding wire of power supply and of servo motor.	
Regeneration resistance connector	RB1·RB2 RB4	RS3□01 RS3□02 RS3□03 RS3A05 RS3A30 RS3W60	Connects regenerative resistance to terminal RB1 and RB2. Built-in regenerative resistor model has already connected at factory setting. Connects external regenerative resistor to terminal RB1 and RB2 when regenerative performance is insufficient. RB4 terminal is not equipped.
		RS3A07 RS3A10 RS3A15	Built-in regenerative resistor model has short-bar between RB1 and RB4 at factory setting. Connects external regenerative resistor to terminal RB1 and RB2 after removing the short-bar when regenerative performance is insufficient.
Maker maintenance	P·⊖	For maker maintenance. Do not connect anything.	

■　Input voltage 400V AC

Terminal name	Connector marking	Remarks	
Main circuit power supply	R・S・T	Three-phase 380 to 480 VAC +10%, -15% 50/60Hz±3%	
Control power supply	24V・0V	24 VDC ±10%	
Servo motor connector	U・V・W	Connected with servo motor	
Protective grounding terminal	⏚	Connected with grounding wire of power supply and of servo motor.	
Regenerative resistor connector	RB1・RB2 RB4	RS3C02 RS3C05 RS3C10	It has shorting-wire between RB1 and RB4 at factory setting. Connects external regenerative resistor to terminal RB1 and RB2 after removing the shorting-wire, if regenerative performance is insufficient. Note) Do not connect the shorting-wire between RB1 and RB2.
		RS3C15 RS3C30	RB4 is not equipped. Connects external regenerative resistor to terminal RB1 and RB2.
Holding brake output terminal	B+ ・ B-	Connects to a holding brake of servo motor.	

* For 24 VDC control power connector of RS3C02/05/10, left/right pins below are connected. However, do not use them for different side of daisy chain in multi-axis connection. Connector pin of some amplifier may be insufficient of current capacity. If daisy chain is required to multi-axis connection, use left side pins only (in the white line circle below) for avoiding flow of total current into contact point of connector.

Control power
24 VDC

Connect left side only
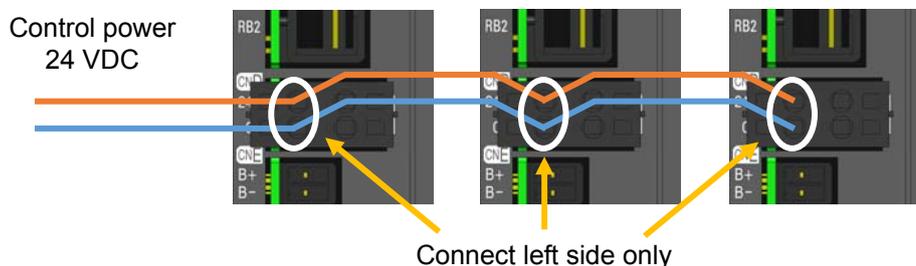
For 24 VDC control power of RS3C15/30, connect to terminal block.
* For use of holding brake power supply built in servo amplifier, brake power voltage may drop by influence of cable impedance. Make sure the voltage at power plug of motor is 21.6 VDC or more. If it is less than 21.6 VDC, adjust control power voltage up to 26.4 VDC and check the voltage again.
* 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. Wiring

■ Input voltage 400V AC/800A (Power unit/Amplifier unit combination)

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 Amplifier unit	457 to 747 VDC Connects a power unit output to amplifier unit.
Servo motor connector	U1・V1・W1 U2・V2・W2	Amplifier unit	Connects 2 systems output to servo motor.
Protective grounding terminal	⏚	Power unit 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 Amplifier unit	24 VDC ±15%
Thermostat connecting terminal	TH1-1・ 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. Contact rating: 5 A, 250 VAC/ 30 VDC (resistance load) Mechanical life: 2 million times Electrical life: Hundred thousand times (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 servo amplifier 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.
*   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).

4.1.3 Wire size - allowable current

AWG size	Nominal cross-sectional area [mm²]	Conductor resistance [Ω/km]	Allowable current over ambient temperature [A]		
			30°C	40°C	55°C
20	0.5	39.5	6.6	5.6	4.2
19	0.75	26.0	8.8	7.0	5.4
18	0.9	24.4	9.0	7.7	5.8
16	1.25	15.6	12.0	11.0	8.3
14	2.0	9.53	23.0	20.0	15.0
12	3.5	5.41	33.0	29.0	21.8
10	5.5	3.47	43.0	38.0	28.5
8	8.0	2.41	55.0	49.0	36.8
6	14.0	1.35	79.0	70.0	52.5

Nominal cross-sectional area [mm²]	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

Wiring

4. Wiring

4.1.4 Recommended wire size (Rotary motor)

The recommendation electric wire size used for servo amplifiers and servo motors are shown below.

■ Input voltage 200V AC

Servo motor model No.	Motor power (U·V·W·⏚)		Combination servo amplifier	Main circuit power supply (R·S·T)		Control power supply		Regenerative resistance		⏚	
	mm²	AWG No.		mm²	AWG No.	mm²	AWG No.	mm²	AWG No.	mm²	AWG No.
R1AA04005F	0.5	20	RS3#01#	1.25	16						
R1AA04010F											
R2AA04003F											
R2AA04005F											
R2AA04010F											
R2AA06010F											
R5AA06020H											
R1AA06020F	0.75	19	RS3#02#								
R1AA06040F											
R2AA06020F											
R2AA06040H											
R5AA06020F											
R5AA06040H											
R2AA08020F											
R2AA06040F											
R2AA08040F											
R5AA06040F											
R1AA08075V	0.75	19	RS3#03#	2.0	14	1.25	16	2.0	14	2.0	14
R1AA10100H											
R1AA10150H											
R2AA08075F											
R2AAB8100H											
R2AA10075F											
R2AA13050D											
R2AA13050H											
R2AA13120B											
R5AA08075D											
R5AA08075D											
R5AA08075F											
R1AA08075F	2.0	14	RS3A05#								
R1AA10100F											
R1AA10150F											
R1AA10200H											
R1AA10250H											
R2AAB8075F											
R2AAB8100F											
R2AA10100F											
R2AA13120D											
R2AA13120L											
R2AA13180H											
R2AA13200L											

* Mark "#" shows optional number or alphabetical letter.
* 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 Wiring for the terminal of high voltage and grounding

■ Input voltage 200V AC, continued

Servo motor model No.	Motor power (U·V·W·⏚)		Combination servo amplifier	Main circuit power supply (R·S·T)		Control power supply		Regenerative resistance		⏚	
	mm²	AWG No.		mm²	AWG No.	mm²	AWG No.	mm²	AWG No	mm²	AWG No.
R1AA10200F	3.5	12									
R1AA10250F											
R1AA13300H			RS3A07#					3.5	12		
R2AA13180D											
R2AA13200D											
R2AA18350V				5.5	10					5.5	10
R1AA13300F	5.5	10									
R1AA13400H											
R1AA13500H			RS3A10#					5.5	10		
R2AA13200D											
R2AA13180D											
R2AA18350L											
R1AA13400F											
R1AA13500F						1.25	16				
R2AA18350D	5.5	10									
R2AA18450H			RS3A15#	8.0	8			8.0	8	8.0	8
R2AA22500L											
R2AA18550R	8.0	8									
R2AA22700S	5.5	10									
R1AA18550H											
R1AA18750L											
R1AA1811KR											
R1AA1815KB											
R2AA18550H	14.0	6	RS3A30#	14.0	6			8.0	8	14.0	6
R2AA18750H											
R2AA1811KR											
R2AA2211KB											
R2AA2215KB											

■ Input voltage 100V AC

Servo motor model No.	Motor power (U·V·W·⏚)		Combination servo amplifier	Main circuit power supply (R·S·T)		Control power supply		Regenerative resistance		⏚	
	mm²	AWG No.		mm²	AWG No.	mm²	AWG No.	mm²	AWG No.	mm²	AWG No.
R2EA04003F			RS3#01#								
R2EA04005F											
R1EA04005F								1.25	16		
R1EA04010F	0.5	20	RS3#02#	1.25	16					2.0	14
R2EA04008F						1.25	16				
R2EA06010F											
R1EA06020F	0.75	19	RS3#03#	2.0	14			2.0	14		
R2EA06020F											

* Mark "#" shows optional number or alphabetical letter.
* 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. Wiring

■ Input voltage 200 VAC (600 A)

Combination power unit	Main circuit power supply (R·S·T·E)		Control power supply		Regenerative resistance		⏚	
	mm²	AWG No.	mm²	AWG No.	mm²	AWG No.	mm²	AWG No.
RS3PAA270	38	2	1.25	16	8	8	5.5	10

Servo motor model No.	Motor power (U·V·W·E)		Combination amplifier unit	Control power supply		⏚	
	mm²	AWG No.		mm²	AWG No.	mm²	AWG No.
R1AA2220KV R2AA2220KB R2AA2225KB R2AA2830KV	38	2	RS3#60#	1.25	16	5.5	10

* Mark "#" shows optional number or alphabetical letter.
* 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 Wiring for the terminal of high voltage and grounding

■ Input voltage 400 VAC

Servo motor model No.	Motor power (U·V·W·⏚)		Combination servo amplifier	Main circuit power supply (R·S·T)		Control power supply		Regenerative resistance		⏚	
	mm²	AWG No.		mm²	AWG No.	mm²	AWG No.	mm²	AWG No.	mm²	AWG No.
R1CA10150V	1.25	16	RS3C02#	1.25	16	1.25	16	1.25	16	1.25	16
R2CA10075F											
R2CA13050D											
R2CA13120R											
R2CA13180H											
R2CA13200L											
R1CA10200V	2.0	14	RS3C05#	2.0	14			1.25	16	2.0	14
R1CA13300V											
R2CA10100F											
R2CA13120F											
R2CA13180D											
R2CA13200H											
R2CA18350L											
R2CA18350D	3.5	12	RS3C10#	2.0	14			2.0	14	2.0	14
R2CA18450H											
R2CA18550R											
R1CA18550H	8	8	RS3C15#	5.5	10					5.5	10
R1CA18750L											
R1CA1811KR											
R1CA1815KB											
R2CA18550H	5.5	10									
R2CA18750H	8	8									
R2CA2211KB											
R2CA2215KV											
R1CA2220KV	14	5,6	RS3C30#	14	5,6			3.5	12	14	5,6
R2CA2220KV											
R2CA2830KV											

■ Input voltage 400 VAC (800 A)

Servo motor model No.	Motor power (U·V·W·⏚)		Combination servo amplifier	Main circuit power supply (R·S·T)		Control power supply		Regenerative resistance		⏚	
	mm²	AWG No		mm²	AWG No	mm²	AWG No	mm²	AWG No	mm²	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 Wiring

4-8

4. Wiring

4.1.5 Recommended wire size (Linear motor)

■ Input-voltage 200V AC (DS-series: flat type linear motor with core)

Linear motor model No.	Motor power (U·V·W·⏚)		Combination servo amplifier	Main circuit power supply (R·S·T)		Control power supply		Regenerative resistor		⏚	
	mm²	AWG No.		mm²	AWG No.	mm²	AWG No.	mm²	AWG No.	mm²	AWG No.
DS030C1N2	0.75	19	RS3A03L	2.0	14			2.0	14	2.0	14
DS050C1N2											
DS075C1N2											
DS045CC1AN											
DS030C2N2	2.0	14	RS3A05L								
DS050C2N2											
DS075C2N2											
DS100C1N2											
DS150C1N2											
DS030C3N2	5.5	10	RS3A07L	5.5	10	1.25	16	3.5	12	5.5	10
DS050C3N2											
DS075C3N2											
DS030C3N2	5.5	10	RS3A10L	5.5	10			5.5	10	5.5	10
DS050C3N2											
DS075C3N2											
DS100C2N2											
DS150C2N2											
DS100C3N2	8.0	8	RS3A15L	8.0	8			8.0	8	8.0	8
DS150C3N2											

4.1 Wiring for the terminal of high voltage and grounding

■ Input-voltage 200V AC (DD-series: twin type linear motor with core)

Linear motor model No.	Motor power (U·V·W·⏚)		Combination servo amplifier	Main circuit power supply (R·S·T)		Control power supply		Regenerative resistor		⏚	
	mm²	AWG No.		mm²	AWG No.	mm²	AWG No.	mm²	AWG No.	mm²	AWG No.
DD030C1Y4	2.0	14	RS3A05L	2.0	14			2.0	14	2.0	14
DD030C2Y4	5.5	10	RS3A07L	5.5	10			3.5	12	5.5	10
DD050C1Y2											
DD075C1Y2											
DD045CB4AN											
DD030C2Y4	5.5	10	RS3A10L	5.5	10	1.25	16	5.5	10	5.5	10
DD030C3Y4											
DD050C1Y2											
DD075C1Y2											
DD045CB4AN											
DD050C2Y2	8.0	8	RS3A15L	8.0	8			8.0	8	8.0	8
DD075C2Y2											
DD050C3Y2	14.0	6	RS3A30L	14.0	6			8.0	8	14.0	6
DD075C3Y2											
DD075C4Y2											

■ Input-voltage 200V AC (DT-series: center magnet type linear motor)

Linear motor model No.	Motor power (U·V·W·⏚)		Combination servo amplifier	Main circuit power supply (R·S·T)		Control power supply		Regenerative resistor		⏚	
	mm²	AWG No.		mm²	AWG No.	mm²	AWG No.	mm²	AWG No.	mm²	AWG No.
DT030CD1AN	0.75	19	RS3A03L	2.0	14	1.25	16	2.0	14	2.0	14

■ Input-voltage 200V AC (DD-series: twin type linear motor)

Linear motor model No.	Motor power (U·V·W·⏚)		Combination servo amplifier	Main circuit power supply (R·S·T)		Control power supply		Regenerative resistor		⏚	
	mm²	AWG No.		mm²	AWG No.	mm²	AWG No.	mm²	AWG No.	mm²	AWG No.
DD035CC2AN	3.5	12	RS3A07L	3.5	12	1.25	16	3.5	12	3.5	12

* 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 linear motor capacity, thinner electric wires than indicated in the above table can be used for the main circuit power terminal.

4. Wiring

4.1.6 Wiring for servo motor

■ Specifications for lead wires and pin assignment of R-series servo motor

Servo motor model number:
R1#A04***, R1#A06***, R1AA08***, R2#A04***, R2#A06***, R2AA08***,
R2AAB8***, R2AA10***, R5AA06***, R5AA08***

Lead color	Name	Remarks
Yellow	Brake	Power for brake (24V DC)
Yellow	Brake	Power for brake (GND of 24V DC)
Red	U	Phase U
White	V	Phase V
Black	W	Phase W
Green/Yellow	⏚	Protective grounding terminal

* No polarity on terminal for brake power.
Please contact us for specifications for 90V DC power supply for brake.
* We recommend 1.25mm^2(AWG16)-wiring size of power supply for brake.

■ Specification and model number for cannon plug of R-series servo motor
(Products of Japan Aviation Electronics Industry, Ltd.)

Servo motor model number	Plug for powering and braking line (Cable clamp type) 【Plug + clamp model number】		Plug for braking line (Cable clamp type) 【Plug + clamp model number】	
	Straight	Angle	Straight	Angle
R1AA10100	N/MS3106B20-15S (N/MS3057-12A) 【MS06B20-15S-12】	N/MS3108B20-15S (N/MS3057-12A) 【MS08B20-15S-12】		
R1AA10150				
R1AA10200				
R1AA10250				
R1AA13300	N/MS3106B24-11S (N/MS3057-16A) 【MS06B24-11S-16】	N/MS3108B24-11S (N/MS3057-16A) 【MS08B24-11S-16】	Note 1)	Note 1)
R1AA13400				
R1AA13500				
R2AA13050				
R2AA13120				
R2AA13180				
R2AA13200				
R2AA18350				
R2AA18450				
R2AA22500				
R2AA22700				
R1AA18550	N/MS3106B32-17S (N/MS3057-20A) 【MS06B32-17S-20】	N/MS3108B32-17S (N/MS3057-20A) 【MS08B32-17S-20】	JL04V-6A10SL-3SE-EB-R (JL04-1012CK(05)-R) 【332706X1】	JL04V-8A10SL-3SE-EB-R (JL04-1012CK(05)-R) 【332707X1】
R1AA18750				
R1AA1811K				
R1AA1815K				
R2AA18550				
R2AA18750				
R2AA1811K				
R2AA2211K				
R2AA2215K				

Note1) Plug for braking line is used in common with powering line.
* Please contact us for waterproof type and TÜV-compliant products.
Please place your order by [plug + clamp model number], our exclusive model numbers.

■ Pin assignment of cannon plug
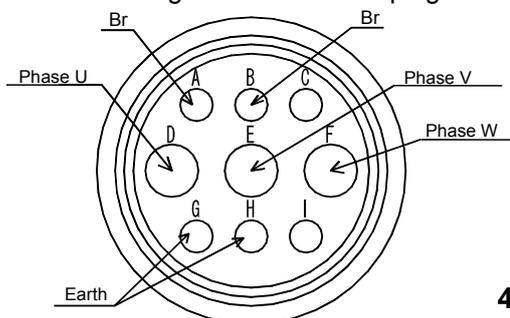
Cannon plug for power line
(For N/MS3106 (8) B24-11S)
Pin assignment (Viewed from motor)

4.1 Wiring for the terminal of high voltage and grounding

■ Specification and model number for cannon plug of R-series servo motor
(Products of Japan Aviation Electronics Industry, Ltd.)

Servo motor model number	Plug for powering and braking line ①Plug (Manufacturer model number) ②Cable clamp (Manufacturer model number) ③Plug and Cable clamp (SANYO DENKI model number)		Plug for braking line ①Plug (Manufacturer model number) ②Cable clamp (Manufacturer model number) ③Plug and Cable clamp (SANYO DENKI model number)	
	Straight	Angle	Straight	Angle
R1CA10150V R1CA10200V R2CA10075F R2CA10100F	①N/MS3106B20-15S ②N/MS3057A-12A ③MS06B20-15S-12	①N/MS3108B20-15S ②N/MS3057A-12A ③MS08B20-15S-12	Note 1)	Note 1)
R1CA13300V R2CA13050D R2CA13120R R2CA13120F R2CA13180H R2CA13180D R2CA13200L R2CA13200H R2CA18350L R2CA18350D R2CA18450H R2CA18550R R2CA18550H	①N/MS3106B24-11S ②N/MS3057-16A ③MS06B24-11S-16	①N/MS3108B24-11S ②N/MS3057-16A ③MS08B24-11S-16		
R1CA18550H R1CA18750L R1CA1811KR R1CA1815KB R2CA18750H R2CA2211KB R2CA2215KV	①N/MS3106B32-17S ②N/MS3057-20A ③MS06B32-17S-20	①N/MS3108B32-17S ②N/MS3057-20A ③MS08B32-17S-20	①JL04V-6A10SL-3SE-EB-R ②JL04-1012CK(05)-R ③332706X1	①JL04V-8A10SL-3SE-EB-R ②JL04-1012CK(05)-R ③332707X1
R2CA2220KV R1CA2220KV R2CA2230KV R2CA3255KB	Terminal block		Note 2) Terminal block Note 2)	

Note 1) Plug for braking line is used in common with powering line.
Note 2) There is no model with brake.
* Please contact us for waterproof type and TÜV-compliant products.

4 Wiring

4. Wiring

■ Model number of fan plug for motor connection
  (Products of Japan Aviation Electronics Industry, Ltd.)

Servo motor model number	Plug model number for cooling fan (Cable clamp model number) [Plug + clamp model number]	Connector type	Disposition symbol of pins
			200V AC±10% Single-phase50/60Hz
All of R1 series, R2AA1811K	N/MS3106B10SL-4S (N/MS3057-4A) 【MS06B10SL-4S-4】	Straight	A, B
	N/MS3108B10SL-4S (N/MS3057-4A) 【MS08B10SL-4S-4】	Angle	A, B

* No polarity.
  Please place your order by [plug + clamp model number], our exclusive model numbers.
* For wire size of cooling fan, 1.25mm^2 (AWG16) is recommended.

■ Specification and model number for cannon plug of R-series servo motor
  (Products of Japan Aviation Electronics Industry, Ltd.)

Servo motor model number	Plug model number for cooling fan ①Plug (Manufacturer model number) ②Cable clamp (Manufacturer model number) ③Plug and Cable clamp (SANYO DENKI model number)		Cooling fan specifications
	Straight	Angle	
R1CA18750L R1CA1811KR R1CA1815KB R1CA2220KV	①N/MS3106B10SL-4S ②N/MS3057-4A ③MS06B10SL-4S-4	①N/MS3108B10SL-4S ②N/MS3057-4A ③MS08B10SL-4S-4	Power: Single-phase Thermostat: None
R2CA2220KV	①JL04V-6A18-12SE-EB-R ②JL04-18CK(13)-R ③332706X3	①JL04V-8A18-12SE-EB-R ②JL04-18CK(13)-R ③332707X3	Power: Three-phase Thermostat: Equipped
R2CA3255KB	Terminal block Note 1)		Power: Single-phase Thermostat: None

Note 1) Use 200V AC power supply for cooling fan.
       Recommended wire size for cooling fan is 1.25mm^2 (AWG16).
       Contact us for fan motor power supply except 200 VAC.

* Use 200V AC power supply for cooling fan.
* Recommended wire size for cooling fan is 1.25mm^2 (AWG16).
* Please contact us for waterproof type and TÜV-compliant products.

■ Pin assignment of cannon plug
Pin assignments are below, depending on model number for power, brake and cooling fan cable.
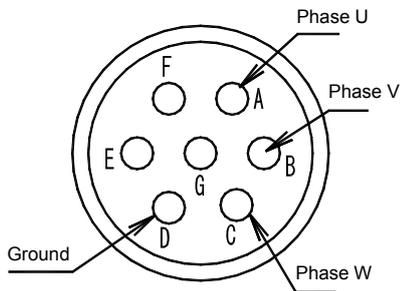
Cannon plug for power line
(for N/MS3106(8)B20-15S)
Pin assignment (Viewed from motor)
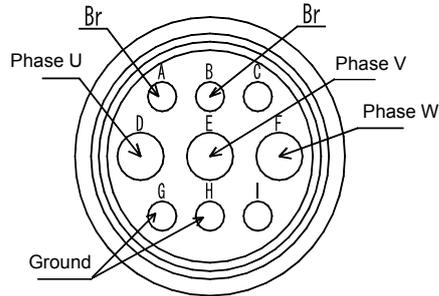
Cannon plug for power line
(for N/MS3106(8)B24-11S)
Pin assignment (Viewed from motor)
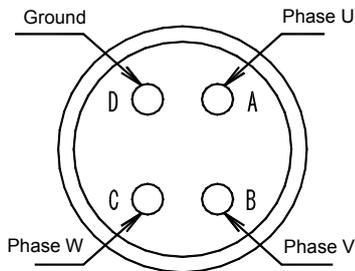
Cannon plug for power line
(for N/MS3106(8)B32-17S)
Pin assignment (Viewed from motor)
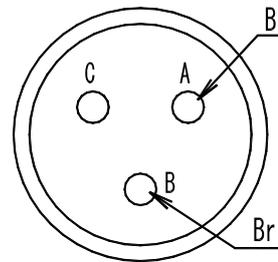
Cannon plug for brake line
(for JL04V-6(8)A10SL-3SE-EB)
Pin assignment (Viewed from motor)
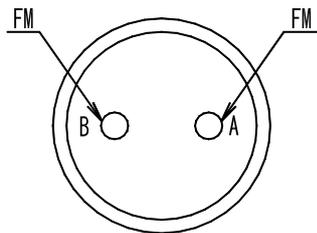
Cannon plug for cooling fan
(for N/MS3106(8)B10SL-4S)
Pin assignment (Viewed from motor)
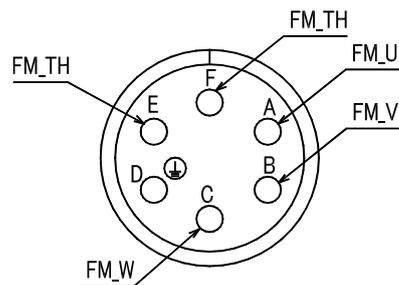
Cannon plug for cooling fan
(for L04V-6A(8)18-12SE-EB-R)
Pin assignment (Viewed from motor)

4. Wiring

4.1.7 Example of wiring

Even if it turns off power supply, high-pressure voltage may remain in servo amplifier. 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.

■ Three-phase 200 VAC

◆ When using + side of OUT1 or OUT2 for power supply
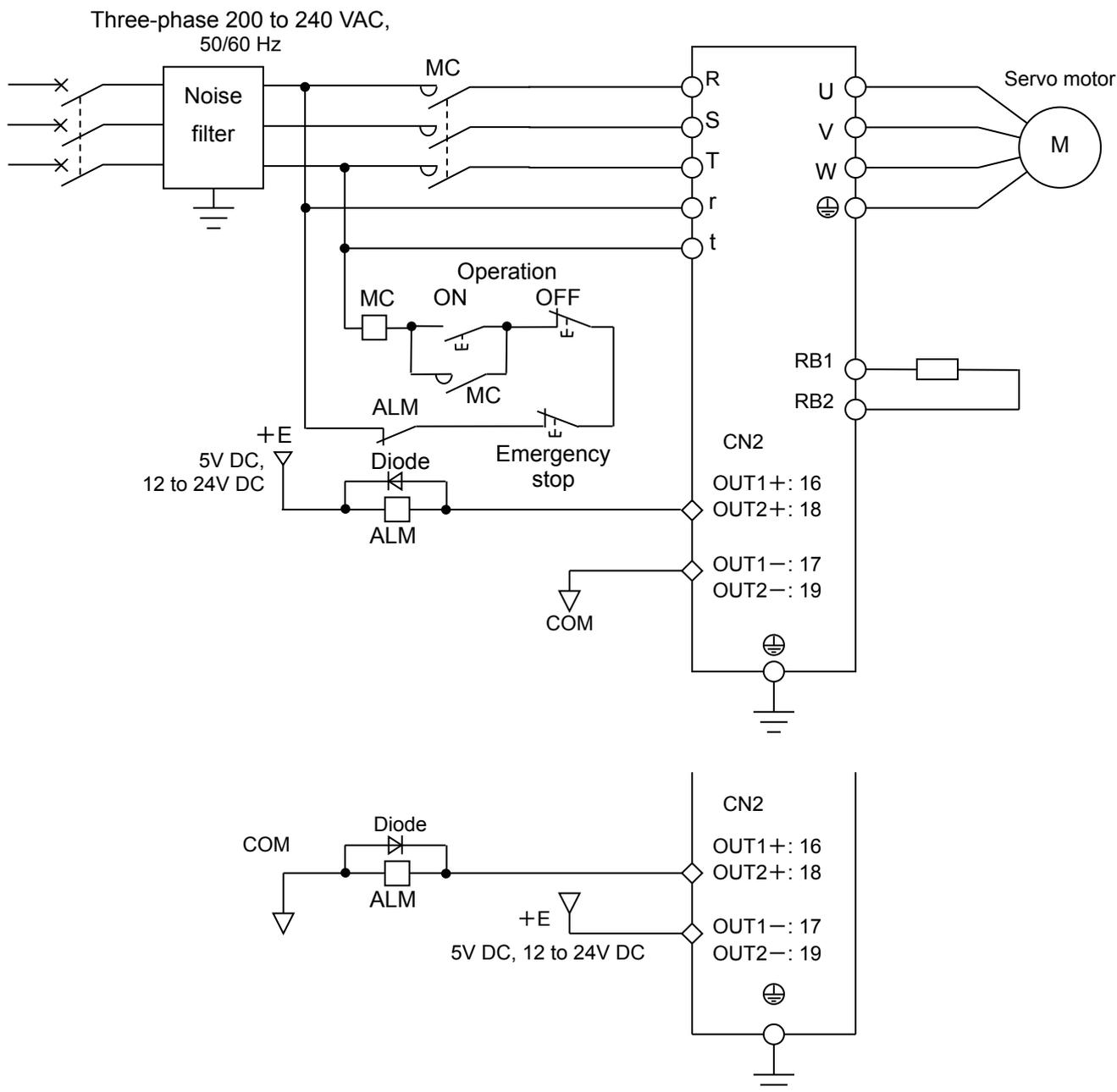
*   Use one of the CN2 - 16 - 19(OUT1, OUT2) outputs, and set either during ALM status output ON or during ALM status output OFF with the selection setting of "Index: 0x20F9 General output function selection".
*   When relay or induction coil load connect to CN2 output, need to connect surge absorbing diode. In order to avoid the failure of the amplifier, please make sure of polarity of the diode.

■ Single-phase 200V AC, single-phase 100V AC

◆ When using + side of OUT1 or OUT2 for power supply

Single-phase 200 to 240V AC
50/60 Hz
or
Single-phase 100 to 120V AC
50/60 Hz
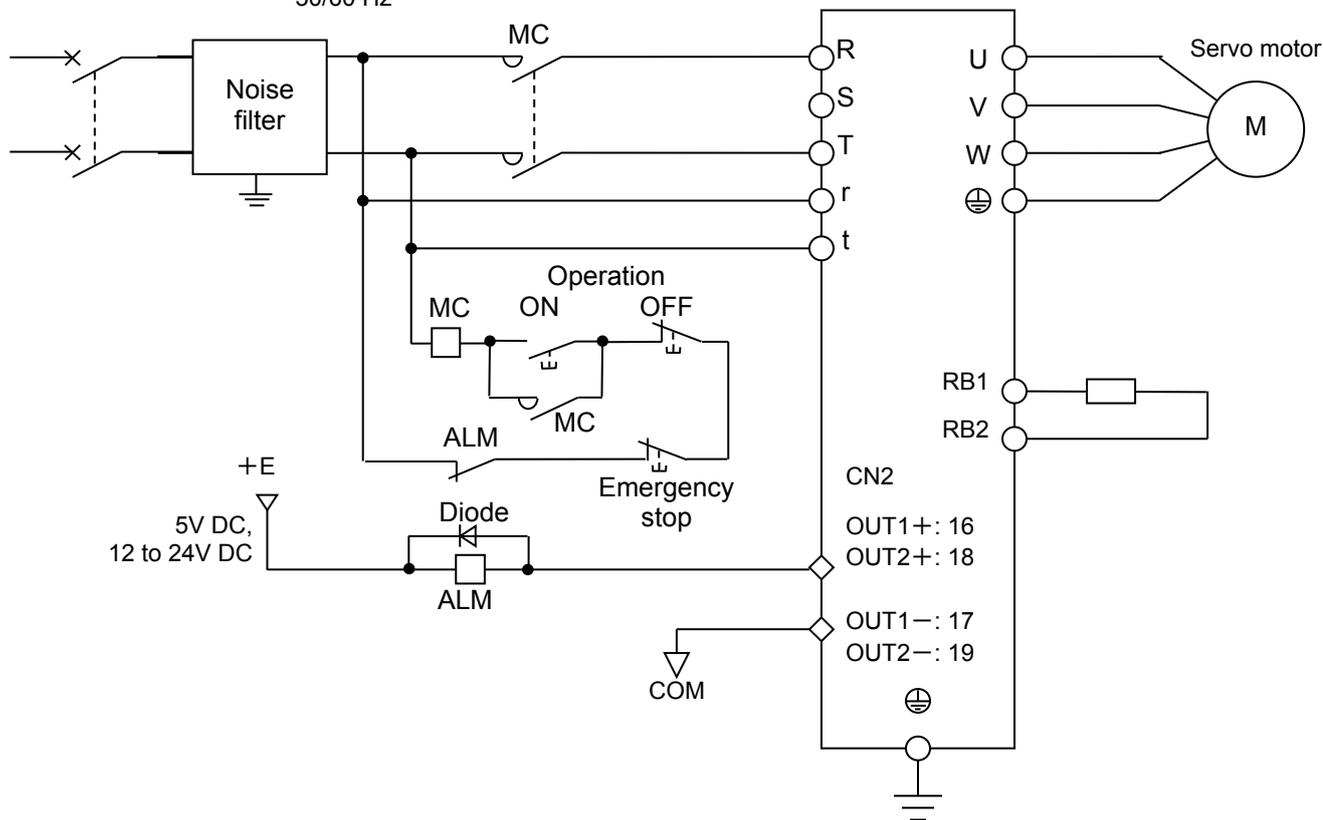
◆ When using - side of OUT1 or OUT2 for power supply
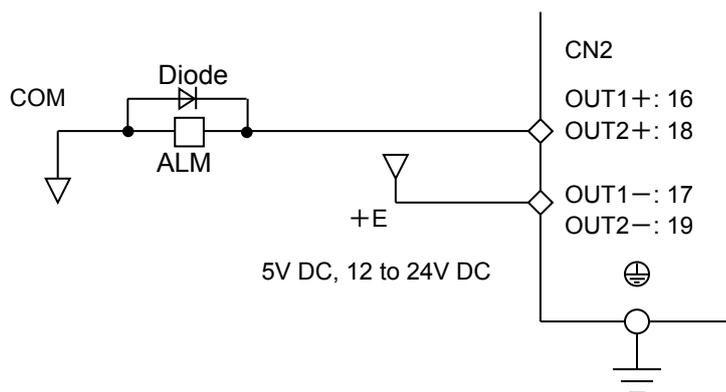
* Use one of the CN2-16-19 (OUT1, OUT2) outputs, and set either during ALM status output ON or during ALM status output OFF with the selection setting of "Index: 0x20F9 General output function selection".
* When relay or induction coil load connect to CN2-16-19 (OUT1, OUT2) outputs, need to connect surge absorbing diode. In order to avoid the failure of the amplifier, please make sure of polarity of the diode.

4. Wiring

■ RS3C02/05/10/15

◆ When using + side of OUT1 or OUT2 for power supply
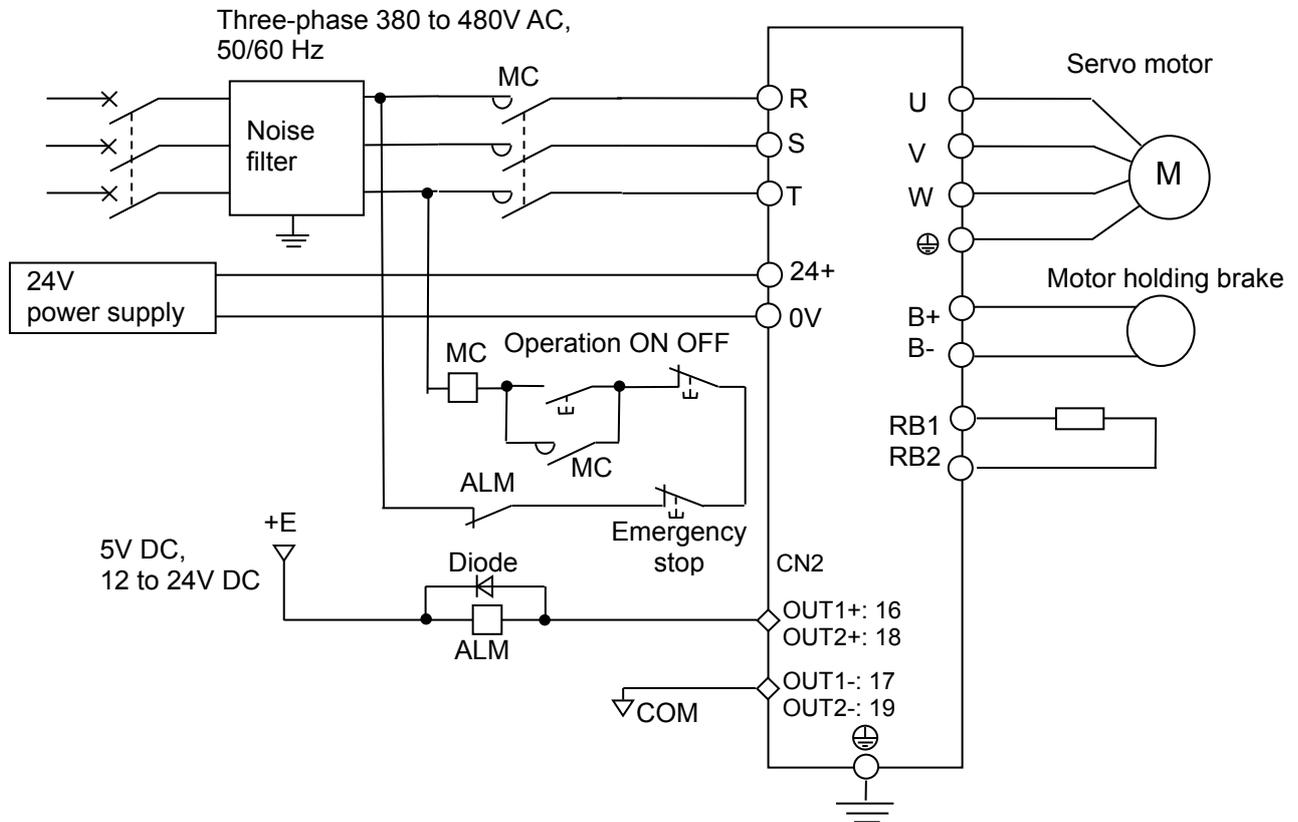
Three-phase 380 to 480V AC, 50/60 Hz

◆ When using - side of OUT1 or OUT2 for power supply

* Use one of the CN2-16-19 (OUT1, OUT2) outputs, and set either during ALM status output ON or during ALM status output OFF with the selection setting of "Index: 0x20F9 General output function selection".
* When relay or induction coil load connect to CN2-16-19 (OUT1, OUT2) outputs, need to connect surge absorbing diode. In order to avoid the failure of the amplifier, please make sure of polarity of the diode.

4.1 Wiring for the terminal of high voltage and grounding

■ Three-phase 200 VAC [General output: Sink type]
  ◆ When using + side of OUT1 or OUT2 for power supply
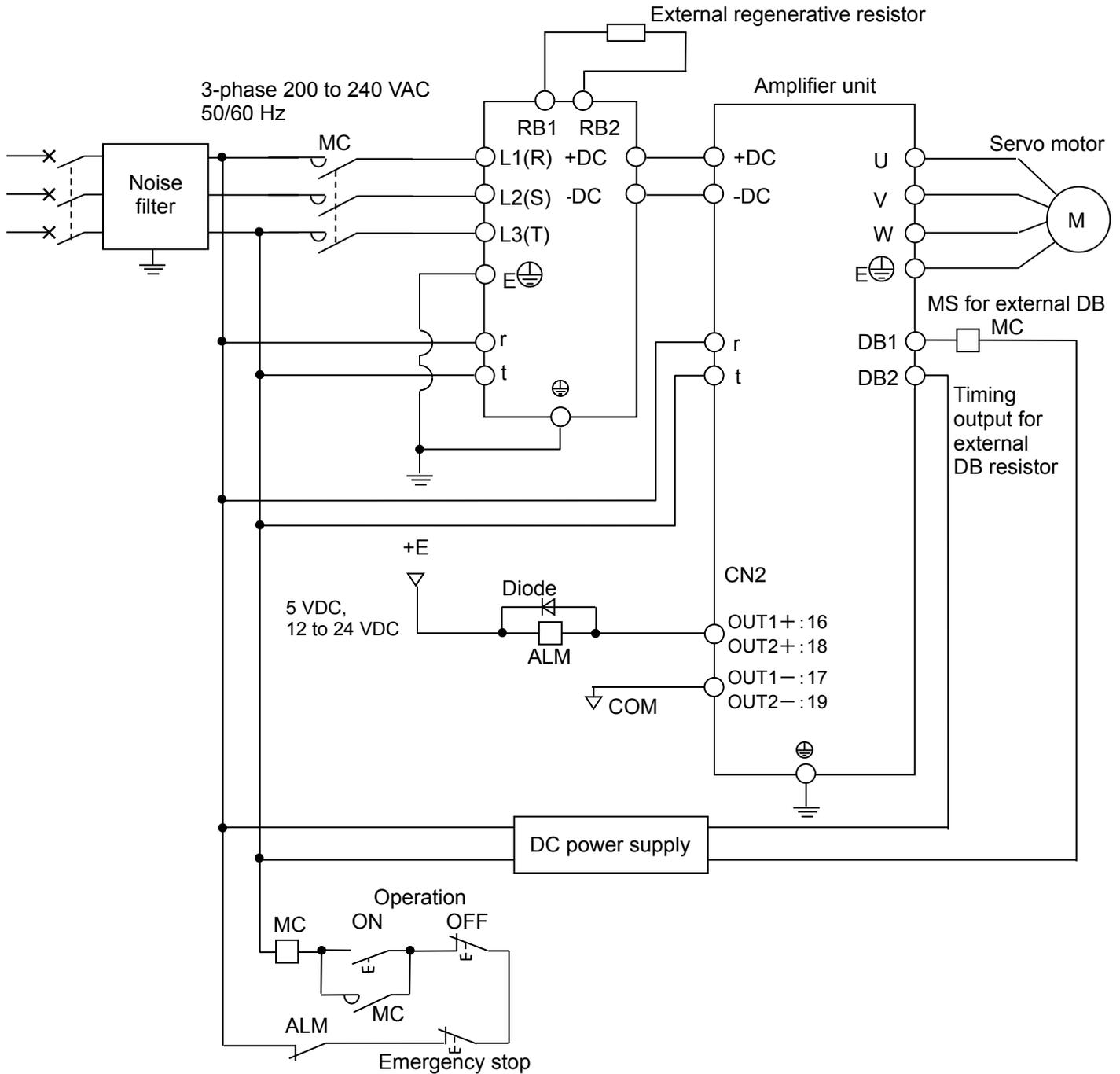
  ◆ When using + side of OUT1 or OUT2 for power supply
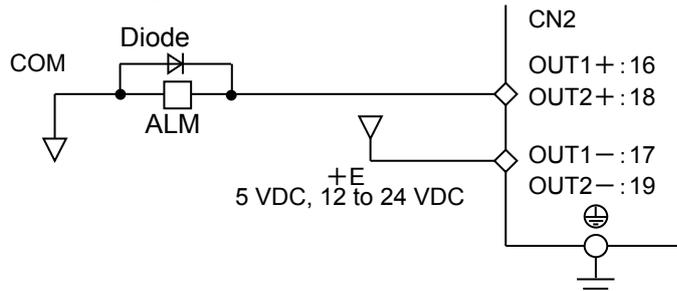
* Use one of the outputs from CN2- 16 to 19 (OUT1,OUT2) by setting either During ALM status output ON or During ALM status output OFF at the selection setting of [Index: 0x20F9].
* Must add the surge absorbing diode to if inductive load as relay connect to CN2- 16 to 19 (OUT1, OUT2). Please take care of polarity of the diode that will be cause of failure.

4. Wiring

■ RS3C30
 ◆ When using + side of OUT1 or OUT2 for power supply

 ◆ When using - side of OUT1 or OUT2 for power supply

* Use one of the CN2-16-19 (OUT1, OUT2) outputs, and set either during ALM status output ON or during ALM status output OFF with the selection setting of "Index: 0x20F9 General output function selection".
* When relay or induction coil load connect to CN2-16-19 (OUT1, OUT2) outputs, need to connect surge absorbing diode. In order to avoid the failure of the amplifier, please make sure of polarity of the diode.

■ RS3PAC550,RS3D80#   When using + side of OUT1 or OUT2 for power supply

* Use one of the CN2-16-19 (OUT1, OUT2) outputs, and set either during ALM status output ON or during ALM status output OFF with the selection setting of "Index: 0x20F9 General output function selection".
* When relay or induction coil load connect to CN2-16-19 (OUT1, OUT2) outputs, need to connect surge absorbing diode. In order to avoid the failure of the amplifier, please make sure of polarity of the diode.

4-20

4. Wiring

■ RS3PAC550,RS3D80#   When using - side of OUT1 or OUT2 for power supply
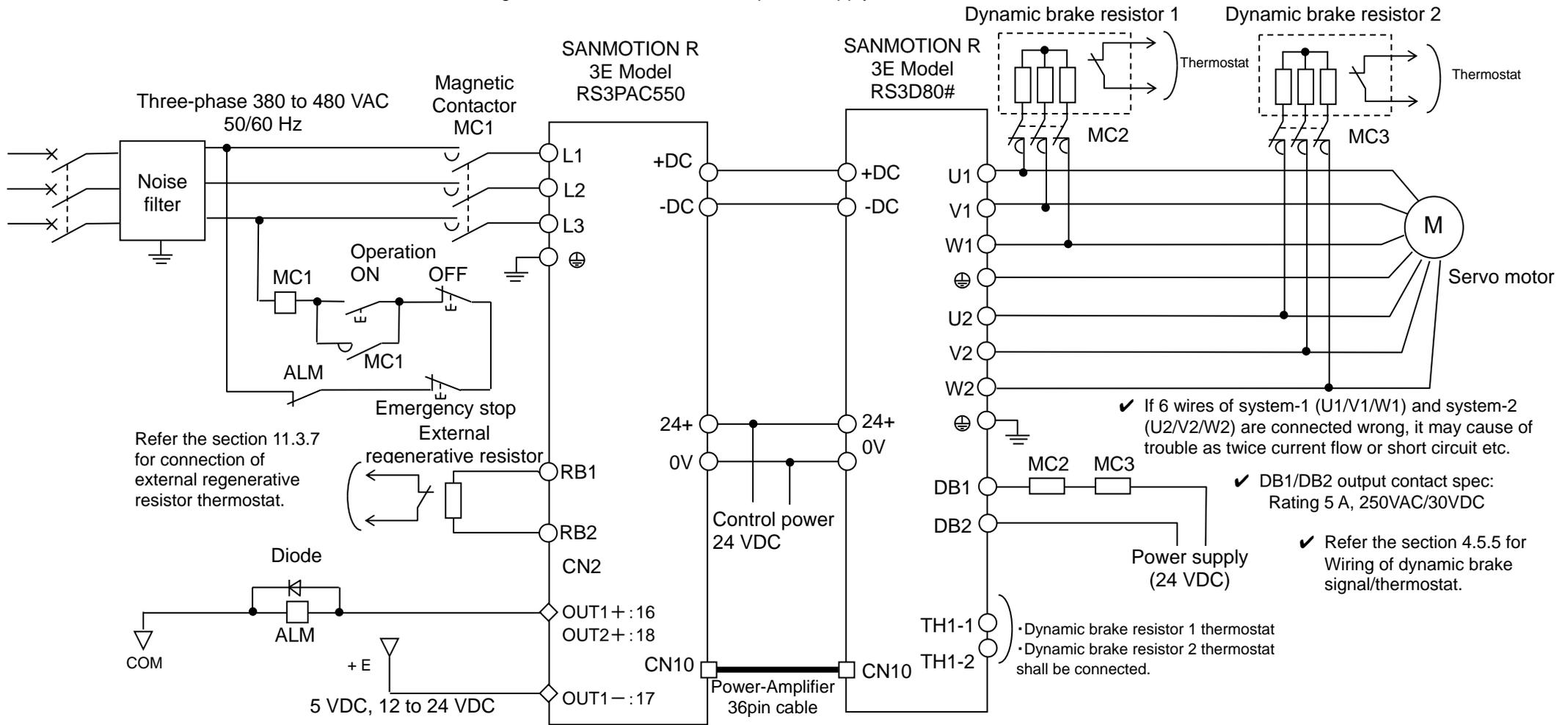
* Use one of the CN2-16-19 (OUT1, OUT2) outputs, and set either during ALM status output ON or during ALM status output OFF with the selection setting of "Index: 0x20F9 General output function selection".
* When relay or induction coil load connect to CN2-16-19 (OUT1, OUT2) outputs, need to connect surge absorbing diode. In order to avoid the failure of the amplifier, please make sure of polarity of the diode.

4.1.8 Crimping of wires

Insert the wire into ferrule, and use a special tool to crimp it in.
Insert the ferrule deep into the connector, and tighten it with a special minus screwdriver or something. The recommended torque is shown in the section 4.1.9.

Process1   Process2   Process3
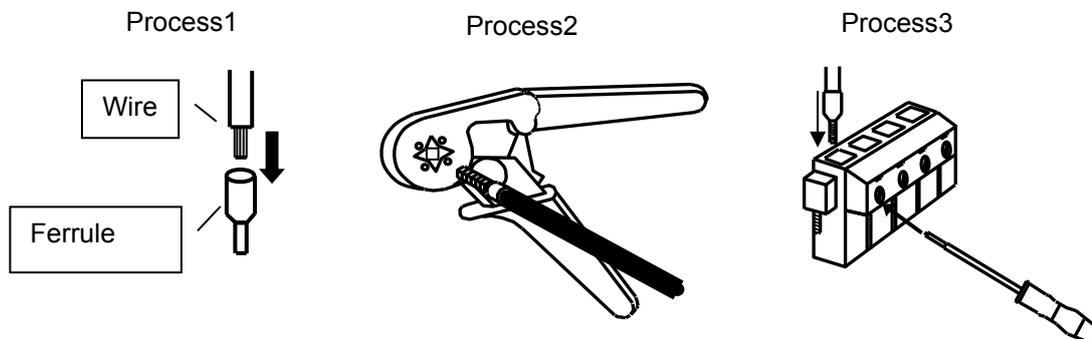
■   Model number of recommended ferrules and crimping tools for various wire sizes
   (Manufactured by Phoenix Contact)

mm²	AWG	Model number		
		1Pcs/Pkt	1000Pcs/Pkt	Taped components
0.75 mm²	19	AI0.75-8GY	AI0.75-8GY-1000	AI0.75-8GY-B(1000Pcs/Pkt)
1.0 mm²	18	AI1-8RD	AI1-8RD-1000	AI1-8RD-B(1000Pcs/Pkt)
1.5 mm²	16	AI1.5-8BK	AI1.5-8BK-1000	AI1.5-8BK-B(1000Pcs/Pkt)
2.5 mm²	14	AI2.5-8BU	AI2.5-8BU-1000	AI2.5-8BU-B(500Pcs/Pkt)
4.0mm²	12	AI4-10GY Note1)	-	-
5.5mm²	10	A6-10 Note1) Note2)	-	-

Note1) Use for CNA/CNB of RS3A07# only.
Note2) Without plastic sleeve.

*   GY: Gray, RD: Red, BK: Black, BU: Blue
*   Crimping tool model number: 0.14mm² to 10mm² : CRIMPFOX 10S

4. Wiring

4.1.9 High voltage circuit terminal; tightening torque

Servo amplifier model number	Terminal marking		
	CNA	CNB	⏚
RS3#01#			
RS3#02#	[0.5 to 0.6 N·m]		[1.18 N·m] M4 (screw size)
RS3#03#			
RS3A05#			

Servo amplifier model number	Terminal marking			
	CNA	CNB	CNC	⏚
RS3A07#	Wire size 4mm^2 or less [0.5 to 0.6 N·m] Wire size 4mm^2 over [0.7 to 0.8 N·m]		[0.5 to 0.6 N·m]	[1.18 N·m] M4 (screw size)

Servo amplifier model number	Terminal marking											
	R	S	T	⊖	RB4	RB1	RB2	U	V	W	⏚	CNA
RS3A10#	[1.18 N·m] M6 (screw size)											[0.5 to 0.6 N·m]
RS3A15#												

Servo amplifier model number	Terminal marking											
	R	S	T	⊖	P	U	V	W	⏚	RB1	RB2	CNA
RS3A30#	[3.73 N·m] M6 (screw size)									[1.18 N·m] M4 (screw size)		[0.5 to 0.6 N·m]

* "#" will be any number or alphabet.

■ RS3W60#

Unit model number	Terminal marking		
	CNA	CNB	⏚
RS3PAA270	[0.5 to 0.6 N·m]		[1.18 N·m] M4 (screw size)
RS3W60A			

4.1 Wiring for the terminal of high voltage and grounding

■ 400V AC input

Servo amplifier model number	Terminal marking
	$\oplus$
RS3C02#	[1.18 N·m] M4 (screw size)
RS3C05#	
RS3C10#	

Servo amplifier model number	Terminal marking											
	R	S	T	RB1	RB2	U	V	W	24V	0V	B+	B-	$\oplus$
RS3C15#	[2.0 N·m] M5 (screw size)								[1.2 N·m] M4 (screw size)				[2.45 N·m] M5 (screw size)

Servo amplifier model number	Terminal marking											
	R	S	T	RB1	RB2	U	V	W	24V	0V	B+	B-	$\oplus$
RS3C30#	[2.0 N·m] M5 (screw size)								[1.2 N·m] M4 (screw size)				[2.45 N·m] M5 (screw size)

Servo amplifier model number	Terminal marking			
	TH1-1	TH1-2	DB1	DB2
RS3C30#	[1.2 N·m] M4 (screw size)			

Unit model number	端子記号							
	R	S	T	$\oplus$	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)	

Unit model number	端子記号												
	U1	V1	W1	$\oplus$	U2	V2	W2	$\oplus$	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. Wiring

4.2 Wiring with Host Unit

4.2.1 Control signals and pin numbers (wiring with host unit)

■ Control signal and pin number (wiring with host unit)

IN/OUT: EtherCAT communication

Servo amplifier

Note 1) For IN/OUT, 4-5 pins and 7-8 pins are shorted circuit at amplifier internal.
Moreover, 4-5 pins and 7-8 pins are connected to 75 ohm resistor as the left drawing.
Also, center of pulse trance are connected to 75 ohm resistor as the left drawing.

CN2: General I/O

CN4: Safe Torque Off

CN3: Battery connection
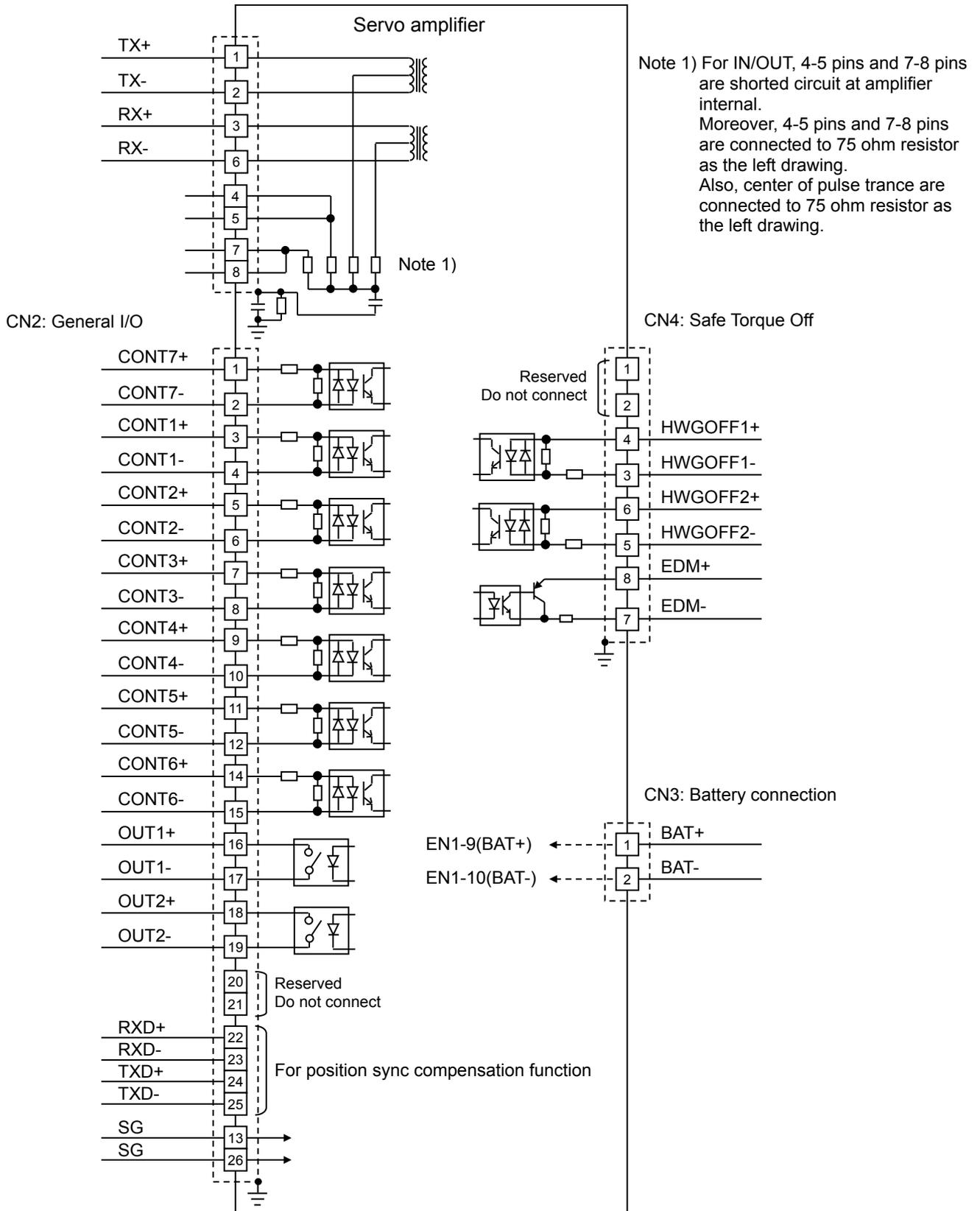
4.2.2 IN, OUT connectors pin assignment

■ Pin assignment

For R 3E Model EtherCAT amplifier, two RJ-45 modular connectors are provided as Port IN and OUT for the EtherCAT communication with host device. The same pin disposition (same signal) is assigned for both connectors and corresponds to the daisy chain topology.
Connect IN (Port 0) to the host device and OUT to the next slave.
Use twisted-pair cables that satisfy at least "Category 5e" to connect the cable.
When you make cables using exclusive tools, use STP (Shielded twisted pair cable) and RJ-45 modular plug with shield.
Either straight or crossed cables can be used for the port connection because an automatic crossover function (Automatic discriminating feature for MDI / MDI-X called Auto MDI / MDI-X) is installed.

IN (port0), OUT (port1)	Terminal number	Signal (Ethernet Connection)	Description
	1	TX+	Transmitting signals +
	2	TX-	Transmitting signals -
	3	RX+	Receiving signals +
	4	-	75Ω Connection
	5	-	75Ω Connection
	6	RX-	Receiving signals -
	7	-	75Ω Connection
	8	-	75Ω Connection

* Refer to "Control signal and pin number (wiring with host unit)" on the previous page for electrical connection of IN and OUT.

■ Connection diagram
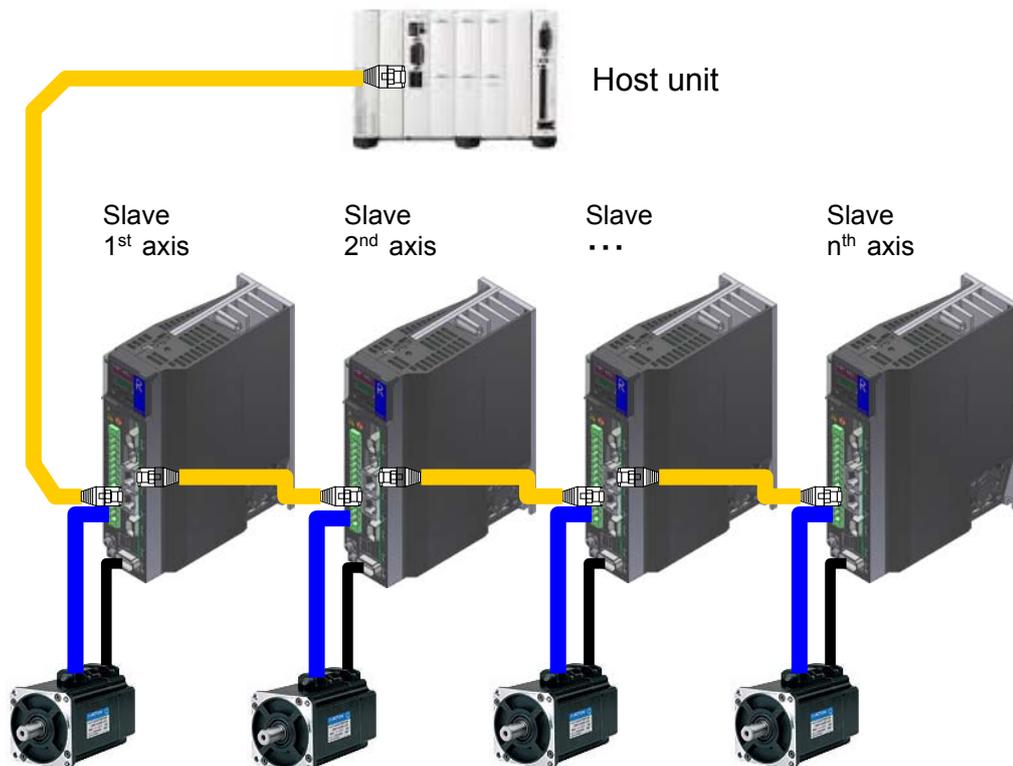
✔ Connect Master (host) cable to the lower connector IN (Port0), and then connect cable of the upper connector OUT (Port1) to the next Slave.

4. Wiring

■ Wiring diagram
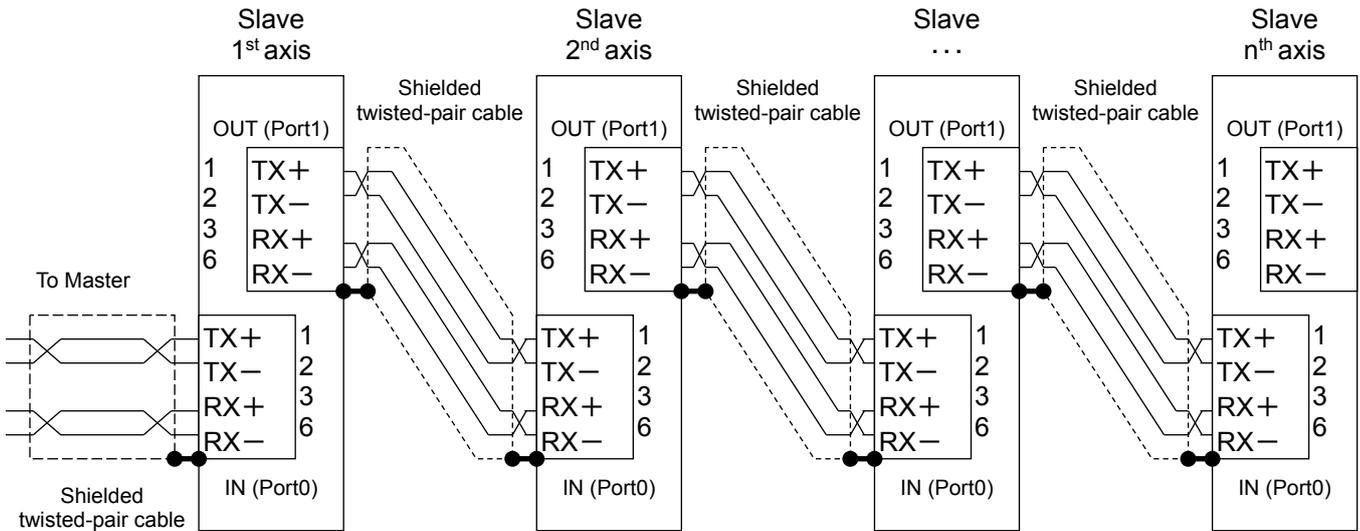
- ✓ R3E Model EtherCAT amplifier is twisted-pair cable and daisy-chain topology-compliant model, and port0 (IN)/ 1 (OUT)are Ethernet connection.
- ✓ Ethernet port-to-port connection can use both straight and cross cable as the model has auto crossover function for slave amplifier. Connecting cable shall be Category 5e cable.

■ Caution for RJ-45 modular connector selection

・ For the modular connector selection and modification, please confirm the standards dimension below (Standards: TIA-968-A).

・ Especially, when the connector (ready-made/ modified product) which has out-of-range dimension at C (from top end of connector housing to lower side of terminal) is used, it gives excessive stress to mating connector and may cause a damage of terminal or connector, and a communication error by contact failure.

Expanded front view

Standards dimension:
A: 11.58 to 11.78 mm
B: 6.49 to 6.70 mm
C: 5.89 to 6.15 mm
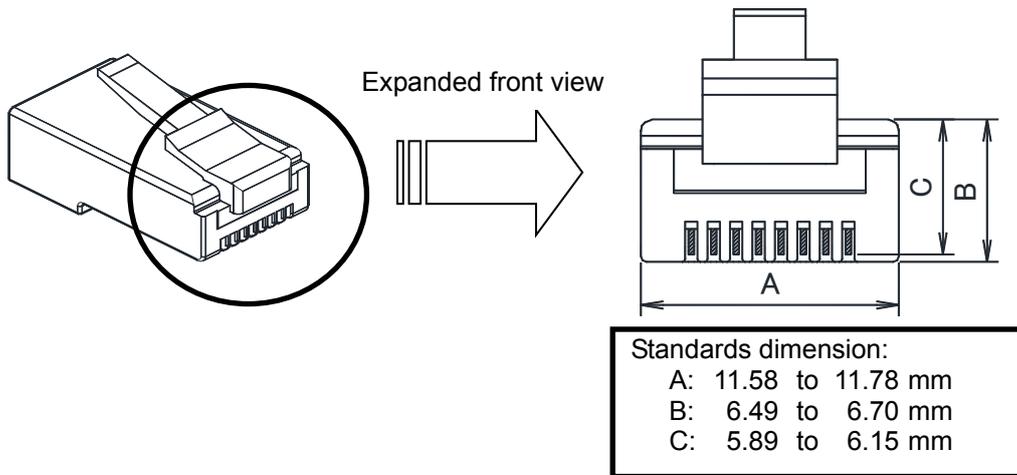
4.2.3 CN4 connector pin assignment

■ 2013595-3 (The figure below is viewed from connector's soldered side.)
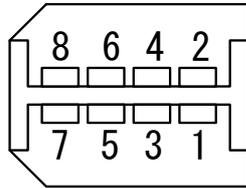
◆ Signal name and its function

Terminal number	Signal name	Description
1	Reserve	Do not use.
2	Reserve	Do not use.
3	HWGOFF1-	Signal-input1 (-) for safety function
4	HWGOFF1+	Signal-input1 (+) for safety function
5	HWGOFF2-	Signal-input2 (-) for safety function
6	HWGOFF2+	Signal-input2 (+) for safety function
7	EDM-	Monitor (-) for safety function
8	EDM+	Monitor (+) for safety function

◆ Signal names and functions

Signal name	Terminal No.	Symbol	Description
Reserved	1	Terminal for	This is a connection terminal when the function is not used.
Reserved	2	maintenance	Do not use these terminals.

Safety input 1	3	HWGOFF1-	This is an input signal to control Safe-Torque-Off state.
			
			Connection circuit
			  Connected to a relay or open collector transistor circuit.
			  Power supply voltage range: 24V DC±10%
			  Internal impedance: 2.2kΩ

	4	HWGOFF1+	
Safety input 2	5	HWGOFF2-	
	6	HWGOFF2+	

Error detection monitor	7	EDM-	This is a signal to monitor errors of Safe-Torque-Off function.
			
			Connection circuit
			  Connected to a photo coupler or relay circuit.
			  Power supply voltage range (Uext): 24V DC±10%
			  Maximum current value: 50mA
			  Output voltage: Uext-0.5 to Uext

	8	EDM+	

If you do not use this function, please connect the short-circuit plug for safety instrument that is attached to this product. If the short-circuit plug for safety instrument is required, please order "AL-00849548-02", as our model number. Also, if you do not use this function with connector "2013595-3", please make short-circuit within terminal No. group 1/3/5 and within terminal No. group 2/4/6.

4. Wiring

4.2.4 CN2 general I/O connector pin assignment

■ HDR-E26MSG1+ (*The figure below is viewed from connector's soldered side.)

```
┌─────────────────────────────────────────────┐
│   ┌ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ┐             │
│  (                             )            │
│ (  ┌──┬──┬──┬──┬──┬──┐          )           │
│ \  │12│10│ 8│ 6│ 4│ 2│         /            │
│  \ ├──┼──┼──┼──┼──┼──┼──┐     /             │
│    │13│11│ 9│ 7│ 5│ 3│ 1│    /              │
│    ├──┼──┼──┼──┼──┼──┼──┤   /               │
│    │26│24│22│20│18│16│14│  /                │
│    └┬─┼──┼──┼──┼──┼──┼──┘ /                 │
│     │25│23│21│19│17│15│  /                  │
│     └──┴──┴──┴──┴──┴──┘ /                   │
│   └ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ┘                  │
└─────────────────────────────────────────────┘
```
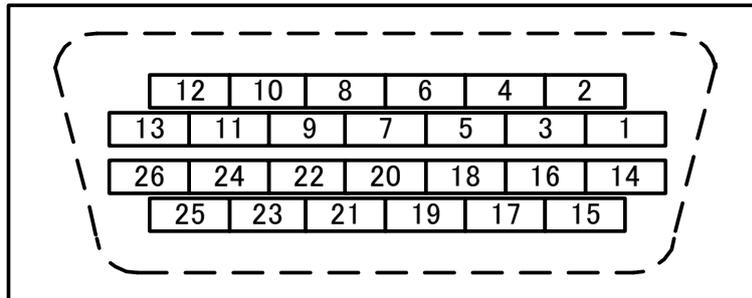
◆ Signal names and functions

Terminal No.	Signal name	Description
1	CONT7+	General-purpose input7 (+)
2	CONT7-	General-purpose input7 (-)
3	CONT1+	General-purpose input1 (+)
4	CONT1-	General-purpose input1 (-)
5	CONT2+	General-purpose input2 (+)
6	CONT2-	General-purpose input2 (-)
7	CONT3+	General-purpose input3 (+)
8	CONT3-	General-purpose input3 (-)
9	CONT4+	General-purpose input4 (+)
10	CONT4-	General-purpose input4 (-)
11	CONT5+	General-purpose input5 (+)
12	CONT5-	General-purpose input5 (-)
13	SG	Signal ground
14	CONT6+	General-purpose input6 (+)
15	CONT6-	General-purpose input6 (-)
16	OUT1+	General-purpose output1 (+)
17	OUT1-	General-purpose output1 (-)
18	OUT2+	General-purpose output2 (+)
19	OUT2-	General-purpose output2 (-)
20	Reserved	Do not connect anything.
21	Reserved	Do not connect anything.
22	RXD+	For the position synchronization compensation communication
23	RXD-	For the position synchronization compensation communication
24	TXD+	For the position synchronization compensation communication
25	TXD-	For the position synchronization compensation communication
26	SG	Signal ground

◆ Signal names and functions

Terminal No.	Symbol	Name	Description
1	CONT7+	General input 7 (+)	■ Connect the general-purpose input circuit to a relay or open collector transistor circuit. Power supply voltage range: 5V DC±5%/12 to 24V DC±10% Current capacity of host unit: 100mA or more (24V DC) Host unit — Servo amplifier Power supply / CONT1+ / 2.2kΩ 3 CONT1- 4.7kΩ 4 CONT2+ 2.2kΩ 5 CONT2- 4.7kΩ 6
2	CONT7-	General input 7 (-)	
3	CONT1+	General input 1 (+)	
4	CONT1-	General input 1 (-)	
5	CONT2+	General input 2 (+)	
6	CONT2-	General input 2 (-)	
7	CONT3+	General input 3 (+)	
8	CONT3-	General input 3 (-)	
9	CONT4+	General input 4 (+)	
10	CONT4-	General input 4 (-)	
11	CONT5+	General input 5 (+)	
12	CONT5-	General input 5 (-)	
14	CONT6+	General input 6 (+)	
15	CONT6-	General input 6 (-)	
16	OUT1+	General output 1 (+)	■ Connect the general output circuit to a photo coupler or relay circuit. Power supply voltage range: 5V DC±5% Max. current value: 50mA Power supply voltage range: 12 to 15V DC±10% Max. current value: 50mA Power supply voltage range: 24V DC±10% Max. current value: 50mA ✔ When host unit input circuit is a TTL or CMOS-input, the maximum current value shall be 20mA or less. Host unit — Servo amplifier OUT1+ 16 OUT1- 17 OUT2+ 18 OUT2- 19
17	OUT1-	General output 1 (-)	
18	OUT2+	General output 2 (+)	
19	OUT2-	General output 2 (-)	
20, 21	-	Reserved	Do not connect anything.
22	RXD+	For the position synchronization compensation communication	■ This is communication interface for the position synchronization compensation function which controls as 2 amplifiers have same position deviation. Connect to the target amplifier. Communication spec is RS-422. ■ Refer the section 9.2.3 for connection method between amplifiers.
23	RXD-		
24	TXD+		
25	TXD-		
13,26	SG	Signal ground	Connected to the signal ground of servo amplifier.

4 Wiring

4. Wiring

4.3 Wiring of motor encoder

4.3.1 EN1, EN2 signal names and pin numbers

■ Battery backup absolute encoder (Encoder code: P)

Servo Amplifier EN1 Terminal No.	Signal name	Flange size 220mm or less Servo motor plug pin number (For lead wire type)	Flange size 275mm Servo motor plug pin number	Description	Remarks Note 1)
1	5V	9 (Red)	7	Power supply	Twisted pair (Recommended)
2	SG	10 (Black)	8	Power supply common	
3	5V	-	-	NC Note 3)	-
4	SG	-	-	NC Note 3)	-
5	(NC)	-	-	NC Note 3)	-
6	(NC)	-	-	NC Note 3)	-
7	ES+	1 (Brown)	1	Serial data signal	Twisted pair
8	ES-	2 (Blue)	2		
9	BAT+	8 (Pink)	5	Battery	Twisted pair
10	BAT-	4 (Purple)	9		
Note 2)	Ground	7 (shielded)	10	Shield	-

Note 1) Use shielded cable and perform twisted-pair wiring.
Note 2) Connect outer-shielded wires of servo amplifier to metal case (ground) of servo amplifier (EN1). For the servo motor with leads, the outer shielded wire of the servo motor shall be connected to shielded wires of leads, and for the cannon plug-type servo motor, perform wiring very close to servo motor. Encoder and outer shields are not connected inside the servo motor equipped with this encoder.
Note 3) Do not connect anything to 3 to 6 pins.

■ Single-turn absolute encoder (Encoder code: H)

Servo Amplifier EN1 Terminal No.	Signal name	Flange size 220mm or less Servo motor plug pin number (For lead wire type)	Flange size 275mm Servo motor plug pin number	Description	Remarks Note 1)
1	5V	9 (Red)	7	Power supply	Twisted pair (Recommended)
2	SG	10 (Black)	8	Power supply common	
3	5V	-	-	NC Note 3)	-
4	SG	-	-	NC Note 3)	-
5	(NC)	-	-	NC Note 3)	-
6	(NC)	-	-	NC Note 3)	-
7	ES+	1 (Brown)	1	Serial data signal	Twisted pair
8	ES-	2 (Blue)	2		
9	(NC)	-	-	NC Note 3)	-
10	(NC)	-	-	NC Note 3)	-
Note 2)	Ground	7 (shielded)	10	Shield	-

Note 1) Use shielded cable and perform twisted-pair wiring.
Note 2) Connect outer-shielded wires of servo amplifier to metal case (ground) of servo amplifier (EN1). For the servo motor with leads, the outer shielded wire of the servo motor shall be connected to shielded wires of leads, and for the cannon plug-type servo motor, perform wiring very close to servo motor. Encoder and outer shields are not connected inside the servo motor equipped with this encoder.
Note 3) Do not connect anything to 3 to 6, 9 and 10 pins.

■ Battery less absolute encoder (Encoder code: R)
■ Resolver type battery-less absolute encoder (Encoder code: W)

Servo Amplifier EN1 Terminal No.	Signal name	Flange size 220mm or less Servo motor plug pin number (For lead wire type)	Flange size 275mm Servo motor plug pin number	Description	Remarks Note 1)
1	5V	9 (Red)	7	Power supply	Twisted pair (Recommended)
2	SG	10 (Black)	8	Power supply common	
3	5V	-	-	NC Note 3)	-
4	SG	-	-	NC Note 3)	-
5	(NC)	-	-	NC Note 3)	-
6	(NC)	-	-	NC Note 3)	-
7	ES+	1 (Brown)	1	Serial data signal	Twisted pair
8	ES-	2 (Blue)	2		
9	(NC)	-	-	NC Note 3)	-
10	(NC)	-	-	NC Note 3)	-
Note 2)	Earth	7 (shielded)	10	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 servo amplifier and a ground of motor encoder.
Note 3) Do not connect anything to 3 to 6, 9 and 10 pins.

■ Wire-saving incremental encoder (Encoder code: S)

Servo Amplifier EN1, EN2 Terminal No.	Signal name	Flange size 220mm or less Servo motor plug pin number (For lead wire type)	Flange size 275mm Servo motor plug pin number	Description	Remarks Note 1)
1	5V	9 (Red)	7	Power supply	Twisted pair (Recommended)
2	SG	10 (Black)	8	Power supply common	
3	5V	-	-	NC Note 4)	-
4	SG	-	-	NC Note 4)	-
5	B	2 (Green)	3	Phase B pulse output	Twisted pair
6	/B	5 (Purple)	4		
7	A	1 (Blue)	1	Phase A pulse output	Twisted pair
8	/A	4 (Brown)	2		
9	Z	3 (White)	5	Phase Z pulse output	Twisted pair
10	/Z	6 (Yellow)	6		
Note 2)	Earth	7 (shielded)	10	Shield	-

Note 1) For amplifier model number "RS3****2***", EN2 is able to use as motor encoder input.
Note 2) Use an exterior covering shielded cable and perform twisted-pair wiring.
Note 3) Connect outer-shielded wires of encoder cable to metallic case (ground) of encoder connector (EN1 or EN2) and a ground of motor encoder.
Note 4) Do not connect anything to 3 and 4 pins.

4. Wiring

4.3.2 EN1, EN2 pin assignment
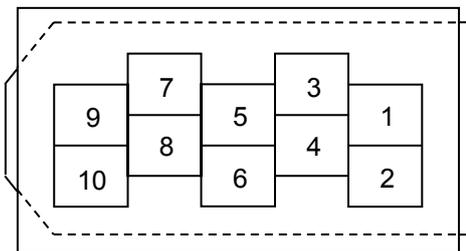
■ EN1, EN2 54593-1016 (soldered side)

9	7	3	1
	8	5	
10		6	4	2

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

■ Connector model number (Molex Japan LLC)

	Model Number	Applicable wire size	Applicable cable diameter
Plug connector	54593-1016	AWG30 to AWG18	―
Plug cable cover set	54599-1016	―	ϕ7 to ϕ9

4.3.3 Connector model number for motor encoder

■ R-series servo motor encoder
Connector model numbers (Products of Japan Aviation Electronics Industry, Ltd.)

Motor model number	Motor encoder plug model number	Connector type	Applicable cable diameter
R1#A04005 R1#A04010 R1#A06020 R1AA06040 R1AA08075 R2#A04003 R2#A04005 R2EA04008 R2#A04010 R2#A06010 R2#A06020 R2AA08020 R2AA06040 R2AA08040 R2AA08075 R2AAB8075 R2AAB8100 R2AA10075 R2AA10100 R5AA06020 R5AA06040 R5AA08075	(Lead wire type)	—	—
R1AA10100 R1AA10150 R1AA10200 R1AA10250	JN2DS10SL1-R	Straight	φ5.7 to φ7.3
R1AA13300 R1AA13400 R1AA13500 R1AA18550	JN2FS10SL1-R	Angle	
R1AA18750 R1AA1811K R1AA1815K R2AA13050	JN2DS10SL2-R	Straight	φ6.5 to φ8.0
R2AA13120 R2AA13180 R2AA13200 R2AA18350	JN2FS10SL2-R	Angle	
R2AA18450 R2AA18550 R2AA18750 R2AA1811K	JN2DS10SL3-R	Straight	φ3.5 to φ5.0
R2AA22500 R2AA22700 R2AA2211K R2AA2215K	JN2FS10SL3-R	Angle	

*   "#" will be any number or alphabet.

4
Wiring

4. Wiring

■ R-series servo motor encoder
Connector model numbers (Products of Japan Aviation Electronics Industry, Ltd.) (Continued)

Motor model number	Motor encoder plug model number	Connector type	Applicable cable diameter
R1CA10150 R1CA10200 R1CA13300 R1CA18550	JN2DS10SL1-R	Straight	φ5.7 to φ7.3
R1CA18750 R1CA1811K R1CA1815K	JN2FS10SL1-R	Angle	
R1CA2220K R2CA10075 R2CA10100 R2CA13050	JN2DS10SL2-R	Straight	φ6.5 to φ8.0
R2CA13120 R2CA13180 R2CA13200	JN2FS10SL2-R	Angle	
R2CA18350 R2CA18450 R2CA18550 R2CA18750	JN2DS10SL3-R	Straight	φ3.5 to φ5.0
R2CA2211K R2CA2215K R2CA2220K	JN2FS10SL3-R	Angle	
R2CA2830K	5557-10R	—	—

■ Contact model numbers (Products of Japan Aviation Electronics Industry, Ltd.)

Motor model number	Type	Model number	Qty.	Applicable wire size
Except R2CA2830K	Manual crimping type	JN1-22-20S-R-PKG100	Note 1)	AWG20
		JN1-22-22S-PKG100	Note 1)	AWG21 to AWG25
		JN1-22-26S-PKG100	Note 1)	AWG26 to AWG28
	Soldering type	JN1-22-22F-PKG100	Note 1)	AWG20 max.

Note 1) At our site, order will be accepted from one piece.
At manufacturer site, order will be accepted 1 pack each
(a hundred pieces are included).
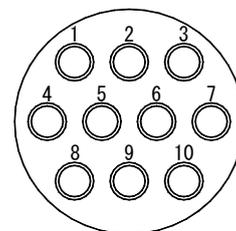
R-series servo motor encoder cannon plug pin assignment (Viewed from motor)

■ Contact model numbers (Molex Japan LLC)

Motor model number	Type	Model number	Applicable wire size
R2CA2830K	Manual crimping type	5556T2L	AWG22 to AWG28
		5556GS2　Note 1)	

Note 1) Gold plating. Use with battery backup absolute encoder
(encoder code: P).
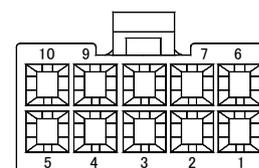
Flange size 280mm Servo motor encoder connector pin assignment (Viewed from motor)

■ 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	―
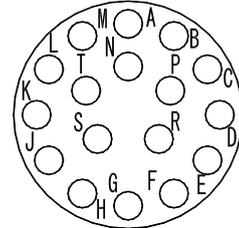
Encoder cannon plug
pin assignment
(Viewed from motor)

4.3.4 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.

4.3.5 Encoder cable length

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

Conductor size		Conductor resistance Ω/km (20°C)	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. Wiring

4.4 Wiring for thermostat of servo motor FAN (for 400V AC)

4.4.1 Connector model number for thermostat of servo motor FAN

■ Connector model number (Molex Japan LLC)
for thermostat of flange size 280 and 320 mm servo motor FAN

Motor model number	Model number	Applicable wire size
R2CA2830K R2CA3255K	5557-02R	AWG22 to AWG28

■ Contact model number (Molex Japan LLC)

Type	Model number	Applicable wire size
Manual crimping type	5556T2L	AWG22 to AWG28
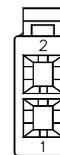
Flange size 280/320 mm
thermostat connector
of servo motor FAN
pin assignment
(Viewed from motor)

4.5 External alarm input, dynamic brake signal and thermostat

4.5.1 Pin assignment of external alarm input (CN8) (RS3W60#)

Pin number	Signal name
1	Thermal signal wiring for external dynamic brake resistor
2	
3	Thermal signal wiring for servo motor or fan motor
4	

4.5.2 Wiring of external alarm input (CN8) (RS3W60#)

■ In case of connecting a thermostat for fan motor

CN8
1
2 — Thermal signal wiring for fan motor
3
4 — Motor
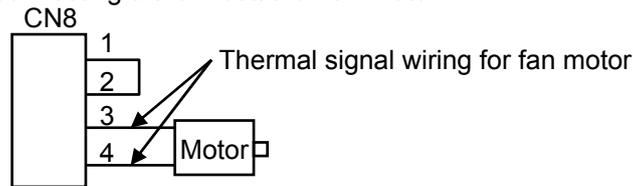
■ In case of connecting thermostats for a fan motor and for an external dynamic brake resistor

Thermal signal wiring for external dynamic brake resistor

CN8
1
2 — External dynamic brake resistor
3
4 — Motor

Thermal signal wiring for fan motor
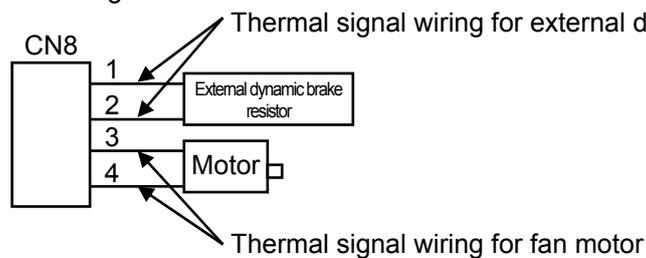
■ In case of no connection to CN8

CN8
1
2 ← Short circuit the pin 1 and 2.
3
4 ← Short circuit the pin 3 and 4.
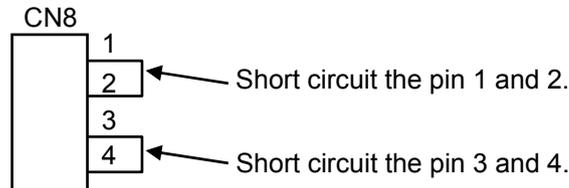
■ In case of connecting thermostats for a fan motor and for a servo motor

Thermal signal wiring for servo motor

CN8
1
2
3 Motor
4

Thermal signal wiring for fan motor
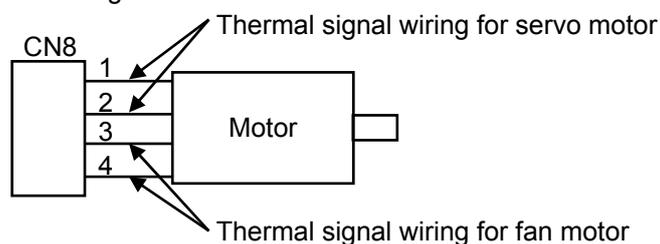
■ In case of connecting thermostats for an external dynamic brake resistor, servo motor and fan motor.

CN8
1
2 External dynamic brake resistor — Thermal signal wiring for servo motor
3
Motor
4

Thermal signal wiring for fan motor

4-38
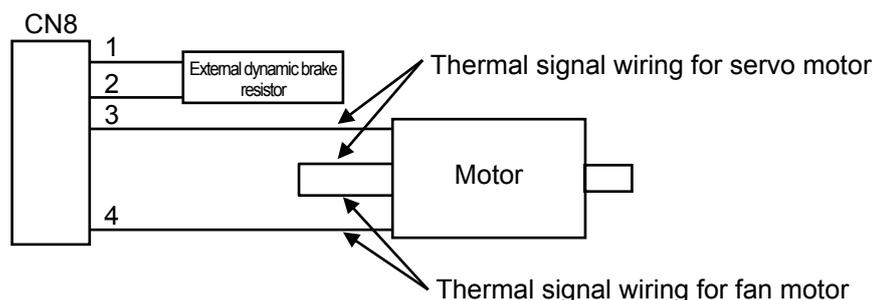
4. Wiring

4.5.3 Terminal block pin assignment for dynamic brake signal/thermostat (400 VAC)

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

* RS3C02/05/10/15 equips dynamic brake circuit internally so no terminal block.

4.5.4 Wiring of dynamic brake signal/thermostat (RS3C30#)

Below shows a wiring example.
Consult us for the other usage.

■ Wiring of dynamic brake signal only

Terminal block

TH1-1 ← Do short circuit between TH1-1 and TH1-2.
TH1-2
  MC2
DB1
DB2

* 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

Thermal signal wire of external dynamic brake resistor

Terminal block

TH1-1
TH1-2 → External dynamic brake resistor
  MC2
DB1
DB2
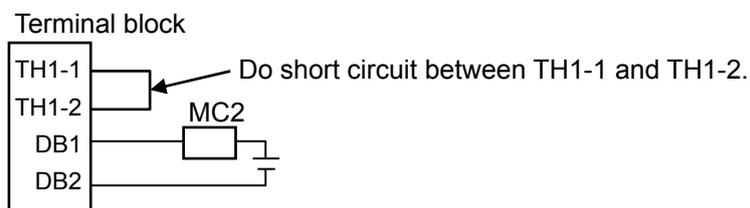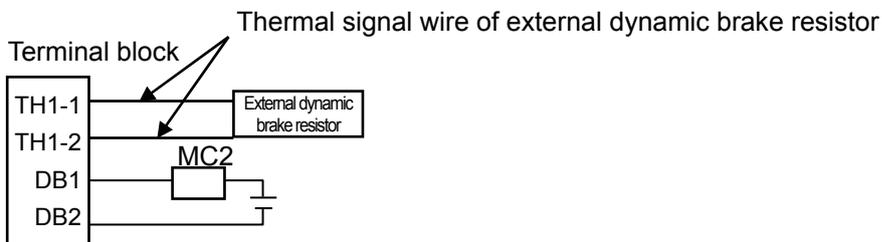
* Use Form b-contact (Normally Close) to magnetic contact (MC) of external dynamic brake circuit.

■ Wiring of fan motor thermostat

Terminal block   Fan motor thermostat wire

TH1-1
TH1-2 → Servo motor

DB1
DB2
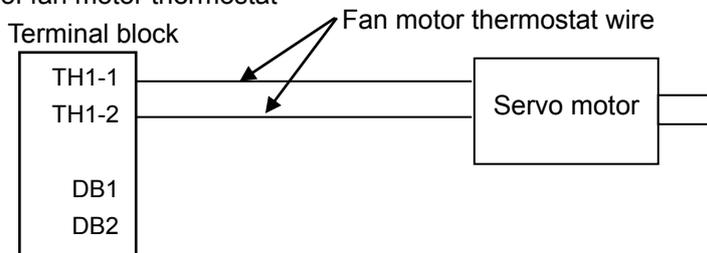
■ In case of using nothing

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

4.5 External alarm input, dynamic brake signal and thermostat

4.5.5 Wiring of dynamic brake signal/thermostat (RS3D80#)

Below shows a wiring example.
Consult us for the other usage.

■ Wiring of dynamic brake signal only

Terminal block

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

TH1-1
TH1-2

MC2   MC3

DB1
DB2

* 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.

Thermostat signal wire of external dynamic brake resistor

Terminal block

TH1-1
TH1-2

External dynamic brake resistor

External dynamic brake resistor

MC2   MC3

DB1
DB2
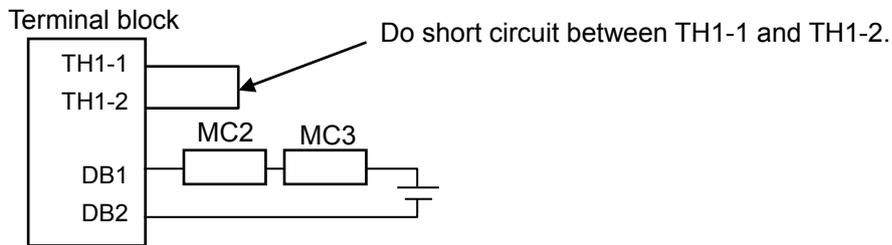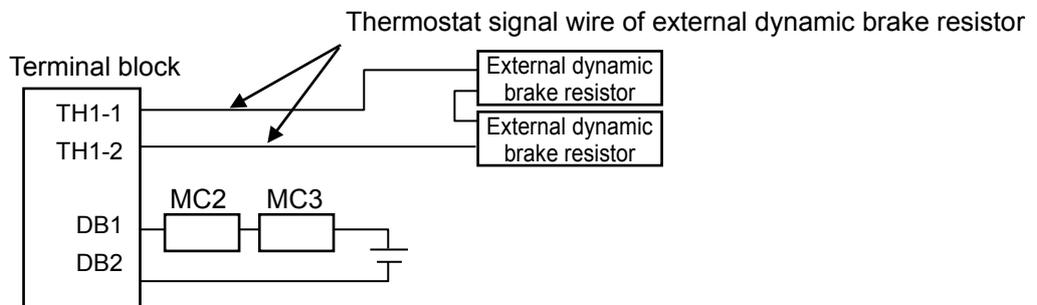
* Use Form b-contact (Normally Close) to magnetic contact (MC) of external dynamic brake circuit.

■ Wiring of servo motor thermostat.

Motor thermostat wire

Terminal block

TH1-1
TH1-2

Servo motor

DB1
DB2
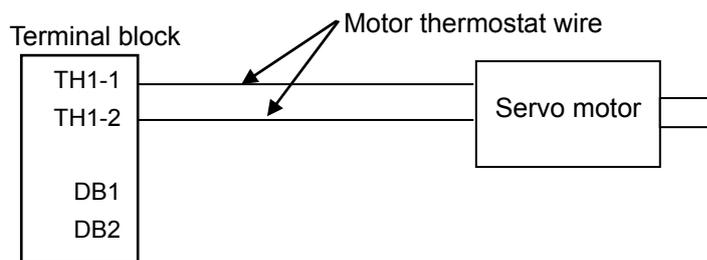
■ In case of using nothing

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

4. Wiring

4.6 Peripheral equipments

4.6.1 Power supply capacity and peripherals list (Rotary motor)

■ 200V AC input

Input voltage	Servo amplifier model number	Servo motor model No.	Main circuit power supply rating (kVA)	Molded Case Circuit Breaker (MCCB)	Noise filter	Magnetic contact	Surge absorber
200V AC	RS3#01#	R1AA04005F	0.2	Model NF32 10A MITSUBISHI ELECTRIC	HF3030C-SZA SOSHIN ELECTRIC Co., Ltd.	S-T10 MITSUBISHI ELECTRIC	LV275DI-U4 OKAYA ELECTRIC INDUSTRIES CO.,LTD.
		R1AA04010F	0.3				
		R2AA04003F	0.2				
		R2AA04005F	0.2				
		R2AA04010F	0.3				
		R2AA06010F	0.3				
		R5AA06020H	0.6				
	RS3#02#	R1AA06020F	0.6				
		R1AA06040F	1.0				
		R2AA06020F	0.6				
		R2AA06040F	1.0				
		R2AA06040H	1.0				
		R2AA08020F	0.6				
		R2AA08040F	1.0				
		R5AA06020F	0.6				
		R5AA06040F	1.0				
		R5AA06040H	1.0				
	RS3#03#	R1AA08075V	1.6				
		R1AA10100H	2.3				
		R1AA10150H	3.0				
		R2AA08075F	1.6				
		R2AAB8100H	2.0				
		R2AA10075F	1.7				
		R2AA13050D	1.2				
		R2AA13050H	1.2				
		R2AA13120B	2.2				
		R5AA08075D	1.6				
		R5AA08075F	1.6				
	RS3A05#	R1AA08075F	1.6	Model NF32 15A MITSUBISHI ELECTRIC			
		R1AA10100F	2.3				
		R1AA10150F	3.0				
		R1AA10200H	4.0				
		R1AA10250H	5.0				
		R2AAB8075F	1.6				
		R2AAB8100F	2.3				
		R2AA10100F	2.3				
		R2AA13120D	2.8				
		R2AA13120L	2.8				
		R2AA13180H	3.6				
		R2AA13200L	4.0				
	RS3A07#	R1AA10200F	4.0	Model NF63 30A MITSUBISHI ELECTRIC		S-T21 MITSUBISHI ELECTRIC	
		R1AA10250F	5.0				
		R1AA13300H	6.0				
		R2AA13180D	4.0				
		R2AA13200D	4.0				
		R2AA18350V	6.0				

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

■ 200V AC input

Input voltage	Servo amplifier model number	Servo motor model No.	Main circuit power supply rating (kVA)	Molded Case Circuit Breaker (MCCB)	Noise filter	Magnetic contact	Surge absorber
200V AC	RS3A10#	R1AA13300F	6.0	Model NF63 30A MITSUBISHI ELECTRIC	3SUPF-CH 40M-F OKAYA ELECTRIC INDUSTRIES CO.,LTD.	S-T21 MITSUBISHI ELECTRIC	LV275DI-U4 OKAYA ELECTRIC INDUSTRIES CO.,LTD.
		R1AA13400H	6.7				
		R1AA13500H	8.3				
		R2AA13180D	4.0				
		R2AA13200D	5.0				
		R2AA18350L	6.0				
	RS3A15#	R1AA13400F	6.7	Model NF63 50A MITSUBISHI ELECTRIC		S-T35 MITSUBISHI ELECTRIC	
		R1AA13500F	8.3				
		R2AA18350D	7.0				
		R2AA18450H	7.4				
		R2AA18550R	8.4				
		R2AA22500L	9.6				
		R2AA22700S	12.2	Model NF125 75A MITSUBISHI ELECTRIC		S-T50 MITSUBISHI ELECTRIC	
	RS3A30#	R1AA18550H	9.3	Model NF100 100A MITSUBISHI ELECTRIC	3SUPF-CH 80M-F OKAYA ELECTRIC INDUSTRIES CO.,LTD.	S-T65 MITSUBISHI ELECTRIC	
		R1AA18750L	11.6				
		R1AA1811KR	16.0				
		R1AA1815KB	21.4				
		R2AA18550H	9.3				
		R2AA18750H	11.6				
		R2AA1811KR	16.0				
		R2AA2211KB	16.0				
		R2AA2215KB	21.4				

■ RS3W60#/ 200V AC input

Input voltage	Power unit Amplifier unit	Servo motor model No.	Main circuit power supply rating (kVA)	Molded Case Circuit Breaker (MCCB)	Noise filter	Magnetic contact	Surge absorber
200V AC	RS3PAA270# RS3W60#	R1AA2220KV	28	Model NF125 100A MITSUBISHI ELECTRIC	3SUPF-CH 150MF-F OKAYA ELECTRIC INDUSTRIES CO.,LTD.	S-T65 MITSUBISHI ELECTRIC	LV275DI-U4 OKAYA ELECTRIC INDUSTRIES CO.,LTD.
		R2AA2220KB	28				
		R2AA2225KB	35				
		R2AA2830KV	42	Model NF225 150A MITSUBISHI ELECTRIC		S-T80 MITSUBISHI ELECTRIC	

■ 100V AC input

Input voltage	Servo amplifier model number	Servo motor model No.	Main circuit power supply rating (kVA)	Molded case circuit breaker (MCCB)	Noise filter	Magnetic contact	Surge absorber
100V AC	RS3#01#	R2EA04003F	0.2	Model NF32 10A MITSUBISHI ELECTRIC	HF3030C-SZA SOSHIN ELECTRIC Co., Ltd.	S-T10 MITSUBISHI ELECTRIC	LV275DI-U4 OKAYA ELECTRIC INDUSTRIES CO.,LTD.
	RS3#02#	R1EA04005F	0.2				
		R1EA04010F	0.4				
		R2EA04005F	0.2				
		R2EA04008F	0.4				
		R2EA06010F	0.5				
	RS3#03#	R1EA06020F	0.6				
		R2EA06020F	0.6				

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

4
Wiring

4. Wiring

■ 400V AC input

Input voltage	Servo amplifier model number	Servo motor model No.	Main circuit power supply rating (kVA)	Molded Case Circuit Breaker (MCCB)	Noise filter	Magnetic contact	Surge absorber
400 VAC	RS3C02#	R1CA10150V	2.5	BW125JAGU-3P020 Fuji Electric Co., Ltd.	HF3010C-SZA SOSHIN ELECTRIC Co., Ltd.	HS10 Hitachi Industrial Equipment Systems Co., Ltd.	LV480DI-U4 OKAYA ELECTRIC INDUSTRIES CO.,LTD.
		R2CA10075F	1.3				
		R2CA13050D	1.0				
		R2CA13120R	2.0				
		R2CA13180H	2.9				
		R2CA13200L	3.3				
	RS3C05#	R1CA10200V	3.7		HF3020C-SZA SOSHIN ELECTRIC Co., Ltd.	HS20 Hitachi Industrial Equipment Systems Co., Ltd.	
		R1CA13300V	5.2				
		R2CA10100F	1.8				
		R2CA13120F	2.3				
		R2CA13180D	3.3				
		R2CA13200D	3.7				
		R2CA18350L	6.0				
	RS3C10#	R2CA18350D	6.0	BW125JAGU-3P030 Fuji Electric Co., Ltd.	HF3030C-SZA SOSHIN ELECTRIC Co., Ltd.		
		R2CA18450H	7.6				
		R2CA18550R	9.5				
	RS3C15#	R1CA18550H	7.0	BW125JAGU-3P050 Fuji Electric Co., Ltd.	HF3100C-SZC SOSHIN ELECTRIC Co., Ltd.	HS50 Hitachi Industrial Equipment Systems Co., Ltd.	
		R1CA18750L	9.5				
		R1CA1811KR	13.8				
		R1CA1815KB	18.2				
		R2CA18550H	7.0				
		R2CA18750H	9.4				
		R2CA2211KB	13.6				
		R2CA2215KV	18.4				
	RS3C30#	R1CA2220KV	24.2	BW125JAGU-3P100 Fuji Electric Co., Ltd.		H100C Hitachi Industrial Equipment Systems Co., Ltd.	
		R2CA2220KV	27.5				
		R2CA2230KV	36.2				

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 RS3D80#	R2CA3255KB	90	EW400EAG-3P250 30mA Fuji Electric Co., Ltd. NV400-CW 3P 250A 30mA Mitsubishi Electric	HF3200C-SZB-4DEDE SOSHIN ELECTRIC Co., Ltd.	H400C Hitachi Industrial Equipment Systems Co., Ltd.	LV480DI-U4 OKAYA ELECTRIC INDUSTRIES CO.,LTD.

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

4.6.2 Power supply capacity and peripherals list (Linear motor)

■ 200V AC input

Input voltage	Servo amplifier model number	Linear motor model number	Main circuit power supply rating (kVA)	Molded Case Circuit Breaker (MCCB)	Noise filter	Magnetic contact	Surge absorber
200V AC	RS3A03L	DS030C1N2	1.4	Model NF32 10A MITSUBISHI ELECTRIC	HF3030C-SZA SOSHIN ELECTRIC	S-T10 MITSUBISHI ELECTRIC	LV275DI-U4 OKAYA ELECTRIC INDUSTRIES CO.,LTD.
		DS050C1N2	1.4				
		DS075C1N2	1.5				
		DS045CC1AN	1.4				
	RS3A05L	DS030C2N2	2.7	Model NF32 15A MITSUBISHI ELECTRIC			
		DS050C2N2	2.7				
		DS075C2N2	3.0				
		DD030C1Y4	2.7				
		DS100C1N2	3.2				
		DS150C1N2	3.2				
	RS3A07L	DS030C3N2	3.5	Model NF63 30A MITSUBISHI ELECTRIC	3SUPF-CH 40M-F OKAYA ELECTRIC INDUSTRIES CO.,LTD.	S-T21 MITSUBISHI ELECTRIC	
		DS050C3N2	3.5				
		DS075C3N2	3.8				
		DD030C2Y4	4.5				
		DD050C1Y2	4.4				
		DD075C1Y2	4.8				
		DD045CB4AN	3.2				
		DD035CC2AN	3.0				
	RS3A10L	DS030C3N2	3.5				
		DS050C3N2	3.5				
		DS075C3N2	3.8				
		DS100C2N2	5.5				
		DS150C2N2	5.5				
		DD030C2Y4	4.5				
		DD030C3Y4	6.8	Model NF63 50A MITSUBISHI ELECTRIC		S-T35 MITSUBISHI ELECTRIC	
		DD050C1Y2	4.4	Model NF63 30A MITSUBISHI ELECTRIC		S-T21 MITSUBISHI ELECTRIC	
		DD075C1Y2	4.8				
		DD045CB4AN	3.2				
	RS3A15L	DS100C3N2	8.2	Model NF63 50A MITSUBISHI ELECTRIC		S-T35 MITSUBISHI ELECTRIC	
		DS150C3N2	8.2				
		DD050C2Y2	8.8				
		DD075C2Y2	9.5				
	RS3A30L	DD075C3Y2	12.2	Model NF125 75A MITSUBISHI ELECTRIC	3SUPF-CH 80M-F OKAYA ELECTRIC INDUSTRIES CO.,LTD.	S-T65 MITSUBISHI ELECTRIC	
		DD075C4Y2	13.2	Model NF125 100A MITSUBISHI ELECTRIC			
		DD030C2Y4	17.5				

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

4
Wiring

No Text on This Page.

Linear motor

In this chapter, each items for servo motor operations are explained.

5. Linear motor

5.1 Illustration of system components

■ RS3A01/02/03/05

T S R

Wiring breaker (MCCB)

Used to protect power line.
Turns off the power supply
when overload runs.

Noise filter

Installed to protect power line
from external noise.

Electromagnetic contactor
Switches power On/Off.
Please place safeguard circuit.

External regenerative resistor

Used in case of insufficient capacity such
that may be caused by high frequency of
use, although internal regenerative resistor
is enough in usual.

Motor power

SANMOTION R 3E Model
With **EtherCAT** Interface

SANMOTION R

EtherCAT
Conformance tested

SANYO DENKI

CHARGE

CNA
R
S
T
r
t
⊖
RB1
RB2

CNB
U
V
W

PC

OUT
L/A
RUN
IN
L/A
ERR

CN2

CN4

EN1

EN2

CN3

Enables parameter setup
and monitoring through
communication with a PC.

USB

Setup software

To next amplifier

Host equipment

General I/O connector
Connects homing,
probing and general
signals.

Safety unit,
safety PLC
etc.

Hall effect sensor

inear motor

Connects I/O signal of
Safe Torque Off function
to safety devices as
safety unit, safety PLC.

5-1

5.2 Wiring of linear encoder

5.2.1 EN1, EN2 signal names and pin numbers

■　EN1 linear encoder (Incremental differential output)

Servo Amplifier EN1 Terminal No.	Signal name	DS/DD series linear motor	Description	Remarks Note 1)
1	5V		Power supply Note 3)	Twisted pair
2	SG		Power supply common Note 4)	
3	5V		Power supply Note 3)	Twisted pair
4	SG	Wiring depending on linear encoder specification. As note, please prepare linear encoder at user side.	Power supply common Note 4)	
5	B		B-phase signal output	Twisted pair
6	/B			
7	A		A-phase signal output	Twisted pair
8	/A			
9	Z		Z-phase signal output	Twisted pair
10	/Z			
Note 2)	Ground		Shield	-

Note 1)　Use an exterior covering shielded cable and perform twisted-pair wiring.
Note 2)　Connect jacketed and shielded wire to metallic case (ground) on EN1 and ground on linear encoder.
Note 3)　Power supply for linear encoder of servo amplifier can supply 5.1 to 5.5 VDC, 300mA. Please prepare external power supply if the specifications for power supply needed for linear encoder you use are different.
Note 4)　Make sure to connect power supply common.
Note 5)　For amplifier model number "RS3****2***", EN2 is able to use as linear encoder.

■　EN1 absolute encoder (EnDat2.2)

Servo Amplifier EN1 Terminal No.	Signal name	DS/DD series linear motor	Description	Remarks Note 1)
1	5V		Power supply　Note 3)	Twisted pair
2	SG		Power supply common Note 4)	
3	5V		Power supply　Note 3)	Twisted pair
4	SG	Wiring depending on linear encoder specification. As note, please prepare linear encoder at user side.	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)	Ground		Shield	-

Note 1)　Use an exterior covering shielded cable and perform twisted-pair wiring.
Note 2)　Connect jacketed and shielded wire to metallic case (ground) on EN1 and ground on linear encoder.
Note 3)　Power supply for linear encoder of servo amplifier can supply 5.1 to 5.5 VDC, 300mA. Please prepare external power supply if the specifications for power supply needed for linear encoder you use are different.
Note 4)　Make sure to connect power supply common.

5 Linear motor

5. Linear motor

■ EN2 hall effect sensor (Line driver output)

Servo Amplifier EN2 Terminal No.	Signal name	DS/DD series linear motor Lead wire spec	Description	Remarks Note 1)
1	5V	Red	Power supply	Twisted pair
2	SG	Black	Power supply common Note 3)	
3	5V	—	Power supply	Twisted pair
4	SG	—	Power supply common Note 3)	
5	S2	Green	V-phase signal output	Twisted pair
6	/S2	Purple		
7	S1	Blue	U-phase signal output	Twisted pair
8	/S1	Brown		
9	S3	White	W-phase signal output	Twisted pair
10	/S3	Yellow		
Note 2)	Ground	Ground	Shield	—

Note 1) Use an exterior covering shielded cable and perform twisted-pair wiring.
Note 2) Connect jacketed and shielded wire to metallic case (ground) on EN1 and ground on linear encoder.
Note 3) Make sure to connect power supply common.

■ EN2 Hall effect sensor (Open-collector output)

Servo Amplifier EN2 Terminal No.	Signal name	DS/DD series linear motor Lead wire spec	Description	Remarks Note 1)
1	5V	Grey	Power supply Note 3)	Twisted pair
2	SG	White	Power supply common Note 4)	
3	5V	—	Power supply Note 3)	Twisted pair
4	SG	—	Power supply common Note 4)	
5	S2	Yellow	V-phase signal output	—
6	—	—	—	NC
7	S1	Green	U-phase signal output	—
8	—	—	—	NC
9	S3	Brown	W-phase signal output	—
10	—	—	—	NC
Note 2)	Ground	Ground	Shield	—

Note 1) Use an exterior covering shielded cable and perform twisted-pair wiring.
Note 2) Connect jacketed and shielded wire to metallic case (ground) on EN1 and ground on linear encoder.
Note 3) Make sure to connect power supply common.

5.2.2 EN1, EN2 pin assignment

■ EN1, EN2 54593-1016 (soldered side)

```
        7       3
   9         5       1
        8           4
   10        6       2
```
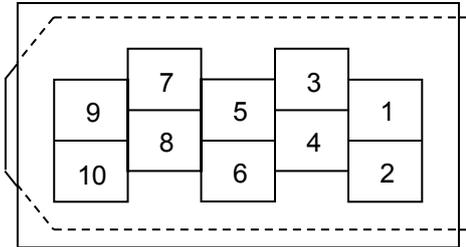
* Wirings vary depending on encoders to be connected, so please carefully perform wiring.

■ Connector model number (Molex Japan LLC)

	Model Number	Applicable wire size	Applicable cable diameter
Plug connector	54593-1016	AWG30 to AWG18	—
Plug cable cover set	54599-1016	—	ϕ7 to ϕ9

5. Linear motor

5.2.3 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.

5.2.4 Encoder cable length

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

Conductor size		Conductor resistance Ω/km (20°C)	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.

5.3 Linear motor control-related parameters

5.3.1 Setting of system parameters

Group ID	CoE Object ID	Contents
System ID30	0x20FE, 0x00 MOCODE	**Motor code** ■ Sets combination motor code you use. Set the combination motor code by the linear motor code you use in Index 0x20FE "Motor code". ✔For the case of 0xFFFF whose motor code is specific , make sure to download motor parameters from setup software. ✍ System parameter becomes effective after control power cycle.
System ID31	0x20FF, 0x01 ENCODE	**Encoder division number code** ■ Sets division number of linear encoder you use. Incremental encoder / Absolute encoder 0x0000: 5µm [200P/mm] 0x0080: 100nm [10,000P/mm] 0x0001: 2.5µm [400P/mm] 0x0080: 50nm [20,000P/mm] 0x0002: 2µm [500P/mm] 0x0080: 10nm [100,000P/mm] 0x0003: 1.25µm [800P/mm] 0x0080: 5nm [200,000P/mm] 0x0004: 1µm [1,000P/mm] 0x0080: 1nm [1,000,000P/mm] 0x0005: 0.5µm [2,000P/mm] 0x0006: 0.25µm [4,000P/mm] 0x0007: 0.125µm [8,000P/mm] 0x0008: 0.1µm [10,000P/mm] 0x0009: 0.05µm [20,000P/mm] ✍ System parameter becomes effective after control power cycle.
System ID32	0x20FF, 0x02 ENTYPE	**Encoder type code** ■ Sets linear encoder and CS-normalization method you use. Incremental encoder (Encoder option / CS decision / CS-normalization) 0x0800: Incremental encoder with CS / Hall effect sensor / Phase U 0x0810: Incremental encoder with CS / Hall effect sensor / Phase Z 0x0820: Incremental encoder with CS / Hall effect sensor / None 0x0830: Wire-saving incremental encoder / Hall effect sensor / Phase Z 0x0840: Wire-saving incremental encoder / Hall effect sensor / None 0x0850: Incremental encoder / Magnetic pole position estimation / None 0x0860: Incremental encoder / Fixed setting / None Absolute encoder (Encoder option / CS decision) 0x0900: EnDat 2MHz / Encoder absolute position 0x0910: EnDat 2MHz / Software setting (Magnetic pole position estimation) 0x0920: EnDat 4MHz / Encoder absolute position 0x0930: EnDat 4MHz / Software setting (Magnetic pole position estimation) ✍ System parameter becomes effective after control power cycle.
GroupA ID10	0x6060, 0x00 OPMODE	**Operation mode** ■ Sets operational mode for the servo amplifier you use. Set as follows. | Value to select		Contents
01	PP	Profile position mode
...	...	...
0A	CST	Cycle synchronization torque mode	
System ID20	0x20F3, 0x02 PLMODE	**Position loop control encoder selection** ■ Verify the set value is as indicated below. 	Present set value	Contents
---	---
00: Motor-Enc	Semi-closed control/ motor encoder	

5. Linear motor

5.3.2 Setting of linear encoder

CS-detection method of linear motor varies depending on "System ID32" of the system parameter or "Index 0x20FF-1 Encoder type code". Verify the following parameter settings.

Group ID	CoE Object ID	Contents
GroupC ID00	0x20F1, 0x02 ENFIL	Encoder digital filter selection (EN1) ■ Sets digital filter for motor pulse encoder pulse signal, which is contained in pulse output encoder. Digital filter value of incremental pulse from the linear encoder you use can be set. When noises superimposed on incremental encoder, pulse under the set value shall be eliminated as noise. Set the value in consideration of encoder resolution and operational maximum velocity of servo motor you use. Use the value under a quarter of encoder pulse width at maximum rotational velocity as a guide.<table><tr><td>Value to select</td><td>Contents</td></tr><tr><td>00:＿110nsec</td><td>Minimum pulse width =110ns（Minimum phase difference37.5ns）</td></tr><tr><td>01:＿220nsec</td><td>Minimum pulse width =220ns（Minimum phase difference75ns）</td></tr><tr><td>02:＿440nsec</td><td>Minimum pulse width =440ns（Minimum phase difference150ns）</td></tr><tr><td>03:＿880nsec</td><td>Minimum pulse width =880ns（Minimum phase difference300ns）</td></tr><tr><td>04:＿75nsec</td><td>Minimum pulse width = 75ns（Minimum phase difference37.5ns）</td></tr><tr><td>05:＿150nsec</td><td>Minimum pulse width =150ns（Minimum phase difference75ns）</td></tr><tr><td>06:＿300nsec</td><td>Minimum pulse width =300ns（Minimum phase difference150ns）</td></tr><tr><td>07:＿600nsec</td><td>Minimum pulse width =600ns（Minimum phase difference300ns）</td></tr></table>
GroupC ID09	0x20F1, 0x07 ENCDIR	Linear encoder polarity selection (EN1) ■ Selects linear encoder (EN1) signal polarity. Phase A and B signal polarity are selectable.<table><tr><td>Value to select</td><td></td><td>Contents</td></tr><tr><td>00</td><td>Standard</td><td>Phase B signal rises in first in forward direction operation.</td></tr><tr><td>01</td><td>Reversed</td><td>Phase A signal rises in first in forward direction operation.</td></tr></table>✍ System parameter becomes effective after control power cycle.

5.3 Linear motor control-related parameters
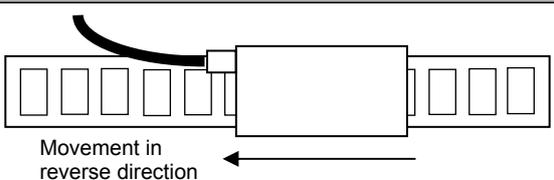
5.3.3 Setting of magnetic pole position parameters

CS-detection method of linear motor varies depending on "System ID32" of the system parameter or "Index 0x20FF-1 Encoder type code". Verify the following parameter settings.

Group ID	CoE Object ID	Contents
GroupC ID01	0x20F1, 0x03 EX-ENFIL	Hall effect sensor digital filter selection (External encoder digital filter selection) ■ Sets digital filter of Hall effect sensor input signal. When noises are superimposed on Hall effect sensor signal, pulse under the set value shall be removed as noise. <table><tr><td>Value to select</td><td>Contents</td></tr><tr><td>00：_110nsec</td><td>Minimum pulse width =110ns（Minimum phase difference 37.5ns）</td></tr><tr><td>01：_220nsec</td><td>Minimum pulse width =220ns（Minimum phase difference 75ns）</td></tr><tr><td>02：_440nsec</td><td>Minimum pulse width =440ns（Minimum phase difference 150ns）</td></tr><tr><td>03：_880nsec</td><td>Minimum pulse width =880ns（Minimum phase difference 300ns）</td></tr><tr><td>04：_ 75nsec</td><td>Minimum pulse width =75ns（Minimum phase difference 37.5ns）</td></tr><tr><td>05：_150nsec</td><td>Minimum pulse width =150ns（Minimum phase difference 75ns）</td></tr><tr><td>06：_300nsec</td><td>Minimum pulse width =300ns（Minimum phase difference 150ns）</td></tr><tr><td>07：_600nsec</td><td>Minimum pulse width =600ns（Minimum phase difference 300ns）</td></tr></table>
GroupC ID02	0x20F1, 0x04 EX-ENPOL	Hall effect sensor polarity selection (External encoder polarity selection) ■ Sets polarity of Hall effect sensor input signal. <table><tr><td>Value to select</td><td></td><td colspan="3">Contents</td></tr><tr><td>00</td><td>Type1</td><td>S3/ not reversed</td><td>S2/ not reversed</td><td>S1/ not reversed</td></tr><tr><td>01</td><td>Type2</td><td>S3/ not reversed</td><td>S2/ not reversed</td><td>S1/ reversed</td></tr><tr><td>02</td><td>Type3</td><td>S3/ not reversed</td><td>S2/ reversed</td><td>S1/ not reversed</td></tr><tr><td>03</td><td>Type4</td><td>S3/ not reversed</td><td>S2/ reversed</td><td>S1/ reversed</td></tr><tr><td>04</td><td>Type5</td><td>S3/ not reversed</td><td>S2/ not reversed</td><td>S1/ not reversed</td></tr><tr><td>05</td><td>Type6</td><td>S3/ reversed</td><td>S2/ not reversed</td><td>S1/ reversed</td></tr><tr><td>06</td><td>Type7</td><td>S3/ reversed</td><td>S2/ reversed</td><td>S1/ not reversed</td></tr><tr><td>07</td><td>Type8</td><td>S3/ reversed</td><td>S2/ reversed</td><td>S1/ reversed</td></tr></table> Encoder type code: 0x20FF, 01＝0x0800, 0x0810, and 0x0820 need to be set. ✍ System parameter becomes effective after control power cycle.
System ID1A	0x20F1, 0x05 CSHIFT	CS-offset ■ Sets electrical angle of motor. [Incremental encoder] For motor with Hall effect sensor, offset from phase U electrical angle 0 degree to phase U hall sensor output edge shall be set in electrical angle. [Absolute encoder] Offset of magnet pole position and absolute encoder absolute position shall be set in electrical angle. 　　Setting range:　　　0 to 359 deg 　　Initial value:　　　　0 deg 　　✔ All of encoder type code (0x20FF, 02) need to be set. ✍ System parameter becomes effective after control power cycle.
System ID1B	0x20F1, 0x06 CSCNOF	Z-phase CS-normalization offset ■ Sets offset of phase Z signal to electrical angle of motor. This is effective only when performing CS-normalization with phase Z signal. Set offset from phase U electrical angle 0 degree to phase Z signal output position shall be set in electrical angle. 　　Setting range:　　　0 to 359 deg 　　Initial value:　　　　0 deg 　　✔Encoder type code: 0x20FF, 02＝0x0810 or 0x0830, need to be set. ✍ System parameter becomes effective after control power cycle.

5. Linear motor
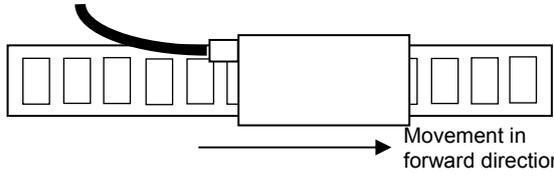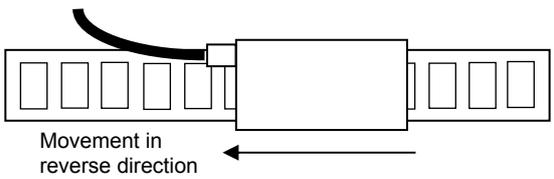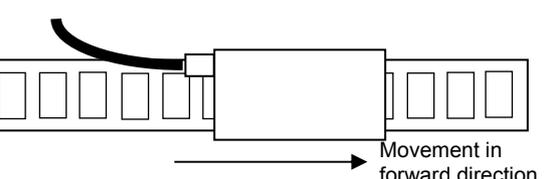
Group ID	CoE Object ID	Contents

GroupD ID01	0x20F1, 0x08 EMPFREQ	**Magnetic pole position estimation frequency**
		■ Sets frequency of torque (force) applied at magnetic pole position estimation.
		    Setting range: 5 to 100Hz
		    Initial value: 50Hz
		✔ Change excitation frequency when detection cannot be normally completed due to resonance point of machine, at amplifier hardware magnetic pole position estimation.
		✍ System parameter becomes effective after control power cycle.

GroupC ID0A	0x20F1, 0x09 CSETMD	**Magnetic pole position estimation mode selection** ■ Sets the magnetic pole position estimation run mode. {{TABLE1}} ✔It becomes effective if 0x0850, 0x910 or 0x930 is set to Encoder type cord: 0x20FF, 02. ✍ System parameter becomes effective after control power cycle.
Group9 ID1D	0x20F8, 0x06 CSET	**Magnetic pole position pointing function** ■ Sets valid condition of magnetic pole position estimation, for linear motor without Hall effect sensor output function. {{TABLE2}} ✔ Input time to become al l the function enabled is 8ms.
Group9 ID40	0x20F8, 0x03 EXT-E	**External trip-input function** ■ Sets the condition that trip input becomes effective to use thermal of linear motor. The setting contents are the same as the above magnetic pole position indication function. ✔ Input time to become al l the function enabled is 8ms.

TABLE1:

Value to select	Contents
00	Follow the setting of the valid condition of magnetic pole position pointing function.
01	Magnetic pole position estimation will run one time automatically only after turning on the main power.

TABLE2:

Value to select	Contents
02:_CONT1_ON	Function enabled when general input CONT1 is ON.
03:_CONT1_OFF	Function enabled when general input CONT1 is OFF.
04:_CONT2_ON	Function enabled when general input CONT2 is ON.
05:_CONT2_OFF	Function enabled when general input CONT2 is OFF.
06:_CONT3_ON	Function enabled when general input CONT3 is ON.
07:_CONT3_OFF	Function enabled when general input CONT3 is OFF.
08:_CONT4_ON	Function enabled when general input CONT4 is ON.
09:_CONT4_OFF	Function enabled when general input CONT4 is OFF.
0A:_CONT5_ON	Function enabled when general input CONT5 is ON.
0B:_CONT5_OFF	Function enabled when general input CONT5 is OFF.
0C:_CONT6_ON	Function enabled when general input CONT6 is ON.
0D:_CONT6_OFF	Function enabled when general input CONT6 is OFF.

5.3 Linear motor control-related parameters

5.3.4 Setting of moving direction

Moving direction of linear motor depends on polarity of command and linear encoder.

■ Setting of command-input polarity

Group ID	CoE Object ID	Contents
GroupA ID11	0x607E, 0x00 CMDPOL	**Polarity** ■ Selects position command polarity from the following contents. Servo motor moving direction can be reversed without changing command wiring. Moving direction is set as follows when command increased.

Polarity
■ Selects position command polarity from the following contents.
   Servo motor moving direction can be reversed without changing command wiring.
   Moving direction is set as follows when command increased.

Value to select		Position command "plus"
00	PC+_VC+_TC+	
20	PC+_VC+_TC-	Movement in forward direction
40	PC+_VC-_TC+	
60	PC+_VC-_TC-	
"APMON"		The value on present position monitor decreases.

Value to select		Position command "minus"
00	PC+_VC+_TC+	
20	PC+_VC+_TC-	
40	PC+_VC-_TC+	Movement in reverse direction
60	PC+_VC-_TC-	
"APMON"		The value on present position monitor increases.

Value to select		Position command "plus"
80	PC-_VC+_TC+	
A0	PC-_VC+_TC-	Movement in reverse direction
C0	PC-_VC-_TC+	
E0	PC-_VC-_TC-	
"APMON"		The value on present position monitor increases.

Value to select		Position command "minus"
80	PC-_VC+_TC+	
A0	PC-_VC+_TC-	
C0	PC-_VC-_TC+	Movement in forward direction
E0	PC-_VC-_TC-	
"APMON"		The value on present position monitor decreases.

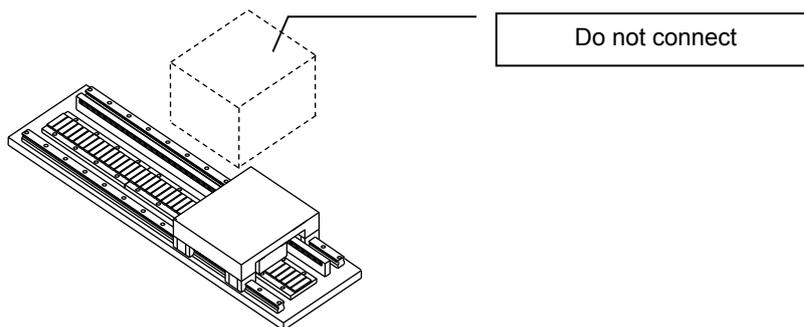5 Linear motor

5. Linear motor

5.4 Test operation

5.4.1 Check of installation and wiring
Check the installation / wiring of servo amplifier and linear motor.

[Step 1: installation]
- ■ Set the servo amplifier and linear motor by following "3. Installation".

- ■ Remove a load on the stage, and keep free from a load.

Do not connect

[Step 2: Wiring/Connection --> Turn power on]
- ■ Please wire the servo amplifier, linear motor and host unit by following "4. Wiring". As note, do not connect CN1 to the amplifier.

- ■ Supply power. Check that the display of upper of servo amplifier 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".

5.4.2 Preparation before operation

Before operation, adjusting a relation between move direction and encoder polarity, and a magnetic pole position.

1) For absolute encoder

[Step 1: Move direction check]
- Move linear motor to the direction where power line lead pulled out, through monitoring the monitor function ID4B "Absolute encoder PS data monitor".
  When the monitoring data decreased, please set "01: Reversed" to Index 0x20F1-7 "Linear encoder polarity selection".

[Step 2: CS offset value setting]
- Set "0x0910 or 0x0930 (CS decision: Magnetic pole position estimation)" to Index 0x20FF-2 "Encoder type code". And make control power cycle.

- Supply main circuit power, and perform the magnetic pole position estimation.
* See "5.4.3 Magnetic pole position estimation method" for detail.

- Confirm the monitor function ID4E "CS offset monitor", and then set the indicated data to Index 0x20F1-5 "CS offset value".
* For the "CS offset value", please set the average of "CS offset value" which are picked up from 3 points (center and both end of linear motor stroke) or more through the magnetic pole position estimation.

- Set "0x0900 or 0x0920 (CS decision: Encoder absolute position)" to Index 0x20FF-2 "Encoder type code". And make control power cycle.

2) For incremental encoder

[Step 1: Move direction check]
- Move linear motor to the direction where power line lead pulled out, through monitoring the monitor function ID42 "Present position monitor".
  When the monitoring data decreased, please set "01: Reversed" to Index 0x20F1-7 "Linear encoder polarity selection".

[Step 2: Magnetic pole position estimation]
- Supply main circuit power, and perform the magnetic pole position estimation.

* Perform only when 0x0850 (CS decision: Magnetic pole position estimation)" is set to Index 0x20FF-2 "Encoder type code".
* See "5.4.3 Magnetic pole position estimation method" for detail.

Linear motor 5

5. Linear motor

5.4.3 Magnetic pole position estimation

Magnetic pole position estimation is able to perform by methods below.

1) Perform through general input operation
   ◆ Set "00: Normal" to Index 0x20F1-9 "Magnetic pole position estimation mode".

   ◆ Set the condition for enabling the function to Index 0x20F8-6 "Magnetic pole position estimation function".

   ◆ Supply main circuit power, and make valid the selected condition.

2) Perform automatically when main circuit power is supplied
   ◆ Set "01: Auto" to Index 0x20F1-9 "Magnetic pole position estimation mode".

   ◆ Supply main circuit power.
     Performs the magnetic pole position estimation automatically.
* Pay attention that the linear motor moves automatically after supplying main circuit power.
* Even if after automatic performing completion, magnetic pole position estimation is able to perform again if the effective condition is satisfied or the digital operator / the setup software perform the function.

3) Perform through the setup software
   Select the magnetic pole position estimation from the menu in the test operation. See "7.4 Magnetic pole position estimation" in another document: M0010842, for operation method of the setup software.

* For the magnetic pole position estimation, forward/reverse force command is performed and pole position is estimated by detecting the acceleration. Force command will be larger automatically if the acceleration is small.
* Pay attention to motor movement because motor moves slightly during the function operation.
* Maximum 5 sec will be required for the magnetic pole position detection.
* Please stop the magnetic pole position estimation immediately if problem occurred on the motion.
* Magnetic pole position is not able to detect correct if Index 0x20F1-8 "Excitation command frequency set value" is near to a resonance frequency of mechanical system. In this case, lower the excitation command frequency set value.
* This function is not able to use to the machine which is vertical axis or getting a large external force.
* For the machine which is combined multi axes as tandem structure, magnetic pole position may not detect correct if magnetic pole position estimations are performed at multi axes at the same time. Must perform magnetic pole position estimation singly. Also, the other axes which are not performed magnetic pole position estimation make servo off.

5.2.4 Check of operation

[Step 1: JOG operation]

■ Run the JOG operation without a load on the stage.

■ Check whether the linear motor is able to move to positive and negative direction full stroke.

Move motor beyond 2 magnets or more.

← Reverse direction   Forward direction →
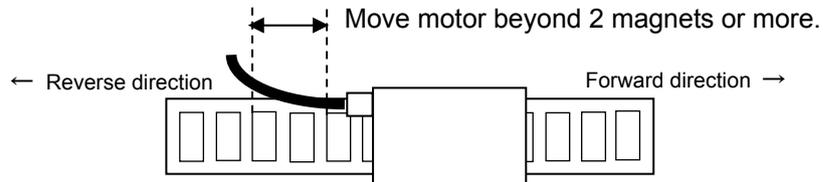
* The forward direction means the direction where motor power line lead pulled out.
* Please perform operation with safety speed.

◆ 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 "7.6.1 Velocity-controlled JOG Operation" for detail of the digital operator operation.
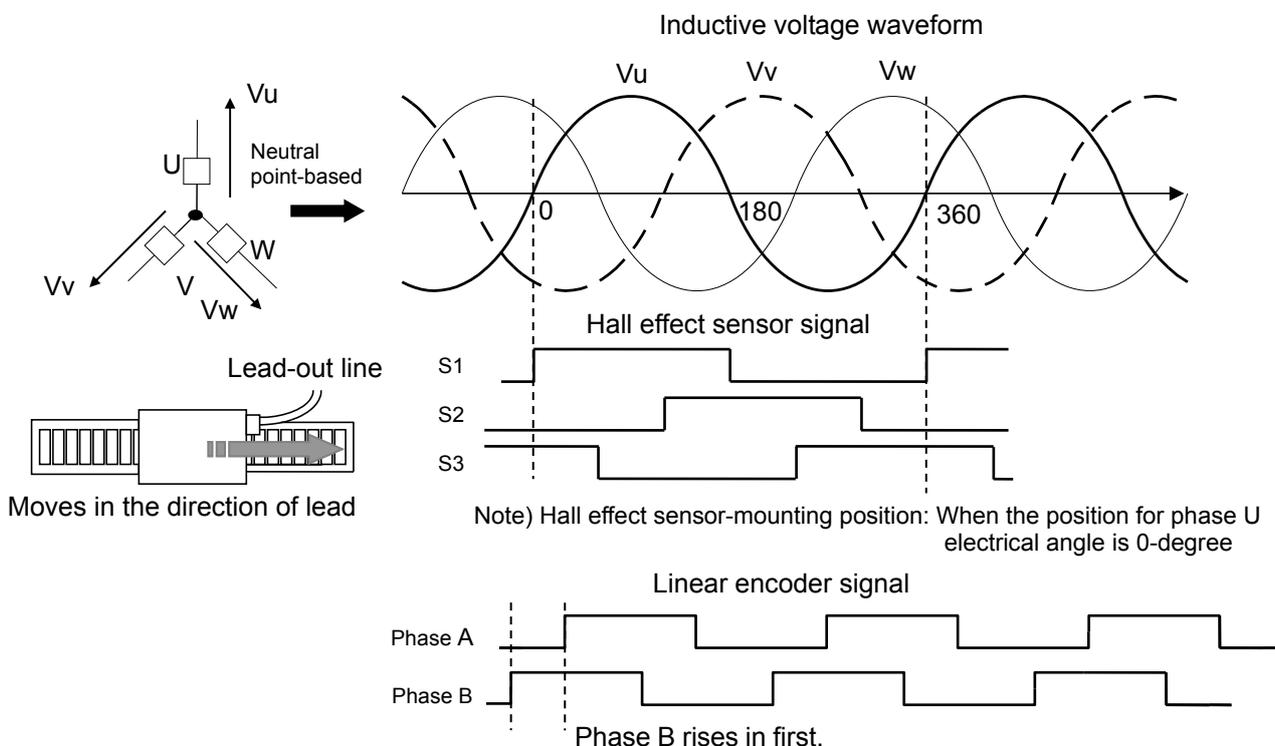
Linear motor   5

5. Linear motor

5.5 Precautions

5.5.1 When you use SANYO DENKI servo amplifier with other manufacturer linear motor combined.

■ When you use our servo amplifier with other manufacturer linear motor combined, we provide "servo amplifier parameter (motor parameter file)" needed to drive the motor based on motor constants you provide to us. In this case, we do not conduct any combination tests of servo amplifier and the linear motor, so we assume no responsibility whatsoever for any combination operations and characteristics of the motor. In addition, we assume no responsibility whatsoever for any failures caused by the linear motor.

5.5.2 Setting of parameters to combine amplifier and motor

■ Set "motor parameter" for the liner motor you use.
■ Maximum moving rate shall be limited by resolution of the linear encoder you use. When using linear motor at maximum moving rate, set the value of minimum pulse width or less to Index 0x20F1-2 "motor incremental encoder digital filter setting value: [ENFIL]". (factory setting is default set value [minimum pulse width =220nsec])
■ When connection of phase sequence or polarity of motor power line, linear encoder signal line, and hall sensor signal line (when you use) is not correct, there may be at a risk of loss of control. Perform wiring so that the relation between each phase of voltage induced by motor and each signal shall be as indicated in the figure below when moving linear motor in the direction of leading out a power line from linear motor core.

Inductive voltage waveform

Hall effect sensor signal

Note) Hall effect sensor-mounting position: When the position for phase U electrical angle is 0-degree

Lead-out line

Moves in the direction of lead

Linear encoder signal

Phase B rises in first.

- "Linear encoder resolution" is set to 1μm (multiplier ratio 1:4) 1000P/mm at factory setting. So select and set the linear encoder resolution you use from "System ID31" or "Index 0x20FF-1 ENCODE".
- When using "motor thermal", connect motor thermal wire to any of CONT1 through CONT7, and then setting condition "Group 9, ID40 or Index 0x20F8-3 EXT-E" of the connected "CONT*" to "external trip function".
- When using Hall effect sensor, set the mounting position of Hall effect sensor to phase U electrical angle to "System ID1A or Index 0x20F1-5 CSOF".

5.5.3 Automatic Magnetic Pole Position Estimation Function

- After power on, if moving to preparation status of magnetic pole position estimation (3 seven-segment LEDs blink) because of an alarm/emergency stop etc., start running automatic execution after deactivating alarm/emergency stop.
- At the time of moving to preparation status of magnetic pole position estimation, when the function of magnetic pole position estimation is set in any other mode than automatic mode, the automatic execution does not start running. To start running automatic execution, temporarily clear off the requests from other than automatic mode.
- When the magnetic pole position estimation does not shut down normally, alarm 44 or DF will be issued.
- After completion of automatic execution, the magnetic pole position estimation is possible by either the valid condition of pointing function of magnetic pole position, or magnetic pole position estimation of assistance function.

Linear motor ⑤

No Text on This Page.

6

Servo Tuning

In this chapter, tuning of servo amplifier are explained.

6. Servo Tuning

6.1 Servo tuning functions and basic adjustment procedure

To operate the servo motor (and machine) using the servo amplifier, 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
    Servo amplifier 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 a servo amplifier 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.
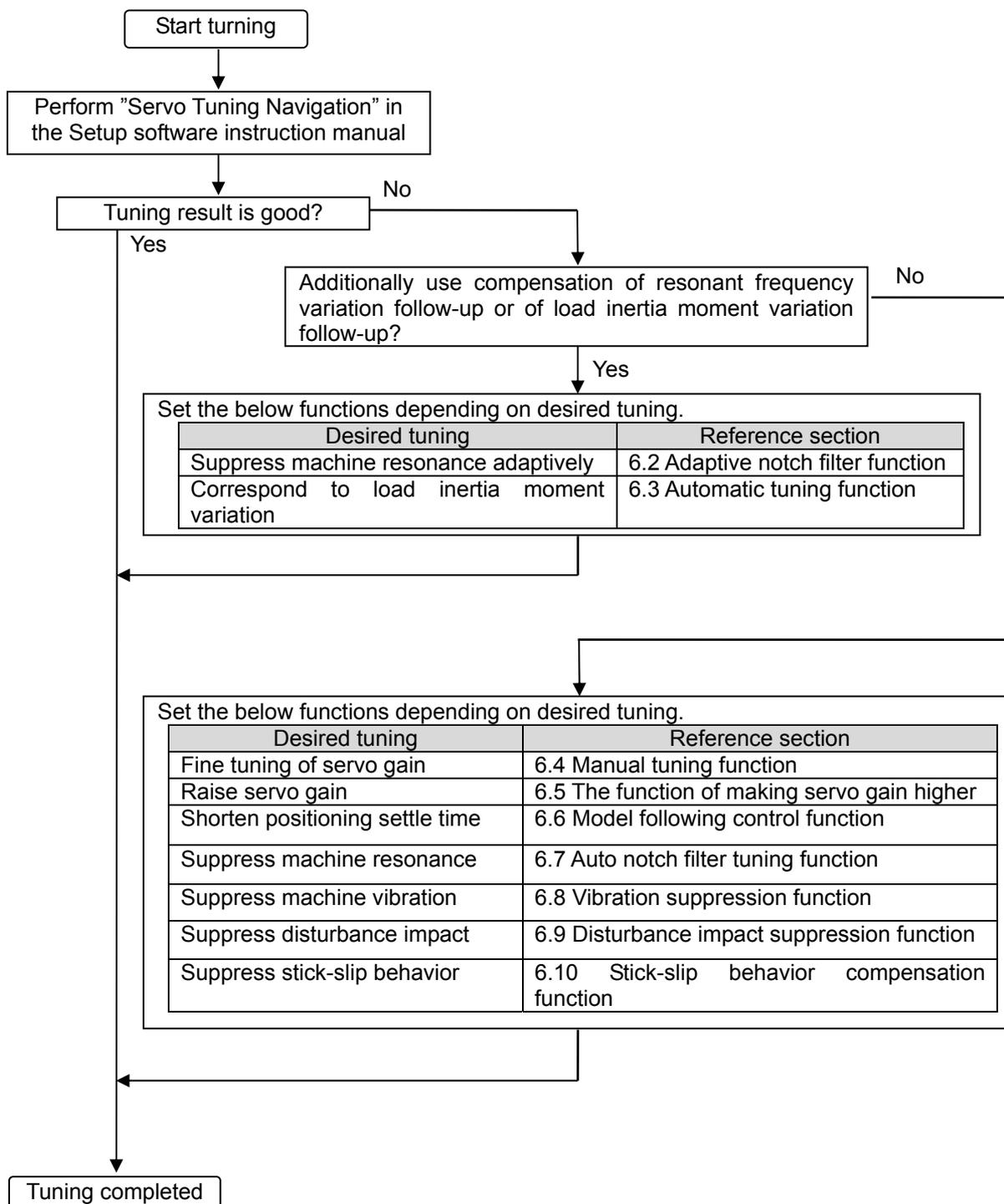
6.1 Servo tuning functions and basic adjustment procedure

■ 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 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.

Servo Tuning ⑥

6. Servo Tuning

6.1.2 Tuning method selection procedure

The selection procedure is displayed in the following chart:

```
                    ┌─────────────────┐
                    │  Start turning  │
                    └────────┬────────┘
                             │
                             ▼
        ┌──────────────────────────────────────┐
        │ Perform "Servo Tuning Navigation" in  │
        │ the Setup software instruction manual │
        └────────────────┬──────────────────────┘
                         │                          No
        ┌────────────────▼─────────────┐─────────────────┐
        │   Tuning result is good?     │                 │
        └──────────────────────────────┘                 │
         Yes                                             ▼
```

Additionally use compensation of resonant frequency variation follow-up or of load inertia moment variation follow-up?   No

Yes

Set the below functions depending on desired tuning.

Desired tuning	Reference section
Suppress machine resonance adaptively	6.2 Adaptive notch filter function
Correspond to load inertia moment variation	6.3 Automatic tuning function

Set the below functions depending on desired tuning.

Desired tuning	Reference section
Fine tuning of servo gain	6.4 Manual tuning function
Raise servo gain	6.5 The function of making servo gain higher
Shorten positioning settle time	6.6 Model following control function
Suppress machine resonance	6.7 Auto notch filter tuning function
Suppress machine vibration	6.8 Vibration suppression function
Suppress disturbance impact	6.9 Disturbance impact suppression function
Suppress stick-slip behavior	6.10 Stick-slip behavior compensation function

┌──────────────────┐
│ Tuning completed │
└──────────────────┘

*   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 "Index 0x2060-2 Adaptive notch filter frequency upper limit E [ADNFUE]", "Index 0x2060-3 Adaptive notch filter frequency lower limit E [ADNFLE]". Adaptive notch filter will work between upper/lower limit which set.

◆ This function will be valid when "Index 0x2060-1 Adaptive notch filter function E [ADNFE]" is selected.

◆ Adaptive notch filter starts an operation with getting the value of "Index 0x2014-05 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 "0x01: No_Saving" to "Index 0x2060-1 Adaptive notch filter function E [ADNFE]" 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 "Index 0x2003-0 Position Command Smoothing Constant [PCSMT]".)

* This function can not use with the tandem operation.

⑥ Servo Tuning

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

Index	Sub-Idx	Selection		Contents
0x2002	0x01	0x00	AutoTun	Auto-tuning
		0x01	AutoTun_JRAT-Fix	Auto-tuning [JRAT manual setting]
		0x02	ManualTun	Manual Tuning

◆ Auto-Tuning characteristic

Index	Sub-Idx	Selection		Contents
0x2002	0x02	0x00	Positioning1	Positioning Control 1 (General Purpose)
		0x01	Positioning2	Positioning Control 2 (High Response)
		0x02	Positioning3	Positioning Control 3 (High Response, FFGN Manual Setting)
		0x03	Positioning4	Positioning Control 4 (High Response, Horizontal Axis Limited)
		0x04	Positioning5	Positioning Control 5 (High Response, Horizontal Axis Limited, FFGN Manual Setting)
		0x05	Trajectory1	Trajectory Control 1
		0x06	Trajectory2	Trajectory Control 2 (KP, FFGN Manual Setting)

◆ Auto-Tuning Response

Index	Sub-Idx	Setting range	Unit
0x2002	0x03	1 to 40	—

◆ Auto-Tuning Automatic Parameter Saving

Index	Sub-Idx	Selection		Contents
0	03	00	Auto_Saving	Automatically Saves in JRAT1
		01	No_Saving	Automatic Saving is Invalid

◆ Auto-Tuning characteristic compatible mode

Index	Sub-Idx	Selection		Contents
0x2002	0x0A	00	Disable	Invalid
		01	Enable	Valid (RS2 Compatible)

■ Explanation for each parameter
Details of each parameter are shown below.

◆ General Parameter Group0 Auto-Tuning

Index/ Sub-Idx	Contents
0x2002/ 0x01	**Tuning Mode [TUNMODE]** <table><tr><td>Selection</td><td>Contents</td></tr><tr><td>00: AutoTun</td><td>Auto-Tuning</td></tr></table> ◆ Servo amplifier 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 servo amplifier, is vary depends on selection of "Index 0x2002-2 Auto-Tuning Characteristic [ATCHA]". ◆ Servo amplifier 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]. <table><tr><td>Selection</td><td>Contents</td></tr><tr><td>01: AutoTun_JRAT-Fix</td><td>Auto-Tuning [JRAT manual setting]</td></tr></table> ◆ Based on "Index 0x200D-1 Load inertia moment ratio 1 [JRAT1]", which has to be set, the servo amplifier automatically tunes to the best servo gain. ◆ Parameters for the servo amplifier to automatically tune will vary depending on "Auto-Tuning characteristic [ATCHA]". <table><tr><td>Selection</td><td>Contents</td></tr><tr><td>02: ManualTun</td><td>Manual Tuning</td></tr></table> ◆ 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.

Servo Tuning

⑥

6. Servo Tuning

Index/ Sub-Idx	Contents
0x2002/ 0x02	**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. <table><tr><th colspan="2">Selection</th><th>Contents</th></tr><tr><td>00</td><td>Positioning1</td><td>Positioning Control 1 (General Purpose)</td></tr></table> ◆ Select for general positioning purposes. ◆ Parameters shown in table at section 6.3.2 cannot be adjusted manually. <table><tr><th colspan="2">Selection</th><th>Contents</th></tr><tr><td>01</td><td>Positioning2</td><td>Positioning Control 2 (High Response)</td></tr></table> ◆ Select for high response positioning. ◆ Parameters shown in table at section 6.3.2 cannot be adjusted manually. <table><tr><th colspan="2">Selection</th><th>Contents</th></tr><tr><td>02</td><td>Positioning3</td><td>Positioning control 3 (High Response, FFGN Manual Setting)</td></tr></table> ◆ Select this mode to adjust "Index 0x2008-1 Feed Forward Gain [FFGN]" manually. ◆ The following parameter is able to adjust manually, if not use model following (vibration suppression) control: <table><tr><th>Index</th><th>Sub-Idx</th><th>Symbol</th><th>Contents</th></tr><tr><td>0x2008</td><td>0x01</td><td>FFGN</td><td>Velocity Feed Forward Gain</td></tr></table> ◆ The following parameter is able to adjust manually, if using model following (vibration suppression) control: <table><tr><th>Index</th><th>Sub-Idx</th><th>Symbol</th><th>Contents</th></tr><tr><td>0x2068</td><td>0x02</td><td>MFFGN</td><td>Model velocity feed forward gain</td></tr></table> <table><tr><th colspan="2">Selection</th><th>Contents</th></tr><tr><td>03</td><td>Positioning4</td><td>Positioning control 4 (High Response, Horizontal Axis Limited)</td></tr></table> ◆ 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.

Index/ Sub-Idx	Contents
0x2002/ 0x02	**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 "Index 0x2008-1 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: | Index	Sub-Idx	Symbol	Contents
---	---	---	---
0x2008	06	FFGN	Velocity Feed Forward Gain | ◆ The following parameter is able to adjust manually, if using model following (vibration suppression) control: | Index	Sub-Idx	Symbol	Contents
---	---	---	---
0x2068	0x02	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 "Index 0x2005-1 Position Loop Proportional Gain 1 [KP1]", "Index 0x2008-1 Feed Forward Gain [FFGN]". ◆ The following parameter is able to adjust manually, if not use model following (vibration suppression) control: | Index	Sub-Idx	Symbol	Contents
---	---	---	---
0x2005	0x01	KP1	Position Loop Proportional Gain 1
0x2008	0x01	FFGN	Velocity Feed Forward Gain | ◆ The following parameter is able to adjust manually, if using model following (vibration suppression) control: | Index	Sub-Idx	Symbol	Contents
---	---	---	---
0x2005	0x01	KP1	Position Loop Proportional Gain 1
0x2068	0x02	MFFGN	Model velocity feed forward gain	

⑥ Servo Tuning

6. Servo Tuning

Index/ Sub-Idx	Contents
0x2002/ 0x03	Auto-Tuning Response [ATRES] ■ Set this parameter when "0x00: Auto Tun" or "01: AutoTun_JRAT-Fix" in "Index 0x2002-1 Auto tuning mode [TUNEMODE]" are used. ■ As the setting value rises, the response increases. Set the value suitable for equipment rigidity. ■ This does not function when "02: ManualTun" of the Tuning mode is selected.
Group0/ ID03	Auto-Tuning Automatic Parameter Saving [ATSAVE] ■ "Load inertia moment ratio" obtained from the result of auto-tuning is automatically saved in "Index 0x200D-1 Load Inertia Moment Ratio 1 [JRAT1]" every 30 minutes. ■ The select value is effective when auto-tuning is used. 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 "Index 0x2002-1 Tuning mode [TUNMODE]" and "Index 0x2002-2 Auto-Tuning Characteristic [ATCHA]".

■ At the standard position control, below parameters are adjusted automatically.

◆ General parameters Group1 "Basic control parameter settings"

Index/Sub-Idx	Symbol	Name	Remarks
0x2005/0x01	KP1	Position Loop Proportional Gain 1	Note 1)
0x2008/0x01	FFGN	Velocity Feed Forward Gain	Note 1), Note 2)
0x200E/0x00	TRCPGN	Higher Tracking Control Position Compensation Gain	
0x200B/0x01	KVP1	Velocity Loop Proportional Gain 1	
0x200C/0x01	TVI1	Velocity Loop Integral Time Constant 1	
0x200D/0x01	JRAT1	Load Inertia Moment Ratio 1	Note 3)
0x200F/0x01	AFBK	Acceleration Feedback Gain	
0x200E/0x00	TRCVGN	Higher Tracking Control Velocity Compensation Gain	
0x2011/0x01	TCFIL1	Torque Command Filter 1	

◆ General parameters Group8 "Control system settings"

Index/Sub-Idx	Symbol	Name	Remarks
0x2021/0x00	LOWV	Low Speed Range	Note 4)

◆ General parameters Group7 "Communication / Function selection settings"

Index/bit	Symbol	Name
0x2000/bit1	PLPCON	Position Loop Proportional Control Enabled
0x2000/bit2	VLPCON	Velocity Loop Proportional Control Enabled

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

6. Servo Tuning

■ At the model following control, below parameters are adjusted automatically.

◆ General parameters Group1 "Basic control parameter settings"

Index/Sub-Idx	Symbol	Name	Remarks
0x2005/0x01	KP1	Position Loop Proportional Gain 1	Note 1)
0x2007/0x00	TRCPGN	Higher Tracking Control Position Compensation Gain	
0x200B/0x01	KVP1	Velocity Loop Proportional Gain 1	
0x200C/0x01	TVI1	Velocity Loop Integral Time Constant 1	
0x200D/0x01	JRAT1	Load Inertia Moment Ratio 1	Note 3)
0x200F/0x01	AFBK	Acceleration Feedback Gain	
0x200E/0x00	TRCVGN	Higher Tracking Control Velocity Compensation Gain	
0x2011/0x01	TCFIL1	Torque Command Filter 1	

◆ General parameters Group3 "Model following control settings"

Index/Sub-Idx	Symbol	Name	Remarks
0x2017/0x01	KM1	Model Control Gain 1	
0x2068/0x02	MFFGN	Model velocity feed forward gain	Note 1), Note 2)

◆ General parameters Group8 "Control system settings"

Index/Sub-Idx	Symbol	Name	Remarks
0x2021/0x00	LOWV	Low Speed Range	Note 4)

◆ General parameters Group7 "Communication / Function selection settings"

Index/bit	Symbol	Name
0x2000/bit1	PLPCON	Position Loop Proportional Control Enabled
0x2000/bit2	VLPCON	Velocity Loop Proportional Control Enabled

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"

Index/Sub-Idx	Symbol	Name
0x2003/0x00	PCSMT	Position Command Smoothing Constant
0x2004/0x00	PCFIL	Position Command Filter
0x2068/0x04	FFFIL	Velocity Feed Forward Filter
0x2009/0x00	VCFIL	Velocity Command Filter
0x200A/0x00	VDFIL	Velocity Feedback Filter
0x2064/0x01	TFFK	Torque Feed Forward Gain
0x2004/0x02	TFFAVE	Torque feed forward averaging
0x2064/0x03	TFFOUT	Torque Feed Forward output selection
0x202B/0x00	TCFILOR	Torque Command Filter Order
0x2066/0x01	DFBCG	Dual position feedback gain
0x2066/0x02	DFBFIL	Dual position feedback filter

◆ General parameters Group2 "FF vibration suppression control/ Notch filter/ Disturbance observer settings"

Index/Sub-Idx	Symbol	Name
0x2012/0x01	SUPFRQA1	FF Vibration Suppression Frequency A1
0x202C/0x00	SUPLVA	FF Vibration Suppression Level Selection A
0x2012/0x06	SUPFRQB1	FF Vibration Suppression Frequency B1
0x2012/0x05	SUPCRB	FF Vibration Suppression Level Selection B
0x2013/0x00	VCNFIL	Velocity Command Notch Filter
0x2014/0x01	TCNFILA	Torque Command Notch Filter A
0x202D/0x01	TCNFPA	TCNFILA, Low Frequency Phase Delay Improvement
0x2014/0x02	TCNFILB	Torque Command Notch Filter B
0x202D/0x02	TCNFDB	TCNFILB, Depth Selection
0x2014/0x03	TCNFILC	Torque Command Notch Filter C
0x202D/0x03	TCNFDC	TCNFILC, Depth Selection
0x2014/0x04	TCNFILD	Torque Command Notch Filter D
0x202D/0x04	TCNFDD	TCNFILD, Depth Selection
0x2014/0x05	TCNFILE	Torque Command Notch Filter E
0x202D/0x05	TCNFDE	TCNFILE, Depth Selection
0x2067/0x01	CPVSFQ	CP vibration suppression control frequency
0x2067/0x02	CPVSLV	CP vibration suppression control level
0x2067/0x03	CPVSSH	CP vibration suppression control characteristics selection
0x2051/0x02	FBHPLS	Minor vibration suppression pulse compensation value
0x2051/0x03	FBHTIM	Minor vibration suppression pulse compensation frequency

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

Index/Sub-Idx	Symbol	Name
0x2012/0x02	SUPFRQA2	FF Vibration Suppression Frequency A2
0x2012/0x03	SUPFRQA3	FF Vibration Suppression Frequency A3
0x2012/0x04	SUPFRQA4	FF Vibration Suppression Frequency A4
0x2012/0x07	SUPFRQB2	FF Vibration Suppression Frequency B2
0x2012/0x08	SUPFRQB3	FF Vibration Suppression Frequency B3
0x2012/0x09	SUPFRQB4	FF Vibration Suppression Frequency B4

⑥
Servo Tuning

6. Servo Tuning

◆ General parameters Group5 "High setting control setting"

Index/Sub-Idx	Symbol	Name
0x2015/0x03	CVFIL	Command Velocity Low-pass Filter
0x2015/0x04	CVTH	Command Velocity Threshold
0x2015/0x01	ACCCO	Acceleration Compensation
0x2015/0x02	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"

Index/Sub-Idx	Symbol	Name
0x2001/0x00	GC	Gain Switching Selection
0x2000/0x00	PLPCON	Position Loop Proportional Control Switching Function
0x2000/0x00	VLPCON	Velocity Loop Proportional Control Switching Function
0x2000/0x00	OBS	Disturbance Observer Function
0x2035/0x07	SYNCEN	Axes-sync compensation function
0x2035/0x08	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 "Index 0x2000-bit11 Disturbance Observer Function [OBS]" invalid.
* SYNCEN and SYNPCNEN are able to use when "0x01: AutoTun_JRAT-Fix" is set to "Index 0x2002-1 Tuning mode". If "0x00: AutoTun" is set, disable Index 0x2035-7 [SYNCEN] and Index 0x2035-8 [SYNPCNEN].

◆ General parameters Group1 "Basic control parameter settings"

Index/Sub-Idx	Symbol	Name
0x2007/0x00	TRCPGN	Higher Tracking Control Position Compensation Gain
0x200F/0x01	AFBK	Acceleration Feedback Gain
0x200E/0x00	TRCVGN	Higher Tracking Control Velocity Compensation Gain

◆ General parameters Group8 "Control system settings"

Index/Sub-Idx	Symbol	Name
0x2021/0x00	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 Index 0x2002-2 Auto-Tuning Characteristic [ATCHA].
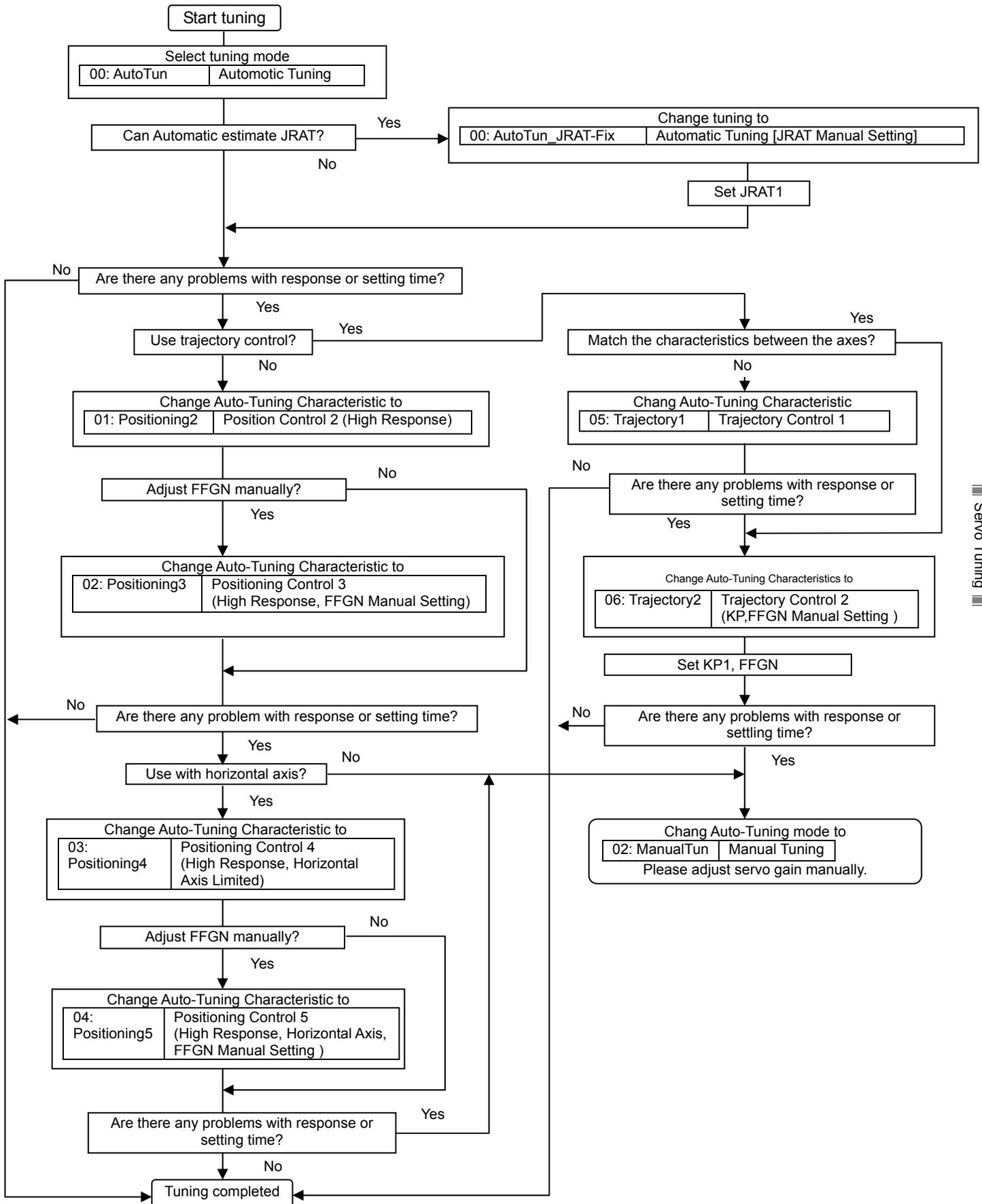
◆ General parameters Group3 "Model following control settings"

Index/Sub-Idx	Symbol	Name
0x2019/0x01	ANRFRQ1	Model Control Antiresonance Frequency 1
0x201A/0x01	RESFRQ1	Model Control Resonance Frequency 1

* "Model following control" is able to use when "0x01: AutoTun_JRAT-Fix" is set to "Index 0x2002-1 Tuning mode". If "0x00: AutoTun" is set, select "00: Standard" or "01: Model1" to "Index 0x20F3-1 Position control selection [PCNTSEL]".

6.3.5 Auto-tuning characteristic selection

Start tuning

Select tuning mode
| 00: AutoTun | Automotic Tuning |

Can Automatic estimate JRAT? — Yes →
Change tuning to
| 00: AutoTun_JRAT-Fix | Automatic Tuning [JRAT Manual Setting] |

No

Set JRAT1

No ← Are there any problems with response or setting time?

Yes

Use trajectory control? — Yes →

Match the characteristics between the axes? — Yes →

No

No

Change Auto-Tuning Characteristic to
| 01: Positioning2 | Position Control 2 (High Response) |

Chang Auto-Tuning Characteristic
| 05: Trajectory1 | Trajectory Control 1 |

Adjust FFGN manually? — No →

No — Are there any problems with response or setting time?

Yes

Yes

Change Auto-Tuning Characteristic to
| 02: Positioning3 | Positioning Control 3 (High Response, FFGN Manual Setting) |

Change Auto-Tuning Characteristics to
| 06: Trajectory2 | Trajectory Control 2 (KP,FFGN Manual Setting) |

Set KP1, FFGN

No ← Are there any problem with response or setting time?

No ← Are there any problems with response or settling time?

Yes

Yes

Use with horizontal axis? — No →

Chang Auto-Tuning mode to
| 02: ManualTun | Manual Tuning |
Please adjust servo gain manually.

Yes

Change Auto-Tuning Characteristic to
| 03: Positioning4 | Positioning Control 4 (High Response, Horizontal Axis Limited) |

Adjust FFGN manually? — No →

Yes

Change Auto-Tuning Characteristic to
| 04: Positioning5 | Positioning Control 5 (High Response, Horizontal Axis, FFGN Manual Setting) |

Are there any problems with response or setting time? — Yes →

No

Tuning completed

6 Servo Tuning

6. Servo Tuning

6.3.6 Adjustment method for auto-tuning

Auto-tuning is a function where the servo amplifier automatically tunes to the best servo gain in real time.

Procedure 1	■ Select "00: AutoTun Auto-Tuning" at "Index 0x2002-1 Tuning mode [TUNMODE]" to estimate load inertia moment ratio by servo amplifier on a real-time basis, and then automatically adjust servo gain. Select "01:AutoTun_JRAT-Fix Automatic Tuning (JRAT Manual Setting)" to automatically adjust optimum servo gain based on manually set value of "Index 0x200D-01 Load Inertia Moment Ratio 1 [JRAT1]".
Procedure 2	■ After setting "Tuning mode [TUNMODE]", select "Index 0x2002-1 Auto-Tuning Characteristic [ATCHA]" for the machine or equipment.
Procedure 3	■ Next, boot the servo motor and adjust "Index 0x20023 -Auto-Tuning Response [ATRES]" according to equipment rigidity. ◆ 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. ◆ 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. ◆ If increasing the response has caused the machine to get vibration, lower the value of the "Auto-Tuning Response [ATRES]" slightly. * 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". * 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.

Index/Sub-Idx	Symbol	Name	Unit
0x2104/0x05	JRAT MON	Load Inertia Moment Ratio monitor	%
0x2104/0x07	MKP MON	Model Control Gain monitor	1/s
0x2104/0x01	KP MON	Position Loop Proportional Gain monitor	1/s
0x2104/0x03	KVP MON	Velocity Loop Proportional Gain monitor	Hz
0x2104/0x04	TVI MON	Velocity Loop Integral Time Constant monitor	ms
0x2104/0x06	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"

Index/Sub-Idx	Symbol	Name	Unit
0x2005/0x01	KP1	Position Loop Proportional Gain 1	1/s
0x2008/0x01	FFGN	Velocity Feed Forward Gain	%
0x200E/0x00	TRCPGN	Higher Tracking Control Position Compensation Gain	%
0x200B/0x01	KVP1	Velocity Loop Proportional Gain 1	Hz
0x200C/0x01	TVI1	Velocity Loop Integral Time Constant 1	ms
0x200D/0x01	JRAT1	Load Inertia Moment Ratio 1	%
0x200F/0x01	AFBK	Acceleration Feedback Gain	%
0x200E/0x00	TRCVGN	Higher Tracking Control Velocity Compensation Gain	%
0x2011/0x01	TCFIL1	Torque Command Filter 1	Hz

◆ General parameters Group3 "Model following control settings"

Index/Sub-Idx	Symbol	Name	Unit
0x2017/0x01	KM1	Model Control Gain 1	1/s
0x2068/0x02	MFFGN	Model velocity feed forward gain	%

◆ General parameters Group8 "Control system settings"

Index/Sub-Idx	Symbol	Name	Unit
0x2021/0x00	LOWV	Low Speed Range	min^{-1}

◆ General parameters Group7 "Communication / Function selection settings"

Index/bit	Symbol	Name	Unit
0x2000/bit1	PLPCON	Position Loop Proportional Control Enabled	—
0x2000/bit2	VLPCON	Velocity Loop Proportional Control Enabled	—

6 Servo Tuning

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 "0x02: ManualTun Manual Tuning" at "Index 0x2002-1 Tuning mode [TUNMODE]".

■ Setting parameters
   ◆ General parameters Group0 ID00 "Tuning Mode [TUNMODE]"

Selection		Contents
0x2002/0x01	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.
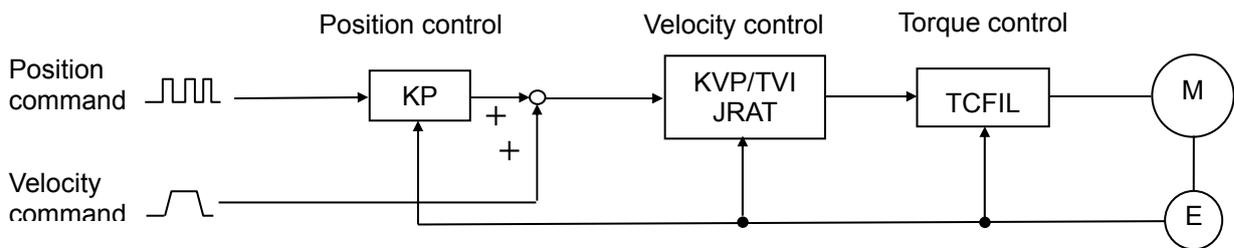
See below explanation for each servo parameter

■ "Index 0x2003-0 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.

■ "Index 0x2004-0 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 "Index 0x2007-0 Higher Tracking Control Position Compensation Gain [TRCPGN]" is set to other than 0%, this parameter is automatically set.

■ "Index 0x2005-1 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.

■ "Index 0x2008-1 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 "Index 0x2007-0 Higher Tracking Control Position Compensation Gain [TRCPGN]" is set to other than 0%, this parameter is automatically set.

■ "Index 0x2008-2 Feed Forward Filter [FFFIL]"
When position command resolution is low, set this parameter to suppress ripples.

■ "Index 0x2007-0 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.

■ "Index 0x200B-1 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 "Index 0x200D-1 Load Inertia Moment Ratio 1 [JRAT1]" is properly set, the set value as "Velocity Loop Proportional Gain 1 [KVP1]" becomes velocity control responsive band.

■ "Index 0x200C-1 Velocity Loop Integral Time Constant 1 [TVI1]"
Set this to: TVI1 [ms] = 1000/(KVP1 [Hz]), as a rough indication.

■ "Index 0x200D-1 Load inertia moment ratio 1 [JRAT1]"
Set this value to the calculation shown below:

$$JRAT= \frac{\text{Motor axis converted load inertia moment (JL)}}{\text{Servo motor rotor inertia moment (JM)}} \times 100\%$$

■ "Index 0x200E-0 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 "Index 0x2000-bit2 Velocity Loop Proportional Control Switching Function [VLPCON]" during operation.

◆ Set at 100% to equal Q-series servo amplifier.

■ "Index 0x2011-1 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.

Servo Tuning ⑥

6. Servo Tuning

6.4.2 Basic manual tuning method for velocity control

■ Set value of "Index 0x200B-1 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 "Index 0x200C-1 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 "Index 0x200B-1 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 "Index 0x200C-1 Velocity Loop Integral Time Constant 1 [TVI1]" by referring to "TVI1 [ms] = 1000/ KVP1 [Hz]", as a rough indication.

■ Set value of "Index 0x2005-1 Position Loop Proportional Gain 1 [KP1]" by referring to "KP1 [1/s] = KVP1 [Hz]/ $4 \cdot 2\pi$", 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 "Index 0x200B-1 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 "Index 0x2062-2 Velocity loop phase lead compensation frequency [VLPHLF]", and set near 30% to "Index 0x2062-1 Velocity loop phase lead compensation gain [VLPHLK]", and then confirm increase of phase margin at higher frequency.

◆ "Index 0x2062-1 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"

Index/Sub-Idx	Symbol	Name	Unit	Setting range
0x2062/0x01	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"

Index/Sub-Idx	Symbol	Name	Unit	Setting range
0x2062/0x02	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.

Servo Tuning ⑥

6. Servo Tuning

6.5.2 Position loop phase lead compensation

This is the function to compensate phase delay of Position control system, and helps "Index 0x2005-1 Position Loop Proportional Gain 1 [KP1]" change higher.
Use when "Position Loop Proportional Gain 1 [KP1]" 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 "Index 0x2061-2 Position loop phase lead compensation frequency [PLPHLF]", and set near 30% to "Index 0x2061-1 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"

Index/Sub-Idx	Symbol	Name	Unit	Setting range
0x2061/0x01	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"

Index/Sub-Idx	Symbol	Name	Unit	Setting range
0x2061/0x02	PLPHLF	Position loop phase lead compensation frequency	Hz	10 to 4000

* Up to 1000Hz setting is valid at normal sampling mode.

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 "Index 0x2064-1 Torque feed forward gain [TFFK]", at condition of setting value except 0% to "Index 0x2008-1 Feed Forward Gain [FFGN]".

◆   When there is no Improvement even if increasing "Torque feed forward gain [TFFK]", please change value of "Index 0x2064-2 Torque feed forward averaging [TFFAVE]" or "Index 0x2064-3 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"

Index/Sub-Idx	Symbol	Name	Unit	Setting range
0x2064/0x01	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 Index 0x2008-1 "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 Index 0x2002-2 "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"

Index/Sub-Idx	Symbol	Name	Unit	Setting range
0x2064/0x02	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"

Index/Sub-Idx	Symbol	Name	Unit	Setting range
0x2064/0x03	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. Servo Tuning

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 a servo amplifier and drive a servo motor in order to track the Model control system.

Select "0x01: Profile Position mode" or "0x08: Cyclic Sync Position mode" at "Index 0x6060 Operation mode", and "0x01: Model1 Model-following control" at "Index 0x20F3-1 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

Index/Sub-Idx	Content		
0x20F3/0x01	Position Control Selection		
	Select value		Content
	01	Model1	Model following control

* 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 "Index 0x200B-1 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 "Index 0x200C-1 Velocity Loop Integral Time Constant 1 [TVI1]" by referring "TVI1 [ms] = 1000/ KVP1 [Hz]", as a rough indication.

■ Set value of "Index 0x2005-1 Position Loop Proportional Gain 1 [KP1]" by referring to "KP1 [1/s] = KVP1 [Hz]/ $4 \cdot 2\pi$", as a rough indication.

■ Set value of "Index 0x2017-1 Model control gain 1 [KM1]" by referring to "KM1 $\fallingdotseq$ 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"

Index/Sub-Idx	Symbol	Name
0x2017/0x01	KM1	Model Control Gain 1
0x2068/0x01	MZETA	Model control damping coefficient
0x2018/0x00	OSSFIL	Overshoot Suppression Filter

◆ Model Control Gain 1 [KM1]
Proportional gain fro Model following control position controller.
Adjust this to: KM1 $\fallingdotseq$ 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. Servo Tuning

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 "0x01: Profile Position mode" or "0x08: Cyclic Sync Position mode" at "Index 0x6060 Operation mode", and select "0x03: Model3 Model-following / standard position control switching" or "0x04: Model4 Model-following vibration suppression / standard position control switching" at "Index 0x20F3-1 Position control selection".

■ How to use

◆ The function is valid when condition that is selected in "Index 0x206A-1 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 CONT7)".

■ Setting parameters
◆ System parameters

Index/Sub-Idx	Content		
0x20F3/0x01	Position Control Selection		
		Select value	Content
		03 Model3	Model-following / standard position control switching
		04 Model4	Model-following vibration suppression / standard position control switching

* 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"

Index/Sub-Idx	Symbol	Name	Unit	Setting range
0x206A/0x01	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 "Index 0x2068-2 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 "Index 0x2068-3 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"

Index/Sub-Idx	Symbol	Name	Unit	Setting range
0x2068/0x02	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"

Index/Sub-Idx	Symbol	Name	Unit	Setting range
0x2068/0x03	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"

Index/Sub-Idx	Symbol	Name	Unit	Setting range
0x2068/0x04	MFFFIL	Model velocity feed forward filter	Hz	1 to 4000

* The function is Invalid at 1,000Hz or more.

6. Servo Tuning

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 "Index 0x2014-1 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 "Index 0x2002-3 Auto-tuning response [ATRES]" or "Index 0x200B-1 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"

Index/Sub-Idx	Symbol	Name	Unit	Setting range
0x2002/0x07	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"

Index/Sub-Idx	Symbol	Name	Unit	Setting range
0x2013/0x01	TCNFILA	Torque Command Notch Filter A	Hz	100 to 4000

* The above parameter is saved automatically with auto notch filter tuning.

6.7 Auto notch filter tuning function

■ Adaptive notch filter function E
  Selects the valid/invalid of the Adaptive notch filter.
  ◆ General parameters Group0 "Auto-Tuning"

Index/Sub-Idx	Symbol	Name	Unit	Setting range
0x2060/0x01	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, "Index0x202D-5 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"

Index/Sub-Idx	Symbol	Name	Unit	Setting range
0x2060/0x02	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"

Index/Sub-Idx	Symbol	Name	Unit	Setting range
0x2060/0x03	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"

Index/Sub-Idx	Symbol	Name	Unit	Setting range
0x2060/0x04	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 "0x01: Model1 model following control" at "Index 0x20F3-1 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 "Index 0x2002-1 Tuning mode" to "0x02: ManualTun manual tuning" after performing auto tuning result saving function.

◆ Set "0x02: Model2 model following vibration suppression control" at "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 can not 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 "Index 0x200B-1 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 "Index 0x200C-1 Velocity Loop Integral Time Constant 1 [TVI1]" by referring to "TVI1 [ms] = 1000/KVP1 [Hz]", as a rough indication.

◆ Set value of "Index 0x2005-1 Position Loop Proportional Gain 1 [KP1] by referring to "KP1 [1/s] = KVP1 [Hz]/ $4 \cdot 2\pi$", as a rough indication.

◆ Set value of "Index 0x2017-1 Model Control Gain 1 [KM1]" by referring to "KM1 $\fallingdotseq$ KP1", as a rough indication.
If vibration increases, lower the value.

6.8 Vibration suppression function

◆ 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 "Index 0x2012-1 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"

Index/Sub-Idx	Symbol	Name	Unit	Setting range
0x2017/0x01	KM1	Model Control Gain 1	1/s	15 to 315
0x2068/0x01	MZETA	Model control damping coefficient	%	0 to 100
0x2018/0x00	OSSFIL	Overshoot Suppression Filter	Hz	1 to 4000
0x2019/0x01	ANRFRQ1	Model Control Antiresonance Frequency 1	Hz	10.0 to 80.0
0x201A/0x01	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.

Servo Tuning ⑥

6-30

6. Servo Tuning

■ Parameter setting range for model following vibration suppression control
Setting ranges for the following parameters are restricted:

◆ General parameters Group1 "Basic control parameter settings"

Index/Sub-Idx	Symbol	Name	Unit	Setting range
0x2007/0x01	JRAT1	Load Inertia Moment Ratio 1	%	100 to 3000
0x2011/0x01	TCFIL1	Torque Command Filter 1	Hz	100 to 1000

◆ General parameters Group3 "Model following control settings"

Index/Sub-Idx	Symbol	Name	Unit	Setting range
0x2017/0x01	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 "Index 0x2012 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 "Index 0x2005-1 Position Loop Proportional Gain 1 [KP1]" or "Index 0x200B-1 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 "Index 0x200E-0 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"

Index/Sub-Idx	Symbol	Name	Unit	Setting range
0x2002/0x08	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"

Index/Sub-Idx	Symbol	Name	Unit	Setting range
0x2002/0x09	ASUPFC	Auto-FF Vibration Suppression Frequency Tuning Friction Compensation Value	%	0.0 to 50.0

Servo Tuning ⑥

6. Servo Tuning

■ 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"

Index/Sub-Idx	Symbol	Name	Unit	Setting range
0x2012/0x01	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 (Index 0x2012 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 (Index 0x2012-6 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 "Index 0x2005-1 Position Loop Proportional Gain 1 [KP1]" or "Index 0x200B-1 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"

Index/Sub-Idx	Symbol	Name	Unit	Setting range
0x2012/0x01	SUPFRQA1	FF Vibration Suppression Frequency A1	Hz	1.0 to 500.0
0x202C/0x00	SUPLVA	FF Vibration Suppression Level Selection A	—	00 to 03
0x2012/0x06	SUPFRQB1	FF Vibration Suppression Frequency B1	Hz	1.0 to 500.0
0x2012/0x05	SUPCRB	FF Vibration Suppression Level Selection B	—	00 to 01

* Do not change the setting value when the servo motor is running.

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

Index/Sub-Idx	Symbol	Name
0x2012/0x02	SUPFRQA2	FF Vibration Suppression Frequency A2
0x2012/0x03	SUPFRQA3	FF Vibration Suppression Frequency A3
0x2012/0x04	SUPFRQA4	FF Vibration Suppression Frequency A4
0x2012/0x07	SUPFRQB2	FF Vibration Suppression Frequency B2
0x2012/0x08	SUPFRQB3	FF Vibration Suppression Frequency B3
0x2012/0x09	SUPFRQB4	FF Vibration Suppression Frequency B4

6.8 Vibration suppression function

◆ General parameters Group9 "Function enabling condition settings"

Index/Sub-Idx	Symbol	Name	Unit	Setting range
0x2010/0x01	SUPFSELA1	FF Vibration Suppression Frequency Select Input A1	-	00 to 29
0x2010/0x02	SUPFSELA2	FF Vibration Suppression Frequency Select Input A2	-	00 to 29
0x2010/0x03	SUPFSELB1	FF Vibration Suppression Frequency Select Input B1	-	00 to 29
0x2010/0x04	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. Servo Tuning

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 "Index 0x2067-1 CP vibration suppression control frequency [CPVSFQ]".

◆ If effect of CP vibration suppression is weak, it is able to make strong by increasing value of "Index 0x2067-2 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"

Index/Sub-Idx	Symbol	Name	Unit	Setting range
0x2067/0x01	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"

Index/Sub-Idx	Symbol	Name	Unit	Setting range
0x2067/0x02	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"

Index/Sub-Idx	Symbol	Name	Unit	Setting range
0x2067/0x03	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 "Index 0x2051-1 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"

Index/Sub-Idx	Symbol	Name	Unit	Setting range
0x2051/0x01	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"

Index/Sub-Idx	Symbol	Name	Unit	Setting range
0x2051/0x02	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"

Index/Sub-Idx	Symbol	Name	Unit	Setting range
0x2051/0x03	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 "Index 0x200C-1 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 "Index 0x200B-1 Velocity Loop Proportional Gain 1 [KVP1]" to "Index 0x2063-2 High order integral control frequency [HKVIF]".

◆ Set 30% to "Index 0x2063-1 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 can not use along with higher tracking control. For use of High order integral control, set 0% to "Index 0x200E-0 Higher Tracking Control Velocity Compensation Gain [TRCVGN]".

■ High order integral control gain

◆ General parameters Group1 "Basic control parameter settings"

Index/Sub-Idx	Symbol	Name	Unit	Setting range
0x2063/0x01	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"

Index/Sub-Idx	Symbol	Name	Unit	Setting range
0x2063/0x02	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 servo amplifier 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 "Index 0x2000-bit11 Disturbance Observer compensation enabling [OBS]" is filled.

◆ Select appropriate observer characteristic depending on disturbance frequency which is desired to suppress.

◆ Increase the value of "Index 0x2016-2 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.

◆ "Index 0x2016-2 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"

Index/Sub-Idx	Symbol	Name	Setting range
0x2000/0x00	OBS	Disturbance Observer compensation enabling	0 to 1

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

Index/Sub-Idx	Symbol	Name	Unit	Setting range
0x2016/0x01	OBCHA	Observer Characteristic	—	00 to 02
0x2016/0x02	OBG	Observer Compensation Gain	%	0 to 100
0x2016/0x03	OBLPF	Observer Output Low-pass Filter	Hz	1 to 4000
0x2016/0x04	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 "Index 0x2000-bit11 Disturbance Observer compensation enabling [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 "Index 0x2050-1 Stick-slip behavior compensation function" is filled.
Example: The function will be always valid when "0x01: Always_Enable" is selected.

◆ Set 70% of "Index 0x200C-1 Velocity Loop Integral Time Constant 1 [TVI1]" to "Index 0x2050-4 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"

Index/Sub-Idx	Symbol	Name	Unit	Setting range
0x2050/0x01	STC	Stick-slip behavior compensation function	-	00 to 29

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

Index/Sub-Idx	Symbol	Name	Unit	Setting range
0x2050/0x02	STV	Effective velocity for compensating stick-slip behavior	min^{-1}	0.1 to 128.0
0x2050/0x03	STHLD	Retention time for compensating stick-slip behavior	ms	1 to 500
0x2050/0x04	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 servo amplifier 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 servo amplifier 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.

7. Digital Operator

7.1 EtherCAT Indicator

The servo amplifier has seven (7) indicators: four (4) indicators standardized by EtherCAT specifications and three (3) indicators with characteristics particular to the R 3E Model.
There are 3 LEDs in green and 1 LED in red for the EtherCAT indicators.

* IN Link/Activity indicator	: LED (GREEN)
* OUT Link/Activity indicator	: LED (GREEN)
* RUN indicator	: LED (GREEN)
* ERR indicator	: LED (RED)

■   Names

OUT Link / Act LED (GREEN)

RUN Indicator LED (GREEN)

IN Link / Act LED (GREEN)

Error Indicator LED (RED)
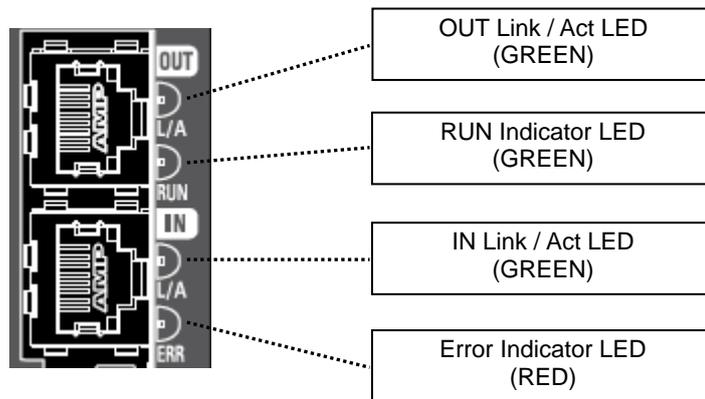
EtherCAT Status LED

7.1.1 IN/OUT Link / Activity Indicator   Code: IN L/A, OUT L/A

Link / Activity Indicator (Green LED) can confirm physical link state and operation status of each port with Lighting / Extinguishing / Blinking. Explanation of Link / Activity Indicator state is shown below.

Link / Activity Indicator

Link	Activity	Link / Activity Indicator LED State	
Yes	No	ON	(light)
Yes	Yes	Flickering	(flicker)
No	−	OFF	(extinguish)

7.1.2 RUN Indicator   Code: RUN

RUN indicator (Green LED) displays EtherCAT communication State machine status with Lighting/ Extinguishing/ Flickering of the LED. Explains the RUN indicator below.

RUN Indicator explanation

RUN state	ESM	Explanation
Off	INIT	"INIT" state
Blinking	PRE-OPERATIONAL	"PRE-OPERATIONAL" state
Single flash	SAFE-OPERATIONAL	"SAFE-OPERATIONAL" state
On	OPERATIONAL	"OPERATIONAL" state
Flickering	INITIALISATION or BOOTSTRAP	"INIT" state not ready in initialization state or in "Bootstrap" state. (Firmware download is under operation)

Please refer to ERR / RUN LED display state and flickering cycle for details of the flickering cycle.

RUN LED display state and Flickering Cycle
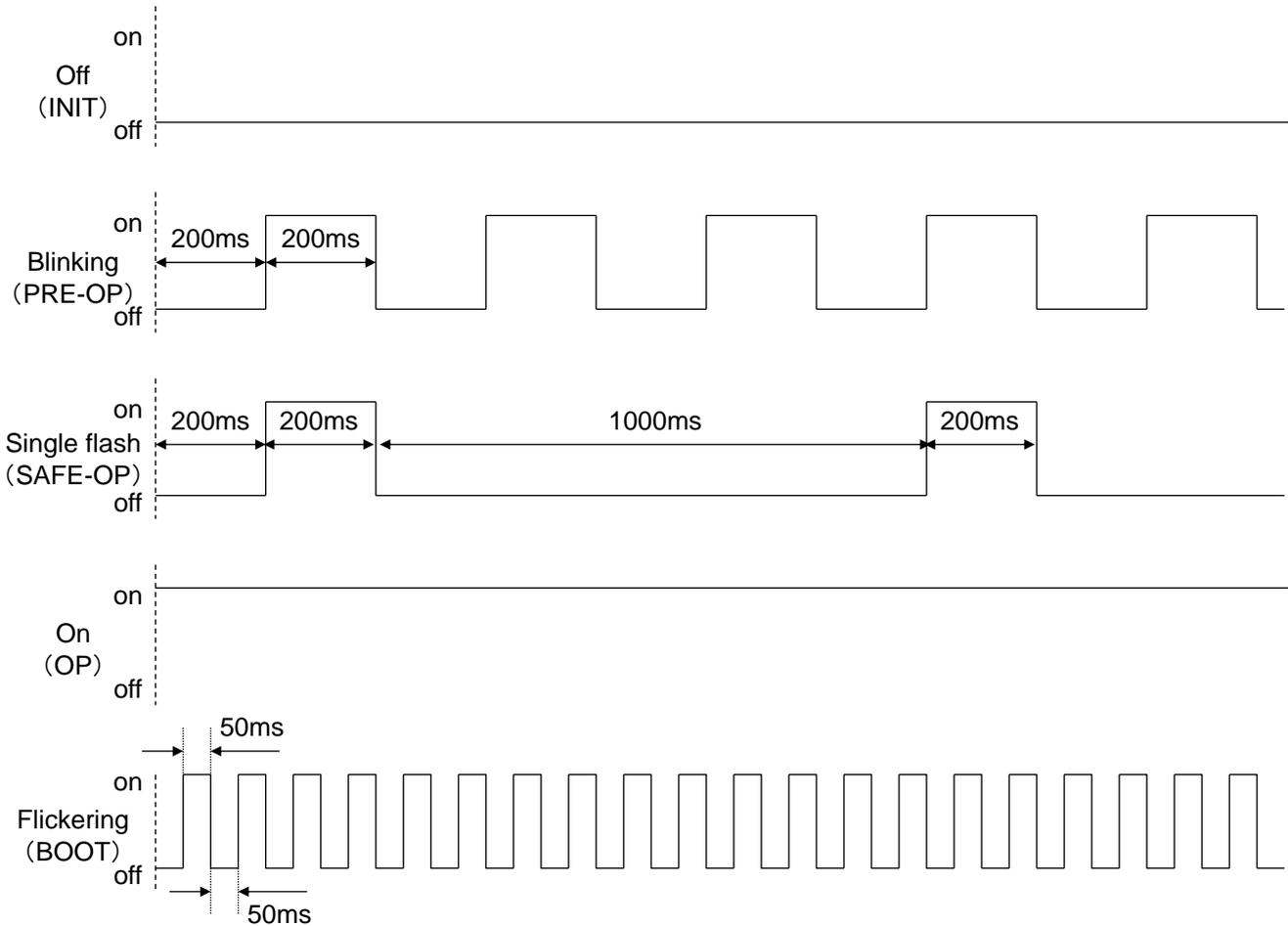
Digital Operator 7

7. Digital Operator

7.1.3 Error Indicator   Code: ERR

Error Indicator (Red LED) displays invalid state machine (ESM) change and/or watchdog error with an ON/OFF flickering of the LED.

Explains the Error Indicator status below.

Error Indicator Explanation

Error State	State	Explanation
Off	No error	EtherCAT operating normally
Flickering	Boot error	Boot error has occurred *Transitioned to INIT state but error was set in AL status register
Blinking	Invalid configuration	General configuration error *ESM commands from master became invalid caused by settings of register and/or object
Single flash	Invalid ESM change	Error has been set in AL status register because ESM has changed slave independently *In cases of transition to Safe-Operational automatically with synchronization error, etc.
Double flash	Application Watchdog timeout	Application Watchdog timeout has occurred *SyncManager Watchdog timeout has occurred
On	PDI Watchdog timeout	PDI Watchdog timeout has occurred *CPU application controller is not working

Display of "Blinking", "Single flash" and "Flickering" and display method of flickering cycle, RUN Indicator "RUN" and Error Indicator "ERR" is shown below.

ERR LED display state and flickering cycle
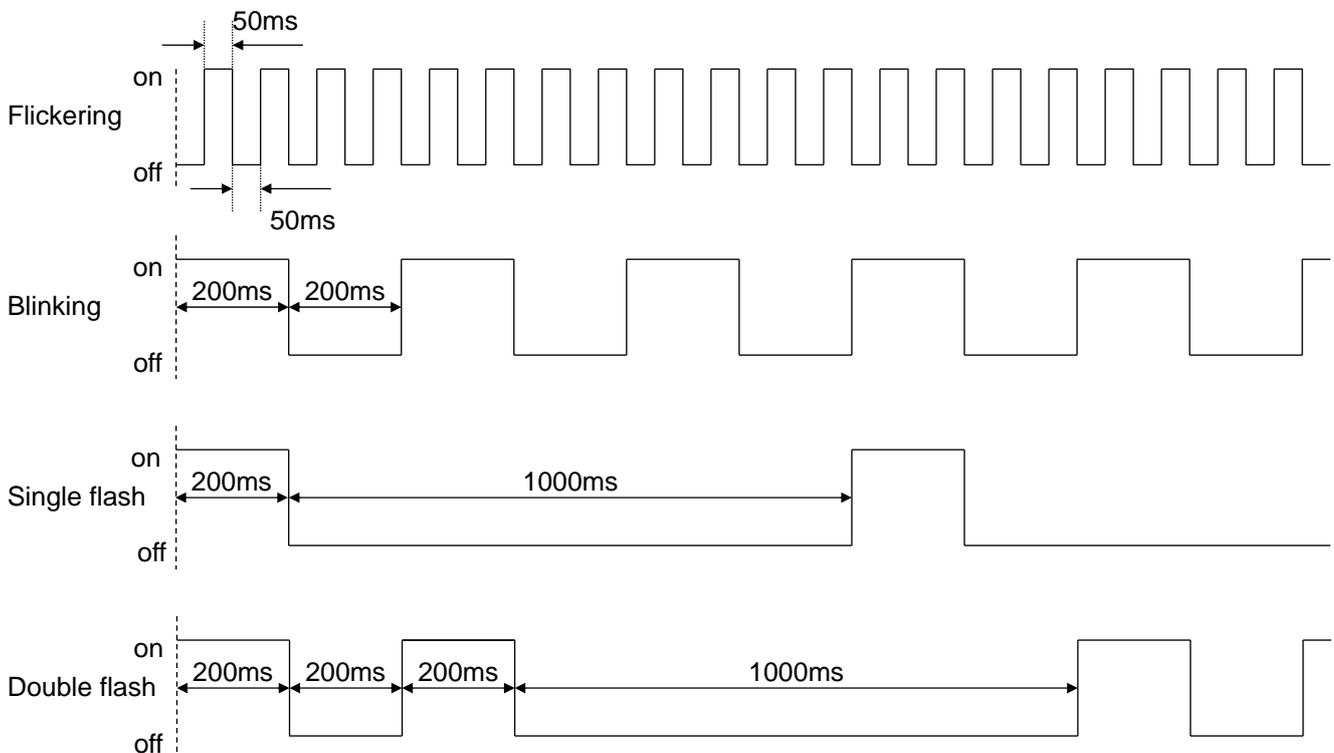
7.2 Servo Amplifier Indicator

This servo amplifier has three types of indicator characteristics for the R 3E MODEL, other than EtherCAT indicators:

* Main circuit power charge indicator: LED (RED)
* Control power supply establish indicator: LED (BLUE)
* Digital Operator indicator: 7 segment LED×5 (RED)

The details of the Digital Operator are explained in 7.3.

7.2.1 Main Circuit Power Supply Indicator   Code: CHARGE

Main Circuit Power Supply Indicator (Red LED) shows the main circuit power (R,S,T) has been input and power is charging in the main circuit power supply smoothing capacitor.
The LED stays ON until electric discharge has completed even after the main circuit power supply has shut down.

*   Make sure not to touch the servo amplifier until this LED goes OFF. Electric shock may result.

7.2.2 Control Power Supply Establish Indicator Code: POW

Control Power Supply Establish Indicator (Blue LED) shows the control power supply (r/t or 24 VDC) has been input and the 5V control power supply has been established through the switching power supply inside the amplifier.

Digital Operator 7

7. Digital Operator

7.3 Digital Operator Indicator

7.3.1 Digital Operator Names and Functions

Status display, Alarm history and Monitor can be confirmed with the 5-digit, 7-segment Red LED on the upper front of the servo amplifier.

■　Names

Display, 7-segment LED ··········

Digital Operator Operation Key
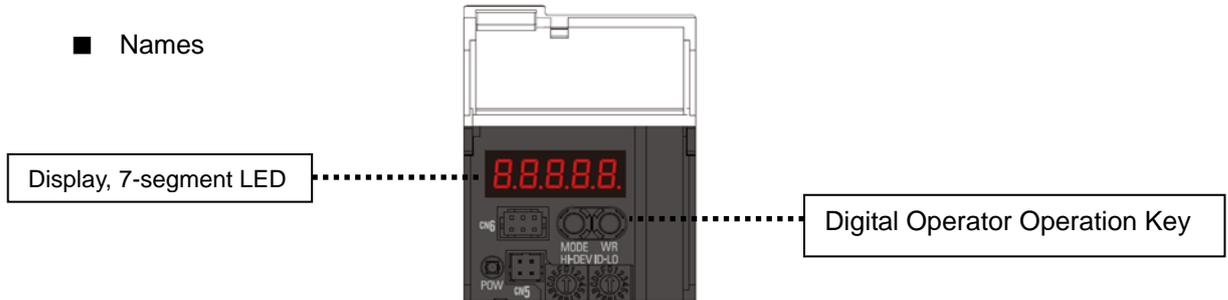
■　Functions of each parts

Functions	Description	Operation method	
1 [MODE]	MODE Switch / Cancel	MODE key ON (once):	Keeps ON for more than 100ms and less than 1s, then turns OFF.
2 〔WR〕	MODE / Page Data Determination	WR key ON (once):	Keeps ON for more than 100ms and less than 1s, then turns OFF.
3 〔INC〕	Increment value	MODE key pushed long (once):	ON for more than 1s causes page increment.
4 〔DEC〕	Decrement value	WR key pushed long (once):	ON for more than 1s causes page decrement.

7.3.2 Mode changes

MODE Change is performed by "MODE" operation of the Push Button Switch.
Switches as following order.

```
Status Display        ⟵        Monitor display
   MODE                             MODE
     ⬇                               ⬆
Test operation        ⟹        Alarm history display
   MODE                             MODE
```
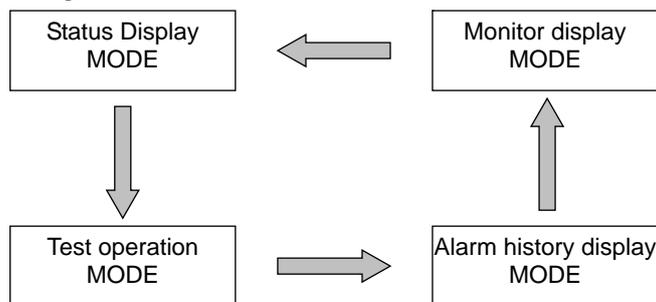
MODE Switching Order

■　Status Display MODE
Displays the establishment of control or main power supply, Servo ON, over-travel, warning and alarm status.
Also performs Alarm Reset.
■　Test operation MODE
JOG Operation, Auto-Tuning Result Writing and Encoder Clear can be executed.
■　Alarm history display MODE
Alarm history for the previous 15 times can be checked and can clear alarm history.
■　Monitor MODE
Displays the servo amplifier status such as Velocity, Velocity Command, Torque, Torque command, Position Deviation and Servo Adjustment Gain when using auto-tuning.

7.4 Digital Operator Display Form

Digital operator displays data becomes the following form.

■ Data of 0 to+65535

Symbol	Digital operator display	Range of a digit display	
Plus	0	Position of 1 display	0 to 9
Plus	1 0	Position of 10 display	10 to 99
Plus	1 0 0	Position of 100 display	100 to 999
Plus	1 0 0 0	Position of 1000 display	1000 to 9999
Plus	1 0 0 0 0	Position of 10000 display	10000 to 99999

■ Data of -9999 to +9999

Symbol	Digital operator display	Range of a digit display	
Plus	0	Position of 1 display	0 to 9
Plus	1 0	Position of 10 display	10 to 99
Plus	1 0 0	Position of 100 display	100 to 999
Plus	9 9 9 9	Position of 1000 display	1000 to 9999
Minus	- 9 9 9 9	Position of 1000 display	1000 to 9999

* Left end - expresses minus.

■ Data of 0 to +4199999999

Symbol	Digital operator display	Range of a digit display	
Plus	1 0 0 0	Low position of 1 to 1000 display	0 to 9999
Plus	1 0 0 0	Middle position of 10000 to 10000000 display	0 to 9999
Plus	4 1	High position of 100000000 to 10000000000 display	0 to 41

* Left end LED expresses low position, middle position, and high position. It switches when MODE is pushed 1sec or more.

7. Digital Operator

■ Hexadecimal data

Symbol	Digital operator display	Range of a digit display
1 byte	F 0	00 to FF
2bytes	F 0 0 0	0000 to FFFF
4 bytes low	L. F 0 0 0	0000 to FFFF (Bit15 to Bit0) display
4 bytes high	H. F 0 0 0	0000 to FFFF (Bit31 to Bit16) display

■ Decimal point indication

First position of a decimal point	1 0 0 0. 0
Second position of a decimal point	1 0 0. 0 0

■ Data of amplifier operating time

Symbol	Digital operator display	Range of a digit display
Digits of msec unit	9 9 9	0 to 999
Digits of sec unit	5 9	0 to 59
Digits of minute unit	5 9	0 to 59
Lower 4 digits of hour unit	9 9 9 9	0 to 9999
Higher 4 digits of hour unit	9 9 9 9	0 to 9999

*   Left end LED expresses digits of data. It switches when MODE is pushed 1sec or more.

■ 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	H - 9 9 9	[kW]
-99950.0 W	< Average power ≦-9995.0 W	H - 9 9. 9	[kW]
-9995.0 W	< Average power ≦-1000.0 W	H - 9. 9 9	[kW]
-999.9 W	≦ Average power ≦+999.9 W	- 9 9 9. 9	[W]
		9 9 9. 9	
1000.0 W	≦ Average power <+9995.0 W	H 9. 9 9	[kW]
9995.0 W	≦ Average power <+99950.0 W	H 9 9. 9	[kW]
99950.0 W	≦ Average power <+999999.9 W	H 9 9 9	[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 Digital Operator

7. Digital Operator

7.5 Status Display Mode

Normal Display: Servo amplifier status can be confirmed in this MODE.

7.5.1 Servo Amplifier Status Display

Marking	Servo amplifier status
8.8.8.8.⁻	・Control power supply established. Control power supply (r, t) is established and amplifier (RDY) is ON. ・EtherCAT FSA "Switch ON Disabled" or "Ready to Switch ON"
8.8.8.8.≡	・Main circuit power supply established. Main power supply (R, S, T) is established, but operation preparation completion signal is OFF. ・EtherCAT FSA "Switch ON Disabled" or "Ready to Switch ON".
8.8.8.8. (cycling top→mid→bottom)	・Safe Torque Off working status. Main Circuit Power Supply (R,S,T) is established and one or both of the Safe Torque OFF Input 1/2 is/are OFF. ・EtherCAT FSA "Switch ON Disabled" "Ready to Switch ON" or "Switch ON" ・Lights as " ⎺→⎼→⎽ " this order.
8.8.8.8.≡	・Operation preparation completion signal established. Main power supply (R, S, T) is established and operation preparation completion signal is ON. ・EtherCAT FSA "Switch ON Disabled" "Ready to Switch ON" or "Switch ON"
8.8.8.8.8	・Servo is ON. Shows "8" shape continuously ・EtherCAT FSA "Operation Enabled"
☼☼☼☼ LoAd	・The state firmware is re-writing. Shows the state that flash ROM of amplifier CPU is being re-written by the firmware downloaded via EtherCAT FoE (bootstrap mode) 　(Do not turn off the control power supply.)
End	**・Firmware rewriting completion** Amplifier CPU has re-written by the firmware downloaded via EtherCAT FoE. (Amplifier shall be restart after shut down control power.)

7.5.2 Forward/Inverse Limit state Display

Marking	Servo amplifier status
8.8.8.8.⊣	・Forward direction limit status 　Command input of forward direction is disabled by forward direction limit switch input
8.8.8.8.⊢	・Inverse direction limit status 　Command input of inverse direction is disabled by inverse direction limit switch input

7.5.3 Display of linear motor magnetic pole position detection process

Marking	Servo amplifier status
☼ 🔒🔒🔒🔒🔒	・Magnetic pole position not detected state (flashing) Linear motor CS-position setting is needed when Hall effect sensor is not used for detecting magnetic pole. The display changes from flashing to lighting showing operation preparation completed, after completing magnetic pole position detection via CS-position setting.
🔒🔒🔒🔒🔒	・Magnetic pole position not detected state (CS-position setting being performed) Shows magnetic pole position not detected during CS-position setting.
🔒🔒🔒🔒🔒	・Magnetic pole position detection completed state (CS-position setting being performed) Shows the state magnetic pole position detection completed during CS-position setting.

7.5.4 Display of warning state

Marking	Description
🔒 🔒 🔒 🔒 🔒	Encoder system warning status Occurred warning below ■ Battery voltage sag
🔒 🔒 🔒 🔒 🔒	Load system warning status Occurred one of warnings below ■ Regeneration overload ■ Overload ■ Servo amplifier internal temperature Note 1)
🔒 🔒 🔒 🔒 🔒	Power system warning status Occurred warning below ■ Control power voltage reduction
🔒 🔒 🔒 🔒 🔒	Control system warning status Occurred one of warnings below ■ Restricting torque command ■ Restricting velocity command ■ Excessive position deviation ■ Dual position error excess ■ Sync error excess ■ Adaptive notch filter E frequency ■ Excessive position deviation difference warning

* Descriptions of each warning are shown at "8.2.1 Warning List".
* Confirm occurring warning by the digital operator referring "7.16 Monitor display" or by warning information of the setup software. For operation of the setup software, see another document: M0010842.

Note 1) For RS3D80#, it shows when either of power unit or amplifier unit into warning status.

Digital Operator 7

7. Digital Operator

7.5.5 Alarm Display

Alarm number can be confirmed at the time of alarm occurrence.

Marking	Servo amplifier status
☼☼☼☼☼ **AL. 8 5 0**	Displays Alarm Code with "2 digits" following "AL." and Status Code at the time of alarm occurrence with "1 digit" after the alarm code. Please take a measure according to the contents of "Maintenance" when alarm occurring.

Status code of servo amplifier at the time of alarm

Alarm Code

Alarm status
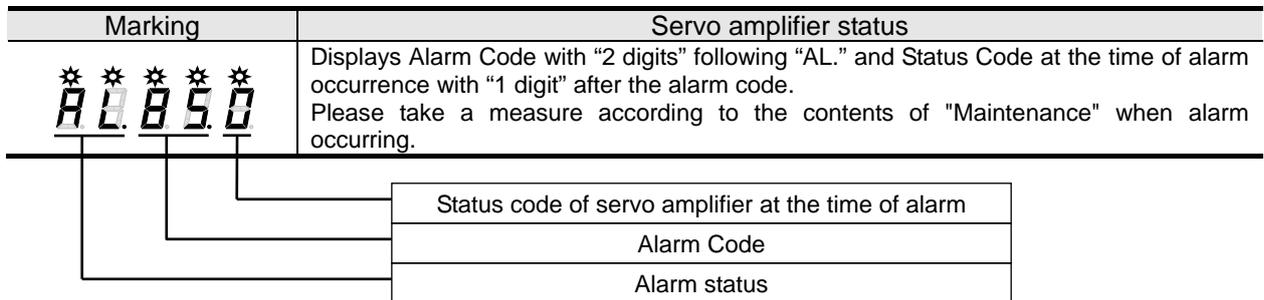
Code	State	
1	Power OFF	(P-OFF)
2	Power ON	(P-ON)
3	Servo Ready	(S-RDY)
4	Servo ON	(S-ON)
5	Servo OFF Stop	(S-OFF)
6	Emergency Stop	(EMR)
F	Initialized	

7.5.6 How to Reset Alarm When Alarm Occurring

Alarm can be reset with the Digital Operator, except for alarms necessary for re-input of power.

Process	Displayed character, number, code	MODE key operation	How to operate
1	☼☼☼☼☼ **AL. 1 8 0**	[MODE]	Make the state (Status Display) where the alarm No. is displayed.
2	**AL. r 5 E**	[WR]	Changes to as the left after turn ON MODE key 1sec or more. Alarm will be cleared by pushing WR key.
3	**A. r. u. n. A.**	—	Display changes as the left for 2 seconds.
4	**8. 8. 8. 8. −**	—	When the cause of alarm is removed, the state of servo amplifier is displayed.
—	**AL. r 5 E**	[MODE]	When pushing "MODE" once in the status of Process 2, it will be cancelled and revert to Process 1.

7.6 Trial Run Mode

7.6.1 Velocity-controlled JOG Operation

Process	Displayed character, number, code	Key input operation	How to operate
1	*Ad.00*	[MODE]	Push MODE key until it show display on the left. Display changes and right end LED blinks.
2	*Ad.00*	[INC]	Push MODE key more than 1 sec to show display on the left.
3	*JoG*	[WR]	Displays "JOG" mode by pushing WR key once.
4	*8*	[WR]	Shows a shape of "8" by pushing WR key once and powers on the servo motor.
5	*8*	[INC]	Rotates in CCW direction with one long push of MODE key. Default value 50min^{-1} Note 1)
6	*JoG*	[MODE]	Returns to Process 3 by pushing MODE key once.
7	*ALdFY*	[MODE]	Ends Process by pushing MODE key once and shows display on the left.

Note 1) The number of rotations can be changed to an arbitrary number at GroupD ID00 in the setup software.

For stopping during operation, please push the MODE button.

MODE is pushed in Process 2.	
AcH.1	Changes to the left display and displays alarm history.
MODE is pushed in Process 3.	
Ad.00	Changes to the left display and returns to Process 2.
MODE is pushed in Process 4.	
JoG	Changes to the left display and returns to Process 3.
Mode is pushed again.	
ALdFY	Completes and changes to the left display.

7. Digital Operator

7.6.2 Encoder clear

Process	Displayed character, number, code	Key input operation	How to operate
1	*Ad 00* ☼	[MODE]	Push MODE key until it shows display the left. Display changes and right end LED blinks.
2	*Ad 01* ☼	[INC]	Push MODE key more than 1 sec to display "Ad 01" on left.
3	*EnCLr*	[WR]	Displays "EnCLr" mode by pushing WR key.
4	*.r.u.n.*	[WR]	Display changes to that on the left and executes Encoder Clear by pushing WR key.
5	*EnCLr*		Displays image on left "EnCLr" after normal completion
6	*Ad 01* ☼	[MODE]	Returns to Process 2 by pushing MODE key.
7	*ALH 1* ☼	[MODE]	Displays Alarm History mode by pushing MODE key.

7.6.3 Automatic Tuning Result Writing

Process	Displayed character, number, code	Key input operation	How to operate
1	*Ad 00* ☼	[MODE]	Push MODE key until it shows display on the left. Display changes and right end LED blinks.
2	*Ad 02* ☼	[INC]	Push MODE key more than 1 sec to display "Ad 02"on left.
3	*turSL*	[WR]	Displays "turSL" mode by pushing WR key.
4	*.r.u.n.*	[WR]	Display changes to that on the left and executes Automatic Tuning Result Writing by pushing WR key.
5	*turSL*		Displays image on left "turSL" after normal completion
6	*Ad 02* ☼	[MODE]	Returns to Process 2 by pushing MODE key.
7	*ALH 1* ☼	[MODE]	Displays Alarm History mode by pushing MODE key.

7.7 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.

Digital Operator 7

7. Digital Operator

7.8 Alarm History Mode

7.8.1 Alarm History Display Mode

Process	Displayed character, number, code	Key input operation	How to operate
1	ALH 1 ☼	[MODE]	Push MODE key until it shows display on the left. Display changes and right end LED blinks.
2	ALH 3 ☼	[INC]	Displays an Alarm History number that requests to be checked. Previous 7 alarms can be checked.
3	AL.850	[WR]	Displays the previous 3 alarms from the current by pushing WR key.
4	802	[WR]	Displays elapsed time until alarm occurrence by pushing WR key. msec unit digits.
5	29	[INC]	Displays elapsed time until alarm occurrence by pushing WR key. Second unit digits.
6	1	[INC]	Displays elapsed time until alarm occurrence by pushing WR key. Minute unit digits.
7	0	[INC]	Displays elapsed time until alarm occurrence by pushing WR key. Hour unit lower 4 digits.
8	0	[INC]	Displays elapsed time until alarm occurrence by pushing WR key. Hour unit higher 4 digits.
9	AL.850	[MODE]	Returns to Process 3 by pushing MODE key once.
10	ALH 3 ☼	[MODE]	Returns to Process 3.
11	ob	[MODE]	Changes to the next monitor display mode.
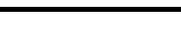
7.8.2 Clear Alarm History

Process	Displayed character, number, code	Key input operation	How to operate
1	ALH.CL	[MODE]	Displays Clear mode after Alarm History number 7 has been checked by MODE key.
2	rdy ☼☼☼	[WR]	Clears preparations screen (as shown on the left) will be displayed by pushing WR key until the display changes.
3	.r.u.n.	[WR]	Displays as shown on the left by pushing WR key until the display changes, and executes Alarm History Clear.
4	ALH 1 ☼	–	Returns to History Selection Screen automatically after normal completion.
5	ALH.CL	[MODE]	Pushing MODE key in Process 3 cancels the corresponding operation and returns to Process 1.
7	ob	[MODE]	Changes to the next monitor display mode.

7.9 Monitor Display Mode

Process	Displayed character, number, code	Key input operation	How to operate
1	*ob.00*	[MODE]	Press MODE key until you see the display on the left, then you can change the display. The right end of the LED blinks after the change.
2	*ob.09*	[INC], [DEC]	Displays ID that requests monitoring.
3	*0.3*	[WR]	Displays set data and status.
4	*ob.09*	[WR]	Displays as on the left. Repeat from Process 2 when another parameter setting is following.
5	*F*	[MODE]	Changes to the next status display mode.
—	*non*	Displays as on the left in Process 3 for reserved parameters that cannot be shown.	

7. Digital Operator

7.9.1 Monitor list

ID	Symbol	Name		Unit
00	STATUS	Servo amplifier 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	CONT7-1	General input CONT7 - 1 monitor		---
06	OUT2-1	General output OUT2 - 1 monitor		---
07	INC-E MON	Incremental encoder signal monitor		---
10	APMON	Actual position monitor (Motor encoder)	Digital operator: Higher digits data	×2^{32} Pulse
11			Digital operator: Lower digits data	Pulse
12	CPMON	Command position monitor	Digital operator: Higher digits data	×2^{32} Pulse
13			Digital operator: Lower digits 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 (Estimated value)		%
30	FMON1	Position command pulse frequency monitor		k Pulse/s
31	VC/TC-IN	Analog velocity command/Analog torque command inputting voltage monitor		mV
32	MTCOMP	Analog torque compensation command inputting voltage monitor		mV
33	ABSPS	Absolute encoder PS data monitor	Digital operator: Higher digits data	×2^{32} Pulse
34			Digital operator: Lower digits 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	Main circuit DC voltage monitor		V
45	ENTMP	Encoder temperature monitor		degreeC
46	MATEMP	Amplifier internal temperature monitor		degreeC
47	RUNTIM	Amplifier operation time		h:mm:ss.ms
4A	MAVEPOW1	Average power monitor		W
4B	MAVEPOW2	Average power monitor		kW
4C	RegPOW	Regenerative power monitor		W
50	JRAT MON	Load inertia moment rating 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	Adaptive notch filter frequency monitor E		Hz
60	DFERR-MON	Dual position deviation monitor		Pulse
61	EX-APMON	Actual position monitor (External encoder)	Digital operator: Higher digits data	×2^{32} Pulse
62			Digital operator: Lower digits data	Pulse
63	EX-ABSPS	External absolute encoder PS data monitor	Digital operator: Higher digits data	×2^{32} Pulse
64			Digital operator: Lower digits data	Pulse
65	MEXENCF	External encoder frequency monitor		kPulse/s
66	SYNERR	Axes sync error monitor		Pulse
70	RSRLYLF	Remaining life of relay for an inrush current prevention		%
71	DBRLYLF	Remaining life of relay for a dynamic brake		%
72	HBRLYLF	Remaining life of relay for a holding brake		%
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		%

7.9.2 Monitor Details

ID	Description
00	**Servo amplifier 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 status</td><td>(S-ON)</td></tr><tr><td>5</td><td>Servo OFF and stop state</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>

Warning status 1 monitor [WARNING1]

■ Displays warning status. "1" or "ON" shows that the warning is active.

Bit	3	2	1	0
Function	Regenerative overload	Overload	---	Servo amplifier temperature

Bit	7	6	5	4
Function	Excessive deviation	Control power decrease	Velocity command under limit	Torque command under limit

(ID: 01)

Warning status 2 monitor [WARNING2]

■ Displays warning status. "1" or "ON" shows that the warning is active.

Bit	3	2	1	0
Function	Negative direction Over-travel	Positive direction Over-travel	---	Main circuit power being charged

Bit	7	6	5	4
Function	---	Absolute encoder warning	---	---

(ID: 02)

Warning status 3 monitor [WARNING3]

■ Displays warning status. "1" or "ON" shows that the warning is active.

Bit	3	2	1	0
Function	Adaptive notch filter E frequency	---	Dual position error excess	Axes-sync error excess

Bit	7	6	5	4
Function	---	Excessive position deviation difference warning	External encoder warning	---

(ID: 03)

Warning status 4 monitor [WARNING4]

■ Displays warning status. "1" or "ON" shows that the warning is active.

Bit	3	2	1	0
Function	---	---	---	---

Bit	7	6	5	4
Function	---	---	---	---

(ID: 04)

Digital Operator 7

7. Digital Operator

ID	Description
05	**General input CONT7 to 1 monitor [CONT7-1]** ■ Displays generic input terminal status. It will be in a photo coupler excitation state by "1" or "ON". {table below}
06	**General output OUT2 to 1 monitor [OUT2-1]** ■ Displays generic output terminal status. It will be in a photo coupler excitation state by "1" or "ON". {table below}
07	**Incremental encoder signal monitor [INC-E MON]** ■ Displays incremental encoder signal status. "1" or "ON" shows an incoming signal level "H" state {table below}

ID 05:

Bit	3	2	1	0
Function	CONT4	CONT3	CONT2	CONT1

Bit	7	6	5	4
Function	---	CONT7	CONT6	CONT5

ID 06:

Bit	3	2	1	0
Function	---	---	OUT2	OUT1

Bit	7	6	5	4
Function	---	---	---	---

ID 07:

Bit	3	2	1	0
Function	---	EN1 encoder Z-phase signal	EN1 encoder B-phase signal	EN1 encoder A-phase signal

Bit	7	6	5	4
Function	---	EN2 encoder Z-phase signal	EN2 encoder B-phase signal	EN2 encoder A-phase signal

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	
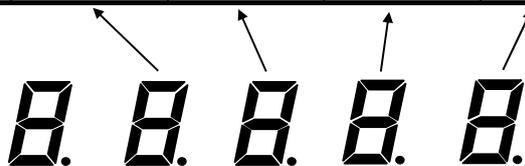
Digital operator at the front of servo amplifier

ID	Description
10 11	**Actual position monitor (Motor encoder) [APMON]** ■ Displays the current position of the motor encoder that has the origin as the position at the time the control power was turned ON. As this is a free run counter, if the current position exceeds the displayed range, the maximum reverse polarity value will be displayed. ◆ Setup software displays the data to ID10. Display range / Unit table: ◆ Digital operator displays the data to ID10, ID11 by hexadecimal notation (32-bit data).
12 13	**Command position monitor [CPMON]** ■ Displays the current position of the pulse command that has the origin as the position at the time the control power was turned ON. As this is a free run counter, if the current position exceeds the displayed range, the maximum reverse polarity value will be displayed. ◆ Setup software displays the data to ID12. Display range / Unit table: ◆ Digital operator displays the data to ID12, ID13 by hexadecimal notation (32-bit data).
14	**Position deviation monitor [PMON]** ■ Displays the position deviation value. ◆ Setup software displays values in decimal notation. Display range / Unit table: ◆ Digital operator displays values in hexadecimal notation.

ID 10, 11 — Actual position monitor (Motor encoder) [APMON]

Display range	Unit
-9223372036854775808 to 9223372036854775807	Pulse

ID	Data range	Display range	Unit
10	Bit63 to Bit32	H.8000 L.0000 to H.7FFF L.FFFF	$\times 2^{32}$ Pulse
11	Bit31 to Bit0	H.0000 L.0000 to H.FFFF L.FFFF	Pulse

ID 12, 13 — Command position monitor [CPMON]

Display range	Unit
-9223372036854775808～9223372036854775807	Pulse

ID	Data range	Display range	Unit
12	Bit63 to Bit32	H.8000 L.0000 to H.7FFF L.FFFF	$\times 2^{32}$ Pulse
13	Bit31 to Bit0	H.0000 L.0000 to H.FFFF L.FFFF	Pulse

ID 14 — Position deviation monitor [PMON]

Display range	Unit
-2147483648 to 2147483647	Pulse

ID	Data range	Display range	Unit
14	Bit31 to Bit0	H.8000 L.0000 to H.7FFF L.FFFF	Pulse

7 Digital Operator

7. Digital Operator

ID	Description
15	**Velocity monitor [VMON]** ■ Displays the rotation speed of the servo motor. ◆ Setup software displays values in decimal notation. {table A} ◆ Digital operator displays values in hexadecimal notation. {table B}
16	**Velocity command monitor [VCMON]** ■ Displays the velocity command value. ◆ Setup software displays values in decimal notation. {table C} ◆ Digital operator displays values in hexadecimal notation. {table D}
17	**Torque monitor [TMON]** ■ Displays the output torque of servo motor. {table E}
18	**Torque command monitor [TCMON]** ■ Displays the torque command value. {table F}
19	**Acceleration monitor [ACCMON]** ■ Displays the servo motor acceleration. ◆ Setup software displays values in decimal notation. {table G} ◆ Digital operator displays values in hexadecimal notation. {table H}

Table A (ID 15, decimal):

Display range	Unit
-2147483648 to 2147483647	min^{-1}

Table B (ID 15, hexadecimal):

ID	Data range	Display range	Unit
15	Bit31 to Bit0	H.8000 L.0000 to H.7FFF L.FFFF	min^{-1}

Table C (ID 16, decimal):

Display range	Unit
-2147483648 to 2147483647	min^{-1}

Table D (ID 16, hexadecimal):

ID	Data range	Display range	Unit
16	Bit31 to Bit0	H.8000 L.0000 to H.7FFF L.FFFF	min^{-1}

Table E (ID 17):

Display range	Unit
-499.9 to 499.9	%

Table F (ID 18):

Display range	Unit
-499.9 to 499.9	%

Table G (ID 19, decimal):

Display range	Unit
-2147483648 to 2147483647	rad/s^2

Table H (ID 19, hexadecimal):

ID	Data range	Display range	Unit
19	Bit31 to Bit0	H.8000 L.0000 to H.7FFF L.FFFF	rad/s^2

ID	Description
1A	**Load Torque monitor (Estimate value) [MTLMON-EST]** ■ Displays the estimated value of load torque. <table><tr><td>Display range</td><td>Unit</td></tr><tr><td>-499.9 to 499.9</td><td>%</td></tr></table>

Load Torque monitor (Estimate value) [MTLMON-EST]

■ Displays the estimated value of load torque.

Display range	Unit
-499.9 to 499.9	%

Position command pulse frequency monitor [FMON1]

■ Displays the entered command pulse frequency.

◆ Setup software displays values in decimal notation.

Display range	Unit
-2147483648 to 2147483647	kPulse/s

◆ Digital operator displays values in hexadecimal notation.

ID	Data range	Display range	Unit
30	Bit31 to Bit0	H.8000 L.0000 to H.7FFF L.FFFF	kPulse/s

Analog velocity command/Analog torque command input voltage monitor [VC/TC-IN]

■ Displays the entered command voltage.

◆ Displays with mV unit at the setup software.

Display range	Unit
-12000 to 12000	mV

◆ Displays with 10mV unit at the digital operator.

Display range	Unit
-1200 to 1200	x10mV

Analog torque addition command input voltage monitor [MTCOMP]

■ Displays the entered command voltage.

◆ Displays with mV unit at the setup software.

Display range	Unit
-12000 to 12000	mV

◆ Displays with 10mV unit at the digital operator.

Display range	Unit
-1200 to 1200	x10mV

Absolute encoder PS data monitor (motor encoder) [ABSPS]

■ Displays position data of absolute encoder.

◆ Setup software displays the data to ID33.

Display range	Unit
0 to FFFFFFFFFFFFFFFF	Pulse

(Actual display range varies depending on the encoder specifications.)

◆ Digital operator displays the data to ID33, ID34 by hexadecimal notation (32-bit data).

ID	Data range	Display range	Unit
33	Bit63 to Bit32	H.0000 L.0000 to H.FFFF L.FFFF	$\times 2^{32}$ Pulse
34	Bit31 to Bit0	H.0000 L.0000 to H.FFFF L.FFFF	Pulse

The ID values 30, 31, 32, 33, 34 correspond to the respective sections above.

7 Digital Operator

7. Digital Operator

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

* 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

ID	Description
46	**Amplifier temperature monitor [MATEMP]** ■ Displays internal temperature of servo amplifier. | Display range	Unit | |---|---| | -15 to 150 | degree C | ◆ Internal temperature of servo amplifier is the point near to power device.
47	**Amplifier Operation Time [RUNTIM]** ■ Displays the total time of control power ON. | Display format | |---| | Hour (h) : Minute (mm) : Second (ss) . Millisecond (ms) | ◆ See "7.3 Setting and display range" for the digital operator display.
4A	**Average electric power monitor** **[MAVEPOW1]** ■ Average electric power monitor shows a measurement result every 1 minute. | Display range	Unit | |---|---| | -999,999.9 to 999,999.9 | [W] | ◆ Refer to "7.3 Setting and display range" for the display of the digital operator. * Not shown with the motor except standard spec R series. * When 3-phase 200V AC is used to the 200V AC input type, accuracy will be ±25% (at the accel/decel operation with 100% effective torque). * When single-phase 200V AC is used to the 200V AC input type, accuracy will be ±30% (at the accel/decel operation with 100% effective torque). * For the 100V AC input type, accuracy will be ±30% (at the accel/decel operation with 100% effective torque). (Accuracy may be worse when it is used at the instantaneous area of Velocity-torque characteristics.)
4B	**Average electric power monitor** **[MAVEPOW2]** ■ Average electric power monitor shows a measurement result every 1 minute. | Display range	Unit | |---|---| | -999.9 to 999.9 | [kW] | * Not shown with the motor except R series. * When 3-phase 200V AC is used to the 200V AC input type, accuracy will be ±25% (at the accel/decel operation with 100% effective torque). * When single-phase 200V AC is used to the 200V AC input type, accuracy will be ±30% (at the accel/decel operation with 100% effective torque). * For the 100V AC input type, accuracy will be ±30% (at the accel/decel operation with 100% effective torque). (Accuracy may be worse when it is used at the instantaneous area of Velocity-torque characteristics.)
4C	**Regenerative power monitor** **[RegPOW]** ■ Displays the power dissipation of regenerative resistor. | Display range	Unit | |---|---| | 0 to 4,294967.295 | [W] |

7 Digital Operator

7. Digital Operator

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

ID	Description
61 62	**Present position monitor (External encoder) [EX-APMON]** ■ Displays the current position of the external encoder that has the origin as the position at the time the control power was turned ON. As this is a free run counter, if the current position exceeds the displayed range, the maximum reverse polarity value will be displayed. ◆ Setup software displays the data to ID61. {table1} ◆ Digital operator displays the data to ID61, ID62 by hexadecimal notation (32-bit data). {table2}
63 64	**External absolute encoder PS data monitor [EX-ABSPS]** ■ Displays position data of external absolute encoder. ◆ Setup software displays the data to ID63. {table3} (Actual display range varies depending on the encoder specifications.) ◆ Digital operator displays the data to ID63, ID64 by hexadecimal notation (32-bit data). {table4}
65	**Ext. Encoder frequency monitor [MEXENCF]** ■ Displays the external encoder frequency of incremental encoder. ◆ Setup software displays values in decimal notation. {table5} ◆ Digital operator displays values in hexadecimal notation (32-bit data). {table6}
66	**Axes-sync error monitor [SYNERR]** ■ Displays position deviation error between own axis and counterpart axis. ◆ Setup software displays values in decimal notation. {table7} ◆ Digital operator displays values in hexadecimal notation. {table8}

table1:

Display range	Unit
-9223372036854775808 to 9223372036854775807	Pulse

table2:

ID	Data range	Display range	Unit
61	Bit63 to Bit32	H.8000 L.0000 to H.7FFF L.FFFF	$\times 2^{32}$ Pulse
62	Bit31 to Bit0	H.0000 L.0000 to H.FFFF L.FFFF	Pulse

table3:

Display range	Unit
0 to FFFFFFFFFFFFFFFF	Pulse

table4:

ID	Data range	Display range	Unit
63	Bit63 ～ Bit32	H.0000 L.0000 to H.FFFF L.FFFF	$\times 2^{32}$ Pulse
64	Bit31 ～ Bit0	H.0000 L.0000 to H.FFFF L.FFFF	Pulse

table5:

Display range	Unit
-2147483648 to 2147483647	kPulse/s

table6:

ID	Data range	Display range	Unit
65	Bit31 to Bit0	H.8000 L.0000 to H.7FFF L.FFFF	kPulse/s

table7:

Display range	Unit
-2147483648 to 2147483647	Pulse

table8:

ID	Data range	Display range	Unit
66	Bit31 to Bit0	H.8000 L.0000 to H.7FFF L.FFFF	Pulse

Digital Operator 7

7. Digital Operator

ID	Description
70	**Remaining life of relay for an inrush current prevention [RSRLYLF]** ■ Displays the remaining life of relay for an inrush current prevention. | Display range	Unit | |---|---| | 0 to 100.00 | % |
71	**Remaining life of relay for a dynamic brake [DBRLYLF]** ■ Displays the remaining life of relay for a dynamic brake. | Display range	Unit | |---|---| | 0 to 100.00 | % |
72	**Remaining life of relay for a holding brake [HBRLYLF]** ■ Displays the remaining life of relay for a holding brake. | Display range	Unit | |---|---| | 0 to 100.00 | % |
73	**Error rate of motor encoder communication [MOTE-ERRAT]** ■ Displays the error rate of motor encoder communication. | Display range	Unit | |---|---| | 0.000000 to 1.000000 | --- |
74	**Error rate of external encoder communication [EXTE-ERRAT]** ■ Displays the error rate of external encoder communication. | Display range	Unit | |---|---| | 0.000000 to 1.000000 | --- |
77	**Remaining life of a holding brake [HBLF]** ■ Displays the remaining life of a holding brake. | Display range	Unit | |---|---| | 0 to 100.00 | % | * Displays only when combining with the motor which has holding brake. * Not shown if combine with the motor which doesn't support this function.

7.10 Analog monitor

All signals and internal status of the servo amplifier 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.

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

Digital monitor	Disabled	Disabled
Analog monitor1 [MON1]	0x2023, 0x01: Analog Monitor Output Selection 1	General parameters Group9 ID61
Analog monitor2 [MON2]	0x2023, 0x02: Analog Monitor Output Selection 2	General parameters Group9 ID62

7.11 Fixed monitor display

The display shows monitoring value after initialization completion.
It shows monitoring value set at Group D ID11 "Monitor Display Selection [MONDISP]" in status display mode. Set it referring the section "7.8.1 Monitor list".

"Monitor" to be displayed is the same as parameter ID in monitor display mode, but in the setting value "00 STATUS servo amplifier 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. In case that the digital operator of servo amplifier is "Status display mode" and Group D ID11 "Monitor Display Selection [MONDISP]" has set via the setup software, perform power cycle or show "Status display mode" again by pushing "MODE" button of the digital operator.

Digital Operator 7

No Text on This Page.

8

Maintenance

In this chapter, trouble shooting, inspection and service parts are explained.

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. ■ Check that wires and screws are fastened properly.
Red "CHARGE" LED goes out.	■ Internal power circuit of servo amplifier is defective, so replace the servo amplifier.
Over-travel status. Emergency Stop status.	■ Stop the input of Over-travel or the input of Emergency Stop. ■ 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 an inputting command by communication parameter. 0x2106: Internal Velocity Command Monitor 0x2107: Internal Torque Command Monitor 0x60FC: Internal Position Command Value	■ 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. ■ Check of "Functions enabling condition settings "
Check the deviation clear input status.	■ Stop the input of deviation clear if the signal is in. ■ Check of "Functions enabling condition settings "
Check the encoder clear input status.	■ Stop the input of encoder clear if the signal is in. ■ 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. ■ 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. ■ 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

Maintenance 8

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. ■ 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. ■ Confirm that the wiring for motor encoder line and servo motor power line are not installed in the same duct. ■ Confirm that the power supply voltage is sufficient.

■   The multi-turn part of the absolute encoder cannot be cleared by clearing the encoder although the absolute encoder that has multi-turn is used.

Investigation	Assumed causes and corrective actions
Check the setting value of system parameter.	■ Check that the set value of 0x20FF-2 is either of 0x300 or 0x400. ■ Check that the set value of 0x20F1-1 is 0x00.

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
	Amplifier Temperature Warning	■ Ambient temperature of the amplifier is out of range of the operation temperature Note 1)
Power supply system	Control power voltage sag warning	■ Voltage of control power is below 152 VAC (200 VAC input type), or 76 VAC (100 VAC input type).
	Main circuit charging	■ Main circuit is charging.
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) ■ 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.
	Excessive position deviation difference warning	■ Excessive position deviation difference is exceeding the warning set value.
	Minimum position limit	■ Position command exceeds minimum value of software position limit.
	Maximum position limit	■ Position command exceeds maximum value of software position limit.
	Modulo initial process warning	■ Difference of stored modulo position and actual position exceeds a warning set value.
	Pitch error table setting warning	■ Entry number of pitch error table is "1". ■ Compensated positions are not in order of smaller number.

Note 1) For RS3D80#, it shows when either of power unit or amplifier unit into warning status.

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. (However, it performs free-run operation if alarm 53H (DB resistor overheat) is issued while stop with dynamic brake.)

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 free servo brake operation at the time of alarm 53H (DB resistor overheating) detection.)

For RS3D80#, refer page 8-47 for corrective actions of abnormality related to drive/load. The other alarms are common with another amplifier capacity.

	Alarm code 0x2101 0x2102	Error register 0x1001	Error code 0x603F	Alarm name	Alarm contents	Detection Operations	Alarm reset
Abnormality related to communication	10	Bit4	0x7510	IN Rx invalid frame error	■ Invalid frame received continuously in port 0	SB	Yes
	11	Bit4	0x7510	OUT Rx invalid frame error	■ Invalid frame received continuously in port 1	SB	Yes
	12	Bit4	0x7510	IN Rx CRC error	■ Rx error occurred continuously in port 0	SB	Yes
	13	Bit4	0x7510	OUT Rx CRC error	■ Rx error occurred continuously in port 1	SB	Yes
	14	Bit4	0x7510	IN Tx error	■ Tx error occurred continuously in port 0	SB	Yes
	15	Bit4	0x7510	OUT Tx error	■ Tx error occurred continuously in port 1	SB	Yes
	18	Bit4	0x7520	IN lost link	■ Port 0/1 cable was broken or disconnected. Power supply was shut down.	SB	Yes
	19	Bit4	0x7520	OUT lost link		SB	Yes
	1A	Bit4	0x7510	Communication timeout	■ Output data was unreceived during prescript cycle time.	SB	Yes
Abnormality related to drive	21	Bit1	0x5400	Main Circuit Power Device Error (Over current)	■ Over current of drive module ■ Abnormality in drive power supply ■ Overheating of drive module	DB	Yes
	22	Bit1	0x5210	Current Detection Error 0	■ Abnormality of electric current detection value	DB	Yes
	23	Bit1	0x5210	Current Detection Error 1	■ Abnormality of Electric current detection circuit	DB	Yes
	24	Bit1	0x5210	Current Detection Error 2	■ Abnormality in communication with Electric current detection circuit	DB	Yes
	25	Bit1	0x8312	Safe Torque Off Error 1	■ Logic unmatched in safe torque off input	DB	No
	26	Bit1	0x8312	Safe Torque Off Error 2	■ Failure of safe torque off circuit	DB	No
	27	Bit0	0x5200	Fan stop	■ Speed reduction of fan	DB	No
Abnormality related to load	41	Bit1	0x8311	Overload 1	■ Excessive effective torque	SB	Yes
	42	Bit1	0x2220	Overload 2	■ Stall over load	DB	Yes
	43	Bit1	0x3212	Regenerative Overload	■ Regeneration load ratio exorbitance	DB	Yes
	44	Bit1	0x7300	Magnetic pole position estimation error	■ Magnetic pole position estimation operation failed.	DB	Yes
	45	Bit1	0x8400	Average continuous over speed	■ Over speed in average rotational speed	SB	Yes
	52	Bit3	0x4210	RS Overheat	■ Detection of in-rush prevention resistance overheating	SB	Yes
	53	Bit3	0x4210	Dynamic Brake Resistance Overheat	■ Overheating detection of dynamic brake resistor ■ External thermostat operated	SB	Yes
	54	Bit3	0x4310	Internal Regenerative Resister Overheat	■ Overheating detection of Internal regenerative resistor	DB	Yes
	55	Bit3	0x4310	External Error	■ Overheating detection of External regenerative resistor	DB	Yes
	56	Bit3	0x4210	Servo Amplifier Temperature Error	■ Overheating detection of Drive module Note 9)	DB	Yes
Abnormality in power supply	61	Bit2	0x3211	Over-voltage	■ DC Excess voltage of main circuit	DB	Yes
	62	Bit2	0x3220	Main Circuit Under-voltage Note1)	■ DC Main circuit low voltage	DB	Yes
	63	Bit2	0x3130	Main Power Supply Fail Phase Note1)	■ 1 phase of the 3 phase main circuit power supply disconnected	SB	Yes
	68	Bit2	0x3220	Main circuit voltage detection error	■ Failure of VBUS detection circuit	DB	No
	71	Bit2	0x5114	Control Power Supply Under-voltage Note2)	■ Control power supply low voltage	DB	Yes Note 3)
	72	Bit2	0x5115	Control Circuit Under-voltage 1	■ Under voltage of ±12V	SB	Yes
	73	Bit2	0x5113	Control Circuit Under-voltage 2	■ Under voltage of +5V	DB	No

	Alarm code 0x2101 0x2102	Error register 0x1001	Error code 0x603F	Alarm name	Alarm contents	Detection Operations	Alarm reset
Abnormality related to encoder wiring	81	Bit0	0x7305	Encoder Connector 1 Disconnection	■ Incremental encoder (A, B, Z) signal line break ■ Power supply break	DB	No
	83	Bit0	0x7306	Encoder Connector 2 Disconnection Note 7)	■ Incremental encoder (A, B, Z) signal line break ■ Power supply break	DB	No/Yes
	84	Bit0	0x7300	Absolute Encoder Communication Error	■ Encoder serial signal time out ■ Serial communication data error	DB	No
	85	Bit0	0x7300	Encoder Initial Process Error	■ Failed to read CS data of incremental encoder ■ Abnormality in initial process of absolute encoder	—	No
	86	Bit0	0x7300	CS error	■ Position jumping on CS data	DB	No
	87	Bit0	0x7300	CS Signal Disconnection	■ CS signal line break	DB	No
	88	Bit0	0x7300	External Absolute Encoder Communication Error	■ Encoder serial signal time out ■ Serial communication data error	DB	No
	89	Bit0	0x7300	External Encoder Initial Process Error	■ Abnormality in initial process of absolute encoder	-	No
	8C	Bit0	0x7300	Motor encoder (EnDat) combination error	■ Motor encoder (EnDat) is out of applicable range.	-	No
	8D	Bit0	0x7300	External encoder (EnDat) combination error	■ External encoder (EnDat) is out of applicable range.	-	No
Abnormality in encoder main body	A0	Bit0	0x7300	Absolute Encoder Internal Error 0	■ Encoder failure	DB	No
	A1	Bit0	0x7300	Absolute Encoder Internal Error 1	■ Encoder internal error	DB	Note 4)
	A2	Bit0	0x7300	Absolute Encoder Internal Error 2	■ Encoder internal error	DB	Note 4)
	A3	Bit0	0x7310	Absolute Encoder Internal Error 3	■ Encoder internal error	DB	Note 4)
	A4	Bit0	0x7300	Absolute Encoder Internal Error 4	■ Encoder internal error	DB	Note 4)
	A5	Bit0	0x7300	Absolute Encoder Internal Error 5	■ Encoder internal error	DB	Note 4)
	A6	Bit0	0x7300	Absolute Encoder Internal Error 6	■ Encoder internal error	DB	Note 4)
	A9	Bit0	0x7300	Absolute Encoder Internal Error 9	■ Encoder internal error	DB	Note 4)
	AA	Bit0	0x7320	Absolute Encoder Internal Error 10	■ Encoder internal error	DB	Note 4)
	AC	Bit0	0x7320	Absolute Encoder Internal Error 12	■ Encoder internal error	DB	Note 4)
	AD	Bit0	0x7320	Absolute Encoder Internal Error 13	■ Encoder internal error	DB	Note 4)
	AF	Bit0	0x7304	Absolute Encoder Internal Error 15	■ Encoder internal error	DB	Note 4)
Abnormality in external encoder main body	B0	Bit0	0x7300	External Absolute Encoder Internal Error 0	■ Encoder failure	DB	No
	B1	Bit0	0x7300	External Absolute Encoder Internal Error 1	■ Encoder internal error	DB	Note 4)
	B2	Bit0	0x7300	External Absolute Encoder Internal Error 2	■ Encoder internal error	DB	Note 4)
	B3	Bit0	0x7300	External Absolute Encoder Internal Error 3	■ Encoder internal error	DB	Note 4)
	B4	Bit0	0x7300	External Absolute Encoder Internal Error 4	■ Encoder internal error	DB	Note 4)
	B5	Bit0	0x7300	External Absolute Encoder Internal Error 5	■ Encoder internal error	DB	Note 4)
	B6	Bit0	0x7300	External Absolute Encoder Internal Error 6	■ Encoder internal error	DB	Note 4)
	B7	Bit0	0x7300	External Absolute Encoder Internal Error 7	■ Encoder internal error	DB	Note 4)
	B8	Bit0	0x7300	External Absolute Encoder Internal Error 8	■ Encoder internal error	DB	Note 4)
	B9	Bit0	0x7300	External Absolute Encoder Internal Error 9	■ Encoder internal error	DB	Note 4)
	BA	Bit0	0x7300	External Absolute Encoder Internal Error 10	■ Encoder internal error	DB	Note 4)
	BB	Bit0	0x7300	External Absolute Encoder Internal Error 11	■ Encoder internal error	DB	Note 4)
	BC	Bit0	0x7300	External Absolute Encoder Internal Error 12	■ Encoder internal error	DB	Note 4)
	BD	Bit0	0x7300	External Absolute Encoder Internal Error 13	■ Encoder internal error	DB	Note 4)
	BE	Bit0	0x7300	External Absolute Encoder Internal Error 14	■ Encoder internal error	DB	Note 4)
	BF	Bit0	0x7300	External Absolute Encoder Internal Error 15	■ Encoder internal error	DB	Note 4)

Maintenance

8

8. Maintenance

Alarm code 0x2101 0x2102	Error register 0x1001	Error code 0x603F	Alarm name	Alarm contents	Detection Operations	Alarm reset
C1	Bit0	0x8400	Over-speed	■ Motor rotation speed reaches 120 % of the highest speed limit.	DB	Yes
C2	Bit0	0x8400	Velocity Control Error	■ Torque command and acceleration direction are not matching.	DB	Yes
C3	Bit0	0x7122	Velocity Feedback Error	■ Servo motor power disconnection Note 5)	DB	Yes
C5	Bit0	0x8500	Model tracking vibration suppression control error	■ Operation pattern is not match with model tracking vibration suppression control.	DB	Yes
D1	Bit0	0x8611	Excessive Position Deviation	■ Position Deviation exceeds setup value.	DB	Yes
D2	Bit0	0x8500	Position Command Error 1	■ Frequency of entered position command pulse is excessive	SB	Yes
D3	Bit0	0x8500	Position Command Error 2	■ Position command frequency after electronic gear is high.	SB	Yes
D4	Bit0	0x8611	Axes-sync error excess	■ Position deviation error between own axis and counterpart axis exceeds setting value.	DB	Yes
D5	Bit0	0x8611	Dual position error excess	■ The difference of servo motor position and load position exceeds the setting value.	DB	Yes
D6	Bit0	0x8500	Dual position error feedback error	■ The motor encoder frequency after feedback electronic gear is too high.	DB	Yes
D7	Bit4	0x7500	Amplifier communication error	■ Amplifier communication error during axes-sync operation	DB	No
D8	Bit4	0x8611	Excessive position deviation difference	■ Position Deviation difference exceeds setup value.	DB	Yes
DE	Bit0	0xFF01	Parameter Change Completion	■ Motor/encoder code parameter change is completed.	—	No
DF	Bit0	0xFF00	Test Run Close Note6)	■ Detection in 'Test mode end' status	DB	Yes
E1	Bit7	0x5530	Memory Error 1	■ Abnormality of amplifier with built-in EEPROM	DB	No
E2	Bit7	0x6310	Memory Error 2	■ Error in check sum of EEPROM (entire area)	—	No
E3	Bit7	0x5510	CPU error 1	■ Access error in CPU built in RAM	—	No
E4	Bit7	—	CPU error 2	■ Checksum error of FLASH memory with built in CPU	—	No
E5	Bit7	0x6320	System Parameter Error 1	■ System parameter is outside a setting range.	—	No
E6	Bit7	0x6320	System Parameter Error 2	■ The combination of a system parameter is abnormal.	—	No
E7	Bit7	0x6320	Motor Parameter Error	■ Setup of a motor parameter is abnormal.	—	No
E8	Bit7	0x5220	Control circuit error 1	■ Access abnormality in CPU to ASIC	—	No
E9	Bit7	0x5220	Control circuit error 2	■ Abnormalities of control circuit.	—	No
EA	Bit7	0x6320	Memory Error 3	■ Abnormality of FLASH memory in servo amplifier.	SB	No
EB	Bit7	0x6320	Control circuit error 3	■ Abnormalities of control circuit.	—	No
EE	Bit7	0x6320	Motor Parameter Automatic Setting Error 1	■ Motor parameter automatic setting function cannot be performed.	—	No
EF	Bit7	0x6320	Motor Parameter Automatic Setting Error 2	■ The result of motor parameter automatic setting is abnormal.	—	No
F1	Bit7	0x8700	Task Process Error	■ Error in interruption process of CPU	DB	No
F2	Bit7	0x6010	Initial Process Time-Out	■ Initial process does not end within initial process time	—	No
F3	Bit7	0x6320	CPU error 3	■ Abnormality of CPU setting	—	No

Control system abnormality (C1–DF)
Control system/Memory system abnormality (E1–F3)

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) Control power supply under-voltage or servo ready OFF is detected during instantaneous break of 1.5 to 2 cycles. Detection of control power supply under-voltage and servo ready OFF can be delayed by setting larger value of Index 0x2027-0 "Power Failure Detection Delay Time [PFDDLY]".

Note 3) 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 4) 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 5) 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 6) Alarm that occurs in 'Test mode end' status is not recorded in the alarm history.

Note 7) 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 8) For the servo amplifier 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.

Note 9) For RS3D80#, alarm occurs when either of power unit and amplifier unit gets into overheat state of unit internal module.

Maintenance 8

8. Maintenance

8.3 Trouble shooting when alarm activated

8.3.1 Alarm display

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

Display	Description
A L . 8 5 ✳	Take appropriate action based on "8.3.2 Corrective action for alarm".

Servo amplifier status code

Alarm code

■ 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	

8.3.2 Corrective action for alarm

■ Alarm code 10 (IN Rx invalid frame error)
    ● Invalid frame received continuously in port 0
■ Alarm code 11 (OUT Rx invalid frame error)
    ● Invalid frame received continuously in port 1
■ Alarm code 12 (IN Rx CRC error)
    ● Rx error occurred continuously in port 0
■ Alarm code 13 (OUT Rx CRC error)
    ● Rx error occurred continuously in port 1
■ Alarm code 14 (IN Tx error)
    ● Tx error occurred continuously in port 0
■ Alarm code 15 (OUT Tx error)
    ● Tx error occurred continuously in port 1

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 communication cable.	■ Confirm contact failure of communication cable wiring.
2	■ Malfunction due to noise.	■ Confirm proper grounding of the amplifier. ■ Check the shielding of the encoder cable. ■ Add ferrite core or similar countermeasures to against noise.
3	■ Defect in internal circuit of servo amplifier.	■ Replace the servo amplifier.

■ Alarm code 18 (IN lost link)
■ Alarm code 19 (OUT lost link)
    ● Port 0/1 cable was broken or disconnected.
     Power supply was shut down.
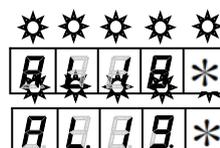
Status at the time of alarm	Cause	
	1	2
Cable was unplugged.	✔	
Issued during operation.		✔

◆ Corrective actions

	Cause	Investigation and corrective actions
1	■ Cable was unplugged while motor operation.	■ Plug/unplug of cable shall be performed during servo OFF or under Pre-OP state.
2	■ Communication cable disconnection. ■ Contact failure between connector and terminal.	■ Check the wiring conditions between motor encoder/servo amplifier, and correct it if improper.

Maintenance

∞

8. Maintenance

■ Alarm code 1A (Communication timeout)
- ● Output data was unreceived during prescript cycle time.

✿ ✿ ✿ ✿ ✿
`AL.1A *`

Status at the time of alarm	Cause	
	1	2
Issued in Safe-OP or OP state.	✔	
Issued during operation.	✔	✔

◆ Corrective actions

	Cause	Investigation and corrective actions
1	■ Command was unreceived during prescript set time of communication timeout. (SM2 event: PDO output data cannot received.)	■ Review whether output data is issued with communication timing of controller, or not.
2	■ Malfunction due to noise.	■ Confirm proper grounding of the amplifier. ■ Check the shielding of the encoder cable. ■ Add ferrite core or similar countermeasures to against noise.

■ Alarm code 21 (Main Circuit Power Device Error)
- ● Over current of drive module
- ● Abnormality in drive power supply
- ● Overheating of drive module

✿ ✿ ✿ ✿ ✿
`AL.21 *`

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 U/V/W-phases of amplifier, or wiring between amplifier and motor. Otherwise, U/V/W-phases are grounded to the earth.	■ Check the wiring conditions and correct it if improper.
2	■ Short circuit or earth fault in U/V/W phases on servo motor side.	■ Replace the servo motor.
3	■ Defect in internal circuit of servo amplifier.	■ Replace the servo amplifier.
4	■ Overheating detection of the main circuit power device functioned. (50A or more of models only)	■ Confirm temperature in cabinet (or ambient of the amplifier), then refine installation method of the servo amplifier and ventilation of the cabinet.

■ Alarm code 22 (Current Detection Error 0)
  ● Abnormality of electric current detection value

☼ ☼ ☼ ☼ ☼
A L. 2 2. ✳

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 servo amplifier.	■ Replace the servo amplifier.
2	■ Servo amplifier 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

☼ ☼ ☼ ☼ ☼
A L. 2 3. ✳

☼ ☼ ☼ ☼ ☼
A L. 2 4. ✳

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 servo amplifier.	■ Replace the servo amplifier.
2	■ Malfunction due to noise.	■ Confirm proper grounding of the amplifier. ■ Add ferrite core or similar countermeasures to against noise.

■ Alarm code 25 (Safe Torque Off error 1)
  ● Logic unmatched in safe torque off input

☼ ☼ ☼ ☼ ☼
A L. 2 5. ✳

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. ■ Check the wiring of both the HWGOFF1 and /HWGOFF2 signals, and correct the wiring if needed. ■ 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 servo amplifier.	■ Replace the servo amplifier.

Maintenance

8. Maintenance

■ Alarm code 26 (Safe Torque Off error 2)
  ● Failure of safe torque off circuit

☼ ☼ ☼ ☼ ☼
AL.26✳

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 servo amplifier.	■ Replace the servo amplifier.
2	■ Malfunction due to noise.	■ Check grounding of the amplifier. ■ Take care of noise by adding ferrite core etc.

■ Alarm code 27 (Fan stop)
  ● Speed reduction of fan

☼ ☼ ☼ ☼ ☼
AL.27✳

Status at the time of alarm	Cause	
	1	2
Occurred during the operation.	✔	✔

◆ Corrective actions

	Cause	Investigation and corrective actions
1	■ Defect in internal circuit of servo amplifier.	■ Replace the servo amplifier.
2	■ The end of fan life.	■ Replace the cooling fan.

8.3 Trouble shooting when alarm activated

■ Alarm code 41 (Overload 1)
   ● Excessive effective torque

✵ ✵ ✵ ✵ ✵
`A L. 4 1 ✳`

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 servo amplifier.	■ Replace the servo amplifier.
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 Index 0x2108 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 servo amplifier 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 servo amplifier 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 servo amplifier / 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 Index 0x20FF-1 "Encoder resolution code".

*   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.

Maintenance ∞

8. Maintenance

■ Alarm code 42 (Overload 2)
  ● Stall over load

☼ ☼ ☼ ☼ ☼
`A L. 4 2. *`

Status at the time of alarm	Cause										
	1	2	3	4	5	6	7	8	9	10	11
Issued at input of servo ON.	✔	✔							✔		
After command input, issued without rotating the servo motor.		✔			✔	✔	✔		✔	✔	✔
After command input, brief motor rotation.			✔	✔	✔		✔	✔			

◆ Corrective actions

	Cause	Investigation and corrective actions
1	■ Defect in internal circuit of servo amplifier.	■ Replace the servo amplifier.
2	■ Defect in internal circuit of motor encoder.	■ Replace the servo motor.
3	■ Rotation is less than 50min^{-1} and torque command exceeds approx. 2 times of rated torque.	■ Check if torque command exceeds approx. 2 times of the rated torque by the Index 0x2107-0 "Torque command monitor [TCMON]". If any of the conditions (load condition when motor stops, operation condition at low velocity, and static load condition) exceed twice of rated torque, review an operation or load condition. Or replace with larger sized servo motor.
4	■ Defect in servo motor and servo amplifier 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 servo amplifier 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 servo amplifier / 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 Index 0x20FF-1 "Encoder resolution code [ENCODE]".
10	■ Rotation directions of 2 axes are different, in the tandem operation.	■ Change to "1: With Polarity Reversal" in the Index 0x2035-6 [SDEVPOR].
11	■ Wiring of servo motor and encoder is wrong, in the tandem operation.	■ Check the wiring and fix if wrong.

8.3 Trouble shooting when alarm activated

■ Alarm code 43 (Regenerative Overload)
  ● Regeneration load ratio exorbitance

☼ ☼ ☼ ☼ ☼
| A | L | 4 | 3 | ✳ |

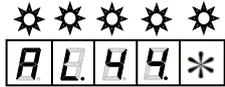| Status at the time of alarm	Cause							
	1	2	3	4	5	6	7	8
Issued when control power supply is turned ON.							✔	
Issued when main circuit power supply is turned ON.		✔	✔	✔		✔	✔	✔
Issued during operation.	✔			✔	✔		✔	

◆ Corrective actions

	Cause	Investigation and corrective actions
1	■ Exceeds a permitted value of the regenerative power at built-in regenerative resistance model. ■ Excessive load inertia moment, or tact time is short.	■ Check the load and operating conditions. ■ Change to external regenerative resistor. ■ Set to be the load inertia moment within the specified range. ■ Increase the deceleration time. ■ Increase the tact time.
2	■ Regenerative resistor is connected to the model without regenerative resistor.	■ Remove regenerative resistor.
3	■ Resistor wiring is wrong at built-in or external regenerative resistor model.	■ Check the wiring conditions and correct it if improper.
4	■ Regenerative resistor wire breaks.	■ For built-in regeneration resistor specifications, replace the servo amplifier. ■ For external regeneration resistor specifications, replace the regeneration resistor.
5	■ Resistance value of external regenerative resistor is excessive.	■ Replace to the resister that matching the specifications.
6	■ Input power supply voltage exceeds the specified range.	■ Check the input power supply voltage level.
7	■ Defect in internal circuit of servo amplifier.	■ Replace the servo amplifier.
8	■ External regenerative resistor does not connect although "0x02: External_R" is set in the Index 0x20FD-2 "Regenerative resistor selection".	■ Connect external regenerative resistor. ■ Set "0x00: Not_connect" in the Index 0x20FD-2 "Regenerative resistor selection".

* If the setting of Index 0x20FD-2 "Regenerative Resistor Selection" is incorrect, regeneration overload is not detected properly, and the amplifier and surrounding circuit may be damaged or burnt.

Maintenance

∞

8. Maintenance

■   Alarm code 44 (Magnetic pole position estimation error)
   ● Magnetic pole position estimation operation failed.

☼ ☼ ☼ ☼ ☼
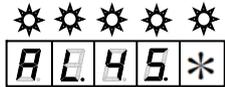`A` `L.` `4` `4` `✳`

Status at the time of alarm	Cause							
	1	2	3	4	5	6	7	8
Issued when control power supply is turned ON.				✔				
Issued during magnetic pole position detection.	✔	✔	✔		✔	✔	✔	✔

◆   Corrective actions

	Cause	Investigation and corrective actions
1	■ Magnetic pole position detecting frequency is same as mechanical resonance. ■ Motor reaches to end of stroke.	■ Changing the Index 0x20F1-8 "Excitation command frequency setting value". ■ Keep distance to end of stroke.
2	■ Load mass is too large.	■ Sizing a linear motor, again.
3	■ Force limitation command is too small.	■ Increase a set value of the Index 0x20E0 "Forward Direction Force Limit Value", Index 0x20E1 "Reverse Direction Force Limit Value".
4	■ Defect in internal circuit of servo amplifier.	■ Replace the servo amplifier.
5	■ Wiring of U/V/W-phase between servo amplifier and linear motor is wrong.	■ Check the wiring conditions and correct it if improper.
6	■ Wiring of A/B-phase of linear encoder is wrong.	■ Check the wiring conditions and correct it if improper.
7	■ Linear encoder resolution setting is wrong.	■ Set correct value to the Index 0x20FF-1 "Encoder resolution code [ENCODE]".
8	■ Operation direction of linear encoder is wrong.	■ Set the Index 0x20F1-7 "Linear Encoder Polarity Selection" correctly.

■   Alarm code 45 (Average continuous over speed)
   ● Over speed in average rotational speed

☼ ☼ ☼ ☼ ☼
`A` `L.` `4` `5` `✳`

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. ■ 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

☼ ☼ ☼ ☼ ☼
`AL.52.*`

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 servo amplifier.	■ Replace the servo amplifier.
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 amplifier), then refine installation method of the servo amplifier and ventilation of the cabinet.

■ Alarm Code 53 (Dynamic Brake Resistor Overheat)
   ● Overheating detection of dynamic brake resistor

☼ ☼ ☼ ☼ ☼
`AL.53.*`

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 CN8 or TH1-1/TH1-2, for dynamic brake thermostat wiring.	■ For RS3W60#, Wire to CN8. ■ For RS3C30#, 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 or fan motor thermostat is connected to CN8 or TH1-1/TH1-2.

* Amplifier unit does not include dynamic brake resistor.

Maintenance ⑧

8. Maintenance

■ Alarm Code 54 (Built-in Regenerative Resistance Overheat)
  ● Overheating detection of internal regenerative resistor

Status at the time of alarm	Cause		
	1	2	3
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	■ Regenerative power excessive.	■ Check the built-in regenerative resistor allowable power. ■ Check the operating conditions to keep that consumption power is below of allowable power. ■ Use an external regenerative resistor.
3	■ Resistor wiring is wrong at built-in regenerative resistor model.	■ Check the wiring conditions and correct it if improper.

* When using a regenerative resistor built in the servo amplifier, make sure to set "0x01: Built-in_R" at the Index 0x20FD-2 "Regenerative Resistor Selection". This setting decides enabled/disabled of the overheating protection detection treatment of the built-in regeneration resistance.

* Built-in regenerative resistance overheat does not detected when "0x02 External_R" is selected. Therefore, there is a danger that built-in regenerative resistance will burn out or be damaged.

8.3 Trouble shooting when alarm activated

■ 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.	✔	✔

☼ ☼ ☼ ☼ ☼
$A\ L.\ 5\ 5\ *$

◆ Corrective actions

	Cause	Investigation and corrective actions
1	■ Validity condition for external trip function is set to 'Valid'.	■ When not used, set "0x00:_Always_Disable" at the Index 0x20F8-3 "External Trip Input Function [EXT-E]".
2	■ Defect in internal circuit of servo amplifier.	■ Replace the servo amplifier.

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. ■ Increase the capacity of the external regeneration resistor.
3	■ Defect in internal circuit of servo amplifier.	■ Replace the servo amplifier.

* When output terminal of upper level device is connected, eliminate the alarm trigger of the host level device.

8. Maintenance

■ Alarm Code 56 (Servo Amplifier Temperature Error)
● Overheating detection of Drive module

☼ ☼ ☼ ☼ ☼
`A L. 5 6. *`

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	■ U/V/W-phase of amplifier is short circuited due to the wiring in amplifier and motor. Or, U/V/W-phases have earth fault.	■ Check the wiring conditions and correct it if improper.
2	■ Short circuit or earth fault of U/V/W phases, at servo motor side.	■ Replace the servo motor.
3	■ Defect in internal circuit of servo amplifier.	■ Replace the servo amplifier.
4	■ Ambient temperature is high.	■ Confirm temperature in cabinet (or ambient of the amplifier), then refine installation method of the servo amplifier and ventilation of the cabinet to keep 55℃ or lower of ambient temperature.

* This temperature is measured at the point very near to driving module.
It is different from measurement point of temperature monitor for R ADVANCED MODEL (at the point near to control IC of control board).

■ Alarm Code 61 (Over-Voltage)
● DC Excess voltage of main circuit

☼ ☼ ☼ ☼ ☼
`A L. 6 1. *`

Status at the time of alarm	Cause			
	1	2	3	4
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 servo amplifier.	■ Replace the servo amplifier.
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. ■ Built-in regenerative circuit is not functioning.	■ Wire the regenerative resistor correctly. ■ Check the wiring and resistance value if using the external regenerative resistor. ■ Replace the servo amplifier if any abnormality occurs after countermeasure above.

■ Alarm Code 62 (Main Circuit Under-voltage)
  ● DC Main circuit low voltage

☼ ☼ ☼ ☼ ☼
`A L. 6 2 ✳`

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 servo amplifier.
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 servo amplifier.	■ Replace the servo amplifier.

■ Alarm Code 63 (Main Power Supply phase loss)
  ● 1 phase of the 3 phase main circuit power supply disconnected

☼ ☼ ☼ ☼ ☼
`A L. 6 3 ✳`

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 servo amplifier.	■ Replace the servo amplifier.
3	■ Servo amplifier is not specified for single phase.	■ Change the Index 0x20FD-1 "Main circuit power input type [MPWRIN]" to "0x01： 1φAC ".

■ Alarm Code 68 (Main circuit voltage detection error)
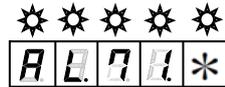 ● Failure of VBUS detection circuit

☼ ☼ ☼ ☼ ☼
`A L. 6 8. ✳`

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 servo amplifier.	■ Replace the servo amplifier.

Maintenance ∞

8. Maintenance

■ Alarm Code 71 (Control Power Supply Under-voltage)
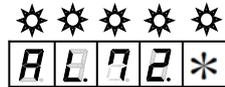 ● Control power supply low voltage

☼ ☼ ☼ ☼ ☼
A L. 7 1 ✳

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 servo amplifier.	■ Replace the servo amplifier.
2	■ Input power supply voltage is below the specified range.	■ Confirm that the power supply is set within the specified range.
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)
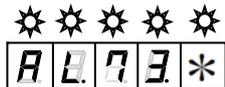 ● Under voltage of ±12V

☼ ☼ ☼ ☼ ☼
A L. 7 2 ✳

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 servo amplifier.	■ Replace the servo amplifier.
2	■ Defect in external circuit.	■ Restart the power supply after removing the connector: CN1. Check the external circuit if alarm is not issued.

■ Alarm Code 73 (Control Circuit voltage reduction 2)
  ● Under voltage of +5V

☼ ☼ ☼ ☼ ☼
A L. 7 3 ✳

Status at the time of alarm	Cause	
	1	2
Issued when control power is turned ON.	✔	✔

◆ Corrective actions

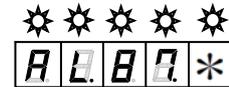|	Cause	Investigation and corrective actions
1	■ Defect in internal circuit of servo amplifier.	■ Replace the servo amplifier.
2	■ Defect in external circuit.	■ Restart the power supply after removing the connector: CN1. Check the external circuit if alarm is not issued. ■ Restart the power supply after replacing the servo motor; if alarm is not issued, there is defect in internal circuit of motor encoder. Replace the servo motor.

■ Alarm Code 81 (Encoder Connector 1 Disconnection)
  ● Incremental encoder (A, B, Z) signal line break
  ● Power supply break

☼ ☼ ☼ ☼ ☼
A L. 8 1. ✳
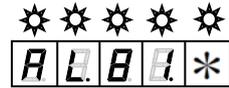
■ Alarm Code 87 (CS Signal Disconnection)
  ● CS signal line break

☼ ☼ ☼ ☼ ☼
A L. 8 7. ✳

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:
	  ◆ Improper wiring.
	  ◆ Connector is removed.
	  ◆ Loose connection.
	  ◆ Encoder cable is too long.
	  ◆ Encoder cable is too thin.
		■ Check the wiring conditions and correct it if improper.
		■ Confirm that the encoder power supply voltage at the motor side is above 4.75 V, correct it if improper.

2	■ Servo amplifier and motor encoder are not combined properly.	■ Replace with servo motor equipped with proper encoder.
3	■ Defect in internal circuit of servo amplifier.	■ Replace the servo amplifier.
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

☼ ☼ ☼ ☼ ☼
A L. 8 3. ✳

[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 Index 0x20F3-2 Position Loop-controlling Encoder Selection [PLMODE] to "0x00:Motor_Enc".
2	■ EN2 is selected as encoder connector. (In case of that the 8th digit of servo amplifier model number (encoder type) is "2".)	■ Change the Index 0x20FF-8 Motor Encoder Input Selection [MOTESEL] to "0x00:EN1".

Maintenance ∞

8. Maintenance

[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: 　◆　Improper wiring. 　◆　Connector is removed. 　◆　Loose connection. 　◆　Encoder cable is too long. 　◆　Encoder cable is too thin.	■ Check the wiring conditions and correct it if improper. ■ Confirm that the encoder power supply voltage at the motor side is above 4.75 V, correct it if improper.
2	■ Servo amplifier and motor encoder are not combined properly.	■ Replace with servo motor equipped with proper encoder.
3	■ Defect in internal circuit of servo amplifier.	■ Replace the servo amplifier.
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, 　◆　Improper wiring. 　◆　Connector is removed. 　◆　Loose connection. 　◆　Encoder cable is too long. 　◆　Encoder cable is too thin.	■ Check the wiring conditions and correct it if improper. ■ 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 servo amplifier.	■ Replace the servo amplifier.
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

☼ ☼ ☼ ☼ ☼
`A L. 8 4 *`

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 amplifier. ■ Check the shielding of the encoder cable. ■ 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

☼ ☼ ☼ ☼ ☼
`A L. 8 5. *`

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: ◆ Improper wiring. ◆ Connector is removed. ◆ Loose connection. ◆ Encoder cable is too long. ◆ Encoder cable is too thin.	■ Check the wiring conditions and correct it if improper. ■ Confirm that the encoder power supply voltage at the motor side is above 4.75 V, and correct it if improper.
2	■ Servo amplifier and motor encoder are not combined properly.	■ Replace with servo motor equipped with proper encoder.
3	■ Defect in internal circuit of servo amplifier.	■ Replace the servo amplifier.
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.)

Maintenance 8

8-26

8. Maintenance

■ Alarm Code 86 (CS error)
  ● Position jumping on CS data

☆ ☆ ☆ ☆ ☆
| A | L. | 8 6. | ✳ |
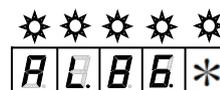
Status at the time of alarm	Cause 1
Issued during motor operation.	✔

◆ Corrective actions

	Cause	Investigation and corrective actions
1	■ Malfunction due to noise, concerned to linear encoder wiring.	■ Confirm proper grounding of the amplifier. ■ Check the shielding of the encoder cable. ■ Add ferrite core or similar countermeasures to against noise.

8.3 Trouble shooting when alarm activated

■ 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 amplifier. ■ Check the shielding of the encoder cable. ■ 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: 　◆ Improper wiring. 　◆ Connector is removed. 　◆ Loose connection. 　◆ Encoder cable is too long. 　◆ Encoder cable is too thin.	■ Check the wiring conditions and correct it if improper. ■ 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 servo amplifier.	■ Replace the servo amplifier.
4	■ Defect in internal circuit of external encoder.	■ Replace the external encoder.

Maintenance ∞

8. Maintenance

■ Alarm Code 8C (Motor encoder (EnDat) combination error)
   ● Motor encoder (EnDat) is out of applicable range.
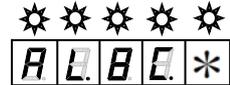
☼ ☼ ☼ ☼ ☼
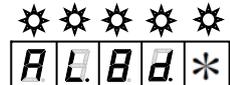`A L. 8 C. ✳`

Status at the time of alarm	Cause 1
Issued when control power is turned ON.	✔

◆ Corrective actions

	Cause	Investigation and corrective actions
1	■ Combination linear encoder is not apply to servo amplifier.	■ Replace to recommendation linear encoder. (See "2.4 Linear encoder".)

■ Alarm Code 8D (External encoder (EnDat) combination error)
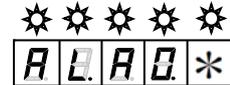   ● External encoder (EnDat) is out of applicable range.

☼ ☼ ☼ ☼ ☼
`A L. 8 d. ✳`

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 servo amplifier.	■ Replace to our recommended encoder. (Refer the section 9.1.3)

■ Alarm Code A0 (Absolute Encoder Internal Error 0)
   ● Encoder failure

☼ ☼ ☼ ☼ ☼
`A L. A 0. ✳`

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 amplifier. ■ Check the shielding of the encoder cable. ■ Add ferrite core or similar countermeasures to against noise.

8.3 Trouble shooting when alarm activated

■ Alarm Code A1 (Absolute Encoder Internal Error 1)
 ● Encoder internal error
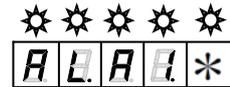
☼ ☼ ☼ ☼ ☼
`A L. A 1. ✳`

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)
  ● Encoder internal error

☼ ☼ ☼ ☼ ☼
`A L. A 2. ✳`
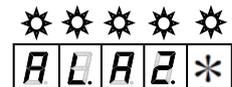
Status at the time of alarm	Cause		
	1	2	3
Issued while stopping the servo motor.	✔	✔	
Issued while rotating the servo motor.	✔	✔	✔

◆ 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 amplifier. ■ Check the shielding of the encoder cable. ■ 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".

Maintenance 8

8. Maintenance

■ Alarm Code A3 (Absolute Encoder Internal Error 3)
　　● Encoder internal error

☆ ☆ ☆ ☆ ☆
| A | L. | A | 3. | ✶ |

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 amplifier. ■ Check the shielding of the encoder cable. ■ 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".

8.3 Trouble shooting when alarm activated

■ Alarm Code A4 to A6 (Absolute Encoder Internal Error 4 to 6)
  ● Encoder internal error
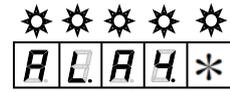
■ Alarm Code AA, AC, AD, AF (Absolute Encoder Internal Error 10, 12, 13, 15)
  ● Encoder internal error

Status at the time of alarm	Cause	
	1	2
Issued when control power is turned ON.	✔	
Issued during operation.	✔	✔

◆ Corrective actions

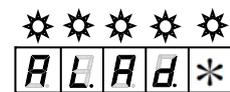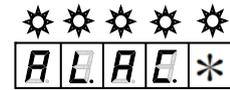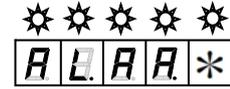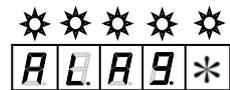|	Cause	Investigation and corrective actions
1	■ Defect in internal circuit of motor encoder.	■ Turn ON the power supplies again, if not corrected, replace the servo motor.
2	■ Malfunction due to noise	■ Confirm proper grounding of the amplifier. ■ Check the shielding of the encoder cable. ■ Add ferrite 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. Maintenance

■　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.	✔	✔

☆ ☆ ☆ ☆ ☆
| A | L. | b | 0. | ✳ |

☆ ☆ ☆ ☆ ☆
| A | L. | b | F. | ✳ |

◆　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 of the amplifier. ■ Check the shielding of the encoder cable. ■ Add ferrite core or similar countermeasures to against noise.

8.3 Trouble shooting when alarm activated

■ Alarm Code C1 (Over-speed)
● Motor rotation speed reaches 120 % of the highest speed limit

☼ ☼ ☼ ☼ ☼
| A | L. | C | 1. | ✳ |
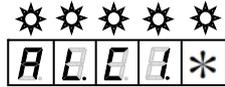
Status at the time of alarm	Cause				
	1	2	3	4	5
Issued when command is entered after Servo ON.	✔	✔			
Issued when the servo motor is started.			✔	✔	✔
Issued other than operating and starting the motor.		✔	✔		

◆ Corrective actions

	Cause	Investigation and corrective actions
1	■ Defect in internal circuit of servo amplifier.	■ Replace the servo amplifier.
2	■ Defect in internal circuit of motor encoder.	■ Replace the servo motor.
3	■ Excessive overshoot while starting.	■ Adjust the servo parameters. ■ Loose the slope of acceleration / deceleration command. ■ Reduce the load inertia moment, or change motor capacity.
4	■ Wiring of U/V/W –phase between servo amplifier 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

☼ ☼ ☼ ☼ ☼
| A | L. | C | 2. | ✳ |
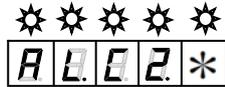
Status at the time of alarm	Cause			
	1	2	3	4
Issued while due to input of Servo ON.	✔		✔	
Issued when command has entered.	✔	✔	✔	
Issued while starting and stopping the servo motor.				✔

◆ Corrective actions

	Cause	Investigation and corrective actions
1	■ Wiring of U/V/W –phase between servo amplifier 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. ■ Loose the slope of acceleration / deceleration command. ■ Change the Index 0x20FF-2 "Velocity Control Alarm (ALM_C2) Detection [VCALM]" to "0x00: 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. Maintenance

■ Alarm Code C3 (Velocity Feedback Error)
   ● Servo motor power disconnection
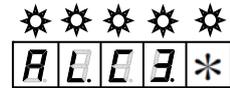
☼ ☼ ☼ ☼ ☼
| A | L. | C | 3. | ✳ |

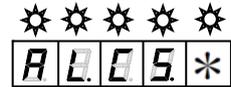| Status at the time of alarm	Cause		
	1	2	3
Issued when command has entered.	✔	✔	✔
Issued when control power is turned ON.		✔	

◆ 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. ■ Replace the servo motor.
2	■ Defect in internal circuit of servo amplifier.	■ Replace the servo amplifier.
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.

☼ ☼ ☼ ☼ ☼
| A | L. | C | 5 | ✳ |

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.

☼ ☼ ☼ ☼ ☼

```
A L. d 1 *
```

■ 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 servo amplifier 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. ■ Setting of a velocity limit command is too small. ■ Motor encoder pulse setting is not match with actual servo motor.	■ Enlarge a torque limit value, or disable a torque limitation. ■ Enlarge setting value of velocity limit command. ■ Sets a correct value to the Index 0x20FF-1 "Encoder resolution code [ENCODE]", 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 an excessive position deviation is too small.	■ Set a value larger of the Index 0x6065-0 "Deviation Counter Overflow Value".
10	■ Rotation directions of 2 axes are different, in the tandem operation.	■ Change to "1: With Polarity Reversal" in the Index 0x2035-6 [SDEVPOR].
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 servo amplifier.	■ Replace the servo amplifier.
13	■ Defect in internal circuit of motor encoder.	■ Replace the servo motor.
14	■ Power supply voltage is low.	■ Check the power supply voltage.

Maintenance

∞

8. Maintenance

■ Alarm Code D2 (Position Command Error 1)
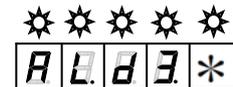 ● Frequency of entered position command pulse is excessive

☼ ☼ ☼ ☼ ☼
`A L. d 2. *`

Status at the time of alarm	Cause	
	1	2
Issued after entering position command.	✔	✔

◆ Corrective actions

	Cause	Investigation and corrective actions
1	■ Velocity conversion of position command exceeds a threshold of internal position command error. ■ CSP: Velocity conversion from previous/present position command exceeds a threshold of internal error. ■ PP: Velocity conversion from trajectory generated position exceeds a threshold of internal error.	■ Decrease a travel distance by command input.
2	■ Position command may not be received by CRC error occurring.	■ Add ferrite core or similar countermeasures to against noise.

■ Alarm Code D3 (Position Command Error 2)
 ● Position command frequency after electronic gear is high.

☼ ☼ ☼ ☼ ☼
`A L. d 3. *`

Status at the time of alarm	Cause	
	1	2
Issued after entering position command.	✔	✔

◆ Corrective actions

	Cause	Investigation and corrective actions
1	■ Difference between previous/present position commands is so large.	■ Decrease a travel distance by command input.
2	■ Position command may not be received by CRC error occurring.	■ Add ferrite core or similar countermeasures to against noise.

■ Alarm Code D4 (Axes-sync5 error excess)
  ● Position deviation error between own axis and counterpart axis exceeds setting value

☼ ☼ ☼ ☼ ☼
`A L. d 4. *`
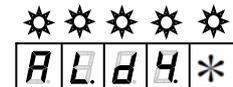
Status at the time of alarm	Cause				
	1	2	3	4	5
Issued immediately after entering the command.	✔	✔	✔	✔	✔
Issued during starting / stopping at high speed.	✔		✔	✔	✔

◆ 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 the Index 0x2035-4 "Axes Sync Excessive Error Value [PSDEVAL]".
4	■ Defect in internal circuit of servo amplifier.	■ Replace the servo amplifier.
5	■ Defect in internal circuit of motor encoder.	■ Replace the servo motor.

8.3 Trouble shooting when alarm activated

■ Alarm Code D5 (Dual position error excess)
   ● The difference of servo motor position and load position exceeds the setting value
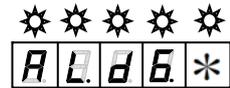
Status at the time of alarm	Cause									
	1	2	3	4	5	6	7	8	9	10
Issued immediately after entering the command.	✔		✔	✔	✔		✔	✔	✔	✔
Issued during starting / stopping at high speed.	✔	✔					✔	✔	✔	✔
Issued during the operations by lengthy command.						✔				

◆ 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 "9.1.5.6 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 is mismatched.	■ Review the Index 20FF-3 "External encoder resolution", 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. ■ Set the Index 0x20F1-4 "External Encoder Polarity Selection [EX-ENPOL]", 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 the Index 0x206C-2 "Dual position error excess value [DFOFLV]".
7	■ Setting value of Dual position error excess error is too small.	■ Larger the setting of the Index 0x206C-2 "Dual position error excess value [DFOFLV]".
8	■ Defect in internal circuit of servo amplifier.	■ Replace the servo amplifier.
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. Maintenance

■ Alarm Code D6 (Dual position error feedback error)
   ● The motor encoder frequency after feedback electronic gear is too high
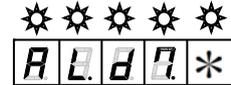
☼ ☼ ☼ ☼ ☼
$AL.d6.*$

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

☼ ☼ ☼ ☼ ☼
$AL.d7.*$

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
	   ◆ wrong wiring
	   ◆ connector is unplugged
	   ◆ connector has contact failure
	   ◆ cable is too long
		■ Check the wiring and fix if wrong.

2	■ With tandem operation Tandem operation is not set to the parameter of counterpart axis.	■ Change to "0x01: Tandem" in counterpart axis Index 0x2035-A "Amplifier communication function [AMPIF]".
3	■ Without tandem operation Tandem operation is set to the parameter of own axis.	■ Change to "0x00: Disabled" in own axis Index 0x2035-A "Amplifier communication function [AMPIF]".
4	■ Defect in internal circuit of servo amplifier.	■ Replace the servo amplifier.
5	■ Malfunction due to noise.	■ Confirm proper grounding of the amplifier. ■ Add ferrite core or similar countermeasures to against noise.

8.3 Trouble shooting when alarm activated

■ Alarm Code D8 (Excessive position deviation difference)
● Position Deviation difference exceeds setup value

☼ ☼ ☼ ☼ ☼
`AL.d8.*`

Status at the time of alarm	Cause															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
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	■ The Model following control mode or the Model following vibration suppression control mode is used, and Excessive position deviation difference value is not zero.	■ Use the standard position control mode, or set zero to Index 0x2052-2 "Excessive position deviation difference value".
2	■ Position command frequency is too high.	■ Correct the position command of the controller.
3	■ Excessive load inertia moment or low motor capacity.	■ Correct the load condition or increase the motor capacity.
4	■ 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.
5	■ Application collided to something or locked mechanically.	■ Refine application system.
6	■ One or all phases of U/V/W -phase of the servo amplifier and motor has disconnected.	■ Check the wiring conditions and correct it if improper.
7	■ Encoder wiring is disconnected or wrong.	■ Check the wiring conditions and correct it if improper.
8	■ Motor is being rotated by an external force (Gravity, etc.) during stopping (positioning completion).	■ Check the load, or increase the servo motor capacity.
9	■ Valid torque limit command is entered by the controller, and its setting is too small. ■ Setting of a velocity limit command is too small. ■ Motor encoder pulse setting is not match with actual servo motor.	■ Enlarge a torque limit value, or disable a torque limitation. ■ Enlarge setting value of velocity limit command. ■ Sets a correct value to Index 0x20FF-1 "Encoder resolution code", for matching with servo motor encoder.
10	■ Settings of servo parameters (Position Loop Gain, etc.) are not appropriate.	■ Adjust the servo parameter settings (Raise the position loop gain, etc.).
11	■ Set parameters of excessive position deviation difference (Excessive position deviation difference value, Low-pass filter of excessive position deviation difference detection, Continuing time of excessive position deviation difference detection) are not appropriate.	■ Enlarge a setting value of Index 0x2052-2 "Excessive position deviation difference value". ■ Adjust a setting value of Index 0x2052-3 "Low-pass filter of excessive position deviation difference detection". ■ Enlarge a setting value of Index 0x2052-4 "Continuing time of excessive position deviation difference detection".
12	■ Rotation directions of 2 axes are different, in the tandem operation.	■ Sets "04：PC-_VC+_TC+" to Group8 ID00. Sets "01：Reversed" to Group8 ID80.
13	■ Wiring of servo motor and encoder is wrong, in the tandem operation.	■ Check the wiring and fix if wrong.
14	■ Defect in internal circuit of servo amplifier.	■ Replace the servo amplifier.
15	■ Defect in internal circuit of motor encoder.	■ Replace the servo motor.
16	■ Power supply voltage is low.	■ Check the power supply voltage.

Maintenance ∞

8. Maintenance

■   Alarm Code DE (Parameter Change Completion)
   ● Motor/encoder code parameter change is completed

```
☼ ☼ ☼ ☼ ☼
A L. d E. *
```

Status at the time of alarm	Cause 1
Issued after setting of initial process (0x20FE, 0x20FF).	✔
Issued at system parameter change.	✔
Issued at parameter downloading completion.	✔

◆   Corrective actions

	Cause	Investigation and corrective actions
1	■ Normal operation caused by the alarm detecting change of motor code/ encoder code/ system parameter. (Set value becomes valid after control power cycle, so issuing alarm.)	■ Shutdown control power, and startup servo amplifier again.

■   Alarm Code DF (Test mode has closed)
       ● Detection in 'Test mode end' status

```
☼ ☼ ☼ ☼ ☼
A L. d F. *
```
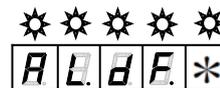
Status at the time of alarm	Cause 1
Occurred after execution of test mode.	✔

◆   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.)

8.3 Trouble shooting when alarm activated

■ Alarm Code E1 (Memory Error 1)
   ● Abnormality of amplifier with built-in EEPROM

☼ ☼ ☼ ☼ ☼
`A L. E 1 *`

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 servo amplifier.	■ Replace the servo amplifier.

■ Alarm Code E2 (Memory Error 2)
   ● Error in check sum of EEPROM (entire area)

☼ ☼ ☼ ☼ ☼
`A L. E 2. *`

Status at the time of alarm	Cause		
	1	2	3
Issued when control power is turned ON.	✔	✔	
Issued when downloading parameters.			✔

◆ Corrective actions

	Cause	Investigation and corrective actions
1	■ Correct value did not read to CPU from EEPROM of servo amplifier.	■ Replace the servo amplifier.
2	■ Failed to write into the EEPROM during last power supply cutoff.	■ Replace the servo amplifier.
3	■ Parameter writing via FoE parameter downloading is failed.	■ Replace the servo amplifier. ■ Shutdown control power, and startup servo amplifier again.

8. Maintenance

■ Alarm Code E3 (CPU error 1)
- ● Access error in CPU built in RAM

■ 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
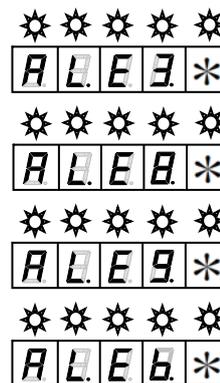
Status at the time of alarm	Cause 1
Issued when control power is turned ON.	✔

◆ Corrective actions

	Cause	Investigation and corrective actions
1	■ Defect in internal circuit of servo amplifier.	■ Replace the servo amplifier.

■ Alarm Code E4 (CPU error 2)
- ● Checksum error of FLASH memory with built in CPU

Status at the time of alarm	Cause	
	1	2
Issued when control power is turned ON.	✔	
Issued while self-programing.		✔

◆ Corrective actions

	Cause	Investigation and corrective actions
1	■ Defect in internal circuit of servo amplifier.	■ Replace the servo amplifier.
2	■ Self-programing failed.	■ Replace the servo amplifier.

8.3 Trouble shooting when alarm activated

■ Alarm Code E5 (System Parameter Error 1)
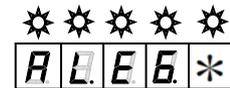   ● System parameter is outside a setting range.

☼ ☼ ☼ ☼ ☼
`AL.E5.*`
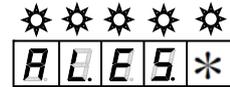
Status at the time of alarm	Cause		
	1	2	3
Issued when control power is turned ON.	✔	✔	
Issued at an operation transition.			✔

◆ Corrective actions

	Cause	Investigation and corrective actions
1	■ The data out of setting range was given to system parameter. ■ The scale of exceeding allowable range at internal coordinates has set.	■ Confirm the model number of the servo amplifier. 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 servo amplifier.	■ Replace the servo amplifier.
3	■ Communication cycle which is not able to use scale setting is set.	■ Confirm a communication cycle and scale setting, and then correct it.

■ Alarm Code E6 (System Parameter Error 2)
   ● The combination of a system parameter is abnormal.

☼ ☼ ☼ ☼ ☼
`AL.E6.*`

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. ■ Wrong combination of motor parameter and servo amplifier parameter. ■ Wrong combination between system parameters.	■ Confirm the model number of the servo amplifier. ■ Set a correct parameter applying to servo amplifier capacity. ■ 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 servo amplifier.	■ Replace the servo amplifier.

■ Alarm Code E7 (Motor Parameter Error)
   ● Setup of a motor parameter is abnormal.

☼ ☼ ☼ ☼ ☼
`AL.E7.*`

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 servo amplifier.	■ If alarm recurs by control power cycle after re-setting the motor parameter, replace servo amplifier.
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 servo amplifier.

Maintenance

8

8. Maintenance

■   Alarm Code EA (Memory Error 3)
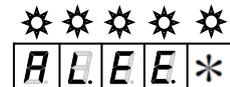   ● Abnormality of FLASH memory in servo amplifier.
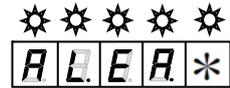
� � � � �
`A L. E A ✳`

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 servo amplifier.	■ Replace the servo amplifier.

■   Alarm Code EE (Motor Parameter Automatic Setting Error 1)
     ● Motor parameter automatic setting function cannot be performed.

✦ ✦ ✦ ✦ ✦
`A L. E E ✳`

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 servo amplifier.	■ Replace with the supported servo motor.
2	■ The connected encoder does not support a motor parameter automatic setting function.	■ Change the Index 0x20FE-1 "Motor Code [MOCODE]" to "0xFFFF". Then download a motor parameter from the setup software.
3	■ Defect in internal circuit of motor encoder.	■ Replace the servo motor.

■   Alarm Code EF (Motor Parameter Automatic Setting Error 2)
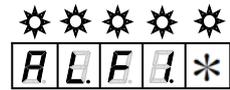   ● The result of motor parameter automatic setting is abnormal.

✦ ✦ ✦ ✦ ✦
`A L. E F ✳`

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 servo amplifier and servo motor is wrong.	■ Please correct combination by checking the model number of servo amplifier and servo motor.
2	■ The connected encoder does not support a motor parameter automatic setting function.	■ Change the Index 0x20FE-1 "Motor Code [MOCODE]" to "0xFFFF". Then download a motor parameter from the setup software.
3	■ Defect in internal circuit of motor encoder.	■ Replace the servo motor.

8.3 Trouble shooting when alarm activated

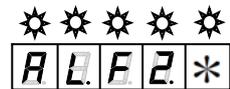■ Alarm Code F1 (Task Process Error)
　● Error in interruption process of CPU

☼ ☼ ☼ ☼ ☼
`A L. F I. *`

Status at the time of alarm	Cause 1
Issued during operation.	✔

　◆ Corrective actions

	Cause	Investigation and corrective actions
1	■ Defect in internal circuit of servo amplifier.	■ Replace the servo amplifier.

■ Alarm Code F2 (Initial Process Time-Out)
　● Initial process does not end within initial process time

☼ ☼ ☼ ☼ ☼
`A L. F 2. *`

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 servo amplifier. ■ Defect in communication ASIC.	■ Replace the servo amplifier.
2	■ Malfunction due to noise.	■ Confirm proper grounding of the amplifier. ■ Add ferrite core or similar countermeasures to against noise.
3	■ ESI file is something wrong.	■ Rewrite the ESI file.

■ Alarm Code F3 (CPU error 3)
　● Abnormality of CPU setting

☼ ☼ ☼ ☼ ☼
`A L. F 3. *`
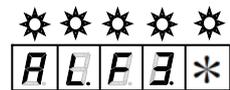
Status at the time of alarm	Cause 1
Issued after firmware updating.	✔

　◆ Corrective actions

	Cause	Investigation and corrective actions
1	■ CPU setting was wrong at firmware updating.	■ Correcting CPU setting of firmware updating tool.

Maintenance   8

8-46

8. Maintenance

Below shows alarm description for RS3D80#.

- ■ Alarm code 21 (Main Circuit Power Device Error)
  - ● Over current of drive module
  - ● Abnormality in drive power supply
  - ● Overheating of drive module

☼ ☼ ☼ ☼ ☼
$AL.21*$

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

- Dedicated to RS3D80# -

■ Alarm code 22 (Current Detection Error 0)
  ● Abnormality of electric current detection value

☆ ☆ ☆ ☆ ☆
`A L. 2 2. ✳`

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

☆ ☆ ☆ ☆ ☆
`A L. 2 3. ✳`

■ Alarm code 24 (Current Detection Error 2)
  ● Abnormality in communication with Electric current detection circuit

☆ ☆ ☆ ☆ ☆
`A L. 2 4. ✳`

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. ■ Add ferrite core or similar countermeasures to against noise.

■ Alarm code 25 (Safe Torque Off error 1)
  ● Logic unmatched in safe torque off input

☆ ☆ ☆ ☆ ☆
`A L. 2 5. ✳`

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. ■ Check the wiring of both the HWGOFF1 and /HWGOFF2 signals, and correct the wiring if needed. ■ 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.

Maintenance 8

8. Maintenance

- Dedicated to RS3D80# -

■ Alarm code 26 (Safe Torque Off error 2)
  ● Failure of safe torque off circuit

☼ ☼ ☼ ☼ ☼
`A L. 2 6. ✳`

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. ■ Take care of noise by adding ferrite core etc.

■ Alarm code 27 (Fan stop)
  ● Speed reduction of fan

☼ ☼ ☼ ☼ ☼
`A L. 2 7. ✳`

Status at the time of alarm	Cause	
	1	2
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.

- Dedicated to RS3D80# -

■ Alarm code 41 (Overload 1)
  ● Excessive effective torque

☼ ☼ ☼ ☼ ☼

| A | L. | 4 | 1 | * |

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.

Maintenance

8. Maintenance

- Dedicated to RS3D80# -

■　Alarm code 43 (Regenerative Overload)
●　Regeneration load ratio exorbitance

☼ ☼ ☼ ☼ ☼
| A | L. | 4 | 3 | ✳ |

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. ■ Excessive load inertia moment, or tact time is short.	■ Check the load and operating conditions. ■ Set to be the load inertia moment within the specified range. ■ Increase the deceleration time. ■ 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. ■ 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.

- Dedicated to RS3D80# -

■ Alarm code 45 (Average continuous over speed)
- ● Over speed in average rotational speed

☼ ☼ ☼ ☼ ☼
`R L. 4 5. ✳`

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. ■ Resize the servo motor.

■ Alarm Code 52 (In-rush prevention resistance Overheat)
- ● Detection of in-rush prevention resistance overheating

☼ ☼ ☼ ☼ ☼
`R L. 5 2. ✳`

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

☼ ☼ ☼ ☼ ☼
`R L. 5 3. ✳`

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 4.5.5.)
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.

Maintenance ∞

8. Maintenance

- Dedicated to RS3D80# -

■   Alarm Code 54 (Built-in Regenerative Resistor Overheat)
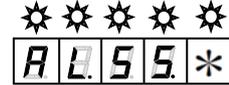
☀ ☀ ☀ ☀ ☀
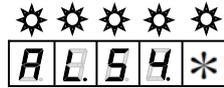
`A L. 5 4 ✳`

* This amplifier unit doesn't detect AL-54.

■   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.	✔	✔

☀ ☀ ☀ ☀ ☀

`A L. 5 5 ✳`

◆   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. ■ 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

- Dedicated to RS3D80# -

■　Alarm Code 56 (Servo Amplifier Temperature Error)
　　● Overheat of internal power module of power unit or amplifier unit

☼ ☼ ☼ ☼ ☼
| A | L. | 5. | 6. | ✳ |

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

☼ ☼ ☼ ☼ ☼
| A | L. | 6. | 1. | ✳ |

Status at the time of alarm	Cause			
	1	2	3	4
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. ■ Built-in regenerative circuit is not functioning.	■ Wire the regenerative resistor correctly. ■ Check the wiring and resistance value if using the external regenerative resistor. ■ Replace the power unit or amplifier unit if any abnormality occurs after countermeasure above.

Maintenance　⑧

8-54

8. Maintenance

- Dedicated to RS3D80# -

■ Alarm Code 62 (Main Circuit Under-voltage)
- ● DC Main circuit low voltage

✿ ✿ ✿ ✿ ✿
A L. 6 2. ✳

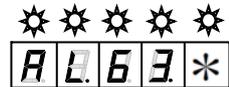| Status at the time of alarm	Cause				
	1	2	3	4	5
Issued when control power is turned ON.				✔	✔
Issued when main circuit power supply is turned ON.	✔	✔	✔		
Issued during operation.		✔	✔		

◆ 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

✿ ✿ ✿ ✿ ✿
A L. 6 3. ✳

Status at the time of alarm	Cause	
	1	2
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.

8.3 Trouble shooting when alarm activated

- Dedicated to RS3D80# -

■ Alarm Code 68 (Main circuit voltage detection error)
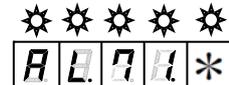   ● Failure of VBUS detection circuit
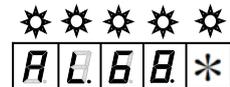
```
☼ ☼ ☼ ☼ ☼
A L. 6 8. ✳
```

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

```
☼ ☼ ☼ ☼ ☼
A L. 7 l ✳
```

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

```
☼ ☼ ☼ ☼ ☼
A L. 7 2. ✳
```

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 or amplifier unit.	■ Replace the power unit or amplifier unit.
2	■ Defect in external circuit. ■ Connection cable between power unit/amplifier unit has disconnection.	■ Restart the power supply after removing the connector: CN1. Check the external circuit if alarm is not issued. ■ Replace the connection cable between power unit/amplifier unit.

8. Maintenance

- Dedicated to RS3D80# -

■ Alarm Code 73 (Control Circuit voltage reduction 2)
  ● Under voltage of +5V

☀ ☀ ☀ ☀ ☀
| A | L. | 7 | 3 | ✳ |

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. ■ 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.

8.3.3 Correspondence table for EnDat Error message and alarm code

EnDat Error message		RS3 Servo Amplifier		
Bit		Alarm Code		Priority
		External	Linear	
0	Light Source	B0	A0	1
1	Signal amplitude	B1	A1	2
2	Position	B2	A2	3
3	Overvoltage	B3	A3	4
4	Undervoltage	B4	A4	5
5	Overcurrent	B5	A5	6
6	Battery	B6	A6	7
7		B7	A7	8
8		B8	A8	9
9		B9	A9	10
10	Currently not allocated Extension planned	B10	A10	11
11		B11	A11	12
12		B12	A12	13
13		B13	A13	14
14		B14	A14	15
15		B15	A15	16

*   "Error message" means Operation Status Word0 of EnDat.

*   "Alarm Code" means the alarm code output from servo amplifier against applicable Error Message.

*   "Priority" is given to alarm codes to be output when Error Messages are received simultaneously. Alarm Code output from servo amplifier is only one (which has higher priority) even if Error Messages are received multiple.

Maintenance   8

8. Maintenance

8.4 Encoder clear and alarm reset

Procedure of "encoder clear and alarm reset method" varies depending on motor encoder you use.
See table below and return to normal operation from alarm state. Please operate "alarm reset" after solving alarm cause.

Alarm reset method

Alarm code	Single-turn Absolute Encoder (Encoder code: H)	Battery Backup Absolute Encoder (Encoder code: P)	Battery-less Absolute Encoder (Encoder code: R)	Resolver Type Battery-less Absolute Encoder (Encoder code: W)
A1	—	· "Alarm reset" after "Encoder clear"	· "Alarm reset" after "Encoder clear" · "Power-cycle"	· "Alarm reset" after "Encoder clear" · "Power-cycle"
A2	—	—	—	· "Alarm reset" after "Encoder clear" · "Power-cycle"
A3	· "Alarm reset" after "Encoder clear" · "Power-cycle"	· "Alarm reset" after "Encoder clear" · "Power-cycle"	· "Alarm reset" after "Encoder clear" · "Power-cycle"	· "Alarm reset" after "Encoder clear" · "Power-cycle"
A4	· "Alarm reset" after "Encoder clear" · "Power-cycle"	· "Alarm reset" after "Encoder clear" · "Power-cycle"	· "Alarm reset" after "Encoder clear" · "Power-cycle"	· "Alarm reset" after "Encoder clear" · "Power-cycle"
A5	· "Power-cycle"	· "Power-cycle"	· "Alarm reset" after "Encoder clear" · "Power-cycle"	· "Alarm reset" after "Encoder clear" · "Power-cycle"
A6	· Power-cycle	· "Power-cycle"	· Perform "Power-cycle". Then perform "Alarm reset" after "Encoder clear".	· "Power-cycle"
A9	· "Alarm reset"	· "Power-cycle"	· "Alarm reset"	· "Alarm reset"
AA	—	—	· "Alarm reset" after "Encoder clear" · "Power-cycle"	· "Alarm reset" after "Encoder clear" · "Power-cycle"
AC	—	—	—	· "Power-cycle"
AD	—	—	—	· "Power-cycle"
AF	—	—	· "Alarm reset" after "Encoder clear" · "Power-cycle"	· "Power-cycle"

* Multi-turn part of encoder position data will be cleared when "encoder clear" is performed. Adjust the relations between position data and machine coordinate system, and then perform operation.

* Encoder clear is able to perform by the method below.
1) Absolute encoder clearing function in "Test operation" mode of the setup software. Refer another document M0010842 for how to operate the setup software.
2) Encoder Clear Function of servo amplifier
Encoder Clear Function is able to perform by the Index 0x6040 "Control Word". Encoder Clear is performed when "bit12 Encoder Clear Enable of the Control Word" is "1".
Refer chapter "4. Object Dictionary" in another Document M0011697 for sequence of encoder clearing.

8.5 Inspection

For maintenance purposes, a daily inspection is typically sufficient. 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		✔	cleanliness	Check for dirt and dust.	Clean with cloth or air. Note 1)
	Yearly		✔	Measure a insulation resistance	Contact dealer or sales office.	
	5000 hours Note 2)		✔	Replacement of oil seal		
Servo amplifier (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.
Battery for absolute encoder	Regularly Note 3)		✔	Battery voltage	Confirm that battery voltage is more than DC3.6V.	Replace the Battery.
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 (ER3V: 3.6V, 1000mAh) manufactured by Toshiba Lifestyle Products & Services Corporation is recommended.

Maintenance 8

8. Maintenance

8.6 Service parts

8.6.1 The parts requiring Inspection

Some parts have aging degradation.
Please request us an overhaul by referring to the periods below for preventive maintenance.

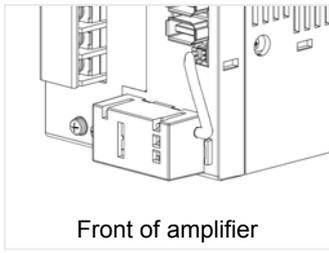| No.	Part name	Number of average replacement periods	Corrective measures / usage conditions
1	Aluminum electrolytic capacitor for smoothing main circuit	5 Years	Replacement with new part is necessary. Load ratio: 50% of rated output current of amplifier. Usage condition: Yearly average 40°C
2	Cooling Fan motor	5 Years	Replacement with new part is necessary. Usage condition: Yearly average 40°C
3	Lithium battery for absolute encoder [ER3VLY]	3 Years	Replacement with new part is necessary.
4	Aluminum electrolytic capacitor (other than capacitor for smoothing main circuit)	5 Years	Replacement with new part is necessary. Usage condition: Yearly average 40°C Annual total usage time is 4800 hours.
5	Fuse	10 Years	Replacement with new part is necessary.
6	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 servo amplifier/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 servo amplifier/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 servo amplifier is 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).

◆ RS3 series servo amplifier models RS3 02, RS3 03, RS3A05, RS3A07, RS3A10, RS3A15, RS3A30 and RS3C## have a built-in cooling fan; therefore be sure to maintain a space of 50mm on the upper and lower side of the amplifier for airflow. Installation in a narrow space may cause failure due to a static 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.

◆ RS3CPAC550 and RS3D80 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.

■ Lithium battery for absolute encoder

◆ The standard replacement period recommended by our company is the life expectancy of lithium battery based on normal usage conditions. However, if the motor is not used for a long period, the life of lithium battery is reduced. If the battery power is less than 3.6 V during inspection, replace it with new one.

Maintenance 8

8. Maintenance

8.6.2 Replacing battery for motor encoder

■　Battery box attached to the servo amplifier

Process	Description
1	Turn ON the servo amplifier control power supply.
2	Prepare the replacement lithium battery. [Our model number: AL-00879511-01]
3	Detach the battery connector from servo amplifier.
4	Detach the battery box from servo amplifier.
5	Open the battery box.
6	Take out the old lithium battery and insert prepared new one to the battery box.
7	Close the battery box.
8	Attach the battery box to the bottom of servo amplifier.
9	Attach the connector in the right direction.

	Battery case position	Process 3 and 9	Process 4 and 8
RS3□01 RS3□02 RS3□03 RS3A05 RS3A07	Bottom of amplifier		
RS3A10 RS3A15 RS3A30 RS3W60 RS3C##	Front of amplifier		
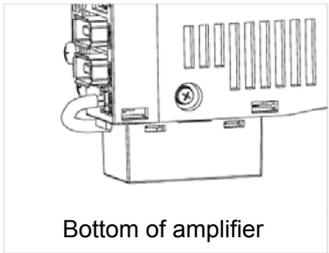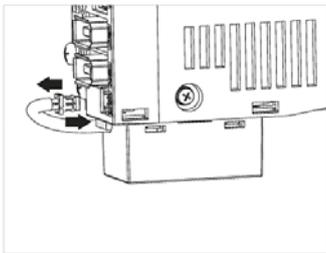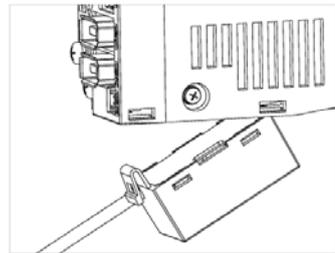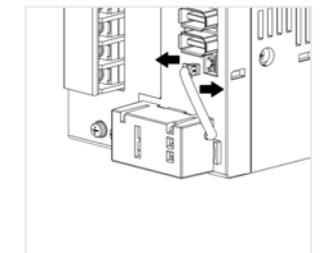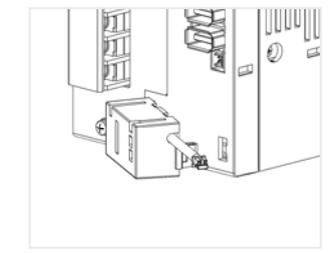
	Process 5 and 7	Process 6
Common		
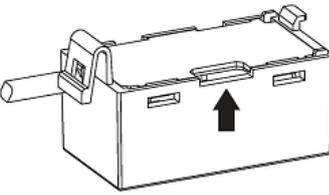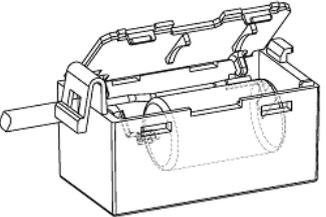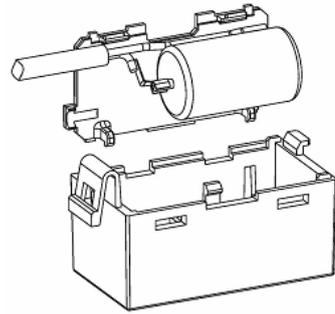
*　If the battery is replaced while the control power is OFF, multiple rotation counter (position data) of the motor encoder might be instable. When the amplifier control power is turned ON in this status, an alarm (AL_A1: Absolute Encoder Internal Error 1) might be issued. For this case, execute encoder clear and alarm reset to release the alarm status. Also, absolute encoder position data might be instable. So adjust the relations between a position data and a machine coordinate system to match, and then perform operation.

■ Battery unit attached to junction cable for motor encoder

Process	Description
1	Turn ON the servo amplifier control power supply.
2	Prepare the replacement lithium battery. [Our model number: AL-00697958-01]
3	Open the battery unit.
4	Detach the battery connector from the battery case.
5	Take out the old lithium battery and insert prepared new one to the battery case.
6	Attach the connector in the right direction.
7	Close the battery unit.

Lithium battery [AL-00697958-01]

Battery connector

Battery case

Maintenance 8

No Text on This Page.

9
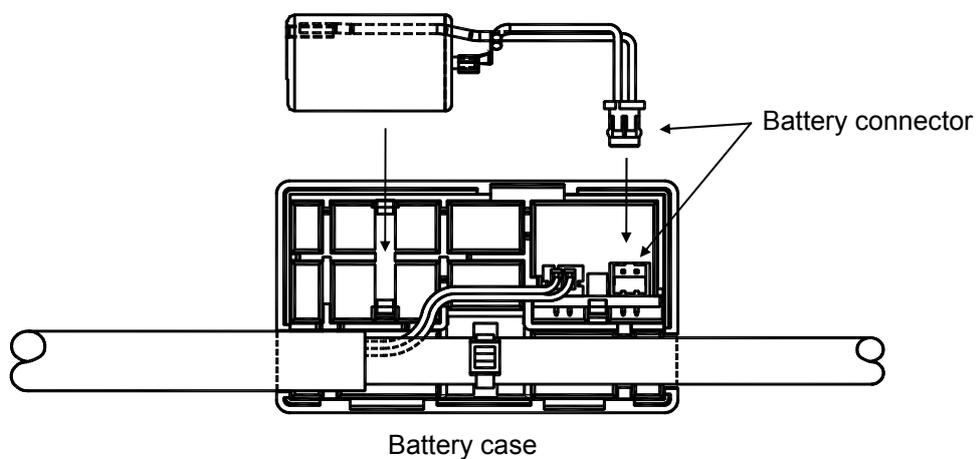
Dedicated function

In this chapter, the things concerning dedicated function are explained.

9. Dedicated function

9.1 Full-closed system

9.1.1 Illustration of system components

■ RS3□01/02/03/05

T S R

Wiring breaker (MCCB)

Used to protect power line. Turns off the power supply when overload runs.

Noise filter

Installed to protect power line from external noise.

Electromagnetic contactor

Switches power On/Off. Please place safeguard circuit.

External regenerative resistor

Used in case of insufficient capacity such that may be caused by high frequency of use, although internal regenerative resistor is enough in usual.

Motor power

Brake power source

Used for Servo motor with brake

SANMOTION R 3E Model
With **EtherCAT** Interface

SAN**MOTION** R

EtherCAT
Conformance tested
SANYO DENKI

CHARGE

CNA
R
S
T
r
t
⊖
RB1
RB2

CNB
U
V
W

OUT
L/A
RUN
IN
L/A
ERR

CN2

CN4

EN1

EN2
CN3

Enables parameter setup and monitoring through communication with a PC.

USB

Setup software

To next amplifier

Host equipment

General I/O connector Connects homing, probing and general signals.

Motor encoder

External encoder

Safety unit, safety PLC etc. Connects I/O signal of Safe Torque Off function to safety devices as safety unit, safety PLC.

9.1.2 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 K.K.	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
EnDAT2.2 interface is only applicable.

Manufacturer	Type	Series name	Power supply	Resolution
HEIDENHAIN K.K.	Linear encoder	LIC4100	5V±5%	0.01µm 0.005µm 0.001µm
		LIC2100		0.1µm 0.05µm
		LC400		0.01µm 0.001µm
	Angle encoder	RCN2000		26,28bit
		RCN5000		26,28bit
		RCN8000		29bit
	Rotary encoder	ECN/ENQ1100		Single-turn resolution: 23bit Multi-turn total count: 12bit
		ECN/ENQ1300		Single-turn resolution: 25bit Multi-turn total count: 12bit

* Above table spec is depending on our servo amplifier combination.
    Something may differ from manufacturer spec.
* Please contact each linear encoder manufacturer for the details of performance,
    specification, warranty, and installation.
* It is not applicable except EnDat2.2 interface classified to EnDat22.
* Contact us if combine with the encoder except recommendation encoder above.
* It is not able to use if the resolution converted to single-turn of motor axis exceeds 23bit
    (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)	Ground	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)	Ground	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.

Dedicated function ⑨

9. Dedicated function

9.1.4.2 EN2 pin assignment

■ EN2: 54593-1016 (soldered side)
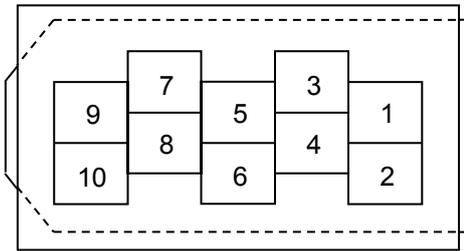
```
        7       3
    9       5       1
        8       4
    10      6       2
```

■ Connector model number (Molex Japan LLC)

	Model Number	Applicable wire size	Applicable cable diameter
Plug connector	54593-1016	AWG30 to AWG18	―
Plug cable/ cover set	54599-1016	―	ϕ7 to ϕ9

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 servo amplifier through the setup software.

[Step 1: How to confirm specifications of servo amplifier]
Confirm that your servo amplifier is fit to full-closed system or not by the information below.

◆ Encoder type

1) Confirmation through the setup software

■ Connect the servo amplifier 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 servo amplifier.
■ Select a desired axis from main window upper side axis icon, and then display popup menu (by right click).
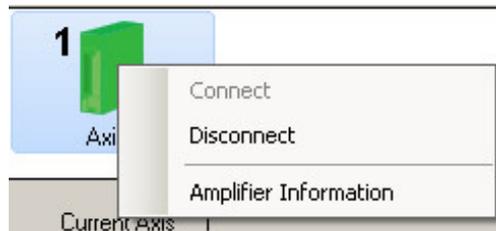
[Step 2: Encoder type confirmation]
See below for allowable encoder of this servo amplifier. Please confirm that your external encoder is allowed.

Servo amplifier model number	Encoder type code	Motor encoder allowed by EN1	External encoder allowed by EN2
RS3###A1##	01	Absolute encoder	Absolute encoder
RS3###A2##	02	Absolute encoder	Incremental encoder
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.

Dedicated function ⑨

9. Dedicated function

9.1.5.2 System parameter setting

Set the parameters as follows for use of full-closed control.

■ Control cycle
Select the control cycle of velocity control/torque control. In use of full-closed control, "00: Standard_Sampling" shall be selected.

Index	Sub-Idx	Selection		Description
0x20FD	0x08	00	Standard_Sampling	Standard sampling mode

■ Operation mode selection
Select the control mode. In use of full-closed control, it is required that the control mode selection is "Position control mode". In the other control mode, full-closed control is disabled.

Index	Sub-Idx	Selection		Description
0x6060	0x00	0x01	PP	Profile Position mode
		0x08	CSP	Cyclic Sync Position mode

■ Motor encoder connector selection
Selects the connector used as motor encoder. "00: EN1" shall be selected for use of full-closed control.

Index	Sub-Idx	Selection		Description
0x20FF	0x08	0x00	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. "0x01: External_Enc" shall be selected for use of full-closed control.

Index	Sub-Idx	Selection		Description
0x20F3	0x02	0x01	External_Enc	Full-closed control/ External encoder

9.1.5 Basic setting of full-closed system

9.1.5.3 Full-closed encoder selection

■ External encoder type code
Selects the external encoder type connected to EN2. Select depending on encoder type as below:

Index	Sub-Idx	Selection		Selection
0x20FF	0x04	0x0000	Pulse	Wire-saving incremental encoder
		0x0002	Pulse_without_CS	Incremental encoder
		0x0900	EnDat_ABS	EnDat2.2, 2Mbps
		0x0920	EnDat_ABS	EnDat2.2, 4Mbps

9. Dedicated function

9.1.5.4 Feedback pulse setting

■ External encoder resolution

Index	Sub-Idx	Setting range	Unit
0x20FF	0x03	500 to 8,388,608 (multiplied 1)	P/R

Incremental encoder
Sets pulse amount (multiply 1) of external encoder per 1 turn of motor axis.
Be valid after control power cycle.

◆ Setting sample
[Use condition]
・ Move distance of work per 1 turn of motor axis: 10mm
・ Minimum resolution of external encoder (multiplied 4): 1.0×10^{-3} mm (=1.0μm)
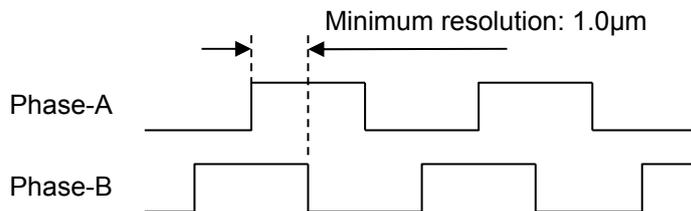
Minimum resolution: 1.0μm

Phase-A

Phase-B

[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

$$= \frac{\text{Move distance of work per 1 turn of motor axis [mm]}}{\text{Minimum resolution of external encoder [mm]}}$$

$= 10mm /(1.0 \times 10^{-3} mm)$
$= 10,000$ P/R (multiplied 4)

Index 0x20FF-3 "External encoder resolution" is "multiplied 1" value (amount of phase-A or phase-B), so the value below is set.

External encoder resolution = 10,000/4 = 2,500 P/R

* Round off the value to the whole number.

Absolute encoder
Sets pulse amount (multiply 1) of external encoder per 1 turn of motor axis.
Be valid after control power cycle.

◆ Setting sample
[Use condition]
・ Move distance of work per 1 turn of motor axis: 10mm
・ Minimum resolution of external encoder (linear encoder): 0.01×10^{-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 0.01μm, so,

Pulse amount of external encoder per 1 turn of motor axis

$$= \frac{\text{Move distance of work per 1 turn of motor axis [mm]}}{\text{Minimum resolution of external encoder [mm]}}$$

= 10mm /(0.01 × 10^{-3} mm)
= 1,000,000 P/R

◆ Setting sample
[Use condition]
・ Rotation amount of work per 1 turn of motor axis: 1/32 turn
・ Resolution of external encoder (angle encoder): 26bit (67,108,864 division)

[Setting value]
Rotation amount of work per 1 turn of motor axis is 1/32 turn, and resolution of external encoder is 67,108,864 division, so,

Pulse amount of external encoder per 1 turn of motor axis
= Rotation amount of work per 1 turn of motor axis [turn]
   × Resolution of external encoder [division]
= (1/32 turn) × (67,108,864 division)
= 2,097,152 P/R

* Round off the value to the whole number.

Dedicated function ⑨

9. Dedicated function

■ External Pulse Encoder Digital Filter
Sets the digital filter for external pulse 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.

Index	Sub-Idx	Selection		Description
0x20F1	0x03	0x00	110nsec	Minimum Pulse Width =110nsec (Minimum pulse Phase Difference = 37.5nsec)
		0x01	220nsec	Minimum Pulse Width = 220nsec
		0x02	440nsec	Minimum Pulse Width = 440nsec
		0x03	880nsec	Minimum Pulse Width = 880nsec
		0x04	75nsec	Minimum Pulse Width = 75nsec (Minimum pulse Phase Difference = 37.5nsec)
		0x05	150nsec	Minimum Pulse Width = 150nsec
		0x06	300nsec	Minimum Pulse Width = 300nsec
		0x07	600nsec	Minimum Pulse Width = 600nsec
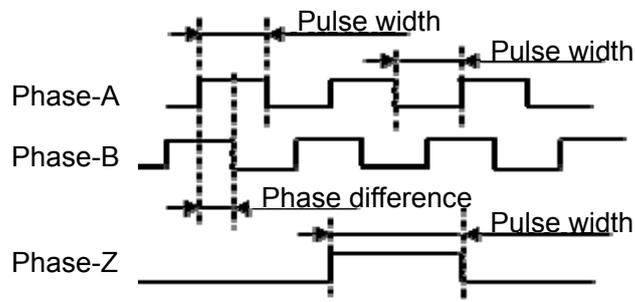
* Be valid when external incremental encoder is used.

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.
Rotation direction of servo motor is able to invert without changing command wiring.
Be valid after control power cycle.

Index	Sub-Idx	Selection		Position Command Plus	Position Command Minus
0x607E	0x00	0x00	PC+_VC+_TC+	CCW rotation	CW rotation
		0x20	PC+_VC+_TC-		
		0x40	PC+_VC-_TC+		
		0x60	PC+_VC-_TC-		
		0x80	PC-_VC+_TC+	CW rotation	CCW rotation
		0xA0	PC-_VC+_TC-		
		0xC0	PC-_VC-_TC+		
		0xE0	PC-_VC-_TC-		
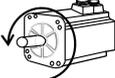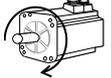
■ External Encoder Polarity Selection
Selects signal polarity of external incremental encoder.
Select polarity to get matching with increase/decrease of "Present position monitor (External encoder) [EX-APMON]" and "Present position monitor (Motor encoder) [APMON]".
Be valid after control power cycle.

Index	Sub-Idx	Selection		Description		
0x20F1	0x04	0x00	Type1	EX-Z /without inversion	EX-B /without inversion	EX-A /without inversion
		0x01	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 "Present position monitor (External encoder) [EX-APMON]" and "Present position monitor (Motor encoder) [APMON]".
Be valid after control power cycle.

Index	Sub-Idx	Selection		Description
0x2074	0x00	0x00	Standard	Inverts not an encoder operation direction.
		0x01	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.

Dedicated function ⑨

9. Dedicated function

9.1.5.6 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.

Index	Sub-Idx	Setting range	Unit
0x2066	0x01	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.

Index	Sub-Idx	Setting range	Unit
0x2066	0x02	0.0 to 2,000.0	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.

$$\text{Dual position feedback filter [ms]} = 3 \div KP \text{ [1/s]} \times 1,000$$

◆ 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.

9.1.5.7 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.
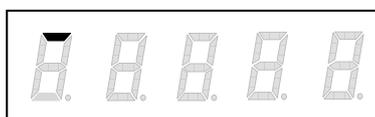
■   Dual position error warning level
Warning will be output when exceeding this setting value by difference between external encoder and current position of motor encoder. Set the value of multiply 4 to external encoder resolution, as a base.
Dual position error warning does not output when 0 pulse is set.

Index	Sub-Idx	Setting range	Unit
0x206C	0x01	0 to 2,147,483,647	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. 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.

Index	Sub-Idx	Setting range	Unit
0x206C	0x02	0 to 2,147,483,647	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. Dedicated function

9.1.5.8 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 servo amplifier 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.

Index	Sub-Idx	Selection	Description
0x2071	0x00	0x00	Invalid
		0x01	1,000ms
		0x02	1,400ms
		0x03	1,800ms
		0x04	2,000ms
		0x05	3,000ms
		0x06	5,000ms
		0x07	10,000ms

* Supply power to external encoder at same timing for control power of servo amplifier 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 0 or 1.

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 servo amplifier 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 "Present position monitor (Motor encoder) [APMON]" and "Present position monitor (External encoder) [EX-APMON]" are opposite, change the Index 0x20F1-4 "External Incremental Encoder Polarity Selection" for external incremental encoder or change the Index 0x2074-0 "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.

Dedicated function 9

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 the servo amplifier.

9.2.1 Illustration of system components

T S R

Wiring breaker (MCCB)

Used to protect power line.
Turns off the power supply when overload runs.

Noise filter

Installed to protect power line from external noise.

Switches power On/Off.
Please place safeguard circuit.

Electromagnetic contactor

External regenerative resistor

Used in case of insufficient capacity such that may be caused by high frequency of use, although internal regenerative resistor is enough in usual.

Brake power source

Used for Servo motor with brake

Motor power

Motor encoder

Motor encoder

Enables parameter setup and monitoring through communication with a PC.

USB

Setup software

To next amplifier

Host equipment

Amplifier communication

Safety device
Safety PLC etc.

Connect input / output signals of Safe Torque Off function to safety devices such as Safety PLC.

SANMOTION R
EtherCAT Conformance tested
SANYO DENKI
CHARGE
CNA R S T r t RB1 RB2
CNB U V W
CN2 CN4 EN1 EN2 CN3

9-17

■   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 amplifiers 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.

Dedicated function

⑨

9. Dedicated function

9.2.2 Internal block diagram
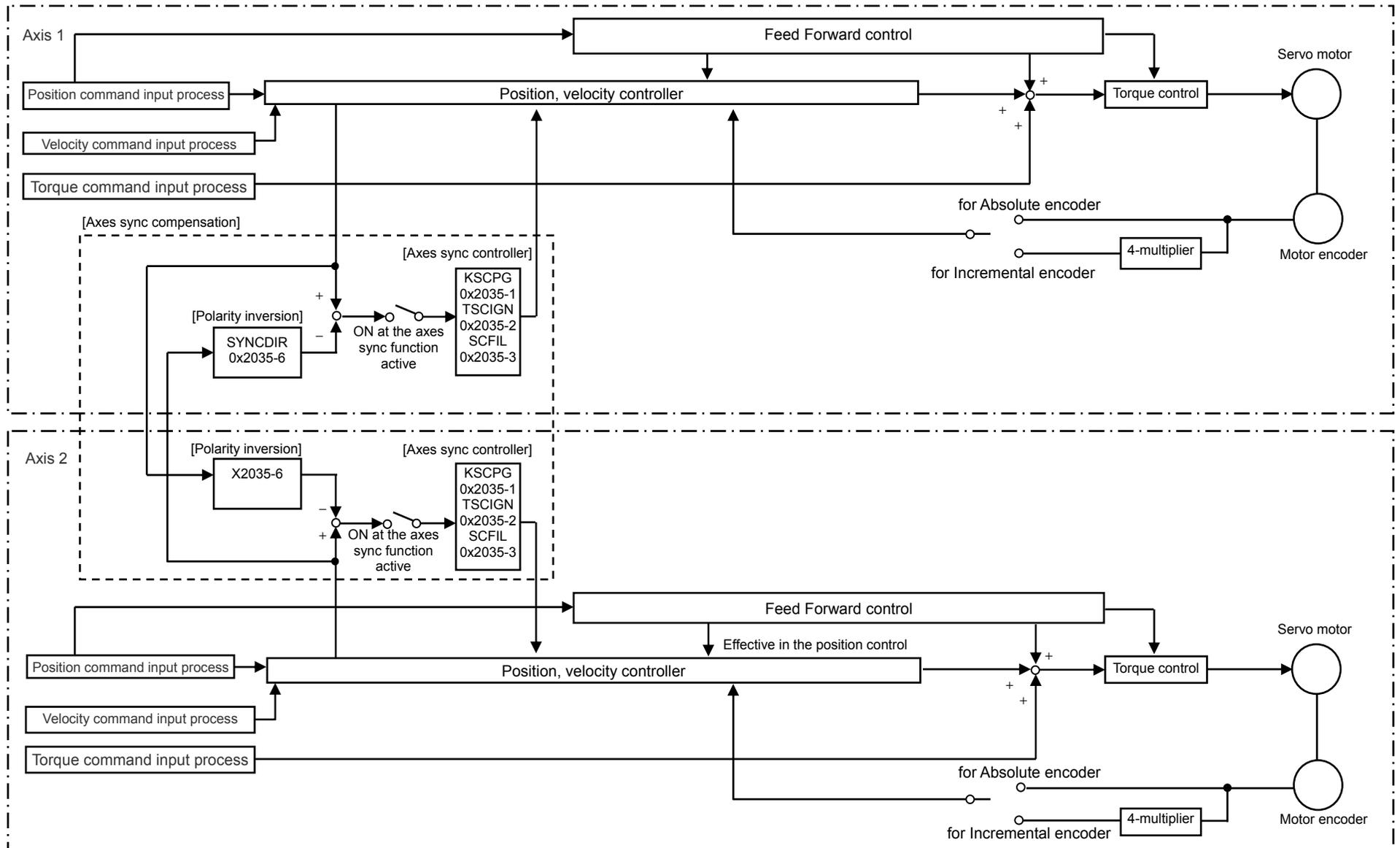
9.2.4 Setting for the tandem operation function

9.2.3 Wiring

For use of the tandem operation, connect CN2 each other.

1st axis side CN2 connector			2nd axis side CN2 connector	
Terminal number	Signal name		Terminal number	Signal name
22	RXD+		24	TXD+
23	RXD-		25	TXD-
24	TXD+		22	RXD+
25	TXD-		23	RXD-
26	SG		26	SG
Shell	Ground		Shell	Ground

Shield
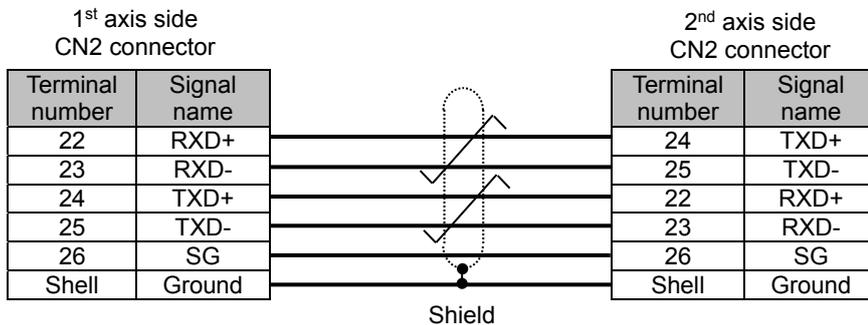
* For use of the Safe Torque Off function, connect the wiring of CN4 (connector for safety device connection), between 2 axes.

9.2.4 Setting for the tandem operation function

For use of the tandem operation, set the parameters below.

■ Amplifier communication function selection
Select use of communication function (at CN2 connector).
Select "01: Tandem" to use this function.
It will activate after performing control power cycle.

Index	Sub-Idx	Selection		Contents
0x2035	0x0A	01	Tandem	Uses as for the tandem operation.

■ 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.

Index	Sub-Idx	Setting range	Default	Unit
0x2035	0x01	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.

Index	Sub-Idx	Setting range	Default	Unit
0x2035	0x02	0.5 to 1,000.0	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.

Index	Sub-Idx	Setting range	Default	Unit
0x2035	0x03	0.0 to 1,000.0	0.0	ms

9. Dedicated function

■ 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.

Index	Sub-Idx	Setting range	Default	Contents
0x2035	0x06	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 the Index 0x2035-A
"Amplifier communication function", and this parameter is valid.

Index	Bit	Setting range	Default	Contents
0x2000	15	0:Disabled	0:Disabled	Invalid
		1:Enabled		Valid

■ Axes-sync compensation proportional control switching function
Selects an input condition to activate the axes-sync compensation proportional control
switching function.

Index	Sub-Idx	Setting range	Default	Unit
0x2035	0x0B	0:Disabled	0:Disabled	Invalid
		1:Enabled		Valid

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 "0x80: PCMD: - (negative rotation) /VCMD: + (positive rotation) /TCMD: + (positive rotation)" to the Index 0x607E-0 "Polarity [CMDPOL]", at one axis. And, set "0x01: Reversed" to the Index 0x2035-6 "Position deviation polarity selection [SDEVPOR]", 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 Index 0x2000 bit15 "Position sync compensation enabled [PSCE]" is set as invalid at Master axis, and the Index 0x2000 bit15 "Position sync compensation enabled [PSCE]" set as valid at Slave axis.

  ◆ If rotation directions of 2 axes are same, set same parameter to the Index 0x607E-0 "Polarity [CMDPOL]", in 2 axes. And, set " 00:Not_Reversed" to "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: 1,000ms (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. Dedicated function

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.

Index	Sub-Idx	Setting range	Unit
0x2035	0x05	1 to 2,147,483,647	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.

Index	Sub-Idx	Setting range	Unit
0x2035	0x04	1 to 2,147,483,647	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 Torque assisting function

Torque assisting function is the function controlling master axis with position or velocity control and sending torque command to slave axis to perform torque assisting.
Set parameters below to use torque assisting function.

■ Amplifier communication function selection
    Selects a usage of communication function (CN2 connector).
    "01: Tandem" shall be selected to use this function.
    Be valid after control power cycle.

Index	Sub-Idx	Setting range		Description
0x2035	0x0A	01	Tandem	Use for tandem operation function.

■ Axes sync compensation input polarity selection
    Matches polarity of torque each other.
    "01: Reverse" shall be selected when 2 axes rotation directions are different.

Index	Sub-Idx	Selection	Standard set value	Description
0x2035	0x06	00:Not_Reversed	00:Not_Reversed	Not reversed
		01:Reversed		Reversed

■ Synchronization compensation enabled
    Selects input condition of torque assisting function valid.
    Torque assist works when "01: Tandem" is selected at Index 0x2035-A and this function is enabled.

Index	Bit	Selection	Standard set value	Description
0x2000	15	0:Disabled	0:Disabled	Invalid
		1:Enabled		Valid

■ Assisting function selection
    Selects a torque assisting function.

Index	Sub-Idx	Selection	Standard set value	Description
0x2035	0x0C	01: Torque assisting function	00: Position assisting function	Torque assisting function

■ Assisting rate
    With set value 100 % to torque assisting function, 1-multiplied torque command is added.
    With set value 0 %, torque assist disabled.

Index	Sub-Idx	Setting range	Standard set value	Unit
0x2035	0x0D	0 to 100	0	%

Dedicated function

⑨

9. Dedicated function

How to use
- ■ Torque assisting function works with Master-Slave method.
  - ◆ Master-Slave method: Just one axis (slave side) receives torque command from other axis (master side), and performs torque control due to received command.

  - ◆ For master axis, selects invalid to Index 0x2000 bit 15 [PSCE]. For slave axis, selects valid to PSCE, Index 0x2000 bit 15.

  - ◆ When 2 axes rotation directions are same, set same setting to Index 0x607E-0 [CMDPOL] of both axis. And set "00:Not_Reversed" to Axes sync compensation input polarity selection of slave axis.

  - ◆ When 2 axes rotation directions are different, just slave axis shall be set as following: "0x20" into Index 0x607E-0 [CMDPOL], and "0x01: Reversed" into Index 0x2035-6 [SDEVPOR].

  - ◆ Set the position control (CSP or PP) or velocity control (CSV or PV) to master axis, and set the torque control (CST or PT) to slave axis.

9.2.8 Velocity assisting function

Velocity assisting function is the function sending velocity command to slave axis to perform velocity assisting.
Set parameters below to use velocity assisting function.

- ■ Amplifier communication function selection
  Selects a usage of communication function (CN2 connector).
  "01: Tandem" shall be selected to use this function.
  Be valid after control power cycle.

Index	Sub-Idx	Setting range		Description
0x2035	0x0A	01	Tandem	Use for tandem operation function.

- ■ Axes sync compensation input polarity selection
  Matches polarity of torque each other.
  "01: Reverse" shall be selected when 2 axes rotation directions are different.

Index	Sub-Idx	Selection	Standard set value	Description
0x2035	0x06	00:Not_Reversed	00:Not_Reversed	Not reversed
		01:Reversed		Reversed

- ■ Synchronization compensation enabled
  Selects input condition of velocity assisting function valid.
  Velocity assist works when "01: Tandem" is selected at Index 0x2035-A and this function is enabled.

Index	Bit	Selection	Standard set value	Description
0x2000	15	0:Disabled	0:Disabled	Invalid
		1:Enabled		Valid

9.2.8 Velocity assisting function

■ Assisting function selection
Selects a velocity assisting function.

Index	Sub-Idx	Selection	Standard set value	Description
0x2035	0x0C	02: Velocity assisting function	00: Position assisting function	Velocity assisting function

■ Assisting rate
With set value 100 % to velocity assisting function, 1-multiplied velocity command is added. With set value 0 %, velocity assist disabled.

Index	Sub-Idx	Setting range	Standard set value	Unit
0x2035	0x0D	0 to 100	0	%

How to use
■ Velocity assisting function works with Master-Slave method.
◆ Master-Slave method: Just one axis (slave side) receives velocity command from other axis (master side), and performs velocity control due to received command.

◆ For master axis, selects invalid to Index 0x2000 bit 15 [PSCE]. For slave axis, selects valid to PSCE, Index 0x2000 bit 15.

◆ When 2 axes rotation directions are same, set same setting to Index 0x607E-0 [CMDPOL] of both axis. And set "00:Not_Reversed" to Axes sync compensation input polarity selection of slave axis.

◆ When 2 axes rotation directions are different, just slave axis shall be set as following: "0x40" into Index 0x607E-0 [CMDPOL], and "0x01: Reversed" into Index 0x2035-6 [SDEVPOR].

◆ Set the position control (CSP or PP) or velocity control (CSV or PV) to master axis, and set the velocity control (CSV or PV) to slave axis.

9. Dedicated function

9.2.9 Precaution

◆ At the tandem operation, different load inertia moment ratios cannot 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 the Index 0x2035-A "Axes-sync compensation function [SYNCEN]" and make counterpart axis servo off.
* Avoid high speed operation. (Dynamic brake of counterpart axis might burn out.)

Safe-Torque-Off (STO) function

In this chapter, details of Safe-Torque-Off (STO) function are explained.

10. Safe Torque Off function

10.1 Illustration of system configuration

T S R

[Molded Case Circuit Breaker (MCCB)]

Used to protect power line. Turns off the power supply when overcurrent runs.

Noise filter

Installed to protect power line from external noise.

[Electromagnetic contactor]
Switches power on/ off. Please place safeguard circuit.

[External regenerative resistor]

Regenerative resistor built in servo amplifier is enough for normal operation; however, external regenerative resistor also can be used in the case of deficiency in performance for frequent operation.

Motor power

[Power supply for brake]

Used for the servo motor with brake

Servo motor

SANMOTION R 3E Model
With **EtherCAT** Interface

Enables parameter setting and monitoring through communication with a PC.

USB

[Setup software]

To next amplifier

Host unit

General I/O connector
Connect homing, probing and general signals.

Motor encoder

[Safety unit Safety PLC, etc.]

Connects input/output signal of safe-torque-off function to safety equipment such as safety unit or safety PLC.

10-1

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 servo amplifier 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.
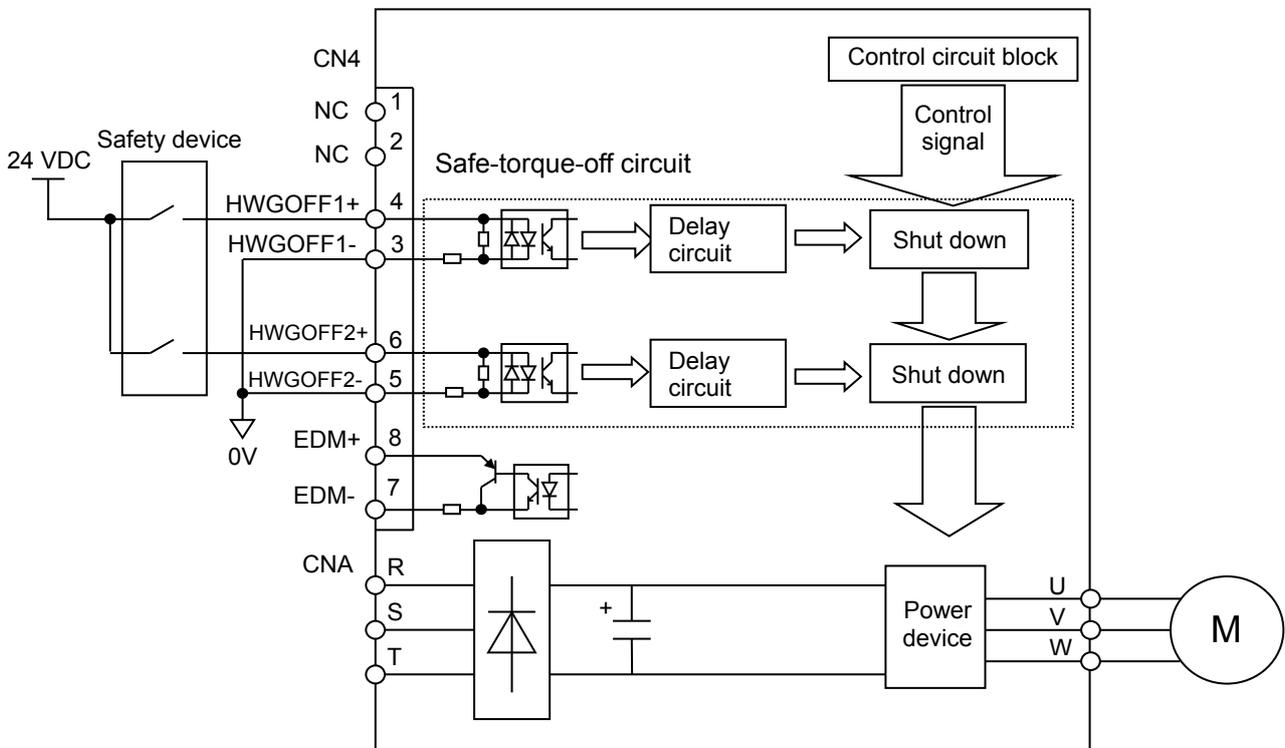
10. Safe Torque Off function

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 ■ IEC62061, SILCL3, HFT=1, type B / EN62061 ■ ISO13849-1:2015, Cat3, PL = e (When error detection performed by using EDM) / EN ISO 13849-1:2015 ■ 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=d, 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 servo 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 of servo amplifier, dynamic brake circuit, holding brake excitation signal, 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 servo amplifier 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 servo amplifier is not shut down. Be sure to shut down power supply before you perform maintenance or checkup of servo amplifier, 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.

Servo amplifier 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)
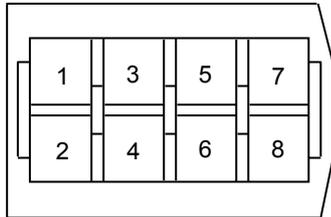
10.3.2 Connection diagram of CN4-terminals

Functions and connection circuit of each CN4-teminal are as shown below.

Signal	Terminal No.	Code	Description
	1		These are connecting terminals when the function is not used. Do not use these terminals.
	2		
Safety input 1	3	HWGOFF1-	This is an input signal to control safe-torque-off state. Connection circuit Connects to relay or transistor circuit of open collector. Power supply voltage range: 24 VDC±10% Internal impedance: 2.2kΩ
	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. Connection circuit: Connects to photo coupler or relay circuit. Power supply voltage range (Uext): 24 VDC±10% Maximum current value: 50mA Output voltage: Uext-0.5 -Uext
	8	EDM+	
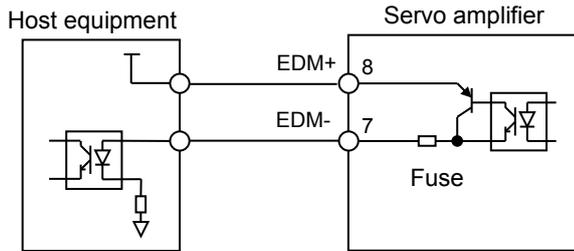
* When you do not use this function, connect terminal 1 and 3, 5, and also connect terminal 2 and 4, 6 (short-circuit). A connector for short-circuit, PN# AL-00849548-02, is available as an option.

10.3.3 Example of wiring

Example of wiring to safety switch (single servo amplifier connected)
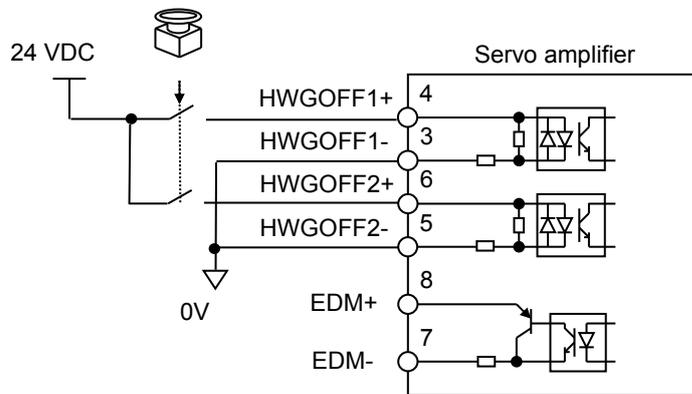
10. Safe Torque Off function

Example of wiring to safety unit (multiple-servo amplifier connected)
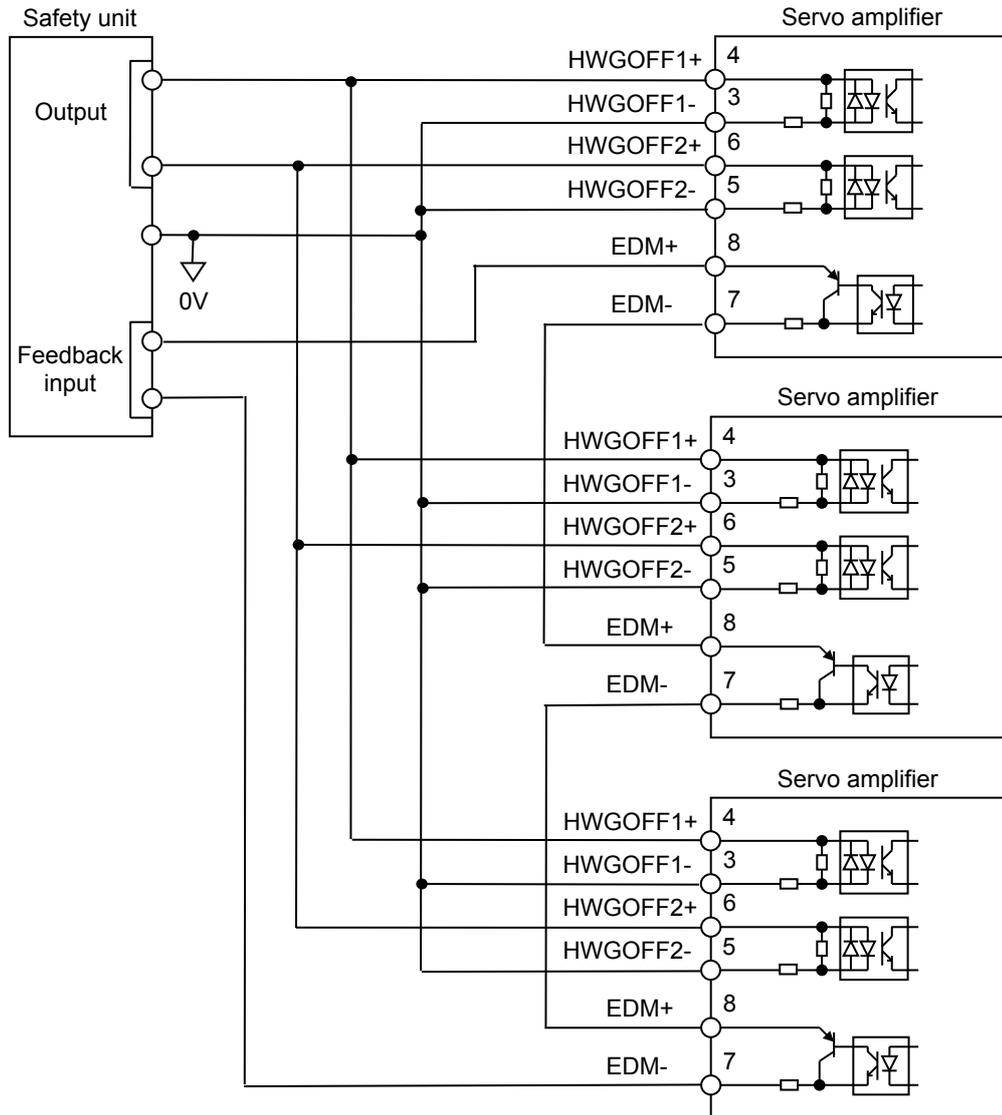
10.3.4 Safety input-off shot pulse for safety device self-diagnosis

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).
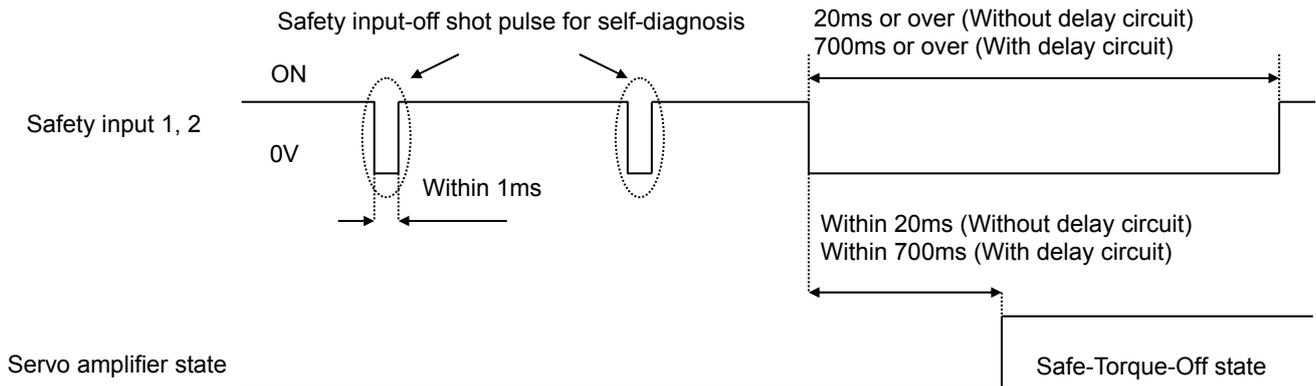
*   Torque may turn off for a moment if the pulse of 1ms over to less than 8ms is input.

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	Servo amplifier condition
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.)

Safety input 1 Safety input 2	Off		On	
Servo On signal	Servo Off			Servo On
W/o delay circuit				
Output for servo ready completion	SRDY OFF		SRDY ON	
Amplifier state	Safe-Torque-Off state	SRDY state		Servo On state
With delay circuit				
Output for servo ready completion	SRDY OFF	Max.700ms		SRDY ON
Servo amplifier state	Safe-Torque-Off state		SRDY state	Servo On state
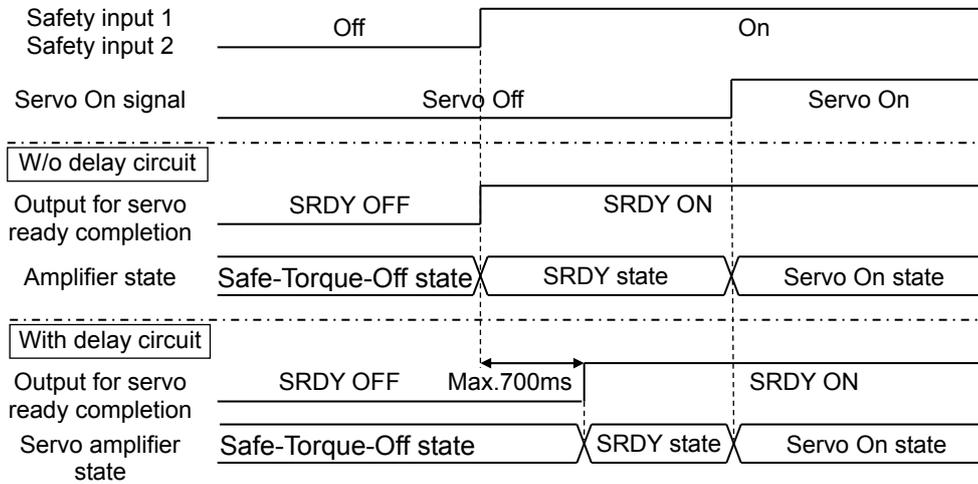
In the state servo-on signal is input, safe-torque-off activated state remains even if safety input 1 or 2 is turned on. To restart operation, turn off servo-on signal to activate SRDY state, then input servo-on signal.

Safety input 1 Safety input 2	Off	On	
Servo On signal	Servo On	Servo Off	Servo On
Output for servo ready completion	SRDY OFF	SRDY ON	
Servo amplifier state	Safe-Torque-Off state	SRDY state	Servo On state
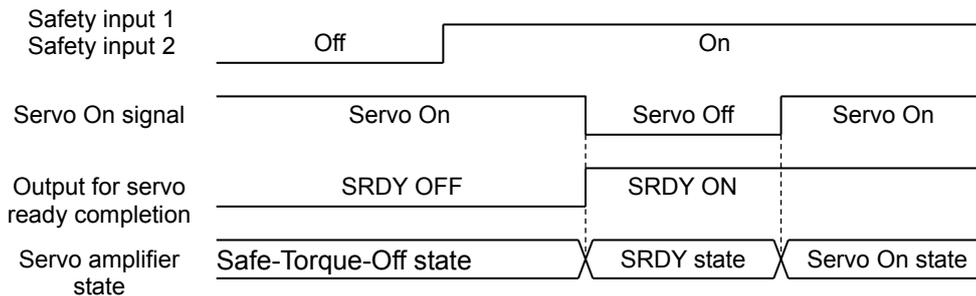
* In case of sending Operation enable signal continuously, it disables return from the Safe Torque Off state. Avoid this setting when using the safe torque off function.

Safe-Torque-Off function

10

10. Safe Torque Off function

10.4.3 Safe-Torque-Off during servo motor running

Stoppage behavior varies depending on the quick stop option code (Index 0x605A-0 [QSTOP]).

◆ Motor stops with servo brake when safety input 1 or 2 is turned off.

Safety input 1 Safety input 2	On	Off
Servo motor current		Stoppage (Motor-free)
Holding brake excitation signal	Released	Brake-activated
Dynamic brake signal	Released	Brake-activated
Velocity monitor	Servo brake	BONDLY
		Max.700ms
Servo amplifier state	Servo On state	Safe-Torque-Off

Power On state
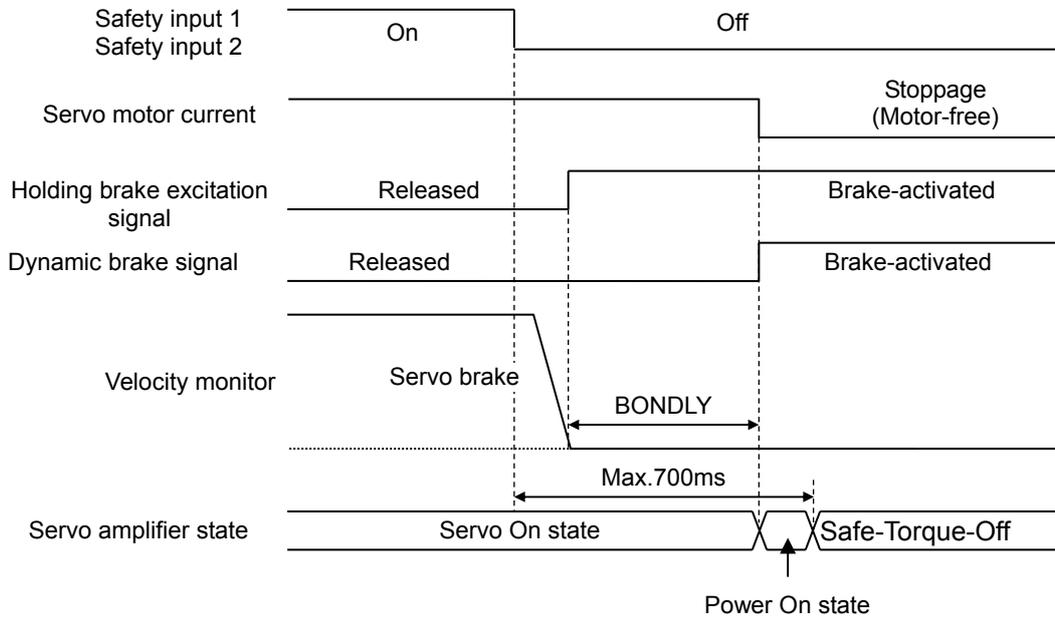
* When set value of the Index 0x2024-0 "Delay Time of Engaging Holding Brake [BONDLY]" is more than safe-torque-off delay time (700ms max.), the state becomes motor-free after period of safe-torque-off delay time. Please note that recommended set value for BONDLY is less than 300ms.

* Servo brake circuit, dynamic brake circuit, and holding brake excitation signal are not safety-related sections.

■ In case that set value of the quick stop option code (Index 0x605A-0 [QSTOP]) is 0.

When safety input 1 or 2 is turned off, this setting blocks servo motor current, and then stops servo motor with dynamic brake after.

◆ 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.
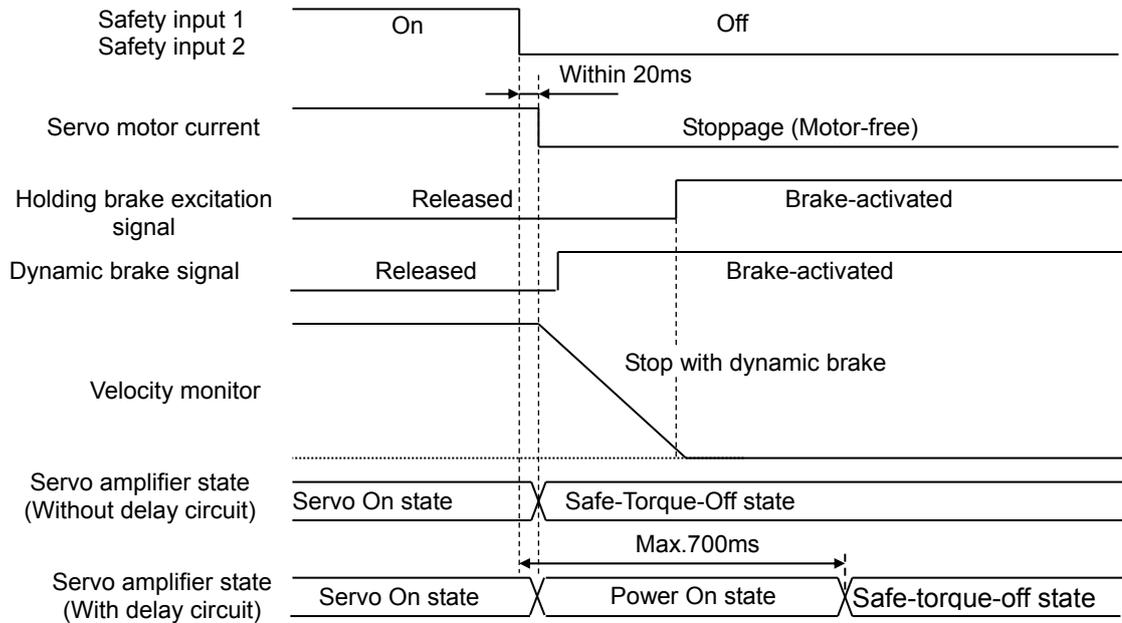
Safety input 1 Safety input 2	On	Off
		Within 20ms
Servo motor current		Stoppage (Motor-free)
Holding brake excitation signal	Released	Brake-activated
Dynamic brake signal	Released	Brake-activated
Velocity monitor		Stop with dynamic brake
Servo amplifier state (Without delay circuit)	Servo On state	Safe-Torque-Off state
		Max.700ms
Servo amplifier state (With delay circuit)	Servo On state	Power On state — Safe-torque-off state

*   Dynamic brake circuit and holding brake excitation signal are not safety-related sections.

10. Safe Torque Off function

10.4.4 Safe-Torque-Off during servo motor stoppage

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.
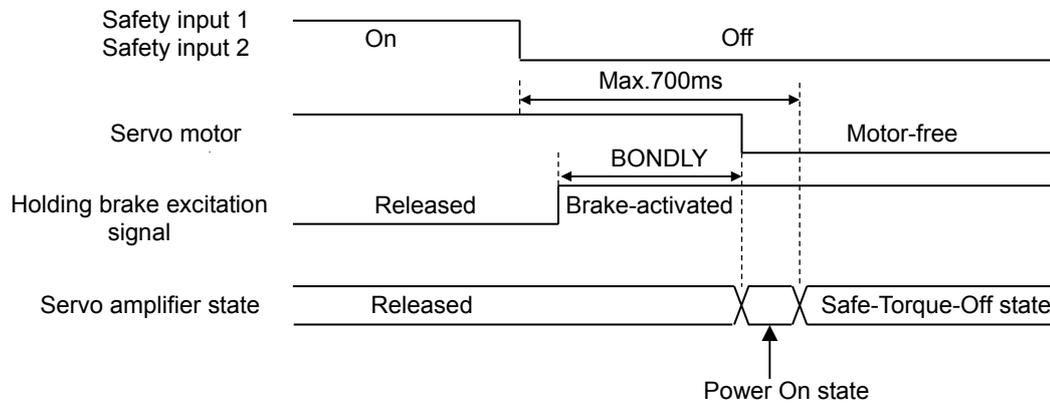
* Set 700ms or less to the Index 0x2024-0 "Delay Time of Engaging Holding Brake [BONDLY]".

* Set 3 or 7 to the quick stop option code (Index 0x605A-0 [QSTOP]).

10.4.5 Deviation clear

When selecting 02:Type3 or 03:Type4 (not to clear deviations at servo-off state) on the Index 0x20F0-5 "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 the Index 0x20F0-5 "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. Safe Torque Off function

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.
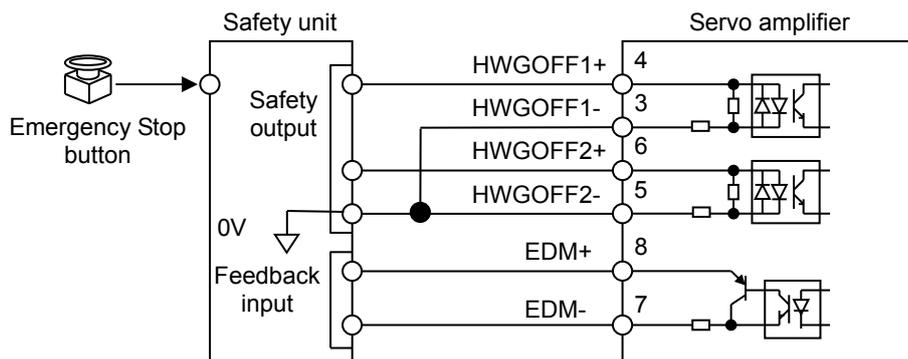
Connect safety output signals of safety unit to safety input 1 (HWGOFF1) and safety input 2 (HWGOFF2) respectively, and then failure detection monitor output signal (EDM) from servo amplifier to feedback input of safety unit. Under normal conditions, pressing emergency stop button turns off both of safety 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 servo amplifier. 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

Safe-Torque-Off function

10. Safe Torque Off function

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, servo amplifier 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 servo amplifier and motor installation and wiring, and with servo amplifier and motor properly operate. Refer to "3. Installation", "4. Wiring" and another document M M0011697 "5 Operations" 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	8. 8. 8. 8. 8

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	8. 8. 8. 8. 8. ↓ 8. 8. 8. 8. 8 ↓ 8. 8. 8. 8. 8.
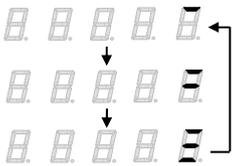
10.7 Safety precautions

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. Servo amplifier 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 servo amplifier 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 servo amplifier, strongly recommended that recording and storing a detail of inspection and maintenance.

10 Safe-Torque-Off function

No Text on This Page.

11

Selection

In this chapter, each kind of selections are explained.

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
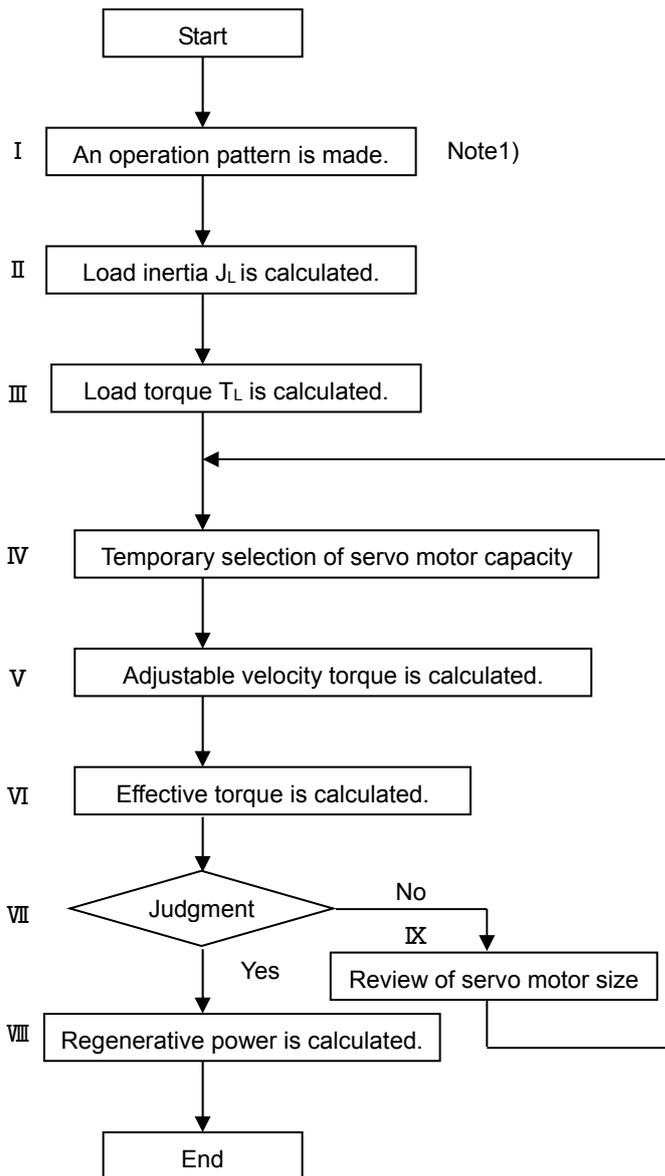
Ⅰ. Create operation pattern.

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% ($T_R \times 0.8$) 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% ($T_p \times 0.8$) or less of the peak torque at stall (T_p) of servo motor
The effective torque (Trms) is 80% ($T_R \times 0.8$) 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
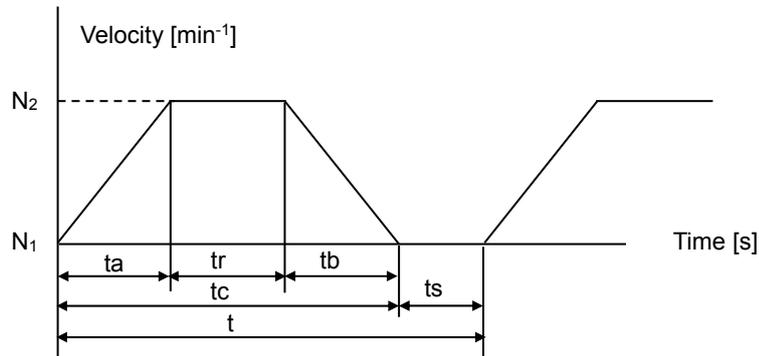
ta=Acceleration time
tb=Deceleration time
tr=Constant velocity time
ts=Stop time
t=1cycle

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
ρ 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=πD)

11. Selection

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]
η : Transmission efficiency
μ: Coefficient of friction
W: Moving part mass [kg]
P: Ball screw lead [m]
G: Reduction ratio

■ Belt pulley (in vertical axis)

$$T_L = \frac{(F + \mu W)}{\eta} \times \frac{D}{2} \times \frac{1}{G} \times 9.8 \quad [\text{N·m}]$$

■ Belt pulley (in vertical axis)

Belt pulley (in vertical axis)

$$T_L = \frac{(F + (\mu + 1)W)}{\eta} \times \frac{D}{2} \times \frac{1}{G} \times 9.8 \quad [\text{N·m}]$$

When motor drives downward

$$T_L = \frac{(F + (\mu - 1)W)}{\eta} \times \frac{D}{2} \times \frac{1}{G} \times 9.8 \quad [\text{N·m}]$$

■ When belt pulley stops (in horizontal axis)

$$T_L = \frac{F}{\eta} \times \frac{D}{2} \times \frac{1}{G} \times 9.8 \quad [\text{N·m}]$$

■ When belt pulley stops (in vertical axis)

$$T_L = \frac{(F + W)}{\eta} \times \frac{D}{2} \times \frac{1}{G} \times 9.8 \quad [\text{N·m}]$$

F: External force [kg]
η : Transmission efficiency
μ: Coefficient of friction
W: Moving part mass [kg]
P: Diameter of a pulley [m]
G: Reduction ratio

11．Selection

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 Linear motor sizing

It is estimated that selection of linear motor capacity computes required linear motor capacity from machine specification (composition). Here, the fundamental formula is described.

11.2.1 Flowchart of linear motor sizing

Start

(1) Tentatively select motor size

(2) Calculate maximum necessary force

(3) Calculate effective force

(4) Select magnet rail

(5) Verify free-running distance when dynamic brake activated.

(6) Verify instantaneous tolerance of dynamic brake

(7) Judge

No

(9) Review motor capacity

Yes

(8) Calculate regenerative power

Completed
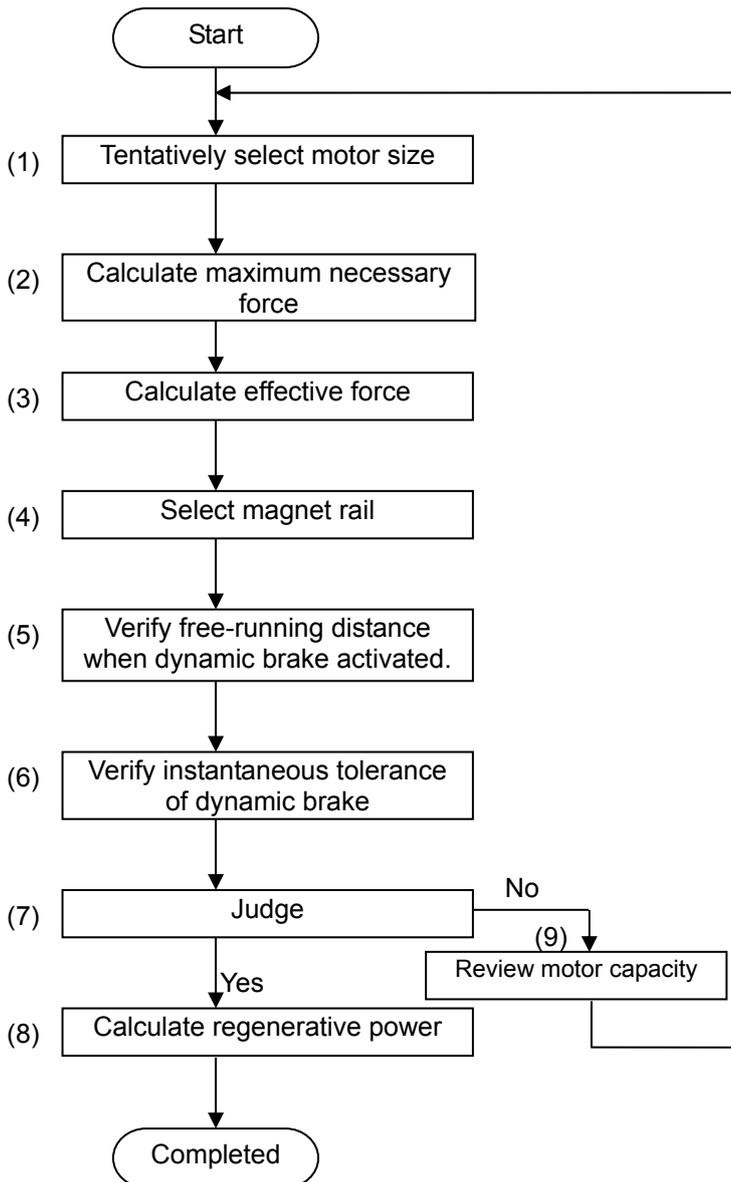
(1) Tentatively select motor size
Tentatively select coil whose maximum force satisfies the necessary force for use.
(At least "load mass × maximum acceleration+α" or more is needed.)

(2) Calculate maximum necessary force
Calculate necessary maximum force in consideration of motor mass, friction, and gravity. Confirm that the maximum force of tentatively selected motor is necessary maximum force or over. Having a margin of 10% or more is recommended in consideration of load fluctuation.

(3) Calculate effective force
Confirm that the continuous rated force of tentatively selected motor is necessary effective force or over.
Having a margin of 10% or more is recommended in consideration of load fluctuation.

(4) Select magnet rail
Select magnet rail to satisfy the necessary stroke for tentatively selected motor.

(5) Verify free-running distance when dynamic brake activated.
Calculate free-running distance of dynamic brake on tentatively selected motor, and confirm that no problems with operation.

(6) Verify instantaneous tolerance of dynamic brake.
Calculate energy for single activation of dynamic brake of selected motor consumed by dynamic brake resistor, and then confirm the energy is amplifier allowable value or less.

(8) Calculate regenerative power
Calculate regenerative power of selected motor, and then confirm that the power is regenerative resistor allowable power or less.

(9) Review motor capacity

11

Selection

11. Selection

11.2.2 Maximum necessary force and necessary effective force

■ Calculate frictional force: Ff

$$Ff = (M \cdot g \cdot \cos\theta + Fatt) \cdot \mu + Fadd \quad [N]$$

Mc	: Mover mass	[kg]
ML	: Load mass	[kg]
M	: Moving part mass = Mc + ML	[kg]
g	: Gravity acceleration= 9.8	[m/s^2]
$\cos\theta$	: Angle to horizontal driving surface	[rad] (For horizontal surface, $\cos\theta$=1)
Fatt	: magnetic attractive force	[N]
μ	: Frictional coefficient	
Fadd	: Sealing resistance	[N] (including kinetic friction, cover friction, and cable routing resistance)

■ Calculate gravity applied to moving parts.

$$Fw = M \cdot g \cdot \sin\theta \quad [N]$$

M	: Mover mass = Mc + ML	[kg]
g	: Gravity acceleration= 9.8	[m/s^2]
θ	: Angle to horizontal driving surface	[rad] (For horizontal surface, $\sin\theta$=0)

■ Calculate maximum necessary force: Fmax,
and then confirm that "maximum motor force Fp > maximum necessary force: Fmax".

$$Fmax = M \cdot amax + Ff + Fw + Fwork \quad [N]$$

M	: Mover mass=Mc + ML	[kg]
amax	: Maximum acceleration	[m/s^2]
Ff	: Frictional force	[N]
Fw	: Gravity	[N]
Fwork	: Process reaction force	[N]

Having a margin of "0.9·Fp $\geqq$ Fmax" or more is recommended in consideration of load fluctuation.

■ Confirm that "motor continuous rated force: Fr > effective force: Frms".

$$Frms = \sqrt{\frac{(F1^2 \cdot t1 + F2^2 \cdot t2 + F3^2 \cdot t3 + \cdots)}{t}} \quad [N]$$
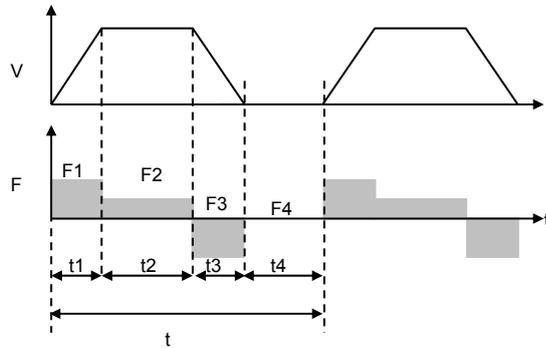
* Having a margin of "$0.9 \cdot Fr \geqq Frms$" or more is recommended in consideration of load fluctuation.

11.2.3 Select magnet rail

5 types of magnet rail (with core or core-less) length are offered as follows:
64, 128, 256, 512 [mm]
Decide the length so as to be "magnet rail length $\geqq$ coil length + stroke + margin".
Provided that mounting magnet rail to the remaining half part from the end of the stage and mounting coil to moving stage where magnet rail not mounted are recommended to facilitate installation of coil into machine.

11. Selection

11.2.4 Cautions on load conditions

■ Negative load

Servo amplifier cannot operate with negative load such that motor is continuously driven by load for more than several seconds.

[e.g.]
・Downward driving force of motor (No counterweight)
 Please contact us to apply this system to negative load.

■ Load mass (ML)

When using this system in the situation that load mass (ML) is too large compared to mover mass, main circuit power supply overvoltage detection or regenerative error can be activated when decelerating.

In this case, the following processes are needed. Please contact us for the details.
 (1) Decrease force limit.
 (2) Lengthen acceleration time (slow down)
 (3) Decrease maximum velocity in use.
 (4) Install external regenerative resistor (optional).

11.3 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.

11.3.1 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. Selection

11.3.2 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]
Keϕ : Voltage constant per phase [Vrms/min^{-1}] (Motor constant)
KT : Torque constant [N·m/Arms] (Motor constant)
N : Motor rotational velocity [min^{-1}]
Rϕ : 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]

11.3.3 Selection of regenerative resistor

Judge whether an internal regenerative resistor can be used from the calculation result. Moreover, when you cannot use it, determine the capacity of an external regeneration resistor.

■ Allowable power of an internal regenerative resistor
If the value of the regeneration effective power "PM" by the calculation result is below the value of [PRI] of the following table, an internal regenerative resistor can be used. Please use an external regenerative resistor at excepting conditions below.

Servo amplifier model number	Allowable regeneration resistance power to be used with an internal regenerative resistor [PRI]	Instantaneous capacity	Internal resistance value
RS3#01A##A#	5 W or less	408 J	50 Ω
RS3#02A##A#	5 W or less	408 J	50 Ω
RS3#03A##A#	5 W or less	408 J	50 Ω
RS3A05A##A#	20 W or less	743 J	17 Ω
RS3A07A##A#	60 W or less	2,300 J	10 Ω
RS3A10A##A#	90 W or less	4,400 J	10 Ω
RS3A15A##A#	120 W or less	6,400 J	6 Ω

◆ 400 VAC input

Servo amplifier model number	Allowable regeneration resistance power to be used with an internal regenerative resistor [PRI]	Instantaneous capacity	Internal resistance value
RS3#02A##A#	15 W or less	500 J	80 Ω
RS3A05A##A#	28 W or less	2,100 J	40 Ω
RS3A10A##A#	40 W or less	10,100 J	20 Ω

11. Selection

■ Allowable power of an external regenerative resistor
When regeneration effective power "PM" becomes more than the allowable power of the amplifier internal regenerative resistor, the optional external regenerative resistor which is shown at "11.2.4" can be connected and operated. Allowable regenerative power and minimum resistance value of regenerative resistor are shown in below table.

Servo amplifier/ power unit model number	Allowable regeneration resistance power to be used by an external regenerative resistor [PR0]	Allowable minimum resistance value of external regenerative resistor
RS3#01A##L#	125 W or less	35 Ω
RS3#02A##L#	125 W or less	35 Ω
RS3#03A##L#	125 W or less	35 Ω
RS3A05A##L#	250 W or less	17 Ω
RS3A07A##L#	500 W or less	10 Ω
RS3A10A##L#	500 W or less	10 Ω
RS3A15A##L#	500 W or less	6 Ω
RS3A30A##L#	500 W or less	2.5 Ω
RS3PAA270##	500 W or less	2.5 Ω

◆ 400 VAC input

Servo amplifier/ power unit model number	Allowable regeneration resistance power to be used by an external regenerative resistor [PR0]	Allowable minimum resistance value of external regenerative resistor
RS3#02A##L#	125 W or less	80 Ω
RS3A05A##L#	220 W or less	40 Ω
RS3A10A##L#	500 W or less	20 Ω
RS3C15A##L#	1,000 W or less	13 Ω
RS3C30A##M#	2,000 W or less	6.5 Ω
RS3PAC550##	5,000 W or less	2.4 Ω

* When regeneration effective power PM exceeds the maximum permitted power (PRO) of the external regeneration resistor, reconsider the acceleration constant, load inertia, etc.
* RS3PAA270 and RS3PAC550 power unit have no built-in regenerative resistor so external regenerative resistor shall be connected for use.
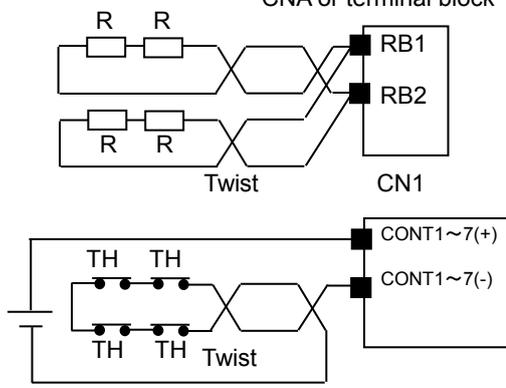* For use of external regenerative resistor, "02: External_R" shall be selected into regenerative resistor selection and resistance value shall be set correct. Refer the section 11.3.8 for detail. Average power monitor doesn't show accurate if resistance value is not set correct.

11.3.4 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.

Servo amplifier model number	[PM]	20W or less	30W or less	55W or less	60W or less	110W or less	125W or less
RS3#01A##L# RS3#02A##L# RS3#03A##L#	Resistor Sign	B×1	D×1	F×1	C×2	E×2	D×4
	Connection Number	Ⅲ	Ⅲ	Ⅲ	Ⅴ	Ⅴ	Ⅵ

Servo amplifier model number	[PM]	55W or less	125W or less	250W or less
RS305A##L#	Resistor Sign	G×1	H×1	I×2
	Connection Number	Ⅲ	Ⅲ	Ⅳ

Servo amplifier model number	[PM]	125W or less	250W or less	500W or less
RS3A07A##L#	Resistor Sign	I×1	H×2	I×4
	Connection Number	Ⅲ	Ⅴ	Ⅵ

Servo amplifier model number	[PM]	125W or less	250W or less	500W or less
RS3A10A##L#	Resistor Sign	I × 1	H × 2	I × 4
	Connection Number	Ⅲ	Ⅴ	Ⅵ

Servo amplifier model number	[PM]	125W or less	250W or less	500W or less
RS3A15A##L#	Resistor Sign	J × 1	K × 2	J × 4
	Connection Number	Ⅲ	Ⅴ	Ⅵ

Servo amplifier model number	[PM]	125W or less	250W or less	500W or less
RS3A30A##L#	Resistor Sign	J × 1	M × 1	M × 2
	Connection Number	Ⅲ	Ⅲ	Ⅴ

Power unit model number	[PM]	250W or less	500W or less
RS3PAA270##	Resistor Sign	L × 2	I × 4
	Connection Number	Ⅴ	Ⅹ

* 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. Selection

◆ 400 VAC input

Servo amplifier model number	[PM]	125W or less		
RS3C02A##A#	Resistor Sign	A' × 1		
	Connection Number	III		

Servo amplifier model number	[PM]	125W or less	250W or less	
RS3C05A##A#	Resistor Sign	B' × 1	A' × 2	
	Connection Number	III	V	

Servo amplifier model number	[PM]	125W or less	250W or less	500W or less
RS3C10A##A#	Resistor Sign	C' × 1	B' × 2	C' × 4
	Connection Number	III	V	VI

Servo amplifier model number	[PM]	125W or less	250W or less	500W or less	1kW or less
RS3C15A##L#	Resistor Sign	D' × 1	E' × 2	D' × 4	E' × 8
	Connection Number	III	IV	VI	VII

Servo amplifier model number	[PM]	125W or less	250W or less	500W or less	1kW or less	2kW or less
RS3C30A##M#	Resistor Sign	E' × 1	D' × 2	E' × 4	D' × 8	E' × 16
	Connection Number	III	V	VI	VIII	IX

Power unit model number	[PM]	250W or less	500W or less	1kW or less	2kW or less	4kW or less
RS3PAC550##	Resistor Sign	G' × 2	F' × 4	C' × 8	B' × 16	A' × 32
	Connection Number	V	X	XI	IX	XII

* 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.

11.3 Selection of regenerative resistor

11.3.5 Specification of external regenerative resistor

The resistor model name corresponds with the sign of the external regeneration resistor selected for the preceding clause.

◆ 200 VAC input

Resistor Sign	Resistor Model Number	Rated power [PR]	Resistance Value	Thermostat Detection temperature (Contact specification)	Permissible Effective Power [PM]	Allowable instantaneous capacity [JI]	Mass
A	REGIST-080W100B	80W	100Ω		20W	35J	0.19kg
B	REGIST-080W50B	80W	50Ω	135°C±7°C (Switching contact b)	20W	35J	
C	REGIST-120W100B	120W	100Ω		30W	50J	0.24kg
D	REGIST-120W50B	120W	50Ω		30W	80J	
E	REGIST-220W100B	220W	100Ω		55W	90J	
F	REGIST-220W50B	220W	50Ω		55W	125J	0.44kg
G	REGIST-220W20B	220W	20Ω		55W	210J	
H	REGIST-500CW20B	500W	20Ω		125W	9,300J	
I	REGIST-500CW10B	500W	10Ω	100°C±5°C (Switching contact b)	125W	9,300J	
J	REGIST-500CW7B	500W	7Ω		125W	7,500J	1.4kg
K	REGIST-500CW14B	500W	14Ω		125W	13,000J	
L	REGIST-500CW5B	500W	5Ω		125W	8,000J	
M	REGIST-1000W6R7B	1000W	6.7Ω	140°C±5°C (Switching contact b)	250W	26,000J	3.0kg

◆ 400 VAC input

Resistor Sign	Resistor Model Number	Rated power [PR]	Resistance Value	Thermostat Detection temperature (Contact specification)	Permissible Effective Power [PM]	Allowable instantaneous capacity [JI]	Mass
A'	REGIST-500CW80B	500W	80Ω		125W	4,200J	
B'	REGIST-500CW40B	500W	40Ω		125W	6,400J	
C'	REGIST-500CW20B	500W	20Ω	100°C±5°C (Switching contact b)	125W	9,300J	
D'	REGIST-500CW14B	500W	14Ω		125W	13,000J	1.4kg
E'	REGIST-500CW7B	500W	7Ω		125W	7,500J	
F'	REGIST-500CW10B	500W	10Ω		125W	9,300J	
G'	REGIST-500CW5B	500W	5Ω		125W	8,000J	

* Refer the section 12.9.10 for external dimension of regenerative resistor.
* Permissible Effective Power value is at condition of natural air cooling.

11. Selection

11.3.6 Connection of regenerative resistor

The connection method of a resistor corresponds with the connection number of the external regeneration resistor selected by the 4) clause.

■ Connection of regenerative resistor

Connection Number Ⅲ	Connection Number Ⅳ
■ One resistance is connected.	■ Series connection about two resistances.
Connect a thermostat to the general-purpose input of CN1.	Connect a thermostat to the general-purpose input of CN1.
Connection Number Ⅴ	Connection Number Ⅵ
■ Parallel connection about two resistances.	■ Series/ parallel connection about four resistances.
Connect a thermostat to the general-purpose input of CN1.	Connect a thermostat to the general-purpose input of CN1.
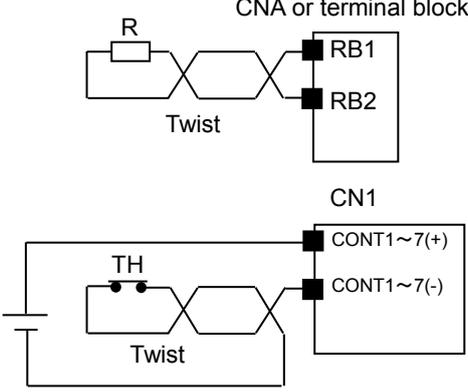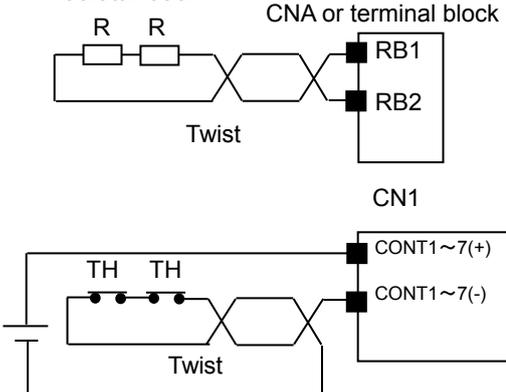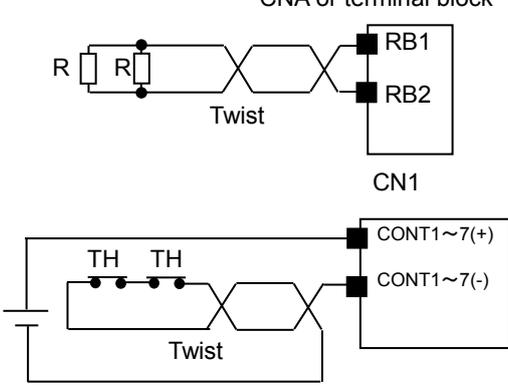
* Thermostat shall be connected to general input in CN2.
* For amplifier: capacity 75A/100A/150A (200VAC input type), mount an external regenerative resistor to terminals of RB1 and RB2 after removing short-bar between RB1 and RB4.
* For RS3C02/05/10, mount an external regenerative resistor to terminals of RB1 and RB2 after removing short-wire between RB1 and RB4.
* Do not connect short-wire between terminals of RB1 and RB2.

11.3 Selection of regenerative resistor

Connection Number Ⅶ	Connection Number Ⅷ
■ 8 resistors connected serial/parallel.	■ 8 resistors connected serial/parallel.

Connection Number Ⅸ
■ 16 resistors connected serial/parallel.
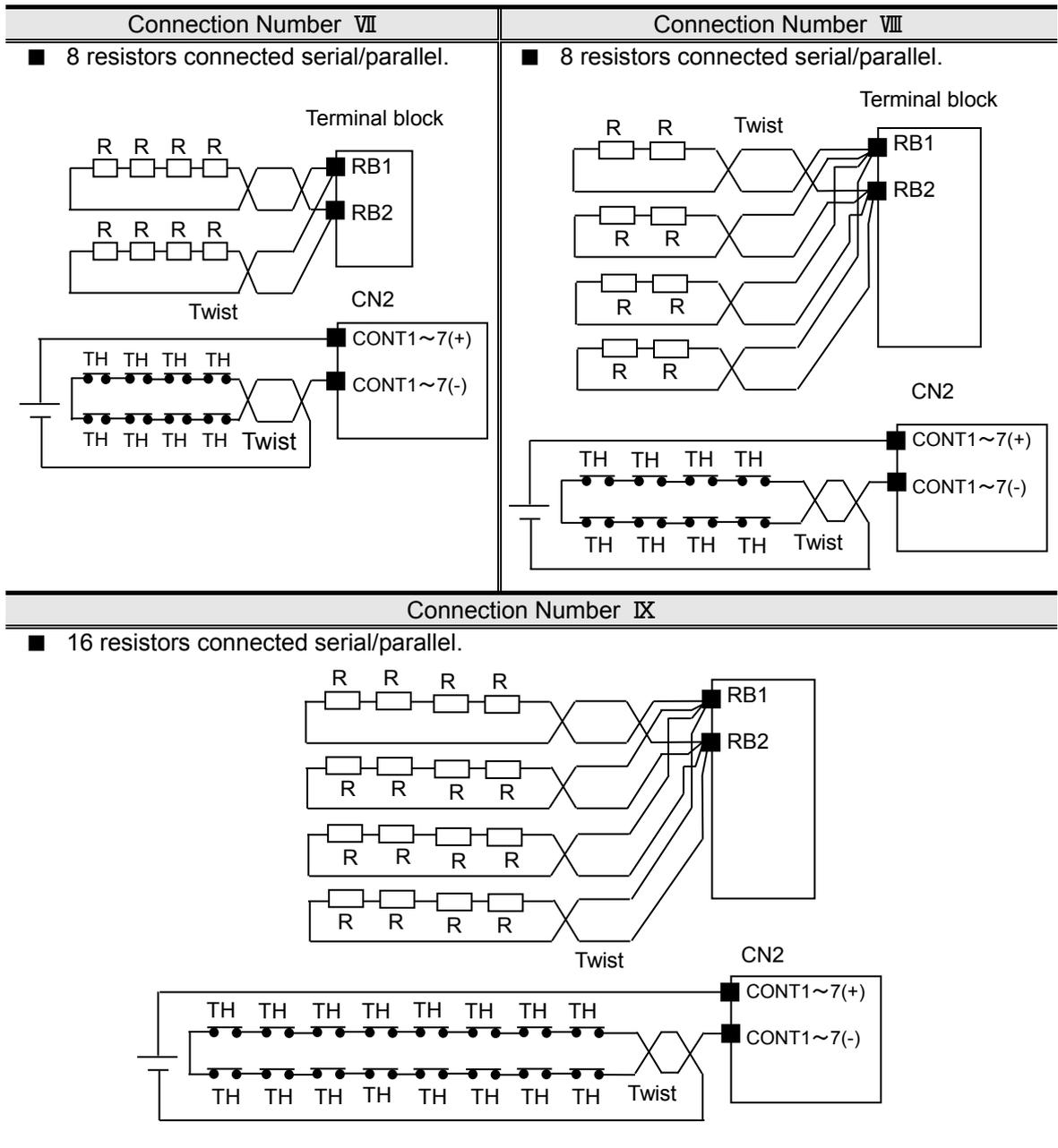
* Thermostat shall be connected to general input in CN2.
* For RS3C02/05/10, mount an external regenerative resistor to terminals of RB1 and RB2 after removing short-wire between RB1 and RB4.
* Do not connect short-wire between terminals of RB1 and RB2.

11-18

11. Selection

Connection Number X

■ 4 resistors connected parallel.

R [R] [R] [R] Twist ■ RB1
■ RB2 Terminal block

CN2
TH TH TH TH Twist ■ CONT1～7(+)
■ CONT1～7(-)
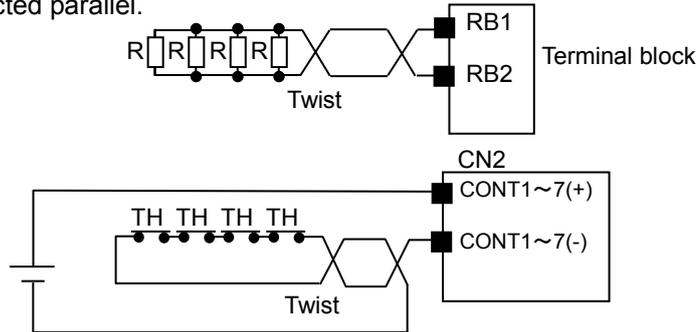
Connection Number XI

■ 8 resistors connected serial/parallel.

R [R] [R] [R]
R [R] [R] [R] Twist ■ RB1
■ RB2 Terminal block

CN2
TH TH TH TH
TH TH TH TH Twist ■ CONT1～7(+)
■ CONT1～7(-)
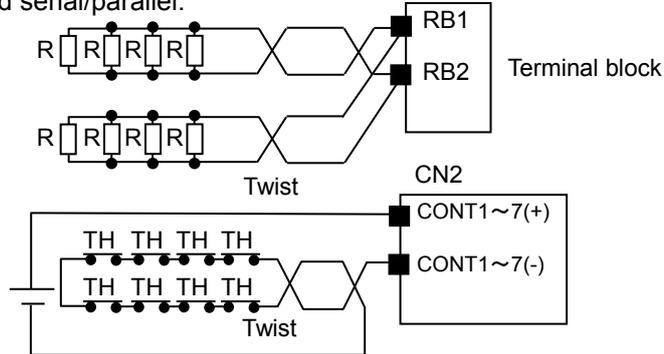
Connection Number XII

■ 32 resistors connected serial/parallel.

R [R] [R] [R]
R [R] [R] [R]
R [R] [R] [R]
R [R] [R] [R]
R [R] [R] [R]
R [R] [R] [R]
R [R] [R] [R]
R [R] [R] [R] Twist

■ RB1
■ RB2 Terminal block

CN2
TH TH TH TH TH TH TH TH TH TH TH TH TH TH TH TH
TH TH TH TH TH TH TH TH TH TH TH TH TH TH TH TH Twist ■ CONT1～7(+)
■ CONT1～7(-)
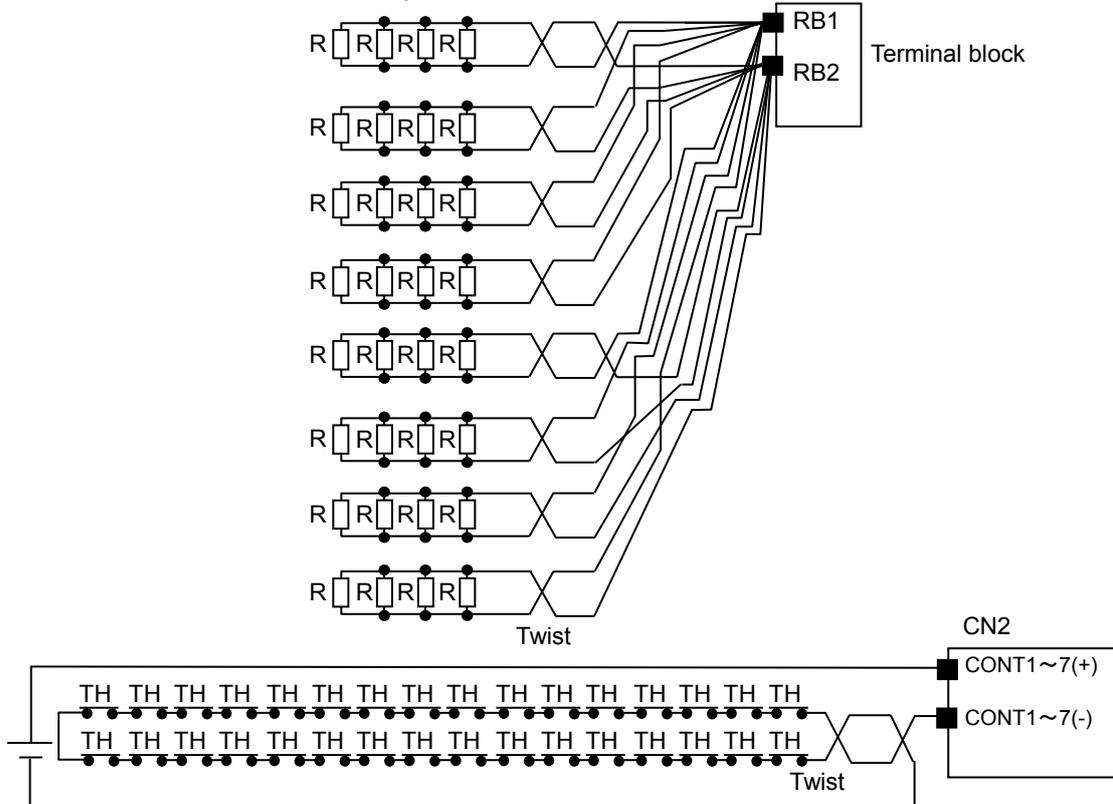
* Thermostat shall be connected to general input in CN2.
* Do not connect short-wire between terminals of RB1 and RB2.

11.3.7 Thermostat connection of external regenerative resistor

Connect a thermostat to either of "the general-purpose inputs CONT1-CONT8". Depending on the connected general-purpose input signal terminal, please set the Index 0x20F8-3 "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 the Index 0x20F8-3 "External Trip Input Function [EXT-E]" and CONT6 is turned off. Alarm AL.55 will be output from the servo amplifier 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".

11.3.8 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.

   ◆ Index 0x20FD-2 "Regenerative resistor selection"
      ● Must set "01: Built-in_R" when internal regenerative resistor is used.
      ● Must set "02: External_R" when external regenerative resistor is used.

   ◆ Index 0x20F8-3 "External Trip Input Function [EXT-E]"
      ● When thermostat is connected to the servo amplifier, please set the Index 0x20F8-3 "External Trip Input Function [EXT-E]" depending on the connected general-purpose input signal terminal.

■ The protection functions are divided into three main types:

   ◆ Protection for a short-time, high load factor (using built-in or external regenerative resistor):
   ◆ An error is detected when the power absorption of regenerative resistor is extremely high over a short time period (100msec to 10 seconds). A 'Regenerative Error' alarm "AL.43" is issued when this error is detected.

   ◆ Protection when allowable power absorption is exceeded for long time (using built-in regenerative resistor):
   An error is detected when the power absorption of the built-in regenerative resistor exceeds the allowable power absorption over a long time period (from a few seconds to a few minutes). An 'Internal Overheat' alarm "AL.54" 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.

   ◆ Monitor ID4C Regenerative power monitor can substitute of calculated value above.

11. Selection

11.3.9 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 200 VAC specification

$$\text{Regeneration effective power [PM](W)} = \frac{400(V) \times 400(V)}{\text{Regeneration resistance}(\Omega)} \times \frac{\text{Regenerative Resistor Operation Percentage (\%)}}{100(\%)}$$

◆ Input Supply Voltage: In case of 100 VAC specification

$$\text{Regeneration effective power [PM](W)} = \frac{200(V) \times 200(V)}{\text{Regeneration resistance}(\Omega)} \times \frac{\text{Regenerative Resistor Operation Percentage (\%)}}{100(\%)}$$

◆ Input Supply Voltage: In case of 400 VAC specification

$$\text{Regeneration effective power [PM](W)} = \frac{800(V) \times 800(V)}{\text{Regeneration resistance}(\Omega)} \times \frac{\text{Regenerative Resistor Operation Percentage (\%)}}{100(\%)}$$

■ Calculation Example
Input Supply Voltage: [200 VAC Specification]
Regeneration resistance value: 50 Ω [Built-in Regenerative Resistor]
Monitor Value (RegP): 0.12%

$$\text{Regeneration effective power [PM](W)} = \frac{400(V) \times 400(V)}{\text{Regeneration resistance}(\Omega)} \times \frac{0.12(\%)}{100(\%)} = 3.84 \quad (W)$$

* 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 servo amplifier 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.

11.3.10 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. Therefore 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.

No Text on This Page.

12

Appendix

In this chapter, servo amplifier outline drawing and option parts are explained.

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

■ Servo amplifier/power unit/amplifier unit implement the standards examinations below.

Product model NO.	Applicable laws and Regulations		Standard code	Certificate authorities
	Class	Detailed class		
RS3###A### #	UL/c-UL standards		UL61800-5-1	UL (Underwriters Laboratories inc.)
RS3###A### 0 (Safe Torque Off function Unequipped model)	Electrical safety	Electrical safety under Low Voltage Directive (2014/35/EU)	IEC61800-5-1 EN61800-5-1	TÜV (TÜV SÜD Japan, Ltd.)
	EMC	EMC under EMC Directive (2014/30/EU)	EN61000-6-2 IEC61800-3 (Note 1) EN61800-3 (Note 1)	TÜV (TÜV SÜD Japan, Ltd.)
RS3###A### 2 RS3###A### 4 (Safe Torque Off function equipped model)	Electrical safety	Electrical safety under Low Voltage Directive (2014/35/EU)	IEC61800-5-1 EN61800-5-1	TÜV (TÜV SÜD Japan, Ltd.) (Blue octagon)
	Functional Safety	Generic Functional safety	IEC61508 EN61508 (SIL3)	
		Functional safety under Machinery Directive (2006/42/EC)	IEC62061 EN62061(SILCL3)	
		Functional safety under Machinery Directive (2006/42/EC)	EN ISO13849-1/ 2015(Cat.3, PL=e)	
		Functional safety for PDS under Machinery Directive (2006/42/EC)	IEC61800-5-2 EN61800-5-2	
	EMC	EMC under EMC Directive(2014/30/EU)	IEC61800-3 (Note 1) EN61800-3 (Note 1)	
		Functional safety EMC for machine, factory automation application	IEC61326-3-1 EN61326-3-1	
RS3###A### #	KC Mark		KN61000-6-2 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

■ The servo motor implements the attestation examination to the following standards.

Standards	Standards code	Certificate authorities
UL standards	UL1004-1 UL1004-5	UL (Underwriters Laboratories inc.)
EN Directive	EN60034-1 EN60034-5	TÜV (TÜV SÜD Japan, Ltd.)

* For products conforming to conformity standards, some specifications may differ from the standard product due to prerequisites necessary for obtaining approval. Contact us for more details.

12.1.2 Over-voltage Category, Protection Grade, Pollution Level

■ The "over-voltage category" of servo amplifier is "III" (EN61800-5-1). For 24VDC of control power and the interface, please use a DC power supply with reinforced and insulated input and outputs.

■ Make sure to install the servo amplifier 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 100/200V AC input type servo amplifiers are IP2X for 50A or less, IP1X for 100 to 300A and IP0X for 600A, and 400V AC input type servo amplifiers are IP2X for 100A or less, IP1X for 150 to 300A and IP0X for 800A. The control panel installation configuration (under IP54) must exclude exposure to water, oil, carbon, dust, etc.

12.1.3 Connection and installation
Be careful of connection and installation as follows.

* Always ground the protective ground terminals of the servo amplifier/power unit/amplifier unit to the power supply ground.

* 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 earth terminal to the power supply earth.

* Connect grounding wire to servo amplifier/power unit/amplifier unit by using a crimping terminal with insulated tube, so that the connected wire will not touch the neighboring terminals.

* For wire relays, use a fixed terminal block to connect wires; never connect wires directly.

* Connect an EMC filter to the input power supply of servo amplifier/power unit.

* 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.

12.1.4 UL File Number

The UL file number of servo amplifier and servo motor is as follows.
Can check from the website of UL. http://www.ul.com/database/

■ The UL file number of servo amplifier: E179775
■ The UL file number of servo motor: E179832

12.2 Compliance with EN Directives

We implement the conformity verification test of "Low Voltage Directive" and "an EMC command" 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 (Servo amplifier)	—	—	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 (Servo amplifier / 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 servo amplifier 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.

■ 200V Input

No.	Name	Remarks
A	Control panel	-
B	Servo amplifier	-
C	Servo motor	-
i	Noise filter (Recommended prevention components)	RS3A01 to RS3A07: HF3030C-SZA: SOSHIN ELECTRIC Co. Ltd. Rated voltage/rated current：Line-Line 480V AC / 30A RS3A10 to RS3A15: 3SUPF-CH40M-F: OKAYA ELECTRIC INDUSTRIES CO., LTD. Rated voltage/rated current：Line-Line 500V AC / 40A RS3A30: 3SUPF-CH80M-F: OKAYA ELECTRIC INDUSTRIES CO., LTD. Rated voltage/rated current：Line-Line 500V AC / 40A
ii	Surge-absorber (Recommended prevention components)	LV275DI-U4: OKAYA ELECTRIC INDUSTRIES CO.,LTD.
iii	Clamp grounding	-
iv	Encoder cable	Shield cable
v	Servo motor power cable	Shield cable

* 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 servo amplifier at a short distance from the secondary side of noise filter, and wire the primary side and secondary side of noise filter separately.

■ 200V Input (600A)

No.	Name	Remarks
A	Control panel	-
B	Power unit	-
C	Amplifier unit	-
D	Servo motor	-
i	Noise filter (Recommended prevention components)	3SUPF-CH150M-F: OKAYA ELECTRIC INDUSTRIES CO., LTD. Rated voltage/rated current：Line-Line 500V AC / 150A
ii	Surge-absorber (Recommended prevention components)	LV275DI-U4: OKAYA ELECTRIC INDUSTRIES CO.,LTD.
iii	Clamp grounding	-
iv	Encoder cable	Shield cable
v	Servo motor power cable	Shield cable

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 servo amplifier at a short distance from the secondary side of noise filter, and wire the primary side and secondary side of noise filter separately.

12. Appendix

■ 400V Input

No.	Name	Remarks
A	Control panel	-
B	Servo amplifier	-
C	Servo motor	-
D	Host device	-

i	Noise filter (Recommended prevention components)	RS3C02: HF3010C-SZA: SOSHIN ELECTRIC Co. Ltd.
		  Rated voltage/rated current: Line-Line 500V AC / 10A
		RS3C05: HF3020C-SZA: SOSHIN ELECTRIC Co. Ltd.
		  Rated voltage/rated current: Line-Line 500V AC / 20A
		RS3C10: HF3030C-SZA: SOSHIN ELECTRIC Co. Ltd.
		  Rated voltage/rated current: Line-Line 500V AC / 30A
		RS3C15/30: HF3100C-SZC: SOSHIN ELECTRIC Co. Ltd.
		  Rated voltage/rated current: Line-Line 500V AC / 100A

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	RS3C02/05/10: GRFC-13 (KITAGAWA INDUSTRIES CO., LTD.)
vii	Split Ferrite Core	RS3C02: E04SR401938 (SEIWA ELECTRIC MFG CO., Ltd.)
viii	Ring core	RS3C15/30: RC5075Y (SOSHIN ELECTRIC 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 servo amplifier 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.

■ 400V Input (800A)

No.	Name	Remarks
A	Control panel	—
B	Power unit	—
C	Amplifier unit	—
D	Servo motor	—
E	Upper device	—
i	Noise filter (Recommended prevention components)	HF3200C-SZB-4DEDE: SOSHIN ELECTRIC Co. Ltd. Rated voltage/rated current: Line-Line 500V AC / 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. Appendix

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.)
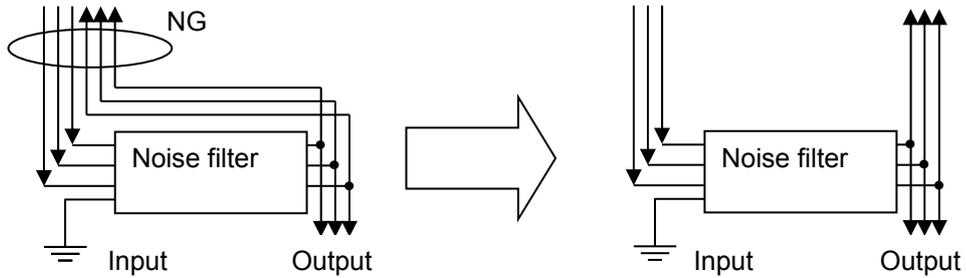
■ Each of earth line shall be connected to grounding plate in a control panel by single-point.
Also in case of multi axes construction in same control panel, grounding by single-point.
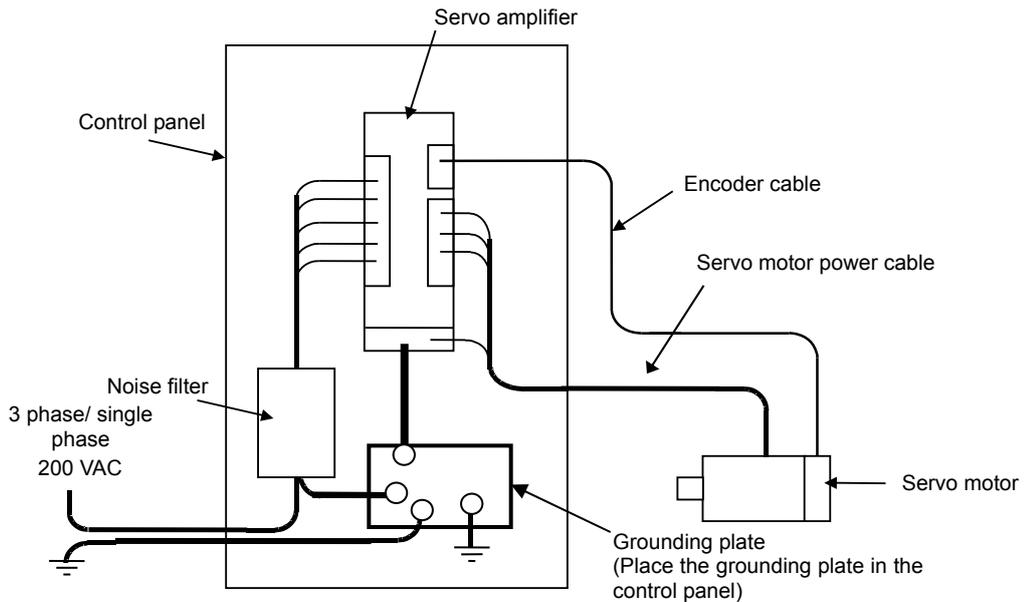
12.3 Servo motor dimensions

Refer another document [M0011792].

12. Appendix

12.4 Servo motor data sheet

Refer another document [M0011792].

12.5 Servo amplifier dimensions

12.5.1   RS3□01A□HL□

12.5.2   RS3□02A□HL□

12. Appendix

12.5.3　RS3□03A□HL□

12.5.4　RS3A05A□HL□

12.5.5　RS3A07A□HL□
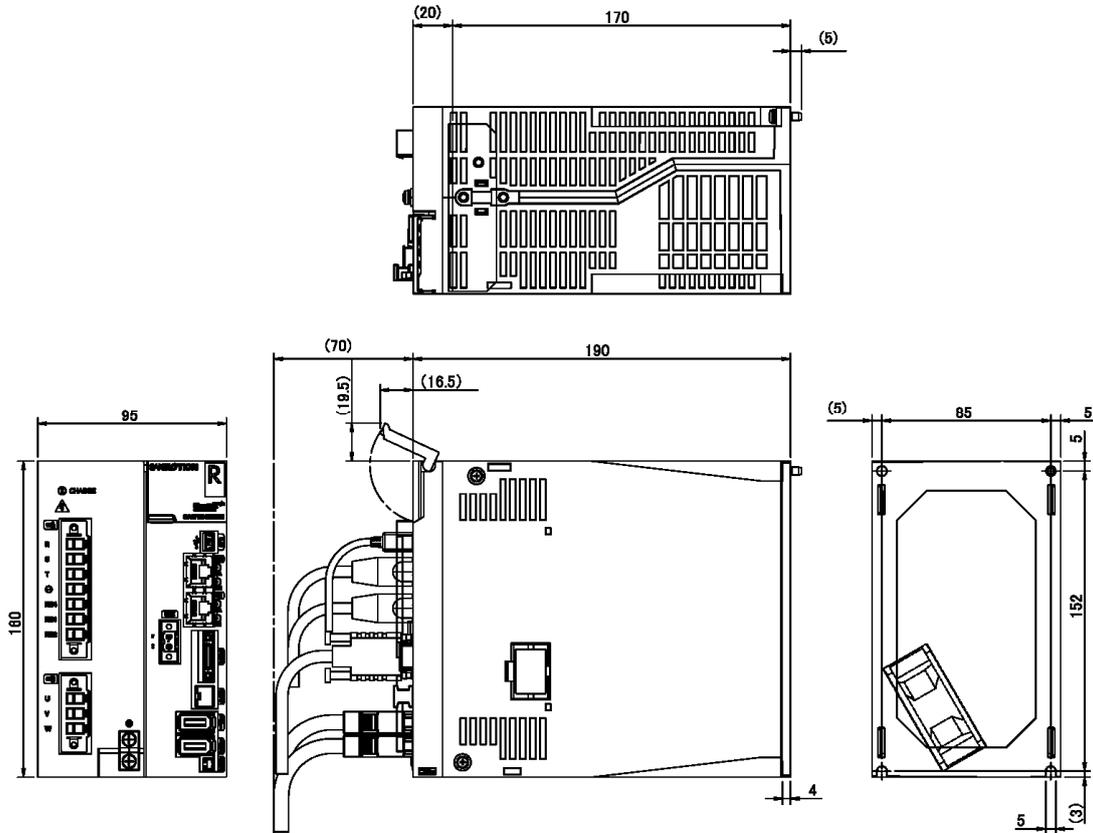
12.5.6　RS3A10A□HA□
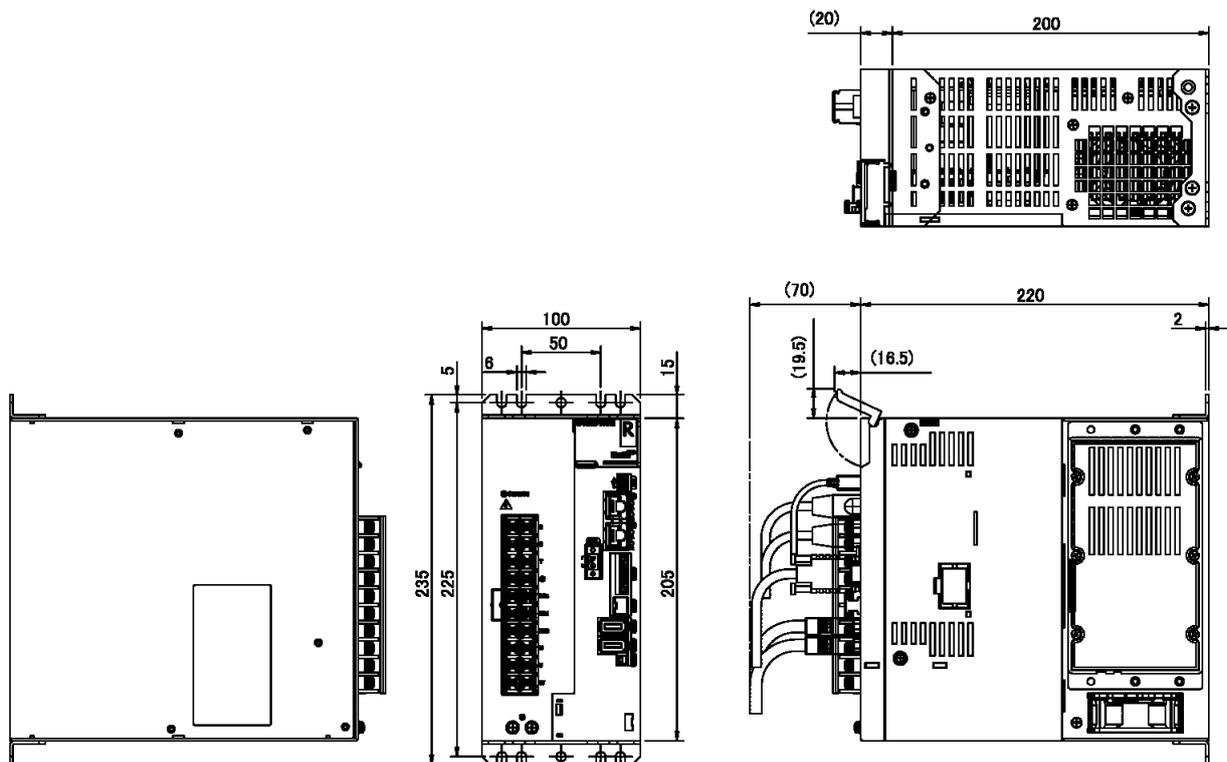
12. Appendix

12.5.7 RS3A15A☐HA☐
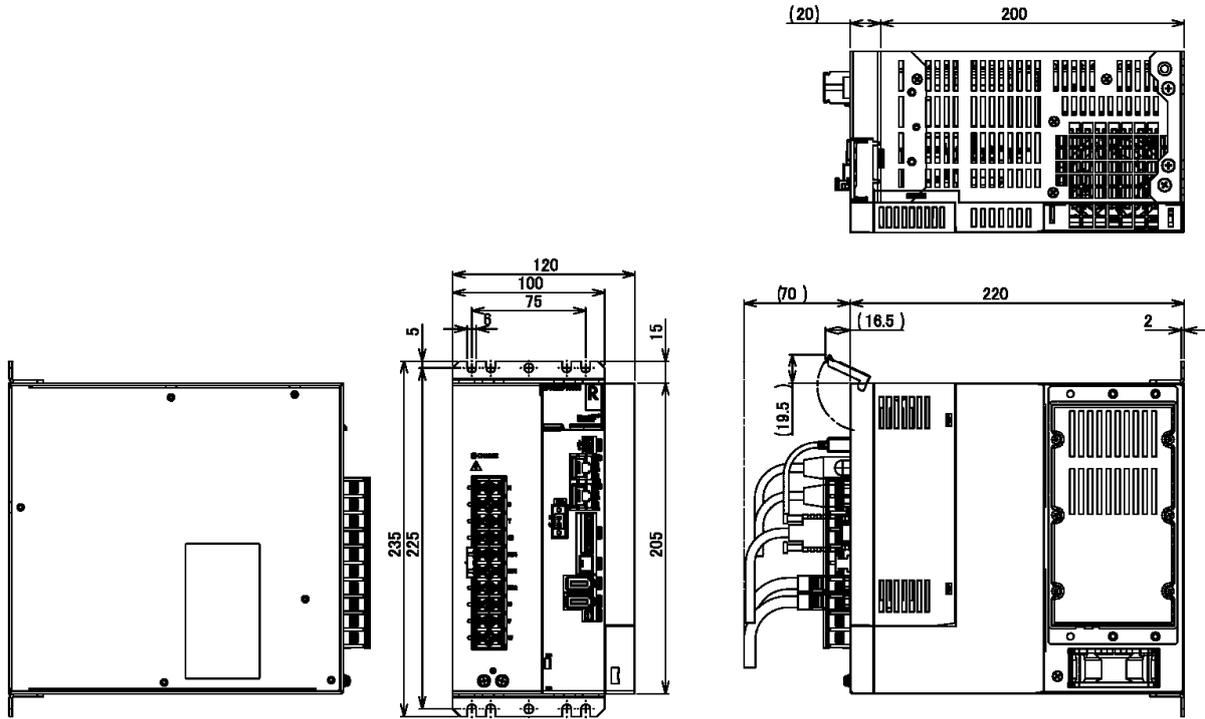
12.5.8 RS3A30A☐HL☐

12.5.9　Power unit ：RS3PAA270
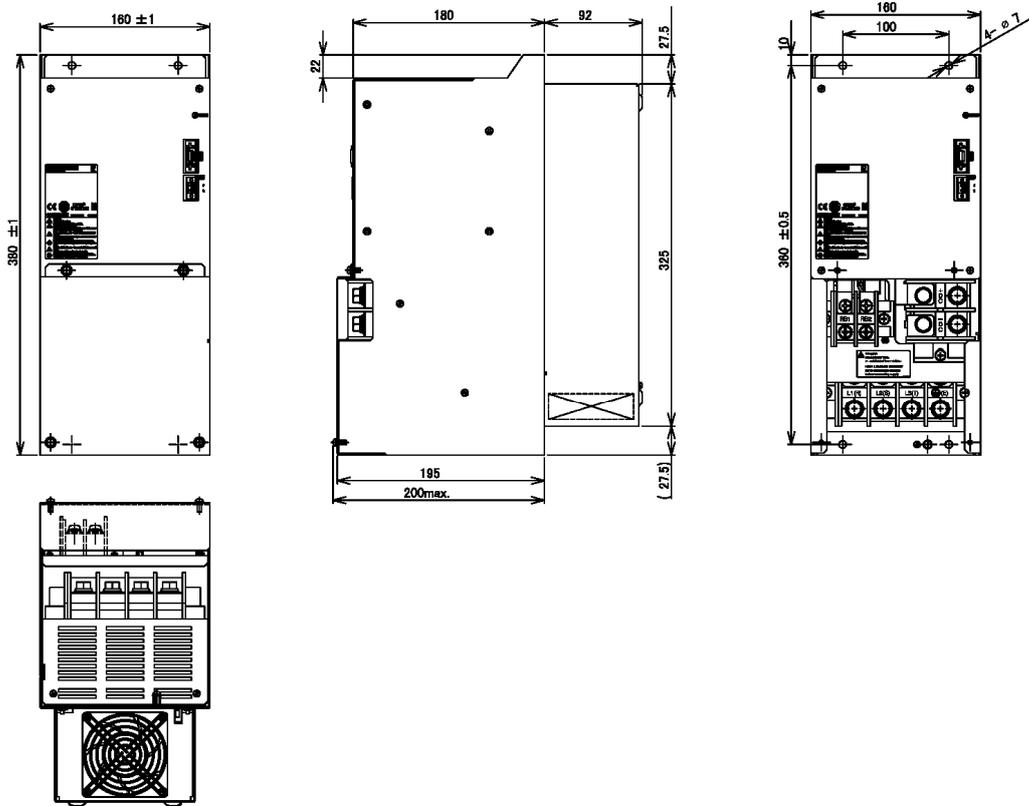
12.5.10　Amplifier unit ：RS3W60
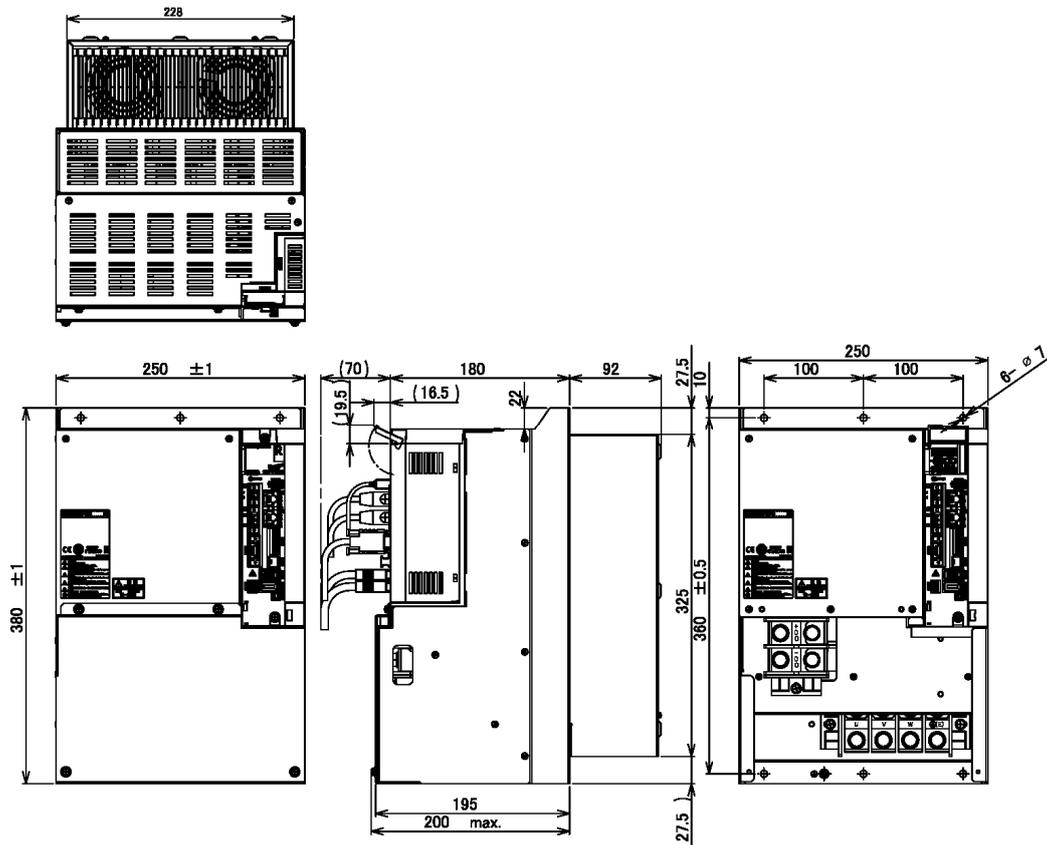
12. Appendix

12.5.11 Unit installation drawing (600 A)

RS3PAA270
Power unit

RS3W60
Amplifier unit

12.5.12 Unit installation drawing (800 A)

RS3PAC550
Power unit

RS3D80A
Amplifier unit

705

300

5

400

380
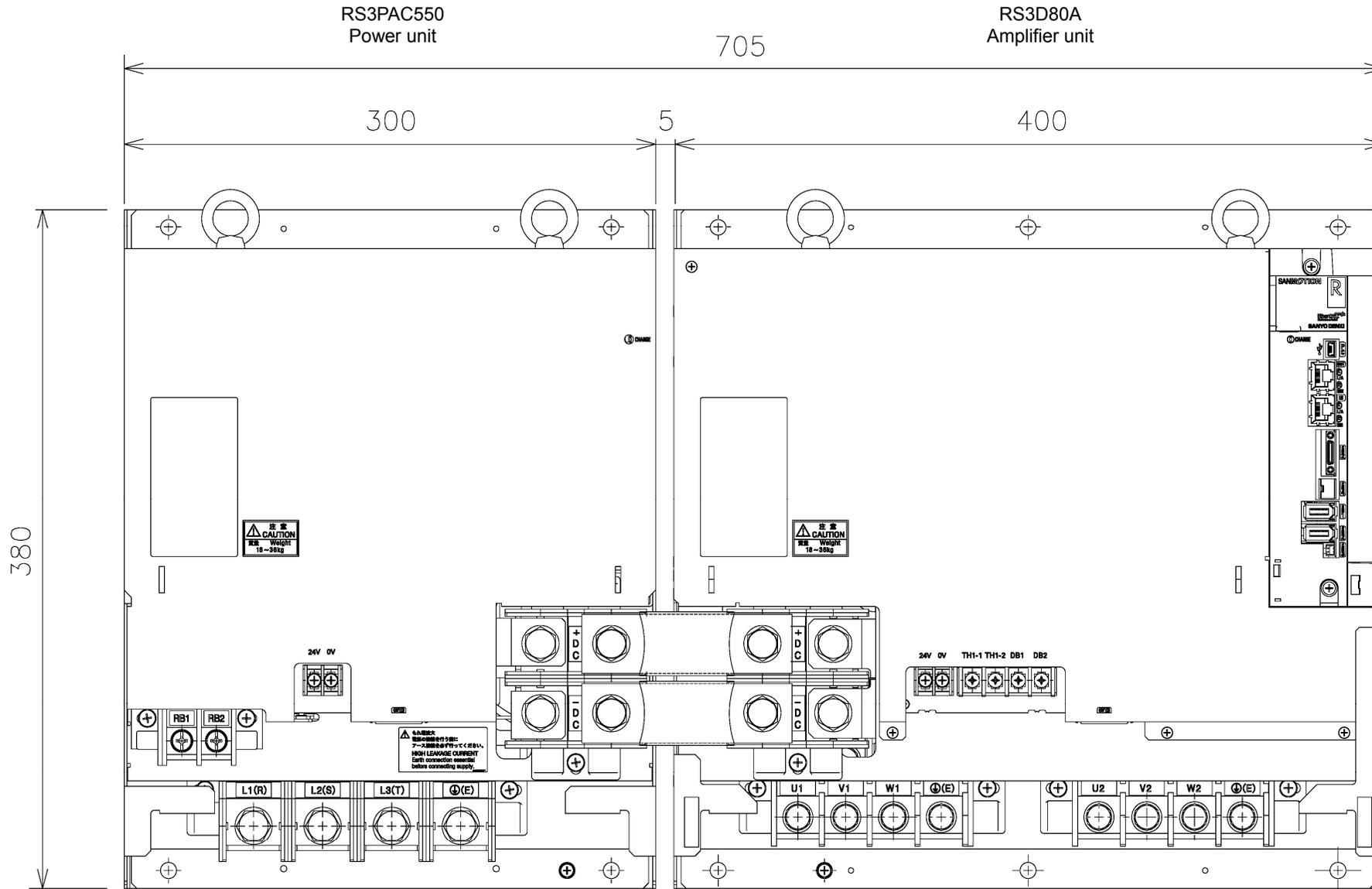
12. Appendix

12.5.13 RS3C02A□HA□

12.5.14 RS3C05A□HA□

12.5.15 RS3C10A□HA□

12.5.16 RS3C15A□HL□
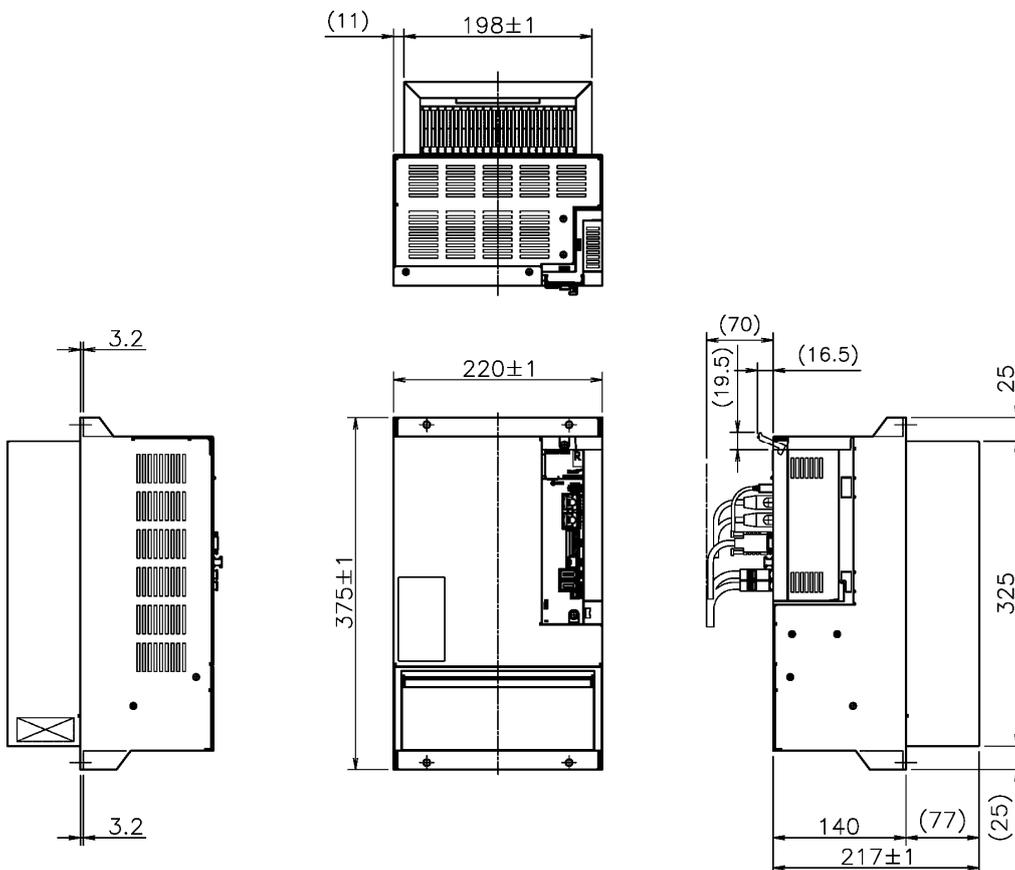
12. Appendix

12.5.17 RS3C30A□HM□
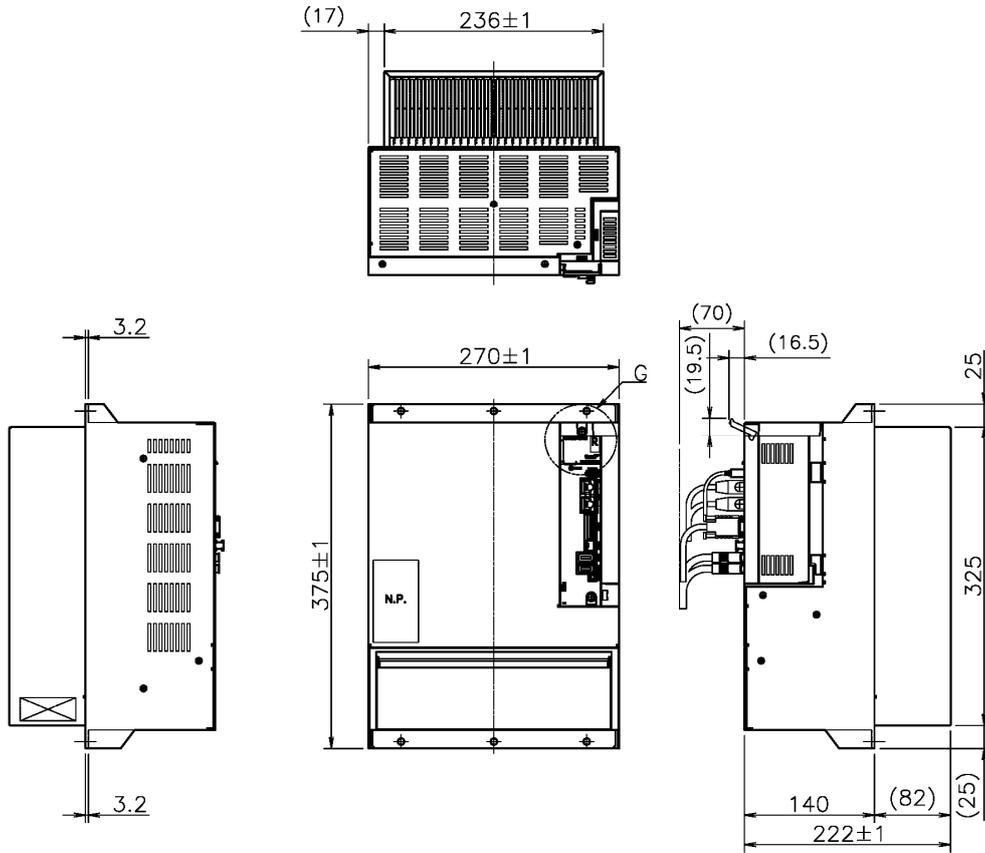
12.6 Power unit dimensions

12.6.1 RS3D80A□HM□

Heat radiation fin

270 ±1

15

Mounting panel dimensions (Reference)

250 ±0.5

4−M8

360 ±0.5

335

280

100 min.

3.2

Mounting direction

300 ±1

10

250 ±0.5

22

200

95

29.5

380 ±1

N.P.

360 ±0.5

N.P.

(336)

(323)

3.2

22

210

(220)

27.5

Air flow

Cooling fan

100 min.

4− ∅9

A

Detail of A

12-21

12. Appendix

12.7 Amplifier unit dimensions

12.7.1 RS3D80A□□M□

Mounting panel dimensions (Reference)

Detail of B

Detail of A
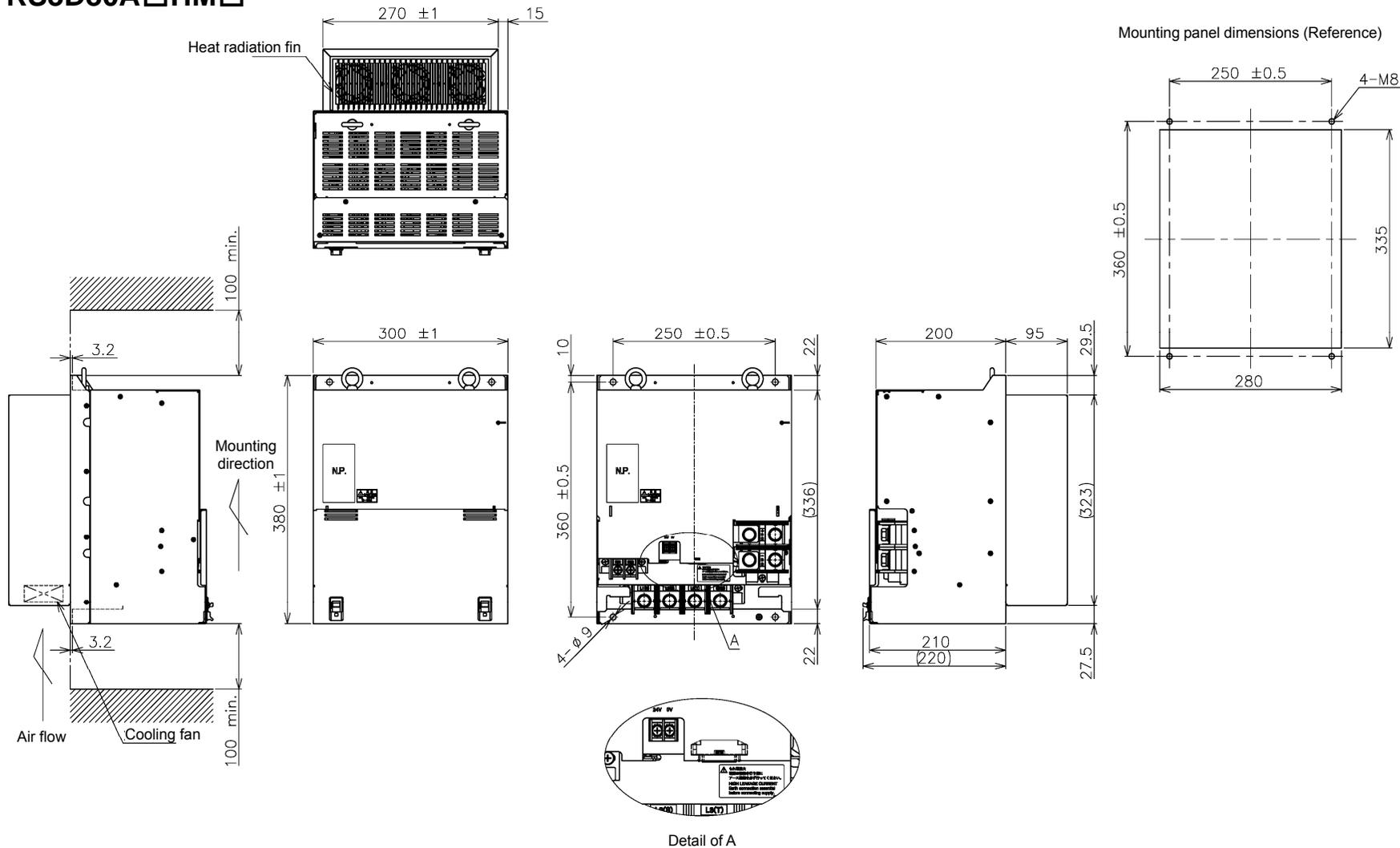
12.8 Optional parts

SANYO DENKI offers the following optional parts.

12.8.1 Connectors of servo amplifier

■ Model numbers of single connectors for RS3□01, RS3□02, RS3□03 and RS3A05

Connector No.	Item	SANYO DENKI model No.	Manufacturer's model No.	Manufacturer
IN, OUT	Ethermet For host unt connection	Not provided by our company. Please use shielded type modular plug (RJ-45) corresponding to the CAT5e standard.		
EN1,EN2	For encoder connection	AL-Y0012504-01	54599-1016	Molex Japan LLC
CNA	For input power supply, and regenerative resistance connection	AL-00686902-01	MSTBT2.5/8-STF-5.08LUB	Phoenix Contact Co. Ltd.
CNB	For servo motor connection	AL-Y0004079-01	MSTBT2.5/3-STF-5.08	
CN2	For general I/O signal	AL-00842383	HDR-E26MSG1+ and HDR-E26LPH	Honda Tsushin Kogyo Co. Ltd.
CN4 Note1)	For safety device connection (For short circuit)	AL-00849548-02	1971153-2	Tyco Electronics Japan G.K.
CN4	For safety device connection (For wiring)	AL-00718252-01	2013595-3	

Note1) If CN4 is unused (open), be sure to insert connecter for safety device (for short circuit) to CN4 of servo amplifier.
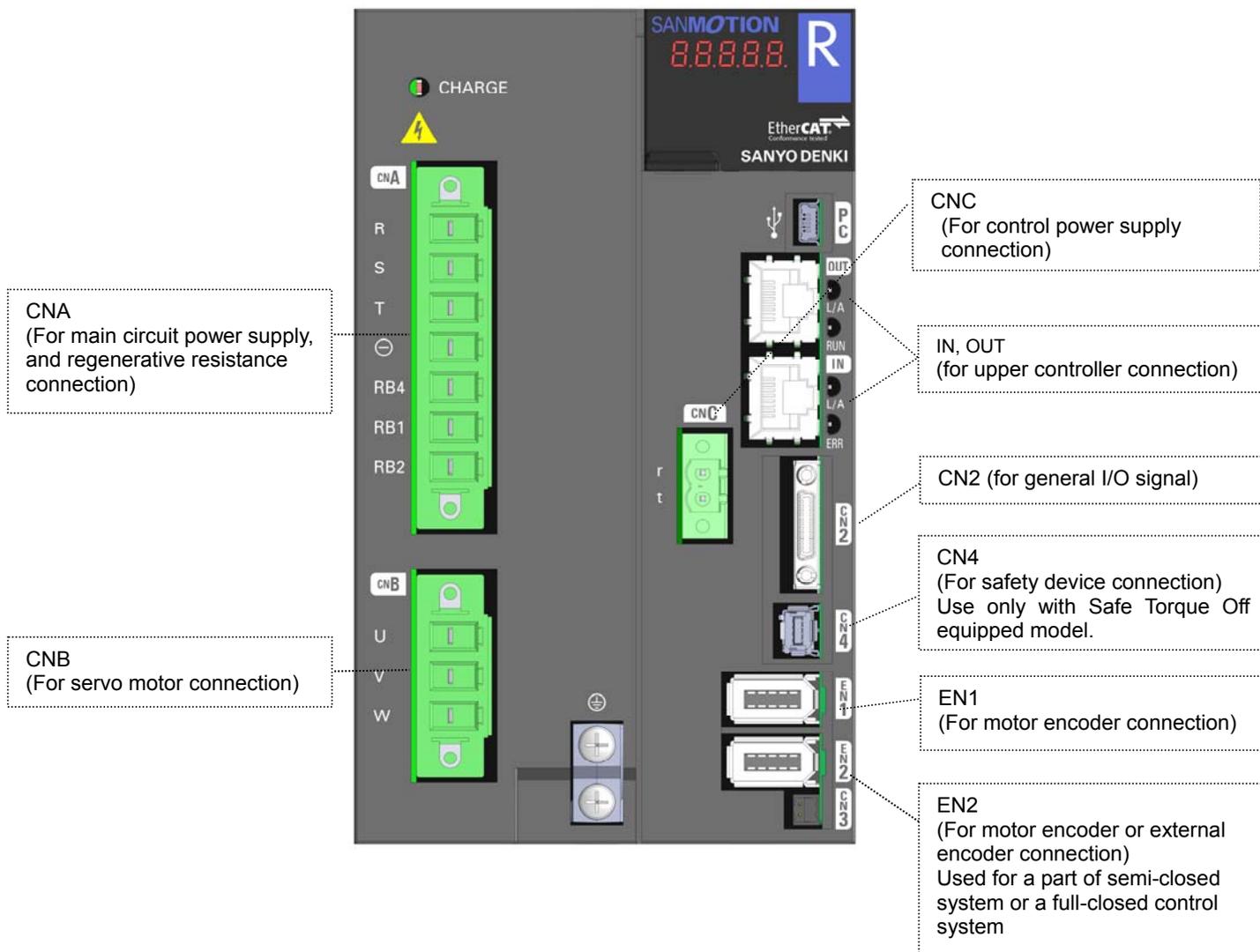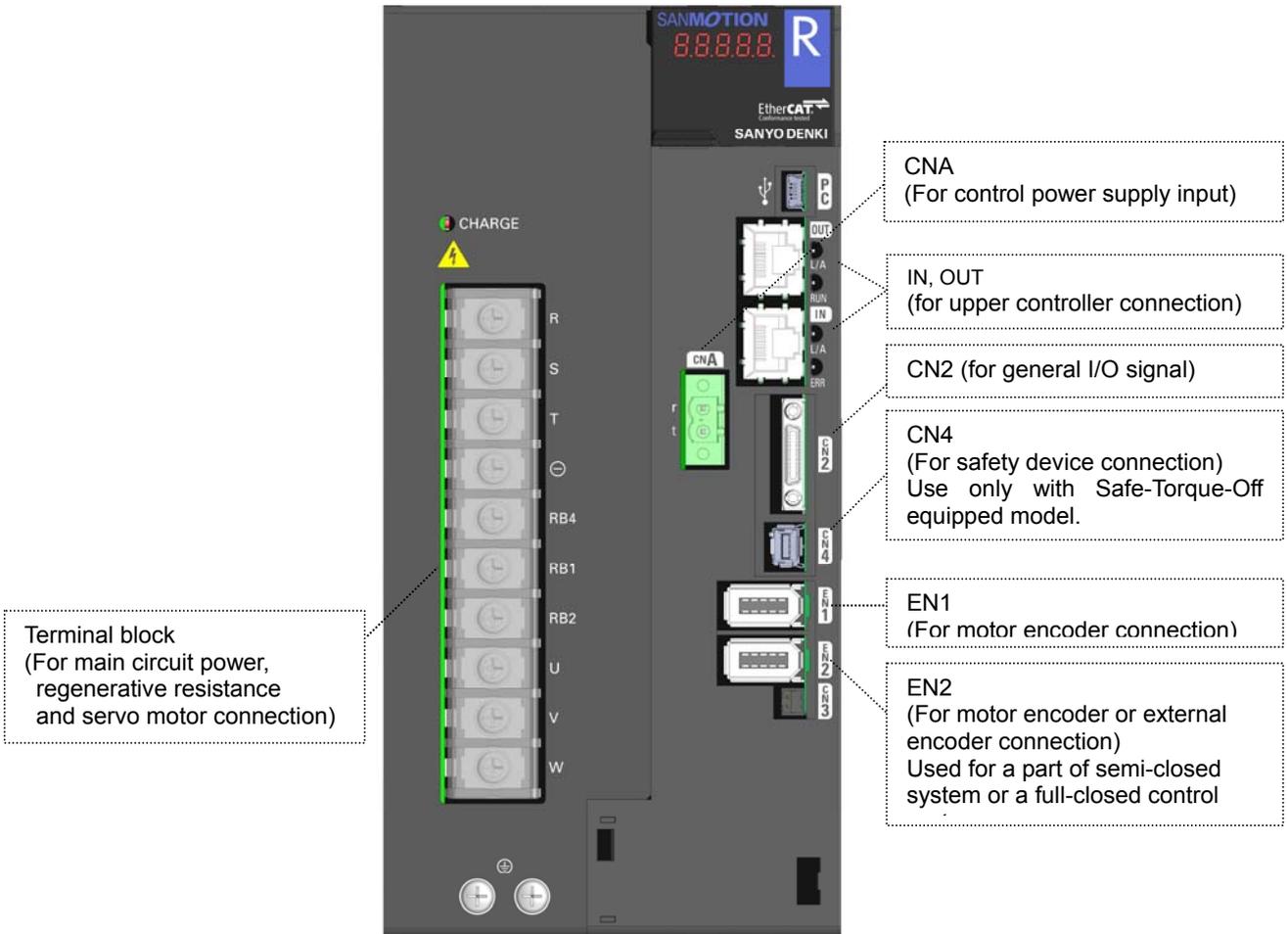
■ Model numbers of connector-kits for RS3□01, RS3□02, RS3□03, and RS3A05
(With safe-torque-off function)

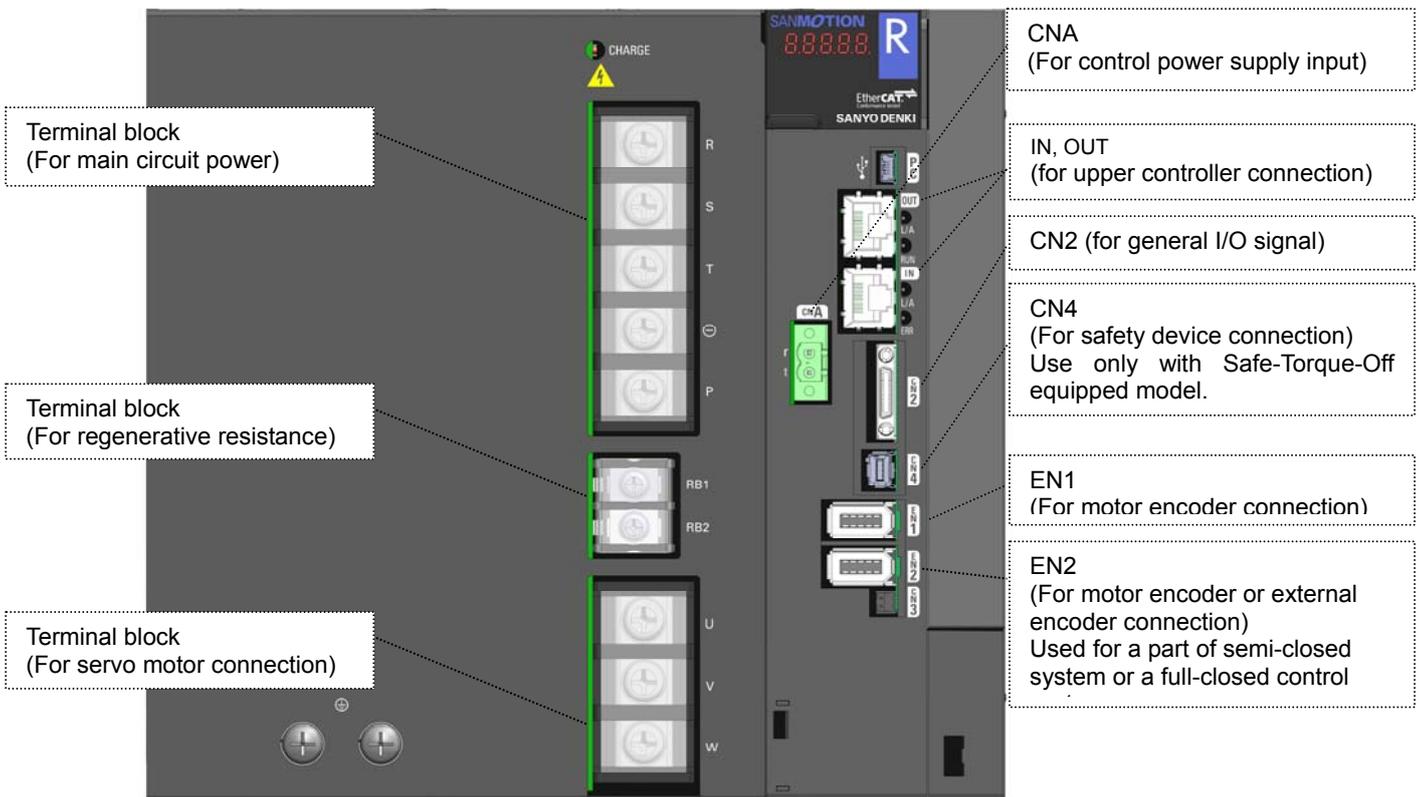| Connector No.	Item	SANYO DENKI model No.	Applicable servo amplifier model number	Remarks
EN1,CNA,CNB,CN2,CN4	Standard	AL-00977724	RS3###A2HL4/RS3###AAHL4	No regenerative resistance
EN1,CNB,CN2,CN4	Standard	AL-00977726	RS3###A2HA4/RS3###AAHA4	With regenerative resistance
,EN1,EN2,CNA,CNB,CN2,CN4	For fully-closed control system	AL-00977728	RS3###A2HL4/RS3###AAHL4	No regenerative resistance
EN1,EN2,CNB,CN2,CN4		AL-00977730	RS3###A2HA4/RS3###AAHA4	With regenerative resistance
EN1,CN2,CN4	Low voltage set	AL-00977732	RS3###A2H#4/RS3###AAH#4	-

* Mark "#" shows arbitrary numerical values or alphabets.
* CN4 in connector-kits is for safety device connection (wiring available). Our model number is AL-00718252-01.
* For amplifier with regenerative resistor, the wire of the regenerative resistor is to be connected to CNA, so CNA is equipped with amplifier. So no optional provisions are offered.

12. Appendix

RS3□01, RS3□02, RS3□03, RS3A05

CNA
(For input power supply,
and regenerative resistance
connection)

CNB
(For servo motor connection)

IN, OUT
(for upper controller connection)

CN2 (for general I/O signal)

CN4
(For safety device connection)
Use only with Safe Torque Off
equipped model.

EN1
(For motor encoder connection)

EN2
(For motor encoder or external
encoder connection)
Used for a part of semi-closed
system or a full-closed control
system
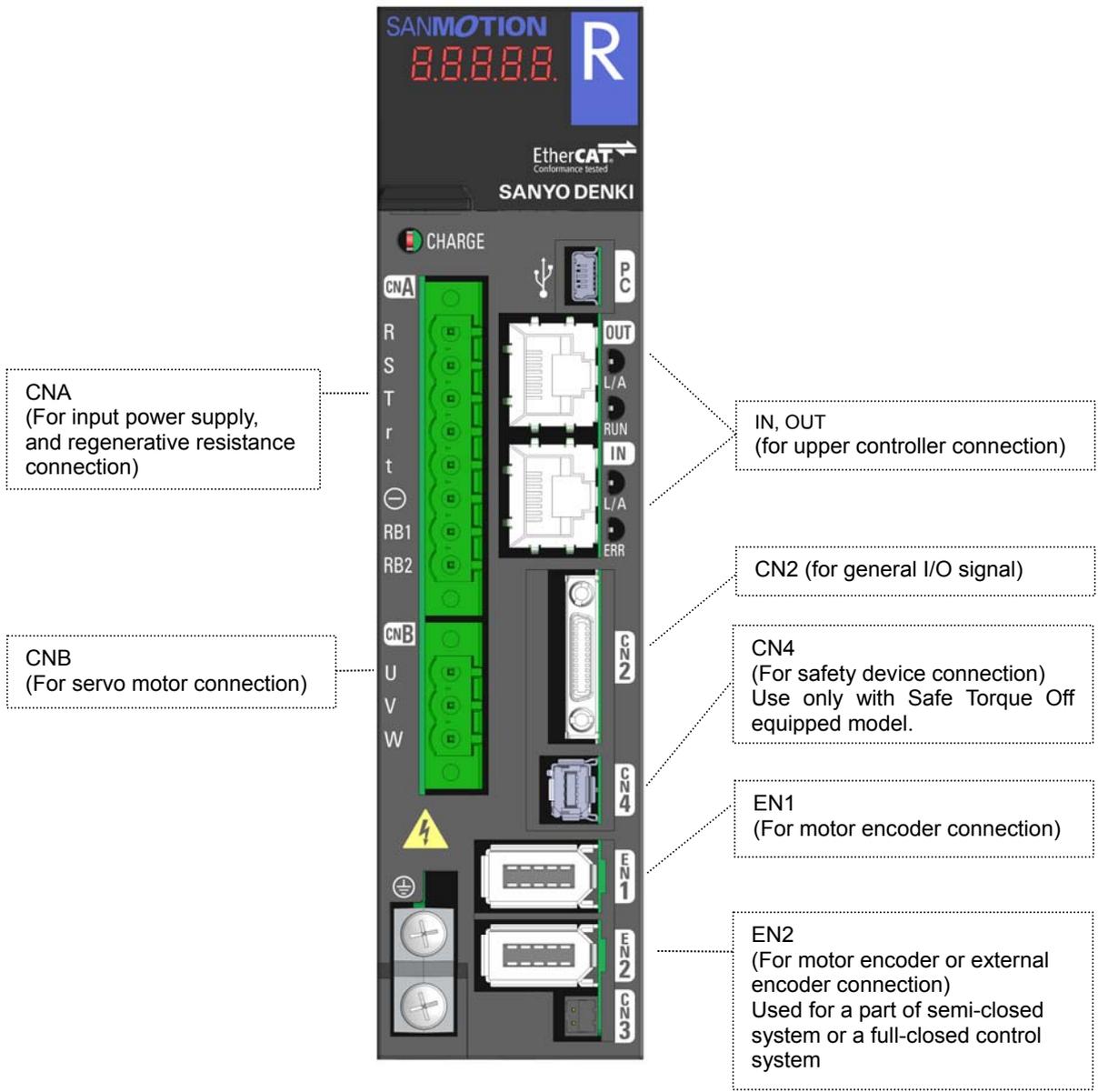
■　Model numbers of single connector for RS3□07

Connector No.	Item	SANYO DENKI model No.	Manufacturer's model No.	Manufacturer
IN, OUT	Ethermet For host unt connection	Not provided by our company. Please use shielded type modular plug (RJ-45) corresponding to the CAT5e standard.		
EN1,EN2	For encoder connection	AL-Y0012504-01	54599-1016	Molex Japan LLC
CNA	For main circuit power supply, and regenerative resistance connection	AL-Y0011766-01	PC5/7-STF1-7.62	Phoenix Contact Co. Ltd.
CNB	For servo motor connection	AL-Y0011768-01	PC5/3-STF1-7.62	
CNC	For control power supply connection	AL-Y0005159-01	MSTBT2.5/2-STF-5.08	
CN2	For general I/O signal	AL-00842383	HDR-E26MSG1+ and HDR-E26LPH	Honda Tsushin Kogyo Co. Ltd.
CN4 Note1)	For safety device connection (For short circuit)	AL-00849548-02	1971153-2	Tyco Electronics Japan G.K.
CN4	For safety device connection (For wiring)	AL-00718252-01	2013595-3	

Note1) If CN4 is unused (open), be sure to insert connecter for safety device (for short circuit) to CN4 of servo amplifier.
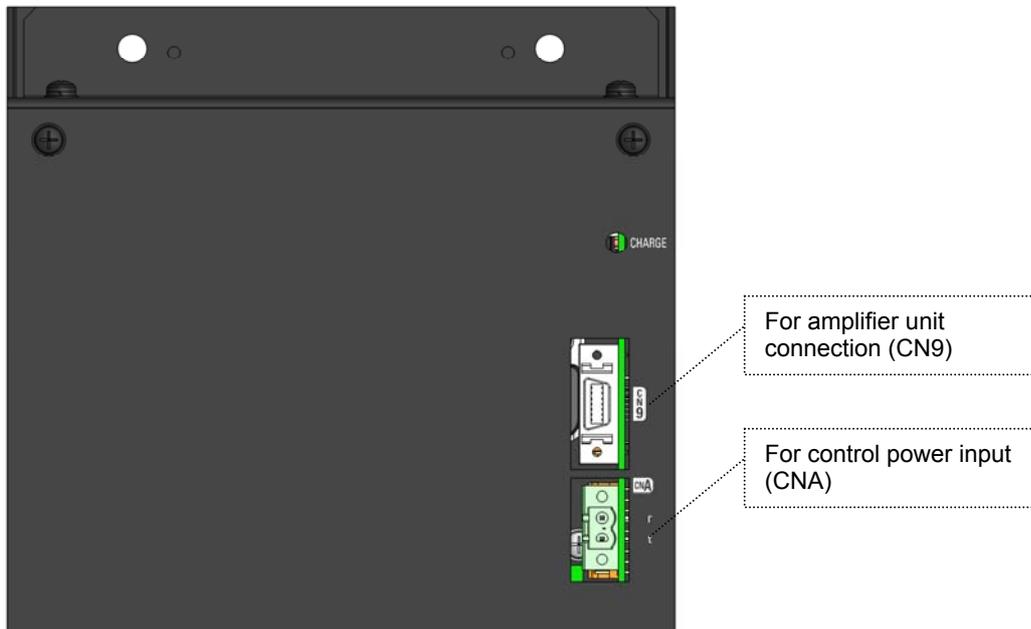
■　Model numbers of connector-kits for RS3□07 (With safe-torque-off function)

Connector No.	Item	SANYO DENKI model No.	Applicable servo amplifier model number	Remarks
EN1,CNA,CNB,CNC,CN2,CN4	Standard	AL-00977734	RS3A07A2HL4/RS3A07AAHL4	No regenerative resistance
EN1,CNB,CNC,CN2,CN4	Standard	AL-00977736	RS3A07A2HA4/RS3A07AAHA4	With regenerative resistance
EN1,EN2,CNA,CNB,CNC,CN2,CN4	For fully-closed control system	AL-00977738	RS3A07A2HL4/RS3A07AAHL4	No regenerative resistance
EN1,EN2,CNB,CNC,CN2,CN4		AL-00977740	RS3A07A2HA4/RS3A07AAHA4	With regenerative resistance
EN1,CN2,CN4	Low voltage set	AL-00977732	RS3###A2H#4/RS3###AAH#4	-

*　Mark "#" shows arbitrary numerical values or alphabets.
*　CN4 in connector-kits is for safety device connection (wiring available). Our model number is AL-00718252-01.
*　For amplifier with regenerative resistor, the wire of the regenerative resistor is to be connected to CNA, so CNA is equipped with amplifier. So no optional provisions are offered.

12. Appendix

RS3A07

CNA
(For main circuit power supply, and regenerative resistance connection)

CNB
(For servo motor connection)

CNC
(For control power supply connection)

IN, OUT
(for upper controller connection)

CN2 (for general I/O signal)

CN4
(For safety device connection)
Use only with Safe Torque Off equipped model.

EN1
(For motor encoder connection)

EN2
(For motor encoder or external encoder connection)
Used for a part of semi-closed system or a full-closed control system

■ Model numbers of single connectors for RS3A10, RS3A15, and RS3A30

Connector No.	Item	SANYO DENKI model No.	Manufacturer's model No.	Manufacturer
IN, OUT	Ethermet For host unt connection	Not provided by our company. Please use shielded type modular plug (RJ-45) corresponding to the CAT5e standard.		
EN1,EN2	To connect encoder	AL-Y0012504-01	54599-1016	Molex Japan LLC
CNA	To input control power	AL-Y0005159-01	MSTBT2.5/2-STF-5.08	Phoenix Contact Co. Ltd.
CN2	For general I/O signal	AL-00842383	HDR-E26MSG1+ and HDR-E26LPH	Honda Tsushin Kogyo Co. Ltd.
CN4 Note1)	To connect safety device (For short-circuiting)	AL-00718251-01	2040978-1	Tyco Electronics Japan G.K.
CN4	To connect safety devices (For wiring)	AL-00718252-01	2013595-3	

Note1) If CN4 is unused (open), be sure to insert connecter for safety device (for short circuit) to CN4 of servo amplifier.
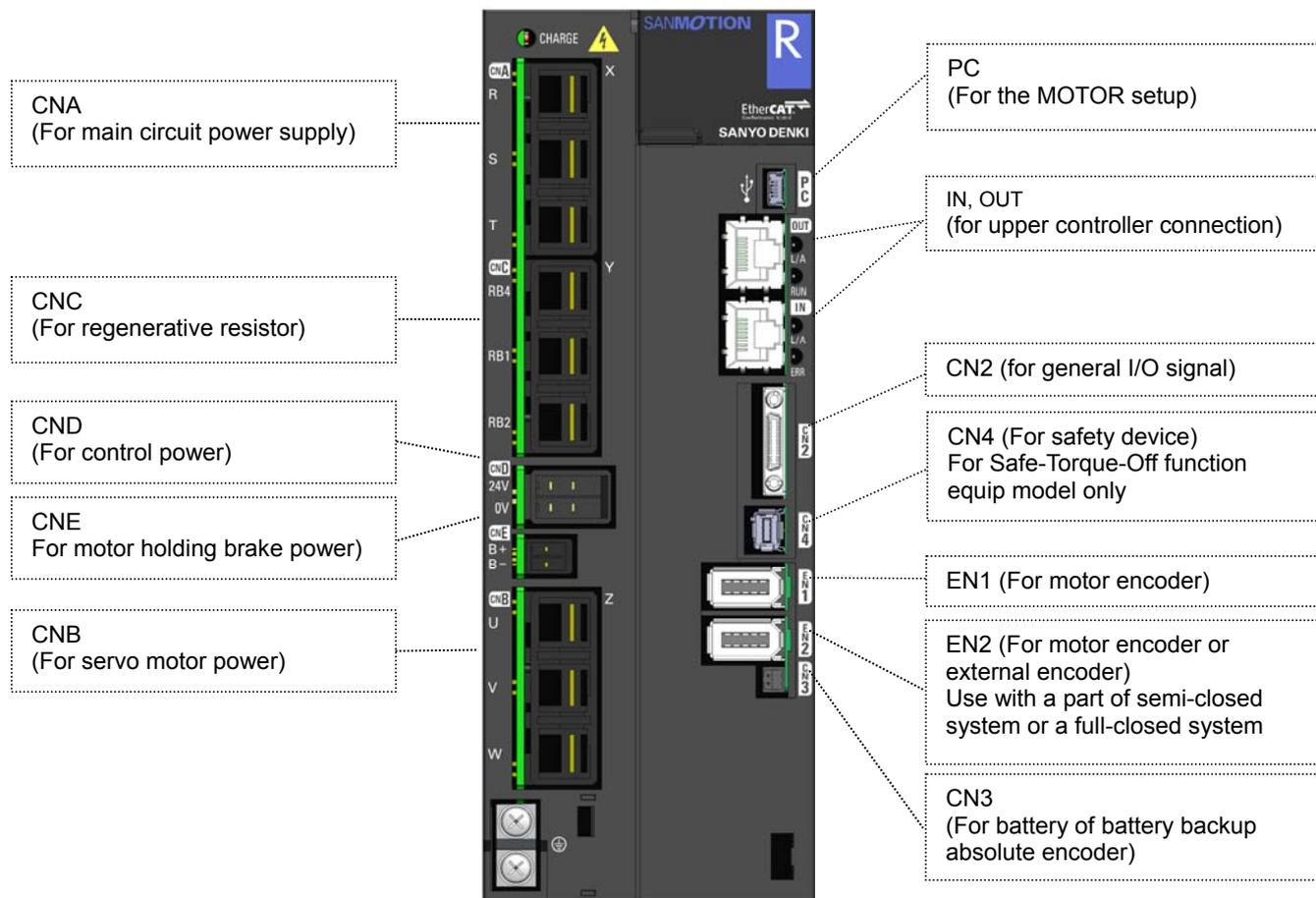
■ Model numbers of connector-kits for RS3A10, RS3A15 and RS3A30
  (With safe-torque-off function)

Connector No.	Item	SANYO DENKI model No.	Applicable servo amplifier model number
EN1,CNA,CN2,CN4	Standard	AL-00977742	RS3###A2H#4/RS3###AAH#4
EN1,EN2,CNA,CN2, CN4	For full-closed system	AL-00977744	RS3###A2H#4/RS3###AAH#4
EN1,CN2,CN4	Low voltage set	AL-00977732	RS3###A2H#4/RS3###AAH#4

* Mark "#" shows arbitrary numerical values or alphabets.
* CN4 in connector-kits is for safety device connection (wiring available). Our model number is AL-00718252-01.

12. Appendix

RS3A10, RS3A15

Terminal block
(For main circuit power,
 regenerative resistance
 and servo motor connection)

CNA
(For control power supply input)

IN, OUT
(for upper controller connection)

CN2 (for general I/O signal)

CN4
(For safety device connection)
Use only with Safe-Torque-Off
equipped model.

EN1
(For motor encoder connection)

EN2
(For motor encoder or external
encoder connection)
Used for a part of semi-closed
system or a full-closed control

RS3A30

Terminal block
(For main circuit power)

Terminal block
(For regenerative resistance)

Terminal block
(For servo motor connection)

CNA
(For control power supply input)

IN, OUT
(for upper controller connection)

CN2 (for general I/O signal)

CN4
(For safety device connection)
Use only with Safe-Torque-Off
equipped model.

EN1
(For motor encoder connection)

EN2
(For motor encoder or external
encoder connection)
Used for a part of semi-closed
system or a full-closed control

12-28

■ Model numbers of single connectors for RS3W60

Connector No.	Item	SANYO DENKI Model No.	Manufacturer's model No.	Manufacturer
IN, OUT	Ethermet For host unt connection	Not provided by our company. Please use shielded type modular plug (RJ-45) corresponding to the CAT5e standard.		
EN1,EN2	To connect encoder	AL-Y0012504-01	54599-1016	Molex Japan LLC
CNA	For control power input	AL-Y0005159-01	MSTBT2.5/2-STF-5.08	Phoenix Contact Co. Ltd.
CNB	For dynamic brake signal	AL-Y0004079-01	MSTBT2.5/3-STF-5.08	
CN8	For external alarm signal	AL-Y0011185-01	FMC0,5/4-ST-2.54	
CN2	For general I/O signal	AL-00842383	HDR-E26MSG1+ and HDR-E26LPH	Honda Tsushin Kogyo Co. Ltd.
CN4 Note 1)	For safety device connection (For short-circuit)	AL-00849548-02	1971153-2	Tyco Electronics Japan G.K.
CN4	For safety device connection	AL-00718252-01	2013595-3	

Note1) If CN4 is unused (open), be sure to insert connecter for safety device (for short-circuit) to CN4 of servo amplifier.

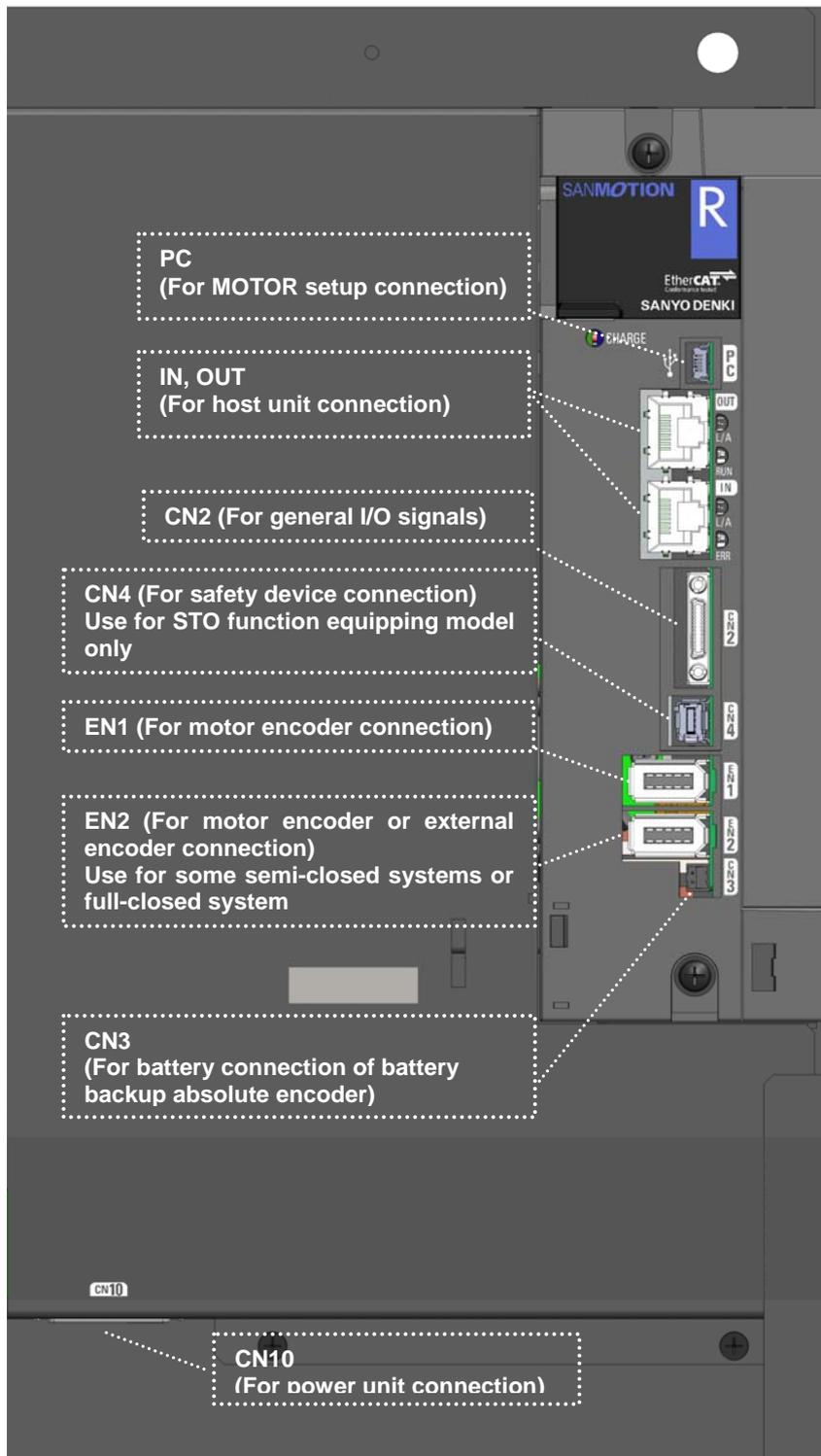■ Model numbers of connector-kits for RS3W60 (With Safe-torque-off function)

Connector No.	Item	SANYO DENKI Model No.
EN1,CNA,CN8,CN2,CN4	Standard	AL-00977746
EN1,EN2,CNA,CN8,CN2, CN4	For fully-closed control system	AL-00977748
EN1,CN2,CN4	Low voltage set	AL-00977732
CNA,CNB,CN4	High voltage set	AL-00892852

* 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

Power unit: RS3PAA270

For amplifier unit
connection (CN9)

For control power input
(CNA)

Amplifier unit: RS3W60

For control power input
(CNA)

For dynamic brake
signal (CNB)

For power unit
connection (CN9)

External alarm
(CN8)

IN, OUT
(for upper controller connection)

CN2 (for general I/O signal)

CN4
(For safety device connection)
Use only with Safe-Torque-Off
equipped model.

EN1
(For motor encoder connection)

EN2
(For motor encoder or external
encoder connection)
Used for a part of semi-closed
system or a full-closed control

■ Model numbers of single connectors for RS3C02, RS3C05 and RS3C10

Connector No.	Item	SANYO DENKI model No.	Manufacturer's model No.	Manufacturer
IN, OUT	Ethermet For host unt connection	Not provided by our company. Please use shielded type modular plug (RJ-45) corresponding to the CAT5e standard.		
EN1, EN2	To connect encoder	AL-Y0012504-01	54599-1016	Molex Japan LLC
CN2	For general I/O signal	AL-00842383	HDR-E26MSG1+ and HDR-E26LPH	Honda Tsushin Kogyo Co. Ltd.
CN4 Note1)	For safety device connection (For short circuit)	AL-00849548-02	1971153-2	Tyco Electronics Japan G.K.
CN4	For safety device connection (For wiring)	AL-00718252-01	2013595-3	
CNA	For main circuit power supply	AL-00953863-01	03JFAT-SAXGDK-P15	J.S.T. Mfg. Co.,Ltd.
CNB	For servo motor connection	AL-00953865-01	03JFAT-SAZGDK-P15	
CNC	For regenerative resistor	AL-00953864-01	03JFAT-SAYGDK-P15	
Open tool	For CNA to CNC	AL-00953866-01	J-FAT-OT-P	
CND	For control power supply	AL-00961843-01	04JFAT-SAGG-G-KK	
Open tool	For CND	AL-00961844-01	J-FAT-OT(N)	
CNE	For holding brake	AL-00953867-01	02MJFAT-SAGF	
Open tool	For CNE	AL-00953868-01	MJFAT-OT	

Note1) If CN4 is unused (open), be sure to insert connecter for safety device (for short circuit) to CN4 of servo amplifier.

■ Model numbers of connector-kits for RS3C02, RS3C05, and RS3C10 (With Safe-torque-off function)

Connector No.	Item	SANYO DENKI model No.	Applicable servo amplifier model number	Remarks
EN1, CN2, CN4	Standard	AL-00977732	RS3C##A2HA4, RS3C##AAHA4	For holding brake Without connector
EN1, CN2		AL-01002534		For safety device connection Without connector
EN1, CN2, CN4 CNE and open tool		AL-00977750		For holding brake With connector
EN1, EN2, CN2, CN4	For full-closed control system	AL-00977752	RS3C##A2HA4, RS3C##AAHA4	For holding brake Without connector
EN1, EN2, CN2		AL-01002536		For safety device connection Without connector
EN1, EN2, CN2, CN4 CNE and open tool		AL-00977754		For holding brake With 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

RS3C02/05/10

CNA
(For main circuit power supply)

CNC
(For regenerative resistor)

CND
(For control power)

CNE
For motor holding brake power)

CNB
(For servo motor power)

PC
(For the MOTOR setup)

IN, OUT
(for upper controller connection)

CN2 (for general I/O signal)

CN4 (For safety device)
For Safe-Torque-Off function
equip model only

EN1 (For motor encoder)

EN2 (For motor encoder or
external encoder)
Use with a part of semi-closed
system or a full-closed system

CN3
(For battery of battery backup
absolute encoder)

■ Model numbers of single connectors for RS3C15 and RS3C30

Connector No.	Item	SANYO DENKI model No.	Manufacturer's model No.	Manufacturer
IN,OUT	Ethermet For host unt connection	Not provided by our company. Please use shielded type modular plug (RJ-45) corresponding to the CAT5e standard.		
EN1, EN2	To connect encoder	AL-Y0012504-01	54599-1016	Molex Japan LLC
CN2	For general I/O signal	AL-00842383	HDR-E26MSG1+ and HDR-E26LPH	Honda Tsushin Kogyo Co. Ltd.
CN4 Note1)	For safety device connection (For short circuit)	AL-00849548-02	1971153-2	Tyco Electronics Japan G.K.
CN4	For safety device connection (For wiring)	AL-00718252-01	2013595-3	

Note1) If CN4 is unused (open), be sure to insert connecter for safety device (for short circuit) to CN4 of servo amplifier.

■ Model numbers of connector-kits for RS3C15 and RS3C30
    (With Safe-torque-off function)

Connector No.	Item	SANYO DENKI model No.	Applicable servo amplifier model number	Remarks
EN1, CN2, CN4	Standard	AL-00977732	RS3C##A2HA4, RS3C##AAHA4	For holding brake Without connector
EN1, CN2		AL-01002534		For safety device connection Without connector
EN1, EN2, CN2, CN4	For full-closed control system	AL-00977752	RS3C##A2HA4, RS3C##AAHA4	For holding brake Without connector
EN1, EN2, CN2		AL-01002536		For safety device connection 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

12. Appendix

RS3C15/30

PC
(For the MOTOR setup)

IN, OUT
(for upper controller connection)

CN2 (for general I/O signal)

CN4 (For safety device)
For Safe-Torque-Off function
equip model only

EN1 (For motor encoder)

EN2 (For motor encoder or
external encoder)
Use with a part of semi-closed
system or a full-closed system

CN3
(For battery of battery backup
absolute encoder)
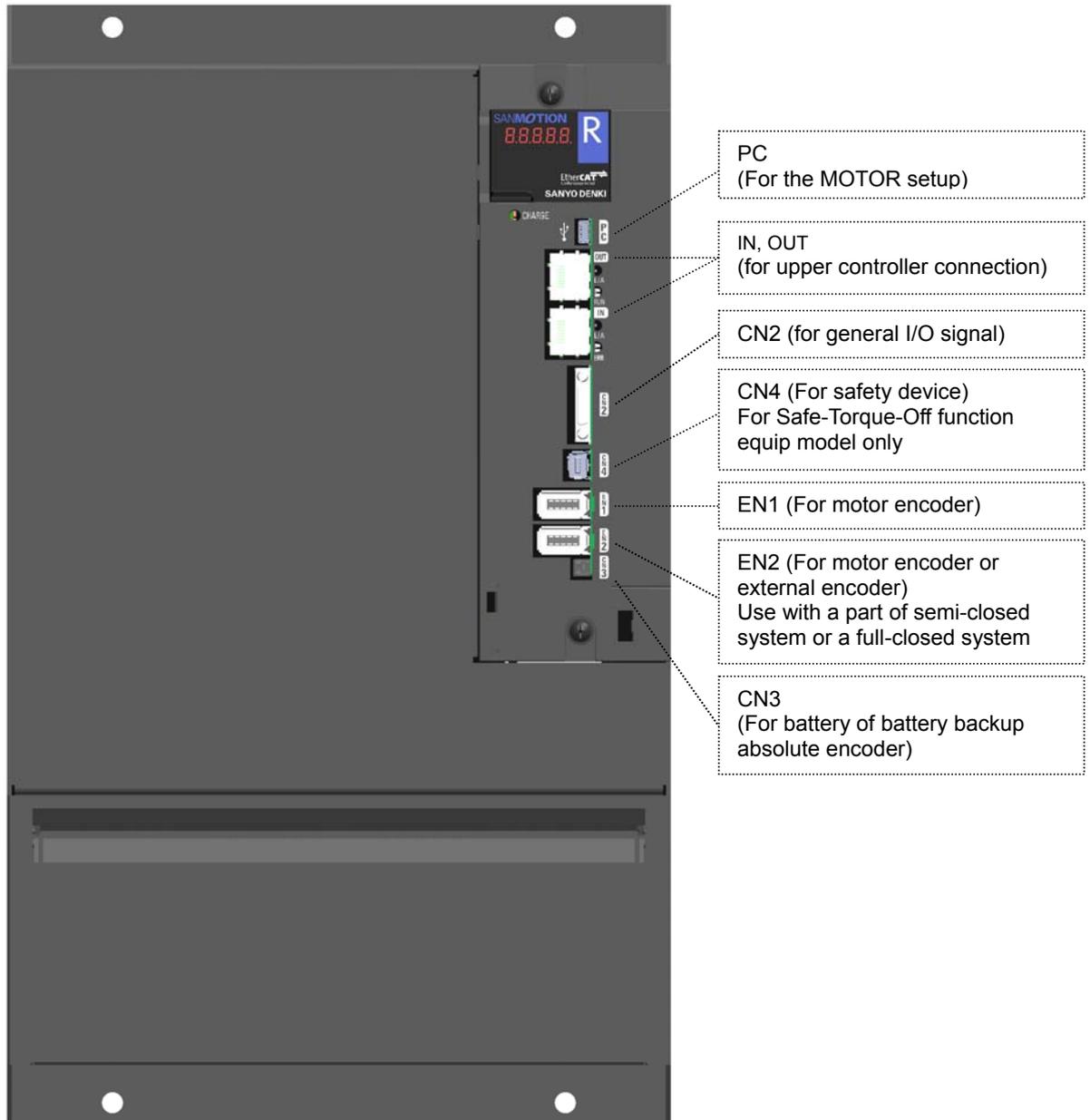
■ Our model numbers of single connectors for RS3D80

Connector No.	Item	SANYO DENKI model No.	Manufacturer's model No.	Manufacturer
IN, OUT	Ethermet For host unt connection	Not provided by our company. Please use shielded type modular plug (RJ-45) corresponding to the CAT5e standard.		
EN1, EN2	For encoder connection	AL-Y0012504-01	54599-1016	Molex Japan LLC
CN2	For general I/O signal	AL-00842383	HDR-E26MSG1+ and HDR-E26LPH	Honda Tsushin Kogyo Co. Ltd.
CN4　Note 1)	For safety device connection (For short circuit)	AL-00849548-02	1971153-2	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 と DF02D036A22	Japan Aviation Electronics Industry, Ltd.

Note 1) If CN4 is unused (open), be sure to insert connecter for safety device (for short circuit) to CN4 of amplifier unit.
Note 2) CN10 connector includes 2 pieces: for power unit side and for amplifier unit side.

■ Our model numbers of connector-kits for RS3D80 (With Safe-torque-off function)

Connector No.	Item	SANYO DENKI model No.	Applicable servo amplifier model number	Remarks
EN1,CN2,CN4	Standard	AL-00977732	RS3D80A2HM4, RS3D80AAHM4	For holding brake Without connector
EN1,CN2		AL-01002534		For safety device connection Without connector
EN1,EN2,CN2,CN4	For full-closed control system	AL-00977752	RS3D80A2HM4, RS3D80AAHM4	For holding brake Without connector
EN1,EN2,CN2		AL-01002536		For safety device connection Without connector

12. Appendix

RS3D80A8AM0

PC
(For MOTOR setup connection)

IN, OUT
(For host unit connection)

CN2 (For general I/O signals)

CN4 (For safety device connection)
Use for STO function equipping model
only

EN1 (For motor encoder connection)

EN2 (For motor encoder or external
encoder connection)
Use for some semi-closed systems or
full-closed system

CN3
(For battery connection of battery
backup absolute encoder)

CN10
(For power unit connection)

12.8.2 Fixing bracket

Fixing brackets for mounting servo amplifier front side are prepared.

■ List of fixing brackets for RS3□01 to 30

Servo amplifier model number	Bracket fixing position	Model number	Contents
RS3□01,02,03	Front	AL-00880390-01	Fixing bracket (upper/bottom): 1 ea, respectively Tightening screw: 4 ea
RS3A05,07	Front	AL-00880391-01	Fixing bracket (upper/bottom): 1 ea, respectively Tightening screw: 4 ea
RS3A10,15 (Common)	Front	AL-00907039-01	Fixing bracket (upper/bottom): 1 ea, respectively Tightening screw: 6 ea
RS3A30	Front	AL-00907040-01	Fixing bracket (upper/bottom): 1 ea, respectively Tightening screw: 8 ea

These optional fixing brackets are processed trivalent chromium plating.
(Surface color: blue-silver/ different from body color.)

For RS3□01, RS3□02, RS3□03   For RS3A05, 07
AL-00880390-01   AL-00880391-01
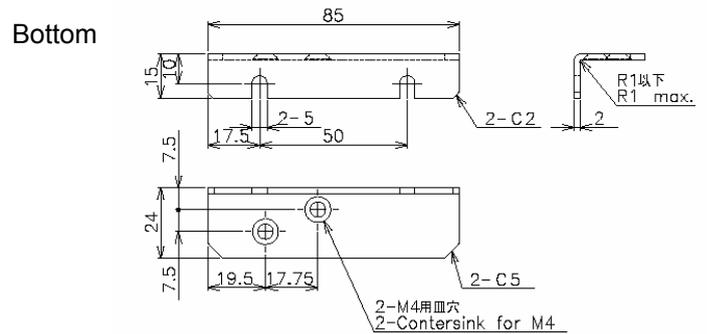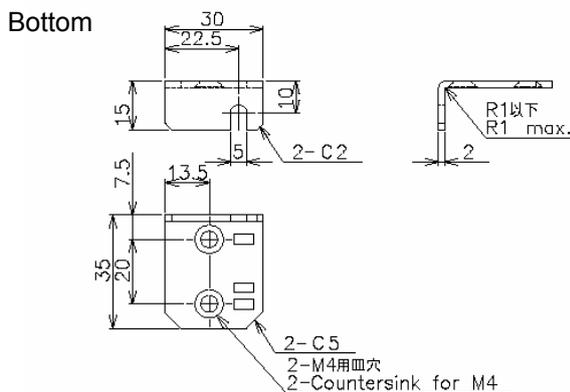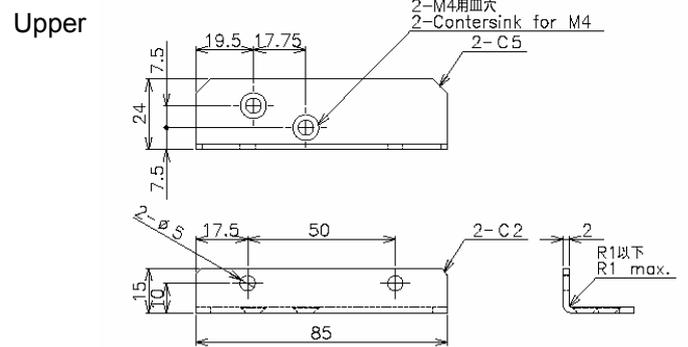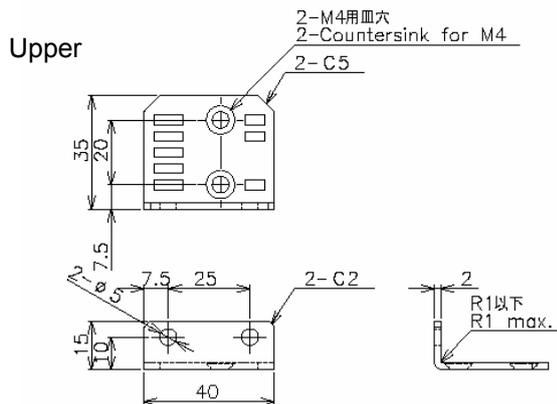
12. Appendix

For RS3A10, RS3A15
AL-00907039-01

Common parts (Upper / Bottom)
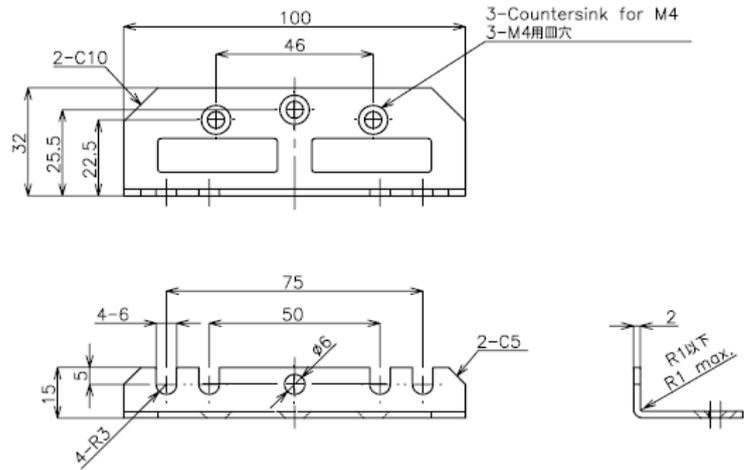
For RS3A30
AL-00907040-01
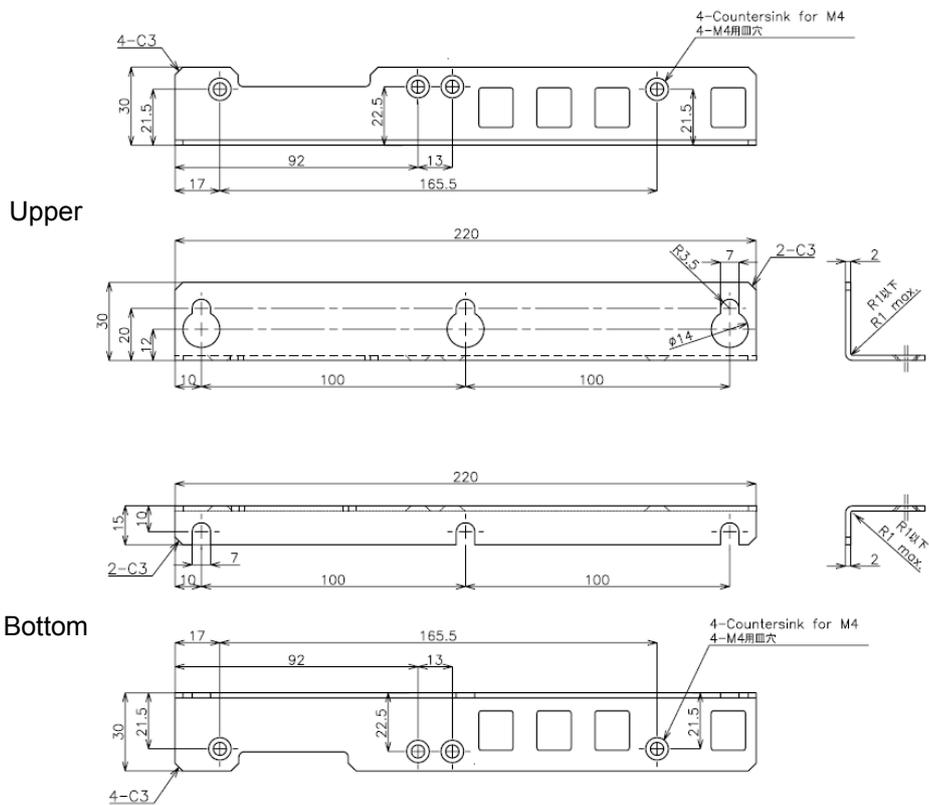
Upper

Bottom

■ List of fixing brackets for RS3C02

Servo amplifier model number	Bracket fixing position	Model number	Contents
RS3C02	Front	AL-00962547-01	Fixing bracket (upper/bottom): 1 ea, respectively Tightening screw: 6 ea

These optional fixing brackets are processed trivalent chromium plating.
(Surface color: blue-silver/ different from body color.)

For RS3C05/10, back side fixing brackets are able to replace to front side of amplifier.

For RS3C02
AL-00962547-01

Common parts（Upper / Bottom）
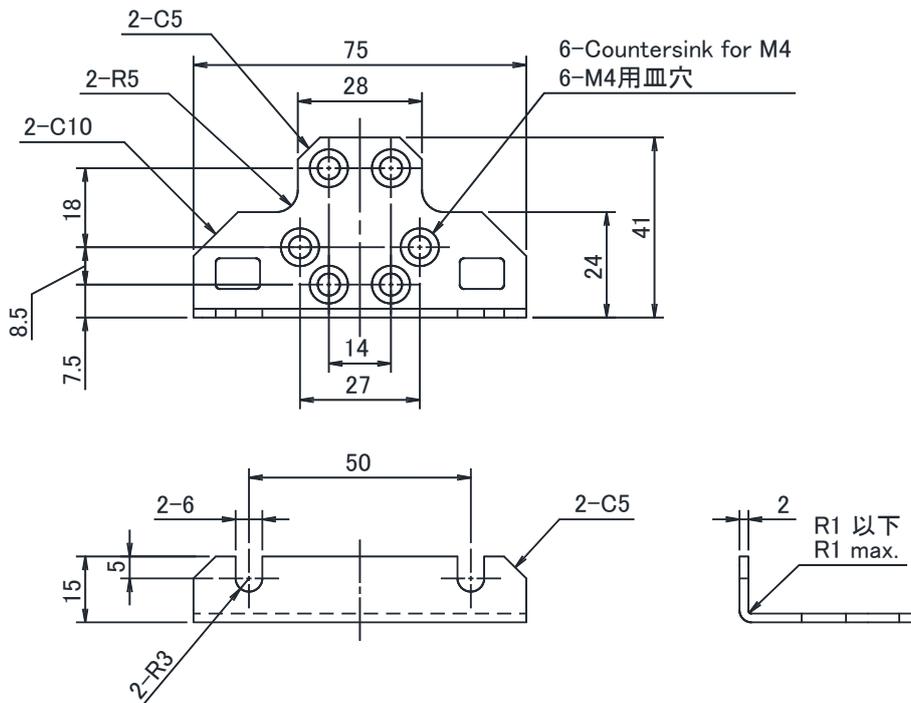
12. Appendix

12.8.3 Battery backup absolute encoder (encoder code: P) related items

Name	Details	SANYO DENKI model No.
Battery body for battery box (Lithium battery)	Lithium battery: ER3VLY Toshiba Lifestyle Products & Services Corporation	AL-00879511-01
Battery BOX	Lithium battery: ER3VLY Toshiba Lifestyle Products & Services Corporation With battery BOX	AL-00880402-01
Battery body for junction cable (Lithium battery)	Lithium battery: ER3VLY Toshiba Lifestyle Products & Services Corporation	AL-00697958-01
Battery trunk cable	—	AL-00697960-01 to -06
Battery trunk cable	—	AL-00731792-01

■ Battery BOX mounting position
  RS3□01, RS3□02, RS3□03, RS3□05, RS3A07   RS3A10, RS3A15, RS3A30
                                             RS3C02, RS3C10, RS3C15

Battery BOX
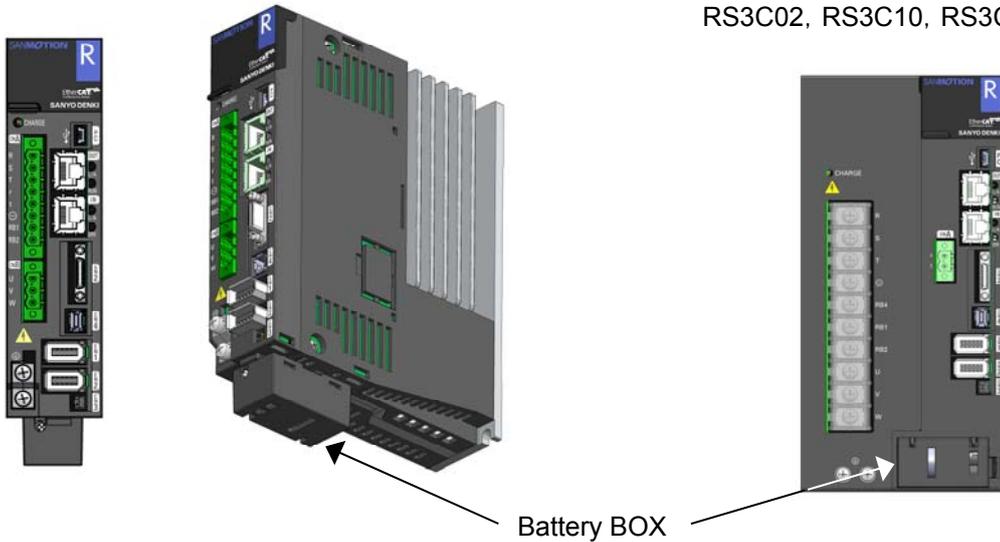
12.8.4 Analog monitor related item

Name	Details	SANYO DENKI model No.
Monitor Box	Monitor box body 2 dedicated cables	Q-MON-3
Dedicated cable	1 dedicated cables	AL-00690525-01

[Open the upper cover of front panel]

[Dedicated cable]

Measurement equipment (Oscilloscope, etc)

CN5
(Connector for Analog monitor)

Monitor Box
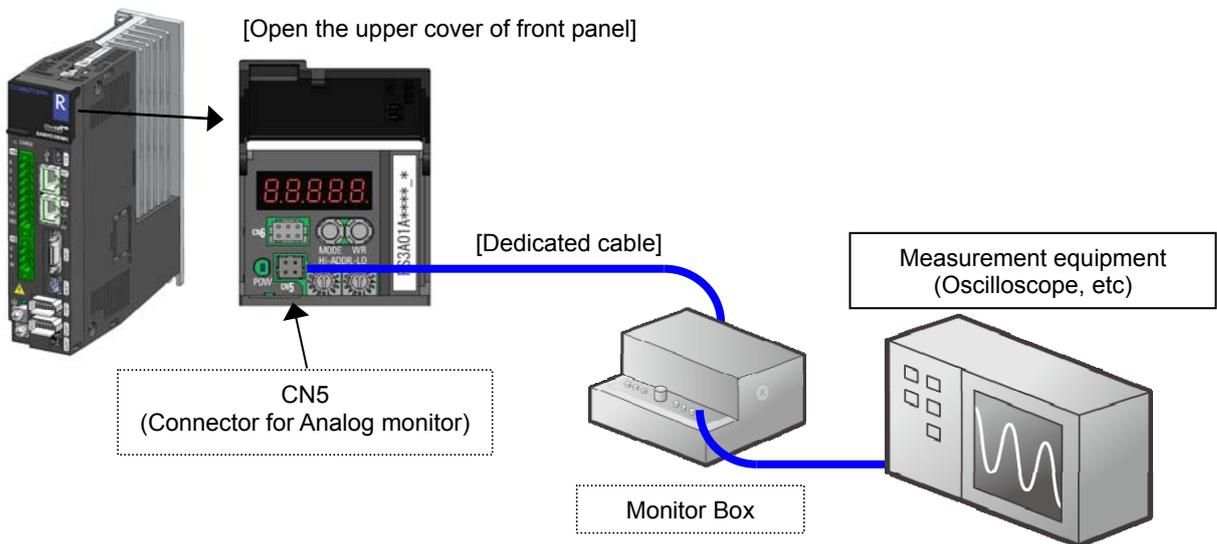
12.8.5 Junction cable for servo motor

Power cable

AMP INC. product,
Connector: 1-480703-0
Contact: 350536-3

(100)

J.S.T. Mfg. Co.,Ltd product,
N1.25-4

PHOENIX CONTACT GmbH
Co. KG product,
MSTBT2.5/3-STF-5.08

Green/Yellow
Red
White
Black

L

NO.	Lead wire color
1	Red
2	White
3	Black
4	Green/ Yellow

Brake cable

AMP INC. product,
Connector: 1-480699-0
Contact: 350570-3

J.S.T. Mfg. Co.,Ltd product,
N1.25-4

L

NO.	Lead wire color
1	White
2	Black

Encoder cable

AMP INC. product,
Connector housing: 172161-1
Contact: 170359-3

Sumitomo 3M Limited, product,
Receptacle: 36210-0100PL
Shell kit: 36310-3200-008

L

NO.	Lead wire color	Signal name
1	Black	0V
2	Red	+5V
3	Blown	ES+
4	Blue	ES-
5	Green	EBAT+
6	Purple	EBAT-
9	White/Black(Shielded)	Earth

NO.	Lead wire color	Signal name
1	Red	5V
2	Black	0V
7	Blown	ES+
8	Blue	ES-
9	Green	EBAT+
10	Purple	EBAT-

Model Number			Cable length
Power cable	For brake	For encoder	: L(mm)
RS-CM4-01-R	RS-CB3-01-R	RS-CA4-01-R	1,000
RS-CM4-02-R	RS-CB3-02-R	RS-CA4-02-R	2,000
RS-CM4-03-R	RS-CB3-03-R	RS-CA4-03-R	3,000
RS-CM4-05-R	RS-CB3-05-R	RS-CA4-05-R	5,000
RS-CM4-10-R	RS-CB3-10-R	RS-CA4-10-R	10,000

12 Appendix

12. Appendix

Servo motor with connectors for junction cables, 200V

Rated output	Motor flange size	Holding brake	Model number	Remarks
30W	40 mm sq.	−	R2AA04003FXPA0	
30W	40 mm sq.	With holding brake (24 VDC)	R2AA04003FCPA0	
50W	40 mm sq.	−	R2AA04005FXPA0	
50W	40 mm sq.	With holding brake (24 VDC)	R2AA04005FCPA0	
100W	40 mm sq.	−	R2AA04010FXPA0	
90W	40 mm sq.	With holding brake (24 VDC)	R2AA04010FCPA0	The rating decreases to 90%
100W	60 mm sq.	−	R2AA06010FXPA0	
100W	60 mm sq.	With holding brake (24 VDC)	R2AA06010FCPA0	
200W	60 mm sq.	−	R2AA06020FXPA0	
200W	60 mm sq.	With holding brake (24 VDC)	R2AA06020FCPA0	
400W	60 mm sq.	−	R2AA06040FXPA0	
360W	60 mm sq.	With holding brake (24 VDC)	R2AA06040FCPA0	The rating decreases to 90%
750W	80 mm sq.	−	R2AA08075FXPA0	
750W	80 mm sq.	With holding brake (24 VDC)	R2AA08075FCPA0	
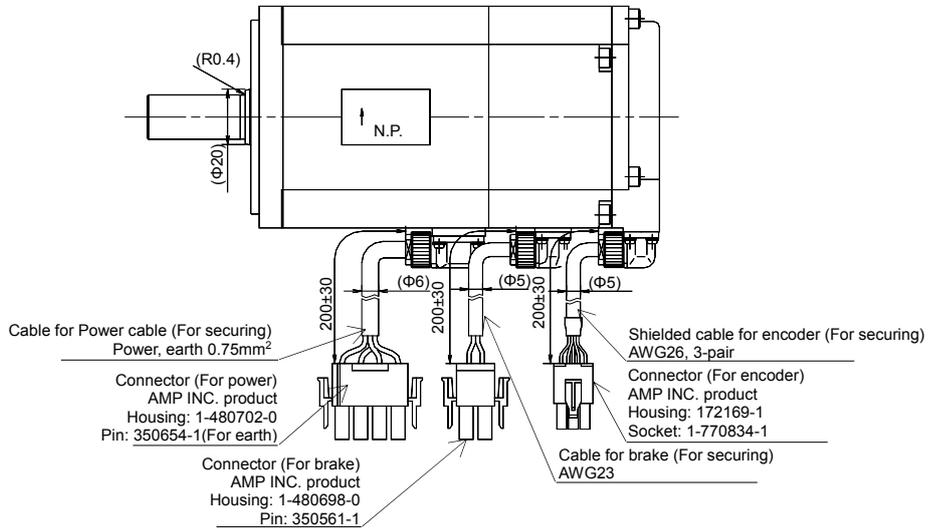
12.8.6 Servo motor power cable

■ Amplifier model number: RS3☐02A and RS3☐03A

Motor/amplifier option For power, AWG#19	Cable length: L (mm)	Applicable motor
RS-CM4-01-R	1,000	R2AA06040F R2AA08075F
RS-CM4-02-R	2,000	
RS-CM4-03-R	3,000	
RS-CM4-05-R	5,000	
RS-CM4-10-R	10,000	

Item	Connector model number	Remarks
Motor side connector	Connector: 1-480703-0 Contact: 350536-3	Tyco Electronics Japan G.K.

Motor/amplifier option For brake, AWG#23	Cable length: L (mm)	Applicable motor
RS-CB3-01-R	1,000	R2AA06040F R2AA08075F
RS-CB3-02-R	2,000	
RS-CB3-03-R	3,000	
RS-CB3-05-R	5,000	
RS-CB3-10-R	10,000	

Item	Connector model number	Remarks
Motor side connector	Connector: 1-480699-0 Contact: 350570-3	Tyco Electronics Japan G.K.

Model number		Cable length: L (mm)	Applicable motor
For power, AWG#16	For power and brake, AWG#16・AWG#20		
AL-00996451-01	AL-00996452-01	1,000	R1AA10100H R1AA10150H
AL-00996451-02	AL-00996452-02	2,000	
AL-00996451-03	AL-00996452-03	3,000	
AL-00996451-05	AL-00996452-05	5,000	
AL-00996451-10	AL-00996452-10	10,000	

Item	Connector model number	Remarks
Motor side connector	Straight plug: JL04V-6A24-11SE-EB-R Cable clamp: JL04-2428CK(17)-R	Japan Aviation Electronics Industry, Ltd.

Model number		Cable length: L (mm)	Applicable motor
For power, AWG#19	For power and brake, AWG#18		
AL-00937696-01	AL-00937697-01	1,000	R2AA13120B
AL-00937696-02	AL-00937697-02	2,000	
AL-00937696-03	AL-00937697-03	3,000	
AL-00937696-05	AL-00937697-05	5,000	
AL-00937696-10	AL-00937697-10	10,000	

Item	Connector model number	Remarks
Motor side connector	Straight plug: JL04V-6A24-11SE-EB-R Cable clamp: JL04-2428CK(17)-R	Japan Aviation Electronics Industry, Ltd.

12. Appendix

■ Amplifier model number: RS3□05A

Model number		Cable length: L(mm)	Applicable motor
For power, AWG#14	For power and brake, AWG#14・AWG#20		
AL-00937698-01	AL-00937699-01	1,000	R2AA13120D R2AA13120L R2AA13180H R2AA13200L
AL-00937698-02	AL-00937699-02	2,000	
AL-00937698-03	AL-00937699-03	3,000	
AL-00937698-05	AL-00937699-05	5,000	
AL-00937698-10	AL-00937699-10	10,000	

Item	Connector model number	Remarks
Motor side connector	Straight plug:　JL04V-6A24-11SE-EB-R Cable clamp:　　JL04-2428CK(17)-R	Japan Aviation Electronics Industry, Ltd.

Model number		Cable length: L(mm)	Applicable motor
For power, AWG#12	For power and brake, AWG#12・AWG#20		
AL-00996453-01	AL-00996454-01	1,000	R1AA10100F R1AA10200H R1AA10250H
AL-00996453-02	AL-00996454-02	2,000	
AL-00996453-03	AL-00996454-03	3,000	
AL-00996453-05	AL-00996454-05	5,000	
AL-00996453-10	AL-00996454-10	10,000	

Item	Connector model number	Remarks
Motor side connector	Straight plug:　JL04V-6A20-15SE-EB-R Cable clamp:　　JL04-2022CK(14)-R	Japan Aviation Electronics Industry, Ltd.

■ Amplifier model number: RS3□07A

Model number		Cable length: L(mm)	Applicable motor
For power, AWG#12	For power and brake, AWG#12・AWG#20		
AL-00962887-01	AL-00962895-01	1,000	R1AA10200F R1AA10250F
AL-00962887-02	AL-00962895-02	2,000	
AL-00962887-03	AL-00962895-03	3,000	
AL-00962887-05	AL-00962895-05	5,000	
AL-00962887-10	AL-00962895-10	10,000	

Item	Connector model number	Remarks
Motor side connector	Straight plug: JL04V-6A20-15SE-EB-R Cable clamp: JL04-2022CK(14)-R	Japan Aviation Electronics Industry, Ltd.

Model number		Cable length: L(mm)	Applicable motor
For power, AWG#10	For power and brake, AWG#10・AWG#20		
AL-00996455-01	AL-00996456-01	1,000	R1AA13300H R2AA13180D R2AA13200D R2AA18350V
AL-00996455-02	AL-00996456-02	2,000	
AL-00996455-03	AL-00996456-03	3,000	
AL-00996455-05	AL-00996456-05	5,000	
AL-00996455-10	AL-00996456-10	10,000	

Item	Connector model number	Remarks
Motor side connector	Straight plug: JL04V-6A24-11SE-EB-R Cable clamp: JL04-2428CK(17)-R	Japan Aviation Electronics Industry, Ltd.

■ Amplifier model number: RS3□10A

Model number		Cable length: L(mm)	Applicable motor
For power, AWG#10	For power and brake, AWG#10・AWG#20		
AL-00918635-01	AL-00918636-01	1,000	R1AA13300F R2AA13180D R2AA13200D R2AA18350L
AL-00918635-02	AL-00918636-02	2,000	
AL-00918635-03	AL-00918636-03	3,000	
AL-00918635-05	AL-00918636-05	5,000	
AL-00918635-10	AL-00918636-10	10,000	

Item	Connector model number	Remarks
Motor side connector	Straight plug: JL04V-6A24-11SE-EB-R Cable clamp: JL04-2428CK(17)-R	Japan Aviation Electronics Industry, Ltd.

12. Appendix

■ Amplifier model number: RS3□15A

Model number		Cable length: L(mm)	Applicable motor
For power, AWG#10	For power and brake, AWG#10・AWG#20		
AL-00918635-01	AL-00918636-01	1,000	R2AA18350D R2AA18450H
AL-00918635-02	AL-00918636-02	2,000	
AL-00918635-03	AL-00918636-03	3,000	
AL-00918635-05	AL-00918636-05	5,000	
AL-00918635-10	AL-00918636-10	10,000	

Item	Connector model number	Remarks
Motor side connector	Straight plug: JL04V-6A24-11SE-EB-R Cable clamp: JL04-2428CK(17)-R	Japan Aviation Electronics Industry, Ltd.

Model number		Cable length: L(mm)	Applicable motor
For power, AWG#10	For power and brake, AWG#10・AWG#20		
AL-00965257-01	AL-00965258-01	1,000	R2AA22500L
AL-00965257-02	AL-00965258-02	2,000	
AL-00965257-03	AL-00965258-03	3,000	
AL-00965257-05	AL-00965258-05	5,000	
AL-00965257-10	AL-00965258-10	10,000	

Item	Connector model number	Remarks
Motor side connector	Straight plug: JL04V-6A24-11SE-EB-R Cable clamp: JL04-2428CK(17)-R	Japan Aviation Electronics Industry, Ltd.

Model number		Cable length: L(mm)	Applicable motor
For power, AWG#8	For brake, AWG#19		
AL-00965259-01	AL-00918630-01	1,000	R2AA22700S
AL-00965259-02	AL-00918630-02	2,000	
AL-00965259-03	AL-00918630-03	3,000	
AL-00965259-05	AL-00918630-05	5,000	
AL-00965259-10	AL-00918630-10	10,000	

Item	Connector model number	Remarks
Motor side connector	■ For power Straight plug: JL04V-6A24-11SE-EB-R Cable clamp: JL04-2428CK(17)-R ■ For brake Straight plug: JL04V-6A10SL-3SE-EB-R Cable clamp: JL04-1012CK(05)-R	Japan Aviation Electronics Industry, Ltd.

■ Amplifier model number: RS3□15A (continued)

Model number		Cable length: L(mm)	Applicable motor
For power, AWG#6	For brake, AWG#19		
AL-00968911-01	AL-00918630-01	1,000	R2AA18550R
AL-00968911-02	AL-00918630-02	2,000	
AL-00968911-03	AL-00918630-03	3,000	
AL-00968911-05	AL-00918630-05	5,000	
AL-00968911-10	AL-00918630-10	10,000	

Item	Connector model number		Remarks
Motor side connector	■ For power		
	Straight plug: JL04V-6A32-17SE-EB-R		Japan Aviation Electronics Industry, Ltd.
	Socket: N2KM2532		SANKEI MANUFACTURING CO. LTD.
	■ For brake Straight plug: JL04V-6A10SL-3SE-EB-R Cable clamp: JL04-1012CK(05)-R		Japan Aviation Electronics Industry, Ltd.

■ Amplifier model number: RS3□30A

Model number		Cable length: L(mm)	Applicable motor
For power, AWG#6	ブレーキ用 AWG#19		
AL-00965260-01	AL-00918630-01	1,000	R2AA18550H R2AA18750H R2AA1811KR R2AA2211KB R2AA2215KB
AL-00965260-02	AL-00918630-02	2,000	
AL-00965260-03	AL-00918630-03	3,000	
AL-00965260-05	AL-00918630-05	5,000	
AL-00965260-10	AL-00918630-10	10,000	

Item	Connector model number		Remarks
Motor side connector	■ For power		
	Straight plug: JL04V-6A32-17SE-EB-R		Japan Aviation Electronics Industry, Ltd.
	Socket: N2KM2532		SANKEI MANUFACTURING CO. LTD.
	■ For brake Straight plug: JL04V-6A10SL-3SE-EB-R Cable clamp: JL04-1012CK(05)-R		Japan Aviation Electronics Industry, Ltd.

12. Appendix

■ For encoder

Model number	Cable length: L(mm)	Applicable motor
RS-CA4-01-R	1,000	R2AA06040F R2AA08075F
RS-CA4-02-R	2,000	
RS-CA4-03-R	3,000	
RS-CA4-05-R	5,000	
RS-CA4-10-R	10,000	

Item	Connector model number		Remarks
Motor side connector	Housing: Contact:	172161-1 170359-3	Tyco Electronics Japan G.K.
Amplifier side connector	Receptacle: Shell kit:	36210-0100PL 36310-3200-008	3M Japan Limited

Model number	Cable length: L(mm)
AL-00937694-01	1,000
AL-00937694-02	2,000
AL-00937694-03	3,000
AL-00937694-05	5,000
AL-00937694-10	10,000

Item	Connector model number		Remarks
Motor side connector	Straight plug: Contact:	JN2DS10SL2-R JN1-22-22F-PKG100	Japan Aviation Electronics Industry, Ltd.
Amplifier side connector	Receptacle: Shell kit:	36210-0100PL 36310-3200-008	3M Japan Limited

■ 400 VAC Input

For R2, 100mm sq.

Model number		Cable length: L (mm)	Applicable motor
For power AWG#16 (1.25mm^2)	For power and holding brake #16 (1.25mm^2)・#20 (0.5mm^2)		
AL-00964811-01	AL-00964812-01	1,000	R2CA10075F, R2CA10100F, R1CA10150V, R1CA10200V
AL-00964811-02	AL-00964812-02	2,000	
AL-00964811-03	AL-00964812-03	3,000	
AL-00964811-05	AL-00964812-05	5,000	
AL-00964811-10	AL-00964812-10	10,000	

Item	Connector model number	Remarks
Motor side connector Common to with or without brake	Straight plug: JL04V-6A20-15SE-EB-R Clamp: JL04-2022CK(14)-R	Japan Aviation Electronics Industry, Ltd.

For R2, 130mm sq.

Model number		Cable length: L (mm)	Applicable motor
For power AWG#16 (1.25mm^2)	For power and holding brake #16 (1.25mm^2)・#20 (0.5mm^2)		
AL-00965739-01	AL-00965740-01	1,000	R2CA13050D, R2CA13120R, R2CA13120F, R2CA13180H, R2CA13200L, R2CA13200H, R1CA13300V
AL-00965739-02	AL-00965740-02	2,000	
AL-00965739-03	AL-00965740-03	3,000	
AL-00965739-05	AL-00965740-05	5,000	
AL-00965739-10	AL-00965740-10	10,000	

Item	Connector model number	Remarks
Motor side connector Common to with or without brake	Straight plug: JL04V-6A24-11SE-EB-R Clamp: JL04-2428CK(17)-R	Japan Aviation Electronics Industry, Ltd.

For R2, 130/180mm sq.

Model number		Cable length: L (mm)	Applicable motor
For power AWG#14 (2.0mm^2)	For power and holding brake #14 (2.0mm^2)・#20 (0.5mm^2)		
AL-00965741-01	AL-00965742-01	1,000	R2CA13180D, R2CA18350L
AL-00965741-02	AL-00965742-02	2,000	
AL-00965741-03	AL-00965742-03	3,000	
AL-00965741-05	AL-00965742-05	5,000	
AL-00965741-10	AL-00965742-10	10,000	

Item	Connector model number	Remarks
Motor side connector Common to with or without brake	Straight plug: JL04V-6A24-11SE-EB-R Clamp: JL04-2428CK(17)-R	Japan Aviation Electronics Industry, Ltd.

12. Appendix

For R2, 180mm sq.

Model number		Cable length: L (mm)	Applicable motor
For power AWG#12 (3.5mm^2)	For power and holding brake #12 (3.5mm^2)・#20 (0.5mm^2)		
AL-00965743-01	AL-00965744-01	1,000	R2CA18350D, R2CA18450H, R2CA18550R
AL-00965743-02	AL-00965744-02	2,000	
AL-00965743-03	AL-00965744-03	3,000	
AL-00965743-05	AL-00965744-05	5,000	
AL-00965743-10	AL-00965744-10	10,000	

Item	Connector model number	Remarks
Motor side connector Common to with or without brake	Straight plug: JL04V-6A24-11SE-EB-R Clamp: JL04-2428CK(17)-R	Japan Aviation Electronics Industry, Ltd.

For R2, 180mm sq.

Model number		Cable length: L (mm)	Applicable motor
For power AWG#10 (5.5mm^2)	For power and holding brake #10 (5.5mm^2)・#20 (0.5mm^2)		
AL-00997919-01	AL-00997920-01	1,000	R2CA18550H
AL-00997919-02	AL-00997920-02	2,000	
AL-00997919-03	AL-00997920-03	3,000	
AL-00997919-05	AL-00997920-05	5,000	
AL-00997919-10	AL-00997920-10	10,000	

Item	Connector model number	Remarks
Motor side connector Common to with or without brake	Straight plug: JL04V-6A24-11SE-EB-R Clamp: JL04-2428CK(17)-R	Japan Aviation Electronics Industry, Ltd.

For R2, 180/220mm sq.

Model number	Cable length: L (mm)	Applicable motor
For power AWG#8 (8mm^2)		
AL-00997921-01	1,000	R2CA18750H, R2CA2211KB, R2CA2215KV, R1CA18550H, R1CA18750L, R1CA1811KR, R1CA1815KB
AL-00997921-02	2,000	
AL-00997921-03	3,000	
AL-00997921-05	5,000	
AL-00997921-10	10,000	

Item	Connector model number	Remarks
Motor side connector	Plug: JL04V-6A32-17SE-EB-R Socket: N2KM2532 Conduit: NS25 Bush: N2HBI2519	Japan Aviation Electronics Industry, Ltd. SANKEI MANUFACTURING CO. LTD.

For R2, 180mm sq.

Model number	Cable length: L (mm)	Applicable motor
For power AWG#5, 6 equivalent (14mm^2 equivalent)		
AL-00999240-01	1,000	R2CA2220KV, R2CA2830KV, R1CA2220KV
AL-00999240-02	2,000	
AL-00999240-03	3,000	
AL-00999240-05	5,000	
AL-00999240-10	10,000	

Item	Crimp terminal model number	Remarks
Motor side crimp terminal	-	No work with motor side crimp terminal.

For encoder

Model number	Cable length:	Applicable motor
For encoder	L (mm)	
AL-00937694-01	1,000	Except R2CA2830KV
AL-00937694-02	2,000	
AL-00937694-03	3,000	
AL-00937694-05	5,000	
AL-00937694-10	10,000	

Item	Connector model number	Remarks
Motor side connector	Straight plug: JN2DS10SL2-R Contact: JN1-22-22F-PKG100	Japan Aviation Electronics Industry, Ltd.
Amplifier side connector	Receptacle: 36210-0100PL Shell kit: 36310-3200-008	3M Japan Limited

Model number	Cable length:	Applicable motor
For encoder	L (mm)	
AL-00999243-01	1,000	R2CA2830KV
AL-00999243-02	2,000	
AL-00999243-03	3,000	
AL-00999243-05	5,000	
AL-00999243-10	10,000	

Item	Connector model number	Remarks
Motor side connector	-	No work with motor side connector. Refer the section 4.3, for connector model number and wiring.
Amplifier side connector	Receptacle: 36210-0100PL Shell kit: 36310-3200-008	3M Japan Limited

12

Appendix

12. Appendix

■ Cable specifications

For servo motor power

(TOTOKU ELECTRIC CO., LTD.) (Operating temperature range: -20 to 105℃)		
V-8C-MP_NO.2	V-8C-MP_NO.1	V-8C-MP_NO.3
AL-00964811-01 to -10; 1 to 10m AL-00964812-01 to -10; 1 to 10m AL-00965739-01 to -10; 1 to 10m AL-00965740-01 to -10; 1 to 10m	AL-00965741-01 to -10; 1 to 10m AL-00965742-01 to -10; 1 to 10m	AL-00965743-01 to -10; 1 to 10m AL-00965744-01 to -10; 1 to 10m
1.25sq. × 4C + 0.5sq. × 4C Sheath thickness: 1.4mm Cable diameter: Around 11.6mm	2sq. × 4C + 0.5sq. × 4C Sheath thickness: 1.3mm Cable diameter: Around 12.5mm	3.5sq. × 4C + 0.5sq. × 4C Sheath thickness: 1.5mm Cable diameter: Around 14mm
Individual wire specification 　3.5 sq. Conductor diameter: 2.47mm, Insulator thickness: 0.8 mm, Overall diameter: 4.07 mm 　2.0 sq. Conductor diameter: 1.8 mm, Insulator thickness: 0.7 mm, Overall diameter: 3.2 mm 　1.25 sq. Conductor diameter: 1.47mm, Insulator thickness: 0.7 mm, Overall diameter: 2.87 mm 　0.5 sq. Conductor diameter: 1.0 mm, Insulator thickness: 0.5 mm, Overall diameter: 2.0 mm		

(BANDO DENSEN Co., ltd.) (Operating temperature range: Up to 105℃)
2586 6C
AL-00997919-01 to 10; 1 to 10m specifications AL-00997920-01 to10; 1 to 10m specifications
5.5sq. x 4C + 0.5sq. x 2C Sheath thickness: 1.35mm Cable diameter: Around 15mm
Individual wire specification 　5.5 sq. Conductor diameter: 3.1mm, Insulator thickness: 0.85mm, Overall diameter: 4.8mm 　0.5 sq. Conductor diameter: 0.95mm, Insulator thickness: 0.59mm, Overall diameter: 2.13mm

(SUMIDEN HITACHI CABLE Ltd.) (Operating temperature range: Up to 90℃)	
600V_CV_4_8SQ	600V_CV_4_14SQ
AL-00997921-01 to 10; 1 to 10m specifications	AL-00999240-01 to 10; 1 to 10m specifications
8sq. x 4C Sheath thickness: 1.5mm Cable diameter: Around 17mm	14sq. x 4C Sheath thickness: 1.5mm Cable diameter: Around 19mm
Individual wire specification 　8 sq. Conductor diameter: 3.6mm, Insulator thickness: 1.0mm, Overall diameter: 5.6mm 　14 sq. Conductor diameter: 4.4mm, Insulator thickness: 1.0mm, Overall diameter: 6.4mm	

For encoder

Robot Cable for high speed motion; UL-OREV30-SB, composite wire spec. (OKANO CABLE Co., Ltd.) With ETFE (fluoroplastic) insulation, vinyl sheath, braided shield
UL STYLE NO.20276 (Rating: 80℃, 30V)
AL-00937694-01 to 10; 1 to 10m specifications AL-00999243-01 to 10; 1 to 10m specifications
22 AWG × 2C + 24 AWG × 2P Sheath thickness: 1.0mm Overall diameter: φ6.7±0.5mm
Individual wire specification 　22 AWG Conductor diameter: φ0.77mm, Insulator thickness: 0.25mm, Overall diameter: φ1.27mm 　24 AWG Conductor diameter: φ0.65mm, Insulator thickness: 0.20mm, Overall diameter: φ1.05mm

12.8.7 Power cable for servo motor FAN

Model number	Cable length:	Applicable motor
FAN for motor	L(mm)	
AL-00997923-01	1,000	R1CA18750L, R1CA1811KR, R1CA1815KB, R1CA2220KV
AL-00997923-02	2,000	
AL-00997923-03	3,000	
AL-00997923-05	5,000	
AL-00997923-10	10,000	

Item	Connector model number	Remarks
Motor side connector	Plug: N/MS3106B10SL-4S Clamp: N/MS3057-4A	Japan Aviation Electronics Industry, Ltd.

Model number	Cable length:	Applicable motor
FAN for motor	L(mm)	
AL-00999241-01	1,000	R2CA2830KV
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

(KURABE Industrial Co., Ltd.) (Operating temperature range: None)
FFR2C
AL-00997923-01 to 10; 1 to 10m specifications
20AWG x 2C Sheath thickness: 1.0mm Cable diameter: Around 4.8mm
Individual wire specification   20 AWG Conductor diameter: Around 0.9mm, Insulator thickness: 0.25mm, Overall diameter: 1.4mm

(NISSEI ELECTRIC CO., LTD.) (Operating temperature range: Up to 105℃)
2103_PVC_AWG#19X4C
AL-00999241 -01 to 10; 1 to 10m specifications
19AWG x 4C Sheath thickness: 0.5mm Cable diameter: Around 6.1mm
Individual wire specification   19 AWG Conductor diameter: Around 1.24mm, Insulator thickness: 0.23mm, Overall diameter: 1.7mm

12. Appendix

12.8.8 External regenerative resistor

Model number	Cable length: L(mm)	Applicable motor
For brake		
AL-00999239-01	1,000	
AL-00999239-02	2,000	
AL-00999239-03	3,000	R2CA2830KV
AL-00999239-05	5,000	
AL-00999239-10	10,000	

Item	Connector model number	Remarks
Motor side crimp terminal	−	No work with motor side crimp terminal.

Cable specifications

(KURABE Industrial Co., Ltd.) (Operating temperature range: None)
FFR2C
AL-00999239-01 to 10; 1 to 10m specifications
20AWG x 2C Sheath thickness: 1.0mm Cable diameter: Around 4.8mm
Individual wire specification   20 AWG Conductor diameter: Around 0.9mm, Insulator thickness: 0.25mm, Overall diameter: 1.4mm

12.8.9 Thermostat cable for servo motor FAN

Model number	Cable length: L(mm)	Applicable motor
For thermostat		
AL-00999242-01	1,000	
AL-00999242-02	2,000	
AL-00999242-03	3,000	R2CA2830KV
AL-00999242-05	5,000	
AL-00999242-10	10,000	

Item	Connector model number	Remarks
Motor side connector	−	No work with motor side connector. Refer the section 4.4, for connector model number and wiring.

Cable specifications

(KURABE Industrial Co., Ltd.) (Operating temperature range: Up to 150℃)
2C FRW-ST sheath cable
AL-00999242-01 to 10; 1 to 10m specifications
22 equivalent AWG x 2C Sheath thickness: 1.2mm Cable diameter: Around 5.0mm
Individual wire specification   20,21 equivalent AWG Conductor diameter: Around 0.75mm, Insulator thickness: 0.275mm, Overall diameter: 1.3mm

12.8.10 Servo motor FAN power cable

Model number For FAN power	Cable length: 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.
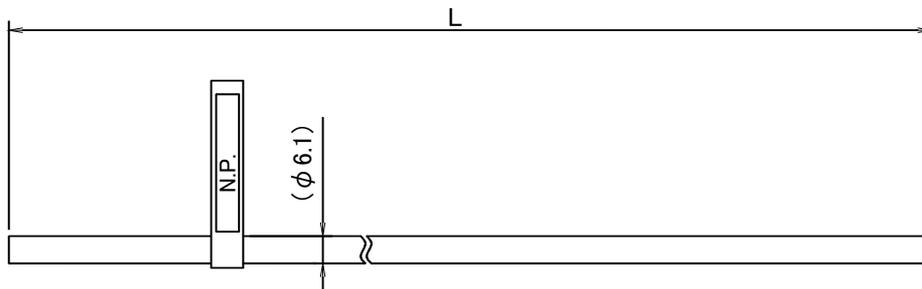
L (mm): 1,000/2,000/3,000/5,000/10,000

12. Appendix

12.8.11 External regenerative resistor

Resistor Model Number	Rated power [PR]	Resistance value	Thermostat Detection temperature (Contact specification)	Mass
REGIST-080W100B	80W	100Ω		0.19kg
REGIST-080W50B	80W	50Ω		0.19kg
REGIST-120W100B	120W	100Ω	135°C±7°C (Switching contact b)	0.24kg
REGIST-120W50B	120W	50Ω		0.24kg
REGIST-220W100B	220W	100Ω		0.44kg
REGIST-220W50B	220W	50Ω		0.44kg
REGIST-220W20B	220W	20Ω		0.44kg
REGIST-500CW80B	500W	80Ω		1.4kg
REGIST-500CW40B	500W	40Ω		1.4kg
REGIST-500CW20B	500W	20Ω	100°C±5°C (Switching contact b)	1.4kg
REGIST-500CW10B	500W	10Ω		1.4kg
REGIST-500CW14B	500W	14Ω		1.4kg
REGIST-500CW7B	500W	7Ω		1.4kg
REGIST-500CW5B	500W	5Ω		1.4kg
REGIST-1000W6R7B	1000W	6.7Ω	140℃±5℃ (Switching contact b)	3.0kg

12.8.12 Connection cable between units

■ For 200V AC, 600A
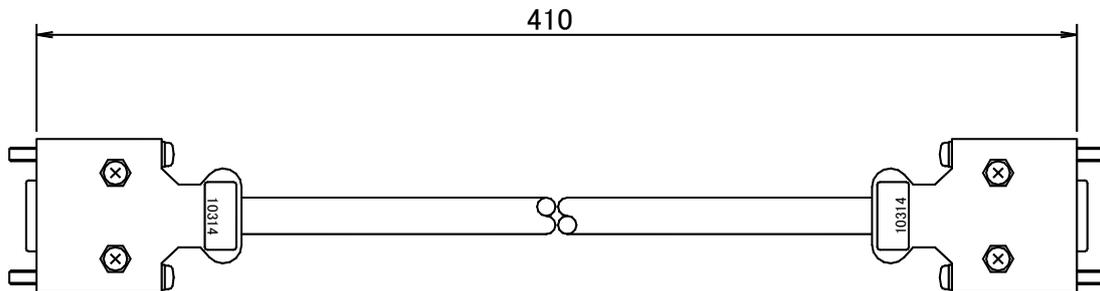
Apply	Model number
Connecting each CN9 of power unit and amplifier unit	AL-00917284

■ For 400V AC, 800A
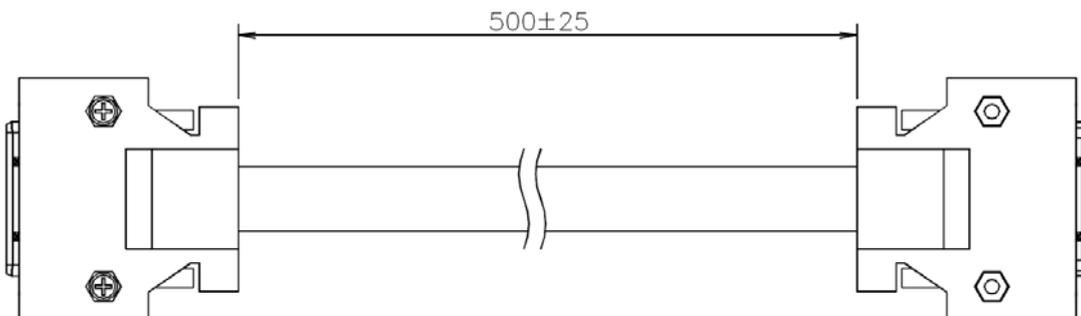
Apply	Model number
Connecting each CN9 of power unit and amplifier unit	AL-01018354-01

12.8.13 Copper bus bar

■ For 200V AC, 600A

Apply	Description	Model number
+DC, -DC connection	2 pieces include	AL-00918125-01

■ For 400V AC, 800A

Apply	Description	Model number
+DC, -DC connection	2 pieces include	AL-01020858-01

12. Appendix

12.9 Optional parts dimensions

12.9.1 Battery peripherals dimensions

■ Battery body for battery box (Model No.: AL-00879511-01)

1. Battery and connector specifications

Lithium battery	Thionyl Chloride Lithium Battery ER3VLY (Toshiba Lifestyle Products & Services Corporation) 　Nominal Voltage: 3.6V 　Nominal Capacity: 1000mAh 　Lithium metal mass as standard: 0.31g
Connector	DF3-2S-2C; Socket Housing (HIROSE) DF3-2428SCFC; Contact (HIROSE)

2. Wiring diagram

■ Battery BOX (Model No.:AL-00880402-01)
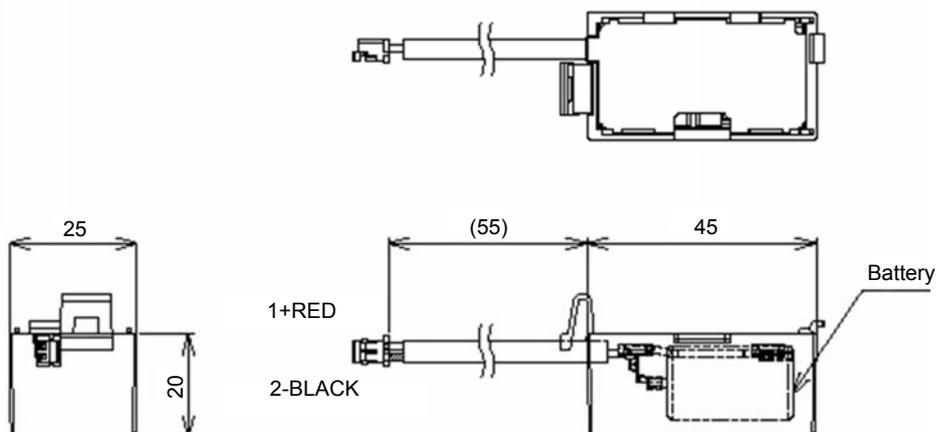
See "8.6.2 Replacing battery for motor encoder" for how to replace battery box.

12.9 Optional parts dimensions

■ Battery body for junction cable (Model No.: AL-00697958-01)

1. Battery and connector specifications

Lithium battery	Thionyl Chloride Lithium Battery ER3VLY (Toshiba Lifestyle Products & Services Corporation) 　Nominal Voltage: 3.6V 　Nominal Capacity: 1000mAh 　Lithium metal mass as standard: 0.31g
Connector	DF3-2S-2C; Socket Housing (HIROSE) DF3-2428SCFC; Contact (HIROSE)

2. Wiring diagram

1	BAT+
2	BAT-

12-59

12. Appendix

■ Battery trunk cable (Model No.: AL-00697960-□□)

| Connector for | Battery unit | The battery back method |
| the servo amplifier side | with built-in battery | absolute encoder side |

Model Number	L[m]
AL-00697960-01	3
AL-00697960-02	5
AL-00697960-03	10
AL-00697960-04	15
AL-00697960-05	20
AL-00697960-06	25

1. Spec: Trunk cable for encoder with the connector in one end and the battery unit for moving part at mid-low speed   *This shall not be designed for moving part at high speed.

2. Wiring specifications

Connector on servo amplifier

Terminal No.	Signal Name
1	5V
2	SG
7	ES+
8	ES-
9	BAT+
10	BAT-
Shell	Ground

Line color	Wire size (AWG)	
	3 - 15m	20, 25m
Red	22	20
Black		
Brown		
Blue	24	24
Green		
Purple		

Shield

Built-in battery unit

Terminal No.	Signal Name
1	BAT+
2	BAT-
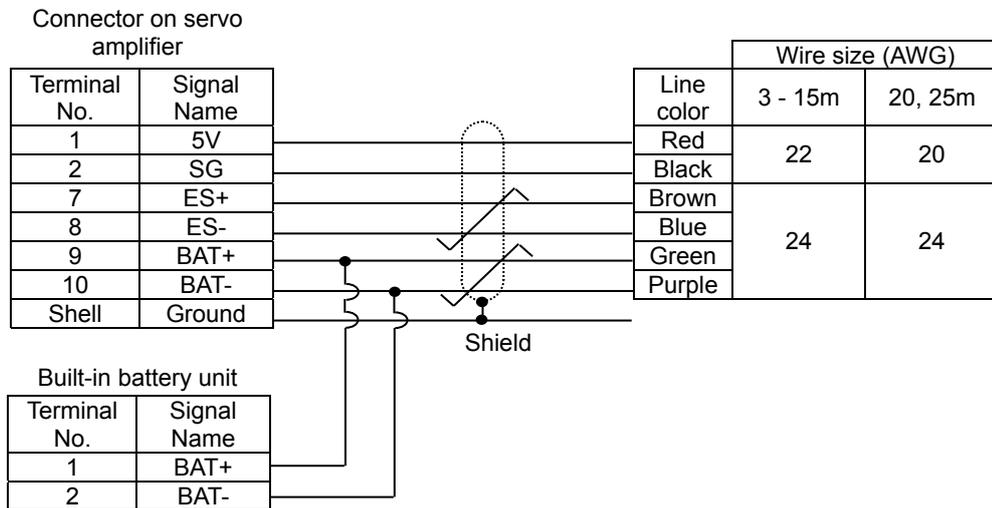
3. Specification for the connector and the battery unit

Connector for servo amplifier	36210-0100PL; Wiremount Receptacle (3M)
	36310-3200-008; Shell Kit (3M)
Battery unit	Built-in battery; ER3VLY (Toshiba Lifestyle Products & Services Corporation)
	Nominal Voltage: 3.6V
	Nominal Capacity: 1000mAh
	Lithium-metal mass: 0.31g

4. Outline specification for cable

Robot cable for moving part at mid-low speed; UL-ORHV30-SB, Composite wire specification (Manufactured by OKANO ELECTRIC WIRE Co., Ltd.) High-density polyethylene insulated wire, Vinyl sheath, Braided shield addition.	
UL STYLE NO. 20276 (Ratings: 80°C, 30V)	
AL-00697960-01 - 04; 3 - 15m	AL-00697960-05, 06; 20,25m
22 AWG x 2C + 24 AWG x 2P Sheath thickness: 1.0mm Cable outer diameter: Φ7.1±0.5mm	20 AWG x 2C + 24 AWG x 2P Sheath thickness: 1.0mm Cable outer diameter: Φ7.1±0.5mm
Respective wire specifications 24 AWG Conductor diameter: Φ0.65mm, Insulator thickness: 0.25mm, Insulator coat outer diameter:Φ1.15mm 22 AWG Conductor diameter: Φ0.77mm, Insulator thickness: 0.25mm, Insulator coat outer diameter: Φ1.27mm 20 AWG Conductor diameter: Φ0.95mm, Insulator thickness: 0.25mm, Insulator coat outer diameter: Φ1.45mm	

5. Battery model number for replacement: AL-00697958-01

■　Battery trunk cable (Model No.: AL-00731792-01)

Connector for the servo amplifier side　Battery unit with built-in battery　Relay connector for the battery backup absolute encoder side

(382)

(40)　300±10　(42)
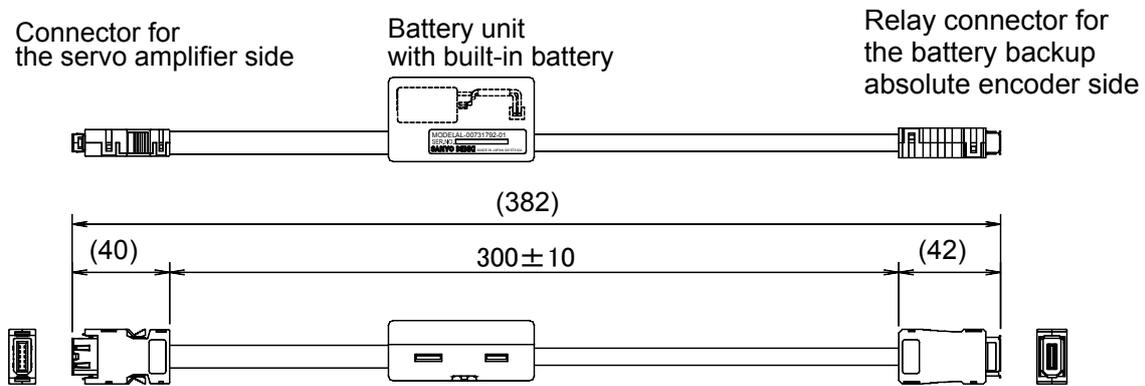
1. Specification: Relay cable for encoder with the connector at both ends and the battery unit

2. Wiring spec

Connectors on servo amplifier

Terminal No.	Signal Name
1	5V
2	SG
3	(NC)
4	(NC)
5	(NC)
6	(NC)
7	ES+
8	ES-
9	BAT+
10	BAT-
Shell	Earth

Relay connectors on encoder

Terminal No.	Signal Name
1	5V
2	SG
3	5V
4	SG
5	(NC)
6	(NC)
7	ES+
8	ES-
9	BAT+
10	BAT-
Shell	Earth

Shielded

Built-in battery unit

Terminal No.	Signal Name
1	BAT+
2	BAT-
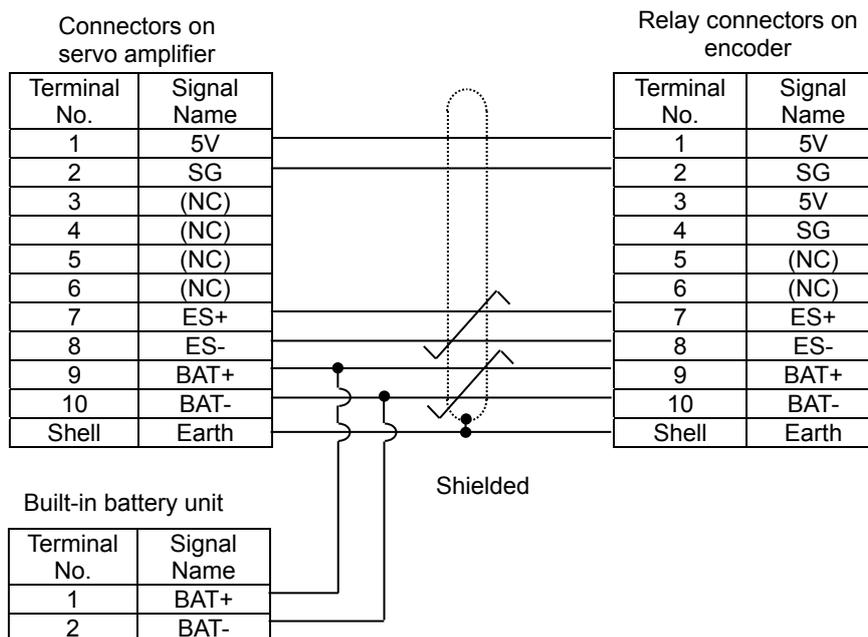
12. Appendix

3. Specification for the connector and the battery unit

Connectors for servo amplifier	36210-0100PL; Wiremount Receptacle (3M) 36310-3200-008; Shell Kit (3M)
Trunk connectors for encoder	36110-3000FD; Wiremount Plug (3M) 36310-F200-008; Shell Kit (3M)

Battery unit	Built-in battery; ER3VLY (Toshiba Lifestyle Products & Services Corporation)
	    Nominal Voltage: 3.6V
	    Nominal Capacity: 1000mAh
	    Lithium-metal mass:0.31g

4. Battery model number or replacement: AL-00697958-01

12.9.2 Monitor box outline drawing

■ Monitor Box (Model No.: Q-MON-3
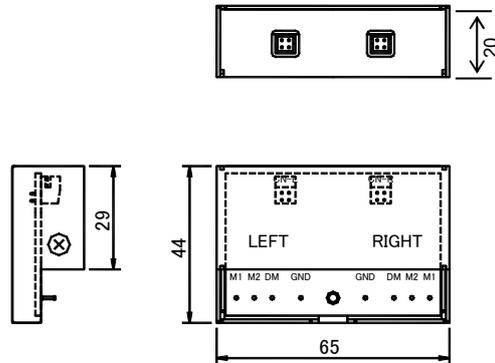
12.9.3 Dedicated Cable outline drawing

■ Dedicated Cable (Model No.: AL-00690525-01)
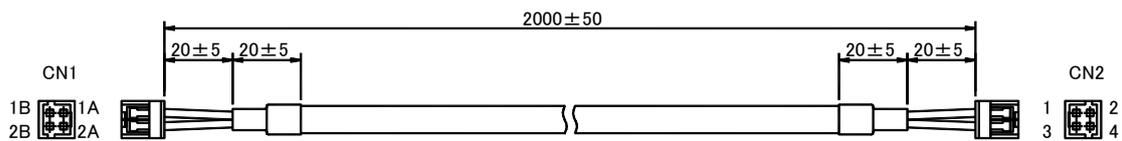
Note 1) A pair of the dedicated cable shown above (model number: AL-00690525-01) are supplied with the Monitor Box (model number: Q-MON-3).

Terminal No. on CN1	Signal name	Terminal No. on CN2
1A	Analog monitor 1	3
1B	Analog monitor 2	4
2A	GND	1
2B	-	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. Appendix

12.9.4 Outline drawing of USB communication cable

■ USB communication cable (1.0m) (Model number: AL-00896515-01)

Standard-A Plug   Mini-B Plug
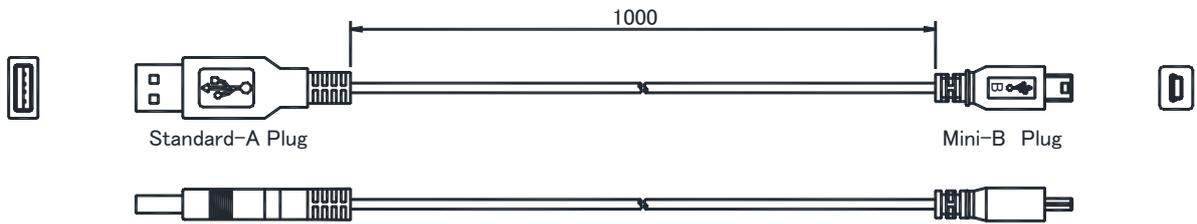
*   Appearance and spec may change without prior notice.

■ USB communication cable (2.0m) (Model number: AL-00896515-02)
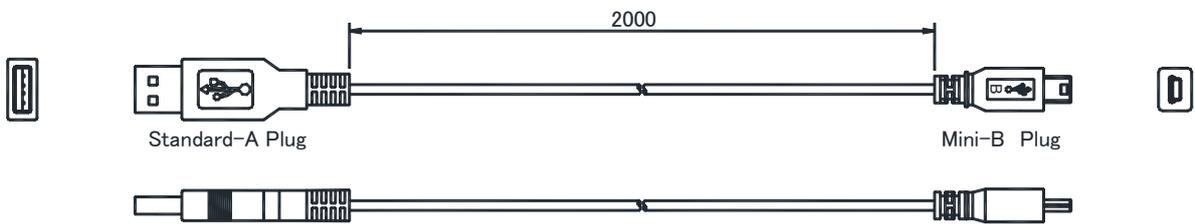
Standard-A Plug   Mini-B Plug

*   Appearance and spec may change without prior notice.

12.9.5 Servo Motor Power Cable outline drawing

Red, White, Black ①
Yellow, Yellow ②
Green (Earth) ③
N.P.
④
⑤ Straight plug：JAE Cable clamp：JAE
L(mm)
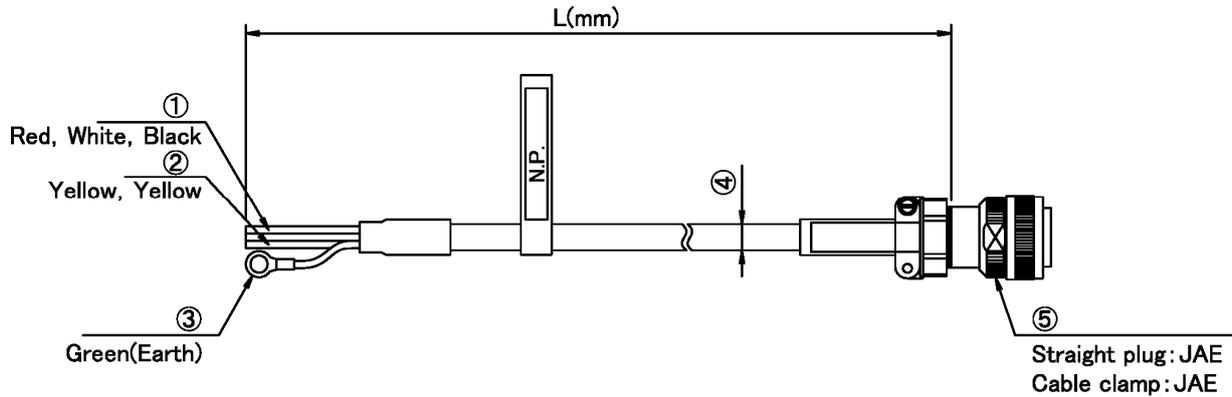
L (mm): Means 1,000, 2,000, 3,000 5,000 or 10,000

Model number		AL-00964811-□□	AL-00964812-□□	AL-00965739-□□	AL-00965740-□□
①Power	Wire	AWG16	AWG16	AWG16	AWG16
	Terminal	—	—	—	—
②Brake	Wire	—	AWG20	—	AWG20
	Terminal	—	—	—	—
③Ground	Wire	AWG16	AWG16	AWG16	AWG16
	Terminal	N2-M4	N2-M4	N2-M4	N2-M4
④Cable diameter		φ11.6	φ11.6	φ11.6	φ11.6
⑤Plug /Clamp		JL04V-6A20-15SE-EB-R / JL04-2022CK(14)-R	JL04V-6A20-15SE-EB-R / JL04-2022CK(14)-R	JL04V-6A24-11SE-EB-R / JL04-2428CK(17)-R	JL04V-6A24-11SE-EB-R / JL04-2428CK(17)-R

Connection

AL-00964811:

Lead wire	Motor side name	Connector pin number
Red	U	A
White	V	B
Black	W	C
Green	Ground	D

AL-00964812:

Lead wire	Motor side name	Connector pin number
Red	U	A
White	V	B
Black	W	C
Green	Ground	D
Yellow	Brake	E
Yellow	Brake	F

AL-00965739:

Lead wire	Motor side name	Connector pin number
Red	U	D
White	V	E
Black	W	F
Green	Ground	G

AL-00965740:

Lead wire	Motor side name	Connector pin number
Red	U	D
White	V	E
Black	W	F
Green	Ground	G
Yellow	Brake	A
Yellow	Brake	B

Model number		AL-00965741-□□	AL-00965742-□□	AL-00965743-□□	AL-00965744-□□
①Power	Wire	AWG14	AWG14	AWG12	AWG12
	Terminal	—	—	—	—
②Brake	Wire	—	AWG20	-	AWG20
	Terminal	—	—	—	—
③Ground	Wire	AWG14	AWG14	AWG12	AWG12
	Terminal	N2-M4	N2-M4	N2-M4	N2-M4
④Cable diameter		φ12.5	φ12.5	φ14.0	φ14.0
⑤Plug /Clamp		JL04V-6A24-11SE-EB-R / JL04-2428CK(17)-R	JL04V-6A24-11SE-EB-R / JL04-2428CK(17)-R	JL04V-6A24-11SE-EB-R / JL04-2428CK(17)-R	JL04V-6A24-11SE-EB-R / JL04-2428CK(17)-R

Connection

AL-00965741:

Lead wire	Motor side name	Connector pin number
Red	U	D
White	V	E
Black	W	F
Green	Ground	G

AL-00965742:

Lead wire	Motor side name	Connector pin number
Red	U	D
White	V	E
Black	W	F
Green	Ground	G
Yellow	Brake	A
Yellow	Brake	B

AL-00965743:

Lead wire	Motor side name	Connector pin number
Red	U	D
White	V	E
Black	W	F
Green	Ground	G

AL-00965744:

Lead wire	Motor side name	Connector pin number
Red	U	D
White	V	E
Black	W	F
Green	Ground	G
Yellow	Brake	A
Yellow	Brake	B

12. Appendix

①Red,White,Black
②Yellow,Yellow
③Green (Ground)

Straight plug: Product of JAE
Cable clamp: Product of JAE

L (mm): Means 1,000, 2,000, 3,000 5,000 or 10,000

Model number		AL-00997919-□□	AL-00997920-□□
①Power	Wire	AWG10	AWG10
	Terminal	N5.5-5	N5.5-5
②Brake	Wire	─	AWG20
	Terminal		N1.25-4
③Ground	Wire	AWG10	AWG10
	Terminal	N5.5-5	N5.5-5
④Cable diameter		φ15	φ15
⑤Plug /Clamp		JL04V-6A24-11SE-EB-R / JL04-2428CK(17)-R	JL04V-6A24-11SE-EB-R / JL04-2428CK(17)-R

Connection

Lead wire	Motor side signal name	Connector pin number
Lead wire Red	U	D
Lead wire White	V	E
Lead wire Black	W	F
Lead wire Green	Earth	G

Lead wire	Motor side signal name	Connector pin number
Lead wire Red	U	D
Lead wire White	V	E
Lead wire Black	W	F
Lead wire Green	Earth	G
Lead wire Yellow	Brake	A
Lead wire Yellow	Brake	B

L (mm): Means 1,000, 2,000, 3,000 5,000 or 10,000

Model number		AL-00997921-□□	AL-00997922-□□
①Power	Wire	AWG8	AWG5,6 equivalent
	Terminal	R8-5	R14-5
②Ground	Wire	AWG8	AWG5,6 equivalent
	Terminal	R8-5	R14-5
③Cable diameter		ϕ17	ϕ19
④Plug/ Socket/ Conduit/ Bush		JL04V-6A32-17SE-EB-R / N2KM2532 / NS25 / N2HBI2519	JL04V-6A32-17SE-EB-R / N2KM2532 / NS25 / N2HBI2519
Connection			

Connection (left — AL-00997921):

	Motor side signal name	Connector pin number
Lead wire Red	U	A
Lead wire White	V	B
Lead wire Black	W	C
Lead wire Green	Earth	D

Connection (right — AL-00997922):

	Motor side signal name	Connector pin number
Lead wire Red	U	A
Lead wire White	V	B
Lead wire Black	W	C
Lead wire Green	Earth	D

12. Appendix

L (mm): Means 1,000, 2,000, 3,000 5,000 or 10,000

Model number		AL-00999240-☐☐
①Power	Wire	AWG5.6 equivalent
	Terminal	R14-5
②Ground	Wire	AWG5.6 equivalent
	Terminal	R14-5
③Cable diameter		φ19
Connection		

	Motor side signal name
Lead wire Red	U
Lead wire White	V
Lead wire Black	W
Lead wire Green	Earth

12.9.6 Servo motor encoder cable dimensions

AL-00937694-□□

JAE
Connector：JN2DS10SL2-R

3M
Receptacle：36210-0100PL
Shell kit：36310-3200-008
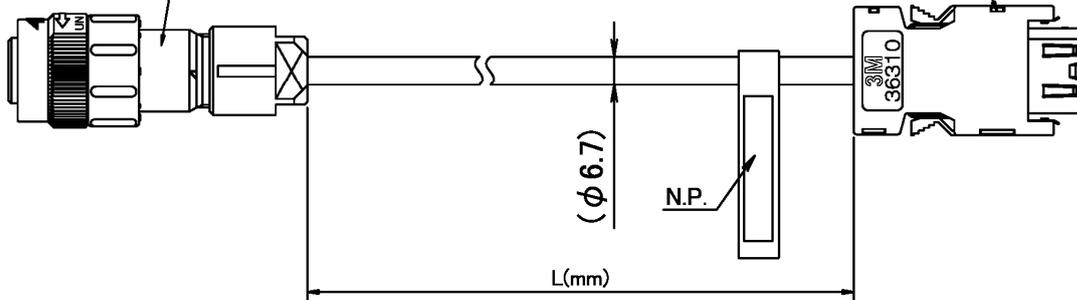
(φ6.7)

N.P.

L(mm)

L (mm): Means 1,000, 2,000, 3,000 5,000 or 10,000

AL-00999243-□□

(φ6.7)

N.P.

L(mm)

3M
Receptacle：36210-0100PL
Shell kit：36310-3200-008
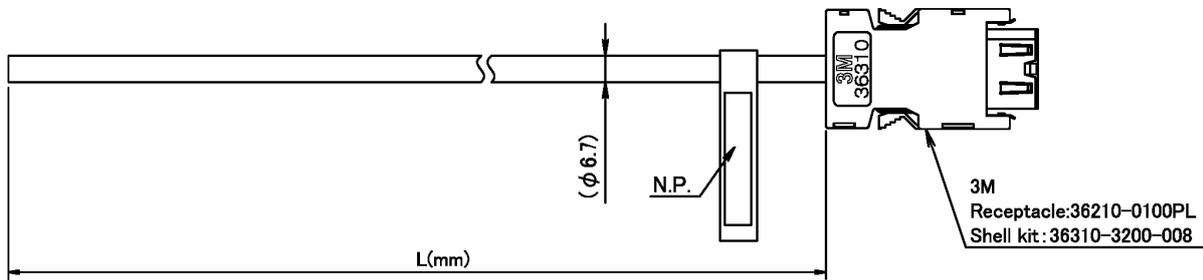
L (mm): Means 1,000, 2,000, 3,000 5,000 or 10,000

12. Appendix

12.9.7 Power cable dimensions for servo motor FAN

AL-00997923-□□

L(mm)

White, White
AWG20

N.P.

(φ4.8)

JAE
Straight plue：N/MS3106B10SL-4S
Cable clamp：N/MS3057-4A
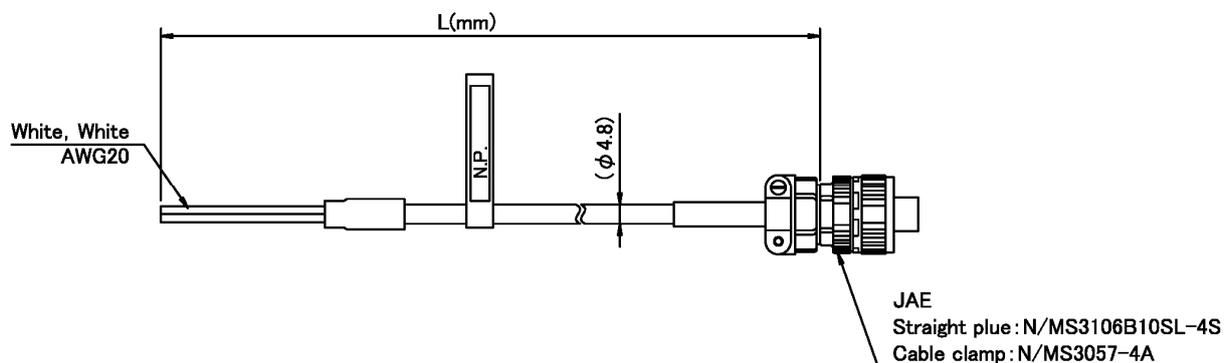
L (mm): Means 1,000, 2,000, 3,000 5,000 or 10,000

AL-00999241-□□

L(mm)

N.P.

(φ6.1)
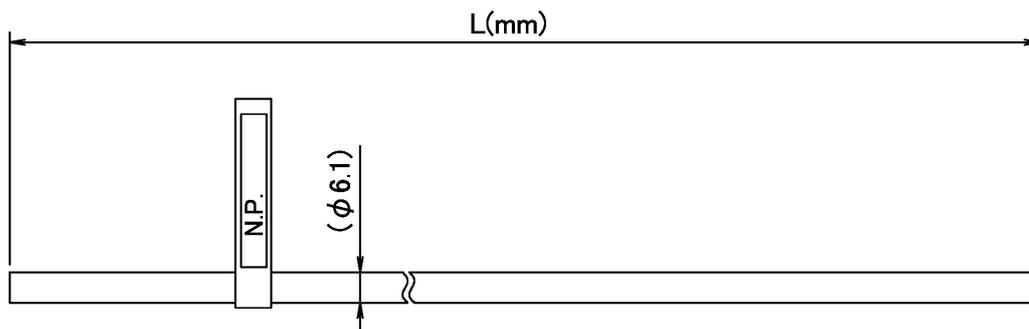
L (mm): Means 1,000, 2,000, 3,000 5,000 or 10,000

12.9.8 Servo motor brake cable dimensions

AL-00918630-☐☐

JAE
Straight plug：JL04V-6A10SL-3SE-EB-R
Cable clamp：JL04-1012CK(05)-R

L(mm)

JST
N1.25-4

(φ5.9)

N.P.

120±7

L (mm): Means 1000, 2000, 3000, 5000 or 10000

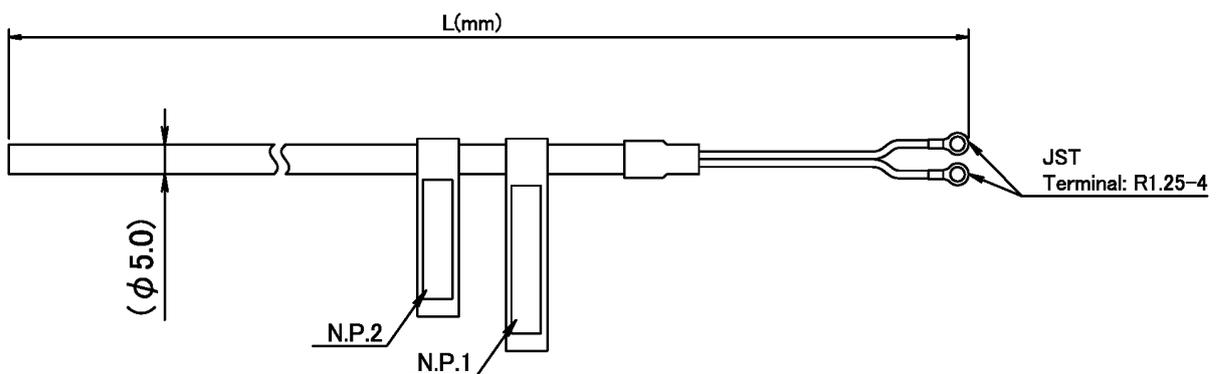AL-00999239-☐☐

L(mm)

White,White
AWG20

N.P.

(φ4.8)

JST
Terminal: N1.25-4
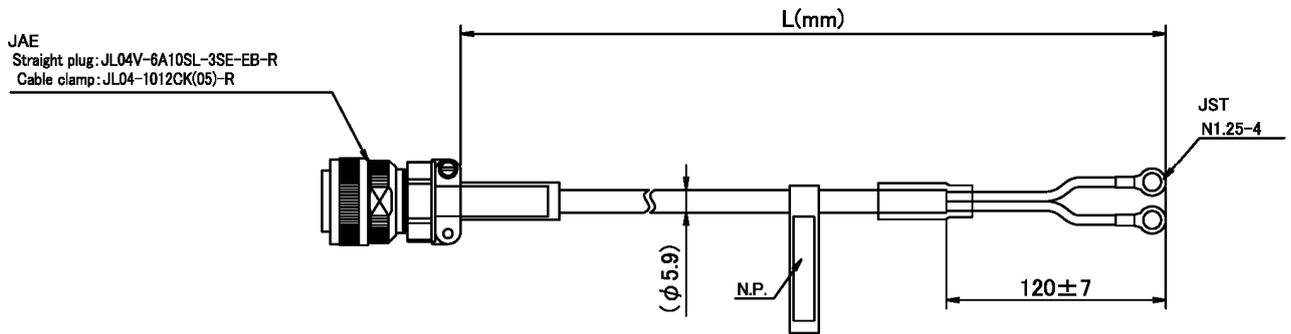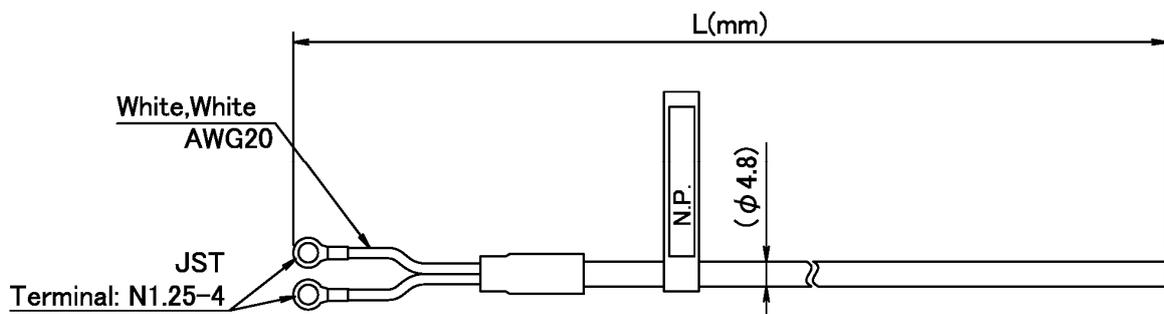
L (mm): Means 1000, 2000, 3000, 5000 or 10000

12.9.9 Thermostat cable dimensions for servo motor FAN

AL-00999242-☐☐
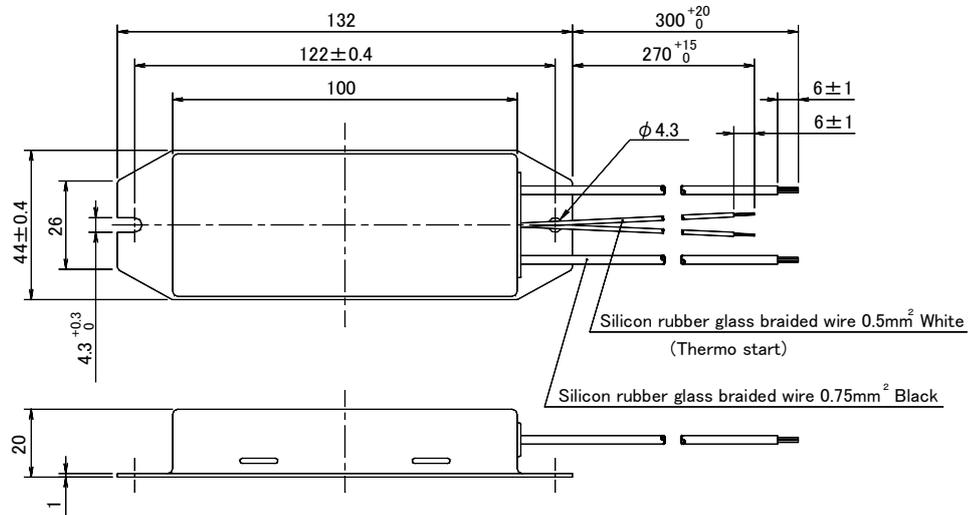
L(mm)

(φ5.0)

N.P.2

N.P.1

JST
Terminal: R1.25-4

L (mm): Means 1000, 2000, 3000, 5000 or 10000

12. Appendix

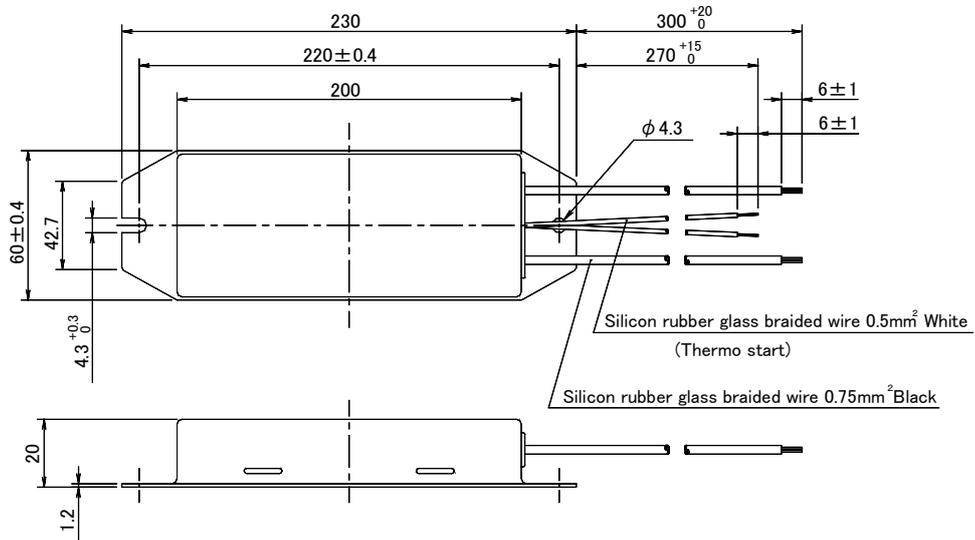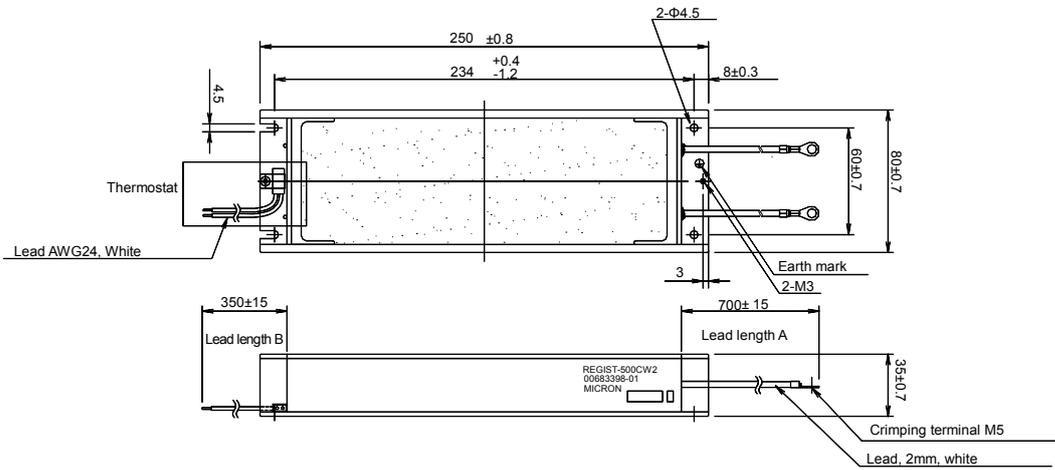## 12.9.10 Outline drawing of regenerative resistor

■ REGIST-080W

132
122±0.4
100
300 +20/0
270 +15/0
6±1
6±1
φ4.3
44±0.4
26
4.3 +0.3/0
20
1

Silicon rubber glass braided wire 0.5mm² White
(Thermo start)

Silicon rubber glass braided wire 0.75mm² Black

■ REGIST-120W

182
172±0.4
150
300 +20/0
270 +15/0
6±1
6±1
φ4.3
42±0.4
23.5
4.3 +0.3/0
20
1.2

Silicon rubber glass braided wire 0.5mm² White
(Thermo start)

Silicon rubber glass braided wire 0.75mm² Black
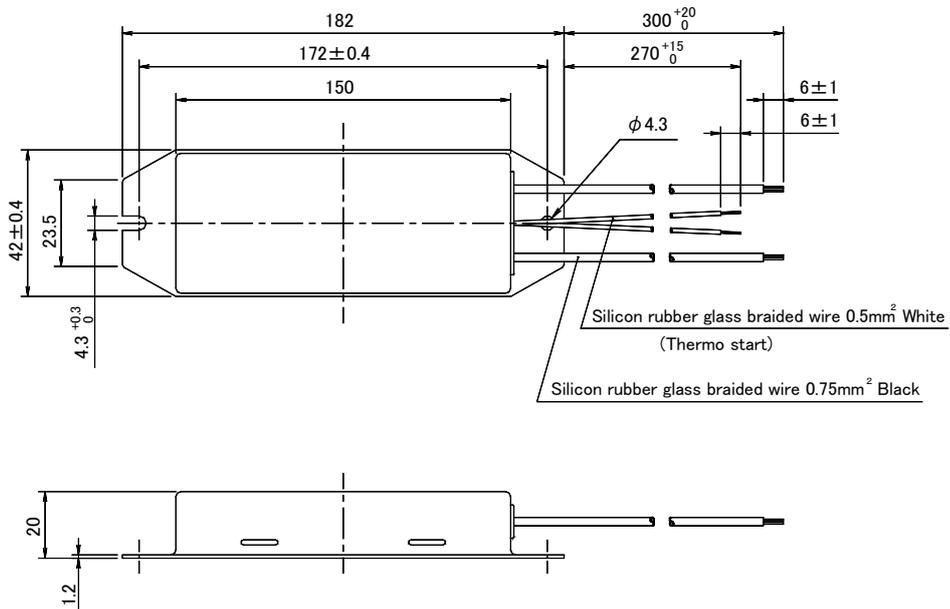
12.9 Optional parts dimensions

■ REGIST-220W

Silicon rubber glass braided wire 0.5mm² White
(Thermo start)

Silicon rubber glass braided wire 0.75mm² Black

■ REGIST-500CW

Thermostat

Lead AWG24, White

Earth mark
2-M3

Lead length B

Lead length A

REGIST-500CW2
00683398-01
MICRON

Crimping terminal M5

Lead, 2mm, white
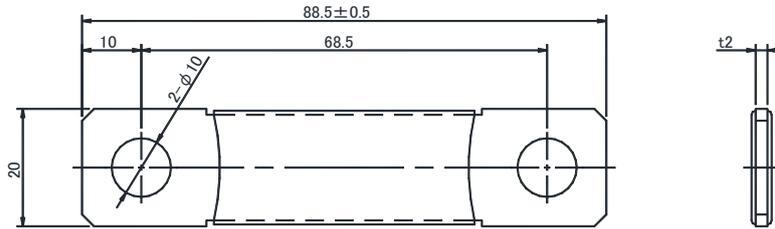
12. Appendix

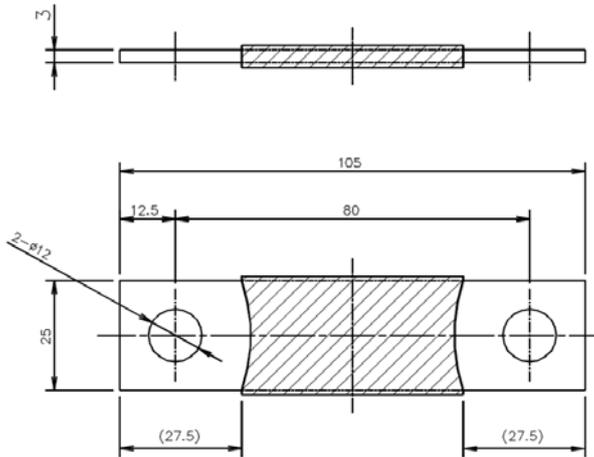■ REGIST-1000W
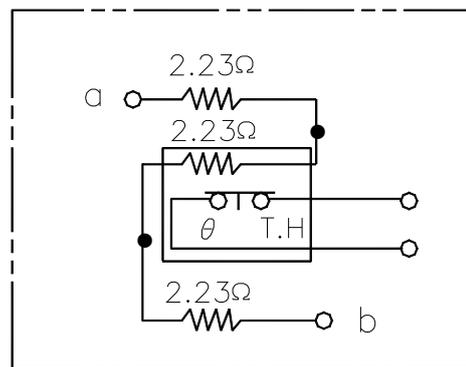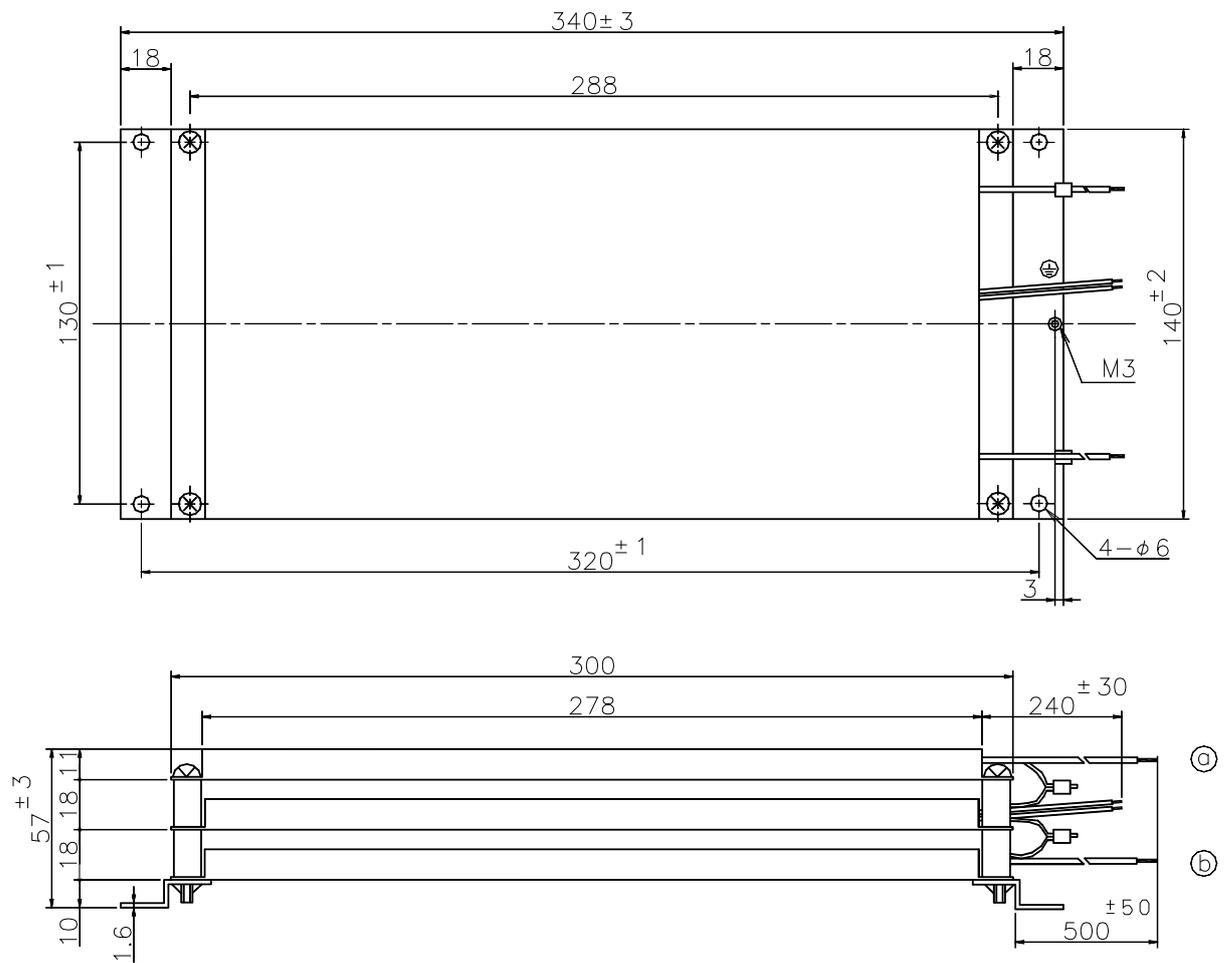
Wiring diagram

12.9.11 Copper bus bar

■ +DC, -DC (Model number: AL-00918125-01)

*   2 pieces include

■ +DC, -DC (Model number: AL-01020858-01)

No Text on This Page.

Release
Revision A   Sep. 2017
Revision B   Sep. 2018
Revision C   Dec. 2018
Revision D   Apr. 2019

■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.

ECO PRODUCTS

■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.

https://www.sanyodenki.com

SANYO DENKI CO., LTD. TEL: +81 3 5927 1020
3-33-1 Minami-Otsuka, Toshima-ku, Tokyo 170-8451, Japan

SANYO DENKI EUROPE SA. TEL: +33 1 48 63 26 61
P.A. Paris Nord Ⅱ, 48 Allée des Erables-VILLEPINTE, BP.57286, F-95958 ROISSY CDG Cedex, France

SANYO DENKI AMERICA, INC. TEL: +1 310 783 5400
468 Amapola Avenue Torrance, CA 90501, U.S.A.

SANYO DENKI SHANGHAI CO., LTD. TEL: +86 21 6235 1107
Room 2106-2110, Bldg A, Far East International Plaza, No.319, Xianxia Road, Shanghai, 200051, China

   Beijing Branch TEL: +86 10 6522 2160
   Room1222, Tower B, Beijing COFCO Plaza, No.8 Jianguomennei Dajie, Dong Cheng District, Beijing 100005 China

SANYO DENKI (H.K.) CO., LIMITED TEL: +852 2312 6250
Room 2305, 23/F, South Tower, Concordia Plaza, 1 Science Museum Rd., TST East, Kowloon, Hong Kong

SANYO DENKI TAIWAN CO., LTD. TEL: +886 2 2511 3938
N-711, 7F, Chia Hsin 2nd Bldg., No.96, Sec.2, Zhongshan N. Rd., Taipei 10449, Taiwan (R.O.C.)

SANYO DENKI SINGAPORE PTE.LTD. TEL: +65 6223 1071
988 Toa Payoh North, #04-08, Singapore 319002

   Indonesia Representative Office TEL: + 62 21 252 3202
   Summitmas II 4th Floor, Jl. Jend. Sudirman Kav.61-62, Jakarta 12190, Indonesia

SANYO DENKI GERMANY GmbH TEL: +49 6196 76113 0
Frankfurter Strasse 80-82, 65760 Eschborn, Germany

SANYO DENKI KOREA CO., LTD. TEL: +82 2 773 5623
15F, KDB Building, 372, Hangang-daero, Yongsan-gu, Seoul, 04323, Korea

   Busan Branch TEL: +82 51 796 5151
   8F, CJ Korea Express Bldg., 119, Daegyo-ro, Jung-gu, Busan, 48943, Korea

SANYO DENKI (Shenzhen) CO., LTD. TEL: +86 755 3337 3868
2F 02-11, Shenzhen International Chamber of Commerce Tower, No.168 Fuhua 3 Road, Futian District, Shenzhen, 518048 China

   Tianjin Branch TEL: +86 22 2320 1186
   Room AB 16th Floor TEDA Building, No. 256 Jie Fang Nan Road, Hexi District, Tianjin 300042 China

   Chengdu Branch TEL: +86 28 8661 6901
   Room2105B, Block A, Times Plaza, 2 Zongfu Road, Jinjiang District, Chengdu, 610016 China

SANYO DENKI (THAILAND) CO., LTD. TEL: +66 2261 8670
388 Exchange Tower, 25th Floor, Unit 2501-1, Sukhumvit Road, Klongtoey, Klongtoey, Bangkok 10110 Thailand

SANYO DENKI INDIA PRIVATE LIMITED TEL: +91 44 420 384 72
#14 (Old No.6/3), Avenue Road, Nungambakkam, Chennai - 600034, Tamil Nadu, India

The names of companies and/or their products specified in this manual are the trade names, and/or trademarks and/or registered trademarks of such respective companies.
*Specifications are subject to change without notice.
Translated version of the original instructions