M0011195B

# SANMOTION

## AC SERVO SYSTEMS

## R ADVANCED MODEL

TYPE F

With EtherCAT® Interface Type H

For Rotary Motor, Linear Motor

# Instruction Manual

SANYO DENKI

## Details of revision history

### The second edition (B)

- p. 1-7
  - ・Manufacturer name of general I/O connector is corrected.
  - ・Front view drawing is changed.

- p. 1-9
  - ・Instruction manual number in notes of section 1) is corrected.

- p. 2-7
  - ・Table is corrected.

- p. 4-9
  - ・Symbols in the terminal arrangement are corrected.

- p. 5-64
  - ・Note is deleted in 0x6067 Position Window.

- p. 5-90
  - ・Contents of bit14 and 15 in 0x2000 are changed.
- p. 5-134
  - ・Liner motor number is corrected in 0x20FE Motor code.

- p. 5-135  
  p. 7-19
  - ・Descriptions about the R ADVANCED setup software are changed to about the MOTOR setup software.

- p. 5-142
  - ・Comment is corrected and note is added, in 0x210D Position Synchronization Deviation Monitor.
- p. 6-12, 6-13
  - ・Main circuit voltage drop detection level is corrected.

- p. 9-22
  - ・Alarm code FF is deleted.

- p. 9-26
  - ・Description drawing of RF2 in section "Replacing battery for motor encoder" is corrected.

- p. 10-3
  - ・Information in the table for standard conformity is added and corrected.

# Details of revision history

- p. 12-1
  - Description of motor sizing flowchart is corrected.

- p. 12-4
  - Contents in section "8) Judgment condition" is corrected.
  - Notes for section "8) Judgment condition" are added.

- p. 13-1
  - Table of standard conformity is corrected.

- p. 13-17
  - Cable length for CNA and CNC are changed. 3m ⇒ 2m

## Safety Precautions

Make sure to follow

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. |

■ Attention in use

## ⚠ Warning

Make certain to follow these safety precautions strictly to avoid electric shock or bodily injury.

- ◆ 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 load 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.
- ◆ Magnetic rails have been magnetized. Keep away from the magnets anyone who has electronic medical device such as a pace maker. Otherwise, the medical device will not work appropriately, leading to a serious danger to the person who has the medical device.

### 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.
- ◆ The motor angling bolts are used for transporting the motor itself; do not use them for transporting the machinery, etc.
  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.
- ◆ Secure the device against falling, overturning, or shifting inadvertently during installation. Use the hardware supplied with the motor (if applicable).
  Bodily injury could otherwise result.
- ◆ Install the device on a metal or other non-flammable support.
  Fire could otherwise result.
- ◆ Magnetic rails have been magnetized. A strong magnetic attraction (or repulsion between magnets) arises between the magnets themselves or the magnets and any other objects made of iron such as jigs. Treat them carefully.
  Bodily injury could otherwise result.
- ◆ Magnetic rails and coil have metal edges. Handle them with care.
  Bodily injury could otherwise result.
- ◆ Voltage is generated at the motor power line when the coil is moved after having been installed.
  Electric shock could otherwise result.
- ◆ Place limit switch and collision safety device to linear motor stroke end.
  Failure to observe this may result in injury.
- ◆ Make sure to install a limit switch and collision safety device at the stroke end.
  Make the collision safety device strong enough to resist the maximum output of the system.
  Bodily injury could otherwise result.

## ■ 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.
- ◆ Do not connect DC90V or AC power to the DC24V Brake of the servo motor. Also, do not connect AC400V to the AC200V Fan of the servo motor.
  An electrical short or fire could otherwise result.
- ◆ There is no safeguard on the linear motor. Use an over-voltage safeguard, short-circuit breaker, overheating safeguard, and emergency stop to ensure safe operation.
  Injury or fire could otherwise result.

## ■ Operation

# ⚠ Caution

- Do not perform extensive adjustments to the device as they may result in unstable operation.
  Bodily injury could otherwise result.
- Trial runs should be performed with the motor in a fixed position, separated from the mechanism. After verifying successful operation, install the motor on the mechanism.
  Bodily injury could otherwise result.
- The securing 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 less than 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.
- Do not touch the rotating part of the linear motor during operation.
  Bodily injury could otherwise result.
- Install sufficient protective cover in moving part of linear motor.
  Bodily injury could otherwise result.
- Keep away dust, water or others from the coil moving area and the magnetic rails.
  Electric shock, injury or damage to the device could otherwise result.

# ⃠ 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.
  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.

## Mandatory

- When transporting the magnetic rail, it must packed as it was.
  Transporting it without package could result in injury, since it has been magnetized.
- 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 interruption, 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) 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.
- When a work must be done with the protective cover removed, start working carefully and safely paying attention to an electric shock or runaway.
  Electric shock or injury 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.
- Do not unplug the connector while the device is powered up.
  (Except those that can be inserted or removed)
  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.

## ■ When you use SANYO DENKI amplifier with other manufacturer servo motor combined.

This Servo amplifier system is designed for using in combination of SANYO DENKI linear motor.
If other companies' linear motors are used in combination, we will provide you necessary parameters (Motor parameter files) to drive that based on your motor constant provided to us.
In that case, SANYO DENKI do not conduct the combination test of this servo amplifier with other companies' linear motors. Therefore, SANYO DENKI assumes no responsibility whatsoever for any motions and characteristics resulting from the use in the combination of that.
Also, SANYO DENKI cannot be held responsible for any damages or failures arising out of the use or inability to use those linear motors, even if SANYO DENKI has been advised of the possibility of such damages or failures.

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## 1. Preface

## 2 Specifications

## 3. Installation

## 4. Wiring

## 5. Object Dictionary

## 6. Operations

## 7. Adjustments

## 8. Indication

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## 10. Safe Torque Off function

## 11. Linear motor

## 12. Selection

## 13. Appendix

# 1

# 1. Preface

# 1.1 Introduction

The AC Servo amplifier SANMOTION R ADVANCED MODEL multi-axes EtherCAT provides two kinds capacity. The servo motor corresponds to the rotary motor of R series 200W or less and the compact linear motor of DE0AC001A03MX00. For motor encoder, rotary motor can use serial encoder and pulse encoder, linear motor can use pulse encoder. Backup batteries for motor encoder can be supplied via servo amplifier dedicated connector. In addition, connectors for EtherCAT communication, PC connection and encoder are equipped.

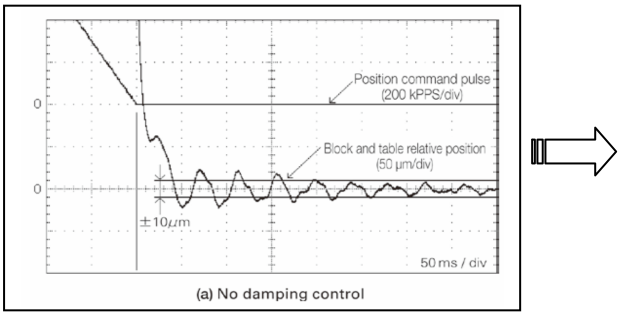
## 1) SANMOTION R ADVANCED MODEL features

■ Downsizing/Energy saving

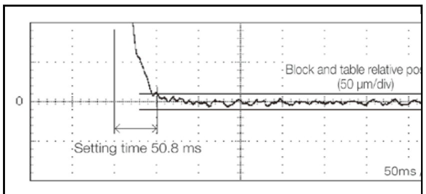
It is appropriate to the system which has limited installation because realizing space saving downsized by 4 axes integration. In addition, it contributes energy saving of system because the motor regenerative power can be used as the power for another motor.
It is DC power input type (Main circuit: DC48V (24V), Control circuit: 24V) servo amplifier.

■ Shortening a settling time (High response position/velocity control)

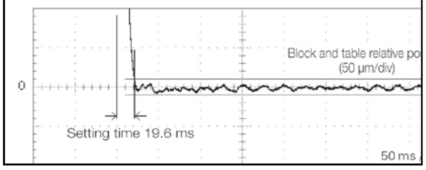
We have shortened the positioning time to 1/2 the current use, which improves the throughput of the machine using a high-response model following control and using model following vibration suppression control and feed forward vibration suppression control simultaneously.
Furthermore, external disturbance suppression can be performed at the same time with parallel use of an external disturbance observer, which creates the target value’s required response and the external disturbance suppression as well as stabilizes the robust activity necessary to operate the servo realistically at a high level.



(a) No damping control



(b) Feed-forward damping control

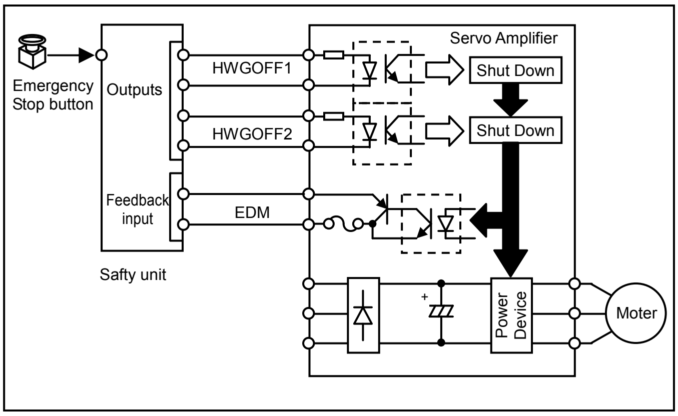


■ MOTOR setup software

4-axes setup operation via single cable is available.
Improvement of operation trace function, ability to measure operational properties of the servo motor with virtually the same operability of an oscilloscope, which increases measurement efficiency of machinery properties. Additionally, the creation of a multi-window display allows the operator to change parameters by checking measurement data for servo tuning, allowing for improved tuning efficiency.

### ■ Safe torque off function

By using hardware equipped with Safe Torque Off function that safely disables motor torque, you can easily incorporate safety functions to the machines.
In this servo system, safe torque off conditions of all 4 axes are changed together depending on single safety input.
Also, failure detection monitor of 4 axes outputs together. (Failure detection is output when any axis has failure condition.)



### ■ Installation of Power supply device and overcurrent protection device

For power supply of this servo amplifier (Main circuit: DC48V (24V), Control circuit: 24V), use of general AC/DC power device (switching power supply) is supposed. Please prepare an overcurrent protection fuse or breaker etc on power line to the input port of servo amplifier from AC power because fuse is not built in to the main and control power input of servo amplifier. (This servo amplifier is getting UL standards with condition that fuse is installed to input port. Refer to chapter 13, about the standards conformity.)

### ■ Digital operator

Digital operator which is built into our AC servo amplifier "SANMOTION R" and "SANMOTION R ADVANCED MODEL", is not equipped.

### ■ Cautions on wiring length

Main circuit power and control power supply are intended to be input from commonly used AC/DC converter.
When wiring length from power supply to servo amplifier is relatively long, the voltage might drop due to cable impedance, and this may cause motor torque decrease and control circuit error. Please perform wiring with use of thick cable and minimal-length as much as possible, so as not to let any voltage drops occur.

### ■ Analog monitor

Analog monitor function which monitors servo amplifier and motor operation condition, is not equipped to the servo amplifier.

# 1.2 Instruction Manual

This manual outlines the specifications, installation, wiring, operations, functions, maintenance, etc., of the AC servo amplifier SANMOTION R ADVANCED MODEL as follows:

## 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 Object Dictionary
  Explanation of EtherCAT Interface Object Dictionary
- Chapter 6 Operations」
  Discussion of operation sequence, test operations and parameters
- Chapter 7 Adjustments
  Explanation of auto tuning, manual servo tuning, etc.
- Chapter 8 Showing
  Explanation of the LED display
- Chapter 9 Maintenance
  Explanation of troubleshooting when alarms occur and inspection
- Chapter 10 Safe Torque Off function
  Explanation of safe torque off function and how to use it
- Chapter 11 Linear motor
  Explanation of how to use when linear motor connected.
- Chapter 12 Selection
  Explanation of selection method for the servo motor as well as regenerative resistance capacity
- Chapter 13 Appendix
  Explanation of EtherCAT terminology, servo motor data sheets, dimensions and international standards

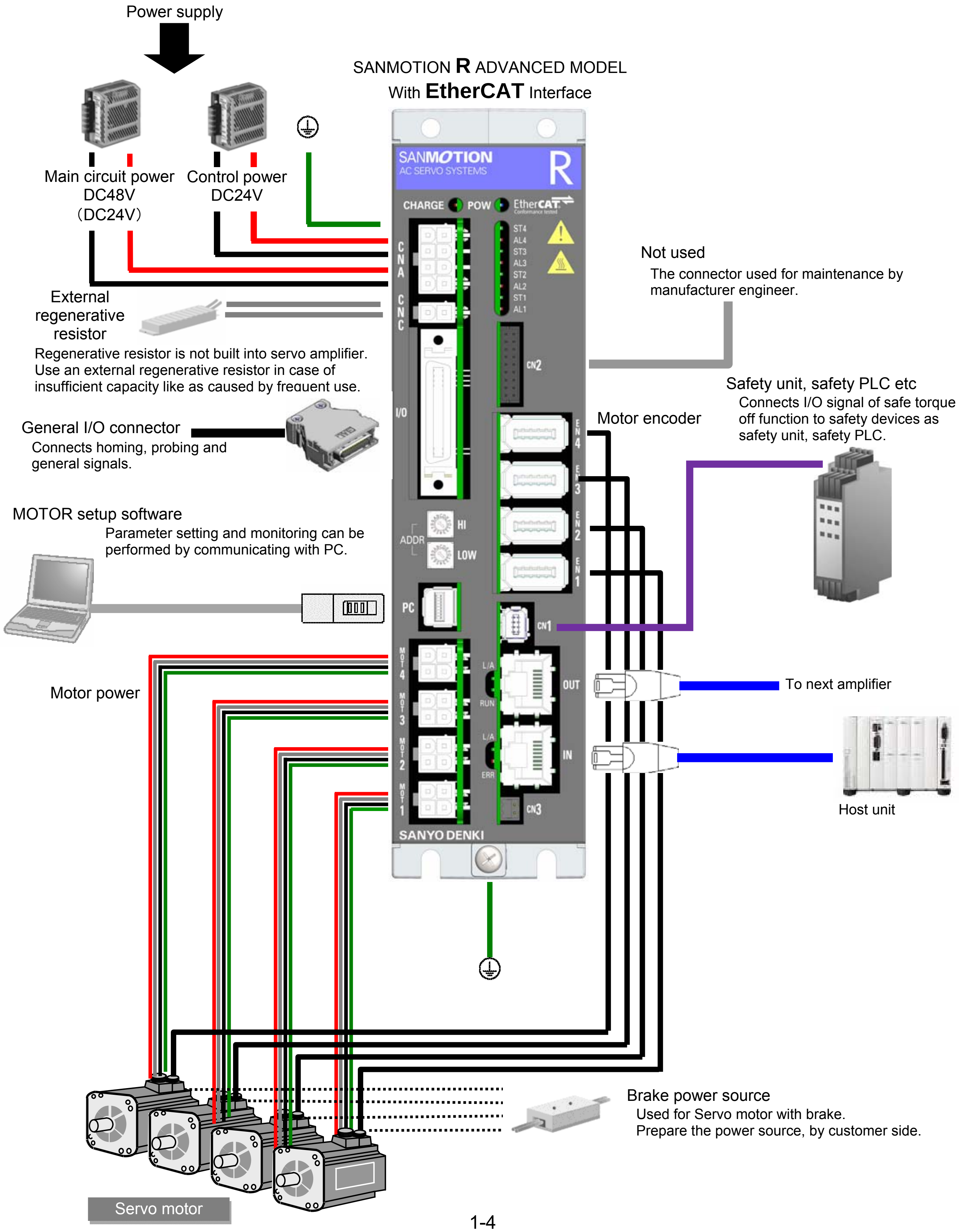
## 2) Precautions related to these Instructions

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 your local sales office or the head office of your findings.

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 System Configuration

■ RF2□24A□HA5



Not used
The connector used for maintenance by manufacturer engineer.

External regenerative resistor
Regenerative resistor is not built into servo amplifier. Use an external regenerative resistor in case of insufficient capacity like as caused by frequent use.

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

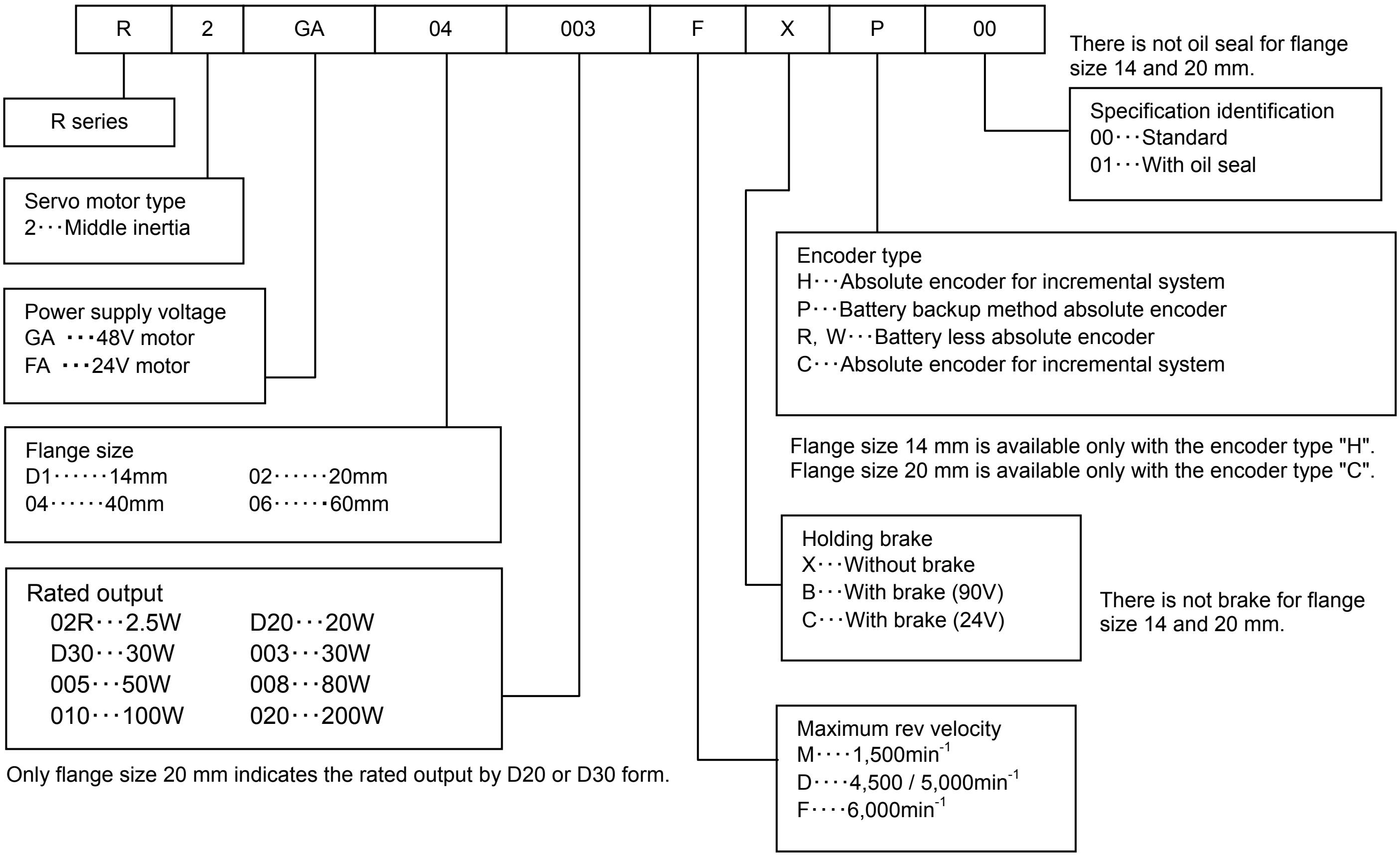
MOTOR setup software
Parameter setting and monitoring can be performed by communicating with PC.

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.
Prepare the power source, by customer side.

Model number structure

## 1) Rotary motor model number (R series)



There is not oil seal for flange size 14 and 20 mm.

Flange size 14 mm is available only with the encoder type "H".
Flange size 20 mm is available only with the encoder type "C".

There is not brake for flange size 14 and 20 mm.

Only flange size 20 mm indicates the rated output by D20 or D30 form.

Decreasing rating may be needed for the model with oil seal and brake.
Some motor may be the type without oil seal or without brake.
Refer to "Section 2.1 6) Degree of decrease rating for R2☐A motor with oil seal/brake".

- Motor encoder

Serial encoder

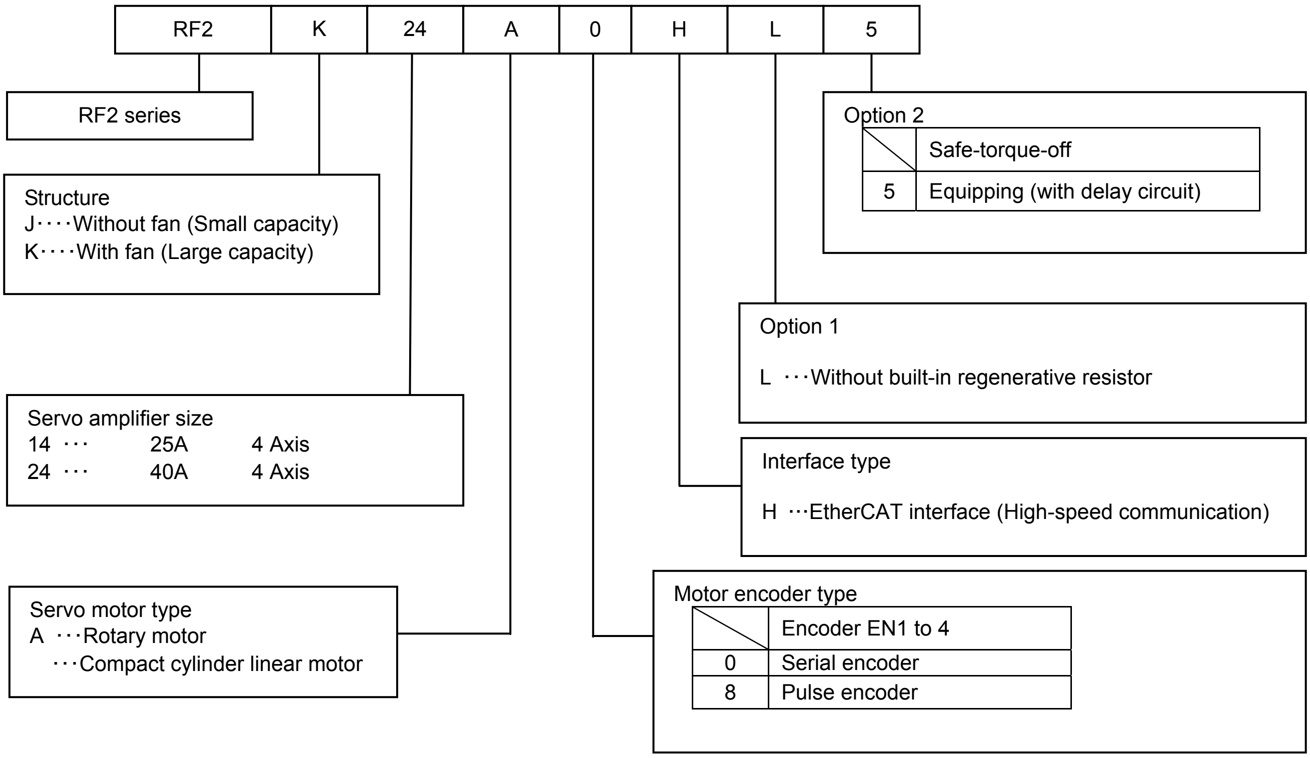
| Model | Resolution within 1 rotation | Resolution within multiple rotations | Name | Transmission format |
|---|---|---|---|---|
| PA035S<br>MLC41A | 131072(17bit) | – | Absolute encoder for incremental system | Half-duplex start/stop synchronization 2.5Mbps (standard) |
| PA035C | 131072(17bit) | 65536(16bit) | Battery backup method absolute encoder | Half-duplex start/stop synchronization 2.5Mbps (standard) |
| HA035<br>RA035 | 131072(17bit) | 65536(16bit) | Battery less absolute encoder | Half-duplex start/stop synchronization 2.5Mbps (standard) |
| MA018 | 8192(13bit) | – | Absolute encoder for incremental system | Half-duplex start/stop synchronization 2.5Mbps (standard) |

Pulse encoder

| Model | Resolution within 1 rotation | Name | Transmission format |
|---|---|---|---|
| PP031T | 1000/2000/2048/4096/5000/6000/8192/10000 (P/R) | 40mm or over | Wire-saving incremental encoder |

Some combinations of motor, sensor, brake etc may not be manufactured. Please contact us before order.

## 2) Servo Amplifier Model Number



| | | | | | | | |
|---|---|---|---|---|---|---|---|
| RF2 | K | 24 | A | 0 | H | L | 5 |

RF2 series

Structure
J····Without fan (Small capacity)
K····With fan (Large capacity)

Servo amplifier size

| | | |
|---|---|---|
| 14 ··· | 25A | 4 Axis |
| 24 ··· | 40A | 4 Axis |

Servo motor type
A ···Rotary motor
···Compact cylinder linear motor

Option 2

| | Safe-torque-off |
|---|---|
| 5 | Equipping (with delay circuit) |

Option 1

L ···Without built-in regenerative resistor

Interface type

H ···EtherCAT interface (High-speed communication)

Motor encoder type

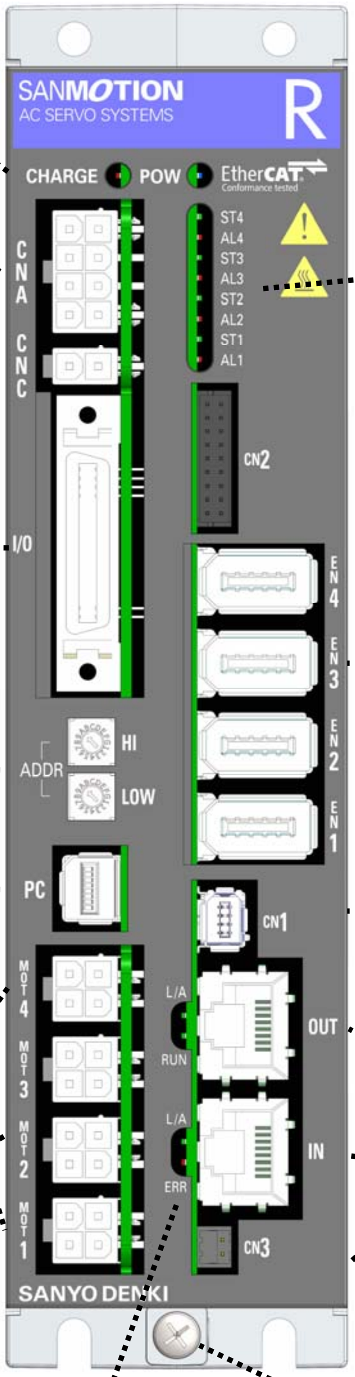
| | Encoder EN1 to 4 |
|---|---|
| 0 | Serial encoder |
| 8 | Pulse encoder |

- * Setup values for the servo amplifier are "default values" at the time of shipment from our factory.
- * Adjustments for system parameters according to your equipment specifications as well as for combination of servo amplifier and servo motor are necessary.
- * Must perform appropriate setting to the system which is to be used.
- * See chapter 10 for Safe Torque Off function.

# 1.4 Product Part Names

## 1) Servo Amplifier

■ RF2 series amplifier



Main circuit power LED (Red, CHARGE)

Control power input
Main circuit power input

CN A: Plug side model number (Molex)
Connector: 5557-08R_NATURAL
Contact: 5556TL

Regenerative resistor connector

CN C: Plug side model number (Molex)
Connector: 5557-02R_NATURAL
Contact: 5556TL

General I/O connector

I/O: Plug side model number (3M)
Plug: 10136-3000PE
Hood: 10336-52A-008

Rotary switch
for station alias address

For setup software

PC: Plug side model number (JST)
MUF-PK8K-X

Servo motor connector

MOT1, MOT2, MOT3, MOT4
Plug side model number (Molex)
Connector: 5557-04R_NATURAL
Contact: 5556TL

Control power establishment LED (Blue)

Axis4 Status LED (Green)
Axis4 ALARM LED (Red)
Axis3 Status LED (Green)
Axis3 ALARM LED (Red)
Axis2 Status LED (Green)
Axis2 ALARM LED (Red)
Axis1 Status LED (Green)
Axis1 ALARM LED (Red)

CN2: Manufacturer maintenance connector
Not for use. Manufacturer engineer uses for maintenance.

Connector for encoder signal

EN1, EN2, EN3, EN4
Plug side model number (3M)
Plug: 36210-0100PL
Shell kit: 36310-3200-008

Safe Torque Off connector

CN1: Plug side model number (Tyco)
2013595－3

Connector for next slave amplifier
(OUT) ["EtherCAT OUT" port]

Connector for host unit input/output signals
(IN) ["EtherCAT IN" port]

IN, OUT: Plug side connector
RJ-45, CAT5e
Twisted pair shield cable

CN3: Encoder battery connector

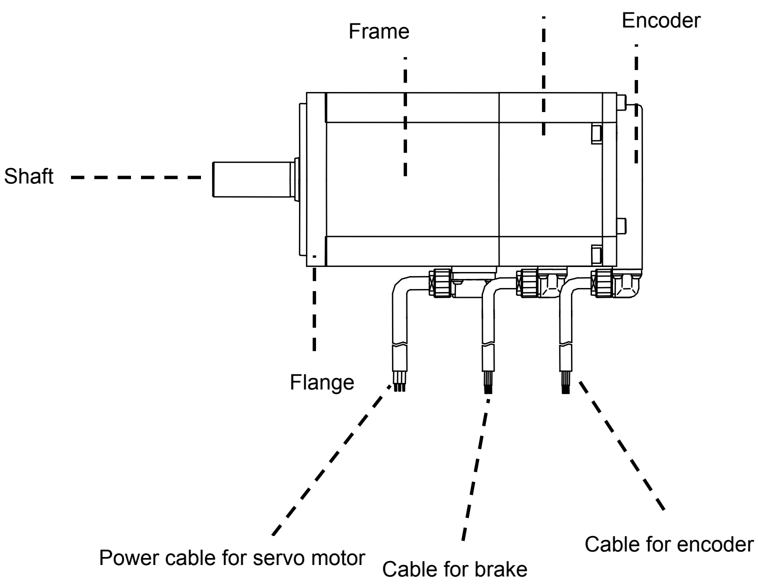
Protective ground terminal

EtherCAT status LED (from upside)

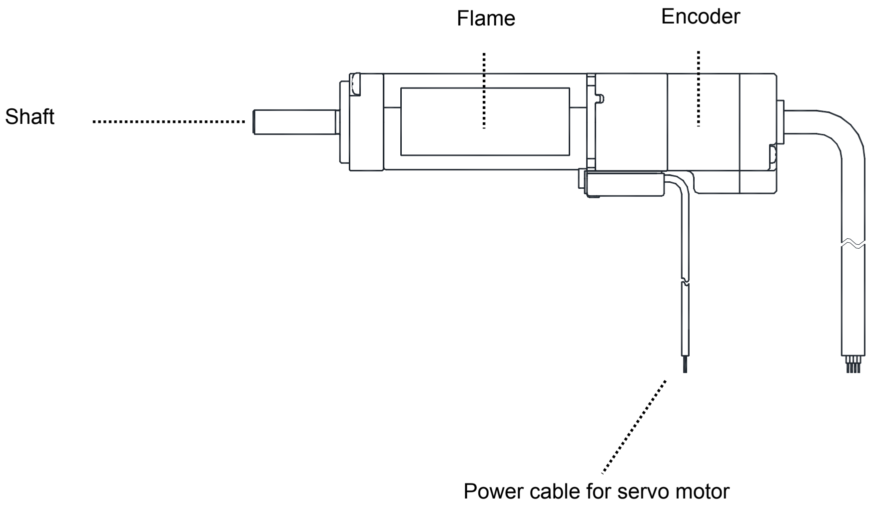
| | |
|---|---|
| OUT Link/Act | LED (Green) |
| RUN indicator | LED (Green) |
| IN Link/Act | LED (Green) |
| Error indicator | LED (Red) |

## 2) Rotary motor

- Lead wire type
  R2□A04○○○△□◇
  R2□A06○○○△□◇



R2GAD10○○△□◇
R2GA02D○○△□◇



# 1.5 Combination

## 1) Combination motor list

✔ If there is no Servo motor in the list, Please refer the file: M0011195-Annex 1 "For All of the motor code lists".

■Rotary motor (DC48V)

| Series | Motor code | Servo motor model number | Input type | Amplifier capacity | Flange size | Output | Maximum speed |
|---|---|---|---|---|---|---|---|
| R2 Series | 0x0261 | R2GA04003F | DC48V | 40A | □40mm | 30W | 6,000 min$^{-1}$ |
| | 0x0262 | R2GA04005F | DC48V | 40A | □40mm | 50W | 6,000 min$^{-1}$ |
| | 0x0263 | R2GA04008D | DC48V | 40A | □40mm | 80W | 5,000 min$^{-1}$ |
| | 0x0264 | R2GA06010D | DC48V | 40A | □60mm | 100W | 5,000 min$^{-1}$ |
| | 0x0265 | R2GA06020D | DC48V | 40A | □60mm | 200W | 4,500 min$^{-1}$ |
| | 0x040C | R2GAD102RM | DC48V | 25A | □14mm | 2.4W | 1,500 min$^{-1}$ |
| | 0x049B | R2GA02D20F | DC48V | 40A | □20mm | 20W | 6,000 min$^{-1}$ |
| | 0x0497 | R2GA02D30F | DC48V | 40A | □20mm | 30W | 6,000 min$^{-1}$ |

■Linear motor (DC48V)

| Series | Motor code | Servo motor model number | Input type | Amplifier capacity | Width | Output | Maximum speed |
|---|---|---|---|---|---|---|---|
| DE Series | 0x435A | DE0AC001A03M | DC48V | 40A | 12mm | 5.1W | 2m/s |

## 2) Combination encoder list

■ Encoder resolution

| Combination amplifier model number | Combination amplifier model number | Combination amplifier model number | Encoder code OD: 0x20FE, 1 |
|---|---|---|---|
| Incremental encoder | Absolute encoder | Linear scale encoder | Code |
| 500 P/R | 2,048 FMT | 5μm (200P/mm) | 0x0000 |
| 512 P/R | 4,096 FMT | 2.5μm (400P/mm) | 0x0001 |
| 1,000 P/R | 8,192 FMT | 2μm (500P/mm) | 0x0002 |
| 1,024 P/R | 16,384 FMT | 1.25μm (800P/mm) | 0x0003 |
| 1,500 P/R | 32,768 FMT | 1μm (1,000P/mm) | 0x0004 |
| 2,000 P/R | 65,536 FMT | 0.5μm (2,000P/mm) | 0x0005 |
| 2,048 P/R | 131,072 FMT | 0.25μm (4,000P/mm) | 0x0006 |
| 2,500 P/R | 262,144 FMT | 0.125μm (8,000P/mm) | 0x0007 |
| 3,000 P/R | 524,288 FMT | 0.1μm (10,000P/mm) | 0x0008 |
| 4,000 P/R | 1,048,576 FMT | 0.05μm (20,000P/mm) | 0x0009 |
| 4,096 P/R | — | — | 0x000A |
| 5,000 P/R | — | — | 0x000B |
| 6,000 P/R | — | — | 0x000C |
| 8,192 P/R | — | — | 0x000D |
| 16,384 P/R | — | — | 0x000E |
| 32,768 P/R | — | — | 0x000F |
| 10,000 P/R | — | — | 0x0010 |

- ■ Encoder type (Rotary motor)

| Encoder code OD：0x20FE,2 | Combination encoder | Specification | Encoder type in Amplifier model number | Encoder type in Motor number | Remarks (Description) |
|---|---|---|---|---|---|
| 0x0000 | Incremental encoder (Wire-saving incremental) | 4 pairs | 0 | S | Set when motor encoder is wire-saving incremental encoder. |
| 0x0101 | Asynchronous encoder (Incremental system) | 2.5MHz Without multi turn output | 0 | H | Encoder for incremental system, which is serial-output only within rotation, set to use in the same way as incremental encoder.<br>* Use the position at power-on as zero. |
| 0x0201 | | 4.0MHz Without multi turn output | | | |
| 0x0301 | Optical asynchronous encoder | 2.5MHz With multi turn output | 0 | P，R | Encoder normally used in absolute system, set to use in incremental system.<br>No backup lithium battery cell is needed to connect. |
| 0x0401 | | 4.0MHz With multi turn output t | | | |
| 0x0501 | Resolver type asynchronous encoder | 2.5MHz With multi turn output t | 0 | W | Encoder normally used in absolute system, set to use in incremental system.<br>* Use the position at power-on as zero. |
| 0x0601 | | 4.0MHz With multi turn output | | | |
| 0x0300 | Optical asynchronous encoder | 2.5MHz With multi turn output | 0 | P，R | Set to use in absolute system.<br>This is multi turn backup system. For encoder type P, lithium battery connection to motor is required. |
| 0x0400 | | 4.0MHz With multi turn output | | | |
| 0x0500 | Resolver type asynchronous encoder | 2.5MHz With multi turn output | 0 | W | Set to use in absolute system.<br>Multi turn is mechanical backup system, no battery cell is needed to connect. |
| 0x0600 | | 4.0MHz With multi turn output | | | |

- ■ Encoder type (Linear scale encoder, hall sensor)

| Encoder code OD：0x20FE，2 | Linear scale encoder (Incremental) | Hall sensor | CS-normalization (CS-reset method) | Encoder type in Amplifier model number | Remarks (Description) |
|---|---|---|---|---|---|
| 0x0850 | Phase A, B, Z | No | Software setting (Magnetic pole position estimation) | 8 | System not using hall sensor.<br>Set to perform magnetic pole position estimation process. |
| 0x0860 | Phase A, B, Z | No | Software setting (Forced setting) | 8 | System not using hall sensor.<br>Set when CS-normalization not performed. |

# 2

# 2 Specifications

## 2.1 Servo Motor

### 1) General Specifications

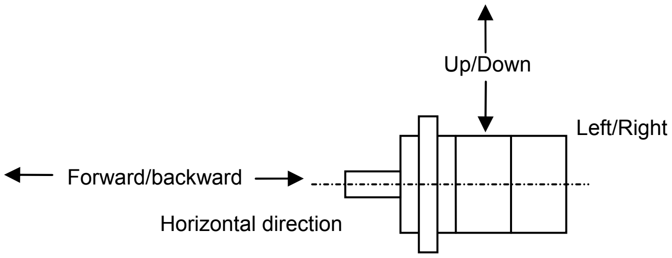
| Series name | R2 series servo motor | R2GAD102R |
|---|---|---|
| Time rating | Continuous | |
| Insulation classification | Class F | Class B |
| Voltage/Dielectric strength | AC1500V, 1 minute | AC600V, 1 minute |
| Insulation resistance | DC500V, 10MΩ or more | |
| Protection method | Fully closed, natural cooling type | |
| | Motor flange size 40 and 60: IP67<br>(However, except for axial penetration part and cable tip part)<br>Motor flange size 20: IP40 | IP4X |
| Existence of oil sealing | Motor flange size 40 and 60: None (Optionally available)<br>Motor flange size 20: None | None<br>(Installation impossible) |
| Ambient temperature | 0 to +40℃ | |
| Storage temperature | −20 to +65℃ | |
| Ambient humidity | 20 to 90% (without condensation) | |
| Vibration classification | V15 | |
| Excitation method | Permanent magnet type | |
| Installation method | Flange mount | |

### 2) Exterior Dimensions / Specifications / Weight

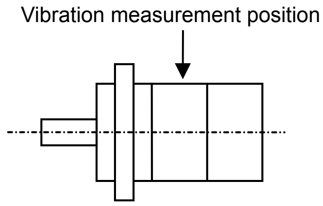
Refer to [Servo Motor Dimension (Section 13)]
Refer to [Servo Motor Data Sheet (Section 13)]

### 3) Mechanical Specifications / Mechanical Strength / Working Accuracy

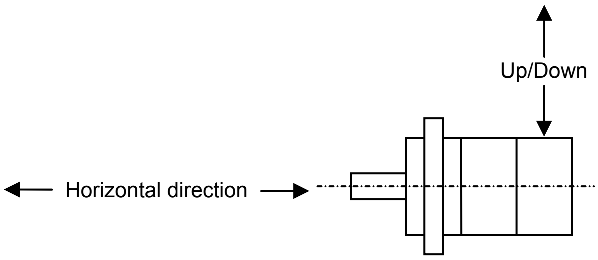
- ■ Vibration Resistance
  Install the servo motor horizontally (shown in the figure below), so when vibration occurs in any of three (3) directions (up/down, backward/forward, left/right) the motor will withstand vibration acceleration up to 24.5m/s$^2$.



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



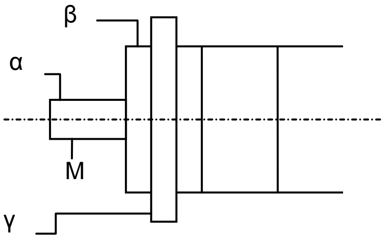
- Shock Resistance
  Install the shaft of servo motor in a horizontal direction (shown in the figure below). This shaft should withstand shock acceleration up to $98m/s^2$ (when shock is applied in an upward/downward direction) for two (2) times. However, since a precision motor encoder is fixed to the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



- Mechanical Strength
  The axis strength of the servo motor can withstand instantaneous maximum torque.

- 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 |  |
| Eccentricity of external mating diameter of flange against output shaft M: β | 0.06 (20 to 60) | |
| | 0.02 (14) | |
| Perpendicularity of flange face against output shaft M: γ | 0.04 (20) | |
| | 0.02 (14) | |
| | 0.07 (40 to 60) | |

* Values in ( ) are the motor flange size.

## 4) Oil Seal Type

Oil sealing for output shaft of servo amplifier is available as optional.
Contact us for replacing oil sealing.

| Servo motor model number | Oil seal type |
|---|---|
| R2□A04○○○□ | Standard: N/A<br>Optional: G-Type |
| R2□A06○○○□ | Standard: N/A<br>Optional: S-Type |

* Flange size 14 and 20 motor cannot equip oil sealing.

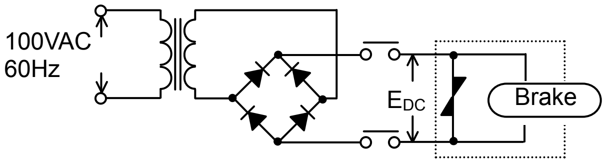
## 5) Holding Brake

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.
Turn the brake excitation On or Off using the "holding brake timing signal output". When using this signal, set the command for brake release time to 0min$^{-1}$ for the servo amplifier.
To externally control the holding brake, a response time (as in the table below) is required.
When using a motor with the brake, determine a time sequence that accounts for this delay.

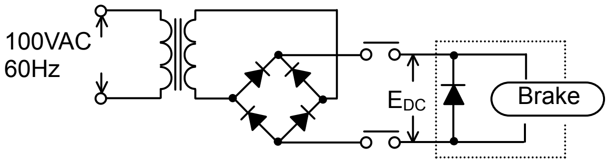
| Servo motor model number | Static friction torque N・m | Release time msec | Braking delay time msec | |
|---|---|---|---|---|
| | | | Varistor | Diode |
| R2GA04003 | 0.32 | 25 | 15 | 100 |
| R2GA04005 | 0.32 | | | |
| R2GA04008 | 0.32 | | | |
| R2GA06010 | 0.36 | 30 | 20 | 120 |
| R2GA06020 | 1.37 | | | |

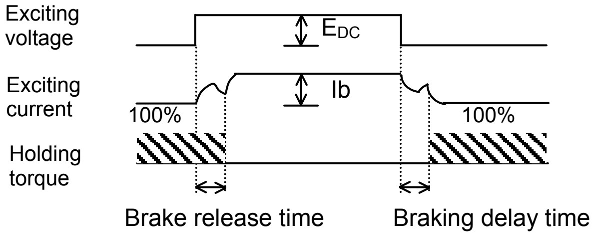
✔ Flange size 14 and 20 motor cannot equip holding brake.

- ■ Brake operating time is measured in the following circuit:
  - ◆ Varistor used circuit



  - ◆ Diode used circuit





* Brake release time and Braking delay time refers to those times mentioned in the above table.
The Brake release time is the same for both the varistor and diode.

### 6) Degree of decrease rating for R2☐A Motor, with Oil Seal and Brake

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

| Condition | | Degree of decrease rating |
|---|---|---|
| Brake | Oil seal | R2GA04005 |
| No | No | - |
| Yes | No | |
| No | Yes | 90% |
| Yes | Yes | |

## 2.2 Motor Encoder

### 1) Serial Encoder

■ Absolute Encoder for Incremental System

| Model | Resolution | Synchronization method | Transmission method | Baud rate |
|---|---|---|---|---|
| PA035S<br>CLM41A | 131,072 division (17bits) | Asynchronous | Half duplex serial communication | 2.5Mbps |
| MA018 | 8,192division (13bit) | | | |

Model number example: R2-series, square size: 40mm, 30W-model R2AA04003FXH00

■ Battery Backup Method Absolute Encoder

| Model | Resolution | Multiple rotations | Synchronization method | Transmission method | Baud rate |
|---|---|---|---|---|---|
| PA035C | 131,072 division (17bits) | 65,536 (16bit) | Asynchronous | Half duplex serial communication | 2.5Mbps |
| | 131,072 division (17bits) | 65,536 (16bit) | Asynchronous | Half duplex serial communication | 4.0Mbps |

Model number example: R2-series, square size: 40mm, 50W-model R2GA04005FCP00

■ Battery-less Absolute Encoder

| Model | Resolution | Multiple rotations | Synchronization method | Transmission method | Baud rate |
|---|---|---|---|---|---|
| RA035C | 131,072 division (17bits) | 65,536(16bit) | Asynchronous | Half duplex serial communication | 2.5Mbps |
| HA035 | 131,072 division (17bits) | 65,536（16bit） | Asynchronous | Half duplex serial communication | 2.5Mbps |
| | 1,048,578 division (20bits) | | | | 4.0Mbps |

Model number example: R2-series, square size: 60mm, 80W-model R2GA04008DXR03

✔ The motor of flange size 14 can equip only the Absolute Encoder for Incremental System. It cannot select the spec of Battery Backup Method Absolute Encoder, Battery-less Absolute Encoder and Pulse encoder.

### 2) Pulse Encoder Specifications

■ Wire-saving incremental encoder

| Model | Resolution | Applicable flange size |
|---|---|---|
| PP031 | 1000/2000/2048/4096/5000/6000/8192/10000 P/R | 40mm, 60mm |
| PP018T | 8192 P/R | 20mm |

Model number example: R2-series, square size: 20mm, 30W-model R2GA02D30FXS00

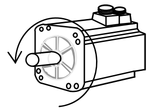
✔ Pulse encoder may not be able to equip depending on motor type. Please contact us when you are planning to purchase.

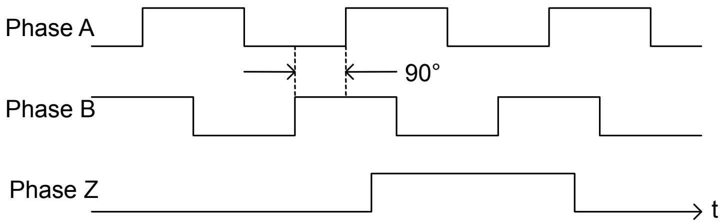
## 2.3 Servo motor rotational and moving direction

### 1) Rotary motor rotational direction

- Servo motor rotation direction and encoder signal pulses of pulse encoder
  Motor rotation direction and motor encoder signal phases are related as follows:

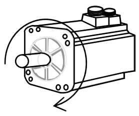
Servo motor rotation direction
[CCW]

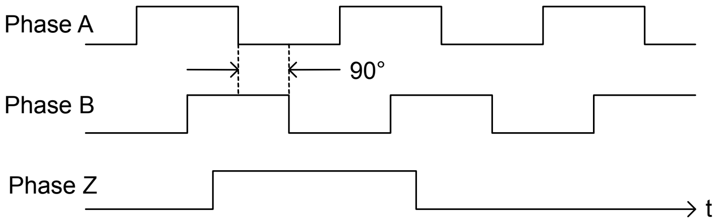




Phase B is behind Phase A 90˚

Servo motor rotation direction
[CW]

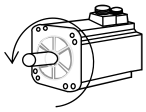




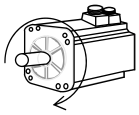
Phase B is behind Phase A 90˚

* When Z Phase is at high level, both Phases A and B cross the low level once every rotation

- Serial Encoder
  Servo motor rotation direction :Counterclockwise rotation from the load side “CCW”
  ･･･Note : Position signal output : Increase



Servo motor rotation direction :Clockwise rotation from the load side “CW”
･･･Note : Position signal output : Decrease



* This is the serial encoder output position, and the rotation direction differs in EtherCAT communication.

### 2) Battery Specification

Model: ER3VLY (produced by TOSHIBA LIFESTYLE PRODUCTS & SERVICES CORPORATION)
Voltage：3.6V

# 2.4 Servo Amplifier

## 1) General Specifications

■ General Specifications

| Item | | RF2J24A (Small capacity)<br>20 to 30W,<br>DE0AC001A03M | RF2K24 (Large capacity)<br>20 to 200W | RF2J14<br>2.4W<br>For R2GAD102R |
|---|---|---|---|---|
| Control function | | Position/Velocity/Torque control<br>(Switching by parameter) | | |
| Control system | | MOS-FET: PWM control, sine wave drive | | |
| Main circuit power supply | | DC48V±10% or DC24V±10% | | |
| Control power supply | | DC24V±10% | | |
| Environment | Operating ambient temperature | 0 to 55℃ | | |
| | Operating storage temperature | −20 to +65℃ | | |
| | Operating and storage humidity | 90%RH or less (No condensation) | | |
| | Height above sea level | 1000m or less | | |
| | Vibration | 4.9m/s$^2$, Frequency range: 10 to 55Hz, X, Y and Z direction, each within 2H | | |
| | Impact (shock) | 19.6m/s$^2$ | | |
| Configuration | | Tray shape, external DC power supply | | |
| | | Natural air cooling (without fan) | Forced air cooling (built-in fan) | Natural air cooling (without fan) |
| Lineup model number | | RF2J24A0HL5<br>RF2J24A8HL5 | RF2K24A0HL5 | RF2J14A0HL5 |
| Rated Input | Control power, Current | DC24V 1.2 A | | |
| | Main power Input, Current | DC24/48V 6.2 A | DC24/48V 11.7 A | DC24/48V 6.2 A |
| Single axis | Rated output voltage and current | 3φ 0-24/0-48V<br>6.0Arms | | 3φ0-24/0-48V<br>2.0Arms |
| | Instantaneous maximum output voltage and current | 3φ 0-24/0-48V<br>14.1Arms | | 3φ0-24/0-48V<br>6.0Arms |
| | Output limitation | 30W or less | 200W less | 2.4W less |
| Total 4 axes output limitation | | 120W less | 300W less | 9.6W less |
| Amplifier capacity x controlled axes number | | 40A x 4 axes | | 25A x 4 axes |
| Outline dimension | | H200 x W50 x D130mm | | |
| Mass | | 0.75kg | 0.8kg | 0.75kg |

Note 1) Input power voltage shall be within the scope of this specification.

Note 2) Main circuit power depression decrease torque in the motor momentary range. Select motor with sufficient margin.

Note 3) Fuses are not built in servo amplifier. Place an over current protection (such as fuse) on the line toward DC input part of servo amplifier from AC power through DC power (user to prepare). (Please confirm that fuse is built in the DC power supply you purchase before use.)

Note 4) To use battery for main circuit DC power supply, make sure to install electrolytic capacitor in parallel to protect the servo amplifier. (2,000μF or more-sized capacitor is recommended)

■ Performance

| | |
|---|---|
| Frequency characteristic | 800Hz |
| Allowable load inertia moment | 10 times of motor rotor inertia moment. Note 5) |

Note 5) If exceeding the allowable load inertia moment, please consult us.

- ■ Built-in functions

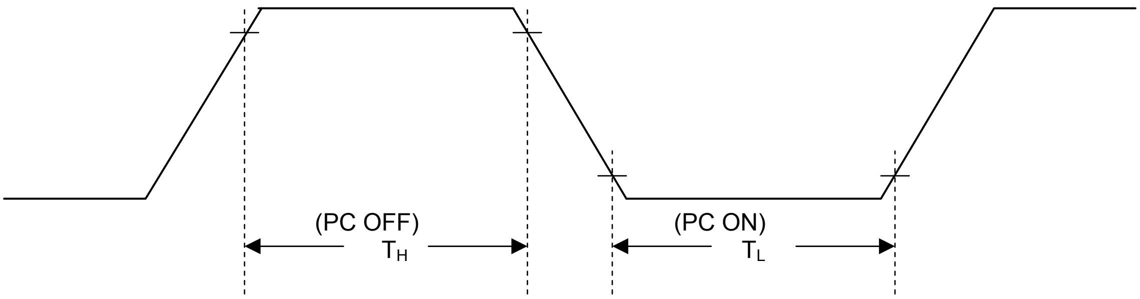
| | |
|---|---|
| Protection functions | Over current, Current detection error, Overload, Amplifier overheating, External overheating, Over voltage, Main circuit power low voltage, Control power supply low voltage, Encoder error, Over velocity, Velocity control error, Velocity feedback error, Position deviation excess, Position command pulse error, Built-in memory error, Parameter error |
| Display (LED) | Control power establishment (Blue), Main circuit charging (Red), Servo condition (Green x4), Servo alarm (Red x4), Port 0/1 linkage (Green x2), Communication RUN (Green), Communication error (Red) |
| External encoder | Not applicable. |
| Hall effect sensor | Not applicable. |
| General I/O | Input: 8 points (4 axes common), Output: 8 points (2 points per axis) |
| Regeneration process/ Regenerative resistor | Regeneration process: built-in/ Regenerative resistor (14 to 20Ω): external |
| Dynamic brake circuit | None |
| Analog monitor | Not applicable. |
| Safety function | Safe-Torque-Off |

- ■ Refer to chapter 10 for detail of option.

## 2) General Input/Output

- ■ General input signals

| | |
|---|---|
| Sequence input signals | Interactive photo coupler (sink, source connection): × 8 inputs |
| | External power supply: DC12 to 24V±10%, 100mA or more (DC24V) |
| | Forward direction limit switch, Reverse direction limit switch, External trip, Forced discharge and Emergency stop.<br>Refer to [Index: 0x20F8 General input function selection (chapter 5)]. |



* $T_H$ 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 validity conditions of each function. 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. 250μs | Min. 250μs |
| Forward direction limit switch<br>Reverse direction limit switch<br>Forced discharge input<br>External trip input | Min. 8ms | Min. 8ms |

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

■ General output signals

| | |
|---|---|
| Sequence output signals | Photorelay output (SYNC, Source connection): x 8 outputs (2 per axis) |
| | External power supply voltage: DC12 to 24V±10%, 20mA or more |
| | Circuit power for output signal: DC12 to 15V±10% / Maximum current value 30mA (per 1 output)<br>Circuit power for output signal: DC24 to 15V±10% / Maximum 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, etc.<br>Refer to [Index: 0x20F9 (chapter 5)], for all of signal names. |

## 2.5 Power Supply, Calorific Value

### 1) Main circuit Power supply capacity, Control Power supply capacity

■ DC48V Input (Rotary motor)

| Servo amplifier model number | Rated output (W) | Input current of main circuit power supply (A) | Input current of control power supply (A) |
|---|---|---|---|
| R2GA04003F | 30 | 2.5 | 0.7 |
| R2GA04005F | 50 | 5.3 | |
| R2GA04008D | 80 | 6.6 | |
| R2GA06010D | 100 | 6.9 | |
| R2GA06020D | 200 | 8.0 | |
| R2GAD102RM | 2.4 | 0.8 | |
| R2GA02D20F | 20 | 1.7 | |
| R2GA02D30F | 30 | 2.5 | |

- ✔ Input current value of main circuit power is effective value in the case of rated revolution velocity and rated torque. Two to three times of the current value shown in the table may be momentarily curried depending on operating patterns such as start-up or stop.
- ✔ The input current of control power supply above is the mean value. The value may vary depending on operating conditions or the encoder connected to your motor, so select the power supply with a margin of more than 1.5 times.

### 2) Inrush Current, Leakage Current

■ Inrush Current

Large-capacitance capacitors are not contained in main circuit power and control power input part of this series, so high inrush current is not curried at power-on.

■ Leakage Current

| Servo amplifier | Leakage current per motor | Total leakage current of 4 motors |
|---|---|---|
| RF2 series | 0.8 mA | 3.5 mA |

- ✔ This is the value in the case of using 2m-length tough rubber sheath cable as a power line. Leakage current increases and decreases depending on cable length, so refer to the value in the above table only as a guide of selection.
- ✔ Grounding of control board is mandatory to prevent occurrence of dangerous level voltage on operating panel in the unlikely event of ground leakage. (Grounding resistance value shall be 100Ω or less.)
- ✔ Leakage current value is the value by measuring filter 700Hz with leak-checker. Use earth leakage breaker supporting inverter loads, which is taken as a measure against the possibility that high-frequency earth leakage current is carried and then this causes error on ground-fault circuit interrupter and earth leakage protective relay placed on power supply conducting path, that are caused by floating earth capacitance of servo motor winding, power cable, and servo amplifier.

## 3) Calorific value

■ Rotary motor

| Servo amplifier | Servo motor model number | Servo amplifier total calorific value (W) |
|---|---|---|
| RF2 | R2GA04003F | 9 |
| | R2GA04005F | 15 |
| | R2GA04008D | 20 |
| | R2GA06010D | 22 |
| | R2GA06020D | 26 |
| | R2GAD102RM | 5 |
| | R2GA02D20F | 7 |
| | R2GA02D30F | 9 |

- ✔ For the value in the table, calorific value of regenerative resistor is not included. So, it is required adding as necessary.
- ✔ For installation, strictly follow the way written in "3.1 Installation".
- ✔ These are the value with rated speed and rated torque.

## 2.6 Operation Pattern

### 1) Time of acceleration and deceleration, Permitted repetition, Loading precaution (For rotary motor)

The motor's acceleration time($t_a$), and deceleration time($t_b$) 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 ($kg\cdot m^2$)
- ◆ $J_L$ :Load inertia ($kg\cdot m^2$)
- ◆ N1, N2 :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.

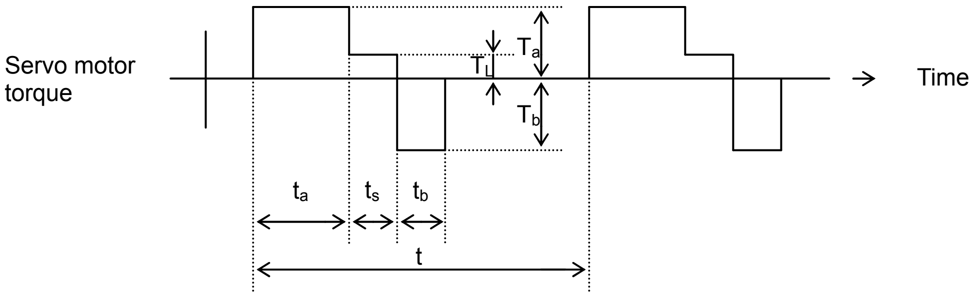
■ Loading precaution
There are separate limitations on repetitive operations for both the servo motor and servo amplifier, and the conditions of both must be met simultaneously.

■ 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, adjustable speed current value and motor rotation speed of the motor in use. If the load inertia = motor inertia 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.

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



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

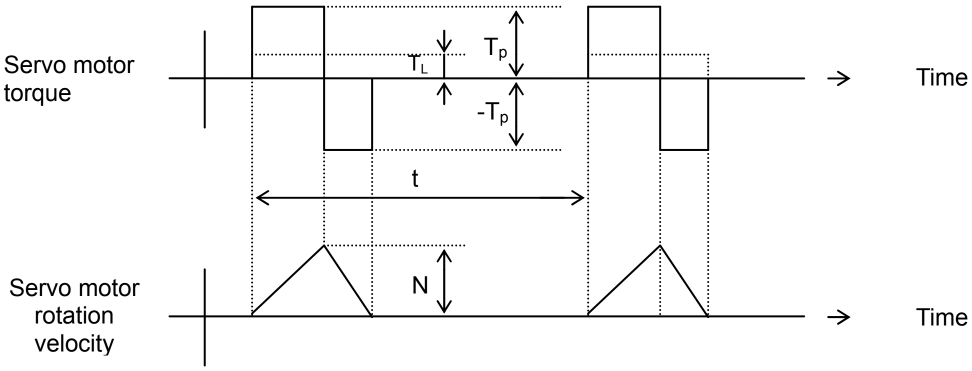
$$t >= \frac{T_a^2 t_a + T_L^2 t_s + T_b^2 t_b}{T_R^2} \text{ [s]}$$

$T_a$ :Acceleration torque
$T_b$ :Deceleration torque
$T_L$ :Load torque
$T_{rms}$ :Effective torque
$T_R$ :Rated torque
$t_s$ :constant speed time [s]

◆ When the cycle time (t) is predetermined Ta, Tb, $t_a$, $t_b$ 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 < $0.9T_R$.

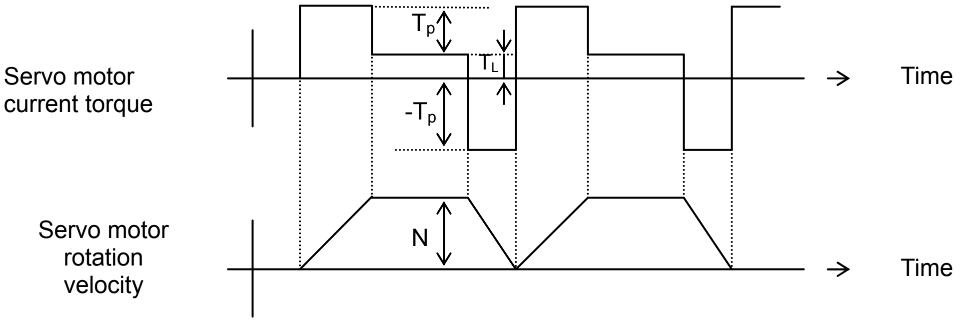
- When the motor repeats acceleration, deceleration and stop status
  In operating status (shown below) the value of permitted repetitions n (times/minutes) is found with the following equation:



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

$T_R$: Rated torque

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



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

$T_R$: Rated torque

- Negative load
  The 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.

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

- Load inertia ($J_L$)
  When the servo amplifier is used with a load inertia exceeding the allowable load inertia 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
  - Reexamine regenerative resistance

## 2) Time of acceleration and deceleration, Permitted repetition, Loading precaution (For linear motor)

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

- Acceleration time : $t_a = (M_C+M_L) \cdot \{(V_2-V_1) / (0.8\times F_P-F_L)\}$ [s]
- Deceleration time : $t_b = (M_C+M_L) \cdot \{(V_2-V_1) / (0.8\times F_P-F_L)\}$ [s]

  - $t_a$ :Acceleration time (s)
  - $t_b$ :Deceleration time (s)
  - $M_C$ : Linear motor coil mass (kg)
  - $M_L$ :Load weight (kg)
  - V1,V2 :Speed of motor (m/s)
  - $F_P$ :Maximum thrust (N)
  - $F_L$ :Load thrust (N)

* The above are calculation formulas within rated velocity with frictional force and gravity applied to moving part ignored.

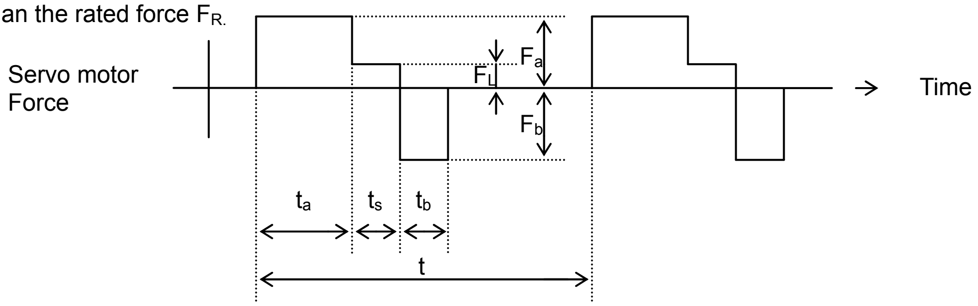
- Loading precaution
  There are separate limitations on repetitive operations for both the servo motor and servo amplifier, and the conditions of both must be met simultaneously.

- 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, and load mass, adjustable speed current value and motor velocity of the motor in use. If the load mass = motor coil mass 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 execution force and regenerating power is critical.

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

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

- When the motor repeats continuous speed status and stop status
  In operating status (shown below) the motor should be used at a frequency in which its execution force is less than the rated force $F_R$.



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

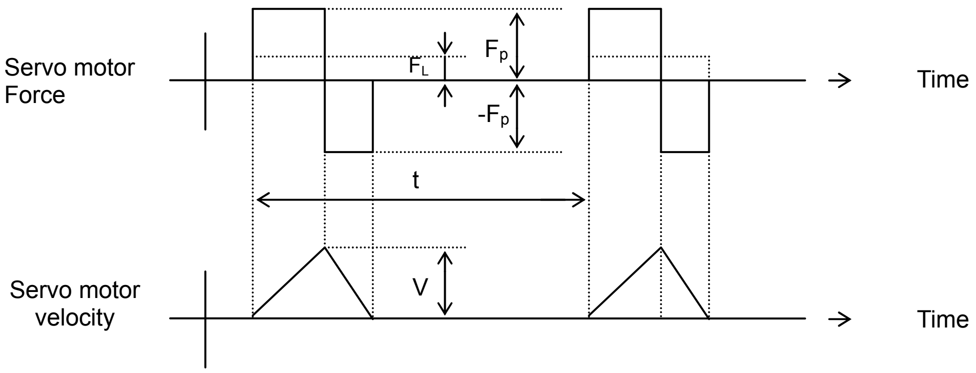
$$t \;>=\; \frac{F_a^{\,2} t_a + F_L^{\,2} t_s + F_b^{\,2} t_b}{F_R^{\,2}} \quad [s]$$

$F_a$ : Acceleration force $F_b$ : Deceleration force $F_L$ : Load force
$F_{rms}$ : Effective force $F_R$ : Rated force $t_s$ : constant speed time [s]

- When the cycle time (t) is predetermined Fa, Fb, $t_a$, $t_b$ 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 Frms < $0.9F_R$.

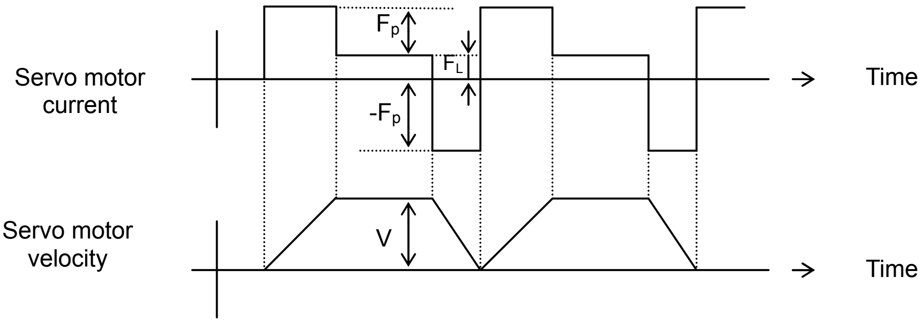
■ When the motor repeats acceleration, deceleration and stop status
In operating status (shown below) the value of permitted repetitions n (times/minutes) is found with the following equation:



$$n = 30 \times \frac{1}{V\,(M_C+M_L)} \times \frac{F_P^2 - F_L^2}{F_P^3} \times F_R^2$$ [times/min]

$F_R$ : Rated force

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



$$n = 30 \times \frac{1}{V\,(M_C+M_L)} \times \frac{F_R^2 - F_L^2}{F_P}$$ [times/min]

$F_R$ : Rated force

■ Negative load
The 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.

Examples:

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

■ Load mass ($M_L$)
For the intended usage in extremely large load mass ($M_L$ ) for coil (moving factor) mass, “overvoltage” or “regenerative overload” alarm may be activated during decelerating.
In this case, the following procedures are required. Please contact us for the details.

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

## 2.7 Regeneration Process

For this amplifier, built-in regenerative resister is not equipped. The table below shows tolerable regenerative power of our optional external resistor. Refer to [Capacity Selection of Regenerative Resistor (12.2)] for the selection method of regenerative resistor.

### 1) Resistance value of optional regenerative resistor

■ Tolerable power of optional regenerative resistor

| Optional regenerative resistor | Resistance value | Tolerable regeneration resistance power-external type [PR0] |
|---|---|---|
| REGIST-080W50B | 50Ω | 10W |
| REGIST-120W50B | 50Ω | 30W |
| REGIST-220W20B | 20Ω | 55W |

- ✔ The tolerable effective power of external regenerative resistor is maximum 25% of the rated power under natural air cooling.
- ✔ The tolerable effective power of external regenerative resistor is maximum 50% of the rated power under forced air cooling by fan.

# 3

# 3. Installation

# 3.1 Servo Amplifier

## 1) Servo Amplifier

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, and 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.<br>The attachment 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. |
| The thing that damage and mounting parts have damaged should fix by returning to our company immediately. |

■ If enclosed in a cabinet

The temperature inside the cabinet can 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 may increase due to 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 contacts, regenerative resistors and other parts can 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.

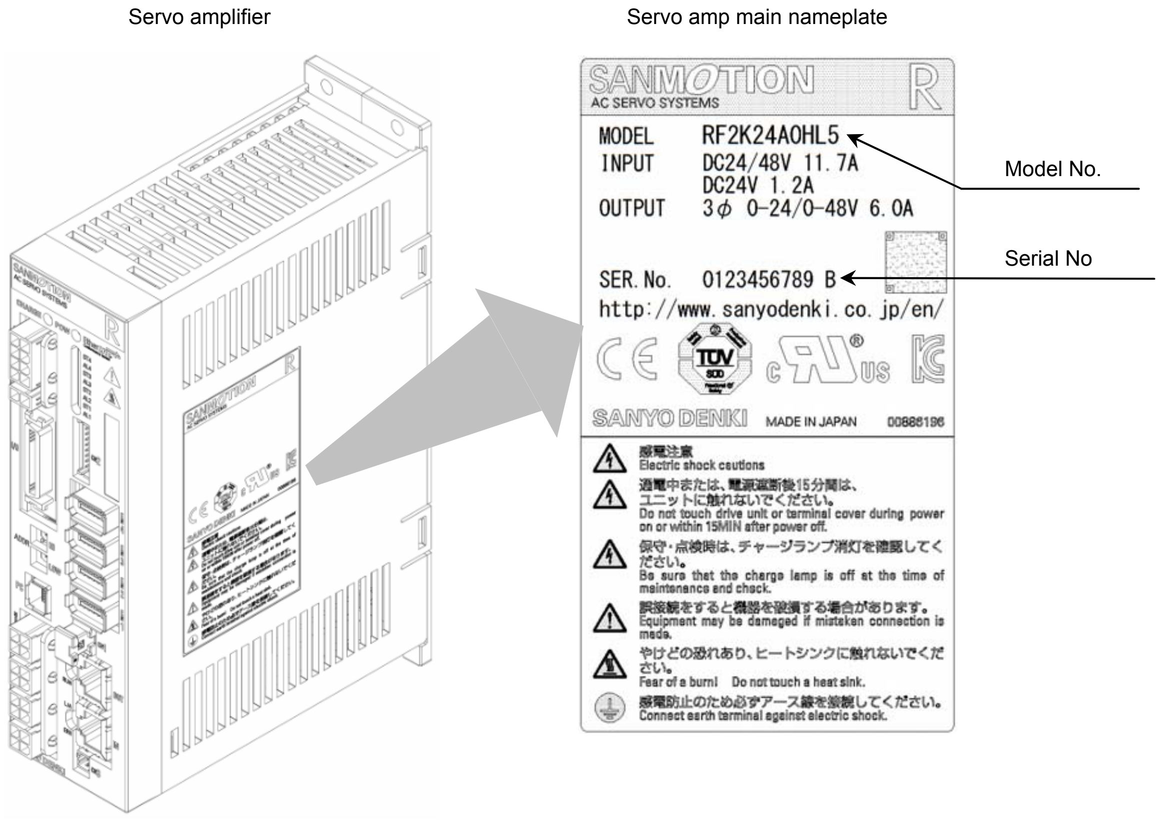
■ If a large noise source is present

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 to protect the servo amplifier.

## 2) Open package

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

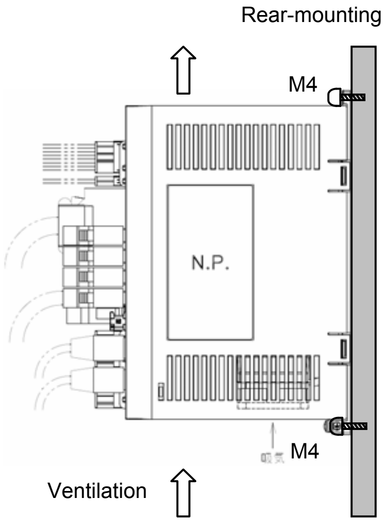
- ■ Verify that the model number of the servo motor or servo amplifier is the same as ordered.
  The model number is located on the main nameplate, following the word “MODEL”.
- ■ Verify that there is no problem in the appearance of servo amplifier.
- ■ Verify that there are no loose screws on the servo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



| |
|---|
| Interpretation of the serial number<br>Month (2 digits) + Year (2 digits) + Day (2 digits) + Serial number (4 digits) + Revision ("A" is abbreviated) |

✔ Main nameplate may change depending on support status of the standards etc.

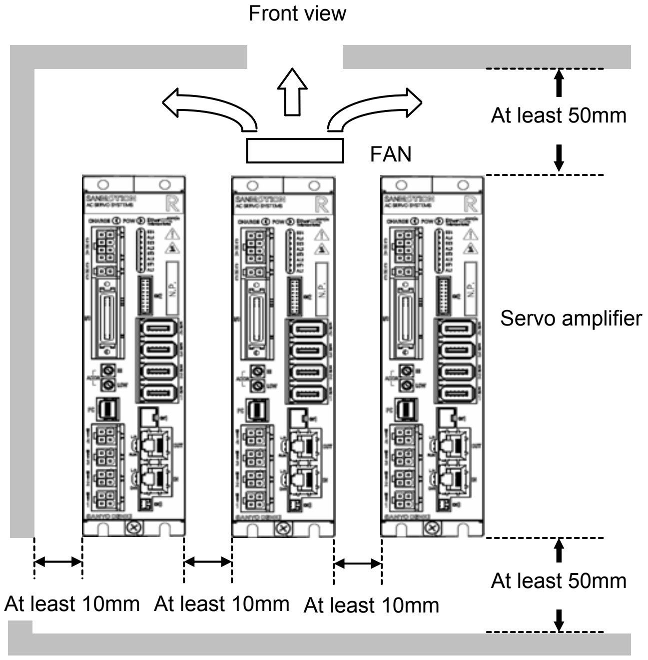
### 3) Mounting direction and location

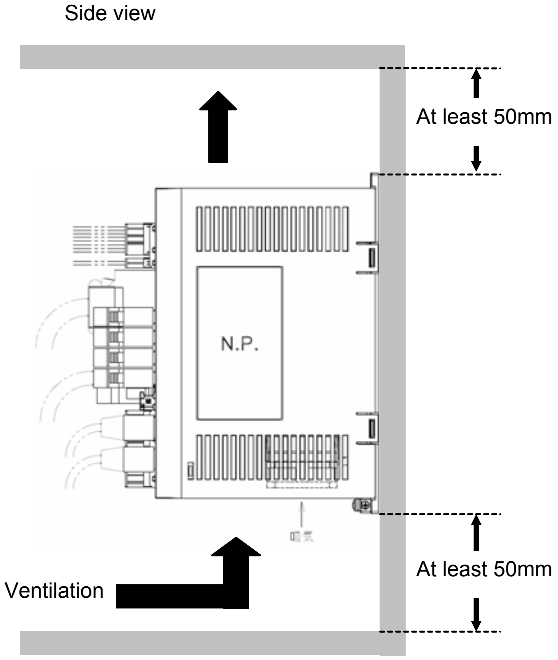


* Refer to Appendix, optional parts, for side mounting plate.

### 4) Control arrangement within the machine

- ■ Leave at least 50 mm 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.
- ■ If the servo amplifier is installed on its side, make sure that the ambient temperature does not exceed 50°C, and mount the back panel to a metal plate. Recommended metal plate thickness is 2mm or more.





# 3.2 Rotary Motor

## 1) Precautions

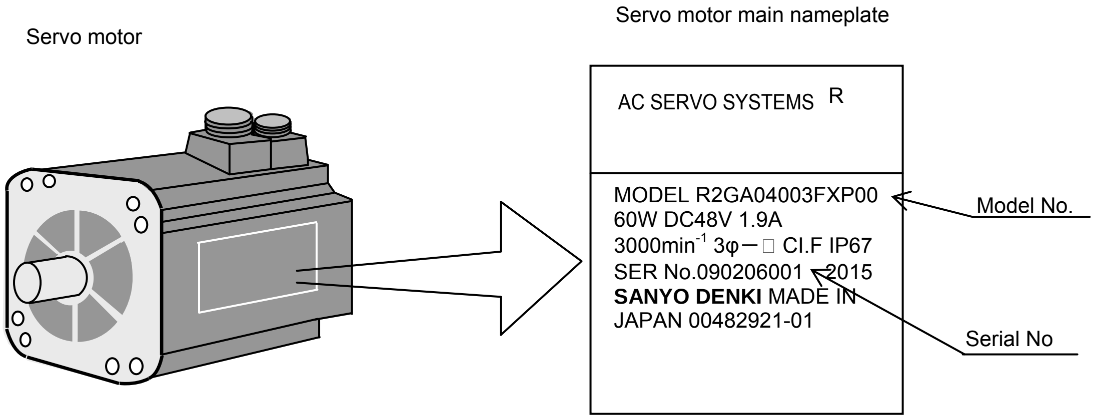
■ Various precautions

| |
|---|
| The device should be installed on non-flammable surfaces only. Installation on or near flammable materials can cause fire. |
| Do not stand, and 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 attachment direction should be observed strictly. |
| The thing that damage and mounting parts have damaged should fix by returning to our company immediately. |

## 2) Open package

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.



## 3) Installation

Please note the following regarding the installation location and mounting method for the servo motor.

<table>
<tr><td colspan="2">The servo motor is designed for indoor use. Make sure to install it indoors.</td></tr>
<tr><td colspan="2">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.</td></tr>
<tr><td>Ambient temperature: 0 to 40°C<br>Storage temperature: -20 to 65°C<br>Ambient humidity: 20 to 90%</td><td>Good ventilation, no corrosive or explosive gases present.<br>No dust or dirt accumulation in the environment.<br>Easy access for inspection and cleaning.</td></tr>
</table>

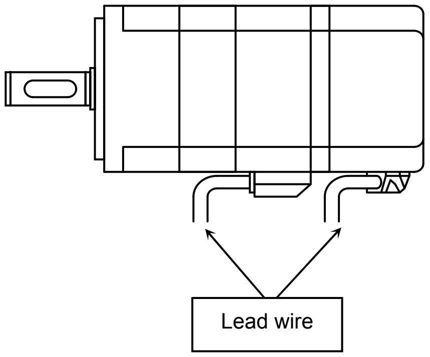
## 4) Mounting method

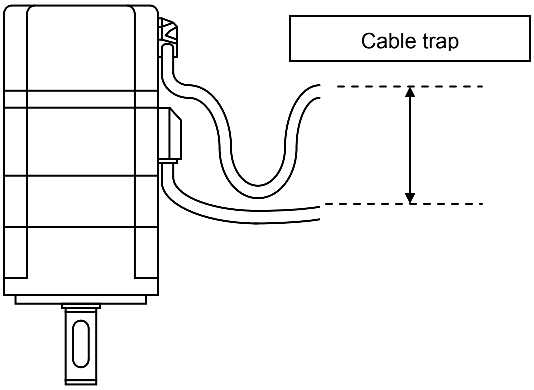
- Mounting in several orientations - horizontal, or with the shaft on top or bottom- is acceptable.

- If the output shaft is used in reduction devices that use grease, oil, or other lubricants, or in mechanisms exposed to liquids, the motor 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.





## 5) Waterproofing and dust proofing

- The protection inside the motor conforms to IEC standards (IEC34-5). 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.

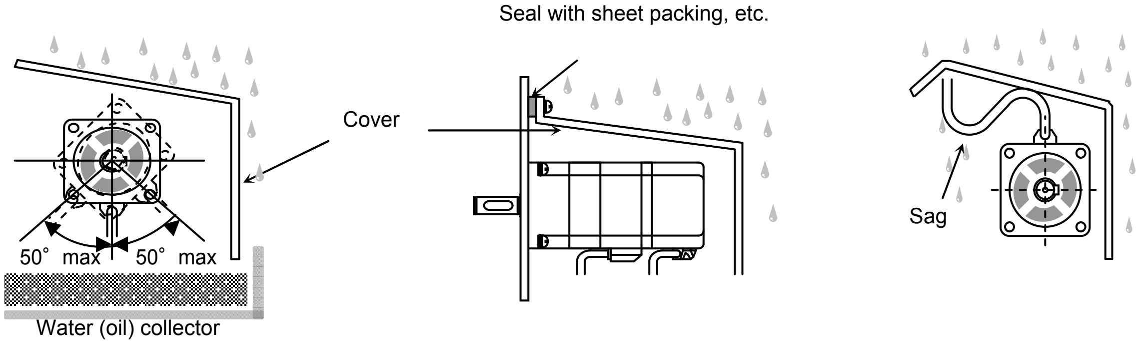
- The motor waterproofing is of IPX 7 class level, but still requires careful handling. If the motor is continuously wet, due to the respiratory effect of the motor, liquid may penetrate inside the motor.

- 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 the case of a cannon plug type motor, use a waterproofed type plug.

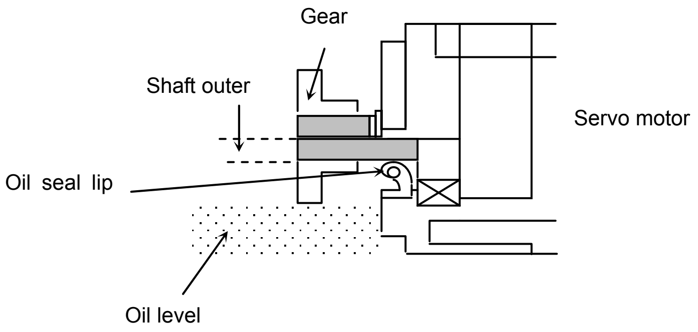
## 6) Protective cover installation

- ■ 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 at an angle (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.

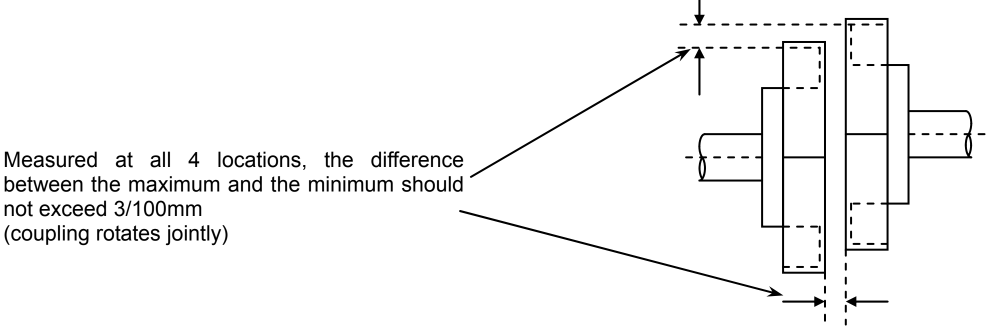


## 7) Gear installation and Integration with the target machinery

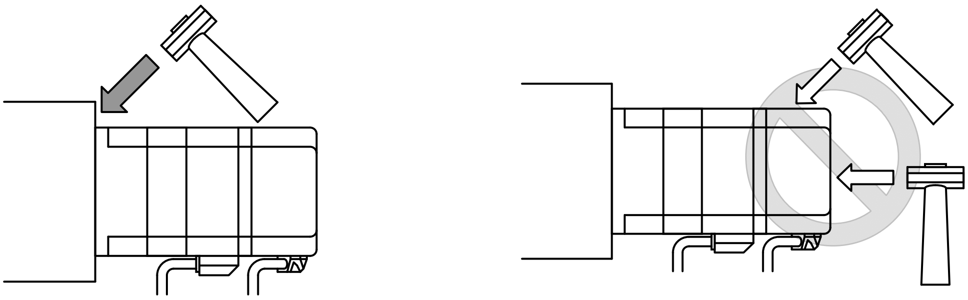
- ■ The oil level of the gear box should be below the oil seal lip, for a slight spraying effect on the lip.
- ■ Create a hole to prevent pressure build-up inside the gear box, as pressure can cause water or oil to penetrate the oil seal and enter inside the motor
- ■ If the motor is used with the shaft 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.



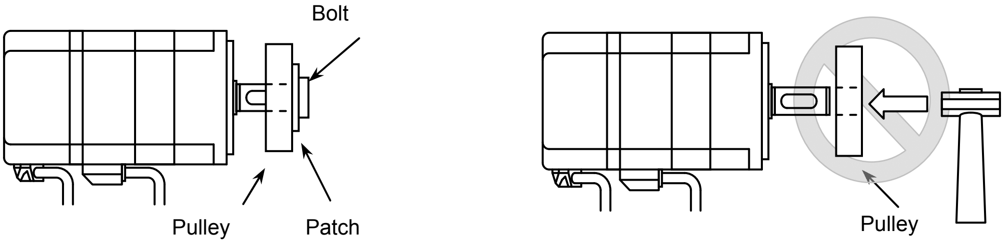
- Refer to the drawing below for correct centering of the motor shaft and the target machinery. Please note when using a rigid coupling that even a slight mistake in centering can damage the output shaft.



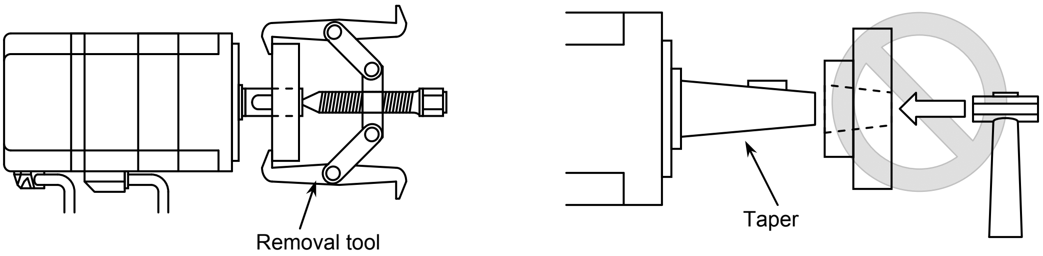
- Do not subject the servo motor shaft to shock, as the precision encoder is directly connected to it. If it is absolutely necessary to hit the motor for position adjustment or other reasons, use a rubber or plastic hammer and hit the front flange area.



- If mounting to a machine, create 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.



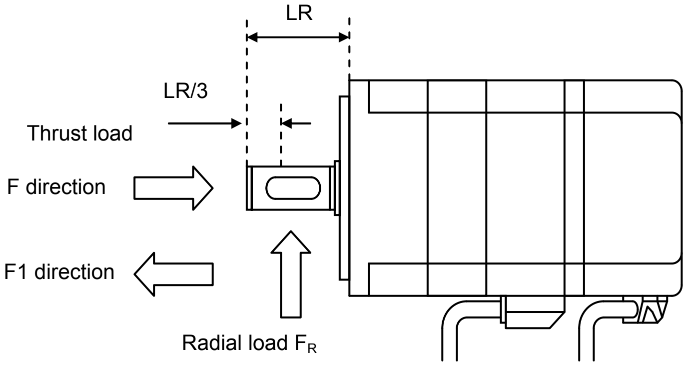
- Tapered servo motor shafts transmit the torque via the tapered surface. Make sure the key fits without rattling. The tapered surface contact should be no less than 70%.
- Use a special tool for removing the gear, pulley, etc.



## 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.



| Series | Servo motor model number | Assembly | | | Operation | | |
|---|---|---|---|---|---|---|---|
| | | Radial load (N) | Thrust load (N) | | Radial load (N) | Thrust load (N) | |
| | | FR | F direction | F1 direction | FR | F direction | F1 direction |
| R2 | R2GA04003F | 98 | 78 | 78 | 49 | 29 | 29 |
| | R2GA04005F | 150 | 98 | 98 | 98 | 29 | 29 |
| | R2GA04008D | 150 | 98 | 98 | 98 | 29 | 29 |
| | R2GA06010D | 150 | 98 | 98 | 98 | 29 | 29 |
| | R2GA06020D | 390 | 200 | 200 | 200 | 68 | 68 |
| | R2GAD102RM | 10 | 5 | 5 | 10 | 5 | 5 |
| | R2GA02D20F | 20 | 20 | 20 | 20 | 20 | 20 |
| | R2GA02D30F | 20 | 20 | 20 | 20 | 20 | 20 |

* For specifications on other motor, please contact us.

## 9) Cable Installation Considerations

- Make sure that no stress is applied to the cable and that it is undamaged.

- If the servo motor is installed in a moving location, make sure that no excessive stress is applied to the cable, by allowing a large bending radius.

- Avoid pulling the cable over sharp objects such as cutting scrap that can damage its exterior. Make sure the cable is not touching any machinery, and that it is out of the path of people and machines.

- Prevent bending or additional weight stress on the cable connection by clamping the cable to the machinery.
  In applications where the motor or the cable is moving using a cable bear, the bending radius should be based on the required cable-life and the type of cable used.

- Install the cables of moving parts in a manner that permits easy regular replacement.
  Consult with your distributor or sales office for recommendations, if you use cables for moving parts.

# 4

# 4. Wiring

# 4.1 Control power supply, Regeneration resistance, and Wiring protective ground

## 1) Name and its function

| Terminal name | Connector | Terminal symbol | Remarks |
|---|---|---|---|
| Main circuit power | CNA | Pin 4 and 8: P<br>Pin 3 and 7: N | DC48V±10% or DC24V±10% |
| Control power | CNA | Pin 6: +24V<br>Pin 2: 24G | DC24V±10% |
| Power ground | CNA | Pin 1 and 5: PE | Connect to power ground. |
| Servo motor connecting terminal | MOT1 to MOT4 | Pin 1: Motor ground<br>Pin 2: Phase W<br>Pin 3: Phase V<br>Pin 4: Phase U | Connect to servo motor. |
| Protective ground | ⏚ | – | Connect to FG of cabinet. |
| Regenerative resistor connecting terminal | CNC | Pin 1 and 2 | Connect to regenerative resistor if lack a regeneration capacity.<br>Regenerative resistor is not built into this amplifier. |

## 2) Wire

The electric wire used for a servo amplifier main circuit power is 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 current flowing through three bundled lead wires in ambient temperature of 40°C.

✔ 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.

✔ If ambient temperature is high, service life of the wires becomes shorter due to heat-related deterioration. In this case, we recommend using heat-resistant vinyl wires.

## 3) Wire diameter - Permissible current

| AWG sizes | Nominal cross-sectional area [mm$^2$] | Conductor resistance [Ω/km] | Allowable current over ambient temperature [A] | | |
|---|---|---|---|---|---|
| | | | 30℃ | 40℃ | 55℃ |
| 20 | 0.5 | 39.5 | 6.6 | 5.6 | 4.2 |
| 19 | 0.75 | 26.0 | 8.8 | 7.0 | 5.4 |
| 18 | 0.75 | 24.4 | 9.0 | 7.7 | 5.8 |
| 16 | 1.25 | 15.6 | 12.0 | 11.0 | 8.3 |

✔ It is a reference value in the case of a special heat-resistant vinyl wire (HIV).

✔ The diameter of an electric wire and permissible current in the case of doing the bundle line of the three electric wires are shown.

✔ Use it below by the above-mentioned permissible current.

## Recommended Wire Diameter

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

■ Input voltage DC48V (R-series rotary motor)

| Servo motor model No. | Motor power (U・V・W・⏚) | | Servo amplifier to be combined | Main circuit power supply (P, N) | | Control power supply (CP, CN) | | Regenerative resistor | | ⏚ | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | mm$^2$ | AWG No | | mm$^2$ | AWG No | mm$^2$ | AWG No | mm$^2$ | AWG No | mm$^2$ | AWG No |
| R2GA02D20F | 0.52 | 20 | RF2□24 | 0.83 | 18 | 0.33 | 22 | 0.83 | 18 | 0.83 | 18 |
| R2GA02D30F | | | | | | | | | | | |
| R2GA04003F | | | RF2K24 | | | | | | | | |
| R2GA04005F | | | | | | | | | | | |
| R2GA04008D | | | | | | | | | | | |
| R2GA06010D | | | | | | | | | | | |
| R2GAD102RM | 0.33 | 22 | RF2J14 | 0.83 | 18 | 0.33 | 22 | 0.83 | 18 | 0.83 | 18 |

- ✔ "□" is optional number or alphabetical letter.
- ✔ The above values are provided under condition that ambient temperature is 40℃ and rated current is applied to 3 lead bands.
- ✔ Consider wire allowable current reduction rate, when you band wires and then insert them into duct such as cured vinyl tube or metal tube.
- ✔ If ambient temperature is relatively high, the lifetime is shortened due to heat deterioration. In this case special heat-resistant vinyl covered wire (HIV) is recommended.
- ✔ For the main circuit power supply, wire diameter less than above table is able to use depending on servo motor capacity.

■ Caution on cable length

◆ Control power (24V, 24G)

When control power input part is relatively long, input voltage for servo amplifier can drop due to cable impedance.
Attention necessary especially when multiple servo amplifiers are supplied power from one power supply. Control power input shall be directly applied to encoder, so if the voltage is out of the scope of 24V±10%-specification (for servo amplifier and encoder) due to voltage drop, servo amplifier and encoder cannot operate. Please consider to shorten and thicken the wiring between power and servo amplifier as much as possible, or use wire corresponding to variable output voltage power supply and remote sensing, when wiring.

◆ Main circuit power (P, N)

When control power input part is relatively long, 48V<24V> can drop due to cable impedance.
Attention necessary especially when multiple servo amplifiers are supplied power from one power supply.
Please be ware that if main circuit power drops, motor generated torque shall drop (momentary range of high-velocity revolution).

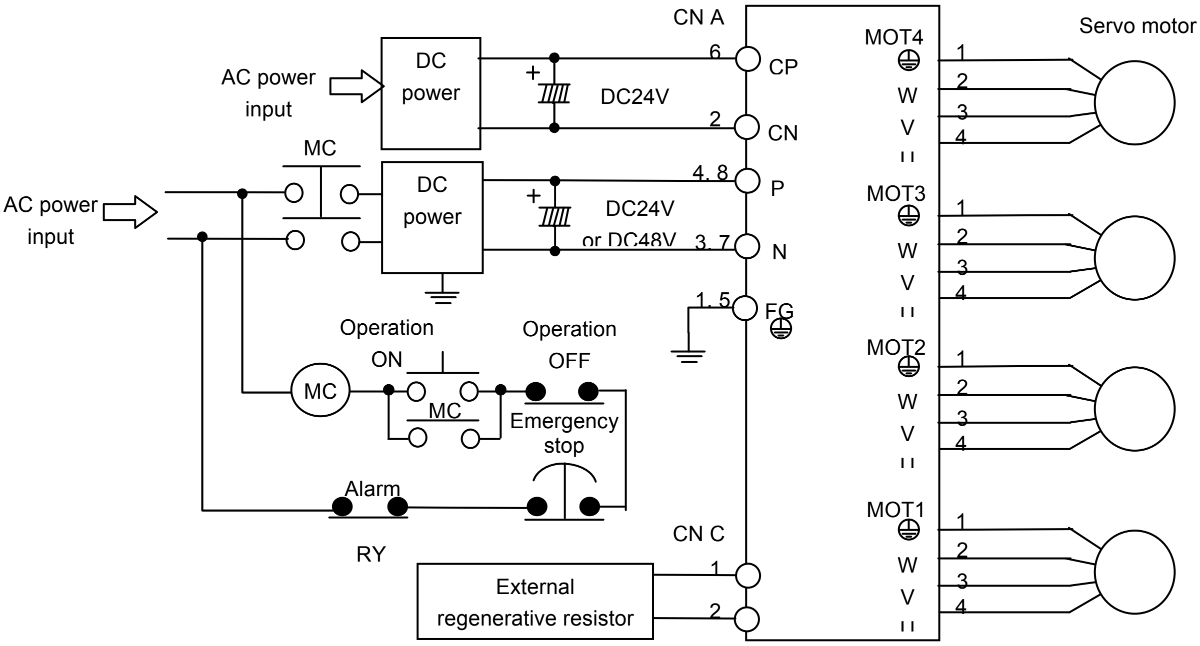
◆ Motor input (U, V, and W)

When motor input line is relatively long, the voltage can drop due to cable impedance, and then motor generated torque can decrease. (Momentary range of high-velocity revolution.)
To solve this problem, we recommend selecting motor with sufficient margin for acceleration and deceleration torque calculation.

## 4) Wiring Example

Even if it turns off power supply, high-pressure voltage may remain in servo amplifier. Completion of electric discharge turns off the lamp of CHARGE. Please do connection check work after checking putting out lights.

- Recommended wiring for power



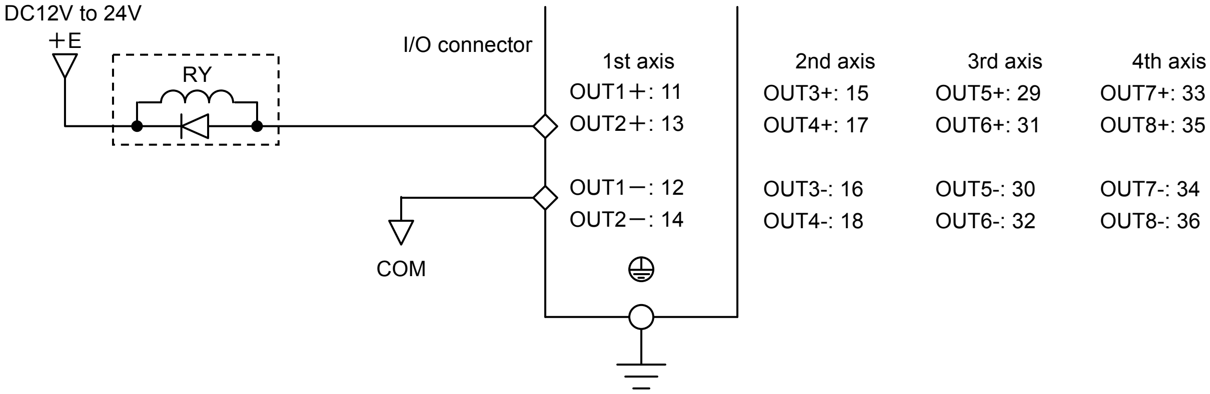
* Use one of the OUT1 - OUT8 outputs, and set either during ALM status output ON or during ALM status output OFF with the selection setting of “Index: 0x20F9 General output function selection”.

* Place electrolytic capacitor between P and N, or CP and CN on amplifier side as required, when wiring from DC power to servo amplifier is relatively long. In this case, inrush current runs into electrolytic capacitor on power-on, so DC power supply needs to respond the inrush current.

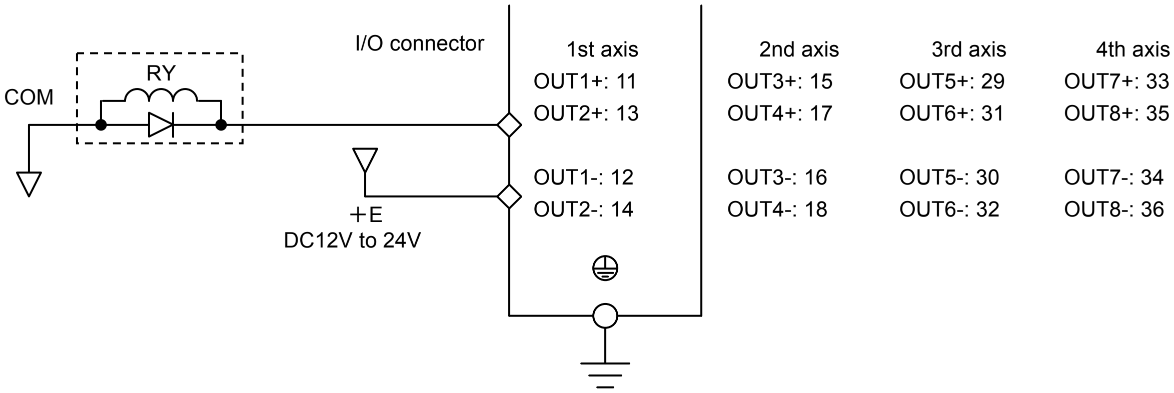
* To use battery for main circuit DC power supply, make sure to install electrolytic capacitor in parallel to protect the servo amplifier. (2,000μF or more-sized capacitor is recommended)

- In case of connecting inductive load (relay) to output

◆ When using + side of OUT1 or OUT2 for power supply (1st axis)
◆ When using + side of OUT3 or OUT4 for power supply (2nd axis)
◆ When using + side of OUT5 or OUT6 for power supply (3rd axis)
◆ When using + side of OUT7 or OUT8 for power supply (4thaxis)



◆ When using - side of OUT1 or OUT2 for power supply (1st axis)
◆ When using - side of OUT3 or OUT4 for power supply (2nd axis)
◆ When using - side of OUT5 or OUT6 for power supply (3rd axis)
◆ When using - side of OUT7 or OUT8 for power supply (4thaxis)

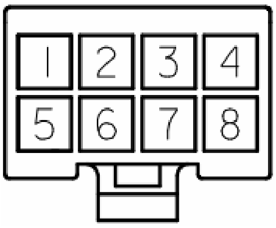


* Make sure to install diode as a surge absorber when connecting induction load, such as relay, to the output: OUT1 to OUT8. Please carefully install diode so as not to connect polarity of diode. Failure to do this causes servo amplifier malfunction.

## 5) Wiring of control power, main circuit power, regenerative resistor and motor power

■CN A: terminal arrangement of power input connector (see from cable crimping side)

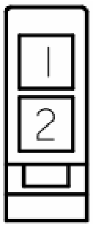
| Terminal number | Signal name | Description |
|---|---|---|
| 1 | FG | Frame grounding |
| 2 | CN | Control power: Minus |
| 3 | N | Main circuit power: Minus |
| 4 | P | Main circuit power: Plus |
| 5 | FG | Frame grounding |
| 6 | CP | Control power: Plus |
| 7 | N | Main circuit power: Minus |
| 8 | P | Main circuit power: Plus |



| CN A | Model number | Applicable wire size | Manufacturer |
|---|---|---|---|
| Housing | 5557-8R | - | Molex |
| Contact | 5556-TL | AWG18 to AWG24 | |

■CNC: terminal arrangement of regenerative resistor connection (see from cable crimping side)

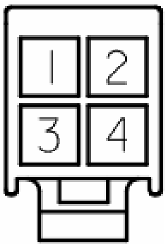
| Terminal number | Signal name | Description |
|---|---|---|
| 1 | － | Generative resistor terminal |
| 2 | － | Generative resistor terminal |



| CN C | Model number | Applicable wire size | Manufacturer |
|---|---|---|---|
| Housing | 5557-2R | - | Molex |
| Contact | 5556-TL | AWG18 to AWG24 | |

■MOT1 to MOT4: terminal arrangement of motor power connection (see from cable crimping side)

| Terminal number | Signal name | Description |
|---|---|---|
| 1 | | Motor grounding |
| 2 | W | W-phase |
| 3 | V | V-phase |
| 4 | U | U-phase |



| MOT1 to 4 | Model number | Applicable wire size | Manufacturer |
|---|---|---|---|
| Housing | 5557-4R | - | Molex |
| Contact | 5556-TL | AWG18 to AWG24 | |

※For contact crimping, dedicated crimping tool of manufacturer required.

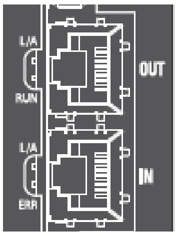
| Crimping tool | Model number | Applicable wire size | Manufacturer |
|---|---|---|---|
| Parts No. | 57026-5000 | AWG18 to AWG24 | Molex |

Refer the instruction manual #IS-001J, for how to use crimping tool.

## 6) Pin disposition of IN, OUT connector

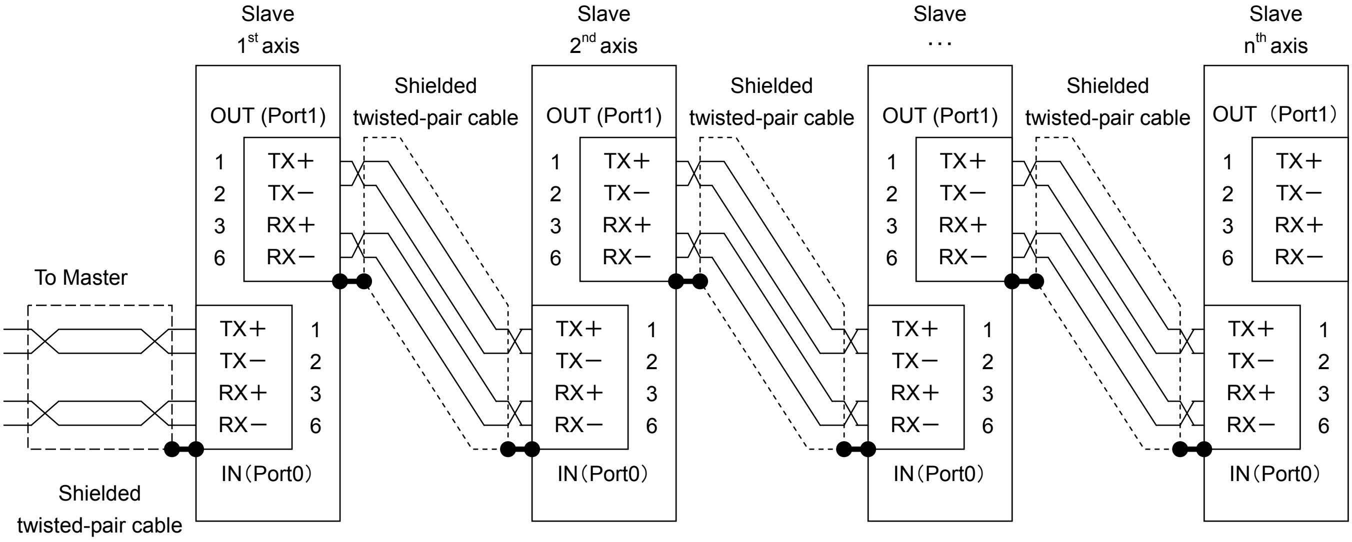
- Pin assignment

For R-ADVANCED EtherCAT amplifier, port IN/ OUT standard Ethernet connection RJ-45 modular connectors are provided for the EtherCAT communication with a higher-level 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 higher-level 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 |

* Connect the master cable (from host unit) to low side connector IN (Port 0), and connect the cable from high side connector OUT (Port 1) to the next slave.

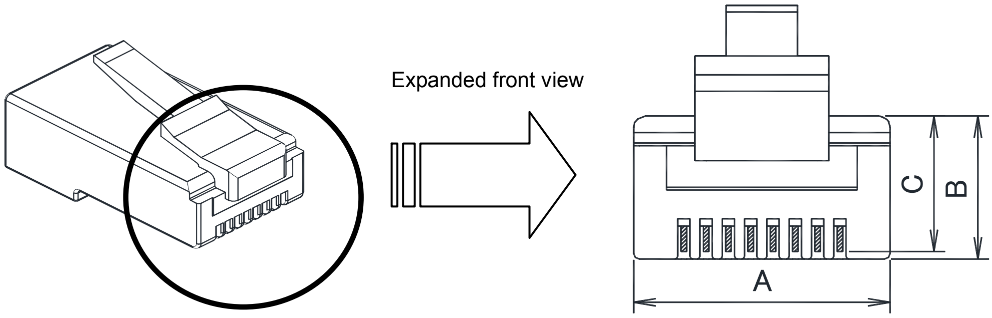
- Wiring diagram



- R-ADVANCED 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 shielded twist- pair cable.

- Caution for RJ-45 modular connector selection

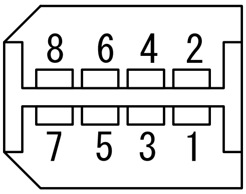
- For the modular connector selection and modification, please confirm the standards dimension below (Standards: TIA-968-A).
- Especially, when the connector (ready-made/ modified product) which has out-of-range dimension at C (from top end of connector housing to lower side of terminal) is used, it gives excessive stress to mating connector and may cause a damage of terminal or connector, and a communication error by contact failure.



Standards dimension:
A: 11.58 to 11.78 mm
B: 6.49 to 6.70 mm
C: 5.89 to 6.15 mm

## 7) CN1 connector disposition

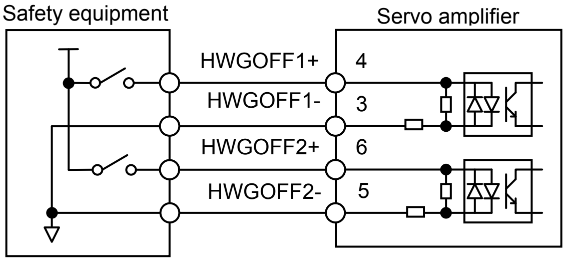
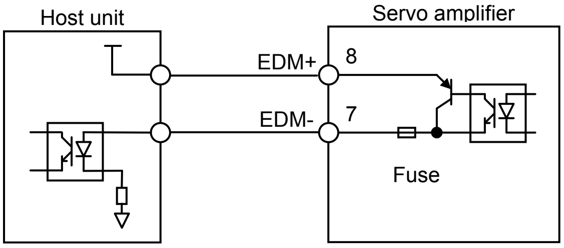
- 2013595－3 (*The figure below is viewed from connector's soldered side.)



- ◆ Signal name and its function

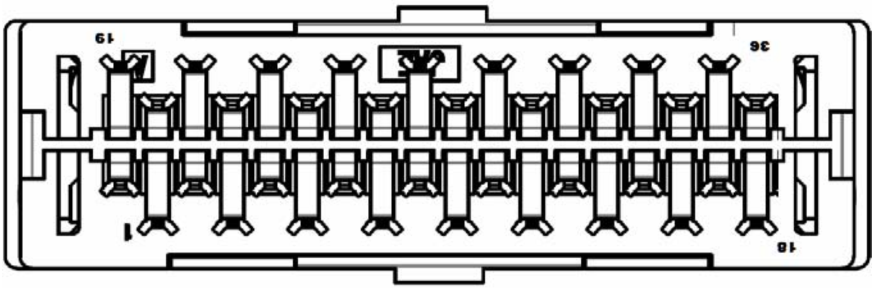
| Terminal number | Signal name | Description |
|---|---|---|
| 1 | Reserve | Do not use. |
| 2 | Reserve | Do not use. |
| 3 | HWGOFF1 - | Signal-input1 (-) for safety function |
| 4 | HWGOFF1 + | Signal-input1 (+) for safety function |
| 5 | HWGOFF2 - | Signal-input1 (-) for safety function |
| 6 | HWGOFF2 + | Signal-input1 (+) 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 maintenance | This is a connection terminal when the function is not used.<br>Do not use this terminal. |
| Reserved | 2 | | |
| Safety input 1 | 3 | HWGOFF1- | This is an input signal to control Safe-Torque-Off state.<br>Connection circuit<br>Connected to a relay or open collector transistor circuit.<br>Power supply voltage range: DC24V±10%<br>Internal impedance ： 2.2kΩ<br> |
| | 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.<br>Connection circuit<br>Connected to a photo coupler or relay circuit.<br>Power supply voltage range（Uext）: DC24V±10%<br>Maximum current value: 50mA<br>Output voltage: Uext-0.5 to Uext<br> |
| | 8 | EDM+ | |

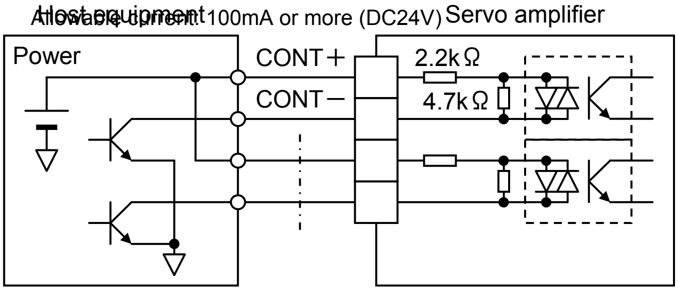
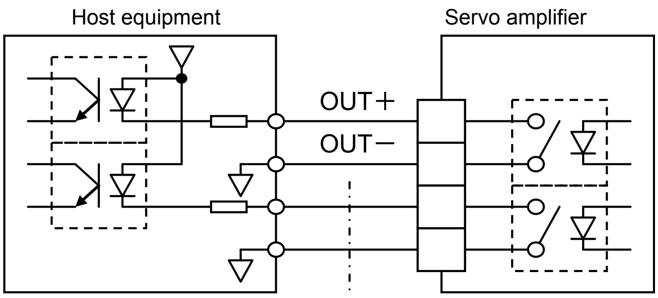
- * If you do not use this function, please connect the short-circuit plug for safety instrument that is attached to this product.
- * If the short-circuit plug for safety instrument is required additionally, please order "AL-00849548-02", as our model number.
- * If you do not use this function, please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

## 8) General input-output connector disposition



| I/O | Model number | Applicable wire size | Manufacturer |
|---|---|---|---|
| Hood (Straight long screw hook) | 10336-52A-008 | - | 3M |
| Plug (Soldering type) | 10136-3000PE | AWG22 to AWG30 | |

■Terminal arrangement of I/O connector (The figure below is viewed from connector's soldered side.)

| Terminal number | Signal name | Symbol | Description |
|---|---|---|---|
| 1 | CONT1+ | General input 1 + | ■ General-purpose input circuit shall connect to relay or Open collector transistor circuit.<br>Power-supply voltage range: DC12V to 24V±10%<br>Allowable current: 100mA or more (DC24V)<br><br> <br>✔ There are 8 general inputs, and sharing by 4 axes. |
| 2 | CONT1- | General input 1 - | |
| 3 | CONT2+ | General input 2 + | |
| 4 | CONT2- | General input 2 - | |
| 5 | CONT3+ | General input 3 + | |
| 6 | CONT3- | General input 3 - | |
| 7 | CONT4+ | General input 4 + | |
| 8 | CONT4- | General input 4 - | |
| 19 | CONT5+ | General input 5 + | |
| 20 | CONT5- | General input 5 - | |
| 21 | CONT6+ | General input 6 + | |
| 22 | CONT6- | General input 6 - | |
| 23 | CONT7+ | General input 7 + | |
| 24 | CONT7- | General input 7 - | |
| 25 | CONT8+ | General input 8 + | |
| 26 | CONT8- | General input 8 - | |
| 11 | OUT1+ | 1st axis, general output 1 (+) | ■ General-purpose output circuit shall connect to relay or Open collector transistor circuit.<br>Power-supply: DC12V to 15V±10%, Maximum current: 50mA<br>Power-supply: DC24V±10%, Maximum current: 50mA<br>Maximum current shall be 20mA or less if the circuit of host equipment is TTL or CMOS input.<br><br> <br>✔ There are 2 general inputs per axis. |
| 12 | OUT1- | 1st axis, general output 1 (-) | |
| 13 | OUT2+ | 1st axis, general output 2 (+) | |
| 14 | OUT2- | 1st axis, general output 2 (-) | |
| 15 | OUT3+ | 2nd axis, general output 1 (+) | |
| 16 | OUT3- | 2nd axis, general output 1 (-) | |
| 17 | OUT4+ | 2nd axis, general output 2 (+) | |
| 18 | OUT4- | 2nd axis, general output 2 (-) | |
| 29 | OUT5+ | 3rd axis, general output 1 (+) | |
| 30 | OUT5- | 3rd axis, general output 1 (-) | |
| 31 | OUT6+ | 3rd axis, general output 2 (+) | |
| 32 | OUT6- | 3rd axis, general output 2 (-) | |
| 33 | OUT7+ | 4th axis, general output 1 (+) | |
| 34 | OUT7- | 4th axis, general output 1 (-) | |
| 35 | OUT8+ | 4th axis, general output 2 (+) | |
| 36 | OUT8- | 4th axis, general output 2 (-) | |
| 9 | NC | Reserved | – |
| 10 | NC | Reserved | |
| 27 | NC | Reserved | |
| 28 | NC | Reserved | |

## 4.2 Wiring of Motor Encoder

### 1) EN1 to 4: connector name and its function

- Battery backup absolute encoder

| Servo Amplifier EN1 to 4 Terminal No. | Signal name | Servo motor lead color | Description | Remarks |
|---|---|---|---|---|
| 1 | 5V | 9 (Red) | Power supply | Twisted-pair |
| 2 | SG | 10 (Black) | Power supply common | |
| 3 | (NC) | - | Non connection | - |
| 4 | (NC) | - | | |
| 5 | (NC) | - | Non connection | - |
| 6 | (NC) | - | | |
| 7 | ES + | 1 (Brown) | Serial data signal | Twisted-pair |
| 8 | ES - | 2 (Blue) | | |
| 9 | BAT + | 8 (Pink) | Battery | Twisted-pair |
| 10 | BAT - | 4 (Purple) | | |
| - | Earth | 7 (Shield) | Shield | - |

✔ Use shielded cable and perform twisted-pair wiring.

✔ Connect outer-shielded wires of servo amplifier to metal case (earth) of servo amplifier (EN1 to 4). 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.

- Absolute encoder for incremental system

| Servo Amplifier EN1 to 4 Terminal No. | Signal name | Servo motor lead color | Description | Remarks |
|---|---|---|---|---|
| 1 | 5V | 9 (Red) | Power supply | Twisted-pair |
| 2 | SG | 10 (Black) | Power supply common | |
| 3 | (NC) | - | Non connection | - |
| 4 | (NC) | - | | |
| 5 | (NC) | - | Non connection | - |
| 6 | (NC) | - | | |
| 7 | ES + | 1 (Brown) | Serial data signal | Twisted-pair |
| 8 | ES - | 2 (Blue) | | |
| 9 | (NC) | - | Non connection | - |
| 10 | (NC) | - | | |
| - | Earth | 7 (Shield) | Shield | - |

✔ Use shielded cable and perform twisted-pair wiring.

✔ Connect outer-shielded wires of servo amplifier to metal case (earth) of servo amplifier (EN1 to 4). 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.

- Battery less absolute encoder

| Servo Amplifier EN1 to 4 Terminal No. | Signal name | Servo motor lead color | Description | Remarks |
|---|---|---|---|---|
| 1 | 5V | 9 (Red) | Power supply | Twisted-pair |
| 2 | SG | 10 (Black) | Power supply common | |
| 3 | (NC) | - | Non connection | - |
| 4 | (NC) | - | | |
| 5 | (NC) | - | Non connection | - |
| 6 | (NC) | - | | |
| 7 | ES + | 1 (Brown) | Serial data signal | Twisted-pair |
| 8 | ES - | 2 (Blue) | | |
| 9 | (NC) | - | Non connection | - |
| 10 | (NC) | - | | |
| — | Earth | 7 (Shield) | Shield | - |

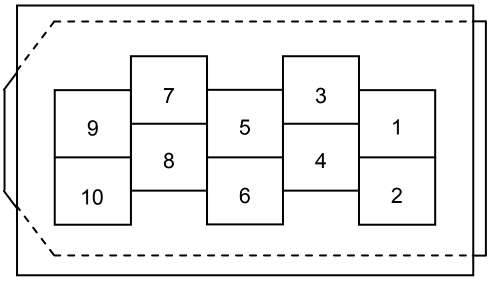
✔ Use shielded cable and perform twisted-pair wiring.
✔ Connect the shielded cable to the metal case (ground) on EN1 to 4 sides and connect the ground to the motor encoder side.

- Pulse encoder

| Servo Amplifier EN1 to 4 Terminal No. | Signal name | Servo motor lead color | Description | Remarks |
|---|---|---|---|---|
| 1 | 5V | 9 (Red) | Power supply | Twisted-pair |
| 2 | SG | 10 (Black) | Power supply common | |
| 3 | (NC) | - | Non connection | |
| 4 | (NC) | - | | |
| 5 | B | 2 (Green) | B-phase pulse output | Twisted-pair |
| 6 | /B | 5 (Purple) | | |
| 7 | A | 1 (Blue) | A-phase pulse output | Twisted-pair |
| 8 | /A | 4 (Brown) | | |
| 9 | Z | 3 (White) | Z-phase pulse output | Twisted-pair |
| 10 | /Z | 6 (Yellow) | | |
| - | Earth | 7 (Shield) | Shield | |

✔ Use shielded cable and perform twisted-pair wiring.
✔ Connect the shielded cable to the metal case (ground) on EN1 to 4 sides and connect the ground to the motor encoder side.

## 2) Servo amplifier side terminal number



(Soldered side)

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

| I/O | Model number | Applicable wire size | Applicable cable outer diameter | Manufacturer |
|---|---|---|---|---|
| Connector | 36210-0100PL | AWG30 to AWG18 | — | 3M |
| Shell kit (Soldering type) | 36310-3200-008 | — | φ7 to φ9 | |

### 3) Recommended encoder cable specification

Shielded cables with multiple twisted pairs

| | |
|---|---|
| Cable Ratings | 80°C 30V |
| Conductor resistance value | 1Ω or less Note1) |
| Conductor size | AWG26 - AWG18 |
| SQ (mm$^2$) | 0.15 - 0.75 |

Note 1) The conductor resistance value is recommended with the cable length actually used.

### 4) Encoder cable length

The maximum cable lengths under the conductor size of the power supply cable (5V, SG).

| Conductor size | | Conductor resistance Ω/km (20℃) | Battery backup method absolute encoder<br>Absolute encoder for incremental system<br>Pulse encoder | Battery less absolute encoder |
|---|---|---|---|---|
| | | | Length (m) | Length (m) |
| AWG | 26 | 150 or less | 4 | 6 |
| | 24 | 100 or less | 6 | 10 |
| | 22 | 60 or less | 10 | 16 |
| | 20 | 40 or less | 15 | 25 |
| | 18 | 25 or less | 25 | 41 |
| SQ(mm$^2$) | 0.15 | 150 or less | 4 | 6 |
| | 0.2 | 100 or less | 6 | 10 |
| | 0.3 | 65 or less | 10 | 16 |
| | 0.5 | 40 or less | 15 | 25 |
| | 0.75 | 28 or less | 25 | 41 |

* The above conductor resistance values are for reference. Cable lengths are calculated according to the above conductor lengths. Please consult manufacturers, as actual conductor resistance values shall be varied by cable specifications.

* When encoder cable is relatively long, place relay connector on wiring between servo amplifier and encoder so as to ground wires in parallel, or use thicker wire diameter-conducting wire sized cable.

5

# 5. Object Dictionary

# 5.1 About EtherCAT

For the technical specifications for the network communication construction method, physical parameter adjustment method and the function activation method, another technical document is preparing. Please contact us.
Detailed information of EtherCAT can be obtained from the following ETG(EtherCAT Technology Group)website:

http://www.ethercat.org/

■ Trademark
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# 5.2 Object Dictionary summary

## 1) Structure of Object Dictionary

Each object is addressed using a 16-bit index displaying 4 digits hexadecimal, assigned to each group in the object dictionary. RF2 multi axis EtherCAT amplifier accepts the objects of 4 axes by single ESC, so, the numbering of object from 2nd to 4th axis differ from 1st axis.
Structure of the Object Dictionary of CoE (CANopen over EtherCAT) comply with CiA draft standard proposal 402 is shown as below.

Structure of Object Dictionary

| Index (Hex) | Index (Hex) | Object |
|---|---|---|
| 0x0000 to 0x0FFF | Common object | Data Type Area |
| 0x1000 to 0x1FFF | Common object | Communication Profile Area<br>(CoE communication area) |
| 0x2000 to 0x21FF, 0x5000 to 0x51FF | 1st object | Manufacturer Specific Profile Area<br>(Manufacturer spec area) |
| 0x2200 to 0x23FF, 0x5200 to 0x53FF | 2nd object | |
| 0x2400 to 0x25FF, 0x5400 to 0x55FF | 3rd object | |
| 0x2600 to 0x27FF, 0x5600 to 0x57FF | 4th object | |
| 0x2800 to 0x4FFF, 0x5800 to 0x57FF | Reserved | |
| 0x6000 to 0x67FF | 1st object | Standardized Device Profile Area<br>(Profile area) |
| 0x6800 to 0x6FFF | 2nd object | |
| 0x7000 to 0x77FF | 3rd object | |
| 0x7800 to 0x7FFF | 4th object | |
| 0x8000 to 0x9FFF | Reserved | |
| 0xA000 to 0xFFFF | Reserved | - |

## 2) Access types

The Attribute column defines the access rights for a particular object.
Means of access are access to attribute data objects, and also direction of access is indicated from Master to Slave.

Access Attributes for Data Objects

| Attribute | Description |
|---|---|
| Rw, RW, rw, | Read and write access |
| Wo, WO, wo | Write only access |
| Ro, RO, ro | Read only access |
| Const, CONST | Read only access, value is constant |

## 5.3 CoE Communication Area

CoE communication object list, Object type, Data length, Access (Dir), PDO Mapping, and parameter effective timing (Update). Are shown. The shapes in the Update column stand for effective timing; #=immediately, $=ESM (EtherCAT State Machine) transition required, &=control power cycle required.

Communication Area

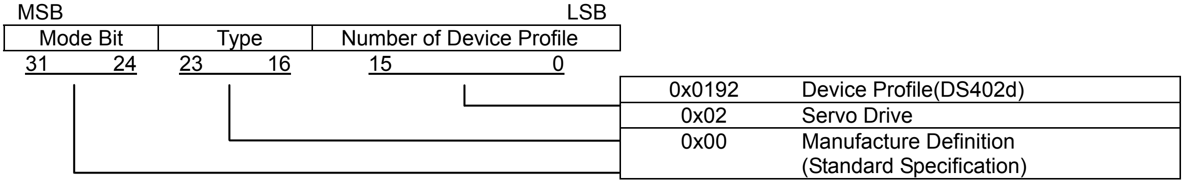
| Index | Sub-Index | Object Type | Name | Data length | Dir | PDO Mapping | Update | NVRAM |
|---|---|---|---|---|---|---|---|---|
| 0x1000 | 0x00 | VAR | Device Type | Unsigned32 | RO | No | - | - |
| 0x1001 | 0x00 | VAR | Error Register | Unsigned8 | RO | Possible | - | - |
| 0x1008 | 0x00 | VAR | Device Name of Manufacturer | VisibleString | RO | No | - | - |
| 0x1009 | 0x00 | VAR | Hardware Version of Manufacturer | VisibleString | RO | No | - | - |
| 0x100A | 0x00 | VAR | Software Version of Manufacturer | VisibleString | RO | No | - | - |
| 0x1010 | - | ARRAY | Store Parameters | - | - | - | - | - |
|  | 0x00 | - | Number of entry | Unsigned8 | RO | No | - | - |
|  | 0x01 | - | Save all parameters | Unsigned32 | RW | No | # | - |
| 0x1018 | - | RECORD | Identity Object | - | - | - | - | - |
|  | 0x00 | - | Number of Entry | Unsigned8 | RO | No | - | - |
|  | 0x01 | - | Vender ID | Unsigned32 | RO | No | - | - |
|  | 0x02 | - | Product Code | Unsigned32 | RO | No | - | - |
|  | 0x03 | - | Revision Number | Unsigned32 | RO | No | - | - |
|  | 0x04 | - | Not supported [Serial Number] | Unsigned32 | RO | No | - | - |
| 0x10F0 | - | ARRAY | Backup parameters | - | - | - | - | - |
|  | 0x00 | - | Number of entry | Unsigned8 | RO | No | - | - |
|  | 0x01 | - | Checksum | Unsigned32 | RO | No | - | Yes |
| 0x1400-0x1403<br>0x1500-0x1503 | - | RECORD | RxPDO Parameter | - | - | - | - | - |
|  | 0x00 | - | Number of Entry | Unsigned8 | RO | No | - | - |
|  | 0x01-0x05 | - | Reserved | Unsigned32 | RW | No | $ | - |
|  | 0x06 | - | RxPDO exception PDO | Octet-String | RW | No | $ | - |
|  | 0x07 | - | RxPDO State | BOOLEAN | RO | Possible | - | - |
|  | 0x08 | - | RxPDO Control | BOOLEAN | RW | Possible | # | - |
|  | 0x09 | - | RxPDO Toggle | BOOLEAN | RW | Possible | # | - |
| 0x1600-0x1603<br>0x1700-0x1703 | - | RECORD | 1st to 4th,257th to 260th Reception PDO Mapping | PDO Mapping | - | - | - | - |
|  | 0x00 | - | Number of Entry to RxPDO | Unsigned8 | RW | No | $ | - |
|  | 0x01-n | - | Object mapped in the 1st<br>...<br>Object mapped in the n-th | Unsigned32 | RW | No | $ | - |
| 0x1800-0x1803<br>0x1900-0x1903 | - | RECORD | TxPDO Parameter | - | - | - | - | - |
|  | 0x00 | - | Number of Entry | Unsigned8 | RO | No | - | - |
|  | 0x01-0x05 | - | Reserved | Unsigned32 | RW | No | $ | - |
|  | 0x06 | - | TxPDO exception PDO | Octet-String | RW | No | $ | - |
|  | 0x07 | - | TxPDO State | BOOLEAN | RO | Possible | - | - |
|  | 0x08 | - | Reserved | BOOLEAN | - | - | - | - |
|  | 0x09 | - | TxPDO Toggle | BOOLEAN | RO | Possible | - | - |
| 0x1A00-0x1B03 | - | RECORD | 1st to 512th Reception PDO Mapping | PDO Mapping | - | - | - | - |
|  | 0x00 | - | Number of Entry to TxPDO | Unsigned8 | RW | No | $ | - |
|  | 0x01-n | - | Object mapped in the 1st<br>...<br>Object mapped in the n-th | Unsigned32 | RW | No | $ | - |
| 0x1C00 | - | ARRAY | SM(Sync Manager) Communication Type | - | - | - | - | - |
|  | 0x00 | - | Number of Entry | Unsigned8 | RO | No | - | - |
|  | 0x01-0x08 | - | Communication Type of SM0<br>…<br>Communication Type of SM7 | Unsigned8 | RO | No | $ | - |
| 0x1C10−0x1C11 | — | ARRAY | PDO Assignment of SM 0 to SM1 | — | — | — | — | - |
|  | 0x00 | — | No. of Objects PDO assigned | Unsigned8 | RW(RO) | No | $ | - |
| 0x1C12-0x1C13 | — | ARRAY | PDO Assignment of SM 2 to SM3 | — | — | — | — | - |
|  | 0x00 | — | No. of Objects PDO assigned | Unsigned8 | RW(RO) | No | $ | - |
|  | 0x01−0x07 | — | Index of Objects PDO assigned | Unsigned16 | RW | No | $ | - |
| 0x1C32-0x1C33 | - | RECORD | SM 2 to SM3 Synchronization | - | - | - | - | - |
|  | 0x00 | - | Number of Synchronous Parameter | Unsigned8 | RO | No | - | - |
|  | 0x01 | - | Synchronous Type | Unsigned16 | RW | No | $ | Yes |
|  | 0x02 | - | Cycle Time | Unsigned32 | RW(RO) | No | - | Yes |
|  | 0x03 | - | Shift Time | Unsigned32 | RO | No | - | - |
|  | 0x04 | - | Synchronous Type Support | Unsigned16 | RO | No | - | - |
|  | 0x05 | - | Minimum Cycle Time | Unsigned32 | RO | No | - | - |
|  | 0x06 | - | Calculate and Copy Time | Unsigned32 | RO | No | - | - |
|  | 0x07 | - | Reserved | - | - | - | - | - |
|  | 0x08 | - | Get Cycle Time | Unsigned16 | RW | No | - | - |
|  | 0x09 | - | Delay Time | Unsigned32 | RO | No | - | - |
|  | 0x0A | - | Sync0 Cycle Time | Unsigned32 | RW(RO) | No | - | - |
|  | 0x0B | - | Cycle Time Too Small | Unsigned16 | RO | No | - | - |
|  | 0x0C | - | SM-Event Missed | Unsigned16 | RO | No | - | - |
|  | 0x0D | - | Shift Time Too Short | Unsigned16 | RO | No | - | - |
|  | 0x0E | - | RxPDO Toggle Failed | Unsigned16 | RO | No | - | - |
|  | 0x0F-0x1F |  | Reserved | - | - | - | - | - |
|  | 0x20 | - | Sync Error | BOOL | RO | Possible | - | - |

* The index which does not appear in the list among 0x1000 to 0x1FFF is Reserved.

## 1) Parameter Details of Object Group from 0x1000

0x1000: Device Type

| Index | 0x1000 | Indicates type and profile function of device | | Object Code | | VAR |
|---|---|---|---|---|---|---|
| Sub-Idx | Name | | Data Type | Access | PDO | Value |
| 0x00 | Device Type [DEVICE]<br>Displays device type for EtherCAT servo drive. | | Unsigned32 | RO | Possible | 0x00020192 |



0x1001: Error Register

| Index | 0x1001 | Indicates error state of slave.<br>Refer to (Error Field Definition) for the details of error. | | Object Code | | VAR |
|---|---|---|---|---|---|---|
| Sub-Idx | Name/Description | | Data Type | Access | PDO | Initial Value |
| 0x00 | Error Register [ERRREG] | | Unsigned8 | RO | Possible | 0x00 |
| | Bit7:Maker Definition Error<br>Bit6:Reserved<br>Bit5:Device Profile Definition Error<br>Bit4:Communication Error | Bit3:Temperature Error<br>Bit2:Voltage Error<br>Bit1:Current Error<br>Bit0:Generic error | | | | |

0x1008: Device Name

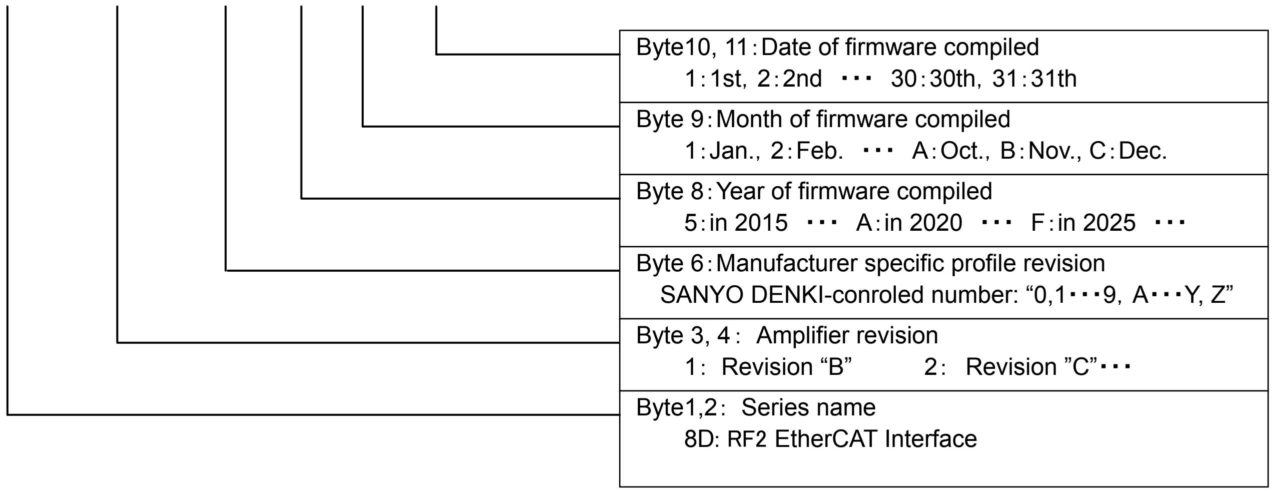
| Index | 0x1008 | Indicates product device name. | | Object Code | | VAR |
|---|---|---|---|---|---|---|
| Sub-Idx | Name/Description | | Data Type | Access | PDO | Value |
| 0x00 | Device Name [DEVICE]<br>Product Device Name (ASCII Code) | | Visible String<br>(Unsigned32) | RO | No | Character String<br>(-) |
| RF2 K 2 4 A 0 H L 5<br>✔ Refer to secton 1.3, Servo amplifier model number, for model number structure details. | | | | | | |

0x1009: Hardware Version

| Index | 0x1009 | Indicates product hardware version. | | Object Code | | VAR |
|---|---|---|---|---|---|---|
| Sub-Idx | Name/Description | | Data Type | Access | PDO | Value |
| 0x00 | Hardware Version [HARDVER]<br>Hardware Version of Device | | Visible String<br>(Unsigned32) | RO | No | Character String<br>( - ) |

0x100A: Software Version

| Index | 0x100A | Indicates product software version. | | Object Code | | VAR |
|---|---|---|---|---|---|---|
| Sub-Idx | Name/Description | | Data Type | Access | PDO | Value |
| 0x00 | Software Version [SOFTVER]<br>Software Version of Device | | Visible String<br>(Unsigned32) | RO | No | Character String<br>( - ) |
| 8 D 0 0 . 0 . 5 5 2 5 | | | | | | |



Byte10, 11：Date of firmware compiled
1：1st, 2：2nd ･･･ 30：30th, 31：31th

Byte 9：Month of firmware compiled
1：Jan., 2：Feb. ･･･ A：Oct., B：Nov., C：Dec.

Byte 8：Year of firmware compiled
5：in 2015 ･･･ A：in 2020 ･･･ F：in 2025 ･･･

Byte 6：Manufacturer specific profile revision
SANYO DENKI-conroled number: “0,1･･･9, A･･･Y, Z”

Byte 3, 4： Amplifier revision
1： Revision “B” 2： Revision ”C”･･･

Byte1,2： Series name
8D: RF2 EtherCAT Interface

0x1010:Store Parameters

<table>
<tr><td>Index</td><td colspan="2">0x1010 Store current amplifier parameters to non-volatile memory</td><td colspan="2">Object Code</td><td>ARRAY</td></tr>
<tr><td>Sub-Idx</td><td>Name/Description</td><td>Data Type</td><td>Access</td><td>PDO</td><td>Initial value</td></tr>
<tr><td>0x00</td><td>Number of Entry</td><td>Unsigned8</td><td>RO</td><td>No</td><td>0x0C</td></tr>
<tr><td rowspan="2">0x01</td><td>Store all parameters of AX1 [PARASAVE]<br>Store all storable parameters of axis 1, in a lump.</td><td>Unsigned32</td><td>RW</td><td>No</td><td>0x0000 0001</td></tr>
<tr><td colspan="5">In order to avoid storage of parameters by misstate, storage is only executed when a specific signature is written to the “Sub-index 0x01”. The signature is “save”.<br>&Write-access Sequence<br>1) Master writes ”0x65 76 61 73” (ASCII：s：73，a：61，v：76，e：65) in “Sub-index 01.”<br>2) Slave stores storable parameters in EEPROM[*] of CPU performing servo control when received correct signs.<br>* Slave information connected to ASIC is not the stored EEPROM.<br>3) Slave responds by SDO sending (download-initiating response) after normal storage completion.<br>If failed to store, slave responds via SDO abort transfer servis (abort code: 0606 0000h).<br>If incorrect sign was written, slave responds via SDO abort transfer service (abort code: 0800 0020h).<br><br>&Read-access Sequence<br>Slave provides information on parameter storing function in the following formats.
<table>
<tr><th>Bit</th><th>Value</th><th>Description</th></tr>
<tr><td>31-2: Reserved</td><td>0</td><td>Reserved</td></tr>
<tr><td>1: Auto</td><td>0</td><td>Slave does not store parameters on an autonomous basis.</td></tr>
<tr><td>0: Cmd</td><td>1</td><td>Slave stores parameters when commanded via the above write -access.</td></tr>
</table>
✔ If NVRAM is Yes at each area of object list , paramaters will be store by this command.</td></tr>
<tr><td>0x02</td><td>Not supported ［Save communication parameter］</td><td>Unsigned32</td><td>RW</td><td>No</td><td>0x0000 0000</td></tr>
<tr><td>0x03</td><td>Not supported ［Save application parameter］</td><td>Unsigned32</td><td>RW</td><td>No</td><td>0x0000 0000</td></tr>
<tr><td>0x04</td><td>Store all parameters of AX2 ［PARASAVE］<br>Store all storable parameters of axis 2, in a lump.<br>✔Parameter description is same as Sub-Index 0x01.</td><td>Unsigned32</td><td>RW</td><td>No</td><td>0x0000 0001</td></tr>
<tr><td>0x05</td><td>Not supported ［Save communication parameter］</td><td>Unsigned32</td><td>RW</td><td>No</td><td>0x0000 0000</td></tr>
<tr><td>0x06</td><td>Not supported ［Save application parameter］</td><td>Unsigned32</td><td>RW</td><td>No</td><td>0x0000 0000</td></tr>
<tr><td>0x07</td><td>Store all parameters of AX ［PARASAVE］<br>Store all storable parameters of axis 3, in a lump.<br>✔Parameter description is same as Sub-Index 0x01.</td><td>Unsigned32</td><td>RW</td><td>No</td><td>0x0000 0001</td></tr>
<tr><td>0x08</td><td>Not supported ［Save communication parameter］</td><td>Unsigned32</td><td>RW</td><td>No</td><td>0x0000 0000</td></tr>
<tr><td>0x09</td><td>Not supported ［Save application parameter］</td><td>Unsigned32</td><td>RW</td><td>No</td><td>0x0000 0000</td></tr>
<tr><td>0x0A</td><td>Store all parameters of AX4 ［PARASAVE］<br>Store all storable parameters of axis 4, in a lump.<br>✔Parameter description is same as Sub-Index 0x01.</td><td>Unsigned32</td><td>RW</td><td>No</td><td>0x0000 0001</td></tr>
<tr><td>0x0B</td><td>Not supported ［Save communication parameter］</td><td>Unsigned32</td><td>RW</td><td>No</td><td>0x0000 0000</td></tr>
<tr><td>0x0C</td><td>Not supported ［Save application parameter］</td><td>Unsigned32</td><td>RW</td><td>No</td><td>0x0000 0000</td></tr>
</table>

0x10F0：Back up parameter

| Index | 0x10F0 Checksum value of XML parameter file | | Object Code | | RECORD |
|---|---|---|---|---|---|
| Sub-Idx | Number of Entry | Data Type | Access | PDO | Value |
| 0x00 | Number of Entry | Unsigned8 | RO | No | 0x01 |
| 0x01 | Check Sum ［FoEChecksum］<br>Indicate checksum value of XML parameter file.<br>When saved parameter or download XML parameter file by FoE. | Unsigned32 | RO | No | - |

0x1018:Identity Object

| Index | 0x1018 Indicates information of salve device. | | Object Code | | RECORD |
|---|---|---|---|---|---|
| Sub-Idx | Name/Description | Data Type | Access | PDO | Value |
| 0x00 | Number of Entry | Unsigned8 | RO | No | 0x04 |
| 0x01 | Vender ID [VENDOR]<br>Vender ID registered in ETG | Unsigned32 | RO | Possible | 0x0000 01B9 |
| 0x02 | Product Code [PRODUCT]<br>Product Code of Production | Unsigned32 | RO | No | 0x00000006 |
| 0x03 | Revision No. [AMPREV]<br>Revision Number of Product (Not used: fixed value 0) | Unsigned32 | RO | No | ( - ) |
| 0x04 | Serial No. [SERIAL]<br>Serial Number of Product (Not used: fixed value 3) | Unsigned32 | RO | No | ( - ) |

1) Synchronous Setup

The features of time and diagnostic function are described by object 0x1C32, 0x1C33, 0x1C02, 0x1400-0x15FF, and 0x1800-0x19FF in the supported synchronous mode.

The supported synchronous mode is described by the portion in OP mode of device description.

The PDO parameter includes the information on PDO and a PDO mapping object (0x1600-0x17FF and 0x1A00-0x1BFF) is related with PDO parameter object (0x1400-0x15FF, 0x1800-0x19FF), respectively.

Sub-Index 1 to 5 of the PDO parameter object is reserved in order to maintain compatibility with CANopen.

0x1400-0x1403, 1500-1503: RxPDO Parameter 1 to 4, 257 - 260 (rxpdo)

| Index | 0x1400-0x1403<br>0x1500-0x1503 | The receiving PDO parameters 1 to 4, 257 to 260 show rxpdo setup and state of rxpdo 1 to 4, 257 to 260 corresponded. | | Object Code | RECORD |
|---|---|---|---|---|---|
| Sub-Idx | Name/Description | Data Type | Access | PDO | Range<br>(Initial Value) |
| 0x00 | Number of Entry | Unsigned8 | Ro | No | 0x09 |
| 0x01 | Not supported : COB-ID RxPDO1(-512) | Unsigned32 | RW | No | - |
| 0x02 | Not supported : Transmission Type | Unsigned8 | RW | No | - |
| 0x03 | Not supported : Inhibit Time | Unsigned16 | RW | No | - |
| 0x04 | Reserved | Unsigned8 | RO | No | - |
| 0x05 | Not supported : Event Timer | Unsigned16 | RW | No | - |
| 0x06 | Not supported : RxPDO Exclude PDO | Octet-String | RW | No | - |
| | Includes the index of object mapping RxPDO which was not able to assign in this RxPDO. | | | | |
| 0x07 | Not supported : RxPDO State | BOOLEAN | RO | Possible | - |
| | When output data of this RxPDO were not arranged to hardware, slave sets it to TRUE =1. | | | | |
| 0x08 | Not supported : RxPDO Control | BOOLEAN | RW | Possible | - |
| | When output of this RxPDO does not have an effective value, master sets it to TRUE =1. | | | | |
| 0x09 | Not supported : RxPDO Toggle | BOOLEAN | RW | Possible | - |
| | Toggles every update of supporting RxPDO to be written by master. | | | | |

## 2) PDO Mapping

Can always optimize because PDO setting is able to change transfer data between the master and slave freely in the EtheCAT CoE profile.

The change of the RxPDO mapping uses reception of PDO mapping parameter (0x1600 - 0x1603, 0x1700 - 0x1703) with this servo amplifier, and the TxPDO mapping parameter uses transmission of PDO mapping parameter (0x1A00 - 0x1A03, 0x1B00 - 0x1B03).
For mapping, set Index of PDO, Sub-Index, and data length (bit length) to transmit.
Data length must agree with the one in the object dictionary.

Perform mapping in the following procedures.

1. Once clear the number of the objects (Set the sub-index to 0.) for mapping to zero.
2. Write in setup sequentially from the object (sub-index 1) assigned to the head.
3. Write in the number of objects assigned to the number of the objects to map (sub-index 0).

■ Restrictions on PDO-mapping

- BOOLEAN-type object is mappable from the 16-bit-boundary to the next 16-bit-data-field continuously.
- Byte object (8-bit), Half-word object (16-bit), word object (32-bit) are mappable by starting from the boundary of 8-bit, and also can be arranged to either of even/odd address.
- In the case shown below requires that address must start from boundary of 8-bit or 16-bit.
  【The case of mapping for Byte object after BOOLEAN-type object】
  Fill blank bits by using Padding object (OD:0x0000 SI:0) to reach boundary of 8-bit or 16-bit.
- The number of objects which can be mapped, are maximum 10 objects per axis for RxPDO and TxPDO respectively, and the size of objects are maximum 32 bytes per axis for RxPDO and TxPDO respectively.
  If mapping is done exceeding the limit, a malfunction may occur.
- Must set the mapping data size per axis as even-bytes. If the data is odd byte, add 1 bit by using Padding object (OD:0x0000 SI:0) to make an even-byte. If the data is odd byte, sets 1 to the error indicator (0x130.4) of AL status and sets the error code 0x0024 or 0x0025 to AL status code (0x134-0x135).

0x1600 - 0x1603 and 0x1700 - 0x1703 are entry of the RxPDO mapping object dictionary.

0x1600:Reception PDO Mapping 1

| Index Ax1 0x1600<br>Ax2 0x1610<br>Ax3 0x1620<br>Ax4 0x1630 | Reception PDO Mapping 1 | | Object Code | | RECORD |
|---|---|---|---|---|---|
| Sub-Idx | Name/Description | Data Type | Access | PDO | Range<br>(Initial Value) |
| 0x00 | Number of Entry : Number of RxPDO1 Object | Unsigned8 | RW | No | 0x00 to 0x1F |
| 0x01 | Entry 1<br>Object Mapped in the 1st - RxPDO1 | Unsigned32 | RW | No | 0x60400010 |
| 0x02<br>-<br>n | Entry 2 - Entry-n<br>Object Mapped in the 2nd to n of - RxPDO1<br>* “n” is up to 0x1F in maximum. | Unsigned32 | RW | No | 0x00000000<br>-<br>0xFFFFFFFF |

0x1601 - 0x1603,0x1700 - 0x1703:RxPDO Mapping 2 - 4,257 - 260(RxPDO x)

| Index | Ax1 0x1601-0x1603<br>0x1700-0x1703<br>Ax2 0x1611-0x1613<br>0x1710-0x1713<br>Ax3 0x1621-0x1623<br>0x1720-0x1723<br>Ax4 0x1631-0x1633<br>0x1730-0x1733 | Reception PDO Mapping 2 - 4,257 - 260 | Object Code | | RECORD |
|---|---|---|---|---|---|
| Sub-Idx | Name/Description | Data Type | Access | PDO | Range (Initial Value) |
| 0x00 | Number of Entry : “n” Number of RxPDOx Object | Unsigned8 | RW | No | 0x00 to 0x1F |
| 0x01<br>-<br>n | Entry 1 - Entry n<br>Object Mapped in the 1st to n of – RxPDOx | Unsigned32 | RW | No | 0x00000000<br>-<br>0xFFFFFFFF |

0x1800-0x1803,0x1900-0x1903:TxPDO Parameter 1 - 4,257 - 260(TxPDO)

| Index | 0x1800-0x1803<br>0x1900-0x1903 | The transmitting PDO parameters 1 - 4 and 257 - 260 show TxPDO setup and state of RxPDO 1 – 4 and 257 - 260 corresponded. | Object Code | | RECORD |
|---|---|---|---|---|---|
| Sub-Idx | Name/Description | Data Type | Access | PDO | Range (Initial Value) |
| 0x00 | Number of Entry | Unsigned8 | RO | No | 0x09 |
| 0x01 | Not supported : COB-ID RxPDO1(-512) | Unsigned32 | RW | No | 0x0000 0000 |
| 0x02 | Not supported : Transmission Type | Unsigned8 | RW | No | - |
| 0x03 | Reserved | Unsigned16 | RW | No | - |
| 0x04 | Reserved | Unsigned8 | RO | No | - |
| 0x05 | Reserved | Unsigned16 | RW | No | - |
| 0x06 | Not supported : TxPDO exception PDO | Octet-String | RW | No | |
| | Includes the index of object mapping TxPDO which was not able to assign in this RxPDO. | | | | |
| 0x07 | Not supported : TxPDO State | BOOLEAN | RO | Possible | - |
| | When output data of this TxPDO were not arranged to hardware, slave sets it to TRUE =1. | | | | |
| 0x08 | Reserved | BOOLEAN | RO | No | - |
| 0x09 | Not supported : TxPDO Toggle | BOOLEAN | RO | Possible | - |
| | Toggles every update of supporting TxPDO to be written by master. | | | | |

0x1A00 - 0x1A03 and 0x1B00 - 0x1B03 are entry of the TxPDO mapping object dictionary.

0x1A00: TxPDO Mapping 1 (TxPDO 1)

| Index | Ax1 0x1A00<br>Ax2 0x1A10<br>Ax3 0x1A20<br>Ax4 0x1A30 | Transmission PDO Mapping 1 | Object Code | | RECORD |
|---|---|---|---|---|---|
| Sub-Idx | Name/Description | Data Type | Access | PDO | Range (Initial Value) |
| 0x00 | Number of Entry : Number of TxPDO1 Object | Unsigned8 | RW | No | 0x00 - 0x1F |
| 0x01 | Entry 1<br>Object Mapped in the 1st to TxPDO1 | Unsigned32 | RW | No | 0x60410010 |
| 0x02<br>-<br>n | Entry 2 - Entry n<br>Object Mapped in the 2nd to n of - TxPDO1<br>* “n” is up to 0x1F in maximum. | Unsigned32 | RW | No | 0x00000000<br>-<br>0xFFFFFFFF |

0x1A01-0x1A03,0x1B00-0x1B03: TxPDO Mapping 2-4,257-260(TxPDO x)

| Index | Ax1 0x1A01-0x1A03<br>0x1B00-0x1B03<br>Ax2 0x1A11-0x1A13<br>0x1B10-0x1B13<br>Ax3 0x1A21-0x1A23<br>0x1B20-0x1B23<br>Ax4 0x1A31-0x1A33<br>0x1B30-0x1B33 | Transmission PDO Mapping 4,257 - 260 | Object Code | | RECORD |
|---|---|---|---|---|---|
| Sub-Idx | Name/Description | Data Type | Access | PDO | Range (Initial Value) |
| 0x00 | Number of Entry : “n” Number of TxPDOx Object | Unsigned8 | RW | No | 0x00 - 0x1F |
| 0x01<br>-<br>n | Entry 1 - Entry n<br>Object Mapped in the 1st to n of –TxPDOx<br>* “n” is to 0x1F in maximum. | Unsigned32 | RW | No | 0x00000000<br>-<br>0xFFFFFFFF |

0x1C00:SM (Sync Manager) Communication Type

| Index | 0x1C00 | Indicates Sync Manager communication type. | | Object Code | | ARRAY |
|---|---|---|---|---|---|---|
| Sub-Idx | Name | Description | Data Type | Access | PDO | Range (Initial Value) |
| 0x00 | Number of Entry | :SM number of channels to be used | Unsigned8 | RO | No | 0x08 |
| 0x01 | Communication Type SM0 | 1:Mailbox Reception(from master to slave) | Unsigned8 | RO | No | 0x01 |
| 0x02 | Communication Type SM1 | 2:Mailbox Transmission (from slave to master) | Unsigned8 | RO | No | 0x02 |
| 0x03 | Communication Type SM2 | 3:PD Output (from master to slave) | Unsigned8 | RO | No | 0x03 |
| 0x04 | Communication Type SM3 | 4:PD Input (from slave to master) | Unsigned8 | RO | No | 0x04 |
| 0x05<br>-<br>0x08 | Communication Type SM4<br>...<br>Communication Type SM7 | 0:Not used<br>1:Mailbox Reception<br>2:Mailbox Transmission<br>3:PD Output<br>4:PD Inpu | Unsigned8 | RO | No | 0x00 |

SM (Sync Manager) PDO Assignment

0x1C10:SM Channel 0(Mailbox Receive)

| Index | 0x1C10 | Indicates the number of the object assigned to SM0 as PDO. | Object Code | | ARRAY |
|---|---|---|---|---|---|
| Sub-Idx | Description | Data Type | Access | PDO | Value |
| 0x00 | Number assigned by PDO | Unsigned8 | RO | No | 0x00 |

0x1C11:SM Channel 1(Mailbox Send)

| Index | 0x1C11 | Indicates the number of the object assigned to SM1 as PDO. | Object Code | | ARRAY |
|---|---|---|---|---|---|
| Sub-Idx | Description | Data Type | Access | PDO | Value |
| 0x00 | Number assigned by PDO | Unsigned8 | RO | No | 0x00 |

0x1C12:SM Channel 2(Process Data Output)

| Index | 0x1C12 | Indicates the object assigned to SM2 as PDO. | | Object Code | ARRAY |
|---|---|---|---|---|---|
| Sub-Idx | Description | Data Type | Access | PDO | Range |
| 0x00 | n [ several ] number of object assigned to RxPDO | Unsigned8 | RW | No | 0x00 to 0x04 |
| 0x01<br>-<br>4 | Index of the PDO object assigned to RxPDO | Unsigned16 | RW | No | 0x1600:RxPDO 1<br>...<br>0x1603:RxPDO 4<br>0x1700:RxPDO257<br>...<br>0x1703:RxPDO260 |

0x1C13:SM Channel 3(Process Data Input)

| Index | 0x1C13 | Indicates the object assigned to SM3 as PDO. | | Object Code | ARRAY |
|---|---|---|---|---|---|
| Sub-Idx | Description | Data Type | Access | PDO | Range |
| 0x00 | n [ several ] number of object assigned to TxPDO | Unsigned8 | RW | No | 0x00 to 0x04 |
| 0x01<br>-<br>4 | Index of the PDO object assigned to TxPDO | Unsigned16 | RW | No | 0x1A00:TxPDO 1<br>...<br>0x1A03:TxPDO 4<br>0x1B00:TxPDO257<br>...<br>0x1B03:TxPDO260 |

0x1C32:SM2 Synchronization (Output Sync Manager Parameter)

| Index | 0x1C32 | SM2 synchronization setup | Object Code | | RECORD |
|---|---|---|---|---|---|
| Sub-Idx | Name/Description | Data Type | Access | PDO | Range |
| 0x00 | Number of synchronization parameter | Unsigned8 | RO | No | 0x20 |
| 0x01 | Synchronization Type [SM2TYP]<br>Sets up synchronous mode. | Unsigned16 | RW | No | 0x0002 |
| | | Setting Range | 0x0000-0x0003 | | |
| | 0x00:Not Synchronized (Free Run)<br>0x01:Reserved<br>0x02:DC Sync0 SYNC0 Event Synchronization (Synchronized with SYNC0 Hardware Signal)<br>0x03:DC Sync1 SYNC1 Event Synchronization (Synchronized with SYNC1 Hardware Signal)<br>✔ This is the storing parameter into non volatile memory. RF2 multi axes amplifier is controlled with Axis 1 setting, even though 4 axes are there and each axis has this parameter. | | | | |
| 0x02 | Cycle Time : Unit(ns) [SM2SYC]<br>Sets up communication cycle between master and slave.<br>Set Value: When T (ns) =125000x2$^{Y}$ (ns), it is in the range of Y= 1 to 7. | Unsigned32 | RW | No | 0x0007A120<br>（500μs） |
| | | Setting Range | 0x0001E848 - 0x00F42400<br>(0.125 - 16ms) | | |
| | Free Run (Synchronization Type=0x0) : Local Timer Event Cycle of Slave<br>DC SYNC0 (Synchronization Type=0x02) : SYNC0 Cycle Time (0x09A0 - 0x09A3)<br>DC SYNC1 (Synchronization Type=0x03) : SYNC0 Cycle Time (0x09A0 - 0x09A3)<br>Possible Setting Value:T$_{(ns)}$<br>125us :0x0001E848 250us :0x0003D090 500us :0x0007A120<br>1ms :0x000F4240 2ms :0x001E8480 4ms :0x003D0900<br>8ms :0x007A1200 16ms :0x00F42400<br>✔ Error is returned when the value is set except the value that can be set as above.<br>✔ Synchronizes with Interpolation time period (0x60C2) by the setting of Special Function Selection (0x20F7).<br>✔ This is the storing parameter into non volatile memory. RF2 multi axes amplifier is controlled with Axis 1 setting, even though 4 axes are there and each axis has this parameter. | | | | |
| 0x03 | Shift Time : Unit (ns)<br>Time between Hardware Output Effective Operation and Related Event | Unsigned32 | RO | No | 0x0 |
| 0x04 | Synchronization Type Supported | Unsigned16 | RO | No | 0x4007 |

MSB LSB

| Res. | Dyna | Res. | Shift | DC | Sync | Free |
|---|---|---|---|---|---|---|
| 15 | 14 | 13 - 7 | 6 5 | 4 3 2 | 1 | 0 |

Bit0 : FreeRun Mode Support
0:Un-supported 1:FreeRun Mode Support

Bit1 : SyncManager Synchronous Support
0:Un-supported 1:SyncManager 2 Event Sync Support

Bit4-2 : DC Type Support
000 : Un-supported
001 : DC SYNC0 Event Sync Support
010 : DC SYNC0 Event Sync Support
100 : Synchronization by Slave Application Cycle

Bit6-5 : Output Shift Support
00 : Un-supported
01 : Shift Support to Local Timer
11 : Shift Support to SYNC1

bit13-7 : Reserved

bit14 : Not supported : Dinamic Cycle Time
The time displayed on 0x1C32 is variable since it depends on the system structure. Therefore, in order to make a precise measurement, to read the online value of 0x1C32 instead of the device description value measured by the master will be more accurate than that. Therefore, the slave supports measuring Cycle time in OP state. Writing "1" in 0x1C32:08 makes Cycle time measuring start. At the time of setting this bit, the default value during the time measured in "Minimum Cycle Time", "Calc and Copy Time" and "Delay Time" will be "0" . And also, the default value is set in "INIT" and "Pre-OP" state.

bit15 : Reserved

| Sub-Idx | Name/Description | Data Type | Access | PDO | Range |
|---|---|---|---|---|---|
| 0x05 | Minimum Cycle Time : Unit(ns) | Unsigned32 | RO | No | 0x0001E848<br>（125μs） |
| | The minimum cycle time is supported by slave. (Maximum time of local cycle) | | | | |
| 0x06 | Copy and Operation Time (Calc and Copy Time) Unit (ns) | Unsigned32 | RO | No | 0x0000F424<br>（62.5μs） |
| | Time required of micro controller in order to copy process data to local memory from SyncManager. Operation is processed, if required before data's transmitting to process. | | | | |
| 0x07 | Reserved | Unsigned32 | - | - | - |
| 0x08 | Get Cycle Time<br>0:Stops local cycle time measurement.<br>1:Starts local cycle time measurement.<br>*Measurement value is reset when written into again. | Unsigned16 | RW | No | - |
| 0x09 | Delay Time | Unsigned32 | RO | No | 0x00007530<br>（30μs） |
| | It is time during trigger reception of SYNC0 or SYNC1 event to be effective in order to do output drive of the value by the hardware delay time of slave,<br>*Only the synchronous type 0x02, or DC SYNC0/1 of 0x03 | | | | |
| 0x0A | Not supported : Sync0 Cycle Time | Unsigned32 | RW | No | - |
| | When SYNC0 fixed cycle time is required of application, it is the time between two Sync0 signals.<br>*Synchronous Time = Only DC SYNC0 of 0x03, and local cycle control | | | | |
| 0x0B | Cycle Time Too Small | Unsigned16 | RO | No | - |
| | This error counter is incremented when cycle time is too short as local cycle cannot be completed or input data cannot prepare by the next SM event. | | | | |
| 0x0C | SM-Event Missed | Unsigned16 | RO | No | - |
| | This error counter is incremented when application demands SM event and cannot receive it. As a result, data may be unable to be copied any more. | | | | |
| 0x0D | Shift Time Too Short | Unsigned16 | RO | No | - |
| | This error counter is incremented when the time interval of SYNC0 trigger and an output is too short, by the fact that shift time or SYNC1 cycle time is too short. | | | | |
| 0x0E | Not supported : RxPDO Toggle Failed | Unsigned16 | RO | No | - |
| | This error counter is incremented when slave supports a RxPDO toggle and then new RxPDO data cannot be received from a master. (When RxPDO toggle is set to TRUE.) | | | | |
| 0x0F:0x1F | Reserved | - | - | - | - |
| 0x20 | Not supported : Sync Error | BOOL | RO | | |
| | TxPDO mapping is possible at the time of SM-Event Missed or Shift Time Too Short Counter support.<br>0: Not Sync. Error or unsupported Sync.Error<br>1: Sync. Error | | | | |

0x1C33:SM3 Synchronization (Input SyncManager Parameter)

| Index | 0x1C33 SM3 Synchronization | | Object Code | | RECORD |
|---|---|---|---|---|---|
| Sub-Idx | Name/Description | Data Type | Access | PDO | Initial Value |
| 0x00 | Number of Synchronization Parameter | Unsigned8 | RO | No | 0x20 |
| 0x01 | Synchronization Type [SM3TYP] | Unsigned16 | RW | No | 0x0002 |
| | | Setting Range | 0x00, 0x02, 0x03, 0x22 | | |
| | 0x00:Not synchronized (Free Run)<br>0x01:Reserved<br>0x02:DC Sync0 SYNC0 Event Synchronization (Synchronized with SYNC0 Hardware Signal)<br>0x03:DC Sync1 SYNC1 Event Synchronization (Synchronized with SYNC1 Hardware Signal)<br>0x04 - 0x21:Reserved<br>0x22:Synchron SM2 Event Synchronization (When Output is transmitted by Safe-Ope and OP)<br>✔ This is the storing parameter into non volatile memory. RF2 multi axes amplifier is controlled with Axis 1 setting, even though 4 axes are there and each axis has this parameter. | | | | |
| 0x02 | Cycle Time : Unit (ns) [SM3CYC] | Unsigned32 | RO | No | 0x0007A120<br>（500μs） |
| | Free Run (Synchronous Type=0x00) : Local Timer Event Cycle of Slave<br>DC SYNC0 (Synchronous Type=0x02) : SYNC0 Cycle Time (0x09A0 - 0x09A3)<br>DC SYNC1 (Synchronous Type=0x03) : SYNC0 Cycle Time (0x09A0 - 0x09A3)<br>✔ The value shall be the same as Index:0x1C32,Sub-index2. | | | | |
| 0x03 | Shift Time : Unit(ns) | Unsigned32 | RO | No | 0x0 |
| | Time between Input Latch Operation from Hardware and Related Operation<br>✔ The value shall be the same as Index:0x1C32,Sub-index2. | | | | |
| 0x04 | Synchronous Type Support | Unsigned16 | Ro | No | 0x4007 |

MSB LSB

| Res. | Dyna | Res. | Shift | DC | Sync | Free |
|---|---|---|---|---|---|---|
| 15 | 14 | 13...7 | 6 5 | 4 3 2 | 1 | 0 |

Bit0 : FreeRun Mode Support
0:Un-supported 1:FreeRun Mode Support

Bit1 : SyncManager Sync. Support
0:Un-supported 1:SyncManager 2 Event Sync. Support

Bit4-2 : DC Type Support
000 : Un-supported
001 : DC SYNC0 Event Sync Support
010 : DC SYNC0 Event Sync Support
100 : Synchronization by Slave Application Cycle

Bit6-5 : Output Shift Support
00 : Un-supported
01 : Shift Support to Local Timer
11 : Shift Support to SYNC1

Bit13-7 : Reserved

Bit14 : Dinamic Cycle Time(Refer to 0x1C32,0x08)

Bit15 : Reserved

| Sub-Idx | Name/Description | Data Type | Access | PDO | Range |
|---|---|---|---|---|---|
| 0x05 | Minimum Cycle Time : Unit (ns) | Unsigned32 | RO | No | 0x0001E848<br>（125μs） |
| | The minimum cycle time is supported by slave. (Maximum time of local cycle)<br>✔ The value shall be the same as Index:0x1C32,Sub-index5. | | | | |
| 0x06 | Copy and Operation Time (Calc and Copy Time) Unit (ns) | Unsigned32 | RO | No | 0x0001E848<br>（125μs） |
| | Time required from Input Latch through minimum cycle time. | | | | |
| 0x07 | Reserved | - | - | - | - |
| 0x08 | Get Cycle Time<br>0:Stops local cycle time measurement.<br>1:Starts local cycle time measurement.<br>*Measurement value is reset when written into again. | Unsigned16 | RW | No | - |
| 0x09 | Delay Time | Unsigned32 | RO | No | - |
| | Hardware delay time of a slave, period from trigger reception of SYNC0 or SYNC1 event until latching input value.<br>*Only the synchronous type 0x02, or DC SYNC0/1 of 0x03 | | | | |
| 0x0A | Not supported ： Sync0 Cycle Time | Unsigned32 | RW | No | - |
| | When SYNC0 fixed cycle time is required of application, it is the time between two Sync0 signals.<br>*Synchronous Time = Only DC SYNC0 of 0x03, and local cycle control | | | | |
| 0x0B | Cycle Time Too Small | Unsigned16 | RO | No | - |
| | This error counter is incremented when cycle time is too short as local cycle cannot be completed or input data cannot prepare by the next SM event. | | | | |
| 0x0C | SM-Event Missed | Unsigned16 | RO | No | - |
| | This error counter is incremented when application demands SM event and cannot receive it. As a result, data may be unable to be copied any more. | | | | |
| 0x0D | Shift Time Too Short | Unsigned16 | RO | No | - |
| | This error counter is incremented when the time interval of SYNC0 trigger and an output is too short, by the fact that shift time or SYNC1 cycle time is too short. | | | | |
| 0x0E | Not supported ： RxPDO Toggle Failed | Unsigned16 | RO | No | - |
| | This error counter is incremented when slave supports a RxPDO toggle and then new RxPDO data cannot be received from a master. (When RxPDO toggle is set to TRUE.) | | | | |
| 0x0F:0x1F | Reserved | - | - | - | - |
| 0x20 | Not supported (Sync Error) | BOOL | RO | | |
| | TxPDO mapping is possible at the time of SM-Event Missed or Shift Time Too Short Counter support.<br>0: Not Sync. Error or unsupported Sync-Error<br>1: Sync. Error | | | | |

## 3) Communication Timing

Since application is synchronized with master and slave, data handling of EtherCAT makes a peculiar motion.
As for synchronization type, synchronization mode discernment is possible by the combination of 0x1C32 and 0x1C33 of sub index in Object Dictionary. Terms used to Communication Timing are explained below.

Copy and Prepare Outputs

Output data in trigger events, such as local timer event and SM2/3 event and SYNC0/1 event, are read from SyncManager output area. Then, slave operates process using output data, and is outputted to motor.
The overview of "Copy and Prepare Output" time is the hardware delay depending on the time and software operating time for copying process data to a local memory from SyncManager, when accurate operation move is required. They follow the value described by SyncManager Object: 0x1C32.

| Index | Sub-Index | Time Definition |
|---|---|---|
| 0x1C32 | 0x06 | Process data copy from SyncManager and accurate operation |
| 0x1C32 | 0x09 | Hardware Delay Time |

Get and Copy Inputs

The abstract of "Get and Copy Inputs" time is the delay for copying input process data to hardware reading of a encoder signal and SyncManager 3 area, when accurate operation move is required. They follow the value described by SyncManager Object: 0x1C33.
Input can be used in SyncManager 3 area after spending 0x1C32 0x05 "Minimum Cycle Time".

| Index | Sub-Index | Time Definition |
|---|---|---|
| 0x1C33 | 0x06 | Data copy from accurate operation and local memory to SyncManager |
| 0x1C33 | 0x09 | Hardware delay time for input latch preparation |

Outputs Valid

"Outputs Valid" in this servo amplifier indicates the time, which added together the following three kinds of time.
1) Time until copies process data to local memory from SyncManager by trigger event
2) Time until servo loop operation process and the current command to ASIC for servo are written in
3) Hardware delay to current loop operation process within ASIC and IGBT gate output

Start Driving Outputs

"Start Driving Outputs" is the timing to write current command in ASIC for servo by micro controller.
0x1C32 0x09 "Hardware Delay Time" indicate between "Start Driving Outputs" and "Outputs Valid".

Start Latch

"Start Latch" is start signal to input latch process.
Between "Start Latch" and "Input Latch", defines as 0x1C33 0x09 "Delay Time" in consideration of hardware delay time and the software operating time mounted in slave.

Input Latch

"Input Latch" in this servo amplifier indicates the real position acquisition timing of motor encoder.
However, when position cannot be received from encoder (serial encoder), data is not copied to SyncManager area.

User Shift Time

"User Shift Time" is value in consideration to the jitter of the master.

SYNC1 Cycle Time

"SYNC1 Cycle Time" may be used for the shift of "Start Input Latch" or "Start Driving Output". "SYNC1 Cycle Time" is defined as a register 0x984 - 0x987 as a shift time between SYNC0 and SYNC1, as long as SYNC0 is a standard signal.

Shift Time

"Shift Time" defines time between the synchronous event such as SM2 event, SYNC0, and SYNC1, and also "Outputs Valid" and "Input Latch". Possible to write if its specifications can shift "Outputs Valid" or "Input Latch".

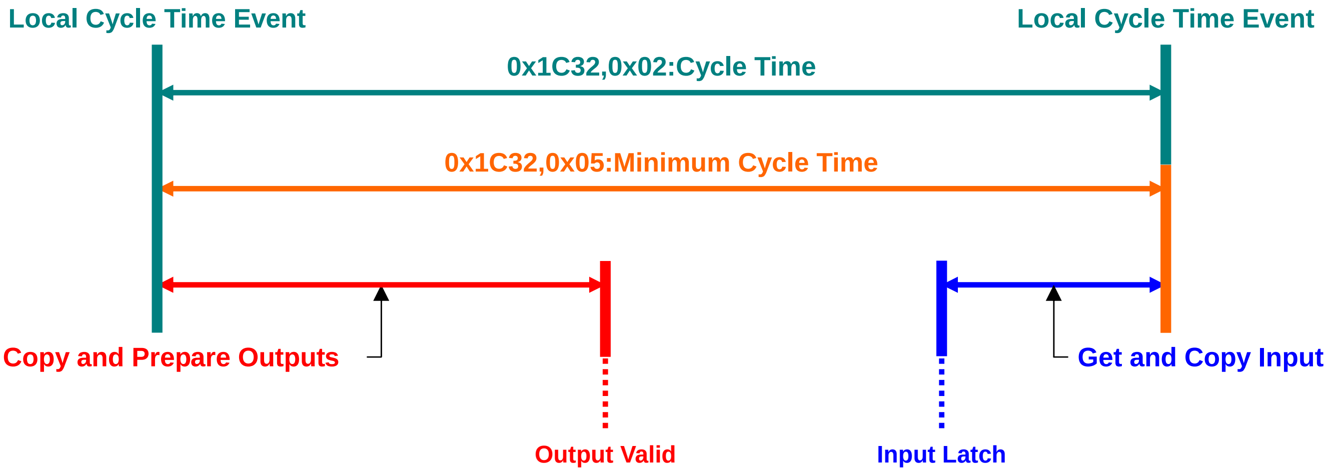
The synchronous mode supported to this servo amplifier is shown the following.

## 4) Free Run Mode (Free Run:Asynchronous Operation)

In free run mode, starts by the local timer interrupt of an application controller.
Local cycle moves independently of communication cycle or master cycle.
As an optional feature, slave supports 0x02 of 0x1C32 "Cycle Time". In this case, 0x05 of 0x1C32 "Minimum Cycle Time" is also supported with slave.
Free run mode is set as 0x1C32:0x01=0x00 and 0x1C33:0x00=0x00.

Parameter of Free Run Mode List

| Index | Sub-Index | Dir | Name | Remarks |
|---|---|---|---|---|
| 0x1C32 | 0x01 | RW | Synchronization Type | 0x00:Free Run Support |
| | 0x02 | RO | Cycle Time | Control Cycle Time of Slave |
| | 0x04 | RO | Synchronization Type Supported | Bit0=1:FreeRun Support |
| | 0x05 | RO | Minimum Cycle Time | RS2-EtherCAT(s) are the same setup to 0x1C32:0x02. |
| 0x1C33 | 0x01 | RW | Synchronization Type | 0x00:Free Run Support |
| | 0x02 | RO | Cycle Time | Same setup to 0x1C32:0x02 |
| | 0x04 | RO | Synchronization Type Supported | Same setup to 0x1C32:0x04 |
| | 0x05 | RO | Minimum Cycle Time | Same setup to 0x1C32:0x05 |



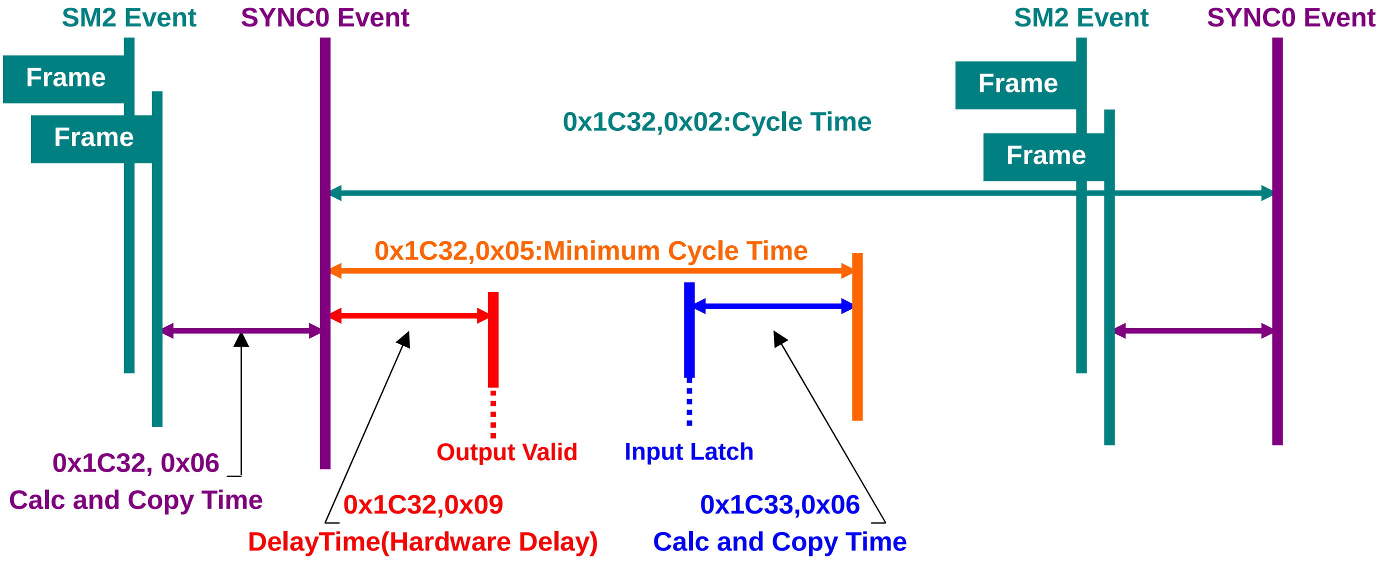
Communication Timing of Free Run Mode

## 5) DC Mode (SYNC0 Event Synchronization)

Local cycle of slave is started to SYNC0 event reception.
Process data frame must complete data reception within slave before the next SYNC0 interruption generating.
"Calc and Copy Time" contains the minimum time lag between frame reception and SYNC0 event.

Parameter of DC Mode (SYNC0 Event Synchronization)

| Index | Sub-Index | Dir | Name | Remarks |
|---|---|---|---|---|
| 0x1C32 | 0x01 | RW | Synchronization Type | Synchronized with 0x02:DC SYNC0 |
| | 0x02 | RO | Cycle Time | SYNC0 Cycle Time |
| | 0x04 | RO | Synchronization Type Supported | Bit4:2=001:DC SYNC0 |
| | 0x05 | RO | Minimum Cycle Time | |
| | 0x06 | RO | Calc and Copy Time | Minimum Time between Frame and SYNC0 |
| | 0x08 | RW | Cycle Time Acquisition | |
| | 0x09 | RO | Delay Time | |
| | 0x0B | RO | Cycle Time Short | |
| | 0x0C | RO | SM Event Missed(Event Omission) | |
| | 0x0E | RO | RxPDO Toggle Failed | |
| | 0x20 | RO | Synchronization Error | |
| 0x1C33 | 0x01 | RW | Synchronization Type | Synchronized with 0x02:DC SYNC0 |
| | 0x02 | RO | Cycle Time | Same set to 0x1C32:0x02 |
| | 0x04 | RO | Synchronization Type Support | Same set to 0x1C32:0x04 |
| | 0x05 | RO | Minimum Cycle Time | Same set to 0x1C32:0x05 |
| | 0x06 | RO | Calc and Copy Time | Time between Input Latch and Minimum Cycle Time |
| | 0x08 | RW | Cycle Time Acquisition | Same set to 0x1C32:0x08 |
| | 0x0B | RO | Cycle Time Short | Same set to 0x1C32:0x0B |
| | 0x0C | RO | SM Event Missed(Event Omission) | Same set to 0x1C32:0x0C |
| | 0x0E | RO | RxPDO Toggle Failed | Same set to 0x1C32:0x0E |
| | 0x20 | RO | Synchronization Error | Same set to 0x1C32:0x20 |



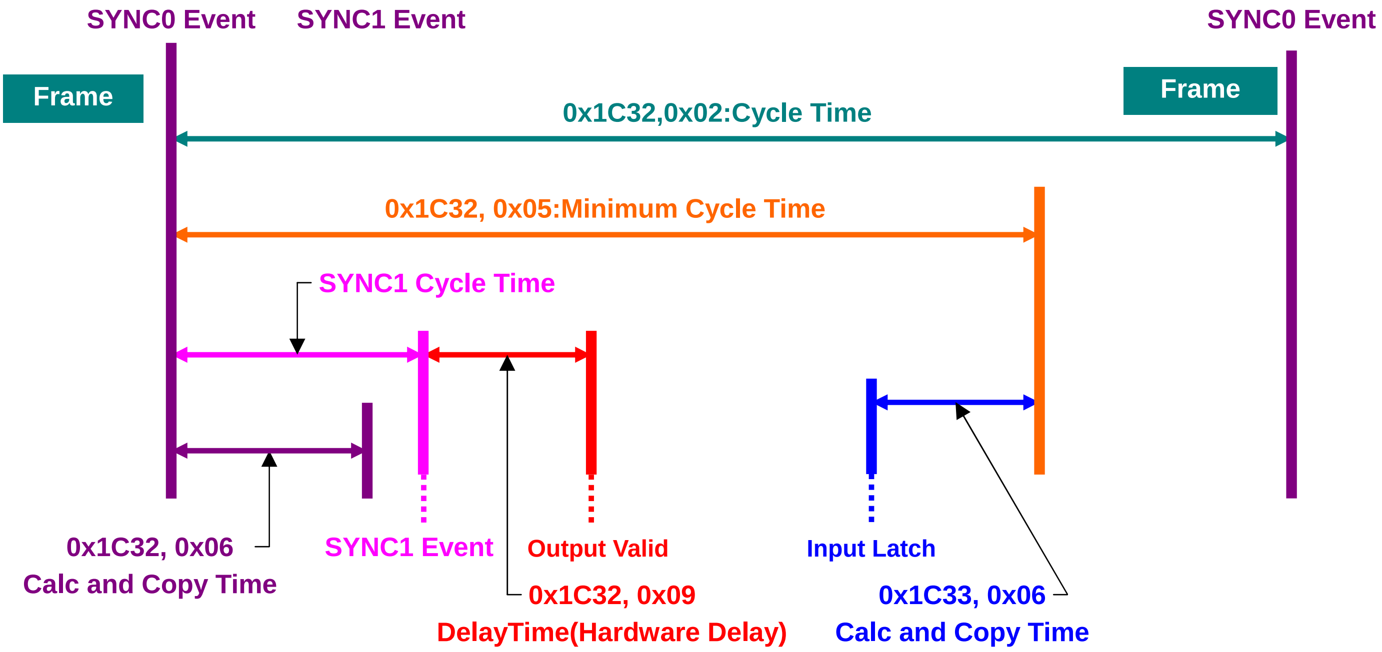
Communication Timing of DC Synchronization Mode (SYNC0)

### 6) DC Mode (SYNC1 Event Synchronization)

Local cycle of slave is started to SYNC0 event reception.
Should receive process data frame before the next SYNC0 interruption generating.
Since SYNC1 is used for "Output Valid", SYNC1 cycle time defines the time lag between SYNC0 and "Start Driving Output".
0x1C32: 0x06 (Calc and Copy Time) indicate the allowance time for SYNC1 cycle time, and 0x1C32: 0x09 (Delay Time) define the hardware delay for driving an output.

Parameter of DC Mode (SYNC1 Event Synchronization)

| Index | Sub-Index | Dir | Name | Remarks |
|---|---|---|---|---|
| 0x1C32 | 0x01 | RW | Synchronization Type | Synchronized with 0x03:DC SYNC0 |
| | 0x02 | RO | Cycle Time | SYNC0 Cycle Time |
| | 0x04 | RO | Synchronization Type Supported | Bit4:2=010:DC SYNC1 |
| | 0x05 | RO | Minimum Cycle Time | |
| | 0x06 | RO | Calc and Copy Time | Value between SYNC0 and Minimum SYNC1 Cycle Time |
| | 0x08 | RW | Cycle Time Acquisition | |
| | 0x09 | RO | Delay Time | |
| | 0x0B | RO | Cycle Time Short | |
| | 0x0C | RO | SM Event Missed(Event Omission) | |
| | 0x0E | RO | RxPDO Toggle Failed | |
| | 0x20 | RO | Synchronization Error | |
| 0x1C33 | 0x01 | RW | Synchronization Type | Synchronized with 0x03:DC SYNC1 |
| | 0x02 | RO | Cycle Time | Same set to 0x1C32:0x02 |
| | 0x04 | RO | Synchronization Type Supported | Same set to 0x1C32:0x04 |
| | 0x05 | RO | Minimum Cycle Time | Same set to 0x1C32:0x05 |
| | 0x06 | RO | Calc and Copy Time | Time between Input Latch and Minimum Cycle Time |
| | 0x08 | RW | Cycle Time Acquisition | Same set to 0x1C32:0x08 |
| | 0x0B | RO | Cycle Time Short | Same set to 0x1C32:0x0B |
| | 0x0C | RO | SM Event Missed(Event Omission) | Same set to 0x1C32:0x0C |
| | 0x0E | RO | RxPDO Toggle Failed | Same set to 0x1C32:0x0E |
| | 0x20 | RO | Synchronization Error | Same set to 0x1C32:0x20 |

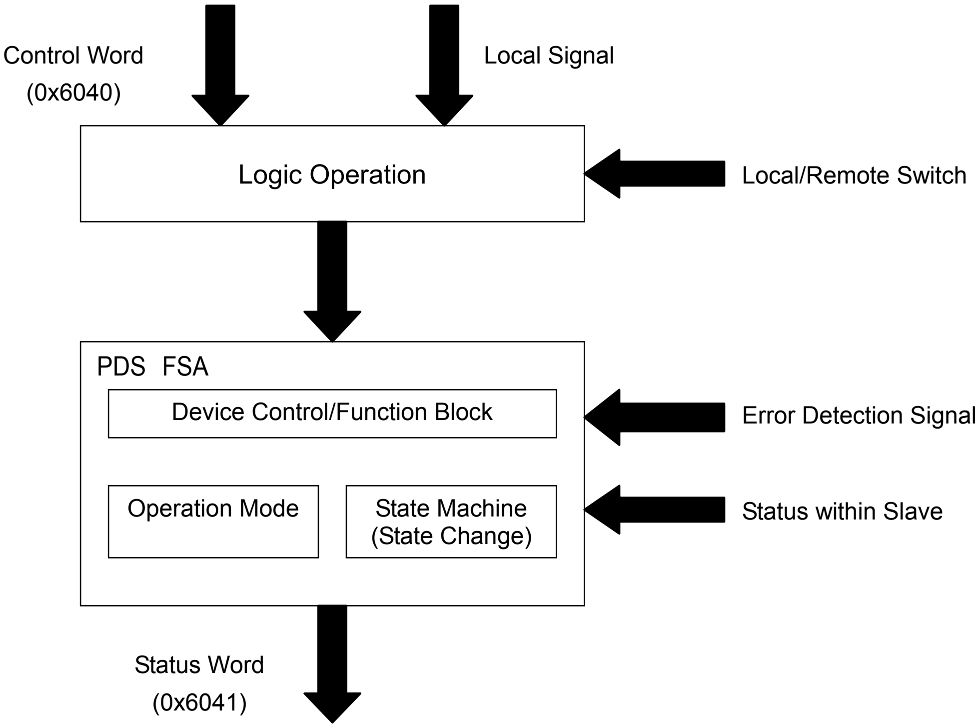


Communication Timing of DC Synchronization Mode(SYNC0)

# 5.4 PDS FSA

## 1) Abstract

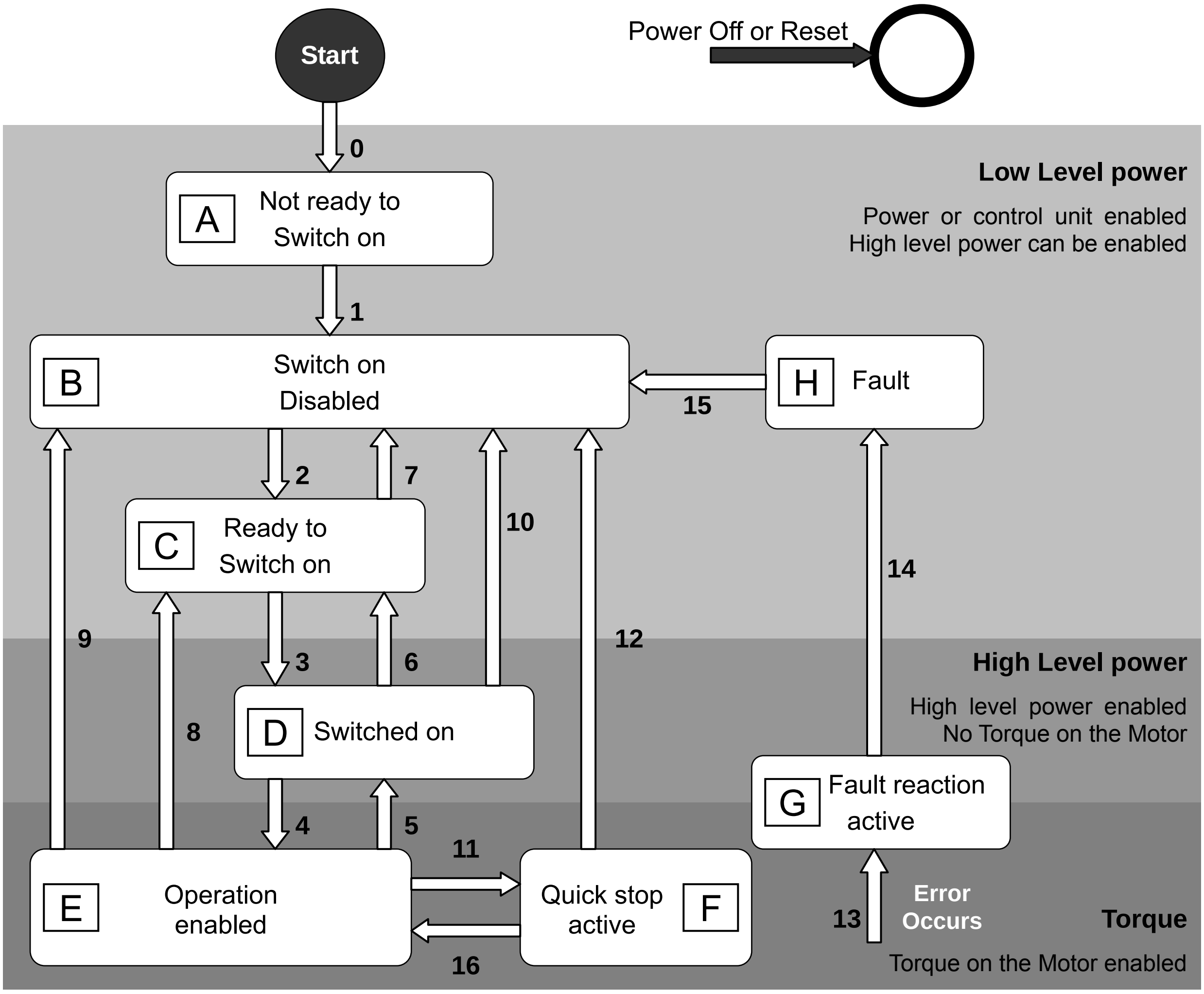
PDS (Power System Device) FSA (Finite States Automaton)of this servo amplifier is an abstract concept which defines the state of the control device stays or passes, operation with the Black Box. It defines the slave's application operating. Slave controls State Device, Mode, and State Change with Object "Control Word (0x6040)" sent via the network.
By "Status word (0x6041)" generated with slave device, the State returns the present state. Besides, PDS and FSA are controlled also by Error Detection Signal.
The slave local and network shows you how to be driving.



Control Word / Status Word Concept of Slave

## 2) FSA (Finite States Automaton)

FSA of RS2 EtherCAT slave amplifier determines the sequence of device state and drive control, and operation peculiar to each state is shown.
With this State Machine, what kind of command slave amplifier receives is changed.



FSA of EtherCAT Amplifier

Low Level power Area
: The control source is established and the state can switch on main circuit power supply.

High Level Power Area
: Main circuit power supply is in SwithOn state. However, motor is in servo-off (torque(force)-off) state, and when the main circuit is not established, Shift 3 is canceled by slave. Target and set point value are invalid.

Torque Area
: After slave completes servo-on (torque(force)-on) preparation, excited by motor with SwithOn. Motor is operated by target or set point value.

FSA and FSA state describes the state transitions.

FSA State Definition

| No. | State | Description |
|---|---|---|
| [A] | Not Ready to Switch on | The control source is provided to the slave and established.<br>Slave is performing initialization or self-test. |
| [B] | Switch on Disabled | Initialization is completed, and slave is in condition to be able to set parameter.<br>However, main circuit power supply is not in the state should be supplied. |
| [C] | Ready to Switch on | In input permission state about main circuit power supply.<br>Although parameter can be set, function is in invalid state. |
| [D] | Switch on | Main circuit power supply is provided and in the completion state of Operation enabled preparation. Parameter to slave can be set. This amplifier is able to transit even if main power is OFF. |
| [E] | Operation Enabled | Fault (alarm) is not generated, where drive function is effective and motor is excited.<br>Parameter to slave can be set. |
| [F] | Quick Stop Active | In the state where the Quick stop (scram) function is performed.<br>In the state where drive function is effective and motor is excited. |
| [G] | Fault Reaction Active | In the state where Fault (alarm) occurs with slave and the Quick stop (scram) function is performed. Also, in the state that motor is excited by the drive function effective. |
| [H] | Fault | In the state which the fault (alarm) generated with the slave and Fault reaction completed.<br>Drive function is invalid, and main circuit power supply is turned on or off by application. |

State Shift of FSA

| No. | [Before Shift]->[After] | Event / Action |
|---|---|---|
| 0 | [Start]<br>↓<br>[Not ready to Switch on] | Event : After control power supply ON or reset application, shifts automatically.<br>Action : Slave performs initialization and self-test. |
| 1 | [Not ready to Switch on]<br>↓<br>[Switch on Disabled] | Event : Shifts automatically.<br>Action : Communication is permitted. |
| 2 | [Switch on Disabled]<br>↓<br>[Ready to Switch on] | Event : [Shut down] command (Bit2, 1, 0=1, 1, 0) is received from master.<br>Action : None |
| 3 | [Ready to Switch on]<br>↓<br>[Switch on] | Event : [Switch On] command (Bit3, 2, 1, 0=0, 1, 1, 1) is received from master.<br>Action : Since in main circuit power supply permission state, provide main circuit power supply. |
| 4 | [Switch on]<br>↓<br>[Operation enabled] | Event : [Enable operation] command (Bit3, 2, 1, 0=1, 1, 1, 1) is received from master.<br>Action : Slave is Servo-ON and all the internal preset values are cleared. |
| 5 | [Operation enabled]<br>↓<br>[Switch on] | Event : [Disabled operation] command (Bit3, 2, 1, 0=0, 1, 1, 1) is received from master.<br>Action : Slave is Servo-ON. |
| 6 | [Switch on]<br>↓<br>[Ready to Switch on] | Event : [Shut down] command (Bit2, 1, 0=1, 1, 0) is received from master.<br>Action : Master should intercept main circuit power supply. |
| 7 | [Ready to Switch on]<br>↓<br>[Switch on Disabled] | Event : [Quick Stop] command (Bit2, 1=0, 1) or<br>[Disable voltage] command (Bit1=0) is received from master.<br>Action : None |
| 8 | [Operation enabled]<br>↓<br>[Ready to Switch on] | Event : [Shut down] command (Bit2, 1, 0=1, 1, 0) is received from master.<br>Action : Slave is Servo-Off. Master should intercept main circuit power supply. |
| 9 | [Operation enabled]<br>↓<br>[Switch on Disabled] | Event : [Disable voltage] command (Bit1=0) is received from master.<br>Action : Slave is Servo-Off. Master should intercept main circuit power supply. |
| 10 | [Switch on]<br>↓<br>[Switch on Disabled] | Event : [Quick Stop] command (Bit2, 1=0, 1) or<br>[Disable voltage] command (Bit1=0) is received from master.<br>Action : Master should intercept main circuit power supply. |
| 11 | [Operation enabled]<br>↓<br>[Quick stop active] | Event : [Quick Stop] command (Bit2, 1=0, 1) is received from master.<br>Action : Quick Stop function is performed. |
| 12 | [Quick stop active]<br>↓<br>[Switch on Disabled] | Event : Shifts automatically when Quick Stop operation is completed or when the "Disable voltage" command (Bit1=0) is received at Quick Stop option code 1-3.<br>Action : Slave is Servo-Off. Master should intercept main circuit power supply. |
| 13 | Error occurs<br>↓<br>[Fault reaction active] | Event : Fault (Alarm) occurs at slave.<br>Action : Set-up Fault operation function is performed. |
| 14 | [Fault reaction active]<br>↓<br>[Fault] | Event : Shifts automatically.<br>Action : Slave is Servo-Off. Master should intercept main circuit power supply. |
| 15 | [Fault]<br>↓<br>[Switch on Disabled] | Event : [Fault reset] command (Bit7=0 -> 1) is received from master.<br>Action : Without slave's Fault factor, Fault reset is performed.<br>Master should clear the "Fault reset" bit (Bit7=1->0) after normal state check. |
| 16 | [Quick stop active]<br>↓<br>[Operation enabled] | Event : [Enable operation] command (Bit3, 2, 1, 0=1, 1, 1, 1) is received by Quick Stop option code5 to 7.<br>Action : Slave function is permitted. |

## 3) Control Word

Control Word (Object: 0x6040) indicates the command for controlling the FSA state of slave.
Control Word consists of "FSA Control Bit", "Operation Mode spec. Control Bit", and "Maker Option Control Bit."
All the operation mode common "FSA Control Bit" allotment and command coding are described below.

Allotment for Each Bit of Control Word

| Bit15 | Bit14 | Bit13 | Bit12 | Bit11 | Bit10 | Bit9 | Bit8 |
|---|---|---|---|---|---|---|---|
| Manufacturer Specific (Manufacture Specification) | | | | | Reserved | Operation mode Specific | Halt |

| Bit7 | Bit6 | Bit5 | Bit4 | Bit3 | Bit2 | Bit1 | Bit0 |
|---|---|---|---|---|---|---|---|
| Fault Reset | Operation mode Specific (Operation Mode Specification) | | | Enable Operation | Quick Stop | Enable Voltage | Switch On |

Bit9, 6, 5,and 4 are Operation Mode Specification. Halt functional operation of Bit8 is also Operation Mode Specification.
Motion under command is interrupted when Bit8 =1. Slave is defined by Halt option code and operated.
Since Bit10 is Reserved, set to "0."
Bit15 to 11 are Manufacturer Specification.

0x6040:Control Word (Intersection)

| | | | | | |
|---|---|---|---|---|---|
| Index Ax1 0x6040<br>Ax2 0x6840<br>Ax3 0x7040<br>Ax4 0x7840 | Indicates reception command of FSA (State Machine) that PDS (Power Device System) is controlled. | | Object Code | | Variable |
| Sub-Idx | Description | Data Type | Access | PDO | Initial Value |
| 0x00 | Control Word [CWORD]<br>Bit pattern (Bit 7, 3, 2, 1, 0) of Control Word<br>The composition is as follows. | Unsigned16 | RW | Possible | 0x0000 |
| | | Display Range | 0x0000 - 0xFFFF | | |

MSB LSB

| Manufacturer Specific | Reserved | Operation mode Specific | Halt | Fault reset | Operation mode Spacific | Enable operation | Quick stop | Enable voltage | Switch on |
|---|---|---|---|---|---|---|---|---|---|
| 15 ... 11 | 10 | 9 | 8 | 7 | 6 ... 4 | 3 | 2 | 1 | 0 |

**Control word bit pattern command**

| Command | Control Word bit | | | | | Transition No. |
|---|---|---|---|---|---|---|
| | bit7 | bit3 | bit2 | bit1 | bit0 | |
| Shut down | 0 | x | 1 | 1 | 0 | 2,6,8 |
| Switch On | 0 | 0 | 1 | 1 | 1 | 3 |
| Switch On+Enable operation | 0 | 1 | 1 | 1 | 1 | 3+4 *1 |
| Disable voltage | 0 | x | x | 0 | x | 7,9,10,12 |
| Quick Stop | 0 | x | 0 | 1 | x | 7,10,11 |
| Disabled operation | 0 | 0 | 1 | 1 | 1 | 5 |
| Enable operation | 0 | 1 | 1 | 1 | 1 | 4,16 |
| Fault reset | 0->1 | x | x | x | x | 15 |

*1) When Switch On and Enable operation are simultaneously received from master, after performing the "Switch On" function, shifts to "Enable operation" automatically.

### 4) Status Word

Status Word (Object: 0x6041) provides the status of slave FSA.
Status Word consists of a "Slave FSA Status Bit", "Operation Mode spec. Status Bit", and "Maker Option Status Bit."
"FSA State Bit of Slave" allotment of servo amplifier common portion and command coding are described below.

Allotment for Bit of Status Word

| Bit15 | Bit14 | Bit13 | Bit12 | Bit11 | Bit10 | Bit9 | Bit8 |
|---|---|---|---|---|---|---|---|
| Reserved (Manufacture Specification) | | Reserved (Operation Mode Specification) | Target Value Ignored | Internal Limit Active | Target Reached | Remote | Reserved (Maker Specification) |

| Bit7 | Bit6 | Bit5 | Bit4 | Bit3 | Bit2 | Bit1 | Bit0 |
|---|---|---|---|---|---|---|---|
| Warning | Switch On Disabled | Quick Stop | Voltage Enabled | Fault | Operation Enabled | Switched On | Ready to Switch on |

Each state will be displayed in the status word bit pattern that indicates the current state.

0x6041:Status Word (Intersection)

| Index | Ax1 0x6041<br>Ax2 0x6841<br>Ax3 0x7041<br>Ax4 0x7841 | Indicates status of FSA (State Machine) that PDS (Power Device System) is controlled. | | Object Code | | Variable |
|---|---|---|---|---|---|---|
| Sub-Idx | Description | | Data Type | Access | PDO | Initial Value |
| 0x00 | Status Word [STSWORD] | | Unsigned16 | RO | Possible | 0x0000 |
| | Bit pattern (Bit 6, 5, 3, 2, 1, 0) of Status Word<br>The composition is as follows. | | Display Range | 0x0000 - 0xFFFF | | |

MSB LSB

| Manufac-turer Specific | Operation mode Specific | Target Value Ignored | Internal Limit Active | Target reached | Remote | Manufac-turer Specific | Warning | Switch on disabled | Quick stop | Voltage Enabled | Fault | Operation enabled | Switch on | Ready to switch on |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15,14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |

Status Word List Bit Pattern(Bit 6,5,3,2,1,0)

| No. | FSA State | Bit of Status Word | | | | | |
|---|---|---|---|---|---|---|---|
| | | bit6 | bit5 | bit3 | bit2 | bit1 | bit0 |
| [A] | Not ready to Switch on | 0 | x | 0 | 0 | 0 | 0 |
| [B] | Switch on Disabled | 1 | x | 0 | 0 | 0 | 0 |
| [C] | Ready to Switch on | 0 | 1 | 0 | 0 | 0 | 1 |
| [D] | Switch on | 0 | 1 | 0 | 0 | 1 | 1 |
| [E] | Operation enabled | 0 | 1 | 0 | 1 | 1 | 1 |
| [F] | Quick stop active | 0 | 0 | 0 | 1 | 1 | 1 |
| [G] | Fault reaction active | 0 | x | 1 | 1 | 1 | 1 |
| [H] | Fault | 0 | x | 1 | 0 | 0 | 0 |

Bit4 :Voltage Enabled (Main Circuit Bit 14 : Voltage Enabled (Main Circuit Establishment Status)
Means that main circuit power supply is impressed at the time of "1."
Bit5 :Quick Stop (Quick Stop)
Shows that it is under operation by Quick Stop Request at the time of "0"
Bit7 :Warning(Warning Status)
It is set to "1" when warning is occurring in slave. This bit is not cleared even if warning factor is lost.
Bit9 :Remote(Control Word Remote)
Operation through EtherCAT communication enabled at the time of "1".
Operation through EtherCAT communication disabled at the time of "0" although setup software enabled.
Bit10:Target reached
It is set to "1" when an operation mode is changed.
It is set to "1" when Quick stop operation is finished and motor stops with Quick stop Option Code;-2,5 to7
Besides, when Bit10 (Target reached) of status word is "1", Indicates that the motor reached the preset value.
Then cleared to "0" when target position is changed. (Only Profile Position (pp):Reserved)
Bit11:Internal Limit Active
When target position is outside of range, and at invalid, soft limit, and forward/backward side limit, it is set to "1".
Setting range is based on specification.
Bit12:Target value ignored Inposition(csp),Velocity Attainment(csv),Torque (force) Limit(cst)
When Target value ignored bit is in Position (csp), Velocity (csv), and Torque (force) (cst) mode, the update of the command becomes permission "0" with command update permission monitor within servo amplifier. Other than this (when command is prohibited), is set to "1."
* At SOFF -> SON, holding brake operation open time after motor excitation is set up, and it becomes "0"after BOFDRY passes.
Bit13 and 8 are based on operation mode specifications, and Bit15 and 14 are maker specifications.

## 5) Manufacture specific area

Shared parts with the entire operating mode in manufacture specific area for control words are described below.

Allocation for control words (manufacture specific area)

| bit15 | bit14 | bit13 | bit12 | bit11 |
|---|---|---|---|---|
| Cseten | Reserved | Reserved | Eclr | Reserved |

0x6040：Control words (shared parts with manufacture specific area）

| | | | | |
|---|---|---|---|---|
| Index | Ax1 0x6040<br>Ax2 0x6840<br>Ax3 0x7040<br>Ax4 0x7840 | Indicates status of FSA (State Machine) that PDS (Power Device System) is controlled. | Object code | Variable |

| Sub-Idx | Description | Data Type | Access | PDO | Initial value |
|---|---|---|---|---|---|
| 0x00 | Control words ［CWORD］<br>*For bit 7, 3, 2, 1 and 0, please refer to the list of commands for control word patterns. | Unsigned16 | RW | Possible | 0x0000 |
| | | Setting range | 0x0000 - 0xFFFF | | |

MSB LSB

| Cseten | Resrved | Eclr | Reserved | Reserved | Operation mode Specific | Halt | Fr※ | Operation mode Specific | Hs※ | qs※ | ev※ | so※ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15 | 14,13 | 12 | 11 | 10 | 9 | 8 | 7 | 6･･･4 | 3 | 2 | 1 | 0 |

bit12：Encoder clear enable ［ECLR］
Clear absolute encoder battery malfunction or multiple rotating positions.
“0”: Encoder clear disable “1”: Encoder clear enable

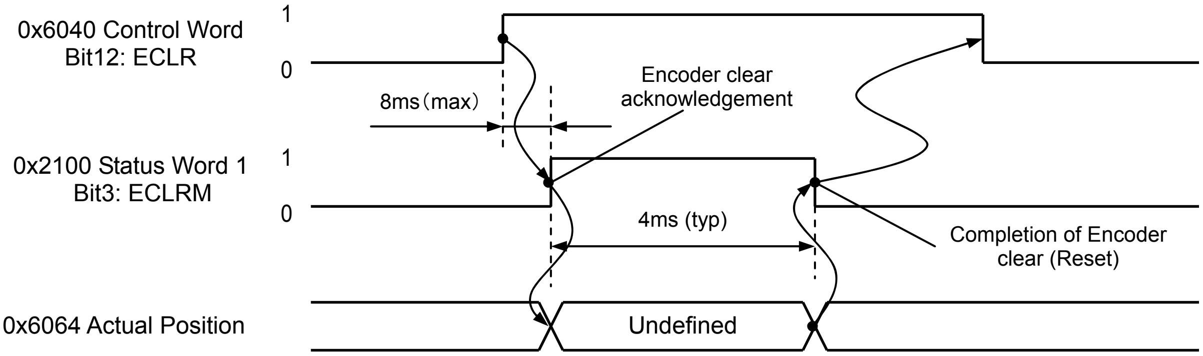
bit15：Magnetic pole position estimation enabled ［CSET］
Magnetic pole position estimation command when using linear motor without hall effect sensor input.
“0”: Magnetic pole position estimation disabled
“1”: Magnetic pole position estimation enabled

Bit 12: Encoder clear enabled

This Bit 12 unsets multi turn position (Multi turn clear) in memory and so do Battery malfunction.

When the position is Position reverse polarity 0x607E：bit7=0, the actual position will be within minus one rotation.

Encoder clear (Reset encoder) sequence is shown below.



Shared parts with the entire operating mode in manufacture specific area for status words are described below.

Layout for control words (manufacture specific area)

| bit15 | bit14 | bit8 |
|---|---|---|
| Csetfix | Csetpro | Reserved |

These words are displayed in the status word bit patterns indicating current state in each state.

0x6041：Status words (Cycle Synchronous Velocity mode：csv, Profile Velocity：pv)

| | | | | |
|---|---|---|---|---|
| Index | Ax1 0x6041<br>Ax2 0x6841<br>Ax3 0x7041<br>Ax4 0x7841 | Indicates status of FSA (State Machine) that PDS (Power Device System) is controlled. | Object code | Variable |

| Sub-Idx | Description | Data Type | Access | PDO | Initial value |
|---|---|---|---|---|---|
| 0x00 | Status words ［STSWORD］<br>*For bit 6, 5, 3, 2, 1 and 0, please refer to the list for status word bit pattern states. | Unsigned16 | RO | Possible | 0x0000 |
| | | Display range | 0x0000 - 0xFFFF | | |

MSB LSB

| Csetfix | Csetpro | Operation mode Specific | Target Value Ignored | Internal Limit active | Tr | Rm | Reserved | W | Sod※ | Qs※ | Ve | F※ | Oe※ | So※ | Rtso※ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |

bit15-14：Magnetic pole position estimation status
［CSETSTS］
The following are linear motor magnetic pole position estimation status.

| Bit15 | 14 | |
|---|---|---|
| 0 | 0 | ：Magnetic pole position estimation disabled |
| 0 | 1 | ：Magnetic pole position estimation in process |
| 1 | 1 | ：Magnetic pole position estimation completed |

## 5.5 Profile Area

The followings are shown in Table ; profile area of CoE (CANopen over EtherCAT) object list, RS2-EtherCAT Supported / Un-supported, Data length, Access (Dir), PDO Mapping, and parameter effective timing (updating).
#=immediately, $=ESM change required, and &=controlpower cycle required.

Profile Area (No.1)

○:Support, ×:Not Supported, □:Support (Not changeable :Fixed Value), -:None

| Index | S-Idx | FP | FV | FT | FH | Name | Data Type | Dir | PDO_M | Update | NVRAM |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0x6007 | 0x00 | ○ | ○ | × | ○ | Abort Connection Option Code | Integer16 | RW | No | # | Yes |
| 0x603F | 0x00 | ○ | ○ | ○ | ○ | Error Code | Unsigned16 | RO | Possible | - | - |
| 0x6040 | 0x00 | ○ | ○ | ○ | ○ | Control Word | Unsigned16 | RW | Possible | # | - |
| 0x6041 | 0x00 | ○ | ○ | ○ | ○ | Status Word | Unsigned16 | RO | Possible | - | - |
| 0x605A | 0x00 | ○ | ○ | ○ | ○ | Quick Stop Option Code | Integer16 | RW | No | # | Yes |
| 0x605B | 0x00 | ○ | ○ | × | ○ | Shutdown Option Code | Integer16 | RW | No | # | Yes |
| 0x605C | 0x00 | ○ | ○ | ○ | × | Disable Operation Option Code | Integer16 | RW | No | # | Yes |
| 0x605D | 0x00 | ○ | ○ | ○ | ○ | Halt Option Code | Integer16 | RW | No | # | Yes |
| 0x605E | 0x00 | ○ | ○ | □ | □ | Fault Reaction Option Code | Integer16 | RW | No | - | Yes |
| 0x6060 | 0x00 | ○ | ○ | ○ | ○ | Operation Mode | Integer8 | RW | Possible | # | Yes |
| 0x6061 | 0x00 | ○ | ○ | ○ | ○ | Operation Display | Integer8 | RO | Possible | - | - |
| 0x6062 | 0x00 | ○ | × | × | × | Position Demand Value | Integer32 | RO | Possible | - | - |
| 0x6063 | 0x00 | ○ | ○ | ○ | ○ | Internal Actual Position | Integer32 | RO | Possible | - | - |
| 0x6064 | 0x00 | ○ | ○ | ○ | ○ | Real Position | Integer32 | RO | Possible | - | - |
| 0x6065 | 0x00 | ○ | × | × | × | Excessive Position Deviation Value | Unsigned32 | RW | Possible | - | Yes |
| 0x6066 | 0x00 | □ | × | × | × | Excessive Position Deviation Time-out | Unsigned16 | RW | No | - | - |
| 0x6067 | 0x00 | ○ | × | × | × | Position Window<br>(Positioning complete range) | Unsigned32 | RW | No | # | Yes |
| 0x6068 | 0x00 | □ | × | × | × | Position Window Time | Unsigned16 | RW | No | - | - |
| 0x6069 | 0x00 | ○ | ○ | × | × | Real Velocity Sensor Value | Integer32 | RO | Possible | - | - |
| 0x606A | 0x00 | □ | □ | □ | □ | Sensor Selection Code | Integer16 | RW | Possible | - | - |
| 0x606B | 0x00 | × | × | × | × | Velocity Demand Value | - | - | - | - | - |
| 0x606C | 0x00 | × | ○ | × | × | Real Velocity Value (Velocity Monitor) | Integer32 | RO | Possible | - | - |
| 0x606D | 0x00 | × | ○ | × | × | Velocity Window (Velocity matching range) | Unsigned16 | RW | Possible | # | - |
| 0x606E | 0x00 | × | ○ | × | × | Velocity Window Time | Unsigned16 | RW | Possible | # | - |
| 0x606F | 0x00 | × | ○ | × | × | Velocity Threshold | Unsigned16 | RW | Possible | # | - |
| 0x6070 | 0x00 | × | ○ | × | × | Velocity Threshold Time | Unsigned16 | RW | Possible | # | - |
| 0x6071 | 0x00 | × | × | ○ | × | Target Torque (force)<br>(Torque (force) Command) | Integer16 | RW | Possible | # | - |
| 0x6072 | 0x00 | ○ | ○ | ○ | ○ | Maximum Torque (force)<br>(Torque (force) Limit) | Unsigned16 | RW | Possible | # | - |
| 0x6073 | 0x00 | × | × | × | × | Maximum Current | - | - | - | - | - |
| 0x6074 | 0x00 | × | × | × | × | Torque (force) Demand | - | - | - | - | - |
| 0x6075 | 0x00 | × | × | × | × | Motor Rating Current | - | - | - | - | - |
| 0x6076 | 0x00 | ○ | ○ | ○ | ○ | Motor Rating Torque (force) | Unsigned32 | RO | Possible | - | - |
| 0x6077 | 0x00 | ○ | ○ | ○ | ○ | Real Torque (force)<br>Value (Torque (force) Monitor) | Integer16 | RO | Possible | - | - |
| 0x6078 | 0x00 | ○ | ○ | ○ | ○ | Real Current Value | Integer16 | RO | Possible | - | - |
| 0x6079 | 0x00 | ○ | ○ | ○ | ○ | DC Link Circuit Voltage | Unsigned32 | RO | Possible | - | - |
| 0x607A | 0x00 | ○ | × | × | × | Target Position (Position Command) | Integer32 | RW | Possible | # | - |
| 0x607B | 0x00 | - | - | - | - | Position Range Limit | Unsigned8 | RO | No | - | - |
| ↑ | 0x01 | ○ | × | × | × | Mimi nun Position Limit | Integer32 | RW | Possible | $ | Yes |
| ↑ | 0x02 | ○ | × | × | × | Maximum Position Limit | Integer32 | RW | Possible | $ | Yes |
| 0x607C | 0x00 | ○ | ○ | ○ | ○ | Coordinates Offset (Homing Offset) | Integer32 | RW | Possible | # | Yes |
| 0x607D | 0x00 | - | - | - | - | Software Position Limit | Unsigned8 | RO | No | - | - |
| ↑ | 0x01 | ○ | × | × | × | Software Mimi nun Position Limit | Integer32 | RW | Possible | # | Yes |
| ↑ | 0x02 | ○ | × | × | × | Software Maximum Position Limit | Integer32 | RW | Possible | # | Yes |
| 0x607E | 0x00 | ○ | ○ | ○ | ○ | Polarity | Unsigned8 | RW | Possible | $ | Yes |
| 0x607F | 0x00 | ○ | × | × | × | Max. Profile Velocity<br>(Velocity Control Command) | Unsigned32 | RW | Possible | # | Yes |
| 0x6080 | 0x00 | × | × | × | × | Maximum Motor Speed | Unsigned32 | RW | Possible | - | - |
| 0x6081 | 0x00 | ○ | ○ | × | × | Profile Velocity | Unsigned32 | RW | Possible | # | - |
| 0x6082 | 0x00 | ○ | ○ | × | × | End Velocity | Unsigned32 | RW | Possible | - | - |
| 0x6083 | 0x00 | ○ | ○ | × | × | Profile Acceleration (Accelerating Constant) | Unsigned32 | RW | Possible | # | Yes |
| 0x6084 | 0x00 | ○ | ○ | × | × | Profile Deceleration (Decelerating Constant) | Unsigned32 | RW | Possible | # | Yes |
| 0x6085 | 0x00 | ○ | ○ | ○ | ○ | Quick Stop Deceleration | Unsigned32 | RW | Possible | # | Yes |
| 0x6086 | 0x00 | ○ | × | × | × | Motion Profile Type | Integer16 | RW | Possible | # | - |
| 0x6087 | 0x00 | × | × | ○ | × | Torque (force) Slope | Unsigned32 | RW | Possible | # | - |
| 0x6088 | 0x00 | × | × | □ | × | Torque (force) Profile Type | Integer16 | RW | Possible | - | - |
| 0x608F | 0x00 | — | — | — | — | Position Encoder Resolution<br>(Encoder Resolution) | Unsigned8 | RO | No | - | - |
| ↑ | 0x01 | □ | × | × | × | Encoder Resolution | Unsigned32 | RW | Possible |  | - |
| ↑ | 0x02 | □ | × | × | × | Motor Resolution | Unsigned32 | RW | Possible |  | - |
| 0x6090 | 0x00 | × | × | × | × | Velocity Encoder Resolution | — | — | — | - | - |

Profile Area (No.2)

| Index | S-Idx | FP | FV | FT | FH | Name | Data Type | Dir | PDO_M | Update | NVRAM |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0x6091 | 0x00 | — | — | — | — | Gear Ratio | Unsigned8 | RO | No | - | - |
| ↑ | 0x01 | □ | × | × | × | Motor Shaft Resolution | Unsigned32 | RW | Possible | | - |
| ↑ | 0x02 | □ | × | × | × | Drive Shaft Resolution | Unsigned32 | RW | Possible | | - |
| 0x6092 | 0x00 | — | — | — | — | Feed Constant | Unsigned8 | RO | No | - | - |
| ↑ | 0x01 | □ | × | × | × | Feed | Unsigned32 | RW | Possible | | - |
| ↑ | 0x02 | □ | × | × | × | Drive Shaft Resolution | Unsigned32 | RW | Possible | | - |
| 0x6098 | 0x00 | × | × | × | ○ | Homing Method | Integer8 | RW | Possible | # | Yes |
| 0x6099 | 0x00 | - | - | - | - | Homing Speed | Unsigned8 | RO | No | — | - |
| ↑ | 0x01 | × | × | × | ○ | Speed during search for switch | Unsigned32 | RW | Possible | # | Yes |
| ↑ | 0x02 | × | × | × | ○ | Speed during search for Zero | Unsigned32 | RW | Possible | # | Yes |
| 0x609A | 0x00 | × | × | × | ○ | Homing Acceleration | Unsigned32 | RW | Possible | # | Yes |
| 0x60A3 | 0x00 | ○ | × | × | × | Profile Jerk Use | Unsigned 8 | RW | No | - | - |
| 0x60A4 | 0x00 | - | - | - | - | Profile Jerk | Unsigned8 | RO | No | - | - |
| ↑ | 0x01 | ○ | × | × | × | Profile Jerk 1 | Unsigned32 | RW | No | # | - |
| ↑ | 0x02 | ○ | × | × | × | Profile Jerk 2 | Unsigned32 | RW | No | # | - |
| 0x60B0 | 0x00 | ○ | × | × | × | Position Offset (Position Addition) | Integer32 | RW | Possible | # | - |
| 0x60B1 | 0x00 | ○ | ○ | - | × | Speed Offset (Speed Addition) | Integer32 | RW | Possible | # | - |
| 0x60B2 | 0x00 | ○ | ○ | ○ | × | Torque (force) Offset (Torque (force) Addition) | Integer16 | RW | Possible | # | - |
| 0x60B8 | 0x00 | × | × | × | ○ | Touch probe function | Unsigned16 | RW | Possible | # | - |
| 0x60B9 | 0x00 | × | × | × | ○ | Touch probe state | Unsigned16 | RO | Possible | # | - |
| 0x60BA | 0x00 | × | × | × | ○ | Touch probe1 positive edge position stored | Integer32 | RO | Possible | # | - |
| 0x60BB | 0x00 | × | × | × | ○ | Touch probe1 negative edge position stored | Integer32 | RO | Possible | # | - |
| 0x60BC | 0x00 | × | × | × | × | Touch probe1 positive edge position stored | Integer32 | RO | Possible | # | - |
| 0x60BD | 0x00 | × | × | × | × | Touch probe1 negative edge position stored | Integer32 | RO | Possible | # | - |
| 0x60C0 | 0x00 | ○ | × | × | × | Interpolation sub mode select | Integer16 | RW | No | | - |
| 0x60C1 | 0x00 | - | - | - | - | Interpolation data record | Unsigned8 | RO | No | | - |
| ↑ | 0x01 | ○ | × | × | × | Interpolation position target | Integer32 | RW | Possible | # | - |
| ↑ | 0x02 | ○ | × | × | × | Interpolation time | Unsigned8 | RW | Possible | # | - |
| 0x60C2 | 0x00 | - | - | - | - | Interpolation time period | Unsigned8 | RO | No | - | - |
| ↑ | 0x01 | ○ | ○ | ○ | ○ | Interpolation time period value | Unsigned8 | RW | No | # | - |
| ↑ | 0x02 | ○ | ○ | ○ | ○ | Interpolation time index | Integer8 | RW | No | # | - |
| 0x60C4 | 0x00 | - | - | - | - | Interpolation data configuration | Unsigned8 | RO | No | - | - |
| ↑ | 0x01 | ○ | × | × | × | Maximum buffer size | Unsigned32 | RO | No | - | - |
| ↑ | 0x02 | ○ | × | × | × | Actual buffer size | Unsigned32 | RW | Possible | # | - |
| ↑ | 0x03 | ○ | × | × | × | Buffer format | Unsigned8 | RW | Possible | # | - |
| ↑ | 0x04 | ○ | × | × | × | Point of buffer | Unsigned16 | RW | Possible | # | - |
| ↑ | 0x05 | ○ | × | × | × | Data size of interpolation data record | Unsigned8 | RO | No | - | - |
| ↑ | 0x06 | ○ | × | × | × | Clear buffer | Unsigned8 | WO | Possible | # | - |
| 0x60C5 | 0x00 | × | ○ | × | × | Maximum Acceleration | Unsigned32 | RW | Possible | — | Yes |
| 0x60C6 | 0x00 | × | ○ | × | × | Maximum Deceleration | Unsigned32 | RW | Possible | — | Yes |
| 0x60E0 | 0x00 | ○ | ○ | ○ | ○ | Forward Torque (force) Limit Value | Unsigned16 | RW | Possible | # | Yes |
| 0x60E1 | 0x00 | ○ | ○ | ○ | ○ | Backward Torque (force) Limit Value | Unsigned16 | RW | Possible | # | Yes |
| 0x60E3 | 0x00 | - | - | - | - | Support Homing Method | Unsigned8 | RO | No | - | - |
| ↑ | 0x01 ~ 0x25 | × | × | × | ○ | Support Homing Method 1 - 37 | Integer8 | RO | No | - | - |
| 0x60F2 | 0x00 | ○ | × | × | × | Position Option Code | Unsigned16 | RW | Possible | # | - |
| 0x60F4 | 0x00 | ○ | × | × | × | Actual Position Deviation (Following Error Actual Value) | Integer32 | RO | Possible | - | - |
| 0x60F8 | 0x00 | × | × | × | × | Maximum Deviation (Amount of Max. Gaps) | - | - | - | - | - |
| 0x60FA | 0x00 | ○ | × | × | × | Control Effort | Integer32 | RO | Possible | - | - |
| 0x60FC | 0x00 | ○ | × | × | × | Internal Position Command Value | Integer32 | RO | Possible | - | - |
| 0x60FD | 0x00 | ○ | ○ | ○ | ○ | Digital Input | Unsigned32 | RO | Possible | - | - |
| 0x60FE | 0x00 | — | — | — | — | Digital Output | Unsigned8 | RW | Possible | # | - |
| ↑ | 0x01 | ○ | ○ | ○ | ○ | Physical Output | Unsigned32 | RW | Possible | # | - |
| ↑ | 0x02 | ○ | ○ | ○ | ○ | Bitmask | Unsigned32 | RW | Possible | # | - |
| 0x60FF | 0x00 | × | ○ | × | × | Target Velocity (Velocity Command) | Integer32 | RW | Possible | # | - |
| 0x6402 | 0x00 | ○ | ○ | ○ | ○ | Motor Type | Unsigned16 | RW | Possible | - | - |
| 0x6403 | 0x00 | ○ | ○ | ○ | ○ | Motor Catalog No. | VisibleString | RO | No | - | - |
| 0x6404 | 0x00 | ○ | ○ | ○ | ○ | Motor Manufacture | VisibleString | RO | No | - | - |
| 0x6405 | 0x00 | ○ | ○ | ○ | ○ | http Motor Catalog Address | VisibleString | RO | No | - | - |
| 0x6406 | 0x00 | × | × | × | × | Motor Calibration date | - | - | - | - | - |
| 0x6407 | 0x00 | × | × | × | × | Motor Service Period | - | - | - | - | - |
| 0x6502 | 0x00 | ○ | ○ | ○ | ○ | Support Drive Mode | Unsigned32 | RO | Possible | - | - |
| 0x6503 | 0x00 | ○ | ○ | ○ | ○ | Drive Catalog No. | VisibleString | RO | No | - | - |
| 0x6505 | 0x00 | ○ | ○ | ○ | ○ | http Drive Catalog Address | VisibleString | RO | No | - | - |

## 1) Error Code and Error Operation

0x6007: Abort Connection Option Code

| Index Ax1 0x6007<br>Ax2 0x6807<br>Ax3 0x7007<br>Ax4 0x7807 | When an abnormality occurs in the communication system (Ex. communication timeout, Link lost, Crc error etc..), This object indicates how the servo amplifier to behave. | | | Object Code | Variable |
|---|---|---|---|---|---|
| Sub-Idx | Description | Data Type | Access | PDO | Initial Value |
| 0x00 | Abort Connection Option Code | Integer16 | RW | No | 0x0001 |
| | | Setting Range | 0x0000-0x0003 | | |
| | 0 : No Action<br>1 : Fault Signal<br>2 : Desable Voltage Command<br>3 : Even if it is the setting of the Quick Stop Active state, shifts to Switch On Disabled after a stop by Quick Stop Command (quick stop setting (0x605A). | | | | |

0x603F: Error code

| Index Ax1 0x603F<br>Ax2 0x683F<br>Ax3 0x703F<br>Ax4 0x783F | Displays codes of errors occurred in the servo amplifier. | | | Object code | Variable |
|---|---|---|---|---|---|
| Sub-Idx | Description | Data Type | Access | PDO | Initial value |
| 0x00 | Error codes [ERRCODE] | Unsigned16 | RO | Possible | 0x0000 |
| | For the list of error codes, please refer to the list of alarm codes in chanpter 11.3. | Display range | 0x0000 - 0xFFFF | | |
| | ✔Represents the same information as lower 16-bit of Sub-index 0x01 in pre-defined errorfield 0x1003 in CANopen communication method. | | | | |

0x605A: Quick Stop Option Code (EMR)

| Index Ax1 0x605A<br>Ax2 0x685A<br>Ax3 0x705A<br>Ax4 0x785A | When quick stop (EMR) command is inputted, it is set up by which action motor is stopped. | | Object Code | | Variable |
|---|---|---|---|---|---|
| Sub-Idx | Description | Data Type | Access | PDO | Initial Value |
| 0x00 | Quick Stop Option Code [QSTOP] | Integer16 | RW | No | 0x0002 |
| | By Control mode, treated in the amplifier internally as shown below. | Setting Range | 0x0000-0x0007<br>(0 - 7) | | |
| | -128 to-1,4,8 to 127 are reserved. Not possible to be set.<br># Profile position (pp), Cyclic sync position(csp), Interpolated Position (ip) mode<br># Cyclic sync velocity mode (csv), Profile velocity (pv), Homing mode (hm)<br>0 : Drive function is Disabled. (To Switch On Disabled after motor stop by dynamic brake operation)<br>1 : To Switch On Disabled after stop at slowdown deceleration (0x6084)<br>2 : To Switch On Disabled after stop at quick stop deceleration (0x6085)<br>3 : To Switch On Disabled after stop by Current Limit<br>5 : Quick Stop Active state after stop at slowdown deceleration (0x6084)<br>6 : Quick Stop Active state after stop at quick stop deceleration (0x6085)<br>7 : Quick Stop Active state after stop by Current Limit<br><br># Cyclic sync torque (force) mode (cst), Torque (force) profile mode (tq)<br>0 : Drive function is disabled (After a motor stops by dynamic brake operation, Switch On Disabled)<br>1, 2 : Switch On Disabled after Stops by 0x6087(Torque (force) Slope)<br>3 : To Switch On Disabled after stop by Current Zero<br>5, 6 : Quick Stop Active state after Stops by 0x6087(Torque (force) Slope)<br>7 : Quick Stop Active state after stop by Current Zero<br><br>*When Quick Stop Operation, not only Maximum torque (force) (0x6072), Clock wise side torque (force) limit (0x60E0), Counter clockwise torque (force) limit (0x60E1), but also Sequence current limit value (0x201E) are limited.<br>When external EMR signal is input through I/O, it will be "Switch On Disable" even if "Quick Stop Active" is set.<br>*RF2 series servo amplifier does not have dynamic brake circuit. So, it will be Free Run Stop if set value is zero. | | | | |

0x605B: Shutdown Option Code

| | | | | |
|---|---|---|---|---|
| Index Ax1<br>Ax2<br>Ax3<br>Ax4 | 0x605B<br>0x685B<br>0x705B<br>0x785B | When shifts from Operation Enabled to the Ready to Switch On State, determined how it operates. | Object Code | Variable |

| Sub-Idx | Description | Data Type | Access | PDO | Initial Value |
|---|---|---|---|---|---|
| 0x00 | Shutdown Option Code | Integer16 | RW | No | 0x0000 |
| | | Setting Range | 0x0000 - 0x0001<br>(0 to 1) | | |

# Profile position (pp), Cyclic sync position(csp), Interpolated Position (ip) mode
# Cyclic sync velocity mode (csv), Profile velocity (pv), Homing mode
0 : Disable Drive: Servo-Off(Switch OFF Drive Power Stage
1 : Slow down with slow down ramp; Disable of the drive function

# Cyclic sync torque (force) mode (cst), Torque (force) profile mode (tq)
0 : Disable Drive: Servo-Off(Switch OFF Drive Power Stage
1 : Stop at 0x6087 Torque (thrust force) slop

0x605C:Disable Operation Option Code

| | | | | |
|---|---|---|---|---|
| Index Ax1<br>Ax2<br>Ax3<br>Ax4 | 0x605C<br>0x685C<br>0x705C<br>0x785C | When shifts from Operation Enabled to the Switch On State, determined how it operates. | Object Code | Variable |

| Sub-Idx | Description | Data Type | Access | PDO | Initial Value |
|---|---|---|---|---|---|
| 0x00 | Disable Operation Option Code [DISOP] | Integer16 | RW | No | 0x0000 |
| | | Setting Range | 0x0000 - 0x0001<br>(0 to 1) | | |

Set how to stop a motor at shifts from servo-on to servo-off.
# Profile position (pp), Cyclic sync position(csp), Interpolated Position (ip) mode
# Cyclic sync velocity mode (csv), Profile velocity (pv), Homing mode
0 : Disable Drive function Switch OFF srive power stage.
1 : Slow down with slow down ramp; disable of drive function

# Cyclic sync torque (force) mode (cst), Torque (force) profile mode (tq)
0 : Disable Drive: Servo-Off(Switch OFF Drive Power Stage
1 : Stop at 0x6087 Torque (thrust force) slop

✔When main power is shut down, it will be dynamic brake operation regardless of the setting. However, RF2 series servo amplifier does not have dynamic brake circuit. So, it will be Free Run Stop if set value is zero.

0x605D:Halt option code

| | | | | |
|---|---|---|---|---|
| Index Ax1<br>Ax2<br>Ax3<br>Ax4 | 0x605D<br>0x685D<br>0x705D<br>0x785D | This object shall indicate what action is performed when the Halt function is executed. | Object Code | Variable |

| Sub-Idx | Name/Description | Data Type | Access | PDO | Initial Value |
|---|---|---|---|---|---|
| 0x00 | Halt option code | Integer16 | RW | No | 0x0001 |
| | By Control mode, treated in the amplifier internally as shown below.<br>-128 to -1, 4 to 127 are reserved. Not possible to be set up. | Setting Range | 0x0001 - 0x0003(1-3) | | |

# Profile position (pp), Cyclic sync velocity mode (csv), Profile velocity (pv), Homing mode
1 : Operation enabled state after Stop at slowdown deceleration (0x6084).
2 : Operation enabled state after stop at quick stop deceleration (0x6085)
3 : To Switch On Disabled after stop by Current Limit

# Cyclic sync position mode (csp) ,Interpolated Position (ip) mode
1, 2, 3 : Operation enabled state after stop by Current Limit

# Cyclic sync torque (force) mode (cst), Torque (force) profile mode (tq)
1, 2 : Operation enabled state after Stops by 0x6087(Torque (force) Slope)
3 : Operation enabled state after stop by Current Zero.

✔For being servo OFF after stop by halt state, perform servo OFF with the state of setting a halt bit of the control word.

0x605E: Fault Reaction Option Code

| | | | |
|---|---|---|---|
| Index Ax1 0x605E<br>Ax2 0x685E<br>Ax3 0x705E<br>Ax4 0x785E | When alarm is generated with servo amplifier, determined how it operates. | Object Code | Variable |

| Sub-Idx | Description | Data Type | Access | PDO | Initial Value |
|---|---|---|---|---|---|
| 0x00 | Fault Reaction Option Code | Integer16 | RW | No | 0x0002 |
| | | Setting Range | 0x0000～0x0003<br>（0～3） | | |

# Profile Position (pp) Mode, Interpolated Position Mode (ip), Cycle Synchronous Position Mode (csp)
# Profile Velocity (pv) Mode, Homing Mode (hm), Cycle Synchronous Velocity Mode (csv)

| | |
|---|---|
| 0 | : Drive function is Disabled. (Motor stop by dynamic brake operation) |
| 1 | : Stop at slowdown deceleration（0x6084） |
| 2 | : Stop at quick stop deceleration（0x6085） |
| 3 | : Stop by Current Limit |

# Torque Profile (tq) Mode, Cycle Synchronous Torque Mode (cst)

| | |
|---|---|
| 0 | : Drive function is Disabled. (Motor stop by dynamic brake operation |
| 1, 2 | : Stop at 0x6087 (Torque (thrust force) slope) |
| 3 | : Stop by Current Limit |

*RF2 series servo amplifier does not have dynamic brake circuit. So, it will be Free Run Stop if set value is zero.

## 2) Operation Mode

EtherCAT-CoE specification has modes of operation shown in operation mode list.
Profiles applicable to RS2 EtherCAT-CoE slave amplifier are listed in the following Operation Mode List.
Besides, operation mode supported can check at "Supported Drive Mode:0x6502."

Operation Mode List

| Operation Mode | Mark | R-ADVANCED EtherCAT Supported |
|---|---|---|
| Profile Position Mode | pp | Yes |
| Profile Velocity Mode | pv | Yes |
| Homing Mode | hm | Yes |
| Interpolated Position Mode | ip | Yes |
| Torque (force) Mode | tq | Yes |
| Velocity Mode (ex. Inverter) | vl | No |
| Cycle Sync. Position Mode | csp | Yes |
| Cycle Sync. Velocity Mode | csv | Yes |
| Cycle Sync. Torque (force) Mode | cst | Yes |

Shift of an operation mode uses the object "operation mode:0x6060."
Also, the object "operation mode display:0x6061" is used for the present operation mode check.
At each operation mode, the bit assigned to Control Word and Status Word is prepared.

Unique Mode Bit Assigned to Control Word

| Operation Mode | | bit8 | bit6 | bit5 | bit4 |
|---|---|---|---|---|---|
| pp | Profile Position Mode | Halt | Absolute / Relative Position | Change set immediately | New set point |
| csp | Cycle Sync. Position Mode | | | Reserved | Reserved |
| ip | Interpolated position | | Reserved | Reserved | Interpolation Enable |
| csv | Cycle Sync. Velocity Mode | | Reserved | Reserved | Reserved |
| pv | Profile Velocity Mode | | | | |
| cst | Cycle Sync. Torque (force) Mode | | Reserved | Reserved | Reserved |
| tq | Torque (force) Mode | | | | |
| hm | Homing Mode | | Homing offset Active | Reserved | Homing Enable |

Manufacturer own Bit Assigned to Status Word

| Operation Mode | | bit13 | bit12 | bit10 |
|---|---|---|---|---|
| pp | Profile Position Mode | Following error | Set-point Acknowledge | Target reached<br>Quick Stop Finished<br>Operation Change Finished<br>Halt Active |
| csp | Cycle Sync. Position Mode | Following error | Target Position ignore | |
| ip | Interpolated position | Reserved | Interpolation active | |
| csv | Cycle Sync. Velocity Mode | Reserved | Target velocity ignore | |
| pv | Profile Velocity Mode | | | |
| cst | Cycle Sync. Torque (force) Mode | Reserved | Target torque (force) ignore | |
| tq | Torque (force) Mode | | | |
| hm | Homing Mode | Homing error | Homing attained | |

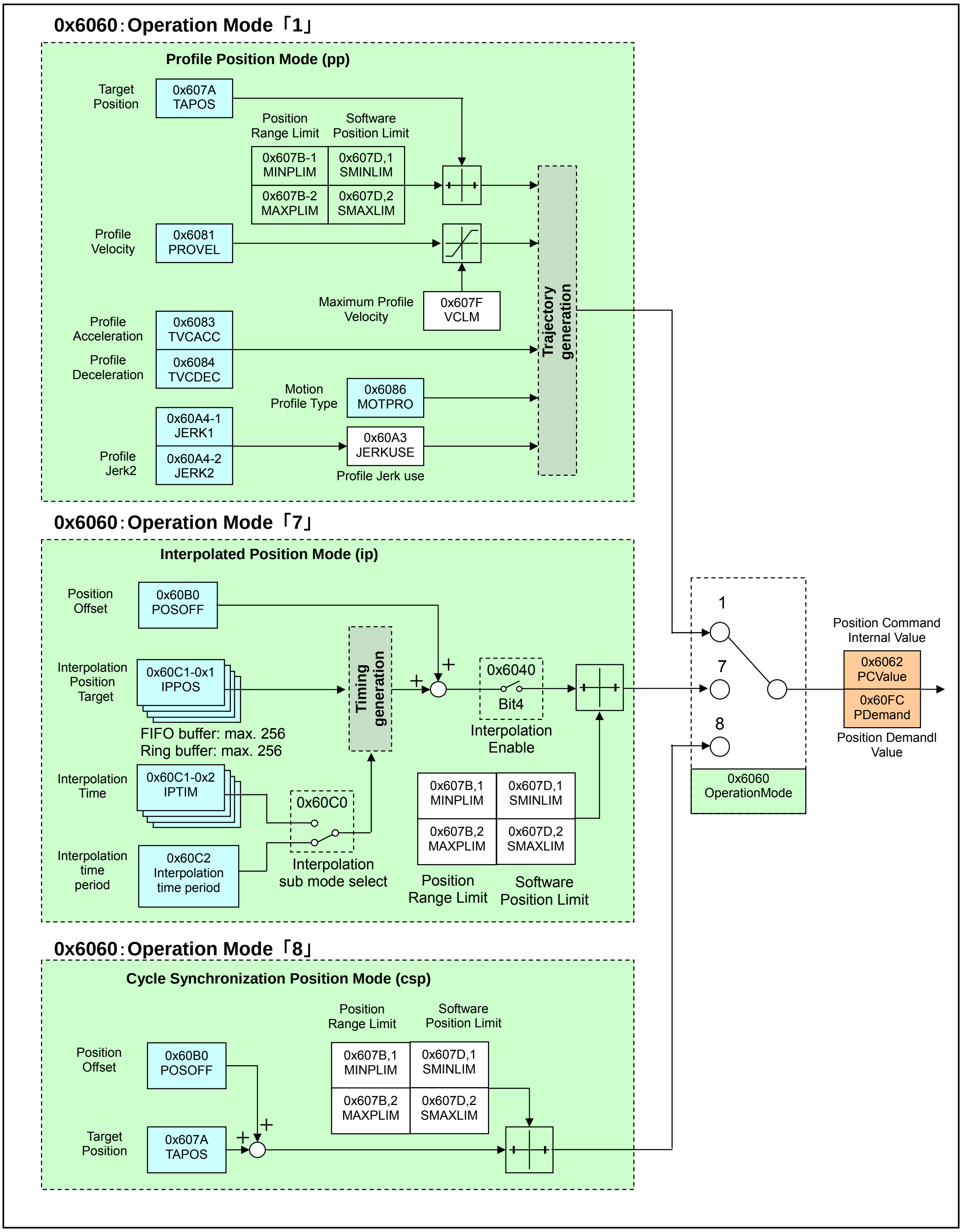
Selection and change of an operation mode use mode:0x6060 of operation, and mode display:0x6061 of operation is used for the check of the operation mode under present operation.

## 3) Function Group “Position” Mode

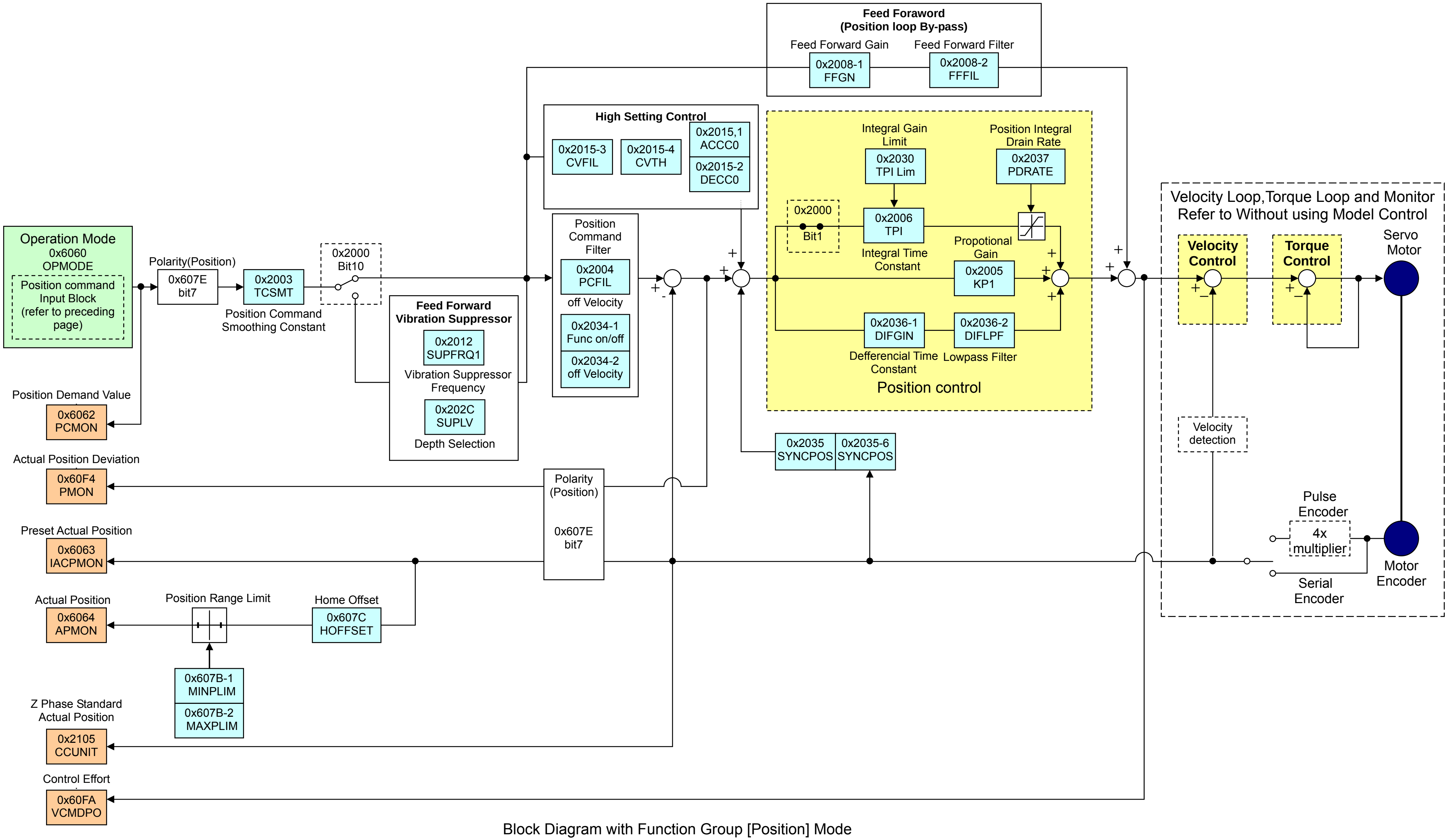
### # Abstract of Function Group “Position” Mode

As for function group “Position” operation mode, “Profile position Mode” , “Cyclic Synchronous Position Mode” and “Interpolated Position Mode”are supported. 0x6060: Operate “Profile Position Mode” by setting “1” in operation mode, “Cyclic Synchronous Position Mode” by setting “8” and “Interpolated Position Mode” by setting “7”.

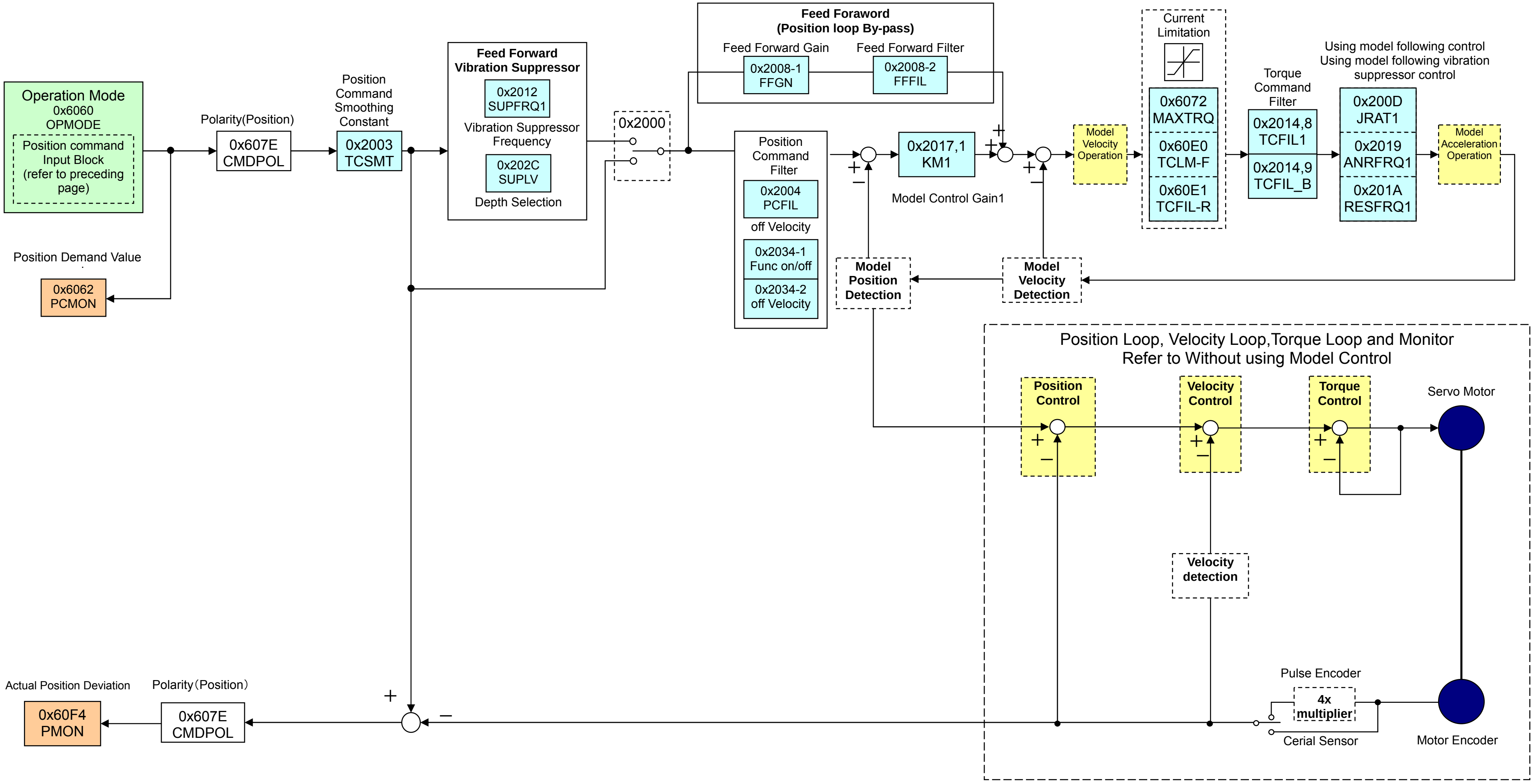
Here is the main object list for the function group “Profile Position Mode”



Block Diagram of each operation mode when the function group is in "Position" mode



Block Diagram with Function Group [Position] Mode



Block Diagram with Using model following control, Using model following vibration suppressor control of Function Group [Position] mode

## 4) Profile Position Mode

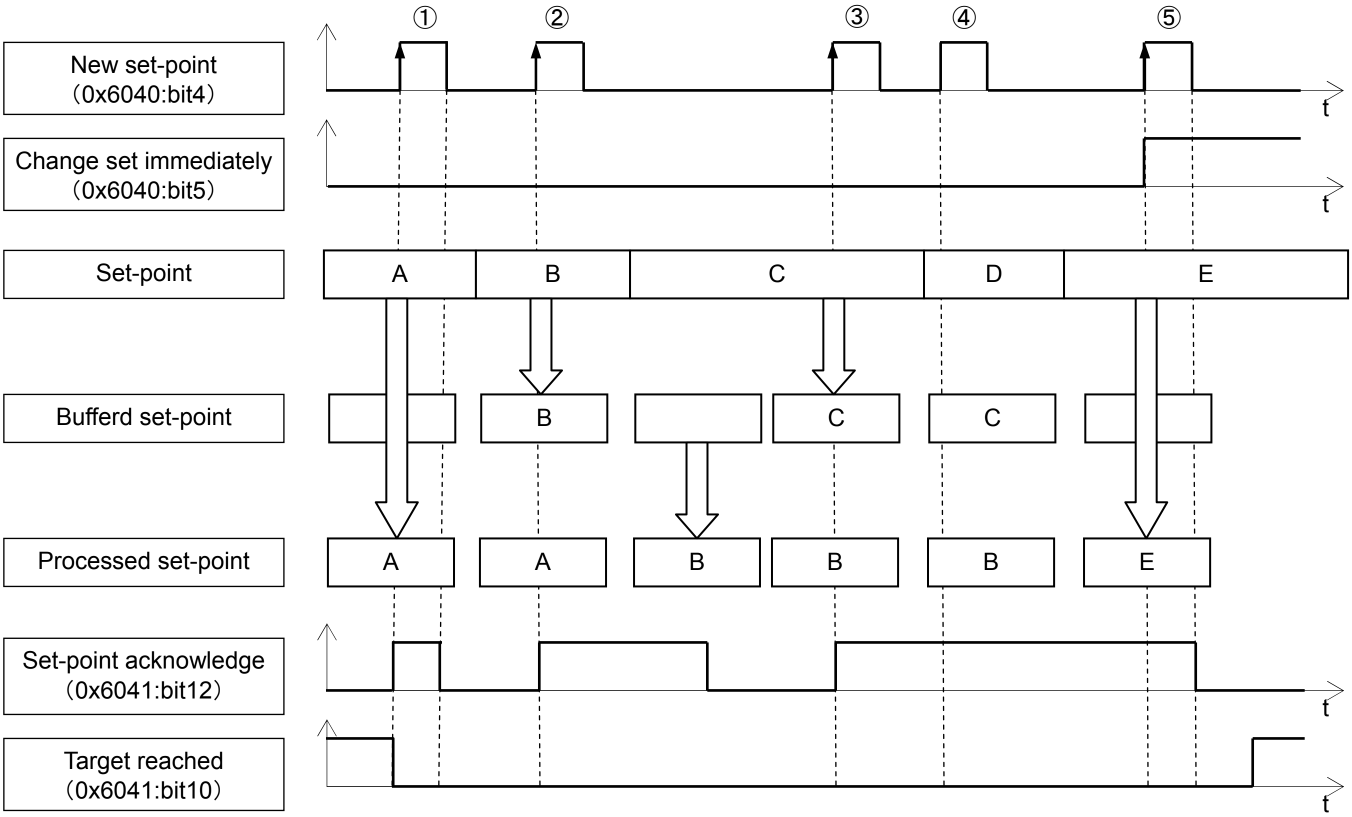
0x6060：When Operation Mode is set“1”,“Profile Position Mode”shall be operated.
The master sends“Target Position（0x607A)”,“Profile Velocity (0x6081),“Profile Acceleration and Deceleration（0x6083, 0x6084).
The slave (servo amplifier) executes trajectory generation and starts to move to the target position by setting bit4=1：New set-point of Control word 0x6040.
The slave executes all of Position Control, Velocity control, and Torque (force) control.
Also, Velocity offset and Torque (force) offset can be used as Velocity Additional value and Torque (force) Additional value.

The following two different ways to apply to a servo amplifier supported by device profile.
There are two different ways as follows to set target positions to a servo amplifier supported by the device profile.

1. Single set point: [Change set immediately bit(0x6040：Control word bit5）= 1]
   During the set point processing, if a new set-point is set by “New set-point (bit 4)” in Control word, the servo amplifier immediately processes the new set-point.
   For relative position move, new set-point will be as relative move value from processing point. In this case, please make not to exceed maximum value (0x7FFFFFFF) by sum of processing point and new set-point move value.

2. Set of set points: [Change set immediately bit(0x6040：Control word bit5）= 0]
   During the set point processing, if a new set-point is set by “New set-point (bit 4)” in Control word, the servo amplifier immediately processes the new set-point after reaching the target position.

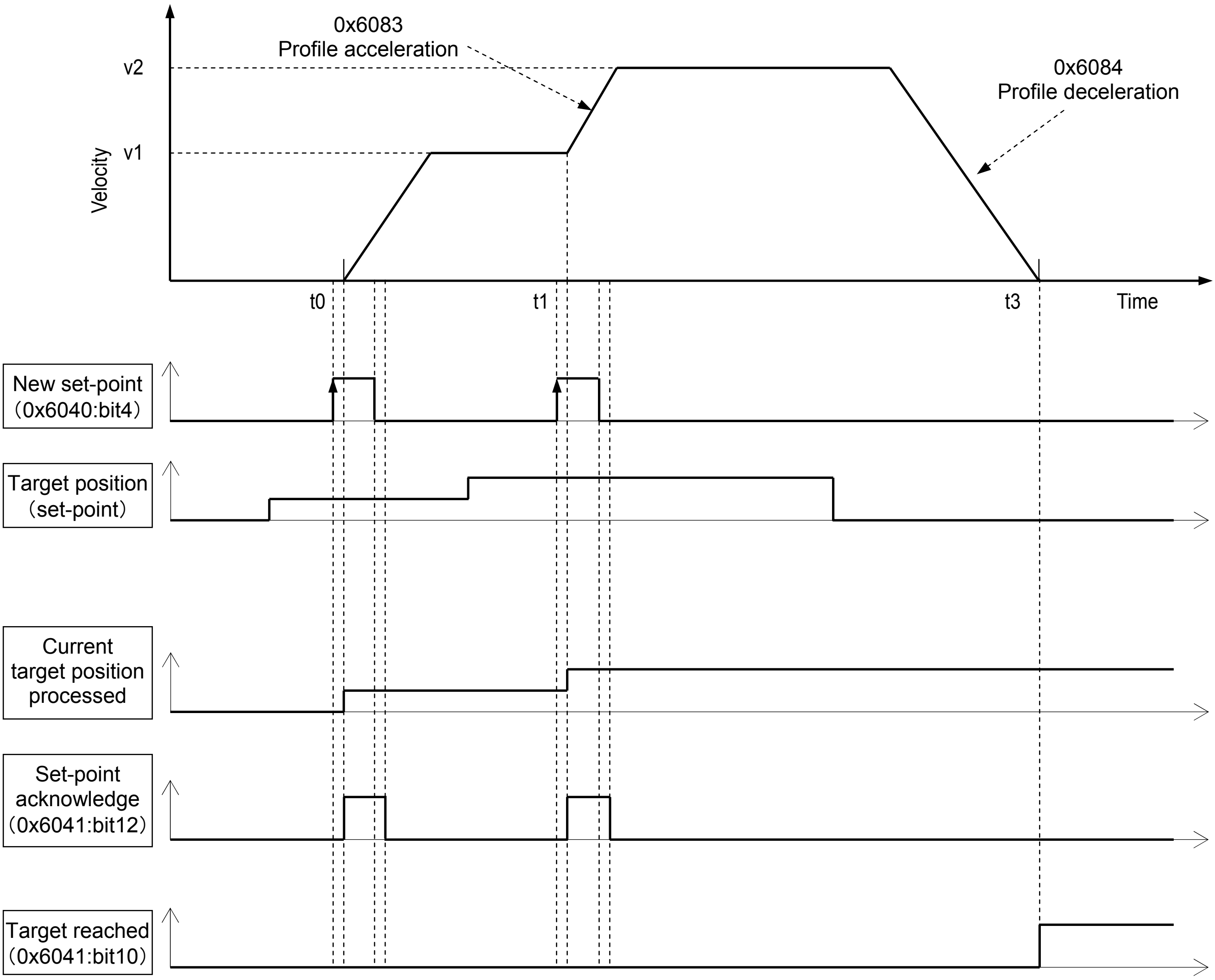
   The master controller switches the two modes mentioned above by the timing of the following bits;
   “New set-point(bit4)”, ”Change set immediately(bit5)”, ”Change of set-point(bit9)” in the Control Word（0x6040)and “Set-point acknowledge(bit12)” in the Status Word（0x6041).
   These bits allow to set up a request response mechanism in order to prepare the next set points while a previous set point still is processed in the servo amplifier.
   This minimizes reaction times within a control program on the master.



Sequence Diagram for Profile Position Mode

& Single set-point

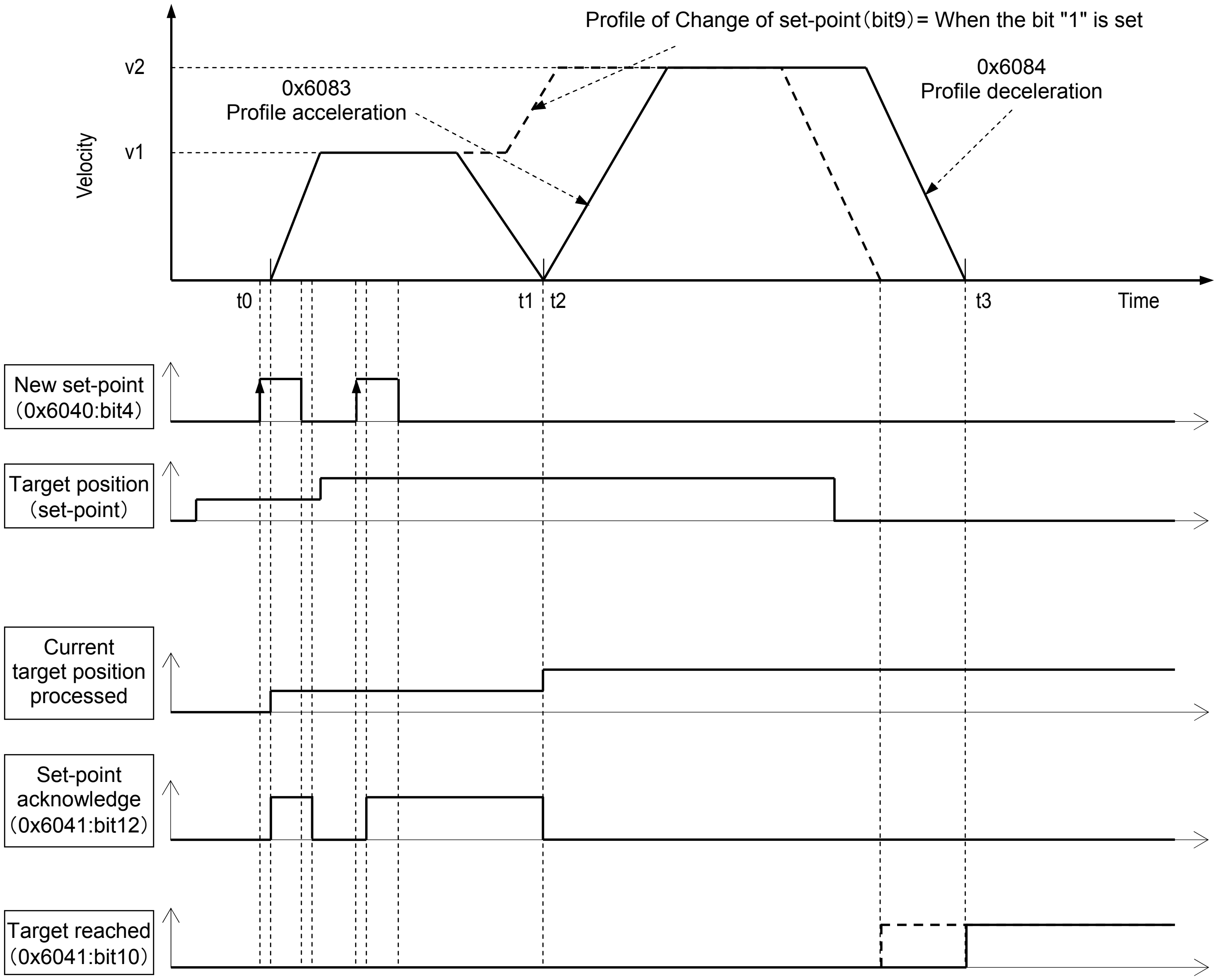
(1) If the bit“Change set immediately（bit5）” is “1”, a single set point is executed by the servo amplifier.
(2) After a set point is applied to a servo amplifier, the master sets “new set-point (bit4)” in Control word to “1” in order to notify completion of the set point to the slave(servo amplifier).
(3) A slave(servo amplifier) acknowledges a requested bit and buffers a new set-point, and in order to respond, sets“Set-point acknowledge（bit12）” to “1”.
(4) After the master recognized the new valid data, “New set-point (bit4)” is released to “0”.
(5) Even if the set point that is received at the time point “t0” is being processed, a new set-point will be immediately valid.
(6) The servo amplifier validates the actual move to the new target position immediately when the second target position as “New set-point” at the time point “t1” is received.



Single set-point (Update a set point immediately)

& Set of set-points

(1) If the bit “Change set immediately（bit5）” is “0", the servo amplifier executes settings for the set-point.
(2) After a set point is applied to a servo amplifier, the master sets “new set-point (bit4)” in Control word to “1” in order to notify completion of the set point to the slave(servo amplifier).
(3) A slave(servo amplifier) acknowledges a requested bit and buffers a new set-point, and in order to respond, sets “Set-point acknowledge(bit12)” to “1”.
(4) After the master recognized the new valid data, “New set-point (bit4)” is released to “0”.
(5) A new set-point will be valid after completion of a Set-point processing received at the time point “t0”.
(6) The servo amplifier validates the actual move to the new target position ”t3” immediately as long as that receives the second target position as “New set-point” before arriving to the first target position “t1”.
(7) When the bit Change of set-point (bit 9)" is set to “1”, the servo amplifier moves to the next set-point processing without reducing the velocity once to Zero during set-point processing.



Set of set points (Update to the next set point after completion of a set point)

0x6040:Control Word (Profile Position Mode: pp)

| | | | | | |
|---|---|---|---|---|---|
| Index Ax1 0x6040<br>Ax2 0x6840<br>Ax3 0x7040<br>Ax4 0x7840 | This object shall indicate Operation Mode Specific bit and Manufacturer specific bit of Profile Position Mode (pp). | | Object Code | | Variable |
| Sub-Idx | Description | Data Type | Access | PDO | Initial value |
| 0x00 | Control Word [CWORD]<br>* See the Command table for “Control word bit pattern (Bit 7, 3, 2,1, 0,) | Unsigned16 | RW | Possible | 0x0000 |
| | | Range | 0x0000-0xFFFF | | |

MSB LSB

| Cseten | - | Eclr | - | Change of set-point | Halt | Fr* | Abs / Rel | Change set immediately | New Set point | Hs* | qs* | ev* | so* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15 | 14..13 | 12 | 11..10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |

bit4:New setpoint [New setpoint]
0:Does not assume target position
1:Assume target position
Set "1" to this bit after change of bit6 of status word 1 from "0" to "1".

bit5:Change set immediately [Change set immediately]
Used for changing the target position during operation.
If this bit is set to 1, and bit 4 is changed “Zero” to “One” again, the trajectory generation to the new set point shall be processed immediately. All previously loaded set points shall be discarded.

bit6:ABS/REL [ABS/REL]
0:Target position (0x607A) is an absolute value
1:Target position (0x607A) is a relative value

bit8:HALT [HALT]
0:Activate Profile Position Positioning process
1:Stop axle with halt option code(0x605D)

Bit9: Change of set point [Change of set point]
This bit9 is used for the slave (servo amplifier) that moves to the next set-point processing without reducing the velocity once to Zero during set operation of set point.

1: Set point processing without reducing the velocity to Zero.

0x6041:Status Word (Profile Position Mode: pp)

| | | | | |
|---|---|---|---|---|
| Index | Ax1 0x6041<br>Ax2 0x6841<br>Ax3 0x7041<br>Ax4 0x7841 | This object indicates Operation Mode Specific bit and Manufacturer Specific bit of the Profile Position mode (pp). | Object code | Variable |

| Sub-Idx | Discription | Data Type | Access | PDO | Initial value |
|---|---|---|---|---|---|
| 0x00 | Status Word [STSWORD]<br>* See the Pattern Status table for"Status word bit pattern (Bit 6,5, 3,2,1,0,) | Unsigned16 | RO | Possible | 0x0000 |
| | | Range | 0x0000-0xFFFF | | |

MSB LSB

| Csetfix | Csetpro | Fe | Set-point Acknowledge | Internal Limit active | Tr | Rm | Res | W | Sod* | Qs* | Ve | F* | Oe* | So* | Rtso* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |

bit4:Voltage Enabled [Voltage Enabled]
0:Voltage disenabled 1:Voltage enabled

bit7:warning [warning]
0:No warning 1:Warning condition

bit9:remote [remote]
0: Control word is not processed
1: Being processed by control word

bit10:Target reached [Target reached]
1: Reached at target position
Set to “1” when the actual position in “in-position” range after internal command generated from start-up profile reached at target position.
Also set to "1" in the halt state, when quick stop operation activated (quick stop option code-2, 5, 6, and 7), and operational mode change completed (for about 1 sec set) .
*This bit won't change to 1, while New setpoint of the control word is 1.

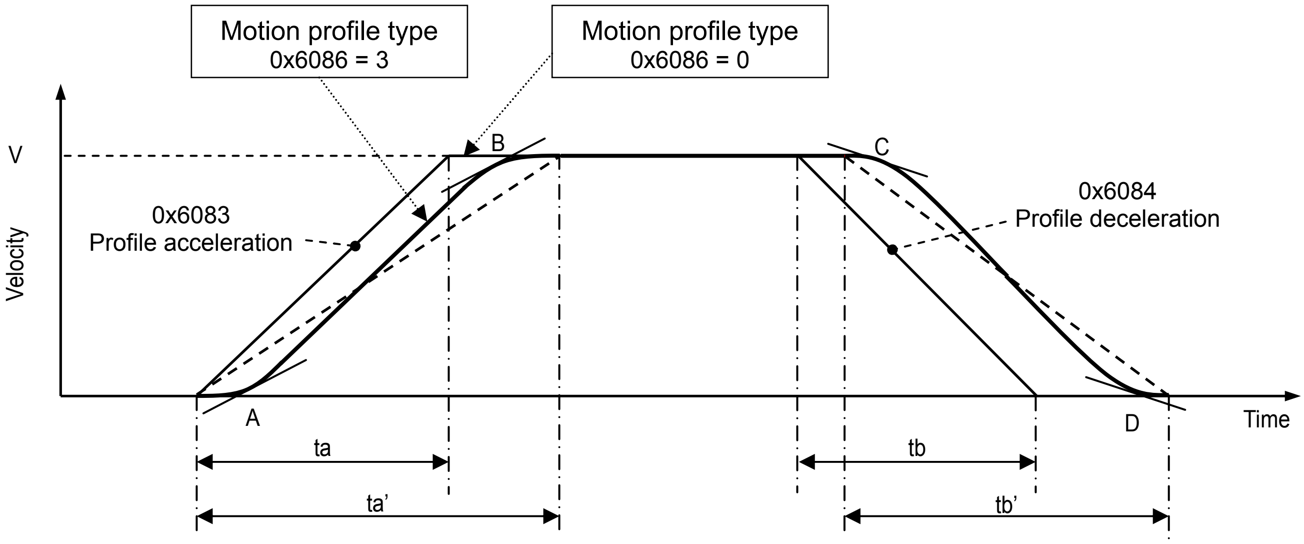
bit11：Internal limit active [Internal Limit active]
0：In normal operation, or standby state after previous normal profiling.
1：Set in the following cases.
・When relative position command selected and wrap around inactivated, the value oversteps the coordinate from positive (present position ≦ 0x7FFFFFFF) to negative （0x80000000≦target position）, or from negative（0x80000000≦present position） to positive (target position≦ 0x7FFFFFFF).
・When operation not started in the procedure in accordance with profile position mode sequence diagram.
・In the halt state
・At the software limit, forward rotation limit/ reverse rotation limit
*Please start to operate only after correct setting or state achived.

bit12:New set-point Acknowledge [Set-point Acknowledge]
0:No accept a new set-point Acknowledge
1:Accept a new set-point Acknowledge and start generating targetry agin.

bit13:Following error [Following error]
0:No following error 1:Following error

& Motion Profile

In this servo amplifier, S-shape acceleration/deceleration motion profile can be executed at the time of acceleration or deceleration.
(1) Motion profile type is selected by 0x6086.
(2) Combination of S-shape acceleration/deceleration time (A, B, C, D) is set by 0x60A3.
(3) S-shape acceleration/deceleration time A, B, C, D is set by 0x60A4.



Motion profile operation

V = Profile Velocity
A,B,C,D = Acceleration(Deceleration) at the jerk slope period time
ta = Acceleration time (Linear ramp)
tb = Deceleration time (Linear ramp)
ta' = Acceleration time (Jerk-limited ramp)
tb' = Deceleration time (Jerk-limited ramp)

0x6086: Motion Profile Type

| Index | Motion Profile Type | | | Object Code | | Variable |
|---|---|---|---|---|---|---|
| Ax1 0x6086<br>Ax2 0x6886<br>Ax3 0x7086<br>Ax4 0x7886 | | | | | | |
| Sub-Idx | Description | | Data Type | Access | PDO | Initial Value |
| 0x00 | Motion Profile Type | | Integer16 | RW | Possible | 0x0000 |
| | | | Setting Range | 0x0000, 0x0003 (0 or 3) | | |
| | Sets up type of motion profile operation.<br><br>0x0000: Linear ramp (trapezoidal profile)<br>0x0003: Jerk-limited ramp | | | | | |

0x60A3: Profile Jerk Use

| Index | Profile Jerk Use | | | Object Code | | Variable |
|---|---|---|---|---|---|---|
| Ax1 0x60A3<br>Ax2 0x68A3<br>Ax3 0x70A3<br>Ax4 0x78A3 | | | | | | |
| Sub-Idx | Description | | Data Type | Access | PDO | Initial Value |
| 0x00 | Profile Jerk Use | | Unsigned8 | RW | No | 0x01 |
| | | | Setting Range | 0x01-0x02 (1 or 2) | | |

Sets up combinations of sub index numbers of profile jerk object (0x60A4) for jerk profile operation.

| Value of 0x60A3 | Jerk assignment Value (Sub Index Number of 0x60A4) | | | |
|---|---|---|---|---|
| | A | B | C | D |
| 0x01 | 0x01 | 0x01 | 0x01 | 0x01 |
| 0x02 | 0x01 | 0x01 | 0x02 | 0x02 |

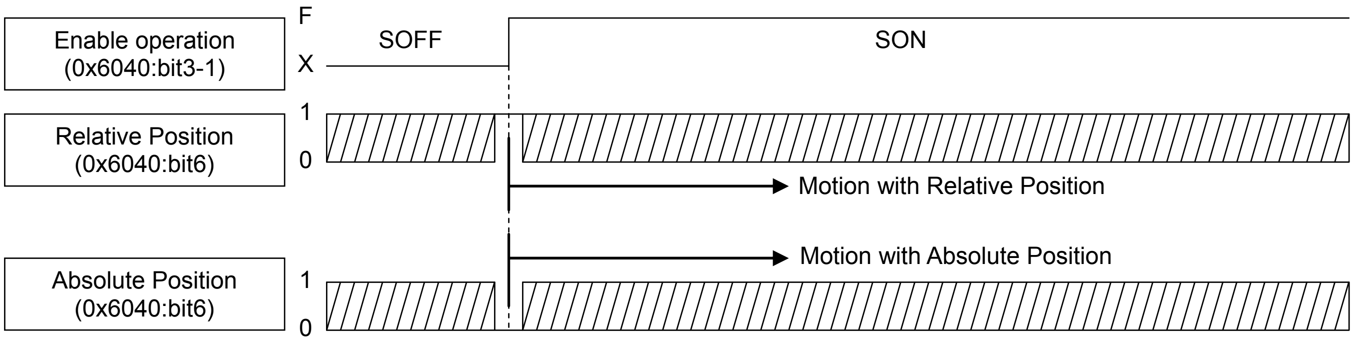
0x60A4: Profile Jerk

| Index | | | | | |
|---|---|---|---|---|---|
| Index Ax1 0x60A4<br>Ax2 0x68A4<br>Ax3 0x70A4<br>Ax4 0x78A4 | Profile Jerk | | Object Code | | Array |
| Sub-Idx | Description | Data Type | Access | PDO | Initial value |
| 0x00 | Number of entry | Unsigned8 | RO | No | 0x02 |
| 0x01 | Profile Jerk 1<br>Sets up value of jerk 1.<br>Sets up variation of the acceleration/deceleration per second. | Unsigned32 | RW | No | 0xFFFFFFFF |
| | | Setting range | 0x00000000-0xFFFFFFFF<br>(0-4294967295 pps$^3$) | | |
| 0x02 | Profile Jerk 2<br>Sets up value of jerk 2.<br>Sets up variation of the acceleration/deceleration per second. | Unsigned32 | RW | No | 0xFFFFFFFF |
| | | Setting range | 0x00000000-0xFFFFFFFF<br>(0-4294967295 pps$^3$) | | |

* Refer M0011028 for setting of jerk function.

## 5) Cycle Synchronization Position Mode

0x6060:When Operation Mode is “8”, Servo amplifier is operated by Cycle Synchronization Position Mode.
In “Cycle Synchronization Position control system”, the master (Control Device) generate trajectory and transmit the Target position continuously to the slave to make control Position, Velocity and Torque (force).
Velocity offset and Torque (force) offset are used for as Additive velocity value and Additive torque (force) value, then the Position offset function calculates offset value for the new target position.
A command type - Absolute/Relative position - is selectable by 0x6040:Bit 6. (Bit 6 = 0: Absolute position, Bit 6 = 1: Relative position).
However, when the master sets Operation enabled state (Bit 0 to 3 = 0x0F), it shall be defined after the amplifier refers it.



0x6040:Control Word (Cyclic Sync. Position Mode: csp)

| Index | | | | | |
|---|---|---|---|---|---|
| Index Ax1 0x6040<br>Ax2 0x6840<br>Ax3 0x7040<br>Ax4 0x7840 | This object indicates Operation Mode Specific bit and Manufacturer Specific bit under the Cyclic Sync. Position mode (csp). | | Object code | | Variable |
| Sub-Idx | Description | Data Type | Access | PDO | Initial value |
| 0x00 | Control Word [CWORD]<br>* See the Pattern command table for “Control word bit pattern (Bit7,3,2,1,0) | Unsigned16 | RW | Possible | 0x0000 |
| | | Range | 0x0000-0xFFFF | | |

MSB LSB

| Cset en | - | Eclr | - | Halt | Fr* | Abs / Rel | Reserved | Reserved | Hs* | Qs* | Ev* | So* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15 | 14…13 | 12 | 11..9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |

bit6:ABS/REL [ABS/REL]
0:Target position (0x607A) is an absolute value
1:Target position (0x607A) is a relative value

bit8:HALT [HALT]
0: Activate Cycle Synchronization Position Mode (Enable bit4)
1:Stop axle with halt option code(0x605D)

0x6041:Status Word (Cyclic Sync. Position Mode: csp)

| | | | | | |
|---|---|---|---|---|---|
| Index Ax1 0x6041<br>Ax2 0x6841<br>Ax3 0x7041<br>Ax4 0x7841 | This object indicates Operation Mode Specific bit and Manufacturer Specific bit under Cyclic Sync. Position Mode (csp). | | Object code | | Variable |
| Sub-Idx | Description | Data Type | Access | PDO | Initial value |
| 0x00 | Status Word [STSWORD]<br>*See the Pattern status table for “Status word bit” (Bit6,5, 3,2,1,0) | Unsigned16 | RO | Possible | 0x0000 |
| | | Range | 0x0000-0xFFFF | | |

MSB LSB

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Csetfix | Csetpro | Fe | Target Value Ignored | Internal Limit active | Tr | Rm | Res | W | Sod* | Qs* | Ve | F* | Oe* | So* | Rtso* |
| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |

bit4:Voltage Enabled [Voltage Enabled]
0:Voltage disenabled 1:Voltage enabled

bit7:warning [warning]
0:No warning 1:Warning condition

bit9:remote [remote]
0: Control word is not processed
1: Being processed by control word

bit10:Target reached [Target reached]
1: Reached at target position
Set to “1” when the actual position in “in-position” range after internal command generated from start-up profile reached at target position.
Also set to "1" in the halt state, when quick stop operation activated (quick stop option code-2, 5, 6, and 7), and operational mode change completed (for about 1 minute set) .

bit11:Internal Limit active [Internal Limit active]
0 : In normal operation
1 : Software position limit, forward rotation limit／reverse rotation limit.

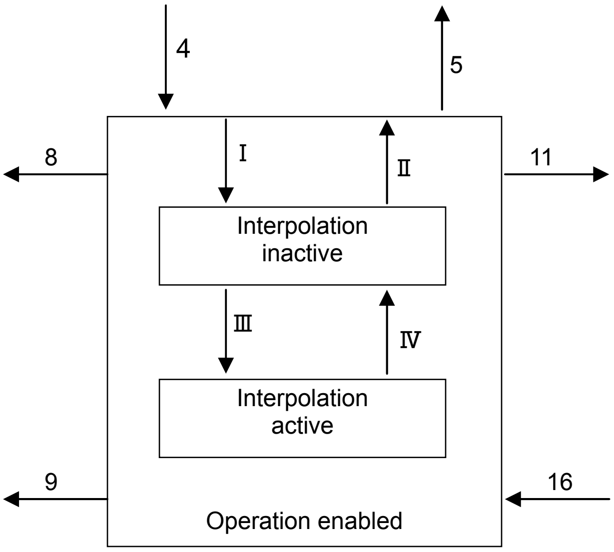
bit12:Target value ignored [Target value ignored]
(Command acceptance prohibition)
0:Target position shall be used as input to position control loop.
1:Target position ignored.

bit13:Following error [Following error]
0:No following error 1:Following error

### 6) Interpolated Position Mode

0x6060: When Operation Mode is set “7”, “Interpolated Position Mode” shall be operated.
Trajectory generation of Interpolated Position Control depend on master.
The master sends Interpolated Position command.
The slave (Drive device) executes Position Control, Velocity Control, and Torque (force) Control.
Velocity offset and Torque (force) offset can be used as Velocity Additional value and Torque (force) Additional value.
Position offset adds offset to Position command.
There are two kinds of interpolation methods for interpolation position target. Select by using Interpolation sub mode select (0x60C0).
Provided Interpolated Position Command is buffered with 0x60C4 setting.
There are 2 kinds of buffer format, FIFO (first-in-first-out) and Ring. Ring buffers can be used for circular operation.
Domain for 256 buffers is allocated within servo amplifier and Index 0x60C4-2 sets up the number of buffers which will actually be used. When interpolated position command value is received in the situation where there are no empty buffers, the oldest Interpolated position command value is automatically overwritten.
The slave picks up Interpolated Position command from buffer at each every interpolation cycle and uses it to Position command while interpolation allowed (Interpolation active). In the case that the buffer format is FIFO, when there is no Interpolated position command value stored in the buffer, it will cease to read values, and motors will stop at the last read Interpolated position command value. In the case that the buffer format is Ring, after all Interpolated position command values are read, the reading process will restart from the beginning.
Also, Interpolated command is treated as absolute value.

State Change ofInterpolated position mode



FSA status and FSAstate change

FSA status definition

| Status | Description |
|---|---|
| ［Interpolation inactive］ | Amplifier allow inputting data. But, it has no influence. |
| ［Interpolation active］ | Amplifier allow inputting data. And, it works. |

FSA state change

| State change | Event |
|---|---|
| I | Select Interpolated Position Mode out from Operation Mode. |
| Ⅱ | Select other than Interpolated Position Mode out from Operation Mode. |
| Ⅲ | Receive “IP mode enable (Controlword: bit4=1)” |
| Ⅳ | Receive “IP mode disable (Controlword: bit4=0)” |

&Interpolation sub mode select (0x60C0)

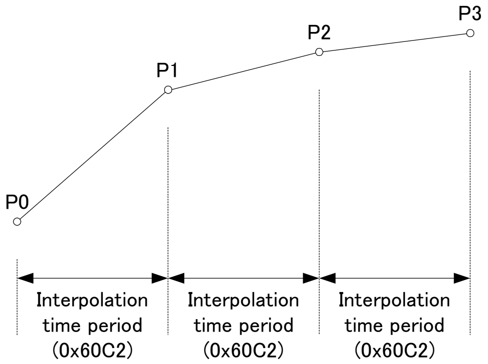
This servo amplifier corresponds to two kinds of interpolation methods. Select by using interpolation sub mode select (0x60C0).

| Interpolation sub mode select | Contents |
|---|---|
| 0 | Linear Interpolation (fixation time) |
| -1 | Linear Interpolation (variable Time) |

・Linear Interpolation (fixation time)

Reads interpolation position target (0x60C1-1) from buffer at each interpolation time period (0x60C2) and uses it for position control.

Sets interpolation position target (0x60C1-1) and interpolation time period (0x60C2). Interpolation time (0x60C1-2) is not used.

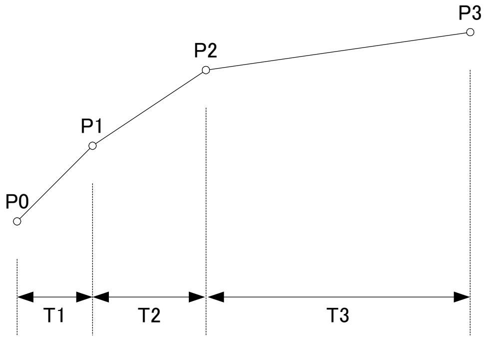


| Buffer | |
|---|---|
| Interpolation Position Target 0x60C1-1 | Interpolation Time 0x60C1-2 |
| P0 | − |
| P1 | − |
| P2 | − |
| P3 | − |

・Linear Interpolation (variable time)

Calculate the linear interpolation between two points of the interpolation position target (0x60C1-1) by interpolation time (0x60C1-2) and use it for position control.

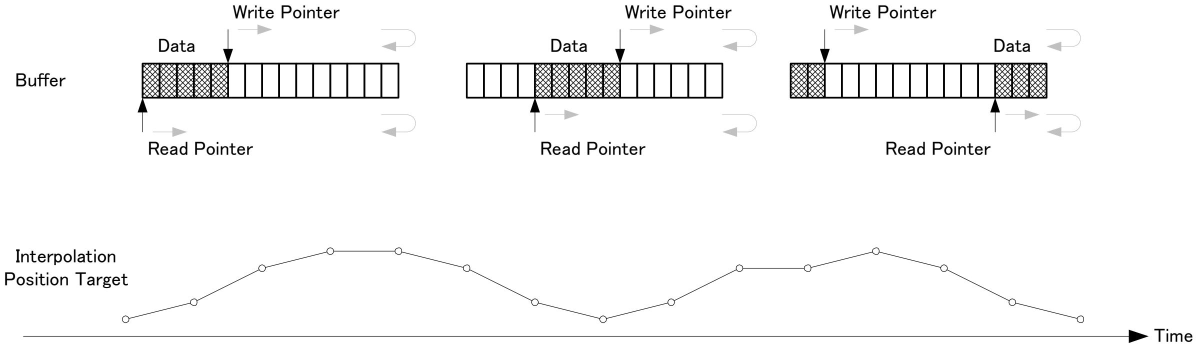
Sets interpolation position target (0x60C1-1) and interpolation time (0x60C1-2). Interpolation time period (0x60C2) is not used.



| Buffer | |
|---|---|
| Interpolation Position Target 0x60C1-1 | Interpolation Time 0x60C1-2 |
| P0 | T0 |
| P1 | T1 |
| P2 | T2 |
| P3 | T3 |

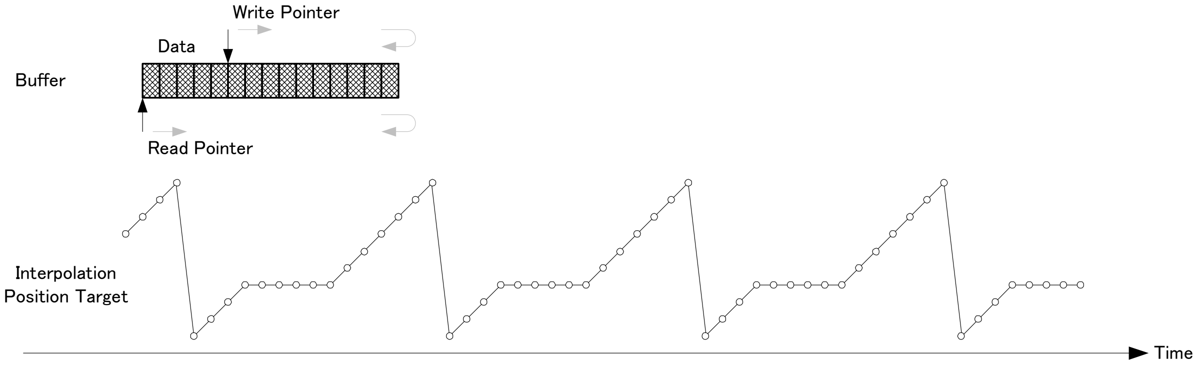
&Usage when buffer format is set to FIFO

(1) Set communication cycle time on Index 0x1C32-2.
(2) Set Interpolation sub mode select (0x60C0).
(3) When setting interpolation sub mode select at 0, set interpolation time period (0x60C2).Interpolation time period is the cycle in which the servo amplifiers read interpolation position target from the buffer. Generally, the same value as the communication cycle time is set. For setting a different value for the communication cycle time, bit0 of the special function selection of Index 0x20F7 should be set at 1.
The setting value will be reflected to internal parameter of servo amplifiers other than when ESM is Operational. When changes are carried out in Operational Mode, it is necessary to temporarily lower ESM to Safe-Operational.
(4) Change operation mode to 7: Interpolated position mode.
(5) Set the number of buffer which will actually be used on Index 0x60C4-2 (Actual buffer size). The maximum number of buffers of this servo amplifier is 256.
(6) Set 0 on Index 0x60C4-3 (Buffer format), and select a FIFO buffer.
(7) Enable operation.
(8) Set 1 on Index 0x60C4-6 (Buffer clear), and enable access to buffer. As all buffers are cleared at 0 statuses, the transmitted interpolation position target will be disabled.
(9)When setting interpolation sub mode select at 0, set interpolation position target (0x60C1-1). Interpolation time (0x60C1-2) does not need to be set.Set interpolation position target on Index 0x60C1. The transmitted interpolation position target will be stored in buffer in the servo amplifier. In the servo amplifier, at each data reception, the buffer write pointer is incremented and stored in buffer.
When setting interpolation sub mode select at -1, set interpolation position target (0x60C1-1) and interpolation time (0x60C1-2). In servo amplifier, increment write pointer of the buffer when storing interpolation time in buffer. After setting interpolation position target, set interpolation time in response to interpolation position target. (Set interpolation position target, interpolation time, interpolation position target and interpolation time, ･･･in this order.)
(10)When setting bit4=1 (Enable Interpolation) of Control Word (0x6040), the servo amplifier starts reading interpolation position target and the motor starts running.
(11) The master transmits interpolation position target and interpolation time (in the case that interpolation sub mode select is -1) at each communication cycle time. In the case that there is no interpolation position target in the buffer while interpolated position mode is permitted, the servo amplifier will stop reading interpolation position target, and the motors will stop at the last read interpolation position target.
(12) Following are methods to stop the motor:
･Set bit4=0 of Control Word (0x6040).
･Set bit8 (halt) =1of Control Word (0x6040).
･Stop renewing interpolation position target.
･Set Interpolation time at 0. (In the case that interpolation sub mode select is -1)



&Usage when buffer format is set to Ring

(1) Sets communication cycle time on Index 0x1C32-2.
(2) Set Interpolation sub mode select (0x60C0).
(3) When setting interpolation sub mode select at 0, set interpolation time period (0x60C2). Interpolation time period is the cycle in which the servo amplifiers read interpolation position target from the buffer. Generally, the same value as the communication cycle time is set. For setting a different value for the communication cycle time, bit0 of the special function selection of Index 0x20F7 should be set at 1.
The setting value will be reflected to internal parameter of servo amplifiers other than when ESM is Operational. When changes are carried out in Operational Mode, it is necessary to temporarily lower ESM to Safe-Operational.
(4) Change operation mode to 7: Interpolated position mode.
(5) Set the number of buffer which will actually be used on Index 0x60C4-2 (Actual buffer size). The maximum number of buffers of this servo amplifier is 256.
(6) Set 1 on Index 0x60C4-3 (Buffer format), and select a Ring buffer.
(7) Enable operation.
(8) Set 1 on Index 0x60C4-6 (Buffer clear), and enable access to buffer.As all buffer are cleared at 0 status, the transmitted interpolation position target will be disabled.
(9) When setting interpolation sub mode select at 0, set interpolation position target (0x60C1-1). Interpolation time (0x60C1-2) does not need to be set.The transmitted interpolation position target will be stored in buffer in the servo amplifier. In the servo amplifier, at each data reception, the buffer write pointer is incremented and stored in buffer. When setting interpolation sub mode select at -1, set interpolation position target (0x60C1-1) and interpolation time (0x60C1-2). In servo amplifier, increment write pointer of the buffer when storing interpolation time in buffer. After setting interpolation position target, set interpolation time in response to interpolation position target. (Set interpolation position target, interpolation time, interpolation position target and interpolation time, ･･･in this order.)
Ring buffer mode can be used for circular operation. By setting all interpolation position target for circular operation within the buffer, there is no need to transmit interpolation position target from the master during operation.
(10) When setting bit4=1 (Enable Interpolation) of Control Word (0x6040), the servo amplifier starts reading interpolation position target and the motor starts running. After reading the last value in the buffer, the reading process will restart from the beginning domain in the buffer.
(11) Following are methods to stop the motor:
･Set bit4=0 of Control Word (0x6040).
･Set bit8 (halt) =1of Control Word (0x6040).
･Stop renewing interpolation position target.
･Set interpolation Time at 0. (In the case that interpolation sub mode select is -1)



0x6040：Control word（Interpolated Position Mode: ip）

| | | | |
|---|---|---|---|
| Index Ax1 0x6040<br>Ax2 0x6840<br>Ax3 0x7040<br>Ax4 0x7840 | This object indicates operation mode specific bits and manufacturer specific bits of the Interpolated Position Mode (ip) | Object code | Variable |

| Sub-Idx | Description | Data Type | Access | PDO | Initial value |
|---|---|---|---|---|---|
| 0x00 | Control word ［CWORD］<br>*For details on Bit 7,3,2,1 and 0, see the table of Control Word Bit Pattern Command. | Unsigned16 | RW | Possible | 0x0000 |
| | | Range | 0x0000 - 0xFFFF | | |

MSB LSB

| Cseten | - | Eclr | - | Halt | Fr* | Reserved | Reserved | IP enable | Hs* | Qs* | Ev* | So* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15 | 14･･･13 | 12 | 11･･9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |

Bit4：Interpolation ［IP enable］
0：Interpolation disable
1：Interpolation enable

bit8: HALT ［HALT］
0：Accept Interpolation Position Command（Enable bit4）
1：Stop axis according to halt option code (0x605D)

0x6041：Status word（Interpolated Position Mode: ip）

| | | | |
|---|---|---|---|
| Index Ax1 0x6041<br>Ax2 0x6841<br>Ax3 0x7041<br>Ax4 0x7841 | This object indicates operation mode specific bits and manufacturer specific bits of the Interpolated Position Mode (ip) | Object code | Variable |

| Sub-Idx | Description | Data Type | Access | PDO | Initial value |
|---|---|---|---|---|---|
| 0x00 | Status word ［STSWORD］<br>*For details on Bit 6, 5, 3, 2, 1 and 0, see the Status Word List Bit Pattern. (Bit 6,5,3,2,1,0) | Unsigned16 | RO | Possible | 0x0000 |
| | | Range | 0x0000 - 0xFFFF | | |

MSB LSB

| Csetfix | Csetpro | Fe | IP active | Internal Limit active | Tr | Rm | Res | W | Sod※ | Qs※ | Ve | F※ | Oe※ | So※ | Rtso※ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |

bit4：Voltage Enabled ［Voltage Enabled］
0: Voltage disenabled 1: Voltage Enabled

bit7：Warning ［warning］
0: No warning 1: Warning condition

bit9：Remote ［remote］
0：Controlword is not processed
1：Controlword is processed

bit10: Target reached ［Target reached］
1：Reached at target position
Set to “1” when the actual position in “in-position” range.
Also set to "1" in the halt state, when quick stop operation activated (quick stop option code-2, 5, 6 and 7), and operational mode change completed (for about 1minute set).

bit11：Internal limit active ［Internal Limit active］
0: Normal operation
1：On Software Position limit, CW limit or CCW limit.

bit12：Interpolation active ［IP active］
0：Interpolation stopping
1：Interporation operating

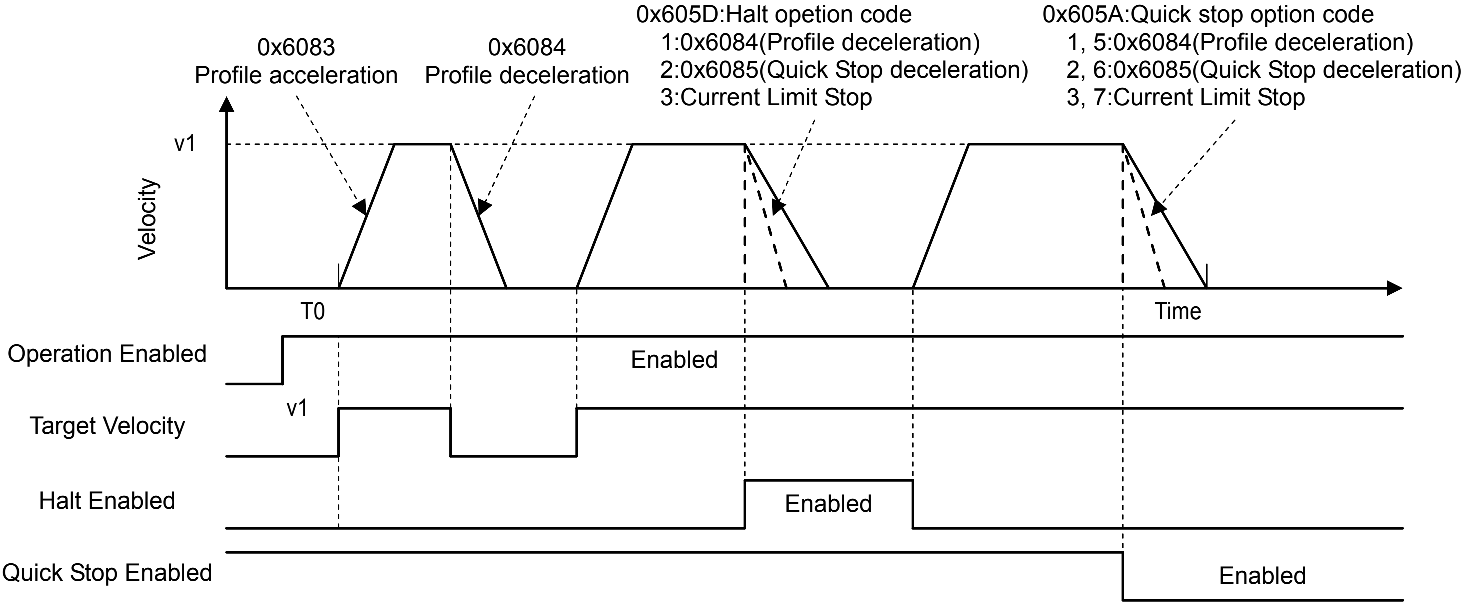
bit13：Following error ［Following error］
0: No following error 1: Following error

## 7) Function Group “Velocity”, ”Homing mode”
## # Abstract of Function Group “Velocity”, ”Homing mode”

In Function Group "Velocity" the operation mode, “Profile Velocity mode” and "Cyclic Synchronous Velocity Mode" shall be supported.
0x6060:When the bit is set “3” in Operation Mode it is operated profile Velocity Mode, and when the bit is set “9”, it is operated by Cyclic Synchronous Velocity Mode.
And also, when the bit is “6” in Homing mode, the slave performs Returning to the origin position in Velocity mode.

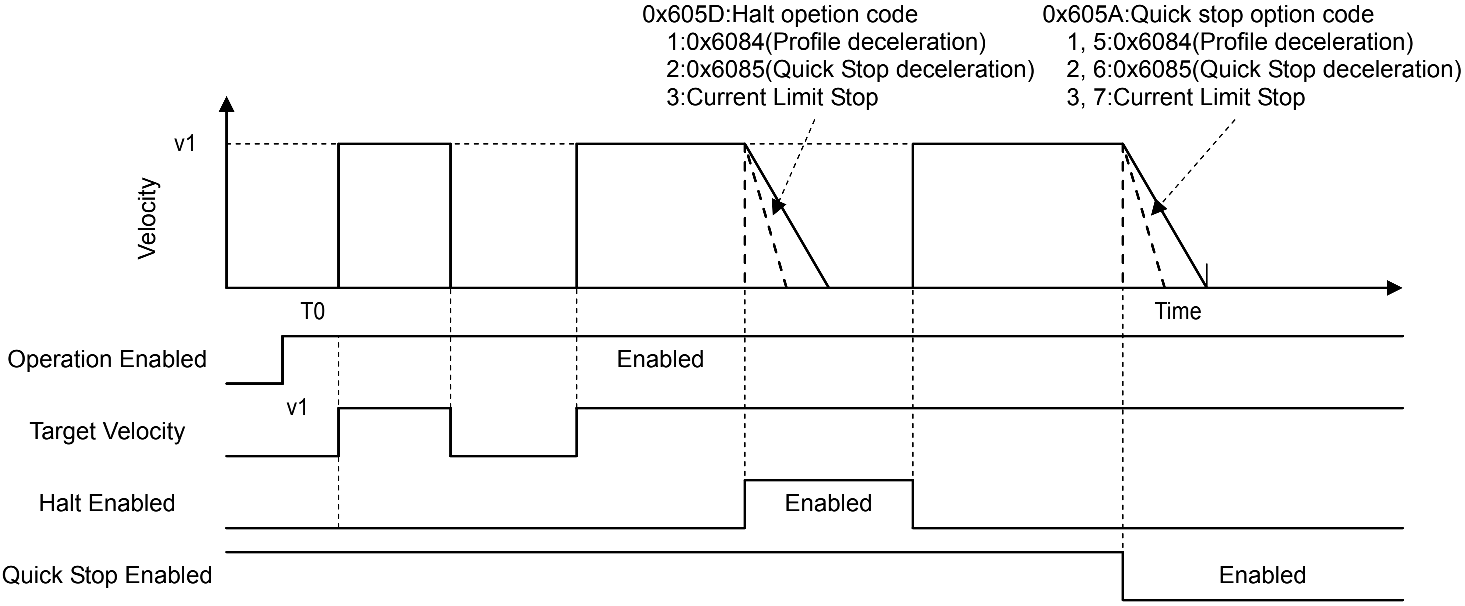
## 8) Profile Velocity Mode

In this mode, trajectory is generated by the slave.
The master (Control Device) transmits 0x60FF: Target velocity through Cyclic Sync mode or Asynchronous mode, and the slave makes control of velocity and torque (force).
And also, be able to give slope reaching the target velocity by setting 0x6083: Profile Acceleration and 0x6084: Profile deceleration.

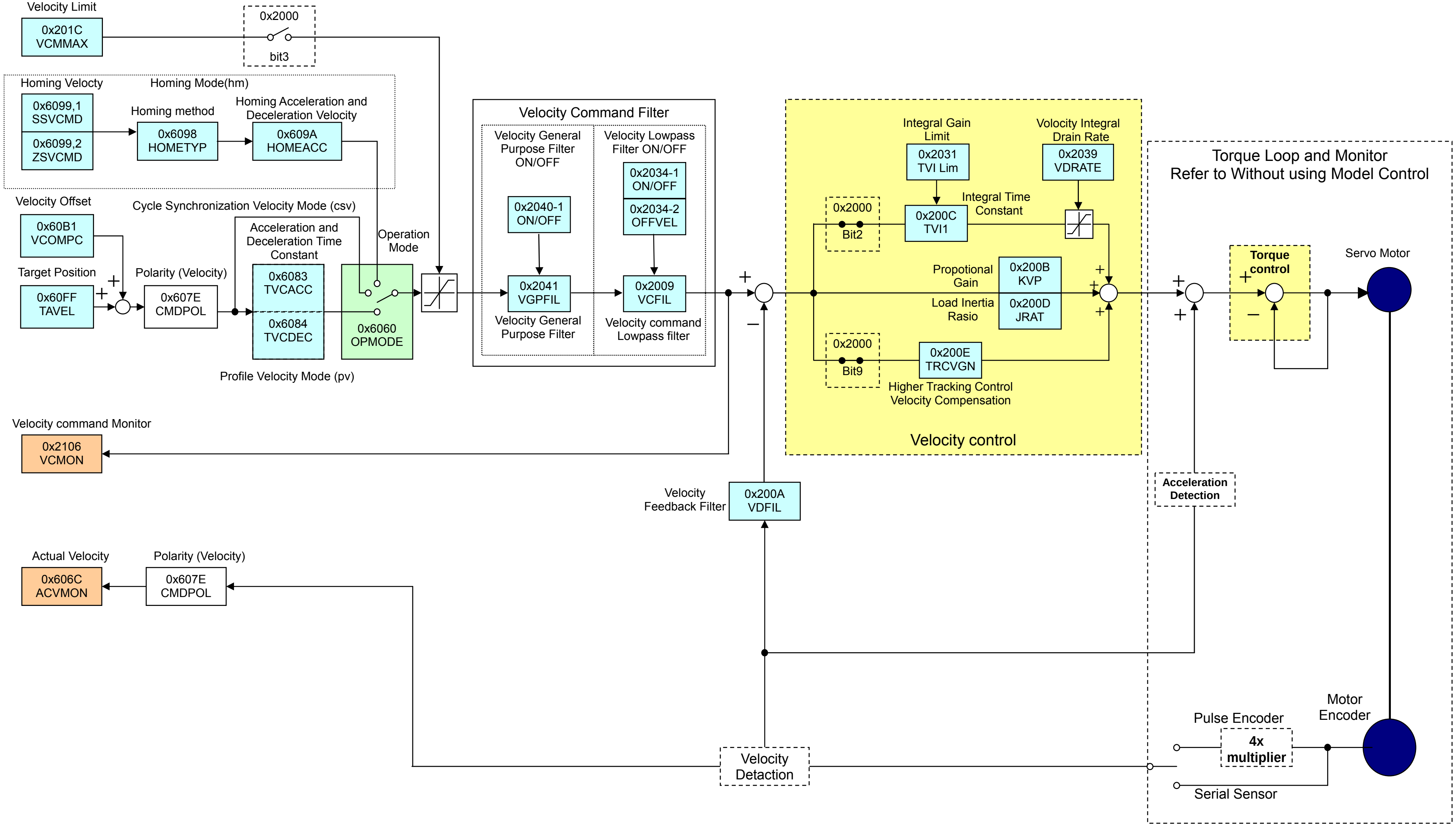


## 9) Cyclic Synchronous Velocity Mode

In this mode, trajectory is generated by the master, not the slave.
The master (Control Device) transmits 0x60FF: Target velocity through Cyclic Sync mode, and the slave makes control of velocity and torque (force).
When the Profile acceleration and deceleration 0x60083, 0x6084 are used, they function only for Halt and Quick stop operations.



Block diagrams of Function Group “Velocity” “Homing” mode are indicated in the following pages.



Block Diagram with Function Group [Velocity] [Homing] Mode

0x6040:Control Word (Cyclic Sync. Velocity Mode: csv, Profile Velocity Mode: pv)

| Index | | This object shall indicate the operation mode specific and manufacturer specific bit in Cyclic Sync-position mode (csv), Profile velocity mode (pv) | Object code | | Variable |
|---|---|---|---|---|---|
| Index Ax1 0x6040<br>Ax2 0x6840<br>Ax3 0x7040<br>Ax4 0x7840 | | | | | |
| Sub-Idx | Description | Data Type | Access | PDO | Initial value |
| 0x00 | Control word [CWORD]<br>* See the bit patter command list for the detail on Bit 7, 3, 2, 1, 0 | Unsigned16 | RW | Possible | 0x0000 |
| | | Range | 0x0000-0xFFFF | | |

MSB LSB

| Cseten | - | Eclr | - | Halt | Fr* | Reserved | Reserved | Reserved | Hs* | qs* | ev* | so* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15 | 14…13 | 12 | 11..9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |

bit8:HALT [HALT]
0: Acceptpt Velocity Command(Enable bit4)
1:Stop axle with halt option code(0x605D)

0x6041:Status Word (Cyclic Sync. Velocity Mode: csv, Profile Velocity Mode:pv)

| Index 0x6041 | This object indicates Operation mode specific bits and Manufacturere specific bits in Cyclic Shunc. Mode (csv) and Profile velocity (pv)mode. | | Object code | | Variable |
|---|---|---|---|---|---|
| Sub-Idx | Description | Data Type | Access | PDO | Initial value |
| 0x00 | Status Word [STSWORD]<br>* See the Status word bit patterns status lists for the details on Bit 6, 5, 3, 2, 1, 0 | Unsigned16 | RO | Possible | 0x0000 |
| | | Range | 0x0000-0xFFFF | | |

MSB LSB

| Csetfix | Csetpr | Res | Speed | Internal Limit active | Tr | Rm | Res | W | Sod* | Qs* | Ve | F* | Oe* | So* | Rtso* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |

bit4:Voltage Enabled [Voltage Enabled]
0:voltage disenabled 1:voltage enabled

bit7:warning [warning]
0:No warning 1:warning condition

bit9:remote [remote]
0: Control word is not processed
1: Being processed by control word

bit10:Target velocity reached [Target reached]
1: Reached at target velocity
Set to “1” when the actual velocity is within constant velocity. Coincident velocity output has two settings, “OD: 0x606D rotational rate setting” and “OD: 0x202A ratio setting,” and shall be selected on “OD: 0x20F0. 4 velocity window unit output.” Also set to "1" in the halt state, when quick stop operation activated (quick stop option code-2, 5, 6, and 7), and operational mode change completed (for about 1 minute set).

bit11:Internal Limit active [Internal Limit active]
0:nomal operation
1:Software Position limit, CW limit/CCW limit

bit12: Zero-speed status [Speed]
0: Not Zero-speed status
1: Zero-speed status

## 10) Homing Mode

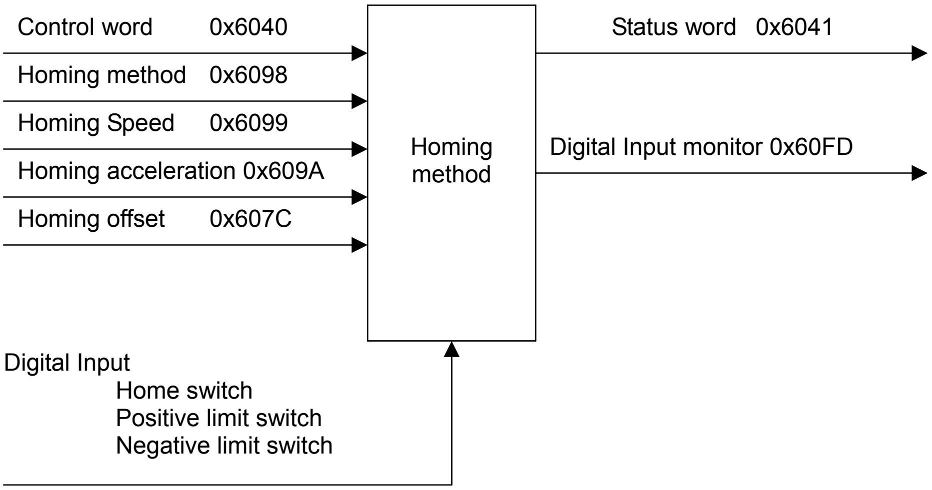
This clause describes the method by which a drive seeks the home position (also called, the datum, reference point or zero point)
Input objects are defined as well as the output objects. The user may specify the speed, acceleration and the method of homing. There is a further object home offset, which allows the user to displace zero in the user's coordinate system from the home position.
There is no output data except for those bits in the status word, which return the status or result of the homing process and the demand to the position control loops.

There are two homing speeds; the faster speed is used to find the home switch (Sub-Index 1) and slower speed is used to find the index pulse.

Here is the Objects list in the Homing mode.

List of Homing Mode Object

| Index | Sub-Index | Name | PDO Mapping |
|---|---|---|---|
| 0x607C | 0x00 | Home offset | Possible |
| 0x6098 | 0x00 | Homing method | Possible |
| 0x6099 | 0x00 | Homing speeds | Possible |
| 0x609A | 0x00 | Homing acceleration | Possible |
| 0x60E3 | 0x00 | Support Homing Method | No |
| 0x60FD | 0x00 | Digital Input | Possible |



Homing mode function

By choosing a homing method, the following behavior is determined: the homing signal (positive limit switch, negative limit switch, home switch and touch-probe 1), the direction of actuation and where appropriate, the position of index pulse.
The home position and the zero position are offset by the home offset. (0x607C: See the definition of home offset for how this offset is used.) There are five sources of homing signal available: These are the negative and positive limit switches, the home switch, touch-probe 1 and index pulse from an encoder.

The drive that reached to the limit switch shall move in the other direction to leave the position. In the diagrams of homing sequences shown below, the encoder count increases as the axis position moves to the right. (The left is the minimum position ad the right is the maximum position.)

The below shows the supported Homing Methods list. No.-4 to -1 are manufacturer specific homing methods

Homing Method

| Method | Homing Mode | Stop direction |
|---|---|---|
| －4 | Homing on hard stop (Butt) and index pulse in negative direction | positive |
| －3 | Homing on hard stop (Butt) and index pulse in positive direction | negative |
| －2 | Homing on hard stop (Butt) in positive direction | negative |
| －1 | Homing on hard stop (Butt) in negative direction | positive |
| 0 | Undefined homing methods (Homing does not start) | - |
| 1 | Homing on negative limit switch and index pulse | positive |
| 2 | Homing on positive limit switch and index pulse | negative |
| 3 | Homing on positive home switch and index pulse | negative |
| 4 | Homing on positive home switch and index pulse | positive |
| 5 | Homing on negative home switch and index pulse | positive |
| 6 | Homing on negative home switch and index pulse | negative |
| 7 | Homing on positive limit switch, homing on positive home switch and index pulse | negative |
| 8 | Homing on positive limit switch, homing on positive home switch and index pulse | positive |
| 9 | Homing on positive limit switch, homing on negative home switch and index pulse | negative |
| 10 | Homing on positive limit switch, homing on negative home switch and index pulse | positive |
| 11 | Homing on negative limit switch, homing on positive home switch and index pulse | positive |
| 12 | Homing on negative limit switch, homing on positive home switch and index pulse | negative |
| 13 | Homing on negative limit switch, homing on negative home switch and index pulse | positive |
| 14 | Homing on negative limit switch, homing on negative home switch and index pulse | negative |
| 17 | Homing on negative limit switch | positive |
| 18 | Homing on positive limit switch | negative |
| 19 | Homing on positive home switch | positive |
| 20 | Homing on positive home switch | negative |
| 21 | Homing on negative home switch | positive |
| 22 | Homing on negative home switch | negative |
| 23 | Homing on positive limit switch and Homing on positive home switch | negative |
| 24 | Homing on positive limit switch and Homing on positive home switch | positive |
| 25 | Homing on positive limit switch and Homing on negative home switch | negative |
| 26 | Homing on positive limit switch and Homing on negative home switch | positive |
| 27 | Homing on negative limit switch and Homing on positive home switch | positive |
| 28 | Homing on negative limit switch and Homing on positive home switch | negative |
| 29 | Homing on negative limit switch and Homing on negative home switch | positive |
| 30 | Homing on negative limit switch and Homing on negative home switch | negative |
| 33 | Homing on the index pulse | negative |
| 34 | Homing on the index pulse | positive |
| 35 | Homing on the current position | - |
| 37 | Homing on the current position | - |

# Object:0x607C Use of the object 0x607C Homing Offset

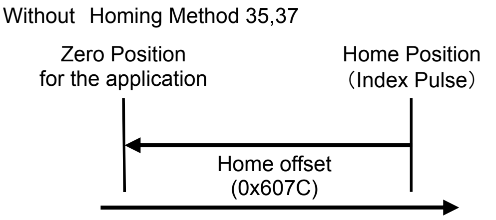
The set homing offset (0x607C) is used to calculate actual position during homing. Homing offset can be always Written, however is used only in the homing mode to re-calculate actual position.

The position actual value (0x6064) is the current software position in the amplifier. It is based on the unprocessed position encoder information (single or multi turn encoder).

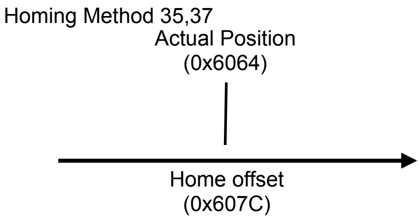
For a single turn encoder the single turn information represents the position actual value. For a multi turn encoder the multi turn information represents the position actual value.

Settings of actual position calculation method”.

The actual position (0x6064) in home position during homing is as follows:


Without Homing Method 35,37

Zero Position = Home Position +Home offset (0x607C)

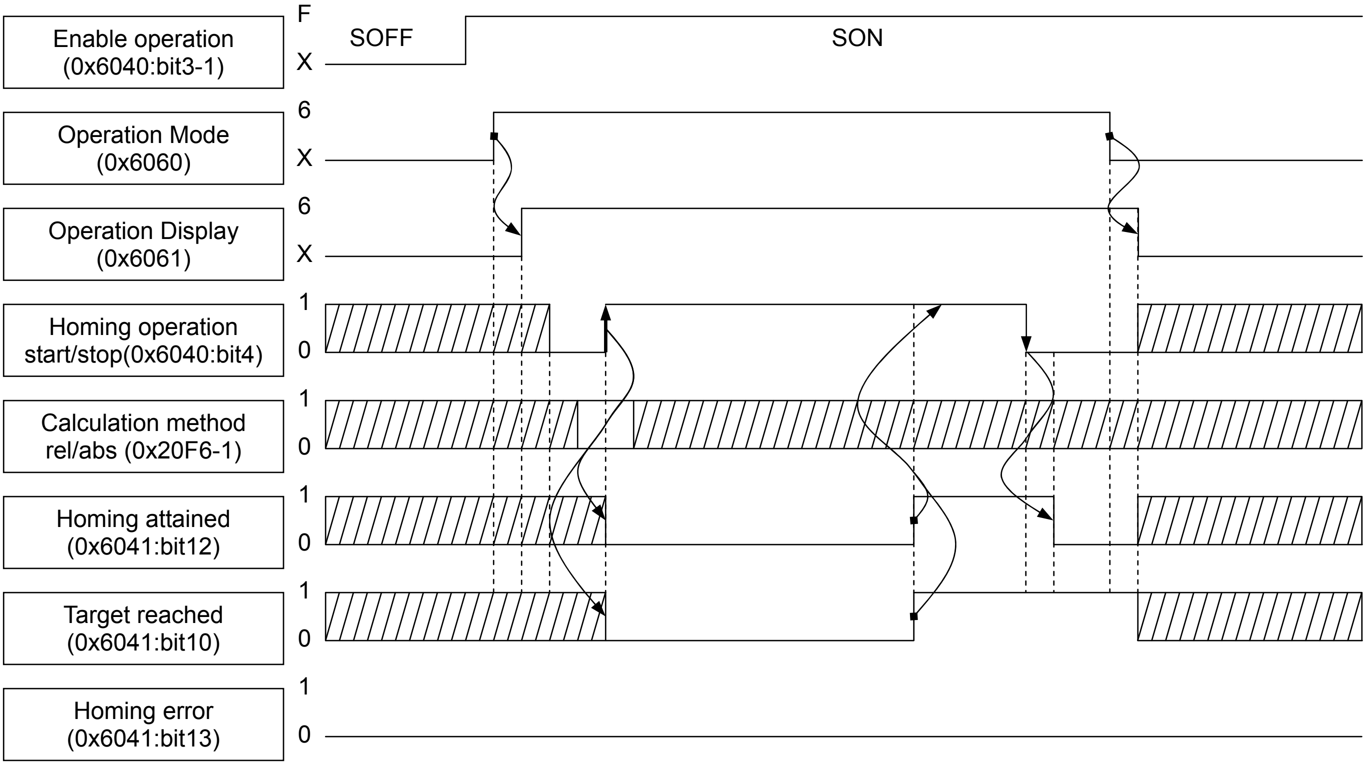

Homing Method 35,37

Actual Position(0x6064) = Home offset (0x607C)

The following figures show sequences in the homing mode of Control word (0x6040), Operation mode (0x6060) and Operation display (0x6061).

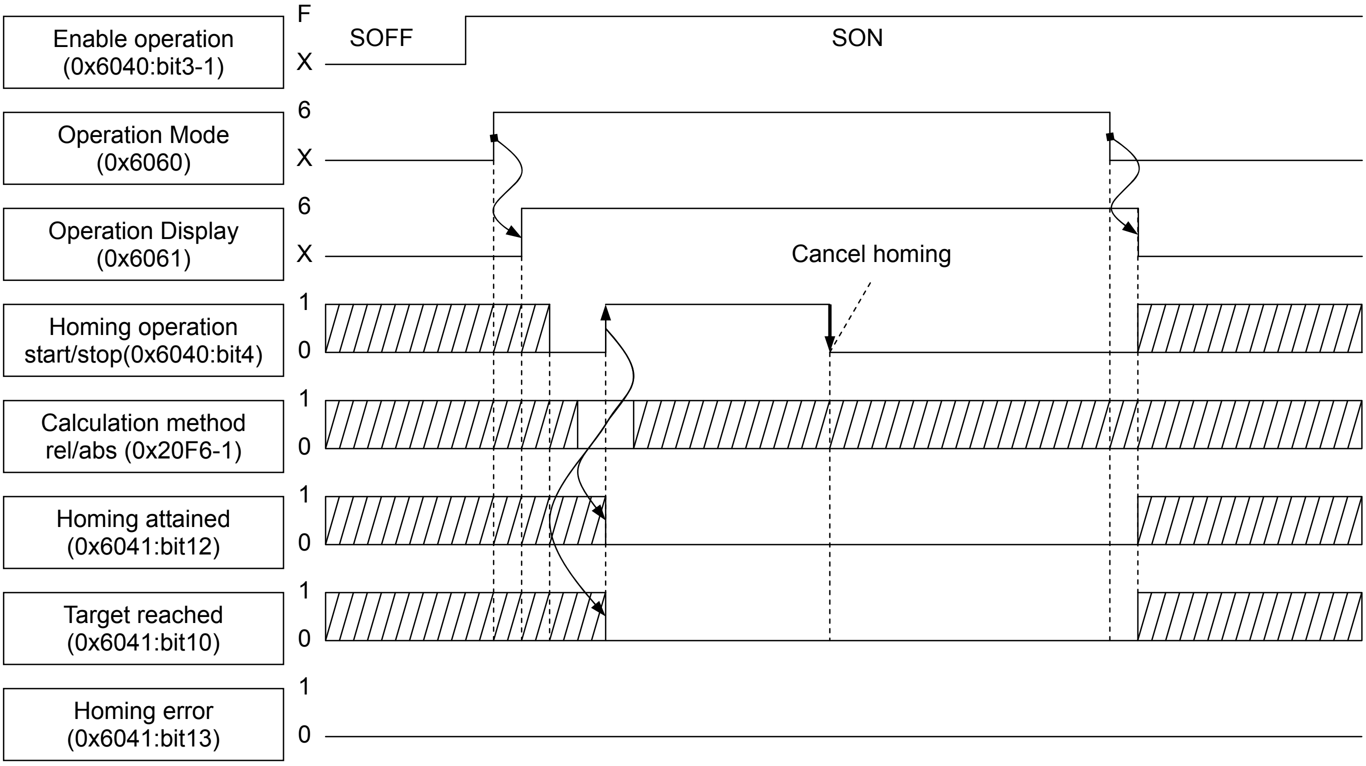
The following sequence shows homing modes corresponding to the Amplifier of Servo Amplifier

1) Start and completion sequence of homing mode



Homing sequence

2) Cancel before homing completion



Homing Cancel sequence

# Definitions of general purpose input signals in the homing mode

1) In the homing mode, input allocation and sequence of positive limit switch (CC:OT) and negative limit switch (CCW:OT) are determined by setting of 0x01:Positive limit switch and 0x02:negative limit switch in 0x20F0.
2) The home switch in a homing mode is allocated an exclusive use connector CONT1 (Home Switch) automatically.
This is dual input both of general-purpose input and exclusive input. Therefore, when you use Home switch input, set 0x20F8 General input function selection as “00: CONT1 Always_OFF”.
* If CONT1 is allocated to the other operation, a homing may not work normally.
* The definition of home switch setting is fixed as follows:
・Home switch is on: Photocoupler of the amplifier is on
・Home switch is off: Photocoupler of the amplifier is off

3) For the Homing Switch, CONT1 is assigned exclusively. So, the homing using Home Switch is not able to use by multiple axis.
For the other axis excepting Home Switch use axis, use the homing without Home Switch.

# Homing mode which cannot use with multiple axis

| | |
|---|---|
| Homing Method [3][4] | :Homing on positive home switch and index Pulse |
| Homing Method [5][6] | :Homing on positive home switch and index Pulse |
| Homing Method [7][8][9][10] | :Homing on positive home switch, home switch and index Pulse |
| Homing Method [11][12][13][14] | :Homing on negative home switch, home switch and index Pulse |
| Homing Method [19][20] | :Homing on positive home switch |
| Homing Method [21][22] | :Homing on negative home switch |

# Operation direction by homing method

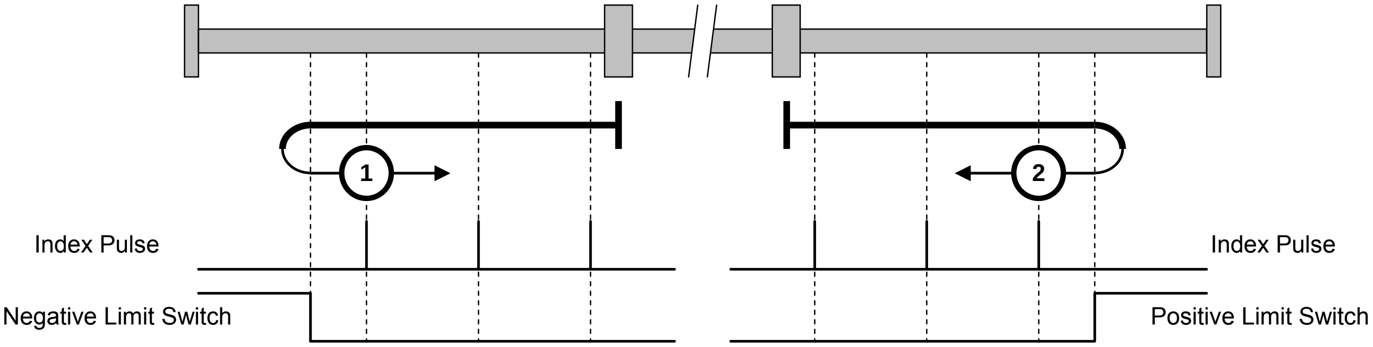
Move direction in each homing drawing and rotation direction are depending on 0x607E: Polarity.
Move direction in drawing and motor rotation direction are shown below.

| 0x607E Polarity | Move to right/ Positive rotation (Actual position increased) | Move to left/ Negative rotation (Actual position decreased) |
|---|---|---|
| 0x00 (Position polarity Bit7＝0) | CW | CCW |
| 0xE0 (Position polarity Bit7＝1) | CCW | CW |

# Homing Method [1]: Homing on negative limit switch and index Pulse
# Homing Method [2]: Homing on positive limit switch and index Pulse

In the method [1], the initial direction of movement shall be leftward (negative rotation) if the negative limit switch is inactive. The home position shall be at the first index pulse to the right of the position (positive side) where the negative limit switch becomes active.

And using the method [2] , the initial direction of movement shall be rightward (negative rotation) if the positive limit switch is inactive The position of home shall be at the first index pulse to the left of the position (negative side) where the positive limit switch becomes inactive.

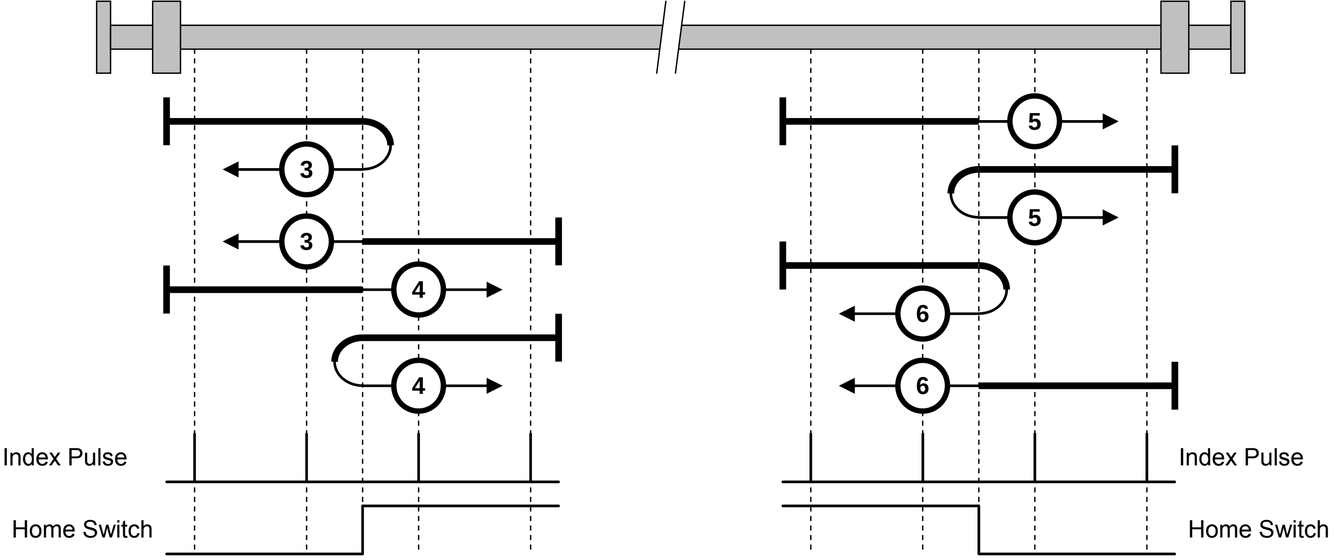


[1]Homing on negative limit switch and index pulse [2] Homing on positive limit switch and index pulse

0x6099, 0x01: Speed during search for switch
0x6099, 0x02 : Speed during search for zero

# Homing Method [3][4]: Homing on positive home switch and index Pulse
# Homing Method [5][6]: Homing on positive home switch and index Pulse

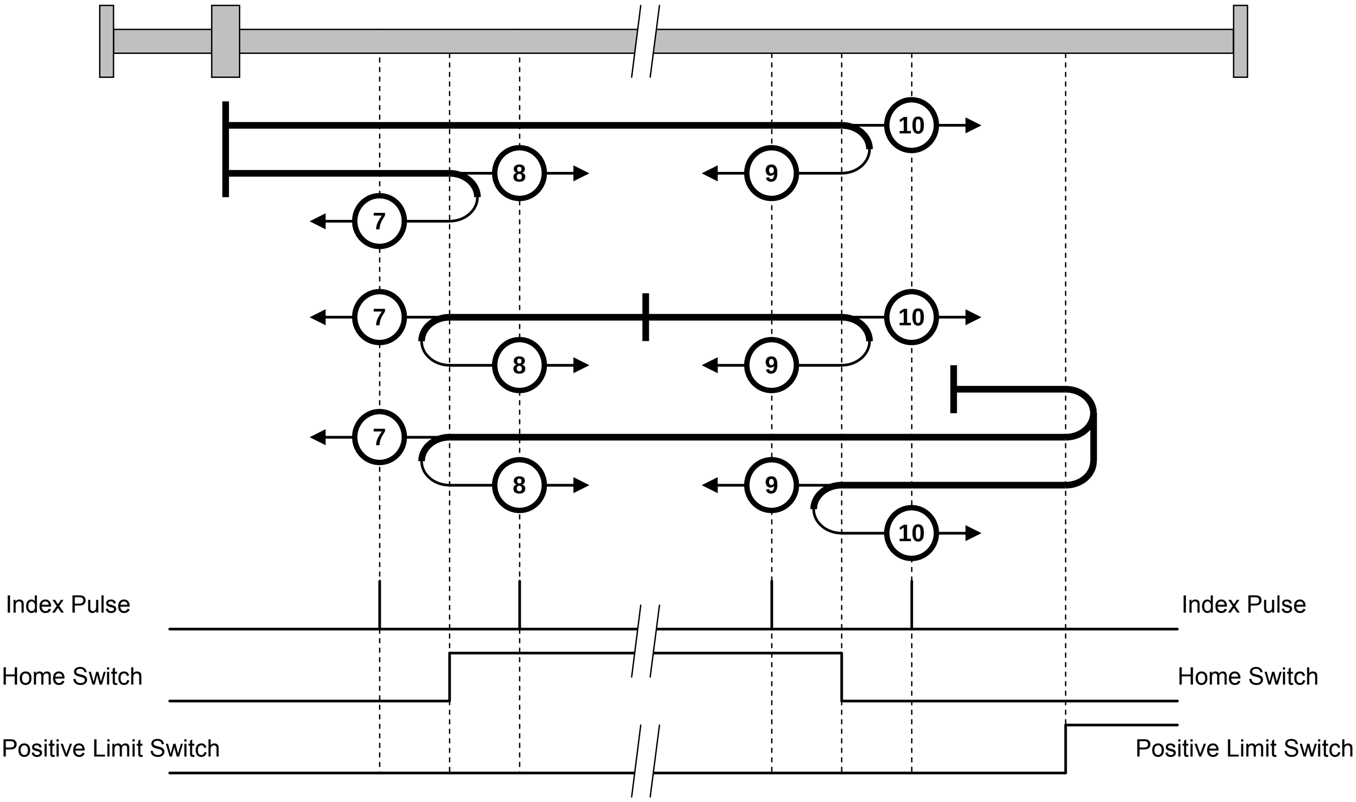
Using these methods as shown in the below figure, the initial direction of movement shall be dependent on the state of the home switch input. In the method [3] and [6], the home position shall be at the left position where the home switch changes state, and in the method [4] and [5], the home position shall be at the initial index pulse to the right of the point where the home switch changes state. If the initial position is situated so that the direction of movement shall reverse during homing, the point at which the reversal takes place is anywhere after a change of state to the home switch.



[3] Homing on positive home switch and index pulse (Neg)
[4] Homing on positive home switch and index pulse (Pos)

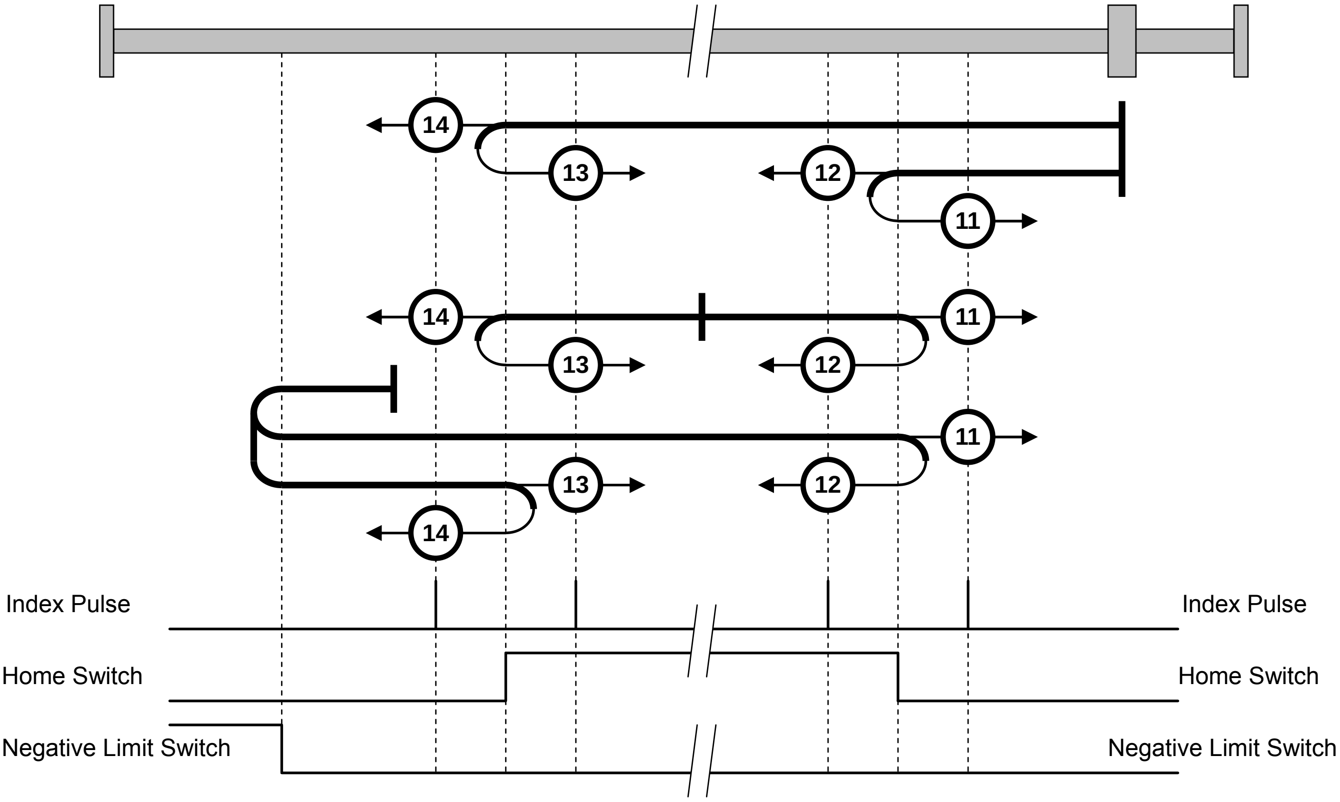
[5] Homing on positive home switch and index pulse (Pos)
[6] Homing on positive home switch and index pulse (Neg)

# Homing Method [7][8][9][10]: Homing on positive home switch, home switch and index Pulse



| | |
|---|---|
| [7] | Homing on positive limit switch, homing on positive home switch and index pulse (Neg) |
| [8] | Homing on positive limit switch, homing on positive home switch and index pulse (Pos) |
| [9] | Homing on positive limit switch, homing on negative home switch and index pulse (Neg) |
| [10] | Homing on positive limit switch, homing on negative home switch and index pulse(Pos) |

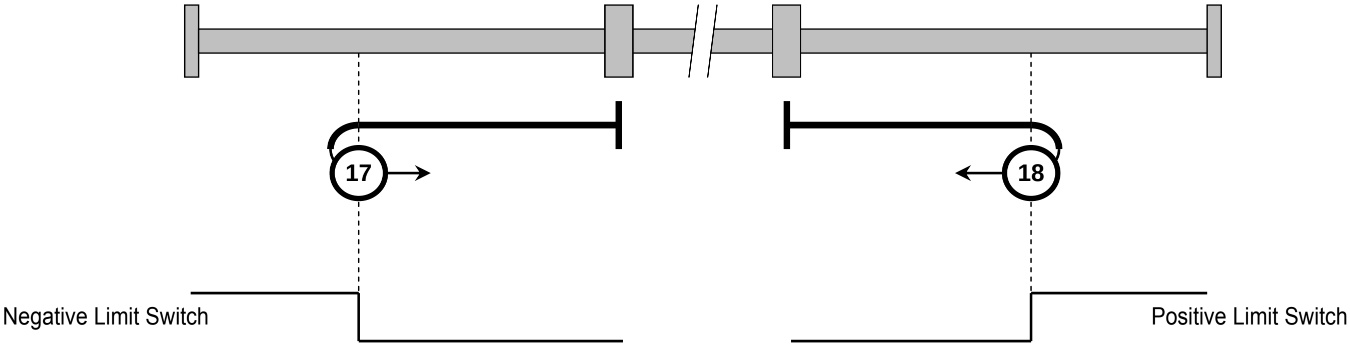
# Homing Method [11][12][13][14]: Homing on negative home switch, home switch and index Pulse



[11] Homing on negative limit switch, homing on positive home switch and index pulse (Pos)
[12] Homing on negative limit switch, homing on positive home switch and index pulse (Neg)
[13] Homing on negative limit switch, homing on negative home switch and index pulse (Pos)
[14] Homing on negative limit switch, homing on negative home switch and index pulse (Neg)

# Homing Method [17]: Homing on negative limit switch
# Homing Method [18]: Homing on positive limit switch

In the method [17], the initial direction of movement shall be leftward (Negative rotation) if the negative limit switch is inactive. The home position shall be at the potision by the negative limit switch becomes active.
And using the method [18] , the initial direction of movement shall be rightward (positive rotation) if the positive limit switch is inactive The position of home shall be at the position by the positive limit switch becomes active.
Positive Limit Switcha and Negative Limit Switch used in homing method [17] and [18] cannot be used for the inputs other than the following versatile input: CONT1, CONT2, CONT3. Error occurs when homing is enabled, if set to CONT4, 5, 6, 7 and8.

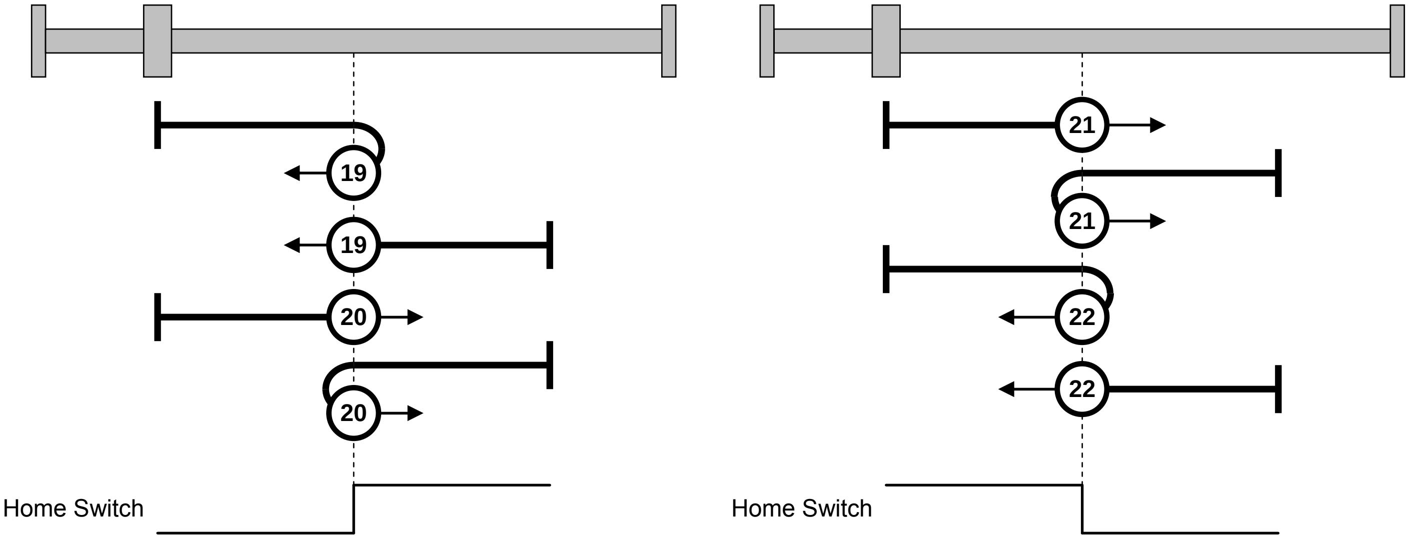


[17] Homing on negative limit switch

[18] Homing on positive limit switch

# Homing Method [19][20]: Homing on positive home switch [21][22]: Homing on negative home switch

There methods are similar to methods 3 to 6 that the home position is not dependent on the index pulse but only depend on the relevant home or limit switch transitions. The initial move direction depending on state of home switch and the move direction at home switch change are matched as follows: [3]=[19], [4]=[20], [5]=[21], [6]=[22].

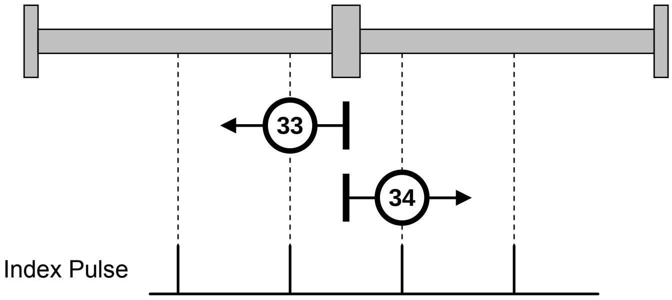


[19] Homing on positive home switch (negative direction stop)
[20] Homing on positive home switch (positive direction stop)

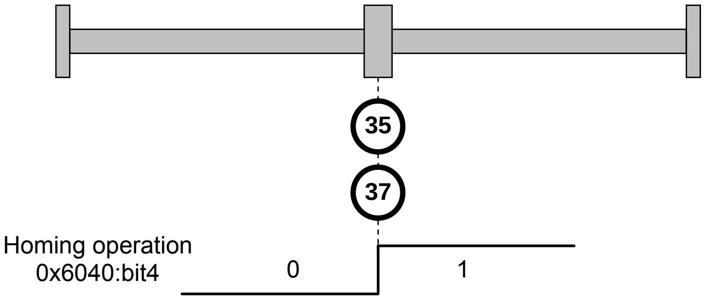
[21] Homing on negative home switch (positive direction stop)
[22] Homing on negative home switch (negative direction stop)

\# Homing Method [33][34]: Homing on index Pulse
\# Homing Method [35][37]: Homing on current position

In homing method [33][34], the home position shall be at the nearest index pulse that is found in the selected direction ([33] is negative direction, [34] is positive direction).
In homing method [35][37], the current position shall be taken to be the home position. This method does not require the drive device to be in operation-enabled state (Servo-ON).
Note) However, the actual position calculation method is only absolute homing.



[33] Homing on negative direction Index Pulse
[34] Homing on positive direction Index Pulse

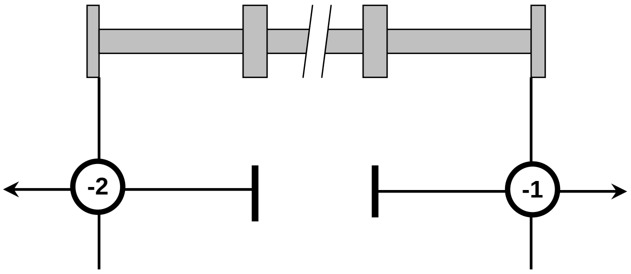


[35][37]Homing on Current position Note)

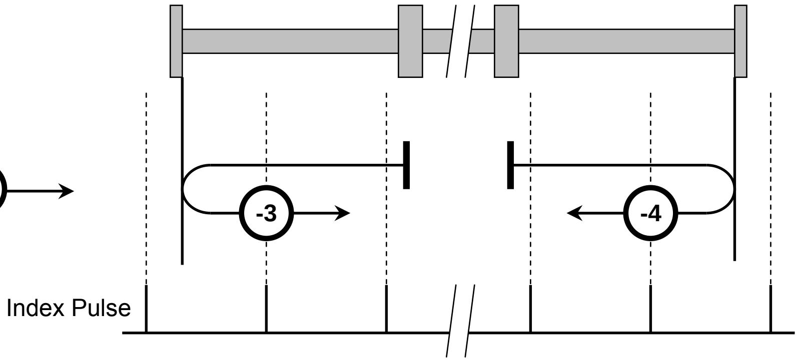
Note) Homing method [35]: Homing on current position is void at CiA402 Work Draft CANopen Drive and motion control device profile part2 Version：3.0.1.13 (26 April 2012)

\# Homing Method [-1] [-2]: Homing on hard stop Note
\# Homing Method [-3] [-4]: Homing on hard stop and index pulse Note

Note) Methods [-1] to [-4] are manufacturer-specific methods.
In homing methods [-1] and [-2], the direction of homing is positive or negative respectively.
The home position shall be the mechanical end where the motor stopped.
In homing methods [-3] and [-4], the direction of homing is negative or positive respectively.
The home position shall be the first index pulse after reversing at the mechanical end where the motor stopped.



[-1] Homing on hard stop in negative direction
[-2] Homing on hard stop in positive direction



[-3] Homing on hard stop and index pulse in positive direction
[-4] Homing on hard stop and index pulse in negative direction

& Home position retention function when using absolute system

Execution result of “OD: 0x6098 Homing method 35 (Homing to present position)“ can be retained by performing all parameters retention in “OD: 0x1010 Store parameter,” and then the origin coordinate shall be retained in “OD: 0x6064: Actual position” even when re-turning on the power next time.
In this regard, however if any encoder clear or battery errors occur, correct origin coordinate shall not be presented, so re-homing is required. Absolute system homing “origin coordinate retention procedure” is shown below:

Step 1 Preparation of homing
OD: 0x6098 Set homing method to “35 (0x23): Homing to present position.”
OD: 0x607C Setting of home offset (When using ”0: Absolute homing,” set the position you want to set to “detection reference position,“when using”1: Relative position homing,” set to zero.)
OD：0x6060 Change operation mode to ”6: Homing mode.”

Step 2 Homing start
OD: 0x6040 Set “Control word, Bit4＝1 (0x0010): Homing start.”

Step 3 Confirmation of reference position detection
OD: 0x6041 Monitor “Status word, Bit12＝1: Homing completed.”
When performing “0: Absolute homing,” proceed to step 5, when performing “1: Relative homing,” proceed to step 4.

Step 4 Setting of home offset
OD: 0x210C Calculate “OD: 0x607C Home offset” value from home index position to set.
Home offset (0x607C) = Origin coordinate after homing completed - Home index (0x210C)

Step 5 Homing completion
Exit “OD: 0x6040 Control word, Bit4 = 0 (0x0000): Homing,” and then change the control mode back to the one using “OD: 0x6060 Operation mode.”

Step 6 Storage of origin coordinate
Write ”0x65766173” in “Sub-Idx01: All parameters storage” of “OD: 0x1010 Parameter storage.”

Step 7 Confirmation of storage completion
Storing is completed by turing back to “Sub-Idx01=1” of “OD：0x1010 Parameter storage.”
(0: Now in storing)

- ✔ In use of absolute system, it is not available except homing method 35 (0x23).
- ✔ To clear stored “origin coordinate after homing completed,” perform encoder clear, and then re-perform parameter retension procedure (step 6 and 7).

0x6040:Control Word (Homing Mode: hm)

| | | | | | |
|---|---|---|---|---|---|
| Index Ax1 0x6040<br>Ax2 0x6840<br>Ax3 0x7040<br>Ax4 0x7840 | This object indicates the Operation Mode Specific bit and Manufacturer Specific bit in Homing Mode. | | Object code | | Variable |
| Sub-Idx | Description | Data Type | Access | PDO | Initial value |
| 0x00 | Control Word [CWORD]<br>*For details on Bit 7,3,2,1 and 0, see the table of Control Word Bit Pattern Command. | Unsigned16 | RW | Possible | 0x0000 |
| | | Range | 0x0000-0xFFFF | | |

MSB LSB

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Csete n | - | Eclr | - | Halt | Fr* | Reserved | Res | Homing operation start | Hs* | Qs* | Ev* | So* |
| 15 | 14..13 | 12 | 11..9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |

bit4:Homing operation start [Homing operation start]
Start or continue homing procedure

bit8: HALT ［HALT］
0：Homing function enable （Enable bit4）
1：Stop axis according to halt option code (0x605D)

0x6041:Status Word(Homing Mode: hm)

<table>
<tr><td colspan="2">Index Ax1 0x6041<br>Ax2 0x6841<br>Ax3 0x7041<br>Ax4 0x7841</td><td colspan="2">This object indicates Operation Mode Specific bit and Manufacturer Specific bit in Homing Mode.</td><td colspan="2">Object code</td><td>Variable</td></tr>
<tr><td>Sub-Idx</td><td colspan="2">Description</td><td>Data Type</td><td>Access</td><td>PDO</td><td>Initial value</td></tr>
<tr><td rowspan="2">0x00</td><td colspan="2" rowspan="2">Status Word [STSWORD]<br>*For details on Bit 6, 5, 3, 2, 1 and 0, see the Status Word List Bit Pattern.</td><td>Unsigned16</td><td>RO</td><td>Possible</td><td>0x0000</td></tr>
<tr><td>Range</td><td colspan="3">0x0000-0xFFFF</td></tr>
</table>

MSB LSB

| Csetfix | Csetpro | Homing error | Homing attained | Internal Limit active | Target reached | Rm | Res | W | Sod* | Qs* | Ve | F* | Oe* | So* | Rtso* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |

bit4:Voltage Enabled [Voltage Enabled]
0:Voltage disenabled 1:Voltage enabled

bit7:warning [warning]
0:No warning 1:warning condition

bit9:remote [remote]
0: Control word is not processed
1: Being processed by control word

bit11:Internal Limit active [Internal Limit active]
0:nomal operation
1:Software Position limit ,CW limit/CCW limit

| bit13 | bit12 | bit10 | Discription |
|---|---|---|---|
| 0 | 0 | 0 | Homing procedure is in progress |
| 0 | 0 | 1 | Homing procedure is interrupted or not started |
| 0 | 1 | 0 | Homing is attained, but target is not reached |
| 0 | 1 | 1 | Homing procedure is completed successfully |
| 1 | 0 | 0 | Homing error occurred, velocity is not 0 |
| 1 | 0 | 1 | Homing error occurred, velocity is 0 (ZV) |
| 1 | 1 | X | Reserved |

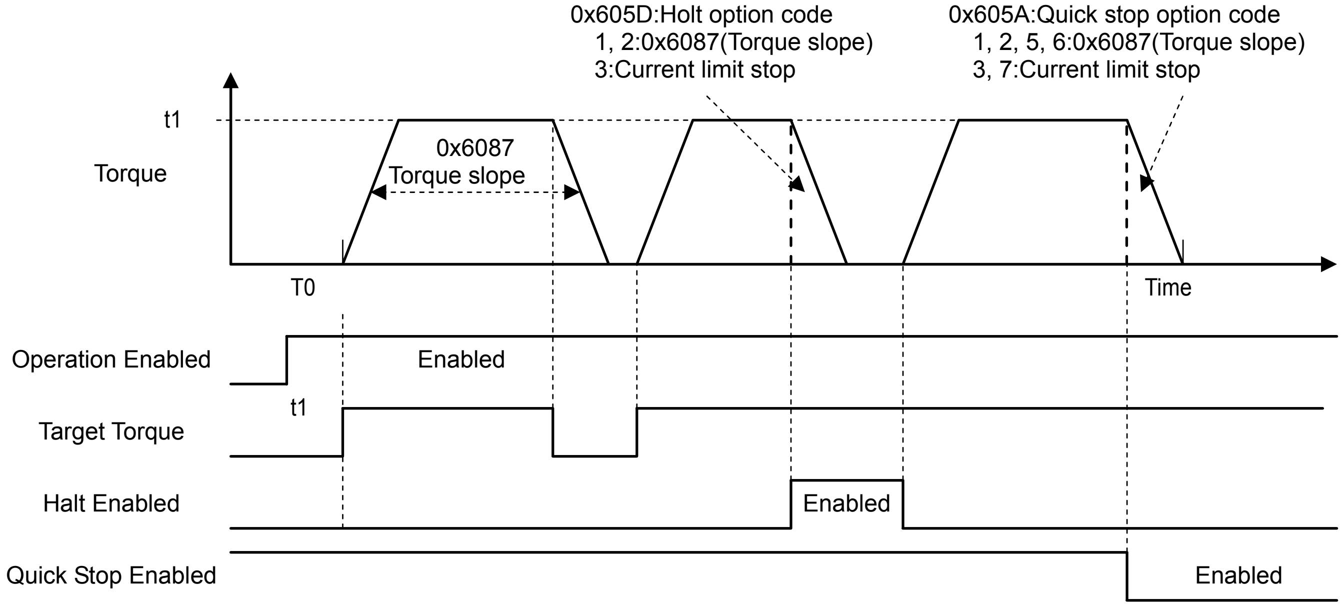
## 11) Function Group “Torque (force)”

### # Abstract of Function Group “Torque (force)”

As for function group ” Torque (force)” Mode, “Profile Torque (force) Mode” and ”Cyclic Synchronous Torque (force) Mode” are supported.
0x6060: If Operation Mode is set “4”, it is operated by Profile torque (force) mode. If it is set “10”, Cyclic synchronous torque (force) mode is operated. The below list indicates the main Objects as for function group “Torque (force)”.

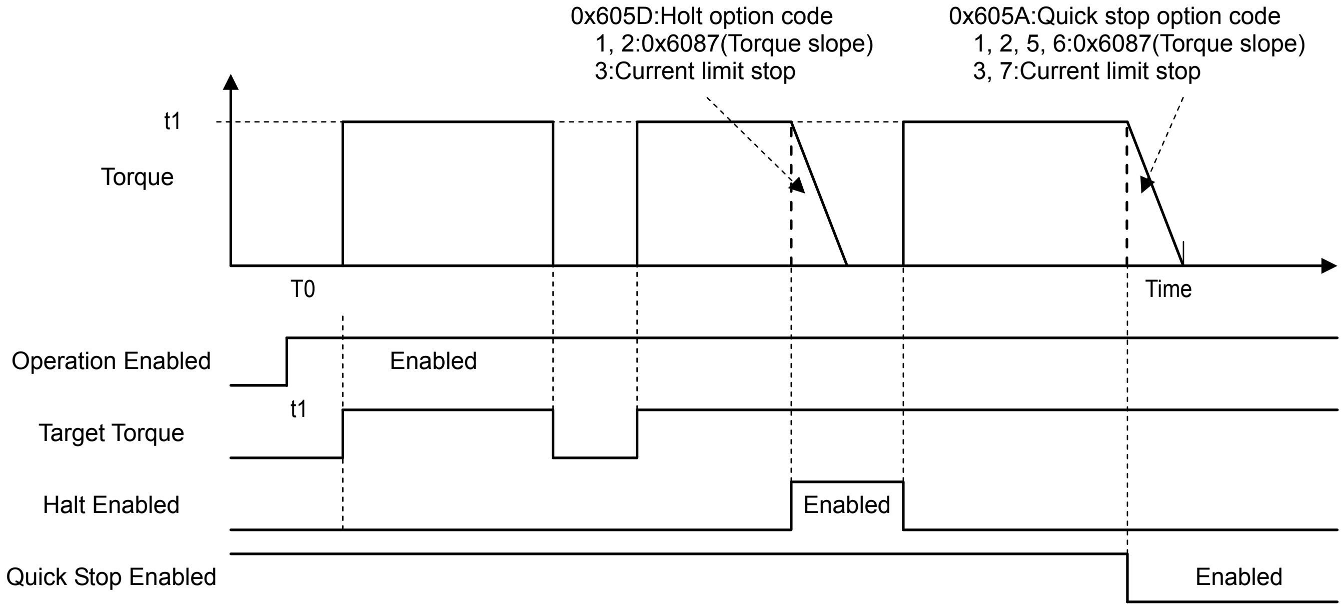
## 12) Profile torque (force) mode

In this mode, trajectory is generated by the slave.
The master (Control Device) transmits 0x6071: Target torque (force) through Cyclic Sync mode or Asynchronous mode, and the slave makes control of velocity and torque (force).
And also, be able to give slope reaching the target torque (force) by setting 0x6087: Torque Slope.

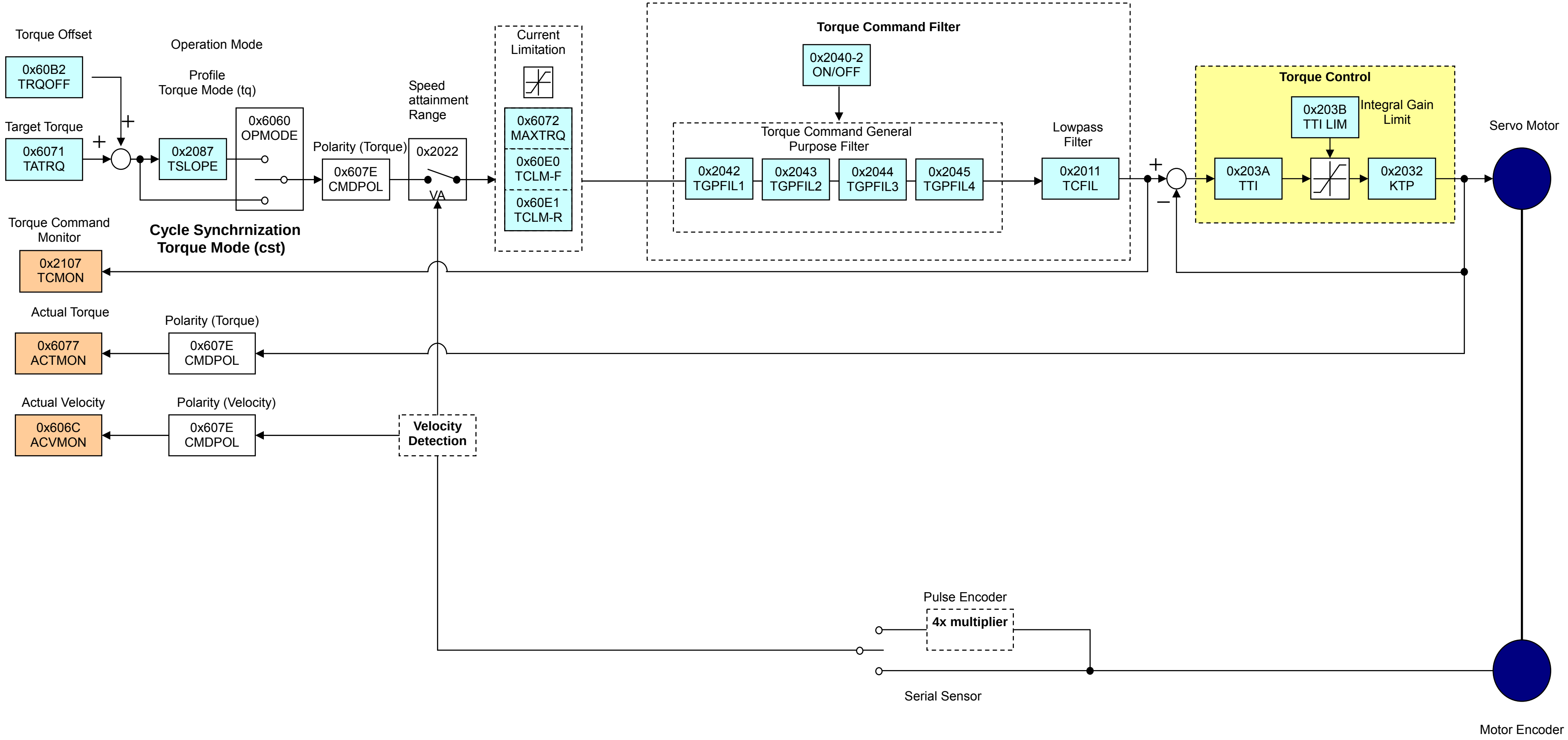


## 13) Cyclic Synchronous torque (force) mode

In this mode, trajectory is generated by the master, not the slave.
The master (Control Device) transmits 0x6071: Target torque (force) through Cyclic Sync mode, and the slave makes control of torque (force).
0x6087 Torque (force) slope functions only in Holt or Quick stop operation.



Block diagrams of Function Group “Torque” mode are indicated in the following pages.



Block Diagram with Function Torque Mode

0x6040:Control word (Cyclic synchronous torque (force) mode: cst, Profile torque (force) mode:tq)

| | | | | | |
|---|---|---|---|---|---|
| Index Ax1 0x6040<br>Ax2 0x6840<br>Ax3 0x7040<br>Ax4 0x7840 | This object indicates operation mode specific bits and manufacturer specific bits of the Cyclic synchronous torque (force) mode (cst) and Profile torque (force) mode (tq) | | Object code | | Variable |
| Sub-Idx | Description | Data Type | Access | PDO | Initial value |
| 0x00 | Control word [CWORD]<br>* See the Command table for "Control word bit pattern (Bit 7, 3, 2,1, 0,) command | Unsigned16 | RW | Possible | 0x0000 |
| | | Range | 0x0000-0xFFFF | | |

MSB LSB

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Csetein | - | Eclr | - | Halt | Fr※ | Reserved | Reserved | Reserved | Hs* | qs* | ev* | so* |
| 15 | 14..13 | 12 | 11..9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |

bit8:HALT [HALT]
0:Accept Torque Command(Enable bit4)
1:Stop axis according to halt option code (0x605D)

0x6041:Status word (Cycle synchronous torque (force) mode: cst, Profile torque (force) mode: tq)

| | | | | | |
|---|---|---|---|---|---|
| Index Ax1 0x6041<br>Ax2 0x6841<br>Ax3 0x7041<br>Ax4 0x7841 | This object indicates Operation modes specific and Manufacturer specific bits of Cycle synchronous torque (force) mode: cst, Profile torque (force) mode: tq | | Object code | | Variable |
| Sub-Idx | Description | Data Type | Access | PDO | Initial value |
| 0x00 | Status word [STSWORD]<br>* See the Pattern Status table for "Status word bit pattern (Bit 6,5, 3,2,1,0,) | Unsigned16 | RO | Possible | 0x0000 |
| | | Range | 0x0000-0xFFFF | | |

MSB LSB

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Csetfix | Csetpro | Res | Target Value Ignored | Internal Limit active | Tr | Rm | Res | W | Sod* | Qs* | Ve | F* | Oe* | So* | Rtso* |
| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |

Bit4:Voltage Enabled [Voltage Enabled]
0:voltage disenabled 1:voltage enabled

bit7:warning [warning]
0:No warning 1:warning condition

bit9:remote [remote]
0: Control word is not processed
1: Being processed by control word

bit10:Target reached [Target reached]
1: Reached at target torque
"1" is set when actual torque is torque attainment range or more.
Actual torque attainment output is set to "1" when it is over "OD: 0x202E Torque attainment set value" depending on selection of "OD: 0x20F0.6 Motor rated torque ratio" or "torque limit ratio."
Also set to "1" in the halt state, when quick stop operation activated (quick stop option code-2, 5, 6, and 7), and operational mode change completed (for about 1 minute set).

bit11:Internal Limit active [Internal Limit active]
0:nomal operation
1:Software Position limit ,CW limit/CCW limit

bit12:Target value ignored (Command enabled status)
[Target value ignored]
0: Target torque ignored.
1: Target torque to be used current control loop input.

## 14) Function Group “Touch Probe”

### Abstract of Touch Probe

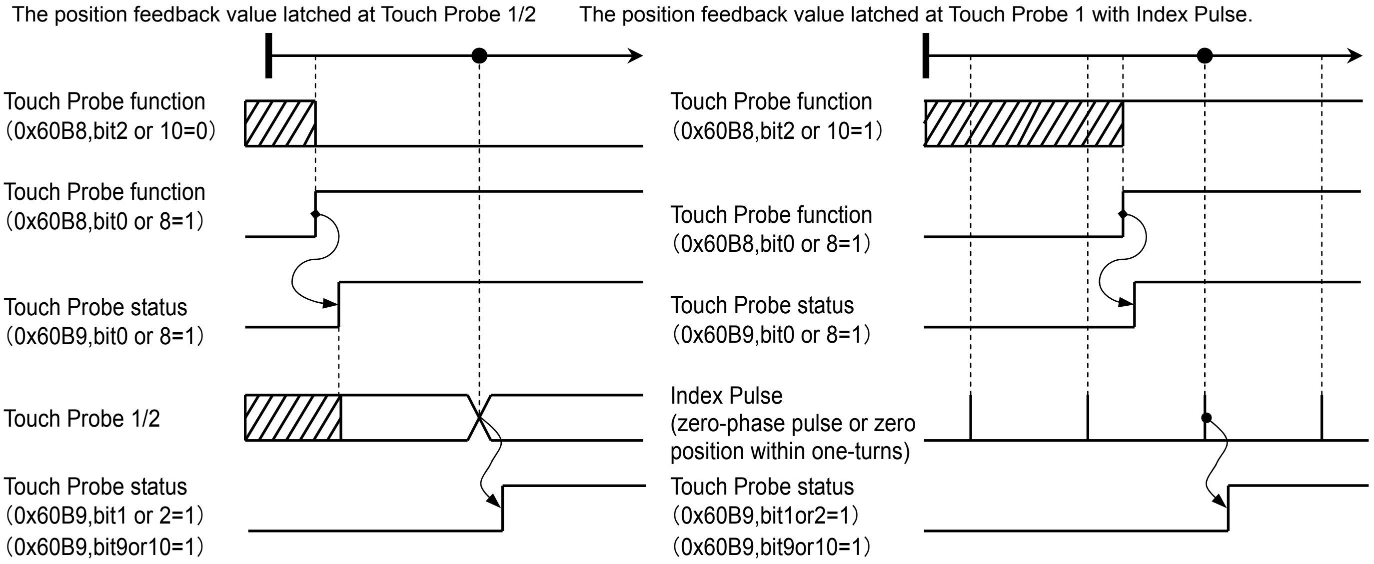
“Touch Probe function” is a latching function to latch the edge-triggered encoder position by digital input.
”Touch Probe in the event” is independent from NC cycle time function since it
latches the sensor position in the hardware of the slave, therefore, it enables capture it more precisely.
This amplifier provides two of channels - Touch Prove 1 (CONT1), Touch Probe 2 (CONT2) - for inputting “Touch Probe function”.
Set all of selections of General input functions in 0x20F8 to [00:Always function disabled] before using “Touch Probe function” , since the input channels are provided for dual-purpose input.
The objects used for “Touch Probe” are indicated in the following list.

Object Lists of Touch Probe

| Index | Sub-Index | Name | PDO Mapping |
|---|---|---|---|
| 0x60B8 | 0x00 | Touch Probe Function | Possible |
| 0x60B9 | 0x00 | Touch Probe Status | Possible |
| 0x60BA | 0x00 | Touch probe pos 1 pos value (positive edge) | Possible |
| 0x60BB | 0x00 | Touch probe pos 1 neg value (negative edge) | Possible |
| 0x60BC | 0x00 | Touch probe pos 2 pos value (positive edge) | Possible |
| 0x60BD | 0x00 | Touch probe pos 2 neg value (negative edge) | Possible |

- Touch prove 1 (CONT1) signal can be triggered with “touch prove 1 input or position encoder index pulse $^{\text{Note 1}}$” by “0x60B8, bit 2: Trigger selection.”
- Touch prove 2 (CONT2) signal can be triggered with “touch prove 2 input or position encoder index pulse $^{\text{Note 1}}$” by “0x60B8, bit 10: Trigger selection.”

Note1) When setting trigger with position encoder index pulse, if you use incremental encoder Z-phase is used, if you use absolute encoder, “the position that absolute data within single turn is zero” is used as index.
The sequence of Touch Probe Function is indicated as follows.

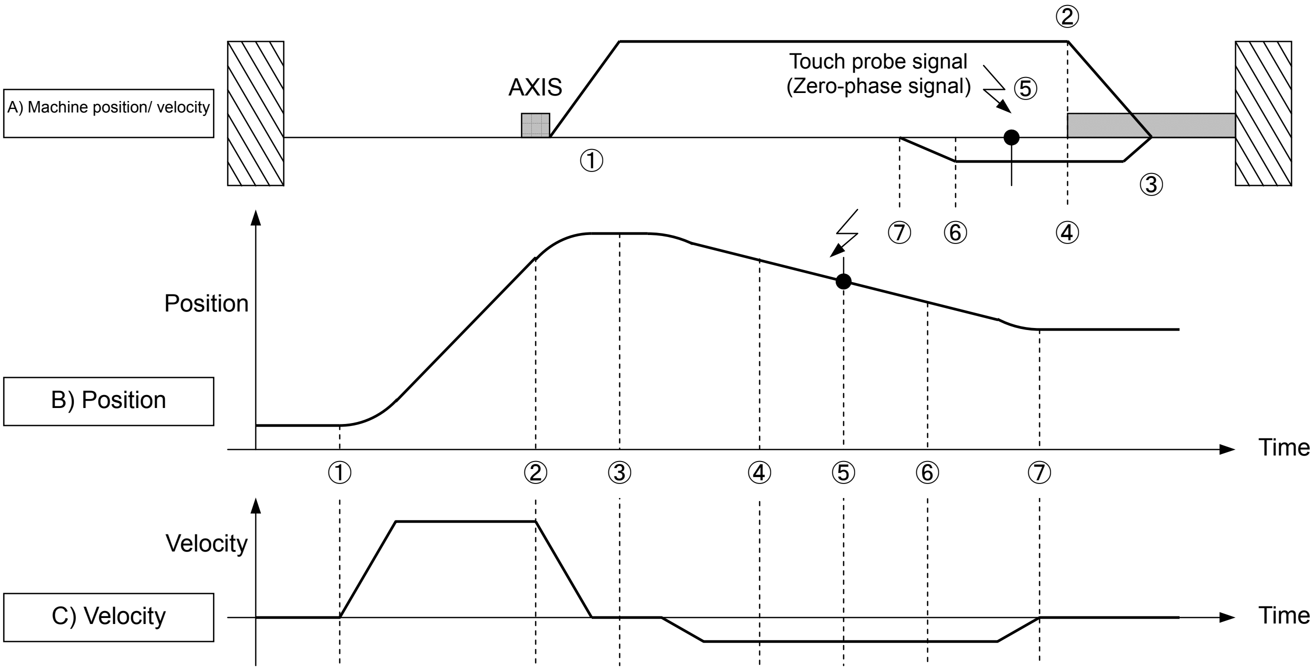

The position feedback value latched at Touch Probe 1/2 The position feedback value latched at Touch Probe 1 with Index Pulse.

The position value of positive edge latched at Touch Probe 1 (position encoder index pulse) is stored in 0x60BA
The position value of negative edge latched at Touch Probe 1 (position encoder index pulse) is stored in 0x60BB
The position value of positive edge latched at Touch Probe 2 (position encoder index pulse) is stored in 0x60BC
The position value of negative edge latched at Touch Probe 2 (position encoder index pulse) is stored in 0x60BD

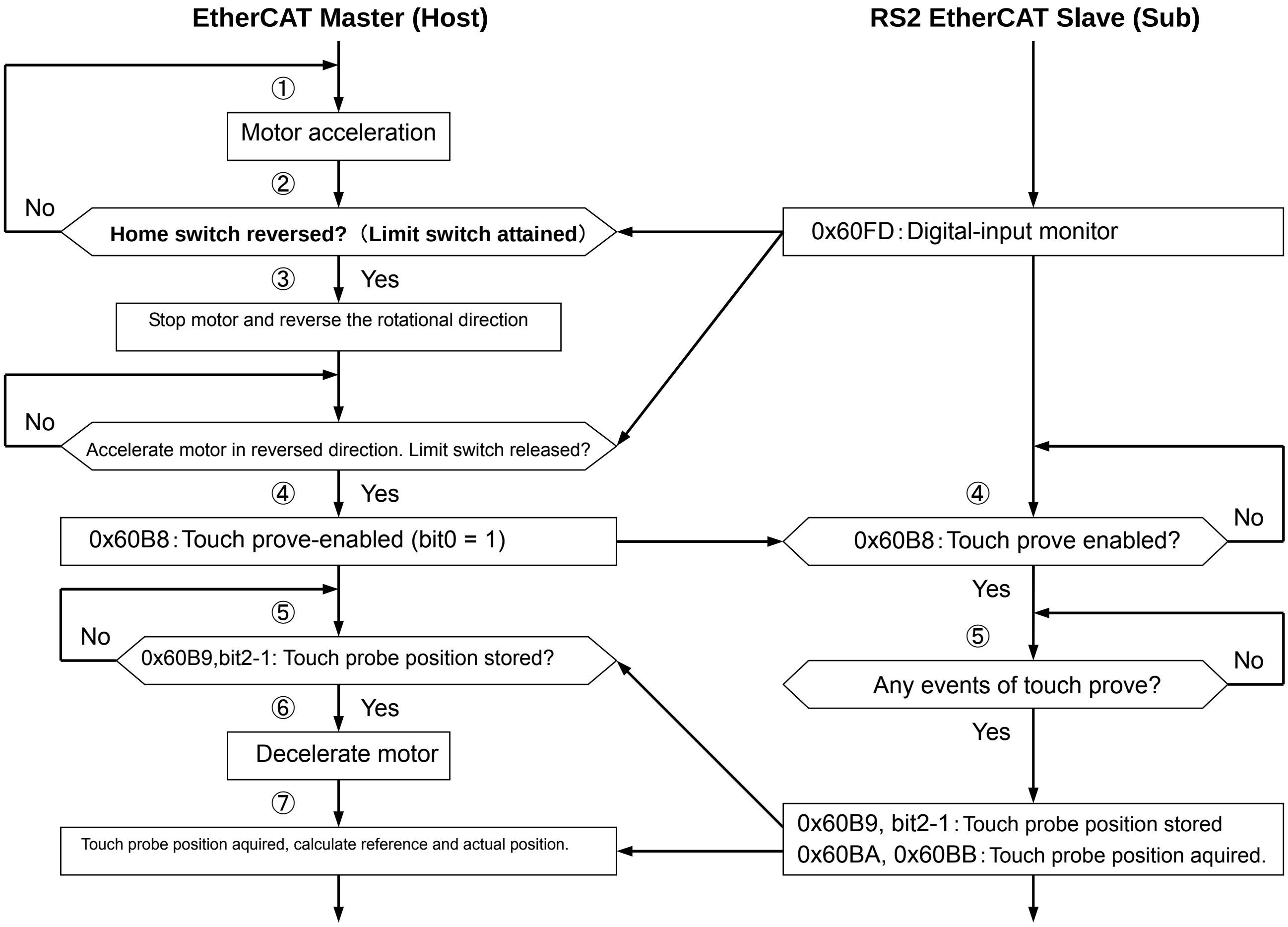
The position value latched by Touch Probe function

& Master-led homing (Touch probe homing method): Homing with touch-probe (without Limit Switch)

EtherCAT-support is recommended for touch probe homing to support correct and fast homing. Toucn probe events can be accurately captured as the events function separately inside slave hardware, unlike master/ slave sampling frequency. Examples of homing using tuch probe function are shown below:



Master-based homing using touch probe
*A) shows machine axis position, the red line shows velocity, B) shows motor position chart, and C) shows motor velocity chart.



Example of touch prove homing procesure

## 15) Operation Mode Parameter (Profile Area)

0x6060:Operation Mode

| | | | | |
|---|---|---|---|---|
| Index | Ax1 0x6060<br>Ax2 0x6860<br>Ax3 0x7060<br>Ax4 0x7860 | Indicates requested operation mode. | Object Code | Variable |

| Sub-Idx | Description | Data Type | Access | PDO | Initial Value |
|---|---|---|---|---|---|
| 0x00 | Operation Mode [OPMODE]<br>0 :No Mode/Mode is not assigned.<br>1 :(pp) Profile Position Mode<br>2 : Reserved<br>3 :(pv) Profile Velocity Mode<br>4 :(tp) Torque (force) Profile Mode<br>5 : Reserved<br>6 :(hm) Homing Mode<br>7 :(ip) Interpolated position mode<br>8 :(csp) Cycle Sync. Position Mode<br>9 :(csv) Cycle Sync. Velocity Mode<br>10 :(cst) Cycle Sync. Torque (force) Mode | Integer8 | RW | Possible | 0x00 |
| | | Setting Range | 0x00 - 0x0A<br>(0 to 10) | | |

* When this parameter is read, setup "operation mode" is read out.
Operation mode under actual operation serves as "Operation Mode Display" (0x6061).

* Make sure to change at the time of the main power supply OFF, Servo-off, or motor stop.

* Changing mode while motor rotating is dangerous. Make sure to change at the time of the main power supply OFF, Servo-off, or motor stop.

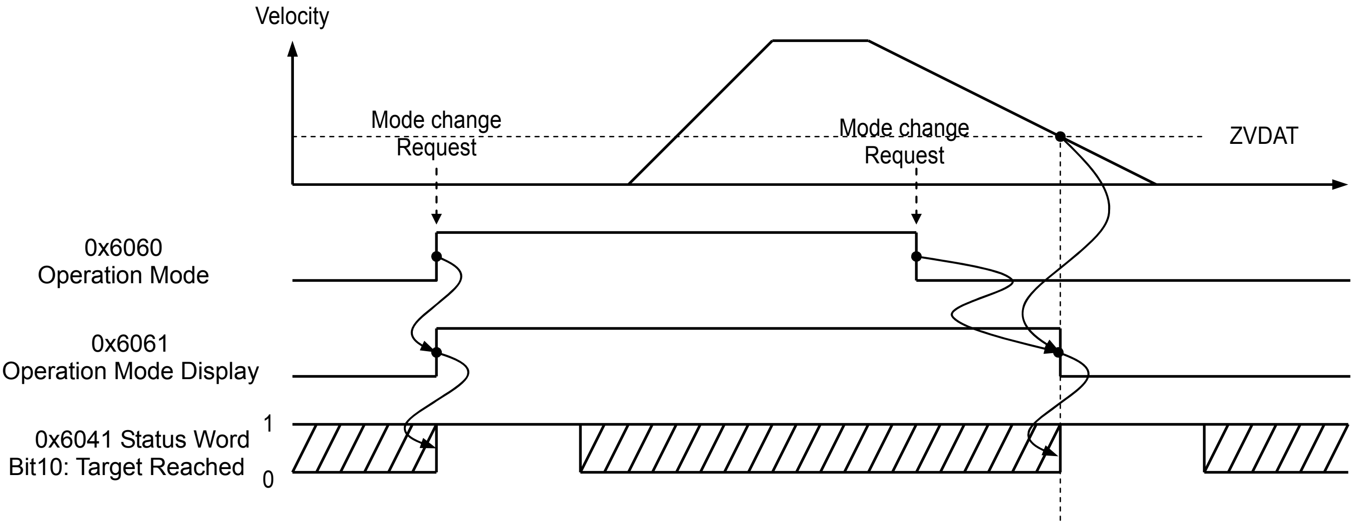
* Servo ON is not available when operation Mode is set “0”.

0x6061:Operation Mode Display

| | | | | |
|---|---|---|---|---|
| Index | Ax1 0x6061<br>Ax2 0x6861<br>Ax3 0x7061<br>Ax4 0x7861 | Indicates actual operation mode.<br>Definition is the same as 0x6060: Operation Mode. | Object Code | Variable |

| Sub-Idx | Description | Data Type | Access | PDO | Initial Value |
|---|---|---|---|---|---|
| 0x00 | Operation Mode Display [OPDISP]<br>0 : No Mode/Mode is not assigned.<br>1 :(pp) Profile position Mode<br>2 : Reserved<br>3 :(pv) Profile Velocity Mode<br>4 :(tp) Torque (force) Profile Mode<br>5 : Reserved<br>6 :(hm) Homing Mode<br>7 :(ip) Interpolated position mode<br>8 :(csp) Cycle Sync. Position Mode<br>9 :(csv) Cycle Sync. Velocity Mode<br>10 :(cst) Cycle Sync. Torque (force) Mode | Integer8 | RO | Possible | 0x00 |
| | | Display Range | 0x00 - 0x0A<br>(0 to 10) | | |

Operation modes changed at the time of motor rotation will be valid after the motor stops completely.



0x6062: Position Demand Value

| | | | |
|---|---|---|---|
| Index Ax1 0x6062<br>Ax2 0x6862<br>Ax3 0x7062<br>Ax4 0x7862 | Indicates the internal target position. | Object Code | Variable |

| Sub-Idx | Description | Data Type | Access | PDO | Initial Value |
|---|---|---|---|---|---|
| 0x00 | Target position ［PositionDemandValue］<br>Indicates the internal command when position control mode is in profile position mode<br>This command position update by the servo control cycle 125us. | Integer32 | RO | Possible | — |
| | | Display Range | 0x80000000～0x7FFFFFFF<br>（－2147483648～2147483647 Pulse） | | |
| | | Unit | Pulse | | |

0x6063: Internal Actual Position

| | | | |
|---|---|---|---|
| Index Ax1 0x6063<br>Ax2 0x6863<br>Ax3 0x7063<br>Ax4 0x7863 | Indicates real position of motor encoder. | Object Code | Variable |

| Sub-Idx | Description | Data Type | Access | PDO | Initial Value |
|---|---|---|---|---|---|
| 0x00 | Internal Actual Position [IACPMON]<br>Internal actual position data update by the servo control cycle 125us.<br>Monitor unit indicates the resolution of motor encoder to be used. | Integer32 | RO | Possible | - |
| | | Display Range | 0x80000000 - 0x7FFFFFFF<br>(-2147483648 to 2147483647 Pulse) | | |
| | | Unit | 1 pulse | | |
| | *Encoder combination: In the case of Absolute encoder<br>Effective bit length=Multiply 1 rotation resolution by multiple-rotation bit, effective bit length become ”x” unfixed.<br>* Encoder combination: In the case of Incremental encoder<br>When the voltage enabled, define the position as zero, and the value of 32-bit that quadruplicate the A/B signal, which rise/down on “the free run counter” is displayed.<br>* If the 0x607E position polarity(bit7) = 1, this data is inverted.<br>Therefor, From an anterior view of the motor the value increases in the direction of Counter-Clockwise rotation (CCW).。 | | | | |

0x6064: Position Actual Value

| | | | |
|---|---|---|---|
| Index Ax1 0x6064<br>Ax2 0x6864<br>Ax3 0x7064<br>Ax4 0x7864 | Indicates after offset process or the actual position of motor encoder. | Object Code | Variable |

| Sub-Idx | Description | Data Type | Access | PDO | Initial Value |
|---|---|---|---|---|---|
| 0x00 | Position Actual Value [APMON]<br>Position Actual Value indicates present position<br>In case of synchronization by distributed clock (0x1C32-01 is DC Sync0 or DC Sync1), position data that is latched by SYNC signal will reply.<br>In case of non-synchronization system, latest present position (Same as 0x6063) will reply. | Integer32 | RO | Possible | - |
| | | Display Range | 0x80000000 - 0x7FFFFFFF<br>(-2147483648 to 2147483647 Pulse) | | |
| | | Unit | Pulse | | |
| | * Encoder combination: In the case of Incremental encoder<br>When the voltage enabled, define the position as zero, and the value of 32-bit that quadruplicate the A/B signal, which rise/down on “the free run counter” is displayed. From an anterior view of the motor the value increases in the direction of Counter-Clockwise rotation (CCW).<br>*When the position polarity of 0x607E is reversed, the value increases in the CW direction. | | | | |

0x6065: Position Deviation Window (Position Deviation Counter Overflow Value)

| | | | |
|---|---|---|---|
| Index Ax1 0x6065<br>Ax2 0x6865<br>Ax3 0x7065<br>Ax4 0x7865 | Permissible position range is set as a position request value relatively to. | Object Code | Variable |

| Sub-Idx | Description | Data Type | Access | PDO | Initial Value |
|---|---|---|---|---|---|
| 0x00 | Position Deviation Window [OFLV]<br>When position actual value crosses position deviation window, becomes Excessive position deviation alarm.<br>\|Position Actual Value Deviation\| >= Set Value | Unsigned32 | RW | Possible | 0x4C4B40<br>(5000000Pulse) |
| | | Setting Range | 0x00000001 - 0x7FFFFFFF<br>(1 to 2147483647 Pulse)) | | |
| | | Unit | Pulse | | |

0x6066:Position Deviation Time-out

| | | | |
|---|---|---|---|
| Index Ax1 0x6066<br>Ax2 0x6866<br>Ax3 0x7066<br>Ax4 0x7866 | Setting time to be the position deviation excessive alarm state after Bit13 of the status word is set to 1.Operating reaction when excessive position deviation occurs is peculiar to a maker. | Object Code | Variable |

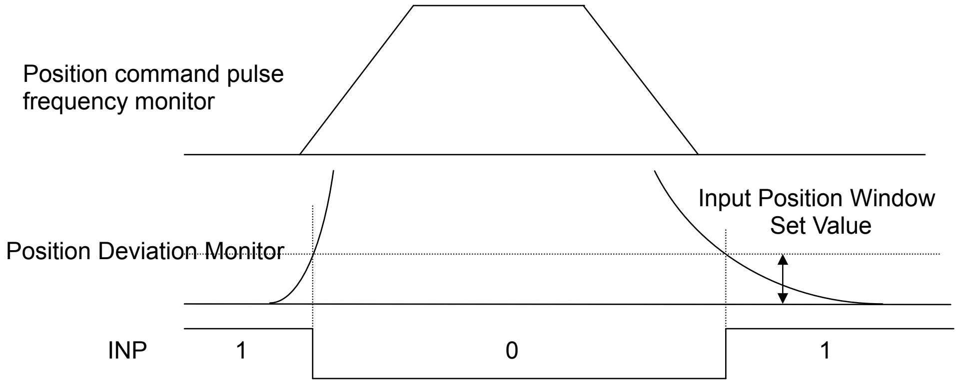
| Sub-Idx | Description | Data Type | Access | PDO | Initial Value |
|---|---|---|---|---|---|
| 0x00 | Position Deviation Time-out<br>Unit is "ms" and stops immediately after alarm occurring. | Unsigned16 | RW | No | 0x0000 |
| | | Setting Range | 0x0000 - 0x0000 | | |
| | | Unit | ms | | |

0x6067:Position Window (Input Position Window)

| | | | |
|---|---|---|---|
| Index Ax1 0x6067<br>Ax2 0x6867<br>Ax3 0x7067<br>Ax4 0x7867 | Sets up the range permissible as target position attainment.<br>When position actual value of position encoder is in Position Window, means arriving at target position. | Object Code | Variable |

| Sub-Idx | Description | Data Type | Access | PDO | Initial Value |
|---|---|---|---|---|---|
| 0x00 | Position Window [INP]<br>When position deviation counter value is below this preset value, outputs IN-Position signal (INP).<br>When \|Position Actual Value Deviation\|<= Set Value, outputs Position Window Monitor (INP monitor). | Unsigned32 | RW | No | 0x64<br>(100Pulse) |
| | | Setting Range | 0x00000000 - 0x7FFFFFFF<br>(0 to 2147483647 Pulse) | | |
| | | Unit | pulse | | |

*In the case of incremental encoder, 4 times of the number of encoder pulses are standard.
*In the case of absolute encoder (except for incremental output), absolute value is standard.



0x6068:Position Window Time

| | | | |
|---|---|---|---|
| Index Ax1 0x6068<br>Ax2 0x6868<br>Ax3 0x7068<br>Ax4 0x7868 | Sets up time until outputs to INP monitor after arriving in Position Window. | Object Code | Variable |

| Sub-Idx | Description | Data Type | Access | PDO | Initial Value |
|---|---|---|---|---|---|
| 0x00 | Position Window Time<br>RS2-EtherCAT slave amplifier is outputted immediately after arriving in setting range. | Unsigned16 | RW | No | 0x0000 |
| | | Setting Range | 0x0000 - 0x0000 | | |
| | | Unit | ms | | |

0x6069:Actual Sensor Velocity

| | | | |
|---|---|---|---|
| Index Ax1 0x6069<br>Ax2 0x6869<br>Ax3 0x7069<br>Ax4 0x7869 | Indicates actual value of velocity sensor. | Object Code | Variable |

| Sub-Idx | Description | Data Type | Access | PDO | Initial value |
|---|---|---|---|---|---|
| 0x00 | Actual Value of Velocity Sensor<br>Indicates actual velocity calucurated by motor encoder. | Integer32 | RO | Possible | – |
| | | Setting Range | 0x80000000～0xFFFFFFFF<br>(-2147483648 to 2147483647 pps) | | |
| | | Unit | Pulse／Sec | | |

0x606A:Sensor Selection Code

| | | | |
|---|---|---|---|
| Index Ax1 0x606A<br>Ax2 0x686A<br>Ax3 0x706A<br>Ax4 0x786A | With the object provide the source of velocity sensor actual value. It determines whether a differentiated position signal or the signal from a separate velocity sensor evaluated. | Object Code | Variable |

| Sub-Idx | Description | Data Type | Access | PDO | Initial Value |
|---|---|---|---|---|---|
| 0x00 | Sensor Selection Code<br>0:Actual velocity from position encoder<br>1:Actual velocity from velocity encoder<br>Position encoder and velocity encoder use the same encoder. | Integer16 | RW | Possible | 0x0000 |
| | | | 0x0000 - 0x0001 | | |

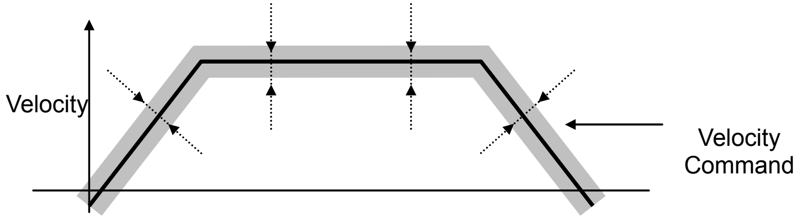
0x606C: Velocity Actual Value

| | | | |
|---|---|---|---|
| Index Ax1 0x606C<br>Ax2 0x686C<br>Ax3 0x706C<br>Ax4 0x786C | Has actual velocity value calculated from position encoder. Value shall be given in the velocity unit of user definition. | Object Code | Variable |

| Sub-Idx | Description | Data Type | Access | PDO | Initial Value |
|---|---|---|---|---|---|
| 0x00 | Velocity Actual Value [ACVMON]<br>*Filter is processed to data, and cutoff frequency is 250Hz. | Integer32 | RO | Possible | - |
| | | Display Range | 0x80000000 - 0x7FFFFFFF<br>(-2147483648-2147483647 pps) | | |
| | | Unit | Pulse/sec | | |

0x606D: Velocity Window (Velocity Matching: Rotation Speed Setup)

| | | | |
|---|---|---|---|
| Index Ax1 0x606D<br>Ax2 0x686D<br>Ax3 0x706D<br>Ax4 0x786D | Sets the range regarded as Velocity matching range by the unit [min-1].<br>Use this setting when “Velocity Matching Unit Selection” is “0x00_min-1”. | Object Code | Variable |

| Sub-Idx | Description | Data Type | Access | PDO | Initial Value |
|---|---|---|---|---|---|
| 0x00 | Velocity Window<br>When the actual velocity remains within the range of the target velocity during the time period set in velocity window time shown in 0x605E, the status word “TargetReached” is set.<br>This is enabled in profile velocity mode. | Unsigned16 | RW | No | 0x32<br>（50 $\text{min}^{-1}$） |
| | | Display Range | 0x0000～0xFFFF<br>（0～65535$\text{min}^{-1}$） | | |
| | | Unit | $\text{min}^{-1}$ | | |
| | <br> <br>✔The velocity matching output is switched by the setting of rotation speed (min-1) and ratio (%) at Velocity matching unit output selection (0x20F0.4).<br>At selection of rotation speed setup, the condition under this setting value can be monitored with the status word (0x6040) bit 10: Target matching monitor. | | | | |

0x606E: Velocity Window Time

| | | | |
|---|---|---|---|
| Index Ax1 0x606E<br>Ax2 0x686E<br>Ax3 0x706E<br>Ax4 0x786E | After velocity attainment, sets up time (timer) until the status word “TargetReached” is set. | Object Code | Variable |

| Sub-Idx | Description | Data Type | Access | PDO | Initial Value |
|---|---|---|---|---|---|
| 0x00 | Velocity Window Time<br>This servo amplifier sets the status word Bit 10: Target matching monitor when the velocity reaches the setting range and remains within the range for a time longer than the setting. | Unsigned16 | RW | No | 0x0001 |
| | | Display Range | 0x0001～0x1388<br>（1～5000） | | |
| | | Unit | ms | | |

0x606F: Velocity Threshold (Speed Zero Setting)

| | | | |
|---|---|---|---|
| Index Ax1 0x606F<br>Ax2 0x686F<br>Ax3 0x706F<br>Ax4 0x786F | Sets the range regarded as speed zero by the unit [min-1]. | Object Code | Variable |

| Sub-Idx | Description | Data Type | Access | PDO | Initial Value |
|---|---|---|---|---|---|
| 0x00 | Speed Zero Window<br>When the actual velocity falls below this setting value, the status word “Speed zero detection” is set.<br>This is enabled only in profile velocity mode. | Unsigned16 | RW | No | 0x0032<br>（50 $\text{min}^{-1}$） |
| | | Display Range | 0x0005 to 0x01F4<br>（5 to 500$\text{min}^{-1}$） | | |
| | | Unit | $\text{min}^{-1}$ | | |

0x6070: Velocity Threshold Time

| | | | |
|---|---|---|---|
| Index Ax1 0x6070<br>Ax2 0x6870<br>Ax3 0x7070<br>Ax4 0x7870 | Sets up time (timer) until the status word “Speed zero detection” is canceled. | Object Code | Variable |

| Sub-Idx | Description | Data Type | Access | PDO | Initial Value |
|---|---|---|---|---|---|
| 0x00 | Velocity Threshold Time<br>When the actual velocity is higher than the threshold velocity for a time longer than the setting, the status word bit 12: Speed zero detection is canceled. This is enabled only in profile velocity mode. | Unsigned16 | RW | No | 0x0001 |
| | | Display Range | 0x0001 to 0x1388<br>（1 to 5000） | | |
| | | Unit | ms | | |

0x6071： Target Torque (force)

| | | | |
|---|---|---|---|
| Index Ax1 0x6071<br>Ax2 0x6871<br>Ax3 0x7071<br>Ax4 0x7871 | Torque (force) command value set to torque (force) controls in Function Torque (force) Mode. | Object Code | Variable |

| Sub-Idx | Description | Data Type | Access | PDO | Initial Value |
|---|---|---|---|---|---|
| 0x00 | Target Torque (force) ［TATRQ］<br>Setting units are 0.1% LSB in 1/1000 unit of rated torque (force). However, it is limited by max torque (force) for the value that exceeds the max torque (force) of the motor. | Integer16 | RW | Possible | 0x0000 |
| | | Display Range | 0x8000 to 0x7FFF<br>（－3276.8 to 3276.7%） | | |
| | | Unit | 0.1 % | | |

0x6072: Maximum Torque (force)

| | | | |
|---|---|---|---|
| Index Ax1 0x6072<br>Ax2 0x6872<br>Ax3 0x7072<br>Ax4 0x7872 | Indicates maximum set value of the torque (force) permitted to the motor. | Object Code | Variable |

| Sub-Idx | Description | Data Type | Access | PDO | Initial Value |
|---|---|---|---|---|---|
| 0x00 | Maximum Torque (force) [MAXTRQ]<br>Setting units are 0.1% / LSB in 1/1000 unit of rated torque (force). However, it is limited by max torque (force) for the value that exceeds the max torque (force) of the motor. | Unsigned16 | RW | Possible | 0x1388<br>(500.0%) |
| | | Setting Range | 0x0000 - 0x1388<br>(0 to 500.0%) | | |
| | | Unit | 0.1% | | |

0x6076: Rated torque

| | | | |
|---|---|---|---|
| Index Ax1 0x6076<br>Ax2 0x6876<br>Ax3 0x7076<br>Ax4 0x7876 | Indicates rated torque of selected motor. | Object Code | Variable |

| Sub-Idx | Description | Data Type | Access | PDO | Initial value |
|---|---|---|---|---|---|
| 0x00 | Rated torque<br>Indicates rated torque of selected motor.<br>Only the Sanyo Denki R series motor is accepted. | Unsigned32 | RO | Possible | — |
| | | Setting range | 0x00000000 to 0xFFFFFFFF | | |
| | | Unit | m N･m | | |

6077: Actual Torque (force) Value

| | | | |
|---|---|---|---|
| Index Ax1 0x6077<br>Ax2 0x6877<br>Ax3 0x7077<br>Ax4 0x7877 | Indicates actual torque (force) value of motor. | Object Code | Variable |

| Sub-Idx | Description | Data Type | Access | PDO | Initial Value |
|---|---|---|---|---|---|
| 0x00 | Real Torque (force) Value [ACTMON]<br>Setting units are 1% / LSB in 1/1000 unit of rated torque (force). | Integer16 | RO | Possible | - |
| | | Display Range | 0x8000 - 0x7FFF<br>(-3276.8 to 3276.7%) | | |
| | | Unit | 0.1% | | |

0x6078: Actual Current Value

| | | | |
|---|---|---|---|
| Index Ax1 0x6078<br>Ax2 0x6878<br>Ax3 0x7078<br>Ax4 0x7878 | Indicates actual current value of motor. | Object Code | Variable |

| Sub-Idx | Description | Data Type | Access | PDO | Initial value |
|---|---|---|---|---|---|
| 0x00 | Actual Current Value<br>Monitor unit is 1/1000 unit of the rated current, and is 0.1%/LSB. | Integer16 | RO | Possible | — |
| | | Setting range | 0x8000-0x7FFF<br>（－3276.8-3276.7%） | | |
| | | Unit | 0.1 % | | |

0x6079： DC link circuit voltage

| Index | | This object shall provide the instantaneous DC link current voltage at the drive device. The value shall be given in mV. | Object Code | Variable |
|---|---|---|---|---|
| Ax1<br>Ax2<br>Ax3<br>Ax4 | 0x6079<br>0x6879<br>0x7079<br>0x7879 | | | |

| Sub-Idx | Description | Data Type | Access | PDO | Initial Value |
|---|---|---|---|---|---|
| 0x00 | DC link circuit voltage<br>✔For AC100V, AC200V DC24V, DC48V Rotary, Linear , Direct Drive Motor<br>(RS2E TypeH, RS2A TypeH, RS2J TypeH, RS2K TypeH ) | Unsigned32 | RO | Possible | — |
| | | Display Range | 0x00000000～0xFFFFFFFF | | |
| | | Unit | mV | | |
| | This monitor is simplified. This shows 280,000mV at 200VAC input, 140,000mV at 100VAC input, 48,000mV at 48VDC input, 24,000mV at 24VDC input and 0V at POFF state.<br>✔For AC400V Rotary, Linear , Direct Drive, Induction Motor AC200V input type (SS1A typeH, RS2C typeH)<br>It displays the actual DC voltage by detected internal circuit. | | | | |

0x607A:Target Position

| Index | | Command position of drive moved by setup of motion control parameters, such as velocity, acceleration, deceleration, and motion profile type. | Object Code | Variable |
|---|---|---|---|---|
| Ax1<br>Ax2<br>Ax3<br>Ax4 | 0x607A<br>0x687A<br>0x707A<br>0x787A | | | |

| Sub-Idx | Description | Data Type | Access | PDO | Initial Value |
|---|---|---|---|---|---|
| 0x00 | Target Position [TAPOS]<br>Sets up absolute position command for every communication cycle. | Integer32 | RW | Possible | 0 |
| | | Display Range | 0x80000000 - 0x7FFFFFFF | | |
| | | Unit | pulse | | |

0x607B:Position range Limit (Modulo value)

| | | | | | |
|---|---|---|---|---|---|
| Index Ax1 0x607B<br>Ax2 0x687B<br>Ax3 0x707B<br>Ax4 0x787B | At position command type motion mode, set the range of position coordinates able to be set (able to be assigned). Both controller (position command) and driver (actual position) communicate position data within the range of position coordinates set here. | | | Object Code<br>Array | |
| Sub-Idx | Name/Description | Data Type | Access | PDO | Range (Initial Value) |
| 0x00 | Number of Entry | - | RO | No | 0x2 |
| 0x01 | Min position range limit [MINPLIM] | Unsigned8 | RW | Possible | 0x80000000 |
| | | Setting value | 0x80000000−0x7FFFFFFF | | |
| 0x02 | Max position range limit [MAXPLIM] | Integer32 | RW | Possible | 0x7FFFFFFF |
| | | Setting value | 0x80000000-0x7FFFFFFF | | |
| Refer to the next page for details. | | | | | |

< About Setting Value >

— Unit is the same user definition as target position, and in this servo amplifier, the unit is 1 Pulse/LSB.

— When minimum position range limit= 0x00000000 and maximum position range limit = 0x00000000 are set, or when minimum position range limit = 0x80000000 and maximum position range limit = 0x7FFFFFFF are set, the position coordinate is recognized as "Linear coordinate".

— When setting is other than the above, position coordinate indicates "Modulo coordinate". In this case, although the setting value can be any value, set actual range of motion at no more than the positive maximum value (0x7FFFFFFF) of 32bit

( "maximum position range limit - "minimum position range limit" ≦ 2147483647 (0x7FFFFFFF) )

< Linear coordinate(Straight Axis) >

— The limit value of coordinates is the lower limit = 0x80000000, and upper limit = 0x7FFFFFFF. However for PP mode, wraparound exceeding position range limit is available if 0 is set to Min/Max position range limit.
For CSP mode, wraparound at any range limit is available.
To set limits on the range of motion within position range limit, set the appropriate software position limits (0x607D).

< Modulo Coordinate (Rotation Axis) >

— When the current position reaches the maximum position range limit in the direction of coordinate increase, the following coordinate value will indicate the setting value of minimum position range limit.

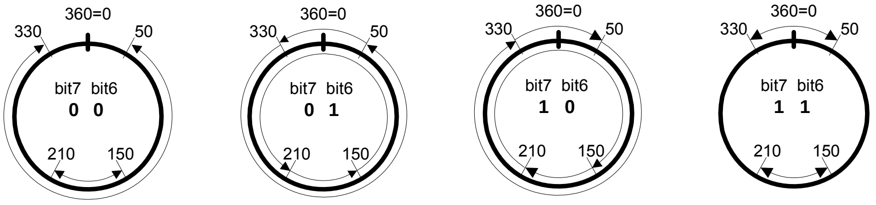
— In the opposite situation, when the current position reaches the minimum position range limit in the direction of coordinate decrease, the following coordinate value will indicate the setting value of maximum position range limit.

— Except for the motion modes listed below in brackets, all position information set by the controllers should be modulo coordinates.
(In the following case, in the setting of "Standard positioning same as straight axis," for example, if you wish to move from current position by a value of 90°, the following commands are possible:
"positioning to absolute displacement 630° = 360° (1 revolution) + 270° (in this case, relative displacement of 540°",
"positioning to relative displacement 500° = 360° (1 revolution) + relative displacement of 140 (in the result, positioning to 230°)"

In this case, the current position information always indicates modulo calculated value by 360°.

— In modulo mode, the parameter to set rotation direction in the profile position mode is 0x60F2 bit7, 6.

Modulo coordinate image, in the case that minimum position range limit = 0, and maximum position range limit = 359 is set, is shown below.



normal
(similar to linear axis)

only negative
direction

only positive
direction

optimized
(shortest way)

Example of Positioning at Rotation Axis

< Regarding timing in which the setting parameter is reflected to coordinate >

— In the case that the previously set position range limit value has been written in the nonvolatile memory of the servo amplifier
⇒ Immediately after control power is On, the setting value of the position range limit will be reflected on position information.

— In the case that setting of position range limit is changed when ESM is in Pre-Operational status.
⇒ The changed setting value will be reflected when ESM is shifted from Pre-Operational to Safe-Operational.

— In the case that ESM changes setting of position range limit in another status than that of Pre-Operational
⇒ Because the changed setting value will be reflected when ESM is shifted from Pre-Operational to Safe-Operational, temporarily lower ESM to Pre-Operational and increase ESM again.

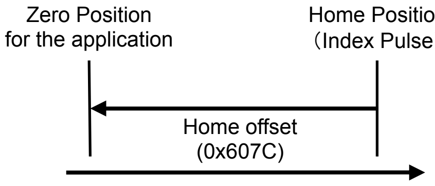
0x607C: Home offset (homing mode)

| Index | | | |
|---|---|---|---|
| Index Ax1 0x607C<br>Ax2 0x687C<br>Ax3 0x707C<br>Ax4 0x787C | Normalizes homing position (mechanical origin) detected in homing mode by homing offset value. | Object code | Variable |

| Sub-Idx | Description | Data Type | Access | PDO | Initial Value |
|---|---|---|---|---|---|
| 0x00 | Home offset [HOFFSET]<br>&The set homing offset (0x607C) is used to calculate actual position.<br>✔ Homing offset can be always written, however, is used to re-calculate only in homing mode. | Integer32 | RW | Possible | 0x00000000<br>(0 pulse) |
| | | Setting Range | 0x80000000-0x7FFFFFFF<br>(-2147483648-2147483647 Pulse) | | |
| | | Unit | Pulse | | |

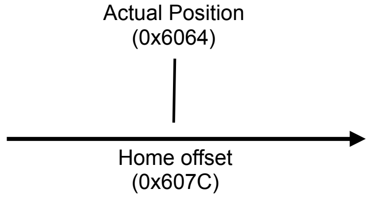
The actual position（0x6064）using homing position during homing is calculated as follows:

Without Homing Method 35,37



Zero Position = Home Position +Home offset (0x607C)

Homing Method 35,37



Actual Position(0x6064) = Home offset (0x607C)

✔If not Homing Method 35 or 37 and ZeroPosition＝Home Offset Homing need to sets 0x20F6-1 = 1.

0x607D:Software Position Limit

| Index | | |
|---|---|---|
| Index Ax1 0x607D<br>Ax2 0x687D<br>Ax3 0x707D<br>Ax4 0x787D | Consists of the Maximum / Minimum software position limits.<br>Position command and actual position are calculated by target position (0x607A) and position offset (0x60B0) to be limited in absolute position. | Object Code<br>Array |

| Sub-Idx | Name/Description | Data Type | Access | PDO | Range (Initial Value) |
|---|---|---|---|---|---|
| 0x00 | Number of Entry | - | RO | No | 0x2 |
| 0x01 | Minimum Position Limit [SMINLIM]<br>Unit is 1 pulse/LSB with RS2EtherCAT amplifier in the same user definition as a target position. | Integer32 | RW | Possible | 0x80000000<br>-<br>0x7FFFFFFF<br>(0) |
| 0x02 | Maximum Position Limit [SMAXLIM]<br>Unit is 1 pulse/LSB with RS2EtherCAT amplifier in the same user definition as a target position. | Integer32 | RW | Possible | 0x80000000<br>-<br>0x7FFFFFFF<br>(0) |

Since the actually used limit value includes Home Offset (0x607C), it is normalized internally before being compared with target position.

Minimum Position Limit for Normalization = Minimum Position Limit - Home Offset
Maximum Position Limit for Normalization = Maximum Position Limit - Home Offset

*Function is invalid when the Minimum Position Limit >= Maximum Position Limit.

0x607E: Polarity (Position, Velocity, Torque (force) Command/Offset Input Polarity)

| | | | |
|---|---|---|---|
| Index Ax1 0x607E<br>Ax2 0x687E<br>Ax3 0x707E<br>Ax4 0x787E | Sets command for input polarity.<br>When Bit=1, the command value is multiplied by -1, and it serves as a reverse command. | Object Code | Variable |

| Sub-Idx | Description | Data Type | Access | PDO | Initial Value |
|---|---|---|---|---|---|
| 0x00 | Polarity [CMDPOL]<br>Selects the combination of each command polarity over position command, velocity command, torque (force) command input, position offset, velocity offset (velocity addition), and torque (force) offset (torque (force) addition) from the following contents. | Unsigned8 | RW | Possible | 0x00 |
| | | Setting Range | 0x00 - 0xE0 | | |

Bit7 : Position Polarity "0": Command is multiplied by +1. "1": Multiplied by -1. (only csp,ip enable)

- Valid only in Cycle sync. position mode (csp) , Interpolated position mode (ip) , 0x607A Target position and 0x60B0 Position offset input value are multiplied by -1 with "1", and then command polarity is reversed.

Bit6 : Velocity Polarity "0": Command is multiplied by +1. "1": Multiplied by -1.

- In Cycle sync. position mode (csp), Interpolated position mode (ip), "1" 0x60B0 Velocity offset input value as velocity compensation is multiplied by -1 with "1", and then compensation polarity is reversed.
- In Cycle sync. position mode (csv), 0x60FF Target velocity and 0x60B1 Velocity offset input value are multiplied by -1 with "1", and then command polarity is reversed.

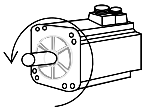
Bit5 : Torque (force) Polarity "0": Command is multiplied by +1. "1": Multiplied by -1.

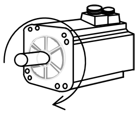
- In Cycle sync. position mode (csp) , Interpolated position mode (ip) and Cycle sync. velocity mode(csv),0x60B2 Torque (force) offset input value as torque (force) compensation is multiplied by -1 with "1", and then compensation command polarity is reversed.
- In Cycle sync. torque (force) mode(cst), 0x6071 Target torque and 0x6082 Torque offset input value are multiplied by -1 with "1", and then command polarity is reversed.

Bit4 - 0: Reserved

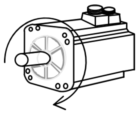
*Direction with positive (+) polarity command supply according to the setting value is shown below.

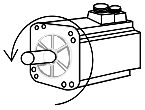
*When command input polarity is standard set value "Bit7=0, Bit6=0, Bit5=0",
rotates to positive direction (CCW)by command polarity + / to negative direction (CW) by -.





*When command input polarity is standard set value "Bit7=1, Bit6=1, Bit5=1",
rotates to negative direction (CW) by command polarity + / to positive direction (CCW) by -.





Note) Change will be impossible if ESM of this parameter is Operational.
Make sure to change after servo-off and shift to Pre-Operational.

✔Refer to section 13, Linear motor control parameter list for the descriprion of linear motor porality.

✔When OT is used, set 0x00 or 0xE0.

0x607F: Maximum Profile Velocity (Velocity Limit Command)

| | | | |
|---|---|---|---|
| Index Ax1 0x607F<br>Ax2 0x687F<br>Ax3 0x707F<br>Ax4 0x787F | Sets permissible velocity to Velocity command. | Object Code | Variable |

| Sub-Idx | Description | Data Type | Access | PDO | Initial Value |
|---|---|---|---|---|---|
| 0x00 | Maximum Profile Velocity [VCLM]<br>Limit maximal allowed profile velocity (0x6081) during a profiled position (pp) motion.<br>*The unit is in user definition as same as 0x6081 | Unsigned32 | RW | Possible | 0xFFFFFFFF |
| | | Setting Range | 0x00000001 - 0xFFFFFFFF<br>（1 - 4294967295 pps） | | |
| | | Unit | Pulse/sec | | |

0x6080: Maximum motor velocity

| | | | |
|---|---|---|---|
| Index Ax1 0x6080<br>Ax2 0x6880<br>Ax3 0x7080<br>Ax4 0x7880 | Sets the selected motor's maximum velocity. | Object Code | Variable |

| Sub-Idx | Description | Data Type | Access | PDO | Initial value |
|---|---|---|---|---|---|
| 0x00 | Maximum motor velocity<br>Sets the selected motor's maximum velocity.<br>When the Sanyo Denki R series motor is selected, it is automatically set at the time of amplifier power input. | Unsigned32 | RW | Possible | 0x00000000 |
| | | Setting range | 0x00000000-0xFFFFFFFF<br>(0-4294967295 min-1) | | |
| | | Unit | min-1 | | |

0x6081: Profile Velocity

| | | | |
|---|---|---|---|
| Index Ax1 0x6081<br>Ax2 0x6881<br>Ax3 0x7081<br>Ax4 0x7881 | This object shall indicate the configured velocity normally attained at the end of the acceleration ramp during a profile position mode motion. | Object code | Variable |

| Sub-Idx | Description | Data Type | Access | PDO | Initial value |
|---|---|---|---|---|---|
| 0x00 | Profile velocity [PROVEL]<br>The value is effective for both of CW and CCW. | Unsigned32 | RW | Possible | 0xFFFFFFFF |
| | | Display range | 0x00000000-0xFFFFFFFF<br>(0-4294967295 pps) | | |
| | | unit | Pulse/sec | | |

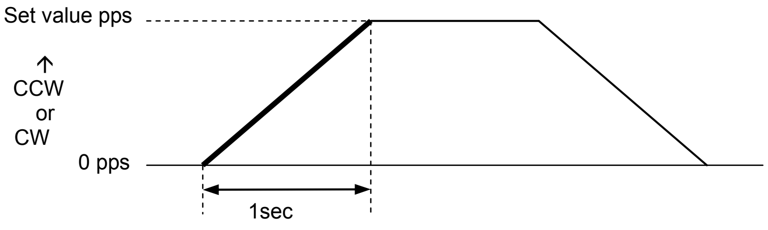
0x6082: End velocity

| | | | |
|---|---|---|---|
| Index Ax1 0x6082<br>Ax2 0x6882<br>Ax3 0x7082<br>Ax4 0x7882 | Sets end velocity. | Object Code | Variable |

| Sub-Idx | Description | Data Type | Access | PDO | Initial value |
|---|---|---|---|---|---|
| 0x00 | End velocity<br>Sets the end velocity in position mode at the time of reaching the target.<br>This servo amplifier does not support this function. | Unsigned32 | RW | Possible | 0x00000000 |
| | | Setting range | 0x00000000-0xFFFFFFFF | | |
| | | Unit | Pulse/sec | | |

0x6083: Profile acceleration

| | | | |
|---|---|---|---|
| Index Ax1 0x6083<br>Ax2 0x6883<br>Ax3 0x7083<br>Ax4 0x7883 | Parameters to decide the gradient at the time of motor acceleration during Profile position, Function velocity mode. | Object Code | Variable |

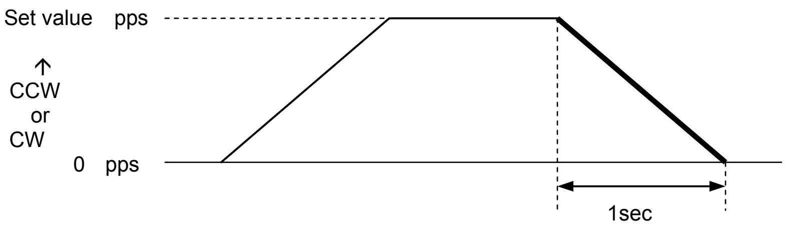
| Sub-Idx | Description | Data Type | Access | PDO | Initial value |
|---|---|---|---|---|---|
| 0x00 | Profile acceleration [TVCACC]<br>The parameters to give acceleration incline against preset velocity command, and set the rate of velocity per second. | Unsigned32 | RW | Possible | 0xFFFFFFFF |
| | | Setting Range | 0x00000000-0xFFFFFFFF<br>(0-4294967295 pps$^2$) * | | |
| | | Unit | Pulse/sec$^2$ | | |
| | Note) This parameter is effective only against Profile position mode (pp), Profile velocity mode (pv).<br> <br>Note) If value is set to “0”, the amplifier proceeds it as "1."<br>* At the pv mode, upper limit value will be kept at 16,000msec if the value exceeding 16,000msec is set with conversion per 1,000min-1. | | | | |

0x6084: Profile Deceleration

| | | | |
|---|---|---|---|
| Index Ax1 0x6084<br>Ax2 0x6884<br>Ax3 0x7084<br>Ax4 0x7884 | Parameters to decide the gradient at the time of motor deceleration. | Object Code | Variable |

| Sub-Idx | Description | Data Type | Access | PDO | Initial Value |
|---|---|---|---|---|---|
| 0x00 | Profile Deceleration [TVCDEC]<br>The parameters to give deceleration incline against preset velocity command, and set the rate of velocity per second. | Unsigned32 | RW | Possible | 0xFFFFFFFF |
| | | Setting Range | 0x00000000-0xFFFFFFFF<br>(0-4294967295 pps2) * | | |
| | | Unit | Pulse/sec2 | | |

*This parameter is effective only against Profile position mode (pp), Profile velocity mode (pv).



Note) If value is set to “0”, the amplifier proceeds it as "1."

* At the pv mode, upper limit value will be kept at 16,000msec if the value exceeding 16,000msec is set with conversion per 1,000min-1.

0x6085: Quick Stop Deceleration

| | | |
|---|---|---|
| Index Ax1 0x6085<br>Ax2 0x6885<br>Ax3 0x7085<br>Ax4 0x7885 | Slowdown parameter used for motor stop when quick stop function is active and "2" or "6" is set to quick stop code object (0x605A). Used also when Fault reaction code object (0x605E) and the Halt option code object (0x605D) are "2." | Object Code<br>Variable |

| Sub-Idx | Description | Data Type | Access | PDO | Initial Value |
|---|---|---|---|---|---|
| 0x00 | Quick Stop Deceleration [QSDEC]<br>Value serves as the same unit as a Profile acceleration object (0x6083).<br>Note) If value is set to “0”, the amplifier proceeds it as "1." | Unsigned32 | RW | Possible | 0xFFFFFFFF |
| | | Setting Range | 0x00000000-0xFFFFFFFF<br>(0-4294967295 pps2) | | |
| | | Unit | Pulse/sec2 | | |

0x6087: Torque (force) slope

| | | | |
|---|---|---|---|
| Index Ax1 0x6087<br>Ax2 0x6887<br>Ax3 0x7087<br>Ax4 0x7887 | This object shall give incline to torque (force) command in Torque (force) profile mode (tq) | Object Code | Variable |

| Sub-Idx | Description | Data Type | Access | PDO | Initial Value |
|---|---|---|---|---|---|
| 0x00 | Torque (force) slope [TSLOPE]<br>Setting units are 0.1% / sec.<br>Even Torque (force) slope is set the value more than maximum current of the motor, it will be limited to Maximum current. | Unsigned32 | RW | Possible | 0xFFFFFFFF |
| | | Setting range | 0x00000001～0xFFFFFFFF | | |
| | | Unit | 0.1%/sec | | |

0x6088: Torque Profile Type

| | | | |
|---|---|---|---|
| Index Ax1 0x6088<br>Ax2 0x6888<br>Ax3 0x7088<br>Ax4 0x7888 | This is a parameter to set the Torque (force) Profile Type in torque (force) profile mode(tq). | Object Code | Variable |

| Sub-Idx | Description | Data Type | Access | PDO | Initial value |
|---|---|---|---|---|---|
| 0x00 | Torque (force) Profile Type<br>Setting unit is 0 (Linear ramp) fixed. | Integer16 | RW | Possible | 0x0000 |
| | | Setting Range | 0x0000～0x0000 | | |

0x608F: Position Encoder Resolution

| | | | |
|---|---|---|---|
| Index Ax1 0x608F<br>Ax2 0x688F<br>Ax3 0x708F<br>Ax4 0x788F | Sets the resolution of the output shaft encoder. | Object Code | Variable |

| Sub-Idx | Description | Data Type | Access | PDO | Initial Value |
|---|---|---|---|---|---|
| 0x00 | Number of entry | Unsigned8 | RO | No | 0x02 |
| 0x01 | Sets the number of pulses of position encoder.<br>Indicates resolution of the connected encoder. | Unsigned32 | RW | Possible | 0x01 |
| | | Setting Range | 0x00000001～0xFFFFFFFF | | |
| | | Unit | Pulse | | |
| 0x02 | Sets the rotation speed of the motor shaft.<br>Since this servo amplifier is not compatible with this function, values other than 1 cannot be set. | Unsigned32 | RW | Possible | 0x01 |
| | | Setting Range | 0x01～0x01 | | |
| | | Unit | | | |

0x6091: Gear Ratio

| Index | | Description | | |
|---|---|---|---|---|
| Index | Ax1 0x6091<br>Ax2 0x6891<br>Ax3 0x7091<br>Ax4 0x7891 | Sets the gear ratio of the motor shaft and the output shaft. | Object Code | Variable |

| Sub-Idx | Description | Data Type | Access | PDO | Initial Value |
|---|---|---|---|---|---|
| 0x00 | Number of entry | Unsigned8 | RO | No | 0x02 |
| 0x01 | Sets the rotation speed of the motor shaft.<br>With this servo amplifier, the rotation speed of the motor shaft is fixed to 1. | Unsigned32 | RW | Possible | 0x01 |
| | | Setting Range | 0x01～0x01 | | |
| | | Unit | | | |
| 0x02 | Sets the rotation speed of the output shaft.<br>With this servo amplifier, the rotation speed of the output shaft is fixed to 1. | Unsigned32 | RW | Possible | 0x01 |
| | | Setting Range | 0x01～0x01 | | |
| | | Unit | | | |

0x6092: Feed Constant

| Index | | Description | | |
|---|---|---|---|---|
| Index | Ax1 0x6092<br>Ax2 0x6892<br>Ax3 0x7092<br>Ax4 0x7892 | Sets the travel distance in one rotation of the output shaft. | Object Code | Variable |

| Sub-Idx | Description | Data Type | Access | PDO | Initial Value |
|---|---|---|---|---|---|
| 0x00 | Number of entry | Unsigned8 | RO | No | 0x02 |
| 0x00 | Sets the travel distance.<br>Since this servo amplifier is not compatible with this function, values other than 1 cannot be set. | Unsigned32 | RW | Possible | 0x01 |
| | | Setting Range | 0x01～0x01 | | |
| | | Unit | | | |
| 0x01 | Sets the rotation speed of the motor shaft.<br>With this servo amplifier, the rotation speed of the motor shaft is fixed to 1. | Unsigned32 | RW | Possible | 0x01 |
| | | Setting Range | 0x01～0x01 | | |
| | | Unit | | | |

0x6098: Homing method

| Index | | Description | | |
|---|---|---|---|---|
| Index | Ax1 0x6098<br>Ax2 0x6898<br>Ax3 0x7098<br>Ax4 0x7898 | This object shall set the homing method that shall be used. | Object code | Variable |

| Sub-Idx | Description | Data Type | Access | PDO | Initial value |
|---|---|---|---|---|---|
| 0x00 | Homing method [HOMETYP]<br>Configured homing method (Origin return method) | Integer8 | RW | Possible | 0x23<br>(35) |
| | | Setting range | 0xFC～0x25 (－4～37) | | |

－4 (0xFC) : Homing on positive hard stop and index pulse
－3 (0xFD) : Homing on negative hard stop and index pulse
－2 (0xFE) : Homing on negative hard stop
－1 (0xFF) : Homing on positive hard stop
0 (0x00) : No Homing method
1 (0x01) : Homing on negative limit and index pulse
2 (0x02) : Homing on positive limit and index pulse
3 (0x03) : Homing on positive home switch and index pulse
4 (0x04) : Homing on positive home switch and index pulse
5 (0x05) : Homing on negative home switch and index pulse
6 (0x06) : Homing on negative home switch and index pulse
7 (0x07) : Homing on positive limit switch, homing on positive home switch and index pulse
8 (0x08) : Homing on positive limit switch, homing on positive home switch and index pulse
9 (0x09) : Homing on positive limit switch, homing on negative home switch and index pulse
10 (0x0A) : Homing on positive limit switch, homing on negative home switch and index pulse
11 (0x0B) : Homing on negative limit switch, homing on positive home switch and index pulse
12 (0x0C) : Homing on negative limit switch, homing on positive home switch and index pulse
13 (0x0D) : Homing on negative limit switch, homing on negative home switch and index pulse
14 (0x0E) : Homing on negative limit switch, homing on negative home switch and index pulse
17 (0x11) : Homing on negative limit switch
18 (0x12) : Homing on positive limit switch
19 (0x13) : Homing on positive home switch
20 (0x14) : Homing on positive home switch
21 (0x15) : Homing on negative home switch
22 (0x16) : Homing on negative home switch
33 (0x21) : Homing on negative index pulse
34 (0x22) : Homing on positive index pulse
35 (0x23) : Homing on the current position
37 (0x25) : Homing on the current position
－5 to －128(0xFB-0x80),15（0x0F）,16（0x10）23～32（0x17-0x20）,36（0x24）,38～127（0x26-0x7F）:Reserved

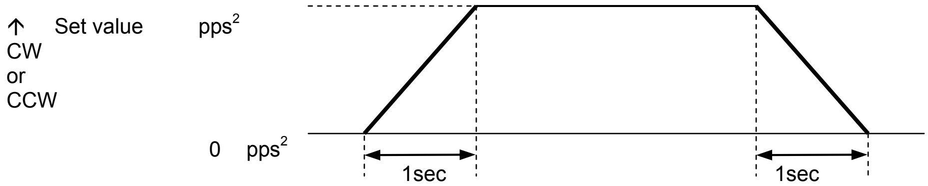
0x6099: Homing Velocity

| Index | | | | |
|---|---|---|---|---|
| Index | Ax1 0x6099<br>Ax2 0x6899<br>Ax3 0x7099<br>Ax4 0x7899 | Homing velocity is used during the procedure command “Homing operation” | Object code | ARRAY |

| Sub-Idx | Description | Data Type | Access | PDO | Initial value |
|---|---|---|---|---|---|
| 0x00 | Number of entry | Unsigned8 | RO | No | 0x02 |
| 0x01 | Switch search speed [SSVCMD]<br>Set the motor speed during search for a end position switch on homing mode | Unsigned32 | RW | Possible | 0x000A0000 |
| | | Setting range | 0x0-0xFFFFFFFF<br>(0-4294967295 pps) | | |
| | | Unit | Pulse/sec | | |
| 0x02 | Zero phase search speed [ZSVCMD]<br>Assign the motor speed during search for the index pulse (zero) detection | Unsigned32 | RW | Possible | 0x00008000 |
| | | Setting range | 0x0-0xFFFFFFFF<br>(0-4294967295 pps) | | |
| | | Unit | Pulse/sec | | |

0x609A: Homing acceleration and deceleration

| | | | | |
|---|---|---|---|---|
| Index | Ax1 0x609A<br>Ax2 0x689A<br>Ax3 0x709A<br>Ax4 0x789A | This object is the parameters that define the velocity slope of the acceleration and deceleration ramp on homing mode. | Object code | Variable |

| Sub-Idx | Description | Data Type | Access | PDO | Initial value |
|---|---|---|---|---|---|
| 0x00 | Homing acceleration ad deceleration [HOMEACC]<br>The parameters to Homing velocity that restrain velocity slope of the acceleration and deceleration ramp during acceleration, zero speed, direction change<br>Note) This parameter is effective only during Homing mode (hm) | Unsigned32 | RW | Possible | 0xFFFFFFFF |
| | | Setting range | 0x00000000-0xFFFFFFFF<br>(0-4294967295 pps2) * | | |
| | | Unit | Pulse/sec2 | | |
| |  <br>Note) If value is set “0”, the amplifier proceeds it as "1."<br>* At the hm mode, upper limit value will be kept at 16,000msec if the value exceeding 16,000msec is set with conversion per 1,000min-1. | | | | |

0x60B0: Position Offset

| | | | | |
|---|---|---|---|---|
| Index | Ax1 0x60B0<br>Ax2 0x68B0<br>Ax3 0x70B0<br>Ax4 0x78B0 | Provides Target position with Offset. | Object Code | Variable |

| Sub-Idx | Description | Data Type | Access | PDO | Initial Value |
|---|---|---|---|---|---|
| 0x00 | Position Offset [POSOFF]<br>Offset value is added to Target position.<br>If this value is not zero, Target position and Actual position shift for the amount of position offset value when motor stop. | Integer32 | RW | Possible | 0x00000000<br>(0 pulse) |
| | | Display Range | 0x80000000 - 0x7FFFFFFF | | |
| | | Unit | 1pulse/lsb | | |

0x60B1: Velocity Offset (Velocity Compensation Value)

| | | | | |
|---|---|---|---|---|
| Index | Ax1 0x60B1<br>Ax2 0x68B1<br>Ax3 0x70B1<br>Ax4 0x78B1 | Offset is given to Velocity command. | Object Code | Variable |

| Sub-Idx | Description | Data Type | Access | PDO | Initial Value |
|---|---|---|---|---|---|
| 0x00 | Velocity Offset (Velocity Compensation Value) [VCOMPC]<br>In Cycle sync. Position mode (csp) and Interpolated Position mode (ip), added to Preset Velocity Command and valid with Velocity compensation enable bit set.<br>In Cycle sync. Velocity mode (csv), gives Offset to Velocity demand value. | Integer32 | RW | Possible | 0 |
| | | Display Range | 0x80000000 - 0x7FFFFFFF<br>(-2147483648-2147483647 pps) | | |
| | | Unit | Pulse/sec | | |

0x60B2: Torque (force) Offset (Torque (force) Compensation)

| Index | | In cst Mode, object gives Offset to Target torque (force). In csp, ip and csv Mode, Feed forward function to Torque (force) control system as a Torque (force) compensation function. | Object Code | Variable |
|---|---|---|---|---|
| Ax1<br>Ax2<br>Ax3<br>Ax4 | 0x60B2<br>0x68B2<br>0x70B2<br>0x78B2 | | | |

| Sub-Idx | Description | Data Type | Access | PDO | Initial Value |
|---|---|---|---|---|---|
| 0x00 | Torque (force) Offset (Torque (force) Compensation) [TRQOFF]<br>*In Cycle sync. Position / Velocity mode (csp, csv), Interpolated position mode (ip) Torque (force) compensation value is added to Torque (force) command when torque (force) compensation enable [ICMPEN] Bit4=1 of the Control word 1 (0x2000).<br>*In Cycle sync. Torque (force) mode (csv), gives Offset to Torque (force) demand value. | Integer16 | RW | Possible | 0x0000<br>(0 %) |
| | | Setting Range | 0xEC78 - 0x1388<br>(-500.0 to 500.0 %) | | |
| | | Unit | 0.1% | | |

0x60B8:Touch probe function

| Index | | Controls the functions of the touch probe. | Object Code | Variable |
|---|---|---|---|---|
| Ax1<br>Ax2<br>Ax3<br>Ax4 | 0x60B8<br>0x68B8<br>0x70B8<br>0x78B8 | | | |

| Sub-Idx | Description | Data Type | Access | PDO | Initial Value |
|---|---|---|---|---|---|
| 0x00 | Touch probe function [TPFUNC]<br>Controls the functions of the touch probe. | Unsigned16 | RW | Possible | 0x0000 |
| | | Setting Range | 0x0000-0xFFFF | | |
| | bit0: Touch probe 1 switch enable<br>0: Switch off touch probe 1 1:Enable touch probe 1<br>bit1: Touch probe 1 Trigger operation<br>0:Trigger first event 1:continous<br>bit2: Touch probe 1 Trigger selection<br>0:Trigger with touch probe 1 input 1:Trigger with position encoder index pulse※<br>bit4: Touch probe 1 positive edge enable<br>0:Switch off sampling at positive edge of touch probe 1<br>1:Enable sampling at positive edge of touch probe 1<br>bit5: Touch probe 1 negative edge enable<br>0:Switch off sampling at negative edge of touch probe 1<br>1:Enable sampling at negative edge of touch probe 1<br>bit8: Touch probe 2 switch enable<br>0: Switch off touch probe 2 1:Enable touch probe 2<br>bit9: Touch probe 2 Trigger operation<br>0:Trigger first event 1:continous<br>bit10: Touch probe 2 Trigger selection<br>0:Trigger with touch probe 2 input 1:Trigger with position encoder index pulse※<br>bit12: Touch probe 2 positive edge enable<br>0:Switch off sampling at positive edge of touch probe 2<br>1:Enable sampling at positive edge of touch probe 2<br>bit13: Touch probe 2 negative edge enable<br>0:Switch off sampling at negative edge of touch probe 2<br>1:Enable sampling at negative edge of touch probe 2<br>bit15, 14, 11, 7, 6, 3: Reserved<br>◆When using absolute encoder, index pulse is position data at 0 within single-turn.<br>When using “Modulo coordination”, be sure to set bit2 and bit10 to “0: Trigger with touch probe input”. | | | | |

0x60B9:Touch probe status

| Index Ax1 0x60B9<br>Ax2 0x68B9<br>Ax3 0x70B9<br>Ax4 0x78B9 | Displays the status of the touch probe | | Object Code | | Variable |
|---|---|---|---|---|---|
| Sub-Idx | Description | Data Type | Access | PDO | Initial Value |
| 0x00 | Touch probe status [TPSTS]<br>Displays the status of the touch probe | Unsigned16 | RO | Possible | 0x0000 |
| | | Setting Range | 0x0000-0xFFFF | | |
| | bit0: Touch probe 1 switch enable monitor<br>0:Touch probe 1 is switched off 1:Touch probe 1 is enabled<br>bit1: Touch probe 1 positive edge value stored monitor<br>0:Touch probe 1 no positive edge value stored 1:Touch probe 1 positive edge position stored<br>bit2: Touch probe 1 negative edge value stored monitor<br>0:Touch probe 1 no negative edge value stored 1:Touch probe 1 negative edge position stored<br>bit6: Touch probe 1 Trigger selection monitor (User-defined : for testing)<br>0:Trigger with touch probe 1 input mode 1:Position encoder index pulse trigger mode<br>Bit7:Touch probe 1input monitor (User-defined : for testing)<br>0:Photocoupler is off (CONT1:OFF) 1:Photocoupler is on (CONT1:ON)<br>bit8: Touch probe 2 switch enable monitor<br>0:Touch probe 2 is switched off 1:Touch probe 2 is enabled<br>bit9: Touch probe 2 positive edge value stored monitor<br>0:Touch probe 2 no positive edge value stored 1:Touch probe 2 positive edge position stored<br>bit10: Touch probe 2 negative edge value stored monitor<br>0:Touch probe 2 no negative edge value stored 1:Touch probe 2 negative edge position stored<br>bit14: Touch probe 2 Trigger selection monitor (User-defined: for testing)<br>0:Trigger with touch probe 1 input mode 1:Position encoder index pulse trigger mode<br>bit15: Touch probe 2input monitor (User-defined : for testing)<br>0:Photocoupler is off (CONT2:OFF) 1:Photocoupler is on (CONT2:ON)<br>bit13～11, 5～3:Reserved | | | | |

Note) If using pulse encoder, Index pulse is Z-phase signal (C-phase signal).
If using Absolute encoder, it is the position of zero data in one rotation.

0x60BA:Touch probe pos 1 pos value (positive edge)

| Index Ax1 0x60BA<br>Ax2 0x68BA<br>Ax3 0x70BA<br>Ax4 0x78BA | Position value of the touch probe 1 at positive edge. | | Object Code | | Variable |
|---|---|---|---|---|---|
| Sub-Idx | Description | Data Type | Access | PDO | Initial Value |
| 0x00 | Touch probe pos1 pos value [TP1PPOS] | Integer32 | RO | Possible | - |
| | | Display Range | 0x80000000-0x7FFFFFFF<br>(-2147483648-2147483647 Pulse) | | |
| | | Unit | 1 Pulse | | |

0x60BB:Touch probe pos1 neg value (negative edge)

| Index Ax1 0x60BB<br>Ax2 0x68BB<br>Ax3 0x70BB<br>Ax4 0x78BB | Position value of the touch probe 1 at negative edge. | | Object Code | | Variable |
|---|---|---|---|---|---|
| Sub-Idx | Description | Data Type | Access | PDO | Initial Value |
| 0x00 | Touch probe pos1 neg value [TP1NPOS] | Integer32 | RO | Possible | - |
| | | Display Range | 0x80000000-0x7FFFFFFF<br>(-2147483648-2147483647 Pulse) | | |
| | | Unit | 1 Pulse | | |

0x60BC:Touch probe pos2 pos value (positive edge)

| Index Ax1 0x60BC<br>Ax2 0x68BC<br>Ax3 0x70BC<br>Ax4 0x78BC | Position value of the touch probe 2 at positive edge. | | Object Code | | Variable |
|---|---|---|---|---|---|
| Sub-Idx | Description | Data Type | Access | PDO | Initial Value |
| 0x00 | Touch probe pos2 pos value [TP2PPOS] | Integer32 | RO | Possible | - |
| | | Display Range | 0x80000000-0x7FFFFFFF<br>(-2147483648-2147483647 Pulse) | | |
| | | Unit | 1 Pulse | | |

0x60BD:Touch probe pos 2 neg value (negative edge)

| | | | | | |
|---|---|---|---|---|---|
| Index Ax1 0x60BD<br>Ax2 0x68BD<br>Ax3 0x70BD<br>Ax4 0x78BD | Position value of the touch probe 2 at negative edge. | | Object Code | | Variable |
| Sub-Idx | Description | Data Type | Access | PDO | Initial Value |
| 0x00 | Touch probe pos 2 neg value [TP2NPOS] | Integer32 | RO | Possible | - |
| | | Display Range | 0x80000000-0x7FFFFFFF<br>(-2147483648-2147483647 Pulse) | | |
| | | Unit | 1 Pulse | | |

0x60C0: Interpolation sub mode select

| | | | | | |
|---|---|---|---|---|---|
| Index Ax1 0x60C0<br>Ax2 0x68C0<br>Ax3 0x70C0<br>Ax4 0x78C0 | Select algorithm of interpolation | | Object code | | Variable |
| Sub-Idx | Description | Data Type | Access | PDO | Initial Value |
| 0x00 | Interpolation algorithm selection [IPSUBM]<br>0: Linear interpolation(fixation time)<br>-1: Linear interpolation(Variable time) | Integer16 | RW | No | 0x0000 |
| | | Display Range | 0xFFFF - 0x0000<br>(-1 - 0) | | |

0x60C1: Interpolation data record

| | | | | | |
|---|---|---|---|---|---|
| Index Ax1 0x60C1<br>Ax2 0x68C1<br>Ax3 0x70C1<br>Ax4 0x78C1 | Interpolation position target in interpolation algorithm. It is buffered with format in 0x60C4. | | Object code | | ARRAY |
| Sub-Idx | Description | Data Type | Access | PDO | Initial Value |
| 0x00 | Number of entry | Unsigned8 | RO | No | 0x02 |
| 0x01 | Interpolation position target [IPPOS] | Integer32 | RW | Possible | 0x00000000 |
| | | Setting Range | 0x80000000 - 0x7FFFFFFF<br>（-2147483648 - 214783647Pulse） | | |
| | | Unit | Pulse | | |
| 0x02 | Interpolation time [IPTIME] | Unsigned8 | RW | Possible | 0x00 |
| | | Setting Range | 0x00 - 0xFF<br>（0 - 255ms） | | |
| | | Unit | ms | | |

0x60C2: Interpolation time period

| | | | |
|---|---|---|---|
| Index Ax1 0x60C2<br>Ax2 0x68C2<br>Ax3 0x70C2<br>Ax4 0x78C2 | Set the interpolation time period value (sub-index 01) in seconds. Then set the interpolation time index (sub-index 02) as exponential in decimal. | Object Code | RECORD |

| Sub-Idx | Name/Description | Data Type | Access | PDO | Range (Initial Value) |
|---|---|---|---|---|---|
| 0x00 | Number of Entry | Unsigned8 | RO | No | 0x02 |
| 0x01 | Interpolation time period value<br>Indicates the value of the time interval used for interpolation. Value makes a degree decision by 10^(interpolation time index) sec of S-Idx:0x02. | Unsigned8 | RW | No | 0x1 - 0xFA<br>(1 - 250) |
| 0x02 | Interpolation time index<br>Indicates the degree (what multiplies) of interpolation time.<br>Examlple:Setting value 0xFC(-4) means 100μsec. | Integer8 | RW | No | 0xFA - 0xFD<br>($10^{-6}$ – $10^{-3}$) |
| It will be synchronized with SM2 cycle time (0x1C32.2) by the setting of special function selection (0x20F7). | | | | | |

Setting Example:

| Interpolation time period | Interpolation time period value (Index 0x60C2, Sub-Index 01) | Interpolation time index (Index 0x60C2, Sub-Index 02) | In the case of synchronizing SM2 cycle time (0x1C32.2) | |
|---|---|---|---|---|
| | | | Dir | Cycle Time (Index 0x1C32,Sub-Index 02) |
| 125us | 125(0x7D) | -6(0xFA) | ←→ | 0x0001E848 (125μs) |
| 250us | 250(0xFA) | -6(0xFA) | → | 0x0003D090 (250μs) |
| | 25(0x19) | -5(0xFB) | ←→ | |
| 500us | 50(0x32) | -5(0xFB) | → | 0x0007A120 (500μs) |
| | 5(0x05) | -4(0xFC) | ←→ | |
| 1ms | 1(0x01) | -3(0xFD) | ←→ | 0x000F4240 (1ms) |
| | 10(0x0A) | -4(0xFD) | → | |
| | 100(0x64) | -5(0xFD) | → | |
| 2ms | 2(0x02) | -3(0xFD) | ←→ | 0x001E8480 (2ms) |
| | 20(0x14) | -4(0xFD) | → | |
| | 200(0xC8) | -5(0xFD) | → | |
| 4ms | 4(0x04) | -3(0xFD) | ←→ | 0x003D0900 (4ms) |
| | 40(0x28) | -4(0xFC) | → | |
| 8ms | 8(0x08) | -3(0xFD) | ←→ | 0x007A01200 (8ms) |
| | 80(0x50) | -4(0xFC) | → | |
| 16ms | 16(0x10) | -3(0xFD) | ←→ | 0x00F42400 (16ms) |
| | 160(0xA0) | -4(0xFC) | → | |

0x60C4: Interpolation data configuration

| | | | |
|---|---|---|---|
| Index Ax1 0x60C4<br>Ax2 0x68C4<br>Ax3 0x70C4<br>Ax4 0x78C4 | The format of interpolation data. | Object code | RECORD |

| Sub-Idx | Description | Data Type | Access | PDO | Initial Value |
|---|---|---|---|---|---|
| 0x00 | Number of entry | Unsigned8 | RO | No | 0x06 |
| 0x01 | Maximum buffer size [MAXSIZE]<br>Show the size of allowable buffer. | Unsigned32 | RO | No | 0x00000100 |
| | | Value | 0x00000100 | | |
| 0x02 | Actual buffer size [BUFFSIZE]<br>Set the buffer size. | Unsigned32 | RW | Possible | 0x00000000 |
| | | Setting Range | 0x00000000 - 0x00000100 | | |
| 0x03 | Buffer format [BUFSTR]<br>0x00 : FIFO<br>0x01 : Ring | Unsigned8 | RW | Possible | 0x00 |
| | | Setting Range | 0x00 - 0x01 | | |
| 0x04 | Point of buffer [BUFPOS]<br>Empty buffer point for next interpolation data record. | Unsigned16 | RW | Possible | 0x0000 |
| | | Setting Range | 0x0000 - 0x00FF | | |
| 0x05 | Data size of interpolation data record [RECSIZE]<br>Show the size of each data in Interpolated position mode. | Unsigned8 | RO | No | 0x04 |
| | | Value | 0x04 - 0x05 | | |
| | | Unit | byte | | |
| 0x06 | Clear buffer [BUFCLR]<br>0x00: Clear all record in buffer and disable data access.<br>0x01: Enabe data access to buffer. Interpolation data record come from upper controller into buffer. | Unsigned8 | WO | Possible | 0x00 |
| | | Setting Range | 0x00 - 0x01 | | |

0x60C5：Maximum deceleration

<table>
<tr><td>Index Ax1 0x60C5<br>Ax2 0x68C5<br>Ax3 0x70C5<br>Ax4 0x78C5</td><td>Sets the limit value of deceleration</td><td>Object Code</td><td>Variable</td></tr>
</table>

<table>
<tr><th>Sub-Idx</th><th>Description</th><th>Data Type</th><th>Access</th><th>PDO</th><th>Initial Value</th></tr>
<tr><td rowspan="4">0x00</td><td rowspan="3">Deceleration limit value<br>Limits the deceleration set value by this parameter if the deceleration setting of 0x6084 exceeds this value.<br>Invalid when the set value is 0.</td><td>Unsigned32</td><td>RW</td><td>Possible</td><td>0xFFFFFFFF</td></tr>
<tr><td>Setting Range</td><td colspan="3">0x00000000 to 0xFFFFFFFF<br>(0 to 4294967295 pps$^2$)</td></tr>
<tr><td>Unit</td><td colspan="3">Pulse/sec$^2$</td></tr>
<tr><td colspan="5">✔Valid for PV mode only.</td></tr>
</table>

0x60C6：Maximum acceleration

<table>
<tr><td>Index Ax1 0x60C6<br>Ax2 0x68C6<br>Ax3 0x70C6<br>Ax4 0x78C6</td><td>Sets the limit value of acceleration</td><td>Object Code</td><td>Variable</td></tr>
</table>

<table>
<tr><th>Sub-Idx</th><th>Description</th><th>Data Type</th><th>Access</th><th>PDO</th><th>Initial Value</th></tr>
<tr><td rowspan="4">0x00</td><td rowspan="3">Acceleration limit value<br>Limits the acceleration set value by this parameter if the acceleration setting of 0x6083 exceeds this value.<br>Invalid when the set value is 0.</td><td>Unsigned32</td><td>RW</td><td>Possible</td><td>0xFFFFFFFF</td></tr>
<tr><td>Setting Range</td><td colspan="3">0x00000000 to 0xFFFFFFFF<br>(0 to 4294967295 pps$^2$)</td></tr>
<tr><td>Unit</td><td colspan="3">Pulse/sec$^2$</td></tr>
<tr><td colspan="5">✔Valid for PV mode only.</td></tr>
</table>

0x60E0: Forward Direction Torque (force) Limit Value

<table>
<tr><td>Index Ax1 0x60E0<br>Ax2 0x68E0<br>Ax3 0x70E0<br>Ax4 0x78E0</td><td>Sets limit value of motor forward direction max. torque (force).</td><td>Object Code</td><td>Variable</td></tr>
</table>

<table>
<tr><th>Sub-Idx</th><th>Description</th><th>Data Type</th><th>Access</th><th>PDO</th><th>Initial Value</th></tr>
<tr><td rowspan="4">0x00</td><td rowspan="3">Forward Direction Torque (force) Limit Value [TCLM-F]<br>Setting units are 1% / LSB in 1/1000 unit of rated torque (force).<br>However, it is limited by max torque (force) for the value that exceeds the max torque (force) of the motor.</td><td>Unsigned16</td><td>RW</td><td>Possible</td><td>0x1388<br>(500.0%)</td></tr>
<tr><td>Setting Range</td><td colspan="3">0x0000 - 0x1388<br>(0 - 500.0%)</td></tr>
<tr><td>Unit</td><td colspan="3">0.1%</td></tr>
<tr><td colspan="5">*Set up in consideration of Acceleration / Deceleration time.<br>If setting value is too low, Acceleration / Deceleration torque (force) will be insufficient and normal control cannot be performed.</td></tr>
</table>

0x60E1: Reverse Direction Torque (force) Limit Value

<table>
<tr><td>Index Ax1 0x60E1<br>Ax2 0x68E1<br>Ax3 0x70E1<br>Ax4 0x78E1</td><td>Sets limit value of motor reverse direction max. torque (force).</td><td>Object Code</td><td>Variable</td></tr>
</table>

<table>
<tr><th>Sub-Idx</th><th>Description</th><th>Data Type</th><th>Access</th><th>PDO</th><th>Initial Value</th></tr>
<tr><td rowspan="4">0x00</td><td rowspan="3">Reverse Direction Torque (force) Limit Value [TCLM-R]<br>Setting units are 1%/ LSB in 1/1000 unit of rated torque (force).<br>However, it is limited by max torque (force) for the value that exceeds the max torque (force) of the motor.</td><td>Unsigned16</td><td>RW</td><td>Possible</td><td>0x1388<br>(500.0%)</td></tr>
<tr><td>Setting Range</td><td colspan="3">0x0000 - 0x1388<br>(0 - 500.0 %)</td></tr>
<tr><td>Unit</td><td colspan="3">0.1%</td></tr>
<tr><td colspan="5">*Set up in consideration of Acceleration / Deceleration time.<br>If setting value is too low, Acceleration / Deceleration torque (force) will be insufficient and normal control cannot be performed.</td></tr>
</table>

0x60E3: Support homing method

| Index | | | | |
|---|---|---|---|---|
| Ax1 0x60E3<br>Ax2 0x68E3<br>Ax3 0x70E3<br>Ax4 0x78E3 | Specifies the value definition of homing method supported | Object code | ARRAY | |

| Sub-Idx | Description | Data Type | Access | PDO | Value |
|---|---|---|---|---|---|
| 0x00 | Number of Entry | Unsigned8 | RO | No | 0x1C |
| 0x01 | Support homing method 1 [HSUP01] | Unsigned16 | RO | No | 0x0001 |
| | Supports Homing method 1 “Homing on negative limit switch and index pulse” | | | | |
| 0x02 | Support homing method 2 [HSUP02] | Unsigned16 | RO | No | 0x0002 |
| | Supports Homing method 2” Homing on positive limit switch and negative index pulse” | | | | |
| 0x03 | Support homing method 3 [HSUP03] | Unsigned16 | RO | No | 0x0003 |
| | Supports Homing method 3” Homing on positive home switch and negative index pulse” | | | | |
| 0x04 | Support homing method 4 [HSUP04] | Unsigned16 | RO | No | 0x0004 |
| | Supports Homing method 4” Homing on positive home switch and positive index pulse” | | | | |
| 0x05 | Support homing method 5 [HSUP05] | Unsigned16 | RO | No | 0x0005 |
| | Supports Homing method 5” Homing on negative home switch and positive index pulse” | | | | |
| 0x06 | Support homing method 6 [HSUP06] | Unsigned16 | RO | No | 0x0006 |
| | Supports Homing method 6” Homing on negative home switch and negative index pulse” | | | | |
| 0x07 | Support homing method 7 [HSUP07] | Unsigned16 | RO | No | 0x0007 |
| | Supports Homing method 7 “Homing on positive limit switch, homing on positive home switch and negative index pulse | | | | |
| 0x08 | Support homing method 8 [HSUP08] | Unsigned16 | RO | No | 0x0008 |
| | Supports Homing method 8 “Homing on positive limit switch, homing on positive home switch and positive index pulse” | | | | |
| 0x09 | Support homing method 9 [HSUP09] | Unsigned16 | RO | No | 0x0009 |
| | Supports Homing method 9 “Homing on positive limit switch, homing on negative home switch and negative index pulse” | | | | |
| 0x0A | Support homing method 10 [HSUP0A] | Unsigned16 | RO | No | 0x000A |
| | Supports Homing method 10 “Homing on positive limit switch, homing on negative home switch and positive index pulse” | | | | |
| 0x0B | Support homing method 11 [HSUP0B] | Unsigned16 | RO | No | 0x000B |
| | Supports Homing method 11” Homing on negative limit switch, homing on positive home switch and positive index pulse” | | | | |
| 0x0C | Support homing method 12 [HSUP0C] | Unsigned16 | RO | No | 0x000C |
| | Supports Homing method 12 ” Homing on negative limit switch, homing on positive home switch and negative index pulse” | | | | |
| 0x0D | Support homing method13 [HSUP0D] | Unsigned16 | RO | No | 0x000D |
| | Supports Homing method 13 ” Homing on negative limit switch, homing on negative home switch and positive index pulse” | | | | |
| 0x0E | Support homing method 14 [HSUP0E] | Unsigned16 | RO | No | 0x000E |
| | Supports Homing method 14 ” Homing on negative limit switch, homing on negative home switch and negative index pulse” | | | | |
| 0x0F | Support homing method 15 [HSUP0F] | Unsigned16 | RO | No | 0x0011 |
| | Supports Homing method 17” Homing on negative limit switch.” | | | | |
| 0x10 | Support homing method 16 [HSUP10] | Unsigned16 | RO | No | 0x0012 |
| | Supports Homing method 18 “Homing on positive limit switch.” | | | | |
| 0x11 | Support homing method 17 [HSUP11] | Unsigned16 | RO | No | 0x0013 |
| | Supports Homing method 19” Homing on home switch (positive logic), stop in positive direction.” | | | | |
| 0x12 | Support homing method 18 [HSUP12] | Unsigned16 | RO | No | 0x0014 |
| | Supports Homing method 20” Homing on home switch (positive logic), stop in negative direction.” | | | | |
| 0x13 | Support homing method 19 [HSUP13] | Unsigned16 | RW | No | 0x0015 |
| | Supports Homing method 21 ”Homing on home switch (negative logic), stop in positive direction.” | | | | |
| 0x14 | Support homing method 20 [HSUP14] | Unsigned16 | RW | No | 0x0016 |
| | Supports Homing method 22 ” Homing on home switch (negative logic), stop in negative direction.” | | | | |
| 0x15 | Support homing method 21 [HSUP15] | Unsigned16 | RO | No | 0x0021 |
| | Supports Homing method 33 ” Homing on index pulse in negative direction.” | | | | |
| 0x16 | Support homing method 22 ［HSUP16］ | Unsigned16 | RO | No | 0x0022 |
| | Supports Homing method 34 ” Homing on index pulse in positive direction.” | | | | |
| 0x17 | Support homing method 23 ［HSUP17］ | Unsigned16 | RO | No | 0x0023 |
| | Support Honing method 35 ”Homing position on actual position” | | | | |
| 0x18 | Support homing method 24 ［HSUP18］ | Unsigned16 | RO | No | 0x0025 |
| | Supports homing method 37 “Homing on actual position or homing position” | | | | |
| 0x19 | Support homing method 25 ［HSUP19］ | Unsigned16 | RO | No | 0x00FF |
| | Supports homing method -1 “Homing on hard stop (Butt) to the Positive direction” | | | | |
| 0x1A | Support homing method 26 ［HSUP1A］ | Unsigned16 | RO | No | 0x00FE |
| | Supports homing method －2 “Homing on hard stop (Butt) to the Negative direction” | | | | |
| 0x1B | Support homing method 27 ［HSUP1B］ | Unsigned16 | RO | No | 0x00FD |
| | Supports homing method －3 “Homing on Negative side hard stop (Butt) and index pulse in Positive derection | | | | |
| 0x1C | Support homing method 28 ［HSUP1C］ | Unsigned16 | RO | No | 0x00FC |
| | Suppots homing method －4 “Homing on Positive side hard stop (Butt) and index pulse in Negative derection | | | | |

| MSB | | | LSB |
|---|---|---|---|
| Reserved | Reserved | Reserved | Supported homing method |
| 15...10 | 9 | 8 | 7...0 |

Bit7-0: Supported homing method
Index 6098 corresponding to that indicated on Homing methods number

0x60F2: Positioning option code

| | | | | |
|---|---|---|---|---|
| Index | Ax1 0x60F2<br>Ax2 0x68F2<br>Ax3 0x70F2<br>Ax4 0x78F2 | Set the behavior of positioning. | Object Code | Variable |

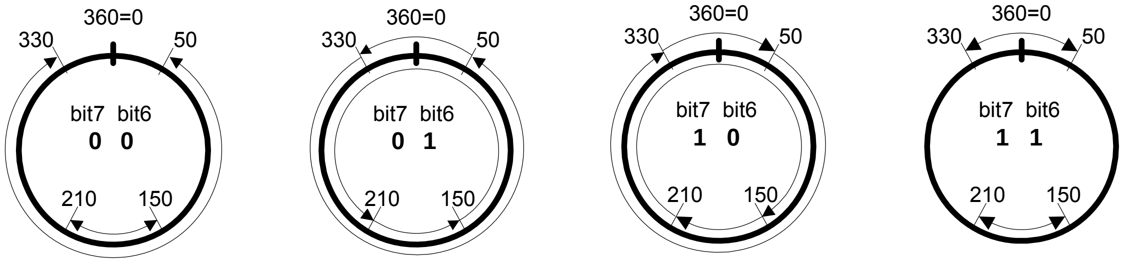
| Sub-Idx | Description | Data Type | Access | PDO | Initial Value |
|---|---|---|---|---|---|
| 0x00 | Positioning option code ［POSOP］<br>See table below for definition of bit 7 and 6.<br>Set 0 except bit 7 and 6. | Unsigned16 | RW | Possible | 0x0000 |
| | | Setting Range | 0x0000-0xFFFF | | |

MSB LSB

| | | | |
|---|---|---|---|
| Reserved | Rotary axis direction option | | Reserved |
| 15･･･8 | 7 | 6 | 5･･･0 |

| bit7 | bit6 | Rotation direction definition on rotation axis |
|---|---|---|
| 0 | 0 | Standard positioning same as straight axis:<br>When position reached limit value, position value goes wraparound to the other side. Positioning at absolute value and relative value is allowable. |
| 0 | 1 | Positioning at negative rotation direction:<br>Move to target through minimum limit of position range, even though target position is bigger than actual position. |
| 1 | 0 | Positioning at positive rotation direction:<br>Move to target through maximum limit of position range, even though target position is smaller than actual position. |
| 1 | 1 | Positioning at shortcut:<br>Automatically decide shortcut direction, and move.<br>When target position and actual position are just opposite, rotation direction is decided to positive. |

Modulo coordinate image at minimum position range limit=0, maximum position range limit = 359



normal (similar to linear axis)

only negative direction

only positive direction

optimized (shortest way)

0x60F4: Actual Position Deviation (Following error actual value)

| | | | | |
|---|---|---|---|---|
| Index | Ax1 0x60F4<br>Ax2 0x68F4<br>Ax3 0x70F4<br>Ax4 0x78F4 | This object shall provide the actual value of the following error. | Object code | Variable |

| Sub-Idx | Description | Data Type | Access | PDO | Initial value |
|---|---|---|---|---|---|
| 0x00 | Actual Position Deviation [PMON]<br>Unit is 1 pulse/LSB with RS2EtherCAT amplifier in the user definition.<br>In incremental encoder, the value that quadruplicate the A/B signal is provided. | Integer32 | RO | Possible | 0x00000000 |
| | | Setting range | 0x80000000-0x7FFFFFFF<br>(-2147483648-2147483647 Pulse) | | |
| | | Unit | Pulse | | |

0x60FA: Control effort

| | | | | |
|---|---|---|---|---|
| Index | Ax1 0x60FA<br>Ax2 0x68FA<br>Ax3 0x70FA<br>Ax4 0x78FA | Indication of the target value after positioning. | Object code | Variable |

| Sub-Idx | Description | Data Type | Access | PDO | Initial value |
|---|---|---|---|---|---|
| 0x00 | Indicatevelocity command value after positioning.<br>This object indicate value at Profile position and Cycle position mode only. | Integer32 | RO | Possible | 0x00000000 |
| | | Setting range | 0x80000000-0x7FFFFFFF<br>（−2147483648-2147483647 Pulse） | | |
| | | Unit | PPS | | |

0x60FC: Position Demand Internal Value

| | | | |
|---|---|---|---|
| Index Ax1 0x60FC<br>Ax2 0x68FC<br>Ax3 0x70FC<br>Ax4 0x78FC | Indicates the internal target position. | Object Code | Variable |

| Sub-Idx | Description | Data Type | Access | PDO | Initial Value |
|---|---|---|---|---|---|
| 0x00 | Internal Target Position<br>Displays internal target position command in profile position mode.<br>This value same as Position Demand Value(0x6062) as measured by the control cycle unit（125μs）.<br>✔Other modes<br>Values are not displayed. (always displayed as 0) | Integer32 | RO | Possible | — |
| | | Display Range | 0x80000000-0x7FFFFFFF<br>（-2147483648-2147483647 Pulse） | | |
| | | Unit | Pulse | | |

0x60FD: Digital inputs

| | | | |
|---|---|---|---|
| Index Ax1 0x60FD<br>Ax2 0x68FD<br>Ax3 0x70FD<br>Ax4 0x78FD | This object shall monitor the status of general-purpose input, output and hardware gate off. | Object code | Record |

| Sub-Idx | Description | Data Type | Access | PDO | Initial value |
|---|---|---|---|---|---|
| 0x00 | Digital input monitor [DINPUT]<br>Monitor the state of general input: CONT1 to 8.<br>1: Photocoupler is on.<br>* For hardware detection, digital input has about 4msec delay. | Unsigned32 | RO | Possible | - |
| | | Display range | 0x00000000-0xFFFFFFFF | | |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MSB | | | | | | | | | | | | | LSB |
| Res | CONT8 | CONT7 | CONT6 | CONT5 | CONT4 | CONT3 | CONT2 | CONT1 | Res | EMR | Home | Positive limit | Negative limit |
| 31‥24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15‥4 | 3 | 2 | 1 | 0 |

0x60FE: Digital output

| | | | |
|---|---|---|---|
| Index Ax1 0x60FE<br>Ax2 0x68FE<br>Ax3 0x70FE<br>Ax4 0x78FE | This object sets output of holding brake timing output monitor and general-purpose output OUT1 and OUT2 | Object Code | Record |

| Sub-Idx | Description | Data Type | Access | PDO | Initial Value |
|---|---|---|---|---|---|
| 0x00 | Number of entry | Unsigned8 | RO | No | 0x0 |
| 0x01 | Physical output [DOUTPUT]<br>Bit 0: Monitoring Holding brake output timing<br>Bit17-16: Enables control output OUT1 and OUT2 when it is set 0x42 through 0x45 for “Controls by EtherCAT communication”.<br>* For hardware detection, digital output has about 4msec delay. | Unsigned32 | RW | Possible | - |
| | | Display range | 0x000000-0xFFFFFFFF | | |

| | | | | |
|---|---|---|---|---|
| MSB | | | | LSB |
| Reserved | FOUT2 | FOUT1 | Reserved | Set brake |
| 31 - 18 | 17 | 16 | 15...3 | 0 |

| Sub-Idx | Description | Data Type | Access | PDO | Initial Value |
|---|---|---|---|---|---|
| 0x02 | Bit mask<br>bit0: Disabled<br>bit17-16 mask the bits corresponding to physical output<br>When the setting of General Purpose Output setting is set by any of “Controls by EtherCAT communication”, if the mask of the setting bit is set, output of OUT1.2 will be disabled.<br>When the bit mask is set to “1”, it is Enable OUTPUT and the bit mask is set to “0”, it is Disable OUTPUT. | Unsigned32 | RW | Possible | 0xFFFFFFFF |
| | | Setting Range | 0x000000～0xFFFFFFFF | | |

0x60FF: Target Velocity

| | | | |
|---|---|---|---|
| Index Ax1 0x60FF<br>Ax2 0x68FF<br>Ax3 0x70FF<br>Ax4 0x78FF | Indicates to set Target velocity, and used for inputting trajectory generator. | Object Code | Variable |

| Sub-Idx | Description | Data Type | Access | PDO | Initial Value |
|---|---|---|---|---|---|
| 0x00 | Target Velocity (Velocity command) [TAVEL]<br>Velocity command input for Cyclic Sync. Velocity (csv), Profile velocity (pv) | Integer32 | RW | Possible | - |
| | | Display range | 0x80000000-0x7FFFFFFF<br>(-2147483648-2147483647 pps) | | |
| | | Unit | Pulse/sec | | |

0x6402: Motor Type

| | | | |
|---|---|---|---|
| Index Ax1 0x6402<br>Ax2 0x6C02<br>Ax3 0x7402<br>Ax4 0x7C02 | Select running motor type. | Object Code | VAR |

| Sub-Idx | Name/Description | Data Type | Access | PDO | Value |
|---|---|---|---|---|---|
| 0x00 | Motor Type<br>This product does not support any motor other than AC motor. | Unsigned16 | RW | Possible | 0x000C |

0x6403: Motor Catalog Number

| | | | |
|---|---|---|---|
| Index Ax1 0x6403<br>Ax2 0x6C03<br>Ax3 0x7403<br>Ax4 0x7C03 | Indicates setting motor model number. | Object Code | VAR |

| Sub-Idx | Name/Description | Data Type | Access | PDO | Value |
|---|---|---|---|---|---|
| 0x00 | Motor Model Number<br>Setting Motor Model Number (ASCIICode) | Visible String | RO | No | Character String<br>(—) |

R2 G A 04 003 F ✔ Please refer to chapter 1.4 "Motor model number" for the detail of motor model number.

※ Only the Sanyo Denki R series are supported. Non supported motors are indicated as Not Supported.

0x6404:Motor Manufacture

| | | | |
|---|---|---|---|
| Index Ax1 0x6404<br>Ax2 0x6C04<br>Ax3 0x7404<br>Ax4 0x7C04 | Indicates manufacturer of setting motor. | Object Code | VAR |

| Sub-Idx | Name/Description | Data Type | Access | PDO | Value |
|---|---|---|---|---|---|
| 0x00 | Manufacturer<br>Manufacturer of setting motor (ASCII code) | Visible String | RO | No | Character String<br>(—) |

※ It is indicated as SANYO DENKI Co., LTD because Sanyo Denki motors are recommended.

0x6405: Motor Catalog Address of our Home Page

| | | | |
|---|---|---|---|
| Index Ax1 0x6405<br>Ax2 0x6C05<br>Ax3 0x7405<br>Ax4 0x7C05 | Indicates catalog address of selected motor. | Object Code | VAR |

| Sub-Idx | Name/Description | Data Type | Access | PDO | Value |
|---|---|---|---|---|---|
| 0x00 | Home Page Address<br>Home Page Address of setting motor<br>(ASCIICode) | Visible String | RO | No | Character String<br>(－) |

※ SANYO DENKI's home page address is indicated because Sanyo Denki motors are recommended.

0x6502:Supported Drive mode

| | | | |
|---|---|---|---|
| Index Ax1 0x6502<br>Ax2 0x6D02<br>Ax3 0x7502<br>Ax4 0x7D02 | This object shall provide information on the supported drive modes by the servo amplifier. | Object code | Variable |

| Sub-Idx | Description | Data Type | Access | PDO | Initial value |
|---|---|---|---|---|---|
| 0x00 | Support drive mode [SUPMODE]<br>0:Not supported 1: Supported | Unsigned32 | RO | Possible | 0x03ED |
| | | Display range | 0x03ED～0x03ED | | |

MSB LSB

| - | - | cst | csv | csp | ip | hm | - | tq | pv | vl | pp |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 31 - 16 | 15 - 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |

| | |
|---|---|
| bit0:pp | Profile Position mode |
| bit1:vl | Velocity mode |
| bit2:pv | Profile Velocity mode |
| bit3:tq | Torque profile mode |
| bit5:hm | Homing mode |
| bit6:ip | Interpolated position mode |
| bit7:csp | Cycle synchronous Position Mode |
| bit8:csv | Cycle synchronous Velocity Mode |
| bit9 :cst | Cycle synchronous Torque Mode |

0x6503：Drive Catalog No.

| | | | |
|---|---|---|---|
| Index Ax1 0x6503<br>Ax2 0x6D03<br>Ax3 0x7503<br>Ax4 0x7D03 | Indicates Catalog No. of this product. | Object Code | VAR |

| Sub-Idx | Name/Description | Data Type | Access | PDO | Value |
|---|---|---|---|---|---|
| 0x00 | Catalog No.<br>The Catalog No. of this product is indicated. | Visible String | RO | No | Character String<br>(－) |

Indicates the bookbinding Catalog No. of this product (944-1 or 946-2)

0x6505：http Drive Catalog Address

| Index | 0x6505 | Indicates the website address of the catalog for this product. | Object Code | VAR |
|---|---|---|---|---|

| Sub-Idx | Name/Description | Data Type | Access | PDO | Value |
|---|---|---|---|---|---|
| 0x00 | Website address<br>The address of the website catalog for this Product. (ASCII Code) | Visible String | RO | No | Character String<br>(－) |

※Indicates the address of the catalog of servo amplifiers on the Sanyo Denki website.

# 5.6 Manufacturer Specific Area

## 1) Object Group (0x2000-)

The followings are shown in Table; Manufacturer area of CoE (CANopen over EtherCAT) object list, RS2-EtherCAT Supported / Un-supported, Data length, Access (Dir), PDO Mapping, and parameter effective timing (updating).
#=immediately, $=ESM change required, and &=control-power-source re-input.

Manufacturer Specific Area (No.1)

| Index | S-Idx | FP | FV | FT | FH | Name | Data Type | Dir | PDO Mapping | Update | NVRAM |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0x2000 | 0x00 | ○ | ○ | ○ | ○ | Control Word 1 | Unsigned16 | RW | Possible | # | Yes |
| 0x2001 | 0x00 | ○ | ○ | ○ | ○ | Parameter Select | Unsigned16 | RW | Possible | # | - |
| 0x2002 | 0x00 | - | - | - | - | Auto-tuning settings | Unsigned8 | RO | No | - | - |
| ↑ | 0x01 | ○ | ○ | ○ | ○ | Auto-Tuning Mode | Unsigned8 | RW | No | # | Yes |
| ↑ | 0x02 | ○ | ○ | ○ | ○ | Auto-Tuning Characteristic | Unsigned8 | RW | No | # | Yes |
| ↑ | 0x03 | ○ | ○ | ○ | ○ | Auto-Tuning Response | Unsigned8 | RW | No | # | Yes |
| ↑ | 0x04 | ○ | ○ | ○ | ○ | Running tune | Unsigned8 | RW | No | - | - |
| ↑ | 0x05 | ○ | ○ | ○ | ○ | Monitoring on tune | Unsigned8 | RO | No | - | - |
| ↑ | 0x06 | ○ | ○ | ○ | ○ | Tune result saving parameter selection | Unsigned8 | RW | No | - | - |
| 0x2003 | 0x00 | ○ | × | × | × | Position Command Smoothing Constant | Unsigned16 | RW | Possible | # | Yes |
| 0x2004 | 0x00 | ○ | × | × | × | Position Command Filter | Unsigned16 | RW | No | # | Yes |
| 0x2005 | 0x00 | - | - | - | - | Position Loop Proportional Gain | Unsigned8 | RO | No | - | - |
| ↑ | 0x01 | ○ | × | × | × | Position Loop Proportional Gain 1 | Unsigned16 | RW | Possible | # | Yes |
| ↑ | 0x02-0x04 | ○ | × | × | × | Position Loop Proportional Gain 2 - 4 | Unsigned16 | RW | No | # | Yes |
| 0x2006 | 0x00 | - | - | - | - | Position Integral Time Constant | Unsigned8 | RO | No | - | - |
| ↑ | 0x01 | ○ | × | × | × | Position Integral Time Constant 1 | Unsigned16 | RW | Possible | # | Yes |
| ↑ | 0x02-0x04 | ○ | × | × | × | Position Integral Time Constant 2 - 4 | Unsigned16 | RW | No | # | Yes |
| 0x2007 | 0x00 | ○ | × | × | × | Higher Tracking Control Position Compensation Gain | Unsigned16 | RW | No | # | Yes |
| 0x2008 | 0x00 | - | - | - | - | Feed forward compensation parameter | Unsigned8 | RO | No | - | - |
| ↑ | 0x01 | ○ | × | × | × | Feed Forward Gain | Unsigned16 | RW | Possible | # | Yes |
| ↑ | 0x02 | ○ | × | × | × | Feed Forward Filter | Unsigned16 | RW | No | # | Yes |
| 0x2009 | 0x00 | - | - | - | - | Velocity Command Filter Settings | Unsigned8 | RO | No | - | Yes |
| 0x200A | 0x00 | ○ | ○ | × | ○ | Velocity Feedback Filter | Unsigned16 | RW | No | # | Yes |
| 0x200B | 0x00 | - | - | - | - | Velocity Loop Proportional Gain | Unsigned8 | RO | No | - | - |
| ↑ | 0x01 | ○ | ○ | × | ○ | Velocity Loop Proportional Gain 1 | Unsigned16 | RW | Possible | # | Yes |
| ↑ | 0x02-0x04 | ○ | ○ | × | ○ | Velocity Loop Proportional Gain 2 - 4 | Unsigned16 | RW | No | # | Yes |
| 0x200C | 0x00 | - | - | - | - | Velocity Loop Integral Time Constant | Unsigned8 | RO | No | - | - |
| ↑ | 0x01 | ○ | ○ | × | ○ | Velocity Loop Integral Time Constant 1 | Unsigned16 | RW | Possible | # | Yes |
| ↑ | 0x02-0x04 | ○ | ○ | × | ○ | Velocity Loop Integral Time Constant 2 - 4 | Unsigned16 | RW | No | # | Yes |
| 0x200D | 0x00 | - | - | - | - | Load Inertia Moment Ratio | Unsigned8 | RO | No | - | - |
| ↑ | 0x01 | ○ | ○ | ○ | ○ | Load Inertia Moment Ratio 1 | Unsigned16 | RW | Possible | # | Yes |
| ↑ | 0x02-0x04 | ○ | ○ | ○ | ○ | Load Inertia Moment Ratio 2 - 4 | Unsigned16 | RW | No | # | Yes |
| 0x200E | 0x00 | ○ | ○ | × | ○ | Higher Tracking Control Velocity Compensation Gain | Unsigned16 | RW | No | # | Yes |
| 0x200F | 0x00 | - | - | - | - | Acceleration Feedback Compensation | Unsigned8 | RO | No | - | - |
| ↑ | 0x01 | ○ | ○ | × | ○ | Acceleration Feedback Gain | Integer16 | RW | No | # | Yes |
| ↑ | 0x02 | ○ | ○ | × | ○ | Acceleration Feedback Filter | Unsigned16 | RW | No | # | Yes |
| 0x2011 | 0x00 | - | - | - | - | Command Filter | Unsigned8 | RO | No | - | - |
| ↑ | 0x01 | ○ | ○ | ○ | ○ | Torque (force) Command Filter 1 | Unsigned16 | RW | Possible | # | Yes |
| ↑ | 0x02-0x04 | ○ | ○ | ○ | ○ | Torque (force) Command Filter 2 - 4 | Unsigned16 | RW | Possible | # | Yes |
| 0x2012 | 0x00 | - | - | - | - | FF Vibration Suppressor Frequency | Unsigned8 | RO | No | - | - |
| ↑ | 0x01 | ○ | × | × | × | FF Vibration Suppressor Frequency 1 | Unsigned16 | RW | Possible | # | Yes |
| ↑ | 0x02-0x04 | ○ | × | × | × | FF Vibration Suppressor Frequency 2 - 4 | Unsigned16 | RW | No | # | Yes |
| 0x2015 | 0x00 | - | - | - | - | High setting control settings | Unsigned8 | RO | No | - | - |
| ↑ | 0x01 | ○ | × | × | × | Acceleration Compensation | Integer16 | RW | No | # | Yes |
| ↑ | 0x02 | ○ | × | × | × | Deceleration Compensation | Integer16 | RW | No | # | Yes |
| ↑ | 0x03 | ○ | × | × | × | Command Velocity Low-pass Filter | Unsigned16 | RW | No | # | Yes |
| ↑ | 0x04 | ○ | × | × | × | Command Velocity Threshold | Unsigned16 | RW | No | # | Yes |

○: Supported, ×: Not supported

FP: Function Group “Position” FV: Function Group “ Velocity “ FT: Function Group ” Torque (force) ”
FH: Function Group ”Homing mode”

Manufacturer Specific Area (No.2)

| Index | S-Idx | FP | FV | FT | FH | Name | Data Type | Dir | PDO Mapping | Update | NVRAM |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0x2016 | 0x00 | - | - | - | - | Observer Parameter | Unsigned8 | RO | No | - | - |
| ↑ | 0x01 | ○ | ○ | × | ○ | Observer Characteristic | Unsigned8 | RW | No | # | Yes |
| ↑ | 0x02 | ○ | ○ | × | ○ | Observer Compensation Gain | Unsigned16 | RW | No | # | Yes |
| ↑ | 0x03 | ○ | ○ | × | ○ | Observer Output Filter | Unsigned16 | RW | No | # | Yes |
| ↑ | 0x04 | ○ | ○ | × | ○ | Observer Notch Filter | Unsigned16 | RW | No | # | Yes |
| ↑ | 0x05 | ○ | ○ | × | ○ | Observer Load Inertia Ratio | Unsigned16 | RW | No | # | Yes |
| ↑ | 0x06 | ○ | ○ | × | ○ | Observer Loop Proportional Gain | Unsigned16 | RW | No | # | Yes |
| ↑ | 0x07 | ○ | ○ | × | ○ | Observer Load Torque (force) Filter | Unsigned16 | RW | No | # | Yes |
| 0x2017 | 0x00 | - | - | - | - | Model Control Gain | Unsigned8 | RO | No | - | - |
| ↑ | 0x01 | ○ | × | × | × | Model Control Gain 1 | Unsigned16 | RW | Possible | # | Yes |
| ↑ | 0x02-0x04 | ○ | × | × | × | Model Control Gain 2 - 4 | Unsigned16 | RW | No | # | Yes |
| 0x2018 | 0x00 | ○ | × | × | × | Overshoot Suppressor Filter | Unsigned16 | RW | No | # | Yes |
| 0x2019 | 0x00 | - | - | - | - | Model Control Antiresonance Frequency | Unsigned8 | RO | No | - | - |
| ↑ | 0x01 | ○ | × | × | × | Model Control Antiresonance Frequency 1 | Unsigned16 | RW | Possible | # | Yes |
| ↑ | 0x02-0x04 | ○ | × | × | × | Model Control Antiresonance Frequency 2 - 4 | Unsigned16 | RW | No | # | Yes |
| 0x201A | 0x00 | - | - | - | - | Model Control Resonance Frequency | Unsigned8 | RO | No | - | - |
| ↑ | 0x01 | ○ | × | × | × | Model Control Resonance Frequency 1 | Unsigned16 | RW | Possible | # | Yes |
| ↑ | 0x02-0x04 | ○ | × | × | × | Model Control Resonance Frequency 2 - 4 | Unsigned16 | RW | No | # | Yes |
| 0x201B | 0x00 | ○ | ○ | × | ○ | Gain Switching Filter | Unsigned16 | RW | No | # | Yes |
| 0x201C | 0x00 | ○ | ○ | × | ○ | Internal Velocity Command limit | Unsigned16 | RW | No | # | Yes |
| 0x201D | 0x00 | ○ | × | × | × | Position Command error 1 level | Unsigned32 | RW | No | # | Yes |
| 0x201E | 0x00 | ○ | ○ | × | ○ | Sequence Operation Torque (force) Limit Value | Unsigned16 | RW | No | # | Yes |
| 0x201F | 0x00 | ○ | × | × | × | Near Range | Unsigned32 | RW | No | # | Yes |
| 0x2020 | 0x00 | ○ | ○ | × | ○ | Speed Zero Range | Unsigned16 | RW | No | # | Yes |
| 0x2021 | 0x00 | ○ | ○ | × | ○ | Low Speed Range | Unsigned16 | RW | No | # | Yes |
| 0x2022 | 0x00 | ○ | ○ | × | ○ | Speed Attainment Setting (high-speed setting) | Unsigned16 | RW | No | # | Yes |
| 0x2023 | 0x00 | - | - | - | - | Analog Monitor Select Output | Unsigned8 | RO | No | - | - |
| ↑ | 0x01,0x02 | ○ | ○ | ○ | ○ | Analog Monitor Select Output 1 ,2 | Unsigned8 | RW | No | # | Yes |
| ↑ | 0x03 | ○ | ○ | ○ | ○ | Analog Monitor Output Polarity | Unsigned8 | RW | No | # | Yes |
| 0x2024 | 0x00 | ○ | ○ | ○ | ○ | Delay Time of Engaging Holding Brake (Holding Brake Holding Delay Time) | Unsigned16 | RW | Possible | # | Yes |
| 0x2025 | 0x00 | ○ | ○ | ○ | ○ | Delay Time of Releasing Holding Brake (Holding Brake Release Delay Time) | Unsigned16 | RW | No | # | Yes |
| 0x2026 | 0x00 | ○ | ○ | ○ | ○ | Brake Operation Beginning Time | Unsigned16 | RW | Possible | # | Yes |
| 0x2027 | 0x00 | ○ | ○ | ○ | ○ | Power Failure Detection Delay Time | Unsigned16 | RW | No | # | Yes |
| 0x2028 | 0x00 | ○ | × | × | × | Excessive Deviation Warning Level | Unsigned32 | RW | No | # | Yes |
| 0x2029 | 0x00 | ○ | ○ | ○ | ○ | Overload Warning Level | Unsigned16 | RW | No | # | Yes |
| 0x202A | 0x00 | ○ | ○ | ○ | ○ | Speed Matching Width | Unsigned16 | RW | No | # | Yes |
| 0x202B | 0x00 | ○ | ○ | ○ | ○ | Torque (force)Command Filter Characteristic | Unsigned8 | RW | No | # | Yes |
| 0x202C | 0x00 | ○ | × | × | × | Feed Forward Filter, Depth Selection | Unsigned8 | RW | No | # | Yes |
| 0x202E | 0x00 | ○ | ○ | ○ | ○ | Torque attainement setting | Unsigned16 | RW | No | # | Yes |
| 0x202F | 0x00 | ○ | ○ | ○ | ○ | Brake Activation Speed | Unsigned16 | RW | Possible | # | Yes |
| 0x2030 | 0x00 | ○ | ○ | ○ | × | Position Loop Integral Gain Limit | Unsigned16 | RW | Possible | # | Yes |
| 0x2031 | 0x00 | × | ○ | ○ | × | Velocity Control Integral Gain Limit | Unsigned16 | RW | Possible | # | Yes |
| 0x2032 | 0x00 | × | × | ○ | × | Torque (force) Control Proportional Gain | Unsigned8 | RW | Possible | # | Yes |
| 0x2034 | 0x00 | - | - | - | - | Command Filter off Speed | Unsigned8 | RO | No | # | |
| ↑ | 0x01 | ○ | ○ | ○ | ○ | Position / Velocity Command Filter off Speed selection | Unsigned8 | RW | Possible | # | Yes |
| ↑ | 0x02 | ○ | ○ | ○ | ○ | Position / Velocity Command Filter off Speed | Unsigned16 | RW | Possible | # | Yes |
| 0x2035 | 0x00 | - | - | - | - | Assist-Function Parameter | Unsigned8 | RO | No | | |
| ↑ | 0x01 | ○ | - | - | - | Correction Proportional Gain | Unsigned8 | RW | No | | Yes |
| ↑ | 0x02 | ○ | - | - | - | Correction Integral Time Constant | Unsigned16 | RW | No | | Yes |
| ↑ | 0x03 | ○ | - | - | - | Correction Low-pass Filter | Unsigned16 | RW | No | | Yes |
| ↑ | 0x04 | ○ | - | - | - | Excessive Position Synchronization Deviation Level | Unsigned32 | RW | No | | Yes |
| ↑ | 0x05 | ○ | - | - | - | Position Synchronization Deviation Warning Level | Unsigned32 | RW | No | | Yes |
| ↑ | 0x06 | ○ | - | - | - | Position Deviation Polarity Selection | Unsigned8 | RW | No | | Yes |
| ↑ | 0x07 | ○ | ○ | ○ | — | Assist-target axis address | Unsigned8 | RW | No | # | Yes |
| ↑ | 0x08 | ○ | ○ | ○ | — | Assist-function selection | Unsigned8 | RW | No | # | Yes |
| ↑ | 0x09 | — | — | ○ | — | Torque assisting rate | Unsigned16 | RW | Possible | - | Yes |
| 0x2036 | 0x00 | - | - | - | - | Position Differential Gain setting | Unsigned8 | RO | No | - | - |
| ↑ | 0x01 | ○ | × | × | × | Position differential time constant | Unsigned16 | RW | Possible | # | Yes |
| ↑ | 0x02 | ○ | × | × | × | Position differential filter | Unsigned16 | RW | Possible | # | Yes |
| 0x2037 | 0x00 | ○ | × | × | × | Position Drain Ratio | Unsigned32 | RW | Possible | # | Yes |
| 0x2038 | 0x00 | ○ | × | × | × | Velocity Control Bypass Setting | Unsigned16 | RW | Possible | # | Yes |
| 0x2039 | 0x00 | ○ | ○ | × | × | Verifications Drain Ratio | Unsigned16 | RW | Possible | # | Yes |
| 0x203A | 0x00 | ○ | ○ | ○ | ○ | Torque (force) Control Integral Gain Setting | Unsigned8 | RW | Possible | # | Yes |
| 0x203B | 0x00 | ○ | ○ | ○ | ○ | Torque (force) Control Integral Gain Limit Setting | Unsigned8 | RW | Possible | # | Yes |
| 0x203C | 0x00 | ○ | × | × | × | Software Deceleration Limit | Unsigned32 | RW | No | # | Yes |
| 0x203D | 0x00 | — | — | — | — | Amplifier temperature warning level | Unsigned8 | RO | No | - | |
| ↑ | 0x01 | ○ | ○ | ○ | ○ | Amplifier temperature warning high level setting | Integer16 | RW | No | # | Yes |
| ↑ | 0x02 | ○ | ○ | ○ | ○ | Amplifier temperature warning low level setting | Integer16 | RW | No | # | Yes |

○: Supported, ×: Not supported

Manufacturer Specific Area (No.3)

| Index | S-Idx | FP | FV | FT | FH | Name | Data Type | Dir | PDO Mapping | Update | NVRAM |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0x2040 | 0x00 | — | — | — | — | Command Filter Setting | Unsigned8 | RO | No | — | - |
| ↑ | 0x01 | ○ | ○ | × | ○ | Velocity Command Filter | Unsigned8 | RW | Possible | # | Yes |
| ↑ | 0x02 | ○ | ○ | ○ | ○ | Torque（force）Command Filter | Unsigned8 | RW | Possible | # | Yes |
| 0x2041<br>0x2042-<br>0x2045 | 0x00 | — | — | — | — | Velocity Command Filter Setting<br>Torque（force）Command Filter1 – 4 Setting | Unsigned8 | - | - | - | Yes |
| ↑ | 0x01 | ○ | ○ | × | ○ | Filter ON/OFF | Integer8 | RW | Possible | # | Yes |
| ↑ | 0x02 | ○ | ○ | × | ○ | Filter Type | Integer8 | RW | Possible | # | Yes |
| ↑ | 0x03 | ○ | ○ | × | ○ | Low Pass Filter Cutoff frequency | Unsigned16 | RW | Possible | # | Yes |
| ↑ | 0x04 | ○ | ○ | × | ○ | High Pass Filter Cutoff frequency | Unsigned16 | RW | Possible | # | Yes |
| ↑ | 0x05 | ○ | ○ | × | ○ | Band PassFilter Cutoff frequency | Unsigned16 | RW | Possible | # | Yes |
| ↑ | 0x06 | ○ | ○ | × | ○ | Band width of Band Pass Filter | Unsigned16 | RW | Possible | # | Yes |
| ↑ | 0x07 | ○ | ○ | × | ○ | Center frequency of Notch Filter | Unsigned16 | RW | Possible | # | Yes |
| ↑ | 0x08 | ○ | ○ | × | ○ | Band width of Notch Filter | Unsigned16 | RW | Possible | # | Yes |
| ↑ | 0x09 | ○ | ○ | × | ○ | Bi-quad Filter a1 | Float32 | RW | Possible | # | Yes |
| ↑ | 0x0A | ○ | ○ | × | ○ | Bi-quad Filter a2 | Float32 | RW | Possible | # | Yes |
| ↑ | 0x0B | ○ | ○ | × | ○ | Bi-quad Filter b0 | Float32 | RW | Possible | # | Yes |
| ↑ | 0x0C | ○ | ○ | × | ○ | Bi-quad Filter b1 | Float32 | RW | Possible | # | Yes |
| ↑ | 0x0D | ○ | ○ | × | ○ | Bi-quad Filter b2 | Float32 | RW | Possible | # | Yes |
| 0x2050 | 0x00 | — | — | — | — | Quadrant Glitch Compensation function | Unsigned8 | RO | No | — | — |
| ↑ | 0x01 | ○ | ○ | ○ | ○ | Effective condition selection | Unsigned8 | RW | Possible | # | Yes |
| ↑ | 0x02 | ○ | ○ | ○ | ○ | Effective velocity | Unsigned16 | RW | Possible | # | Yes |
| ↑ | 0x03 | ○ | ○ | ○ | ○ | Keeping time | Unsigned16 | RW | Possible | # | Yes |
| ↑ | 0x04 | ○ | ○ | ○ | ○ | Velocity Loop Integral Time Constant | Unsigned16 | RW | Possible | # | Yes |
| 0x2051 | 0x00 | ○ | ○ | ○ | ○ | Micro Vibration Suppression function | Unsigned8 | RW | Possible | # | Yes |
| 0x5080 | 0x00 | ○ | - | - | - | Correction Table Control | Unsigned8 | RW | No | # | Yes |
| 0x5081 | 0x00 | ○ | - | - | - | Correction Table Interpolation Method | Unsigned8 | RW | No | # | Yes |
| 0x5082 | 0x00 | ○ | - | - | - | Correction Table Extrapolation Method | Unsigned8 | RW | No | # | Yes |
| 0x5083 | 0x00 | - | - | - | - | Correction Table, Number of Entry | Unsigned8 | RW | No | & | Yes |
| ↑ | 0x01-0x40 | ○ | - | - | - | Correction Position | Unsigned32 | RW | No | # | Yes |
| 0x5084 | 0x00 | - | - | - | - | Correction Table, Number of Entry | Unsigned8 | RW | No | & | Yes |
| ↑ | 0x01-0x40 | ○ | - | - | - | Offset | Integer32 | RW | No | # | Yes |
| 0x5090 | 0x00 | ○ | × | × | × | Selection of Backlash Correction Function | Unsigned8 | RW | No | # | Yes |
| 0x5091 | 0x00 | ○ | × | × | × | Correction amount of Backlash | Unsigned32 | RW | No | # | Yes |
| 0x5092 | 0x00 | ○ | × | × | × | Correction direction of Backlash | Unsigned8 | RW | No | # | Yes |

○: Supported, ×: Not supported

Manufacturer Specific Area (No.4)

| Index | S-Idx | FP | FV | FT | FH | Name | Data Type | Dir | PDO Mapping | Update | NVRAM |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0x20F0 | 0x00 | - | - | - | - | Amplifier Function Selection | Unsigned8 | RO | No | - | - |
| ↑ | 0x01 | ○ | ○ | ○ | ○ | Limit behavior | Unsigned8 | RW | No | # | Yes |
| ↑ | 0x02 | ○ | × | × | × | Positioning Method | Unsigned8 | RW | No | & | Yes |
| ↑ | 0x03 | ○ | × | × | × | In position / Position deviation monitor | Unsigned8 | RW | No | # | Yes |
| ↑ | 0x04 | ○ | ○ | ○ | ○ | Velocity Window Unit Output | Unsigned8 | RW | No | # | Yes |
| ↑ | 0x05 | ○ | × | × | × | Deviation Clear | Unsigned8 | RW | No | # | Yes |
| ↑ | 0x06 | ○ | ○ | ○ | ○ | Torque (force) attainment function selection | Unsigned8 | RW | No | # | Yes |
| 0x20F1 | 0x00 | - | - | - | - | Encoder Function Selection | Unsigned8 | RO | No | - | - |
| ↑ | 0x01 | ○ | ○ | ○ | ○ | Serial Encoder Clear Function | Unsigned8 | RW | No | # | Yes |
| ↑ | 0x02 | ○ | ○ | ○ | ○ | Incremental Encoder, Digital Filter | Unsigned8 | RW | No | # | Yes |
| ↑ | 0x03 | ○ | × | × | × | External Pulse Encoder, Digital Filter | Unsigned8 | RW | No | # | Yes |
| ↑ | 0x04 | ○ | × | × | × | External Pulse Encoder Polarity | Unsigned8 | RW | No | & | Yes |
| ↑ | 0x05 | ○ | ○ | ○ | ○ | CS offset onlinear encoder | Unsigned16 | RW | No | & | Yes |
| ↑ | 0x06 | ○ | ○ | ○ | ○ | CS normalization offset of phase Z on linear encoder | Unsigned16 | RW | No | & | Yes |
| ↑ | 0x07 | ○ | ○ | ○ | ○ | Polarity selection on linear encoder | Unsigned8 | RW | No | & | Yes |
| ↑ | 0x08 | ○ | ○ | ○ | ○ | Magnetic pole position detecting frequency | Unsigned16 | RW | No | & | Yes |
| ↑ | 0x09 | ○ | ○ | ○ | ○ | Magnetic Pole Position Estimation Mode Selection | Unsigned8 | RW | No | & | Yes |
| 0x20F2 | 0x00 | - | - | - | - | Amplifier Alarm Detect Selection | Unsigned8 | RO | No | - | - |
| ↑ | 0x01 | ○ | ○ | ○ | ○ | Main Circuit Under-voltage Detection | Unsigned8 | RW | No | # | Yes |
| ↑ | 0x02 | ○ | ○ | ○ | ○ | Velocity Control Alarm Detection | Unsigned8 | RW | No | # | Yes |
| ↑ | 0x03 | ○ | ○ | ○ | ○ | Velocity Feedback Alarm Detection | Unsigned8 | RW | No | # | Yes |
| ↑ | 0x04 | ○ | ○ | ○ | ○ | Communication Frame Error Detection | Unsigned8 | RW | No | # | Yes |
| ↑ | 0x05 | ○ | ○ | ○ | ○ | Communication Timeout Detection | Unsigned8 | RW | No | # | Yes |
| 0x20F3 | 0x00 | - | - | - | - | Position Control Selection | Unsigned8 | RO | No | - | - |
| ↑ | 0x01 | ○ | × | × | × | Model Control Characteristic | Unsigned8 | RW | No | & | Yes |
| ↑ | 0x02 | ○ | × | × | × | Position Loop Encoder Selection | Unsigned8 | RW | No | & | Yes |
| 0x20F4 | 0x00 | ○ | ○ | ○ | ○ | Servo Loop Delay Time | Unsigned8 | RW | No | & | Yes |
| 0x20F5 | 0x00 | ○ | ○ | ○ | ○ | Torque (force) Limit at Power Supply Shortage | Unsigned8 | RW | No | # | Yes |
| 0x20F6 | 0x00 | — | — | — | — | Manufacturer Homing Function Selection | Unsigned8 | RO | No | — | - |
| ↑ | 0x01 | × | × | × | ○ | Actual Position Calculation Method | Unsigned8 | RW | No | # | Yes |
| ↑ | 0x02 | × | × | × | ○ | Hard Stop Torque Limit | Unsigned16 | RW | No | # | Yes |
| ↑ | 0x03 | × | × | × | ○ | Hard Stop Detection Time | Unsigned16 | RW | No | # | Yes |
| 0x20F7 | 0x00 | ○ | ○ | ○ | ○ | Amplifier special setting | Unsigned16 | RW | No | # | Yes |
| 0x20F8 | 0x00 | - | - | - | - | General Purpose Input Setting | Unsigned8 | RO | No | - | - |
| ↑ | 0x01 | ○ | ○ | ○ | ○ | Positive Limit Switch Function (Positive Over-Travel) | Unsigned8 | RW | No | # | Yes |
| ↑ | 0x02 | ○ | ○ | ○ | ○ | Negative Limit Switch Function (Negative Over-Travel) | Unsigned8 | RW | No | # | Yes |
| ↑ | 0x03 | ○ | ○ | ○ | ○ | External Error Input Function | Unsigned8 | RW | No | # | Yes |
| ↑ | 0x04 | ○ | ○ | ○ | ○ | Main Power Discharge Function | Unsigned8 | RW | No | # | Yes |
| ↑ | 0x05 | ○ | ○ | ○ | ○ | Emergency Sop Function | Unsigned8 | RW | No | # | Yes |
| ↑ | 0x06 | ○ | ○ | ○ | ○ | Detecton function of magnetic pole position | Unsigned8 | RW | No | # | Yes |
| 0x20F9 | 0x00 | - | - | - | - | General Purpose Output Setting | Unsigned8 | RO | No | - | - |
| ↑ | 0x01 0x02 | ○ | ○ | ○ | ○ | General Purpose Output 1 – 2 | Unsigned8 | RW | No | # | Yes |
| 0x20FA | 0x00 | - | - | - | - | Extend Station Alias | Unsigned8 | RO | No | - | - |
| ↑ | 0x01 | ○ | ○ | ○ | ○ | Extended Alias Number | Unsigned8 | RW | No | # | Yes |
| ↑ | 0x02 | ○ | ○ | ○ | ○ | Station Alias Selection | Unsigned8 | RW | No | # | Yes |
| | | | | | | | | | | | |
| 0x20FD | 0x00 | - | - | - | - | Amplifier System Selection | Unsigned8 | RO | No | - | - |
| ↑ | 0x01 | ○ | ○ | ○ | ○ | Main power input type | Unsigned8 | RW | No | & | Yes |
| ↑ | 0x02 | ○ | ○ | ○ | ○ | Regenerative Resistor Selection | Unsigned8 | RW | No | & | Yes |
| ↑ | 0x03 | ○ | ○ | ○ | ○ | Setup Communication Baud Rate | Unsigned8 | RW | No | & | Yes |
| ↑ | 0x04 | ○ | ○ | ○ | ○ | Main circuit power input voltage | Unsigned8 | RW | No | & | Yes |
| 0x20FE | 0x00 | ○ | ○ | ○ | ○ | Combination Motor Code | Unsigned16 | RW | No | & | Yes |
| 0x20FF | 0x00 | ○ | ○ | ○ | ○ | Combination Encoder Selection | Unsigned8 | RO | No | - | - |
| ↑ | 0x01 | ○ | ○ | ○ | ○ | Encoder Resolution Setting | Unsigned16 | RW | No | & | Yes |
| ↑ | 0x02 | ○ | ○ | ○ | ○ | Encoder Type | Unsigned16 | RW | No | & | Yes |
| ↑ | 0x03 | ○ | × | × | × | External Encoder Resolution | Unsigned32 | RW | No | & | Yes |

○: Supported, ×: Not supported

Manufacturer Specific Area (No.5)

| Index | S-Idx | FP | FV | FT | FH | Name | Data Type | Dir | PDO Mapping | Update | NVRAM |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0x2100 | 0x00 | ○ | ○ | ○ | ○ | Status Word 1 | Unsigned16 | RO | Possible | - | - |
| 0x2101 | 0x00 | - | - | - | - | Amplifier error field | Unsigned8 | RO | No | - | - |
| ↑ | 0x01-0x04 | ○ | ○ | ○ | ○ | Alarm actual 1 – 4 | Unsigned8 | RO | Possible | - | - |
| 0x2102 | 0x00 | - | - | - | - | Description of Alarm Trace | Unsigned8 | RO | No | - | - |
| ↑ | 0x01 | ○ | ○ | ○ | ○ | Now Status | Unsigned32 | RO | Possible | - | - |
| ↑ | 0x02-0x08 | ○ | ○ | ○ | ○ | 1st - 7th Latest Alarm | Unsigned16 | RO | Possible | - | - |
| 0x2103 | 0x00 | - | - | - | - | Warning Status | Unsigned8 | RO | No | - | - |
| ↑ | 0x01 | ○ | ○ | ○ | ○ | Warning Monitor | Unsigned16 | RO | Possible | - | - |
| ↑ | 0x02 | ○ | ○ | ○ | ○ | Warning mask Selection | Unsigned16 | RW | No | # | Yes |
| 0x2104 | 0x00 | - | - | - | - | Actual Gain Value Monitor | Unsigned8 | RO | No | - | - |
| ↑ | 0x01 | ○ | - | - | - | Actual Position Loop Proportional Gain | Unsigned16 | RO | Possible | - | - |
| ↑ | 0x02 | ○ | - | - | - | Actual Position Integral Time Constant | Unsigned16 | RO | Possible | - | - |
| ↑ | 0x03 | ○ | ○ | ○ | ○ | Actual Velocity Loop Proportional Gain | Unsigned16 | RO | Possible | - | - |
| ↑ | 0x04 | ○ | ○ | - | ○ | Actual Velocity Loop Integral Time Constant 1 | Unsigned16 | RO | Possible | - | - |
| ↑ | 0x05 | ○ | ○ | - | ○ | Actual Load Inertia Moment Ratio | Unsigned16 | RO | Possible | - | - |
| ↑ | 0x06 | ○ | ○ | ○ | ○ | Actual Torque (force) Command Filter | Unsigned16 | RO | Possible | - | - |
| ↑ | 0x07 | - | - | - | - | Actual Model Control Gain | Unsigned16 | RO | Possible | - | - |
| 0x2105 | 0x00 | ○ | ○ | ○ | ○ | Z-phase Signal Base Actual Position | Unsigned32 | RO | Possible | - | - |
| 0x2106 | 0x00 | ○ | ○ | × | ○ | Internal Velocity Command Monitor | Integer32 | RO | Possible | - | - |
| 0x2107 | 0x00 | ○ | ○ | ○ | ○ | Internal Torque (force) Command Monitor | Integer16 | RO | Possible | - | - |
| 0x2108 | 0x00 | - | - | - | - | Effective Torque (force) Monitor | Unsigned8 | RO | No | - | - |
| ↑ | 0x01 | ○ | ○ | ○ | ○ | Effective Torque (force) Estimated Value | Unsigned16 | RO | Possible | - | - |
| ↑ | 0x02 | ○ | ○ | ○ | ○ | Fast Effective Torque (force) Estimate Value | Unsigned16 | RO | Possible | - | - |
| 0x2109 | 0x00 | ○ | ○ | ○ | ○ | Temperature inside the servo amplifier | Integer16 | RO | Possible | - | - |
| 0x210A | 0x00 | ○ | ○ | ○ | ○ | Regenerative Resistor Operation Percentage Monitor | Unsigned16 | RO | Possible | - | - |
| 0x210B | 0x00 | ○ | ○ | ○ | ○ | Encoder Temperature Monitor | Integer16 | RO | Possible | - | - |
| 0x210C | 0x00 | ○ | ○ | ○ | ○ | Home Index Position Detection Value | Integer32 | RO | Possible | - | - |
| 0x210D | 0x00 | ○ | — | — | — | Position Synchronization Deviation Monitor | Integer32 | RO | Possible | — | - |
| 0x2110 | 0x00 | - | - | - | - | Internal Control Cycle Position Actual Value | Unsigned8 | RO | No | - | - |
| ↑ | 0x01-0x07 | ○ | ○ | ○ | ○ | Internal Control Cycle Actual Position 1 –7 (125us Latest) | Integer32 | RO | Possible | - | - |
| 0x2111 | 0x00 | - | - | - | - | Internal Control Cycle Actual Velocity | Unsigned8 | RO | No | - | - |
| ↑ | 0x01-0x07 | ○ | ○ | ○ | ○ | Internal Control Cycle Actual Velocity 1 – 7 (125us Latest) | Integer32 | RO | Possible | - | - |
| 0x2112 | 0x00 | - | - | - | - | Internal Control Cycle Actual Torque (force) | Unsigned8 | RO | No | - | - |
| ↑ | 0x01-0x07 | ○ | ○ | ○ | ○ | Internal Control Cycle Actual Torque (force) 1 – 7 (125us Latest) | Integer16 | RO | Possible | - | - |
| 0x2116 | 0x00 | ○ | ○ | ○ | ○ | Actual Velocity Value (Velocity Monitor) 2 | Integer32 | RO | Possible | — | - |
| 0x2117 | 0x00 | ○ | ○ | ○ | ○ | Actual Position Value (Position Monitor) 2 | Integer32 | RO | Possible | — | - |
| 0x2120 | 0x00 | — | — | — | — | Amplifier Parameter | Unsigned8 | RO | — | — | - |
| ↑ | 0x01 | ○ | ○ | ○ | ○ | Alarm Mask monitor | Unsigned32 | RO | Possible | — | - |
| ↑ | 0x02 | ○ | ○ | ○ | ○ | Amplifier Control Status | Unsigned8 | RW | — | # | - |
| ↑ | 0x03 | ○ | ○ | ○ | ○ | Amplifier Operation Time | Unsigned32 | RO | — | — | - |
| ↑ | 0x04 | ○ | ○ | ○ | ○ | External Regenerative Resistor Value | Unsigned32 | RW | Possible | # | - |
| 0x2151 | 0x00 | ○ | ○ | ○ | ○ | Error Register | Unsigned8 | RO | Possible | — | - |
| 0x2152 | 0x00 | ○ | ○ | ○ | ○ | Device Name | Visible String | RO | No | — | - |
| 0x2153 | 0x00 | ○ | ○ | ○ | ○ | FPGA Hardware Version | Visible String | RO | No | — | - |
| 0x2154 | 0x00 | ○ | ○ | ○ | ○ | Communication Software Version | Visible String | RO | No | — | - |
| 0x2155 | 0x00 | ○ | ○ | ○ | ○ | Servo Software Version | Visible String | RO | No | — | - |
| 0x2156 | 0x00 | — | — | — | — | Alarm Estimation Cause code | Unsigned8 | RO | No | — | - |
| ↑ | 0x01-0x08 | ○ | ○ | ○ | ○ | Alarm cause estimation code 1-8 | Unsigned16 | RO | No | — | - |
| 0x2157 | 0x00 | ○ | ○ | ○ | ○ | FPGA Initialization error | Unsigned16 | RO | No | — | - |
| 0x5010 | 0x00 | — | — | — | — | Motor Data | Unsigned8 | RO | No | - | - |
| ↑ | 0x01 | ○ | ○ | ○ | ○ | Number of motor pole | Unsigned8 | RO | Possible | - | - |
| ↑ | 0x02 | ○ | ○ | ○ | ○ | Phase resistance | Unsigned16 | RO | Possible | - | - |
| ↑ | 0x03 | ○ | ○ | ○ | ○ | Phase inductance | Unsigned16 | RO | Possible | - | - |
| ↑ | 0x04 | ○ | ○ | ○ | ○ | Moment of inertia | Unsigned32 | RO | Possible | - | - |
| ↑ | 0x05 | ○ | ○ | ○ | ○ | Voltage constant for each phase | Unsigned32 | RO | Possible | - | - |
| ↑ | 0x06 | ○ | ○ | ○ | ○ | Rated torque | Unsigned16 | RO | Possible | - | - |
| 0x5040<br>0x5041<br>0x5042 | 0x00 | — | — | — | — | Position Unit System<br>Acceleration Unit System<br>Acceleration Unit System | Unsigned8 | RO | No | - | - |
| ↑ | 0x01 | ○ | ○ | ○ | ○ | 100% Full-scale Software Resolution | Unsigned8 | RO | Possible | - | - |
| ↑ | 0x02 | ○ | ○ | ○ | ○ | Full-scale Unit | Unsigned16 | RO | Possible | - | - |
| ↑ | 0x03 | ○ | ○ | ○ | ○ | Full-scale Data Type | Unsigned16 | RO | Possible | - | - |
| ↑ | 0x04 | ○ | ○ | ○ | ○ | Full-scale Value | Unsigned32 | RO | Possible | - | - |

○: Supported, ×: Not supported

## 2) Control Command Parameter

0x2000: Control Word 1

<table>
<tr><td colspan="2">Index Ax1 0x2000<br>Ax2 0x2200<br>Ax3 0x2400<br>Ax4 0x2600</td><td colspan="2">Manufacturer-specific object for the servo amplifier control.</td><td colspan="2">Object Code</td><td>Variable</td></tr>
<tr><td>Sub-Idx</td><td colspan="2">Description</td><td>Data Type</td><td>Access</td><td>PDO</td><td>Initial value</td></tr>
<tr><td>0x00</td><td colspan="2">Control Woad1 [CWORD1]<br>Enables various functions.<br>0:disabled 1:enabled</td><td>Unsigned16</td><td>RW</td><td>Possible</td><td>-</td></tr>
</table>

| MSB | | | | | | | LSB |
|---|---|---|---|---|---|---|---|
| discen | intpodi | vcmpen | icmpen | vcmlim | pcon | ppcon | pclr |
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |

bit0:clearance of location deviation enabled [PCLR]
Clear the location deviation.

bit1:proportional positioning control enabled [PPCON]
Clear the integral terms of the positioning controller. It is enabled at "1" and proportionally controlled.

bit2:proportional-speed control enabled [PCON]
Clear the integral terms of the positioning controller. It is enabled at "1" and proportionally controlled.

Bit3：Velocity Limit Command ［VCMLIM］
Limit the internal speed command at the velocity limit command value.

bit4:torque addition enabled [ICMPEN]
Add the torque addition value to the torque command. Enabled at “1".

bit5:speed addition enabled [VCMPEN]
Add the speed addition value to the command. Enabled at “1".

bit6:location-complement disabled(csp only) [INTPODI]
When position commands cannot be received cyclically(SM2 event not received), keep operating at “1” using the previous amount of travel.
“0”: Disabled. “1”: Enabled.

bit7:compulsory discharge enabled [DISCEN]
When the main circuit is off, the main circuit charged voltage is compulsorily discharged at “1”.

| MSB | | | | | | | LSB |
|---|---|---|---|---|---|---|---|
| psce | pscme | ETMPDIS | loscon | obscon | vibcon | htrv | htrp |
| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 |

bit8:highly compliant position compensation enabled [HTRP]
Highly compliant position compensation is performed at “1.”

bit9:highly compliant speed compensation enabled [HTRV]
Highly compliant speed compensation is performed at “1.”

bit10:FF vibration control enabled [VIBCON]
Vibration control is performed at “1.”

bit11:disturbance observer compensation enabled[OBSCON]
Observer compensation is performed at “1.”

bit12:
Reserved.

bit13:encoder temperature monitor [ETMPDIS]
Encoder temperature detection is disabled at “1.”

bit14:
Reserved.

bit15: Synchronizing function enabled
[SYCON]
Position sync compensation is enabled at “1”.

0x2001: Parameter Select

| Index Ax1 0x2001<br>Ax2 0x2201<br>Ax3 0x2401<br>Ax4 0x2601 | Controls the selection of various parameters. | | Object Code | | Variable |
|---|---|---|---|---|---|
| Sub-Idx | Description | Data Type | Access | PDO | Initial value |
| 0x00 | Parameter Select [PARSEL]<br>Enables various functions. | Unsigned16 | RW | Possible | - |

| MSB | | | LSB |
|---|---|---|---|
| - | gc | supfsel | mdlfsl |
| 7 6 | 5 4 | 3 2 | 1 0 |

bit1-0:model suppression frequency switch selection *1 [MDLFSEL]
Under the model control, resonance/anti-resonance frequency 1-4 to be used is selected.
Use the setting: bit1, 0=0, 0 frequency 1 Sub-Index:0x01.
Use the setting: bit1, 0=0,1 frequency 2 Sub-Index:0x02.
Use the setting: bit1, 0=1, 0 frequency 3 Sub-Index:0x02.
Use the setting: bit1, 0=1, 1 frequency 4 Sub-Index:0x04.

bit3-2:FF suppression frequency selection [SUPFSEL]
The suppression frequency value to be used is selected from sub-Index 1-4.
Use the setting: bit3, 2=0, 0 frequency 1 Sub-Index:0x01.
Use the setting: bit3, 2=0, 1 frequency 2 Sub-Index:0x02.
Use the setting: bit3, 2=1, 0 frequency 3 Sub-Index:0x02.
Use the setting: bit3, 2=1, 1 frequency 4 Sub-Index:0x04.

bit5-4：Gain change selection *2 ［GC］
The value to be used is selected by various gain settings from Sub-Index 1-4.
Use the setting bit5, 4=0, 0 gain1 Sub-Index:0x01.
Use the setting bit5, 4=0, 1 gain2 Sub-Index:0x02.
Use the setting bit5, 4=1, 0 gain3 Sub-Index:0x03.
Use the setting bit5, 4=1, 1 gain4 Sub-Index:0x04.

bit7-6:
Reserved

*1 Model control gains 1-4 are switched by bit5-4: gain switching selection, and bit1-0 is a parameter to switch model control anti-resonance frequency 1-4 and model control resonance frequency 1-4.

*2 The parameter of switching by the Gain change selection is below.
Position loop proportional gain (0x2005), Position integral time constant (0x2006), Velocity loop proportional gain (0x200B), Velocity loop integral time constant (0x200C), Load inertia moment ratio (0x200D), Command filter (0x2011)
Also, for use of this function, please enable Torque low pass filter setting at the Special Function Selection Setting.

| MSB | | | LSB |
|---|---|---|---|
| Orgtc | Res | Res | Res |
| 15 14 | 13 12 | 11 10 | 9 8 |

bit15-8：
Reserved

## 3) Auto-Tuning Parameter

0x2002: Auto-tuning

| Index Ax1 0x2002<br>Ax2 0x2202<br>Ax3 0x2402<br>Ax4 0x2602 | Auto-tuning settings | | Object Code | | Array |
|---|---|---|---|---|---|
| Sub-Idx | Description | Data Type | Access | PDO | Initial value |
| 0x00 | Number of entry | Unsigned8 | RO | No | 0x06 |
| 0x01 | Auto-tuning Mode [TUNEMODE]<br>Set the validity, invalidity of Auto-tuning, and Load inertia moment rate estimation. | Unsigned8 | RW | No | 0x02 |
| | | Setting range | 0x00-0x02 | | |
| | <u>0x00:_AutoTun (Automatic Tuning)</u><br><u>0x01:_AutoTun_JRAT-Fix (Automatic Tuning JRAT Manual Setting)</u><br><u>0x02:_ManualTun (Manual Tuning)</u><br>*Under the following operating conditions, Load inertia rate is not estimated properly: operation at low velocity, at low acceleration and at low acceleration/deceleration torque (force).<br>*Load intertia moment ratio of machines applied large disturbance torque (force), machine with majour backlash, and machine whose moving part vibrate partially can not correctly estimetd.<br>*If you use model following vibration suppressor control, set “02: Manual tuning.”<br>*If 00:_AutoTun is selected, vibration suppressor control will be disabled though state feedback model following vibration suppressor control (base vibration suppressor) is selected. | | | | |
| 0x02 | Auto-Tuning Characteristic [ATCHA]<br>Selects the tuning characteristic. | Unsigned8 | RW | No | 0x00 |
| | | Setting range | 0x00-0x06 | | |
| | <u>0x00:_Positioning1 Positioning Control 1 (General Purpose)</u><br><u>0x01:_Positioning2 Positioning Control 2 (High Response)</u><br><u>0x02:_Positioning3 Positioning Control 3 (High Response, FFGN Manual Setting)</u><br><u>0x03:_Positioning4 Positioning Control 4 (High Response, Horizontal Axis Limited)</u><br><u>0x04:_Positioning5 Positioning Control 5 (High Response, Horizontal Axis Limited)</u><br><u>0x05:_Trajectory1 Trajectory Control 1</u><br><u>0x06:_Trajectory2 Trajectory Control 2 (KP,FFGN Manual Setting)</u><br>*[Positioning Control 1] * For general-purpose positioning like fast forward operations.<br>*[Positioning Control 2] * For high-response positioning like fast forward operations (gravity axis or external force axis.) Shocks could occur to the machine in “Positioning Control 4, 5.”<br>*[Positioning Control 3] * For further adjusting FFGN.<br>*[Positioning Control 4] * When “Tuning mode” is set at “Automatic Tuning [JRAT Manual Setting]” in a machine in which JRAT is fixed by “Automatic Tuning [JRAT Manual Setting]” but the actual load inertia vary during the operation.<br>* When the estimation accuracy of the Load Inertia moment ratio is low or cannot be obtained due to operation patterns or machine characteristics.<br>*[Positioning Control 5] * When you want to adjust forward gain in case of the horizontal axis without external forces.<br>*[Trajectory Control 1] * When there is no need to follow position commands and coordination with other axes (such as in cutting operations.)<br>*[Trajectory Control 2] * For coordination with other axes (please adjust KPPGIN.)<br>* For following position commands. Do not use at “model following vibration suppressor control.” At Model following vibration suppressor control, trajectory will be out of alignment.<br>*When “Tuning mode” is set at “02 manual tuning,” the set value will not be reflected.<br>*According to the characteristics selected, parameters will be set automatically.<br>Position Loop Proportional Control Switch Function, Proportional Control Switch Function, Low Speed Setting, Higher Tracking Velocity Compensation Gain, Feed Forward Gain, as well as Higher Tracking Position, Acceleration Feedback, and Gain Parameter (regardless of selected conditions) are regarded as 0[%] internally. | | | | |
| 0x03 | Sets the Auto-Tuning Response [ATRES]<br>*The larger the set value, the higher the response.<br>*Caution, if the response is set too high, the machine may oscillate.<br>*Make the setting suitable for rigidity of the device. | Unsigned8 | RW | No | 0x05 |
| | | Setting range | 0x01-0x1E<br>(1-30) | | |

| | | | | | |
|---|---|---|---|---|---|
| 0x04 | Save Notch/FF Vibration Suppression frequency/ Auto-Tuning data | Unsigned8 | RW | No | 0x00 |
| | ◆Result of above tuning data can save by EtherCAT communication network. | Setting range | 0x00～0x05<br>（0～5） | | |

◆Selects thecommand

0x00： Disable tuning
0x01： Execute Auto- Notch Filter tuning
0x02： Execute Auto FF Vibration Suppression tuning
0x03： Save result of Auto-tuning
0x04： Stop Auto Notch Filter tuning / Auto FF Vibration Suppression tuning
0x05： Stop save result of Auto-tuning

◆Make sure of motor stop before start to Auto-tuning.
Auto-tuning will get wrong value when it runs with rotating motor.
When Auto-tuning is working, command relate to motor operation and the other tuning will not be accept.
When motor is rotating, Auto-tuning command from master will not be accepted. Command will ignored and terminated abnormally.

◆Master will not able to run Auto-tuning while run by Setup software.

◆Setup software will not able to run Auto-tuning while run by master.

◆When Auto-tuning is working, master can be stop Auto-tuning.

◆Slave could receive a execute command then slave will continue to Auto-tuning even if communication error by some reason. If alarm occur by communication error then slave will stop Auto-tuning.

◆Auto Notch Filter tuning
When Auto Notch Filter tuning is working, need to follow below.
≫Don`t change 0x2040.2, 0x2042.1 and 0x2042.2.
≫Tuning result need to save Torque Command Notch Filter frequency.

◆Tuning result of Auto FF Vibration Suppression need to save 0x2012.

◆When execute Auto-tuning result save, save parameter will follow selected sub index (0x06).
。There are 6 kind of save parameter.、Each save parameter has 5 sub index（0x06）
≫Load inertia 1(0x200D.1)
≫Position Loop Proportional Gain 1(0x2005.1)
≫Velocity Loop Proportional Gain 1(0x200B.1)
≫Velocity Loop Integral Time Constant 1(0x200C.1)
≫Torque Command Filter 1(0x2011.1)
Don`t change 0x20F7 bit1.
≫ModelFollowing Control Gain 1(0x2017.1)

◆Result of Auto Notch filter tuning and Auto FF Vibration Suppression tuning can not save at the same time.

| | | | | | |
|---|---|---|---|---|---|
| 0x05 | Notch /FF Vibration Suppression frequency/ Monitor of save tuning result. | Unsigned8 | RO | No | 0x01 |
| | ◆Indicate state of Notch Filter,FF Vibration Suppression frequency and tuning result. | Setting range | 0x00～0x02<br>（0～2） | | |

0x00： Running tuning
0x01： Completion
0x02： Abnormal termination
If finish tuning, 0x01 or 0x02 will indicate.

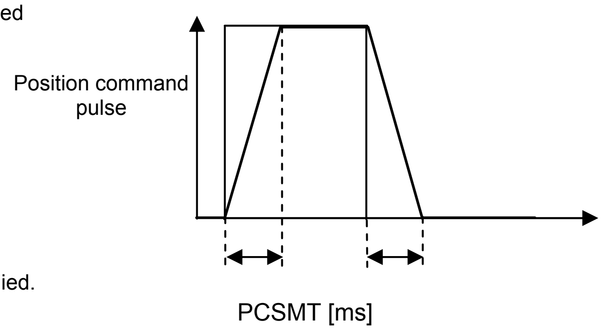
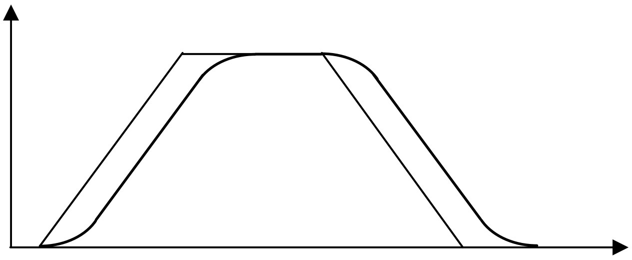
| | | | | | |
|---|---|---|---|---|---|
| 0x06 | Parameter setting of save Auto-tuning result | Unsigned8 | RW | No | 0x00 |
| | ◆Setting of save parameter | Setting range | 0x00-0x04<br>（0-5） | | |

◆Description

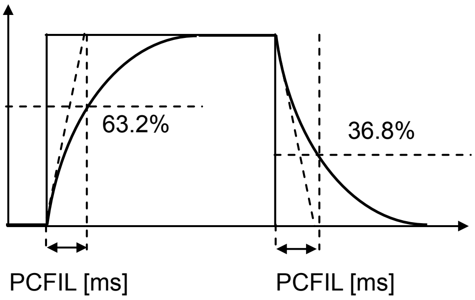
| Setting value | Load inertia | Position Proportional Gain | Velocity Proportional Gain | Velocity Integral Constant | Torque Command Filter | Model Control Gain |
|---|---|---|---|---|---|---|
| 0 | ○ | ○ | ○ | ○ | ○ | ○ |
| 1 | ○ | × | ○ | ○ | ○ | × |
| 2 | ○ | × | × | × | × | × |
| 3 | × | ○ | ○ | ○ | ○ | ○ |
| 4 | × | × | ○ | ○ | ○ | × |

## 4) Basic Control Parameter

0x2003: Position Command Smoothing Constant

<table>
<tr><td>Index Ax1 0x2003<br>Ax2 0x2203<br>Ax3 0x2403<br>Ax4 0x2603</td><td colspan="2">This moving low-pass filter smoothes the position command pulse. Sets time constants.</td><td colspan="2">Object Code</td><td>Variable</td></tr>
<tr><td>Sub-Idx</td><td>Description</td><td>Data Type</td><td>Access</td><td>PDO</td><td>Initial value</td></tr>
<tr><td rowspan="4">0x00</td><td rowspan="3">Position Command Smoothing Constant [PCSMT]<br>*Applies gradient to the step condition positioning pulse.<br>*Applies S curve to the lamp condition position command pulse.<br>*When position command differences in each communication cycle are large, position command will be smoothed.</td><td>Unsigned16</td><td>RW</td><td>Possible</td><td>0x0005<br>(0.5 ms)</td></tr>
<tr><td>Setting range</td><td colspan="3">0x0000-0x1388<br>(0.0-500.0 ms)</td></tr>
<tr><td>Unit</td><td colspan="3">0.1 ms</td></tr>
<tr><td colspan="5">(This may decrease the operating noise of the servo motor.)<br>*When this moving-average filter is used, the value is set at “0.3ms and higher”.<br>*When the set value is “0.0ms-0.2ms”, this filter is invalid.<br>*Set in increments of 0.5ms.<br>(Under the set value “0.4ms and less”, there may be cases where the set value cannot be applied to the operation.)<br><br>* Position command pulse with step condition applied<br> <br>* Position command pulse with lamp condition applied.<br></td></tr>
</table>

0x2004: Position Command Filter

<table>
<tr><td>Index Ax1 0x2004<br>Ax2 0x2204<br>Ax3 0x2404<br>Ax4 0x2604</td><td colspan="2">This low-pass filter suppresses any sudden change of the position control pulse. Sets time constants.</td><td colspan="2">Object Code</td><td>Variable</td></tr>
<tr><td>Sub-Idx</td><td>Description</td><td>Data Type</td><td>Access</td><td>PDO</td><td>Initial value</td></tr>
<tr><td rowspan="4">0x00</td><td rowspan="3">Position Command Filter [PCFIL]<br>Time constant for the filter will be set.<br>Filter will be invalid at the set value 0.0 ms.<br>Does not influence Feed Forward.</td><td>Unsigned16</td><td>RW</td><td>No</td><td>0x0000<br>(0.0 ms)</td></tr>
<tr><td>Setting range</td><td colspan="3">0x0000-0x4E20<br>(0.0-2000.0 ms)</td></tr>
<tr><td>Unit</td><td colspan="3">0.1 ms</td></tr>
<tr><td colspan="5">*This parameter setting is valid when the value of Higher Tracking Control Position Compensation Gain is set at 0%.<br>*When Higher Tracking Control Position Compensation Gain is 0%, value is set at 0.0ms, the filter becomes invalid.<br>*This filter can suppress overshoot caused by the rise of the feed forward compensation gain.<br> </td></tr>
</table>

0x2005: Position Loop Gain

<table>
<tr><td>Index Ax1 0x2005<br>Ax2 0x2205<br>Ax3 0x2405<br>Ax4 0x2605</td><td colspan="2">Proportional gain for position controller.<br>By setting bit5, 4 gain change selection (GC) in the parameter selection (0x2001), the position loop proportional gain to be used is selected.</td><td colspan="2">Object Code</td><td>Array</td></tr>
<tr><td>Sub-Idx</td><td>Description</td><td>Data Type</td><td>Access</td><td>PDO</td><td>Initial value</td></tr>
<tr><td>0x00</td><td>Number of entry</td><td>Unsigned8</td><td>RO</td><td>No</td><td>0x04</td></tr>
<tr><td rowspan="2">0x01</td><td>Position Loop Gain 1 [KP1]</td><td>Unsigned16</td><td>RW</td><td>Possible</td><td>0x001E<br>(30 /s)</td></tr>
<tr><td colspan="4">*Automatically saved by Auto-tuning result saving.<br>*When Auto-tuning function is valid, this setting value is not applied.<br>*When gain 1(bit5, 4=0, 0) is selected, in the Gain Switching function, it operates at this setting value.</td><td></td></tr>
<tr><td>0x02</td><td>Position Loop Gain 2 [KP2]<br>* When gain 2(bit5, 4=0, 1) is selected, in the Gain Switching function, it operates at this setting value.</td><td>Unsigned16</td><td>RW</td><td>No</td><td>0x001E<br>(30 /s)</td></tr>
<tr><td>0x03</td><td>Position Loop Gain 3 [KP3]<br>* When gain 3(bit5, 4=1, 0) is selected, in the Gain Switching function, it operates at this setting value.</td><td>Unsigned16</td><td>RW</td><td>No</td><td>0x001E<br>(30 /s)</td></tr>
<tr><td>0x04</td><td>Position Loop Gain 4 [KP4]<br>* When gain 4(bit5, 4=1, 1) is selected, in the Gain Switching function, it operates at this setting value.</td><td>Unsigned16</td><td>RW</td><td>No</td><td>0x001E<br>(30 /s)</td></tr>
<tr><td colspan="2"></td><td>Setting range</td><td colspan="3">0x0001-0x0BB8<br>(1-3000 /s)</td></tr>
<tr><td colspan="2"></td><td>Unit</td><td colspan="3">1/s</td></tr>
</table>

0x2006: Position Integral Time Constant 1

<table>
<tr><td>Index Ax1 0x2006<br>Ax2 0x2206<br>Ax3 0x2406<br>Ax4 0x2606</td><td colspan="2">Integral time constant for position controller.<br>By setting bit5, 4, gain change selection (GC), in parameter selection (0x2001), the position integral time constant to be used is selected.</td><td colspan="2">Object Code</td><td>Array</td></tr>
<tr><td>Sub-Idx</td><td>Description</td><td>Data Type</td><td>Access</td><td>PDO</td><td>Initial value</td></tr>
<tr><td>0x00</td><td>Number of entry</td><td>Unsigned8</td><td>RO</td><td>No</td><td>0x04</td></tr>
<tr><td rowspan="2">0x01</td><td>Position Integral Time Constant 1 [TPI1]</td><td>Unsigned16</td><td>RW</td><td>Possible</td><td>0x2710<br>(1000ms)<br>proportional control</td></tr>
<tr><td colspan="5">* Automatically saved by Auto-tuning result saving.<br>* When Auto-tuning function is valid, this setting value is not applied.<br>*When gain 1(bit5, 4=0, 0) is selected, in the Gain Switching function, it operates at this setting value.</td></tr>
<tr><td>0x02</td><td>Position Integral Time Constant 2 [TPI2]<br>*When gain 2(bit5, 4=0, 1) is selected, in the Gain Switching function, it operates at this setting value.</td><td>Unsigned16</td><td>RW</td><td>No</td><td>0x2710<br>(1000ms)<br>proportional control</td></tr>
<tr><td>0x03</td><td>Position Integral Time Constant 3 [TPI3]<br>*When gain 3(bit5, 4=1, 0) is selected, in the Gain Switching function, it operates at this setting value.</td><td>Unsigned16</td><td>RW</td><td>No</td><td>0x2710<br>(1000ms)<br>proportional control</td></tr>
<tr><td>0x04</td><td>Position Integral Time Constant 4 [TPI4]<br>*When gain 4(bit5, 4=1, 1) is selected, in the Gain Switching function, it operates at this setting value.</td><td>Unsigned16</td><td>RW</td><td>No</td><td>0x2710<br>(1000ms)<br>proportional control</td></tr>
<tr><td colspan="2"></td><td>Setting range</td><td colspan="3">0x0003-0x2710<br>(0.3-1000 ms)</td></tr>
<tr><td colspan="2"></td><td>Unit</td><td colspan="3">0.1ms</td></tr>
</table>

0x2007:Higher Tracking Control Position Compensation Gain

| | | | |
|---|---|---|---|
| Index Ax1 0x2007<br>Ax2 0x2207<br>Ax3 0x2407<br>Ax4 0x2607 | Improves the Command Tractability using Compensation Gain Parameter to the position system.<br>The larger value can raise command tracking performance. | Object Code | Variable |

| Sub-Idx | Description | Data Type | Access | PDO | Initial value |
|---|---|---|---|---|---|
| 0x00 | Higher Tracking Control Position Compensation Gain [TRCPGN]<br>When higher tracking control position compensation bit is enabled, Feed Forward Gain (FFGN), Position Command Filter Time Constant (PCFIL) will be automatically set to the intended proportion.<br>KFGN [%] = 0.9 × Setting value [%] | Unsigned16 | RW | No | 0x0000<br>(0 %) |
| | | Setting range | 0x0000-0x0064<br>(0-100 %) | | |
| | | Unit | 1 % | | |
| | PCFIL [Hz] = Velocity Loop Proportional Gain / Setting value [%] / 100<br>When the value is greater, Command Track ability will be improved.<br>■ When a value other than 0% is set, Position Command Filter and Feed Forward Gain are automatically set in the servo amplifier.<br>■ When Auto-tuning function is valid, this setting value not applied. | | | | |

0x2008: Feed Forward compensation parameter

| | | | |
|---|---|---|---|
| Index Ax1 0x2008<br>Ax2 0x2208<br>Ax3 0x2408<br>Ax4 0x2608 | Sets parameters regarding Feed Forward compensation functions. | Object Code | Array |

| Sub-Idx | Description | Data Type | Access | PDO | Initial value |
|---|---|---|---|---|---|
| 0x00 | Number of entry | Unsigned8 | RO | No | 0x0002 |
| 0x01 | Feed Forward Gain [FFGN]<br>Sets feed forward compensation gain to position control system.<br>Model control system compensates for feed forward to Model following system when Position Control Selection is at Model following control. | Unsigned16 | RW | Possible | 0x0000<br>(0 %) |
| | | Setting range | 0x0000-0x0064<br>(0-100 %) | | |
| | | Unit | 1 % | | |
| | *Valid when Higher Tracking Control Position Compensation Gain is set at 0%.<br>*The setting value is not applied when using the Auto-Tuning Characteristics listed below.<br>Positioning1 Positioning Control 1 (General Purpose)<br>Positioning2 Positioning Control 2 (High Response)<br>Positioning4 Positioning Control 4 (High Response, Horizontal Axis Limited)<br>Trajectory1 Trajectory Control 1 | | | | |
| 0x02 | Feed Forward Filter [FFFIL]<br>First low-pass filter to eliminate pulsed ripple caused by the position command pulse included in the feed forward command. Sets the cutoff frequency.<br>* Sets values to disable the filter differ according to the setting of “position control selection.” | Unsigned16 | RW | No | 0x0FA0<br>(4000Hz)<br>Invalid |
| | | Setting range | 0x0001-0x0FA0<br>(1-4000Hz) | | |
| | | Unit | 1 Hz | | |
| | Position Control Selection — Value when the filter is invalid<br>00:Standard Standard — 2000Hz or more<br>01:Model1 Model 1 Model Following Control — 500Hz or more<br>02:Model2 Model 2 Model Flowing Vibration Suppress Control — 500Hz or more | | | | |

0x2009: Command Filter Settings

| | | | |
|---|---|---|---|
| Index Ax1 0x2009<br>Ax2 0x2209<br>Ax3 0x2409<br>Ax4 0x2609 | Sets primary low pass filter regarding velocity command. | Object Code | Variable |

| Sub-Idx | Description | Data Type | Access | PDO | Initial value |
|---|---|---|---|---|---|
| 0x00 | Velocity Command Filter [VCFIL]<br>This primary low pass filter to suppress the sudden changes of the velocity command.<br>Sets the cutoff frequency.<br>When sets over 2000Hz（0x07D0）then setting become disable. | Unsigned16 | RW | No | 0x0FA0<br>(4000 Hz)<br>Invalid |
| | | Setting Range | 0x0001~0x0FA0<br>(1~4000 Hz) | | |
| | | Unit | 1 Hz | | |

0x200A: Velocity Feedback Filter

| Index | | Description | Object Code | |
|---|---|---|---|---|
| Index Ax1<br>Ax2<br>Ax3<br>Ax4 | 0x200A<br>0x220A<br>0x240A<br>0x260A | Parameter to switch on the primary low-pass filter in response to velocity feedback. | Object Code | Variable |

| Sub-Idx | Description | Data Type | Access | PDO | Initial value |
|---|---|---|---|---|---|
| 0x00 | Velocity Feedback Filter [VDFIL]<br>First low-pass filter to eliminate ripples caused by encoder pulse included in the velocity control system feedback. Sets the cutoff frequency.<br>Setting value: the filter will be disabled at 2000Hz(0x07D0) or greater. | Unsigned16 | RW | No | 0x05DC<br>(1500 Hz) |
| | | Setting range | 0x0001-0x0FA0<br>(1-4000 Hz) | | |
| | | Unit | 1 Hz | | |
| | *When the encoder resolution is low, lowering the setting value and suppressor the ripples can suppress motor drive noise. In addition, when the encoder resolution is high, raising the setting value may improve the response of the velocity control system. For general use, set at the Standard value. | | | | |

0x200B: Velocity Loop Proportional Gain

| Index | | Description | Object Code | |
|---|---|---|---|---|
| Index Ax1<br>Ax2<br>Ax3<br>Ax4 | 0x200B<br>0x220B<br>0x240B<br>0x260B | Proportional gain of velocity controller. By setting bit5, 4, gain change selection (GC), in the parameter selection (0x2001), the Position Loop Proportional Gain to be used is selected. | Object Code | Array |

| Sub-Idx | Description | Data Type | Access | PDO | Initial value |
|---|---|---|---|---|---|
| 0x00 | Number of entry | Unsigned8 | RO | No | 0x04 |
| 0x01 | Velocity Loop Proportional Gain 1 [KVP1]<br>∗Automatically saved by Auto-tuning result saving. | Unsigned16 | RW | Possible | 0x0032<br>(50Hz) |
| | *When Auto-tuning function is valid, this setting value is not applied.<br>*When the Gain switching function is valid, select gain 1 and this setting value is applied.<br>*When gain 1(bit5, 4=0, 0) is selected, in the Gain Switching function, it operates at this setting value. | | | | |
| 0x02 | Velocity Loop Proportional Gain 2 [KVP2]<br>*When gain 2(bit5, 4=0, 1) is selected, in the Gain Switching function, it operates at this setting value. | Unsigned16 | RW | No | 0x0032<br>(50Hz) |
| 0x03 | Velocity Loop Proportional Gain 3 [KVP3]<br>*When gain 3(bit5, 4=1, 0) is selected, in the Gain Switching function, it operates at this setting value. | Unsigned16 | RW | No | 0x0032<br>(50Hz) |
| 0x04 | Velocity Loop Proportional Gain 4 [KVP4]<br>*When gain 4(bit5, 4=1, 1) is selected, in the Gain Switching function, it operates at this setting value. | Unsigned16 | RW | No | 0x0032<br>(50Hz) |
| | | Setting range | 0x0001-0x07D0<br>(1-2000 Hz) | | |
| | | Unit | 1Hz | | |

0x200C: Velocity Loop Integral Time Constant

| Index | | Description | Object Code | |
|---|---|---|---|---|
| Index Ax1<br>Ax2<br>Ax3<br>Ax4 | 0x200C<br>0x220C<br>0x240C<br>0x260C | Integral time constant of velocity controller. Selects Velocity Loop Integral Time Constant to use by Gain change selection (GC) (Parameter Select: 0x2001 bit5, 4).<br>Integral term is invalid (proportional control) with the setting value of 1000ms (0x2710). | Object Code | Array |

| Sub-Idx | Description | Data Type | Access | PDO | Initial value |
|---|---|---|---|---|---|
| 0x00 | Number of entry | Unsigned8 | RO | No | 0x04 |
| 0x01 | Velocity Loop Integral Time Constant 1 [TVI1]<br>∗Automatically saved by Auto-tuning result saving. | Unsigned16 | RW | Possible | 0x00C8<br>(20ms) |
| | *When Auto-tuning function is valid, this setting value is not applied.<br>*When Gain switching function is valid, select gain 1 and this setting value is applied.<br>*When gain 1(bit5, 4=0, 0) is selected, in the Gain Switching function, it operates at this setting value. | | | | |
| 0x02 | Velocity Loop Integral Time Constant 2 [TVI2]<br>* When gain 2(bit5, 4=0, 1) is selected, in the Gain Switching function, it operates at this setting value. | Unsigned16 | RW | No | 0x00C8<br>(20ms) |
| 0x03 | Velocity Loop Integral Time Constant 3 [TVI3]<br>* When gain 3(bit5, 4=1, 0) is selected, in the Gain Switching function, it operates at this setting value. | Unsigned16 | RW | No | 0x00C8<br>(20ms) |
| 0x04 | Velocity Loop Integral Time Constant 4 [TVI4]<br>* When gain 4(bit5, 4=1, 1) is selected, in the Gain Switching function, it operates at this setting value. | Unsigned16 | RW | No | 0x00C8<br>(20ms) |
| | | Setting range | 0x0003-0x2710<br>(0.3-1000 ms) | | |
| | | Unit | 0.1ms | | |

0x200D: Load Inertia Moment Ratio

| | | | | | |
|---|---|---|---|---|---|
| Index Ax1 0x200D<br>Ax2 0x220D<br>Ax3 0x240D<br>Ax4 0x260D | Sets inertia moment of the loading device to the servo motor roter inertia.<br>Setting value=$J_L/J_M$×100%<br>($J_L$: Load inertia, $J_M$: Motor roter inertia)<br>By setting bit5, 4, gain change selection (GC) in the parameter selection (0x2001), the Load Inertia Moment Ratio to be used is selected. | | Object Code | | Array |
| Sub-Idx | Description | Data Type | Access | PDO | Initial value |
| 0x00 | Number of entry | Unsigned8 | RO | No | 0x04 |
| 0x01 | Load Inertia Moment Ratio 1 [JRAT1]<br>*For velocity control parameters.<br>*Automatically saved by Auto-tuning result saving.<br>*When Auto-tuning function is valid, this setting value not applied.<br>*When Gain switching function is valid, select gain 1 and this setting value is applied.<br>*When gain 1(bit5, 4=0, 0) is selected, in the Gain Switching function, it operates at this setting value. | Unsigned16 | RW | Possible | 0x0064<br>(100%) |
| 0x02 | Load Inertia Moment Ratio 2 [JRAT2]<br>*When gain 2(bit5, 4=0, 1) is selected, in the Gain Switching function, it operates at this setting value. | Unsigned16 | RW | No | 0x0064<br>(100%) |
| 0x03 | Load Inertia Moment Ratio 3 [JRAT3]<br>*When gain 3(bit5, 4=1, 0) is selected, in the Gain Switching function, it operates at this setting value. | Unsigned16 | RW | No | 0x0064<br>(100%) |
| 0x04 | Load Inertia Moment Ratio 4 [JRAT4]<br>*When gain 4(bit5, 4=1, 1) is selected, in the Gain Switching function, it operates at this setting value. | Unsigned16 | RW | No | 0x0064<br>(100%) |
| | | Setting range | 0x0000-0x3A98<br>(0-15000%) | | |
| | | Unit | 1% | | |

0x200E: Higher Tracking Control Velocity Compensation Gain

| | | | | | |
|---|---|---|---|---|---|
| Index Ax1 0x200E<br>Ax2 0x220E<br>Ax3 0x240E<br>Ax4 0x260E | Parameter to adjust command following prerformance of velocity control. | | Object Code | | Variable |
| Sub-Idx | Description | Data Type | Access | PDO | Initial value |
| 0x00 | Higher Tracking Control Velocity Compensation Gain [TRCVGN]<br>*The higher the value, the more improved command following performance.<br>*When using Velocity Loop Proportional Control Switching Function, set it to 0%.<br>*When synchronizing with other axes, set it to 0%.<br>*When corresponding with Q series servo amplifier, set it to 100%.<br>*When auto-tuning enabled, this setting value is not reflected.<br>*The setting value is invalid with Model following control or Model following vibration suppressor control. | Unsigned16 | RW | No | 0x0000 |
| | | Setting range | 0x0000 - 0x0064<br>(0-100 %) | | |
| | | Unit | 1% | | |

0x200F: Acceleration Feedback Compensation

| | | | | | |
|---|---|---|---|---|---|
| Index Ax1 0x200F<br>Ax2 0x220F<br>Ax3 0x240F<br>Ax4 0x260F | Sets acceleration feedback compensation gain to make the velocity loop stable. Sets the cutoff frequency. | | Object Code | | Array |
| Sub-Idx | Description | Data Type | Access | PDO | Initial value |
| 0x00 | Number of entry | Unsigned8 | RO | No | 0x02 |
| 0x01 | Acceleration Feedback Gain [AFBK]<br>Multiply this gain with the detected acceleration to compensate torque (force) command.<br>■When Auto-tuning function is valid, this setting value not applied.<br>■If the value is too large, the motor may oscillate. Set within range ±15.0% for general use. | Integer16 | RW | No | 0x0000<br>(0.0 %) |
| | | Setting range | 0xFC18-0x03E8<br>(-100.0-+100.0%) | | |
| | | Unit | 0.1 % | | |
| 0x02 | Acceleration Feedback Filter [AFBFIL]<br>First low-pass filter to eliminate ripples caused by encoder pulse included in acceleration feedback compensation.<br>Sets the cutoff frequency.<br>■Lower this setting value when the encoder resolution is low.<br>■Setting value: the filter will be disabled at 2000Hz(0x07D0) or greater. | Unsigned16 | RW | No | 0x01F4<br>(500Hz) |
| | | Setting range | 0x0001-0x0FA0<br>(1-4000Hz) | | |
| | | Unit | Hz | | |

0x2011: Torque Command Filter

| Index Ax1 0x2011<br>Ax2 0x2211<br>Ax3 0x2411<br>Ax4 0x2611 | Low-pass filter to eliminate high frequency component included in the torque (force) command. Sets cutoff frequency.<br>By setting bit5, 4 gain, change selection (GC) in the parameter selection (0x2001), the Torque (force) Command Filter to be used is selected. | | Object Code | | Array |
|---|---|---|---|---|---|
| Sub-Idx | Description | Data Type | Access | PDO | Initial value |
| 0x00 | Number of entry | Unsigned8 | RO | No | 0x04 |
| 0x01 | Torque(force) command filter 1 ［TCFIL1］<br>* This setting update when save Auto-Tuning data. | Unsigned16 | RW | Possible | 0x0258<br>（600Hz） |
| | * When Auto-Tuning activate , this setting invalid.<br>* When Auto-Tuning activate and System analysis activate, this setting valid.<br>* When Gain Switching activate and select gain 1（bit5,4＝0,0）, this setting enable. | | | | |
| 0x02 | Torque (force) Command Filter 2 [TCFIL2]<br>*When the gain permission is enabled and gain 2 (bit5,4 = 0,1) is selected in the Gain Switching function, it operates at this setting value. | Unsigned16 | RW | No | 0x0258<br>(600Hz) |
| 0x03 | Torque (force) Command Filter 3 [TCFIL3]<br>* When the gain permission is enabled and gain 3 (bit5,4 = 1,0) is selected in the Gain Switching function, it operates at this setting value. | Unsigned16 | RW | No | 0x0258<br>(600Hz) |
| 0x04 | Torque (force) Command Filter 4 [TCFIL4]<br>* When the gain permission is enabled and gain 4 (bit5,4 = 1,1) is selected in the Gain Switching function, it operates at this setting value. | Unsigned16 | RW | No | 0x0258<br>(600Hz) |
| | | Setting value | 0x0001 - 0x0FA0<br>(1 - 4000 Hz) | | |
| | | Unit | Hz | | |

## 5) Feed Forward vibration suppressor control / Notch filter Parameter

0x2012: FF Vibration Suppressor Frequency

<table>
<tr><td>Index Ax1 0x2012<br>Ax2 0x2212<br>Ax3 0x2412<br>Ax4 0x2612</td><td colspan="2">Sets the frequency of the machine vibration to be suppressed by FF vibration suppressor function. Change this while the servo motor is OFF.<br>Shows the center frequency of the notch filter in response to the position command and set the frequency of the resonance to be constrained (anti-resonance frequency).<br>By setting bit3, 2 FF Vibration Suppressor Frequency switch selection (supfsel) in parameter selection (0x2001), the notch filter to be used is selected.</td><td colspan="2">Object Code</td><td>Array</td></tr>
<tr><td>Sub-Idx</td><td>Description</td><td>Data Type</td><td>Access</td><td>PDO</td><td>Initial value</td></tr>
<tr><td>0x00</td><td>Number of entry</td><td>Unsigned8</td><td>RO</td><td>No</td><td>0x04</td></tr>
<tr><td rowspan="2">0x01</td><td>FF Vibration Suppressor Frequency 1 [SUPFRQ1]<br>*This parameter is automatically saved by executing FF vibration suppressor frequency tuning.</td><td>Unsigned16</td><td>RW</td><td>Possible</td><td>0x01F4 (500 Hz) proportional control</td></tr>
<tr><td colspan="5">*Tuning result will be automatically saved in this parameter.<br>*When frequency 2 (bit 3, 2=0, 1) is selected in the vibration suppressor frequency selection function, it will operate at this setting value.</td></tr>
<tr><td>0x02</td><td>FF Vibration Suppressor Frequency 2 [SUPFRQ2]<br>*When frequency 2 (bit 3, 2=0, 1) is selected in the vibration suppressor frequency selection function, it will operate at this setting value.</td><td>Unsigned16</td><td>RW</td><td>No</td><td>0x01F4 (500 Hz) proportional control</td></tr>
<tr><td>0x03</td><td>FF Vibration Suppressor Frequency 3 [SUPFRQ3]<br>*When frequency 3 (bit 3, 2=1, 0) is selected in the vibration suppressor frequency selection function, it will operate at this setting value.</td><td>Unsigned16</td><td>RW</td><td>No</td><td>0x01F4 (500 Hz) proportional control</td></tr>
<tr><td>0x04</td><td>FF Vibration Suppressor Frequency 4 [SUPFRQ4]<br>*When frequency 4 (bit 3, 2=1, 1) is selected in the vibration suppressor frequency selection function, it will operate at this setting value.</td><td>Unsigned16</td><td>RW</td><td>No</td><td>0x01F4 (500 Hz) proportional control</td></tr>
<tr><td rowspan="3"></td><td rowspan="2">*Setting value can be input by 1Hz; inside the servo amplifier, the units listed below are used.<br>Setting range Unit value inside servo amplifier</td><td>Setting range</td><td colspan="3">0x0005-0x01F4 (5-500Hz)</td></tr>
<tr><td>Unit</td><td colspan="3">Hz</td></tr>
<tr><td colspan="5">5-99Hz Valid by 1Hz<br>100-499Hz Valid by 5Hz and drop less than 5<br>*Setting value: FF vibration suppressor control is invalid<br>*Do not use while synchronizing with other axis such as controlling XY table trajectory for cutting operation.</td></tr>
</table>

## 6) High stabilized control settings

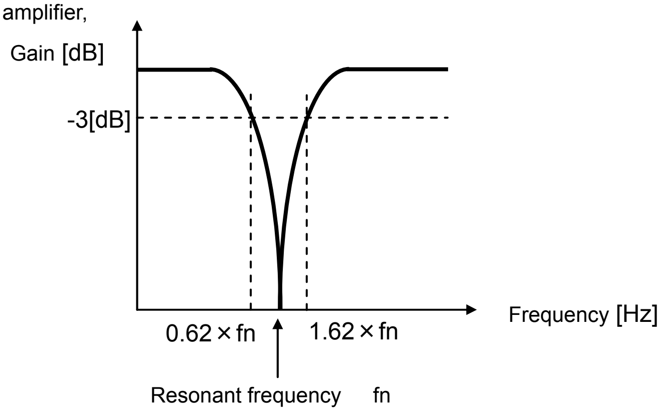
0x2015: High stabilized control settings

| | | | | | |
|---|---|---|---|---|---|
| Index Ax1 0x2015<br>Ax2 0x2215<br>Ax3 0x2415<br>Ax4 0x2615 | Parameter setting to implement high setting control by adding position deviation to Acceleration and Deceleration Compensation Values. | | Object Code | | Array |
| Sub-Idx | Description | Data Type | Access | PDO | Initial value |
| 0x00 | Number of entry | Unsigned8 | RO | No | 0x04 |
| 0x01 | Acceleration Compensation [ACCC0]<br>Sets the Acceleration Compensation Value using high-stabilized control.<br>* Set with the Position Deviation Pulse unit (in case of the pulse encoder, with the quadruple encoder resolution unit.)<br>*Compensation is provided in response to position deviation.<br>*Greater setting values result in increased compensation.<br>*Greater accelerations converted from the Position Command Pulse result in increased compensation.<br>*Greater Load inertia result in increased compensation.<br>*High Stabilized Control results in Position Deviation.<br>*In case of model following control or model following anti-resonance control, this setting value is not reflected. | Indeger16 | RW | No | 0x0<br>(0 Pulse) |
| | | Setting range | 0xD8F1-0x270F<br>(-9999-+9999×50 Pulse) | | |
| | | Unit | ×50 Pulse | | |
| 0x02 | Deceleration Compensation [DECC0]<br>Sets the Deceleration Compensation Value with High Stabilized Control.<br>✔Setting is in unit of position deviation pulse (for pulse encoder, unit of 4-multiplied encoder resolution).<br>✔Compensation shall be performed for position deviation.<br>✔The higher the set value, the more the compensation increases.<br>✔The higer the acceleration converterted from position command pulse, the more the compensation increases.<br>✔The higher the load inertia value, the more the compensation increases.<br>✔Position deviation decreases by high-stabilized control.<br>*In case of model following control or model following anti-resonance control, this setting value is not reflected. | Indeger16 | RW | No | 0x0<br>(0 Pulse) |
| | | Setting range | 0xD8F1-0x270F<br>(-9999-+9999×50 Pulse) | | |
| | | Unit | ×50 Pulse | | |
| 0x03 | Command Velocity Low-pass Filter [CVFIL]<br>Sets the cutoff frequency of the primary low-pass filter to eliminate high-frequency component (ripples etc.,) included in the Velocity (Command Velocity) calculated from the position command inside the higher established control.<br>* When the encoder resolution is low, lower the cutoff frequency.<br>* The filter is disabled by setting value 2000Hz or more. | Unsigned16 | RW | No | 0x03E8<br>(1000Hz) |
| | | Setting range | 0x001-0x0FA0<br>(1-4000Hz) | | |
| | | Unit | Hz | | |
| 0x04 | Command Velocity Threshold [CVTH]<br>Sets the Velocity Threshold to validate the Acceleration and Deceleration Compensation Values in the higher established control.<br>* When the velocity (command velocity) converted from the Position Command is higher than this velocity, implement the Acceleration or Deceleration Compensations.<br>✍The rotary motor differs from linear motor in unit. | Unsigned16 | RW | No | 0x0014<br>(20 min$^{-1}$)<br>[20mm/s] |
| | | Setting range | 0x0000-0xFFFF<br>(0-65536) | | |
| | | Unit | Rotary : min$^{-1}$<br>[Linear : mm/s] | | |

## 7) Observer Parameter

0x2016: Observer Parameter

| | | | |
|---|---|---|---|
| Index Ax1 0x2016<br>Ax2 0x2216<br>Ax3 0x2416<br>Ax4 0x2616 | Sets various parameters in the disturbance suppression observer. Observer compensation operates with control word 1 (0x2000) bit 11: disturbance Observer compensation enable [OBCON]="1" | Object Code | Record |

| Sub-Idx | Description | Data Type | Access | PDO | Initial value |
|---|---|---|---|---|---|
| 0x00 | Number of entry | Unsigned8 | RO | No | 0x07 |
| 0x01 | Observer Characteristic [OBCHA] | Unsigned8 | RW | No | 0x00 |
| | | Setting range | 0x00-0x02 | | |
| | 0x00: Low For Low Frequency<br>0x01: Middle For Middle Frequency<br>0x02: High For High Frequency<br>0x03-0xFF: Reserved<br>*Select "00 Low, Low Frequency Disturbance Observer Suppressor" for Load torque (force) monitor (estimate value).<br>*Select 02 High, High Frequency Disturbance Observer Suppressor, when the encoder resolution is over 1048576P/R (20bit). | | | | |
| 0x02 | Compensation gain for Disturbance Observer.[OBG]<br>Observer Compensation gain in response to the Torque (force)command.<br>*The larger the value, the higher the suppression performance. By making this too large to oscillate, the disturbance suppression characteristics improve. | Unsigned16 | RW | No | 0x0000<br>(0 %) |
| | | Setting range | 0x0000-0x0064<br>(0-100 %) | | |
| | | Unit | 1 % | | |
| 0x03 | Observer Output Filter [OBLPF]<br>First low-pass filter to eliminate high frequency elements included in the observer compensation.<br>Sets the cutoff frequency.<br>*Filter is invalid at the setting value more than 2000Hz. | Unsigned16 | RW | No | 0x032<br>(50 Hz) |
| | | Setting range | 0x0001-0x0FA0<br>(1-4000 Hz) | | |
| | | Unit | Hz | | |
| | *The larger the value is, the faster the response of disturbance observer suppression. However, it may cause a louder driving sound depending on the ripple components included in disturbance observer output.<br>*Filter is invalid when observer characteristic is set to [01 Middle, For Middle Frequency], or [02 High, For High Frequency]. | | | | |
| 0x04 | Observer Notch Filter [OBNFIL]<br>Notch filter to eliminate arbitrarily selected frequency from observer compensation. Set the center frequency of the filter.<br>*When resonance appears in disturbance observer output, such as sympathetic vibration with the mechanical system, this notch filter sometimes suppresses the vibration. | Unsigned16 | RW | No | 0x0FA0<br>(4000 Hz) |
| | | Setting range | 0x0001-0x0FA0<br>(1-4000 Hz) | | |
| | | Unit | Hz | | |
| | *Setting value can be input by 1Hz; inside the servo amplifier, the units listed below are applied.<br>Setting value: Unit value inside servo amplifier<br>100-1999Hz: Valid by 10Hz and drop less than 10<br>2000-4000Hz: Filter invalid<br> | | | | |
| 0x05 | Observer Load Inertia Ratio [OBJLJM]<br>Sets the Inertia moment (Load Inertia) of the loading device for the motor inertia moment at the disturbance suppression observer.<br>Setting value=JL/JM×100% | Unsigned16 | RW | No | 0x0064<br>(100%) |
| | | Setting range | 0x0000-0x1388<br>(0-5000%) | | |
| | | Unit | % | | |
| | (JL: Load inertia, JM: Motor rotor inertia)<br>* Selection of disturbance suppression observer characteristics: JRAT 1-4 are used when frequency setting is made. | | | | |
| 0x06 | Observer Loop Proportional Gain [OBPGIN]<br>Proportional gain of the observer control. | Unsigned16 | RW | No | 0x012C<br>(300Hz) |
| | | Setting range | 0x0001-0x07D0<br>(1-2000Hz) | | |
| | | Unit | Hz | | |
| 0x07 | Load Torque (force) Filter [TESLPF]<br>After the disturbance suppression observer output low-pass filter, set the cutoff frequency of the primary low-pass filter against the Load torque (force) estimate.<br>Sets the cutoff frequency.<br>Setting value: the filter will be disabled at 2000Hz(0x07D0) or greater. | Unsigned16 | RW | No | 0x0032<br>(50 Hz) |
| | | Setting range | 0x0001-0x07D0<br>(1-2000Hz) | | |
| | | Unit | Hz | | |

## 8) Model Following Control Settings Parameter

# A note of caution in using Model Following Control
- * If oscillation is restrained when using Model Following Vibration Suppressor Control, the vibration suppression effect disappears when the alarm occurs.
- * When the Gain Switching Function is used, please stop the servo motor.
- * When the Model Vibration Suppressor Frequency switching is used, please stop the servo motor.
- * If the alarm “AL.C5 Model Following Vibration Suppressor Control trouble” occurs during the operation, please lower the “KM Model Control Gain” or change the operation pattern so that the acceleration and deceleration will be slowed.
- * In the JOG operation, Model Following Vibration Suppressor Control function does not operate.

0x2017: Model Control Gain

| Index Ax1 0x2017<br>Ax2 0x2217<br>Ax3 0x2417<br>Ax4 0x2617 | Proportional gain of the Model Following Control Position Controller. | | Object Code | | Array |
|---|---|---|---|---|---|
| Sub-Idx | Description | Data Type | Access | PDO | Initial value |
| 0x00 | Number of entry | Unsigned8 | RO | No | 0x04 |
| 0x01 | Model Control Gain 1 [KM1]<br>*Automatically saved by Auto-tuning result saving. | Unsigned16 | RW | Possible | 0x001E<br>(30 /s) |
| | *When gain 1(bit5, 4=0, 0) is selected, in the Gain Switching function, it operates at this setting value. | | | | |
| 0x02 | Model Control Gain 2 [KM2]<br>*When gain 2(bit5, 4=0, 1) is selected, in the Gain Switching function, it operates at this setting value. | Unsigned16 | RW | No | 0x001E<br>(30 /s) |
| 0x03 | Model Control Gain 3 [KM3]<br>*When gain 3(bit5, 4=1, 0) is selected, in the Gain Switching function, it operates at this setting value. | Unsigned16 | RW | No | 0x001E<br>(30 /s) |
| 0x04 | Model Control Gain 4 [KM4]<br>*When gain 4(bit5, 4=1, 1) is selected, in the Gain Switching function, it operates at this setting value. | Unsigned16 | RW | No | 0x001E<br>(30 /s) |
| | Depends on the setting value of Position control selection (0x20F3:01), the range is different.<br>01: Model Following Control<br>0x0001-0x0BB8 (1-3000 /s)<br>02: Condition Feedback Model Following Vibration Suppress Control<br>0x000F-0x013B (15-315 /s) | Setting range | 0x0001-0x0BB8<br>(1-3000 /s) | | |
| | | Unit | 1/s | | |
| | * In case of operating at Model following anti-resonance control, use in the range of 15 - 315/s.<br>* Change value while the servo motor is OFF. | | | | |

0x2018: Overshoot Suppressor Filter

| Index Ax1 0x2018<br>Ax2 0x2218<br>Ax3 0x2418<br>Ax4 0x2618 | Filter to suppress overshoot with Model following control or Model following vibration suppressor control.<br>Sets cutoff frequency. | | Object Code | | Variable |
|---|---|---|---|---|---|
| Sub-Idx | Description | Data Type | Access | PDO | Initial value |
| 0x00 | Overshoot Suppressor Filter [OSSFIL]<br>Cutoff frequency of primary low-pass filter in response the velocity integral feedback.<br>*If any overshoots occur on position deviation, lower the setting value.<br>*Filter is invalid at the setting value more than 2000Hz. | Unsigned16 | RW | No | 0x05DC<br>(1500 Hz) |
| | | Setting range | 0x0001-0x0FA0<br>(1-4000 Hz) | | |
| | | Unit | Hz | | |

0x2019: Model Control Antiresonance Frequency

<table>
<tr><td>Index Ax1 0x2019<br>Ax2 0x2219<br>Ax3 0x2419<br>Ax4 0x2619</td><td colspan="2">Sets antiresonance frequency to the mechanical device with Model following vibration suppressor control. Sets actual antiresonance frequency value of the mechanical system by using System Analysis function of the Software Setup.</td><td colspan="2">Object Code</td><td>Array</td></tr>
<tr><td>Sub-Idx</td><td>Description</td><td>Data Type</td><td>Access</td><td>PDO</td><td>Initial value</td></tr>
<tr><td>0x00</td><td>Number of entry</td><td>Unsigned8</td><td>RO</td><td>No</td><td>0x04</td></tr>
<tr><td>0x01</td><td>Model Control Antiresonance Frequency 1 [ANRFRQ1]<br>*When frequency 1(bit1, 0=0, 0) is selected in the model anti-resonance frequency switch at 0x2001, it operates at this setting value.</td><td>Unsigned16</td><td>RW</td><td>Possible</td><td>0x0320<br>(80.0 Hz)<br>proportional control</td></tr>
<tr><td>0x02</td><td>Model Control Antiresonance Frequency 2 [ANRFRQ2]<br>*When frequency 2(bit1, 0=0, 1) is selected in the model anti-resonance frequency switch at 0x2001, it operates at this setting value.</td><td>Unsigned16</td><td>RW</td><td>No</td><td>0x0320<br>(80.0 Hz)<br>proportional control</td></tr>
<tr><td>0x03</td><td>Model Control Antiresonance Frequency 3 [ANRFRQ3]<br>*When frequency 3(bit1, 0=1, 0) is selected in the model anti-resonance frequency switch at 0x2001, it operates at this setting value.</td><td>Unsigned16</td><td>RW</td><td>No</td><td>0x0320<br>(80.0 Hz)<br>proportional control</td></tr>
<tr><td>0x04</td><td>Model Control Antiresonance Frequency 4 [ANRFRQ4]<br>*When frequency 4(bit1, 0=1, 1) is selected in the model anti-resonance frequency switch at 0x2001, it operates at this setting value.</td><td>Unsigned16</td><td>RW</td><td>No</td><td>0x0320<br>(80.0 Hz)<br>proportional control</td></tr>
<tr><td colspan="3" rowspan="2">■Setting value is invalid with following control.<br>■If the sitting value is over the Model Control Resonance Frequency, vibration suppressor control is invalid.<br>■If “Model Control Anti-resonance Frequency 2-4” are selected in the “Model vibration suppressor frequency switching function”, it operates at this setting value.<br>■Change value while the servo motor is OFF.</td><td>Setting range</td><td colspan="2">0x0064-0x0320<br>(10.0-80.0 Hz)</td></tr>
<tr><td>Unit</td><td colspan="2">0.1 Hz</td></tr>
</table>

0x201A: Model Control Resonance Frequency

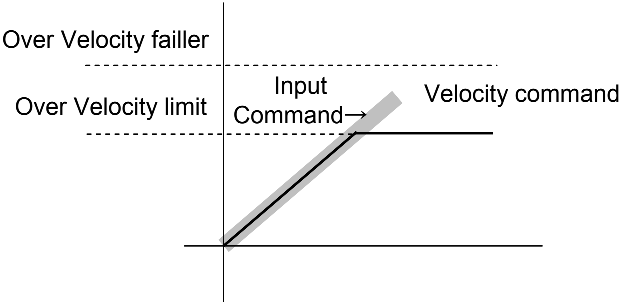
<table>
<tr><td>Index Ax1 0x201A<br>Ax2 0x221A<br>Ax3 0x241A<br>Ax4 0x261A</td><td colspan="2">Sets resonance frequency of the mechanical device with Model following vibration suppressor control. Sets actual resonance frequency value of the mechanical system by using System Analysis function of the Software Setup.</td><td colspan="2">Object Code</td><td>Array</td></tr>
<tr><td>Sub-Idx</td><td>Description</td><td>Data Type</td><td>Access</td><td>PDO</td><td>Initial value</td></tr>
<tr><td>0x00</td><td>Number of entry</td><td>Unsigned8</td><td>RO</td><td>No</td><td>0x04</td></tr>
<tr><td>0x01</td><td>Model Control Resonance Frequency 1 [RESFRQ1]<br>*When frequency 1(bit1, 0=0, 0) is selected in the model anti-resonance frequency switch at 0x2001, it operates at this setting value.</td><td>Unsigned16</td><td>RW</td><td>Possible</td><td>0x0320<br>(80.0 Hz)<br>proportional control</td></tr>
<tr><td>0x02</td><td>Model Control Resonance Frequency 2 [RESFRQ2]<br>*When frequency 2(bit1, 0=0, 1) is selected in the model anti-resonance frequency switch at 0x2001, it operates at this setting value.</td><td>Unsigned16</td><td>RW</td><td>No</td><td>0x0320<br>(80.0 Hz)<br>proportional control</td></tr>
<tr><td>0x03</td><td>Model Control Resonance Frequency 3 [RESFRQ3]<br>*When frequency 3(bit1, 0=1, 0) is selected in the model anti-resonance frequency switch at 0x2001, it operates at this setting value.</td><td>Unsigned16</td><td>RW</td><td>No</td><td>0x0320<br>(80.0 Hz)<br>proportional control</td></tr>
<tr><td>0x04</td><td>Model Control Resonance Frequency 4 [RESFRQ4]<br>*When frequency 1(bit1, 0=1, 1) is selected in the model anti-resonance frequency switch at 0x2001, it operates at this setting value.</td><td>Unsigned16</td><td>RW</td><td>No</td><td>0x0320<br>(80.0 Hz)<br>proportional control</td></tr>
<tr><td colspan="2" rowspan="2">* Setting value is invalid with Model following control.<br>* The filter is disabled by setting value 0x320(80Hz) or more.<br>* If Model Control Antiresonance Frequency 2-4 selected in Model vibration suppressor frequency switching setting, it works in this setting.<br>* Change value while the servo motor is OFF.</td><td>Setting range</td><td colspan="3">0x0064-0x0320<br>(10.0-80.0 Hz)</td></tr>
<tr><td>Unit</td><td colspan="3">0.1 Hz</td></tr>
</table>

0x201B: Gain Switching Filter

<table>
<tr><td>Index Ax1 0x201B<br>Ax2 0x221B<br>Ax3 0x241B<br>Ax4 0x261B</td><td colspan="2">Low-pass filter to change gain moderately when switching.<br>Sets time constant.</td><td colspan="2">Object Code</td><td>Variable</td></tr>
<tr><td>Sub-Idx</td><td>Description</td><td>Data Type</td><td>Access</td><td>PDO</td><td>Initial value</td></tr>
<tr><td rowspan="4">0x00</td><td rowspan="3">Gain Switching Filter [GCFIL]<br>By setting bit5, 4, gain change selection (GC) in the parameter selection (0x2001), the time constant at the parameter switching is set.<br>* The larger the value, the gentler the gain changes.<br>* The filter is disabled at the setting value 0ms.</td><td>Unsigned16</td><td>RW</td><td>No</td><td>0x0000<br>(0 ms)</td></tr>
<tr><td>Setting range</td><td colspan="3">0x0000-0x064<br>(0-100ms)</td></tr>
<tr><td>Setting Unit</td><td colspan="3">ms</td></tr>
<tr><td colspan="5">* When the mechanical system is shocked by the change of gain resulted from gain switching, making a moderate gain change will modify the shock.</td></tr>
</table>

## 9) Amplifier Function Parameter

0x201C: Internal Velocity Command limit

<table>
<tr><td>Index Ax1<br>Ax2<br>Ax3<br>Ax4</td><td>0x201C<br>0x221C<br>0x241C<br>0x261C</td><td colspan="2">Sets the allowable velocity in response to the Internal Velocity Command.</td><td colspan="2">Object Code</td><td>Variable</td></tr>
<tr><td>Sub-Idx</td><td colspan="2">Description</td><td>Data Type</td><td>Access</td><td>PDO</td><td>Initial value</td></tr>
<tr><td rowspan="4">0x00</td><td colspan="2" rowspan="3">Internal Velocity Command limit [VCMMAX]<br>In the cycle synchronous position (csp) or the profile position (pp) mode, Interpolated position (ip) the internal velocity command is limited.<br>In the cycle synchronous velocity (csv) or the profile velocity (pv) mode, it is clamped at the setting value in response to the velocity command. Moreover, when<br>Setting value = |Velocity Command|<br>velocity-limit warning bit is set.</td><td>Unsigned16</td><td>RW</td><td>No</td><td>0xFFFF<br>(65535min$^{-1}$)<br>[65535mm/s]</td></tr>
<tr><td>Setting range</td><td colspan="3">0x0000 - 0xFFFF<br>(0 - 65535min$^{-1}$)<br>[0 - 65535mm/s]</td></tr>
<tr><td>Unit</td><td colspan="3">Rotary : min$^{-1}$<br>[Linear : mm/s]</td></tr>
<tr><td colspan="6">■When the setting value is 0 min$^{-1}$, or 50000 min$^{-1}$ or more, 0 min$^{-1}$ it is limited at 1.1 fold the highest rotation velocity of the motor (combining the velocity commands).<br>* It works at the state that bit3 of control word (0x2000) is valid.<br> <br>✍The rotary motor differs from linear motor in unit.</td></tr>
</table>

0x201D: Position Command error 1 level

<table>
<tr><td>Index Ax1<br>Ax2<br>Ax3<br>Ax4</td><td>0x201D<br>0x221D<br>0x241D<br>0x261D</td><td colspan="2">Position Command error 1 alarm detection level is set.</td><td colspan="2">Object Code</td><td>Variable</td></tr>
<tr><td>Sub-Idx</td><td colspan="2">Description</td><td>Data Type</td><td>Access</td><td>PDO</td><td>Initial value</td></tr>
<tr><td rowspan="4">0x00</td><td colspan="2" rowspan="3">Position Command error 1 level [OVFSET]<br>* Profile Position mode (pp)<br>When the velocity-converted value of trajectory generation distance exceeds the setting value, alarm “D2” is detected.</td><td>Unsigned32</td><td>RW</td><td>No</td><td>0xFFFFFFFF</td></tr>
<tr><td>Setting range</td><td colspan="3">0x1-0xFFFFFFFF<br>(1 - 4294967295 p/s)</td></tr>
<tr><td>Unit</td><td colspan="3">Pulse/sec</td></tr>
<tr><td colspan="6">* Cycle synchronous position mode (csp), Interpolated position mode (ip)<br>When the velocity-converted value of position command variation (the previous target position – the target position) exceeds the setting value, alarm “D2” is detected.<br><br>* The weight treated inside the amplifier is set by the servo control cycle 125μs steps; therefore, please set it according to the following equation indicating the resulting value:<br>Internal Unit [LSB] = 480000÷1 rotary resolution [Pulse/sec]</td></tr>
</table>

0x201E: Sequence Operation Torque (force) Limit Value

<table>
<tr><td>Index Ax1<br>Ax2<br>Ax3<br>Ax4</td><td>0x201E<br>0x221E<br>0x241E<br>0x261E</td><td colspan="2">Parameter to set the output torque (force) in Sequence Operation.</td><td colspan="2">Object Code</td><td>Variable</td></tr>
<tr><td>Sub-Idx</td><td colspan="2">Description</td><td>Data Type</td><td>Access</td><td>PDO</td><td>Initial value</td></tr>
<tr><td rowspan="4">0x00</td><td colspan="2" rowspan="3">Sequence Operation Torque (force) Limit Value [SQTCLM]<br>This is Torque (force) Limit Value for the following sequence controls.<br>*Sequence Operation Torque (force) Limit is adapted with “Quick stop operation,” “Emergency Stop operation,” as well as “Servo-braking operation,” “JOG operation,” “Forward/Reverse limit operations” at alarm occurrence, and “holding brake down time” when the servomotor is on.</td><td>Unsigned16</td><td>RW</td><td>No</td><td>0x04B0<br>(120.0 %)</td></tr>
<tr><td>Setting range</td><td colspan="3">0x0064-0x1388<br>(10.0-500.0 %)</td></tr>
<tr><td>Unit</td><td colspan="3">0.1 %</td></tr>
<tr><td colspan="6">Moreover, when power lowering torque (force) limit selection (0x20F5) is “0x01,” electric current is limited including this setting value.<br>* Sets the limiting torque (force) by the ratio of rated output torque (force). (100.0%=rated torque (force))<br>* When the value is set exceeding the Maximum instant stall torque (force) ($T_P$) of the combining servo motor, it is limited by the Maximum instant stall torque (force) ($T_P$) of the combining servo motor.<br>* When overload 1 alarm occurs, it is limited to 120% in case a value of more than 120% is set.</td></tr>
</table>

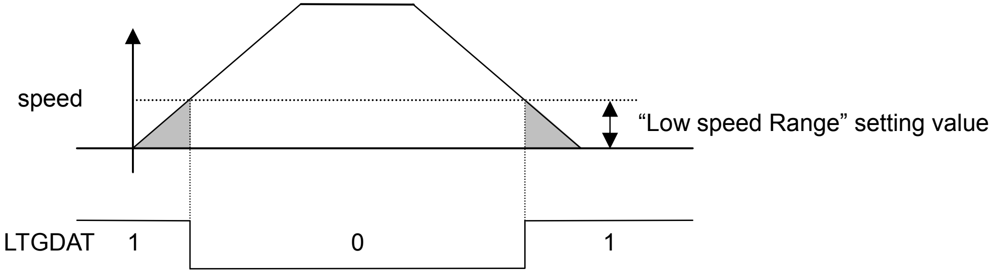
0x201F: Near Range

<table>
<tr><td>Index Ax1<br>Ax2<br>Ax3<br>Ax4</td><td>0x201F<br>0x221F<br>0x241F<br>0x261F</td><td colspan="2">A position range variation counter for positioning completion/ near range completion monitoring.</td><td colspan="2">Object Code</td><td>Variable</td></tr>
<tr><td>Sub-Idx</td><td colspan="2">Description</td><td>Data Type</td><td>Access</td><td>PDO</td><td>Initial value</td></tr>
<tr><td rowspan="4">0x00</td><td colspan="2" rowspan="3">Near Range [NEAR]<br>* Outputs Near range signal when the Position deviation counter is set lower that this set value.<br>* Sets at the resolution of the encoder pulse<br>|Following Error Actual Value| <= Setting value</td><td>Unsigned32</td><td>RW</td><td>No</td><td>0x01F4<br>(500 pulse)</td></tr>
<tr><td>Setting range</td><td colspan="3">0x00000000-0x7FFFFFFF<br>(0-2147483647 Pulse)</td></tr>
<tr><td>Unit</td><td colspan="3">1 Pulse</td></tr>
<tr><td colspan="6">When the actual position variation is greater than the setting value, it is output from near range completion monitor (NEAR monitor.)</td></tr>
</table>

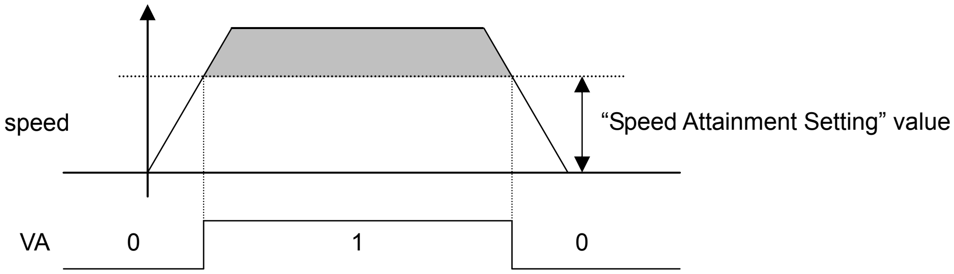
0x2020: Speed Zero Range

<table>
<tr><td>Index Ax1<br>Ax2<br>Ax3<br>Ax4</td><td>0x2020<br>0x2220<br>0x2420<br>0x2620</td><td colspan="2">Setting value for detecting Zero-speed status (motor stop).<br>Sets the allowable range at Zero-speed.</td><td colspan="2">Object Code</td><td>Variable</td></tr>
<tr><td>Sub-Idx</td><td colspan="2">Description</td><td>Data Type</td><td>Access</td><td>PDO</td><td>Initial value</td></tr>
<tr><td rowspan="3">0x00</td><td colspan="2" rowspan="3">Speed Zero Range [ZV]<br>|Actual Velocity| <= Setting value<br>When the Actual Velocity condition below the Setting value is continuously detected for 1ms or more, zero velocity monitor (ZV) is output.<br>✍The rotary motor differs from linear motor in unit.</td><td>Unsigned16</td><td>RW</td><td>No</td><td>0x0032<br>(50min$^{-1}$)<br>[50mm/s]</td></tr>
<tr><td>Setting range</td><td colspan="3">0x0005 - 0x01F4<br>(5 - 500min$^{-1}$)<br>[5 - 500mm/s]</td></tr>
<tr><td>Unit</td><td colspan="3">Rotary : min$^{-1}$<br>[Linear : mm/s]</td></tr>
</table>

0x2021: Low Speed Range

<table>
<tr><td>Index Ax1<br>Ax2<br>Ax3<br>Ax4</td><td>0x2021<br>0x2221<br>0x2421<br>0x2621</td><td colspan="2">Sets the acceptable Low Speed Range of the motor rotation speed.</td><td colspan="2">Object Code</td><td>Variable</td></tr>
<tr><td>Sub-Idx</td><td colspan="2">Description</td><td>Data Type</td><td>Access</td><td>PDO</td><td>Initial value</td></tr>
<tr><td rowspan="4">0x00</td><td colspan="2" rowspan="3">Low Speed Range [LOWV]<br>When the speed is lower than this value, Low speed range is output.<br>|Actual Velocity|<= Setting value<br>then LTG flag is set.</td><td>Unsigned16</td><td>RW</td><td>No</td><td>0x0032<br>(50min$^{-1}$)<br>[50mm/s]</td></tr>
<tr><td>Setting range</td><td colspan="3">0x0000 - 0xFFFF<br>(0 - 65535min$^{-1}$)<br>[0 - 65535mm/s]</td></tr>
<tr><td>Unit</td><td colspan="3">Rotary : min$^{-1}$<br>[Linear : mm/s]</td></tr>
<tr><td colspan="6"> <br>■ If Auto Tuning Mode setting is 0x01 and Auto Tuning Characteristics setting is 0x02, 50min-1 will be set automatically.<br>✍The rotary motor differs from linear motor in unit.</td></tr>
</table>

0x2022: Speed Attainment Setting (High Speed Range)

<table>
<tr><td>Index Ax1 0x2022<br>Ax2 0x2222<br>Ax3 0x2422<br>Ax4 0x2622</td><td colspan="2">Sets the speed attainment level of the motor rotation speed.</td><td colspan="2">Object Code</td><td>Variable</td></tr>
<tr><td>Sub-Idx</td><td>Description</td><td>Data Type</td><td>Access</td><td>PDO</td><td>Initial value</td></tr>
<tr><td rowspan="4">0x00</td><td rowspan="3">Speed Attainment Setting [VA]<br>Used as arrival confirmation in response to a high-speed rotation command; When the speed exceeds this setting value, Speed attainment is output.<br>|Actual Velocity|>= Setting value<br>then VA flag is set.</td><td>Unsigned16</td><td>RW</td><td>No</td><td>0x03E8<br>(1000min$^{-1}$)<br>[1000mm/s]</td></tr>
<tr><td>Setting range</td><td colspan="3">0x0000 - 0xFFFF<br>(0 - 65535min$^{-1}$)<br>[0 - 65535mm/s]</td></tr>
<tr><td>Unit</td><td colspan="3">Rotary : min$^{-1}$<br>[Linear : mm/s]</td></tr>
<tr><td colspan="5"> <br>■ While operating with torque (force) control mode, simple velocity control is exercised by this parameter.<br>*when Motor speed exceeds this setting value, as the velocity sets at zero, control of unstable velocity cannot be exercised. Avoid the use of such status to continue.<br>✍The rotary motor differs from linear motor in unit.</td></tr>
</table>

0x2023: Analog Monitor Select Output

| Index | | Description | | |
|---|---|---|---|---|
| Ax1 | 0x2023 | Selects the output selection and the polarization character of Analog Monitor 1, 2. | Object Code | Record |
| Ax2 | 0x2223 | | | |
| Ax3 | 0x2423 | | | |
| Ax4 | 0x2623 | | | |

| Sub-Idx | Description | Data Type | Access | PDO | Initial value |
|---|---|---|---|---|---|
| 0x00 | Number of entry | Unsigned8 | RO | No | 0x03 |
| 0x01 | Analog Monitor Select Output 1 [MON1]<br>Select data to output from Analog Monitor 1. | Unsigned8 | RW | No | 0x05 |
| | | Setting range | 0x01-0x24 | | |

& Rotary motor

| | | |
|---|---|---|
| 0x00： | Reserved（For maintenance by manufacturer） | |
| 0x01： | Torque（force） monitor | 2V／ratedTorque（force） |
| 0x02： | Torque（force） command monitor | 2V／ratedTorque（force） |
| 0x03： | Velocity monitor | 0.2mV／min$^{-1}$ |
| 0x04： | Velocity monitor | 1mV／min$^{-1}$ |
| 0x05： | Velocity monitor | 2mV／min$^{-1}$ |
| 0x06： | Velocity monitor | 3mV／min$^{-1}$ |
| 0x07： | Velocity command monitor | 0.2mV／min$^{-1}$ |
| 0x08： | Velocity command monitor | 1mV／min$^{-1}$ |
| 0x09： | Velocity command monitor | 2mV／min$^{-1}$ |
| 0x0A： | Velocity command monitor | 3mV／min$^{-1}$ |
| 0x0B： | Position deviation monitor | 0.01mV／Pulse |
| 0x0C： | Position deviation monitor | 0.1mV／Pulse |
| 0x0D： | Position deviation monitor | 1mV／Pulse |
| 0x0E： | Position deviation monitor | 10mV／Pulse |
| 0x0F： | Position deviation monitor | 20mV／Pulse |
| 0x10： | Position deviation monitor | 50mV／Pulse |
| 0x11： | Position command monitor1 | 2mV／kPulse／sec |
| 0x12： | Position command monitor1 | 10mV／kPulse／s |
| 0x13： | Position command monitor2 | 0.05mV／kPulse／s |
| 0x14： | Position command monitor2 | 0.5mV／kPulse／s |
| 0x15： | Position command monitor2 | 2mV／kPulse／s |
| 0x16： | Position command monitor2 | 10mV／kPulse／s |
| 0x17： | Load Torque（force）monitor | 2V／ratedTorque（force） |
| 0x18： | Phase U electrical angle monitor | 8Vpeak |
| 0x19： | Position command monitor1 | 0.05mV／kPulse／sec |
| 0x1A： | Position command monitor1 | 0.5mV／kPulse／sec |
| 0x1B： | Acceleration monitor | 0.01mV／rad／sec$^2$ |
| 0x1C： | Acceleration monitor | 0.1mV／rad／sec$^2$ |
| 0x1D： | Acceleration monitor | 1mV／rad／sec$^2$ |
| 0x1E： | Acceleration monitor | 10mV／rad／sec$^2$ |
| 0x1F to 0xFF：reserved | | |
| 0x1F: | Position Synchronization Deviation Monitor | 0.01mV/Pulse |
| 0x20: | Position Synchronization Deviation Monitor | 0.1mV/Pulse |
| 0x21: | Position Synchronization Deviation Monitor | 1mV/Pulse |
| 0x22: | Position Synchronization Deviation Monitor | 10mV/Pulse |
| 0x23: | Position Synchronization Deviation Monitor | 20mV/Pulse |
| 0x24: | Position Synchronization Deviation Monitor | 50mV/Pulse |
| 0x25～0xFF: Reserved | | |

& Linear motor

| | | |
|---|---|---|
| 0x00： | Reserved （For maintenance by manufacturer） | |
| 0x01： | Torque（force）monitor | 2V／ratedTorque（force） |
| 0x02： | Torque（force）monitor | 2V／ratedTorque（force） |
| 0x03： | Velocity monitor | 0.2mV／mm／sec |
| 0x04： | Velocity monitor | 1mV／mm ／sec |
| 0x05： | Velocity monitor | 2mV／mm ／sec |
| 0x06： | Velocity monitor | 3mV／mm ／sec |
| 0x07： | Velocity command monitor | 0.2mV／mm／sec |
| 0x08： | Velocity command monitor | 1mV／mm／sec |
| 0x09： | Velocity command monitor | 2mV／mm／sec |
| 0x0A： | Velocity command monitor | 3mV／mm／sec |
| 0x0B： | Position deviation monitor | 0.01mV／Pulse |
| 0x0C： | Position deviation monitor | 0.1mV／Pulse |
| 0x0D： | Position deviation monitor | 1mV／Pulse |
| 0x0E： | Position deviation monitor | 10mV／Pulse |
| 0x0F： | Position deviation monitor | 20mV／Pulse |
| 0x10： | Position deviation monitor | 50mV／Pulse |
| 0x11： | Position command monitor1 | 2mV／kPulse／sec |
| 0x12： | Position command monitor1 | 10mV／kPulse／s |
| 0x13： | Position command monitor2 | 0.05mV／kPulse／s |
| 0x14： | Position command monitor2 | 0.5mV／kPulse／s |
| 0x15： | Position command monitor2 | 2mV／kPulse／s |
| 0x16： | Position command monitor2 | 10mV／kPulse／s |
| 0x17： | Load Torque（force）monitor | 2V／ratedTorque（force） |
| 0x18： | Phase U electrical angle monitor | 8Vpeak |
| 0x19： | Position command monitor1 | 0.05mV／kPulse／sec |
| 0x1A： | Position command monitor1 | 0.5mV／kPulse／sec |
| 0x1B： | Acceleration monitor | 0.01mV／mm／sec$^2$ |
| 0x1C： | Acceleration monitor | 0.1mV／mm／sec$^2$ |
| 0x1D： | Acceleration monitor | 1mV／mm／sec$^2$ |
| 0x1E： | Acceleration monitor | 10mV／mm／sec$^2$ |
| 0x1F to 0xFF：reserved | | |
| 0x1F: | Position Synchronization Deviation Monitor | 0.01mV/Pulse |
| 0x20: | Position Synchronization Deviation Monitor | 0.1mV/Pulse |
| 0x21: | Position Synchronization Deviation Monitor | 1mV/Pulse |
| 0x22: | Position Synchronization Deviation Monitor | 10mV/Pulse |
| 0x23: | Position Synchronization Deviation Monitor | 20mV/Pulse |
| 0x24: | Position Synchronization Deviation Monitor | 50mV/Pulse |
| 0x25～0xFF: Reserved | | |

◆Position command monitor1 monitors position command pulse before position somoothing passing.

◆Position command monitor2 monitors position command pulse after position somoothing passing.

✔Position command pulse frequency monitor1 and 2 are output in the form of pulse when command pulsefrequency is 10kHz or less.
Average the frequency when convering to position command frequency.

◆Torque(force)monitor, velocity monitor, and load torque monitor are placed the following low-path filters.
Torque（force）monitor 250Hz, Velocity monitor 250Hz, Load torque monitor 20Hz

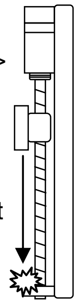
| Sub-Idx | Description | Data Type | Access | PDO | Initial value |
|---|---|---|---|---|---|
| 0x02 | Analog Monitor Select Output 2 [MON2]<br>Selects the data to output from Analog Monitor 2.<br>The setting value is the same as in Analog Monitor output selection 1. | Unsigned8 | RW | No | 0x02 |
| | | Setting range | 0x01～0x24 (Rotary)<br>0x01～0x1E (Linear) | | |
| 0x03 | Analog Monitor Output Polarity Selection [MONPOL]<br>Selects the output polarity of analog monitor 1/2. | Unsigned8 | RW | No | 0x00 |
| | | Setting range | 0x00-0x08 | | |

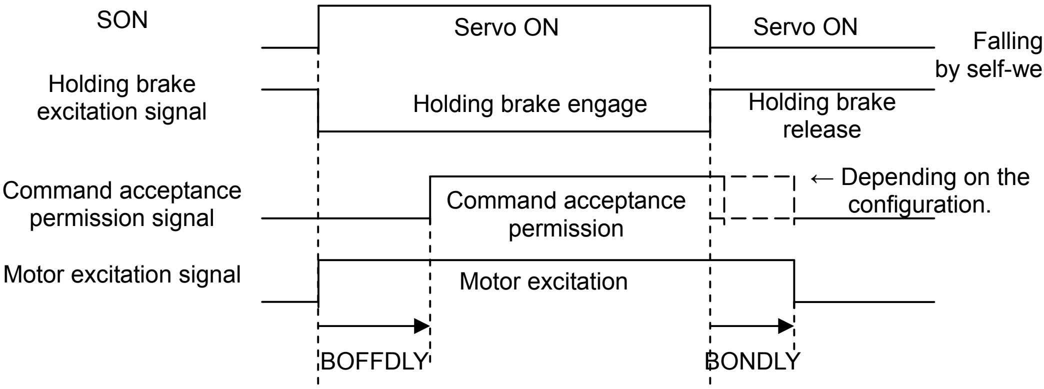
*For both MON1 and MON2, set from any of the followings: +No Polarity Rotation, - Polarity Rotation, ABS Absolute Value Output

0x00:AMON1/AMON2 at positive rotation+voltage output/at positive rotation+output
0x01:AMON1/AMON2 at positive rotation-voltage output/at positive rotation+output
0x02:AMON1/AMON2 at positive rotation+voltage output/at positive rotation-output
0x03:AMON1/AMON2 at positive rotation-voltage output/at positive rotation-output
0x04:AMON1/AMON2 at positive/reverse rotations+voltage output(absolute value)/at positive rotation+output
0x05:AMON1/AMON2 at positive/reverse rotations+voltage output (absolute value)/at positive rotation-output
0x06:AMON1/AMON2 at positive rotation+output/at positive/reverse rotations+voltage output (absolute value)
0x07:AMON1/AMON2 at positive rotation-output/at positive/reverse rotations+voltage output (absolute value)
0x08:AMON1/AMON2 at positive/reverse rotations+voltage output (absolute value/at positive/reverse rotations+voltage output (absolute value)
0x09-0xFF:Reserved

# About Holding Brake

Servo motor with Holding brake function is usually used with an axis that is always affected by gravity and external forces in order to avoid movable parts falling off from its position when main circuit power is OFF, or servo OFF.
Holding brake is to support the movable parts against gravity and other external force when at rest. Do not use it to stop a moving machine.





0x2024: Delay Time of Engaging Holding Brake

<table>
<tr><td>Index Ax1 0x2024<br>Ax2 0x2224<br>Ax3 0x2424<br>Ax4 0x2624</td><td colspan="2">Sets holding-brake-activation delay time from when power distribution to holding brake stopped till when holding torque generated.</td><td colspan="2">Object Code</td><td>Variable</td></tr>
<tr><td>Sub-Idx</td><td>Description</td><td>Data Type</td><td>Access</td><td>PDO</td><td>Initial value</td></tr>
<tr><td rowspan="4">0x00</td><td rowspan="3">Delay Time of Engaging Holding Brake [BONDLY]<br>* While shifting from servo ON to servo OFF, during the setting time, Excitation command 0 is given to servo motor. (Even when servo is turned OFF, power is supplied to the motor until the setting time is over.)</td><td>Unsigned16</td><td>RW</td><td>Possible</td><td>0x01C2<br>(300ms)</td></tr>
<tr><td>Setting range</td><td colspan="3">0x0000-0x03E8<br>(0-1000ms)</td></tr>
<tr><td>Unit</td><td colspan="3">ms</td></tr>
<tr><td colspan="5">By this, until Holding brake functions, servo motor generates Holding torque (force).<br>* This is valid when servo brake operation at servo OFF condition is set in the “dynamic brake operation setting”<br>(This does not function in the dynamic brake operation and the free-run operation.)<br>* When the setting value is 0ms, after servo OFF, command is invalid (command 0) for approximately 4ms.<br>* Because the setting unit is valid in 4ms steps, the remainder, divided by 4, is cut off inside the amplifier.<br>* RF2 series servo amplifier does not have dynamic brake circuit. So, it will be Free Run Stop if dynamic brake operation is set.</td></tr>
</table>

0x2025: Delay Time of Releasing Holding Brake (Holding Brake Releasing Delay time)

<table>
<tr><td>Index Ax1 0x2025<br>Ax2 0x2225<br>Ax3 0x2425<br>Ax4 0x2625</td><td colspan="2">Sets holding-brake-release delay time from when power distribution to holding brake started till when holding torque disappeared.</td><td colspan="2">Object Code</td><td>Variable</td></tr>
<tr><td>Sub-Idx</td><td>Description</td><td>Data Type</td><td>Access</td><td>PDO</td><td>Initial value</td></tr>
<tr><td rowspan="4">0x00</td><td rowspan="3">Delay Time of Releasing Holding Brake [BOFFDLY]<br>* While shifting from servo OFF to servo ON, during the setting time, Excitation command 0 is given to servo motor.</td><td>Unsigned16</td><td>RW</td><td>No</td><td>0x01C2<br>(300ms)</td></tr>
<tr><td>Setting range</td><td colspan="3">0x0000-0x03E8<br>(0-1000ms)</td></tr>
<tr><td>Unit</td><td colspan="3">ms</td></tr>
<tr><td colspan="5">(Even when servo is turned ON, command is not accepted until the setting time is complete.)<br>* Therefore, until Holding brake is released, servo motor does not operate.<br>* When the setting value is 0ms, after servo ON, command is invalid (command 0) for approximately 4ms.<br>* Because the setting unit is valid in 4ms steps, the remainder, divided by 4, is cut off inside the amplifier.</td></tr>
</table>

0X2026: BRAKE OPERATION BEGINNING TIME

<table>
<tr><td>Index Ax1 0x2026<br>Ax2 0x2226<br>Ax3 0x2426<br>Ax4 0x2626</td><td colspan="2">Parameter to compulsorily set the time to operate the Dynamic brake and the Holding brake when motor does not stop at Servo OFF and EMR upon entry.</td><td colspan="2">Object Code</td><td>Variable</td></tr>
<tr><td>Sub-Idx</td><td>Description</td><td>Data Type</td><td>Access</td><td>PDO</td><td>Initial value</td></tr>
<tr><td rowspan="4">0x00</td><td rowspan="3">Brake Operation Beginning Time [BONBGN]<br>Sets permissible time from servo OFF until servo motor stop.<br>* At the time of Quick Stop operation, Emergency Stop (EMR), Servo brake stop alarm occurrence, if motor velocity does not reach less than 50min$^{-1}$, it signals the Dynamic</td><td>Unsigned16</td><td>RW</td><td>Possible</td><td>0x2710<br>(10sec)</td></tr>
<tr><td>Setting range</td><td colspan="3">0x0000-0xFFFF<br>(0-65535ms)</td></tr>
<tr><td>Unit</td><td colspan="3">ms</td></tr>
<tr><td colspan="5">brake operation and the Holding brake operation that are then output and motor excitation is discharged.<br>* This is the limit when, if the speed is not zero at the setting time after the transition from servo ON to servo OFF (ex. when the motor does not stop after servo OFF at the gravity axis etc.,) the Holding brake and the Dynamic brake operate and compulsorily brake.<br>* If the servo motor velocity reaches below 0x202F Brake Activation Speed within the set time, this function does not operate.<br>* When forced to stop by Holding brake, the Holding brake may possibly be broken. Be cautious about device specifications and sequence when using this function.<br>* RF2 series servo amplifier does not have dynamic brake circuit. So, it will be Free Run Stop during dynamic brake operation.</td></tr>
</table>

0x2027: Power Failure Detection Delay Time

<table>
<tr><td>Index Ax1 0x2027<br>Ax2 0x2227<br>Ax3 0x2427<br>Ax4 0x2627</td><td colspan="2">Sets the delay time from Control power OFF to Control power error detection.</td><td colspan="2">Object Code</td><td>Variable</td></tr>
<tr><td>Sub-Idx</td><td>Description</td><td>Data Type</td><td>Access</td><td>PDO</td><td>Initial value</td></tr>
<tr><td rowspan="4">0x00</td><td rowspan="3">Power Failure Detection Delay Time [PFDDLY]<br>* By making the setting value greater, delay in alarm detection time is possible. However, this does not guarantee the retention of Control power until the setting time.</td><td>Unsigned16</td><td>RW</td><td>No</td><td>0x0020<br>(32ms)</td></tr>
<tr><td>Setting range</td><td colspan="3">0x0014-0x03E8<br>(20-1000ms)</td></tr>
<tr><td>Unit</td><td colspan="3">ms</td></tr>
<tr><td colspan="5">* When power source of the control logic expires, it operates the same as when Control power is interrupted. When the Main circuit power reaches a lower point than Control power, other alarms may occur.<br>* In case of power failure of Internal logic circuit, operation is same as when Control power is turned ON again. In case of energy shortage of Main circuit power, other errors such as Main circuit power loss may be detected.<br>* In this setting, actual detection delay time varies by -12ms - +6ms.</td></tr>
</table>

0x2028: Excessive Deviation Warning Level

<table>
<tr><td>Index Ax1 0x2028<br>Ax2 0x2228<br>Ax3 0x2428<br>Ax4 0x2628</td><td colspan="3">Sets Warning output level before Excessive position deviation alarm is output.</td><td>Object Code</td><td>Variable</td></tr>
<tr><td>Sub-Idx</td><td>Description</td><td>Data Type</td><td>Access</td><td>PDO</td><td>Initial value</td></tr>
<tr><td rowspan="3">0x00</td><td rowspan="3">Excessive Deviation Warning Level [OFWLV]<br>When the actual deviation exceeds the setting value, within the range relatively regarded as warning against the position, Excessive Deviation Warning engages.<br><br>|Following Error Actual Value| >= Setting value</td><td>Unsigned32</td><td>RW</td><td>No</td><td>0x7FFFFFFF<br>(2147483647Pulse)</td></tr>
<tr><td>Setting range</td><td colspan="3">0x00000001～0x7FFFFFFF<br>(1-2147483647 Pulse)</td></tr>
<tr><td>Unit</td><td colspan="3">Pulse</td></tr>
</table>

Positioning completion range -> See Position Deviation Window (0x6065 of the function group “position”.)

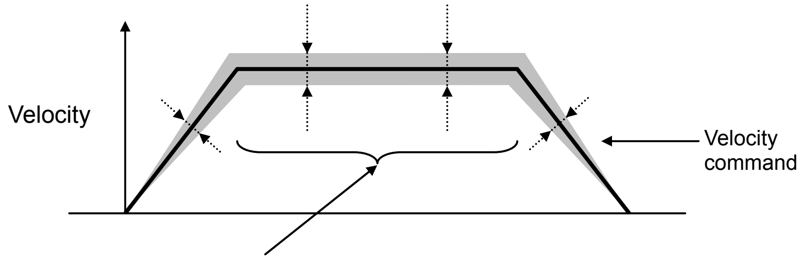
0x2029: Overload Warning Level

<table>
<tr><td>Index Ax1 0x2029<br>Ax2 0x2229<br>Ax3 0x2429<br>Ax4 0x2629</td><td colspan="2">Parameter to output Warning before detecting the Overload warning.</td><td colspan="2">Object Code</td><td>Variable</td></tr>
<tr><td>Sub-Idx</td><td>Description</td><td>Data Type</td><td>Access</td><td>PDO</td><td>Initial value</td></tr>
<tr><td rowspan="4">0x00</td><td rowspan="3">Overload Warning Level [OLWLV]<br>* the allowable setting Level range is as follows (the Overload warning level =100%;)<br><br><u>Setting value < 20% or 100% >= Setting value</u></td><td>Unsigned16</td><td>RW</td><td>No</td><td>0x005A<br>(90%)</td></tr>
<tr><td>Setting range</td><td colspan="3">0x0014-0x0064<br>(20-100 %)</td></tr>
<tr><td>Unit</td><td colspan="3">%</td></tr>
<tr><td colspan="5">When set to 100%, Overload warning and Overload alarm are output at one time.<br>* Overload detection is assumed and set as 75%, of a rated load when Control power is turned ON (hot start).<br>This is to prevent motor damage due to the estimation value reset by power re-closing and operation resumption immediately after the occurrence of Overload alarm when it is set at 0%.<br>Therefore, when Overload warning level is set at 75% or less, Overload warning may be output when Control power is turned ON.</td></tr>
</table>

0x202A: Speed Matching Width (Velocity matching range rate)

| | | | |
|---|---|---|---|
| Index Ax1 0x202A<br>Ax2 0x222A<br>Ax3 0x242A<br>Ax4 0x262A | Sets the ratio [%] of the range regarded as velocity matching against velocity commands. This value setting is used when “Speed Matching unit selection” is “0x01_Percent.” | Object Code | Variable |

| Sub-Idx | Description | Data Type | Access | PDO | Initial value |
|---|---|---|---|---|---|
| 0x00 | Speed Matching Width [VCMPR]<br>Velocity matching is output when the Velocity deviation (difference between the velocity command and actual velocity) is within this setting range.<br>\|Actual Velocity\| <= Setting value<br>then VCMP monitor is set. | Unsigned16 | RW | No | 0x0032<br>(5.0 %) |
| | | Setting range | 0x0000-0x03E8<br>(0-100%) | | |
| | | Unit | 0.1 % | | |



Output ETGDAT=1 during the setting width of the Velocity matching range.

*The Velocity matching output is switched by the setting of rotation speed (min$^{-1}$) and ratio (%) at Velocity matching unit output selection (0x20F0.4). At ratio selection, the condition under this setting value can be monitored with the status word 1(0x2100) bit 10: Velocity matching monitor.

0x202B: Torque (force) Command Filter Characteristic

| | | | |
|---|---|---|---|
| Index Ax1 0x202B<br>Ax2 0x222B<br>Ax3 0x242B<br>Ax4 0x262B | The filter order is set at Torque (force)command filter | Object Code | Variable |

| Sub-Idx | Description | Data Type | Access | PDO | Initial value |
|---|---|---|---|---|---|
| 0x00 | Torque (force) Command Filter Characteristic [TCFILOR]<br>If the cutoff frequency of the torque (force) order filter is switched with the gain switch, the order is fixed at this setting value. | Unsigned8 | RW | No | 0x02 |
| | | Setting range | 0x01-0x03 | | |
| | 0x01: primary Filter<br>0x02: secondary Filter<br>0x03: tertiary Filter<br>0x00, 0x04-0xFF: Reserved | | | | |

0x202C:Feed Forward Filter, Depth Selection (FF Vibration Suppressor Level Selection)

| | | | |
|---|---|---|---|
| Index Ax1 0x202C<br>Ax2 0x222C<br>Ax3 0x242C<br>Ax4 0x262C | Sets the characteristics of 0x2012 Feed Forward vibration suppressor frequency in operation. | Object Code | Variable |

| Sub-Idx | Description | Data Type | Access | PDO | Initial value |
|---|---|---|---|---|---|
| 0x00 | Feed Forward Filter, Depth Selection [SUPLV]<br>Parameter to set the magnitude of the vibration suppressor frequency effect. | Unsigned8 | RW | No | 0x00 |
| | | Setting range | 0x00-0x03 | | |
| | * Change while servo motor is OFF.<br>* The smaller the value, the greater the effect will be.<br>* FF vibration suppressor frequency switching function does not affect this.<br>0x00: -∞<br>0x01: -30dB<br>0x02: -20dB<br>0x03: -10dB<br>0x04-0xFF: Reserved | | | | |

0x202E: Torque (force) attainment setting

| | | | |
|---|---|---|---|
| Index Ax1 0x202E<br>Ax2 0x222E<br>Ax3 0x242E<br>Ax4 0x262E | Sets detection level of torque attainment monitor (a function to detect that commanded internal torque value exceeds set value). | Object Code | Variable |

| Sub-Idx | Description | Data Type | Access | PDO | Initial value |
|---|---|---|---|---|---|
| 0x00 | Torque (force) attainment setting [TA]<br>Sets the ratio of torque (force) attainment. | Unsigned16 | RW | No | 0x03E8<br>(100%) |
| | Data subjected to the ratio set by this paramenter vary depending on torque (force) attainment function selection (0x20F4.6). | Setting range | 0x0000 - 0x1388<br>(0.0 - 500.0%) | | |
| | Sets flag TA (bit11 of 0x2100) in the following case:<br>\|Torque (force) command\| >= Set value | Unit | 0.1 % | | |

✔ Torque (force) attainment output switches between maximum motor torque ratio and limited torque ratio depending on function selection of torque (force) attainment (0x20F0.6).

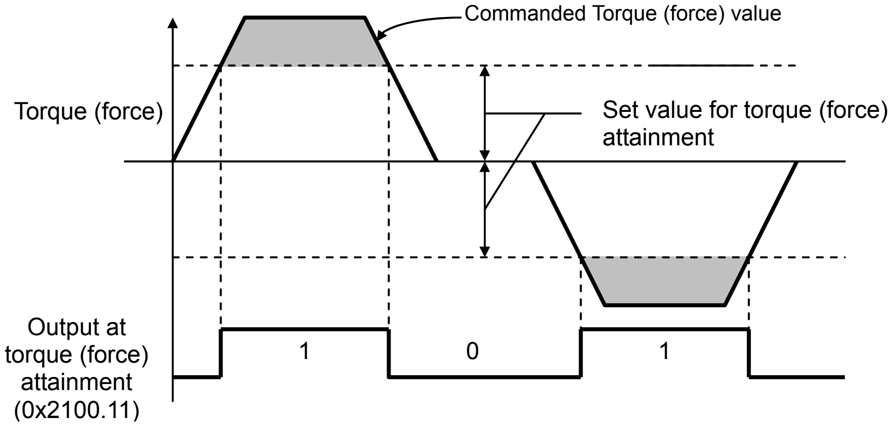
◆ Function selection of torque (force) attainment (0x20F0.6): In the case of 0x00

Sets the ratio of torque (force) attainment level by using the ratio to motor rated torque (force).

"100.0% = rated torque (force)"

Torque (force) attainment level is the same value in both forward and reverse direction.

Bit 11, output at torque (force) attainment OD:2100 is set to "1" when torque (force) command exceeds torque (force) attainment level.



◆ Function selection of torque (force) attainment (0x20F0.6): In the case of 0x01

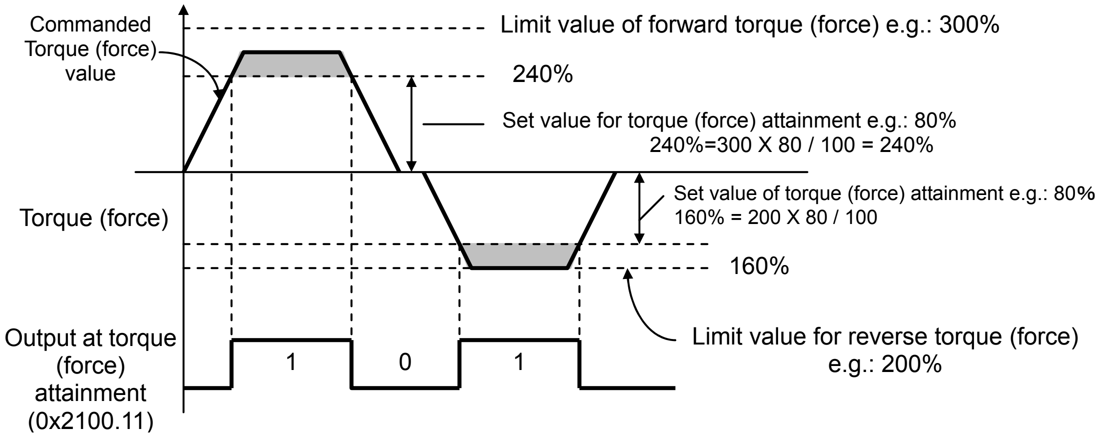
Sets the ratio of torque (force) attainment level by using the ratio to limited torque (force) value.

"100.0% = rated torque (force)"

Torque (force) attainment level is also independently calculated for both forward and reverse direction respectively in amplifier, as limited torque (force) value is independent in both directions respectively.

Forward torque (force) attainment level = Limited forward torque (force) value X set value /100.0 [%]

Reverse torque (force) attainment level = Limited reverse torque (force) value X set value /100.0 [%]



Detection shall be independently performed in both forward and reverse direction, and if the first one commanded torque (force) value in either direction exceeds torque (force) attainment level, Bit11, output at torque (force) attainment OD:2100, is set to "1."

0x202F: Brake activation speed

| | | | |
|---|---|---|---|
| Index Ax1 0x202F<br>Ax2 0x222F<br>Ax3 0x242F<br>Ax4 0x262F | Set the brake activation speed when decelerating motor.<br>It works while running servo-brake. | Object Code | Variable |

| Sub-Idx | Description | Data Type | Access | PDO | Initial value |
|---|---|---|---|---|---|
| 0x00 | Brake activation speed ［ZVDAT］<br>Motor brake works at lower rotation speed than set value with condition below.<br>Quick Stop, Alarm, Emergency Stop.<br><br>Motor stop will detect when relation below continued 1 msec or more.<br>Absolute value of actual speed ≦Set value<br><br>Holding brake signal will provide after detecting motor stop. | Unsigned16 | RW | Possible | 0x32<br>（50min$^{-1}$） |
| | | Setting range | 0x000A～0x01F4<br>（10～500min$^{-1}$） | | |
| | | Unit | min$^{-1}$ | | |
| | ✔ DDM（Direct Drive Motor）has different setting range conversion below.<br>0x000A～0x01F4 --> 1 to 50.0min$^{-1}$ (0.1min$^{-1}$／lsb) | | | | |

0x2030: Position Loop Integral Gain Limit

| | | | |
|---|---|---|---|
| Index Ax1 0x2030<br>Ax2 0x2230<br>Ax3 0x2430<br>Ax4 0x2630 | Set the limit of Position Loop Integral Gain | Object Code | Variable |

| Sub-Idx | Description | Data Type | Access | PDO | Initial value |
|---|---|---|---|---|---|
| 0x00 | Limit value of position integral time constant 1 (TPI1).<br><br>If setting value of position integral time constant is lower than this setting value.<br>Position integral time constant use this setting value. | Unsigned16 | RW | Possible | 0x2710 |
| | | Setting range | 0x0003～0x2710<br>(0.3～1000) | | |
| | | Unit | 0.1ms | | |

0x2031: Velocity Control Integral Gain Limit

| | | | |
|---|---|---|---|
| Index Ax1 0x2031<br>Ax2 0x2231<br>Ax3 0x2431<br>Ax4 0x2631 | Set the Velocity Control Integral Gain Limit. | Object Code | Variable |

| Sub-Idx | Description | Data Type | Access | PDO | Initial value |
|---|---|---|---|---|---|
| 0x00 | Limit value of velocity integral time constant 1 (TVI1).<br><br>If setting value of velocity integral time constant is lower than this setting value.<br>Velocity integral time constant use this setting value. | Unsigned16 | RW | Possible | 0x0003 |
| | | Setting range | 0x0003～0x2710<br>(0.3～1000) | | |
| | | Unit | 0.1ms | | |

0x2032: Torque (force) control proportional gain

| | | | |
|---|---|---|---|
| Index Ax1 0x2032<br>Ax2 0x2232<br>Ax3 0x2432<br>Ax4 0x2632 | Set the Torque (force) control proportional gain. | Object Code | Variable |

| Sub-Idx | Description | Data Type | Access | PDO | Initial value |
|---|---|---|---|---|---|
| 0x00 | Proportional gain of Torque (force) control mode.<br><br>Torque (force) control proportional gain is set from desired percentage of default torque gain.<br>Setting range is from 50 to 140%, and higher the set value increase the proportional gain. | Unsigned8 | RW | No | 0x64 |
| | | Setting range | 0x32～0x8C<br>（50 ～ 140） | | |
| | | Unit | % | | |

0x2034: Low Pass Filter OFF Velocity for Position loop / Velocity loop command.

| | | | |
|---|---|---|---|
| Index Ax1 0x2034<br>Ax2 0x2234<br>Ax3 0x2434<br>Ax4 0x2634 | Set the Low Pass Filter OFF Velocity. | Object Code | Array |

| Sub-Idx | Description | Data Type | Access | PDO | Initial value |
|---|---|---|---|---|---|
| 0x00 | Number of entry | Unsigned8 | RO | No | 0x02 |
| 0x01 | Switch ON / OFF of the object.<br>This object become active by setting 1 to Sub-Idx :0x01. | Unsigned8 | RW | Possible | 0x00 |
| | | Setting range | 0x00-0x01 | | |
| 0x02 | Low Pass Filter OFF Velocity<br>Disable low pass filter at less than this velocity.<br>Setting range is from 0 to 50 rpm. | Unsigned16 | RW | Possible | 0x0000 |
| | | Setting range | 0x0000-0x0032 | | |
| | | Unit | min$^{-1}$ | | |
| Disable low pass filter for Position/ Velocity command at less than the value set at Sub-Idx2.<br>Cutting off is performed with the value in 0x2004 or 0x2009, while position/velocity command low pass filter is effective. | | | | | |

0x2035: Assist-Function Parameter

| | | | | |
|---|---|---|---|---|
| Index Ax1<br>Ax2<br>Ax3<br>Ax4 | 0x2035<br>0x2235<br>0x2435<br>0x2635 | The parameter which sets for use of assist function between amplifier 1 to 4. | Object Code | Record |

| Sub-Idx | Description | Data Type | Access | PDO | Initial value |
|---|---|---|---|---|---|
| 0x00 | Number of entry | Unsigned8 | RO | No | 0x06 |
| 0x01 | Correction Proportional Gain [KSCP]<br>When the position-assist correction is enabled and the set value is 100%, add the same value as assist deviation value (error pulse volume) to the position command.<br>Correction will be invalid at the set value 0%.<br>✔If the value is too large, a vibration may oocur. | Unsigned8 | RW | No | 0x0064<br>(100%) |
| | | Setting Range | 0x0000～0x03E8<br>(0-1000%) | | |
| | | Unit | % | | |
| 0x02 | Correction Integral Time Constant [TSCI]<br>Sets integral time constant of position-assist controller.<br>When the set value is 1000.0ms, the proportional control (without integral compensation) is activated.<br>✔If the value is too small, a vibration may oocur.<br>✔When 2 sets of amplifiers are mutually corrected their synchronizations, set correction integral time constant at 1000ms (invalid). | Unsigned16 | RW | No | 0x2710<br>(1000ms)<br>Propotional Control |
| | | Setting Range | 0x0005-0x2710<br>(0.5-1000.0ms) | | |
| | | Unit | 0.1ms | | |
| 0x03 | Correction Low-pass Filter [PSYNLPF]<br>Sets time constant of the first low-pass filter which suppresses any sudden change in the correction command pulses.<br>Filter will be invalid at the set value 0.0 ms. | Unsigned16 | RW | No | 0x0000(0.0 ms)<br>Invalid Filter |
| | | Setting Range | 0x0000-0x2710<br>(0.0-1000.0 ms) | | |
| | | Unit | 0.1 ms | | |
| 0x04 | Excessive Position-assist Deviation Level [PSDEVAL]<br>Sets acceptable error range for error pulse quntity (synchronization deviation) of 2 amplifiers.<br>When the actual synchronization position deviation exceeds the set value, a position synchronization deviation alarm is issued.<br>Setup Value ≦ ｜Synchronization Error Pulse Quntity｜ | Unsigned32 | RW | No | 0x7FFFFFFF(2147483647) |
| | | Setting Range | 0x00000001-0x7FFFFFFF<br>(1-2147483647 Pulse) | | |
| | | Unit | Pulse | | |
| 0x05 | Position-assist Deviation Warning Level [PSDEVWN]<br>Sets Warning output level before Excessive position-assist deviation alarm is issued.<br>When the actual synchronization position deviation exceeds the set value,<br>position synchronization deviation warning is issued.<br>Setup Value ≦ ｜Synchronization Error Pulse Quntity｜ | Unsigned32 | RW | No | 0x7FFFFFFF<br>(2147483647) |
| | | Setting Range | 0x00000001-0x7FFFFFFF<br>(1-2147483647 Pulse) | | |
| | | Unit | Pulse | | |
| 0x06 | Position Deviation Polarity Slection [SDEVPOR]<br>Selects polarity of position deviation signal which is sent to another amplifier for position-assist.<br>✔Regarding command polarity and motor installation angle, set position deviation polarity selection in order to have the same output deviation polarity.<br>✍**It will be valid with control-power-source re-input.** | Unsigned8 | RW | No | 0x00 |
| | | Setting Range | 0x00-0x01<br>0:Without Position Deviation Polarity Reversal<br>1:With Position Deviation Polarity Reversal | | |
| 0x07 | Assist-target axis address ［MSTERID］<br>Set the address of target axis if sync compensation function is used.<br>✍**It will be valid with control-power-source re-input.** | Unsigned16 | RW | No | 0x0001 |
| | | Setting Range | 0x0001-0x0004 | | |
| 0x08 | Assist-function selection ［ASSEL］<br>0x00: Without sync.<br>0x01: Mutual assisting correction mode, Master mode (Position-assist function : Position control)<br>0x02: Mutual assisting correction mode, Slave mode (Position-assist function : Position control)<br>0x03: Master amplifier mode (Position-assist function, Master : Position control)<br>0x04: Slave amplifier mode (Position-assist function, Slave : Position control)<br>0x05: Master amplifier mode (Torque-assist function : Position control, Velocity control)<br>0x06: Slave amplifier mode (Torque-assist function : Torque control)<br>✍**It will be valid with control-power-source re-input.** | Unsigned8 | RW | No | 0x00 |
| | | Setting Range | 0x00-0x06 | | |
| | | Unit | – | | |
| 0x09 | Torque assisting rate ［TSCP］<br>When the torque-assist function is enabled and the set value is 100%, add the same value of torque command. Torque-assist will be invalid at the set value 0%. | Unsigned16 | RW | Possible | 0x0064<br>(100%) |
| | | Setting Range | 0x0000-0x0064 (0-100%) | | |
| | | Unit | % | | |

0x2036: Position Differential Gain

| | | | |
|---|---|---|---|
| Index Ax1 0x2036<br>Ax2 0x2236<br>Ax3 0x2436<br>Ax4 0x2636 | Sets the differential time constant of the position controller. | Object Code | Variable |

| Sub-Idx | Description | Data Type | Access | PDO | Initial value |
|---|---|---|---|---|---|
| 0x00 | Number of entry | Unsigned8 | RO | No | 0x02 |
| 0x01 | Position Controller Differential Time Constant<br>The position control characteristic is improved by multiplying the difference of the position differential by the gain equivalent to the derivation time constant.<br>This function will be disabled during auto-tuning. | Unsigned16 | RW | Possible | 0x0000<br>（0） |
| | | Setting Range | 0x0000 to 0x2710<br>（0.0 to 1000.0） | | |
| | | Unit | 0.1ms | | |
| 0x02 | Position Controller Derivative Compensation LPF<br>LPF to be applied to the command value after setting the position differential time constant.<br>Improves the position differential command value.<br>This function will be disabled during auto-tuning. | Unsigned16 | RW | Possible | 0x0FA0<br>（4000） |
| | | Setting Range | 0x0001 to 0x0FA0<br>(1 to 4000) | | |
| | | Unit | Hz | | |

0x2037: Position Integral Time Constant Limit

| | | | |
|---|---|---|---|
| Index Ax1 0x2037<br>Ax2 0x2237<br>Ax3 0x2437<br>Ax4 0x2637 | Sets the velocity to limit the integral output of the position controller. | Object Code | Variable |

| Sub-Idx | Description | Data Type | Access | PDO | Initial value |
|---|---|---|---|---|---|
| 0x00 | Output limit of the position controller<br>Disables the integral time constant of the position controller.<br>When the motor velocity exceeds the setting value, it disables the position integral time constant.<br>This function will be disabled during auto-tuning. | Unsigned32 | RW | Possible | 0x3FFFFFFF<br>（1073741823） |
| | | Setting range | 0x00000000 to 0x7FFFFFFF<br>(0 to 2147483647) | | |
| | | Unit | pulse | | |

0x2038: Velocity Control Bypass Setting

| | | | |
|---|---|---|---|
| Index Ax1 0x2038<br>Ax2 0x2238<br>Ax3 0x2438<br>Ax4 0x2638 | Bypasses the velocity controller during position control. | Object Code | Variable |

| Sub-Idx | Description | Data Type | Access | PDO | Initial value |
|---|---|---|---|---|---|
| 0x00 | Bypass of Velocity Controller<br>Transmits the command from the position controller to the torque (force) control without the velocity controller. | Unsigned8 | RW | Possible | 0x00 |
| | | Setting range | 0x00-0x01 | | |
| | The setting value 0 disables the function. The setting value 1 enables the function. | | | | |

0x2039: Velocity Integral Time Constant Limit

| | | | |
|---|---|---|---|
| Index Ax1 0x2039<br>Ax2 0x2239<br>Ax3 0x2439<br>Ax4 0x2639 | Sets the torque (force) to limit the integral output of the velocity controller. | Object Code | Variable |

| Sub-Idx | Description | Data Type | Access | PDO | Initial value |
|---|---|---|---|---|---|
| 0x00 | Output limit of the velocity controller<br>Disables the integral time constant of the velocity controller.<br>When the motor torque (force) exceeds the setting value or more, it disables the position integral time constant.<br>This function will be disabled during auto-tuning. | Unsigned16 | RW | Possible | 0xFFFF<br>（65535） |
| | | Setting range | 0x0000～0xFFFF<br>（0 ～ 65535） | | |
| | | Unit | min-1 | | |

0x203A: Torque (force) Integral Gain

| | | | |
|---|---|---|---|
| Index Ax1 0x203A<br>Ax2 0x223A<br>Ax3 0x243A<br>Ax4 0x263A | Sets the integral gain of the torque (force) controller. | Object Code | Variable |

| Sub-Idx | Description | Data Type | Access | PDO | Initial value |
|---|---|---|---|---|---|
| 0x00 | Torque (force) Control Integral Gain<br>Sets the integral gain of the torque (force) control by using the ratio.<br>Against the integral gain output by each motors is 100%, it can be adjusted within the range of 50% - 200%.<br>This function will be disabled during auto-tuning. | Unsigned8 | RW | Possible | 0x64 |
| | | Setting range | 0x32～0xC8<br>（50 ～ 200） | | |
| | | Unit | % | | |

### 0x203B: Torque (force) Integral Gain limit

| | | | |
|---|---|---|---|
| Index Ax1 0x203B<br>Ax2 0x223B<br>Ax3 0x243B<br>Ax4 0x263B | Sets the limit value of the integral gain of the torque (force) controller. | Object Code | Variable |

| Sub-Idx | Description | Data Type | Access | PDO | Initial value |
|---|---|---|---|---|---|
| 0x00 | Torque (force) Control Integral Gain Limit<br>Limits the setting of gain within the range of 50% - 200% against the value of the object 0x203A.<br>Cuts the large value of the setting by the limit value. | Unsigned8 | RW | Possible | 0xC8<br>（200） |
| | | Setting range | 0x32～0xC8<br>（50 ～ 200） | | |
| | | Unit | % | | |

### 0x203C: Software limit Deceleration

| | | | |
|---|---|---|---|
| Index Ax1 0x203C<br>Ax2 0x223C<br>Ax3 0x243C<br>Ax4 0x263C | Sets the deceleration in the case that it reaches the software limit switch in CSP, IP mode. | Object Code | Variable |

| Sub-Idx | Description | Data Type | Access | PDO | Initial value |
|---|---|---|---|---|---|
| 0x00 | Software Limit Deceleration ［SLTDEC］<br>When it reaches the software position limit of 0x607D, the motor will perform a deceleration stop.<br>This parameter sets the deceleration. | Unsigned32 | RW | No | 0xFFFFFFFF |
| | | Setting range | 0x00000000～0xFFFFFFFF | | |

### 0x203D: Amplifier temperature warning level

| | |
|---|---|
| Index Ax1 0x203D<br>Ax2 0x223D<br>Ax3 0x243D<br>Ax4 0x263D | Sets the warning output level which is issuing before the amplifier temperature error. |

| Sub-Idx | Description | Data Type | Access | PDO | Initial value |
|---|---|---|---|---|---|
| 0x01 | Amplifier temperature warning high level setting [DEGWHL]<br>Sets high level of the amplifier temperature warning detection. | Signed16 | RW | No | 0x4B（75℃） |
| | | Display range | 0x038 to 0x005F (56 to 95℃） | | |
| | | Unit | ℃ | | |
| | When this set value is more than the object 0x2109 "Temperature inside the servo amplifier", sets Bit0 (tpw)=1 "Temperature warning bit" to the object 0x2103. And, when Bit0=1 is set to the object 0x2103-02 "Warning mask selection", also Bit7 "Warning status" of the object 0x6041 "Status word" is set.<br>0x203D-01 "Amplifier temperature warning high level setting" ≦ 0x2109 "Temperature inside the servo amplifier"<br>✔Temperature warning will be set even if internal temperature value is less than this set value, when condition of 0x203D-02 is satisfied.<br>✔When this parameter sets to 95℃, amplifier temperature warning will issue at same timing of amplifier temperature error. | | | | |
| 0x02 | Amplifier temperature warning low level setting [DEGWLL]<br>Sets low level of the amplifier temperature warning detection. | Signed16 | RW | No | 0xFFF6（-10℃） |
| | | Display range | 0xFFFF to 0xFFF1（-1 to -15℃） | | |
| | | Unit | ℃ | | |
| | When this set value is less than the object 0x2109 "Temperature inside the servo amplifier", sets Bit0 (tpw)=1 "Temperature warning bit" to the object 0x2103. And, when Bit0=1 is set to the object 0x2103-02 "Warning mask selection", also Bit7 "Warning status" of the object 0x6041 "Status word" is set.<br>0x203D-01 "Amplifier temperature warning low level setting" ≧ 0x2109 "Temperature inside the servo amplifier"<br>✔Temperature warning will be set even if internal temperature value is more than this set value, when condition of 0x203D-01 is satisfied.<br>✔When this parameter sets to -15℃, amplifier temperature warning will issue at same timing of amplifier temperature error. | | | | |

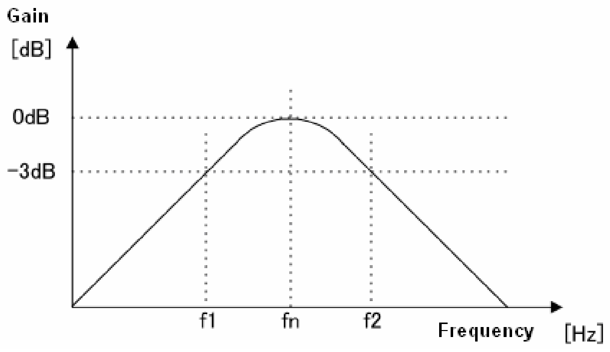
0x2040 Command Filter Setting

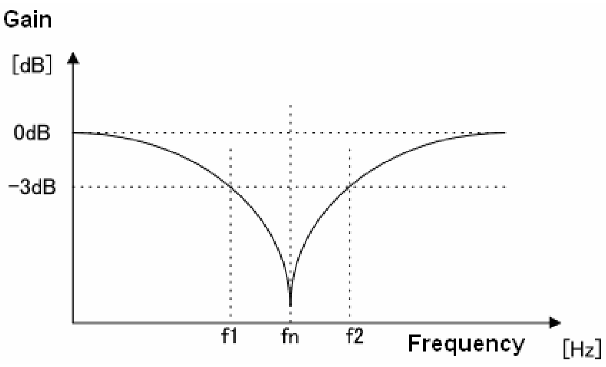
| Index | Description | Object Code | Variable |
|---|---|---|---|
| Index Ax1 0x2040<br>Ax2 0x2240<br>Ax3 0x2440<br>Ax4 0x2640 | Sets Velocity Command Filter and Torque（force）Command Filter1～4 functions. | Object Code | Variable |

| Sub-Idx | Description | Data Type | Access | PDO | Initial value |
|---|---|---|---|---|---|
| 0x00 | Number of entry | Unsigned8 | RO | No | 0x02 |
| 0x01 | Sets Velocity Command Filter<br>Sets Velocity Command Filter object 0x2041 valid or invalid.<br>When valid filter work by 0x2041setting. | Unsigned8 | RW | Possible | 0x00 |
| | | Setting range | 0x00～0x01 | | |
| | 0：Velocity Command Filter disabled<br>1：Velocity Command Filter enabled | | | | |
| 0x02 | Torque（force）Command Filter<br>Sets Torque（force）Command Filter object 0x2042～0x2045 valid or invalid.<br>When valid filter work by 0x2041～0x2045setting. | Unsigned8 | RW | Possible | 0x01 |
| | | Setting range | 0x00～0x01 | | |
| | 0：Torque（force）Command Filter1～4 disabled<br>1：Torque（force）Command Filter1～4 enabled | | | | |

0x2041： Velocity Command Filter Setting, 0x2042-0x2045： Torque（force）Command Filter1 – 4 Setting

| Index | Description | Object Code | Array |
|---|---|---|---|
| Index Ax1 0x2040-0x2045<br>Ax2 0x2240-0x2245<br>Ax3 0x2440-0x2445<br>Ax4 0x2640-0x2645 | Sets Velocity Command Filter［VCNFIL］, Torque（force）Command Filter. | Object Code | Array |

| Sub-Idx | Description | Data Type | Access | PDO | Initial value |
|---|---|---|---|---|---|
| 0x00 | Number of entry | Unsigned8 | RO | No | 0x10 |
| 0x01 | Filter ON/OFF<br>Sets filter ON or OFF.<br>The initial value of 0x2045 is effective. | Integer8 | RW | Possible | 0x00（0x01） |
| | | Setting range | 0x00-0x01 | | |
| 0x02 | FilterType<br>Sets type of filter<br>The initial value of 0x2045 is 0x01:Low Pass Filter. | Integer8 | RW | Possible | 0x04（0x01） |
| | | Setting range | 0x01-0x05 | | |
| | 0x01：Low Pass Filter<br>0x02：High Pass Filter<br>0x03：Band Pass Filter<br>0x04：Notch Filter<br>0x05：Bi-quad Filter<br>0x06-0xFF：Reserved | | | | |
| 0x03 | Low Pass Filter cutoff frequency<br>When filter type（Sub-Idx2） stes Low Pass Filter（0x01）,<br>Low Pass Filter work by this cutoff frequency.<br>✔When sets over 2000Hz（0x07D0） then setting become disable. | Unsigned16 | RW | Possible | 0x0258<br>（600Hz） |
| | | Setting range | 0x000A-0x07D0<br>（10-2000Hz） | | |
| 0x04 | High Pass Filter cutoff frequency<br>When filter type（Sub-Idx2） sets High Pass Filter（0x02）,<br>High Pass Filter work by this cutoff frequency.<br>✔When sets over 2000Hz（0x07D0） then setting become disable. | Unsigned16 | RW | Possible | 0x07D0<br>（invalid） |
| | | Setting range | 0x000A-0x07D0<br>（10-2000Hz） | | |
| 0x05 | Center frequency of Band Pass Filter<br>When filter type（Sub-Idx2） sets Band Pass Filter（0x03）,<br>Band Pass Filter work by this center frequency.<br>When sets over 2000Hz（0x07D0） then setting become disable. | Unsigned16 | RW | Possible | 0x07D0<br>（2000Hz） |
| | | Setting range | 0x000A-0x07D0<br>（10-2000Hz） | | |
| 0x06 | Band width of Band Pass Filter<br>When filter type（Sub-Idx2） sets Band Pass Filter（0x03）,<br>Band Pass Filter work by this band width.<br>Setting value small become band width narrow.<br> | Unsigned16 | RW | Possible | 0x0005 |
| | | Setting Range | 0x0001～0x01F4 （0.1-50） | | |
| | | Setting Value | f1 | f2 | |
| | | 0.1 | fn × 0.91 | fn × 1.10 | |
| | | 0.2 | fn × 0.82 | fn × 1.22 | |
| | | 0.3 | fn × 0.75 | fn × 1.34 | |
| | | 0.4 | fn × 0.68 | fn × 1.47 | |
| | | 0.5 | fn × 0.62 | fn × 1.61 | |
| | | 0.6 | fn × 0.57 | fn × 1.75 | |
| | | 0.7 | fn × 0.52 | fn × 1.91 | |
| | | 0.8 | fn × 0.48 | fn × 2.07 | |
| | | 0.9 | fn × 0.45 | fn × 2.23 | |
| | | 1.0 | fn × 0.42 | fn × 2.39 | |
| | | Example of setting value vs band width.<br>Magnification from center frequency(fn) | | | |

| | | | | | |
|---|---|---|---|---|---|
| 0x07 | Center frequency of Notch Filter<br>When filter type（Sub-Idx2）sets Notch Filter（0x04）, Notch Filter work by this center frequency..<br>✔When sets over 2000Hz(0x07D0), then setting become invalid. | Unsigned16 | RW | Possible | 0x07D0<br>（2000Hz） |
| | | Setting range | 0x000A-0x07D0<br>（10-2000Hz） | | |
| 0x08 | Band width of Notch Filter<br>When filter type（Sub-Idx2）sets Notch Filter（0x04）, Notch Filter work by this Band width.<br>Setting value small become band width narrow.<br> | Unsigned16 | RW | Possible | 0x0010 |
| | | Setting range | 0x0001-0x01F4 （0.1-50）<br>0.1 / LSB | | |
| | | Setting value | f1 | f2 | |
| | | 0.1 | fn × 0.95 | fn × 1.05 | |
| | | 0.2 | fn × 0.90 | fn × 1.11 | |
| | | 0.4 | fn × 0.82 | fn × 1.22 | |
| | | 0.6 | fn × 0.74 | fn × 1.35 | |
| | | 0.8 | fn × 0.67 | fn × 1.49 | |
| | | 1.0 | fn × 0.62 | fn × 1.63 | |
| | | 1.2 | fn × 0.57 | fn × 1.77 | |
| | | 1.4 | fn × 0.52 | fn × 1.94 | |
| | | 1.6 | fn × 0.48 | fn × 2.08 | |
| | | 1.8 | fn × 0.44 | fn × 2.25 | |
| | | 2.0 | fn × 0.41 | fn × 2.42 | |
| | | 5.0 | fn ×0.19 | fn × 5.18 | |
| | | 10.0 | fn × 0.098 | fn × 9.66 | |
| | | 20.0 | fn × 0.050 | fn × 17.1 | |
| | | 30.0 | fn × 0.033 | fn × 22.2 | |
| | | 40.0 | fn × 0.025 | fn × 25.6 | |
| | | 50.0 | fn × 0.020 | fn × 28.1 | |
| | | Example of setting value vs band width.<br>Magnification from center frequency(fn) | | | |
| 0x09 | Bi-quad Filter a1<br>When filter type（Sub-Idx2）sets Bi-quad Filter（0x05）, Bi-quad Filter work by this a1. | Float32 | RW | Possible | 0.0 |
| | | Setting range | -3.402823e38 to 3.402823e38 | | |
| 0x0A | Bi-quad Filter a2<br>When filter type（Sub-Idx2）sets Bi-quad Filter（0x05）, Bi-quad Filter work by this a2. | Float32 | RW | Possible | 0.187561 |
| | | Setting range | -3.402823e38 to 3.402823e38 | | |
| 0x0B | Bi-quad Filter b0<br>When filter type（Sub-Idx2）sets Bi-quad Filter（0x05）, Bi-quad Filter work by this b0. | Float32 | RW | Possible | 0.296890 |
| | | Setting range | -3.402823e38 to 3.402823e38 | | |
| 0x0C | Bi-quad Filter b1<br>When filter type（Sub-Idx2）sets Bi-quad Filter（0x05）, Bi-quad Filter work by this b1. | Float32 | RW | Possible | 0.593780 |
| | | Setting range | -3.402823e38 to 3.402823e38 | | |
| 0x0D | Bi-quad Filter b2<br>When filter type（Sub-Idx2）sets Bi-quad Filter（0x05）, Bi-quad Filter work by this b2. | Float32 | RW | Possible | 0.296890 |
| | | Setting range | -3.402823e38 to 3.402823e38 | | |

0x2050 Stick Motion compensation

<table>
<tr><td>Index Ax1 0x2050<br>Ax2 0x2250<br>Ax3 0x2450<br>Ax4 0x2650</td><td colspan="2">Setting of Stick Motion compensation</td><td colspan="2">Object Code</td><td>Variable</td></tr>
<tr><td>Sub-Idx</td><td>Description</td><td>Data Type</td><td>Access</td><td>PDO</td><td>Initial Value</td></tr>
<tr><td>0x00</td><td>Number of entry</td><td>Unsigned8</td><td>RO</td><td>No</td><td>0x04</td></tr>
<tr><td rowspan="3">0x01</td><td rowspan="2">Set the validity of Stick Motion compensation [STC]</td><td>Unsigned8</td><td>RW</td><td>Possible</td><td>0x00</td></tr>
<tr><td>Setting range</td><td colspan="3">0x00-0x27</td></tr>
<tr><td colspan="5">◆ Setting validity condition of Stick Motion compensation<br>Stick Motion compensation is enable when STC is enable.<br>◆ Setting range of Stick Motion compensation will follow 0x00～0x27.</td></tr>
<tr><td rowspan="4">0x02</td><td rowspan="3">Valid speed of Stick Motion compensation [STV]</td><td>Unsigned16</td><td>RW</td><td>Possible</td><td>10.0</td></tr>
<tr><td>Setting range</td><td colspan="3">0.1-128.0</td></tr>
<tr><td>Unit</td><td colspan="3">min$^{-1}$</td></tr>
<tr><td colspan="5">◆Stick Motion compensation will work when setting value is less than internal velocity command.</td></tr>
<tr><td rowspan="4">0x03</td><td rowspan="3">Valid time of Stick Motion compensation [STHLD]</td><td>Unsigned16</td><td>RW</td><td>Possible</td><td>20</td></tr>
<tr><td>Setting range</td><td colspan="3">1-500</td></tr>
<tr><td>Unit</td><td colspan="3">ms</td></tr>
<tr><td colspan="5">◆Stick Motion compensation will work until this setting time, even if internal velocity command is over speed.<br>◆If velocity loop response is low , set the this time longer.</td></tr>
<tr><td rowspan="4">0x04</td><td rowspan="3">Set the integral constant of Stick Motion compensation [STTVI]</td><td>Unsigned16</td><td>RW</td><td>Possible</td><td>0.3</td></tr>
<tr><td>Setting range</td><td colspan="3">0.3-1000.0</td></tr>
<tr><td>Unit</td><td colspan="3">ms</td></tr>
<tr><td colspan="5">◆Vaild velocity loop integral constant when Stick Motion compensation is activating.<br>◆Velocity loop integral constant of Stick Motion compensation should set lower than normal setting.<br>If set higher than normal value, efficiency will low.<br>◆Stick Motion compensation will disable when velocity loop is proportional control.</td></tr>
</table>

0x2051： Micro Vibration Suppression

<table>
<tr><td>Index Ax1 0x2051<br>Ax2 0x2251<br>Ax3 0x2451<br>Ax4 0x2651</td><td colspan="2">Suppress mechanical micro vibration by moving encoder pulse when motor stop.</td><td colspan="2">Object Code</td><td>Variable</td></tr>
<tr><td>Sub-Idx</td><td>Description</td><td>Data Type</td><td>Access</td><td>PDO</td><td>Initial value</td></tr>
<tr><td rowspan="3">0x00</td><td rowspan="2">Set the validity of Micro Vibration Suppression ［FBHYST］</td><td>Unsigned8</td><td>RW</td><td>No</td><td>0x00</td></tr>
<tr><td>Setting range</td><td colspan="3">0x00-0x27</td></tr>
<tr><td colspan="5">◆ Suppress mechanical micro vibration when motor stop and encoder pulse moving ±1pulse<br>◆ Micro Vibration Suppression will valid when FBHYST is valid.<br>◆ Setting range of Micro Vibration Suppression will follow 0x00 to 0x27.</td></tr>
</table>

0x5080: Correction Table Control

<table>
<tr><td>Index Ax1<br>Ax2<br>Ax3<br>Ax4</td><td>0x5080<br>0x5280<br>0x5480<br>0x5680</td><td>Enables/disables the correction table function.</td><td>Object Code</td><td>Variable</td></tr>
</table>

<table>
<tr><th>Sub-Idx</th><th>Description</th><th>Data Type</th><th>Access</th><th>PDO</th><th>Initial value</th></tr>
<tr><td rowspan="2">0x00</td><td rowspan="2">Correction Table Control ［COTBLEN］<br>Enables/disables the correction table function.<br>0x00: Disabled<br>0x01: Enabled<br>0x02 - 0xFF: Reserved</td><td>Unsigned8</td><td>RW</td><td>No</td><td>0x00</td></tr>
<tr><td>Setting range</td><td colspan="3">0x00-0x01</td></tr>
</table>

0x5081: Correction Table Interpolation Method

<table>
<tr><td>Index Ax1<br>Ax2<br>Ax3<br>Ax4</td><td>0x5081<br>0x5281<br>0x5481<br>0x5681</td><td>Sets the interpolation method of the correction table.</td><td>Object Code</td><td>Variable</td></tr>
</table>

<table>
<tr><th>Sub-Idx</th><th>Description</th><th>Data Type</th><th>Access</th><th>PDO</th><th>Initial value</th></tr>
<tr><td rowspan="2">0x00</td><td rowspan="2">Correction Table Interpolation Method ［COTBLINTP］<br>Sets the interpolation method of the correction table.<br>0x00: Linear<br>0x01: Polynomial<br>0x02: Spline<br>0x03 - 0xFF: Reserved</td><td>Unsigned8</td><td>RW</td><td>No</td><td>0x00</td></tr>
<tr><td>Setting range</td><td colspan="3">0x00-0x02</td></tr>
</table>

0x5082: Correction Table Extrapolation Method

<table>
<tr><td>Index Ax1<br>Ax2<br>Ax3<br>Ax4</td><td>0x5082<br>0x5282<br>0x5482<br>0x5682</td><td>Sets the extrapolation method of the correction table.</td><td>Object Code</td><td>Variable</td></tr>
</table>

<table>
<tr><th>Sub-Idx</th><th>Description</th><th>Data Type</th><th>Access</th><th>PDO</th><th>Initial value</th></tr>
<tr><td rowspan="2">0x00</td><td rowspan="2">Correction Table Extrapolation Method ［COTBLEXTP］<br>Sets the extrapolation method of the correction table.<br>0x00: Linear<br>0x01: Polynomial<br>0x02: Spline<br>0x03 - 0xFF: Reserved</td><td>Unsigned8</td><td>RW</td><td>No</td><td>0x00</td></tr>
<tr><td>Setting range</td><td colspan="3">0x00-0x02</td></tr>
</table>

0x5083: Correction Table Position

<table>
<tr><td>Index Ax1<br>Ax2<br>Ax3<br>Ax4</td><td>0x5083<br>0x5283<br>0x5483<br>0x5683</td><td>Correction Table Position</td><td>Object Code</td><td>Record</td></tr>
</table>

<table>
<tr><th>Sub-Idx</th><th>Description</th><th>Data Type</th><th>Access</th><th>PDO</th><th>Initial value</th></tr>
<tr><td rowspan="2">0x00</td><td rowspan="2">Number of entry<br>✔This becomes valid by re-closing the control source.</td><td>Unsigned8</td><td>RW</td><td>No</td><td>0x00</td></tr>
<tr><td>Setting range</td><td colspan="3">0x00-0x40</td></tr>
<tr><td rowspan="4">0x01</td><td rowspan="3">Entry 1<br>Correction Position 1</td><td>Unsigned32</td><td>RW</td><td>No</td><td>0x00000000</td></tr>
<tr><td>Setting range</td><td colspan="3">0x00000000-0xFFFFFFFF</td></tr>
<tr><td>Unit</td><td colspan="3">Pulse</td></tr>
<tr><td colspan="5">✔ If correction posotion over the coordinate axes（-1⇔0）, 0x5083 correction position 1 and 0x5084 No1 offset value need to set 0.<br>Caution, if not 0, the machine may oscillate at the correction posotion over the coordinate axes.<br>✔This becomes valid by re-closing the control source.</td></tr>
<tr><td rowspan="4">0x02<br>~<br>n</td><td rowspan="3">Entry 2 to n<br>Correction Position 2 to n<br>-</td><td>Unsigned32</td><td>RW</td><td>No</td><td>0x00000000</td></tr>
<tr><td>Setting range</td><td colspan="3">0x00000000-0xFFFFFFFF</td></tr>
<tr><td>Unit</td><td colspan="3">Pulse</td></tr>
<tr><td colspan="5">✔"n" is up to 0x40 in maximum.<br>✔Please set so as to ensure that the correction position n-1 < the correction position n. (n=2-64)<br>If not correction position n-1< correction position n at the power on and initial state then it indicates warning of 0x2013,Bit9. Correction position need to correction and then re-turn on control power.<br>✔ If correction posotion over the coordinate axes（0x7FFFFFFF⇔0x80000000）, 0x5083 correction position n=0x7FFFFFFF and 0x5084 Number n offset value need to set 0.<br>Caution, if not 0, the machine may oscillate at the correction posotion over the coordinate axes.<br>✔This becomes valid by re-closing the control source.</td></tr>
<tr><td colspan="6">✔ When the symbol of the actual position (0x6064) is negative, it refers to the table after translating the actual position to the absolute value. After reversing the plus and minus signs of the offset retrieved from the table, use for control.</td></tr>
</table>

0x5084: Correction Table Offset

<table>
<tr><td>Index Ax1 0x5084<br>Ax2 0x5284<br>Ax3 0x5484<br>Ax4 0x5684</td><td colspan="2">Correction Table Offset</td><td colspan="2">Object Code</td><td>Record</td></tr>
<tr><td>Sub-Idx</td><td>Description</td><td>Data Type</td><td>Access</td><td>PDO</td><td>Initial value</td></tr>
<tr><td rowspan="2">0x00</td><td rowspan="2">Number of entry<br>✔This becomes valid by re-closing the control source.</td><td>Unsigned8</td><td>RW</td><td>No</td><td>0x00</td></tr>
<tr><td>Setting range</td><td colspan="3">0x00~0x40</td></tr>
<tr><td rowspan="4">0x01</td><td rowspan="3">Entry 1<br>Offset 1</td><td>Integer32</td><td>RW</td><td>No</td><td>0x00000000</td></tr>
<tr><td>Setting range</td><td colspan="3">0x80000000-0x7FFFFFFF</td></tr>
<tr><td>Unit</td><td colspan="3">Pulse</td></tr>
<tr><td colspan="5">✔ If correction posotion over the coordinate axes（-1⇔0）, 0x5083 correction position 1 and 0x5084 No1 offset value need to set 0.<br>Caution, if not 0, the machine may oscillate at the correction posotion over the coordinate axes.</td></tr>
<tr><td rowspan="4">0x02<br>~<br>n</td><td rowspan="3">Entry 2 - Entry n<br>Offset 2 - Offset n</td><td>Integer32</td><td>RW</td><td>No</td><td>0x00000000</td></tr>
<tr><td>Setting range</td><td colspan="3">0x80000000-0x7FFFFFFF</td></tr>
<tr><td>Unit</td><td colspan="3">Pulse</td></tr>
<tr><td colspan="5">✔"n" is up to 0x40 in maximum.<br>✔ If correction posotion over the coordinate axes（0x7FFFFFFF⇔0x80000000）, 0x5083 correction position n=0x7FFFFFFF and 0x5084 Number n offset value need to set 0.<br>Caution, if not 0, the machine may oscillate at the correction posotion over the coordinate axes.</td></tr>
</table>

0x5090: Backlash correction function selection

<table>
<tr><td>Index Ax1 0x5090<br>Ax2 0x5290<br>Ax3 0x5490<br>Ax4 0x5690</td><td colspan="2">Set the Backlash correction function on / off.</td><td colspan="2">Object Code</td><td>Variable</td></tr>
<tr><td>Sub-Idx</td><td>Description</td><td>Data Type</td><td>Access</td><td>PDO</td><td>Initial value</td></tr>
<tr><td rowspan="2">0x00</td><td rowspan="2">Backlash correction function [BLCEN]<br>Set the Backlash correction function on / off.<br>0x00: Disabled<br>0x01: Enabled<br>0x02 - 0xFF: Reserved</td><td>Unsigned8</td><td>RW</td><td>No</td><td>0x00</td></tr>
<tr><td>Setting range</td><td colspan="3">0x00-0x01</td></tr>
</table>

0x5091: Backlash correction value

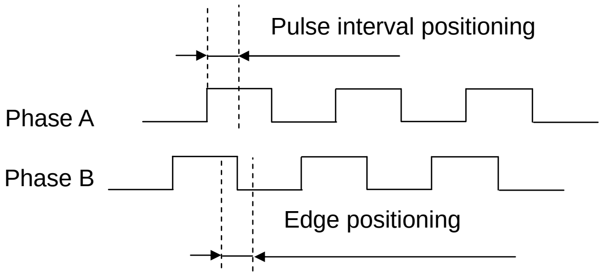
<table>
<tr><td>Index Ax1 0x5091<br>Ax2 0x5291<br>Ax3 0x5491<br>Ax4 0x5691</td><td colspan="2">Set the backlash correction value.</td><td colspan="2">Object Code</td><td>Variable</td></tr>
<tr><td>Sub-Idx</td><td>Description</td><td>Data Type</td><td>Access</td><td>PDO</td><td>Initial value</td></tr>
<tr><td rowspan="4">0x00</td><td rowspan="3">Backlash correction value. [BLCVAL]<br>Set the Backlash correction value.</td><td>Unsigned32</td><td>RW</td><td>No</td><td>0x00000000</td></tr>
<tr><td>Setting range</td><td colspan="3">0x00000000-0x7FFFFFFF<br>（0 - 2147483647）</td></tr>
<tr><td>Unit</td><td colspan="3">Pulse</td></tr>
<tr><td colspan="5">◆0 is set to bit 6 of Control Word. (Target position is treated as absolute value. )<br>Backlash correction value is incremented from target position when position command had increased target position.<br>Backlash correction value is not incremented from target position when position command had decreased target position.<br>◆1 is set to bit 6 of Control Word. (Target position is treated as relative value. )<br>Backlash correction value is decremented from target position when target position polarity had changed from positive to negative.<br>Backlash correction value is incremented from target position when target position polarity had changed from negative to positive.</td></tr>
</table>

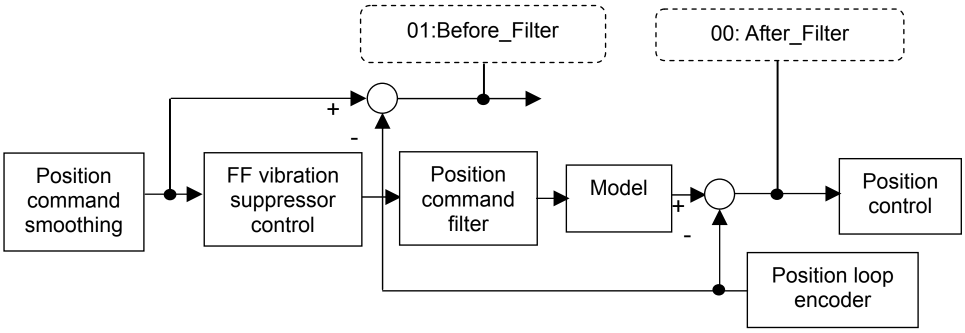
0x5092: Correction direction of Backlash

<table>
<tr><td>Index Ax1 0x5092<br>Ax2 0x5292<br>Ax3 0x5492<br>Ax4 0x5692</td><td colspan="2">Sets the correction direction of Backlash</td><td colspan="2">Object Code</td><td>Variable</td></tr>
<tr><td>Sub-Idx</td><td>Description</td><td>Data Type</td><td>Access</td><td>PDO</td><td>Initial value</td></tr>
<tr><td rowspan="2">0x00</td><td rowspan="2">Correction direction of Backlash [BLCDIR]<br>Sets the command direction of Backlash correction.<br>0x00: Positive direction<br>0x01: Negative direction<br>0x02-0xFF: Reserved</td><td>Unsigned8</td><td>RW</td><td>No</td><td>0x00</td></tr>
<tr><td>Setting range</td><td colspan="3">0x00-0x01</td></tr>
</table>

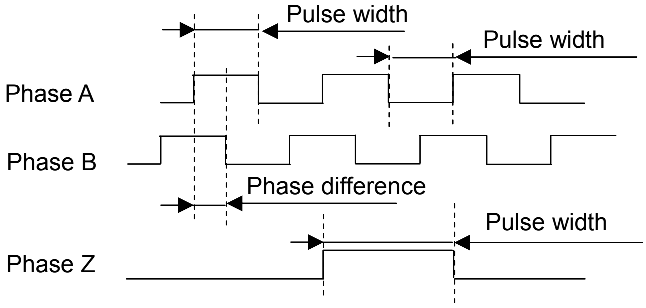
## 10) System Parameter

0x20F0: Amplifier Function Selection

<table>
<tr><td colspan="2">Index Ax1 0x20F0<br>Ax2 0x22F0<br>Ax3 0x24F0<br>Ax4 0x26F0</td><td colspan="2">Set the Sequence function.</td><td>Object Code</td><td>Record</td></tr>
<tr><td>Sub-Idx</td><td>Description</td><td>Data Type</td><td>Access</td><td>PDO</td><td>Initial value</td></tr>
<tr><td>0x00</td><td>Number of entry</td><td>Unsigned8</td><td>RO</td><td>No</td><td>0x06</td></tr>
<tr><td rowspan="3">0x01</td><td rowspan="2">Limit behavior Selection [ACTOT]<br>Selects the operation when the positive direction limit switch (normal rotation over travel) or the negative direction limit switch (reverse rotation over travel) is on.</td><td>Unsigned8</td><td>RW</td><td>No</td><td>0x06</td></tr>
<tr><td>Setting range</td><td colspan="3">0x00-0x06</td></tr>
<tr><td colspan="5">* Profile Position (PP), Profile Velocity (PV), Cycle synchronous position (CSP), Interpolated position（ip）, Cycle synchronous velocity (CSV)<br>0x00:Command entry disabled, after the motor stops with the servo brake, servo ON *1<br>0x01:Command entry disabled, after the motor stops with the dynamic brake, servo ON<br>0x02:Command entry disabled, after the motor stops with free run, servo ON<br>0x03:Command entry disabled, after the motor stops with the servo brake, servo OFF *1<br>0x04:Command entry disabled, after the motor stops with the dynamic brake, servo OFF<br>0x05:Command entry disabled, after the motor stops with free run, servo OFF<br>0x06:Command entry enabled, after servo motor stops without internal velocity limit command, servo ON<br>0x07-0xFF:Reserved<br><br>* Profile torque (force) (TQ), Cycle synchronous torque (force) (CST)<br>0x00 - 0x02, 0x06: Limit the Torque (force) command with Sequence Torque (force) limit (servo ON) *1, *2<br>0x03, 0x04: After servo Off, the motor stops with dynamic brake (servo Off)<br>0x05: After servo Off, the motor stops with free run (servo Off)<br>0x07-0xFF:Reserved<br><br>*1 The Sequence Operational Torque(force) limit value(0x201E) is valid with power running direction.<br>*2 When the Torque (force) Command is smaller than sequence operational torque limit value, it is limited by the Target Torque (force).<br>* RF2 series servo amplifier does not have dynamic brake circuit. So, it will be Free Run Stop during dynamic brake operation.</td></tr>
<tr><td rowspan="3">0x02</td><td rowspan="2">Positioning Methods selection [EDGEPOS]<br>Select the Encoder pulse positioning.</td><td>Unsigned8</td><td>RW</td><td>No</td><td>0x00</td></tr>
<tr><td>Setting range</td><td colspan="3">0x00-0x01</td></tr>
<tr><td colspan="5">0x00:Specify Pulse Interval<br>0x01:Specify Pulse Edge<br>0x02-0xFF:Reserved<br><br>■Positioning accuracy is improved by selecting Edge positioning when the encoder resolution is coarse. However, this may cause the driving sound of the mechanical system to increase as this edge is always the center of vibration.<br>■Select standard value for usual operation.<br>*The function becomes valid through control source re-closing.<br> </td></tr>
</table>

<table>
<tr><th>Sub-Idx</th><th>Description</th><th>Data Type</th><th>Access</th><th>PDO</th><th>Initial value</th></tr>
<tr><td rowspan="2">0x03</td><td rowspan="2">In-Position Signal/ Position Deviation Monitor [PDEVMON]<br>Select in-position signal (INP) and Position deviation monitor output before and after passing through the Position Command Filter.<br>0x00:After Filter Compare Position command value with Feedback value after passing through the filter.<br>0x01:Before Filter Compare Position command value with Feedback value before passing through the filter.<br>■For 00 After_Filter, use the Position deviation value of the Position controller.<br>■For 01 Before_Filter, use the Position deviation value based on Position command before FF vibration suppressor control.<br>■With system parameter ID0A Position Control Selection at 01 Model 1 Model Following Control, or 02 Model 2 Model Following Vibration Suppress Control, 01:Before_Filter always operates no matter the selection.<br><br> </td><td>Unsigned8</td><td>RW</td><td>No</td><td>0x00</td></tr>
<tr><td>Setting range</td><td colspan="3">0x00-0x01</td></tr>
<tr><td rowspan="2">0x04</td><td rowspan="2">Velocity Window Unit Output Selection [VCMPUS]<br>Sets the comparison method of the Velocity matching output.<br>0x00:min-1 0x606D(rotation frequency setting:min$^{-1}$)compare with setting value.<br>0x01:percent 0x202A(proportion setting:%)compare with setting value.<br>*The function becomes valid through control source re-closing.</td><td>Unsigned8</td><td>RW</td><td>No</td><td>0x00</td></tr>
<tr><td>Setting range</td><td colspan="3">0x00-0x01</td></tr>
<tr><td rowspan="2">0x05</td><td rowspan="2">Deviation Clear Selection [CLR]<br>Sets ON/OFF of position deviation clear during servo OFF, and deviation clear signal treatment.<br>* Selects operation during servo OFF. Deviation clear/ Deviation NOT clear.<br>* Selects deviation signal treatment. Level detection /Edge detection.<br>* Select proper setting corresponding to above combination from the list below.<br>
<table>
<tr><th colspan="2">Selection</th><th colspan="2">Contents</th></tr>
<tr><td>0x00</td><td>Type1</td><td>When Servo OFF -> Clear Deviation<br>Deviation Clear Input =Level Detection</td><td>During servo OFF, Deviation clear is always executed.<br>While Deviation clear input is ON, Deviation clear is always executed.</td></tr>
<tr><td>0x01</td><td>Type2</td><td>When Servo OFF -> Clear Deviation<br>Deviation Clear Input =Edge Detection</td><td>At the edge of OFF->ON of Deviation clear input, Deviation clear is executed.</td></tr>
<tr><td>0x02</td><td>Type3</td><td>When Servo OFF<br>-> NOT Clear Deviation<br>Deviation Clear Input =Level Detection</td><td>During servo OFF, Deviation clear is not executed.<br>(After servo ON, the motor may operate suddenly.)</td></tr>
<tr><td>0x03</td><td>Type4</td><td>When Servo OFF<br>-> NOT Clear Deviation<br>Deviation Clear Input =Edge Detection</td><td>During servo OFF, Deviation clear is not executed.<br>(After servo ON, the motor may operate suddenly.)</td></tr>
</table>
* Used, for example, to force the position variation counter inside the servo amplifier to zero from higher-level devices.</td><td>Unsigned8</td><td>RW</td><td>No</td><td>0x00</td></tr>
<tr><td>Setting range</td><td colspan="3">0x00-0x03</td></tr>
<tr><td rowspan="2">0x06</td><td rowspan="2">Torque (force) attainment function selection [TASEL]<br>Sets detection method of torque (force) attainment setting (0X202E).<br>
<table>
<tr><th colspan="2">Selection</th><th>Contents</th></tr>
<tr><td>00</td><td>TA/TZR</td><td>Sets by using the ratio of rated torque (force) of the motor.<br>(100%= rated torque (force))</td></tr>
<tr><td>01</td><td>TA/TCOM</td><td>Sets by using the ratio of limit value of torque(force).<br>(100%=limit value of torque (force))</td></tr>
</table></td><td>Unsigned8</td><td>RW</td><td>No</td><td>0x00</td></tr>
<tr><td>Setting range</td><td colspan="3">0x00 - 0x01</td></tr>
</table>

0x20F1: Encoder Function Selection

| Index Ax1 0x20F1<br>Ax2 0x22F1<br>Ax3 0x24F1<br>Ax4 0x26F1 | Sets the Encoder Function. | | Object Code | | Record |
|---|---|---|---|---|---|
| Sub-Idx | Description | Data Type | Access | PDO | Initial value |
| 0x00 | Number of entry | Unsigned8 | RO | No | 0x09 |
| 0x01 | Serial encoder Clear Function Selection [ECLRFUNC]<br>Selects the encoder clear method. | Unsigned8 | RW | No | 0x00 |
| | | Setting range | 0x00-0x01 | | |
| | * Use to clear Serial encoder warning when the warning is not automatically restored.<br>* Valid when using with Battery Backup Method Absolute Encoder and Battery-less Absolute Encoder.<br>* When used with Absolute Encoder for Incremental System, even 01:_Status_MultiTurn is selected; it works as the selection, Clear only encoder status.<br><br>0x00: Clear Encoder Status (Alarm and Warning) and Multi Turn Data<br>0x01: Clear Only Encoder Status (Alarm and Warning)<br><br>* Parameter set when amplifier hardware matches to Serial Encoder.<br>* Valid when Battery backup system absolute encoder, or Battery less absolute encoder is used. | | | | |
| 0x02 | Encoder Digital Filter selection [ENFIL]<br>Thie parameter can be set only when using pulse encoder. This sets digital filter of motor pulse encoder. | Unsigned8 | RW | No | 0x01 |
| | | Setting range | 0x00-0x07 | | |
| | * It is possible to set the value of incremental pulse digital filter for using incremental encoder.<br>Pulse lower than the set value is eliminated as noise when noise superposition occurs in Incremental encoder signals.<br>* Consider Encoder resolution and Maximum rotation velocity of the servo motor in operation when selecting value. Set the value roughly less than 1/4 of the Encoder pulse width at Maximum rotation velocity.<br><br>0x00:Minimum Pulse Width=110ns(Minimum pulse Phase Difference 37.5ns)<br>0x01:Minimum Pulse Width=220ns(Minimum pulse Phase Difference 75ns)<br>0x02:Minimum Pulse Width=440ns(Minimum pulse Phase Difference 150ns)<br>0x03:Minimum Pulse Width=880ns(Minimum pulse Phase Difference 300ns)<br>0x04:Minimum Pulse Width= 75ns(Minimum pulse Phase Difference 37.5ns)<br>0x05:Minimum Pulse Width=150ns(Minimum pulse Phase Difference 75ns)<br>0x06:Minimum Pulse Width=300ns(Minimum pulse Phase Difference 150ns)<br>0x07:Minimum Pulse Width=600ns(Minimum pulse Phase Difference 300ns)<br>0x08-0x0F:Reserved<br><br>* This parameter can be set when amplifier hardware supports Pulse encoder.<br> | | | | |
| 0x03 | Reserved [ENPOL] | Unsigned8 | | | |
| | | Setting range | | | |
| | | | | | |
| 0x04 | Reserved [ENPOL] | Unsigned8 | | | |
| | | Setting range | | | |
| | | | | | |

<table>
<tr><td rowspan="3">0x05<br>[Linear]</td><td rowspan="2">CS offset ［CSOF］<br>Sets electrical degree of the motor.<br>For rotary motor use<br>Must set it 0 degree.</td><td>Unsigned16</td><td>RW</td><td>No</td><td>0x0000<br>（0deg）</td></tr>
<tr><td>Setting range</td><td colspan="3">0x0000 - 0x0167<br>（0 - 359deg）</td></tr>
<tr><td colspan="5">For linear motor and Direct Drive Motor use<br>In case with hall effect sensor, sets an offset value with electrical angle conversion between 0 degree of U phase electrical angle and hall sensor output signal edge of U phase.<br>✔ This parameter is settable only under condition that amplifier hardware can support hall effect sensor input option.<br>✍ This function becomes effective after re-turning the control power supply on.</td></tr>
<tr><td rowspan="3">0x06<br>[Linear]</td><td rowspan="2">CS normalization offset of phase Z ［ZPHOF］<br>Sets offset of phase Z signal to electrical degree of the motor.<br>For rotary motor use<br>Must set it 0 degree.</td><td>Unsigned16</td><td>RW</td><td>No</td><td>0x0000<br>（0deg）</td></tr>
<tr><td>Setting range</td><td colspan="3">0x0000 - 0x0167<br>（0 - 359deg）</td></tr>
<tr><td colspan="5">For linear motor and Direct Drive Motor use<br>This function is valid when performing CS normalization with use of phase Z signal.<br>Sets an offset value with electrical angle conversion between 0 degree of U phase electrical angle and Z phase signal output position.<br>✍ This function becomes effective after re-turning the control power supply on.</td></tr>
<tr><td rowspan="3">0x07<br>[Linear]</td><td rowspan="2">Polarity selection on linear encoder ［ENCDIR］<br>Select linear encoder signal polarity EN1.<br>You can select phase A and B signal polarity.<br>Phase U and V signal polarity shall not be changed in case of omitted wiring incremental encoder.)</td><td>Unsigned8</td><td>RW</td><td>No</td><td>0x00</td></tr>
<tr><td>Setting range</td><td colspan="3">0x00 - 0x01</td></tr>
<tr><td colspan="5">✍ This function becomes effective after re-turning the control power supply on.</td></tr>
<tr><td rowspan="3">0x08<br>[Linear]</td><td rowspan="2">Magnetic pole position estimation frequency ［EMPFREQ］<br>Sets frequency for torque (force) command that is applied to estimate magnetic pole position.<br>✔Change excitation frequency if amplifier hardware magnetic pole position estiation cannot be normally completed due to resonance of equipment.</td><td>Unsigned16</td><td>RW</td><td>No</td><td>0x0032<br>（50Hz）</td></tr>
<tr><td>Setting range</td><td colspan="3">0x05 - 0x0064<br>（5 - 100Hz）</td></tr>
<tr><td colspan="5">✍This function becomes effective after re-turning the control power supply on.</td></tr>
<tr><td rowspan="3">0x09<br>[Linear]</td><td rowspan="2">Magnetic pole position estimation selection ［CSETMD］<br>Select the Magnetic pole position estimationmode.<br>✔This object is valid when 0x0850 is set to 0x20FF_0x02.</td><td>Unsigned8</td><td>RW</td><td>No</td><td>0x00</td></tr>
<tr><td>Setting range</td><td colspan="3">0x00～0x01</td></tr>
<tr><td colspan="5">0x00: Follow the setting of 0x20F8. 6.<br>0x01: Magnetic pole position estimation will run at once only after turn on main power.<br>✍Change is valid after control power-cycle.</td></tr>
</table>

0x20F2: Amplifier Alarm Detect Selection

| | | | |
|---|---|---|---|
| Index Ax1 0x20F2<br>Ax2 0x22F2<br>Ax3 0x24F2<br>Ax4 0x26F2 | Sets the Sequence function. | Object Code | Record |

| Sub-Idx | Description | Data Type | Access | PDO | Initial value |
|---|---|---|---|---|---|
| 0x00 | Number of entry | Unsigned8 | RO | No | 0x05 |
| 0x01 | Main Circuit Under-voltage (ALM_62) Detection [MPESEL] | Unsigned8 | RW | No | 0x01 |
| | | Setting range | 0x00-0x01 | | |
| | When DC input power specification is selected, select whether the Main Circuit Under-voltage alarm should be detected or not.<br>0x00: Do not detect the Main Circuit Under-voltage Alarm.<br>0x01: Detect the Main Circuit Under-voltage Alarm. | | | | |
| 0x02 | Velocity Control Alarm (ALM_C2) Detection [VCALM]<br>Select valid / invalid from the velocity control trouble detection. | Unsigned8 | RW | No | 0x00 |
| | | Setting range | 0x00-0x01 | | |
| | Trouble can be detected in operation patterns where the motor results in overshooting in response to commands; in these systems, please set as "invalid."<br>0x00: invalid<br>0x01: valid | | | | |
| 0x03 | Velocity Feedback Alarm (ALM_C3) Detection [FBKEEN]<br>0x00:invalid<br>0x01:valid | Unsigned8 | RW | No | 0x01 |
| | | Setting range | 0x00-0x01 | | |
| | Select valid / invalid for the velocity feedback trouble detection. | | | | |
| 0x04 | Communication Frame Error (ALM_10-15) Detection [CRCSET]<br>0x00-0x02:invalid<br>0x03: valid (error detected three times in row) | Unsigned8 | RW | No | 0x00 |
| | | Setting range | 0x00-0x08 | | |
| | 0x04: valid (error detected four times in row) ... 0x08: valid (error detected eight times in row)<br>Monitor the following communication error registers at each communication cycle and set as valid / invalid for each alarm and for the detection filter.<br>Reg:0x300 Port 0 Rx invalid frame error (AL_10) Reg:0x301 Port0 RxCRC error (AL_12)<br>Reg:0x302 Port 1 Rx invalid frame error (AL_11) Reg:0x302 Port1 RxCRC error (AL_13)<br>Reg:0x308 Port0 Tx error (AL_14) Reg:0x309 Port1 Tx error (AL_15) | | | | |
| 0x05 | Communication Timeout (ALM_1A) Detection [COTOUT]<br>0x00, 0x01: invalid | Unsigned8 | RW | No | 0x00 |
| | | Setting range | 0x00-0xFF | | |
| | 0x02: valid (not received twice in row)<br>0x03: valid (not received three times in row) ... 0xFF: valid (not received 255 times in row)<br>Monitor SM2 event (command receipt) at each communication cycle and set as valid / invalid for AL_1A and the detection filter. | | | | |

0x20F3: Position Control Selection

| | | | |
|---|---|---|---|
| Index Ax1 0x20F3<br>Ax2 0x22F3<br>Ax3 0x24F3<br>Ax4 0x26F3 | Selects Position control Compensation and encoder to use to control the position loop in PP, CSP, IP modes. | Object Code | Record |

| Sub-Idx | Description | Data Type | Access | PDO | Initial value |
|---|---|---|---|---|---|
| 0x00 | Number of entry | Unsigned8 | RO | No | 0x02 |
| 0x01 | Position Control Selection [PCNTSEL] | Unsigned8 | RW | No | 0x00 |
| | | Setting range | 0x00-0x02 | | |
| | Selects the model following control form and presence/absence.<br>0x00: Normal Control (Model Following Position Control detached)<br>0x01: Model Following Position Control (rigid body model)<br>0x02: Model Following Position Control (base vibration model)<br>0x03 - 0xFF: Reserved<br>*The setting value is switched by re-closing.<br>*The function becomes valid through control source re-closing. | | | | |
| 0x02 | Position Loop Control, Encoder Selection [PLMODE]<br>Selects the encoder that the servo amplifier uses for Position Loop Control. | Unsigned8 | RW | No | 0x00 |
| | | Setting range | 0x00-0x01 | | |
| | 0x00: Semi-closed Control (motor encoder used)<br>0x01: Full-closed Control (external encoder used)<br>*The function becomes valid through control source re-closing. | | | | |

0x20F4: Servo Loop Delay Time

| Index | | Description | | |
|---|---|---|---|---|
| Ax1 0x20F4<br>Ax2 0x22F4<br>Ax3 0x24F4<br>Ax4 0x26F4 | | In SM2 SYNC, set the delay time from IRQ interruption to the beginning of the computation of the servo amplifier control loop. | Object Code | Variable |

| Sub-Idx | Description | Data Type | Access | PDO | Initial value |
|---|---|---|---|---|---|
| 0x00 | Servo Loop Delay Time [SLPDLY]<br>In SM2 event SYNC, each axis reaches misalignment because of cable impedance and processing delay caused by the occurrence of IRQ signals in frame transmission.<br>This parameter can adjust the time from the IRQ signal occurrence to the beginning of the amplifier location loop computation. | Unsigned8 | RW | No | 0xEF<br>(120μs) |
| | | Setting range | 0x00-0xEF<br>(0.5-120μs) | | |
| | | Unit | 0.5μs | | |
| | Delay Time (usec) = (Setting value + 1) / 2<br>"Example : 62.5us = 62.5 * 2 – 1 = 124 =Setting value:0x7C"<br>*Adjust to the last slave axis. | | | | |

0x20F5: Torque (force) Limit at Power Supply Shortage

| Index | Description | | |
|---|---|---|---|
| Ax1 0x20F5<br>Ax2 0x22F5<br>Ax3 0x24F5<br>Ax4 0x26F5 | When a power supply shortage is detected, select whether the normal limit value or the sequence operation torque (force) limit of the motor output current is used.<br>Provided as a SEMI F47support function. | Object Code | Variable |

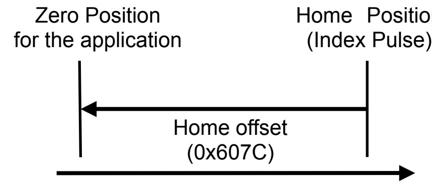
| Sub-Idx | Description | Data Type | Access | PDO | Initial value |
|---|---|---|---|---|---|
| 0x00 | Torque (force) Limit at Power Supply Shortage [CPETLSEL] | Unsigned8 | RW | No | 0x00 |
| | For torque (force) limit upon detection of Power Supply Shortage, select whether the sequence operation torque (force) Limit (0x201E) should be included in addition to the maximum torque（0x6072）, positive direction Torque limit (0x60E0), and negative direction Torque limit（0x60E1）. | Setting range | 0x00-0x01 | | |
| | 0x00: Limit to minimum value of 0x6072, 0x60E0, 0x60E1(By normal torque limit method)<br>0x01: 0x201E:Limit to minimum value of the Sequence Torque Operation Torque limit and the minimum value of 0x6072, 0x60E0, and 0x60E1.<br><br>*For the operation sequence, see chapter 8, "SEMI F47 support function." | | | | |

0x20F6: Manufacturer Homing Parameter

| Index | Description | | |
|---|---|---|---|
| Ax1 0x20F6<br>Ax2 0x22F6<br>Ax3 0x24F6<br>Ax4 0x26F6 | In the homing mode (hm), set the parameter that maker decided. | Object Code | Record |

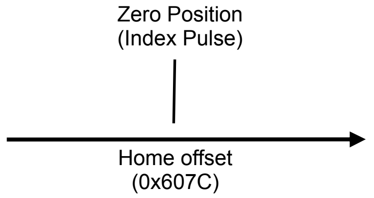
| Sub-Idx | Description | Data Type | Access | PDO | Initial value |
|---|---|---|---|---|---|
| 0x00 | Number of entry | Unsigned8 | RO | No | 0x03 |
| 0x01 | Actual position calculation method [HMPSEL] | Unsigned8 | RW | No | 0x00 |
| | At homing process, define calculation of actual position (0x6064). | Setting range | 0x00～0x01 | | |

0x20F6-1=0 : Calculation method 1



Except for homing method 35,37.
Zero Position = Home Position +Home offset (0x606C)

0x20F6 - 1 = 1 : Calculation method 2



Except for homing method 35,37.
Zero Position = Home offset (0x606C)
Homing Method 35,37
Actual Position(0x6064) = Home offset (0x606C)

✔ When homing method 35 or 37 and 0x20F6-1=0 ,calculation is calculation method 2.

| Sub-Idx | Description | Data Type | Access | PDO | Initial value |
|---|---|---|---|---|---|
| 0x02 | Hard stop torque (force) limit [HSTRQ]<br>In the Hard stop homing (0x6098:from -4 to -1), this value is torque (force) limitation when reaching hard stop.<br><br>Hard stop is detected with this value. | Unsigned16 | RW | No | 0x03E8<br>（100.0%） |
| | | Setting range | 0x0000～0x1388<br>（0～500.0%） | | |
| | | Unit | 0.1 % | | |
| 0x03 | Hard stop detection time [HSTIM]<br>In the Hard stop homing (0x6098:from -4 to -1), hard stop is detected after spending this time with torque value beyond above.<br>After hard stop detection, state will change by homing method as below.<br>Homing method (0x6098)<br>-1, -2 --> Home position detected. (Finished homing. )<br>-3, -4 --> Go reverse to find index position. (Continuing homing.) | Unsigned16 | RW | No | 0x000A<br>（10ms） |
| | | Setting range | 0x000A～0xFFFF<br>（10～65535ms） | | |
| | | Unit | ms | | |

### 0x20F7: Special Function Selection Setting

| | | | |
|---|---|---|---|
| Index Ax1 0x20F7<br>Ax2 0x22F7<br>Ax3 0x24F7<br>Ax4 0x26F7 | Sets whether or not the special function of the servo amplifier is usable. | Object Code | Variable |

<table>
<tr><th>Sub-Idx</th><th>Description</th><th>Data Type</th><th>Access</th><th>PDO</th><th>Initial value</th></tr>
<tr><td rowspan="3">0x00</td><td rowspan="2">Bit0: Independent setting of SM2 synchronization and interpolated synchronization<br>Sets whether or not the synchronized time in the interpolation mode is synchronized.</td><td>Unsigned16</td><td>RW</td><td>No</td><td>0x0000</td></tr>
<tr><td>Setting Range</td><td colspan="3">0x0000-0xFFFF</td></tr>
<tr><td colspan="5">The interpolation synchronized time is synchronized to SM2 synchronization at the setting value 0.<br>The interpolation synchronized time is independently set from SM2 synchronization at the setting value 1.<br>✔ When using the SANMotionC, please make sure to use it under the conditions synchronizing to SM2 synchronization.<br>Bit1: Torque low pass filter setting<br>Sets torque command filter（0x2011）.<br>0: Torque command filter（0x2011）disable.<br>1: Torque command filter（0x2011）enable.<br>Bit2：Reserved<br>Bit3:Reserved<br>Bit4: Shutdown command state selection<br>In the FSA status transition, selects the amplifier state at the time of shutdown command inputting.<br>Emergency stop state can set every time at the time of shutdown command inputting.<br>0: Not to be an emergency stop state at the time of shutdown command inputting.<br>However, transition from Operation state, it is to be an emergency stop state.<br>1: To be an emergency stop state at the time of shutdown command inputting.<br>Bit5 to 15: Reserved</td></tr>
</table>

0x20F8: General Purpose Input Setting

| | | | | |
|---|---|---|---|---|
| Index Ax1<br>Ax2<br>Ax3<br>Ax4 | 0x20F8<br>0x22F8<br>0x24F8<br>0x26F8 | Select the function of General Purpose input 1, 2(CONT1, CONT2). Input time until all the function become enabled is 8ms. | Object Code | Record |

| Sub-Idx | Description | Data Type | Access | PDO | Initial value |
|---|---|---|---|---|---|
| 0x00 | Number of entry | Unsigned8 | RO | No | 0x06 |
| 0x01 | Positive Limit Switch Function [PLIMSW] | Unsigned8 | RW | No | 0x00 |
| | Select the valid condition of the positive direction limit switch function. | Setting range | 0x00～0x11 | | |
| | 00：Always_Disable Always function disabled.<br>01：Always_Enable Always function enabled.<br>02：CONT1_ON Function enabled when versatile input CONT1 is ON.<br>03：CONT1_OFF Function enabled when versatile input CONT1 is OFF.<br>04：CONT2_ON Function enabled when versatile input CONT2 is ON.<br>05：CONT2_OFF Function enabled when versatile input CONT2 is OFF.<br>06：CONT3_ON Function enabled when versatile input CONT3 is ON.<br>07：CONT3_OFF Function enabled when versatile input CONT3 is OFF.<br>08：CONT4_ON Function enabled when versatile input CONT4 is ON.<br>09：CONT4_OFF Function enabled when versatile input CONT4 is OFF.<br>0A：CONT5_ON Function enabled when versatile input CONT5 is ON.<br>0B：CONT5_OFF Function enabled when versatile input CONT5 is OFF.<br>0C：CONT6_ON Function enabled when versatile input CONT6 is ON.<br>0D：CONT6_OFF Function enabled when versatile input CONT6 is OFF.<br>0E：CONT7_ON Function enabled when versatile input CONT7 is ON.<br>0F：CONT7_OFF Function enabled when versatile input CONT7 is OFF.<br>10：CONT8_ON Function enabled when versatile input CONT8 is ON.<br>11：CONT8_OFF Function enabled when versatile input CONT8 is OFF. | | | | |
| 0x02 | Negative Limit Switch Function [NLIMSW] | Unsigned8 | RW | No | 0x00 |
| | Select the valid condition of the negative direction limit switch function | Setting range | 0x00-0x11 | | |
| | The same as Sub Index:01(positive direction limit switch function.) | | | | |
| 0x03 | External Trip Input Function [EXT-E] | Unsigned8 | RW | No | 0x00 |
| | Sets the trip valid condition the same as the trip input of the external regenerative resistance. | Setting range | 0x00-0x11 | | |
| | The same as Sub Index:01(positive direction limit switch function.) | | | | |
| 0x04 | Main Power Discharge Function [DISCHRGE] | Unsigned8 | RW | No | 0x00 |
| | Sets the valid condition of the discharge function in case of main circuit power shutdown. | Setting range | 0x00-0x11 | | |
| | The same as Sub Index:01(positive direction limit switch function.) | | | | |
| 0x05 | Emergency Stop Function [EMR] | Unsigned8 | RW | No | 0x00 |
| | Sets the valid condition of the input function in case of emergency stop. | Setting range | 0x00-0x11 | | |
| | The same as Sub Index:01(positive direction limit switch function.) | | | | |
| 0x06<br>[Linear] | Detetion function of magnetic pole position ［CSET］ | Unsigned8 | RW | No | 0x00 |
| | Sets valid condition for inputting fixed excitation operation on the linear motor without hall efefct sensor output. | Setting range | 0x00～0x11 | | |
| | Sets valid condition for inputting fixed magnetic pole position estimation function on the linear motor without hall efefct sensor output.<br>This selection functions the same way as SubIndex：01 (limit switch function in positive direction). | | | | |

## 0x20F9: General Purpose Output Setting

| | | | |
|---|---|---|---|
| Index Ax1 0x20F9<br>Ax2 0x22F9<br>Ax3 0x24F9<br>Ax4 0x26F9 | Selects General Output 1, 2(OUT1, OUT2) function | Object Code | Record |

| Sub-Idx | Description | Data Type | Access | PDO | Initial value |
|---|---|---|---|---|---|
| 0x00 | Number of entry | Unsigned8 | RO | No | 0x02 |
| 0x01 | General Purpose Output 1 [OUT1] | Unsigned8 | RW | No | 0x42 |
| | Selects the Output signal for General Purpose Output 1. For a detailed list, see the General Purpose Output Parameters list. | Setting range | 0x00-0x5F<br>(Initial value: 42:FOUT1_ON) | | |
| 0x02 | General Purpose Output 2 [OUT2] | Unsigned8 | RW | No | 0x44 |
| | Selects the Output signal for General Purpose Output 2. For a detailed list, see the General Purpose Output Parameters list. | Setting range | 0x00-0x55<br>(Initial value: 44: FOUT2_ON) | | |

■ To control from EtherCAT communication

| | | |
|---|---|---|
| Physical output 0x60FE, 0x01:bit16 setting | 42:FOUT1_ON | 43:FOUT1_OFF |
| Physical output 0x60FE, 0x01:bit17 setting | 44:FOUT2_ON | 45:FOUT2_OFF |

■ When Generic input signal status it to be Output.

| | | |
|---|---|---|
| General Input, CONT1 is ON | 3A:CONT1_ON | 3B:CONT1_OFF |
| General Input, CONT2 is ON | 3C:CONT2_ON | 3D:CONT2_OFF |
| General Input, CONT3 is ON | 3E:CONT3_ON | 3F:CONT3_OFF |
| General Input, CONT4 is ON | 40:CONT4_ON | 41:CONT4_OFF |

■ When Servo amplifier Preset status is to be output.

| | | |
|---|---|---|
| While Servo Ready Complete | 02:S-RDY_ON | 03:S-RDY_OFF |
| | 50:S-RDY2_ON | 51:S-RDY2_OFF |
| While Power Supply ON | 04:P-ON_ON | 05:P-ON_OFF |
| While Power Supply ON Permission | 06:A-RDY_ON | 07:A-RDY_OFF |
| While Motor Excitation | 08:S-ON_ON | 09:S-ON_OFF |
| While Holding Brake Excitation Signal Output | 0A:MBR-ON_ON | 0B:MBR-ON_OFF |
| While Torque (force) Limiting | 0C:TLC_ON | 0D:TLC_OFF |
| While Velocity Limiting | 0E:VLC_ON | 0F:VLC_OFF |
| While Low Speed Status | 10:LOWV_ON | 11:LOWV_OFF |
| While Speed Attainment Status | 12:VA_ON | 13:VA_OFF |
| While Speed Matching Status | 14:VCMP_ON | 15:VCMP_OFF |
| While Speed Zero Status | 16:ZV_ON | 17:ZV_OFF |
| While Command Acceptance Permission Status | 1C:CMD-ACK_ON | 1D:CMD-ACK_OFF |
| While Gain Switching Status | 1E:GC-ACK_ON | 1F:GC-ACK_OFF |
| While Velocity Loop Proportional Control Switching Status | 20:PCON-ACK_ON | 21:PCON-ACK_OFF |
| While Control Mode Switching Status | 24:MS-ACK_ON | 25:MS-ACK_OFF |
| While in positive direction limit condition | 26:F-OT_ON | 27:F-OT_OFF |
| While in negative direction limit condition | 28:R-OT_ON | 29:R-OT_OFF |
| While Main Circuit Power Supply Charging | 4A:CHARGE_ON | 4B:CHARGE_OFF |
| While Dynamic Braking | 4C:DB_OFF | 4D:DB_ON |
| While in Alarm Status | 38:ALM_ON | 39:ALM_OFF |

■ When Positioning signal is to be output

| | | |
|---|---|---|
| While In-Position Status | 18:INP_ON | 19:INP_OFF |
| While Near Range Status | 1A:NEAR_ON | 1B:NEAR_OFF |
| While In-Position with Position Command 0 Status | 52:INPZ_ON | 53:INPZ_OFF |

*All codes not on the list are Reserved and indeterminate.

* RF2 series servo amplifier does not have dynamic brake circuit.
So, it will be Free Run Stop during dynamic brake operation.

■ General output parameter list

| Item | Setting value | Item | Setting value |
|---|---|---|---|
| The output is always OFF. | 00:Always_OFF | The output is always ON. | 01:Always_ON |
| The output is ON during Servo Ready complete. | 02:S-RDY_ON | The output is OFF during Servo Ready complete. | 03:S-RDY_OFF |
| The output is ON while the main power supply is turned on. | 04:P-ON_ON | The output is OFF while the main power supply is turned on. | 05:P-ON_OFF |
| The output is ON during the main power supply ON permission. | 06:A-RDY_ON | The output is OFF during the main power supply ON permission. | 07:A-RDY_OFF |
| The output is ON during motor excitation. | 08:S-ON_ON | The output is OFF during motor excitation. | 09:S-ON_OFF |
| The output is ON while holding brake excitation signal outputs. | 0A:MBR-ON_ON | The output is OFF while holding brake excitation signal outputs. | 0B:MBR-ON_OFF |
| The output is ON during torque (force) limiting. | 0C:TLC_ON | The output is OFF during torque (force) limiting. | 0D:TLC_OFF |
| The output is ON during velocity limiting. | 0E:VLC_ON | The output is OFF during velocity limiting. | 0F:VLC_OFF |
| The output is ON during low speed status. | 10:LOWV_ON | The output is OFF during low speed status. | 11:LOWV_OFF |
| The output is ON during speed attainment status. | 12:VA_ON | The output is OFF during speed attainment status. | 13:VA_OFF |
| The output is ON during speed matching status. | 14:VCMP_ON | The output is OFF during speed matching status. | 15:VCMP_OFF |
| The output is ON during zero speed status. | 16:ZV_ON | The output is OFF during zero speed status. | 17:ZV_OFF |
| The output is ON during In-Position status. | 18:INP_ON | The output is OFF during In-Position status. | 19:INP_OFF |
| The output is ON during In-Position Near status. | 1A:NEAR_ON | The output is OFF during In-Position Near status. | 1B:NEAR_OFF |
| The output is ON while command can be accepted. | 1C:CMD-ACK_ON | The output is OFF while command can be accepted. | 1D: CMD-ACK_OFF |
| The output is ON during gain switching. | 1E:GC-ACK_ON | The output is OFF during gain switching. | 1F:GC-ACK_OFF |
| The output is ON during velocity loop proportional control switching. | 20:PCON-ACK_ON | The output is OFF during velocity loop proportional control switching. | 21: PCON-ACK_OFF |
| The output is ON during control mode switching. | 24:MS-ACK_ON | The output is OFF during control mode switching. | 25:MS-ACK_OFF |
| The output is ON during positive over-travel status. | 26:F-OT_ON | The output is OFF during positive over-travel status. | 27:F-OT_OFF |
| The output is ON during negative over-travel status. | 28:R-OT_ON | The output is OFF during negative over-travel status. | 29:R-OT_OFF |
| The output is ON during excessive deviation warning status. | 2A:WNG-OFW_ON | The output is OFF during excessive deviation warning status. | 2B: WNG-OFW_OFF |
| The output is ON during over-load warning status. | 2C:WNG-OLW_ON | The output is OFF during over-load warning status. | 2D: WNG-OLW_OFF |
| The output is ON during regenerative over-load warning status. | 2E: WNG-ROLW_ON | The output is OFF during regenerative over-load warning status. | 2F: WNG-ROLW_OFF |
| The output is ON during battery warning. | 30:WNG-BAT_ON | The output is OFF during battery warning. | 31: WNG-BAT_OFF |
| The output is alarm Code Bit 5 (positive logic). | 32:ALM5_ON | The output is alarm Code Bit 5 (negative logic). | 33:ALM5_OFF |
| The output is alarm Code Bit 6 (positive logic). | 34:ALM6_ON | The output is alarm Code Bit 6 (negative logic). | 35:ALM6_OFF |
| The output is alarm Code Bit 7 (positive logic). | 36:ALM7_ON | The output is alarm Code Bit 7 (negative logic). | 37:ALM7_OFF |
| The output is ON during alarm status. | 38:ALM_ON | The output is OFF during alarm status. | 39:ALM_OFF |
| The output is ON during generic input CONT1 is ON. | 3A:CONT1_ON | The output is OFF during generic input CONT1 is ON. | 3B:CONT1_OFF |
| The output is ON during generic input CONT2 is ON. | 3C:CONT2_ON | The output is OFF during generic input CONT2 is ON. | 3D:CONT2_OFF |
| The output is ON during generic input CONT3 is ON. | 3E:CONT3_ON | The output is OFF during generic input CONT3 is ON. | 3F:CONT3_OFF |
| The output is ON during generic input CONT4 is ON. | 40:CONT4_ON | The output is OFF during generic input CONT4 is ON. | 41:CONT4_OFF |
| The output is ON during physical output is “0x60FE, 1:bit16=1”. | 42:FOUT1_ON | The output is OFF during physical output is “0x60FE, 1:bit16=1”. | 43:FOUT1_OFF |
| The output is ON during physical output is “0x60FE, 1:bit17=1”. | 44:FOUT2_ON | The output is OFF during physical output is “0x60FE, 1:bit17=1”. | 45:FOUT2_OFF |
| The output is always OFF. | 46:Always_OFF | The output is always OFF. | 47:Always_OFF |
| The output is always OFF. | 48:Always_OFF | The output is always OFF. | 48:Always_OFF |
| The output is ON during main circuit power is charging, | 4A:CHARGE_ON | The output is OFF during main circuit power is charging, | 4B:CHARGE_OFF |
| The output is OFF during dynamic brake is operating. | 4C:DB_OFF | The output is ON during dynamic brake is operating. | 4D:DB_ON |
| The output is ON during magnetic pole position estimation is finished. | 4E:CRDY_ON | The output is OFF during magnetic pole position estimation is finished. | 4F:CRDY_OFF |
| The output is ON during Servo Ready 2 complete. | 50:S-RDY2_ON | The output is OFF during Servo Ready 2 complete. | 51:S-RDY2_OFF |
| The output is ON during PCMD=0 and In-position Status. | 52:INPZ_ON | The output is OFF during PCMD=0 and In-position Status. | 53:INPZ_OFF |
| The output is ON during power supply shortage warning. | 54:PEWNG_ON | The output is OFF during power supply shortage warning. | 55:PEWNG_OFF |
| The ourput is ON in during detecting torque (force) attainment. | 56:TA_ON | The ourput is OFF in during detecting torque (force) attainment. | 57：TA_OFF |
| When versatile input CONT5 is ON, output is ON | 58:CONT5_ON | When versatile input CONT5 is ON, output is OFF | 59:CONT5_OFF |
| When versatile input CONT6 is ON, output is ON | 5A:CONT6_ON | When versatile input CONT6 is ON, output is OFF | 5B:CONT6_OFF |
| When versatile input CONT7 is ON, output is ON | 5C:CONT7_ON | When versatile input CONT7 is ON, output is OFF | 5D:CONT7_OFF |
| When versatile input CONT8 is ON, output is ON | 5E:CONT8_ON | When versatile input CONT8 is ON, output is OFF | 5F:CONT8_OFF |
| Reserved | FF: RESERVE | - | - |

✔RF2 series servo amplifier does not have dynamic brake circuit. So, dynamic brake operation monitor will be Free Run operation monitor.

0x20FA：Extend Station Alias

| | | | | |
|---|---|---|---|---|
| Index | 0x20FA | Sets the rotary switch for Station of Alias to use more than 0 to 256 points rotary switch. This amplifier has single ESC. So, this is single object, also. | Object Code | Variable |

| Sub-Idx | Description | Data Type | Access | PDO | Initial Value |
|---|---|---|---|---|---|
| 0x00 | Number of entry | Unsigned8 | RO | No | 0x02 |
| 0x01 | Extended Alias Number ［EXALIAS］ | Unsigned8 | RW | No | 0x00 |
| | Sets the Inherent Slave address（Station Alias Reg：0x0012，0x0013）to bit15-8 | Setting range | 0x00～0xFF | | |
| | bit7-0 Rotary switch of amplifier front panel ,bit15-8 This setting value at initialization<br>If 0x20FA.02＝0x00 then logical add will write to station alias Reg：0x0012,0x0013<br>*The function becomes valid through control source re-closing. | | | | |
| 0x02 | Station Alias Selection ［ALIASEL］ | Unsigned8 | RW | No | 0x00 |
| | Sets the station alias Reg：0x0012,0x0013 | Setting range | 0x00～0x01 | | |
| | 0x00：Use value of rotary switch of amplifier front panel（bit7-0）and extended alias number(bit15-8)<br>0x01：Use value of EEPROM address 0x04<br>*The function becomes valid through control source re-closing. | | | | |

0x20FD: Amplifier System Selection

<table>
<tr><td>Index Ax1 0x20FD<br>Ax2 0x22FD<br>Ax3 0x24FD<br>Ax4 0x26FD</td><td colspan="2">Selects the system configuration of the servo amplifier.</td><td colspan="2">Object Code</td><td>Record</td></tr>
<tr><td>Sub-Idx</td><td>Description</td><td>Data Type</td><td>Access</td><td>PDO</td><td>Initial value</td></tr>
<tr><td>0x00</td><td>Number of entry</td><td>Unsigned8</td><td>RO</td><td>No</td><td>0x03</td></tr>
<tr><td rowspan="2">0x01</td><td rowspan="2">Main power input type [MPWRIN]<br>Selects the main circuit mode to actually be wired.<br>0x00:3φAC(three-phase AC input)<br>0x01:1φAC(single phase AC input)<br>0x02:DC (DC power source input) supplied from the power supply unit<br>0x03 - 0xFF:Reserved<br>*The function becomes valid through control source re-closing.</td><td>Unsigned8</td><td>RW</td><td>No</td><td>0x02</td></tr>
<tr><td>Setting range</td><td colspan="3">0x00-0x02</td></tr>
<tr><td rowspan="2">0x02</td><td rowspan="2">Regenerative Resistor Selection [RGKIND]<br>Selects the presence/absence of regenerative resistance and the connection forms.<br>0x00:regenerative resistance disconnected<br>0x01:embedded regenerative resistance used<br>0x02:external regenerative resistance used<br>0x03 - 0xFF:Reserved<br>*The function becomes valid through control source re-closing.</td><td>Unsigned8</td><td>RW</td><td>No</td><td>0x02</td></tr>
<tr><td>Setting range</td><td colspan="3">0x00-0x02</td></tr>
<tr><td rowspan="2">0x03</td><td rowspan="2">Setup Communication Baud Rate [COMBAUD]<br>Selects the baud rate when PC communication is performed by the setup software.<br>0x03 : 9600bps<br>0x04 : 19200bps<br>0x05 : 38400bps<br>0x06 : 57600bps<br>0x00-0x02,0x07-0xFF:Reserved<br>*The function becomes valid through control source re-closing.</td><td>Unsigned8</td><td>RW</td><td>No</td><td>0x05</td></tr>
<tr><td>Setting range</td><td colspan="3">0x03-0x06</td></tr>
<tr><td rowspan="2">0x04</td><td rowspan="2">Main circuit power input voltage [MPWRVL]<br>Selects a main circuit power input voltage.<br>0x00 to 0x02: Reserved<br>0x03:DC48V<br>0x04:DC24V<br>0x05 to 0xFF: Reserved<br>*The function becomes valid through control source re-closing.</td><td>Unsigned8</td><td>RW</td><td>No</td><td>0x03</td></tr>
<tr><td>Setting range</td><td colspan="3">0x03-0x04</td></tr>
</table>

0x20FE: Motor code

<table>
<tr><td colspan="2">Index Ax1 0x20FE<br>Ax2 0x22FE<br>Ax3 0x24FE<br>Ax4 0x26FE</td><td colspan="2">Sets the code of the drive motor.</td><td colspan="2">Object Code</td><td>Variable</td></tr>
<tr><td>Sub-Idx</td><td colspan="2">Description</td><td>Data Type</td><td>Access</td><td>PDO</td><td>Initial value</td></tr>
<tr><td rowspan="3">0x00</td><td colspan="2" rowspan="2">Combination Motor code [MOCODE]<br>Sets the combination motor code.<br>The motor code list can be set via communication.</td><td>Unsigned16</td><td>RW</td><td>No</td><td>0xFFFF</td></tr>
<tr><td>Setting range</td><td colspan="3">0x0000-0xFFFF</td></tr>
<tr><td colspan="6">✔ If there is no Servo motor in the list, Please refer the Annex File “M0011195-Annex 1”. (For All of the motor code lists).</td></tr>
</table>

■ Rotary motor (48V)

| Series | Motor code | Servo motor model number | Input type | Amplifier capacity | Flange size | Output | Maximum speed |
|---|---|---|---|---|---|---|---|
| R2 Series | 0x0261 | R2GA04003F | DC48V | 40A | □40mm | 30W | 6,000 min$^{-1}$ |
| | 0x0262 | R2GA04005F | DC48V | 40A | □40mm | 50W | 6,000 min$^{-1}$ |
| | 0x0263 | R2GA04008D | DC48V | 40A | □40mm | 80W | 5,000 min$^{-1}$ |
| | 0x0264 | R2GA06010D | DC48V | 40A | □60mm | 100W | 5,000 min$^{-1}$ |
| | 0x0265 | R2GA06020D | DC48V | 40A | □60mm | 200W | 4,500 min$^{-1}$ |
| | 0x040C | R2GAD102RM | DC48V | 25A | □14mm | 2.4W | 1,500 min$^{-1}$ |
| | 0x049B | R2GA02D20F | DC48V | 40A | □20mm | 20W | 6,000 min$^{-1}$ |
| | 0x0497 | R2GA02D30F | DC48V | 40A | □20mm | 30W | 6,000 min$^{-1}$ |

■ Linear motor

| Series | Motor code | Servo motor model number | Input type | Amplifier capacity | Width | Output | Maximum speed |
|---|---|---|---|---|---|---|---|
| DE Series | 0x435A | DE0AC001A03M | DC48V | 40A | 30mm | 5.1N | 2.0m/s |

■ Specific setting

| | Motor code | Contents |
|---|---|---|
| – | 0x8000 | Auto setting of motor parameter (When connected to applicable motor) |
| | 0xFFFF | R ADVANCED – Based on motor setting (EEPROM setting value) set by setup software. |

✍ Please contact our sales for the other motor above.

✍ To be Initialized by motor code set on EEPROM at power-on.

When the motor code whose set parameter is differenet from EEPROM value, function becomes enabled when control power is re-turned on.

Re-turn on control power since alram “DE: parameter change completed” becomes active after new value is set to EEPROM.

✍ Automatic setting of motor parameter is performed when re-turning on the power supply after 0x8000 is set to any of motor code (0x20FE: 0x00), encoder division number code (0x20FF: 0x01), or encoder type code (0x20FF: 0x02). After that the three values are updated automatically.

0x20FF: Combination Encoder Selection

| | | | |
|---|---|---|---|
| Index Ax1 0x20FF<br>Ax2 0x22FF<br>Ax3 0x24FF<br>Ax4 0x26FF | Selects the motor encoder specifications and functions driven by combination.<br>* Reactivate the control power after changing the setting this will reset the setting. | Object Code | Record |

| Sub-Idx | Description | Data Type | Access | PDO | Initial value |
|---|---|---|---|---|---|
| 0x00 | Number of entry | Unsigned8 | RO | No | 0x03 |
| 0x01 | Encoder Resolution setting [ENCODE]<br>Sets the division number of the motor encoder. | Unsigned16 | RW | No | 0xFFFF |
| | | Setting range | 0x0000-0x000F | | |

| ■ When the incremental encoder is used | ■ When the absolute encoder is used | ■ when linear scale encoder is used. | |
|---|---|---|---|
| 0x0000 : 500P/R | 0x0000 : 2,048FMT | 0x0000 : 5μm | [200P/mm] |
| 0x0001 : 512P/R | 0x0001 : 4,096FMT | 0x0001 : 2.5μm | [400P/mm] |
| 0x0002 : 1,000P/R | 0x0002 : 8,192FMT | 0x0002 : 2μm | [500P/mm] |
| 0x0003 : 1,024P/R | 0x0003 : 16,384FMT | 0x0003 : 1.25μm | [800P/mm] |
| 0x0004 : 1,500P/R | 0x0004 : 32,768FMT | 0x0004 : 1μm | [1,000P/mm] |
| 0x0005 : 2,000P/R | 0x0005 : 65,536FMT | 0x0005 : 0.5μm | [2,000P/mm] |
| 0x0006 : 2,048P/R | 0x0006 : 131,072FMT | 0x0006 : 0.25μm | [4,000P/mm] |
| 0x0007 : 2,500P/R | 0x0007 : 262,144FMT | 0x0007 : 0.125μm | [8,000P/mm] |
| 0x0008 : 3,000P/R | 0x0008 : 524,288FMT | 0x0008 : 0.1μm | [10,000P/mm] |
| 0x0009 : 4,000P/R | 0x0009 : 1,048,576FMT | 0x0009 : 0.05μm | [20,000P/mm] |
| 0x000A : 4,096P/R | | | |
| 0x000B : 5,000P/R | | | |
| 0x000C : 6,000P/R | | | |
| 0x000D : 8,192P/R | | | |
| 0x000E : 16,384P/R | | | |
| 0x000F : 32,768P/R | | | |
| 0x0010 : 10,000P/R | | | |

0x8000: Auto setting of motor parameter (When connected to applicable motor.)
0xFFFF: Depends on division number setting (EEPROM setting value) of the MOTOR Setup software.

# Initialized by the encoder resolution number set in EEPROM at the turn-on state.
When the encoder resolution number set parameter is different from the EEPROM value set, the function will be enabled by control source re-closing. After the new value is set in EEPROM, alarm ”DE: parameter change completed” occurs, then re-close control source.

✍ Automatic setting of motor parameter is performed when re-turning on the power supply after 0x8000 is set to any of motor code (0x20FE: 0x00), encoder division number code (0x20FF: 0x01), or encoder type code (0x20FF: 0x02). After that the three values are updated automatically.

■ Automatic setting of motor parameter

There are two ways to perform automatic setting of motor parameter.

(1) 0x8000 is set to any of motor code (0x20FE: 0x00), encoder division number code (0x20FF: 0x01), or encoder type code (0x20FF: 0x02). After that all the three values are read out automatically from encoder on re-turning on the control power.

(2) When using sutomatic setting button on parameter setting display of MOTOR setup software, the procedure is as follow:
  (a) Click automatic setting button on parameter setting display.
  (b) Click OK-buton if normally completed.
  (c) Set motor code of system parameter tub to 0xFFFF.
  (d) Re-turn on the control power.

✔ Refer to separate document, M0010842 for the details.

In the following cases, automatic setting of motor parameter function is not available.

✔ When alarm activated, in servo-on state, when encode-clear being performed.
✔ Connected to the motor which is not supported by automatic setting.
✔ Connected to the motor which is improper combination with the amplifier (motor size, encoder baud rate).

| | | | | | |
|---|---|---|---|---|---|
| 0x02 | Encoder type [ENTYPE]<br>Selects the type of motor encoder. | Unsigned16 | RW | No | 0xFFFF |
| | | Setting range | 0x0000-0xFFFF | | |

■ Incremental system (Wire-saving incremental encoder: 4pairs)
0x0000: Wire-saving incremental encoder
0x0002: Incremental encoder: CS normalization/ software setting (Magnetic pole position estimation)

■ Incremental System (Absolute encoder for incremental system)
0x0101:asynchronous encoder 2.5MHz(without multiple rotation output)
0x0201:asynchronous encoder 4.0MHz(without multiple rotation output)
*Used when the position at the turn-on state is zero.

■absolute system (multiple rotation backup system)
0x0300:optical asynchronous encoder 2.5MHz(with multiple rotation output)
0x0400:optical asynchronous encoder 4.0MHz(with multiple rotation output)
0x0600:resolver asynchronous encoder 2.5MHz(with multiple rotation output)
0x0600:resolver asynchronous encoder 4.0MHz(with multiple rotation output)

■Incremental system (multiple rotation output system)
0x0301:optical asynchronous encoder 2.5MHz(with multiple rotation output)
0x0401:optical asynchronous encoder 4.0MHz(with multiple rotation output)
0x0501:resolver asynchronous encoder 2.5MHz(with multiple rotation output)
0x0601:resolver asynchronous encoder 4.0MHz(with multiple rotation output)
*When the absolute encoder is used in the Incremental system, it is used when the turn-on state position is zero.
In this setting, battery trouble and battery warnings are not detected.

■Incremental system (Clearing multiple rotation at initialization: +/- 1 turn or less)
0x0302:optical asynchronous encoder 2.5MHz(with multiple rotation output. +/- 1 turn or less at initialization)
0x0402:optical asynchronous encoder 4.0MHz(with multiple rotation output. +/- 1 turn or less at initialization)
0x0502:resolver asynchronous encoder 2.5MHz(with multiple rotation output. +/- 1 turn or less at initialization)
0x0602:resolver asynchronous encoder 4.0MHz(with multiple rotation output. +/- 1 turn or less at initialization)
*Performing encoder clearing by initialization when power turns on.
In this setting, battery trouble and battery warnings are not detected.

■Linear scale encoder (Only when using linear motor)
0x0850:signal/ limited to A,B, and Z :CS normalization/ software setting (Magnetic pole position estimation)
0x0860:signal/ limited to A,B, and Z :CS normalization/ software setting (forced setting)

■Setting with the Setup software configuration
0x8000: Auto setting of motor parameter (When connected to applicable motor.)
0xFFFF: R ADVANCED – with the encoder setting (EEPROM setting value) set in Setup software

✍ Initialized by the encoder variety code set in EEPROM at the turn-on state.
When the encoder variety set parameter is different from the EEPROM value set, the function will be enabled by control source re-closing. After the new value is set in EEPROM, alarm ”DE: parameter change completed” occurs, then re-close control source.
✍ Automatic setting of motor parameter is performed when re-turning on the power supply after 0x8000 is set to any of motor code (0x20FE: 0x00), encoder division number code (0x20FF: 0x01), or encoder type code (0x20FF: 0x02). After that the three values are updated automatically.

## 11) Monitor Parameter

0x2100: Status Word 1

| | | | | | |
|---|---|---|---|---|---|
| Index Ax1 0x2100<br>Ax2 0x2300<br>Ax3 0x2500<br>Ax4 0x2700 | Indicates servo amplifier status. | | Object Code | | Variable |
| Sub-Idx | Description | Data Type | Access | PDO | Initial value |
| 0x00 | Status Word 1<br>Indicates various internal statuses of the amplifier. | Unsigned16 | RO | Possible | - |

MSB LSB

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| zv | sact | eact | bcnt | eclrm | ecsm | near | inps |
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |

bit0:In-Position Monitor [INPS]
Set to "1" when the actual position is within the position window (0x6067) (indefinite except for csp and ip.)

bit1:Near Range Monitor [NEAR]
Set to "1" when the actual position is within the near range (0x201F) (Indefinite except for csp and ip.)

bit2: encoder C phase monitor [ECSM]
Set to "1" when the C signal(Z) of the incremental encoder is input. (indefinite except for INC-E.)

bit3:Encoder Clear Monitor [ECLRM]
Set to "1" during encoder clearance.

bit4: Brake Control [BCNT]
This is a holding brake release timing output.
Set to "1" while the brake is released.

bit5: Actual position effective monitor [EACT]
Set to "1" when encoder signal can be read.

bit6: Command reception-enable monitor ［SACT］
Set to"1" when command reception enabled.

bit7:Speed Zero Monitor [ZV]
Set to "1" when the actual velocity is within zero velocity range (0x2020) for 1ms or more.

MSB LSB

| | | | | | | |
|---|---|---|---|---|---|---|
| pse | psr | Gests | Ta | vcmp | vp | ltg |
| 15 | 14 | 13-12 | 11 | 10 | 9 | 8 |

bit8:Low Speed Monitor [LTG]
When the actual velocity is in the low velocity range or less (0x2021), set at "1."

bit9:Speed Attainment Monitor [VA]
When the actual velocity is in the speed attainment range or greater (0x2002), set at "1."

bit10:Speed Matching Monitor [VCMP]
When the actual velocity is within the set rotation set by 0x20F0.3 velocity window (velocity consistent) unit output selection, set at "1."
*When the velocity window (0x606D) selected: compare with the rotation number setting (min-1).
* When the velocity window (0x606D) selected: compare with the proportion setting (%).

Bit11: Torque (force) attainment monitor ［TA］
Set to "1" when internal velocity command is over Torque (force) attainment (0x202E）.

bit13,12：PP trajectory generation status monitor ［GESTS］
The status of trajectory generator is shown.
Bit13,12 = 0,0 : Stop
Bit13,12 = 0,1 : In acceleration
Bit13,12 = 1,0 : In constant velocity
Bit13,12 = 1,1 : In deceleration

bit15-14: Position sync compensation status monitor [PSE,PSR]
Monitors the status of position sync compensation.
Bit14 = 1 : In position sync compensation
Bit15 = 1 : In position deviation data receiving

0x2101: Amplifier Error Field

| Index | | | | | | | |
|---|---|---|---|---|---|---|---|
| Ax1 0x2101<br>Ax2 0x2301<br>Ax3 0x2501<br>Ax4 0x2701 | Indicates the alarm occurring in the servo amplifier. Sub-Index 0x00 indicates the number of alarms that are currently occurring, and Sub-Index 0x01-0x04 indicates the contents of alarms and Amplifier Status when the alarms occur up to four. Resets the alarm by setting Alarm reset in Control Word (0x6040.7). | | | | | | Object Code<br>Array |
| Sub-Idx | Name | Description | Data Type | Access | PDO | Initial value | |
| 0x00 | Number of entry | | Unsigned8 | RO | No | 0x04 | |
| 0x01 | Error 1 | : Alarm 1 [ALMACT1] | Unsigned8 | RO | Possible | 0x00 | |
| 0x02 | Error 2 | : Alarm 2 [ALMACT2] | Unsigned8 | RO | Possible | 0x00 | |
| 0x03 | Error 3 | : Alarm 3 [ALMACT3] | Unsigned8 | RO | Possible | 0x00 | |
| 0x04 | Error 4 | : Alarm 4 [ALMACT4] | Unsigned8 | RO | Possible | 0x00 | |

| MSB | | | | | | | LSB |
|---|---|---|---|---|---|---|---|
| ALMCODE | | | | | | | |
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |

bit7-0:Alarm Code defined by this servo amplifier
See the Alarm Code list.

0x2102: Description of Alarm Trace

| Index | | | | | |
|---|---|---|---|---|---|
| Ax1 0x2102<br>Ax2 0x2302<br>Ax3 0x2502<br>Ax4 0x2702 | Indicates the Alarm history of the servo amplifier occurring now or previously. | | Object Code | | Array |
| Sub-Idx | Description | Data Type | Access | PDO | Initial value |
| 0x00 | Number of entry | Unsigned8 | RO | No | 0x08 |
| 0x01 | Now Status [NOWALM]<br>*When the Alarm doesn't occur, it becomes 0x0000. | Unsigned32 | RO | Possible | 0x00000000 |
| 0x02 | 1st Latest Alarm [LASTAL1] | Unsigned32 | RO | Possible | 0x00000000 |
| 0x03 | 2nd Latest Alarm [LASTAL2] | Unsigned32 | RO | Possible | 0x00000000 |
| 0x04 | 3rd Latest Alarm [LASTAL3] | Unsigned32 | RO | Possible | 0x00000000 |
| 0x05 | 4th Latest Alarm [LASTAL4] | Unsigned32 | RO | Possible | 0x00000000 |
| 0x06 | 5th Latest Alarm [LASTAL5] | Unsigned32 | RO | Possible | 0x00000000 |
| 0x07 | 6th Latest Alarm [LASTAL6] | Unsigned32 | RO | Possible | 0x00000000 |
| 0x08 | 7th Latest Alarm [LASTAL7] | Unsigned32 | RO | Possible | 0x00000000 |

| MSB | | LSB |
|---|---|---|
| ALMRUNTIME | ALMSTS | ALMCODE |
| 31 - 16 | 15 - 8 | 7 - 0 |

bit7-0: Ararm Code defined by this servo amplifier
See the Ararm Code list.

bit15-8：Status when an alarm occurs
See the Status list.

bit32-16: Cumulative operating times when an alarm occurs
(The value at the time of shipment：0H)
The cumulative operation times when an alarm occurs (2 Hour / LSB units)
Increments every two hours after control power on.
* Please use as a guide by the hour increments.

Status (ALMSTS) function

| Status Display | ALMSTS | Status Display | ALMSTS |
|---|---|---|---|
| Power OFF | 0x00 | Servo ON 1(Reprocessing the electric current detector) | 0x07 |
| Power ON 1<br>(electric current detector during setting) | 0x01 | Servo ON 2<br>(command reception allowed) | 0x08 |
| Power ON 2(main circuit charging) | 0x02 | magnetic pole position detected<br>(Reserved) | 0x09 |
| Power ON 3(main circuit charged) | 0x03 | Emergency stop 1<br>(Emergency Stop status) | 0x0A |
| Servo ready | 0x04 | Emergency stop 2(CNOTRDY) | 0x0B |
| Prepared for magnetic pole position detection (Reserved) | 0x05 | Reserved | 0x0C-0x0E |
| Power ON 4 | 0x06 | Initial State | 0x0F |

0x2103: Warning Status

| | | | |
|---|---|---|---|
| Index Ax1 0x2103<br>Ax2 0x2303<br>Ax3 0x2503<br>Ax4 0x2703 | Indicates the warnings and limitation status of the servo amplifier. | Object Code | Record |

| Sub-Idx | Description | Data Type | Access | PDO | Initial value |
|---|---|---|---|---|---|
| 0x00 | Number of entry | Unsigned8 | RO | No | 0x02 |
| 0x01 | Warning monitor [WARMON]<br>0:no warning (without limitation)<br>1:during warning (under limitation) | Unsigned16 | RO | Possible | 0x0000 |

| MSB | | | | | | | LSB |
|---|---|---|---|---|---|---|---|
| tlw | - | vlw | tlw | rolw | olw | modw | tpw |
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |

bit0:Temperature Warning
bit1:Modulo initialization warning
bit2:While Overload Warning
bit3:While Regenerative Overload Warning
bit4:Torque controlled
bit5:Velocity command controlled
bit6: Position Synchronization Deviation
bit7:Position deviation Warning

| MSB | | | | | | | LSB |
|---|---|---|---|---|---|---|---|
| cpew | btw | maxw | minw | hlw | llw | - | pow |
| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 |

bit8: Main circuit power being charged
bit9: Correction Table Data Warning
bit10:Forward direction Over-travel(positive direction)
bit11:Reverse direction Over-travel(negative direction)
bit12: While the minimum position is limited
bit13: While the maximum position is limited
bit14:While Battery Warning
bit15: Control electricity and voltage decrease warning

| Sub-Idx | Description | Data Type | Access | PDO | Initial value |
|---|---|---|---|---|---|
| 0x02 | Warning mask Selection [WARMSK]<br>Sets the condition to set status word (0x6041) bit7: warning status. Clears the corresponding bits for warning monitors to get rid of from the warning status condition.<br>After the AND operation of the Warning Monitor/ Mask, if flags are set, sets Warning status. | Unsigned16 | RW | No | 0x4E8D |

0x2104: Actual Gain Monitor

| | | | | | |
|---|---|---|---|---|---|
| Index Ax1 0x2104<br>Ax2 0x2304<br>Ax3 0x2504<br>Ax4 0x2704 | Indicates the actual setting value of the gain parameter to switch to real time various gain parameters through auto-tuning or gain switching selection. | | Object Code | | Array |
| Sub-Idx | Description | Data Type | Access | PDO | Initial value |
| 0x00 | Number of entry | Unsigned8 | RO | No | 0x07 |
| 0x01 | Actual Position Loop Proportional Gain [KPMON]<br>Outputs the value of the position loop gain (0x2005) that is switched in auto-tuning mode (0x2002) or the gain switching selection (0x2001, bit 5-4), and is currently used for the servo control. | Unsigned16 | RO | Possible | 0x001E<br>(30 /s) |
| | | Setting range | 0x0001-0x0BB8<br>(1-3000 /s) | | |
| | | Unit | 1/s | | |
| 0x02 | Actual Position Integral Time Constant [TPIMON]<br>Outputs the value of the position integral time constant (0x2006) that is switched in auto-tuning mode (0x2002) or the gain switching selection (0x2001, bit 5-4), and is currently used for the servo control. | Unsigned16 | RO | Possible | 0x2710<br>(1000ms)<br>proportional control |
| | | Setting range | 0x0003-0x2710<br>(0.3-1000 ms) | | |
| | | Unit | 0.1ms | | |
| 0x03 | Actual Velocity Loop Proportional Gain [KVPMON]<br>Outputs the value of the velocity loop proportional gain (0x200B) that is switched in auto-tuning mode (0x2002) or the gain switching selection (0x2001, bit 5-4), and is currently used for the servo control. | Unsigned16 | RO | Possible | 0x0032<br>(50Hz) |
| | | Setting range | 0x0001-0x07D0<br>(1-2000 Hz) | | |
| | | Unit | Hz | | |
| 0x04 | Actual Velocity Loop Integral Time Constant [TVIMON]<br>Outputs the value of the velocity loop integral time constant (0x200C) that is switched in auto-tuning mode (0x2002) or the gain switching selection (0x2001, bit 5-4), and is currently used for the servo control. | Unsigned16 | RO | Possible | 0x00C8<br>(20ms) |
| | | Setting range | 0x0003-0x2710<br>(0.3-1000 ms) | | |
| | | Unit | 0.1ms | | |
| 0x05 | Actual Load Inertia Moment Ratio [JRATMON]<br>Outputs the value of the load inertia moment ratio (0x200D) that is switched in auto-tuning mode (0x2002) or the gain switching selection (0x2001, bit 5-4), and is currently used for the servo control. | Unsigned16 | RO | Possible | 0x0064<br>(100%) |
| | | Setting range | 0x0000-0x3A98<br>(0-15000%) | | |
| | | Unit | % | | |
| 0x06 | Actual Torque (force) Command Filter [TCFILMON]<br>Outputs the value of the torque command filter (0x2011) that is switched in auto-tuning mode (0x2002) or the gain switching selection (0x2001, bit 5-4), and is currently used for the servo control. | Unsigned16 | RO | Possible | 0x0258<br>(600Hz) |
| | | Setting range | 0x0001-0x07D0<br>(1-2000 Hz) | | |
| | | Unit | Hz | | |
| 0x07 | Actual Model Control Gain [MKPMON]<br>Outputs the value of the model control gain (0x2017) that is switched in auto-tuning mode (0x2002) or the gain switching selection (0x2001, bit 5-4), and is currently used for the servo control. | Unsigned16 | RO | Possible | 0x001E<br>(30 /s) |
| | | Setting range | 0x0001-0x0BB8 (1-3000 /s) | | |
| | | Unit | 1/s | | |

0x2105: Z-phase Signal Base Actual Position

| | | | | | |
|---|---|---|---|---|---|
| Index Ax1 0x2105<br>Ax2 0x2305<br>Ax3 0x2505<br>Ax4 0x2705 | Indicates the Actual Position from Zero-phase. | | Object Code | | Variable |
| Sub-Idx | Description | Data Type | Access | PDO | Initial value |
| 0x00 | Z-phase Signal Base Actual Position [CCUNIT]<br>*In the incremental encoder<br>indicates the position within one rotation based on C phase.<br>The location increases to the direction of CCW seen head-on.<br>The unit is 1 Pulse/LSB, four-fold value of A･B phases.<br>It is indefinite after the turning-on until C phase is detected. (Example: At the 1024P/Re encoder, 0 - 4095Pulse indicated)<br>*In the Absolute Encoder,<br>indicates the position within one rotation based on Absolute Positon. | Integer32 | RO | Possible | - |
| | | Setting range | 0x00000000-0xFFFFFFFF<br>(0-4294967295 Pulse) | | |
| | | Unit | Pulse | | |

0x2106: Internal Velocity Command Monitor

| | | | | | |
|---|---|---|---|---|---|
| Index Ax1 0x2106<br>Ax2 0x2306<br>Ax3 0x2506<br>Ax4 0x2706 | Has the actual velocity value calculated from the position encoder<br>The value is provided by the user-defined velocity unit. | | Object Code | | Variable |
| Sub-Idx | Description | Data Type | Access | PDO | Initial value |
| 0x00 | Internal Velocity Command Monitor [VCMON]<br>An Internal Velocity Command Value after passing the Velocity Command low-pass filter. | Integer32 | RO | Possible | - |
| | | Setting range | 0x80000000-0x7FFFFFFF<br>(-2147483648-2147483647 pps) | | |
| | | Unit | Pulse/sec | | |

### 0x2107: Internal Torque (force) Command Monitor

| | | | | | |
|---|---|---|---|---|---|
| Index Ax1 0x2107<br>Ax2 0x2307<br>Ax3 0x2507<br>Ax4 0x2707 | Indicates the torque (force) indication monitor inside the servo amplifier. | | Object Code | | Variable |
| Sub-Idx | Description | Data Type | Access | PDO | Initial value |
| 0x00 | Internal Torque Command Monitor [TCMON]<br>An Internal Torque (force) Command value after passing the Velocity Command low-pass filter. It is indicated at the ratio with the motor rated torque (force) 100%. | Integer16 | RO | Possible | - |
| | | Setting range | 0x8000-0x7FFF<br>(-3276.8-3276.7 %) | | |
| | | Unit | 0.1 % | | |

### 0x2108: Motor utilization monitor (Effective torque (force) estimate value)

| | | | | | |
|---|---|---|---|---|---|
| Index Ax1 0x2108<br>Ax2 0x2308<br>Ax3 0x2508<br>Ax4 0x2708 | Indicates the estimation value of the Effective Motor Torque (force). | | Object Code | | Variable |
| Sub-Idx | Description | Data Type | Access | PDO | Initial value |
| 0x00 | Number of entry | Unsigned8 | RO | No | 0x02 |
| 0x01 | Effective Torque (force) Estimated Value [TRMS]<br>Indicates the Effective Motor Torque (force) against the motor rated torque (force).<br>* The exact value is indicated, but in some operation patterns, it may take several hours to stabilize the figure. | Unsigned16 | RO | Possible | - |
| | | Setting range | 0x0000-0xFFFF<br>(0-65535 %) | | |
| | | Unit | % | | |
| 0x02 | Fast Effective Torque (force) Estimate Value [ETRMS]<br>Indicates the Effective Motor Torque (force) of time constant (1/16) against TRMS.<br>* Quick estimation is possible in applications where short-cycle operation patterns are repeated. | Unsigned16 | RO | Possible | - |
| | | Setting range | 0x0000-0xFFFF<br>(0-65535 %) | | |
| | | Unit | % | | |

### 0x2109: Temperature inside the servo amplifier

| | | | | | |
|---|---|---|---|---|---|
| Index Ax1 0x2109<br>Ax2 0x2309<br>Ax3 0x2509<br>Ax4 0x2709 | Indicates the temperature inside the servo amplifier. | | Object Code | | Variable |
| Sub-Idx | Description | Data Type | Access | PDO | Initial value |
| 0x00 | Temperature inside the servo amplifier [ATEMP]<br>The monitor value inside the servo amplifier (near the control CPU). The unit is the Celsius scale and indicated by 1 °C / LSB. | Integer16 | RO | Possible | - |
| | | Setting range | 0x8000-0x7FFF<br>(-32768-32767 °C) | | |
| | | Unit | °C | | |
| | If Monitor value <= -10 ゚C, +75 ゚C <= Monitor value, it indicates temperature warning.<br>If Monitor value <= -15 ゚C, +95 ゚C <= Monitor value , it indicates temperature alarm.<br>Conversion to Fahrenheit (F) is calculated according to the following formula: F = 9 / 5 * C+32.F = 9 / 5 * C+32. | | | | |

### 0x210A: Regenerative resistor operation percentage monitor

| | | | | | |
|---|---|---|---|---|---|
| Index 0x210A | An estimate monitor of the operation ratio of the servo amplifier regenerative resistor. This amplifier has single ESC. So, this is single object, also. | | Object Code | | Variable |
| Sub-Idx | Description | Data Type | Access | PDO | Initial value |
| 0x00 | Regenerative resistor operation percentage monitor [REGP]<br>An operation percentage monitor of regenerative resistors representing the regenerator-on time ratio in 1sec. The regenerative electricity PM is calculated according to the following formula, using this monitor value. | Unsigned16 | RO | Possible | 0x0000<br>(0%) |
| | | Setting range | 0x0000-0xFFFF<br>(0-655.35%) | | |
| | | Unit | 0.01 % | | |
| | For DC48V input:<br>PM (W)=$60^2$(V)/regenerative resistance value (ohm)×Regenerative resistor operation percentage (%)/100(%)<br>For DC24V input:<br>PM (W)=$30^2$(V)/regenerative resistance value (ohm)×Regenerative resistor operation percentage (%)/100(%) | | | | |

### 0x210B: Encoder Temperature Monitor

| | | | | | |
|---|---|---|---|---|---|
| Index Ax1 0x210B<br>Ax2 0x230B<br>Ax3 0x250B<br>Ax4 0x270B | The temperature of an encoder is displayed. | | Object Code | | Variable |
| Sub-Idx | Description | Data Type | Access | PDO | Initial value |
| 0x00 | Encoder Temperature Monitor [ETEMP]<br>The monitor value of the temperature of the encoder control board, shown in the unit of ℃ Celsius/LSB. | Integer16 | RO | Possible | — |
| | | Setting range | 0xFF80-0x007F<br>（－128-127 ℃） | | |
| | | Unit | ℃ | | |
| | ✔The encoder temperature is detected at the time that the servo amplifier stops. If the stop status continues, the encoder temperature monitor continuously and repeatedly detects the temperature of the encoder each 1s cycle.<br>✔When the encoder temperature detection is set to disable (0x2000 bit13 = 1), it will not detect the temperature. | | | | |

0x210C: Home Index Position Detection Value

| | | | | |
|---|---|---|---|---|
| Index Ax1 | 0x210C | Home Index Positions latched by various systems of homing modes. | Object Code | Variable |
| Ax2 | 0x230C | | | |
| Ax3 | 0x250C | | | |
| Ax4 | 0x270C | | | |

| Sub-Idx | Description | Data Type | Access | PDO | Initial value |
|---|---|---|---|---|---|
| 0x00 | Home Index Position Detection Value [HOMEIDX]<br>When homing activate and lached home index then indicates Internal position.<br>*Incremental system<br>Internal position is based on counter value when control power on.<br>*Absolute system<br>Internal position is based on absolute encorder value. | Integer32 | RO | Possible | - |
| | | Setting range | 0x80000000-0x7FFFFFFF<br>(-2147483648-2147483647Pulse) | | |
| | | Unit | Pulse | | |

0x210D: Position Synchronization Deviation Monitor

| | | | | |
|---|---|---|---|---|
| Index Ax1 | 0x210D | Position deviation between two synchronous connected amplifiers is monitored. | Object Code | Variable |
| Ax2 | 0x230D | | | |
| Ax3 | 0x250D | | | |
| Ax4 | 0x270D | | | |

| Sub-Idx | Description | Data Type | Access | PDO | Initial value |
|---|---|---|---|---|---|
| 0x00 | Position Synchronization Deviation Monitor [PSYNDEV]<br>When positon synchronization correction function is valid, the monitor indicates error pulse quantity from position deviation of amplifiers which are subject to synchronization.<br>✔This is valid when 0x01 - 0x04 in 0x2035-8 Assist-function selection is set. | Integer32 | RO | Possible | — |
| | | Setting range | 0x80000000-0x7FFFFFFF<br>(—2147483648-2147483647 pulse) | | |
| | | Unit | Pulse | | |

0x2110: Internal Control Cycle Position Actual Value

| | | | | |
|---|---|---|---|---|
| Index Ax1 | 0x2110 | Returns the Actual Position value latched every control cycle (125μs).<br>Monitor unit is expressed by the resolution of the motor encoder used. | Object Code | Array |
| Ax2 | 0x2310 | | | |
| Ax3 | 0x2510 | | | |
| Ax4 | 0x2710 | | | |

| Sub-Idx | Description | Data Type | Access | PDO | Initial value |
|---|---|---|---|---|---|
| 0x00 | Number of entry | Unsigned8 | RO | No | 0x07 |
| 0x01 | Internal Control Cycle Actual Position 1<br>Actual position of 0x6064, 125μs ago. | Integer32 | RO | Possible | - |
| 0x02 | Internal Control Cycle Actual Position 2<br>Actual position of 0x6064, 250μs ago. | Integer32 | RO | Possible | - |
| 0x03 | Internal Control Cycle Actual Position 3<br>Actual position of 0x6064, 375μs ago. | Integer32 | RO | Possible | - |
| 0x04 | Internal Control Cycle Actual Position 4<br>Actual position of 0x6064, 500μs ago. | Integer32 | RO | Possible | - |
| 0x05 | Internal Control Cycle Actual Position 5<br>Actual position of 0x6064, 625μs ago. | Integer32 | RO | Possible | - |
| 0x06 | Internal Control Cycle Actual Position 6<br>Actual position of 0x6064, 750μs ago. | Integer32 | RO | Possible | - |
| 0x07 | Internal Control Cycle Actual Position 7<br>Actual position of 0x6064, 875μs ago. | Integer32 | RO | Possible | - |
| | | Setting range | 0x80000000-0x7FFFFFFF<br>(-2147483648-2147483647 Pulse) | | |
| | | Unit | Pulse | | |

0x2111: Internal Control Cycle Actual Velocity

| Index | | Description | | Object Code | | Array |
|---|---|---|---|---|---|---|
| Index Ax1 0x2111<br>Ax2 0x2311<br>Ax3 0x2511<br>Ax4 0x2711 | Returns the Actual Velocity value latched every control cycle (125μs). | | | Object Code | | Array |
| Sub-Idx | Description | Data Type | | Access | PDO | Initial value |
| 0x00 | Number of entry | Unsigned8 | | RO | No | 0x07 |
| 0x01 | Internal Control Cycle Actual Velocity 1<br>Actual velocity of 0x606C, 125μs ago. | Integer32 | | RO | Possible | - |
| 0x02 | Internal Control Cycle Actual Velocity 2<br>Actual velocity of 0x606C, 250μs ago. | Integer32 | | RO | Possible | - |
| 0x03 | Internal Control Cycle Actual Velocity 3<br>Actual velocity of 0x606C, 375μs ago. | Integer32 | | RO | Possible | - |
| 0x04 | Internal Control Cycle Actual Velocity 4<br>Actual velocity of 0x606C, 500μs ago. | Integer32 | | RO | Possible | - |
| 0x05 | Internal Control Cycle Actual Velocity 5<br>Actual velocity of 0x606C, 625μs ago. | Integer32 | | RO | Possible | - |
| 0x06 | Internal Control Cycle Actual Velocity 6<br>Actual velocity of 0x606C, 750μs ago. | Integer32 | | RO | Possible | - |
| 0x07 | Internal Control Cycle Actual Velocity 7<br>Actual velocity of 0x606C, 875μs ago. | Integer32 | | RO | Possible | - |
| *Data is filtered and the cutoff frequency is 250Hz. | | Setting range | | 0x80000000-0x7FFFFFFF<br>(-2147483648-2147483647 pps) | | |
| | | Unit | | Pulse/sec | | |

0x2112: Internal Control Cycle Actual Torque (force)

| Index | | Description | | Object Code | | Array |
|---|---|---|---|---|---|---|
| Index Ax1 0x2112<br>Ax2 0x2312<br>Ax3 0x2512<br>Ax4 0x2712 | Returns the Actual Torque (force) value latched every control cycle (125μs). | | | Object Code | | Array |
| Sub-Idx | Description | Data Type | | Access | PDO | Initial value |
| 0x00 | Number of entry | Unsigned8 | | RO | No | 0x03 |
| 0x01 | Internal Control Cycle Actual Torque (force) 1<br>Actual torque(force)position of 0x6077, 125μs ago. | Integer16 | | RO | Possible | - |
| 0x02 | Internal Control Cycle Actual Torque (force) 2<br>Actual torque(force) of 0x6077, 250μs ago. | Integer16 | | RO | Possible | - |
| 0x03 | Internal Control Cycle Actual Torque (force) 3<br>Actual torque(force) of 0x6077, 375μs ago. | Integer16 | | RO | Possible | - |
| 0x04 | Internal Control Cycle Actual Torque (force) 4<br>Actual torque(force) of 0x6077, 500μs ago. | Integer16 | | RO | Possible | - |
| 0x05 | Internal Control Cycle Actual Torque (force) 5<br>Actual torque(force) of 0x6077, 625μs ago. | Integer16 | | RO | Possible | - |
| 0x06 | Internal Control Cycle Actual Torque (force) 6<br>Actual torque(force) of 0x6077, 750μs ago. | Integer16 | | RO | Possible | - |
| 0x07 | Internal Control Cycle Actual Torque (force) 7<br>Actual torque(force) of 0x6077, 875μs ago. | Integer16 | | RO | Possible | - |
| Monitor unit is the 1/1000 units of the rated torque (force) and 0.1% / LSB. | | Setting range | | 0x8000-0x7FFF<br>(-3276.8-3276.7%) | | |
| | | Unit | | 0.1% | | |

0x2116： Actual Velocity 2

| | | | |
|---|---|---|---|
| Index Ax1 0x2116<br>Ax2 0x2316<br>Ax3 0x2516<br>Ax4 0x2716 | Has actual velocity value caluculated from position encoder. Value shall be given in the velocity unit of user definition. | Object Code | Variable |

| Sub-Idx | Description | Data Type | Access | PDO | Initial value |
|---|---|---|---|---|---|
| 0x00 | Actual Velocity ［ACVMON2］ | Integer32 | RO | Possible | － |
| | ✔Filter is processed data, and cutoff frequency is 20Hz | Setting range | 0x80000000-0x7FFFFFFF<br>（－2147483648-2147483647 pps） | | |
| | | Unit | Pulse/sec | | |

0x2117: Position Actual Value 2

| | | | |
|---|---|---|---|
| Index Ax1 0x2117<br>Ax2 0x2317<br>Ax3 0x2517<br>Ax4 0x2717 | Indicates the actual position without backlash correction value. | Object Code | Variable |

| Sub-Idx | Description | Data Type | Access | PDO | Initial value |
|---|---|---|---|---|---|
| 0x00 | Position Actual Value 2 ［APMON2］<br>Indicates the actual position without backlash correction value. | Integer32 | RO | Possible | － |
| | | Setting range | 0x80000000-0x7FFFFFFF<br>（－2147483648-2147483647） | | |
| | | Unit | Pulse | | |
| | ◆With backlash correction<br>Position Actual Value 2 ＝Position Actual Value (0x6064) - Backlash correction value (0x5091)<br>◆Without backlash correction<br>Position Actual Value 2 ＝Position Actual Value | | | | |

0x2120： Amplifier Parameter Information

| | | | |
|---|---|---|---|
| Index Ax1 0x2120<br>Ax2 0x2320<br>Ax3 0x2520<br>Ax4 0x2720 | Indicate servo amplifier status. | Object Code | Array |

| Sub-Idx | Description | Data Type | Access | PDO | Initial value |
|---|---|---|---|---|---|
| 0x00 | Number of entry | Unsigned8 | RO | No | 0x04 |
| 0x01 | Indicate status of alarm masking.<br>Each bit fit to alarm below. | Unsigned32 | RO | Possible | 0x00000000 |

| | Alarm | | Alarm |
|---|---|---|---|
| Bit31 | EEPE2 | Bit15 | PARE |
| Bit30 | MPARA | Bit14 | OVC |
| Bit29 | VCCE | Bit13 | OVF |
| Bit28 | IPMOH | Bit12 | All of encoder alarm |
| Bit27 | RSOH | Bit11 | All of communication alarm |
| Bit26 | HWBBE1,2 | Bit10 | RGOL |
| Bit25 | Reserved | Bit9 | IFBE1 - 3 |
| Bit24 | SOL | Bit8 | IPME |
| Bit23 | Main Circuit Under-voltage alarm | Bit7 | EXOH |
| Bit22 | DBOH | Bit6 | RGOH |
| Bit21 | TSKE | Bit5 | AOH |
| Bit20 | ADBUSE | Bit4 | OVC |
| Bit19 | RAME | Bit3 | OL |
| Bit18 | PE | Bit2 | OS |
| Bit17 | CPE | Bit1 | FP |
| Bit16 | OVE | Bit0 | MPE |

Alarm is masked by setting 1 to each bit.

| Sub-Idx | Description | Data Type | Access | PDO | Initial value |
|---|---|---|---|---|---|
| 0x02 | Control status<br>Indicate control by<br>Since this amplifier is controlled by only the EtherCAT communication, values other than 1 cannot be set. | Unsigned8 | RW | No | 0x01 |
| 0x03 | Amplifier running time<br>Indicate total power on time after shipping from factory in increments of 2 hours. | Unsigned32 | RO | No | － |
| | | Unit | 2 hour | | |
| 0x04 | External regenerative resistance<br>Indicate recommended value of minimum external regenerative resistance. | Unsigned32 | RW | Possible | ※ |
| | | Setting range | 0x00000000-0xFFFFFFFF | | |
| | | Unit | mΩ | | |

※) Initial value varies addording to amplifier capacity.

0x2151: Error Register

| | | | |
|---|---|---|---|
| Index Ax1 0x2151<br>Ax2 0x2351<br>Ax3 0x2551<br>Ax4 0x2751 | Indicates error state of slave.<br>Refer to (Error Field Definition) for the details of error. | Object Code | VAR |

| Sub-Idx | Name/Description | Data Type | Access | PDO | Initial Value |
|---|---|---|---|---|---|
| 0x00 | Error Register ［ERRREG］<br>Bit7:Maker Definition Error<br>Bit6:Reserved<br>Bit5:Device Profile Definition Error<br>Bit4:Communication Error<br>Bit3:Temperature Error<br>Bit2:Voltage Error<br>Bit1:Current Error<br>Bit0:Generic error<br>✔Index 0x2151 is same as Index 0x1001. | Unsigned8 | RO | Possible | 0x00 |

0x2152: Device Name

| | | | |
|---|---|---|---|
| Index Ax1 0x2152<br>Ax2 0x2352<br>Ax3 0x2552<br>Ax4 0x2752 | Indicates product device name. | Object Code | VAR |

| Sub-Idx | Name/Description | Data Type | Access | PDO | Value |
|---|---|---|---|---|---|
| 0x00 | Device Name ［DEVICE］<br>Product Device Name (ASCII Code)<br>✔Index 0x2152 is same as Index 0x1008. | Visible String | RO | No | Character String<br>(-) |
| RF2 | | | | | |

0x2153: FPGA Hardware Version

| | | | | |
|---|---|---|---|---|
| Index | 0x2153 | Indicates FPGA hardware version. | Object Code | VAR |

| Sub-Idx | Name/Description | Data Type | Access | PDO | Value |
|---|---|---|---|---|---|
| 0x00 | Hardware Version ［HARDVER］<br>Hardware Version of Device | Visible String<br>（Unsigned32） | RO | No | Character String<br>(-) |

0x2154: Communication Software Version

<table>
<tr><td>Index</td><td>0x2154</td><td colspan="2">Indicates product software version.</td><td colspan="2">Object Code</td><td>VAR</td></tr>
<tr><td>Sub-Idx</td><td colspan="2">Name/Description</td><td>Data Type</td><td>Access</td><td>PDO</td><td>Value</td></tr>
<tr><td>0x00</td><td colspan="2">Software Version [SOFTVER]<br>Communication Software Version of Device</td><td>Visible String<br>（Unsigned32）</td><td>RO</td><td>No</td><td>Character String<br>(-)</td></tr>
<tr><td colspan="7">8 E 0 0 . 0 . 5 7 2 0</td></tr>
</table>

Byte 10, 11: Date of firmware compiled
1: 1st, 2: 2nd ・・・ 30: 30th, 31: 31th

Byte 9: Month of firmware compiled
1: Jan., 2: Feb. ・・・ A: Oct., B: Nov., C: Dec.

Byte 8: Year of firmware compiled
5: in 2015 ・・・ A: in 2020 ・・・ F: in 2025 ・・・

Byte 6: Manufacturer specific profile revision
SANYO DENKI-conroled number: “0,1・・・9,A・・・Y, Z”

Byte 3,4: Amplifier revistion
1: Revision “B” 2: Revision “C” ・・・

Byte 1, 2: Series Name
8E: RF2-EtherCAT Interface

0x2155: Servo Software Version

<table>
<tr><td>Index Ax1<br>Ax2<br>Ax3<br>AX4</td><td>0x2155<br>0x2355<br>0x2555<br>0x2755</td><td colspan="2">Indicates product software version.</td><td colspan="2">Object Code</td><td>VAR</td></tr>
<tr><td>Sub-Idx</td><td colspan="2">Name/Description</td><td>Data Type</td><td>Access</td><td>PDO</td><td>Value</td></tr>
<tr><td>0x00</td><td colspan="2">Software Version [SOFTVER]<br>Servo Software Version of Device<br><br>✔Index 0x2155 is nearly same as Index 0x100A.</td><td>Visible String<br>（Unsigned32）</td><td>RO</td><td>No</td><td>Character String<br>(-)</td></tr>
<tr><td colspan="7">8 D 0 0 . 0 . 0 7 2 0</td></tr>
</table>

Byte 10,11: Date of firmware compiled
1: 1st, 2: 2nd ・・・ 30: 30th, 31: 31th

Byte 9: Month of firmware compiled
1: Jan., 2: Feb. ・・・ A: Oct., B: Nov., C: Dec.

Byte 8: Year of firmware compiled
5: in 2015 ・・・ A: in 2020 ・・・ F: in 2025 ・・・

Byte 6: Manufacturer specific profile revision
SANYO DENKI-conroled number: “0,1・・・9,A・・・Y, Z”

Byte 3,4: Amplifier revistion
1: Revision “B” 2: Revision “C” ・・・

Byte 1, 2: Series Name
8D: RF2-EtherCAT Interface

0x2156: Alarm Estimation Cause Code

| | | | | |
|---|---|---|---|---|
| Index Ax1<br>Ax2<br>Ax3<br>Ax4 | 0x2156<br>0x2356<br>0x2556<br>0x2756 | Indicates estimated cause code for alarm occurrence.<br>Amount of indicating estimated cause code differs depending on kinds of occurred alarm. | Object Code | Variable |

| Sub-Idx | Description | | Data Type | Access | PDO | Initial Value |
|---|---|---|---|---|---|---|
| 0x00 | Number of entry | | Unsigned8 | RO | No | 0x08 |
| 0x01 | Alarm Estimation Cause Code 1 | [ALMCAUSE1] | Unsigned16 | RO | No | 0x0000 |
| 0x02 | Alarm Estimation Cause Code 2 | [ALMCAUSE2] | Unsigned16 | RO | No | 0x0000 |
| 0x03 | Alarm Estimation Cause Code 3 | [ALMCAUSE3] | Unsigned16 | RO | No | 0x0000 |
| 0x04 | Alarm Estimation Cause Code 4 | [ALMCAUSE4] | Unsigned16 | RO | No | 0x0000 |
| 0x05 | Alarm Estimation Cause Code 5 | [ALMCAUSE5] | Unsigned16 | RO | No | 0x0000 |
| 0x06 | Alarm Estimation Cause Code 6 | [ALMCAUSE6] | Unsigned16 | RO | No | 0x0000 |
| 0x07 | Alarm Estimation Cause Code 7 | [ALMCAUSE7] | Unsigned16 | RO | No | 0x0000 |
| 0x08 | Alarm Estimation Cause Code 8 | [ALMCAUSE8] | Unsigned16 | RO | No | 0x0000 |
| | | | Display Range | 0x0000-0xFFFF | | |

✔It will be 0x0000 if there is no estimated cause.

0x2157: FPGA Initialization error

| | | | | |
|---|---|---|---|---|
| Index | 0x2157 | Indicates state of FPGA initialization. | Object Code | VAR |

| Sub-Idx | Name/Description | | Data Type | Access | PDO | Initial Value |
|---|---|---|---|---|---|---|
| 0x00 | FPGA Initialization error<br><br>bit7-15: Reserved<br>bit6: SRAM error<br>bit5: Internal RAM2 error<br>bit4: Internal RAM1 error<br>bit3: DPRAM error for AX4<br>bit2: DPRAM error for AX3<br>bit1: DPRAM error for AX2<br>bit0: DPRAM error for AX1 | [FPGAINIERR] | Unsigned16 | RO | No | 0x0000 |

0x5010：Motor data

| | | | |
|---|---|---|---|
| Index Ax1 0x5010<br>Ax2 0x5210<br>Ax3 0x5410<br>Ax4 0x5610 | Indicate selected motor data. | Object Code | Array |

| Sub-Idx | Description | Data Type | Access | PDO | Initial value |
|---|---|---|---|---|---|
| 0x00 | Number of entry | Unsigned8 | RO | No | 0x07 |
| 0x01 | Number of motor pole | Unsigned8 | RO | Possible | 0x00 |
| | | Unit | Pole | | |
| 0x02 | Phase resistance | Unsigned16 | RO | Possible | 0x0000 |
| | | Unit | mΩ | | |
| 0x03 | Phaseinductance | Unsigned16 | RO | Possible | 0x0000 |
| | | Unit | μH | | |
| 0x04 | Moment of inertia | Unsigned16 | RO | Possible | 0x0000 |
| | | Unit | gmm^2 | | |
| 0x05 | Voltage constant for each phase | Unsigned32 | RO | Possible | 0x0000 |
| | | Unit | μVrms/min-1 | | |
| 0x06 | Rated torque | Unsigned16 | RO | Possible | 0x0000 |
| | | Unit | mN･m/Arms | | |
| Support R series motor only.<br>Disabled to Q series or previous motor. | | | | | |

0x5040: Position Unit System

| | | | |
|---|---|---|---|
| Index Ax1 0x5040<br>Ax2 0x5240<br>Ax3 0x5440<br>Ax4 0x5640 | Indicates the unit system of the position. | Object Code | Array |

| Sub-Idx | Description | Data Type | Access | PDO | Initial value |
|---|---|---|---|---|---|
| 0x00 | Number of entry | Unsigned8 | RO | No | 0x05 |
| 0x01 | Software expression in 100% of full scale<br>100% of full scale expression is applied in the value of the software.<br>The display value is 1 (1bit) fixed. | Unsigned8 | RO | Possible | 0x01 |
| 0x02 | Full-scale Unit<br>Unit of full scale value.<br>The display value is 1 (Encoder Count) fixed. | Unsigned16 | RO | Possible | 0x0001 |
| 0x03 | Full-scale Data Type<br>Indicates the data type to be used in the full scale value.<br>The display value is 1 (Integer Type 32bit) fixed. | Unsigned16 | RO | Possible | 0x0001 |
| 0x04 | Full-scale Unit<br>Transforms into the actual unit.<br>The display value is 1 (1bit) fixed. | Unsigned16 | RO | Possible | 0x0001 |

0x5041: Position Unit System

| | | | |
|---|---|---|---|
| Index Ax1 0x5041<br>Ax2 0x5241<br>Ax3 0x5441<br>Ax4 0x5641 | Indicates the unit system of velocity. | Object Code | Array |

| Sub-Idx | Description | Data Type | Access | PDO | Initial value |
|---|---|---|---|---|---|
| 0x00 | Number of entry | Unsigned8 | RO | No | 0x05 |
| 0x01 | Software expression in 100% of full scale<br>100% of full scale expression is applied in the value of the software. The display value is 1 (pps) fixed. | Unsigned8 | RO | Possible | 0x01 |
| 0x02 | Full-scale Unit<br>Unit of full scale value.<br>The display value is 1 (pps) fixed. | Unsigned16 | RO | Possible | 0x0001 |
| 0x03 | Full-scale Data Type<br>Indicates the data type to be used in the full scale value.<br>The display value is 1 (Integer Type 32bit) fixed. | Unsigned16 | RO | Possible | 0x0001 |
| 0x04 | Full-scale Value<br>Transforms into the actual unit.<br>The display value is 1 (pps) fixed. | Unsigned16 | RO | Possible | 0x0001 |

0x5042: Acceleration Unit System

| | | | |
|---|---|---|---|
| Index Ax1 0x5042<br>Ax2 0x5242<br>Ax3 0x5442<br>Ax4 0x5642 | Indicates the unit system of velocity. | Object Code | Array |

| Sub-Idx | Description | Data Type | Access | PDO | Initial value |
|---|---|---|---|---|---|
| 0x00 | Number of entry | Unsigned8 | RO | No | 0x05 |
| 0x01 | Software expression in 100% of full scale<br>100% of full scale expression is applied in the value of the software.<br>The display value is 1 (pps^2) fixed. | Unsigned8 | RO | Possible | 0x01 |
| 0x02 | Full-scale Unit<br>Unit of full scale value.<br>The display value is 1 (pps^2) fixed. | Unsigned16 | RO | Possible | 0x0001 |
| 0x03 | Full-scale Data Type<br>Indicates the data type to be used in the full scale value.<br>The display value is 1 (Integer Type 32bit) fixed. | Unsigned16 | RO | Possible | 0x0001 |
| 0x04 | Full-scale Value<br>Transforms into the actual unit.<br>The display value is 1 (pps^2) fixed. | Unsigned16 | RO | Possible | 0x0001 |

# 6

# 6. Operations

# 6.1 Standard Setting Value upon Shipment

The system parameters setting value upon shipment from the factory is shown below.

■ Servo Amplifier Model Number: RF2○##A△HL5

| ID | Name | Code | Setting Value | Object |
|---|---|---|---|---|
| 00 | Main Circuit Power Input Classification | ○ : K<br>○ : J | 48VDC input<br>24VDC input<br>02 : DC | 0x20FD.1: MPWRIN |
| 01 | Regenerative Resistance Selection | - | Without resistor 02 : External_R | 0x20FD.2: RGKIND |
| 02 | Motor Code | ## : 14<br>## : 24 | 48VDC input<br>025A : 0x040C（R2GAD102RM）<br>040A : 0x0261（R2GA04003F） | 0x20FE.0: MOCODE |
| 03 | Encoder Division Number Code | △ : 0<br>△ : 8 | Absolute : 0x0006(131,072FMT)<br>Incremental : 0x0005(2,000P/R) | 0x20FF.1: ENCODE |
| 04 | Encoder Classification Code | △ : 0<br>△ : 8 | Absolute: 0x0300<br>(Asynchronous Communication 2.5MHz High-rotation backup method)<br>Incremental: 0x0000<br>(Wiring-saving Incremental Encoder) | 0x20FF.2: ENTYPE |
| 05 | Extension Station Alias | - | 00:PA_S_2.5M | 0x20FA.0: EXALOAS |
| 06 | Operation Mode | - | 0x00 (No Mode, No Mode Definitions) | 0x6060.0: OPMODE |
| 07 | Position Control Selection | - | 00:Standard | 0x20F3.0: PCNTSEL |

* Please confirm with separate volume M0010842 for operation methods of Setup Software

# 6.2 Test oueartion

## 1) Installation and Wiring

Confirm the installation and wiring of the servo amplifier and servo motor.

| Process | Items and Contents |
|---|---|
| 1 | Installation |
| | ■ Install servo amplifier and servo motor according to “Installation 3-1”. Servo motor shaft should be in disengaged state and machine should not be connected.<br><br> |
| 2 | Wiring / Connecting → Input Power |
| | ■ Power supply wire, servo motor and host device, however, do not connect CN0 (Port 0) / CN1 (Port 1) to servo amplifier after wiring.<br>■ Input power supply: Confirm no alarm code is displayed on the display screen on the upper front of the amplifier. When alarm code is displayed, take appropriate measures based on “Troubleshooting (Chapter 9)”.<br>■ When 7 segment LED does not light “≡” through main circuit power input, take appropriate measures based on “Troubleshooting (Chapter 9)”. |

## 2) Safe Torque OFF Function

When using a product that corresponds to the Safe Torque OFF (STO) function, please check the function followed with a Confirmation Test (Chapter 13) to verify normal operation.

### 3) Movement Confirmation

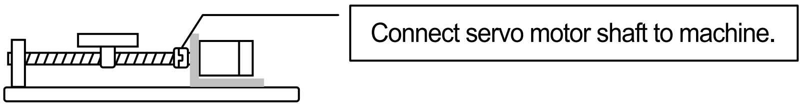
Perform JOG operations using Setup Software or Digital Operator.

<table>
<tr><th>Process</th><th>Items and Contents</th></tr>
<tr><td rowspan="2">1</td><td>Input signal check: Generic Input signals (CN2)</td></tr>
<tr><td>Select Input signals to be used from General parameter Group9 and assign in CONT1, and CONT2.
<table>
<tr><th></th><th></th><th>Factory Shipment Setting Value</th></tr>
<tr><th>Input Signal</th><th>CN2 Pin No.</th><th>Setting Value</th></tr>
<tr><td>CONT1</td><td>1, 2</td><td>00:Always_Disable</td></tr>
<tr><td>CONT2</td><td>3, 4</td><td>00:Always_Disable</td></tr>
<tr><td>CONT3</td><td>5, 6</td><td>00:Always_Disable</td></tr>
<tr><td>CONT4</td><td>7, 8</td><td>00:Always_Disable</td></tr>
<tr><td>CONT5</td><td>19, 20</td><td>00:Always_Disable</td></tr>
<tr><td>CONT6</td><td>21, 22</td><td>00:Always_Disable</td></tr>
<tr><td>CONT7</td><td>23, 24</td><td>00:Always_Disable</td></tr>
<tr><td>CONT8</td><td>25, 26</td><td>00:Always_Disable</td></tr>
</table>
* The factory default gives no assignment function to the general signal.</td></tr>
<tr><td rowspan="2">2</td><td>Output signal check: Generic Output signals (CN3)</td></tr>
<tr><td>■ Select Output signals to be used from General parameter Group9 and assign in OUT1 and OUT2.
<table>
<tr><th></th><th></th><th colspan="2">Factory Shipment Setting Value</th></tr>
<tr><th>Output Signal</th><th>CN2 Pin No</th><th>Setting Value</th><th>Object: Index，Sub-index</th></tr>
<tr><td>OUT1</td><td>11, 12</td><td>42:FOUT1_ON</td><td>0x20F9,0x01 (Axis1 OUT1)</td></tr>
<tr><td>OUT2</td><td>13, 14</td><td>44:FOUT2_ON</td><td>0x20F9,0x01 (Axis1 OUT2)</td></tr>
<tr><td>OUT3</td><td>15, 16</td><td>42:FOUT1_ON</td><td>0x20F9，0x01（Axis2 OUT1）</td></tr>
<tr><td>OUT4</td><td>17, 18</td><td>44：FOUT2_ON</td><td>0x20F9，0x01（Axis2 OUT2）</td></tr>
<tr><td>OUT5</td><td>29, 30</td><td>42:FOUT1_ON</td><td>0x20F9，0x01（Axis3 OUT1）</td></tr>
<tr><td>OUT6</td><td>31, 32</td><td>44：FOUT2_ON</td><td>0x20F9，0x01（Axis3 OUT2）</td></tr>
<tr><td>OUT7</td><td>33, 34</td><td>42:FOUT1_ON</td><td>0x20F9，0x01（Axis4 OUT1）</td></tr>
<tr><td>OUT8</td><td>35, 36</td><td>44：FOUT2_ON</td><td>0x20F9，0x01（Axis4 OUT2）</td></tr>
</table></td></tr>
<tr><td rowspan="2">3</td><td>Input/Output Signal Check</td></tr>
<tr><td>■ Check that the set Input/Output signals are functioning normally with the monitor.<br>Refer to “Monitor Functions (chapter 9)” for monitor explanation.<br><br>◆ Check using Setup Software with monitor in menu.<br>Read separate manual M0010842 for MOTOR Setup Software operations.</td></tr>
</table>

| | |
|---|---|
| 4 | JOG Operation (Input Servo ON signal) |
| | ■ Performs JOG operation without connection motor shaft to machine under disengaged condition.<br>■ Check that servo motor rotates in both Forward and Inverse directions.<br>■ Rotaion direction of JOG operation is reverse to the one if communication on EtherCAT.<br>◆ Operating with “MOTOR Setup Software” Select JOG operation from Test Run in menu. Read separate manual M0010842 for Setup Software operations. |
| | ■ Input Servo ON signal. Confirm that motor excitation and LED blinking of concerned axis in the front surface of servo amplifier. |

## 4) Machine Movement Check

Connect servo motor shaft to machine and check movement.

| Process | Items and Contents | |
|---|---|---|
| 1 | Connect to machine | |
| | ■ Connect motor shaft to machine.<br><br> <br>■ Input low velocity command and check that movements such as movement direction, travel distance, emergency stop and forward/inverse direction limit, switch, etc. are normal.<br>■ Be prepared to stop immediately in case of abnormal movement. | |
| 2 | Operation | |
| | ■ Input commands of actual operation patterns and operate machine.<br>■ Real time auto-tuning (Automatic tuning for servo gain, filter, etc.) is enabled at the time of factory shipment. Manual tuning is not necessary if there are no problems with movement and/or characteristics. Refer to “Adjustments (Chapter 6)” for servo tuning methods. | |
| 3 | Power OFF | Turn OFF power after turning OFF Servo ON signal. |

# 6.3 ESC Power ON Sequence

Shows RS2 EtherCAT slave amplifier power ON sequence at input of control power supply.

1 Power ON : Control voltage reaches operational voltage of ESC

⇩

2 PLL Clock : Output PLL clock

⇩

3 Reset Cancel: Starts ESC operation. Prohibits memory access until ESI EEPROM is loaded.
Access enabled for μ controller after reset cancellation.

⇩

4 Establish Link : Starts EtherCAT communication. Accessible to master.
(Setting data for μ controller inside ESC also prohibits access.)
EEPROM load : Access will be enabled only when EEPROM load to ESC success.

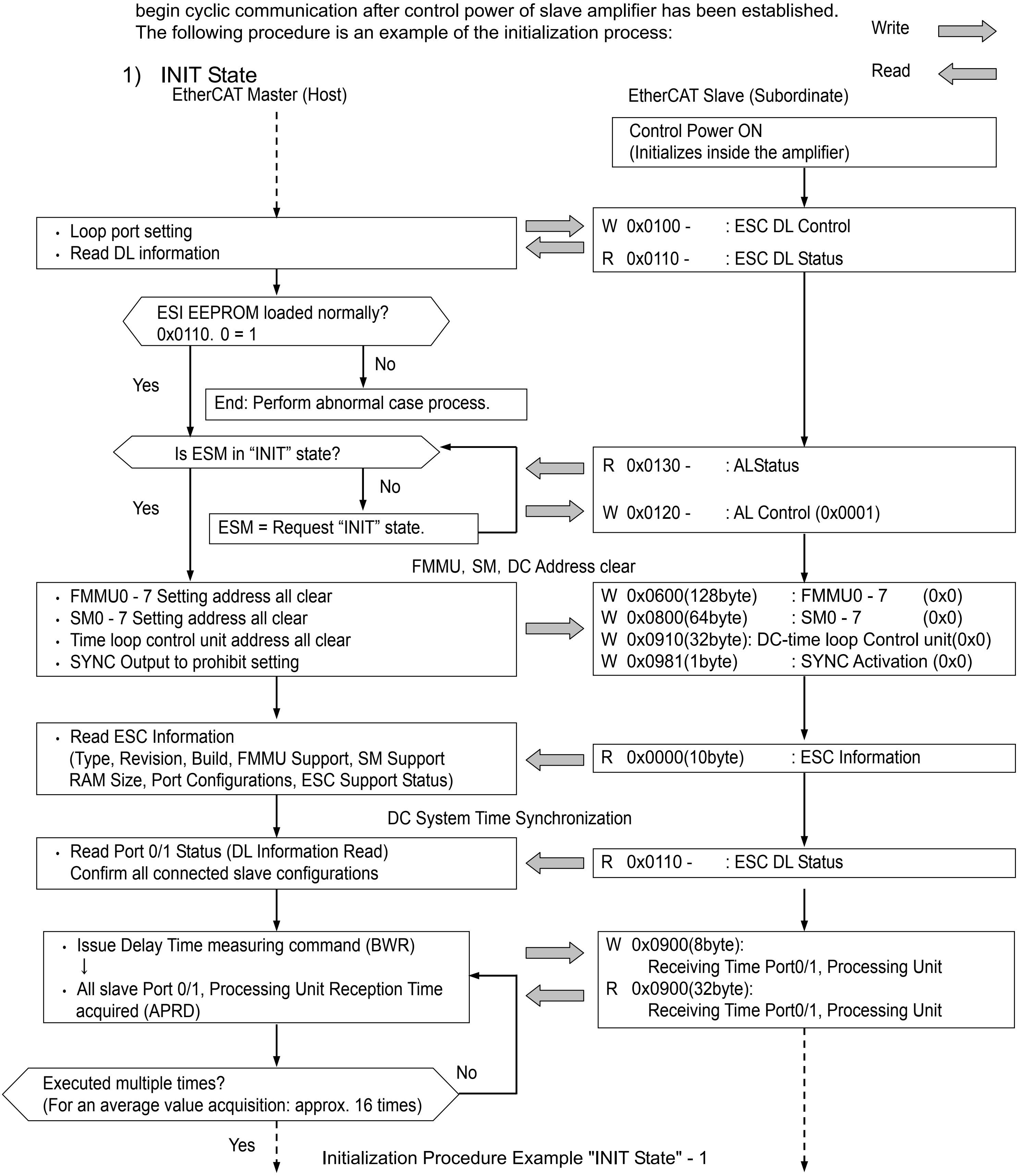
- ESC setting register initialization completed
- μ controller starts operation
- Changes to 0x0110.1=1
- Process data RAM enabled
- ESM of ESC reaches "Init" state

ESC Power ON Sequence

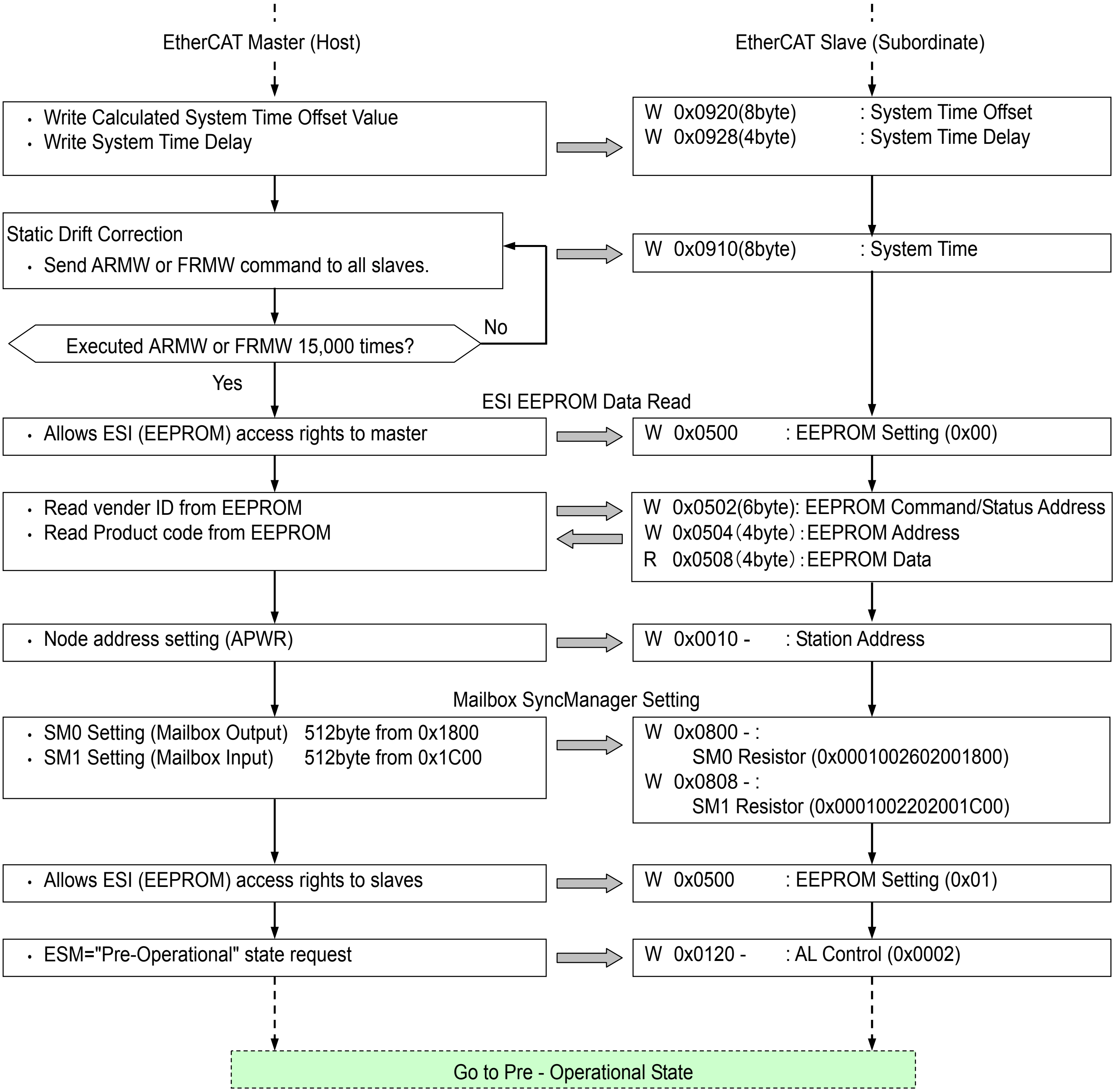
## 6.4 EtherCAT Initialization Process

Various parameter settings from master to slave datalink layer and application layer are required to begin cyclic communication after control power of slave amplifier has been established.
The following procedure is an example of the initialization process:

### 1) INIT State

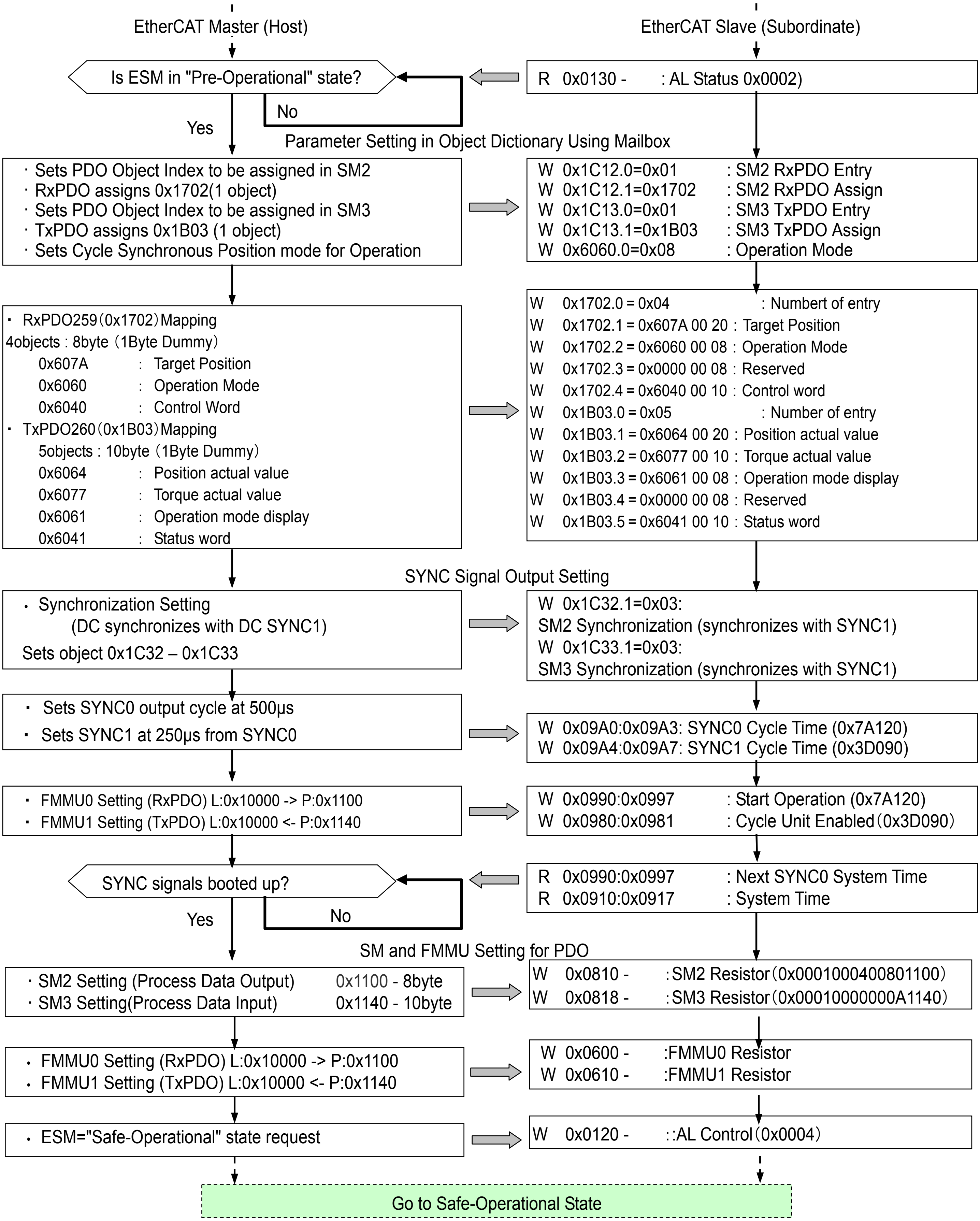


Initialization Procedure Example "INIT State" - 1



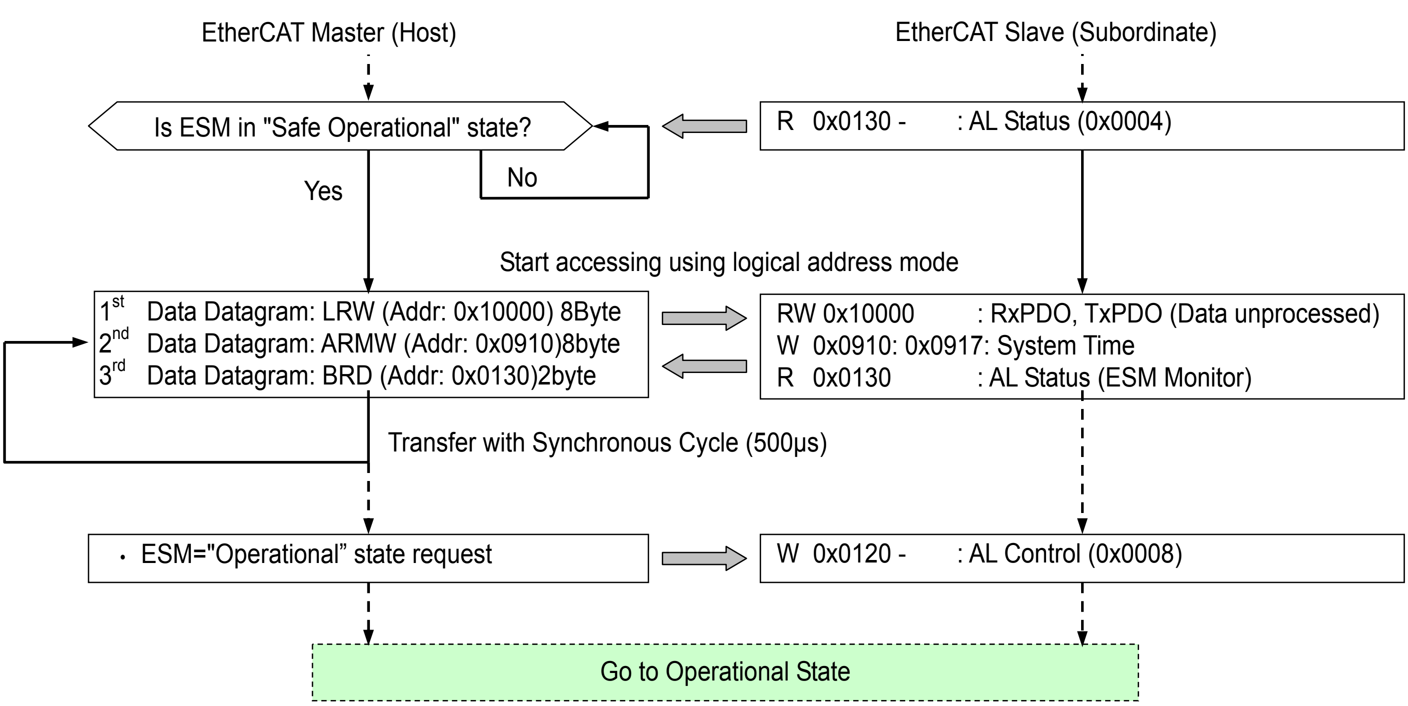
Initialization Procedure Example "INIT State" -2

### 2) Pre-Operational State



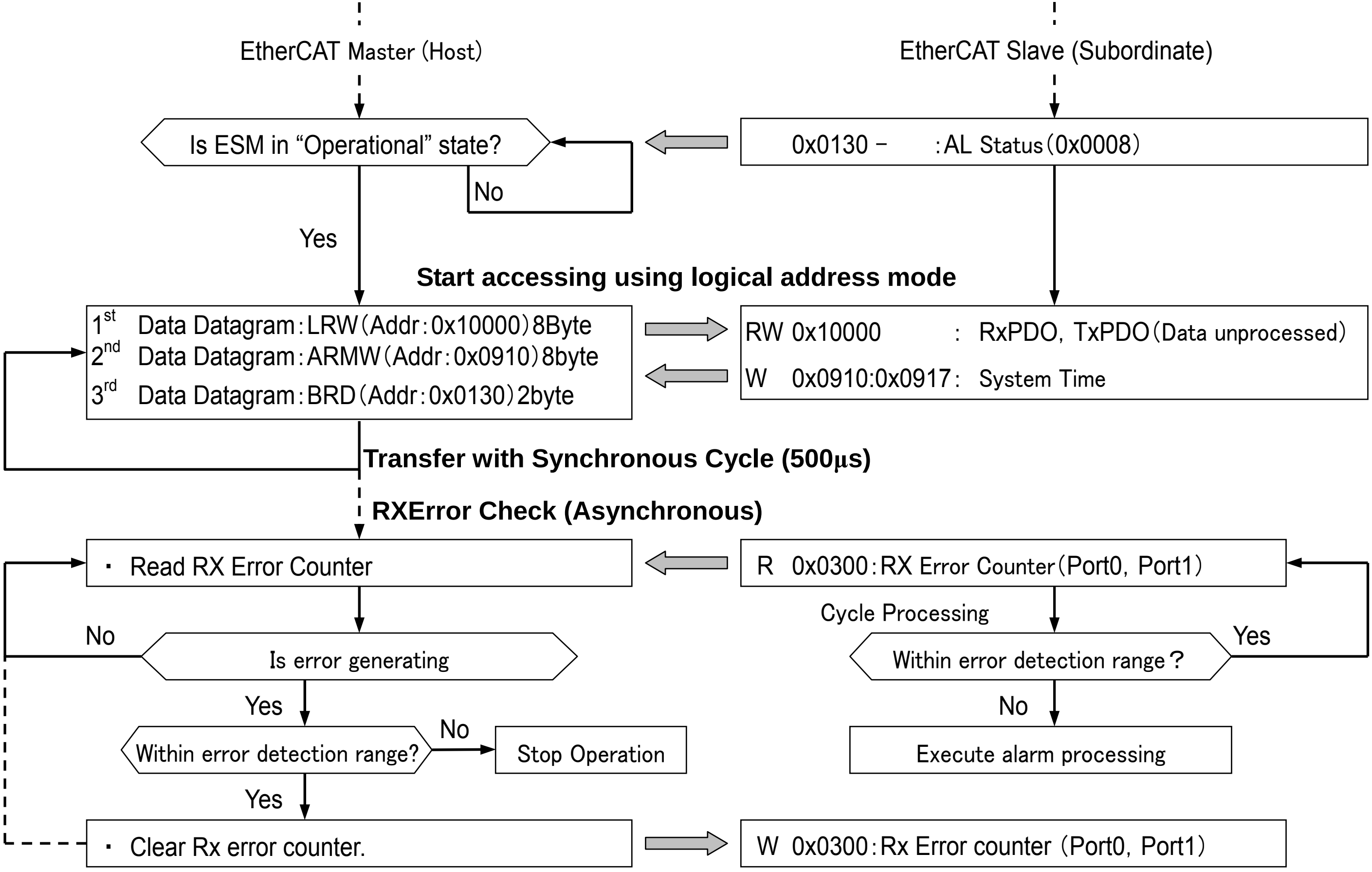
Initialization Procedure Example (Pre-Operational State)

### 3) Safe-Operational State



Initialization Procedure Example (Safe-Operational State)

### 4) Operational State

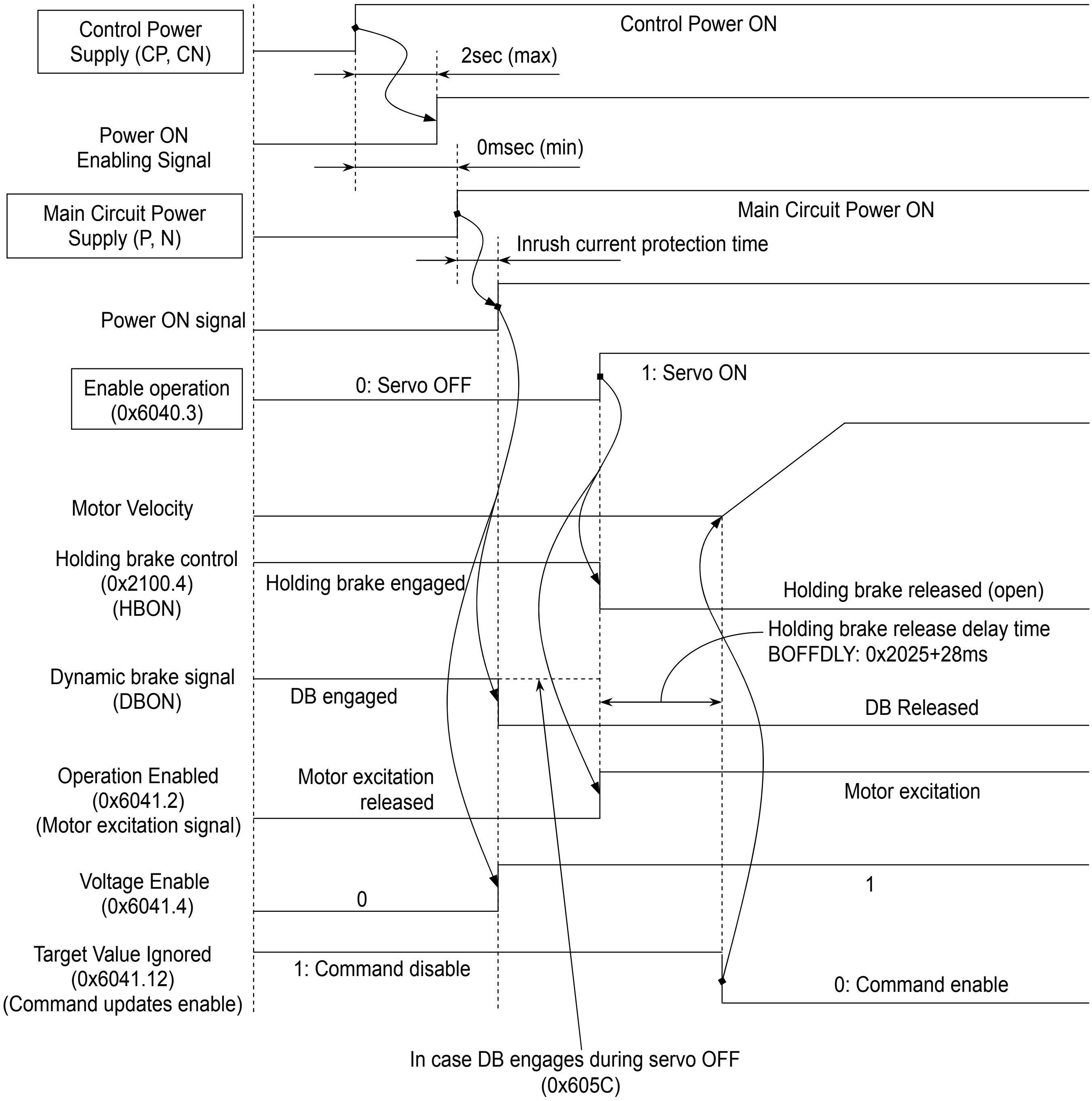


Initialization Procedure Example (Operational State)

## 6.5 Operation Sequence

### 1) Operation Sequence from Power ON to Power OFF

■ Power ON → Servo ON



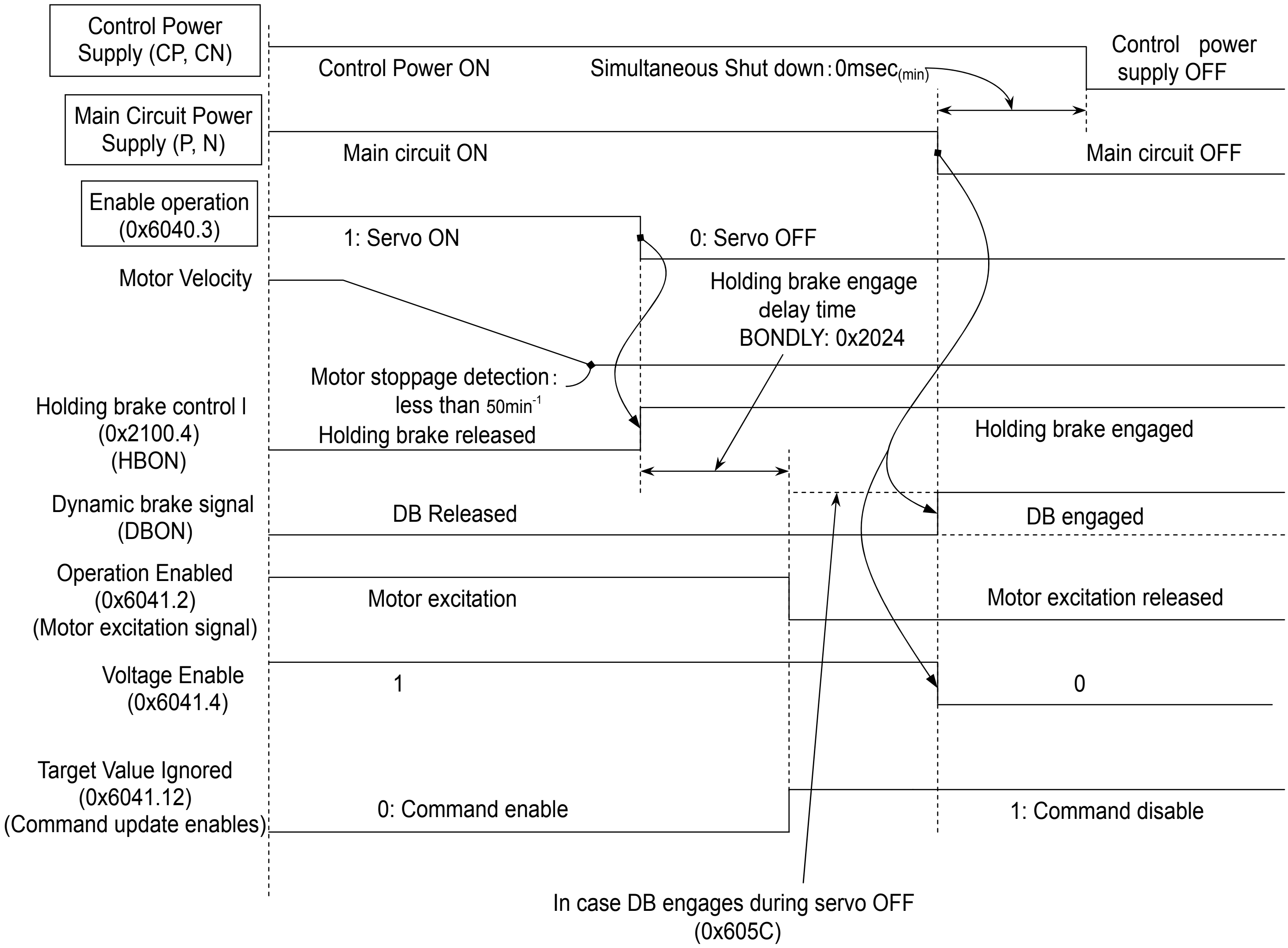
* The frequency of powering the servo amplifier ON/OFF must be less than 5 times/H and 30 times/day. In addition, the intervals between Power ON/OFF must be longer than 10 minutes.

* Inrush current suppression times of each servo amplifier size are as follows:

| Servo amplifier size | Inrush current suppression time |
|---|---|
| RF2 series | 100[ms] |

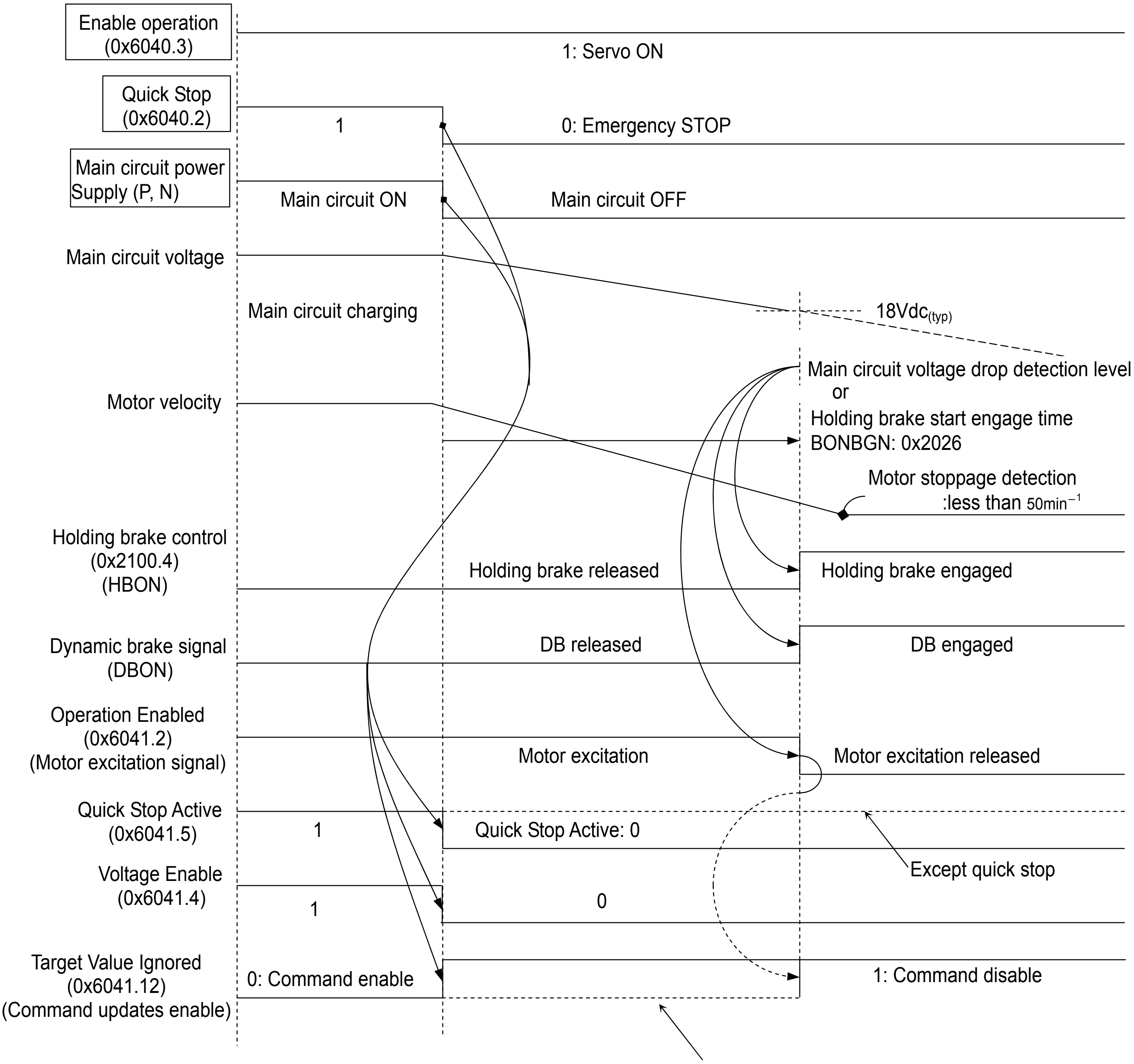
## ■ Servo OFF → Power OFF

Sequence in case of Servo OFF during motor rotation depends on Disable Option Code (0x605C) setting.



## ■ Main Circuit OFF, Quick STOP (Emergency STOP) Sequence

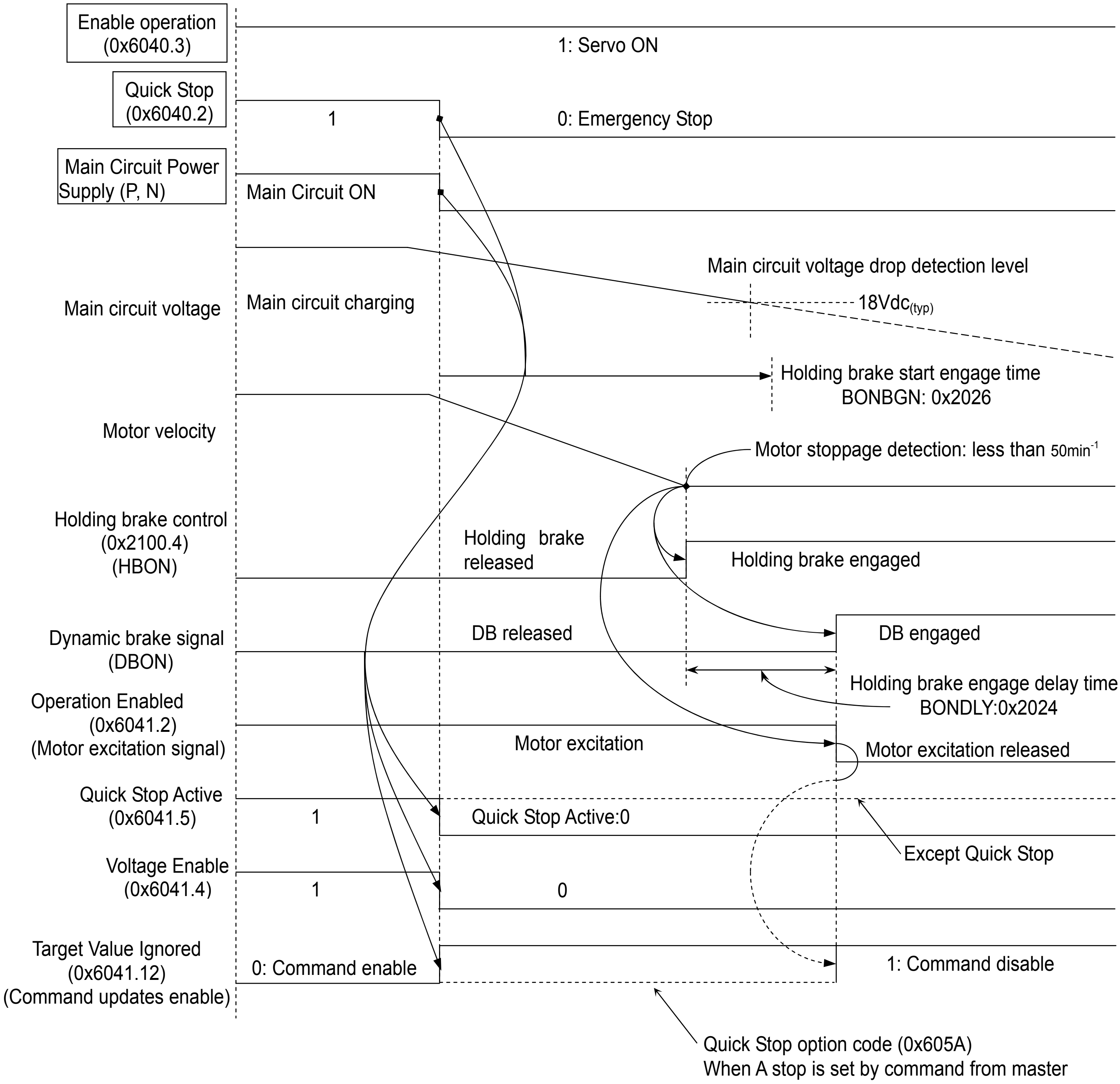
1. When motor did not stop with the setting value of the holding brake engage starting time, or main circuit voltage drop is detected



Quick Stop option code (0x605A)
When Stop is set by command from master

## ■ Main Circuit OFF, Quick STOP (Emergency STOP) Sequence

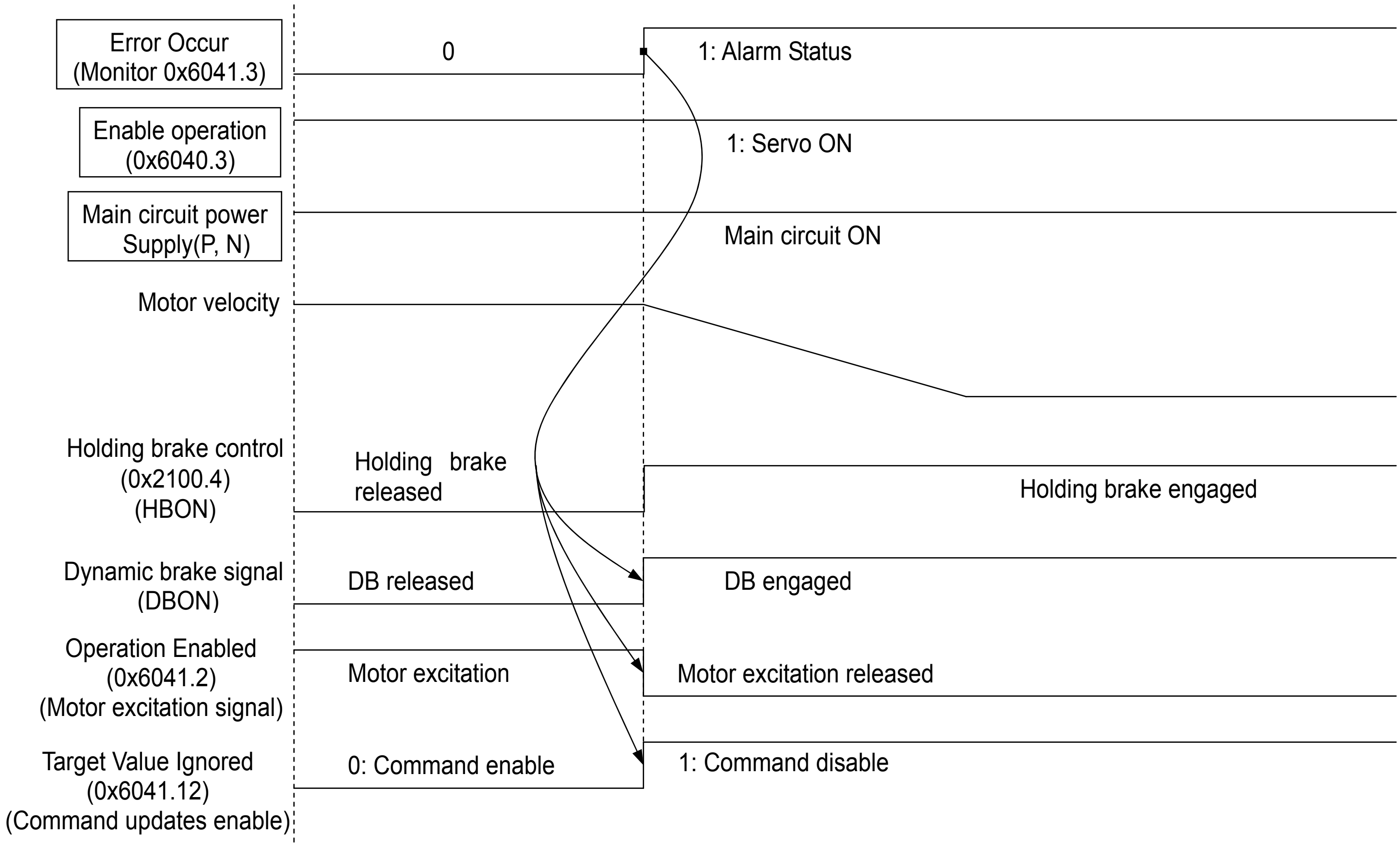
2. When motor is stopped within holding brake start engage time or before main circuit voltage drop detection



## 2) Alarm Occurrence Stop Sequence

Servo motor is stopped by dynamic brake or servo brake with alarm occurrence. To stop either with dynamic brake or servo brake, please refer to “Movement of SB, DB at the time of Alarm detection” in the alarm code list. (SB: Servo brake Stop, DB: Dynamic brake Stop)
The stop method can be selected with Quick Stop option code (0x605A) for alarms that can be stopped with the servo brake. Please refer to “Alarm Display List (9-3)” for details.

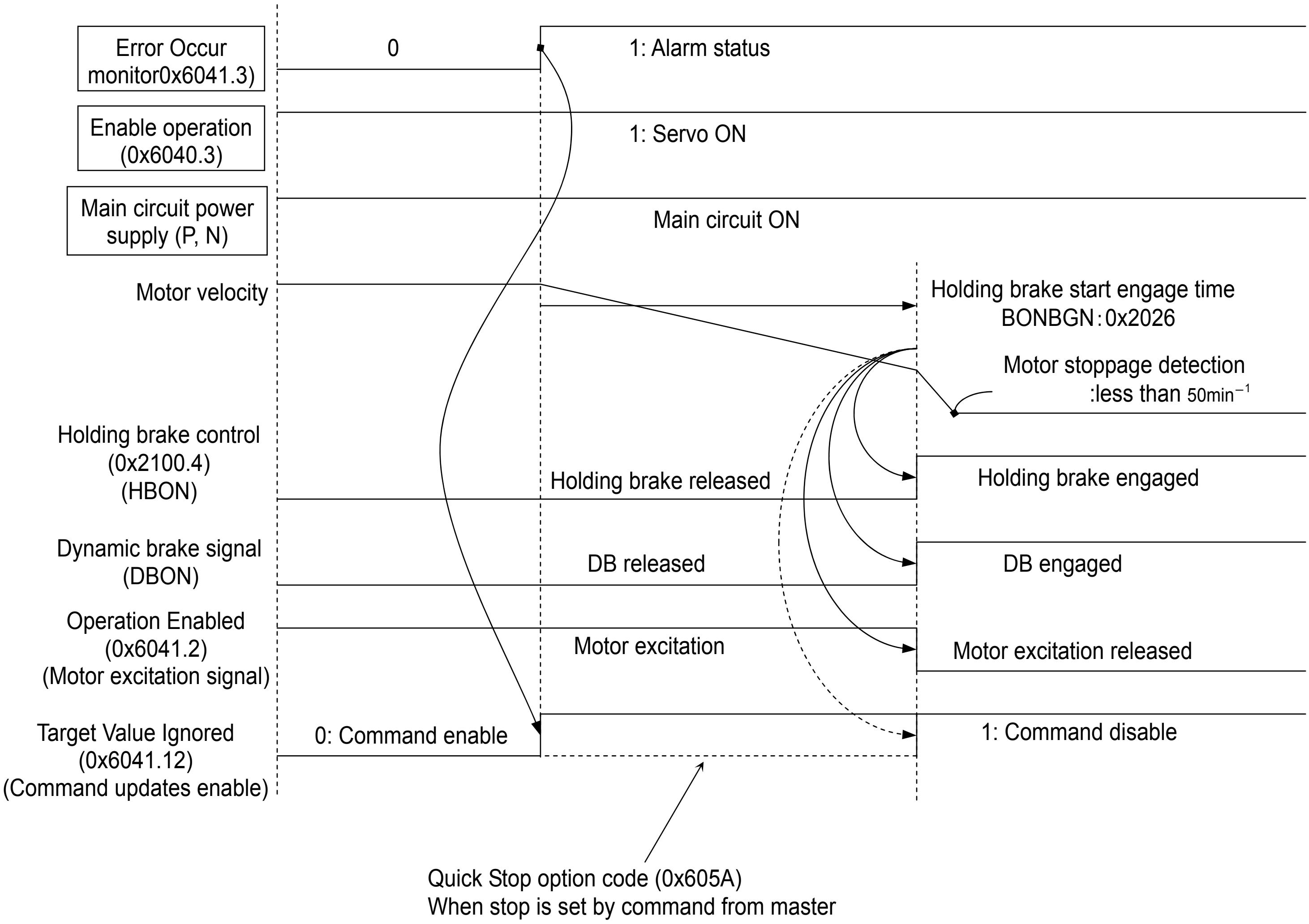
### ■ Stop Sequence with Dynamic brake at Alarm Occurrence



* This servo amplifier does not have dynamic brake. So, it will stop by Free Run operation.

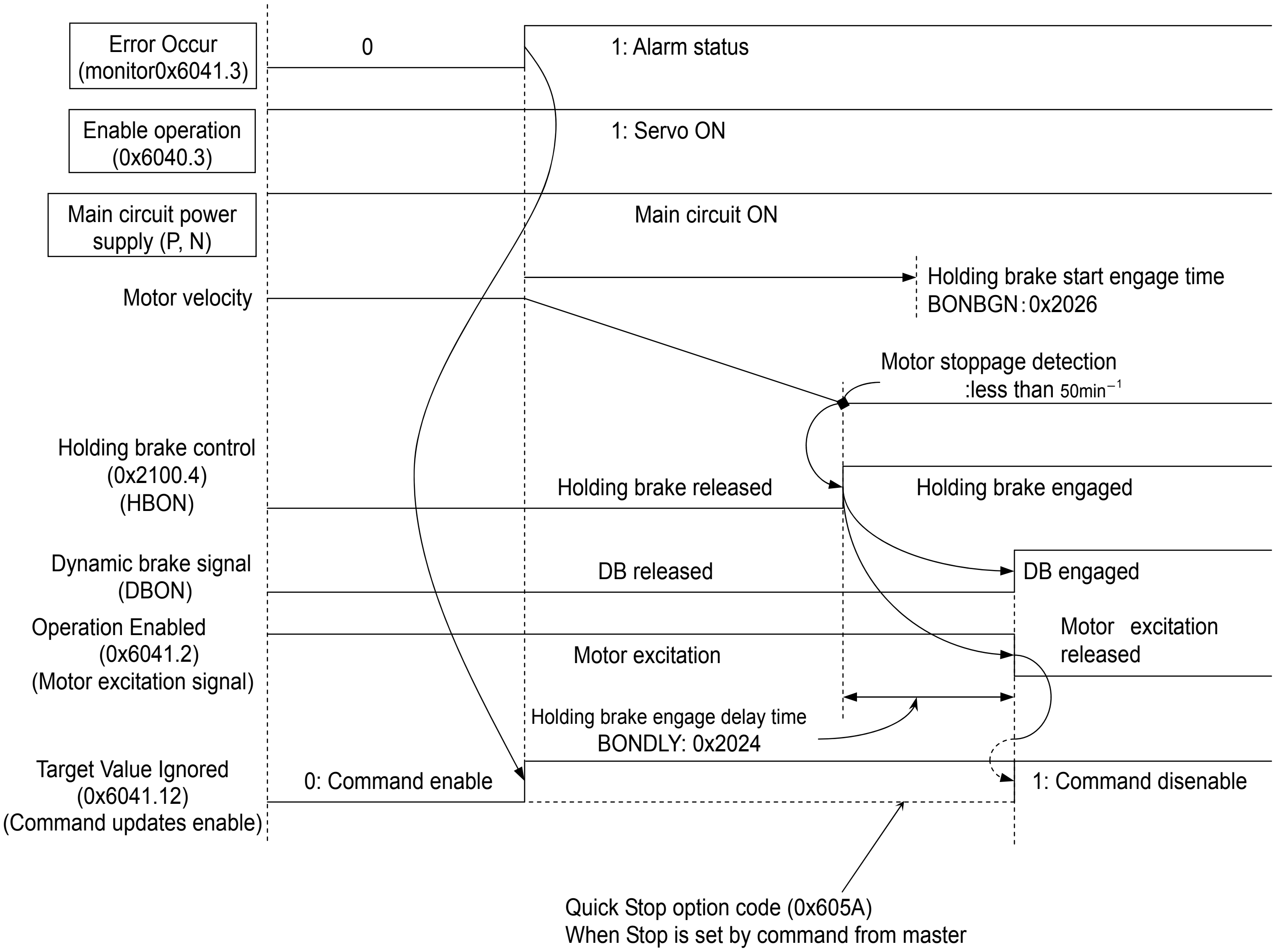
## ■ Stop Sequence with Servo Stop (Quick Stop option code) at Alarm Occurrence

1. When a motor does not stop with the setting value of holding brake engage start time



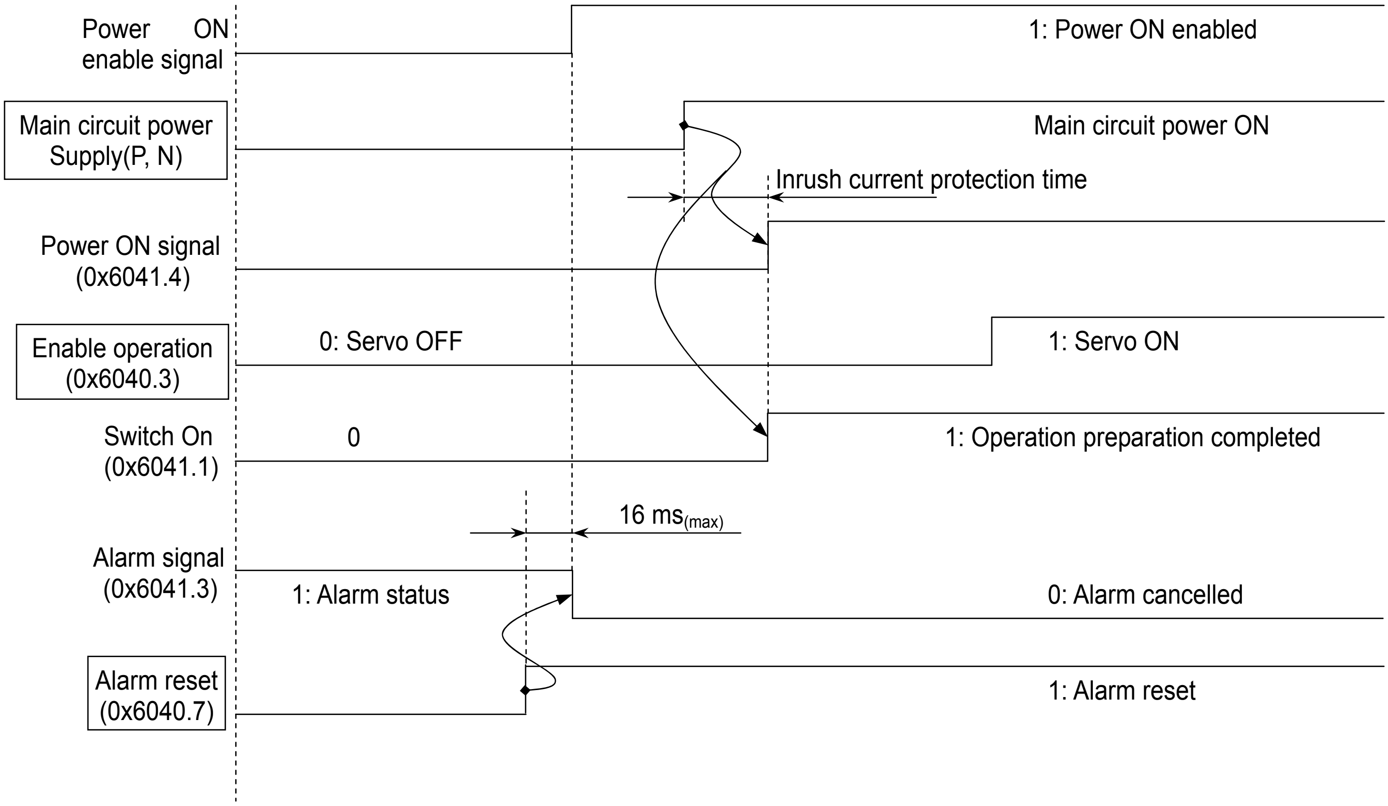
## ■ Stop Sequence with Servo Stop (Quick Stop option code) at Alarm Occurrence

2. When a motor has stopped with the setting value of holding brake engage start time



### 3) Alarm Reset Sequence

Alarm can be reset by inputting alarm reset signal from generic input signals.



* Power reset (Turn off power once and re-input) or encoder clear is required for the alarm reset depending on alarm type. Refer to “Alarm Display List (11-3)” for details.

7

# 7. Adjustments

# 7.1 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:

## 1) Servo tuning functions

- Servo gain tuning procedures

  Following is an explanation of the Servo tuning procedure:

  - Automatic Tuning
    The servo amplifier estimates the Load inertia moment ratio, during real time operations, and the amplifier automatically tunes the servo gain and filter frequency. 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.

- Vibration suppressor of mechanical system

  - Automatic tuning of FF Vibration Suppression Frequency
    This is used to obtain the vibration frequency when FF vibration suppressor control is initiated.

  - Automatic tuning of notch filter
    This method is used for suppressing high frequency resonance caused by coupling and/or rigidity of the mechanical system using a notch filter.

- Model following control

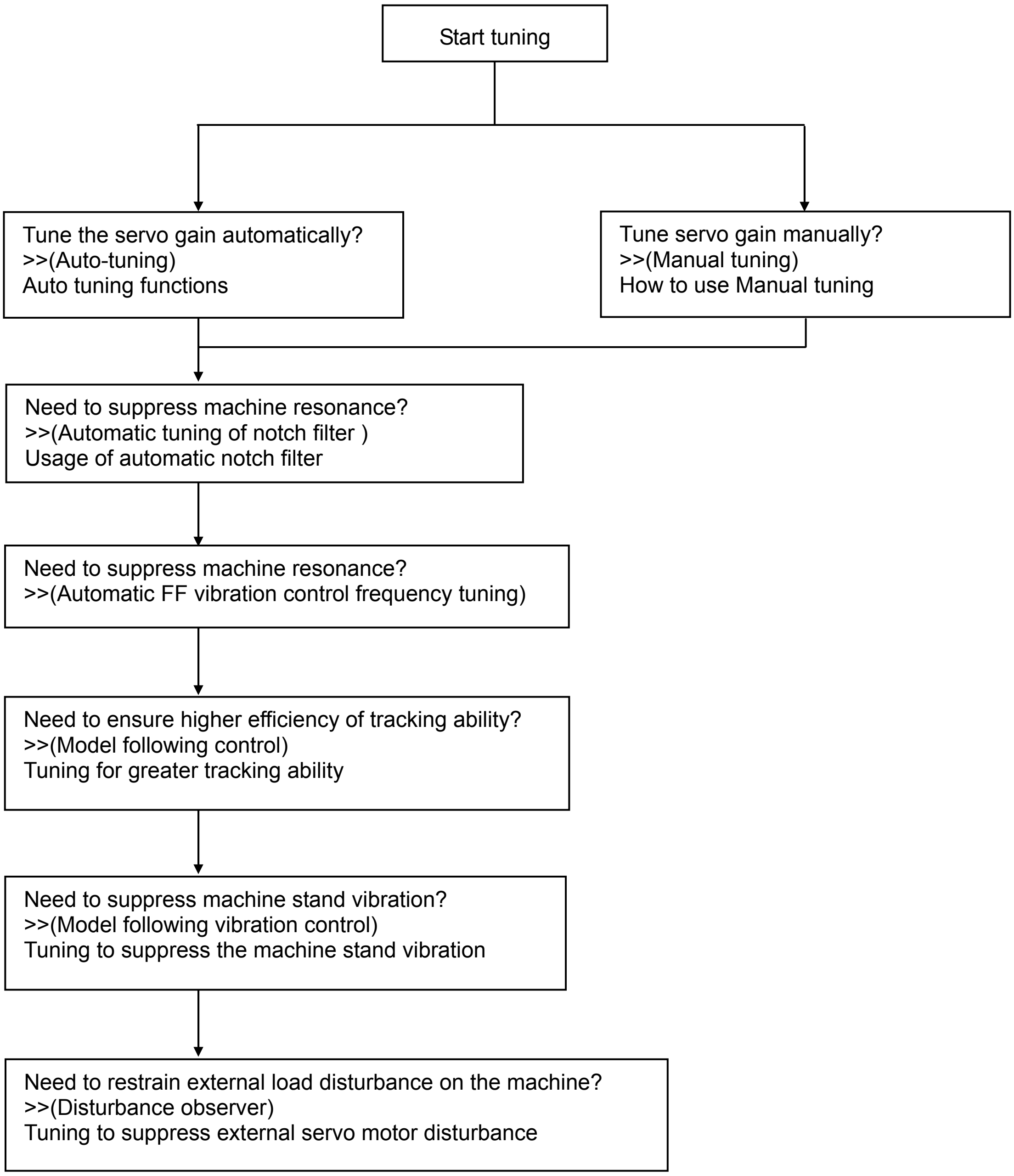
  Model following control is a control method that ensures a higher detection response by composing a model control system including the mechanical system in a servo amplifier to operate the actual servo motor in order to follow the model control system.

  - Model following control
    Use Model control system to ensure higher detection response.

  - Model following vibration suppressor control
    Use the model control system to ensure a higher detection response by suppressing the machine stand vibration.

## 2) Tuning method selection procedure

The selection procedure is displayed in the following chart:



* Depending on the combination of these functions, use of more than two (2) methods jointly will invalidate the procedure.

## 7.2 Automatic Tuning

### 1) Use the following parameters for Automatic tuning”

Parameter List
The following parameters are used for auto-tuning.

◆ Group0 ID00: Tuning Mode Index: 0x2002, 0x01 [TUNMODE]

| | |
|---|---|
| 00:_AutoTun | Automatic Tuning |
| 01:_AutoTun_JRAT-Fix | Automatic Tuning [JRAT manual setting] |
| 02:_ManualTun | Manual Tuning |

◆ Group0 ID01: Auto-Tuning Characteristic Index:0x2002, 0x02 [ATCHA]

| | |
|---|---|
| 00:_Positioning1 | Positioning Control 1(General) |
| 01:_Positioning2 | Positioning Control 2(High Response) |
| 02:_Positioning3 | Positioning Control 3(High Response, FFGN Manual Setting) |
| 03:_Positioning4 | Positioning Control 4(High Response, Horizontal Axis Limited) |
| 04:_Positioning5 | Positioning Control 5<br>(High Response, Horizontal Axis Limited, FFGN Manual Setting) |
| 05:_Trajectory1 | Trajectory Control 1 |
| 06:_Trajectory2 | Trajectory Control 2(KP, FFGN Manual Setting) |

◆ Group0 ID02: Auto-Tuning Response Index:0x2002, 0x03 [ATRES]

| | |
|---|---|
| 1 - 30 | Automatic Tuning Response |

◆ Group0 ID03: Auto-Tuning Automatic Parameter Saving Index:- [ATSAVE]

| | |
|---|---|
| 00:_Auto_Saving | Automatically Saves in JRAT1 |
| 01:_No_Saving | Automatic Saving is Invalid |

■ Explanation for each parameter
Explains the details of each parameter below.

<table>
<tr><th>ID</th><th>CoE<br>Object ID</th><th>Contents</th></tr>
<tr><td rowspan="2">00</td><td rowspan="2">0x2002, 0x01</td><td>Tuning Mode [TUNMODE]</td></tr>
<tr><td>
<table>
<tr><th colspan="2">Selection</th><th>Meaning</th></tr>
<tr><td>00</td><td>AutoTun</td><td>Automatic 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.<br>
◆ Parameters for the servo amplifier to automatically tune vary depending on selected auto-tuning characteristics.<br>
◆ 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 (force) in low velocity, this mode cannot be used.<br>
Also, for operations with high disturbance torque (force) or with major mechanical clearance, this mode cannot be used.<br>
[01:_AutoTun_JRAT-Fix Automatic Tuning [JRAT Manual Setting]
<table>
<tr><th colspan="2">Selection</th><th>Meaning</th></tr>
<tr><td>01</td><td>AutoTun_JRAT-Fix</td><td>Automatic Tuning [JRAT manual setting]</td></tr>
</table>
◆ Based on the Load inertia moment ratio (JRAT1) [Group1 ID14], which has to be set, the servo amplifier automatically tunes to the best servo gain.<br>
◆ Parameters for the servo amplifier to automatically tune will vary depending on the selected auto-tuning characteristics.
<table>
<tr><th colspan="2">Selection</th><th>Meaning</th></tr>
<tr><td>02</td><td>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.
</td></tr>
</table>

<table>
<tr><th>ID</th><th>CoE<br>Object ID</th><th>Contents</th></tr>
<tr><td rowspan="2">01</td><td rowspan="2">0x2002, 0x02</td><td>Auto-Tuning Characteristic [ATCHA]</td></tr>
<tr><td>
■ Auto-Tuning Characteristic to fit the mechanical requirements and movements are provided.<br>Parameters that can be adjusted vary depending on each auto-tuning characteristic. Set the parameters based on the situation.<br>
■ [Positioning control (Positioning)]<br>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 point by point is necessary.<br><br>
■ [Trajectory control (Trajectory)]<br>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.<br><br>
<table>
<tr><th colspan="2">Selection</th><th>Meaning</th></tr>
<tr><td>00</td><td>Positioning1</td><td>Positioning Control 1(General)</td></tr>
</table>
◆ Select for general positioning purposes.<br>
◆ Parameters shown in table 2 cannot be adjusted manually.<br><br>
<table>
<tr><th colspan="2">Selection</th><th>Meaning</th></tr>
<tr><td>01</td><td>Positioning2</td><td>Positioning Control 2(High Response)</td></tr>
</table>
◆ Select for high response positioning.<br>
◆ Parameters shown in table 2 cannot be adjusted manually.<br><br>
<table>
<tr><th colspan="2">Selection</th><th>Meaning</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 FFGN manually.<br>
◆ The following parameter adjustment is made manually:<br>General parameters GROUP1 [Basic control parameter settings]<br><br>
<table>
<tr><th>ID</th><th>Symbol</th><th>Name</th></tr>
<tr><td>05</td><td>FFGN</td><td>Feed Forward Gain</td></tr>
</table>
</td></tr>
</table>

<table>
<tr><th>ID</th><th>CoE<br>Object ID</th><th>Contents</th></tr>
<tr><td rowspan="2">01</td><td rowspan="2">0x2002, 0x02</td><td>Auto-Tuning Characteristic [ATCHA]</td></tr>
<tr><td>
<table>
<tr><th colspan="2">Selection</th><th>Meaning</th></tr>
<tr><td>03</td><td>Positioning4</td><td>Positioning control 4<br>(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.<br>
◆ Positioning time may be shortened compared to “Positioning Control 2”.<br>
◆ Parameters shown in table 2 cannot be adjusted manually.
<table>
<tr><th colspan="2">Selection</th><th>Meaning</th></tr>
<tr><td>04</td><td>Positioning5</td><td>Positioning control 5<br>(for high response, horizontal axis only,<br>FFGN manual setting)</td></tr>
</table>
◆ Select this mode when the machine movement is on a horizontal axis and receives no disturbing influence from external sources or when you want to adjust FFGN manually.<br>
◆ Positioning time may be shortened compared to “Positioning control 2”.<br>
◆ The following parameter adjustment is done manually.<br>
General parameters GROUP1 [Basic Control Parameter Settings]
<table>
<tr><th>ID</th><th>Symbol</th><th>Name</th></tr>
<tr><td>05</td><td>FFGN</td><td>Feed Forward Gain</td></tr>
</table>
<table>
<tr><th colspan="2">Selection</th><th>Meaning</th></tr>
<tr><td>05</td><td>Trajectory1</td><td>Trajectory Control 1</td></tr>
</table>
◆ Select this mode for single axis use. The response of each axis can be different.<br>
◆ Parameters shown in table 2 cannot be adjusted manually.
<table>
<tr><th colspan="2">Selection</th><th>Meaning</th></tr>
<tr><td>06</td><td>Trajectory2</td><td>Trajectory Control 2<br>(KP, FFGN Manual Setting)</td></tr>
</table>
◆ Select this mode when you need equal responses from multiple axes, respectively. Adjust KP, FFGN.<br>
◆ The following parameter adjustment is done manually.<br>
General parameters GROUP1 [Basic control parameter settings]
<table>
<tr><th>ID</th><th>Symbol</th><th>Name</th></tr>
<tr><td>02</td><td>KP1</td><td>Position Loop Proportional Gain 1</td></tr>
<tr><td>05</td><td>FFGN</td><td>Feed Forward Gain</td></tr>
</table>
</td></tr>
<tr><td rowspan="2">02</td><td rowspan="2">0x2002, 0x03</td><td>Auto-Tuning Response [ATRES]</td></tr>
<tr><td>■ Select this mode when Auto-tuning and Auto-tuning [JRAT manual setting] are used.<br>
■ As the setting value rises, the response increases.<br>
Set the value suitable for equipment rigidity.<br>
■ This does not function for manual tuning.</td></tr>
<tr><td rowspan="2">03</td><td rowspan="2">( - )</td><td>Auto-Tuning Automatic Parameter Saving [ATSAVE]</td></tr>
<tr><td>■ Load inertia moment ratio obtained from the result of auto-tuning is automatically saved in parameter JRAT1 every two (2) hours.<br>
■ The value is effective when auto-tuning is used.<br>
This does not function for [JRAT manual setting].</td></tr>
</table>

## 2) Automatically adjusted parameters in auto-tuning

The following parameters are automatically adjusted at the time of auto-tuning. These parameters will not reflect on motor movements by changing or overriding those values. However, some of them can be adjusted manually depending on selected [Tuning Mode] and [Auto-Tuning Characteristic].

- General parameters Group1 [Basic control parameter settings]

| ID | CoE Object ID | Symbol | Name | Notes |
|---|---|---|---|---|
| 02 | 0x2005, 0x01 | KP1 | Position Loop Proportional Gain 1 | Note 1) |
| 05 | 0x2008, 0x01 | FFGN | Feed Forward Gain | Note 1)<br>Note 2) |
| 12 | 0x200B, 0x01 | KVP1 | Velocity Loop Proportional Gain 1 | |
| 13 | 0x200C, 0x01 | TVI1 | Velocity Loop Integral Time Constant 1 | |
| 14 | 0x200D, 0x01 | JRAT1 | Load Inertia Moment Ratio 1 | Note 3) |
| 15 | 0x200E, 0x00 | TRCVGN | Higher Tracking Control Velocity Compensation Gain | |
| 1A | 0x2011, 0x01 | TCFIL1 | Torque (force) Command Filter 1 | |

Note 1) Manual setting is available on Trajectory Control 2 (KP, FFGN Manual Setting).
Note 2) Manual setting is available on Positioning Control 3 (High Response, FFGN Manual Setting).
Manual setting is available on Positioning Control 5 (High Response, Horizontal Axis Limited, FFGN Manual Setting).
Manual setting is available on Trajectory Control 2 (KP,FFGN Manual Setting).
Note 3) Manual is available on auto-tuning [JRAT manual setting].

## 3) Adjustable parameters during auto-tuning

The following parameters are adjustable during auto-tuning:

- General parameters Group1 [Basic control parameter settings]

| ID | CoE Object ID | Symbol | Name |
|---|---|---|---|
| 00 | 0x2003, 0x00 | PCSMT | Position Command Smoothing Constant |
| 01 | 0x2004, 0x00 | PCFIL | Position Command Filter |
| 06 | 0x2008, 0x02 | FFFIL | Feed Forward Filter |
| 10 | 0x2009, 0x00 | VCFIL | Velocity Command Filter |
| 11 | 0x200A, 0x00 | VDFIL | Velocity Feedback Filter |
| 21 | 0x202B, 0x00 | TCFILOR | Torque (force) Command Filter Order |

■ General parameters Group2 [FF vibration suppressor control/ Notch filter/ Disturbance observer settings]

| ID | CoE Object ID | Symbol | Name |
|---|---|---|---|
| 00 | 0x2012, 0x01 | SUPFRQ1 | FF Vibration Suppressor Frequency 1 |
| 01 | 0x202C, 0x00 | SUPLV | FF Vibration Suppressor Level Selection |
| 02 | 0x2040, 0x01 | VCFIL_SET | Velocity Command Filter Setting |
| 03 | 0x2041, 0x01 | VCGFIL_SET | Velocity Command Filter Setting |
| 04 | 0x2041, 0x02 | VCGFIL_TYP | Type of Velocity Filter |
| 05 | 0x2041, 0x03 | VCGFIL_LPF | Velocity Low Pass Filter cutoff frequency * |
| 06 | 0x2041, 0x04 | VCGFIL_HPF | Cutoff frequency of Velocity Bypass Filter * |
| 07 | 0x2041, 0x05 | VCGFIL_BPFC | Center frequency of Velocity Band Pass Filter * |
| 08 | 0x2041, 0x06 | VCGFIL_BPFW | Band width of Velocity Band Pass Filter |
| 09 | 0x2041, 0x07 | VCGFIL_NCFC | Center frequency of Velocity Notch Filter * |
| 0A | 0x2041, 0x08 | VCGFIL_NCFW | Band width of Velocity Notch Filter * |
| 10 | 0x2040, 0x02 | TCFIL_SET | Torque Command Filter Setting |
| 11<br>-<br>30<br>** | 0x204n, 0x01 | TCGFILn_SET | General Torque Command Filter Setting n ** |
|  | 0x204n, 0x02 | TCGFILn_TYP | Type of Torque Filter |
|  | 0x204n, 0x03 | TCGFILn_LPF | Cutoff frequency of Torque Low Pass Filter n ** |
|  | 0x204n, 0x04 | TCGFILn_HPF | Cutoff frequency of Torque High Pass Filter n ** |
|  | 0x204n, 0x05 | TCGFILn_BPFC | Cutoff frequency of Torque Band Pass Filter n ** |
|  | 0x204n, 0x06 | TCGFILn_BPFW | Band width of Torque Band Pass Filter n ** |
|  | 0x204n, 0x07 | TCGFILn_NCFC | Center frequency of Torque Notch Filter n ** |
|  | 0x204n, 0x08 | TCGFILn_NCFW | Band width of Torque Notch Filter n ** |
| 31 | 0x2016, 0x01 | OBCHA | Observer Characteristic |
| 32 | 0x2016, 0x02 | OBG | Observer Compensation Gain |
| 33 | 0x2016, 0x03 | OBLPF | Observer Output Low-pass Filter |
| 34 | 0x2016, 0x04 | OBNFIL | Observer Output Notch Filter |
| 35 | 0x2034, 0x01 | PVLPFset | (Position/Velocity) command Low Pass Filter On/Off |
| 36 | 0x2034, 0x02 | LPF_OFF_V | Off velocity of (Position/Velocity) command Low Pass Filter |

* Setting value is valid when filter on, setting type and values are correct.

** General torque filter has 1 to 4.

■ General parameters Group4 [Gain switching control/Vibration suppressor frequency switching settings]

| ID | CoE Object ID | Symbol | Name |
|---|---|---|---|
| 40 | 0x2012, 0x02 | SUPFRQ2 | FF Vibration Suppressor Frequency 2 |
| 41 | 0x2013, 0x03 | SUPFRQ3 | FF Vibration Suppressor Frequency 3 |
| 42 | 0x2013, 0x04 | SUPFRQ4 | FF Vibration Suppressor Frequency 4 |

■ General parameters Group5 [High setting control setting]

| ID | CoE Object ID | Symbol | Name |
|---|---|---|---|
| 00 | 0x2015, 0x01 | CVFIL | Command Velocity Low-pass Filter |
| 01 | 0x2015, 0x02 | CVTH | Command Velocity Threshold |
| 02 | 0x2015, 0x03 | ACCC0 | Acceleration Compensation |
| 03 | 0x2015, 0x04 | DFCC0 | Deceleration Compensation |

## 4) Unstable functions during auto-tuning

The following functions cannot be used during auto-tuning:

■ General parameters Group1 [Basic control parameter setting]

| ID | CoE Object ID | Symbol | Name |
|---|---|---|---|
| 04 | 0x2007, 0x00 | TRCPGN | Higher Tracking Control Position Compensation Gain |
| 16 | 0x200E, 0x00 | AFBK | Acceleration Feedback Gain |

* [Disturbance observer] cannot be used together with auto-tuning.
Render [Disturbance observer] function invalid when auto-tuning is used.

■ Parameter characteristics for EtherCAT objects

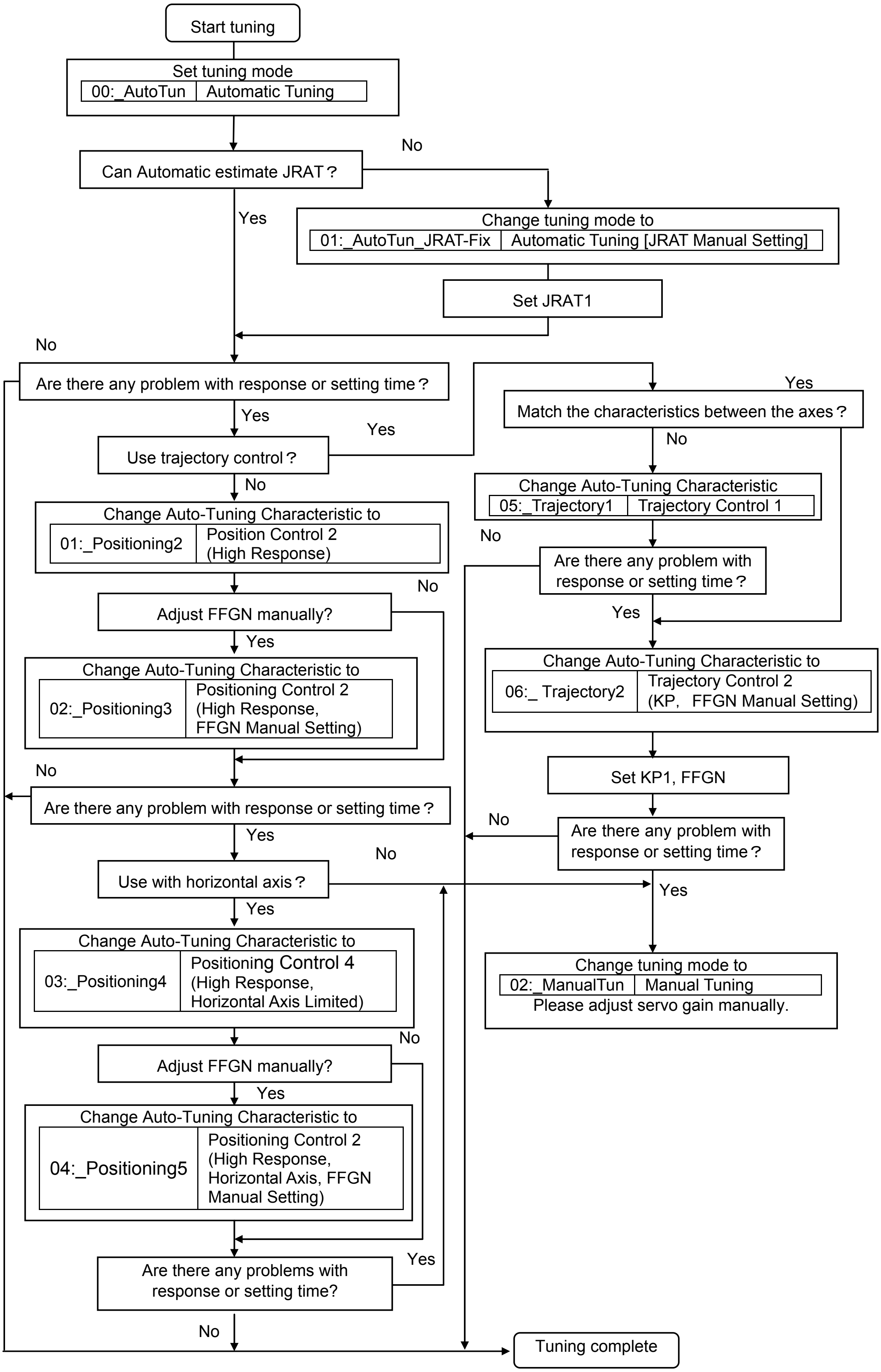
| ID | CoE Object ID | Symbol | Name |
|---|---|---|---|
| - | 0x2001, 0x00 bit5-4 | GC | Gain Switching Selection |
| - | 0x2000, 0x00 bit1 | PPCON | Position Loop Proportional Control Switching Function |
| - | 0x2000, 0x00 bit2 | PCON | Velocity Loop Proportional Control Switching Function |

## 5) 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 | ■ Estimate the load inertia ratio with the servo amplifier in real time and adjust the servo gain automatically >> [Tuning Mode] to 00:_AutoTun Automatic Tuning]<br>When automatically tuned, the best servo gain based on the previous manual setting load inertia ratio (JRAT1) >> Set [Tuning Mode] to 01:_AutoTun_JRAT-Fix Automatic Tuning [JRAT Manual Setting]. |
| Procedure 2 | ■ After setting [Tuning Mode] select [Auto-Tuning Characteristic] for the machine or equipment. |
| Procedure 3 | ■ Next, boot the servo motor and adjust [Auto-Tuning Response] according to equipment rigidity.<br>◆ Set [Auto-Tuning Response] at a low value initially and allow the machine to work about 10 times or more by commanding higher-rank equipment.<br>◆ When response is low and the positioning setting time is slow, after machine movement, try to improve the response and positioning times by increasing [Auto-tuning] gradually.<br>◆ If increasing the response has caused the machine to develop vibration, lower the value of the [Auto-Tuning Response] slightly.<br>* If the machine has not developed vibration, enable the Vibration suppressor by setting the Notch filter and /or FF Vibration suppressor frequency. Set the filter frequency to suppress mechanical vibration by using [Automatic tuning of notch filter ] and/or [Automatic tuning of FF Vibration Suppression Frequency].<br>* Tuning methods are the same in [01:_AutoTun_JRAT-Fix [JRAT Manual Setting]. |

## 6) Auto-Tuning Characteristic selection flowchart



## 7) Monitoring servo gain adjustment parameters

The following parameters can be monitored with Digital Operator and Software Setup when auto-tuning is used. Refer to [See Section 10] for use of Digital Operator.

| ID | CoE Object ID | Symbol | Name | Unit |
|---|---|---|---|---|
| 1D | 0x2104, 0x05 | JRAT MON | Load Inertia Moment Ratio monitor | % |
| 1E | 0x2104, 0x01 | KP MON | Position Loop Proportional Gain monitor | 1 / s |
| 1F | 0x2104, 0x02 | TPI MON | Position Loop Integral Time Constant monitor | Mss |
| 20 | 0x2104, 0x03 | KVP MON | Velocity Loop Proportional Gain monitor | Hz |
| 21 | 0x2104, 0x04 | TVI MON | Velocity Loop Integral Time Constant monitor | ms |
| 22 | 0x2104, 0x06 | TCFIL MON | Torque (force) Command Filter monitor | Hz |
| 23 | 0x2104, 0x07 | MKP MON | Model Control Gain monitor | 1／s |

## 8) Manual tuning method using auto-tuning results

Save auto-tuning results as a batch, and it can be utilized in manual tuning.
For Software Setup, use Auto-tuning >> Auto-tuning result saving.

■ Saving parameters

◆ General parameters Group1 [Basic control parameter settings]

| ID | CoE Object ID | Symbol | Name | Unit |
|---|---|---|---|---|
| 02 | 0x2005, 0x01 | KP1 | Position Loop Proportional Gain 1 | 1 / s |
| 12 | 0x200B, 0x01 | KVP1 | Velocity Loop Proportional Gain 1 | Hz |
| 13 | 0x200C, 0x01 | TVI1 | Velocity Loop Integral Time Constant 1 | ms |
| 14 | 0x200D, 0x01 | JRAT1 | Load Inertia Moment Ratio 1 | % |
| 1A | 0x2011, 0x01 | TCFIL1 | Torque (force) Command Filter 1 | Hz |

◆ General parameters Group3 [Model following control settings]

| ID | CoE Object ID | Symbol | Name | Unit |
|---|---|---|---|---|
| 00 | 0x2017, 0x01 | KM1 | Model Control Gain 1 | 1 / s |

# 7.3 Automatic tuning of notch filter

Automatic notch filter can suppress high frequency resonance resulting from coupling and rigidity from the device mechanism.
With short periods of operation of servo amplifier and servo motor, the mechanical resonance frequency can be found easily.

## 1) Operation method

- ■ Operate from Auto-tuning mode in Software Setup.
- ■ The tuning results are saved automatically in [Group2 ID17: Center frequency of Torque (force) Notch Filter1.

* Torque (force) command notch filter function can be used together with Auto-tuning.
* Holding torque (force) falls while auto notch filter is running. Do not use as a gravity axis.

- ■ 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 2, 3, 4 (Manual setting) to suppress each resonance. If resonance is still not suppressed, there is a possibility that auto-tuning response or gain control is too high. Lower the Auto-Tuning Response or control gain.

## 2) Setting parameters

- ■ Torque (force) command value for notch filter tuning
  Setting the Torque (force) command value to the motor at the time of Automatic tuning of notch filter:

◆ General parameters Group0 [Auto-tuning settings]

| ID | CoE Object ID | Symbol | Name | Unit | Setting range |
|---|---|---|---|---|---|
| 10 | ― | ANFILTC | Automatic tuning of notch filter Torque (force) Command | % | 10.0 - 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 suppressor control/Notch filter/ Disturbance observer settings]

| ID | CoE Object ID | Symbol | Name | Unit | Setting range |
|---|---|---|---|---|---|
| 13 | 0x2042，0x03 | TCGFIL1_LPF | Cutoff frequency of Torque Low Pass Filter n ** | Hz | 10 - 2000 |

* The above parameter is saved automatically with Automatic tuning of notch filter

## 7.4 Automatic tuning of FF Vibration Suppression Frequency

Set FF vibration suppressor frequency to suppress low frequency vibration at the tip or body of the machine. Automatic tuning of FF Vibration suppression frequency simply enables the frequency tune in minimal motion cycle time between the servo amplifier and the servo motor.

### 1) Operation method

- Operate from Auto-tuning mode in Software Setup.
- The tuning result is automatically saved in Group2 ID00: FF Vibration suppressor frequency 1 [SUPFREQ1].
- FF vibration suppressor frequency is obtained by executing auto-tuning of vibration suppressor frequency or by calculating vibration frequency from the mechanical vibration period at the time of positioning.

* When vibration does not stop with FF vibration suppressor frequency, there is a possibility that the gain for control system may be too high. In this case, lower the control system gain.

* When used together with Higher Tracking Control Velocity Compensation Gain, vibration- suppressor effect may be improved.

* FF vibration suppressor control function can be used with auto-tuning.

* Holding torque (force) falls while Automatic tuning of FF Vibration Suppression Frequency is executing. Do not use as gravity axis.

### 2) Setting parameters

- Torque (force) command value of Auto-FF vibration suppressor frequency
  Sets torque (force) command value to servo motor at the time of Automatic tuning of FF Vibration Suppression Frequency execution.

◆ General parameters Group0 [Auto-tuning setup]

| ID | CoE Object ID | Symbol | Name | Unit | Setting range |
|---|---|---|---|---|---|
| 11 | - | ASUPTC | Automatic tuning of FF Vibration Suppression Frequency Friction torque (force) Compensation Value | % | 10.0 - 100.0 |

* As the value increases so does tuning accuracy. However, machine movement will increase as well. Please monitor it closely.

- Friction torque (force) compensation amount during Automatic tuning of FF Vibration Suppression Frequency.
  Sets additional frictional torque (force) compensation amount when Automatic tuning of FF Vibration Suppression Frequency is executed.
  By setting the value close to the actual friction torque (force), the accuracy of Automatic tuning of FF Vibration Suppression Frequency can be improved.

◆ General parameters Group0 [Auto-tuning setup]

| ID | CoE Object ID | Symbol | Name | Unit | Setting range |
|---|---|---|---|---|---|
| 12 | - | ASUPFC | Automatic tuning of FF Vibration Suppression Frequency Friction torque (force) Compensation Value | % | 0.0 - 50.0 |

- Automatically saved parameter of Automatic tuning of FF Vibration Suppression Frequency.

◆ General parameters Group2 [FF vibration suppressor control/Notch filter/ Disturbance observer settings]

| ID | CoE Object ID | Symbol | Name | Unit | Setting range |
|---|---|---|---|---|---|
| 00 | 0x2012, 0x01 | SUPFRQ1 | FF Vibration Suppressor Frequency 1 | Hz | 5 - 500 |

# 7.5 Using Manual Tuning

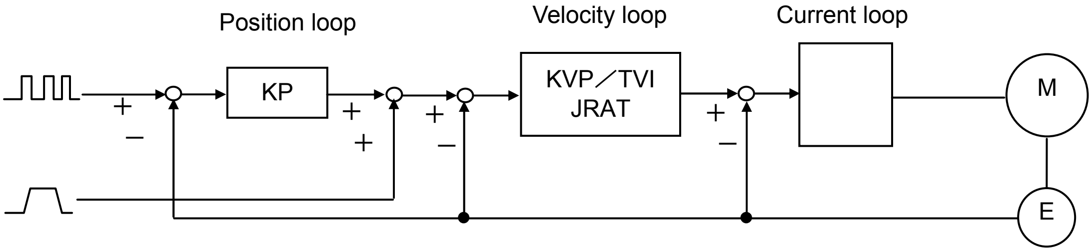
All gain is adjustable manually using manual tuning mode when characteristics in auto-tuning are insufficient.
Sets the Tuning Mode to Manual tuning.

■ General parameters Group0 ID00: Tuning Mode Index:0x2002, Sub-Index:0x01 [TUNMOD]

| | |
|---|---|
| 02:_ManualTun | Manual Tuning |

## 1) Servo system structure and servo adjustment parameters

The servo system consists of three (3) subsystems: Position loop, Velocity loop and Current loop.
Higher response is required for internal loops. If this structure is compromised, it could result in instability, low response, vibration or oscillation.



Explains each servo parameter (Group 1) below

■ Position Command Smoothing Constant Index:0x2003, 0x00 [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 communication cycle is long.

■ Position Command Filter Index:0x2004, 0x00 [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 Higher Tracking Control Position Compensation Gain is set to other than 0%, this parameter is automatically set.

■ Position Loop Proportional Gain Index:0x2005, 0x01 - 0x04 [KP]
Sets the response of Position control.
Set this to: $KP_{[1/S]} = KVP_{[Hz]} / 4 \cdot 2\pi$

■ Higher Tracking Control Position Compensation Gain Index:0x2007, 0x00 [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.

■ Feed Forward Gain Index:0x2008, 0x01 [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 Higher Tracking Control Position Compensation Gain is set to other than 0%, this parameter is automatically set.

■ Feed Forward Filter Index:0x2008, 0x02 [FFFIL]
When position command resolution is low, set this parameter to suppress ripples.

■ Velocity Loop Proportional Gain Index:0x200B, 0x01 - 0x04 [KVP]
Sets the response of Velocity control. Set this parameter as high as possible within a stable operating range that does not cause vibration or oscillation.
If JRAT is accurately set, the set value of KVP becomes the Velocity loop response zone.

■ Velocity Loop Integral Time Constant Index:0x200C, 0x01 - 0x04 [TVI]
Set this to: $TVI_{[ms]}=1000 / (KVP_{[Hz]})$

- ■ Load inertia moment ratio Index:0x200D, 0x01 - 0x04 [JRAT]
  Set this value to the calculation shown below:

$$\text{JRAT} = \frac{\text{Motor axis converted load inertia } (J_L)}{\text{Motor rotor inertia } (J_M)} \times 100\%$$

- ■ Higher Tracking Control Velocity Compensation Gain Index:0x2007, 0x00 [TRCVGN]
  Tracking effect can be improved by increasing compensation gain.
  Adjust this to shorten the position setting time.

* Set the value of JRAT properly to use this function.
* Set 0% when you use [Velocity Loop Proportional Control Switching Function] during operation.
* Set at 100% to equal Q-series servo amplifier.

- ■ Torque (force) Command Filter Index:0x2011, 0x01
  When rigidity of the mechanical device is high, set this value high and the Velocit0 Loop Proportional Gain 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.

## 2) Basic manual tuning method for velocity control

- ■ Set Velocity Loop Proportional Gain( 0x200B, 0x01) (KVP1) as high as possible within the range that allows the mechanical device to maintain stability without causing vibration or oscillation.
  If vibration increases, lower the value.

- ■ Set Velocity Loop Integral Time Constant (0x200C, 0x01) (TV1) to: TVI [ms]=1000/(KVP[Hz])

* 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 suppressor frequency to suppress resonance) try the procedure again.

## 3) Basic manual tuning method for position control

- ■ Set Velocity Loop Proportional Gain (0x200B, 0x01)(KVP1) as high as possible within the range that allows the mechanical device to maintain stability without causing vibration or oscillation.
  If vibration increases, lower the value.
- ■ Set Velocity Loop Integral Time Constant (0x200C, 0x01)(TVI1) to: $\text{TVI}_{[ms]}=1000 / (\text{KVP}_{[Hz]})$
- ■ Position Loop Proportional Gain (0x2005, 0x01)(KP1) to: $\text{KP}_{[1/S]} = \text{KVP}_{[H]}/4 \cdot 2\pi$
  In case 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 suppressor frequency to suppress resonance) try the procedure again.

# 7.6 Model Following Control

Model following control is a method used to obtain a higher response. Model control systems include mechanical devices in a servo amplifier and run a servo motor in order to track the Model control system.
Select [Position control form] in [Control mode]
Select [Model following control] in [Position control selection]

<table>
<tr><th>ID</th><th>CoE Object ID</th><th>Content</th></tr>
<tr><td rowspan="2">0A</td><td rowspan="2">0x20F3, 0x01</td><td>Position Control Selection</td></tr>
<tr><td><table><tr><th colspan="2">Select value</th><th>Content</th></tr><tr><td>01</td><td>Model1</td><td>Model following control</td></tr></table></td></tr>
</table>

- * Model following control cannot be used when in velocity control mode or torque (force) control mode.
- * Model following control can be used with auto-tuning.
- * Model following control can be used with full-closed control.

## 1) Automatic tuning method for Model following control

The Model following control can be used in conjunction with the Auto-tuning.
Follow the tuning procedure shown in [Adjustment method for auto-tuning].
Model Control Gain 1 is tuned in addition to tuning the parameter at Standard position control.

■ Automatically adjust parameters using Model following control auto-tuning.

◆ General parameters Group1 [Basic control parameter settings]

| ID | CoE Object ID | Symbol | Name | Notes |
|---|---|---|---|---|
| 02 | 0x2005, 0x01 | KP1 | Position Loop Proportional Gain 1 | Note 1) |
| 12 | 0x200B, 0x01 | KVP1 | Velocity Loop Proportional Gain 1 | |
| 13 | 0x200C, 0x01 | TVI1 | Velocity Loop Integral Time Constant 1 | |
| 14 | 0x200D, 0x01 | JRAT1 | Load Inertia Moment Ratio 1 | Note 2) |
| 1A | 0x2011, 0x01 | TCFIL1 | Torque (force) Command Filter 1 | |

Note 1) Manual setting is available in Trajectory Control 2 [KP, FFGN manual setting]
Note 2) Manual setting is available in Automatic Tuning [JRAT Manual Setting]

◆ General parameters Group3 [Model following control settings]

| ID | CoE Object ID | Symbol | Name | Notes |
|---|---|---|---|---|
| 00 | 0x2017, 0x01 | KM1 | Model Control Gain 1 | Note 3) |

Note 3) KP1 setting value is set in Trajectory Control 2 [KP, FFGN Manual Setting]

- * Parameters automatically adjusted by the servo amplifier vary according to selected Auto-Tuning Characteristic.

## 2) Manual tuning method for Model following control

- ■ Set Velocity Loop Proportional Gain (0x2005, 0x01)(KVP1) at as high a value as possible within a stable range that will not cause vibration or oscillation. If vibration increases, lower the value.
- ■ Set Velocity Loop Integral Time Constant (0x200C, 0x01)(TVI1) to: $TVI_{[ms]}$=1000/($KVP_{[Hz]}$).
- ■ Set Position Loop Proportional Gain (0x2005, 0x01)(KP1) to: $KP_{[1/S]}$=$KVP_{[Hz]}$ / 4･2π.
- ■ Set Model Control Gain (0x2017, 0x01)(KM1) to: KM≒KP. If vibration increases, lower the value.
- ■ When response is low, set the value of KM to: approximately 1.1 - 1.2 times.

* When the gain cannot rise because of mechanical vibration, etc., and the response time is insufficient, use Torque notch filter and/or FF Vibration suppressor frequency to suppress resonance and attempt it again.

- ■ Adjustable parameters in Model following control
  In addition to the parameters in Standard position control, the following parameters are also adjustable:

◆ General parameters Group3 [Model following control settings]

| ID | CoE Object ID | Symbol | Name |
|---|---|---|---|
| 00 | 0x2017, 0x01 | KM1 | Model Control Gain 1 |
| 01 | 0x2018, 0x01 | OSSFIL | Overshoot Suppressor Filter |

◆ Model Control Gain 1 Index：0x2017, 0x01 [KM1]

Proportional gain fro Model following control position controller. Adjust this to: KM≒KP.

◆ Overshoot Suppressor Filter index：0x2019, 0x01 [OSSFIL]

Set cutoff frequency of overshoot suppressor filter in Model following control.
If overshoot occurred on a position deviation, lower the setting value.

# 7.7 Tuning to Suppress Vibration

## 1) FF vibration suppressor control

FF vibration suppressor control can be used as a method of suppressing the vibration of the mechanical tip.

- ■ Adjust this gain by using the same basic tuning procedures from Position control.
- ■ When vibration rises on the machine tip during operation, use [Auto-FF vibration suppressor frequency tuning] or calculate the vibration frequency from the vibration period and set the vibration frequency to [FF vibration suppressor frequency (SUPFRQ1)].

◆ General parameters Group2 [FF vibration suppressor control/Notch filter/ Disturbance observer settings]

| ID | CoE Object ID | Symbol | Name | Unit | Setting range |
|---|---|---|---|---|---|
| 00 | 0x2012, 0x01 | SUPFRQ1 | FF Vibration Suppressor Frequency 1 | Hz | 5 - 500 |

* If the machine tip vibration does not stop after taking the above steps, there is a possibility the gain for the control system could be too high. In this case, lower the Control system gain.

* Do not change the Setting value when the motor is running.

## 2) Model tracking vibration suppressor 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 suppressor control suppresses this type of machine stand vibration and improves Position stabilization time and response.

- ■ When you use Model following vibration suppressor control, select Position control at Control Mode Selection and Model following vibration suppressor control at Position Control Selection at System parameters.
  You can run the servo motor under the condition that the machine stand vibration is suppressed using Model control system.

<table>
<tr><th>ID</th><th>CoE Object ID</th><th>Contents</th></tr>
<tr><td rowspan="2">0A</td><td rowspan="2">0x20F3, 0x01</td><td>Position Control Selection</td></tr>
<tr><td><table><tr><th colspan="2">Select value</th><th>Contents</th></tr><tr><td>02</td><td>Model2</td><td>Model Following Vibration Suppress Control</td></tr></table></td></tr>
</table>

* Do not use Auto-tuning with Model following vibration suppressor control.

* Full-closed control cannot be used with Model following vibration suppressor control.

* Model following vibration suppressor control cannot be used when in Velocity control mode or Torque (force) control mode.

- Adjustable parameters in Model following vibration suppressor control

◆ General parameters Group3 [Model following control settings]

| ID | CoE Object ID | Symbol | Name | Unit | Setting range |
|---|---|---|---|---|---|
| 00 | 0x2017, 0x01 | KM1 | Model Control Gain 1 | 1 / s | 15 - 315 |
| 01 | 0x2018, 0x01 | OSSFIL | Overshoot Suppressor Filter | Hz | 1 - 4000 |
| 02 | 0x2019, 0x01 | ANRFRQ1 | Model Control Antiresonance Frequency 1 | Hz | 10.0 - 80.0 |
| 03 | 0x201A, 0x01 | RESFRQ1 | Model Control Resonance Frequency 1 | Hz | 10.0 - 80.0 |

◆ Model Control Gain 1 Index:0x2017, 0x01 [KM1]

This is the proportional gain of the Model following controlling position controller and set response for Model control system.

◆ Overshoot Suppressor Filter Index:0x2018, 0x01 [OSSFIL]

This parameter is to set the cutoff frequency of the Overshoot suppressor filter in Model following vibration suppressor control. If overshoot occurred on a position deviation, lower the setting value.

◆ Model Control Antiresonance Frequency 1 Index:0x2019, 0x01 [ANRFRQ1]

This is to set the Anti-resonance frequency of the machine using Model following vibration suppressor control.
When the value is set higher than Model Control Resonance Frequency, vibration suppressor control will be invalid.

◆ Model Control Resonance Frequency 1 Index:0x201A, 0x01 [RESFRQ1]

This is to set the Resonance frequency of the machine model using Model following vibration suppressor control.
Vibration suppressor control will be invalid at 80.0Hz.

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

- Parameter setting range for Model following vibration suppressor control
  Setting ranges for the following parameters are restricted:

◆ General parameters Group1 [Basic control parameter settings]

| ID | CoE Object ID | Symbol | Name | Unit | Setting Range |
|---|---|---|---|---|---|
| 14 | 0x200D, 0x01 | JRAT1 | Load Inertia Moment Ratio 1 | % | 100 - 3000 |
| 1A | 0x2011, 0x01 | TCFIL1 | Torque (force) Command Filter 1 | Hz | 10-600 |

◆ General parameters Group3 [Model following control settings]

| ID | CoE Object ID | Symbol | Name | Unit | Setting Range |
|---|---|---|---|---|---|
| 00 | 0x2017, 0x01 | KM1 | Model Control Gain1 | 1 / s | 15 - 315 |

## 3) Tuning methods

- First, execute Model following control auto-tuning by selecting [01:_Model following control] in [Position Control Selection(0x20F3, 0x01)(ID07)] at System parameters and tune the machine with the best servo gain.
  Refer to Auto-tuning method in Model following control for instructions on tuning.

  * When the best servo gain for the machine has been selected, ignore this step.

- When servo gain tuning is completed, please change tuning mode to manual tuning after performing an auto tuning result storing function.

- After completing servo gain tuning, set the Resonance frequency and Anti-resonance frequency of the mechanical device using [02:_ Model following vibration suppressor control] in [Position Control Selection (0x20F3, 0x01)(ID07)] at System parameters.
  When anti-resonance and resonance frequencies are already known, set the values. When these values are unknown, these frequencies can be measured using System analysis.

  * Refer to MOTOR Setup Software Instruction manual M0010842 for instructions on using 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 suppressor control may not be measured.
  1 - 125Hz for [Frequency range selection] is recommended.
  * When the mass of the drive motor is smaller than the machine stand mass, the anti-resonance and resonance frequencies may not be measured in system analysis. 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 the Velocity Loop Proportional Gain (0x200B,0x01)(KVP1) as high as possible within stable range without causing vibration or oscillation. If vibration increases, lower the value.
- Set the Velocity Loop Integral Time Constant (0x200C, 0x01)(TVI1) to: $TVI_{[ms]}=1000/(KVP_{[Hz]})$.
- Set the Position Loop Proportional Gain (0x2005, 0x01)(KP1) to: $KP_{[1/S]}=KVP_{[Hz]}/4\cdot 2\pi$.
- Set the Model Control Gain (0x2017, 0x01)(KM1) to: $KM \fallingdotseq KP$. If vibration increases, lower the value.
- Set the Model Control Gain (0x2017, 0x01)(KM1) value to: 1.1 - 1.2times when the response is low.
- 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 suppressor controls together. Set the vibration frequency to: [Group02 ID00 : FF vibration suppressor frequency 1(0x2012, 0x01)(SUPFRQ1)] 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 (force) command notch filter and FF vibration suppressor frequency to suppress the resonance, and then try again.

## 7.8 Using the Disturbance Observer Function

The servo motor speed will fluctuate when an external force is applied to the operating machine, and it may affect the machine operation. The Disturbance Observer is a function to suppress the influence of external load torque (force) by estimating the load torque (force) inside the servo amplifier and adding the load torque (force) compensation to the torque (force) command. To use the Disturbance Observer, set [Group9 ID33: Disturbance Observer Function] in [Functions Valid]. Adjust the observer related parameters in [Group2 ID30-33] and suppress or reject the disturbance.

■ Parameters for using the Disturbance Observer

◆ Parameter characteristics for EtherCAT objects

| ID | CoE Object ID | Symbol | Name | Setting range |
|---|---|---|---|---|
| — | 0x2000, 0x00 bit11 | OBS | Disturbance observer compensation Enable | 00, - 27 |

◆ General parameters Group2
[FF vibration suppressor control/Notch filter/Disturbance observer settings]

| ID | CoE Object ID | Symbol | Name | Unit | Setting range |
|---|---|---|---|---|---|
| 30 | 0x2016, 0x01 | OBCHA | Observer Characteristic | — | 00 - 02 |
| 31 | 0x2016, 0x02 | OBG | Observer Compensation Gain | % | 0 - 100 |
| 32 | 0x2016, 0x03 | OBLPF | Observer Output Low-pass Filter | Hz | 1 - 4000 |
| 33 | 0x2016, 0x04 | OBNFIL | Observer Output Notch Filter | Hz | 100 - 4000 |

■ Explanation of the parameters using the Disturbance Observer.

Provides three observer characteristics: “00_Low for low frequency disturbance suppression” “01_Middle for middle frequency disturbance suppression” and “02_High for high frequency disturbance suppression” depending on the disturbance frequency to be suppressed.

- 10 - 40[Hz] [00_Low for low frequency disturbance suppression]
- 40 - 80[Hz] [01_Middle for middle frequency disturbance suppression]
- 80 - 200[Hz] [02_High for high frequency disturbance suppression]

◆ Increase the Observer Compensation Gain gradually. (Do not set the value at the beginning.)
The higher the Observer Compensation Gain becomes, the more disturbance suppressing characteristics will improve. However, if the gain is excessively high, oscillation may result. Use this within a range that will not cause oscillation.

* Disturbance Observer cannot be used with Auto-tuning.

* Observer low-pass filter can be used when the encoder resolution is high or the Load inertia ratio is low. Observer characteristics can be improved by setting the frequency high.

* Use the Observer notch filter to suppress vibration in case the resonance in high frequency zones has changed.

* Use [02_High for High frequency disturbance suppression] when encoder resolution is above 1048576 division.

8

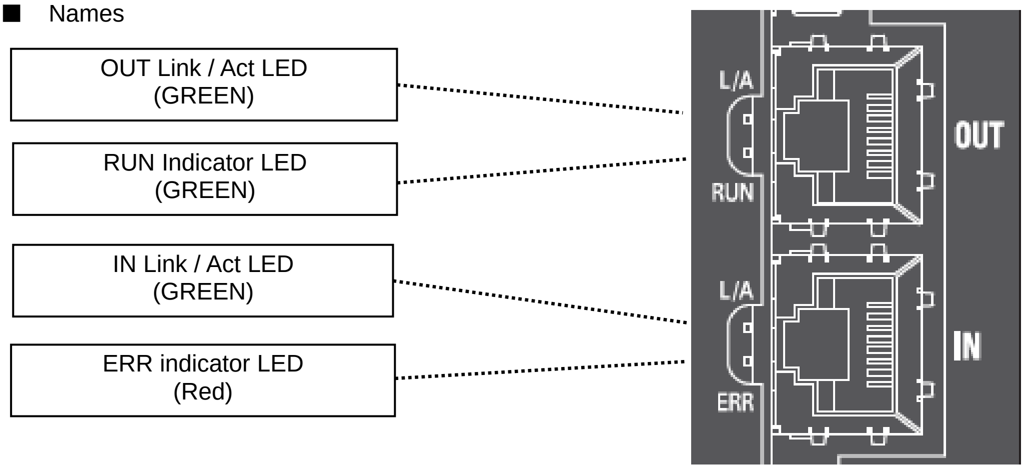
# 8. Indication

# 8.1 EtherCAT Indicator

The servo amplifier has four (4) indicators standardized by EtherCAT specifications, two (2) indicators for power establishment, four (4) indicators for amplifier status with green and for (4) indicators for amplifier error with red LED.
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



EtherCAT Status LED

## 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) |

## 2) RUN Indicator Code：RUN

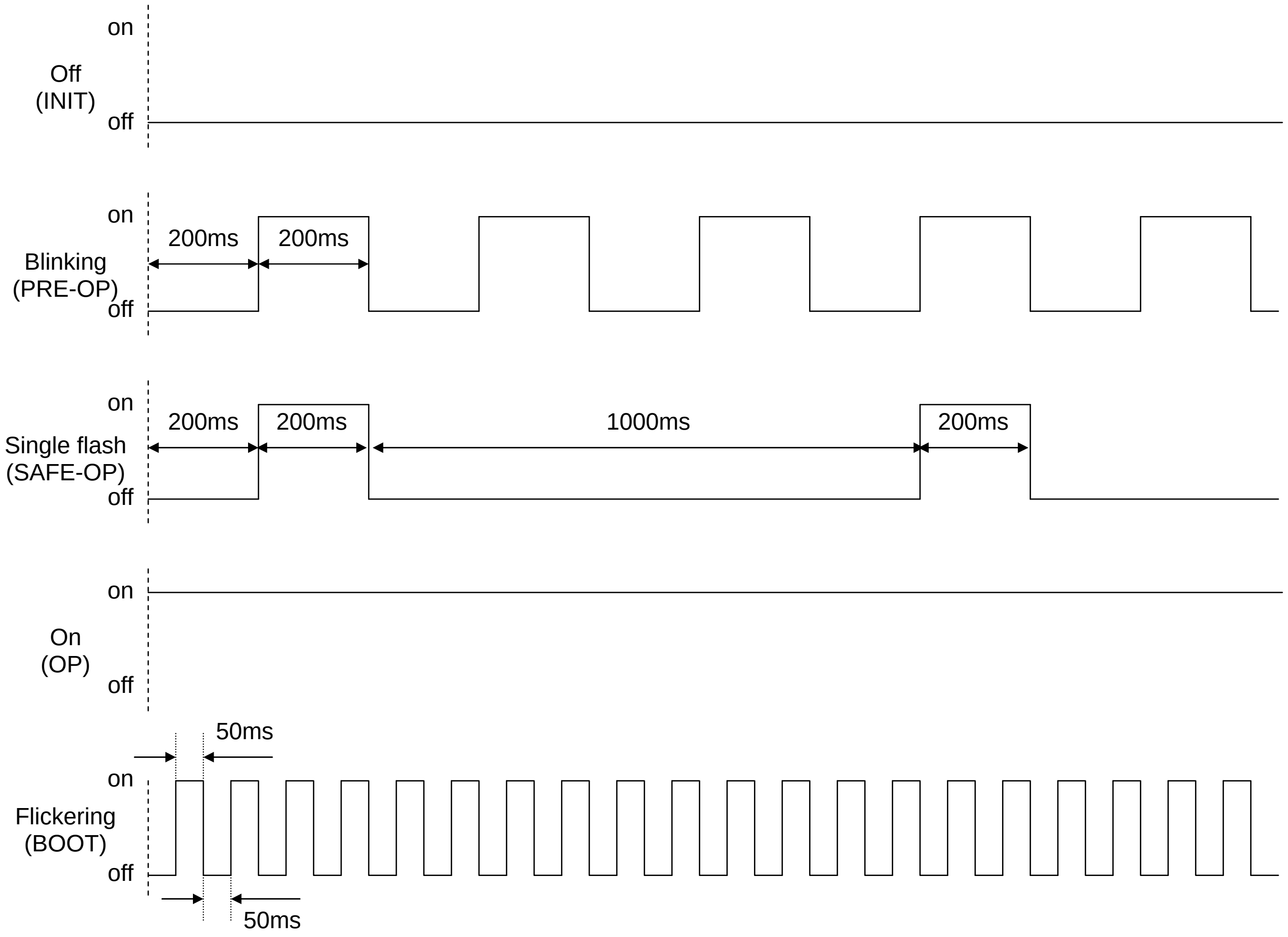
RUN indicator (Green LED) displays EtherCAT communication State machine status with Lighting /Extinguishing/ Flickering of the LED. Explains the RUN indicator below.

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.<br>(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



### 3) Error Indicator Code：ERR

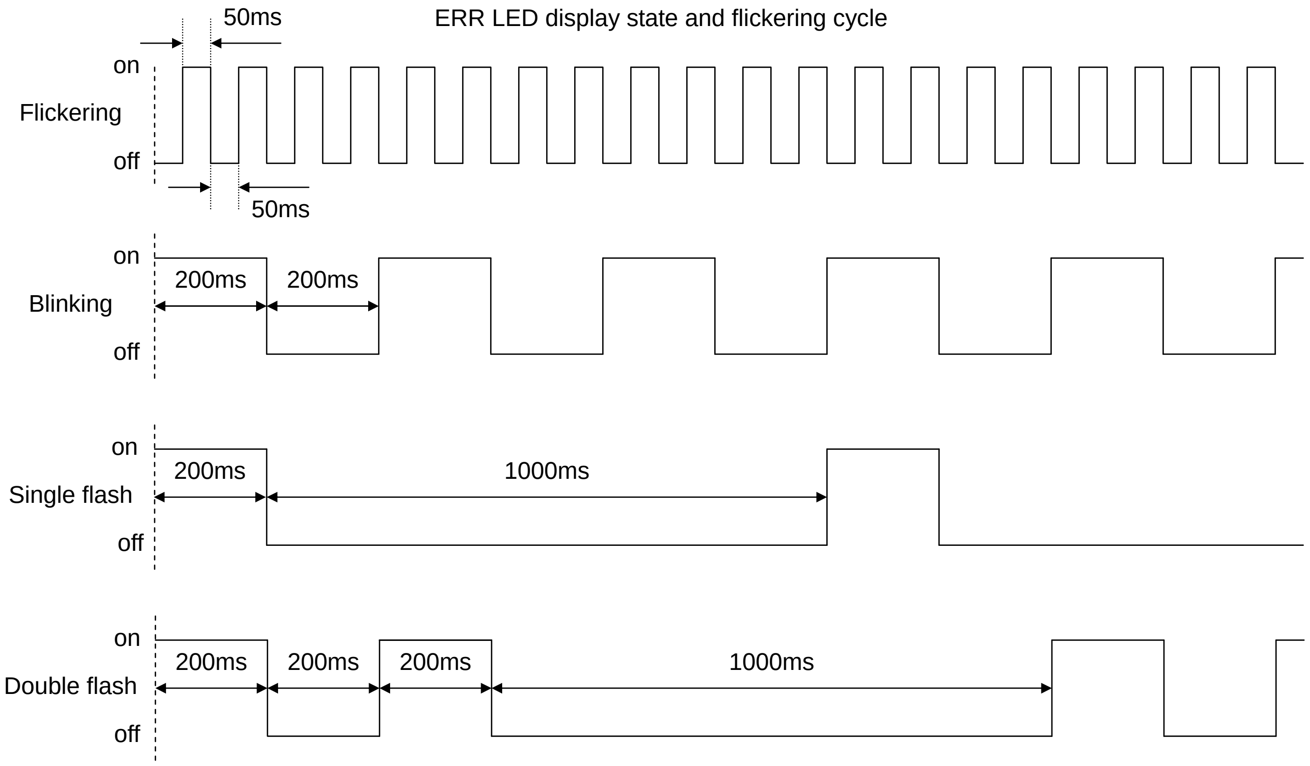
Error Indicator (Red LED) displays invalid state machine (ESM) change and/or watchdog error with an ON/OFF flickering of the LED.

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<br>*Transitioned to INIT state but error was set in AL status register |
| Blinking | Invalid configuration | General configuration error<br>*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<br>*In cases of transition to Safe-Operational automatically with synchronization error, etc. |
| Double flash | Application Watchdog timeout | Application Watchdog timeout has occurred<br>*SyncManager Watchdog timeout has occurred |
| On | PDI Watchdog timeout | PDI Watchdog timeout has occurred<br>*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.



# 8.2 Servo Amplifier Indicator

This servo amplifier has four types of indicator characteristics for the R ADVANCED MODEL, other than EtherCAT indicators:

| | |
|---|---|
| * Main circuit power charge indicator | : LED (RED) |
| * Control power supply establish indicator | : LED (BLUE) |
| * Amplifier status indicator | : LED (GREEN) |
| * Amplifier alarm indicator | : LED (RED) |

## 1) Main Circuit Power Supply Indicator Code：CHARGE

Main Circuit Power Supply Indicator (Red LED) shows the main circuit power (P, N) 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.

## 2) Control Power Supply Establish Indicator Code：POW

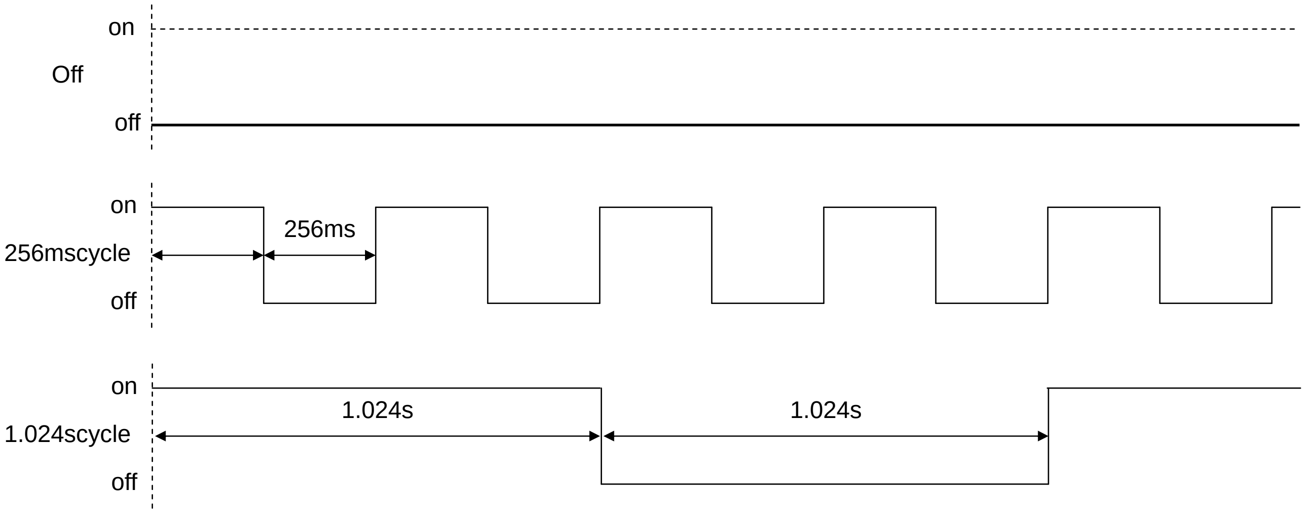
Control Power Supply Establish Indicator (Blue LED) shows the control power supply (CP, CN) has been input and the 5V control power supply has been established through the switching power supply inside the amplifier.

## 3) Amplifier Status Indicator Code: ST1, ST2, ST3, ST4

Indicates servo amplifier status.

| Indication | State of servo amplifier |
|---|---|
| Off | ・ Main circuit power is not established.<br>・ EtherCAT FSA is state of "Switch on Disabled" or "Ready to Switch on". |
| Blinking with 256ms cycle | ・ Main circuit power is established.<br>Main circuit power (P, N) is established and operation preparation completion signal is state of OFF.<br>・ EtherCAT FSA is state of "Switch on Disabled" or "Ready to Switch on". |
| | ・ State of operation preparation completion.<br>Main circuit power (P, N) is established and operation preparation completion signal is state of ON.<br>・ EtherCAT FSA is state of "Switch on Disabled", "Ready to Switch on" or "Switch on". |
| Blinking with 1.024s cycle | ・ State of servo ON.<br>・ EtherCAT FSA is state of "Operation Enabled". |

LED blinking cycle

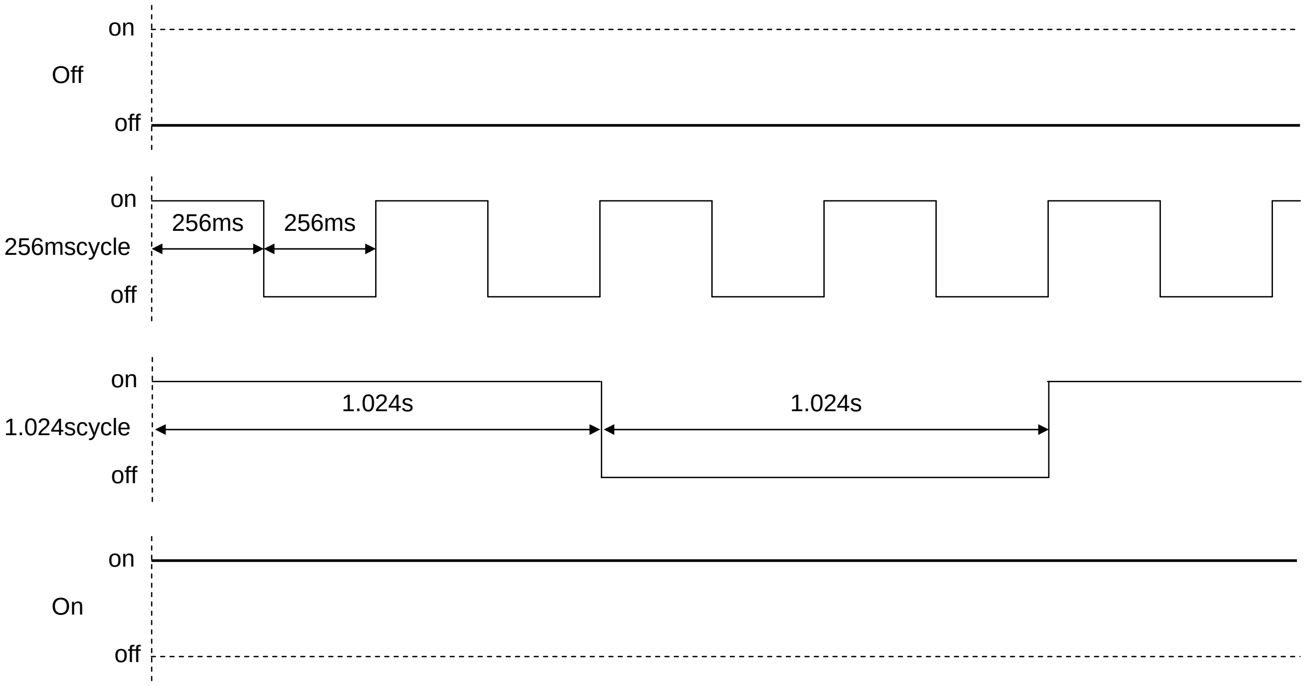


### 4) Amplifier Alarm Indicator Code: AL1, AL2, AL3, AL4

Indicates servo amplifier alarm/warning.

| Indication | State of servo amplifier |
|---|---|
| Off | ・ No alarm/warning. |
| Blinking with 256ms cycle | ・ State of Safe Torque Off.<br>Main circuit power (P, N) is established and both or either of Safe Torque Off input is OFF.<br>・ EtherCAT FSA is state of "Switch on Disabled", "Ready to Switch on" or "Switch on". |
| Blinking with 1.024s cycle | ・ State of warning.<br>Battery warning, position deviation warning, overload warning, amplifier temperature warning, positive/negative over travel, velocity limiting or torque limiting. |
| On | ・ State of alarm.<br>For alarm occurrence, take action according to "Maintenance". |

LED blinking cycle



# 9

# 9. Maintenance

## 9.1 Trouble shooting

When troubles occur without any alarm displayed, check and take corrective actions for them referring to the description below. When alarm occurs take corrective measures referring to “Trouble Shooting When Alarm Occurs”.

■ Cannot transit to state of Servo Ready even if main power is ON.

| Investigation | Assumed causes and corrective actions |
|---|---|
| Check the voltage at the power input terminal. | ■ If voltage is low, check the power supply.<br>■ Check that wires and screws are fastened properly. |
| Red "CHARGE" LED goes out. | ■ Internal power circuit of servo amplifier is defective, so replace the servo amplifier. |
| Over-travel status, or Emergency Stop status. | ■ Stop the input of Over-travel.<br>■ Stop the input of Emergency Stop.<br>■ Check of “Functions enabling condition settings”. |
| Safe Torque Off working status. | ■ Turn on /HWGOFF1 and /HWGOFF2 inputs. |
| Check which axis has alarm. | ■ Solve cause of alarm and then perform alarm clearing. Note) |

Note) When one axis has alarm, the other axis will be state of emergency stop and disabling servo-ON.

■ 7-segment LED displays a rotating character “8” (Servo ON status), but motor does not rotate.

| Investigation | Assumed causes and corrective actions |
|---|---|
| Check the command is inputted or not by the monitor in the MOTOR seup software .<br>Page07: Velocity command monitor(VCMON)<br>Page09: Torque (force) command monitor(TCMON)<br>Page13: Position command pulse frequency monitor (FMON1) | ■ If the value of a monitor is zero, input a command. |
| Check the servo motor is locked or not. | ■ Check that the power line of a servo motor is connected. |
| Check if torque (force) limit is input. | ■ Since torque (force) restrictions are inputted, a servo motor cannot output the torque (force) beyond the load torque (force).<br>■ Check of “Functions enabling condition settings” |
| Enter deviation clear to check if process is continued. | ■ Stop the input of deviation clear.<br>■ Check of “Functions enabling condition settings” |
| Enter encoder clear to check if process is continued. | ■ Stop the input of encoder clear.<br>■ Check of “Functions enabling condition settings” |

* When performing the work for correction processing, be sure to intercept power supply.

■ Rotations of servo motor are unstable and less than the specified velocity command.

| Investigation | Assumed causes and corrective actions |
|---|---|
| Check if proportional control is entered. | ■ Stop the input of proportional control.<br>■ Check of “Functions enabling condition settings” |
| Check if torque (force) limit is input. | ■ Stop the input of torque (force) limit.<br>■ Check of “Functions enabling condition settings” |

- ■ Servo motor rotates only once, and stops.

| Investigation | Assumed causes and corrective actions |
|---|---|
| Check motor power line. | ■ The servo motor power line is not connected. |
| Check a setup of a combination motor. | ■ Change the settings and turn ON the power again. |
| Check a setup of encoder resolution. (System parameter) | |

* When performing the work for correction processing, be sure to intercept power supply.

- ■ Servo motor hangs up.

| Investigation | Assumed causes and corrective actions |
|---|---|
| Check 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 processing, be sure to intercept power supply.

- ■ Servo motor is vibrating.

| Investigation | Assumed causes and corrective actions |
|---|---|
| Motor is vibrating with frequency above 200 Hz. | ■ Reduce the loop gain speed.<br>Set the torque (force) command low-pass filter and torque (force) command notch filter. |

- ■ Occurs over shoot/ under shoot during starting / stopping.

| Assumed causes and corrective actions |
|---|
| ■ Adjust the auto tuning “response”.<br>■ Reduce the loop gain speed.<br>■ Increase the velocity integral time constant.<br>■ Simplify the acceleration and declaration command.<br>■ Use position command low-pass filter. |

- ■ Abnormal sound occurs

| Investigation | Assumed causes and corrective actions |
|---|---|
| Check whether there is any problem in mechanical attachment. | ■ Observe by operating one servo motor.<br>■ Pay attention while coupling and confirm that there is no core shift or unbalance. |
| Operate at a low speed and check whether abnormal sound has periodicity. | ■ Confirm that the twisted pair and shield processing of motor encoder signal line are correct.<br>■ Confirm that the wiring for motor encoder line and servo motor power line are not installed in the same port.<br>■ Confirm that the power supply voltage is sufficient. |

## 9.2 Warning and Alarm List

### 1) Warning Overview

The method of warning displayed, the name of alarm, contents, stop operation at the time of detection, and alarm reset is described on the following tables.
Corresponding bit of the warning monitor (Index:0x2103, 0x01) is set when a warning has occurred.
Normal operation is possible even when detecting a warning; however, an alarm may result if operation is continued.
Examine operational conditions prior to alarm occurrence.
Warning detected status will not be locked. It will be automatically cancelled when warning status returns to normal.
The overload detection process is estimated as 75% of rated load at control power input (Hot Start). Therefore, in case the setting value of the overload warning is below 75%, an overload warning may be detected at the time of control power input.

### 2) Warning List

Warning Table

| Affiliate | Index, Sub-Index, Bit | Warning Title | Warning Contents |
|---|---|---|---|
| Load system | 0x2103, 0x01, Bit2 | Overload Warning | *The effective torque (force) is exceeding the set torque |
| | 0x2103, 0x01, Bit3 | Regenerated Overload Warning | *In case of overload of regenerative resistance |
| | 0x2103, 0x01, Bit0 | Amplifier Overheating Warning | *The ambient temperature of the amplifier is greater than the range of the preset temperature |
| Power supply system | 0x2103, 0x01, Bit8 | Main circuit is charging | *Voltage of main circuit is above DC 105 V |
| | 0x2103, 0x01, Bit15 | Detecting power failure | *Detecting decrease in control power voltage |
| Sensor system | 0x2103, 0x01, Bit14 | Serial encoder Battery warning | *Battery voltage is below 3.0 V |
| Control system | 0x2103, 0x01, Bit4 | Restricting torque (force) command | *While restricting the torque command by torque (force) restriction value. |
| | 0x2103, 0x01, Bit5 | Restricting speed command | *While restricting the speed command by speed value. |
| | 0x2103, 0x01, Bit7 | Excessive position deviation | *When position deviation warning setup value is outside the proscribed limits |
| | 0x2103, 0x01, Bit10 | Restricting position command | *Exceeding position command range |

## 9.3 Alarm Display

### 1) Alarm Display Overview

Displays a corresponding alarm code on alarm occurrence to alarm history of MOTOR setup software.
Alarms shall be diplayed with Error Register (0x1001), Error code (0x603F) read via EtherCAT communication when alarm activated, and servo amplifier definition（0x2001, 0x2002）code list is shown in 2).

Operation at detecting: "DB" performs the slowdown stop of the servo motor in dynamic brake operation when the alarm generating. This servo amplifier does not have dynamic brake. So, it will stop by Free Run operation.
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.
Operation at detecting:“-” means an alarm is detected only in initial processing after control power input.
Alarm reset:“No” means an alarm that cannot be cancelled unless control power is shut off and re-input.

Bit definitions of Error Register (0x1001) are as follows:

Bit7: Maker definition error
Bit6: Reserved
Bit5: Device profile definition error
Bit4: Communication error
Bit3: Temperature error
Bit2: Voltage error
Bit1: Current error
Bit0: General error

## 2) Alarm display list

Alarm code list 1/2

| 0x1001 Error Resister | 0x603F Error Code | 0x2101 0x2102 Code | Alarm name | Alarm contents | Detection Operations | Alarm Reset |
|---|---|---|---|---|---|---|
| Bit4 | 0x7510 | 0x10 | IN Rx Invalidity Frame Error | * Received invalid frame successively at Port 0 | SB | Yes |
| | | 0x11 | OUT Rx Invalidity Frame Error | * Received invalid frame successively at Port 1 | SB | Yes |
| | | 0x12 | IN Rx CRC Error | * Port 0 Successive Rx error | SB | Yes |
| | | 0x13 | OUT Rx CRC Error | * Port 1 Rx occurrence error | SB | Yes |
| | | 0x14 | IN Tx Error | * Port 0 Successive TX error | SB | Yes |
| | | 0x15 | OUT Tx Error | * Port 1 TX occurrence error | SB | Yes |
| | 0x7520 | 0x18 | IN Lost link | * Port 0/1 cable was disconnected or unplugged in servo-on state. Host power supply was shutdown. | SB | Yes |
| | | 0x19 | OUT Lost link | | SB | Yes |
| | 0x7510 | 0x1A | Communication time out | * Did not receive output data within regulated cycle time | SB | Yes |
| | 0x7510 | 0x1E | Position Synchronization Communication Time-Out | * Position sync communication is not able to receive correctly. | SB | Yes |
| Bit1 | 0x5400 | 0x21 | Main Circuit Power Device Error（Power Device Error） | * Over current of drive module<br>* Abnormality in drive power supply<br>* Overheating of drive module | DB | Yes |
| | 0x5210 | 0x22 | Current Detection Error 0 | * Abnormality of electric current detection value | DB | Yes |
| | | 0x23 | Current Detection Error 1 | * Abnormality of Electric current detection circuit | DB | Yes |
| | | 0x24 | Current Detection Error 2 | * Abnormality in communication with Electric current detection circuit | DB | Yes |
| | 0x8312 | 0x25 | Safe Torque (force) Off Error 1 | * Timing error of safe torque (force) off input | DB | No |
| | | 0x26 | Safe Torque (force) Off Error 2 | * Failure of safe torque (force) off circuit | SB, (DB) | No |
| Bit1 | 0x8311 | 0x41 | Overload 1 | * Failure of safe torque (force) off circuit | SB | Yes |
| | 0x2220 | 0x42 | Overload 2 | * Stall over load | DB | Yes |
| | 0x3212 | 0x43 | Regenerative Overload | * Regeneration load ratio exorbitance | DB | Yes |
| | 0x7300 | 0x44 | Magnetic Pole Position Detection Error | * CS detection error | ― | Yes |
| | 0x8400 | 0x45 | Average continuous over speed | * Over speed in average rotational speed | SB | Yes |
| Bit3 | 0x4110 | 0x51 | Servo Amplifier Temperature Error | * Overheating detection of amplifier ambient temperature | SB | Yes |
| | 0x4210 | 0x52 | RS Overheat | * Detection of in-rush prevention resistance overheating | SB | Yes |
| | | 0x53 | Dynamic Brake Resistance Overheat | * Overheating detection of dynamic brake resistor | SB | Yes |
| | 0x4310 | 0x54 | Internal Regenerative Resister Overheat | * Overheating detection of Internal regeneration resistor | DB | Yes |
| | 0x4310 | 0x55 | External Error | * Abnormality of external regenerative resistor, etc. | SB | Yes |
| | 0x4210 | 0x56 | Main Circuit Power Device Overheat | * Overheating detection of Drive module（15, 30, 50A） | DB | Yes |
| Bit2 | 0x3211 | 0x61 | Over-voltage | * DC Excess voltage of main circuit | DB | Yes |
| | 0x3220 | 0x62 | Main Circuit Under-voltage | * DC Main circuit low voltage | DB | Yes |
| Bit2 | 0x5114 | 0x71 | Control Power Supply Under-voltage | * Control power supply low voltage or instantaneous stoppage occurred | DB | Yes<br>Note3 |
| | 0x5115 | 0x72 | Control Power Supply Under-voltage 1 | * Under voltage of ±12V of control switching power supply | SB | Yes |
| | 0x5113 | 0x73 | Control Power Supply Under-voltage 2 | * Under voltage of ±5V of control switching power supply | DB | Yes |
| Bit0 | 0x7305 | 0x81 | Encoder Connector 1 Disconnection | * Incremental encoder (A, B, Z) signal line break<br>* Power supply cable break | DB | No |
| | 0x7306 | 0x83 | Encoder Connector 2 Disconnection | * Full close encoder (A, B, Z) signal line break<br>* Power supply cable break | DB | Yes<br>note4 |
| | 0x7300 | 0x84 | Serial Encoder Communication Error | * CRC, SYNC, FORM, Command error occurrence in communication with sensor | DB | No |
| | | 0x85 | Encoder Initial Process Error | * CS data read failure of Incremental encoder<br>* Initial processing abnormality of Absolute encoder<br>* Cable break | - | No |
| | | 0x86 | CS error | * Position skip of CS data | DB | No |
| | | 0x87 | CS Signal Disconnection | * CS signal line break | DB | No |

Note 1) When the main power voltage increases or decreases gradually or is suspended, main circuit low voltage or main power failed phase may be detected.

Note 2) 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 PFDDLY (GroupB ID16).

Note3) 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.)

Alarm code list 2/2

| 0x1001 Error Resister | 0x603F Error Code | 0x2001 0x2002 Code | Alarm name | Alarm contents | Detection Operations | Alarm Reset |
|---|---|---|---|---|---|---|
| Bit0 | 0x7300 | 0xA0 | Serial Encoder Internal Error 0 | * Absolute encoder rotation overflow<br>* Frequent rotation counter overflow | DB | No |
| | | 0xA1 | Serial Encoder Internal Error 1 | * Multi-turn error<br>* Battery low voltage | DB | Yes |
| | 0x7310 | 0xA2 | Serial Encoder Internal Error 2 | * Accelerate error | DB | Note 5 |
| | 0x7310 | 0xA3 | Serial Encoder Internal Error 3 | * Over-speed error | DB | Note 5 |
| | 0x7300 | 0xA4 | Serial Encoder Internal Error 4 | * Access error of Encoder internal EEPROM | DB | Note 5 |
| | | 0xA5 | Serial Encoder Internal Error 5 | * Detection of single rotation coefficient incorrect | DB | Note 5 |
| | | 0xA6 | Serial Encoder Internal Error 6 | * Detection of multiple rotation coefficient incorrect | DB | Note 5 |
| | | 0xA9 | Serial Encoder Internal Error 9 | * Overheating of encoder with built-in servo motor | DB | Note 5 |
| | 0x7320 | 0xAA | Serial Encoder Internal Error 10 | * Incremental error（Position data error） | DB | Note 5 |
| | 0x7300 | 0xAB | Serial Encoder Internal Error 11 | * Encoder error | DB | Note 5 |
| | | 0xAC | Serial Encoder Internal Error 12 | * Multi-rotation error generation | DB | Note 5 |
| | | 0xAD | Serial Encoder Internal Error 13 | * Encoder built-in EEPROM data is not set | DB | Note 5 |
| | 0x7303 | 0xAE | Serial Encoder Internal Error 14 | * Resolver output abnormality | DB | Note 5 |
| | 0x7304 | 0xAF | Serial Encoder Internal Error 15 | * Resolver disconnection | DB | Note 5 |
| Bit0 | 0x8400 | 0xC1 | Over-speed | * Motor rotation speed is 120 % more than the highest speed limit | DB | Yes |
| | | 0xC2 | Velocity Control Error | * Nonconformity of electrical current command and acceleration signs | DB | Yes |
| | 0x7122 | 0xC3 | Velocity Feedback Error | * Servo motor power disconnection Note 6 | DB | Yes |
| | 0x8500 | 0xC5 | Model tracking vibration suppression control error | * Machine cycle time is not mach with model tracking vibration suppression control. | DB | Yes |
| Bit0 | 0x8611 | 0xD1 | Excessive Position Deviation | * Position Deviation exceeds setup value. | DB | Yes |
| | 0x8500 | 0xD2 | Position Command Error 1 | * Position command exceeded setting range 0x201D | SB | Yes |
| | | 0xD3 | Position Command Error 2 | * Position command input exceeded processing range | SB | Yes |
| | 0x8611 | 0xD4 | Excessive Position Synchronization Deviation | ・Position Synchronization Deviation exceeds setup value | DB | Yes |
| | 0xFF01 | 0xDE | Parameter change completion Note7 | * Parameter change of motor and sensor codes is complete | － | No |
| | 0xFF00 | 0xDF | Test Run Close Note 7 | * Detection in ‘Test mode end’ status | DB | Yes |
| Bit7 | 0x5530 | 0xE1 | EEPROM Error | * Abnormality of amplifier with built-in EEPROM | DB | No |
| | 0x6310 | 0xE2 | EEPROM Check Sum Error | * Access error in CPU built in RAM EPROM (entire area) | － | No |
| | 0x5510 | 0xE3 | Memory Error 1 | * Access error in CPU built in RAM | － | No |
| | Note7 | 0xE4 | Memory Error 2 Note7 | * Error in check sum of Flash memory | － | No |
| | 0x6320 | 0xE5 | System Parameter Error 1 | * System parameter is outside a setting range. | － | No |
| | | 0xE6 | System Parameter Error 2 | * Combination of a system parameter is abnormal.<br>* System parameter and amplifier mismatch | － | No |
| | | 0xE7 | Motor Parameter Error | * Check sum of a motor parameter is abnormal. | － | No |
| | 0x5220 | 0xE8 | CPU Circumference Circuit Error | * Abnormal access to CPU and peripheral devices | － | No |
| | | 0xE9 | System Code Error | * Control board code and sensor setting mismatch | － | No |
| | 0x6320 | 0xEA | Motor code setting Error | * Motor code is outside a setting range. | － | No |
| | | 0xEB | Sensor code setting Error | * Sensor code is outside a setting range. | － | No |
| | | 0xEE | Motor parameter automatic setting error 1 | * Motor parameter automatic setting disabled. | － | No |
| | | 0xEF | Motor parameter automatic setting error 2 | * The result of motor parameter automatic setting has an abonormality. | － | No |
| Bit7 | 0x8700 | 0xF1 | Task Process Error | * Error in interruption process of CPU | DB | No |
| | 0x6010 | 0xF2 | Initial Process Time-Out | * Initial process does not end within initial process time | － | No |
| －<br>Note9 | －<br>Note8 | 0xFF | Self flash timeout Note7 | * Self-flash re-writing procedure is completed within the sepecifed time. | － | No |

Note 4) It can not reset, depens on the kinds of encorder.

Note 5) Detecting only Synchronization encoder.
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 "11.5 Encoder clear and the alarm reset method."

Note 6) 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 7) Alarm activated at test mode completeion, alarm when changing, memory error 2, and self-flashtimeout are not stored in alarm-record.

Note 8) “Memory Error 2” shall not be set to object dictionary “0x603F.”

Note 9) Self-flash timeout shall not be set to object dictionary “0x1001.”

## 9.4 Trouble shooting When Alarm Occurs

Note) V means the cause number with possibility.

- Alarm code 10 (IN Rx Invalid Frame Error)
- Alarm code 11 (OUT Rx Invalid Frame Error)
- Alarm code 12 (IN Rx CRC Error)
- Alarm code 13 (OUT Rx CRC Error)
- Alarm code 14 (IN Tx Error)
- Alarm code 15 (OUT Tx Error)

| Status at the time of alarm | Cause | | |
|---|---|---|---|
| | 1 | 2 | 3 |
| Issued when control power is turned ON. | V | V | V |
| Issued during operation of servo motor | V | V | V |

Corrective actions

| Cause | | Investigative and Corrective Actions |
|---|---|---|
| 1 | ■ Defect of communications cable | ■ Check if there is contact failure in the communication cable wiring system |
| 2 | ■ Malfunction due to noise | ■ Confirm proper grounding of the amplifier.<br>■ Check encoder cable shield<br>■ Add ferrite core or similar countermeasures against noise. |
| 3 | ■ Defect of control printed wiring board | ■ Replace the servo amplifier. |

- Alarm code 18 (IN Lost link)
- Alarm code 19 (OUT Lost link)

| Status at the time of alarm | Cause | |
|---|---|---|
| | 1 | 2 |
| The cable was unplugged. | V | |
| Issued during operation. | | V |

Corrective actions

| Cause | | Investigative and Corrective Actions |
|---|---|---|
| 1 | ■ Cable unplugged when motor was in operation. | ■ Plug in / unplug cable in servo-off or below Pre-OP state. |
| 2 | ■ Communication cable break.<br>■ Contact failure of connector and/or terminal. | ■ Check the wiring of motor encoder and servo amplifier, and correct the wiring if needed. |

- Alarm code 1A (Communication Time-Out)

| Status at the time of alarm | Cause | |
|---|---|---|
| | 1 | 2 |
| Issued in Safe-OP or OP status | V | |
| Issued during operation. | | V |

Corrective actions

| Cause | | Investigation and corrective actions |
|---|---|---|
| 1 | ■ Could not receive command within the prescribed time of the Communication Timeout value (SM2 Event: Cannot receive Output data of PDO) | ■ Examine if data is being Output by controller communication timing. |
| 2 | ■ Malfunction due to noise | ■ Confirm proper grounding of the amplifier.<br>■ Check the shielding of the encoder cable.<br>■ Add ferrite core or similar countermeasures against noise. |

- Alarm code 1E (Corrected Position Synchronization Communication Time-Out）

| Status at the time of alarm | Cause | |
|---|---|---|
| | 1 | 2 |
| Issued before use. | V | V |
| Issued during operation. | | V |

Corrective actions

| Cause | | Investigation and corrective actions |
|---|---|---|
| 1 | ■ After enabling position synchronization, data transmission from amplifier for synchronization does not start.<br>(After enabling, 4sec passed but data could not be recieved.) | ■ Confirm that the communication cable is connected through CN4 in another amplifier for synchronization.<br>■ Check cable wiring, and review. |
| 2 | ■ Malfunction due to noise.<br>(Data from amplifier for synchronization could not be received for consecutive 4ms.) | ■ Confirm proper grounding of the amplifier.<br>■ Check communication cable shield.<br>■ Add ferrite core or similar countermeasures against noise. |

- Alarm code 21 (Main Circuit Power Device Error)

| Status at the time of alarm | Cause | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| Issued when control power is turned ON. | V | | V | V |
| Issued at input of servo ON. | V | V | V | |
| Issued while starting and stopping the servo motor. | V | V | V | |
| Issued after extended operating time. | V | V | V | V |

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. Also, U/V/W-phases are grounded in the earth. | ■ Check the wiring conditions and restore if improper. |
| 2 | ■ Short circuit or 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. | ■ For an amplifier equipped with a cooling fan motor, check that the cooling fan motor is running; if not, replace the servo amplifier.<br>■ Confirm that the temperature of the control panel (ambient temperature of the servo amplifier) does not exceed 55°C. If in excess of 55(C, check the installation method of the servo amplifier, and confirm that the cooling temperature of the control panel is set to below 55°C |

- Alarm code 22 (Current Detection Error 0)

| Status at the time of alarm | Cause | |
|---|---|---|
| | 1 | 2 |
| Issued when servo is turned ON. | V | V |

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. Electric current has exceeded maximum current (IP) of combined motor. (MOC: Motor Overcurrent) | ■ Confirm that the proper codes (per the specified Motor Codes) have been used for the servo motor; if not, replace the servo motor. |

- Alarm code 23 (Current Detection Error 1)

| Status at the time of alarm | Cause | |
|---|---|---|
| | 1 | 2 |
| Issued at input of servo ON. | V | |
| Issued during operation. | V | V |

Corrective actions

| Cause | | Investigation and corrective actions |
|---|---|---|
| 1 | ■ Defect in internal circuit of servo amplifier. Data from electric current detector is always fixed. | ■ Replace the servo amplifier. |
| 2 | ■ Malfunction due to noise | ■ Confirm proper grounding of the amplifier.<br>■ Add ferrite core or similar countermeasures against noise. |

- Alarm code 24 (Current Detection Error 2)

| Status at the time of alarm | Cause | |
|---|---|---|
| | 1 | 2 |
| Issued at input of servo ON. | V | |
| Issued during operation. | V | V |

Corrective actions

| Cause | | Investigation and corrective actions |
|---|---|---|
| 1 | ■ Defect in internal circuit of servo amplifier. Cannot get data from electric current detector. | ■ Replace the servo amplifier. |
| 2 | ■ Malfunction due to noise | ■ Confirm proper grounding of the amplifier.<br>■ Add ferrite core or similar countermeasures against noise. |

■ Alarm code 25 (Safe Torque (force) Off error 1)

| Status at the time of alarm | Cause | |
|---|---|---|
| | 1 | 2 |
| Occurred in about 10 sec. after control power turned on | V | V |
| Issued during operation. | V | |

Corrective actions

| Cause | | Investigation and corrective actions |
|---|---|---|
| 1 | ■ Input logic of Safe Torque (force) Off 1 and Safe Torque (force) Off 2 are mismatched | ■ Match Input logic of SAFETOFF1/2<br>■ Check wiring of SAFETOFF1, SAFETOFF2 and correct if necessary<br>■ When switching either signal logic of SAFETOFF1or SAFETOFF2 always switch the other one's signal within 10 sec |
| 2 | ■ Defect in internal circuit of servo amplifier. | ■ Replace the servo amplifier. |

■ Alarm code 26 (Safe Torque (force) Off error 2)

| Status at the time of alarm | Cause | |
|---|---|---|
| | 1 | 2 |
| Occurred when control power is turned on. | V | V |
| Issued during operation. | | V |

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.<br>■ Add ferrite core or similar countermeasures against noise. |

■ Alarm code 41 (Overload 1)

| Status at the time of alarm | Cause | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| Issued at input of servo ON. | V | V | | | | | | | V |
| After command input, issued without rotating the motor. | | V | | | V | V | V | | V |
| After command input, brief motor rotation | | | V | V | V | | V | V | |

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 (force) exceeds the rated torque (force). | ■ Monitor the load status by using execution torque (force) monitor (TRMS), and check if effective torque (force) exceeds the rated value. Then calculate servo motor effective torque (force) according to load and operation conditions. If the effective torque (force) is excessive, check the operating or loading, or replace with large sized servo motor. |
| 4 | ■ Defect in servo motor-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 does not release. | ■ Check that the wiring and voltage of the holding brake are acceptable; if not, repair. If the above are OK, replace the servo motor. |
| 6 | ■ Wiring of U/V/W –phase between servo amplifier and motor do not match. | ■ Check the wiring conditions and restore if improper. |
| 7 | ■ One or all connections of U/V/W -phase wiring of servo amplifier / motor is disconnected. | ■ Check the wiring conditions and restore if improper. |
| 8 | ■ Machines collided. | ■ Check the operating conditions and limit switch. |
| 9 | ■ Motor encoder pulse number setting does not match with the servo motor. | ■ Match the encoder pulse number with the servo motor. |

Note) During the alarm caused by conditions in #3 (above), if OFF -> ON of control power supply is repeated, there is a risk of burning out the servo motor. Wait for longer than 30 min. for cooling purposes after power shut OFF, and resume operations.

■ Alarm code 42 (Overload 2)

| Status at the time of alarm | Cause | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| Issued at input of servo ON. | V | V | | | | | | | V |
| After command input, issued without rotating the servo motor. | | V | | | V | V | V | | V |
| After command input, brief motor rotation. | | | V | V | V | | V | V | |

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 (force) command exceeds approx. 2 times of rated torque (force). | ■ Check if torque (force) command exceeds approx. 2 times of the rated torque by torque (force) command monitor (TCMON). Or, calculate the motor effective torque from load conditions and operation conditions. If the effective torque (force) is excessive, check the operating or loading, or replace with large sized servo motor. |
| 4 | ■ Defect in servo motor-servo amplifier combination | ■ Check the motor type setting and the motor in use are matching. If not, correct them. |
| 5 | ■ Holding brake of servo motor does not release. | ■ Check that wirings and voltage for holding brake are correct. If not, repair them. If they are appropriate, replace the servo motor. |
| 6 | ■ Wiring of U/V/W –phase between servo amplifier and motor do not match. | ■ Check the wiring conditions and restore if improper. |
| 7 | ■ One or all connections of U/V/W -phase wiring of servo amplifier / motor is disconnected. | ■ Check the wiring conditions and restore if improper. |
| 8 | ■ Machines collided. | ■ Check the operating conditions and limit switch. |
| 9 | ■ Motor encoder pulse number setting does not match with the servo motor. | ■ Match the encoder pulse number with the servo motor. |

■ Alarm code 43 (Regenerative Overload)

| Status at the time of alarm | Cause | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| Issued when control power supply is turned ON. | | | | | | | V | |
| Issued when power supply of main circuit is turned ON. | | V | V | V | | V | V | V |
| Issued during operation. | V | V | V | V | V | | V | |

Corrective actions

| Cause | | Investigation and corrective actions |
|---|---|---|
| 1 | ■ Exceeded permitted value of regenerating power in built-in regenerative resistance specifications.<br>■ Excessive load inertia, or tact time is short. | ■ Check the load and operating conditions.<br>■ Use an external regeneration resistor.<br>■ Set the load inertia within the specified range.<br>■ Increase the deceleration time.<br>■ Increase the tact time. |
| 2 | ■ Regenerative resistance wiring conflicts with built-in regenerative resistance specifications. | ■ Check wiring and replace if incorrect. |
| 3 | ■ Regenerative resistance wiring conflicts with external regeneration resistor specifications. | ■ Check wiring and replace if incorrect. |
| 4 | ■ Regeneration resistor is disconnected. | ■ For built-in regeneration resistor specifications, replace the servo amplifier.<br>■ For external regeneration resistor specifications, replace the regeneration resistor. |
| 5 | ■ Resistance value of external regeneration resistor is excessive. | ■ Replace the current resistance value with a value 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 | ■ When external regenerative resistance is selected for system parameter ID02 and external regenerative resistance is not installed. | ■ Install the external regenerative resistance.<br>■ Set to “Do not connect regenerative resistance“. |

Note) If the setting of system parameter Regenerative Resistor Selection is incorrect, regeneration overload is not detected properly, and the amplifier and surrounding circuit may be damaged or burnt.

- Alarm code 44 (Magnetic pole position estimation error)

| Status at the time of alarm | Cause | |
|---|---|---|
| | 1 | 2 |
| Occurred when control power supply was turned on. | | V |
| Occurred during magnetic pole position error detection. | V | |

Corrective action

| | Cause | Investigation and corrective actions |
|---|---|---|
| 1 | ■ Magnetic pole position detection frequency and mechanical resonance point are matched.<br>■ Motor hit the stroke end. | ■ Change magnetic pole position detection frequency.<br>■ Secure the distance to the stroke end. |
| 2 | ■ Control circuit fault of servo amplifier. | ■ Replace servo amplifier. |

- Alarm code 45 (Average continuous over speed)

| Status at the time of alarm | Cause |
|---|---|
| | 1 |
| Occurred during operation. | V |

Corrective actions

| | Cause | Investigation and corrective actions |
|---|---|---|
| 1 | ■ The average speed exceeds the maximum speed of continuous rotation speed range. | ■ Review the operating conditions.<br>■ Resize the servo motor. |

- Alarm code 51 (Amplifier Overheat)

| Status at the time of alarm | Cause | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| Issued when control power supply is turned ON. | V | | V | V | |
| Issued during operation. | V | V | V | V | |
| Issued after emergency stop. | | | | | V |

Corrective actions

| | Cause | Investigation and corrective actions |
|---|---|---|
| 1 | ■ Defect in internal circuit of servo amplifier. | ■ Replace the servo amplifier. |
| 2 | ■ Regenerating power exceeded. | ■ Check the operating conditions.<br>■ Use external regeneration resistor. |
| 3 | ■ Regenerating power is within the specified range but ambient temperature of servo amplifier is out of specified range. | ■ Confirm that the cooling method maintains the temperature of control board between 0 to 55°C. |
| 4 | ■ Regenerating power is within the specified range but built-in cooling fan of servo amplifier is stopped. | ■ For an amplifier equipped with a cooling fan motor, check that the cooling fan motor is running; if not, replace the servo amplifier. |
| 5 | ■ Regeneration energy during emergency stop exceeded. | ■ Change the servo amplifier.<br>■ Check the loading condition. |

Note) Abnormalities are detected in the internal temperature of the amplifier regardless of its ambient temperature. When an amplifier temperature warning is issued, please be sure to check the cooling method of the control panel.

- Alarm Code 52 (In-rush prevention resistance Overheat)

| Status at the time of alarm | Cause | | |
|---|---|---|---|
| | 1 | 2 | 3 |
| Issued when control power supply is turned ON. | V | | |
| Issued when main circuit power supply is turned ON. | | V | |
| Issued during operation. | | | V |

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. | ■ For an amplifier equipped with a cooling fan motor, check that the cooling fan motor is running; if not, replace the servo amplifier.<br>■ Check if the temperature inside the control board (servo amplifier ambient temperature) exceeds 55°C. If it does, review the servo amplifier installing method and cooling method of control board to make it below 55°C. |

■ Alarm Code 55 (External Error)

◆ 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 supply is turned ON. | V | V |

Corrective actions

| Cause | | Investigation and corrective actions |
|---|---|---|
| 1 | ■ Validity condition for external trip function is set to 'Valid'. | ■ Set Generic Input signal to 00:_Always_Disable |
| 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 supply is turned ON. | V | | V |
| Issued after operation for some time. | | V | V |

Corrective actions

| Cause | | Investigation and corrective actions |
|---|---|---|
| 1 | ■ Improper wiring of external regenerative resistance. | ■ Check wiring and replace if necessary. |
| 2 | ■ External regeneration resistor is operating. | ■ Check the operating conditions.<br>■ Increase the capacity of the external regeneration resistor. |
| 3 | ■ Defect in internal circuit of servo amplifier. | ■ Replace the servo amplifier. |

Note) When output terminal of upper level device is connected, eliminate the alarm trigger of the host level device.

- Alarm Code 56 (Main Circuit Power Device Overheat)

| Status at the time of alarm | Cause | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| Issued when control power is turned ON. | V | | V | V |
| Issued at input of servo ON. | V | V | V | |
| Issued while starting and stopping the servo motor. | V | V | V | |
| Issued after operation for some time. | V | V | V | V |

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. Also, U/V/W-phases are grounded in the earth. | ■ Check wiring and replace if necessary. |
| 2 | ■ Short circuit or 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 | ■ Ambient temperature is high. | ■ For an amplifier equipped with a cooling fan motor, check that the cooling fan motor is running; if not, replace the servo amplifier.<br>■ Confirm that the temperature of the control board (ambient temperature of the servo amplifier) does not exceed 55°C. If in excess of 55°C, check the installation method of the servo amplifier, and confirm that the cooling temperature of the control board is set to below 55°C. |

- Alarm Code 61 (Over-Voltage)

| Status at the time of alarm | Cause | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| Issued when control power supply is turned ON. | V | | | |
| Issued when power supply of main circuit is turned ON. | V | V | | |
| Issued while decelerating the servo motor. | | V | V | V |

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. | ■ Reduce the load inertia to within the specified range. |
| 4 | ■ Incorrect wiring for regeneration resistance.<br>■ Built-in regeneration circuit is not functioning. | ■ Wire the regeneration resistance correctly.<br>■ While using the external regenerative resistance, check the wiring and resistance value.<br>■ Replace the servo amplifier if any abnormality occurs. |

- Alarm Code 62 (Main Circuit Under-voltage)

| Status at the time of alarm | Cause | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| Issued when control power supply is turned ON. | | | | V | V |
| Issued after power supply of main circuit is turned ON. | V | V | V | | |
| Issued during operation. | | V | V | | |

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 and/or blinking. | ■ Check the power supply and confirm that there is no blinking 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 71 (Control Power Supply Under-voltage)

| Status at the time of alarm | Cause | | |
|---|---|---|---|
| | 1 | 2 | 3 |
| Issued when control power supply is turned ON. | V | V | |
| Issued during operation. | V | | V |

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 blinking. | ■ Confirm that the power supply is not going to neither blink nor reduce the power. |

- ■ Alarm Code 72 (Control Circuit Under-voltage 1)

| Status at the time of alarm | Cause | |
|---|---|---|
| | 1 | 2 |
| Issued when control power supply is turned ON. | V | V |

Corrective actions

| Cause | | Investigation and corrective actions |
|---|---|---|
| 1 | ■ Defect in internal circuit of the servo amplifier. | ■ Replace the servo amplifier. |
| 2 | ■ Defect in external circuit. | ■ Restart the power supply after removing the connector; if alarm is not issued, check the external circuit.<br>■ Restart the power supply after replacing the servo motor; if alarm is not issued, there is defect in internal circuit of motor encoder. |

- ■ Alarm Code 73 (Control Circuit Under-voltage 2)

| Status at the time of alarm | Cause | |
|---|---|---|
| | 1 | 2 |
| Issued when control power supply is turned ON. | V | V |

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; if alarm is not issued, check the external circuit. |

- ■ Alarm Code 81 (Encoder Connector Disconnection 1)
- ■ Alarm Code 83 (Encoder Connector Disconnection 2)
- ■ Alarm Code 87 (CS Signal Disconnection)

| Status at the time of alarm | Cause | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| Issued when control power supply is turned ON. | V | V | V | V | V |
| Issued during operation. | V | | V | V | |

Corrective actions

| Cause | | Investigation and corrective actions |
|---|---|---|
| 1 | ■ For motor encoder wiring:<br>◆ Improper wiring.<br>◆ Connector is removed.<br>◆ Loose connection.<br>◆ Encoder cable is too long.<br>◆ Encoder cable is too thin. | ■ Check wiring and replace if necessary.<br>■ Confirm that the encoder power supply voltage of the motor is above 4.75 V; increase it if below 4.75 V. |
| 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 | ■ Parameter set to 'Full-closed servo system'. | ■ Change of system parameter to "Semi-close Control / Motor Encoder" (Only with alarm code 83) |

- ■ Alarm Code 84 (Serial Encoder Communication Error)

| Status at the time of alarm | Cause | | |
|---|---|---|---|
| | 1 | 2 | 3 |
| Issued when control power supply is turned ON. | V | V | V |

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.<br>■ Check the shielding of the encoder cable.<br>■ Add ferrite core or similar countermeasures against noise. |
| 3 | ■ Motor encoder wiring has abnormalities. | ■ Check the wiring of motor encoder and servo amplifier, and correct the wiring if needed. |

- ■ Alarm Code 85 (Encoder Initial Process Error)

| Status at the time of alarm | Cause | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| Issued when control power supply is turned ON. | V | V | V | V | V |

Corrective actions

| Cause | | Investigation and corrective actions |
|---|---|---|
| 1 | ■ For motor encoder wiring:,<br>◆ Improper wiring.<br>◆ Connector is removed.<br>◆ Loose connection.<br>◆ Encoder cable is too long.<br>◆ Encoder cable is too thin. | ■ Check wiring and replace if necessary.<br>■ Confirm that the encoder power supply voltage of the motor is above 4.75 V; increase it if below 4.75 V. |
| 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, as the number of rotations of the motor is more than 250 min$^{-1}$ during power supply. | ■ Restart the power supply after motor is stopped. (Only when PA035C and PA035S encoder is used.) |

- ■ Alarm Code 86 (CS Error)

| State when alarm activated | Cause |
|---|---|
| | 1 |
| Occurred motor was in operation. | V |

Corrective action

| Cause | | Investigation and corrective actions |
|---|---|---|
| 1 | ■ Malfunction due to noise occurred in linear sensor and hole sensor wirings. | ■ Check to see if ground lead is properly placed.<br>■ Check shielding of linear sensor cable.<br>■ Add ferritic core to protect from noise. |

:

■ Alarm Code A0 (Serial Encoder Internal Error 0)

| Status at the time of alarm | Cause | |
|---|---|---|
| | 1 | 2 |
| Issued when control power supply is turned ON. | V | V |
| Issued while driving the servo motor. | V | V |

Corrective actions

| Cause | | Investigation and corrective actions |
|---|---|---|
| 1 | ■ Defect in internal circuit of motor encoder. | ■ Turn ON the power supplies again; if not restored, replace the servo motor. |
| 2 | ■ Malfunction due to noise. | ■ Confirm proper grounding of the amplifier.<br>■ Check the shielding of the encoder cable.<br>■ Add ferrite core or similar countermeasures against noise. |

■ Alarm Code A1 (Serial Encoder Internal Error 1)

| Status at the time of alarm | Cause | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| Issued when control power supply is turned ON. | V | V | | |
| Issued during operation. | | | V | V |

Corrective actions

| Cause | | Investigation and corrective actions |
|---|---|---|
| 1 | ■ Loose connection of battery cable. | ■ Check the battery connector of encoder cable attachment. |
| 2 | ■ The fall of battery voltage. | ■ Check the voltage of battery. |
| 3 | ■ Loose connection of encoder connector. | ■ Check the wiring of motor encoder and servo amplifier, and correct the wiring if needed. |
| 4 | ■ Defect in internal circuit of motor encoder. | ■ Turn ON the power supplies again; if not restored, replace the servo motor. |

Note) “Encoder clear and alarm reset methods” vary depending on the motor encoder in use.

■ Alarm Code A2 (Serial Encoder Internal Error 2)

| Status at the time of alarm | Cause | | |
|---|---|---|---|
| | 1 | 2 | 3 |
| Issued while stopping the servo motor. | V | V | |
| Issued while rotating the servo motor. | V | V | V |

Corrective actions

| Cause | | Investigation and corrective actions |
|---|---|---|
| 1 | ■ Defect in internal circuit of motor encoder. | ■ Turn ON the power supplies again; if not restored, replace the servo motor. |
| 2 | ■ Malfunction due to noise. | ■ Confirm proper grounding of the amplifier.<br>■ Check the shielding of the encoder cable.<br>■ Add ferrite core or similar countermeasures against noise. |
| 3 | ■ The acceleration of motor rotation exceeds the permitted acceleration. | ■ Check the operation condition, and extend the acceleration and declaration time. |

Note) “Encoder clear and alarm reset methods” vary depending on the motor encoder in use.

■ Alarm Code A3 (Serial Encoder Internal Error 3)

| Status at the time of alarm | Cause | | |
|---|---|---|---|
| | 1 | 2 | 3 |
| Issued when control power supply is turned ON. | V | | V |
| Issued while stopping the servo motor. | V | V | |
| Issued while stopping the servo motor. | V | V | V |

Corrective actions

| Cause | | Investigation and corrective actions |
|---|---|---|
| 1 | ■ Defect in internal circuit of motor encoder. | ■ Turn ON the power supplies again; if not restored, replace the motor. |
| 2 | ■ Malfunction due to noise. | ■ Confirm proper grounding of the amplifier.<br>■ Check the shielding of the encoder cable.<br>■ Add ferrite core or similar countermeasures against noise. |
| 3 | ■ Number of motor rotations exceeds the permitted velocity. | ■ Check the operation condition and reduce the maximum number of rotations. |

Note) “Encoder clear and alarm reset methods” vary depending on the motor encoder in use.

- Alarm Code A4 to A6 (Serial Encoder Internal Error 4 - 6)
- Alarm Code AA to AF (Serial Encoder Internal Error 10 - 15)

| Status at the time of alarm | Cause | |
|---|---|---|
| | 1 | 2 |
| Issued when control power supply is turned ON. | V | |
| Issued during operation. | V | V |

Corrective actions

| Cause | | Investigation and corrective actions |
|---|---|---|
| 1 | ■ Defect in internal circuit of motor encoder. | ■ Turn ON the power supplies again; if not restored, replace the motor. |
| 2 | ■ Malfunction due to noise. | ■ Confirm proper grounding of the amplifier.<br>■ Check the shielding of the encoder cable.<br>■ Add ferrite core or similar countermeasures against noise. |

Note) “Encoder clear and alarm reset methods” vary depending on the motor encoder in use.

- Alarm Code A9 (Serial Encoder Internal Error 9)

| Status at the time of alarm | Cause | | |
|---|---|---|---|
| | 1 | 2 | 3 |
| Issued when control power supply is turned ON. | V | V | |
| Issued while stopping the servo motor. | V | V | |
| Issued while rotating the servo motor. | | V | V |

Corrective actions

| Cause | | Investigation and corrective actions |
|---|---|---|
| 1 | ■ Defect in internal circuit of motor encoder. | ■ Turn ON the power supplies again; if not restored, 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 below 80°C |
| 3 | ■ Servo motor is overheated. | ■ Confirm the cooling procedure of the servo motor. |

Note) “Encoder clear and alarm reset methods” vary depending on the motor encoder in use.

- Alarm Code C1 (Over-speed)

| Status at the time of alarm | Cause | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| Issued when command is entered after Servo ON. | V | V | | |
| Issued when the servo motor is started. | | | V | V |
| Issued other than operating and starting the motor. | | V | V | |

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.<br>■ Simplify the acceleration and declaration command pattern.<br>■ Reduce the load inertia. |
| 4 | ■ Wiring of U/V/W -phase between servo amplifier and motor do not match. | ■ Check the wiring and repair any irregularities. |

■ Alarm Code C2 (Velocity Control Error)

| Status at the time of alarm | Cause | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| Issued at input of servo ON. | V | | V | |
| Issued if command is entered. | V | V | V | |
| Issued while starting and stopping the servo motor | | | | V |

Corrective actions

| Cause | | Investigation and corrective actions |
|---|---|---|
| 1 | ■ Wiring of U/V/W -phase between servo amplifier and motor do not match. | ■ Check the wiring and repair any irregularities. |
| 2 | ■ Wiring of A/B -phase of pulse encoder do not match. | ■ Check the wiring and repair any irregularities. |
| 3 | ■ The servo motor is vibrating (oscillating). | ■ Adjust the servo parameters so that servo motor will not vibrate (oscillate). |
| 4 | ■ Excessive overshoot and undershoot. | ■ Monitor speed with the analog monitor.<br>■ Adjust the servo parameters to reduce overshoot and undershoot.<br>■ Simplify the acceleration and declaration command pattern.<br>■ Increase the acceleration and deceleration time of the command. Mask the alarm. |

Note) For the velocity control error alarm, an alarm may occur while starting and stopping when load inertia is excessive.
For this reason, in the gravitational axis applications, "Do not detect" is selected as the standard setting. If its detection is needed, consult our representatives.

■ Alarm Code C3 (Velocity Feedback Error)

| Status at the time of alarm | Cause | | |
|---|---|---|---|
| | 1 | 2 | 3 |
| Issued when command is entered. | V | V | V |
| Generated at the time of control input. | | V | |

Corrective actions

| Cause | | Investigation and corrective actions |
|---|---|---|
| 1 | ■ Motor is not rotating. | ■ Confirm that the power line is properly connected.<br>■ Replace the servo motor. |
| 2 | ■ Defect in internal circuit of servo amplifier. | ■ Replace the servo amplifier. |
| 3 | ■ The motor is vibrating (oscillating). | ■ Adjust the servo parameter so that servo motor will not vibrate (oscillate). |

■ Alarm Code C5 (Model Tracking Vibration Suppression, Control Error)

| Status at the time of alarm | Cause | | |
|---|---|---|---|
| | 1 | 2 | 3 |
| Issued after entering position command | V | V | V |

Corrective actions

| Cause | | Investigation and corrective actions |
|---|---|---|
| 1 | ■ Setup of model control gain is high. | ■ Lower model control gain. |
| 2 | ■ The acceleration and deceleration time of a position command is short. | ■ Simplify the acceleration and declaration command pattern. |
| 3 | ■ Torque (force) limiting value is low. | ■ Enlarge a torque (force) limiting value or repeal torque (force) restrictions. |

* These alarms may be generated if the servo brake performs alarm reset during a slowdown.

### ■ Alarm Code D1 (Following Error / Excessive Position Deviation)

| Status at the time of alarm | Cause | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| Issued when control power supply is turned ON. | | | | | | | | | | V | | |
| Issued when servo ON is stopped. | | | | | | V | | | | | V | |
| Issued immediately after entering the command. | V | V | V | V | V | | V | V | V | | V | |
| Issued during starting or stopping at high speed. | V | V | | | | | V | V | V | | V | V |
| Issued during the operations by lengthy command. | | V | | | | | V | V | | | V | |

Corrective actions

| Cause | | Investigation and corrective actions |
|---|---|---|
| 1 | ■ Position command changes excessively, or acceleration and declaration time is short. | ■ Correct the position command of the controller. |
| 2 | ■ Excessive initial load or low motor capacity. | ■ Correct the load condition or increase the motor capacity. |
| 3 | ■ Holding brake is not released. | ■ Check wiring and replace if necessary. If specified voltage is applied, replace the servo motor. |
| 4 | ■ Servo motor is mechanically locked or machine is colliding. | ■ Check the machinery system. |
| 5 | ■ One or all phases of U/V/W -phase of the servo amplifier and motor has disconnected. | ■ Check wiring and replace if necessary. |
| 6 | ■ Motor is being rotated by an external force (Gravity, etc.) during stopping (positioning completion). | ■ Check the load, and/or increase the servo motor capacity. |
| 7 | ■ Valid torque (force) limit command is entered by the controller, and the torque (force) limit setting is too much reduced.<br>■ Setting of a Velocity Limit Command is too little.<br>■ Number of motor encoder pulses does not match with the servo motor. | ■ Increase the torque (force) limit value or disable the torque (force) limit.<br>■ Enlarge setting of a Velocity Limit Command.<br>■ Match the number of servo motor encoder pulses. |
| 8 | ■ Settings of servo parameters (Position Loop Gain, etc.) are not appropriate. | ■ Check the servo parameter settings (Raise the position loop gain, etc.). |
| 9 | ■ Excessive deviation setting value is much reduced. | ■ Set a greater value for excessive deviation. |
| 10 | ■ Defect in internal circuit of servo amplifier. | ■ Replace the servo amplifier. |
| 11 | ■ Defect in internal circuit of motor encoder. | ■ Replace the servo motor. |
| 12 | ■ Power supply voltage is low. | ■ Check the power supply voltage. |

### ■ Alarm Code D2 (Position Command Error 1)※

| Status at the time of alarm | Cause | |
|---|---|---|
| | 1 | 2 |
| Issued after entering position command | V | V |

Corrective actions

| Cause | | Investigation and corrective actions |
|---|---|---|
| 1 | ■ Velocity converted value of Position command exceeds the setting value of Position command error 1.<br>■ CSP: Converted velocity has exceeded setting level of previous and current position commands.<br>■ PP : Converted velocity of trajectory generated position command has exceeded setting value. | ■ Lower command input travel distance. |
| 2 | ■ In cases where Position command cannot be received due to CRC error generation. | ■ Add ferrite core or similar countermeasures against noise. |

Note) Alarm "D2" must reset after deviation clear.

### ■ Alarm Code D3 (Position Command Error 2)

| Status at the time of alarm | Cause | |
|---|---|---|
| | 1 | 2 |
| Issued after entering position command | V | V |

Corrective actions

| Cause | | Investigation and corrective actions |
|---|---|---|
| 1 | ■ Excessive difference of recent command compared to previous Position command | ■ Lower command input travel distance. |
| 2 | ■ In cases where Position command cannot be received due to CRC error generation. | ■ Add ferrite core or similar countermeasures against noise. |

Note) Alarm "D3" must reset after deviation clear.

■ Alarm Code D4 (Excessive Position Synchronization Deviation)

| Status at the time of alarm | Cause | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| Issued immediately after entering the command. | V | V | V | V | V |
| Issued during starting or stopping at high speed. | V | V | | | V |
| Issued during long run. | V | V | | | V |

Corrective actions

| Cause | | Investigation and corrective actions |
|---|---|---|
| 1 | ■ 2-axis position loop control parameters are not appropriate.<br>■ Response setting of corrected position synchronization is too high.<br>■ Parameters setting for corrected position synchronization are not appropriate. | ■ In mutual synchronization correction mode, disable integral compensation. Also, set the parameter at the same setting.<br>■ In master-slave mode position synchronization correction,<br>■ Turn on mutual synchronization correction mode. |
| 2 | ■ 2-axis load inertia balance is not appropriate. | ■ Review the load condition, or perform countermeasures such as increasing the capacity of servomotor. |
| 3 | ■ Valid torque (force) limit command is entered by the controller, and the torque (force) limit setting is too low.<br>■ Setting of Velocity Limit Command is too low.<br>■ No. of pulses of 2-axis sensor is not appropriate. | ■ Increase the torque (force) limit value. Or disable the torque (force) limit.<br>■ Increase the Velocity Limit Command.<br>■ Replace the motor which has same No. of sensor pulses. |
| 4 | ■ Holding brake does not release.<br>■ Servo motor is mechanically locked or machine has a collision. | ■ Check the wiring, and correct the wiring if needed. If the specified voltage is applied, replace the servo motor.<br>■ Check if the machinery system is mechanically locked. |
| 5 | ■ Setting of Position Synchronization Deviation is too low. | ■ Increase setting of Position Synchronization Deviation. |

■ Alarm Code DE (Parameter change completion)

| Status at the time of alarm | Cause |
|---|---|
| | 1 |
| Issued after setting initialization (0x20FE, 0x20FF) | V |

Corrective actions

| Cause | | Investigation and corrective actions |
|---|---|---|
| 1 | ■ Normal operation in alarm status.<br>Motor code or encoder code change has detected.<br>(The change above needs control power-cycle.) | ■ Shut down control power supply and restart servo amplifier. |

■ Alarm Code DF (Test Run Close)

| Status at the time of alarm | Cause |
|---|---|
| | 1 |
| Occurred after execution of test mode. | V |

Corrective actions

| Cause | | Investigation and corrective actions |
|---|---|---|
| 1 | ■ Normal operation of alarm in test mode completion. (After completion of test mode, to confirm any deviation in the controller). | ■ Clear the alarm and restore operation. |

* Alarm will not be issued by marking the checkmark in “(Disabling support function completion alarm) at completion time” in test mode operation screen.

■ Alarm Code E1 (EEPROM Error)

| Status at the time of alarm | Cause |
|---|---|
| | 1 |
| Issued during parameter change in Setup Software | V |

Corrective actions

| Cause | | Investigation and corrective actions |
|---|---|---|
| 1 | ■ Defect in internal circuit of servo amplifier.<br>■ No response from EEPROM when saving servo parameters. (Defect in amplifier control board) | ■ Replace the servo amplifier. |

- Alarm Code E2 (EEPROM Check Sum Error)

| Status at the time of alarm | Cause | |
|---|---|---|
| | 1 | 2 |
| Issued when control power supply is turned ON. | V | V |

Corrective actions

| | Cause | Investigation and corrective actions |
|---|---|---|
| 1 | ■ Correct value not read by CPU by EEPROM built-in servo amplifier. | ■ Replace the servo amplifier. |
| 2 | ■ Failed to write into the EEPROM during last power supply cutoff. | ■ Replace the servo amplifier. |

- Alarm Code E3 (Memory Error 1)

| Status at the time of alarm | Cause |
|---|---|
| | 1 |
| Issued when control power supply is turned ON. | V |

Corrective actions

| | Cause | Investigation and corrective actions |
|---|---|---|
| 1 | ■ Proper access failure of CPU internal RAM<br>■ (Defect in control board of servo amplifier.) | ■ Replace the servo amplifier. |

- Alarm Code E4 (Memory Error 2)

| Status at the time of alarm | Cause |
|---|---|
| | 1 |
| Issued when control power supply is turned ON. | V |

Corrective actions

| | Cause | Investigation and corrective actions |
|---|---|---|
| 1 | ■ Defect in internal circuit of servo amplifier. (Program check sum of flash memory was incorrect at control power input.) (Firmware defect in amplifier CPU) | ■ Replace the servo amplifier. |

- Alarm Code E5 (System Parameter Error 1)

| Status at the time of alarm | Cause | |
|---|---|---|
| | 1 | 2 |
| Issued when control power supply is turned ON. | V | V |

Corrective actions

| | Cause | Investigation and corrective actions |
|---|---|---|
| 1 | ■ Selected value is outside the specified range for a system parameter. | ■ Confirm the model number of the servo amplifier.<br>■ 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 E6 (System Parameter Error 2)

| Status at the time of alarm | Cause | |
|---|---|---|
| | 1 | 2 |
| Issued when control power supply is turned ON. | V | V |

Corrective actions

| | Cause | Investigation and corrective actions |
|---|---|---|
| 1 | ■ Selected values of system parameters and actual hardware do not match.<br>■ Improper assembly of system parameter settings. | ■ Confirm the model number of the servo amplifier.<br>■ 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)

| Status at the time of alarm | Cause | |
|---|---|---|
| | 1 | 2 |
| Issued when control power supply is turned ON. | V | V |

Corrective actions

| | Cause | Investigation and corrective actions |
|---|---|---|
| 1 | ■ Correct value not read by CPU by EEPROM built-in servo amplifier. | ■ If control power supply is re-switched on and alarm recurs after re-setting a motor parameter, replace servo amplifier. |
| 2 | ■ Failed to write into the EEPROM when changing motor parameter. | ■ If control power supply is re-switched on and alarm recurs after re-setting a motor parameter, replace servo amplifier. |

- ■ Alarm Code E8 (CPU Circumference Circuit Error)

| Status at the time of alarm | Cause |
|---|---|
| | 1 |
| Issued when control power supply is turned ON. | V |

Corrective actions

| Cause | | Investigation and corrective actions |
|---|---|---|
| 1 | ■ Access failure of CPU and peripheral devices at initialization.<br>■ Defect in control circuit board of servo amplifier. | ■ Replace the servo amplifier. |

- ■ Alarm Code E9 (System code Error)

| Status at the time of alarm | Cause |
|---|---|
| | 1 |
| Issued when control power supply is turned ON. | V |

Corrective actions

| Cause | | Investigation and corrective actions |
|---|---|---|
| 1 | ■ Corresponding encoder on servo amplifier control board and encoder setting value do not match. (Defect in control circuit board of servo amplifier.) | ■ Replace the servo amplifier. |

- ■ Alarm Code EA (Motor code setting Error)

| Status at the time of alarm | Cause |
|---|---|
| | 1 |
| Issued during amplifier initialization. | V |

Corrective actions

| Cause | | Investigation and corrective actions |
|---|---|---|
| 1 | ■ Motor code transferred to 0x20FE is out of combination range. | ■ Combinable motor code of amplifier capacity is not set.<br>■ Check if a combinable motor is set. |

- ■ Alarm Code EB (Sensor code setting Error)

| Status at the time of alarm | Cause |
|---|---|
| | 1 |
| Issued during amplifier initialization. | V |

Corrective actions

| Cause | | Investigation and corrective actions |
|---|---|---|
| 1 | ■ Sensor division number transferred to 0x20FF is out of range or is an unsupported sensor. | ■ Sensor classification code or division number cannot be combined. Set combinable sensor code or division number.<br>■ Change motor sensor to supported amplifier when motor sensor differs from sensor specification of non-responding amplifier. |

- ■ Alarm Code EE (Motor Parameter Automatic Setting Error 1)

| Status at the time of alarm | Cause | | |
|---|---|---|---|
| | 1 | 2 | 3 |
| Occurred after motor parameter automatic setting functional performed. | V | V | V |

Corrective actions

| Cause | | Investigation and corrective actions |
|---|---|---|
| 1 | ■ Encoder being connected is not supported by motor parameter automatic setting function. | ■ Replace with supported servo motor. |
| 2 | ■ Servo motor being connected is not supported by motor parameter automatic setting function. | ■ The servo motor you use cannot be supported by this function, so please download motor parameters from setup software. |
| 3 | ■ Failure in internal circuit of motor encoder. | ■ Replace the servo motor. |

- ■ Alarm Code EF (Motor Parameter Automatic Setting Error 2)

| Status at the time of alarm | Cause | |
|---|---|---|
| | 1 | 2 |
| Occurred after motor parameter automatic setting functional performed. | V | V |

Corrective actions

| Cause | | Investigation and corrective actions |
|---|---|---|
| 1 | ■ Combination of servo amplifier and motor is incorrect. | ■ Check the model number of servo amplifier and servo motor, and correct the combination. |
| 2 | ■ Failure in internal circuit of motor encoder. | ■ Replace the servo motor. |

- Alarm Code F1 (Task Process Error)

| Status at the time of alarm | Cause | |
|---|---|---|
| | 1 | 2 |
| Issued during operation. | V | |
| Issued in Safe-OP or OP status, with SM2 event sync mode. | | V |

Corrective actions

| | Cause | Investigation and corrective actions |
|---|---|---|
| 1 | ■ Defect in internal circuit of servo amplifier. | ■ Replace the servo amplifier. |
| 2 | ■ There is jitter in the transfer frame from master for the cycle time setting (0x1C32:0x02). | ■ Drives with Free Run mode or SYNC0/1 mode in Synchronous mode.<br>■ Please check that the jitter of master frame is less than 5us, and transmit the frame exactly. |
| 3 | ■ Excesive number of PDO mappings | ■ Revise No. of mappings. |

- Alarm Code F2 (Initial Process Time-Out)

| Status at the time of alarm | Cause | |
|---|---|---|
| | 1 | 2 |
| Issued when control power supply is turned ON. | V | V |

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 servo amplifier.<br>■ Add ferrite core or similar countermeasures against noise. |

## 9.5 Encoder Clear and Alarm Reset Methods

A procedure of "encoder clear and alarm reset method “differs by the motor encoder in use.
Refer table below and recover from alarm state depending on alarm reset method applicable to motor encoder in use. In addition, please operate "Alarm reset" in the state where the issuing factor of "alarm" is removed.

Alarm reset method

| Alarm code | Absolute encoder for incremental system | Battery backup method absolute encoder | Battery-less absolute encoder |
|---|---|---|---|
| A1 | — | ・ Perform “Alarm reset” after “Encoder clear” | ・ Perform “Alarm reset” after “Encoder clear”<br>・ Power cycle |
| A3 | ・ Perform “Alarm reset” after “Encoder clear”<br>・ Power cycle | ・ Perform “Alarm reset” after “Encoder clear”<br>・ Power cycle | ・ Perform “Alarm reset” after “Encoder clear”<br>・ Power cycle |
| A4 | ・ Perform “Alarm reset” after “Encoder clear”<br>・ Power cycle | ・ Perform “Alarm reset” after “Encoder clear”<br>・ Power cycle | ・ Perform “Alarm reset” after “Encoder clear”<br>・ Power cycle |
| A5 | ・ Power cycle | ・ Power cycle | ・ Perform “Alarm reset” after “Encoder clear”<br>・ Power cycle |
| A6 | ・ Power cycle | ・ Power cycle | ・ Power cycle after “Encoder clear” |
| A9 | ・ Perform “Alarm reset” | ・ Perform “Alarm reset” | ・ Perform “Alarm reset” |
| AA | — | — | ・ Perform “Alarm reset” after “Encoder clear”<br>・ Power cycle |
| AF | — | — | ・ Perform “Alarm reset” after “Encoder clear”<br>・ Power cycle |

* When performed encoder clearing, multi turn part of encoder position data is cleared.
Operate after matching an encoder position data and mechanical coordinate.

## 9.6 Inspection

For maintenance purposes, a daily inspection is typically sufficient. Upon inspection, refer to the following description.

| Inspection location | Testing conditions | | | Inspection Items | Inspection Methods | Solution if abnormal |
|---|---|---|---|---|---|---|
| | Time | During operation | While stopping | | | |
| Servo motor | Daily | V | | Vibration | Check for excessive vibration. | Contact dealer/sales office. |
| | Daily | V | | Sound | Check if there is no abnormal sound as compared to normal sound. | |
| | Periodic | | V | Cleanliness | Check for dirt and dust. | Clean with cloth or air. Note 1) |
| | Yearly | | V | Measure value of insulation resistance | Contact dealer or sales office. | |
| | 5000 hours Note 2) | | V | Replacement of oil seal | | |
| Servo amplifier | Periodic | | V | Cleaning | Check for dust accumulated in the accessories. | Clean with air. Note 1) |
| | Yearly | | V | Loose screws | Check for loose connections. | Fasten the screws properly. |
| Battery for serial encoder | Regularly Note 3) | | V | Battery voltage | Confirm that battery voltage is more than DC3.6V. | Replace the Battery. |
| Temperature | Periodic | V | | Measure temperature | Ambient temperature<br>Motor frame temperature | Set the ambient temperature within the specified range.<br>Check the load condition. |

Note 1) While cleaning with air, confirm that there is no oil content and/or moisture in the 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 2 years, when its power is OFF throughout the year. For replacement, a lithium battery (ER3VLY: 3.6V, 1000mAh) manufactured by Toshiba Lifestyle Products & Services Corporation is recommended.

## 9.7 Maintenance Parts

1) Inspection Parts

Parts may deteriorate over time. Perform periodic inspection for preventive maintenance.

| No. | Part name | Number of average replacement years | Corrective measures / usage conditions |
|---|---|---|---|
| 1 | Cooling Fan motor | 5 Years | Replacement with new part is necessary.<br>Usage condition: Average temp. 40°C year-round. |
| 2 | Lithium battery for serial encoder [ER3VLY] | 3 Years | Replacement with new part is necessary. |
| 3 | Electrolytic capacitor | 5 Years | Replacement with new part is necessary.<br>Usage condition: Average temp. 40°C year-round.<br>Annual usage period is 4800 hours. |

- Cooling Fan motor
  - This Amplifier is set corresponding to the degree of pollution specified in EN50178 or IEC 664-1. As it is not dust proof or oil proof, use it in an environment above Pollution Level 2 (i.e., Pollution Level 1,2).
  - RF2-Series servo amplifiers models RF2K have a built-in cooling fan; therefore make 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 damage due to a reduction in the static pressure of the cooling fan and/or degradation of electronic parts. Replacement is necessary if abnormal noise occurs, or oil or dust is observed on the parts. Also, at an average temperature of 40°C year-round, the life expectancy is 5 years.

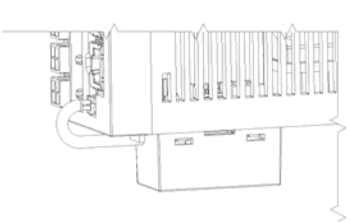
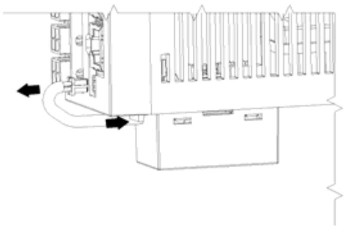
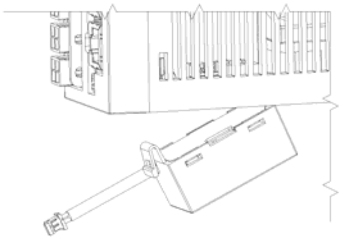
- Lithium battery for serial encoder
  - The standard replacement period recommended by our company is the life expectancy of lithium battery based on normal usage conditions. However, if there is high frequency of turning the power ON/OFF, or the motor is not used for a long period, then the life of lithium battery is reduced. If the battery power is less than 3.6 V during inspection, replace it with new one.

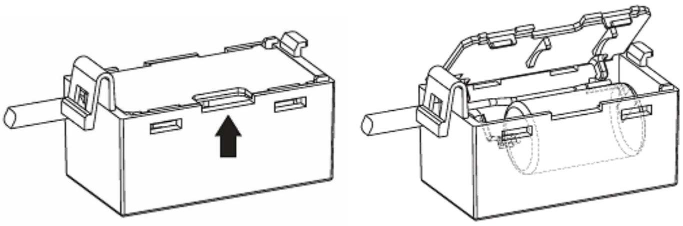
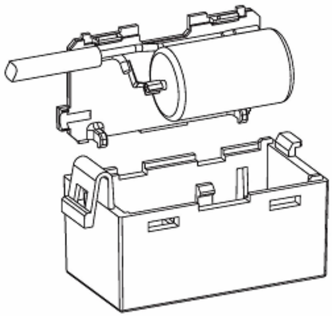
- At SANYO DENKI, the overhauled servo amplifier is shipped with the same parameters as the ones before overhauling, however, be sure to confirm the parameters before use.

## 9.8 Replacing battery for motor encoder

For 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. |

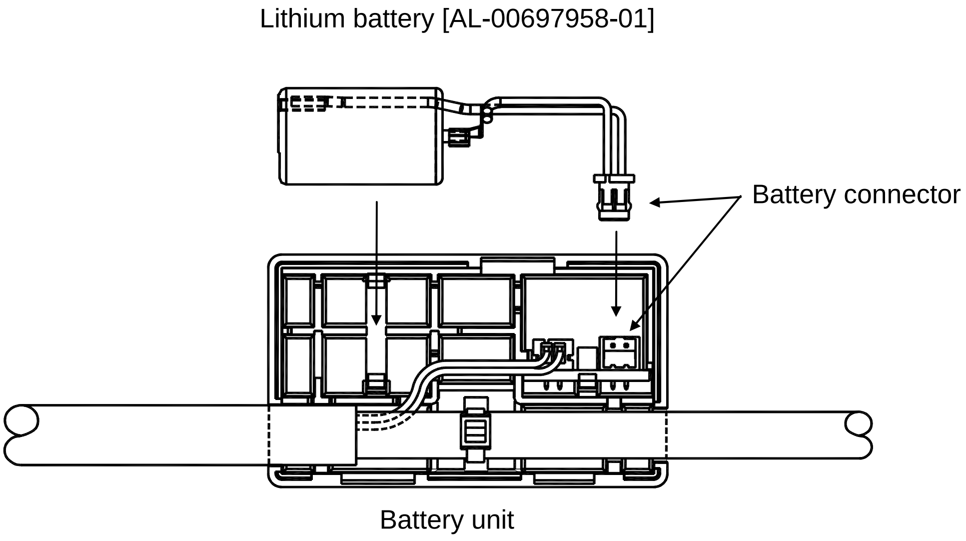
| | Battery case position | Process 3 and 9 | Process 4 and 8 |
|---|---|---|---|
| RF2 | <br>Bottom of amplifier |  |  |

| | 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: Serial 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.

For 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 | Remove the battery connector. |
| 5 | Take out the used lithium battery and put in the new replacement one. |
| 6 | Attach the connector in the right direction. |
| 7 | Close the battery unit. |

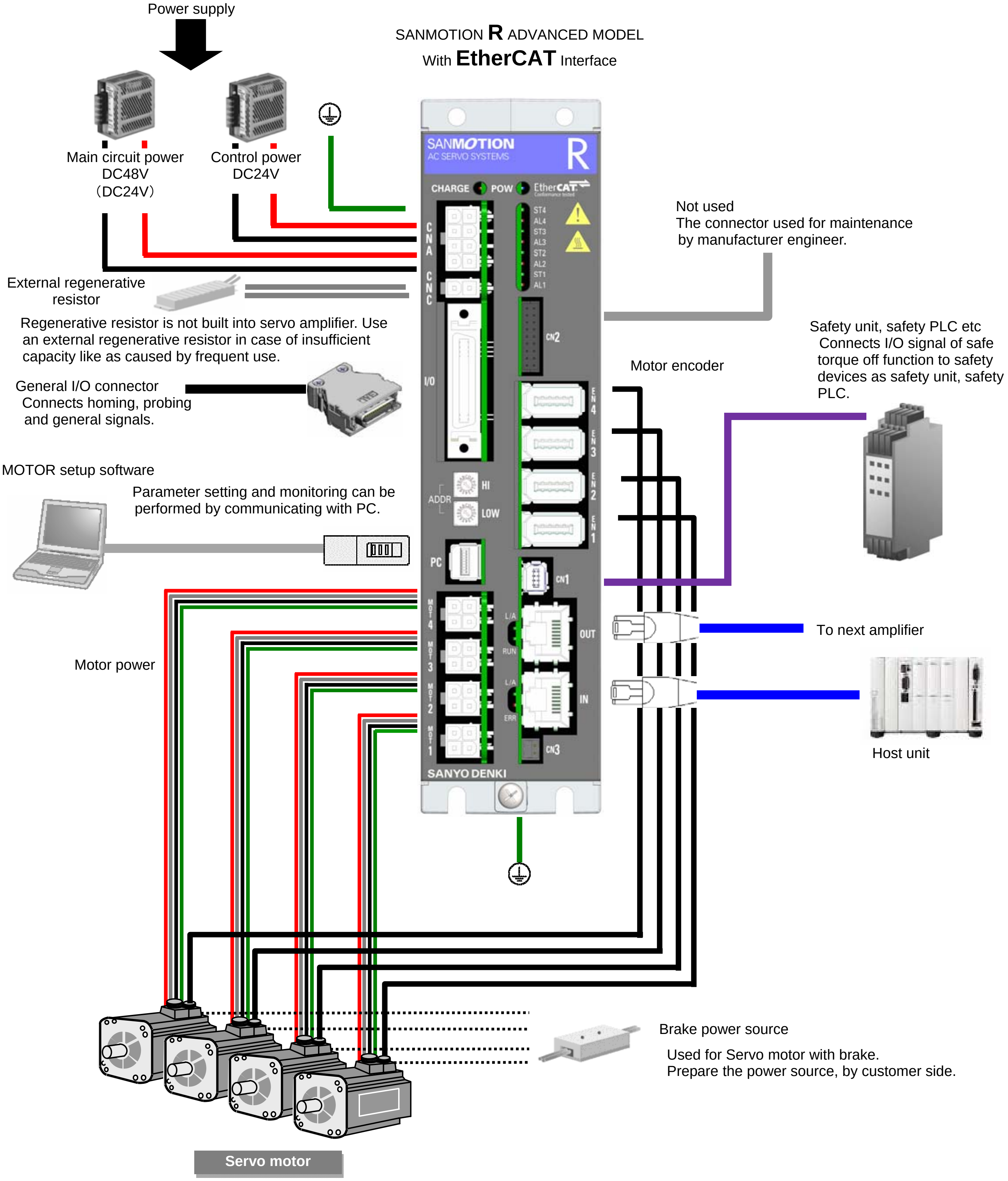


# 10

# 10 Safe Torque Off (STO) Function

# 10.1 System configuration

■RF2□24A□HL5



SANMOTION **R** ADVANCED MODEL
With **EtherCAT** Interface

Main circuit power DC48V （DC24V）

Control power DC24V

Not used
The connector used for maintenance by manufacturer engineer.

External regenerative resistor

Regenerative resistor is not built into servo amplifier. Use an external regenerative resistor in case of insufficient capacity like as caused by frequent use.

Safety unit, safety PLC etc
Connects I/O signal of safe torque off function to safety devices as safety unit, safety PLC.

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

MOTOR setup software
Parameter setting and monitoring can be performed by communicating with PC.

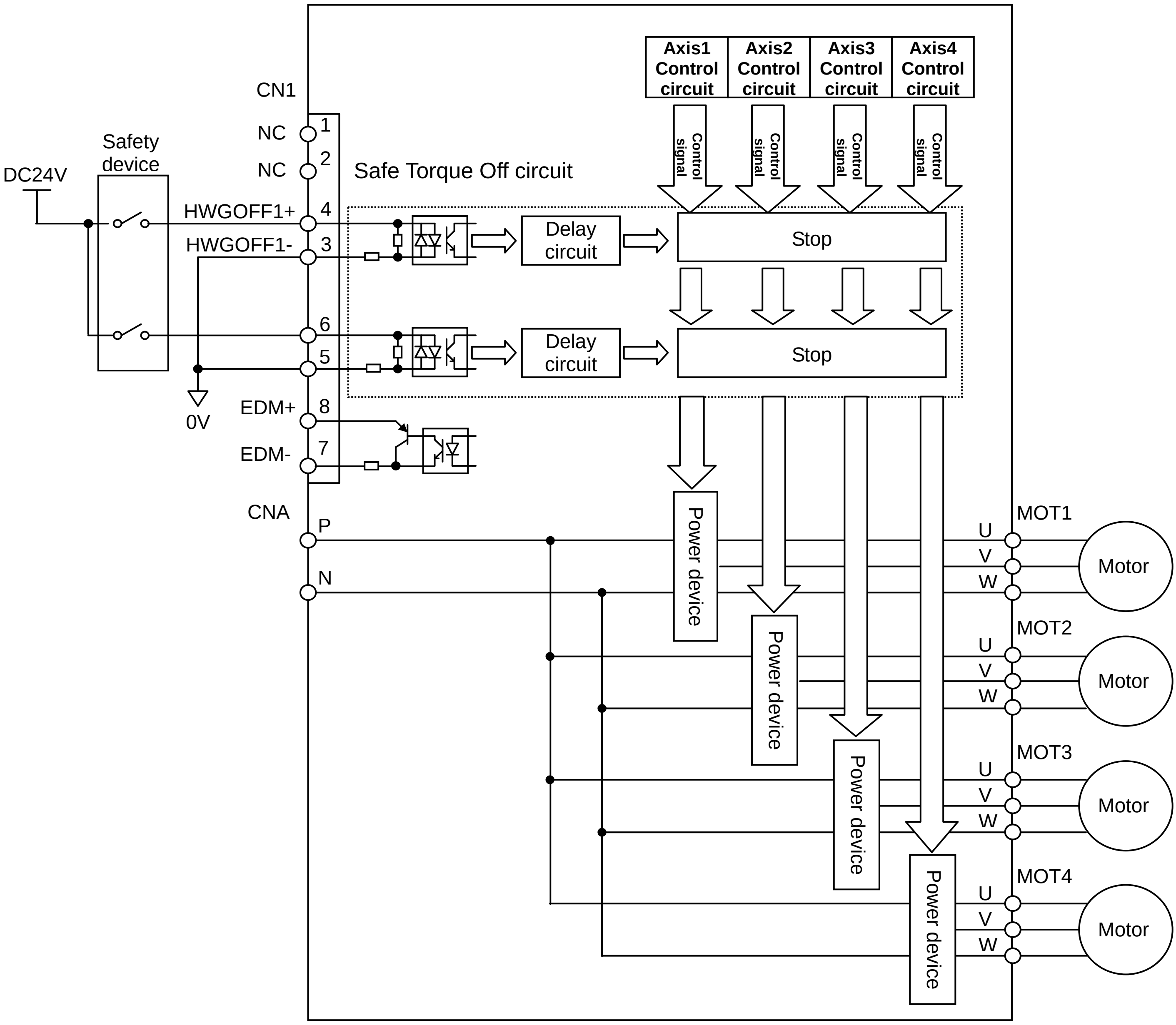
Brake power source
Used for Servo motor with brake.
Prepare the power source, by customer side.

## 10.2 Safe Torque Off (STO) Function

The Safe Torque Off function reduces injury risks for those working near the moving parts of the equipment. This function uses 2-channel input signals to interrupt electric current to the servo motor.
Historically, we used to keep machine safety by shutting down power supply to servo amplifier using Circuit breaker etc.
Thanks to STO function, you can keep machine safety without shutting down power supply even when you need to do jobs like machine maintenance in some dangerous area.
Because you do not have to shut down power supply, you can expect improvement in working efficiency.

### 1) Overview

One of the circuits connected to the 2-channel safety input signal paths (HWGOFF1, HWGOFF2) suspends current control signals for the servo motor generated by the control circuit and shut down current from the power device to the servo motor.



## 2) Standards Conformity

The Safe Torque Off function is applicable to the following safety function, functional safety standards and safety-related parameters.

| Item | Standard |
|---|---|
| Safety Function | ■ IEC61800-5-2, Safe Torque Off (STO) / EN61800-5-2<br>■ IEC60204, Stop Category 0 / EN60204 |
| Safety Standard | ■ IEC61508(2$^{nd}$), SIL3 / EN61508<br>■ IEC62061, SILCL3/ EN62061<br>■ ISO13849-1: 2006, Cat3, PL = e (In case of detecting failure by using EDM) / EN ISO 13849-1 / AC: 2009<br>■ ISO13849-1: 2006, Cat3, PL = c (In case of without failure detection) / EN ISO 13849-1 / AC: 2009 |

* PFH (Probability of a dangerous Failure per Hour) of this function (Safe Torque Off circuit) achieves less than 3% of required level of SIL2 or less than 25% of required level of SIL3.

* To suffice ISO13849-1, PL=e, you need to design machine safety system so as to detect failure of STO circuit by surely using Error Detection Monitor (EDM).

* Mean Time to Dangerous Failure (MTTFd) of this function is 100 years. When Error Detection Monitor (EDM) is used, Diagnostic Coverage (DC) is 92%.

* For another standards conformity of Safety Function and Safety Standard, refer to Chapter 13.

## 3) Risk assessment

The servo amplifier meets the requirements of the above functional safety standards. However, before activating this safety function, be sure to assess the risks associated with the overall equipment to ensure safety.

## 4) Residual risk

Note that activating the STO function does not address the following hazards. Perform risk assessments to ensure safety in cases that may involve exposure to such hazards.

■ When this function is activated while servo motor running, the power supply to the motor is shut down, however, the motor continues to run a while because of inertia. Make sure to design safety system to prevent any danger until the motor stops completely.

■ When in vertical axes and the like, the motor rotates because of gravity loads. Take measures to hold the motor shaft such as mechanical brake. Incidentally, servo brake circuit, dynamic brake circuit of servo amplifier, holding brake excitation signal or holding brake of servo motor 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 wrong wiring 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.

## 5) Delay Circuit

With this product, two kinds of hardware are provided, with or without delay circuit between safety input 1 (HGWOFF1), safety input 2 (HWGOFF2) signal input circuit and servo motor current control signal blocking circuit (optional). In vertical axis and the like, by choosing the hardware with delay circuit, you can prevent falling of the load by holding motor shaft with holding brake when the safe torque off function is activated.

| Servo amplifier model number | Delay Circuit (Max. delay time) |
|---|---|
| RF2###A#HL3 | Without (Max.20ms) |
| RF2###A#HL5 | With (Max.500ms) |

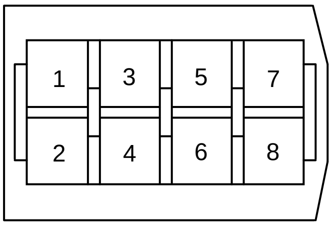
* Even the hardware without delay circuit, there are still max. 20ms of delay until the safe torque off function works due to the delay in the input circuit.

* Holding brake excitation signal and servo motor holding brake are not safety related parts.

# 10.3 Wiring

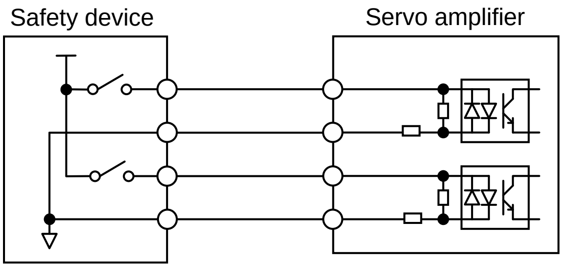
## 1) CN1 connector disposition

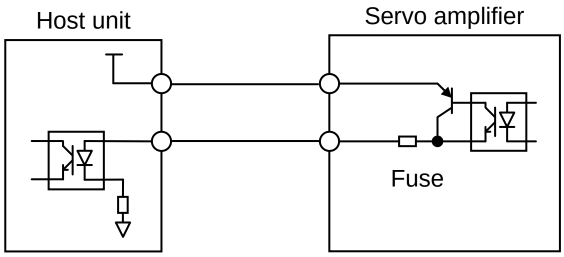
CN1: 2013595-3 (The figure below is viewed from connector's soldered side.)



## 2) CN1 terminal connection circuit

Indicates the functions and connection circuit for CN1 terminals.

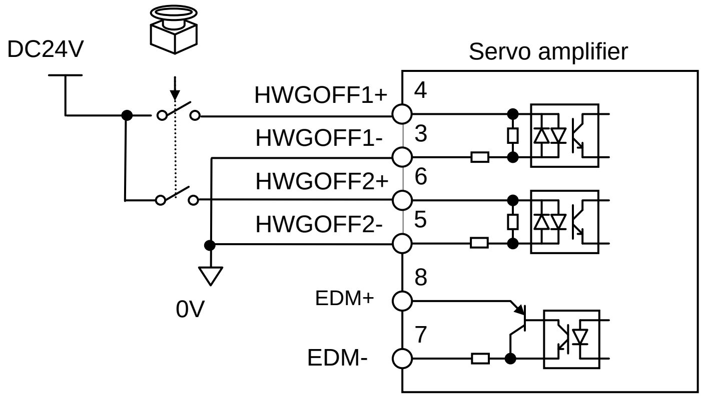
| Signal name | Terminal number | Symbol | Description |
|---|---|---|---|
| | 1 | | This is a connecting terminal when function is not used.<br>Do not use this terminal. |
| | 2 | | |
| Safety input 1 | 3 | HWGOFF1- | Input signal to control Safe-Torque-Off state.<br>Connection circuit<br>Connected to a relay or open collector transistor circuit.<br>Power supply voltage range : DC24V±10%<br>Internal impedance : 2.2kΩ<br> |
| | 4 | HWGOFF1+ | |
| Safety input 2 | 5 | HWGOFF2- | |
| | 6 | HWGOFF2+ | |

| Signal name | Terminal number | Symbol | Description |
|---|---|---|---|
| Error Detection Monitor | 7 | EDM- | The signal for monitoring a failure of Safe Torque Off function.<br>Connection circuit<br>Connects to photo coupler or relay circuit.<br>Power supply voltage range (Uext): DC24V±10%<br>Maximum current: 50mA<br>Output voltage: Uext-0.5 to Uext<br> |
| | 8 | EDM+ | |

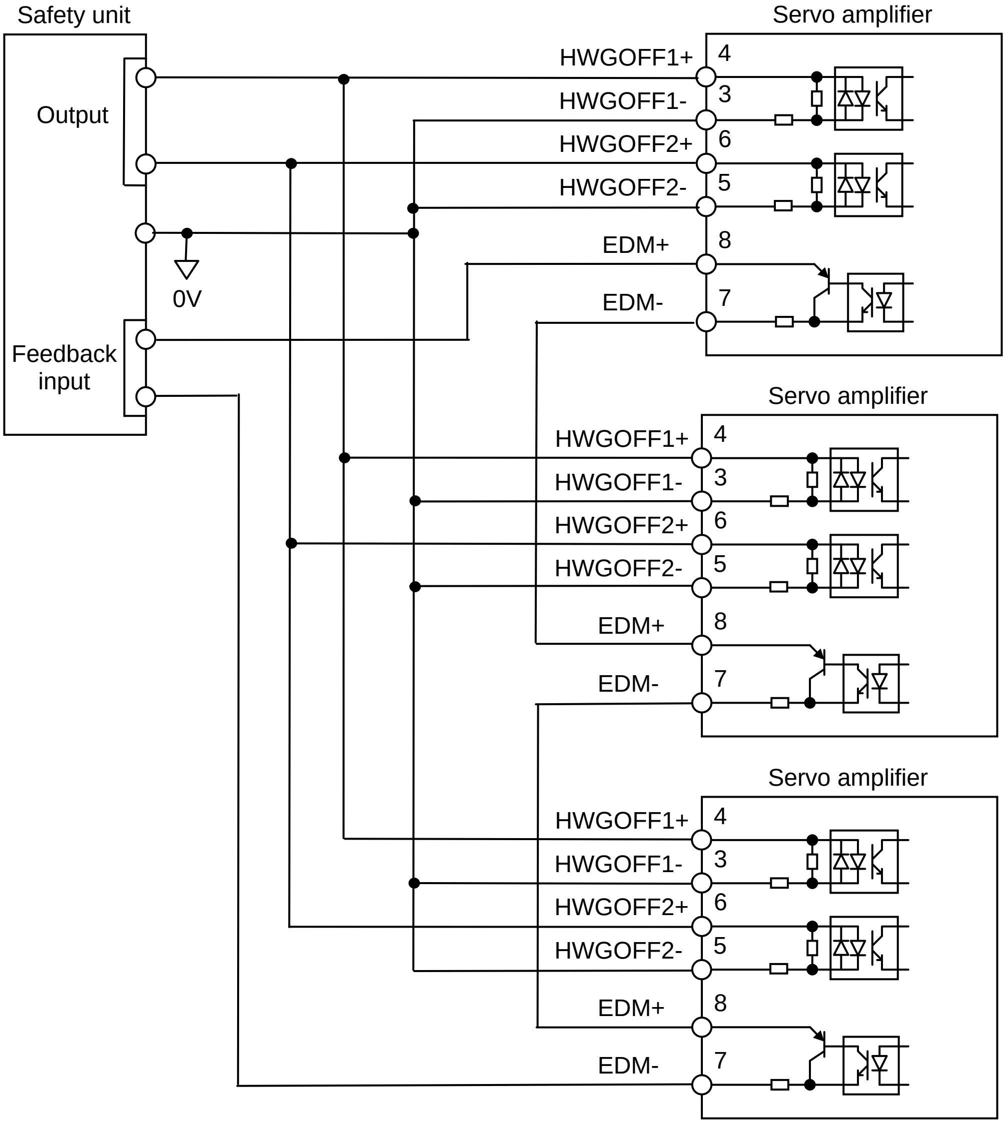
If you do not use this function, please connect the short-circuit plug for safety instrument that is attached to this product. If the short-circuit plug for safety instrument is required, please order "AL-00849548-02", as our model number. Also, if you do not use this function by connector "2013595-3",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

### 3) Example of wiring

Example of wiring to safety switch (1-axis used) (In case of Performance Level: PL=C)

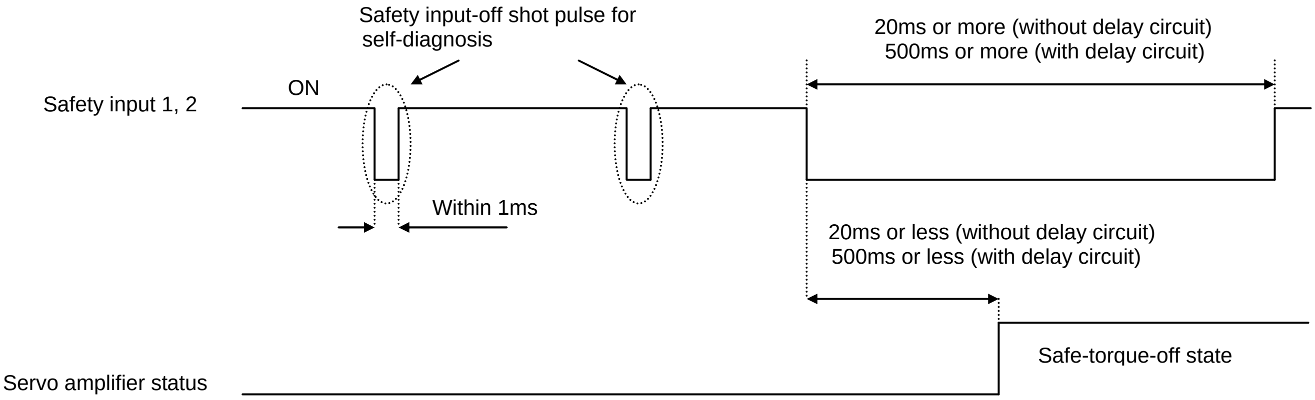


Example of wiring to safety unit (multiple axis used) (In case of Performance Level: PL=e)



### 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 the safe-torque-off function, turn off safety input signal for 500ms or more.



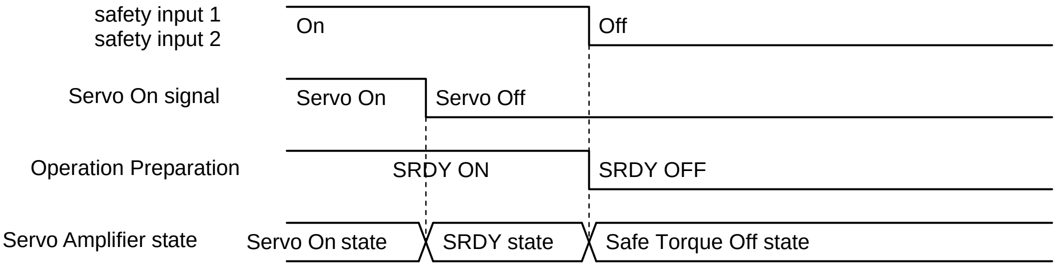
## 10.4 Safe Torque Off Operations

### 1) Safe Torque Off active state

The safe torque off is active when the safety input 1(HWGOFF1) or safety input 2(HWGOFF2) signal is Off (see the table below). In the safe torque off active state, the Servo Ready signal is Off. The Servo On signal will not be accepted in this state.

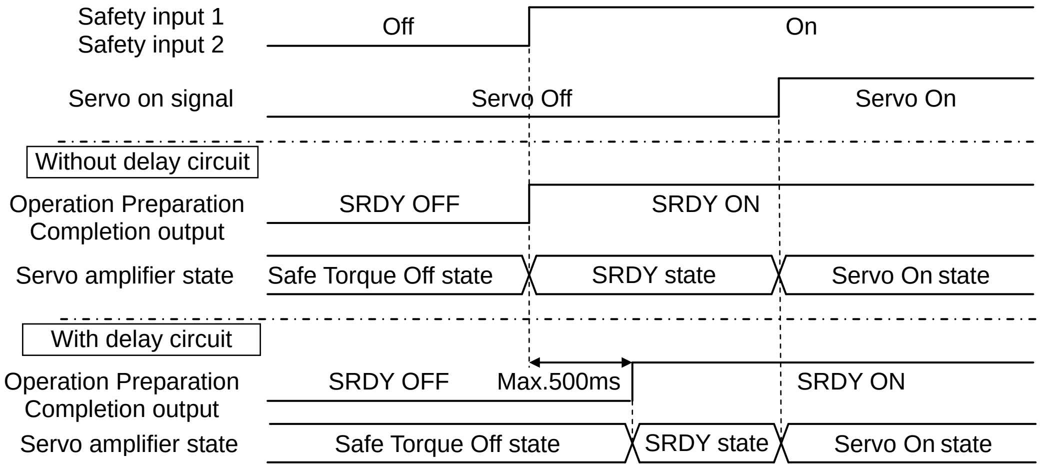
| Signal | Input condition | Servo Amplifier condition |
|---|---|---|
| Safety input 1 (HWGOFF1) | On | Normal state |
| | Off | Safe torque off active state |
| Safety input 2 (HWGOFF2) | On | Normal state |
| | Off | Safe torque off active state |

* Off: Electric current will not flow (contact open).
* On: Electric current will flow (contact closed).

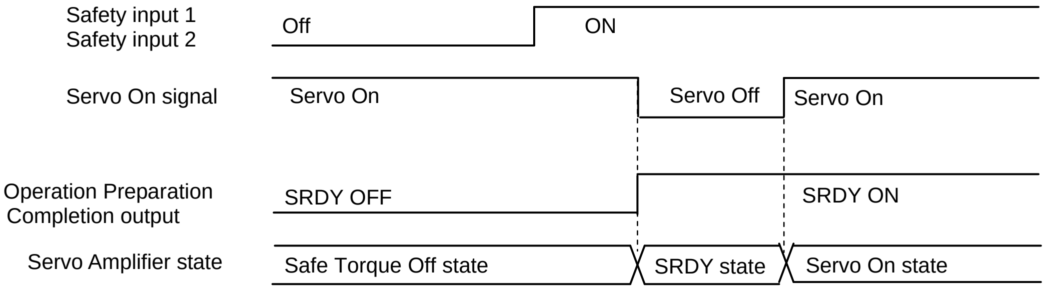


## 2) Recovery from Safe Torque Off active state

While servo-on signal is not input as described in 10.4.1, turning on the safety input 1 or safety input 2 signal activates SRDY state. Operations may resume when servo-on signal is input. (The time to transit to SRDY state is maximum 550ms.)



While servo-on signal is input, it will stay to Safe Torque Off state if safety input 1 or safety input 2 signal is turned on. To re-start the operation, input the servo-off signal, and then input the servo-on signal again.



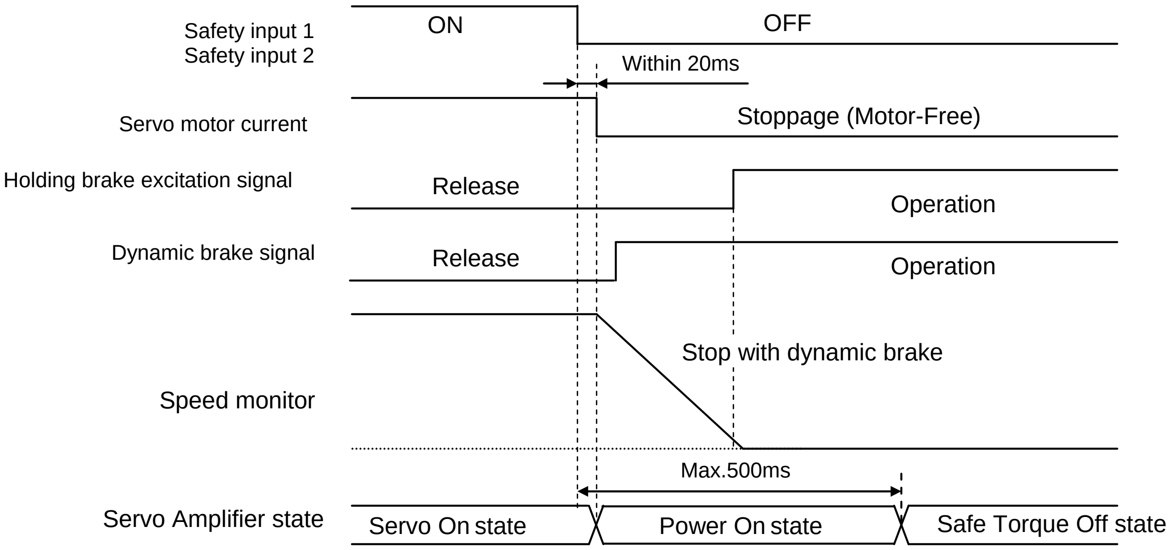
* If always sending the operation enabled signal, it may not be able to recover from Safe Torque Off state. Avoid this setting when using the Safe Torque Off function.

### 3) Safe Torque Off while Servo Motor Running

Depending on setting of quick stop option code (0x605A, 0x00:[QSTOP]), it will be vary how the motor stops.

■ In case the setting value is 0

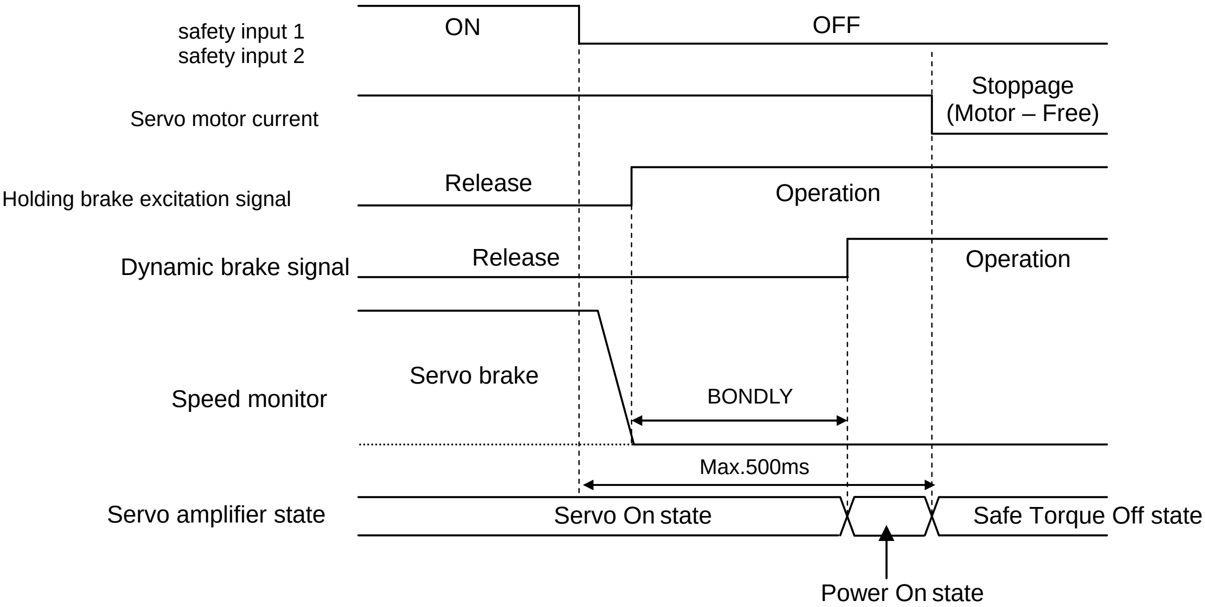
When either safety input 1 or safety input 2 is off, the current to servo motor is shut down, then the motor stops by dynamic brake after moving to safe-torque-off state.
After turning off safety input and elapsing delay time (Max.500ms), the state moves to safe-torque-off state.
Dynamic brake is activated on turning off safety input.



* Dynamic brake circuit and holding brake excitation signal are not safety-related sections.

- ■ In case the setting value is either 3 or 7(motor stops with servo brake when servo off)

If either safety input 1or safety input 2 input is off, motor stops with servo brake.

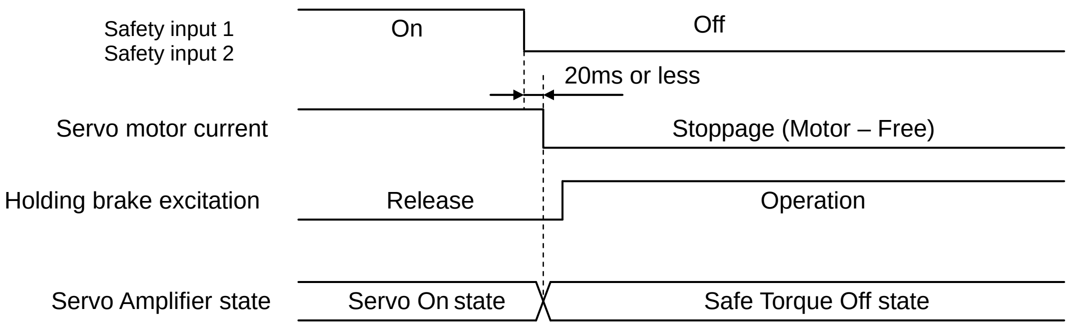


* When set value of BONDLY (holding brake activation delay time OD: 0x2024) is more than safe-torque-off delay time (500ms max.), the states comes to be motor-free after period of safe-torque-off delay time. Please note that recommended set value for BONDLY is less than 500ms.

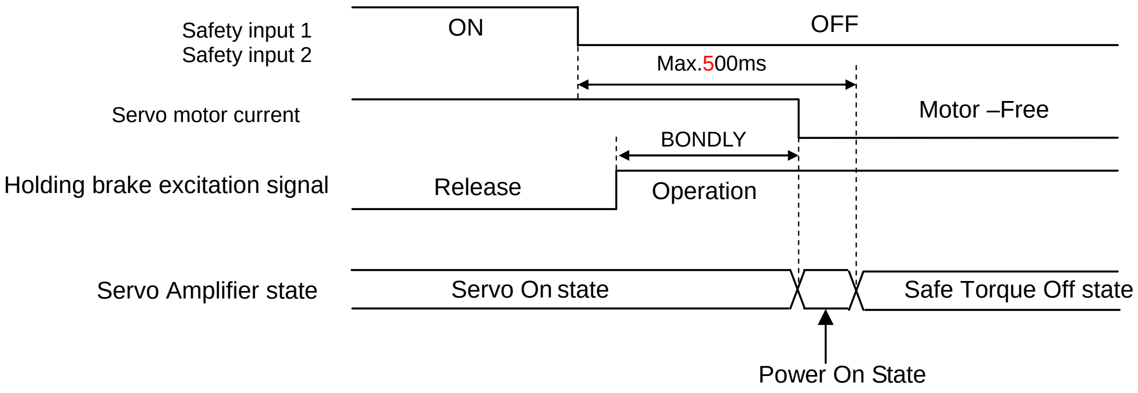
* Servo brake circuit, dynamic brake circuit, and holding brake excitation signal are not safety-related sections.

## 4) Safe Torque Off while Servo Motor stoppage

Turning Off safety input 1 or safety input 2 input causes the holding brake signal to issue notification of the operating status. However, since this interrupts current supply to the servo motor, the "holding brake delay time" setting is disabled. This means the servo motor is subject to and may be moved by external forces during the interval from the output of the operating status via the holding brake signal to actual operation of the holding brake.



For amplifier model number RF2###A#HL5 (with Safe Torque Off delay circuit), 500ms maximum delay time is there between turning off safety input 1 or safety input 2 and activating Safe Torque Off function. So, it is able to get the operating time of holding brake.



* Set below 500ms in BONDLY (Delay Time of Engaging Holding Brake OD:0x2024)

## 5) Deviation clear

Note the following if the Deviation Clear Selection parameter (0x20F0,0x05:[CLR]) is set to Type 3 or Type 4 (do not clear deviations when Servo Off).

As long as positioning commands are being issued during position control, activating the safe torque off function will trigger the excessive cumulative positional deviation error (alarm D1). If the Servo On signal is input once again before this alarm is issued, the servo motor will continue to operate according to cumulative positional deviations. To keep this from happening, stop issuing positioning commands as soon as the safe torque off function is activated and clear any positional deviations.

(If the Deviation Clear Selection parameter (0x20F0,0x05[CLR]) is set to Type 1 or Type 2 (clear deviation when Servo On), any positional deviation is automatically cleared when the Servo Off signal is transmitted.

## 6) Detecting HWGOFF signal errors

■ Safe Torque Off function error 1 (alarm 25)

After the safety input 1 or safety input 2 signal is turned Off, this alarm is issued if the other signal does not turn Off within 10 seconds. This enables detection of a broken wire or disconnected HWGOFF signals.

■ Safe Torque Off function error 2 (alarm 26)

This alarm is issued when an internal circuit failure is detected based on the safety signal input status and internal status. This enables detection of circuit problems that interrupt control signals to the power module based on the safety signal input.

# 10.5 Error Detection Monitor (EDM)

## 1) Specifications

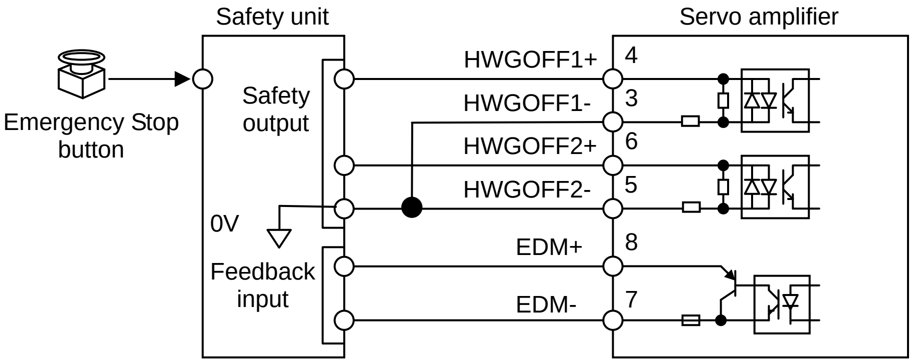
The EDM output signals monitor errors in the safe torque off circuit, /HWGOFF1 wire, or /HWGOFF2 wire. The following table shows the relationships among /HWGOFF1 input, /HWGOFF2 input, and EDM output.

| 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 relationships are not satisfied, the Safe Torque Off circuit or EDM output circuit shall be malfunctions.

## 2) Connection example

The following is a connection example. This example uses a safety unit and activates the Safe Torque Off function when the operator presses the Emergency Stop button.



Connect safety unit output signal to safety input1 (HWGOFF1) and safety input 2 (HWGOFF2) respectively, and then connect error detection monitor (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 the emergency stop button is cancelled, as EDM output is on, the feedback circuit of safety unit is reset, and both safety inputs are turned on, which resumes the operation.

* In case such a malfunction occurs that EDM will not be turned on despite both the safety input 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 Safety Torque Off state).

### 3) Error detection method

When any failures occurred with any of safety inputs remained ON inside the servo amplifier, EDM output will not be turned on, and EDM signal will remain OFF even if emergency stop button pressed.
Errors can be detected by system configuration with safety unit detecting the condition that relationship between safety input and EDM output in the above table is not effective.

* In case you need to meet requirements of ISO13849-1, PL=e, make sure to perform testing of failure detection by 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 safety output. Do not use EDM signal for any purpose other than malfunction monitoring.

# 10.6 Confirmation Test

For use of the Safe Torque Off function, you must confirm that the safe torque off operations correctly during machine startup, servo amp replacement and test operation.
Even if it is not fit to the case above, strongly recommended that confirmation of function operation at least annually.

## 1) Preparations

Before performing the confirmation test, perform a test operation to confirm that the equipment operates properly and that there are no problems in the servo amp, servo motor installation, or wire connections.
For a discussion of installation, wiring, and test operations, refer from "3. Installation" to "6.2. Test operation".

## 2) Confirmation procedure

Follow the procedure described below to run an STO function confirmation test:
Procedure 1. Supply control power and main circuit power.
Procedure 2. Turn On both safety input 1and 2 input signals.
Procedure 3. Input the Servo On signal to excite the servo motor.
Procedure 4. Turn Off both the safety input 1and 2 input signals.

## 3) Acceptance criteria

Confirmation procedure 2 to 4, confirm the states listed below.

Procedure 1 and 2, make sure that the EDM output and LED indication are as follows:

| Confirmation item | State |
|---|---|
| EDM output | Off |
| LED indication | [ST]LED (Green) : Blinking with 256mscycle<br>[AL]LED (Red) : Off |

Procedure 2 and 3, confirm that the servo motor is excited.

Procedure 3 and 4, confirm that the EDM output and LED indication are as follows:
Also, confirm that servo motor excitation has been cancelled.

| Confirmation item | State |
|---|---|
| EDM output | On |
| LED indication | [ST]LED (Green) : Blinking with 256mscycle<br>[AL]LED (Red) : Blinking with 256mscycle |

# 10.7 Safety Precautions

As for Safe Torque Off function, strictly adhere to the following safety precautions.
Incorrect use of this function can result in physical injury and damage to people and/or machinery.

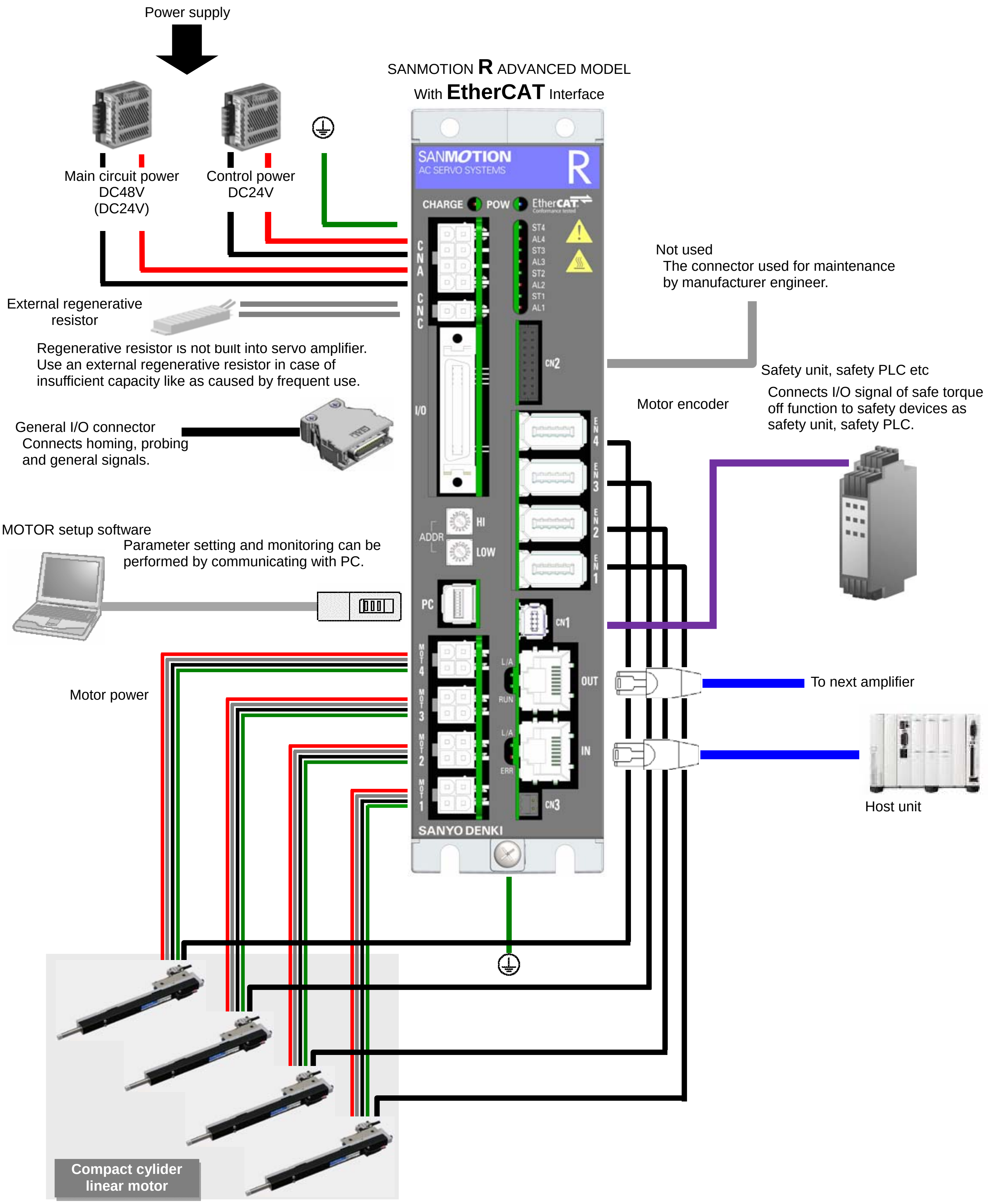
- ✓ The person who designs a system using the safety function (STO function) must have full knowledge of the related safety standards and full understanding of the instructions in this manual.
- ✓ Ensure performing Risk assessment when designing safety system using this function.
- ✓ When STO function is activated while servo motor running, the power supply to the motor is shut down, however ,the motor continues to run a while through inertia. Make sure to design safety system to prevent any danger until the motor stops completely.
- ✓ When in vertical axes and the like, the motor rotates because of gravity loads. Take measures to hold the motor shaft with mechanical brake etc. Incidentally, dynamic brake of servo amplifier, holding brake excitation signal or holding brake of servo motor are not safety related parts.
- ✓ The motor may rotate within the electric angle of 180 degrees keeping motor excitation in case of servo motor between phases short-circuit due to the power device failure, etc. Use the function only in the applications where you can judge the above behavior will not lead to dangerous condition.
- ✓ 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 faulty wiring of input / output signals, this function will not work properly, which may incur danger.
- ✓ 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.

# 11

# 11. Linear motor

## 11.1 System configuration diagram

■RF2J24A8HL5



The connector used for maintenance by manufacturer engineer.

Regenerative resistor is not built into servo amplifier. Use an external regenerative resistor in case of insufficient capacity like as caused by frequent use.

Connects I/O signal of safe torque off function to safety devices as safety unit, safety PLC.

Connects homing, probing and general signals.

Parameter setting and monitoring can be performed by communicating with PC.

# 11.2 Wiring

For RF2 series multi axis EtherCAT servo amplifier, only apply to compact cylinder linear motor DE0AC001A03M.

## 1) Recommended specification for encoder cable

| | | |
|---|---|---|
| Shielded many-to-one cable | Cable rating | 80℃ 30V |
| | Conductor resistance value | 1Ω or less Note1) |
| | Conductor size | AWG size: 26 to 18<br>SQ（mm$^2$）: 0.15 to 0.75 |

Note1) Shows conductor resistance value for the conductor length to be actually used.

## 2) Encoder cable length

Maximum cable lengths by conductor size of power (5V, SG) cable

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

Conductor resistance varies depending on conductor specifications.

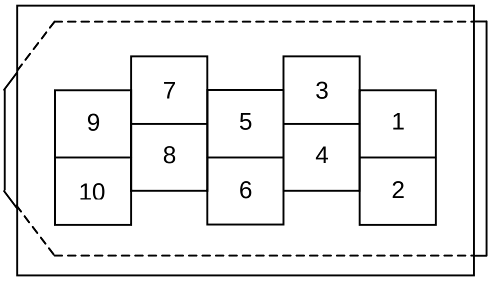
## 3) Linear encoder wiring (Incremental differential output)

Indicates the terminal number and signal name of linear scale sensor EN1 to EN4.

| Servo amplifier EN1 to 4 Terminal No. | Servo motor lead color | Signal name | Description | Remarks |
|---|---|---|---|---|
| 1 | Red | 5V | Power supply | Twisted-pair |
| 2 | Black | SG | Power supply common | |
| 3 | - | - | - | |
| 4 | - | - | | |
| 5 | Green | B | B-phase pulse output | Twisted-pair |
| 6 | Purple | /B | | |
| 7 | Blue | A | A-phase pulse output | Twisted-pair |
| 8 | Brown | /A | | |
| 9 | White | Z | Z-phase pulse output | Twisted-pair |
| 10 | Yellow | /Z | | |
| - | Earth | Shield | - | |

- * Use shielded cable and perform twisted-pair wiring.
- * Connect the shielded cable to the metal case (ground) on EN1 to 4 sides and connect the ground to the motor encoder side.
- * Must connect to power supply common.

## 4) Terminal numbers on servo amplifier



Solder connection

* Please make sure to check wiring as wiring varies depending on encoder types to be connected.

| I/O | Model number | Applicable wire size | Applicable cable outer diameter | Manufacturer |
|---|---|---|---|---|
| Connector | 36210－0100PL | AWG30 to AWG18 | － | 3M |
| Shell kit<br>(Soldering type) | 36310－3200－008 | － | ϕ7 to ϕ9 | |

## 5) Linear encoder signal on motor (D-sub 9 pin)

For wiring from D-sub 9 pin output of linear motor encoder to EN1 -EN4, please prepare at customer side.

| Motor Terminal No. | Signal name | Description |
|---|---|---|
| 1 | NC | - |
| 2 | Z | Z-phase pulse＋ output |
| 3 | B | B-phase pulse＋ output |
| 4 | A | A-phase pulse＋ output |
| 5 | 5V | DC5V input for encoder |
| 6 | /Z | Z-phase pulse- output |
| 7 | /B | B-phase pulse- output |
| 8 | /A | A-phase pulse- output |
| 9 | SG | GND/inner shield |

* Use shielded cable and perform twisted-pair wiring.

## 6) Wire diameter - Permissible current

Refer to chapter 4, for wiring example.
Indicate wire diameter and permissible current for DE0AC001A03M motor, to below.

| Servo motor model No. | Motor power （U･V･W･ ⏚ | | Servo amplifier to be combined | Main circuit power supply (P, N) | | Control power supply (CP, CN) | | Regenerative resistor | | ⏚ | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | $mm^2$ | AWG No | | $mm^2$ | AWG No | $mm^2$ | AWG No | $mm^2$ | AWG No | $mm^2$ | AWG No |
| DE0AC001A03M | 1.25 | 16 | RF2#24 | 1.25 | 16 | 1.25 | 16 | 1.25 | 16 | 2.0 | 14 |

* "#" is optional number or alphabetical letter.
* The above values are provided under condition that ambient temperature is 40℃ and rated current is applied to 3 lead bands.
* Consider wire allowable current reduction rate, when you band wires and then insert them into duct such as cured vinyl tube or metal tube.
* If ambient temperature is relatively high, the lifetime is shortened due to heat deterioration. In this case special heat-resistant vinyl covered wire (HIV) is recommended.
* For the main circuit power supply, wire diameter less than above table is able to use depending on servo motor capacity.

# 11.3 Linear motor control-related parameters

Set the parameters as follows to use linear motor.

## 1) Setting of system parameter

<table>
<tr><th>Group<br>ID</th><th>Parameter symbol</th><th>Contents</th></tr>
<tr><td>System<br>ID10</td><td>MOCODE</td><td>Motor code<br>■ Set combination motor code you use.<br>Set the combination motor code by selecting the linear motor code you use from "section 1.5, Combination motor list" or "section 5, Motor code".<br>✔For the case of 0xFFFF whose motor code is specific , make sure to download motor parameters from setup software.<br>✍System parameter becomes effective by control power cycle.</td></tr>
<tr><td>System<br>ID05</td><td>ENCODE</td><td>Sensor division number code<br>■ Set division number of linear scale sensor you use.<br>Set 0x0004 because resolution of DE0AC001A03M is 1μm.<br>0x0000 : 5μm [200P/mm]<br>0x0001 : 2.5μm [400P/mm]<br>0x0002 : 2μm [500P/mm]<br>0x0003 : 1.25μm [800P/mm]<br>0x0004 : 1μm [1,000P/mm]<br>0x0005 : 0.5μm [2,000P/mm]<br>0x0006 : 0.25μm [4,000P/mm]<br>0x0007 : 0.125μm [8,000P/mm]<br>0x0008 : 0.1μm [10,000P/mm]<br>0x0009 : 0.05μm [20,000P/mm]<br>✍System parameter becomes effective by control power cycle.</td></tr>
<tr><td>System<br>ID04</td><td>ENTYPE</td><td>Sensor type code<br>■ Set linear sensor and CS-normalization method you use.<br>0x0830：signal/ wire-saving incremental encoder ：CS-normalization/ phase Z<br>0x0840：signal/ wire-saving incremental encoder ：CS-normalization/ none<br>0x0850：signal/ A, B, Z only：CS-normalization/ Software setting (Magnetic pole position estimation)<br>0x0860：signal/ A, B, Z only：CS-normalization/ Software setting (fixed excitation)<br><br>✍System parameter becomes effective by control power cycle.<br>✍This RF2 series amplifier cannot use as the control system using hall effect sensor. For use of hall effect sensor, please use RS2 series single axis type amplifier.</td></tr>
<tr><td>System<br>ID0B</td><td>PLMODE</td><td>Encoder selection to control position loop<br>■ Verify the set value is as indicated below.<table><tr><th>Present set value</th><th>Contents</th></tr><tr><td>00: External-Enc</td><td>Semi-closed control/ motor encoder</td></tr></table></td></tr>
</table>

## 2) Setting of linear scale sensor

CS-detection method of linear motor varies depending on system parameter "System ID04" or "Device parameter：0x0x0004 sensor type code". Verify the following parameter settings.

<table>
<tr><th>Group ID</th><th>Parameter symbol</th><th>Contents</th></tr>
<tr><td>GroupC<br>ID00</td><td>ENFIL</td><td>Encoder digital filter selection（EN1）<br>■ Set digital filter for motor pulse encoder pulse signal, which is contained in pulse output encoder. Digital filter value of incremental pulse from the linear scale sensor 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><th>Value to select</th><th>Contents</th></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></td></tr>
<tr><td>GroupC<br>ID09</td><td>ENCDIR</td><td>Linear sensor polarity selection (EN1 - EN4)<br>■ Select linear encoder (EN1 - EN4) signal polarity. Phase A and B signal polarity are selectable.
<table>
<tr><th colspan="2">Value to select</th><th>Contents</th></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>
✍Function enabled on re-turning control power on.</td></tr>
</table>

## 3) Setting of magnetic pole position estimation method

CS-detection method of linear motor varies depending on system parameter "System ID04" or "Device parameter：0x0x0004 sensor type code". Verify the following parameter settings.

<table>
<tr><th>Group ID</th><th>Parameter symbol</th><th>Contents</th></tr>
<tr><td>System<br>ID0D</td><td>CSOF</td><td>CS-offset<br>■ Set electrical angle of motor. For motor with hall sensor, offset from phase U electrical angle 0 degree to phase U hall sensor output edge shall be set in electrical angle.<br>Setting range ：0 to 359deg<br>Initial value ：330deg<br>✔Sensor type code: 0x0004 = 0x0830, 0x0840, 0x0850 and 0x0860 need to be set.<br>✍ Function enabled on re-turning control power on.</td></tr>
<tr><td>System<br>ID0E</td><td>ZPHOF</td><td>Phase Z CS-normalization offset<br>■ Set 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.<br>Setting range ：0 to 359deg<br>Initial value ：330deg<br>✔Sensor type code: 0x0004 = 0x0810, 0x0830 need to be set.<br>✍ Function enabled on re-turning control power on.</td></tr>
</table>

<table>
<tr><th>Group ID</th><th>Parameter symbol</th><th>Contents</th></tr>
<tr><td>GroupB<br>ID01</td><td>EMPFREQ</td><td>Magnetic pole position estimation frequency<br>■ Set frequency of torque (force) applied at magnetic pole position estimation.<br>Setting range : 5 to 100Hz<br>Initial value : 50Hz<br>✔ Change excitation frequency when detection cannot be normally completed due to resonance point of machine, at amplifier hardware magnetic pole position estimation.<br>✍ Function enabled on re-turning control power on.</td></tr>
<tr><td>–</td><td>CSETMD</td><td>Magnetic pole position estimation mode selection<br>■ Set the magnetic pole position estimation run mode.
<table>
<tr><th>Value to select</th><th>Contents</th></tr>
<tr><td>00</td><td>Follow the setting of the valid condition of magnetic pole position pointing function.</td></tr>
<tr><td>01</td><td>Magnetic pole position estimation will run one time automatically only after turning on the main power.</td></tr>
</table>
✔Sensor Classification Cord Function will be enabled by setting0x0004 = 0x0850.<br>✍ Function enabled on re-turning control power on.</td></tr>
<tr><td>Group9<br>ID1A</td><td>CSET</td><td>Magnetic pole position pointing function<br>■ Set valid condition of magnetic pole position estimation, for linear motor without hall sensor output function.
<table>
<tr><th>Value to select</th><th>Contents</th></tr>
<tr><td>02:_CONT1_ON</td><td>Function enabled when general input CONT1 is ON.</td></tr>
<tr><td>03:_CONT1_OFF</td><td>Function enabled when general input CONT1 is OFF.</td></tr>
<tr><td>04:_CONT2_ON</td><td>Function enabled when general input CONT2 is ON.</td></tr>
<tr><td>05:_CONT2_OFF</td><td>Function enabled when general input CONT2 is OFF.</td></tr>
<tr><td>06:_CONT3_ON</td><td>Function enabled when general input CONT3 is ON.</td></tr>
<tr><td>07:_CONT3_OFF</td><td>Function enabled when general input CONT3 is OFF.</td></tr>
<tr><td>08:_CONT4_ON</td><td>Function enabled when general input CONT4 is ON.</td></tr>
<tr><td>09:_CONT4_OFF</td><td>Function enabled when general input CONT4 is OFF.</td></tr>
<tr><td>0A:_CONT5_ON</td><td>Function enabled when general input CONT5 is ON.</td></tr>
<tr><td>0B:_CONT5_OFF</td><td>Function enabled when general input CONT5 is OFF.</td></tr>
<tr><td>0C:_CONT6_ON</td><td>Function enabled when general input CONT6 is ON.</td></tr>
<tr><td>0D:_CONT6_OFF</td><td>Function enabled when general input CONT6 is OFF.</td></tr>
<tr><td>0E:_CONT7_ON</td><td>Function enabled when general input CONT7 is ON.</td></tr>
<tr><td>0F:_CONT7_OFF</td><td>Function enabled when general input CONT7 is OFF.</td></tr>
<tr><td>10:_CONT8_ON</td><td>Function enabled when general input CONT8 is ON.</td></tr>
<tr><td>11:_CONT8_OFF</td><td>Function enabled when general input CONT8 is OFF.</td></tr>
</table>
✔ Input time to become al l the function enabled is 8ms.<br>✍ Function enabled on re-turning control power on.</td></tr>
<tr><td>Group9<br>ID40</td><td>EXT-E</td><td>External trIp-input function<br>Set the condition that trip input becomes effective to use thermal of linear motor.<br>■ The setting contents are the same as the above magnetic pole position indication function.<br>✔ Input time to become al l the function enabled is 8ms.<br>✍ Function enabled on re-turning control power on.</td></tr>
</table>

## 4) Setting of moving direction

Moving direction of linear motor depends on polarity of command and linear scale sensor.

■ Setting of command-input polarity

| Group ID | Parameter symbol | Contents |
|---|---|---|
| Group8<br>ID00 | CMDPOL | Polarity<br>■ Select position command polarity from the following contents.<br>Servo motor moving direction can be reversed without changing command wiring.<br>✍Please use, after verifying move direction that the command polarity is set to plus. |

No Text on This Page.

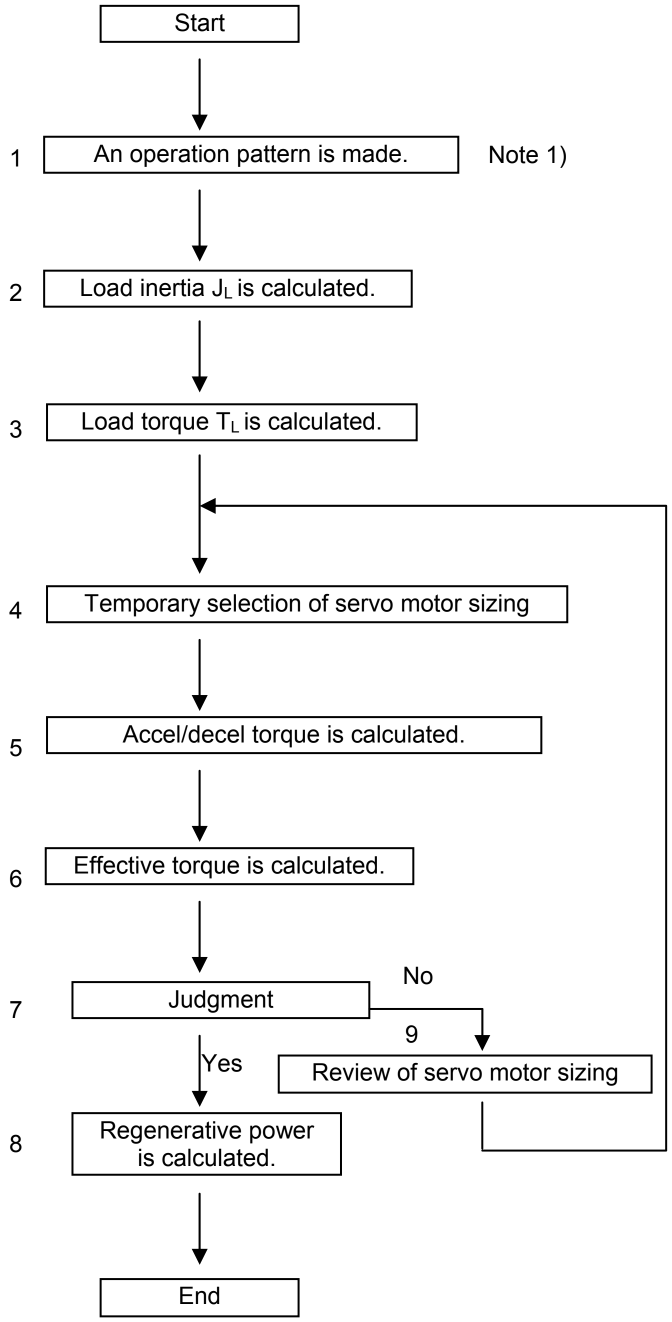
# 12

# 12. Selection

## 12.1 Rotary 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.

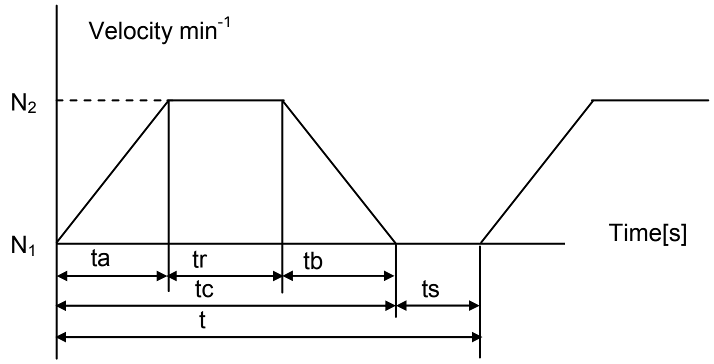
### 1) Flowchart of Servo Motor Sizing



1. Make an operation pattern.
2. Calculate load moment of inertia from a machine configuration.
3. Calculate load torque from a machine configuration.
4. Load moment of inertia (JL) is 10 or less times of the rotor moment of a servo motor inertia (JM), and the load torque (TL) should do temporary motor selection less than 80% of a motor rating torque (TR).
$J_L < = J_M \times 10$
$T_L < = T_R \times 0.8$
5. Calculate the required accel/decel torque from an operation pattern.
6. Calculate the effective torque from a torque pattern.
7. Judge whether the accel/decel torque (Ta, Tb) is less than 80% of the instant maximum torque (Tp) of a servo motor, and the effective torque (Trms) is less than 70% of the rating torque (TR) of a servo motor.
$T_a < = T_p \times 0.8$
$T_b < = T_p \times 0.8$
$Trms < = T_R \times 0.7$
8. Calculate regeneration electric power, and if required, select an external regeneration resistor.
9. Improve servo motor capacity, such as raising the capacity of a servo motor.

Note1) The operational pattern shall be created so that average motor rotational velocity does not exceed maximum rotational velocity.

## 2) Make an operation pattern



ta= Acceleration time

tb= Deceleration time

tr= Constant velocity time

ts= Stop time

t=1 cycle

## 3) Calculate motor axis conversion load inertia ($J_L$)

- The load inertia of a moving part

$$J_L = \left(\frac{1}{G}\right)^2 \times \frac{\pi \times \rho \times D^4 \times L}{32} \quad [kg \cdot m^2]$$

G: Reduction ratio

$\rho$ : Moving part specific gravity [kg/m$^3$]

D: Moving part diameter [m]

L: Moving part length [m]

- The load inertia of a work

$$J_L = \left(\frac{1}{G}\right)^2 \times W \times \left(\frac{P}{2\pi}\right)^2 \quad [kg \cdot m^2]$$

G: Reduction ratio

W: Moving part mass [kg]

P: In the case of a ball screw, is the lead of a ball screw. [m]

In the case of a belt pulley, is an outside diameter of a pulley. [m]

($P=\pi D$)

### 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)

$$TL = \frac{(F+W)}{\eta} \times \frac{P}{2\pi} \times \frac{1}{G} \times 9.8 \quad [N \cdot m]$$

F: External force [kg] $\eta$ : Transmission efficiency
$\mu$ : Coefficient of frictionW: Moving part mass [kg]
P: Ball screw lead [m]G: Reduction ratio

- Belt pulley (in horizontal axis)

$$T_L = \frac{(F+(\mu+1)W)}{\eta} \times \frac{D}{2} \times \frac{1}{G} \times 9.8 \quad [N \cdot m]$$

- Belt pulley (in vertical axis)

When motor drives upward

$$T_L = \frac{(F+(\mu+1)W)}{\eta} \times \frac{D}{2} \times \frac{1}{G} \times 9.8 \quad [N \cdot m]$$

When motor drives downward

$$T_L = \frac{(F+(\mu-1)W)}{\eta} \times \frac{D}{2} \times \frac{1}{G} \times 9.8 \quad [N \cdot m]$$

- When belt pulley stops (in horizontal axis)

$$T_L = \frac{F}{\eta} \times \frac{D}{2} \times \frac{1}{G} \times 9.8 \quad [N \cdot m]$$

- When belt pulley stops (in vertical axis)

$$T_L = \frac{(F+W)}{\eta} \times \frac{D}{2} \times \frac{1}{G} \times 9.8 \quad [N \cdot m]$$

F: External force [kg] $\eta$ : Transmission efficiency
$\mu$ : Coefficient of frictionW: Moving part mass [kg]
D: Diameter of a pulley [m]G: Reduction ratio

### 5) Calculate acceleration torque ($T_a$)

$$T_a = \frac{2\pi(N_2 - N_1) \times (J_L + J_M)}{60 \times ta} + T_L \qquad [N \cdot m]$$

$N_2$: Servo motor rotation velocity after acceleration [$min^{-1}$]

$N_1$: Servo motor rotation velocity before acceleration [$min^{-1}$]

$J_L$: Load inertia [$kg \cdot m^2$]

$J_M$: Rotor inertia of servo motor [$kg \cdot m^2$]

### 6) Calculate deceleration torque ($T_b$)

$$T_b = \frac{2\pi(N_2 - N_1) \times (J_L + J_M)}{60 \times tb} - T_L \qquad [N \cdot m]$$

$N_2$: Servo motor rotation velocity before deceleration [$min^{-1}$]

$N_1$: Servo motor rotation velocity after deceleration [$min^{-1}$]

$J_L$: Load inertia [$kg \cdot m^2$]

$J_M$: Rotor inertia of servo motor [$kg \cdot m^2$]

### 7) Calculate effective torque (Trms)

$$Trms = \sqrt{\frac{(T_a^2 \times ta) + (T_L^2 \times tr) + (T_b^2 \times tb)}{t}} \qquad [N \cdot m]$$

### 8) Judgment condition

■ We consider the followings as the standard of the judgment.

- Load factor of load torque $T_L <= T_R \times 0.8$

  (Load torque is 80% or less of rated torque)
- Load factor of acceleration torque $T_a <= T_P \times 0.8$

  (Acceleration torque is 80% or less of peak torque at stall )
- Load factor of deceleration torque $T_b <= T_P \times 0.8$

  (Deceleration torque is 80% or less of peak torque at stall)
- Load factor of effective torque $Trms <= T_R \times 0.7$

  (The effective torque is 70% or less of rated torque)
- Inertia moment ratio $J_L <= J_M \times 10$

  (It is 10-times or less of rotor inertia moment of motor.)

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.

* In DC48V<24V>-input servo system, when wiring of main circuit power or motor input line is relatively long, motor-generated torque notably decreases due to voltage drop on cables. Make sure to verify torque on actual machine with sufficient torque to select motor capacity.

* Regenerative energy can occur, depending on mechanical specification and selected motor. Refer to “Section 12.2, Caution on regeneration” for the detail of regenerative energy and confirm.

## 12.2 Capacity 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.

### 1) How to find "regeneration effective power (PM)" of the horizontal axis drive by a formula (Rotary motor)

■ Calculate regeneration energy.

$$EM = Ehb = \frac{1}{2} \times N \times 3 \cdot Ke\phi \times \frac{Tb}{KT} \times tb - \left[\frac{Tb}{KT}\right]^2 \times 3 \cdot R\phi \times tb$$

| | | | |
|---|---|---|---|
| EM | : | Regeneration energy during operations along horizontal axis | [J] |
| Ehb | : | Regeneration energy during deceleration | [J] |
| $Ke\phi$ | : | Induced voltage constant | [Vrms/min$^{-1}$] (Motor constant) |
| KT | : | Torque constant | [N·m/Arms] (Motor constant) |
| N | : | Motor rotation speed | [min$^{-1}$] |
| $R\phi$ | : | Armature resistance | [Ω] (Motor constant) |
| tb | : | Deceleration time | [s] |
| Tb | : | Torque during deceleration | [N·m] |

■ Calculate "regeneration effective power" from regeneration energy.

$$PM \quad \frac{EM}{to}$$

| | | | |
|---|---|---|---|
| PM | : | Effective regeneration power | [W] |
| EM | : | Regeneration energy | [J] |
| to | | Cycle time | [s] |

## 2) How to find "regeneration effective power (PM)" of the vertical axis drive by a formula (Rotary motor)

- Calculate regeneration energy.

EM = EVUb + EVD + EVDb

$$= \frac{1}{2} \times N \times 3 \cdot Ke\phi \times \frac{TUb}{KT} \times tUb - \left[\frac{TUb}{KT}\right]^2 \times 3 \cdot R\phi \times tUb$$

$$+ N \times 3 \cdot Ke\phi \times \frac{TD}{KT} \times tD - \left[\frac{TD}{KT}\right]^2 \times 3 \cdot R\phi \times tD$$

$$+ \frac{1}{2} \times N \times 3 \cdot Ke\phi \times \frac{TDb}{KT} \times tDb - \left[\frac{TDb}{KT}\right]^2 \times 3 \cdot R\phi \times tDb$$

Keϕ : Induced voltage constant [Vrms/min$^{-1}$] (Motor constant)
KT : Torque constant [N·m/Arms] (Motor constant)
N : Motor rotation speed [min$^{-1}$]
Rϕ : Armature resistance [Ω] (Motor constant)
EM : Regeneration energy during operations along vertical axis [J]
EVD : Regeneration energy during descending run [J]
Tub : Torque during increased deceleration [N·m]
TD : Torque during descending run [N·m]
td : Descending run time [s]
TDb : Torque during decreased deceleration [N·m]
tDb : Decreased deceleration time [s]
EVUb : Regeneration energy during increased deceleration [J]
EVDb : Regeneration energy during decreased deceleration [J]
tUb : Increased deceleration time [s]

* When the calculation result of either of **EVUb**, **EVD**, or **EVDb** is negative, calculate **EM** by considering the value of those variables as 0.

- Calculate "regeneration effective power" from regeneration energy.

$$PM \quad \frac{EM}{to}$$

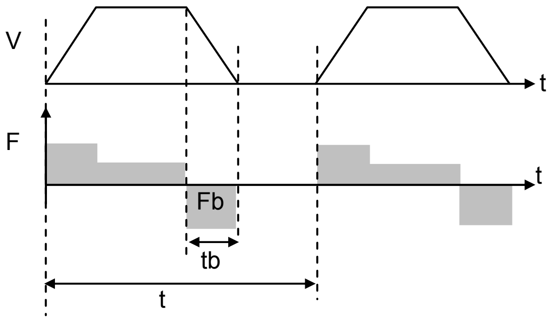
PM : Effective regeneration power [W]
EM : Regeneration energy during deceleration [J]
to : Cycle time [s]

### 3) How to find "regeneration effective power (PM)" of the vertical axis drive by a formula (Linear motor)

- Calculate regeneration energy.

$$PM = \left[ \left( \frac{1}{2\cdot t} \cdot M \cdot V^2 \right) \left( \frac{v}{2\cdot t} \cdot Ff\cdot tb \right) \right] - \left[ \left( \frac{3\cdot R\phi\cdot tb}{t} \right) \times \left( \frac{M\cdot V - Ff\cdot tb}{Kf\cdot tb} \right)^2 \right] \quad [J/s]=[W]$$

| | | | |
|---|---|---|---|
| PM | : | Regenerative electrical power | [W] |
| M | : | Moving part mass | [kg] |
| V | : | Acceleration just before decelerating | [m/s] |
| t | : | Cycle | [s] |
| tb | : | Decelerating time | [s] |
| Ff | : | Frictional force | [N] |
| Rϕ | : | Resistance per 1 motor | [Ω] |
| Kf | : | Force constant | [N/A] |



Fb=M·V/tb-Ff

## 4) Capacity 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.
For DC input amplifier use, decide a regenerative resistor so that the voltage rise does not exceed 60V in the main circuit by the regenerative energy.

■ Allowable power of a regeneration resistor

When regeneration effective power "PM" turns into more than the allowable power of the amplifier internal regenerative resistor, the external regeneration resistor (option) of the following table can be connected to operate.

| Optional regenerative resistor | Resistance value | Allowable power for external regenerative resistor [PR0] |
|---|---|---|
| REGIST-080W50B | 50Ω | 10W |
| REGIST-120W50B | 50Ω | 30W |
| REGIST-220W20B | 20Ω | 55W |

- * When regeneration effective power **PM** exceeds the maximum permitted power (**PRO**) of the external regeneration resistor, reconsider the acceleration constant, load inertia, etc.
- * 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.
- * A regeneration resistance usage rate can be raised about a maximum of 50% by carrying out an air cooling with blower using a cooling fan.

## 5) Selection of external regenerative resistor instantaneous tolerance

Verify the regenerative energy calculated according to 1) horizontal axis drive and 2) vertical axis drive is the resistor allowable instantaneous tolerance JI [J] selected according to in the above 4) or less.

$$EM\ [J] \leqq JI\ [J]$$

When regenerative energy exceeds the instantaneous tolerance of resistor you use, select the resistor with large instantaneous tolerance.

- * Abnormal regeneration may occurred when vertial axis continously driven, even if the value is under allowable regenerative reistor power ” PR0” and allowable instantaneous torelenace “JI “of usable external regenerative resistor.

## 6) Capacity of External Regenerative Resistor and Resistor Model Name

The resistor model name corresponds with the sign of the external regeneration resistor selected for the preceding clause.

| Resistor Model Number | Resistance Value | Thermostat Detection temperature (Contact specification) | Permissible Effective Power [PM] | Allowable instantaneous tolerance [JI] | Mass |
|---|---|---|---|---|---|
| REGIST-080W50B | 50Ω | 135℃±7℃<br>(Contact b) | 10W | 35J | 0.19kg |
| REGIST-120W50B | 50Ω | | 30W | 80J | 0.24kg |
| REGIST-220W20B | 20Ω | | 55W | 210J | 0.44kg |

Refer to "13.7 Regenerative resistor outline drawing" for resistor outer shape.
Permissible Effective Power is the value under natural air cooling.

## 7) Thermostat Connection of External Regenerative Resistor

Connect a thermostat to either of "the general inputs CONT1-CONT8."
Please allocate the connected general input signal to [Group9 ID40: External Trip Input Function [EXT-E]].

- ■ Example: When connecting the thermostat to CONT2

The external trip function will be valid when【05H:CONT2_OFF】CONT2 is turned off in [Grop9 ID02 External Trip Input Function(0x20F8,0x03)[EXT-E]]. Alarm (ALM-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 [Wiring with host unit for the wiring method (Chapter 4)].

## 8) Protection Function of Regenerative Resistance

The regenerative resistance protection function is specified by parameter selections. Appropriate protection for regenerative resistance is applied by setting parameters according to the type of regenerative resistance to be connected. Set the appropriate parameters by following the instructions given below.

- ■ The two parameters requiring settings are given below.
  - ◆ Regenerative Resistor Selection [System parameter ID01 (0x20FD,0x02)]
  - ◆ External Trip Input Function [General parameter [Group9 ID02](0x20F8, 0x03)]

- ■ The protection functions are divided into three main types:
  - ◆ Protection for a short-time, high load factor (using built-in or external regenerative resistance):
    An error is detected when the power absorption of regenerative resistance is extremely high over a short time period (100msec to 10 seconds). A ‘Regenerative Error’ alarm (“ALM_43”) is issued when this error is detected.
    - ● When the internal regenerative resistor is being used, be sure to set a setup of "system-parameter ID01(0X20FD,0X02)" Regeneration Resistor Selection as [01:_Built-in_R.]
    - ● When external regeneration resistance is being used, be sure to set a setup of "system-parameter ID01(0X20FD,0X02)" Regeneration Resistor Selection as [02:_External_R.]

  - ◆ Protection when allowable power absorption is exceeded for long time (using built-in regenerative resistance):
    An error is detected when the power absorption of the built-in regenerative resistance exceeds the allowable power absorption over a long time period (from a few seconds to a few minutes).
    An ’Internal Overheat’ alarm (“ALM_54”) is issued when this error is detected.
    - ● When the internal regenerative register is being used, be sure to set it as a setup [01:_Built-in_R] of "system-parameter ID01(0X20FD,0X02)" Regeneration resistor Selection.

  - ◆ Protection during thermostat operation of the external regenerative resistor:
    An error is detected when the external trip function is started. An ‘External error / external trip’ alarm (“ALM_55”) is issued when this error is detected.
    - ● When the thermostat is connected to servo amplifier, be sure to set up [general parameter Group9 ID02: external trip input function (0x20F8, 0x03)[EXT-E]].

## 9) Confirmation method of regeneration effective power PM in actual operation

Regeneration effective power **PM** can be easily confirmed by MOTOR setup software or CoE Object.

- ■ MOTOR setup software･･･････Monitor display : ID16･RegP･Regeneration circuit operating rate
- ■ CoE Object･･･････････Index : 0x210A, 0x00･Regeneration circuit operating rate[REGP]
  - * The monitor value of the regeneration circuit operating rate shows the operating rate of regeneration circuit.
  - * The display range is 0.01% - 99.99%.

- ■ The actual regeneration effective power **PM** can be calculated from this monitor value by following equation.
  - ◆ Input Supply Voltage: In case of DC48V specification

$$\text{Regeneration effective power PM (W)=}\ \frac{60(\text{V})\times 60(\text{V})}{\text{Regeneration resistance }(\Omega)} \times \frac{\text{Regeneration circuit operating rate (\%)}}{100(\%)}$$

  - ◆ Input Supply Voltage : In case of DC48V specification

● $$\text{Regeneration effective power PM (W)=}\ \frac{30(\text{V})\times 30(\text{V})}{\text{Regeneration resistance }(\Omega)} \times \frac{\text{Regeneration circuit operating rate (\%)}}{100(\%)}$$

- ■ Calculation Example

  Input Supply Voltage: [DC48V Specification]
  Regeneration resistance value: 20Ω[Built-in Regenerative Resistor]
  Monitor Value (RegP): 0.12%

$$\text{Regeneration power PM (W)=}\ \frac{60(\text{V}) \times 60(\text{V})}{20\ (\Omega)} \times \frac{0.12\ (\%)}{100\ (\%)} = 0.22\ (\text{W})$$

- * The regeneration effective power calculated from this monitor value continues to be the target until the end of operations. Regeneration power varys 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.

## 10) Precaution for external regenerative resistor installation

- ■ The place where corrosive gas has occurred, and when there is much dust, insulated degradation, corrosion, etc., may arise. There fore be careful of an attachment place.
- ■ Arrangement of the external regeneration resistor should open an interval so that it is not influenced by generation of heat from other parts.
- ■ Must wire an external regeneration resistor with using twisted line. Wiring length shall be shorter as possible, at least less than 5m.
- ■ For wire, use fireproof type or perform fireproof process (as silicon tube), and wires avoiding touch with regenerative resistor.

# 13

# 13. Appendix

# 13.1 Standards Conformity

In our company, conformance test is carried out in certificate authorities according to concerned standards, laws and regulations, and attestation markings are done based on the published certificate of attestation.

## 1） Standards conformity

- The following overseas standard examinations are implemented.

| Product model NO. | Applicable laws and Regulations | | Standard code | Certificate authorities |
|---|---|---|---|---|
| | Classification | Detailed Classification | | |
| RF2####### # | UL/c-UL standard | --- | UL508C | UL<br>（Underwriters Laboratories inc.） |
| RF2####### **0**<br>(Safe Torque Off function Unequipped model) | Electrical safety | Electrical safety under Low Voltage Directive (2006/95/EC) | IEC61800-5-1:2007/ EN61800-5-1:2007 | TÜV<br>（TÜV SÜD Japan, Ltd.） |
| | EMC | EMC under EMC directive （2004/108/EC） | EN61000-6-2:2005<br>IEC61800-3:2004/ EN61800-3:2004 | TÜV<br>（TÜV SÜD Japan, Ltd.） |
| RF2####### **2**<br>RF2####### **4**<br>(Safe Torque Off function equipped model) | Electrical safety | Electrical safety under Low Voltage Directive (2006/95/EC) | IEC61800-5-1:2007/ EN61800-5-1:2007 | TÜV<br>（TÜV SÜD Japan, Ltd.）<br>(Blue octagon) |
| | Machine safety | Machine safety under Machinery Directive (2006/42/EC) | IEC60204-1:2005/ EN60204-1:2006 | |
| | Functional safety | Generic Functional safety | IEC61508:2000/ EN61508:2001(SIL2) | |
| | | Functional safety under machinery directive (2006/42/EC) | IEC62061:2005/ EN62061:2005 (SILCL2) | |
| | | Functional safety under machinery directive (2006/42/EC) | EN ISO13849-1 / AC:2009(Cat.3, PL=d) | |
| | | Functional safety for PDS under machinery directive (2006/42/EC) | IEC61800-5-2 :2007/ EN61800-5-2 :2007 | |
| | EMC | EMC under EMC directive （2004/108/EC） | IEC61800-3:2004/ EN61800-3:2004 | |
| | | Functional safety EMC for machine, factory automation application | IEC61326-3-1 :2008/ EN61326-3-1 :2008 | |

■ The servo motor implements the conformance test against the following standards.

| Standard | Standard code | Certificate authorities |
|---|---|---|
| UL standard | UL1004<br>UL1446 | UL<br>(Underwriters Laboratories inc.) |
| EU directive | IEC-34-1<br>IEC34-5 | TÜV<br>(TÜV SÜD Japan, Ltd.) |

✔ For servo motor 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.

## 2） Appliance classes, Degrees of Protection, Pollution Level

■ RF2 servo amplifier is Class III appliance which depends on Safety Extra-Low Voltage (SELV) power source with respect to protection against electric shock, and without higher voltage than Safety Extra-Low Voltage.
Use 4mm$^2$ or more wire when protective grounding terminal is used for protective grounding. Use the wire described in this manual when protective grounding terminal is used for frame grounding (FG).
■ For control/interface power supply to servo amplifier, use the SELV 24 V DC power supply.
For main circuit power supply, use the DC power supply with reinforced insulation.
■ 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 ( polution level 1, 2). The protection grade of servo amplifier is IP1X. The control panel installation configuration (under IP54) must exclude exposure to water, oil, carbon, dust, etc.

## 3） Connection and installation

Be careful of connection and installation as follows.

✔ Always ground the protective earth terminals of the servo amplifier to the power supply earth.
✔ When connecting grounding wire to the protective earth terminal, always connect one wire in one terminal; never connect jointly with multiple wires or terminals.
✔ When connecting the leakage stopper, make sure to connect the protective earth terminal to the power supply earth.
✔ Connect earthing wire 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 the unit.
✔ Use an EN/ IEC-standard compatible no-fuse Circuit breaker and electromagnetic contactor.

✔ This product is certified at the state of arranging the fuses below to power input port of servo amplifier.

| Grounding position | Model number | Manufacturer | Current | Voltage | Spec |
|---|---|---|---|---|---|
| Control power input | 0215005.MXP | Littelfuse | 5 A | 250Vac / 125Vdc | UL certified product |
| Main circuit power input | 400KH-30UL | Hinode | 30 A | 400Vac / 400Vdc | UL certified product |

## 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

## 13.2 Compliance with EU Directives

In our company, for ease of user's CE Marking acquisition, conformity verification test for "Low Voltage Directive" and "an EMC command" is carried out in certificate authority, and servo amplifier CE Marking is done based on the published certificate of attestation.

### 1） Conformity verification test

The following conformity verification tests are implemented.

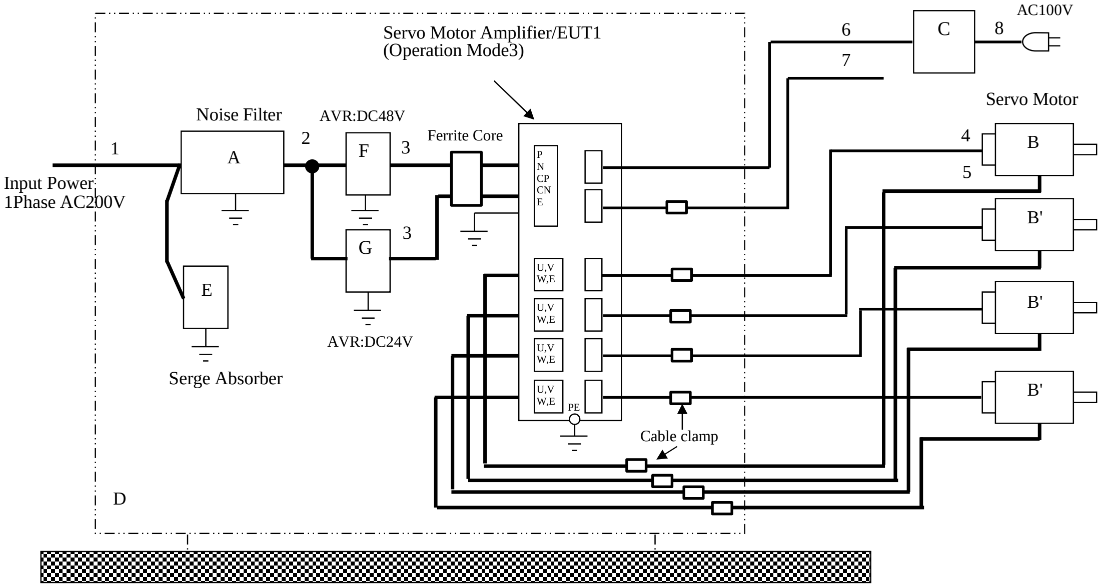
| Directive classification | Classification | Test | Test standard |
|---|---|---|---|
| Low voltage Directive (Servo amplifier) | - | - | EN61800-5-1: 2007 |
| Low voltage Directive (Servo motor) | - | Rotating electrical machines- Part1: Rating and performance | IEC-34-1 |
| | | Rotating electrical machines-Part5: Classification of degrees of protection provided by enclosures of rotating electrical machines (IP code) | IEC34-5 |
| | | Rotating electrical machines-Prat9: Noise limits | IEC34-9 |
| EMC Directive (Servo amplifier / servo motor) | Emission | Conducted emission | EN61800-3 (Category C2) |
| | | Radiated emission | EN61800-3 (Category C2) |
| | 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) Note1) |

Note1) Standards applicable only to Safe Torque Off function equipped models.

## 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.

The terminal marked with "⏚" is certified by TUV as functional earth terminal. Connect to FG terminal of customer application.



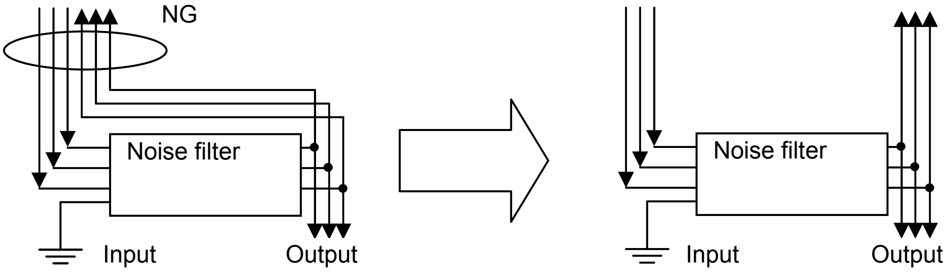
| No | Name | Remarks |
|---|---|---|
| A | Noise filter | HF3030C-UQA: SOSHIN ELECTRIC Co. Ltd.<br>Rated voltage / rated current: Line-Line 480V AC / 30A |
| B | Servo Motor | - |
| B` | Servo Motor | - |
| C | Sequencer | Fxo-30MR |
| D | Control panel | - |
| E | Surge-absorber (Recommended prevention components) | LV275DI-U4: OKAYA |
| F | DC power supply (for main circuit) | HWS1500-48: TDK-Lambda |
| G | DC power supply (for control) | DC power supply for 24Vdc must be used SELV 24VDC model.<br>HWS50-24/A: TDK-Lambda |
| 1 | Power Line 1 | - |
| 2 | Power Line 2 | - |
| 3 | Power Line 3 | - |
| 4 | Motor Encoder | Sielded cable |
| 5 | Motor Drive | Sielded cable |
| 6 | Safety I/O | Sielded cable |
| 7 | EtherCAT Line | Sielded cable |
| 8 | AC Line | - |

- ✔ 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.
- ✔ Please close cabinet door which has this product, in use.
- ✔ Ground noise filter frame to control panel.
- ✔ Use shielded 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.

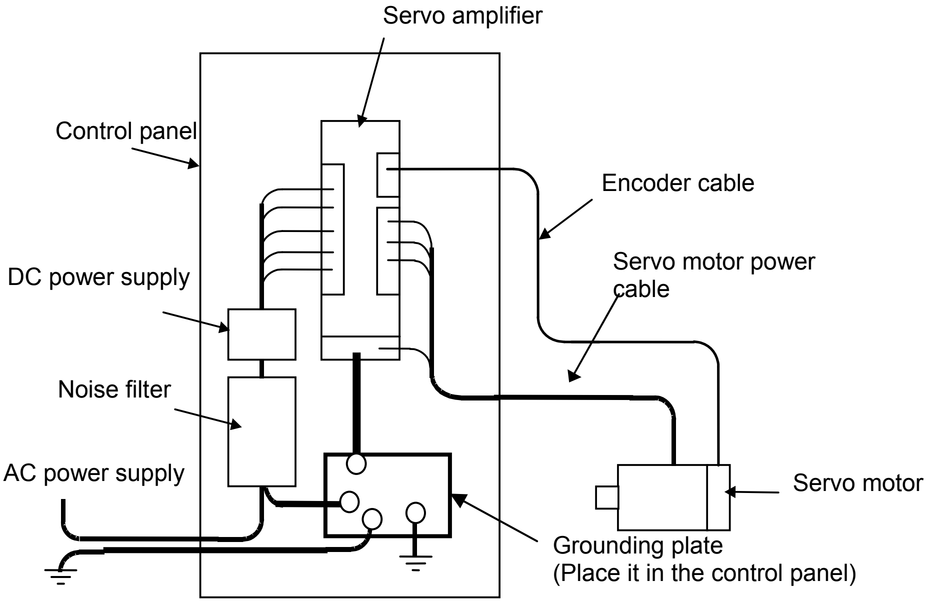
### 3） Precautions for noise filter connection

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.)

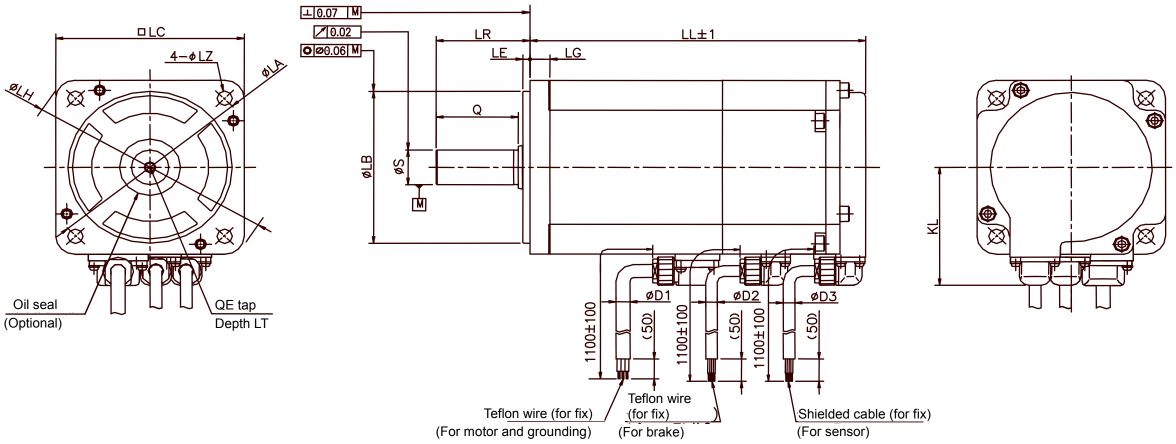


Each of earth line shall be connected to grounding plate in a control panel by single-point.
Also in case of multi axes construction in same control panel, grounding by single-point.



# 13.3 Servo motor outline drawing

## 1） R2 motor, flange size 40mm and 60mm

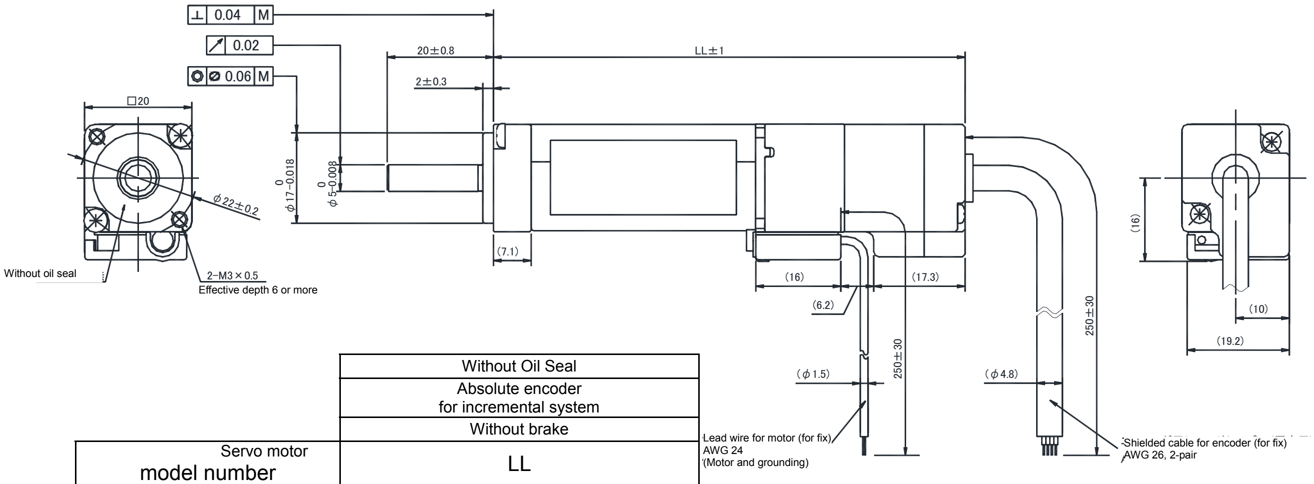


| | Without Oil Seal | | With Oil Seal | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Battery backup method absolute encoder | | | | | | | | | |
| | Absolute encoder for incremental system | | | | | | | | | |
| | Without brake | With brake | Without brake | With brake | | | | | | |
| Servo motor model number | LL | LL | LL | LL | LG | KL | LA | LB | LE | LH |
| R2GA04003△□◇ | 51.5 | 87.5 | 56.5 | 92.5 | 5 | 35.4 | 46 | 0<br>30-0.021 | 2.5 | 56 |
| R2GA04005△□◇ | 56.5 | 92.5 | 61.5 | 97.5 | | | | | | |
| R2GA04008△□◇ | 72 | 108 | 77 | 113 | | | | | | |
| R2GA06010△□◇ | 58.5 | 82.5 | 65.5 | 89.5 | 6 | 44.6 | 70 | 0<br>50-0.025 | 3 | 82 |
| R2GA06020△□◇ | 69.5 | 97.5 | 76.5 | 104.5 | | | | | | |

| Servo motor model number | LC | LZ | LR | S | Q | QE | LT | D1 | D2 | D3 |
|---|---|---|---|---|---|---|---|---|---|---|
| R2GA04003△□◇ | 40 | 2-φ 4.5 | 25 | 0<br>6-0.008 | 20 | — | — | 6 | 5 | 5 |
| R2GA04005△□◇ | | | | 0<br>8-0.009 | | | | | | |
| R2GA04008△□◇ | | | | | | | | | | |
| R2GA06010△□◇ | 60 | 4-φ 5.5 | 25 | 0<br>8-0.009 | 20 | — | — | | | |
| R2GA06020△□◇ | | | 30 | 0<br>14-0.011 | 25 | M5 | 12 | | | |

- ✔ If oil seal is required, whole motor length shall be changed.
- ✔ For motor without brake, no brake connector (or cable) attached.
- ✔ Contact us for the other motor spec above.

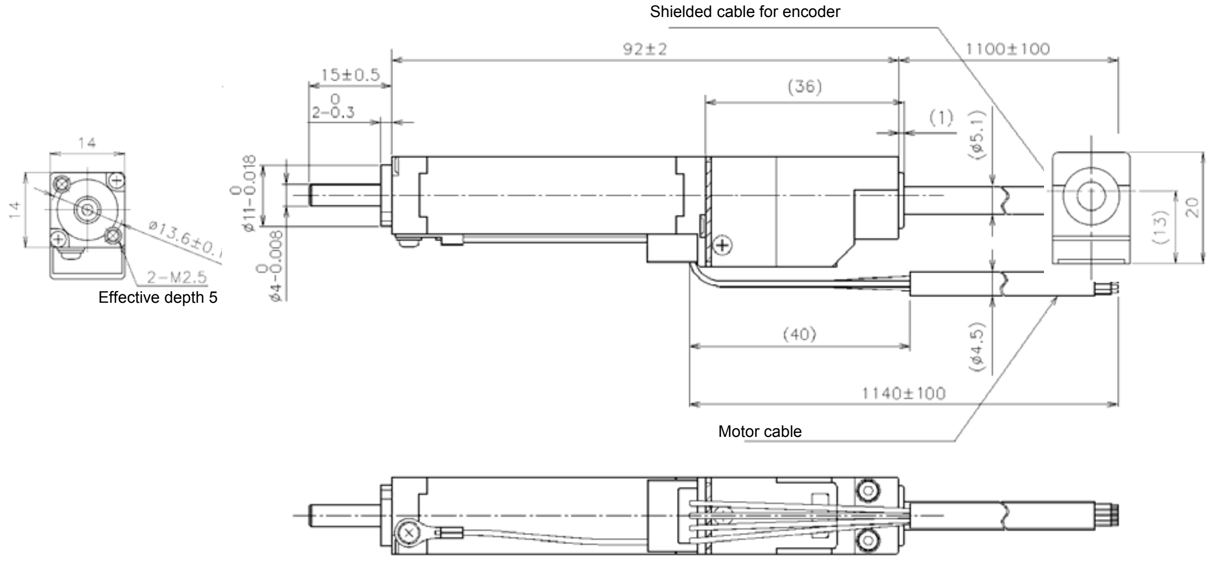
## 2) R2 motor, flange size 20mm



| | |
|---|---|
| | Without Oil Seal |
| | Absolute encoder for incremental system |
| | Without brake |
| Servo motor model number | LL |
| R2GA02D20△□◇ | 89 |
| R2GA02D30△□◇ | 108 |

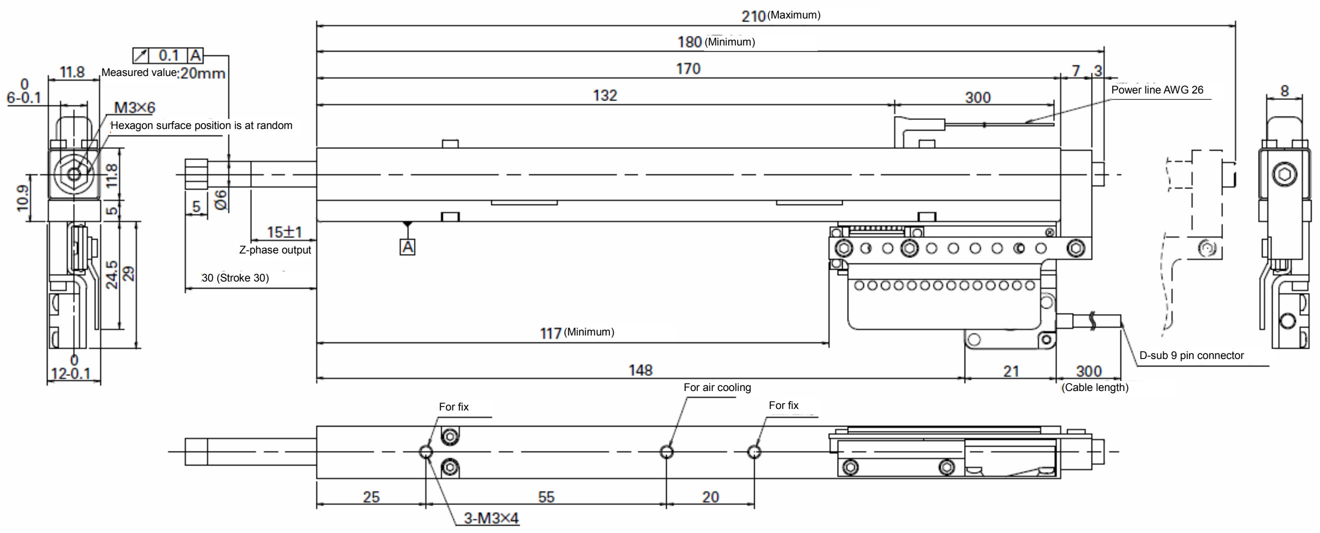
- ✔ Oil seal is not attached.
- ✔ It is the spec without a holding brake. The spec with a holding brake is unselectable.
- ✔ Sensor spec is only the absolute encoder for incremental system. Spec of battery backup method absolute encoder, battery-less encoder and pulse encoder is not selectable.

## 3) Flange size 14mm R2GAD102RM (DC48V)



- ✔ Oil seal is not attached.
- ✔ It is the spec without a holding brake. The spec with a holding brake is unselectable.
- ✔ Sensor spec is only the absolute encoder for incremental system. Spec of battery backup method absolute encoder, battery-less encoder and pulse encoder is not selectable.

### 4） Compact cylinder linear motor DE0AC001A03MX00 (DC48V)



## 13.4 Servo Motor Data Sheet

### 1） Characteristics table

■ R2 motor, DC48V input spec

| Servo motor model number R2GA | | | D102RM | 04003F | 04005F | 04008F | 06010F | 06020F |
|---|---|---|---|---|---|---|---|---|
| Combination servo amplifier capacity | | | RF2J14 | RF2J24<br>RF2K24 | RF2K24 | | | |
| *Rated output | $P_R$ | W | 2.4 | 30 | 50 | 80 | 100 | 200 |
| *Rated velocity | $N_R$ | min$^{-1}$ | 1000 | 3000 | 3000 | 3000 | 3000 | 3000 |
| *Maximum velocity | $N_{max}$ | min$^{-1}$ | 1500 | 6000 | 6000 | 5000 | 5000 | 4500 |
| *Rated torque | $T_R$ | N·m | 0.023 | 0.098 | 0.159 | 0.255 | 0.318 | 0.637 |
| *Continuous Torque at stall | $T_S$ | N·m | 0.023 | 0.108 | 0.167 | 0.255 | 0.353 | 0.637 |
| * Peak Torque at stall | $T_P$ | N·m | 0.06 | 0.24 | 0.54 | 0.86 | 0.84 | 1.5 |
| * Rated armature current | $I_R$ | Arms | 0.67 | 1.9 | 3.8 | 4.1 | 5.1 | 6.0 |
| * Armature current at stall | $I_S$ | Arms | 0.64 | 2.0 | 3.9 | 4.1 | 5.5 | 6.0 |
| * Peak armature current at stall | $I_P$ | Arms | 1.7 | 4.8 | 13.7 | 14.1 | 14.1 | 14.1 |
| Torque constant | $K_T$ | N·m/Arms | 0.042 | 0.0582 | 0.047 | 0.0693 | 0.0673 | 0.117 |
| Voltage constant for each phase | $K_{E\varphi}$ | mV/min$^{-1}$ | 1.47 | 2.03 | 1.64 | 2.42 | 2.35 | 4.07 |
| Phase resistance | $R_{\varphi}$ | Ω | 7.2 | 1.00 | 0.33 | 0.32 | 0.19 | 0.19 |
| * Rated power rate | $Q_R$ | W/s | 2.2 | 3.9 | 6.7 | 10 | 8.6 | 19 |
| Rotor inertia Note1) | $J_M$ | kg·m$^2$(GD$^2$/4)×10$^{-4}$ | 0.0023 | 0.0247 | 0.0376 | 0.0627 | 0.117 | 0.219 |
| Mass Note1) | WE | kg | 0.08 | 0.35 | 0.39 | 0.51 | 0.71 | 0.96 |
| Brake mass | W | kg | - | 0.27 | 0.27 | 0.27 | 0.34 | 0.39 |
| Aluminum plate | | mm | t6×250 | t6×250 | t6×250 | t6×250 | t6×250 | t6×250 |

Note1) Contains battery backup method absolute encoder.

✔ Constant in the table above is the value when motor is installed on heat releasing aluminum plate, indicates "thickness" x "length of a side of square".

✔ Items marked with * and Velocity-Torque Characteristics indicate values after temperature rise saturation. The others indicate values at 20°C.
Each value indicates TYP.

| Servo amplifier model number | | | | RF2J24, RF2K24 | |
|---|---|---|---|---|---|
| Servo amplifier model number | | | | R2GA02D20FXC<br><□20> | R2GA02D30FXC<br><□20> |
| Item | Condition | Code | Unit | | |
| Rated output | ★ | $P_R$ | W | 20 | 30 |
| Rated revolution velocity | ★ | $N_R$ | min$^{-1}$ | 3000 | 3000 |
| Maximum revolution velocity | ★ | $N_{max}$ | min$^{-1}$ | 6000 | 6000 |
| Rated torque | ★ | $T_R$ | N·m | 0.064 | 0.095 |
| Continuous stall torque | ★ | $T_S$ | N·m | 0.064 | 0.095 |
| Peak Torque at stall | ★ | $T_P$ | N·m | 0.23 | 0.38 |
| Rated armature current | ★ | $I_R$ | Arms | 1.8 | 2.6 |
| Armature current at stall | ★ | $I_S$ | Arms | 1.8 | 2.6 |
| Peak armature current at stall | ★ | $I_P$ | Arms | 6.0 | 9.6 |
| Torque constant | | $K_T$ | N·m/ Arms | 0.0458 | 0.0487 |
| Voltage constant per phase | | $K_{E\phi}$ | mV/ min$^{-1}$ | 1.6 | 1.7 |
| Phase resistance | | $R_\phi$ | Ω | 1.06 | 0.76 |
| Rates power rate | ★ | $Q_R$ | kW/s | 12.4 | 20 |
| Inertia moment note 1) | | $J_M$ | kg·m$^2$<br>(GD$^2$/4)×10$^{-4}$ | 0.0033 | 0.0046 |
| Mass note 1) | | WE | kg | 0.14 | 0.18 |
| Brake mass | | | | IP40 | IP40 |

Note 1) This value includes the absolute encoder.

- ✔ The above values show the figures with 20W motor mounted in t6x150mm and 30W motor mounted in t6x150mm-heat sink aluminum plate.
- ✔ Items marked with ★ and Velocity-Torque Characteristics indicate values after temperature rise saturation. The others indicate values at 20°C. Each value indicates TYP.
- ✔ The spec without holding brake. The spec with holding brake can not select.
- ✔ Sensor spec is only the absolute encoder for incremental system. It cannot select the spec of Battery Backup Method Absolute Encoder, Battery-less Absolute Encoder and Pulse encoder.

■ Compact cylinder linear motor (DC48V spec)

| | | | |
|---|---|---|---|
| Linear motor model number | | | DE0AC001A03MX00 |
| Combination servo amplifier capacity | | | RF2J24A8HL5 |
| ☆☆Rated output | Pr | W | 5.1 |
| ☆☆Rated force | Fr | N | 5.1 |
| ☆☆Continuous force at stall | Fs | N | 5.1 |
| Peak force | Fp | N | 16.5 |
| ☆☆Rated current | Ir | Arms | 0.6 |
| ☆☆Continuous current at stall | Ir | Arms | 0.6 |
| ☆☆Peak current | Ip | Arms | 2.0 |
| Rated velocity | vr | m/s | 1.0 |
| Maximum velocity | vp | m/s | 2.0 |
| Force constant | Kf | N/A | 8.8±10% |
| Inductive voltage constant | Keφ | V･m/s | 2.93±10% |
| Mover mass | Mc | g | 45±10% |
| ☆☆Motor constant | Km | N/√W | 1.5 |
| Phase resistance | Rφ | Ω | 8.3Ω±10% |
| Phase inductance | Lφ | mH | 0.75±20% |
| Mass | W | g | 185±10% |

✔ Mark "☆☆" indicates the value after temperature increase. The other values are the ones at 20℃. Each value is typical.

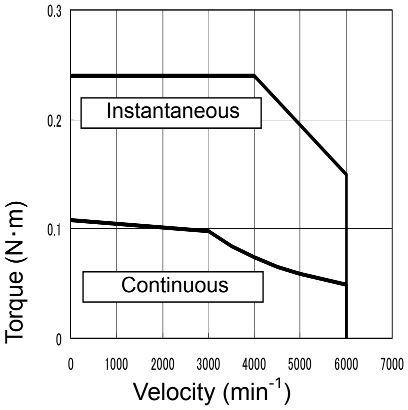
■ DE0AC001A03MX00 Linear encoder characteristics

| | | | |
|---|---|---|---|
| Signal cycle | P | μm | 4 |
| Resolution | S | μm | 1.0 |
| Maximum move velocity | V | m/s | 2.0 |
| Power voltage | - | DC V | 5±5% |
| Output circuit method | - | - | EIA RS422 differential driver |
| Operating temperature | - | ℃ | 0 to 70 |
| Z-phase channel signal width | Zw | μm | 20 |
| Forced excitation CSU | - | ° | 75<br>(Electrical angle at the position that mover is pulled out maximally.) |

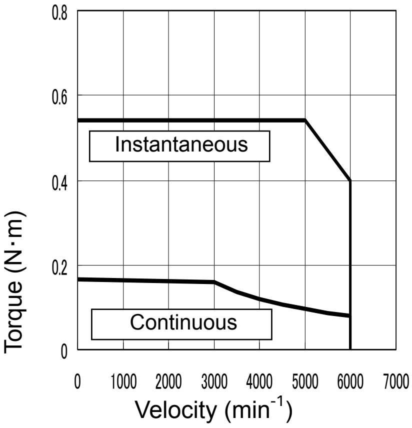
## 2） Velocity-torque characteristics

Velocity-torque characteristic of R2GA servo motor shows the value when input power is DC48V. When power voltage drops, impedance on power input line is high, or cable between amplifier and servo motor is relatively long, high-velocity revolution in momentary range shall decrease, so please consider sufficient margins for these values when selecting servo motor.

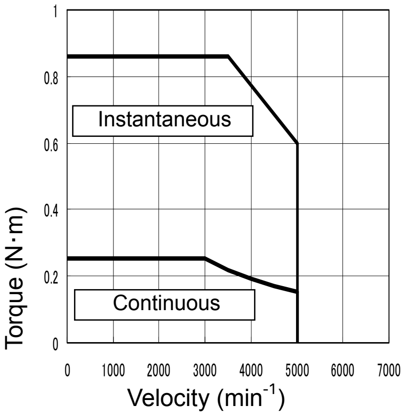
R2GA04003F



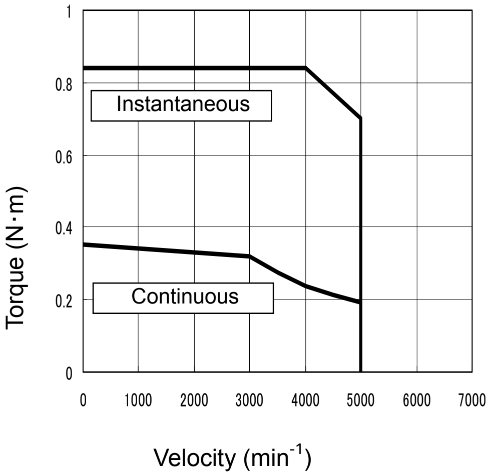
R2GA04005F



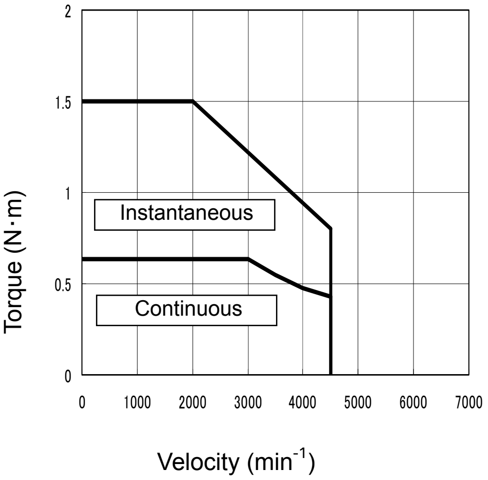
R2GA04008D



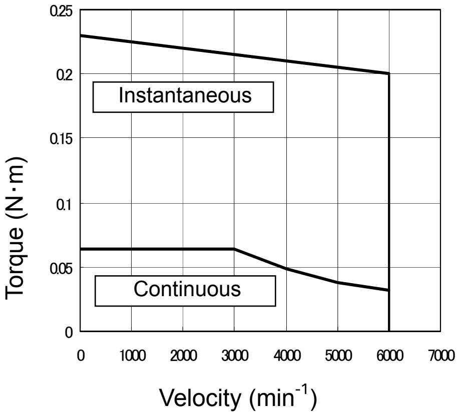
R2GA06010D



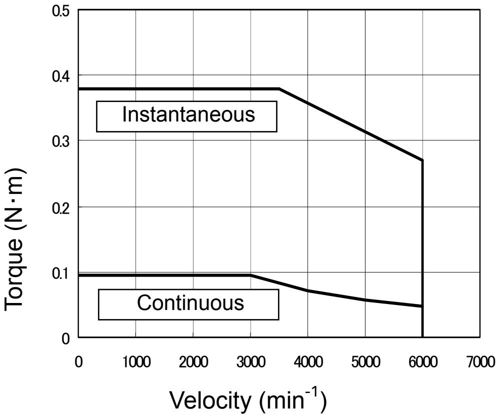
R2GA06020D



R2GA02D20F

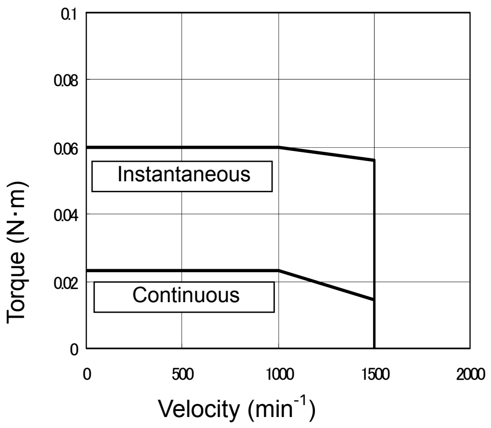


R2GA02D30F

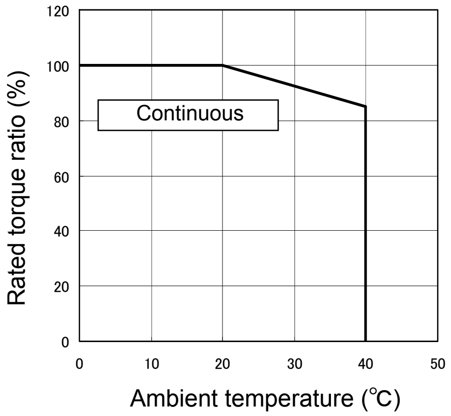


### 3） R2GAD102RM velocity-torque characteristics

R2GAD102RM



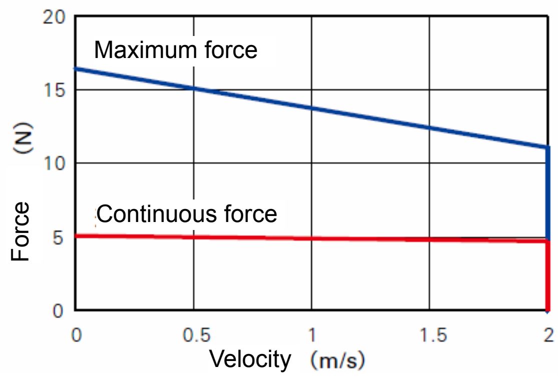
R2GAD102RM
Rated torque－ambient temperature characteristic



### 4） DE0AC001A03MX00 velocity－force characteristic

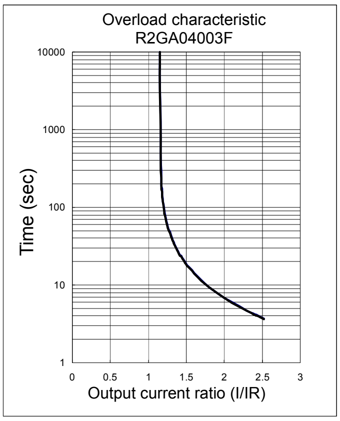
Velocity-force characteristic of DS linear motor shows the value when input power is DC48V. When power voltage drops less than 48V, instantaneous area will decrease.

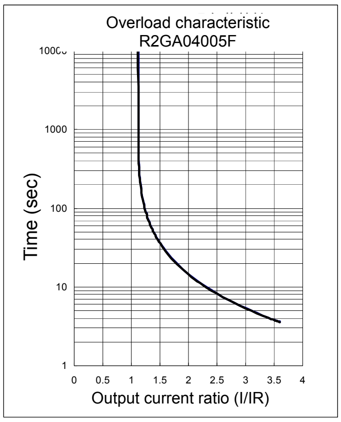
Velocity－force characteristic
DE0AC001A03MX00

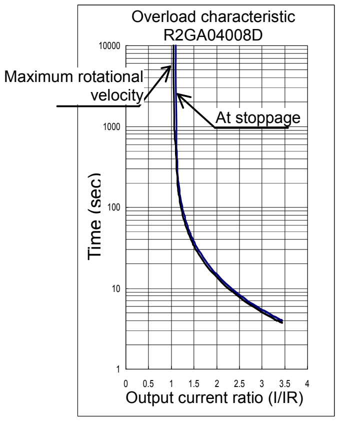


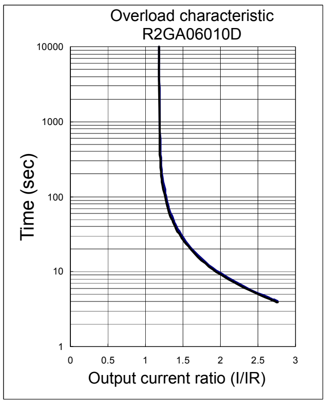
## 5） Overload characteristics

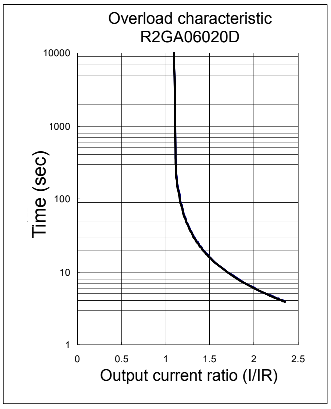
R2GA Motor overload characteristics are indicated below.

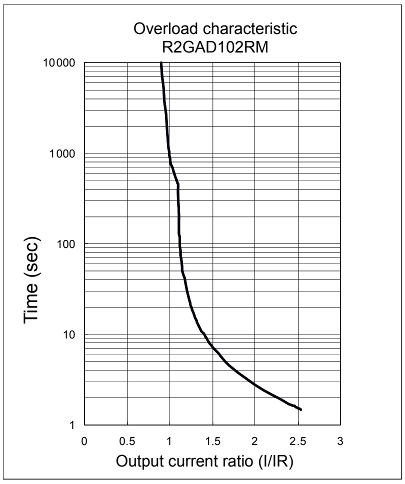

Overload characteristic
R2GA04003F

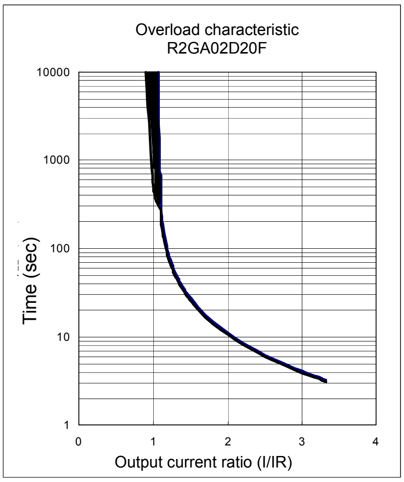

Overload characteristic
R2GA04005F

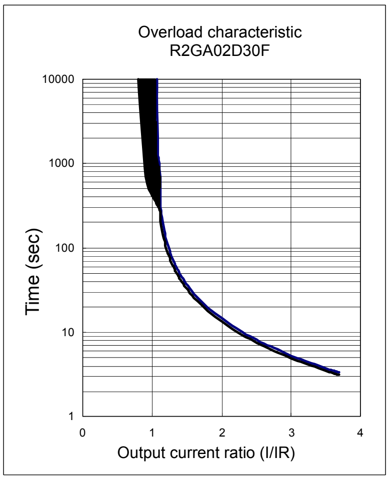

Overload characteristic
R2GA04008D


Overload characteristic
R2GA06010D


Overload characteristic
R2GA06020D

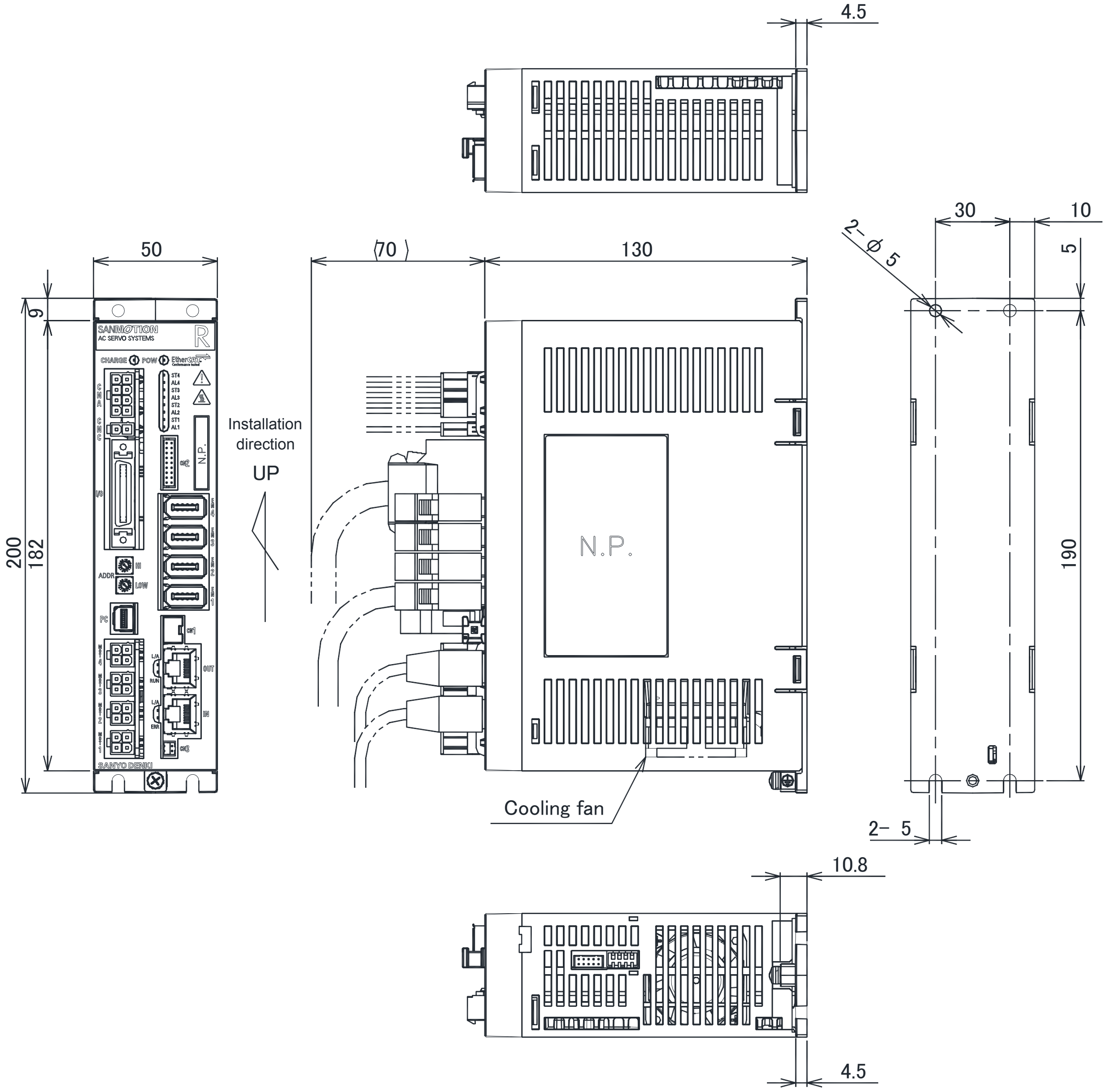

Overload characteristic
R2GAD102RM


Overload characteristic
R2GA02D20F


Overload characteristic
R2GA02D30F

## 13.5 Outline drawing of servo amplifier

### ■ RF2□□□A□HL□

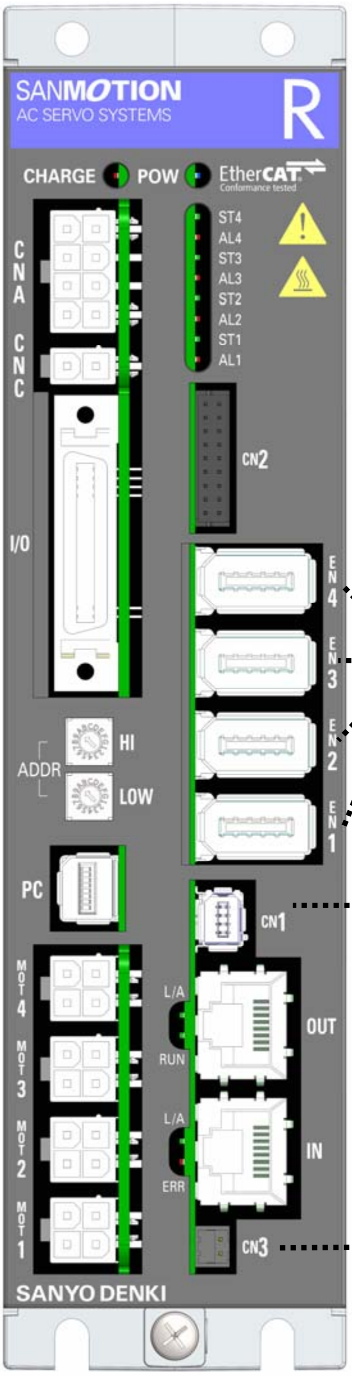


## 13.6 Optional items

### 1） Connector arrangement drawing

Optional items prepared in our company are shown below.

■RF2##A#HL5



Fixing bracket for side surface of servo amplifier
Connector set for interface
Connector set for power supply and motor
・Cable

For inputting control/main circuit power supply
・Connector
・Cable

For connecting regenerative resistor
・Connector
・Cable

For general I/O
・Connector

For MOTOR setup
・Cable

For servo motor
・Connector
・Cable

For encoder signal
・Connector

For Safe Torque Off
・Connector
・Mask connector

For encoder battery
・Battery box

## 2） Connector set model number

■ Our model number for connecter as single item

| Connector number | Contents | Our model number | Manufacturer model number | Quantity | Manufacturer name |
|---|---|---|---|---|---|
| IN, OUT | Ethernet For host unit connection | Not provided by our company.<br>Please use shielded type modular plug (RJ-45) corresponding to the CAT5e standard. | | | |
| CN A | For power supply | AL-00922656 | 5557-08R_NATURAL x 1 pcs<br>5556TL x 8pcs （Note1） | 1 | MOLEX |
| CN C | For regenerative resistor connection | AL-00922658 | 5557-02R_NATURAL x 1 pcs<br>5556TL x 2pcs（Note1） | 1 | MOLEX |
| MOT1 to 4 | For servo motor connection, single axis | AL-00922660 | 5557-04R_NATURAL x 1 pcs<br>5556TL x 4 pcs（Note1） | 1 | MOLEX |
| EN1 to 4 | For encoder connection, single axis | AL-00632607 | 36210-0100PL x 1 pcs<br>36310-3200-008 x 1 pcs | 1 | Sumitomo 3M Ltd. |
| I/O | For general I/O signal | AL-00922662 | 10136-3000PE x 1 pcs<br>10336-52A-008 x 1 pcs | 1 | Sumitomo 3M Ltd. |
| CN1 | For safety device connection | AL-00718252-01 | 2013595-3 | 1 | Tyco Electronics AMP K.K. |
| CN1 | Safety device short plug | AL-00849548-02 | 1971153-2 | 1 | Tyco Electronics AMP K.K. |

■ Our model number for connecter set

| Set connector | Contents | Our model number |
|---|---|---|
| CN A, CN C, MOT1 to 4 | The set including Power supply input connector x1pcs, Regenerative resistor connector x1pcs, Motor connector x 4pcs, Contact x 26pcs. Note 1) | AL-00922664 |
| EN1 to 4, CN1, I/O | The set including Encoder connector x 4pcs, Connector for safety x1pcs, General I/O connector x1pcs. | AL-00922666 |

Note 1) For 5556TL contact, dedicated crimp tool below is required.
For automatic crimping, contact to the connector manufacturer.

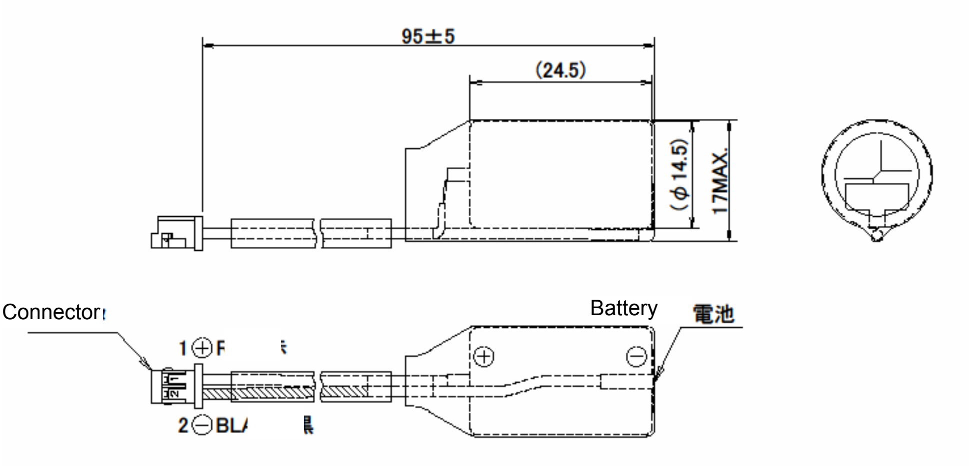
| Crimp tool | Model number | Applicable wire size | Manufacturer |
|---|---|---|---|
| Part No. | 63819-0900 | AWG16 to AWG24 | MOLEX |

■ Our model number for one side finished cable

| Set connector | Contents | Our model number | Remarks |
|---|---|---|---|
| For CN A | Power supply input cable (Amplifier side connector has assembled) | AL-00921367-01 | Cable length 2m, Qty 1 |
| For CN C | Regenerative resistor connection cable (Amplifier side connector has assembled) | AL-00921368-01 | Cable length 2m, Qty 1 |
| For MOT1 to 4 | Motor power cable (Amplifier side connector has assembled) | AL-00921369-01 | Cable length 3m, Qty 1 |
| | | AL-00921369-02 | Cable length 5m, Qty 1 |
| | | AL-00921369-03 | Cable length 10m, Qty 1 |
| For EN1 to 4 | Serial encoder cable (Amplifier side connector has assembled) | AL-00921370-01 | Cable length 3m, Qty 1 |
| | | AL-00921370-02 | Cable length 5m, Qty 1 |
| | | AL-00921370-03 | Cable length 10m, Qty 1 |

### 3） Related items of battery for battery backup method absolute encoder

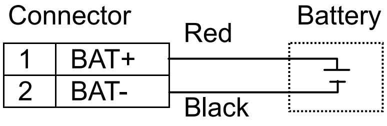
Battery body for battery box (Model No.: AL-00879511-01)



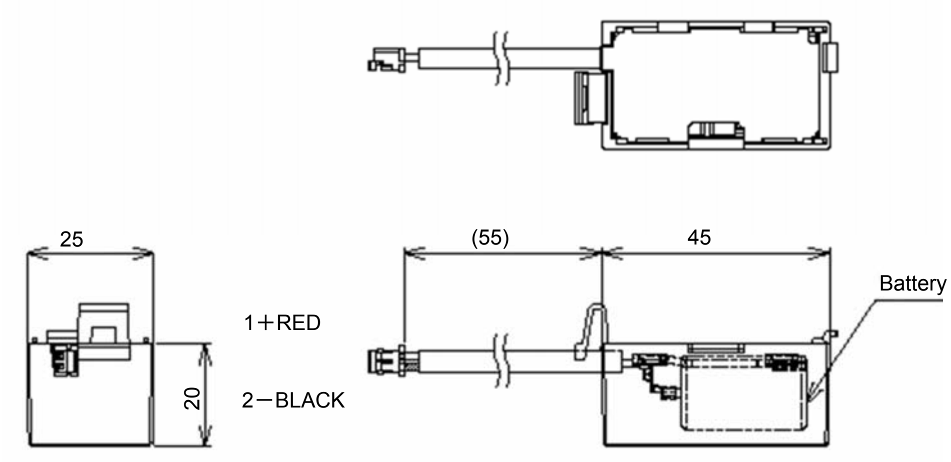
1. Battery and connector specifications

| | |
|---|---|
| Lithium battery | Thionyl Chloride Lithium Battery<br>ER3VLY (Toshiba Lifestyle Products & Services Corporation)<br>Nominal Voltage: 3.6V<br>Nominal Capacity: 1000mAh<br>Lithium metal mass as standard: 0.31g |
| Connector | DF3-2S-2C; Socket Housing (HIROSE)<br>DF3-2428SCFC; Contact (HIROSE) |

2. Wiring diagram

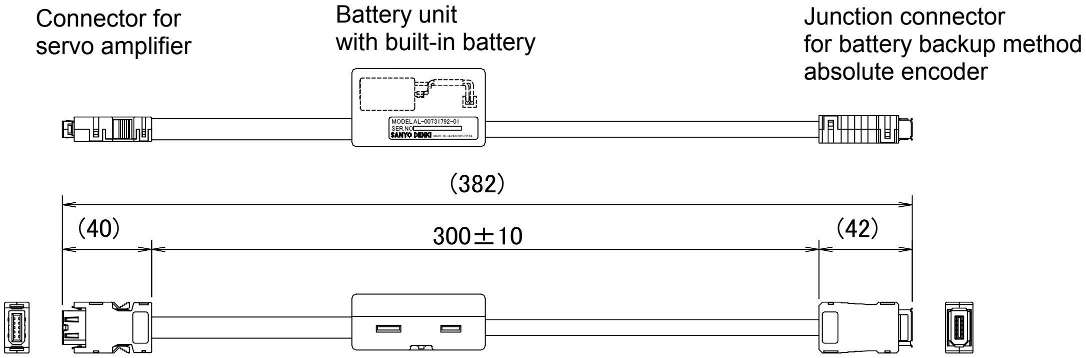


Battery BOX (Model No.:AL-00880402-01)



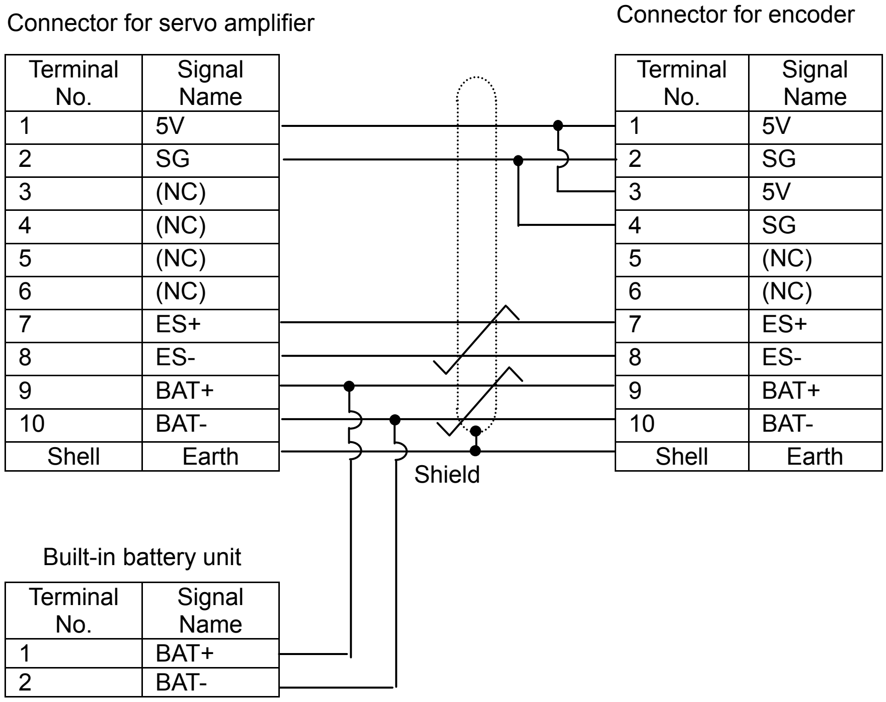
See "9.8 Replacing battery for motor encoder" for how to replace battery box.

- ■ Battery trunk cable with both side connectors (Model number: AL-00731792-01)



1. Spec: Trunk cable for encoder with the both side connectors and the battery unit

2. Wiring spec



Connector for 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 |

Connector for 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 |

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)<br>36310-3200-008; Shell Kit (3M) |
| Connector for encoder | 36110-3000FD; Wiremount Plug (3M)<br>36310-F200-008; Shell Kit (3M) |
| Battery unit | Built-in battery; ER3VLY<br>(Toshiba Lifestyle Products & Services Corporation)<br>Nominal Voltage: 3.6V<br>Nominal Capacity: 1000mAh<br>Lithium-metal mass: 0.31g |

4. Battery model number for replacement: AL-00697958-01
As note, model number of replacement battery differs with for battery box and for trunk cable.

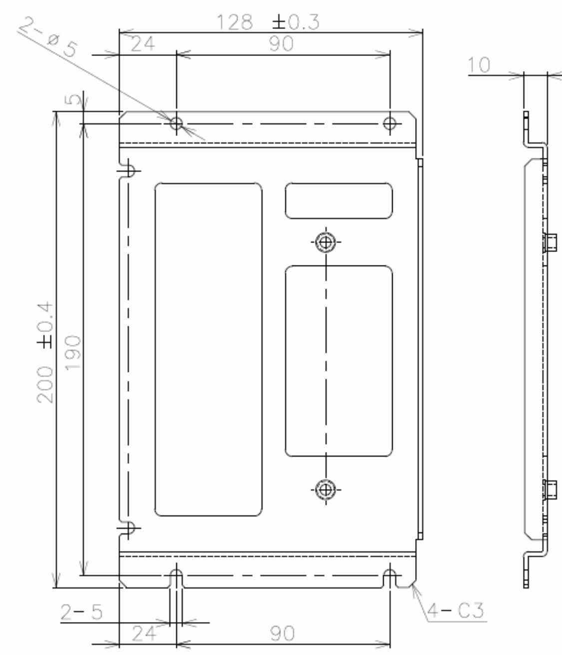
## 4） Fixing bracket for side surface

Fixing bracket for side surface is prepared for RF2 servo amplifier.

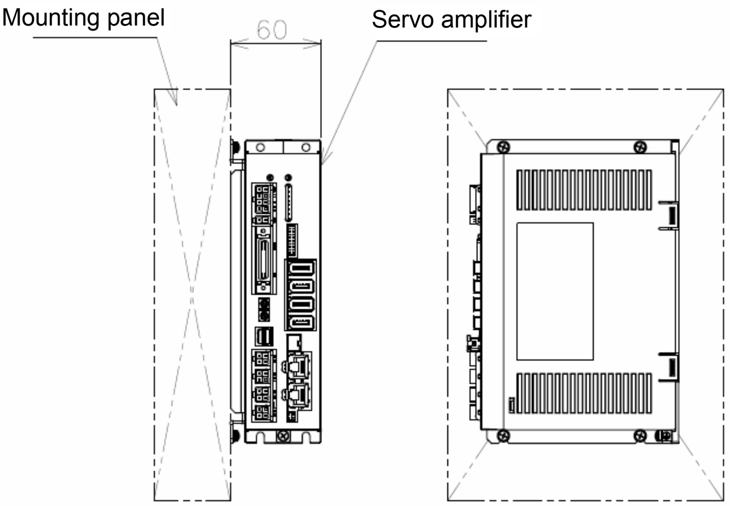
■ Fixing bracket list for side surface of RF2

| Position of fixing bracket | Model number | Contents |
|---|---|---|
| Side surface | AL-00921371-01 | Includes a bracket and M4 screw (qty 4) for bracket mount |

These fixing brackets are processed trivalent chromium plating.
(Surface color: blue-silver/ different from body color.)



Fixing bracket outer dimension (Unit: mm)

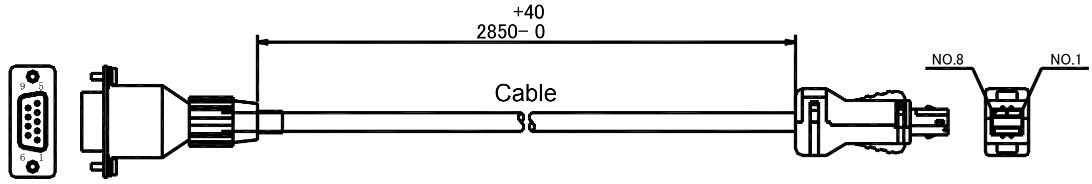


Mounting image (Unit: mm)

## 5） Related items for MOTOR setup software and serial communication

| Connector number | Name | Contents | Quantity | Our model number |
|---|---|---|---|---|
| PC | PC communication cable | Connection cable between PC and servo amplifier | 1 | AL-00689703-01 |

PC communication cable outline drawing (Model number: AL-00689703-01)

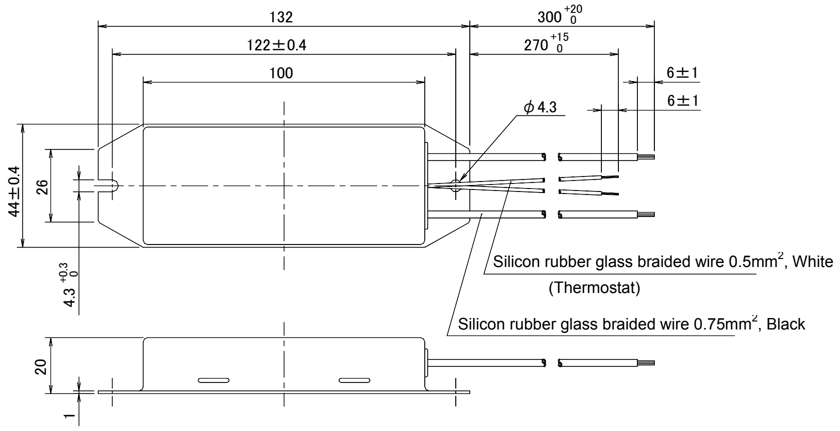


## 6） External regenerative resistor

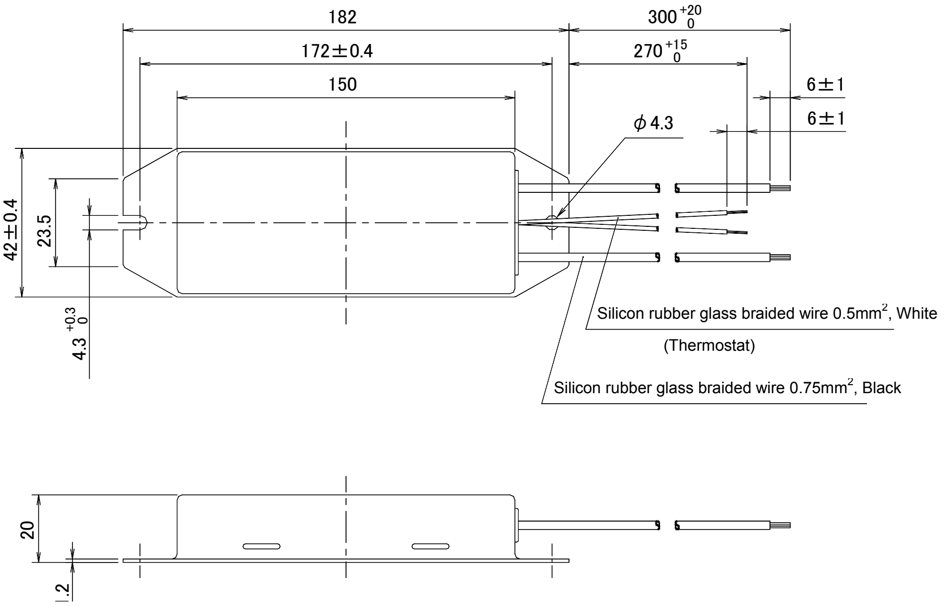
| Resistor Model Number | Rated power [PR] | Resistance value | Thermostat Detection temperature (Contact specification) | Mass |
|---|---|---|---|---|
| REGIST-080W50B | 80W | 50Ω | 135℃±7℃<br>(b contact) | 0.19kg |
| REGIST-120W50B | 120W | 50Ω | | 0.24kg |
| REGIST-220W20B | 220W | 20Ω | | 0.44kg |

# 13.7 Outline drawing of regenerative resistor

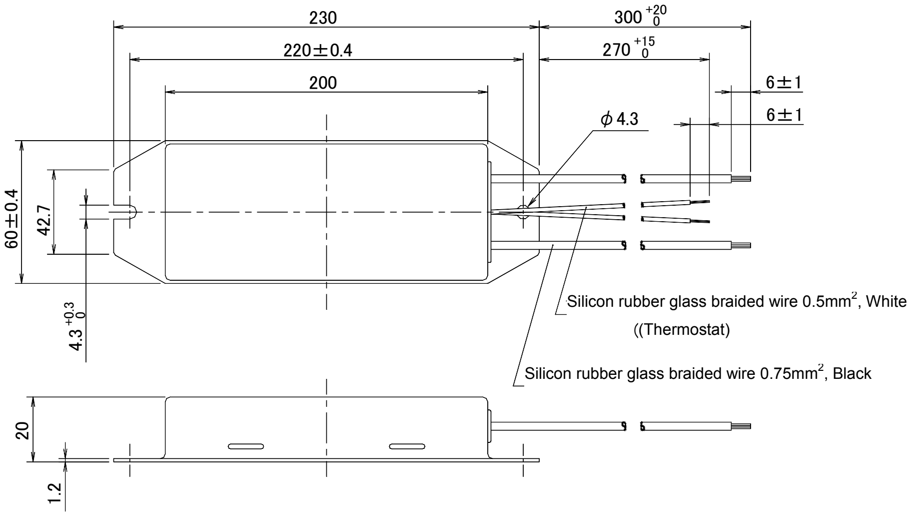
- REGIST-080W



- REGIST-120W



- REGIST-220W



M0011195B Annex 1
Revision.1.00
Sep. 2015

# R ADVENCED MODEL EtherCAT interface amplifier (RF2 type H)
# Combination motor code list

Indicates list of servo motor which is able to set Object Index: 0x20FE.
Gray colored cell is standard combination motor.

■Rotary motor (48V)

| Series | Motor code | Motor model number | Input type | Amplifier capacity | Flange size | Output | Maximum speed |
|---|---|---|---|---|---|---|---|
| R2 Series | 0x0261 | R2GA04003F | DC48V | 40A | 40mm sq. | 30W | 6,000 min$^{-1}$ |
| | 0x0262 | R2GA04005F | DC48V | 40A | 40mm sq. | 50W | 6,000 min$^{-1}$ |
| | 0x0263 | R2GA04008D | DC48V | 40A | 40mm sq. | 80W | 5,000 min$^{-1}$ |
| | 0x0264 | R2GA06010D | DC48V | 40A | 60mm sq. | 100W | 5,000 min$^{-1}$ |
| | 0x0265 | R2GA06020D | DC48V | 40A | 60mm sq. | 200W | 4,500 min$^{-1}$ |
| | 0x040C | R2GAD102RM | DC48V | 25A | 14mm sq. | 2.4W | 1,500 min$^{-1}$ |
| | 0x049B | R2GA02D20F | DC48V | 40A | 20mm sq. | 20W | 6,000 min$^{-1}$ |
| | 0x0497 | R2GA02D30F | DC48V | 40A | 20mm sq. | 30W | 6,000 min$^{-1}$ |

■Linear motor

| Series | Motor code | Motor model number | Input type | Amplifier capacity | Width | Output | Maximum speed |
|---|---|---|---|---|---|---|---|
| DE Series | 0x435A | DE0AC0001M | DC48V | 40A | 30mm | 5.1N | 2.0m/s |

| | |
|---|---|
| Release | |
| Revision A | Jun. 2015 |
| Revision B | Sep. 2015 |

■ECO PRODUCTS

Sanyo Denki's ECO PRODUCTS are designed with the concept of lessening impact on the environment in the process from product development to waste. The product units and packaging materials are designed for reduced environmental impact.

We have established our own assessment criteria on the environmental impacts applicable to all processes, ranging from design to manufacture.

■Precautions For Adoption

Failure to follow the precautions on the right may cause moderate injury and property damage, or in some circumstances, could lead to a serious accident.

Always follow all listed precautions.

### ⚠ Cautions

- Read the accompanying Instruction Manual carefully prior to using the product.
- If applying to medical devices and other equipment affecting people's lives please contact us beforehand and take appropriate safety measures.
- If applying to equipment that can have significant effects on society and the general public, please contact us beforehand.
- Do not use this product in an environment where vibration is present, such as in a moving vehicle or shipping vessel.
- Do not perform any retrofitting, re-engineering, or modification to this equipment.
- The Products presented in this Instruction Manual are meant to be used for general industrial applications. If using for special applications related to aviation and space, nuclear power, electric power, submarine repeaters, etc., please contact us beforehand.

* For any question or inquiry regarding the above, contact our Sales Department.

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Translated version of the original instructions