

**SANMOTION**

**AC SERVO SYSTEMS**

**R** ***ADVANCED  
MODEL***

**TYPE S**

With Ether**CAT**<sup>®</sup>  Interface Type H

**For Rotary Motor, Linear Motor**

**Instruction Manual**

**SANYO DENKI**



## Details of revision history

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### The sixth edition (K)

- Overall
  - R1GA04005F, R1GA04010F and R1GA06020D are added to rotary motor list.
  - DE0BC005A05CX00 is added to linear motor list.
  - Encoder names are unified.
  - Linear motor installation part is reviewed.
  
- p. 1-13
  - Note below is added.
    - ✓ Refer the section 13.5 for DE series motor.
  
- p. 1-19 to 1-21,
  - Motor model numbers and outline drawings are corrected.
  
- p. 2-1
  - Words are changed as follows: Insulation classification → Heat resistant class.
  - Words are changed as follows: Weight → Mass.
  
- p. 4-10
  - Note below is added.
    - ✓ Surge occurs if cutting the DC main power by relay or something. So, must adding the surge measure like a surge absorber circuit or cutting power line at AC side, not at DC side.
  
- p. 7-103
  - Initial values of 0x2024 and 0x2025 are corrected to 0x012C from 0x01C2.
  
- p. 7-133
  - Automatic setting example for connecting R2GA04003F and optic type asynchronous 2.5Mhz 17bits resolution encoder is added.
  
- p. 8-20
  - Sequence drawing is corrected, and Note is added.
  
- p. 11-23
  - Alarm reset methods for battery-less absolute encoder with alarm code A5 and A6 are corrected.
  
- p. 13-13
  - 13.5 Cylinder type linear servo motor (DE series) is added.
  
- p. 16-1
  - Standards conformity table is updated.
  
- p. 16-5
  - Section 3) Ground fault test is added.
  
- p. 16-18
  - Model number is corrected to DE0AC001A03CX00 from DE0AC001A03MX00.
  - Outline drawing is changed.
  
- p. 16-32
  - Model numbers are corrected.
  - Small cylinder linear motor mass is changed to 192 from 185.
  - Linear encoder characteristics are updated.
  
- p. 16-33
  - Graph for velocity-torque characteristic of R1AA10100F (1kW) is corrected.
  
- p. 16-46
  - Model number is corrected to DE0AC001A03 from DE0AC001A03MX00.

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

■ Warning Symbol

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

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

■ Prohibited, Mandatory Symbols

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

## ■ 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

 <b>Prohibited</b>
<ul style="list-style-type: none"><li>◆ 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.</li><li>◆ 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.</li></ul>

 <b>Mandatory</b>
<ul style="list-style-type: none"><li>◆ 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.</li><li>◆ 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.</li><li>◆ 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.</li></ul>

■ Transportation

 <b>Caution</b>
<ul style="list-style-type: none"><li>◆ 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.</li><li>◆ Keep in mind that it is dangerous at the time of conveyance if it falls and overturns. Bodily injury could otherwise result.</li></ul>

 <b>Mandatory</b>
<ul style="list-style-type: none"><li>◆ Follow the directions written on the outside box. Excess stacking could result in collapse. Bodily injury could otherwise result.</li><li>◆ 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.</li></ul>

## ■ 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 be 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 and relays) 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

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## 1.1 Introduction

The AC Servo amplifier SANMOTION R ADVANCED MODEL is a consolidated power supply, single-shaft type servo amplifier consisting of eight (8) models according to capacity.

The servomotor corresponds to the Rotary Motor R series, Q-series over-2kW model, linear motor DS-series, DD-series, DT series and DE series.

For motor encoder, rotary motor can use absolute encoder and incremental encoder, linear motor can use incremental encoder. Furthermore, this system also corresponds to external incremental encoder for fully closed control system. Backup batteries for motor encoder can be supplied via servo amplifier connector and installed in encoder cable.

Moreover, the connectors for EtherCAT communication, PC connection, encoder and monitor are equipped.

### 1) SANMOTION R ADVANCED MODEL features (Differences from SANMOTION R)

#### ■ Reduced size

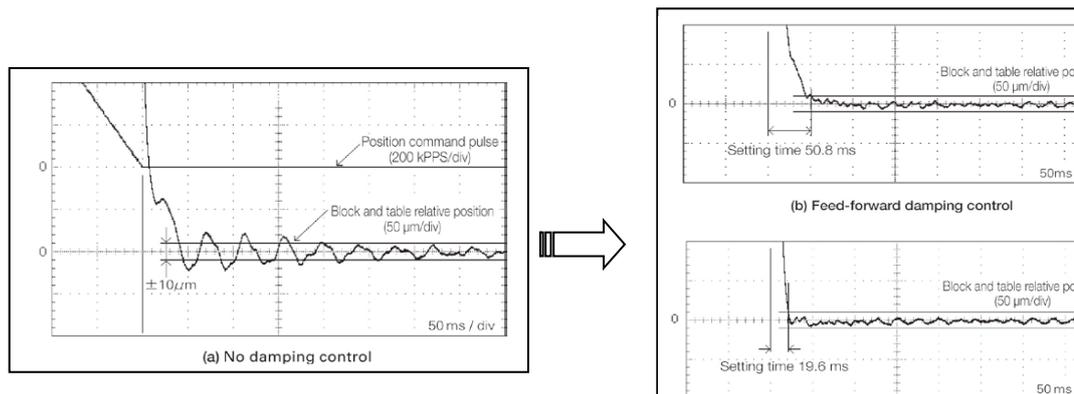
The integrated power connector uses a smaller connector for the motor encoder.

In addition, we intend to reduce the cubic volume by a maximum of 15% by miniaturizing the power circuit and save 19% of energy by adopting a new generation IPM.

#### ■ Increased response time (High response speed control position)

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.



#### ■ Noise reduction

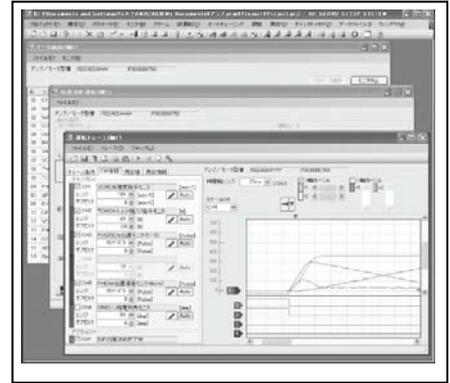
Using “model following vibration control” and “feed forward vibration control” the entire machinery system vibration is suppressed with an added bonus of cutbacks in energy expenditure.

#### ■ Improved positioning resolution

The motor encoder resolution ability has increased and as a result positioning resolution has improved which increases the processing accuracy of your equipment.

■ Improved Software Setup functions

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.

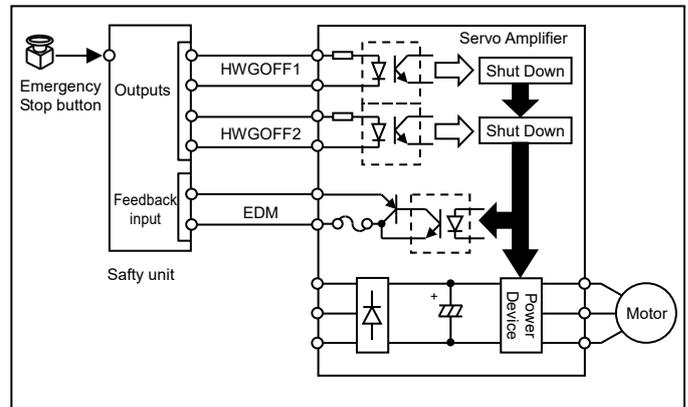


■ Alarm display function

With the addition of “status display function at the time of alarm” and “time-stamp function of alarm history” diagnosing the specific cause of an alarm has become easier, improving maintenance.

■ 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.



## 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 EtherCAT Interface  
Explanation of EtherCAT Interface Overview
- Chapter 6 EtherCAT Datalink  
Explanation of EtherCAT Slave Controller (ESC)
- Chapter 7 Object Dictionary  
Explanation of EtherCAT Interface Object Dictionary
- Chapter 8 Operations  
Discussion of operation sequence, test operations and parameters
- Chapter 9 Adjustments  
Explanation of auto tuning, manual servo tuning, etc.
- Chapter 10 Digital Operator  
Explanation of the LED display and the digital operator
- Chapter 11 Maintenance  
Explanation of troubleshooting when alarms occur and inspection
- Chapter 12 Full-closed Control  
Explanation of full-closed control and how to use it
- Chapter 13 Linear motor  
Explanation of how to use when linear motor connected.
- Chapter 14 Safe Torque Off function  
Explanation of safe torque off function and how to use it
- Chapter 15 Selection  
Explanation of selection method for the servo motor as well as regenerative resistance capacity
- Chapter 16 Appendix (Materials)  
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.

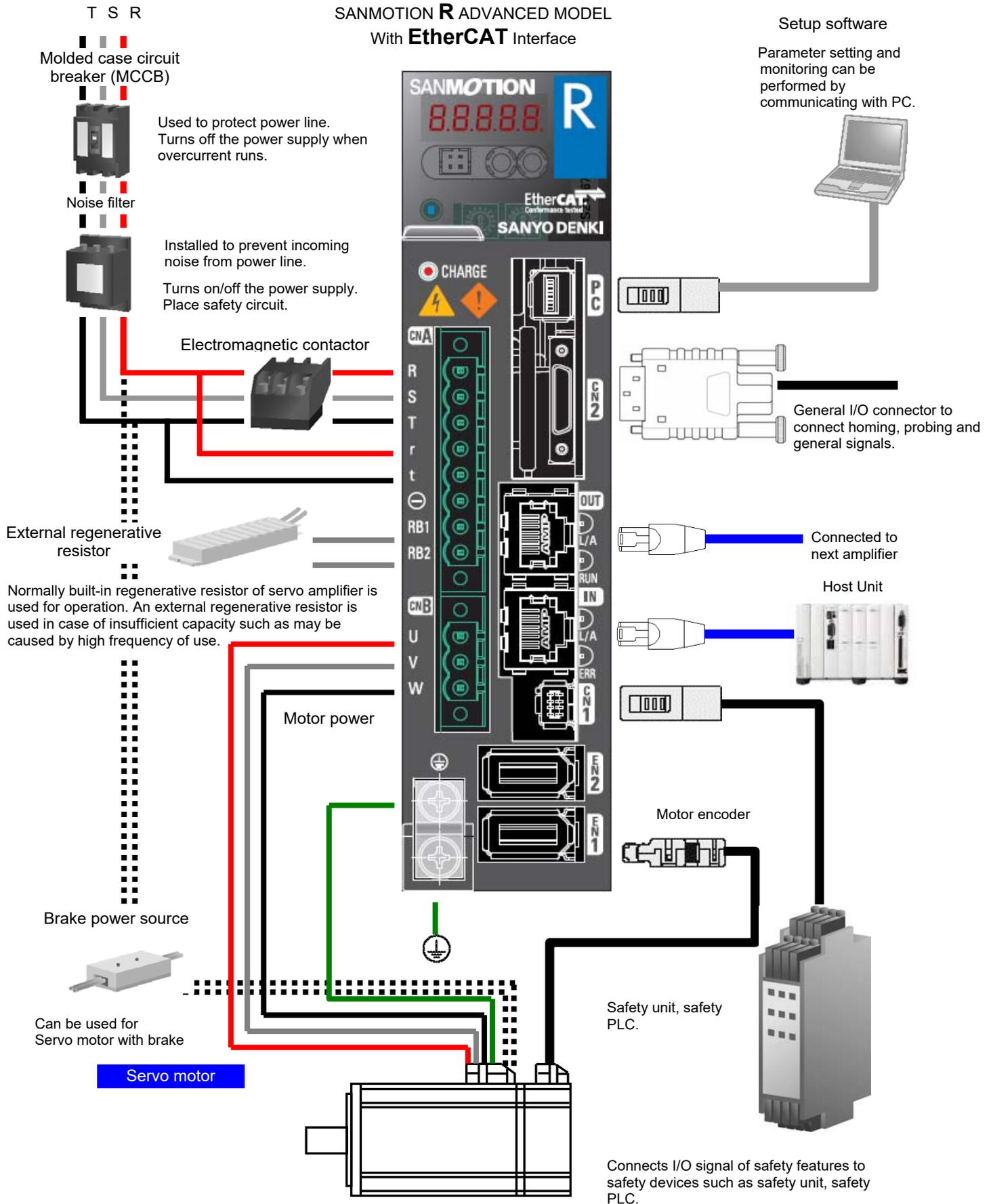
The contents of this manual may be modified without prior notice as revisions or additions are created regarding the usage method of the product. Modifications are performed as per the revisions of this manual

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.

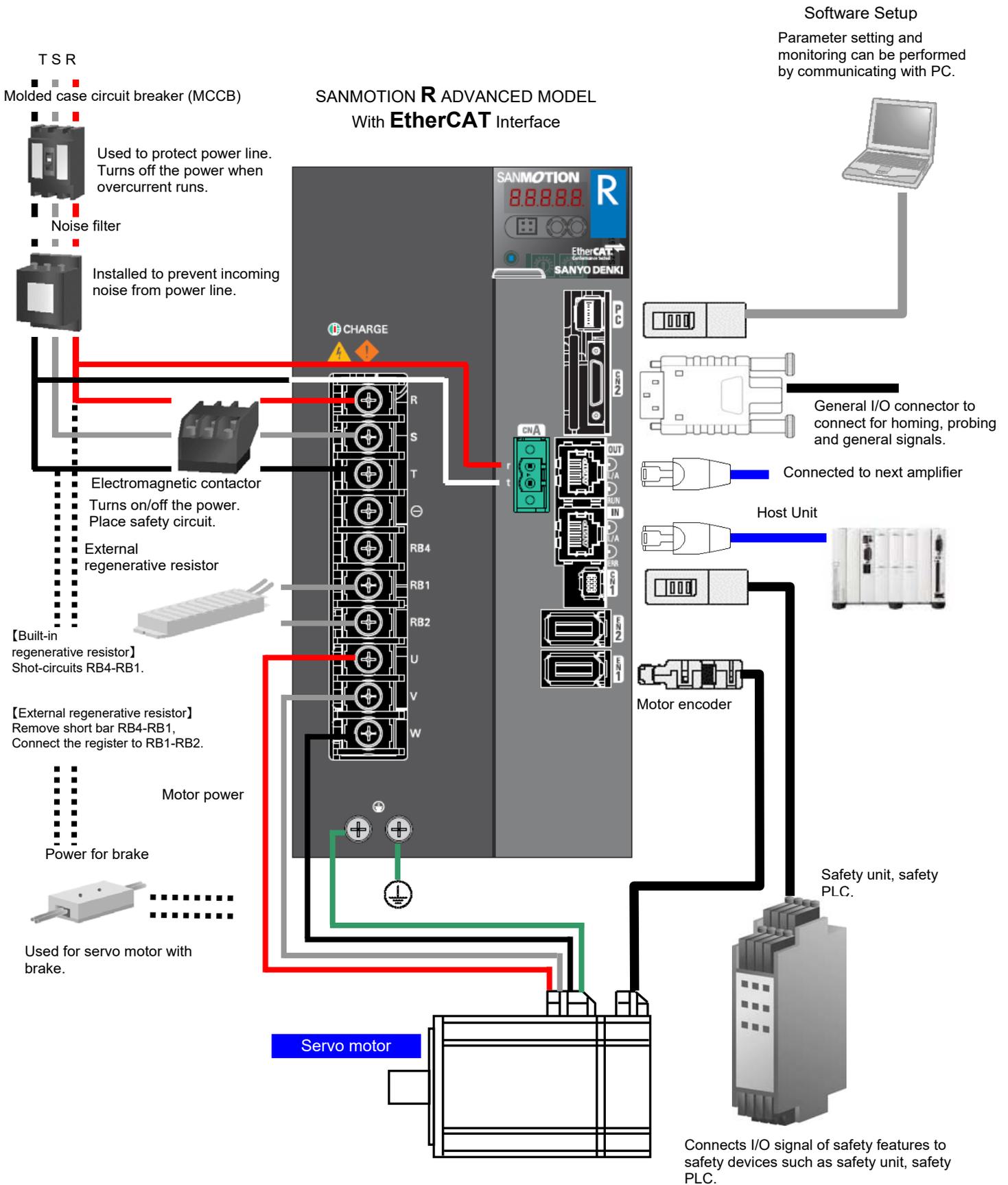
Original text of this instruction manual is Japanese. Original text writing has priority if there is difference between original text and the other language writing.

# 1.3 System Configuration

■ RS2□01A/RS2□03A/ RS2□05A (Rotary motor)

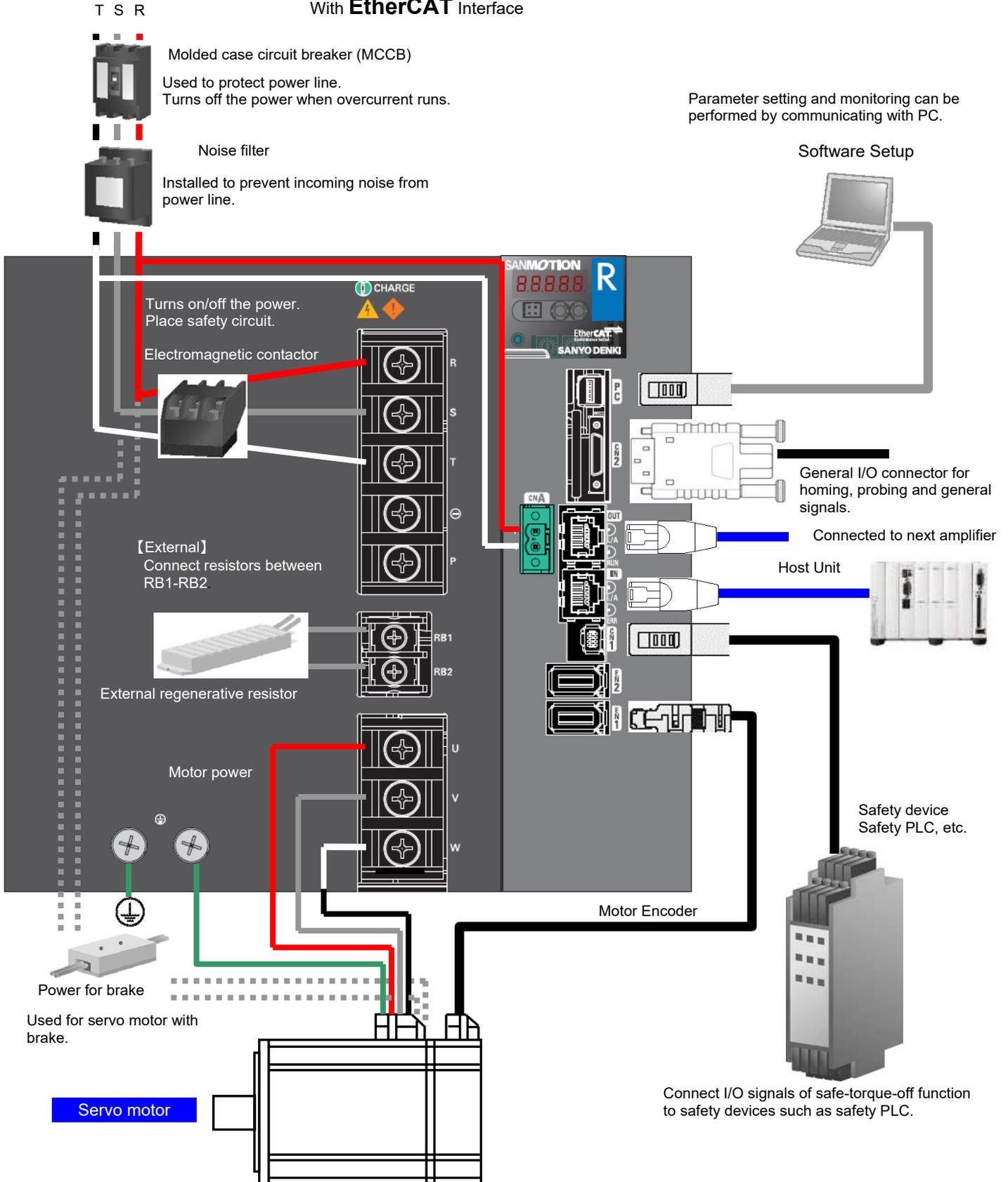


■RS2□10A/RS2□15A (Rotary motor)



■RS2□30A (Rotary motor)

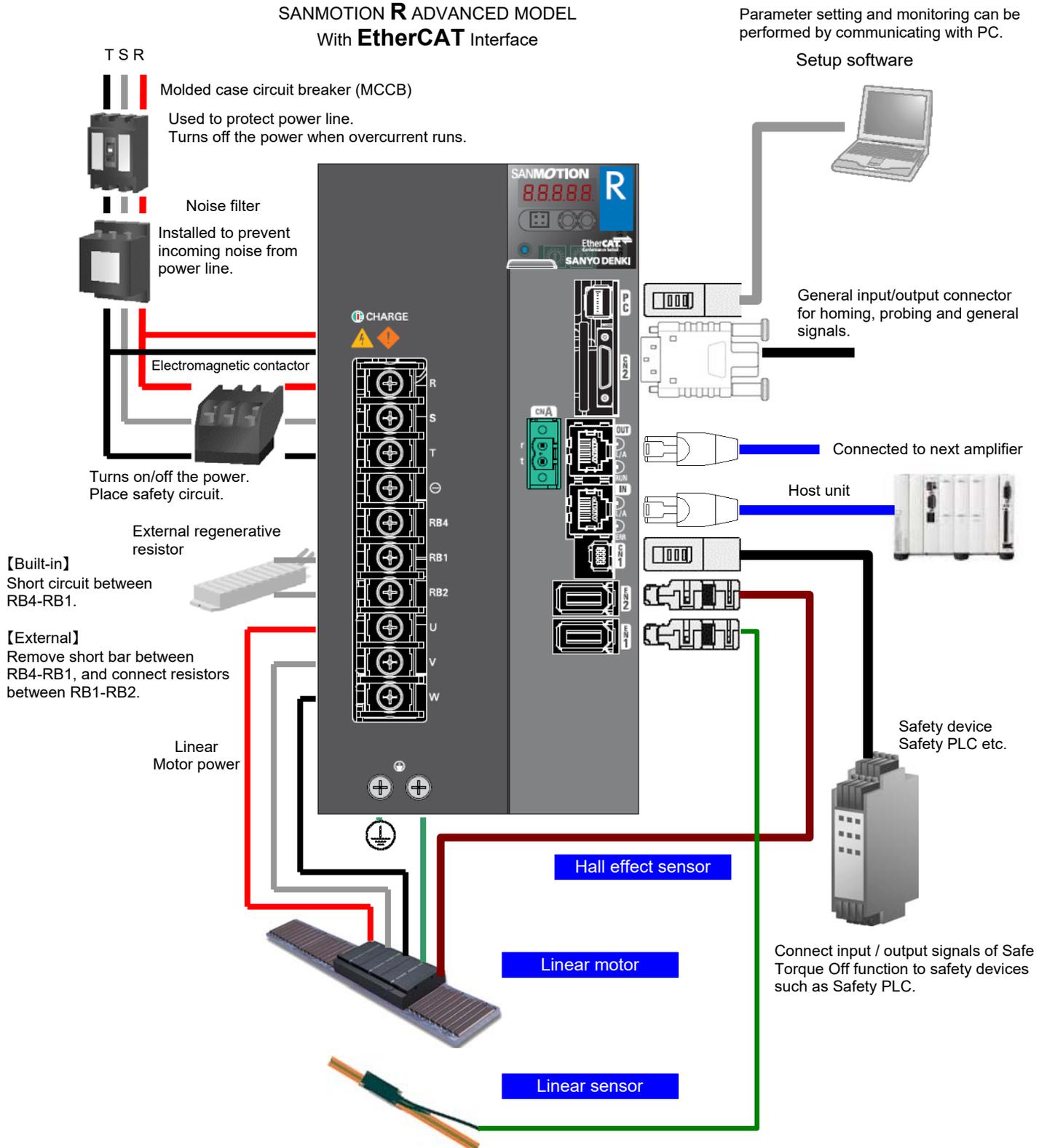
SANMOTION R ADVANCED MODEL  
With **EtherCAT** Interface



■RS2□##A (Linear motor)

This system configuration is for RS2□10A.

Refer to section 13 Linear motor, system configuration diagram for the other system configuration.

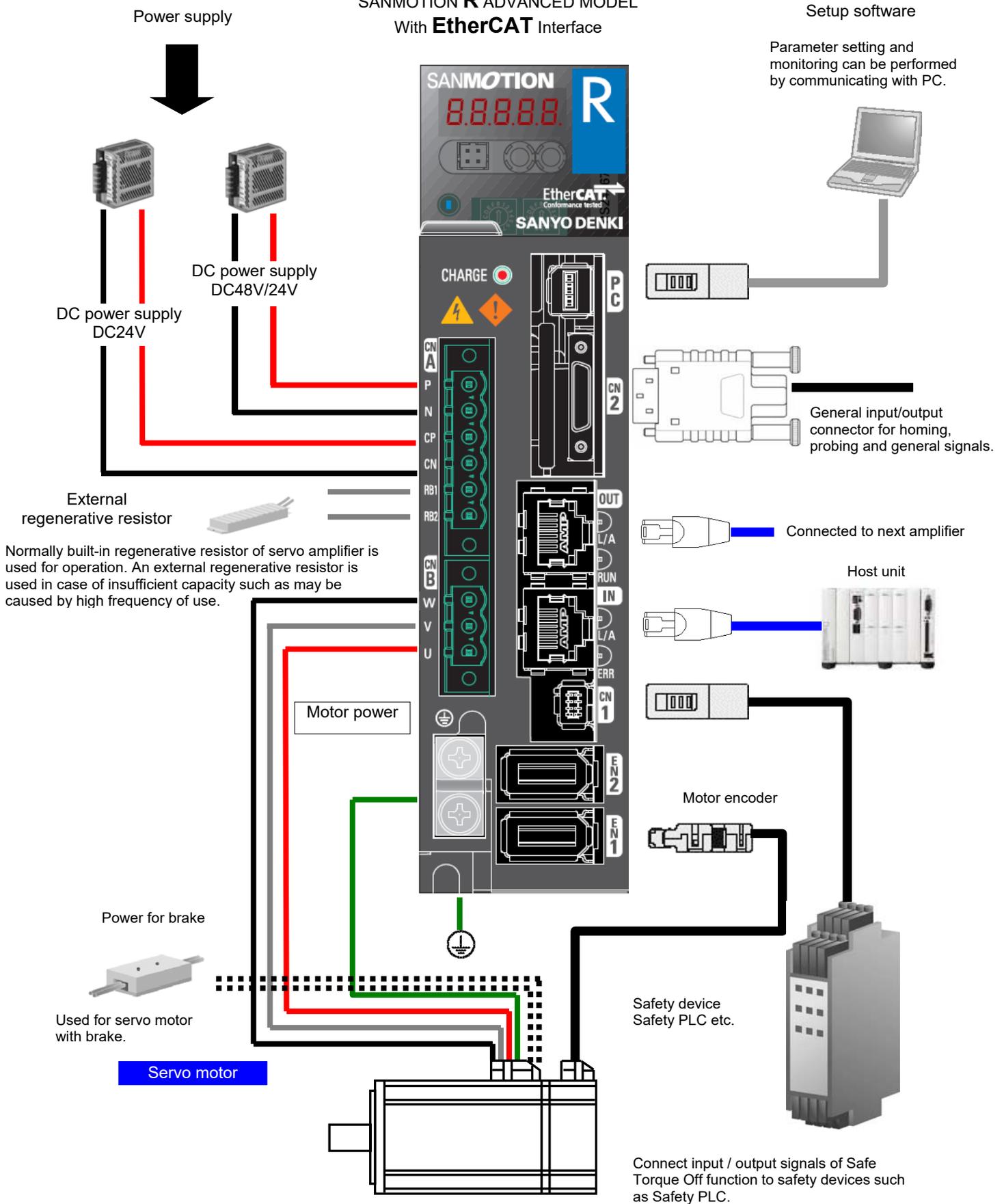


■RS2□##A (DC48V/24V)

SANMOTION R ADVANCED MODEL  
With **EtherCAT** Interface

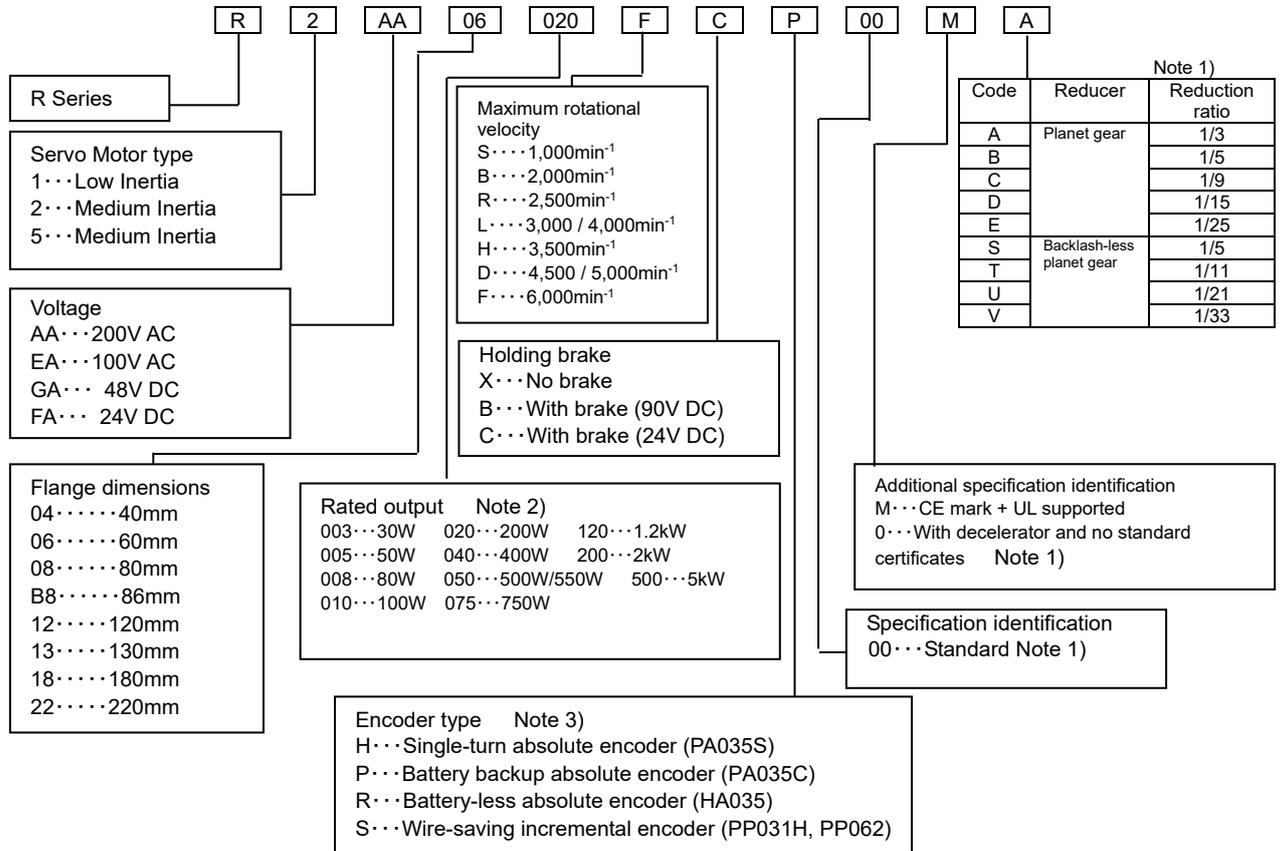
Setup software

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



### 1.4 Model number structure

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



Note 1) Applicable to the model whose flange size is 86mm or less.  
 Note 2) Alphabet is added to indication of the model whose flange size is 20mm only.  
 Note 3) For the Encoder type, flange size 14mm sq. has just "H", and flange size 20mm sq. has just "C".

■ Motor Encoder Model Number

◆ Absolute Encoder

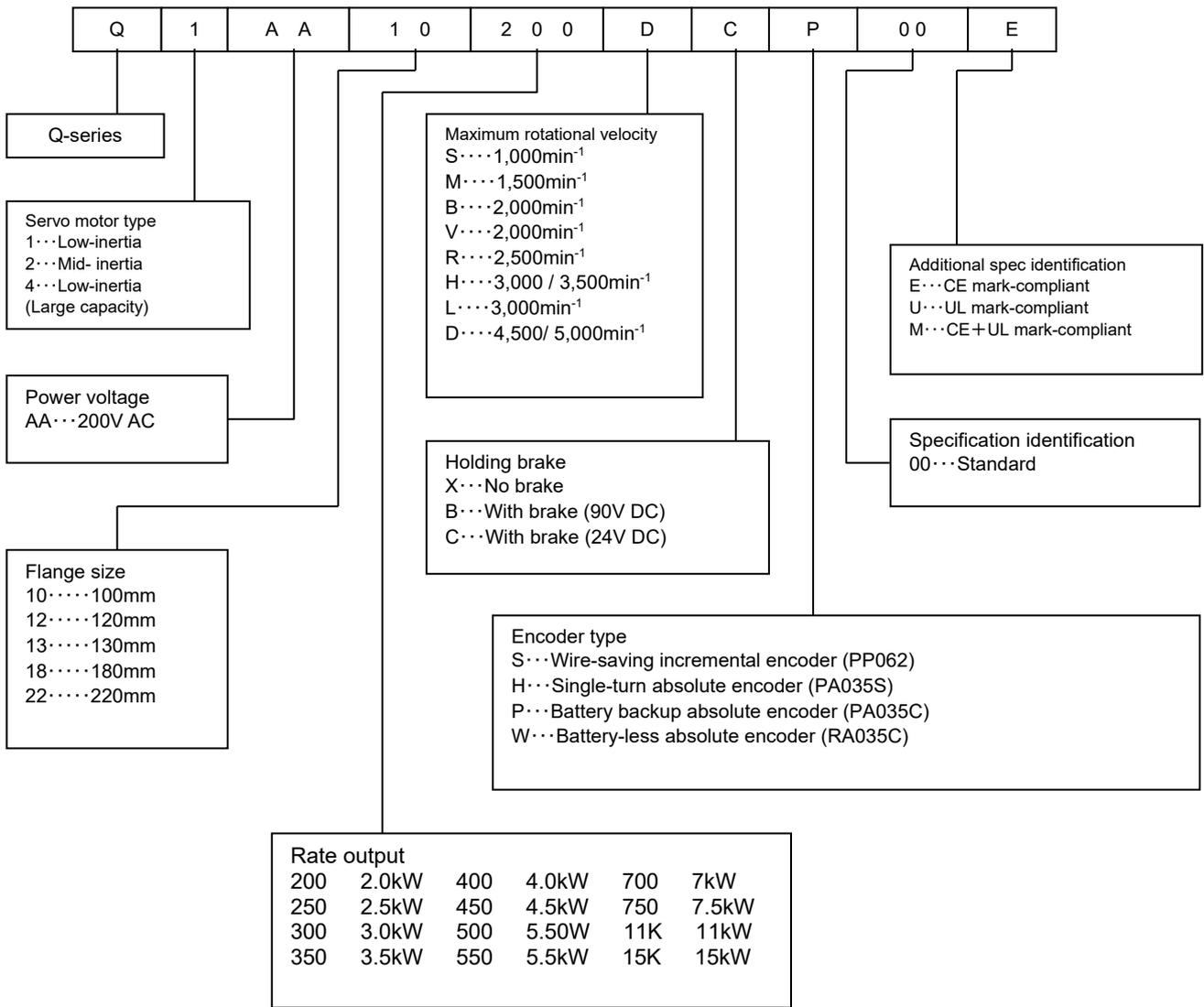
Model type	Resolution within 1 rotation	Resolution within multiple rotations	Name	Transmission system
PA035S	131072 (17bit)	-	Single-turn absolute encoder	Half-duplex asynchronous 2.5Mbps (standard)
PA035C	131072 (17bit)	65,536(16bit)	Battery backup absolute encoder	Half-duplex asynchronous 2.5Mbps (standard)
RA035C	131072 (17bit)	65,536(16bit)	Battery-less absolute encoder	Half-duplex asynchronous 2.5Mbps (standard)
HA035	131,072(17bit)	65,536 (16bit)	Battery-less absolute encoder	Half-duplex asynchronous 2.5Mbps (standard)

◆ Incremental Encoder

Model type	Standard	Applicable range	Name
	No. of divisions (No. of pulses)	No. of divisions, No. of (pulses)	
PP031H PP031T PP062	8000(2000P/R)	8192·20000·32768·40000 (2048·5000·8192·10000P/R)	Wire-saving incremental encoder

\* Please contact us for combinations with servo motor.

2) Rotary motor model number (Q-series)



- Motor encoder
- ◆ Absolute encoder

Model	Resolution within 1 rotation.	Resolution in multiple rotation	Name	Transmission method
PA035S	131,072(17bit)	—	Single-turn absolute encoder	Half-duplex asynchronous type, 2.5Mbps (standard)
PA035C	131,072(17bit)	65,536 (16bit)	Battery backup absolute encoder	Half-duplex asynchronous type, 2.5Mbps (standard)
RA035C	131,072(17bit)	65,536 (16bit)	Battery-less absolute encoder	Half-duplex asynchronous type, 2.5Mbps (standard)

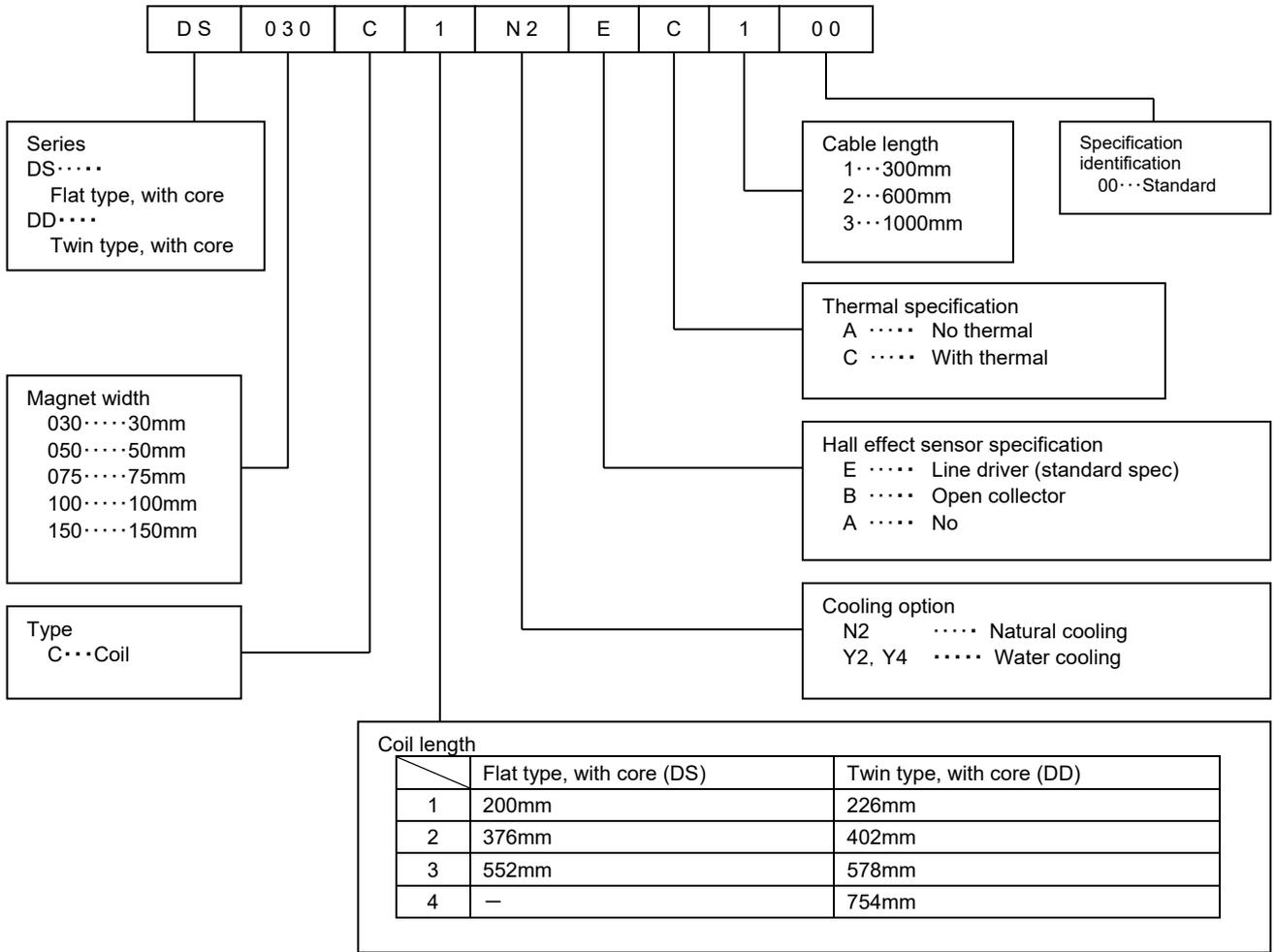
- ◆ Incremental encoder

Model type	Standard	Applicable range	Name
	Division number (pulse number)	No. of divisions, N(o. of pulses)	
PP031H PP031T PP062	8000(2000P/R)	8192·20000·32768·40000· 80000·100000 (2048·5000·8192·10000· 20000·25000P/R)	Wire-saving incremental encoder

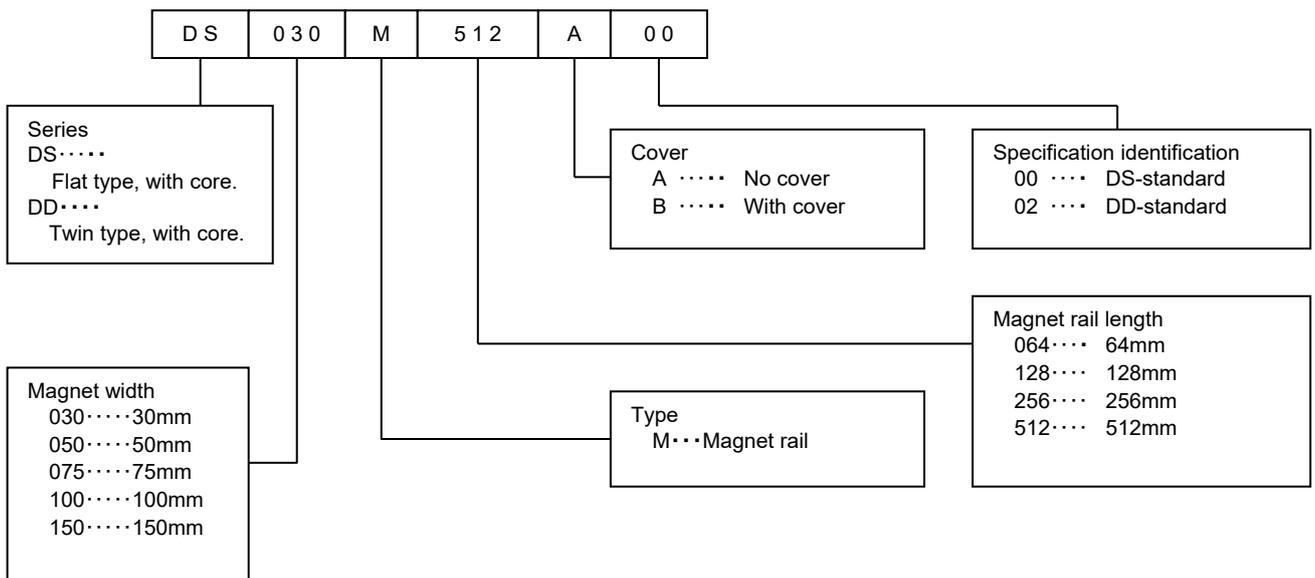
\* Please contact us for motor combination.

3) Linear motor model number (DS, DD-series)

■ Coil model number

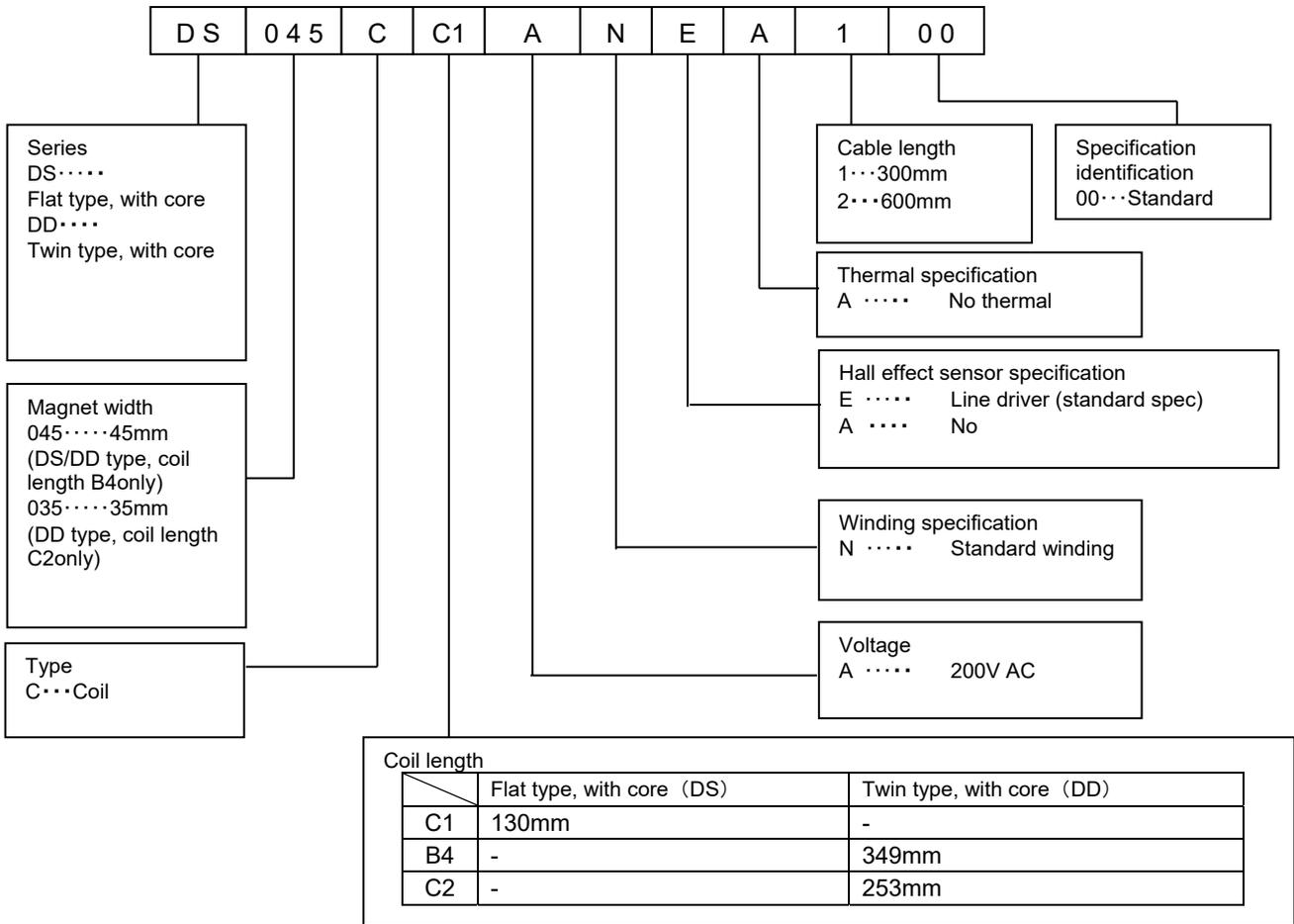


■ Magnet rail model number

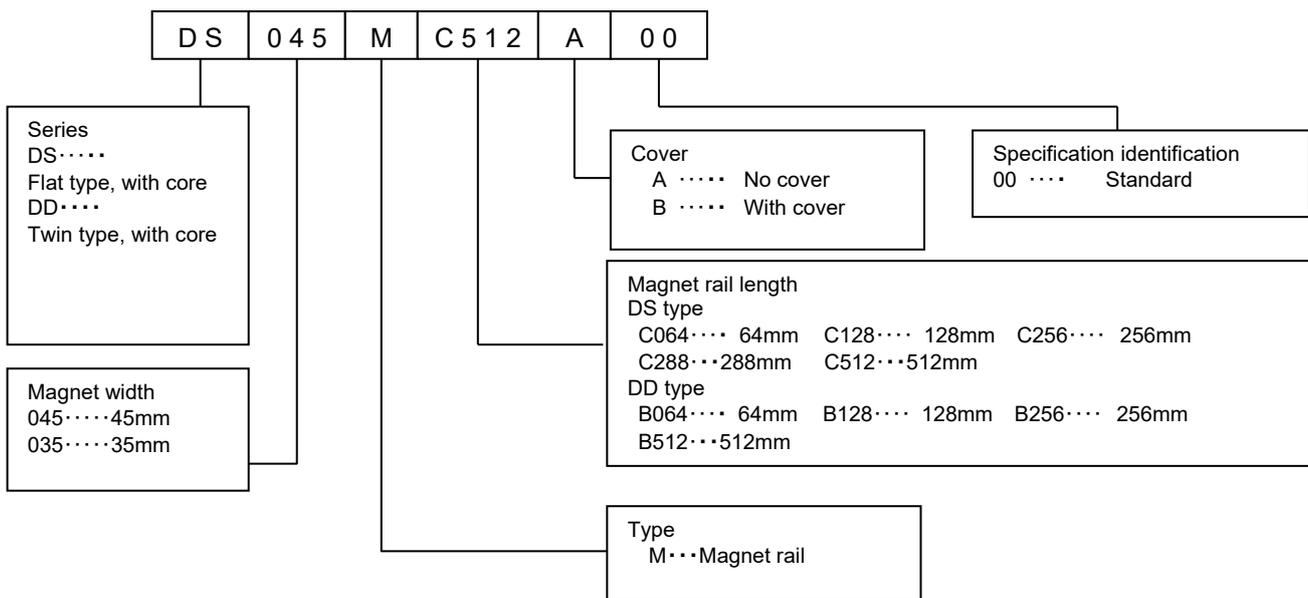


4) Linear Motor Model Number (DS/DD series, Small type)

■ Coil model number

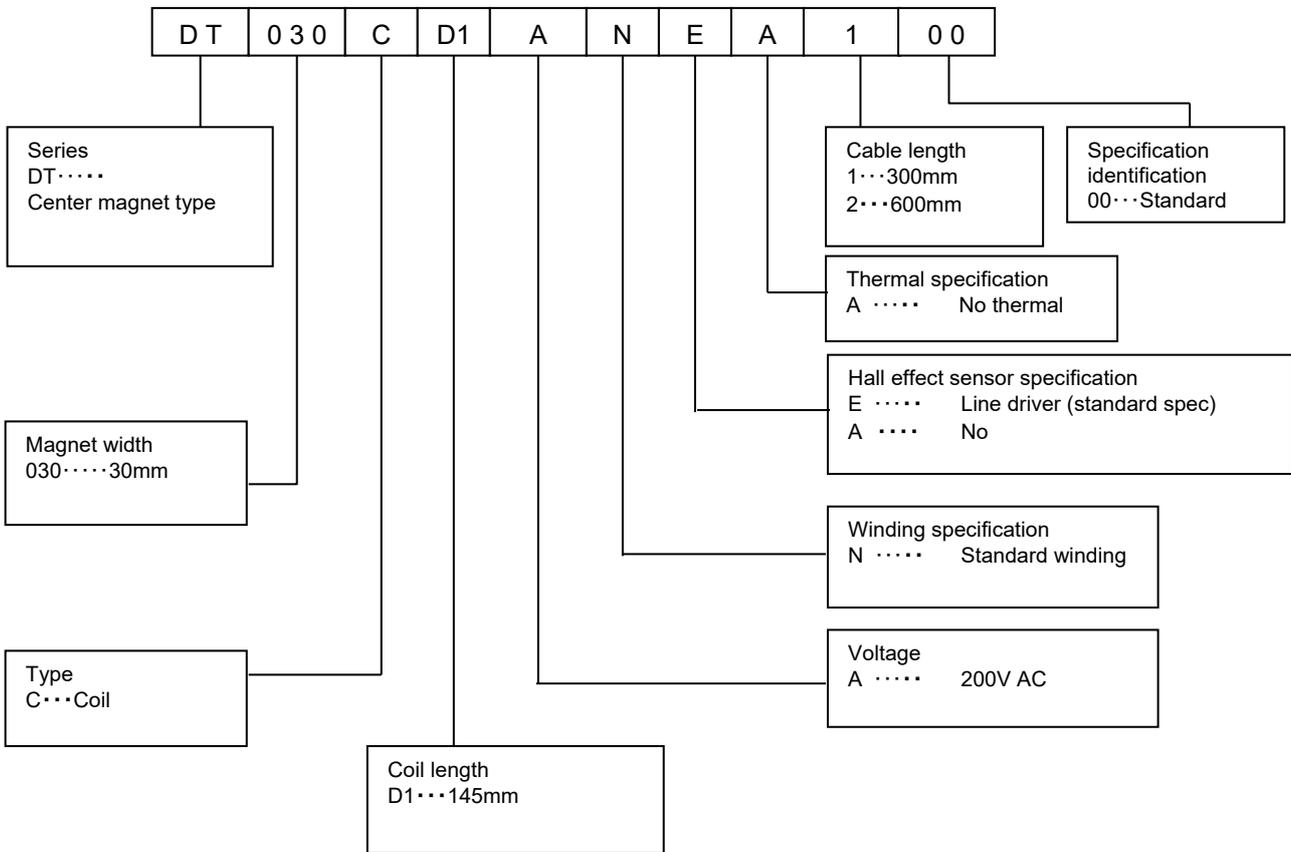


■ Magnet rail model number

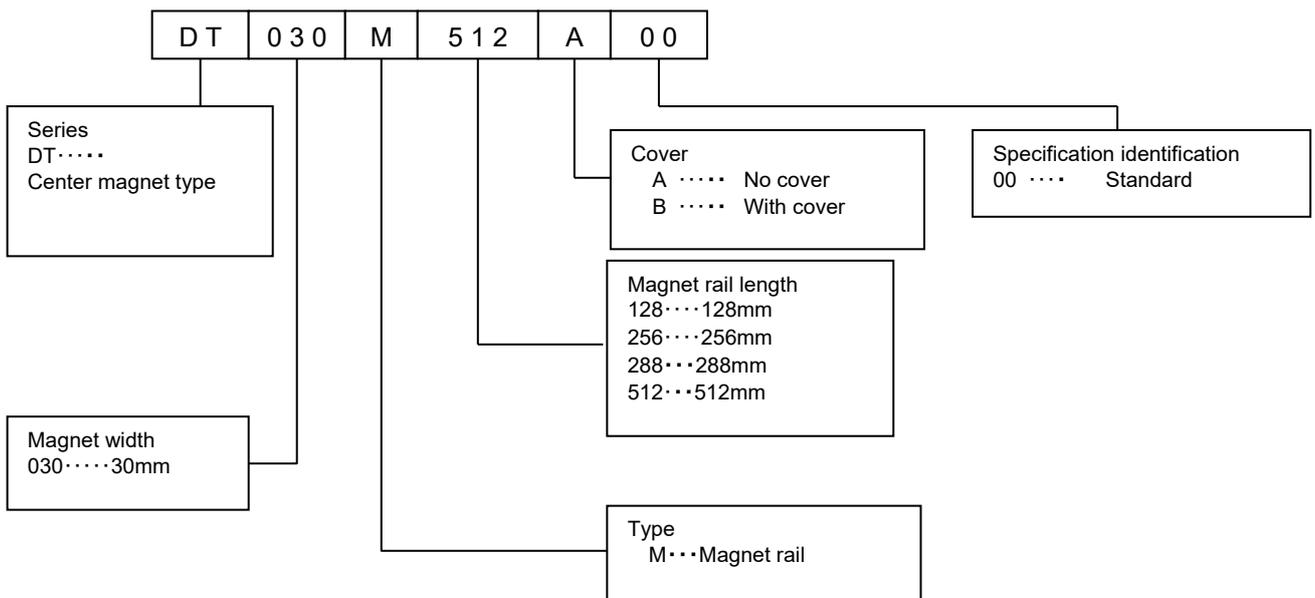


5) Linear Motor Model Number (DT series)

■ Coil model number

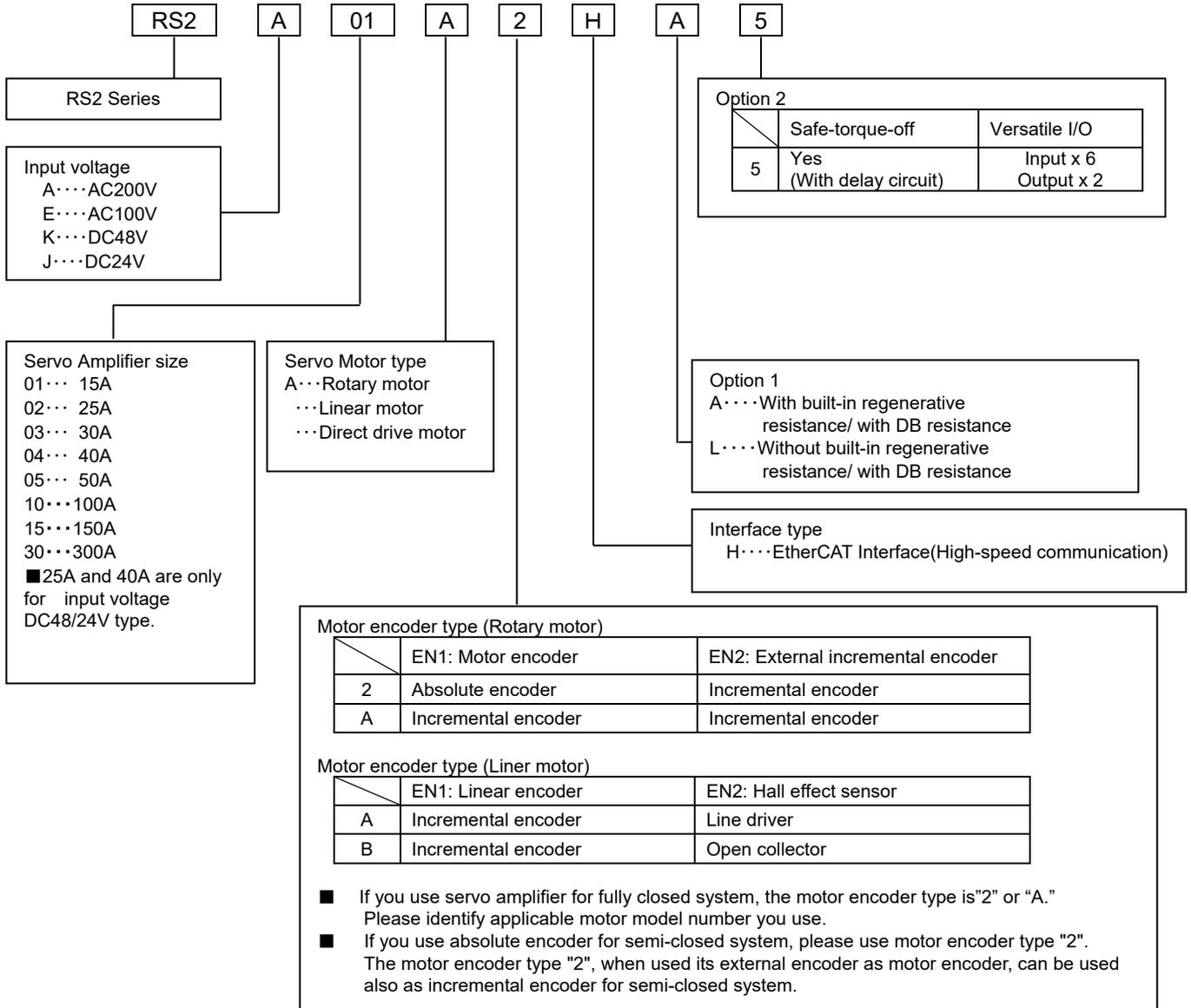


■ Magnet rail model number



\* Refer the section 13.5 for DE series motor.

6) Servo Amplifier Model Number

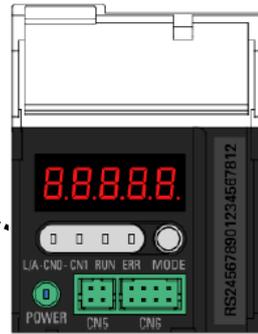


- \* Setup values for the servo amplifier are (default values) at the time of shipment from our factory.
- \* Adjustments for system parameters according to your equipment specifications as well as for combination of servo amplifier and servo motor are necessary.
- \* Make certain to follow the appropriate set-up procedure to operate your system by referring to the following pages.
- \* See chapter 13 for Safe Torque Off function.

# 1.5 Part Names

## 1) Servo Amplifier

■ RS2\*01 / RS2\*03/RS2□05



Open front cover.

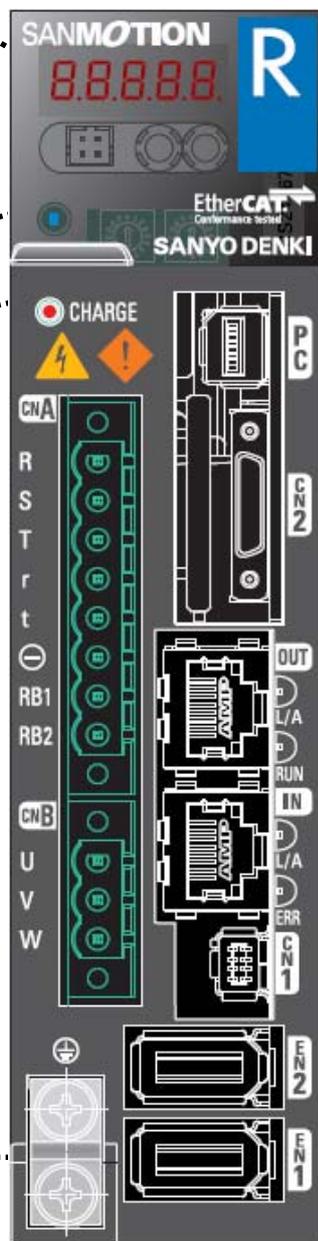
Connector for analog monitor

CN3: Model NO. on plug side  
 Connector : DF11-4DS-2C  
 Contact : DF11-2428SCA  
 (Products of Hirose Electric)

Digital Operator operation keys

Rotary switch for station alias address

5-digit 7-segment LED



Control power status LED  
 (POWER - Blue)

Main circuit power LED  
 (Red·CHARGE)

Main circuit power input  
 Control power input  
 Regenerative resistor connector

CNA: Side plug model  
 MSTBT2.5 / 8-STF-5.08LUB  
 (Phoenix Contact)

Servo motor connector

CNB: Side plug model  
 MSTBT2.5 / 3-STF-5.08  
 (Phoenix Contact)

Protective ground terminal

For setup software

PC : Side plug model  
 MUF-PK8K-X  
 (J.S.T Mfg. Co., Ltd.)

General input/output connector

CN2 : Side plug model  
 Plug: HDR-E26MSG1+  
 Shellkit: HDR-E26LPH  
 (Honda Tsushin Kogyo Co. Ltd)

EtherCAT Status LED (from upside)

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

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

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

IN, OUT: Side plug model  
 RJ-45 CAT5e

Safe torque Off input/output connector and  
 sensor backup battery input

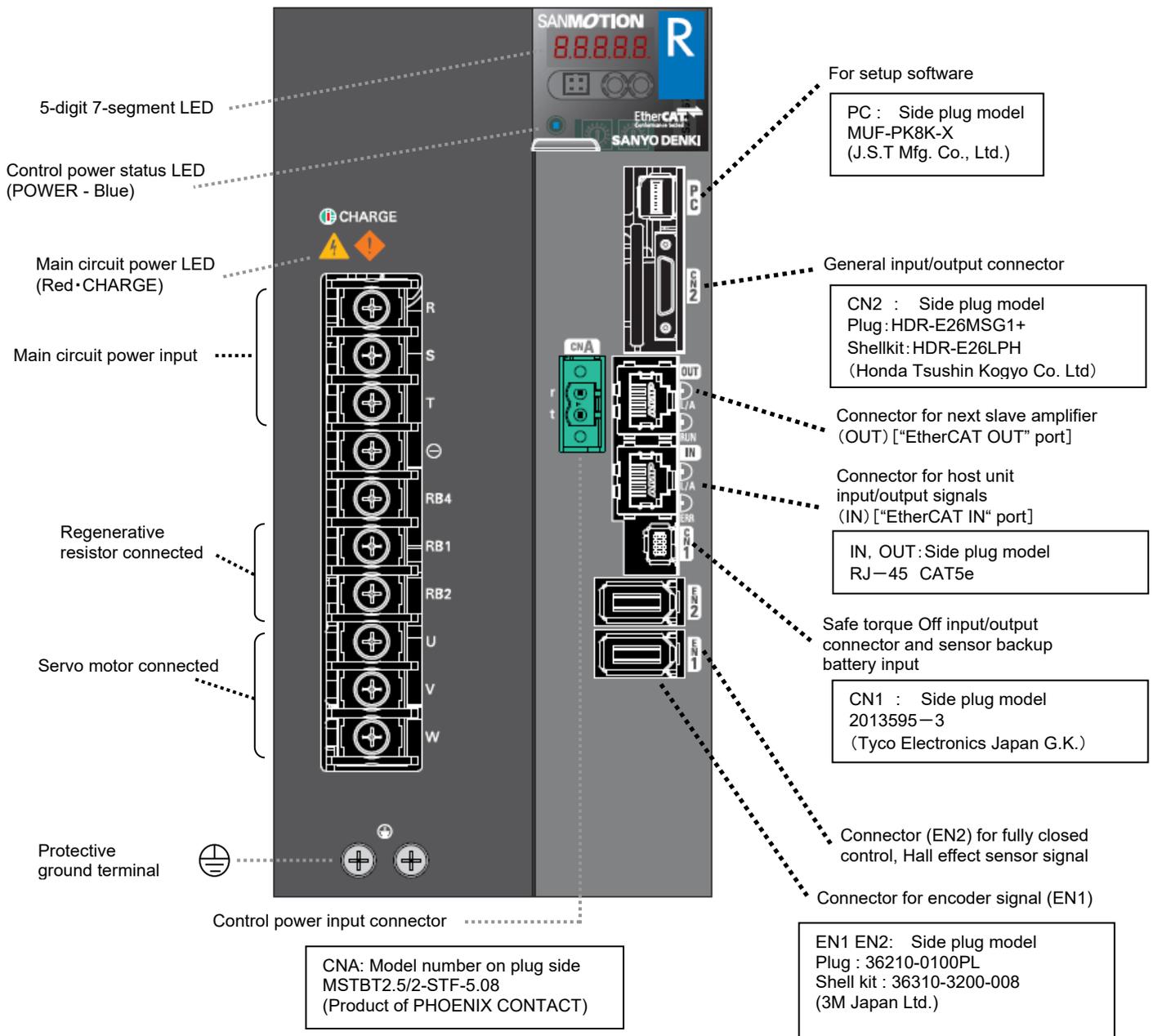
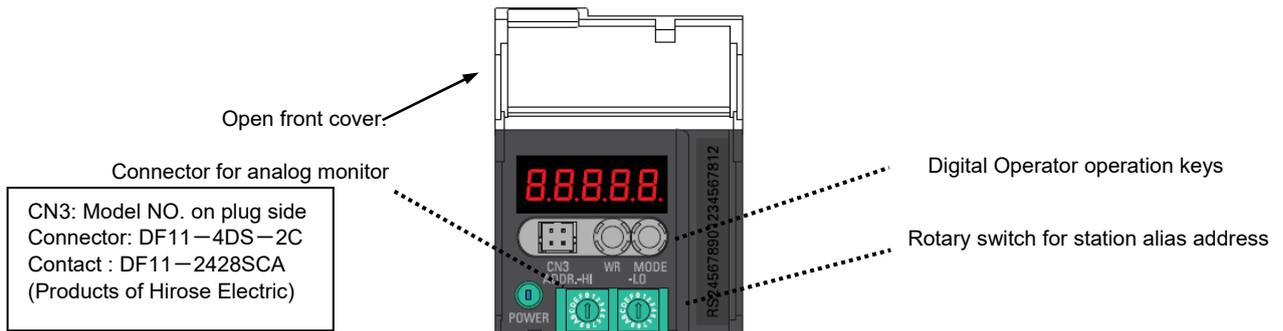
CN1 : Side plug model  
 2013595-3  
 (Tyco Electronics Japan G.K.)

Connector (EN2) for fully closed  
 control, Hall effect sensor signal

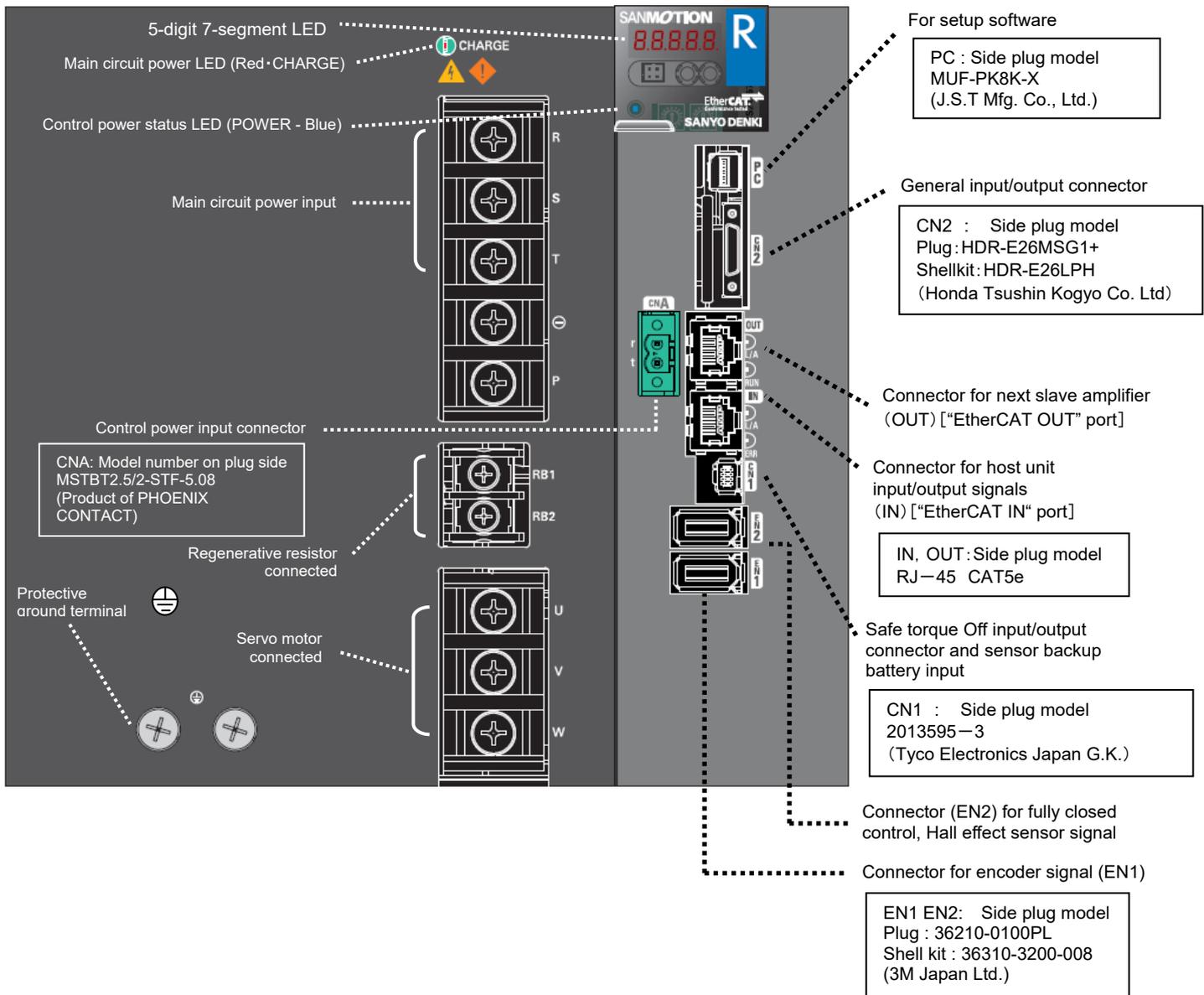
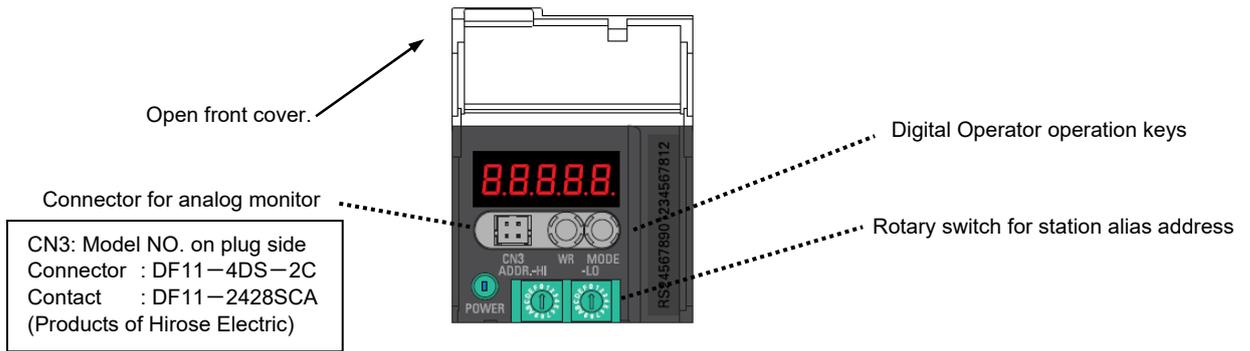
Connector for encoder signal (EN1)

EN1 EN2: Side plug model  
 Plug : 36210-0100PL  
 Shell kit : 36310-3200-008  
 (3M Japan Ltd.)

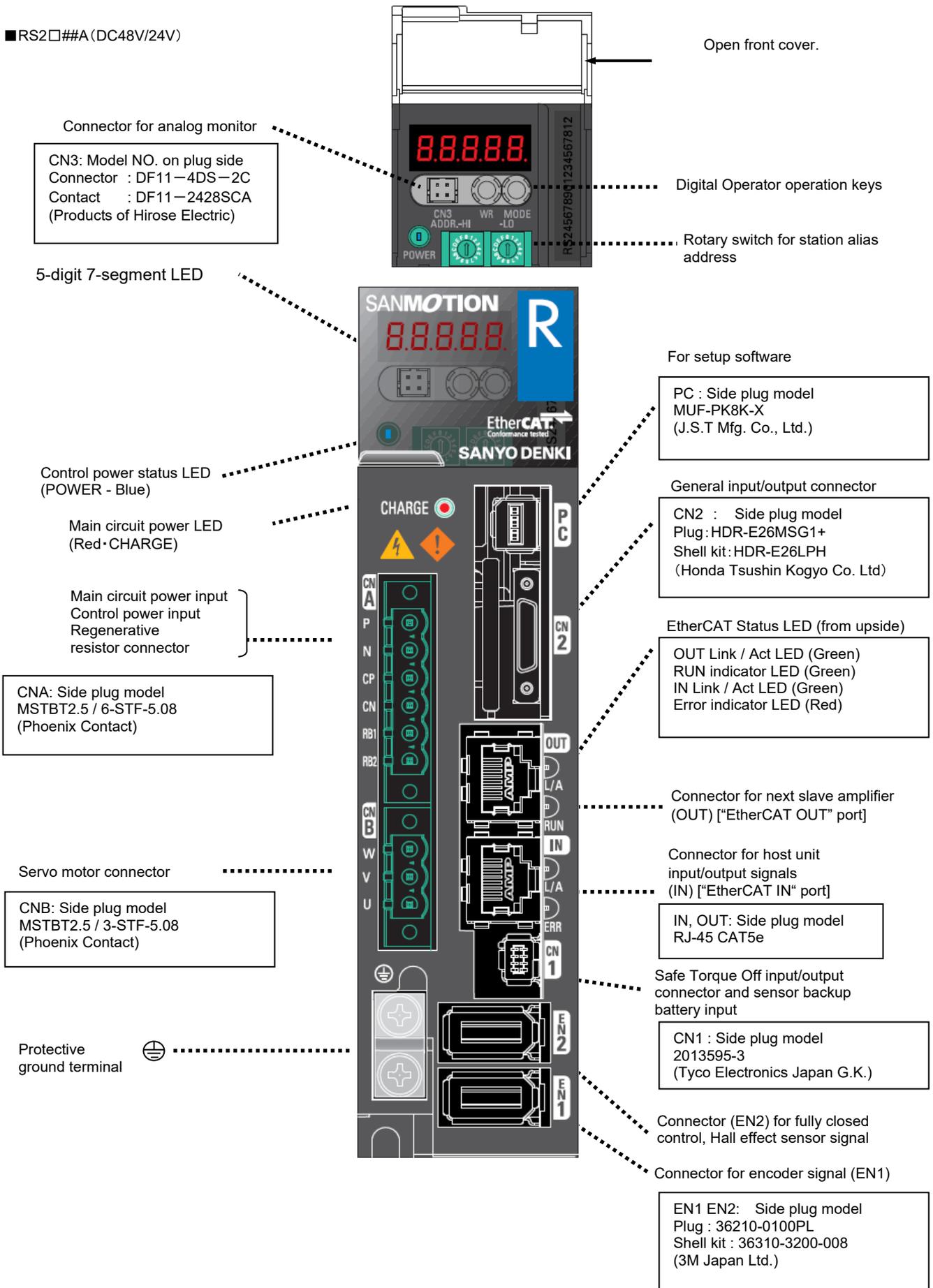
■ RS2□10/RS2□15



■ RS2□30

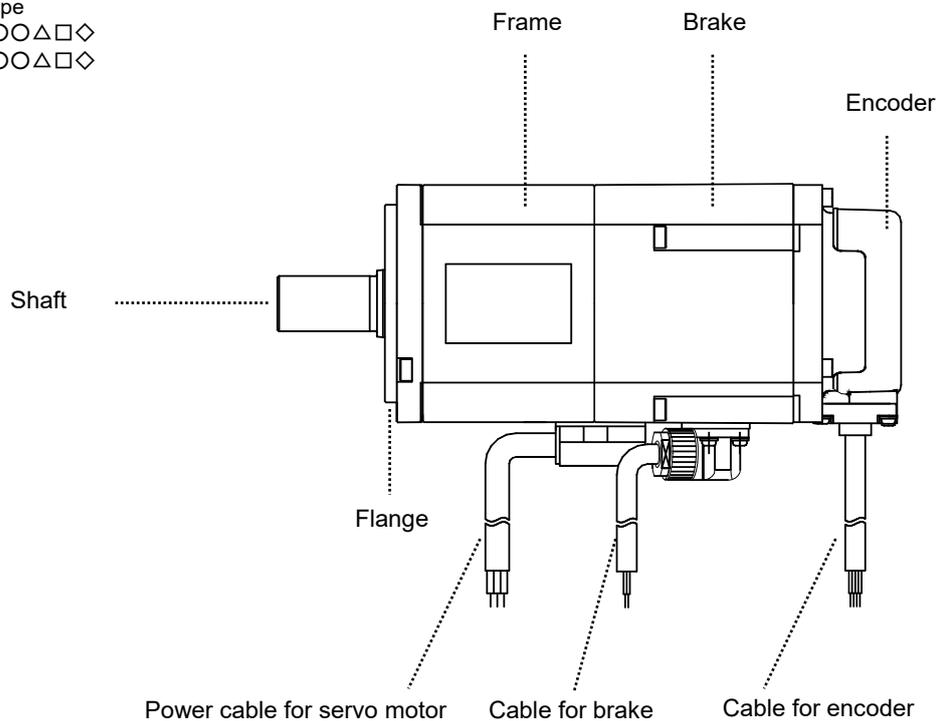


■RS2□##A(DC48V/24V)

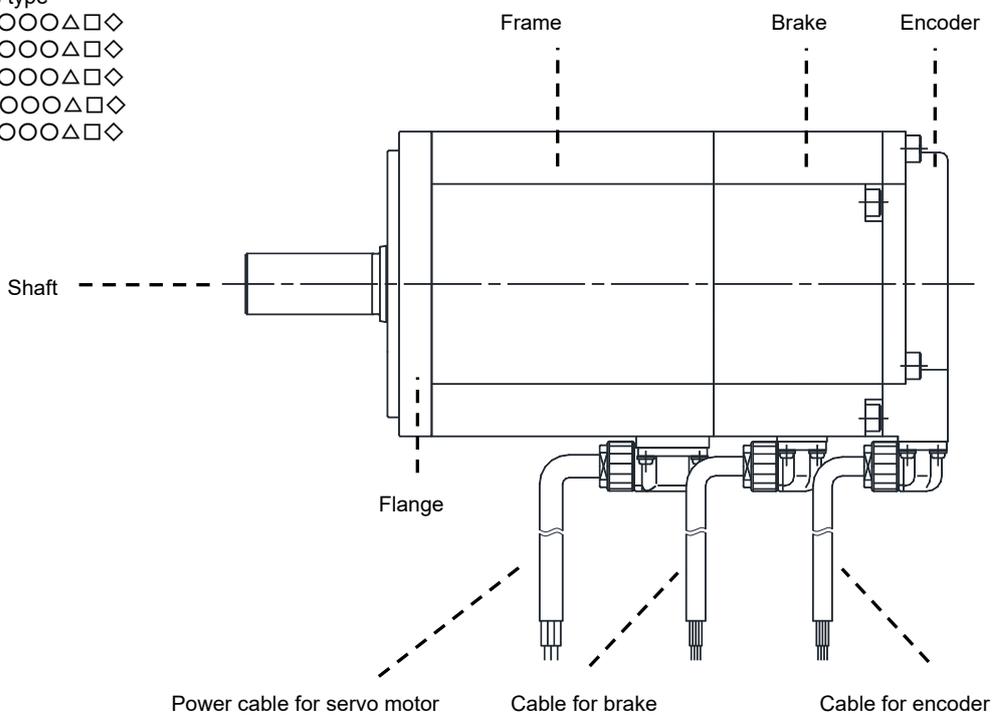


2) Rotary motor

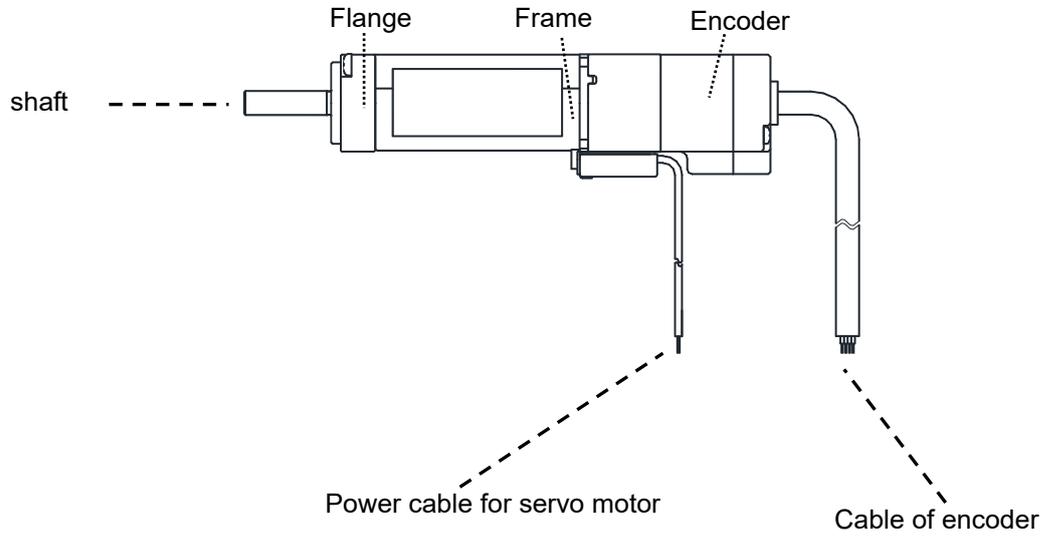
- Lead wire type
- R1GA04○○○△□◇
- R1GA06○○○△□◇



- Lead wire type
- R2□A04○○○△□◇
- R2□A06○○○△□◇
- R2□A08○○○△□◇
- R2□AB8○○○△□◇
- R2□A10○○○△□◇

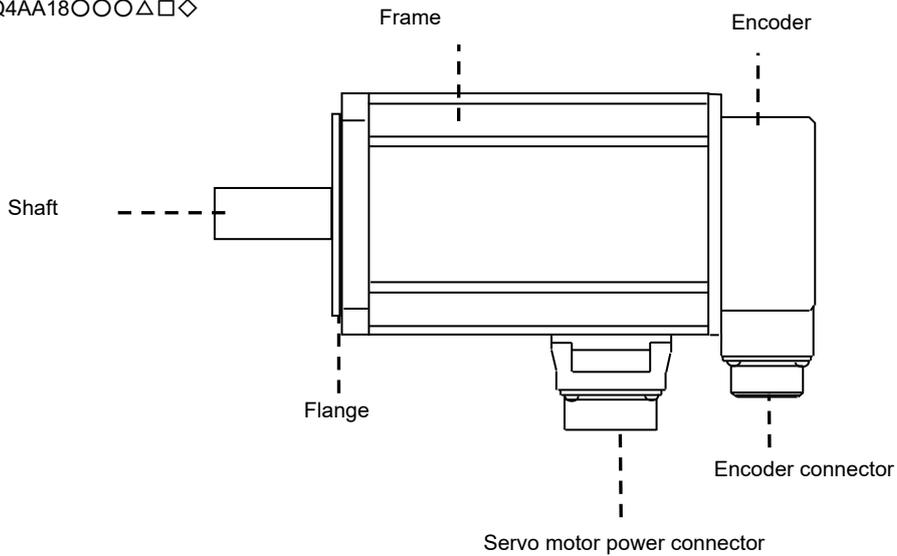


- Lead wire type
- R2GAD10○○△□◇
- R2GA02D○○△□◇



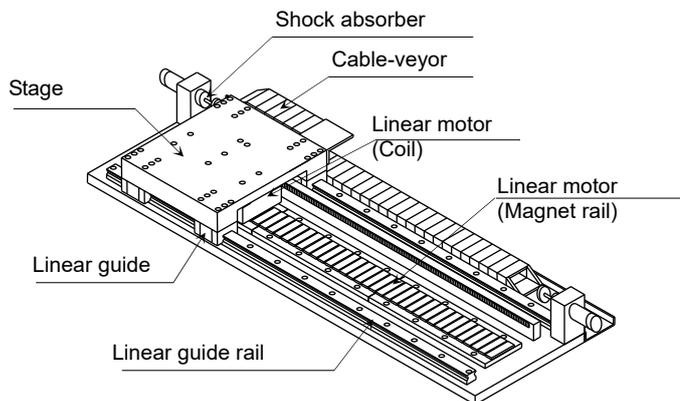
■ Connector Type

- R1AA18○○○△□◇
- R2AA13○○○△□◇
- R2AA22○○○△□◇
- Q1AA10○○○△□◇
- Q1AA12○○○△□◇
- Q1AA13○○○△□◇
- Q1AA18○○○△□◇
- Q2AA10○○○△□◇
- Q2AA13○○○△□◇
- Q2AA18○○○△□◇
- Q2AA22○○○△□◇
- Q4AA18○○○△□◇

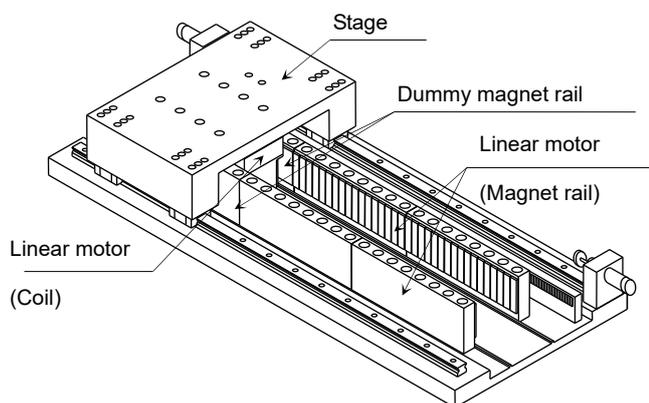


3) Linear motor

- Flat type with core
  - DS030□△○○
  - DS050□△○○
  - DS075□△○○
  - DS100□△○○
  - DS150□△○○
  - DS045□△○○



- Twin type with core
  - DD030□△○○
  - DD050□△○○
  - DD075□△○○
  - DD045□△○○
  - DD035□△○○



## 1.6 Combination

### 1) Combination motor list

- Refer "Motor Code (0x20FE)" in "chapter 7 Object Dictionary".

### 2) Combination encoder list

- Encoder division number

Combination amplifier model number RS2###A2H# RS2###AAH# RS2###ABH#	Combination amplifier model number RS2###A2H#	Combination amplifier model number RS2###A2H# RS2###AAH# RS2###ABH#	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	Amplifier model number Encoder type	Motor model number Encoder type	Remarks (Description)
0x0000	Incremental encoder (Wire-saving incremental)	4 pairs	2, A	S	Set when motor encoder is wire-saving incremental encoder.
0x0101	Asynchronous encoder (Incremental system)	2.5MHz Without multi turn output	2	H	Encoder for incremental system, which is serial-output only within rotation, set to use in the same way as incremental encoder. * 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	2	P, R	Encoder normally used in absolute system, set to use in incremental system. No backup lithium battery cell is needed to connect.
0x0401		4.0MHz With multi turn output			
0x0501	Revolver type asynchronous encoder	2.5MHz With multi turn output	2	W	Encoder normally used in absolute system, set to use in incremental system. * 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	2	P, R	Set to use in absolute system. This is multiple rotation backup system. For encoder type P, lithium battery connection to motor is required.
0x0400		4.0MHz With multi turn output			
0x0500	Revolver type asynchronous encoder	2.5MHz With multi turn output	2	W	Set to use in absolute system. Multiple rotations is mechanical backup system, no battery cell is needed to connect.
0x0600		4.0MHz With multi turn output			

■ Encoder type (Linear scale encoder Hall effect sensor)

Encoder code OD: 0x20FE, 2	Linear scale encoder (Incremental)	Hall effect sensor	CS-normalization (CS-reset method)	Amplifier model number Encoder type	Remarks (Description)
0x0800	Phase A, B, Z	Yes	Hall effect sensor Phase U	A, B Note1)	Set to perform CS-normalization with phase U signal of Hall effect sensor.
0x0810	Phase A, B, Z	Yes	Incremental Phase Z	A, B Note1)	Set to perform CS-normalization with phase Z of linear scale encoder.
0x0820	Phase A, B, Z	Yes	No	A, B Note1)	On powering-on Hall effect sensor performs CS-normalization, but set when CS-normalization not performed.
0x0830	Incremental encoder (Wire-saving incremental)	Yes	Incremental Phase Z	2, A, B	System using Hall effect sensor. Set to perform CS-normalization by CS-output of wire-saving incremental sensor and phase Z, at power-on.
0x0840	Incremental encoder (Wire-saving incremental)	Yes	No	2, A, B	System using Hall effect sensor. Set to perform CS-normalization by CS-output of wire-saving incremental sensor at power-on.
0x0850	Phase A, B, Z	No	Software setting (Magnetic pole position estimation)	2, A, B Note2)	System not using Hall effect sensor. Set to perform magnetic pole position estimation process.
0x0860	Phase A, B, Z	No	Software setting (Forced setting)	2, A, B Note2)	System not using Hall effect sensor. Set when CS-normalization not performed.

Note 1) When specification for Hall effect sensor output is for line driver, select encoder type "A" of amplifier model number.  
When specification for Hall effect sensor output is for open collector, select encoder type "B" of amplifier model number.  
Note 2) Both encoder type "A" and "B" can be used, however, select amplifier "2" when Hall effect sensor not used.

# 2

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## 2 Specifications

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## 2.1 Servo Motor

### 1) General Specifications

Series name	R1, R2, R5, Q1, Q2, Q4
Time rating	Continuous
Heat resistant class	Type F
Voltage/Dielectric strength	AC1500V 1 minute
Insulation resistance	DC500V, greater than 10MΩ
Protection method	Fully closed, Auto cooling
	Motor flange angle: 86 or less: IP67 Motor flange angle: 130 or over: IP65 However, except for axial penetration part and cable tip part
Oil Sealing	Motor flange angle: 86 or less: No oil seal (Optionally available) Motor flange angle: 130 or over: With oil seal
Ambient temperature	0 to + 40°C
Storage temperature	-20 to +65°C
Ambient humidity	20 to 90% (without condensation)
Vibration classification	V15
Coating color	Munsell N1.5 equivalent
Excitation method	Permanent magnet type
Installation method	Flange mount

### 2) Exterior Dimensions / Specifications / Mass

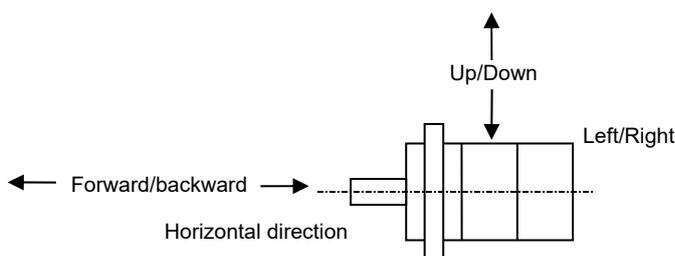
Refer to [Servo Motor Dimension (Section 16)]

Refer to [Servo Motor Data Sheet (Section 16)]

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

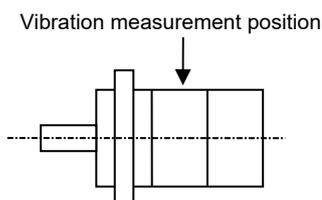
■ Vibration Resistance

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<sup>2</sup>.

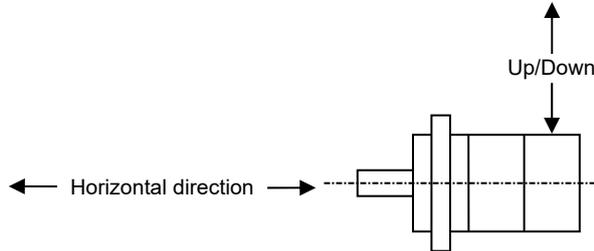


■ Vibration Classification

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  $98\text{m/s}^2$  (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: $\alpha$	0.02	
	0.03 (220)	
Eccentricity of external diameter of flange on output shaft M: $\beta$	0.06 (below 80)	
	0.08 (above 100)	
Perpendicularity of flange face to output shaft M: $\gamma$	0.07 (below 86)	
	0.08 (130-180)	
	0.10 (220)	

\* Values in ( ) are the motor flange angle.

#### 4) Oil Seal Type

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

Servo Motor Model	Oil Seal Type
R1AA18○○○□	Standard: S-Type
R1GA04○○○□/ R1GA06○○○□	Standard: N/A Optional: G-Type
R2□A04○○○□	Standard: N/A Optional: G-Type
R2□A06○○○□/R2□A08○○○□	Standard: N/A Optional: S-Type
R2□A13○○○□	Standard: Double lip-type
R2□A22○○○□	Standard: Double lip-type
Q1□A10○○○□	Standard: S-Type
Q1□A12○○○□/Q1□A13○○○□	Standard: S-Type
Q1□A18○○○□	Standard: S-Type
Q2□A13○○○□	Standard: S-Type
Q2□A18○○○□	Standard: S-Type
Q2□A22○○○□	Standard: S-Type
Q4□A18○○○□	Standard: S-Type

## 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<sup>-1</sup> 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 ms	Braking delay time ms		
				Varistor	Diode	
R1	R1AA18550H	54.9	300	140	400	
	R1AA18750L					
	R1AA1811KR	75				
	R1AA1815KB	120		60	600	
	R1GA04005	0.32		25	15	100
	R1GA04010	0.32				
	R1GA06020	1.37		30	20	120
R2	R2AA04003F	0.32	25	15	100	
	R2AA04005F	0.32				
	R2AA04010F	0.32				
	R2AA06010F	0.36	30	20	120	
	R2AA06020F	1.37				
	R2AA08020F	2.55	40	20	200	
	R2AA06040□	1.37	30	20	120	
	R2AA08040F	2.55	40	20	200	
	R2AA08075F	2.55				
	R2AAB8100F	3.92	40	20	200	
	R2AA10100F	3.92	40	20	200	
	R2AA13050□	3.50	40	30	120	
	R2AA13120□	9.0	100	30	130	
	R2AA13180□	9	100	30	130	
	R2AA13200□	12.0	100	30	140	
	R2AA18350L	22				
	R2AA18450H	32	150	40	250	
	R2AA18550□	42				
	R2AA18750H	54.9				
	R2AA22500L	42	150	60	250	
	R2EA04003F	0.32	25	15	100	
	R2EA04005F	0.32				
	R2EA04008F	0.32				
	R2EA06010F	0.36	30	20	120	
	R2EA06020F	1.37				
	R2GA04003F	0.32	25	15	100	
	R2GA04005F	0.32				
	R2GA04008D	0.32				
	R2GA06010D	0.36	30	20	120	
	R2GA06020D	1.37				
R2GA04003F R2FA04003F	0.32	25	15	100		
R2GA04005F R2FA04005D	0.32					
R2GA04008D R2FA04006R	0.32					
R2GA06010D R2FA06007R	0.36	30	20	120		
R2GA06020D R2FA06008A	1.37					
R5	R5AA06020H	1.37	30	20	120	
	R5AA06020F	1.37	30	20	120	
	R5AA06040H	1.37	30	20	120	
	R5AA06040F	1.37	30	20	120	
	R5AA08075D	2.55	40	20	200	
	R5AA06075F	2.55	40	20	200	

\* For specifications on other motor, please contact us.

\* For flange size 14 and 20 sq. motor, holding brake cannot be equipped.

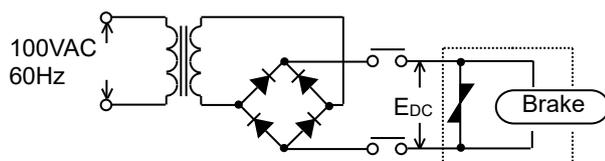
Servo motor model number		Static friction torque N·m	Release time ms	Braking delay time ms	
				Varistor	Diode
Q1	Q1AA10200D	7.84	100	30	140
	Q1AA10250D	9.80	100	30	140
	Q1AA12200D	7.84	100	30	140
	Q1AA12300D	11.8	100	30	140
	Q1AA13400D	19.6	120	50	150
	Q1AA13500D	19.6			
	Q1AA18450M	32.0	150	40	250
	Q1AA18750H	54.9	300	140	400
Q2	Q2AA13200H	12.0	100	30	140
	Q2AA18200H	12.0	100	30	140
	Q2AA18350H	32.0	120	40	150
	Q2AA18450H	32.0	150	40	250
	Q2AA18550H	54.9	300	140	400
	Q2AA18750L				
	Q2AA22550B	90.0	300	140	400
	Q2AA22700S	90.0	300	140	400
	Q2AA2211KV				
	Q2AA2215KV				

\* For specifications on other motor, please contact us.

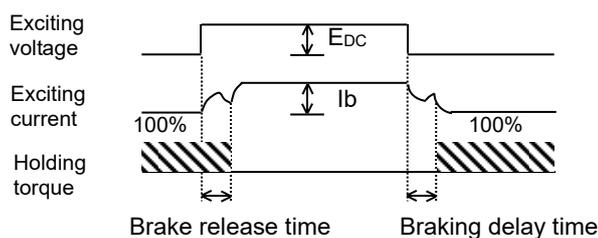
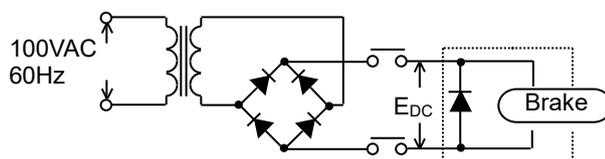
\* For flange size 14 and 20 sq. motor, holding brake cannot be equipped.

■ 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 R□□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.

Oil seal Brake	Without oil seal	With oil seal
Without brake	-	Degree of decrease rating 2
With brake	Degree of decrease rating 1	Degree of decrease rating 2

Condition		Degree of decrease rating	
Brake	Oil seal	R1GA04005	R1GA04010
No	No	-	-
Yes	No		80%
No	Yes	90%	
Yes	Yes		

	R2AA04005F	R2AA04010F	R2AA06040F	R2AA08075F	R2□A04005F
Degree of decrease rating 1	-	90%	90%	—	—
Degree of decrease rating 2	90%	85%	80%	90%	90%

## 2.2 Motor Encoder

### 1) Absolute Encoder Specifications

#### ■ Single-turn absolute Encoder for Incremental System

Model	Resolution	Multiple rotations	Synchronization method	Transmission method	Baud rate
PA035S	131,072 division (17bits)	None	Asynchronous	Half duplex serial communication	2.5Mbps

Model number example: R2-series, square type: 40mm, 200W-model R2AA04020FCH00

#### ■ Battery Backup Absolute Encoder

Model	Resolution	Multiple rotations	Synchronization method	Transmission method	Baud rate
PA035C	131,072 division (17bits)	65536 (16bit)	Asynchronous	Half duplex serial communication	2.5Mbps
	131,072 division (17bits)	65536 (16bit)	Asynchronous	Half duplex serial communication	4.0Mbps

Model number example: R2-series, square type: 40mm, 200W-model R2AA04020FCP00

#### ■ Battery-less Absolute Encoder

Model	Resolution	Multiple rotations	Synchronization method	Transmission method	Baud rate
RA035C	131,072 division (17bits)	65536 (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)		Asynchronous	Half duplex serial communication	4.0Mbps

Model number example: R2-series, square type: 40mm, 200W-model R2AA04020FCW00, R2AA04020FCR00

### 2) Incremental Encoder Specifications

#### ■ Wire-saving incremental encoder

Model	Resolution	Conform to motor flange size
PP031H	1000/2000/2048/4096/5000/6000/8192/10000 P/R	Greater than 40mm
PP062	1000/2000/2048/4096/5000/6000/8192/10000 P/R	Greater than 80mm

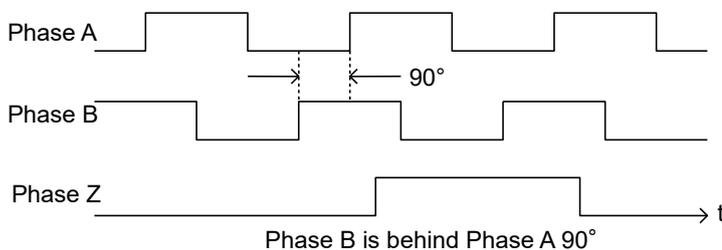
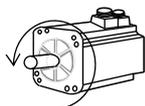
Model number example: R2-series, square type: 40mm, 200W-model R2AA04020FCS00

## 2.3 Servo motor rotational and moving direction

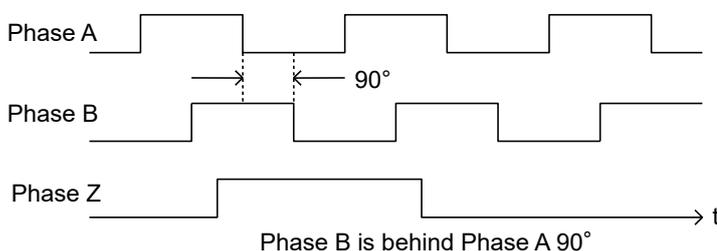
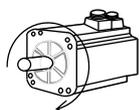
### 1) Rotary motor rotational direction

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

Servo motor rotation direction  
[CCW]

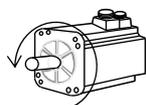


Servo motor rotation direction  
[CW]

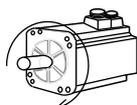


- \* When Z Phase is at high level, both Phases A and B cross the low level once every rotation

- Absolute 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



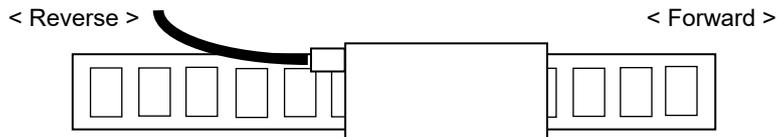
- \* This is the absolute encoder output position, and the rotation direction differs in EtherCAT communication.

### 2) Battery Specification

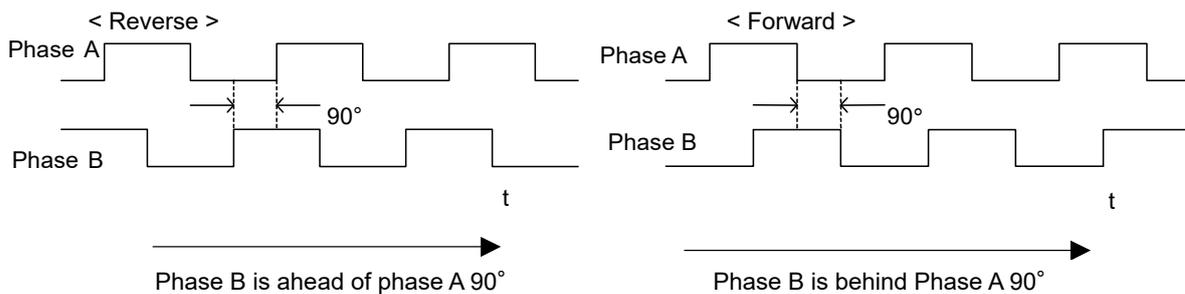
Model: ER3VLY (produced by TOSHIBA LIFESTYLE PRODUCTS & SERVICES CORPORATION)  
Voltage: 3.6V

### 3) Linear motor moving direction

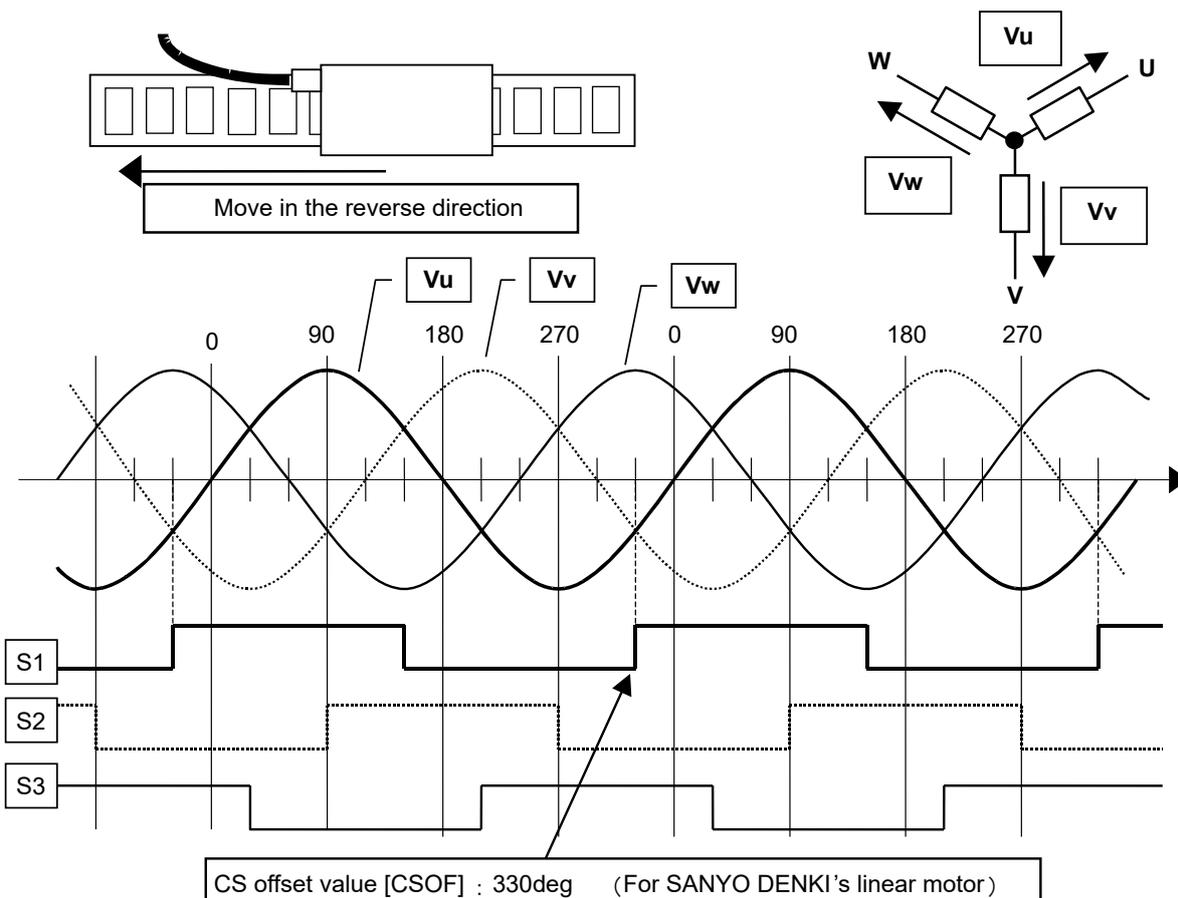
- Forward move of the linear motor means that of the power line leading when a command for position increasing is input.



- Linear encoder signal phase



- Linear motor voltage and hall sensor phase sequence when moving in the reverse direction.



## 2.4 Servo Amplifier

### 1) General Specifications

■ General Specifications

Control function	Speed control/Torque control/Position control (Parameter changeover)							
Control system	IGBT: PWM control Sinusoidal drive (MOS-FET: PWM control Sinusoidal drive)							
Main Circuit Power Note 1)	Three-phase: AC200 - 230V+10, -15% , 50/60Hz±3Hz Single-phase: AC200 - 230V+10, -15% , 50/60Hz±3Hz Note 2) Single-phase: AC100 - 115V+10, -15% , 50/60Hz±3Hz Note 3) Direct current: DC48V±10%(RS2K), DC24V±10%(RS2J) Note 4)							
Control Power Note 1)	Single-phase: AC200 - 230V+10, -15% ,50/60Hz±3Hz Single-phase: AC100 - 115V+10, -15% ,50/60Hz±3Hz Note 3) Direct current: DC24V±10%(RS2K, RS2J) Note 4)							
Environment	Ambient temperature	0 - 55°C (0 - 40°C Note 4))						
	Storage temperature	-20 - +65°C						
	Operation/ Storage humidity	Below 90%RH (no condensation)						
	Elevation	Below 1000m						
	Vibration	5m/s <sup>2</sup> Frequency range 10 - 55Hz tested for 2H in each direction X.Y.Z						
Shock	20m/s <sup>2</sup>							
Structure	Built-in tray type power supply							
Servo amplifier model number	RS2#01A#HA RS2#01A#HL	RS2#03A#HA RS2#03A#HL	RS2#05A#HA RS2#05A#HL	RS2A10A#HA RS2A10A#HL	RS2A15A#HA RS2A15A#HL	RS2A30A#HL	RS2K/J#A#HA RS2K/J#A#HL	
External dimensions (H×W×D)	40×160×130	50×160×130	85×160×130	100×205(235) ×220	120×205(235) ×220	220×205(235) ×220	40×160×85	
Weight	No built-in regenerative resistor	0.70kg±0.2kg	0.90kg±0.2kg	1.60kg±0.2kg	4.8±0.2kg	5.1±0.2kg	9.6±0.2kg	0.50kg±0.2kg
	With built-in regenerative resistor	0.75kg±0.2kg	0.95kg±0.2kg	1.65kg±0.2kg	5.0±0.2kg	5.3±0.2kg	No	0.55kg±0.2kg

Note 1) Power source voltage should be within the specified range

200V AC Power input type: Specified power supply range = 170 to 253V AC

100V AC Power input type: Specified power supply range = 85 to 127V AC

Note 2) 200V AC single-phase input type corresponds only to RS2□01/RS2□03/RS2□05.

Note 3) 100V AC single-phase input type corresponds only to, RS2\*01/RS2\*03

Note 4) DC input type corresponds only to RS2K02/ RS2K04/ RS2J02/ RS2J04.

■ Performance

Speed control range	1:5000
Frequency characteristics	800Hz

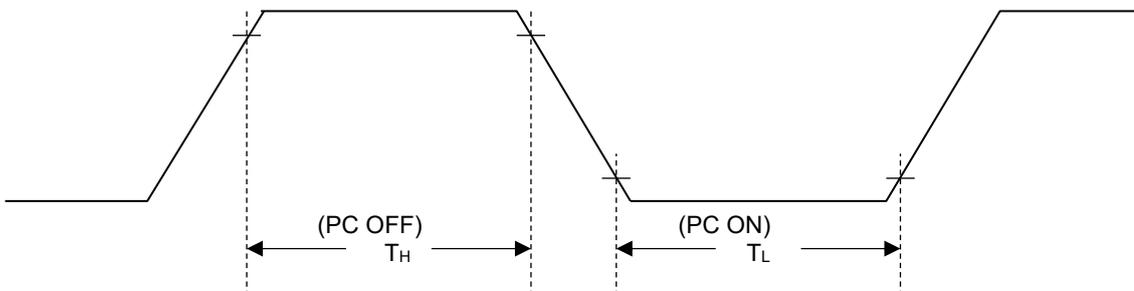
■ Built-in functions

Protection functions	Over current, Current detection error, Overload, Regeneration error, Magnetic pole position estimation error, Amplifier overheating, External overheating, Over voltage, Main circuit power low voltage, Main circuit power supply open phase, Control power supply low voltage, Encoder error, Over speed, Speed control error, Speed feedback error, Excessive position, Position command error, Built-in memory error, Parameter error	
Digital operator	Status display, Monitor display, Alarm display, Test operation, Adjustment mode	
Dynamic brake circuit	Built -in	
Regeneration process circuit	Built -in	
Monitor	Speed monitor (VMON)	2.0V±10% (at 1000min <sup>-1</sup> )
	Torque (Thrust) (TCMON)	2.0V±10% (at 100%)

2) General Input/Output

■ General input signals

Sequence input signals	Interactive photo coupler (sink, source connection) : ×6 input
	Input power voltage range: 5V DC ±5% / 12 to 24V DC±10%, 100mA or over (24V DC)
	Forward direction limit switch, Reverse direction limit switch, External trip, Forced discharge and Emergency stop.
	Refer to [Index:0x20F8 General input function selection (Section 7)]



- \* TH denotes the minimum time that H-level input signal must be held and TL denotes the minimum time that L-level input signals must be held.
- \* Generic input signals will be set depending on the selection of each function. Validity conditions and AC characteristics differ depending on set functions.
- \* Shows AC characteristics in respective functions.

General input functions	Photo coupler ON Hold time (TL)	Photo coupler OFF Hold time (TH)
Emergency stop function (Emergency Stop)	Min.250µs	Min.250µs
Forward direction limit switch Reverse direction limit switch Forced discharge input External trip input	Min.8ms	Min.8ms

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

■ General output signals

Sequence output signals	Photo relay output (SYNC, Source connection) x 2 outputs
	External power supply voltage: 5V DC±5% / 12 to 24V DC±10%, 20mA or over
	Circuit power for output signal: 5V DC±5% / Maximum current value 50mA (per 1 output)
	Circuit power for output signal: 12 to 15V DC±10% / Maximum current value 50mA (per 1 output)
	Circuit power for output signal: 24 to 15V DC±10% / Maximum current value 50mA (per 1 output)
Servo ready, Power ON, Servo ON, Holding brake timing, Torque limiting, Low speed, Velocity attainment, Matching speed, Zero speed, Command acceptable, Status of gain switch, Velocity loop proportional control status, Control mode switchover status, Forward/Reverse direction limit, Reverse OT, Warning, Alarm code (3bits), etc.	
Refer to [Index:0x20F9 (Section 7)]	

## 2.5 Power Supply, Calorific Value

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

■ AC200V Input (Rotary motor)

Input voltage	Servo amplifier capacity	Servo motor model number	Rated output (W)	Rated main circuit power supply (kVA)	Control power supply (VA)
200V AC	RS2A01A	R2AA04003F	30	0.2	40
		R2AA04005F	50	0.2	
		R2AA04010F	100	0.4	
		R2AA06010F	100	0.4	
		R2AA06020F	200	0.8	
		R2AA08020F	200	0.8	
		R5AA06020H	200	0.6	
		R5AA06020F	200	0.6	
		R5AA06040H	400	1.0	
	RS2A03A	R1AA10100H	1000	2.3	
		R1AA10150H	1500	3.0	
		R2AA06040F	400	1.0	
		R2AA08040F	400	1.0	
		R2AA08075F	750	1.7	
		R2AAB8100H	1000	2.0	
		R2AA13050H	550	1.2	
		R2AA13050D	550	1.5	
		R2AA13120B	1200	2.2	
		R5AA06040F	400	1.0	
		R5AA08075D	750	1.6	
		R5AA08075F	750	1.6	
		RS2A05A	R1AA10100F	1000	
	R1AA10150F		1500	3.0	
	R1AA10200H		2000	4.0	
	R1AA10250H		2500	5.0	
	R2AAB8100F		1000	2.5	
	R2AA10100F		1000	2.3	
	R2AA13120D		1200	2.8	
	R2AA13120L		1200	2.8	
	R2AA13180H		1800	3.6	
	R2AA13200L		2000	4.0	
	RS2A10A	R1AA10200F	2000	4.0	
		R1AA10250F	2500	5.0	
		R1AA13300H	3000	6.0	
		R1AA13300F	3000	6.0	
		R1AA13400H	4000	6.7	
		R1AA13500H	5000	8.3	
		R2AA13180D	1800	4.0	
		R2AA13200D	2000	5.0	
		R2AA18350L	3500	6.0	
Q1AA10200D		2000	4.0		
Q1AA10250D		2500	4.2		
Q1AA12200D		2000	4.0		
Q1AA12300D		3000	5.0		
Q1AA13300D		3000	5.0		
Q2AA13200H		2000	4.0		
Q2AA18200H		2000	4.0		

\* The values are of rated speed, torque ratings  
 \* For specifications on other motor, please contact us.

## 2. Specifications

### Main circuit power supply capacity, Control Power supply capacity

Input voltage	Servo amplifier capacity	Servo motor model number	Rated output (W)	Rated main circuit power supply (KVA)	Control power supply (VA)
200V AC	RS2A15A	R1AA13400F	4000	6.7	40
		R1AA13500F	5000	8.3	
		R2AA18450H	4500	7.4	
		R2AA18550R	5500	8.4	
		R2AA22500L	5000	9.6	
		Q1AA13400D	4000	6.7	
		Q1AA13500D	5000	8.3	
		Q1AA18450M	4500	7.4	
		Q2AA18350H	3500	6.9	
		Q2AA18450H	4500	7.4	
		Q2AA18550R	5500	8.4	
		Q2AA22550B	5500	10.0	
	Q2AA22700S	7000	12.2		
	RS2A30A	R1AA18550H	5500	9.3	
		R1AA18750L	7500	11.6	
		R1AA1811KR	11000	16.0	
		R1AA1815KB	15000	21.4	
		R2AA18550H	5500	9.3	
		R2AA18750H	7500	11.6	
		Q1AA18750H	7500	12.6	
		Q2AA18550H	5500	10.0	
		Q2AA18750L	7500	12.6	
		Q2AA2211KV	11000	16.0	
		Q2AA2215KV	15000	21.4	
Q4AA1811KB		11000	15.7		
Q4AA1815KB	15000	21.4			

\* The values are of rated speed, torque ratings

\* For specifications on other motor, please contact us.

#### ■ AC100V Input (Rotary motor)

Input voltage	Servo amplifier capacity	Servo motor model number	Rated output (W)	Rated main circuit power supply (KVA)	Control power supply (VA)
100V AC	RS2E01A	R2EA04003F	30	0.2	40
		R2EA04005F	50	0.2	
		R2EA04008F	80	0.3	
		R2EA06010F	100	0.4	
	RS2E03A	R2EA06020F	200	0.6	

\* The values are of rated speed, torque ratings

#### ■ DC48V Input (Rotary motor)

Input voltage	Servo amplifier capacity	Servo motor model number	Rated output (W)	Rated main circuit power supply (A)	Control power supply (A)
48V DC	RS2K04A	R1GA04005F	50	5.3	0.7
		R1GA04010F	100	6.8	
		R1GA06020D	200	8.0	
		R2GA04003F	30	2.5	
		R2GA04005F	50	5.3	
		R2GA04008D	80	6.6	
		R2GA06010D	100	6.9	
		R2GA06020D	200	8.0	
		R2GA02D20F	20	1.7	
		R2GA02D30F	30	2.5	
	RS2K02A	R2GAD102RM	2.4	0.8	

\* The values are of rated speed, torque ratings

#### ■ DC24V Input (Rotary motor)

Input voltage	Servo amplifier capacity	Servo motor model number	Rated output (W)	Rated main circuit power supply (A)	Control power supply (A)
24V DC	RS2J04A	R2FA04003F	30	4.0	0.7
		R2FA04005D	50	6.4	
		R2FA04006R	60	7.3	
		R2FA06007R	70	7.6	
		R2FA06008A	80	7.8	
		R2FA02D20D	20	2.6	
		R2FA02D30H	30	3.8	

\* The values are of rated speed, torque ratings

## 2. Specifications Main circuit power supply capacity, Control Power supply capacity

### ■ AC200V Input (Linear motor)

Input voltage	Servo amplifier capacity	Servo motor model number	Rated output (W)	Rated main circuit power supply (KVA)	Control power supply (VA)
200V AC	RS2A03A	DS030C1N2	160	1.4	40
		DS050C1N2	260	1.4	
		DS075C1N2	400	1.5	
	RS2A05A	DS030C2N2	320	2.7	
		DS050C2N2	520	2.7	
		DS075C2N2	800	3.0	
		DS100C1N2	540	3.2	
		DS150C1N2	800	3.2	
		DD030C1Y4	430	2.7	
	RS2A10A	DS030C3N2	480	3.5	
		DS050C3N2	780	3.5	
		DS075C3N2	1200	3.8	
		DS100C2N2	1080	5.5	
		DS150C2N2	1600	5.5	
		DD030C2Y4	860	4.5	
		DD030C3Y4	1290	6.8	
		DD050C1Y2	700	4.4	
	RS2A15A	DD075C1Y2	1050	4.8	
		DS100C3N2	1620	8.2	
		DS150C3N2	2400	8.2	
		DD050C2Y2	1400	8.8	
RS2A30A	DD075C2Y2	2100	9.5		
	DD050C3Y2	2100	12.2		
	DD075C3Y2	3100	13.2		
		DD075C4Y2	4150	17.5	

\* The values are of rated speed and force.

2) Inrush Current, Leakage Current

■ Inrush Current

Input Voltage	Servo amplifier capacity	Control power (Maximum value between 1ms after input)	Main circuit power (Maximum value between 1.2seconds after input)
200V AC	RS2A01#	40A (O-P)	22A (O-P)
	RS2A03#		
	RS2A05#		
	RS2A10#		17A (O-P)
	RS2A15#		
100V AC	RS2A30#	20A (O-P)	11A (O-P)
	RS2E01#		
	RS2E03#		

- \* "#" = Optional alphabetical letter
- \* Using thermistor for incoming prevention circuit of control power supply. This is the maximum current value under normal temperature conditions when 230V AC or 115V AC is supplied.
- \* Incoming current value is the value when 230V AC or 115V AC is supplied.
- \* When the power is turned ON again immediately after disconnection, power supply disconnection is repeated for a short period of time, ambient temperature is high, or, the thermistor temperature rises, the incoming current exceeding the above table may pass.

■ Leakage Current

Servo amplifier capacity	Electric leakage current per motor
RS2#01#	0.8 mA
RS2#03#	0.8 mA
RS2#05#	1.5 mA
RS2A10#	3.0 mA
RS2A15#	3.0 mA
RS2A30#	3.0 mA
RS2K(J)#	0.8 mA

- \* # = Optional alphabetical letter
- \* While using two (2) or more motors, leakage current from each motor should be added.
- \* These values are applicable when a tough rubber sheath cable of 2M is used as a power line. In the case of a shorter or longer cable length, values of the above table should be selected as closely as possible.
- \* The machine should be grounded so that dangerous voltage does not occur at the main part of the machine, such as the operation panel, etc., during a period of emergency leakage current.
- \* The value of leaked current is the measured value using ordinary leak checkers (Filter 700Hz). When electric leakage current of high frequency flows through the floating capacity of the motor winding, power cable or amplifier, malfunctions may occur in the short circuit breaker and protective relay in the power supply electric circuit. Use the inverter as an electricity leakage breaker to provide countermeasures for incorrect operations.

3) Calorific value

■ Rotary motor

Input voltage	Servo amplifier capacity	Servo motor model number	Servo amplifier total calorific value (W)	Input voltage	Servo amplifier capacity	Servo motor model number	Servo amplifier total calorific value (W)
200V AC	RS2A01A	R2AA04003F	13	200V AC	RS2A15A	R1AA13400F	157
		R2AA04005F	14			R1AA13500F	180
		R2AA04010F	15			R2AA18450H	163
		R2AA06010F	15			R2AA18550R	213
		R2AA06020F	20			R2AA22500L	164
		R2AA08020F	20			Q1AA13400D	157
		R5AA06020H	20			Q1AA13500D	180
		R5AA06020F	20			Q1AA18450M	150
	R5AA06040H	22	Q2AA18350H			148	
	RS2A03A	R1AA10100H	45			Q2AA18450H	163
		R1AA10150H	60			Q2AA18550R	213
		R2AA06040F	31			Q2AA22550B	230
		R2AA08040F	30			Q2AA22700S	235
		R2AA08075F	43			RS2A30A	R1AA18550H
		R2AAB8100H	45		R1AA18750L		365
		R2AA13050H	40		R1AA1811KR		430
		R2AA13050D	44		R1AA1815KB		450
		R2AA13120B	49		R2AA18550H		315
		R5AA06040F	31		R2AA18750H		365
	R5AA08075D	43	Q1AA18750H		380		
	R5AA08075F	43	Q2AA18550H		315		
	RS2A05A	R1AA10100F	60		Q2AA18750L		365
		R1AA10150F	70	Q2AA2211KV	440		
		R1AA10200H	70	Q2AA2215KV	450		
		R1AA10250H	80	Q4AA1811KB	430		
		R2AAB8100F	45	Q4AA1815KB	450		
		R2AA10100F	50	RS2E01A	R2EA04003F	13	
		R2AA13120D	68		R2EA04005F	15	
		R2AA13120L	60		R2EA04008F	16	
	R2AA13180H	87	R2EA06010F		17		
	R2AA13200L	87	RS2E03A		R2EA06020F	26	
	RS2A10A	R1AA10200F			100		
		R1AA10250F	115				
		R1AA13300H	120				
		R1AA13300F	135				
		R1AA13400H	157				
		R1AA13500H	170				
		R2AA13180D	92				
		R2AA13200D	100				
		R2AA18350L	148				
		Q1AA10200D	112				
		Q1AA10250D	118				
		Q1AA12200D	104				
		Q1AA12300D	125				
Q1AA13300D		127					
Q2AA13200H		98					
Q2AA18200H		108					

\* For specifications on other motor, please contact us.

■ Rotary motor

Input voltage	Servo amplifier capacity	Servo motor model number	Servo amplifier total calorific value (W)
48V DC	RS2K04A	R1GA04005F	15
		R1GA04010F	22
		R1GA06020D	26
		R2GA04003F	9
		R2GA04005F	15
		R2GA04008D	20
		R2GA06010D	22
		R2GA06020D	26
		R2GA02D20F	7
	R2GA02D30F	9	
	RS2K02A	R2GAD102RM	5

\* For specifications on other motor, please contact us.

Input voltage	Servo amplifier capacity	Servo motor model number	Servo amplifier total calorific value (W)
24V DC	RS2J04A	R2FA04003F	10
		R2FA04005D	16
		R2FA04006R	18
		R2FA06007R	20
		R2FA06008A	22
		R2FA02D20D	8
		R2FA02D30H	10

\* For specifications on other motor, please contact us.

■ Linear motor

Input voltage	Servo amplifier capacity	Servo motor model number	Servo amplifier total calorific value (W)	Input voltage	Servo amplifier capacity	Servo motor model number	Servo amplifier total calorific value (W)	
200V AC	RS2A03A	DS030C1N2	41	200V AC	RS2A10L	DD030C3Y4	138	
		DS050C1N2	41			DD050C1Y2	110	
		DS075C1N2	42			DD075C1Y2	110	
		DS045CC1AN	41			DS100C3N2	185	
		DT030CD1AN	41			DS150C3N2	185	
	RS2A05A	DS030C2N2	68		RS2A15L	DD050C2Y2	210	
		DS050C2N2	68			DD075C2Y2	210	
		DS075C2N2	69			RS2A30L	DD050C3Y2	270
		DS100C1N2	70				DD075C3Y2	275
		DS150C1N2	70				DD075C4Y2	380
	RS2A10A	DD030C1Y4	65					
		DS030C3N2	91					
		DS050C3N2	91					
		DS075C3N2	93					
		DS100C2N2	135					
		DS150C2N2	135					
			DD030C2Y4	110				

- \* Generation of heat from regeneration resistance is not included in the numerical value of the above table. It is necessary to add it if needed.
- \* Strictly follow installation method written in the section 3.1.
- \* Value are 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]

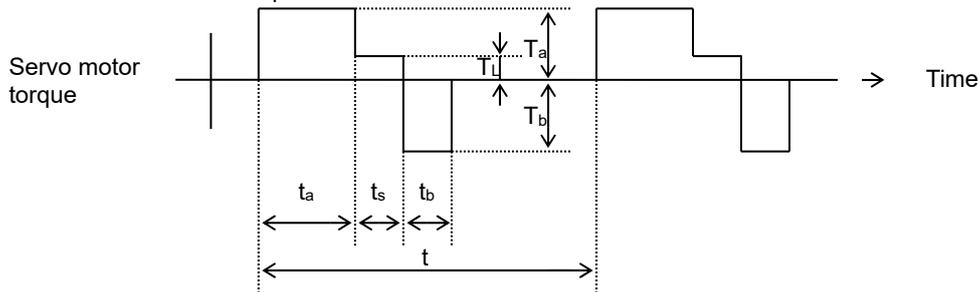
- ◆  $t_a$  : Acceleration time (s)
- ◆  $t_b$  : Deceleration time (s)
- ◆  $J_M$  : Motor inertia ( $\text{kg} \cdot \text{m}^2$ )
- ◆  $J_L$  : Load inertia ( $\text{kg} \cdot \text{m}^2$ )
- ◆  $N_1, N_2$  : Rotational speed of motor ( $\text{min}^{-1}$ )
- ◆  $T_P$  : Instantaneous maximum stall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

\* 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:

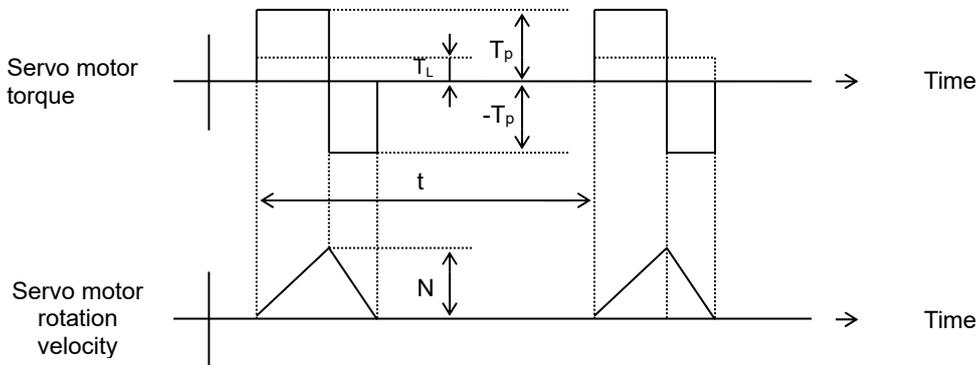
$$t \geq \frac{T_a^2 t_a + T_L^2 t_s + T_b^2 t_b}{T_R^2} \quad [\text{s}]$$

- $T_a$  : 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  $T_a, T_b, t_a, t_b$  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  $T_{rms} < 0.9T_R$ .

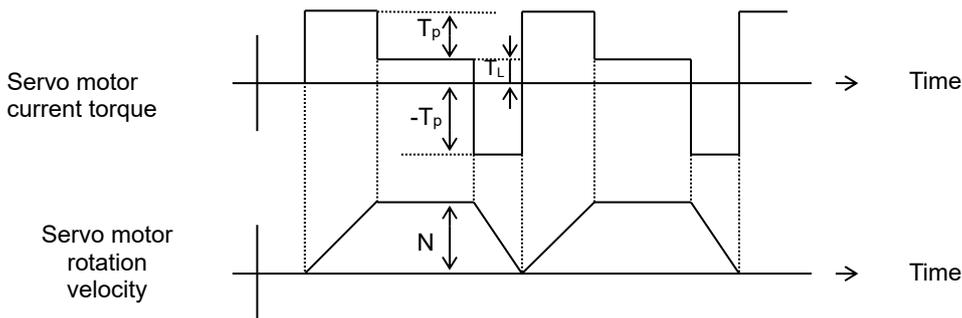
- When the motor repeats acceleration, deceleration and stop status  
In operating status (shown below) the value of permitted repetitions n (times/minutes) is found with the following equation:



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

$T_R$ : 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:



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

$T_R$ : 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]

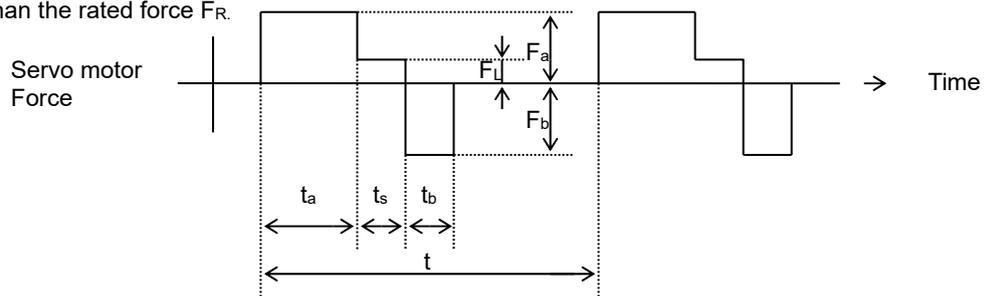
- ◆  $t_a$  :Acceleration time (s)
- ◆  $t_b$  :Deceleration time (s)
- ◆  $M_C$  : Linear motor coil mass (kg)
- ◆  $M_L$  :Load weight (kg)
- ◆  $V_1, V_2$  :Speed of motor (m/s)
- ◆  $F_P$  :Maximum thrust (N)
- ◆  $F_L$  :Load thrust (N)

\* 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.

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

- 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:

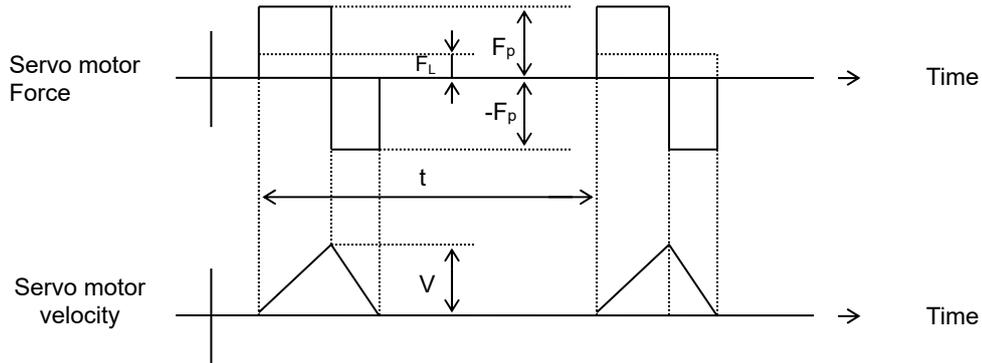
$$t \geq \frac{F_a^2 t_a + F_L^2 t_s + F_b^2 t_b}{F_R^2} \quad [s]$$

- |                            |                           |                                 |
|----------------------------|---------------------------|---------------------------------|
| $F_a$ :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  $F_a, F_b, t_a, t_b$  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  $F_{rms} < 0.9F_R$ .

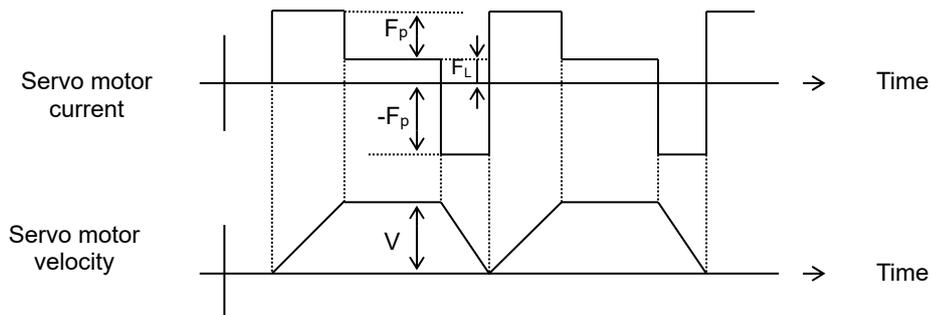
- When the motor repeats acceleration, deceleration and stop status  
In operating status (shown below) the value of permitted repetitions n (times/minutes) is found with the following equation:



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

$F_R$ : 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:



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

$F_R$ : 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

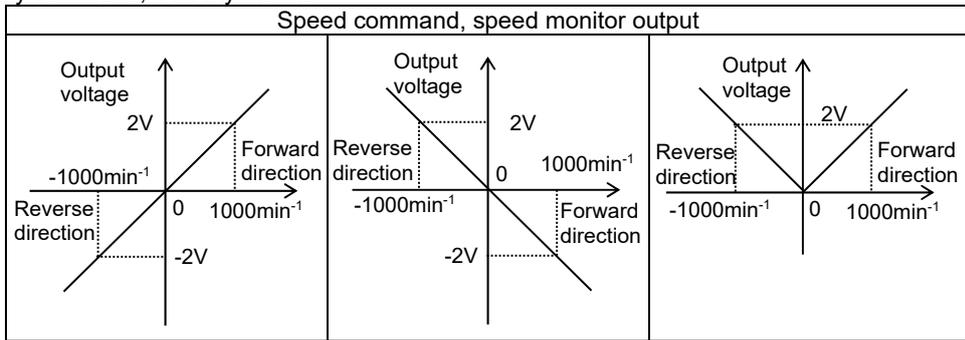
## 2.7 Specifications for Analog Monitor

■ Electrical specifications

- ◆ Output voltage range:  $\pm 8V$  DC
- ◆ Output resistance:  $1k\Omega$
- ◆ Load: less than  $2mA$

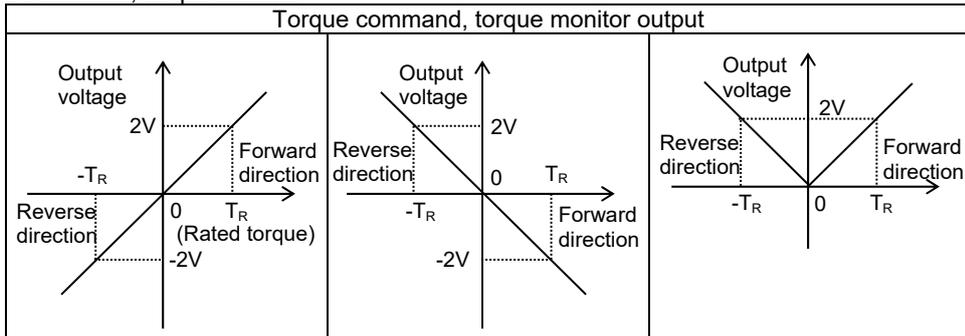
\* Monitor output is indefinite at the time of power ON/OFF and may output  $12V$  DC  $+10\%$  around.

■ Velocity command, Velocity monitor



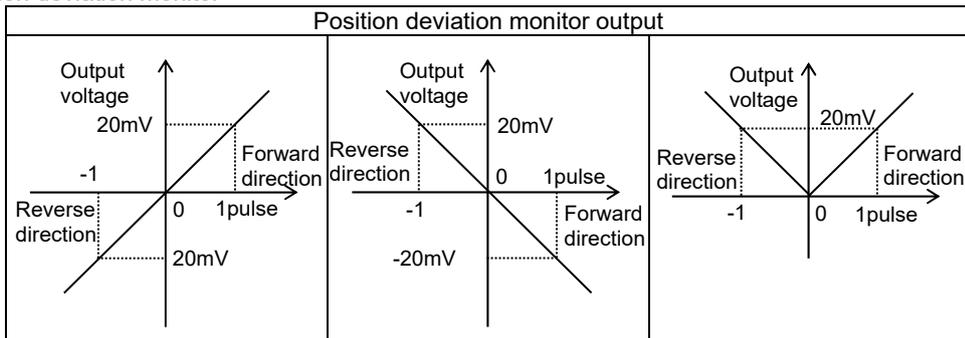
\* Horizontal unit when using linear motor is changed from " $\text{min}^{-1}$ " to " $\text{mm/s}$ ."

■ Torque command, torque monitor



\* Horizontal axis unit when using linear motor is change from " $T_R$  (rated torque)" to " $FR$  (rated force)."

■ Position deviation monitor



## 2.8 Specifications for Dynamic Brake

### 1) Allowable frequency

- Allowable frequency of the dynamic brake (main circuit power ON/OFF)  
Less than 10 times per hour and 50 times per day at maximum speed within the applied load inertia.
- Operation intervals  
In basic terms, operation of the dynamic brake in six (6) minute intervals is acceptable. If the brake is to be operated more frequently, the motor speed must be reduced sufficiently.  
Refer to the following expression to find a standard of operation:

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

- If/When the load inertia (J<sub>L</sub>) substantially exceeds the applicable load inertia, abnormal heat can generate due to dynamic brake resistance. Take precautions against (Overheat alarm of the dynamic break) or (failure of dynamic brake resistance). Please consult us if such a situation is evident.

### 2) Instantaneous tolerance

The consumption of energy E<sub>RD</sub> by dynamic brake resistance in one dynamic brake operation is as follows:

- Rotary motor

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

- R $\Phi$  : Servo motor phase winding resistance( $\Omega$ )
- J<sub>M</sub> : Rotor inertia of servo motor (kg·m<sup>2</sup>)
- J<sub>L</sub> : Load inertia (motor axis conversion)(kg·m<sup>2</sup>)
- N : Servo motor rotation speed in feed rate V(min<sup>-1</sup>)
- I : Integrated stage-down rotation angle(rad)
- T<sub>L</sub> : Load torque (N·m)

- Linear motor

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

- R $\Phi$  : Servo motor phase winding resistance( $\Omega$ )
- M : Moving part mass (kg)
- V : Velocity just before deceleration (m/s)

- Instantaneous tolerance of dynamic brake

Servo amplifier Model number	ERD (J)
RS2#01A#HA#, RS2#01A#HL#	360
RS2#03A#HA#, RS2#03A#HL#	360
RS2#05A#HA#, RS2#05A#HL#	1800
RS2#10A#HA#, RS2#10A#HL#	2450
RS2#15A#HA#, RS2#15A#HL#	2450
RS2#30A#HL#	9384

\* "#" = Optional number or alphabetical letter.

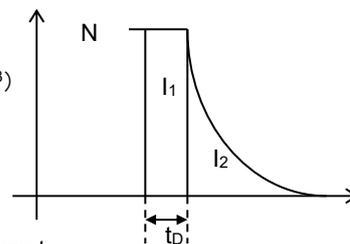
3) Decreasing the rotation angle

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

■ Rotary motor

$$\text{Coasting distance} = l_1 + l_2 = \frac{2\pi N \times t_D}{60} + (J_M + J_L) \times (\alpha N + \beta N^3)$$

- $J_M$  :Rotor inertia of servo motor (kg·m<sup>2</sup>)
- $J_L$  :Load inertia (motor axis conversion) (kg·m<sup>2</sup>)
- $N$  :Servo motor rotation speed (min<sup>-1</sup>)
- $l_1$  :Stage down rotation angle (rad) using amplifier internal process  $t_D$
- $l_2$  :Stage down rotation angle (rad) using dynamic brake operation
- $t_D$  :Brake activation delay time:  $t_D$  [s]
- $\alpha \cdot \beta$ : Constants for dynamic brake



$\alpha \cdot \beta$ :

Servo amplifier capacity	Servo motor model number	$\alpha$	$\beta$	$J_M(\text{kg} \cdot \text{m}^2)$
RS2#01A	R2AA04003F	227	$4.29 \times 10^{-6}$	$0.0247 \times 10^{-4}$
	R2AA04005F	119	$2.96 \times 10^{-6}$	$0.0376 \times 10^{-4}$
	R2AA04010F	41.2	$1.56 \times 10^{-6}$	$0.0627 \times 10^{-4}$
	R2AA06010F	32.6	$5.04 \times 10^{-6}$	$0.117 \times 10^{-4}$
	R2AA06020F	14.5	$2.46 \times 10^{-6}$	$0.219 \times 10^{-4}$
	R2AA08020F	11.3	$1.13 \times 10^{-6}$	$0.52 \times 10^{-4}$
	R5AA06020H	11.7	$3.76 \times 10^{-6}$	$0.2 \times 10^{-4}$
	R5AA06020F	15.36	$2.92 \times 10^{-6}$	$0.2 \times 10^{-4}$
	R5AA06020H	6.09	$2.3 \times 10^{-6}$	$0.416 \times 10^{-4}$
RS2#03A	R2AA06040F	8.82	$1.00 \times 10^{-6}$	$0.412 \times 10^{-4}$
	R2AA08040F	6.91	$4.25 \times 10^{-6}$	$1.04 \times 10^{-4}$
	R2AA08075F	5.84	$9.10 \times 10^{-8}$	$1.82 \times 10^{-4}$
	R2AAB8100H	3.09	$3.83 \times 10^{-7}$	$2.38 \times 10^{-4}$
	R2AA13050H	4.37	$3.55 \times 10^{-6}$	$3.1 \times 10^{-4}$
	R2AA13050D	6.46	$2.14 \times 10^{-6}$	$3.1 \times 10^{-4}$
	R2AA13120B	1.68	$1.56 \times 10^{-6}$	$6 \times 10^{-4}$
	R5AA06040F	10.11	$1.55 \times 10^{-6}$	$0.416 \times 10^{-4}$
	R5AA06020H	4.67	$1.67 \times 10^{-6}$	$1.65 \times 10^{-4}$
	R5AA06020H	6.45	$2.75 \times 10^{-6}$	$1.65 \times 10^{-4}$
RS2#05A	R2AAB8100F	5.46	$2.08 \times 10^{-7}$	$2.38 \times 10^{-4}$
	R2AA13050D	6.47	$2.54 \times 10^{-6}$	$3.4 \times 10^{-4}$
	R2AA10100F	5.35	$4.86 \times 10^{-7}$	$3.5 \times 10^{-4}$
	R2AA13120D	4.06	$5.92 \times 10^{-7}$	$6.3 \times 10^{-4}$
	R2AA13120L	2.99	$1.21 \times 10^{-6}$	$6 \times 10^{-4}$
	R2AA13180H	2.17	$4.667 \times 10^{-7}$	$9.0 \times 10^{-4}$
	R2AA13200L	1.83	$3.1 \times 10^{-7}$	$12.2 \times 10^{-4}$
RS2A10A	R2AA13200D	1.69	$0.91 \times 10^{-7}$	$12.2 \times 10^{-4}$
	R2AA18350L	0.82	$1.6 \times 10^{-8}$	$40 \times 10^{-4}$
	Q1AA10200D	4.19	$0.47 \times 10^{-7}$	$2.15 \times 10^{-4}$
	Q1AA10250D	2.70	$0.46 \times 10^{-7}$	$2.65 \times 10^{-4}$
	Q1AA12200D	2.85	$0.33 \times 10^{-7}$	$4.37 \times 10^{-4}$
	Q1AA12300D	1.53	$0.27 \times 10^{-7}$	$6.40 \times 10^{-4}$
	Q1AA13300D	1.78	$0.53 \times 10^{-7}$	$4.92 \times 10^{-4}$
	Q2AA18200H	1.49	$0.36 \times 10^{-7}$	$20 \times 10^{-4}$

Servo amplifier capacity	Servo motor model number	$\alpha$	$\beta$	$J_M(\text{kg}\cdot\text{m}^2)$
RS2A15A	R2AA18450H	0.67	$1.2 \times 10^{-8}$	$50 \times 10^{-4}$
	R2AA18550R	0.53	$7 \times 10^{-9}$	$68 \times 10^{-4}$
	R2AA22500L	0.8	$0.41 \times 10^{-7}$	$55 \times 10^{-4}$
	Q1AA13400D	2.13	$0.25 \times 10^{-7}$	$6.43 \times 10^{-4}$
	Q1AA13500D	1.52	$0.20 \times 10^{-7}$	$8.47 \times 10^{-4}$
	Q1AA18450M	0.43	$0.35 \times 10^{-7}$	$27.5 \times 10^{-4}$
	Q2AA22550B	0.46	$0.11 \times 10^{-7}$	$95 \times 10^{-4}$
	Q2AA22700S	0.18	$0.10 \times 10^{-7}$	$185 \times 10^{-4}$
RS2A30A	R1AA18550H	1.08	$4 \times 10^{-9}$	$33 \times 10^{-4}$
	R1AA18750L	0.67	$2 \times 10^{-9}$	$42 \times 10^{-4}$
	R1AA1811KR	0.41	$2 \times 10^{-9}$	$64 \times 10^{-4}$
	R1AA1815KB	0.26	$2 \times 10^{-9}$	$86 \times 10^{-4}$
	R2AA18550H	1.13	$4 \times 10^{-9}$	$68 \times 10^{-4}$
	R2AA18750H	0.72	$2 \times 10^{-9}$	$98 \times 10^{-4}$
	Q2AA2211KV	0.46	$2.58 \times 10^{-9}$	$186 \times 10^{-4}$
	Q2AA2215KV	0.32	$2.04 \times 10^{-9}$	$255 \times 10^{-4}$
RS2E01A	R2EA04005F	171	$2.06 \times 10^{-6}$	$0.0376 \times 10^{-4}$
	R2EA04008F	69.7	$1.06 \times 10^{-6}$	$0.0627 \times 10^{-4}$
	R2EA06010F	59.1	$2.84 \times 10^{-6}$	$0.117 \times 10^{-4}$
RS2E03A	R2EA06020F	38.8	$9.10 \times 10^{-7}$	$0.219 \times 10^{-4}$
RS2K04A	R1GA04005F	83.2	$9.39 \times 10^{-6}$	$0.0146 \times 10^{-4}$
	R1GA04010F	36.5	$5.26 \times 10^{-6}$	$0.0242 \times 10^{-4}$
	R1GA06020D	10.5	$6.51 \times 10^{-6}$	$0.122 \times 10^{-4}$
	R2GA04003F	185	$5.14 \times 10^{-6}$	$0.0247 \times 10^{-4}$
	R2GA04005F	93.9	$3.82 \times 10^{-6}$	$0.0376 \times 10^{-4}$
	R2GA04008D	32.5	$2.00 \times 10^{-6}$	$0.0627 \times 10^{-4}$
	R2GA06010D	21.9	$7.53 \times 10^{-6}$	$0.117 \times 10^{-4}$
	R2GA06020D	7.4	$4.88 \times 10^{-6}$	$0.219 \times 10^{-4}$
	R2GA20D20F	317	$1.44 \times 10^{-6}$	$0.0033 \times 10^{-4}$
	R2GA20D30F	201	$8.99 \times 10^{-7}$	$0.0046 \times 10^{-4}$
RS2K02A	R2GAD102RM	2551	$3.63 \times 10^{-7}$	$0.0023 \times 10^{-4}$
RS2J04A	R2FA04003F	204	$4.68 \times 10^{-6}$	$0.0247 \times 10^{-4}$
	R2FA04005D	104	$2.65 \times 10^{-6}$	$0.0376 \times 10^{-4}$
	R2FA04006R	41.8	$1.98 \times 10^{-6}$	$0.0627 \times 10^{-4}$
	R2FA06007R	26.3	$7.26 \times 10^{-6}$	$0.117 \times 10^{-4}$
	R2FA06008A	8.8	$3.56 \times 10^{-6}$	$0.219 \times 10^{-4}$
	R2FA02D20D	317	$8.98 \times 10^{-6}$	$0.0033 \times 10^{-4}$
	R2FA02D30H	201	$8.99 \times 10^{-6}$	$0.0046 \times 10^{-4}$

- \* The values for  $\alpha$ ,  $\beta$  are reached based on an assumed resistance value of the power line being  $0\Omega$ . Contact us when the combination with an amplifier is different than those shown above (invariably values are different).
- \* For specifications on other motor, please contact us.

Brake operation delay time:  $t_b$

Servo amplifier model number	Delay time $t_b(\text{S})$
RS2#01A#HA#, RS2#01A#HL#	$10 \times 10^{-3}$
RS2#03A#HA#, RS2#03A#HL#	$10 \times 10^{-3}$
RS2#05A#HA#, RS2#05A#HL#	$10 \times 10^{-3}$
RS2#10A#HA#, RS2#10A#HL#	$24 \times 10^{-3}$
RS2#15A#HA#, RS2#15A#HL#	$24 \times 10^{-3}$
RS2#30A#HL#	$42 \times 10^{-3}$
RS2K#A#H#, RS2J#A#H#	$10 \times 10^{-3}$

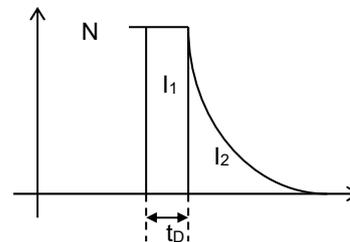
■ Linear motor

Linear servo motor can apply dynamic brake by short-circuiting motor power line, as linear servo motor is permanent-magnet type. Dynamic brake is activated at an emergency stop due to alarm. When any frictions are ignored in horizontal axis, the coasting distance of moving stage when dynamic brake activated is calculated by the following guide calculation formulas.

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

\* When frictional force (Ff) is zero,

- V : Motor velocity [m/s]
- t<sub>D</sub> : Brake operation delay time [s]  
t<sub>D</sub> is the same constant as the one for rotary motor.
- M : Moving part mass = M<sub>c</sub> + M<sub>L</sub> [kg]  
(M<sub>C</sub> : Coil mass [Kg] , M<sub>L</sub> : Load mass [Kg])
- α , β : Constants for dynamic brake



α · β :

Servo amplifier capacity	Servo motor model number	α	β	M (kg)
RS2A03A	DS030C1N2	6.88 × 10 <sup>-3</sup>	1.59 × 10 <sup>-3</sup>	2.8
	DS050C1N2	3.05 × 10 <sup>-3</sup>	1.27 × 10 <sup>-3</sup>	3.8
	DS045CC1AN	4.16 × 10 <sup>-3</sup>	3.62 × 10 <sup>-3</sup>	1.8
	DT030CD1AN	2.85 × 10 <sup>-3</sup>	1.06 × 10 <sup>-3</sup>	2.4
	DS075C1N2	1.75 × 10 <sup>-3</sup>	1.03 × 10 <sup>-3</sup>	5.2
RS2A05A	DS030C2N2	5.42 × 10 <sup>-3</sup>	5.04 × 10 <sup>-4</sup>	5.4
	DS050C2N2	2.27 × 10 <sup>-3</sup>	4.26 × 10 <sup>-4</sup>	7.4
	DS075C2N2	1.23 × 10 <sup>-3</sup>	3.64 × 10 <sup>-4</sup>	10
	DS100C1N2	2.65 × 10 <sup>-3</sup>	4.05 × 10 <sup>-4</sup>	6.6
	DS150C1N2	1.30 × 10 <sup>-3</sup>	3.49 × 10 <sup>-4</sup>	9.4
	DD030C1Y4	3.98 × 10 <sup>-3</sup>	1.08 × 10 <sup>-3</sup>	8.3
RS2A10A	DS030C3N2	4.46 × 10 <sup>-3</sup>	6.83 × 10 <sup>-5</sup>	7.8
	DS050C3N2	1.75 × 10 <sup>-3</sup>	6.17 × 10 <sup>-5</sup>	10.9
	DS075C3N2	8.91 × 10 <sup>-4</sup>	5.59 × 10 <sup>-5</sup>	14.8
	DS100C2N2	2.09 × 10 <sup>-3</sup>	3.21 × 10 <sup>-5</sup>	12.6
	DS150C2N2	9.60 × 10 <sup>-4</sup>	2.96 × 10 <sup>-5</sup>	17.8
	DD030C2Y4	2.21 × 10 <sup>-3</sup>	1.22 × 10 <sup>-4</sup>	15.0

Servo amplifier capacity	Servo motor model number	α	β	M (kg)
RS2A10A	DD030C3Y4	2.02 × 10 <sup>-3</sup>	5.92 × 10 <sup>-5</sup>	21.6
	DD050C1Y2	3.25 × 10 <sup>-3</sup>	1.09 × 10 <sup>-4</sup>	11.2
	DD075C1Y2	1.63 × 10 <sup>-3</sup>	9.95 × 10 <sup>-5</sup>	14.7
RS2A15A	DS100C3N2	2.03 × 10 <sup>-3</sup>	1.47 × 10 <sup>-5</sup>	18.6
	DS150C3N2	9.23 × 10 <sup>-4</sup>	1.37 × 10 <sup>-5</sup>	26.2
	DD050C2Y2	2.93 × 10 <sup>-3</sup>	3.01 × 10 <sup>-5</sup>	21.2
	DD075C2Y2	1.43 × 10 <sup>-3</sup>	2.83 × 10 <sup>-5</sup>	26.5
RS2A30A	DD050C3Y2	2.83 × 10 <sup>-3</sup>	1.39 × 10 <sup>-5</sup>	29.0
	DD075C3Y2	1.37 × 10 <sup>-3</sup>	1.32 × 10 <sup>-5</sup>	38.1
	DD075C4Y2	1.33 × 10 <sup>-3</sup>	7.60 × 10 <sup>-6</sup>	49.5

## 2.9 Regeneration Process

The tables below are resistance value of the built-in regeneration resistor and regeneration resistance power that can be tolerated by the amplifier regeneration circuit.

Refer to the section 14.2 for the selection method of regeneration resistance.

### 1) Resistance value of built-in regeneration resistor

Servo amplifier model	Resistance value of built-in resistor
RS2#01A#HA#	50Ω
RS2#03A#HA#	50Ω
RS2#05A#HA#	17Ω
RS2A10A#HA#	10Ω
RS2A15A#HA#	6Ω
RS2K#A#HA# RS2J#A#HA#	15Ω

"#" = Optional number or alphabetical letter.

\* RS2A30A##L# has no built-in regenerative resistor, so please connect a regenerative resistor.

### ■ Tolerable power of regeneration resistance

Servo amplifier model	Tolerable regeneration resistance power-built-in type [PRI]	Tolerable regeneration resistance power-external type [PR0]
RS2#01A#HA# RS2#01A#HL#	5W	220W
RS2#03A#HA# RS2#03A#HL#	5W	220W
RS2#05A#HA# RS2#05A#HL#	20W	500W
RS2A10A#HA# RS2A10A#HL#	90W	500W
RS2A15A#HA# RS2A15A#HL#	120W	500W
RS2A30A#HL#	-	500W
RS2K#A#HA# RS2J#A#HA#	7W	55W

"#" = Optional number or alphabetical letter.

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# 3

## 3. Installation

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## 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 on or put heavy items on the servo amplifier.

Operate the device within the specified environmental conditions.

Do not drop the device or subject it to excessive shock.

Make sure no screws or other conductive or flammable materials get inside the servo amplifier.

Do not obstruct the air intake and exhaust vents.

The 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.

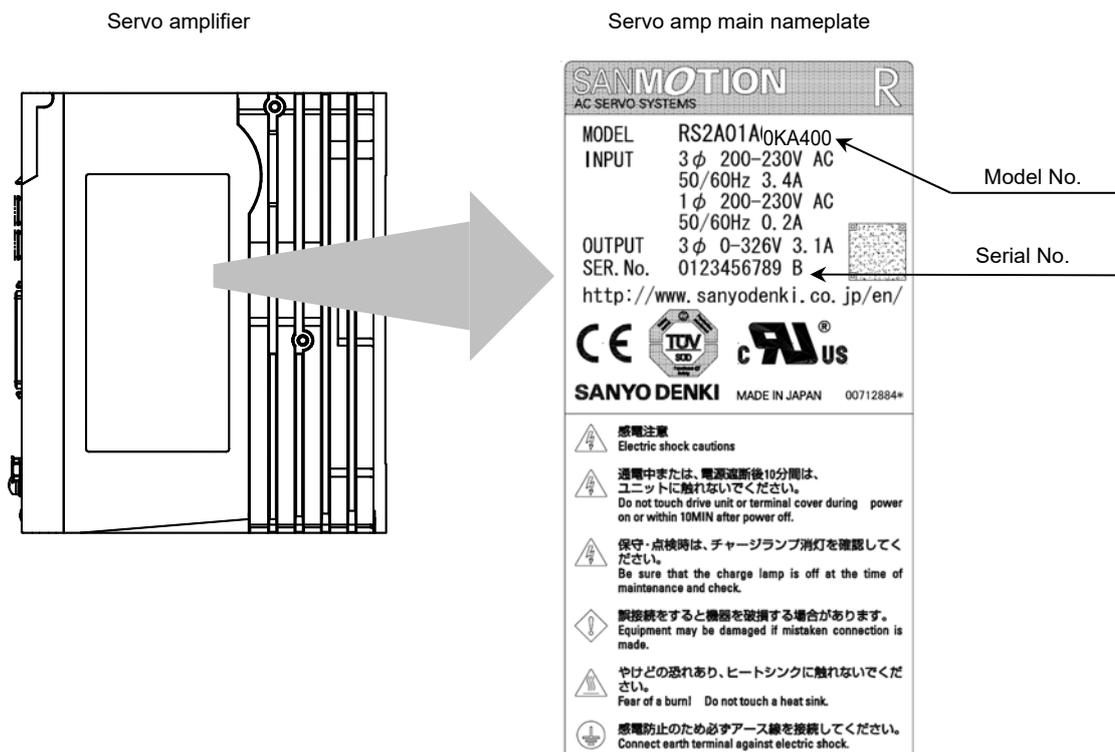
#### ■ If a large noise source is present

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

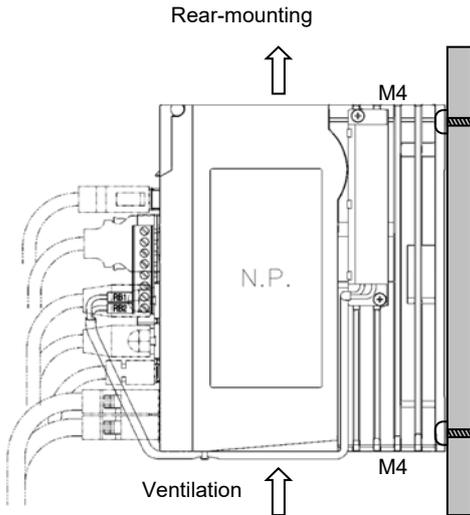
Verify the followings when the product arrives. If you find any discrepancy, contact your distributor or sales office.

- 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  
 Month (2 digits) + Year (2 digits) + Day (2 digits) + Serial number (4 digits) + Revision ("A" is abbreviated)

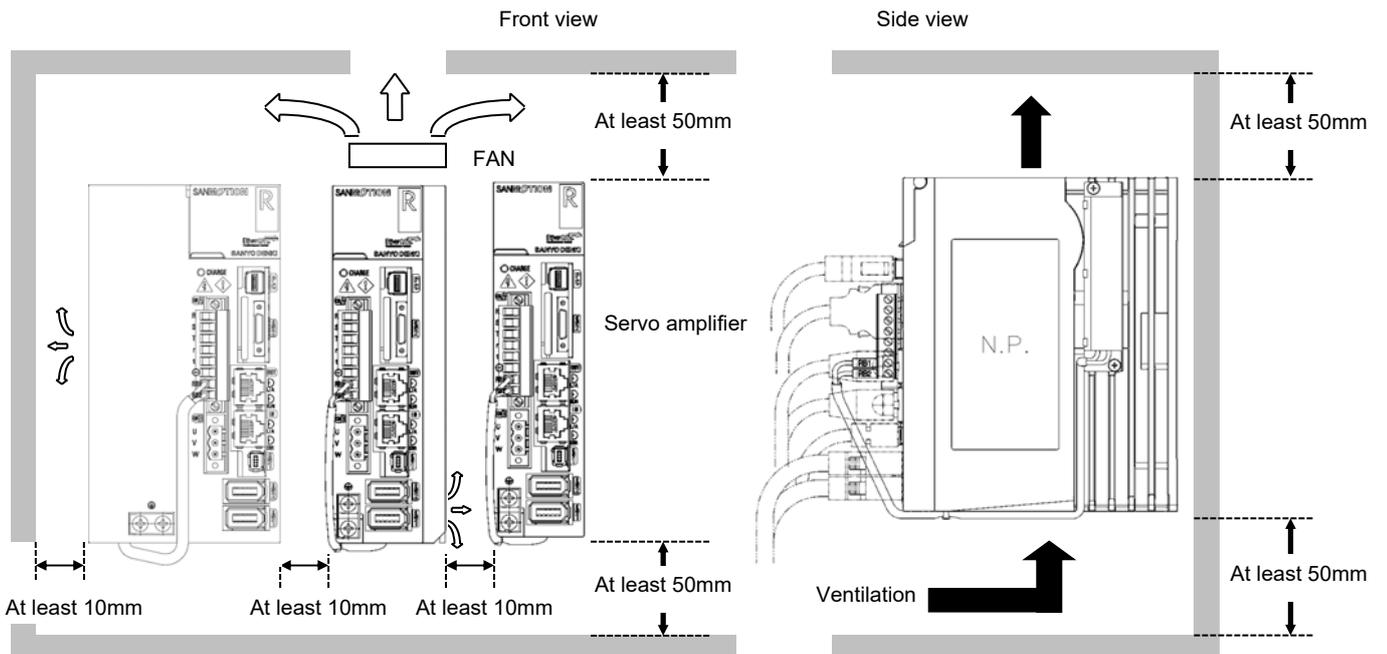
3) Mounting direction and location



\* Refer to Appendix, optional parts, for front 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 R-series 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.  
 RS2\*01, RS2\*03, RS2\*05 : 2mm or more (recommended metal plate thickness)  
 RS2\*10, RS2\*15, RS2\*30 : 5mm or more (recommended metal plate thickness)
- For RS2\*03 - RS2\*05, a cooling fan is attached at the side. Therefore, it is recommended that the servo amplifier be mounted in an arrangement as shown below.



## 5) Cooling condition (for DC input type amplifier only)

Please force air cooling for heatsink of the amplifier certainly in case of load condition of the servo motor below.

- Confirmation by calculation of effective output current.

Effective output current:  $I_{rms}$  is calculated with  $T_{rms}$  which is shown in "15.1 Rotary Motor Sizing ",  $T_R$  and  $I_R$  which are shown in "16.4 Servo Motor Data Sheet ". See calculation formula below.

$$I_{rms} = I_R \times \frac{T_{rms}}{T_R} \quad [A]$$

- $T_R$  : Rated torque of servo motor (Catalog value) [N·m]
- $I_R$  : Rated current of servo motor (Catalog value) [A]
- $T_{rms}$  : Effective torque that calculated with operation pattern and load condition [N·m]
- $I_{rms}$  : Effective output current calculated by formula above [A]

Please force air cooling for the amplifier in case of " $I_{rms} > 3.3 [A]$ " by calculation above.

- Confirmation on actual application

Check surface temperature of heatsink center by heat run test at actual system.

Please force air cooling for the amplifier in case of "The temperature above  $> 65 \text{ }^\circ\text{C}$ ".

- \* Please use hardest condition for heat run test.
  - \* See fan recommendation below for force air cooling.
    - DC San Ace series Fan, 60 mm sq. /80 mm sq. (Standard type, SANYO DENKI)
    - San L series Fan, 60 mm sq. /80 mm sq. (Long life type, SANYO DENKI)
- Ask our sales person to use of cooling fan.

### 3.2 Rotary Motor

#### 1) Precautions

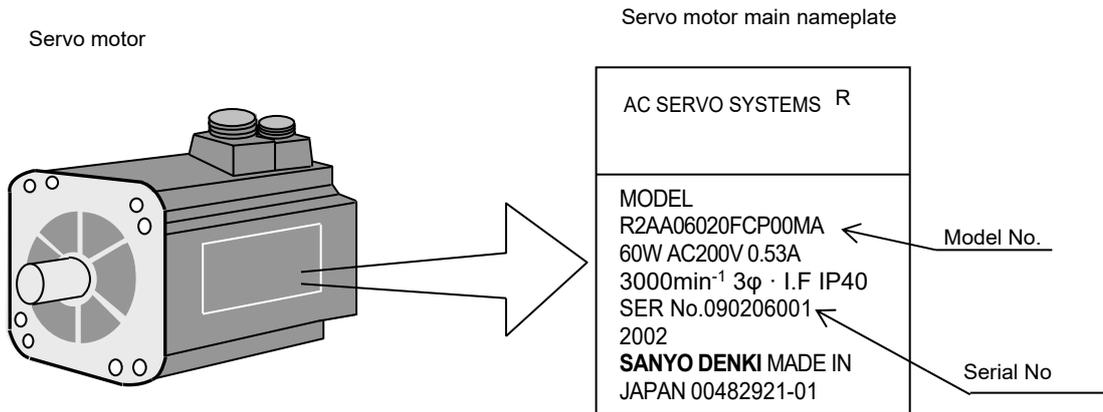
■ Various precautions

The device should be installed on non-flammable surfaces only. Installation on or near flammable materials can cause fire.
Do not stand on or put heavy items on the servo motor.
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.



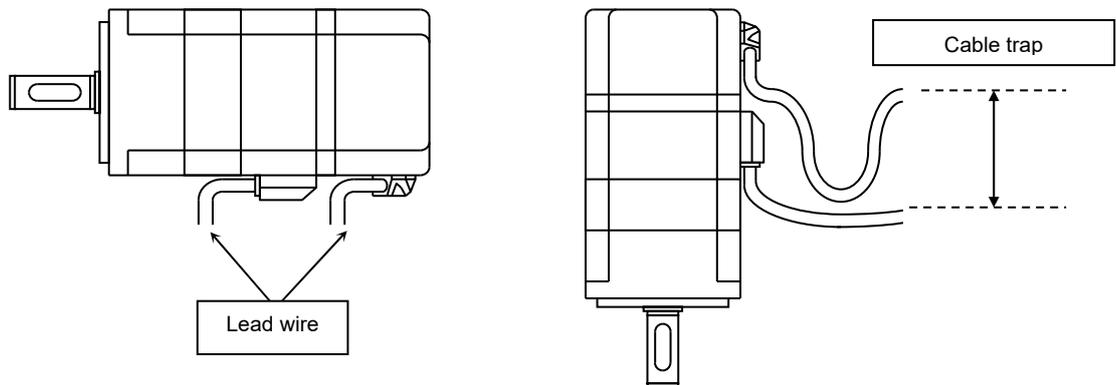
#### 3) Installation

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

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

## 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.

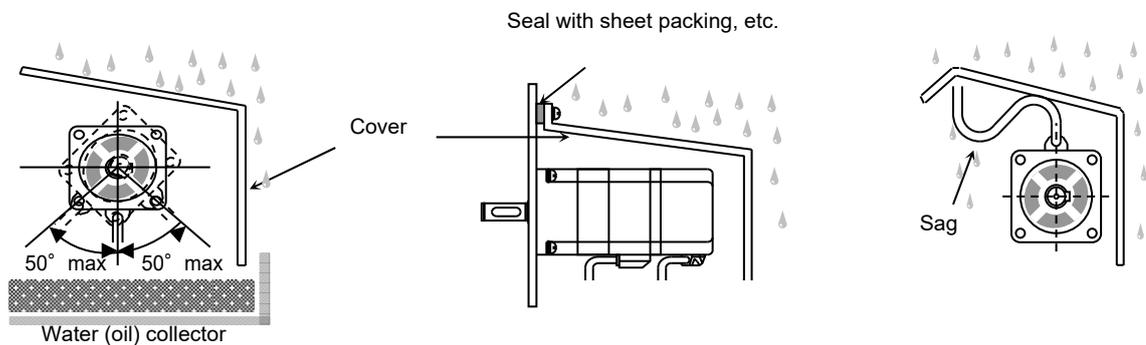


## 5) Waterproofing and dust proofing

- 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 canon plug type motor, use a waterproofed type plug.

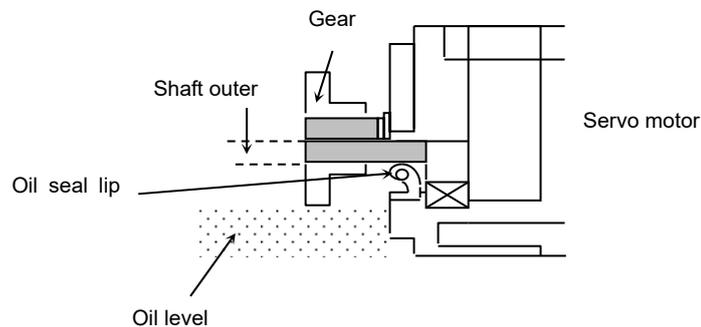
## 6) Protective cover installation

- 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.



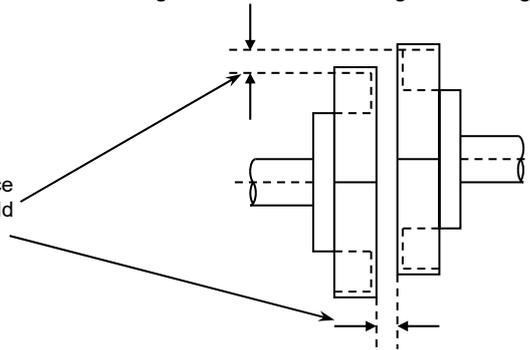
## 7) Gear installation and Integration with the target machinery

- 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.

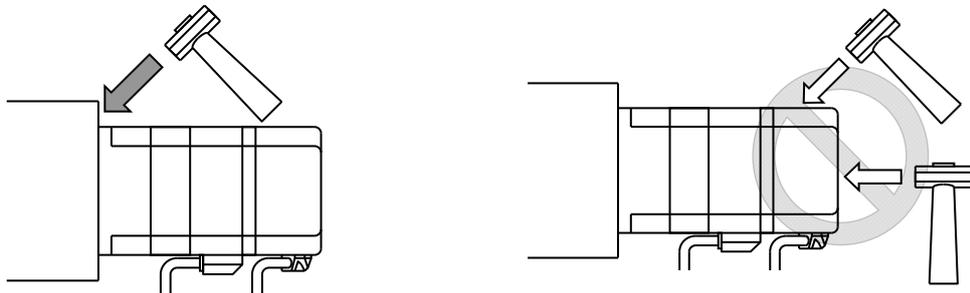


- Refer to the drawing below for correct centering of the motor shaft and the target machinery. Please note when using a rigid coupling that even a slight mistake in centering can damage the output shaft.

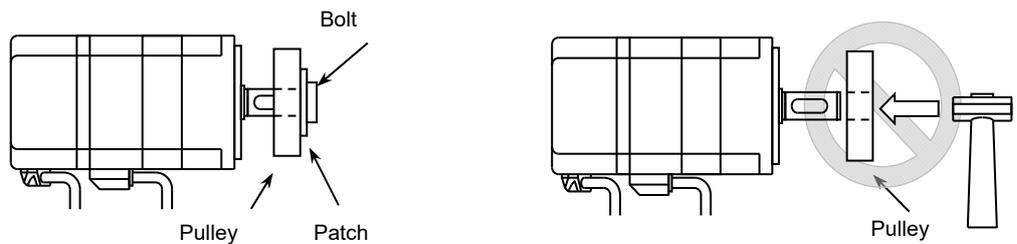
Measured at all 4 locations, the difference between the maximum and the minimum should not exceed 3/100mm (coupling rotates jointly)



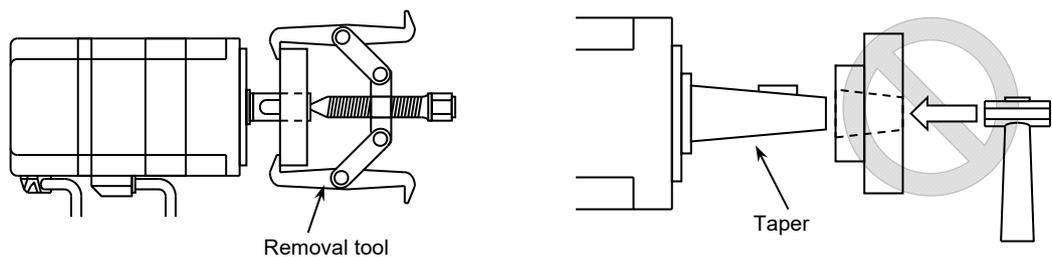
- Do not subject the servo motor shaft to shock, as the precision encoder is directly connected to it. If it is absolutely necessary to hit the motor for position adjustment or other reasons, use a rubber or plastic hammer and hit the front flange area.



- 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.

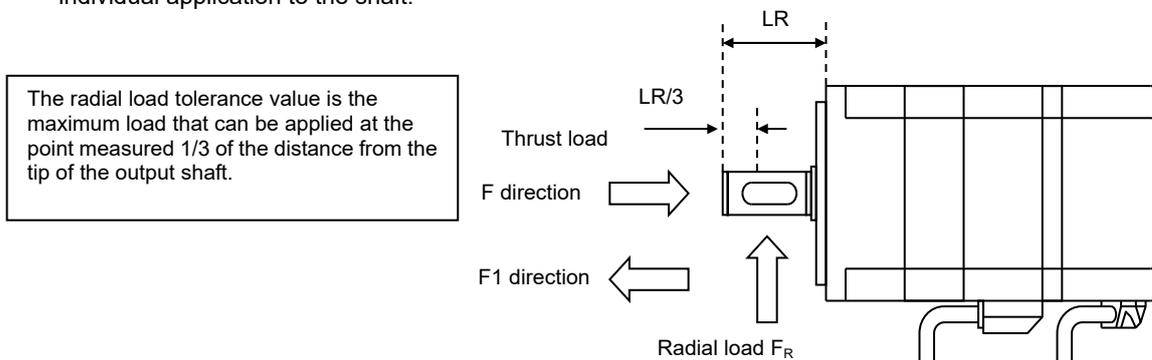


- Tapered servo motor shafts transmit the torque via the tapered surface. Make sure the key fits without rattling. The tapered surface contact should be no less than 70%.
- Use a special tool for removing the gear, pulley, etc.



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.



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
R1	R1AA10100	980	290	290	690	290	290
	R1AA10150	980	290	290	690	290	290
	R1AA10200	980	290	290	690	290	290
	R1AA10250	980	290	290	690	290	290
	R1AA13300	2000	390	390	980	390	390
	R1AA13400	2000	390	390	980	390	390
	R1AA13500	2000	390	390	1200	390	390
	R1AA18550	3900	2000	2000	1800	590	590
	R1AA18750	3900	2000	2000	1800	590	590
	R1AA1811K	3900	2000	2000	1800	590	590
	R1AA1815K	3900	2000	2000	2700	1500	1500
	R1GA04005F	150	98	98	98	29	29
	R1GA04010F	150	98	98	98	29	29
R1GA06020D	390	200	200	200	68	68	
R2	R2□A04003	98	78	78	49	29	29
	R2□A04005	150	98	98	98	29	29
	R2□A04008	150	98	98	98	29	29
	R2AA04010	150	98	98	98	29	29
	R2□A06010	150	98	98	98	29	29
	R2□A06020	390	200	200	200	68	68
	R2AA08020	390	200	200	200	98	98
	R2AA06040	390	200	200	250	68	68
	R2AA08040	390	200	200	250	98	98
	R2AA08075	590	390	390	340	200	200
	R2AAB8100	590	780	290	340	200	200
	R2AA10100	590	780	290	340	200	200
	R2AA13050	980	1400	1400	640	490	490
	R2AA13120	1700	1900	1900	640	490	490
	R2AA13180	1700	1900	1900	640	490	490
	R2AA13200	1700	1900	1900	640	490	490
	R2AA18350	2300	1900	1900	1500	290	290
	R2AA18450	2300	1900	1900	1500	290	290
	R2AA18550	3900	2000	2000	1800	590	590
	R2AA18750	3000	2000	2000	2000	1100	1100
	R2AA22500	2300	1900	1900	1500	490	490
R2GAD102RM	10	5	5	10	5	5	
R2□A02D20F	20	20	20	20	20	20	
R2□A02D30F	20	20	20	20	20	20	
R5	R5AA06020	390	200	200	200	68	68
	R5AA06040	390	200	200	250	68	68
	R5AA08075	590	390	390	340	200	200

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
Q1	Q1AA07075	590	390	390	340	200	200
	Q1AA10150	980	290	290	690	290	290
	Q1AA10200	980	290	290	690	200	200
	Q1AA10250	980	290	290	690	200	200
	Q1AA12200	980	290	290	690	290	290
	Q1AA12300	980	290	290	690	290	290
	Q1AA13300	2000	390	390	980	390	390
	Q1AA13400	2000	390	390	1200	390	390
	Q1AA13500	2000	390	390	1200	390	390
Q1AA18450	2300	1900	1900	1500	490	490	
Q1AA18750	3900	2000	2000	1800	590	590	
Q2	Q2AA04006	150	98	98	98	29	29
	Q2AA04010	150	98	98	98	29	29
	Q2AA05020	250	200	150	200	78	78
	Q2AA08075	590	780	290	340	200	200
	Q2AA08100	590	780	290	340	200	200
	Q2AA10100	980	290	290	690	200	200
	Q2AA10150	980	290	290	690	290	290
	Q2AA13050	980	1400	1400	640	490	490
	Q2AA13150	1700	1900	1900	640	490	490
	Q2AA13200	1700	1300	1300	690	290	290
	Q2AA13300	1700	1900	1900	880	390	390
	Q2AA18200	2300	1900	1900	1500	490	490
	Q2AA18350	2300	1900	1900	1500	490	490
	Q2AA18450	2300	1900	1900	1500	490	490
	Q2AA18550	3900	2000	2000	1800	590	590
	Q2AA18750	3000	2000	2000	2000	1100	1100
	Q2AA22550	3900	2000	2000	1800	590	590
Q2AA22700	3900	2000	2000	2500	1100	1100	
Q2AA2211K	3900	2000	2000	2700	1500	1500	
Q2AA2215K	3900	2000	2000	2300	1500	1500	
Q4	Q4AA1811KB	3900	2000	2000	1800	590	590
	Q4AA1815KB	3900	2000	2000	2700	1500	1500

\* 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.

### 3.3 Linear motor

#### 1) Precautions on linear motor installation

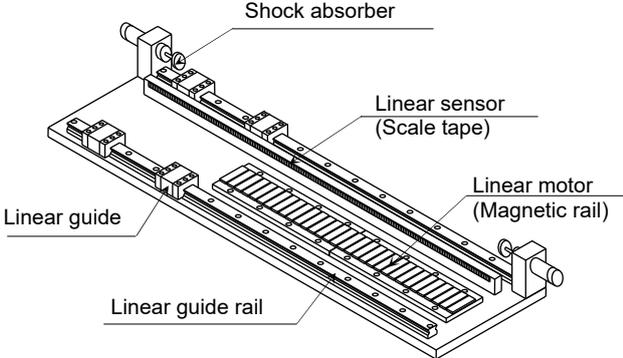
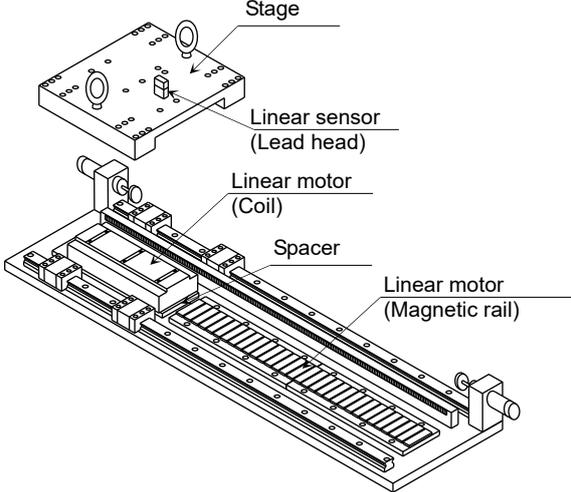
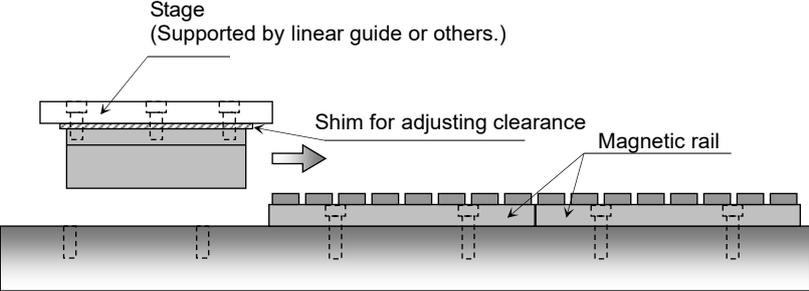
Make sure to read “Safety precautions” carefully to use properly. Failure to observe the safety precautions may result in damages or accidents.

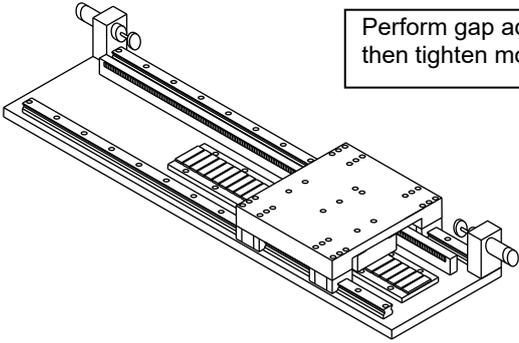
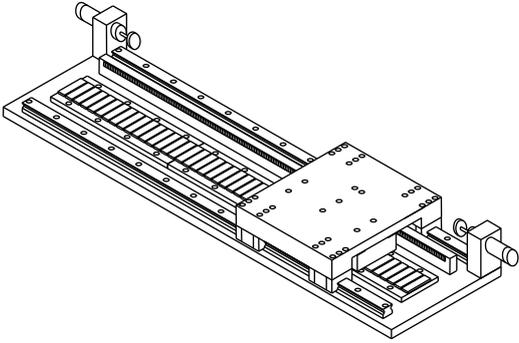
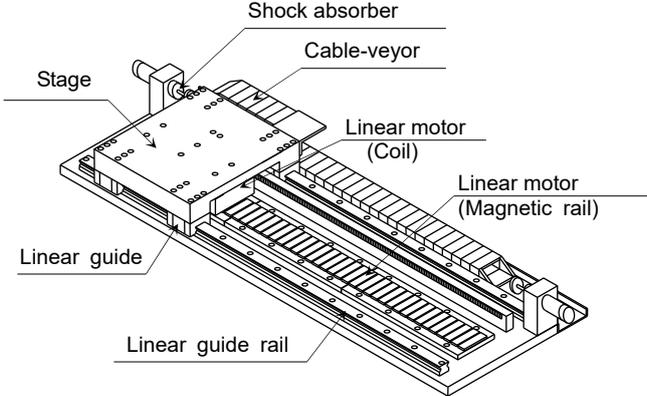
#### 2) Installation of flat-type linear motor with core

■ Installation of magnetic rails

Step	Description
1	Strong magnet is set in the surface of the magnetic rail. High magnetic attraction force exists between themselves and between the rails and the motor coil or tools made of iron. Take care not to have your hands caught
2	Attraction force between the motor coil and the magnetic rail is more than 5 times as strong as the maximum force, which is constant even when the motor power is off. Therefore, the system structure must be rigid enough to support the magnetic attraction and maintain precision.
3	Do not start operation having any magnetic dust or metal, or dirt on the surface of the magnetic rails, otherwise, those foreign materials may be caught in the mover and cause troubles. Depending on the operation condition, bellows or sliding cover is needed to prevent foreign materials from attaching. Take care to keep the surface of the magnetic rails clean.
4	When installing, the bottom of the magnetic rails (flat surface) must be the contact point. If the top surface (uneven surface) comes near the base, high magnetic force is generated and may cause injury or breakage.
5	If a positioning pinhole (Φ5.1) is there at the magnetic rail, that hole must be all on the same side for multiple magnetic rails installation. If not, polarity order of the magnetic rails is inappropriate and there is a danger of runaway.
6	Install the magnetic rails one by one using all the installing screws. Tighten the installing screws with specified tightening torque and engagement length and use screw locking adhesive. If some magnetic rails are not fixed by appropriate screws, magnetic attraction will be generated when other magnetic rails or magnetized metal come near, resulting in injury or breakage.
7	Install the magnetic rails in order from end. When installing one magnetic rail next to the one already fixed, do not place the former above the latter but place it from the side of the latter. Otherwise, magnetic force will be generated and may cause injury or breakage.

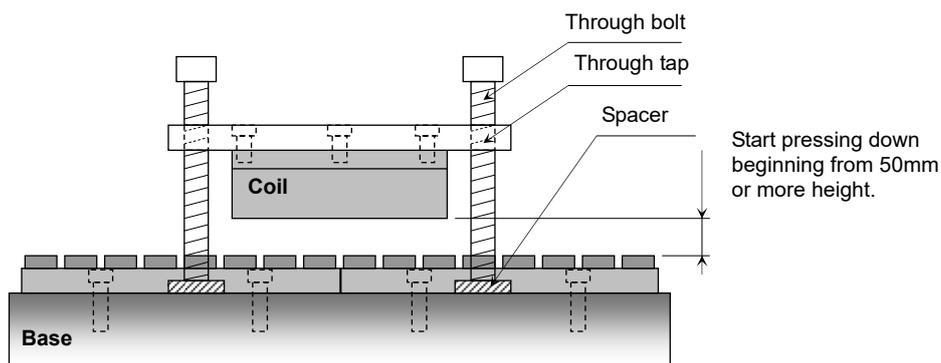
■ Installation of coil <Mounting in the place no magnetic rail exist. >

Step	Description
1	<p>Install the magnetic rail at only the half of the whole stroke, and confirm that the area without magnetic rail is longer than the coil length by 50 mm minimum.</p> 
2	<p>Place the coil on the base where there is no magnetic rail using a spacer. Use a spacer of appropriate material which does not damage the base and the coil. Take care not to have your fingers caught in between the coil and the spacer. Use a spacer which is a little thinner than the magnetic rails.</p> 
3	<p>All the tap holes for installing the coil must be used. Tighten the installing screws with specified tightening torque and engagement length and use screw locking adhesive. Insert a shim between the coil and the stage to adjust the gap between the magnetic rail and the coil. Its appropriate length is or the one without magnet cover, for the one with magnet cover.</p> 

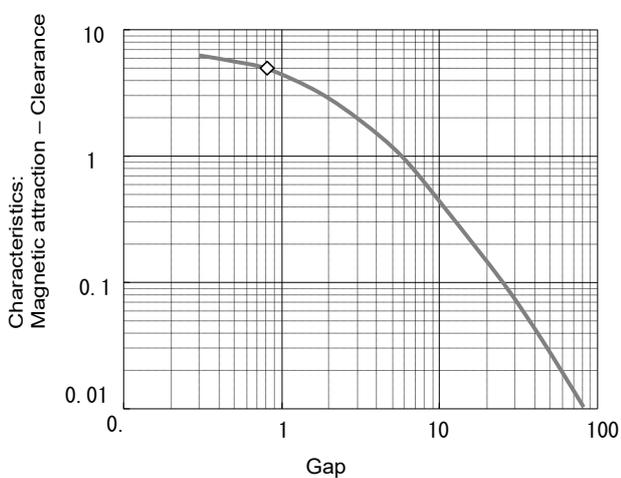
<p>4</p>	<p>Slide the movable stage which has the coil installed onto the magnetic rails which have been fixed by screws. Pay attention that coil will be attracted to the above of magnetic rail by magnetic force. When the whole coil is on the magnetic rail, attraction force no longer exists.</p> <div style="border: 1px solid black; padding: 5px; margin: 10px auto; width: fit-content;"> <p>Perform gap adjust between the motor coil and magnetic rail, and then tighten mounting bolts.</p> </div> 
<p>5</p>	<p>Install the remaining magnetic rails.</p> 
<p>6</p>	<p>Installation is complete when the motor has been installed. Then conduct wiring.</p> 

■ Installation of coil <Mounting in the place magnetic rail exist. >

Step	Description
1	After having installed all the magnetic rails, place the coil above the magnetic rails using non-magnetic spacer of 50mm or thicker. Non-magnetic spacer must be of the material which would not be compressed by the coil self weight.
2	Prepare through taps to horizontally raise or lower the stage by bolts. Tips of the through bolts must contact the base so that the stage can be lifted. To avoid any damage between the through bolts and the base, use spacers made of resin. Take the magnetic attraction force into account when choosing the bolt length/number and spacers.
3	Install the stage on top of the coil and connect them together. Insert through bolts into through taps and lift the stage and the coil together, then separate the coil and non-magnetic spacers and remove the spacers.
4	Press more than two through screws down in order to lower the stage horizontally until the guide block can support it. Then remove the through bolts. Adjust the stage where the space between the coil and the magnet is wide and attraction force is small.



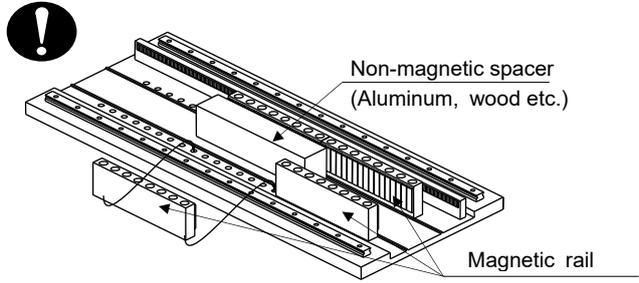
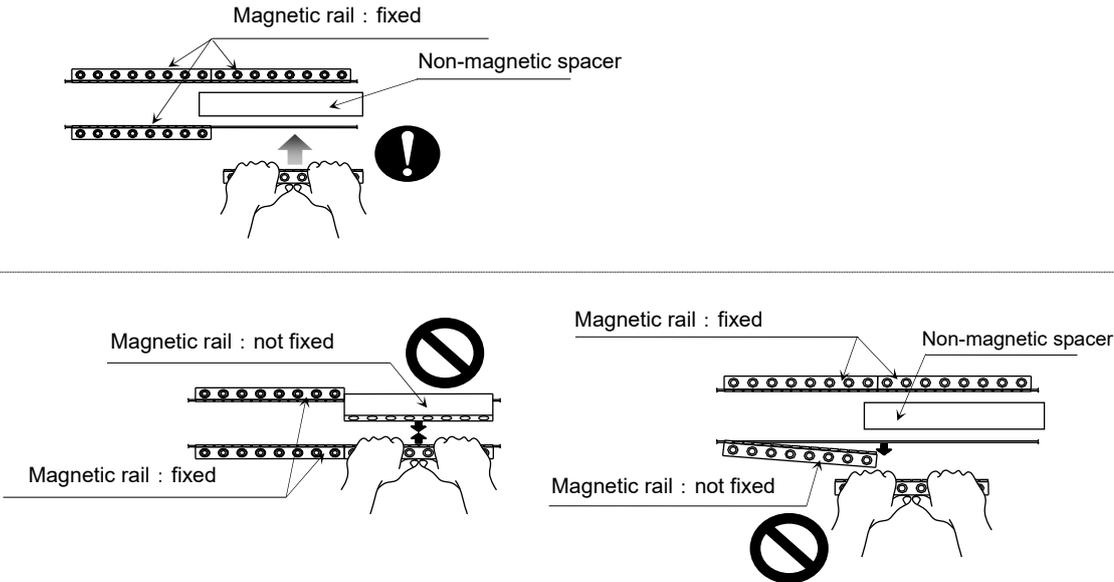
Characteristics of Magnetic Force

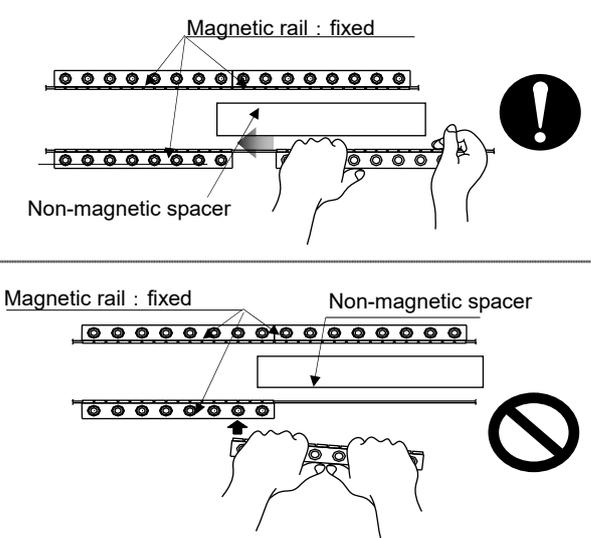


Keep 50mm or more for security reasons.

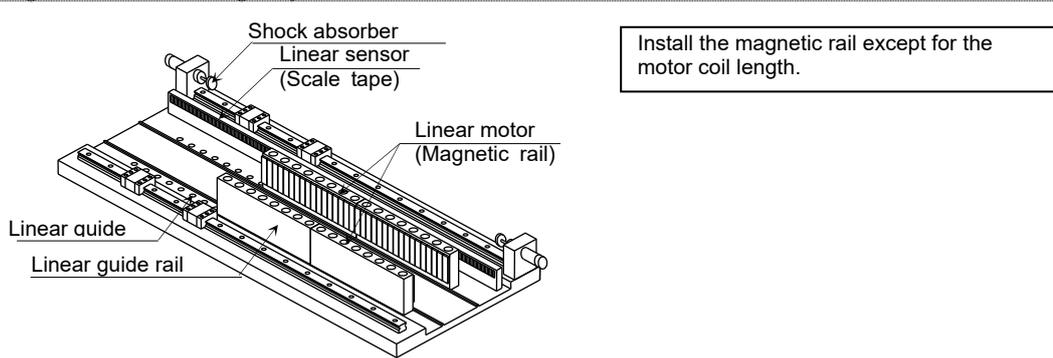
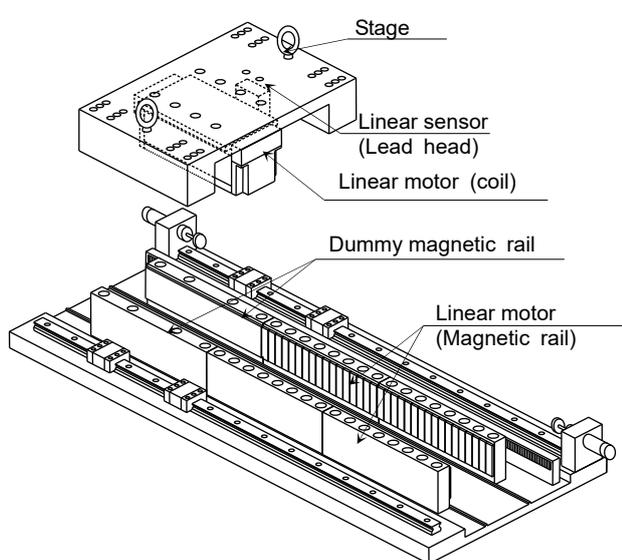
3) Installation of twin-type linear motor with core

■ Installation and precautions of magnetic rails

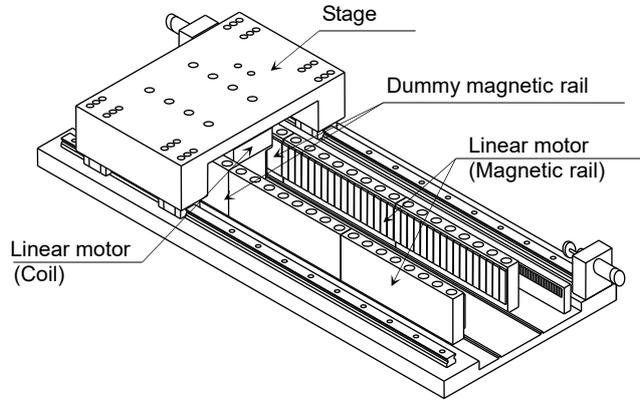
Step	Description
1	Strong magnet is set on the surface of the magnetic rails. High magnetic attraction force is generated between the magnets themselves and between the motor coil, tools or jigs made of iron when they are placed near the magnetic rails. Take care not to have your hands caught.
2	Magnetic attraction force exists between the magnetic rails and the motor coil, which is constant even when the motor power is turned off. Therefore, the system structure must be rigid enough to support the magnetic attraction and maintain precision.
3	Do not start operation having any magnetic dust or metal, or dirt on the surface of the magnetic rails, otherwise, those foreign materials may be caught in the mover and cause troubles. Depending on the operation condition, bellows or sliding cover is needed to prevent foreign materials from attaching. Take care to keep the surface of the magnetic rails clean.
4	<p>When installing the magnetic rails, make sure to set the magnet surface (uneven surface) of the magnetic rail on each side facing each other. For security reasons, place a non-magnetic spacer of 30 to 80mm in width and 100mm or higher between the facing magnetic rails to avoid magnetic attraction between the magnetic rails on both sides.</p> 
5	When installing the magnetic rails, make sure that the counter sinking on the installation holes should be facing up. If installed in wrong direction, the installing bolt head will interfere the motor coil and cause breakage.
6	<p>Install the magnetic rails one by one using all the installing bolts. Tighten the installing screws with specified tightening torque and engagement length and use screw locking adhesive. If any magnetic rails are not fixed by appropriate bolts, magnetic attraction will be generated when other magnetic rails or magnetized metal come near, resulting in injury or breakage.</p> 

7	<p>Install the magnetic rails in order from end. When installing one magnetic rail next to the one already fixed, do not place the former from the side of the latter but place it from front or back of the latter. Otherwise, magnetic force will be generated and may cause injury or breakage.</p> 
---	---

■ Installation of coil

Step	Description
1	<p>Install the magnetic rail at only the half of the whole stroke, and confirm that the area without magnetic rail is longer than the coil length by 50 mm minimum.</p> 
2	<p>Install a dummy magnetic rail on the stroke without magnetic rails and insert the motor coil between the dummy magnetic rail. Take care not to have your fingers caught in between the motor coil and the base. (See "External View for the shape of dummy magnetic rail".)</p> 

Temporarily fix the motor coil and the stage using installing bolts and adjust the gap between the dummy magnetic rail and the coil within the specified ranges. Recommended difference of gaps at any two points between dummy magnetic rail and coil is 0.2mm or less.  
 After adjusting the gap, tighten the installing bolts for the motor coil and the stage. All the tap holes for installing the motor coil must be used. Tighten the installing screws with specified tightening torque and engagement length and use screw locking adhesive.



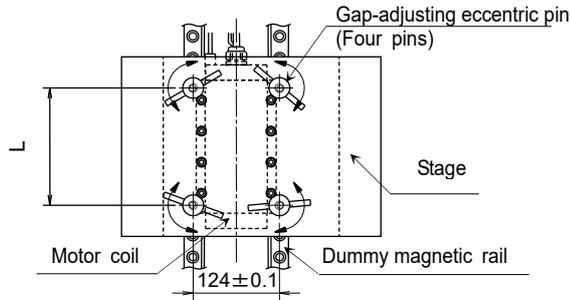
How to adjust the gap

Make sure to perform gap adjustment on the area where the motor coil is facing dummy magnetic rail. If adjustment is performed on the area with magnetic rails, injury or breakage may occur, because high magnetic attraction force exists on the motor coil. Never adjust the gap on the area with the magnetic rails.

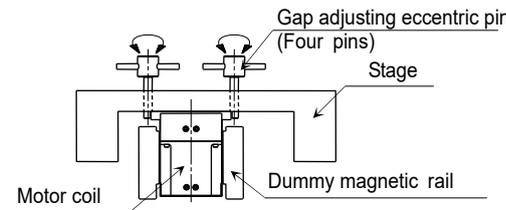
When eccentric pins are used.

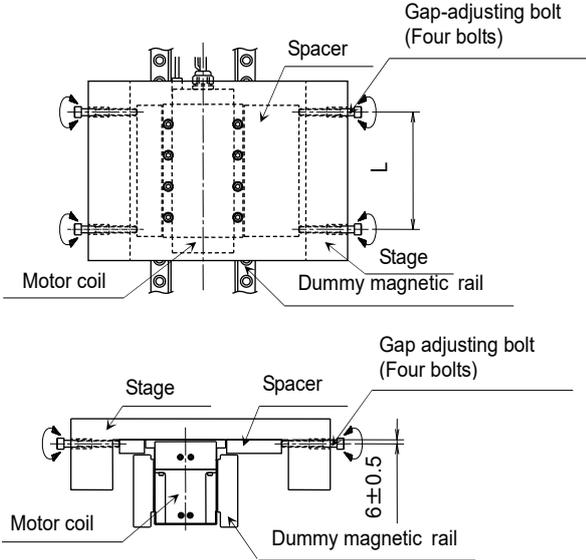
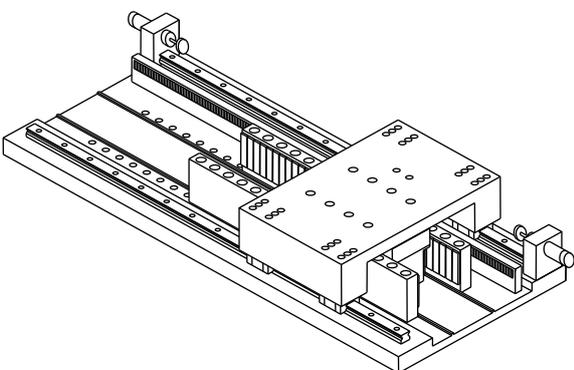
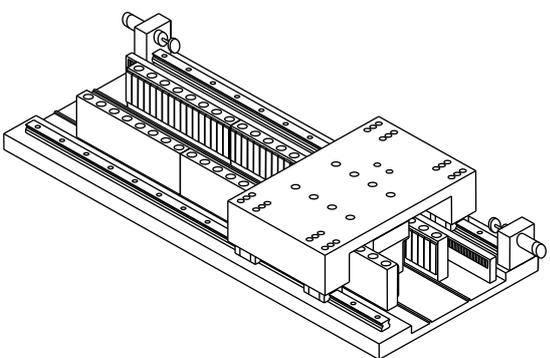
3

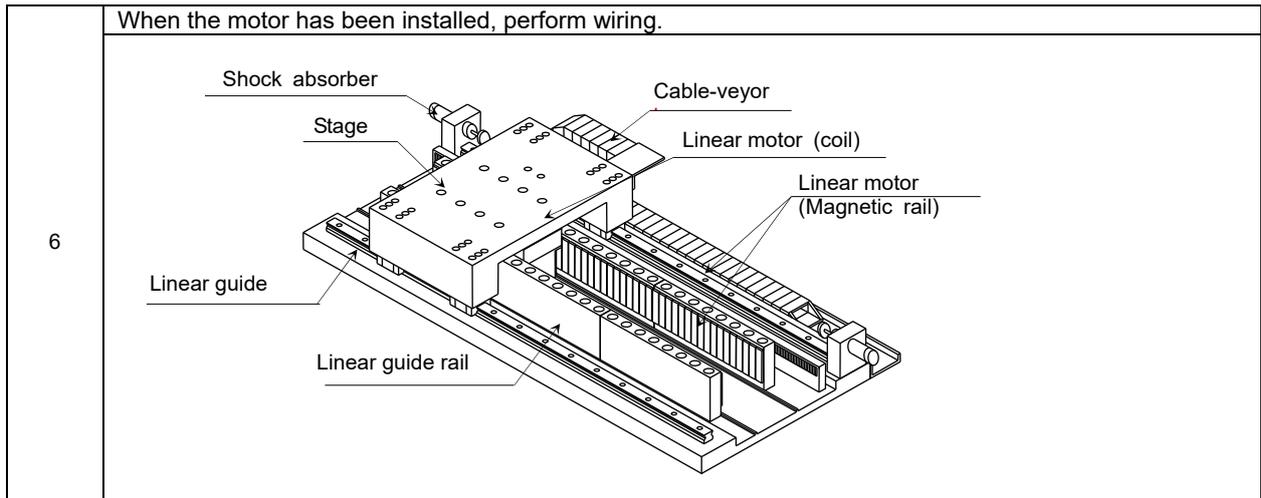
When eccentric pins are used, adjust the gap from top of the stage.  
 Make four or more holes for eccentric pins on top of the stage. The hole location must be determined so that the eccentric pins touch the upper plate of the motor coil. If the eccentric pins stress other point than the upper plate, the motor coil may break. See the recommended values in the figure below for the location of the pin holes. Refer to the external diagram for recommended shape of the eccentric pins.  
 Insert the eccentric pins into the eccentric pin holes on the stage and turn them left and right to adjust the gap. It is recommended that the difference of gaps at two points between the dummy magnetic rail and the motor coil be 0.2mm maximum.



(Recommended location value of gap adjusting eccentric pin)



<p>3</p>	<p style="text-align: center;">When bolts are used.</p> <p>When bolts are used, adjust the gap from side of the stage.                  Prepare four or more taps for gap adjusting bolts on the side of the stage. The hole position must be determined so that the tip of the gap adjusting bolt touches the upper plate of the motor coil. If the bolts stress other point than the upper plate, the motor coil may break. See the recommended values in the figure below for the location of taps of bolts. As tap diameter, M8 or M10 is recommended.                  Insert the gap adjusting bolts into the taps on the side of the stage and turn them left and right to adjust the gap. If the bolt is too short for its tip to reach the upper plate of the motor coil, put a spacer between the tip of the bolt and upper plate. It is recommended that the difference of gaps at two points between the dummy magnetic rail and the motor coil be 0.2mm maximum.</p> 
<p>4</p>	<p>Slide the movable stage with the motor coil installed towards the magnetic rail side which was fixed with screws. Pay attention that coil will be attracted to between magnetic rails by magnetic force. When the motor coil is completely inside the magnetic rails, the force no longer exists.</p> 
<p>5</p>	<p>Remove the dummy magnetic rail and install the remaining magnetic rail.</p> 



#### 4) Cable installation and considerations

- Please be careful not to apply any stresses on or damages to cables.
- When it is anticipated to move the servomotor, allow enough flexion radius of the cable to avoid stress.
- Install the cables where there is no danger of their sheaths being damaged by cutting flakes or other sharp materials. Avoid contact with any corner of machines.  
Take care not to step on the cables or not to have any machine mounted on them.
- Clamp the cables to the machine to avoid stress and self-gravity at the connection point.
- Cables connected from the coil are not robot cables, so fix them firmly and do not make them bend repeatedly. When cables are moved by cable bearer or others, prepare a robot cable as an extension cable. In that case, determine a flexion radius of each cable by the necessary flexion lifetime and type of wire.
- It is recommended that the cables of a mover should have a structure that enables periodic replacement.

# 4

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## 4. Wiring

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

### 1) Name and its function

Terminal name	Connector marking	Remarks	
Main circuit power supply	R·T or R·S·T	Single-phase 100 to 115V AC +10%, -15% 50/60Hz ±3%	
		Single-phase 200 to 230V AC +10%, -15% 50/60Hz ±3%	
	P·N	Three-phase 200 to 230V AC +10%, -15% 50/60Hz ±3%	
Control power supply	r·t	48V DC ±10%, 24V DC ±10%	
	CP·CN	Single-phase 100 to 115V AC +10%, -15% 50/60Hz ±3%	
Servo motor connector	U·V·W	Single-phase 200 to 230V AC +10%, -15% 50/60Hz ±3%	
Safeguard connector		24V DC ±10%	Connected with servo motor
Regeneration resistance connector	RB1·RB2 RB4	U·V·W	Connected with grounding wire of power supply and of servo motor.
			
Regeneration resistance connector	RB1·RB2 RB4	RS2#01 RS2#02 RS2#03 RS2#04 RS2#05 RS2#30	Connects regenerative resistance to terminal RB1 and RB. Built-in regenerative resistance is already connected at factory setting. Connects external regenerative resistance to terminal RB1 and RB when regenerative performance is insufficient. Terminal RB4 is not supplied.
		RS2#10 RS2#15	In the case of built-in regenerative resistance, terminal RB1 and RB4 are already short-circuited by short bar at factory setting. Remove short bar of terminal RB1 and RB4 (opened), to connect external regenerative resistance to terminal RB1 and RB4, when regenerative performance is insufficient.
Maker maintenance	P· 		For maker maintenance. Do not connect anything.

### 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. Use the electric wire beyond proof-pressure 600V.
- ✓ When wires are bundled or put into a wire-duct, such as a hardening vinyl pipe or a metallic conduit, take the allowable current reduction ratio into account.
- ✓ 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.

#### 4. Wiring Wire diameter – Permissible current/ Recommended Wire Diameter (Rotary motor)

##### 3) Wire diameter - Permissible current

AWG size	Nominal cross-sectional area [mm <sup>2</sup> ]	Conductor resistance [Ω/km]	Permissible current over ambient temperature [A]		
			30°C	40°C	55°C
20	0.5	39.5	6.6	5.6	4.2
19	0.75	26.0	8.8	7.0	5.4
18	0.9	24.4	9.0	7.7	5.8
16	1.25	15.6	12.0	11.0	8.3
14	2.0	9.53	23.0	20.0	15.0
12	3.5	5.41	33.0	29.0	21.8
10	5.5	3.47	43.0	38.0	28.5
8	8.0	2.41	55.0	49.0	36.8
6	14.0	1.35	79.0	70.0	52.5

- ✓ 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.

##### 4) Recommended Wire Diameter (Rotary motor)

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

■ Input voltage 200V AC

Servo motor model No.	Motor power (U·V·W·⊕)		Servo amplifier to be combined	Main circuit power supply (R·S·T·⊕)		Control power supply		Regeneration resistance		⊕						
	mm <sup>2</sup>	AWG No.		mm <sup>2</sup>	AWG No.	mm <sup>2</sup>	AWG No.	mm <sup>2</sup>	AWG No.	mm <sup>2</sup>	AWG No.					
R2AA04003F	0.5	20	RS2#01A	1.25	16	1.25	16	1.25	16	2.0	14					
R2AA04005F																
R2AA04010F																
R2AA06010F																
R2AA06020F	0.75	19						RS2#03A	2.0			14	2.0	14	2.0	14
R2AA06040H																
R2AA08020F																
R5AA06020H																
R5AA06020F																
R5AA06040H																
R1AA10100H	0.75	19	RS2#03A	2.0	14	2.0	14	2.0	14							
R1AA10150H																
R2AA06040F																
R2AA08040F																
R2AA08075F																
R2AAB8100H																
R2AA10075F																
R2AA13050D																
R2AA13050H																
R2AA13120B																
R5AA08075D																
R5AA06040F																
R5AA08075D																
R5AA08075F																

- ✓ # = Optional number or alphabetical letter.
- ✓ 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, 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, use special heat-resistant vinyl wire (HIV).
- ✓ Depending on the servo motor capacity, thinner electric wires than indicated in the above table can be used for the main circuit power terminal.

#### 4. Wiring Wire diameter – Permissible current/ Recommended Wire Diameter (Rotary motor)

■ Input voltage 200V AC

Servo motor model No.	Motor power (U·V·W·  )		Servo amplifier to be combined	Main circuit power supply (R·S·T·  )		Control power supply		Regeneration resistance			
	mm <sup>2</sup>	AWG No.		mm <sup>2</sup>	AWG No.	mm <sup>2</sup>	AWG No.	mm <sup>2</sup>	AWG No.	mm <sup>2</sup>	AWG No.
R1AA10100F	2.0	14	RS2#05A	2.0	14	1.25	16	2.0	14	2.0	14
R1AA10150F											
R1AA10200H											
R1AA10250H											
R2AAB8075F											
R2AAB8100F											
R2AA10100F											
R2AA13120D											
R2AA13120L											
R2AA13180H											
R2AA13200L											
Q1AA10100D											
Q1AA10150D											
Q1AA12100D											
R1AA10200F	5.5	10	RS2#10A	5.5	10	1.25	16	5.5	10	5.5	10
R1AA10250F											
R1AA13300H											
R1AA13300F											
R1AA13400H											
R1AA13500H											
R2AA13180D											
R2AA13200D											
R2AA18350L											
Q1AA10200D											
Q1AA10250D											
Q1AA12200D	5.5	10	RS2#15A	8.0	8	1.25	16	8.0	8	8.0	8
Q1AA12300D											
Q1AA13300D											
Q2AA13200H											
Q2AA18200H											
R1AA13400F											
R1AA13500F											
R2AA18350D											
R2AA18450H											
R2AA22500L											
R2AA18550R	8.0	8	RS2#15A	8.0	8	1.25	16	8.0	8	8.0	8
R2AA22700S											
Q1AA13400D											
Q1AA13500D											
Q1AA18450M											
Q2AA18350H											
Q2AA18450H											
Q2AA18550R											
Q2AA22550B											
Q2AA22700S											
Q4AA1811KB											
Q4AA1815KB											

- ✓ # = Optional number or alphabetical letter.
- ✓ 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, 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, use special heat-resistant vinyl wire (HIV).
- ✓ Depending on the servo motor capacity, thinner electric wires than indicated in the above table can be used for the main circuit power terminal.

#### 4. Wiring Wire diameter – Permissible current/ Recommended Wire Diameter (Rotary motor)

■ Input voltage 200V AC

Servo motor model No.	Motor power (U·V·W· $\oplus$ )		Servo amplifier to be combined	Main circuit power supply (R·S·T· $\oplus$ )		Control power supply		Regeneration resistance			
	mm <sup>2</sup>	AWG No.		mm <sup>2</sup>	AWG No.	mm <sup>2</sup>	AWG No.	mm <sup>2</sup>	AWG No.	mm <sup>2</sup>	AWG No.
R2AA18550H	14.0	6	RS2#30A	14.0	6	1.25	16	8.0	8	14.0	6
R2AA18750H											
R2AA1811KR											
R2AA2211KB											
R2AA2215KB											
R1AA18550H											
R1AA18750L											
R1AA1811KR											
R1AA1815KB											
Q1AA18750H											
Q2AA18550H											
Q2AA18750L											
Q2AA2211KV											
Q2AA2215KV											
Q4AA1811KB											
Q4AA1815KB											

■ Input voltage 100V AC

Servo motor model No.	Motor power (U·V·W· $\oplus$ )		Servo amplifier to be combined	Main circuit power supply (R·S·T· $\oplus$ )		Control power supply		Regeneration resistance			
	mm <sup>2</sup>	AWG No.		mm <sup>2</sup>	AWG No.	mm <sup>2</sup>	AWG No.	mm <sup>2</sup>	AWG No.	mm <sup>2</sup>	AWG No.
R2EA04003F	0.5	20	RS2#01A	1.25	16	1.25	16	1.	16	2.0	14
R2EA04005F											
R2EA04008F											
R2EA06010F											
R2EA06020F	0.75	19	RS2#03A	2.0	14			2.	14		

■ Input voltage 48V DC

Servo motor model No.	Motor power (U·V·W· $\oplus$ )		Servo amplifier to be combined	Main circuit power supply (R·S·T· $\oplus$ )		Control power supply		Regeneration resistance			
	mm <sup>2</sup>	AWG No.		mm <sup>2</sup>	AWG No.	mm <sup>2</sup>	AWG No.	mm <sup>2</sup>	AWG No.	mm <sup>2</sup>	AWG No.
R1GA04005F	1.25	16	RS2K04A	1.25	16	1.25	16	1.25	16	2.0	14
R1GA04010F											
R1GA06020D											
R2GA04003F											
R2GA04005F											
R2GA04008D											
R2GA06010D											
R2GA02D20F											
R2GA02D30F											
R2GAD102RM	1.25	16	RS2K02A	1.25	16	1.25	16	1.25	16	2.0	14

- ✓ # = Optional number or alphabetical letter.
- ✓ 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, 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, use special heat-resistant vinyl wire (HIV).
- ✓ Depending on the servo motor capacity, thinner electric wires than indicated in the above table can be used for the main circuit power terminal.
- ✓ 1.25mm<sup>2</sup> is recommended for the wire for brake.

5) Recommended wire diameter (Linear motor)

The following shows recommended wire diameter for use in servo amplifier and linear motor.

■ Input voltage 200V AC (DS-series: Linear motor)

Servo motor model No.	Motor power (U·V·W· $\oplus$ )		Servo amplifier to be combined	Main circuit power supply (R·S·T· $\oplus$ )		Control power supply		Regeneration resistance			
	mm <sup>2</sup>	AWG No.		mm <sup>2</sup>	AWG No.	mm <sup>2</sup>	AWG No.	mm <sup>2</sup>	AWG No.	mm <sup>2</sup>	AWG No.
DS030C1N2	0.75	19	RS2#03A	2.0	14	1.25	16	2.0	14	2.0	14
DS050C1N2											
DS075C1N2											
DS030C2N2	20	14	RS2#05A	2.0	8						
DS050C2N2											
DS075C2N2											
DS100C1N2											
DS150C1N2	5.5	10	RS2#10A	5.5	10						
DS030C3N2											
DS050C3N2											
DS075C3N2											
DS100C2N2											
DS150C2N2	8.0	8	RS2#15A	8.0	8						
DS100C3N2											
DS150C3N2											

■ Input voltage 200V AC (DD-series: Linear motor)

Servo motor model No.	Motor power (U·V·W· $\oplus$ )		Servo amplifier to be combined	Main circuit power supply (R·S·T· $\oplus$ )		Control power supply		Regeneration resistance			
	mm <sup>2</sup>	AWG No.		mm <sup>2</sup>	AWG No.	mm <sup>2</sup>	AWG No.	mm <sup>2</sup>	AWG No.	mm <sup>2</sup>	AWG No.
DS030C1Y4	2.0	14	RS2#05A	2.0	14	1.25	16	5.5	14	2.0	14
DS030C2Y4	5.5	10	RS2#10A	5.5	10						
DS030C3Y4											
DS050C1Y2											
DS075C1Y2											
DS050C2Y2	8.0	8	RS2#15A	8.0	8						
DS075C2Y2											
DS050C3Y2											
DS075C3Y2	14.0	6	RS2#30A	14.0	6						
DS050C4Y2											

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

Servo motor model No.	Motor power (U·V·W· $\oplus$ )		Servo amplifier to be combined	Main circuit power supply (R·S·T· $\oplus$ )		Control power supply		Regeneration resistance			
	mm <sup>2</sup>	AWG No.		mm <sup>2</sup>	AWG No.	mm <sup>2</sup>	AWG No.	mm <sup>2</sup>	AWG No.	mm <sup>2</sup>	AWG No.
DT030CD1AN	0.75	19	RS2#03L	2.0	14	1.25	16	2.0	14	2.0	14

- ✓ # = Optional number or alphabetical letter.
- ✓ 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, 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, use special heat-resistant vinyl wire (HIV).
- ✓ Depending on the servo motor capacity, thinner electric wires than indicated in the above table can be used for the main circuit power terminal.

6) Wiring of servo motor

- Plug model number for power and brake of R-series servo motor (Products of Japan Aviation Electronics Industry, Limited)

Servo motor model number	Plug for power and brake (Cable clamp) 【Plug + clamp model number】		Plug for brake (Cable clamp) 【Plug + clamp model number】	
	Straight	Angle	Straight	Angle
R2AA13050	N/MS3106B24-11S (N/MS3057-16A) 【MS06B24-11S-16】	N/MS3108B24-11S (N/MS3057-16A) 【MS08B24-11S-16】	Note 1)	Note 1)
R2AA13120				
R2AA13180				
R2AA13200				
R2AA18350				
R2AA18450				
R2AA22500				
R2AA18550	N/MS3106B32-17S (N/MS3057-20A) 【MS06B32-17S-20】	N/MS3108B32-17S (N/MS3057-20A) 【MS08B32-17S-20】	JL04V-6A10SL-3SE-EB-R (JL04-1012CK(05)-R) 【332706X1】	JL04V-8A10SL-3SE-EB-R (JL04-1012CK(05)-R) 【332707X1】
R2AA18750				
R2AA1811K				

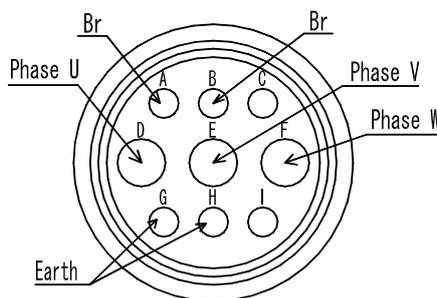
Note 1) Brake plug is shared with motor power plug.

- ✓ Please contact us for waterproofing specifications and TÜV-compliant products.  
Please place your order by “plug + clamp model number,” our exclusive model numbers.

<Specification for leads and plugs and pin assignment table>

Lead color	Plug pin No.	Name	Remarks
Yellow	A	Brake	Power for brake (24V DC)
Yellow	B	Brake	Power for brake (GND of 24V DC)
-	C	NC	-
Red	D	U	Phase U
White	E	V	Phase V
Black	F	W	Phase W
Green/yellow	G	⊕	Protective grounding terminal
Green/yellow	H	⊕	Protective grounding terminal
-	I	NC	-

- ✓ No polarity on terminal for brake power.



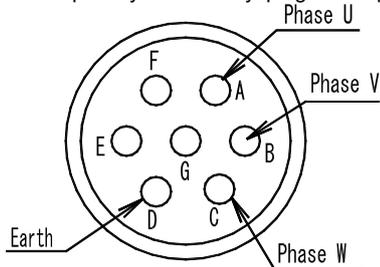
R-series servo motor  
Canon plug for power line  
Pin assignment (Viewed from motor)

- Plug model number for power and brake of Q-series servo motor  
(Products of Japan Aviation Electronics Industry, Limited)

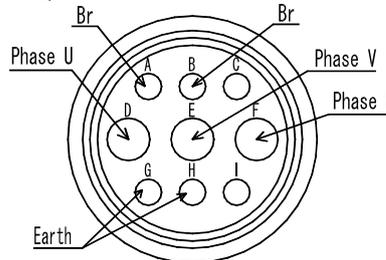
Servo motor model number	Plug for power (Cable clamp) 【Plug + clamp model number】		Plug for brake (Cable clamp) 【Plug + clamp model number】		Remarks
	Straight	Angle	Straight	Angle	
Q1AA10200D	N/MS3106B20-15S (N/MS3057-12A)	N/MS3108B20-15S (N/MS3057-12A)	JL04V-6A10SL-3SE-EB (JL04-1012CK (50)) 【332706X1】	JL04V-8A10SL-3SE-EB (JL04-1012CK (50)) 【332707X1】	
Q1AA10250D	【MS06B20-15S-12】	【MS08B20-15S-12】			
Q1AA12200D	N/MS3106B24-11S (N/MS3057-16A) 【MS06B24-11S-16】	N/MS3108B24-11S (N/MS3057-16A) 【MS08B24-11S-16】	JL04V-6A10SL-3SE-EB (JL04-1012CK (50)) 【332706X1】	JL04V-8A10SL-3SE-EB (JL04-1012CK (50)) 【332707X1】	
Q1AA12300D					
Q1AA13300D					
Q1AA13400D					
Q1AA13500D					
Q1AA18450M					Note 1
Q1AA18750H	N/MS3106B32-17S (N/MS3057-20A) 【MS06B32-17S-20】	N/MS3108B32-17S (N/MS3057-20A) 【MS08B32-17S-20】	JL04V-6A10SL-3SE-EB (JL04-1012CK (50)) 【332706X1】	JL04V-8A10SL-3SE-EB (JL04-1012CK (50)) 【332706X1】	
Q2AA13200H	N/MS3106B24-11S (N/MS3057-16A) 【MS06B24-11S-16】	N/MS3108B24-11S (N/MS3057-16A) 【MS08B24-11S-16】	Note 1	Note 1	
Q2AA18200H					
Q2AA18350H					
Q2AA18450H					
Q2AA18550R					
Q2AA18550H	N/MS3106B32-17S (N/MS3057-20A) 【MS06B32-17S-20】	N/MS3108B32-17S (N/MS3057-20A) 【MS08B32-17S-20】	JL04V-6A10SL-3SE-EB (JL04-1012CK (50)) 【332706X1】	JL04V-8A10SL-3SE-EB (JL04-1012CK (50)) 【332707X1】	
Q2AA18750L					
Q2AA22550B					
Q2AA22700S					
Q2AA2211KV					
Q2AA2215KV					
Q4AA1811KB	N/MS3106B32-17S (N/MS3057-20A) 【MS06B32-17S-20】	N/MS3108B32-17S (N/MS3057-20A) 【MS08B32-17S-20】			
Q4AA1815KB					

Note 1) TÜV-compliant, DC24V with brake model needs separate plug for brake.  
Plug for brake is used in common with for power line except for the above model.

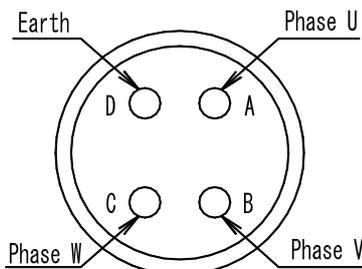
- ✓ Please contact us for waterproofing specifications and TÜV-compliant products.  
Please place your order by【plug + clamp model number】, our exclusive model numbers.



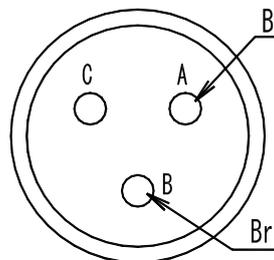
Q-series servo motor  
Canon plug for power line  
(For N/MS3106 (8)B20-15S)  
Pin assignment (Viewed from motor)



Q-series servo motor  
Canon plug for power line  
(For N/MS3106 (8)B24-11S)  
Pin assignment (Viewed from motor)



Q-series servo motor  
Canon plug for power line  
(For N/MS3106 (8)B32-17S)  
Pin assignment (Viewed from motor)



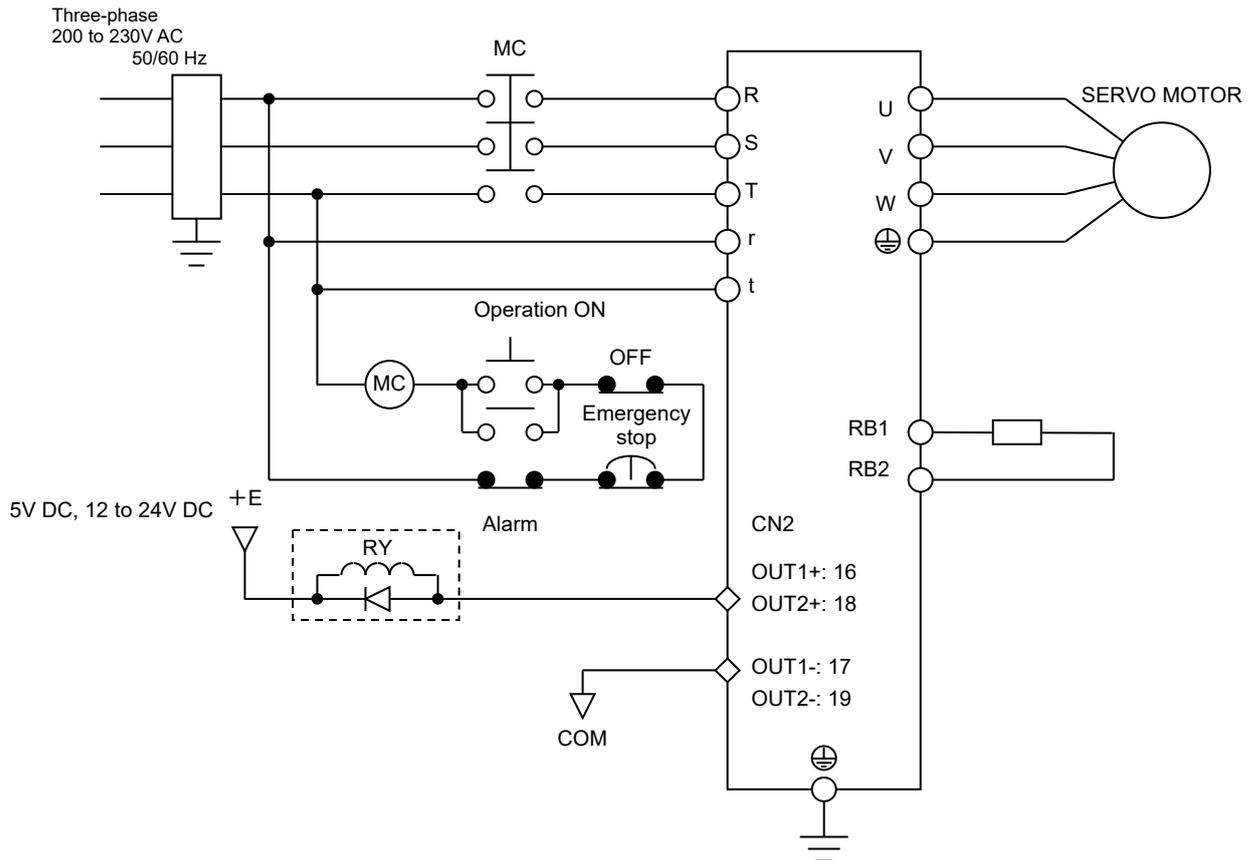
Q-series servo motor  
Canon plug for brake line  
(For JL04V-6 (8)A10SL-3SE-EB)  
Pin assignment (Viewed from motor)

7) Wiring Example

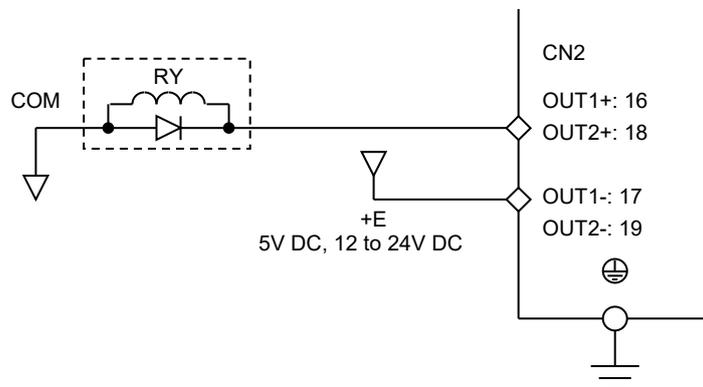
Even if it turns off power supply, high-pressure voltage may remain in servo amplifier. Therefore, do not touch a power supply terminal for 5 minutes for the prevention from an electric shock. Completion of electric discharge turns off the lamp of CHARGE. Please do connection check work after checking putting out lights.

■ Three phase 200V AC [Generic output]

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



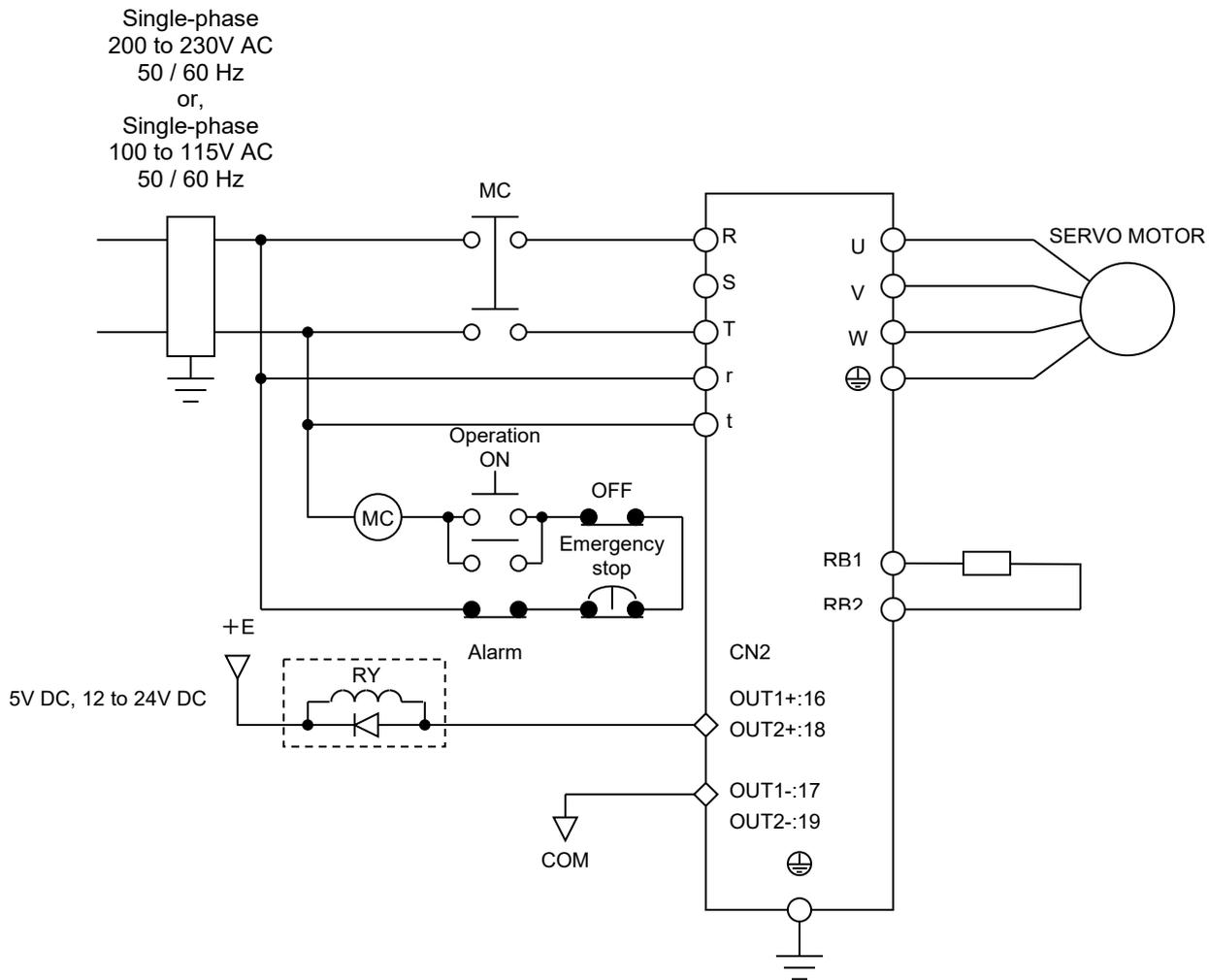
◆ When using - side of OUT1 or OUT2 for power supply



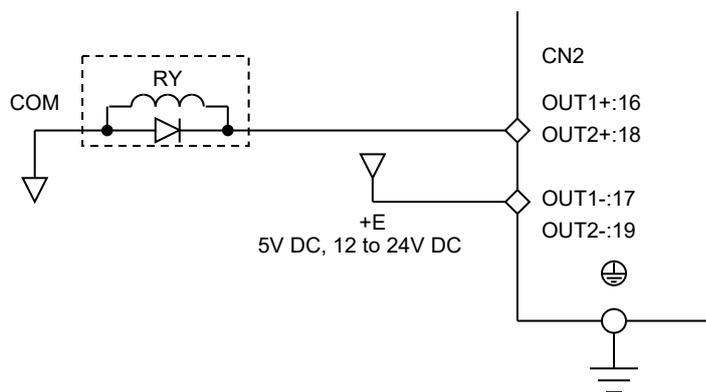
- ✓ Use one of the CN2 - 16 - 19(OUT1, OUT2) outputs, and set either during ALM status output ON or during ALM status output OFF with the selection setting of "Index: 0x20F9 General output function selection".
- ✓ When relay or induction coil load connect to CN2 output, need to connect surge absorbing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

- Single-phase 200V AC, Single-phase 100V AC [Generic output]

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

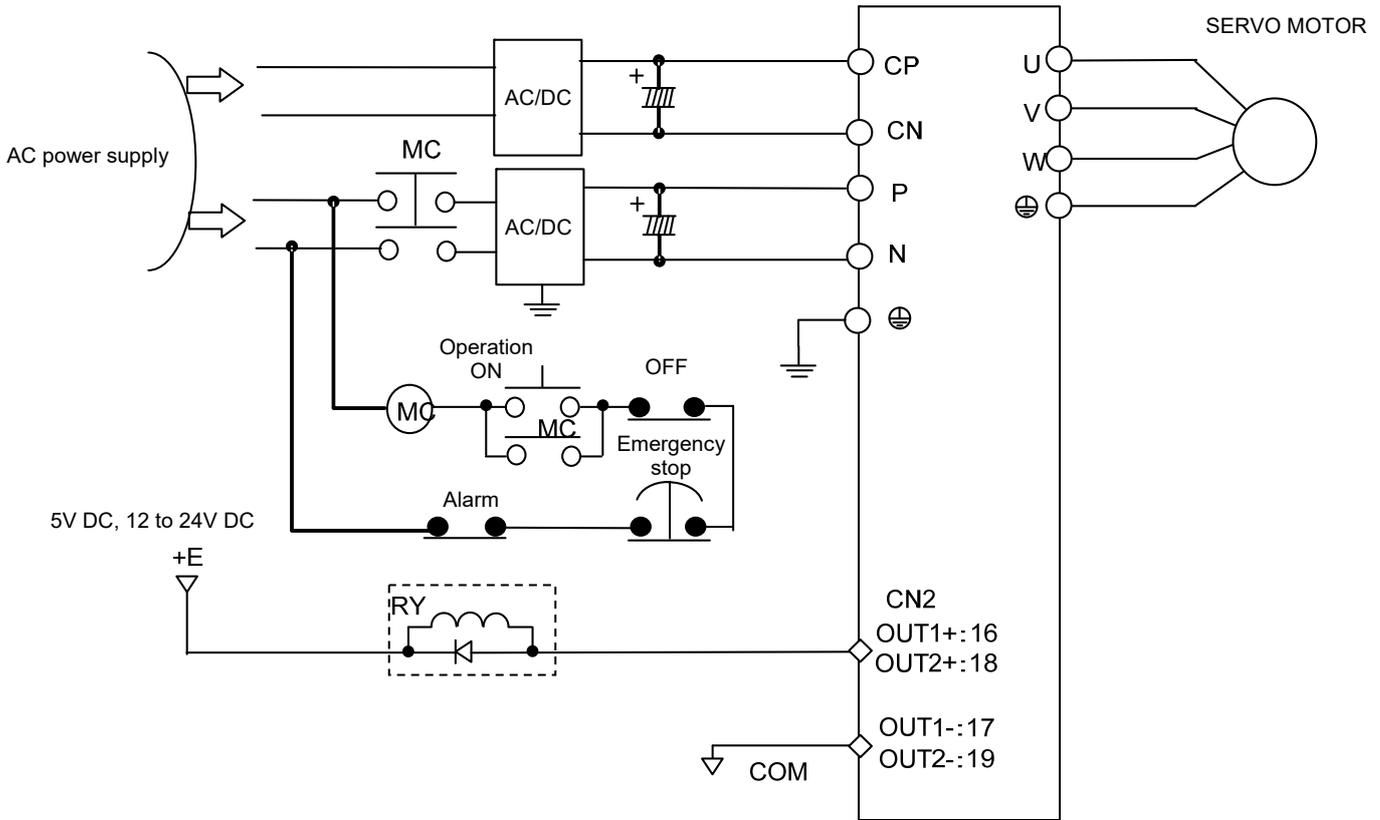


- ◆ When using - side of OUT1 or OUT2 for power supply

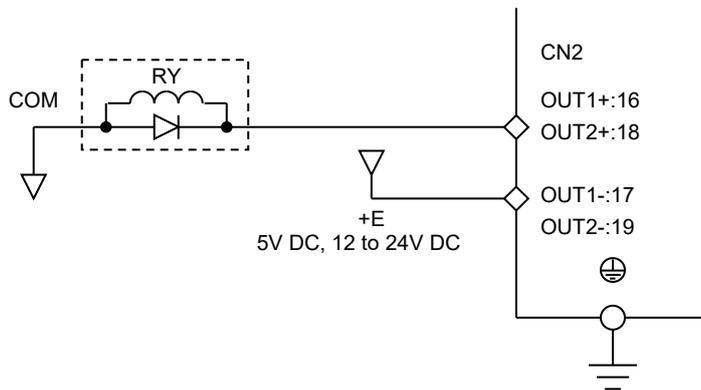


- ✓ Use one of the CN2-16-19 (OUT1, OUT2) outputs, and set either during ALM status output ON or during ALM status output OFF with the selection setting of "Index: 0x20F9 General output function selection".
- ✓ When relay or induction coil load connect to CN2 output, need to connect surge absorbing diode.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

- 48V DC, 24V DC [Generic output]
- ◆ When using + side of OUT1 or OUT2 for power supply



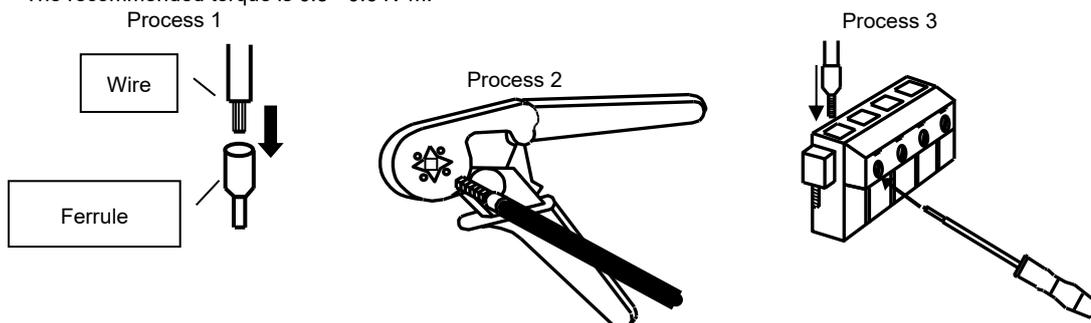
- ◆ When using - side of OUT1 or OUT2 for power supply



- ✓ Use one of the CN2-16-19 (OUT1, OUT2) outputs, and set either during ALM status output ON or during ALM status output OFF with the selection setting of "Index: 0x20F9 General output function selection".
- ✓ When relay or induction coil load connect to CN2 output, need to connect surge absorbing diode. In order to avoid the failure of the amplifier, please make sure of polarity of the diode.
- ✓ The aluminum capacitors between P-N and CP-CN are recommended to install to amplifier side when power cable is long. In this case, power supply should be able to provide rush current to the capacitors at power on.
- ✓ The aluminum capacitor between P-N should be installed to protect the amplifier when battery is used to main power supply. (Over 2,000  $\mu$ F is recommended.)
- ✓ Surge occurs if cutting the DC main power by relay or something. So, must adding the surge measure like a surge absorber circuit or cutting power line at AC side, not at DC side.

8) Electric wire crimping processing

Insert the wire into ferrule, and use a special tool to crimp it in.  
 Insert the ferrule deep into the connector, and tighten it with a special minus screwdriver or something.  
 The recommended torque is 0.5 - 0.6 N·m.



Model number of recommended ferrules and crimping tools for various wire sizes

mm <sup>2</sup>	AWG	Model number		
		1Pcs / Pkt	1000Pcs / Pkt	Taped components
0.75 mm <sup>2</sup>	18	AI0.75 - 8GY	AI0.75 - 8GY - 1000	AI0.75-8GY-B (1000Pcs/Pkt)
1.0 mm <sup>2</sup>	18	AI1 - 8RD	AI1 - 8RD - 1000	AI1-8RD-B (1000Pcs/Pkt)
1.5 mm <sup>2</sup>	16	AI1.5 - 8BK	AI1.5 - 8BK - 1000	AI1.5-8BK-B (1000Pcs/Pkt)
2.5 mm <sup>2</sup>	14	AI2.5 - 8BU	AI2.5 - 8BU - 1000	AI2.5-8BU-B (500Pcs/Pkt)

- ✓ GY: Gray, RD: Red, BK: Black, BU: Blue
- ✓ Crimping tool model number: 0.25mm<sup>2</sup> - 6mm<sup>2</sup>: CRIMPFOX UD 6-4,  
0.75mm<sup>2</sup> - 10mm<sup>2</sup>: CRIMPFOX UD 10-4GY
- ✓ Manufactured by Phoenix Contact.

9) High voltage circuit terminal; tightening torque

Servo amplifier capacity	Terminal marking		
	CNA	CNB	⊖
RS2#01#	[0.5 - 0.6 N·m]		[1.18 N·m] M4 (screw size)
RS2#03#			
RS2#05#			

Servo amplifier size	Terminal code										CNA
	R	S	T	⊖	RB4	RB1	RB2	U	V	W	
RS2#10#	[1.18 N·m]										[0.5 to 6 N·m]
RS2#15#	M4 (screw size)										

Servo amplifier size	Terminal code										CNA	
	R	S	T	⊖	P	U	V	W	⊖	RB1		RB2
RS2#30#	[3.73 N·m] M6 (screw size)										[1.18 N·m] M4 (screw size)	[0.5 to 6 N·m]

- ✓ Mark “#” shows optional number or alphabetical letter.

10) Wiring of the canon connector for servo motors

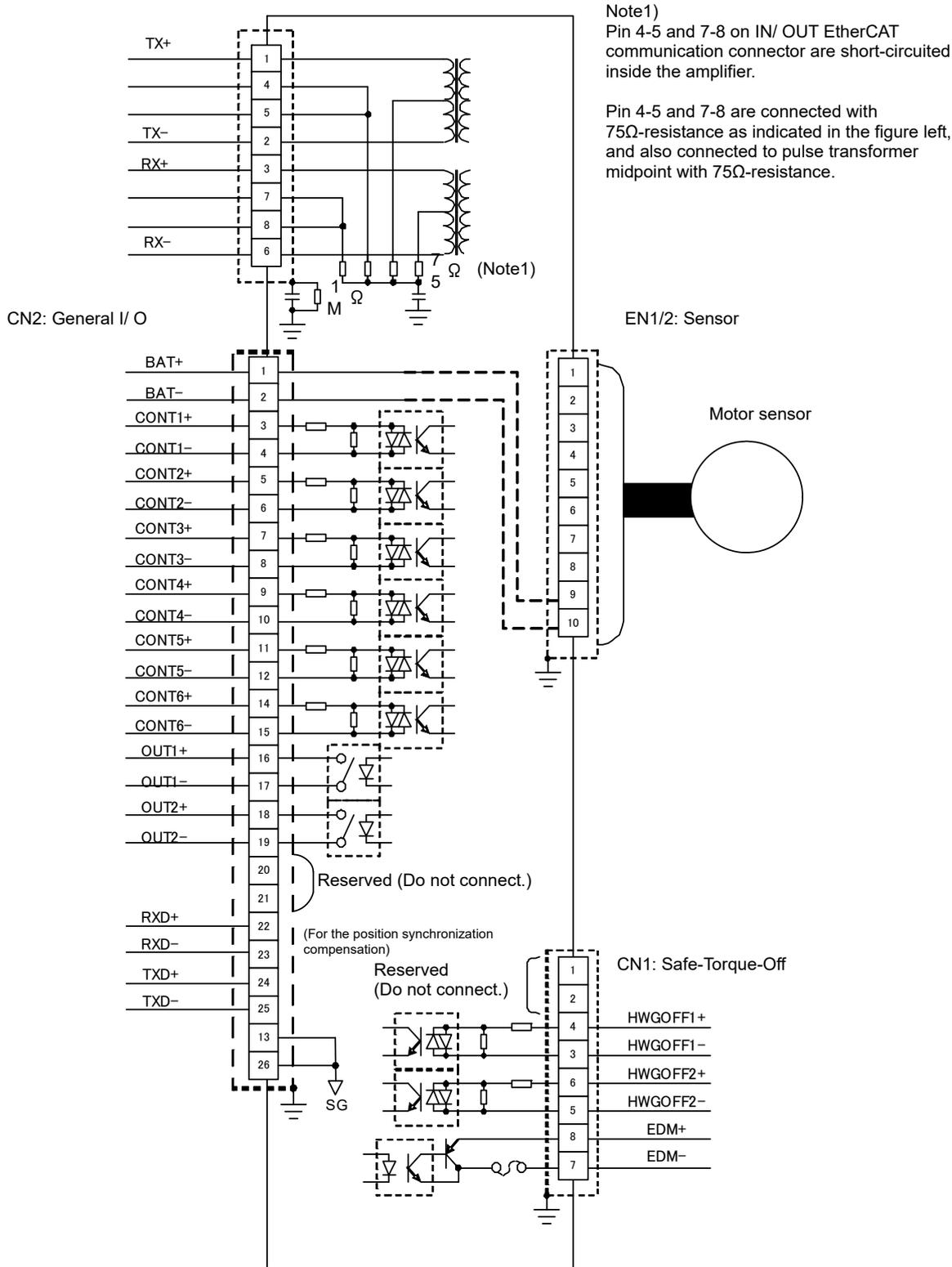
Canon plug pin No.	Name	Remark
A	Brake	Brake power supply connection
B	Brake	Brake power supply connection
C	NC	-
D	U	U phase
E	V	V phase
F	W	W phase
G	⊖	Protective ground terminal
H	⊖	Protective ground terminal

Plug side model No.	Remarks	Manufacture name
MS3106B24-11S	Straight type	DDK
MS3108B24-11S	Angle type	
JL04V-6A24-11SE-E B	Straight type	JAE
JL04V-8A24-11SE-E B	Angle type	

## 4.2 Wiring with Host Unit

### 1) Control signal and pin number (wiring with host unit)

IN/ OUT: EtherCAT communication



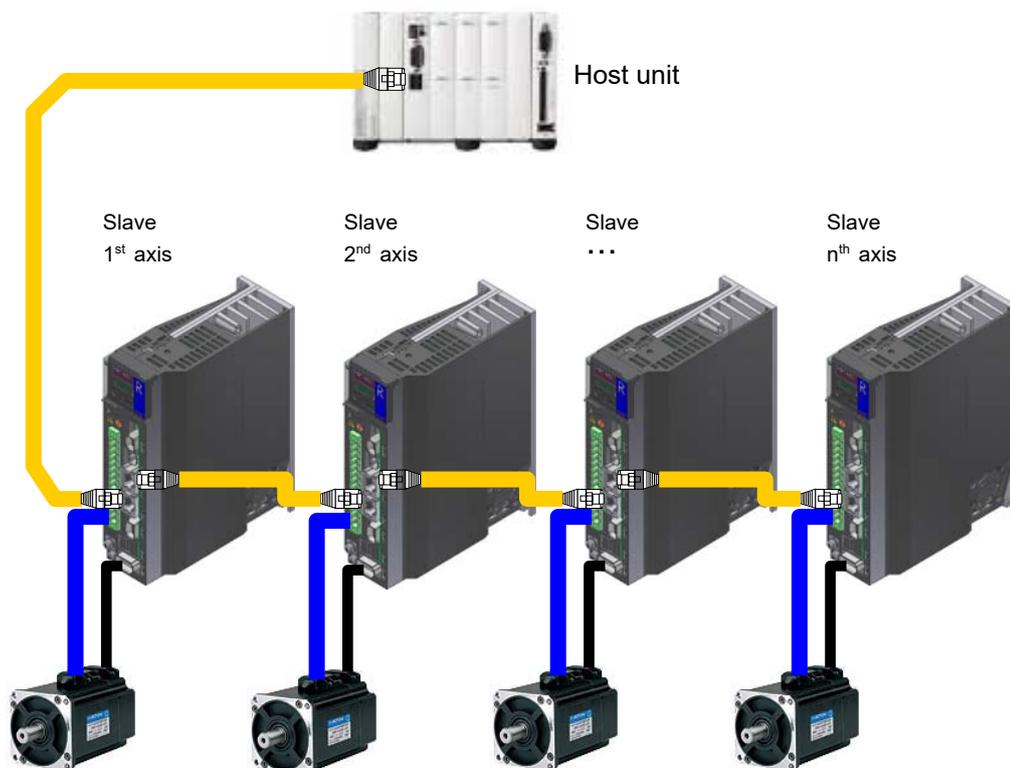
2) IN, OUT connector disposition

- Pin assignment**  
 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

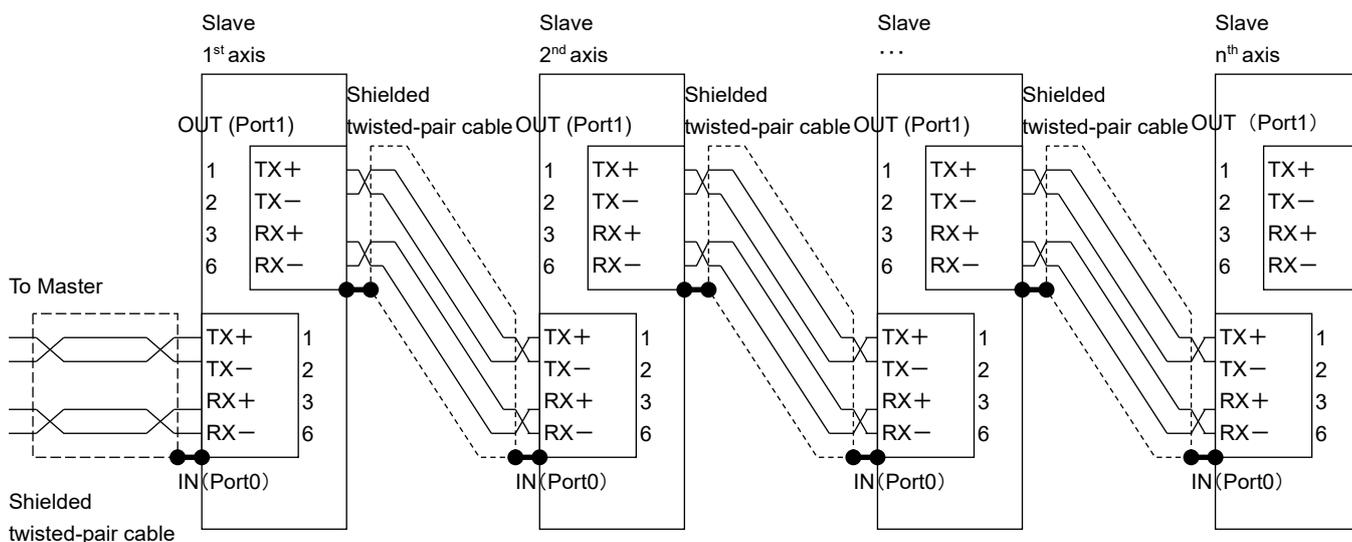
- ✓ Refer to "Control signal and pin number (wiring with host unit)" on the previous page for electrical connection of IN and OUT. Pins 4 and 5 and pins 7 and 8 are shorted inside the amplifier and connected with 150Ω to the midpoint of the pulse transmission between pin 4/5 and 7/8.

- Connection diagram**



- ✓ Connect Master (host) cable to the lower connector IN (Port0), and then connect cable of the upper connector OUT (Port1) to the next Slave.

■ Wiring diagram

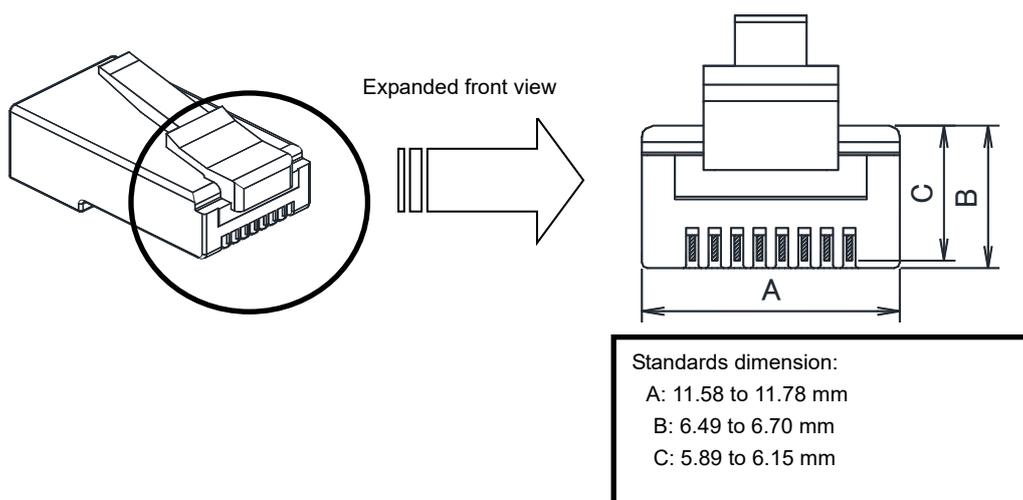


■ R-ADVANCED EtherCAT amplifier is twisted-pair cable and daisy-chain topology-compliant model, and port0(IN) / 1 (OUT) are Ethernet connection.

■ 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 cable.

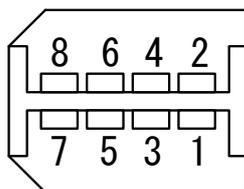
■ Caution for RJ-45 modular connector selection

- 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.



3) 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	Reserved	Do not use.
2	Reserved	Do not use.
3	HWGOFF1-	Signal-input1 (-) for safety function
4	HWGOFF1+	Signal-input1 (+) for safety function
5	HWGOFF2-	Signal-input2 (-) for safety function
6	HWGOFF2+	Signal-input2 (+) for safety function
7	EDM -	Monitor (-) for safety function
8	EDM +	Monitor (+) for safety function

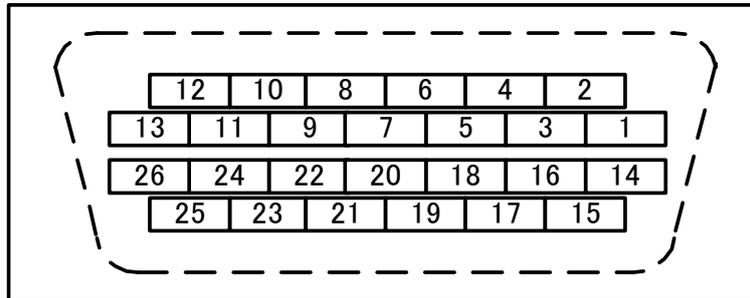
◆ Signal names and functions

Signal name	Terminal NO.	Symbol	Description
Reserved	1	Terminal for maintenance	This is a connection terminal when the function is not used. Do not use this terminal.
Reserved	2		
Safety input 1	3	HWGOFF1-	This is an input signal to control Safe-Torque-Off state. Connection circuit Connected to a relay or open collector transistor circuit. Power supply voltage range: 24V DC±10% Internal impedance : 2.2kΩ
	4	HWGOFF1+	
Safety input 2	5	HWGOFF2-	
	6	HWGOFF2+	
Error detection monitor	7	EDM-	This is a signal to monitor errors of Safe-Torque-Off function. Connection circuit Connected to a photo coupler or relay circuit. Power supply voltage range (Uext): 24V DC±10% Maximum current value: 50mA Output voltage: Uext-0.5 to Uext
	8	EDM+	

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

## 4) CN2 General input-output connector layout

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



◆ Signal names and functions

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

◆ Terminal connection circuit

Terminal NO.	Symbol	Name	Description	
1	BAT+	Battery(+)	<p>■ When using a battery backup type absolute encoder, the backup battery can be installed in the host unit, and then the battery can be connected via servo amplifier. When installing a battery between servo amplifier and servo motor, you don't need install the battery.</p> <p>Host unit                      Servo amplifier</p> <p>Power supply                      Twisted-pair</p>	
2	BAT-	Battery(-)		
3	CONT1+	General input 1 (+)	<p>■ Connect the general-purpose input circuit to a relay or open collector transistor circuit.</p> <p>■ Power supply voltage range: 5V DC±5%/12 to 24V DC±10% Current capacity: 100mA or more (24V DC)</p> <p>Host unit                      Servo amplifier</p> <p>Power supply</p>	
4	CONT1-	General input 1 (-)		
5	CONT2+	General input 2 (+)		
6	CONT2-	General input 2 (-)		
7	CONT3+	General input 3 (+)		
8	CONT3-	General input 3 (-)		
9	CONT4+	General input 4 (+)		
10	CONT4-	General input 4 (-)		
11	CONT5+	General input 5 (+)		
12	CONT5-	General input 5 (-)		
14	CONT6+	General input 6 (+)		
15	CONT6-	General input 6 (-)		<p>Home switch shall be connected to CONT1. Touch Probe 1 shall be connected to CONT1. And Touch Probe 2 shall be connected to CONT2.</p>
16	OUT1+	General-purpose input1(+)		<p>■ Connect the general output circuit to a photo coupler or relay circuit.</p> <p>Power supply voltage range: 5V DC±5%                      Maximum current value : 50mA Power supply voltage range: 12 to 15V DC±10%                      Maximum current value : 50mA Power supply voltage range: 24V DC±10%                      Maximum current value : 50mA</p> <p>When host unit input circuit is a TTL or CMOS-input, the maximum current value shall be 20mA or less.</p> <p>Host unit                      Servo amplifier</p>
17	OUT1-	General-purpose input1(-)		
18	OUT2+	General-purpose input2(+)		
19	OUT2-	General-purpose input2(-)		
20, 21	-	Reserved	Do not connect anything.	
22	RXD+	For the position synchronization compensation communication	<p>■ This is communication interface for the position synchronization compensation function which controls as 2 amplifiers have same position deviation. Connect to the target amplifier. Communication spec is RS-422.</p>	
23	RXD-			
24	TXD+			
25	TXD-			
13,26	SG	Signal ground	Connected to the signal ground of servo amplifier.	

### 4.3 Wiring of Motor Encoder

#### 1) EN1, EN2 connector name and its function

■ Battery backup absolute encoder

Servo Amplifier EN1 Terminal No.	Signal name	R-series Servo motor Plug pin number (Specification for leads)	Q-series Servo motor Plug pin number	Description	Remarks Note 1)
1	5V	9 (Red)	H	Power supply	Twisted pair (Recommended)
2	SG	10 (Black)	G	Power supply common	
3	(NC)	-	-	Unconnected	-
4	(NC)	-	-	Unconnected	-
5	(NC)	-	-	Unconnected	-
6	(NC)	-	-	Unconnected	-
7	ES+	1 (Brown)	E	Serial data signal	Twisted pair
8	ES-	2 (Blue)	F		
9	BAT+	8 (Pink)	T	Battery	Twisted pair
10	BAT-	4 (Purple)	S		
Note 2)	Ground	7 (shielded)	J	Shield	-

Note 1) Use shielded cable and perform twisted-pair wiring.

Note 2) Connect outer-shielded wires of servo amplifier to metal case (ground) of servo amplifier (EN1). For the servo motor with leads, the outer shielded wire of the servo motor shall be connected to shielded wires of leads, and for the canon 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.

■ Single-turn absolute encoder for incremental system

Servo Amplifier EN1, 2 Terminal No.	Signal name	R-series Servo motor Plug pin number (Specification for leads)	Q-series Servo motor Plug pin number	Description	Remarks Note 1)
1	5V	9 (Red)	H	Power supply	Twisted pair (Recommended)
2	SG	10 (Black)	G	Power supply common	
3	(NC)	-	-	Unconnected	-
4	(NC)	-	-	Unconnected	-
5	(NC)	-	-	Unconnected	-
6	(NC)	-	-	Unconnected	-
7	ES+	1 (Brown)	E	Serial data signal	Twisted pair
8	ES-	2 (Blue)	F		
9	(NC)	-	-	Unconnected	-
10	(NC)	-	-	Unconnected	-
Note 2)	Ground	7 (Shielded)	J	Shield	-

Note 1) Use shielded cable and perform twisted-pair wiring.

Note 2) Connect outer-shielded wires of servo amplifier to metal case (ground) of servo amplifier (EN1). For the servo motor with leads, the outer shielded wire of the servo motor shall be connected to shielded wires of leads, and for the canon 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 Terminal No.	Signal name	R-series Servo motor Plug pin number (Specification for leads)	Q-series Servo motor Plug pin number	Description	Remarks Note 1)
1	5V	9 (Red)	H	Power supply	Twisted pair (Recommendation)
2	SG	10 (Black)	G	Power supply common	
3	(NC)	-	-	Un connected	-
4	(NC)	-	-	Un connected	-
5	(NC)	-	-	Un connected	-
6	(NC)	-	-	Un connected	-
7	ES+	1 (Brown)	E	Serial data signal	Twisted pair
8	ES-	2 (Blue)	F		
9	(NC)	-	-	Un connected	-
10	(NC)	-	-	Un connected	-
Note 2)	Ground	7 (Shielded)	J	Shield	-

Note 1) Use shielded cable and perform twisted-pair wiring.

Note 2) Connect the shielded cable to the metal case (ground) on EN1 side and connect the ground to the motor encoder side.

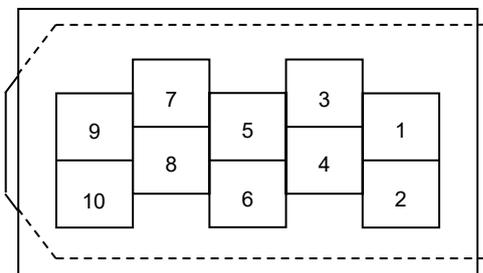
■ Wire-saving incremental encoder

Servo Amplifier EN1 Terminal No.	Signal name	R-series Servo motor Plug pin number (Specification for leads)	Q-series Servo motor Plug pin number	Description	Remarks Note 1)
1	5V	9 (Red)	J	Power supply	Twisted pair (Recommendation)
2	SG	10 (Black)	N	Power supply common	
3	(NC)	-	-	Unconnected	-
4	(NC)	-	-	Unconnected	-
5	B	2 (Green)	B	B-phase pulse output	Twisted pair
6	/B	5 (Purple)	E		
7	A	1 (Blue)	A	A-phase pulse output	Twisted pair
8	/A	4 (Brown)	D		
9	Z	3 (White)	F	Z-phase pulse output	Twisted pair
10	/Z	6 (Yellow)	G		
Note 2)	Ground	7 (shielded)	H	Shield	-

Note 1) Use shielded cable and perform twisted-pair wiring.

Note 2) Connect the shielded cable to the metal case (ground) on EN1 side and connect the ground to the motor encoder side.

2) Terminal number



(Soldered side)

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

■ Connector number (3M Japan Ltd.)

	Model Number	Application wire size	Application cable diameter
Connector	36210-0100PL	AWG30 - AWG18	-
Shell kit	36310-3200-008	-	Φ7 to 9

3) Connector model number for motor encoder

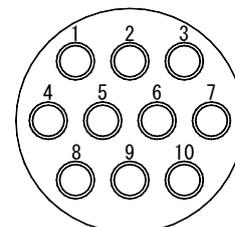
- R-series servo motor encoder Connector model numbers (Products of Japan Aviation Electronics Industry, Limited)

Motor model number	Motor encoder plug model number	Connector type	Applicable cable diameter	
R2GAD102 R2#A02D20 R2#A02D30 R2#A04003 R2#A04005 R2#A04008 R2#A04010 R2#A06010 R2AA06020	R2AA08020 R2AA06040 R2AA08040 R2AA08075 R2AAB8075 R2AAB8100 R2AA10075 R2AA10100 R5AA08075	(Specification for lead locating)	-	
R1AA18550 R1AA18750 R1AA1811K R1AA1815K	R2AA13050 R2AA13120 R2AA13180 R2AA13200	JN2DS10SL1-R	φ 5.7 to 7.3	
	R2AA18350 R2AA18450	JN2FS10SL1-R		
	R2AA18550 R2AA18750	JN2DS10SL2-R	φ 6.5 to 8.0	
	R2AA1811K R2AA1815K	JN2FS10SL2-R		
	R2AA22350 R2AA22500 R2AA22700 R2AA2215K	JN2DS10SL3-R	φ 3.5 to 5.0	
		JN2FS10SL3-R		
	R2AAB8100	(Specification for lead locating)	-	-

✓ Mark “#” shows Optional number or alphabetical letter.

- Contact model numbers (Products of Japan Aviation Electronics Industry, Limited)

Type	Model number	Qty	Applicable wire size
Manual crimping type	JN1-22-20S-R-PKG100	Note1)	AWG20
	JN1-22-22S-PKG100	Note1)	AWG21 to 25
	JN1-22-26S-PKG100	Note1)	AWG26 to 28
Soldering type	JN1-22-22F-PKG100	Note1)	AWG20 max.



R-series servo motor Encoder canon plug Pin assignment (Viewed from motor)

Note1) Please note that you can order us the contact separately.

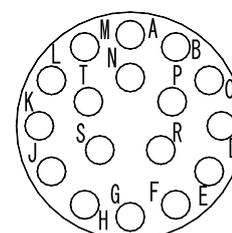
If you directly order the contact manufacturer, you can order the contact by the pack (100 contacts).

- Q-series servo motor encoder Connector model numbers (Products of Japan Aviation Electronics Industry, Limited)

Motor model number	Motor encoder plug model number (Cable clamp) 【Plug + clamp model number】	Connector type	Remarks
All the model Q1, Q2, and Q4	N/MS3106B20-29S (N/MS3057-12A) 【MS06B20-29S-12】	Straight	-
	N/MS3108B20-29S (N/MS3057-12A) 【MS08B20-29S-12】	Angle	-

Please contact us for waterproofing specifications and TÜV-compliant products.

Please place your order by “plug + clamp model number,” our exclusive model numbers.



Q-series servo motor Canon plug for encoder Pin assignment (Viewed from motor)

## 4) Canon connector plug and contact for motor encoder

■ Plug model number (Japan Aviation Electronics Industry Ltd.)

Model Number	Connector type	Application cable diameter
JN2DS10SL1-R	Straight	φ 5.7 to 7.3
JN2FS10SL1-R	Angle	
JN2DS10SL2-R	Straight	φ 6.5 to 8.0
JN2FS10SL2-R	Angle	
JN2DS10SL3-R	Straight	φ 3.5 to 5.0
JN2FS10SL3-R	Angle	

■ Contact model number (Japan Aviation Electronics Industry Ltd.)

Model Number	Application cable diameter
JN1-22-20S-R-PKG100	AWG20
JN1-22-22S-PKG100	AWG21 to 25
JN1-22-26S-PKG100	AWG26 to 28

## 5) 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 to 18

SQ (mm<sup>2</sup>) 0.15 to 0.75

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

## 6) 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°C)	Length (m)
AWG	26	150 or less	5
	24	100 or less	10
	22	60 or less	15
	20	40 or less	25
	18	25 or less	40
Sq. (mm <sup>2</sup> )	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 is different by conductor specifications.

## 4.4 Peripherals

## 1) Power supply capacity and peripherals list (Rotary motor)

■ 200V AC input

Input voltage	Servo amplifier capacity	Servo motor model No.	Main circuit power supply rating (KVA)	Circuit breaker	Noise filter	Magnetic contact	Surge absorber
200V AC	RS2#01A	R2AA04003F	0.2	Model NF30 10A MITSUBISHI ELECTRIC		S-N10 MITSUBISHI ELECTRIC	LT- C32G801WS SOSHIN ELECTRIC Co., Ltd.
		R2AA04005F	0.2				
		R2AA04010F	0.4				
		R2AA06010F	0.4				
		R2AA06020F	0.8				
		R2AA08020F	0.8				
		R5AA06020H	0.6				
		R5AA06020F	0.6				
		R5AA06040H	1.0				
	R2AA06040F	1.0					
	RS2#03A	R2AA08040F	1.0				
		R2AA08040F	1.0				
		R2AA08075F	1.7				
		R2AA13050H	1.5				
		R2AA13050D	1.5				
		R2AA13120B	2.2				
		R5AA06040F	1.0				
	RS2#05A	R5AA08075D	1.6				
		R5AA08075F	1.6				
		R2AAB8100F	2.5	Model NF30 15A MITSUBISHI ELECTRIC	HF3030C-UQA SOSHIN ELECTRIC Co., Ltd.		
		R2AA13120D	2.8				
	R2AA13120L	2.7					
	R2AA13200L	5.0					
	RS2#10A	R2AA13200D	5.0	Model NF50 30A MITSUBISHI ELECTRIC		S-N18 MITSUBISHI ELECTRIC	
		Q1AA10200D	4.0				
		Q1AA10250D	4.2				
		Q1AA12200D	4.0				
		Q1AA12300D	5.0				
		Q1AA13300D	5.0				
		Q2AA13200H	5.0				
	RS2#15A	Q2AA18200H	5.0	Model NF100 75A MITSUBISHI ELECTRIC		S-N50 MITSUBISHI ELECTRIC	
		R2AA22500L	9.6				
		Q1AA13400D	6.7				
		Q1AA13500D	8.3				
		Q1AA18450M	7.4				
		Q2AA18350H	6.9				
		Q2AA18450H	7.4				
		Q2AA18550R	8.4				
	Q2AA22550B	10.1					
	RS2#30A	Q2AA22700S	12.2	Model NF100 100A MITSUBISHI ELECTRIC	HF3050C-UQA	S-N65 MITSUBISHI ELECTRIC	
		R1AA18550H	9.3				
		R1AA18750L	11.6				
R1AA1811KR		16.0					
R1AA1815KB		21.4					
Q1AA18750H		12.6					
Q2AA18550H		10.1					
Q2AA18750L		12.6					
Q2AA2211KV		15.7					
Q2AA2215KV		21.4					
Q4AA1811KB	15.7						
Q4AA1815KB	21.4						

✓ Mark “#” is optional number or alphabetical letter.

✓ For Molded Case Circuit Breaker (MCCB)/Noise filter/Magnetic contact, the model required to single axis is shown.

■ 100V AC input

Input voltage	Servo amplifier capacity	Servo motor model No.	Main circuit power supply rating (KVA)	Circuit breaker	Noise filter	Magnetic contact	Surge absorber
100V AC	RS2#01A	R2EA04003F	0.2	NF30 Type 10A  MITSUBISHI ELECTRIC	HF3030C-UQA  SOSHIN ELECTRIC Co., Ltd.	S-N10  MITSUBISHI ELECTRIC	LT-C12G801WS  SOSHIN ELECTRIC Co., Ltd.
		R2EA04005F	0.2				
		R2EA04008F	0.4				
		R2EA06010F	0.5				
	RS2#03A	R2EA06020F	0.8				

- ✓ Mark “#” is optional number or alphabetical letter.
- ✓ For Molded Case Circuit Breaker (MCCB)/Noise filter/Magnetic contact, the model required to single axis is shown.

2) Power supply capacity and peripherals list (Linear motor)

■ 200V AC input

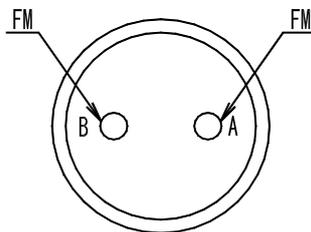
Input voltage	Servo amplifier capacity	Servo motor model No.	Main circuit power supply rating (KVA)	Circuit breaker	Noise filter	Magnetic contact	Surge absorber
200V AC	RS2#03A	DS030C1N2	1.4	Model NF30 10A MITSUBISHI ELECTRIC	HF3030C-UQ A SOSHIN ELECTRIC Co., Ltd.	S-N10 MITSUBISHI ELECTRIC	LT-C32G801WS SOSHIN ELECTRIC Co., Ltd.
		DS050C1N2	1.4				
		DS075C1N2	1.5				
	RS2#05A	DS030C2N2	2.7	Model NF30 15A MITSUBISHI ELECTRIC			
		DS050C2N2	2.7				
		DS075C2N2	3.0				
		DS030C1Y4	2.7				
		DS100C1N2	3.2				
		DS150C1N2	3.2				
	RS2#10A	DS030C3N2	3.5	Model NF50 30A MITSUBISHI ELECTRIC		S-N18 MITSUBISHI ELECTRIC	
		DS050C3N2	3.5				
		DS075C3N2	3.8				
		DS100C2N2	5.5			S-N35 MITSUBISHI ELECTRIC	
		DS150C2N2	5.5				
		DS030C2Y4	4.5				
		DS050C1Y2	4.4				
		DS075C1Y2	4.8				
	RS2#15A	DS030C3Y4	6.8	Model NF50 50A MITSUBISHI ELECTRIC			
		DS100C3N2	8.2				
		DS150C3N2	8.2				
		DS050C2Y2	8.8				
	RS2#30A	DS075C2Y2	9.5	Model NF100 75A MITSUBISHI ELECTRIC		S-N50 MITSUBISHI ELECTRIC	
		DS050C3Y2	12.2				
		DS075C3Y2	13.2			Model NF100 100A MITSUBISHI ELECTRIC	
DS050C4Y2		8.2					

- ✓ Mark “#” is optional number or alphabetical letter.
- ✓ For Molded Case Circuit Breaker (MCCB)/Noise filter/Magnetic contact, the model required to single axis is shown.

3) Cooling fan connectors to connect motor

Motor model number	Cooling fan plug model number (Cable clamp model number) 【Plug + clamp model number】	Connector type	Pin assignment code
			200V AC ± 10% Single-phase 50/60Hz
All of model Q4	N/MS3106B10SL-4S (N/MS3057-4A) 【MS06B10SL-4S-4】	Straight	A, B
	N/MS3108B10SL-4S (N/MS3057-4A) 【MS08B10SL-4S-4】	Angle	A, B

- ✓ No polarity for the above parts.  
Please place your order by “plug + clamp model number,” our exclusive model numbers.



Q4-series servo motor plug for cooling fan Pin assignment  
(Viewed from motor)

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# 5

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## 5. Interface

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## 5.1 About EtherCAT

This chapter describes the technical specifications for the network communication construction method, physical parameter adjustment method and the function activation method.

An appropriate knowledge of servo amplifiers, motion control, networking and EtherCAT CoE (CANopen over EtherCAT) is required for the reader of this chapter.

Detailed information of EtherCAT can be obtained from the following ETG(EtherCAT Technology Group)website:

<http://www.ethercat.org/>

- Trademark  
EtherCAT® is registered trademark and patented technology, licensed by Beckhoff Automation GmbH, Germany.

### 1) Overview

Ether CAT is an abbreviation of **Ethernet for Control Automation Technology**. Ether CAT is an open network communication between master and slave units using the real time Ethernet developed at BECKHOFF Automation and is controlled by ETG (Ether CAT Technology Group).

Twisted pair or fiber optic cables can be used for the Ether CAT connection and the Ether CAT also makes various topological configurations possible, such as line, tree, daisy chain, drop line, etc.

Each slave node reads the output data transmitted from the master, while a telegram is forwarded to the next device. Similarly, the input data is inserted while the telegram passes through. Standard Ethernet protocol in accordance with IEEE802.3 maintained as the communication protocol; therefore, a new sub-bus construction is unnecessary for the EtherCAT connection.

This protocol allows transport of control data directly to each Ethernet frame. The frame may consist of multiple sub-telegrams and realized Broadcast and Multicast communications with logical process images up to a possible 4 gigabytes in size.

A cable length of 100m maximum is possible between devices, and the size of the network is virtually unlimited since up to 65535 slaves can be connected under the 100BASE-TX Ethernet.

In addition, a switch-based reciprocal connection with ordinary TCP / IP is also possible.

### 2) EtherCAT Profile

- IEC61158 Section12
  - IEC61158-2-12 (EtherCAT Physical Layer Specification and service definition)
  - IEC61158-3-12 (EtherCAT Data-link service definition)
  - IEC61158-5-12 (EtherCAT layer service definition)
  - IEC61158-6-12 (EtherCAT layer protocol specification)

IEC61158 is the forms of the international fieldbus standards including Ethernet-based field buses with the descriptions that define the basic communication structure of the networks.

EtherCAT protocol is added as "Type 12" that directs EtherCAT Communication Profiles such as EtherCAT State Machine (ESM), Process Data Communication System using the features of the Fieldbus Memory Management Unit (FMMU), CoE Service Channel maps to the EtherCAT Mailbox, SyncManager (SM) and synchronization structure using Distributed Clocks (DS).

- IEC61800 Part7 (Adjustable speed electrical power drive systems)
  - IEC61800-7-1 (Generic interface and use of profiles for power drive systems - Interface definition)
  - IEC61800-7-200 (Generic interface and use of profiles for power drive systems - Profile specifications)
  - IEC61800-7-300 (Generic interface and use of profiles for power drive systems - Mapping of profiles to network technologies)

IEC61800 in Part7, Power Drive System(PDS) profile, defines the functional operations of the servo drive systems. Section1 defines the generic interface and use of profiles for PDS.

Section200 defines the specifications of profile types. The object dictionary of data protocol, CiA402, state transition FSA and operation mode functions are explained in Profile type1 (-201) and primarily SERCOS IDN and phase are explained in Profile type4(-204) in detail.

Section300 defines mapping of network technologies. CANopen and CANopen over EtherCAT are explained in the Mapping of profile type1 (-301) and the communication protocols such as SERCOS and Servo drive over EtherCAT are explained in the Mapping of profile type4 (-304).

## 5.2 Model (Reference Model)

### 1) OSI Reference Model

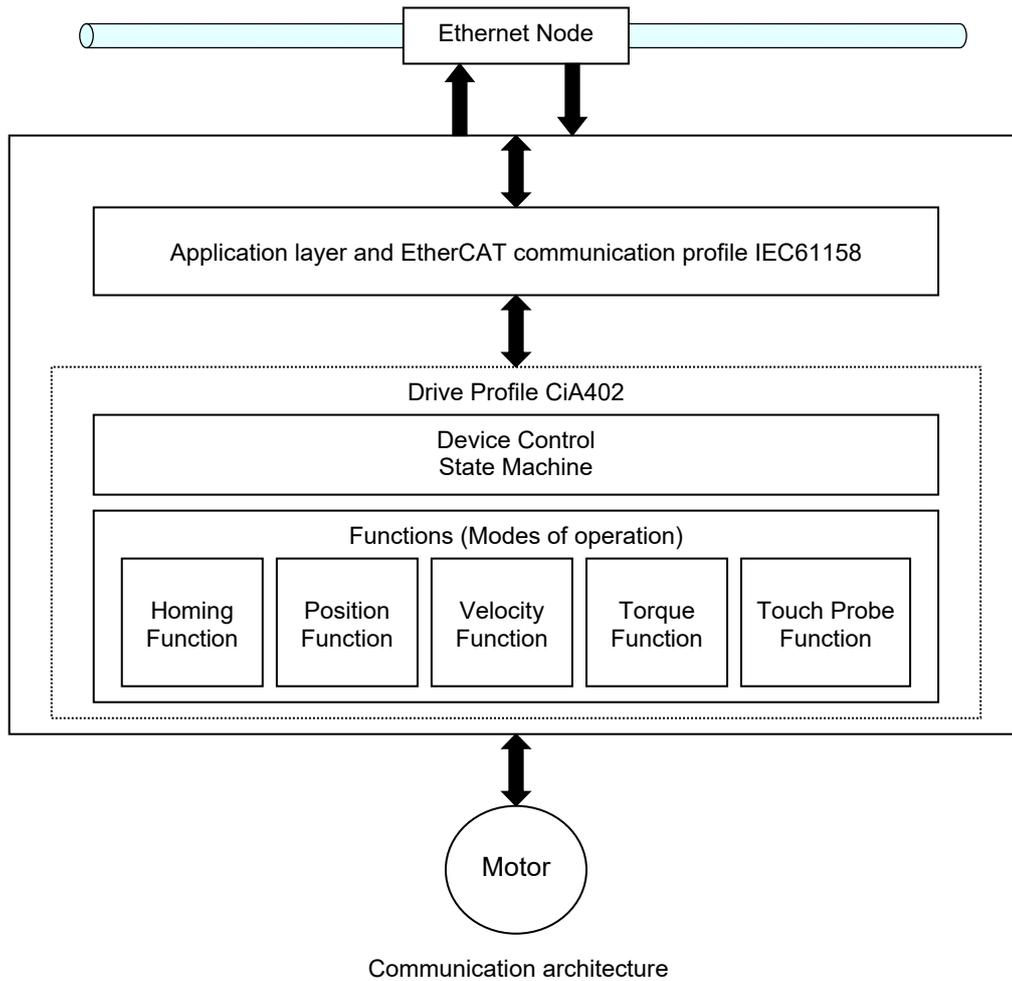
Compared with the OSI (Open Systems Interconnection) reference model, the EtherCAT communication model has no layers in layers 3 - 6.

Comparison of OSI reference model and EtherCAT (CoE) model

Layer	OSI reference model		EtherCAT model
7	Application (Application layer)		SDO (Service Data Object : Mailbox)
			PDO (Process Data Object)
			ESM (EtherCAT State Machine)
			ESI (Slave Information Interface)
6	Presentation (Presentation layer)	}	Empty
5	Session (Session layer)		
4	Transport (Transport layer)		
3	Network (Network layer)		
2	Data link (Data link layer)		SM (Sync Manager)
			FMMU (Field Memory Management Unit)
			PDI (Process Data Interface)
			DC (Distributed Clock)
1	Physical (Physical layer)		100BASE-TX
			E-BUS (LVDS for back plane)

- Layer 1 (Physical layer)  
Takes charge of electrical conversion and mechanical work to send out data to communication circuits. The pin shapes and cable characteristics are also specified on this layer.
- Layer 2 (Data link layer)  
Ensures the physical communication path and detects data errors passing through the path.
- Layer 3 (Network layer)  
Selects the communication path to deliver the data and controls the address inside the path.
- Layer 4 (Transport layer)  
Performs data compression, error correction and resends data delivery controls absolutely and efficiently.
- Layer 5 (Session layer)  
Establishes and releases virtual connection for sending / receiving data between communication programs.
- Layer 6 (Presentation layer)  
Transforms received data from the session layer into an easier to use form and changes the data from the application layer into a form applicable for communication.
- Layer 7 (Application layer)  
Provides various services utilizing data communication to users as well as to other programs.

2) Drive Architecture



## 5.3 Settings

### 1) Node ID

Each slave drive in the EtherCAT network can have its own respective node ID and the unique node ID setting is basically performed in the position addressing mode.

Besides, 0 - 65535 axes addresses can be set using the 8bit rotary switch (0x00 to 0xFF: bit 7 to 0) at the front of the amplifier and with a set value of bit 15 to 8, previously written in the non-volatile memory (on R2 setup) inside the amplifier.

The setting values will be written in the station alias setting register (0x0012) in an address space after the control power has been turned ON.

When an axis address has changed under the control power ON status, re-input the power to enable the change in axis address.

### 2) Physical Communication Specifications

Physical Communication Specifications

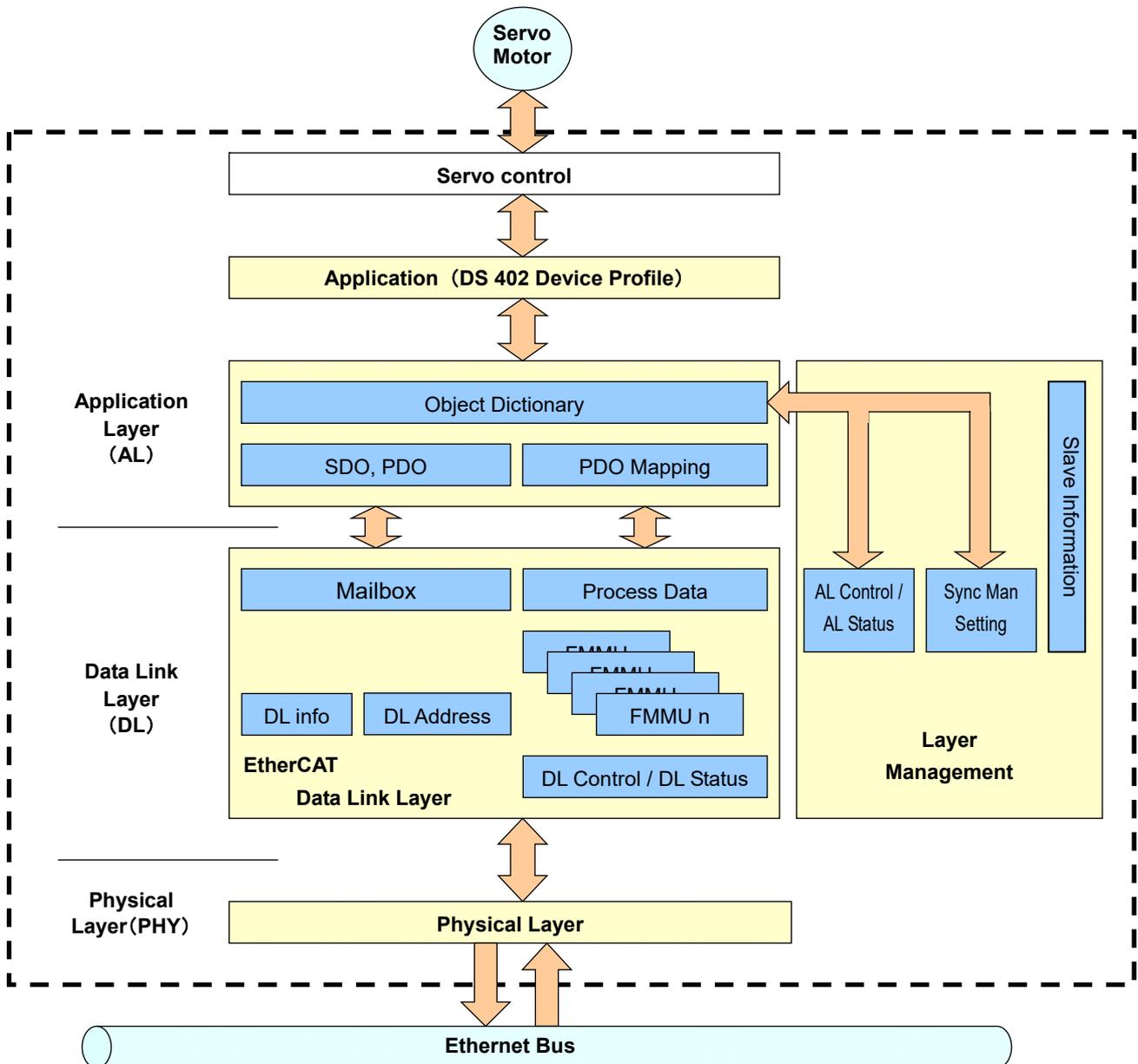
Item	Specifications	Notes
Topology	Line	
Data flow	Line: From the master to the first slave and then on to the last slave, shuttling back and forth.	
Communication media	Twisted pair cable	
Communication rate	100 Mbit/s	
Communication parameter settings	Auto-negotiation function with ISO/IEC 8802-3 Auto-crossover function	
Cycle time	Depends on application	
Device address	Selected address	
Synchronization	Special protocol for data change(DC)	
Slave telegram	Mailbox SDO telegram using EtherCAT CoE specifications	
Master telegram	Mailbox SDO telegram using EtherCAT CoE specifications	
Initialization	Input power >> Init >> Pre-Operational >> Safe-Operational >> Operational mode	
Cable length	100m max	Between nodes
Node	65,535 max.	Single segment

### 5.4 Communication Specifications

#### 1) Device Model

- Communication  
This unit includes the data transfer function via the network architecture base.
- Object Dictionary  
The Object Dictionary affects the application object, the communication object and the state machine operations used in this device.
- Application  
The communication device function of data conversion, according to the operational environment, is included in the application.

The Object Dictionary has a role as an interface between communication and application.  
The explanation of the device application of each data item in the Object Dictionary is called a "Device Profile".



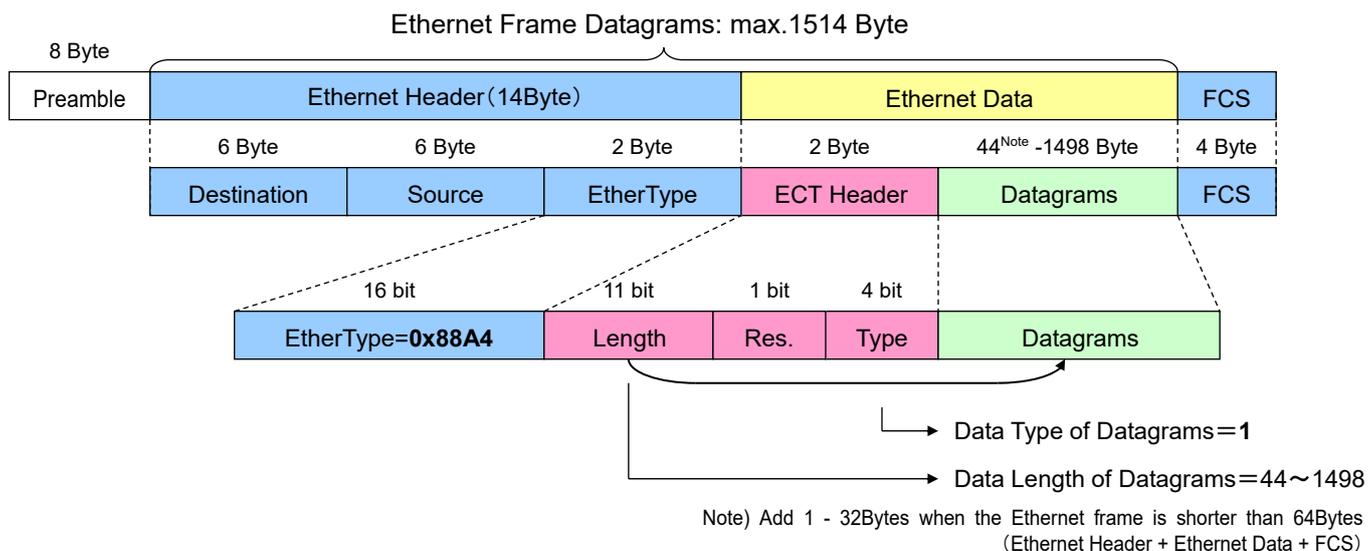
Object Dictionary and Device model

- Object Index**  
 All objects are addressed with a 16-bit index using a 4-digit hexadecimal number. Objects are assigned in the Object Dictionary by individual groups. The Object Dictionary outline prescribed in CoE is as follows:

Object Index Assignment	
Index (Hex)	Object
0x1000 - 0x1FFF	Communication Profile Area
0x2000 - 0x5FFF	Manufacturer Specific Profile Area
0x6000 - 0x9FFF	Standardized Device Profile Area
0xA000 - 0xFFFF	Reserved

## 2) Communication

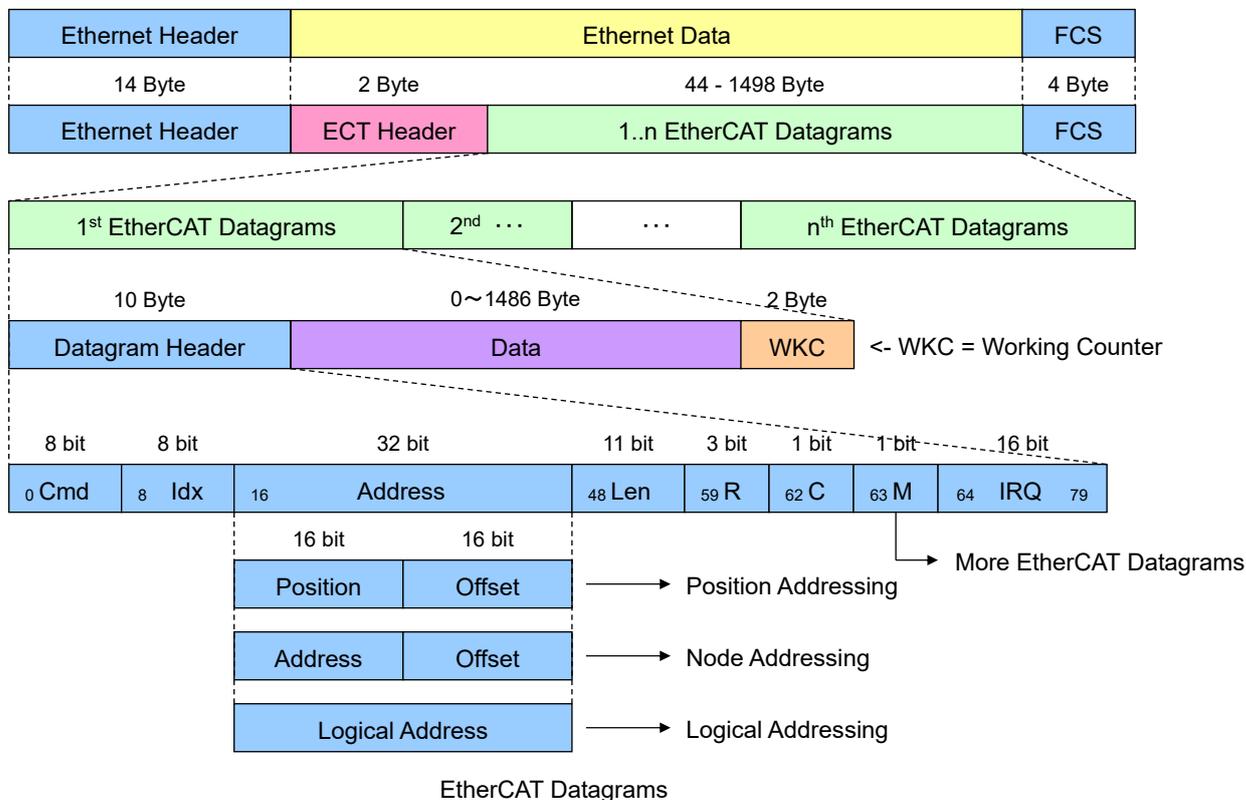
- Ethernet Protocol**  
 Since EtherCAT is adopting IEEE 802.3 as its standard Ethernet frame, a standard network controller can be used. Therefore, system construction is possible on the master side without designing specific hardware. "0x88A4" is reserved for the Ether type of EtherCAT and is distinguished from the other Ethernet frames. EtherCAT does not require IP protocol. The frame defines EtherCAT datagrams and divides them into detailed accounts at the EtherCAT frame header. Only theType1 EtherCAT frame is processed by the slave in the EtherCAT header.



Ether Type and Ethernet Data Headers

### 3) EtherCAT Protocol

The commands are standardized as default values with the IEC61158 EtherCAT Communication Profile to simplify network structuring. Each node in a segment can be addressed individually and the EtherCAT datagrams can be used by one (1) Ethernet. The frame ends at the EtherCAT datagrams.



### 4) Datagram Header

A 10 Byte datagram header at the beginning of the datagram determines how to handle the following data:

EtherCAT Datagram Header

Field	Data Type	Value / Explanation
Cmd	BYTE	EtherCAT command type
Idx	BYTE	Index is handled by the master for copy / datagram identification. This is a numeric identifier. It cannot be changed in a slave.
Address	BYTE [4]	Indicates the access method of the slave with a 32-bit address. ·Auto-increment address (16bit device address+16bit offset address) ·Node address (16bit device address+16bit offset address) ·Logical address (32bit logical address)
Len	11bit	Data length following these datagrams
R	3bit	Reserved, 0
C	1bit	Circulating frame 0 : Frame is not circulating 1 : Frame was circulated before
M	1bit	Contiguous EtherCAT datagrams 0 : The last EtherCAT datagram (n <sup>th</sup> EtherCAT Datagrams) 1 : EtherCAT provide further contiguity (Example:2 <sup>nd</sup> EtherCAT Datagrams will about the 1 <sup>st</sup> EtherCAT Datagrams
IRQ	WORD	EtherCAT interrupt request register for all slaves is interlocked with the logic OR
Data	BYTE [n]	Read / Write data
WKC	WORD	Working counter

## 5) Command Type

Address and access method are determined by the 8-bit command at the head of the EtherCAT datagram. EtherCAT command types are listed below.

Read / Write operations and Read operation are executed before Write operation.

EtherCAT Command Types

CMD	Abbreviation	Name	Explanation
0 (0x00)	NOP	No Operation	Disregard commands
1 (0x01)	APRD	Auto Increment Read	Creates the increment address Sets Read data in the datagram when the receive address is 0.
2 (0x02)	APWR	Auto Increment Write	Creates the increment address. Writes data in the memory domain when the receive address is 0.
3 (0x03)	APRW	Auto Increment Read Write	Creates the increment address. Sets Read data in datagrams and writes the data in the same memory domain.
4 (0x04)	FPRD	Configured Address Read	Sets Read data in datagrams when address is matched.
5 (0x05)	FPWR	Configured Address Write	Writes data in datagrams when address is matched.
6 (0x06)	FPRW	Configured Address Read Write	Sets Read data in the EtherCAT datagrams and writes the data in the same memory domain when the address is matched.
7 (0x07)	BRD	Broadcast Read	All slaves set the logical OR of the memory domain data and datagrams data.
8 (0x08)	BWR	Broadcast Write	All slaves write data in the memory domain.
9 (0x09)	BRW	Broadcast Read Write	All slaves set the logical OR of the memory domain data and the datagram data then write the data in the memory domain (BWR is not generally used).
10 (0x0A)	LRD	Logical Memory Read	Sets read data for the datagrams when the receive address is matched with read setting FMMU
11 (0x0B)	LWR	Logical Memory Write	Writes the data in the memory domain when the receive address is matched with write setting FMMU.
12 (0x0C)	LRW	Logical Memory Read Write	Sets read data for the datagrams when the receive address is matched with read setting FMMU. Writes the data in the memory domain when the receive address is matched with write setting FMMU.
13 (0x0D)	ARMW	Auto Increment Read Multiple Write	Creates increment address. Inputs read data to the datagrams when receive address is 0. Other slaves write data in the memory domain.
14 (0x0E)	FRMW	Configured Read Multiple Write	Sets read data to the datagrams when address is matched. Other slaves write data in the memory domain.
15~255(0x0F - 0xFF)			Reserved

Addressing mode of EtherCAT datagrams 32bit Address is explained in the following table (1-7)

EtherCAT Addressing Mode

Mode	Field	Data Type	Value / Explanation
Auto Increment Address	Position	WORD	Each slave increment is respective to its position, and the slave at Position = 0 will be addressed.
	Offset	WORD	ESC Local register or Memory address
Configured Station Address	Address	WORD	Slave will be addressed when the set axis address matches the set station address (under the enabled condition)
	Offset	WORD	ESC Local register or Memory address
Logical Address	Address	DWORD	Slave will be addressed when the logical address (set by FMMU) FMMU configuration matches the address.

6) WKC (Working Counter)

Each EtherCAT datagram will end with a 16 bit working counter (WKC).  
 The working counter counts the device number normally accessed by EtherCAT datagrams.  
 Also, the working counter is incremented by the ESC (hardware) in which the slave amplifier is loaded.  
 Each datagram should have an estimated working counter value calculated in the master.  
 The master can confirm if EtherCAT datagrams have executed processing or not by comparing the estimated value to counted by the WKC and the result of the commands to each slave.

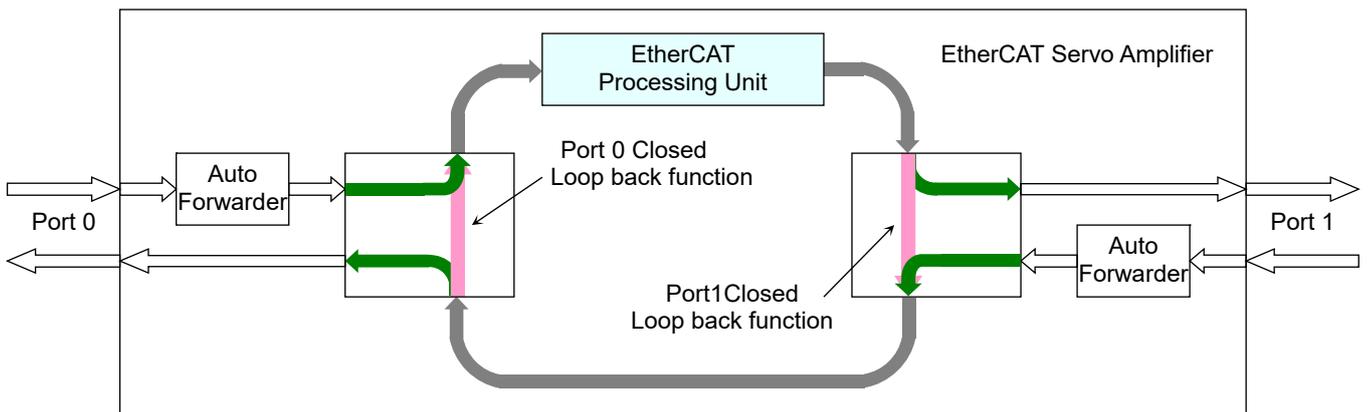
Working Counter Increment		
Command	Data Type	Increment
Read Command	Failed	No change
	Read succeeded	+1
Write Command	Failed	No change
	Write succeeded	+1
Read / Write Command	Failed	No change
	Read succeeded	+1
	Write succeeded	+2
	Read / Write succeeded	+3

7) Frame Processing

R-ADVANCED EtherCAT amplifier has two (2) parts and the frame processing order (processing) is according to the logical port number.

Usage Port		Frame Processing Order			
1 Port	Port0	->	Processing	->	Port 0
	Port1	->	Processing	->	Port 1
2 Ports	Port0	->	Processing	->	Port 1
	Port1	->	->	->	Port 0

The direction via the EtherCAT processing unit is called "Processing" and the direction that does not pass through the processing unit is called "Forwarding".



Frame Processing of R-ADVANCED EtherCAT Amplifier

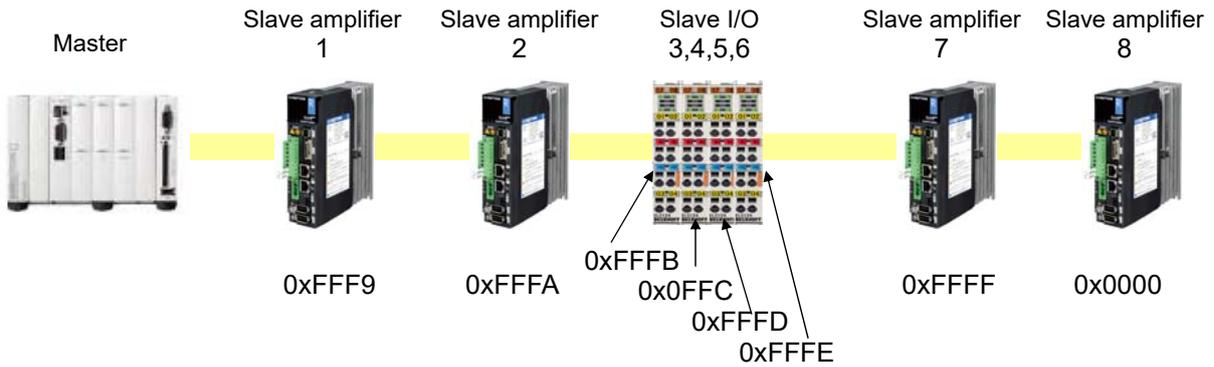
## 5.5 Addressing Image

### 1) Position Addressing (Auto-Increment Addressing)

Position addressing is a command to access slaves from the master according to the connection order (physical position).

Each slave device provides one (1) 16-bit address field every time datagrams pass through and a slave "0x0000" will be addressed and will respond when receiving the address field.

Position addressing image is as follows: Frame must be transmitted under the position setting of "0x0000" when addressing the 1<sup>st</sup> axis and "0xFFFF9" when addressing the 8<sup>th</sup> axis.



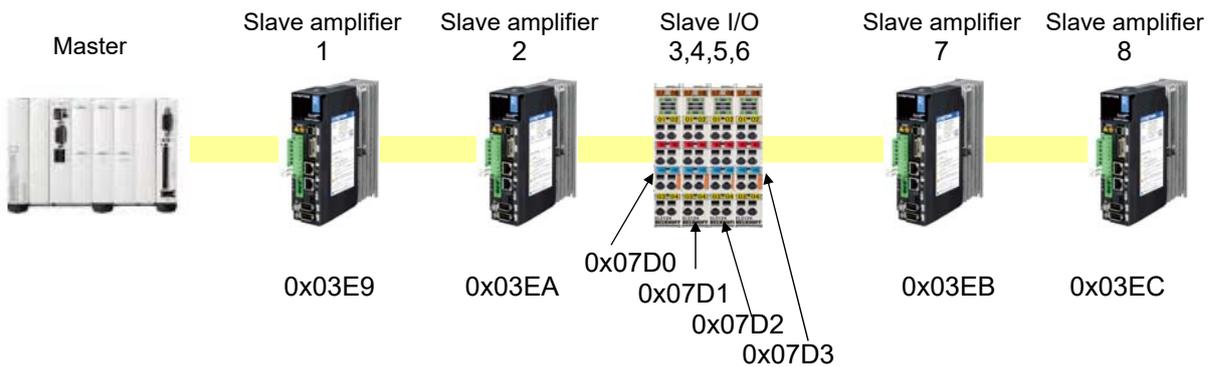
Position Addressing Image (Example: Addressing the 8<sup>th</sup> axis)

### 2) Node Addressing (Fixed Addressing)

The slave matched to the address set at station register (0x0010) from the master by position addressing is normally addressed in node addressing.

This enables access without fail even when a device is added, the segment topology has changed and/or the slave has been removed.

The respective slave node address is set with the rotary switch at the front of the amplifier and CoE Object Dictionary: an added value of the extension station alias (0x20FA) in the station alias. Therefore, identification is possible even if the connection order differs. Also, this address pattern is accessible by setting in DL Control.

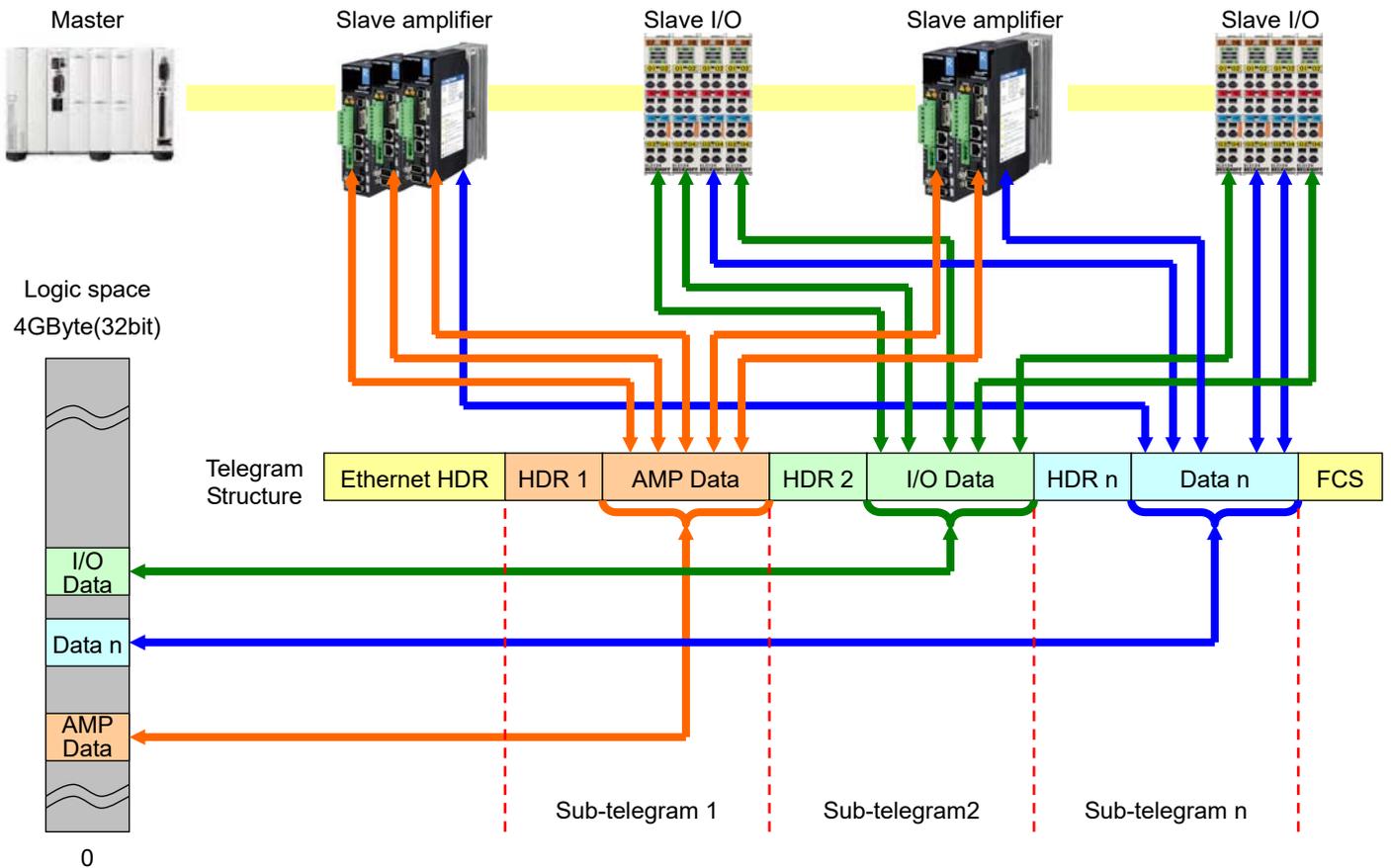


Node Addressing Image

### 3) Logical Addressing

A 32-bit address field for logical addressing inside the segment is used as one (1) address value. Logical addressing is not done individually but addresses the 4GB segment width of the logical address space. This section can be used for any slave number and can translate the 32 bit logical address to a physical address using the internal address mapping method of the Fieldbus Memory Management Unit (FMMU). Each FMMU channel maps the logical address space that abuts the contiguous physical address space of one of the slaves.

Logical addressing image is shown below.



Logical Addressing Image

### 4) FMMU(Fieldbus Memory Management Unit)

FMMU (Fieldbus Memory Management Unit) translates the ESC physical address and the 4GB (32bit channel) master logical address. Each FMMU channel can manage a logical address controlled in the master and physical address extending over the respective slave in batch by allocating the contiguous logical address space of the master to the contiguous physical address space of the slaves. The types of access configurations supported by FMMU are "Read", "Write" and "Read / Write".

## 5) SM (SyncManager)

ESC memory can be used for data conversion between the master and the slave *M*-controller without any limitation; however, it has some weak points because the internal ESC is addressed for using communication memory.

- The data integrity will not be guaranteed.  
Signals must be executed with software for coordinate data conversion.
- The data security will not be guaranteed.  
It is necessary to process the data security mechanism with the software.
- Both the EtherCAT master and slave (s) must poll the memory until either master or slave has confirmed the access completion notification.

Definite SM enable and normal data reception are converted between the master and slave and generate change notification interrupts to both sides.

SM is set in the master and uses a buffer set in the memory area for data conversion.

The communication direction is configured the same as the buffer and mailbox modes.

Access to this buffer is controlled by SM hardware, and it is necessary to access the Start address first. If not, access will be refused.

The entire buffer will be accessible after the start address is accessed.

The buffer ends with access to the end address and the buffer status will change. An interrupt will also be generated when the watchdog trigger pulse has been set.

The end address cannot be accessed twice in one frame.

Two (2) communication modes are supported in SM.

- **Buffer Mode**  
Buffer mode enables access to the communication buffer at any time on both the EtherCAT master and slave side.  
The reception side can always Read the latest buffer written on the transmission side. The transmission side can always update the buffer value.  
However, old data will be dropped when the Write buffer is faster than the Read.  
Buffer mode is generally used for PDO communications of T x PDO·R x PDO.
- **Mailbox Mode**  
Data will not be lost in mailbox mode because of the handshaking mechanism associated with data conversion.  
Either the EtherCAT master or slave can access the buffer, but only when the other side has ended its access.  
To begin, the transmission side Writes on the buffer, and the next Write command is locked until Read by the reception side.  
Mailbox mode is generally used as an application layer protocol. The SM reception buffer will change in the master only when FCS (Frame Check Sequence) is normal. Therefore, the buffer will respond immediately after the frame ends.  
The SM setting register is assigned from the address 0x0800.

## 6) Buffer Mode (3 Buffer Mode)

Buffer mode enables simultaneous data Read/Write on both the master and slave and is called 3 Buffer Mode.

Physically, three (3) same-sized buffers are allocated in this buffer mode and these set the start address as well as the first buffer size at configuration register SM 0-7 of 0x0800.

This buffer address will be defined for data Read/Write to be used for the master and slave.

Accessing the first (0) address width is performed by SM with automatic switching accessing to one of the three buffers.

Therefore, the master and slave only need to access the buffer (0) address.

Also, the memory to be used for buffers (1) and (2) will be reserved automatically and disabled. Please consider this domain carefully when setting another SM.

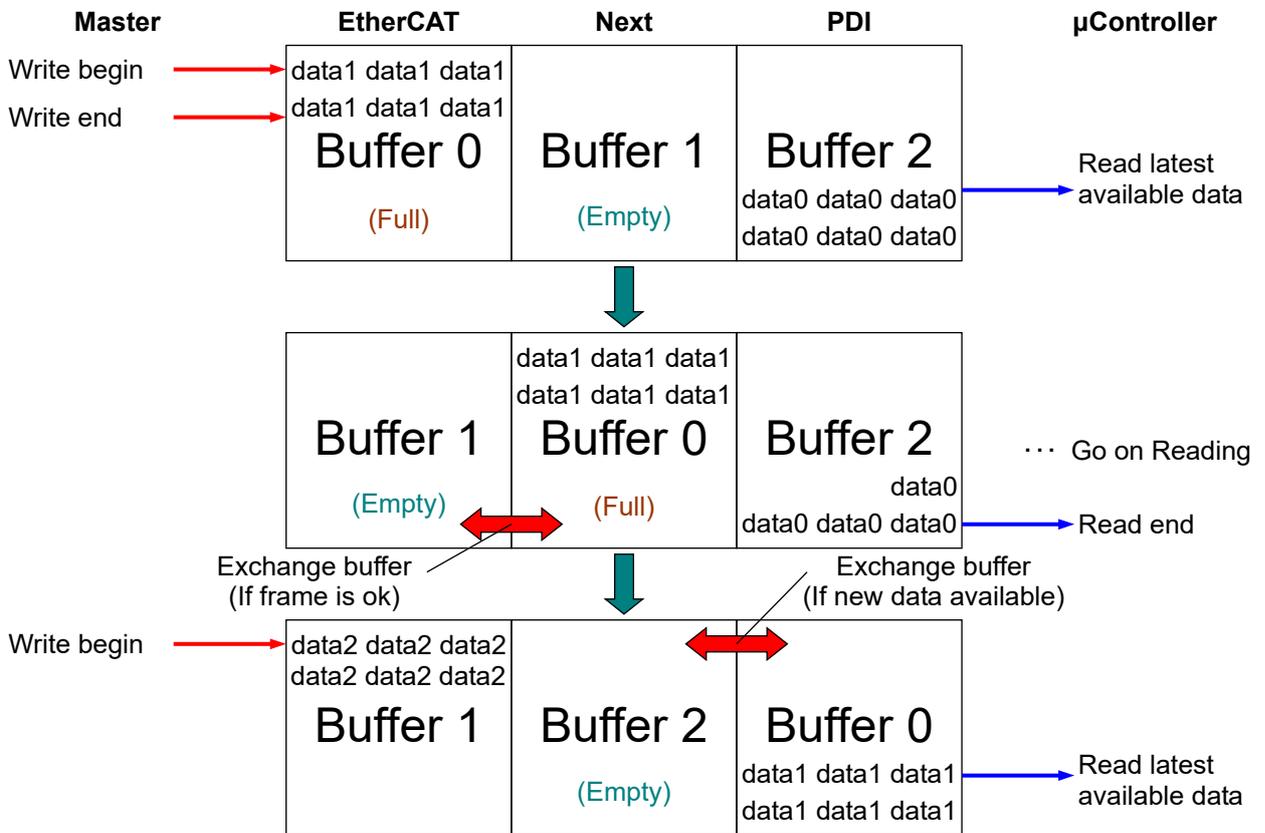
Generally, one buffer among the three is for Write use, one for Read use and another is reserved for Write use.

Shows the definition and data conversion example under the setting of: Start address: 0x0100 Data length: 0x0100

Buffer address	Object index
0x1000 - 0x10FF	Buffer 0 (Visible)
0x1100 - 0x11FF	Buffer 1 (Invisible disable)
0x1200 - 0x12FF	Buffer 2 (Invisible disable)
0x1300 -	Next useable domain

Both the master and slave access Buffer 0 because SM controls all buffers. Sets only Buffer 0 for SM setting.

Buffer Allocation for SyncManager Buffer Mode



Conversion example of SyncManager Buffer Mode (Master => Slave)

SM status register reflects the current status and the latest Write buffer status is displayed as in interrupt status. The latest Write buffer status shows "3" until the first Write of the SM buffer.

### 7) Mailbox Mode

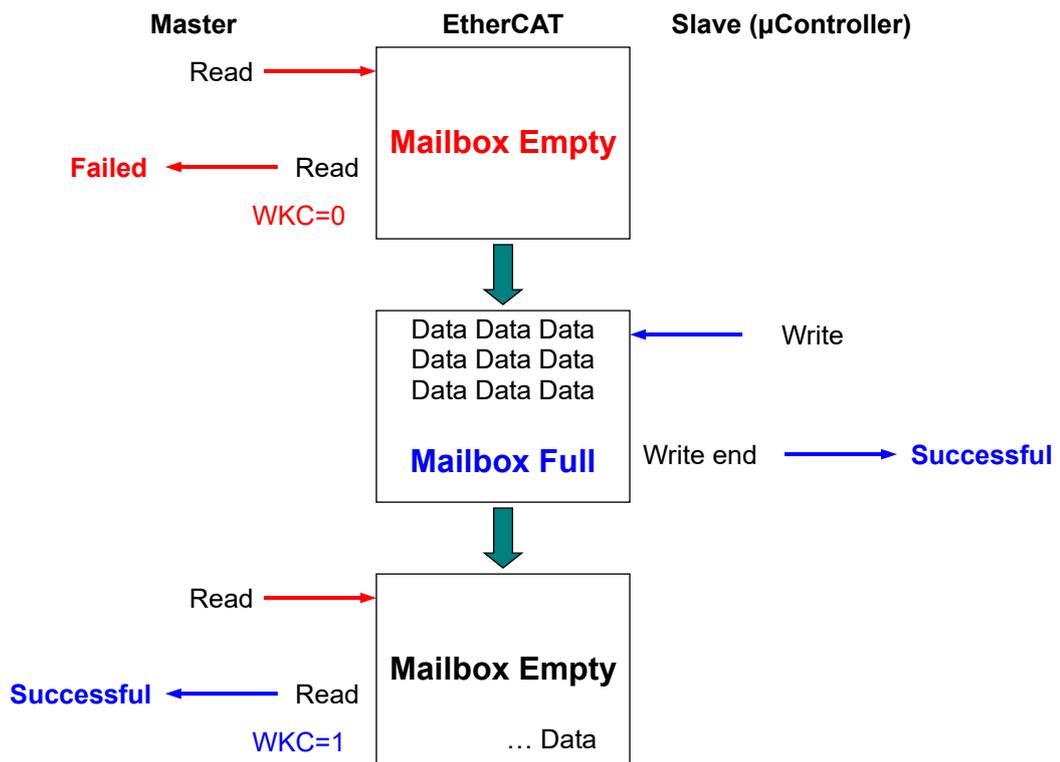
It is guaranteed that all transmitted data will be delivered to the reception side because the Write/Read are converted with handshaking in the mailbox mode.

Mailbox mode uses only one (1) size buffer set in advance and will be able to be used as a mailbox buffer after the initial settings and boot to SM.

When the initial data writing to the data is complete, write access will be blocked and the data can be read on the reception side.

After the data has been read normally, writing access to the buffer is permitted again.

The time required for data Read/Write is not important in this mode.



Mailbox Mode data conversion example (Master => Slave)

## 5.6 Accessing to Object Dictionary

R-ADVANCED EtherCAT amplifier supports CoE (CANopen over EtherCAT) with two (2) methods provided for accessing the Object Dictionary device.

- Service Data Object (SDO)
- Process Data Object (PDO)

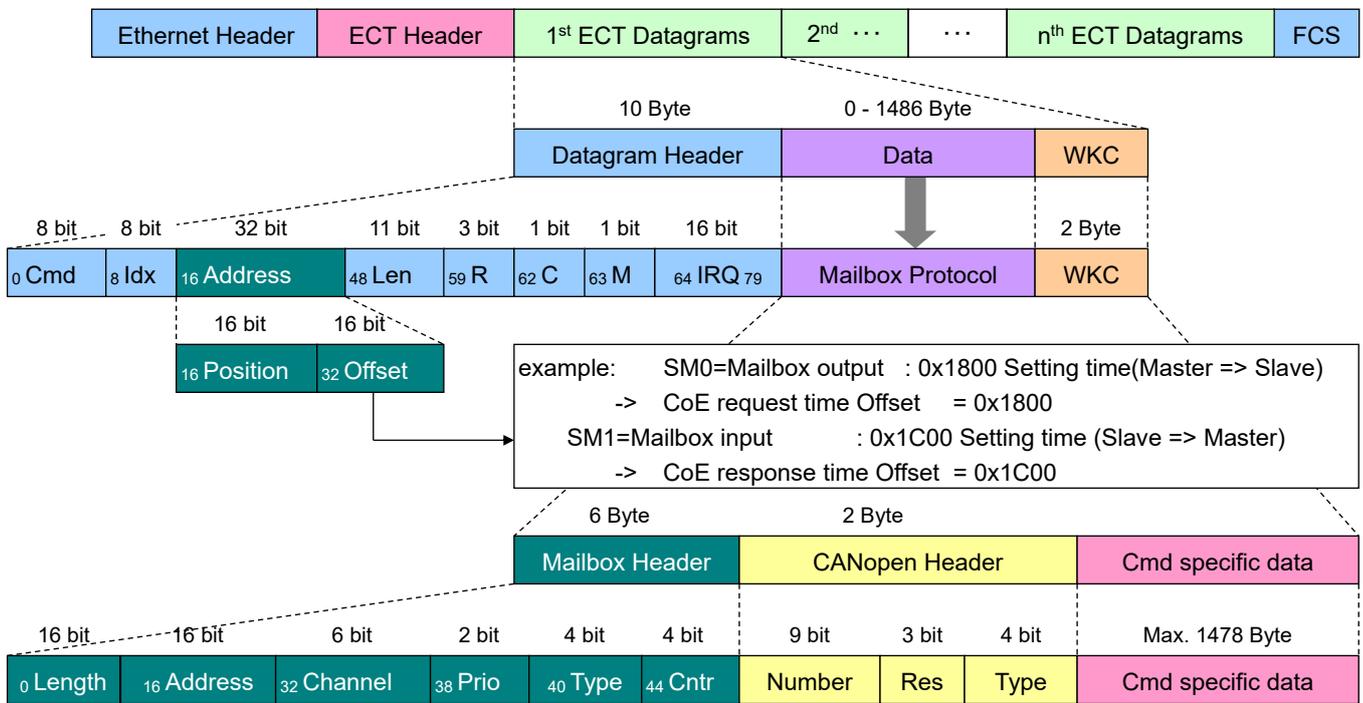
### 1) Service Data Object (SDO)

The master can control many of the slave amplifier parameters such as device settings and the monitor, through Read/Write in the Object Dictionary entry, using SDO transfer.  
 The master, supporting EtherCAT CoE, performs SDO transfer to each slave device.  
 The data changes and the Read R\_SDO is requested by T\_SDO and transmitted from the SDO master.

### 2) Mailbox Protocol

The mailbox functions as a communication direction of master to slave / slave to master and supports various DL user protocols with an independent communication system differing from logical addressing.  
 Data transfer from slave to slave must be processed by the master.  
 The Mailbox Header has an address field in the master that enables re-direction service.  
 Mailbox uses two (2) SyncManager (SM) channels: one (1) in each direction.  
 (Example: SM0: Master -> Slave direction, SM1: Slave -> Master direction)  
 The physical addressing method, with no FMMU, is necessary in mailbox communication instead of logical addressing because mailbox communication addresses a single slave intermittently.

Diagram for Mailbox - Interface and protocol configurations are shown below.



Mailbox - Interface

Mailbox Header Configurations

Name (Abbreviation)	Data Length	Explanation
Length (Len)	2 Byte	Data length to abut the next
Address (Ad)	2 Byte	Sender's station address
Channel (Ch)	6 bit	Reserved (0x00)
Priority (Pr)	2 bit	Reserved Priority(0x00 - 0x03)
Type (Typ)	4 bit	Mailbox type. Protocol identifier for contiguous data 0 : Mailbox Error 3 : CoE (CAN open over EtherCAT)
Counter (Ct)	4 bit	Sequence number Incremented in every mailbox service as a duplicate detection. (Only 1 – 7 can be used because of compatibility to an old version)

### 3) CANopen Header Protocol

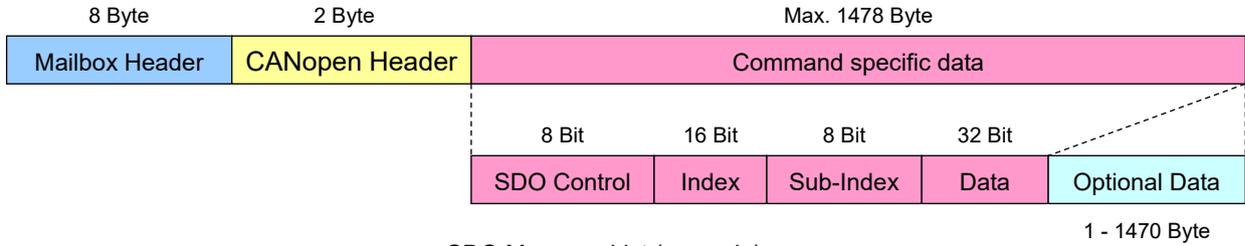
"CANopen Header" is configured with a 2Byte identifier composed of "Number" and "Type".  
"CANopen Header" configuration is shown below.

CoE Command Configuration

Name (Abbreviation)	Data Length	Explanation
Number (Num)	9 bit	PDO number (PDO Use only in transmission time) 0x000 - 0x1FF
Type (Type)	4 bit	Message Type 0 : Reserved 1 : Emergency Message 2 : SDO Request 3 : SDO Response 4 : Reserved (TxPDO) 5 : Reserved (RxPDO) 6 : Reserved (Remote transmission Request of TxPDO) 7 : Reserved (Remote transmission Request of RxPDO) 8 : SDO Information 9 - 15 : Reserved

4) SDO Message

SDO message is configured by “CANopen Header” and “SDO Data frame”.  
 Data transfer capacity is up to 4Byte standard and is possible for up to 1470Byte using the “optional Data” domain.  
 Since most of them are smaller than 4Byte in the R-ADVANCED EtherCAT CoE amplifier, an expedited SDO transfer is possible.  
 SDO message configuration is shown below.



SDO Message Configuration

Name (Abbreviation)	Data Length	Explanation
SDO Control	1 Byte	Standard CANopen SDO service
Index	2 Byte	Object address by index
Sub-index	1 Byte	Object address by sub-index
Data	4 Byte	Data for SDO service
Option Data	1 - 1470 Byte	Transmission possible for heavier than 4Byte data with 1 frame at the time of Option command (Can be used up to full mailbox size)

■ SDO Command

Data Read / Write by the master begins by transmitting a command code “Index” and “Sub-index”.  
 The slave responds to the request by returning the request data.  
 The same “Index” and “Sub-Index (Sub-idx)” of the request are added to the SDO response.  
 The response data length is determined by the SDO Command (cmd).  
 The slave returns an error message when the message is not accepted (Refer to SDO error messages).  
 The explanation for each command will be shown starting on the next page.

SDO Message List

Command	Page/Diagram	Notes
SDO Download Expedited Request	Diagram 1	
SDO Download Expedited Response	Diagram 2	
SDO Upload Expedited Request	Diagram 3	
SDO Upload Expedited Response	Diagram 4	
SDO Download Normal Request	Diagram 5	
SDO Download Normal Response	Diagram 2	Same as Diagram 2
SDO Upload Normal Request	Diagram 3	Same as Diagram 3
SDO Upload Normal Response	Diagram 6	

Command specific Abbreviation Definition List

0 Size Indicator	: 0 S I	1 Transfer Type	: 1 T T
2 Data Set Size	: 2 D S	4 Complete Access	: 4 C A
5 Command Specific	: 5 C S	0 SDO Control	: 0 SDO
8 Index	: 8 Idx	24 Sub-Index	: 24 Sub
32 Completer Size	: 32 Cmp S		

■ SDO Download Expedited Request

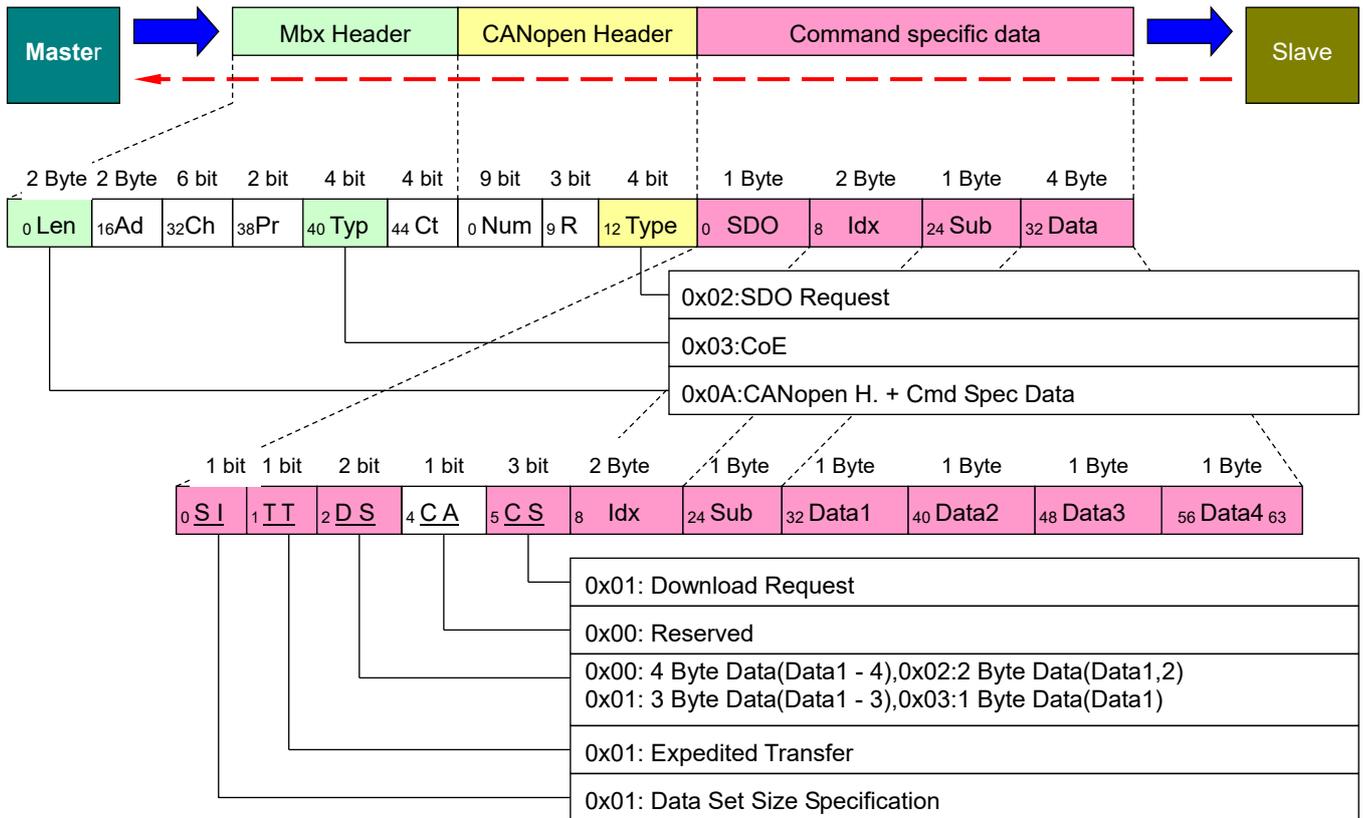


Diagram 1 : SDO Download Expedited Request

■ SDO Download Expedited Response

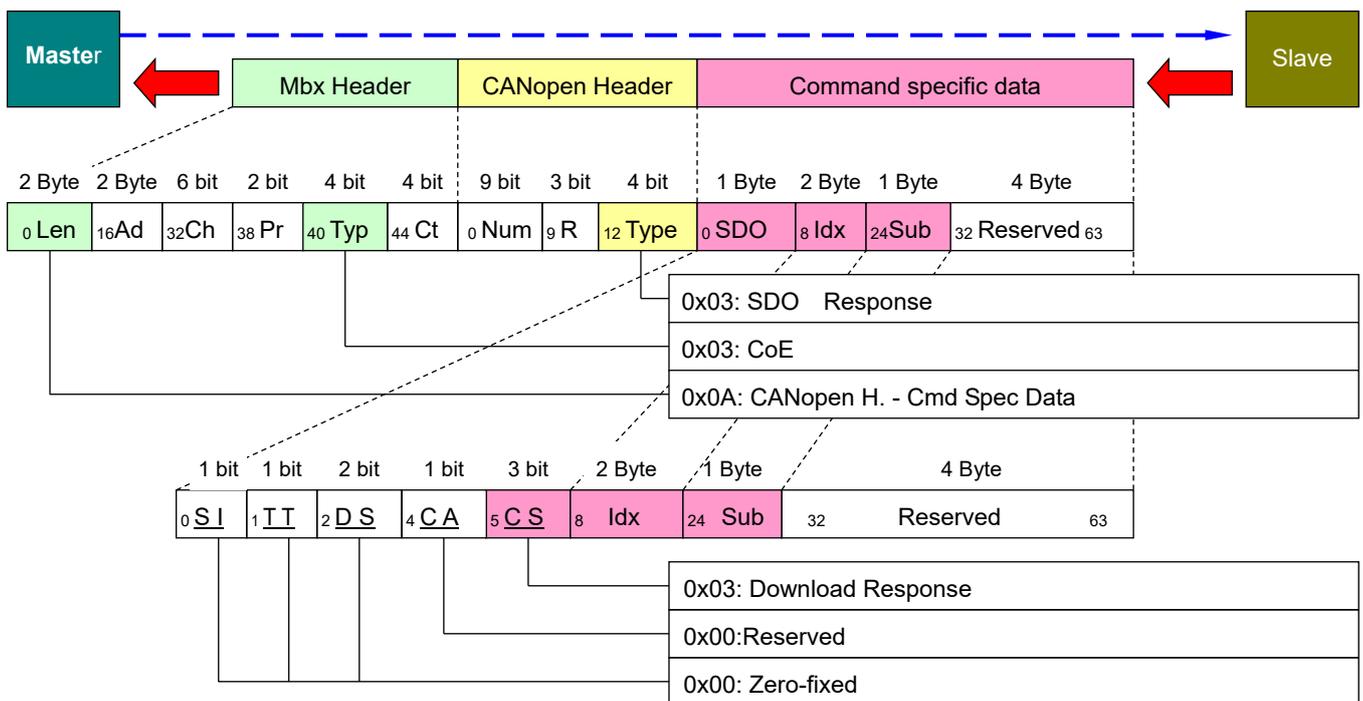


Diagram 2 : SDO Download Expedited Response

■ SDO Upload Expedited Request

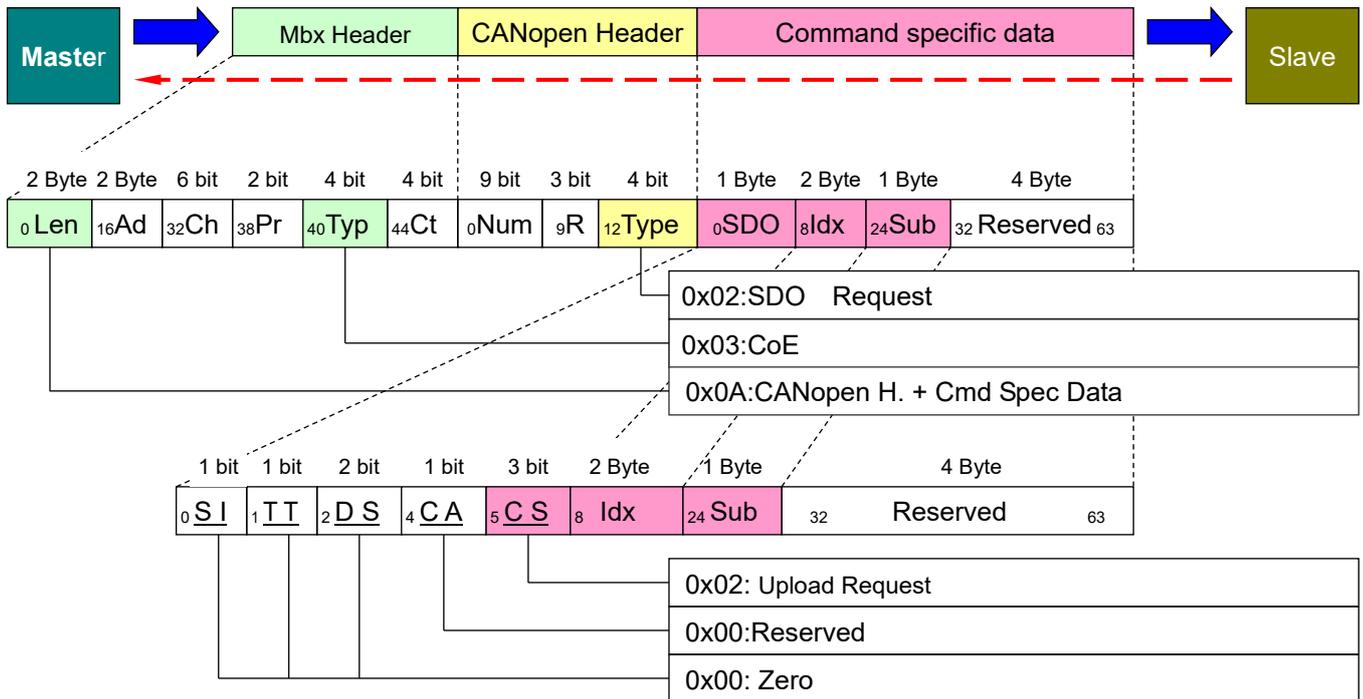


Diagram 3 : SDO Upload Expedited Request

■ SDO Upload Expedited Response

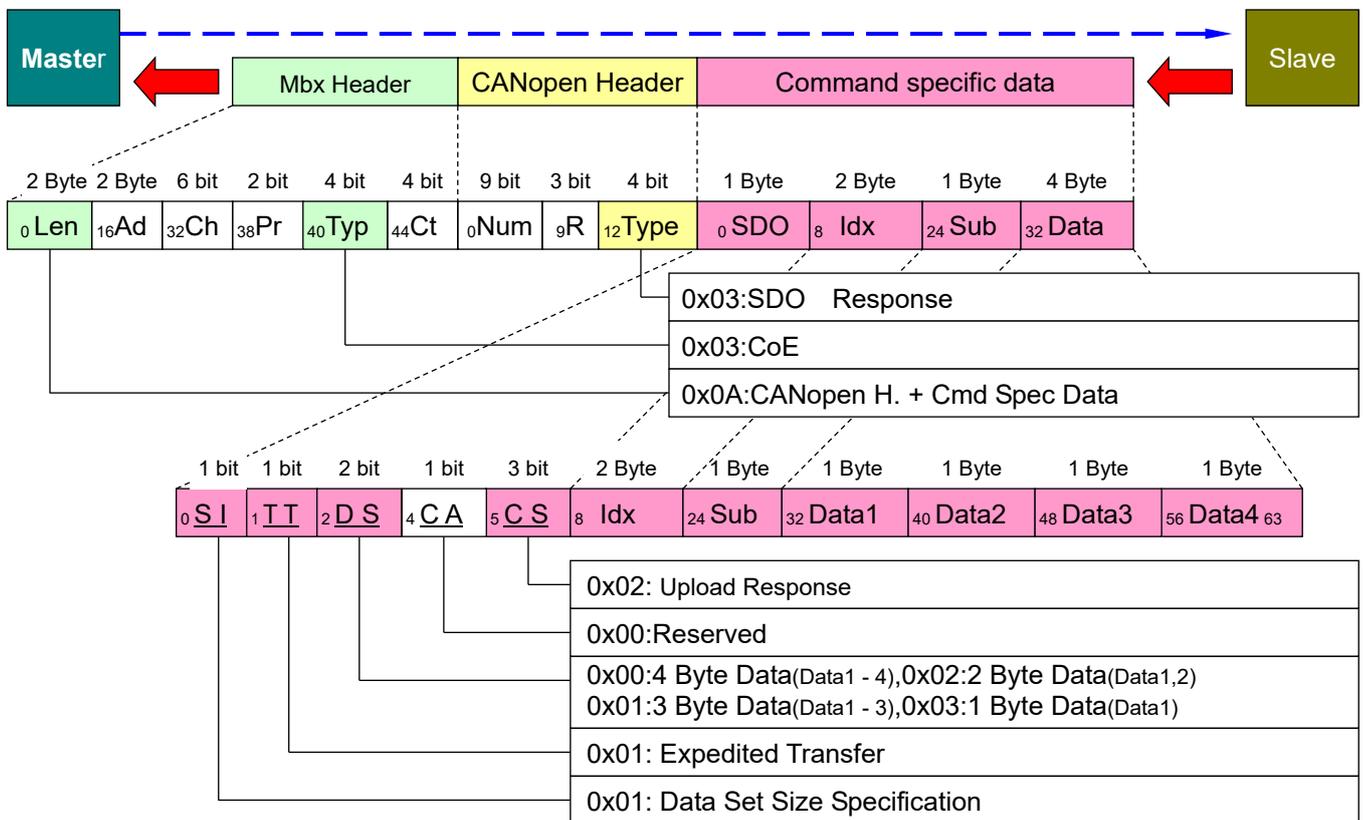


Diagram 4 : SDO Upload Expedited Response

■ SDO Download Normal Request

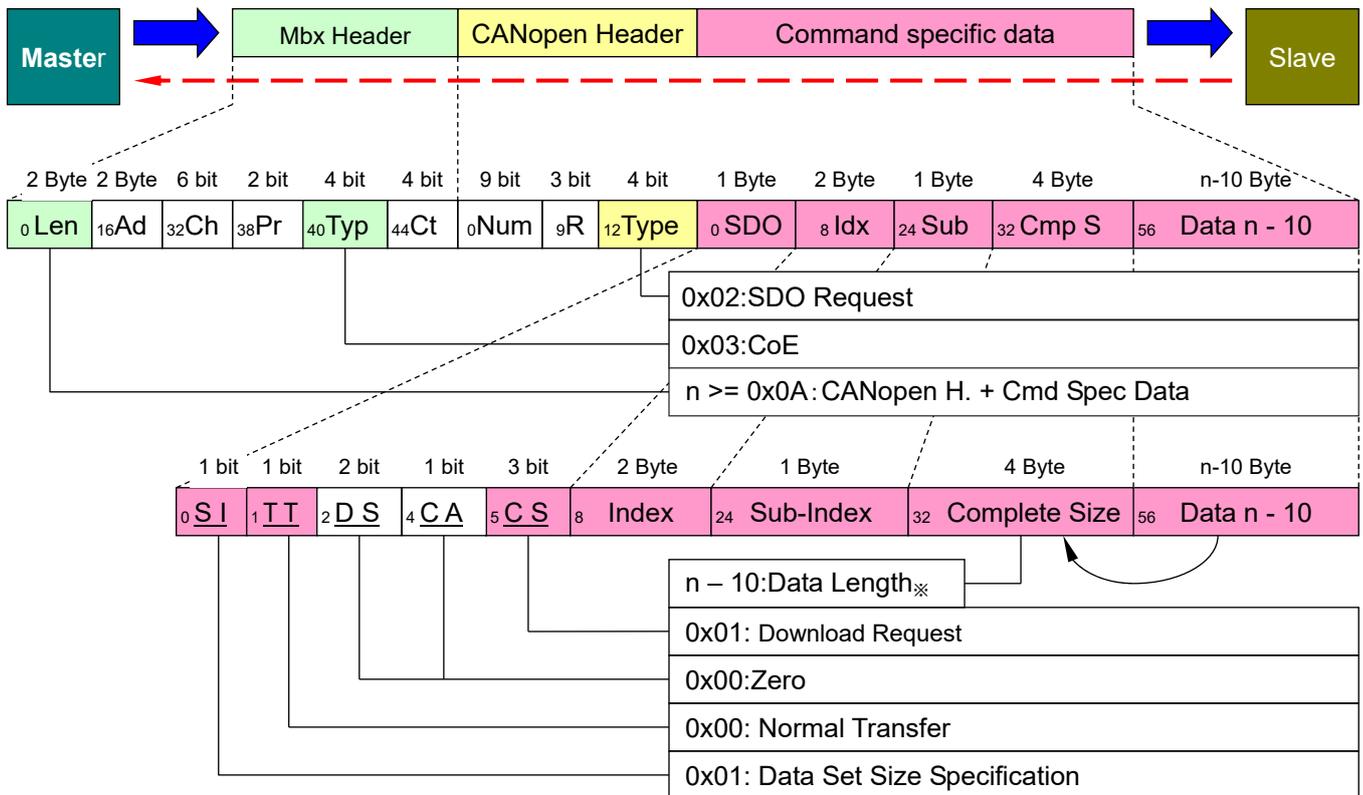


Diagram 5 : SDO Download Normal Request

■ SDO Download Normal Response

SDO Download Normal Response has the same configuration as SDO Download Expedited Response  
Please refer to Diagram 2: SDO Download Expedited Response

- SDO Upload Normal Request  
 “SDO Download Normal Response” has the same frame configuration as “SDO Upload Expedited Request”.  
 Please refer to Diagram 3 : SDO Upload Expedited Request

■ SDO Upload Normal Response

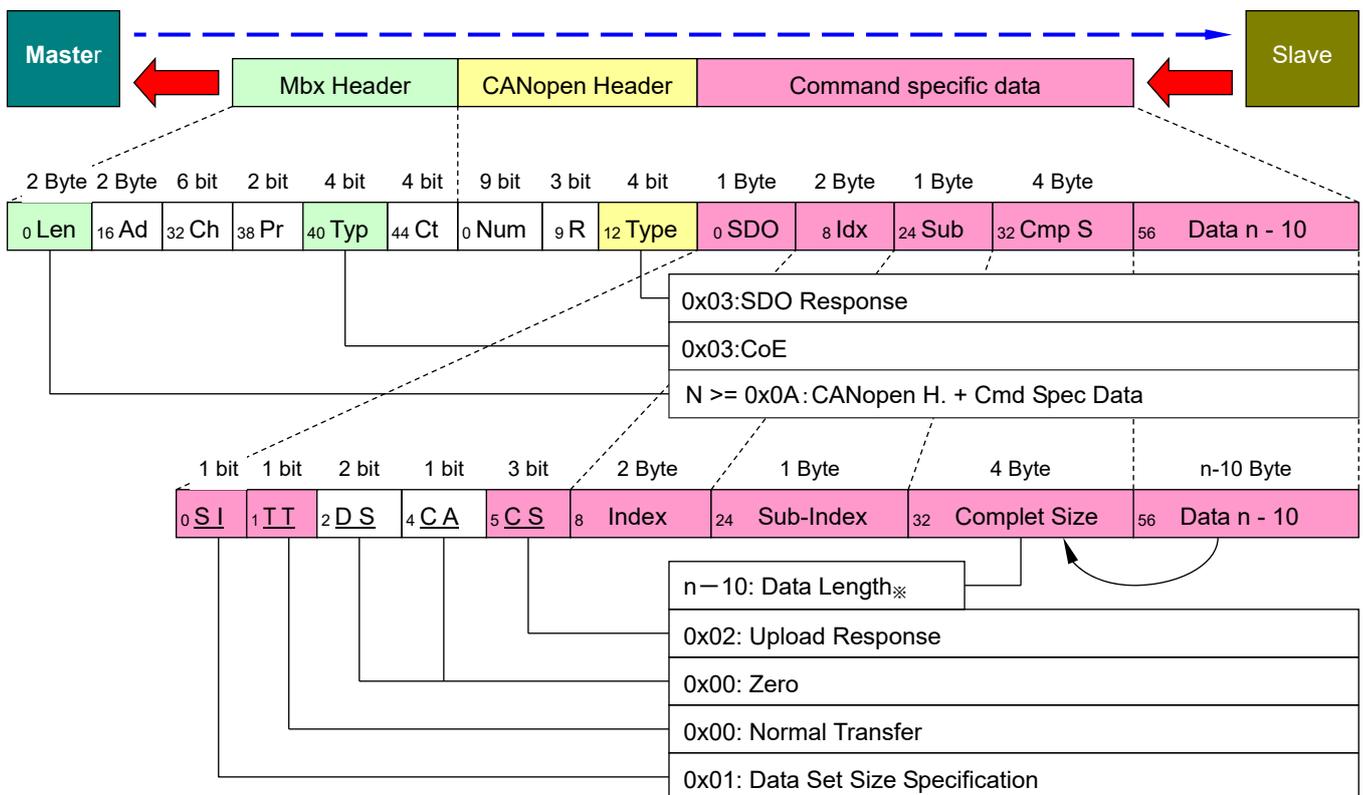


Diagram 6 : SDO Upload Normal Response

■ Abort SDO Transfer

The slave returns an error message as a response to the SDO request when the SDO message has not been accepted for some reason (value is out of set range, etc.)  
 The Abort SDO message structure details and abort code list are as follows:

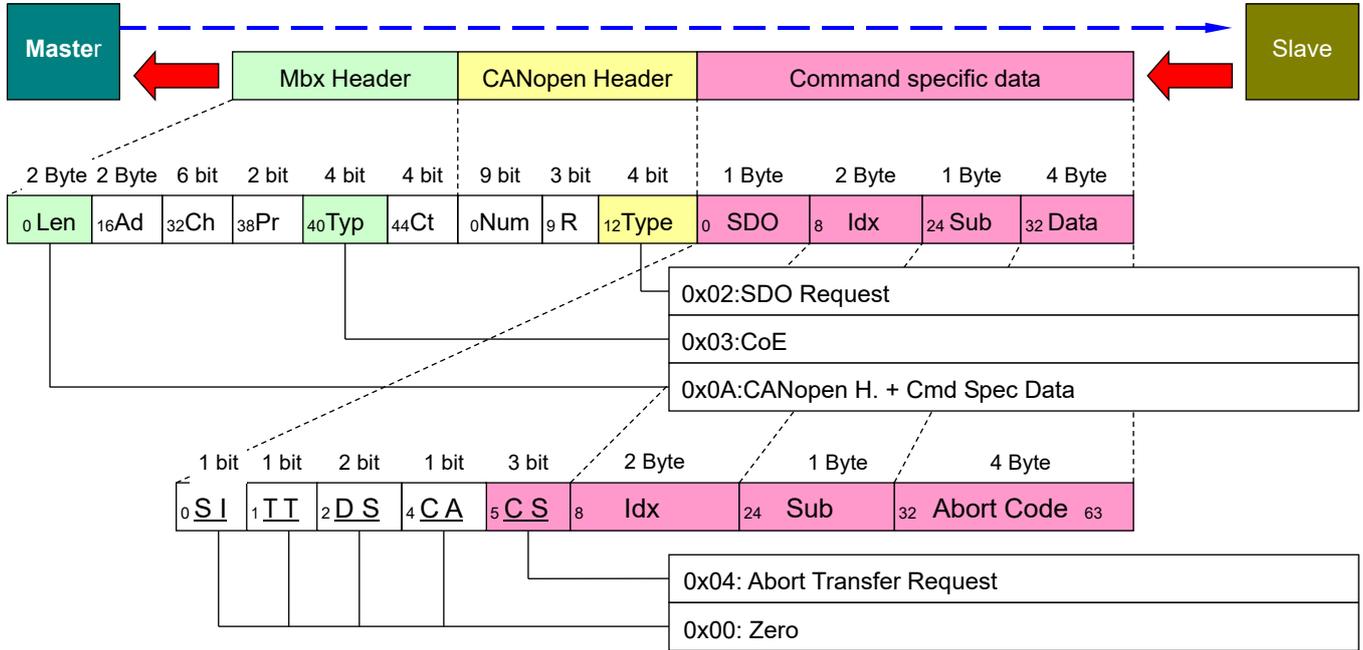


Diagram7 : Abort SDO Transfer Request

SDO Abort Code

SDO Error Code	Explanation
0x05 03 00 00	Toggle bit did not change
0x05 04 00 00	SDO Protocol Timeout
0x05 04 00 01	Client/Server Command Code disability unknown
0x05 04 00 05	Out of memory range
0x06 01 00 00	An access is not corresponding to the object
0x06 01 00 01	Read has been executed to the object corresponding to Write only
0x06 01 00 02	Write has been executed to the object corresponding to Read only
0x06 02 00 00	The object does not exist in the Object Dictionary
0x06 04 00 41	Cannot map the object with PDO
0x06 04 00 42	The number of mapping objects or the data length has exceeded PDO limitation
0x06 04 00 43	Non-compatibility of generic parameters
0x06 04 00 47	Non-compatibility of generic internals of device
0x06 06 00 00	Access failure because of hardware error (Failure by write prohibition setting)
0x06 07 00 10	Data type not coordinated because service parameter length does not match
0x06 07 00 12	Data type not coordinated because service parameter length is too long
0x06 07 00 13	Data type not coordinated because service parameter length is too short
0x06 09 00 11	Sub-index does not exist
0x06 09 00 30	Exceeds the parameter value range (Exclusive for Write access)
0x06 09 00 31	Write parameter is too large
0x06 09 00 32	Write parameter is too small
0x06 09 00 36	The maximum value is smaller than the minimum value
0x08 00 00 00	General error
0x08 00 00 20	Cannot transfer or store data into an application
0x08 00 00 21	Cannot transfer or store data into an application because of local control
0x08 00 00 22	Cannot transfer or store data into an application under present device state
0x08 00 00 23	Object Dictionary does not exist

■ Emergency (EMCY)

Emergency object will be transferred by the master to the request command for mailbox input at the time of error occurrence inside the device.

This object permits transfer only once to one error event.

In other words, an emergency object will not be transferred unless a new error occurs in the device.

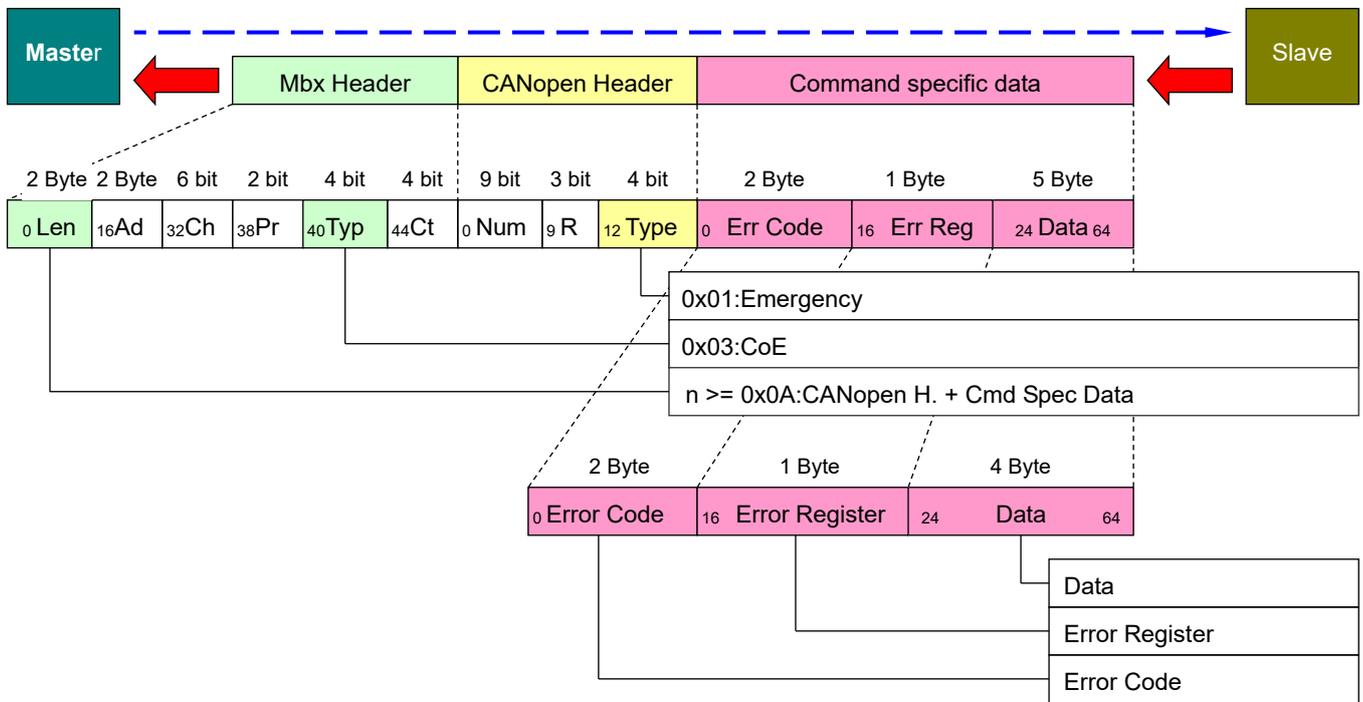


Diagram 8: EMCY Emergency

Error Code List

Error Code	Explanation
0x0000	Error reset or No error
0x1001	SOE Invalid service
0x1002	SOE Unsupported
0x1101	SDO Invalid command
0x1102	SDO Invalid header
0x1103	SDO Unsupported
0xA000	SM Transfer Error: Transition from PRE-OP to SAFE-OP unsuccessful
0xA001	SM Transfer Error: Transition from SAFE-OP to OP unsuccessful

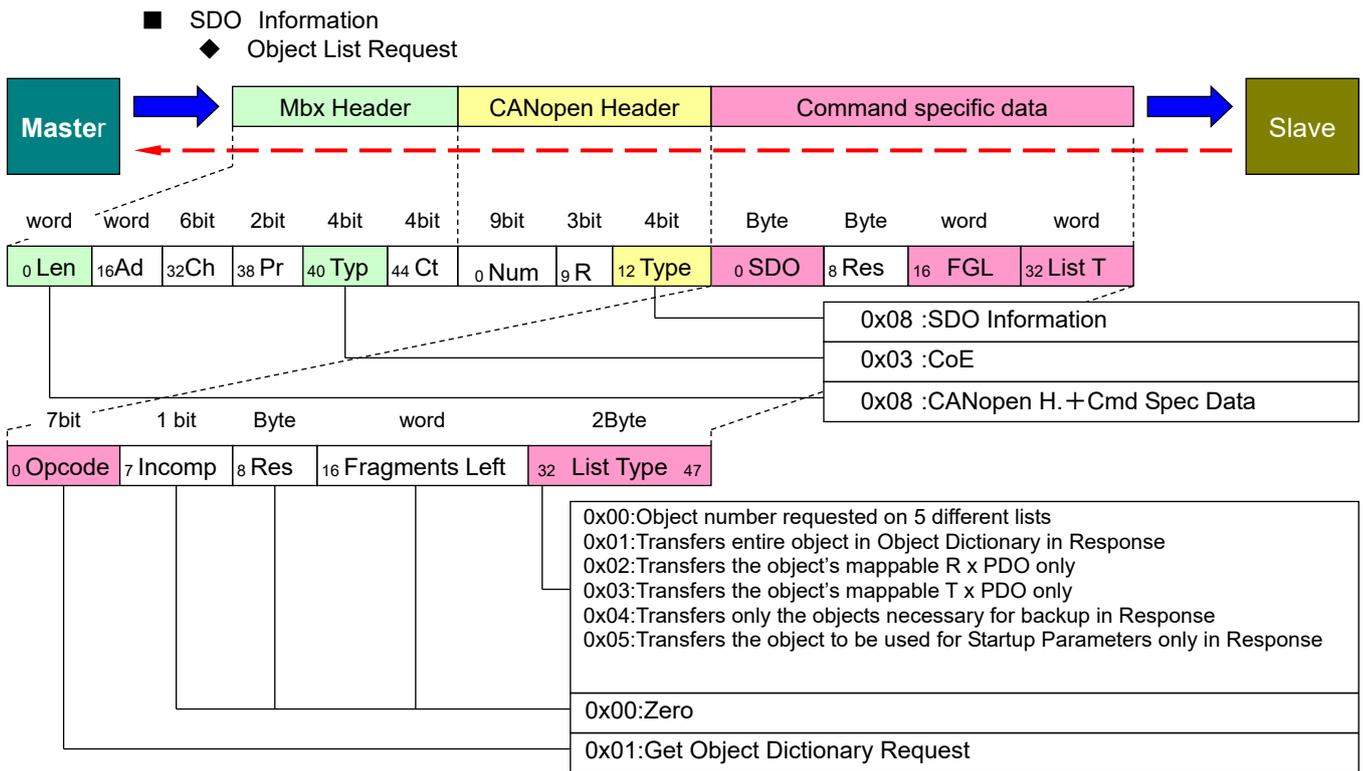


Diagram 9 : Get OD List Request (Object Dictionary Request)

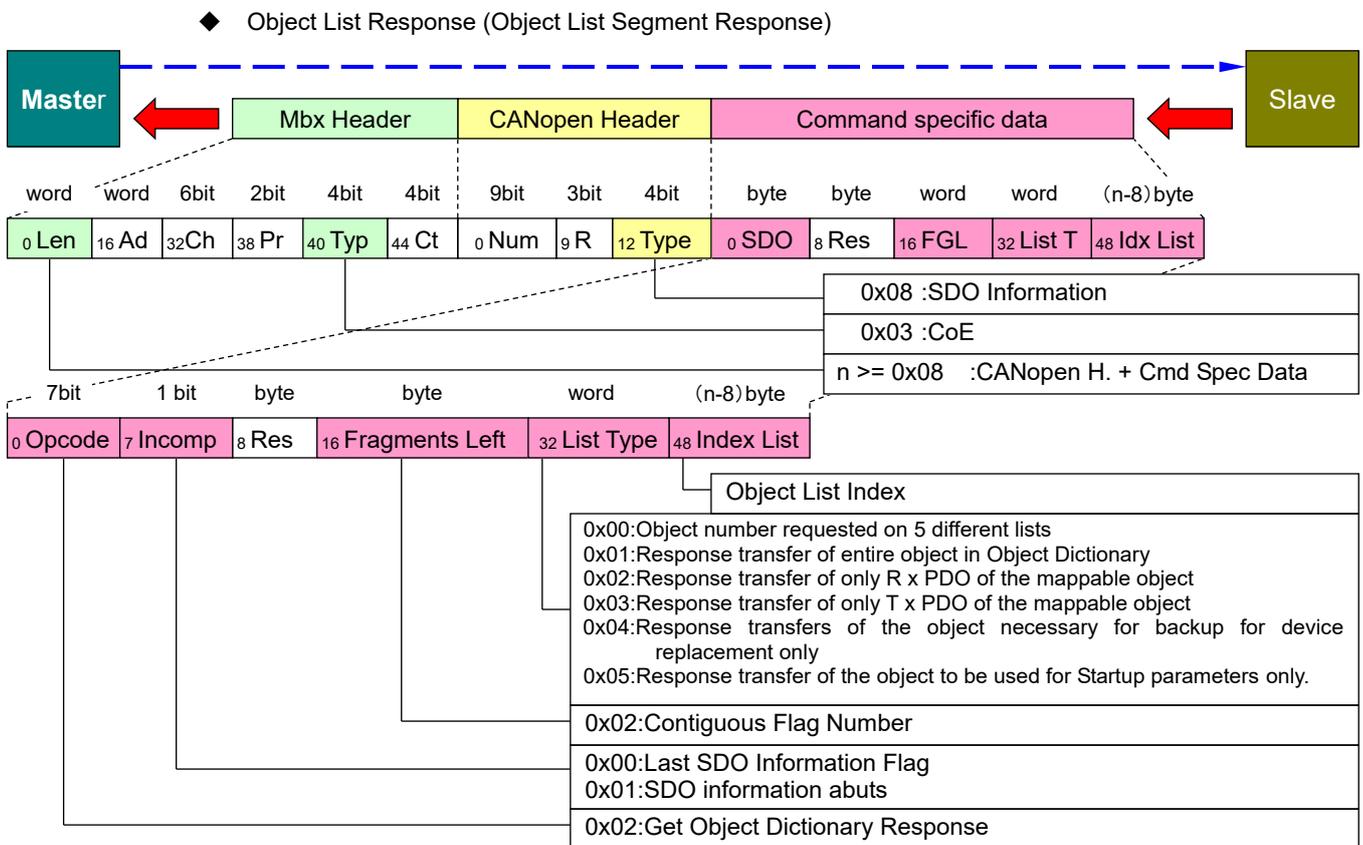


Diagram 10 : Get OD List Response (Object Dictionary Response)

◆ Object Dictionary Request

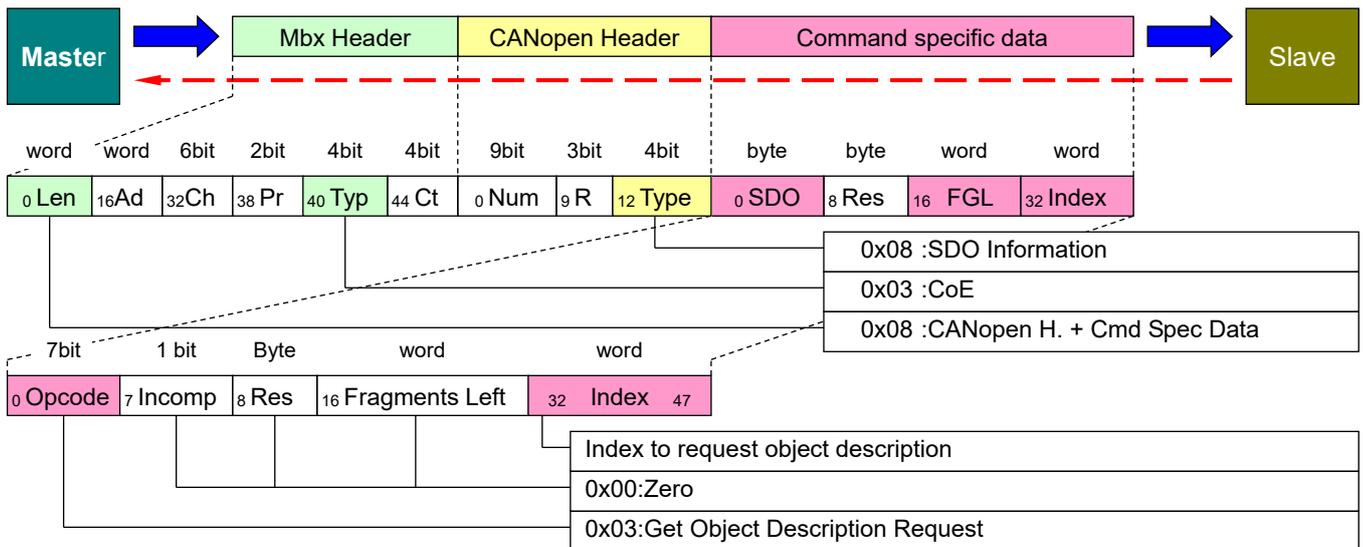


Diagram 11 : Get Object Description Request (Object Description Request)

◆ Object Description Response

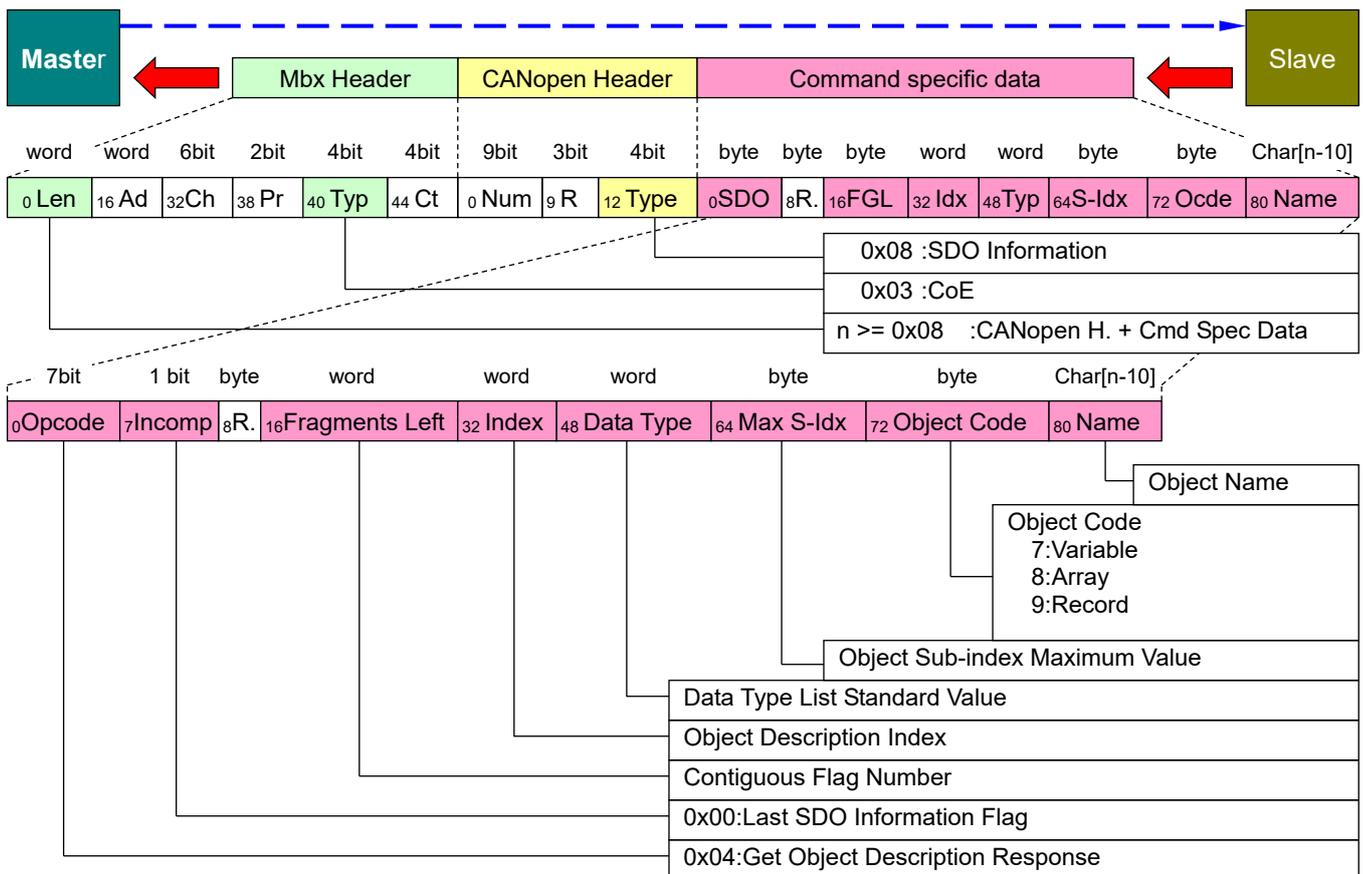


Diagram 12 : Get Object Description Response (Object Dictionary Response)

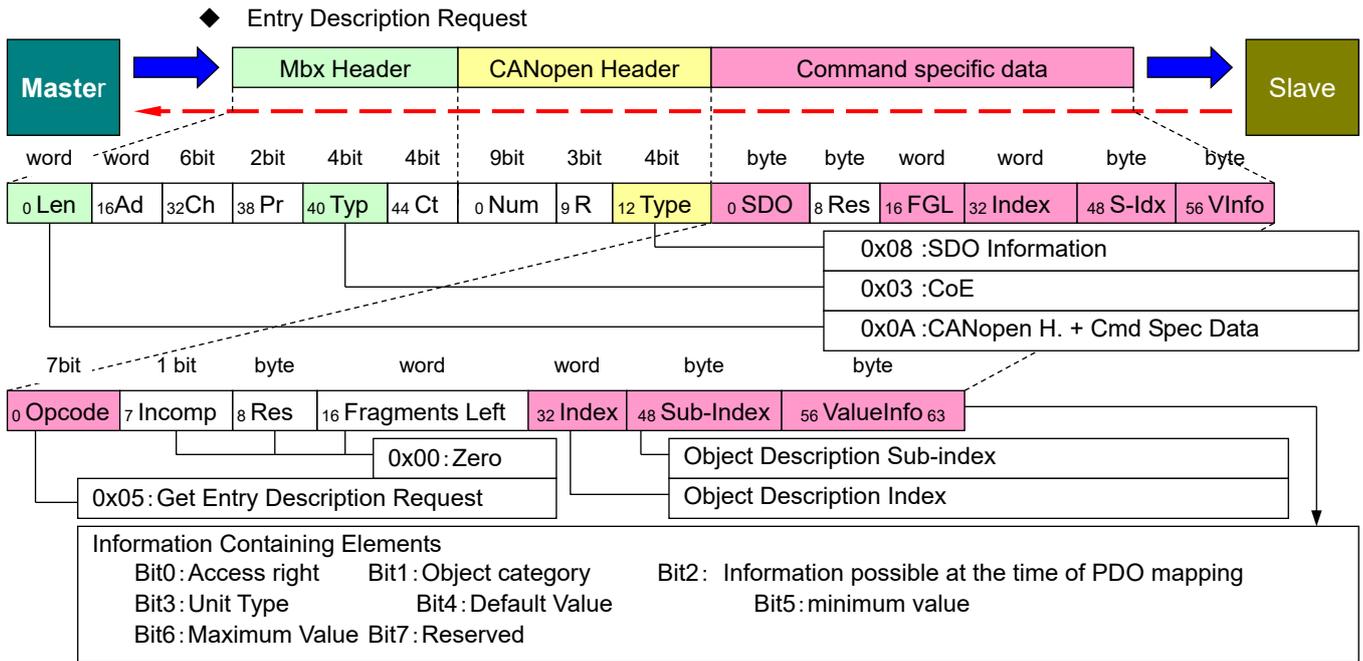


Diagram 13 : Get Entry Description Request (Object Description Request)

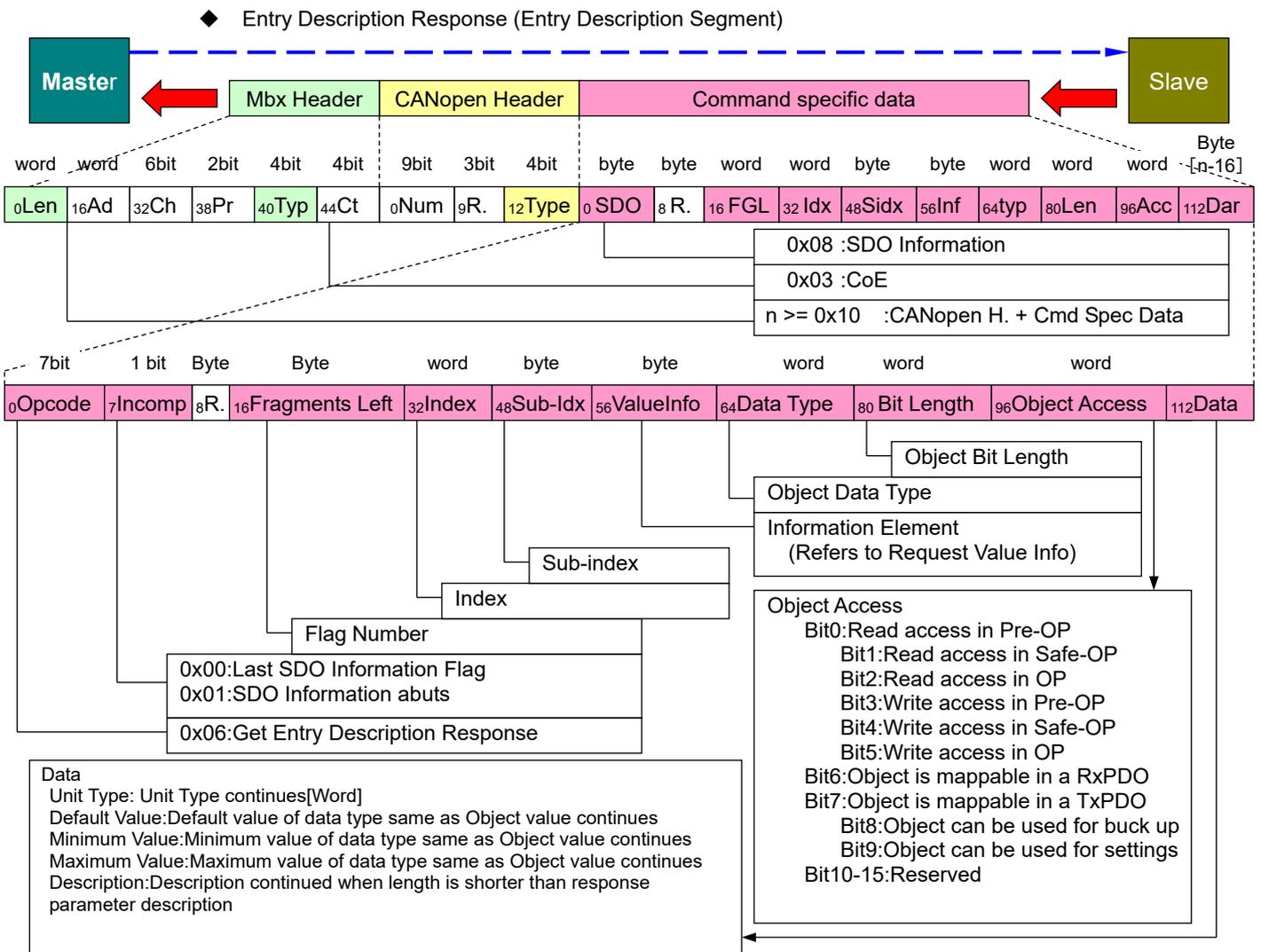


Diagram 14 : Get Entry Description Response (Object Dictionary Response)

◆ SDO information Error Request

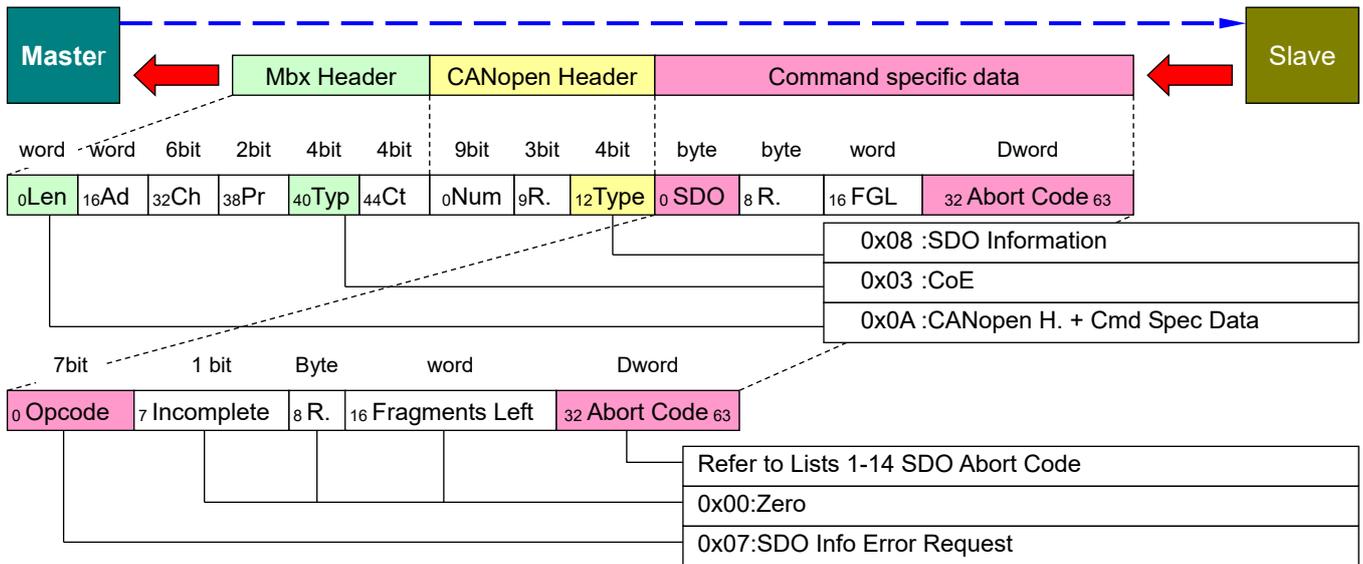


Diagram 15 : Error Request (SDO Information Error Request)

5) Process Data Object(PDO)

- Overview

Real time data transfer of EtherCAT is performed with “Process Data Object” (PDO).  
 PDO transfer does not need protocol transfer processing overhead.  
 There are two (2) types of PDO transfers: R x PDO (Reception PDO) from master to slave and T x PDO (Transmission PDO) from slave to master.  
 PDO mapping of the R-Advanced EtherCAT CoE amplifier can assign necessary PDO numbers and PDO objects to applicable entries of the Object Dictionary using SDO service at the device setting stage.
- PDO Setting

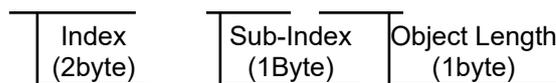
The user can optimize the “Message area with PDO mapping” and “Reception/Transmission form (transmission type) and Trigger conditions” by setting the PDO.
- PDO Mapping

PDO mapping of the R-ADVANCED EtherCAT is changeable.  
 Specifically, the EtherCAT CoE Network Manager can change the PDO transfer data freely during operation.  
 Use “Reception PDO mapping parameters (0x1600 - 0x1603,0x1700 - 0x1703)” to change R x PDO mapping and “Transmission PDO mapping parameters (0x1A00 - 0x1A03,0x1B00 - 0x1B03)” to change T x DO mapping.  
 Index, Sub-index and Data length have to be set to each PDO to be transferred.  
 The data length must match the data length inside the Object Dictionary.

A mapping example of T x PDO is shown below

“0x1B0y” Transmit PDO Mapping (Example)

Sub-Index	Data (32bit)			Name
0x00	5			Number of Entry
0x01	0x6064	0x00	0x20	Position actual value
0x02	0x6077	0x00	0x10	Torque actual value
0x03	0x6061	0x00	0x08	Operation Mode Display
0x04	0x0000	0x00	0x08	Reserved
0x05	0x6041	0x00	0x10	Status Word



Byte	0	1	2	3	4	5	6	7	8	9
PDO “0x1B0y”	0x6064:00				0x6077:00		0x6061:0	Reserved	0x6041:00	

PDO Mapping (example)

Use the following procedures for mapping:

1. Clear the object number (Sub-index 0) zero (0) once.
2. Write the settings from the object to be assigned beginning with the head (Sub-index 1).
3. Write the assigned object number to the mapping object number (Sub-index 0).

The relation between PDO and SM is defined as Sync Manager PDO Assign in Sync Manager Channel (SM) for processing data objects.

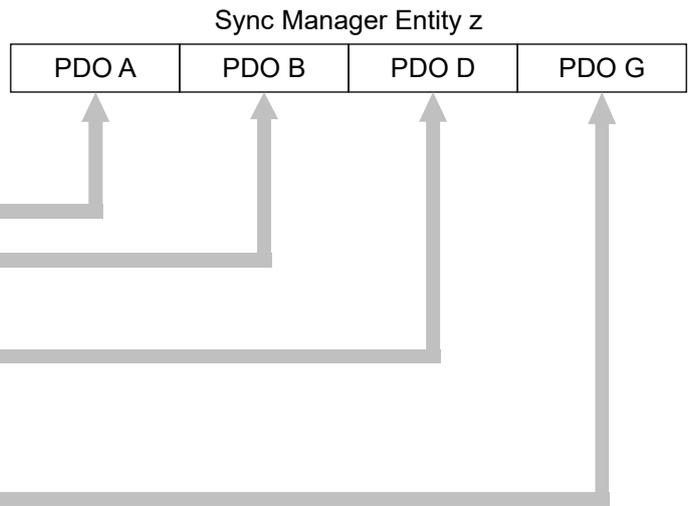
The Sub-index: 0x00 in the SM-PDO Assign table will be assigned a PDO number.

Index:0x1C12(SM Channel 2) becomes the Output PDO setting and Index:0x1C13(SM Channel 3) becomes the Input PDO Object Dictionary in the RS2-Advanced EtherCAT CoE amplifier.

Object Dictionary

Sync Manager Assign Object

Index	Sub-index	Object contents
0x1C1z	0x01	0x1B00
0x1C1z	0x02	0x1B01
0x1C1z	0x03	0x1B03
0x1C1z	0x04	0x1B06
Mapping Object		
	0x1B00	PDO A
	0x1B01	PDO B
	0x1B02	PDO C
	0x1B03	PDO D
	0x1B04	PDO E
	0x1B05	PDO F
	0x1B06	PDO G



Sync Manager PDO Assignment (example)

■ Default PDO Mapping

Only the settings of Sub-Index : x01 for R x PDO:0x1600 and T x PDO:0x1A00 are established CoE specifications.

The other Sub-Indices and Indices are available for free mapping.

Default PDO Mapping is shown in the following table.

Default PDO Mapping

Index, Sub-Index	Object Index	Object Name	Explanation
0x1600.0x01:R x PDO (Master => Slave)	0x6040	Control Word	Controls State Machine
0x1A00.0x01:T x PDO (Slave => Master)	0x6041	Control Word	Displays Status

Besides Sub Index1 - 4 settings for, RxPDO Transmission Type:0x1400 – and TxPDO Transmission Type:0x1800 – are required in CANopen. However, those will not be used in EtherCAT (Reserved).

## 5.7 Distributed Clocks (DC)

EtherCAT is supported by the Distributed clock (DC) unit of the slave controller for synchronization between slaves and master.

The DC functions provided with R-Advanced EtherCAT amplifier are described as follows:

- Clock synchronization between slave-master
- Accurate time recording for input events
- Accurate synchronous processing by interruptions according to the DC settings
- Synchronous digital input sampling

### 1) Clock Synchronization

DC synchronization is performed as having the same EtherCAT System Time as all EtherCAT devices in the master as well as the slaves.

Since the EtherCAT devices can synchronize one another, local applications will, consequently, be synchronized. Concerning the system synchronization, all slaves will be synchronized to one reference clock.

Generally, the first slave within one (1) segment of the master holds the "System Time" and this "System Time" is used as a reference clock to synchronize the other slaves' DC local clocks "System Time" with the master.

### 2) System Time

The System Time(0x0910 - 0x0918)of R-Advanced EtherCAT amplifier is 8 Byte in length, 1ns/Lsb and will easily cover time up to 500years. Data "0x0" signifies 0:00Hour 0sec 000ms 000ns 000ns on January 1, 2000.

Following are explanations of the terms used in synchronization:

- Reference clock  
One EtherCAT device is used as a reference clock.  
Generally, the reference clock is the first slave with DC function to synchronize between the master and all slaves.  
The reference clock supplies the System Time.
- Local Clock  
Each of the slaves works with a local clock independently from the reference clock in the beginning.  
The difference between the local clock and the reference clock can be corrected as can clock drift.  
Offset will be accomplished by adding a local clock velocity measurement and the adjusted clock drift to the local clock value.  
Each DC slave maintains reference clock copies calculated from the local clock and local offset.
- Propagation Delay  
The propagation delay between reference clock and slave clock must be acquired when System Time is transferred to slaves.
- Offset  
There are two reasons for offset between the local clock and the reference clock.  
This offset is corrected by each slave respectively according to the propagation delay from the reference clock hold to the local clock device with the initial difference of local time caused by the power input time difference.  
The slave that holds the reference clock will find the System Time from local time by adding the local offset.  
This offset signifies the difference between local time (beginning with power input) and the master time.
- Drift  
Reference clock and DC slave clock are not provided by the same clock source normally, so their clock sources are affected by deviations between clocks. In line with this, the sources of the clocks run faster than the other clocks in no small measure, local clocks drift separately.

R-ADVANCED EtherCAT amplifier fully supports the Distributed Clock (DC) for the reception time stamp, the System Time validity and synchronous signal generation.

### 3) Clock Synchronization Process

The clock synchronization process consists of three (3) steps.

#### 1) Propagation Delay Measurement

The master begins propagation delay measurement in each direction toward all slaves.

Each slave measures the received time of the measurement frame.

Then, the master calculates the propagation delay between the slaves by reading the time stamps.

#### 2) Offset Correction to the Reference Clock (System Time)

Compares the local time of each of the slave's clocks to System Time.

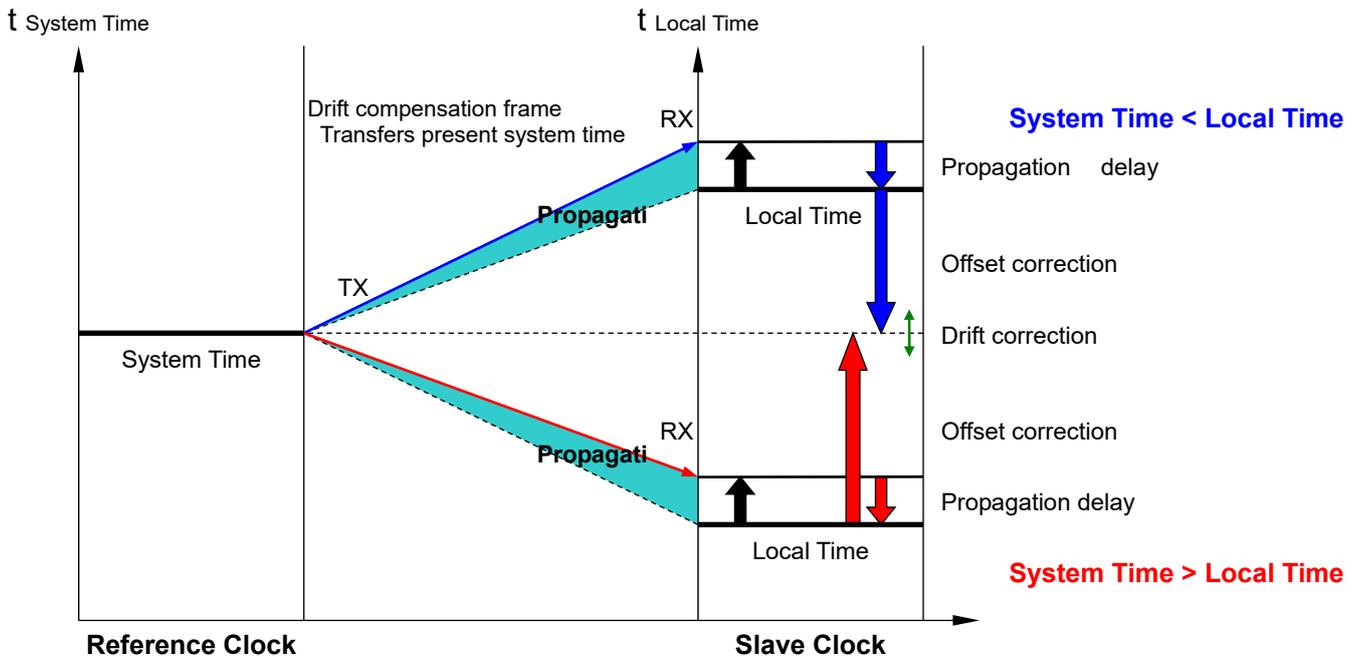
For the time difference, correct each respectively by Writing the value to each slave.

All slaves acquire the same absolute system.

#### 3) Drift Correction to the Reference Clock

The drift between the reference clock and the local clock must be corrected regularly with a difference time measurement and local clock readjustment.

Correction calculations in both cases, when the system is smaller or larger than the slaves' local time, is shown below.



Corrections for Propagation Delay, Offset and Drift

Please refer to Chapter 7: Distributed Clock (DC) for details of Clock Synchronization:

1) Propagation Delay Measurement 2) Reference Clock Offset Correction and 3) Reference Clock Drift Correction.

#### 4) Clock Synchronization Initialization Procedure (example)

Initialization procedure of clock synchronization including propagation delay measurement, offset correction and drift correction is as follows:

- 1) The master discovers the network configuration by reading the DL status register of the slaves.
- 2) The master transmits a minimum of 1byte of data with broadcast Write to Read the receive time of port 0 register. All slaves match local time with all ports and the ECAT processing unit.
- 3) The master waits until the broadcast Write frame returns.
- 4) The master, depending on the network configuration, reads receive time ports 0 / 1 and ECAT processing unit receive time register (0x0918:0x091F) in all slaves.
- 5) The master calculates respective propagation delays and writes the values to the system time delay register in the slaves.
- 6) The master sets the reference clock (the first slave) in the system time offset register so the reference clock will be equivalent to the master time. By subtracting the receive time of the ECAT processing unit of the reference clock (local time) from the master time, it becomes the offset value for the reference clock.
- 7) The master calculates the system time offset of all DC slaves and writes it in the system time offset register. By subtracting the ECAT processing unit receive time of each DC slave from the receive time ECAT processing unit of the reference clock; it becomes the offset value for each slave (from the 2<sup>nd</sup> axis onward).
- 8) For static drift correction, the master transmits the command "ARMW" or "FRMW" to all DC slaves at the beginning and any number of times separately (example:15,000 frames)
- 9) For dynamic drift correction, the master transmits the command "ARMW" or "FRMW" to all DC slaves periodically.  
The command proportion for drift correction depends on an acceptable maximum deviation.

#### 5) SYNC0 / 1 Signal Output Initialization Procedure (example)

Synchronous signal output is initialized according to the following procedure:

- 1) Enables DC SYNC Out Unit bit in PDI control register (0x0140.10=1)
- 2) Set SYNC0/1 output in SYNC/Latch PDI Configuration register so the output driver setting conforms to the circuit configuration inside the slave \* For 0x0151,EEPROM value is set at the time of initialization.
- 3) Set SYNC signal pulse width in Pulse Length register (must be SYNC0 Cycle Time> 0)  
Note) 0x0982: 0x0983 set from EEPROM at initialization.
- 4) Assign the synchronizing unit in the ECAT or the device description PDI to 0x0980.
- 5) Set SYNC 0 signal cycle time to(0x09A0:0x09A3)and SYNC1 signal cycle time to (0x09A4:0x09A7).
- 6) Set a later time than the time cycle permits in the start cycle time operation to (0x0990:0x0997).  
(example: Add system Read time + start time and permission Write time)
- 7) Permits the active cycle operation bit (0x0981.0=1) as a synchronous signal to SYNC0 / SYNC1 active bit (0x0981[2:1]=0x3).

Synchronizing unit stands by until the first SYNC 0 pulse is output.

Cycle motion start time register and the next SYNC 1 pulse register can be read to acquire the next output event time.



### 5.9 EtherCAT State Machine (ESM)

ESM contains states defined by EtherCAT.

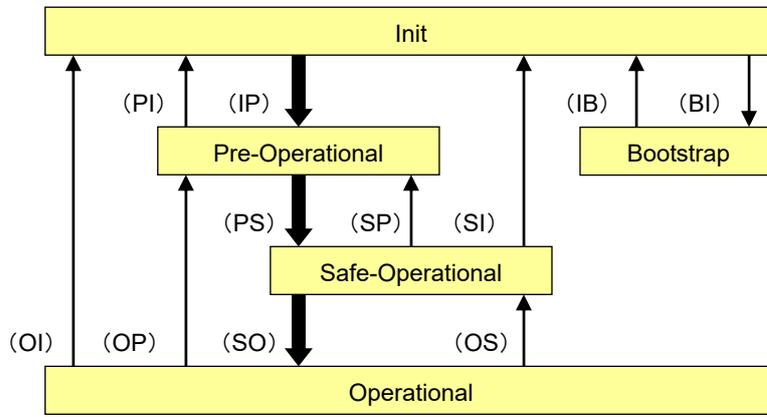
- Init
- Pre-Operational
- Safe-Operational
- Operational
- Bootstrap

#### 1) ESM

ESM change is requested from the master.

The master requests the change by writing the ESM with the request to be changed in the AL control register of the slave(s). The slave confirms the result of the state change as either successful or failed and then responds to the master with the local AL status.

If the requested state change fails, the slave responds with an error flag.



ESM Diagram

State Transition and Local Management Service

Transition Symbol	Direction =>	Local Management Service
IP	INIT TO PREOP	Start Mailbox Communication
PI	PREOP TO INIT	Stop Mailbox Communication
PS	PREOP TO SAFEOP	Start Input Update
SP	SAFEOP TO PREOP	Stop Input Update
SO	SAFEOP TO OP	Start Output Update
OS	OP TO SAFEOP	Stop Output Update
OP	OP TO PREOP	Stop Input Update, Stop Output Update
SI	SAFEOP TO INIT	Stop Input Update, Stop Mailbox Communication
OI	OP TO INIT	Stop Input Update, Stop Output Update, Stop Mailbox Communication
IB	INIT TO BOOT	Start Bootstrap Mode(FoE),
BI	BOOT TO INIT	Restart Device(FoE),

## 2) State

- **Init State**  
“Init” state defines basic communication relations between the master and slaves in the application layer. Direct communication between the master and slaves is not possible in the application layer. The master uses the “Init” state to initialize the setting for the configuration of the slaves. When the slaves support the mailbox service, the corresponding SM settings will also be executed in “Init” state.
  
- **Pre - Operational State**  
The mailbox communication can be performed in the “Pre - Operational” state when the slaves support the optional mailbox. Both master and slaves can use the mailbox to initialize application specifications and to change parameters. Process data communication cannot be executed in this state.
  
- **Safe - Operational State**  
In “Safe - Operational” state, slave applications transfer the actual input data, but not the output data that may not be available for processing. The output must be set in Safe state.
  
- **Operational State**  
In “Operational” state slave applications transfer the actual input data and the master application transfers the actual output data.
  
- **Bootstrap State**  
In the “Bootstrap” state, slave applications can receive new firmware and servo amplifire parameter downloaded by FoE (File access Over EtherCAT) protocol.

### 5.10 Bootstrap state

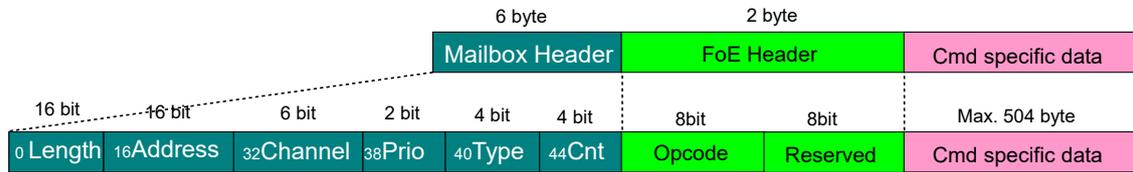
In the Bootstrap state, servo amplifier firmware and parameter can be downloaded and upload to servo amplifier by FoE(File access over EtherCAT) protocol. Re-writing of servoamplifier firmware is performed by changing "Bootstrap state" to "Init state" in the consideration that firmware re-writing has no risks, after the firmware downloaded completely. In line with this, the downloaded firmware is written in CPU flash. The time to write is several seconds. Servo amplifier parameter can be change by download xml files.

The conditions considered firmware re-writing has no risks are shown below:

- Firmware to be written into servo amplifier has been completely downloaded.
- The result of downloaded firmware checksum is normal.
- No control power voltage drop alarm activated.
- Main circuit power supply is not applied or STO State.

#### 1) Mailbox protocol of FoE (File access over EtherCAT)

The following shows mailbox interface protocol and the structure when using FoE.



Mailbox interface

Mailbox Header configuration

Code (Abbrev.)	Data length	Description
Length (Len)	2 Byte	Successive data length
Address (Ad)	2 Byte	Station address of originator
Channel (Ch)	6 bit	Reserved (0x00)
Priority (Pr)	2 bit	Reserved Priority (0x00 to 0x03)
Type (Typ)	4 bit	Protocol identifier of mailbox type, successive data 0 : Mailbox Error 3 : CoE (CAN open over EtherCAT) 4 : FoE (File access over EtherCAT)
Counter (Ct)	4 bit	Sequence number Incremented every mailbox service as duplicate detention. (Only 1 to 7 are usable as they have compatibility with old versions.)

### 2) FoE Header protocol

“FoE Header” is 2-byte identifier, and comprised of 1-byte “OpCode” and 1-byte “Reserve” area. The following shows “FoE Header” configuration.

FoE Header configuration		
Code (Abbrev.)	Data length	Description
Opcode	8 bit	FoE commnad
		0x01 : Reserved (Read request)
		0x02 : Write request
		0x03 : Data request
		0x04 : Ack request
		0x05 : Error request
0x06 : Reserved (Busy request)		
Reserved	8 bit	0x00

### 3) FoE command

Download of the file is started by sending “Write request” from Master to compare password \*1 with file name. Slave returns “Ack request” to Master only when Slave received data normally and verified file name and password are matched. Then Master sends “Data request” to send File data. Slave returns “Ack request” to Master only when the request from Master normally recived. “Data request” and “Ack request” are repeatedly transmitted and received until the firmware data sent from Master runs out.

When Slave does not judge the File data is valid, Slave returns “Error request,” an error meddage to Master. (Refer to FoE error code.)

Master send Read Request to slave to confirm file name and password and then slave will start to file upload.

If slave was able to successfully receive correct file name and password and then slave will send Data Requet to master.

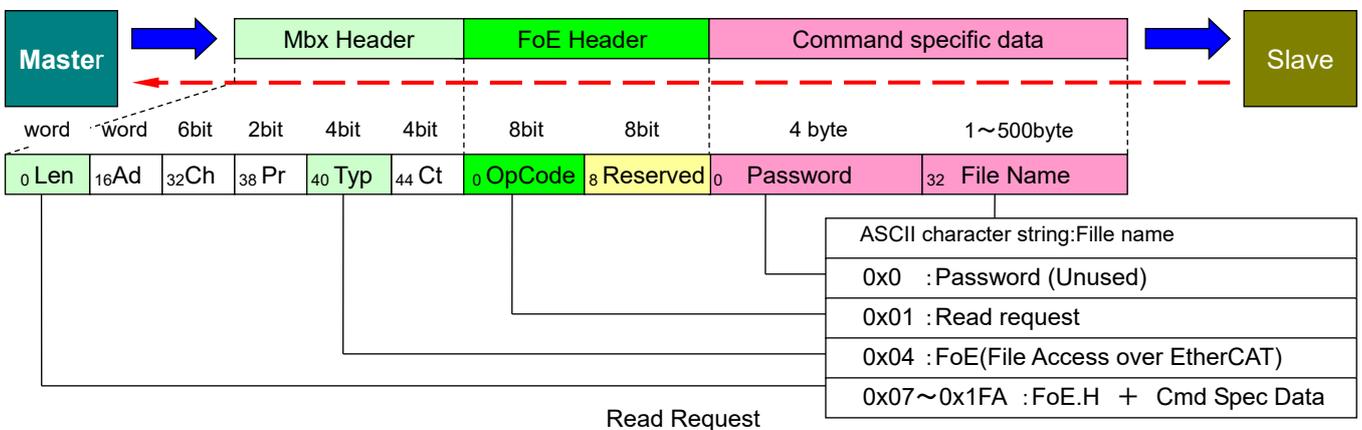
If master was able to successfully receive file data and then master need to send Ask Request to slave.

Data Request and Ask Request repeats until there is no more file data in slave.

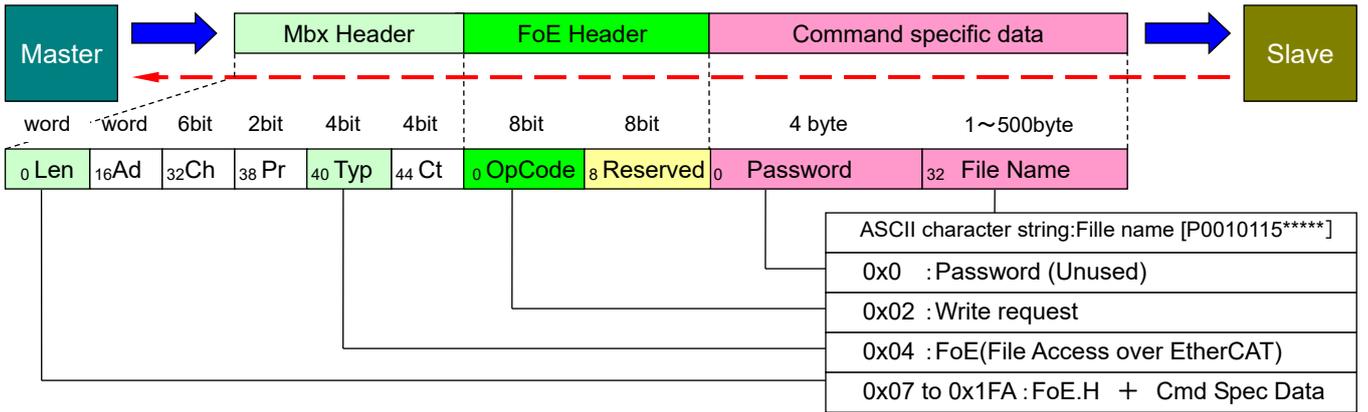
If slave does not have file data, slave will send error message to master by Error Request.

Note) Password \*1: Password identification function for R-ADVANCED EtherCAT amplifier is disabled.

#### ■ Read Request

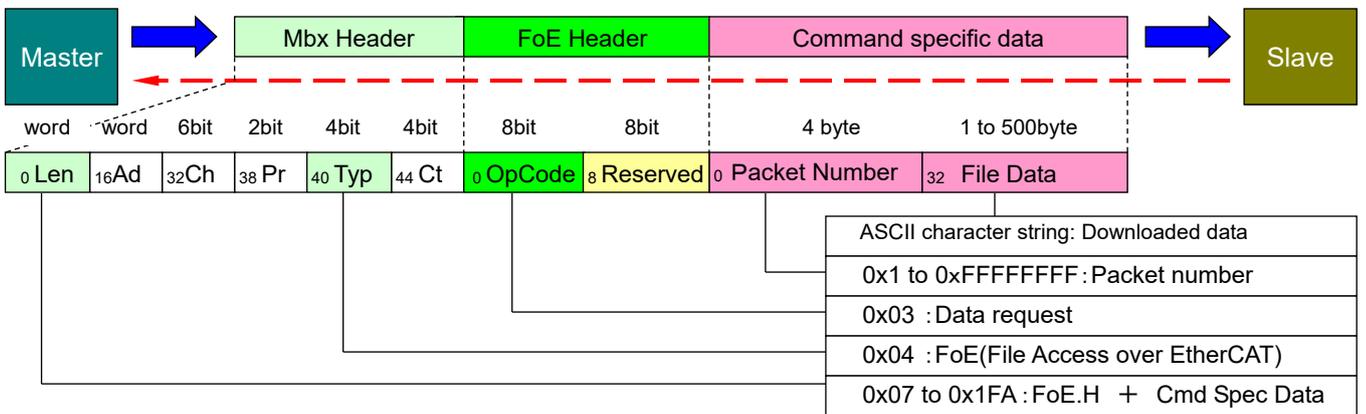


■ Write request



Write request

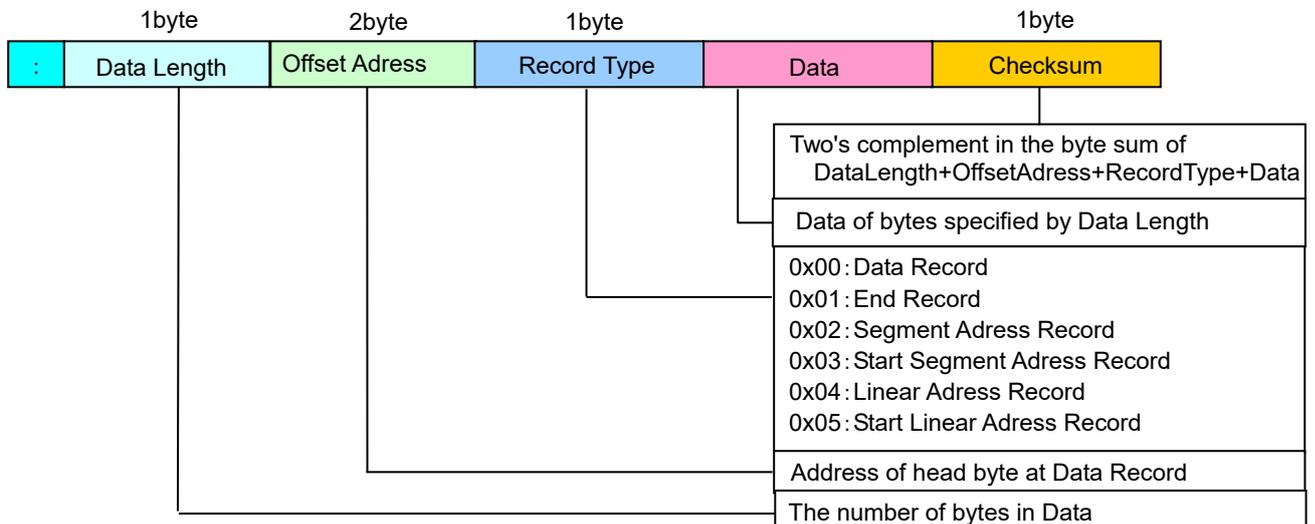
■ Data request



Data request

※ For File Data, use firmware data in Intel Hex format provided by SANYO DENKI. The following shows the structure of Intel Hex format.

Structure of Intel Hex format [1-record (1-line) structure]



Structure of xml format provided by SANYO DENKI at parameter download.

Tag of xml parameter

```
<DriveConfig>
<Common>
<FirmwareVersion>
<AutoSaveFlag>
<Checksum>
<Parameters>
<AttributeN>
<Name>
<Index>
<Subindex>
<Value>
<Size>
<Address>
```

<DriveConfig> : Definition of one amplifier's parameter .

This tag is highest. Sets one in one file.  
Can be include Common・Paramerters tag.

<Common> : Definition of common data type.

Only one definition in the file.  
Processing the common domain data at the first found from the beginning of the file.

<FirmwareVersion> : Definition of servo amplifier firmware version.

Defined in the Common.  
Indicates the firmware version that can be applied to this parameter.

<AutoSaveFlag> : Definition of auto parameter save

Defined in the Common.  
0: After the parameter download, value not save to EEPROM.  
1: After the parameter download, value save to all domain. (Need reset)

<Checksum> : Check Sum of transferred parameter files.

Defined in the Common.  
Sets Check Sum calculation about transferred parameter

<Parameters> : Definition of body parameter.

Only one definition in the file.

<AttributeN> : Definition of Attribute parameter.

Defined in the Parameters.  
Exist same as unnumber of parameter. More than N=1  
Domain of Attribute need to include below tag.

<Name> : Definition of parameter name

Defined in the Attribute.  
Describe name of parameter.

<Value> : Definition of setting value of parameter.

Defined in the Attribute.  
Describe setting value of parameter.

<Index> : Definition of index number of parameter.

Defined in the Attribute.  
Describe object index number of parameter.

<SubIndex> : Definition of sub-index number of parameter.

Defined in the Attribute.  
Describe object sub-index number of parameter.  
0: None sub-index number.

<Size> : Definition of data size.

Defined in the Attribute.  
Describe data length of parameter.

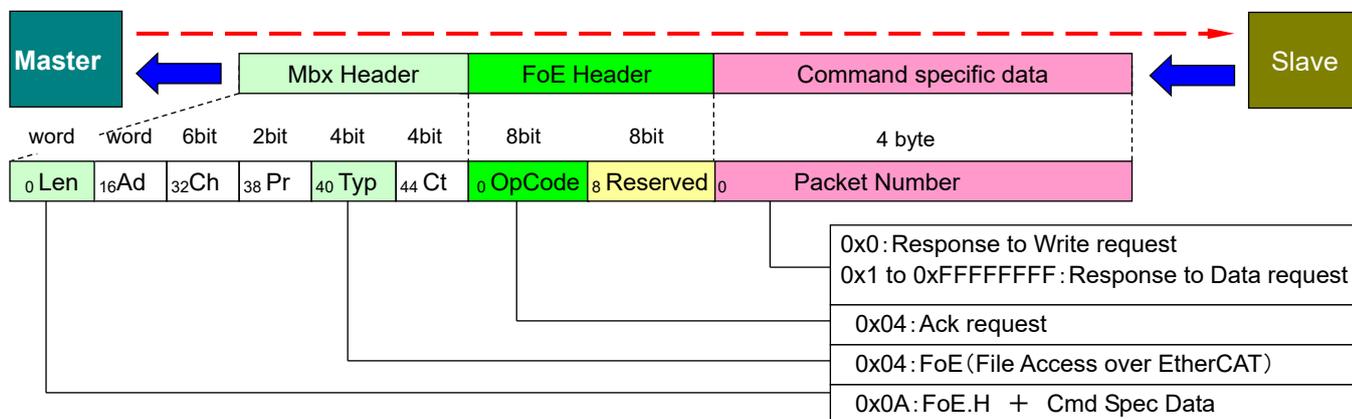
<Address>: Definition of save address of parameter data.  
 Defined in the Attribute.  
 Describe save address of parameter data.

- Auto save 1: When back to INIT state , start to save to EEPROM all domain (Parameter change alarm will occur)
- Auto save 0: Not save the value (Because it is used as a formal parameter) System parameter is not reflected.
- Check Sum value obtained by inverting the inside of Value tag data's sum saturation calculation. This data is 32bit.
- N in the Attribute is 1 to parameter number.
- If name of object, index number and sub-index number does not exist then reserved word will substitute.

Example

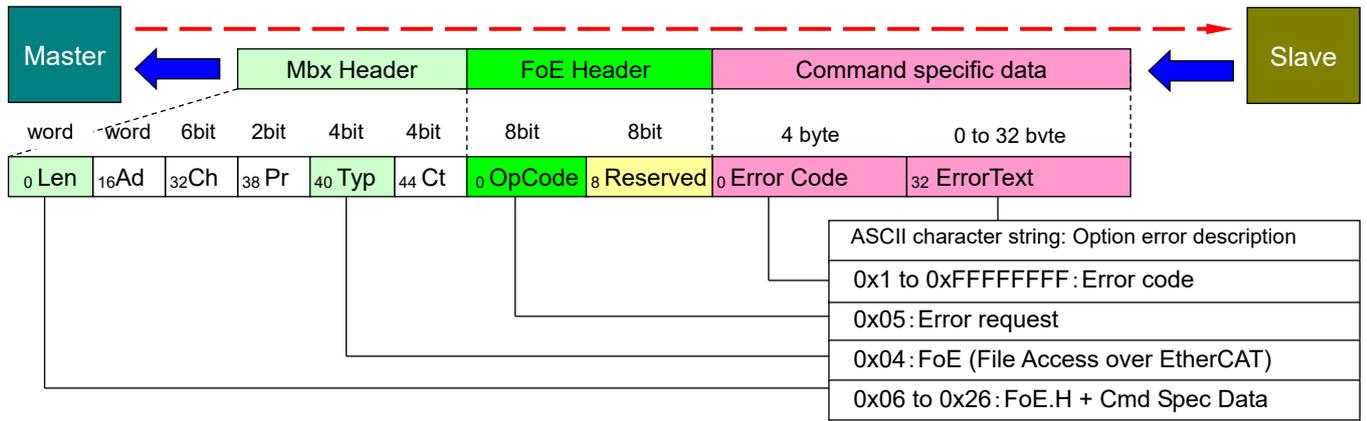
```
<?xml version="1.0" encoding="utf-8"?>
<DriveConfig>
  <Common>
    <FirmwareVersion>8200.0.1234</FirmwareVersion>
    <AutoSaveFlag>1</AutoSaveFlag>
    <Checksum>12345678H</Checksum>
  </Common>
  <Parameters>
    <AttributeN>
      <Name>Name of objects</Name>
      <Value>1234H</Value>
      <Index>2005H</Index>
      <Subindex>01H</Subindex>
      <Size>2H</Size>
      <Address>FFFF0000H</Address>
    </AttributeN>
  </Parameters>
</DriveConfig>
```

■ Ack request



Ack request

■ Error request



Error request

FoE error code list

Error Code	Error Text	Description
0x0000	DATA CHECKSUM ERROR	Undefined error code. 1 record checksum in the data being downloaded has an abnormality.
0x0000	HEX CHECKSUM ERROR	Undefined error code. Checksum of firmware downloaded has an abnormality.
0x0000	MAIN POWER ON ERROR	Undefined error code. Main circuit power is applied.
0x0000	CONTROL POWER DOWN ERROR	Undefined error code. Control power voltage has decreased.
0x0000	XML DATA ERROR	Undefined error code. Structure of XML abnormality.
0x0000	XML DATA CHECKSUM ERROR	Undefined error code. XML data sent abnormality.
0x0001	—	File not found. Because READ command is not supported.
0x0004	—	Disabled to respond to operation.
0x0005	—	Incorrect packet number.
0x0008	—	Not in Bootstrap state.
0x0009	—	Incorrect file name to be downloaded.

# 6

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## 6. Data Link Layer

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### 6.1 Device Addressing

#### 1) Address Space Overview

The device can be addressed via Device Position Address (Auto Increment address), by Node Address (Configured Station Address/Configured Station Alias), or by a Broadcast.

■ **Position Address / Auto Increment Address:**

The datagram holds the position address of the addressed slave as a negative value.

Each slave increments the address. The slave which reads the address equal zero is addressed and will execute the appropriate command at receives.

Position Addressing should only be used during start up of the EtherCAT system to scan the fieldbus and later only occasionally to detect newly attached slaves.

■ **Node Address / Configured Station Address and Configured Station Alias:**

The configured Station Address is assigned by the master during start up and cannot be changed by the EtherCAT slave. The Configured Station Alias address is stored in the ESI EEPROM and can be changed by the EtherCAT slave. The Configured Station Alias has to be enabled by the master. The appropriate command action will be executed if Node Address matches with either Configured Station Address or Configured Station Alias.

Each ESC device of the RS2 EtherCAT slave amplifier has a 14 bit local address space.

The address range 0x0000:0x0FFF is dedicated to EtherCAT registers and address range 0x1000:0x2FFF is used as process memory, which is addressed via a 16 bit Offset address field belonging to the EtherCAT datagram. The process memory space is used communication applications such as PDO interface and SDO (mailbox) interface.

#### 2) Shadow Buffer for Register Write Operations

The ESCs have shadow buffers for write operations to registers (0x0000 to 0x0F7F). During a frame, write data is stored in the shadow buffers. If the frame is received correctly, the values of the shadow buffers are transferred into the effective registers. Otherwise, the values of the shadow buffers are not taken over. As a consequence of this behavior, registers take their new value shortly after the FCS of an EtherCAT frame is received. SyncManagers also change the buffers after the frame was received correctly.

User and Process Memory do not have shadow buffers. Accesses to these areas are taking effect directly. If a SyncManager is configured to User Memory or Process Memory, write data will be placed in the memory, but the buffer will not change in case of an error.

#### 3) EtherCAT Slave Controller Function Blocks

■ **EtherCAT Interface (Ethernet/EBUS)**

The EtherCAT interfaces or ports connect the ESC to other EtherCAT slaves and the master.

The MAC layer is integral part of the ESC. The physical layer may be Ethernet or EBUS.

The physical layer for EBUS is fully integrated into the ASICs. For Ethernet ports,

external Ethernet PHYs connect to the MII/RMII ports of the ESC. Transmission speed for EtherCAT is fixed to 100 Mbit/s with Full Duplex communication. Link state and communication status are reported to the Monitoring device.

RS2 EtherCAT slave amplifier supports 2 ports and the logical ports are numbered 0 and 1.

■ **EtherCAT Processing unit**

The EtherCAT Processing Unit (EPU) receives, analyses and processes the EtherCAT data stream. It is logically located between port 0 and port 1. The EtherCAT Processing Units contains the main function blocks of EtherCAT slaves besides Auto-Forwarding, Loop-back function, and PDI.

## 6. Data Link Layer

### 6.2 Address Space

RS2 EtherCAT servo amplifier has an address space of 12kByte. The lower block of 4kByte (0x0000 - 0x1000) is dedicated for configuration registers common to all EtherCAT products.

RS2 EtherCAT amplifier has 8kByte of process data RAM space beginning at 0x1000 to 0x2FFF

The address space list is shown below.

**Table 1: ESC address space**

Address	Length (Byte)	Description	Address	Length (Byte)	Description
<b>ESC Information</b>			<b>Watchdogs</b>		
0x0000	1	Type	0x0400:0x0401	2	Watchdog Divider
0x0001	1	Revision	0x0410:0x0411	2	Watchdog Time PDI
0x0002:0x0003	2	Build	0x0420:0x0421	2	Watchdog Time Process Data
0x0004	1	FMMUs supported	0x0440:0x0441	2	Watchdog Status Process Data
0x0005	1	SyncManagers supported	0x0442	1	Watchdog Counter Process Data
0x0006	1	RAM Size	0x0443	1	Watchdog Counter PDI
0x0007	1	Port Descriptor	<b>ESI EEPROM Interface (ESI)</b>		
0x0008:0x0009	2	ESC Features supported	0x0500	1	EEPROM Configuration
<b>Station Address</b>			0x0501	1	EEPROM PDI Access State
0x0010:0x0011	2	Configured Station Address	0x0502:0x0503	2	EEPROM Control/Status
0x0012:0x0013	2	Configured Station Alias	0x0504:0x0507	4	EEPROM Address
<b>Write Protection</b>			0x0508:0x050F	4/8	EEPROM Data
0x0020	1	Write Register Enable	<b>MII Management Interface (ESI)</b>		
0x0021	1	Write Register Protection	0x0510:0x0511	2	MII Management Control/Status
0x0030	1	ESC Write Enable	0x0512	1	PHY Address
0x0031	1	ESC Write Protection	0x0513	1	PHY Register Address
<b>Data Link Layer</b>			0x0514:0x0515	2	PHY Data
0x0040	1	ESC Reset ECAT	<b>FMMU (Fieldbus Memory Management Unit)</b>		
0x0100:0x0103	4	ESC DL Control	0x0600:0x06FF	8x16	FMMU[7:0]
0x0108:0x0109	2	Physical Read/Write Offset	+0x0:0x3	4	Logical Start Address
0x0110:0x0111	2	ESC DL Status	+0x4:0x5	2	Length
<b>Application Layer</b>			+0x6	1	Logical Start bit
0x0120:0x0121	2	AL Control	+0x7	1	Logical Stop bit
0x0130:0x0131	2	AL Status	+0x8:0x9	2	Physical Start Address
0x0134:0x0135	2	AL Status Code	+0xA	1	Physical Start bit
<b>PDI</b>			+0xB	1	Type
0x0140:0x0141	2	PDI Control	+0xC	1	Activate
0x0150	1	SYNC/LATCH PDI Configuration	+0xD:0xF	3	Reserved
0x0151:0x0153	3	Extended PDI Configuration	<b>SyncManager (SM)</b>		
<b>Interrupts</b>			0x0800:0x087F	8x8	SyncManager [7:0]
0x0200:0x0201	2	ECAT Event Mask	+0x0:0x1	2	Physical Start Address
0x0204:0x0207	4	AL Event Mask	+0x2:0x3	2	Length
0x0210:0x0211	2	ECAT Event Request	+0x4	1	Control Register
0x0220:0x0223	4	AL Event Request	+0x5	1	Status Register
<b>Error Counters</b>			+0x6	1	Activate
0x0300:0x0307	4x2	Rx Error Counter [3:0]	+0x7	1	PDI Control
0x0308:0x030B	4x1	Forwarded Rx Error counter [3:0]			
0x030C	1	ECAT Processing Unit Error Counter			
0x030D	1	PDI Error Counter			
0x0310:0x0313	4x1	Lost Link Counter [3:0]			

\* Address areas not listed here are reserved. They are not writable. A read access to reserved addresses will typically return 0.

## 6. Data Link Layer

Table 2: ESC address space

Address	Length (Byte)	Description	Address	Length (Byte)	Description
<b>Distributed Clocks (DC)</b>			<b>DC – Latch In Unit</b>		
0x0900:0x09FF	-	Distributed Clocks (DC)	0x09A8	1	Latch0 Control
0x0900:0x0903	4	Receive Time Port 0	0x09A9	1	Latch1 Control
0x0904:0x0907	4	Receive Time Port 1	0x09AE	1	Latch0 Status
0x0908:0x090B	4	Receive Time Port 2	0x09AF	1	Latch1 Status
0x090C:0x090F	4	Receive Time Port 3	0x09B0:0x09B7	4/8	Latch0 Time Positive Edge
<b>DC – Time Loop Control Unit</b>			0x09B8:0x09BF	4/8	Latch0 Time Negative Edge
0x0910:0x0917	4/8	System Time	0x09C0:0x09C7	4/8	Latch1 Time Positive Edge
0x0918:0x091F	8	Receive Time ECAT Processing Unit	0x09C8:0x09CF	4/8	Latch1 Time Negative Edge
0x0920:0x0927	4/8	System Time Offset	<b>DC – SyncManager Event Times</b>		
0x0928:0x092B	4	System Time Delay	0x09F0:0x09F3	4	EtherCAT Buffer Change Event Time
0x092C:0x092F	4	System Time Difference	0x09F8:0x09FB	4	PDI Buffer Start Event Time
0x0930:0x0931	2	Speed Counter Start	0x09FC:0x09FF	4	PDI Buffer Change Event Time
0x0932:0x0933	2	Speed Counter Diff	<b>ESC specific</b>		
0x0934	1	System Time Difference Filter Depth	0x0E00:0x0EFF	256	ESC specific registers (e.g., Power-On Values / Product and Vendor ID)
0x0935	1	Speed Counter Filter Depth	<b>Digital Input/Output</b>		
<b>DC – Cyclic Unit Control</b>			0x0F00:0x0F03	4	Digital I/O Output Data
0x0980	1	Cyclic Unit Control	0x0F10:0x0F11	2	General Purpose Outputs
<b>DC – SYNC Out Unit</b>			0x0F18:0x0F19	2	General Purpose Inputs
0x0981	1	Activation	<b>User RAM</b>		
0x0982:0x0983	2	Pulse Length of Sync Signals	0x0F80:0x0FA1	33	Extended ESC features
0x098E	1	SYNC0 Status	0x0FC0:0x0FFF	64	User RAM
0x098F	1	SYNC1 Status	<b>Process Data RAM</b>		
0x0990:0x0997	4/8	Start Time Cyclic Operation/ Next SYNC0 Pulse	0x1000:0x2FFF	8192	Process Data RAM
0x0998:0x099F	4/8	Next SYNC1 Pulse			
0x09A0:0x09A3	4	SYNC0 Cycle Time			
0x09A4:0x09A7	4	SYNC1 Cycle Time			

For Registers longer than one byte, the LSB has the lowest and MSB the highest address.

## 6. Data Link Layer

### Register description

#### 1) ESC Information

##### Type

Address	bit	Description	Master	Slave	Length	Rest Value
0x0000	7:0	Type of EtherCAT controller	R/-	R/-	1Byte	0x11

##### Revision

Address	bit	Description	Master	Slave	Length	Rest Value
0x0001	7:0	Revision of EtherCAT controller	R/-	R/-	1Byte	0x00

##### Build

Address	bit	Description	Master	Slave	Length	Rest Value
0x0002 - 0x0003	15:0	Actual build of EtherCAT controller	R/-	R/-	2Byte	0x0000

##### FMMUs supported

Address	bit	Description	Master	Slave	Length	Rest Value
0x0004	7:0	Number of supported FMMU channels (or entities) of the EtherCAT Slave Controller	R/-	R/-	1Byte	0x08

##### SyncManagers supported

Address	bit	Description	Master	Slave	Length	Rest Value
0x0005	7:0	Number of supported SyncManager channels (or entities) of the EtherCAT Slave Controller	R/-	R/-	1Byte	0x08

##### RAM Size

Address	bit	Description	Master	Slave	Length	Rest Value
0x0006	7:0	Process Data RAM size supported by the EtherCAT Slave Controller in KByte	R/-	R/-	1Byte	0x08

##### Port Descriptor

Address	bit	Description	Master	Slave	Length	Rest Value
0x0007	1:0	Port 0	R/-	R/-	1Byte	0x0F
	3:2	Port 1				
	7:4	Reserved				
		Port configuration: 00:Not implemented, 10:EBUS, 11:MII				

##### ESC Features supported

Address	bit	Description	Master	Slave	Length	Rest Value	
0x0008 - 0x0009	0	FMMU Operation	R/-	R/-	2Byte	0x00FC	
	1	Reserved					
	2	Distributed Clocks					0:Not available, 1:Available
	3	Distributed Clocks (width)					0:32 bit, 1:64 bit
	4	Low Jitter BUS					0:Not available, standard jitter 1:Available, jitter minimized
	5	Enhanced Link Detection EBUS					0:Not available 1:Available
	6	Enhanced Link Detection MII					0:Not available 1:Available
	7	Separate Handling of FCS Errors					0:Not supported 1:Supported, frames with wrong FCS and additional nibble will be counted separately in Forwarded RX Error Counter
15:8	Reserved						

## 6. Data Link Layer

### 2) Station Address

#### Configured Station Address

Address	bit	Description	Master	Slave	Length	Rest Value
0x0010 - 0x0011	15:0	Address used for node addressing (FPxx commands) Sets node address.	R/W	R/-	2 Byte	0x0000

#### Configured Station Alias

Address	bit	Description	Master	Slave	Length	Rest Value
0x0012 - 0x0013	15:0	Alias Address used for node addressing (FPxx commands) The use of this alias is activated by Register DL Control Bit 24 (0x0100.24/0x0103.0) Note) EEPROM load from 0x0004	R/-	R/W	2 Byte	0x0000 Note)

### 3) Write Protection

ESC contained in this amplifier handles all ESC protection (or write protection register).  
Registers used for write protection are described

#### Registers for Write Protection

Register Address	Name	Description
0x0020	Write Register Enable	Temporarily release register write protection
0x0021	Write Register Protection	Activate register write protection
0x0030	ESC Write Enable	Temporarily release ESC write protection
0x0031	ESC Write Protection	Activate ESC write protection

#### ■ Register Write Protection

With register write protection, only the register area (0x0000 to 0x0FFF) is write protected (except for registers 0x0020 and 0x0030).  
If register write protection is enabled (register 0x0021.0=1), the Register Write Enable bit (0x0020.0) has to be set in the same frame before any register write operations. This is also true for disabling the register write protection. Otherwise, write operation to registers are discarded.

#### ■ ESC Write Protection

ESC write protection disables write operations to any memory location (except for registers 0x0020 and 0x0030).  
If ESC write protection is enabled (register 0x0031.0=1), the ESC Write Enable bit (0x0030.0) has to be set in the same frame before any write operations.  
This is also true for disabling the ESC write protection as well as the register write protection. Otherwise, write operations are discarded.

NOTE: If both register write protection and ESC write protection are enabled (not recommended), both enable bits have to be set before the write operations are allowed.

## 6. Data Link Layer

### Write Register Enable

Address	bit	Description	Master	Slave	Length	Rest Value
0x0020	0	If write register protection is enabled, this register has to be written in the same Ethernet frame (value does not care) before other writes to this station are allowed. Write protection is still active after this frame (if Write Register Protection register is not changed).	-/W	-/-	1 Byte	0x00
	7:1	Reserved, write 0	-/-			

### Write Register Protection

Address	bit	Description	Master	Slave	Length	Rest Value
0x0021	0	Write register protection 0:Protection disabled 1:Protection enabled	R/W	R/-	1 Byte	0x00
	7:1	Reserved, write 0	R/-			

### ESC Write Enable

Address	bit	Description	Master	Slave	Length	Rest Value
0x0030	0	If ESC write protection is enabled, this register has to be written in the same Ethernet frame (value does not care) before other writes to this station are allowed. ESC write protection is still active after this frame (if ESC Write Protection register is not changed).	-/w	-/-	1 Byte	0x00
	7:1	Reserved, write 0	-/-			

### ESC Write Protection

Address	bit	Description	Master	Slave	Length	Rest Value
0x0031	0	Write protect 0: Protection disabled 1: Protection enabled	R/W	R/-	1 Byte	0x00
	7:1	Reserved, write 0	R/-			

## 4) ESC Data Link Layer

### ■ ESC Reset

ESC loaded RS2 EtherCAT slave amplifier is capable of issuing a hardware reset from the EtherCAT master. A special sequence of three independent and consecutive frames/commands has to be sent do the slave (Reset register ECAT 0x0040 or PDI 0x0041). Afterwards, the slave is reset.

It is likely that some transmitting sequence frames will not return to the master because the links will go down with the reset after the normal reception of data.

### ESC Reset

Address	bit	Description	Master	Slave	Length	Rest Value
0x0040	7:0	A reset is asserted after writing 0x52 ('R'), 0x45 ('E') and 0x53 ('S') in this register with 3 consecutive frames.	R/W	R/-	1 Byte	0x00
	1:0	Progress of the reset procedure: 01: after writing 0x52 10: after writing 0x45 (if 0x52 was written before) 00: else				

## 6. Data Link Layer

### ESC DL Control

Address	bit	Description	Master	Slave	Length	Rest Value
0x0100 - 0x0103	0	Forwarding rule: 0:EtherCAT frames are processed, Non-EtherCAT frames are forwarded without processing 1:EtherCAT frames are processed, Source MAC Address is changed (SOURCE_MAC [1] is set to 1 - locally administered address), Non-EtherCAT frames are destroyed	R/W	R/-	4 Byte	0x01
	1	Temporary use of settings in Register 0x101: 0:permanent use 1:use for about 1 second, then revert to previous settings				
	7:2	Reserved, write 0	R/-			
	9:8	Loop Port 0: 00:Auto => closed at "link down", opened with "link up" 01:Auto close => closed at "link down", opened with writing 01 after "link up" 10:Always open, regardless of link state 11:Always closed, regardless of link state	R/W	R/-		
	11:10	Loop Port 1: 00:Auto => closed at "link down", opened with "link up" 01:Auto close => closed at "link down", opened with writing 01 after "link up" 10:Always open, regardless of link state 11:Always closed, regardless of link state				0x00
	15:12	Reserved, write 0	R/-			
	18:16	RX FIFO Size: (ESC delays start of forwarding until FIFO is at least half full). RX FIFO Size/RX delay reduction 0: EBUS:-50ns , MII:-40ns 1: EBUS:-40ns , MII:-40ns 2: EBUS:-30ns , MII:-40ns 3: EBUS:-20ns , MII:-40ns 4: EBUS:-10ns , MII:No change 5: EBUS:No change , MII:No change 6: EBUS:No change , MII:No change 7: EBUS:default , MII:default The possibility of RX FIFO Size reduction depends on the clock source accuracy of the ESC and of every connected EtherCAT/Ethernet devices (master, slave, etc.). RX FIFO Size of 7 is sufficient for 100ppm accuracy, FIFO Size 0 is possible with 25ppm accuracy (frame size of 1518/1522 Byte).	R/W	R/-		0x07
	19	EBUS Low Jitter: 0:Normal jitter 1:Reduced jitter				
	23:20	Reserved, write 0	R/-			
	24	Station alias: 0:Ignore Station Alias 1:Alias can be used for all configured address command types (FPRD, FPWR, ...)	R/W	R/-		0x00
31:25	Reserved, write 0	R/-				

### Physical Read/Write Offset

Address	bit	Description	Master	Slave	Length	Rest Value
0x0108 - 0x0109	15:0	Offset of R/W Commands (FPRW, APRW) between Read address and Write address. RD_ADR=ADR and WR_ADR=ADR+R/W-Offset	R/W	R/-	2 Byte	0x0000

## 6. Data Link Layer

### ESC DL Status

Address	bit	Description	Master	Slave	Length	Rest Value
0x0110 - 0x0111	0	PDI operational/EEPROM loaded correctly: 0:EEPROM not loaded, PDI not operational (no access to Process Data RAM) 1:EEPROM loaded correctly, PDI operational (access to Process Data RAM)	R/-	R/-	2 Byte	-
	1	PDI Watchdog Status: 0:Watchdog expired 1:Watchdog reloaded				
	2	Enhanced Link detection: Note) EEPROM ADR0x0000.9 0:Deactivated for all ports 1:Activated for at least one port NOTE: EEPROM value is only taken over at first EEPROM load after power-on or reset				
	3	Reserved				
	4	Physical link on Port 0: 0: No link 1:Link detected				
	5	Physical link on Port 1: 0: No link 1: Link detected				
	7:6	Reserved				
	8	Loop Port 0: 0: Open 1: Closed	R/-	R/-		-
	9	Communication on Port 0: 0: No stable communication 1: Communication established				
	10	Loop Port 1: 0: Open 1: Closed				
	11	Communication on Port 1: 0: No stable communication 1: Communication established				
	12	Reserved (Loop Port 2: ) 1: Closed (Fixed)				
	13	Reserved (Communication on Port 2: ) 0: No stable communication (Fixed)				
	14	Reserved (Loop Port 3: ) 1: Closed (Fixed)				
	15	Reserved (Communication on Port 3: ) 0: No stable communication (Fixed)				

## 5) Application layer

### ■ EtherCAT State Machine (ESM) Registers

The state machine is controlled and monitored via registers within the ESC. The master requests state changes by writing to the AL Control register. The slave indicates its state in the AL Status register and puts error codes into the AL Status Code register.

Registers for the EtherCAT State Machine (ESM)

Register Address	Name	Description
0x0120:0x0121	AL Control	Requested state by the master
0x0130:0x0131	AL Status	AL Status of the slave application
0x0134:0x0135	AL Status Code	Error codes from the slave application
0x0140.8	PDI Control	Device emulation configuration

\* PDI control register is set via powered up EEPROM (12C).

## 6. Data Link Layer

### ■ AL Control and AL Status Register

Writing the AL Control register (0x0120:0x0121) initiates a state transition of the device state machine. The AL Status register (0x0130:0x0131) reflects the current state of the slave.

### ■ Device Emulation

Simple devices (without microcontroller) have the device emulation enabled (0x0140.8=1). The AL Control register is directly copied into the AL Status register by the ESC. The master should not set the Error Indication Acknowledge bit for such slaves at all, because setting this bit would result in setting the Error Indication bit – although no error occurred. The device emulation is :0x0140.8=0 in the RS2 EtherCAT slave amplifier.

#### AL Control

Address	bit	Description		Master	Slave	Length	Rest Value
0x0120 - 0x0121	3:0	Initiate State Transition of the Device State Machine:	1: Request Init State 2: Request Pre-Operational State 3: Request Bootstrap State 4: Request Safe-Operational State 8: Request Operational State	R/(W)	R/-	2 Byte	0x0001
	4	Error Ind Ack:	0: No Ack of Error Ind in AL status register 1: Ack of Error Ind in AL status register				
	15:5	Reserved, write 0					

- \* AL Control register behaves like a mailbox if Device Emulation is off (0x0140.8=0): The PDI has to read the AL Control register after ECAT has written it. Otherwise ECAT can not write again to the AL Control register.
- \* If Device Emulation is on (0x0140.8=1), the AL Control register can always be written, its content is copied to the AL Status register.

#### AL Status

Address	bit	Description		Master	Slave	Length	Rest Value
0x0130 - 0x0131	3:0	Actual State of the Device State Machine:	1:Init State 2:Pre-Operational State 3:Request Bootstrap State 4:Safe-Operational State 8:Operational State	R/-	R/(W)	2 Byte	0x0001
	4	Error Ind:	0:Device is in State as requested or cleared by bit 4, an error indicator Ack=1 of AL controller. 1:Device has not entered requested State or changed State as result of a local action				
	15:5	Reserved, write 0					

- \* AL Status register is only writable if Device Emulation is off (0x0140.8=0), otherwise AL Status register will reflect AL Control register values.

### ■ Error Indication and AL Status Code Register

The slave indicates errors during a state transition by setting the Error Indication flag (0x0130.4=1) and writing an error description into the AL Status Code register (0x0134:0x0135). The master acknowledges the Error Indication flag of the slave by setting the Error Ind Ack flag (0x0120.4). AL status codes are listed below.

## 6. Data Link Layer

### AL Status Code

Address	bit	Description	Master	Slave	Length	Rest Value
0x0134 - 0x0135	15:0	AL Status Code: The slave indicates errors during a state transition by setting the Error Indication flag (0x0130.4=1) and writing an error description into the AL Status Code register (0x0134:0x0135). The master acknowledges the Error Indication flag of the slave by setting the Error Ind Ack flag (0x0120.4).	R/-	R/W	2 Byte	0x0000
	Code	Overview	Current ESM		Resulting ESM	
	0x0000	No error	Any ESM		Current ESM	
	0x0001	Unspecified error	Any ESM		Any ESM	
	0x0002	NO MEMORY	Any ESM		Current ESM	
	0x0011	Invalid requested EMS change (O->B, S->B, P->B)	I->S, I->O, P->O		Current ESM + E	
	0x0012	Unknown requested state	Any ESM		Current ESM + E	
	0x0013	Bootstrap not supported	I->B		I + E	
	0x0014	No valid firmware	I->P		I + E	
	0x0015	Invalid mailbox configuration	I->B		I + E	
	0x0016	Invalid mailbox configuration	I->P		I + E	
	0x0017	Invalid sync manager configuration	P->S, S->O		Current ESM + E	
	0x0018	No valid inputs available	O, S, P->S		P + E	
	0x0019	No valid outputs	O, S->O		S + E	
	0x001A	Synchronization error	O, S->O		S + E	
	0x001B	Sync manager watchdog	O		S + E	
	0x001C	Invalid Sync Manager Types	O, S P->S		S + E P + E	
	0x001D	Invalid Output Configuration	O, S P->S		S + E P + E	
	0x001E	Invalid Input Configuration	O, S, P->S		P + E	
	0x001F	Invalid Watchdog Configuration	O, S, P->S		P + E	
	0x0020	Slave needs cold start	Any ESM		Current ESM + E	
	0x0021	Slave needs INIT	B, P, S, O		Current ESM + E	
	0x0022	Slave needs PREOP	S, O		S + E, O + E	
	0x0023	Slave needs SAFEOP	O		O + E	
	0x0024	Invalid Input Mapping	P->S		P + E	
	0x0025	Invalid Output Mapping	P->S		P + E	
	0x0026	Unmatched setting	P->S		P + E	
	0x0027	Free-run mode unsupported	P->S		P + E	
	0x0028	SYNC mode unsupported	P->S		P + E	
	0x0029	Free-run mode, 3 Buffer mode not set	P->S		P + E	
	0x002A	BACK GROUND WATCH DOG	P->S		P + E	
	0x002B	NO VALID INPUTS SAND OUTPUTS	P->S		P + E	
	0x002C	FATAL SYNC ERROR	P->S		P + E	
	0x002D	NO SYNC ERROR	S->O, O		S + E	
	0x0030	Invalid DC SYNC Configuration	O, S		S + E	
	0x0031	Invalid DC Latch Configuration	O, S		S + E	
	0x0032	PLL Error	O		S + E	
	0x0033	Invalid DC IO Error	O, S		S + E	
	0x0034	Invalid DC Timeout Error	O, S		S + E	
	0x0035	DC Invalid SYNC CYCLE TIME	P->S		P + E	
	0x0036	DC SYNC0 CYCLE TIME	P->S		P + E	
	0x0037	DC SYNC1 CYCLE TIME	P->S		P + E	
	0x0042	MBX_EOE	B, P, S, O		Current ESM + E	
	0x0043	MBX_COE	B, P, S, O		Current ESM + E	
	0x0044	MBX_FOE	B, P, S, O		Current ESM + E	
	0x0045	MBX_SOE	B, P, S, O		Current ESM + E	
	0x004F	MBX_VOE	B, P, S, O		Current ESM + E	
	0x0050	EE NO ACCSESS	B, P, S, O		Current ESM + E	
	0x0050	EE ERROR	B, P, S, O		Current ESM + E	

\* "+E" in the resulting state column indicates setting of the Error Indication flag.

## 6. Data Link Layer

### 6) Process Data Interface (PDI)

#### PDI Control

Address	bit	Description	Master	Slave	Length	Rest Value
0x0140 -	7:0	Process data interface: 8:16 Bit asynchronous microcontroller interface	R/-	R/-	2 Byte	0x08 (Note)
0x0141	8	Device emulation (control of AL status): 0:AL status register has to be set by slave 1:AL status register will be set to value written to AL control register				0x0C (Note)
	9	Enhanced Link detection all ports: 0:disabled 1:enabled "0" when using MII port.				
	10	Distributed Clocks SYNC Out Unit: 0:disabled (power saving) 1:enabled				
	11	Distributed Clocks Latch In Unit: 0:disabled (power saving) 1:enabled				
	15:12	Reserved				

Note) EEPROM ADR 0x0000

#### 8/16Bit asynchronous microcontroller configuration

Address	bit	Description	Master	Slave	Length	Rest Value
0x0150	1:0	BUSY output driver/polarity: 00:Push-Pull active low 01:Open Drain (active low) 10:Push-Pull active high 11:Open Source (active high)	R/-	R/-	1 Byte	0x00 (Note)
	3:2	IRQ output driver/polarity: 00:Push-Pull active low 01:Open Drain (active low) 10:Push-Pull active high 11:Open Source (active high)				
	4	BHE polarity: 0:Active low 1:Active high				
	6:5	Reserved, set EEPROM value 0				
	7	RD Polarity: 0:Active low 1:Active high				

Note) EEPROM ADR 0x0001

#### Sync/Latch PDI Configuration

Address	bit	Description	Master	Slave	Length	Rest Value
0x0151	1:0	SYNC0 output driver/polarity: 00:Push-Pull active low 01:Open Drain (active low) 10:Push-Pull active high 11:Open Source (active high)	R/-	R/-	1 Byte	0xCC (Note)
	2	SYNC0/LATCH0 configuration: 0:LATCH0 Input 1:SYNC0 Output				
	3	SYNC0 mapped to AL Event Request register 0x0220.2: 0:Disabled 1:Enabled				
	5:4	SYNC1 output driver/polarity: 00:Push-Pull active low 01:Open Drain (active low) 10:Push-Pull active high 11:Open Source (active high)				
	6	SYNC1/LATCH1 configuration: 0:LATCH1 input 1:SYNC1 output				
	7	SYNC1 mapped to AL Event Request register 0x0220.3: 0:Disabled 1:Enabled				

Note) EEPROM ADR 0x0001

#### Register Asynchronous microcontroller extended Configuration

Address	bit	Description	Master	Slave	Length	Rest Value
0x0152 -	0	Read BUSY delay: 0:Normal read BUSY output 1:Delayed read BUSY output	R/-	R/-	2 Bytes	0x0000 (Note)
0x0153	15:1	Reserved, set EEPROM value 0				

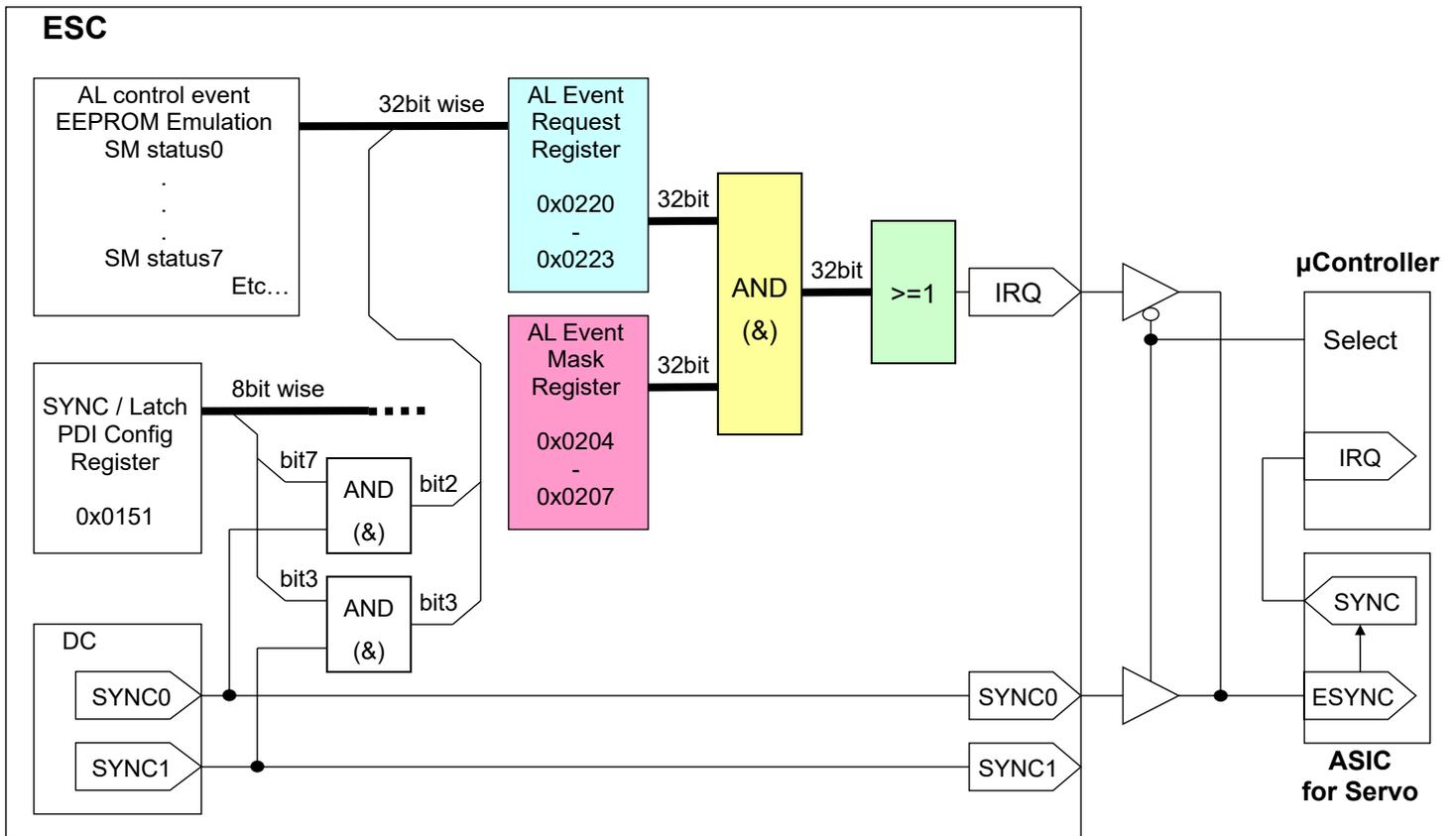
Note) Reset Value is "0". After that, depends on configuration EEPROM ADR 0x0003.

7) Interrupts

ESCs support two types of interrupts: AL Event Requests dedicated for a microcontroller, and ECAT event requests dedicated for the EtherCAT master. Additionally, the Distributed Clocks Sync Signals can be used as interrupts for a microcontroller as well.

■ AL Event Request (PDI Interrupt)

AL Event Requests can be signaled to a microcontroller using the PDI Interrupt Request signal (IRQ/SPI\_IRQ, etc.). For IRQ generation, the AL Event Request register (0x0220:0x0223) is combined with the AL Event Mask register (0x0204:0x0207) using a logical AND operation, then all resulting bits are combined (logical OR) into one interrupt signal. The output driver characteristics of the IRQ signal are configurable using the SYNC/LATCH PDI configuration register (0x0151). The AL Event Mask register allows for selecting the interrupts which are relevant for the microcontroller and handled by the application.



PDI Interrupt Masking and interrupt signals

The DC Sync Signals can be used for interrupt generation in two ways:

- The DC SYNC signals are mapped into the AL Event Request Register (configured with SYNC/LATCH PDI Configuration register 0x0151.3/7). In this case, all interrupts from the ESC to the µController are combined into one IRQ signal, and the Distributed Clocks LATCH0/1 inputs can still be used. The IRQ signal has a jitter of ~40 ns.
- The DC Sync Signals are directly connected to microcontroller interrupt inputs. The µController can react on DC Sync Signal interrupts faster (without reading AL Request register), but it needs more interrupt inputs. The jitter of the Sync Signals is ~12 ns. The DC Latch functions are only available for one Latch input or not at all (if both DC SYNC outputs are used).

## 6. Data Link Layer

Registers used for AL event requests are described:

**Registers for AL Event Requests**

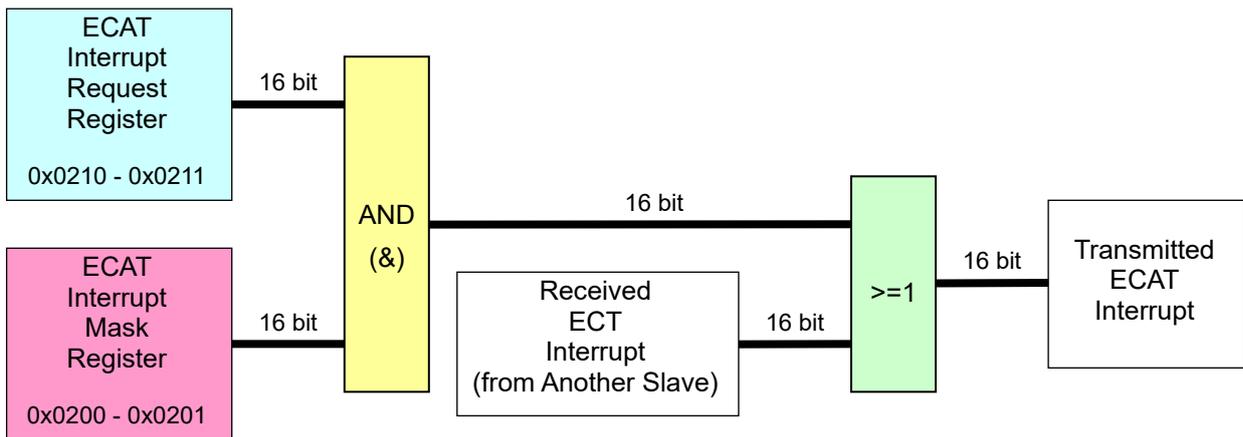
Register Address	Name	Description
0x0150	PDI Configuration	IRQ driver characteristics, depending on PDI
0x0151	SYNC/LATCH PDI Configuration	Mapping DC Sync Signals to Interrupts
0x0204:0x0207	AL Event Mask	Mask register
0x0220:0x0223	AL Event Request	Pending Interrupts
0x0804+N*8	Sync Manager Control	Mapping Sync Manager Interrupts

\* Some registers are set by EEPROM at initialization.

### ■ ECAT Event Request (ECAT Interrupt)

ECAT event requests are used to inform the EtherCAT master of slave events. ECAT events make use of the IRQ field inside EtherCAT datagrams. The ECAT Event Request register (0x0210:0x0211) is combined with the ECAT Event Mask register (0x0200:0x0201) using a logical AND operation. The resulting interrupt bits are combined with the incoming ECAT IRQ field using a logical OR operation, and written into the outgoing ECAT IRQ field. The ECAT Event Mask register allows for selecting the interrupts which are relevant for the EtherCAT master and handled by the master application.

NOTE: The master can not distinguish which slave (or even more than one) was the origin of an interrupt.



**ECAT Interrupt Masking**

Registers used for ECAT Interrupts are described:

**Registers for ECAT Interrupts**

Register Address	Name	Description
0x0200: 0x0201	ECAT Interrupt Mask	Mask register
0x0210: 0x0211	ECAT Interrupt Request	Pending Interrupts
0x0804 + N*8	SyncManager Control	Mapping SyncManager Interrupts

## 6. Data Link Layer

### ECAT Event Mask

Address	bit	Description	Master	Slave	Length	Rest Value
0x0200 - 0x0201	15:0	ECAT Event masking of the ECAT Event Request Events for mapping into ECAT event field of EtherCAT frames: 0:Corresponding ECAT Event Request register bit is not mapped 1:Corresponding ECAT Event Request register bit is mapped	R/W	R/-	2 Bytes	0x0000

### AL Event Mask

Address	bit	Description	Master	Slave	Length	Rest Value
0x0204 - 0x0207	31:0	AL Event masking of the AL Event Request register Events for mapping to PDI IRQ signal: 0: Corresponding AL Event Request register bit is not mapped 1: Corresponding AL Event Request register bit is mapped	R/-	R/W	4 Bytes	0x000000FF - 0x0000FF0F

### ECAT Event Request

Address	bit	Description	Master	Slave	Length	Rest Value
0x0210 - 0x0211	0	DC Latch event (Bit is cleared by reading DC Latch event times for ECAT controlled Latch Units, so that Latch 0/1 Status 0x09AE:0x09AF indicates no event): 0: No change on DC Latch Inputs 1: At least one change on DC Latch Inputs	R/-	R/-	2 Bytes	0x0000
	1	Reserved				
	2	DL Status event (Bit is cleared by reading out DL Status): 0: No change in DL Status 1:DL Status change				
	3	AL Status event (Bit is cleared by reading out AL Status): 0: No change in AL Status 1:AL Status change				
	4	Mirrors values of each SyncManager Status 0: No Sync Channel 0 event 1: Sync Channel 0 event pending				
	...	...				
	11	Mirrors values of each SyncManager Status 0: No Sync Channel 7 event 1: Sync Channel 7 event pending				
	15:12	Reserved				

### AL Event Request

Address	bit	Description	Master	Slave	Length	Rest Value
0x0220 - 0x0223	0	AL Control event:(Bit is cleared by reading AL Control register.) 0: No AL Control Register change 1: AL Control Register has been written3	R/-	R/-	4 Bytes	0x00000000
	1	DC Latch event:(Bit is cleared by reading DC Latch event times.) 0: No change on DC Latch Inputs 1: At least one change on DC Latch Inputs				
	2	SYNC0 status when 0x0151.3=1 (Bit clear at SYNC0 status red)				
	3	SYNC1 status when 0x0151.7=1 (Bit clear at SYNC1 status red)				
	4	SyncManager activation register (Offset:0x0806 + y × 8) 0: SM0 - 7 No change 1: Some of SM0 - 7 has changed (SM) (Bit clear by read of SM activation register)				
	7:5	Reserved				
	8	SM status mirror 0: No SyncManager 0 interrupt 1: SyncManager 0 interrupt pending				
	...	...				
	15	SM status mirror 0: No SyncManager 7 interrupt 1: SyncManager 7 interrupt pending				
	31:16	Reserved				

## 6. Data Link Layer

### 8) Error Counter

#### RX Error Counter

Errors are only counted if the corresponding port is enabled.

Address	bit	Description	Master	Slave	Length	Rest Value
0x0300 -	7:0	Invalid frame counter of Port 0 (counting is stopped when 0xFF is reached). Note)	R/W (clr)	R/-	8 Bytes	0x00
0x0307	15:8	RX Error counter of Port 0 (counting is stopped when 0xFF is reached). Note) This is coupled directly to RX ERR of MII interface/EBUS interface.				0x00
	23:16	Invalid frame counter of Port 1 (counting is stopped when 0xFF is reached). Note)				0x00
	31:24	RX Error counter of Port 1 (counting is stopped when 0xFF is reached). Note) This is coupled directly to RX ERR of MII interface/EBUS interface.				0x00
	63:32	Reserved				0x00000000

\* Cleared if one of the RX Error counters 0x0300-0x030B is written.

The invalid frame counters are incremented if there is an error in the frame format (Preamble, SFD – Start of Frame Delimiter, FCS – Checksum, invalid length). If the FCS is invalid and an additional nibble is appended, the FCS error is not counted. This is why EtherCAT forwards frames with errors with an invalid FCS and an additional nibble.

RX Errors may appear either inside or outside frames. RX Errors inside frames will lead to invalid frames.

#### Forwarded RX Error Counter

Address	bit	Description	Master	Slave	Length	Rest Value
0x0308 -	7:0	Forwarded error counter of Port 0 (counting is stopped when 0xFF is reached). Note)	R/W (clr)	R/-	4 Bytes	0x00
0x030B	15:8	Forwarded error counter of Port 1 (counting is stopped when 0xFF is reached). Note)				0x00
	23:16	Reserved				0x0000

Note) Cleared if one of the RX Error counters 0x0300-0x030B is written.

#### ECAT Processing Unit Error Counter

Address	bit	Description	Master	Slave	Length	Rest Value
0x030C	7:0	ECAT Processing Unit error counter (counting is stopped when 0xFF is reached). Note) Counts errors of frames passing the Processing Unit (e.g., FCS is wrong or datagram structure is wrong).	R/W (clr)	R/-	1 Byte	0x00

\* Cleared if register is written.

#### PDI Error Counter

Address	bit	Description	Master	Slave	Length	Rest Value
0x030D	7:0	PDI Error counter (counting is stopped when 0xFF is reached). Note) Counts if a PDI access has an interface error.	R/W (clr)	R/-	1 Byte	0x00

\* Cleared if register is written.

#### Lost Link Counter

Address	bit	Description	Master	Slave	Length	Rest Value
0x0310 -	7:0	Lost Link counter of Port 0 (counting is stopped when 0xff is reached). Note)	R/W (clr)	R/-	4 Bytes	0x00
0x0313	15:8	Lost Link counter of Port 1 (counting is stopped when 0xff is reached). Note)				0x00
	31:16	Reserved				0x0000

\* Cleared if one of the Lost Link counter registers is written.

## 6. Data Link Layer

### 9) Watchdog

#### Watchdog Divider

Address	bit	Description	Master	Slave	Length	Rest Value
0x0400 - 0x0401	15:0	Watchdog divider: Number of 25 MHz tics (minus 2) that represents the basic watchdog increment. (Default value is $100\mu\text{s} = 2,500 \cdot 2 = 2498$ )	R/W	R/-	2 Bytes	0x09C2

#### Watchdog Time PDI

Address	bit	Description	Master	Slave	Length	Rest Value
0x0410 - 0x0411	15:0	Watchdog Time PDI: number or basic watchdog increments (Default value with Watchdog divider $100\mu\text{s}$ means 100ms Watchdog at $0x0400=0x09C2$ )	R/W	R/-	2 Bytes	0x03E8

#### Watchdog Time Process Data

Address	bit	Description	Master	Slave	Length	Rest Value
0x0420 - 0x0421	15:0	Watchdog Time Process Data: number of basic watchdog increments (Default value with Watchdog divider $100\mu\text{s}$ means 100ms Watchdog) There is one Watchdog for all SyncManagers.	R/W	R/-	2 Bytes	0x03E8

- \* Watchdog is restarted with every write access to SyncManagers with Watchdog Trigger Enable Bit set.
- \* Watchdog is disabled if Watchdog time is set to  $0x0420=0$ .

#### ■ Watchdog Status PDI

The Watchdog Status for the PDI can be read in the DL Status register 0x0110.1.

#### Watchdog Status Process Data

Address	bit	Description	Master	Slave	Length	Rest Value
0x0440 - 0x0441	0	Watchdog Status of Process Data (triggered by SyncManagers)	R/-	R/-	2 Bytes	0x0000
	15:1	0: Watchdog Process Data expired 1: Watchdog Process Data is active or disabled Reserved				

#### Watchdog Counter Process Data

Address	bit	Description	Master	Slave	Length	Rest Value
0x0442	7:0	Watchdog Counter Process Data (counting is stopped when 0xFF is reached). Counts if Process Data Watchdog expires.	R/W (clr)	R/-	1 Byte	0x00

- \* Cleared if one of the Watchdog counters 0x0442:0x0443 is written.

#### Watchdog Counter PDI

Address	bit	Description	Master	Slave	Length	Rest Value
0x0443	7:0	Watchdog PDI counter (counting is stopped when 0xFF is reached). Counts if PDI Watchdog expires.	R/W (clr)	R/-	1 Byte	0x00

- \* Cleared if one of the Watchdog counters 0x0442:0x0443 is written.

## 6. Data Link Layer

### 10) ESI EEPROM Interface (Slave Information Interface)

EtherCAT controls the ESI EEPROM interface if EEPROM configuration register 0x0500.0=0 and EEPROM PDI Access register 0x0501.0=0, otherwise PDI controls the EEPROM interface.

#### EEPROM Configuration

Address	bit	Description	Master	Slave	Length	Rest Value
0x0500	0	EEPROM control is offered to PDI	R/W	R/-	1 Byte	0x00
	1	Force ECAT access				
	7:2	Reserved, write 0	R/-	R/-		

#### EEPROM PDI Access State

Address	bit	Description	Master	Slave	Length	Rest Value
0x0501	0	Access to EEPROM (Note)	R/-	R/(W)	1 Byte	0x00
	7:1	Reserved, write 0	R/-	R/-		

Note) R/(W): write access is only possible if 0x0500.0=1 and 0x0500.1=0.

#### EEPROM Control/Status

Address	bit	Description	Master	Slave	Length	Rest Value	
0x0502 - 0x0503	0	ECAT write enable (Note 1)	R/(W)	R/-	2 Bytes	0xC0	
	4:1	Reserved, write 0					R/-
	5	EEPROM emulation	0: Normal operation (I <sup>2</sup> C interface used) 1: PDI emulates EEPROM (I <sup>2</sup> C not used)				
	6	Supported number of EEPROM read bytes	0: 4Byte 1: 8Byte				
	7	Selected EEPROM Algorithm	0: 1 address byte (1KBit – 16KBit EEPROMs) 1: 2 address bytes (32KBit – 4 MBit EEPROMs)				
	8	EEPROM Read Commands (Note 1)	Write: 0:No Action 1: Begin read access Read: 0:No read 1: Read processing	R/(W)			R/(W)
	9	EEPROM Write Commands (Note 1)	Write: 0:No Action 1: Begin write access Read: 0:No write 1: Write processing				
	10	EEPROM Reload Commands (Note 1)	Write: 0:No Action 1: Begin reload Read: 0: No reload 1: Reloading				
	11	Checksum Error at in ESC Configuration Area	0: Checksum ok 1: Checksum error				
	12	EEPROM loading status	0: EEPROM loaded, device information ok 1: EEPROM not loaded, device information not available				
	13	Error Acknowledge/ Commands (Note 1)	0: No error 1: Missing EEPROM acknowledge or invalid command				
	14	Error Write Enable (Note 2)	0: No error 1: Write Command without Write enable				
	15	Busy	0: EEPROM Interface is idle 1: EEPROM Interface is busy				

\* R/(W): write access depends upon the assignment of the EEPROM interface (ECAT/PDI).

\* Write access is generally blocked if EEPROM interface is busy (0x0502.15=1).

Note 1) Write Enable bit 0 and Command bits [10:8] are self-clearing. Manually clearing the command register will also clear the error bits [14:13]. Command bits [10:8] are ignored if Error Acknowledge/Command is pending (bit 13).

Note 2) Error bits are cleared by writing "000" (or any valid command) to Command Register Bits [10:8].

## 6. Data Link Layer

### EEPROM Address

Address	bit	Description	Master	Slave	Length	Rest Value
0x0504 -	15:0	EEPROM Address, to be read or written Lower Word(=16bit)	R/(W)	R/(W)	4 Bytes	0x00000000
0x0507	31:16	Upper Word				

- \* R/(W): write access depends upon the assignment of the EEPROM interface (ECAT/PDI).
- \* Write access is generally blocked if EEPROM interface is busy (0x0502.15=1).

### EEPROM Data

Address	bit	Description	Master	Slave	Length	Rest Value
0x0508 -	15:0	EEPROM Write data / Read data (lower bytes : 2Byte)	R/(W)	R/(W)	8 Bytes	0x0000
0x050F	63:16	EEPROM Write data / Read data (higher bytes : 6Byte)	R/-	R/-		0x000000000000

- \* R/(W): write access depends upon the assignment of the EEPROM interface (ECAT/PDI).
- \* Write access is generally blocked if EEPROM interface is busy (0x0502.15=1).

## 11) MII Management Interface

### MI Management Control/Status

Address	bit	Description	Master	Slave	Length	Rest Value
0x0510 -	0	Write enable (Note)	R/(W)	R/(W)	2 Bytes	0x00
0x0511	1	Management Interface can be controlled by PDI (registers 0x0516-0x0517)	R/-	R/-		
	2	MI link detection(0x0518:0x051B)				
	7:3	PHY address offset				
	9:8	Command register	R/(W)	R/(W)		0x00
	12:10	Reserved, write 0	R/-	R/-		
	13	Read error	R/(W)	R/(W)		
	14	Command error				
	15	Busy				

- \* R/(W): write access depends on assignment of MI (ECAT/PDI).
- \* Write access is generally blocked if Management interface is busy (0x0510.15=1).

Note) Write enable bit 0 and Command bits [9:8] are self-clearing. Manually clearing the command register will also clear the status information. The Write enable bit is cleared at the SOF/at the end of the PDI access. The Command bits are cleared after the command is executed.

### PHY Address

Address	bit	Description	Master	Slave	Length	Rest Value
0x0512	4:0	PHY Address	R/(W)	R/(W)	1 Byte	0x00
	7:5	Reserved, write 0	R/-	R/-		

- R/(W): write access depends on assignment of MI (ECAT/PDI).
- \* Write access is generally blocked if Management interface is busy (0x0510.15=1).

## 6. Data Link Layer

### PHY Register Address

Address	bit	Description	Master	Slave	Length	Rest Value
0x0513	4:0	Address of PHY Register that shall be read/written	R/(W)	R/(W)	1 Byte	0x00
	7:5	Reserved, write 0	R/-	R/-		

R/(W): write access depends on assignment of MI (ECAT/PDI).

\* Write access is generally blocked if Management interface is busy (0x0510.15=1).

### PHY Data

Address	bit	Description	Master	Slave	Length	Rest Value
0x0514 - 0x0515	15:0	PHY Read/Write Data	R/(W)	R/(W)	2 Bytes	0x0000

R/(W): write access depends on assignment of MI (ECAT/PDI).

\* Access is generally blocked if Management interface is busy (0x0510.15=1).

### MII Management ECAT Access State

Address	bit	Description	Master	Slave	Length	Rest Value
0x0516	0	Access to MII management 0: ECAT enables PDI takeover of MII management control 1: ECAT claims exclusive access to MII management	R/(W)	R/-	1 Byte	0x00
	7:1	Reserved, write 0	R/-	R/-		

\* R/(W): write access is only possible if 0x0517.0=0.

### MII Management PDI Access State

Address	bit	Description	Master	Slave	Length	Rest Value
0x0517	0	Access to MII management 0: ECAT has access to MII management 1: PDI has access to MII management	R/-	R/(W)	1 Byte	0x00
	1	Force PDI Access State 0: Do not change Bit 517.0 1: Reset Bit 517.0 to 0	R/W	R/-		
	7:2	Reserved, write 0	R/-	R/-		

\* R/(W): write access to bit 0 is only possible if 0x0516.0=0 and 0x0517.1=0.

### PHY Port 0/1 Status

Address	bit	Description	Master	Slave	Length	Rest Value
0x0518 - 0x0519	0	Physical link Port 0 status 0: No physical link 1: Physical link detected (PHY status register 1.2)	R/-	R/-	2 Bytes	0x00
	1	Port 0 Link status 0: No link 1: Link detected (100 Mbit/s, Full Duplex, Auto negotiation)				
	2	Port 0 Link status error 0: No error 1: Link error, link inhibited				
	3	Port 0 Read error 0: No read error occurred 1: A read error has occurred	R/(W)	R/(W)		
	4	Port 0 Link partner error 0: No error detected 1: Link partner error	R/-	R/-		
	7:5	Reserved	R/-	R/-		
	8	Physical link Port 1 status 0: No physical link 1: Physical link detected (PHY status register 1.2)	R/-	R/-		
	9	Port 1 Link status 0: No link 1: Link detected (100 Mbit/s, Full Duplex, Auto negotiation)				
	10	Port 1 Link status error 0: No error 1: Link error, link inhibited				
	11	Port 1 Read error 0: No read error occurred 1: A read error has occurred	R/(W)	R/(W)		
	12	Port 1 Link partner error 0: No error detected 1: Link partner error	R/-	R/-		
	15:13	Reserved	R/-	R/-		

Note) Cleared by writing any value to at least one of the PHY Status Port 0 registers.

\* R/(W): write access depends on assignment of MI (ECAT/PDI).

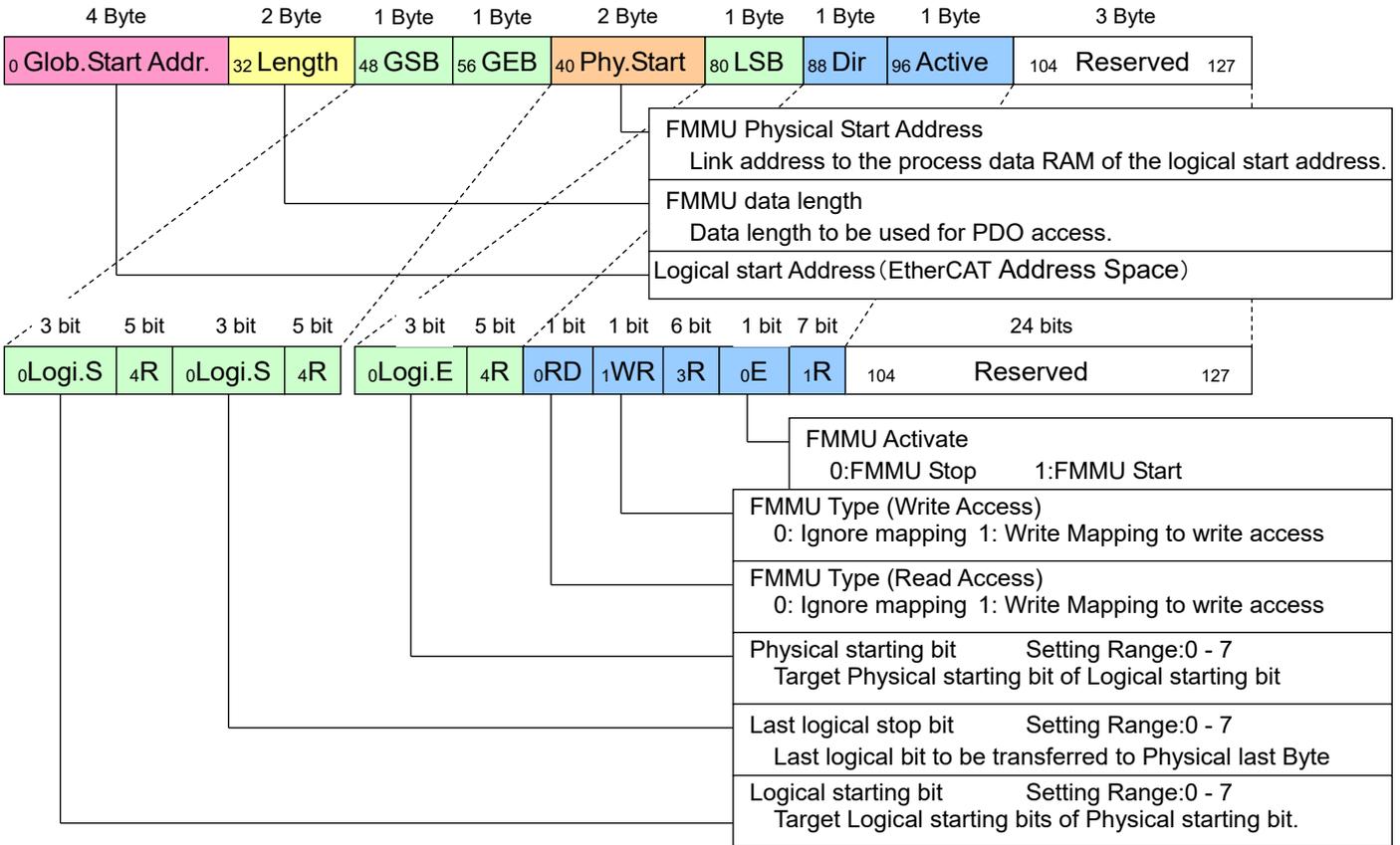
## 6. Data Link Layer

### 12) FMMU [7:0] (Fieldbus Memory Management Units)

Each FMMU entry is described in 16 Bytes from 0x0600:0x060F to 0x0670:0x067F.  
 RS2 EtherCAT slave amplifier has 8 FMMUs from FMMU0 - FMMU7.  
 y is the FMMU index (y=0 to 7).

#### ■ FMMU configuration register

FMMU entity configuration is shown below.



FMMU Configuration Register Formation

#### FMMU Characteristics and Remarks

- \* Each logical address byte can, at most, be mapped either by one FMMU (read) plus one FMMU (write) or by one FMMU (read/write). If two or more FMMUs (with the same direction – read or write) are configured for the same logical byte, the FMMU with the lower number (lower configuration address space) is used and the others are ignored.
- \* One or more FMMUs may point to the same physical memory-all are used. Collisions cannot occur.
- \* A read/write FMMU cannot be used together with SyncManagers since independent read and write SyncManagers cannot be configured to use the same (or overlapping) physical address range.
- \* Bit-wise reading is supported with any address. Bits not mapped to logical addresses are not changed in the EtherCAT datagram, (e.g., this allows mapping bits from several ESCs into the same logical byte).
- \* Reading an unconfigured logical address space will not change the data.

## 6. Data Link Layer

### Logical Start address FMMU y

Address	bit	Description	Master	Slave	Length	Rest Value
0x06y0 - 0x06y3	31:0	Logical start address within the EtherCAT Address Space.	R/W	R/-	4 Bytes	0x00000000

### Length FMMU y

Address	bit	Description	Master	Slave	Length	Rest Value
0x06y4 - 0x06y5	15:0	Offset from the first logical FMMU Byte to the last FMMU Byte + 1 (e.g., if two bytes are used then this parameter shall contain 2)	R/W	R/-	2 Bytes	0x0000

### Start bit FMMU y in logical address space

Address	bit	Description	Master	Slave	Length	Rest Value
0x06y6	2:0	Logical starting bit that shall be mapped (bits are counted from least significant bit (=0) to most significant bit(=7))	R/W	R/-	1 Byte	0x00
	7:3	Reserved, write 0	R/-	R/-		

### Stop bit FMMU y in logical address space

Address	bit	Description	Master	Slave	Length	Rest Value
0x06y7	2:0	Last logical bit that shall be mapped (bits are counted from least significant bit (=0) to most significant bit(=7))	R/W	R/-	1 Byte	0x00
	7:3	Reserved, write 0	R/-	R/-		

### Physical Start address FMMU y

Address	bit	Description	Master	Slave	Length	Rest Value
0x06y8 - 0x06y9	15:0	Physical Start Address (mapped to logical Start address)	R/W	R/-	2 Byte	0x0000

### Physical Start bit FMMU y

Address	bit	Description	Master	Slave	Length	Rest Value
0x06yA	2:0	Physical starting bit as target of logical start bit mapping (bits are counted from least significant bit (=0) to most significant bit(=7))	R/W	R/-	1 Byte	0x00
	7:3	Reserved, write 0				

### Type FMMU y

Address	bit	Description	Master	Slave	Length	Rest Value
0x06yB	0	0:Ignore mapping for read accesses 1:Use mapping for read accesses	R/W	R/-	1 Byte	0x00
	1	0:Ignore mapping for write accesses 1:Use mapping for write accesses				
	7:2	Reserved, write 0	R/-	R/-		

### Activate FMMU y

Address	bit	Description	Master	Slave	Length	Rest Value
0x06yC - 0x06yF	0	0:FMMU deactivated 1:FMMU activated. FMMU checks logical addressed blocks to be mapped according to mapping configured	R/W	R/-	4 Bytes	0x00000000
	31:1	Reserved, write 0	R/-	R/-		

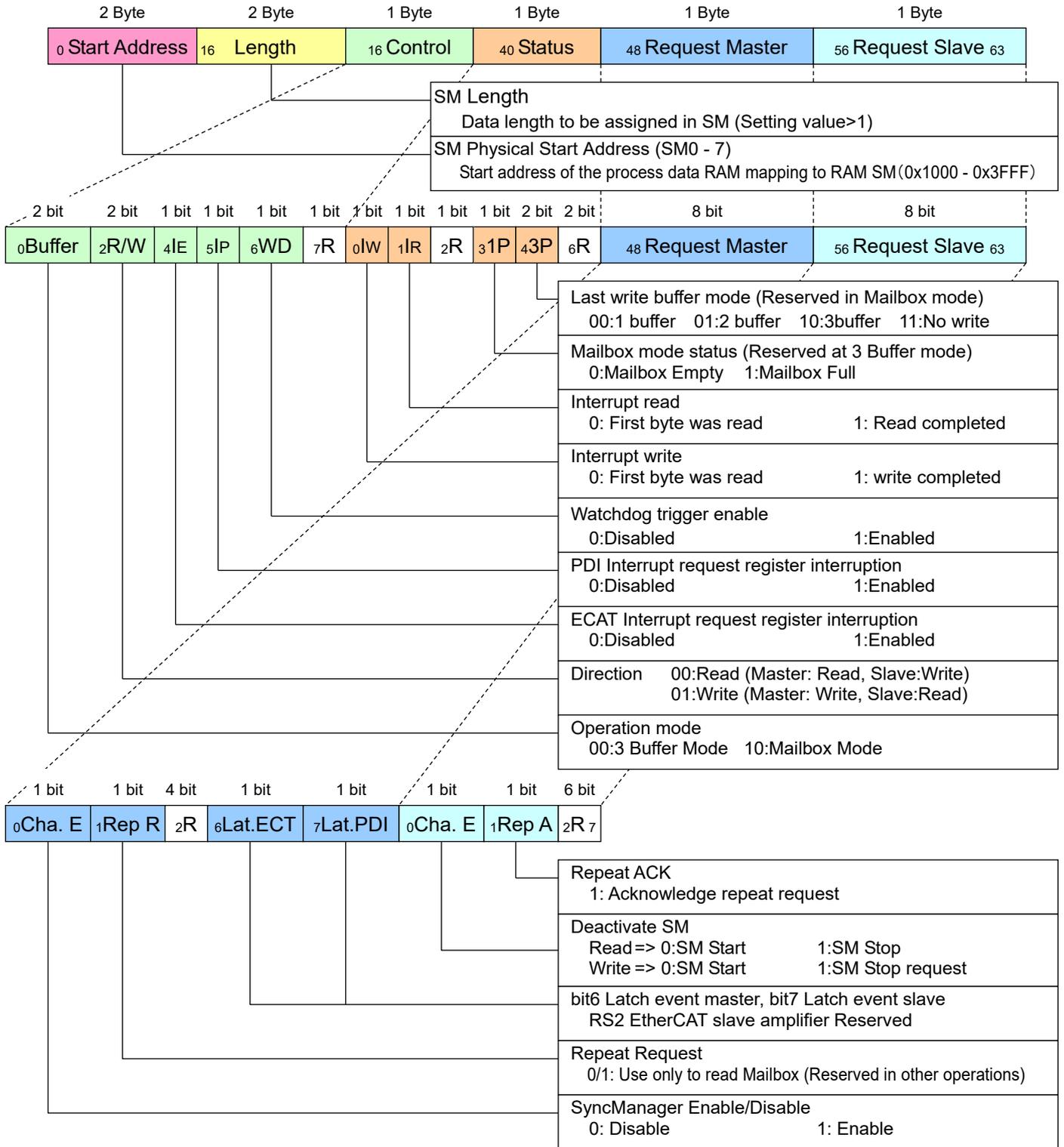
## 6. Data Link Layer

### 13) SyncManager (sm [7:0])

SyncManager registers are mapped from 0x0800:0x0807 to 0x0838:0x083F.  
 The RS2 EtherCAT slave amplifier has eight SM from SM0 to SM7.  
 y specifies SyncManager (y=0 to 7).

#### ■ Channel Configuration Register Formation.

SM Configuration Register Formation is shown below.



SMConfiguration Register Formation

## 6. Data Link Layer

### Physical Start Address SyncManager y

Address	bit	Description	Master	Slave	Length	Rest Value
0x0800+y <sup>x8</sup> - 0x0801+y <sup>x8</sup>	15:0	Specifies first byte that will be handled by SyncManager R/(W): Register can only be written if SyncManager is disabled (+0x6.0 = 0).	R/(W)	R/-	2 Bytes	0x0000

### Length SyncManager y

Address	bit	Description	Master	Slave	Length	Rest Value
0x0802+y <sup>x8</sup> - 0x0803+y <sup>x8</sup>	15:0	Number of bytes assigned to SyncManager (shall be greater 1, otherwise SyncManager is not activated. If set to 1, only Watchdog Trigger is generated if configured) R/(W): Register can only be written if SyncManager is disabled (+0x6.0 = 0).	R/(W)	R/-	2 Bytes	0x0000

\* Setting range is 0x0080(128Byte) - 0x0400(1024Byte) with even numbered settings.

\* AL status code [0x0016: Invalid Mailbox Setting] will responded to at Pre-Operation request when value is written out of setting range.

### Control Register SyncManager y

Address	bit	Description		Master	Slave	Length	Rest Value
0x0804 +y <sup>x8</sup>  SM0 0x0804	1:0	Operation Mode	00: Buffered (3 buffer mode) 01: Reserved 10: Mailbox (Single buffer mode) 11: Reserved	R/W	R/-	1 Byte	0x00
	3:2	Direction	00: Read: ECAT read access, PDI write access. 01: Write: ECAT write access, PDI read access. 10: Reserved 11: Reserved				
SM1 0x080C	4	Interrupt in ECAT Event Request Register	0: Disabled 1: Enabled				
SM2 0x0814	5	Interrupt in PDI Event Request Register	0: Disabled 1: Enabled				
SM3 0x081C	6	Watchdog Trigger Enable Note)	0: Disabled 1: Enabled				
	7	Reserved, write 0					

\* R/(W): Register can only be written if SyncManager is disabled (+0x6.0 = 0).

\* The SyncManager Watchdog function will be disabled by setting 0x0400:Watchdog Divider zero when Watchdog Trigger enable bit6=0:Disable is set. It can also be disabled by setting 0x0420: Watchdog Time Process Data to zero.

## 6. Data Link Layer

### Status Register SyncManager y

Address	bit	Description		Master	Slave	Length	Rest Value
0x0805 +y <sup>x8</sup>	0	Interrupt Write	1: Interrupt after buffer was completely and successfully written (0x0804+y <sup>x8</sup> ) 0: Interrupt cleared after first byte of buffer was read	R/-	R/-	1 Byte	0x00
	1	Interrupt Read:	1: Interrupt after buffer was completely and successful read (0x0804+y <sup>x8</sup> ) 0: Interrupt cleared after first byte of buffer was written				
	2	Reserved					
SM0 0x0805	3	Mailbox mode: mailbox status	0: Mailbox empty 1: Mailbox full Note) 3 Buffered mode: reserved				
SM1 0x080D	5:4	Buffered mode: buffer status (last written buffer)	00: 1buffer01: 2buffer 10: 3buffer 11: (no buffer written) Note) Mailbox mode: reserved				
SM2 0x0815	7:6	Reserved					
SM3 0x081D							

### Activate SyncManager y

Address	bit	Description		Master	Slave	Length	Rest Value
0x0806 +y <sup>x8</sup>	0	SyncManager Enable/ Disable	0: Disable: Access to Memory without SyncManager control 1: Enable: SyncManager is active and controls Memory area set in configuration	R/W	R/-	1 Byte	0x00
	1	Repeat Request	0/1: A toggle of Repeat Request means that a mailbox retry is needed (primarily used in conjunction with ECAT Read Mailbox)				
SM0 0x0806	5:2	Reserved, write 0					
SM1 0x080E	6	Latch Event ECAT	0: No 1: Generate Latch event if EtherCAT master issues a buffer exchange	R/W	R/-		
SM2 0x0816	7	Latch Event PDI	0: No 1: Generate Latch events if PDI issues a buffer exchange or if PDI accesses buffer start address				
SM3 0x081E							

### PDI Control SyncManager y

Address	bit	Description		Master	Slave	Length	Rest Value
0x0807 +y <sup>x8</sup>	0	Deactivate SyncManager	Read: 0: Normal operation, SyncManager activated. 1: SyncManager deactivated and reset SyncManager locks access to Memory area. Write: 0: Activate SyncManager 1: Request SyncManager deactivation Writing 1 is delayed until the end of a frame which is currently processed.	R/-	R/W	1 Byte	0x00
	SM0 0x0807						
SM1 0x080F							
SM2 0x0817	1	Repeat Ack	If this is set to the same value as set by Repeat Request, the PDI acknowledges the execution of a previous set Repeat request.				
SM3 0x081F	7:2	Reserved, write 0		R/-	R/-		

14) Distributed Clocks (DC)

Propagation delay measurement, Offset compensation and Drift compensation to Reference Clock are required to perform clock synchronization. Each method is described below.

■ Propagation Delay Measurement

Since each slave introduces a small processing/forwarding delay in each direction (within the device and also in the physical layer), as well as the cable between the ESCs has a delay, the propagation delay between Reference Clock and the respective slave clock has to be considered for the synchronization of the slave clocks.

1. For measuring the propagation delay, the master sends a broadcast write to register DC Receive Time Port 0 (at least first byte).
2. Each slave device stores the time of its local clock when the first bit of the Ethernet preamble of the frame was received, separately for each port (Receive Time Port 0-1 registers).
3. The master reads all time stamps and calculates the delay times with respect to the topology. The delay time between Reference Clock and the individual slave is written to slave's System Time Delay register (0x0928:0x092B).

The receive time registers are used to sample the receive time of a specific frame (a broadcast write to Receive Time Port 0 register).

The clocks must not be synchronized for the delay measurement, only local clock values are used.

Since the local clocks of the slaves are not synchronized, there is no relation between the Receive Times of different slaves. So the propagation delay calculation has to be based on receive time differences between the ports of a slave.

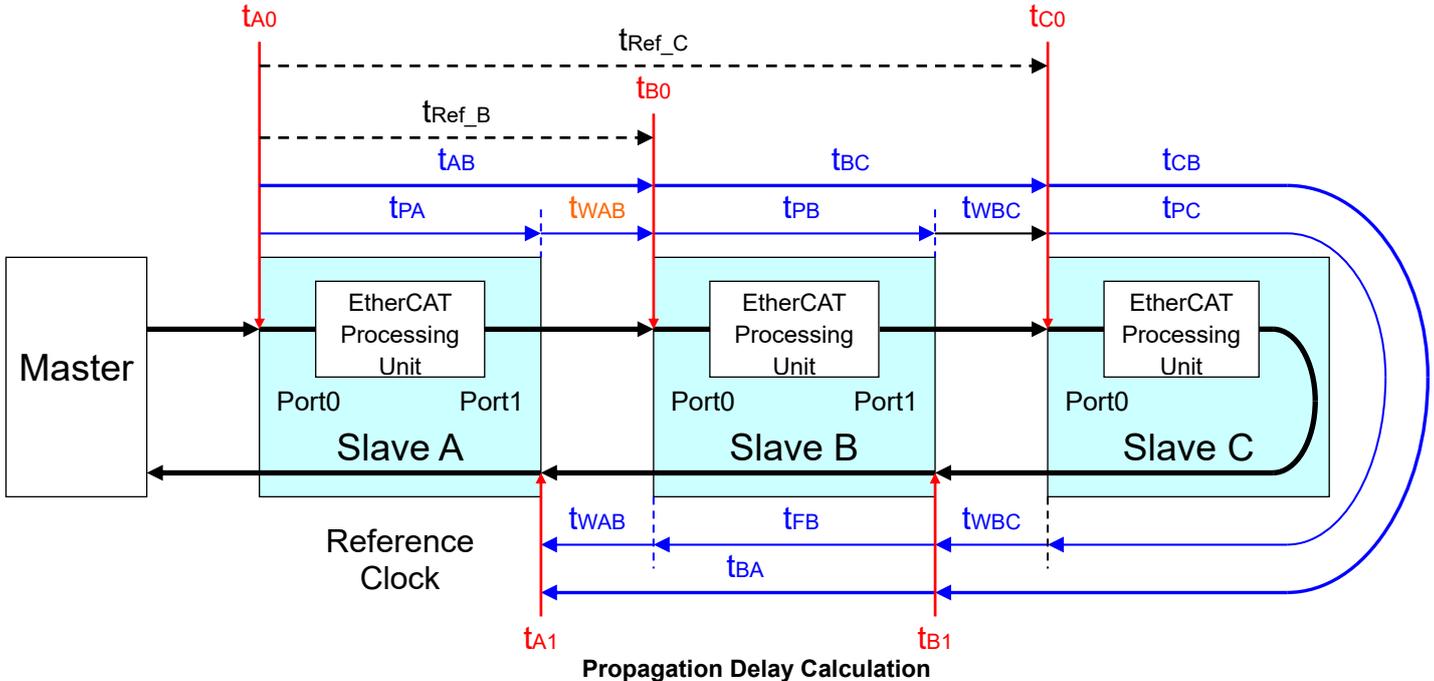
Registers for Propagation Delay Measurement

Register Address	Name	Description
0x0900:0x903	Receive Time Port 0	Local time when receiving frame on Port 0
0x0904:0x907	Receive Time Port 1	Local time when receiving frame on Port 1
0x0908:0x90B	-	Reserved
0x090C:0x90F	-	Reserved
0x0918:0x91F	Receive Time ECAT Processing Unit	Local time when receiving frame at the ECAT Processing Unit

■ Propagation Delay Measurement Example

The propagation delay between the local device and the Reference Clock device is calculated for the network example shown in Figure below. The example assumes that slave A is the Reference Clock.

The loops of slave C are closed internally. The wire delays are assumed to be symmetrical.



## 6. Data Link Layer

**Parameters for Propagation Delay Calculation**

Parameter	Description
tPA, tPB, tPC	Processing delay of slave (EtherCAT Processing Delay)
tFB	Forwarding delay of slave (EtherCAT Forwarding Delay)
tAB, tBC, tCB, tBA	Propagation delay from slave to slave
tWAB, tWBC, tWCB, tWBA	Wire propagation delay between slaves (assumed to be symmetrical in both directions)
tA0, tB0, tC0, tA1, tB1	Receive Time Port 0/1 values of slave (time when first preamble bit is detected)
tP	Processing delay (EtherCAT Processing) if all slaves are identical
tF	Forwarding delay (EtherCAT Forwarding) if all slaves are identical
tDiff	Difference between Processing delay and forwarding delay $tDiff = tP - tF$ if all slaves are identical. Note) $tDiff$ of the RS2 EtherCAT slave amplifier is 40ns at MII(Ethernet). When one or more Port is EBUS (LVDS), it is 20ns.
tRef_B, tRef_C	Propagation delay from Reference Clock (slave A) to slave

### ■ Propagation delay between Slave B and C

The propagation delays between slave B and C (tBC and tCB) are calculated as follows:

$$tBC = tPB + tWBC, \quad tCB = tPC + tWBC$$

assuming the processing delays are equal in slave bands B·C ( $tP = tPB = tPC$ )

$$tBC = tCB = tP + tWBC$$

The Receive Times (port 0 and 1) of slave B have the following relation:

$$tB1 = tB0 + tBC + tCD + tDC + tCB$$

So the propagation delay between slave B and C is

$$TBC = tCB = (tB1 - tB0) / 2$$

### ■ Propagation delay between Slave A and B

The propagation delays between slave A and B (tAB+tBA) are calculated as follows:

$$tAB = tPA + tWAB, \quad tBA = tFB + tWAB$$

Assuming that the processing delays of all slaves are identical ( $tP = tPA = tPB = tPC$ ), and the difference between forwarding and processing delay of (FoR/Warding Delay) these slaves is  $tDiff = tP - tF$  :

$$TAB = tP + tWAB, \quad tBA = tAB - tDiff$$

The Receive Times of slave A (port 0 and 1) have the following relation:

$$tA1 = tA0 + tAB + tBC + tCB + tBA$$

So the propagation delay between slave A and B is

$$2 \times tAB - tDiff = (tA1 - tA0) - (tB1 - tB0)$$

$$tAB = ((tA1 - tA0) - (tB1 - tB0) + tDiff) / 2$$

And for the other direction:

$$tBA = ((tA1 - tA0) - (tB1 - tB0) - tDiff) / 2$$

### ■ Summary of Propagation Delay Calculation between Slaves

$$tAB = ((tA1 - tA0) - (tB1 - tB0) + tDiff) / 2$$

$$tBA = ((tA1 - tA0) - (tB1 - tB0) - tDiff) / 2$$

$$tBC = (tB1 - tB0) / 2$$

$$tCB = (tB1 - tB0) / 2$$

### ■ Propagation Delays between Reference Clock and Slave Clocks

The System Time Delay register of each slave clock takes the propagation delay from the Reference Clock to the slave. This delay is calculated like this:

$$tRef\_B = tAB$$

$$tRef\_C = tAB + tBC$$

## 6. Data Link Layer

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### ■ Offset Compensation

The local time of each device is a free running clock which typically will not have the same time as the Reference Clock. To achieve the same absolute System Time in all devices, the offset between the Reference Clock and every slave device's clock is calculated by the master. The offset time is written to register System Time Offset to adjust the local time for every individual device. Small offset errors are eliminated by the drift compensation after some time, but this time might become extremely high for large offset errors.

Each slave calculates its local copy of the System time using its local time and the local offset value:

$$t_{\text{Local copy of System Time}} = t_{\text{Local time}} + t_{\text{Offset}}$$

This time is used in synchronous signal output (SyncSignal) inside the slave amplifier.

The reference clock system time works as a master clock using and compensating for the calculated difference and reference clock system time offset.

Registers for offset compensation are shown below.

**Registers for Offset Compensation**

Register Address	Name	Description
0x0910:0x0917	System Time	Local copy of System Time (read from PDI)
0x0920:0x0927	System Time Offset	Difference between local time and System Time

### ■ Drift Compensation

After the delay time between the Reference Clock and the slave clocks has been measured, and the offset between both clocks has been compensated, the natural drift of every local clock (emerging from quartz variations between Reference Clock's quarts and local quarts) is compensated by the time control loop which is integrated within each ESC.

For drift compensation, the master distributes the System Time from the Reference Clock to all slave clocks periodically. The ARMW or FRMW commands can be used for this purpose. The time control loop of each slave takes the lower 32 bit of the System Time received from the Reference Clock and compares it to its local copy of the System Time. For this difference, the propagation delay has to be taken into account:

$$\Delta t = (t_{\text{Local time}} + t_{\text{Offset}} - t_{\text{Propagation delay}}) - t_{\text{Received System Time}}$$

If  $\Delta t$  is positive, the local time is running faster than the System time, and has to be slowed down. If  $\Delta t$  is negative, the local time is running slower than the System time, and has to be sped up. The time control loop adjusts the speed of the local clock.

For a fast compensation of the static deviations of the clock speeds, the master should initially send many ARMW/FRMW commands (e.g. 15,000) for drift compensation in separate frames after initialization of the propagation delays and offsets. The control loops compensate the static deviations and the distributed clocks are synchronized. Afterwards, the drift compensation frames are send periodically for compensation of dynamic clock drifts.

## 6. Data Link Layer

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### Receive Time Port 0

Address	bit	Description	Master	Slave	Length	Rest Value
0x0900 - 0x0903	31:0	<p>[Write access] A write access to register 0x0900 with BWR, APWR (any address) or FPWR (configured address) latches the local time of the beginning of the receive frame (start first bit of preamble) at each port</p> <p>[Read access] Local time of the beginning of the last receive frame containing a write access to this register.</p> <p>Note) The time stamps cannot be read in the same frame in which this register was written.</p>	R/W (special function)	R/-	4 Bytes	Undefined

### Receive Time Port 1

Address	bit	Description	Master	Slave	Length	Rest Value
0x0904 - 0x0907	31:0	Local time of the beginning of a frame (start first bit of preamble) received at port 1 containing a BWR/APWR or FPWR to Register 0x0900.	R/-	R/-	4 Bytes	Undefined

### Receive Time Port 2/3

Address	bit	Description	Master	Slave	Length	Rest Value
0x0908 - 0x090F	64:0	Reserved	R/-	R/-	8 Bytes	Undefined

### Receive Time ECAT Processing Unit

Address	bit	Description	Master	Slave	Length	Rest Value
0x0918 - 0x091F	64:0	Local time of the beginning of a frame (start first bit of preamble) received at the ECAT Processing Unit containing a BWR or FPWR (configured address) to Register 0x0900	R/-	R/-	8 Bytes	Undefined

## 6. Data Link Layer

### 15) DC-Time Loop Control Unit

Time loop control unit is defined by master, and the write operation from slave to time loop control register is not performed.

#### ■ Time control loop settings and status

Time control loop consists of the following five (5) registers:

- \* The System Time Difference register (0x092C:0x092F) corresponds to the mean value of the difference between local copy of the System Time and the System Time ( $\Delta t$ ). This value converges to zero when both times are identical.
- \* The Speed Counter Start register (0x0930:0x0931) represents the bandwidth of the drift compensation.
- \* The value of the Speed Counter Difference register (0x0932:0x0933) represents the deviation between the clock periods of the Reference Clock and the local ESC.
- \* The System Time Difference Filter Depth register (0x0934) and the Speed Counter Filter Depth register (0x0935) set filter depths for mean value calculation of the received System Times and of the calculated clock period deviations. In addition, the control loop capability improves by setting the Speed Counter Filter Depth at "0".

**Registers for Drift Compensation**

Register Address	Name	Description
0x0900:0x090F	Receive Time Port n	Local time when receiving frame on Port n
0x0910:0x0917	System Time	Local copy of System Time (read from PDI) (Local time if System Time Offset=0)
0x0920:0x0927	System Time Offset	Time difference between System Time and local time
0x0928:0x092B	System Time Delay	Delay between Reference Clock and the ESC
0x092C:0x092F	System Time Difference	Mean difference between local copy of System Time and received System Time values
0x0930:0x0931	Speed Counter Start	Bandwidth for adjustment of local copy of System Time
0x0932:0x0933	Speed Counter Difference	Deviation between local clock period and Reference Clock's clock period
0x0934	System Time Difference Filter Depth	Filter depth for averaging the received System Time deviation
0x0935	Speed Counter Filter Depth	Filter depth for averaging the clock period deviation

#### System Time

Address	bit	Description	Master	Slave	Length	Rest Value
0x0910 - 0x0917	63:0	[read access] Local copy of the System Master : Latch at the first Ethernet SOF DMZ frame. Slave : Latch at the last byte read of 0x0910		R/(W) (special function)	8 Bytes	0x0
	31:0	[Write access] Written value will be compared with local copy of System Time. The compensated result will be input to the time control unit and denoted as System Time difference (0x092C). Master : written value will be compared at the end of the frame with the latched (SOF) local copy of the System time if at least the first byte (0x0910) was written. Note) Usable when 0x0140.10=1 Slave : Reserved Written value will be compared at the end of the access with Latch0 Time Positive Edge (0x09B0:0x09B3) if at least the last byte (0x0913) was written. Note) Usable when 0x0140.11=1(Reserved)				

#### System Time Offset

Address	bit	Description	Master	Slave	Length	Rest Value
0x0920 - 0x0927	63:0	Difference between local time and System Time. Offset is added to the local time. Note) Usable when 0140.10=1 or 0x0140.11=1	R/(W)	R/(W)	8 Bytes	0x0

## 6. Data Link Layer

### System Time Delay

Address	bit	Description	Master	Slave	Length	Rest Value
0x0928 - 0x092B	31:0	Delay between Reference Clock and the ESC * Write access to this register depends on the setting. Usable when 0140.10=1 or 0x0140.11=1	R/(W)	R/(W)	4 Bytes	0x0

### System Time Difference

Address	bit	Description	Master	Slave	Length	Rest Value
0x092C - 0x092F	30:0	Actual time difference between received local time value and local copy of system time.	R/-	R/-	4 Bytes	0x0
	31	0:Local copy of System Time greater than or equal received System Time 1:Local copy of System Time smaller than received System Time				

\* Usable when 0x0140.10=1 or 0x0140.11=1

### Speed Counter Start

Address	bit	Description	Master	Slave	Length	Rest Value
0x0930 - 0x0931	14:0	Bandwidth for adjustment of local copy of System Time (larger values -> smaller bandwidth and smoother adjustment) A write access resets System Time Difference (0x092C:0x092F) and Speed Counter Diff (0x0932:0x0933). Minimum value: 0x0080	R/(W)	R/(W)	2 Bytes	0x1000
	15	Reserved, write 0	R/-	R/-		

\* Write access to this register depends on the setting. Usable when 0x0140.10=1 or 0x0140.11=1.

### Speed Counter Diff

Address	bit	Description	Master	Slave	Length	Rest Value
0x0932 - 0x0933	15:0	Representation of the deviation between local clock period and Reference Clock's clock period	R/-	R/-	2 Bytes	0x0000

\* Usable when 0x0140.10=1 or 0x0140.11=1

$$\text{Deviation} = \frac{\text{Speed Counter Diff}}{5(\text{Speed Counter Start} + \text{Speed Counter Diff} + 2)(\text{Speed Counter Start} - \text{Speed Counter Diff} + 2)}$$

### System Time Difference Filter Depth

Address	bit	Description	Master	Slave	Length	Rest Value
0x0934	3:0	Filter depth for averaging the received System Time deviation	R/(W)	R/(W)	1 Byte	0x0C
	7:4	Reserved, write 0	R/-	R/-		

\* Usable when 0x0140.10=1 or 0x0140.11=1. Reset control loop by writing the speed counter start (0x0930:0x0931) after this value has been changed.

### Speed Counter Filter Depth

Address	bit	Description	Master	Slave	Length	Rest Value
0x0935	3:0	Filter depth for averaging the clock period deviation	R/(W)	R/(W)	1 Byte	0x0C
	7:4	Reserved, write 0	R/-	R/-		

\* Usable when 0x0140.10=1 or 0x0140.11=1. Reset control loop by writing the speed counter start (0x0930:0x0931) after this value has been changed.

## ■ DC-Cycle Unit Control

### 1. Synchronize Signal

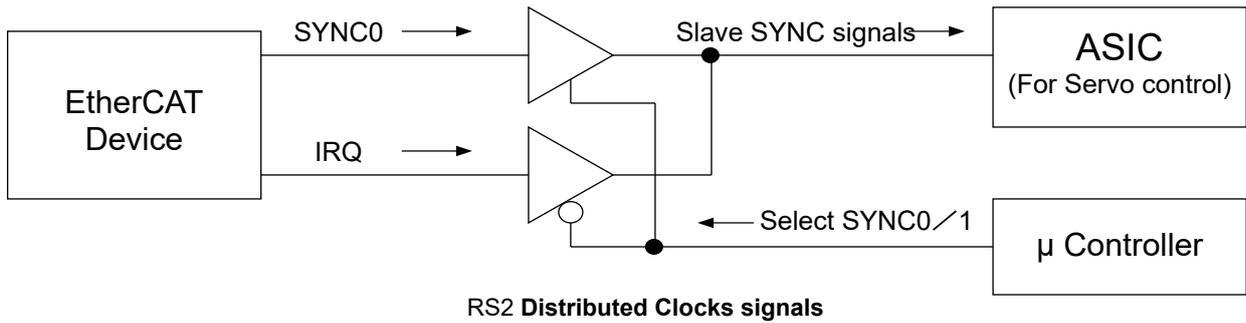
RS2 EtherCAT amplifier supports Distribution Clock (DC) function and Synchronize Signal is used for the Interrupt signal generation of process start timing inside the amplifier.

Synchronizing to either signal, SYNC0 or SYNC1, is decided by the setting of the CoE Object SM

Synchronization :0x1C32 - 0x1C33 in the amplifier.

Either ECAT (Master) or PDI (Slave side microcontroller) controls SyncSignals (SYNC0 / 1) output and can be set at the Cycle unit control register (0x0980).

## 6. Data Link Layer



### 2. Configuration

The mapping of Distributed Clocks SyncSignals driver characteristics and SyncSignals to the AL Event Request register is controlled by the setting of the Sync/Latch PDI Configuration register 0x0151. The length of a SyncSignal pulse is defined in the DC Pulse Length of SYNC Signals register (0x0982:0x0983). A value of 0 selects acknowledged modes. SYNC Signals cannot be output if ESI EEPROM was loaded incorrectly at time of power up.

### 3. SyncSignal Generation

ESC has two synchronizing signals: SYNC0 and SYNC1 and supports four types of synchronous output: [Cyclic generation], [Single shot], [Cyclic Acknowledge], [Single shot Acknowledge]. However, use [Cyclic generation] in the RS2 EtherCAT slave amplifier (the other synchronous outputs are unsupported). The Sync Signal mode is selected by Pulse length and SYNC0 cycle time.

**SyncSignal Generation Mode Selection**

Pulse Length of SYNC Signals (0x0982:0x0983)	SYNC0 Cycle Time(0x09A0:0x09A3)	
	>0	=0
>0	Cyclic Generation	Single Shot
=0	Cyclic Acknowledge	Single Shot Acknowledge

The cycle time of the SYNC0 signal is configured in the SYNC0 Cycle Time register (0x09A0:0x09A3), the start time is set in the Start Time Cyclic Operation register (0x0990:0x0997). After the Sync Unit is activated and the output of the SYNC0/1 signals is enabled (DC Activation register 0x0981), the Sync Unit waits until the start time is reached and generates the first SYNC0 pulse.

Internally, the SyncSignals are generated with an update rate of 100 MHz (10 ns update cycle). The jitter of the internal SyncSignal generation in comparison to the System Time is 12 ns.

**Registers for SyncSignal Generation**

Register Address	Name	Description
0x0140[11:10]	PDI Control	Enable/Disable DC Units (power saving)
0x0151	Sync/Latch PDI Configuration	Configuration of SYNC/LATCH [1:0] pins
0x0980.0	Unit Cycle Control	Assignment of cyclic function to EtherCAT or PDI
0x0981	Activation	Activation of cyclic function and SYNC pins
0x0982:0x0983	Pulse Length of SYNC Signal	Length of SYNC impulse length
0x098E	SYNC0 Status	Status of SYNC0 signal
0x098F	SYNC1 Status	Status of SYNC1 signal
0x0990:0x0997	SYNC0 Start Time	Start System time of cyclic operation
0x0998:0x099F	Next SYNC1 Pulse	System Time of next Sync1 Pulse
0x09A0:0x09A3	SYNC0 Cycle Time	Cycle Time of SYNC0
0x09A4:0x09A7	SYNC1 Cycle Time	Cycle Time of SYNC1

\* Some of these registers are set via EEPROM at the time of power ON.

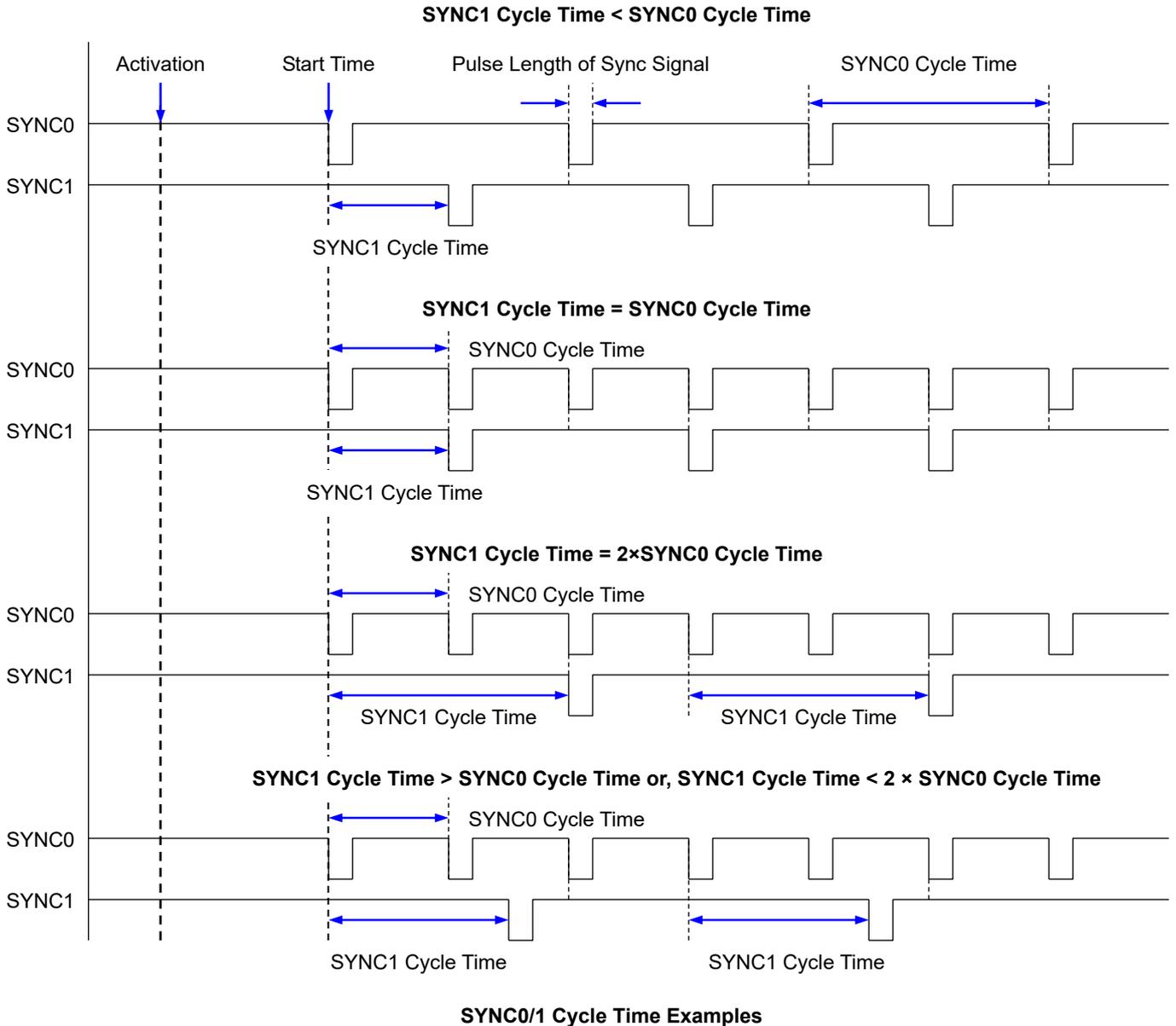
## 6. Data Link Layer

### Cyclic Generation (Cyclic Generation)

If the SYNC1 Cycle Time is larger than the SYNC0 Cycle Time, it will be generated as follows: when the Start Time Cyclic Operation is reached, a SYNC0 pulse is generated. The SYNC1 pulse is generated after the SYNC0 pulse with a delay of SYNC1 Cycle Time. The next SYNC1 pulse is generated when the next SYNC0 pulse was generated, plus the SYNC1 Cycle Time.

### SYNC1 Generation

The second SyncSignal (SYNC1) depends on SYNC0, it can be generated with a predefined delay after SYNC0 pulses. The delay is configured in the SYNC1 Cycle Time register (0x09A4:0x09A7). The following shows the output waveform by setting SYNC1 cycle time.



If the SYNC1 cycle time is greater than the SYNC0 cycle time, the SYNC1 pulse will be output with the timing shown in the lower of the two.

## 6. Data Link Layer

### Cyclic Unit Control

Address	bit	Description		Master	Slave	Length	Rest Value
0x0980	0	SYNC out unit control	0: Master controlled (ECAT) 1: Slave controlled (PDI)	R/W	R/-	1 Byte	0x00
	3:1	Reserved		R/-			
	4	Latch In Unit0	Reserved (The Latch function is uncorrespondence.) (0:Master controlled 1:Slave controlled)	R/W			
	5	Latch In Unit1	Reserved (The Latch function is uncorrespondence.) (0:Master controlled 1:Slave controlled)	R/W			
	7:6	Reserved		R/-			

\* Usable when 0x0140.10=1 or 0x0140.11=1

### DC-SYNC Out Unit

#### SYNC OUT Unit Activation register

Address	bit	Description		Master	Slave	Length	Rest Value
0x0981	0	Active Cycle Operation	0:Disable 1:Enable Note) When the SYNC0 cycle time is 0, the SYNC0 pulse is output only once.	R/(W)	R/(W)	1 Byte	0x00
	1	SYNC0 Active	0:Disable 1:SYNC0 pulse is generated				
	2	SYNC1 Active	0:Disable 1:SYNC0 pulse is generated				
	7:3	Reserved		R/-	R/-		

\* Write to this register depends upon setting of 0x0980.0. Usable when 0x0140.10=1.

#### Pulse Length of SyncSignals

Address	bit	Description		Master	Slave	Length	Rest Value
0x0982 - 0x0983	15:0	Pulse length of SyncSignals (in Units of 10ns) 0:Acknowledge mode: SyncSignal will be cleared by reading SYNC0/SYNC1 Status register Note) Load from EEPROM address0x0002		R/-	R/-	2 Bytes	0x0064 Note)

\* Usable when 0x0140.10=1

#### SYNC0 Status

Address	bit	Description		Master	Slave	Length	Rest Value
0x098E	0	SYNC0 state for Acknowledge mode. SYNC0 in Acknowledge mode is cleared by reading this register from PDI, use only in Acknowledge mode Usable when 0x0140.10=1		R/-	R/-	1 Byte	0x00
	7:1	Reserved					

#### SYNC1 Status

Address	bit	Description		Master	Slave	Length	Rest Value
0x098F	0	SYNC1 state for Acknowledge mode. SYNC1 in Acknowledge mode is cleared by reading this register from PDI, use only in Acknowledge mode Usable when 0x0140.10=1		R/-	R/-	1 Byte	0x00
	7:1	Reserved					

#### Start Time Cyclic Operation

Address	bit	Description		Master	Slave	Length	Rest Value
0x0990 - 0x0997	63:0	Write: Start time (System time) of cyclic operation in ns Write to this register depends upon setting of 0x0980.0. Read: System time of next SYNC0 pulse in ns (Unit: 1ns), Usable when 0x0140.10=1		R/(W)	R/(W)	8 Bytes	0x0

#### Next SYNC1 Pulse

Address	bit	Description		Master	Slave	Length	Rest Value
0x0998 - 0x099F	63:0	Read: System time of next SYNC1 pulse in ns (Unit: 1ns), Usable when 0x0140.10=1		R/-	R/-	8 Bytes	0x0

## 6. Data Link Layer

### SYNC0 Cycle Time

Address	bit	Description	Master	Slave	Length	Rest Value
0x09A0 - 0x09A3	31:0	Time between two consecutive SYNC0 pulses in ns. Write to this register depends upon setting of 0x0980.0. 0:Single shot mode, generate only one SYNC0 pulse. (Unit: 1ns), Usable when 0x0140.10=1	R/(W)	R/(W)	4 Bytes	0x0

### SYNC1 Cycle Time

Address	bit	Description	Master	Slave	Length	Rest Value
0x09A4 - 0x09A7	31:0	Time between SYNC1 pulses and SYNC0 pulse in ns Write to this register depends upon setting of 0x0980.0. (Unit: 1ns) Usable when 0x0140.10=1	R/(W)	R/(W)	4 Bytes	0x0

### DC-Latch input unit

Latch function is not supported in RS2 EtherCAT slave amplifier.  
Sets the Latch 0 / 1 control and the status registers shown below at "0".

Latch 0 Control : 0x09A8                      Latch 1 Control : 0x09A9  
 Latch 0 Status : 0x09AE                      Latch 1 Status : 0x09AF  
 Latch 0 Time Positive Edge : 0x09B0 - 0x09B7      Latch 0 Time Negative Edge : 0x09B8- 0x09BF  
 Latch 1 Time Positive Edge : 0x09C0 - 0x09C7      Latch 1 Time Negative Edge : 0x09C8 - 0x09CF

### Latch0 Control

Address	bit	Description	Master	Slave	Length	Rest Value
0x09A8	0	Latch 0 positive edge 0: Continuous Latch active 1: Single event (only first event active)	R/W	R/-	1 Byte	0x00
	1	Latch 0 negative edge 0: Continuous Latch active 1: Single event (only first event active)				
	7:2	Reserved, write 0	R/-			

Note) Write access depends upon setting of 0x0980.4. Usable when 0x0140.11=1

### Latch1 Control

Address	bit	Description	Master	Slave	Length	Rest Value
0x09A9	0	Latch 1 positive edge 0: Continuous Latch active 1: Single event (only first event active)	R/W	R/-	1 Byte	0x00
	1	Latch 1 negative edge 0: Continuous Latch active 1: Single event (only first event active)				
	7:2	Reserved	R/-			

\* Write access depends upon setting of 0x0980.5. Usable when 0x0140.11=1

### Latch0 Status

Address	bit	Description	Master	Slave	Length	Rest Value
0x09AE	0	Event Latch0 positive edge,"0" other than for single event Flag is cleared by reading Latch0 time positive edge	R/W	R/-	1 Byte	0x00
	1	Event Latch0 negative edge,"0" other than for single event Flag is cleared by reading Latch0 time negative edge				
	7:2	Reserved	R/-			

\* Usable when 0x0140.11=1

### Latch1 Status

Address	bit	Description	Master	Slave	Length	Rest Value
0x09AF	0	Event Latch1 positive edge,"0" other than for single event Flag is cleared by reading Latch1 time positive edge	R/W	R/-	1 Byte	0x00
	1	Event Latch1 negative edge,"0" other than for single event Flag is cleared by reading Latch1 time negative edge				
	7:2	Reserved	R/-			

\* Usable when 0x0140.11=1

## 6. Data Link Layer

### Latch0 Time Positive Edge

Address	bit	Description	Master	Slave	Length	Rest Value
0x09B0 - 0x09B7	63:0	Register captures System time at the positive edge of the Latch0 signal. (Usable when 0x0140.11=1)	R/-	R/-	8 Bytes	0x0

### Latch0 Time Negative Edge

Address	bit	Description	Master	Slave	Length	Rest Value
0x09B8 - 0x09BF	63:0	Register captures System time at the negative edge of the Latch0 signal. (Usable when 0x0140.11=1)	R/-	R/-	8 Bytes	0x0

### Latch1 Time Positive Edge

Address	bit	Description	Master	Slave	Length	Rest Value
0x09C0 - 0x09C7	63:0	Register captures System time at the positive edge of the Latch1 signal. (Usable when 0x0140.11=1)	R/-	R/-	8 Bytes	0x0

### Latch1 Time Negative Edge

Address	bit	Description	Master	Slave	Length	Rest Value
0x09C8 - 0x09CF	63:0	Register captures System time at the negative edge of the Latch1 signal. (Usable when 0x0140.11=1)	R/-	R/-	8 Bytes	0x0

## ■ DC-SyncManager Event Times

### EtherCAT Buffer Change Event Time

Address	bit	Description	Master	Slave	Length	Rest Value
0x09F0 - 0x09F3	31:0	Register captures local time of the beginning of the frame which causes at least one SyncManager to assert an ECAT event (Usable when 0x0140.10=1 or 0x0140.11=1)	R/-	R/-	4 Bytes	0x0

### PDI Buffer Start Event Time

Address	bit	Description	Master	Slave	Length	Rest Value
0x09F8 - 0x09FB	31:0	Register captures local time when at least one SyncManager asserts an PDI buffer start event (Usable when 0x0140.10=1 or 0x0140.11=1)	R/-	R/-	4 Bytes	0x0

### PDI Buffer Change Event Time

Address	bit	Description	Master	Slave	Length	Rest Value
0x09FC - 0x09FF	31:0	Register captures local time when at least one SyncManager asserts an PDI buffer change event (Usable when 0x0140.10=1 or 0x0140.11=1)	R/-	R/-	4 Bytes	0x0

## 6. Data Link Layer

### 16) ESC specific registers

#### Power-On Values

Address	bit	Description	Master	Slave	Length	Rest Value				
0x0E00 - 0x0E01	1:0	Port mode (P_MODE)	R/-	R/-	2 Bytes	0x8C				
							00: Logical ports 0 and 1 available 01: Logical ports 0, 1 and 2 available 10: Logical ports 0, 1 and 3 available 11: Logical ports 0, 1, 2 and 3 available			
	2	Physical layer of available ports (P_CONF)					logical port 0	0: EBUS	1: MII	
	3						logical port 1	0: EBUS	1: MII	
	4						logical port 2	0: EBUS	1: MII	
	5						logical port 3	0: EBUS	1: MII	
	7:6	CPU clock output (CLK_MODE)					00: OFF	01: 25MHz	10: 20MHz	11: 10MHz
	9:8	MII TX signal shift (C25_SHI)					00: MII TX signals shifted by 0° 01: MII TX signals shifted by 90° 10: MII TX signals shifted by 180° 11: MII TX signals shifted by 270°	R/-	R/-	0x84
	10	CLK25 Output Enable (C25_ENA)					0: Disabled – PDI [31] available as PDI port 1: Enabled – PDI [31] = 25MHz (OSC)			
	11	Transparent Mode MII (Trans_Mode_Ena)					0: Disabled 1: Enabled – ERR is input (0: TX signals are tristated, 1: ESC is driving TX signals)			
12	Digital Control/State Move (Ctrl_Status_Move)	0: Control/Status signals are mapped to PDI [39:32] - if available 1: Control/Status signals are remapped to the highest available PDI Byte.								
13	PHY Address Offset (PHYAD_OFF)	0: No PHY address offset 1: PHY address offset is 16								
14	PHY Link Polarity (LINKPOL)	0: LINK_MII is active low 1: LINK_MII is active high								
15	Reserved	Always "1"								

#### ■ Digital I/O Output Data

##### Digital I/O Output Data

Address	bit	Description	Master	Slave	Length	Rest Value
0x0F00 - 0x0F03	31:0	Output Data Note) Register size depends on PDI setting and/or device configuration.	R/W	R/-	4 Bytes	0x0

##### General Purpose Outputs

Address	bit	Description	Master	Slave	Length	Rest Value
0x0F10 - 0x0F11	15:0	General Purpose Output Data Note) Register size depends on PDI setting and/or device configuration	R/W	R/W	2 Bytes	0x0

##### General Purpose Inputs

Address	bit	Description	Master	Slave	Length	Rest Value
0x0F18 - 0x0F19	15:0	General Purpose Input Data Note) Register size depends on PDI setting and/or device configuration	R/-	R/-	2 Bytes	0x0

## 6. Data Link Layer

### 17) User RAM

#### Extended ESC Features (Reset values of User RAM)

Address	bit	Description	Master	Slave	Length	Rest Value	
0x0F80 - 0x0FA0	7:0	Number of extended feature bits	R/W	R/W	33 Bytes	0xFF	
	8	0x0102:0x0103 DL Control Register				0:Not available 1:Available	-
	9	0x0134:0x0135 AL Status Code Register				0:Not available 1:Available	-
	10	0x0200:0x0201 ECAT Event Mask				0:Not available 1:Available	-
	11	0x0012:0x0013 Configured Station Alias				0:Not available 1:Available	-
	12	0x0F18:0x0F1F General Purpose Inputs				0:Not available 1:Available	-
	13	0x0F10:0x0F17 General Purpose Outputs				0:Not available 1:Available	-
	14	0x0204:0x0207 AL Event Mask				0:Not available 1:Available	-
	15	0x0108:0x0109 Physical Read/Write Offset				0:Not available 1:Available	-
	16	0x0400:0x0401 Watchdog divider writeable and Watchdog PDI 0x0410:0x0411				0:Not available 1:Available	-
	17	0x0442:0x0443 Watchdog counters				0:Not available 1:Available	-
	18	0x0020:0x0031 Write Protection				0:Not available 1:Available	-
	20:19	Reserved				0:Not available 1:Available	-
	21	0x09F0:0x09F0 DC SyncManager Event Times				0:Not available 1:Available	-
	22	0x030C:0x030D ECAT Processing Unit/PDI Error Counter				0:Not available 1:Available	-
	23	0x0502.7 EEPROM Size configurable				0: EEPROM Size fixed to sizes up to 16 Kbit 1: EEPROM Size configurable	-
	26:24	Reserved					-
	27	0x0300:0x0313 Lost Link Counter				0:Not available 1:Available	-
	28	0x0510:0x0515 MII Management Interface				0:Not available 1:Available	-
	29	Enhanced Link Detection MII				0:Not available 1:Available	-
	30	Enhanced Link Detection EBUS				0:Not available 1:Available	-
	31	Run LED (DEV_STATE LED)				0:Not available 1:Available	-
	32	Link Activity LED				0:Not available 1:Available	-
	37:33	Reserved					-
	38	DC Time loop control assigned to PDI				0:Not available 1:Available	-
	39	Link detection and configuration by MI				0:Not available 1:Available	-
	40	MI control by PDI possible				0:Not available 1:Available	-
	41	Automatic TX shift				0:Not available 1:Available	-
	42	EEPROM emulation by $\mu$ Controller				0:Not available 1:Available	-
	47:43	Reserved					-
	263:48	Reserved					0x0

#### User-RAM

Address	Byte	Description	Master	Slave	Length	Rest Value
0x0FA1 - 0x0FBF	0x1F	Application specification information	R/W	R/W	31 Bytes	Undefined

#### Slave Response (User-RAM)

Address	bit	Description	Master	Slave	Length	Rest Value
0x0FC0 - 0x0FFF		Use for response check of slaves. Acknowledge nonresponsive slaves with broadcast reading (BRD) of this address after corresponding axis bit is set.	R/W	R/(W)	64 Bytes	Undefined
	0	1:1 <sup>st</sup> slave				
	1	1:2 <sup>nd</sup> slave				
	2	1:3 <sup>rd</sup> slave				
	...	...				
	510	1:511 <sup>th</sup> slave				
	511	1:512 <sup>th</sup> slave				

### 18) Process Data RAM

Address for Process Data RAM is from 0x1000 to 0x2FFF.

#### Process Data RAM

Address	Byte	Description	Master	Slave	Length	Rest Value
0x1000 - 0x2FFF	0x2000	Process Data RAM Note) (R/W): Process Data RAM is only accessible if EEPROM was correctly loaded (register 0x0110.0 = 1).	(R/W)	(R/W)	8,192 Bytes	Undefined

## 6. Data Link Layer

### 6.3 EEPROM Mapping

#### 1) Address Space Overview

64kbit I<sup>2</sup>C (Inter-Integrated Circuit) Interface EEPROM (Electrically Erasable Programmable Read Only Memory) is loaded in the slave controller of the RS2 EtherCAT slave amplifier for device configuration and for various parameters.

It can be used with word addressing for device configuration up to 1kbit, for servo amplifier information from 1kbit - 32kbit and for various parameters from 32kbit - 64kbit. EEPROM layout is shown below.

Word	0	1	2	3	4	5	6	7
0x000	PDI Control	PDI Config.	SYNC Pulse Length	Ex. PDI Config.	Station Alias	Reserved	Reserved	Checksum
0x008	Vender ID		Product Code		Revision Number		Serial Number.	
0x010	Ex. Delay	Port 0 Delay	Port 1 Delay	Reserved	Boot RX Mailbox offset	Boot RX Mailbox Size	Boot TX Mailbox offset	Boot TX Mailbox Size
0x018	Standard RX Mailbox offset	Standard RX Mailbox Size	Standard TX Mailbox offset	Standard TX Mailbox Size	Mailbox Protocol	Reserved		
0x020								
0x028	Reserved							
0x030								
0x038	Reserved						EEPROM Size	Version
0x040	1 <sup>st</sup> Category Type	1 <sup>st</sup> Category Word Size	1 <sup>st</sup> Category DATA ...					
.	...							
.	2 <sup>nd</sup> Category Type	2 <sup>nd</sup> Category Word Size	2 <sup>nd</sup> Category DATA ...					
0x7F8	...							
0x800	Parameter (Future use)							
.	Reserved							
.	Reserved							
0xFF8	Reserved							

EEPROM layout

#### 2) Address Space Definition

The data descriptions stored in the configuration address (Word:0x000 - 0x03F) and device configuration address (Word:0x040 - 0x7FF) are explained below.

## 6. Data Link Layer

### ■ Slave Information Interface Area

#### PDI Control

Address 0x0000	The initial value of PDI Control Register (0x0140:0x0141) bit: 9 will be copied in DL Status Register 0x110.2 (EX Link Detection) and enabled/disabled by this bit.			Length 1 word
bit	Description		Value	Register
7:0	Process data interface	8:16 Bit asynchronous microcomputer interface	0x08	0x0140
8	Device emulation (control of AL status)	0:AL status register has to be set by slave 1:AL status register will be set to value written to AL control register	0x0C	0x0141
9	Enhanced Link detection all ports	0:disabled 1:enabled "0" when MII port is used.		
10	DC SYNC Out Unit	0:disabled (power saving) 1:enabled		
11	DC Latch In Unit	0:disabled (power saving) 1:enabled		
15:12	Reserved			

#### PDI Configuration

Address 0x0001	PDI Configuration Register (0x0150:0x0151) Initial value			Length 1 word
bit	Description		Value	Register
1:0	BUSY output driver BUSY output polarity 00:Push-Pull active low 01:Open Drain (active low) 10:Push-Pull active high 11:Open Source (active high)		0x00	0x0150
3:2	IRQ output driver IRQ output polarity 00:Push-Pull active low 01:Open Drain (active low) 10:Push-Pull active high 11:Open Source (active high)			
4	BHE polarity 0:Active low 1:Active high			
6:5	Reserved			
7	RD Polarity 0:Active low 1:Active high			
9:8	SYNC0 output driver/polarity 00:Push-Pull active low 01:Open Drain (active low) 10:Push-Pull active high 11:Open Source (active high)		0xCC	0x0151
10	SYNC0/LATCH0 configuration 0:LATCH0 Input 1:SYNC0 Output			
11	SYNC0 mapped to AL Event Request register 0x0220.2 0:Disabled 1:Enabled			
13:12	SYNC1 output driver/polarity 00:Push-Pull active low 01:Open Drain (active low) 10:Push-Pull active high 11:Open Source (active high)			
14	SYNC1/LATCH1 configuration 0:LATCH1 Input 1:SYNC1 Output			
15	SYNC1 mapped to AL Event Request register 0x0220.3: 0:Disabled 1:Enabled			

#### Pulse Length of SyncSignals

Address 0x0002	SYNC impulse with multiples of 10ns			Length 1 word
bit	Description		Rest Value	Register
15:0	Pulse length of SyncSignals (in Units of 10ns) 0: Acknowledge mode: SyncSignal will be cleared by reading SYNC0/SYNC1 Status register Note) Usable when 0x0140.10=1		0x0064 (1µs)	0x0982 - 0x0983

#### Extended PDI Configuration

Address 0x0003	Extended PDI configuration area.			Length 1 word
bit	Description		Rest Value	Register
0	Read BUSY delay 0:Normal read BUSY output 1:Delayed read BUSY output		0x0000	0x0152 - 0x0153
15:1	Reserved			

## 6. Data Link Layer

### Configured Station Alias

Address	Description	Rest Value	Length
0x0004	Alias Address used for node addressing		1 word
bit	Description	Rest Value	Register
15:0	The use of this alias is activated by Register DL Control Bit 24 (0x0100.24)	0x0000	0x0012 - 0x0013

### Checksum

Address	Description	Rest Value	Length
0x0007	For debug. Can be disabled by checking the checksum with a value of 0x88A4		1 word
bit	Description	Rest Value	Register
15:0	low byte contains remainder of division of word 0 to word 6 as unsigned number divided by the polynomial $x^8+x^2+x+1$ (initial value 0xFF)	0x0000	-

### Vendor ID

Address	Description	Value	Length
0x0008	Vendor ID for our EtherCAT products registered in ETG. CoE Object Index:0x1018 Sub index:0x01		2 words
bit	Description	Value	Register
31:0	Manufacturer's proper ID: Vendor ID for Sanyo Denki is 0x000001B9, the same as our CAN open amplifier.	0x000001B9	-

### Product Code

Address	Description	Value	Length
0x000A	Product code for our EtherCAT products: CoE Object Index:0x1018 Sub index:0x02		2 words
bit	Description	Value	Register
31:0	Product code is "2" for EtherCAT amplifier.	0x00000002	-

### Revision Number

Address	Description	Value	Length
0x000C	Revision number for the servo amplifier: CoE Object Index:0x1018 Sub index:0x03		2 words
bit	Description	Value	Register
31:0	Unsupported	Unsupported	-

### Serial Number

Address	Description	Value	Length
0x000E	Serial number for servo amplifier: CoE Object Index:0x1018 Sub index:0x04		2 words
bit	Description	Value	Register
31:0	Unsupported	Unsupported	-

### Execution Delay

Address	Description	Rest Value	Length
0x0010	Correction factor for line Delay in 100ps to be added if this is the last station		1 word
bit	Description	Rest Value	Register
15:0	Unit: 100ps	0x0000	-

### Port0 Delay

Address	Description	Rest Value	Length
0x0011	Correction factor for line Delay in 100ps to be added if Master is behind Port 0		1 word
bit	Description	Rest Value	Register
15:0	Unit: 100ps / LSB, Integer	0x0000	-

### Port1 Delay

Address	Description	Rest Value	Length
0x0012	Correction factor for line Delay in 100ps to be added if Master is behind Port 1		1 word
bit	Description	Rest Value	Register
15:0	Unit: 100ps / LSB, Integer	0x0000	-

## 6. Data Link Layer

### Bootstrap Receive Mailbox Offset

Address 0x0014	Mailbox offset for forwarding from master to the slave to be used in Bootstrap mode.		Length 1 word
bit	Description	Rest Value	Register
15:0	Use from register address 0x1800.	0x1800	-

### Bootstrap Receive Mailbox Size

Address 0x0015	Mailbox size for forwarding from master to the slave to be used in Bootstrap mode.		Length 1 word
bit	Description	Rest Value	Register
15:0	Size of 0x0200(512byte).	0x0200	-

### Bootstrap Send Mailbox Offset

Address 0x0016	Mailbox offset for forwarding from slave to the master to be used in Bootstrap mode.		Length 1 word
bit	Description	Rest Value	Register
15:0	Use from register address 0x1C00.	0x1C00	-

### Bootstrap Send Mailbox Size

Address 0x0017	Mailbox size for forwarding from slave to the master to be used in Bootstrap mode.		Length 1 word
bit	Description	Rest Value	Register
15:0	Size of 0x0200(512byte).	0x0200	-

### Standard Receive Mailbox Offset

Address 0x0018	Mailbox offset for forwarding from master to the slave to be used mainly in SMO.		Length 1 word
bit	Description	Rest Value	Register
15:0	Use from register address 0x1800	0x1800	-

### Standard Receive Mailbox Size

Address 0x0019	Mailbox size for forwarding from master to the slave to be used mainly in SMO.		Length 1 word
bit	Description	Rest Value	Register
15:0	0x0200(512Byte) in size.	0x0200	-

### Standard Send Mailbox Offset

Address 0x001A	Mailbox offset for forwarding from slave to the master to be used mainly in SM1.		Length 1 word
bit	Description	Rest Value	Register
15:0	Use from register address 0x1C00	0x1C00	-

### Standard Send Mailbox Size

Address 0x001B	Mailbox size for forwarding from slave to the master to be used mainly in SM1.		Length 1 word
bit	Description	Rest Value	Register
15:0	0x0200(512Byte) in size.	0x0200	-

### Mailbox Protocol

Address 0x001C	Mailbox Protocols Supported		Length 1 word
bit	Description	Rest Value	Register
0	AoE: ADS over EtherCAT (available at <a href="http://www.beckhoff.com">www.beckhoff.com</a> )	0x0004	-
1	EoE: Ethernet over EtherCAT (tunnelling of Data Link services)		
2	CoE: CANopen over EtherCAT (access to SDO)		
3	FoE: File Service over EtherCAT		
4	SoE: Servo Profile over EtherCAT		
5	VoE: Vender specific protocol		
15:6	Reserved		

## 6. Data Link Layer

### Port0 Tx Delay

Address	Description	Rest Value	Length
0x0020	Correction factor for line delay of Port 0 transmission time.		1 word
bit	Description	Rest Value	Register
15:0	Unit: 100ps / LSB, Unsigned16	0x0000	-

### Port1 Tx Delay

Address	Description	Rest Value	Length
0x0021	Correction factor for line delay of Port 1 transmission time		1 word
bit	Description	Rest Value	Register
15:0	Unit: 100ps / LSB, Unsigned16	0x0000	-

### Port0 Rx Delay

Address	Description	Rest Value	Length
0x0024	Correction factor for line delay of Port 0 receiving time		1 word
bit	Description	Rest Value	Register
15:0	Unit: 100ps / LSB, Unsigned16	0x0000	-

### Port1 Rx Delay

Address	Description	Rest Value	Length
0x0025	Correction factor for line delay of Port 1 receiving time		1 word
bit	Description	Rest Value	Register
15:0	Unit: 100ps / LSB, Unsigned16	0x0000	-

### Port 0 transfer to the next port

Address	Description	Rest Value	Length
0x0028	Correction factor between PhL reception of Port and 0 PhL transmission to the next port		1 word
bit	Description	Rest Value	Register
15:0	Unit: 100ps / LSB, Unsigned16	0x0000	-

### Transfer to the next port except Port 0

Address	Description	Rest Value	Length
0x0029	Correction factor between PhL reception of Port and 0 PhL transmission to the next port except Port 0		1 word
bit	Description	Rest Value	Register
15:0	Unit: 100ps / LSB, Integer	0x0000	-

### Closed port additional transfer time

Address	Description	Rest Value	Length
0x002A	Additional correction factor between port and BAT WAN port		1 word
bit	Description	Rest Value	Register
15:0	Unit:100ps / LSB, Integer	0x0000	-

### EEPROM Size

Address	Description	Rest Value	Length
0x003E	size of E2PROM in KBit-1		1 word
bit	Description	Rest Value	Register
15:0	The EEPROM capacity loaded on this amplifier is 32kbit [32kbit-1:0x1F]	0x001F	-

### Version

Address	Description	Rest Value	Length
0x003F	Version		1 word
bit	Description	Rest Value	Register
15:0	This Version is 1	0x0001	-

## 6. Data Link Layer

### 3) Slave Information Interface Categories

#### 1<sup>st</sup>Category Header

Address 0x0040	Slave information category			Length 1 word
bit	Description			Rest Value Register
15:0	Category Type	00(0x00) : NOP	No info	0x000A
		10(0x0A) : STRING	Character string frame for other category	
		20(0x14) : Data Types	Reserved	
		30(0x1E) : General	Summary	
		40(0x28) : FMMU	For FMMU use	
		41(0x29) : SyncManager	SyncManager setting	
		42(0x2A) : -	Reserved	
		43(0x2B) : -	Reserved	
		50(0x32) : TxPDO	TxPDO Description	
		51(0x33) : RxPDO	RxPDO Description	
		60(0x3C) : DC	Distributed Clock Description	
	(0xFFFF) : End	Vendor specification protocol	-	

\* STRING category stores all character strings used in other categories. The other categories can be connected to the index inside the STRING category.

#### 1<sup>st</sup>Category Word Size

Address 0x0041	1 <sup>st</sup> Word data size following the address of the 1 <sup>st</sup> category.			Length 1 word
bit	Description			Rest Value Register
15:0	Word size			Depends on setting -

#### 1<sup>st</sup>Category Data

Address 0x0042:	1 <sup>st</sup> Category Data			Length 1 word
bit	Description			Rest Value Register
15:0	1 <sup>st</sup> Category Data			Depends on setting -

The table below describes the description according to the category type of each category header.

#### Structure Category String

Parameter	Address	Data Type	Value / Description
nStrings	0x0000	Byte	Number of Strings
Str1_len	0x0001	Byte	Length String1
Str_1	0x0002	Byte [Str1_Len]	String1 Data
Str2_len	0x0002+Str1_Len	Byte	Length String2
Str_2	0x0003+Str1_Len	Byte [Str2_Len]	String2 Data
...	...	...	-
Strn_len	0x000z	Byte	Length String n
Strn_2	0x000z+1	Byte [Strn_Len]	String n Data
PAD_Byte	0x000y	Byte	Padding (0x00) if Category length is odd

## 6. Data Link Layer

### Category Summary Configuration

Parameter	Address	Data Type	Value / Description	
GroupIdx	0x0000	Unsigned8	(Vendor Specification) Group information: Shown with character strings	
ImgIdx	0x0001	Unsigned8	(Vendor Specification) Image name: Shown with character strings	
OderIdx	0x0002	Unsigned8	(Vendor Specification) Device request number: Shown with character strings	
NameIdx	0x0003	Unsigned8	(Vendor Specification) Device name information: Shown with character strings	
Physical layer Port0	0x0004	Unsigned2	0:Ebus	
Physical layer Port1		Unsigned2	1:100BASE-TX	
Physical layer Port2		Unsigned2	2:100BASE-FX	
Physical layer Port3		Unsigned2		
CoE Details	0x0005	Unsigned8	bit0: Enable SDO bit1: Enable PDO Information bit2: Enable PDO Assign	bit3: Enable PDO Configuration bit4: Enable Start upload bit5: Enable SDO Access complete
FoE Details	0x0006	Unsigned8	bit0: Enable FoE	
EoE Details	0x0007	Unsigned8	bit0: Enable EoE	
SoE Details	0x0008	Unsigned8	Reserved	
DS402Channels	0x0009	Unsigned8	Reserved	
SysmanClass	0x000A	Unsigned8	Reserved	
Flags	0x000B	Unsigned8	bit0: Enable Safe-OP	bit1: Enable without LR/W
CurrentOnEbus	0x000C	Unsigned16	Ebus Actual current consumption (mA), Negative value is absorption current	
PAD_Byte	0x000B	Byte [18]	Reserved	

### FMMU Category Configuration

Parameter	Address	Data Type	Value / Description	
	0x0000	Byte	1:FMMU0 is for Output 3:FMMU0 is for SyncManagerStatus (Read Mailbox)	2:FMMU0 is for Input
	0x0001	Byte	1:FMMU1 Output 3:FMMU1 is for SyncManagerStatus (Read Mailbox)	2:FMMU1 is for Input
	...			
	0x0007	Byte	1:FMMU7 Output 3:FMMU7 is for SyncManagerStatus (Read Mailbox)	2:FMMU7 is for Input

### SyncManager Category Configuration (each element)

Parameter	Address	Data Type	Value / Description	
Physical Start Address	0x0000	Word	Origin point of data (Refer to physical start address of SM)	
Length	0x0002	Word		
Control Register	0x0004	Byte	Operation mode definition (Refer to control register of SM)	
Status Register	0x0005	Byte	Don't care	
Activate	0x0006	Byte	Enable SyncManager	
PDI CTRL	0x0007	Byte	Don't care	

### RXPDO & TXPDO Category Configuration (each element)

Parameter	Address	Data Type	Value / Description	
PDO Index	0x0000	Word	RxPDO : 0x1600 - 0x1603, TxPDO : 0x1A00 - 0x1A00,	0x1700 - 0x1703 0x1b00 - 0x1B03
nEntry	0x0002	Byte	Entry number	
SyncM	0x0003	Byte	SyncManager Association 0x02 : Associate to SM2, 0xFF : No association	0x03 : Associate to SM3
Synchronization	0x0004	Byte	Standard value for DC Sync	
NameIdx	0x0005	Byte	Object name: Character String Index	
Flags	0x0006	Word	Reserved	
Entry Index	0x0008	Word	Entry Index	
SubIndex	0x000A	Byte	SubIndex	
Entry Name Idx	0x000B	Byte	Entry name: Character String Index	
Data Type	0x000C	Byte	Entry data type	
bitLen	0x000D	Byte	Entry bit length	
Flags	0x000E	Word	Reserved	
Next Entry	0x0010	8Byte	Next entry...continue to each element	

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## 7. Object Dictionary

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## 7.1 Object Dictionary

### 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. Structure of the Object Dictionary of CoE (CANopen over EtherCAT) comply with CiA draft standard proposal 402 is shown as below.

Index (Hex)	Meaning
0x0000-0x0FFF	Data Types Description
0x1000-0x1FFF	CoE Communication objects
0x2000-0x5FFF	Manufacturer Specific
0x6000-0x9FFF	Profile specific
0xA000-0xFFFF	Reserved

### 2) Object Code Definition

Object code definition entries are organized as follows.

Object Code	Object Name	Comments
0x0000	NULL	A dictionary entry with no data fields
0x0002	DOMAIN	Large variable amount of data e.g. executable program code.
0x0005	DEFTYPE	Denotes a type definition such as Boolean, Unsigned16, float and so on.
0x0006	DEFSTRUCT	Defines a new record type e.g. the PDO mapping structure at 21st.
0x0007	VARIABLE	A single value such as Unsigned8, Boolean, float, Integer16, and visible string etc.
0x0008	ARRAY	A multiple data field object where each data field is a simple variable of the SAME basic data type e.g. array of UNSIGNED16 etc. Sub-index 0 is of UNSIGNED8 and therefore not part of the ARRAY data.
0x0009	RECORD	A multiple data field object where each data fields may be any combination of simple variables. Sub-index 0 is of UNSIGNED8 and therefore not part of the RECORD data.

### 3) 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.

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

## 4) Data Type Area

Data type Indicates the data type index of the object contained in Object Dictionary.  
Standard data type is assigned to the index:0x0001-0x001F, and the data type of the special definition is to the index:0x0020 - 0x07FF. Object Dictionary area indicates the data type.

Object Dictionary of Data Type

Index	Object	Name	Index	Object	Name
0x0001	DEFTYPE	BOOLEAN	0x0026	-	Reserved
0x0002	DEFTYPE	INTEGER8	0x0027	DEFTYPE	PDOCOMPAR
0x0003	DEFTYPE	INTEGER16	0x0028	DEFTYPE	ENUM
0x0004	DEFTYPE	INTEGER32	0x0029	DEFSTRUCT	SYNC_PAR
0x0005	DEFTYPE	UNSIGNED8	0x002A	DEFTYPE	RECORD
0x0006	DEFTYPE	UNSIGNED16	0x002B	DEFTYPE	BACKUP
0x0007	DEFTYPE	UNSIGNED32	0x002C	DEFTYPE	MDP
0x0008	DEFTYPE	FLOAT32(REAL32)	0x002D-02F	-	Reserved
0x0009	DEFTYPE	VISIBLE_STRING	0x0030	DEFTYPE	BIT1
0x000A	DEFTYPE	OCTET_STRING	0x0031	DEFTYPE	BIT2
0x000B	DEFTYPE	UNICODE_STRING	0x0032	DEFTYPE	BIT3
0x000C	DEFTYPE	TIME_OF_DAY	0x0033	DEFTYPE	BIT4
0x000D	DEFTYPE	TIME_DIFFERENCE	0x0034	DEFTYPE	BIT5
0x000E	-	Reserved	0x0035	DEFTYPE	BIT6
0x000F	DEFTYPE	DOMAIN	0x0036	DEFTYPE	BIT7
0x0010	DEFTYPE	INTEGER24	0x0037	DEFTYPE	BIT8
0x0011	DEFTYPE	REAL64	0x0038-03F	-	Reserved
0x0012	DEFTYPE	INTEGER40	0x0040-05F	DEFSTRUCT	Manufacturer Specific Complex Data Type
0x0013	DEFTYPE	INTEGER48	0x0060-07F	DEFTYPE	Device Profile 0 Specific Standard Data Types
0x0014	DEFTYPE	INTEGER56	0x0080-09F	DEFSTRUCT	Device Profile 0 Specific Complex Data Types
0x0015	DEFTYPE	INTEGER64	0x00A0-0BF	DEFTYPE	Device Profile 1 Specific Standard Data Types
0x0016	DEFTYPE	UNSIGNED24	0x00C0-0DF	DEFSTRUCT	Device Profile 1 Specific Complex Data Types
0x0017	-	Reserved	0x00E0-0FF	DEFTYPE	Device Profile 2 Specific Standard Data Types
0x0018	DEFTYPE	UNSIGNED40	0x0100-11F	DEFSTRUCT	Device Profile 2 Specific Complex Data Types
0x0019	DEFTYPE	UNSIGNED48	0x0120-13F	DEFTYPE	Device Profile 3 Specific Standard Data Types
0x001A	DEFTYPE	UNSIGNED56	0x0140-15F	DEFSTRUCT	Device Profile 3 Specific Complex Data Types
0x001B	DEFTYPE	UNSIGNED64	0x0160-17F	DEFTYPE	Device Profile 4 Specific Standard Data Types
0x001C	DEFTYPE	SAFETY	0x0180-19F	DEFSTRUCT	Device Profile 4 Specific Complex Data Types
0x001D-1F	-	Reserved	0x01A0-1BF	DEFTYPE	Device Profile 5 Specific Standard Data Types
0x0020	-	Reserved	0x01C0-1DF	DEFSTRUCT	Device Profile 5 Specific Complex Data Types
0x0021	DEFSTRUCT	PDO_MAPPING	0x01E0-1FF	DEFSTRUCT	Device Profile 6 Specific Standard Data Types
0x0022	-	Reserved	0x0200-21F	DEFSTRUCT	Device Profile 6 Specific Complex Data Types
0x0023	DEFSTRUCT	IDENTITY	0x0320-23F	DEFTYPE	Device Profile 7 Specific Standard Data Types
0x0024	-	Reserved	0x0440-25F	DEFSTRUCT	Device Profile 7 Specific Complex Data Types
0x0025	DEFSTRUCT	COMMAND_PAR	0x0260-7FF	-	Reserved

Also, the Enumerated data type areas are assigned to reserved Index 0x0800 - 0x0FFF.

Each of objects is defined as one of two types of data:

Designates number of bits reserved exclusively (ex. BIT3 or UNSIGNED 16) and integer values (UNSIGNED 32), they are shown strings.

Definition of the Enumerated data type

Sub-Index	Description	Data type	Access type	PDO mapping	Values
0x00	Number of entry	UNSIGNED8	RO	No	the number of the enumerated data type "N"
-	Padding	UNSIGNED8	-	-	0: Even number data (adding byte allocated for 8 bit)
0x01	Enum 1	OCTET STRING	RO	No	VISIBLE STRING of the enumerated data type Integer values of UNSIGNED 32
...					
0xN	Enum N	OCTET STRING	RO	No	

## 7.2 CoE Communication Area

The followings are shown CoE communication object list, Object type, Data length, Access (Dir), PDO Mapping, and parameter effective timing (updating). The shapes in the Update column stand for effective timing; #=immediately, \$=ESM (EtherCAT State Machine) change required, &=control-power-source re-input.

Communication Area (No.1)

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 Rsister	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	-	-
0x10F0	-	ARRAY	Backup parameters	-	-	-	-	-
	0x00	-	Number of entry	Unsigned8	RO	No	-	-
	0x01	-	Checksum	Unsigned32	RO	No	-	Yes
0x1400-0x1403	-	RECORD	RxPDO Parameter	-	-	-	-	-
	0x00	-	Number of Entry	Unsigned8	RO	No	-	-
	0x01-0x05	-	Reserved	Unsigned32	RW	No	\$	-
0x1500-0x1503	0x06	-	RxPDO exception PDO	Octet-String	RW	No	\$	-
	0x07	-	RxPDO State	BOOLEAN	RO	Possible	-	-
	0x08	-	RxPDO Control	BOOLEAN	RW	Possible	#	-
0x1600-0x1603	0x09	-	RxPDO Toggle	BOOLEAN	RW	Possible	#	-
	-	RECORD	1 <sup>st</sup> to 4 <sup>th</sup> ,257 <sup>th</sup> to 260 <sup>th</sup> Reception PDO Mapping	PDO Mapping	-	-	-	-
	0x00	-	Number of Entry to RxPDO	Unsigned8	RW	No	\$	-
0x1700-0x1703	0x01-n	-	Object mapped in the 1 <sup>st</sup> ... Object mapped in the n-th	Unsigned32	RW	No	\$	-
0x1800-0x1803	-	RECORD	TxPDO Parameter	-	-	-	-	-
	0x00	-	Number of Entry	Unsigned8	RO	No	-	-
	0x01-0x05	-	Reserved	Unsigned32	RW	No	\$	-
0x1900-0x1903	0x06	-	TxPDO exception PDO	Octet-String	RW	No	\$	-
	0x07	-	TxPDO State	BOOLEAN	RO	Possible	-	-
	0x08	-	Reserved	BOOLEAN	-	-	-	-
0x1A00-0x1B03	0x09	-	TxPDO Toggle	BOOLEAN	RO	Possible	-	-
	-	RECORD	1 <sup>st</sup> to 512 <sup>th</sup> Reception PDO Mapping	PDO Mapping	-	-	-	-
	0x00	-	Number of Entry to TxPDO	Unsigned8	RW	No	\$	-
0x1C00	0x01-n	-	Object mapped in the 1 <sup>st</sup> ... Object mapped in the n-th	Unsigned32	RW	No	\$	-
	-	ARRAY	SM(Sync Manager) Communication Type	-	-	-	-	-
	0x00	-	Number of Entry	Unsigned8	RO	No	-	-
0x1C10-0x1C11	0x01-0x08	-	Communication Type of SM0 ... Communication Type of SM7	Unsigned8	RO	No	\$	-
	-	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		Access	PDO	Value
0x00	Device Type [DEVICE] Displays device type for EtherCAT servo drive.		RO	Possible	0x00020192

MSB			LSB		
Mode Bit	Type	Number of Device Profile			
31	24	23	16	15	0

0x0192	Device Profile(DS402d)
0x02	Servo Drive
0x00	Manufacturer Definition (Standard Specification)

0x1001:Error Register

Index	0x1001	Indicates error state of slave. Refer to (Error Field Definition) for the details of error.	Object Code		VAR
Sub-Idx	Name/Description		Access	PDO	Initial Value
0x00	Error Register [ERRREG]		RO	Possible	0x00

Bit7:Maker Definition Error	Bit3:Temperature Error
Bit6:Reserved	Bit2:Voltage Error
Bit5:Device Profile Definition Error	Bit1:Current Error
Bit4:Communication Error	Bit0:Generic error

0x1008:Device Name

Index	0x1008	Indicates product device name.	Object Code		VAR
Sub-Idx	Name/Description		Access	PDO	Value
0x00	Device Name [DEVICE] Product Device Name (ASCII Code)		RO	No	Character String (-)

RS2 A 0 1 A 2 H A 5  
 ✓ Refer to section 1.4, Servo amplifier model number, for model number structure details.

0x1009:Hardware Version

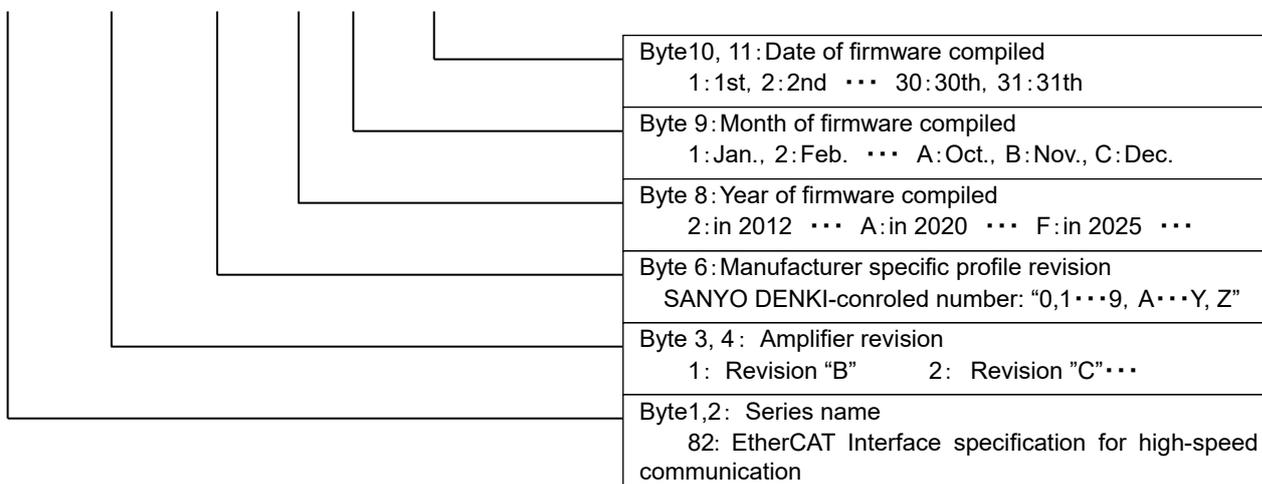
Index	0x1009	Indicates product hardware version.	Object Code		VAR
Sub-Idx	Name/Description		Access	PDO	Value
0x00	Hardware Version [HARDVER] Hardware Version of Device		RO	No	Character String (-)

0x100A:Software Version

Index	0x100A	Indicates product software version.	Object Code		VAR
Sub-Idx	Name/Description		Access	PDO	Value
0x00	Software Version [SOFTVER] Software Version of Device		RO	No	Character String (-)

8 2 0 0 . 0 . 2 7 2 0



## 0x1010:Store Parameters

Index	0x1010	Store current amplifier parameters to non-volatile memory	Object Code		ARRAY													
Sub-Idx	Name/Description		Data Type	Access	PDO	Initial value												
0x00	Number of Entry		Unsigned8	RO	No	0x01												
0x01	Store all parameters [PARASAVE] Store all reservable parameters in a lump		Unsigned32	RO	No	0x0000 0001												
<p>In order to avoid storage of parameters by misstate, storage is only executed when a specific signature is written to the "sub-index 1". The signature is "save"</p> <p>&amp;Write-access Sequence</p> <ol style="list-style-type: none"> <li>1) Master writes "0x65 76 61 73" (ASCII:s:73, a:61, v:76, e:65) in "Sub-index 01."</li> <li>2) Slave stores storable parameters in EEPROM of CPU performing servo control when received correct signs. * Slave information connected to ASIC is not the stored EEPROM.</li> <li>3) Slave responds by SDO sending (download-initiating response) after normal storage completion. If failed to store, slave responds via SDO abort transfer servis (abort code: 0606 0000h). If incorrect sign was written, slave responds via SDO abort transfer servis (abort code: 0800 0020h).</li> </ol> <p>&amp;Read-access Sequence</p> <p>Slave provides information on parameter storing function in the following formats.</p> <table border="1"> <thead> <tr> <th>Bit</th> <th>Value</th> <th>Description</th> </tr> </thead> <tbody> <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> </tbody> </table> <p>✓ If NVRAM is Yes at each area of object list , paramaters will be store by this command.</p>							Bit	Value	Description	31-2: Reserved	0	Reserved	1: Auto	0	Slave does not store parameters on an autonomous basis.	0: Cmd	1	Slave stores parameters when commanded via the above write -access.
Bit	Value	Description																
31-2: Reserved	0	Reserved																
1: Auto	0	Slave does not store parameters on an autonomous basis.																
0: Cmd	1	Slave stores parameters when commanded via the above write -access.																

## 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] Indicate checksum value of XML parameter file. 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] Vender ID registered in ETG		Unsigned32	RO	Possible	0x0000 01B9
0x02	Product Code [PRODUCT] Product Code of Production		Unsigned32	RO	No	0x00000006
0x03	Revision No. [AMPREV] Revision Number of Product (Not used: fixed value 0)		Unsigned32	RO	No	(-)
0x04	Serial No. [SERIAL] 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 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 (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 EtherCAT CoE profile.

The change of the RxPDO mapping uses reception of PDO mapping parameter (0x1600 - 0x1603, 0x1700 - 0x1703) with the R-ADVANCED EtherCAT 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 reached to either A-boundary or B-boundary
- 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 20 objects for RxPDO and TxPDO respectively.  
If mapping is done exceeding the limit, a malfunction may occur.

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

## 0x1600:Reception PDO Mapping 1

Index	0x1600	Reception PDO Mapping 1	Object Code		RECORD	
Sub-Idx	Name/Description		Data Type	Access	PDO	Range (Initial Value)
0x00	Number of Entry : Number of RxPDO1 Object		Unsigned8	RW	No	0x00 to 0x1F
0x01	Entry 1 Object Mapped in the 1st - RxPDO1		Unsigned32	RW	No	0x60400010
0x02 - n	Entry 2 - Entry-n Object Mapped in the 2nd to n of - RxPDO1 * "n" is up to 0x1F in maximum.		Unsigned32	RW	No	0x00000000 - 0xFFFFFFFF

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

Index	0x1601-0x1603 0x1700-0x1703	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 - n	Entry 1 - Entry n Object Mapped in the 1st to n of - RxPDOx		Unsigned32	RW	No	0x00000000 - 0xFFFFFFFF

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

Index	0x1800-0x1803 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 Includes the index of object mapping TxPDO which was not able to assign in this RxPDO.		Octet-String	RW	No	
0x07	Not supported : TxPDO State When output data of this TxPDO were not arranged to hardware, slave sets it to TRUE =1.		BOOLEAN	RO	Possible	-
0x08	Reserved		BOOLEAN	RO	No	-
0x09	Not supported : TxPDO Toggle Toggles every update of supporting TxPDO to be written by master.		BOOLEAN	RO	Possible	-

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

## 0x1A00: TxPDO Mapping 1(TxPDO 1)

Index	0x1A00	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 Object Mapped in the 1st to TxPDO1		Unsigned32	RW	No	0x60410010
0x02 - n	Entry 2 - Entry n Object Mapped in the 2nd to n of - TxPDO1 * "n" is up to 0x1F in maximum.		Unsigned32	RW	No	0x00000000 - 0xFFFFFFFF

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

Index	0x1A01-0x1A03 0x1B00-0x1B03	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 - n	Entry 1 - Entry n Object Mapped in the 1st to n of -TxPDOx * "n" is to 0x1F in maximum.		Unsigned32	RW	No	0x00000000 - 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 - 0x08	Communication Type SM4 ... Communication Type SM7	0:Not used 1:Mailbox Reception 2:Mailbox Transmission 3:PD Output 4:PD Input	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 - n	Index of the PDO object assigned to RxPDO		Unsigned16	RW	No	0x1600:RxPDO 1 ... 0x1603:RxPDO 4 0x1700:RxPDO257 ... 0x1703:RxPDO260

## 0x1C13:SM Channel 3(Process Data Input)

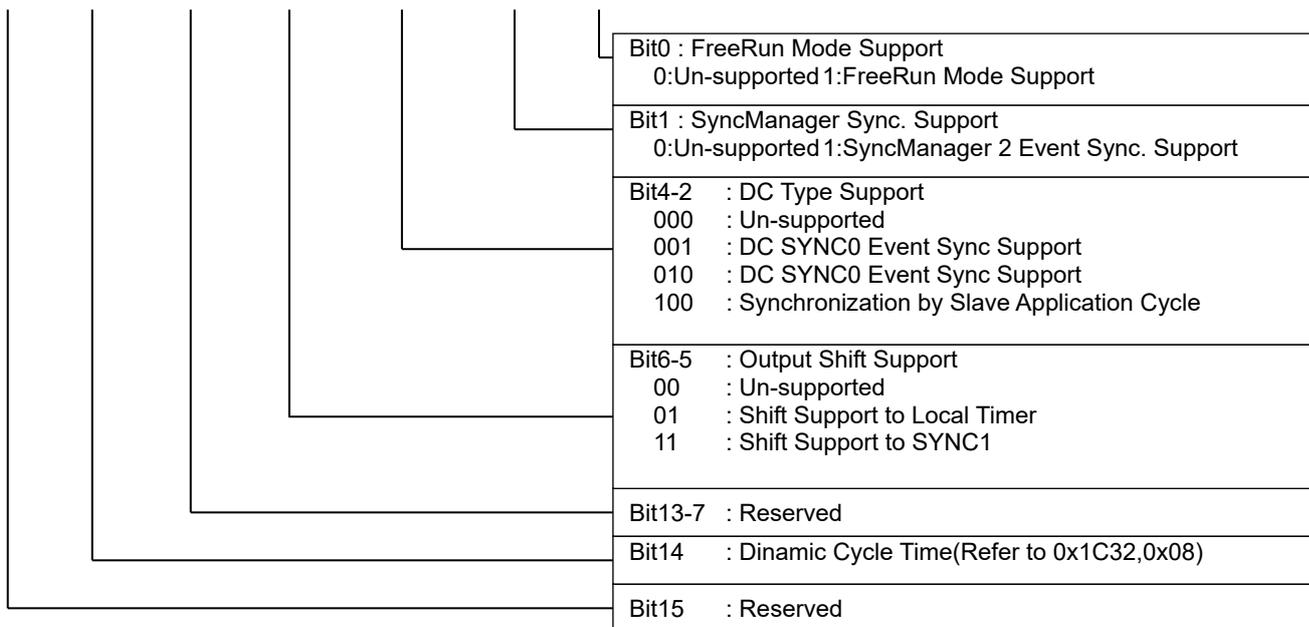
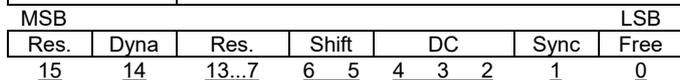
Index	0x1C13	Indicates the object assigned to SM3 as PDO.		Object Code		ARRAY
Sub-Idx	Description		Data Type	Access	PDO	Range
0x00	n [ several ] number of object assigned to TxPDO		Unsigned8	RW	No	0x00 to 0x04
0x01 - n	Index of the PDO object assigned to TxPDO		Unsigned16	RW	No	0x1A00:TxPDO 1 ... 0x1A03:TxPDO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



Sub-Idx	Name/Description	Data Type	Access	PDO	Range
0x05	Minimum Cycle Time : Unit(ns) The minimum cycle time is supported by slave. (Maximum time of local cycle)	Unsigned32	RO	No	0x0001E848 (125µs)
0x06	Copy and Operation Time (Calc and Copy Time) Unit (ns) 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.	Unsigned32	RO	No	0x0000F424 (62.5µs)
0x07	Reserved	-	-	-	-
0x08	Get Cycle Time 0:Stops local cycle time measurement. 1:Starts local cycle time measurement. ✓Measurement value is reset when written into again.	Unsigned16	RW	No	-
0x09	Delay Time 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, ✓Only the synchronous type 0x02, or DC SYNC0/1 of 0x03	Unsigned32	RO	No	0x00007530 (30µs)
0x0A	Not supported : Sync0 Cycle Time When SYNC0 fixed cycle time is required of application, it is the time between two Sync0 signals. ✓Synchronous Time = Only DC SYNC0 of 0x03, and local cycle control	Unsigned32	RW	No	-
0x0B	Cycle Time Too Small 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.	Unsigned16	RO	No	-
0x0C	SM-Event Missed 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.	Unsigned16	RO	No	-
0x0D	Shift Time Too Short 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.	Unsigned16	RO	No	-
0x0E	RxPDO Toggle Failed 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.)	Unsigned16	RO	No	-
0x0F:0x1F	Reserved	-	-	-	-
0x20	Not supported : Sync Error TxPDO mapping is possible at the time of SM-Event Missed or Shift Time Too Short Counter support. 0: Not Sync. Error or unsupported Sync.Error 1: Sync. Error	BOOL	RO		

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]  0x00:Not synchronized (Free Run) 0x01:Reserved 0x02:DC Sync0 SYNC0 Event Synchronization (Synchronized with SYNC0 Hardware Signal) 0x03:DC Sync1 SYNC1 Event Synchronization (Synchronized with SYNC1 Hardware Signal) 0x04 - 0x21:Reserved ✓ Must set this from controller at communication configuration.		Unsigned16	RW	No	0x0002
			Setting Range			0x00, 0x02, 0x03
0x02	Cycle Time : Unit (ns) [SM3CYC]  Free Run (Synchronous Type=0x00) : Local Timer Event Cycle of Slave DC SYNC0 (Synchronous Type=0x02) : SYNC0 Cycle Time (0x09A0 - 0x09A3) DC SYNC1 (Synchronous Type=0x03) : SYNC0 Cycle Time (0x09A0 - 0x09A3) ✓ The value shall be the same as Index:0x1C32,Sub-index2.		Unsigned32	RO	No	0x0007A120 (500µs)
0x03	Shift Time : Unit(ns) Time between Input Latch Operation from Hardware and Related Operation ✓ The value shall be the same as Index:0x1C32,Sub-index2.		Unsigned32	RO	No	0x0
0x04	Synchronous Type Support		Unsigned16	Ro	No	0x4007



Sub-Idx	Name/Description	Data Type	Access	PDO	Range
0x05	Minimum Cycle Time : Unit (ns) The minimum cycle time is supported by slave. (Maximum time of local cycle) ✓The value shall be the same as Index:0x1C32,Sub-index5.	Unsigned32	RO	No	0x0001E848 (125µs)
0x06	Copy and Operation Time (Calc and Copy Time) Unit (ns) Time required from Input Latch through minimum cycle time.	Unsigned32	RO	No	0x0001E848 (125µs)
0x07	Reserved	-	-	-	-
0x08	Get Cycle Time 0:Stops local cycle time measurement. 1:Starts local cycle time measurement. ✓Measurement value is reset when written into again.	Unsigned16	RW	No	-
0x09	Delay Time Hardware delay time of a slave, period from trigger reception of SYNC0 or SYNC1 event until latching input value. ✓Only the synchronous type 0x02, or DC SYNC0/1 of 0x03	Unsigned32	RO	No	-
0x0A	Not supported : Sync0 Cycle Time When SYNC0 fixed cycle time is required of application, it is the time between two Sync0 signals. ✓Synchronous Time = Only DC SYNC0 of 0x03, and local cycle control	Unsigned32	RW	No	-
0x0B	Cycle Time Too Small 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.	Unsigned16	RO	No	-
0x0C	SM-Event Missed 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.	Unsigned16	RO	No	-
0x0D	Shift Time Too Short 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.	Unsigned16	RO	No	-
0x0E	Not supported : RxPDO Toggle Failed 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.)	Unsigned16	RO	No	-
0x0F:0x1F	Reserved	-	-	-	-
0x20	Reserved (Sync Error) TxPDO mapping is possible at the time of SM-Event Missed or Shift Time Too Short Counter support. <u>0: Not Sync. Error or unsupported Sync-Error</u> <u>1: Sync. Error</u>	BOOL	RO	-	-

### 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 0x1C32 and 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 RS2-EtherCAT slave 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 and 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 and 0x09:"Delay Time" in consideration of hardware delay time and the software operating time mounted in slave.

#### Input Latch

"Input Latch" in RS2-EtherCAT slave amplifier indicates the real position acquisition timing of motor encoder.

However, when position cannot be received more correctly than 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 RS2-EtherCAT 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.

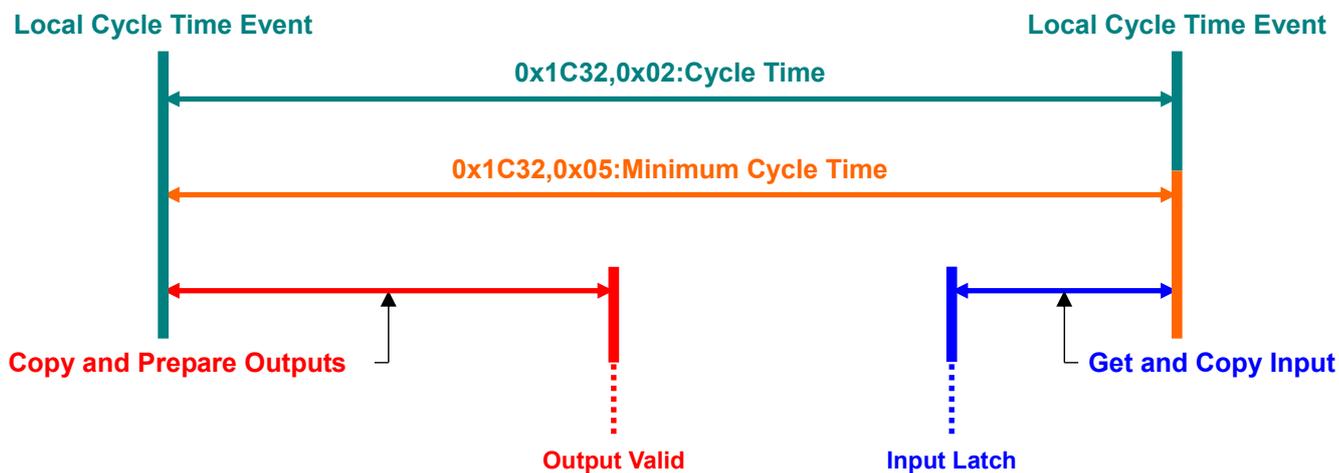
Local cycle moves independently of communication cycle or master cycle.

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



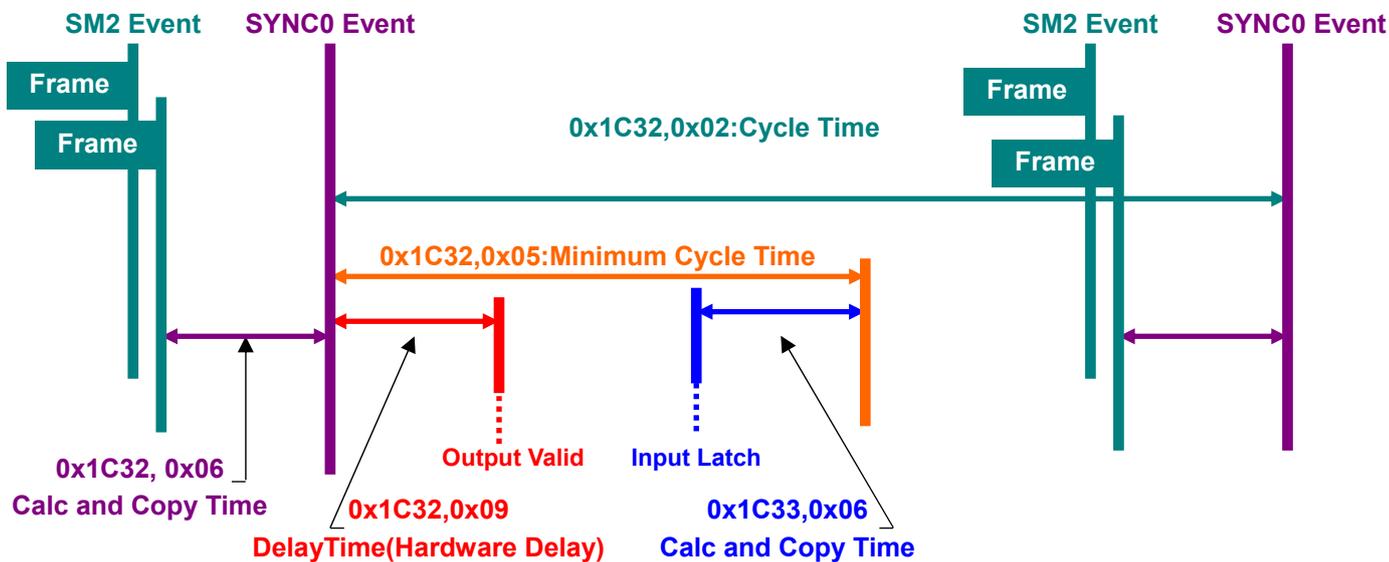
Communication Timing of Free Run Mode

### 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



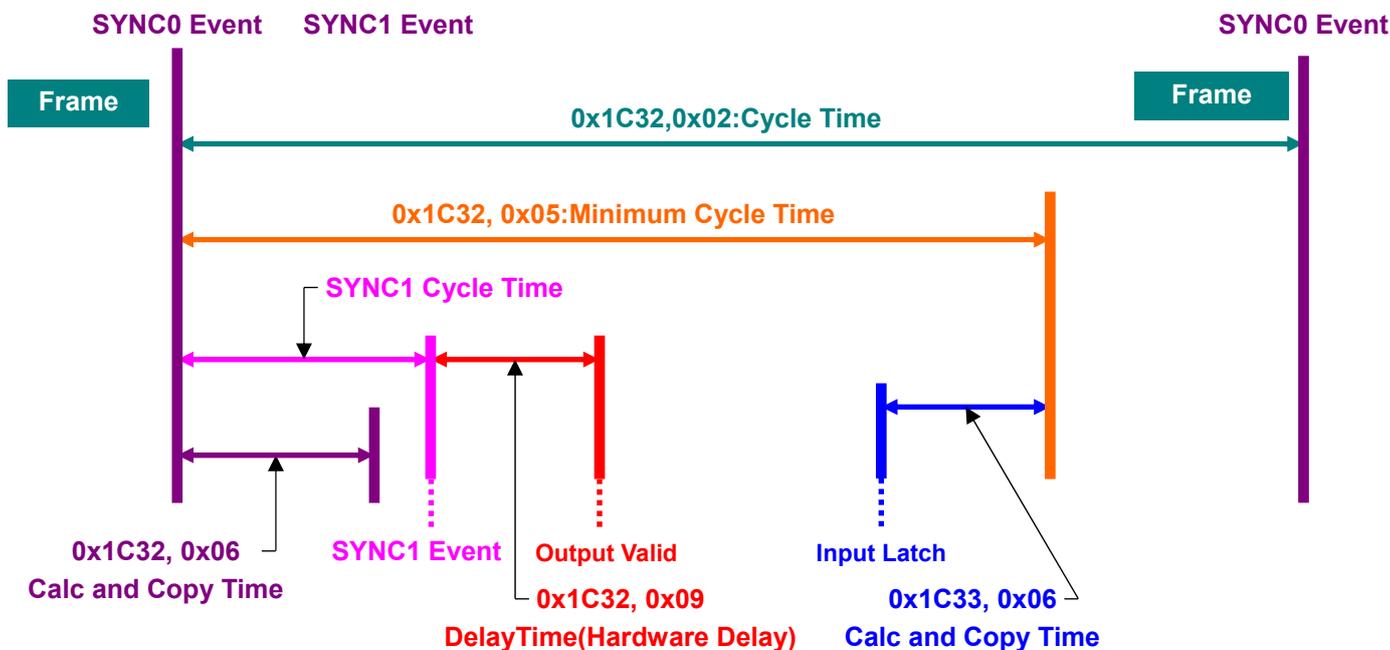
Communication Timing of DC Synchronization Mode (SYNC0)

### 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 and 0x06 (Calc and Copy Time) indicate the allowance time for SYNC1 cycle time, and 0x1C32 and 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)

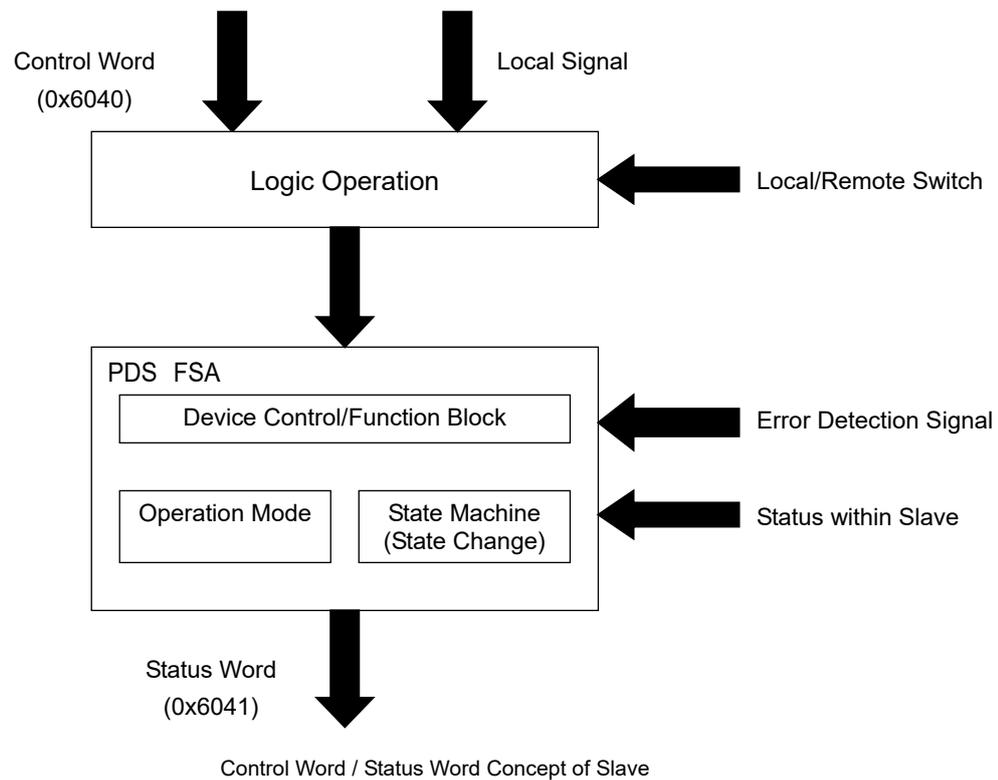
## 7.3 PDS FSA

### 1) Abstract

PDS (Power Drive System) FSA (Finite States Automaton) of the EtherCAT slave 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.

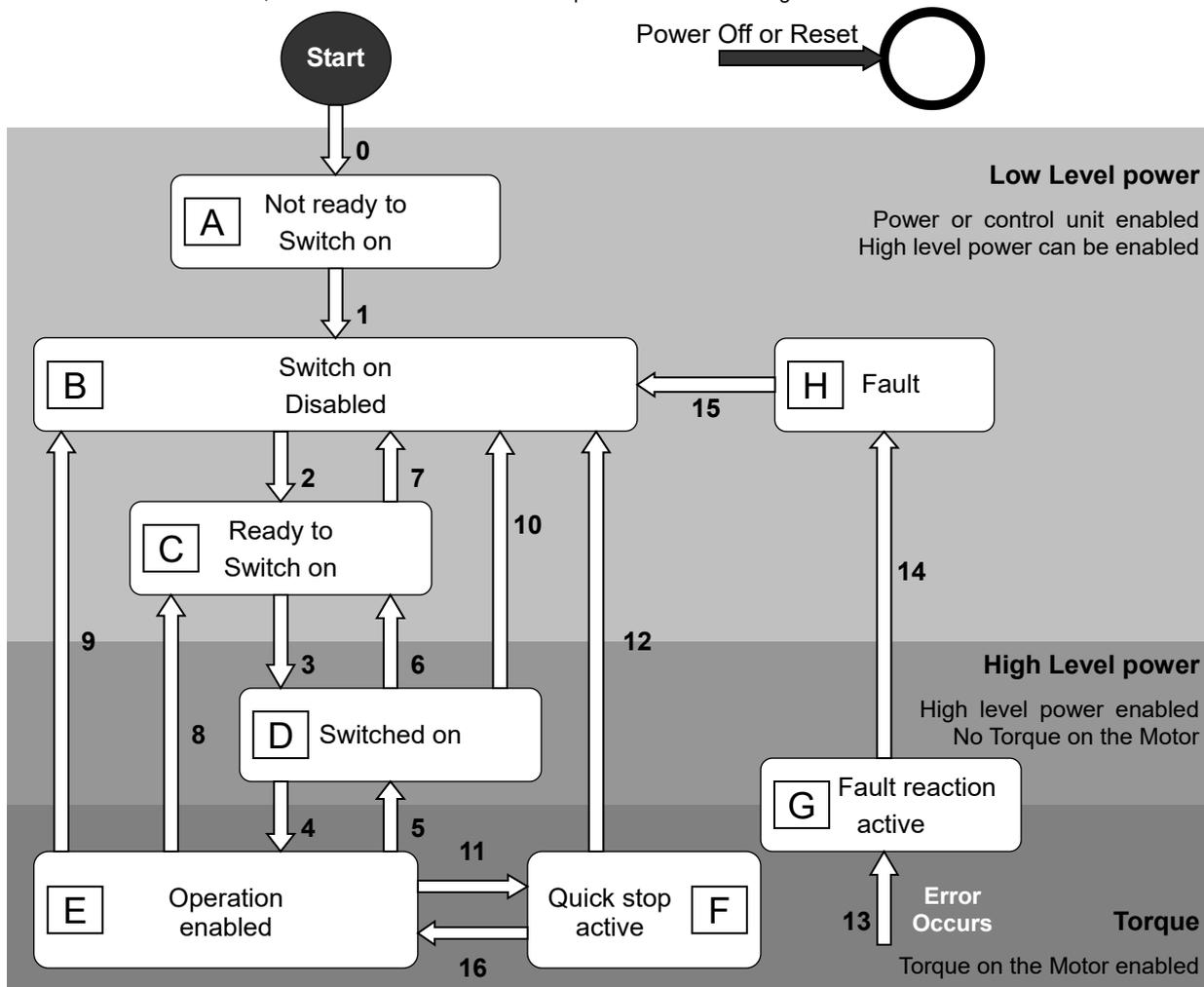
The slave local and network shows you how to be driving.



## 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 RS2 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 SwitchOn 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 SwitchOn. 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. 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. 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. 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. Parameter to slave can be set.
[F]	Quick Stop Active	In the state where the Quick stop (scram) function is performed. 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. 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] ↓ [Not ready to Switch on]	Event : After control power supply ON or reset application, shifts automatically. Action : Slave performs initialization and self-test.
1	[Not ready to Switch on] ↓ [Switch on Disabled]	Event : Shifts automatically. Action : Communication is permitted.
2	[Switch on Disabled] ↓ [Ready to Switch on]	Event : [Shut down] command (Bit2, 1, 0=1, 1, 0) is received from master. Action : None
3	[Ready to Switch on] ↓ [Switch on]	Event : [Switch On] command (Bit3, 2, 1, 0=0, 1, 1, 1) is received from master. Action : Since in main circuit power supply permission state, provide main circuit power supply.
4	[Switch on] ↓ [Operation enabled]	Event : [Enable operation] command (Bit3, 2, 1, 0=1, 1, 1, 1) is received from master. Action : Slave is Servo-ON and all the internal preset values are cleared.
5	[Operation enabled] ↓ [Switch on]	Event : [Disabled operation] command (Bit3, 2, 1, 0=0, 1, 1, 1) is received from master. Action : Slave is Servo-ON.
6	[Switch on] ↓ [Ready to Switch on]	Event : [Shut down] command (Bit2, 1, 0=1, 1, 0) is received from master. Action : Master should intercept main circuit power supply.
7	[Ready to Switch on] ↓ [Switch on Disabled]	Event : [Quick Stop] command (Bit2, 1=0, 1) or [Disable voltage] command (Bit1=0) is received from master. Action : None
8	[Operation enabled] ↓ [Ready to Switch on]	Event : [Shut down] command (Bit2, 1, 0=1, 1, 0) is received from master. Action : Slave is Servo-Off. Master should intercept main circuit power supply.
9	[Operation enabled] ↓ [Switch on Disabled]	Event : [Disable voltage] command (Bit1=0) is received from master. Action : Slave is Servo-Off. Master should intercept main circuit power supply.
10	[Switch on] ↓ [Switch on Disabled]	Event : [Quick Stop] command (Bit2, 1=0, 1) or [Disable voltage] command (Bit1=0) is received from master. Action : Master should intercept main circuit power supply.
11	[Operation enabled] ↓ [Quick stop active]	Event : [Quick Stop] command (Bit2, 1=0, 1) is received from master. Action : Quick Stop function is performed.
12	[Quick stop active] ↓ [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. Action : Slave is Servo-Off. Master should intercept main circuit power supply.
13	Error occurs ↓ [Fault reaction active]	Event : Fault (Alarm) occurs at slave. Action : Set-up Fault operation function is performed.
14	[Fault reaction active] ↓ [Fault]	Event : Shifts automatically. Action : Slave is Servo-Off. Master should intercept main circuit power supply.
15	[Fault] ↓ [Switch on Disabled]	Event : [Fault reset] command (Bit7=0 -> 1) is received from master. Action : Without slave's Fault factor, Fault reset is performed. Master should clear the "Fault reset" bit (Bit7=1->0) after normal state check.
16	[Quick stop active] ↓ [Operation enabled]	Event : [Enable operation] command (Bit3, 2, 1, 0=1, 1, 1, 1) is received by Quick Stop option code5 to 7. 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.

Alotment for Each Bit of Control Word

Bit15	Bit14	Bit13	Bit12	Bit11	Bit10	Bit9	Bit8
Manufacturer Specific (Manufacturer 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	0x6040	Description	Indicates reception command of FSA (State Machine) that PDS (Power Drive System) is controlled.		Object Code		Variable	
Sub-Idx	0x00	Description	Control Word [CWORD] Bit pattern (Bit 7, 3, 2, 1, 0) of Control Word The composition is as follows.		Data Type	Unsigned16	Access	RW
					Display Range	0x0000 - 0xFFFF		
					Access	Possible	Initial Value	0x0000

MSB

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

LSB

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.

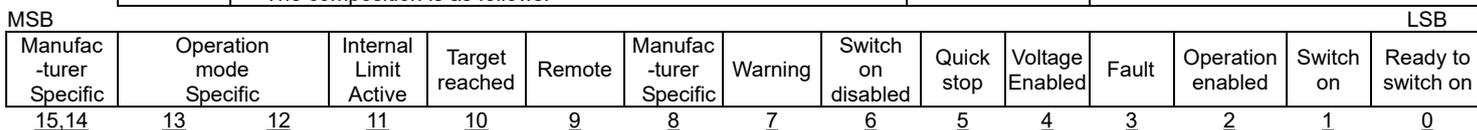
Alotment for Bit of Status Word

Bit15	Bit14	Bit13	Bit12	Bit11	Bit10	Bit9	Bit8
Reserved (Manufacturer 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	0x6041	Indicates status of FSA (State Machine) that PDS (Power Drive System) is controlled.		Object Code		Variable
Sub-Idx	0x00	Description		Data Type	Access	PDO
		Status Word [STSWORD] Bit pattern (Bit 6, 5, 3, 2, 1, 0) of Status Word The composition is as follows.		Unsigned16	RO	Possible
				Display Range	0x0000 - 0xFFFF	
						Initial Value 0x0000



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.

Bit13, 12 and 8 are based on operation mode specifications, and Bit15 and 14 are maker specifications.

5) Manufacturer specific area

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

Allocation for control words (manufacturer specific area)

bit15	bit14	bit13	bit12	bit11
Cseten	Reserved	Reserved	Eclr	Reserved

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

Index	0x6040	Indicates status of FSA (State Machine) that PDS (Power Drive System) is controlled.	Object code	Variable		
Sub-Idx		Description	Data Type	Access	PDO	Initial value
0x00		Control words [CWORD] *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	Resrvd	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

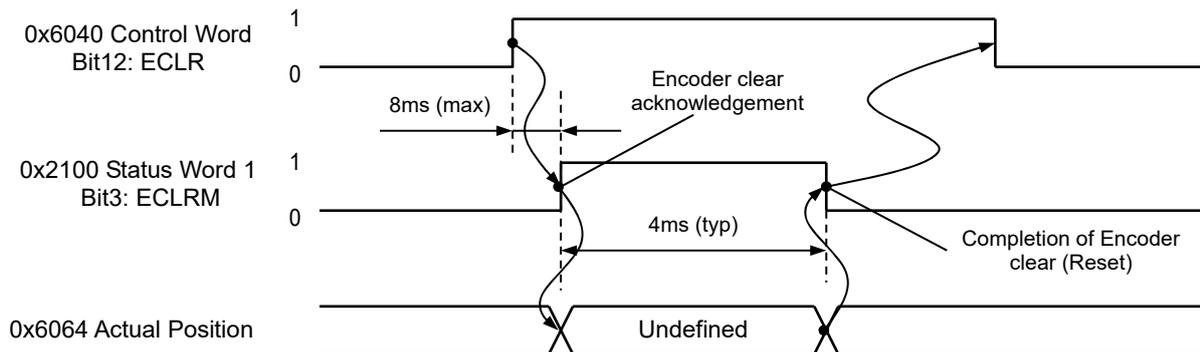
bit15: Magnetic pole position estimation enabled [CSET]  
Magnetic pole position estimation command when using linear motor without hall effect sensor input.  
"0": Magnetic pole position estimation disabled  
"1": Magnetic pole position estimation enabled

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 manufacturer specific area for status words are described below.

Layout for control words (manufacturer 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	0x6041	Indicates status of FSA (State Machine) that PDS (Power Drive System) is controlled.	Object code	Variable		
Sub-Idx		Description	Data Type	Access	PDO	Initial value
0x00		Status words [STSWORD] *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

## 7.4 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 &=control-power-source re-input.

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 (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	No	-	-
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) (Torque (force) Command)	Integer16	RW	Possible	#	-
0x6072	0x00	○	○	○	○	Maximum Torque (force) (Torque (force) Limit)	Unsigned16	RW	Possible	#	Yes
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) 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 (Velocity Control Command)	Unsigned32	RW	Possible	#	Yes
0x6080	0x00	✖	✖	✖	✖	Maximum Motor Speed	Unsigned32	RW	Possible	-	-
0x6081	0x00	○	○	✖	✖	Profile Velocity	Unsigned32	RW	Possible	#	Yes
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 (Sensor 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	□	x	x	x	Motor Shaft Resolution	Unsigned32	RW	Possible	-	-
↑	0x02	□	x	x	x	Drive Shaft Resolution	Unsigned32	RW	Possible	-	-
0x6092	0x00	—	—	—	—	Feed Constant	Unsigned8	RO	No	-	-
↑	0x01	□	x	x	x	Feed	Unsigned32	RW	Possible	-	-
↑	0x02	□	x	x	x	Drive Shaft Resolution	Unsigned32	RW	Possible	-	-
0x6098	0x00	x	x	x	○	Homing Method	Integer8	RW	Possible	#	Yes
0x6099	0x00	-	-	-	-	Homing Speed	Unsigned8	RO	No	—	-
↑	0x01	x	x	x	○	Speed during search for switch	Unsigned32	RW	Possible	#	Yes
↑	0x02	x	x	x	○	Speed during search for Zero	Unsigned32	RW	Possible	#	Yes
0x609A	0x00	x	x	x	○	Homing Acceleration	Unsigned32	RW	Possible	#	Yes
0x60A3	0x00	○	x	x	x	Profile Jerk Use	Unsigned 8	RW	No	-	-
0x60A4	0x00	-	-	-	-	Profile Jerk	Unsigned8	RO	No	-	-
↑	0x01	○	x	x	x	Profile Jerk 1	Unsigned32	RW	No	#	-
↑	0x02	○	x	x	x	Profile Jerk 2	Unsigned32	RW	No	#	-
0x60B0	0x00	○	x	x	x	Position Offset (Position Addition)	Integer32	RW	Possible	#	-
0x60B1	0x00	○	○	-	x	Speed Offset (Speed Addition)	Integer32	RW	Possible	#	-
0x60B2	0x00	○	○	○	x	Torque (force) Offset (Torque (force) Addition)	Integer16	RW	Possible	#	-
0x60B8	0x00	x	x	x	○	Touch probe mode	Unsigned16	RW	Possible	#	-
0x60B9	0x00	x	x	x	○	Touch probe state	Unsigned16	RO	Possible	#	-
0x60BA	0x00	x	x	x	○	Touch probe1 positive edge position stored	Integer32	RO	Possible	#	-
0x60BB	0x00	x	x	x	○	Touch probe1 negative edge position stored	Integer32	RO	Possible	#	-
0x60BC	0x00	x	x	x	○	Touch probe1 positive edge position stored	Integer32	RO	Possible	#	-
0x60BD	0x00	x	x	x	○	Touch probe1 negative edge position stored	Integer32	RO	Possible	#	-
0x60C0	0x00	○	x	x	x	Interpolation sub mode select	Integer16	RW	No	-	Yes
0x60C1	0x00	-	-	-	-	Interpolation data record	Unsigned8	RO	No	-	-
↑	0x01	○	x	x	x	Interpolation position target	Integer32	RW	Possible	#	-
↑	0x02	○	x	x	x	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	x	x	x	x	Interpolation data configuration	Unsigned8	RO	No	-	-
↑	0x01	○	x	x	x	Maximum buffer size	Unsigned32	RO	No	-	-
↑	0x02	○	x	x	x	Actual buffer size	Unsigned32	RW	Possible	#	Yes
↑	0x03	○	x	x	x	Buffer format	Unsigned8	RW	Possible	#	-
↑	0x04	○	x	x	x	Point of buffer	Unsigned16	RW	Possible	#	-
↑	0x05	○	x	x	x	Data size of interpolation data record	Unsigned8	RO	No	-	-
↑	0x06	○	x	x	x	Clear buffer	Unsigned8	WO	Possible	#	-
0x60C5	0x00	x	○	x	x	Maximum Acceleration	Unsigned32	RW	Possible	—	Yes
0x60C6	0x00	x	○	x	x	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	x	x	x	○	Support Homing Method 1 - 37	Integer8	RO	No	-	-
0x60F2	0x00	○	x	x	x	Position Option Code	Unsigned16	RW	Possible	#	-
0x60F4	0x00	○	x	x	x	Actual Position Deviation (Following Error Actual Value)	Integer32	RO	Possible	-	-
0x60F8	0x00	x	x	x	x	Maximum Deviation (Amount of Max. Gaps)	-	-	-	-	-
0x60FA	0x00	○	x	x	x	Control Effort	Integer32	RO	Possible	-	-
0x60FC	0x00	○	x	x	x	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	x	○	x	x	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	x	x	x	x	Motor Calibration date	-	-	-	-	-
0x6407	0x00	x	x	x	x	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	0x6007	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 1 : Fault Signal 2 : Desable Voltage Command 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	0x603F	Displays codes of errors occurred in the servo amplifier.	Object code	Variable		
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Error Code [ERRCODE] For the list of error codes, please refer to the list of alarm codes in the section 11.3. ✓ Represents the same information as lower 16-bit of Sub-index 0x01 in pre-defined errorfield 0x1003 in CANopen communication method.		Unsigned16	RO	Possible	0x0000
			Display range	0x0000 - 0xFFFF		

## 0x605A: Quick Stop Option Code (EMR)

Index	0x605A	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] ✓ By Control mode, treated in the amplifier internally as shown below.  -128 to-1,4,8 to 127 are reserved. Not possible to be set. # Profile position (pp), Cyclic sync position(csp), Interpolated Position (ip) mode # Cyclic sync velocity mode (csv), Profile velocity (pv), Homing mode 0 : Drive function is Disabled. (To Switch On Disabled after motor stop by dynamic brake operation) 1 : To Switch On Disabled after stop at slowdown deceleration (0x6084) 2 : To Switch On Disabled after stop at quick stop deceleration (0x6085) 3 : To Switch On Disabled after stop by Current Limit 5 : Quick Stop Active state after stop at slowdown deceleration (0x6084) 6 : Quick Stop Active state after stop at quick stop deceleration (0x6085) 7 : Quick Stop Active state after stop by Current Limit  # Cyclic sync torque (force) mode (cst), Torque (force) profile mode (tq) 0 : Drive function is disabled (After a motor stops by dynamic brake operation, Switch On Disabled) 1, 2 : Switch On Disabled after Stops by 0x6087(Torque (force) Slope) 3 : To Switch On Disabled after stop by Current Zero 5, 6 : Quick Stop Active state after Stops by 0x6087(Torque (force) Slope) 7 : Quick Stop Active state after stop by Current Zero  ✓ 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. When external EMR signal is input through I/O, it will be "Switch On Disable" even if "Quick Stop Active" is set.		Integer16	RW	No	0x0002
			Setting Range	0x0000-0x0007 (0 to 7)		

## 0x605B: Shutdown Option Code

Index	0x605B	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 (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	0x605C	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 (0 to 1)		
<p>Set how to stop a motor at shifts from servo-on to servo-off.</p> <p># Profile position (pp), Cyclic sync position(csp), Interpolated Position (ip) mode</p> <p># Cyclic sync velocity mode (csv), Profile velocity (pv), Homing mode</p> <p><u>0</u> : Disable Drive function Switch OFF drive power stage.</p> <p><u>1</u> : Slow down with slow down ramp; disable of drive function</p> <p># Cyclic sync torque (force) mode (cst), Torque (force) profile mode (tq)</p> <p><u>0</u> : Disable Drive (Servo brake stop)</p> <p><u>1</u> : Stop at 0x6087 Torque (thrust force) stop</p> <p>✓When main circuit power shutdown, it will be dynamic brake operation regardless of setting.</p>						

## 0x605D:Halt Option Code

Index	0x605D	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. -128 to -1, 4 to 127 are reserved. Not possible to be set up.		Setting Range	0x0001 - 0x0003 (1 to 3)		
<p># Profile position (pp), Cyclic sync velocity mode (csv), Profile velocity (pv), Homing mode</p> <p><u>1</u> : Operation enabled state after Stop at slowdown deceleration (0x6084).</p> <p><u>2</u> : Operation enabled state after stop at quick stop deceleration (0x6085)</p> <p><u>3</u> : To Switch On Disabled after stop by Current Limit</p> <p># Cyclic sync position mode (csp) .Interpolated Position (ip) mode</p> <p><u>1, 2, 3</u> : Operation enabled state after stop by Current Limit</p> <p># Cyclic sync torque (force) mode (cst), Torque (force) profile mode (tq)</p> <p><u>1, 2</u> : Operation enabled state after Stops by 0x6087(Torque (force) Slope)</p> <p><u>3</u> : Operation enabled state after stop by Current Zero.</p> <p>✓If servo-off is desired after stopping with the halt state, servo-off with set of halt bit of the control word is required.</p>						

## 0x605E: Fault Reaction Option Code

Index	0x605E	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 to 0x0003 (0 to 3)		
<p># Profile Position (pp) Mode, Interpolated Position Mode (ip), Cycle Synchronous Position Mode (csp)</p> <p># Profile Velocity (pv) Mode, Homing Mode (hm), Cycle Synchronous Velocity Mode (csv)</p> <p><u>0</u> : Drive function is Disabled. (Motor stop by dynamic brake operation)</p> <p><u>1</u> : Stop at slowdown deceleration (0x6084)</p> <p><u>2</u> : Stop at quick stop deceleration (0x6085)</p> <p><u>3</u> : Stop by Current Limit</p> <p># Torque Profile (tq) Mode, Cycle Synchronous Torque Mode (cst)</p> <p><u>0</u> : Drive function is Disabled. (Motor stop by dynamic brake operation)</p> <p><u>1, 2</u> : Stop at 0x6087 (Torque (thrust force) slope)</p> <p><u>3</u> : Stop by Current Limit</p>						

## 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 Cyclic Sync. Position Mode			Reserved	Reserved
ip Interpolated position		Reserved	Reserved	Interpolation Enable
csv Cyclic Sync. Velocity Mode		Reserved	Reserved	Reserved
pv Profile Velocity Mode				
cst Cyclic 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

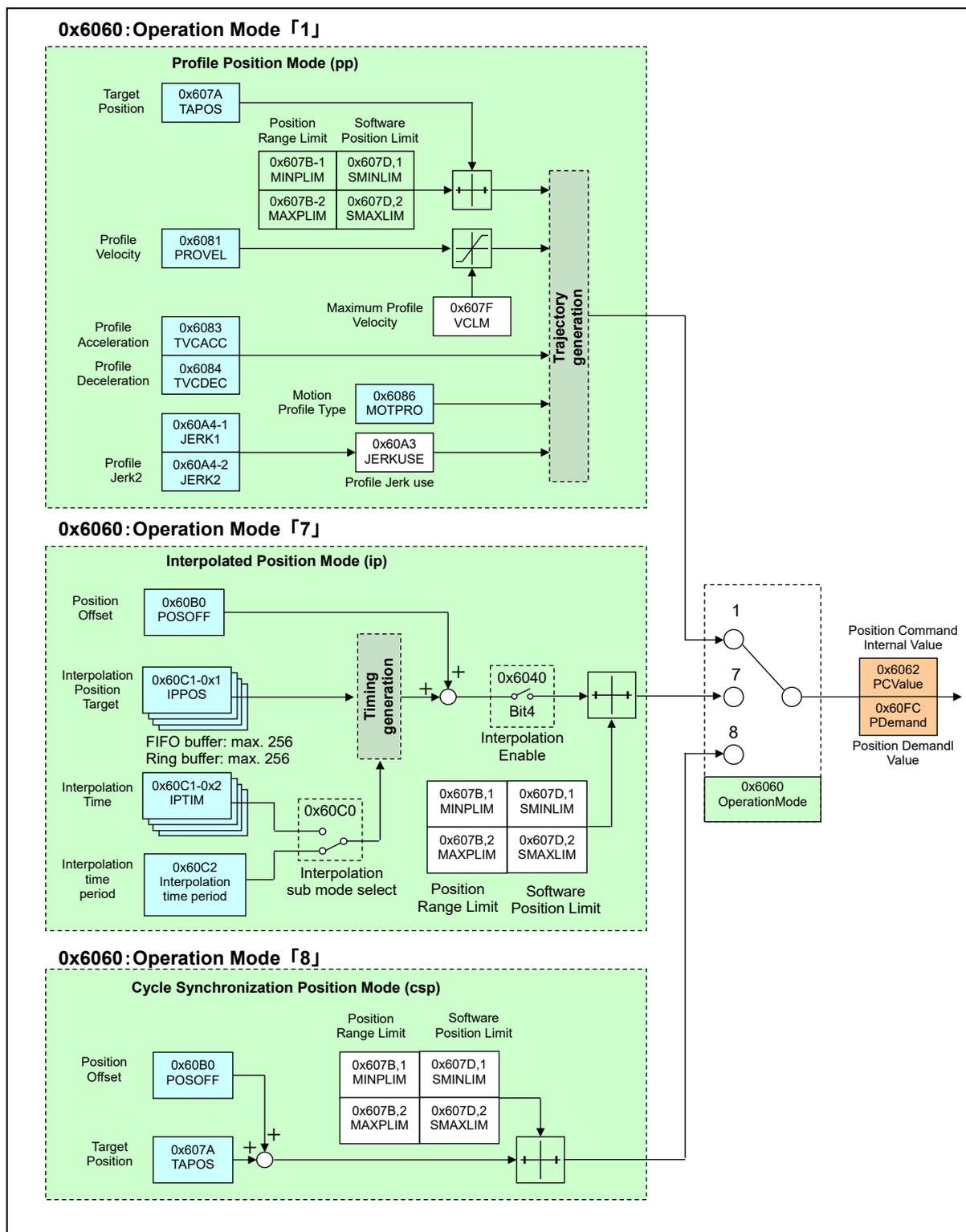
Operation Mode	bit13	bit12	bit10
pp Profile Position Mode	Following error	Set-point Acknowledge	Target reached Quick Stop Finished Operation Change Finished Halt Active
csp Cyclic Sync. Position Mode	Following error	Target Position ignore	
ip Interpolated position	Reserved	Interpolation active	
csv Cyclic Sync. Velocity Mode	Reserved	Target velocity ignore	
pv Profile Velocity Mode			
cst Cyclic 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.

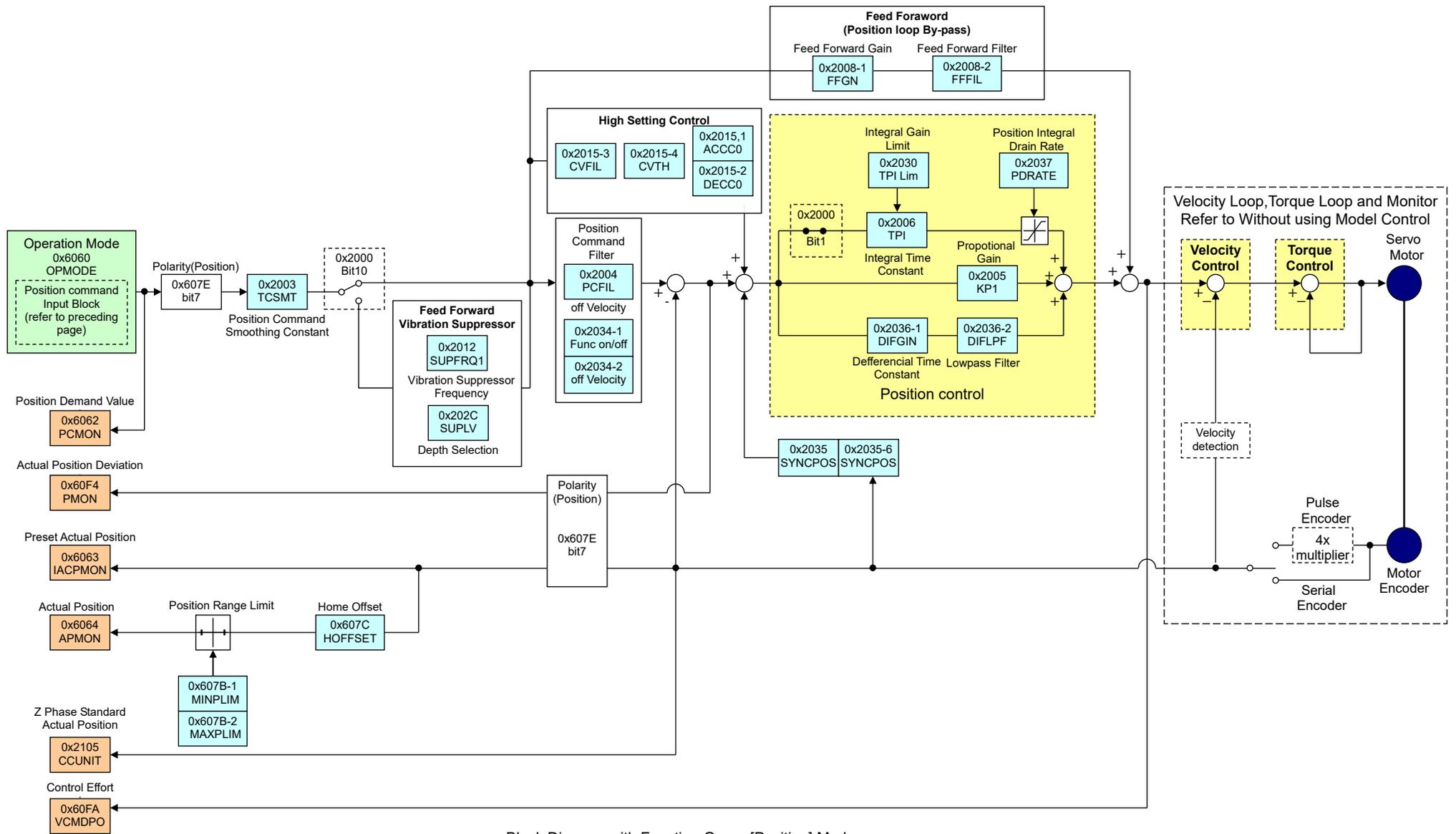
3) Function Group "Position" Mode

# Abstract of Function Group "Position" Mode

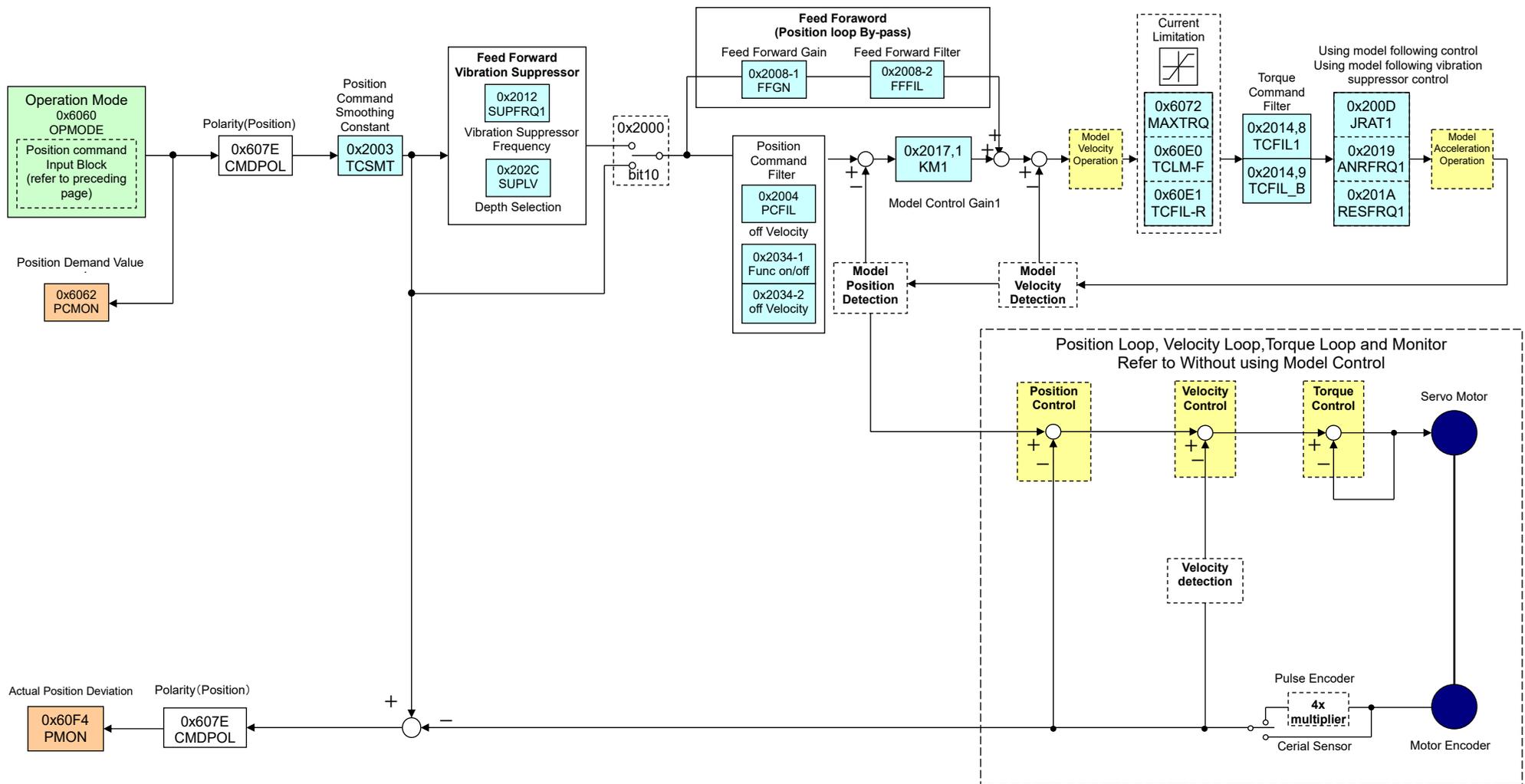
As for function group "Position" operation mode, "Profile position Mode", "Cyclic Synchronous Position Mode" and "Interpolated Position Mode" are supported. 0x6060: Operate "Profile Position Mode" by setting "1" in operation mode, "Cyclic Synchronous Position Mode" by setting "8" and "Interpolated Position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

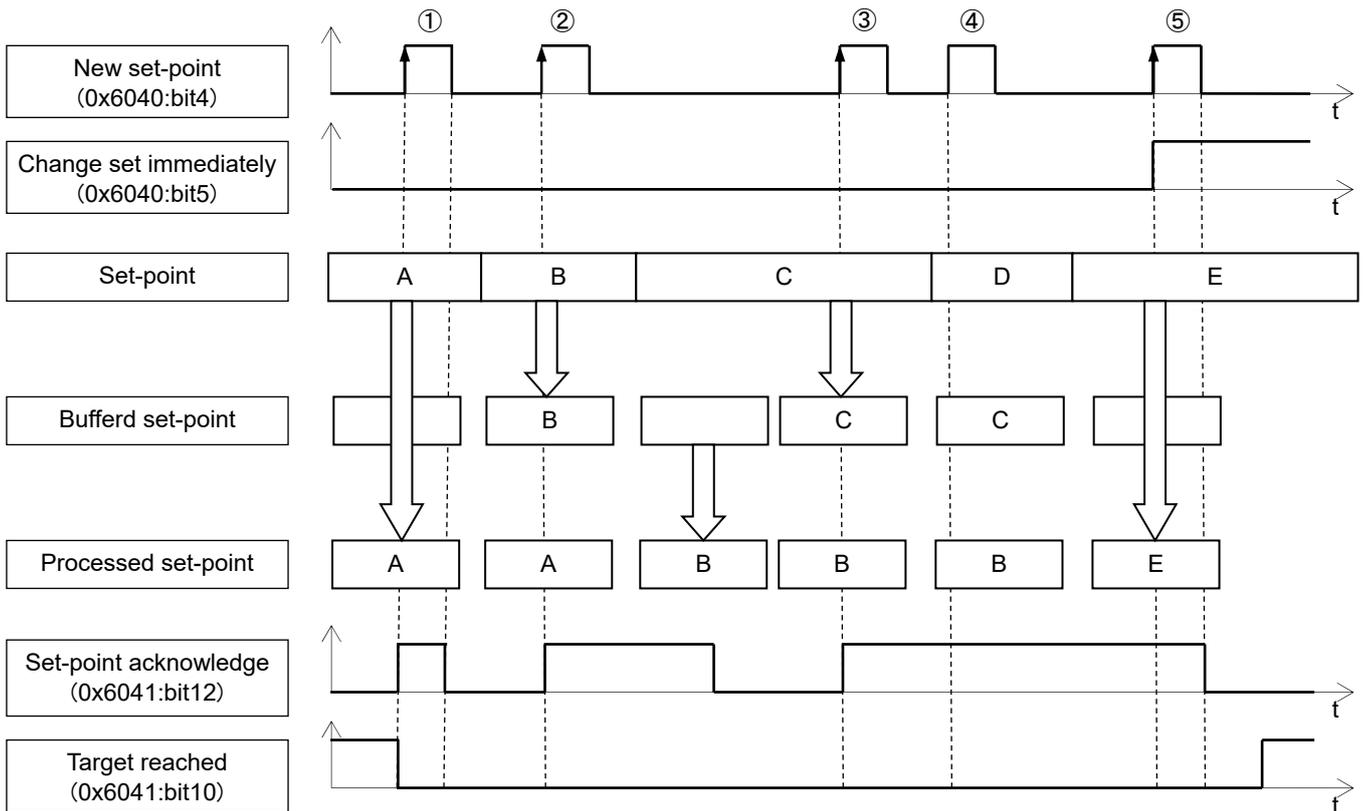
1. Single set point: [Change set immediately bit (0x6040: Control word bit5) = 1]  
 During the set point processing, if a new set-point is set by "New set-point (bit 4)" in Control word, the servo amplifier immediately processes the new set-point.  
 For relative position move, new set-point will be 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.

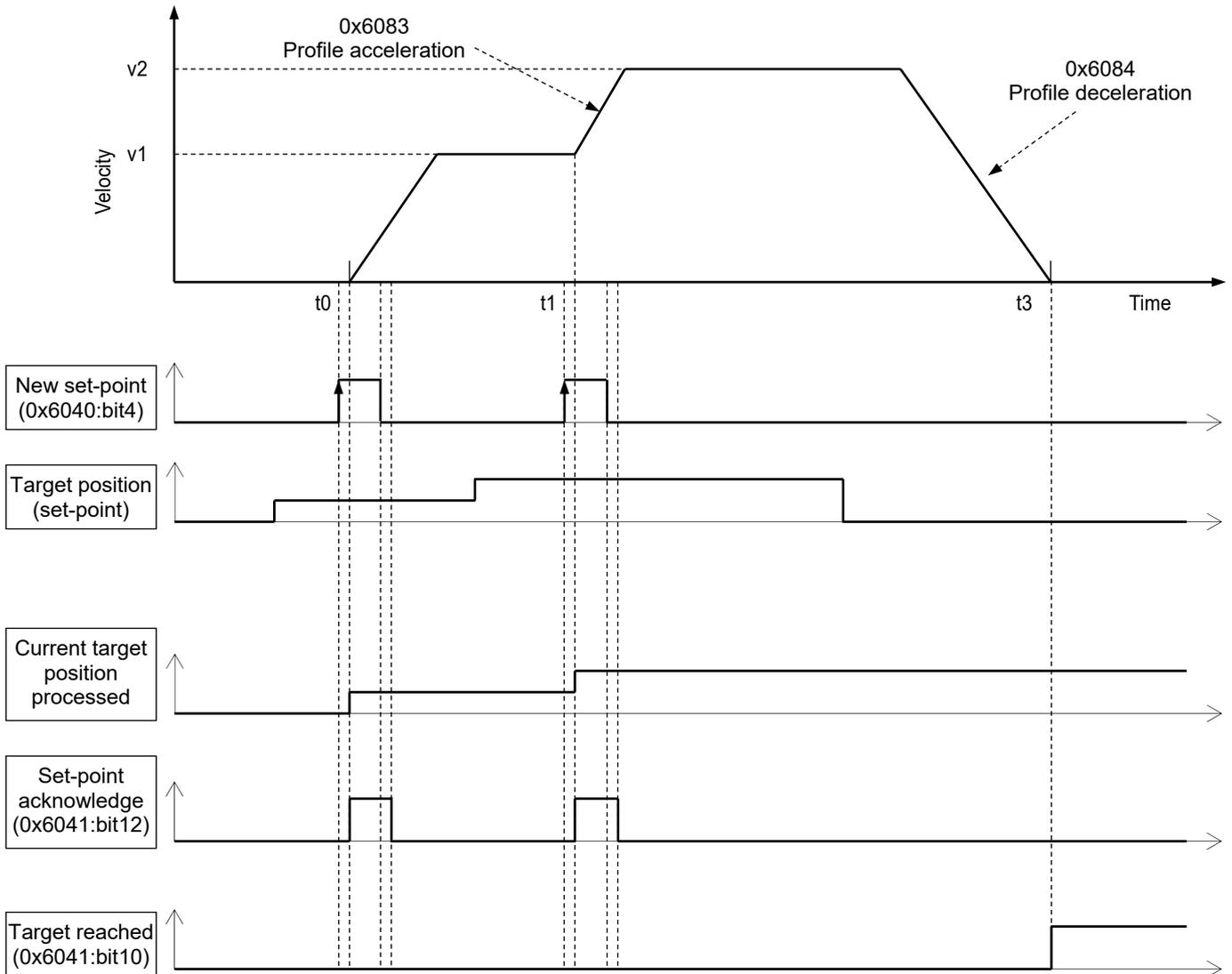


Sequence Diagram for Profile Position Mode

## 7. Object Dictionary

### # 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.

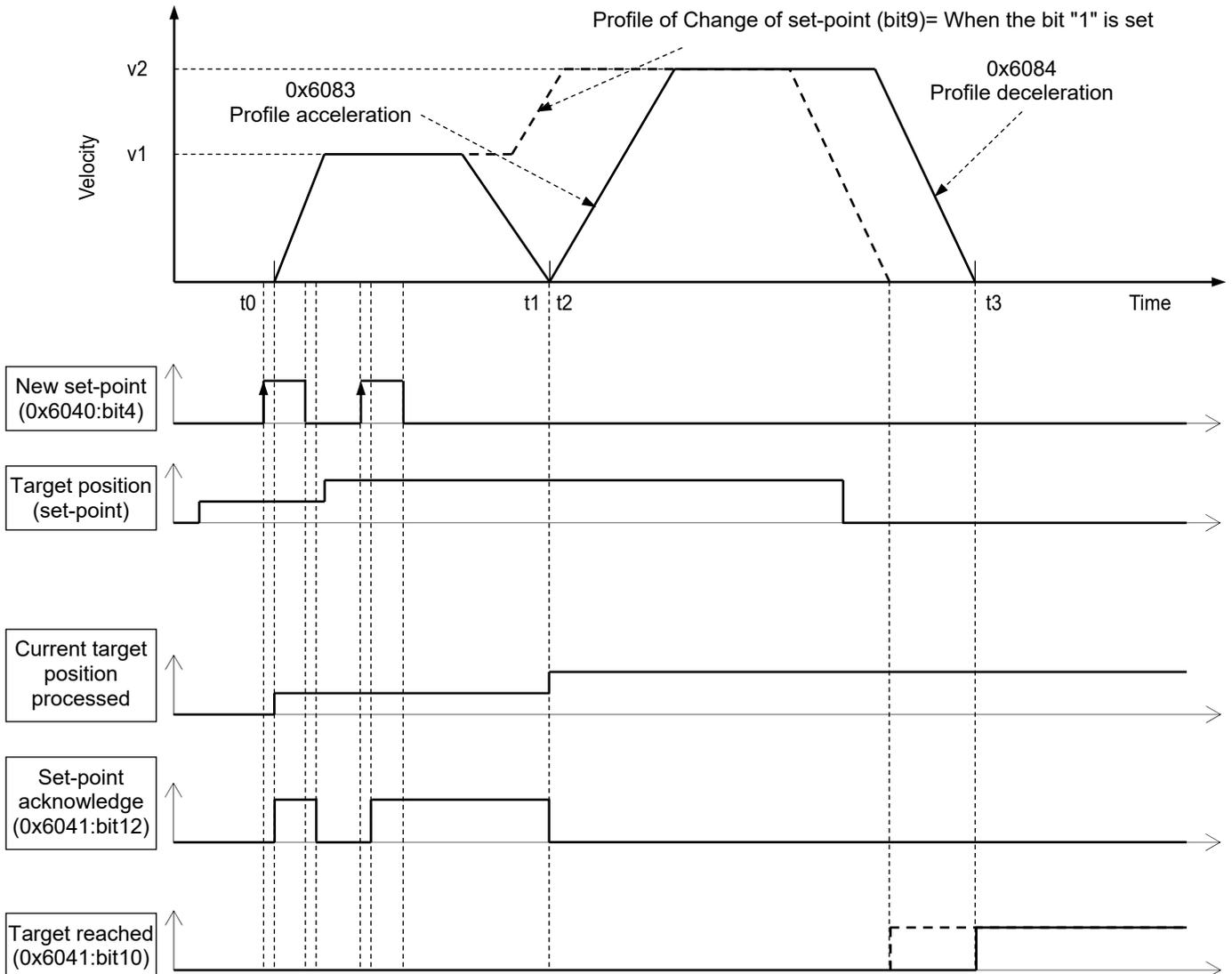


Single set-point (Update a set point immediately)

## 7. Object Dictionary

### # 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.



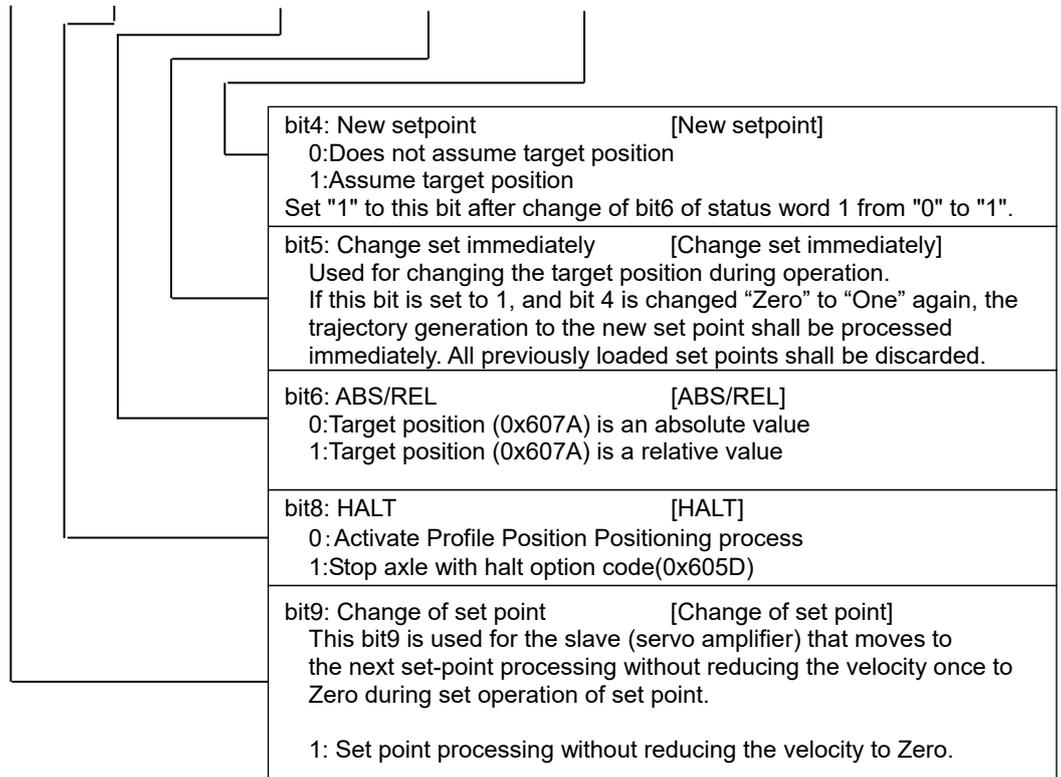
Set of set points (Update to the next set point after completion of a set point)

## 7. Object Dictionary

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

Index	0x6040	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] * See the Command table for "Control word bit pattern (Bit 7, 3, 2,1, 0,)	Unsigned16	RW	Possible	0x0000
			Range	0x0000-0xFFFF		

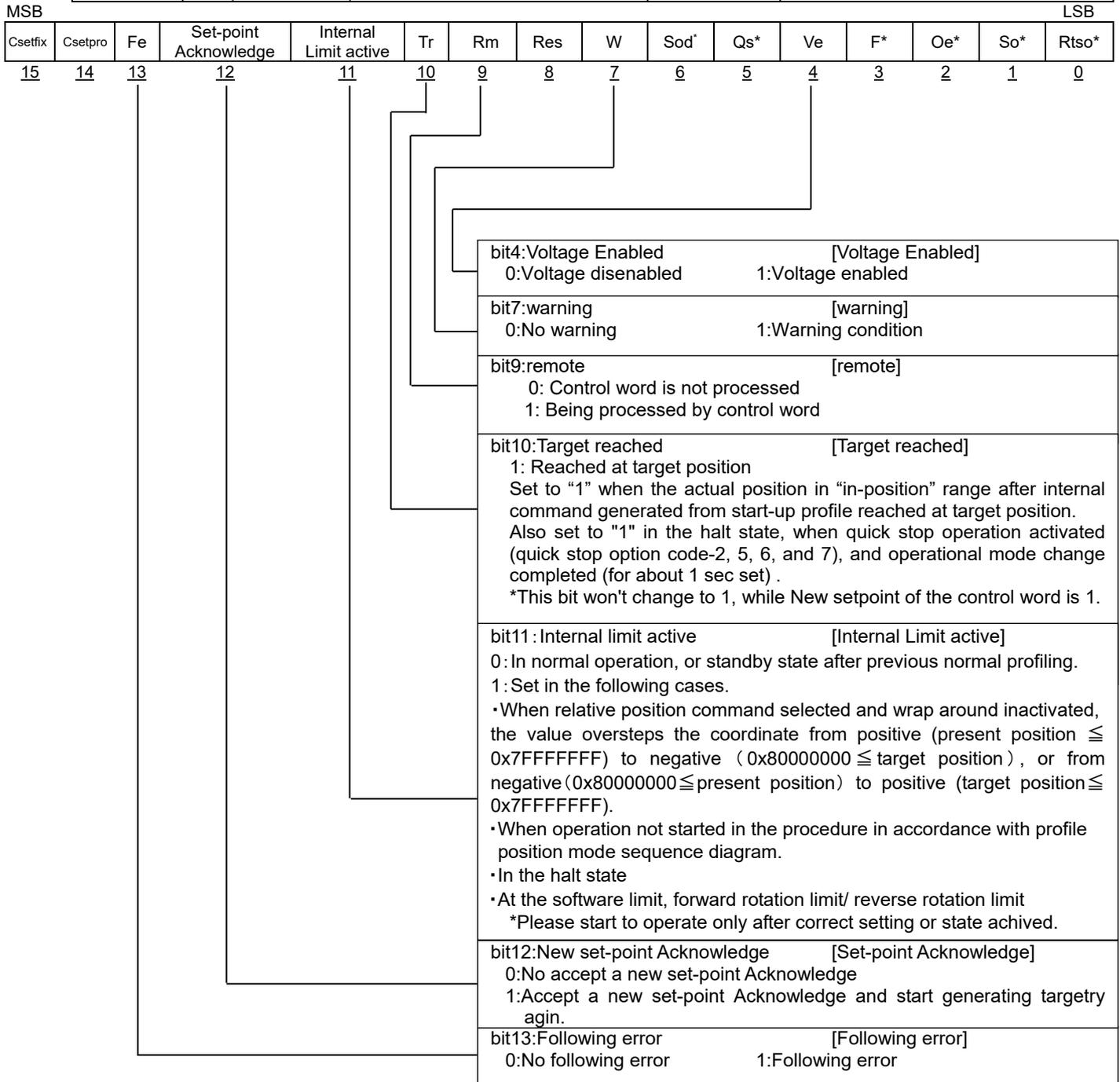
MSB													LSB	
Cseten	-	Eclr	-	Change of set-point	Halt	Fr*	Abs / Rel	Change set immediately	New Set point	Hs*	qs*	ev*	so*	
15	14..13	12	11..10	9	8	7	6	5	4	3	2	1	0	



## 7. Object Dictionary

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

Index	0x6041	This object indicates Operation Mode Specific bit and Manufacturer Specific bit of the Profile Position mode (pp).	Object code	Variable
Sub-Idx	0x00	Status Word [STSWORD] * See the Pattern Status table for "Status word bit pattern (Bit 6,5, 3,2,1,0.)"	Access	Initial value
			RO	0x0000
			Range	0x0000-0xFFFF

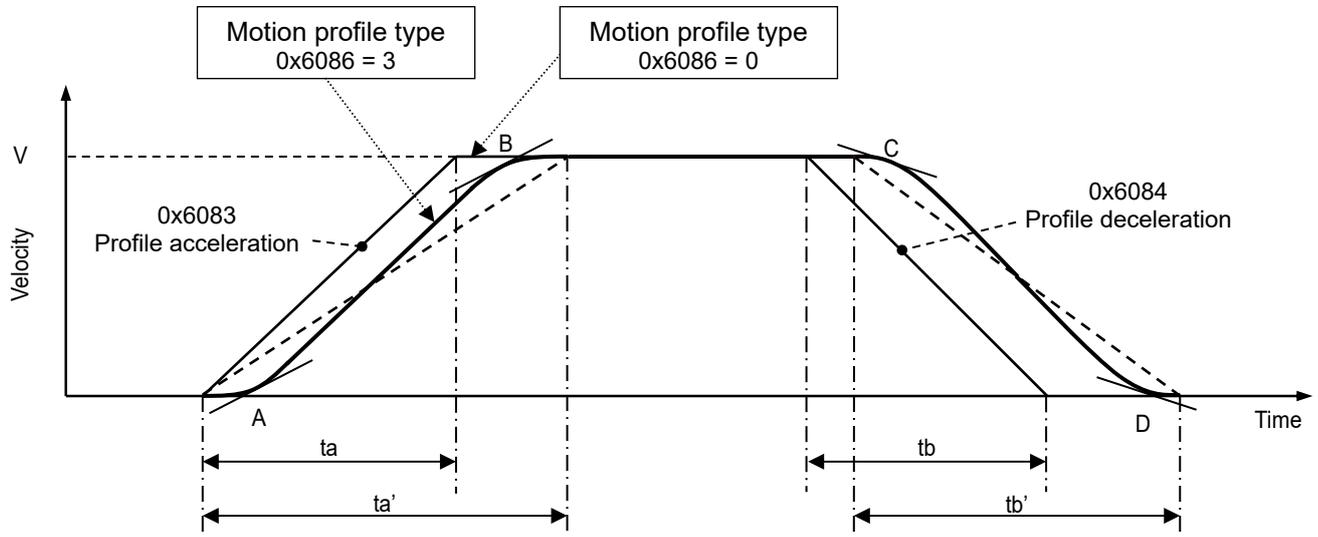


## 7. Object Dictionary

### & 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.



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	0x6086	Motion Profile Type	Object Code			Variable
Sub-Idx	Description		Data Type	Access	PDO	Initial Value
0x00	Motion Profile Type		Integer16	RW	Possible	0x0000
Sets up type of motion profile operation.			Setting Range			0x0000, 0x0003 (0 or 3)
<u>0x0000: Linear ramp (trapezoidal profile)</u> <u>0x0003: Jerk-limited ramp</u>						

#### 0x60A3: Profile Jerk Use

Index	0x60A3	Profile Jerk Use	Object Code			Variable																		
Sub-Idx	Description		Data Type	Access	PDO	Initial Value																		
0x00	Profile Jerk Use		Unsigned8	RW	No	0x01																		
Sets up combinations of sub index numbers of profile jerk object (0x60A4) for jerk profile operation.			Setting Range			0x01-0x02 (1 or 2)																		
		<table border="1"> <thead> <tr> <th rowspan="2">Value of 0x60A3</th> <th colspan="4">Jerk assignment Value (Sub Index Number of 0x60A4)</th> </tr> <tr> <th>A</th> <th>B</th> <th>C</th> <th>D</th> </tr> </thead> <tbody> <tr> <td>0x01</td> <td>0x01</td> <td>0x01</td> <td>0x01</td> <td>0x01</td> </tr> <tr> <td>0x02</td> <td>0x01</td> <td>0x01</td> <td>0x02</td> <td>0x02</td> </tr> </tbody> </table>				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
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	0x60A4	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 Sets up value of jerk 1. Sets up variation of the acceleration/deceleration per second.		Unsigned32	RW	No	0xFFFFFFFF
			Setting range			0x00000000-0xFFFFFFFF (0 to 4294967295 pps <sup>3</sup> )
0x02	Profile Jerk 2 Sets up value of jerk 2. Sets up variation of the acceleration/deceleration per second.		Unsigned32	RW	No	0xFFFFFFFF
			Setting range			0x00000000-0xFFFFFFFF (0 to 4294967295 pps <sup>3</sup> )

## 7. Object Dictionary

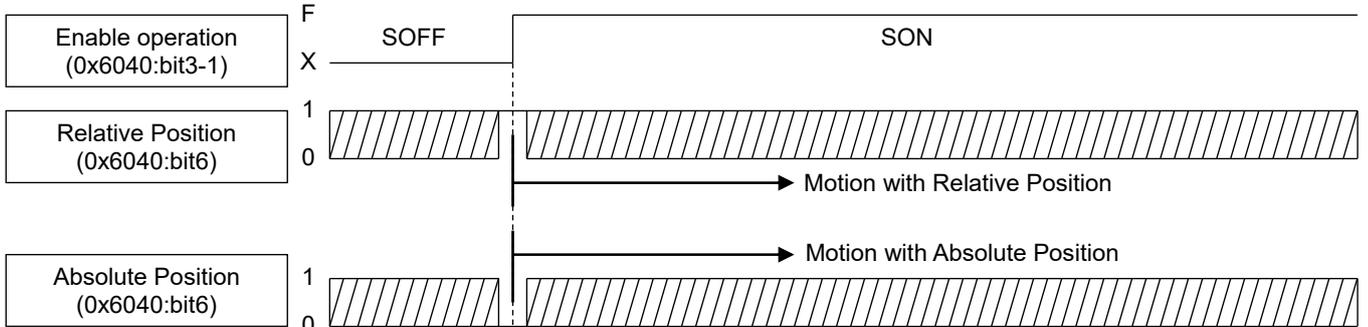
### 5) Cycle Synchronization Position Mode

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).

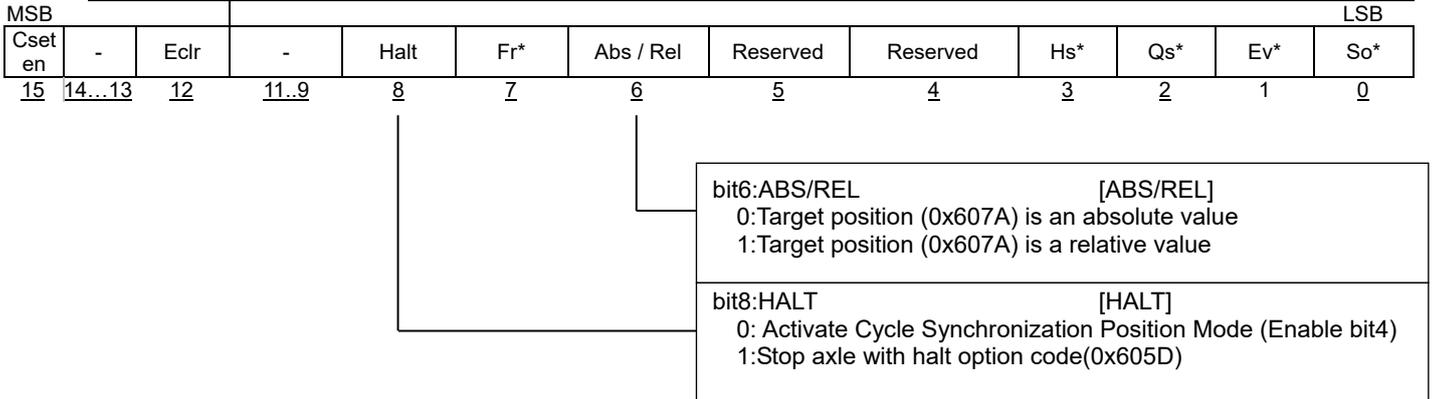
Velocity offset and Torque (force) offset are used for as Additive velocity value and Additive torque (force) value, then the Position offset function calculates offset value for the new target position.

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	0x6040	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] * See the Pattern command table for "Control word bit pattern (Bit7,3,2,1,0)		Unsigned16 Range	RW	Possible	0x0000 0x0000-0xFFFF

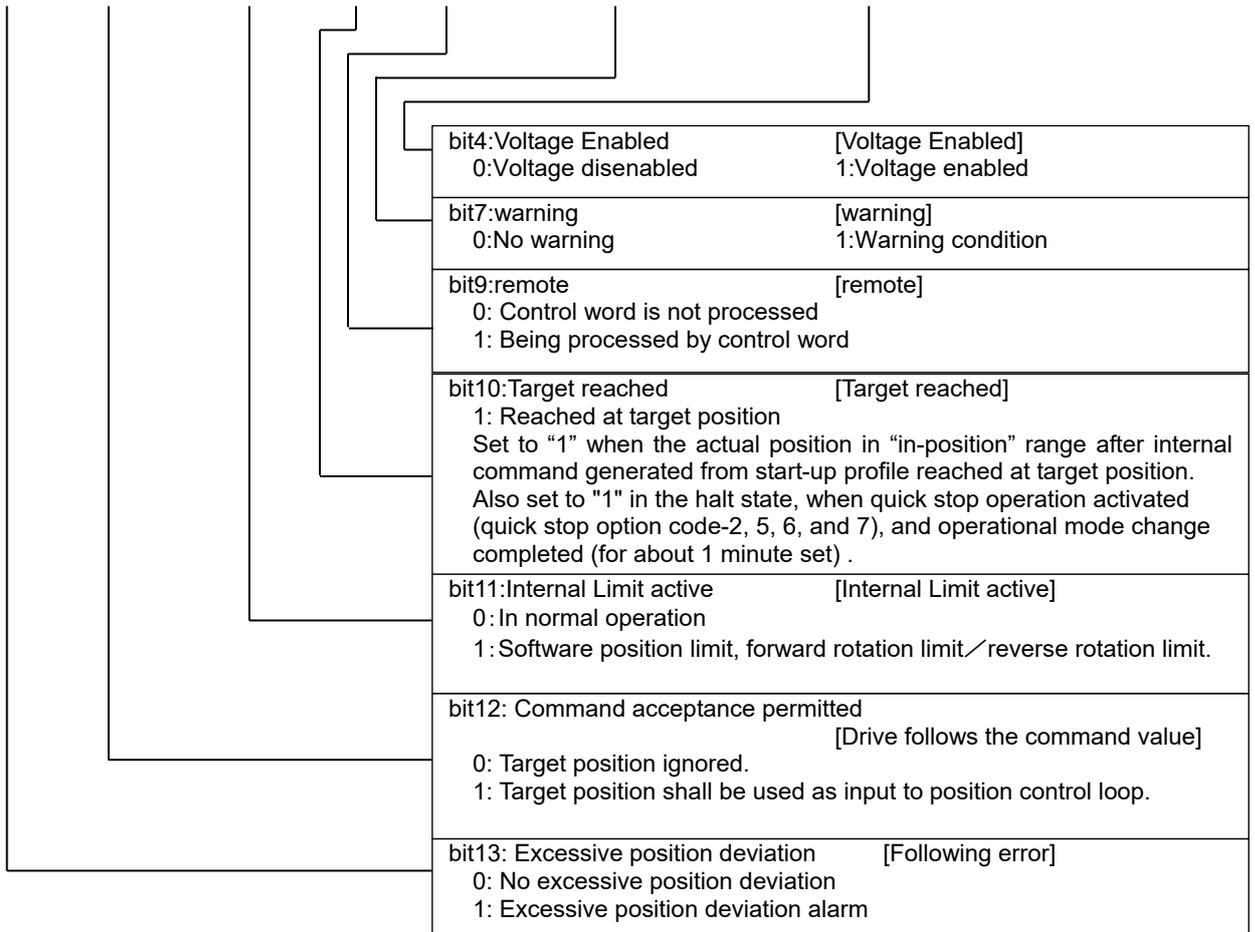


## 7. Object Dictionary

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

Index	0x6041	This object indicates Operation Mode Specific bit and Manufacturer Specific bit under Cyclic Sync. Position Mode (csp).	Object code	Variable	
Sub-Idx	Description		Access	PDO	Initial value
0x00	Status Word [STSWORD] *See the Pattern status table for "Status word bit" (Bit6,5, 3,2,1,0)		RO	Possible	0x0000
Range			0x0000-0xFFFF		

MSB																LSB															
Csetfix	Csetpro	Fe	Drive follows the command value	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																



## 7. Object Dictionary

### 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.

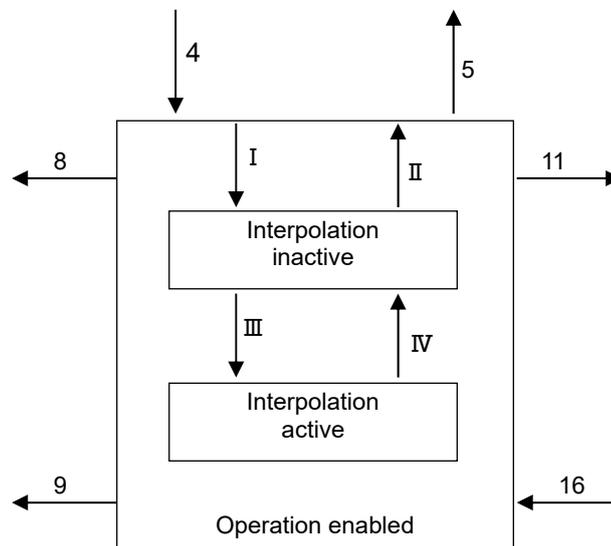
There are 2 kinds of buffer format, FIFO (first-in-first-out) and Ring. Ring buffers can be used for circular operation.

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 of Interpolated position mode



FSA status and FSAsstate 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)"

## 7. Object Dictionary

### # Interpolation sub mode select (0x60C0)

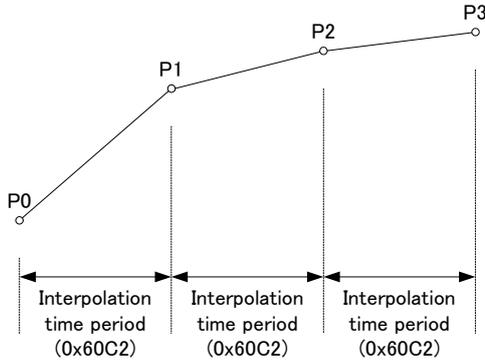
This servo amplifier corresponds to two kinds of interpolation methods. Select by using interpolation sub mode select (0x60C0).

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.

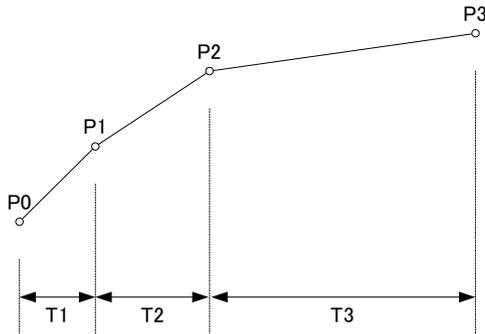


Buffer	
Interpolation Position Target 0x60C1-1	Interpolation Time 0x60C1-2
P0	-
P1	-
P2	-
P3	-

#### • 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.

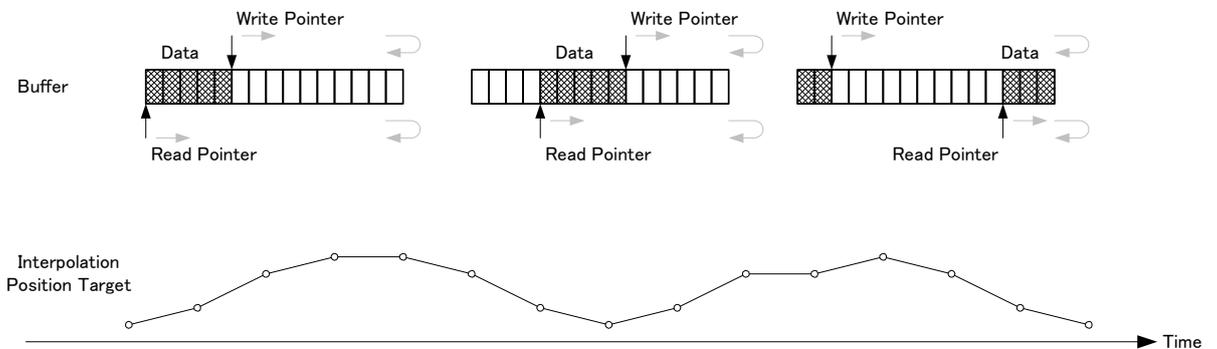


Buffer	
Interpolation Position Target 0x60C1-1	Interpolation Time 0x60C1-2
P0	T0
P1	T1
P2	T2
P3	T3

## 7. Object Dictionary

# Usage when buffer format is set to FIFO

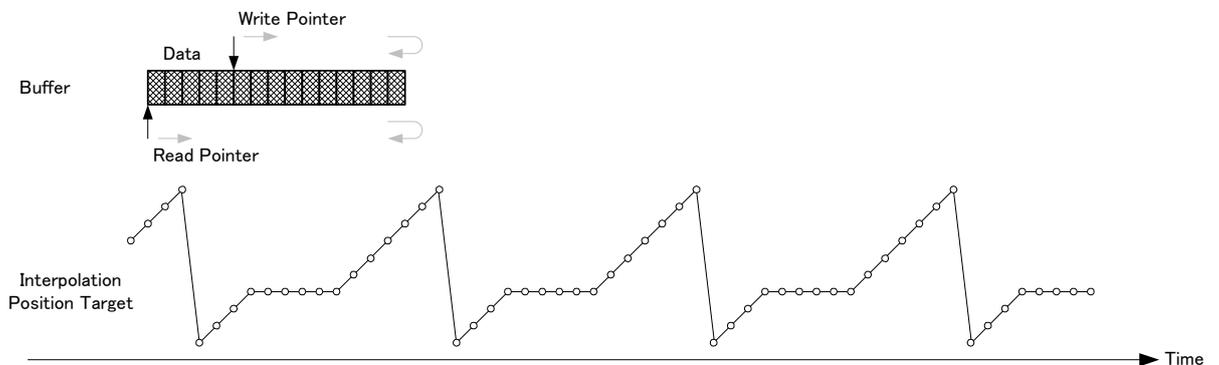
- (1) Set communication cycle time on Index 0x1C32-2.
- (2) Set Interpolation sub mode select (0x60C0).
- (3) When setting interpolation sub mode select at 0, set interpolation time period (0x60C2). Interpolation time period is the cycle in which the servo amplifiers read interpolation position target 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, 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) =1 of Control Word (0x6040).
  - Stop renewing interpolation position target.
  - Set Interpolation time at 0. (In the case that interpolation sub mode select is -1)



## 7. Object Dictionary

# Usage when buffer format is set to Ring

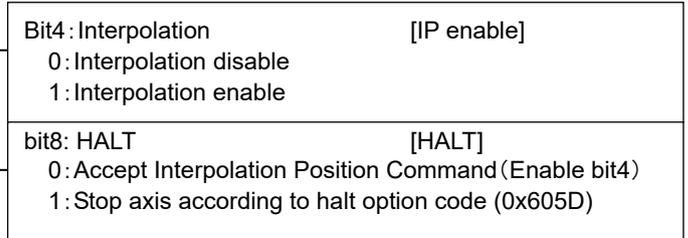
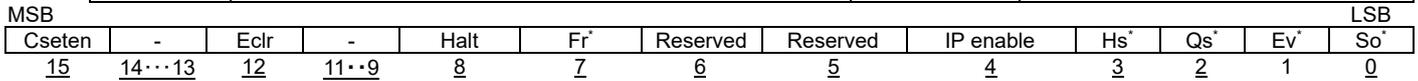
- (1) Sets communication cycle time on Index 0x1C32-2.
- (2) Set Interpolation sub mode select (0x60C0).
- (3) When setting interpolation sub mode select at 0, set interpolation time period (0x60C2). Interpolation time period is the cycle in which the servo amplifiers read interpolation position target 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) =1 of Control Word (0x6040).
  - Stop renewing interpolation position target.
  - Set interpolation Time at 0. (In the case that interpolation sub mode select is -1)



## 7. Object Dictionary

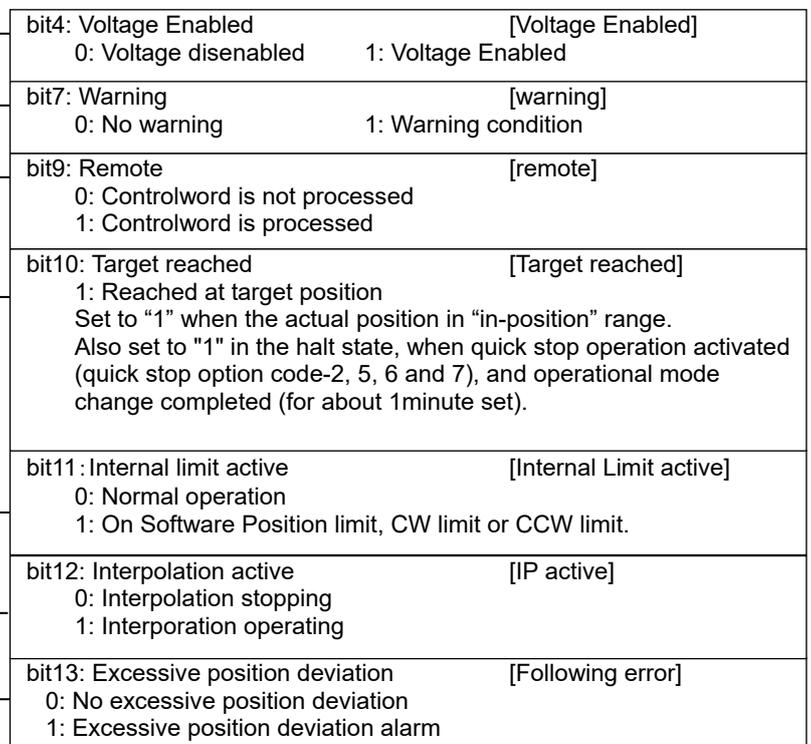
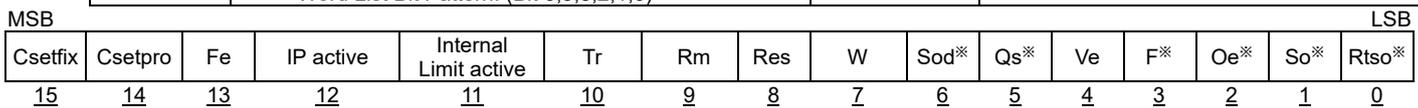
0x6040: Control word (Interpolated Position Mode: ip)

Index	0x6040	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] Note) For details on Bit 7,3,2,1 and 0, see the table of Control Word Bit Pattern Command.		Unsigned16 Range	RW	Possible	0x0000
			0x0000 - 0xFFFF			



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

Index	0x6041	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] Note) 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 Range	RO	Possible	0x0000
			0x0000 - 0xFFFF			



## 7. Object Dictionary

### 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.

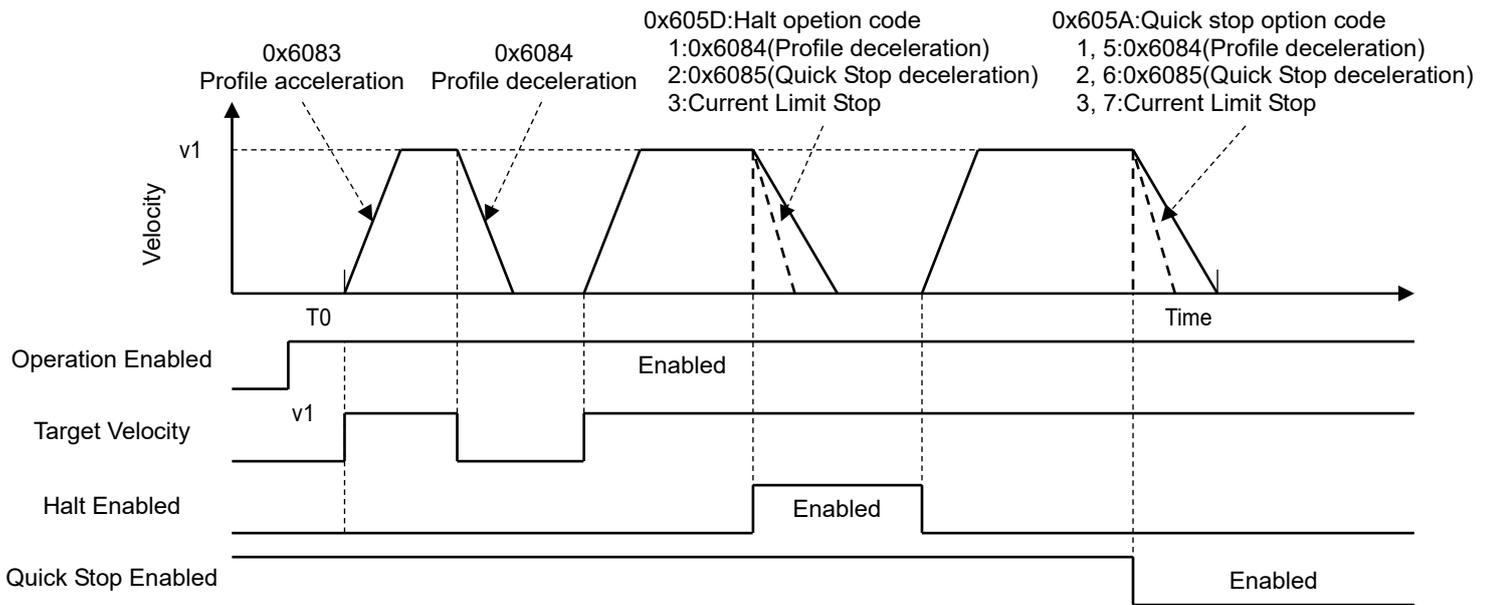
And also, when the bit is "6" in Homing mode, the slave performs Returning to the origin position in Velocity mode.

### 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.

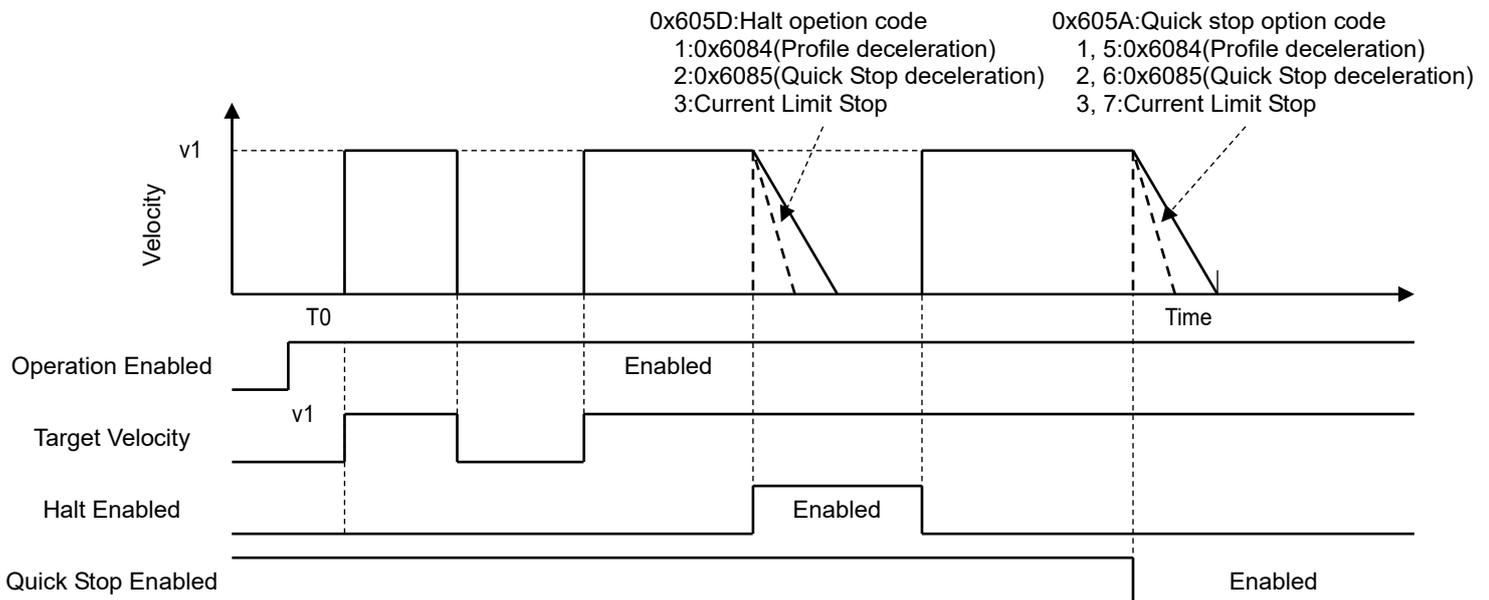


### 9) Cyclic Synchronous Velocity Mode

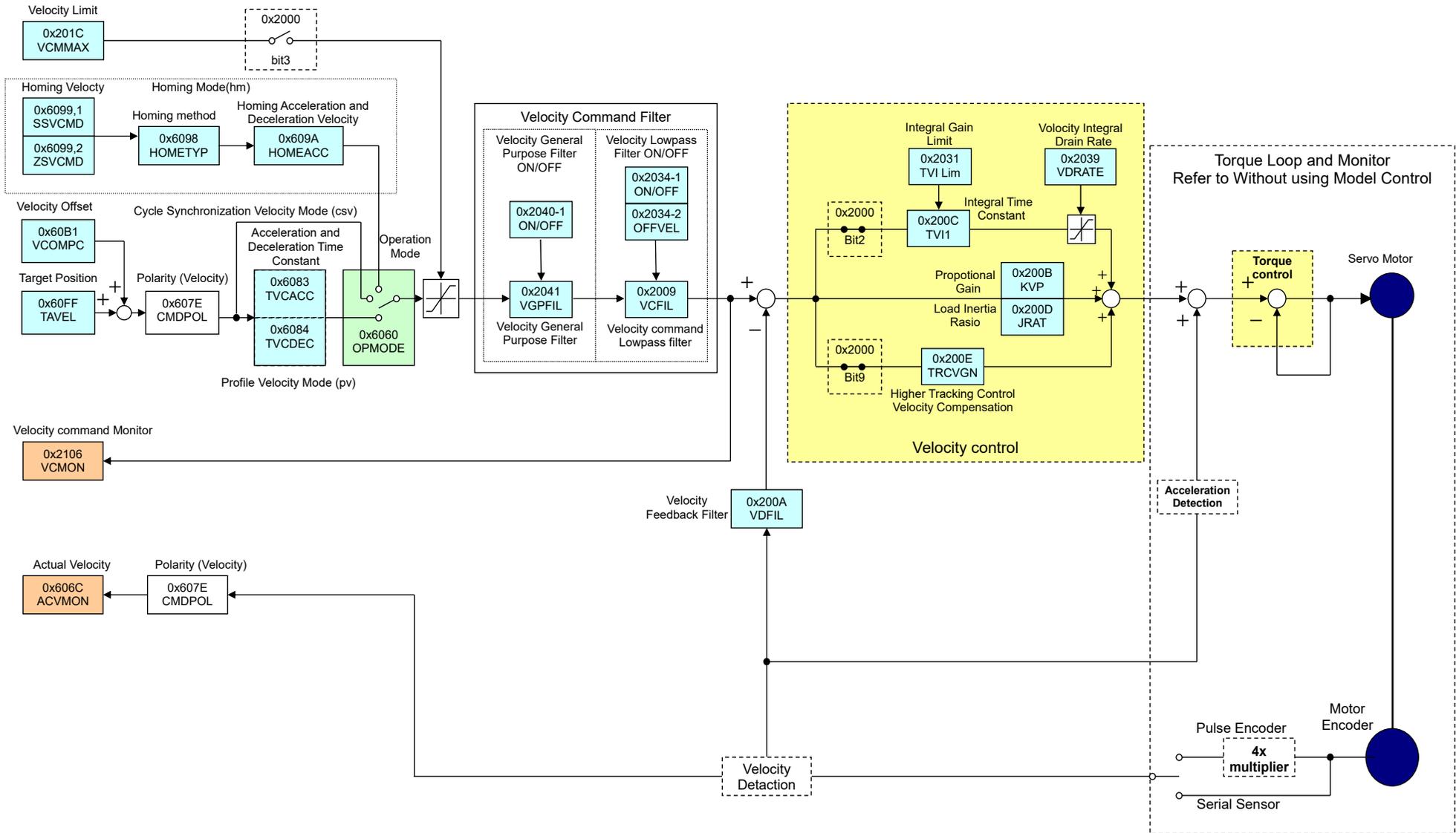
In this mode, trajectory is generated by the master, not the slave.

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.

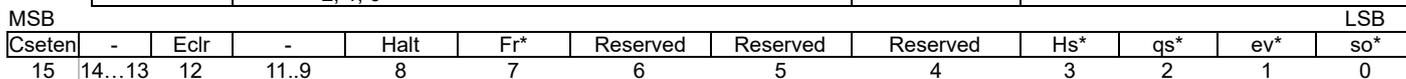


Block Diagram with Function Group [Velocity] [Homing] Mode

## 7. Object Dictionary

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

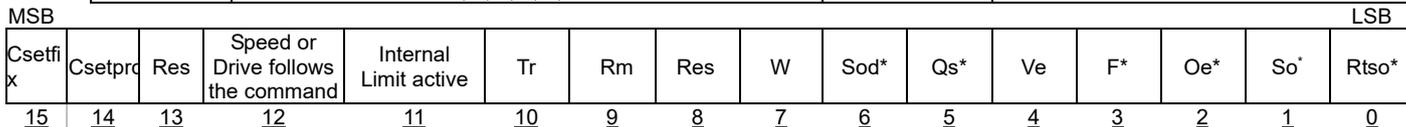
Index	0x6040	This object shall indicate the operation mode specific and manufacturer specific bit in Cyclic Sync-position mode (csv), Profile velocity mode (pv)	Object code	Variable
Sub-Idx	0x00	Control word [CWORD] Note) See the bit pattr command list for the detail on Bit 7, 3, 2, 1, 0	Data Type Unsigned16 Range	Access RW PDO Possible Initial value 0x0000 0x0000-0xFFFF



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 Manufacturerer specific bits in Cyclic Shunc. Mode (csv) and Profile velocity (pv)mode.	Object code	Variable
Sub-Idx	0x00	Status Word [STSWORD] Note) See the Status word bit patterns status lists for the details on Bit 6, 5, 3, 2, 1, 0	Data Type Unsigned16 Range	Access RO PDO Possible Initial value 0x0000 0x0000-0xFFFF



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: Normal operation  
1: Software Position limit, CW limit/CCW limit

bit12: Command acceptance permitted [Drive follows the command value] (CSV)  
0: Target velocity ignored.  
1: Target velocity to be used as velocity control loop input.

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

## 7. Object Dictionary

### 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)

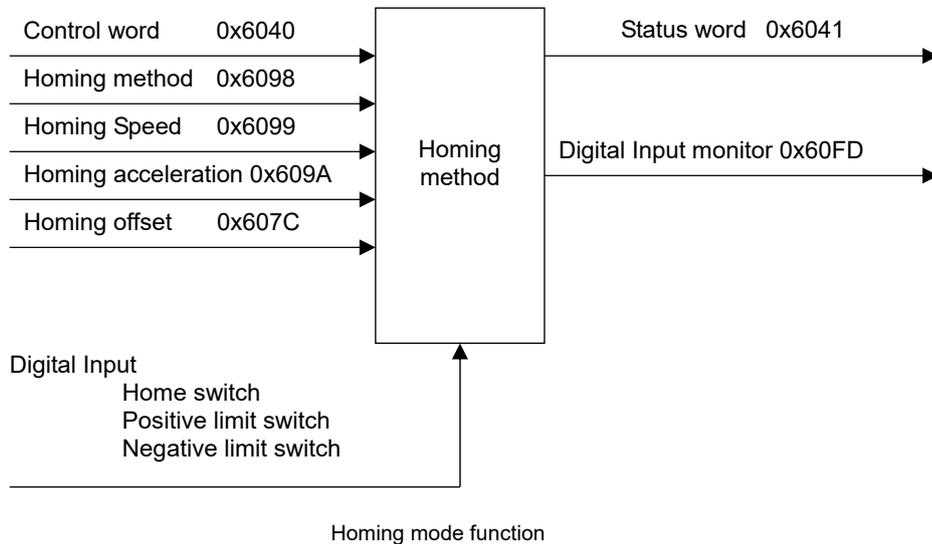
Input objects are defined as well as the output objects. The user may specify the speed, acceleration and the method of homing. There is a further object home offset, which allows the user to displace zero in the user's coordinate system from the home position.

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 values for homing speed (0x6099): faster speed for home switch searching (Sub-Index1), and slower speed for index pulse searching (Sub-Index2). For the homing speed, set larger value than the speed zero range (0x2020). Homing might not perform correctly if smaller value than the speed zero range is set.

Here is the Objects list in the Homing mode.

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



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 and the right is the maximum position.)

## 7. Object Dictionary

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

Method	Homing Mode	Stop direction	Function
-4	Homing on hard stop (Butt) and index pulse in negative direction	positive	Supported
-3	Homing on hard stop (Butt) and index pulse in positive direction	negative	Supported
-2	Homing on hard stop (Butt) in positive direction	negative	Supported
-1	Homing on hard stop (Butt) in negative direction	positive	Supported
0	Undefined homing methods	-	-
1	Homing on negative limit switch and index pulse	positive	Supported
2	Homing on positive limit switch and index pulse	negative	Supported
3	Homing on positive home switch and index pulse	negative	Supported
4	Homing on positive home switch and index pulse	positive	Supported
5	Homing on negative home switch and index pulse	positive	Supported
6	Homing on negative home switch and index pulse	negative	Supported
7	Homing on positive limit switch, homing on positive home switch and index pulse	negative	Supported
8	Homing on positive limit switch, homing on positive home switch and index pulse	positive	Supported
9	Homing on positive limit switch, homing on negative home switch and index pulse	negative	Supported
10	Homing on positive limit switch, homing on negative home switch and index pulse	positive	Supported
11	Homing on negative limit switch, homing on positive home switch and index pulse	positive	Supported
12	Homing on negative limit switch, homing on positive home switch and index pulse	negative	Supported
13	Homing on negative limit switch, homing on negative home switch and index pulse	positive	Supported
14	Homing on negative limit switch, homing on negative home switch and index pulse	negative	Supported
17	Homing on negative limit switch	positive	Supported
18	Homing on positive limit switch	negative	Supported
19	Homing on positive home switch	positive	Supported
20	Homing on positive home switch	negative	Supported
21	Homing on negative home switch	positive	Supported
22	Homing on negative home switch	negative	Supported
23	Homing on positive limit switch and Homing on positive home switch	negative	Not Supported
24	Homing on positive limit switch and Homing on positive home switch	positive	Not Supported
25	Homing on positive limit switch and Homing on negative home switch	negative	Not Supported
26	Homing on positive limit switch and Homing on negative home switch	positive	Not Supported
27	Homing on negative limit switch and Homing on positive home switch	positive	Not Supported
28	Homing on negative limit switch and Homing on positive home switch	negative	Not Supported
29	Homing on negative limit switch and Homing on negative home switch	positive	Not Supported
30	Homing on negative limit switch and Homing on negative home switch	negative	Not Supported
33	Homing on the index pulse	negative	Supported
34	Homing on the index pulse	positive	Supported
35	Homing on the current position	-	Supported
37	Homing on the current position	-	Supported
-128 to -5, 15, 16, 31, 32, 36, 38 to 127	Reserved	-	-

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

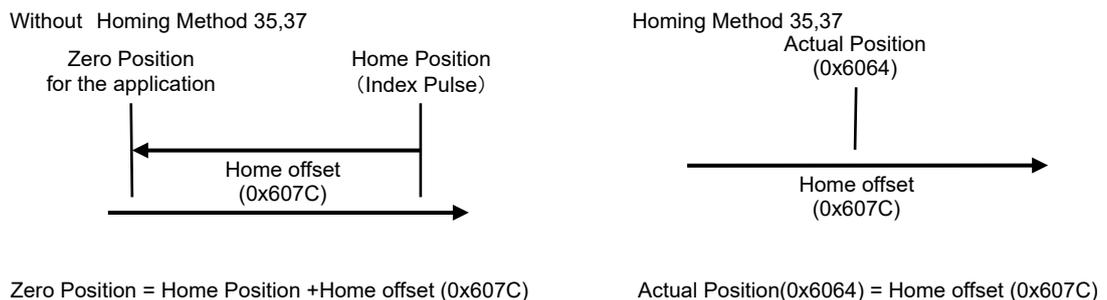
The set homing offset (0x607C) is used to calculate actual position during homing. Homing offset can be always written, however is used only in the homing mode to re-calculate actual position.

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:

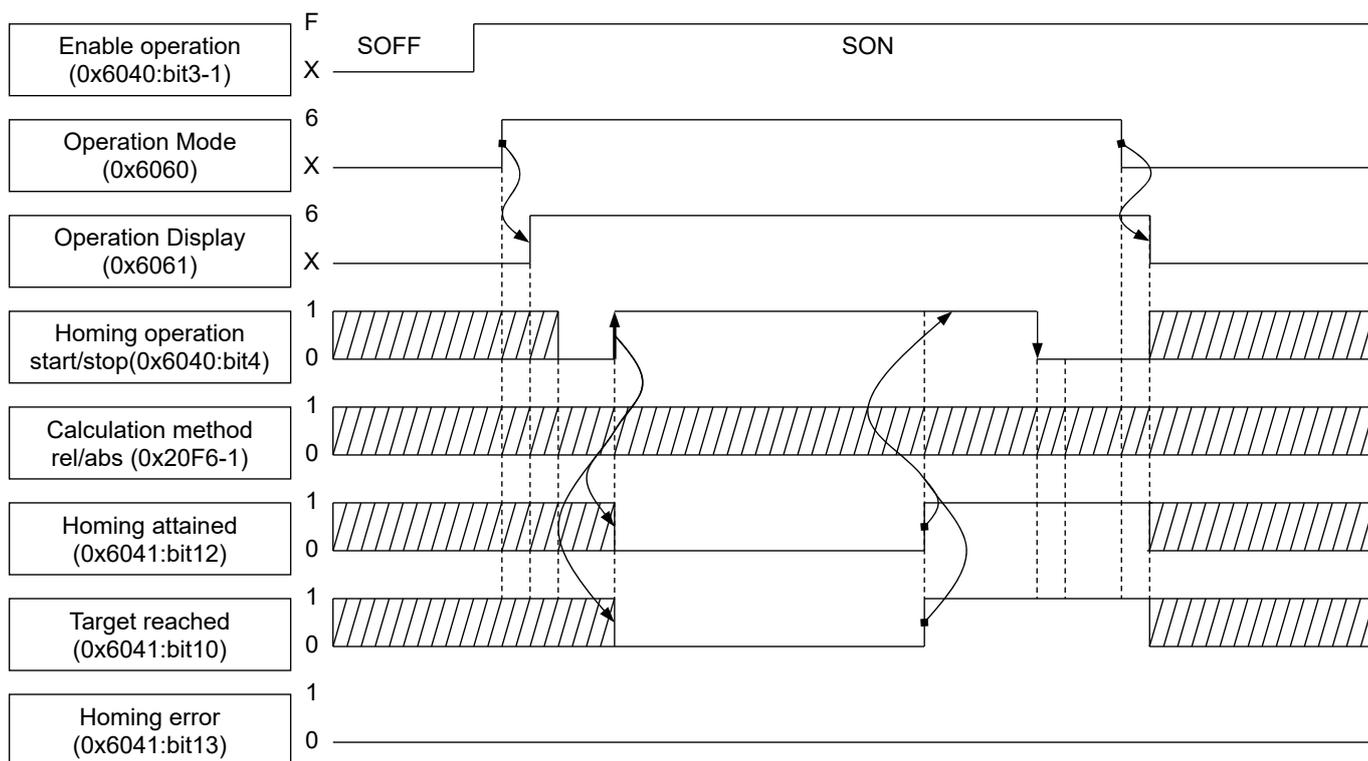


The following figures show sequences in the homing mode of Control word (0x6040), Operation mode (0x6060) and Operation display (0x6061).

## 7. Object Dictionary

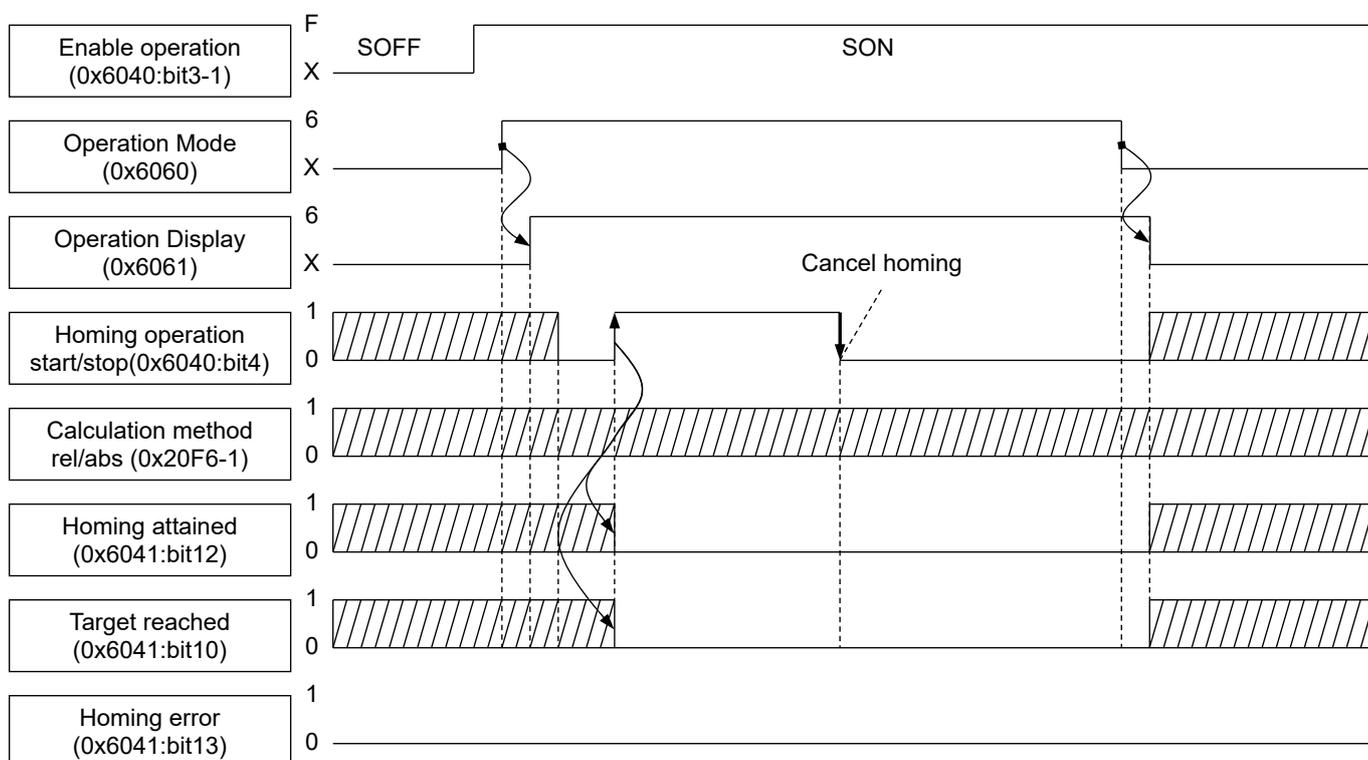
The following sequence shows homing modes corresponding to the Amplifier of Servo Amplifier

### 1) Start and completion sequence of homing mode



Homing sequence

### 2) Cancel before homing completion



Homing Cancel sequence

## 7. Object Dictionary

### # 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 0x20F. And also, the limit switch for the homing direction is determined by the homing method, regardless 0x01: Positive limit switch and 0x02: Negative limit switch in 0x20F8 that were previously loaded and shall be discarded. However, the limit switch that is in the direction of no use actuates the function that is set in 0x20F8.
- 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 all selection of general-purpose input in 0x20F8 as other than "02:CONT1 ON" and "03:CONT1 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

### # Operation direction of homing method

Move/rotation direction (see from motor shaft end) in each homing drawing depends on 0x607E: Polarity.

Move direction in drawing and motor rotation are shown below.

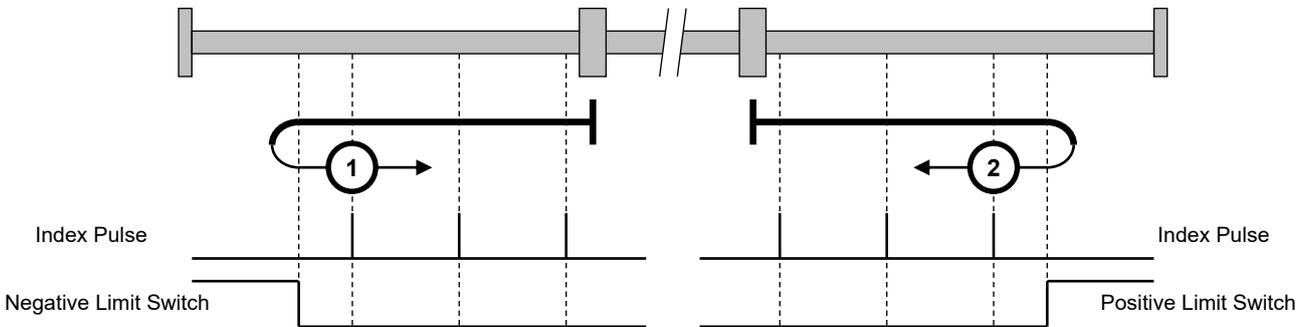
0x607E Polarity	Move to right/ Positive rotation (Actual position increased)	Move to left/ Negative rotation (Actual position decreased)
0x00 (Position polarity Bit7=0)	CW	CCW
0xE0 (Position polarity Bit7=1)	CCW	CW

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

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

Using these method [1] and [2] as shown in the below figure. 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 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

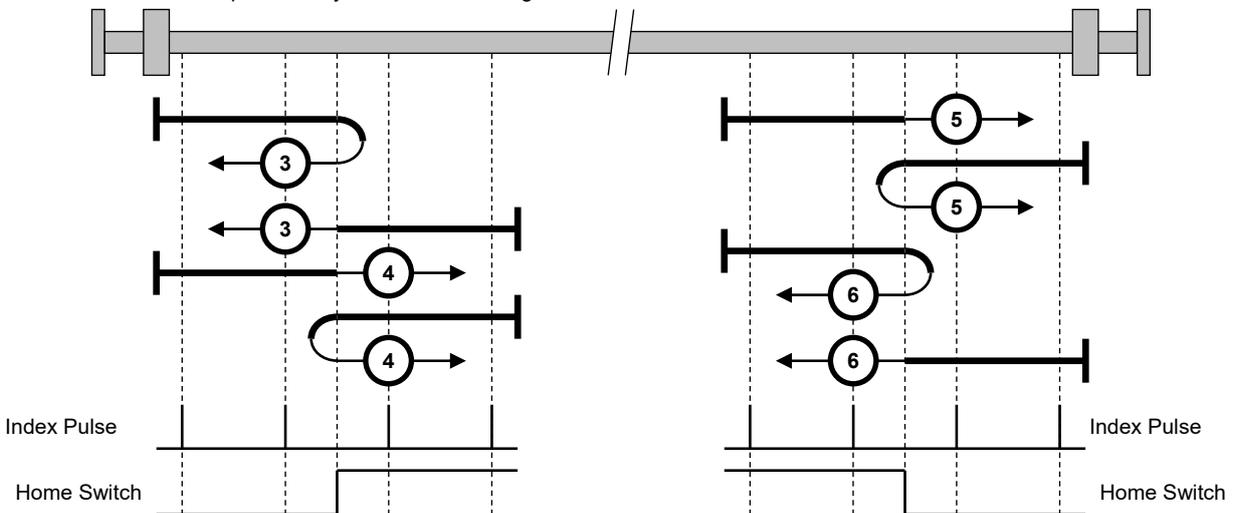
[2] Homing on positive limit switch and index pulse

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)

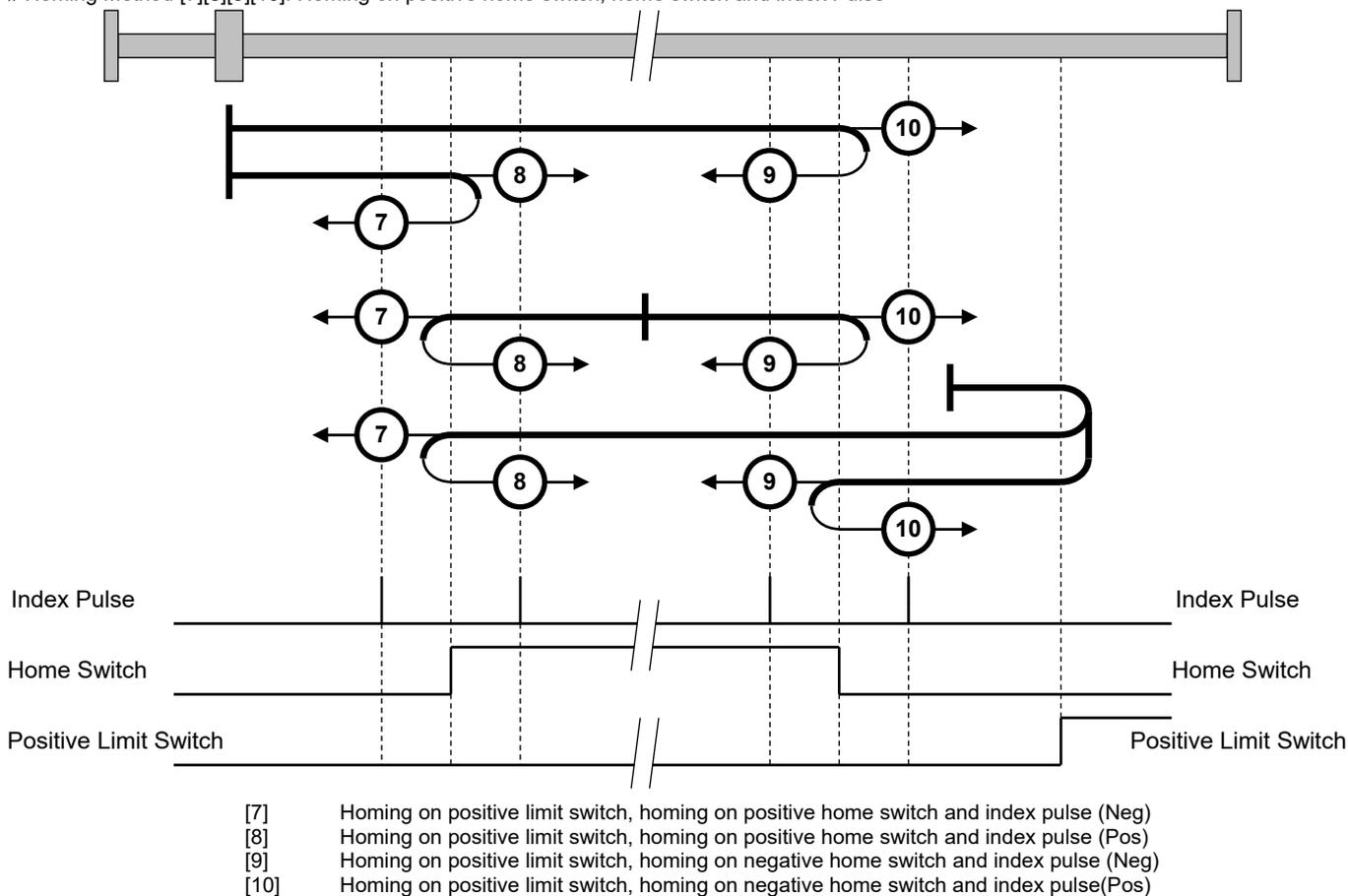
[4] Homing on positive home switch and index pulse (Pos)

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

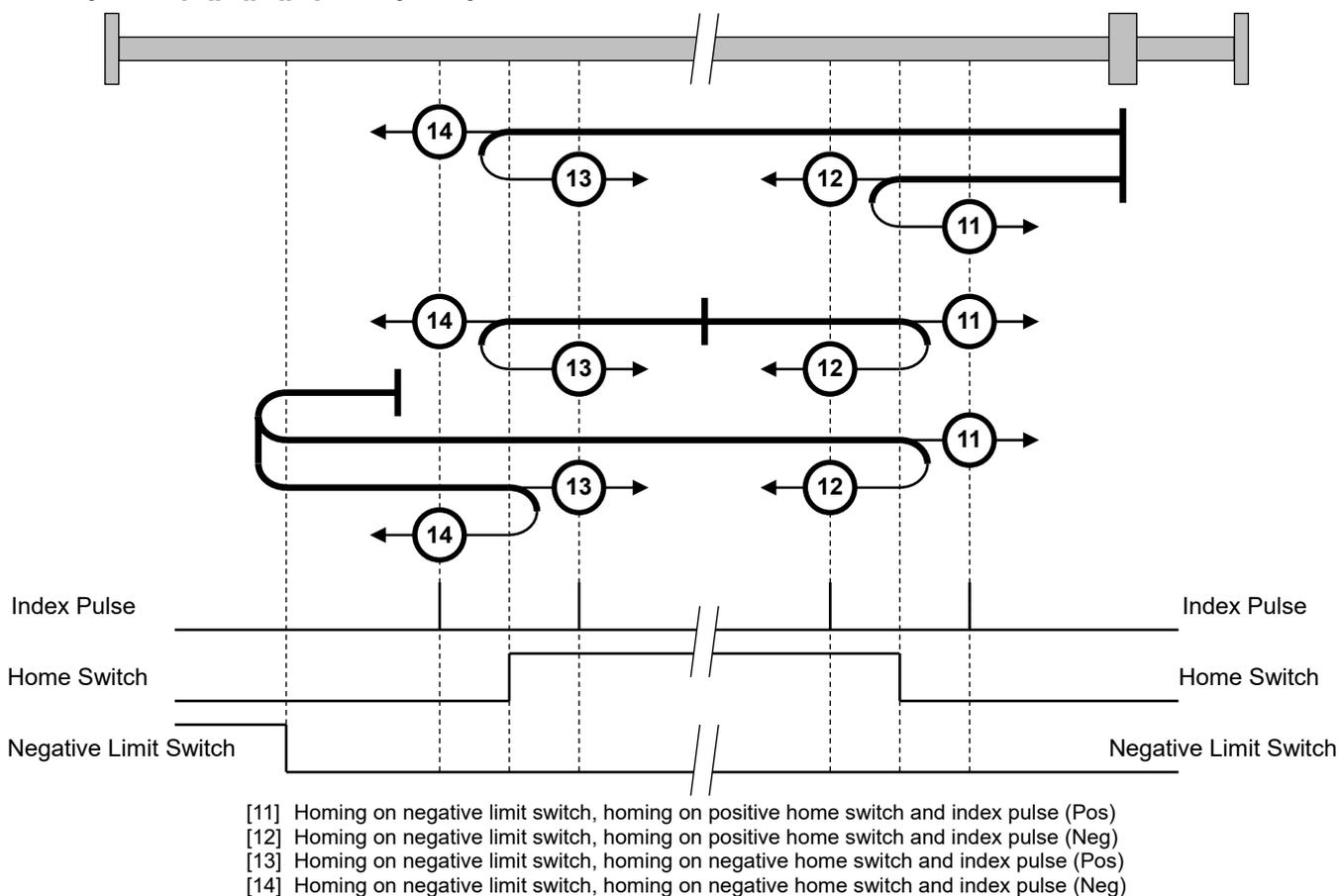
[6] Homing on positive home switch and index pulse (Neg)

## 7. Object Dictionary

# 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

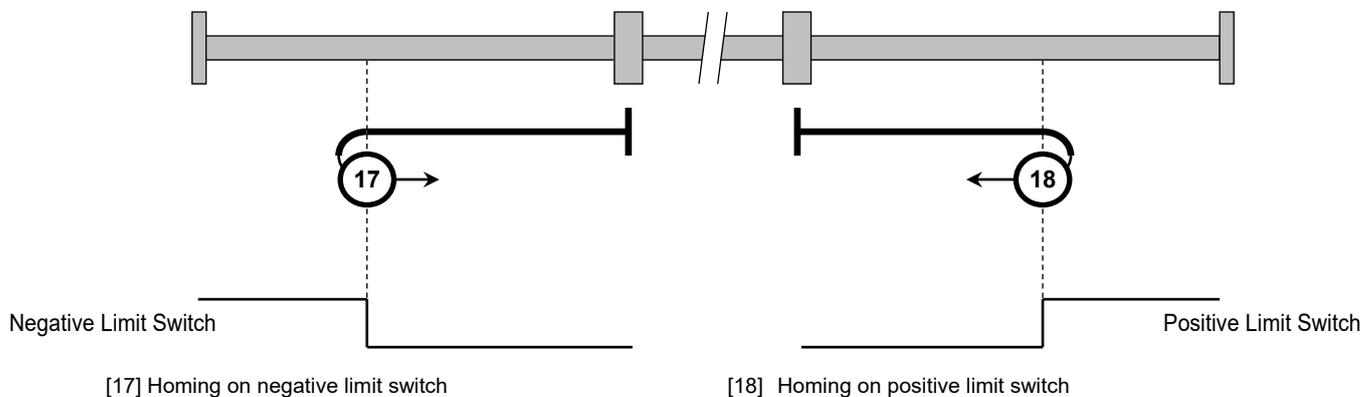


## 7. Object Dictionary

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

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

These methods are similar to methods [1] and [2]. Using these method [17] and [18] as shown in the below figure. 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 position 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 inactive.

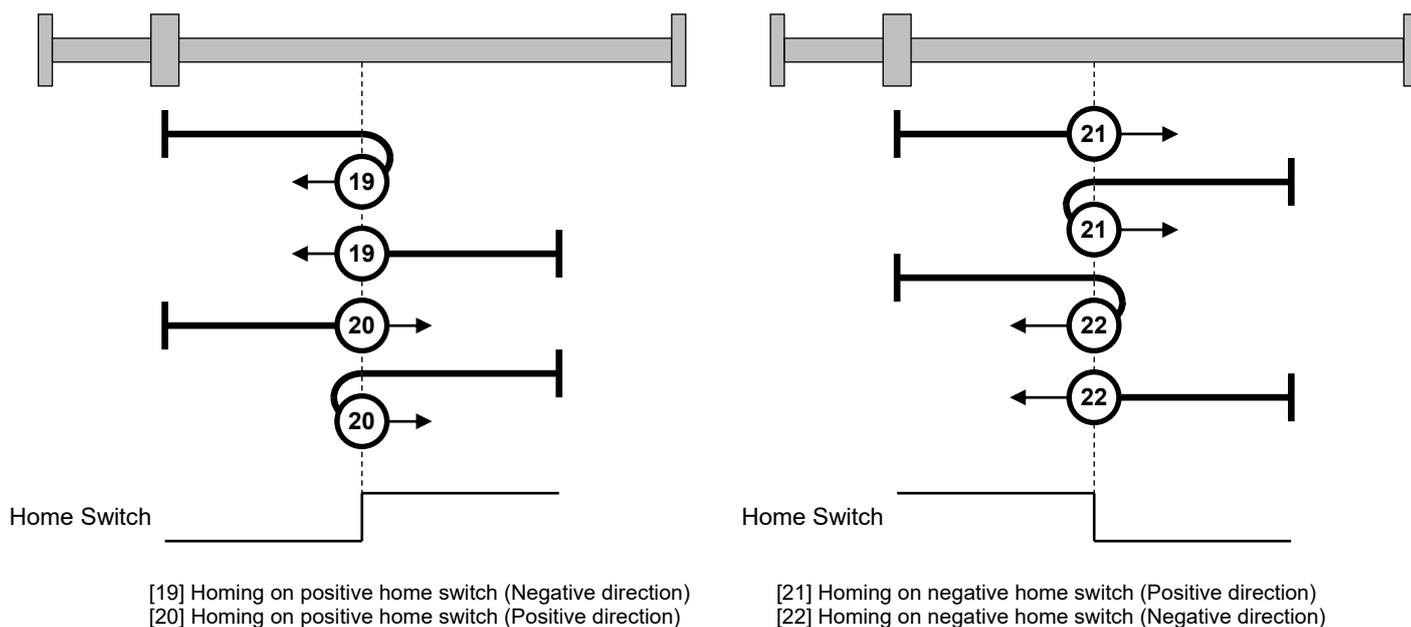


# Homing Method [19][20]: Homing on positive home switch

[21][22]: Homing on negative home switch

Homing without index pulse

These methods are similar to methods 3 to 6 that the home position is not depend on the index pulse but only depend on the relevant home or limit switch transitions. The home position is found by the homing switches and Index pulses. Methods 19 to 21 stop by the homing position only.



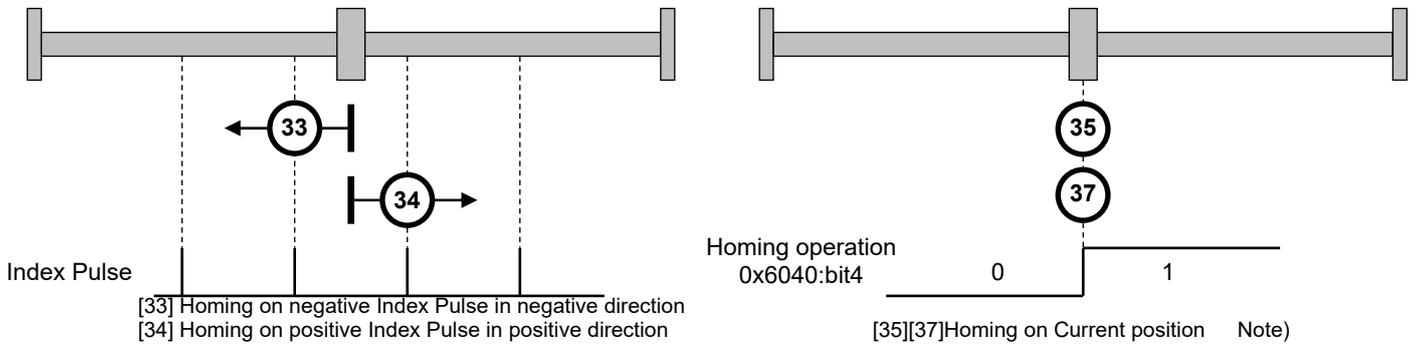
## 7. Object Dictionary

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

In homing method [33][34], homing direction of [33] is left side (negative rotation), and of [34] is right side (positive rotation). The home position shall be at the nearest index pulse that is found in the selected 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.



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

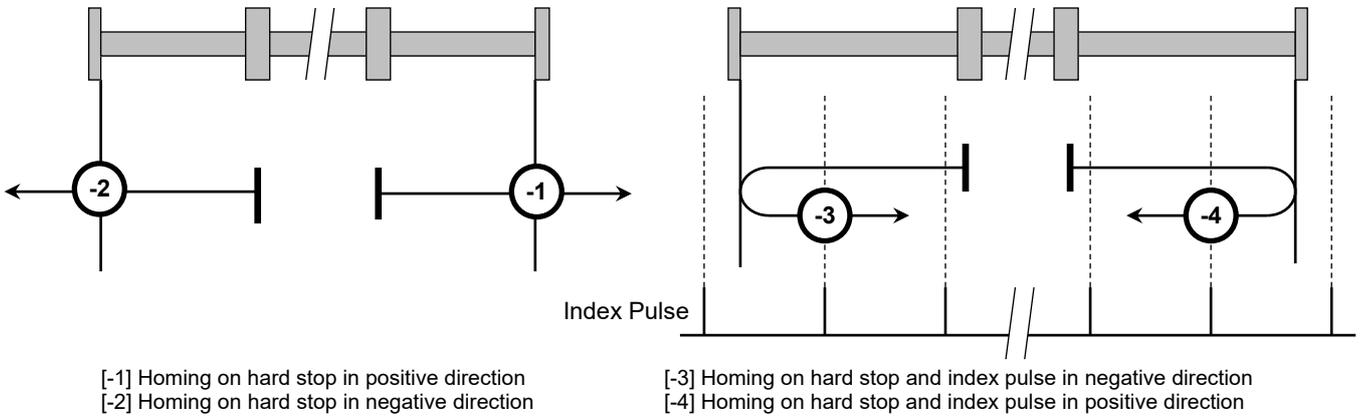
Note) Methods [-1] to [-4] are manufacturer-specific methods.

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.



## 7. Object Dictionary

### # Home position retention function when using absolute system

Execution result of "OD: 0x6098 Homing method 35,37 (Homing to present position)" will be stored automatically after a homing completion. "OD: 0x6064: Actual position" can retain the origin coordinates 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

Set "OD: 0x6098 Homing method" to "35 (0x23), 37 (0x25): Homing to present position".  
 Setting of "OD: 0x607C 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.)  
 Change "OD: 0x6060 Operation mode" to "6: Homing mode".

#### Step 2 Homing start

Set "OD: 0x6040 Control word, Bit4=1 (0x0010): Homing start".

#### Step 3 Confirmation of reference position detection

Monitor "OD: 0x6041 Status word, Bit12=1: Homing completed".

When performing "Absolute homing", proceed to step 5, when performing "Relative homing", proceed to step 4.

#### Step 4 Setting of home offset

Calculate "OD: 0x607C Home offset" value from "OD: 0x210C Home index position", and set.  
 $\text{Home offset (0x607C)} = \text{Origin coordinate after homing completed} - \text{Home index (0x210C)}$

#### Step 5 Storage of origin coordinate

The origin coordinates which was performed homing is stored automatically. Do not turn off a control power at that time.

Wait until it becomes "OD: 0x6041 Status word, Bit12=1".

#### Step 6 Homing completion

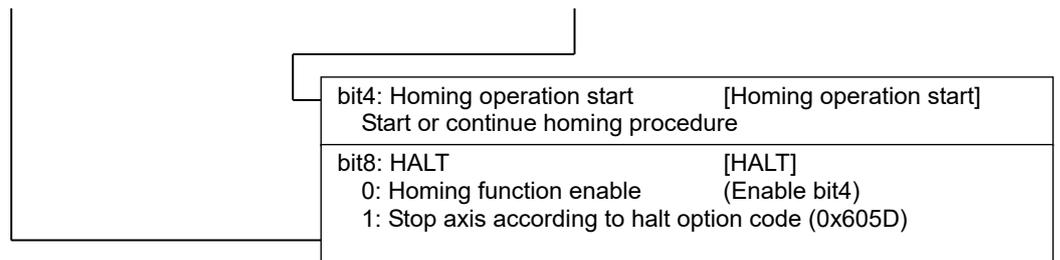
Exit "OD: 0x6040 Control word, Bit4 = 0 (0x0000): Homing," and then change the control mode back to the one using "OD: 0x6060 Operation mode".

- ✓ Automatic save is not valid except the homing method of absolute system: 35(0x23) and 37(0x25).
- ✓ To update the stored origin coordinate, perform a homing of absolute system again.
- ✓ To clear stored "origin coordinate after homing completed," perform encoder clear, and then re-perform parameter retention procedure (0x1010).

#### 0x6040:Control Word (Homing Mode: hm)

Index	0x6040	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] Note) 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	Res	Homing operation start	Hs*	Qs*	Ev*	So*	
15	14..13	12	11..9	8	7	6	5	4	3	2	1	0	

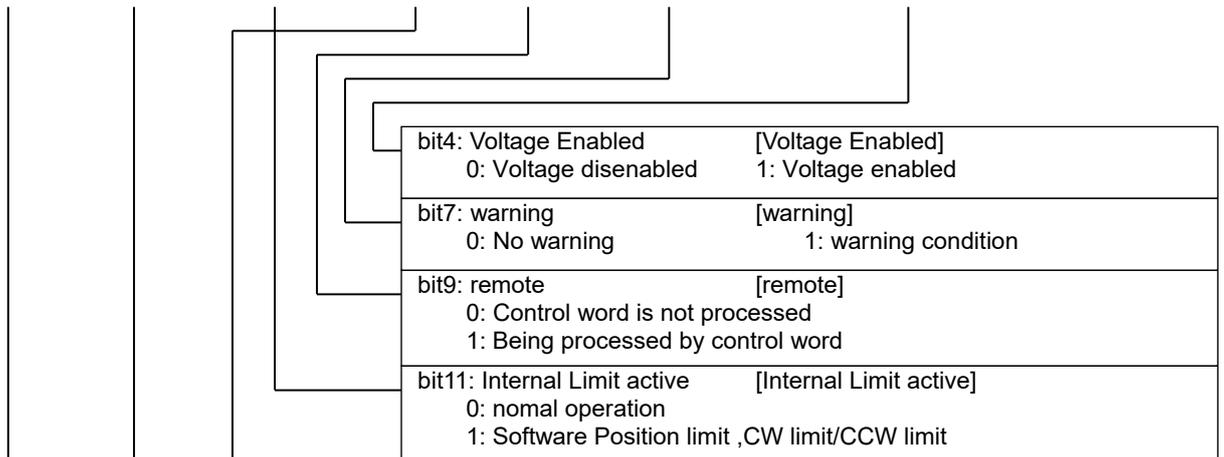


## 7. Object Dictionary

0x6041:Status Word(Homing Mode: hm)

Index	0x6041	This object indicates Operation Mode Specific bit and Manufacturer Specific bit in Homing Mode.	Object code		Variable
Sub-Idx	Description		Data Type	Access	PDO
0x00	Status Word [STSWORD] Note) 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
			Range	0x0000-0xFFFF	
			Initial value		0x0000

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



bit13	bit12	bit10	Description
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

## 7. Object Dictionary

### 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.

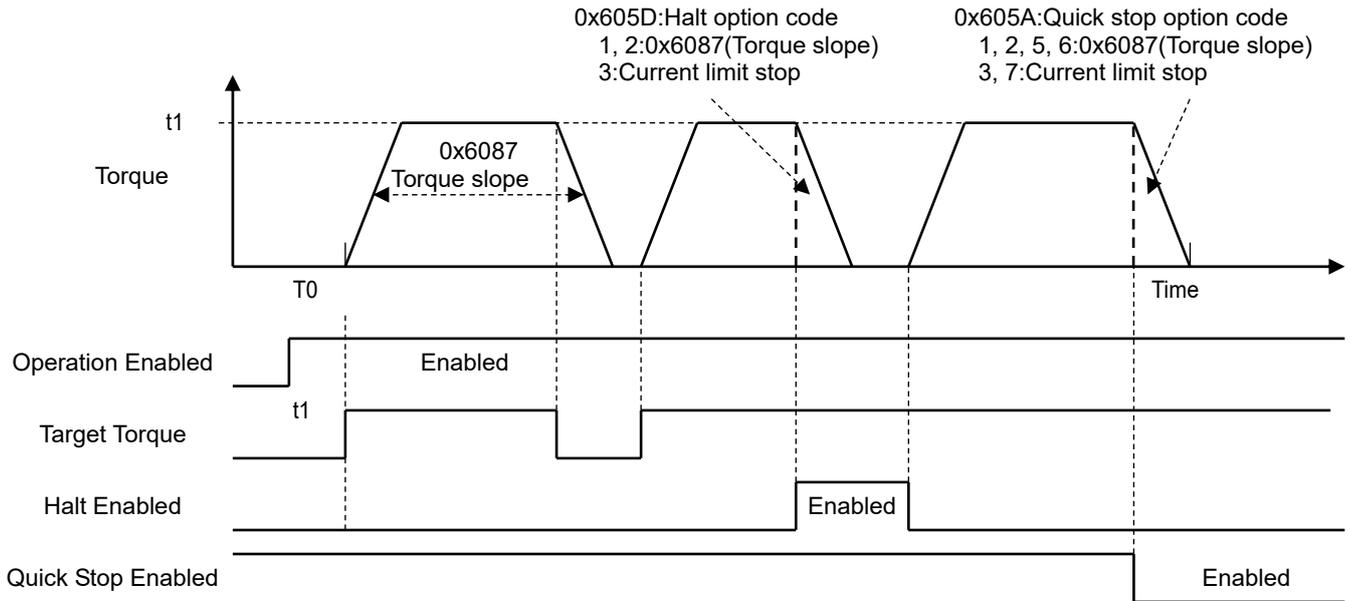
0x6060: If Operation Mode is set "4", it is operated by Profile torque (force) mode. If it is set "10", Cyclic synchronous torque (force) mode is operated. The below list indicates the main Objects as for function group "Torque (force)".

### 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.

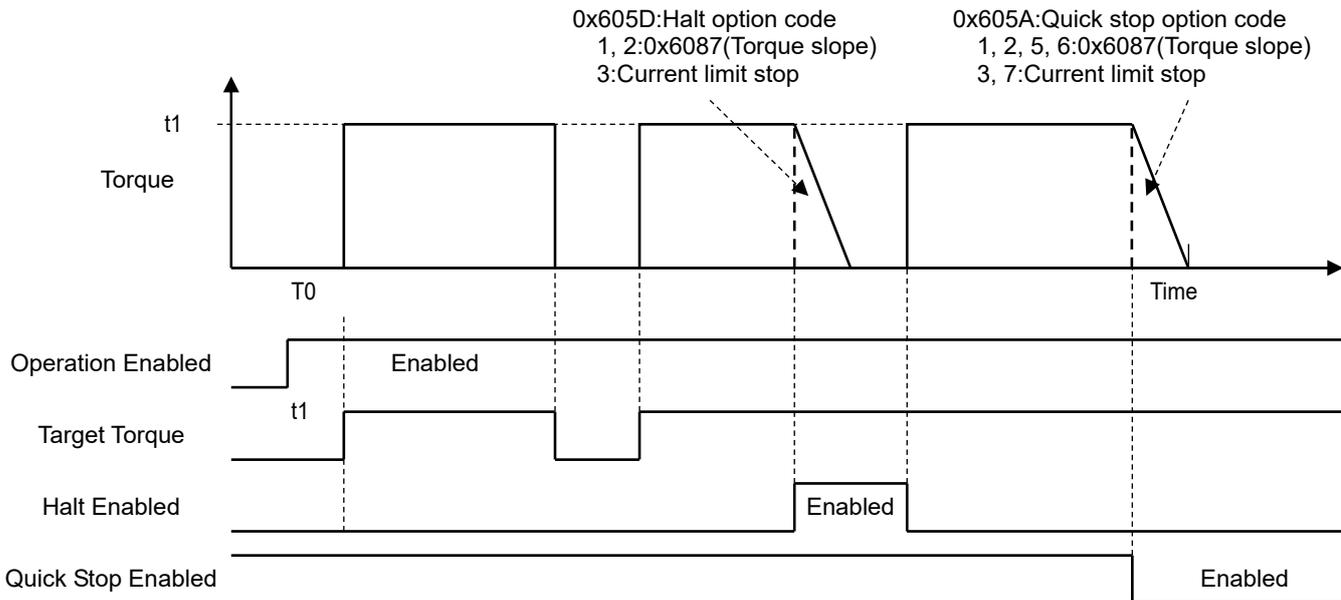


### 13) Cyclic Synchronous torque (force) mode

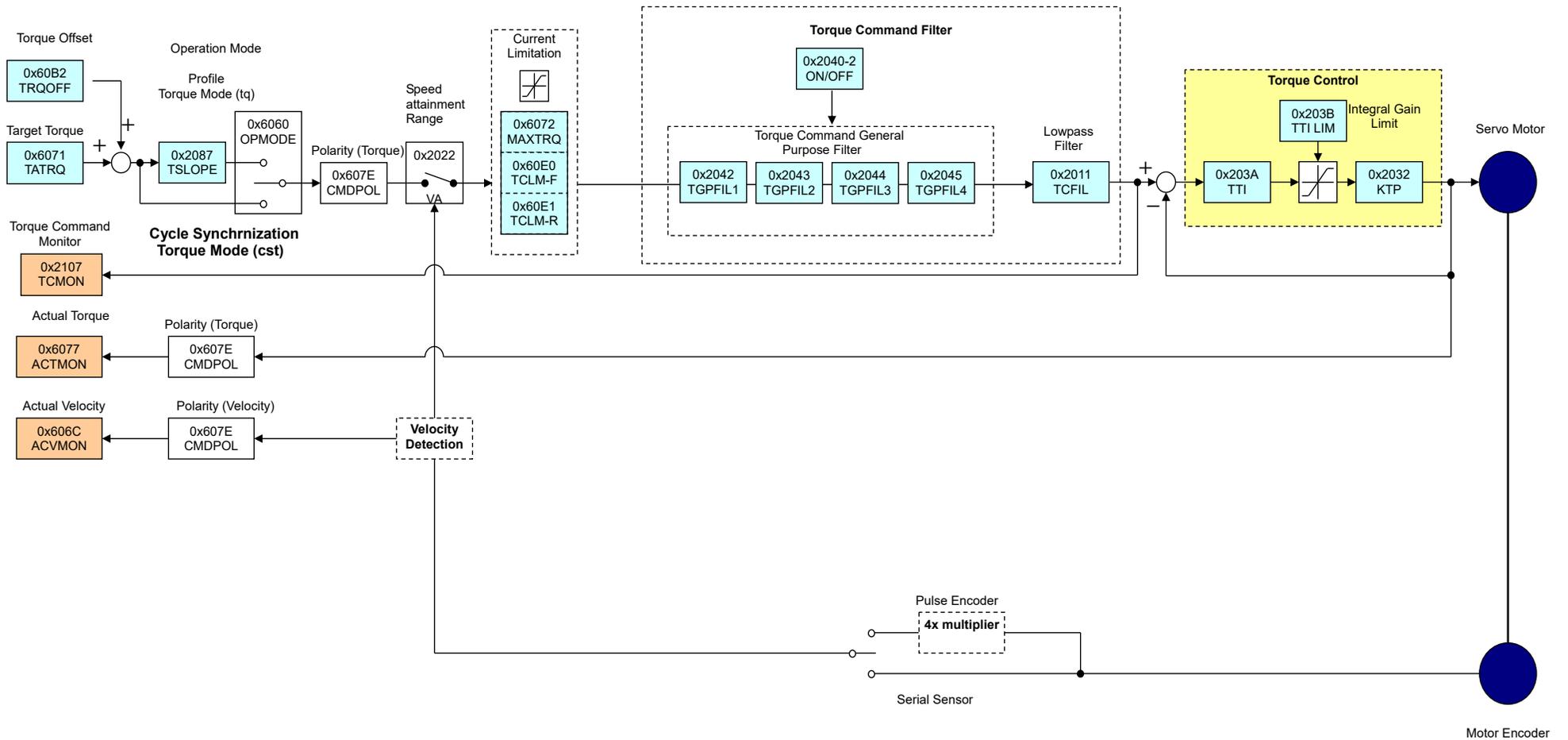
In this mode, trajectory is generated by the master, not the slave.

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 Halt or Quick stop operation.



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

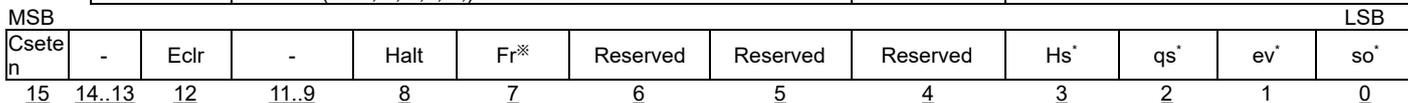


Block Diagram with Function Torque Mode

## 7. Object Dictionary

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

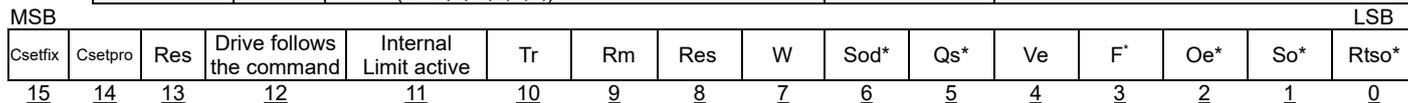
Index	0x6040	This object indicates operation mode specific bits and manufacturer specific bits of the Cyclic synchronous torque (force) mode (cst) and Profile torque (force) mode (tq)	Object code	Variable		
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Control word [CWORD] Note) See the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



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	0x6041	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] Note) See the Pattern Status table for "Status word bit pattern (Bit 6,5, 3,2,1,0.)"		Unsigned16 Range	RO	Possible	0x0000
			0x0000-0xFFFF			



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: Command acceptance permitted [Drive follows the command value]  
 0: Target position ignored.  
 1: Target torque to be used current control loop input.

14) Function Group “Touch Probe”

Abstract of Touch Probe

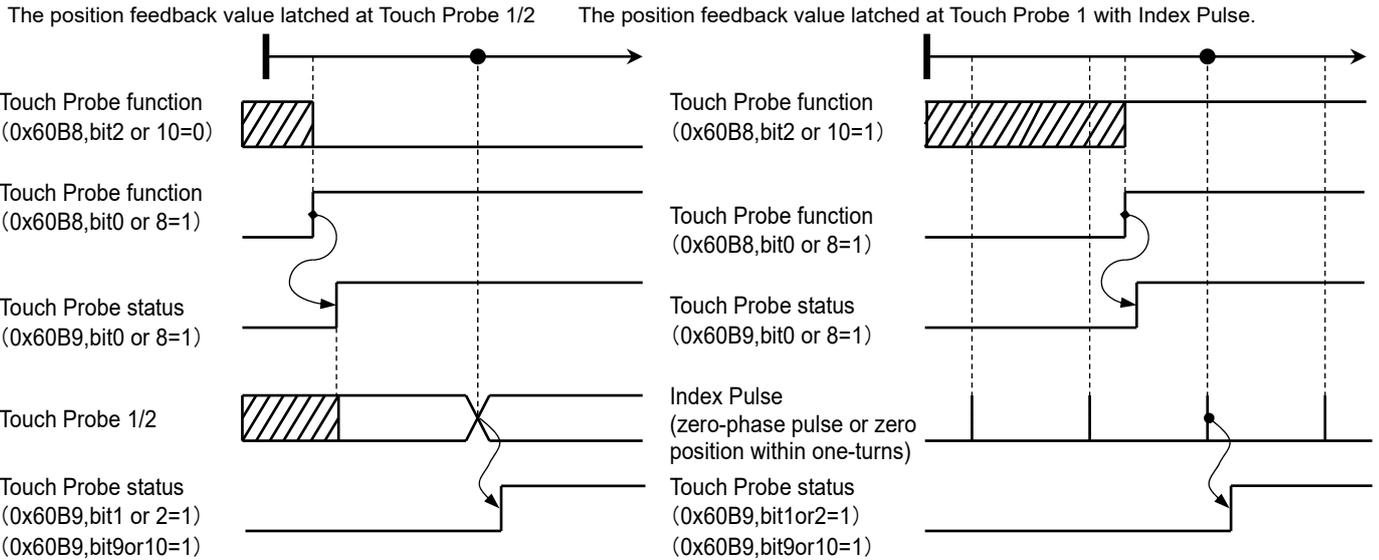
“Touch Probe function” is a latching function to latch the edge-triggered encoder position by digital input. “Touch Probe in the event” is independent from NC cycle time function since it latches the sensor position in the hardware of the slave, therefore, it enables capture it more precisely. This amplifier provides two of channels - Touch Probe 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 probe 1 (CONT1) signal can be triggered with “touch probe 1 input or position encoder index pulse <sup>Note 1)</sup> by “0x60B8, bit 2: Trigger selection.”
- Touch probe 2 (CONT2) signal can be triggered with “touch probe 2 input or position encoder index pulse <sup>Note 1)</sup> by “0x60B8, bit 10: Trigger selection.”

Note 1) 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.



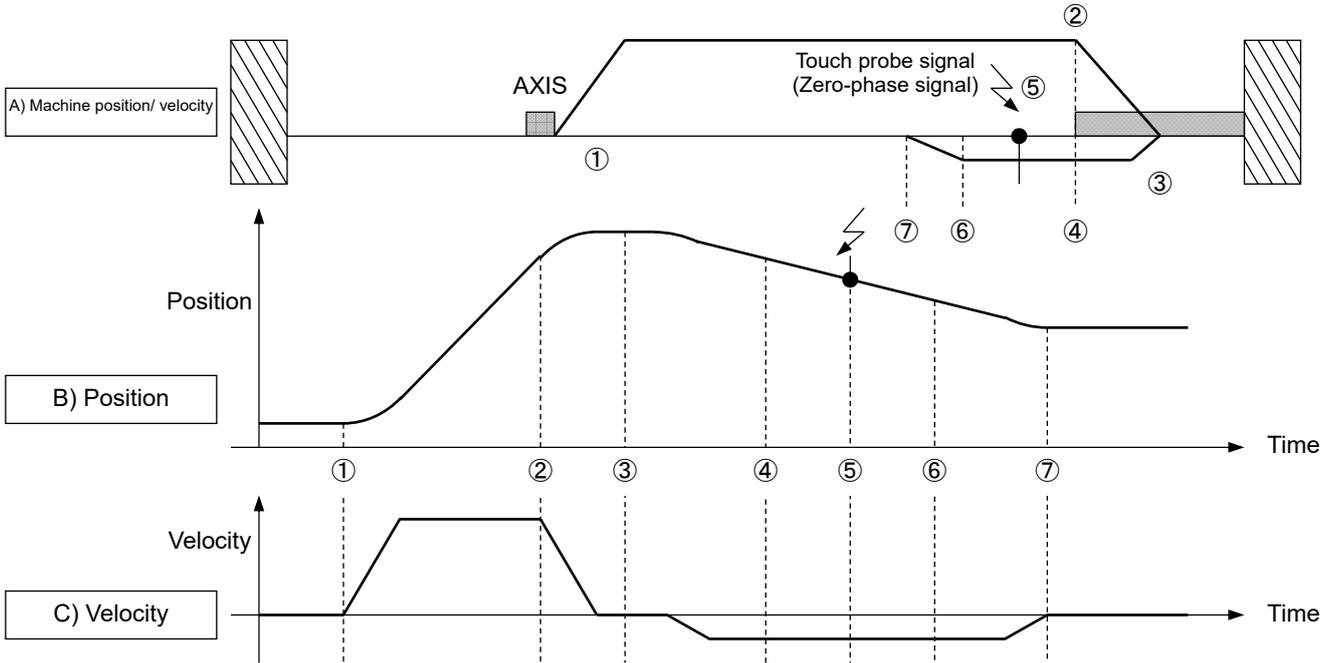
The position value of positive edge latched at Touch Probe 1 (position encoder index pulse) is stored in 0x60BA  
 The position value of negative edge latched at Touch Probe 1 (position encoder index pulse) is stored in 0x60BB  
 The position value of positive edge latched at Touch Probe 2 (position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

# 7. Object Dictionary

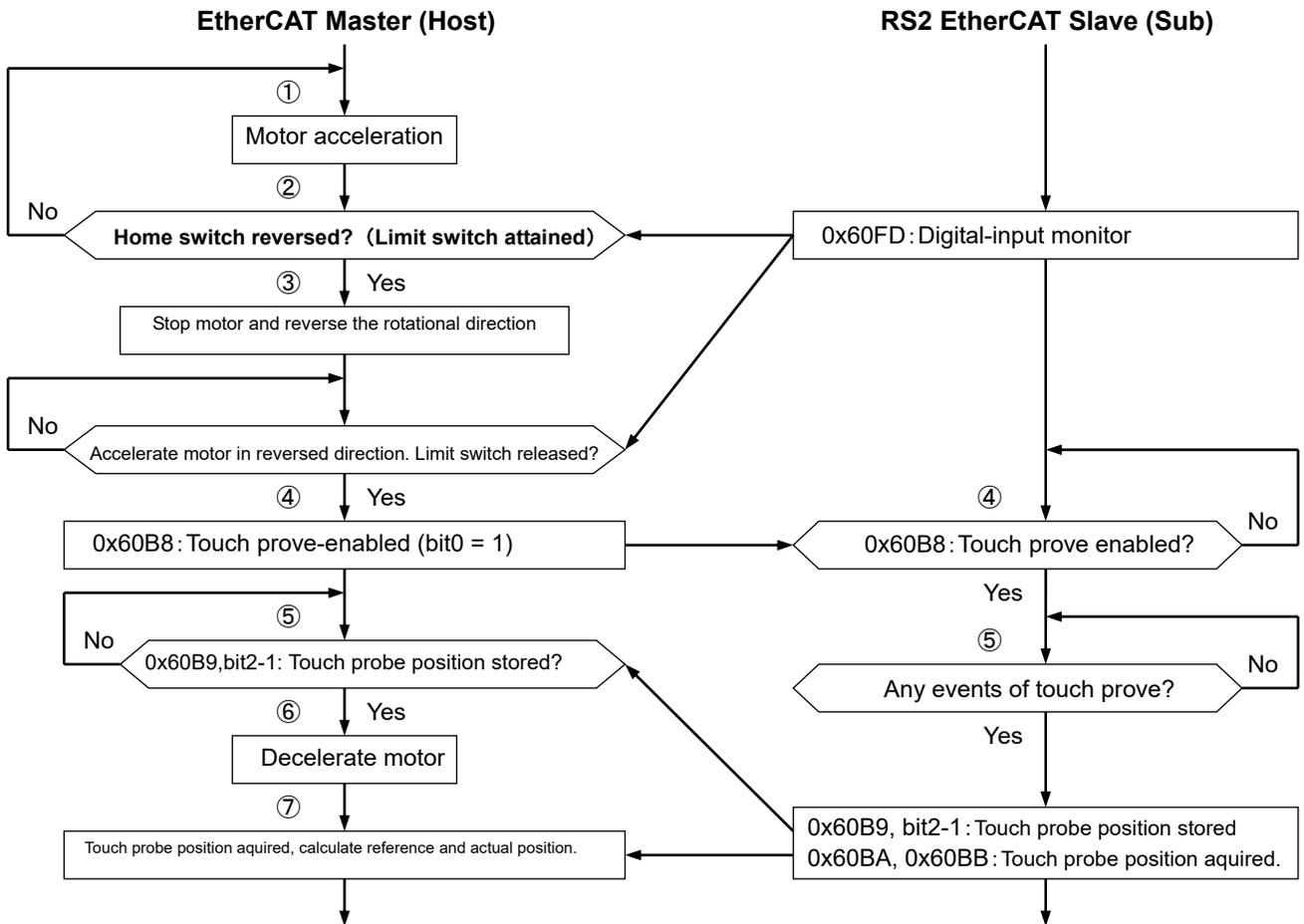
& Master-led homing (Touch probe homing method): Homing with touch-probe (without Limit Switch)

EtherCAT-support is recommended for touch probe homing to support correct and fast homing. Touch 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 probe homing procedure

## 7. Object Dictionary

### 15) Operation Mode Parameter (Profile Area)

#### 0x6060:Operation Mode

Index	0x6060	Indicates requested operation mode.	Object Code	Variable
Sub-Idx	Description		Access	Initial Value
0x00	Operation Mode [OPMODE]		RW	0x00
	0 :No Mode/Mode is not assigned. 1 :(pp) Profile Position Mode 2 : Reserved 3 :(pv) Profile Velocity Mode 4 :(tp) Torque (force) Profile Mode 5 :(ip) Interpolated Position Mode 6 :(hm) Homing Mode 7 :(ip) Interpolated position mode 8 :(csp) Cycle Sync. Position Mode 9 :(csv) Cycle Sync. Velocity Mode 10 :(cst)Cycle Sync. Torque (force) Mode		Setting Range	0x00 - 0x0A (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.

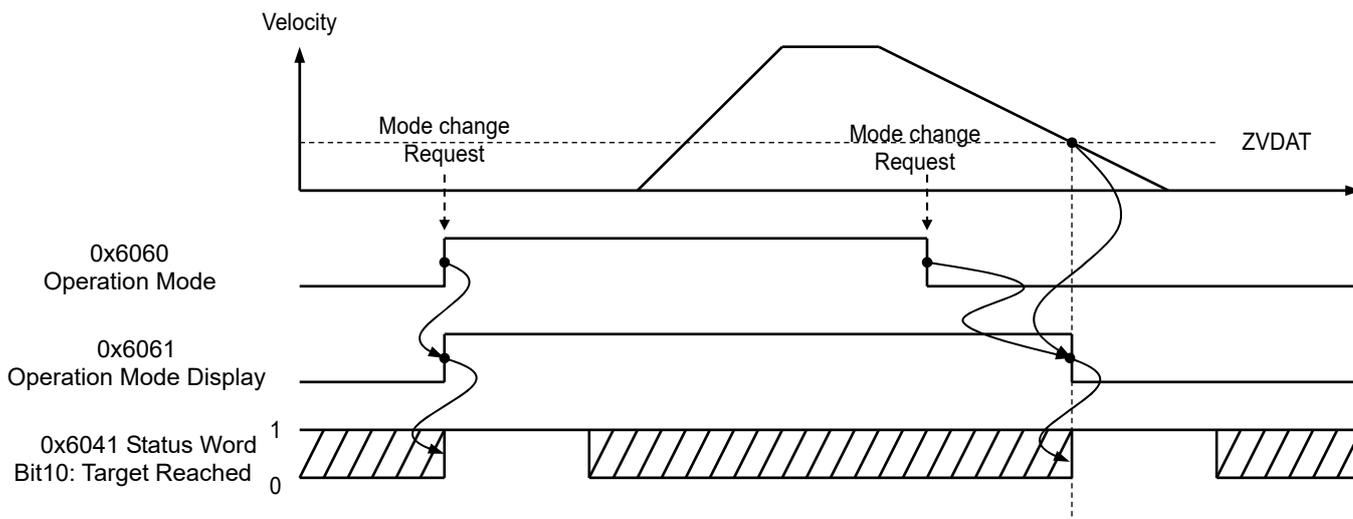
\* Changing mode while motor rotating is dangerous. Make sure to change at the time of the main power supply OFF, Servo-off, or motor stop.

\* Servo ON is not available when operation Mode is set "0".

#### 0x6061:Operation Mode Display

Index	0x6061	Indicates actual operation mode. Definition is the same as 0x6060: Operation Mode.	Object Code	Variable
Sub-Idx	Description		Access	Initial Value
0x00	Operation Mode Display [OPDISP]		RO	0x00
	0 : No Mode/Mode is not assigned. 1 :(pp) Profile position Mode 2 : Reserved 3 :(pv) Profile Velocity Mode 4 :(tp) Torque (force) Profile Mode 5 :(ip) Interpolated Position Mode 6 :(hm) Homing Mode 7 :(ip) Interpolated position mode 8 :(csp) Cycle Sync. Position Mode 9 :(csv) Cycle Sync. Velocity Mode 10 :(cst) Cycle Sync. Torque (force) Mode		Display Range	0x00 - 0x0A (0 to 10)

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



## 7. Object Dictionary

### 0x6062: Position Demand Value

Index	0x6062	Indicates the internal target position.	Object Code		Variable	
Sub-Idx	Description		Data Type	Access	PDO	Initial Value
0x00	Target position [PositionDemandValue] Indicates the internal command when position control mode is in profile position mode This command position update by the servo control cycle 125µs.		Integer32	RO	Possible	—
			Display Range	0x80000000 - 0x7FFFFFFF (-2147483648 to 2147483647 Pulse)		
			Unit	Pulse		

### 0x6063: Internal Actual Position

Index	0x6063	Indicates real position depending on control cycle.	Object Code		Variable	
Sub-Idx	Description		Data Type	Access	PDO	Initial Value
0x00	Internal Actual Position [IACPMON] Internal actual position data update by the servo control cycle 125µs. Monitor unit indicates the resolution of motor encoder to be used.		Integer32	RO	Possible	-
			Display Range	0x80000000 - 0x7FFFFFFF (-2147483648 to 2147483647 Pulse)		
			Unit	1 pulse		
	<ul style="list-style-type: none"> <li>✓ Encoder combination: In the case of Absolute encoder Effective bit length=Multiply 1 rotation resolution by multiple-rotation bit, effective bit length become "x" unfixed.</li> <li>✓ Encoder combination: In the case of Incremental encoder 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.</li> <li>✓ If the 0x607E position polarity(bit7) = 1, this data is inverted. Therefore, From an anterior view of the motor the value increases in the direction of Counter-Clockwise rotation (CCW)..</li> </ul>					

### 0x6064: Position Actual Value

Index	0x6064	Indicates real position depending on communication cycle.	Object Code		Variable	
Sub-Idx	Description		Data Type	Access	PDO	Initial Value
0x00	Position Actual Value [APMON] Position Actual Value indicates present position 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. In case of non-synchronization system, latest present position (Same as 0x6063) will reply.		Integer32	RO	Possible	-
			Display Range	0x80000000 - 0x7FFFFFFF (-2147483648 to 2147483647 Pulse)		
			Unit	Pulse		
	<ul style="list-style-type: none"> <li>✓ Encoder combination: In the case of Incremental encoder 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).</li> <li>✓ When the position polarity of 0x607E is reversed, the value increases in the CW direction.</li> </ul>					

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

Index	0x6065	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] When position actual value crosses position deviation window, becomes Excessive position deviation alarm.  Position Actual Value Deviation  >= Set Value		Unsigned32	RW	Possible	0x4C4B40 (5000000Pulse)
			Setting Range	0x00000001 - 0x7FFFFFFF (1 to 2147483647 Pulse))		
			Unit	Pulse		

### 0x6066: Position Deviation Time-out

Index	0x6066	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 Unit is "ms" and stops immediately after alarm occurring with RS2 (tentative name) amplifier.		Unsigned16	RW	No	0x0000
			Setting Range	0x0000 - 0x0000		
			Unit	ms		

## 7. Object Dictionary

### 0x6067:Position Window (Input Position Window)

Index	0x6067	Sets up the range permissible as target position attainment. 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] When position deviation counter value is below this preset value, outputs IN-Position signal (INP). When  Position Actual Value Deviation  ≤ Set Value, outputs Position Window Monitor (INP monitor). *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.		Unsigned32	RW	No	0x64 (100Pulse)
			Setting Range	0x00000000 - 0x7FFFFFFF (0 to 2147483647 Pulse)		
			Unit	pulse		

### 0x6068:Position Window Time

Index	0x6068	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 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	0x6069	Indicates actual value of velocity sensor.	Object Code	Variable		
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Actual Value of Velocity Sensor Indicates actual velocity calculated by motor encoder.		Integer32	RO	Possible	-
			Setting Range	0x80000000 to 0xFFFFFFFF (-2147483648 to 2147483647 pps)		
			Unit	Pulse/Sec		

### 0x606A:Sensor Selection Code

Index	0x606A	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 0:Actual velocity from position encoder 1:Actual velocity from velocity encoder Position encoder and velocity encoder use the same encoder.		Integer16	RW	Possible	0x0000
				0x0000 - 0x0001		

### 0x606C: Velocity Actual Value

Index	0x606C	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] ✓ Filter is processed to data, and cutoff frequency is 250Hz.		Integer32	RO	Possible	-
			Display Range	0x80000000 - 0x7FFFFFFF (-2147483648-2147483647 pps)		
			Unit	Pulse/sec		

## 7. Object Dictionary

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

Index	0x606D	Sets the range regarded as Velocity matching range by the unit [ $\text{min}^{-1}$ ]. Use this setting when "Velocity Matching Unit Selection" is "0x00 $\text{min}^{-1}$ ".	Object Code	Variable		
Sub-Idx	Description		Data Type	Access	PDO	Initial Value
0x00	Velocity Window 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. This is enabled in profile velocity mode.		Unsigned16	RW	No	0x32 (50 $\text{min}^{-1}$ )
			Display Range	0x0000 to 0xFFFF (0 to 65535 $\text{min}^{-1}$ )		
			Unit	$\text{min}^{-1}$		
<p>✓The velocity matching output is switched by the setting of rotation speed (<math>\text{min}^{-1}</math>) and ratio (%) at Velocity matching unit output selection (0x20F0.4). 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.</p>						

### 0x606E: Velocity Window Time

Index	0x606E	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 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 to 0x1388 (1 to 5000)		
			Unit	ms		

### 0x606F: Velocity Threshold (Speed Zero Setting)

Index	0x606F	Sets the range regarded as speed zero by the unit [ $\text{min}^{-1}$ ].	Object Code	Variable		
Sub-Idx	Description		Data Type	Access	PDO	Initial Value
0x00	Speed Zero Window When the actual velocity falls below this setting value, the status word "Speed zero detection" is set. This is enabled only in profile velocity mode.		Unsigned16	RW	No	0x0032 (50 $\text{min}^{-1}$ )
			Display Range	0x0005 to 0x01F4 (5 to 500 $\text{min}^{-1}$ )		
			Unit	$\text{min}^{-1}$		

### 0x6070: Velocity Threshold Time

Index	0x6070	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 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 (1 to 5000)		
			Unit	ms		

### 0x6071: Target Torque (force)

Index	0x6071	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] 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 (-3276.8 to 3276.7%)		
			Unit	0.1 %		

### 0x6072: Maximum Torque (force)

Index	0x6072	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] 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 (500.0%)
			Setting Range	0x0000 - 0x1388 (0 to 500.0%)		
			Unit	0.1%		

## 7. Object Dictionary

### 0x6076: Rated torque

Index	0x6076	Indicates rated torque of selected motor.	Object Code		Variable	
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Rated torque Indicates rated torque of selected motor. 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	0x6077	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] Setting units are 1% / LSB in 1/1000 unit of rated torque (force).		Integer16	RO	Possible	-
			Display Range	0x8000 - 0x7FFF (-3276.8 to 3276.7%)		
			Unit	0.1%		

### 0x6078: Actual Current Value

Index	0x6078	Indicates actual current value of motor.	Object Code		Variable	
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Actual Current Value Monitor unit is 1/1000 unit of the rated current, and is 0.1%/LSB.		Integer16	RO	Possible	—
			Setting range	0x8000-0x7FFF (-3276.8 to 3276.7%)		
			Unit	0.1 %		

### 0x6079: DC link circuit voltage

Index	0x6079	This object shall provide the instantaneous DC link current voltage at the drive device. The value shall be given in mV.	Object Code		Variable	
Sub-Idx	Description		Data Type	Access	PDO	Initial Value
0x00	DC link circuit voltage ✓For AC100V, AC200V DC24V, DC48V Rotary, Linear , Direct Drive Motor (RS2E TypeH, RS2A TypeH, RS2J TypeH, RS2K TypeH )		Unsigned32	RO	Possible	—
			Display Range	0x00000000 to 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 POF state. ✓For AC400V Rotary, Linear , Direct Drive, Induction Motor AC200V input type (SS1A typeH, RS2C typeH) It displays the actual DC voltage by detected internal circuit.					

### 0x607A: Target Position

Index	0x607A	Command position of drive moved by setup of motion control parameters, such as velocity, acceleration, deceleration, and motion profile type.	Object Code		Variable	
Sub-Idx	Description		Data Type	Access	PDO	Initial Value
0x00	Target Position [TAPOS] Sets up absolute position command for every communication cycle.		Integer32	RW	Possible	0
			Display Range	(-2147483648 to 2147483647)		
			Unit	pulse		

## 7. Object Dictionary

### 0x607B:Position range Limit (Modulo value)

Index	0x607B	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 Array			
Sub-Idx	Name/Description		Data Type	Access	PDO	Initial Value
0x00	Number of Entry		-	RO	No	0x2
0x01	Min position range limit	[MINPLIM]	Unsigned8	RW	Possible	0x80000000
			Setting value	0x80000000 to 0x7FFFFFFF		
0x02	Max position range limit	[MAXPLIM]	Integer32	RW	Possible	0x7FFFFFFF
			Setting value	0x80000000 to 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) >

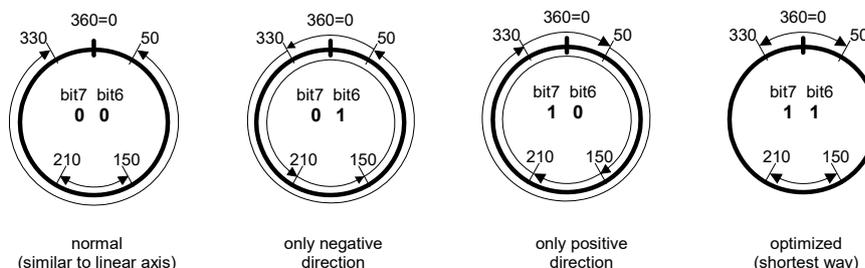
- The limit value of coordinates is the lower limit = 0x80000000, and upper limit = 0x7FFFFFFF. However for PP mode, wraparound exceeding position range limit is available if 0 is set to Min/Max position range limit.  
For CSP mode, wraparound at any range limit is available.  
To set limits on the range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



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.

#### < Regarding Modulo value at power on > Note 1), Note 2)

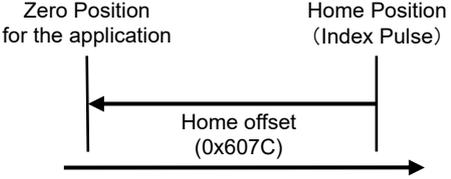
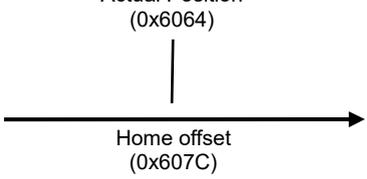
- In case of "0" set to bit2 of 0x20F7. (Normal process)  
⇒ Modulo value is the remainder when encoder position (lower 32 bit) is divided by modulo coordinate.  
Modulo value after cycled encoder-coordinate will be different between before and after power cycle, if the remainder is existed when encoder coordinate is divided by modulo coordinate.
- In case of "1" set to bit2 of 0x20F7. (Special process)  
⇒ Recording the modulo value to non-volatile memory at control power off. At power on again, absolute position is checked and modulo value is calculated even if motor rotates during control power off. When the motor has rotated over the pulse that calculated with 0x20FC during power off, warning (0x2103-1, bit1=1) will be detected at power on. The modulo value at that time is different from before power off. Do Homing again and reset the coordinate.

Note 1) Please ask our sales if DC input type servo amplifier is used.

Note 2) Modulo value saving function at power ON is only for absolute encoder.

## 7. Object Dictionary

### 0x607C: Home offset (homing mode)

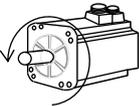
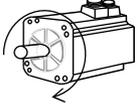
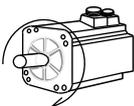
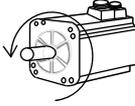
Index	0x607C	Normalizes homing position (mechanical origin) detected in homing mode by homing offset value.	Object code		Variable	
Sub-Idx	Description		Data Type	Access	PDO	Initial Value
0x00	Home offset [HOFFSET] &The set homing offset (0x607C) is used to calculate actual position. ✓ Homing offset can be always written, however, is used to re-calculate only in homing mode. The actual position (0x6064) using homing position during homing is calculated as follows:  <div style="display: flex; justify-content: space-around;"> <div style="text-align: center;"> <p>Without Homing Method 35,37</p>  <p>Zero Position = Home Position + Home offset (0x607C)</p> </div> <div style="text-align: center;"> <p>Homing Method 35,37</p>  <p>Actual Position(0x6064) = Home offset (0x607C)</p> </div> </div> <p>✓If not Homing Method 35 or 37 and ZeroPosition=Home Offset Homing need to sets 0x20F6-1 = 1.</p>		Integer32	RW	Possible	0x00000000 (0 pulse)
			Setting Range	0x80000000 to 0x7FFFFFFF (-2147483648 to 2147483647 Pulse)		
			Unit	Pulse		

### 0x607D:Software Position Limit

Index	0x607D	Consists of the Maximum / Minimum software position limits. Position command and actual position are calculated by target position (0x607A) and position offset (0x60B0) to be limited in absolute position.	Object Code Array			
Sub-Idx	Name/Description		Data Type	Access	PDO	Range (Initial Value)
0x00	Number of Entry		-	RO	No	0x2
0x01	Minimum Position Limit [SMINLIM] Unit is 1 pulse/LSB with RS2EtherCAT amplifier in the same user definition as a target position.		Integer32	RW	Possible	0x80000000 - 0x7FFFFFFF (0)
0x02	Maximum Position Limit [SMAXLIM] Unit is 1 pulse/LSB with RS2EtherCAT amplifier in the same user definition as a target position.		Integer32	RW	Possible	0x80000000 - 0x7FFFFFFF (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.						

## 7. Object Dictionary

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

Index	0x607E	Sets command for input polarity. 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]		Unsigned8	RW	Possible	0x00
	<p>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.</p> <p><u>Bit7 : Position Polarity</u> "0": Command is multiplied by +1. "1": Multiplied by -1. (only csp,ip, pp enable)            • Valid only in Cyclic sync. position mode (csp), Interpolated position mode (ip), Profile position mode (pp), 0x607A Target position and 0x60B0 Position offset input value are multiplied by -1 with "1", and then command polarity is reversed.</p> <p><u>Bit6 : Velocity Polarity</u> "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.</p> <p><u>Bit5 : Torque (force) Polarity</u> "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.</p> <p><u>Bit4 - 0: Reserved</u></p> <p>◆Direction with positive (+) polarity command supply according to the setting value is shown below.</p> <p>◆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 -.</p> <div style="display: flex; justify-content: space-around;">   </div> <p>◆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 -.</p> <div style="display: flex; justify-content: space-around;">   </div> <p>✓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 chapter 13, Linear motor control parameter list for the description of linear motor polarity.            ✓If OT is used, set 0x00 or 0xE0.</p>		Setting Range		0x00 to 0xE0	

0x607F: Maximum Profile Velocity (Velocity Limit Command)

Index	0x607F	Sets permissible velocity to Velocity command.	Object Code	Variable		
Sub-Idx	Description		Data Type	Access	PDO	Initial Value
0x00	Maximum Profile Velocity [VCLM] Limit maximal allowed profile velocity (0x6081) during a profiled position (pp) motion. ✓The unit is in user definition as same as 0x6081		Unsigned32	RW	Possible	0xFFFFFFFF
			Setting Range	0x00000001 to 0xFFFFFFFF (1 to 4294967295 pps)		
			Unit	Pulse/sec		

0x6080: Maximum motor velocity

Index	0x6080	Sets the selected motor's maximum velocity.	Object Code	Variable		
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Maximum motor velocity Sets the selected motor's maximum velocity. 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 to 0xFFFFFFFF (0 to 4294967295 min <sup>-1</sup> )		
			Unit	min <sup>-1</sup>		

## 7. Object Dictionary

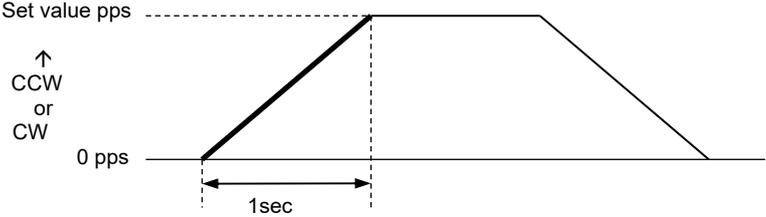
### 0x6081: Profile Velocity

Index	0x6081	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] The value is effective for both of CW and CCW.		Unsigned32	RW	Possible	0xFFFFFFFF
			Display range	0x00000000 to 0xFFFFFFFF (0 to 4294967295 pps)		
			unit	Pulse/sec		

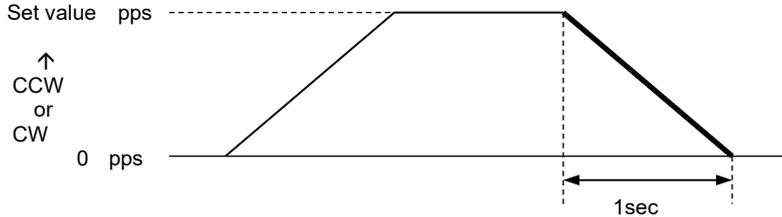
### 0x6082: End velocity

Index	0x6082	Sets end velocity.	Object Code	Variable		
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	End velocity Sets the end velocity in position mode at the time of reaching the target. This servo amplifier does not support this function.		Unsigned32	RW	Possible	0x00000000
			Setting range	0x00000000 to 0xFFFFFFFF		
			Unit	Pulse/sec		

### 0x6083: Profile acceleration

Index	0x6083	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 [TVACC] 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 to 0xFFFFFFFF (0 to 4294967295 pps <sup>2</sup> ) *		
			Unit	Pulse/sec <sup>2</sup>		
<p>Note) This parameter is effective only against Profile position mode (pp), Profile velocity mode (pv).</p>  <p>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<sup>-1</sup>.</p>						

### 0x6084: Profile Deceleration

Index	0x6084	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 [TVDEC] 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 to 0xFFFFFFFF (0 to 4294967295 pps <sup>2</sup> ) Note)		
			Unit	Pulse/sec <sup>2</sup>		
<p>*This parameter is effective only against Profile position mode (pp), Profile velocity mode (pv).</p>  <p>*If value is set to "0", the amplifier proceeds it as "1." Note) 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<sup>-1</sup>.</p>						

## 7. Object Dictionary

### 0x6085: Quick Stop Deceleration

Index 0x6085	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 Variable
Sub-Idx	Description	Data Type	Access	PDO	Initial Value
0x00	Quick Stop Deceleration [QSDEC] Value serves as the same unit as a Profile acceleration object (0x6083).  (Note) If value is set to "0", the amplifier proceeds it as "1."	Unsigned32	RW	Possible	0xFFFFFFFF
		Setting Range	0x00000000 to 0xFFFFFFFF (0 to 4294967295 pps <sup>2</sup> )		
		Unit	Pulse/sec <sup>2</sup>		

### 0x6087: Torque (force) slope

Index 0x6087	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] 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 to 0xFFFFFFFF		
		Unit	0.1%/sec		

### 0x6088: Torque Profile Type

Index 0x6088	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 Setting unit is 0 (Linear ramp) fixed.	Integer16	RW	Possible	0x0000
		Setting Range	0x0000 to 0x0000		

### 0x608F: Position Encoder Resolution

Index 0x608F	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. Indicates resolution of the connected encoder.	Unsigned32	RW	Possible	0x01
		Setting Range	0x00000001 to 0xFFFFFFFF		
		Unit	Pulse		
0x02	Sets the rotation speed of the motor shaft. Since this servo amplifier is not compatible with this function, values other than 1 cannot be set.	Unsigned32	RW	Possible	0x01
		Setting Range	0x01 to 0x01		
		Unit			

### 0x6091: Gear Ratio

Index 0x6091	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. With this servo amplifier, the rotation speed of the motor shaft is fixed to 1.	Unsigned32	RW	Possible	0x01
		Setting Range	0x01 to 0x01		
		Unit			
0x02	Sets the rotation speed of the output shaft. With this servo amplifier, the rotation speed of the output shaft is fixed to 1.	Unsigned32	RW	Possible	0x01
		Setting Range	0x01 to 0x01		
		Unit			

### 0x6092: Feed Constant

Index 0x6092	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. Since this servo amplifier is not compatible with this function, values other than 1 cannot be set.	Unsigned32	RW	Possible	0x01
		Setting Range	0x01 to 0x01		
		Unit			
0x01	Sets the rotation speed of the motor shaft. With this servo amplifier, the rotation speed of the motor shaft is fixed to 1.	Unsigned32	RW	Possible	0x01
		Setting Range	0x01 to 0x01		
		Unit			

## 7. Object Dictionary

### 0x6098: Homing method

Index	0x6098	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] Configured homing method (Origin return method)		Integer8	RW	Possible	0x23 (35)
			Setting range	0xFC to 0x25 (-4 to 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 to 0x80), 15(0x0F), 16(0x10)23 to 32(0x17 to 0x20), 36(0x24), 38 to 127(0x26 to 0x7F): Reserved					

### 0x6099: HOMING VELOCITY

Index	0x6099	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] Set the motor speed during search for a end position switch on homing mode		Unsigned32	RW	Possible	0x000A0000
			Setting range	0x0-0xFFFFFFFF (0 to 4294967295 pps)		
			Unit	Pulse/sec		
0x02	Zero phase search speed [ZSVCMD] Assign the motor speed during search for the index pulse (zero) detection		Unsigned32	RW	Possible	0x00008000
			Setting range	0x0-0xFFFFFFFF (0 to 4294967295 pps)		
			Unit	Pulse/sec		

### 0x609A: Homing acceleration and deceleration

Index	0x609A	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] The parameters to Homing velocity that restrain velocity slope of the acceleration and deceleration ramp during acceleration, zero speed, direction change Note) This parameter is effective only during Homing mode (hm)		Unsigned32	RW	Possible	0xFFFFFFFF
			Setting range	0x00000000-0xFFFFFFFF (0 to 4294967295 pps <sup>2</sup> ) *		
			Unit	Pulse/sec <sup>2</sup>		
	Note) If value is set "0", the amplifier proceeds it as "1." * 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 <sup>-1</sup> .					

## 7. Object Dictionary

### 0x60B0: Position Offset

Index	0x60B0	Provides Target position with Offset.	Object Code		Variable	
Sub-Idx	Description		Data Type	Access	PDO	Initial Value
0x00	Position Offset [POSOFF] Offset value is added to Target position. 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 (0 pulse)
			Display Range	0x80000000 - 0x7FFFFFFF		
			Unit	1pulse/lsb		

### 0x60B1: Velocity Offset (Velocity Compensation Value)

Index	0x60B1	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] In Cycle sync. Position mode (csp) and Interpolated Position mode (ip), added to Preset Velocity Command and valid with Velocity compensation enable bit set. In Cycle sync. Velocity mode (csv), gives Offset to Velocity demand value.		Integer32	RW	Possible	0
			Display Range	0x80000000 - 0x7FFFFFFF (-2147483648 to 2147483647 pps)		
			Unit	Pulse/sec		

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

Index	0x60B2	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	
Sub-Idx	Description		Data Type	Access	PDO	Initial Value
0x00	Torque (force) Offset (Torque (force) Compensation) [TRQOFF] *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). *In Cycle sync. Torque (force) mode (cst), gives Offset to Torque (force) demand value.		Integer16	RW	Possible	0x0000 (0 %)
			Setting Range	0xEC78 - 0x1388 (-500.0 to 500.0 %)		
			Unit	0.1%		

### 0x60B8: Touch probe function

Index	0x60B8	Controls the functions of the touch probe.	Object Code		Variable	
Sub-Idx	Description		Data Type	Access	PDO	Initial Value
0x00	Touch probe function [TPFUNC] Controls the functions of the touch probe.		Unsigned16	RW	Possible	0x0000
			Setting Range	0x0000-0xFFFF		
	<u>bit0: Touch probe 1 switch enable</u> 0: Switch off touch probe 1 1: Enable touch probe 1 <u>bit1: Touch probe 1 Trigger operation</u> 0: Trigger first event 1: Continuous* <sup>1</sup> <u>bit2: Touch probe 1 Trigger selection</u> 0: Trigger with touch probe 1 input 1: Trigger with position encoder index pulse* <sup>2</sup> <u>bit4: Touch probe 1 positive edge enable</u> 0: Switch off sampling at positive edge of touch probe 1 1: Enable sampling at positive edge of touch probe 1 <u>bit5: Touch probe 1 negative edge enable</u> 0: Switch off sampling at negative edge of touch probe 1 1: Enable sampling at negative edge of touch probe 1 <u>bit8: Touch probe 2 switch enable</u> 0: Switch off touch probe 2 1: Enable touch probe 2 <u>bit9: Touch probe 2 Trigger operation</u> 0: Trigger first event 1: Continuous* <sup>1</sup> <u>bit10: Touch probe 2 Trigger selection</u> 0: Trigger with touch probe 2 input 1: Trigger with position encoder index pulse* <sup>2</sup> <u>bit12: Touch probe 2 positive edge enable</u> 0: Switch off sampling at positive edge of touch probe 2 1: Enable sampling at positive edge of touch probe 2 <u>bit13: Touch probe 2 negative edge enable</u> 0: Switch off sampling at negative edge of touch probe 2 1: Enable sampling at negative edge of touch probe 2					
	* <sup>1</sup> : When "Continuous" is selected, latched position will be cleared by reverse edge of a latching edge. * <sup>2</sup> : When using absolute encoder, index pulse is position data at 0 within single-turn. When using "Modulo coordination", be sure to set bit2 and bit10 to "0: Trigger with touch probe input".					



## 7. Object Dictionary

### 0x60C1: Interpolation data record

Index	0x60C1	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 (-2147483648 to 214783647Pulse)		
			Unit	Pulse		
0x02	Interpolation time	[IPTIME]	Unsigned8	RW	Possible	0x00
			Setting Range	0x00 - 0xFF (0 to 255ms)		
			Unit	ms		

### 0x60C2: Interpolation time period

Index	0x60C2	The interpolation time period value (sub-index 01) shall be given in 10(interpolation time index) s(econd). The interpolation time index (sub-index 02) shall be dimentionless.	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 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 (1 to 250)
0x02	Interpolation time index Indicates the degree (what multiplies) of interpolation time. Example:Setting value 0xFC(-4) means 100µsec.		Integer8	RW	No	0xFA - 0xFD (10 <sup>-6</sup> to 10 <sup>-3</sup> )
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)	→	

## 7. Object Dictionary

### 0x60C4: Interpolation data configuration

Index	0x60C4	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] Show the size of allowable buffer.	Unsigned32	RO	No	0x00000100	
		Value	0x00000100			
0x02	Actual buffer size [BUFFSIZE] Set the buffer size.	Unsigned32	RW	Possible	0x00000000	
		Setting Range	0x00000000 - 0x00000100			
0x03	Buffer format [BUFSTR] 0x00: FIFO 0x01: Ring	Unsigned8	RW	Possible	0x00	
		Setting Range	0x00 - 0x01			
0x04	Point of buffer [BUFPOS] Empty buffer point for next interpolation data record.	Unsigned16	RW	Possible	0x0000	
		Setting Range	0x0000 - 0x00FF			
0x05	Data size of interpolation data record [RECSIZE] Show the size of each data in Interpolated position mode.	Unsigned8	RO	No	0x04	
		Value	0x04 - 0x05			
		Unit	byte			
0x06	Clear buffer [BUFCLR] 0x00: Clear all record in buffer and disable data access. 0x01: Enable data access to buffer. Interpolation data record come from upper controller into buffer.	Unsigned8	WO	Possible	0x00	
		Setting Range	0x00 - 0x01			

### 0x60C5: Maximum acceleration

Index	0x60C5	Sets the limit value of acceleration	Object Code			Variable
Sub-Idx	Description		Data Type	Access	PDO	Initial Value
0x00	Acceleration limit value Limits the acceleration set value by this parameter if the acceleration setting of 0x6083 exceeds this value. Invalid when the set value is 0. ✓Valid for PV mode only.	Unsigned32	RW	Possible	0xFFFFFFFF	
		Setting Range	0x00000000 to 0xFFFFFFFF (0 to 4294967295 pps <sup>2</sup> )			
		Unit	Pulse/sec <sup>2</sup>			

### 0x60C6: Maximum deceleration

Index	0x60C6	Sets the limit value of deceleration	Object Code			Variable
Sub-Idx	Description		Data Type	Access	PDO	Initial Value
0x00	Deceleration limit value Limits the deceleration set value by this parameter if the deceleration setting of 0x6084 exceeds this value. Invalid when the set value is 0. ✓Valid for PV mode only.	Unsigned32	RW	Possible	0xFFFFFFFF	
		Setting Range	0x00000000 to 0xFFFFFFFF (0 to 4294967295 pps <sup>2</sup> )			
		Unit	Pulse/sec <sup>2</sup>			

### 0x60E0: Forward Direction Torque (force) Limit Value

Index	0x60E0	Sets limit value of motor forward direction max. torque (force).	Object Code			Variable
Sub-Idx	Description		Data Type	Access	PDO	Initial Value
0x00	Forward Direction Torque (force) Limit Value [TCLM-F] Setting units are 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. ✓Set up in consideration of Acceleration / Deceleration time. If setting value is -o low, Acceleration / Deceleration torque (force) will be insufficient and normal control cannot be performed.	Unsigned16	RW	Possible	0x1388 (500.0%)	
		Setting Range	0x0000 - 0x1388 (0 to 500.0%)			
		Unit	0.1%			

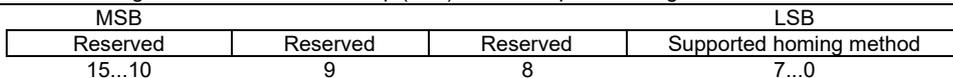
### 0x60E1: Reverse Direction Torque (force) Limit Value

Index	0x60E1	Sets limit value of motor reverse direction max. torque (force).	Object Code			Variable
Sub-Idx	Description		Data Type	Access	PDO	Initial Value
0x00	Reverse Direction Torque (force) Limit Value [TCLM-R] Setting units are 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. ✓Set up in consideration of Acceleration / Deceleration time. If setting value is too low, Acceleration / Deceleration torque (force) will be insufficient and normal control cannot be performed.	Unsigned16	RW	Possible	0x1388 (500.0%)	
		Setting Range	0x0000 - 0x1388 (0 to 500.0%)			
		Unit	0.1%			

## 7. Object Dictionary

0x60E3: Support homing method

Index	0x60E3	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]	Integer8	RO	No	0x0001
	Supports Homing method 1 "Homing on negative limit switch and index pulse"					
0x02	Support homing method 2	[HSUP02]	Integer8	RO	No	0x0002
	Supports Homing method 2" Homing on positive limit switch and negative index pulse"					
0x03	Support homing method 3	[HSUP03]	Integer8	RO	No	0x0003
	Supports Homing method 3" Homing on positive home switch and negative index pulse"					
0x04	Support homing method 4	[HSUP04]	Integer8	RO	No	0x0004
	Supports Homing method 4" Homing on positive home switch and positive index pulse"					
0x05	Support homing method 5	[HSUP05]	Integer8	RO	No	0x0005
	Supports Homing method 5" Homing on negative home switch and positive index pulse"					
0x06	Support homing method 6	[HSUP06]	Integer8	RO	No	0x0006
	Supports Homing method 6" Homing on negative home switch and negative index pulse"					
0x07	Support homing method 7	[HSUP07]	Integer8	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]	Integer8	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]	Integer8	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]	Integer8	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]	Integer8	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]	Integer8	RO	No	0x000C
	Supports Homing method 12 " Homing on negative limit switch, homing on positive home switch and negative index pulse"					
0x0D	Support homing method 13	[HSUP0D]	Integer8	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]	Integer8	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]	Integer8	RO	No	0x0011
	Supports Homing method 17" Homing on negative limit switch."					
0x10	Support homing method 16	[HSUP10]	Integer8	RO	No	0x0012
	Supports Homing method 18 "Homing on positive limit switch."					
0x11	Support homing method 17	[HSUP11]	Integer8	RO	No	0x0013
	Supports Homing method 19" Homing on home switch (positive logic), stop in positive direction."					
0x12	Support homing method 18	[HSUP12]	Integer8	RO	No	0x0014
	Supports Homing method 20" Homing on home switch (positive logic), stop in negative direction."					
0x13	Support homing method 19	[HSUP13]	Integer8	RW	No	0x0015
	Supports Homing method 21 "Homing on home switch (negative logic), stop in positive direction."					
0x14	Support homing method 20	[HSUP14]	Integer8	RW	No	0x0016
	Supports Homing method 22 " Homing on home switch (negative logic), stop in negative direction."					
0x15	Support homing method 21	[HSUP15]	Integer8	RO	No	0x0021
	Supports Homing method 33 " Homing on index pulse in negative direction."					
0x16	Support homing method 22	[HSUP16]	Integer8	RO	No	0x0022
	Supports Homing method 34 " Homing on index pulse in positive direction."					
0x17	Support homing method 23	[HSUP17]	Integer8	RO	No	0x0023
	Support Homing method 35 "Homing position on actual position"					
0x18	Support homing method 24	[HSUP18]	Integer8	RO	No	0x0025
	Supports homing method 37 "Homing on actual position or homing position"					
0x19	Support homing method 25	[HSUP19]	Integer8	RO	No	0x00FF
	Supports homing method -1 "Homing on hard stop (Butt) to the Positive direction"					
0x1A	Support homing method 26	[HSUP1A]	Integer8	RO	No	0x00FE
	Supports homing method -2 "Homing on hard stop (Butt) to the Negative direction"					
0x1B	Support homing method 27	[HSUP1B]	Integer8	RO	No	0x00FD
	Supports homing method -3 "Homing on Negative side hard stop (Butt) and index pulse in Positive drection"					
0x1C	Support homing method 28	[HSUP1C]	Integer8	RO	No	0x00FC
	Supports homing method -4 "Homing on Positive side hard stop (Butt) and index pulse in Negative drection"					

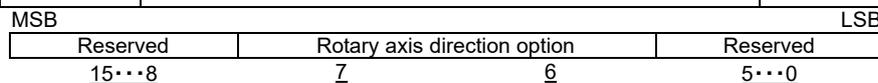


Bit7-0: Supported homing method Index 6098 corresponding to that indicated on Homing methods number

## 7. Object Dictionary

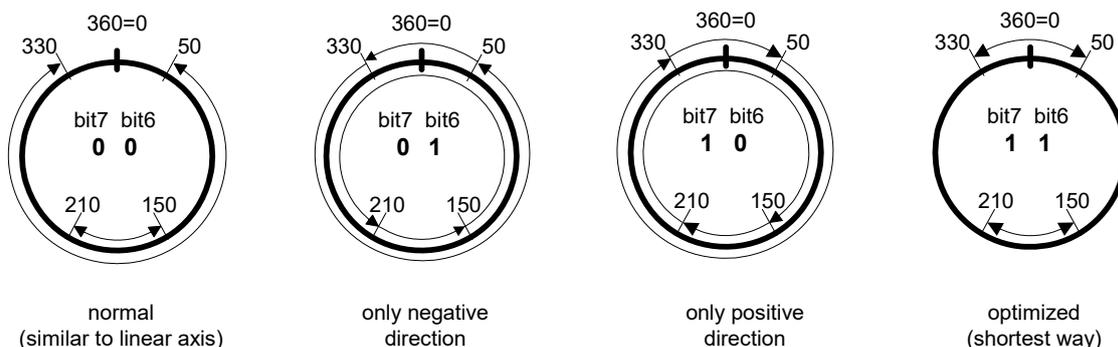
### 0x60F2: Positioning option code

Index	0x60F2	Set the behavior of positioning.	Object Code		Variable	
Sub-Idx	Description		Data Type	Access	PDO	Initial Value
0x00	Positioning option code [POSOP] See table below for definition of bit 7 and 6. Set 0 except bit 7 and 6.		Unsigned16	RW	Possible	0x0000
			Setting Range	0x0000 to 0xFFFF		



bit7	bit6	Rotation direction definition on rotation axis
0	0	Standard positioning same as straight axis: 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: 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: Move to target through maximum limit of position range, even though target position is smaller than actual position.
1	1	Positioning at shortcut: Automatically decide shortcut direction, and move. 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



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

Index	0x60F4	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] Unit is 1 pulse/LSB with RS2EtherCAT amplifier in the user definition. In incremental encoder, the value that quadruplicate the A/B signal is provided.		Integer32	RO	Possible	0x00000000
			Setting range	0x80000000-0x7FFFFFFF (-2147483648-2147483647 Pulse)		
			Unit	Pulse		

### 0x60FA: Control effort

Index	0x60FA	Indication of the target value after positioning.	Object code		Variable	
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Indicate velocity command value after positioning. This object indicate value at Profile position and Cycle position mode only.		Integer32	RO	Possible	0x00000000
			Setting range	0x80000000 to 0x7FFFFFFF (-2147483648 to 2147483647 pps)		
			Unit	pps		

### 0x60FC: Position Demand Internal Value

Index	0x60FC	Indicates the internal target position.	Object Code		Variable	
Sub-Idx	Description		Data Type	Access	PDO	Initial Value
0x00	Internal Target Position Displays internal target position command in profile position mode. This value same as Position Demand Value(0x6062) as measured by the control cycle unit(125us). ✓Other modes Values are not displayed. (always displayed as 0)		Integer32	RO	Possible	-
			Display Range	0x80000000 to 0x7FFFFFFF (-2147483648 to 2147483647 Pulse)		
			Unit	Pulse		

## 7. Object Dictionary

### 0x60FD: Digital inputs

Index	0x60FD	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] Monitor general-purpose input: CONT1 to 6 and HWGOFF1. 1: Photocoupler is on. ✓ Digital input has about 4msec delay for reflecting hardware input.		Unsigned32	RO	Possible	-							
			Display range	0x00000000-0xFFFFFFFF									
MSB							LSB						
Res	HWGOFF2 (*CONT8) Note1)	HWGOFF1 (*CONT7) Note1)	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	0x60FE	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] Bit 0: Monitoring Holding brake output timing  Bit17-16: Enables control output OUT1 and OUT2 when it is set 0x42 through 0x45 for "Controls by EtherCAT communication". ✓ 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		
0x02	Bit mask bit0: Disabled bit17-16 mask the bits corresponding to physical output 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. 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	0x00000000	
			Setting Range	0x000000 to 0xFFFFFFFF			

### 0x60FF: Target Velocity

Index	0x60FF	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]  Velocity command input for Cyclic Sync. Velocity (csv), Profile velocity (pv)		Integer32	RW	Possible	-	
			Display range	0x80000000-0x7FFFFFFF (-2147483648-2147483647 pps)			
			Unit	Pulse/sec			

### 0x6402: Motor Type

Index	0x6402	Select running motor type.	Object Code				VAR
Sub-Idx	Name/Description		Data Type	Access	PDO	Value	
0x00	Motor Type This product does not support any motor other than AC motor.		Unsigned16	RW	Possible	0x000C	

### 0x6403: Motor Catalog Number

Index	0x6403	Indicates setting motor model number.	Object Code				VAR
Sub-Idx	Name/Description		Data Type	Access	PDO	Value	
0x00	Motor Model Number Setting Motor Model Number (ASCII Code)		Visible String	RO	No	Character String (-)	
<u>R2</u> <u>A</u> <u>A</u> <u>04</u> <u>03</u> <u>F</u> ✓ Please refer to chapter 1.4 "Motor type number" for the detail of motor type number. ※ Only the Sanyo Denki R series are supported. Non supported motors are indicated as Not Supported.							

### 0x6404: Motor Manufacturer

Index	0x6404	Indicates manufacturer of setting motor.	Object Code				VAR
Sub-Idx	Name/Description		Data Type	Access	PDO	Value	
0x00	Manufacturer Manufacturer of setting motor (ASCII code)		Visible String	RO	No	Character String (-)	
※ It is indicated as SANYO DENKI Co., LTD because Sanyo Denki motors are recommended.							

## 7. Object Dictionary

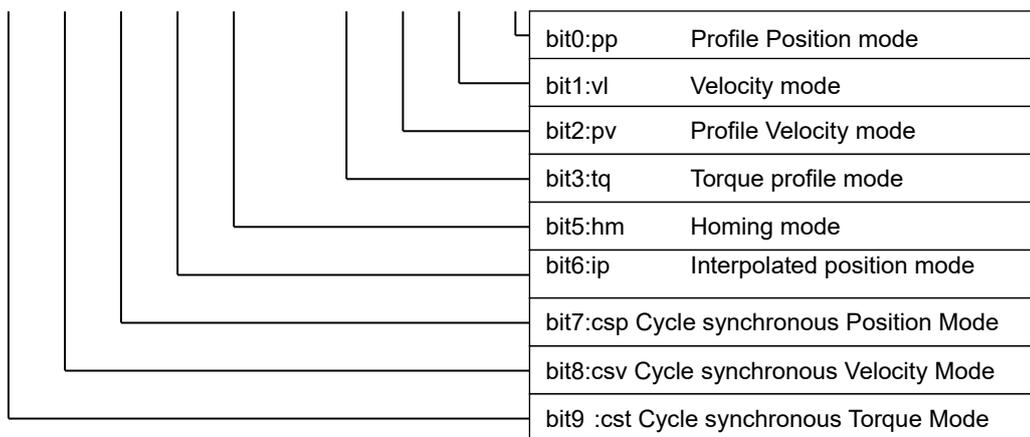
### 0x6405: Motor Catalog Address of our Home Page

Index	0x6405	Indicates catalog address of selected motor.	Object Code		VAR	
Sub-Idx	Name/Description		Data Type	Access	PDO	Value
0x00	Home Page Address Home Page Address of setting motor (ASCII Code)		Visible String	RO	No	Character String (-)
※ SANYO DENKI's home page address is indicated because Sanyo Denki motors are recommended.						

### 0x6502: Supported Drive mode

Index	0x6502	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] 0: Not supported 1: Supported		Unsigned32 Display range	RO	Possible	0x03ED 0x03ED to 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



### 0x6503: Drive Catalog No.

Index	0x6503	Indicates Catalog No. of this product.	Object Code		VAR	
Sub-Idx	Name/Description		Data Type	Access	PDO	Value
0x00	Catalog No. The Catalog No. of this product is indicated.		Visible String	RO	No	Character String (-)
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 The address of the website catalog for this Product. (ASCII Code)		Visible String	RO	No	Character String (-)
※Indicates the address of the catalog of servo amplifiers on the Sanyo Denki website.						

## 7. Object Dictionary

### 7.5 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	-	-
↑	0x07	○	○	○	○	Auto-Notch Filter Tuning Torque Command	Unsigned16	RW	No	#	Yes
↑	0x08	○	○	○	○	Auto-FF Vibration Suppression Frequency Tuning Torque Command	Unsigned16	RW	No	#	Yes
↑	0x09	○	○	○	○	Auto-FF Vibration Suppression Frequency Tuning Friction Compensation Value	Unsigned16	RW	No	#	Yes
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 1	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 settling 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"

## 7. Object Dictionary

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 attainment 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	-	-	-	-	Position Synchronization Correction Function Parameter	Unsigned8	RO	No		
↑	0x01	○	-	-	-	Correction Proportional Gain	Unsigned16	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
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 integral drain rate	Unsigned32	RW	Possible	#	Yes
0x2038	0x00	○	×	×	×	Velocity Control Bypass Setting	Unsigned8	RW	Possible	#	Yes
0x2039	0x00	○	○	×	×	Velocity differential drain rate	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

## 7. Object Dictionary

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 0x2042- 0x2045	0x00	—	—	—	—	Velocity Command Filter Setting 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
0x2046	0x00	—	—	—	—	Multi Stage Notch Tuning Setting	Unsigned8	RO	No	-	-
↑	0x01	○	○	○	○	Auto-Notch Tuning Mode	Unsigned8	RW	No	-	-
↑	0x02	○	○	○	○	Resonant Frequency Monitor	Unsigned16	RO	No	-	-
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
0x2080	0x00	—	—	—	—	Gain Switching Condition	Unsigned8	RO	No	#	Yes
↑	0x01	○	○	○	○	Gain Switching Condition 1	Unsigned8	RW	No	#	Yes
↑	0x02	○	○	○	○	Gain Switching Condition 2	Unsigned8	RW	No	#	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
0x5085	0x00	○	×	×	×	Correction Table Function Selection	Unsigned8	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

## 7. Object Dictionary

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	○	x	x	x	Positioning Method	Unsigned8	RW	No	&	Yes
↑	0x03	○	x	x	x	In position / Position deviation monitor	Unsigned8	RW	No	#	Yes
↑	0x04	○	○	○	○	Velocity Window Unit Output	Unsigned8	RW	No	#	Yes
↑	0x05	○	x	x	x	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	○	x	x	x	External Pulse Encoder, Digital Filter	Unsigned8	RW	No	#	Yes
↑	0x04	○	x	x	x	External Pulse Encoder Polarity	Unsigned8	RW	No	&	Yes
↑	0x05	○	○	○	○	CS offset online 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
↑	0x0A	○	○	○	○	Encoder clear 2	Unsigned8	RW	No	#	-
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
↑	0x06	○	○	○	○	Alarm History Clearing Command	Unsigned32	RW	No	-	-
↑	0x07	○	○	○	○	Alarm History Clearing Operation Monitor	Unsigned8	RO	No	-	-
0x20F3	0x00	-	-	-	-	Position Control Selection	Unsigned8	RO	No	-	-
↑	0x01	○	x	x	x	Model Control Characteristic	Unsigned8	RW	No	&	Yes
↑	0x02	○	x	x	x	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	x	x	x	○	Actual Position Calculation Method	Unsigned8	RW	No	#	Yes
↑	0x02	x	x	x	○	Hard Stop Torque Limit	Unsigned16	RW	No	#	Yes
↑	0x03	x	x	x	○	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 Stop Function	Unsigned8	RW	No	#	Yes
↑	0x06	○	○	○	○	Detection 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
0x20FC	0x00	○	○	○	○	Modulo initialization warning detection setting	Unsigned16	RW	No	&	Yes
0x20FB	0x00	○	x	x	x	Torque addition at S-ON	Integer32	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
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	○	x	x	x	External Encoder Resolution	Unsigned32	RW	No	&	Yes

○: Supported, x: Not supported

## 7. Object Dictionary

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	○	○	○	○	1 <sup>st</sup> - 7 <sup>th</sup> 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	-	-
0x2118	0x00	-	-	-	-	Encoder monitor	Unsigned8	RO	-	-	-
↑	0x01	○	○	○	○	Motor encoder monitor	Integer32	RO	Possible	-	-
↑	0x02	○	○	○	○	External encoder monitor	Integer32	RO	Possible	-	-
0x211F	0x00	○	○	○	○	Digital input (Short)	Unsigned16	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	#	-
0x2121	0x00	○	○	○	○	Production number	VisibleString	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 0x5041 0x5042	0x00	-	-	-	-	Position Unit System Velocity Unit System 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	-	-

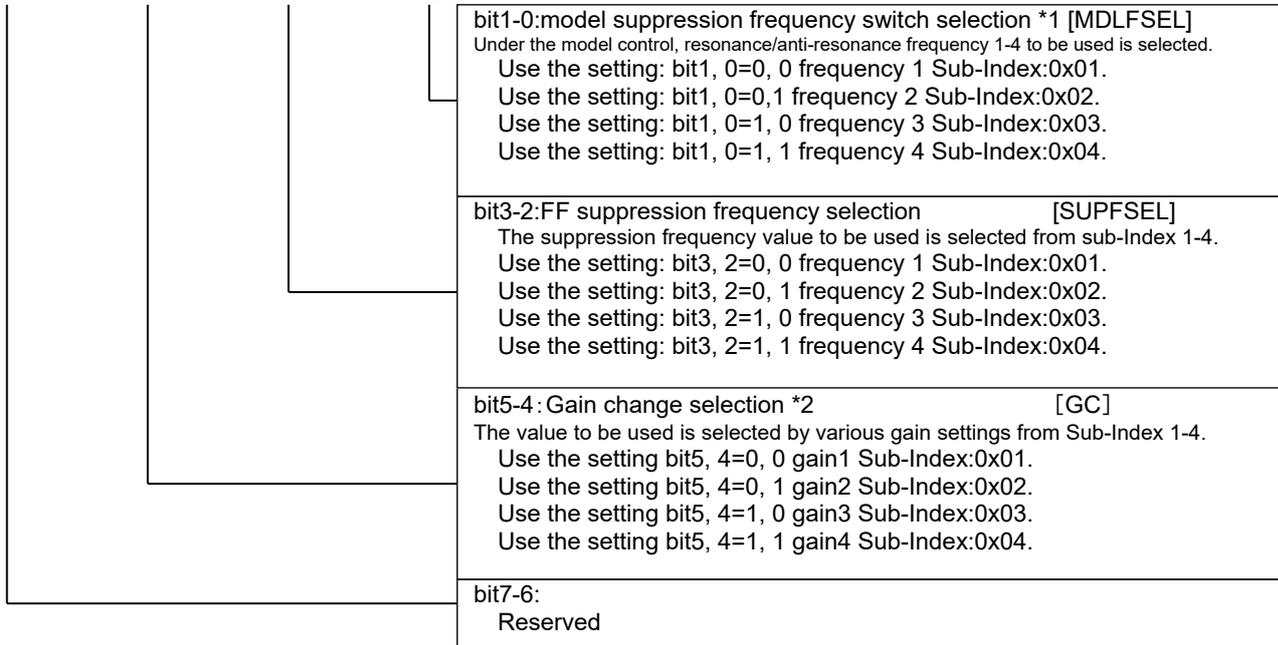
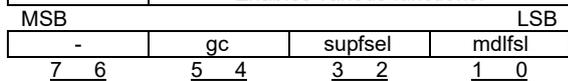
○: Supported, ×: Not supported



## 7. Object Dictionary

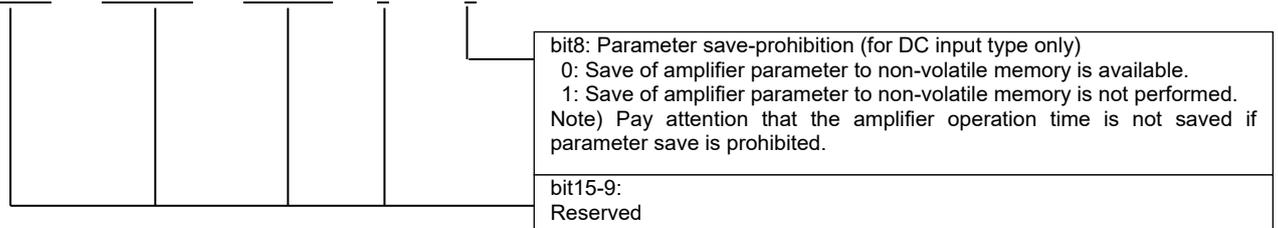
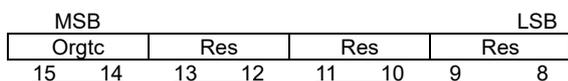
### 0x2001: Parameter Select

Index	0x2001	Controls the selection of various parameters.	Object Code		Variable
Sub-Idx	Description		Access	PDO	Initial value
0x00	Parameter Select [PARSEL] Enables various functions.		RW	Possible	-



\*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.



## 7. Object Dictionary

### 3) Auto-Tuning Parameter

0x2002: Auto-tuning

Index	0x2002	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]	Unsigned8	RW	No	0x02
	Set the validity, invalidity of Auto-tuning, and Load inertia moment rate estimation.		Setting range	0x00-0x02		
	<p><u>0x00: AutoTun</u> (Automatic Tuning)  <u>0x01: AutoTun_JRAT-Fix</u> (Automatic Tuning JRAT Manual Setting)  <u>0x02: ManualTun</u> (Manual Tuning)</p> <p>*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).  *Load inertia moment ratio of machines applied large disturbance torque (force), machine with major backlash, and machine whose moving part vibrate partially can not correctly estimated.  *If you use model following vibration suppressor control, set "02: Manual tuning."  *If 00: AutoTun is selected, vibration suppressor control will be disabled though state feedback model following vibration suppressor control (base vibration suppressor) is selected.</p>					
0x02	Auto-Tuning Characteristic	[ATCHA]	Unsigned8	RW	No	0x00
	Selects the tuning characteristic.		Setting range	0x00-0x06		
	<p><u>0x00: Positioning1 Positioning Control 1 (General Purpose)</u>  <u>0x01: Positioning2 Positioning Control 2 (High Response)</u>  <u>0x02: Positioning3 Positioning Control 3 (High Response, FFGN Manual Setting)</u>  <u>0x03: Positioning4 Positioning Control 4 (High Response, Horizontal Axis Limited)</u>  <u>0x04: Positioning5 Positioning Control 5 (High Response, Horizontal Axis Limited)</u>  <u>0x05: Trajectory1 Trajectory Control 1</u>  <u>0x06: Trajectory2 Trajectory Control 2 (KP,FFGN Manual Setting)</u></p> <p>*[Positioning Control 1] * For general-purpose positioning like fast forward operations.  *[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."  *[Positioning Control 3] * For further adjusting FFGN.  *[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.  * When the estimation accuracy of the Load Inertia moment ratio is low or cannot be obtained due to operation patterns or machine characteristics.  *[Positioning Control 5] * When you want to adjust forward gain in case of the horizontal axis without external forces.  *[Trajectory Control 1] * When there is no need to follow position commands and coordination with other axes (such as in cutting operations.)  ■ [Trajectory Control 2] * For coordination with other axes (please adjust KPPGIN.)  * 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.</p> <p>*When "Tuning mode" is set at "02 manual tuning," the set value will not be reflected.  *According to the characteristics selected, parameters will be set automatically.  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.</p>					
0x03	Sets the Auto-Tuning Response	[ATRES]	Unsigned8	RW	No	0x05
	*The larger the set value, the higher the response. *Caution, if the response is set too high, the machine may oscillate. *Make the setting suitable for rigidity of the device.		Setting range	0x01-0x1E (1 to 30)		

## 7. Object Dictionary

0x04	<p>Save Notch/FF Vibration Suppression frequency/ Auto-Tuning data</p> <p>◆Result of above tuning data can save by EtherCAT communication network.</p> <p>◆Selects the command</p> <p><u>0x00: Disable tuning</u></p> <p><u>0x01: Execute Auto- Notch Filter tuning</u></p> <p><u>0x02: Execute Auto FF Vibration Suppression tuning</u></p> <p><u>0x03: Save result of Auto-tuning</u></p> <p><u>0x04: Stop Auto Notch Filter tuning / Auto FF Vibration Suppression tuning</u></p> <p><u>0x05: Stop save result of Auto-tuning</u></p> <p>◆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.</p> <p>◆Master will not able to run Auto-tuning while run by Setup software.</p> <p>◆Setup software will not able to run Auto-tuning while run by master.</p> <p>◆When Auto-tuning is working, master can be stop Auto-tuning.</p> <p>◆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.</p> <p>◆Auto Notch Filter tuning When Auto Notch Filter tuning is working, need to follow below.          &gt;Don't change 0x2040.2, 0x2042.1 and 0x2042.2.          &gt;Tuning result need to save Torque Command Notch Filter frequency.</p> <p>◆Tuning result of Auto FF Vibration Suppression need to save 0x2012.</p> <p>◆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)          &gt;Load inertia 1(0x200D.1)          &gt;Position Loop Proportional Gain 1(0x2005.1)          &gt;Velocity Loop Proportional Gain 1(0x200B.1)          &gt;Velocity Loop Integral Time Constant 1(0x200C.1)          &gt;Torque Command Filter 1(0x2011.1)          Don't change 0x20F7 bit1.          &gt;ModelFollowing Control Gain 1(0x2017.1)</p> <p>◆Result of Auto Notch filter tuning and Auto FF Vibration Suppression tuning can not save at the same time.</p>	Unsigned8 Setting range	RW	No 0x00 to 0x05 (0 to 5)	0x00																																										
0x05	<p>Notch /FF Vibration Suppression frequency/ Monitor of save tuning result.</p> <p>◆Indicate state of Notch Filter,FF Vibration Suppression frequency and tuning result.</p> <p><u>0x00: Running tuning</u></p> <p><u>0x01: Completion</u></p> <p><u>0x02: Abnormal termination</u></p> <p>If finish tuning 0x01 or 0x02 will indicate.</p>	Unsigned8 Setting range	RO	No 0x00 to 0x02 (0 to 2)	0x01																																										
0x06	<p>Parameter setting of save Auto-tuning result</p> <p>◆Setting of save parameter</p> <p>◆Description</p> <table border="1"> <thead> <tr> <th>Setting value</th> <th>Load inertia</th> <th>Position Proportional Gain</th> <th>Velocity Proportional Gain</th> <th>Velocity Integral Constant</th> <th>Torque Command Filter</th> <th>Model Control Gain</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>Yes</td> <td>Yes</td> <td>Yes</td> <td>Yes</td> <td>Yes</td> <td>Yes</td> </tr> <tr> <td>1</td> <td>Yes</td> <td>No</td> <td>Yes</td> <td>Yes</td> <td>Yes</td> <td>No</td> </tr> <tr> <td>2</td> <td>Yes</td> <td>No</td> <td>No</td> <td>No</td> <td>No</td> <td>No</td> </tr> <tr> <td>3</td> <td>No</td> <td>Yes</td> <td>Yes</td> <td>Yes</td> <td>Yes</td> <td>Yes</td> </tr> <tr> <td>4</td> <td>No</td> <td>No</td> <td>Yes</td> <td>Yes</td> <td>Yes</td> <td>No</td> </tr> </tbody> </table>	Setting value	Load inertia	Position Proportional Gain	Velocity Proportional Gain	Velocity Integral Constant	Torque Command Filter	Model Control Gain	0	Yes	Yes	Yes	Yes	Yes	Yes	1	Yes	No	Yes	Yes	Yes	No	2	Yes	No	No	No	No	No	3	No	Yes	Yes	Yes	Yes	Yes	4	No	No	Yes	Yes	Yes	No	Unsigned8 Setting range	RW	No 0x00 to 0x04 (0 to 4)	0x00
Setting value	Load inertia	Position Proportional Gain	Velocity Proportional Gain	Velocity Integral Constant	Torque Command Filter	Model Control Gain																																									
0	Yes	Yes	Yes	Yes	Yes	Yes																																									
1	Yes	No	Yes	Yes	Yes	No																																									
2	Yes	No	No	No	No	No																																									
3	No	Yes	Yes	Yes	Yes	Yes																																									
4	No	No	Yes	Yes	Yes	No																																									

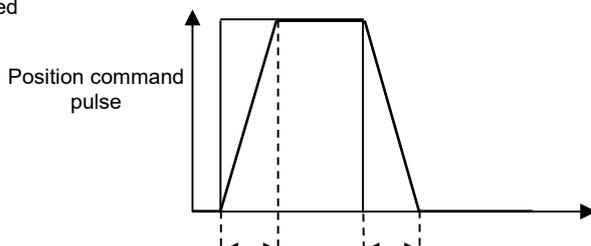
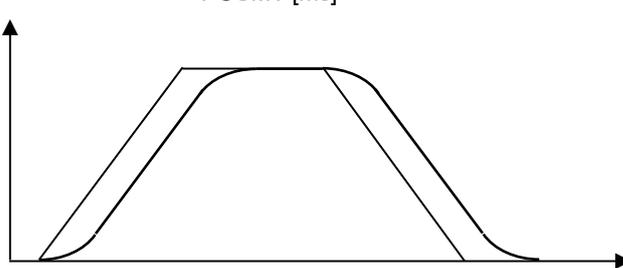
## 7. Object Dictionary

0x07	Auto-Notch Filter Tuning Torque Command [ANFILTC] ◆Sets torque command value in auto-notch filter tuning.  ✓ Larger value makes the tuning more accurate; however, note that it also makes the movement of the machine greater.	Unsigned16	RW	No	0x01F4
		Display range	0x0064-0x03E8 (10.0 to 100.0)		
		Unit	0.1%		
0x08	Auto-FF Vibration Suppression Frequency Tuning Torque Command [ASUPTC] ◆Sets torque command value in auto-FF vibration suppression frequency tuning. ✓ Larger value makes the tuning more accurate; however, note that it also makes the movement of the machine greater.	Unsigned16	RW	No	0x01F4
		Display range	0x0064-0x03E8 (10.0 to 100.0)		
		Unit	0.1%		
0x09	Auto-FF Vibration Suppression Frequency Tuning Friction Compensation Value [ASUPFC] ◆Sets friction compensation value in auto-FF vibration suppression frequency tuning.	Unsigned16	RW	No	0x0032
		Display range	0x0000-0x01F4 (0.0 to 50.0)		
		Unit	0.1%		

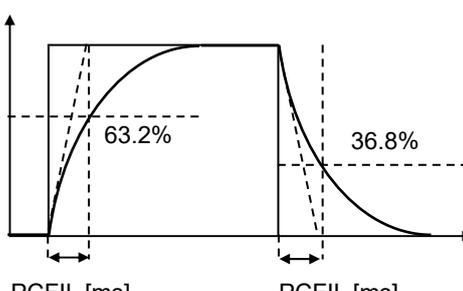
## 7. Object Dictionary

### 4) Basic Control Parameter

#### 0x2003: Position Command Smoothing Constant

Index	0x2003	Description	This moving low-pass filter smooths the position command pulse. Sets time constants.		Object Code	Variable
Sub-Idx	0x00	Description	Data Type	Access	PDO	Initial value
		Position Command Smoothing Constant [PCSMT] *Applies gradient to the step condition positioning pulse. *Applies S curve to the ramp condition position command pulse. *When position command differences in each communication cycle are large, position command will be smoothed. (This may decrease the operating noise of the servo motor.) *When this moving-average filter is used, the value is set at "0.3ms and higher". *When the set value is "0.0ms-0.2ms", this filter is invalid. *Set in increments of 0.5ms. (Under the set value "0.4ms and less", there may be cases where the set value cannot be applied to the operation.)	Unsigned16	RW	Possible	0x0005 (0.5 ms)
			Setting range	0x0000-0x1388 (0.0 to 500.0 ms)		
			Unit	0.1 ms		
		* Position command pulse with step condition applied 				
		* Position command pulse with ramp condition applied. 				

#### 0x2004: Position Command Filter

Index	0x2004	Description	This low-pass filter suppresses any sudden change of the position control pulse. Sets time constants.		Object Code	Variable
Sub-Idx	0x00	Description	Data Type	Access	PDO	Initial value
		Position Command Filter [PCFIL] Time constant for the filter will be set. Filter will be invalid at the set value 0.0 ms. Does not influence Feed Forward.	Unsigned16	RW	No	0x0000 (0.0 ms)
			Setting range	0x0000-0x4E20 (0.0 to 2000.0 ms)		
			Unit	0.1 ms		
		*This parameter setting is valid when the value of Higher Tracking Control Position Compensation Gain is set at 0%. *When Higher Tracking Control Position Compensation Gain is 0%, value is set at 0.0ms, the filter becomes invalid. *This filter can suppress overshoot caused by the rise of the feed forward compensation gain.				
						

## 7. Object Dictionary

### 0x2005: Position Loop Gain

Index	0x2005	Proportional gain for position 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	Position Loop Gain 1	[KP1]	Unsigned16	RW	Possible	0x001E (30 /s)
		*Automatically saved by Auto-tuning result saving. *When Auto-tuning function is valid, this setting value is not applied. *When gain 1(bit5, 4=0, 0) is selected, in the Gain Switching function, it operates at this setting value.				
0x02	Position Loop Gain 2	[KP2]	Unsigned16	RW	No	0x001E (30 /s)
		* When gain 2(bit5, 4=0, 1) is selected, in the Gain Switching function, it operates at this setting value.				
0x03	Position Loop Gain 3	[KP3]	Unsigned16	RW	No	0x001E (30 /s)
		* When gain 3(bit5, 4=1, 0) is selected, in the Gain Switching function, it operates at this setting value.				
0x04	Position Loop Gain 4	[KP4]	Unsigned16	RW	No	0x001E (30 /s)
		* When gain 4(bit5, 4=1, 1) is selected, in the Gain Switching function, it operates at this setting value.				
			Setting range	0x0001-0x0BB8 (1 to 3000 /s)		
			Unit	1/s		

### 0x2006: Position Integral Time Constant 1

Index	0x2006	Integral time constant for position controller. By setting bit5, 4, gain change selection (GC), in parameter selection (0x2001), the position integral time constant 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	Position Integral Time Constant 1	[TPI1]	Unsigned16	RW	Possible	0x2710 (1000ms) proportional control
		* Automatically saved by Auto-tuning result saving. * When Auto-tuning function is valid, this setting value is not applied. *When gain 1(bit5, 4=0, 0) is selected, in the Gain Switching function, it operates at this setting value.				
0x02	Position Integral Time Constant 2	[TPI2]	Unsigned16	RW	No	0x2710 (1000ms) proportional control
		*When gain 2(bit5, 4=0, 1) is selected, in the Gain Switching function, it operates at this setting value.				
0x03	Position Integral Time Constant 3	[TPI3]	Unsigned16	RW	No	0x2710 (1000ms) proportional control
		*When gain 3(bit5, 4=1, 0) is selected, in the Gain Switching function, it operates at this setting value.				
0x04	Position Integral Time Constant 4	[TPI4]	Unsigned16	RW	No	0x2710 (1000ms) proportional control
		*When gain 4(bit5, 4=1, 1) is selected, in the Gain Switching function, it operates at this setting value.				
			Setting range	0x0003-0x2710 (0.3 to 1000 ms)		
			Unit	0.1ms		



## 7. Object Dictionary

### 0x200A: Velocity Feedback Filter

Index	0x200A	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] First low-pass filter to eliminate ripples caused by encoder pulse included in the velocity control system feedback. Sets the cutoff frequency. Setting value: the filter will be disabled at 2000Hz(0x07D0) or greater.		Unsigned16	RW	No	0x05DC (1500 Hz)
			Setting range	0x0001-0x0FA0 (1 to 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	0x200B	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] *Automatically saved by Auto-tuning result saving.		Unsigned16	RW	Possible	0x0032 (50Hz)
*When Auto-tuning function is valid, this setting value is not applied. *When the Gain switching function is valid, select gain 1 and this setting value is applied. *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] *When gain 2(bit5, 4=0, 1) is selected, in the Gain Switching function, it operates at this setting value.		Unsigned16	RW	No	0x0032 (50Hz)
0x03	Velocity Loop Proportional Gain 3 [KVP3] *When gain 3(bit5, 4=1, 0) is selected, in the Gain Switching function, it operates at this setting value.		Unsigned16	RW	No	0x0032 (50Hz)
0x04	Velocity Loop Proportional Gain 4 [KVP4] *When gain 4(bit5, 4=1, 1) is selected, in the Gain Switching function, it operates at this setting value.		Unsigned16	RW	No	0x0032 (50Hz)
			Setting range	0x0001-0x07D0 (1 to 2000 Hz)		
			Unit	1Hz		

### 0x200C: Velocity Loop Integral Time Constant

Index	0x200C	Integral time constant of velocity controller. Selects Velocity Loop Integral Time Constant to use by Gain change selection (GC) (Parameter Select: 0x2001 bit5, 4). 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] *Automatically saved by Auto-tuning result saving.		Unsigned16	RW	Possible	0x00C8 (20ms)
*When Auto-tuning function is valid, this setting value is not applied. *When Gain switching function is valid, select gain 1 and this setting value is applied. *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] * When gain 2(bit5, 4=0, 1) is selected, in the Gain Switching function, it operates at this setting value.		Unsigned16	RW	No	0x00C8 (20ms)
0x03	Velocity Loop Integral Time Constant 3 [TVI3] * When gain 3(bit5, 4=1, 0) is selected, in the Gain Switching function, it operates at this setting value.		Unsigned16	RW	No	0x00C8 (20ms)
0x04	Velocity Loop Integral Time Constant 4 [TVI4] * When gain 4(bit5, 4=1, 1) is selected, in the Gain Switching function, it operates at this setting value.		Unsigned16	RW	No	0x00C8 (20ms)
			Setting range	0x0003-0x2710 (0.3 to 1000 ms)		
			Unit	0.1ms		

## 7. Object Dictionary

### 0x200D: Load Inertia Moment Ratio

Index	0x200D	Sets inertia moment of the loading device to the servo motor roter inertia. Setting value= $J_L/J_M \times 100\%$ ( $J_L$ : Load inertia, $J_M$ : Motor roter inertia) 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]	*For velocity control parameters. *Automatically saved by Auto-tuning result saving. *When Auto-tuning function is valid, this setting value not applied. *When Gain switching function is valid, select gain 1 and this setting value is applied. *When gain 1 (bit5, 4=0, 0) is selected, in the Gain Switching function, it operates at this setting value.	Unsigned16	RW	Possible	0x0064 (100%)
0x02	Load Inertia Moment Ratio 2 [JRAT2]		Unsigned16	RW	No	0x0064 (100%)
0x03	Load Inertia Moment Ratio 3 [JRAT3]		Unsigned16	RW	No	0x0064 (100%)
0x04	Load Inertia Moment Ratio 4 [JRAT4]		Unsigned16	RW	No	0x0064 (100%)
			Setting range	0x0000-0x3A98 (0 to 15000%)		
			Unit	1%		

### 0x200E: Higher Tracking Control Velocity Compensation Gain

Index	0x200E	Parameter to adjust command following performance of velocity control.	Object Code	Variable		
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Higher Tracking Control Velocity Compensation Gain [TRCVGN]	*The higher the value, the more improved command following performance.  *When using Velocity Loop Proportional Control Switching Function, set it to 0%. *When synchronizing with other axes, set it to 0%. *When corresponding with Q series servo amplifier, set it to 100%. *When auto-tuning enabled, this setting value is not reflected. *The setting value is invalid with Model following control or Model following vibration suppressor control.	Unsigned16	RW	No	0x0000
			Setting range	0x0000 - 0x0064 (0 to 100 %)		
			Unit	1%		

### 0x200F: Acceleration Feedback Compensation

Index	0x200F	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]	Multiply this gain with the detected acceleration to compensate torque (force) command. ■When Auto-tuning function is valid, this setting value not applied. ■If the value is too large, the motor may oscillate. Set within range $\pm 15.0\%$ for general use.	Integer16	RW	No	0x0000 (0.0 %)
			Setting range	0xFC18-0x03E8 (-100.0 to +100.0%)		
			Unit	0.1 %		
0x02	Acceleration Feedback Filter [AFBFIL]	First low-pass filter to eliminate ripples caused by encoder pulse included in acceleration feedback compensation. Sets the cutoff frequency. ■Lower this setting value when the encoder resolution is low. ■Setting value: the filter will be disabled at 2000Hz(0x07D0) or greater.	Unsigned16	RW	No	0x01F4 (500Hz)
			Setting range	0x0001-0x0FA0 (1 to 4000Hz)		
			Unit	Hz		

## 7. Object Dictionary

### 0x2011: Torque Command Filter

Index	0x2011	Low-pass filter to eliminate high frequency component included in the torque (force) command. Sets cutoff frequency. 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] * This setting update when save Auto-Tuning data. * When Auto-Tuning activate , this setting invalid. * When Auto-Tuning activate and System analysis activate, this setting valid. * When Gain Switching activate and select gain 1(bit5,4=0,0), this setting enable.		Unsigned16	RW	Possible	0x0258 (600Hz)
0x02	Torque (force) Command Filter 2 [TCFIL2] *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 (600Hz)
0x03	Torque (force) Command Filter 3 [TCFIL3] * 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 (600Hz)
0x04	Torque (force) Command Filter 4 [TCFIL4] * 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 (600Hz)
<ul style="list-style-type: none"> <li>✓ Function enabled by setting "Special Function Selection Setting (0x20F7), bit1".</li> <li>✓ Gain changes depending on setting of the gain switching condition (0x20B0).</li> </ul>			Setting value	0x0001 - 0x0FA0 (1 to 4000 Hz)		

## 7. Object Dictionary

### 5) Feed Forward vibration suppressor control / Notch filter Parameter

0x2012: FF Vibration Suppressor Frequency

Index	0x2012	<p>Sets the frequency of the machine vibration to be suppressed by FF vibration suppressor function. Change this while the servo motor is OFF.</p> <p>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).</p> <p>By setting bit3, 2 FF Vibration Suppressor Frequency switch selection (supfsel) in parameter selection (0x2001), the notch filter to be used is selected.</p>	Object Code		Array
Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Number of entry	Unsigned8	RO	No	0x04
0x01	<p>FF Vibration Suppressor Frequency 1 [SUPFRQ1]</p> <p>*This parameter is automatically saved by executing FF vibration suppressor frequency tuning.</p> <p>*Tuning result will be automatically saved in this parameter.</p> <p>*When frequency 2 (bit 3, 2=0, 1) is selected in the vibration suppressor frequency selection function, it will operate at this setting value.</p>	Unsigned16	RW	Possible	0x01F4 (500 Hz) proportional control
0x02	<p>FF Vibration Suppressor Frequency 2 [SUPFRQ2]</p> <p>*When frequency 2 (bit 3, 2=0, 1) is selected in the vibration suppressor frequency selection function, it will operate at this setting value.</p>	Unsigned16	RW	No	0x01F4 (500 Hz) proportional control
0x03	<p>FF Vibration Suppressor Frequency 3 [SUPFRQ3]</p> <p>*When frequency 3 (bit 3, 2=1, 0) is selected in the vibration suppressor frequency selection function, it will operate at this setting value.</p>	Unsigned16	RW	No	0x01F4 (500 Hz) proportional control
0x04	<p>FF Vibration Suppressor Frequency 4 [SUPFRQ4]</p> <p>*When frequency 4 (bit 3, 2=1, 1) is selected in the vibration suppressor frequency selection function, it will operate at this setting value.</p>	Unsigned16	RW	No	0x01F4 (500 Hz) proportional control
	<p>*Setting value can be input by 1Hz; inside the servo amplifier, the units listed below are used.</p> <p>Setting range      Unit value inside servo amplifier</p> <p>5 to 99Hz          Valid by 1Hz</p> <p>100 to 499Hz      Valid by 5Hz and drop less than 5</p> <p>*Setting value: FF vibration suppressor control is invalid</p> <p>*Do not use while synchronizing with other axis such as controlling XY table trajectory for cutting operation.</p>	Setting range	0x0005-0x01F4 (5 to 500Hz)		
		Unit	Hz		

## 7. Object Dictionary

### 6) High stabilized control settings

0x2015: High stabilized control settings

Index	0x2015	Parameter setting to implement high settling 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	<b>Acceleration Compensation [ACCC0]</b> Sets the Acceleration Compensation Value using high-stabilized control. ✓Set with the Position Deviation Pulse unit (in case of the pulse encoder, with the quadruple encoder resolution unit.) ✓Compensation is provided in response to position deviation. ✓Greater setting values result in increased compensation. ✓Greater accelerations converted from the Position Command Pulse result in increased compensation. ✓Greater Load inertia result in increased compensation. ✓High Stabilized Control results in Position Deviation. ✓In case of model following control or model following anti-resonance control, this setting value is not reflected.		Indeger16	RW	No	0x0 (0 Pulse)
			Setting range	0xD8F1-0x270F (-9999 to +9999×50 Pulse)		
			Unit	×50 Pulse		
0x02	<b>Deceleration Compensation [DECC0]</b> Sets the Deceleration Compensation Value with High Stabilized Control. ✓Setting is in unit of position deviation pulse (for pulse encoder, unit of 4-multiplied encoder resolution). ✓Compensation shall be performed for position deviation. ✓The higher the set value, the more the compensation increases. ✓The higher the acceleration converted from position command pulse, the more the compensation increases. ✓The higher the load inertia value, the more the compensation increases. ✓Position deviation decreases by high-stabilized control. ✓In case of model following control or model following anti-resonance control, this setting value is not reflected.		Indeger16	RW	No	0x0 (0 Pulse)
			Setting range	0xD8F1-0x270F (-9999 to +9999×50 Pulse)		
			Unit	×50 Pulse		
0x03	<b>Command Velocity Low-pass Filter [CVFIL]</b> 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 high settling control. ✓When the encoder resolution is low, lower the cutoff frequency. ✓The filter is disabled by setting value 2000Hz or more.		Unsigned16	RW	No	0x03E8 (1000Hz)
			Setting range	0x001-0x0FA0 (1 to 4000Hz)		
			Unit	Hz		
0x04	<b>Command Velocity Threshold [CVTH]</b> Sets the Velocity Threshold to validate the Acceleration and Deceleration Compensation Values in the high settling control. ✓When the velocity (command velocity) converted from the Position Command is higher than this velocity, implement the Acceleration or Deceleration Compensations. ⚠The rotary motor differs from linear motor in unit.		Unsigned16	RW	No	0x0014 (20 min <sup>-1</sup> ) [20mm/s]
			Setting range	0x0000-0xFFFF (0 to 65536)		
			Unit	Rotary : min <sup>-1</sup> [Linear : mm/s]		

## 7. Object Dictionary

### 7) Observer Parameter

0x2016: Observer Parameter

Index	0x2016	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    0x01: Middle For Middle Frequency 0x02: High For High Frequency    0x03-0xFF: Reserved					
◆Select "00 Low, Low Frequency Disturbance Observer Suppressor" for Load torque (force) monitor (estimate value). ◆Select 02 High, High Frequency Disturbance Observer Suppressor, when the encoder resolution is over 1048576P/R (20bit).						
0x02	Compensation gain for Disturbance Observer [OBG] Observer Compensation gain in response to the Torque (force)command.		Unsigned16	RW	No	0x0000 (0 %)
	◆The larger the value, the higher the suppression performance. By making this too large to oscillate, the disturbance suppression characteristics improve.		Setting range	0x0000-0x0064 (0 to 100 %)		
			Unit	1 %		
0x03	Observer Output Filter [OBLPF] First low-pass filter to eliminate high frequency elements included in the observer compensation. Sets the cutoff frequency.		Unsigned16	RW	No	0x032 (50 Hz)
	◆Filter is invalid at the setting value more than 2000Hz.		Setting range	0x0001-0x0FA0 (1 to 4000 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. ◆Filter is invalid when observer characteristic is set to [01 Middle, For Middle Frequency], or [02 High, For High Frequency].		Unit	Hz		
0x04	Observer Notch Filter [OBNFIL] Notch filter to eliminate arbitrarily selected frequency from observer compensation. Set the center frequency of the filter.		Unsigned16	RW	No	0x0FA0 (4000 Hz)
	◆When resonance appears in disturbance observer output, such as sympathetic vibration with the mechanical system, this notch filter sometimes suppresses the vibration. ◆Setting value can be input by 1Hz; inside the servo amplifier, the units listed below are applied.		Setting range	0x0064-0x0FA0 (100 to 4000 Hz)		
	Setting value    Unit value inside servo amplifier 100-1999Hz    Valid by 10Hz and drop less than 10 2000-4000Hz    Filter invalid		Unit	Hz		
0x05	Observer Load Inertia Ratio [OBJLJM] Sets the Inertia moment (Load Inertia) of the loading device for the motor inertia moment at the disturbance suppression observer. Setting value=JL/JM×100% (JL: Load inertia, JM: Motor rotor inertia)		Unsigned16	RW	No	0x0064 (100%)
	✓Selection of disturbance suppression observer characteristics: JRAT 1-4 are used when frequency setting is made.		Setting range	0x0000-0x1388 (0 to 5000%)		
			Unit	%		
0x06	Observer Loop Proportional Gain [OBPGIN] Proportional gain of the observer control.		Unsigned16	RW	No	0x012C (300Hz)
			Setting range	0x0001-0x07D0 (1 to 2000Hz)		
			Unit	Hz		
0x07	Load Torque (force) Filter [TESLPF] 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. Setting value: the filter will be disabled at 2000Hz(0x07D0) or greater.		Unsigned16	RW	No	0x0032 (50 Hz)
			Setting range	0x0001-0x07D0 (1 to 2000Hz)		
			Unit	Hz		

## 7. Object Dictionary

### 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	0x2017	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] ◆Automatically saved by Auto-tuning result saving. ◆When gain 1(bit5, 4=0, 0) is selected, in the Gain Switching function, it operates at this setting value.		Unsigned16	RW	Possible	0x001E (30 /s)
0x02	Model Control Gain 2 [KM2] ◆When gain 2(bit5, 4=0, 1) is selected, in the Gain Switching function, it operates at this setting value.		Unsigned16	RW	No	0x001E (30 /s)
0x03	Model Control Gain 3 [KM3] ◆When gain 3(bit5, 4=1, 0) is selected, in the Gain Switching function, it operates at this setting value.		Unsigned16	RW	No	0x001E (30 /s)
0x04	Model Control Gain 4 [KM4] ◆When gain 4(bit5, 4=1, 1) is selected, in the Gain Switching function, it operates at this setting value.		Unsigned16	RW	No	0x001E (30 /s)
Depends on the setting value of Position control selection (0x20F3:01), the range is different. 01: Model Following Control 0x0001-0x0BB8 (1-3000 /s) 02: Condition Feedback Model Following Vibration Suppress Control 0x000F-0x013B (15 to 315 /s)			Setting range	0x0001-0x0BB8 (1 to 3000 /s)		
			Unit	1/s		
◆In case of operating at Model following anti-resonance control, use in the range of 15 to 315/s. ◆Change value while the servo motor is OFF.						

0x2018: Overshoot Suppressor Filter

Index	0x2018	Filter to suppress overshoot with Model following control or Model following vibration suppressor control. Sets cutoff frequency.	Object Code			Variable
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Overshoot Suppressor Filter [OSSFIL] Cutoff frequency of primary low-pass filter in response the velocity integral feedback. ◆If any overshoots occur on position deviation, lower the setting value. ◆Filter is invalid at the setting value more than 2000Hz.		Unsigned16	RW	No	0x05DC (1500 Hz)
			Setting range	0x0001-0x0FA0 (1 to 4000 Hz)		
			Unit	Hz		

## 7. Object Dictionary

### 0x2019: Model Control Antiresonance Frequency

Index	0x2019	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.	Object Code	Array		
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Number of entry		Unsigned8	RO	No	0x04
0x01	Model Control Antiresonance Frequency 1 [ANRFRQ1] ◆When frequency 1(bit1, 0=0, 0) is selected in the model anti-resonance frequency switch at 0x2001, it operates at this setting value.		Unsigned16	RW	Possible	0x0320 (80.0 Hz) proportional control
0x02	Model Control Antiresonance Frequency 2 [ANRFRQ2] ◆When frequency 2(bit1, 0=0, 1) is selected in the model anti-resonance frequency switch at 0x2001, it operates at this setting value.		Unsigned16	RW	No	0x0320 (80.0 Hz) proportional control
0x03	Model Control Antiresonance Frequency 3 [ANRFRQ3] ◆When frequency 3(bit1, 0=1, 0) is selected in the model anti-resonance frequency switch at 0x2001, it operates at this setting value.		Unsigned16	RW	No	0x0320 (80.0 Hz) proportional control
0x04	Model Control Antiresonance Frequency 4 [ANRFRQ4] ◆When frequency 4(bit1, 0=1, 1) is selected in the model anti-resonance frequency switch at 0x2001, it operates at this setting value.		Unsigned16	RW	No	0x0320 (80.0 Hz) proportional control
◆Setting value is invalid with following control. ◆If the sitting value is over the Model Control Resonance Frequency, vibration suppressor control is invalid. ◆If “Model Control Anti-resonance Frequency 2-4” are selected in the “Model vibration suppressor frequency switching function”, it operates at this setting value. ◆Change value while the servo motor is OFF.			Setting range	0x0064-0x0320 (10.0 to 80.0 Hz)		
			Unit	0.1 Hz		

### 0x201A: Model Control Resonance Frequency

Index	0x201A	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.	Object Code	Array		
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Number of entry		Unsigned8	RO	No	0x04
0x01	Model Control Resonance Frequency 1 [RESFRQ1] ◆When frequency 1(bit1, 0=0, 0) is selected in the model anti-resonance frequency switch at 0x2001, it operates at this setting value.		Unsigned16	RW	Possible	0x0320 (80.0 Hz) proportional control
0x02	Model Control Resonance Frequency 2 [RESFRQ2] ◆When frequency 2(bit1, 0=0, 1) is selected in the model anti-resonance frequency switch at 0x2001, it operates at this setting value.		Unsigned16	RW	No	0x0320 (80.0 Hz) proportional control
0x03	Model Control Resonance Frequency 3 [RESFRQ3] ◆When frequency 3(bit1, 0=1, 0) is selected in the model anti-resonance frequency switch at 0x2001, it operates at this setting value.		Unsigned16	RW	No	0x0320 (80.0 Hz) proportional control
0x04	Model Control Resonance Frequency 4 [RESFRQ4] ◆When frequency 1(bit1, 0=1, 1) is selected in the model anti-resonance frequency switch at 0x2001, it operates at this setting value.		Unsigned16	RW	No	0x0320 (80.0 Hz) proportional control
* Setting value is invalid with Model following control. * The filter is disabled by setting value 0x320(80Hz) or more. * If Model Control Antiresonance Frequency 2-4 selected in Model vibration suppressor frequency switching setting, it works in this setting. * Change value while the servo motor is OFF.			Setting range	0x0064-0x0320 (10.0 to 80.0 Hz)		
			Unit	0.1 Hz		

### 0x201B: Gain Switching Filter

Index	0x201B	Low-pass filter to change gain moderately when switching. Sets time constant.	Object Code	Variable		
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Gain Switching Filter [GCFIL] By setting bit5, 4, gain change selection (GC) in the parameter selection (0x2001), the time constant at the parameter switching is set. ◆The larger the value, the gentler the gain changes. ◆The filter is disabled at the setting value 0ms. ◆When the mechanical system is shocked by the change of gain resulted from gain switching, making a moderate gain change will modify the shock.		Unsigned16	RW	No	0x0000 (0 ms)
			Setting range	0x0000-0x064 (0 to 100ms)		
			Setting Unit	ms		

## 7. Object Dictionary

### 9) Amplifier Function Parameter

0x201C: Internal Velocity Command limit

Index	0x201C	Sets the allowable velocity in response to the Internal Velocity Command.	Object Code		Variable	
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Internal Velocity Command limit [VCM_MAX] In the cycle synchronous position (csp) or the profile position (pp) mode, Interpolated position (ip) the internal velocity command is limited. 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 Setting value =  Velocity Command  velocity-limit warning bit is set.		Unsigned16	RW	No	0xFFFF (65535min <sup>-1</sup> ) [65535mm/s]
			Setting range	0x0000 - 0xFFFF (0 to 65535min <sup>-1</sup> ) [0 to 65535mm/s]		
			Unit	Rotary : min <sup>-1</sup> [Linear : mm/s]		
◆When the setting value is 0 min <sup>-1</sup> , or 50000 min <sup>-1</sup> or more, 0 min <sup>-1</sup> it is limited at 1.1 fold the highest rotation velocity of the motor (combining the velocity commands). ✓It works at the state that bit3 of control word (0x2000) is valid.						
⚠The rotary motor differs from linear motor in unit.						

0x201D: Position Command error 1 level

Index	0x201D	Position Command error 1 alarm detection level is set.	Object Code		Variable	
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Position Command error 1 level [OVFSET] ◆Profile Position mode (pp) When the velocity-converted value of trajectory generation distance exceeds the setting value, alarm "D2" is detected.		Unsigned32	RW	No	0xFFFFFFFF
			Setting range	0x1-0xFFFFFFFF (1 to 4294967295 p/s)		
			Unit	Pulse/sec		
◆Cycle synchronous position mode(csp), Interpolated position mode (ip) When the velocity-converted value of position command variation (the previous target position – the target position) exceeds the setting value, alarm "D2" is detected. ✓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: Internal Unit [LSB] = 480000+1 rotary resolution [Pulse/sec]						

0x201E: Sequence Operation Torque (force) Limit Value

Index	0x201E	Parameter to set the output torque (force) in Sequence Operation.	Object Code		Variable	
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Sequence Operation Torque (force) Limit Value [SQTC_LM] This is Torque (force) Limit Value for the following sequence controls.		Unsigned16	RW	No	0x04B0 (120.0 %)
◆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.			Setting range	0x0064-0x1388 (10.0 to 500.0 %)		
Moreover, when power lowering torque (force) limit selection (0x20F5) is "0x01," electric current is limited including this setting value.			Unit	0.1 %		
◆Sets the limiting torque (force) by the ratio of rated output torque (force). (100.0%=rated torque (force)) ◆When the value is set exceeding the Maximum instant stall torque (force) (T <sub>P</sub> ) of the combining servo motor, it is limited by the Maximum instant stall torque (force) (T <sub>P</sub> ) of the combining servo motor. ✓When overload 1 alarm occurs, it is limited to 120% in case a value of more than 120% is set.						

0x201F: Near Range

Index	0x201F	A position range variation counter for positioning completion/ near range completion monitoring.	Object Code		Variable	
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Near Range [NEAR] ◆Outputs Near range signal when the Position deviation counter is set lower than this set value.		Unsigned32	RW	No	0x01F4 (500 pulse)
◆Sets at the resolution of the encoder pulse  Following Error Actual Value  ≤ Setting value			Setting range	0x00000001-0x7FFFFFFF (1-2147483647 Pulse)		
When the actual position variation is greater than the setting value, it is output from near range completion monitor (NEAR monitor.)			Unit	1 Pulse		

## 7. Object Dictionary

### 0x2020: Speed Zero Range

Index	0x2020	Setting value for detecting Zero-speed status (motor stop). Sets the allowable range at Zero-speed.	Object Code		Variable
Sub-Idx	Description		Data Type	Access	PDO
0x00	Speed Zero Range [ZV]   Actual Velocity  <= Setting value  When the Actual Velocity condition below the Setting value is continuously detected for 1ms or more, zero velocity monitor (ZV) is output. ⚠ The rotary motor differs from linear motor in unit.		Unsigned16	RW	No
			Setting range	0x0005 - 0x01F4 (5 to 500min <sup>-1</sup> ) [5 to 500mm/s]	
			Unit	Rotary : min <sup>-1</sup> [Linear : mm/s]	

### 0x2021: Low Speed Range

Index	0x2021	Sets the acceptable Low Speed Range of the motor rotation speed.	Object Code		Variable
Sub-Idx	Description		Data Type	Access	PDO
0x00	Low Speed Range [LOWV] When the speed is lower than this value, Low speed range is output.   Actual Velocity  <= Setting value then LTGDAT flag is set.		Unsigned16	RW	No
			Setting range	0x0000 - 0xFFFF (0 to 65535min <sup>-1</sup> ) [0 to 65535mm/s]	
			Unit	Rotary : min <sup>-1</sup> [Linear : mm/s]	

speed

LTGDAT 1 0 1

“Low speed Range” setting value

✓ If Auto Tuning Mode setting is 0x01 and Auto Tuning Characteristics setting is 0x02, 50min<sup>-1</sup> will be set automatically.  
⚠ The rotary motor differs from linear motor in unit.

### 0x2022: Speed Attainment Setting (High Speed Range)

Index	0x2022	Sets the speed attainment level of the motor rotation speed.	Object Code		Variable
Sub-Idx	Description		Data Type	Access	PDO
0x00	Speed Attainment Setting [VA] Used as arrival confirmation in response to a high-speed rotation command; When the speed exceeds this setting value, Speed attainment is output.   Actual Velocity  >= Setting value then VA flag is set.		Unsigned16	RW	No
			Setting range	0x0000 - 0xFFFF (0 to 65535min <sup>-1</sup> ) [0 to 65535mm/s]	
			Unit	Rotary : min <sup>-1</sup> [Linear : mm/s]	

speed

VA 0 1 0

“Speed Attainment Setting” value

◆ While operating with torque (force) control mode, simple velocity control is exercised by this parameter.  
✓ 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.  
⚠ The rotary motor differs from linear motor in unit.

## 7. Object Dictionary

0x2023: Analog Monitor Select Output

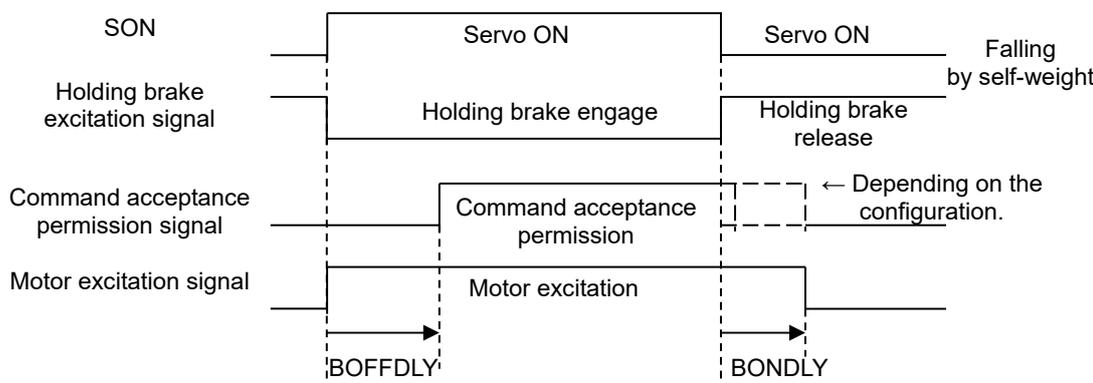
Index	0x2023	Selects the output selection and the polarization character of Analog Monitor 1, 2.	Object Code		Record	
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Number of entry		Unsigned8	RO	No	0x03
0x01	Analog Monitor Select Output 1 [MON1] Select data to output from Analog Monitor 1.		Unsigned8	RW	No	0x05
			Setting range	0x01-0x24		
	<b>&amp; Rotary motor</b> 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/mm/sec 0x04: Velocity monitor 1mV/mm/sec 0x05: Velocity monitor 2mV/mm/sec 0x06: Velocity monitor 3mV/mm/sec 0x07: Velocity command monitor 0.01mV/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 <sup>2</sup> 0x1C: Acceleration monitor 0.1mV/mm/sec <sup>2</sup> 0x1D: Acceleration monitor 1mV/mm/sec <sup>2</sup> 0x1E: Acceleration monitor 10mV/mm/sec <sup>2</sup> 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 to 0xFF: Reserved		<b>&amp; Linear motor</b> 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/mm/sec 0x04: Velocity monitor 1mV/mm/sec 0x05: Velocity monitor 2mV/mm/sec 0x06: Velocity monitor 3mV/mm/sec 0x07: Velocity command monitor 0.01mV/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 <sup>2</sup> 0x1C: Acceleration monitor 0.1mV/mm/sec <sup>2</sup> 0x1D: Acceleration monitor 1mV/mm/sec <sup>2</sup> 0x1E: Acceleration monitor 10mV/mm/sec <sup>2</sup> 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 to 0xFF: Reserved			
	<ul style="list-style-type: none"> <li>◆Position command monitor1 monitors position command pulse before position smoothing passing.</li> <li>◆Position command monitor2 monitors position command pulse after position smoothing passing.</li> <li>✓Position command pulse frequency monitor1 and 2 are output in the form of pulse when command pulse frequency is 10kHz or less. Average the frequency when converging to position command frequency.</li> <li>◆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</li> </ul>					
0x02	Analog Monitor Select Output 2 [MON2] Selects the data to output from Analog Monitor 2. The setting value is the same as in Analog Monitor output selection 1.		Unsigned8	RW	No	0x02
			Setting range	0x01 to 0x24 (Rotary) 0x01 to 0x1E (Linear)		
0x03	Analog Monitor Output Polarity Selection [MONPOL] 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					

## 7. Object Dictionary

### # 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

Index	0x2024	Sets holding-brake-activation delay time from when power distribution to holding brake stopped till when holding torque generated.	Object Code		Variable	
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Delay Time of Engaging Holding Brake [BONDLY]	<ul style="list-style-type: none"> <li>◆ 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.)</li> <li>By this, until Holding brake functions, servo motor generates Holding torque (force).</li> <li>◆ This is valid when servo brake operation at servo OFF condition is set in the "dynamic brake operation setting" (This does not function in the dynamic brake operation and the free-run operation.)</li> <li>◆ When the setting value is 0ms, after servo OFF, command is invalid (command 0) for approximately 4ms.</li> <li>✓ Because the setting unit is valid in 4ms steps, the remainder, divided by 4, is cut off inside the amplifier.</li> </ul>	Unsigned16	RW	Possible	0x012C (300ms)
			Setting range	0x0000-0x03E8 (0 to 1000ms)		
			Unit	ms		

### 0x2025: Delay Time of Releasing Holding Brake (Holding Brake Releasing Delay time)

Index	0x2025	Sets holding-brake-release delay time from when power distribution to holding brake started till when holding torque disappeared.	Object Code		Variable	
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Delay Time of Releasing Holding Brake [BOFFDLY]	<ul style="list-style-type: none"> <li>◆ While shifting from servo OFF to servo ON, during the setting time, Excitation command 0 is given to servo motor. (Even when servo is turned ON, command is not accepted until the setting time is complete.)</li> <li>◆ Therefore, until Holding brake is released, servo motor does not operate.</li> <li>◆ When the setting value is 0ms, after servo ON, command is invalid (command 0) for approximately 4ms.</li> <li>✓ Because the setting unit is valid in 4ms steps, the remainder, divided by 4, is cut off inside the amplifier.</li> </ul>	Unsigned16	RW	No	0x012C (300ms)
			Setting range	0x0000-0x03E8 (0 to 1000ms)		
			Unit	ms		

### 0x2026: BRAKE OPERATION BEGINNING TIME

Index	0x2026	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.	Object Code		Variable	
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Brake Operation Beginning Time [BONBGN]	Sets permissible time from servo OFF until servo motor stop. <ul style="list-style-type: none"> <li>◆ At the time of Quick Stop operation, Emergency Stop (EMR), Servo brake stop alarm occurrence, if motor velocity does not reach less than 50min<sup>-1</sup>, it signals the Dynamic brake operation and the Holding brake operation that are then output and motor excitation is discharged.</li> <li>◆ 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.</li> <li>✓ If the servo motor velocity reaches below 0x202F Brake Activation Speed within the set time, this function does not operate.</li> <li>✓ 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.</li> </ul>	Unsigned16	RW	Possible	0x2710 (10sec)
			Setting range	0x0000-0xFFFF (0 to 65535ms)		
			Unit	ms		

## 7. Object Dictionary

### 0x2027: Power Failure Detection Delay Time

Index	0x2027	Sets the delay time from Control power OFF to Control power error detection.	Object Code		Variable	
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Power Failure Detection Delay Time [PFDDLY] ◆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.  ◆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. ◆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. ✓In this setting, actual detection delay time varies by -12ms - +6ms.		Unsigned16	RW	No	0x0020 (32ms)
			Setting range	0x0014-0x03E8 (20 to 1000ms)		
			Unit	ms		

### 0x2028: Excessive Deviation Warning Level

Index	0x2028	Sets Warning output level before Excessive position deviation alarm is output.	Object Code		Variable	
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Excessive Deviation Warning Level [OFWLVL] When the actual deviation exceeds the setting value, within the range relatively regarded as warning against the position, Excessive Deviation Warning engages.  [Following Error Actual Value] >= Setting value		Unsigned32	RW	No	0x7FFFFFFF (2147483647Pulse)
			Setting range	0x00000001 to 0x7FFFFFFF (1 to 2147483647 Pulse)		
			Unit	Pulse		

Positioning completion range -> See Position Window (0x6065 of the function group "position".)

### 0x2029: Overload Warning Level

Index	0x2029	Parameter to output Warning before detecting the Overload warning.	Object Code		Variable	
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Overload Warning Level [OLWLVL] ◆the allowable setting Level range is as follows (the Overload warning level =100%;)  Setting value < 20% or 100% >= Setting value  When set to 100%, Overload warning and Overload alarm are output at one time. ✓Overload detection is assumed and set as 75%, of a rated load when Control power is turned ON (hot start). 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%. Therefore, when Overload warning level is set at 75% or less, Overload warning may be output when Control power is turned ON.		Unsigned16	RW	No	0x005A (90%)
			Setting range	0x0014-0x0064 (20 to 100 %)		
			Unit	%		

### 0x202A: Speed Matching Width (%)

Index	0x202A	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 [VCMPPR] Velocity matching is output when the Velocity deviation (difference between the velocity command and actual velocity) is within this setting range.  Actual Velocity  <= Setting value then VCMP monitor is set.		Unsigned16	RW	No	0x0032 (5.0 %)
			Setting range	0x0000-0x03E8 (0 to 100%)		
			Unit	0.1 %		
✓The Velocity matching output is switched by the setting of rotation speed (min <sup>-1</sup> ) 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.						

## 7. Object Dictionary

### 0x202B: Torque (force) Command Filter Characteristic

Index	0x202B	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]		Unsigned8	RW	No	0x02
	If the cutoff frequency of the torque (force) order filter is switched with the gain switch, the order is fixed at this setting value.		Setting range	0x01-0x03		
	<u>0x01: primary Filter</u> <u>0x02: secondary Filter</u> <u>0x03: tertiary Filter</u> <u>0x00, 0x04-0xFF: Reserved</u>					

### 0x202C: Feed Forward Filter, Depth Selection (FF Vibration Suppressor Level Selection)

Index	0x202C	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]		Unsigned8	RW	No	0x00
	Parameter to set the magnitude of the vibration suppressor frequency effect.		Setting range	0x00-0x03		
	* Change while servo motor is OFF. * The smaller the value, the greater the effect will be. * FF vibration suppressor frequency switching function does not affect this.  <u>0x00: -∞</u> <u>0x01: -30dB</u> <u>0x02: -20dB</u> <u>0x03: -10dB</u> <u>0x04-0xFF: Reserved</u>					

## 7. Object Dictionary

### 0x202E: Torque (force) attainment setting

Index	0x202E	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] Sets the ratio of torque (force) attainment. Data subjected to the ratio set by this parameter vary depending on torque (force) attainment function selection (0x20F4.6). Sets flag TA (bit11 of 0x2100) in the following case:  Torque (force) command  >= Set value ✓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.		Unsigned16	RW	No	0x03E8 (100%)
			Setting range	0x0000 - 0x1388 (0.0 to 500.0%)		
			Unit	0.1 %		
	◆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. $\text{Forward torque (force) attainment level} = \text{Limited forward torque (force) value} \times \text{set value} / 100.0 \text{ [%]}$ $\text{Reverse torque (force) attainment level} = \text{Limited reverse torque (force) value} \times \text{set value} / 100.0 \text{ [%]}$					
	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."					

## 7. Object Dictionary

### 0x202F: Brake activation speed

Index	0x202F	Set the brake activation speed when decelerating motor. It works while running servo-brake.	Object Code		Variable	
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Brake activation speed [ZVDAT] Motor brake works at lower rotation speed than set value with condition below. Quick Stop, Alarm, Emergency Stop.  Motor stop will detect when relation below continued 1 ms or more. Absolute value of actual speed $\leq$ Set value  Holding brake signal will provide after detecting motor stop. ✓ DDM (Direct Drive Motor) has different setting range conversion below. 0x000A to 0x01F4 --> 1 to 50.0min <sup>-1</sup> (0.1min <sup>-1</sup> /lsb)		Unsigned16	RW	Possible	0x32 (50min <sup>-1</sup> )
			Setting range	0x000A to 0x01F4 (10 to 500min <sup>-1</sup> )		
			Unit	min <sup>-1</sup>		

### 0x2030: Position Loop Integral Gain Limit

Index	0x2030	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 (TP11).  If setting value of position integral time constant is lower than this setting value. Position integral time constant use this setting value.		Unsigned16	RW	Possible	0x2710
			Setting range	0x0003 to 0x2710 (0.3 to 1000)		
			Unit	0.1ms		

### 0x2031: Velocity Control Integral Gain Limit

Index	0x2031	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 (TV11).  If setting value of velocity integral time constant is lower than this setting value. Velocity integral time constant use this setting value.		Unsigned16	RW	Possible	0x0003
			Setting range	0x0003 to 0x2710 (0.3 to 1000)		
			Unit	0.1ms		

### 0x2032: Torque (force) control proportional gain

Index	0x2032	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.  Torque (force) control proportional gain is set from desired percentage of general torque gain.		Unsigned8	RW	No	0x64
			Setting range	0x32 to 0x8C (50 to 140)		
			Unit	%		

## 7. Object Dictionary

0x2034: Low Pass Filter OFF Velocity for Position loop / Velocity loop command.

Index	0x2034	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. This object become active by setting 1 to Sub-Idx :0x01.		Unsigned8	RW	Possible	0x00
			Setting range	0x00 to 0x01		
0x02	Low Pass Filter OFF Velocity Disable low pass filter at less than this velocity.		Unsigned16	RW	Possible	0x0000
			Setting range	0x0000 to 0x0032		
			Unit	min <sup>-1</sup>		
Position loop (0x2004) / Velocity loop (0x2009) command only. Low pass filter works except abovesetting.						

0x2035: Position Synchronization Correction Function Parameter

Index	0x2035	Sets parameters of position synchronization deviation function that control the position deviations of 2 servo motors so that their deviations will be equalized. It is only used at the time of Position control (pp, csp). ✓For this function, a communication cable should be connected between CN2 which is subject of position synchronization correction.	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] When the position synchronization correction is enabled and the set value is 100%, add the same value as synchronization deviation value (error pulse volume) to the position command. Correction will be invalid at the set value 0%. ✓If the value is too large, a vibration may occur.		Unsigned8	RW	No	0x0064 (100%)
			Setting Range	0x0000 to 0x03E8 (0 to 1000%)		
			Unit	%		
0x02	Correction Integral Time Constant [TSCI] Sets integral time constant of position synchronization controller. When the set value is 1000.0ms, the proportional control (without integral compensation) is activated. ✓If the value is too small, a vibration may occur. ✓When 2 sets of amplifiers are mutually corrected their synchronizations, set correction integral time constant at 1000ms (invalid).		Unsigned16	RW	No	0x2710 (1000ms) Propotional Control
			Setting Range	0x0005-0x2710 (0.5 to 1000.0ms)		
			Unit	0.1ms		
0x03	Correction Low-pass Filter [PSYNLFP] Sets time constant of the first low-pass filter which suppresses any sudden change in the correction command pulses. Filter will be invalid at the set value 0.0 ms.		Unsigned16	RW	No	0x0000(0.0 ms) Invalid Filter
			Setting Range	0x0000-0x2710 (0.0 to 1000.0 ms)		
			Unit	0.1 ms		
0x04	Excessive Position Synchronization Deviation Level [PSDEVAL] Sets acceptable error range for error pulse quntity (synchronization deviation) of 2 amplifiers. When the actual synchronization position deviation exceeds the set value, a position synchronization deviation alarm is issued. Setup Value $\leq$   Synchronization Error Pulse Quantity		Unsigned32	RW	No	0x7FFFFFFF(2147 483647)
			Setting Range	0x00000001-0x7FFFFFFF (1 to 2147483647 Pulse)		
			Unit	Pulse		
0x05	Position Synchronization Deviation Warning Level [PSDEVWN] Sets Warning output level before Excessive position synchronization deviation alarm is issued. When the actual synchronization position deviation exceeds the set value, position synchronization deviation warning is issued. Setup Value $\leq$   Synchronization Error Pulse Quantity		Unsigned32	RW	No	0x7FFFFFFF (2147483647)
			Setting Range	0x00000001-0x7FFFFFFF (1 to 2147483647 Pulse)		
			Unit	Pulse		
0x06	Position Deviation Polarity Slection [SDEVPOR] Selects polarity of position deviation signal which is sent to another amplifier for position synchronization. ✓Regarding command polarity and motor installation angle, set position deviation polarity selection in order to have the same output deviation polarity. ✗It will be valid with control-power-source re-input.		Unsigned8	RW	No	0x00
			Setting Range	0x00-0x01  0:Without Position Deviation Polarity Reversal 1:With Position Deviation Polarity Reversal		
✓ If this function is used in PP mode, set the communication cycle setting as DC sync (SYNC0 or SYNC1).						
✓ This function sets the operation mode by but 14,15 of the control word 1 (0x2000).						



## 7. Object Dictionary

### 0x203D: Amplifier temperature warning level

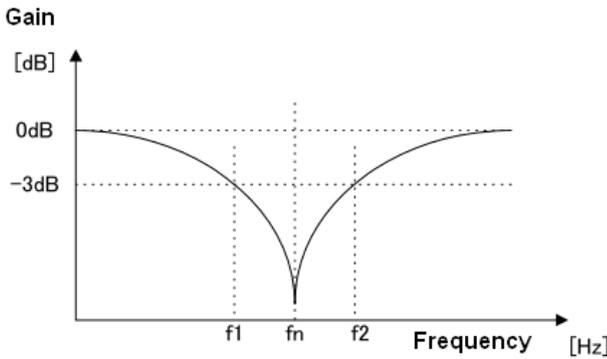
Index	0x203D	Sets the warning output level which is issuing before the amplifier temperature error.			
Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x01	<b>Amplifier temperature warning high level setting [DEGWHL]</b> Sets high level of the amplifier temperature warning detection.  When this 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.  0x203D-01 "Amplifier temperature warning high level setting" $\leq$ 0x2109 "Temperature inside the servo amplifier"  ✓Temperature warning will be set even if internal temperature value is less than this set value, when condition of 0x203D-02 is satisfied. ✓When this parameter sets to 95°C, amplifier temperature warning will issue at same timing of amplifier temperature error.	Signed16	RW	No	0x4B (75°C)
		Display range	0x038 to 0x005F (56 to 95°C)		
		Unit	°C		
0x02	<b>Amplifier temperature warning low level setting [DEGWLL]</b> Sets low level of the amplifier temperature warning detection.  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.  0x203D-01 "Amplifier temperature warning low level setting" $\geq$ 0x2109 "Temperature inside the servo amplifier"  ✓Temperature warning will be set even if internal temperature value is more than this set value, when condition of 0x203D-01 is satisfied. ✓When this parameter sets to -15°C, amplifier temperature warning will issue at same timing of amplifier temperature error.	Signed16	RW	No	0xFFFF6 (-10°C)
		Display range	0xFFFFF to 0xFFFF1 (-1 to -15°C)		
		Unit	°C		

### 0x2040 Command Filter Setting

Index	0x2040	Sets Velocity Command Filter and Torque (force) Command Filter 1 to 4 functions.	Object Code	Variable	
Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Number of entry	Unsigned8	RO	No	0x02
0x01	<b>Velocity Command Filter Setting</b> Sets Velocity Command Filter object 0x2041 valid or invalid. When valid filter work by 0x2041setting.	Unsigned8	RW	Possible	0x00
		Setting range	0x00 to 0x01		
<u>0: Velocity Command Filter disabled</u> <u>1: Velocity Command Filter enabled</u>					
0x02	<b>Torque (Force) Command Filter Setting</b> Sets Torque (Force) Command Filter object 0x2042 to 0x2045 valid or invalid. When valid filter work by 0x2041 to 0x2045setting.	Unsigned8	RW	Possible	0x01
		Setting range	0x00 to 0x01		
<u>0: Torque(force)Command Filter1 to 4 disabled</u> <u>1: Torque(force)Command Filter1 to 4 enabled</u>					



## 7. Object Dictionary

0x07	Center frequency of Notch Filter When filter type (Sub-Idx2) sets Notch Filter (0x04), Notch Filter work by this center frequency. ✓When sets over 2000Hz(0x07D0) then setting become disable.	Unsigned16	RW	Possible	0x07D0 (2000Hz)	
		Setting range	0x000A to 0x07D0 (10 to 2000Hz)			
0x08	Band width of Notch Filter When filter type (Sub-Idx2) sets Notch Filter (0x04), Notch Filter work by this Band width. Setting value small become band width narrow.  	Unsigned16	RW	Possible	0x000A	
		Setting range	0x0001 to 0x01F4 (0.1 to 50) 0.1 / LSB			
		Setting value	f1	f2		
		0.1	$fn \times 0.95$	$fn \times 1.05$		
		0.2	$fn \times 0.90$	$fn \times 1.11$		
		0.4	$fn \times 0.82$	$fn \times 1.22$		
		0.6	$fn \times 0.74$	$fn \times 1.35$		
		0.8	$fn \times 0.67$	$fn \times 1.49$		
		1.0	$fn \times 0.62$	$fn \times 1.63$		
		1.2	$fn \times 0.57$	$fn \times 1.77$		
		1.4	$fn \times 0.52$	$fn \times 1.94$		
		1.6	$fn \times 0.48$	$fn \times 2.08$		
		1.8	$fn \times 0.44$	$fn \times 2.25$		
		2.0	$fn \times 0.41$	$fn \times 2.42$		
		5.0	$fn \times 0.19$	$fn \times 5.18$		
		10.0	$fn \times 0.098$	$fn \times 9.66$		
		20.0	$fn \times 0.050$	$fn \times 17.1$		
30.0	$fn \times 0.033$	$fn \times 22.2$				
40.0	$fn \times 0.025$	$fn \times 25.6$				
50.0	$fn \times 0.020$	$fn \times 28.1$				
Example of setting value vs band width. Magnification from center frequency(fn)						
0x09	Bi-quad Filter a1 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 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 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 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 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			

### 0x2046: Multi Stage Notch Tuning Setting

Index	0x2046	Sets the function of notch tuning.				
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Number of entry		Unsigned8	RO	No	0x02
0x01	Auto-Notch Tuning Mode [ANTMD] Sets whether notch filter of auto-notch tuning is valid or not.		Unsigned8	RW	No	0x00
	Display range		0x00-0x01			
	Unit		—			
0x02	Resonant Frequency Monitor [RESMON] Indicates resonant frequency extracted by auto-notch tuning.		Unsigned16	RO	No	0x0000
	Display range		0x0000-0xFFFF (0 to 65535)			
	Unit		Hz			

## 7. Object Dictionary

### 0x2050: Stick Motion compensation

Index	0x2050	Setting of Stick Motion compensation	Object Code			Variable
Sub-Idx	Description		Data Type	Access	PDO	Initial Value
0x00	Number of entry		Unsigned8	RO	No	0x04
0x01	Set the validity of Stick Motion compensation [STC]	<ul style="list-style-type: none"> <li>◆Setting validity condition of Stick Motion compensation Stick Motion compensation is enable when STC is enable.</li> <li>◆Setting range of Stick Motion compensation will follow 0x00 to 0x27 in the function valid condition list.</li> </ul>	Unsigned8	RW	Possible	0x00
			Setting range	0x00 to 0x27		
0x02	Valid speed of Stick Motion compensation [STV]	<ul style="list-style-type: none"> <li>◆Stick Motion compensation will work when setting value is less than internal velocity command.</li> </ul>	Unsigned16	RW	Possible	10.0
			Setting range	0.1 to 128.0		
			Unit	min <sup>-1</sup>		
0x03	Valid time of Stick Motion compensation [STHLD]	<ul style="list-style-type: none"> <li>◆Stick Motion compensation will work until this setting time, even if internal velocity command is over speed.</li> <li>◆If velocity loop response is low , set the this time longer.</li> </ul>	Unsigned16	RW	Possible	20
			Setting range	1 to 500		
			Unit	ms		
0x04	Set the integral constant of Stick Motion compensation [STTVI]	<ul style="list-style-type: none"> <li>◆Vaild velocity loop integral constant when Stick Motion compensation is activating.</li> <li>◆Velocity loop integral constant of Stick Motion compensation should set lower than normal setting. If set higher than normal value, efficiency will low.</li> <li>◆Stick Motion compensation will disable when velocity loop is proportional control.</li> </ul>	Unsigned16	RW	Possible	0.3
			Setting range	0.3 to 1000.0		
			Unit	ms		

### 0x2051: Micro Vibration Suppression

Index	0x2051	Suppress mechanical micro vibration by moving encoder pulse when motor stop.	Object Code			Variable
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Set the validity of Micro Vibration Suppression [FBHYST]	<ul style="list-style-type: none"> <li>◆Suppress mechanical micro vibration when motor stop and encoder pulse moving <math>\pm 1</math> pulse</li> <li>◆Micro Vibration Suppression will valid when FBHYST is valid.</li> <li>◆Valid condition selection range of Micro Vibration Suppression will follow 0x00 to 0x27 in the function valid condition list.</li> </ul>	Unsigned8	RW	No	0x00
			Setting range	0x00 to 0x27		

## 7. Object Dictionary

### ■Function valid condition list

Item	Set value	Item	Set value
Always invalid the function.	00: Always_Disable	Always valid the function.	01: Always_Enable
Valid the function when CONT1 is ON.	02: CONT1_ON	Valid the function when CONT1 is OFF.	03: CONT1_OFF
Valid the function when CONT2 is ON.	04: CONT2_ON	Valid the function when CONT2 is OFF.	05: CONT1_OFF
Valid the function when CONT3 is ON.	06: CONT3_ON	Valid the function when CONT3 is OFF.	07: CONT1_OFF
Valid the function when CONT4 is ON.	08: CONT4_ON	Valid the function when CONT4 is OFF.	09: CONT1_OFF
Valid the function when CONT5 is ON.	0A: CONT5_ON	Valid the function when CONT5 is OFF.	0B: CONT1_OFF
Valid the function when CONT6 is ON.	0C: CONT6_ON	Valid the function when CONT6 is OFF.	0D: CONT1_OFF
Valid the function during low velocity condition (velocity is lower than set value of LOWV).	12: LOWV_IN	Valid the function except low velocity condition (velocity is lower than set value of LOWV).	13: LOWV_OUT
Valid the function during state of velocity reaching (velocity is VA set value or more).	14: VA_IN	Valid the function except state of velocity reaching (velocity is VA set value or more).	15: VA_OUT
Valid the function during state of velocity match (within the speed matching width).	16: VCMP_IN	Valid the function except state of velocity match (within the speed matching width).	17: VCMP_OUT
Valid the function during state of velocity zero (velocity is ZV set value or less).	18: ZV_IN	Valid the function except state of velocity zero (velocity is ZV set value or less).	19: ZV_OUT
Valid the function during state of positioning completion (position deviation is INP set value or less).	1A: INP_IN	Valid the function except state of positioning completion (position deviation is INP set value or less).	1B: INP_OUT
Valid the function during state of torque limit operation.	1C: TLC_IN	Valid the function except state of torque limit operation.	1D: TLC_OUT
Valid the function during state of velocity limit operation.	1F: VLC_IN	Valid the function except state of velocity limit operation.	1F: VLC_OUT
Valid the function during state of the near range.	20: NEAR_IN	Valid the function except state of the near range.	21: NEAR_OUT
Valid the function during state of positive rotation direction (VMON > +LOWV).	22: VMON > +LV	Valid the function except state of positive rotation direction (VMON ≤ +LOWV).	23: VMON <= +LV
Valid the function during state of negative rotation direction (VMON < -LOWV).	24: VMON > -LV	Valid the function except state of negative rotation direction (VMON ≥ -LOWV).	25: VMON <= -LV
Valid the function during state of position command zero and positioning completion (position deviation is INP set value or less).	26: INPZ_IN	Valid the function during state of position command zero and positioning incompletion (position deviation is larger than INP set value).	27: INPZ_OUT

## 7. Object Dictionary

### 0x20B0: Gain Switching Condition

Index	0x20B0	4種類のゲインを切替えて使用することができます。 ゲイン切替条件を有効にする条件を割りあてます。GC1とGC2の組合せにより、GAIN1~4を切替えます。	Object Code	Record																																																																																																																																	
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0x00	Number of entry		Unsigned8	RO	No	0x02																																																																																																																															
0x01	Gain Switching Condition 1 [GC1] Sets the Gain Switching Condition 1.		Unsigned8	RW	No	0x00																																																																																																																															
			Setting range	0x00-0x29																																																																																																																																	
		<table border="1"> <thead> <tr> <th>Selection</th> <th>Contents</th> </tr> </thead> <tbody> <tr><td>00</td><td>Always_Disable</td><td>Function is always invalid.</td></tr> <tr><td>01</td><td>Always_Enable</td><td>Function is always valid.</td></tr> <tr><td>02</td><td>CONT1_ON</td><td>Function is valid when general input CONT1 is ON.</td></tr> <tr><td>03</td><td>CONT1_OFF</td><td>Function is valid when general input CONT1 is OFF.</td></tr> <tr><td>04</td><td>CONT2_ON</td><td>Function is valid when general input CONT2 is ON.</td></tr> <tr><td>05</td><td>CONT2_OFF</td><td>Function is valid when general input CONT2 is OFF.</td></tr> <tr><td>06</td><td>CONT3_ON</td><td>Function is valid when general input CONT3 is ON.</td></tr> <tr><td>07</td><td>CONT3_OFF</td><td>Function is valid when general input CONT3 is OFF.</td></tr> <tr><td>08</td><td>CONT4_ON</td><td>Function is valid when general input CONT4 is ON.</td></tr> <tr><td>09</td><td>CONT4_OFF</td><td>Function is valid when general input CONT4 is OFF.</td></tr> <tr><td>0A</td><td>CONT5_ON</td><td>Function is valid when general input CONT5 is ON.</td></tr> <tr><td>0B</td><td>CONT5_OFF</td><td>Function is valid when general input CONT5 is OFF.</td></tr> <tr><td>0C</td><td>CONT6_ON</td><td>Function is valid when general input CONT6 is ON.</td></tr> <tr><td>0D</td><td>CONT6_OFF</td><td>Function is valid when general input CONT6 is OFF.</td></tr> <tr><td>0E</td><td>CONT7_ON</td><td>(HWGOFF1) ※Function is valid when general input CONT7 is ON.</td></tr> <tr><td>0F</td><td>CONT7_OFF</td><td>(HWGOFF1) ※Function is valid when general input CONT7 is OFF.</td></tr> <tr><td>10</td><td>CONT8_ON</td><td>(HWGOFF2) ※Function is valid when general input CONT8 is ON.</td></tr> <tr><td>11</td><td>CONT8_OFF</td><td>(HWGOFF2) ※Function is valid when general input CONT8 is OFF.</td></tr> <tr><td>12</td><td>LOWV_IN</td><td>Function is valid while in low speed status (speed is lower than LOWV set value).</td></tr> <tr><td>13</td><td>LOWV_OUT</td><td>Function is valid while not in low speed status (speed is lower than LOWV set value).</td></tr> <tr><td>14</td><td>VA_IN</td><td>Function is valid while in speed attainment status (speed is higher than VA set value).</td></tr> <tr><td>15</td><td>VA_OUT</td><td>Function is valid while not in speed attainment status (speed is higher than VA set value).</td></tr> <tr><td>16</td><td>VCMP_IN</td><td>Function is valid while in speed matching status (within speed matching range).</td></tr> <tr><td>17</td><td>VCMP_OUT</td><td>Function is valid while not in speed matching status (within speed matching range).</td></tr> <tr><td>18</td><td>ZV_IN</td><td>Function is valid while in zero speed status (speed is lower than ZV set value).</td></tr> <tr><td>19</td><td>ZV_OUT</td><td>Function is valid while not in zero speed status (speed is lower than ZV set value).</td></tr> <tr><td>1A</td><td>INP_IN</td><td>Function is valid while in In-Position status (position deviation &lt; 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-LOWV)</td></tr> <tr><td>25</td><td>VMON &gt;= -LV</td><td>Function is valid while rotation direction is not reverse (VMON ≥ -LOWV)</td></tr> <tr><td>26</td><td>INPZ_IN</td><td>Function is valid while in Position command 0 and In-Position status (position deviation &lt; INP)</td></tr> <tr><td>27</td><td>INPZ_OUT</td><td>Function is valid while not in Position command 0 and In-Position status (position deviation &lt; INP)</td></tr> <tr><td>28</td><td>ACK_IN</td><td>Function is valid while in command reception allowable condition</td></tr> <tr><td>29</td><td>ACK_OUT</td><td>Function is valid while not in command reception allowable condition</td></tr> </tbody> </table> <p>※ CONT7 and 8 are dedicated to input of the hardware gate off function.</p>	Selection	Contents	00	Always_Disable	Function is always invalid.	01	Always_Enable	Function is always valid.	02	CONT1_ON	Function is valid when general input CONT1 is ON.	03	CONT1_OFF	Function is valid when general input CONT1 is OFF.	04	CONT2_ON	Function is valid when general input CONT2 is ON.	05	CONT2_OFF	Function is valid when general input CONT2 is OFF.	06	CONT3_ON	Function is valid when general input CONT3 is ON.	07	CONT3_OFF	Function is valid when general input CONT3 is OFF.	08	CONT4_ON	Function is valid when general input CONT4 is ON.	09	CONT4_OFF	Function is valid when general input CONT4 is OFF.	0A	CONT5_ON	Function is valid when general input CONT5 is ON.	0B	CONT5_OFF	Function is valid when general input CONT5 is OFF.	0C	CONT6_ON	Function is valid when general input CONT6 is ON.	0D	CONT6_OFF	Function is valid when general input CONT6 is OFF.	0E	CONT7_ON	(HWGOFF1) ※Function is valid when general input CONT7 is ON.	0F	CONT7_OFF	(HWGOFF1) ※Function is valid when general input CONT7 is OFF.	10	CONT8_ON	(HWGOFF2) ※Function is valid when general input CONT8 is ON.	11	CONT8_OFF	(HWGOFF2) ※Function is valid when general input CONT8 is OFF.	12	LOWV_IN	Function is valid while in low speed status (speed is lower than LOWV set value).	13	LOWV_OUT	Function is valid while not in low speed status (speed is lower than LOWV set value).	14	VA_IN	Function is valid while in speed attainment status (speed is higher than VA set value).	15	VA_OUT	Function is valid while not in speed attainment status (speed is higher than VA set value).	16	VCMP_IN	Function is valid while in speed matching status (within speed matching range).	17	VCMP_OUT	Function is valid while not in speed matching status (within speed matching range).	18	ZV_IN	Function is valid while in zero speed status (speed is lower than ZV set value).	19	ZV_OUT	Function is valid while not in zero speed status (speed is lower than ZV set value).	1A	INP_IN	Function is valid while in In-Position status (position deviation < INP)	1B	INP_OUT	Function is valid while not in In-Position status (position deviation < INP)	1C	TLC_IN	Function is valid while in torque limit status	1D	TLC_OUT	Function is valid while not in torque limit status	1E	VLC_IN	Function is valid while in velocity limit status	1F	VLC_OUT	Function is valid while not in velocity limit status	20	NEAR_IN	Function is valid while in Near range status	21	NEAR_OUT	Function is valid while not in Near range status	22	VMON > +LV	Function is valid while rotation direction is forward (VMON > +LOWV)	23	VMON <= +LV	Function is valid while rotation direction is not forward (VMON ≤ +LOWV)	24	VMON < -LV	Function is valid while rotation direction is reverse (VMON < -LOWV)	25	VMON >= -LV	Function is valid while rotation direction is not reverse (VMON ≥ -LOWV)	26	INPZ_IN	Function is valid while in Position command 0 and In-Position status (position deviation < INP)	27	INPZ_OUT	Function is valid while not in Position command 0 and In-Position status (position deviation < INP)	28	ACK_IN	Function is valid while in command reception allowable condition	29	ACK_OUT	Function is valid while not in command reception allowable condition			
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0x02	Gain Switching Condition 2 [GC2] Sets the Gain Switching Condition 2. Set values are same as Gain Switching Condition 1.		Unsigned8 Setting range	RW	No	0x00 0x00-0x29																																																																																																																															
	<p>Assigns valid condition of the gain switching condition. GAIN1 to 4 are switched by GC1/GC2 combination. This function becomes valid by setting of "0x20F7 bit9 = 1".</p> <table border="1"> <tr> <td>GC1: Gain Switching Condition 1</td> <td>Invalid</td> <td>Valid</td> <td>Invalid</td> <td>Valid</td> </tr> <tr> <td>GC2: Gain Switching Condition 2</td> <td>Invalid</td> <td>Invalid</td> <td>Valid</td> <td>Valid</td> </tr> <tr> <td></td> <td>↓</td> <td>↓</td> <td>↓</td> <td>↓</td> </tr> <tr> <td>Effective gain</td> <td>GAIN1</td> <td>GAIN2</td> <td>GAIN3</td> <td>GAIN4</td> </tr> </table>						GC1: Gain Switching Condition 1	Invalid	Valid	Invalid	Valid	GC2: Gain Switching Condition 2	Invalid	Invalid	Valid	Valid		↓	↓	↓	↓	Effective gain	GAIN1	GAIN2	GAIN3	GAIN4																																																																																																											
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## 7. Object Dictionary

### 0x5080: Correction Table Control

Index	0x5080	Enables/disables the correction table function.	Object Code			Variable
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Correction Table Control [COTBLEN]	Enables/disables the correction table function.	Unsigned8	RW	No	0x00
			Setting range	0x00 to 0x01		
0x00: Disabled 0x01: Enabled 0x02 - 0xFF: Reserved						

### 0x5081: Correction Table Interpolation Method

Index	0x5081	Sets the interpolation method of the correction table.	Object Code			Variable
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Correction Table Interpolation Method [COTBLINTP]	Sets the interpolation method of the correction table.	Unsigned8	RW	No	0x00
			Setting range	0x00 to 0x02		
0x00: Linear 0x01: Polynomial 0x02: Spline 0x03 - 0xFF: Reserved						

### 0x5082: Correction Table Extrapolation Method

Index	0x5082	Sets the extrapolation method of the correction table.	Object Code			Variable
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Correction Table Extrapolation Method [COTBLEXTP]	Sets the extrapolation method of the correction table.	Unsigned8	RW	No	0x00
			Setting range	0x00 to 0x02		
0x00: Linear 0x01: Polynomial 0x02: Spline 0x03 - 0xFF: Reserved						

### 0x5083: Correction Table Position

Index	0x5083	Correction Table Position	Object Code			Record
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Number of entry	<ul style="list-style-type: none"> <li>✓ This becomes valid by re-closing the control source.</li> </ul>	Unsigned8	RW	No	0x00
			Setting range	0x00 to 0x40		
0x01	Entry 1 Correction Position 1	<ul style="list-style-type: none"> <li>✓ If correction position over the coordinate axes (-1↔0), 0x5083 correction position 1 and 0x5084 No1 offset value need to set 0. Caution, if not 0, the machine may oscillate at the correction position over the coordinate axes.</li> <li>✓ This becomes valid by re-closing the control source.</li> </ul>	Unsigned32	RW	No	0x00000000
			Setting range	0x00000000 to 0xFFFFFFFF		
			Unit	Pulse		
0x02 to n	Entry 2 to n Correction Position 2 to n - Entry 1 Correction Position n	<ul style="list-style-type: none"> <li>✓ "n" is up to 0x40 in maximum.</li> <li>✓ Please set so as to ensure that the correction position n-1 &lt; the correction position n. (n=2-64) If not correction position n-1 &lt; 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.</li> <li>✓ If correction position over the coordinate axes (0x7FFFFFFF↔0x80000000), 0x5083 correction position n=0x7FFFFFFF and 0x5084 Number n offset value need to set 0. Caution, if not 0, the machine may oscillate at the correction position over the coordinate axes.</li> <li>✓ This becomes valid by re-closing the control source.</li> </ul>	Unsigned32	RW	No	0x00000000
			Setting range	0x00000000 to 0xFFFFFFFF		
			Unit	Pulse		
<ul style="list-style-type: none"> <li>✓ 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.</li> </ul>						

## 7. Object Dictionary

### 0x5084: Correction Table Offset

Index	0x5084	Correction Table Offset	Object Code			Record
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Number of entry		Unsigned8	RW	No	0x00
	✓ This becomes valid by re-closing the control source.		Setting range	0x00 to 0x40		
0x01	Entry 1 Offset 1		Integer32	RW	No	0x00000000
			Setting range	0x80000000 to 0x7FFFFFFF		
			Unit	Pulse		
	✓ If correction position over the coordinate axes (-1 ⇔ 0), 0x5083 correction position 1 and 0x5084 No1 offset value need to set 0. Caution, if not 0, the machine may oscillate at the correction position over the coordinate axes.					
0x02 to n	Entry 2 - Entry n Offset 2 - Offset n		Integer32	RW	No	0x00000000
			Setting range	0x80000000 to 0x7FFFFFFF		
			Unit	Pulse		
	✓ "n" is up to 0x40 in maximum. ✓ If correction position over the coordinate axes (0x7FFFFFFF ⇔ 0x80000000), 0x5083 correction position n=0x7FFFFFFF and 0x5084 Number n offset value need to set 0. Caution, if not 0, the machine may oscillate at the correction position over the coordinate axes.					
✓ Set the correction point and correction value such in a way that slope of line connecting 2 correction points is 01 or less. It may occur vibration if slope is slanted largely.  Slope = Correction value increment / Correction point increment						

### 0x5085: Correction Table Function Selection

Index	0x5085	Selects spec of Correction Table Function.	Object Code			Variable
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Correction Table Function Selection [COTBLSEL]		Unsigned8	RW	No	0x00
	Decides spec of Correction Table Function.		Setting range	0x00-0x01		
	0x00: Correction position is set as unsigned 32bit data. 0x01: Correction position is set as signed 32bit data.					
	✓ Becomes valid after control power cycle.					

## 7. Object Dictionary

### 0x5090: Backlash correction function selection

Index	0x5090	Set the Backlash correction function on / off.	Object Code		Variable	
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Backlash correction function [BLCEN] Set the Backlash correction function on / off.		Unsigned8	RW	No	0x00
			Setting range	0x00 to 0x01		
	<u>0x00: Disabled</u> <u>0x01: Enabled</u> <u>0x02 - 0xFF: Reserved</u>					
	✓Please contact our sales if this function is used with DC power input type.					

### 0x5091: Backlash correction value

Index	0x5091	Set the backlash correction value.	Object Code		Variable	
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Backlash correction value. [BLCVAL] Set the Backlash correction value.		Unsigned32	RW	No	0x00000000
			Setting range	0x00000000 to 0x7FFFFFFF (0 to 2147483647)		
			Unit	Pulse		
	<p>◆0 is set to bit 6 of Control Word. (Target position is treated as absolute value. )            Backlash correction value is incremented from target position when position command had increased target position.            Backlash correction value is not incremented from target position when position command had decreased target position.</p> <p>◆1 is set to bit 6 of Control Word. (Target position is treated as relative value. )            Backlash correction value is decremented from target position when target position polarity had changed from positive to negative.            Backlash correction value is incremented from target position when target position polarity had changed from negative to positive.</p>					

### 0x5092: Correction direction of Backlash

Index	0x5092	Sets the correction direction of Backlash	Object Code		Variable	
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Correction direction of Backlash [BLCDIR] Sets the command direction of Backlash correction.		Unsigned8	RW	No	0x00
			Setting range	0x00 to 0x01		
	<u>0x00: Positive direction</u> <u>0x01: Negative direction</u> <u>0x02 to 0xFF: Reserved</u>					

## 7. Object Dictionary

### 10) System Parameter

#### 0x20F0: Amplifier Function Selection

Index	0x20F0	Set the Sequence function.	Object Code			Record
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Number of entry		Unsigned8	RO	No	0x06
0x01	Limit behavior Selection [ACTOT] 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.		Unsigned8	RW	No	0x06
			Setting range	0x00-0x08		
<p>* Profile Position (PP), Profile Velocity (PV), Cycle synchronous position (CSP), Interpolated position (ip), Cycle synchronous velocity (CSV)</p> <p><u>0x00, 0x02: Command entry disabled, after the motor stops with the servo brake, servo ON</u></p> <p><u>0x01: Command entry disabled, after the motor stops with the dynamic brake, servo ON</u></p> <p><u>0x02: Command entry disabled, after the motor stops with free run, servo ON</u></p> <p><u>0x00: Command entry disabled, after the motor stops with the servo brake, servo OFF</u></p> <p><u>0x01: Command entry disabled, after the motor stops with the dynamic brake, servo OFF</u></p> <p><u>0x02: Command entry disabled, after the motor stops with free run, servo OFF</u></p> <p><u>0x06: Command entry enabled, after servo motor stops without internal velocity limit command, servo ON</u></p> <p><u>0x07: Reserved</u></p> <p><u>0x08: Command entry disabled, after the motor stops with the servo brake, servo ON</u> (For the torque (force) limit value of servo motor stopping, the sequence torque (force) limit is used.)</p> <p><u>0x09-0xFF: Reserved</u></p> <p>* Profile torque (force) (TQ), Cycle synchronous torque (force) (CST)</p> <p><u>0x00 - 0x02, 0x06: Limit the Torque (force) command with Sequence Torque (force) limit (servo ON)</u></p> <p><u>0x03, 0x04: After servo Off, the motor stops with dynamic brake (servo Off)</u></p> <p><u>0x05: After servo Off, the motor stops with free run (servo Off)</u></p> <p><u>0x07-0xFF: Reserved</u></p> <p>Note1) The sequence operation torque (force) limit value (0x201E) becomes valid to power running direction.</p> <p>Note2) When the Torque (force) Command is smaller than sequence operational torque limit value, it is limited by the Target Torque (force).</p> <p>Note3) Setting of the quick stop option code shall be "motor stop by dynamic brake operation".</p>						
0x02	Positioning Methods selection [EDGEPOS] Select the Encoder pulse positioning.		Unsigned8	RW	No	0x00
			Setting range	0x00-0x01		
<p><u>0x00: Specify Pulse Interval</u></p> <p><u>0x01: Specify Pulse Edge</u></p> <p><u>0x02-0xFF: Reserved</u></p> <p>◆ 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.</p> <p>◆ Select standard value for usual operation.</p> <p>✓ The function becomes valid through control source re-closing.</p>						



## 7. Object Dictionary

### 0x20F1: Encoder Function Selection

Index	0x20F1	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] Selects the encoder clear method.		Unsigned8	RW	No	0x00
			Setting range	0x00-0x01		
<ul style="list-style-type: none"> <li>◆ Use to clear Serial encoder warning when the warning is not automatically restored.</li> <li>◆ Valid when using with Battery Backup Method Absolute Encoder and Battery-less Absolute Encoder.</li> <li>◆ When used with Absolute Encoder for Incremental System, even 01: _Status_MultiTurn is selected; it works as the selection, Clear only encoder status.</li> </ul> <p><u>0x00: Clear Encoder Status (Alarm and Warning) and Multi Turn Data</u> <u>0x01: Clear Only Encoder Status (Alarm and Warning)</u></p> <ul style="list-style-type: none"> <li>✓ Parameter set when amplifier hardware matches to Serial Encoder.</li> <li>✓ Valid when Battery backup system absolute encoder, or Battery less absolute encoder is used.</li> </ul>						
0x02	Encoder Digital Filter selection [ENFIL] This 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		
<ul style="list-style-type: none"> <li>◆ It is possible to set the value of incremental pulse digital filter for using incremental encoder. Pulse lower than the set value is eliminated as noise when noise superposition occurs in Incremental encoder signals.</li> <li>◆ 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.</li> </ul> <p><u>0x00: Minimum Pulse Width=110ns (Minimum pulse Phase Difference 37.5ns)</u> <u>0x01: Minimum Pulse Width=220ns (Minimum pulse Phase Difference 75ns)</u> <u>0x02: Minimum Pulse Width=440ns (Minimum pulse Phase Difference 150ns)</u> <u>0x03: Minimum Pulse Width=880ns (Minimum pulse Phase Difference 300ns)</u> <u>0x04: Minimum Pulse Width= 75ns (Minimum pulse Phase Difference 37.5ns)</u> <u>0x05: Minimum Pulse Width=150ns (Minimum pulse Phase Difference 75ns)</u> <u>0x06: Minimum Pulse Width=300ns (Minimum pulse Phase Difference 150ns)</u> <u>0x07: Minimum Pulse Width=600ns (Minimum pulse Phase Difference 300ns)</u> <u>0x08-0x0F: Reserved</u></p> <ul style="list-style-type: none"> <li>✓ This parameter can be set when amplifier hardware supports Pulse encoder.</li> </ul> <div style="text-align: center;"> <p>The diagram shows three square wave signals labeled Phase A, Phase B, and Phase Z. Phase A and Phase B are square waves that are 180 degrees out of phase. Phase Z is a square wave that is in phase with Phase A. Two horizontal arrows labeled 'Pulse width' indicate the duration of the high pulses for Phase A and Phase B. A horizontal arrow labeled 'Phase difference' indicates the time interval between the rising edges of Phase A and Phase B.</p> </div>						
0x03	External Encoder Digital Filter selection [EX-ENFIL] This parameter can be set only when using fully closed control function. Sets Digital filter to External Pulse Encoder.		Unsigned8	RW	No	0x01
			Setting range	0x00-0x07		
<ul style="list-style-type: none"> <li>◆ Pulse lower than the set value is eliminated as noise when noise superposition occurred in encoder signals.</li> <li>◆ 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.</li> </ul> <p><u>0x00: Minimum Pulse Width=110ns (Minimum pulse Phase Difference 37.5ns)</u> <u>0x01: Minimum Pulse Width=220ns (Minimum pulse Phase Difference 75ns)</u> <u>0x02: Minimum Pulse Width=440ns (Minimum pulse Phase Difference 150ns)</u> <u>0x03: Minimum Pulse Width=880ns (Minimum pulse Phase Difference 300ns)</u> <u>0x04: Minimum Pulse Width= 75ns (Minimum pulse Phase Difference 37.5ns)</u> <u>0x05: Minimum Pulse Width=150ns (Minimum pulse Phase Difference 75ns)</u> <u>0x06: Minimum Pulse Width=300ns (Minimum pulse Phase Difference 150ns)</u> <u>0x07: Minimum Pulse Width=600ns (Minimum pulse Phase Difference 300ns)</u> <u>0x08-0x0F: Reserved</u></p> <ul style="list-style-type: none"> <li>✓ This parameter can be set when amplifier hardware supports Full-closed option.</li> </ul>						
<p>[Full Close] [Linear]</p>						

## 7. Object Dictionary

0x04	External Encoder Polarity Selection [EX-ENPOL] This parameter can be set only when using fully closed controlfunction. Selects External pulse encoder signal polarity.	Unsigned8	RW	No	0x00
		Setting range	0x00-0x07		
[Full Close] [Linear]	<p>✓ This parameter can be used when amplifier hardware supports Full-closed option.</p> <p>0x00:Type1 EX-Z Not Reversed / EX-B Not Reversed / EX-A Not Reversed  0x01:Type2 EX-Z Not Reversed / EX-B Not Reversed / EX-A Reversed  0x02:Type3 EX-Z Not Reversed / EX-B Reversed / EX-A Not Reversed  0x03:Type4 EX-Z Not Reversed / EX-B Reversed / EX-A Reversed  0x04:Type5 EX-Z Reversed / EX-B Not Reversed / EX-A Not Reversed  0x05:Type6 EX-Z Reversed / EX-B Not Reversed / EX-A Reversed  0x06:Type7 EX-Z Reversed / EX-B Reversed / EX-A Not Reversed  0x07:Type8 EX-Z Reversed / EX-B Reversed / EX-A Reversed  0x08-0xFF:Reserved</p> <p>⚡ The function becomes valid through control source re-closing.</p>				
0x05	CS offset [CSOF] Sets electrical degree of the motor. For rotary motor use Must set it 0 degree.  For linear motor and Direct Drive Motor use 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.	Unsigned16	RW	No	0x0000 (0 deg)
		Setting range	0x0000 - 0x0167 (0 to 359 deg)		
[Linear]	<p>✓ This parameter is settable only under condition that amplifier hardware can support hall effect sensor input option.</p> <p>⚡ This function becomes effective after re-turning the control power supply on.</p>				
0x06	CS normalization offset of phase Z [ZPHOF] Sets offset of phase Z signal to electrical degree of the motor. For rotary motor use Must set it 0 degree.  For linear motor and Direct Drive Motor use This function is valid when performing CS normalization with use of phase Z signal. Sets an offset value with electrical angle conversion between 0 degree of U phase electrical angle and Z phase signal output position.	Unsigned16	RW	No	0x0000 (0 deg)
		Setting range	0x0000 - 0x0167 (0 to 359 deg)		
[Linear]	<p>⚡ This function becomes effective after re-turning the control power supply on.</p>				
0x07	Polarity selection on linear encoder [ENCDIR] Select linear encoder signal polarity EN1. You can select phase A and B signal polarity. Phase U and V signal polarity shall not be changed in case of omitted wiring incremental encoder.)	Unsigned8	RW	No	0x00
		Setting range	0x00 - 0x01		
[Linear]	<p>⚡ This function becomes effective after re-turning the control power supply on.</p>				
0x08	Magnetic pole position estimation frequency [EMPFREQ] Sets frequency for torque (force) command that is applied to estimate magnetic pole position. ✓ Change excitation frequency if amplifier hardware magnetic pole position estimation cannot be normally completed due to resonance of equipment. ⚡ This function becomes effective after re-turning the control power supply on.	Unsigned16	RW	No	0x0032 (50Hz)
		Setting range	0x05 - 0x0064 (5 to 100Hz)		
[Linear]					
0x09	Magnetic pole position estimation selection [CSETMD] Select the Magnetic pole position estimationmode.  ✓ This object is valid when 0x0850 is set to 0x20FF_0x02. 0x00: Follow the setting of 0x20F8_6. 0x01: Magnetic pole position estimation will run at once only after turn on main power. ⚡ Change is valid after control power-cycle.	Unsigned8	RW	No	0x00
		Setting range	0x00 to 0x01		
[Linear]					
0x0A	Encoder clear2 [ECLR2] By setting "1" to this parameter, multi turn part data of absolute encoder will be cleared. The state during clearing is shown to the bit3 of the status word1 (0x2100). ⚡ This function will be performed also by the bit12 of the control word, manufacturer spec area.	Unsigned8	RW	No	0x00
		Setting range	0x00 to 0x01		
[Linear]					

## 7. Object Dictionary

### 0x20F2: Amplifier Alarm Detect Selection

Index	0x20F2	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 [MPSEL]		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. 0x00: Do not detect the Main Circuit Under-voltage Alarm. 0x01: Detect the Main Circuit Under-voltage Alarm.						
0x02	Velocity Control Alarm (ALM_C2) Detection [VCALM]		Unsigned8	RW	No	0x00
	Setting range		0x00-0x01			
Select valid / invalid from the velocity control trouble detection. Trouble can be detected in operation patterns where the motor results in overshooting in response to commands; in these systems, please set as "invalid." 0x00: invalid 0x01: valid						
0x03	Velocity Feedback Alarm (ALM_C3) Detection [FBKEEN]		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]		Unsigned8	RW	No	0x00
	Setting range		0x00-0x08			
0x00-0x02: invalid 0x03: valid (error detected three times in row) 0x04: valid (error detected four times in row) ... 0x08: valid (error detected eight times in row)						
Monitor the following communication error registers at each communication cycle and set as valid / invalid for each alarm and for the detection filter. Reg:0x300 Port 0 Rx invalid frame error (AL_10)      Reg:0x301 Port0 RxCRC error (AL_12) Reg:0x302 Port 1 Rx invalid frame error (AL_11)      Reg:0x302 Port1 RxCRC error (AL_13) Reg:0x308 Port0 Tx error (AL_14)                      Reg:0x309 Port1 Tx error (AL_15)						
0x05	Communication Timeout (ALM_1A) Detection [COTOUT]		Unsigned8	RW	No	0x00
	Setting range		0x00-0xFF			
0x00, 0x01: invalid 0x02: valid (not received twice in row) 0x03: valid (not received three times in row) ... 0xFF: valid (not received 255 times in row)						
Monitor SM2 event (command receipt) at each communication cycle and set as valid / invalid for AL_1A and the detection filter.						
0x06	Alarm History Clearing Command [ALMCLR]		Unsigned32	RW	No	0x00
	Setting range		0x00000000-0xFFFFFFFF			
Clears alarm history. To avoid clearing wrongly, it is performed just when specified sign is inputted. Sign "AHCL".						
Alarm clearing sequence Master writes "0x4C434841" (ASCII code). After writing, alarm history will be cleared. After clearing the sign, result of Alarm History Clearing Operation Monitor also cleared.						
0x07	Alarm History Clearing Operation Monitor [ALMCLRMON]		Unsigned8	RO	No	-
	Setting range		0x00-0x03			
Indicates operating status of alarm history clearing. Status of Alarm History Clearing is below. 0x00: Waiting state      0x01: In operation 0x02: Normal completion      0x03: Abnormal completion						

### 0x20F3: Position Control Selection

Index	0x20F3	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			
0x00: Normal Control (Model Following Position Control detached) 0x01: Model Following Position Control (rigid body model) 0x02: Model Following Position Control (base vibration model) 0x03 - 0xFF: Reserved						
✓ The setting value is switched by re-closing.						
⚡ The function becomes valid through control source re-closing.						
0x02	Position Loop Control Encoder Selection [PLMODE]		Unsigned8	RW	No	0x00
	Setting range		0x00-0x01			
Selects the encoder that the servo amplifier uses for Position Loop Control. 0x00: Semi-closed Control (motor encoder used) 0x01: Full-closed Control (external encoder used)						
⚡ The function becomes valid through control source re-closing.						

## 7. Object Dictionary

### 0x20F4: Servo Loop Delay Time

Index	0x20F4	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] 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.  This parameter can adjust the time from the IRQ signal occurrence to the beginning of the amplifier location loop computation. $\text{Delay Time (usec)} = (\text{Setting value} + 1) / 2$ "Example : $62.5\text{us} = 62.5 * 2 - 1 = 124 = \text{Setting value:}0x7C$ "  ✓Adjust to the last slave axis.		Unsigned8	RW	No	0xEF (120μs)
			Setting range	0x00-0xEF (0.5 to 120μs)		
			Unit	0.5μs		

### 0x20F5: Torque (force) Limit at Power Supply Shortage

Index	0x20F5	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. Provided as a SEMI F47 support function.	Object Code			Variable
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Torque (force) Limit at Power Supply Shortage [CPETLSEL]  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).  <u>0x00: Limit to minimum value of 0x6072, 0x60E0, 0x60E1(By normal torque limit method)</u> <u>0x01: 0x201E:Limit to minimum value of the Sequence Torque Operation Torque limit and the minimum value of 0x6072, 0x60E0, and 0x60E1.</u>		Unsigned8	RW	No	0x00
			Setting range	0x00-0x01		
✓For the operation sequence, see chapter 8, "SEMI F47 support function."						

### 0x20F6: Manufacturer Homing Parameter

Index	0x20F6	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]  At homing process, define calculation of actual position (0x6064). 0x20F6-1=0 : Calculation method 1 0x20F6 - 1 = 1 : Calculation method 2  <div style="display: flex; justify-content: space-around;"> <div style="text-align: center;"> <p>Zero Position for the application</p> <p>Home Position (Index Pulse)</p> <p>Home offset (0x607C)</p> </div> <div style="text-align: center;"> <p>Zero Position (Index Pulse)</p> <p>Home offset (0x607C)</p> </div> </div> <p>Except for homing method 35,37. Zero Position = Home Position + Home offset (0x606C)</p> <p>Except for homing method 35,37. Zero Position = Home offset (0x606C) Homing Method 35,37 Actual Position(0x6064) = Home offset (0x606C)</p> <p>✓ When homing method 35 or 37 and 0x20F6-1=0 ,calculation is calculation method 2.</p>		Unsigned8	RW	No	0x00
			Setting range	0x00 to 0x01		
0x02	Hard stop torque (force) limit [HSTRQ] In the Hard stop homing (0x6098 : from -4 to -1), this value is torque (force) limitation when reaching hard stop.  Hard stop is detected with this value.		Unsigned16	RW	No	0x03E8 (100.0%)
			Setting range	0x0000 to 0x1388 (0 to 500.0%)		
			Unit	0.1 %		
0x03	Hard stop detection time [HSTIM] In the Hard stop homing (0x6098 : from -4 to -1), hard stop is detected after spending this time with torque value beyond above. After hard stop detection, state will change by homing method as below.  Homing method (0x6098) -1, -2 --> Home position detected. (Finished homing.) -3, -4 --> Go reverse to find index position. (Continuing homing.)		Unsigned16	RW	No	0x000A (10ms)
			Setting range	0x000A to 0xFFFF (10 to 65535ms)		
			Unit	ms		

## 7. Object Dictionary

### 0x20F7: Special Function Selection Setting

Index	0x20F7	Sets whether or not the special function of the servo amplifier is usable.	Object Code		Variable	
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Bit0: Independent setting of SM2 sync and interpolated sync Sets whether or not the synchronized time in the interpolation mode is synchronized. The interpolation synchronized time is synchronized to SM2 synchronization at the setting value 0. The interpolation synchronized time is independently set from SM2 synchronization at the setting value 1. ✓ When using the SANMotionC, please make sure to use it under the conditions synchronizing to SM2 synchronization.		Unsigned16 Setting Range	RW	No	0x0000
			0x0000-0xFFFF			
	Bit1: Torque low pass filter setting Sets torque command filter (0x2011). 0: Torque command filter(0x2011) disable. 1: Torque command filter(0x2011) enable.		Bit2: Modulo initial processing selection Note 1) Sets modulo initial processing at power-on. 0: Normal process. (Modulo coordinate can divide encoder coordinate w/o remainder.) 1: Special process. (Remainder is there in calculation above.)			
	Bit3: Command direction saving function selection Note 1) Selects whether save or not the command direction to internal memory when control power is shut off. Stored command direction is used as initial command direction of calculation of the actual position 2. 0: Does not save. 1: Save.					
	Bit4: Reserved Bit5: Torque monitor calculation method selection Selects calculation method of the Motor utilization monitor (Effective torque (force) estimate value) (0x2108). 0: Existing method 1: Accuracy improved method Bit6 to 15: Reserved Note 1) Please contact our sales if this function is used with DC power input type.					

### 0x20F8: General Purpose Input Setting

Index	0x20F8	Select the function of General Purpose input 1 to 6 (CONT1 to 6). 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] Select the valid condition of the positive direction limit switch function. 00: Always Disable Always function disabled. 01: Always Enable Always function enabled. 02: CONT1 ON Function enabled when versatile input CONT1 is ON. 03: CONT1 OFF Function enabled when versatile input CONT1 is OFF. 04: CONT2 ON Function enabled when versatile input CONT2 is ON. 05: CONT2 OFF Function enabled when versatile input CONT2 is OFF. 06: CONT3 ON Function enabled when versatile input CONT3 is ON. 07: CONT3 OFF Function enabled when versatile input CONT3 is OFF. 08: CONT4 ON Function enabled when versatile input CONT4 is ON. 09: CONT4 OFF Function enabled when versatile input CONT4 is OFF. 0A: CONT5 ON Function enabled when versatile input CONT5 is ON. 0B: CONT5 OFF Function enabled when versatile input CONT5 is OFF. 0C: CONT6 ON Function enabled when versatile input CONT6 is ON. 0D: CONT6 OFF Function enabled when versatile input CONT6 is OFF. 0E: CONT7 ON (HWG OFF1)* Function enabled when versatile input CONT7 is ON. 0F: CONT7 OFF (HWG OFF1)* Function enabled when versatile input CONT7 is OFF. 10: CONT8 ON (HWG OFF2)* Function enabled when versatile input CONT8 is ON. 11: CONT8 OFF (HWG OFF2)* Function enabled when versatile input CONT8 is OFF. *CONT7 and 8 are dedicated input for hardware gate off function.		Unsigned8 Setting range	RW	No	0x00
			0x00 to 0x0D			
0x02	Negative Limit Switch Function [NLIMSW] Select the valid condition of the negative direction limit switch function The same as Sub Index:01(positive direction limit switch function.)		Unsigned8 Setting range	RW	No	0x00
			0x00-0x0D			
0x03	External Trip Input Function [EXT-E] Sets the trip valid condition the same as the trip input of the external regenerative resistance. The same as Sub Index:01(positive direction limit switch function.)		Unsigned8 Setting range	RW	No	0x00
			0x00-0x0D			
0x04	Main Power Discharge Function [DISCHRG] Sets the valid condition of the discharge function in case of main circuit power shutdown. The same as Sub Index:01(positive direction limit switch function.)		Unsigned8 Setting range	RW	No	0x00
			0x00-0x0D			
0x05	Emergency Stop Function [EMR] Sets the valid condition of the input function in case of emergency stop. The same as Sub Index:01(positive direction limit switch function.)		Unsigned8 Setting range	RW	No	0x00
			0x00-0x0D			
0x06 [Linear]	Magnetic pole position indicating function [CSET] Sets valid condition for inputting fixed magnetic pole position estimation function on the linear motor without hall effect sensor output. The same as Sub Index:01(positive direction limit switch function.)		Unsigned8 Setting range	RW	No	0x00
			0x00 to 0x0D			

Note 1) In the safety function mounted amplifier, this cannot be used as a general purpose input signal.

Note 2) CONT1 is shared with home switch and touch probe 1. CONT2 is shared with touch probe 2.

To use these functions, do not assign any functions. (Always function disabled)

## 7. Object Dictionary

### 0x20F9: General Purpose Output Setting

Index	0x20F9	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] Selects the Output signal for General Purpose Output 1. For a detailed list, see the General Purpose Output Parameters list.		Unsigned8	RW	No	0x42
			Setting range	0x00-0x5F (Initial value: 42:FOUT1_ON)		
0x02	General Purpose Output 2 [OUT2] Selects the Output signal for General Purpose Output 2. For a detailed list, see the General Purpose Output Parameters list.		Unsigned8	RW	No	0x44
			Setting range	0x00-0x55 (Initial value: 44: FOUT2_ON)		

◆To control from EtherCAT communications

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.

## 7. Object Dictionary

### ■ 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 output is ON in during detecting torque (force) attainment.	56:TA_ON	The output 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	-	-

## 7. Object Dictionary

### 0x20FA: Extend Station Alias

Index	0x20FA	Sets the rotary switch for Station of Alias to use more than 0 to 256 points rotary switch.	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] Sets the Inherent Slave address(Station Alias Reg: 0x0012, 0x0013) to bit15-8 bit7-0 Rotary switch of amplifier front panel ,bit15-8 This setting value at initialization If 0x20FA.02=0x00 then logical add will write to station alias Reg: 0x0012,0x0013 ☛The function becomes valid through control source re-closing.	Unsigned8	RW	No	0x00	
		Setting range	0x00 to 0xFF			
0x02	Station Alias Selection [ALIASSEL] Sets the station alias Reg: 0x0012,0x0013 0x00: Use value of rotary switch of amplifier front panel (bit7-0) and extended alias number (bit15-8) 0x01: Use value of EEPROM address 0x04 ☛The function becomes valid through control source re-closing.	Unsigned8	RW	No	0x00	
		Setting range	0x00 to 0x01			

### 0x20FB: Torque addition at S-ON

Index	0x20FB	Sets the torque of addition value of until the command at servo ON becomes valid.	Object Code		Variable	
Sub-Idx	Description		Data Type	Access	PDO	Initial Value
0x00	Torque addition at S-ON [SON_TCSET] During the time to the holding brake release delay time from servo ON, the set torque command will be input. Torque command is reduced 4 msec each, and reaches to zero during the holding brake release delay time. When servo amplifier is used with gravity axis, a self weight fall at servo ON is able to prevent. ☛The function becomes valid after control power cycle. However, it becomes valid without control power cycle by setting the bit12 of control word1.	Integer16	RW	No	0	
		Display range	0xFC18 to 0x03E8 (-100.0 to 100.0)			
		Unit	0.1%			

### 0x20FC: Modulo initialization warning detection setting

Index	0x20FC	Set threshold of Modulo initialization warning detection, when modulo function is enabled and motor is too much rotating during control power off.	Object Code		Variable	
Sub-Idx	Description		Data Type	Access	PDO	Initial Value
0x00	Set warning threshold to multiple of the number of pulse of modulo coordinate. The warning happens at initial processing after motor rotated beyond threshold during power-off. Recording the actual position value at power off. Then calculating motor rotation during power off at initial processing of power on. Warning flag will be set when pulse number of motor rotation is over the value that multiplied [Pulse number of modulo coordinate] by the setting value that has +/-. See below calculation of [Pulse number threshold] for warning detection.  [Pulse number threshold] = [Pulse number of modulo coordinate] x [The setting value of 0x20FC]  Pulse number threshold will be hold to 0x3FFFFFFF when the value became bigger than 0x3FFFFFFF. <ul style="list-style-type: none"> <li>✓ Detection is enabled at condition of 0x20F7 Bit2=1.</li> <li>✓ Detection occur only at 0x3FFFFFFF when the setting value is zero.</li> <li>✓ Contact our sales for use of this function with DC input type.</li> </ul> ☛The function becomes valid through control source re-closing.  For example) 0x607B. 01=0, 0x607B. 02=655359, 0x20FC. 00=5 See below calculation with condition above. [Pulse number of modulo coordinate]: 655360 (= 655359- 0+ 1) [Pulse number threshold]: +/- 3276800 (= 655360 x 5)	Unsigned16	RW	No	0x0000	
		Setting range	0x0000 to 0xFFFF			

## 7. Object Dictionary

### 0x20FD: Amplifier System Selection

Index	0x20FD	Selects the system configuration of the servo amplifier.	Object Code			Record
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Number of entry		Unsigned8	RO	No	0x03
0x01	Main power input type [MPWRIN] Selects the main circuit mode to actually be wired.		Unsigned8	RW	No	0x00
	<u>0x00:3φAC(three-phase AC input)</u> <u>0x01:1φAC(single phase AC input)</u> <u>0x02:DC (DC power source input) supplied from the power supply unit</u> <u>0x03 - 0xFF:Reserved</u> ⚡The function becomes valid through control source re-closing.		Setting range	0x00-0x02		
0x02	Regenerative Resistor Selection [RGKIND] Selects the presence/absence of regenerative resistance and the connection forms.		Unsigned8	RW	No	0x01
	<u>0x00:regenerative resistance disconnected</u> <u>0x01:embedded regenerative resistance used</u> (used as discharge resistance in the power regenerating unit) <u>0x02:external regenerative resistance used</u> (used as discharge resistance in the power regenerating unit) <u>0x03 - 0xFF:Reserved</u> ⚡The function becomes valid through control source re-closing.		Setting range	0x00-0x02		
0x03	Setup Communication Baud Rate [COMBAUD] Selects the baud rate when PC communication is performed by the setup software.		Unsigned8	RW	No	0x05
	<u>0x03 : 9600bps</u> <u>0x04 : 19200bps</u> <u>0x05 : 38400bps</u> <u>0x06 : 57600bps</u> <u>0x00-0x02,0x07-0xFF: Reserved</u> ⚡The function becomes valid through control source re-closing.		Setting range	0x03-0x06		

## 7. Object Dictionary

0x20FE: Motor code

Index	0x20FE	Sets the code of the drive motor.	Object Code		Variable	
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Combination Motor code [MOCODE] Sets the combination motor code. The motor code list can be set via communication. ✓ If there is no Servo motor in the list, please contact our sales.		Unsigned16	RW	No	0xFFFF
			Setting range	0x0000-0xFFFF		

### ■ Rotary motor (100V)

Series	Motor code	Servo motor model number	Input type	Amplifier capacity	Flange size	Output	Maximum speed
R2 Series	0x0197	R2EA04003F	100V AC	15A	40mm sq.	30W	6,000 min <sup>-1</sup>
	0x0198	R2EA04005F	100V AC	15A	40mm sq.	50W	6,000 min <sup>-1</sup>
	0x019D	R2EA04008F	100V AC	15A	40mm sq.	80W	6,000 min <sup>-1</sup>
	0x019A	R2EA06010F	100V AC	15A	60mm sq.	100W	6,000 min <sup>-1</sup>
	0x019B	R2EA06020F	100V AC	30A	60mm sq.	200W	6,000 min <sup>-1</sup>

### ■ Rotary motor (200V)

Series	Motor code	Servo motor model number	Input type	Amplifier capacity	Flange size	Output	Maximum speed
R2 Series	0x0181	R2AA04003F	200V AC	15A	40mm sq.	30W	6,000 min <sup>-1</sup>
	0x0182	R2AA04005F	200V AC	15A	40mm sq.	50W	6,000 min <sup>-1</sup>
	0x0183	R2AA04010F	200V AC	15A	40mm sq.	100W	6,000 min <sup>-1</sup>
	0x0184	R2AA06010F	200V AC	15A	60mm sq.	100W	6,000 min <sup>-1</sup>
	0x0185	R2AA06020F	200V AC	15A	60mm sq.	200W	6,000 min <sup>-1</sup>
	0x0189	R2AA06040H	200V AC	15A	60mm sq.	400W	3,000 min <sup>-1</sup>
	0x018A	R2AA08020F	200V AC	15A	80mm sq.	200W	6,000 min <sup>-1</sup>
	0x0186	R2AA06040F	200V AC	30A	60mm sq.	400W	6,000 min <sup>-1</sup>
	0x0188	R2AA08040F	200V AC	30A	80mm sq.	400W	6,000 min <sup>-1</sup>
	0x0187	R2AA08075F	200V AC	30A	80mm sq.	750W	6,000 min <sup>-1</sup>
	0x0194	R2AAB8100H	200V AC	30A	86mm sq.	1.0kW	3,000 min <sup>-1</sup>
	0x019F	R2AA10075F	200V AC	30A	100mm sq.	750W	6,000 min <sup>-1</sup>
	0x018F	R2AA13050H	200V AC	30A	130mm sq.	550W	3,500 min <sup>-1</sup>
	0x018C	R2AA13050D	200V AC	30A	130mm sq.	500W	5,000 min <sup>-1</sup>
	0x0191	R2AA13120B	200V AC	30A	130mm sq.	1.2kW	2,000 min <sup>-1</sup>
	0x01B7	R2AAB8075H	200V AC	30A	86mm sq.	750W	3,000 min <sup>-1</sup>
	0x01B1	R2AAB8075F	200V AC	50A	86mm sq.	750W	6,000 min <sup>-1</sup>
	0x0193	R2AAB8100F	200V AC	50A	86mm sq.	1.0kW	6,000 min <sup>-1</sup>
	0x04A8	R2AAB8100B	200V AC	50A	86mm sq.	1.0kW	2,000 min <sup>-1</sup>
	0x019E	R2AA10100F	200V AC	50A	100mm sq.	1.0Kw	6,000 min <sup>-1</sup>
	0x018E	R2AA13120L	200V AC	50A	130mm sq.	1.2kW	3,000 min <sup>-1</sup>
	0x018D	R2AA13120D	200V AC	50A	130mm sq.	1.2kW	5,000 min <sup>-1</sup>
	0x01B6	R2AA13180H	200V AC	50A	130mm sq.	1.8kW	4,000 min <sup>-1</sup>
	0x0119	R2AA13180M	200V AC	50A	130mm sq.	1.8kW	4,000 min <sup>-1</sup>
	0x0192	R2AA13200L	200V AC	50A	130mm sq.	2.0kW	3,000 min <sup>-1</sup>
	0x01BC	R2AA18350M	200V AC	50A	180mm sq.	2.7kW	1,500 min <sup>-1</sup>
	0x011B	R2AA13180D	200V AC	100A	130mm sq.	1.8kW	5,000 min <sup>-1</sup>
	0x0190	R2AA13200D	200V AC	100A	130mm sq.	2.0kW	5,000 min <sup>-1</sup>
	0x011C	R2AA18350L	200V AC	100A	180mm sq.	3.5kW	3,000 min <sup>-1</sup>
	0x0493	R2AA18550M	200V AC	100A	180mm sq.	5.5kW	1,500 min <sup>-1</sup>
	0x011D	R2AA18350D	200V AC	150A	180mm sq.	3.5kW	4,000 min <sup>-1</sup>
	0x011E	R2AA18450H	200V AC	150A	180mm sq.	4.5kW	3,500 min <sup>-1</sup>
	0x01B8	R2AA18550R	200V AC	150A	180mm sq.	5.5kW	2,500 min <sup>-1</sup>
	0x01BA	R2AA18750A	200V AC	150A	180mm sq.	6.4kW	1,300 min <sup>-1</sup>
	0x0111	R2AA18750M	200V AC	150A	180mm sq.	7.5kW	1,500 min <sup>-1</sup>
	0x0195	R2AA22500L	200V AC	150A	220mm sq.	5.0kW	4,000 min <sup>-1</sup>
	0x0484	R2AA22700S	200V AC	150A	220mm sq.	7.0kW	1,000 min <sup>-1</sup>
	0x011F	R2AA18550H	200V AC	300A	180mm sq.	5.5kW	3,000 min <sup>-1</sup>
	0x01B9	R2AA18750H	200V AC	300A	180mm sq.	7.5kW	3,000 min <sup>-1</sup>
	0x0120	R2AA1811KR	200V AC	300A	180mm sq.	11kW	2,500 min <sup>-1</sup>
0x0483	R2AA2211KR	200V AC	300A	220mm sq.	11kW	2,000 min <sup>-1</sup>	
0x0117	R2AA2215KB	200V AC	300A	220mm sq.	15kW	2,000 min <sup>-1</sup>	
0x02BC	R2AA2215KR	200V AC	300A	220mm sq.	15kW	2,000 min <sup>-1</sup>	

## 7. Object Dictionary

■ Rotary motor (200V)							
Series	Motor code	Servo motor model number	Input type	Amplifier capacity	Flange size	Output	Maximum speed
R1 Series	0x0515	R1AA10100H	200V AC	30A	100mm sq.	1.0kW	3,000 min <sup>-1</sup>
	0x0512	R1AA10150H	200V AC	30A	100mm sq.	1.5kW	3,000 min <sup>-1</sup>
	0x0516	R1AA10100F	200V AC	50A	100mm sq.	1.0kW	6,000 min <sup>-1</sup>
	0x04FA	R1AA10150F	200V AC	50A	100mm sq.	1.5kW	6,000 min <sup>-1</sup>
	0x0513	R1AA10200H	200V AC	50A	100mm sq.	2.0kW	3,000 min <sup>-1</sup>
	0x0517	R1AA10250H	200V AC	50A	100mm sq.	2.5kW	3,000 min <sup>-1</sup>
	0x050F	R1AA10200F	200V AC	100A	100mm sq.	2.0kW	6,000 min <sup>-1</sup>
	0x0518	R1AA10250F	200V AC	100A	100mm sq.	2.5kW	6,000 min <sup>-1</sup>
	0x0511	R1AA13300H	200V AC	100A	130mm sq.	3.0kW	3,000 min <sup>-1</sup>
	0x0508	R1AA13300F	200V AC	100A	130mm sq.	3.0kW	6,000 min <sup>-1</sup>
	0x0519	R1AA13400H	200V AC	100A	130mm sq.	4.0kW	3,000 min <sup>-1</sup>
	0x050E	R1AA13500H	200V AC	100A	130mm sq.	5.0kW	3,000 min <sup>-1</sup>
	0x051A	R1AA13400F	200V AC	150A	130mm sq.	4.0kW	6,000 min <sup>-1</sup>
	0x051B	R1AA13500F	200V AC	150A	130mm sq.	5.0kW	6,000 min <sup>-1</sup>
	0x0109	R1AA18550H	200V AC	300A	180mm sq.	5.5kW	3,000 min <sup>-1</sup>
	0x010D	R1AA1811KR	200V AC	300A	180mm sq.	11kW	2,500 min <sup>-1</sup>
0x010E	R1AA1815KB	200V AC	300A	180mm sq.	15kW	2,000 min <sup>-1</sup>	
0x010F	R1AA18750L	200V AC	300A	180mm sq.	7.5kW	3,000 min <sup>-1</sup>	

■ Rotary motor (200V)							
Series	Motor code	Servo motor model number	Input type	Amplifier capacity	Flange size	Output	Maximum speed
R5 Series	0x049D	R5AA06020H	200V AC	15A	60mm sq.	200W	3,000 min <sup>-1</sup>
	0x049E	R5AA06020F	200V AC	15A	60mm sq.	200W	6,000 min <sup>-1</sup>
	0x049F	R5AA06040H	200V AC	15A	60mm sq.	200W	3,000 min <sup>-1</sup>
	0x02BA	R5AA08075D	200V AC	30A	80mm sq.	750W	5,000 min <sup>-1</sup>
	0x02BB	R5AA06040F	200V AC	30A	60mm sq.	400W	6,000 min <sup>-1</sup>
	0x04A0	R5AA08075F	200V AC	30A	80mm sq.	750W	6,000 min <sup>-1</sup>

■ Rotary motor (48V)							
Series	Motor code	Servo motor model number	Input type	Amplifier capacity	Flange size	Output	Maximum speed
R2 Series	0x0261	R2GA04003F	48V DC	40A	40mm sq.	30W	6,000 min <sup>-1</sup>
	0x0262	R2GA04005F	48V DC	40A	40mm sq.	50W	6,000 min <sup>-1</sup>
	0x0263	R2GA04008D	48V DC	40A	40mm sq.	80W	5,000 min <sup>-1</sup>
	0x0264	R2GA06010D	48V DC	40A	60mm sq.	100W	5,000 min <sup>-1</sup>
	0x0265	R2GA06020D	48V DC	40A	60mm sq.	200W	4,500 min <sup>-1</sup>
	0x040C	R2GAD102RM	48V DC	25A	14mm sq.	2.4W	1,500 min <sup>-1</sup>
	0x049B	R2GA02D20F	48V DC	40A	20mm sq.	20W	6,000 min <sup>-1</sup>
	0x0497	R2GA02D30F	48V DC	40A	20mm sq.	30W	6,000 min <sup>-1</sup>

■ Rotary motor (24V)							
Series	Motor code	Servo motor model number	Input type	Amplifier capacity	Flange size	Output	Maximum speed
R2 Series	0x018B	R2FA04003F	24V DC	40A	40mm sq.	30W	6,000 min <sup>-1</sup>
	0x0118	R2FA04005D	24V DC	40A	40mm sq.	50W	4,500 min <sup>-1</sup>
	0x0509	R2FA04006R	24V DC	40A	40mm sq.	60W	2,500 min <sup>-1</sup>
	0x050A	R2FA06007R	24V DC	40A	60mm sq.	70W	2,500 min <sup>-1</sup>
	0x050B	R2FA06008A	24V DC	40A	60mm sq.	80W	1,250 min <sup>-1</sup>
	0x04A2	R2FA02D20D	24V DC	40A	20mm sq.	20W	4,500 min <sup>-1</sup>
	0x0498	R2FA02D30H	24V DC	40A	20mm sq.	30W	3,000 min <sup>-1</sup>

## 7. Object Dictionary

■ Linear motor (200V)							
Series	Motor code	Servo motor model number	Input type	Amplifier capacity	Magnet width	Output	Maximum speed
DS Series	0x0343	DS030C1N2E	200V AC	30A	30mm	160N	5.5 m/s
	0x0344	DS030C2N2E	200V AC	50A	30mm	320N	5.5 m/s
	0x0346	DS030C3N2E	200V AC	100A	30mm	480N	5.5 m/s
	0x0347	DS050C1N2E	200V AC	30A	50mm	260N	3.5 m/s
	0x0348	DS050C2N2E	200V AC	50A	50mm	520N	3.5 m/s
	0x034A	DS050C3N2E	200V AC	100A	50mm	780N	3.5 m/s
	0x034C	DS075C1N2E	200V AC	30A	75mm	400N	2.4 m/s
	0x034F	DS075C2N2E	200V AC	50A	75mm	800N	2.4 m/s
	0x0349	DS075C3N2E	200V AC	100A	75mm	1200N	2.4 m/s
	0x0350	DS100C1N2E	200V AC	50A	100mm	540N	4.0 m/s
	0x0351	DS100C2N2E	200V AC	100A	100mm	1080N	4.0 m/s
	0x0352	DS100C3N2E	200V AC	150A	100mm	1620N	4.0 m/s
	0x0353	DS150C1N2E	200V AC	50A	150mm	800N	2.6 m/s
	0x0354	DS150C2N2E	200V AC	100A	150mm	1600N	2.6 m/s
0x034D	DS150C3N2E	200V AC	150A	150mm	2400N	2.6 m/s	
DD Series	0x03D2	DD030C1Y4E	200V AC	50A	30mm	430N	3.0 m/s
	0x03D3	DD030C2Y4E	200V AC	100A	30mm	860N	3.0 m/s
	0x03D4	DD030C3Y4E	200V AC	100A	30mm	1290N	3.0 m/s
	0x03D5	DD050C1Y2E	200V AC	100A	50mm	700N	3.0 m/s
	0x03D6	DD050C2Y2E	200V AC	150A	50mm	1400N	3.0 m/s
	0x03D9	DD050C3Y2E	200V AC	300A	50mm	2100N	3.0 m/s
	0x03DA	DD075C1Y2E	200V AC	100A	75mm	1050N	3.0 m/s
	0x04D4	DD035CC2AN	200V AC	100A	35mm	1400N	3.0 m/s
	0x03DB	DD075C2Y2E	200V AC	150A	75mm	2100N	3.0 m/s
	0x03DC	DD075C3Y2E	200V AC	300A	75mm	3100N	3.0 m/s
0x03DD	DD075C4Y2E	200V AC	300A	75mm	4150N	3.0 m/s	
DT Series	0x04D3	DT030CD1AN	200V AC	30A	30mm	650N	3.0 m/s

■ Linear motor (48V)							
Series	Motor code	Servo motor model number	Input type	Amplifier capacity	Magnet width Stroke width	Output	Maximum speed
Cylinder	0x435A	DE0AC001A3	48V DC	40A	30mm	5.1N	2.0 m/s
Linear motor	0x05AD	DE0BC005A05CX00	48V DC	40A	50mm	15N	1.4 m/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.
	<p>☛ To be Initialized by motor code set on EEPROM at power-on. When the motor code whose set parameter is different from EEPROM value, function becomes enabled when control power is re-turned on. Re-turn on control power since alarm "DE: parameter change completed" becomes active after new value is set to EEPROM.</p> <p>☛ 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.</p>	

## 7. Object Dictionary

### 0x20FF: Combination Encoder Selection

Index	0x20FF	Selects the motor encoder specifications and functions driven by combination. * 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] Sets the division number of the motor encoder.	Unsigned16	RW	No	0xFFFF
			Setting range	0x0000-0x000F		
		<ul style="list-style-type: none"> <li>When the incremental encoder is used</li> </ul>	<ul style="list-style-type: none"> <li>When the absolute encoder is used</li> </ul>	<ul style="list-style-type: none"> <li>when linear scale encoder is used.</li> </ul>		
		0x0000 : 500P/R 0x0001 : 512P/R 0x0002 : 1,000P/R 0x0003 : 1,024P/R 0x0004 : 1,500P/R 0x0005 : 2,000P/R 0x0006 : 2,048P/R 0x0007 : 2,500P/R 0x0008 : 3,000P/R 0x0009 : 4,000P/R 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	0x0000 : 2,048FMT 0x0001 : 4,096FMT 0x0002 : 8,192FMT 0x0003 : 16,384FMT 0x0004 : 32,768FMT 0x0005 : 65,536FMT 0x0006 : 131,072FMT 0x0007 : 262,144FMT 0x0008 : 524,288FMT 0x0009 : 1,048,576FMT	0x0000 : 5μm [200P/mm] 0x0001 : 2.5μm [400P/mm] 0x0002 : 2μm [500P/mm] 0x0003 : 1.25μm [800P/mm] 0x0004 : 1μm [1,000P/mm] 0x0005 : 0.5μm [2,000P/mm] 0x0006 : 0.25μm [4,000P/mm] 0x0007 : 0.125μm [8,000P/mm] 0x0008 : 0.1μm [10,000P/mm] 0x0009 : 0.05μm [20,000P/mm]		
		<u>0x8000: Auto setting of motor parameter (When connected to applicable motor.)</u> <u>0xFFFF: R ADVANCED - by division number setting (EEPROM setting value) of the Setup software.</u>				
		<ul style="list-style-type: none"> <li>initialized by the encoder resolution number set in EEPROM at the turn-on state.</li> <li>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.</li> <li>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.</li> </ul>				

#### Automatic setting of motor parameter

There are two ways to perform automatic setting of motor parameter.

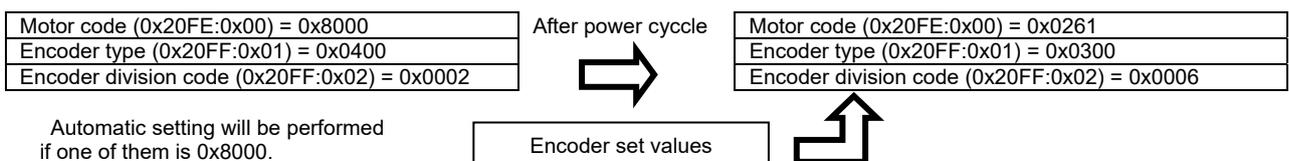
- (1) 0x8000 is set to any of motor code (0x20FE: 0x00), encoder division number code (0x20FF: 0x01), or encoder type code (0x20FF: 0x02). After that all the three values are read out automatically from encoder on re-turning on the control power.
- (2) When using automatic setting button on parameter setting display of SANMOTION MOTOR setup software, the procedure is as follow:
  - (a) Click automatic setting button on parameter setting display.
  - (b) Click OK-button if normally completed.
  - (c) Set motor code of system parameter tab 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).

Automatic setting example: connects to R2GA04003F having optic type asynchronous 2.5Mhz 17bits resolution encoder.



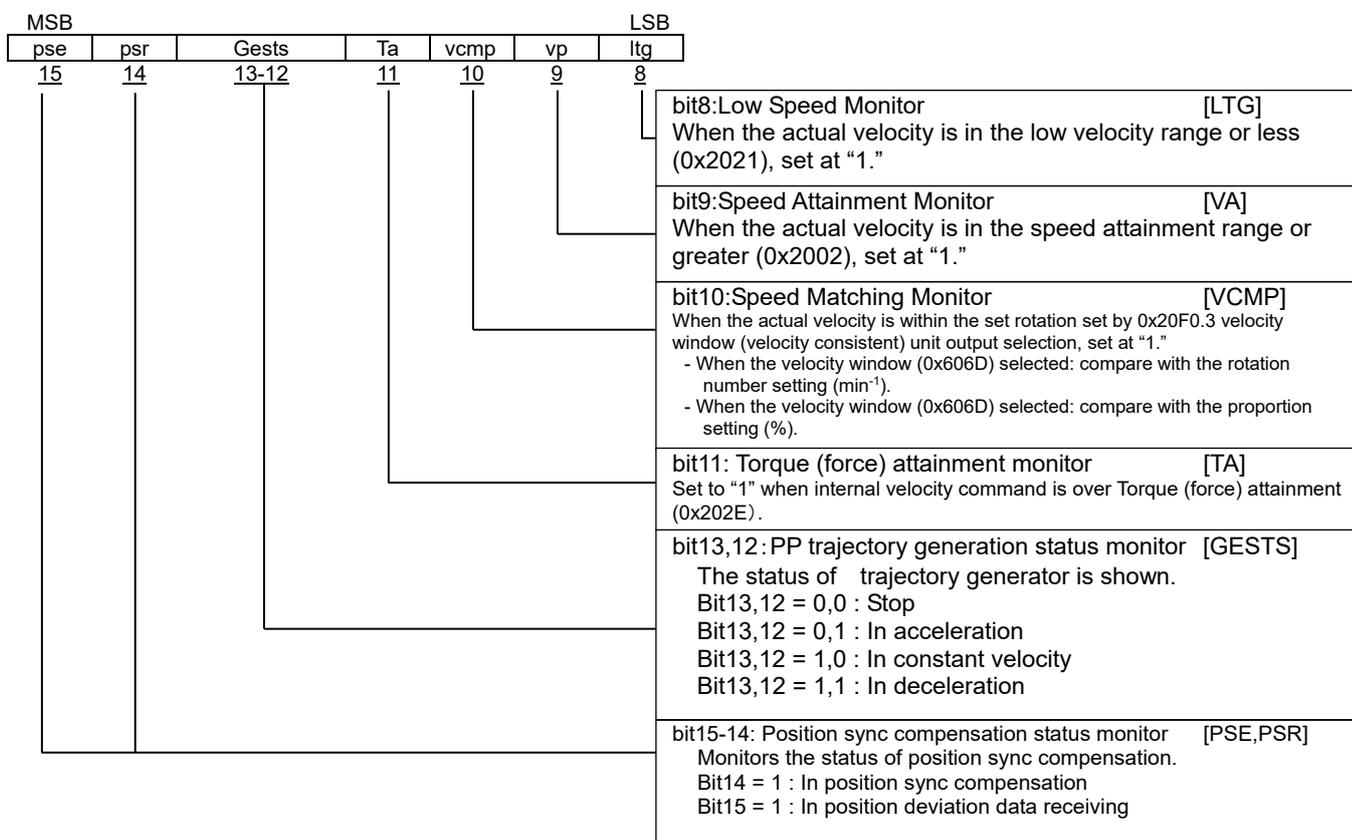
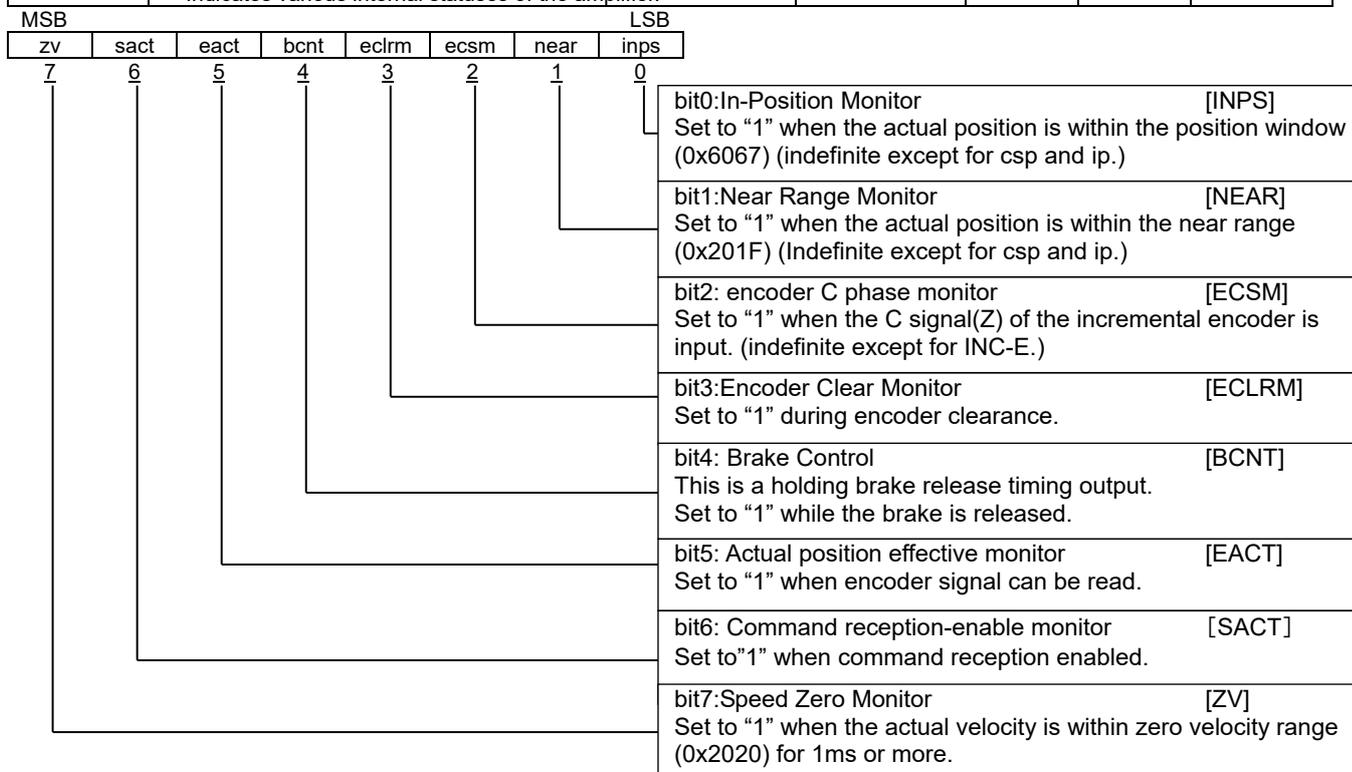


## 7. Object Dictionary

### 11) Monitor Parameter

0x2100: Status Word 1

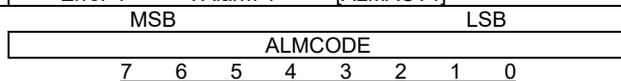
Index	0x2100	Indicates servo amplifier status.	Object Code		Variable
Sub-Idx	Description		Access	PDO	Initial value
0x00	Status Word 1	Indicates various internal statuses of the amplifier.	RO	Possible	-



## 7. Object Dictionary

### 0x2101: Amplifier Error Field

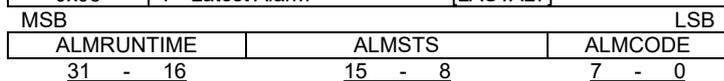
Index 0x2101	Indicates the alarm occurring in the servo amplifier. Sub-Index 0x00 indicates the number of alarms that are currently occurring, and Sub-Index 0x01-0x04 indicates the contents of alarms and Amplifier Status when the alarms occur up to four. Resets the alarm by setting Alarm reset in Control Word (0x6040.7).					Object Code 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



bit7-0: Alarm Code defined by this servo amplifier  
See the Alarm Code list.

### 0x2102: Description of Alarm Trace

Index 0x2102	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] *When the Alarm doesn't occur, it becomes 0x0000.	Unsigned32	RO	Possible	0x00000000
0x02	1 <sup>st</sup> Latest Alarm [LASTAL1]	Unsigned32	RO	Possible	0x00000000
0x03	2 <sup>nd</sup> Latest Alarm [LASTAL2]	Unsigned32	RO	Possible	0x00000000
0x04	3 <sup>rd</sup> Latest Alarm [LASTAL3]	Unsigned32	RO	Possible	0x00000000
0x05	4 <sup>th</sup> Latest Alarm [LASTAL4]	Unsigned32	RO	Possible	0x00000000
0x06	5 <sup>th</sup> Latest Alarm [LASTAL5]	Unsigned32	RO	Possible	0x00000000
0x07	6 <sup>th</sup> Latest Alarm [LASTAL6]	Unsigned32	RO	Possible	0x00000000
0x08	7 <sup>th</sup> Latest Alarm [LASTAL7]	Unsigned32	RO	Possible	0x00000000



bit7-0: Alarm Code defined by this servo amplifier  
See the Alarm 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.

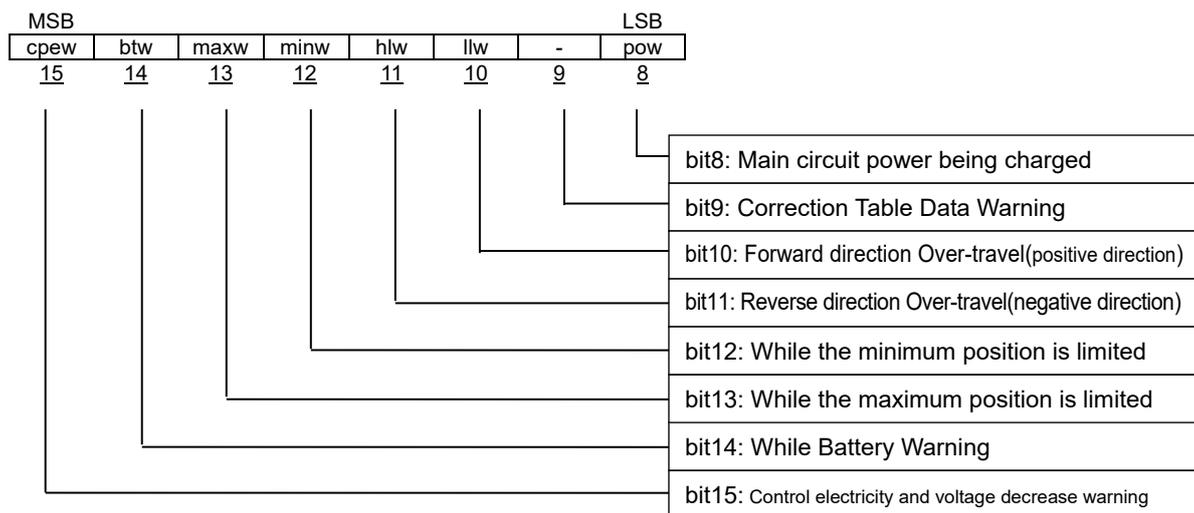
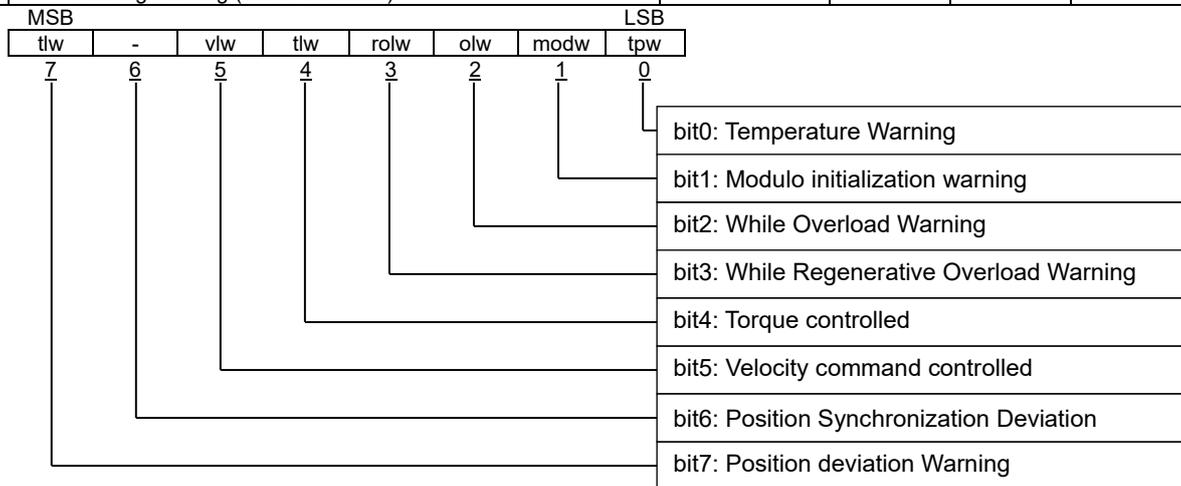
#### Bit15-8 status (ALMSTS) list

Status Display	ALMSTS0	Status Display	ALMSTS0
Power OFF	0x00	Servo ON 1 (Reprocessing the electric current detector)	0x07
Power ON 1 (electric current detector during setting)	0x01	Servo ON 2 (command reception allowed)	0x08
Power ON 2(main circuit charging)	0x02	magnetic pole position detected (Reserved)	0x09
Power ON 3(main circuit charged)	0x03	Emergency stop 1 (Forced Stop status)	0x0A
Servo ready	0x04	Emergency stop 2 (CNOTRDY)	0x0B
Prepared for magnetic pole position detection	0x05	Reserved	0x0C-0x0E
Power ON 4	0x06	Initial Operation	0x0F

## 7. Object Dictionary

### 0x2103: Warning Status

Index	0x2103	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] 0:no warning (without limitation) 1:during warning (under limitation)		Unsigned16	RO	Possible	0x0000



Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x02	Warning mask Selection [WARMSK] 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. After the AND operation of the Warning Monitor/ Mask, if flags are set, sets Warning status.	Unsigned16	RW	No	0x4E8D

## 7. Object Dictionary

### 0x2104: Actual Gain Monitor

Index	0x2104	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] 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 (30 /s)
			Setting range	0x0001-0x0BB8 (1 to 3000 /s)		
			Unit	1/s		
0x02	Actual Position Integral Time Constant [TPIMON] 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 (1000ms) proportional control
			Setting range	0x0003-0x2710 (0.3 to 1000 ms)		
			Unit	0.1ms		
0x03	Actual Velocity Loop Proportional Gain [KVPMON] 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 (50Hz)
			Setting range	0x0001-0x07D0 (1 to 2000 Hz)		
			Unit	Hz		
0x04	Actual Velocity Loop Integral Time Constant [TVIMON] 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 (20ms)
			Setting range	0x0003-0x2710 (0.3 to 1000 ms)		
			Unit	0.1ms		
0x05	Actual Load Inertia Moment Ratio [JRATMON] 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 (100%)
			Setting range	0x0000-0x3A98 (0 to 15000%)		
			Unit	%		
0x06	Actual Torque (force) Command Filter [TCFILMON] 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 (600Hz)
			Setting range	0x0001-0x07D0 (1 to 2000 Hz)		
			Unit	Hz		
0x07	Actual Model Control Gain [MKPMON] 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 (30 /s)
			Setting range	0x0001-0x0BB8 (1 to 3000 /s)		
			Unit	1/s		

### 0x2105: Z-phase Signal Base Actual Position

Index	0x2105	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] ◆ In the incremental encoder Indicates the position within one rotation based on C phase. The location increases to the direction of CCW seen head-on.  The unit is 1 Pulse/LSB, four-fold value of A·B phases. ✔ It is indefinite after the turning-on until C phase is detected. (Example: At the 1024P/Re encoder, 0 - 4095Pulse indicated) ◆ In the Absolute Encoder, Indicates the position within one rotation based on Absolute Position.		Unsigned32	RO	Possible	-
			Setting range	0x00000000-0xFFFFFFFF (0 to 4294967295 Pulse)		
			Unit	Pulse		

### 0x2106: Internal Velocity Command Monitor

Index	0x2106	Has the actual velocity value calculated from the position encoder. 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] An Internal Velocity Command Value after passing the Velocity Command low-pass filter.		Integer32	RO	Possible	-
			Setting range	0x80000000-0x7FFFFFFF (-2147483648 to 2147483647 pps)		
			Unit	Pulse/sec		

### 0x2107: Internal Torque (force) Command Monitor

Index	0x2107	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] 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 (-3276.8 to 3276.7 %)		
			Unit	0.1 %		

## 7. Object Dictionary

### 0x2108: Motor utilization monitor (Effective torque (force) estimate value)

Index	0x2108	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] Indicates the Effective Motor Torque (force) against the motor rated torque (force). ✓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 (0 to 65535 %)		
			Unit	%		
0x02	Fast Effective Torque (force) Estimate Value [ETRMS]  Indicates the Effective Motor Torque (force) of time constant (1/16) against TRMS. ✓Quick estimation is possible in applications where short-cycle operation patterns are repeated.		Unsigned16	RO	Possible	-
			Setting range	0x0000-0xFFFF (0 to 65535 %)		
			Unit	%		

### 0x2109: Temperature inside the servo amplifier

Index	0x2109	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] 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 (-32768 to 32767 °C)		
			Unit	°C		
	The value to be warning depends on 0x203D setting. If Monitor value <= -15 °C, +95 °C <= Monitor value, it indicates temperature alarm. Conversion to Fahrenheit (F) is calculated according to the following formula: $F = 9 / 5 * C + 32$ .					

### 0x210A: Regenerative resistor operation percentage monitor

Index	0x210A	An estimate monitor of the operation ratio of the servo amplifier regenerative resistor.	Object Code		Variable	
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Regenerative resistor operation percentage monitor [REGP]  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.  $PM (W) = 400^2 (V) / \text{regenerative resistance value (ohm)} \times \text{Regenerative resistor operation percentage (\%)} / 100(\%)$		Unsigned16	RO	Possible	0x0000 (0%)
			Setting range	0x0000-0xFFFF (0 to 655.35%)		
			Unit	0.01 %		

### 0x210B: Encoder Temperature Monitor

Index	0x210B	The temperature of an encoder is displayed.	Object Code		Variable	
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Encoder Temperature Monitor [ETEMP] The monitor value of the temperature of the encoder control board, shown in the unit of °C Celsius/LSB.		Integer16	RO	Possible	-
			Setting range	0xFF80 to 0x007F (-128 to 127 °C)		
			Unit	°C		
	<ul style="list-style-type: none"> <li>✓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.</li> <li>✓When the encoder temperature detection is set to disable (0x2000 bit13 = 1), it will not detect the temperature.</li> </ul>					

### 0x210C: Home Index Position Detection Value

Index	0x210C	Home Index Positions latched by various systems of homing modes.	Object Code		Variable	
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Home Index Position Detection Value [HOMEIDX] When homing activate and latched home index then indicates Internal position. For incremental system, internal position is based on counter value when control power on. For absolute system, internal position is based on absolute encoder value.		Integer32	RO	Possible	-
			Setting range	0x80000000-0x7FFFFFFF (-2147483648 to 2147483647Pulse)		
			Unit	Pulse		

### 0x210D: Position Synchronization Deviation Monitor

Index	0x210D	Position deviation between two synchronous connected amplifiers is monitored.	Object Code		Variable	
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Position Synchronization Deviation Monitor [PSYNDEV] When position synchronization correction function is valid, the monitor indicates error pulse quantity from position deviation of amplifiers which are subject to synchronization.		Integer32	RO	Possible	-
			Setting range	0x80000000-0x7FFFFFFF (-2147483648 to 2147483647 pulse)		
			Unit	Pulse		

## 7. Object Dictionary

### 0x2110: Internal Control Cycle Position Actual Value

Index	0x2110	Returns the Actual Position value latched every control cycle (125µs). Monitor unit is expressed by the resolution of the motor encoder used.	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 Position 1 Actual position of 0x6064, 125µs ago.		Integer32	RO	Possible	-
0x02	Internal Control Cycle Actual Position 2 Actual position of 0x6064, 250µs ago.		Integer32	RO	Possible	-
0x03	Internal Control Cycle Actual Position 3 Actual position of 0x6064, 375µs ago.		Integer32	RO	Possible	-
0x04	Internal Control Cycle Actual Position 4 Actual position of 0x6064, 500µs ago.		Integer32	RO	Possible	-
0x05	Internal Control Cycle Actual Position 5 Actual position of 0x6064, 625µs ago.		Integer32	RO	Possible	-
0x06	Internal Control Cycle Actual Position 6 Actual position of 0x6064, 750µs ago.		Integer32	RO	Possible	-
0x07	Internal Control Cycle Actual Position 7 Actual position of 0x6064, 875µs ago.		Integer32	RO	Possible	-
			Setting range	0x80000000-0x7FFFFFFF (-2147483648 to 2147483647 Pulse)		
			Unit	Pulse		

### 0x2111: Internal Control Cycle Actual Velocity

Index	0x2111	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 Actual velocity of 0x606C, 125µs ago.		Integer32	RO	Possible	-
0x02	Internal Control Cycle Actual Velocity 2 Actual velocity of 0x606C, 250µs ago.		Integer32	RO	Possible	-
0x03	Internal Control Cycle Actual Velocity 3 Actual velocity of 0x606C, 375µs ago.		Integer32	RO	Possible	-
0x04	Internal Control Cycle Actual Velocity 4 Actual velocity of 0x606C, 500µs ago.		Integer32	RO	Possible	-
0x05	Internal Control Cycle Actual Velocity 5 Actual velocity of 0x606C, 625µs ago.		Integer32	RO	Possible	-
0x06	Internal Control Cycle Actual Velocity 6 Actual velocity of 0x606C, 750µs ago.		Integer32	RO	Possible	-
0x07	Internal Control Cycle Actual Velocity 7 Actual velocity of 0x606C, 875µs ago.		Integer32	RO	Possible	-
			Setting range	0x80000000-0x7FFFFFFF (-2147483648 to 2147483647 pps)		
			Unit	Pulse/sec		

\*Data is filtered and the cutoff frequency is 250Hz.

### 0x2112: Internal Control Cycle Actual Torque (force)

Index	0x2112	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 Actual torque(force)position of 0x6077, 125µs ago.		Integer16	RO	Possible	-
0x02	Internal Control Cycle Actual Torque (force) 2 Actual torque(force) of 0x6077, 250µs ago.		Integer16	RO	Possible	-
0x03	Internal Control Cycle Actual Torque (force) 3 Actual torque(force) of 0x6077, 375µs ago.		Integer16	RO	Possible	-
0x04	Internal Control Cycle Actual Torque (force) 4 Actual torque(force) of 0x6077, 500µs ago.		Integer16	RO	Possible	-
0x05	Internal Control Cycle Actual Torque (force) 5 Actual torque(force) of 0x6077, 625µs ago.		Integer16	RO	Possible	-
0x06	Internal Control Cycle Actual Torque (force) 6 Actual torque(force) of 0x6077, 750µs ago.		Integer16	RO	Possible	-
0x07	Internal Control Cycle Actual Torque (force) 7 Actual torque(force) of 0x6077, 875µs ago.		Integer16	RO	Possible	-
			Setting range	0x8000-0x7FFF (-3276.8 to 3276.7%)		
			Unit	0.1%		

Monitor unit is the 1/1000 units of the rated torque (force) and 0.1% / LSB.

## 7. Object Dictionary

### 0x2116: Actual Velocity 2

Index	0x2116	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	Actual Velocity	[ACVMON2]	Integer32	RO	Possible	—
	<ul style="list-style-type: none"> <li>✓Filter is processed data, and cutoff frequency is 20Hz</li> </ul>		Setting range	0x80000000 to 0x7FFFFFFF (-2147483648 to 2147483647 pps)		
			Unit	Pulse/sec		

### 0x2117: Position Actual Value 2

Index	0x2117	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]	Integer32	RO	Possible	—
	Indicates the actual position without backlash correction value.		Setting range	0x80000000 to 0x7FFFFFFF (-2147483648 to 2147483647)		
	<ul style="list-style-type: none"> <li>◆With backlash correction Position Actual Value 2 =Position Actual Value (0x6064) - Backlash correction value (0x5091)</li> <li>◆Without backlash correction Position Actual Value 2 =Position Actual Value</li> </ul>		Unit	Pulse		

### 0x2118: Encoder monitor

Index	0x2118	Indicates the position in encoder.	Object Code		Variable	
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Number of entry		Unsigned8	RO	No	0x02
0x01	Encoder monitor	[EPMON]	Integer32	RO	Possible	—
	Indicates the position in motor encoder. This is the value before homing. Indication differs depending on encoder type.		Display range	0x80000000 to 0x7FFFFFFF (-2147483648 to 2147483647 Pulse)		
	<ul style="list-style-type: none"> <li>✓Combination encoder: incremental encoder It becomes zero at power on, and shows the value of 32bit-up/down free run counter that is multiplied 4 to A and B signals.</li> <li>✓Combination encoder: absolute encoder It shows the current position of encoder that includes multi turn data. For the single turn absolute encoder, it shows the current position of encoder within single turn.</li> </ul>		Unit	Pulse		
0x02	External encoder monitor	[EX_EPMON]	Integer32	RO	Possible	—
	Indicates the position in external encoder. This is the value before homing.		Display range	0x80000000 to 0x7FFFFFFF (-2147483648 to 2147483647 Pulse)		
	<ul style="list-style-type: none"> <li>It becomes zero at power on, and shows the value of 32bit-up/down free run counter that is multiplied 4 to A and B signals.</li> <li>✓This monitor is valid when 0x01 is set to 0x20F3.2 "Position Loop Control Encoder Selection". In use of Hall effect sensor with linear motor, it shows the data of Hall effect sensor.</li> </ul>		Unit	Pulse		

### 0x211F: Digital inputs (Short)

Index	0x211F	Indicates lower 16bit of the Digital inputs (0x60FD).	Object Code		Variable	
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Digital input monitor	[DINPUT16]	Unsigned16	RO	Possible	—
	Monitors input status.		Display range	0x0000 to 0xFFFF (0 to 65535)		
	Indicates the same content as lower 16bit of the Digital inputs (0x60FD). It shows state of EMR, Homem, PositiveLimit and NegativeLimit.		Unit	-		

## 7. Object Dictionary

### 0x2120: Amplifier Parameter Information

Index	0x2120	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. 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.					
0x02	Control status Indicate control by Since this amplifier is controlled by only the EtherCAT communication, values other than 1 cannot be set.		Unsigned8	RW	No	0x01
0x03	Amplifier operation time Indicate total power on time after shipping from factory in increments of 2 hours.		Unsigned32 Unit	RO	No	— 2 hour
0x04	External regenerative resistance Indicate recommended value of minimum external regenerative resistance.		Unsigned32 Setting range Unit	RW	Possible	※ 0x00000000 to 0xFFFFFFFF mΩ

※) Initial value varies addording to amplifier capacity.

### 0x2121: Production number

Index	0x2121	Indicates the production number of product.	Object Code			Variable
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Production number [Production number] Production number of servo amplifier at factory shipment is indicated. Production number is 10 digits. 12 15 02 1234 Month Year Date Production number		Visible String (Unsigned32)	RO	No	Character strings (-)

## 7. Object Dictionary

### 0x5010: Motor data

Index	0x5010	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	Phase inductance		Unsigned16	RO	Possible	0x0000
			Unit	μH		
0x04	Moment of inertia		Unsigned16	RO	Possible	0x0000
			Unit	gmm <sup>2</sup>		
0x05	Voltage constant for each phase		Unsigned32	RO	Possible	0x0000
			Unit	μVrms/min <sup>-1</sup>		
0x06	Rated torque		Unsigned16	RO	Possible	0x0000
			Unit	mN·m/Arms		
Support R series motor only. Disabled to Q series or previous motor.						

### 0x5040: Position Unit System

Index	0x5040	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 100% of full scale expression is applied in the value of the software. The display value is 1 (1bit) fixed.		Unsigned8	RO	Possible	0x01
0x02	Full-scale Unit Unit of full scale value. The display value is 1 (Encoder Count) fixed.		Unsigned16	RO	Possible	0x0001
0x03	Full-scale Data Type Indicates the data type to be used in the full scale value. The display value is 1 (Integer Type 32bit) fixed.		Unsigned16	RO	Possible	0x0001
0x04	Full-scale Unit Transforms into the actual unit. The display value is 1 (1bit) fixed.		Unsigned16	RO	Possible	0x0001

### 0x5041: Velocity Unit System

Index	0x5041	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 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 Unit of full scale value. The display value is 1 (pps) fixed.		Unsigned16	RO	Possible	0x0001
0x03	Full-scale Data Type Indicates the data type to be used in the full scale value. The display value is 1 (Integer Type 32bit) fixed.		Unsigned16	RO	Possible	0x0001
0x04	Full-scale Value Transforms into the actual unit. The display value is 1 (pps) fixed.		Unsigned16	RO	Possible	0x0001

### 0x5042: Acceleration Unit System

Index	0x5042	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 100% of full scale expression is applied in the value of the software. The display value is 1 (pps <sup>2</sup> ) fixed.		Unsigned8	RO	Possible	0x01
0x02	Full-scale Unit Unit of full scale value. The display value is 1 (pps <sup>2</sup> ) fixed.		Unsigned16	RO	Possible	0x0001
0x03	Full-scale Data Type Indicates the data type to be used in the full scale value. The display value is 1 (Integer Type 32bit) fixed.		Unsigned16	RO	Possible	0x0001
0x04	Full-scale Value Transforms into the actual unit. The display value is 1 (pps <sup>2</sup> ) fixed.		Unsigned16	RO	Possible	0x0001

# 8

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## 8. Operations

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## 8.1 Standard Setting Value upon Shipment

The system parameters setting value upon shipment from the factory is shown below.

■ Servo Amplifier Model Number: RS2O##A△H□

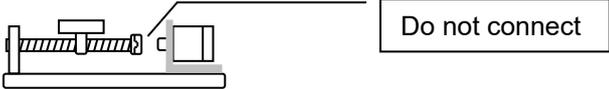
ID	Name	Code	Setting Value	Object
00	Main Circuit Power Input Classification	○: A ○: E ○: K ○: J	200VAC input 00 : _AC_3-Phase 100VAC input 01 : _AC_Single-Phase 48VDC input 02 : DC 24VDC input 02 : DC	0x20FD.1:MPWRIN
01	Regenerative Resistance Selection	□: A □: L	With resistor 01 : Built-in_R Without resistor 02 : External_R	0x20FD.2:RGKIND
02	Motor Code	##: 01 ##: 03 ##: 05 ##: 10 ##: 15 ##: 30 ##: 01 ##: 03 ##: 02 ##: 04	200VAC input 015A : 0x0181 (R2AA04003F) 030A : 0x0186 (R2AA06040F) 050A : 0x018D (R2AA13120D) 100A : 0x0190 (R2AA13200D) 150A : 0x011D (R2AA18350D) 300A : 0x011F (R2AA18550H) 100VAC input 015A : 0x0198 (R2EA04005F) 030A : 0x019B (R2EA06020F) 48VDC input 025A : 0x040C (R2GAD102RM) 040A : 0x0261 (R2GA04003F)	0x20FE.0:MOCODE
03	Encoder Division Number Code	△: 2 △: A	Absolute : 0x0006(131,072FMT) Incremental : 0x0005(2,000P/R)	0x20FF.1:ENCODE
04	Encoder Classification Code	△: 2 △: A	Absolute: 0x0300 (Asynchronous Communication 2.5MHz High-rotation backup method) Incremental: 0x0000 (Wiring-saving Incremental Encoder)	0x20FF.2:ENTYPE
07	Position Control Selection	-	00:Standard	0x20F3.0:PCNTSEL

\* Please confirm with separate volume M0010842 for operation methods of Setup Software

## 8.2 Test operation

### 1) Installation and Wiring

Confirm the installation and wiring of the servo amplifier and servo motor.

Process	Items and Contents
1	<p>Installation</p> <ul style="list-style-type: none"> <li>■ 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.</li> </ul> 
2	<p>Wiring / Connecting → Input Power</p> <ul style="list-style-type: none"> <li>■ Power supply wire, servo motor and host device, however, do not connect CN0 (Port 0) / CN1 (Port 1) to servo amplifier after wiring.</li> <li>■ 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 11)”.</li> <li>■ When 7 segment LED does not light “≡” through main circuit power input, take appropriate measures based on “Troubleshooting (Chapter 11)”.</li> </ul>

### 2) Safe Torque OFF Function

When using a product that corresponds to the Safe Torque OFF function, please check the function followed with a Confirmation Test (Chapter 13) to verify normal operation.

3) Movement Confirmation

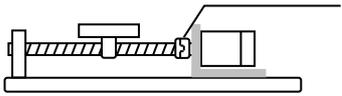
Perform JOG operations using Setup Software or Digital Operator.

Process	Items and Contents																																
1	Input signal check: Generic Input signals (CN2)																																
	<ul style="list-style-type: none"> <li>■ Select Input signals to be used from General parameter Group9 and assign in CONT1, and CONT2.</li> </ul>																																
	<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th colspan="2"></th> <th colspan="2" style="text-align: center;">Factory Shipment Setting Value</th> </tr> <tr> <th style="width: 25%;">Input Signal</th> <th style="width: 25%;">CN2 Pin No.</th> <th style="width: 25%;">Setting Value</th> <th style="width: 25%;"></th> </tr> </thead> <tbody> <tr> <td>CONT1</td> <td>3, 4</td> <td>00:Always_Disable</td> <td></td> </tr> <tr> <td>CONT2</td> <td>5, 6</td> <td>00:Always_Disable</td> <td></td> </tr> <tr> <td>CONT3</td> <td>7, 8</td> <td>00:Always_Disable</td> <td></td> </tr> <tr> <td>CONT4</td> <td>9, 10</td> <td>00:Always_Disable</td> <td></td> </tr> <tr> <td>CONT5</td> <td>11, 12</td> <td>00:Always_Disable</td> <td></td> </tr> <tr> <td>CONT6</td> <td>14, 15</td> <td>00:Always_Disable</td> <td></td> </tr> </tbody> </table>			Factory Shipment Setting Value		Input Signal	CN2 Pin No.	Setting Value		CONT1	3, 4	00:Always_Disable		CONT2	5, 6	00:Always_Disable		CONT3	7, 8	00:Always_Disable		CONT4	9, 10	00:Always_Disable		CONT5	11, 12	00:Always_Disable		CONT6	14, 15	00:Always_Disable	
			Factory Shipment Setting Value																														
	Input Signal	CN2 Pin No.	Setting Value																														
	CONT1	3, 4	00:Always_Disable																														
	CONT2	5, 6	00:Always_Disable																														
CONT3	7, 8	00:Always_Disable																															
CONT4	9, 10	00:Always_Disable																															
CONT5	11, 12	00:Always_Disable																															
CONT6	14, 15	00:Always_Disable																															
* The factory default gives no assignment function to the general signal.																																	
2	Output signal check: Generic Output signals (CN3)																																
	<ul style="list-style-type: none"> <li>■ Select Output signals to be used from General parameter Group9 and assign in OUT1, and OUT2.</li> </ul>																																
	<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th colspan="2"></th> <th colspan="2" style="text-align: center;">Factory Shipment Setting Value</th> </tr> <tr> <th style="width: 25%;">Output Signal</th> <th style="width: 25%;">CN2 Pin No</th> <th style="width: 25%;">Setting Value</th> <th style="width: 25%;">Object: Index, Sub-index</th> </tr> </thead> <tbody> <tr> <td>OUT1</td> <td>16, 17</td> <td>42:FOUT1_ON</td> <td>0x20F9,0x01 (OUT1)</td> </tr> <tr> <td>OUT2</td> <td>18, 19</td> <td>44:FOUT2_ON</td> <td>0x20F9,0x01 (OUT2)</td> </tr> </tbody> </table>			Factory Shipment Setting Value		Output Signal	CN2 Pin No	Setting Value	Object: Index, Sub-index	OUT1	16, 17	42:FOUT1_ON	0x20F9,0x01 (OUT1)	OUT2	18, 19	44:FOUT2_ON	0x20F9,0x01 (OUT2)																
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OUT1	16, 17	42:FOUT1_ON	0x20F9,0x01 (OUT1)																														
OUT2	18, 19	44:FOUT2_ON	0x20F9,0x01 (OUT2)																														
3	Input/Output Signal Check																																
	<ul style="list-style-type: none"> <li>■ Check that the set Input/Output signals are functioning normally with the monitor. Refer to "Monitor Functions (chapter 10)" for monitor explanation.</li> <li>◆ Check using Setup Software with monitor in menu. Read separate manual M0010842 for Setup Software operations.</li> <li>◆ When checking with "Digital Operator" Refer to "Section 10.6 Trial operation for digital opeartot operation method.</li> </ul>																																

4	JOG Operation (Input Servo ON signal)	
	<ul style="list-style-type: none"> <li>■ Performs JOG operation without connection motor shaft to machine under disengaged condition.</li> <li>■ Check that servo motor rotates in both Forward and Inverse directions.</li> <li>■ Rotation direction of JOG operation is reverse to the one if communication on EtherCAT.                             <ul style="list-style-type: none"> <li>◆ Operating with "Setup Software" Select JOG operation from Test Run in menu. Read separate manual M0010842 for Setup Software operations.</li> <li>◆ Checking and Setting method with "Digital Operator" Refer to "Section 10.6 Test operation for digital operator operation method."</li> </ul> </li> </ul>	
	<ul style="list-style-type: none"> <li>■ Input Servo ON signal. Confirm that motor excitation and Digital Operator display on the front of the servo amplifier shows the "8" shape.</li> </ul> <p>The following display indicates servo-on state.</p>	
		<ul style="list-style-type: none"> <li>• Servo-on state</li> <li>"8" is indicated continuously.</li> </ul>
<p>The following display indicates forward/ reverse rotation limit state.</p>		
	Forward rotation side limit state. Forward rotation side over travel state in position and velocity control form.	
	Inverse rotation side limit state. Inverse rotation side over travel state in position and velocity control form.	
<ul style="list-style-type: none"> <li>■ Setting for the limit switch function can be changed in general parameter Group9 ID00, ID01.</li> </ul>		

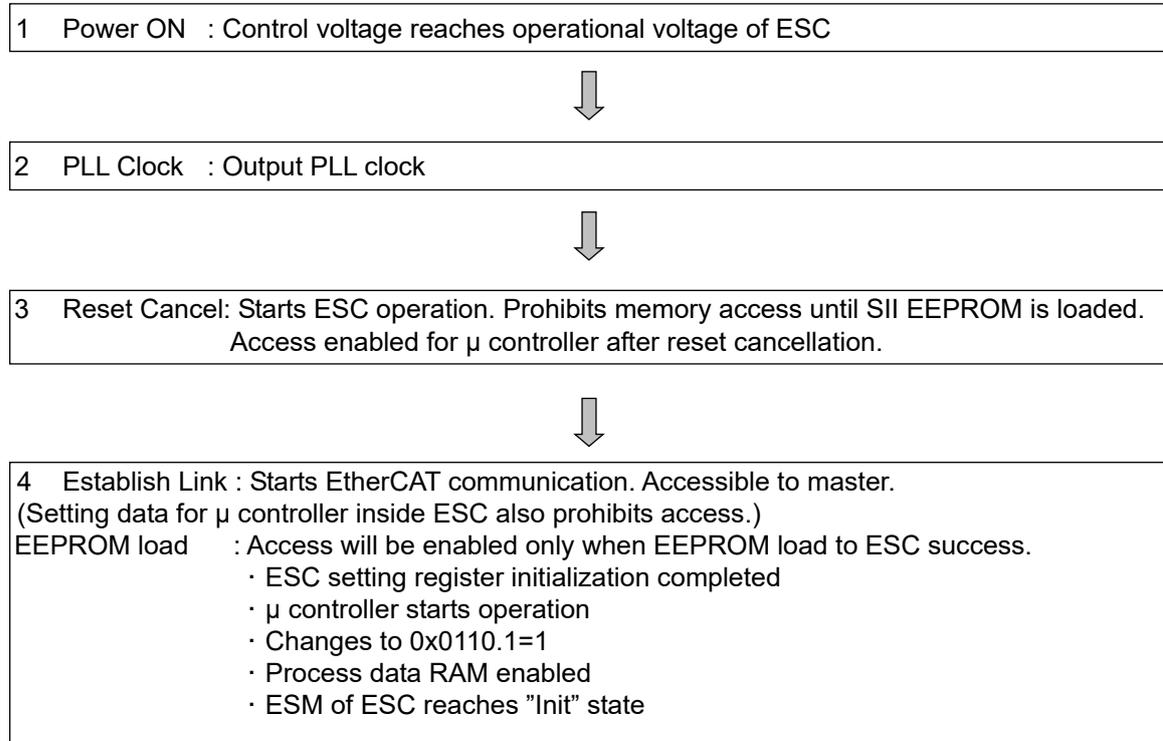
4) Machine Movement Check

Connect servo motor shaft to machine and check movement.

Process	Items and Contents	
1	Connect to machine	
	<ul style="list-style-type: none"> <li>■ Connect motor shaft to machine.</li> </ul> <div style="display: flex; align-items: center; margin: 10px 0;">  <div style="border: 1px solid black; padding: 5px; margin-left: 20px;">Connect servo motor shaft to machine.</div> </div> <ul style="list-style-type: none"> <li>■ 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.</li> <li>■ Be prepared to stop immediately in case of abnormal movement.</li> </ul>	
2	Operation	
	<ul style="list-style-type: none"> <li>■ Input commands of actual operation patterns and operate machine.</li> <li>■ 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.</li> </ul>	
3	Power OFF	Turn OFF power after turning OFF Servo ON signal.

### 8.3 ESC Power ON Sequence

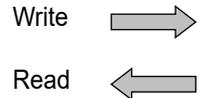
Shows RS2 EtherCAT slave amplifier power ON sequence at input of control power supply.



ESC Power ON Sequence

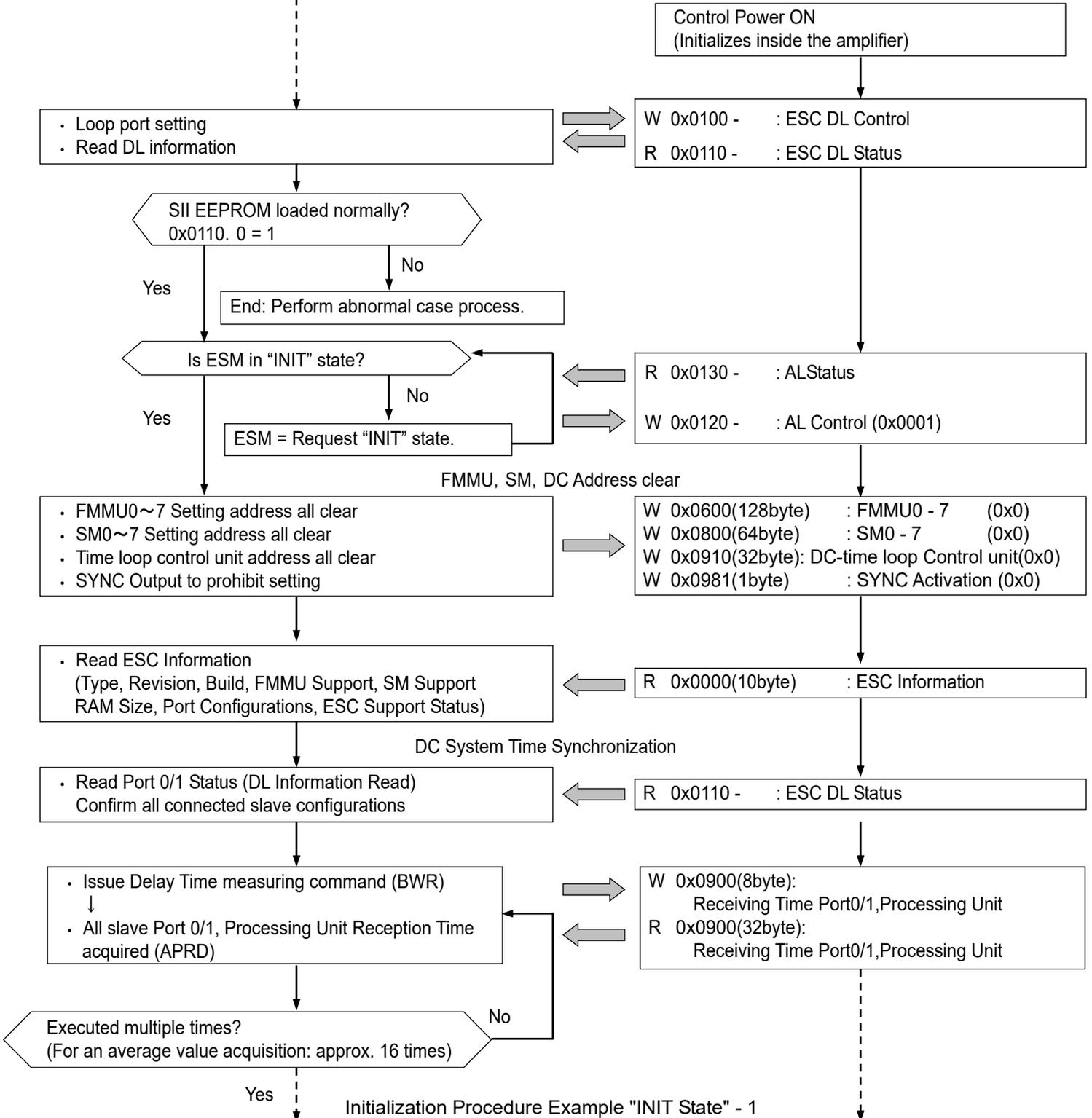
### 8.4 EtherCAT Initialization Process

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:

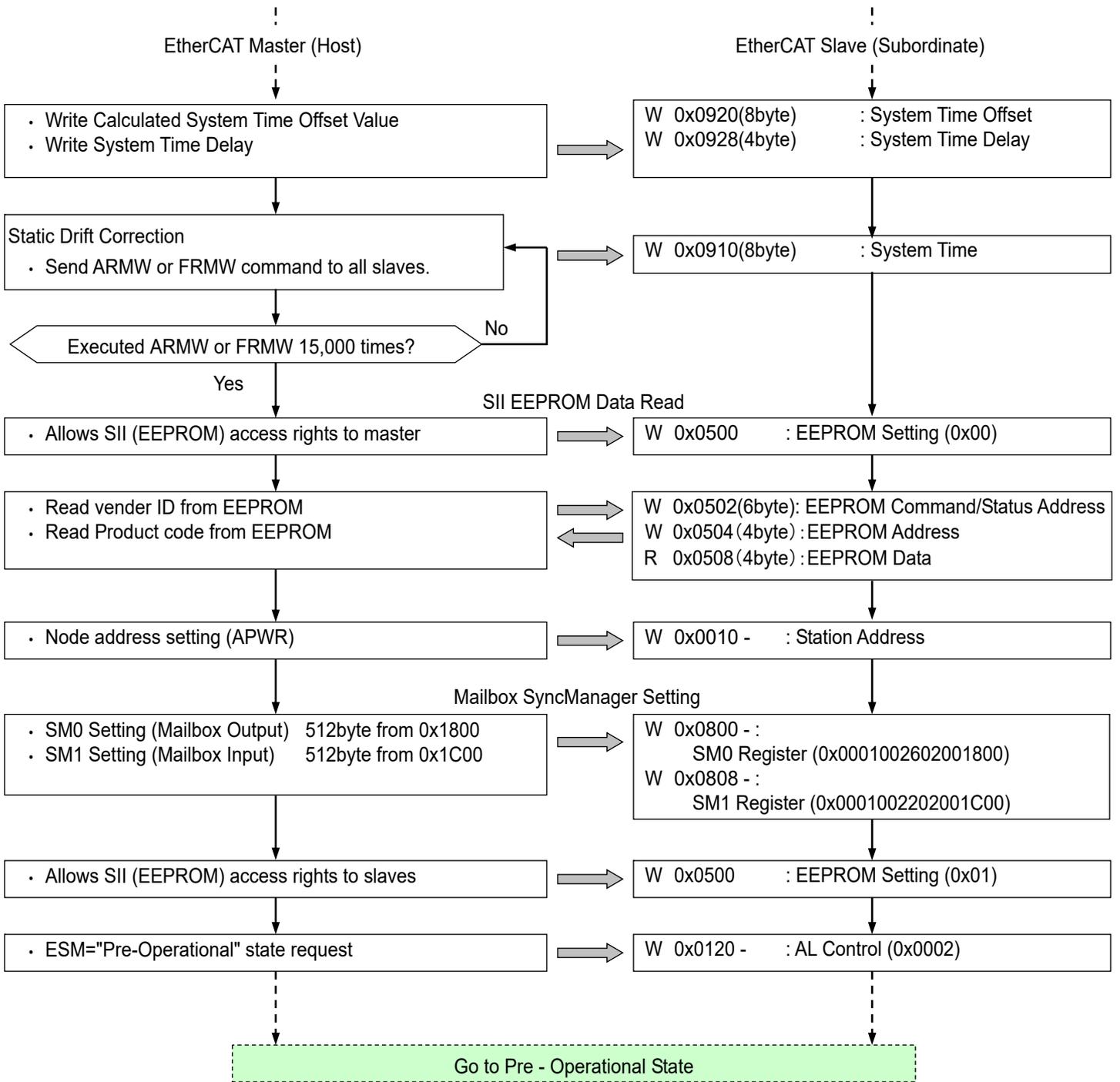


#### 1) INIT State EtherCAT Master (Host)

#### EtherCAT Slave (Subordinate)

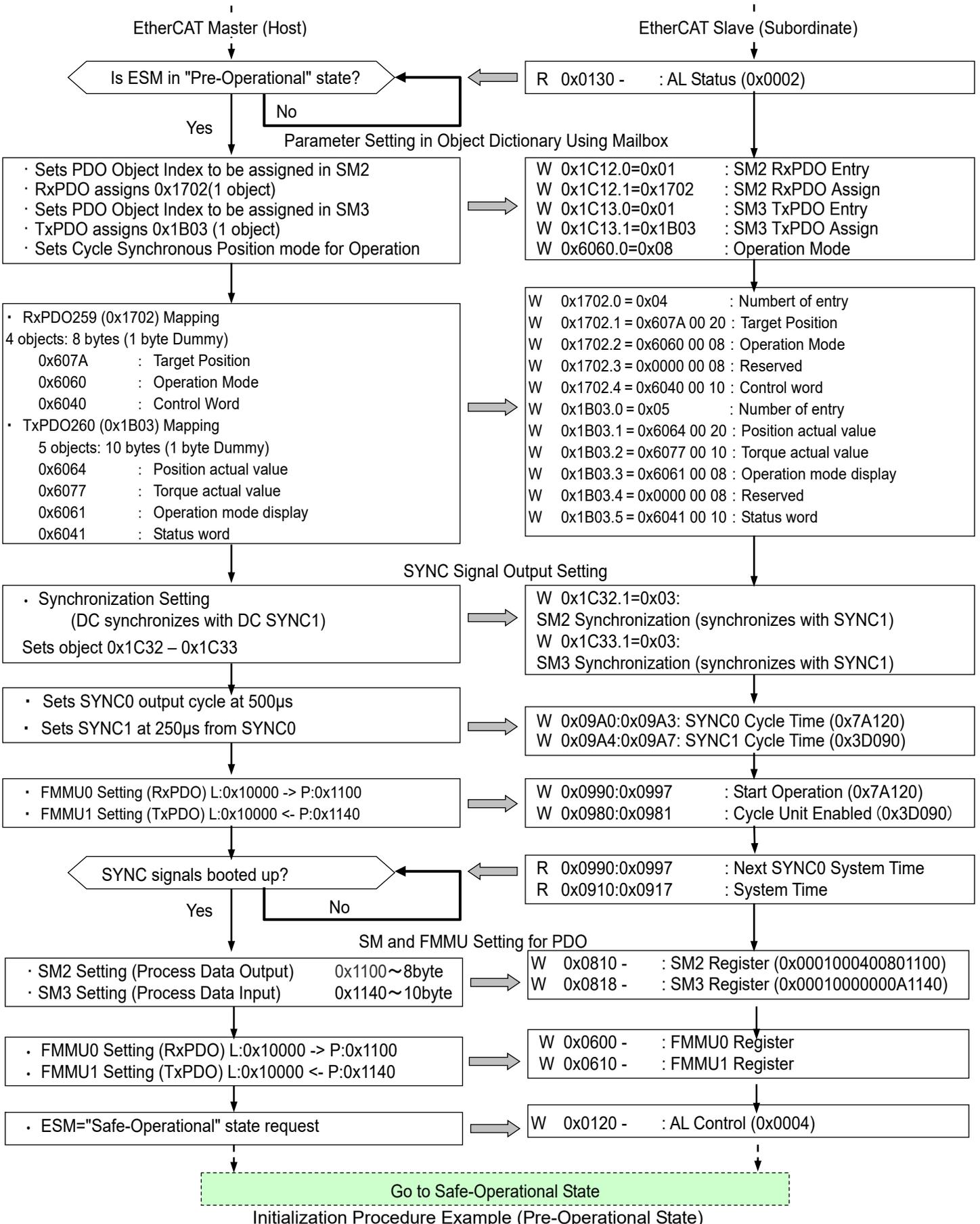


Initialization Procedure Example "INIT State" - 1

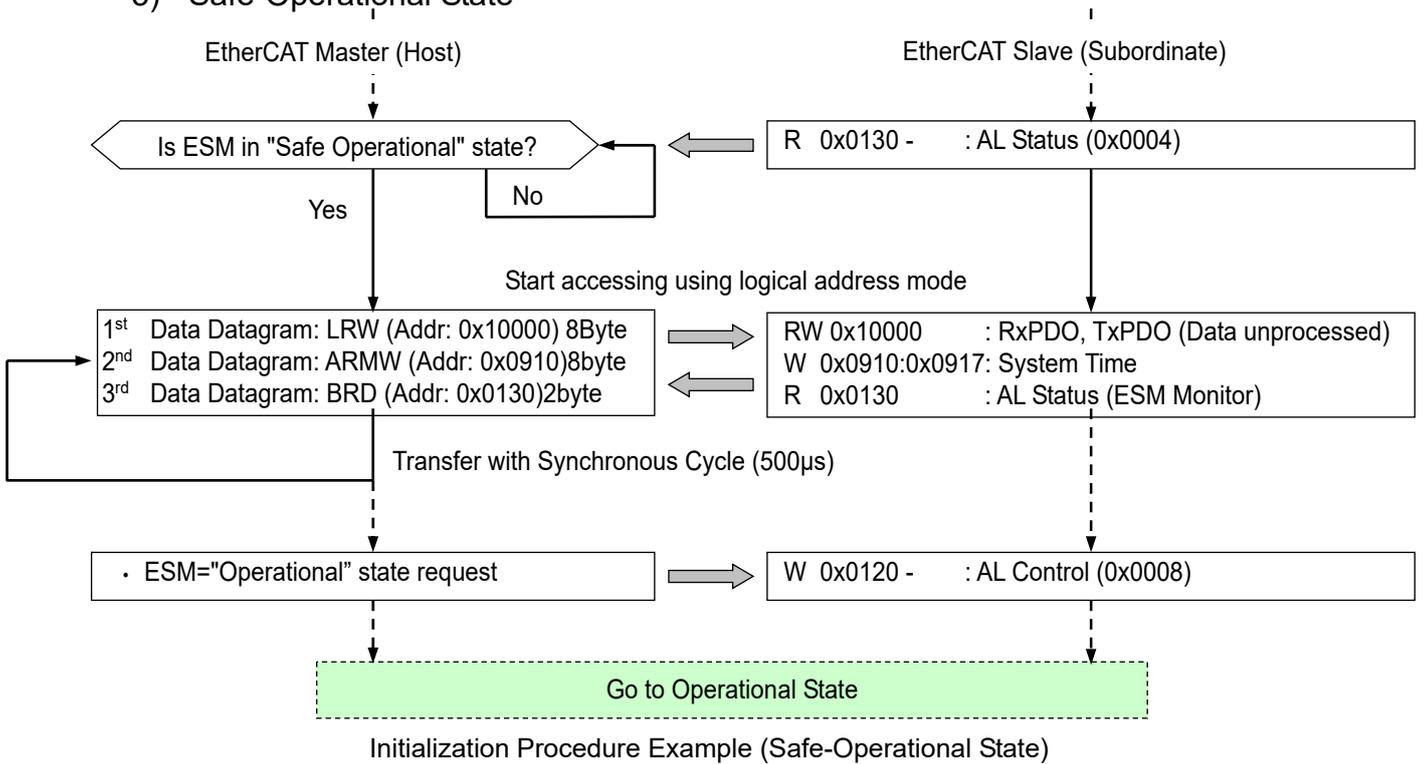


Initialization Procedure Example "INIT State" -2

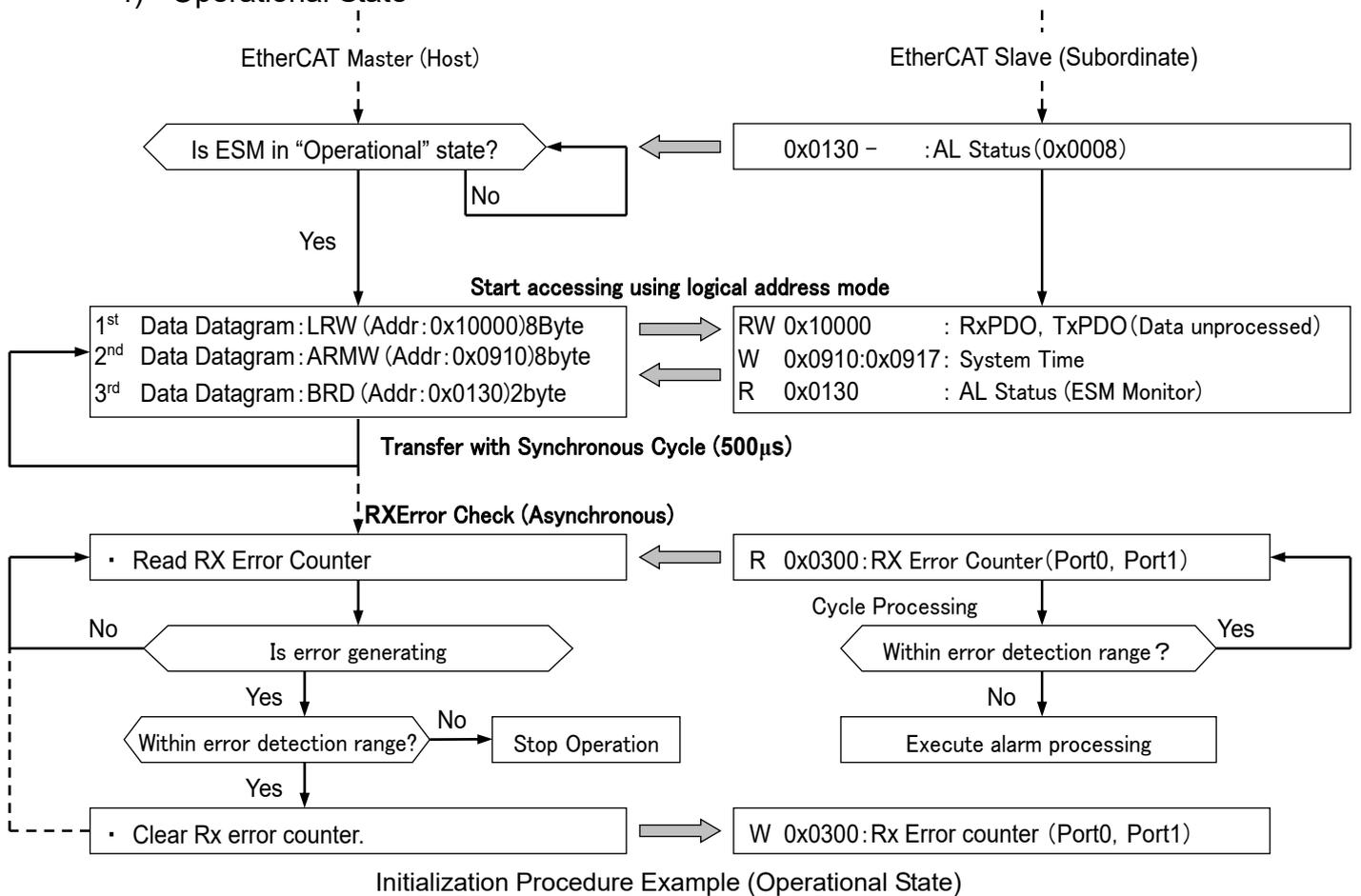
2) Pre-Operational State



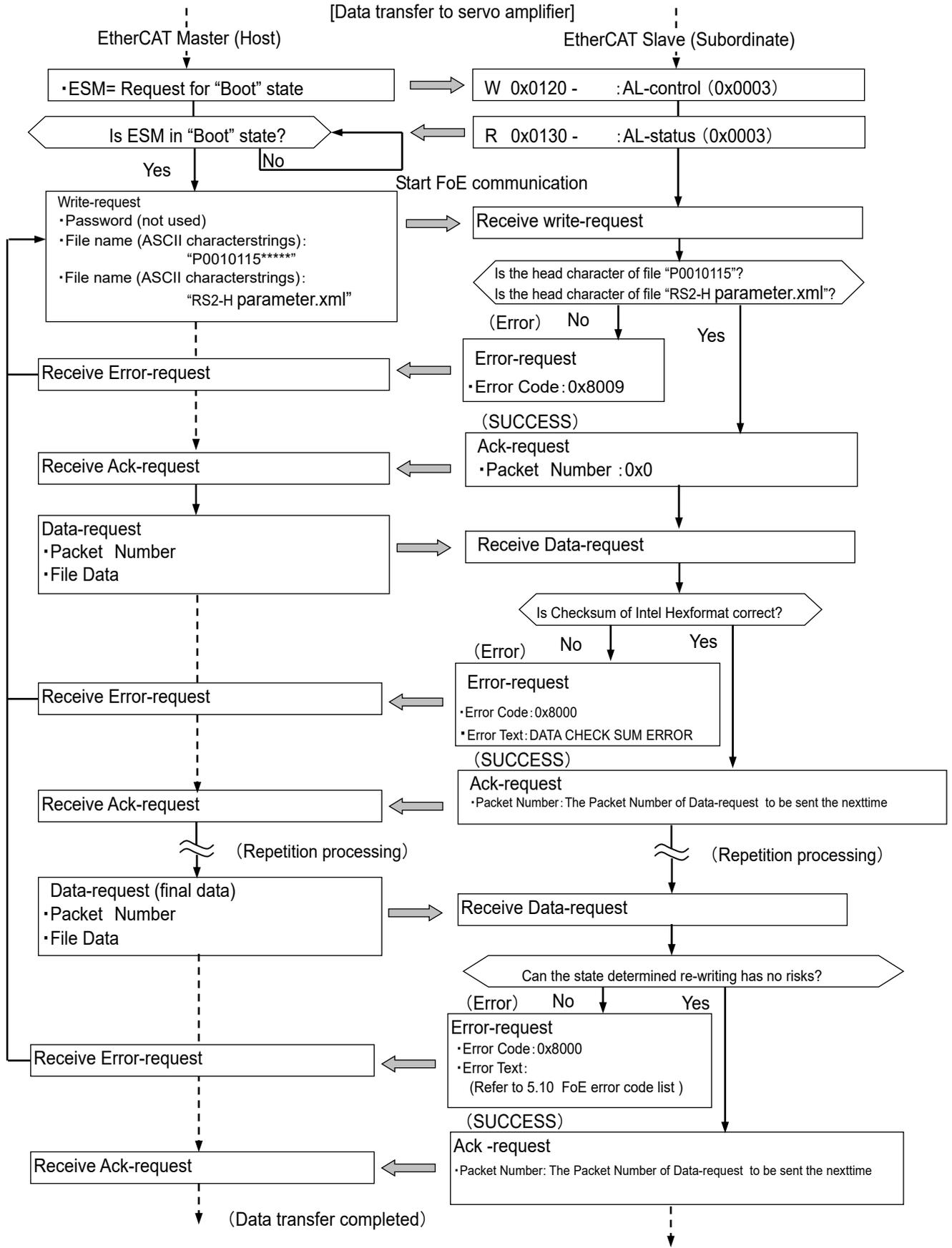
3) Safe-Operational State

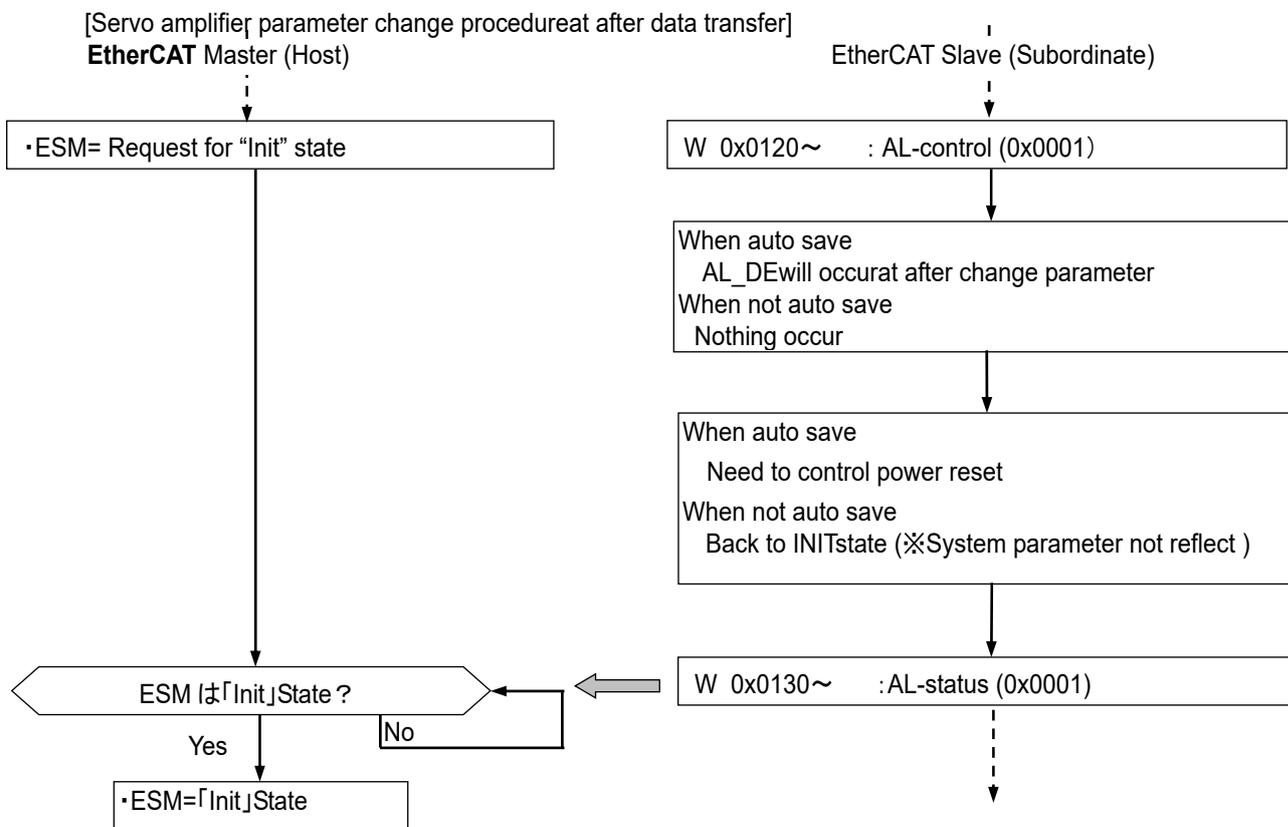
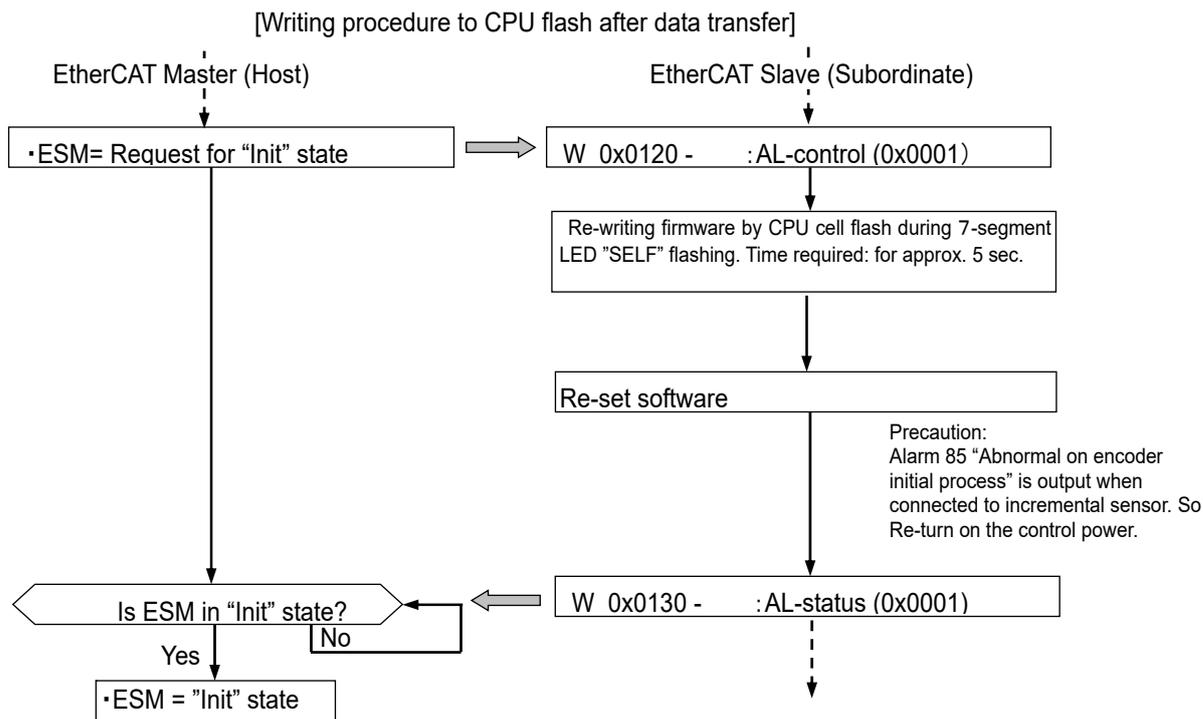


4) Operational State

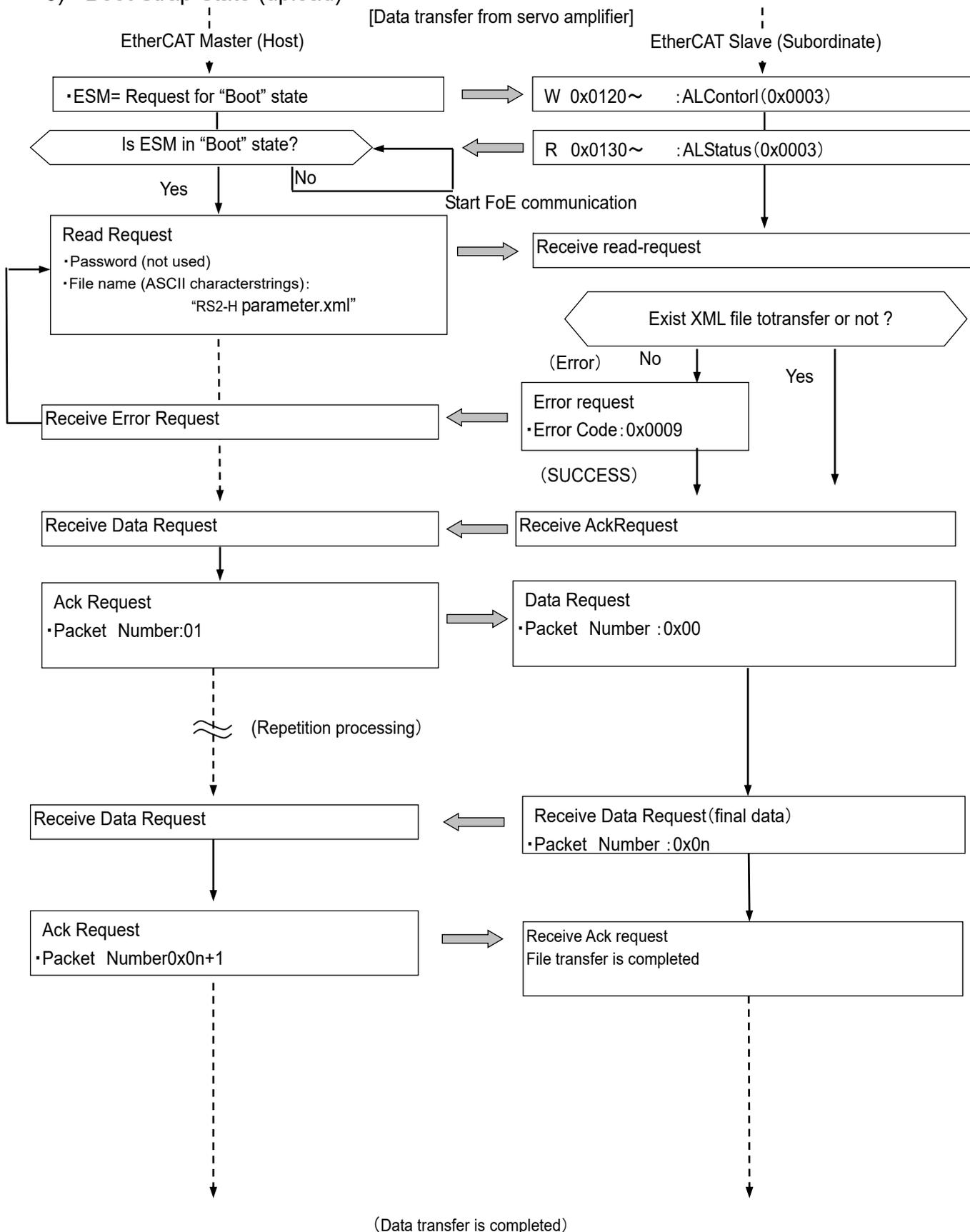


5) Boot Strap state





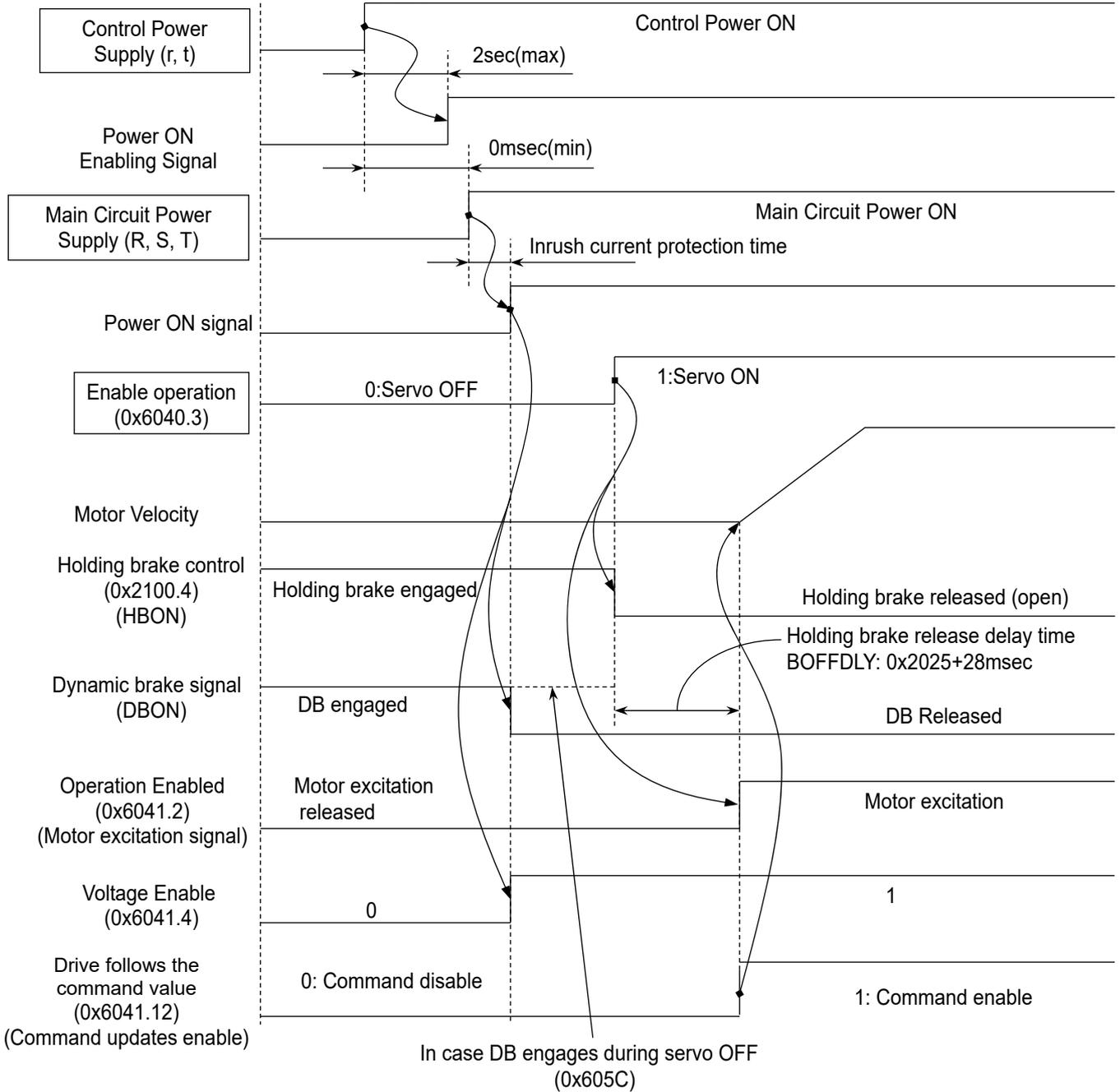
6) Boot Strap State (upload)



### 8.5 Operation Sequence

#### 1) Operation Sequence from Power ON to Power OFF

##### ■ Power ON → Servo ON



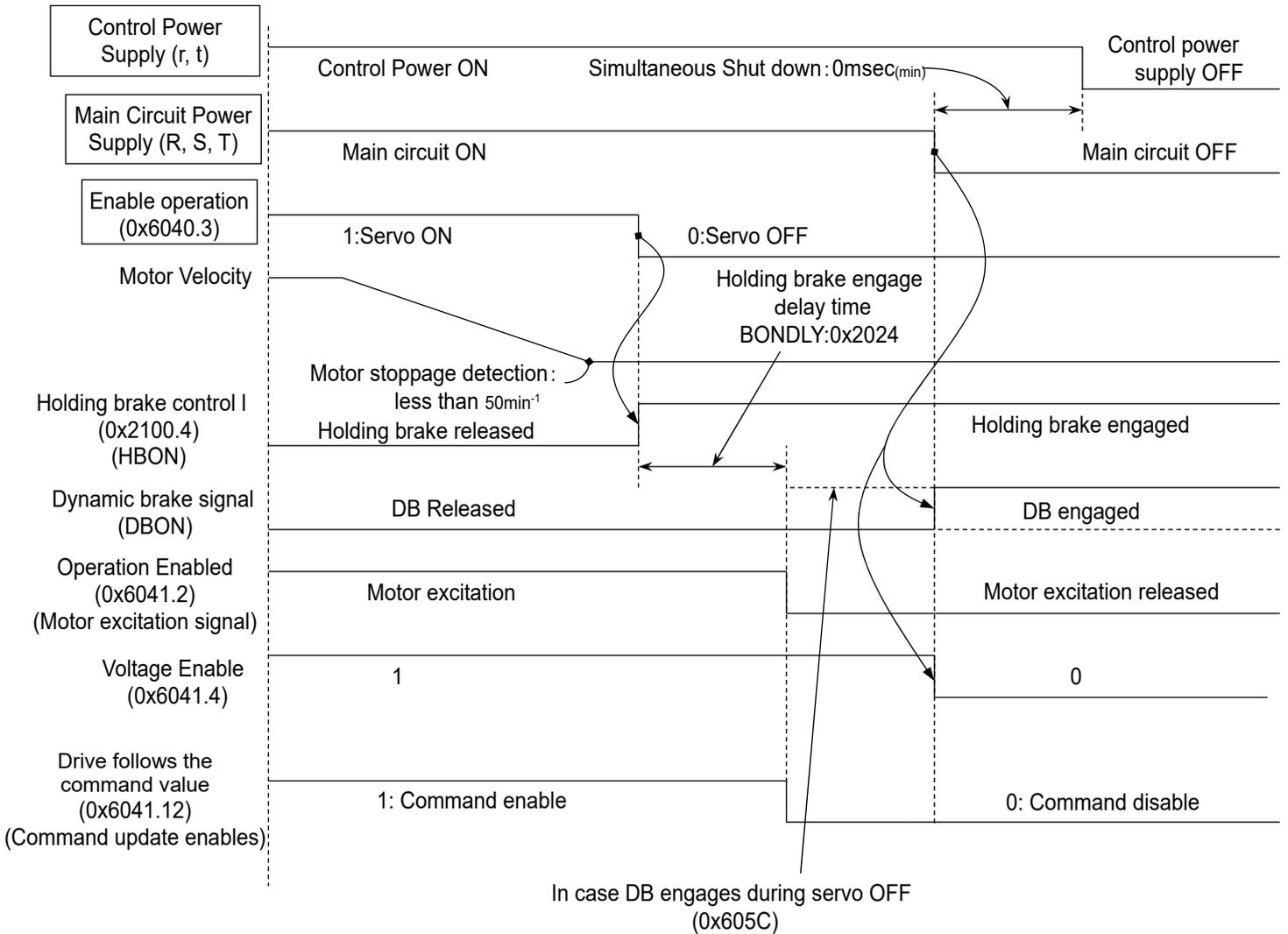
The frequency of powering the servo amplifier ON/OFF must be less than 5 times/H and 30 times/day. In addition, the intervals between Power ON/OFF must be longer than 10 minutes.

Inrush current suppression times of each servo amplifier size are as follows:

Servo amplifier size	Inrush current suppression time
RS2A01#	400[ms]
RS2A03#	400[ms]
RS2A05#	900[ms]
RS2A10#	1400[ms]
RS2A15#	1400[ms]
RS2A30#	1900[ms]
RS2K/J	100[ms]

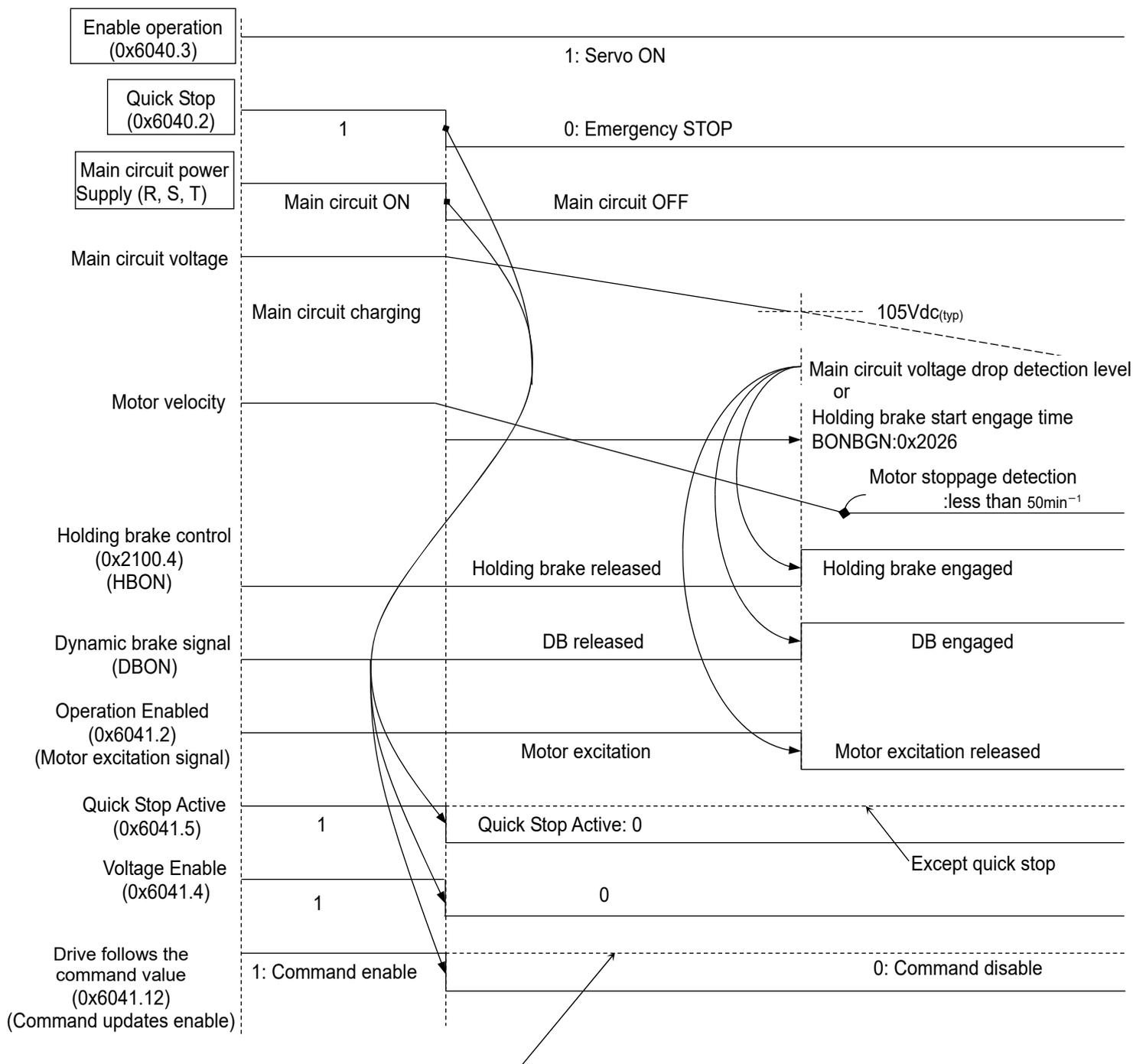
■ Servo OFF → Power OFF

Sequence in case of Servo OFF during motor rotation depends on Disable Option Code (0x605C) setting.



■ Main Circuit OFF, Quick STOP (Emergency STOP) Sequence

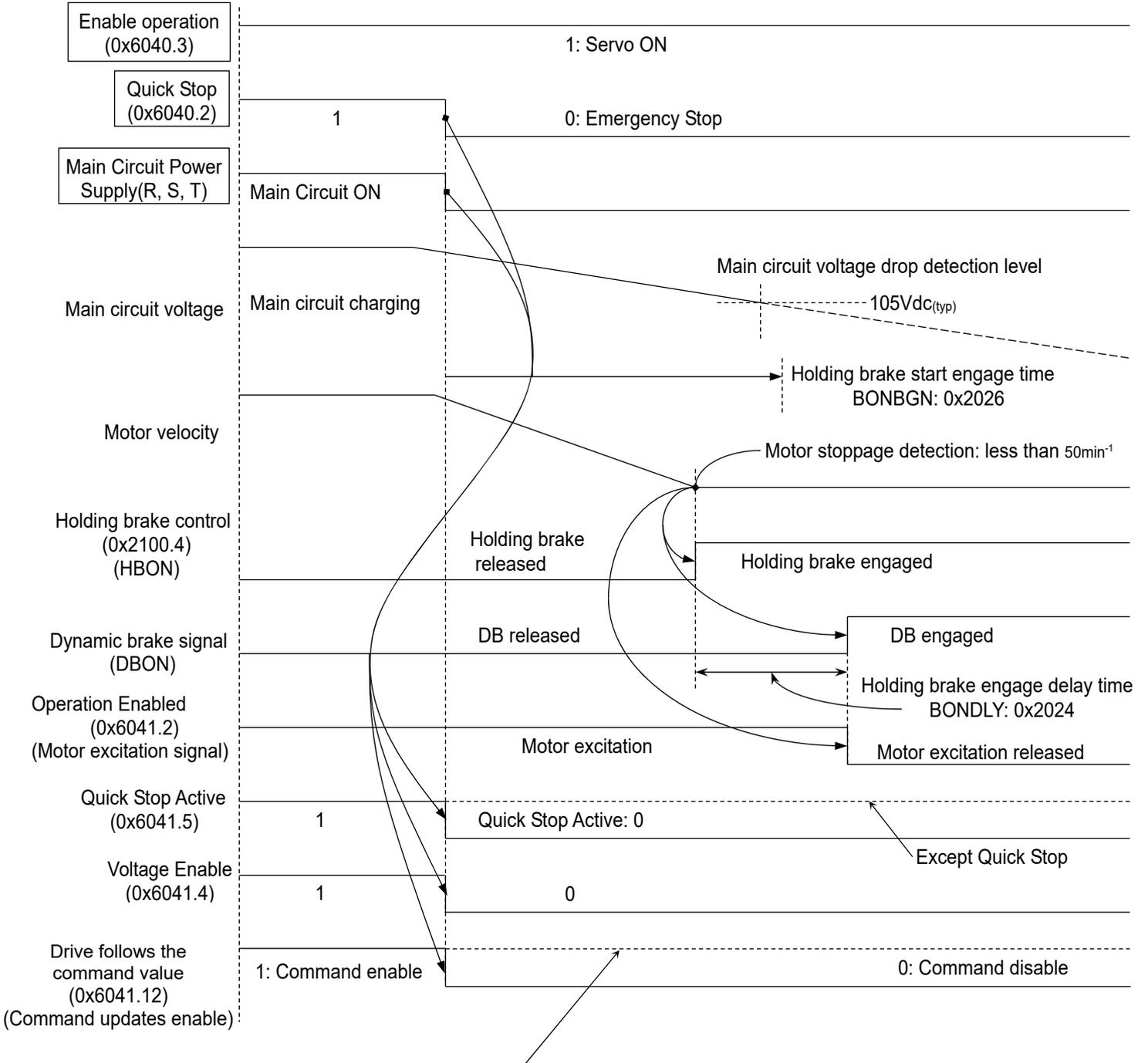
1. When motor did not stop with the setting value of the holding brake engage starting time, or main circuit voltage drop is detected



In the quick stop, "Drive follows the command value (Command updates enable)" becomes command invalid by release of the quick stop signal.

■ 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



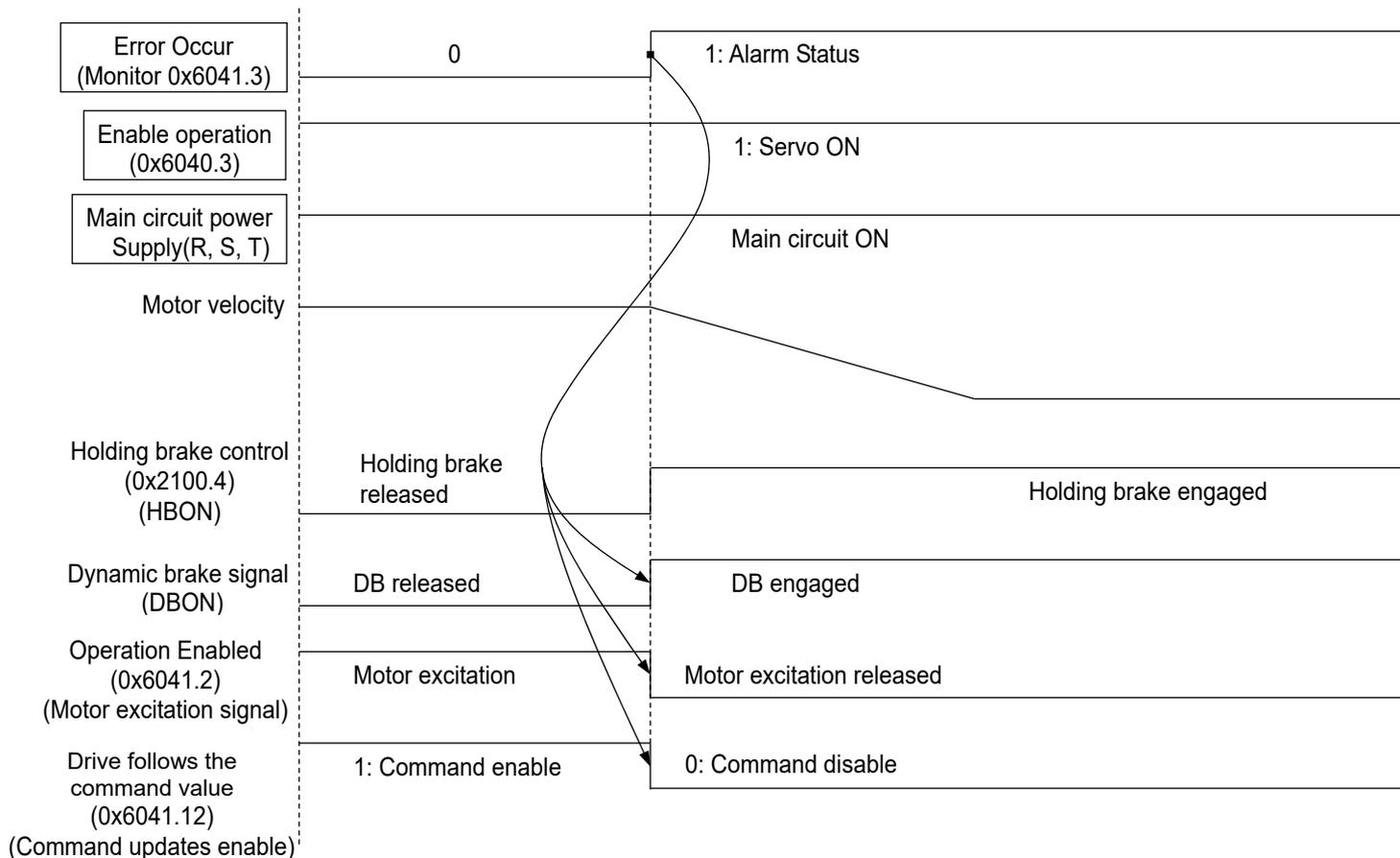
In the quick stop, "Drive follows the command value (Command updates enable)" becomes command invalid by release of the quick stop signal.

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)

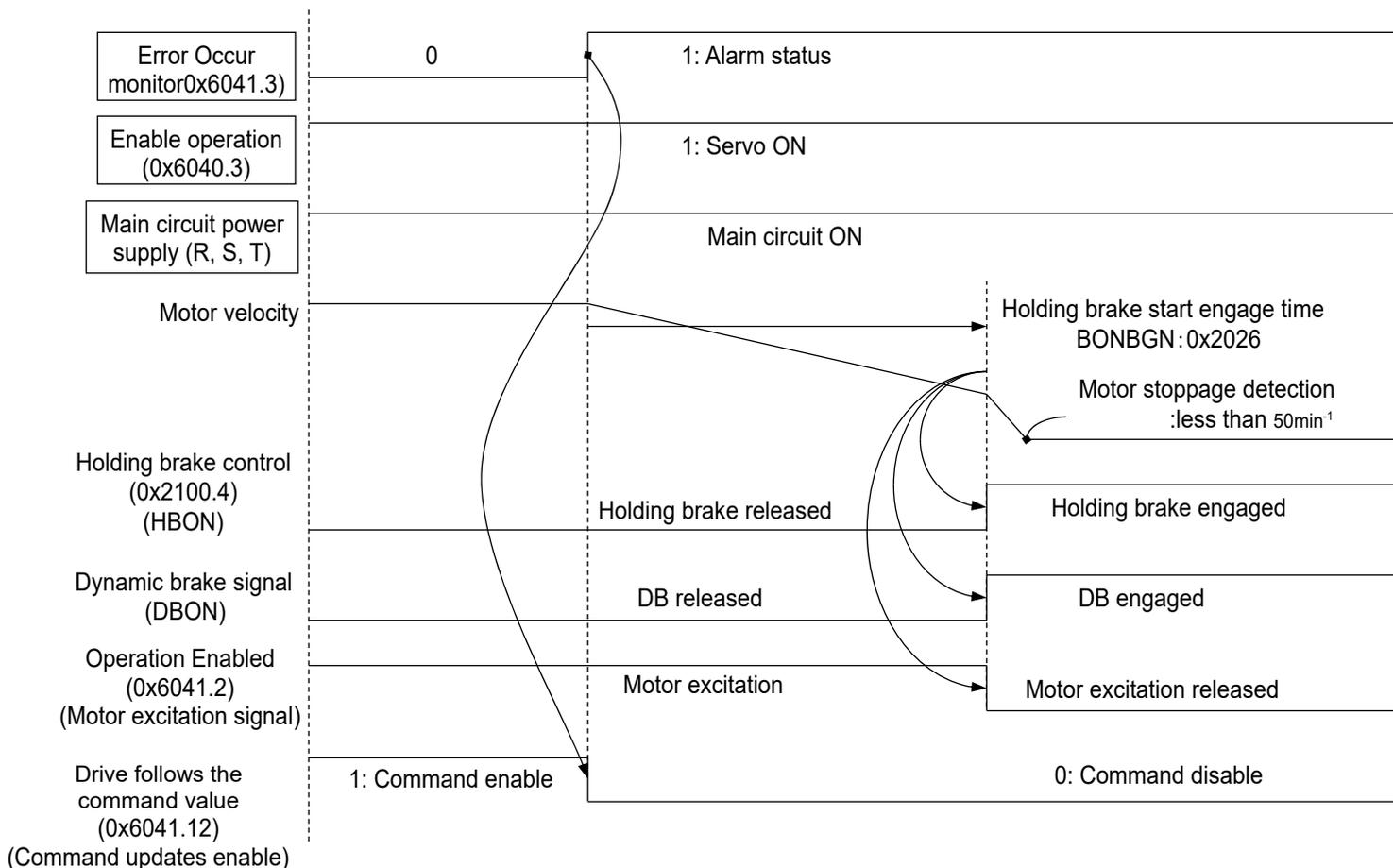
The stop method can be selected with Quick Stop option code (0x605A) for alarms that can be stopped with the servo brake. Please refer to “Alarm Display List (11-3)” for details.

■ Stop Sequence with Dynamic brake at Alarm Occurrence



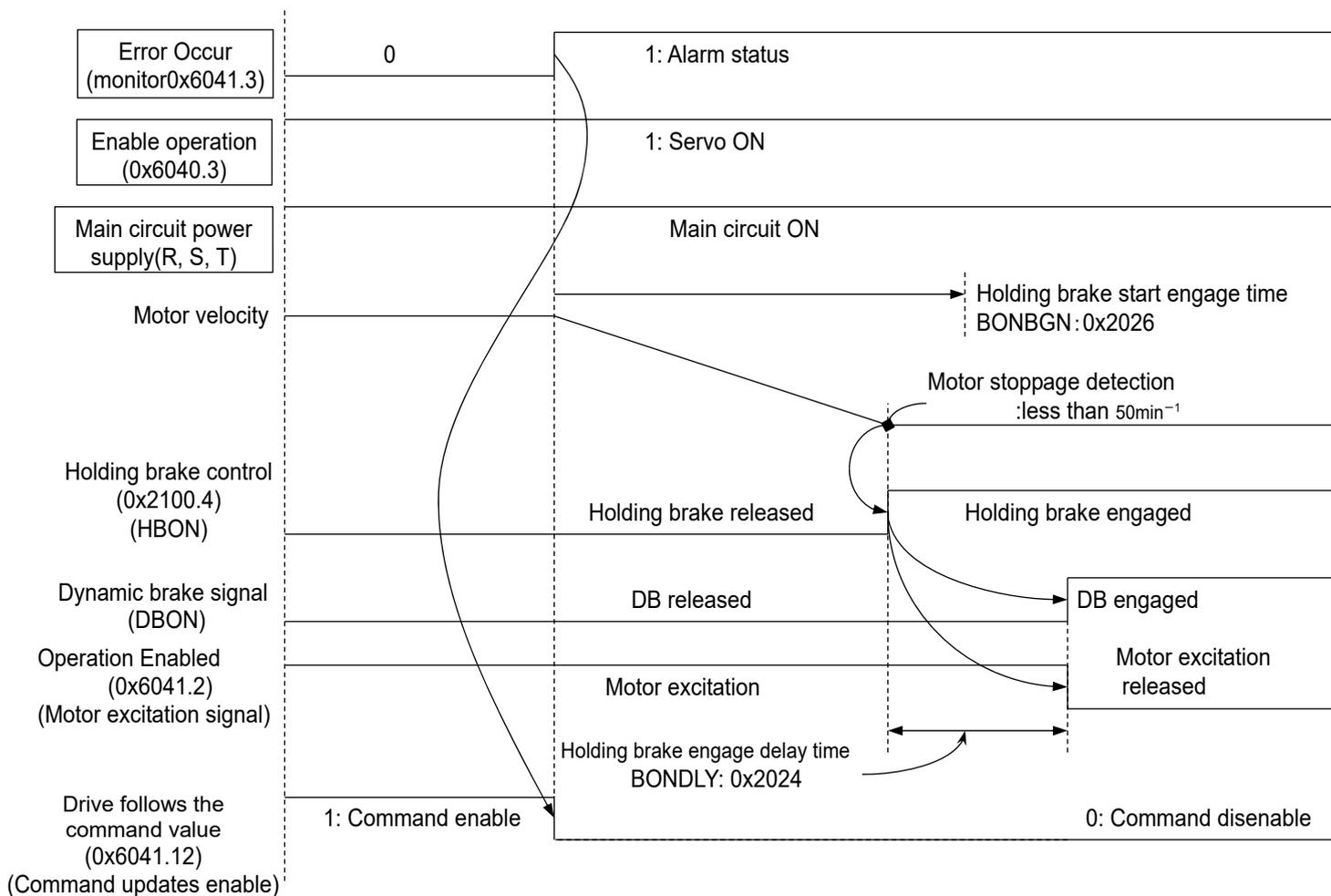
■ Stop Sequence with Servo Stop (Fault Reaction code) at Alarm Occurrence

1. When a motor does not stop with the setting value of holding brake engage start time



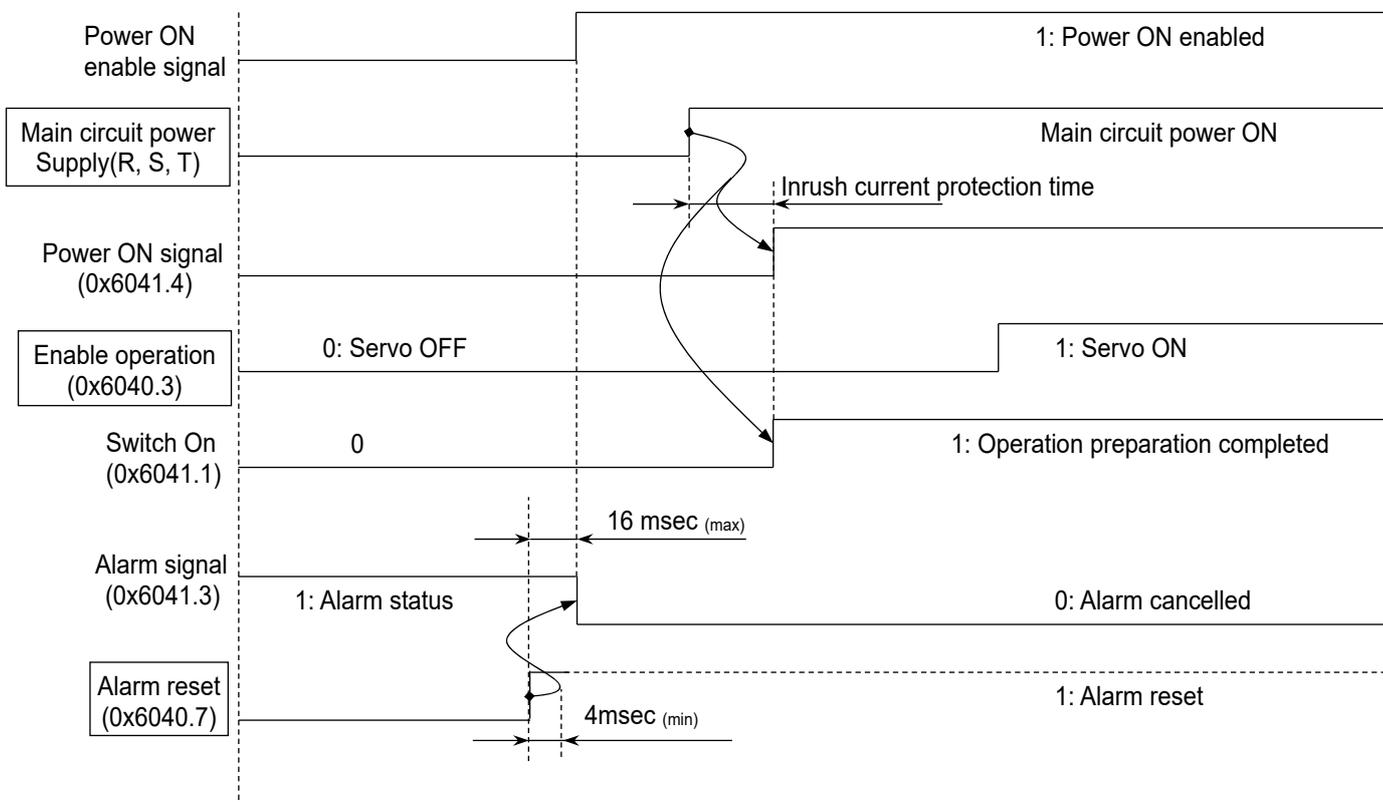
■ Stop Sequence with Servo Stop (Quick Stop option code) at Alarm Occurrence

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 controller (with control word).



- \* 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.
- \* For alarm reset (0x6040.7), reset signal shall be set 4 ms or more.

### 8.6 SEMI F47 Support Functions

This is a function used to limit motor output current by detecting control power sag warning when momentary power interruptions of the control power supply (drop to AC135V - AC152V) are detected. This is provided as a support function of “SEMI F47 Standard” required for semiconductor manufacturing equipment.

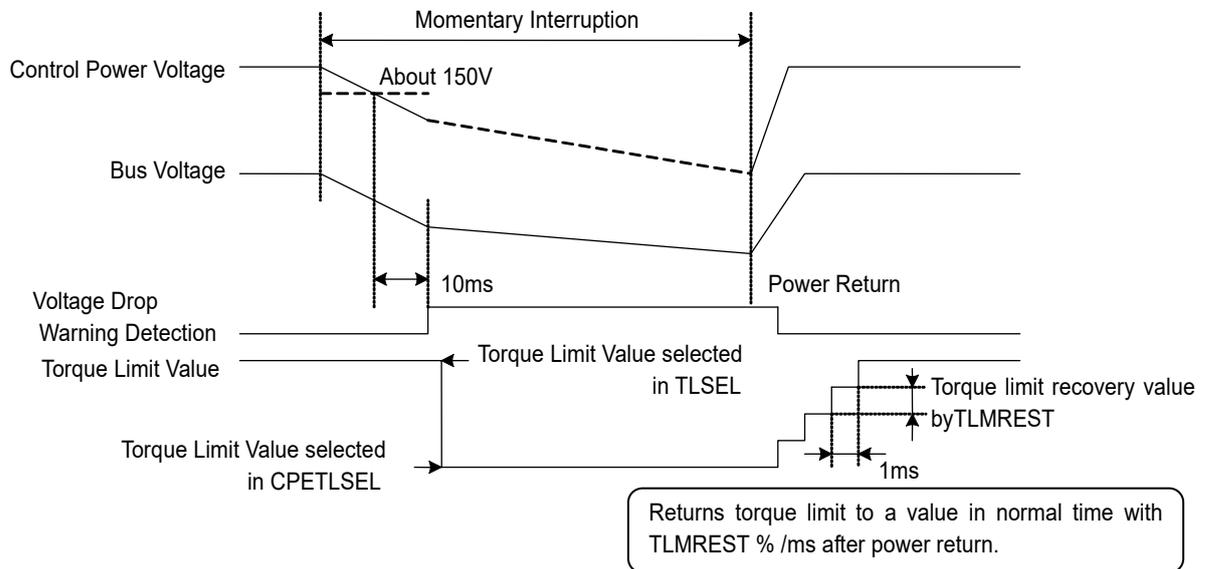
Stoppage by alarm at the time of momentary power interruptions can be avoided and operation can continue by combining with 0x2027: Power failure detection delay time.

1. Parameters to be set

Index	Symbol	Name	Unit	Setting range
0x20F5	CPETLSEL	Torque limit selection at the time of power drop	-	00 - 01
-	TLMREST	Torque limit recovery value at the time of power return.	%	0.0~500.0

2. Operation sequence

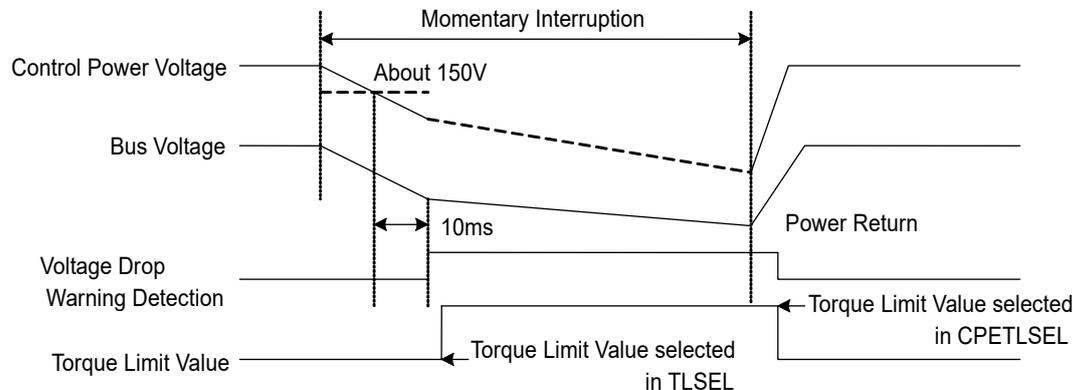
Shows the sequence from the control power drop warning detection until the power return.



3. Remarks

Torque limit value at the time of control power drop warning must be less than the value in normal operation. Torque will be limited by selected value at the time of the power drop even if the torque limit value is larger than the value under normal operation.

Returns to torque limit value in normal operation immediately after power returns.



\* This function is to limit torque under power failure and is not a function corresponding to all kinds of load conditions or operational conditions. Please make sure to use after the operation is confirmed with actual equipment.

# 9

## 9. Adjustments

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## 9.1 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.

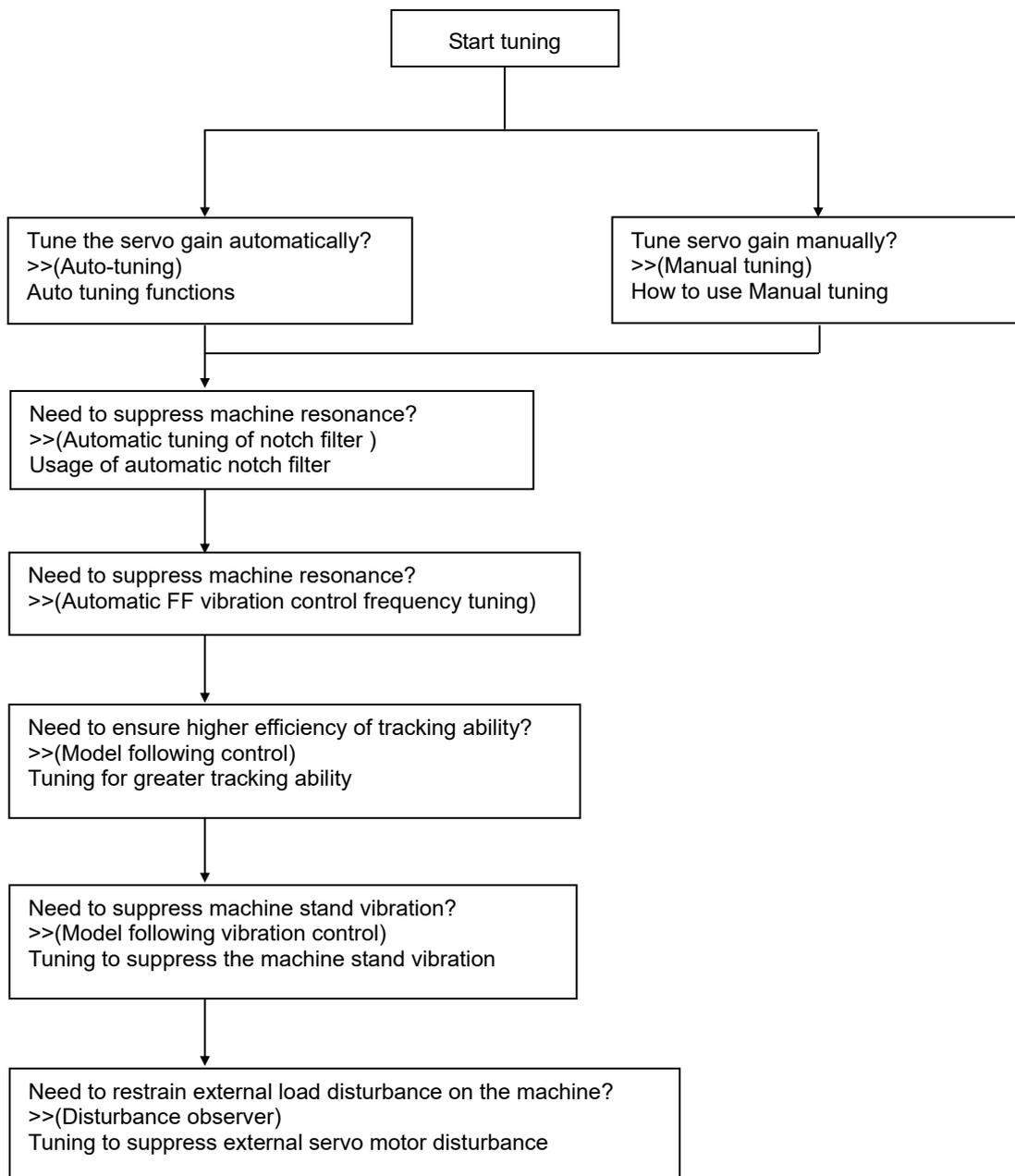
#### ■ Model following control

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.

## 9.2 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 (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.

ID	CoE Object ID	Contents												
00	0x2002, 0x01	Tuning Mode [TUNMODE] <table border="1" style="width: 100%; border-collapse: collapse; margin-top: 10px;"> <thead> <tr> <th style="width: 10%;">Selection</th> <th style="width: 40%;">Meaning</th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">00</td> <td>AutoTun Automatic Tuning</td> </tr> </tbody> </table> <ul style="list-style-type: none"> <li>◆ Servo amplifier estimates Load inertia moment ratio of the machine or equipment during real time and automatically tunes the servo gain.</li> <li>◆ Parameters for the servo amplifier to automatically tune vary depending on selected auto-tuning characteristics.</li> <li>◆ 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. Also, for operations with high disturbance torque (force) or with major mechanical clearance, this mode cannot be used.</li> </ul> <p>[01: _AutoTun_JRAT-Fix Automatic Tuning [JRAT Manual Setting]</p> <table border="1" style="width: 100%; border-collapse: collapse; margin-top: 10px;"> <thead> <tr> <th style="width: 10%;">Selection</th> <th style="width: 40%;">Meaning</th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">01</td> <td>AutoTun_JRAT-Fix Automatic Tuning [JRAT manual setting]</td> </tr> </tbody> </table> <ul style="list-style-type: none"> <li>◆ 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.</li> <li>◆ Parameters for the servo amplifier to automatically tune will vary depending on the selected auto-tuning characteristics.</li> </ul> <table border="1" style="width: 100%; border-collapse: collapse; margin-top: 10px;"> <thead> <tr> <th style="width: 10%;">Selection</th> <th style="width: 40%;">Meaning</th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">02</td> <td>ManualTun Manual Tuning</td> </tr> </tbody> </table> <ul style="list-style-type: none"> <li>◆ 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.</li> </ul>	Selection	Meaning	00	AutoTun Automatic Tuning	Selection	Meaning	01	AutoTun_JRAT-Fix Automatic Tuning [JRAT manual setting]	Selection	Meaning	02	ManualTun Manual Tuning
Selection	Meaning													
00	AutoTun Automatic Tuning													
Selection	Meaning													
01	AutoTun_JRAT-Fix Automatic Tuning [JRAT manual setting]													
Selection	Meaning													
02	ManualTun Manual Tuning													

ID	CoE Object ID	Contents																								
01	0x2002, 0x02	<p><b>Auto-Tuning Characteristic [ATCHA]</b></p> <ul style="list-style-type: none"> <li>■ Auto-Tuning Characteristic to fit the mechanical requirements and movements are provided. Parameters that can be adjusted vary depending on each auto-tuning characteristic. Set the parameters based on the situation.</li> <li>■ [Positioning control (Positioning)] Positioning control is a control method used to reach the servo motor quickly to target a position from the present position by disregarding the trajectory between the positions. Select this mode when positioning point by point is necessary.</li> <li>■ [Trajectory control (Trajectory)] Trajectory control is a method used to move the servo motor to the target position from the present position while considering the trajectory between the positions. Select this mode when the Position command corresponding trajectory control is needed such as in processing work.</li> </ul> <table border="1"> <thead> <tr> <th colspan="2">Selection</th> <th>Meaning</th> </tr> </thead> <tbody> <tr> <td>00</td> <td>Positioning1</td> <td>Positioning Control 1(General)</td> </tr> </tbody> </table> <ul style="list-style-type: none"> <li>◆ Select for general positioning purposes.</li> <li>◆ Parameters shown in table 2 cannot be adjusted manually.</li> </ul> <table border="1"> <thead> <tr> <th colspan="2">Selection</th> <th>Meaning</th> </tr> </thead> <tbody> <tr> <td>01</td> <td>Positioning2</td> <td>Positioning Control 2(High Response)</td> </tr> </tbody> </table> <ul style="list-style-type: none"> <li>◆ Select for high response positioning.</li> <li>◆ Parameters shown in table 2 cannot be adjusted manually.</li> </ul> <table border="1"> <thead> <tr> <th colspan="2">Selection</th> <th>Meaning</th> </tr> </thead> <tbody> <tr> <td>02</td> <td>Positioning3</td> <td>Positioning control 3(High Response, FFGN Manual Setting)</td> </tr> </tbody> </table> <ul style="list-style-type: none"> <li>◆ Select this mode to adjust FFGN manually.</li> <li>◆ The following parameter adjustment is made manually: General parameters GROUP1 [Basic control parameter settings]</li> </ul> <table border="1"> <thead> <tr> <th>ID</th> <th>Symbol</th> <th>Name</th> </tr> </thead> <tbody> <tr> <td>05</td> <td>FFGN</td> <td>Feed Forward Gain</td> </tr> </tbody> </table>	Selection		Meaning	00	Positioning1	Positioning Control 1(General)	Selection		Meaning	01	Positioning2	Positioning Control 2(High Response)	Selection		Meaning	02	Positioning3	Positioning control 3(High Response, FFGN Manual Setting)	ID	Symbol	Name	05	FFGN	Feed Forward Gain
Selection		Meaning																								
00	Positioning1	Positioning Control 1(General)																								
Selection		Meaning																								
01	Positioning2	Positioning Control 2(High Response)																								
Selection		Meaning																								
02	Positioning3	Positioning control 3(High Response, FFGN Manual Setting)																								
ID	Symbol	Name																								
05	FFGN	Feed Forward Gain																								

ID	CoE Object ID	Contents																																							
01	0x2002, 0x02	<p><b>Auto-Tuning Characteristic [ATCHA]</b></p> <table border="1"> <thead> <tr> <th colspan="2">Selection</th> <th>Meaning</th> </tr> </thead> <tbody> <tr> <td>03</td> <td>Positioning4</td> <td>Positioning control 4 (High Response, Horizontal Axis Limited)</td> </tr> </tbody> </table> <ul style="list-style-type: none"> <li>◆ Select this mode when the machine movement is on a horizontal axis and receives no disturbing influence from external sources.</li> <li>◆ Positioning time may be shortened compared to “Positioning Control 2”.</li> <li>◆ Parameters shown in table 2 cannot be adjusted manually.</li> </ul> <table border="1"> <thead> <tr> <th colspan="2">Selection</th> <th>Meaning</th> </tr> </thead> <tbody> <tr> <td>04</td> <td>Positioning5</td> <td>Positioning control 5 (for high response, horizontal axis only, FFGN manual setting)</td> </tr> </tbody> </table> <ul style="list-style-type: none"> <li>◆ 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.</li> <li>◆ Positioning time may be shortened compared to “Positioning control 2”.</li> <li>◆ The following parameter adjustment is done manually.</li> </ul> <p>General parameters GROUP1 [Basic Control Parameter Settings]</p> <table border="1"> <thead> <tr> <th>ID</th> <th>Symbol</th> <th>Name</th> </tr> </thead> <tbody> <tr> <td>05</td> <td>FFGN</td> <td>Feed Forward Gain</td> </tr> </tbody> </table> <table border="1"> <thead> <tr> <th colspan="2">Selection</th> <th>Meaning</th> </tr> </thead> <tbody> <tr> <td>05</td> <td>Trajectory1</td> <td>Trajectory Control 1</td> </tr> </tbody> </table> <ul style="list-style-type: none"> <li>◆ Select this mode for single axis use. The response of each axis can be different.</li> <li>◆ Parameters shown in table 2 cannot be adjusted manually.</li> </ul> <table border="1"> <thead> <tr> <th colspan="2">Selection</th> <th>Meaning</th> </tr> </thead> <tbody> <tr> <td>06</td> <td>Trajectory2</td> <td>Trajectory Control 2 (KP, FFGN Manual Setting)</td> </tr> </tbody> </table> <ul style="list-style-type: none"> <li>◆ Select this mode when you need equal responses from multiple axes, respectively. Adjust KP, FFGN.</li> <li>◆ The following parameter adjustment is done manually.</li> </ul> <p>General parameters GROUP1 [Basic control parameter settings]</p> <table border="1"> <thead> <tr> <th>ID</th> <th>Symbol</th> <th>Name</th> </tr> </thead> <tbody> <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> </tbody> </table>	Selection		Meaning	03	Positioning4	Positioning control 4 (High Response, Horizontal Axis Limited)	Selection		Meaning	04	Positioning5	Positioning control 5 (for high response, horizontal axis only, FFGN manual setting)	ID	Symbol	Name	05	FFGN	Feed Forward Gain	Selection		Meaning	05	Trajectory1	Trajectory Control 1	Selection		Meaning	06	Trajectory2	Trajectory Control 2 (KP, FFGN Manual Setting)	ID	Symbol	Name	02	KP1	Position Loop Proportional Gain 1	05	FFGN	Feed Forward Gain
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06	Trajectory2	Trajectory Control 2 (KP, FFGN Manual Setting)																																							
ID	Symbol	Name																																							
02	KP1	Position Loop Proportional Gain 1																																							
05	FFGN	Feed Forward Gain																																							
02	0x2002, 0x03	<p><b>Auto-Tuning Response [ATRES]</b></p> <ul style="list-style-type: none"> <li>■ Select this mode when Auto-tuning and Auto-tuning [JRAT manual setting] are used.</li> <li>■ As the setting value rises, the response increases. Set the value suitable for equipment rigidity.</li> <li>■ This does not function for manual tuning.</li> </ul>																																							
03	( - )	<p><b>Auto-Tuning Automatic Parameter Saving [ATSAVE]</b></p> <ul style="list-style-type: none"> <li>■ Load inertia moment ratio obtained from the result of auto-tuning is automatically saved in parameter JRAT1 every two (2) hours.</li> <li>■ The value is effective when auto-tuning is used. This does not function for [JRAT manual setting].</li> </ul>																																							

## 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) 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	VCGFIL_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 to 30  **	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

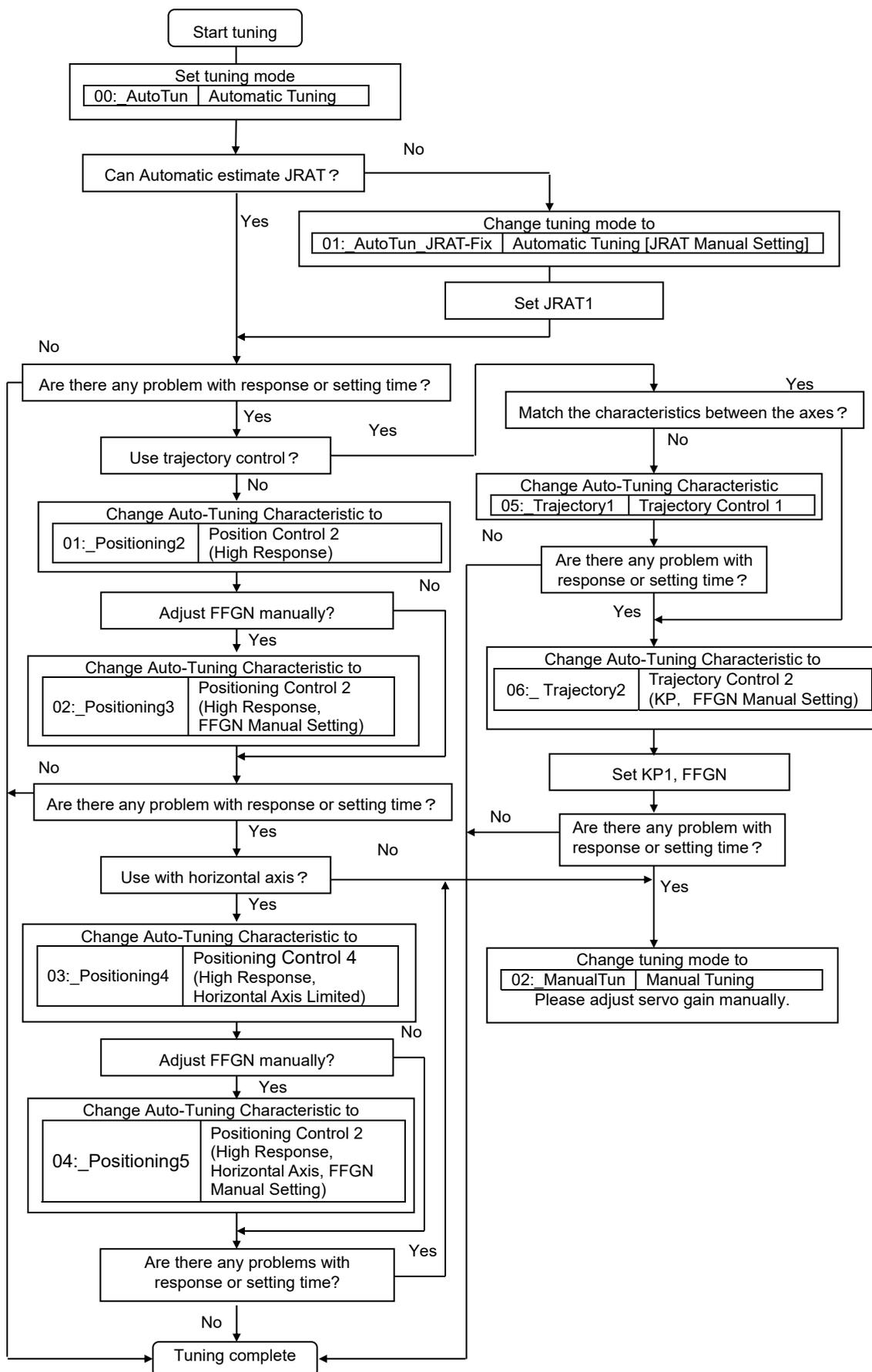
ID	CoE Object ID	Symbol	Name
-	0x2001, 0x00 bit5-4	GC	Gain Switching Selection
-	0x2000, 0x00 bit1	PPCON	Position Loop Proportional Control Switching Function
-	0x2000, 0x00 bit2	PCON	Velocity Loop Proportional Control Switching Function

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	<p>■ Estimate the load inertia ratio with the servo amplifier in real time and adjust the servo gain automatically &gt;&gt; [Tuning Mode] to 00:_AutoTun Automatic Tuning]</p> <p>When automatically tuned, the best servo gain based on the previous manual setting load inertia ratio (JRAT1) &gt;&gt; Set [Tuning Mode] to 01:_AutoTun_JRAT-Fix Automatic Tuning [JRAT Manual Setting].</p>
Procedure 2	<p>■ After setting [Tuning Mode] select [Auto-Tuning Characteristic] for the machine or equipment.</p>
Procedure 3	<p>■ Next, boot the servo motor and adjust [Auto-Tuning Response] according to equipment rigidity.</p> <ul style="list-style-type: none"> <li>◆ 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.</li> <li>◆ 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.</li> <li>◆ If increasing the response has caused the machine to develop vibration, lower the value of the [Auto-Tuning Response] slightly.</li> </ul> <p>* 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].</p> <p>* Tuning methods are the same in [01:_AutoTun_JRAT-Fix [JRAT Manual Setting].</p>

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

## 9.3 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 to 100.0

- ✓ As the value increases so does tuning accuracy. However, machine movement will increase as well. Please monitor it closely.

- Automatically saving parameters with Automatic tuning of notch filter

- ◆ General parameters Group2 [FF vibration 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	Hz	10 to 2000

- ✓ The above parameter is saved automatically with Automatic tuning of notch filter

## 9.4 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 to 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 to 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 to 500

## 9.5 Using Manual Tuning

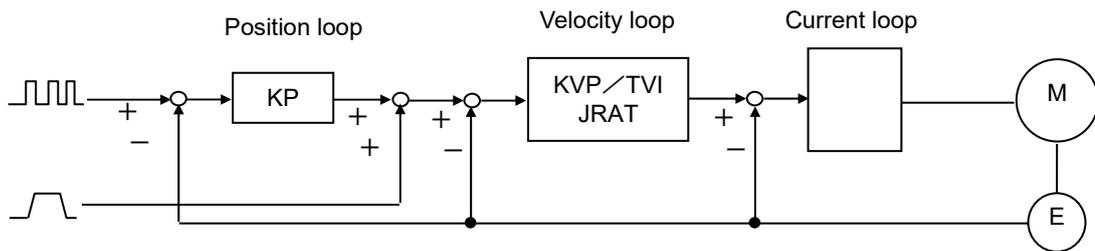
All gain is adjustable manually using manual tuning mode when characteristics in auto-tuning are insufficient.  
Sets the Tuning Mode to Manual tuning.

- 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:

$$JRAT = \frac{\text{Motor axis converted load inertia } (J_L)}{\text{Motor rotor inertia } (J_M)} \times 100\%$$

- 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 Velocity 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:  $TVI \text{ [ms]} = 1000 / (KVP \text{ [Hz]})$ 
  - ✓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)(TV1) to:  $TVI_{\text{[ms]}} = 1000 / (KVP_{\text{[Hz]}})$
- Position Loop Proportional Gain (0x2005, 0x01)(KP1) to:  $KP_{\text{[1/S]}} = KVP_{\text{[Hz]}} / 4 \cdot 2\pi$   
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.

## 9.6 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]

ID	CoE Object ID	Content						
0A	0x20F3, 0x01	Position Control Selection						
		<table border="1"> <thead> <tr> <th>Select value</th> <th>Content</th> </tr> </thead> <tbody> <tr> <td>01</td> <td>Model1</td> </tr> <tr> <td></td> <td>Model following control</td> </tr> </tbody> </table>	Select value	Content	01	Model1		Model following control
		Select value	Content					
01	Model1							
	Model following control							

✓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.



## 9.7 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.

ID	CoE Object ID	Contents				
0A	0x20F3, 0x01	Position Control Selection				
		<table border="1"> <thead> <tr> <th>Select value</th> <th>Contents</th> </tr> </thead> <tbody> <tr> <td>02</td> <td>Model2</td> </tr> </tbody> </table>	Select value	Contents	02	Model2
		Select value	Contents			
02	Model2					
Model Following Vibration Suppress Control						

- ✓ 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.
- 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 Software Setup 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 anti-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:  $KM \approx KP$ . 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.

## 9.8 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.

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# 10

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## 10. Digital Operator

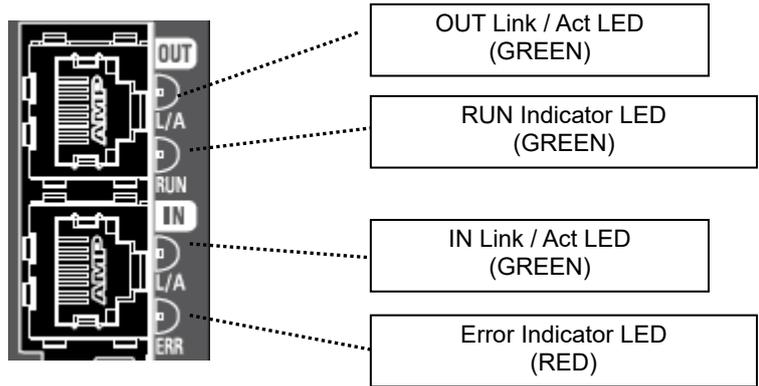
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### 10.1 EtherCAT Indicator

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

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

■ Names



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)

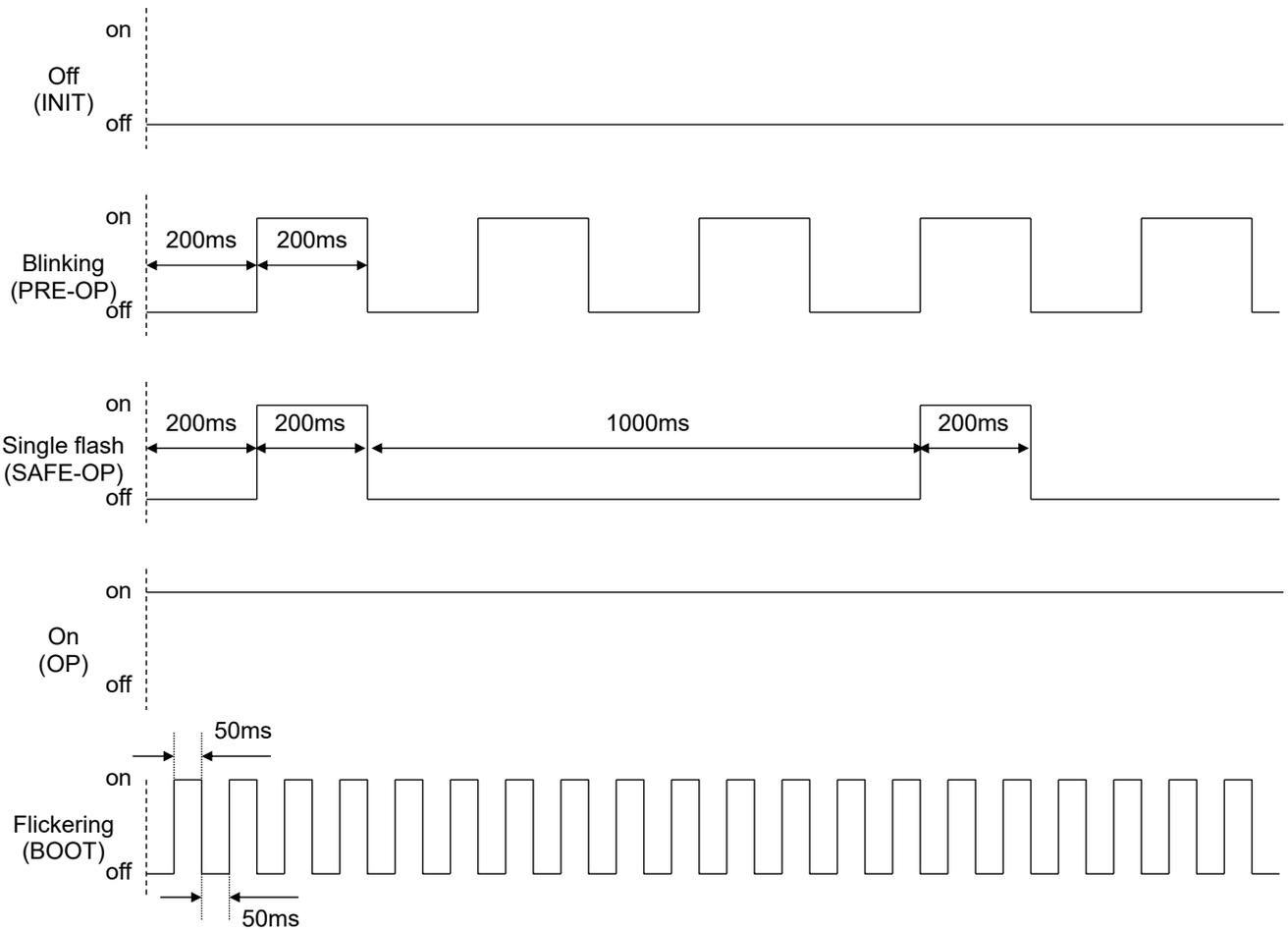
2) RUN Indicator Code: RUN

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. (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

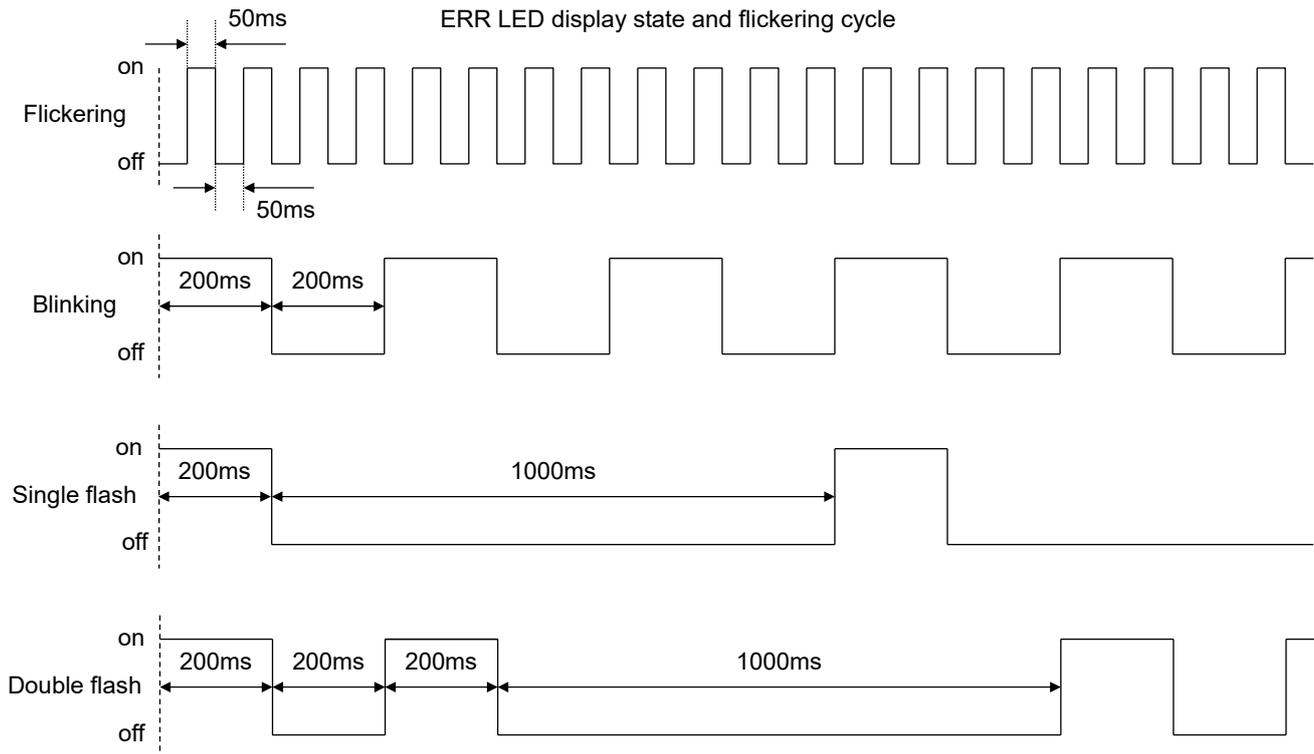
Error Indicator (Red LED) displays invalid state machine (ESM) change and/or watchdog error with an ON/OFF flickering of the LED.

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 *Transitioned to INIT state but error was set in AL status register
Blinking	Invalid configuration	General configuration error *ESM commands from master became invalid caused by settings of register and/or object
Single flash	Invalid ESM change	Error has been set in AL status register because ESM has changed slave independently *In cases of transition to Safe-Operational automatically with synchronization error, etc.
Double flash	Application Watchdog timeout	Application Watchdog timeout has occurred *SyncManager Watchdog timeout has occurred
On	PDI Watchdog timeout	PDI Watchdog timeout has occurred *CPU application controller is not working

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



## 10.2 Servo Amplifier Indicator

This servo amplifier has three 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)
- \* Digital Operator indicator : 7 segment LED×5 (RED)

The details of the Digital Operator are explained in 10.3.

### 1) Main Circuit Power Supply Indicator Code: CHARGE

Main Circuit Power Supply Indicator (Red LED) shows the main circuit power (R,S,T) has been input and power is charging in the main circuit power supply smoothing capacitor.

The LED stays ON until electric discharge has completed even after the main circuit power supply has shut down.

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

### 2) Control Power Supply Establish Indicator

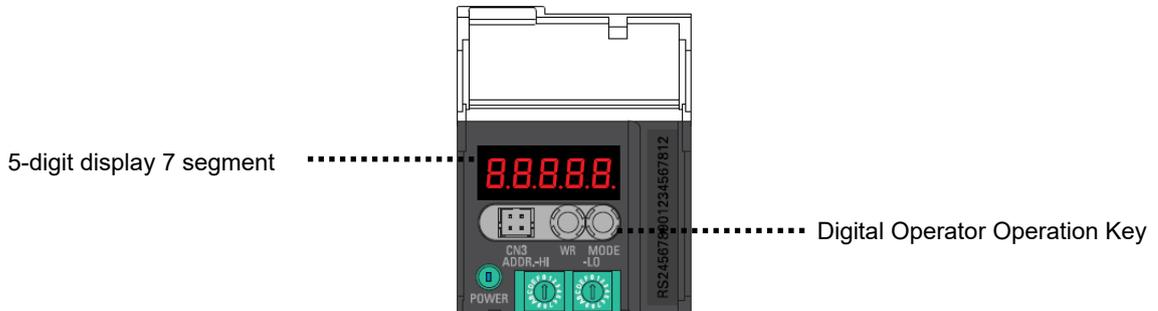
Control Power Supply Establish Indicator (Blue LED) shows the control power supply (r,t) has been input and the 5V control power supply has been established through the switching power supply inside the amplifier.

### 10.3 Digital Operator Indicator

#### 1) Digital Operator Names and Functions

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

■ Names



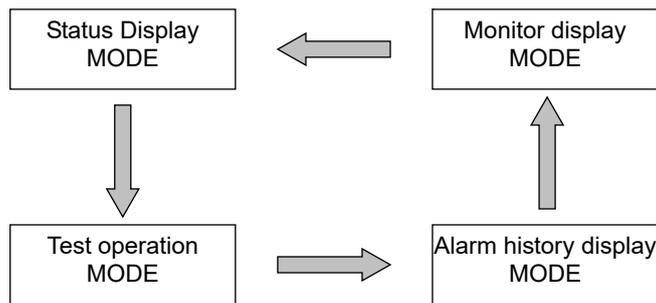
■ Functions of Push Button Switch

MODE Change : MODE Change is performed by MODE Key (Push Button Switch)  
The switching order is as follows:

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

#### 2) Mode changes

MODE Change is performed by "MODE" operation of the Push Button Switch



MODE Switching Order

- Status Display MODE  
Displays the establishment of control or main power supply, Servo ON, over-travel, warning and alarm status.  
Also performs Alarm Reset.
- Test operation MODE  
JOG Operation, Auto-Tuning Result Writing and Encoder Clear can be executed.
- Alarm history display MODE  
Alarm history for the previous 7 times can be checked and can clear alarm history.
- Monitor MODE  
Displays the servo amplifier status such as Velocity, Velocity Command, Torque, Torque command, Position Deviation and Servo Adjustment Gain when using auto-tuning.

### 10.4 Digital Operator Display Form

Digital operator displays data becomes the following form.

■ Data of 0 to +65535

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

■ Data of -9999 to +9999

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

Note) Left end - expresses minus.

■ Data of 0 to +4199999999

Symbol	Digital operator display	Range of a digit display	
Plus		Low position of 1 to 1000 display	0 - 9999
Plus		Middle position of 10000 to 10000000 display	0 - 9999
Plus		High position of 100000000 to 10000000000 display	0 - 419

Note) Left end LED expresses low position, middle position, and high position.

■ Hexadecimal data

Data Size	Digital operator display	Range of a digit display	
1 byte		FF to 00	
2 byte		FFFF to 0000	
8 byte Low		FFFF to 0000(Bit31 to Bit0) display	
8 byte High		FFFF to 0000(Bit63 to Bit32) display	

■ Example display of decimal point data

First position of a decimal point	
Second position of a decimal point	

## 10.5 Status Display Mode

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

### 1) Servo Amplifier Status Display

Marking	Servo amplifier status
	<ul style="list-style-type: none"> <li>Control power supply established.</li> <li>Control power supply (r, t) is established and amplifier (RDY) is ON.</li> <li>EtherCAT FSA "Switch ON Disabled" or "Ready to Switch ON"</li> </ul>
	<ul style="list-style-type: none"> <li>Main circuit power supply established.</li> <li>Main power supply (R, S, T) is established, but operation preparation completion signal is OFF.</li> <li>EtherCAT FSA "Switch ON Disabled" or "Ready to Switch ON" .</li> </ul>
	<ul style="list-style-type: none"> <li>Safe Torque Off working status.</li> <li>Main Circuit Power Supply (R,S,T) is established and one or both of the Safe Torque OFF Input 1/2 is/are OFF.</li> <li>EtherCAT FSA "Switch ON Disabled" "Ready to Switch ON" or "Switch ON"</li> <li>Lights as "  →  →  " this order.</li> </ul>
	<ul style="list-style-type: none"> <li>Operation preparation completion signal established.</li> <li>Main power supply (R, S, T) is established and operation preparation completion signal is ON.</li> <li>EtherCAT FSA "Switch ON Disabled" "Ready to Switch ON" or "Switch ON"</li> </ul>
	<ul style="list-style-type: none"> <li>Servo is ON.</li> <li>Shows "8" shape continuously</li> <li>EtherCAT FSA "Operation Enabled"</li> </ul>
	<ul style="list-style-type: none"> <li>The state firmware is re-writing.</li> <li>Shows the state that flash ROM of amplifier CPU is being re-written by firmware downloaded by EtherCAT FoE (bootstrap mode)</li> <li>(Do not turn off the control power supply.)</li> </ul>

### 2) Forward/Inverse Limit, Emergency Stop Display

Marking	Servo amplifier status
	<ul style="list-style-type: none"> <li>Forward direction limit status</li> <li>Command input of forward direction is disabled by forward direction limit switch input</li> </ul>
	<ul style="list-style-type: none"> <li>Inverse direction limit status</li> <li>Command input of inverse direction is disabled by inverse direction limit switch input</li> </ul>
	<ul style="list-style-type: none"> <li>Emergency Stop status</li> <li>Motor is under STOP status by inputting Quick Stop, Shut Down or Emergency Stop</li> </ul>
	<ul style="list-style-type: none"> <li>Quick Step Active status</li> <li>Under Quick Stop Active status (Quick Stop Code: 5 - 7only) after motor stops as a result of inputting Quick Stop or Emergency Stop function (Generic input).</li> </ul>

3) Display of linear motor magnetic pole position detecting status

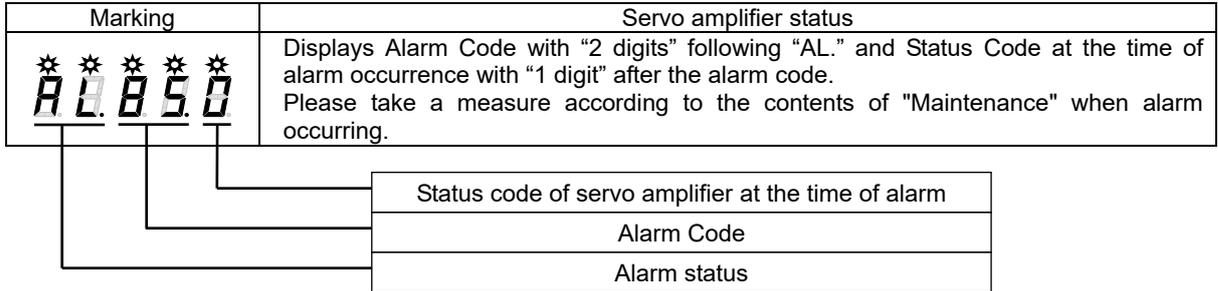
Marking	Servo amplifier status
	<ul style="list-style-type: none"> <li>•Magnetic pole position not detected state (flashing) Linear motor CS-position setting is needed when hall sensor is not used for detecting magnetic pole. The display changes from flashing to lighting showing operation preparation completed, after magnetic pole position detection completed via CS-position setting.</li> </ul>
	<ul style="list-style-type: none"> <li>•Magnetic pole position not detected state (CS-position setting being performed) Shows magnetic pole position not detected during CS-position setting.</li> </ul>
	<ul style="list-style-type: none"> <li>•Magnetic pole position detection completed state (CS-position setting being performed) Shows the state magnetic pole position detection completed during CS-position setting.</li> </ul>

4) Status Display of Battery Warning, Regenerative Overload Warning, and Overload Warning

Marking	Servo amplifier status
	<ul style="list-style-type: none"> <li>•Battery Warning status. Replace battery.</li> </ul>
	<ul style="list-style-type: none"> <li>•Regenerative overload Warning status. If operation is kept on, alarm may be issued.</li> </ul>
	<ul style="list-style-type: none"> <li>•Overload Warning status If operation is kept on, alarm may be issued.</li> </ul>

5) Alarm Display

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



Status code list of servo amplifier when alarm occurs

Status Display	ALMSTS0	Status Display	ALMSTS0
Power OFF	0x00	Servo ON 1 (Reprocessing the electric current detector)	0x07
Power ON 1 (electric current detector during setting)	0x01	Servo ON 2 (command reception allowed)	0x08
Power ON 2(main circuit charging)	0x02	magnetic pole position detected (Reserved)	0x09
Power ON 3(main circuit charged)	0x03	Emergency stop 1 (Forced Stop status)	0x0A
Servo ready	0x04	Emergency stop 2 (CNOTRDY)	0x0B
Prepared for magnetic pole position detection	0x05	Reserved	0x0C-0x0E
Power ON 4	0x06	Initial Operation	0x0F

6) How to Reset Alarm When Alarm Occurring

Alarm can be reset with the Digital Operator, except for alarms necessary for re-input of power.

Process	Displayed character, number, code	MODE Key Operation	How to operate
1		Twice ON [WR]	Make the state(Status Display) where the alarm No. is displayed.
2		Twice ON [WR]	Changes to the left display. Alarm will be cleared by pushing "WR" twice again.
3		-	Display changes as the left for 2 seconds.
4		-	When the cause of alarm is removed, the state of servo amplifier is displayed.
-		Once ON [MODE]	When pushing "MODE" once in the status of Process 2, it will be cancelled and revert to Process 1.

## 10.6 Trial Run Mode

### 1) Velocity-controlled JOG Operation

Process	Displayed character, number, code	MODE Key Operation	How to operate
1		Once ON [MODE]	Push MODE key until it show display on the left. Display changes and right end LED blinks.
2		More than 1sec ON [INC]	Push MODE key more than 1 sec to show display on the left.
3		Twice ON [WR]	Displays "JOG" mode by pushing WR key once.
4		Twice ON [WR]	Shows a shape of "8" by pushing WR key once and powers on the servo motor.
5		On long push [INC]	Rotates in CCW direction with one long push of MODE key. Default value 50min <sup>-1</sup> Note 1
6		Once ON [MODE]	Returns to Process 3 by pushing MODE key once.
7		Once ON [MODE]	Ends Process by pushing MODE key once and shows display on the left.

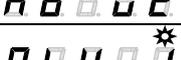
For stopping during operation, please push the MODE button.

MODE is pushed in Process 2.	
	Changes to the left display and displays alarm history.
MODE is pushed in Process 3.	
	Changes to the left display and returns to Process 2.
MODE is pushed in Process 4.	
	Changes to the left display and returns to Process 3.
Mode is pushed again.	
	Completes and changes to the left display.

2) Encoder Clear

Process	Displayed character, number, code	MODE Key Operation	How to operate
1		Once ON [MODE]	Push MODE key until it shows display the left. Display changes and right end LED blinks.
2		More than 1sec ON [INC]	Push MODE key more than 1 sec to display "Ad 01" on left.
3		Twice ON [WR]	Displays "EnCLr" mode by pushing WR key.
4		Twice ON [WR]	Display changes to that on the left and executes Encoder Clear by pushing WR key.
5			Displays image on left "EnCLr" after normal completion
6		Once ON [MODE]	Returns to Process 2 by pushing MODE key.
7		Once ON [MODE]	Displays Alarm History mode by pushing MODE key.

3) Automatic Tuning Result Writing

Process	Displayed character, number, code	MODE Key Operation	How to operate
1		ONCE ON [MODE]	Push MODE key until it shows display on the left. Display changes and right end LED blinks.
2		MORE THAN 1SEC ON [INC]	Push MODE key more than 1 sec to display "Ad 02" on left.
3		TWICE ON [WR]	Displays "turSL" mode by pushing WR key.
4		TWICE ON [WR]	Display changes to that on the left and executes Automatic Tuning Result Writing by pushing WR key.
5			Displays image on left "turSL" after normal completion
6		ONCE ON [MODE]	Returns to Process 2 by pushing MODE key.
7		ONCE ON [MODE]	Displays Alarm History mode by pushing MODE key.

## 10.7 Alarm History Mode

### 1) Alarm History Display Mode

Process	Displayed character, number, code	MODE Key Operation	How to operate
1		Once ON [MODE]	Push MODE key until it shows display on the left. Display changes and right end LED blinks.
2		More than 1sec ON [INC]	Displays an Alarm History number that requests to be checked. Previous 7 alarms can be checked.
3		Twice ON [WR]	Displays the previous 3 alarms from the current by pushing WR key.
4		Twice ON [WR]	Displays elapsed time until alarm occurrence by pushing WR key. The lower digit
5		One long push [INC]	Displays elapsed time until alarm occurrence by one long push of MODE key. The middle digit
6		One long push [INC]	Displays elapsed time until alarm occurrence by one long push of MODE key. The upper digit
7		Once ON [MODE]	Returns to Process 3 by pushing MODE key once.
8		Once ON [MODE]	Returns to Process 3.
9		Once ON [MODE]	Changes to the next monitor display mode.

### 2) Clear Alarm History

Process	Displayed character, number, code	MODE Key Operation	How to operate
1		Once ON [MODE]	Displays Clear mode after Alarm History number 7 has been checked by MODE key.
2		Twice ON [WR]	Clears preparations screen (as shown on the left) will be displayed by pushing WR key until the display changes.
3		Twice ON [WR]	Displays as shown on the left by pushing WR key until the display changes, and executes Alarm History Clear.
4		-	Returns to History Selection Screen automatically after normal completion.
5		Once ON [MODE]	Pushing MODE key in Process 3 cancels the corresponding operation and returns to Process 1.
7		Once ON [MODE]	Changes to the next monitor display mode.

### 10.8 Monitor Display Mode

Process	Displayed character, number, code	MODE Key Operation	How to operate
1		Once ON [MODE]	Press MODE key until you see the display on the left, then you can change the display. The right end of the LED blinks after the change.
2		More than 1sec ON [INC]	Displays ID that requests monitoring.
3		Twice ON [WR]	Displays set data and status.
4		Twice ON [WR]	Displays as on the left. Repeat from Process 3 when another parameter setting is following.
5		Once ON [MODE]	Changes to the next status display mode.
-			Displays as on the left in Process 3 for reserved parameters that cannot be shown.

Note) Decrements with 2<sup>nd</sup> long push "DEC".

#### 1) Monitor function

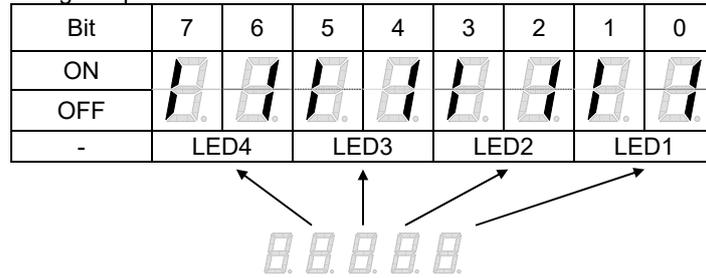
ID	Symbol	Name	Unit
00	STATUS	Servo amplifier status monitor	-
01	WARNING1	Warning status 1 monitor	-
02	WARNING2	Warning status 2 monitor	-
03	CONT8-1	General CONT8 - 1 monitor (Bit without input allocation is indefinite.)	-
04	OUT8-1	General OUT8 - 1 monitor (Bit without input allocation is indefinite.)	-
05	INC-E MON	Incremental encoder signal monitor	-
06	VMON	Velocity monitor (CCW: +, CW: -Display)	min <sup>-1</sup>
07	VCMON	Velocity command monitor (CCW: +, CW: -Display)	min <sup>-1</sup>
08	TMON	Torque monitor (Thrust monitor)	%
09	TCMON	Torque command monitor (Thrust command monitor)	%
0A	PMON	Position deviation monitor	Pulse
0D	APMON	Actual position monitor lower data (0 at time of power input)	Pulse
0F	EX-APMON H	External actual Monitor lower data (0 at time of power input)	Pulse
11	CPMON L	Command position monitor lower data	Pulse
13	FMON1	Position command pulse frequency monitor	Pulse
14	CSU	U-phase electric angle monitor	deg
17	ABSPS L	Absolute encoder PS data lower data	Pulse
1A	RegP	Regenerative resistor operation percentage monitor	%
1B	TRMS	Effective torque monitor (Effective thrust monitor)	%
1C	ETRMS	Effective torque monitor: Estimated value (Effective thrust monitor):Estimated value)	%
1D	JRAT MON	Load Inertia Moment Ratio monitor(Load to weight ratio monitor)	%
1E	KP MON	Position Loop Proportional Gain monitor	1/s
1F	TPI MON	Position Loop Integral Time Constant monitor	ms
20	KVP MON	Velocity Loop Proportional Gain monitor	Hz
21	TVI MON	Velocity Loop Integral Time Constant monitor	ms
22	TCFIL MON	Torque (force) Command Filter monitor	Hz
23	MKP MON	Model Control Gain 1	1/s
24	MTLMON -EST	Load Torque monitor: Estimate value (Load thrust monitor: Estimate value)	%
25	OPE-TIM	Amplifier operation time	×2 hour
26	ACC MON	Acceleration Monitor	rad/s <sup>2</sup>
0B,0C,0E,10,12,15,16,18,19, 27 to 30		Reserved	-

2) Monitor Details

ID	Contents				
00	■ Servo amplifier status code [STATUS]				
	Code		Status		
	00	Power OFF status	(P-OFF)		
	02	Power ON status	(P-ON)		
	04	Servo ready status	(S-RDY)		
	08	Servo ON status	(S-ON)		
	0A	Emergency stop status	(EMR)		
	10	Alarm status and power OFF	(ALARM_P-OFF)		
	12	Alarm status and power ON	(ALARM_P-ON)		
	1A	Alarm status and emergency stop status	(ALARM_EMR)		
22	Gate off and power-on state	(GATE OFF_P-ON)			
01	■ Warning status 1 [WARNING1]				
	Displays warning status. Displays warning status under "1" or "ON"				
	Bit	3	2	1	0
	Function	Regenerative load	Overload	-	Temperature inside the amplifier
02	■ Warning status 2 [WARNING2]				
	Displays warning status. Valid when "1" or "ON".				
	Bit	3	2	1	0
	Function	Inverse rotation limit	Forward rotation limit	-	Main circuit power being charged
03	■ General monitor [CONTMON]				
	Displays General status. "1" shows input the state of photo coupler-on.				
	Bit	3	2	1	0
	Function	CONT4	CONT3	CONT2	CONT1
04	■ General OUT3 - 1 monitor [OUTMON]				
	Displays generic output terminal status. 0 = Output Transistor ON				
	Bit	7-3	2	1	0
	Function	Reserved	Reserved	OUT2	OUT1
05	■ Encoder signal monitor [INC-E MON]				
	Displays incremental encoder signal status. 1 shows an incoming signal level "H" state.				
	Bit	3	2	1	0
	Function	Reserved	Motor encoder ZERO (Z) phase signal	Motor encoder B phase signal	Motor encoder A phase signal
05	■ Encoder signal monitor [INC-E MON]				
	Displays incremental encoder signal status. 1 shows an incoming signal level "H" state.				
	Bit	7	6	5	4
	Function	Reserved	External encoder ZERO (Z) phase signal	External encoder B phase signal	External encoder A phase signal

Refer to the following charts for the display format of ID01 - 05 as Software Setup and Digital Operator have different indicators:

■ Display of the Digital operator



Digital operator at the front of the servo amplifier

ID	Contents		
06	■ Velocity monitor [VMON] Displays the rotation speed of the servo motor.		
	Display range	Unit	
07	■ Velocity command monitor [VCMON] Displays the velocity command value.		
	Display range	Unit	
08	■ Torque (force) monitor [TMON] Displays the output torque.		
	Display range	Unit	
09	■ Torque (force) command monitor [TCMON] Displays the torque command value.		
	Display range	Unit	
0A	■ Position deviation monitor [PMON] Displays deviation between the command position and actual position.		
	Display range	Unit	
0D	■ Actual position monitor(Motor) [APMON] Displays the current position of the encoder motor (assuming that the position at the time the control power was turned ON is the original mode). If the current position exceeds the displayed range, the maximum reverse polarity value will be displayed.		
	Data range	Display range	Unit
	Bit31 - Bit0	H.FFFF - L.0000	Pulse
0F	■ External position monitor (external encoder) [EX-APMON] Displays external encoder present position referring the position at control power-on as the origin. When present position exceeds display range, the value becomes maximum reverse polarity value due to free-run counter.		
	Data range	Display range	Unit
	Bit31 to Bit0	H.FFFF to L.0000	Pulse

\* This ID cannot be used in linear motor.

ID	Contents						
11	<p>■ Command position monitor [CPMON]                      Displays the current position of the pulse command (assuming that the position at the time the control power was turned ON is the original mode). If the current position exceeds the displayed range, the maximum reverse polarity value will be displayed.</p> <table border="1"> <thead> <tr> <th>Data range</th> <th>Display range</th> <th>Unit</th> </tr> </thead> <tbody> <tr> <td>Bit31 - Bit0</td> <td>H.FFFF - L.0000</td> <td>Pulse</td> </tr> </tbody> </table>	Data range	Display range	Unit	Bit31 - Bit0	H.FFFF - L.0000	Pulse
Data range	Display range	Unit					
Bit31 - Bit0	H.FFFF - L.0000	Pulse					
13	<p>■ Position command pulse frequency monitor [FMON1]                      Displays the input command pulse frequency.</p> <table border="1"> <thead> <tr> <th>Data range</th> <th>Display range</th> <th>Unit</th> </tr> </thead> <tbody> <tr> <td>Bit31 to Bit0</td> <td>H.FFFF to L.0000</td> <td>kpulse</td> </tr> </tbody> </table>	Data range	Display range	Unit	Bit31 to Bit0	H.FFFF to L.0000	kpulse
Data range	Display range	Unit					
Bit31 to Bit0	H.FFFF to L.0000	kpulse					
14	<p>■ U-phase electric angle monitor [CSU]                      Displays U-phase electric angle. Always displayed excluding encoder errors.</p> <table border="1"> <thead> <tr> <th>Display range</th> <th>Unit</th> </tr> </thead> <tbody> <tr> <td>0 - 359</td> <td>deg</td> </tr> </tbody> </table>	Display range	Unit	0 - 359	deg		
Display range	Unit						
0 - 359	deg						
17	<p>■ Absolute encoder PS data [ABSPS]                      Displays position data of absolute encoder.</p> <table border="1"> <thead> <tr> <th>Display range</th> <th>Display range</th> <th>Unit</th> </tr> </thead> <tbody> <tr> <td>Bit31 - Bit0</td> <td>H.FFFF - L.0000</td> <td>Pulse</td> </tr> </tbody> </table> <p>In Digital Operator display form, it is displayed in ID17 as hexadecimal (32 bit data).                      * This ID cannot be used in linear motor.</p>	Display range	Display range	Unit	Bit31 - Bit0	H.FFFF - L.0000	Pulse
Display range	Display range	Unit					
Bit31 - Bit0	H.FFFF - L.0000	Pulse					
1A	<p>■ Regenerative resistor operation percentage [RegP]                      Displays run rate of regenerative resistance.</p> <table border="1"> <thead> <tr> <th>Display range</th> <th>Unit</th> </tr> </thead> <tbody> <tr> <td>0.00 - 99.9</td> <td>%</td> </tr> </tbody> </table>	Display range	Unit	0.00 - 99.9	%		
Display range	Unit						
0.00 - 99.9	%						
1B	<p>■ Effective torque (force) monitor [TRMS]                      Displays effective torque. Depending on the operation pattern, it may take some hours to become stable.</p> <table border="1"> <thead> <tr> <th>Display range</th> <th>Unit</th> </tr> </thead> <tbody> <tr> <td>0 - 499</td> <td>%</td> </tr> </tbody> </table> <p>Use the following formula to convert the value to "Motor usage rate monitor value" displayed in RS1 amplifier.                      Motor usage rate monitor[%] = (Effective Torque Monitor display value [%] / 100)<sup>2</sup>×100</p>	Display range	Unit	0 - 499	%		
Display range	Unit						
0 - 499	%						
1C	<p>■ Effective torque (force) monitor (Estimated value) [ETRMS]                      Estimates the approximate value of effective torque from short operation. This can be confirmed shortly if the same operation pattern is repeated.</p> <table border="1"> <thead> <tr> <th>Display range</th> <th>Unit</th> </tr> </thead> <tbody> <tr> <td>0 - 499</td> <td>%</td> </tr> </tbody> </table> <p>Use the following formula to convert the value to "Motor usage rate monitor value" displayed in RS1 amplifier.                      Motor usage rate monitor [%] = (Effective Torque Monitor display value [%] / 100)<sup>2</sup>×100</p>	Display range	Unit	0 - 499	%		
Display range	Unit						
0 - 499	%						
1D	<p>■ Displays actual Load Inertia Moment Ratio. [JRAT MON]                      Displays actual Load Inertia Moment Ratio. Value can be confirmed when changing gain and at Auto-tuning function.</p>						
1E	<p>■ Position Loop Proportional Gain monitor [KP MON]                      Displays actual Position Loop Proportional Gain. Value can be confirmed when changing gain and at Auto-tuning function.</p>						
1F	<p>■ Position Loop Integral Time Constant monitor [TPI MON]                      Displays actual Position Loop Integral Time Constant value. Value can be confirmed when changing the gain function.</p>						

ID	Contents					
20	<ul style="list-style-type: none"> <li>Velocity Loop Proportional Gain monitor [KVP MON] Displays actual Velocity Loop Proportional Gain. Value can be confirmed when changing gain and at Auto-tuning function.</li> </ul>					
21	<ul style="list-style-type: none"> <li>Velocity Loop Integral Time Constant monitor [TVI MON] Displays actual Velocity Loop Integral Time Constant. Value can be confirmed when changing gain and at Auto-tuning function.</li> </ul>					
22	<ul style="list-style-type: none"> <li>Torque Command Filter monitor [TCFIL MON] Displays actual Torque Command Filter. Value can be confirmed when changing gain and at Auto-tuning function.</li> </ul>					
23	<ul style="list-style-type: none"> <li>Model Control Gain 1 monitor [KM1 MON] Displays actual Model Control Gain. Value can be confirmed when changing gain and at Auto-tuning function.</li> </ul>					
24	<ul style="list-style-type: none"> <li>Load Torque(Thrust) monitor (Estimate value) [MTLMON-EST] Displays estimated value of load torque.</li> </ul> <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>Display range</th> <th>Unit</th> </tr> </thead> <tbody> <tr> <td>-499.9 - 499.9</td> <td>%</td> </tr> </tbody> </table>	Display range	Unit	-499.9 - 499.9	%	
Display range	Unit					
-499.9 - 499.9	%					
25	<ul style="list-style-type: none"> <li>Amplifier operation time [OPE-TIM] Counted during period control power is being turned ON. The time is displayed value x 2 hours.</li> </ul> <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>Unit</th> </tr> </thead> <tbody> <tr> <td>×2 hour</td> </tr> </tbody> </table>	Unit	×2 hour			
Unit						
×2 hour						
26	<ul style="list-style-type: none"> <li>Acceleration Monitor [ACCMON] Indicates acceleration of servo motor. Shown with hexadecimal.</li> </ul> <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>Display range</th> <th>Unit</th> </tr> </thead> <tbody> <tr> <td>H.FFFF L.FFFF to H.0000 L.0000</td> <td>rad/s<sup>2</sup></td> </tr> </tbody> </table>	Display range	Unit	H.FFFF L.FFFF to H.0000 L.0000	rad/s <sup>2</sup>	
Display range	Unit					
H.FFFF L.FFFF to H.0000 L.0000	rad/s <sup>2</sup>					

## 10.9 Analog monitor

Respective signals and internal state of servo amplifier can be monitored using an exclusive monitoring box and cable.

Refer to “Optional Goods” (Chapter 15) for the details of the monitor box and cable.

### ■ Selection of Output signal

Output signals to be used can be selected and changed from the following parameters:

Digital monitor	Not available	Not available
Analog monitor 1[MON1]	0x2023, 0x01: Analog monitor output 1 Selection	General Parameter GroupA ID11
Analog monitor 2[MON2]	0x2023, 0x02: Analog monitor output 2 Selection	General Parameter GroupA ID12

## 10.10 Fixed Monitor Display

The display shows monitoring value in a second after powering up.

It also shows monitored values set at setup software [Group9 ID20: Monitor Display Selection [MONDISP]] in status display mode. Perform setting by referring to section 10.8, Monitor display mode, 1) monitor list.

“Monitor” to be displayed is the same as parameter ID in monitor display mode, but in the setting value “00 STATUS servo amplifier status monitor”, the display will be different from the code display in the monitor mode and will show the amplifier status in the status display mode (- or ≡).

In the state of alarm occurring, requiring safety function input, requiring motor magnetic pole detection or detecting the poles, the monitor display prioritize these status over the fixed display.

In case of setting “Group9 ID20: Monitor Display Selection [MONDISP]” from SETUP software with the digital operator in “Status mode”, either reboot the hardware or push “MODE” button on the digital operator to show “Status mode” again.

No Text on This Page.

# 11

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## 11. Maintenance

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## 11.1 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”.

- “≡” does not blink in 7-segment LED even if main power is ON.

Investigation	Assumed causes and corrective actions
Check the voltage at the power input terminal.	<ul style="list-style-type: none"> <li>■ If voltage is low, check the power supply.</li> <li>■ Check that wires and screws are fastened properly.</li> </ul>
Red "CHARGE" LED goes out.	<ul style="list-style-type: none"> <li>■ Internal power circuit of servo amplifier is defective, so replace the servo amplifier.</li> </ul>
Over-travel status. Emergency Stop status.	<ul style="list-style-type: none"> <li>■ Stop the input of Over-travel.</li> <li>■ Stop the input of Emergency Stop.</li> <li>■ Check of “Functions enabling condition settings”</li> </ul>
Safe Torque (force) Off working status.	<ul style="list-style-type: none"> <li>■ Turn on /HWGOFF1 and /HWGOFF2 inputs</li> </ul>

- 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 a digital operator's monitor. Page07: Velocity command monitor (VCMON) Page09: Torque (force) command monitor (TCMON) Page13: Position command pulse frequency monitor (FMON1)	<ul style="list-style-type: none"> <li>■ If the value of a monitor is zero, input a command.</li> </ul>
Check the servo motor is locked or not.	<ul style="list-style-type: none"> <li>■ Check that the power line of a servo motor is connected.</li> </ul>
Check if torque (force) limit is input.	<ul style="list-style-type: none"> <li>■ Since torque (force) restrictions are inputted, a servo motor cannot output the torque (force) beyond the load torque (force).</li> <li>■ Check of “Functions enabling condition settings”</li> </ul>
Enter deviation clear to check if process is continued.	<ul style="list-style-type: none"> <li>■ Stop the input of deviation clear.</li> <li>■ Check of “Functions enabling condition settings”</li> </ul>
Enter encoder clear to check if process is continued.	<ul style="list-style-type: none"> <li>■ Stop the input of encoder clear.</li> <li>■ Check of “Functions enabling condition settings”</li> </ul>

✓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.	<ul style="list-style-type: none"> <li>■ Stop the input of proportional control.</li> <li>■ Check of “Functions enabling condition settings”</li> </ul>
Check if torque (force) limit is input.	<ul style="list-style-type: none"> <li>■ Stop the input of torque (force) limit.</li> <li>■ Check of “Functions enabling condition settings”</li> </ul>

- 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. 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
<ul style="list-style-type: none"> <li>■ Adjust the auto tuning “response”.</li> <li>■ Reduce the loop gain speed.</li> <li>■ Increase the velocity integral time constant.</li> <li>■ Simplify the acceleration and deceleration command.</li> <li>■ Use position command low-pass filter.</li> </ul>

- Abnormal sound occurs

Investigation	Assumed causes and corrective actions
Check whether there is any problem in mechanical attachment.	<ul style="list-style-type: none"> <li>■ Observe by operating one servo motor.</li> <li>■ Pay attention while coupling and confirm that there is no core shift or unbalance.</li> </ul>
Operate at a low speed and check whether abnormal sound has periodicity.	<ul style="list-style-type: none"> <li>■ Confirm that the twisted pair and shield processing of motor encoder signal line are correct.</li> <li>■ Confirm that the wiring for motor encoder line and servo motor power line are not installed in the same port.</li> <li>■ Confirm that the power supply voltage is sufficient.</li> </ul>

## 11.2 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	Absolute 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

## 11.3 Alarm Display

### 1) Alarm Display Overview

Displays a 2-digit alarm code on alarm occurrence as defined by this servo amplifier.

Alarms shall be displayed 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

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 Register	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 * Abnormality in drive power supply * 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	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 Resistor 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 Note 1)	* DC Main circuit low voltage	DB	Yes	
	0x3130	0x63	Main Power Supply Fail Phase Note 1)	* 1 phase of the 3 phase main circuit power supply disconnected	SB	Yes	
Bit2	0x5114	0x71	Control Power Supply Under-voltage Note 2)	* Control power supply low voltage or instantaneous stoppage occurred	DB	Yes 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 * Power supply cable break	DB	No	
	0x7306	0x83	Encoder Connector 2 Disconnection	* Full close encoder (A, B, Z) signal line break * Power supply cable break	DB	Yes note4	
	0x7300	0x84	Absolute 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 * Initial processing abnormality of Absolute encoder * 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 Register	0x603F Error Code	0x2001 0x2002 Code	Alarm name	Alarm contents	Detection Operations	Alarm Reset
Bit0	0x7300	0xA0	Absolute Encoder Internal Error 0	* Absolute encoder rotation overflow * Frequent rotation counter overflow	DB	No
		0xA1	Absolute Encoder Internal Error 1	* Multi-turn error * Battery low voltage	DB	Yes
	0x7310	0xA2	Absolute Encoder Internal Error 2	* Accelerate error	DB	Note 5
	0x7310	0xA3	Absolute Encoder Internal Error 3	* Over-speed error	DB	Note 5
	0x7300	0xA4	Absolute Encoder Internal Error 4	* Access error of Encoder internal EEPROM	DB	Note 5
		0xA5	Absolute Encoder Internal Error 5	* Detection of single rotation coefficient incorrect	DB	Note 5
		0xA6	Absolute Encoder Internal Error 6	* Detection of multiple rotation coefficient incorrect	DB	Note 5
		0xA9	Absolute Encoder Internal Error 9	* Overheating of encoder with built-in servo motor	DB	Note 5
	0x7320	0xAA	Absolute Encoder Internal Error 10	* Incremental error (Position data error)	DB	Note 5
	0x7300	0xAB	Absolute Encoder Internal Error 11	* Encoder error	DB	Note 5
		0xAC	Absolute Encoder Internal Error 12	* Multi-rotation error generation	DB	Note 5
		0xAD	Absolute Encoder Internal Error 13	* Encoder built-in EEPROM data is not set	DB	Note 5
	0x7303	0xAE	Absolute Encoder Internal Error 14	* Resolver output abnormality	DB	Note 5
0x7304	0xAF	Absolute 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
	Note 7)	0xE4	Memory Error 2 Note 7)	* 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. * 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 abnormality.	—	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
— Note 9)	— Note 8)	0xFF	Self flash timeout Note 7)	* Self-flash re-writing procedure is completed within the sepecified time.	—	No

Note 4) It can not reset, depends on the kinds of encoder.

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 completion, motor code, sensor code, 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."

## 11.4 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	<ul style="list-style-type: none"> <li>■ Confirm proper grounding of the amplifier.</li> <li>■ Check encoder cable shield</li> <li>■ Add ferrite core or similar countermeasures against noise.</li> </ul>
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	<ul style="list-style-type: none"> <li>■ Communication cable break.</li> <li>■ Contact failure of connector and/or terminal.</li> </ul>	■ 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	<ul style="list-style-type: none"> <li>■ Confirm proper grounding of the amplifier.</li> <li>■ Check the shielding of the encoder cable.</li> <li>■ Add ferrite core or similar countermeasures against noise.</li> </ul>

- 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. (After enabling, 4sec passed but data could not be recieved.)	<ul style="list-style-type: none"> <li>■ Confirm that the communication cable is connected through CN4 in another amplifier for synchronization.</li> <li>■ Check cable wiring, and review.</li> </ul>
2	■ Malfunction due to noise. (Data from amplifier for synchronization could not be received for consecutive 4ms.)	<ul style="list-style-type: none"> <li>■ Confirm proper grounding of the amplifier.</li> <li>■ Check communication cable shield.</li> <li>■ Add ferrite core or similar countermeasures against noise.</li> </ul>

■ 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.	√		√	√
Issued at input of servo ON.	√	√	√	
Issued while starting and stopping the servo motor.	√	√	√	
Issued after extended operating time.	√	√	√	√

Corrective actions

Cause		Investigation and corrective actions
1	■ U/V/W-phase of amplifier is short circuited due to the wiring in amplifier and motor. 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. ■ 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.	√	√

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.	√	
Issued during operation.	√	√

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. ■ 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.	√	
Issued during operation.	√	√

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. ■ 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	√	√
Issued during operation.	√	

Corrective actions

Cause		Investigation and corrective actions
1	■ Input logic of Safe Torque (force) Off 1 and Safe Torque (force) Off 2 are mismatched	<ul style="list-style-type: none"> <li>■ Match Input logic of SAFETOFF1/2</li> <li>■ Check wiring of SAFETOFF1, SAFETOFF2 and correct if necessary</li> <li>■ When switching either signal logic of SAFETOFF1 or SAFETOFF2 always switch the other one's signal within 10 sec</li> </ul>
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.	√	√
Issued during operation.		√

Corrective actions

Cause		Investigation and corrective actions
1	■ Defect in internal circuit of servo amplifier.	■ Replace the servo amplifier.
2	■ Malfunction due to noise	<ul style="list-style-type: none"> <li>■ Confirm proper grounding of the amplifier.</li> <li>■ Add ferrite core or similar countermeasures against noise.</li> </ul>

■ 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.	√	√							√
After command input, issued without rotating the motor.		√			√	√	√		√
After command input, brief motor rotation			√	√	√		√	√	

Corrective actions

Cause		Investigation and corrective actions
1	■ Defect in internal circuit of servo amplifier.	■ Replace the servo amplifier.
2	■ Defect in internal circuit of motor encoder.	■ Replace the servo motor.
3	■ Effective torque (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 power supply control 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.	√	√							√
After command input, issued without rotating the servo motor.		√			√	√	√		√
After command input, brief motor rotation.			√	√	√		√	√	

Corrective actions

Cause		Investigation and corrective actions
1	■ Defect in internal circuit of servo amplifier.	■ Replace the servo amplifier.
2	■ Defect in internal circuit of motor encoder.	■ Replace the servo motor.
3	■ Rotation is less than 50min <sup>-1</sup> 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 power supply control is turned ON.							√	
Issued when power supply of main circuit is turned ON.		√	√	√		√	√	√
Issued during operation.	√	√	√	√	√		√	

Corrective actions

Cause		Investigation and corrective actions
1	■ Exceeded permitted value of regenerating power in built-in regenerative resistance specifications. ■ Excessive load inertia, or tact time is short.	■ Check the load and operating conditions. ■ Use an external regeneration resistor. ■ Set the load inertia within the specified range. ■ Increase the deceleration time. ■ 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. ■ 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. ■ 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.		√
Occurred during magnetic pole position error detection.	√	

Corrective action

Cause		Investigation and corrective actions
1	<ul style="list-style-type: none"> <li>■ Magnetic pole position detection frequency and mechanical resonance point are matched.</li> <li>■ Motor hit the stroke end.</li> </ul>	<ul style="list-style-type: none"> <li>■ Change magnetic pole position detection frequency.</li> <li>■ Secure the distance to the stroke end.</li> </ul>
2	<ul style="list-style-type: none"> <li>■ Control circuit fault of servo amplifier.</li> </ul>	<ul style="list-style-type: none"> <li>■ Replace servo amplifier.</li> </ul>

■ Alarm code 45 (Average continuous over speed)

Status at the time of alarm	Cause
Occurred during operation.	√

Corrective actions

Cause		Investigation and corrective actions
1	<ul style="list-style-type: none"> <li>■ The average speed exceeds the maximum speed of continuous rotation speed range.</li> </ul>	<ul style="list-style-type: none"> <li>■ Review the operating conditions.</li> <li>■ Resize the servo motor.</li> </ul>

■ Alarm code 51 (Amplifier Overheat)

Status at the time of alarm	Cause				
	1	2	3	4	5
Issued when power supply control is turned ON.	√		√	√	
Issued during operation.	√	√	√	√	
Issued after emergency stop.					√

Corrective actions

Cause		Investigation and corrective actions
1	<ul style="list-style-type: none"> <li>■ Defect in internal circuit of servo amplifier.</li> </ul>	<ul style="list-style-type: none"> <li>■ Replace the servo amplifier.</li> </ul>
2	<ul style="list-style-type: none"> <li>■ Regenerating power exceeded.</li> </ul>	<ul style="list-style-type: none"> <li>■ Check the operating conditions.</li> <li>■ Use external regeneration resistor.</li> </ul>
3	<ul style="list-style-type: none"> <li>■ Regenerating power is within the specified range but ambient temperature of servo amplifier is out of specified range.</li> </ul>	<ul style="list-style-type: none"> <li>■ Confirm that the cooling method maintains the temperature of control board between 0 to 55°C.</li> </ul>
4	<ul style="list-style-type: none"> <li>■ Regenerating power is within the specified range but built-in cooling fan of servo amplifier is stopped.</li> </ul>	<ul style="list-style-type: none"> <li>■ For an amplifier equipped with a cooling fan motor, check that the cooling fan motor is running; if not, replace the servo amplifier.</li> </ul>
5	<ul style="list-style-type: none"> <li>■ Regeneration energy during emergency stop exceeded.</li> </ul>	<ul style="list-style-type: none"> <li>■ Change the servo amplifier.</li> <li>■ Check the loading condition.</li> </ul>

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 power supply control is turned ON.	√		
Issued when main circuit power supply is turned ON.		√	
Issued during operation.			√

Corrective actions

Cause		Investigation and corrective actions
1	<ul style="list-style-type: none"> <li>■ Defect in internal circuit of servo amplifier.</li> </ul>	<ul style="list-style-type: none"> <li>■ Replace the servo amplifier.</li> </ul>
2	<ul style="list-style-type: none"> <li>■ Power turning ON is repeated too frequently.</li> </ul>	<ul style="list-style-type: none"> <li>■ Turn ON/OFF the power less frequently.</li> </ul>
3	<ul style="list-style-type: none"> <li>■ Ambient temperature is high.</li> </ul>	<ul style="list-style-type: none"> <li>■ For an amplifier equipped with a cooling fan motor, check that the cooling fan motor is running; if not, replace the servo amplifier.</li> <li>■ 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.</li> </ul>

■ Alarm Code 53 (Dynamic Brake Resistor Overheat)

Status at the time of alarm	Cause	
	1	2
Issued when power supply control is turned ON.	✓	
Issued during operation.	✓	✓

Corrective actions

	Cause	Investigation and corrective actions
1	■ Defect in internal circuit of servo amplifier.	■ Replace the servo amplifier.
2	■ Dynamic Brake operation frequency exceeded.	■ Use the dynamic brake so as not to exceed the permissive frequency.

■ Alarm Code 54 (Built-in Regenerative Resistance Overheat)

Status at the time of alarm	Cause		
	1	2	3
Issued when power supply control is turned ON.	✓		✓
Issued during operation.	✓	✓	✓

Corrective actions

	Cause	Investigation and corrective actions
1	■ Defect in internal circuit of servo amplifier.	■ Replace the servo amplifier.
2	■ Regenerating power excessive.	■ Check the built-in regenerative resistance absorption power ■ Check the operating conditions, so that regenerating power is within permitted absorption power. ■ Use an external regeneration resistor.
3	■ Improper wiring of built-in regeneration resistor.	■ Confirm improper condition and repair if necessary.

Note) When using a regeneration resistance built in the servo amplifier, make sure to set “built-in regeneration resistance” at system parameter [Regenerative Resistor Selection]. This setting makes the judgment between enabled/disabled of the overheating protection detection treatment of the built-in regeneration resistance. When “No connected regenerative resistance or external regenerative resistance” is selected, overheating of built-in regenerative resistance is not detected. Therefore, there is a danger that built-in regenerative resistance will burn out or be damaged.

■ 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 power supply control is turned ON.	✓	✓

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 power supply control is turned ON.	✓		✓
Issued after operation for some time.		✓	✓

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. ■ 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.	✓		✓	✓
Issued at input of servo ON.	✓	✓	✓	
Issued while starting and stopping the servo motor.	✓	✓	✓	
Issued after operation for some time.	✓	✓	✓	✓

Corrective actions

Cause		Investigation and corrective actions
1	<ul style="list-style-type: none"> <li>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.</li> </ul>	<ul style="list-style-type: none"> <li>Check wiring and replace if necessary.</li> </ul>
2	<ul style="list-style-type: none"> <li>Short circuit or fault in U/V/W phases on servo motor side.</li> </ul>	<ul style="list-style-type: none"> <li>Replace the servo motor.</li> </ul>
3	<ul style="list-style-type: none"> <li>Defect in internal circuit of servo amplifier.</li> </ul>	<ul style="list-style-type: none"> <li>Replace the servo amplifier.</li> </ul>
4	<ul style="list-style-type: none"> <li>Ambient temperature is high.</li> </ul>	<ul style="list-style-type: none"> <li>For an amplifier equipped with a cooling fan motor, check that the cooling fan motor is running; if not, replace the servo amplifier.</li> <li>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.</li> </ul>

■ Alarm Code 61 (Over-Voltage)

Status at the time of alarm	Cause			
	1	2	3	4
Issued when power supply control is turned ON.	✓			
Issued when power supply of main circuit is turned ON.	✓	✓		
Issued while decelerating the servo motor.		✓	✓	✓

Corrective actions

Cause		Investigation and corrective actions
1	<ul style="list-style-type: none"> <li>Defect in internal circuit of servo amplifier.</li> </ul>	<ul style="list-style-type: none"> <li>Replace the servo amplifier.</li> </ul>
2	<ul style="list-style-type: none"> <li>The power supply voltage of main circuit is out of the specification.</li> </ul>	<ul style="list-style-type: none"> <li>Reduce the power supply voltage to within the specified range.</li> </ul>
3	<ul style="list-style-type: none"> <li>Excessive load inertia.</li> </ul>	<ul style="list-style-type: none"> <li>Reduce the load inertia to within the specified range.</li> </ul>
4	<ul style="list-style-type: none"> <li>Incorrect wiring for regeneration resistance.</li> <li>Built-in regeneration circuit is not functioning.</li> </ul>	<ul style="list-style-type: none"> <li>Wire the regeneration resistance correctly.</li> <li>While using the external regenerative resistance, check the wiring and resistance value.</li> <li>Replace the servo amplifier if any abnormality occurs.</li> </ul>

■ Alarm Code 62 (Main Circuit Under-voltage)

Status at the time of alarm	Cause				
	1	2	3	4	5
Issued when power supply control is turned ON.				✓	✓
Issued after power supply of main circuit is turned ON.	✓	✓	✓		
Issued during operation.		✓	✓		

Corrective actions

Cause		Investigation and corrective actions
1	<ul style="list-style-type: none"> <li>Input power supply voltage is below the specified range.</li> </ul>	<ul style="list-style-type: none"> <li>Check the power supply and set it within the specified range.</li> </ul>
2	<ul style="list-style-type: none"> <li>Rectifier of main circuit is broken.</li> </ul>	<ul style="list-style-type: none"> <li>Replace the servo amplifier.</li> </ul>
3	<ul style="list-style-type: none"> <li>Input power supply voltage is reduced and/or blinking.</li> </ul>	<ul style="list-style-type: none"> <li>Check the power supply and confirm that there is no blinking or low voltage.</li> </ul>
4	<ul style="list-style-type: none"> <li>Low voltage outside of the specified range is supplied to the main circuit (R/S/T).</li> </ul>	<ul style="list-style-type: none"> <li>Check the main circuit voltage. Confirm that there is no external power supply to R/S/T when the main circuit is OFF.</li> </ul>
5	<ul style="list-style-type: none"> <li>Defect in internal circuit of servo amplifier.</li> </ul>	<ul style="list-style-type: none"> <li>Replace the servo amplifier.</li> </ul>

■ Alarm Code 63 (Main Power Supply Fail Phase)

Status at the time of alarm	Cause		
	1	2	3
Issued when power supply control is turned ON.		√	
Issued when power supply of main circuit is turned ON.	√		√
Issued during operation.	√		
Alarm issued during single-phase power input selection.			√

Corrective actions

Cause		Investigation and corrective actions
1	■ One out of 3 phases (R/S/T) is not inserted.	■ Check the wiring and repair if necessary.
2	■ Defect in internal circuit of Servo amplifier.	■ Replace the servo amplifier.
3	■ Servo amplifier is not specified for single phase.	■ Check the model number and delivery specifications of the servo amplifier and replace it with a servo amplifier for single-phase power supply. ■ Change of system parameter to "Single phase AC power is supplied to the main circuit".

■ Alarm Code 71 (Control Power Supply Under-voltage)

Status at the time of alarm	Cause		
	1	2	3
Issued when power supply control is turned ON.	√	√	
Issued during operation.	√		√

Corrective actions

Cause		Investigation and corrective actions
1	■ Defect in internal circuit of servo amplifier.	■ Replace the servo amplifier.
2	■ Input power supply voltage is below the specified range.	■ Confirm that the power supply is set within the specified range.
3	■ Input power supply voltage is fluctuating or 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 power supply control is turned ON.	√	√

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. ■ 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 power supply control is turned ON.	√	√

Corrective actions

Cause		Investigation and corrective actions
1	■ Defect in internal circuit of servo amplifier.	■ Replace the servo amplifier.
2	■ Defect in external circuit.	■ Restart the power supply after removing the connector; 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 power supply control is turned ON.	√	√	√	√	√
Issued during operation.	√		√	√	

Corrective actions

Cause		Investigation and corrective actions
1	<ul style="list-style-type: none"> <li>■ For motor encoder wiring:                             <ul style="list-style-type: none"> <li>◆ Improper wiring.</li> <li>◆ Connector is removed.</li> <li>◆ Loose connection.</li> <li>◆ Encoder cable is too long.</li> <li>◆ Encoder cable is too thin.</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>■ Check wiring and replace if necessary.</li> <li>■ Confirm that the encoder power supply voltage of the motor is above 4.75 V; increase it if below 4.75 V.</li> </ul>
2	<ul style="list-style-type: none"> <li>■ Servo amplifier and motor encoder are not combined properly.</li> </ul>	<ul style="list-style-type: none"> <li>■ Replace with servo motor equipped with proper encoder.</li> </ul>
3	<ul style="list-style-type: none"> <li>■ Defect in internal circuit of servo amplifier.</li> </ul>	<ul style="list-style-type: none"> <li>■ Replace the servo amplifier.</li> </ul>
4	<ul style="list-style-type: none"> <li>■ Defect in internal circuit of motor encoder.</li> </ul>	<ul style="list-style-type: none"> <li>■ Replace the servo motor.</li> </ul>
5	<ul style="list-style-type: none"> <li>■ Parameter set to 'Full-closed servo system'.</li> </ul>	<ul style="list-style-type: none"> <li>■ Change of system parameter to "Semi-close Control / Motor Encoder" (Only with alarm code 83)</li> </ul>

- Alarm Code 84 (absolute Encoder Communication Error)

Status at the time of alarm	Cause		
	1	2	3
Issued when power supply control is turned ON.	√	√	√

Corrective actions

Cause		Investigation and corrective actions
1	<ul style="list-style-type: none"> <li>■ Defect in internal circuit of motor encoder.</li> </ul>	<ul style="list-style-type: none"> <li>■ Replace the servo motor.</li> </ul>
2	<ul style="list-style-type: none"> <li>■ Malfunction due to noise.</li> </ul>	<ul style="list-style-type: none"> <li>■ Confirm proper grounding of the amplifier.</li> <li>■ Check the shielding of the encoder cable.</li> <li>■ Add ferrite core or similar countermeasures against noise.</li> </ul>
3	<ul style="list-style-type: none"> <li>■ Motor encoder wiring has abnormalities.</li> </ul>	<ul style="list-style-type: none"> <li>■ Check the wiring of motor encoder and servo amplifier, and correct the wiring if needed.</li> </ul>

- Alarm Code 85 (Encoder Initial Process Error)

Status at the time of alarm	Cause				
	1	2	3	4	5
Issued when power supply control is turned ON.	√	√	√	√	√

Corrective actions

Cause		Investigation and corrective actions
1	<ul style="list-style-type: none"> <li>■ For motor encoder wiring:                             <ul style="list-style-type: none"> <li>◆ Improper wiring.</li> <li>◆ Connector is removed.</li> <li>◆ Loose connection.</li> <li>◆ Encoder cable is too long.</li> <li>◆ Encoder cable is too thin.</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>■ Check wiring and replace if necessary.</li> <li>■ Confirm that the encoder power supply voltage of the motor is above 4.75 V; increase it if below 4.75 V.</li> </ul>
2	<ul style="list-style-type: none"> <li>■ Servo amplifier and motor encoder are not combined properly.</li> </ul>	<ul style="list-style-type: none"> <li>■ Replace with servo motor equipped with proper encoder.</li> </ul>
3	<ul style="list-style-type: none"> <li>■ Defect in internal circuit of servo amplifier.</li> </ul>	<ul style="list-style-type: none"> <li>■ Replace the servo amplifier.</li> </ul>
4	<ul style="list-style-type: none"> <li>■ Defect in internal circuit of motor encoder.</li> </ul>	<ul style="list-style-type: none"> <li>■ Replace the servo motor.</li> </ul>
5	<ul style="list-style-type: none"> <li>■ Initial position data could not be set, as the number of rotations of the motor is more than 250 min<sup>-1</sup> during power supply.</li> </ul>	<ul style="list-style-type: none"> <li>■ Restart the power supply after motor is stopped. (Only when PA035C and PA035S encoder is used.)</li> </ul>

- Alarm Code 86 (CS Error)

State when alarm activated	Cause
	Occurred motor was in operation.

Corrective action

Cause		Investigation and corrective actions
1	<ul style="list-style-type: none"> <li>■ Malfunction due to noise occurred in linear sensor and hole sensor wirings.</li> </ul>	<ul style="list-style-type: none"> <li>■ Check to see if ground lead is properly placed.</li> <li>■ Check shielding of linear sensor cable.</li> <li>■ Add ferritic core to protect from noise.</li> </ul>

■ Alarm Code A0 (Absolute Encoder Internal Error 0)

Status at the time of alarm	Cause	
	1	2
Issued when power supply control is turned ON.	✓	✓
Issued while driving the servo motor.	✓	✓

Corrective actions

Cause		Investigation and corrective actions
1	■ Defect in internal circuit of motor encoder.	■ Turn ON the power supplies again; if not restored, replace the servo motor.
2	■ Malfunction due to noise.	■ Confirm proper grounding of the amplifier. ■ Check the shielding of the encoder cable. ■ Add ferrite core or similar countermeasures against noise.

■ Alarm Code A1 (Absolute Encoder Internal Error 1)

Status at the time of alarm	Cause			
	1	2	3	4
Issued when power supply control is turned ON.	✓	✓		
Issued during operation.			✓	✓

Corrective actions

Cause		Investigation and corrective actions
1	■ Loose connection of battery cable.	■ Check the battery connector of encoder cable attachment.
2	■ 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 (Absolute Encoder Internal Error 2)

Status at the time of alarm	Cause		
	1	2	3
Issued while stopping the servo motor.	✓	✓	
Issued while rotating the servo motor.	✓	✓	✓

Corrective actions

Cause		Investigation and corrective actions
1	■ Defect in internal circuit of motor encoder.	■ Turn ON the power supplies again; if not restored, replace the servo motor.
2	■ Malfunction due to noise.	■ Confirm proper grounding of the amplifier. ■ Check the shielding of the encoder cable. ■ Add ferrite core or similar countermeasures 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 (Absolute Encoder Internal Error 3)

Status at the time of alarm	Cause		
	1	2	3
Issued when power supply control is turned ON.	✓		✓
Issued while stopping the servo motor.	✓	✓	
Issued while stopping the servo motor.	✓	✓	✓

Corrective actions

Cause		Investigation and corrective actions
1	■ Defect in internal circuit of motor encoder.	■ Turn ON the power supplies again; if not restored, replace the motor.
2	■ Malfunction due to noise.	■ Confirm proper grounding of the amplifier. ■ Check the shielding of the encoder cable. ■ Add ferrite core or similar countermeasures 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~A6 (Absolute Encoder Internal Error 4 - 6)
- Alarm Code AA~AF (Absolute Encoder Internal Error 10 - 15)

Status at the time of alarm	Cause	
	1	2
Issued when power supply control is turned ON.	√	
Issued during operation.	√	√

Corrective actions

	Cause	Investigation and corrective actions
1	■ Defect in internal circuit of motor encoder.	■ Turn ON the power supplies again; if not restored, replace the motor.
2	■ Malfunction due to noise.	■ Confirm proper grounding of the amplifier. ■ Check the shielding of the encoder cable. ■ Add ferrite core or similar countermeasures against noise.

Note) "Encoder clear and alarm reset methods" vary depending on the motor encoder in use.

- Alarm Code A9 (Absolute Encoder Internal Error 9)

Status at the time of alarm	Cause		
	1	2	3
Issued when control power supply is turned ON.	√	√	
Issued while stopping the servo motor.	√	√	
Issued while rotating the servo motor.		√	√

Corrective actions

	Cause	Investigation and corrective actions
1	■ Defect in internal circuit of motor encoder.	■ Turn ON the power supplies again; if not 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.	√	√		
Issued when the servo motor is started.			√	√
Issued other than operating and starting the motor.		√	√	

Corrective actions

	Cause	Investigation and corrective actions
1	■ Defect in internal circuit of servo amplifier.	■ Replace the servo amplifier.
2	■ Defect in internal circuit of motor encoder.	■ Replace the servo motor.
3	■ Excessive overshoot while starting.	■ Adjust the servo parameters. ■ Simplify the acceleration and deceleration command pattern. ■ 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.	✓		✓	
Issued if command is entered.	✓	✓	✓	
Issued while starting and stopping the servo motor				✓

Corrective actions

Cause		Investigation and corrective actions
1	■ Wiring of U/V/W -phase between servo amplifier and motor do not match.	■ Check the wiring and repair any irregularities.
2	■ Wiring of A/B -phase of incremental 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. ■ Adjust the servo parameters to reduce overshoot and undershoot. ■ Simplify the acceleration and deceleration command pattern. ■ 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.	✓	✓	✓
Generated at the time of control input.		✓	

Corrective actions

Cause		Investigation and corrective actions
1	■ Motor is not rotating.	■ Confirm that the power line is properly connected. ■ 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	✓	✓	✓

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 deceleration 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.										√		
Issued when servo ON is stopped.						√					√	
Issued immediately after entering the command.	√	√	√	√	√		√	√	√		√	
Issued during starting or stopping at high speed.	√	√					√	√	√		√	√
Issued during the operations by lengthy command.		√					√	√			√	

Corrective actions

Cause		Investigation and corrective actions
1	<ul style="list-style-type: none"> <li>Position command changes excessively, or acceleration and deceleration time is short.</li> </ul>	<ul style="list-style-type: none"> <li>Correct the position command of the controller.</li> </ul>
2	<ul style="list-style-type: none"> <li>Excessive initial load or low motor capacity.</li> </ul>	<ul style="list-style-type: none"> <li>Correct the load condition or increase the motor capacity.</li> </ul>
3	<ul style="list-style-type: none"> <li>Holding brake is not released.</li> </ul>	<ul style="list-style-type: none"> <li>Check wiring and replace if necessary. If specified voltage is applied, replace the servo motor.</li> </ul>
4	<ul style="list-style-type: none"> <li>Servo motor is mechanically locked or machine is colliding.</li> </ul>	<ul style="list-style-type: none"> <li>Check the machinery system.</li> </ul>
5	<ul style="list-style-type: none"> <li>One or all phases of U/V/W -phase of the servo amplifier and motor has disconnected.</li> </ul>	<ul style="list-style-type: none"> <li>Check wiring and replace if necessary.</li> </ul>
6	<ul style="list-style-type: none"> <li>Motor is being rotated by an external force (Gravity, etc.) during stopping (positioning completion).</li> </ul>	<ul style="list-style-type: none"> <li>Check the load, and/or increase the servo motor capacity.</li> </ul>
7	<ul style="list-style-type: none"> <li>Valid torque (force) limit command is entered by the controller, and the torque (force) limit setting is too much reduced.</li> </ul>	<ul style="list-style-type: none"> <li>Increase the torque (force) limit value or disable the torque (force) limit.</li> </ul>
	<ul style="list-style-type: none"> <li>Setting of a Velocity Limit Command is too little.</li> </ul>	<ul style="list-style-type: none"> <li>Enlarge setting of a Velocity Limit Command.</li> </ul>
	<ul style="list-style-type: none"> <li>Number of motor encoder pulses does not match with the servo motor.</li> </ul>	<ul style="list-style-type: none"> <li>Match the number of servo motor encoder pulses.</li> </ul>
8	<ul style="list-style-type: none"> <li>Settings of servo parameters (Position Loop Gain, etc.) are not appropriate.</li> </ul>	<ul style="list-style-type: none"> <li>Check the servo parameter settings (Raise the position loop gain, etc.).</li> </ul>
9	<ul style="list-style-type: none"> <li>Excessive deviation setting value is much reduced.</li> </ul>	<ul style="list-style-type: none"> <li>Set a greater value for excessive deviation.</li> </ul>
10	<ul style="list-style-type: none"> <li>Defect in internal circuit of servo amplifier.</li> </ul>	<ul style="list-style-type: none"> <li>Replace the servo amplifier.</li> </ul>
11	<ul style="list-style-type: none"> <li>Defect in internal circuit of motor encoder.</li> </ul>	<ul style="list-style-type: none"> <li>Replace the servo motor.</li> </ul>
12	<ul style="list-style-type: none"> <li>Power supply voltage is low.</li> </ul>	<ul style="list-style-type: none"> <li>Check the power supply voltage.</li> </ul>

■ Alarm Code D2 (Position Command Error 1)※

Status at the time of alarm	Cause	
	1	2
Issued after entering position command	√	√

Corrective actions

Cause		Investigation and corrective actions
1	<ul style="list-style-type: none"> <li>Velocity converted value of Position command exceeds the setting value of Position command error 1.</li> <li>CSP: Converted velocity has exceeded setting level of previous and current position commands.</li> <li>PP : Converted velocity of trajectory generated position command has exceeded setting value.</li> </ul>	<ul style="list-style-type: none"> <li>Lower command input travel distance.</li> </ul>
2	<ul style="list-style-type: none"> <li>In cases where Position command cannot be received due to CRC error generation.</li> </ul>	<ul style="list-style-type: none"> <li>Add ferrite core or similar countermeasures against noise.</li> </ul>

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	√	√

Corrective actions

Cause		Investigation and corrective actions
1	<ul style="list-style-type: none"> <li>Excessive difference of recent command compared to previous Position command</li> </ul>	<ul style="list-style-type: none"> <li>Lower command input travel distance.</li> </ul>
2	<ul style="list-style-type: none"> <li>In cases where Position command cannot be received due to CRC error generation.</li> </ul>	<ul style="list-style-type: none"> <li>Add ferrite core or similar countermeasures against noise.</li> </ul>

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.	√	√	√	√	√
Issued during starting or stopping at high speed.	√	√			√
Issued during long run.	√	√			√

Corrective actions

Cause		Investigation and corrective actions
1	<ul style="list-style-type: none"> <li>■ 2-axis position loop control parameters are not appropriate.</li> <li>■ Response setting of corrected position synchronization is too high.</li> <li>■ Parameters setting for corrected position synchronization are not appropriate.</li> </ul>	<ul style="list-style-type: none"> <li>■ In mutual synchronization correction mode, disable integral compensation. Also, set the parameter at the same setting.</li> <li>■ In master-slave mode position synchronization correction,</li> <li>■ Turn on mutual synchronization correction mode.</li> </ul>
2	<ul style="list-style-type: none"> <li>■ 2-axis load inertia balance is not appropriate.</li> </ul>	<ul style="list-style-type: none"> <li>■ Review the load condition, or perform countermeasures such as increasing the capacity of servomotor.</li> </ul>
3	<ul style="list-style-type: none"> <li>■ Valid torque (force) limit command is entered by the controller, and the torque (force) limit setting is too low.</li> <li>■ Setting of Velocity Limit Command is too low.</li> <li>■ No. of pulses of 2-axis sensor is not appropriate.</li> </ul>	<ul style="list-style-type: none"> <li>■ Increase the torque (force) limit value. Or disable the torque (force) limit.</li> <li>■ Increase the Velocity Limit Command.</li> <li>■ Replace the motor which has same No. of sensor pulses.</li> </ul>
4	<ul style="list-style-type: none"> <li>■ Holding brake does not release.</li> <li>■ Servo motor is mechanically locked or machine has a collision.</li> </ul>	<ul style="list-style-type: none"> <li>■ Check the wiring, and correct the wiring if needed. If the specified voltage is applied, replace the servo motor.</li> <li>■ Check if the machinery system is mechanically locked.</li> </ul>
5	<ul style="list-style-type: none"> <li>■ Setting of Position Synchronization Deviation is too low.</li> </ul>	<ul style="list-style-type: none"> <li>■ Increase setting of Position Synchronization Deviation.</li> </ul>

■ Alarm Code DE (Parameter change completion)

Status at the time of alarm	Cause
	Issued after setting initialization (0x20FE, 0x20FF)

Corrective actions

Cause		Investigation and corrective actions
1	<ul style="list-style-type: none"> <li>■ Normal operation in alarm status. Motor code or encoder code change has detected. (The change above needs control power-cycle.)</li> </ul>	<ul style="list-style-type: none"> <li>■ Shut down control power supply and restart servo amplifier.</li> </ul>

■ Alarm Code DF (Test Run Close)

Status at the time of alarm	Cause
	Occurred after execution of test mode.

Corrective actions

Cause		Investigation and corrective actions
1	<ul style="list-style-type: none"> <li>■ Normal operation of alarm in test mode completion. (After completion of test mode, to confirm any deviation in the controller).</li> </ul>	<ul style="list-style-type: none"> <li>■ Clear the alarm and restore operation.</li> </ul>

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
	Issued during parameter change in Setup Software

Corrective actions

Cause		Investigation and corrective actions
1	<ul style="list-style-type: none"> <li>■ Defect in internal circuit of servo amplifier.</li> <li>■ No response from EEPROM when saving servo parameters. (Defect in amplifier control board)</li> </ul>	<ul style="list-style-type: none"> <li>■ Replace the servo amplifier.</li> </ul>

■ 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	<ul style="list-style-type: none"> <li>Correct value not read by CPU by EEPROM built-in servo amplifier.</li> </ul>	<ul style="list-style-type: none"> <li>Replace the servo amplifier.</li> </ul>
2	<ul style="list-style-type: none"> <li>Failed to write into the EEPROM during last power supply cutoff.</li> </ul>	<ul style="list-style-type: none"> <li>Replace the servo amplifier.</li> </ul>

■ 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	<ul style="list-style-type: none"> <li>Proper access failure of CPU internal RAM (Defect in control board of servo amplifier.)</li> </ul>	<ul style="list-style-type: none"> <li>Replace the servo amplifier.</li> </ul>

■ Alarm Code E4 (Memory 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	<ul style="list-style-type: none"> <li>Defect in internal circuit of servo amplifier. (Program check sum of flash memory was incorrect at control power input.) (Firmware defect in amplifier CPU)</li> </ul>	<ul style="list-style-type: none"> <li>Replace the servo amplifier.</li> </ul>
2	<ul style="list-style-type: none"> <li>Modulo initial value error in use with special setting. (Modulo initial value is not matched with the value in non-volatile memory.)</li> </ul>	<ul style="list-style-type: none"> <li>Perform modulo initialization process again.</li> </ul>

■ 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	<ul style="list-style-type: none"> <li>Selected value is outside the specified range for a system parameter.</li> </ul>	<ul style="list-style-type: none"> <li>Confirm the model number of the servo amplifier.</li> <li>Turn ON the control power again and confirm that alarm is cleared.</li> </ul>
2	<ul style="list-style-type: none"> <li>Defect in internal circuit of servo amplifier.</li> </ul>	<ul style="list-style-type: none"> <li>Replace the servo amplifier.</li> </ul>

■ 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	<ul style="list-style-type: none"> <li>Selected values of system parameters and actual hardware do not match.</li> <li>Improper assembly of system parameter settings.</li> </ul>	<ul style="list-style-type: none"> <li>Confirm the model number of the servo amplifier.</li> <li>Turn ON the control power again and confirm that alarm is cleared.</li> </ul>
2	<ul style="list-style-type: none"> <li>Defect in internal circuit of servo amplifier.</li> </ul>	<ul style="list-style-type: none"> <li>Replace the servo amplifier.</li> </ul>

■ 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	<ul style="list-style-type: none"> <li>Correct value not read by CPU from EEPROM built-in servo amplifier.</li> </ul>	<ul style="list-style-type: none"> <li>If control power supply is re-switched on and alarm recurs after re-setting a motor parameter, replace servo amplifier.</li> </ul>
2	<ul style="list-style-type: none"> <li>Failed to write into the EEPROM when changing motor parameter.</li> </ul>	<ul style="list-style-type: none"> <li>If control power supply is re-switched on and alarm recurs after re-setting a motor parameter, replace servo amplifier.</li> </ul>

■ 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	<ul style="list-style-type: none"> <li>■ Access failure of CPU and peripheral devices at initialization.</li> <li>■ Defect in control circuit board of servo amplifier.</li> </ul>	<ul style="list-style-type: none"> <li>■ Replace the servo amplifier.</li> </ul>

■ 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	<ul style="list-style-type: none"> <li>■ Corresponding encoder on servo amplifier control board and encoder setting value do not match. (Defect in control circuit board of servo amplifier.)</li> </ul>	<ul style="list-style-type: none"> <li>■ Replace the servo amplifier.</li> </ul>

■ 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	<ul style="list-style-type: none"> <li>■ Motor code transferred to 0x20FE is out of combination range.</li> </ul>	<ul style="list-style-type: none"> <li>■ Combinable motor code of amplifier capacity is not set.</li> <li>■ Check if a combinable motor is set.</li> </ul>

■ 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	<ul style="list-style-type: none"> <li>■ Sensor division number transferred to 0x20FF is out of range or is an unsupported sensor.</li> </ul>	<ul style="list-style-type: none"> <li>■ Sensor classification code or division number cannot be combined. Set combinable sensor code or division number.</li> <li>■ Change motor sensor to supported amplifier when motor sensor differs from sensor specification of non-responding amplifier.</li> </ul>

■ 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	<ul style="list-style-type: none"> <li>■ Encoder being connected is not supported by motor parameter automatic setting function.</li> </ul>	<ul style="list-style-type: none"> <li>■ Replace with supported servo motor.</li> </ul>
2	<ul style="list-style-type: none"> <li>■ Servo motor being connected is not supported by motor parameter automatic setting function.</li> </ul>	<ul style="list-style-type: none"> <li>■ The servo motor you use cannot be supported by this function, so please download motor parameters from setup software.</li> </ul>
3	<ul style="list-style-type: none"> <li>■ Failure in internal circuit of motor encoder.</li> </ul>	<ul style="list-style-type: none"> <li>■ Replace the servo motor.</li> </ul>

■ 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	<ul style="list-style-type: none"> <li>■ Combination of servo amplifier and motor is incorrect.</li> </ul>	<ul style="list-style-type: none"> <li>■ Check the model number of servo amplifier and servo motor, and correct the combination.</li> </ul>
2	<ul style="list-style-type: none"> <li>■ Failure in internal circuit of motor encoder.</li> </ul>	<ul style="list-style-type: none"> <li>■ Replace the servo motor.</li> </ul>

■ Alarm Code F1 (Task Process Error)

Status at the time of alarm	Cause
	1
Issued during operation.	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. ■ Please check that the jitter of master frame is less than 5µs, and transmit the frame exactly.
3	■ Excessive 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. ■ Add ferrite core or similar countermeasures against noise.

■ Alarm Code FF (Self-flash timeout)

Status at the time of alarm	Cause
	1
Occurred during firmware re-writing by using Bootstrap mode.	V

Corrective actions

Cause		Investigation and corrective actions
1	■ Failure in the internal circuit of servo amplifier.	■ Replace the servo amplifier.

## 11.5 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 absolute encoder	Battery-less absolute encoder
A1	—	<ul style="list-style-type: none"> <li>Perform "Alarm reset" after "Encoder clear"</li> </ul>	<ul style="list-style-type: none"> <li>Perform "Alarm reset" after "Encoder clear"</li> <li>Power cycle</li> </ul>
A2	<ul style="list-style-type: none"> <li>Power cycle</li> </ul>	<ul style="list-style-type: none"> <li>Power cycle</li> </ul>	<ul style="list-style-type: none"> <li>Perform "Alarm reset" after "Encoder clear"</li> <li>Power cycle</li> </ul>
A3	<ul style="list-style-type: none"> <li>Perform "Alarm reset" after "Encoder clear"</li> <li>Power cycle</li> </ul>	<ul style="list-style-type: none"> <li>Perform "Alarm reset" after "Encoder clear"</li> <li>Power cycle</li> </ul>	<ul style="list-style-type: none"> <li>Perform "Alarm reset" after "Encoder clear"</li> <li>Power cycle</li> </ul>
A4	<ul style="list-style-type: none"> <li>Perform "Alarm reset" after "Encoder clear"</li> <li>Power cycle</li> </ul>	<ul style="list-style-type: none"> <li>Perform "Alarm reset" after "Encoder clear"</li> <li>Power cycle</li> </ul>	<ul style="list-style-type: none"> <li>Perform "Alarm reset" after "Encoder clear"</li> <li>Power cycle</li> </ul>
A5	<ul style="list-style-type: none"> <li>Power cycle</li> </ul>	<ul style="list-style-type: none"> <li>Power cycle</li> </ul>	<ul style="list-style-type: none"> <li>Perform "Alarm reset" after "Encoder clear"</li> <li>Power cycle</li> </ul>
A6	<ul style="list-style-type: none"> <li>Power cycle</li> </ul>	<ul style="list-style-type: none"> <li>Power cycle</li> </ul>	<ul style="list-style-type: none"> <li>Perform "Power-cycle". Then perform "Alarm reset" after "Encoder clear".</li> </ul>
A9	<ul style="list-style-type: none"> <li>Perform "Alarm reset"</li> </ul>	<ul style="list-style-type: none"> <li>Perform "Alarm reset"</li> </ul>	<ul style="list-style-type: none"> <li>Perform "Alarm reset"</li> </ul>
AA to AF	<ul style="list-style-type: none"> <li>Power cycle</li> </ul>	<ul style="list-style-type: none"> <li>Power cycle</li> </ul>	<ul style="list-style-type: none"> <li>Perform "Alarm reset" after "Encoder clear"</li> <li>Power cycle</li> </ul>

When performed encoder clearing, multi turn part of encoder position data is cleared. Operate after matching an encoder position data and mechanical coordinate.

## 11.6 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	√		Vibration	Check for excessive vibration.	Contact dealer/sales office.
	Daily	√		Sound	Check if there is no abnormal sound as compared to normal sound.	
	Periodic		√	Cleanliness	Check for dirt and dust.	Clean with cloth or air. Note 1)
	Yearly		√	Measure value of insulation resistance	Contact dealer or sales office.	
	5000 hours Note 2)		√	Replacement of oil seal		
Servo amplifier	Periodic		√	Cleaning	Check for dust accumulated in the accessories.	Clean with air. Note 1)
	Yearly		√	Loose screws	Check for loose connections.	Fasten the screws properly.
Battery for absolute encoder	Regularly Note 3)		√	Battery voltage	Confirm that battery voltage is more than DC3.6V.	Replace the Battery.
Temperature	Periodic	√		Measure temperature	Ambient temperature Motor frame temperature	Set the ambient temperature within the specified range. Check the load condition.

Note 1) 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.

## 11.7 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	Capacitor for smoothing main circuit	5 Years	Replacement with new part is necessary. Load ratio: 50% of rated output current of amplifier. Usage condition: Average temp. 40°C year-round.
2	Cooling Fan motor	5 Years	Replacement with new part is necessary. Usage condition: Average temp. 40°C year-round.
3	Lithium battery for absolute encoder [ER3VLY]	3 Years	Replacement with new part is necessary.
4	Electrolysis capacitor (other than condenser for smoothing main circuit)	5 Years	Replacement with new part is necessary. Usage condition: Average temp. 40°C year-round. Annual usage period is 4800 hours.
5	Fuse	10 Years	Replacement with new part is necessary.

#### ■ Capacitor for smoothing the main circuit

- ◆ If the servo amplifier is in use for more than 3 years, contact the dealer or sales office. The capacity of the capacitor for smoothing the main circuit is reduced due to the frequency of motor output current and main circuit power ON/ OFF during usage, and it may cause damage.
- ◆ When the capacitor is used with an average 40°C throughout the year, and exceeds more than 50% of the rated output current of servo amplifier, it is necessary to replace the condenser with a new part every 5 years.
- ◆ When used in an application where the power turn ON/OFF is repeated more than 30 times a day, consult our representatives.

#### ■ 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).
- ◆ R-Series servo amplifiers models RS2\*03, RS2\*05, RS2\*10, RS2\*15 and RS2\*30 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 absolute encoder

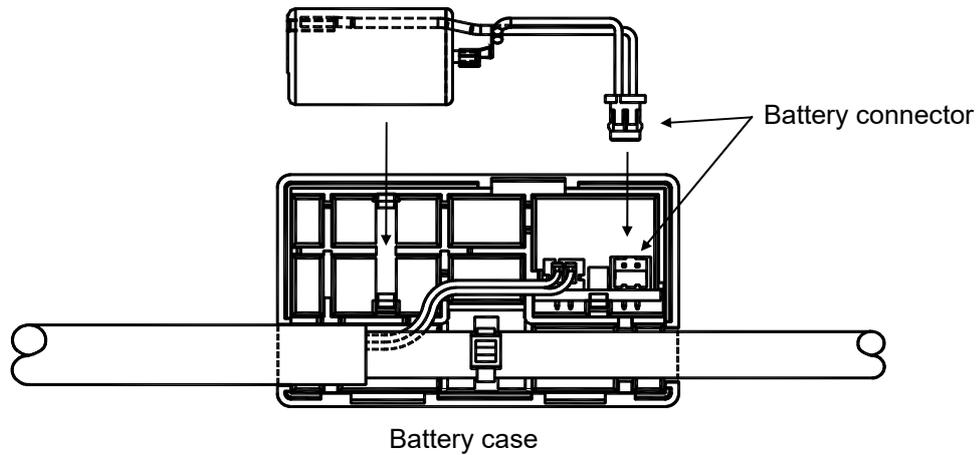
- ◆ The standard replacement period recommended by our company is the life expectancy of lithium battery based on normal usage conditions. However, if there is high frequency of turning the power ON/OFF, or the motor is not used for a long period, then the life of lithium battery is reduced. If the battery 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.

2) How to Replace the Battery 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 case.
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 case.

Lithium battery [AL-00697958-01]



If the battery is replaced while the control power is OFF, multiple rotation counter (position data) of the motor encoder may be instable. When the amplifier control power is turned ON in this status, an alarm (Absolute Encoder Error) may be issued. For this, execute encoder clear and alarm reset to release the alarm status. Also, absolute encoder position data may be instable. Check and adjust the relations between position data and machine coordinate system.

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# 12

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## 12. Fully-closed control

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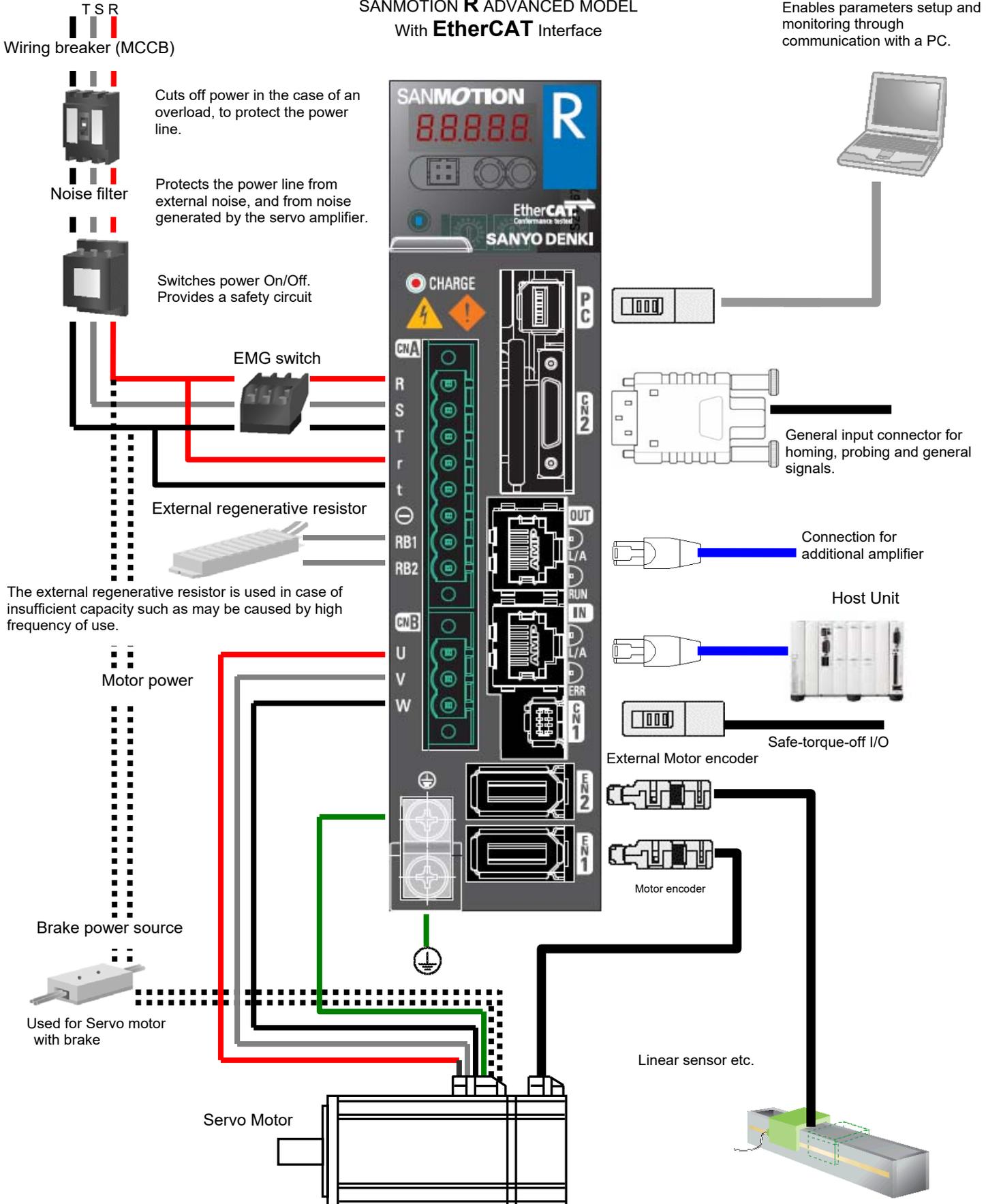
# 12.1 System configuration

■ RS2□01/RS2□03/ RS2□05

SANMOTION R ADVANCED MODEL  
With **EtherCAT** Interface

Software Setup

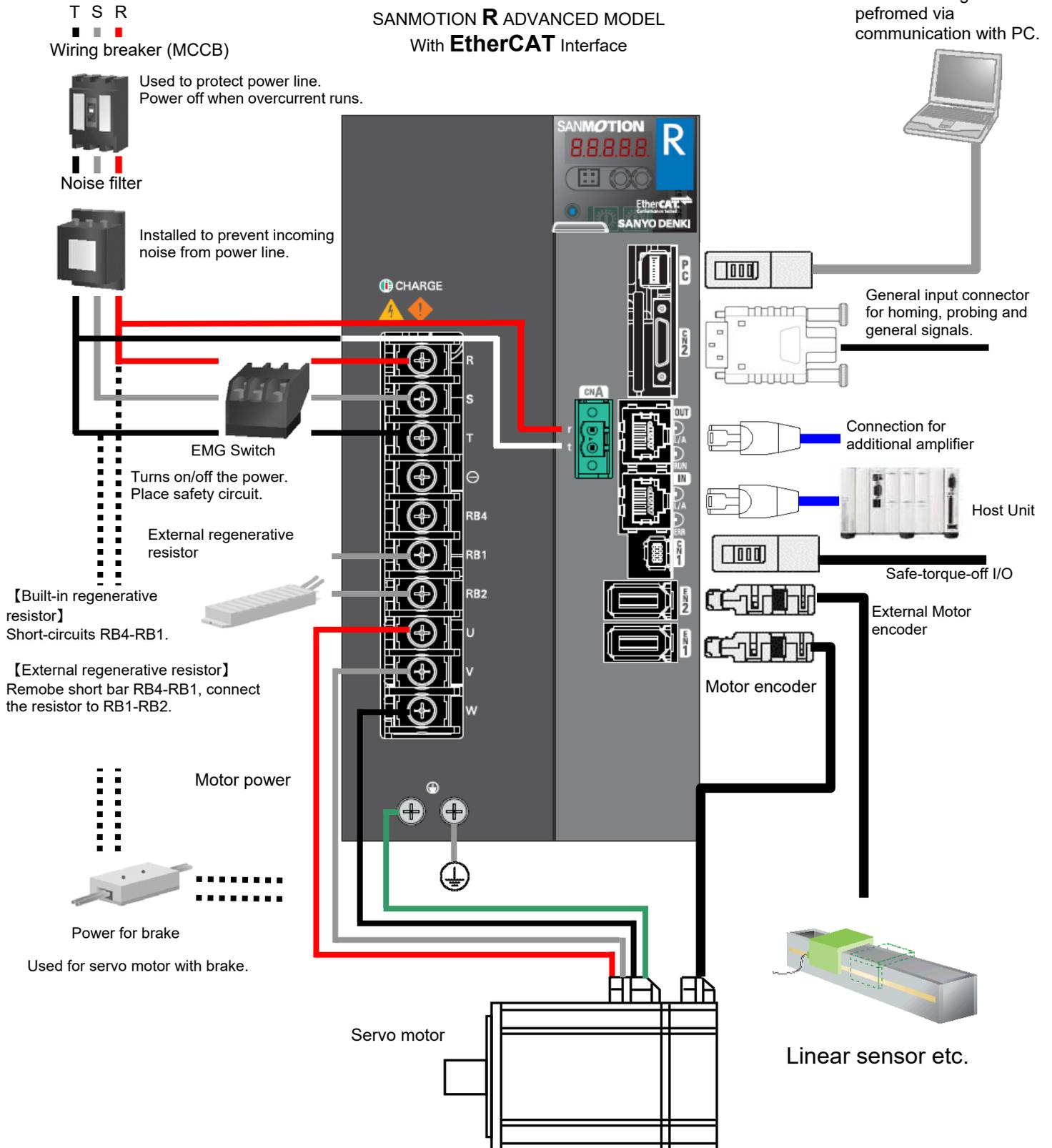
Enables parameters setup and monitoring through communication with a PC.

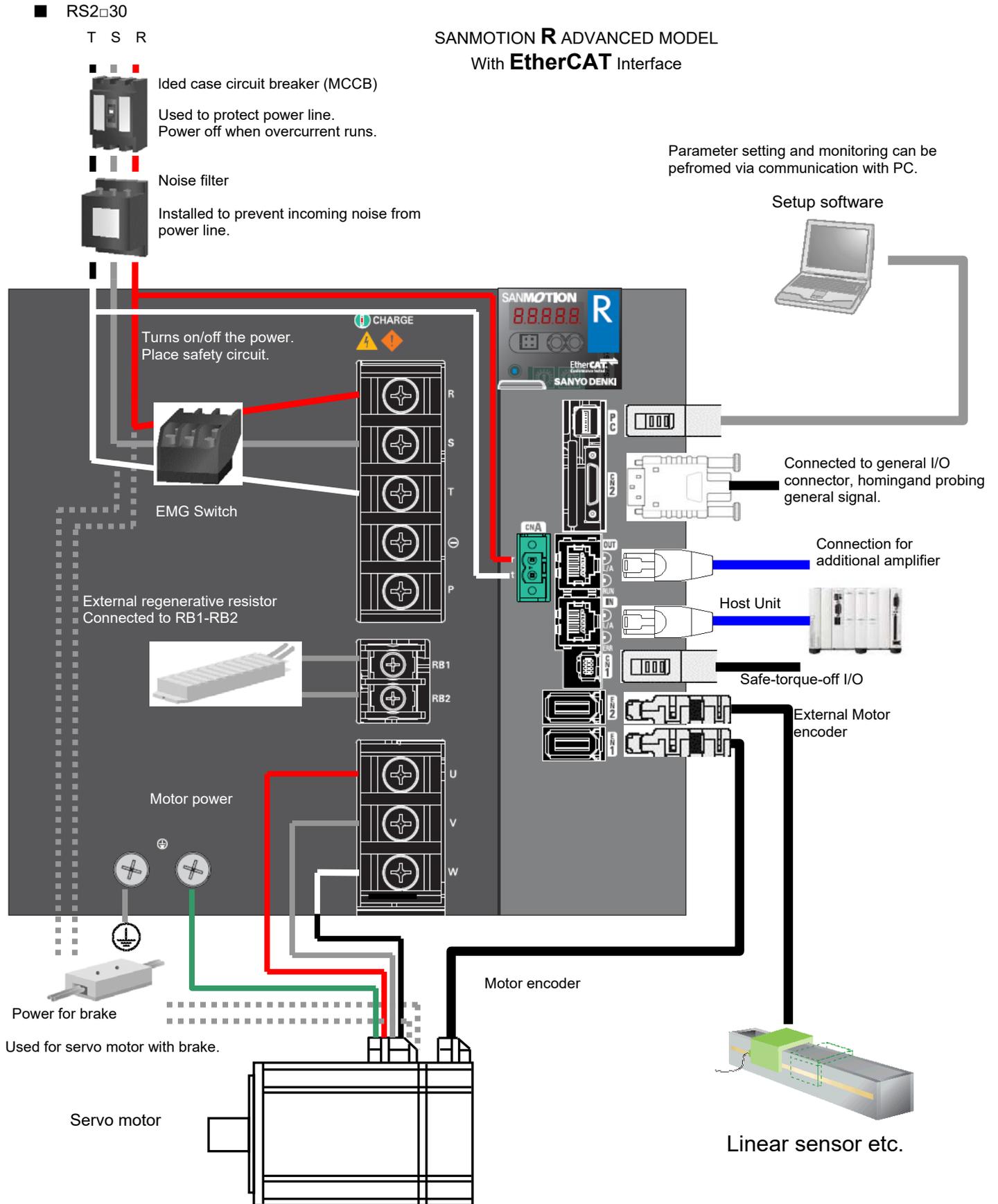


■ RS2□10/RS2□15

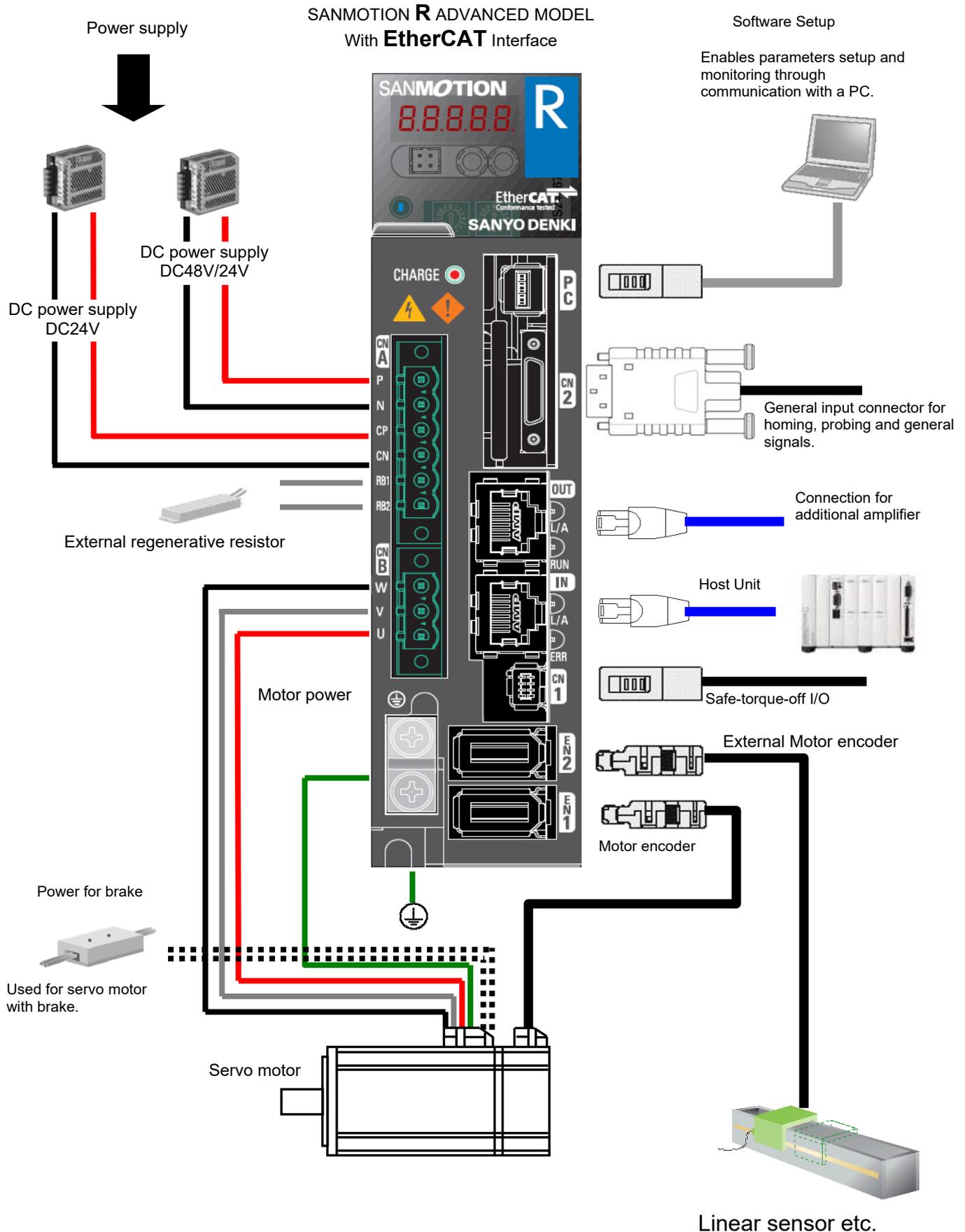
SANMOTION R ADVANCED MODEL  
With EtherCAT Interface

Setup software  
Parameter setting and monitoring can be performed via communication with PC.



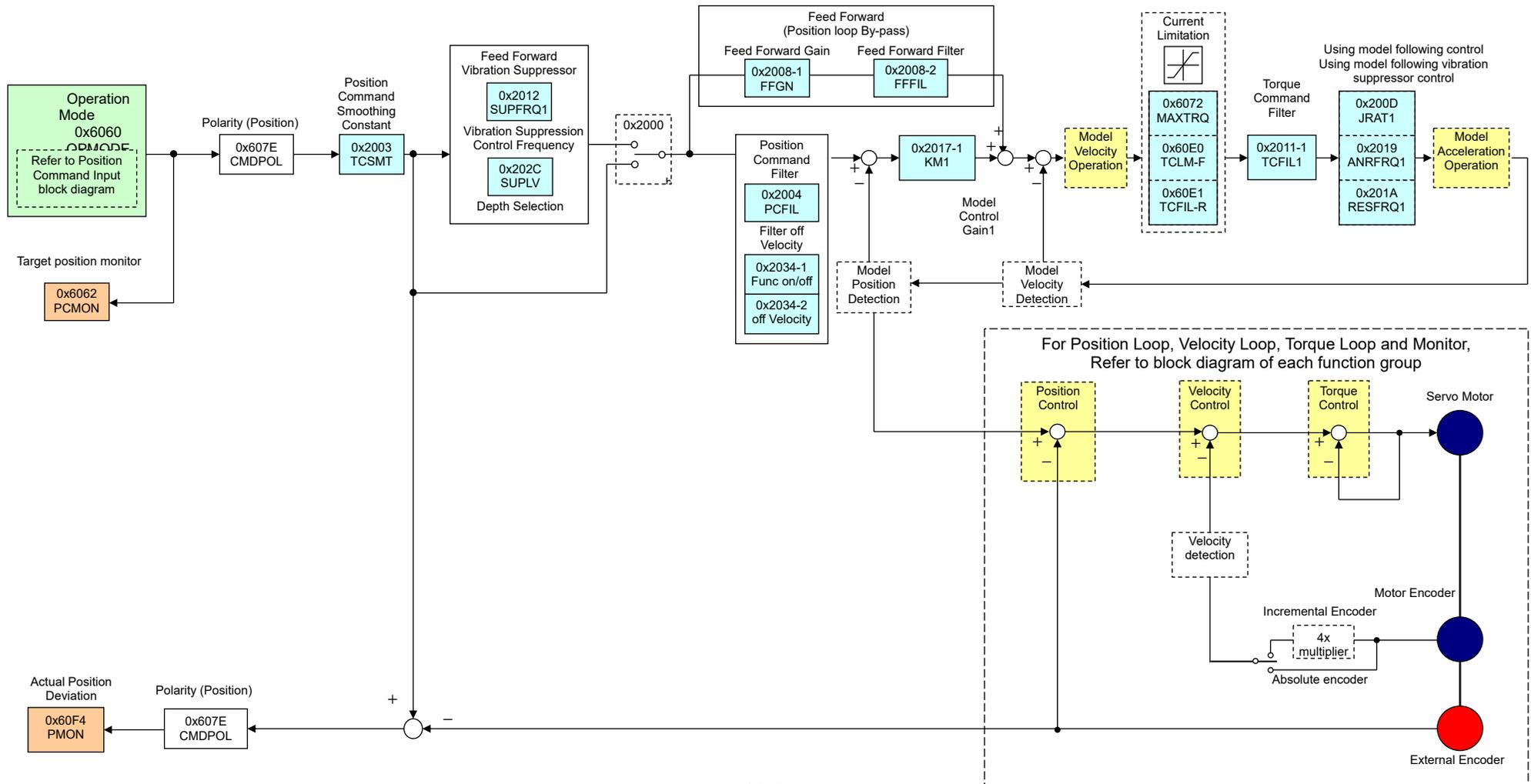


■ RS2□##A (DC48V/24V)

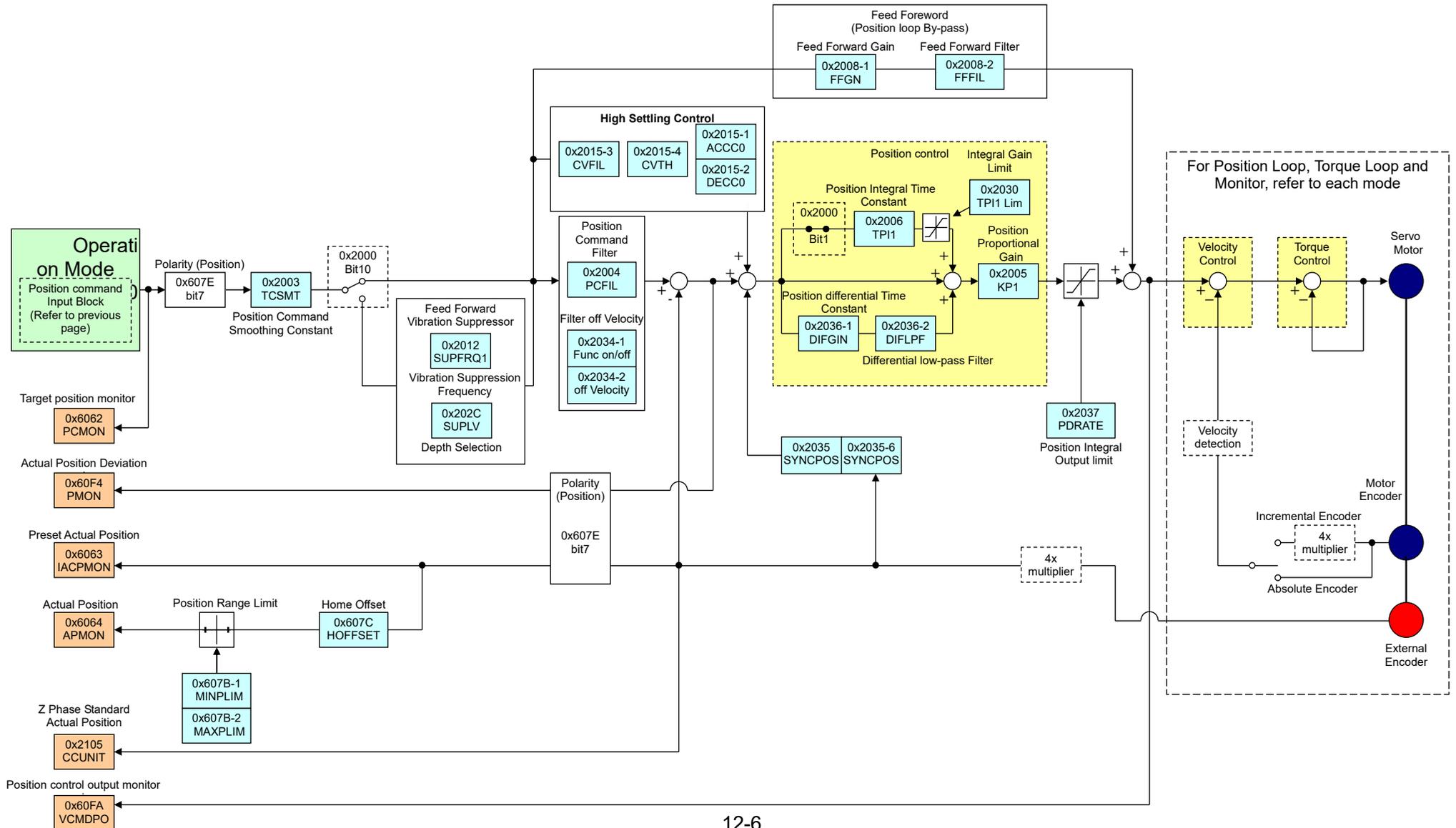


## 12.2 Internal Block Diagram

### 1) Block Diagram with Model Following Control



2) Block Diagram at no use of Model Following Control



## 12.3 Wiring

### 1) Connector name and function

EN2 terminal number and signal name for external encoder are shown below.

\* Refer to 4.3 "Motor Code Wiring" for the connection method of motor encoder (EN1).

■ EN2 External pulse encoder

EN2 Terminal No.	Signal name	Description	Note 1)
1	5V	Note 3)	Twisted pair
2	SG	Common power source Note 4)	
3	5V	Note 3)	Twisted pair
4	SG	Common power source Note 4)	
5	B	B phase pulse output	Twisted pair
6	/B		
7	A	A phase pulse output	Twisted pair
8	/A		
9	Z	C phase pulse output	Twisted pair
10	/Z		
Note 2)	Earth	Shield	-

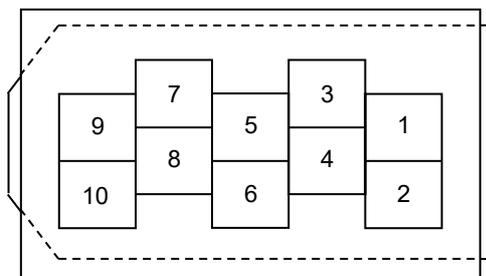
Note 1) Use an exterior covering shielded cable by a twisted pair.

Note 2) Connect shielded wire to metal case (ground) of EN2, and to ground on external incremental encoder.

Note 3) The 5 VDC power supply for an external incremental encoder should be prepared by the customer.

Note 4) Please connect a common power supply.

### 2) Terminal number



(Soldered side)

## 12.4 Fully-closed control related parameters

When using by full-closed control, please set a parameter as follows.  
 When using linear motor, fully closed control is not available.

### 1) System parameters settings

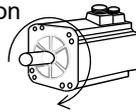
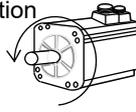
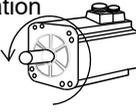
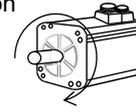
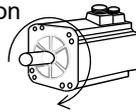
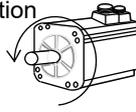
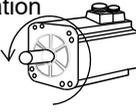
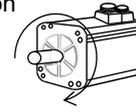
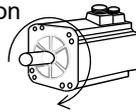
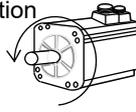
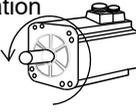
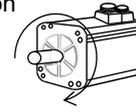
The System parameters have the following restrictions when Full-closed control is used for operation:  
 Full-closed control becomes valid when the Control mode is in [Positions control]. Full-closed operation is invalid with another Control mode except Positions control.  
 Only [Standard] and [Model following control] for Position control selection is valid.

Group ID	CoE Object ID	Contents													
System ID06	0x6060, 0x00 OPMODE	Operation mode ■ Setup Operation mode to the servo amplifier being used Set below.													
		<table border="1"> <thead> <tr> <th>Selection Value</th> <th colspan="2">Contents</th> </tr> </thead> <tbody> <tr> <td>01</td> <td>PP</td> <td>Profile position mode</td> </tr> <tr> <td>08</td> <td>CSP</td> <td>Cycle synchronous position mode</td> </tr> </tbody> </table>	Selection Value	Contents		01	PP	Profile position mode	08	CSP	Cycle synchronous position mode				
Selection Value	Contents														
01	PP	Profile position mode													
08	CSP	Cycle synchronous position mode													
System ID07	0x20F3, 0x01 PCNTSEL	Position Control Selection ■ Select functions of Position control mode Set below.													
		<table border="1"> <thead> <tr> <th>Selection Value</th> <th colspan="2">Contents</th> </tr> </thead> <tbody> <tr> <td>00</td> <td>Standard</td> <td>Standard</td> </tr> <tr> <td>01</td> <td>Model1</td> <td>Model following control</td> </tr> </tbody> </table>	Selection Value	Contents		00	Standard	Standard	01	Model1	Model following control				
Selection Value	Contents														
00	Standard	Standard													
01	Model1	Model following control													
System ID08	0x20F3, 0x02 PLMODE	Position Loop Control, Position Loop Encoder Selection ■ For the system [Full-closed control] is used. Select [Position loop control] method for the servo amplifier and select the encoder the servo amplifier is going to use for [Position loop control].													
		<table border="1"> <thead> <tr> <th>Selection Value</th> <th colspan="2">Contents</th> </tr> </thead> <tbody> <tr> <td>00</td> <td>Motor_Enc</td> <td>Semi-closed control/Motor encoder</td> </tr> <tr> <td>01</td> <td>External—Enc</td> <td>Full-closed control/External encoder</td> </tr> </tbody> </table> <p>■ Confirm and set below.</p> <table border="1"> <thead> <tr> <th>Current set Value</th> <th colspan="2">Contents</th> </tr> </thead> <tbody> <tr> <td>01 : External-Enc</td> <td colspan="2">Full-closed control/External encoder</td> </tr> </tbody> </table> <p>* Changes are not necessary for the system if [Full-closed control] is not used.</p>	Selection Value	Contents		00	Motor_Enc	Semi-closed control/Motor encoder	01	External—Enc	Full-closed control/External encoder	Current set Value	Contents		01 : External-Enc
Selection Value	Contents														
00	Motor_Enc	Semi-closed control/Motor encoder													
01	External—Enc	Full-closed control/External encoder													
Current set Value	Contents														
01 : External-Enc	Full-closed control/External encoder														
System ID09	0x20FF, 0x03 EXENCODE	External incremental Encoder Division Number ■ Set the external incremental encoder resolution per/pulse to be used for “Full-closed Control”. Set 1x multiplier number converted in 1 rotation of motor axis.													
		<p>* Position command becomes 4x multiplier resolution of this setting value.</p> <p>* External encoder is not corresponding to absolute sensor.</p> <p>* Changes are not necessary for the system if Full-closed control is not used.</p>													

2) Rotation direction setting for the servo motor

Rotation of the servo motor in Full-closed control is determined by Command polarity and External incremental encoder polarity.

■ Setting of Command input polarity

Group ID	CoE Object ID	Polarity																																				
Group8 ID00	0x607E, 0x00 CMDPOL	<p>■ Select Command polarity of Position command pulse from the following: The rotation of the servo motor is reversible without changing the command wiring. Rotational directions are as indicated below, depending on selected values and position command directions.</p> <table border="1"> <thead> <tr> <th colspan="2">Selection Value</th> <th>Position command positive</th> <th>Position command negative</th> </tr> </thead> <tbody> <tr> <td>00</td> <td>PC+_VC+_TC+</td> <td rowspan="4">                     CW Rotation  </td> <td rowspan="4">                     CCW Rotation  </td> </tr> <tr> <td>20</td> <td>PC+_VC+_TC-</td> </tr> <tr> <td>40</td> <td>PC+_VC-_TC+</td> </tr> <tr> <td>60</td> <td>PC+_VC-_TC-</td> </tr> <tr> <td colspan="2">"APMON"</td> <td>Current position monitor value decrease</td> <td>Current position monitor value increase</td> </tr> </tbody> </table> <table border="1"> <thead> <tr> <th colspan="2">Selection Value</th> <th>Position command positive</th> <th>Position command negative</th> </tr> </thead> <tbody> <tr> <td>80</td> <td>PC-_VC+_TC+</td> <td rowspan="4">                     CCW Rotation  </td> <td rowspan="4">                     CW Rotation  </td> </tr> <tr> <td>A0</td> <td>PC-_VC+_TC-</td> </tr> <tr> <td>C0</td> <td>PC-_VC-_TC+</td> </tr> <tr> <td>E0</td> <td>PC-_VC-_TC-</td> </tr> <tr> <td colspan="2">"APMON"</td> <td>Current position monitor value increase</td> <td>Current position monitor value decrease</td> </tr> </tbody> </table>	Selection Value		Position command positive	Position command negative	00	PC+_VC+_TC+	CW Rotation 	CCW Rotation 	20	PC+_VC+_TC-	40	PC+_VC-_TC+	60	PC+_VC-_TC-	"APMON"		Current position monitor value decrease	Current position monitor value increase	Selection Value		Position command positive	Position command negative	80	PC-_VC+_TC+	CCW Rotation 	CW Rotation 	A0	PC-_VC+_TC-	C0	PC-_VC-_TC+	E0	PC-_VC-_TC-	"APMON"		Current position monitor value increase	Current position monitor value decrease
		Selection Value		Position command positive	Position command negative																																	
		00	PC+_VC+_TC+	CW Rotation 	CCW Rotation 																																	
		20	PC+_VC+_TC-																																			
		40	PC+_VC-_TC+																																			
		60	PC+_VC-_TC-																																			
		"APMON"		Current position monitor value decrease	Current position monitor value increase																																	
		Selection Value		Position command positive	Position command negative																																	
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C0	PC-_VC-_TC+																																					
E0	PC-_VC-_TC-																																					
"APMON"		Current position monitor value increase	Current position monitor value decrease																																			

■ Setting of External Encoder input polarity

Group ID	CoE Object ID	External Encoder Polarity Selection															
GroupC ID03	0x20F1, 0x04 EX-ENPOL	<p>■ Setup Signal polarity of External incremental encoder</p> <table border="1"> <thead> <tr> <th colspan="2">Selection Value</th> <th colspan="3">Contents</th> </tr> </thead> <tbody> <tr> <td>00</td> <td>Type1</td> <td>EX-Z/ No inversion</td> <td>EX-B/ No inversion</td> <td>EX-A/ No inversion</td> </tr> <tr> <td>01</td> <td>Type2</td> <td>EX-Z/ No inversion</td> <td>EX-B/ No inversion</td> <td>EX-A/ Inversion</td> </tr> </tbody> </table> <p>Set: [External incremental encoder signal polarity] as the increase and decrease of "EX-APMON" External position monitor (External encoder) becomes same as "AMPON" Current position monitor (Motor encoder).</p> <p><b>Note)</b> Becomes valid with Control power reactivation.</p>	Selection Value		Contents			00	Type1	EX-Z/ No inversion	EX-B/ No inversion	EX-A/ No inversion	01	Type2	EX-Z/ No inversion	EX-B/ No inversion	EX-A/ Inversion
		Selection Value		Contents													
		00	Type1	EX-Z/ No inversion	EX-B/ No inversion	EX-A/ No inversion											
01	Type2	EX-Z/ No inversion	EX-B/ No inversion	EX-A/ Inversion													

### 3) Setting for external encoder resolution

- Setting of External Encoder input pulse number

Group ID	CoE Object ID	External Encoder Division Setting Number				
System ID09	0x20FF, 0x03 ENPENRES	<ul style="list-style-type: none"> <li>■ Set the external incremental encoder resolution to be used for Full-closed control.</li> <li>■ Input the pulse number converted in 1 rotation of motor axis.</li> </ul> <table border="1"> <thead> <tr> <th>Setting range</th> <th>Unit</th> </tr> </thead> <tbody> <tr> <td>500 to 99999 (1 multiplier)</td> <td>P/R</td> </tr> </tbody> </table> <p>[Example]</p> <ul style="list-style-type: none"> <li>◆ The minimum resolution of the External incremental encoder to be used: 1.0μm</li> <li>◆ Work moving distance of 1 rotation of the motor axis: 10mm</li> </ul> <p>External incremental encoder minimum resolution: 1.0μm &gt;&gt; converted pulse number per 1mm &gt; &gt;1000P/mm.          Converted pulse number per 1mm from the External pulse encoder's minimum resolution:          1mm becomes 1000P/mm.  <math>10\text{mm}/1\text{R} \times 1000\text{P}/\text{mm} = 10000\text{P}/\text{R}</math> (4x multiplier), since the moving distance of work for 1 motor axis is 10 mm.          Set: <math>10000/4 = 2500\text{P}/\text{R}</math> (setting value is 1x multiplier) Round off decimals.</p> <p>Note) Becomes valid with Control power reactivation.</p>	Setting range	Unit	500 to 99999 (1 multiplier)	P/R
Setting range	Unit					
500 to 99999 (1 multiplier)	P/R					

### 4) Digital filter setting

- Setting of External Encoder input pulse number

Group ID	CoE Object ID	External Incremental Encoder Digital Filter																		
Group C ID02	0x20F1, 0x03 EX-ENFIL	<ul style="list-style-type: none"> <li>■ Setting Digital filter of External incremental encoder</li> </ul> <p>When noise is superimposed on the External incremental encoder, the pulse below set value is removed as noise.</p> <p>Set this value by considering the resolution of the encoder and the maximum rotation speed of the servo motor.</p> <p>Set the value below <math>\frac{1}{4}</math> to the Encoder pulse width under peak motor rotation speed as a standard.</p> <table border="1"> <thead> <tr> <th>Selection Value</th> <th>Contents</th> </tr> </thead> <tbody> <tr> <td>00</td> <td>110 ns Minimum pulse width=110 ns (Minimum phase difference=37.5 ns)</td> </tr> <tr> <td>01</td> <td>220 ns Minimum pulse width =220 ns</td> </tr> <tr> <td>02</td> <td>440 ns Minimum pulse width =440 ns</td> </tr> <tr> <td>03</td> <td>880 ns Minimum pulse width =880 ns</td> </tr> <tr> <td>04</td> <td>75 ns Minimum pulse width=75 ns (Minimum phase difference=37.5 ns)</td> </tr> <tr> <td>05</td> <td>150 ns Minimum pulse width =150 ns</td> </tr> <tr> <td>06</td> <td>300 ns Minimum pulse width =300 ns</td> </tr> <tr> <td>07</td> <td>600 ns Minimum pulse width =600 ns</td> </tr> </tbody> </table> <p>The diagram shows three digital signals: A-phase, B-phase, and Z-phase. A-phase and B-phase are square waves with a phase shift between them. Z-phase is a single pulse. Labels indicate 'Pulse width' for the A-phase and B-phase pulses, and 'Phase difference' between the rising edges of A-phase and B-phase.</p>	Selection Value	Contents	00	110 ns Minimum pulse width=110 ns (Minimum phase difference=37.5 ns)	01	220 ns Minimum pulse width =220 ns	02	440 ns Minimum pulse width =440 ns	03	880 ns Minimum pulse width =880 ns	04	75 ns Minimum pulse width=75 ns (Minimum phase difference=37.5 ns)	05	150 ns Minimum pulse width =150 ns	06	300 ns Minimum pulse width =300 ns	07	600 ns Minimum pulse width =600 ns
Selection Value	Contents																			
00	110 ns Minimum pulse width=110 ns (Minimum phase difference=37.5 ns)																			
01	220 ns Minimum pulse width =220 ns																			
02	440 ns Minimum pulse width =440 ns																			
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04	75 ns Minimum pulse width=75 ns (Minimum phase difference=37.5 ns)																			
05	150 ns Minimum pulse width =150 ns																			
06	300 ns Minimum pulse width =300 ns																			
07	600 ns Minimum pulse width =600 ns																			

## 12.5 Remarks

### 1) Input power timing for the external incremental encoder

- Please provide the power supply for the External incremental encoder on your own.
- Turn the power ON before or at the same time of inputting the Control power to the servo amplifier.  
If there is more than 1s delay from the Control power input, [AL83 Alarm] (encoder connector 2 wire down) may occur.

### 2) Workings of the external incremental encoder

- There is a possibility that the servo motor could run out of control under the following conditions: Check the External incremental encoder before servo-ON excitation to determine if it has any problems.
  - ◆ The count direction (increase/decrease)  
[APMON: Current position monitor (Monitor encoder)] and [EX-APMON: External position monitor (External encoder)] changes to reverse.
    - \* Change External incremental Encoder Polarity Selection and set it to the same count direction (increase/decrease)
  - ◆ When the workings of the External incremental encoder are cut off:
    - \* Use them under the condition where the external incremental encoder is mechanically connected.

# 13

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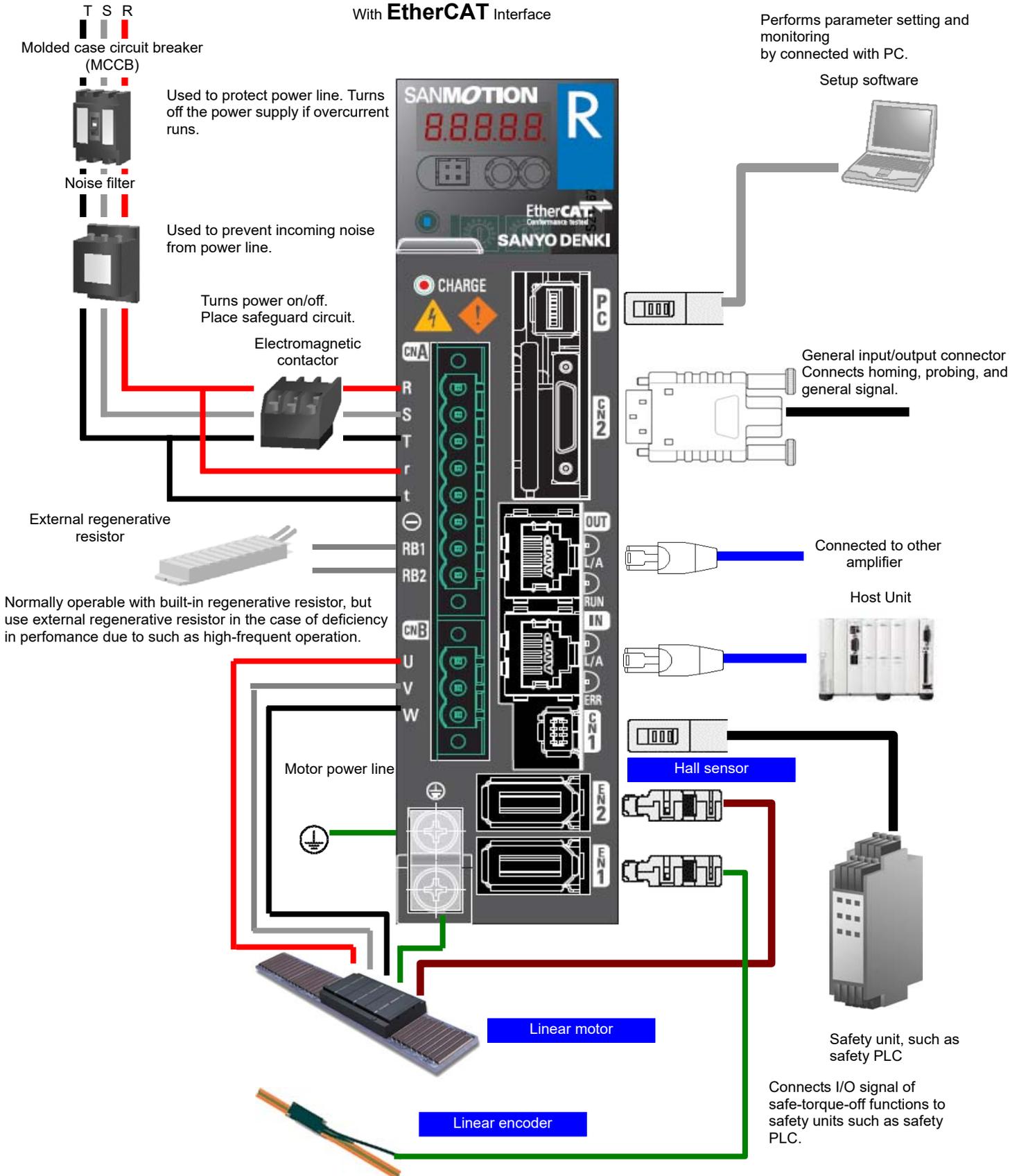
## 13.Linear motor

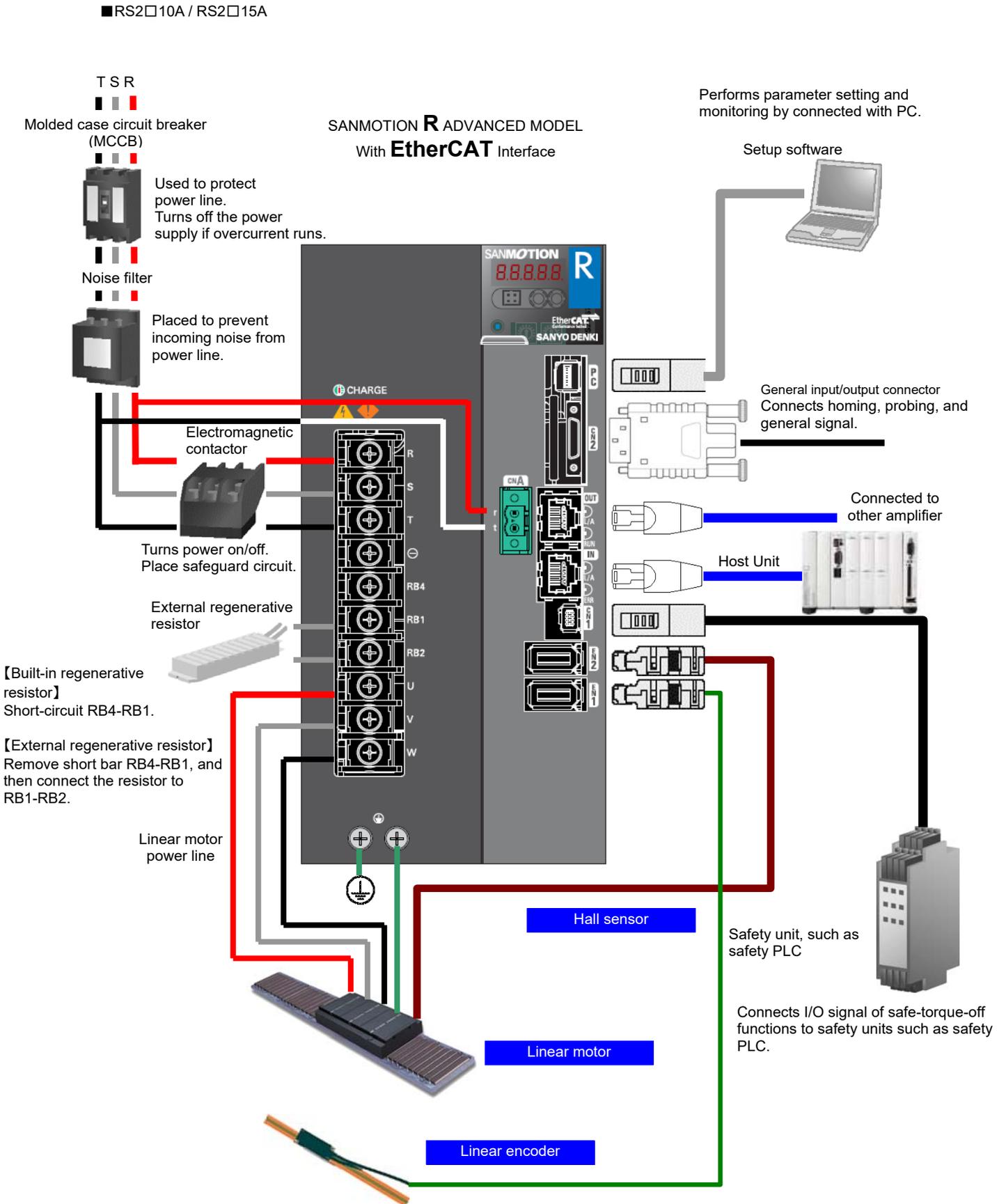
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4)	Precautions in operation .....	13-19
5)	System parameter .....	13-20

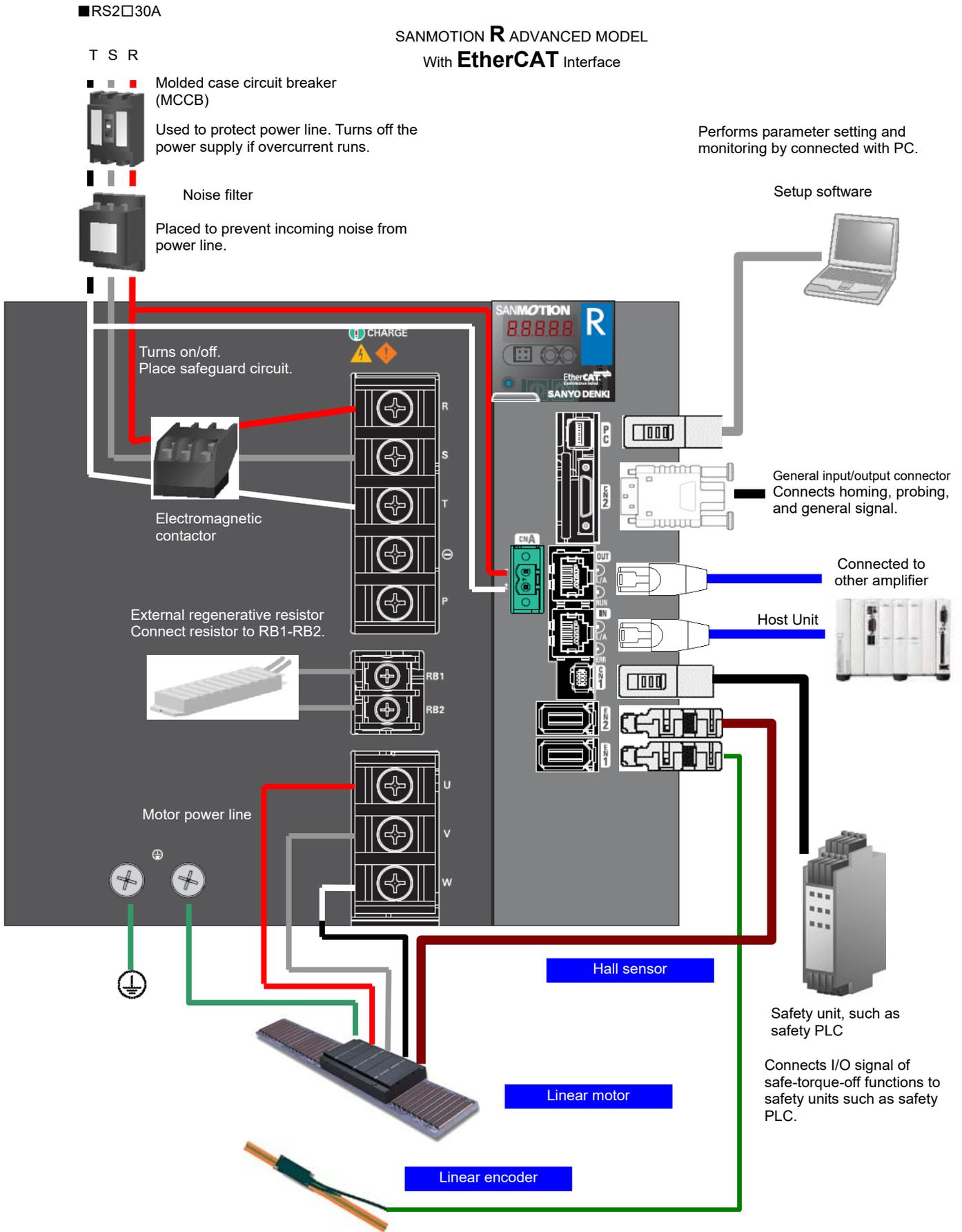
### 13.1 System configuration diagram

RS2□01A / RS2□03A / RS2□05A

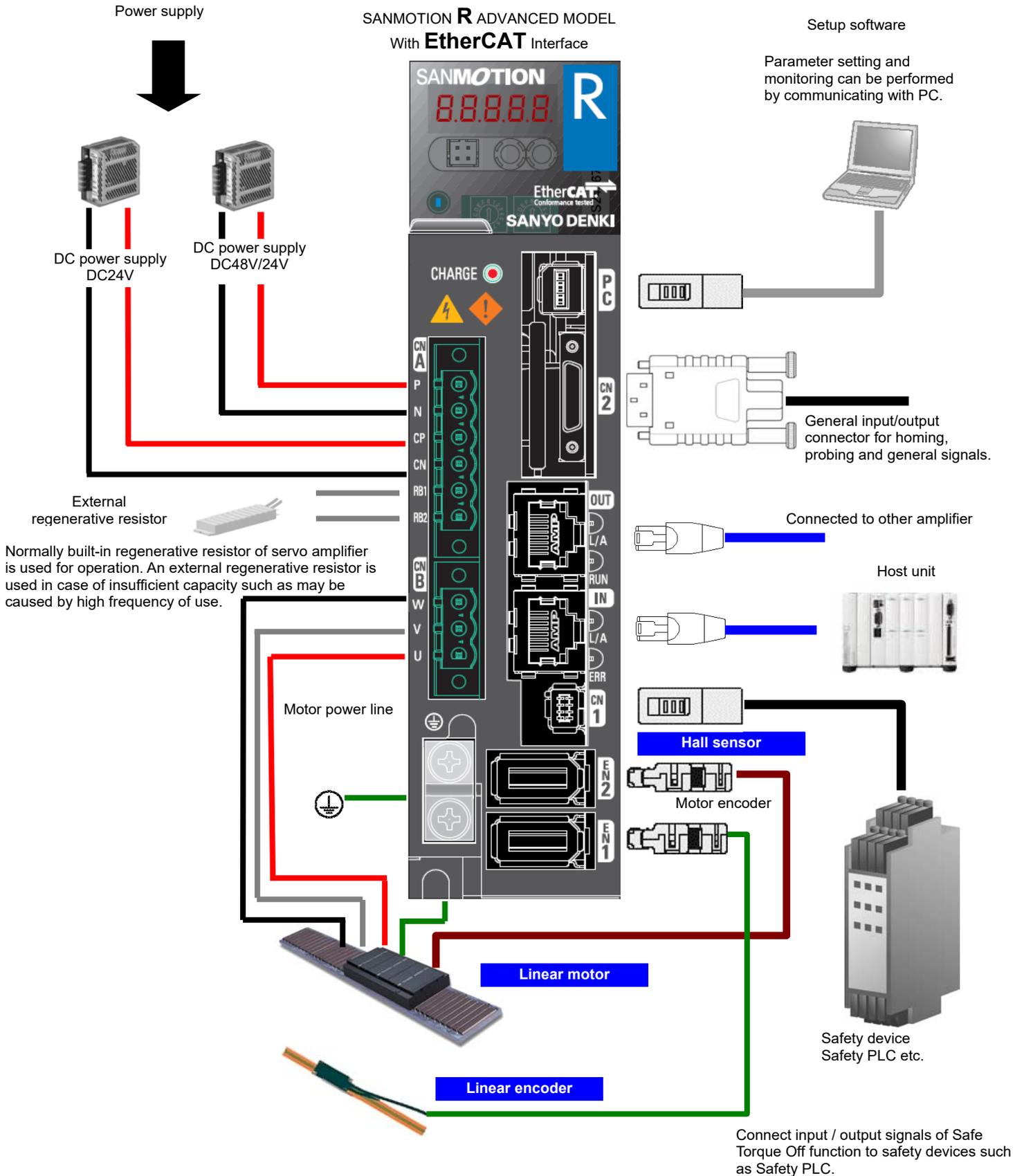
SANMOTION R ADVANCED MODEL  
With **EtherCAT** Interface







■RS2□##A (DC48V/24V)



## 13.2 Wiring

### 1) Recommended specification for encoder cable

Shielded many-to-one cable	Cable rating	80°C 30V
	Conductor resistance value	1 Ω or less Note1)
	Conductor size	AWG size: 26 to 18 Sq. (mm <sup>2</sup> ): 0.15 to 0.75

Note1) Shows conductor resistance value for the conductor length to be actually used.

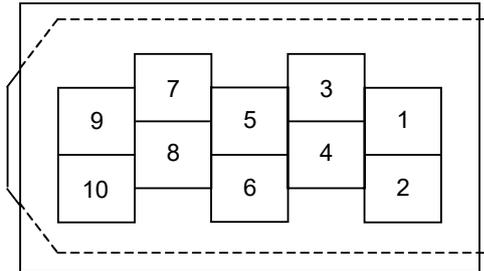
### 2) Encoder cable length

Maximum cable lengths by conductor size of power (5V, SG) cable

Conductor size		Conductor resistance Ω / km (20°C)	Length (m)
AWG	26	150 or less	5
	24	100 or less	10
	22	60 or less	15
	20	40 or less	25
	18	25 or less	40
Sq. (mm <sup>2</sup> )	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) Terminal numbers on servo amplifier



Solder connection

\* Please make sure to check wiring as wiring varies depending on encoder types to be connected.

■ Connector model number (Product of 3M Japan Ltd.)

	Model number	Applicable wire size	Applicable cable outer diameter
Connector	36210-0100PL	AWG30 to AWG18	-
Shellkit	36310-3200-008	-	φ 7 to φ 9

## 4) Connector names and functions

The following shows terminal numbers and signal names of linear scale sensor EN1.

■ Linear sensor EN1 (Incremental differential output)

EN2 Terminal number	Signal name	Description	Remarks Note1)
1	5V	Note3)	Twisted-pair
2	SG	Power supply common Note4)	
3	5V	Note3)	Twisted-pair
4	SG	Power supply common Note4)	
5	B	Phase B position signal pulse output	Twisted-pair
6	/B		
7	A	Phase A position signal pulse output	Twisted-pair
8	/A		
9	Z	Phase Z position signal pulse output	Twisted-pair
10	/Z		
Note2)	Ground	Shielded	-

\* Shows terminal numbers and signal names of hall sensor EN2.

■ Hall sensor EN2 (differential output)

EN2 Terminal number	Signal name	Description	Remarks Note1)
1	5V	Note3)	Twisted-pair
2	SG	Power supply common Note4)	
3	5V	Note3)	Twisted-pair
4	SG	Power supply common Note4)	
5	S2	Phase V signal output	Twisted-pair
6	/S2		
7	S1	Phase U signal output	Twisted-pair
8	/S1		
9	S3	Phase W signal output	Twisted-pair
10	/S3		
Note2)	Ground	Shielded	-

■ Hall sensor EN2 (Open collector output)

EN2 Terminal number	Signal name	Description	Remarks Note1)
1	5V	Note3)	Twisted-pair
2	SG	Power supply common Note4)	
3	5V	Note3)	Twisted-pair
4	SG	Power supply common Note4)	
5	S2	Phase V signal output	—
6	—	—	NC
7	S1	Phase U signal output	—
8	—	—	NC
9	S3	Phase W signal output	—
10	—	—	NC
Note2)	Ground	Shielded	-

Note1) Use shielded twisted-pair cable.

Note2) Connect shielded cables to metal case (ground) on EN1 and EN2 respectively, and to the ground on external incremental encoder.

Note3) Please prepare power supply for external incremental encoder, as the power supply is not included in this system.

Note4) Make sure to connect power supply common.

### 13.3 Linear motor control-related parameters

Set the parameters as follows to use linear motor.

#### 1) Setting of system parameter

Group ID	CoE Object ID	Contents																												
System ID02	0x20FE, 0x00 MOCODE	Motor code																												
		<p>■ Set combination motor code you use. Set the combination motor code by selecting the linear motor code you use from “section 1.6, list of combination motor” or “section7, OD: 0x20FE motor code.”</p> <p>✓ For the case of 0xFFFF whose motor code is specific, make sure to download motor parameters from setup software.</p> <p>⚡ System parameter becomes effective on re-power on.</p>																												
System ID03	0x20FF, 0x01 ENCODE	Encoder division number code																												
		<p>■ Set division number of linear scale sensor you use.</p> <table border="0"> <tr><td>0x0000</td><td>: 5μm</td><td>[200P/mm]</td></tr> <tr><td>0x0001</td><td>: 2.5μm</td><td>[400P/mm]</td></tr> <tr><td>0x0002</td><td>: 2μm</td><td>[500P/mm]</td></tr> <tr><td>0x0003</td><td>: 1.25μm</td><td>[800P/mm]</td></tr> <tr><td>0x0004</td><td>: 1μm</td><td>[1,000P/mm]</td></tr> <tr><td>0x0005</td><td>: 0.5μm</td><td>[2,000P/mm]</td></tr> <tr><td>0x0006</td><td>: 0.25μm</td><td>[4,000P/mm]</td></tr> <tr><td>0x0007</td><td>: 0.125μm</td><td>[8,000P/mm]</td></tr> <tr><td>0x0008</td><td>: 0.1μm</td><td>[10,000P/mm]</td></tr> <tr><td>0x0009</td><td>: 0.05μm</td><td>[20,000P/mm]</td></tr> </table> <p>⚡ System parameter becomes effective on re-power on.</p>	0x0000	: 5μm	[200P/mm]	0x0001	: 2.5μm	[400P/mm]	0x0002	: 2μm	[500P/mm]	0x0003	: 1.25μm	[800P/mm]	0x0004	: 1μm	[1,000P/mm]	0x0005	: 0.5μm	[2,000P/mm]	0x0006	: 0.25μm	[4,000P/mm]	0x0007	: 0.125μm	[8,000P/mm]	0x0008	: 0.1μm	[10,000P/mm]	0x0009
0x0000	: 5μm	[200P/mm]																												
0x0001	: 2.5μm	[400P/mm]																												
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0x0007	: 0.125μm	[8,000P/mm]																												
0x0008	: 0.1μm	[10,000P/mm]																												
0x0009	: 0.05μm	[20,000P/mm]																												
System ID04	0x20FF, 0x02 ENTTYPE	Encoder type code																												
		<p>■ Set linear sensor and CS-normalization method you use.</p> <p>0x0800: signal/ A, B, Z + S1·S2·S3 : CS-normalization/ EU</p> <p>0x0810: signal/ A, B, Z + S1·S2·S3 : CS-normalization/ phase Z</p> <p>0x0820: signal/ A, B, Z + S1·S2·S3 : CS-normalization/ none</p> <p>0x0830: signal/ wire-saving incremental encoder : CS-normalization/ phase Z</p> <p>0x0840: signal/ wire-saving incremental encoder : CS-normalization/ none</p> <p>0x0850: signal/ A, B, Z only: CS-normalization/ Software setting (Magnetic pole position estimation)</p> <p>0x0860: signal/ A, B, Z only: CS-normalization/ Software setting (fixed excitation)</p> <p>⚡ System parameter becomes effective on re-power on.</p>																												
System ID06	0x6060, 0x00 OPMODE	Operational mode																												
		<p>■ Set operational mode for the servo amplifier you use. Set as follows.</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>Value to select</th> <th colspan="2">Contents</th> </tr> </thead> <tbody> <tr> <td>01</td> <td>PP</td> <td>Profile position mode</td> </tr> <tr> <td>...</td> <td>...</td> <td>...</td> </tr> <tr> <td>0A</td> <td>CST</td> <td>Cycle synchronization torque mode</td> </tr> </tbody> </table>	Value to select	Contents		01	PP	Profile position mode	...	...	...	0A	CST	Cycle synchronization torque mode																
Value to select	Contents																													
01	PP	Profile position mode																												
...	...	...																												
0A	CST	Cycle synchronization torque mode																												
System ID08	0x20F3, 0x02 PLMODE	Encoder selection to control position loop																												
		<p>■ Verify the set value is as indicated below.</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>Present set value</th> <th>Contents</th> </tr> </thead> <tbody> <tr> <td>00: External-Enc</td> <td>Semi-closed control/ motor encoder</td> </tr> </tbody> </table>	Present set value	Contents	00: External-Enc	Semi-closed control/ motor encoder																								
Present set value	Contents																													
00: External-Enc	Semi-closed control/ motor encoder																													

2) Setting of linear scale sensor

CS-detection method of linear motor varies depending on system parameter “System ID03” or “OD:0x20FF, 0x01 Encoder type code.” Verify the following parameter settings.

Group ID	CoE Object ID	Contents																
GroupC ID01	0x20F1, 0x02 ENFIL	Encoder digital filter selection (EN1)																
		<p>■ Set digital filter for motor incremental 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.</p> <table border="1"> <thead> <tr> <th>Value to select</th> <th>Contents</th> </tr> </thead> <tbody> <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> </tbody> </table>	Value to select	Contents	00: _110nsec	Minimum pulse width =110ns (Minimum phase difference37.5ns)	01: _220nsec	Minimum pulse width =220ns (Minimum phase difference75ns)	02: _440nsec	Minimum pulse width =440ns (Minimum phase difference150ns)	03: _880nsec	Minimum pulse width =880ns (Minimum phase difference300ns)	04: _75nsec	Minimum pulse width = 75ns (Minimum phase difference37.5ns)	05: _150nsec	Minimum pulse width = 150ns (Minimum phase difference75ns)	06: _300nsec	Minimum pulse width =300ns (Minimum phase difference150ns)
Value to select	Contents																	
00: _110nsec	Minimum pulse width =110ns (Minimum phase difference37.5ns)																	
01: _220nsec	Minimum pulse width =220ns (Minimum phase difference75ns)																	
02: _440nsec	Minimum pulse width =440ns (Minimum phase difference150ns)																	
03: _880nsec	Minimum pulse width =880ns (Minimum phase difference300ns)																	
04: _75nsec	Minimum pulse width = 75ns (Minimum phase difference37.5ns)																	
05: _150nsec	Minimum pulse width = 150ns (Minimum phase difference75ns)																	
06: _300nsec	Minimum pulse width =300ns (Minimum phase difference150ns)																	
07: _600nsec	Minimum pulse width =600ns (Minimum phase difference300ns)																	
GroupC ID0A	0x20F1, 0x07 ENCDIR	Linear sensor polarity selection (EN1)																
		<p>■ <sup>U</sup>J Select linear encoder (EN1) signal polarity. Phase A and B signal polarity are selectable.</p> <table border="1"> <thead> <tr> <th>Value to select</th> <th>Contents</th> </tr> </thead> <tbody> <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> </tbody> </table> <p>⚡Function enabled on re-turning control power on.</p>	Value to select	Contents	00	Standard	Phase B signal rises in first in forward direction operation.	01	Reversed	Phase A signal rises in first in forward direction operation.								
Value to select	Contents																	
00	Standard	Phase B signal rises in first in forward direction operation.																
01	Reversed	Phase A signal rises in first in forward direction operation.																

3) Setting of magnetic pole position estimation method

CS-detection method of linear motor varies depending on system parameter “System ID04” or “OD:0x20FF, 0x02 sensor type code.” Verify the following parameter settings.

Group ID	CoE Object ID	Contents																																											
GroupC ID02	0x20F1, 0x03 EX-ENFIL	Hall sensor digital filter selection (External encoder digital filter selection)																																											
		<p>■ Set digital filter of hall sensor input signal. When noises are superimposed on hall sensor signal, pulse under the set value shall be removed as noise.</p> <table border="1"> <thead> <tr> <th>Value to select</th> <th>Contents</th> </tr> </thead> <tbody> <tr> <td>00: 110nsec</td> <td>Minimum pulse width = 110ns (Minimum phase difference 37.5ns)</td> </tr> <tr> <td>01: 220nsec</td> <td>Minimum pulse width = 220ns (Minimum phase difference 75ns)</td> </tr> <tr> <td>02: 440nsec</td> <td>Minimum pulse width = 440ns (Minimum phase difference 150ns)</td> </tr> <tr> <td>03: 880nsec</td> <td>Minimum pulse width = 880ns (Minimum phase difference 300ns)</td> </tr> <tr> <td>04: 75nsec</td> <td>Minimum pulse width = 75ns (Minimum phase difference 37.5ns)</td> </tr> <tr> <td>05: 150nsec</td> <td>Minimum pulse width = 150ns (Minimum phase difference 75ns)</td> </tr> <tr> <td>06: 300nsec</td> <td>Minimum pulse width = 300ns (Minimum phase difference 150ns)</td> </tr> <tr> <td>07: 600nsec</td> <td>Minimum pulse width = 600ns (Minimum phase difference 300ns)</td> </tr> </tbody> </table>	Value to select	Contents	00: 110nsec	Minimum pulse width = 110ns (Minimum phase difference 37.5ns)	01: 220nsec	Minimum pulse width = 220ns (Minimum phase difference 75ns)	02: 440nsec	Minimum pulse width = 440ns (Minimum phase difference 150ns)	03: 880nsec	Minimum pulse width = 880ns (Minimum phase difference 300ns)	04: 75nsec	Minimum pulse width = 75ns (Minimum phase difference 37.5ns)	05: 150nsec	Minimum pulse width = 150ns (Minimum phase difference 75ns)	06: 300nsec	Minimum pulse width = 300ns (Minimum phase difference 150ns)	07: 600nsec	Minimum pulse width = 600ns (Minimum phase difference 300ns)																									
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01: 220nsec	Minimum pulse width = 220ns (Minimum phase difference 75ns)																																												
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06: 300nsec	Minimum pulse width = 300ns (Minimum phase difference 150ns)																																												
07: 600nsec	Minimum pulse width = 600ns (Minimum phase difference 300ns)																																												
Group C ID03	0x20F1, 0x04 EX-ENPOL	Hall sensor polarity selection (External encoder polarity selection)																																											
		<p>■ Set polarity of hall sensor input signal.</p> <table border="1"> <thead> <tr> <th>Value to select</th> <th colspan="4">Contents</th> </tr> </thead> <tbody> <tr> <td>00</td> <td>Type1</td> <td>S3/ not reversed</td> <td>S2/ not reversed</td> <td>S1/ not reversed</td> </tr> <tr> <td>01</td> <td>Type2</td> <td>S3/ not reversed</td> <td>S2/ not reversed</td> <td>S1/ reversed</td> </tr> <tr> <td>02</td> <td>Type3</td> <td>S3/ not reversed</td> <td>S2/ reversed</td> <td>S1/ not reversed</td> </tr> <tr> <td>03</td> <td>Type4</td> <td>S3/ not reversed</td> <td>S2/ reversed</td> <td>S1/ reversed</td> </tr> <tr> <td>04</td> <td>Type5</td> <td>S3/ not reversed</td> <td>S2/ not reversed</td> <td>S1/ not reversed</td> </tr> <tr> <td>05</td> <td>Type6</td> <td>S3/ reversed</td> <td>S2/ not reversed</td> <td>S1/ reversed</td> </tr> <tr> <td>06</td> <td>Type7</td> <td>S3/ reversed</td> <td>S2/ reversed</td> <td>S1/ not reversed</td> </tr> <tr> <td>07</td> <td>Type8</td> <td>S3/ reversed</td> <td>S2/ reversed</td> <td>S1/ reversed</td> </tr> </tbody> </table> <p>✓Encoder type code: 0x20FF, 01=0x0800, 0x0810, and 0x0820 need to be set. ⚡Function enabled on re-turning control power on.</p>	Value to select	Contents				00	Type1	S3/ not reversed	S2/ not reversed	S1/ not reversed	01	Type2	S3/ not reversed	S2/ not reversed	S1/ reversed	02	Type3	S3/ not reversed	S2/ reversed	S1/ not reversed	03	Type4	S3/ not reversed	S2/ reversed	S1/ reversed	04	Type5	S3/ not reversed	S2/ not reversed	S1/ not reversed	05	Type6	S3/ reversed	S2/ not reversed	S1/ reversed	06	Type7	S3/ reversed	S2/ reversed	S1/ not reversed	07	Type8	S3/ reversed
Value to select	Contents																																												
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05	Type6	S3/ reversed	S2/ not reversed	S1/ reversed																																									
06	Type7	S3/ reversed	S2/ reversed	S1/ not reversed																																									
07	Type8	S3/ reversed	S2/ reversed	S1/ reversed																																									
System ID16	0x20F1, 0x05 CSOF	<p>CS-offset</p> <p>■ 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. Setting range : 0 to 359deg Initial value : 330deg</p> <p>✓Encoder type code: 0x20FF, 02=0x0800, 0x0810, 0x0820, 0x0830, 0x0840, 0x0850 and 0x0860 need to be set. ⚡ Function enabled on re-turning control power on.</p>																																											
System ID17	0x20F1, 0x06 ZPHOF	<p>Phase Z CS-normalization offset</p> <p>■ 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. Setting range : 0 to 359deg Initial value : 330deg</p> <p>✓Encoder type code: 0x20FF, 02=0x0810, 0x0830 need to be set. ⚡ Function enabled on re-turning control power on.</p>																																											

Group ID	CoE Object ID	Contents																										
GroupB ID0C	0x20F1, 0x08 EMPFREQ	<p>Magnetic pole position estimation frequency</p> <ul style="list-style-type: none"> <li>■ Set frequency of torque (force) applied at magnetic pole position estimation. Setting range : 5 to 100Hz Initial value : 50Hz</li> <li>✓ Change excitation frequency when detection cannot be normally completed due to resonance point of machine, at amplifier hardware magnetic pole position estimation.</li> <li>🔌 Function enabled on re-power on.</li> </ul>																										
—	0x20F1, 0x09 CSETMD	<p>Magnetic pole position estimation mode selection</p> <ul style="list-style-type: none"> <li>■ Set the magnetic pole position estimation run mode.</li> </ul> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 15%;">Value to select</th> <th>Contents</th> </tr> </thead> <tbody> <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> </tbody> </table> <ul style="list-style-type: none"> <li>✓ Encoder Classification Cord : 0x20FF, Function will be enabled by setting 02=0x0850.</li> <li>🔌 Function enabled on re-power on.</li> </ul>	Value to select	Contents	00	Follow the setting of the valid condition of magnetic pole position pointing function.	01	Magnetic pole position estimation will run one time automatically only after turning on the main power.																				
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00	Follow the setting of the valid condition of magnetic pole position pointing function.																											
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Group9 ID22	0x20F8, 0x06 CSET	<p>Magnetic pole position pointing function</p> <ul style="list-style-type: none"> <li>■ Set valid condition of magnetic pole position estimation, for linear motor without hall sensor output function.</li> </ul> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 20%;">Value to select</th> <th>Contents</th> </tr> </thead> <tbody> <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> </tbody> </table> <ul style="list-style-type: none"> <li>✓ Input time to become all the function enabled is 8ms.</li> </ul>	Value to select	Contents	02: _CONT1_ON	Function enabled when general input CONT1 is ON.	03: _CONT1_OFF	Function enabled when general input CONT1 is OFF.	04: _CONT2_ON	Function enabled when general input CONT2 is ON.	05: _CONT2_OFF	Function enabled when general input CONT2 is OFF.	06: _CONT3_ON	Function enabled when general input CONT3 is ON.	07: _CONT3_OFF	Function enabled when general input CONT3 is OFF.	08: _CONT4_ON	Function enabled when general input CONT4 is ON.	09: _CONT4_OFF	Function enabled when general input CONT4 is OFF.	0A: _CONT5_ON	Function enabled when general input CONT5 is ON.	0B: _CONT5_OFF	Function enabled when general input CONT5 is OFF.	0C: _CONT6_ON	Function enabled when general input CONT6 is ON.	0D: _CONT6_OFF	Function enabled when general input CONT6 is OFF.
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0C: _CONT6_ON	Function enabled when general input CONT6 is ON.																											
0D: _CONT6_OFF	Function enabled when general input CONT6 is OFF.																											
Group9 ID02	0x20F8, 0x03 EXT-E	<p>External trop-input function</p> <p>Set the condition that trip input becomes effective to use thermal of linear motor.</p> <ul style="list-style-type: none"> <li>■ The setting contents are the same as the above magnetic pole position indication function.</li> <li>✓ Input time to become all the function enabled is 8ms.</li> </ul>																										

### 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	CoE Object ID	Contents															
Group8 ID00	0x607E, 0x00 CMDPOL	<p><b>Polarity</b></p> <p>■ Select position command polarity from the following contents.                      Servo motor moving direction can be reversed without changing command wiring.                      Moving direction is set as follows when command increased.                      Moving direction of linear motor shall be changed as follows depending on selected values and position command directions.</p>															
		<table border="1"> <thead> <tr> <th colspan="2">Value to select</th> <th>Position command "plus"</th> </tr> </thead> <tbody> <tr> <td>00</td> <td>PC+_VC+_TC+</td> <td rowspan="4"> <p>Movement in forward direction</p> </td> </tr> <tr> <td>20</td> <td>PC+_VC+_TC-</td> </tr> <tr> <td>40</td> <td>PC+_VC-_TC+</td> </tr> <tr> <td>60</td> <td>PC+_VC-_TC-</td> </tr> <tr> <td colspan="2">"APMON"</td> <td>The value on present position monitor decreases.</td> </tr> </tbody> </table>	Value to select		Position command "plus"	00	PC+_VC+_TC+	<p>Movement in forward direction</p>	20	PC+_VC+_TC-	40	PC+_VC-_TC+	60	PC+_VC-_TC-	"APMON"		The value on present position monitor decreases.
		Value to select		Position command "plus"													
		00	PC+_VC+_TC+	<p>Movement in forward direction</p>													
		20	PC+_VC+_TC-														
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		60	PC+_VC-_TC-														
		"APMON"		The value on present position monitor increases.													
		<table border="1"> <thead> <tr> <th colspan="2">Value to select</th> <th>Position command "plus"</th> </tr> </thead> <tbody> <tr> <td>80</td> <td>PC-_VC+_TC+</td> <td rowspan="4"> <p>Movement in reverse direction</p> </td> </tr> <tr> <td>A0</td> <td>PC-_VC+_TC-</td> </tr> <tr> <td>C0</td> <td>PC-_VC-_TC+</td> </tr> <tr> <td>E0</td> <td>PC-_VC-_TC-</td> </tr> <tr> <td colspan="2">"APMON"</td> <td>The value on present position monitor increases.</td> </tr> </tbody> </table>	Value to select		Position command "plus"	80	PC-_VC+_TC+	<p>Movement in reverse direction</p>	A0	PC-_VC+_TC-	C0	PC-_VC-_TC+	E0	PC-_VC-_TC-	"APMON"		The value on present position monitor increases.
Value to select		Position command "plus"															
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C0	PC-_VC-_TC+																
E0	PC-_VC-_TC-																
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Value to select		Position command "minus"															
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C0	PC-_VC-_TC+																
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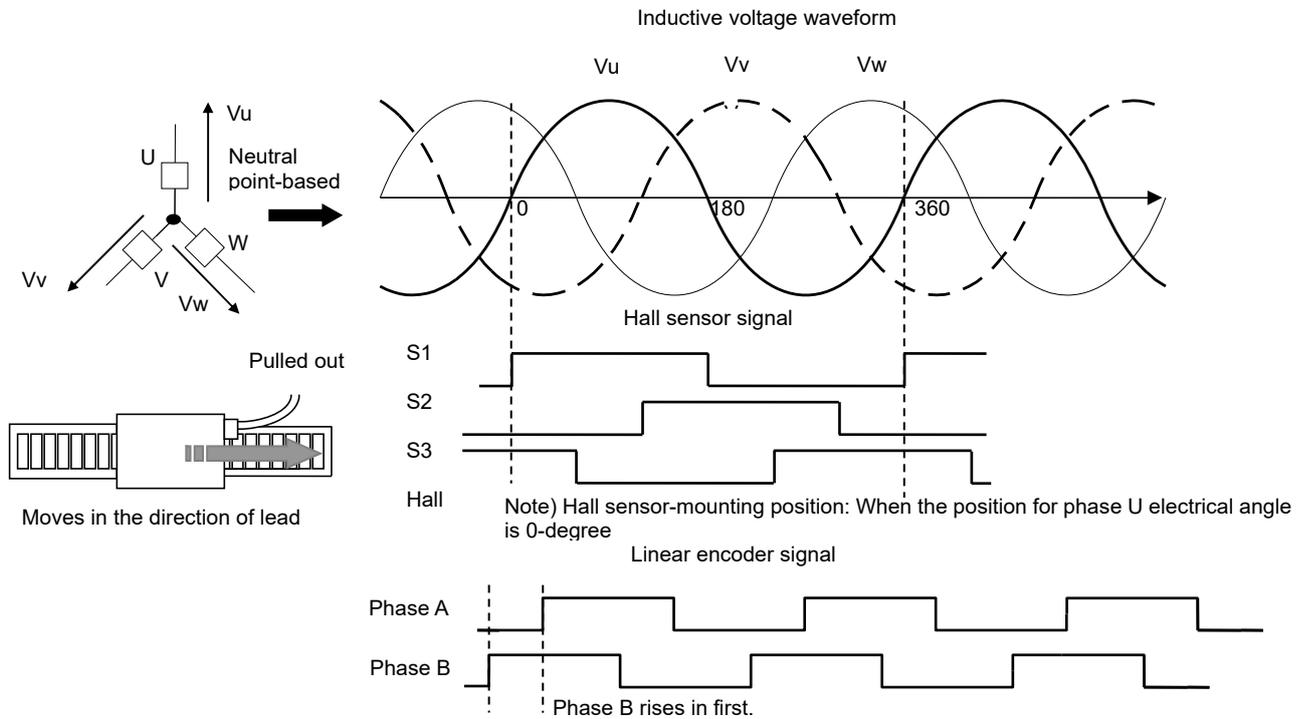
### 13.4 Precautions

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

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

2) Setting of parameters to combine amplifier and motor

- Set “motor parameter” for the liner motor you use.
- Maximum moving rate shall be limited by resolution of the linear encoder you use. When using linear motor at maximum moving rate, set “motor incremental encoder digital filter setting value (standard setting value [minimum pulse width =220nsec] of factory setting)” of “Group C, ID01 or OD:0x20F1, 0x02 ENFIL” to the setting value of minimum pulse width or less that is calculated by the following formula.
- When connecting phase sequence or porality of motor power line, linear encoder signal line, and hall sensor signal line (when you use) is not incorrect, there may be at a risk of loss of control. Perform wiring so that the relation between each phase of voltage induced by motoro and each signal shall be as indicated in the figure below when moving linear motor in the direction of power line pulled out of linear motor core.



- “Linear encoder resolution” is set to 1μm (multiplier ratio 1:4) 1000P/mm at factory setting. So select and set the linear encoder resolution you use from “System ID03” or “OD:0x20FF, 0x01 ENCODE.”
- When using “motor thermal,” connect motor thermal wire to any of CONT1 through CONT6, and then setting condition “Group 9, ID02 or 0x20F8, 0x03 EXT-E” of the connected “CONT\*” to “external trip function.”
- When using hall sensor, set the mounting position of hall sensor to phase U electrical angle to System ID16 or “CS offset of 0x20F1, 0x05 CSOF.”

3) Automatic Magnetic Pole Position Estimation Function

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

### 13.5 Cylinder type linear servo motor (DE series)

Below shows description of cylinder type linear servo motor (hereinafter "cylinder linear motor").

#### 1) Precautions on handling

- Operation by person with expertise

Transportation, installation, wiring, operation, maintenance, and inspection shall be performed by person with expertise.

- Always keep the product surface clean

If you use a motor in an environment such as magnetic powder or dust, the magnetic powder or dust, etc., will get caught in the moving part and cause malfunction. Keep the product surface and mover surface clean at all times.

- Do not apply any impacts on the system

Attention should be given to ensure not to apply any impacts to cylinder linear motor when installing.

- Prohibition of corrosive liquid and gas

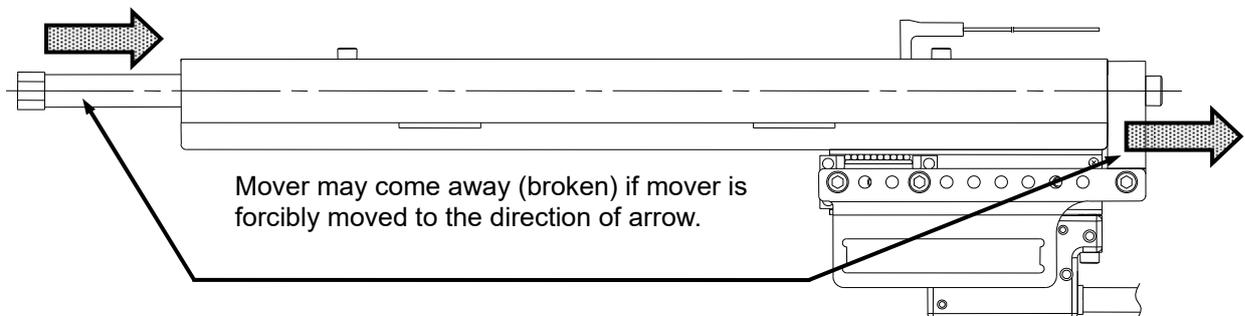
Never use the systems where corrosive (such as acid, alkali), flammable, and explosive liquids or gases exist.

- Do not apply any external force to the mover

Be careful not to apply excessive external force to the movable element or forcibly move it.

- Pay attention to the mover comes away

Mover may come away (broken) if applying force like as arrow below beyond stroke range. Take care with attention.



- Do not hold the motor cables

Do not carry or mount the motor by holding the power lines or the linear encoder cable.

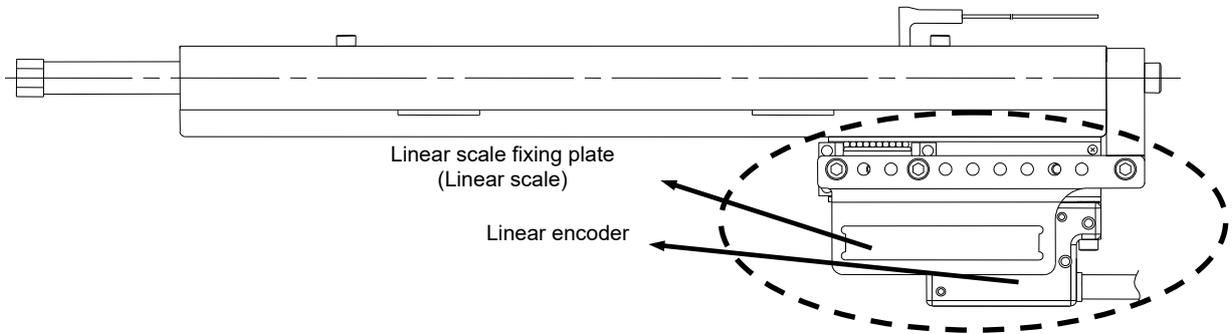
- Do not give any shock to the linear encoder

Do not apply external force or shock to the linear encoder and the linear encoder scale fixing plate. In the unlikely event that deformation of encoder scale fixing plate occurs due to external force or impact, please contact us without using the motor.

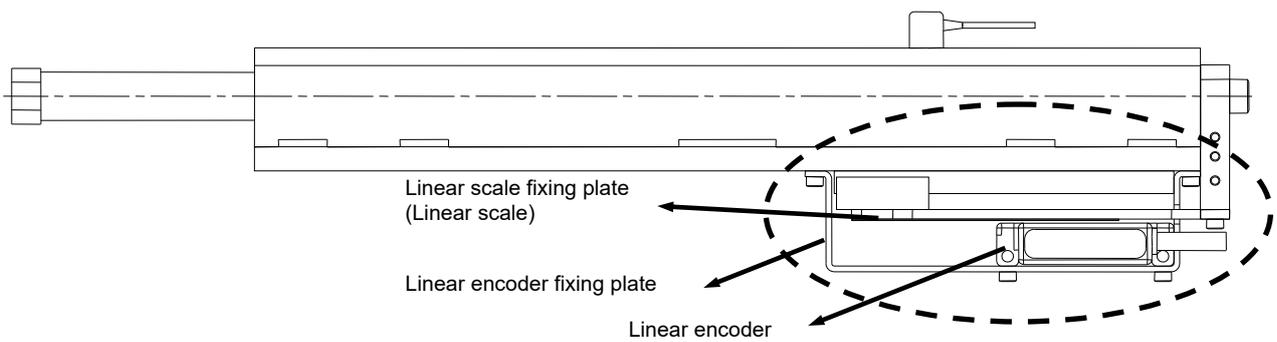
■ Keep the linear encoder clean

Keep the linear encoder and linear encoder scale clean. Be especially careful not to adhere oil, grease, fingerprint, etc., to the detection window and linear scale of the linear encoder.

◆ DE0AC001A03CX00

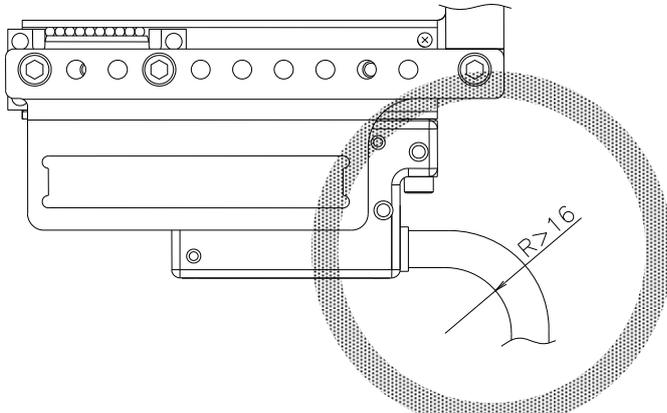


◆ DE0BC005A05CX00

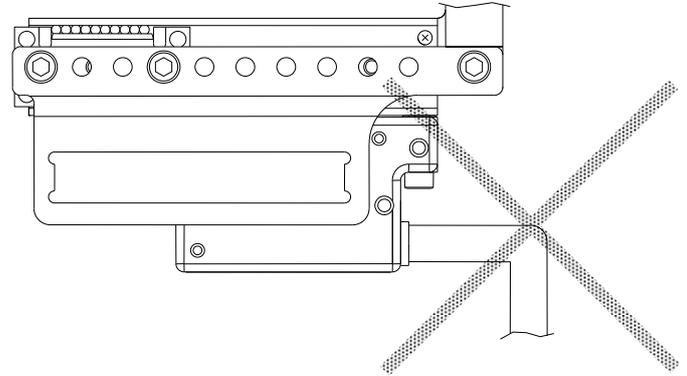


- Do not bend the linear encoder cable at a right angle
  - Do not use the linear encoder cable which it is bent at right angle. Especially, please do not bend the linear encoder mounting part (root) at the right angle.
  - Fix and make sure it is more than 16 mm in radius.

DE0AC001A03CX00

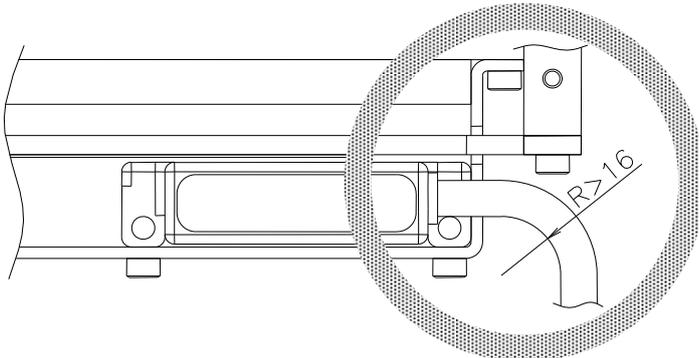


Cable root radius is 16 mm or more (OK)

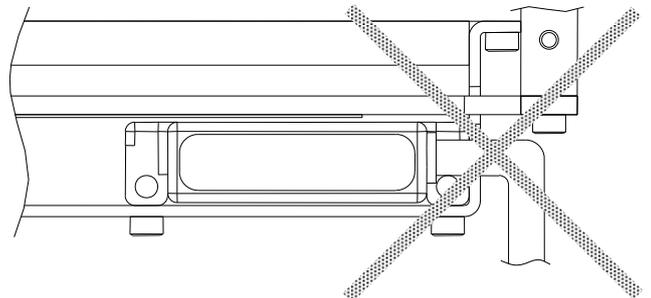


Cable root is right angle (NG)

DE0BC005A05CX00



Cable root radius is 16 mm or more (OK)

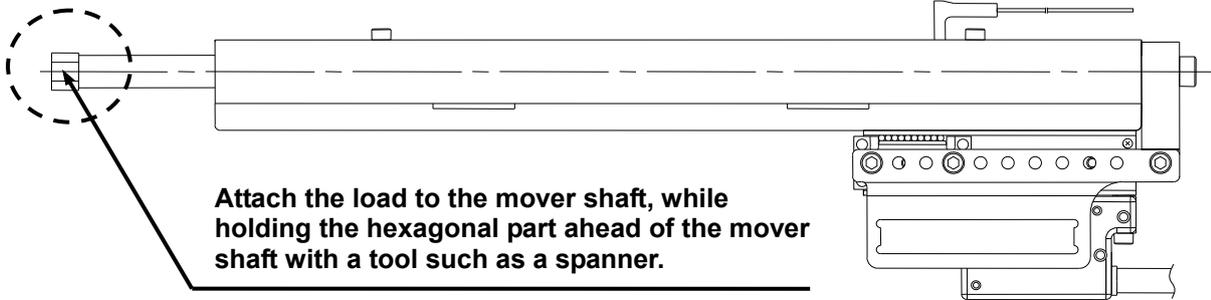


Cable root is right angle (NG)

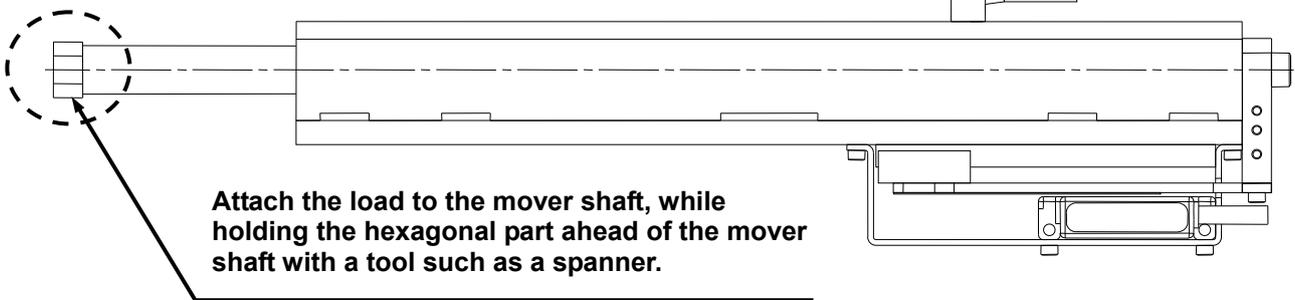
■ When mounting a load, do not apply a moment to the mover shaft

Applying an excessive moment to the top part of the mover shaft causes a stress to the linear encoder scale fixing plate on the rear of the shaft, and may result in deformation of the scale fixing plate. Please fix the load to the mover shaft without applying moment to the shaft.

◆ DE0AC001A03CX00



◆ DE0BC005A05CX00



■ Observe the permissible shaft load

Install and operate the motor, in conditions not exceeding permissible shaft load.

◆ DE0AC001A03CX00

Permissible shaft load

Assembling		Operating			*Installation of the load like chart below. 
Momental load*1(N·m)	Radial load (N)		Radial load (N)		
M	Direction FR1	Direction FR2	Direction FR1	Direction FR2	
0.2	1.5	1.5	1.0	1.0	

◆ DE0BC005A05CX00

Permissible shaft load

Assembling		Operating			*Installation of the load like chart below. 
Momental load*1(N·m)	Radial load (N)		Radial load (N)		
M	Direction FR1	Direction FR2	Direction FR1	Direction FR2	
0.4	3.0	3.0	1.5	1.5	

2) Precautions on wiring

■ Wiring between equipments

Please exactly the wiring between equipments.

Incorrect wiring may result in abnormal operation of any damages to linear servo motor.

■ No insulation resistance test

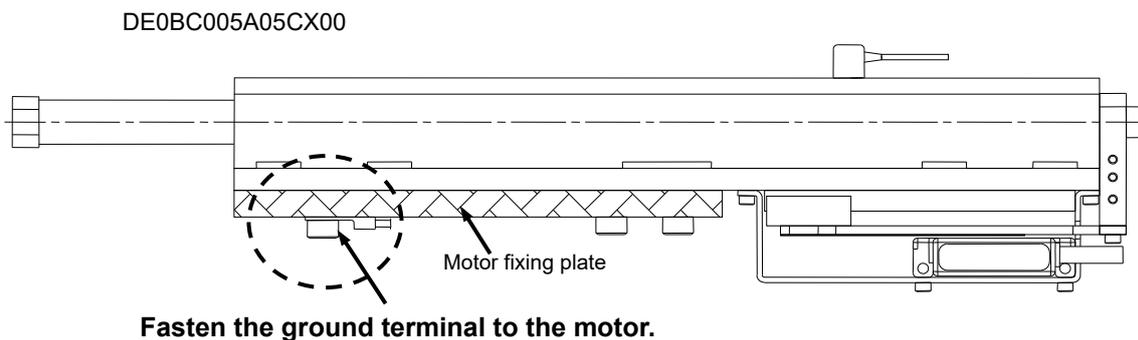
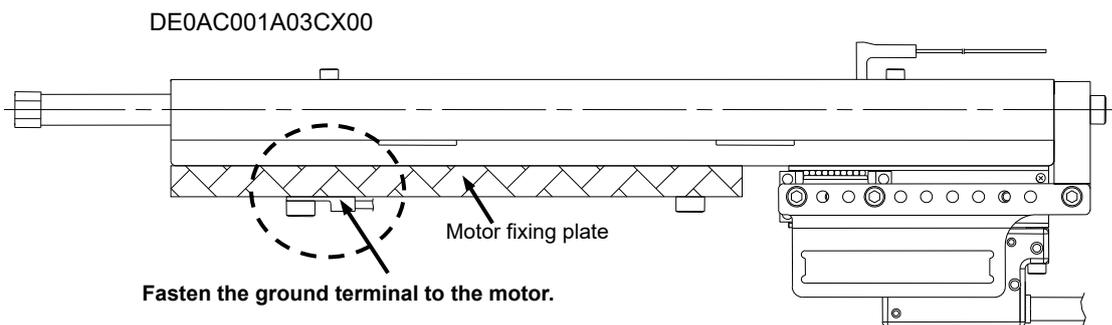
Never perform a withstand voltage test or Insulation resistance test on the cylinder linear motor, otherwise breakage may occur. When such tests are required, consult with us.

■ Connect the ground alone

- Be sure to connect a ground to the machine chassis (close to the product, see the figure below). We recommend using the following crimp terminal and wire.

Linear motor model number	Crimp terminal
DE0AC001A03CX00	R1.25-3, wire: AWG22 to 16
DE0BC005A05CX00	R1.25-4, wire: AWG22 to 16

- It is recommended to connect the ground wire for each motor. Please fasten the grounding terminal to the motor as shown in the figure below.
- When using a large number of motors side by side, you can connect them collectively with one ground wire to reduce wiring. Please contact us for specific method.



3) Precautions before operation

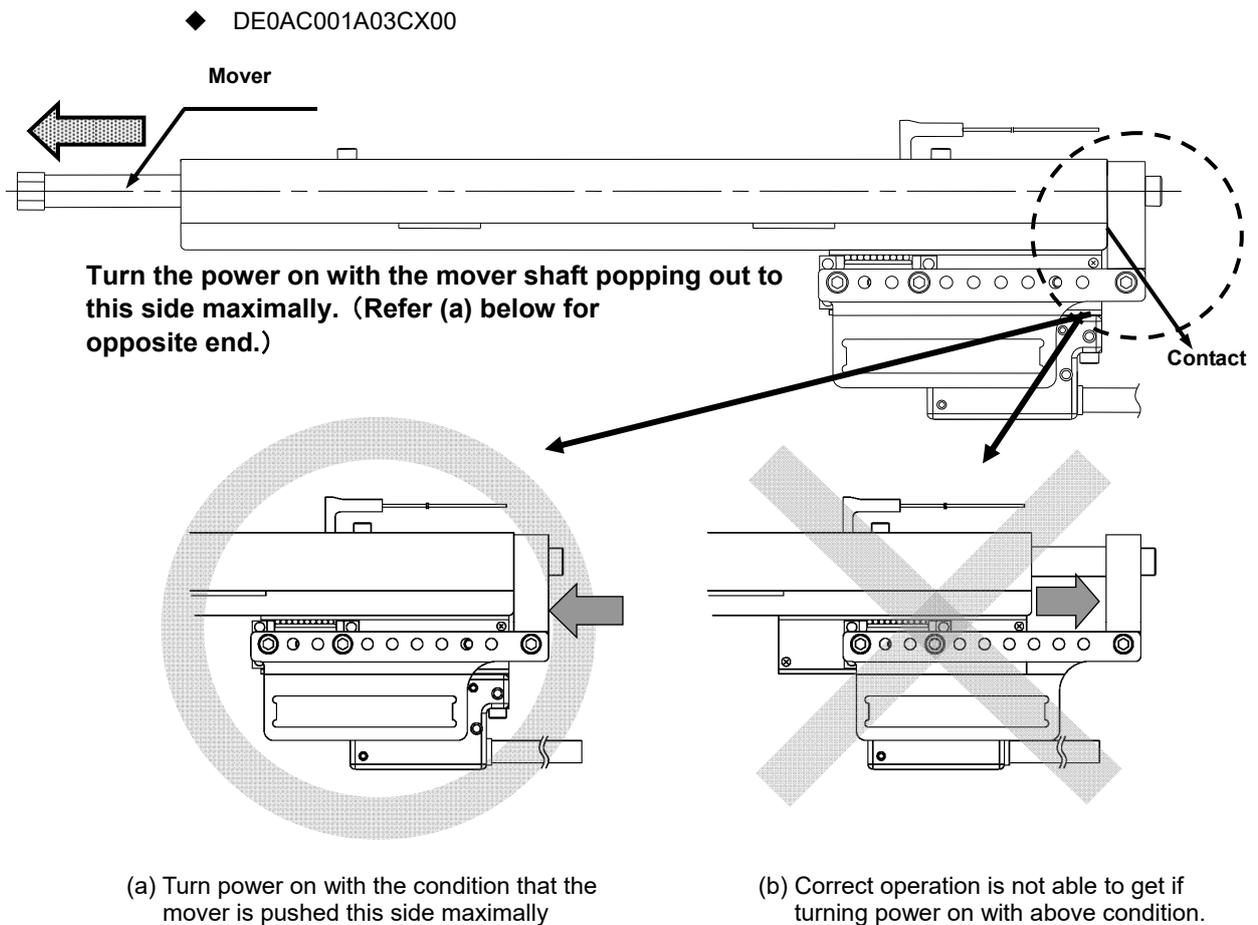
■ Check items before power-on

Use the input power supply and control power supply within the specified ranges.

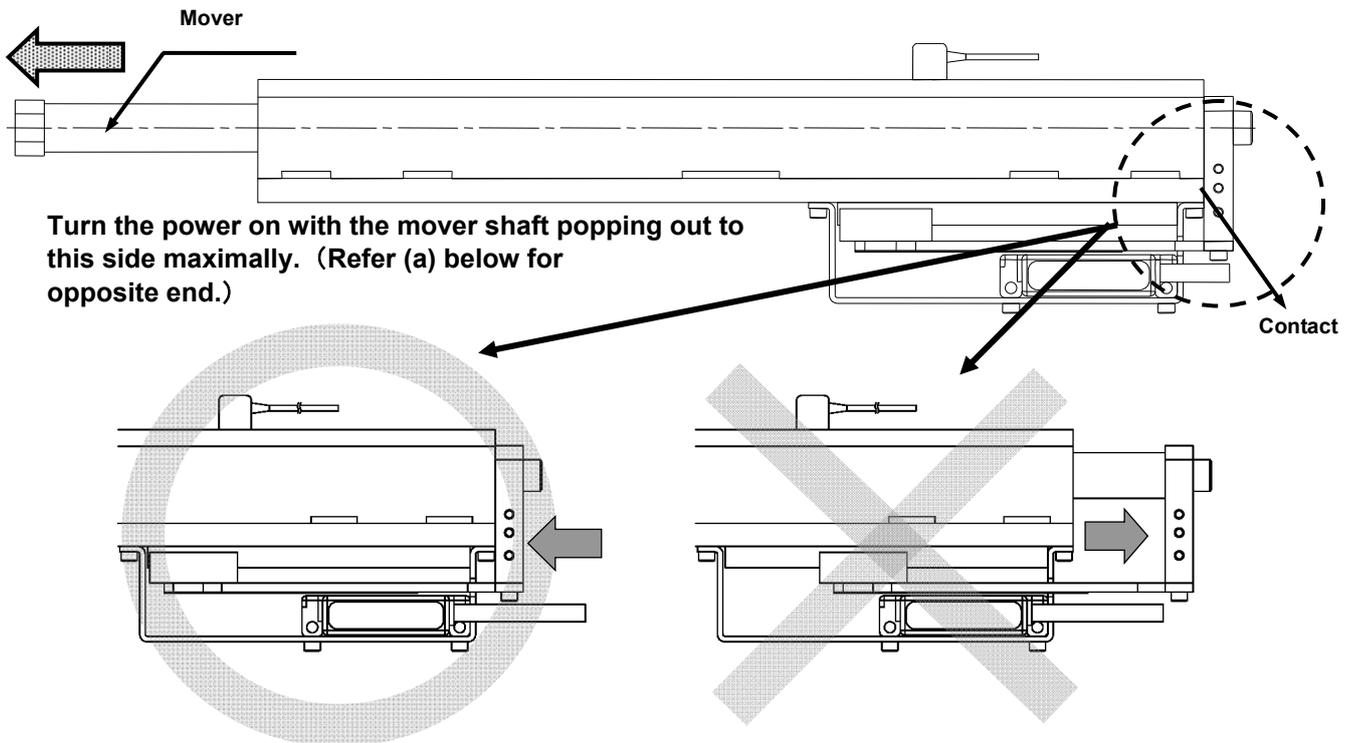
Check the grounding to see if the resistance value to ground is 100 Ω or less.

■ Check the position of the mover when turning on the power

For operation of linear motor, the mover must be shifted to one side as shown in the figure below when turning on the power. The mover may runaway if the power is turned on when the mover different position from the figure below.



◆ DE0BC005A05CX00



Turn the power on with the mover shaft popping out to this side maximally. (Refer (a) below for opposite end.)

(a) Turn power on with the condition that the mover is pushed this side maximally

(b) Correct operation is not able to get if turning power on with above condition.

- Prevent mover free fall  
When using the product vertically, the customer can install a fall prevention spring to prevent the mover shaft from falling. (DE0BC005A05CX00 only) Please contact us for installation method.

#### 4) Precautions in operation

- Temperature and humidity  
Use the ambient temperature and humidity within the range described in the instruction manual.
- Vibration and abnormal noise  
Check linear servo motor for any vibrations and abnormal noise.
- Oil and water  
Do not expose the system to oil and water directly.
- Connection and disconnection of connector  
Perform connection and disconnection of connector in accordance with the instruction manual.
- Be careful of burns  
Do not touch the motor and peripheral devices during operation and for a while after the power is turned off, because it becomes hot. There is a risk of burns.
- Be careful of injuries  
Do not enter the movable range of the machine during operation. There is a risk of injury.

## 5) System parameter

For DE0AC001A03/DE0BC005A05CX00 operation, system parameters below shall be set.

ID	Symbol	Name	Set value
00	CNTCYC	Control cycle	00: Standard Sampling
01	MPWRIN	Main circuit power input type	02: DC
02	MPWRVL	Main circuit power voltage	03: 48V
07	PULENSEL	Pulse encoder function selection	0x0860: Incremental Encoder (CS decision method: Forced setting)
08	PULENRES	Pulse encoder resolution	1000P/mm
09	CNTTYP	Control mode selection	02: Position
0A	PCNTSEL	Position control selection	00: Standard
0D	CSHIFT	CS offset	Set the value of forced excitation CSU of linear encoder characteristics. (16-32)
0E	CSCNOF	Z-phase CS normalizing offset	0 deg.

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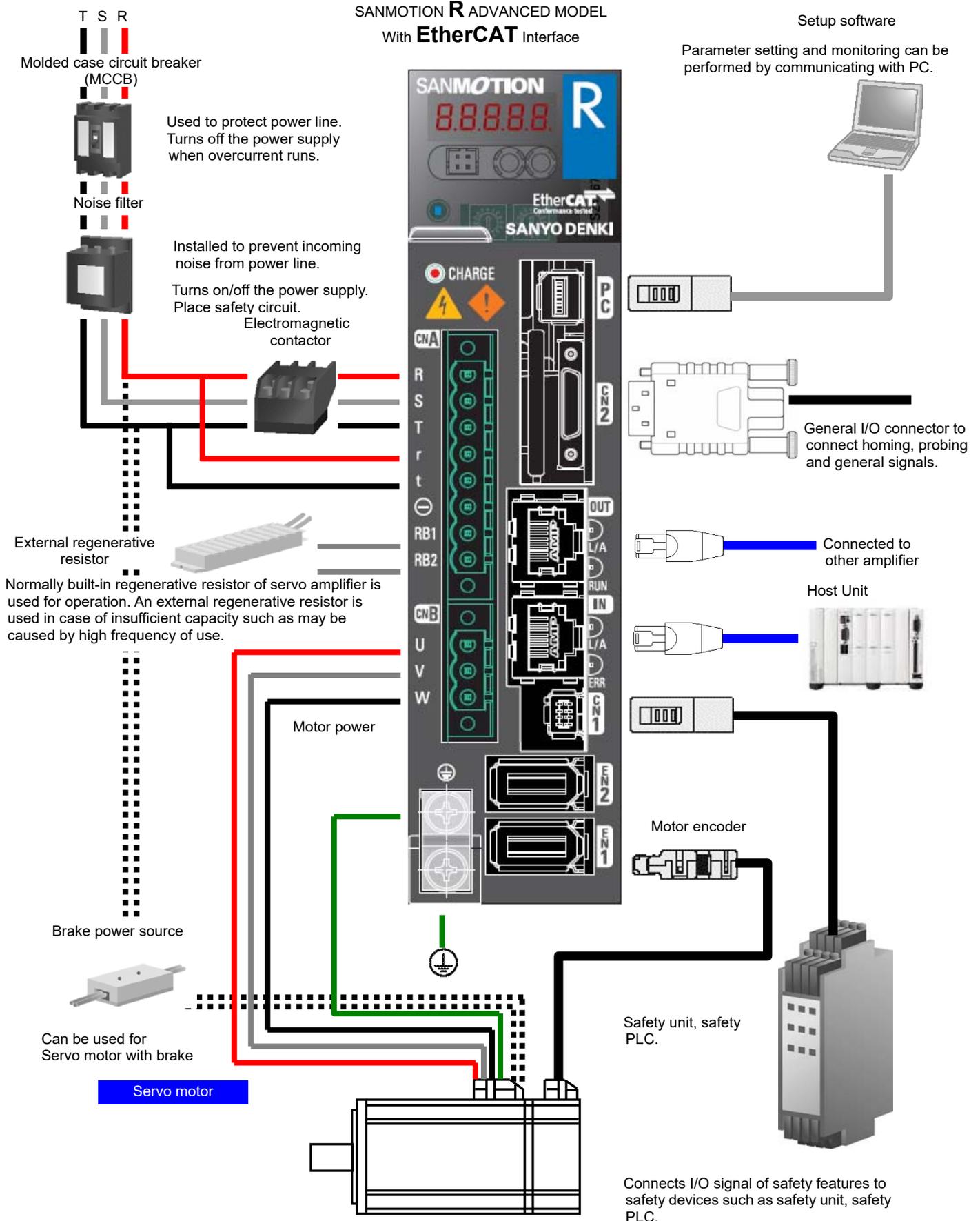
# 14

## 14 Safe Torque Off (STO) Function

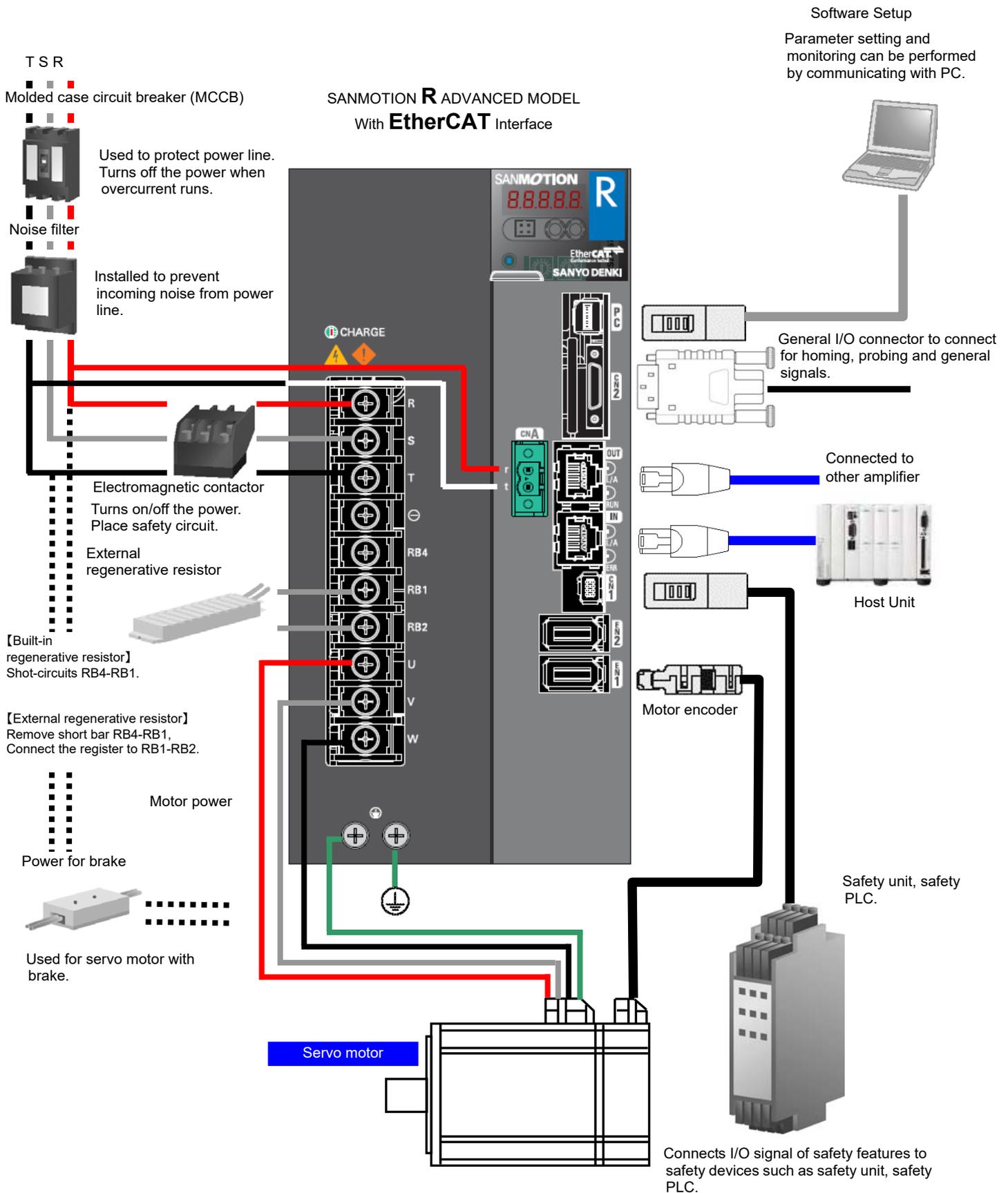
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### 14.1 System configuration

■ RS2□01/RS2□03/ RS2□05 (Rotary motor)

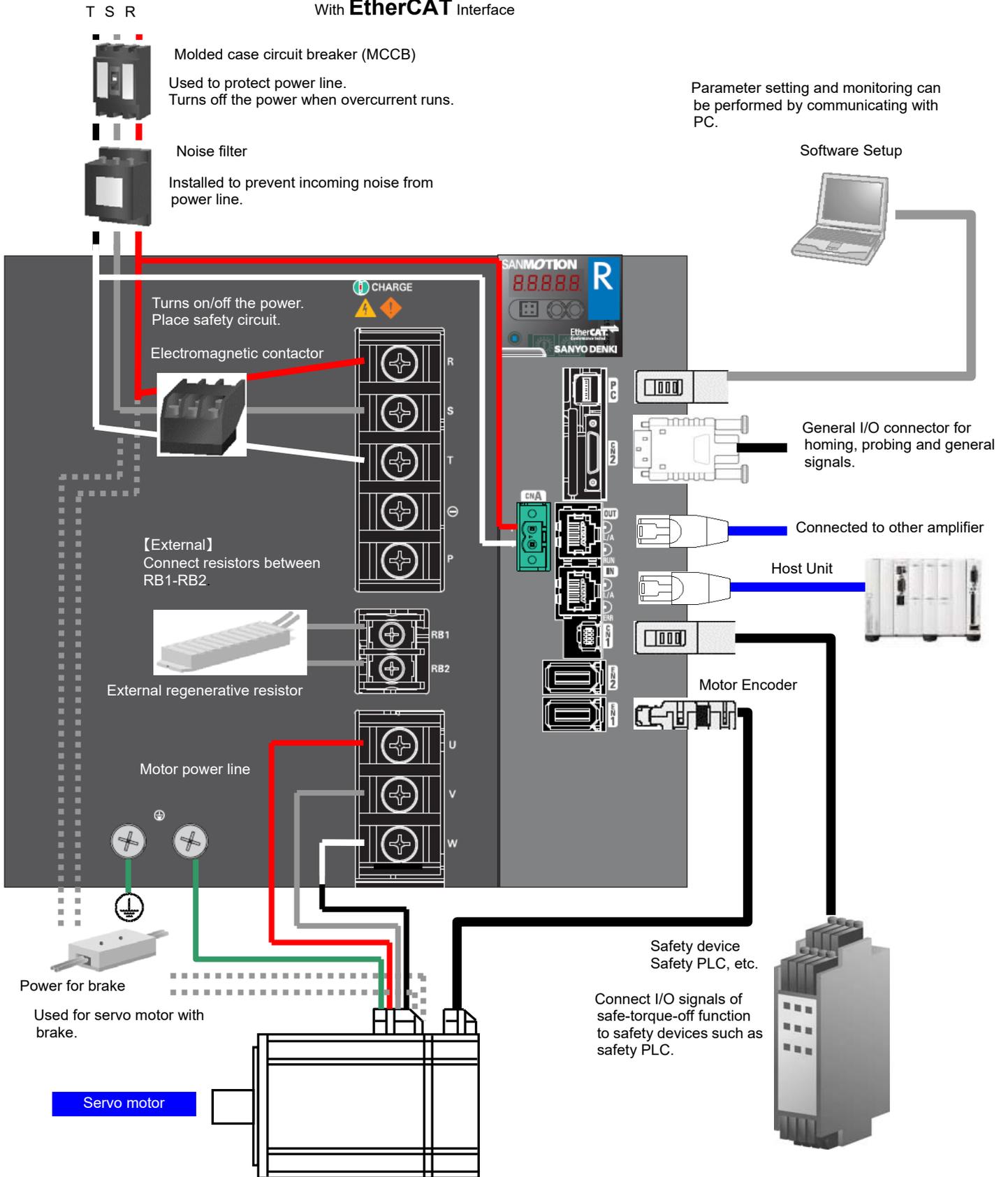


■ RS2□10/RS2□15 (Rotary motor)



■ RS2□30 (Rotary motor)

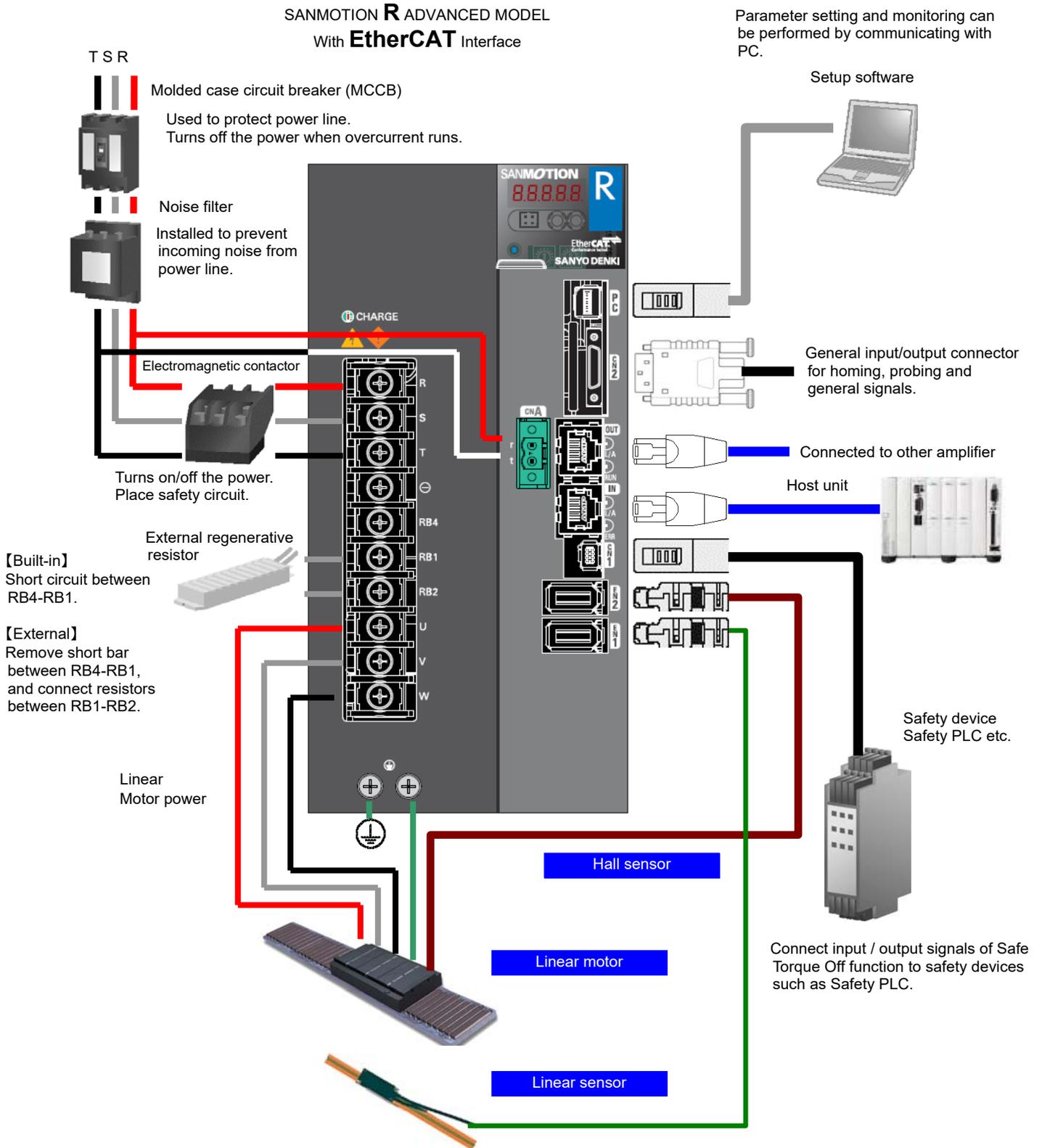
SANMOTION R ADVANCED MODEL  
With EtherCAT Interface



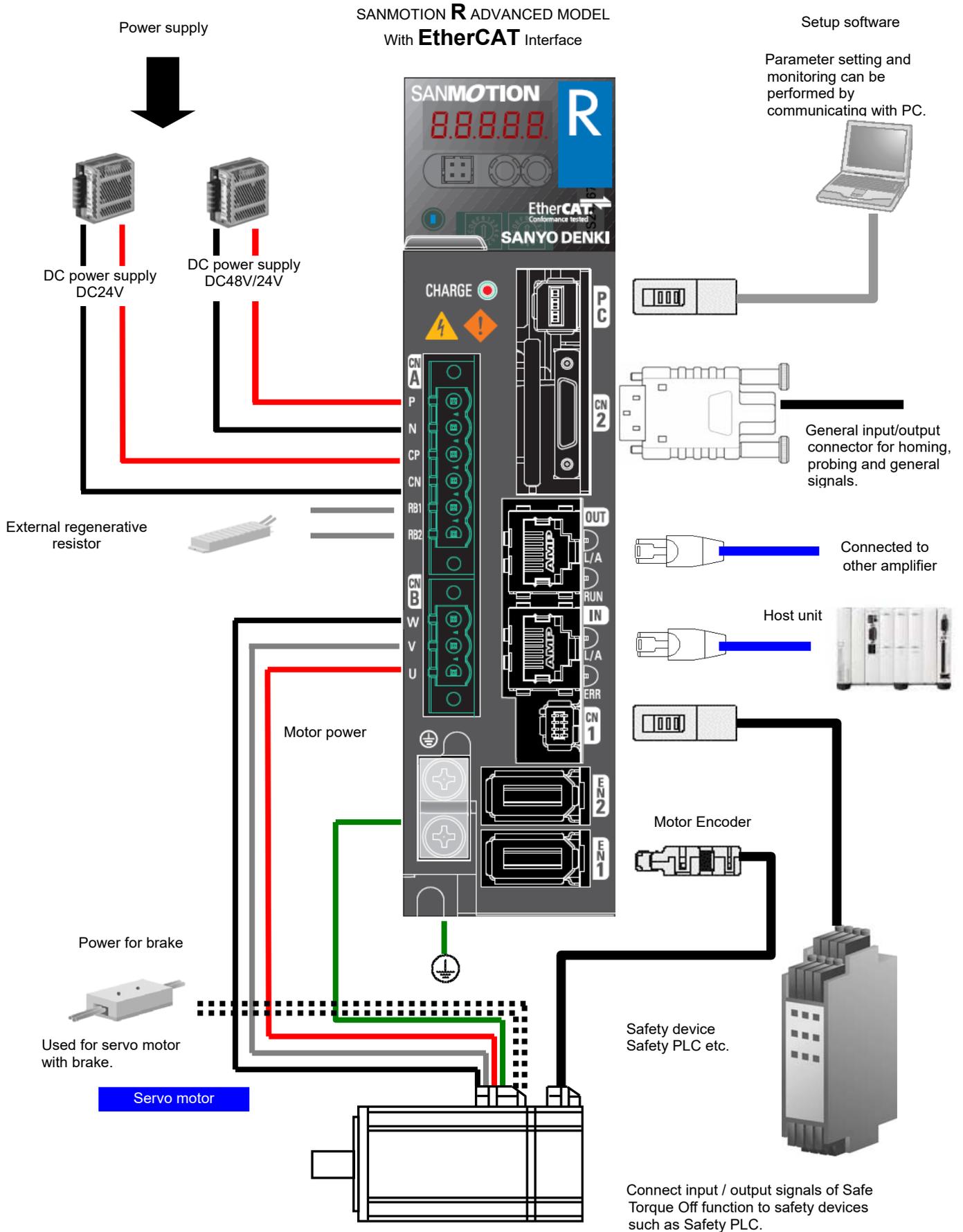
■RS2□##L (Linear motor)

This system configuration is for RS2□10L.

Refer to section 13 Linear motor, system configuration diagram for the other system configuration.



■RS2□##A (DC48V/24V)

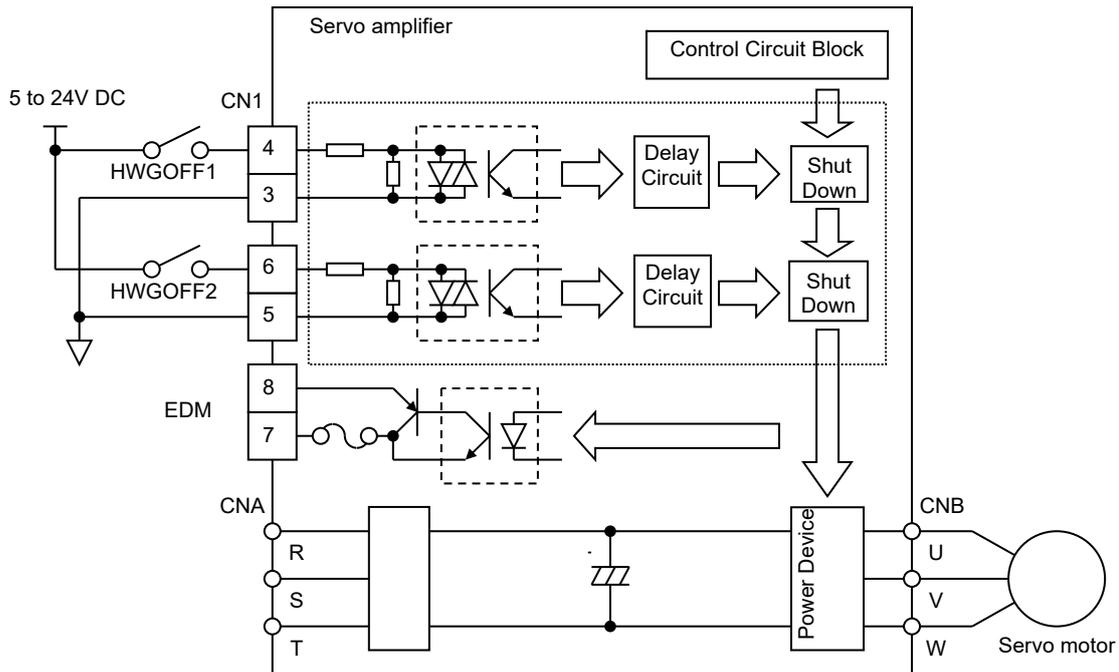


## 14.2 Safe Torque Off (STO) Function

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	<ul style="list-style-type: none"> <li>■ IEC61800-5-2, Safe Torque Off/ EN61800-5-2</li> <li>■ IEC60204, Stop Category 0/ EN60204</li> </ul>
Safety Standard	<ul style="list-style-type: none"> <li>■ IEC61508, SIL2, HFT=1, Type B / EN60204</li> <li>■ IEC62061, SILCL2, type B / EN62061</li> <li>■ ISO13849-1:2015, Cat3, PL = d (In case of detecting failure by using EDM)</li> <li>■ ISO13849-1:2015, Cat3, PL = c (In case of detecting failure)</li> </ul>

PFH (Probability of a dangerous Failure per Hour) of this function (Safe Torque Off circuit) achieves less than 2% of required level of SIL2.

To suffice ISO13849-1: 2015, Cat3, PL=d, you need to design machine safety system so as to detect failure of STO circuit by surely using Error Detection Monitor (EDM).

Refer chapter 16, for the other standards conformity except Safety Function and Safety Standard.

3) Risk assessment

The servo amp unit 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 (HWGOF2) 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.

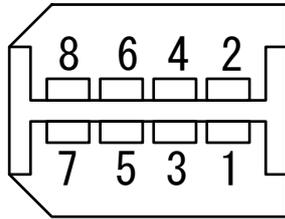
Servo amplifier model number	Delay Circuit (Max. delay time)
RS2#####5	With (Max.500ms)

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.

### 14.3 Wiring

#### 1) CN1 connector disposition

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



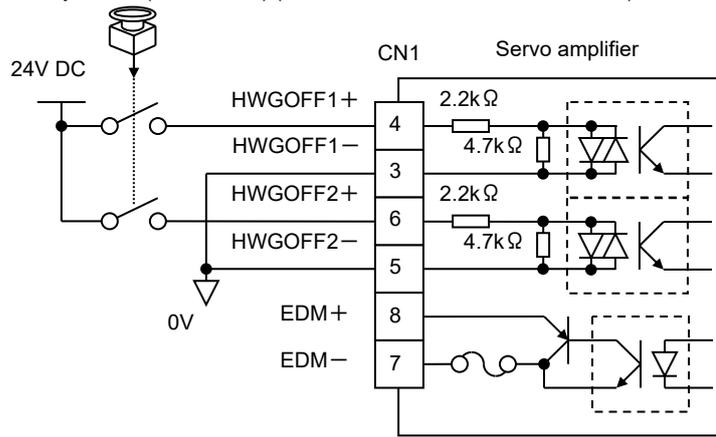
◆ Signal name and its function

Signal name	Terminal number	Symbol	Description
Reserved	1	Terminal for maintenance	This is a connecting terminal when function is not used. Do not use this terminal.
Reserved	2		
Safety input 1	3	HWGOFF1-	Input signal to control Safe-Torque-Off state. Connection circuit Connected to a relay or open collector transistor circuit. Power supply voltage range : 24V DC±10% Internal impedance : 2.2kΩ
	4	HWGOFF1+	
Safety input 2	5	HWGOFF2-	
	6	HWGOFF2+	
Error detection monitor	7	EDM-	Signal to monitor of Safe-Torque-Off function error. Connection circuit Connected to a photo coupler or relay circuit. Power supply voltage range (Uext) : 24V DC±10% Maximum current value : 50mA Output voltage : Uext-0.5 to Uext
	8	EDM+	

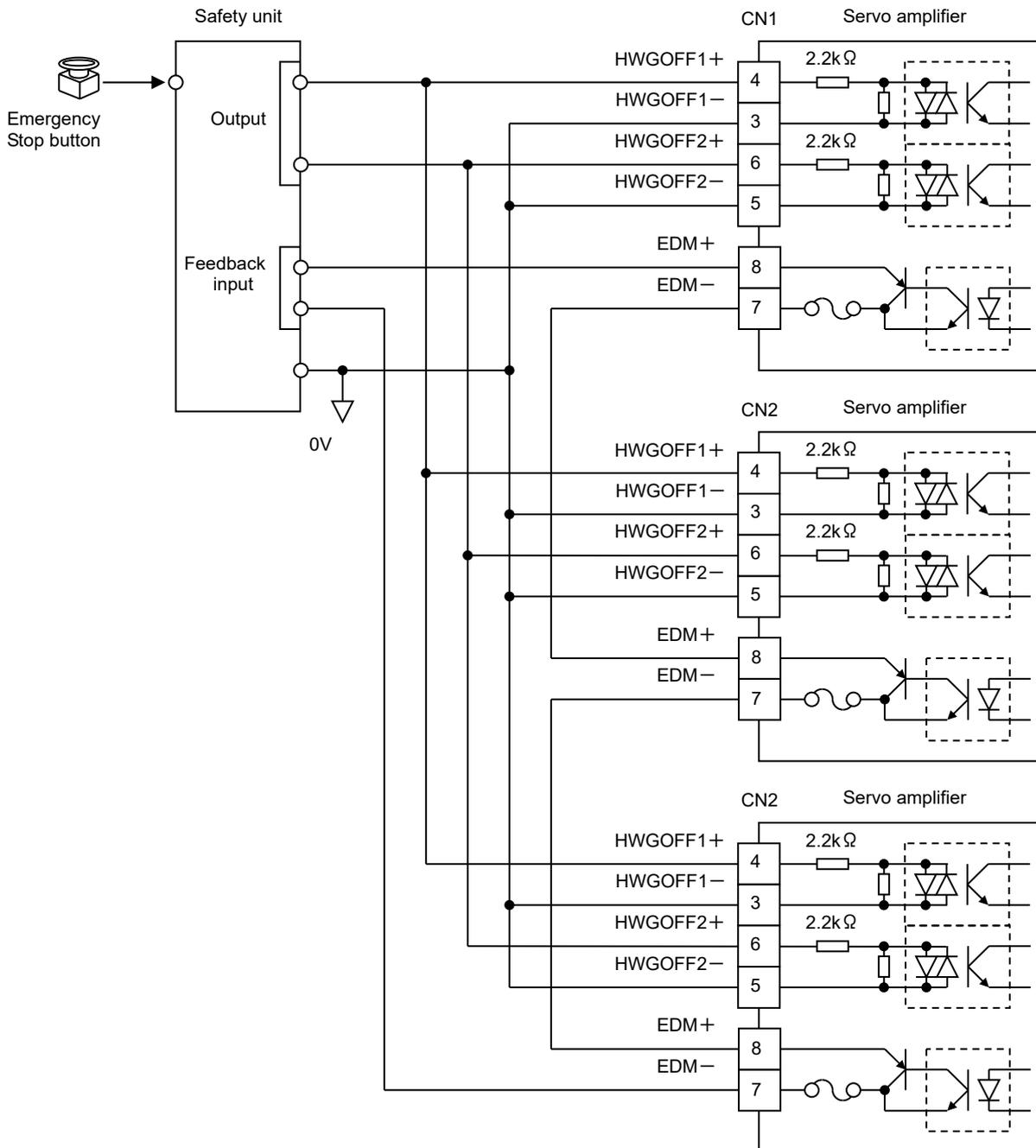
If you do not use this function, please connect the short-circuit plug for safety instrument that is attached to this product. If the short-circuit plug for safety instrument is required, please order "AL-00849548-02", as our model number. Also, if you do not use this function by connector "2013595-3",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

2) Example of wiring

Example of wiring to safety switch (1-axis used) (In case of Performance Level: PL=C)

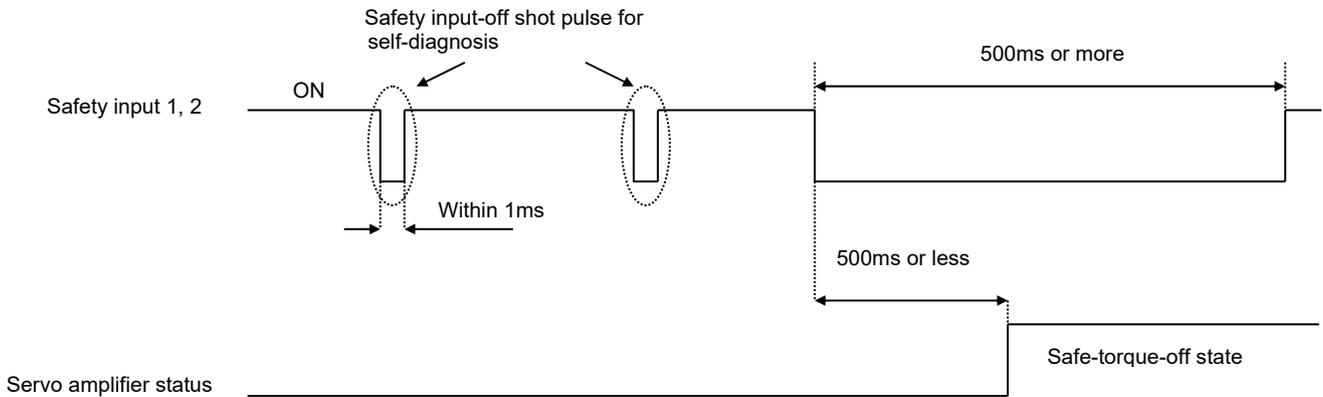


Example of wiring to safety unit (multiple axes used) (In case of Performance Level: PL=D)



### 3) 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.



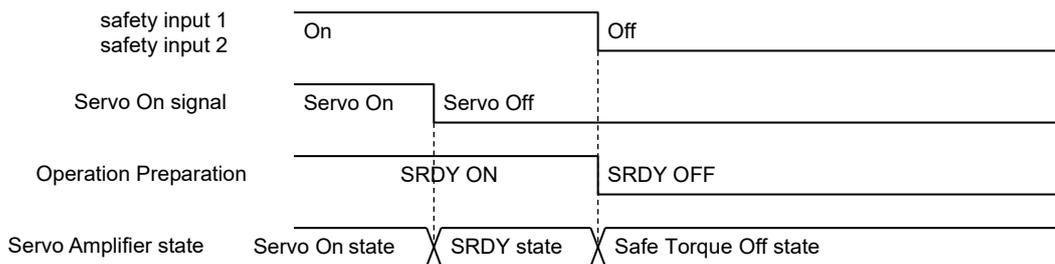
## 14.4 Safe Torque Off Operations

### 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.

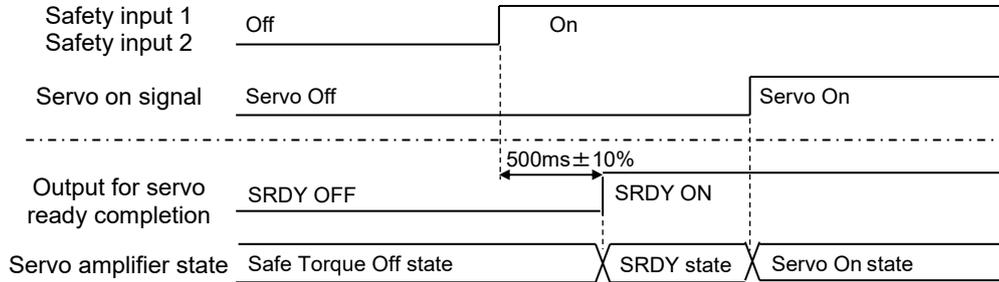
Signal	Input condition	Servo Amplifier condition
Safety input 1(HWGOFF1)	On	Normal state
	Off	Safe torque off active state
Safety input 2(HWGOFF2)	On	Normal state
	Off	Safe torque off active state

- ✓Off: Electric current will not flow (contact open).
- ✓On: Electric current will flow (contact closed).

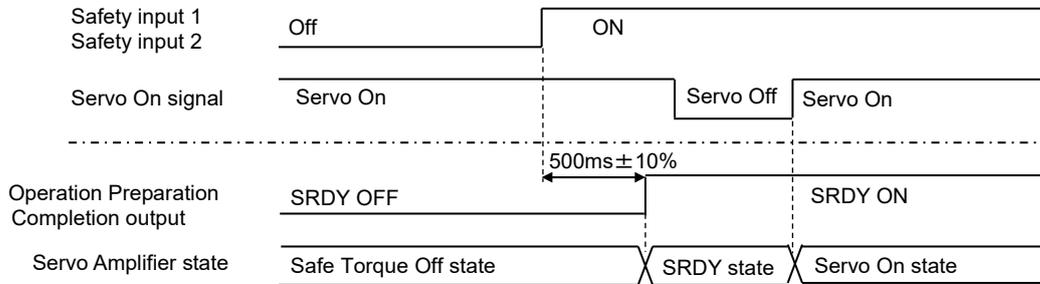


2) Recovery from Safe Torque Off active state

While servo-off signal is input as described in 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 be transited to SRDY 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.



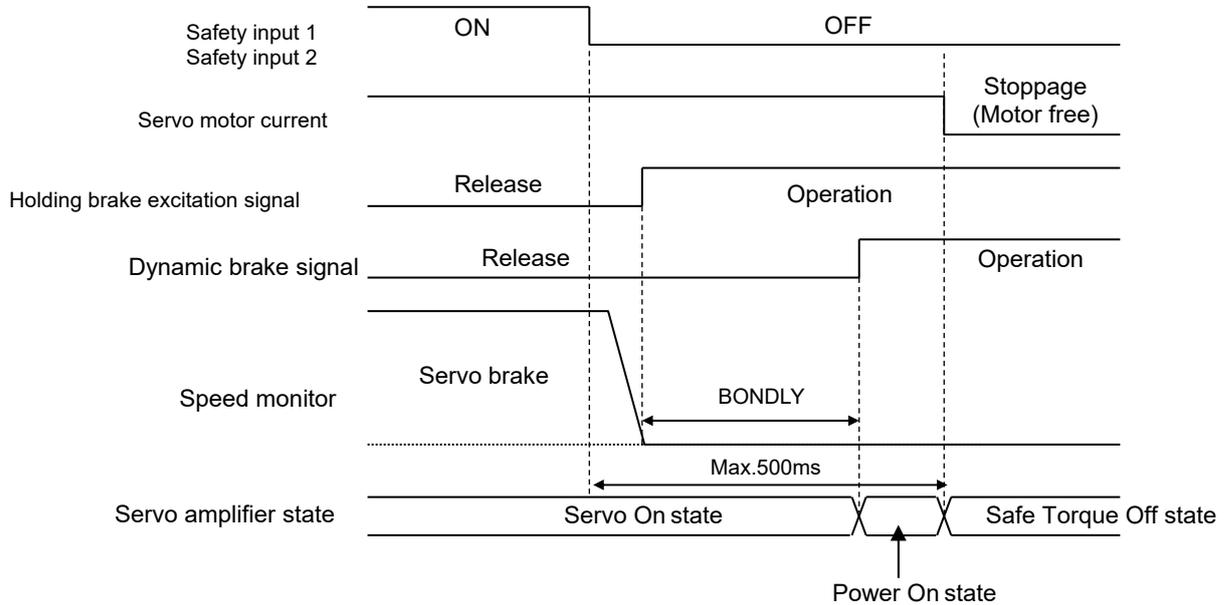
- ✓ Group9 ID06: Setting the Servo-ON Function parameter to "01: Always On" disables resets from the safe torque off state. Avoid this setting when using the safe torque off function.

3) Safe Torque Off while Servo Motor Running

Depending on setting of quick stop option code (0x605A, 0x00:[QSTOP]), it will vary how the motor stops.

- In case the setting value is either 3 or 7 (motor stops with servo brake when servo off)

If either safety input 1 or safety input 2 input is off, motor stops with servo brake.

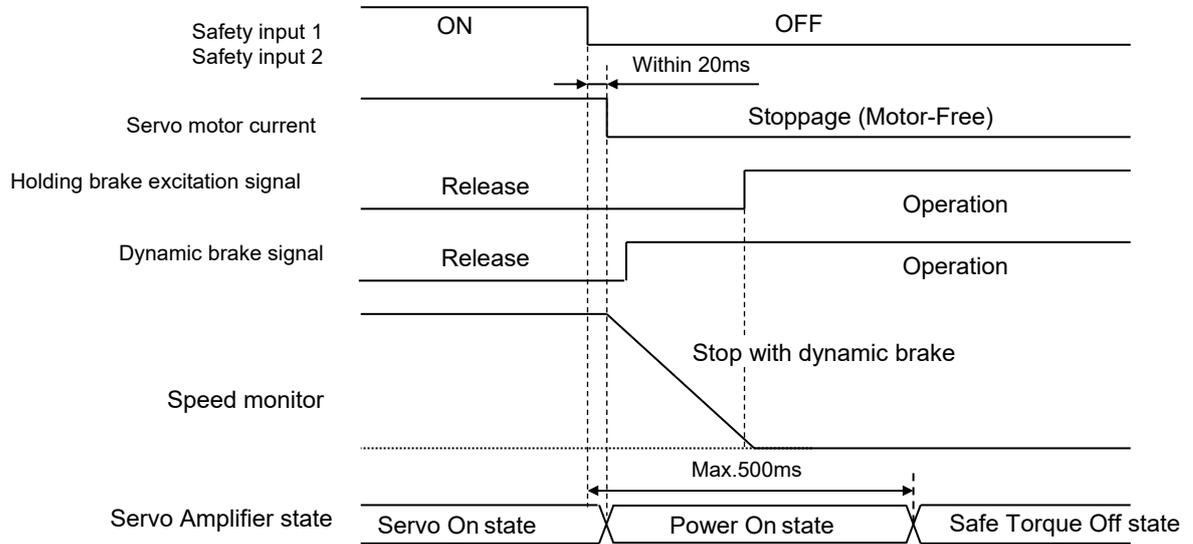


- ✓ When set value of BONDLY (holding brake activation delay time: Group B ID13) is more than safe-torque-off delay time (500ms max.), the state comes to be motor-free after period of safe-torque-off delay time. Please note that recommended set value for BONDLY is less than 500ms.
- ✓ Servo brake circuit, dynamic brake circuit, and holding brake excitation signal are not safety-related sections.

- 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.

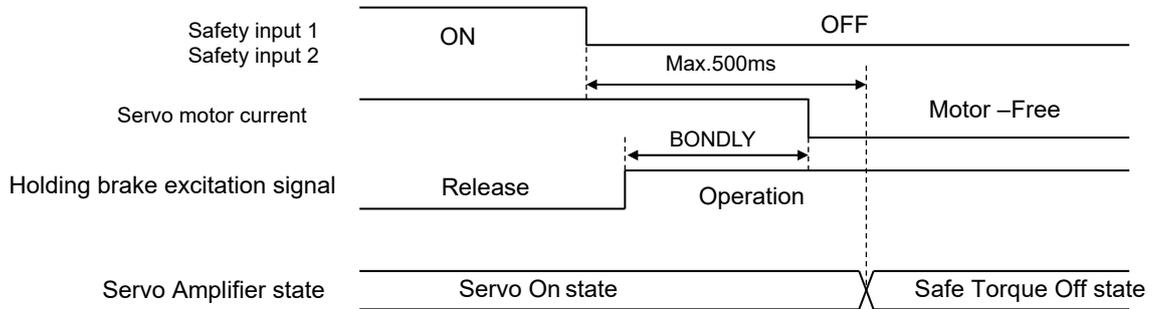
Dynamic brake is activated on turning off safety input.



✓Dynamic brake circuit and holding brake excitation signal are not safety-related sections.

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.



✓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.

## 14.5 Error Detection Monitor (EDM)

### 1) Specifications

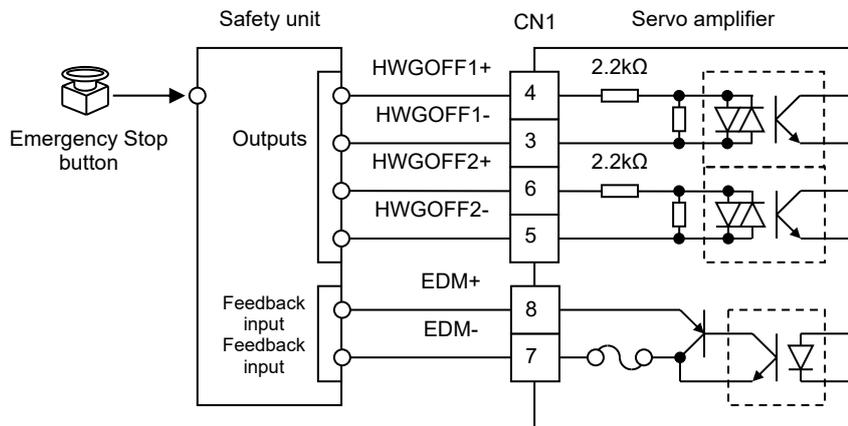
The EDM output signals monitor errors in the safe torque off circuit, /HWGOFF1 wire, or /HWGOFF2 wire. The following table shows the relationships among /HWGOFF1 input, /HWGOFF2 input, and EDM output.

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 ISO13849-1:2015, Cat3, PL=d, 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.

## 14.6 Confirmation Test

Before using the safe torque off function, confirm that the safe torque off operations work correctly during machine startup, servo amplifier replacement and test operation.

Even if in the other case above, function confirmation is recommended strongly, 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, see "3. Installation", "4. Wiring" and "8. 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 1 and 2 input signals.

Procedure 3. Input the Servo On signal to excite the servo motor.

Procedure 4. Turn Off both the safety input 1 and 2 input signals.

### 3) Acceptance criteria

Confirmation procedure 2 to 4, confirm the states listed below.

For procedure 2, make sure that the EDM output and LED indication are as follows:

Confirmation item	State
EDM output	Off
LED indication	

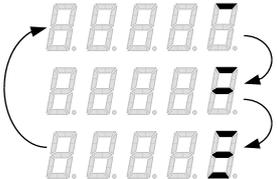
For procedure 3, confirm that the servo motor is excited.

A figure-of-eight continuously traced out, and then EtherCAT FSA becomes "operation-enabled" state.

Confirmation item	State
EDM output	Off
LED indication	

For procedure 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	

## 14.7 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.

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# 15

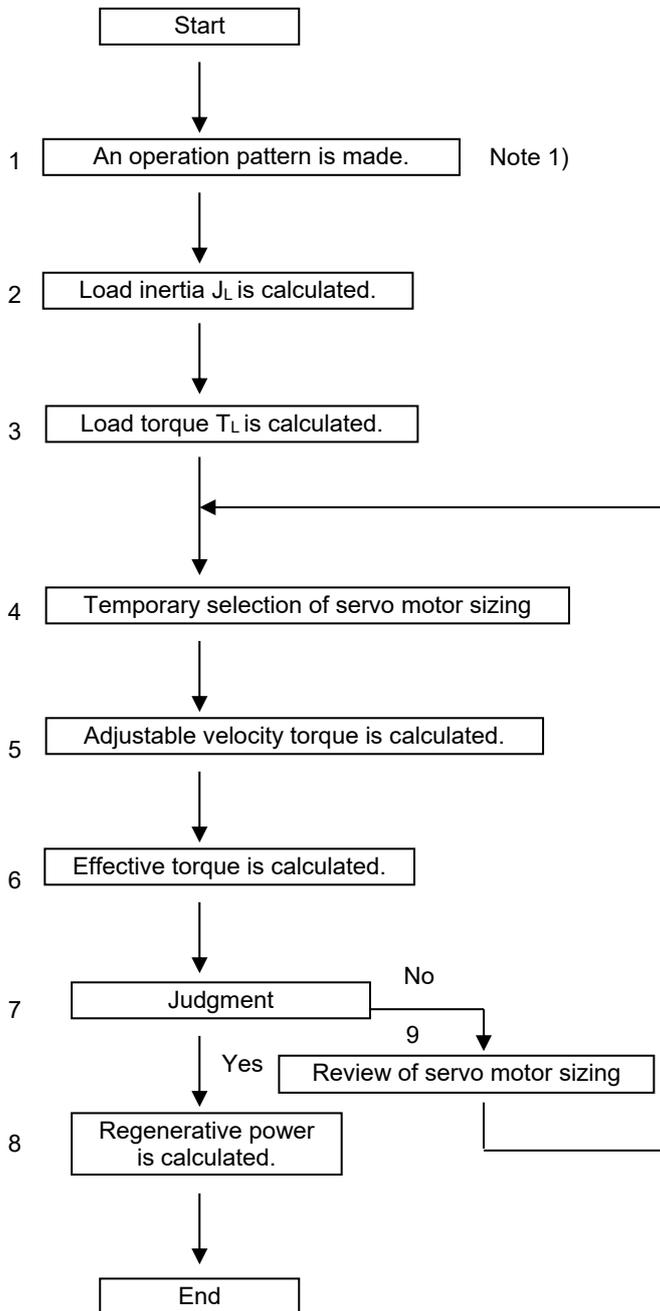
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12)	Installation	15-15

### 15.1 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.

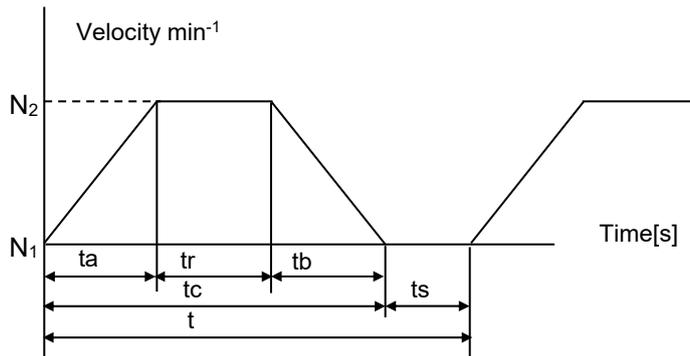
#### 1) Flowchart of Servo Motor Sizing



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 (J<sub>L</sub>) is 10 or less times of the rotor moment of a servo motor inertia (J<sub>M</sub>), and the load torque (T<sub>L</sub>) should do temporary motor selection less than 80% of a motor rating torque (T<sub>R</sub>).  
 $J_L <= J_M \times 10$   
 $T_L < T_R \times 0.8$
5. Calculate the required adjustable velocity torque from an operation pattern.
6. Calculate the effective torque from a torque pattern.
7. Judge whether the adjustable velocity torque (T<sub>a</sub>, T<sub>b</sub>) is less than 80% of the instant maximum torque (T<sub>p</sub>) of a servo motor, and the effective torque (T<sub>rms</sub>) is less than 80% of the rating torque (T<sub>R</sub>) of a servo motor.  
 $T_a < T_p \times 0.8$   
 $T_b < T_p \times 0.8$   
 $T_{rms} < T_R \times 0.8$
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.

Note 1) The operational pattern shall be created so that average motor rotational velocity does not exceed maximum rotational velocity.

2) Make an operation pattern



- t<sub>a</sub>= Acceleration time
- t<sub>b</sub>= Deceleration time
- t<sub>r</sub>= Constant velocity time
- t<sub>s</sub>= Stop time
- t=1 cycle

3) Calculate motor axis conversion load inertia (J<sub>L</sub>)

- The load inertia of a moving part

$$J_L = \left(\frac{1}{G}\right)^2 \times \frac{\pi \times \rho \times D^4 \times L}{32} \quad [\text{kg} \cdot \text{m}^2]$$

- G: Reduction ratio
- ρ : Moving part specific gravity [kg/m<sup>3</sup>]
- D: Moving part diameter [m]
- L: Moving part length [m]

- The load inertia of a work

$$J_L = \left(\frac{1}{G}\right)^2 \times W \times \left(\frac{P}{2\pi}\right)^2 \quad [\text{kg} \cdot \text{m}^2]$$

- 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= π D)

4) Calculate motor shaft conversion load torque ( $T_L$ )

- Ball screw (in horizontal axis)

$$T_L = \frac{(F + \mu W)}{\eta} \times \frac{P}{2\pi} \times \frac{1}{G} \times 9.8 \quad [\text{N}\cdot\text{m}]$$

- Ball screw (in vertical axis)

When motor drives upward

$$T_L = \frac{(F + (\mu + 1)W)}{\eta} \times \frac{P}{2\pi} \times \frac{1}{G} \times 9.8 \quad [\text{N}\cdot\text{m}]$$

When motor drives downward

$$T_L = \frac{(F + (\mu - 1)W)}{\eta} \times \frac{P}{2\pi} \times \frac{1}{G} \times 9.8 \quad [\text{N}\cdot\text{m}]$$

- When ball screw stops (in horizontal axis)

$$T_L = \frac{F}{\eta} \times \frac{P}{2\pi} \times \frac{1}{G} \times 9.8 \quad [\text{N}\cdot\text{m}]$$

- When ball screw stops (in vertical axis)

$$T_L = \frac{(F + W)}{\eta} \times \frac{P}{2\pi} \times \frac{1}{G} \times 9.8 \quad [\text{N}\cdot\text{m}]$$

F: External force [kg]

$\mu$ : Coefficient of friction

P: Ball screw lead [m]

$\eta$ : Transmission efficiency

W: Moving part mass [kg]

G: Reduction ratio

- Belt pulley (Vertical axis)

$$T_L = \frac{(F + (\mu + 1)W)}{\eta} \times \frac{D}{2} \times \frac{1}{G} \times 9.8 \quad [\text{N}\cdot\text{m}]$$

- Belt pulley (in vertical axis)

When motor drives upward

$$T_L = \frac{(F + (\mu + 1)W)}{\eta} \times \frac{D}{2} \times \frac{1}{G} \times 9.8 \quad [\text{N}\cdot\text{m}]$$

When motor drives downward

$$T_L = \frac{(F + (\mu - 1)W)}{\eta} \times \frac{D}{2} \times \frac{1}{G} \times 9.8 \quad [\text{N}\cdot\text{m}]$$

- When belt pulley stops (in horizontal axis)

$$T_L = \frac{F}{\eta} \times \frac{D}{2} \times \frac{1}{G} \times 9.8 \quad [\text{N}\cdot\text{m}]$$

- When belt pulley stops (in vertical axis)

$$T_L = \frac{(F + W)}{\eta} \times \frac{D}{2} \times \frac{1}{G} \times 9.8 \quad [\text{N}\cdot\text{m}]$$

F: External force [kg]

$\mu$ : Coefficient of friction

D: Diameter of a pulley [m]

$\eta$ : Transmission efficiency

W: Moving part mass [kg]

G: Reduction ratio

5) Calculate acceleration torque ( $T_a$ )

$$T_a = \frac{2\pi(N_2 - N_1) \times (J_L + J_M)}{60 \times t_a} + T_L \quad [\text{N} \cdot \text{m}]$$

$N_2$ : Servo motor rotation velocity after acceleration [ $\text{min}^{-1}$ ]

$N_1$ : Servo motor rotation velocity before acceleration [ $\text{min}^{-1}$ ]

$J_L$ : Load inertia [ $\text{kg} \cdot \text{m}^2$ ]

$J_M$ : Rotor inertia of servo motor [ $\text{kg} \cdot \text{m}^2$ ]

6) Calculate deceleration torque ( $T_b$ )

$$T_b = \frac{2\pi(N_2 - N_1) \times (J_L + J_M)}{60 \times t_b} - T_L \quad [\text{N} \cdot \text{m}]$$

$N_2$ : Servo motor rotation velocity before deceleration [ $\text{min}^{-1}$ ]

$N_1$ : Servo motor rotation velocity after deceleration [ $\text{min}^{-1}$ ]

$J_L$ : Load inertia [ $\text{kg} \cdot \text{m}^2$ ]

$J_M$ : Rotor inertia of servo motor [ $\text{kg} \cdot \text{m}^2$ ]

7) Calculate effective torque ( $T_{rms}$ )

$$T_{rms} = \sqrt{\frac{(T_a^2 \times t_a) + (T_L^2 \times t_r) + (T_b^2 \times t_b)}{t}} \quad [\text{N} \cdot \text{m}]$$

## 8) Judgment condition

■ We consider the followings as the standard of the judgment.

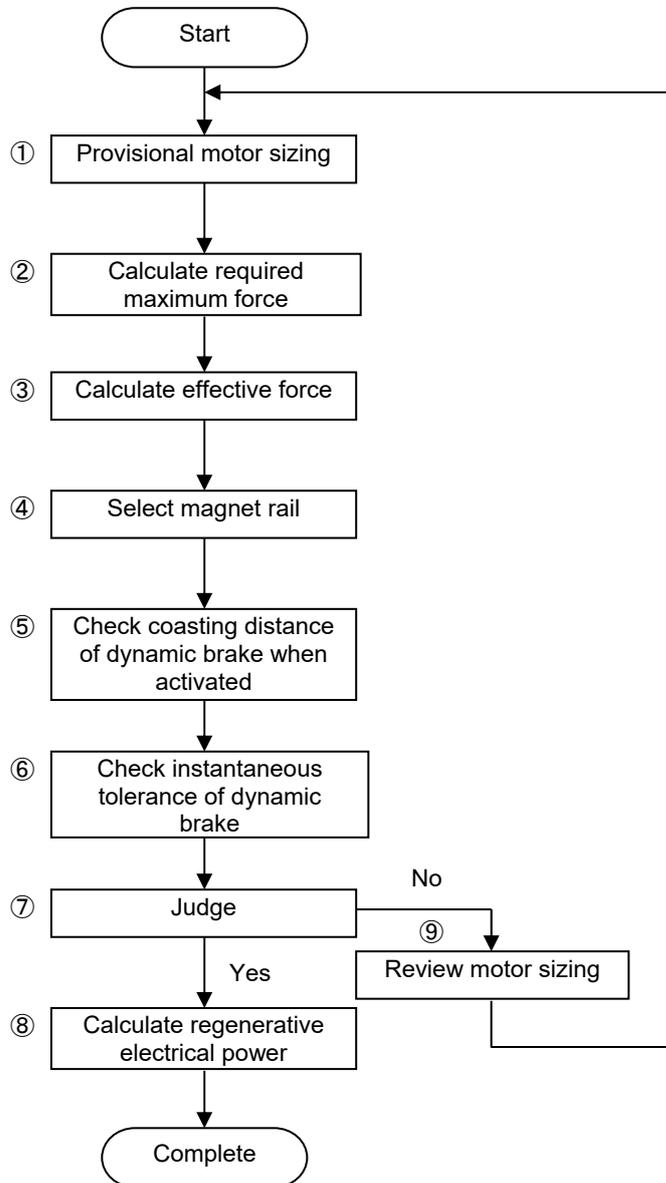
- Load torque load ratio  $T_L < T_R$  (Less than rated torque)
- Acceleration torque load ratio  $T_a < T_P \times 0.8$  (Less than 80% of instant maximum torque)
- Deceleration torque load ratio  $T_b < T_P \times 0.8$  (Less than 80% of instant maximum torque)
- Effective torque load ratio  $T_{rms} < T_R \times 0.8$  (Less than 80% of rated torque)
- Inertia moment ratio  $J_L < J_M \times 10$  (Less than 10 times of the rotor inertia 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.

## 15.2 Linear motor sizing

It is estimated that selection of servo motor capacity computes required servo motor capacity from machine specification (composition). Here, the fundamental formula is described.

### 1) Linear motor sizing flow chart



① Provisional motor sizing

Provisionally select a coil whose maximum force meets the required force in use. (At least more than “load mass x maximum acceleration +  $\alpha$ ” is required.)

② Required maximum force

Calculate required maximum force in consideration of motor mass, friction, and gravity. Verify that the maximum force of provisionally selected motor is more than the required maximum force. More than 10%-margin is recommended in consideration of load change.

③ Effective force

Verify that continuous rated force of the provisionally selected motor is more than the required effective force. More than 10%-margin is recommended in consideration of load change.

④ Select magnet rail

Select magnet rail to meet the required stroke of the provisionally selected motor.

⑤ Coasting distance of dynamic brake when activated

Calculate coasting distance of dynamic of the provisionally selected motor brake when activated, and then verify no problem with operation.

⑥ Instantaneous tolerance of dynamic brake

Calculate the energy consumed by dynamic brake resistance in one-dynamic-braking activation of the selected motor, and then verify the energy is allowable amplifier value or less.

⑧ Regenerative electrical power

Calculate regenerative electrical power of the selected motor, and then verify the power is allowable regenerative resistor electrical power or less.

⑨ Review linear motor size.

2) Required maximum force and effective force

- Calculate frictional force  $F_f$ .

$$F_f = (M \cdot g \cdot \cos \theta + F_{att}) \cdot \mu + F_{add} \quad [N]$$

- $M_c$  : Coil mass [kg]
- $M_L$  : Load mass [kg]
- $M$  : Moving part mass =  $M_C + M_L$  [kg]
- $g$  : Gravity acceleration = 9.8 [m/s<sup>2</sup>]
- $\cos \theta$  : Angle to horizontal driving surface [rad] (When horizontal:  $\cos \theta = 1$ )
- $F_{att}$  : Magnetic attractive force [N]
- $\mu$  : Coefficient of friction
- $F_{add}$  : Sealing resistance [N] (Including dynamic friction and covering friction, and cable routing friction)

- Calculate the gravity force applied to moving part.

$$F_w = M \cdot g \cdot \sin \theta \quad [N]$$

- $M$  : Moving part mass =  $M_C + M_L$  [kg]
- $G$  : Gravity acceleration = 9.8 [m/s<sup>2</sup>]
- $\theta$  : Angle to horizontal driving surface [rad] (When horizontal:  $\sin \theta = 0$ )

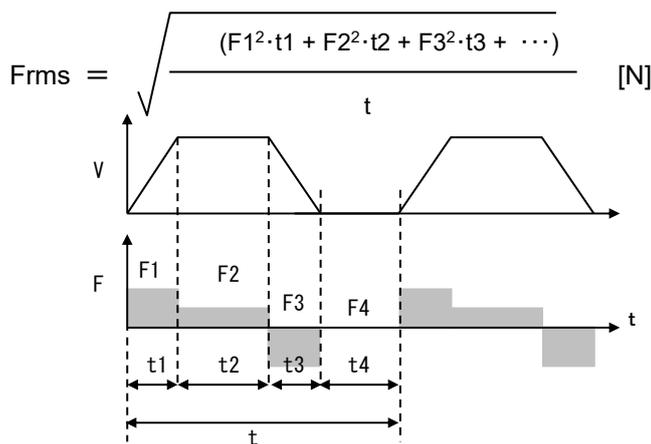
- Calculate required maximum force:  $F_{max}$ , and then verify that “maximum motor force:  $F_p >$  required maximum force:  $F_{max}$ .”

$$F_{max} = M \cdot a_{max} + F_f + F_w + F_{work} \quad [N]$$

- $M$  : Moving part mass =  $M_C + M_L$  [kg]
- $A_{max}$  : Maximum acceleration [m/s<sup>2</sup>]
- $F_f$  : Frictional force [N]
- $F_w$  : Gravity [N]
- $F_{work}$  : Processing reactive force [N]

Margin of 0.9 ·  $F_p \geq F_{max}$  is recommended in consideration of loads change.

- Motor continuous rated force  $F_r >$  Effective force  $F_{rms}$



Margin of 0.9 ·  $F_r \geq F_{rms}$  is recommended in consideration of loads change.

### 3) Selection of magnet rail

The following 4 types of length for magnet rails are prepared.

64, 128, 256, 512 [mm]

Determine the length so that "magnet rail length  $\geq$  coil length + stroke + margin."

Provided that, install magnet rail for the half-length from the end of the entire stroke and enable coil to be installed in moving stage in the part magnet rail not installed, to ease coil installation into machine.

### 4) Precautions on load conditions

#### ■ Minus load

Servo amplifier cannot operate with minus load such that motor drive continuously for more than several seconds.

[e.g.]

- Downward motor drive (No counter-weight)
- Use the amplifier as generator, such as winding-off axis of winder.

When applying the amplifier with minus load, please contact us.

#### ■ Load mass (ML)

When using under the condition that load mass is relatively large to coil mass (moving element), main circuit power overvoltage or abnormal regeneration may be detected when decelerating.

In this case, the following measures are needed. Please contact us for the details.

- ① Reduce current limit.
- ② Extend acceleration/ deceleration time. (Slow-down)
- ③ Reduce maximum velocity you use.
- ④ Install external regenerative resistor.

### 15.3 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.

$$EM = E_{hb} = \frac{1}{2} \times N \times 3 \cdot K_e \phi \times \frac{T_b}{KT} \times t_b - \left[ \frac{T_b}{KT} \right]^2 \times 3 \cdot R \phi \times t_b$$

EM : Regeneration energy during operations along horizontal axis [J]

Ehb : Regeneration energy during deceleration [J]

$K_e \phi$  : Induced voltage constant [ $V_{rms}/min^{-1}$ ] (Motor constant)

KT : Torque constant [ $N \cdot m/Arms$ ] (Motor constant)

N : Motor rotation speed [ $min^{-1}$ ]

$R \phi$  : Armature resistance [ $\Omega$ ] (Motor constant)

$t_b$  : Deceleration time [s]

$T_b$  : Torque during deceleration [ $N \cdot m$ ]

- Calculate "regeneration effective power" from regeneration energy.

$$PM = \frac{EM}{t_o}$$

PM : Effective regeneration power [W]

EM : Regeneration energy [J]

$t_o$  : Cycle time [s]

2) How to find "regeneration effective power (PM)" of the vertical axis drive by a formula (Rotary motor)

- Calculate regeneration energy.

$$\begin{aligned}
 EM &= EVUb + EVD + EVDb \\
 &= \frac{1}{2} \times N \times 3 \cdot Ke\phi \times \frac{TUb}{KT} \times tUb - \left[ \frac{TUb}{KT} \right]^2 \times 3 \cdot R\phi \times tUb \\
 &\quad + N \times 3 \cdot Ke\phi \times \frac{TD}{KT} \times tD - \left[ \frac{TD}{KT} \right]^2 \times 3 \cdot R\phi \times tD \\
 &\quad + \frac{1}{2} \times N \times 3 \cdot Ke\phi \times \frac{TDb}{KT} \times tDb - \left[ \frac{TDb}{KT} \right]^2 \times 3 \cdot R\phi \times tDb
 \end{aligned}$$

$Ke\phi$ : Induced voltage constant [ $V_{rms}/min^{-1}$ ] (Motor constant)  
 $KT$ : Torque constant [ $N \cdot m/Arms$ ] (Motor constant)  
 $N$ : Motor rotation speed [ $min^{-1}$ ]  
 $R\phi$ : Armature resistance [ $\Omega$ ] (Motor constant)  
 $EM$ : Regeneration energy during operations along vertical axis [J]  
 $EVD$ : Regeneration energy during descending run [J]  
 $Tub$ : Torque during increased deceleration [ $N \cdot m$ ]  
 $TD$ : Torque during descending run [ $N \cdot m$ ]  
 $tD$ : Descending run time [s]  
 $TDb$ : Torque during decreased deceleration [ $N \cdot m$ ]  
 $tDb$ : 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.

$$PM = \frac{EM}{to}$$

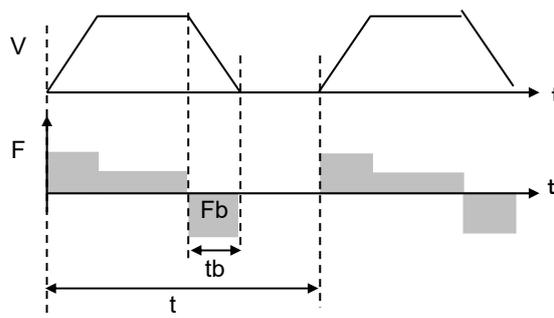
$PM$ : Effective regeneration power [W]  
 $EM$ : Regeneration energy during deceleration [J]  
 $to$ : Cycle time [s]

3) How to find "regeneration effective power (PM)" of the vertical axis drive by a formula (Linear motor)

■ Calculate regeneration energy.

$$PM = \left[ \left( \frac{1}{2 \cdot t} \cdot M \cdot V^2 \right) - \left( \frac{v}{2 \cdot t} \cdot F_f \cdot t_b \right) \right] - \left[ \left( \frac{3 \cdot R \phi \cdot t_b}{t} \right) \times \left( \frac{M \cdot V - F_f \cdot t_b}{K_f \cdot t_b} \right)^2 \right] \text{ [J/s]=[W]}$$

- PM : Regenerative electrical power [W]
- M : Moving part mass [kg]
- V : Acceleration just before decelerating [m/s]
- t : Cycle [s]
- t<sub>b</sub> : Decelerating time [s]
- F<sub>f</sub> : Frictional force [N]
- Rφ : Resistance per 1 motor [Ω]
- K<sub>f</sub> : Force constant [N/A]



$$F_b = M \cdot V / t_b - F_f$$

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 an internal regenerative resistor

If the value of the regeneration effective power "PM" by the calculation result is below the value of [PRI] of the following table, an internal regenerative resistor can be used. Please use an external regeneration resistor except it.

Servo amplifier model number	Allowable regeneration resistance power to be used with an internal regenerative resistor [PRI]	Resistance value
RS2#01A#HA#	5W or less	50Ω
RS2#03A#HA#	5W or less	50Ω
RS2#05A#HA#	20W or less	17Ω
RS2#10A#HA#	90W or less	10Ω
RS2#15A#HA#	120W or less	6Ω
RS2#30A#HA#	—	—
RS2K / J	7W or less	15Ω

■ Allowable power of an external 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.

Servo amplifier model number	Allowable regeneration resistance power to be used by an external regeneration resistor [PRO]
RS2#01A#HL#	220W or less
RS2#03A#HL#	220W or less
RS2#05A#HL#	500W or less
RS2#10A#HA#	500W or less
RS2#15A#HA#	500W or less
RS2#30A#HA#	500W or less
RS2K / J	55W or less

When regeneration effective power "PM" exceeds the maximum permitted power [PRO] of the external regeneration resistor, reconsider the acceleration constant, load inertia, etc.

5) Capacity Selection of External Regenerative Resistor

With the regeneration effective power "PM" found from calculation, choose the external regeneration resistor to be used from the following table.

Servo amplifier model number	[PM]	10W or less	30W or less	55W or less	60W or less	110W or less	Less than 220W	220W or more
RS2#01A#HL# RS2#03A#HL#	Resistor Sign ----- Connection Number	B×1 III	D×1 III	F×1 III	C×2 V	E×2 V	F×4 VI	Please contact us.

Servo amplifier model number	[PM]	55W or less	125W or less	250W or less	Less than 500W	500W or more
RS2#05A#HL#	Resistor Sign ----- Connection Number	G×1 III	H×1 III	I×2 IV	H×4 VI	Please contact us

Servo amplifier model number	[PM]	125W or less	250W or less	500W Less than	500W or more
RS2#10A#HL#	Resistor Sign ----- Connection Number	I×1 III	H×2 V	I×4 VI	Please contact us

Servo amplifier model number	[PM]	125W	125W or less	250W or less	Less than 500W	500W or more
RS2#15A#HL#	Resistor Sign Connection Number	J × 1 III	J × 1 III	K × 2 V	J × 4 VI	Please contact us

Servo amplifier model number	[PM]	250W or less	Less than 500	500W or more
RS2#30A#HL#	Resistor Sign Connection Number	L × 1 III	L × 2 V	Please contact us

- ✓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.

6) 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  $J_I$  [J] selected according to in the above 4) or less.

$$EM [J] \leq J_I [J]$$

When regenerative energy exceeds the instantaneous tolerance of resistor you use, select the resistor with large instantaneous tolerance.

- ✓Abnormal regeneration may occurred when vertical axis continuously driven, even if the value is under allowable regenerative resistor power "PR0" and allowable instantaneous tolerance "JI" of usable external regenerative resistor.

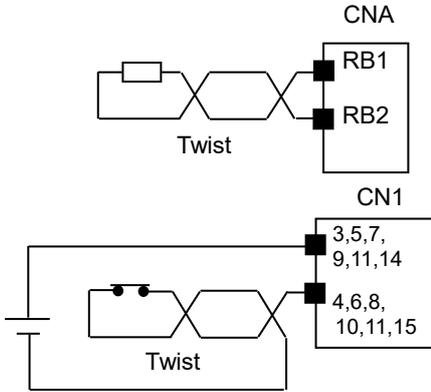
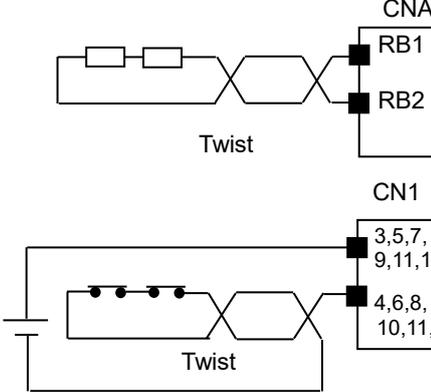
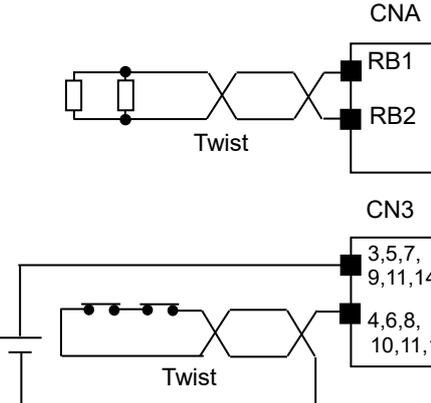
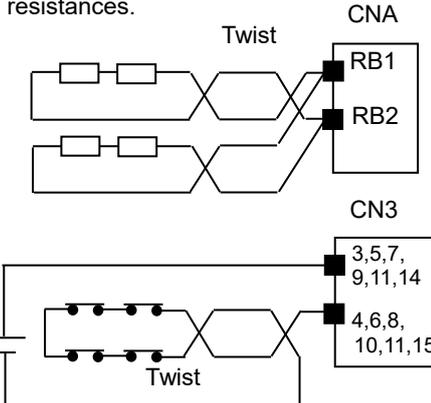
7) Capacity of External Regenerative Resistor and Resistor Model Name

The resistor model name corresponds with the sign of the external regeneration resistor selected for the preceding clause.

Resistor Sign	Resistor Model Number	Resistance Value	Thermostat Detection temperature (Contact specification)	Permissible Effective Power [PM]	Allowable instantaneous tolerance [JI]	Mass	Outline Drawing
A	REGIST-080W100B	100Ω	135°C ± 7°C (Contact b)	10W	35J	0.19kg	"Outline dimensional drawing of regenerative resistor (Chapter 16)"
B	REGIST-080W50B	50Ω		10W	35J	0.24kg	
C	REGIST-120W100B	100Ω		30W	50J		
D	REGIST-120W50B	50Ω		30W	80J	0.44kg	
E	REGIST-220W100B	100Ω		55W	90J		
F	REGIST-220W50B	50Ω		55W	125J		
G	REGIST-220W20B	20Ω		55W	210J	1.4kg	
H	REGIST-500CW0B	20Ω	100°C ± 5°C (Contact b)	125W	9700J		
I	REGIST-500CW10B	10Ω		125W	9300J		
J	REGIST-500CW7B	7Ω		125W	7500J		
K	REGIST-500CW14B	14Ω		125W	13000J		
L	REGIST-1000W6R7B	6.7Ω	140°C ± 5°C (Contact b)	250W	26000J	3.0kg	

### 8) Connection of Regenerative Resistance

The connection method of a resistor corresponds with the connection number of the external regeneration resistor selected by the 4) clause.

■ Connection of regenerative resistance	
<p><b>Connection Number 3</b></p> <p>■ One resistance is connected.</p>  <p>Connect a thermostat and thermal to the general input of CN2.</p>	<p><b>Connection Number 4</b></p> <p>■ Series connection about two resistances.</p>  <p>Connect a thermostat and thermal to the general input of CN2.</p>
<p><b>Connection Number 5</b></p> <p>■ Parallel connection about two resistances.</p>  <p>Connect a thermostat and thermal to the general input of CN2.</p>	<p><b>Connection Number 6</b></p> <p>■ Series/parallel connection about four resistances.</p>  <p>Connect a thermostat and thermal to the general input of CN2.</p>

- ✓ Please make sure to install the external regenerative resistor with twisted wires and use as a short wire that is up to 5 meters long as possible.
- ✓ Use nonflammable electric wire or perform non-combustible processing (silicon tube, etc.) for connecting cable and wired, and install wiring so as to not come in contact with the built-in unit.
- ✓ Please make sure to change the set-up of "System Parameter" and "Regenerative Resistor Selection" in line with the kind of regenerative resistor you connect.

## 9) Thermostat Connection of External Regenerative Resistor

Connect a thermostat to either of "the general inputs CONT1-CONT2."

Please allocate the connected general input signal to [Group9 ID02: External Trip Input Function of General Parameter (0x20F8, 0x03)[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 (4)].

## 10) 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]].

11) Confirmation method of regeneration effective power PM in actual operation

Regeneration effective power **PM** can be easily confirmed in the digital operator or by R ADVANCED MODEL setup software and CoE Object.

- Digital operator·······Monitor mode : ID1A·Regeneration circuit operating rate
  - 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 0.1 to 99.99%.

- The actual regeneration effective power **PM** can be calculated from this monitor value by following equation.

- ◆ Input Supply Voltage: In case of AC200V specification

$$\text{Regeneration effective power PM (W)} = \frac{400(\text{V}) \times 400(\text{V})}{\text{Regeneration resistance } (\Omega)} \times \frac{\text{Regeneration circuit operating rate } (\%)}{100(\%)}$$

- ◆ Input Supply Voltage : In case of AC100V specification

$$\text{Regeneration effective power PM (W)} = \frac{200(\text{V}) \times 200(\text{V})}{\text{Regeneration resistance } (\Omega)} \times \frac{\text{Regeneration circuit operating rate } (\%)}{100(\%)}$$

- Calculation Example

Input Supply Voltage: [AC200V Specification]  
 Regeneration resistance value: 50Ω[Built-in Regenerative Resistor]  
 Monitor Value (RegP): 0.12%

$$\text{Regeneration power PM (W)} = \frac{400(\text{V}) \times 400(\text{V})}{50 (\Omega)} \times \frac{0.12 (\%)}{100 (\%)} = 3.84 (\text{W})$$

The regeneration effective power calculated from this monitor value continues to be the target until the end of operations. Regeneration power varies with the voltage fluctuation of the input power supply and changes across the ages of the servo amplifier and the loading device.

Be sure to opt for selection of regeneration resistance based on the regeneration effective power "PM" found from calculation of a pattern of operation and regeneration power.

Install the external regeneration resistor on equipment, and measure the temperature of the external regeneration resistor by the operating condition that the regeneration effective power PM becomes the maximum. Then do sufficient mounting check of alarm not being generated. In addition, it takes 1 to 2 hours until the temperature of the external regeneration resistor is saturated.

12) 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.

# 16

## 16 Appendixes

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## 16.1 Standards Conformity

In our company, compatibility examinations of overseas standards are carried out in certificate authorities, and attestation markings are done based on the published certificate of attestation.

### 1) Standards conformity

■ The following overseas standard examinations are implemented.

Product model No.	Applicable laws and Regulations		Standard code	Certificate authorities	
	Classification	Detailed Classification			
RS2##### #	UL/c-UL standard	---	UL508C	UL (Underwriters Laboratories inc.) 	
RS2##### 0 (Safe Torque Off function equipped model)	Electrical safety	Low Voltage Directive: LVD	IEC61800-5-1 EN61800-5-1	TÜV (TÜV SÜD Japan, Ltd.) 	
	EMC	EMC directive: EMC (Electromagnetic Compatibility)	EN61000-6-2 IEC61800-3 EN61800-3	TÜV (TÜV SÜD Japan, Ltd.)	
RS2##### 5 (Safe Torque Off function equipped model)	Electrical safety	Low Voltage Directive: LVD	IEC61800-5-1 EN61800-5-1	TÜV (TÜV SÜD Japan, Ltd.)  (Blue octagon)	
	Functional safety	Generic Functional safety	IEC61508 EN61508 (SIL2)		
		Functional Safety: FS	IEC62061 EN62061 (SILCL2)		
		Functional Safety: FS	EN ISO13849-1 / 2015 (Cat.3, PL=d)		
		Functional Safety: FS	IEC61800-5-2 :2007/ EN61800-5-2 :2007		
	EMC	EMC directive: EMC (Electromagnetic Compatibility)	IEC61800-3 EN61800-3		
Functional Safety EMC (FS Electromagnetic Compatibility)		IEC61326-3-1 EN61326-3-1			
RS2##### #	KC standards: (Korea Certification)	---	KN32 (EMI) KN35 (EMS)	National Radio Research Agency Korea Communications Commission Republic of Korea 	
RS2##### #	RoHS Directive (2011/65/EU as amended by (EU)2015/863)	---	IEC 63000:2018 EN 63000:2018	---	

■ The servo motor implements the attestation examination to the following standards.

Standard	Standard code	Certificate authorities
UL standard	UL1004-1	UL (Underwriters Laboratories inc.)
	UL1004-6	
EN standard or IEC standard	EN60034-1	TÜV (TÜV SÜD Japan, Ltd.)
	EN60034-5	
	or IEC60034-1 IEC60034-5	UL (Underwriters Laboratories inc.)

✓ For products conforming to conformity standards, some specifications may differ from the standard product due to prerequisites necessary for obtaining approval. Contact the manufacturer for more details.

2) Over-voltage Category, Protection Grade, Pollution Level

- The "over-voltage category" of servo amplifier is "III" (EN61800-5-1). For the control power (of DC input type) or DC power of interface, use SELV 24V DC power supply. Each DC power supply must have reinforced insulation between input and outputs.
- Make sure to install the servo amplifier in your control panel in an environment where the pollution level specified in EN61800-5-1 and IEC664 is no less than 2 ( pollution level 1, 2). The protection grade of 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.
- ✓ DC input type servo amplifier is getting certification with equipping fuse below to power input port.

Installation site	Model number	Manufacturer	Current	Voltage	Spec.
Main circuit power input	0324020.MXP	Littelfuse	20A	250Vac / 125Vdc	UL certified

4) UL File Number

The UL file number of servo amplifier and servo motor is as follows. Can check from the website of UL.

<https://iq.ulprospector.com/info/>

- The UL file number of servo amplifier: E179775
- The UL file number of servo motor: E179832

## 16.2 Compliance with EN Directives

We implement the conformity verification test of "Low Voltage Directive" and "an EMC command" in a certificate authority so that a user's CE Marking acquisition can be performed easily, and servo amplifier CE Marking is done based on the published certificate of attestation.

### 1) Conformity verification test

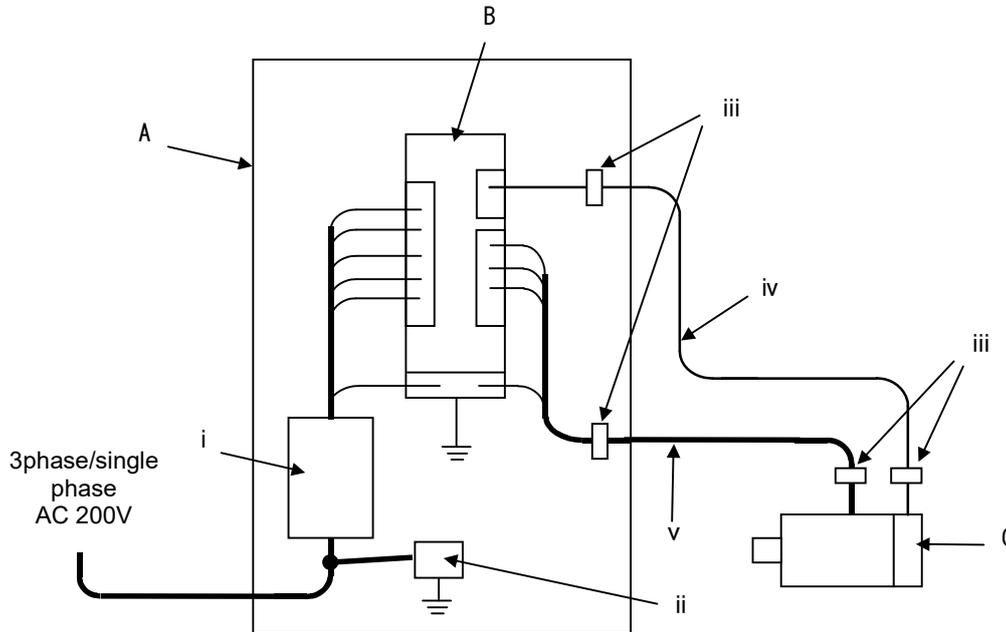
The following conformity verification tests are implemented.

Directive classification	Classification	Test	Test standard
Low voltage Directive (Servo amplifier)	-	-	EN61800-5-1:
Low voltage Directive (Servo motor)	-	Rotating electrical machines-Part1: Rating and performance	EN60034-1 or IEC60034-1
		Rotating electrical machines-Part5: Classification of degrees of protection provided by enclosures of rotating electrical machines (IP code)	EN60034-5 or IEC60034-5
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
		Electrical equipment for measurement, control and laboratory use	IEC61326-3-1 Note 1)
		Safety of machinery	EN62061 (Annex E) Note 1)

Note 1) 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.



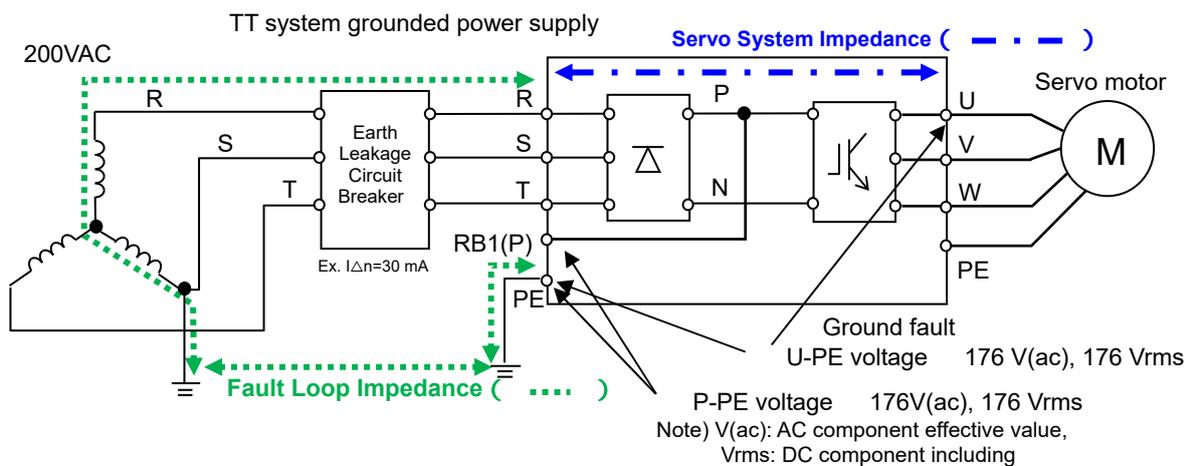
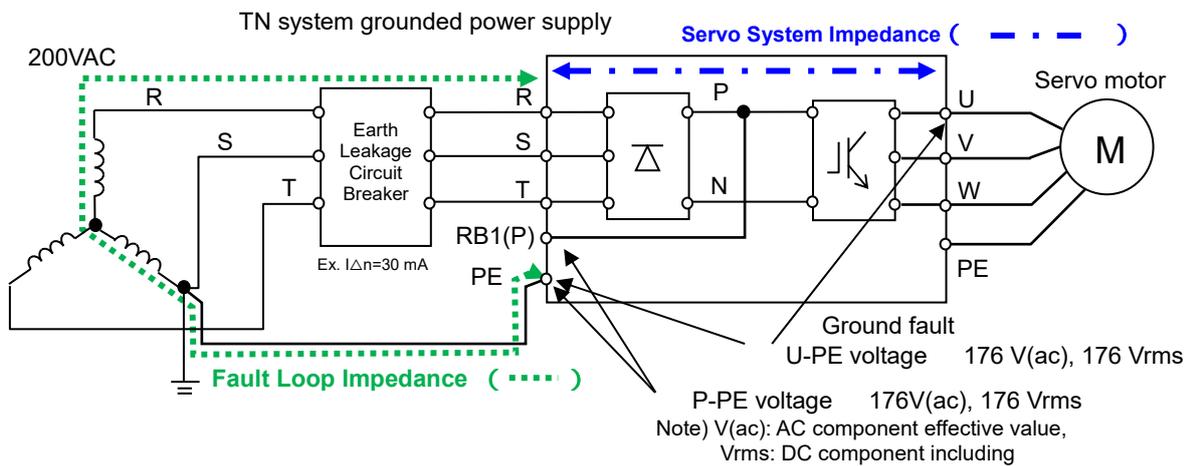
Symbol	Name	Remarks
A	Control panel	-
B	Servo amplifier	-
C	Servo motor	-
i	Noise filter (Recommended prevention components)	RS2*01 - RS2A15:HF3030C-UQA: SOSHIN ELECTRIC Co. Ltd. Rated voltage/rated current: Line-Line 480V AC / 30A RS2A15(Q2AA22700S-combined): HF3050C-UQA: SOSHIN ELECTRIC Co. Ltd. Rated voltage / rated current: Line-Line 480V AC / 50A RS2A30: HF3080C-UQA: SOSHIN ELECTRIC Co. Ltd. Rated voltage / rated current: Line-Line 480V AC / 80A
ii	Surge-absorber (Recommended prevention components)	LT-C32G801WS: SOSHIN ELECTRIC Co. Ltd.
iii	Clamp grounding	-
iv	Encoder cable	Shielded cable
v	Servo motor power cable	Shielded cable

- ✓ Use metallic materials for the door and main body of control panel.
- ✓ Use EMI gasket so that there is zero clearance between the door and control panel. Install EMI gasket uniformly to the contact points between door and main body of control panel to confirm their conductivity.
- ✓ Please close cabinet door which has this product, in use.
- ✓ Ground noise filter frame to control panel.
- ✓ Use shield cables for motor power line and encoder cable. Clamp grounding of shield at the frame of control panel and equipment.
- ✓ Use conducting metal P-clip or U-clip to ground and clamp shielded wire, and fix it directly with metal screws. Do not ground by soldering electric wire to shielded wire.
- ✓ Wire servo amplifier at a short distance from the secondary side of noise filter, and wire the primary side and secondary side of noise filter separately.

3) Ground fault test

RS2 series power unit/amplifier unit have conformity with IEC 60364-4-41: 2005/AMD1: 2016 (HD 60364-4-41: 2007), Clause 411, with conditions below.

- Precautions
  - ✓ TN grounding system  
It shall be set that input wiring is within specified diameter and length, and within the Fault Loop Impedance value shown in table 12-1.
  - ✓ TT grounding system  
It shall be set that input wiring is connected to Earth Leakage Circuit Breaker (30 mA) and is within specified diameter and length, and within the Fault Loop Impedance value shown in table 12-1.
  - ✓ IT grounding system  
Our servo amplifier cannot detect ground fault with IT system so it doesn't supposed.
  - ✓ Peripheral equipment (including Earth Leakage Circuit Breaker) and wire size shall be used depending on Power supply capacity and peripherals list and Recommended wire size.
  
- Wiring for ground fault test (with 200 VAC input type)



Fault Loop Impedance and servo system internal impedance

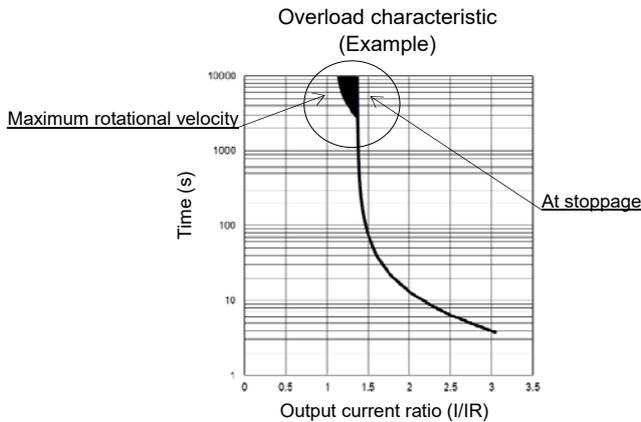
FLI: Fault Loop Impedance  
SSI: Servo System Impedance

Table 12-1

Model number	Power voltage	Rated current	Power system	Shut-off time	Shut-off method	Voltage to ground, AC component	Shut-off current	SSI	FLI
RS2E01	100V AC	7.7A	TN	0.8s	Built-in Amp FUSE	88V(ac)	90A	162mΩ	0.8162Ω
			TT	0.3s	30 mA ELCB		0.03A	162mΩ	2933.2Ω
RS2E03		10A	TN	0.8s	Built-in Amp FUSE		90A	162mΩ	0.8162Ω
			TT	0.3s	30 mA ELCB		0.03A	162mΩ	2933.2Ω
RS2E05		23A	TN	0.8s	Built-in Amp FUSE		90A	246mΩ	0.7313Ω
			TT	0.3s	30 mA ELCB		0.03A	246mΩ	2933.1Ω
RS2A01	200V AC	5.6A	TN	0.4s	Built-in Amp FUSE	176V(ac)	105A	162mΩ	1.5147Ω
TT			0.2s	30 mA ELCB	0.03A		162mΩ	5866.5Ω	
RS2A03		10A	TN	0.4s	Built-in Amp FUSE		105A	162mΩ	1.5147Ω
			TT	0.2s	30 mA ELCB		0.03A	162mΩ	5866.5Ω
RS2A05		23A	TN	0.4s	Built-in Amp FUSE		105A	246mΩ	1.4297Ω
			TT	0.2s	30 mA ELCB		0.03A	246mΩ	5866.4Ω
RS2A10		26.1A	TN	0.4s	Built-in Amp FUSE		280A	116mΩ	0.5125Ω
			TT	0.2s	30 mA ELCB		0.03A	116mΩ	5866.6Ω
RS2A15		37.8A	TN	5.0s	Built-in Amp FUSE		220A	114mΩ	0.6857Ω
			TT	1.0s	30 mA ELCB		0.03A	114mΩ	5866.6Ω
RS2A30		72A	TN	5.0s	Built-in Amp FUSE		660A	103mΩ	0.1633Ω
			TT	1.0s	30 mA ELCB		0.03A	103mΩ	5866.6Ω

## 4) About motor overload characteristics

- Overload characteristic



- ✓ Some motor has the overload characteristic such as above. Characteristic curve becomes broad at maximum rotational velocity around and it means overload detection time varies depending on motor rotational velocity. (at circle internal of above graph)
- ✓ When rotating with maximum velocity, overload alarm is detected by the time according to output current ratio shown left end line. (※1)
- ✓ Output current ratio shown right end line shows overload alarm detection time when motor is locked completely (motor stops with torque limit setting). (※2)

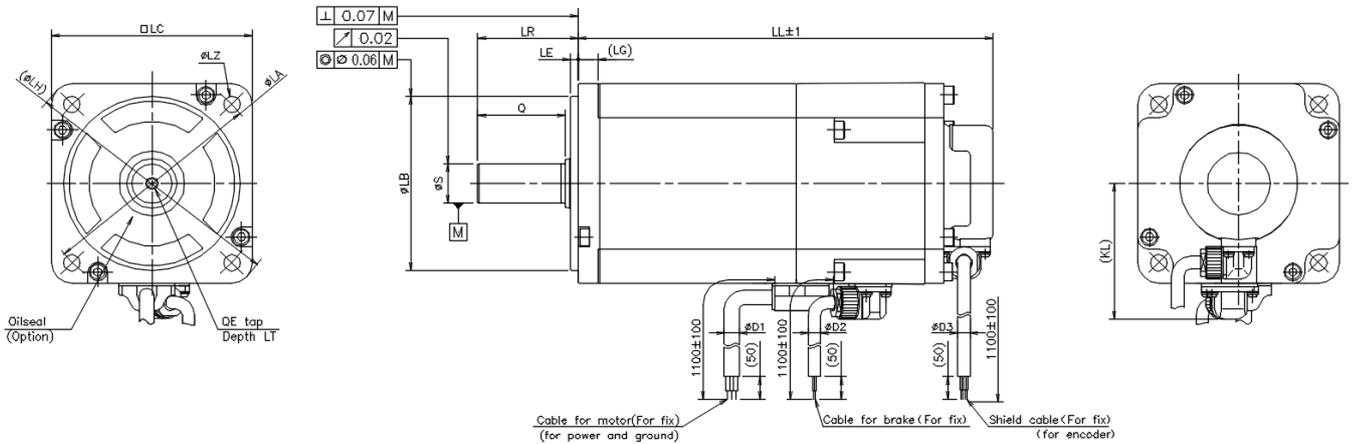
- Thermal memory function

For thermal memory function in our amplifier unit, thermal memory (shut down) is exist but thermal memory (loss of power) function and speed sensitivity function are not exist.

- ✓ Overload alarm is detected by using the time shown in overload characteristic after calculating output current ratio at amplifier unit internal. Detection time may become shorten when alarm is cleared soon after overload detection because output current ratio calculation at amplifier unit internal is still high.
- ✓ There is no thermal memory function at power OFF because output current ratio calculation at amplifier unit internal returns to initial state by control power ON/OFF.
- ✓ For motor overload characteristic, refer the section 12.4.3.

### 16.3 Servo Motor Dimension

#### 1) R1 motor, Flange Size 40mm, 60mm

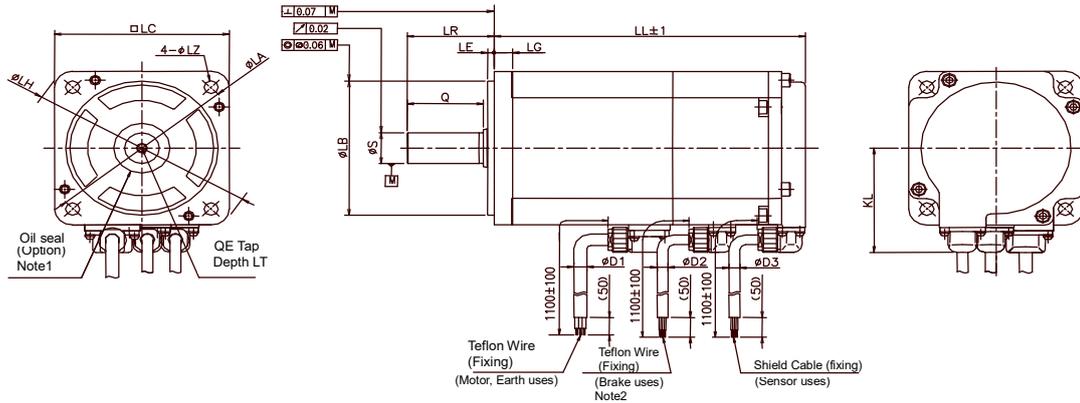


Servo motor model number	Without Oil Seal		With Oil Seal		LL	LG	KL	LA	LB	LE	LH	LC	LZ
	Battery backup absolute encoder		Battery backup absolute encoder										
	Without Brake	With Brake	Without Brake	With Brake									
R1GA04005△□◇	84.0	115.0	89.0	120.0	5	35.3	46	0	2.5	56	40	4-Φ4.5	
R1GA04010△□◇	56.5	92.5	61.5	97.5				30-0.021					
R1GA06020△□◇	72	108	77	113	6	44.4	70	0 50-0.025	3	82	60	4-Φ5.5	

Servo motor model number	LR	S	Q	QE	LT	D1	D2	D3
R1GA04005△□◇	25	0	20	-	-	6	5	5
R1GA04010△□◇		8-0.009						
R1GA06020△□◇	30	0 14-0.011	25	M5	12			

- ✓ If oil seal is required, whole motor length shall be changed.
- ✓ For the motor without brake, no brake cable shall be supplied.
- ✓ All the dimensions above shall be applicable to motor with battery-back up absolute encoder. If you use servo motor having the other encoder specification, please consult us as the dimensions shall be changed.

2) R2 motor, Flange Size 40mm, 60mm, 80mm, 86mm and 100mm

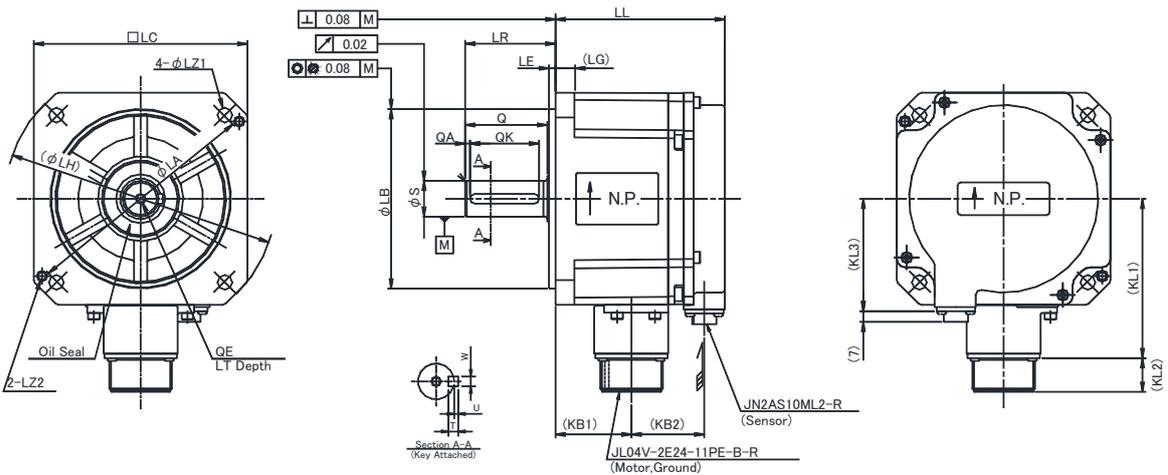


Servo motor model number	Without Oil Seal		With Oil Seal		LG	KL	LA	LB	LE	LH	LC	LZ	LR
	Battery backup absolute encoder		Battery backup absolute encoder										
	Without Brake	With Brake	Without Brake	With Brake									
R2□A04003△□◇	51.5	87.5	56.5	92.5	5	35.4	46	0 30-0.021	2.5	56	40	2- Φ4.5	25
R2□A04005△□◇	56.5	92.5	61.5	97.5									
R2EA04008△□◇	72	108	77	113									
R2AA04010△□◇	58.5	82.5	65.5	89.5	6	44.6	70	0 50-0.025	3	82	60	4- Φ5.5	25
R2□A06020△□◇	69.5	97.5	76.5	104.5									
R2AA08020△□◇	66.3	102	73.3	109	8	54.4	90	0 70-0.030	3	108	80	4- Φ6.6	30
R2AA06040△□◇	95.5	123.5	102.5	130.5									
R2AA08040△□◇	78.3	114	85.3	121	8	54.4	90	0 70-0.030	3	108	80	4- Φ6.6	40
R2AA08075△□◇	107.3	143	114.3	150									
R2AAB8100△□◇	137	163	137	163	10	66.8	115	0 80-0.030	3	115.5	86	4- Φ6.6	35
R2AA10100△□◇	128.3	145.8	128.3	145.8									
R2AA10100△□◇	128.3	145.8	128.3	145.8				0 95-0.035		130	100	4- Φ9	45

Servo motor model number	S	Q	QE	LT	D1	D2	D3
R2□A04003△□◇	0 6-0.008	20	-	-	6	5	5
R2□A04005△□◇	0						
R2EA04008△□◇	8-0.009						
R2AA04010△□◇	0	20	-	-	6	5	5
R2□A06010△□◇	8-0.009						
R2□A06020△□◇	0	25	M5	12	6	5	5
R2AA08020△□◇	14-0.011						
R2AA06040△□◇	0	35	M5	12	6	5	5
R2AA08040△□◇	16-0.011						
R2AA08075△□◇	0	30	M5	12	6	5	5
R2AAB8100△□◇	16-0.011						
R2AA10100△□◇	0 22-0.013	40	M6	20			

- ✓ If an oil seal is needed, the motor whole length differs.
- ✓ For the one without brake, there is no brake connector (or cable) attached.
- ✓ For specifications on other motor, please contact us.

3) R2 motor, Flange Size 130mm and 220mm

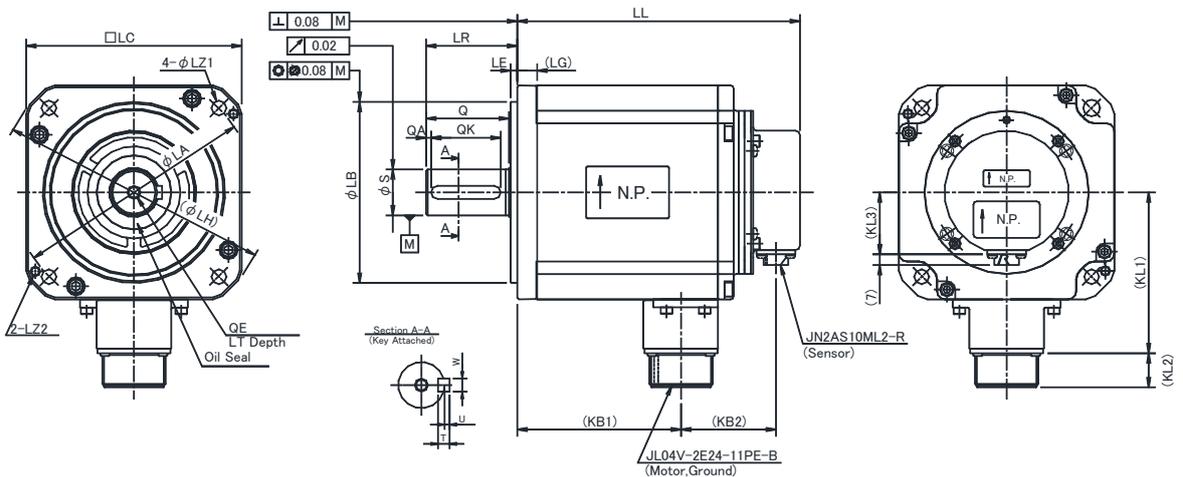


MODEL	Battery backup absolute encoder Absolute encoder for incremental system						Incremental encoder						LG	KL1	KL2	LA
	Without brake			With brake			Without brake			With brake						
	LL	KB2	KL3	LL	KB2	KL3	LL	KB2	KL3	LL	KB2	KL3				
R2AA13050△□◇	103			139.5	81		115.5			153.5	93		12	98	21	145
R2AA13120△□◇	120.5	44	69	160	84	69	133	57	38	174	96	38				
R2AA13180△□◇	138			179	86		150.5			192	96					

MODEL	LB	LE	LH	LC	LZ1	LZ2	LR	S	Q	QA	QK	W	T	U	KB1	QE	LT
R2AA13050△□◇	0							0				0	6	2.5	46		
R2AA13120△□◇	110-0.035	4	165	130	9	M6	55	22-0.013	50	3	42	6-0.030			64	M6	20
R2AA13180△□◇															81		

- ✓ For the following encoders, please make inquiries:  
Battery-less absolute encoder [RA035C]
- ✓ For specifications on other motor, please contact us.

4) R2 motor, Flange Size 130mm, 2kW

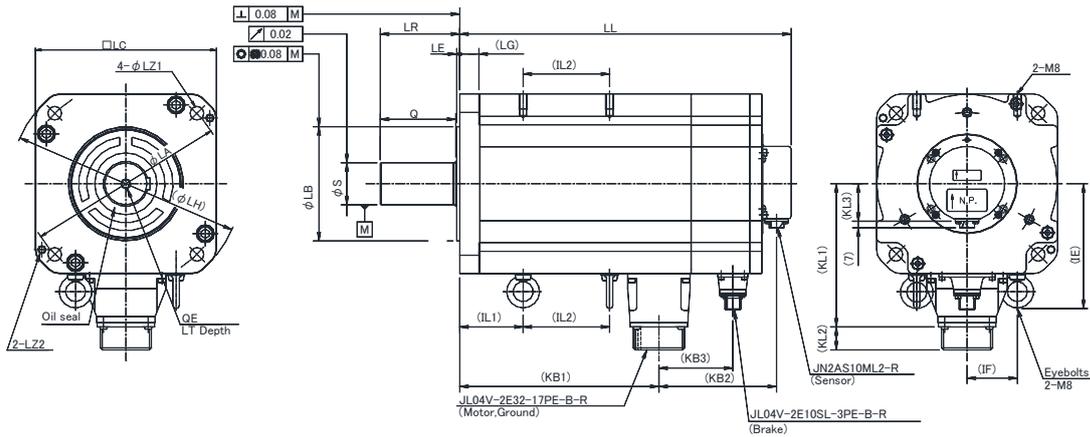


MODEL	Battery backup absolute encoder Absolute encoder for incremental system						Incremental encoder						LG	KL1	KL2	LA
	Without brake			With brake			Without brake			With brake						
	LL	KB2	KL3	LL	KB2	KL3	LL	KB2	KL3	LL	KB2	KL3				
R2AA13200△□◇	171	57	38	216	103	38	185	64	65	230	110	65	12	98	21	145

MODEL	LB	LE	LH	LC	LZ1	LZ2	LR	S	Q	QA	QK	W	T	U	KB1	QE	LT
R2AA13200△□◇	0							0				0	7	3	99	M8	25
	110-0.035	4	165	130	9	M6	55	28-0.013	50	3	42	8-0.036					

- ✓ For the following encoders, please make inquiries:  
Battery-less absolute encoder [RA035C]
- ✓ For specifications on other motor, please contact us.

5) R2 motor, Flange Size 180mm, 3.5 to 7.5kW

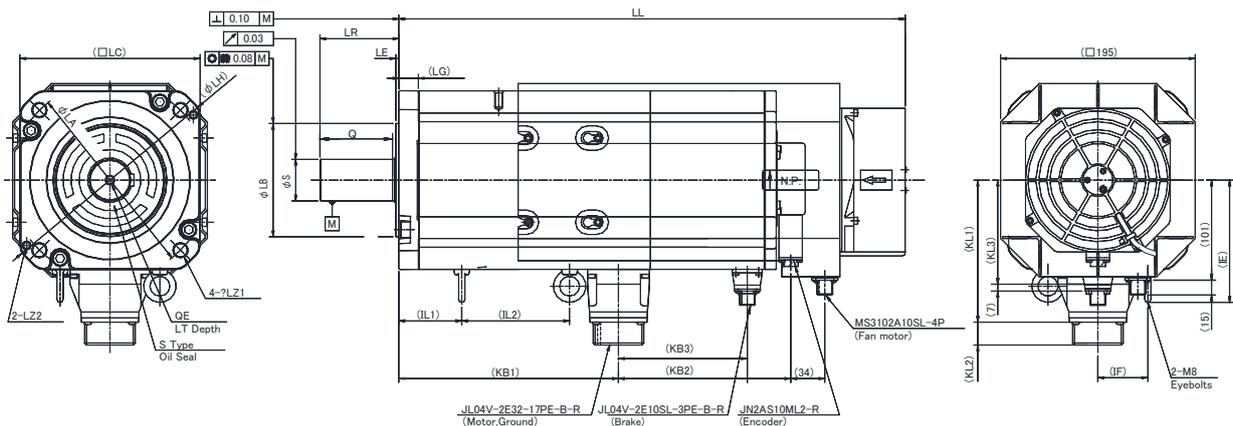


MODEL	Battery backup absolute encoder				Absolute encoder for incremental system				Incremental encoder				LG	KL1	KL2	LA	LB	LE	LH				
	Without brake		With brake		Without brake		With brake																
	LL	KB2	KB3	KL3	LL	KB2	KB3	KL3	LL	KB2	KB3	KL3								LL	KB2	KB3	KL3
R2AA18350△□◇	155	48	-	38	204	97	-	38	172	59	-	65	221	108	-	65	16	123	21	200	0	3	230
R2AA18450△□◇	172				221				189				238								114.3-0.035		
R2AA18550△□◇	228	59			281	114	58	38	242	66		65	295	121	58	65	19	144	22				
R2AA18750△□◇	273				336	124	68		287				350	131	68								

MODEL	LC	LZ1	LZ2	LR	S	Q	KB1	QE	LT	IE	IF	IL1	IL2	Power connector model No.	Brake connector model No.
R2AA18350△□◇	180	13.5	M8	65	0	60	92	M8	25	123	50	50	20	JL04V-2E24-11PE-B-R	-
35-0.016					109		①			①	①	①	②		
0				153	123	50	41	JL04V-2E32-17PE-B-R		JL04V-2E10SL-3PE-B-R					
42-0.016				198	50	86									

- ✓ For the following encoders, please make inquiries:  
Battery-less absolute encoder [RA035C]
- ✓ 1 The R2AA18350 motor without brake comes with no eye bolt.
- ✓ 2 The brake line is shared with the power connector.
- ✓ For specifications on other motor, please contact us.

6) R2 motor, Flange Size 180mm, 11kW

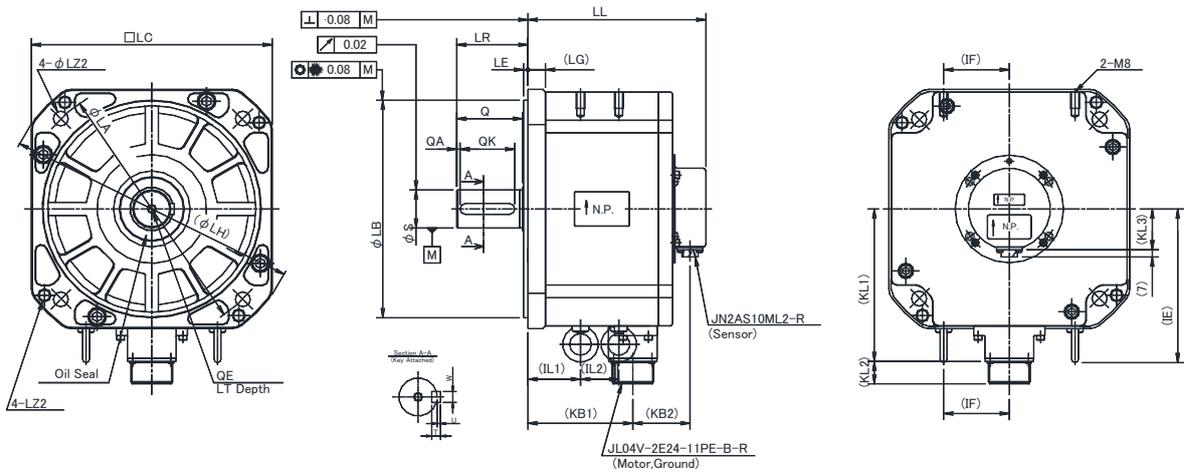


MODEL	Battery backup absolute encoder				Absolute encoder for incremental system				Incremental encoder				LG	KL1	KL2	LA				
	Without brake		With brake		Without brake		With brake													
	LL	KB2	KB3	KL3	LL	KB2	KB3	KL3	LL	KB2	KB3	KL3					LL	KB2	KB3	KL3
R2AA1811K△□◇	385	59	-	102	478	154	83	102	385	66	-	102	478	161	83	102	19	144	22	200

MODEL	LB	LE	LH	LC	LZ1	LZ2	LR	S	Q	KB1	QE	LT	IE	IF	IL1	IL2
R2AA1811K△□◇	114.3-0.035	3	230	180	13.5	M8	79	0	75	223	M10	25	123	50	63	111

- ✓ For the following encoders, please make inquiries:  
Battery-less absolute encoder [RA035C]
- ✓ For specifications on other motor, please contact us.

7) R2 motor, Flange Size 220mm, 3.5 to 5kW



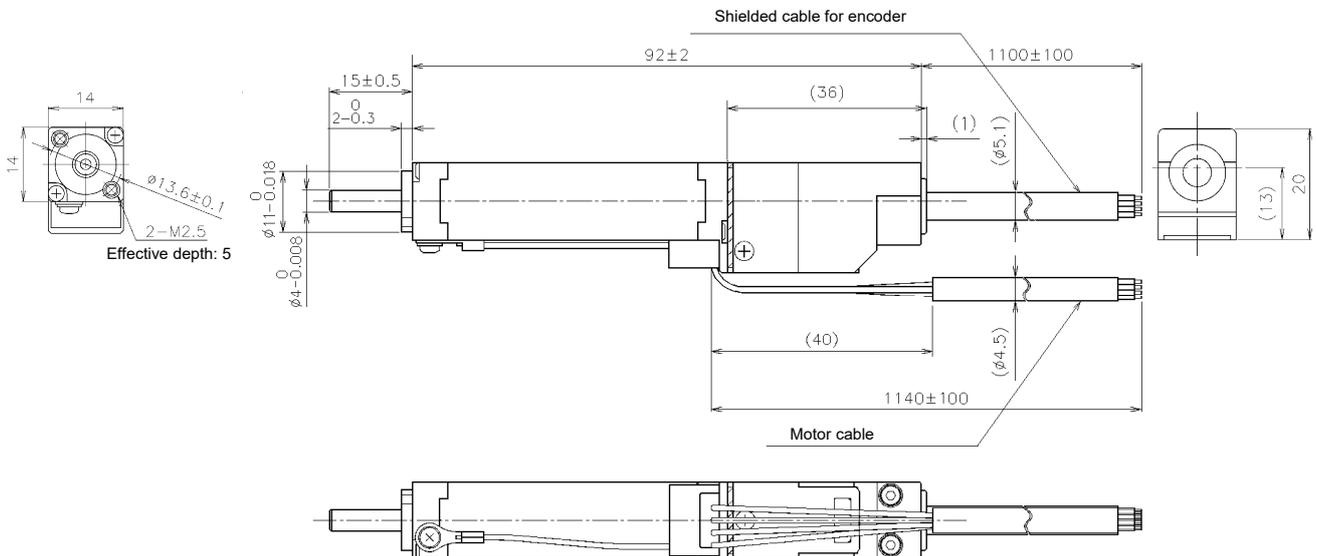
MODEL	Battery backup absolute encoder						Incremental encoder						LG	KL1	KL2	KL3	LA	LB	LE	LH
	Absolute encoder for incremental system			Incremental encoder			Without brake			With brake										
	Without brake	With brake		Without brake	With brake		Without brake	With brake		Without brake	With brake									
R2AA22500△□◇	163	52	38	216	106	38	177	59	65	230	113	65	16	142	21	38	235	200-0.046	4	270

MODEL	LC	LZ1	LZ2	LR	S	Q	QA	QK	W	T	U	KB1	QE	LT	IE	IF	IL1	IL2
R2AA22500△□◇	220	13.5	M12	65	35-0.016	60	3	50	10-0.036	8	3	96	M8	25	142	60	48	35

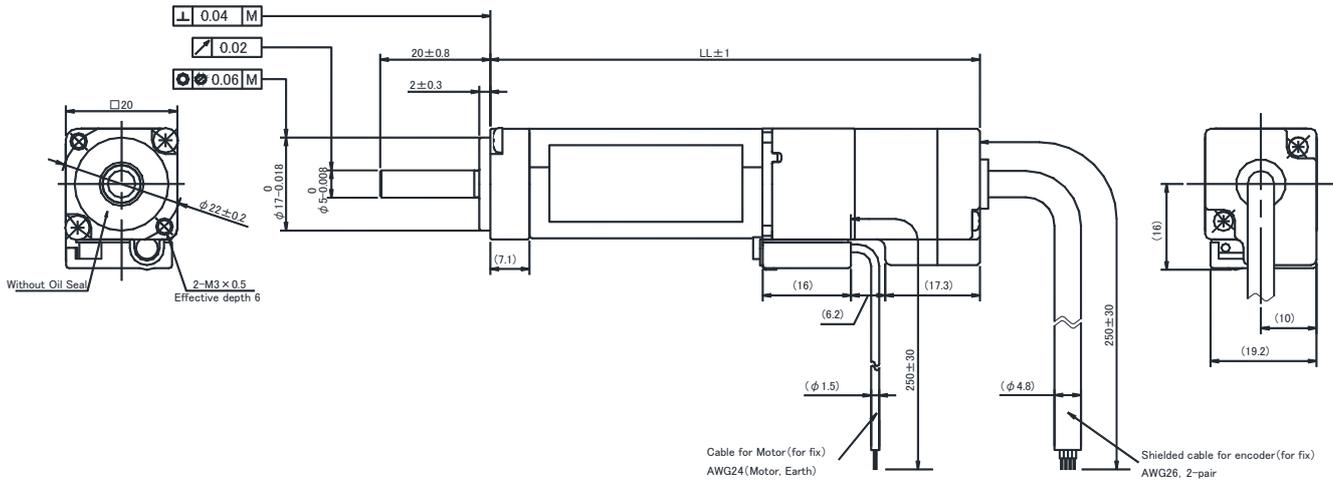
- ✓ For the following encoders, please make inquiries:  
Battery-less absolute encoder [RA035C]
- ✓ For specifications on other motor, please contact us.

8) Flange Size 14mm (48V DC)



- ✓ Without oil seal.
- ✓ Without holding brake. Holding brake cannot be equipped.
- ✓ Sensor spec is absolute encoder for incremental system only. Battery backup absolute encoder, Battery-less absolute encoder and Pulse encoder cannot be equipped.

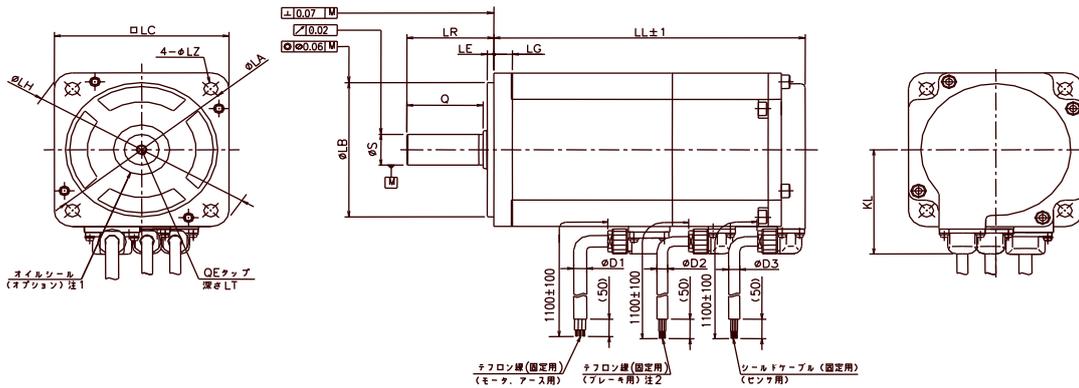
9) R2 motor, Flange Size 20mm



	Without Oil Seal
	Absolute encoder for incremental system
	Without brake
Servo motor model number	LL
R2□A02D20△□◇	89
R2□A02D30△□◇	108

- ✓ Without oil seal.
- ✓ Without holding brake. Holding brake cannot be equipped.
- ✓ Sensor spec is absolute encoder for incremental system only. Battery backup absolute encoder, Battery-less absolute encoder and Pulse encoder cannot be equipped.

10) R5 motor, Flange Size 60mm, 80mm



Without Oil Seal	With Oil Seal		
Battery backup absolute encoder			
Absolute encoder for incremental system			
No brake	With brake	No brake	With brake

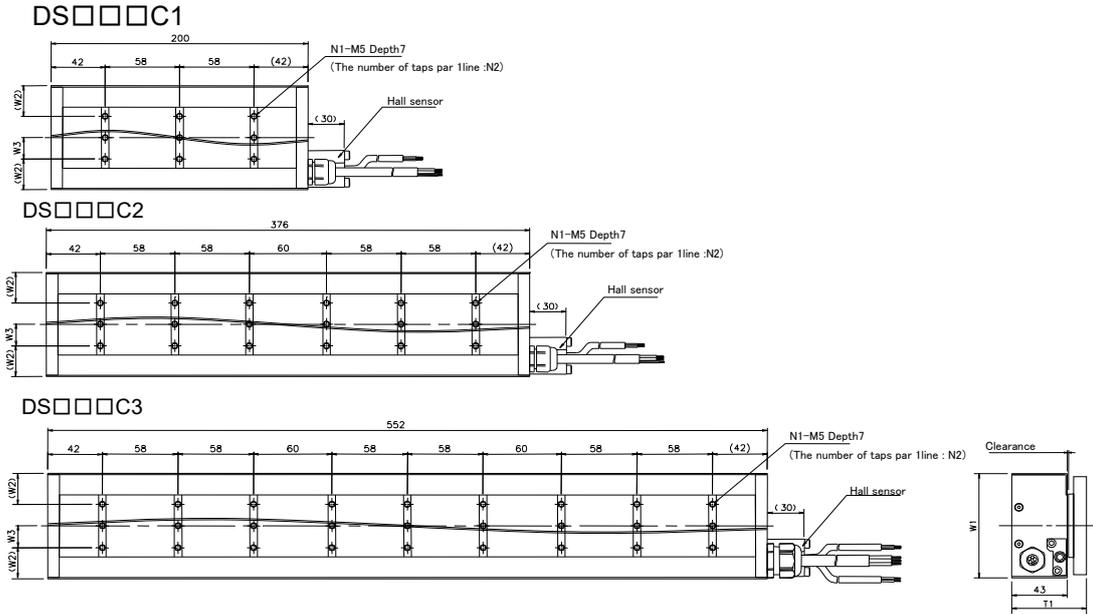
MODEL	LL	LL	LL	LL	LG	KL	LA	LB	LE	LH	LC	LZ	LR
R5□A06020△□◇	72.5	100.5	79.5	107.5	6	44.6	70	0	3	82	60	4-Φ5.5	30
R5□A06040△□◇	98.5	126.5	105.5	133.5				50-0.025				4-Φ5.5	
R5□A08075△□◇	110.3	146	117.3	153	8	54.4	90	0 70-0.03	3	108	80	4-Φ6.6	40

MODEL	S	Q	QE	LT	D1	D2	D3
R5AA06040△□◇	014-0.011	25	M5	12	6	5	5
R5AA08040△□◇							
R5AA08075△□◇	0 16-0.011	35					

- ✓ If an oil seal is needed, the motor whole length differs.
- ✓ For the one without brake, there is no brake connector (or cable) attached.
- ✓ For specifications on other motor, please contact us.

11) DS Linear motor with core, flat-type

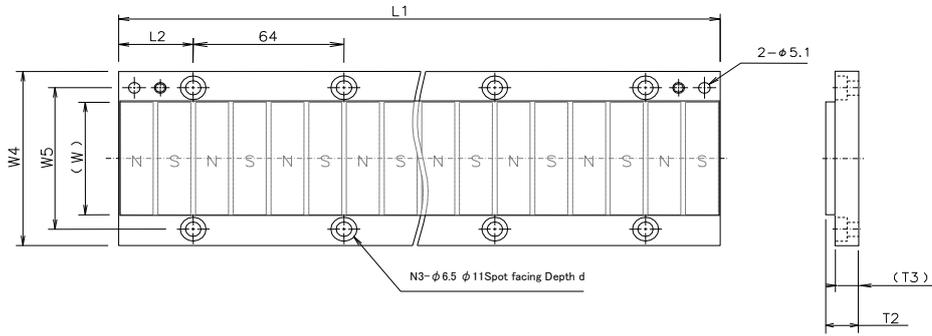
- Outline dimensional drawing of coil with core, flat-type



Coil model no.		Dimension					
		W1(mm)	W2(mm)	W3(mm)	N1	N2	T(mm)
DS030	C1N2	65	25	15	6	2	58
	C2N2				12		
	C3N2				18		
DS050	C1N2	85	25	35	6	2	58
	C2N2				12		
	C3N2				18		
DS075	C1N2	110	25	30	9	3	58
	C2N2				18		
	C3N2				27		
DS100	C1N2	135	32.5	35	9	3	58
	C2N2				18		
	C3N2				27		
DS150	C1N2	185	32.5	30	15	5	60
	C2N2				30		
	C3N2				45		

- Outline dimensional drawing of magnet rail with core, flat-type

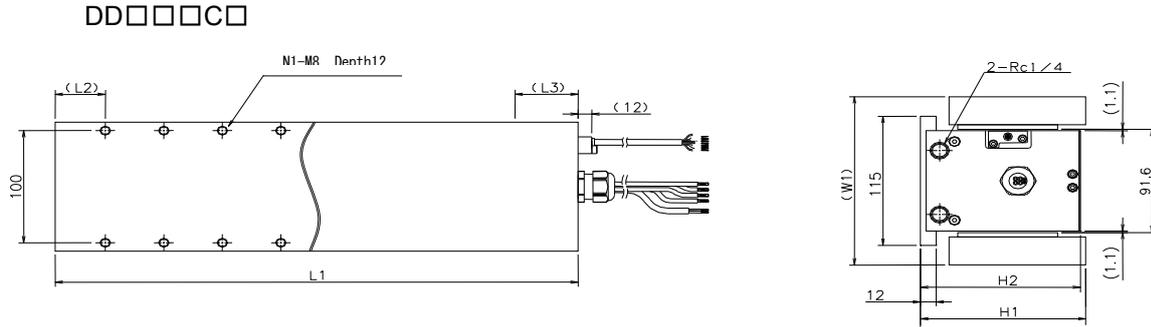
DS□□□M□□□B00



Magnet rail model no.		Dimension								
		W mm	W4 mm	W5 mm	L1 mm	L2 mm	T2 mm	T3 mm	N3	d mm
DS030	M064B00	30	60	45	63.3	31.65	14.25	10	2	6
	M128B00				127.3				4	
	M256B00				255.3				8	
	M512B00				511.3				16	
DS050	M064B00	50	80	65	63.3	31.65	14.25	10	2	5
	M128B00				127.3				4	
	M256B00				255.3				8	
	M512B00				511.3				16	
DS075	M064B00	75	105	90	63.3	31.65	14.25	10	2	5
	M128B00				127.3				4	
	M256B00				255.3				8	
	M512B00				511.3				16	
DS100	M064B00	100	130	115	64	32	14.25	10	2	5
	M128B00				128				4	
	M256B00				256				8	
	M512B00				512				16	
DS150	M064B00	150	180	165	64	32	16.25	12	2	6
	M128B00				128				4	
	M256B00				256				8	
	M512B00				512				16	

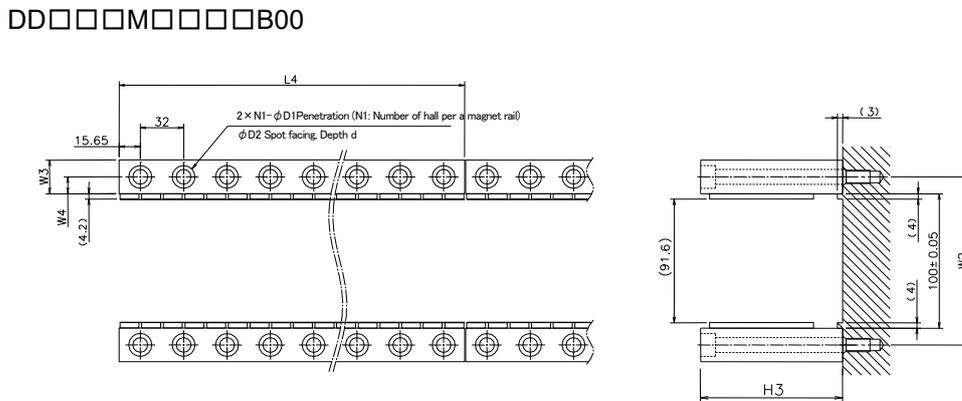
12) DD Linear motor with core, twin-type

- Outline dimensional drawing of coil with core, twin-type



Coil model no.		Dimension						
		W1(mm)	L1(mm)	L2(mm)	L3(mm)	N1	H1(mm)	H2(mm)
DD030	C1Y4	130	226	40.5	50.5	8	82	78
	C2Y4		402	38.5	48.5	16		
	C3Y4		578	36.5	46.5	24		
DD050	C1Y2	140	226	40.5	50.5	8	102	98
	C2Y2		402	38.5	48.5	16		
	C3Y2		578	36.5	46.5	24		
DD075	C1Y2	150	226	40.5	50.5	8	127	123
	C2Y2		402	38.5	48.5	16		
	C3Y2		578	36.5	46.5	24		
	C4Y2		754	34.5	44.5	32		

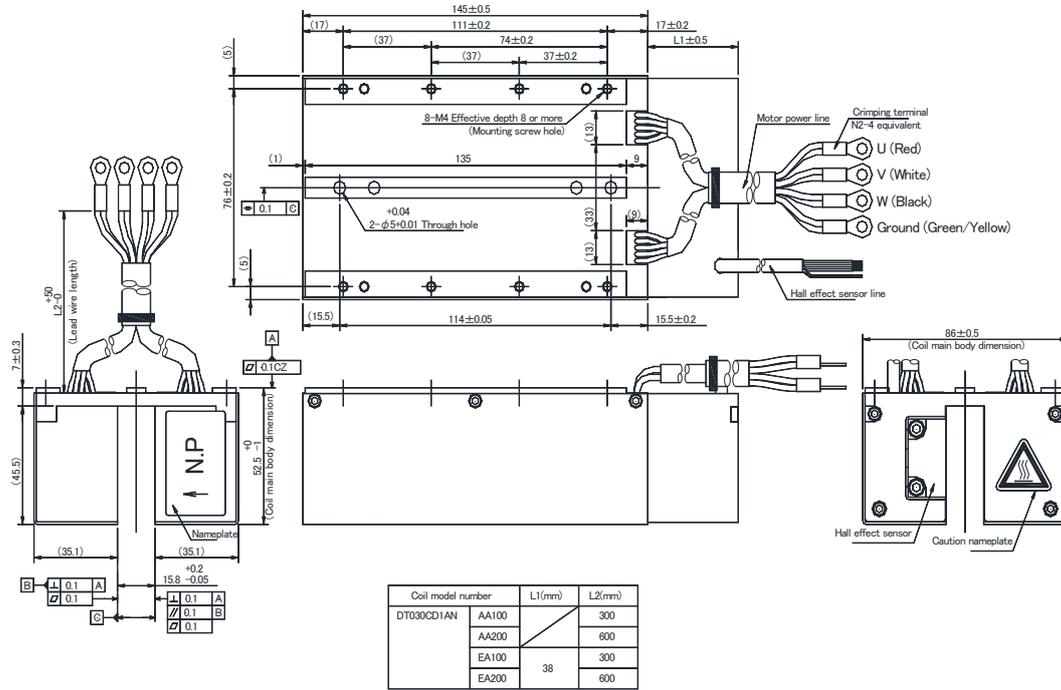
- Outline dimensional drawing of magnet rail with core, twin-type



Magnet rail model no.		Dimension									
		W1 (mm)	W2 (mm)	W3 (mm)	W4 (mm)	H3 (mm)	L4 (mm)	N1	D1 (mm)	D2 (mm)	d (mm)
DD030	M064B02	130	115	15	7.5	60	64	2	7	11	7
	M128B02						128	4			
	M256B02						256	8			
	M512B02						512	16			
DD050	M064B02	140	120	20	10	80	64	2	9	14	9
	M128B02						128	4			
	M256B02						256	8			
	M512B02						512	16			
DD075	M064B02	150	125	25	12.5	105	64	2	11	17	11
	M128B02						128	4			
	M256B02						256	8			
	M512B02						512	16			

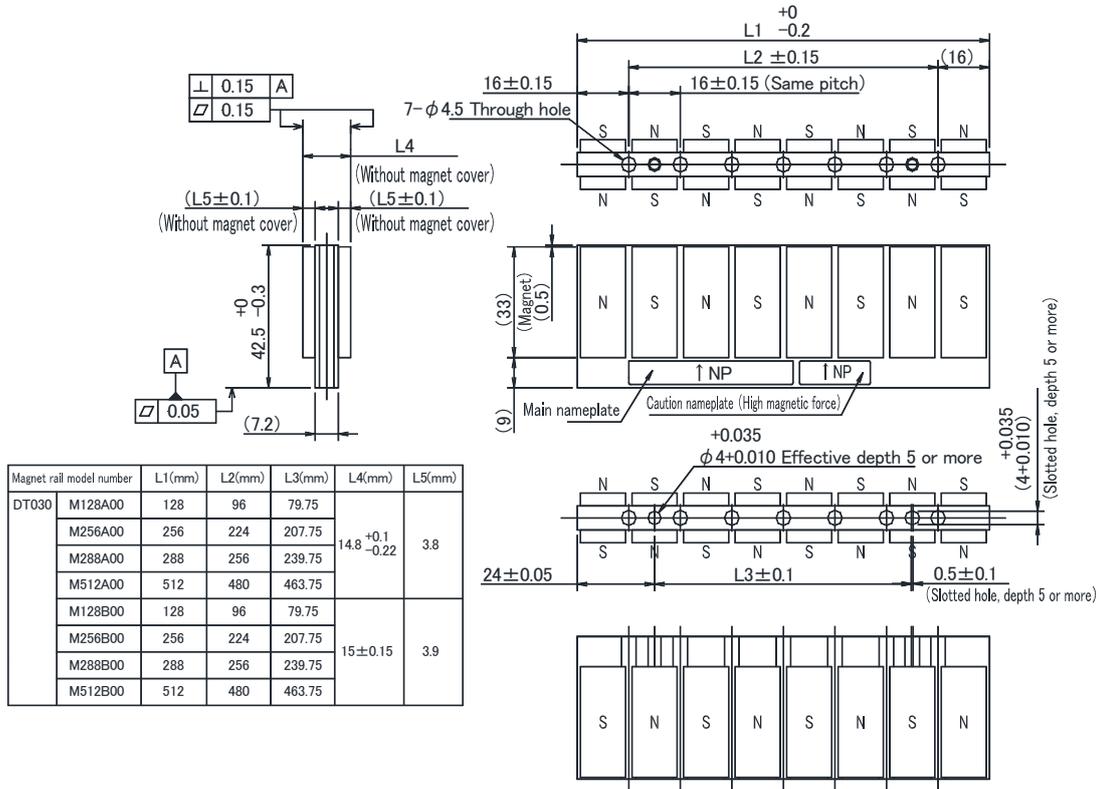


- Outline dimensional drawing of coil, center magnet type DT030CD



- Outline dimensional drawing of magnet rail, center magnet-type

DT030M□□□



## 16.4 Servo Motor Data Sheet

### 1) Characteristics table

#### ■ Specification of R1 motor, 200V AC

Servo motor model number R1AA			10100H	10150H	10100F	10150F	10200H	10250H
Amplifier size combined			RS2A03A	RS2A03A	RS2A05A	RS2A05A	RS2A05A	RS2A05A
*Rated output	$P_R$	kW	1.0	1.5	1.0	1.5	2.0	2.5
*Rated velocity	$N_R$	$\text{min}^{-1}$	3000	3000	3000	3000	3000	3000
*Maximum velocity	$N_{\text{max}}$	$\text{min}^{-1}$	3000	3000	6000	6000	3000	3000
*Rated torque	$T_R$	$\text{N}\cdot\text{m}$	3.2	4.8	3.2	4.8	6.37	7.97
*Continuous Torque at stall	$T_S$	$\text{N}\cdot\text{m}$	3.2	4.9	3.2	4.9	6.37	7.97
*Peak Torque at stall	$T_P$	$\text{N}\cdot\text{m}$	12.6	18.0	10.5	15.0	24.0	26.5
*Rated armature current	$I_R$	Arms	4.5	5.2	7.7	8.2	7.7	9.0
*Armature current at stall	$I_S$	Arms	3.8	3.8	7.4	7.7	6.8	7.2
*Peak armature current at stall	$I_P$	Arms	15.5	15.5	26.5	26.5	26.5	26.5
*Torque constant	$K_T$	$\text{N}\cdot\text{m}/\text{Arms}$	0.97	1.35	0.46	0.64	1.07	1.24
Voltage constant for each phase	$K_{E\Phi}$	$\text{mV}/\text{min}^{-1}$	33.9	47.1	15.9	22.4	37.3	43.2
Phase resistance	$R_\Phi$	$\Omega$	14	1.3	0.27	0.26	0.61	0.58
*Rated power rate	$Q_R$	$\text{kW}/\text{s}$	73	115	73	115	176	227
Rotor inertia Note 1)	$J_M$	$\text{kg}\cdot\text{m}^2(\text{GD}^2/4)$ $\times 10^{-4}$	1.4	2.0	1.4	2.0	2.3	2.8
Mass Note 1)	WE	kg	3.8	5.0	3.8	5.0	5.7	6.7
Brake mass	W	kg	1.5	1.5	1.5	1.5	1.5	1.5
Aluminum plate		mm	t20×400	t20×400	t20×400	t20×400	t20×470	t20×470

Servo motor model number R1AA			10200F	10250F	13300H	13300F
Amplifier size combined			RS2A10A	RS2A10A	RS2A10A	RS2A10A
*Rated output	$P_R$	kW	2.0	2.5	3.0	3.0
*Rated velocity	$N_R$	$\text{min}^{-1}$	3000	3000	3000	3000
*Maximum velocity	$N_{\text{max}}$	$\text{min}^{-1}$	6000	6000	3000	6000
*Rated torque	$T_R$	$\text{N}\cdot\text{m}$	6.37	7.97	9.7	9.7
*Continuous Torque at stall	$T_S$	$\text{N}\cdot\text{m}$	6.37	7.97	9.7	9.7
*Peak Torque at stall	$T_P$	$\text{N}\cdot\text{m}$	20.0	24.0	34.8	29.0
*Rated armature current	$I_R$	Arms	13.9	14.8	14.7	17.5
*Armature current at stall	$I_S$	Arms	13.1	13.9	11.5	16.8
*Peak armature current at stall	$I_P$	Arms	45.5	45.5	45.5	55.0
*Torque constant	$K_T$	$\text{N}\cdot\text{m}/\text{Arms}$	0.51	0.62	0.92	0.63
Voltage constant for each phase	$K_{E\Phi}$	$\text{mV}/\text{min}^{-1}$	17.9	21.8	32.0	21.8
Phase resistance	$R_\Phi$	$\Omega$	0.15	0.17	0.18	0.08
*Rated power rate	$Q_R$	$\text{kW}/\text{s}$	176	227	134	134
Rotor inertia Note 1)	$J_M$	$\text{kg}\cdot\text{m}^2(\text{GD}^2/4)$ $\times 10^{-4}$	2.3	2.8	7.0	7.0
Mass Note 1)	WE	kg	5.7	6.7	9.7	9.7
Brake mass	W	kg	1.5	1.5	2.1	2.1
Aluminum plate		mm	t20×470	t20×470	t20×470	t20×470

Note 1) Contains battery backup 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 typical.

Servo motor model number R1AA			13400H	13500H	13400F	13500F
Amplifier size combined			RS2A10A	RS2A10A	RS2A15A	RS2A15A
*Rated output	P <sub>R</sub>	kW	4.0	5.0	4.0	5.0
*Rated velocity	N <sub>R</sub>	min <sup>-1</sup>	3000	3000	3000	3000
*Maximum velocity	N <sub>max</sub>	min <sup>-1</sup>	3000	3000	6000	6000
*Rated torque	T <sub>R</sub>	N·m	12.8	16.0	12.8	16.0
*Continuous Torque at stall	T <sub>S</sub>	N·m	12.8	16.0	12.8	16.0
*Peak Torque at stall	T <sub>P</sub>	N·m	47.0	55.0	39.0	48.0
*Rated armature current	I <sub>R</sub>	Arms	17.8	20.0	23.4	27.7
*Armature current at stall	I <sub>S</sub>	Arms	15.5	14.1	22.5	26.6
*Peak armature current at stall	I <sub>P</sub>	Arms	55.0	55.0	74.0	83.0
*Torque constant	K <sub>T</sub>	N·m/ Arms	1.01	1.21	0.62	0.65
Voltage constant for each phase	K <sub>EΦ</sub>	mV/min <sup>-1</sup>	35.4	42.3	21.8	22.8
Phase resistance	R <sub>Φ</sub>	Ω	0.13	0.15	0.053	0.047
*Rated power rate	Q <sub>R</sub>	kW/s	186	242	186	242
Rotor inertia Note 1)	J <sub>M</sub>	kg·m <sup>2</sup> (GD <sup>2</sup> /4) ×10 <sup>-4</sup>	8.8	10.6	8.8	10.6
Mass Note 1)	W <sub>E</sub>	kg	12.2	14.3	12.2	14.3
Brake mass	W	kg	2.5	2.5	2.5	2.5
Aluminum plate		mm	t20×470	t20×540	t20×470	t20×540

Servo motor model number R1AA			18550H	18750L	1811KR	1815KB
Amplifier size combined			RS2A30A	RS23A30A	RS2A30A	RS2A30A
*Rated output	P <sub>R</sub>	kW	5.5	7.5	11	15
*Rated velocity	N <sub>R</sub>	min <sup>-1</sup>	1500	1500	1500	1500
*Maximum velocity	N <sub>max</sub>	min <sup>-1</sup>	3000	3000	2500	2000
*Rated torque	T <sub>R</sub>	N·m	35	48	70	95.5
*Continuous Torque at stall	T <sub>S</sub>	N·m	37	48	70	95.5
*Peak Torque at stall	T <sub>P</sub>	N·m	110	135	195	230
*Rated armature current	I <sub>R</sub>	Arms	46	49	55.0	60.0
*Armature current at stall	I <sub>S</sub>	Arms	47	47	54.0	58.0
*Peak armature current at stall	I <sub>P</sub>	Arms	155	155	155	155
*Torque constant	K <sub>T</sub>	N·m/ Arms	0.86	1.09	1.4	1.77
Voltage constant for each phase	K <sub>EΦ</sub>	mV/min <sup>-1</sup>	30	38.1	48.7	61.6
Phase resistance	R <sub>Φ</sub>	Ω	0.029	0.031	0.033	0.033
*Rated power rate	Q <sub>R</sub>	kW/s	370	550	770	1060
Rotor inertia Note 1)	J <sub>M</sub>	kg·m <sup>2</sup> (GD <sup>2</sup> /4) ×10 <sup>-4</sup>	33	42	64	86
Mass Note 1)	W <sub>E</sub>	kg	33	39	52	64
Brake mass	W	kg	2.8	4.5	7.1	8.9
Aluminum plate		mm	t20×540	t20×540	t30×610	t30×610

Note 1) Contains battery backup 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 typical.
- ✓ For specifications on other motor, please contact us.

■ Specification of R2 motor, 200V AC

Servo motor model number R2AA			04003F	04005F	04010F	06010F	06020F	06040H	08020F
Amplifier size combined			RS2A01						
*Rated output	P <sub>R</sub>	kW	0.03	0.05	0.1	0.1	0.2	0.4	0.2
*Rated velocity	N <sub>R</sub>	min <sup>-1</sup>	3000	3000	3000	3000	3000	3000	3000
*Maximum velocity	N <sub>max</sub>	min <sup>-1</sup>	6000	6000	6000	6000	6000	3000	6000
*Rated torque	T <sub>R</sub>	N·m	0.098	0.159	0.318	0.318	0.637	1.27	0.637
*Continuous Torque at stall	T <sub>S</sub>	N·m	0.108	0.167	0.318	0.353	0.686	1.37	0.686
*Peak Torque at stall	T <sub>P</sub>	N·m	0.37	0.59	1.18	1.13	2.2	4.8	2.2
*Rated armature current	I <sub>R</sub>	Arms	0.51	0.67	0.81	0.86	1.5	1.7	1.5
*Armature current at stall	I <sub>S</sub>	Arms	0.56	0.69	0.81	0.86	1.6	1.8	1.5
*Peak armature current at stall	I <sub>P</sub>	Arms	2.15	2.8	3.3	3.5	5.6	7.1	4.8
*Torque constant	K <sub>T</sub>	N·m/Arms	0.201	0.246	0.424	0.375	0.476	0.816	0.516
Voltage constant for each phase	K <sub>EΦ</sub>	mV/min <sup>-1</sup>	7.0	8.6	14.8	13.1	16.6	28.5	18.0
Phase resistance	R <sub>Φ</sub>	Ω	12	9	9.3	4.8	2.7	3.3	2.3
*Rated power rate	Q <sub>R</sub>	kW/s	3.9	6.7	16	8.6	19	39	8
Rotor inertia Note 1)	J <sub>M</sub>	kg·m <sup>2</sup> (GD <sup>2</sup> /4) x10 <sup>-4</sup>	0.028	0.0409	0.066	0.120	0.222	0.415	0.523
Mass Note 1)	W <sub>E</sub>	kg	0.35	0.39	0.51	0.71	0.96	1.4	1.3
Brake mass	W	kg	0.27	0.27	0.27	0.34	0.39	0.39	0.89
Aluminum plate		mm	t6×250						

Servo motor model number R2AA			06040F	08040F	08075F	B8075F	B8100H	B8100F	10075F
Amplifier size combined			RS2A03	RS2A03	RS2A03	RS2A05	R2SA03	RS2A05	RS2A03
*Rated output	P <sub>R</sub>	kW	0.4	0.4	0.75	0.75	1.0	1.0	0.75
*Rated velocity	N <sub>R</sub>	min <sup>-1</sup>	3000	3000	3000	3000	3000	3000	3000
*Maximum velocity	N <sub>max</sub>	min <sup>-1</sup>	6000	6000	6000	6000	3000	6000	6000
*Rated torque	T <sub>R</sub>	N·m	1.27	1.27	2.39	2.38	3.18	3.18	2.39
*Continuous Torque at stall	T <sub>S</sub>	N·m	1.37	1.37	2.55	2.94	3.92	3.92	2.55
*Peak Torque at stall	T <sub>P</sub>	N·m	4.8	4.4	8.5 Note 2)	11.0	11.6	14.3	8.6
*Rated armature current	I <sub>R</sub>	Arms	2.8	2.6	4.6	4.7	4.6	6.0	4.4
*Armature current at stall	I <sub>S</sub>	Arms	2.8	2.6	4.6	5.5	4.7	6.8	4.6
*Peak armature current at stall	I <sub>P</sub>	Arms	10.8	8.9	15.5 Note 2)	23.7	15.5	25.7	15.5
*Torque constant	K <sub>T</sub>	N·m/Arms	0.524	0.559	0.559	0.547	0.825	0.582	0.582
Voltage constant for each phase	K <sub>EΦ</sub>	mV/min <sup>-1</sup>	18.3	19.5	19.5	19.1	28.8	20.3	20.3
Phase resistance	R <sub>Φ</sub>	Ω	1.36	0.93	0.4	0.62	0.85	0.44	0.69
*Rated power rate	Q <sub>R</sub>	kW/s	39	16	31	35	42	42	29
Rotor inertia Note 1)	J <sub>M</sub>	kg·m <sup>2</sup> (GD <sup>2</sup> /4) x10 <sup>-4</sup>	0.415	1.043	1.823	1.643	2.383	2.383	2.003
Mass Note 1)	W <sub>E</sub>	Kg	1.4	1.7	2.7	2.9	3.6	3.6	3.3
Brake mass	W	kg	0.39	0.89	0.89	0.84	0.84	0.84	0.9
Aluminum plate		mm	t6×250	t6×250	t6×250	t12×305	t12×305	t12×305	t12×305

Note 1) Contains battery backup absolute encoder.

Note 2) Peak armature current at stall 8.5[N·m] is the value when using 3-phase 200V. The value when using single-phase 200V is 7[N·m]. Peak armature current 15.5 [Arms] is the value when using 3-phase 200V. The value when using single-phase 200V is 13.1[Arms].

- ✓ 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 typical.
- ✓ For specifications on other motor, please contact us.

Servo motor model number R2AA			10100F	13050H	13050D	13120B	13120D	13120L	13180H
Amplifier size combined			RS2A05	RS2A03	RS2A03	RS2A03	RS2A05	RS2A05	RS2A05
*Rated output	P <sub>R</sub>	kW	1.0	0.55	0.55	1.2	1.2	1.2	1.8
*Rated velocity	N <sub>R</sub>	min <sup>-1</sup>	3000	2000	2000	2000	2000	2000	2000
*Maximum velocity	N <sub>max</sub>	min <sup>-1</sup>	6000	3500	5000	2000	5000	3000	3500
*Rated torque	T <sub>R</sub>	N·m	3.18	2.6	2.6	5.7	5.7	5.7	8.6
*Continuous Torque at stall	T <sub>S</sub>	N·m	3.92	3.0	2.6	6.0	6.0	6.0	10.0
*Peak Torque at stall	T <sub>P</sub>	N·m	14.3	9.0	7.0	16.0	16.0	20.0	22.0
*Rated armature current	I <sub>R</sub>	Arms	5.7	4.2	5.2	5.2	9.1	7.6	11.0
*Armature current at stall	I <sub>S</sub>	Arms	6.8	4.6	5.2	5.2	9.3	8.4	11.8
*Peak armature current at stall	I <sub>P</sub>	Arms	25.7	15.5	15.5	15.5	25.4	26.5	26.5
*Torque constant	K <sub>T</sub>	N·m/Arms	0.584	0.67	0.53	1.09	0.65	0.77	0.89
Voltage constant for each phase	K <sub>EΦ</sub>	mV/min <sup>-1</sup>	20.4	23.5	18.5	37.8	22.7	27.0	31.1
Phase resistance	R <sub>Φ</sub>	Ω	0.35	0.65	0.39	0.64	0.23	0.35	0.23
*Rated power rate	Q <sub>R</sub>	kW/s	29	22	22	54	54	54	82
Rotor inertia Note1)	J <sub>M</sub>	kg·m <sup>2</sup> (GD <sup>2</sup> /4) x10 <sup>-4</sup>	3.5	3.1	3.1	6.0	6.0	6.0	9.0
Mass Note1)	WE	Kg	4.1	4.5	4.5	6.1	6.1	6.1	7.7
Brake mass	W	kg	0.9	1.3	1.3	1.5	1.5	1.5	1.5
Aluminum plate		mm	t12×305	t20×305	t20×305	t20×400	t20×400	t20×400	t20×470

Servo motor model number R2AA			13180D	13200L	13200D	18350L	18350D	18450H	18550R
Amplifier size combined			RS2A10	RS2A05	RS2A10	RS2A10	RS2A15	RS2A15	RS2A15
*Rated output	P <sub>R</sub>	kW	1.8	2.0	2.0	3.5	3.5	4.5	5.5
*Rated velocity	N <sub>R</sub>	min <sup>-1</sup>	2000	2000	2000	2000	2000	2000	1500
*Maximum velocity	N <sub>max</sub>	min <sup>-1</sup>	5000	3000	5000	3000	4000	3500	2500
*Rated torque	T <sub>R</sub>	N·m	8.6	9.5	9.5	17.0	17.0	21.5	35.0
*Continuous Torque at stall	T <sub>S</sub>	N·m	10.0	12.0	12.0	22.0	22.0	30.0	37.3
*Peak Torque at stall	T <sub>P</sub>	N·m	25.0	24.0	30.0	49.0	60.0	75.0	90.0
*Rated armature current	I <sub>R</sub>	Arms	15.6	11.0	14.3	19.1	21.7	23.7	31.6
*Armature current at stall	I <sub>S</sub>	Arms	17.3	12.0	17.5	23.7	27.0	31.7	32.9
*Peak armature current at stall	I <sub>P</sub>	Arms	43.0	26.5	45.5	55.0	83.0	83.0	83.0
*Torque constant	K <sub>T</sub>	N·m/Arms	0.63	0.97	0.7	1.0	0.88	1.02	1.23
Voltage constant for each phase	K <sub>EΦ</sub>	mV/min <sup>-1</sup>	21.8	33.7	24.3	34.8	30.6	35.6	42.8
Phase resistance	R <sub>Φ</sub>	Ω	0.13	0.22	0.11	0.085	0.075	0.065	0.059
*Rated power rate	Q <sub>R</sub>	kW/s	82	74	74	72	72	92	180
Rotor inertia Note1)	J <sub>M</sub>	kg·m <sup>2</sup> (GD <sup>2</sup> /4) x10 <sup>-4</sup>	9.0	12.2	12.2	40	40	50	68
Mass Note1)	WE	Kg	7.7	10.0	10.0	15.5	15.5	19.5	27.7
Brake mass	W	kg	1.5	1.5	1.5	2.4	2.4	2.8	2.8
Aluminum plate		mm	t20×470	t20×470	t20×470	t20×470	t20×470	t20×470	t20×540

Note1) Contains battery backup 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 typical.
- ✓ For specifications on other motor, please contact us.

Servo motor model number R2AA			18550H	18750H	1811KR	22350L	22500L
Amplifier size combined			RS2A30	RS2A30	RS2A30	RS2A10	RS2A15
*Rated output	P <sub>R</sub>	kW	5.5	7.5	11	3.5	5.0
*Rated velocity	N <sub>R</sub>	min <sup>-1</sup>	1500	1500	1500	2000	2000
*Maximum velocity	N <sub>max</sub>	min <sup>-1</sup>	3000	3000	2500	4000	4000
*Rated torque	T <sub>R</sub>	N·m	35.0	48.0	70.0	17.0	24.0
*Continuous Torque at stall	T <sub>S</sub>	N·m	37.5	54.9	80.0	22.0	32.0
*Peak Torque at stall	T <sub>P</sub>	N·m	107.0	140.0	170.0	50.0	75.0
*Rated armature current	I <sub>R</sub>	Arms	46.2	51.2	61.9	18.0	22.0
*Armature current at stall	I <sub>S</sub>	Arms	48.0	56.8	66.0	22.0	34.0
*Peak armature current at stall	I <sub>P</sub>	Arms	155.0	155.0	155.0	55.0	83.0
*Torque constant	K <sub>T</sub>	N·m/Arms	0.84	1.04	1.25	1.04	1.0
Voltage constant for each phase	K <sub>EΦ</sub>	mV/min <sup>-1</sup>	29.3	36.6	43.8	36.2	34.9
Phase resistance	R <sub>Φ</sub>	Ω	0.03	0.03	0.035	0.094	0.047
*Rated power rate	Q <sub>R</sub>	kW/s	180	235	445	69	105
Rotor inertia Note 1)	J <sub>M</sub>	kg·m <sup>2</sup> (GD <sup>2</sup> /4) x10 <sup>-4</sup>	68	98	110	42	55
Mass Note 1)	WE	Kg	27.7	35.7	40	18	22.5
Brake mass	W	kg	2.8	6	5.5	4.5	5.5
Aluminum plate		mm	t20×540	t20×540	T30×610	t20×470	t20×540

■ Specification of R2 motor, 100V AC

Servo motor model number R2EA			04003F	04005F	04008F	06010F	06020F
Amplifier size combined			RS2E01	RS2E01	RS2E01	RS2E01	RS2E03
*Rated output	P <sub>R</sub>	kW	0.03	0.05	0.08	0.1	0.2
*Rated velocity	N <sub>R</sub>	min <sup>-1</sup>	3000	3000	3000	3000	3000
*Maximum velocity	N <sub>max</sub>	min <sup>-1</sup>	6000	6000	6000	6000	6000
*Rated torque	T <sub>R</sub>	N·m	0.098	0.159	0.255	0.318	0.637
*Continuous Torque at stall	T <sub>S</sub>	N·m	0.108	0.167	0.255	0.318	0.686
*Peak Torque at stall	T <sub>P</sub>	N·m	0.37	0.59	0.86	1.0	2.2
*Rated armature current	I <sub>R</sub>	Arms	0.94	1.2	1.3	1.7	3.1
*Armature current at stall	I <sub>S</sub>	Arms	1.0	1.3	1.3	1.7	3.2
*Peak armature current at stall	I <sub>P</sub>	Arms	3.7	4.9	4.5	5.6	11.9
*Torque constant	K <sub>T</sub>	N·m/Arms	0.116	0.142	0.22	0.206	0.224
Voltage constant for each phase	K <sub>EΦ</sub>	mV/min <sup>-1</sup>	4.04	4.97	7.7	7.2	7.82
Phase resistance	R <sub>Φ</sub>	Ω	4.0	3.0	2.9	1.5	0.6
*Rated power rate	Q <sub>R</sub>	kW/s	3.9	6.7	10	8.6	19
Rotor inertia Note 1)	J <sub>M</sub>	kg·m <sup>2</sup> (GD <sup>2</sup> /4) x10 <sup>-4</sup>	0.028	0.0409	0.066	0.120	0.222
Mass Note 1)	WE	Kg	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	t6x250	t6x250	t6x250	t6x250	t6x250

Note 1) Contains battery backup 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 typical.
- ✓ For specifications on other motor, please contact us.

■ Specification of R5 motor, 200V AC

Servo motor model number R5AA			06020H	06020F	06040H	06040F	08075D	08075F
Amplifier size combined			RS2A01	RS2A01	RS2A01	RS2A03	RS2A03	RS2A03
*Rated output	P <sub>R</sub>	kW	0.2	0.2	0.4	0.4	0.75	0.75
*Rated velocity	N <sub>R</sub>	min <sup>-1</sup>	3000	3000	3000	3000	3000	3000
*Maximum velocity	N <sub>max</sub>	min <sup>-1</sup>	3000	6000	3000	6000	5000	6000
*Rated torque	T <sub>R</sub>	N·m	0.637	0.637	1.27	1.27	2.39	2.39
*Continuous Torque at stall	T <sub>S</sub>	N·m	0.686	0.686	1.37	1.37	2.55	2.55
*Peak Torque at stall	T <sub>P</sub>	N·m	2.2	2.2	4.8	4.8	8.5	7.5
*Rated armature current	I <sub>R</sub>	Arms	1.1	1.5	1.8	2.8	3.9	4.5
*Armature current at stall	I <sub>S</sub>	Arms	1.1	1.6	1.8	2.8	3.9	4.5
*Peak armature current at stall	I <sub>P</sub>	Arms	4.2	5.7	7.0	10.8	14.4	15.5
*Torque constant	K <sub>T</sub>	N·m/Arms	0.649	0.476	0.836	0.525	0.763	0.607
Voltage constant for each phase	K <sub>EΦ</sub>	mV/min <sup>-1</sup>	21.7	16.1	27.0	17.3	23.2	18.9
Phase resistance	R <sub>Φ</sub>	Ω	4.8	2.7	3.3	1.36	0.78	0.51
*Rated power rate	Q <sub>R</sub>	kW/s	20	20	39	39	35	35
Rotor inertia Note 1)	J <sub>M</sub>	kg·m <sup>2</sup> (GD <sup>2</sup> /4) ×10 <sup>-4</sup>	0.2	0.2	0.417	0.417	1.653	1.653
Mass Note 1)	WE	kg	0.96	0.96	1.4	1.4	2.7	2.7
Brake mass	W	kg	0.39	0.39	0.39	0.39	0.9	0.9
Aluminum plate		mm	t6×250	t6×250	t6×250	t6×250	t6×250	t6×250

Note 1) Contains single-turn 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 typical.

■ Specification of R1 motor, 48V DC

Servo motor model number R1GA			04005F	04010F	06020D
Amplifier size combined			RS2K02	RS2K04	RS2K04
*Rated output	P <sub>R</sub>	W	50	100	200
*Rated velocity	N <sub>R</sub>	min <sup>-1</sup>	3000	3000	3000
*Maximum velocity	N <sub>max</sub>	min <sup>-1</sup>	6000	6000	5000
*Rated torque	T <sub>R</sub>	N·m	0.159	0.318	0.637
*Continuous Torque at stall	T <sub>S</sub>	N·m	0.167	0.318	0.686
*Peak Torque at stall	T <sub>P</sub>	N·m	0.56	1.11	1.4
*Rated armature current	I <sub>R</sub>	Arms	3.5	3.6	6.0
*Armature current at stall	I <sub>S</sub>	Arms	3.7	3.8	6.0
*Peak armature current at stall	I <sub>P</sub>	Arms	13.3	13.7	14.1
*Torque constant	K <sub>T</sub>	N·m/Arms	0.052	0.101	0.117
Voltage constant for each phase	K <sub>EΦ</sub>	mV/min <sup>-1</sup>	1.82	3.52	4.1
Phase resistance	R <sub>Φ</sub>	Ω	0.36	0.591	0.23
*Rated power rate	Q <sub>R</sub>	W/s	17	42	33
Rotor inertia Note 1)	J <sub>M</sub>	kg·m <sup>2</sup> (GD <sup>2</sup> /4) ×10 <sup>-4</sup>	0.0146	0.0242	0.122
Mass Note 1)	WE	kg	0.46	0.61	1.1
Brake mass	W	kg	0.23	0.23	0.35
Aluminum plate		mm	t6×250	t6×250	t6×250

Note 1) Contains battery backup absolute encoder.

■ Specification of R2 motor, 48V DC

Servo motor model number R2GA			D102RM	04003F	04005F	04008F	06010F	06020F
Amplifier size combined			RS2K02	RS2K04	RS2K04	RS2K04	RS2K04	RS2K04
*Rated output	$P_R$	W	2.4	30	50	80	100	200
*Rated velocity	$N_R$	$\text{min}^{-1}$	1000	3000	3000	3000	3000	3000
*Maximum velocity	$N_{\text{max}}$	$\text{min}^{-1}$	1500	6000	6000	5000	5000	4500
*Rated torque	$T_R$	$\text{N}\cdot\text{m}$	0.023	0.098	0.159	0.255	0.318	0.637
*Continuous Torque at stall	$T_S$	$\text{N}\cdot\text{m}$	0.023	0.108	0.167	0.255	0.353	0.637
*Peak Torque at stall	$T_P$	$\text{N}\cdot\text{m}$	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	$K_T$	$\text{N}\cdot\text{m}/\text{Arms}$	0.042	0.0582	0.047	0.0693	0.0673	0.117
Voltage constant for each phase	$K_{E\Phi}$	$\text{mV}/\text{min}^{-1}$	1.47	2.03	1.64	2.42	2.35	4.07
Phase resistance	$R_\Phi$	$\Omega$	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 Note 1)	$J_M$	$\text{kg}\cdot\text{m}^2(\text{GD}^2/4)$ $\times 10^{-4}$	0.0023	0.0247	0.0376	0.0627	0.117	0.219
Mass Note 1)	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

Note 1) Contains battery backup 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 typical.

Servo motor model number R2GA			02D20F	02D30F
Amplifier size combined			RS2K04	RS2K04
*Rated output	$P_R$	W	20	30
*Rated velocity	$N_R$	$\text{min}^{-1}$	3000	3000
*Maximum velocity	$N_{\text{max}}$	$\text{min}^{-1}$	4500	3000
*Rated torque	$T_R$	$\text{N}\cdot\text{m}$	0.064	0.095
*Continuous Torque at stall	$T_S$	$\text{N}\cdot\text{m}$	0.064	0.095
*Peak Torque at stall	$T_P$	$\text{N}\cdot\text{m}$	0.18	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	4.9	9.6
*Torque constant	$K_T$	$\text{N}\cdot\text{m}/\text{Arms}$	0.0458	0.0487
Voltage constant for each phase	$K_{E\Phi}$	$\text{mV}/\text{min}^{-1}$	1.6	1.7
Phase resistance	$R_\Phi$	$\Omega$	1.06	0.76
*Rated power rate	$Q_R$	W/s	12.4	20
Rotor inertia Note 1)	$J_M$	$\text{kg}\cdot\text{m}^2(\text{GD}^2/4)$ $\times 10^{-4}$	0.0033	0.0046
Mass Note 1)	WE	kg	0.14	0.18
Aluminum plate		mm	t6×150	t6×250

Note 1) This value includes the 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”.
- ✓ The spec without holding brake. The spec with holding brake cannot select.
- ✓ Sensor spec is only the absolute encoder for incremental system. It cannot select the spec of Battery Backup Absolute Encoder, Battery-less Absolute Encoder and Incremental Encoder.
- ✓ Depending on a structure, some motors have a torque ripple which occupies 20% of rated torque. They can perform positioning operation/high speed rotation operation without problem. Please consult us for the operation as below because problem may occur.
  - Operation with setting of lower torque limit as 10 to 20%. (e.g. Pushing-operation)
  - Operation of low speed rotation giving effect by motor speed fluctuation to machine performance.

■ Specification of R2 motor, 24V DC

Servo motor model number R2FA			04003F	04005D	04006R	06007R	06008A
Amplifier size combined			RS2J04	RS2J04	RS2J04	RS2J04	RS2J04
*Rated output	$P_R$	W	30	50	60	70	80
*Rated velocity	$N_R$	$\text{min}^{-1}$	3000	3000	2250	2100	1200
*Maximum velocity	$N_{\text{max}}$	$\text{min}^{-1}$	6000	4500	2500	2500	1250
*Rated torque	$T_R$	$\text{N}\cdot\text{m}$	0.098	0.159	0.255	0.318	0.637
*Continuous Torque at stall	$T_S$	$\text{N}\cdot\text{m}$	0.108	0.159	0.255	0.353	0.637
*Peak Torque at stall	$T_P$	$\text{N}\cdot\text{m}$	0.33	0.40	0.86	0.84	1.5
*Rated armature current	$I_R$	Arms	3.29	5.3	4.1	5.1	6.0
*Armature current at stall	$I_S$	Arms	3.54	5.1	4.1	5.5	6.0
*Peak armature current at stall	$I_P$	Arms	12	13.8	14.1	14.1	14.1
*Torque constant	$K_T$	$\text{N}\cdot\text{m}/\text{Arms}$	0.0333	0.0339	0.0693	0.0673	0.117
Voltage constant for each phase	$K_{E\phi}$	$\text{mV}/\text{min}^{-1}$	1.16	1.18	2.42	2.35	4.07
Phase resistance	$R_\phi$	$\Omega$	0.36	0.19	0.32	0.19	0.19
*Rated power rate	$Q_R$	W/s	3.9	6.7	10	8.6	19
Rotor inertia Note 1)	$J_M$	$\text{kg}\cdot\text{m}^2(\text{GD}^2/4)$ $\times 10^{-4}$	0.0247	0.0376	0.0627	0.117	0.219
Mass Note 1)	WE	kg	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

Note 1) Contains battery backup 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 typical.

■ Flat-type with core (200V AC -specification)

Linear motor model DS			030C1N2	030C2N2	030C3N2	050C1N	050C2N2	050C3N2
Amplifier capacity of the servo amplifier to combine			RS2A03L	RS2A05L	RS2A10L	RS2A03L	RS2A05L	RS2A10L
*Rated output	Pr	kW	0.64	1.28	1.92	0.62	1.25	1.87
*Continuous rated force	Fr	N	160	320	480	260	520	780
* Maximum force	Fp	N	350	700	1050	580	1160	1740
Continuous current	Ir	Arms	4.3	8.6	12.9	4.3	8.6	12.9
Maximum current	Ip	Arms	11.3	22.6	33.9	11.3	22.6	33.9
Rated speed	vr	m/s	4	4	4	2.4	2.4	2.4
Maximum speed	vp	m/s	5.5	5.5	5.5	3.5	3.5	3.5
Coil mass	Mc	kg	2.8	5.4	7.8	3.8	7.4	10.9
Magnetic rail mass	Mw	kg/m	5.5	5.5	5.5	7.6	7.6	7.6
Pole core pitch (N-N)	2τp	mm	32	32	32	32	32	32
Phase resistance	RΦ	Ω	0.92	0.46	0.31	1.32	0.66	0.44
Phase inductance	LΦ	mH	9.2	4.6	3.07	14.6	7.3	4.87
Force constant	Kf	N/Arms	43.5	43.5	43.5	71	71	71
Phase induction voltage constant (Y connection conversion)	KeΦ	Vrms/(m/s)	14.5	14.5	14.5	23.7	23.7	23.7
* Motor constant	Km	N/√W	18.9	26.8	32.6	25.7	36.3	44.5
Magnetic rail model number	—	—	DS030M064, 128, 256, 512			DS050M064, 128, 256, 512		

- ✓ Mark “\*” shows the value after the temperature is raised. Other values are the value at 25 degrees C. Each value is typical.
- ✓ Magnetic attractive force is the reference value when assembling accuracy of coil and magnet rail is ±0.1mm.
- ✓ Each figure and characteristic is the values when the steel stage or equivalents (t30 x coil length x 400mm) is mounted.
- ✓ Velocity-force characteristic shows the value when amplifier power voltage is 200V AC, 3Φ.
- ✓ When the power supply voltage is under 200V AC, instantaneous zone decreases

■ Flat-type with core (200V AC -specification)

Linear motor model DS			075C1N2	075C2N2	075C3N2	100C1N2	100C2N2	100C3N2
Amplifier capacity of the servo amplifier to combine			RS2A03L	RS2A05L	RS2A10L	RS2A05L	RS2A10L	RS2A15L
*Rated output	Pr	kW	0.64	1.28	1.92	1.51	3.02	4.54
*Continuous rated force	Fr	N	400	800	1200	540	1080	1620
* Maximum force	Fp	N	850	1700	2550	1150	2300	3450
Continuous current	Ir	Arms	4.4	8.8	13.2	9.5	19	28.5
Maximum current	Ip	Arms	11.3	22.6	33.9	24.5	49	73.5
Rated speed	vr	m/s	1.6	1.6	1.6	2.8	2.8	2.8
Maximum speed	vp	m/s	2.4	2.4	2.4	4	4	4
Coil mass	Mc	kg	5.2	10	14.8	6.6	12.6	18.6
Magnetic rail mass	Mw	kg/m	10.2	10.2	10.2	12.8	12.8	12.8
Pole core pitch (N-N)	2τp	mm	32	32	32	32	32	32
Phase resistance	RΦ	Ω	1.78	0.89	0.59	0.49	0.245	0.163
Phase inductance	LΦ	mH	20.5	10.25	6.83	6.00	3.00	2.00
Force constant	Kf	N/Arms	102	102	102	62.8	62.8	62.8
Phase induction voltage constant (Y connection conversion)	KeΦ	Vrms/(m/s)	34.0	34.0	34.0	20.9	20.9	20.9
* Motor constant	Km	N/√W	33.2	47.0	57.8	39.6	56.0	68.6
Magnetic rail model number	—	—	DS075M064, 128, 256, 512			DS100M064, 128, 256, 512		

Linear motor model DS			150C1N2	150C2N2	150C3N2
Amplifier capacity of the servo amplifier to combine			RS2A05L	RS2A10L	RS2A15L
*Rated output	Pr	kW	1.44	2.88	4.32
*Continuous rated force	Fr	N	800	1600	2400
* Maximum force	Fp	N	1700	3400	5100
Continuous current	Ir	Arms	9.5	19	28.5
Maximum current	Ip	Arms	24.5	49	73.5
Rated speed	vr	m/s	1.8	1.8	1.8
Maximum speed	vp	m/s	2.6	2.6	2.6
Coil mass	Mc	kg	9.4	17.8	26.2
Magnetic rail mass	Mw	kg/m	20.9	20.9	20.9
Pole core pitch (N-N)	2τp	mm	32	32	32
Phase resistance	RΦ	Ω	0.68	0.34	0.23
Phase inductance	LΦ	mH	8.8	4.40	2.93
Force constant	Kf	N/Arms	94.2	94.2	94.2
Phase induction voltage constant (Y connection conversion)	KeΦ	Vrms/(m/s)	31.4	31.4	31.4
* Motor constant	Km	N/√W	49.8	70.5	85.7
Magnetic rail model number	—	—	DS150M064, 128, 256, 512		

- ✓ Mark “\*” shows the value after the temperature is raised. Other values are the value at 25 degrees C. Each value is typical.
- ✓ Magnetic attractive force is the reference value when assembling accuracy of coil and magnet rail is ±0.1mm.
- ✓ Each figure and characteristic is the values when the steel stage or equivalents (t30 x coil length x 400mm) is mounted.
- ✓ Velocity-force characteristic shows the value when amplifier power voltage is 200V AC, 3Φ.
- ✓ When the power supply voltage is under 200V AC, instantaneous zone decreases.

■ Twin-type with core (DD), 200V AC

Linear motor model DD			030C1Y4	030C2Y4	030C3Y4	050C1Y2	050C3Y2	050C2Y2
Amplifier capacity of the servo amplifier to combine			RS2A05L	RS2A10L	RS2A10L	RS2A10L	RS2A30L	RS2A15L
*Rated output	Pr	kW	0.95	1.89	2.84	2.10	4.20	6.30
*Continuous rated force	Fr	N	430	860	1290	700	1400	2100
* Maximum force	Fp	N	630	1260	1890	1050	2100	3150
Continuous current	Ir	Arms	7.8	15.6	23.4	16	32	48
Maximum current	Ip	Arms	13.1	26.2	39.3	27.4	54.8	82.2
Rated speed	vr	m/s	2.2	2.2	2.2	3.0	3.0	3.0
Maximum speed	vp	m/s	3.5	3.5	3.5	4.5	4.5	4.5
Coil mass	Mc	kg	8.3	15.0	21.6	11.2	21.2	29.0
Magnetic rail mass	Mw	kg/m	15.5	15.5	15.5	26.5	26.5	26.5
Pole core pitch (N-N)	2tp	mm	32	32	32	32	32	32
Phase resistance	RΦ	Ω	1.82	0.91	0.61	0.6	0.3	0.20
Phase inductance	LΦ	mH	14.1	7.05	4.70	5	2.5	1.67
Force constant	Kf	N/Arms	68	68	68	53.5	53.5	53.5
Phase induction voltage constant (Y connection conversion)	KeΦ	Vrms/(m/s)	22.7	22.7	22.7	17.8	17.8	17.8
* Motor constant	Km	N/√W	20.0	28.3	34.5	27.6	39.0	47.7
Magnetic rail model number	—	—	DD030M064, 128, 256, 512			DD050M064, 128, 256, 512		

Linear motor model DD			075C1Y2	075C2Y2	075C3Y2	075C4Y2
Amplifier capacity of the servo amplifier to combine			RS2A10L	RS2A15L	RS2A30L	RS2A30L
*Rated output	Pr	kW	2.10	4.20	6.30	8.40
*Continuous rated force	Fr	N	1050	2100	3150	4200
* Maximum force	Fp	N	1650	3300	4950	6600
Continuous current	Ir	Arms	16	32	48	64
Maximum current	Ip	Arms	28.7	57.4	86.1	114.8
Rated speed	vr	m/s	2.0	2.0	2.0	2.0
Maximum speed	vp	m/s	3.5	3.5	3.5	3.5
Coil mass	Mc	kg	14.7	26.5	38.1	49.5
Magnetic rail mass	Mw	kg/m	42.5	42.5	42.5	42.5
Pole core pitch (N-N)	2tp	mm	32	32	32	32
Phase resistance	RΦ	Ω	0.8	0.4	0.27	0.20
Phase inductance	LΦ	mH	7.2	3.6	2.40	1.80
Force constant	Kf	N/Arms	78	78	78	78
Phase induction voltage constant (Y connection conversion)	KeΦ	Vrms/(m/s)	26.0	26.0	26.0	26.0
* Motor constant	Km	N/√W	35.8	50.6	61.6	71.6
Magnetic rail model number	—	—	DD075M064, 128, 256, 512			

- ✓ Mark “\*” shows the value after the temperature is raised. Other values are the value at 25 degrees C. Each value is typical.
- ✓ Magnetic attractive force is the reference value when assembling accuracy of coil and magnet rail is ±0.1mm.
- ✓ Each figure and characteristic is the values when the steel stage or equivalents (t30 x coil length x 400mm) is mounted.
- ✓ Velocity-force characteristic shows the value when amplifier power voltage is 200V AC, 3Φ.
- ✓ When the power supply voltage is under 200V AC, instantaneous zone decreases.

■ Small cylinder linear motor (48V DC type)

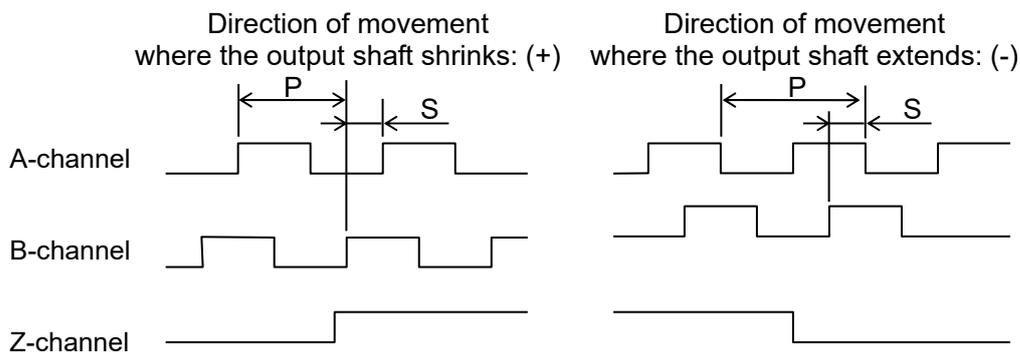
Linear motor model number			DE0AC001A03CX00	DE0BC005A05CX00
Combination servo amplifier capacity			RS2K04	
*Rated output	Pr	W	5.1	10.5
*Rated force	Fr	N	5.1	15.0
Continuous stall force	Fs	N	5.1	15.0
Maximum force	Fp	N	16.5	50.0
*Rated current	Ir	Arms	0.6	1.0
* Continuous stall current	Ir	Arms	0.6	1.0
Maximum current	Ip	Arms	2.0	3.2
Rated speed	vr	m/s	1.0	0.7
Maximum speed	vp	m/s	2.0	1.4
Force constant	Kf	N/A	8.8±10%	16.2±10%
Induction voltage constant	KeΦ	V·m/s	2.93±10%	5.6±10%
Mover mass	Mc	g	45±10%	120±10%
Motor constant	Km	N/√W	1.5	3.5
Phase resistance	RΦ	Ω	8.3Ω±10%	5.0Ω ± 10%
Phase inductance	LΦ	mH	0.75±20%	1.25±20%
Mass	W	G	192±10%	450±10%

✓ Mark “\*” shows the value after the temperature is raised. Other values are the value at 25 degrees C. Each value is typical.

■ Linear encoder characteristics

Item	DE0AC001A03CX00 rated	DE0BC005A05CX00 rated
Signal cycle: P	4 [μm]	
Resolution: S	1.0 [μm]	
Maximum move velocity	2.0 [m/s]	2.0 [m/s]
Power voltage	DC 5V ± 5%	
Output circuit type	EIA RS422 differential driver	
Consumption current	200 [mA] Max.	
Z-phase channel signal width Note 1)	Low/High change	
Z-signal output position	Stroke center (15±1mm)	Stroke center (25±1mm)
Forced excitation CSU Note 2)	75 [°]	82 [°]

(+) indicates when the B-channel signal rises first.



Note 1) Pay attention to the relationship between rising/falling edge of the Z-phase output and the moving direction of the mover.

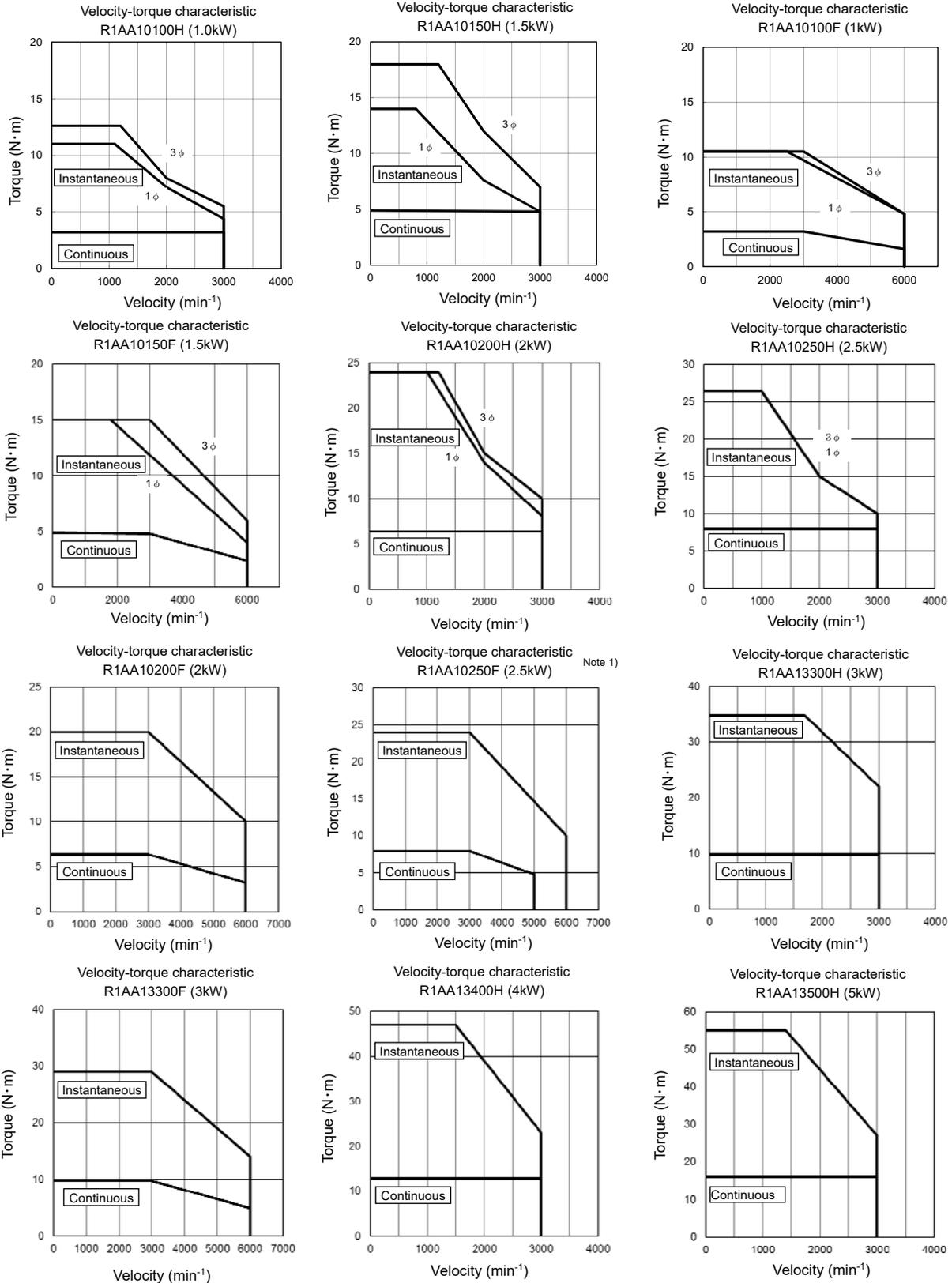
- Operation using Z-phase (return to origin etc.) is supported only in one direction.
- In the case of a combination with our servo amplifiers, the homing using Z-phase should be performed when the output shaft is moving in the direction of shrinking.
- In the motor is used in combination with servo amplifier from the third-party, refer to the product specifications and set each operation.

Note 2) This is an electrical angle in the position which the mover has thrust out the most. (Position shown in the outline drawing)

- This is the value when the option "forced setting" is selected as method of magnetic pole adjustment for the servo amplifier from our company.

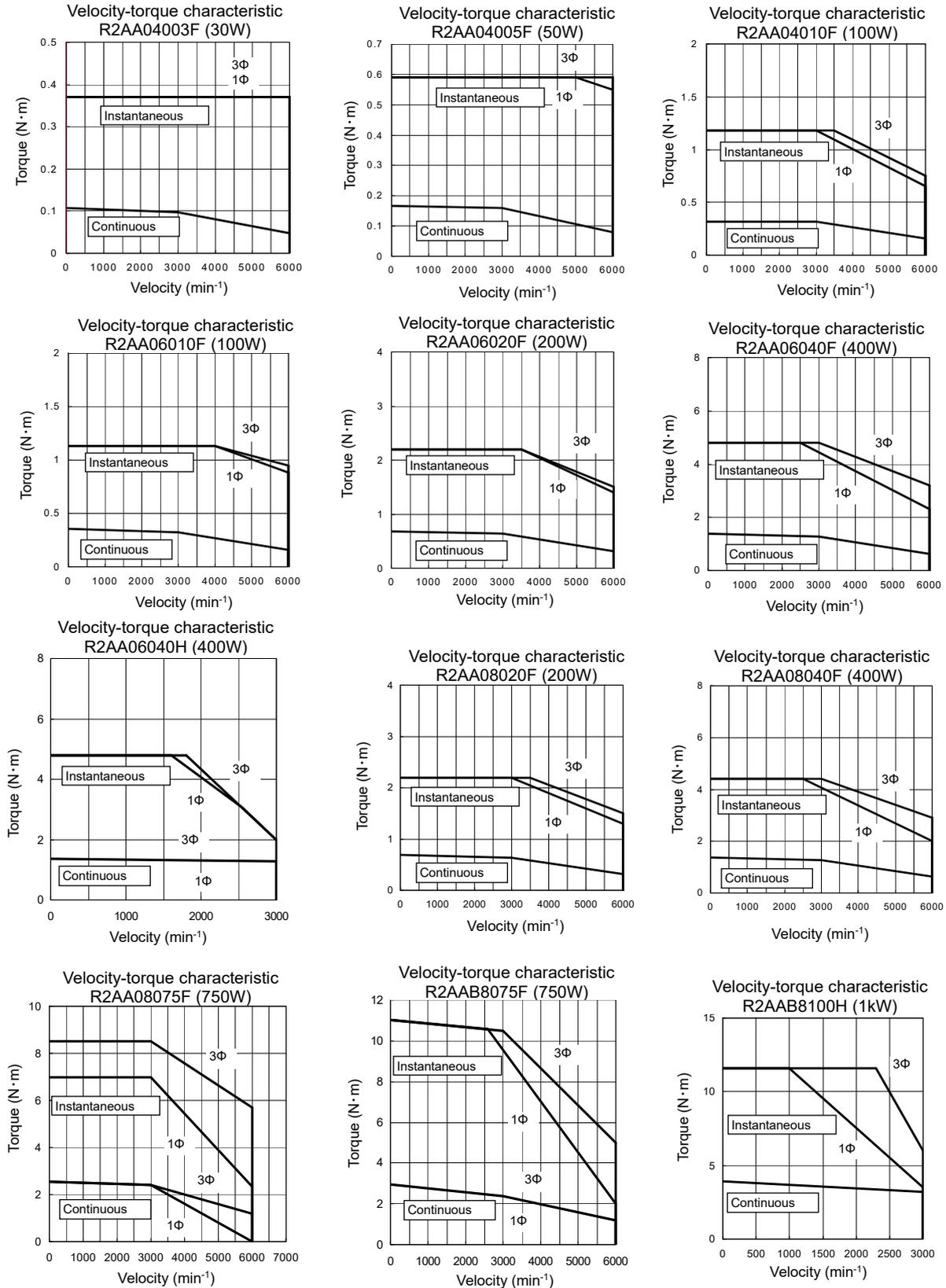
2) Velocity-Torque characteristics

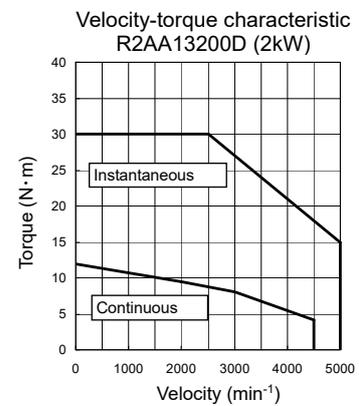
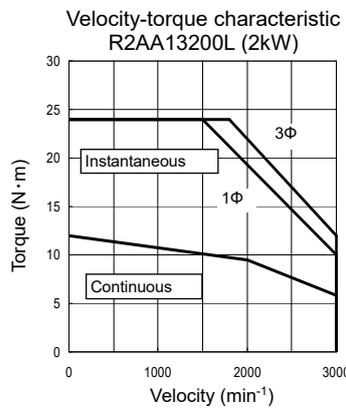
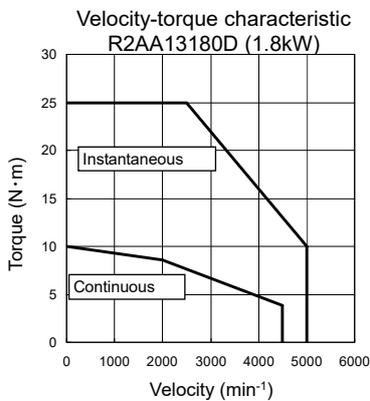
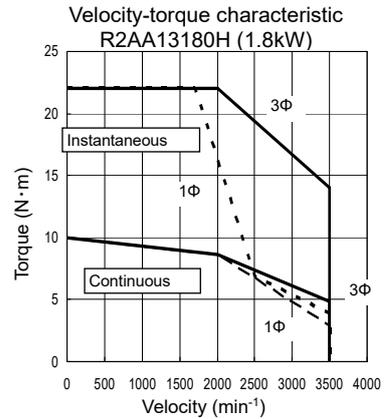
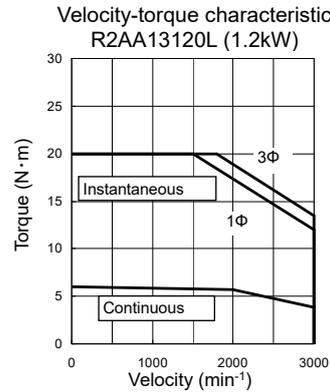
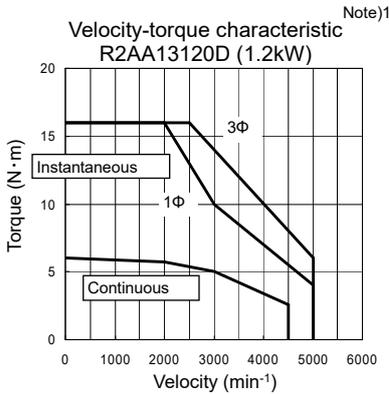
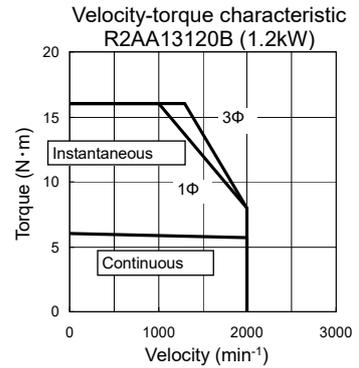
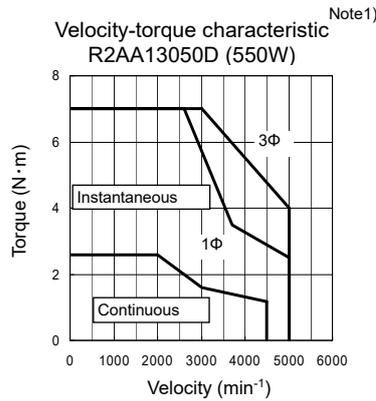
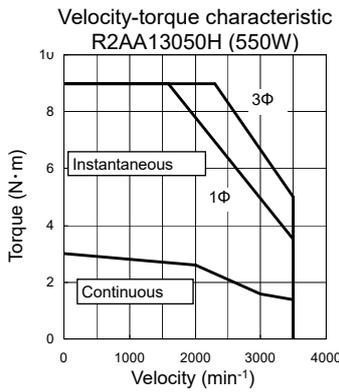
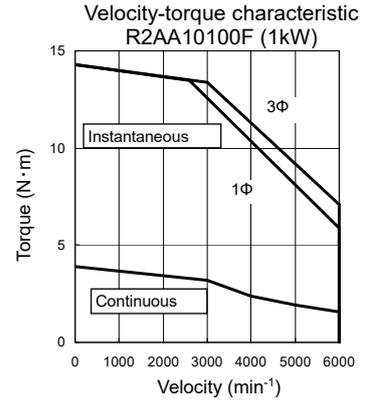
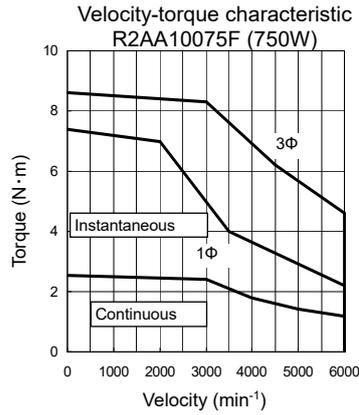
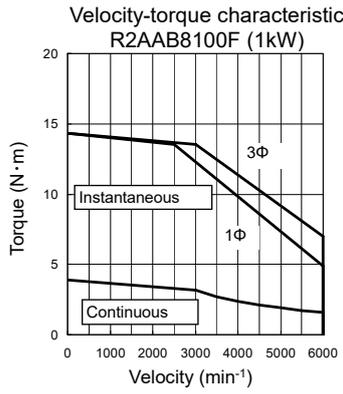
R1AA motor velocity-torque characteristics charts show the values when 200V AC 3-phase and single-phase are used as input power supply. When power supply voltage is less than 200V, instantaneous zone decreases.



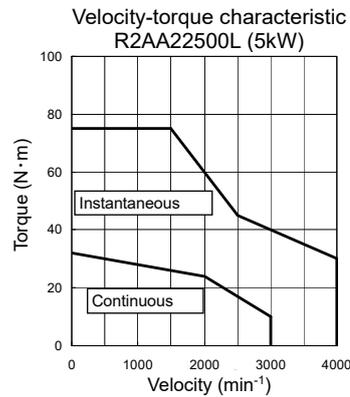
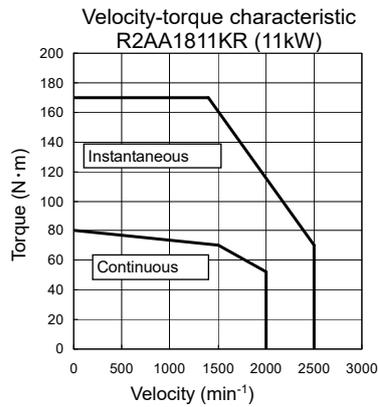
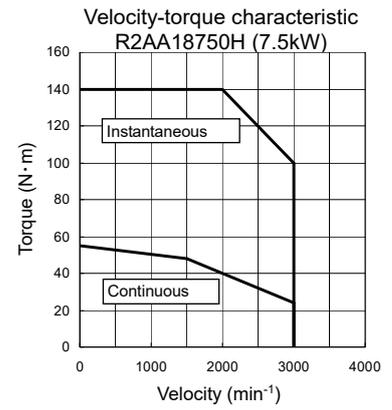
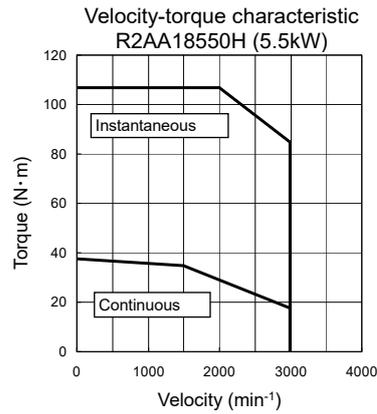
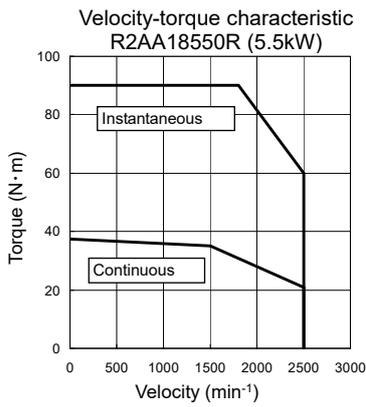
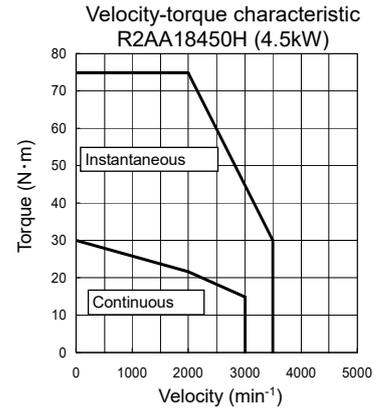
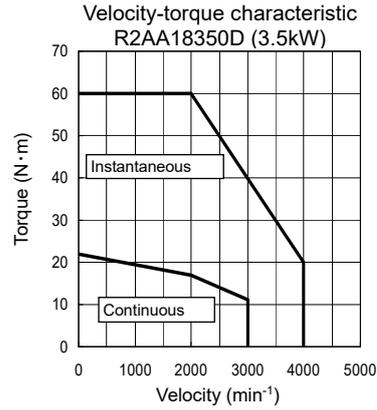
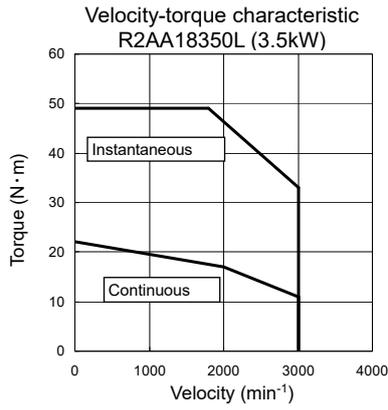
Note1) When you use motor (R1AA10250F, R1AA13500F, R1AA1811KR) whose maximum rotational velocity  $N_{max}$  and maximum rotational velocity in the continuous zone are different, use the motor so that the motor average rotational velocity does not exceed maximum rotational velocity in the continuous zone.

R2AA motor velocity-torque characteristics charts show the values when 200V AC 3-phase and single-phase are used as input power supply. When power supply voltage is less than 200V, instantaneous zone decreases.



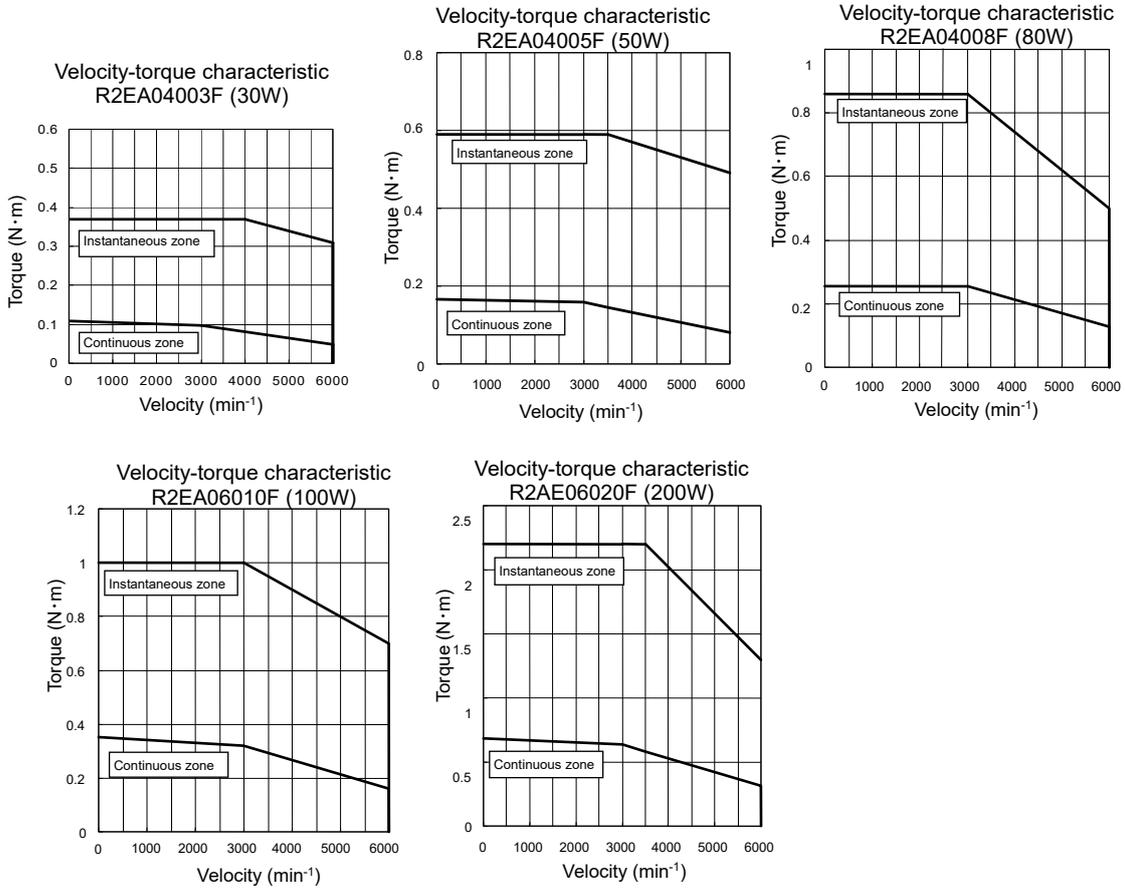


Note1) When you use motor (R2AA13050D, R2AA13120D, R2AA13180D, R2AA13200D, R2AA18450H, R2AA1811KR, or R2AA22500L) whose maximum rotational velocity  $N_{max}$  and maximum rotational velocity in the continuous zone are different, use the motor so that the motor average rotational velocity does not exceed maximum rotational velocity in the continuous zone.



Note1) When you use motor (R2AA13050D, R2AA13120D, R2AA13180D, R2AA13200D, R2AA18450H, R2AA1811KR, or R2AA22500L) whose maximum rotational velocity  $N_{max}$  and maximum rotational velocity in the continuous zone are different, use the motor so that the motor average rotational velocity does not exceed maximum rotational velocity in the continuous zone.

R2EA Motor Velocity-Torque Characteristics indicate the values when amplifier power supply is 100V AC. Instant domain decreases when amplifier power supply is below 100V.

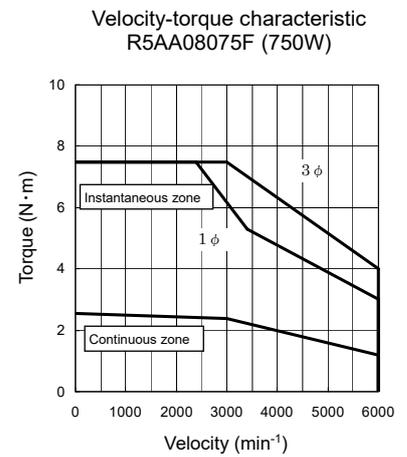
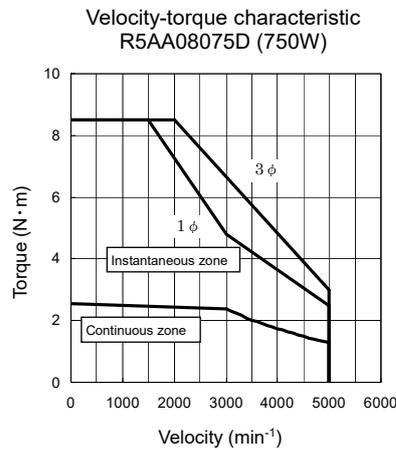
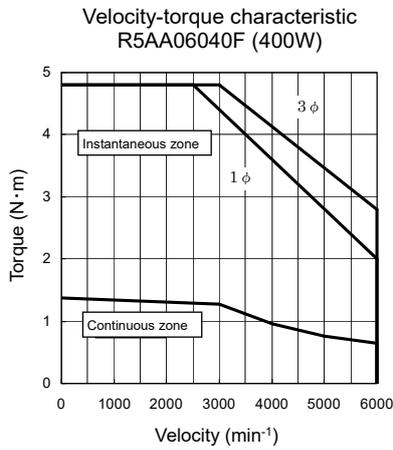
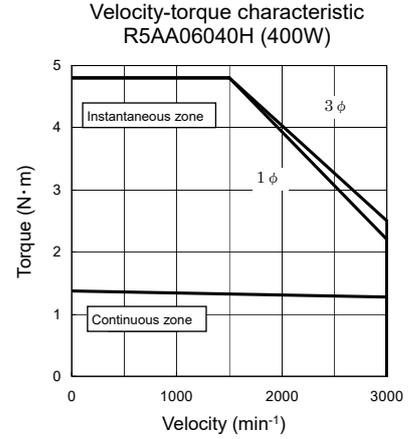
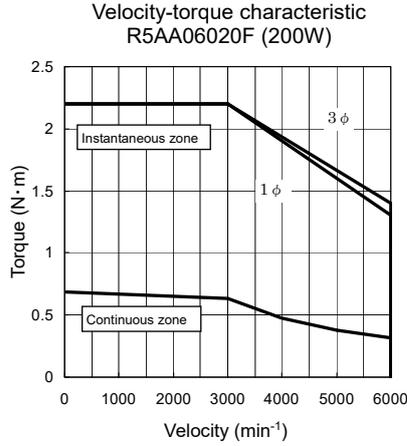
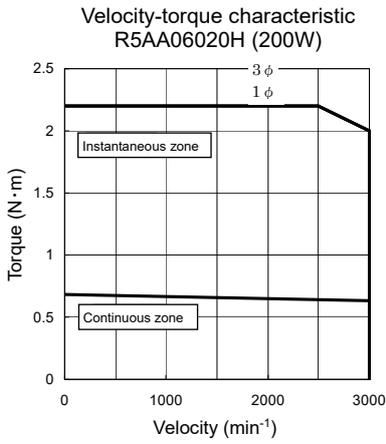


- ✓ For servo motor with oil-seal and/or brake, the following decrease-rating ratios have to be applied to the torque characteristic in the continuous velocity zone.

	Oil seal	Without oil seal	With oil seal
Brake			
Without brake		-	Degree of decrease rating 2
With brake		Degree of decrease rating 1	Degree of decrease rating 2

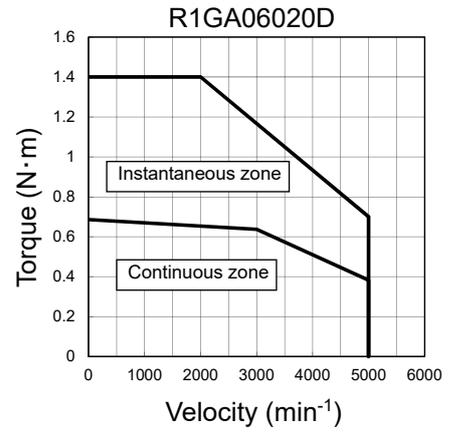
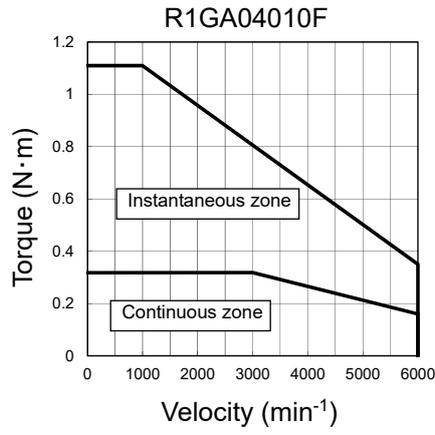
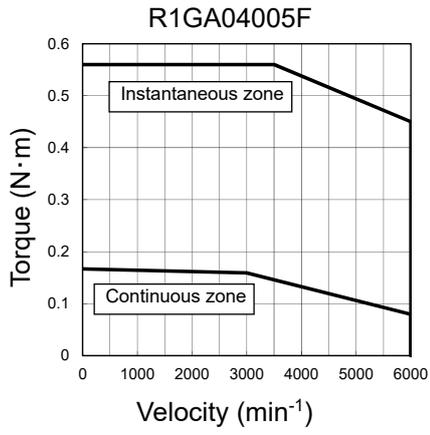
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Degree of decrease rating 1	-	90%	90%	-	-
Degree of decrease rating 2	90%	85%	80%	90%	90%

R5AA Motor Velocity-Torque Characteristics indicate the values when amplifier power supply is 200V AC. Instant domain decreases when amplifier power supply is below 200V.

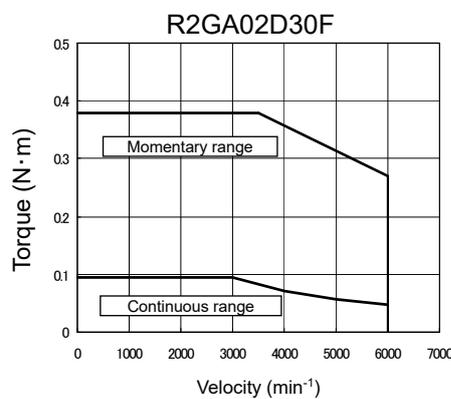
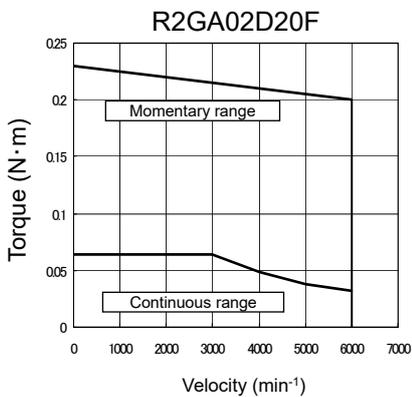
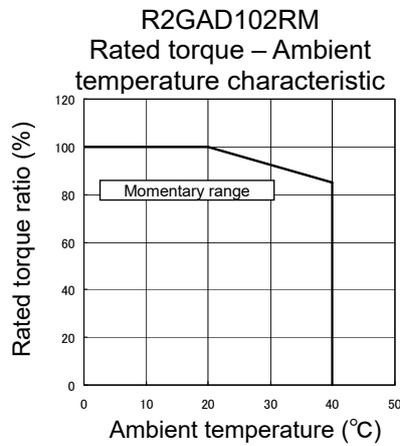
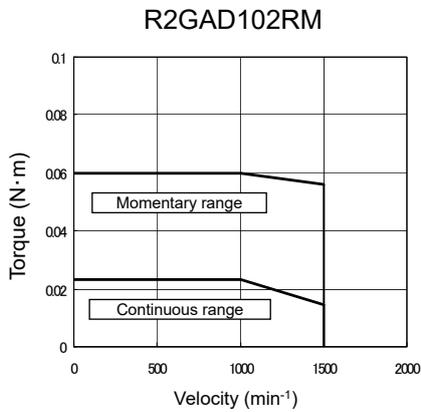
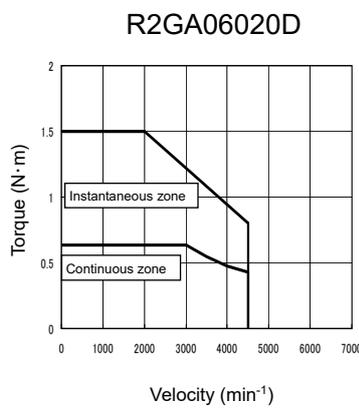
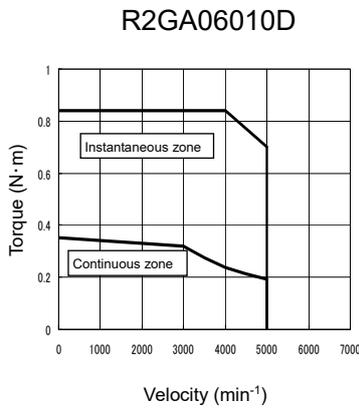
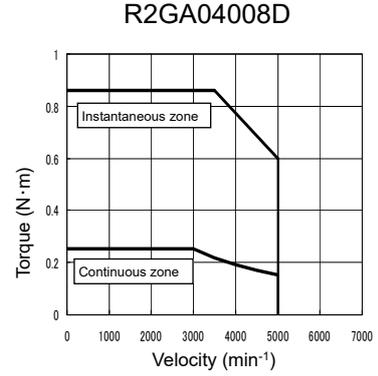
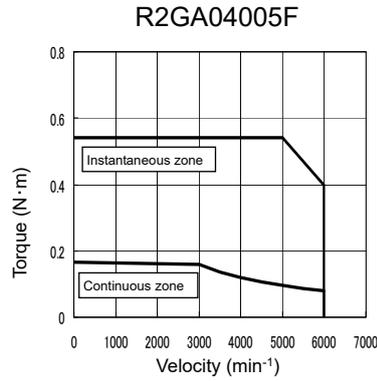
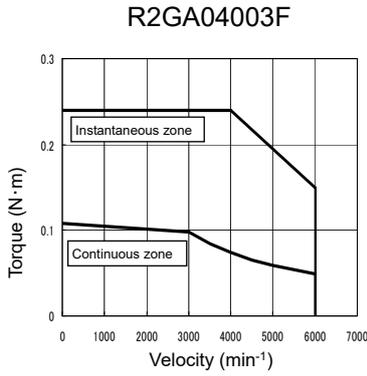


- ✓ For servo motor with oil-seal and/or brake, 90% decrease-rating ratios have to be applied to the torque characteristic in the continuous zone.

■ Specification of 48V DC R1GA Servo motor

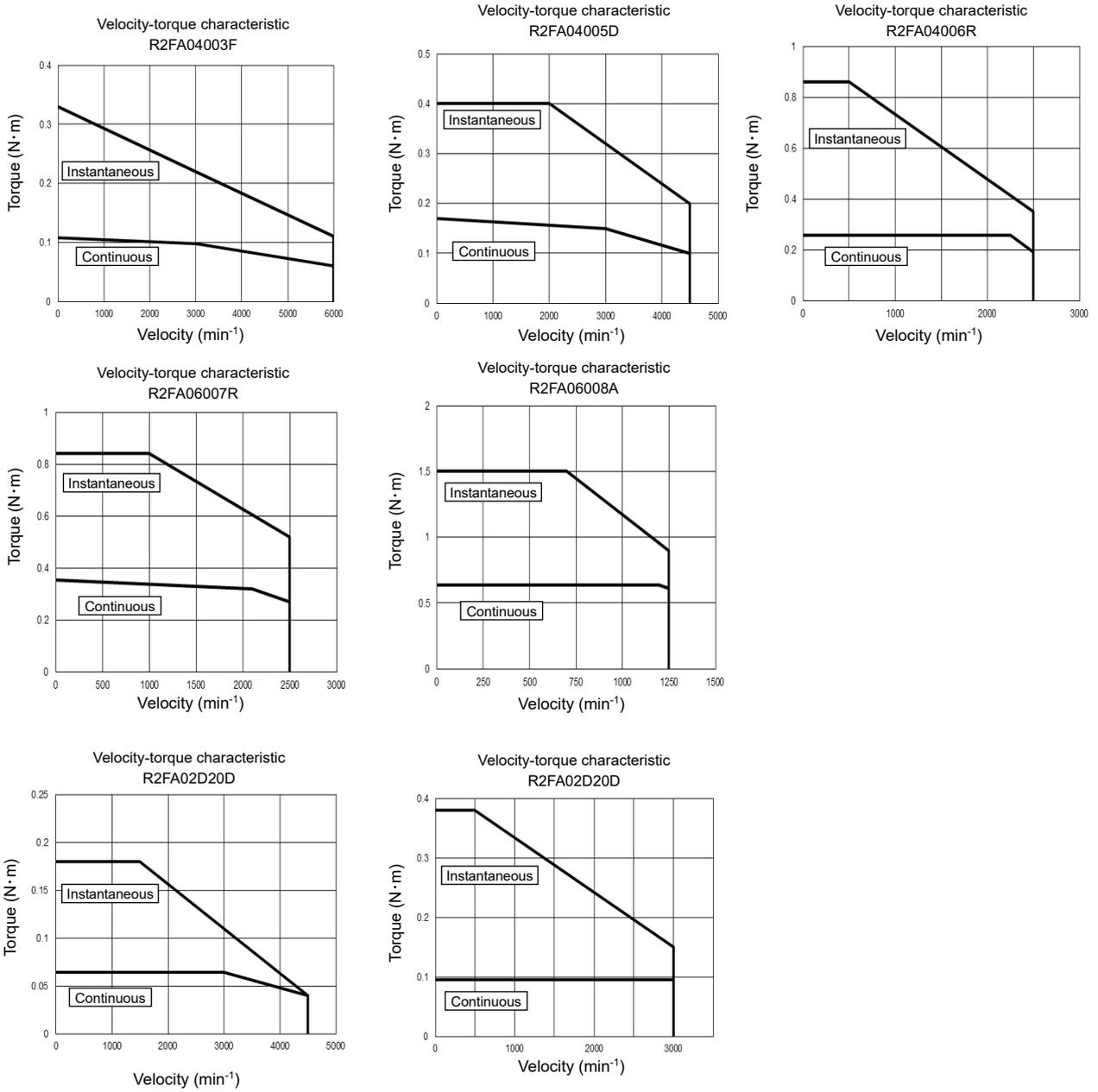


R2GA Motor Velocity-Torque Characteristics indicate the values when amplifier power supply is 48V DC. Instant domain of higher rotation area decreases, when amplifier power supply voltage drops, power line has high impedance or cable length between amplifier and motor is long etc. So, please have margin for servo motor selection.



■ Specification of 24V DC

R2FA Motor Velocity-Torque Characteristics indicate the values when amplifier power supply is 24V DC. Instant domain of higher rotation area decreases, when amplifier power supply voltage drops, power line has high impedance or cable length between amplifier and motor is long etc. So, please have margin for servo motor selection.



3) Derating rate of motor with oil seal

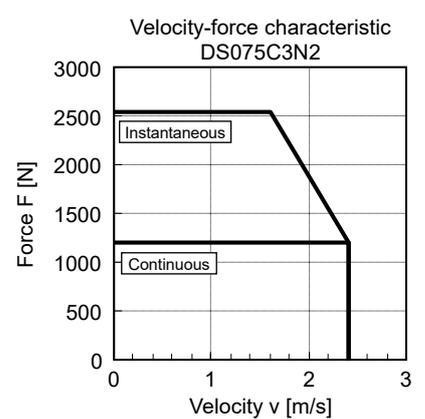
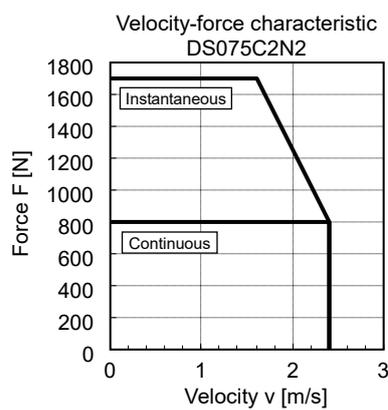
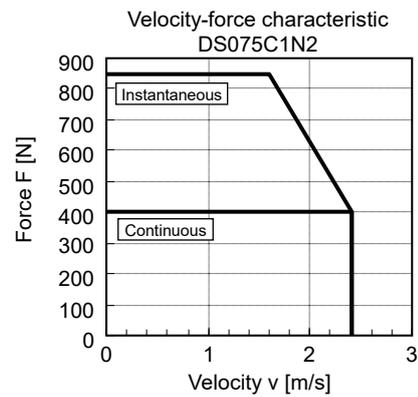
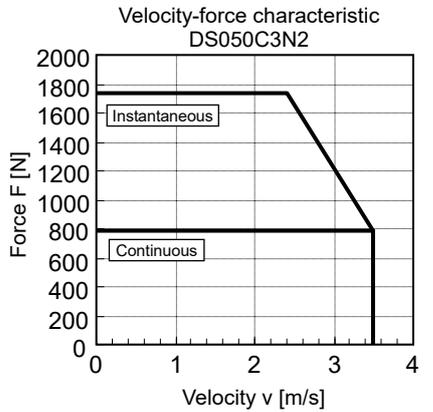
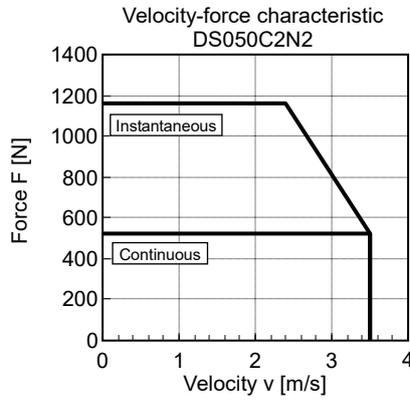
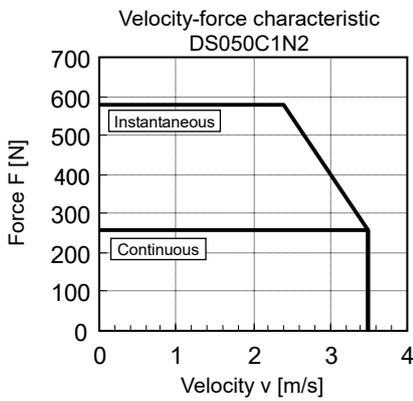
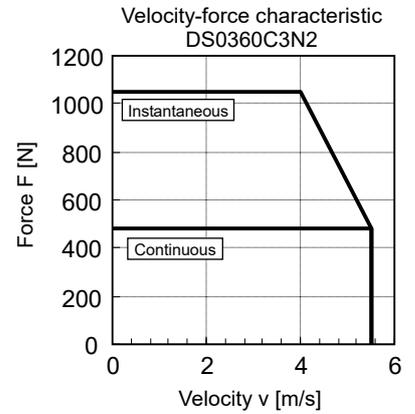
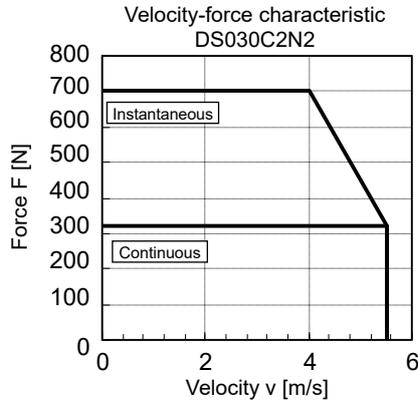
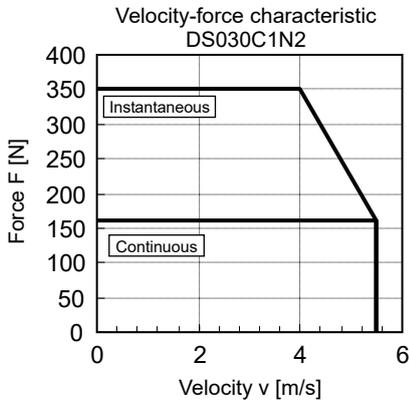
For the servo motor model with brake/oil seal, derating below shall be applied to continuous range of torque characteristic.

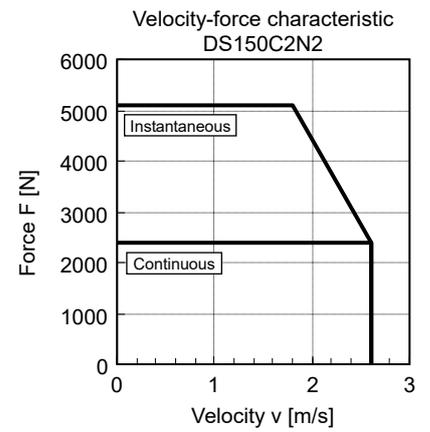
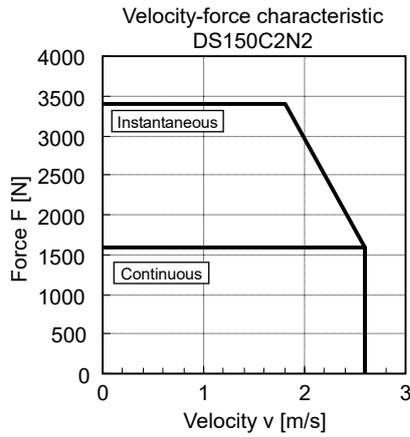
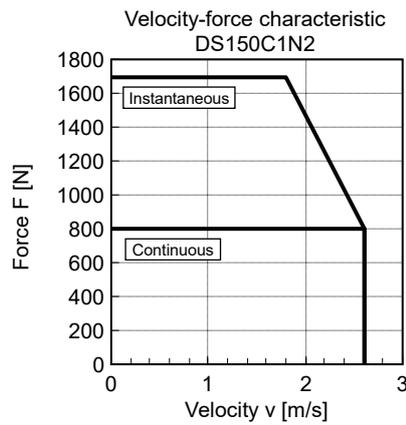
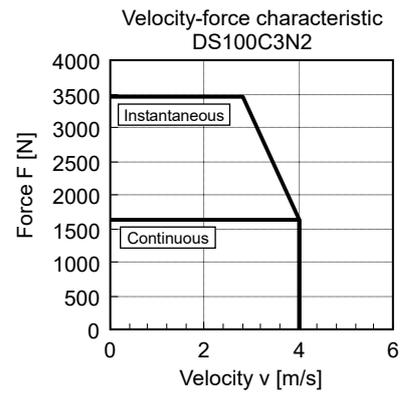
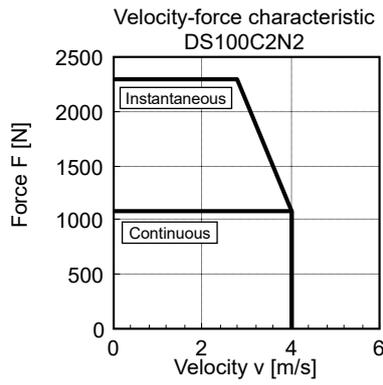
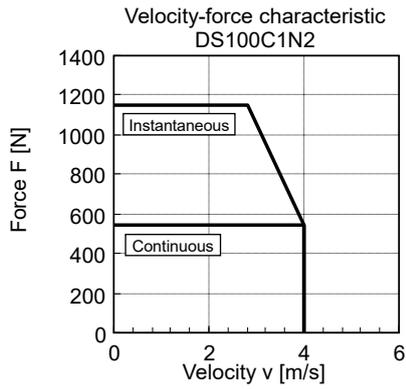
Condition		Derating rate	
Brake	Oil seal	R1GA04005	R1GA04010
No	No	-	-
Yes	No		80%
No	Yes	90%	80%
Yes	Yes		

Condition		Derating rate
Brake	Oil seal	R2GA04005 R2FA04005
No	No	-
Yes	No	
No	Yes	90%
Yes	Yes	

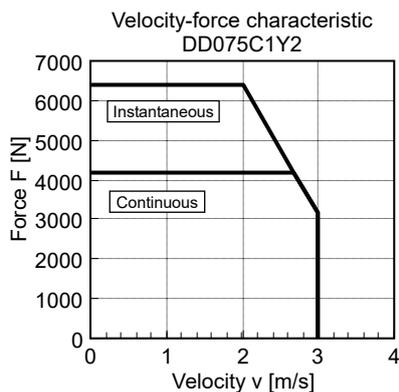
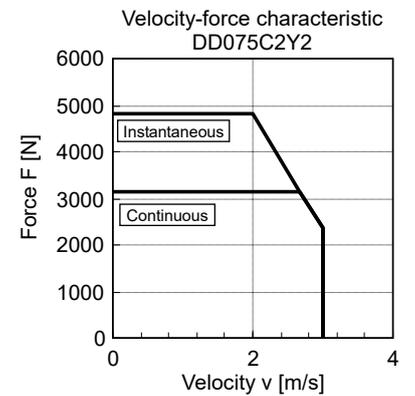
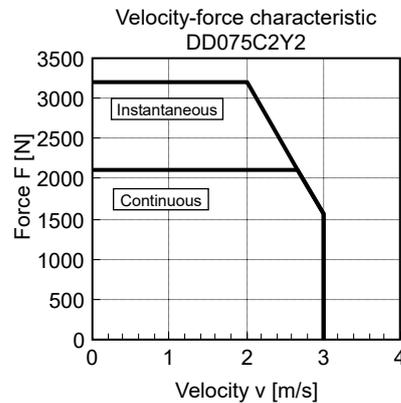
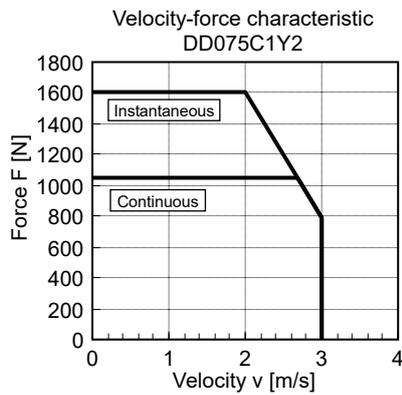
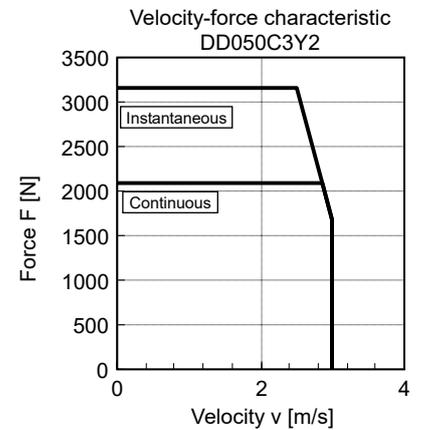
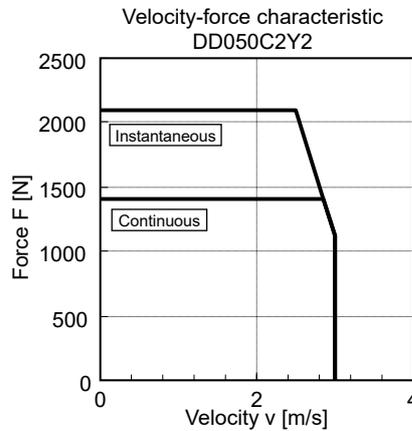
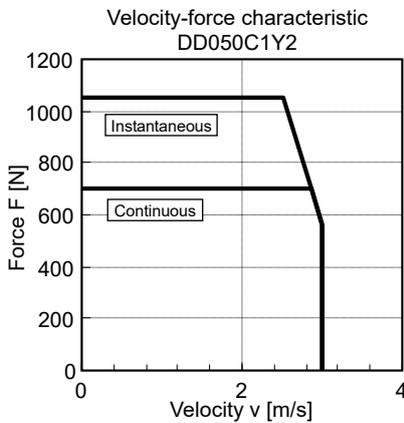
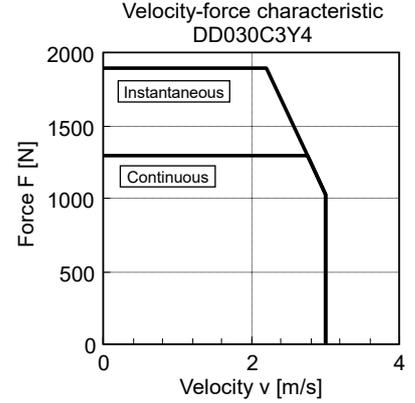
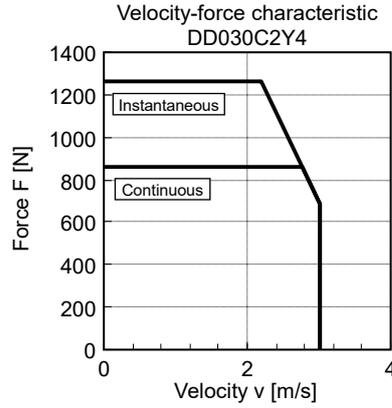
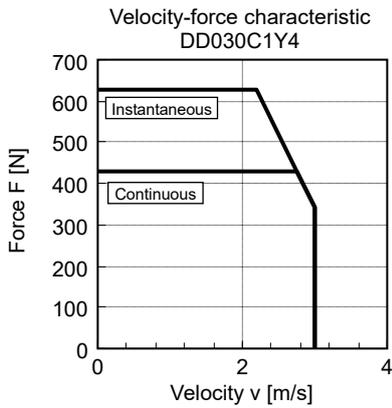
4) Velocity-force characteristics

DS linear motor Velocity-force characteristics indicate the values when amplifier power supply is 3-phase 200V AC. Instant domain decreases when amplifier power supply is below 200V.

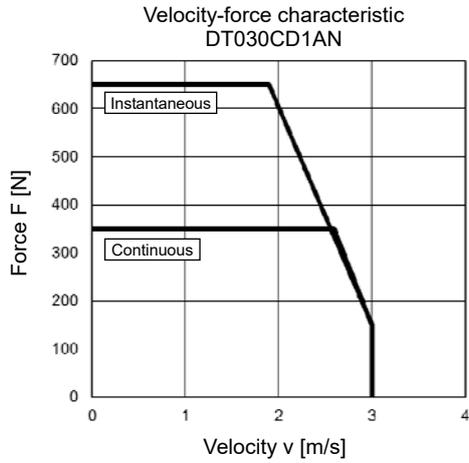




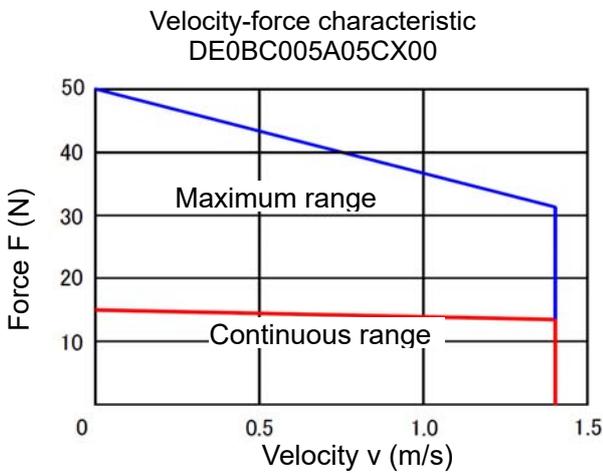
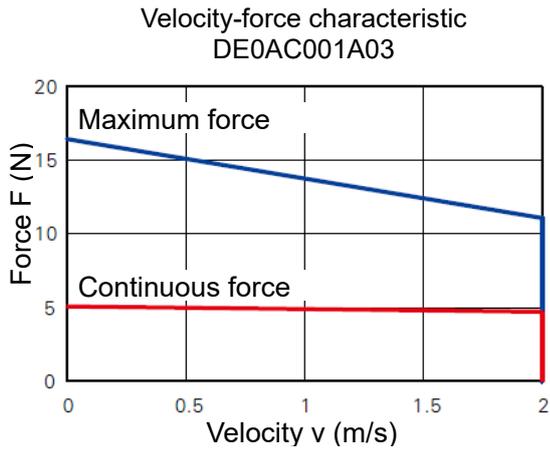
DD linear motor Velocity-force characteristics indicate the values when amplifier power supply is 3-phase 200V AC. Instant domain decreases when amplifier power supply is below 200V.



Center magnet type Velocity-force characteristics indicate the values when amplifier power supply is 3-phase 200V AC. Instant domain decreases when amplifier power supply is below 200V.

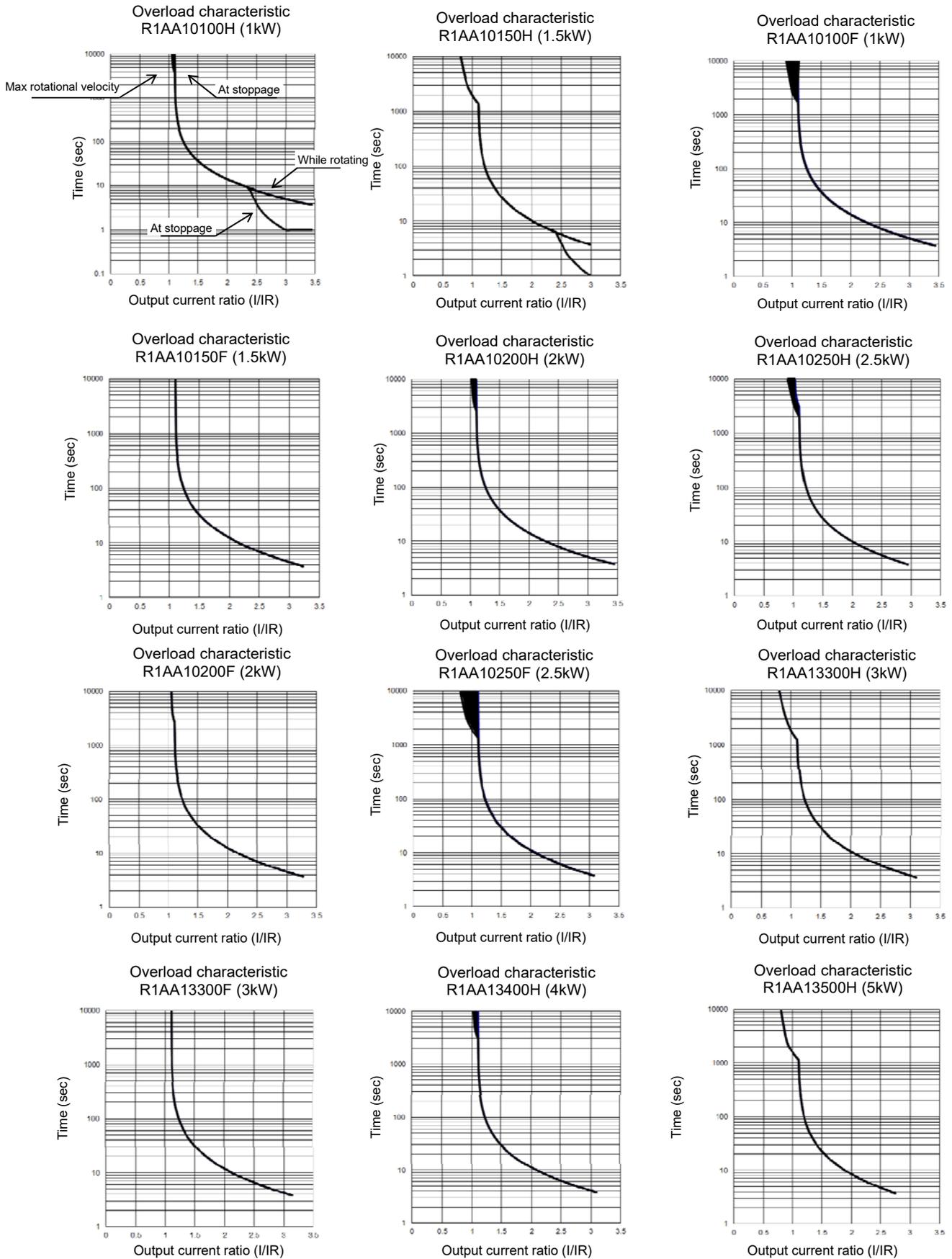


DE linear motor Velocity-force characteristics indicate the values when amplifier power supply is 48V DC. Instant domain decreases when amplifier power supply is below 48V.

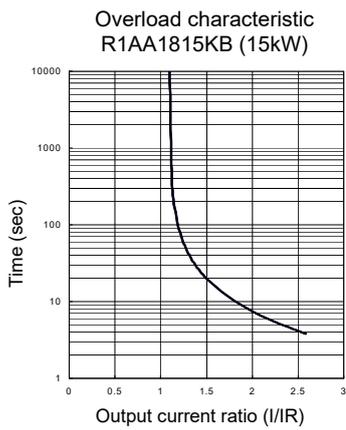
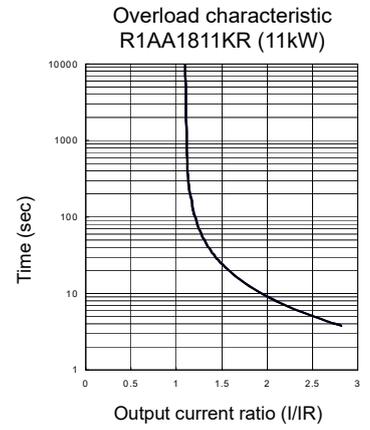
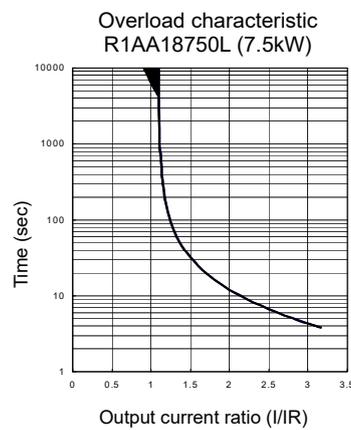
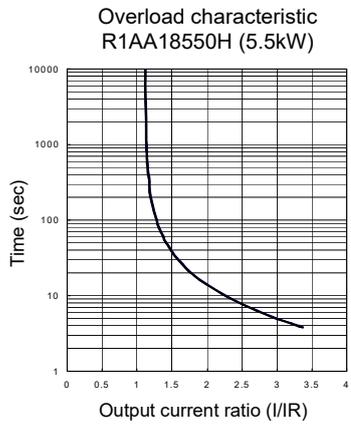
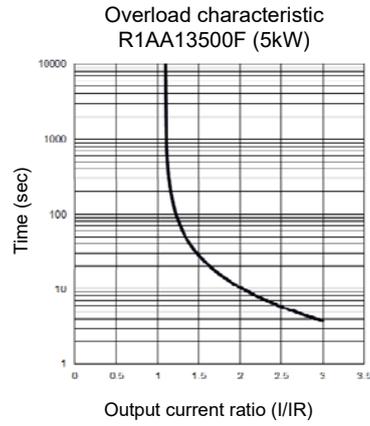
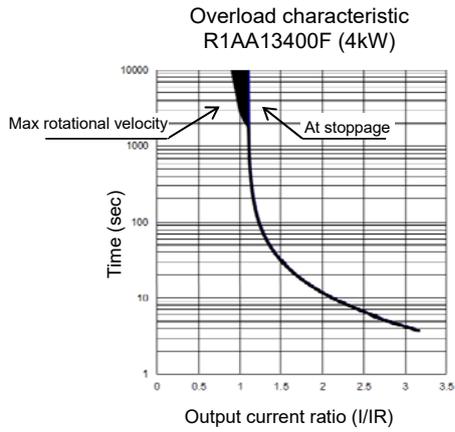


5) Overload characteristic

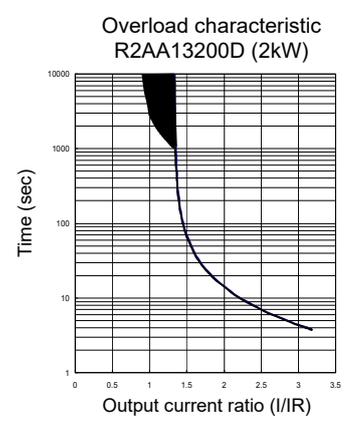
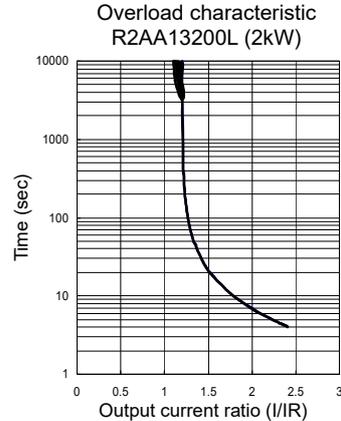
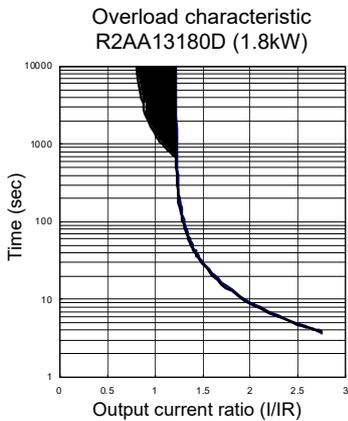
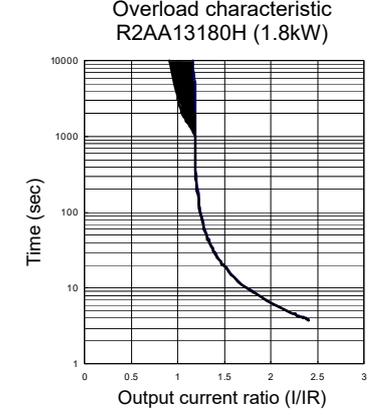
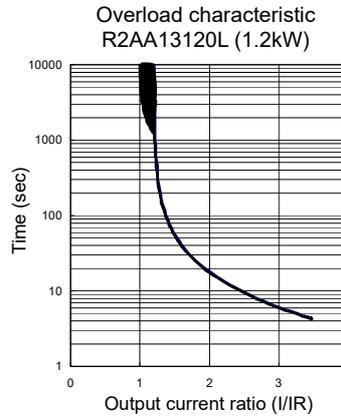
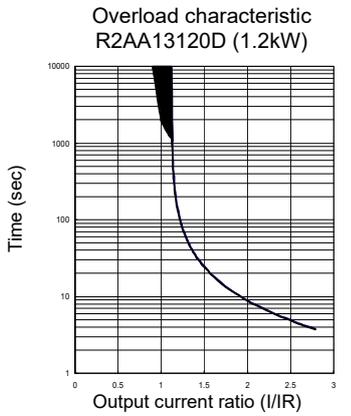
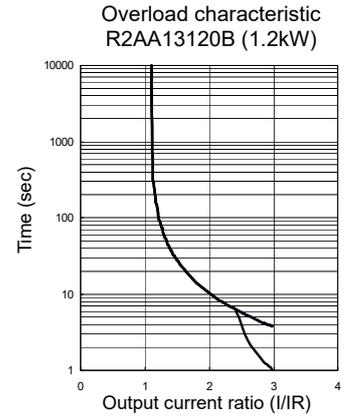
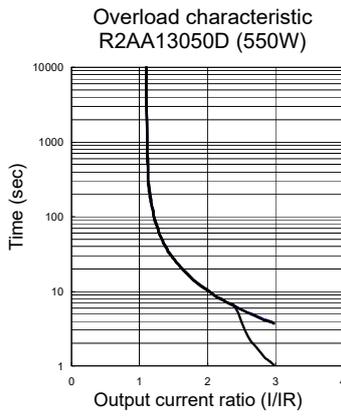
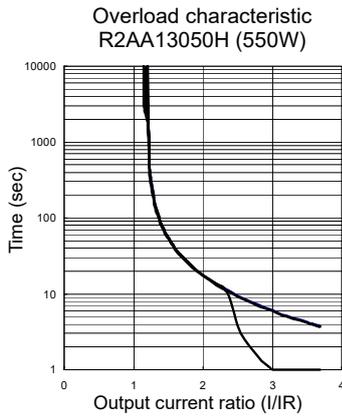
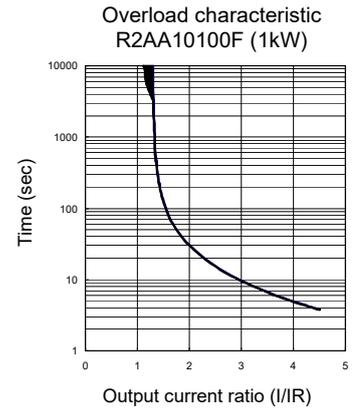
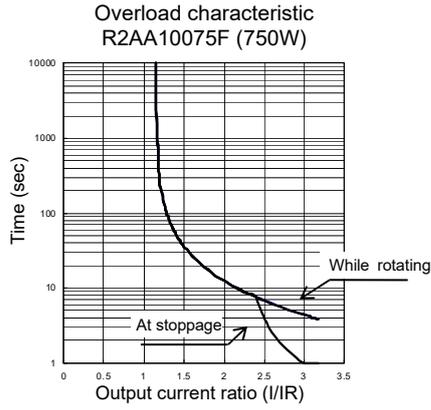
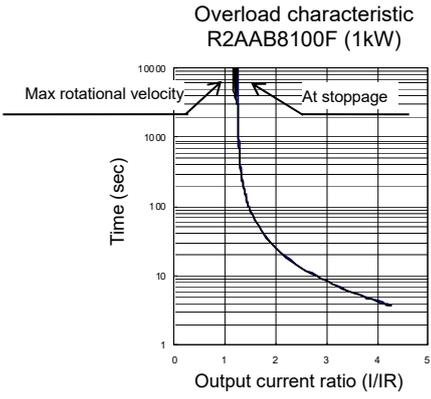
The following show overload characteristics of R1AA motors.

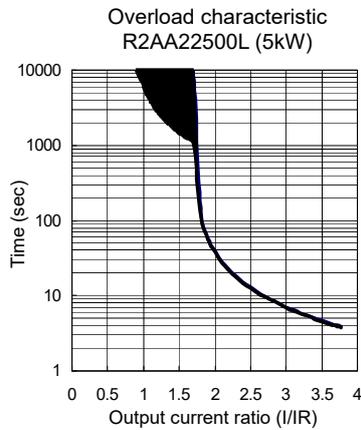
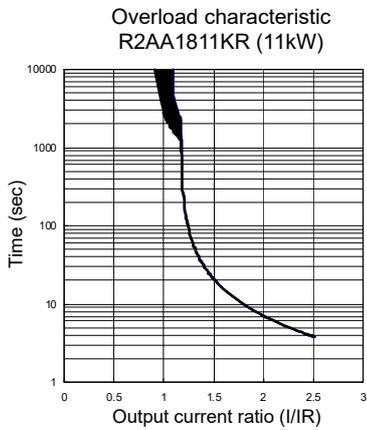
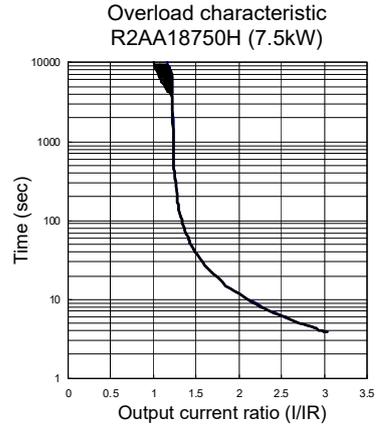
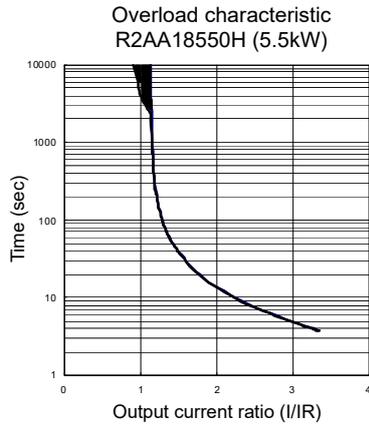
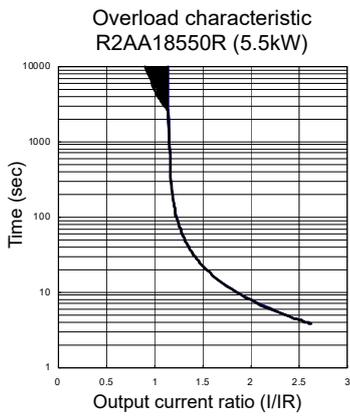
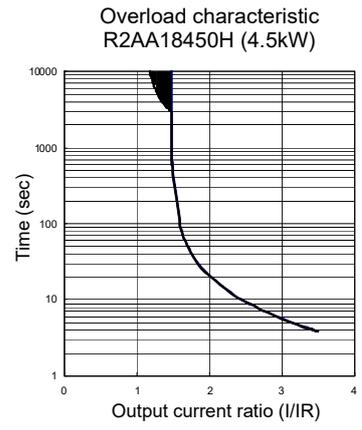
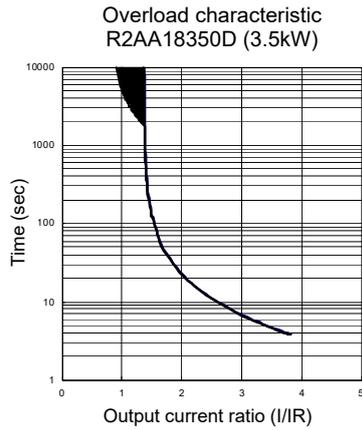
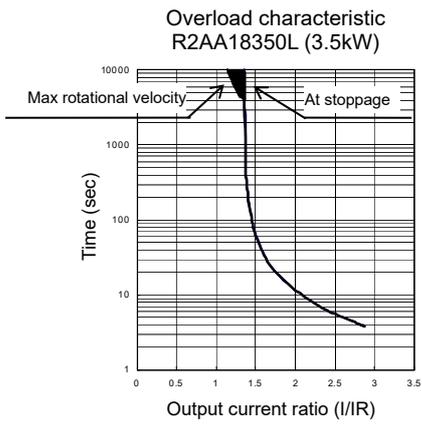


The following show overload characteristics of R1AA motors.

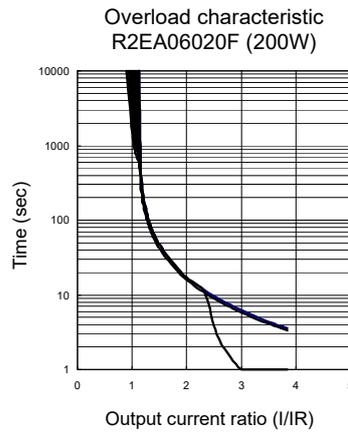
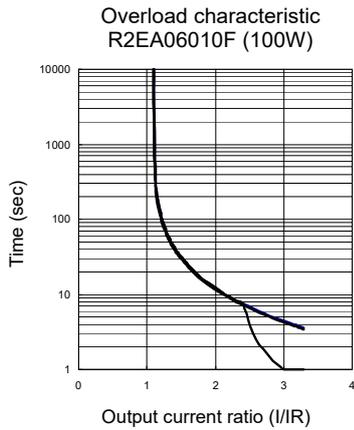
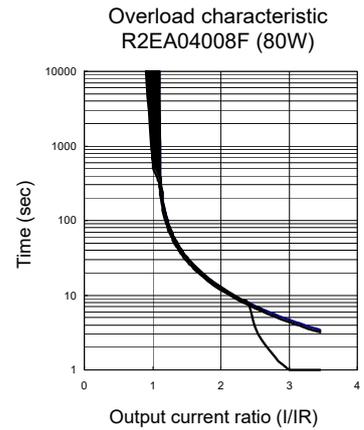
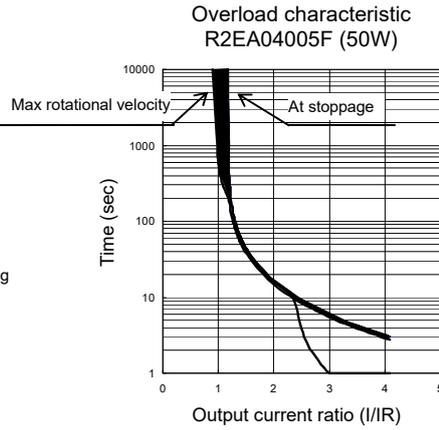
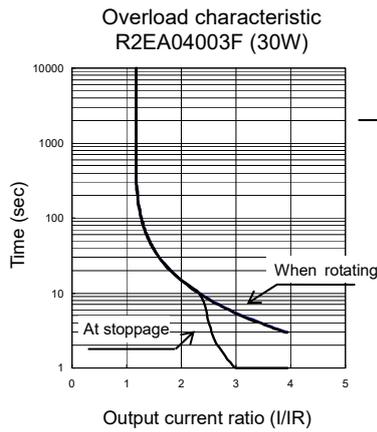




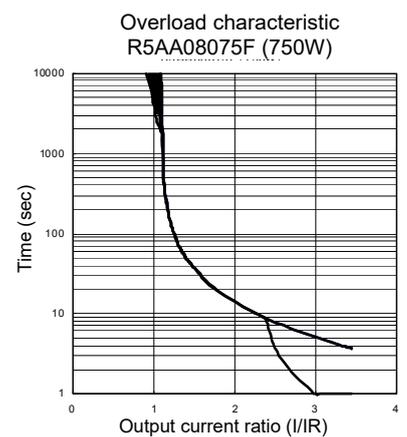
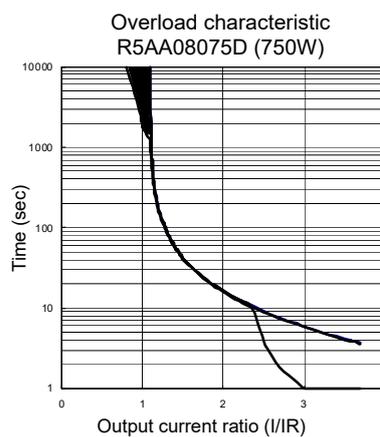
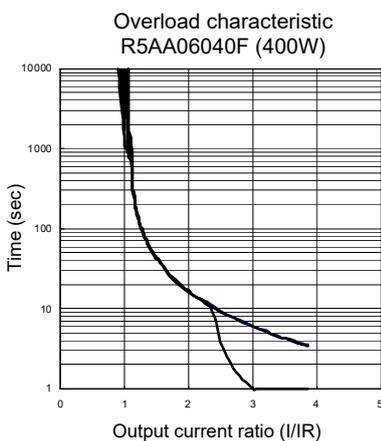
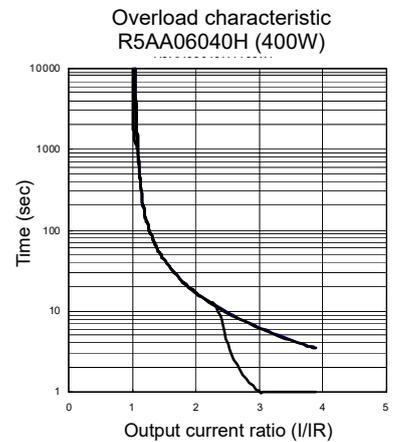
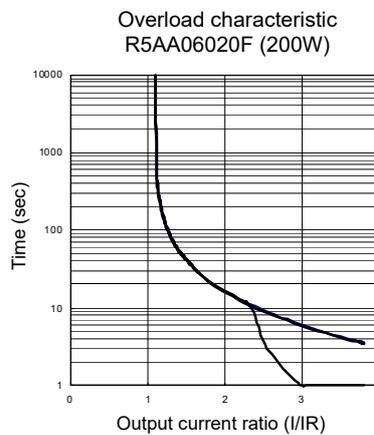
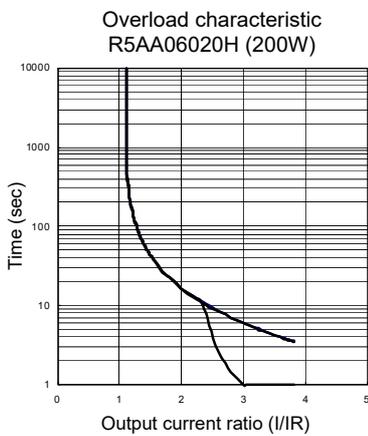




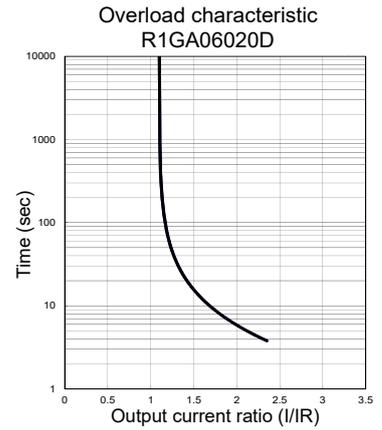
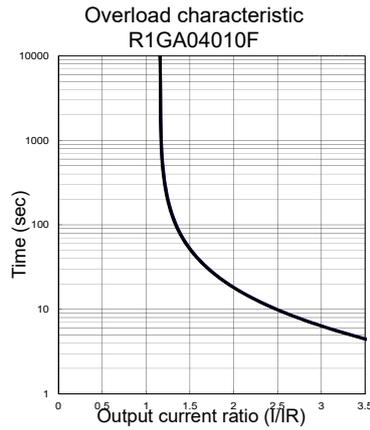
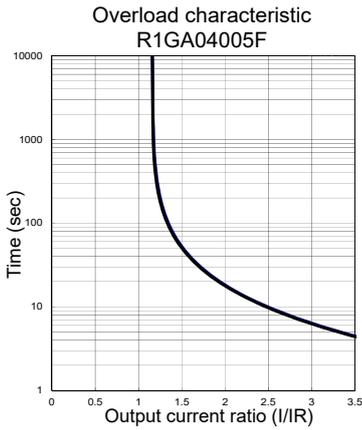
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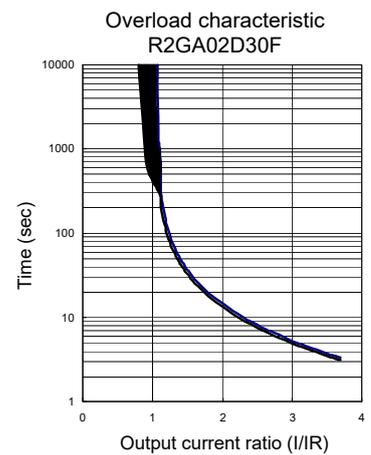
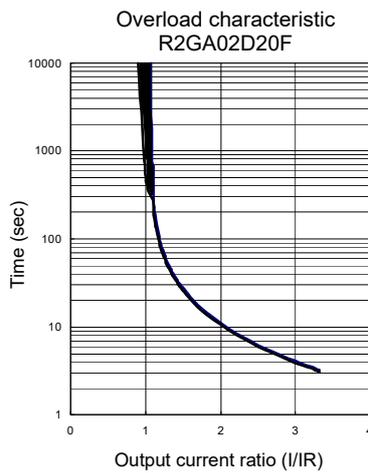
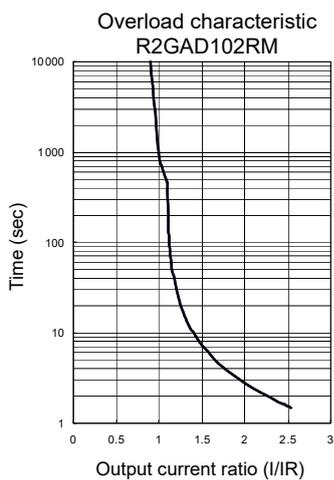
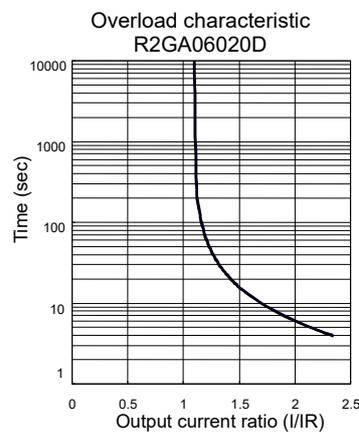
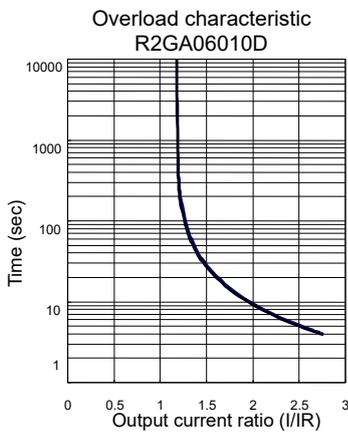
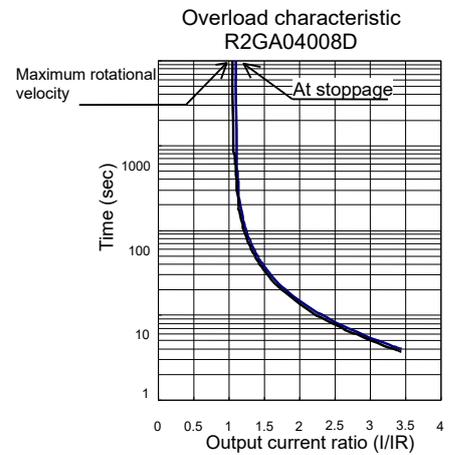
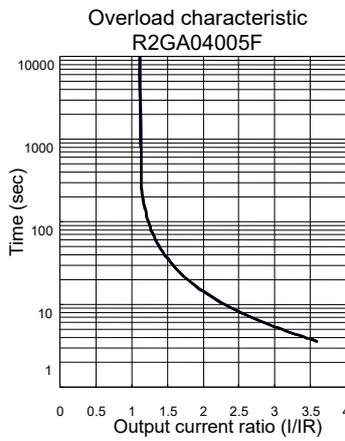
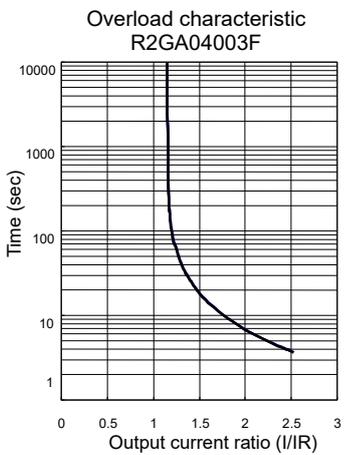
The following show overload characteristic of R5AA motor.



The following show overload characteristics of R1GA motors.

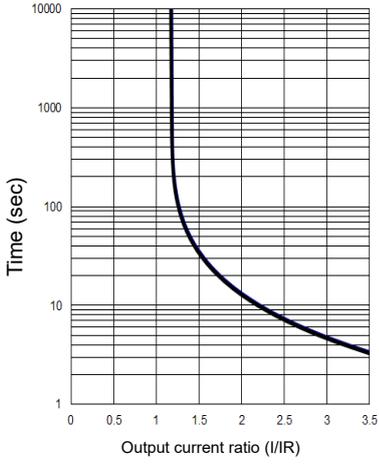


The following show overload characteristics of R2GA motors.

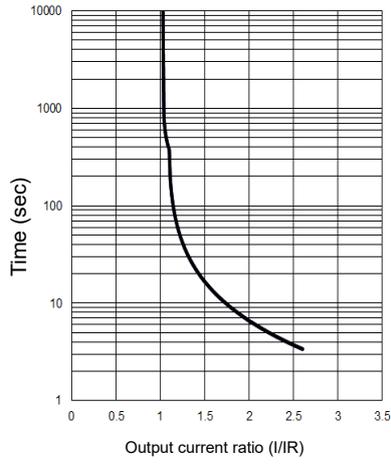


The following show overload characteristics of R2FA motors.

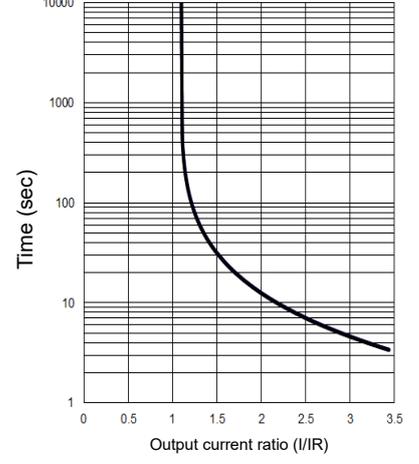
Overload characteristic  
R2FA04003F



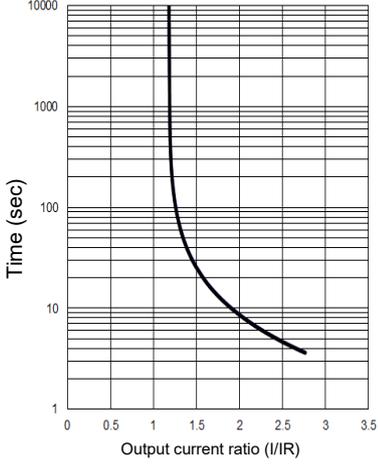
Overload characteristic  
R2FA04005D



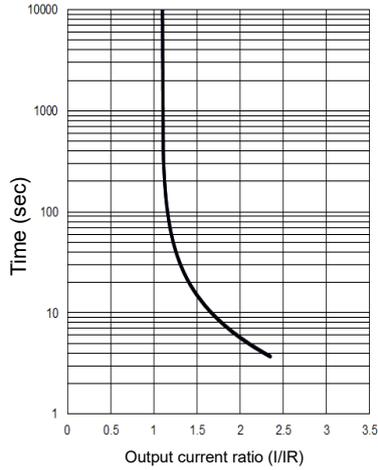
Overload characteristic  
R2FA04006R



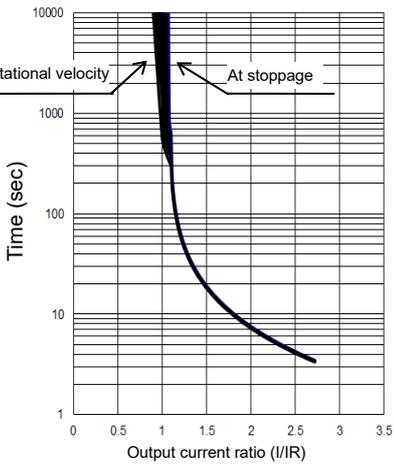
Overload characteristic  
R2FA06007R



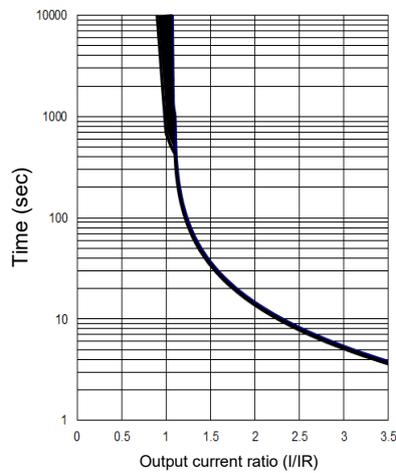
Overload characteristic  
R2FA06008A



Overload characteristic  
R2FA02D20D

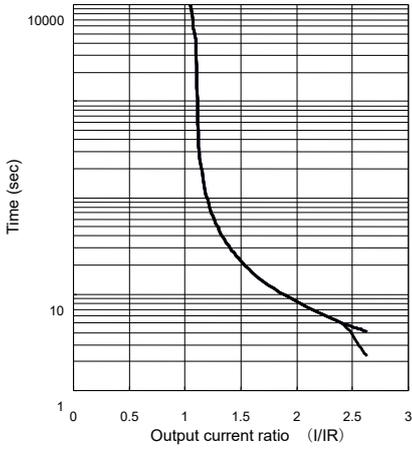


Overload characteristic  
R2FA02D30H

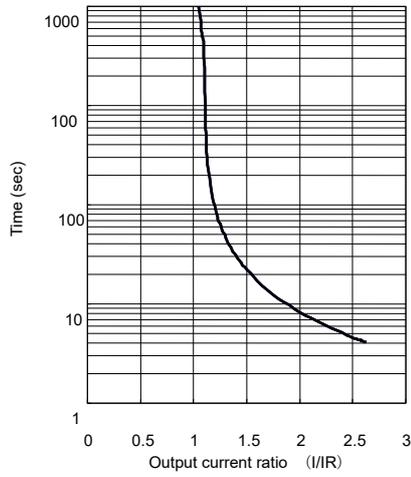


The following show overload characteristic of DS linear motor.

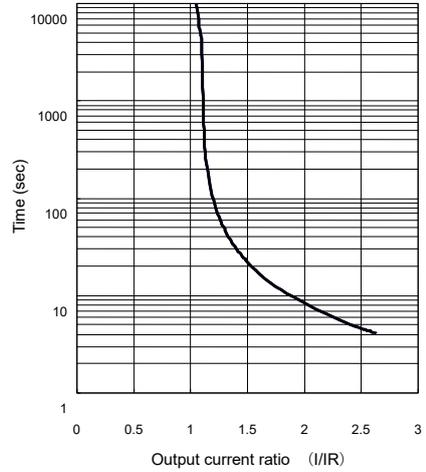
Overload characteristic  
DS030C1N2 (0.64 kW)



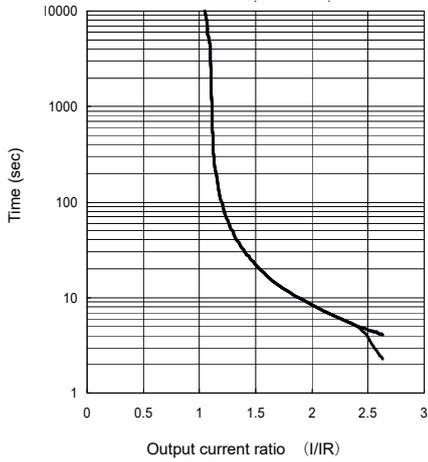
Overload characteristic  
DS030C2N2 (1.28 kW)



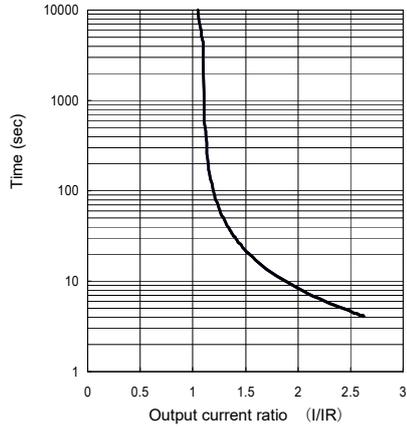
Overload characteristic  
DS030C3N2 (1.92 kW)



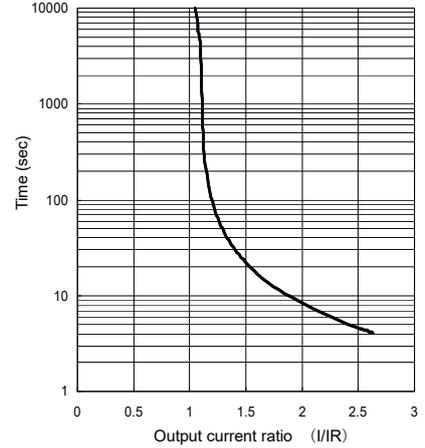
Overload characteristic  
DS050C1N2 (0.624 kW)



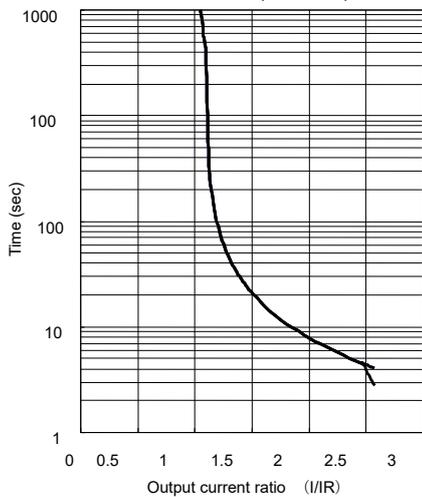
Overload characteristic  
DS050C2N2 (1.248 kW)



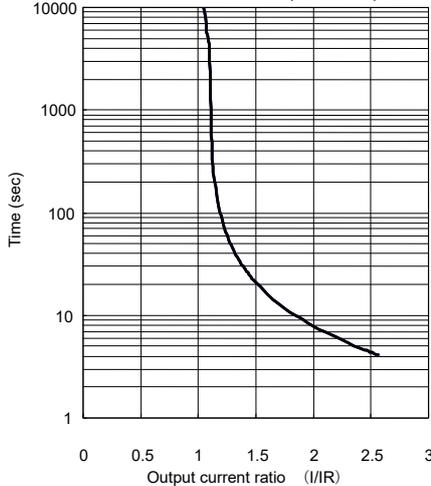
Overload characteristic  
DS050C3N2 (1.872 kW)



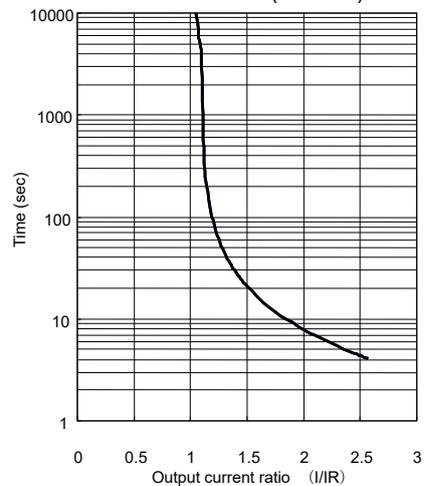
Overload characteristic  
DS075C1N2 (0.64 kW)

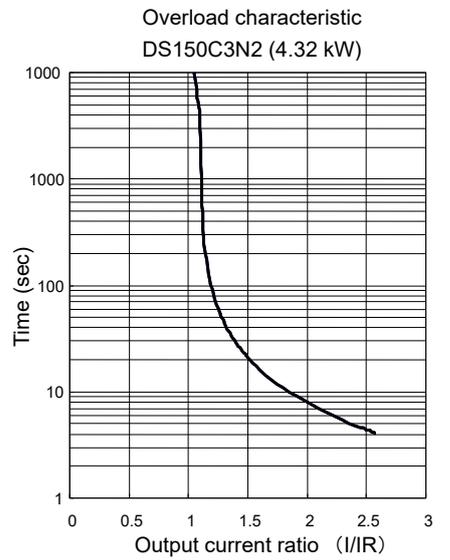
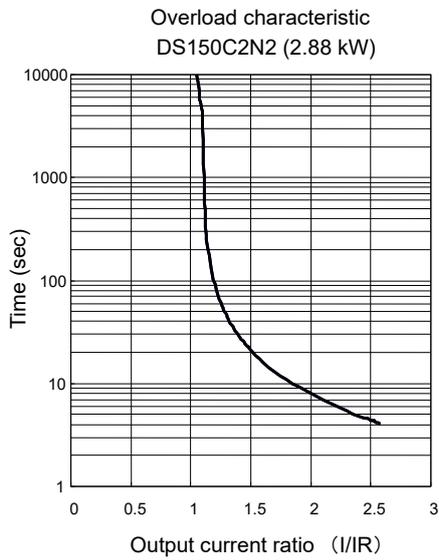
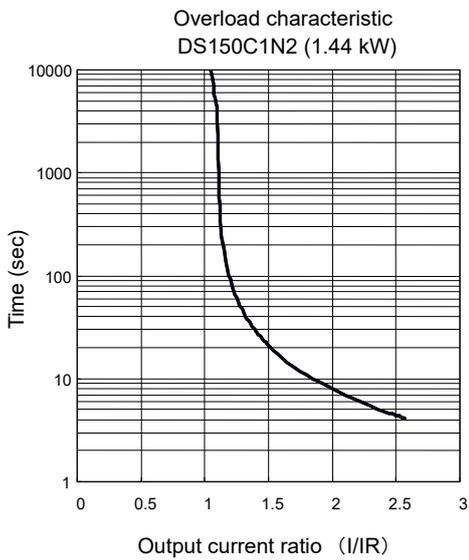
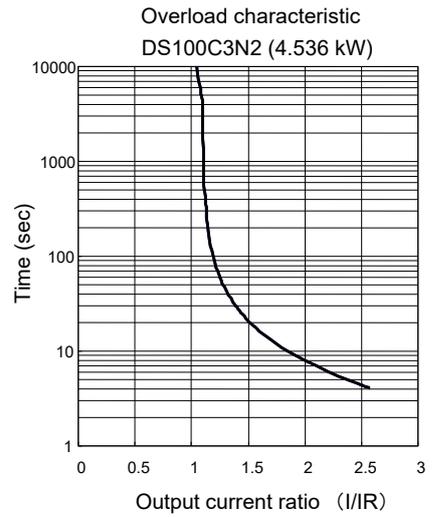
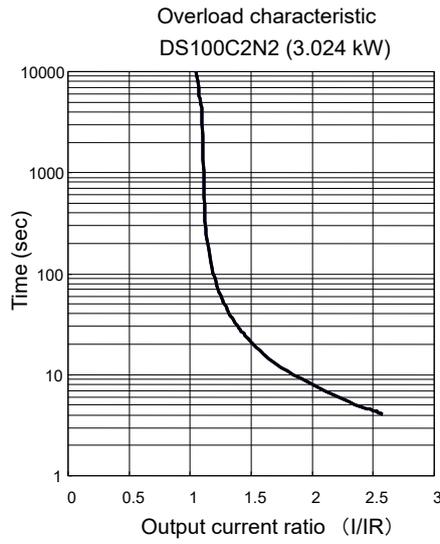
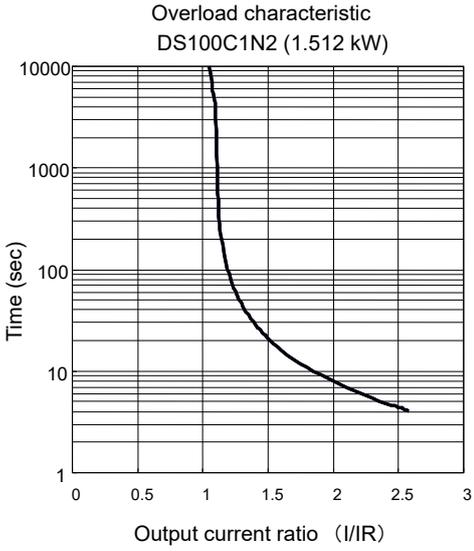


Overload characteristic  
DS075C2N2 (1.28 kW)

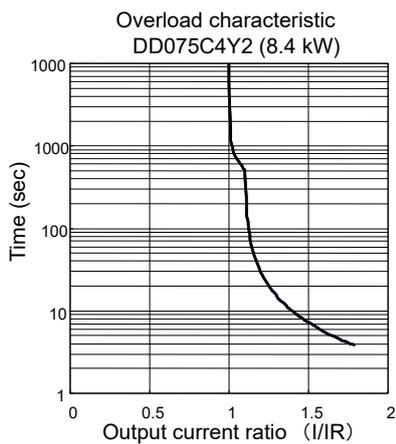
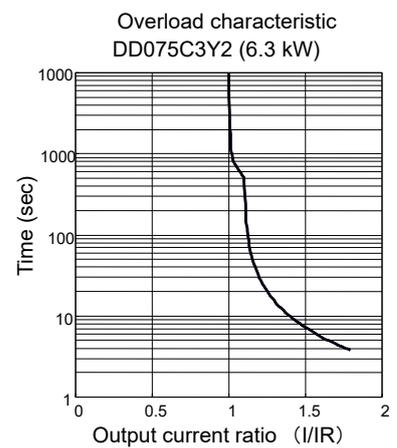
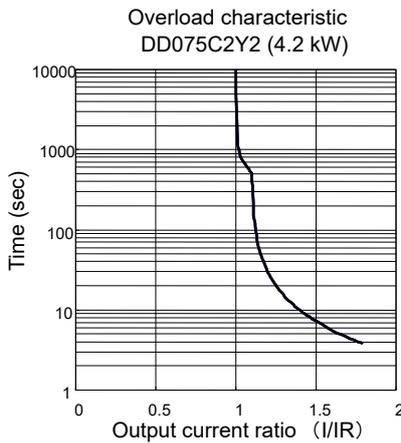
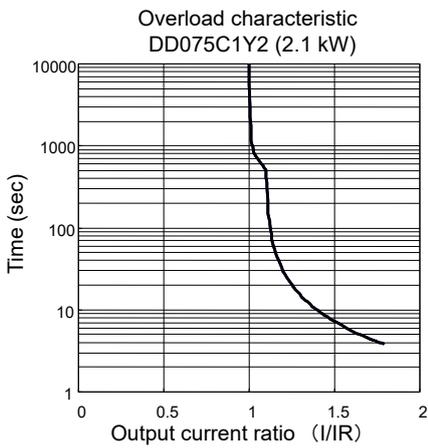
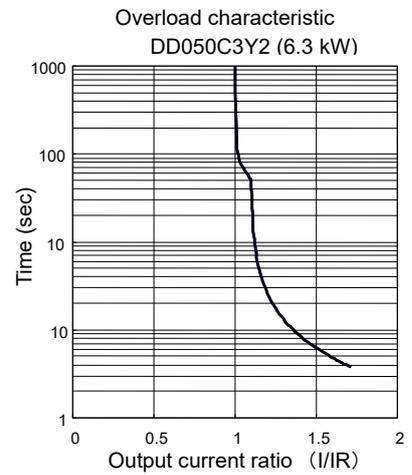
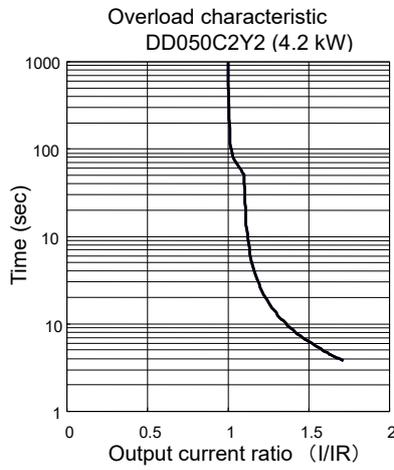
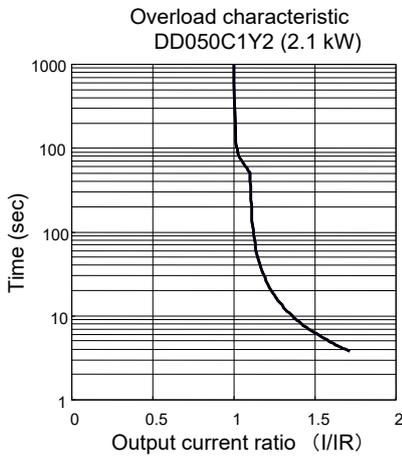
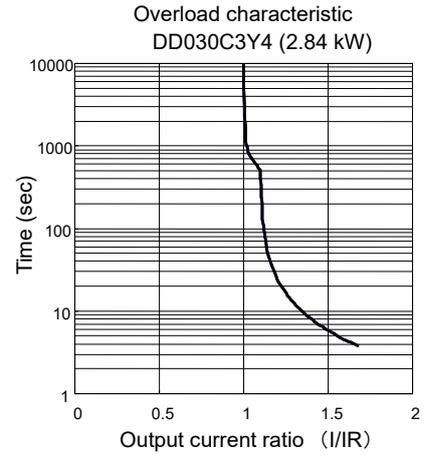
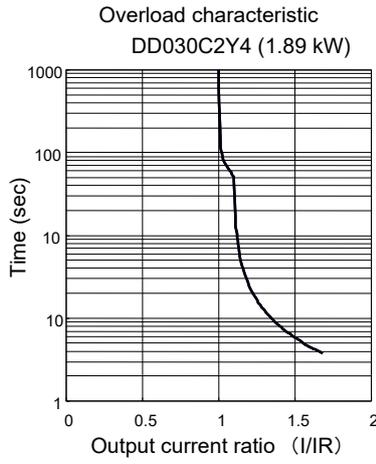
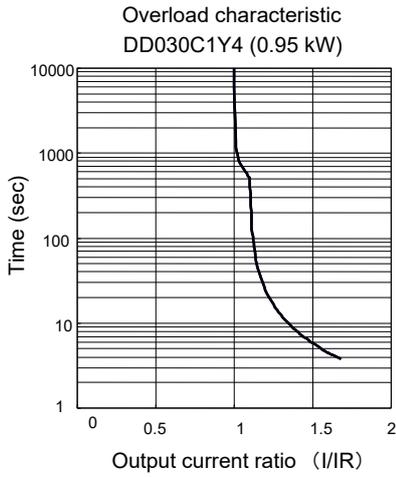


Overload characteristic  
DS075C3N2 (1.92 kW)

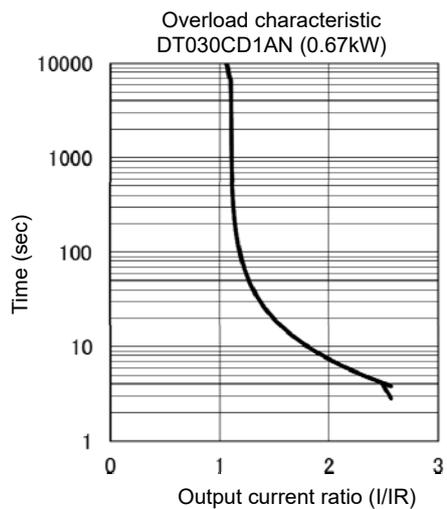




The following show overload characteristic of DD linear motor.

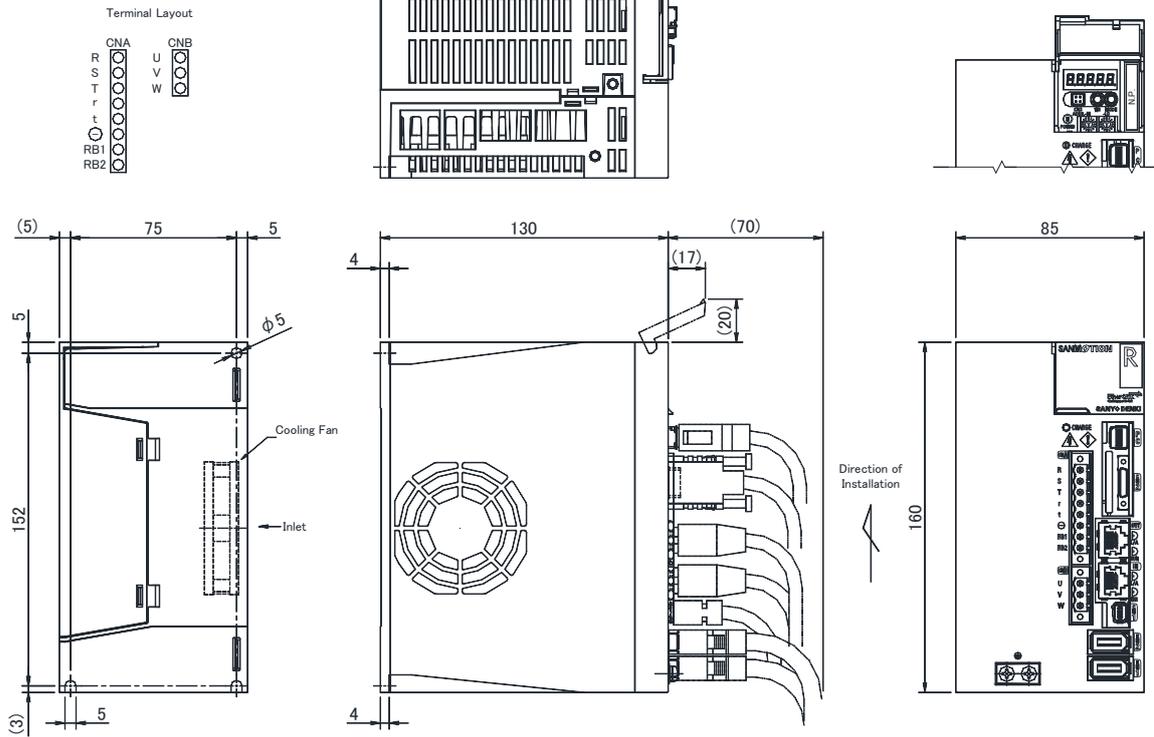


The following show overload characteristic of center magnet type.

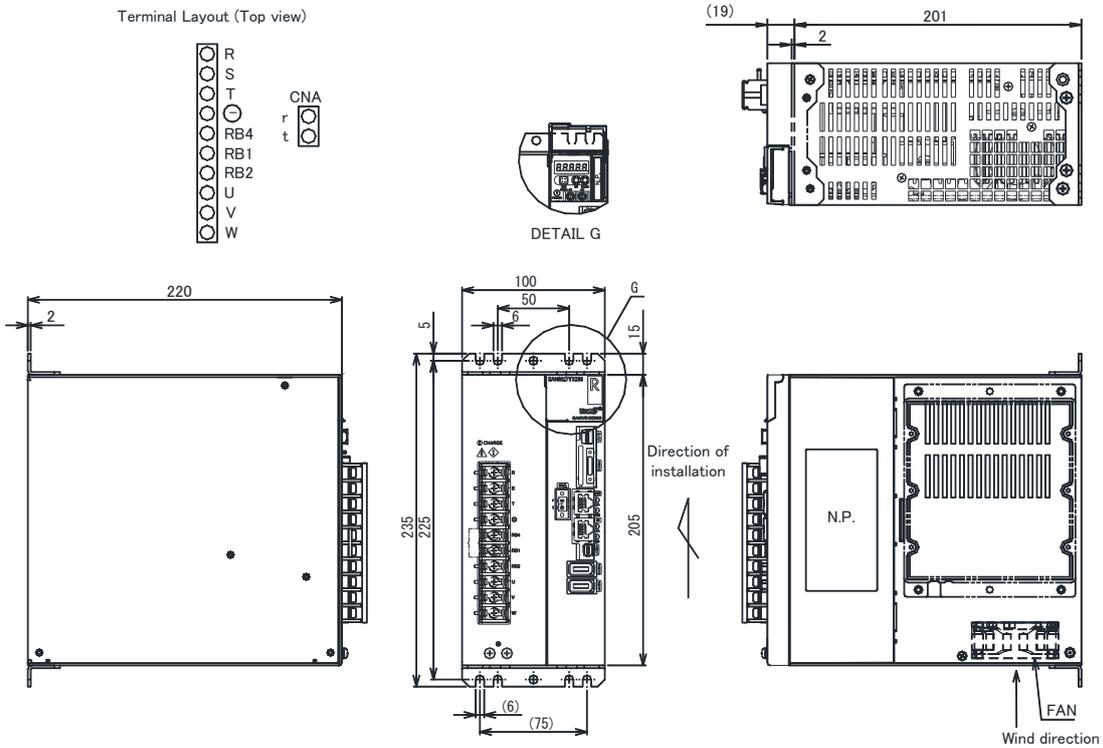




■ RS2□05A□HL□

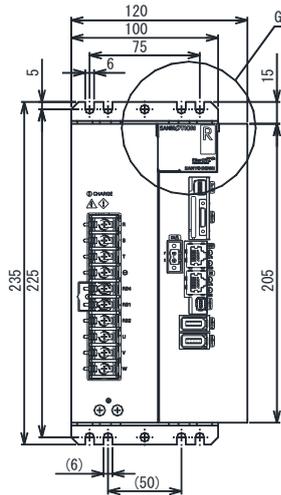
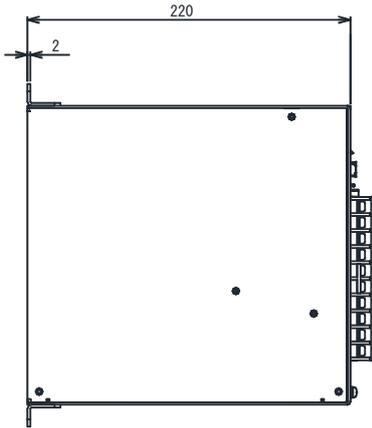
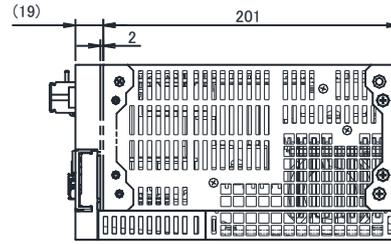
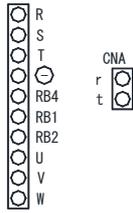


■ RS2□10A□HA□

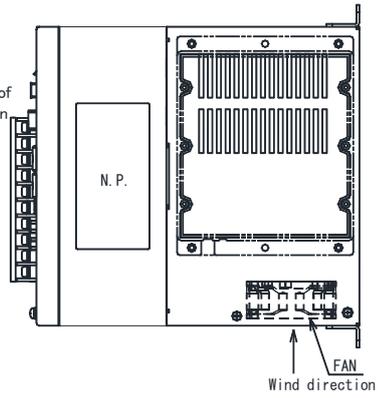


■ RS2□15A□HA□

Terminal Layout (Top view)

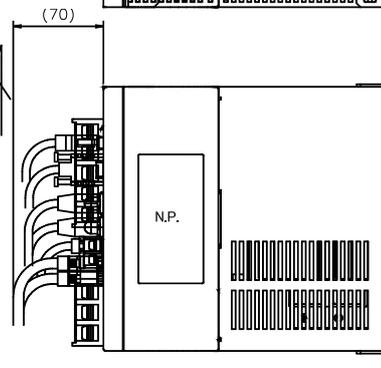
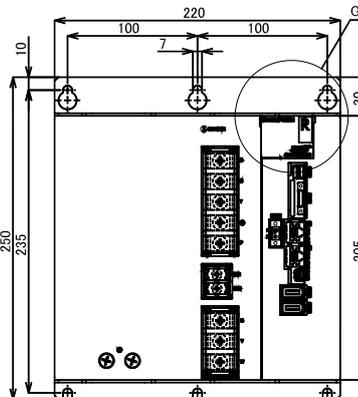
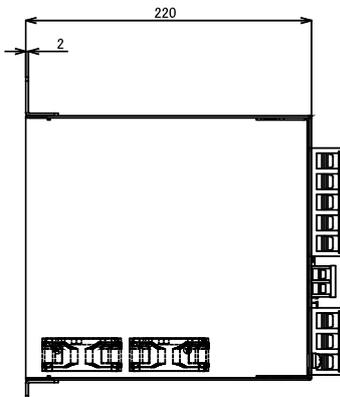
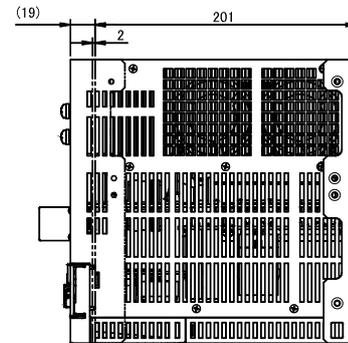
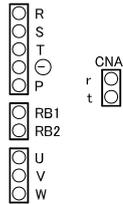


Direction of installation

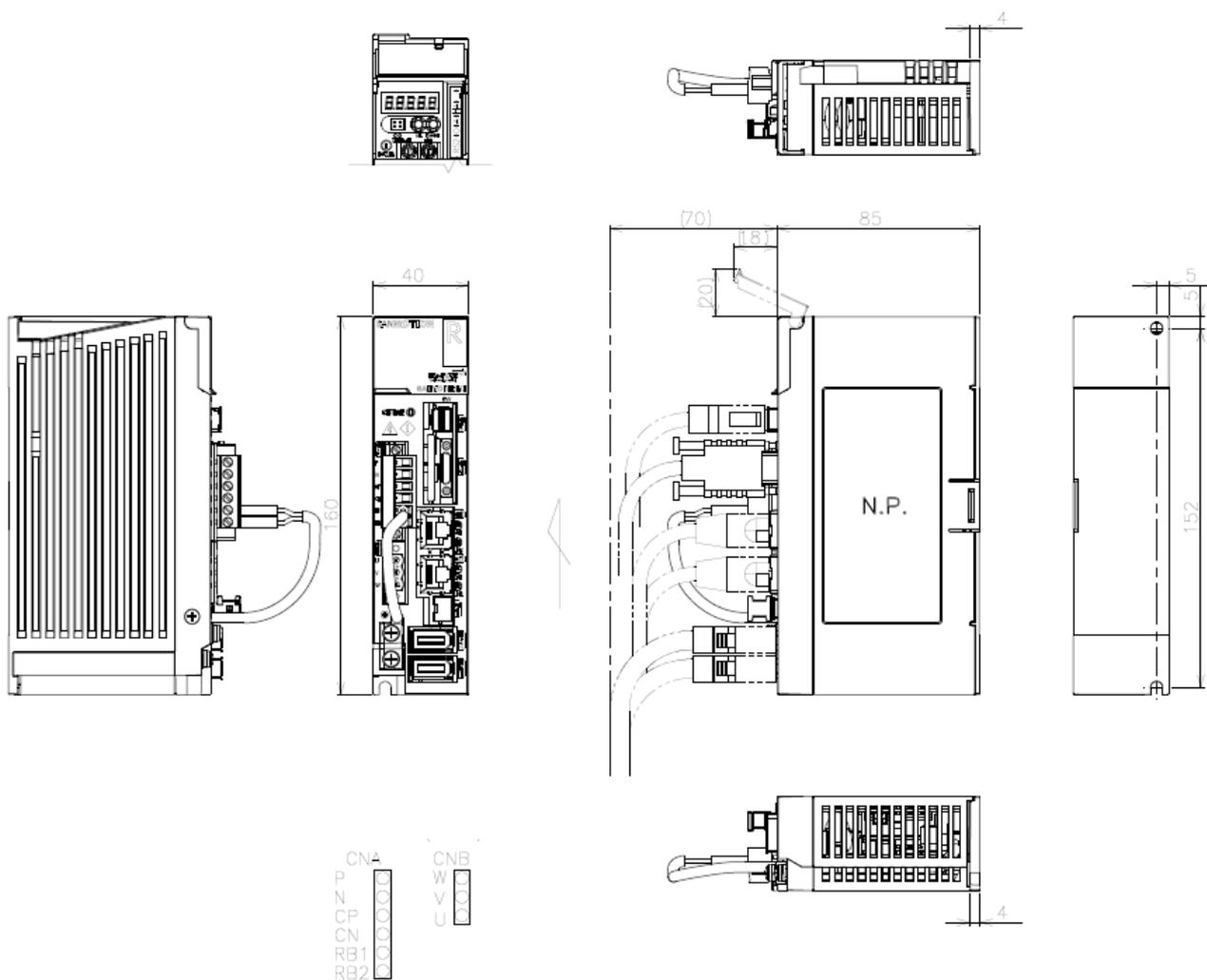


■ RS2□30A□HL□

Terminal Layout (Top view)



■ RS2K□A□H□□/RS2J□A□H□□

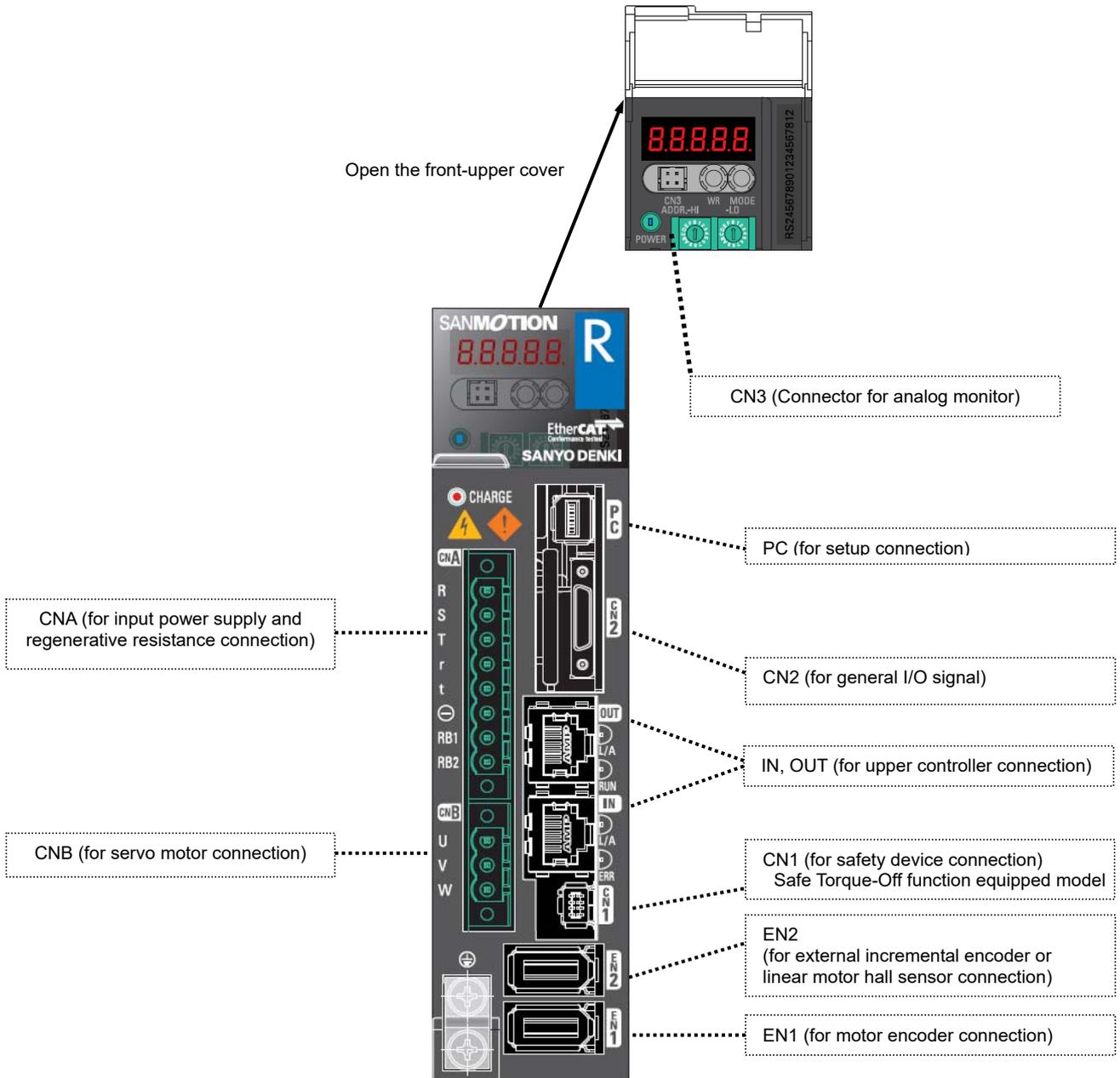


## 16.6 Optional Parts

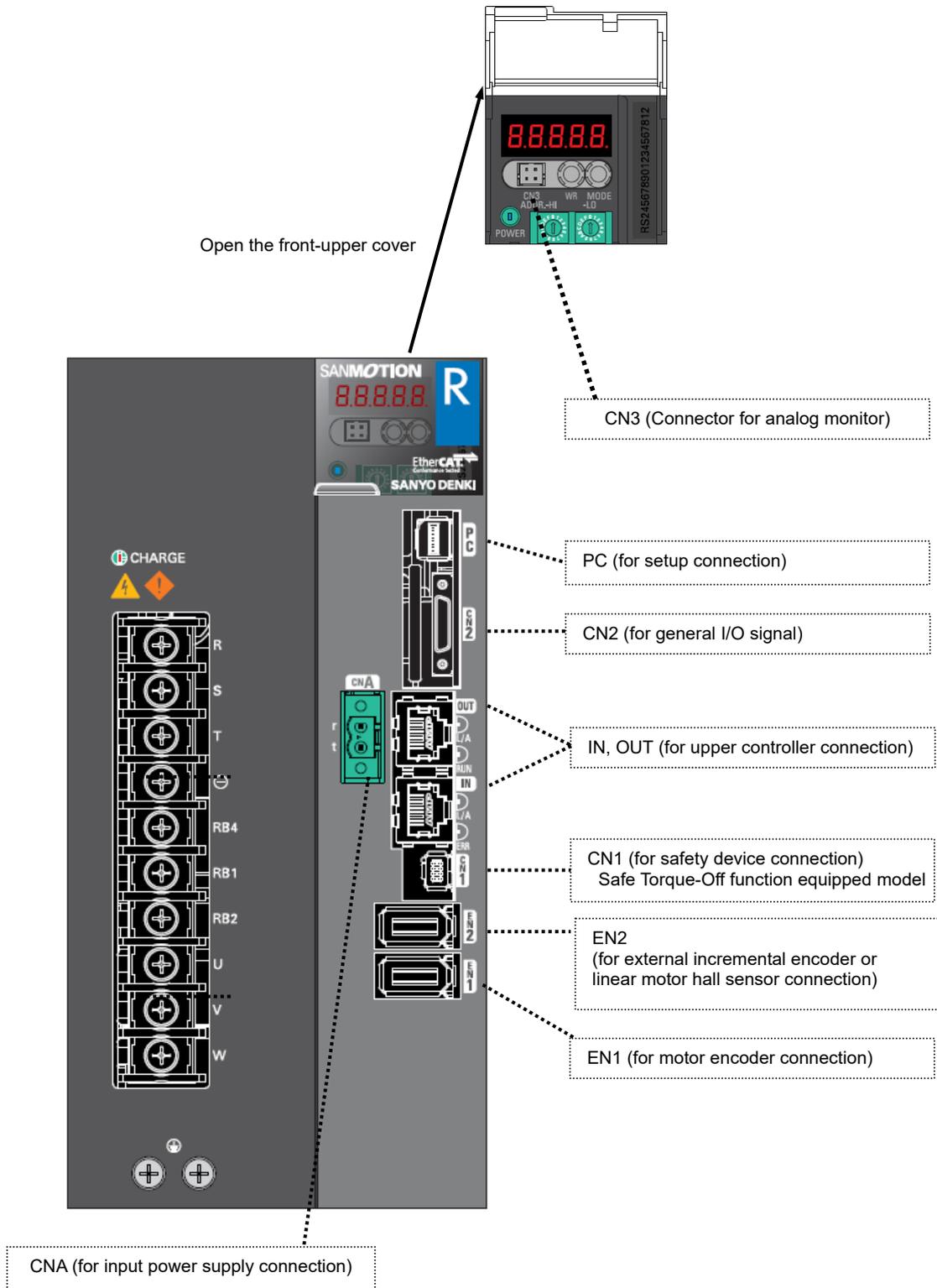
1) We prepare the following option products.

Connector of Servo Amplifier

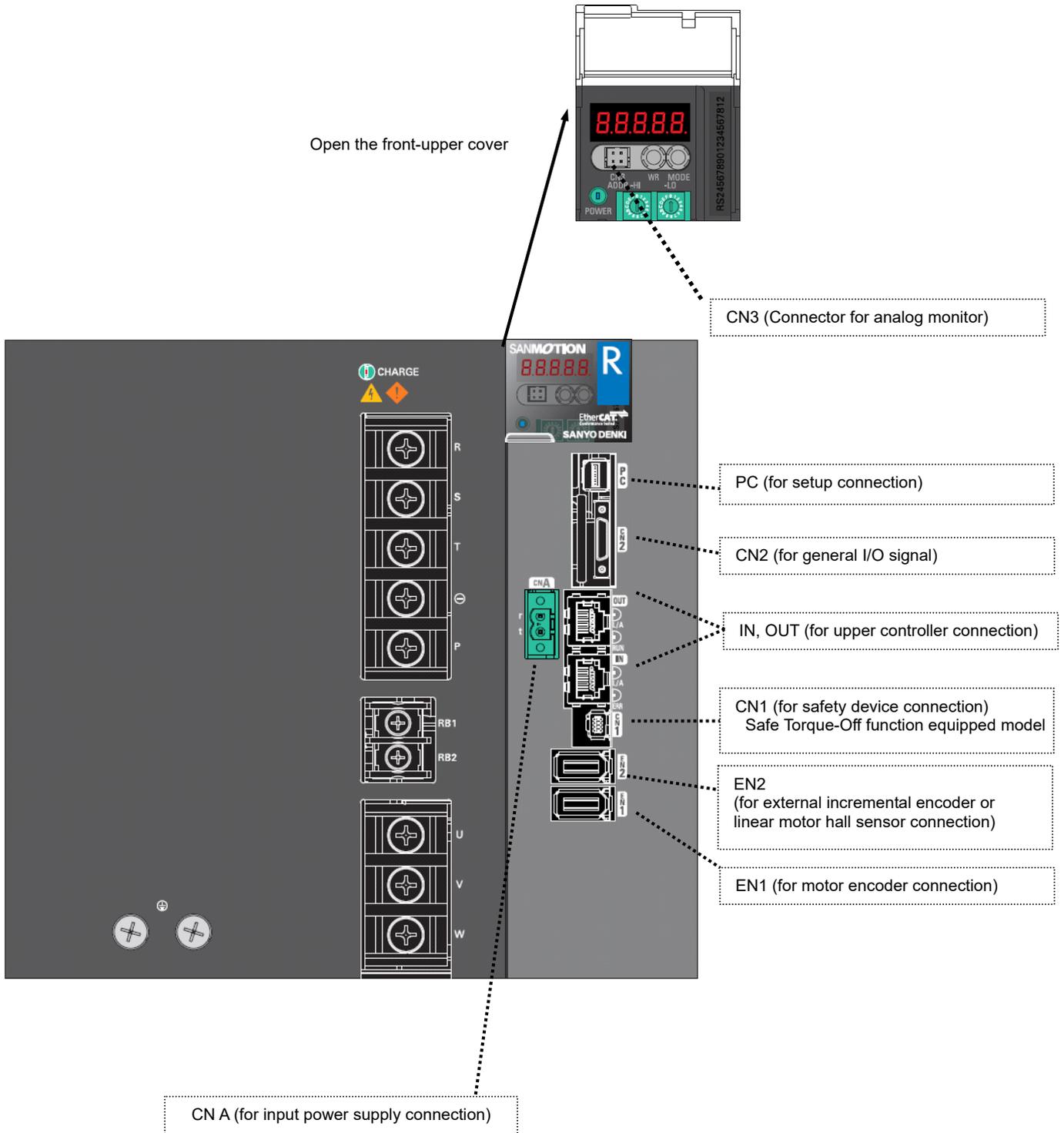
- RS2#01, RS2#03, RS2#05



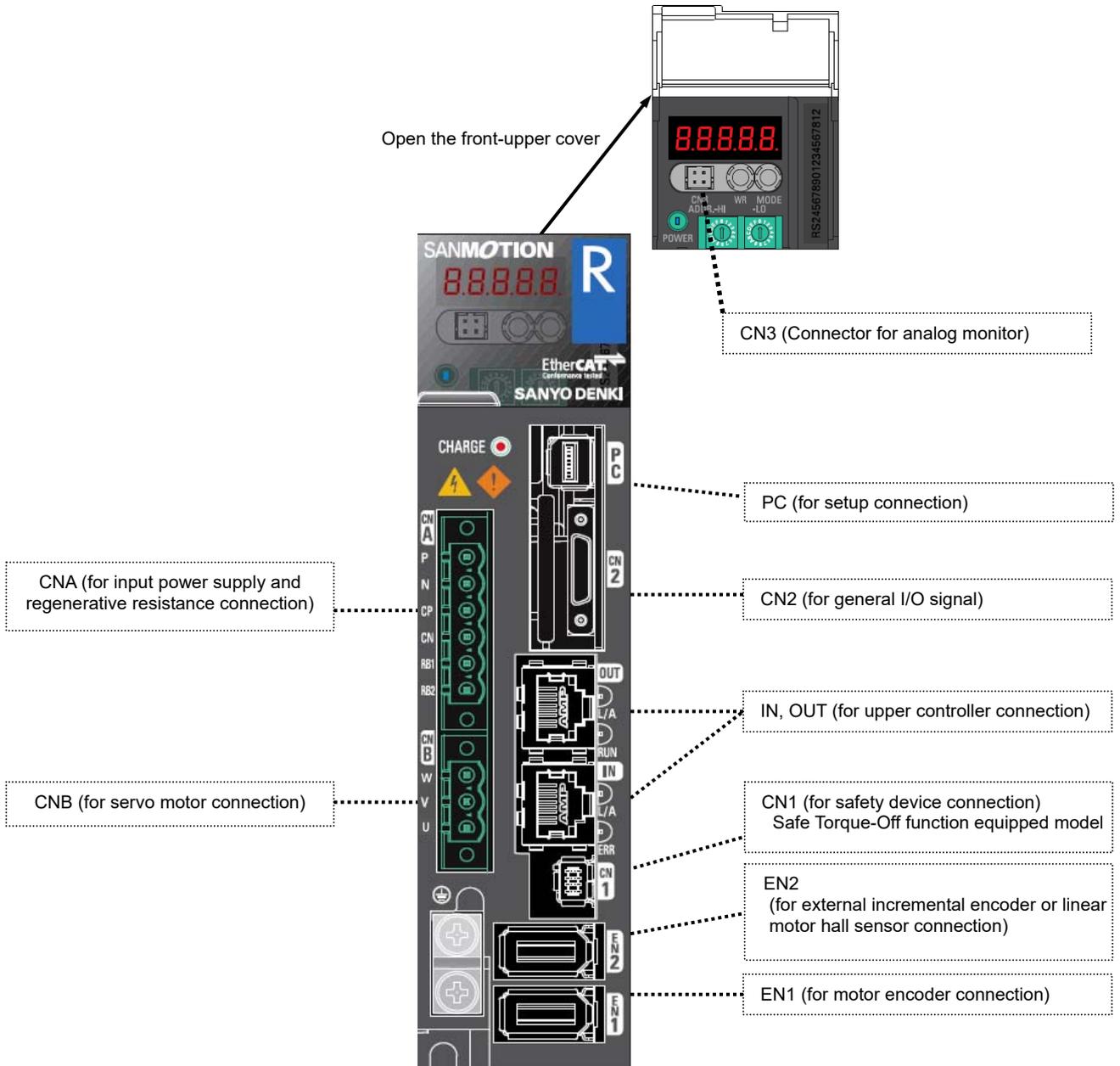
■RS2#10, RS2#15



■ RS2#30



■ RS2□##A(48V/24V DC)



## 2) Connector Model Number

RS2#01, RS2#03, RS2#05

## ■ PN of connector

Connector No.	Item	Our model No.	Manufacturer's model No.	Qty.	Manufacturer
IN, OUT	Ethernet For host unit connection	Not provided by our company. Please use shielded type modular plug (RJ-45) corresponding to the CAT5e standard.			
EN1, EN2	For encoder Connection	AL-00632607	36210-0100PL and 36310-3200-008	1	3M Japan Ltd.
CNA	For input power supply, and regenerative resistance connection	AL-00686902-01	MSTBT2.5/8-STF-5.08LUB	1	Phoenix Contact Co. Ltd.
CNB	For servo motor connection	AL-Y0004079-01	MSTBT2.5/3-STF-5.08	1	Phoenix Contact Co. Ltd.
CN1	For STO	AL-00718252-01	2013595-3	1	Tyco Electronics Japan G.K.
CN1	For STO cancellation	AL-00849548-02	1971153-2	1	Tyco Electronics Japan G.K.
CN2	For general I/O signal	AL-00842383	HDR-E26MSG1+ and HDR-E26LPH	1	Honda Tsushin Kogyo Co. Ltd.

RS2#10, RS2#15, RS2#30

## ■ PN of connector

Connector No.	Item	Our model No.	Manufacturer's model No.	Qty.	Manufacturer
IN, OUT	Ethernet For host unit connection	Not provided by our company. Please use shielded type modular plug (RJ-45) corresponding to the CAT5e standard.			
EN1, EN2	For encoder Connection	AL-00632607	36210-0100PL and 36310-3200-008	1	3M Japan Ltd.
CNA	For input power supply, and regenerative resistance connection	AL-00686902-01	MSTBT2.5/8-STF-5.08LUB	1	Phoenix Contact Co. Ltd.
CN1	For STO	AL-00718252-01	2013595-3	1	Tyco Electronics Japan G.K.
CN1	For STO cancellation	AL-00849548-02	1971153-2	1	Tyco Electronics Japan G.K.
CN2	For general I/O signal	AL-00842383	HDR-E26MSG1+ and HDR-E26LPH	1	Honda Tsushin Kogyo Co. Ltd.

RS2□##A(DC48V/24V)

## ■ PN of connector

Connector No.	Item	Our model No.	Manufacturer's model No.	Qty.	Manufacturer
IN, OUT	Ethernet For host unit connection	Not provided by our company. Please use shielded type modular plug (RJ-45) corresponding to the CAT5e standard.			
EN1, EN2	For encoder Connection	AL-00632607	36210-0100PL and 36310-3200-008	1	3M Japan Ltd.
CNA	For input power supply, and regenerative resistance connection	AL-Y0010913-01	MSTBT2.5/6-STF-5.08	1	Phoenix Contact Co. Ltd.
CNB	For servo motor connection	AL-Y0004079-01	MSTBT2.5/3-STF-5.08	1	Phoenix Contact Co. Ltd.
CN1	For STO	AL-00718252-01	2013595-3	1	Tyco Electronics Japan G.K.
CN1	For STO cancellation	AL-00849548-02	1971153-2	1	Tyco Electronics Japan G.K.
CN2	For general I/O signal	AL-00842383	HDR-E26MSG1+ and HDR-E26LPH	1	Honda Tsushin Kogyo Co. Ltd.

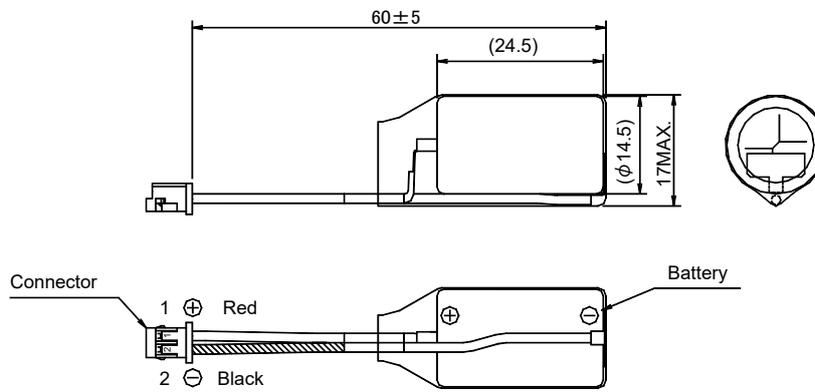
■ PN of connector set

Set connector	Description	Amplifier model number	Our model No.
EN1, CN1, CN2, CNB	With regenerative resistor, Semi-closed amplifier, For DC input, For AC200V 15A to 50A input	RS2K or J RS2#01 to 05	AL-00887322
EN1, EN2, CN1, CN2, CNB	With regenerative resistor, Full-closed amplifier, For DC input, For AC200V 15A to 50A input		AL-00887326
EN1, CN1, CN2, CNA (for DC input), CNB	Without regenerative resistor, Semi-closed amplifier, For DC input	RS2K or J	AL-00887323
EN1, EN2, CN1, CN2, CNA (for DC input), CNB	Without regenerative resistor, Full-closed amplifier, For DC input		AL-00887327
EN1, CN1, CN2, CNA (for small capacity), CNB	Without regenerative resistor, Semi-closed amplifier, For AC200V 15A to 50A input	RS2#01 to 05	AL-00887324
EN1, EN2, CN1, CN2, CNA (for small capacity), CNB	Without regenerative resistor, Full-closed amplifier, For AC200V 15A to 50A input		AL-00887328
EN1, CN1, CN2, CNA (for large capacity)	Semi-closed amplifier, For AC200V 100A to 300A input	RS2# 10 to 30	AL-00887325
EN1, EN2, CN1, CN2, CNA (for large capacity)	Full-closed amplifier, For AC200V 100A to 300A input		AL-00887329

3) Battery-backup absolute encoder battery related parts

Name	Contents	Qty.	SANYO DENKI model No.
Battery unit (lithium battery)	lithium battery: ER3VLY TOSHIBA LIFESTYLE PRODUCTS & SERVICES CORPORATION	1	AL-00697958-01
Battery trunk cable with single connector.	-	1	AL-00697960-01 -
Battery trunk cable with two connectors.	-	1	AL-00731792-01

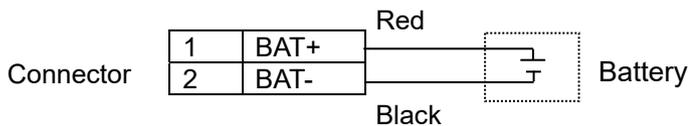
■ Outline dimensional drawing of battery unit (Model No.: AL-00697958-01)



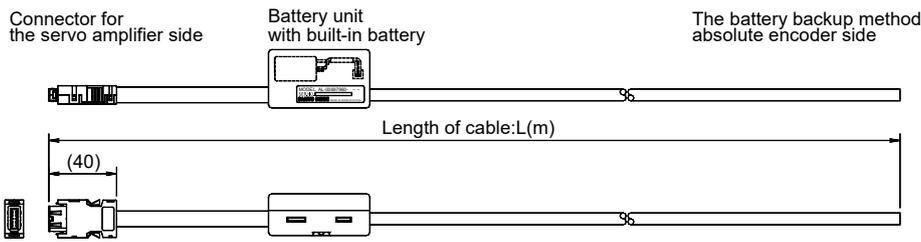
1. Battery and Connector Specifications

Lithium battery	Thionyl Chloride Lithium Battery ER3VLY (TOSHIBA LIFESTYLE PRODUCTS & SERVICES CORPORATION) Nominal Voltage: 3.6V Nominal Capacity: 1000mAh Lithium metal weight as standard: 0.31g
Connector	DF3-2S-2C; Socket Housing (HIROSE) DF3-2428SCFC; Contact (HIROSE)

2. Wiring diagram



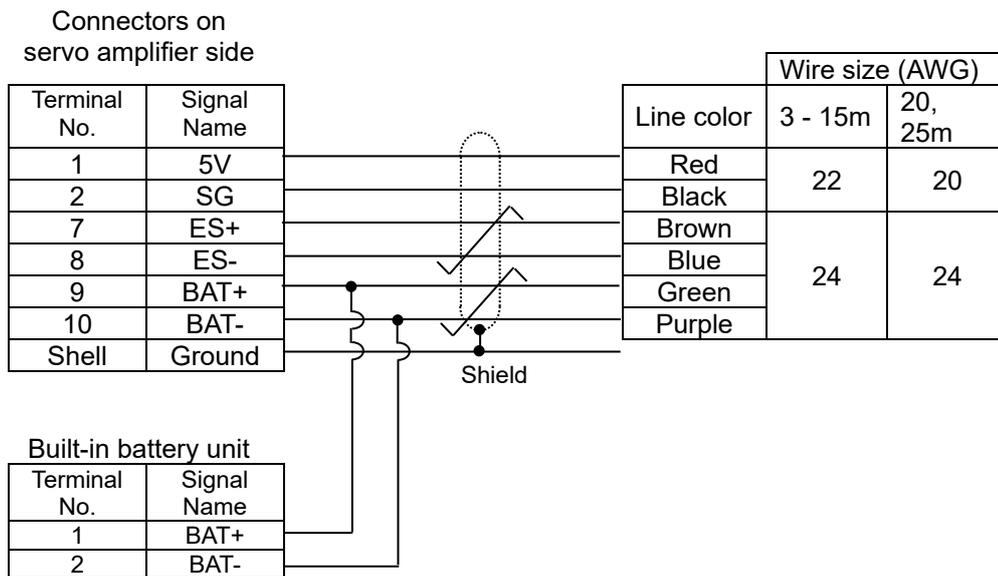
■ Battery trunk cable (Model No.: AL-00697960-□□)



Model number	L [m]
AL-00697960-01	3
AL-00697960-02	5
AL-00697960-03	10
AL-00697960-04	15
AL-00697960-05	20
AL-00697960-06	25

1. Specification: Relay cable for encoder with the connector in one end and the battery unit  
 For moving part at mid-low speed. \*This shall not be designed for moving part at high speed.

2. Specification for wiring:



3. Specification for the connector and the battery unit

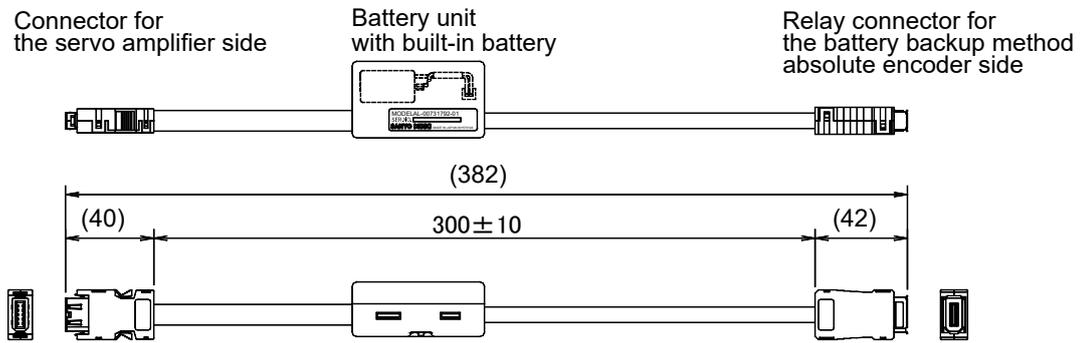
Connector for the servo amplifier side	36210-0100PL; Wiremount Receptacle (3M) 36310-3200-008; Shell Kit (3M)
Battery unit	Battery case: AL-00697959-01 Built-in battery: ER3VLY (TOSHIBA LIFESTYLE PRODUCTS & SERVICES CORPORATION) Nominal Voltage: 3.6V Nominal Capacity: 1000mAh Metallic weight of lithium: 0.31g

4. Outline specification for cable

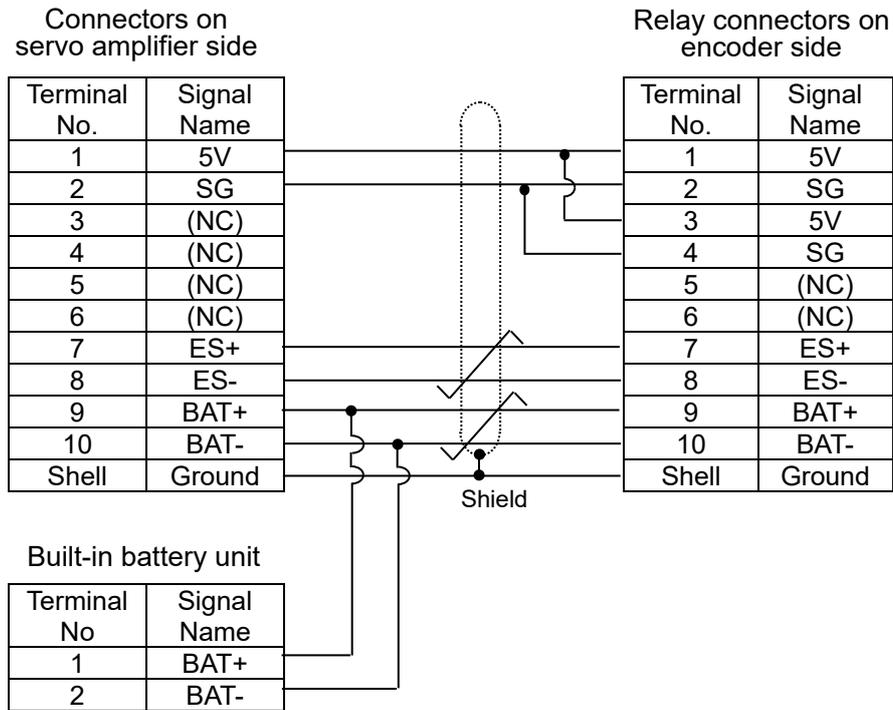
Robot cable for moving part at mid-low speed; UL-ORHV30-SB, Composite wire specification (Manufactured by OKANO ELECTRIC WIRE Co., Ltd.) High-density polyethylene insulated wire, Vinyl sheath, Braided shield addition.	
UL STYLE NO. 20276 (Ratings: 80°C, 30V)	
AL-00697960-01-04; 3 - 15m	AL-00697960-05, 06; 20, 25m
22 AWG × 2C + 24 AWG × 2P Sheath thickness: 1.0mm Cable outer diameter: Φ7.1±0.5mm	20 AWG × 2C + 24 AWG × 2P Sheath thickness 1.0mm Cable outer diameter: Φ7.1±0.5mm
Respective wire specifications 24 AWG Conductor diameter: Φ0.65mm, Insulator thickness: 0.25mm, Insulator coat outer diameter: Φ1.15mm 22 AWG Conductor diameter: Φ0.77mm, Insulator thickness: 0.25mm, Insulator coat outer diameter: Φ1.27mm 20 AWG Conductor diameter: Φ0.95mm, Insulator thickness: 0.25mm, Insulator coat outer diameter: Φ1.45mm	

5. Battery model number for exchange: AL-00697958-01

■ Battery trunk cable (Model No.: AL-00731792-01)



1. Specification: Relay cable for encoder with the connector at both ends and the battery unit
2. Specification for wiring:



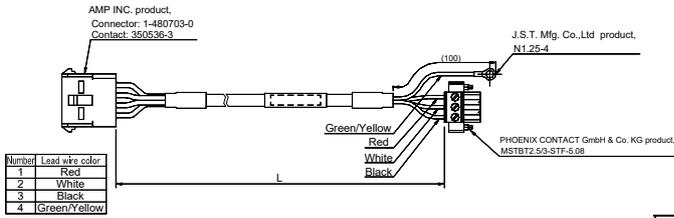
3. Specification for the connector and the battery unit

Connectors for servo amplifier	36210-0100PL; Wiremount Receptacle (3M) 36310-3200-008; Shell Kit (3M)
Relay connectors for encoder side	36110-3000FD; Wiremount Plug (3M) 36310-F200-008; Shell Kit (3M)
Battery unit	Battery case: AL-00697959-01 Built-in battery: ER3VLY (TOSHIBA LIFESTYLE PRODUCTS & SERVICES CORPORATION) Nominal Voltage: 3.6V Nominal Capacity: 1000mAh Metallic weight of lithium: 0.31g

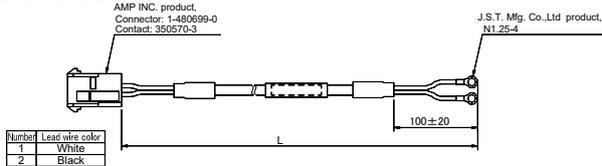
4. Battery model number for exchange: AL-00697958-01

4) Junction cable for servo motor

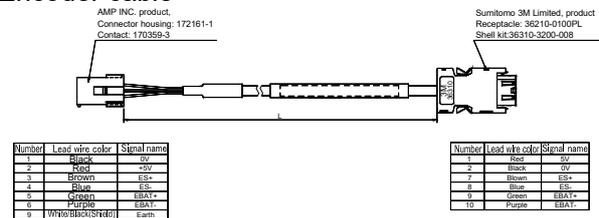
Power cable



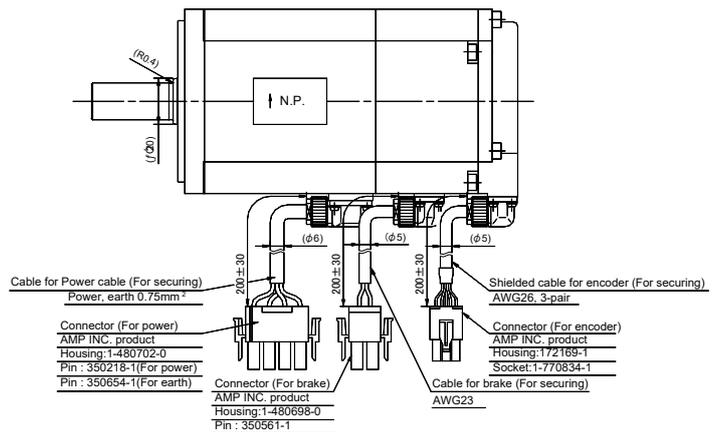
Brake cable



Encoder cable



Power cable	Model Number		Cable length : L (m)
	For brake	For encoder	
RS-CM4-01-R	RS-CB3-01-R	RS-CA4-01-R	1
RS-CM4-02-R	RS-CB3-02-R	RS-CA4-02-R	2
RS-CM4-03-R	RS-CB3-03-R	RS-CA4-03-R	3
RS-CM4-05-R	RS-CB3-05-R	RS-CA4-05-R	5
RS-CM4-10-R	RS-CB3-10-R	RS-CA4-10-R	10



Servo motor with connectors for junction cables, 200V

Rated output	Motor flange size	Holding brake	Model number	Remarks
30W	40mm sq.	No holding brake	R2AA04003FXPA0	
30W	40mm sq.	With holding brake (24V DC)	R2AA04003FCPA0	
50W	40mm sq.	No holding brake	R2AA04005FXPA0	
50W	40mm sq.	With holding brake (24V DC)	R2AA04005FCPA0	
100W	40mm sq.	No holding brake	R2AA04010FXPA0	
90W	40mm sq.	With holding brake (24V DC)	R2AA04010FCPA0	The rating decreases to 90%
100W	60mm sq.	No holding brake	R2AA06010FXPA0	
100W	60mm sq.	With holding brake (24V DC)	R2AA06010FCPA0	
200W	60mm sq.	No holding brake	R2AA06020FXPA0	
200W	60mm sq.	With holding brake (24V DC)	R2AA06020FCPA0	
400W	60mm sq.	No holding brake	R2AA06040FXPA0	
360W	60mm sq.	With holding brake (24V DC)	R2AA06040FCPA0	The rating decreases to 90%
750W	80mm sq.	No holding brake	R2AA08075FXPA0	
750W	80mm sq.	With holding brake (24V DC)	R2AA08075FCPA0	

5) Fixing bracket

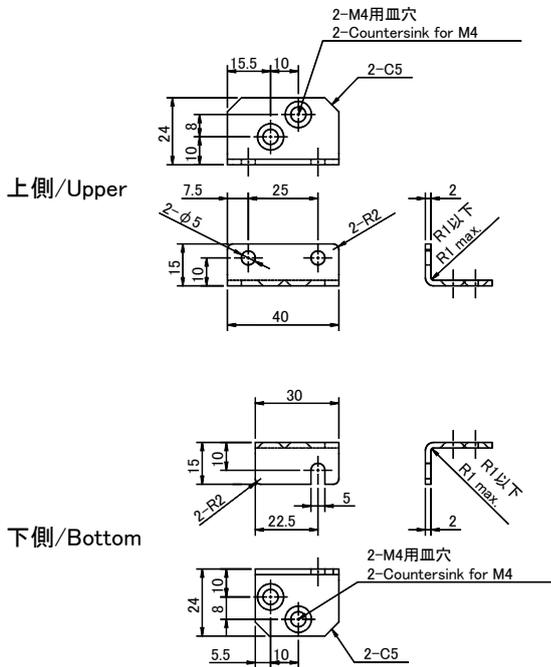
Fixing brackets are supplied with servo amplifier, RS2□01, RS2□03, RS2□05 and RS2□30.

■ List of fixing brackets for RS2□01 through 05

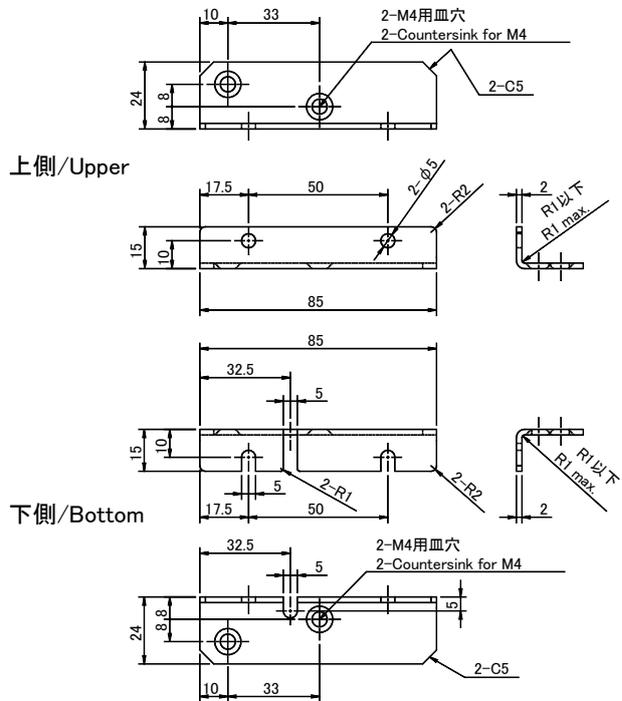
Servo amplifier model number	Bracket fixing position	Model number	Contents
RS2□01 and 03	Front	AL-00736863-01	Fixing bracket (top/bottom set): 1ea, respectively Tightening screw: 4ea
RS2□05	Front	AL-00736864-01	Fixing bracket (top/bottom set): 1ea, respectively Tightening screw: 4ea
RS2□30	Front	AL-00828413-01	Fixing bracket (top/bottom set): 1ea, respectively Tightening screw: 8ea

- These optional fixing brackets are processed trivalent chromium plating. (Surface color: Blue-silver/ different from body color.)
- For RS2□10/15, back side fixing brackets are able to move front side.

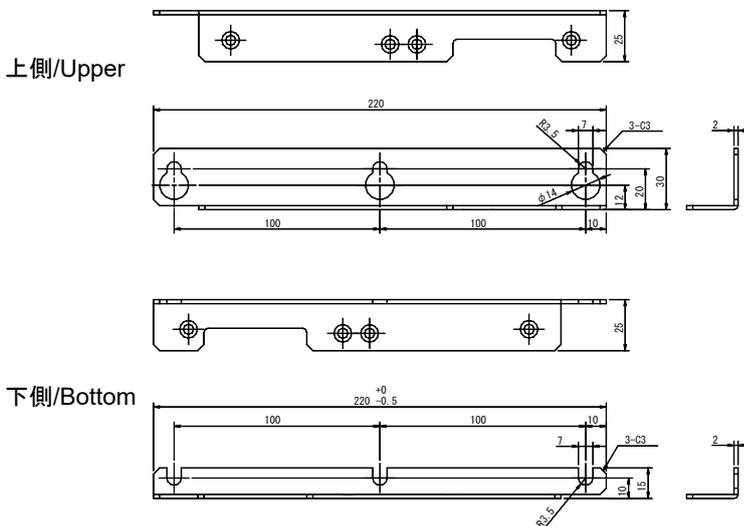
AL-00736863-01



AL-00736864-01



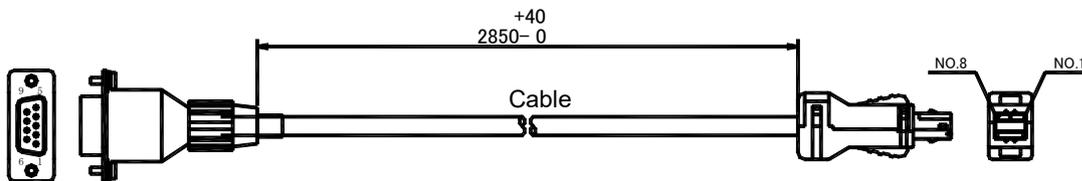
AL-00828413-01



6) Setup software and serial communication-related parts

Connector NO.	Name	Contents	Qty.	SANYO DENKI model NO.
CN4	Cable for communication with PC	PC-servo amplifier	1	AL-00689703-01

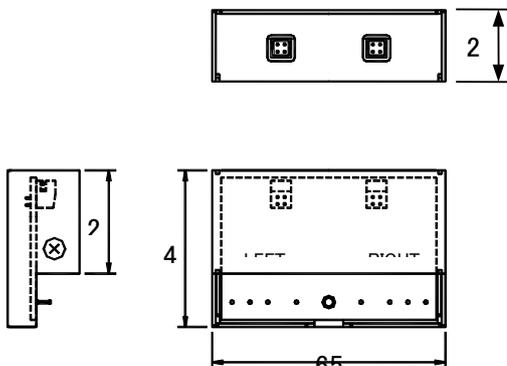
Outline dimensional drawing of cable for communication with PC (Model number: AL-00689703-01)



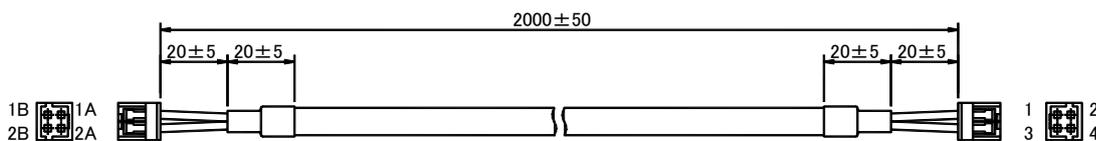
7) Dedicated cable, exclusive to monitor box for analog monitor

Connector NO.	Name	Contents	Set qty.	SANYO DENKI model NO.
CN5	Monitor box	Monitor box unit	1	Q-MON-3
-	Dedicated cable	2 dedicated cables	1	AL-00690525-01

- Outline dimensional drawing of monitor box (Model number: Q-MON-3)



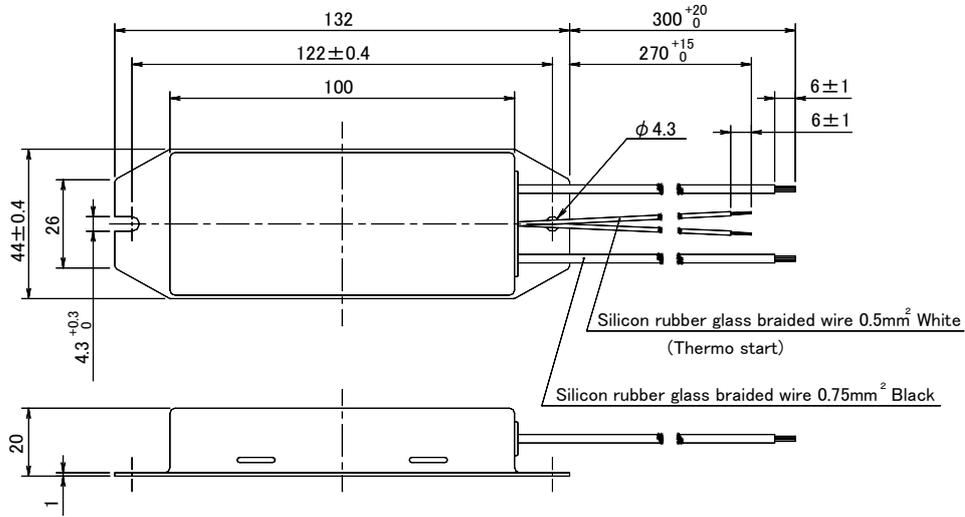
- Outline dimensional drawing of dedicated cable (Model number: AL-00690525-01)



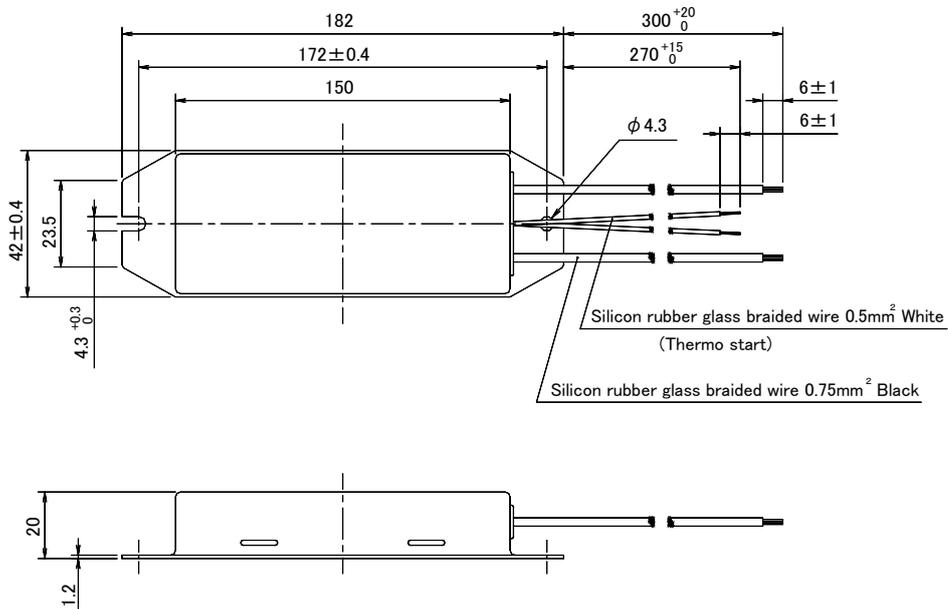
- ✓ Monitor box is supplied with two dedicated cables (model number: AL-00690525-01 in the above 2), exclusive to monitor box (model number: Q-MON-3).

### 16.7 Outline dimension of regenerative resistor

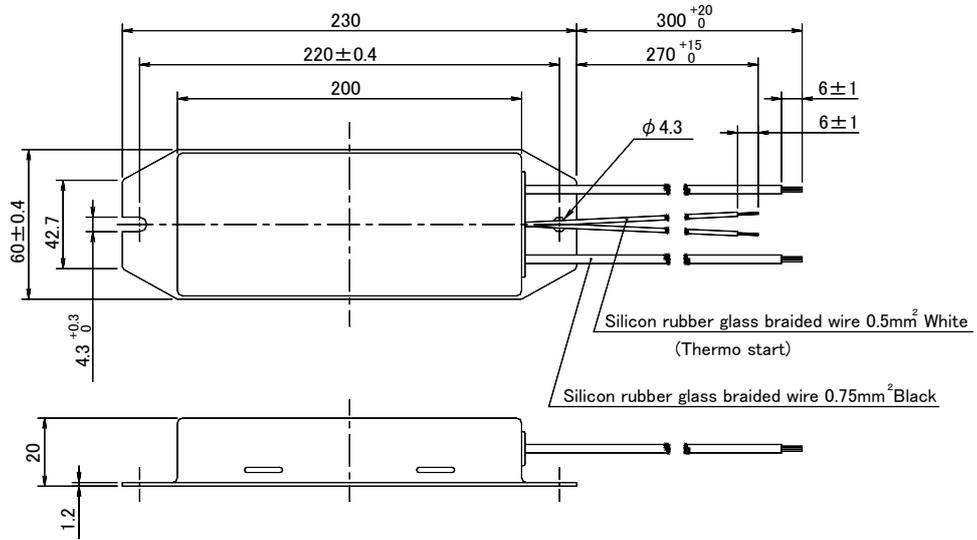
■ REGIST-080W



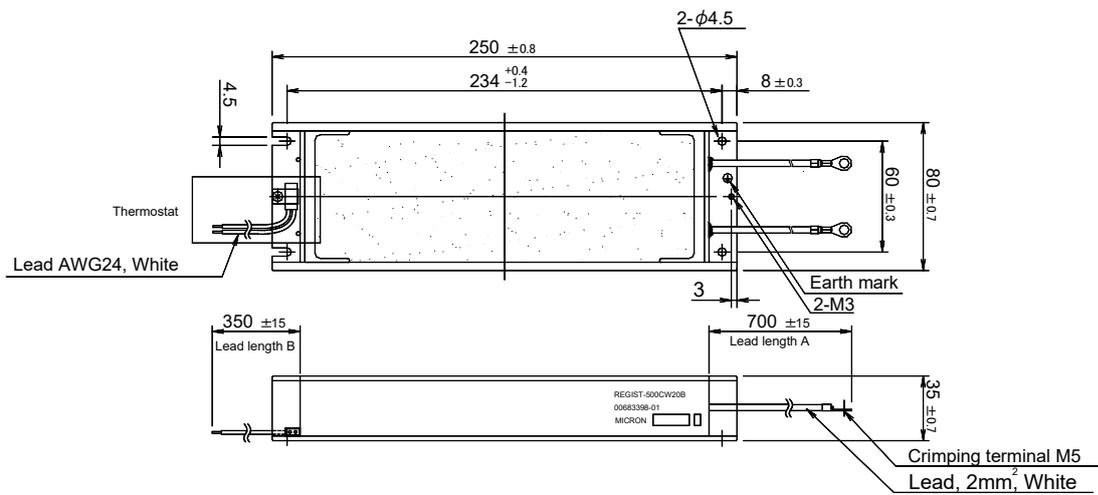
■ REGIST-120W



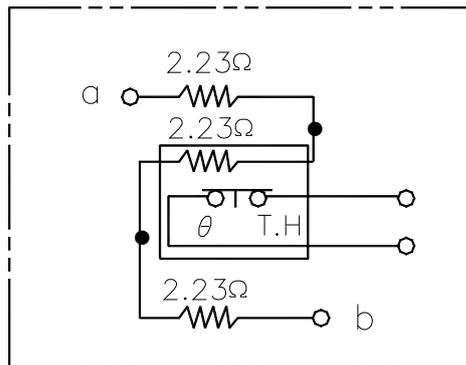
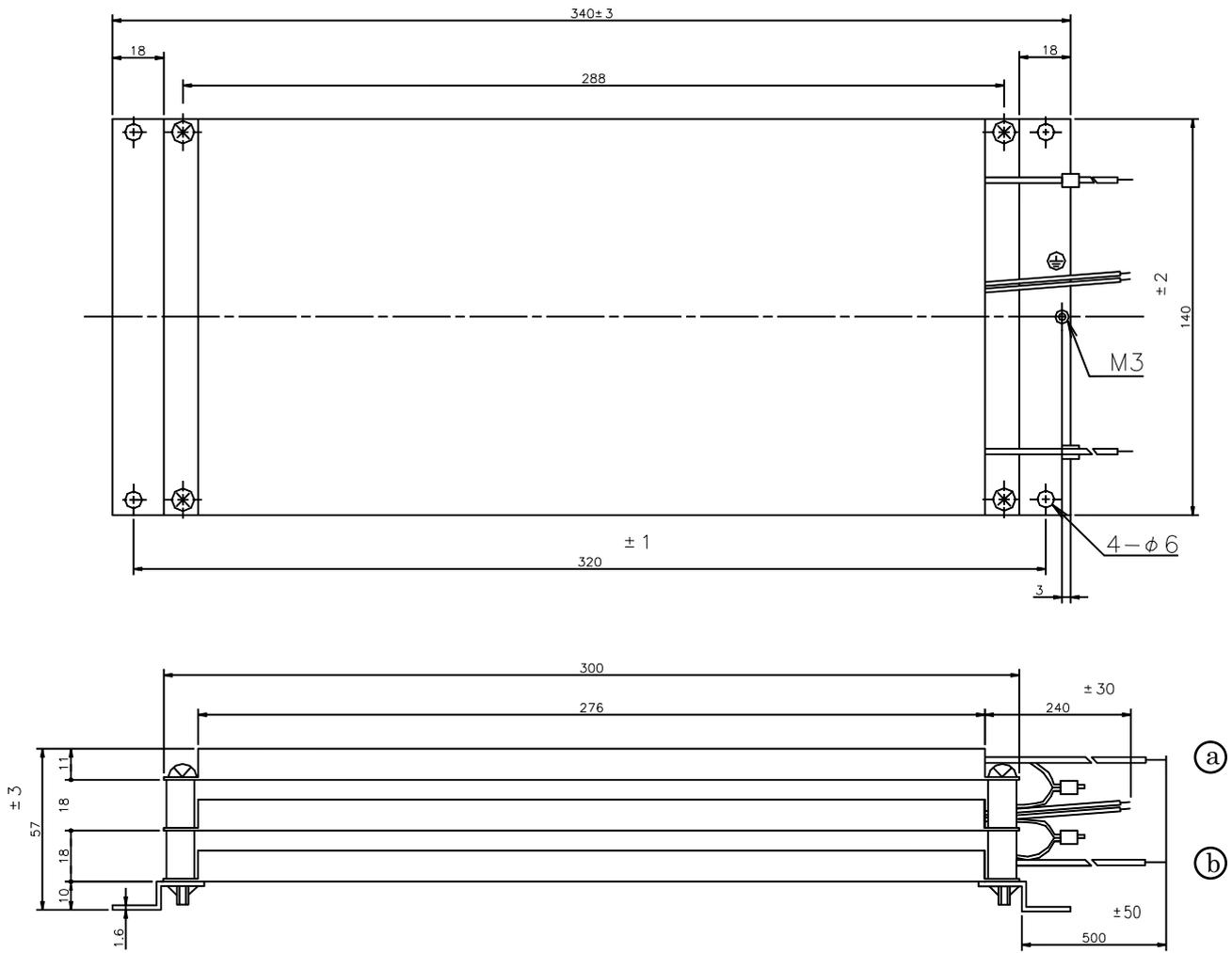
■ REGIST-220W



■ REGIST-500CW



■ REGIST-1000W



Connection wiring diagram

## 16.8 Explanation of EtherCAT Terms and Abbreviations

### [-A-]

ADR	Address
ADS	Automation Device Specification (Beckhoff)
AL	Application Layer
APRD	Auto Increment Physical Read
APWR	Auto Increment Physical Write
APRW	Auto Increment Physical ReadWrite
ARMW	Auto Increment Physical Read Multiple Write
AoE	Automation Device Specification over EtherCAT
ASIC	Application Specific Integrated Chip
Auto Crossover	Automatic detection of whether or not the send and receive lines are crossed.
Auto Negotiation	Automatic negotiation of transmission speeds between two stations.
Avalon	On-chip bus for Altera FPGAs

### [-B-]

Big Endian	Data format (also Motorola format). The more significant byte is transferred first when a word is transferred. However, for EtherCAT the least significant bit is the first on the wire.
BOOT	BOOT state of EtherCAT state machine
Boundary Clock	A station that is synchronized by another station and then passes this information on.
Bridge	A term for switches used in standards. Bridges are devices that pass on messages based on address information.
Broadcast	An unacknowledged transmission to an unspecified number of receivers.
BRD	Broadcast Read
BWR	Broadcast Write
BRW	Broadcast ReadWrite

### [-C-]

Cat	Category - classification for cables that is also used in Ethernet. Cat 5 is the minimum required category for EtherCAT. However, Cat 6 and Cat 7 cables are available.
CoE	CANopen over EtherCAT
Communication Stack	A communication software package that is generally divided into successive layers, which is why it is referred to as a stack.
Confirmed	Means that the initiator of a service receives a response.
CRC	Cyclic Redundancy Check, used for FCS
Cut Through	Procedure for cutting directly through an Ethernet frame by a switch before the complete message is received.
Cycle	Cycle in which data is to be exchanged in a system operating on a periodical basis.
CiA	CAN in Automation
COB	Communication Object
Csp	Cyclic Synchronous Profile mode
Cst	Cyclic Synchronous Torque mode
Csv	Cyclic Synchronous Velocity mode

### [-D-]

DC	Distributed Clocks      Mechanism to synchronize EtherCAT slaves and master
Delay	Delays can be caused by run-times during transfer or internal delays of a network component.
Dest Addr	Destination address of a message (the destination can be an individual network station or a group (multicast)).
DHCP	Dynamic Host Configuration Protocol, used to assign IP addresses (and another important startup parameter in the Internet context).
DL	Data Link Layer, also known as Layer 2. EtherCAT uses the Data Link Layer of Ethernet, which is standardized as IEEE 802.3.

DNS	Domain Name Service, a protocol for domain name to IP addresses resolution.
Distributed Clocks (DC)	Synchronizing method for slaves' global time base. DC makes an accurate synchronization possible between output signals and input cycles and then transfers the entire process to the EtherCAT network.
<b>[-E-]</b>	
EBUS	Based on LVDS (Low Voltage Differential Signaling) standard specified in ANSI/TIA/EIA-644-1995
ECAT	EtherCAT
EEPROM	Electrically Erasable Programmable Read Only Memory. Non-volatile memory used to store ESC configuration and device description. Connected to the SII.
EMC	Electromagnetic Compatibility, describes the robustness of a device with regard to electrical interference from the environment.
EMI	Electromagnetic Interference
Engineering	Here: All applications required to configure and program a machine.
EoE	Ethernet over EtherCAT
EOF	End of Frame
ERR	Error indicator for AL state
Err(x)	Physical Layer RX Error LED for debugging purposes
ESC	EtherCAT Slave Controller
ESM	EtherCAT State Machine
ETG	EtherCAT Technology Group ( <a href="http://www.ethercat.org">http://www.ethercat.org</a> )
EtherCAT	Real-time Standard for Industrial Ethernet Control Automation Technology (Ethernet for Control Automation Technology)
EtherType	Identification of an Ethernet frame with a 16-bit number assigned by IEEE. For example, IP uses EtherType 0x0800 (hexadecimal) and the EtherCAT protocol uses 0x88A4.
EPU	EtherCAT Processing Unit. The logic core of an ESC containing e.g. registers, memory, and processing elements.
<b>[-F-]</b>	
Fast Ethernet	Ethernet with a transmission speed of 100 Mbit/s.
FMMU	Fieldbus Memory Management Unit
FSA	Finite State Automaton
Labeled directed graph	with start and stop node.
FSoE	Safety over EtherCAT
FCC	Federal Communications Commission
FCS	Frame Check Sequence
FIFO	First In, First Out
Firewall	Routers or other network component that acts as a gateway to the Internet and enables protection from unauthorized access.
FMMU	Fieldbus Memory Management Unit
FoE	File access over EtherCAT
Follow Up	Message that follows Sync and indicates when the Sync frame was sent from the last node (defined in IEEE 1588).
FPGA	Field Programmable Gate Array
FPRD	Configured Address Physical Read
FPWR	Configured Address Physical Write
FPRW	Configured Address Physical ReadWrite
FRMW	Configured Address Physical Read Multiple Write
Frame	See PDU
FTP	File Transfer Protocol
<b>[-G-]</b>	
Get	Access method used by a client to read data from a device.
GND	Ground
GPI	General Purpose Input
GPO	General Purpose Output

<b>[-H-]</b>	
HW	Hardware
HDR	Header
HNI	Human Machine Interface
<b>[-I-]</b>	
I/O	Input/Output
I2C	Inter-Integrated Circuit, serial bus used for EEPROM connection to the ESC
ICMP	Internet Control Message Protocol: Mechanisms for signaling IP errors.
IEC	International Electro technical Commission
IEEE	Institute of Electrical and Electronics Engineers
INIT	INIT state of EtherCAT state machine
Interval	Time span
IP	Internet Protocol: Ensures transfer of data on the Internet from end node to end node. Intellectual Property
IRQ	Interrupt Request
ISO	International Standard Organization
ISO/OSI Model	ISO Open Systems Interconnection Basic Reference Model (ISO 7498): describes the division of communication into 7 layers.
IT	Information Technology: Devices and methods required for computer-aided information processing.
<b>[-L-]</b>	
LED	Light Emitting Diode, used as an indicator
Link/Act	Link/Activity Indicator (LED)
Little Endian	Data format (also Intel format). The less significant byte is transferred first when a word is transferred. With EtherCAT, the least significant bit is the first on the wire.
LLDP	Lower Layer Discovery Protocol - provides the basis for topology discovery and configuration definition (see IEEE802.1ab)
LRD	Logical Read
LWR	Logical Write
LRW	Logical ReadWrite
LVDS	Low Voltage Differential Signaling
<b>[-M-]</b>	
MAC	Media Access Control: Specifies station access to a communication medium. With full duplex Ethernet, any station can send data at any time; the orders of access and the response to overload are defined at the network component level (switches).
M12	Connector used for industrial Ethernet
MAC	Address Media Access Control Address: Also known as Ethernet address; used to identify an Ethernet node. The Ethernet address is 6 bytes long and is assigned by the IEEE.
Mandatory Services	Mandatory services, parameters, objects, or attributes. These must be implemented by every station.
MBX	Mailbox
MDI	Media Dependant Interface: Use of connector Pins and Signaling (PC side)
MDI-X	Media Dependant Interface (crossed): Use of connector Pins and Signaling with crossed lines (Switch/hub side)
Memory	The RS2 EtherCAT slave amplifier can have an address space of up to 12Kbyte. The first block of 4 Kbytes (0x0000-0x0FFF) is used for registers and user memory. The memory space of 8 Kbytes (0x1000-0x2FFF) of the remainder is used as the process memory. The ESC address range is directly addressable by the EtherCAT master and slave's $\mu$ Controller.
MI	(PHY) Management Interface
MII	Media Independent Interface: Standardized interface between the Ethernet MAC and PHY.
Multicast	Transmission to multiple destination stations with a frame - generally uses a special

address.

### [-N-]

Node	Single DL-entity as it appears on one local link
NMT	Network-Management: One of the service elements in application layers defined in the CAN reference model. Manages CAN network settings, initialization and errors.
Node-ID	Node identification number to be assigned to respective NMT slaves.
NOP	No Operation
NVRAM	Non-Volatile Random Access Memory e.g. EEPROM or Flash.

### [-O-]

Octet	Term from IEC 61158 - one octet comprises exactly 8 bits.
OP	Operational state of EtherCAT state machine
OPB	On-Chip Peripheral Bus
Optional Service	Optional services can be fulfilled by a PROFINET station in addition to the mandatory services.
OSI	Open System Interconnect
OUI	Organizationally Unique Identifier - are the first 3 Bytes of an Ethernet-Address, that will be assign to companies or organizations and can be used for protocol identifiers as well (e.g. LLDP)

### [-P-]

PDS	Power Drive Systems
Process data	Process for the purpose of processing data objects, including the application object that is designed to transmit periodically or non-periodically.
PDI	Process Data Interface or Physical Device Interface: an interface that allows access to ESC from the process side.
PDO	Process Data Object
PDU	Protocol Data Unit: Contains protocol information (Src Addr, Dest Addr, Checksum and service parameter information) transferred from a protocol instance of transparent data to a subordinate level (the lower level contains the information being transferred).
PE	Protection Earth
PHY	Physical layer device that converts data from the Ethernet controller to electric or optical signals.
PHY Management	PHY Management Unit: Communicates with Ethernet PHY through MII Management Interface and is used in either master or slave. MII is used in ESC itself to restart auto-negotiation after reception error of enhanced link detection mechanism.
Ping	Frame that verifies whether the partner device is still available.
PLL	Phase Locked Loop
PREOP	Pre-Operational state of EtherCAT state machine
Preamble	Preamble: In Ethernet data communication, a 64bit data field that contains a synchronization pattern consisting of alternating 1s and 0s ending with two consecutive 1s is sent from the source node to the destination node to pre-notify frame transmission to the other nodes and is called the Preamble. The destination node finds the beginning of the frame with these last two consecutive 1s.
Protocol	Rules for sequences - here, also the sequences (defined in state machines) and frame structures (described in encoding) of communication processes.
Provider	Device that sends data to other consumers in the form of a broadcast message.
PTP	Precision Time Protocol in accordance with IEEE 1588: Precise time synchronization procedures.
PTP Master	Indicates time in a segment.
PTP Slave	Station synchronized by a PTP master.

### [-Q-]

Quad Cable	Cable types in which the two cable pairs are twisted together. This strengthens the electromagnetic resistance.
------------	---

## 【-R-】

RAM	Random Access Memory. ESC have User RAM and Process Data RAM.
Read	Service enabling read access to an I/O device.
Real-Time	Real-time capability of a system to perform a task within a specific time.
Request	Call of a service in the sender/client.
Response	Response to a service on the client side.
Reset	Reset controller monitors the supply voltage to control the external and internal reset.
RJ45	FCC Registered Jack, standard Ethernet connector (8P8C)
RMII	Reduced Media Independent Interface
Router	Network component acting as a gateway based on the interpretation of the IP address.
RSTP	Rapid Spanning Tree Protocol: Prevents packet from looping infinitely between switches; RSTP is specified in IEEE 802.1 D (Edition 2004)
RT	Real-time. Name for a real-time protocol that can be run in Ethernet controllers without special support.
RTC	Real-time Clock chip of PCs
RT Frames	EtherCAT Messages with Ether Type 0x88A4.
RX	Receive
RXPDO	Receive PDO, i.e. Process Data that will be received by ESC10/20

## 【-S-】

SDO	Service-Data-Object: One-to-One communication access between object dictionary and device.
SAFEOP	Safe-Operational state of EtherCAT state machine
Safety	Safety function, implemented by an electric, electronic programmable fail-safe system that maintains the equipment in a safe state, even during certain critical external events.
Schedule	Determines what should be transferred and when.
Services	Interaction between two components to fulfill a specific task.
Set	Access method used by a client to write data to a server.
SII	Slave Information Interface
SII EEPROM	NVRAM (I2C EEPROM) is generally required for ESC configuration and device description. Status block provides ESC and application information.
SIL	Safety Integrity Level
SM (SyncManager)	SM coordinates mailbox communication and data exchange compatibility between EtherCAT master and slaves. Communication direction can be set respective in respective SM.
SNMP	Simple Network Management Protocol: SNMP is the standard Internet protocol for management and diagnostics of network components (see also RFC 1157 and RFC 1156 at <a href="http://www.ietf.org">www.ietf.org</a> ).
SoE	Servo Profile over EtherCAT
SOF	Start of Frame: Ethernet SOF delimiter at the end of the preamble of Ethernet frames
SPI	Serial Peripheral Interface
Src Addr	Source Address: Source address of a message.
Store and Forward	Currently the common operating mode in switches. Frames are first received in their entirety, the addresses are evaluated, and then they are forwarded. This result in considerable delays, but guarantees that defective frames are not forwarded, causing an unnecessary increase in the bus load.
STP	Shielded Twisted Pair: Shielded cable with at least 2 core pairs to be used as the standard EtherCAT cable.
Subnet Mask	Divides the IP address into two parts: a subnet address (in an area separated from the rest by routers) and a network address.
Switch	Also known as Bridge. Active network component to connect different EtherCAT participants with each other. A switch only forwards the frames to the addressed participants.
SyncManager	ESC unit for coordinated data exchange between master and slave uController
SyncSignal	Signal generated by the Distributed Clocks unit

**[-T-]**

TCP	Transmission Control Protocol: Higher-level IP protocol that ensures secure data exchange and flow control.
TX	Transmit
TXPDO	Transmit PDO, i.e. Process Data that will be transmitted by ESC10/20

**[-U-]**

UDP	User Datagram Protocol: Non-secure multicast/broadcast frame.
UTP	Unshielded Twisted Pair: Unshielded cable with at least 2 core pairs are not recommended for industrial purpose but are commonly used in areas with low electro-magnetic interference.

**[-V-]**

VLAN	Virtual LAN
VoE	Vendor specific profile over EtherCAT

**[-W-]**

WD	Watchdog
WKC	Working Counter

**[-X-]**

XML	Extensible Markup Language: Standardized definition language that can be interpreted by nearly all parsers.
XML Parser	Program for checking XML schemas.

**[Other]**

μC	Microcontroller
Auto Forwarder	receives Ethernet frames. Checks frames and transfers to Loopback function. Time stamp of received frame is created by Auto Forwarder.
Loopback Function	Transfers Ethernet frames to the next port when the port has no link, port is invalid and/or loop is closed at that port. Loopback function at Port 0 transfers frames to EtherCAT processing unit. Loop setting can be controlled in EtherCAT master.
Monitoring Unit	Equipped with Error counter and Watchdog. Watchdog monitors communication and returns safe state upon error occurrence. Error counter detects and analyzes errors.

## R ADVANCED MODEL EtherCAT Interface Amplifier (RS2 type H) Combination motor code list

Below shows servo motor list settable with Object Index: 0x20FE.  
Shaded items are standard combination motor.

■ Rotary Motor (200V)							
Series	Motor code	Motor model name	Input type	Amplifier capacity	Flange size	Output	Highest speed
R1 Series	0x010E	R1AA1815KB	200 VAC	300A	180 mm sq.	15kW	2,000 min <sup>-1</sup>
	0x010F	R1AA18750L	200 VAC	300A	180 mm sq.	7.5kW	3,000 min <sup>-1</sup>
	0x0109	R1AA18550H	200 VAC	300A	180 mm sq.	5.5kW	3,000 min <sup>-1</sup>
	0x010D	R1AA1811KR	200 VAC	300A	180 mm sq.	11kW	2,500 min <sup>-1</sup>

■ Rotary Motor (200V)							
Series	Motor code	Motor model name	Input type	Amplifier capacity	Flange size	Output	Highest speed
R2 Series	0x0181	R2AA04003F	200 VAC	15A	40 mm sq.	30W	6,000 min <sup>-1</sup>
	0x7181	R2AA04003F	200 VAC	30A	40 mm sq.	30W	6,000 min <sup>-1</sup>
	0x0182	R2AA04005F	200 VAC	15A	40 mm sq.	50W	6,000 min <sup>-1</sup>
	0x2182	R2AA04005F	200 VAC	15A	40 mm sq.	50W	6,000 min <sup>-1</sup>
	0x0183	R2AA04010F	200 VAC	15A	40 mm sq.	100W	6,000 min <sup>-1</sup>
	0x2183	R2AA04010F	200 VAC	15A	40 mm sq.	100W	6,000 min <sup>-1</sup>
	0x0184	R2AA06010F	200 VAC	15A	60 mm sq.	100W	6,000 min <sup>-1</sup>
	0x0185	R2AA06020F	200 VAC	15A	60 mm sq.	200W	6,000 min <sup>-1</sup>
	0x7185	R2AA06020F	200 VAC	30A	60 mm sq.	200W	6,000 min <sup>-1</sup>
	0x0186	R2AA06040F	200 VAC	30A	60 mm sq.	400W	6,000 min <sup>-1</sup>
	0x1186	R2AA06040F	200 VAC	15A	60 mm sq.	400W	6,000 min <sup>-1</sup>
	0x0187	R2AA08075F	200 VAC	30A	80 mm sq.	750W	6,000 min <sup>-1</sup>
	0x01B1	R2AAB8075F	200 VAC	50A	86 mm sq.	750W	6,000 min <sup>-1</sup>
	0x0188	R2AA08040F	200 VAC	30A	80 mm sq.	400W	6,000 min <sup>-1</sup>
	0x0189	R2AA06040H	200 VAC	15A	60 mm sq.	400W	3,000 min <sup>-1</sup>
	0x018A	R2AA08020F	200 VAC	15A	80 mm sq.	200W	6,000 min <sup>-1</sup>
	0x018C	R2AA13050D	200 VAC	30A	130 mm sq.	500W	5,000 min <sup>-1</sup>
	0x018D	R2AA13120D	200 VAC	50A	130 mm sq.	1.2kW	5,000 min <sup>-1</sup>
	0x018E	R2AA13120L	200 VAC	50A	130 mm sq.	1.2kW	5,000 min <sup>-1</sup>
	0x118E	R2AA13120L	200 VAC	30A	130 mm sq.	1.2kW	3,000 min <sup>-1</sup>
	0x018F	R2AA13050H	200 VAC	30A	130 mm sq.	550W	3,500 min <sup>-1</sup>
	0x718F	R2AA13050H	200 VAC	50A	130 mm sq.	550W	3,500 min <sup>-1</sup>
	0x0190	R2AA13200D	200 VAC	100A	130 mm sq.	2.0kW	5,000 min <sup>-1</sup>
	0x0191	R2AA13120B	200 VAC	30A	130 mm sq.	1.2kW	2,000 min <sup>-1</sup>
	0x0119	R2AA13180M	200 VAC	50A	130 mm sq.	1.8kW	4,000 min <sup>-1</sup>
	0x11B2	R2AA13200F	200 VAC	100A	130 mm sq.	2.0kW	4,500 min <sup>-1</sup>
	0x0192	R2AA13200L	200 VAC	50A	130 mm sq.	2.0kW	3,000 min <sup>-1</sup>
	0x0193	R2AAB8100F	200 VAC	50A	86 mm sq.	1.0kW	6,000 min <sup>-1</sup>
	0x0194	R2AAB8100H	200 VAC	30A	86 mm sq.	1.0kW	3,000 min <sup>-1</sup>
	0x04A8	R2AAB8100B	200 VAC	50A	86 mm sq.	1.0kW	2000 min <sup>-1</sup>
	0x0195	R2AA22500L	200 VAC	150A	220 mm sq.	5.0kW	4,000 min <sup>-1</sup>
	0x1195	R2AA22500L	200 VAC	100A	220 mm sq.	5.0kW	4,000 min <sup>-1</sup>
	0x0196	R2AA22350L	200 VAC	100A	220 mm sq.	3.5 kW	4,000 min <sup>-1</sup>
	0x019E	R2AA10100F	200 VAC	50A	100 mm sq.	1.0Kw	6,000 min <sup>-1</sup>
	0x019F	R2AA10075F	200 VAC	30A	100 mm sq.	750W	6,000 min <sup>-1</sup>
	0x01B6	R2AA13180H	200 VAC	50A	130 mm sq.	1.8kW	3,500 min <sup>-1</sup>
	0x01B8	R2AA18550R	200 VAC	150A	180 mm sq.	5.5kW	2,500 min <sup>-1</sup>
	0x01B9	R2AA18750H	200 VAC	300A	180 mm sq.	7.5kW	3,000 min <sup>-1</sup>
	0x01BA	R2AA18750A	200 VAC	150A	180 mm sq.	6.4kW	1,300 min <sup>-1</sup>
	0x011B	R2AA13180D	200 VAC	100A	130 mm sq.	1.8kW	5,000 min <sup>-1</sup>
	0x011C	R2AA18350L	200 VAC	100A	180 mm sq.	3.5kW	3,000 min <sup>-1</sup>
	0x011D	R2AA18350D	200 VAC	150A	180 mm sq.	3.5kW	4,000 min <sup>-1</sup>
0x011E	R2AA18450H	200 VAC	150A	180 mm sq.	4.5kW	3,500 min <sup>-1</sup>	
0x011F	R2AA18550H	200 VAC	300A	180 mm sq.	5.5kW	3,000 min <sup>-1</sup>	
0x0120	R2AA1811KR	200 VAC	300A	180 mm sq.	11kW	2,500 min <sup>-1</sup>	
0x51B9	R2AA18750H	200 VAC	300A	180 mm sq.	7.5kW	3,000 min <sup>-1</sup>	
0x7183	R2AA04010F	200 VAC	30A	40 mm sq.	100W	6,000 min <sup>-1</sup>	

■ Rotary Motor (200V)							
Series	Motor code	Motor model name	Input type	Amplifier capacity	Flange size	Output	Highest speed
R2 Series	0x01BC	R2AA18350M	200 VAC	50A	180 mm sq.	2.7kW	1,500min <sup>-1</sup>
	0x01BD	R2AA10100H	200 VAC	30A	100 mm sq.	1kW	3,000 min <sup>-1</sup>
	0x02BC	R2AA2215KR	200 VAC	300A	220 mm sq.	15kW	2,250 min <sup>-1</sup>
	0x0483	R2AA2211KB	200 VAC	300A	220 mm sq.	11kW	2,000 min <sup>-1</sup>
	0x0484	R2AA22700S	200 VAC	150A	220 mm sq.	7kW	1,000 min <sup>-1</sup>
	0x0488	R2AC23220H	200 VAC	300A		※	
	0x0493	R2AA18550M	200 VAC	100A	180 mm sq.	5.5kW	1,500 min <sup>-1</sup>
	0x01B7	R2AAB8075H	200 VAC	30A	86 mm sq.	750W	3,000 min <sup>-1</sup>
	0x0117	R2AA2215KB	200 VAC	300A	220 mm sq.	15kW	2,000 min <sup>-1</sup>
	0x0111	R2AA18750M	200 VAC	150A	180 mm sq.	7.5kW	1,500 min <sup>-1</sup>
0x011A	R2AA10150H	200 VAC	50A		※		

※: Motor model number is not registered.

■ Rotary Motor (200V)							
Series	Motor code	Motor model name	Input type	Amplifier capacity	Flange size	Output	Highest speed
R5 Series	0x049D	R5AA06020H	200 VAC	15A	60 mm sq.	200W	3,000 min <sup>-1</sup>
	0x049E	R5AA06020F	200 VAC	15A	60 mm sq.	200W	6,000 min <sup>-1</sup>
	0x049F	R5AA06040H	200 VAC	15A	60 mm sq.	200W	3,000 min <sup>-1</sup>
	0x02BA	R5AA08075D	200 VAC	30A	80 mm sq.	750W	5,000 min <sup>-1</sup>
	0x02BB	R5AA06040F	200 VAC	30A	60 mm sq.	400W	6,000 min <sup>-1</sup>
	0x04A0	R5AA08075F	200 VAC	30A	80 mm sq.	750W	6,000 min <sup>-1</sup>

■ Rotary Motor (200V)							
Series	Motor code	Motor model name	Input type	Amplifier capacity	Flange size	Output	Highest speed
Q1 Series	0x0043	Q1AA04010D	200 VAC	15A	40 mm sq.	100W	5,000 min <sup>-1</sup>
	0x2043	Q1AA04010D	200 VAC	15A	40 mm sq.	100W	5,000 min <sup>-1</sup>
	0x0046	Q1AA07075D	200 VAC	30A	76 mm sq.	750W	5,000 min <sup>-1</sup>
	0x0047	Q1AA10100D	200 VAC	50A	100 mm sq.	1.0W	5,000 min <sup>-1</sup>
	0x0048	Q1AA10150D	200 VAC	50A	100 mm sq.	1.5kW	4,500 min <sup>-1</sup>
	0x0049	Q1AA10200D	200 VAC	100A	100 mm sq.	2.0kW	5,000 min <sup>-1</sup>
	0x004A	Q1AA10250D	200 VAC	100A	100 mm sq.	2.5kW	5,000 min <sup>-1</sup>
	0x004B	Q1AA12100D	200 VAC	50A	120 mm sq.	1.0W	5,000 min <sup>-1</sup>
	0x004C	Q1AA12200D	200 VAC	100A	120 mm sq.	2.0kW	5,000 min <sup>-1</sup>
	0x004D	Q1AA12300D	200 VAC	100A	120 mm sq.	3.0kW	5,000 min <sup>-1</sup>
	0x504E	Q1AA13300D	200 VAC	100A	130 mm sq.	3.0kW	4,500 min <sup>-1</sup>
	0x004F	Q1AA13400D	200 VAC	150A	130 mm sq.	4.0kW	4,500 min <sup>-1</sup>
	0x0050	Q1AA13500D	200 VAC	150A	130 mm sq.	5.0kW	4,500 min <sup>-1</sup>
	0x0051	Q1AA18450M	200 VAC	150A	180 mm sq.	4.5kW	1,500 min <sup>-1</sup>
	0x0052	Q1AA18750H	200 VAC	300A	180 mm sq.	7.5kW	3,000 min <sup>-1</sup>
	0x0058	Q1AA13500H	200 VAC	150A	130 mm sq.	5.0kW	3,000 min <sup>-1</sup>
	0x00A8	Q1AC06040V	200 VAC	30A	60 mm sq.	400W	8,000 min <sup>-1</sup>

■ Rotary Motor (200V)							
Series	Motor code	Motor model name	Input type	Amplifier capacity	Flange size	Output	Highest speed
Q2 Series	0x0061	Q2AA04006D	200 VAC	15A	42 mm sq.	60W	5,000 min <sup>-1</sup>
	0x0062	Q2AA04010D	200 VAC	15A	42 mm sq.	100W	5,000 min <sup>-1</sup>
	0x0065	Q2AA05020D	200 VAC	15A	54 mm sq.	200W	5,000 min <sup>-1</sup>
	0x006A	Q2AA08050D	200 VAC	30A	86 mm sq.	500W	5,000 min <sup>-1</sup>
	0x006B	Q2AA08075D	200 VAC	50A	86 mm sq.	750W	5,000 min <sup>-1</sup>
	0x106C	Q2AA08100D	200 VAC	30A	86 mm sq.	1.0kW	5,000 min <sup>-1</sup>
	0x006C	Q2AA08100D	200 VAC	50A	86 mm sq.	1.0kW	5,000 min <sup>-1</sup>
	0x006D	Q2AA10100H	200 VAC	50A	100 mm sq.	1.0kW	3,500 min <sup>-1</sup>
	0x00B3	Q2AA10150V	200 VAC	50A	100 mm sq.	1.5kW	3,400 min <sup>-1</sup>
	0x00DD	Q2AA10150H	200 VAC	30A	100 mm sq.	1.5kW	3,000 min <sup>-1</sup>
	0x006F	Q2AA13050H	200 VAC	30A	130 mm sq.	500W	3,500 min <sup>-1</sup>
	0x0070	Q2AA13100H	200 VAC	50A	130 mm sq.	1.0kW	3,000 min <sup>-1</sup>
	0x0071	Q2AA13150H	200 VAC	50A	130 mm sq.	1.5kW	3,500 min <sup>-1</sup>
	0x0072	Q2AA13200H	200 VAC	100A	130 mm sq.	2.0kW	3,500 min <sup>-1</sup>
	0x00E0	Q2AA13300B	200 VAC	100A	130 mm sq.	3.0kW	2,000 min <sup>-1</sup>
	0x0073	Q2AA18200H	200 VAC	100A	180 mm sq.	2.0kW	3,000 min <sup>-1</sup>
	0x0074	Q2AA18350H	200 VAC	150A	180 mm sq.	3.5kW	3,500 min <sup>-1</sup>
	0x0075	Q2AA18450H	200 VAC	150A	180 mm sq.	4.5kW	3,000 min <sup>-1</sup>
	0x0076	Q2AA18550R	200 VAC	150A	180 mm sq.	5.5kW	2,500 min <sup>-1</sup>
	0x007A	Q2AA22550B	200 VAC	150A	220 mm sq.	5.5kW	2,000 min <sup>-1</sup>
	0x007B	Q2AA22700S	200 VAC	150A	220 mm sq.	7.0kW	1,000 min <sup>-1</sup>
	0x00CA	Q2AA08075H	200 VAC	30A	86 mm sq.	750W	3,000 min <sup>-1</sup>
	0x00CB	Q2AA08100H	200 VAC	30A	86 mm sq.	1.0kW	3,000 min <sup>-1</sup>

■ Rotary Motor (200V)							
Series	Motor code	Motor model name	Input type	Amplifier capacity	Flange size	Output	Highest speed
Q2 Series	0x00D5	Q2AA18550H	200 VAC	300A	180 mm sq.	5.5kW	3,000 min <sup>-1</sup>
	0x00D6	Q2AA18750L	200 VAC	300A	180 mm sq.	7.5kW	3,000 min <sup>-1</sup>
	0x00D8	Q2AA2211KV	200 VAC	300A	220 mm sq.	11.0kW	2,000 min <sup>-1</sup>
	0x00D9	Q2AA2215KV	200 VAC	300A	220 mm sq.	13kW	2,000 min <sup>-1</sup>
	0x00F7	Q2AA18750A	200 VAC	150A	180 mm sq.	6.8kW	1250 min <sup>-1</sup>

■ Rotary Motor (200V)							
Series	Motor code	Motor model name	Input type	Amplifier capacity	Flange size	Output	Highest speed
Q4 Series	0x0121	Q4AA1811KB	200 VAC	300A	180 mm sq.	11kW	2,000 min <sup>-1</sup>
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■ Rotary Motor (200V)							
Series	Motor code	Motor model name	Input type	Amplifier capacity	Flange size	Output	Highest speed
P Series	0x100C	P10B13150B	200 VAC	30A	130 mm sq.	1.5kW	2,000 min <sup>-1</sup>
	0x000B	P10B13100B	200 VAC	30A	130 mm sq.	1.0kW	2,000 min <sup>-1</sup>
	0x000D	P10B18200B	200 VAC	50A	180 mm sq.	2.0kW	2,000 min <sup>-1</sup>
	0x002D	P20B13400H	200 VAC	100A	130 mm sq.	4.0kW	3,000 min <sup>-1</sup>
	0x02A7	P30B06010D	200 VAC	15A	60 mm sq.	100W	4,500 min <sup>-1</sup>
	0x020B	P30B06020D	200 VAC	15A	60 mm sq.	200W	5,000 min <sup>-1</sup>
	0x020A	P30B06008D	200 VAC	15A	60 mm sq.	80W	5,000 min <sup>-1</sup>
	0x02B0	P30B08040D	200 VAC	30A	80 mm sq.	400W	4,500 min <sup>-1</sup>
	0x021C	P50B02001D	200 VAC	15A	20 mm sq.	10W	5,000 min <sup>-1</sup>
	0x0278	P50B02002D	200 VAC	15A	20 mm sq.	20W	5,000 min <sup>-1</sup>
	0x0282	P50B04006D	200 VAC	15A	42 mm sq.	60W	4,500 min <sup>-1</sup>
	0x0283	P50B04010D	200 VAC	15A	42 mm sq.	100W	4,500 min <sup>-1</sup>
	0x0208	P50B05008D	200 VAC	15A	54 mm sq.	80W	4,500 min <sup>-1</sup>
	0x0286	P50B05020D	200 VAC	15A	54 mm sq.	200W	4,500 min <sup>-1</sup>
	0x0273	P50B05030K	200 VAC	50A	50 mm sq.	370W	10,000 min <sup>-1</sup>
	0x01F1	P50B07030D	200 VAC	15A	76 mm sq.	300W	4,500 min <sup>-1</sup>
	0x028A	P50B07040D	200 VAC	30A	76 mm sq.	400W	4,500 min <sup>-1</sup>
	0x0217	P50B08100H	200 VAC	30A	86 mm sq.	1kW	3,000 min <sup>-1</sup>
	0x028C	P50B08050D	200 VAC	30A	86 mm sq.	500W	4,500 min <sup>-1</sup>
	0x0270	P50B08056D	200 VAC	30A	86 mm sq.	560W	4,500 min <sup>-1</sup>
	0x027C	P50BA2004D	200 VAC	15A	28 mm sq.	40W	5,000 min <sup>-1</sup>
	0x0312	P60B13100H	200 VAC	30A	130 mm sq.	1.0kW	3,000 min <sup>-1</sup>
	0x02C1	P60B13100H	200 VAC	50A	130 mm sq.	1.0kW	3,000 min <sup>-1</sup>
	0x02C2	P60B13150H	200 VAC	50A	130 mm sq.	1.5kW	3,000 min <sup>-1</sup>
	0x02D2	P60B13200B	200 VAC	50A	130 mm sq.	2.0kW	2,000 min <sup>-1</sup>
	0x02D7	P60B18200B	200 VAC	50A	180 mm sq.	2.0kW	2,000 min <sup>-1</sup>
	0x72C5	P60B18200H	200 VAC	150A	180 mm sq.	2.0kW	3,000 min <sup>-1</sup>
	0x02DE	P60B2215KB	200 VAC	300A	220 mm sq.	15.0kW	2,000 min <sup>-1</sup>
	0x02DF	P60B13150B	200 VAC	50A	130 mm sq.	1.5kW	2,000 min <sup>-1</sup>
	0x0310	P60B13150B	200 VAC	30A	130 mm sq.	1.5kW	2,000 min <sup>-1</sup>
	0x02CF	P60B18350M	200 VAC	50A	180 mm sq.	2.7kW	1,500 min <sup>-1</sup>
	0x02E4	P80B22250H	200 VAC	100A	220 mm sq.	2.5kW	3,000 min <sup>-1</sup>
	0x030A	P60B22700M	200 VAC	150A	220 mm sq.	7.0kW	1,500 min <sup>-1</sup>
	0x32F3	P80C18050B	200 VAC	15A	180 mm sq.	270W	2,000 min <sup>-1</sup>
	0x02E9	P80B22350R	200 VAC	100A	220 mm sq.	3.5kW	2,500 min <sup>-1</sup>

■ Rotary Motor (100V)							
Series	Motor code	Motor model name	Input type	Amplifier capacity	Flange size	Output	Highest speed
R2 Series	0x0197	R2EA04003F	100 VAC	15A	40 mm sq.	30W	6,000 min <sup>-1</sup>
	0x0198	R2EA04005F	100 VAC	15A	40 mm sq.	50W	6,000 min <sup>-1</sup>
	0x019A	R2EA06010F	100 VAC	15A	60 mm sq.	100W	6,000 min <sup>-1</sup>
	0x019B	R2EA06020F	100 VAC	30A	60 mm sq.	200W	6,000 min <sup>-1</sup>
	0x019C	R2EA06008F	100 VAC	15A	60 mm sq.	80W	6,000 min <sup>-1</sup>
	0x019D	R2EA04008F	100 VAC	15A	40 mm sq.	80W	6,000 min <sup>-1</sup>

■ Rotary Motor (100V)							
Series	Motor code	Motor model name	Input type	Amplifier capacity	Flange size	Output	Highest speed
Q2 Series	0x00C1	Q2EA07020D	100 VAC	30A	76 mm sq.	200W	5,000 min <sup>-1</sup>
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■ Rotary Motor (48V)							
Series	Motor code	Motor model name	Input type	Amplifier capacity	Flange size	Output	Highest speed
R2 Series	0x040C	R2GAD102RM	48 VDC	25A	14 mm sq.	2.5W	1,500 min <sup>-1</sup>
	0x0261	R2GA04003F	48 VDC	40A	40 mm sq.	30W	6,000 min <sup>-1</sup>
	0x0262	R2GA04005F	48 VDC	40A	40 mm sq.	50W	6,000 min <sup>-1</sup>
	0x0263	R2GA04008D	48 VDC	40A	40 mm sq.	80W	5,000 min <sup>-1</sup>
	0x0264	R2GA06010D	48 VDC	40A	60 mm sq.	100W	5,000 min <sup>-1</sup>
	0x0265	R2GA06020D	48 VDC	40A	60 mm sq.	200W	4,500 min <sup>-1</sup>
	0x049B	R2GA02D20F	48 VDC	40A	20 mm sq.	30W	6,000 min <sup>-1</sup>
	0x0497	R2GA02D30F	48 VDC	40A	20 mm sq.	30W	6,000 min <sup>-1</sup>

■ Rotary Motor (24V)							
Series	Motor code	Motor model name	Input type	Amplifier capacity	Flange size	Output	Highest speed
R2 Series	0x018B	R2FA04003F	24 VDC	40A	40 mm sq.	30W	6,000 min <sup>-1</sup>
	0x0118	R2FA04005D	24 VDC	40A	40 mm sq.	50W	4,500min <sup>-1</sup>
	0x0116	R2FA04006R	24 VDC	40A	40 mm sq.	60W	3,000min <sup>-1</sup>
	0x0113	R2FA06009H	24 VDC	40A	60 mm sq.	90W	3,000min <sup>-1</sup>
	0x04A2	R2FA02D20D	24 VDC	40A	20 mm sq.	20W	4,500min <sup>-1</sup>
	0x0498	R2FA02D30H	24 VDC	40A	20 mm sq.	30W	3,000min <sup>-1</sup>

■ Rotary Motor (400V)							
Series	Motor code	Motor model name	Input type	Amplifier capacity	Flange size	Output	Highest speed
R2 Series	0x0136	R2CA13250H	400 VAC	50A	130 mm sq.	2.5kW	3,000 min <sup>-1</sup>
	0x1138	R2CA18450H	400 VAC	50A	180 mm sq.	4.5kW	3,000 min <sup>-1</sup>
	0x0139	R2CA2215KB	400 VAC	150A	220 mm sq.	15kW	2,000 min <sup>-1</sup>
	0x013A	R2CA2220KB	400 VAC	300A	220 mm sq.	20kW	2,300 min <sup>-1</sup>

■ Linear motor (200V)							
Series	Motor code	Motor model name	Input type	Amplifier capacity	Magnet width	Output	Highest speed
Linear motor	0x0343	DS030C1N2E	200 VAC	30A	30 mm	160N	5.5 m/s
	0x0344	DS030C2N2E	200 VAC	50A	30 mm	320N	5.5 m/s
	0x0346	DS030C3N2E	200 VAC	100A	30 mm	480N	5.5 m/s
	0x0347	DS050C1N2E	200 VAC	30A	50 mm	260N	3.5 m/s
	0x0348	DS050C2N2E	200 VAC	50A	50 mm	520N	3.5 m/s
	0x034A	DS050C3N2E	200 VAC	100A	50 mm	780N	3.5 m/s
	0x034C	DS075C1N2E	200 VAC	30A	75 mm	400N	2.4 m/s
	0x034F	DS075C2N2E	200 VAC	50A	75 mm	800N	2.4 m/s
	0x0349	DS075C3N2E	200 VAC	100A	75 mm	1200N	2.4 m/s
	0x0350	DS100C1N2E	200 VAC	50A	100 mm	540N	4.0 m/s
	0x0351	DS100C2N2E	200 VAC	100A	100 mm	1080N	4.0 m/s
	0x0352	DS100C3N2E	200 VAC	150A	100 mm	1620N	4.0 m/s
	0x0353	DS150C1N2E	200 VAC	50A	150 mm	800N	2.6 m/s
	0x0354	DS150C2N2E	200 VAC	100A	150 mm	1600N	2.6 m/s
	0x034D	DS150C3N2E	200 VAC	150A	150 mm	2400N	2.6 m/s
	0x03D2	DD030C1Y4E	200 VAC	50A	30 mm	630N	3.0 m/s
	0x03D3	DD030C2Y4E	200 VAC	100A	30 mm	1260N	3.0 m/s
	0x03D4	DD030C3Y4E	200 VAC	100A	30 mm	1890N	3.0 m/s
	0x03D5	DD050C1Y2E	200 VAC	100A	50 mm	1050N	3.0 m/s
	0x03D6	DD050C2Y2E	200 VAC	150A	50 mm	2100N	3.0 m/s
	0x03D9	DD050C3Y2E	200 VAC	300A	50 mm	3150N	3.0 m/s
	0x03DA	DD075C1Y2E	200 VAC	100A	75 mm	1600N	3.0 m/s
	0x03DB	DD075C2Y2E	200 VAC	150A	75 mm	3200N	3.0 m/s
0x03DC	DD075C3Y2E	200 VAC	300A	75 mm	4800N	3.0 m/s	
0x03DD	DD075C4Y2E	200 VAC	300A	75 mm	6400N	3.0 m/s	

■ Linear motor (48V)							
Series	Motor code	Motor model name	Input type	Amplifier capacity	Magnet width	Output	Highest speed
Cylinder	0x435A	DE0AC001A03	48 VDC	40A	30 mm	5-1N	2.0 m/s
Linear motor	0x05AD	DE0BC005A05CX00	48 VDC	40A	50 mm	15N	1.4 m/s

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Release	
Revision A	Nov. 2013
Revision B	OCT. 2014
Revision C	Apr. 2015
Revision D	Apr. 2016
Revision E	Sep. 2017
Revision K	May 2023



#### ■ 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.

#### Cautions

#### ■ 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.

- 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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