M0008957F

SANMOTION

AC SERVO SYSTEMS

R ADVANCED MODEL

TYPE S

With EtherCAT® Interface

For Rotary・Linear Motor

Instruction Manual

SANYO DENKI

Details of revision history

The sixth edition (F)

- Safety precautions ii
  - Description is corrected as below.
    , wait at least 10 minutes before performing these tasks. ⇒ , wait at least 15 minutes before performing these tasks.

- p. 1-12, p. 1-13, p. 1-14, p. 4-20, p. 13-4, p. 16-50, p. 16-51
  - Name of connector manufacturer is changed.
    Sumitomo 3M Ltd ⇒ 3M Japan Limited

- p. 1-12, p. 1-13, p. 1-14, p. 16-50, p. 16-51
  - Name of connector manufacturer is changed.
    Tyco Electronics Amplifier Co. Ltd. ⇒ Tyco Electronics Japan G.K.

- p. 4-8
  - Description is corrected as below.
    Therefore, do not touch a power supply terminal for 10 minutes for the prevention from an electric shock. ⇒ Therefore, do not touch a power supply terminal for 15 minutes for the prevention from an electric shock.

- p. 7-8, p. 7-86, p. 7-120
  - Communication objects below are added.
    0x203D.01 Amplifier temperature warning high level setting
    0x203D.02 Amplifier temperature warning low level setting

- p. 7-72, p. 7-73
  - In body text of 0x6083: Profile acceleration and 0x6084: Profile deceleration, description of "Cyclic Sync. Velocity mode (csv)" is deleted.

- p. 7-90
  - Description below is added.
    0x2000 bit15 Real time setting enabled at the torque command addition during servo-on

- p. 7-110
  - Setting range of communication object below is extended.
    0x2020 Speed Zero Range 0x0032 to 0x01F4 ⇒ 0x0005 to 0x01F4

- p. 7-121
  - Description in the object below is changed.
    0x20F0 Amplifier Function Selection
    01 Limit behavior Selection, Content of body text.

- p. 7-131
  - Description in the object below is changed.
    0x20FB Torque command addition during servo-on, Content of body text.

- p. 7-134, p. 7-135
  - Motors are added.
    0x20FE: Motor code

- p. 10-19
  - Description is corrected as below.
    Group9 ID20: Monitor Display Selection ［MONDISP］
    ⇒ Group7 ID06: Monitor Display Selection［MONDISP］

- p. 11-5
  - Description below is added.
    Note 10) It occurs when the ASIC dedicated for EtherCAT communication is failed to initialization and is not reply to the access from CPU.

- p. 11-25
  - Description below is added.
    Alarm Code F2 (Initial Process Time-Out)
    (Initialization failure of the ASIC dedicating for EtherCAT communication)

- p. 15-10
  - Description is corrected as below.
    td: Descending run time [s] ⇒ tD: Descending run time [s]

- p. 16-56
  - Description below is added.
    Fixing brackets for 300A

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

■ Warning Symbol

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

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

■ Prohibited, Mandatory Symbols

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

■ Attention in use

⚠ Warning

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

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

⚠ Caution

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

■ Storage

Prohibited

- Do not store the device where it could be exposed to rain, water, toxic gases or other liquids.
  Damage to the device could otherwise result.
- Magnetic rails have been magnetized. Keep away from the magnets anyone who has electronic medical device such as a pace maker. Otherwise, the medical device will not work appropriately, leading to a serious danger to the person who has the medical device.

Mandatory

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

■ Transportation

Caution

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

Mandatory

- Follow the directions written on the outside box. Excess stacking could result in collapse.
  Bodily injury could otherwise result.
- The motor angling bolts are used for transporting the motor itself; do not use them for transporting the machinery, etc.
  Damage to the device or bodily injury could otherwise result.

■ Installation

⚠ Caution

- Do not stand on the device or place heavy objects on top of it.
  Bodily injury could otherwise result.
- Make sure the mounting orientation is correct.
  Fire or damage to the device could otherwise result.
- Do not drop this device or subject it to excessive shock of any kind.
  Damage to the device could otherwise result.
- Do not obstruct the air intake and exhaust vents, and keep them free of debris and foreign matter.
  Fire could otherwise result.
- Consult the User Manual regarding the required distance inside the amplifier disposition.
  Fire or damage to the device could otherwise result.
- Open the box only after checking its top and bottom location.
  Bodily injury could otherwise result.
- Verify that the products correspond to the order sheet/packing list.
  Injury or damage could result.
- Secure the device against falling, overturning, or shifting inadvertently during installation.
  Use the hardware supplied with the motor (if applicable).
  Bodily injury could otherwise result.
- Install the device on a metal or other non-flammable support.
  Fire could otherwise result.
- Magnetic rails have been magnetized. A strong magnetic attraction (or repulsion between magnets) arises between the magnets themselves or the magnets and any other objects made of iron such as jigs. Treat them carefully.
  Bodily injury could otherwise result.
- Magnetic rails and coil have metal edges. Handle them with care.
  Bodily injury could otherwise result.
- Voltage is generated at the motor power line when the coil is moved after having been installed.
  Electric shock could otherwise result.
- Place limit switch and collision safety device to linear motor stroke end.
  Failure to observe this may result in injury.
- Make sure to install a limit switch and collision safety device at the stroke end.
  Make the collision safety device strong enough to resist the maximum output of the system.
  Bodily injury could otherwise result.

■ Wiring

⚠ Caution

- ◆ Wiring connections must be secure.
  Bodily injury could otherwise result.
- ◆ Wiring should be completed based on the Wiring Diagram or the User Manual.
  Electric shock or fire could otherwise result.
- ◆ Wiring should follow electric equipment technical standards and indoor wiring regulations.
  An electrical short or fire could otherwise result.
- ◆ Do not connect a commercial power supply to the U, V or W terminals of the servo motor.
  Fire or damage to the device could otherwise result.
- ◆ Install a safety device such as a breaker to prevent external wiring short-circuits.
  Fire could otherwise result.
- ◆ Do not bind or band the power cable, input/output signal cable and/or encoder cable together or pass through the same duct or conduit.
  This action will cause faulty operation.
- ◆ Do not connect DC90V or AC power to the DC24V Brake of the servo motor. Also, do not connect AC400V to the AC200V Fan of the servo motor.
  An electrical short or fire could otherwise result.
- ◆ There is no safeguard on the linear motor. Use an over-voltage safeguard, short-circuit breaker, overheating safeguard, and emergency stop to ensure safe operation.
  Injury or fire could otherwise result.

■ Operation

⚠ Caution

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

⃠ Prohibited

- The built-in brake is intended to secure the motor; do not use it for regular control. Damage to the brake could otherwise result.
  Damage to the device could otherwise result.
- Keep the motor's encoder cables away from static electricity.
  Damage to the device could otherwise result.
- Standard specification servo amplifiers have a dynamic brake resistor. Do not rotate the motor continuously from the outside when the amplifier is not powered on, because the dynamic brake resistor will heat up, and can be dangerous.
  Fire or burn could otherwise result.

Mandatory

- When transporting the magnetic rail, it must packed as it was.
  Transporting it without package could result in injury, since it has been magnetized.
- Install an external emergency stop circuit that can stop the device and cut off the power instantaneously. Install an external protective circuit to the amplifier to cut off the power from the main circuit in the case of an alarm.
  Motor interruption, bodily injury, burnout, fire and secondary damages could otherwise result.
- There is no safeguard on the motor. Use an over-voltage safeguard, short-circuit breaker, overheating safeguard, and emergency stop to ensure safe operation.
  Injury or fire could otherwise result.
- Operate within the specified temperature and humidity range.
  Servo Amplifier
  Temperature 0°C to 55°C
  Humidity below 90% RH (non-condensing).
  Servo Motor
  Temperature 0°C to 40°C
- Humidity below 90% RH (non-condensing).
  Burnout or damage to the device could otherwise result.

■ Maintenance･Inspection

Caution

- Some parts of the servo amplifier (electrolytic capacitor, cooling fan, lithium battery for encoder, fuse) can deteriorate with long-term use. Please contact our offices for replacements.
  Damage to the device could otherwise result.
- Do not touch or get close to the terminal while the device is powered up.
  Electric shock could otherwise result.
- Be careful during maintenance and inspection, as the body of the amplifier becomes hot.
  Burn could otherwise result.
- Please contact your distributor or sales office if repairs are necessary.
  Disassembly could render the device inoperative.
  Damage to the device could otherwise result.
- When a work must be done with the protective cover removed, start working carefully and safely paying attention to an electric shock or runaway.
  Electric shock or injury could otherwise result.

Prohibited

- Do not overhaul the device.
  Fire or electric shock could otherwise result.
- Do not measure the insulation resistance and the pressure resistance.
  Damage to the device could otherwise result.
- Do not unplug the connector while the device is powered up.
  (Except those that can be inserted or removed)
  Electric shock or damage could otherwise result.
- Do not remove the nameplate cover attached to the device.

■ Disposal

Mandatory

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

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

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

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10. Digital Operator

11. Maintenance

12. Fully-closed control

13. Linear motor

14. Safe Torque Off (STO) Function

15. Selection

16. Appendixes

1

1. Preface

1.1 Introduction

The AC Servo amplifier SANMOTION R ADVANCED MODEL is a consolidated power supply, single-shaft type servo amplifier consisting of three (6) models according to capacity.
The servomotor corresponds to the Rotary Motor R series, Q-series over-2kW model, linear motor DS-series and DD-series. For motor encoder, rotary motor can use serial encoder and pulse encoder, linear motor can use pulse encoder. Furthermore, This system also corresponds to external pulse encoder for fully closed control system. Backup batteries for motor encoder can be supplied via servo amplifier connector and installed in encoder cable. EtherCAT communication connectors, PC connection connectors and encoder are all equipped with connectors for the monitor.

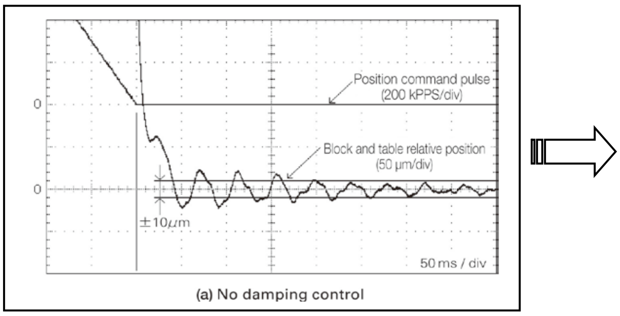
1) SANMOTION R ADVANCED MODEL features (Differences from SANMOTION R)

■ Reduced size

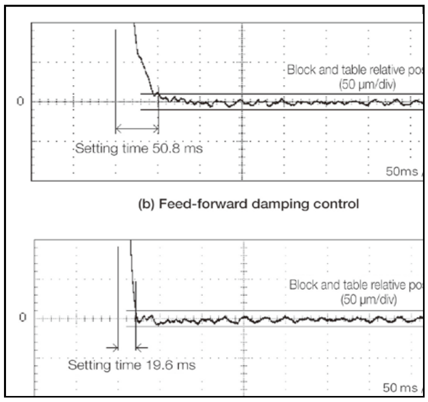
The integrated power connector uses a smaller connector for the motor encoder.
In addition, we intend to reduce the cubic volume by a maximum of 15% by miniaturizing the power circuit and save 19% of energy by adopting a new generation IPM.

■ 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.



(a) No damping control



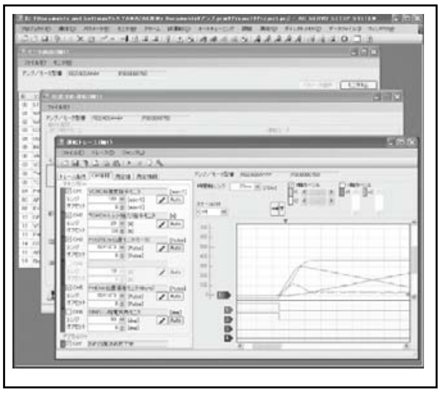
(b) Feed-forward damping control

■ 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

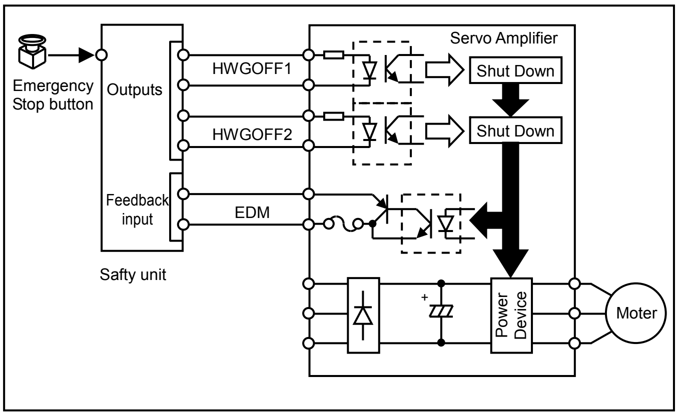
Improvement of operation trace function, ability to measure operational properties of the servo motor with virtually the same operability of an oscilloscope, which increases measurement efficiency of machinery properties. Additionally, the creation of a multi-window display allows the operator to change 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

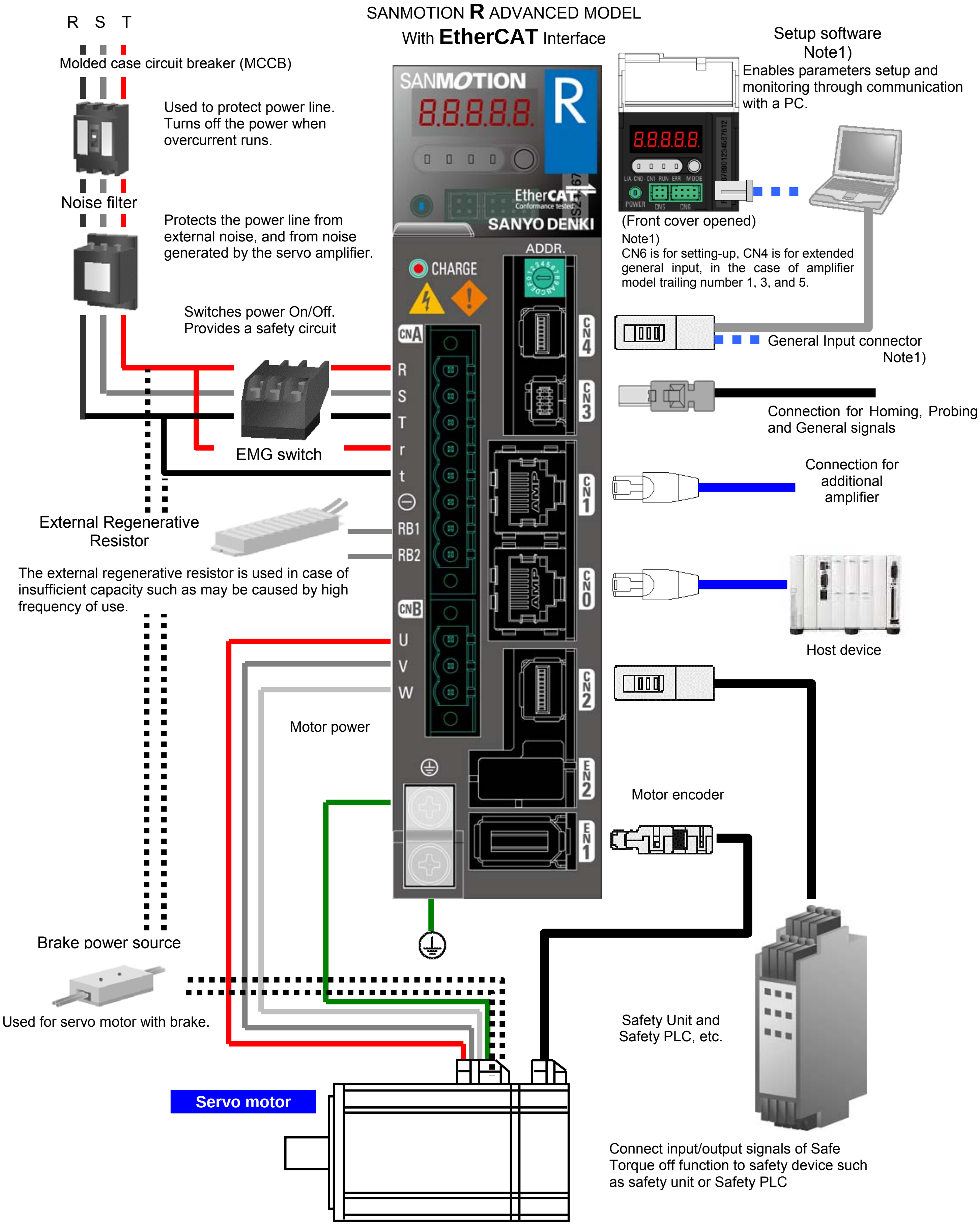
- ■ Chapter 1 Preface
  Product outline, model number, names of components.
- ■ Chapter 2 Specifications
  Detailed specifications for Servo Motor, Servo Amplifier and Motor Encoder.
- ■ Chapter 3 Installation
  Explanation of installation procedure
- ■ Chapter 4 Wiring
  Illustrations and explanations 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

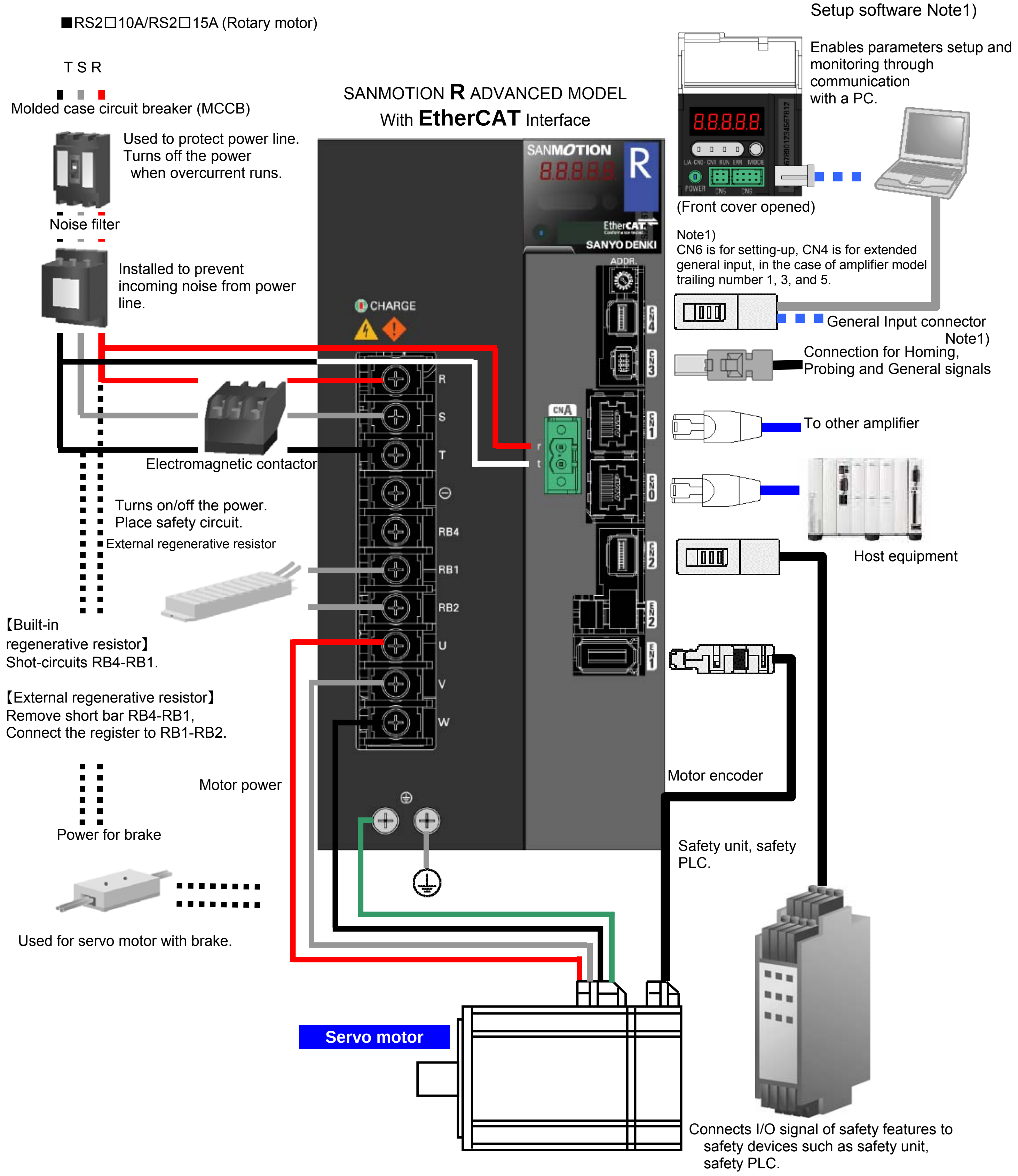
In order to fully understand the functions of this product, please read this instruction manual thoroughly before using the product. After thoroughly reading the manual, keep it handy for reference.
Carefully and completely follow the safety instructions outlined in this manual.
Note that safety is not 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.

1.3 System Configuration

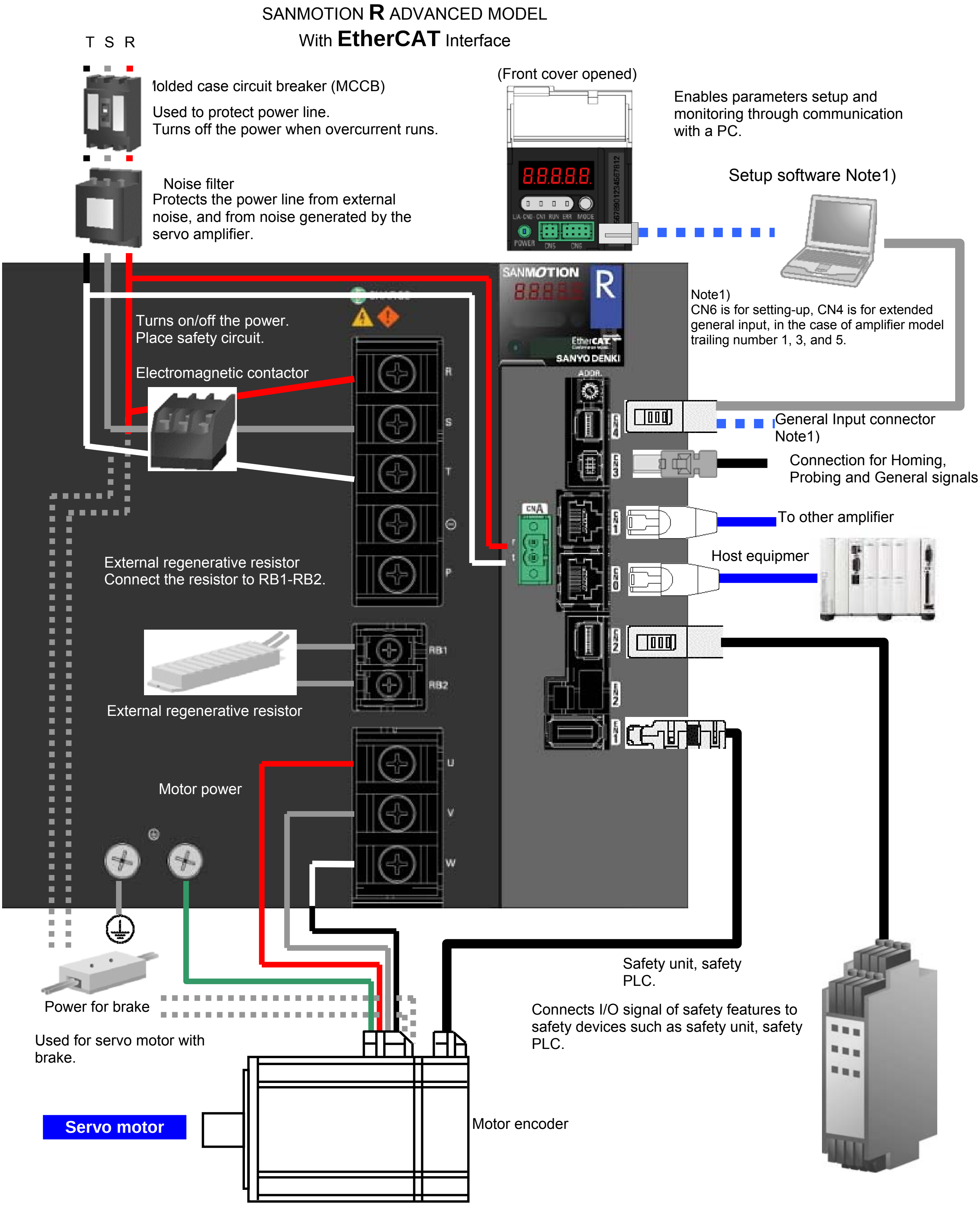
■ RS2□01A/RS2□03A/ RS2□05A (Rotary motor)



■RS2□10A/RS2□15A (Rotary motor)

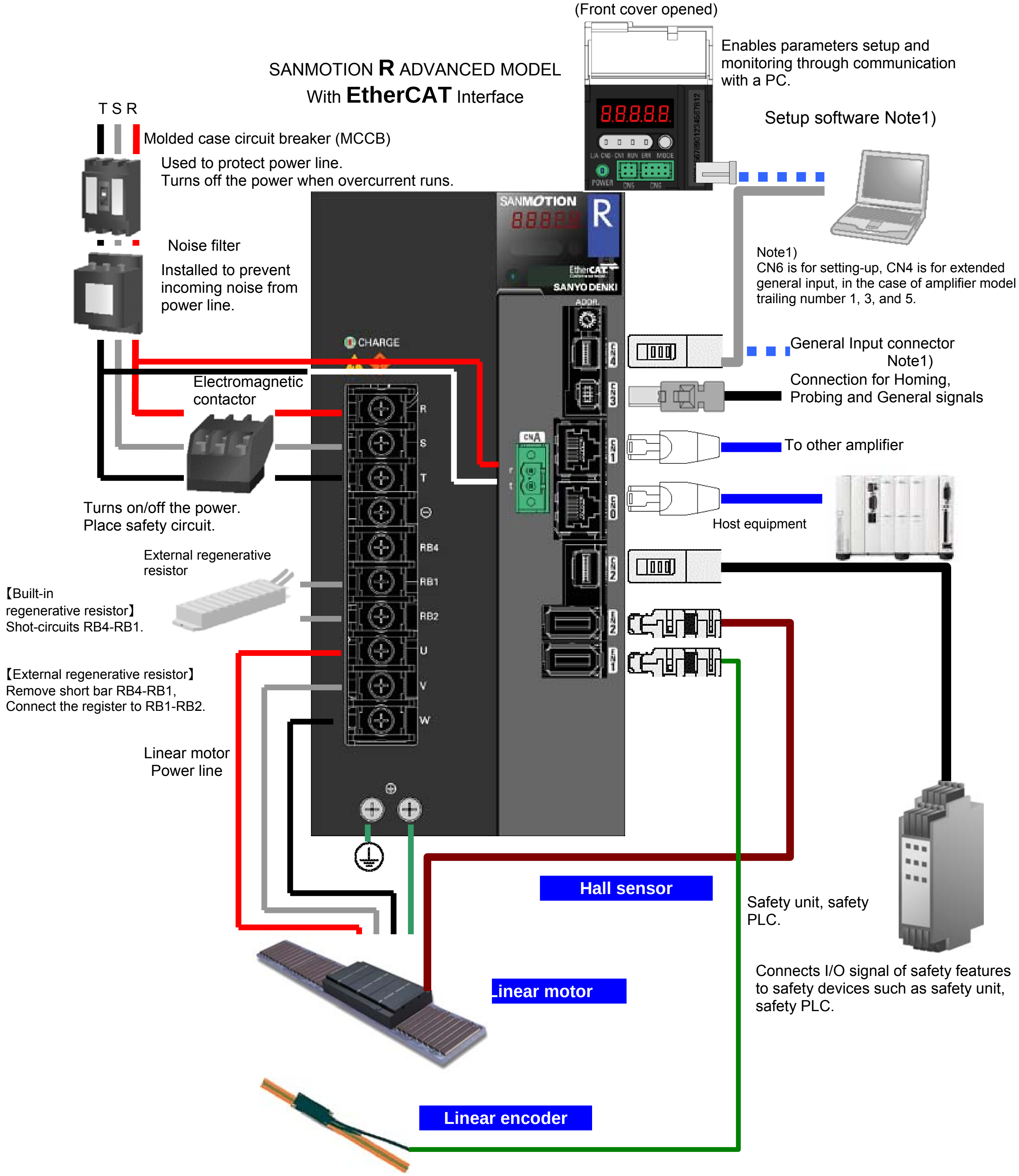


■RS2☐30A (Rotary motor)



■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.



1.4 Model number structure

1) Rotary motor model number (R series)

R | 2 | AA | 06 | 020 | F | C | P | 00 | M | A

- **R** — R Series
- **2** — Servo Motor type
  2･･･Medium Inertia
- **AA** — Voltage
  AA･･･200V-motor
  EA･･･100V-motor
- **06** — Flange dimensions
  04･･････40mm
  06･･････60mm
  08･･････80mm
  B6･･････86mm
  13･････130mm
  22･････220mm
- **020** — Rated output
  003･･･30W 020･･･200W 120･･･1.2kW
  005･･･50W 040･･･400W 200･･･2kW
  008･･･80W 050･･･500W/550W 500･･･5kW
  010･･･100W 075･･･750W
- **F** — Maximum rotational velocity
  B････2,000min-1
  L････3,000 / 4,000min-1
  H････3,500min-1
  D････4,500 / 5,000min-1
  F････6,000min-1
- **C** — Holding brake
  X･･･No brake
  B･･･With brake (90V)
  C･･･With brake (24V)
- **P** — Encoder type
  H･･･Absolute encoder for incremental system (PA035S)
  P･･･Battery backup method absolute encoder (PA035C)
  W･･･Battery-less absolute encoder (RA035C)
  S･･･Wire-saving incremental encoder (PP031, PP062)
- **00** — Specification identification
  00･･･Standard Note 1)
- **M** — Additional specification identification
  M･･･CE mark + UL supported
  0･･･With decelerator and no standard certificates
- **A** — Note 1)

Code	Reducer	Reduction ratio
A	Planet gear	1/3
B		1/5
C		1/9
D		1/15
E		1/25
S	Backlash-less planet gear	1/5
T		1/11
U		1/21
V		1/33

■ Motor Encoder Model Number

Note 1) Applicable to the model whose flange size is 86mm or less.

◆ Serial Encoder

Model type	Resolution within 1 rotation	Resolution within multiple rotations	Name	Transmission system
PA035S	131072 (17bit)	-	Absolute encoder for incremental system	Half-duplex asynchronous 2.5Mbps (standard)
PA035C	131072 (17bit)	65536(16bit)	Battery backup method absolute encoder	Half-duplex asynchronous 2.5Mbps (standard)
RA035C	131072 (17bit)	65536(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)

◆ Pulse Encoder

Model type	Standard	Applicable range	Name
	Division number (pulse number)	Division number (pulse number)	
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)

Q	1	AA	10	200	D	C	P	00	E

Q-series

Servo motor type
1･･･Low-inertia
2･･･Mid- inertia
4･･･Low-inertia
(Large capacity)

Power voltage
AA･･･200V-motor

Flange size
10･････100mm
12･････120mm
13･････130mm
18･････180mm
22･････220mm

Maximum rotational velocity
S････1,000min^{-1}
M････1,500min^{-1}
B････2,000min^{-1}
V････2,000min^{-1}
R････2,500min^{-1}
H････3,000 / 3,500min^{-1}
L････3,000min^{-1}
D････4,500/ 5,000min^{-1}

Holding brake
X･･･No brake
B･･･With brake (90V)
C･･･With brake (24V)

Encoder type
S･･･Wire-saving incremental encoder (PP062)
H･･･Absolute encoder for incremental system (PA035S)
P･･･Battery backup absolute encoder (PA035C)
W･･･Battery-less absolute encoder (RA035C)

Additional spec identification
E･･･CE mark-compliant
U･･･UL mark-compliant
M･･･CE＋UL mark-compliant

Specification identification
00･･･Standard

Rate output

200	2.0kW	400	4.0kW	700	7kW
250	2.5kW	450	4.5kW	750	7.5kW
300	3.0kW	500	5.50W	11K	11kW
350	3.5kW	550	5.5kW	15K	15kW

■ Motor encoder

◆ Serial encoder

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

◆ Pulse encoder

Model type	Standard	Applicable range	Name
	Division number (pulse number)	Division number (pulse number)	
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

DS	030	C	1	N2	E	C	1	00

Series
DS･････
Single magnet-core type
DD････
Dual magnet core type

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

Type
C･･･Coil

Coil length

	Single magnet-core type(DS)	Dual magnet core type(DD)
1	200mm	226mm
2	376mm	402mm
3	552mm	578mm
4	—	754mm

Cooling option
N2 ･････ Natural cooling
Y2, Y4 ･････ Water cooling

Hall sensor specification
E ･････ Line driver (standard spec)
B ･････ Open collector
A ･････ No

Thermal specification
A ･････ No thermal
C ･････ With thermal

Cable length
1･･･300mm
2･･･600mm
3･･･1000mm

Specification identification
00･･･Standard

■ Magnet rail model number

DS	030	M	512	A	00

Series
DS･････
Single magnet-core type
DD････
Dual magnet core type

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

Type
M･･･Magnet rail

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

Cover
A ･････ No cover
B ･････ With cover

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

4) Servo Amplifier Model Number

RS2 A 01 A 0 K A 4

RS2 Series

Input voltage
A････AC200V
E････AC100V

Servo Amplifier size
01･･･ 15A
03･･･ 30A
05･･･ 50A
10･･･100A
15･･･150A
30･･･300A
■For input voltage "E: AC100V"-specification, size 15, 30, and 50A (01, 03, 05) can be only combined.

Servo Motor type
A･･･Rotary motor

Motor encoder type (Rotary motor)

	EN1: Motor encoder	EN2: External pulse encoder
0	Serial encoder	—
2	Serial encoder	Pulse encoder
8	Pulse encoder	—
A	Pulse encoder	Pulse encoder

Motor encoder type (Liner motor)

	EN1: Linear encoder	EN2: Hall sensor
8	Pulse encoder	No
A	Pulse encoder	Line driver
B	Pulse encoder	Open collector

- ■ If you use servo amplifier for fully closed system, the motor encoder type is"2" or "A." Please identify applicable motor model number you use.
- ■ Motor encoder type "0" or "8" is dedicated number for semi-closed system, cannot be used for fully closed system. However, the servo amplifier for fully closed system can be used for semi-closed system.

Interface type
K････EtherCAT Interface

Option 1
A････With built-in regenerative resistance/ with DB resistance
L････Without built-in regenerative resistance/ with DB resistance

Option 2

	Safe-torque-off	Versatile I/O
0	No	Input x 2 Output x 2
1	Yes	Input x 6 Output x 2
4	Yes (With delay circuit)	Input x 2 Output x 2
5	Yes (With delay circuit)	Input x 6 Output x 2

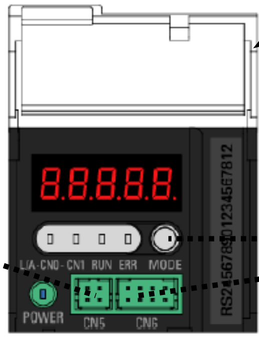
* Setup values for the servo amplifier are (default values) at the time of shipment from our factory. Adjustments for system parameters according to your equipment specifications as well as for combination of servo amplifier and servo motor are necessary.

* 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



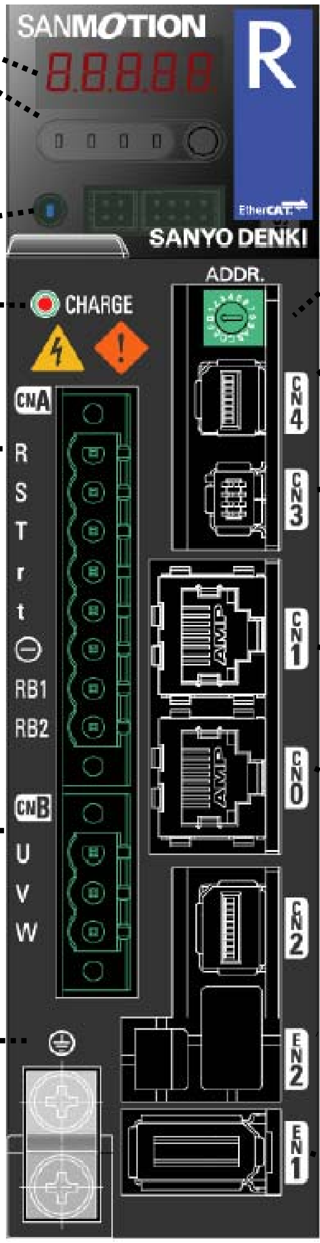
Open front cover.

Connector for analog monitor

CN5: Model NO. on plug side Connector : DF11−4DS−2C Contact : DF11−2428SCA (Products of Hirose Electric)

Digital Operator operation keys

For setup software
(The end NO. of amp model NO. : 1, 3, 5 only)



5-digit 7-segment LED

EtherCAT Status LED(from left)

Port 0 Link / Act LED (Green) Port 1 Link / Act LED (Green) RUN indicator LED (Green) Error indicator LED (Red)

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 ⏚

CN5: Side plug model Connector: DF11-4DS-2C Contact : DF11-2428SCA (Hirose Electric Co., Ltd.)

Rotary switch for station alias address

For setup software
(The end NO. of amp model NO. :0, 2, 4)
For extended general input connector
(The end NO. of amp model NO. :1, 3, 5)

CN4 : Side plug model MUF-PK8K-X (J.S.T Mfg. Co., Ltd.)

General input/output connector

CN3 : Side plug model 2013595-3 (Tyco Electronics Japan G.K.)

Connector for next slave amplifier
(CN1)[“EtherCAT OUT” port]

Connector for host unit input/output signals
(CN0)[“EtherCAT IN” port]

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

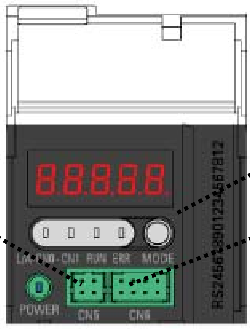
CN2 : Side plug model MUF-PK10K-X (J.S.T Mfg. Co., Ltd.)

Connector (EN2) for fully closed control, hall sensor signal

Connector for encoder signal (EN1)

EN1 EN2: Side plug model Plug : 36210-0100PL Shellkit : 36310-3200-008 (3M Japan Limited)

■ RS2□10/RS2□15



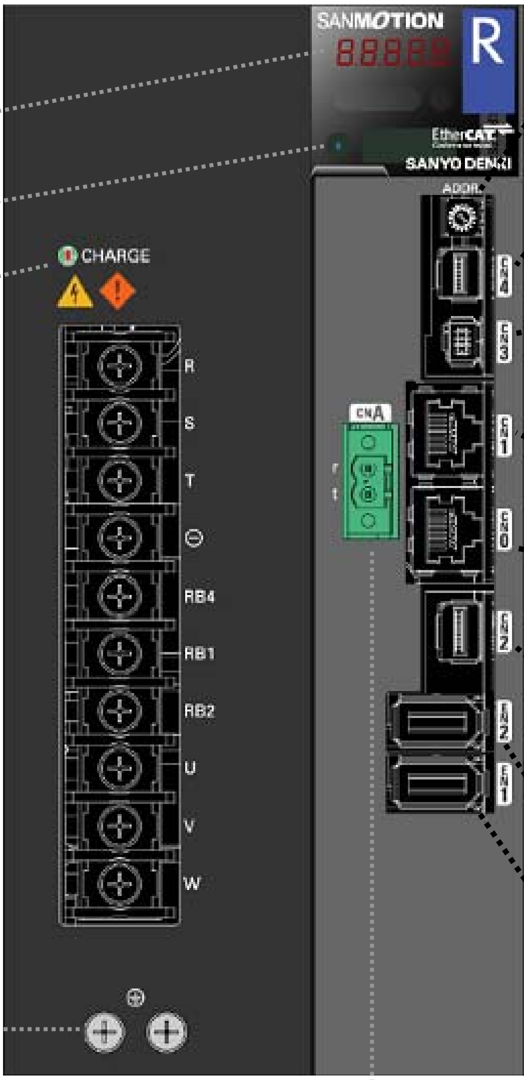
Open front cover.

Digital Operator operation keys

Connector for analog monitor

CN5: Model numbers on plug side
Connector: DF11-4DS-2C
Contact: DF11-2428SCA
(Products of Hirose Electric)

For setup software
(The end NO. of amp model NO. :
1, 3, 5 only)



For station alias address
Rotary switch

For setup software
(The end NO. of amp model NO. :0, 2, 4)
For extended general input connector
(The end NO. of amp model NO. :1, 3, 5)

5-digit 7-segment LED

Control power status LED
(POWER - Blue)

Main circuit power LED
(Red・CHARGE)

CN4: Model number on plug side
MUF-PK8K-X
(Product of J.S.T. Mfg.)

General I/O connector

CN3 : Side plug model
2013595-3
(Tyco Electronics Japan G.K.)

Main circuit power input

Connector for next slave amplifier
(CN1)[“EtherCAT OUT” port]

Connector for host unit input/output
signals(CN0)[“EtherCAT IN” port]

CN0, CN1 : Connector on plug
RJ-45 CAT5e

Regenerative
resistor connected

Sevo motor connected

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

CN2 : Side plug model
MUF-PK10K-X
(J.S.T Mfg. Co., Ltd.)

Connector (EN2) for fully closed
control, hall sensor signal

Protective
ground terminal

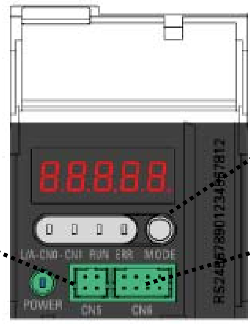
Connector for encoder signal (EN1)

Control power input connector

CNA: Model number on plug side
MSTBT2.5/2-STF-5.08
(Product of PHOENIX CONTACT)

EN1, EN2: Model number on plug side
Plug: 36210-0100PL
Shellkit:36310-3200-008
(3M Japan Limited)

■ RS2□30



Open front cover.

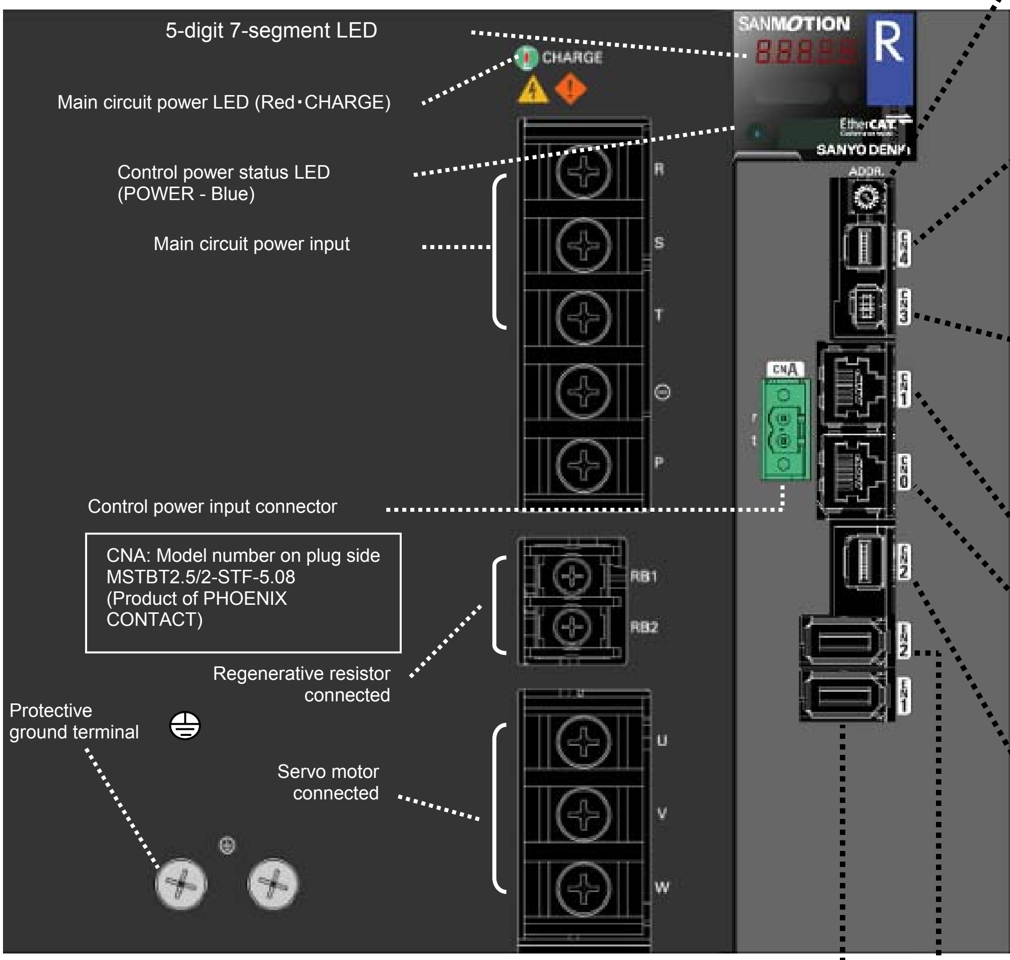
Digital Operator operation keys

Connector for analog monitor

CN5: Model numbers on plug side
Connector: DF11-4DS-2C
Contact: DF11-2428SCA
(Products of Hirose Electric)

For setup software
(The final NO. of amp model NO. : 1, 3, 5 only)

Rotary switch for station alias address



CNA: Model number on plug side
MSTBT2.5/2-STF-5.08
(Product of PHOENIX CONTACT)

For setup software
(The final NO. of amp model NO. :0, 2, 4)
For extended general input connector
(The final NO. of amp model NO. :1, 3, 5)

CN4 : Side plug model
MUF-PK8K-X
(J.S.T Mfg. Co., Ltd.)

General input/output connector

CN3 : Plug model numer
2013595-3
(Tyco Electronics Japan G.K.)

Connector for next slave amplifier
(CN1)[EtherCAT OUT port]

Connector for host unit input/output signals
(CN0)[EtherCAT IN port]

CN0, CN1 : Connector on plug
RJ-45 CAT5e

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

CN2 : Plug model NO.
MUF-PK10K-X
(J.S.T Mfg. Co., Ltd.)

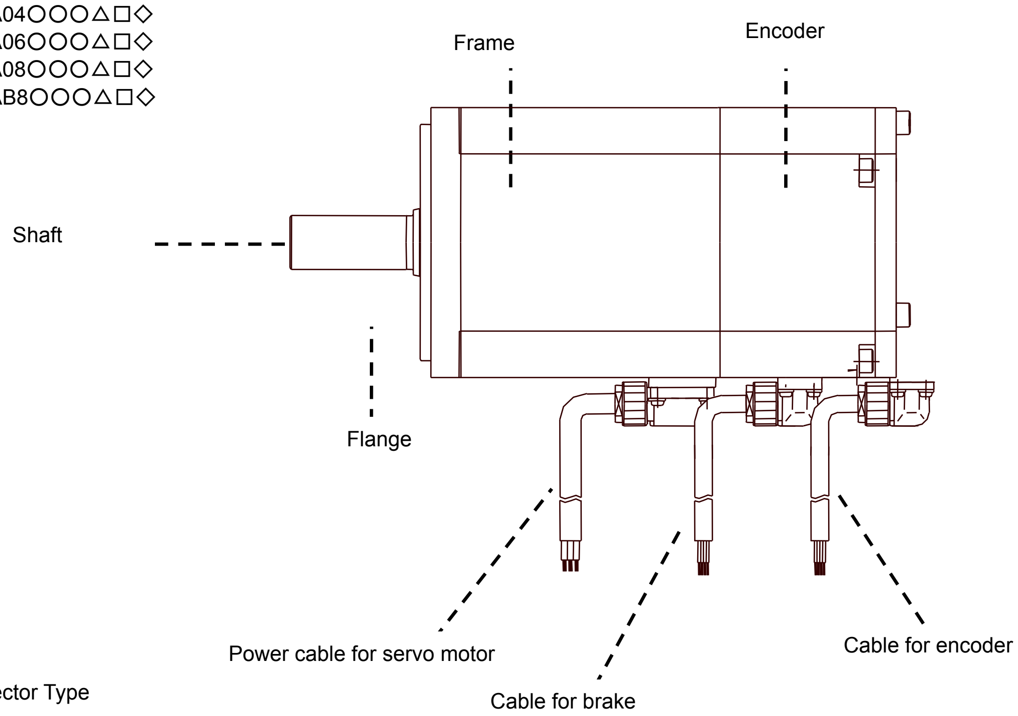
Connector (EN2) for fully closed control, hall sensor signal

Connector for encoder signal (EN1)

EN1, EN2: Model number on plug side
Plug: 36210-0100PL
Shellkit:36310-3200-008
(3M Japan Limited)

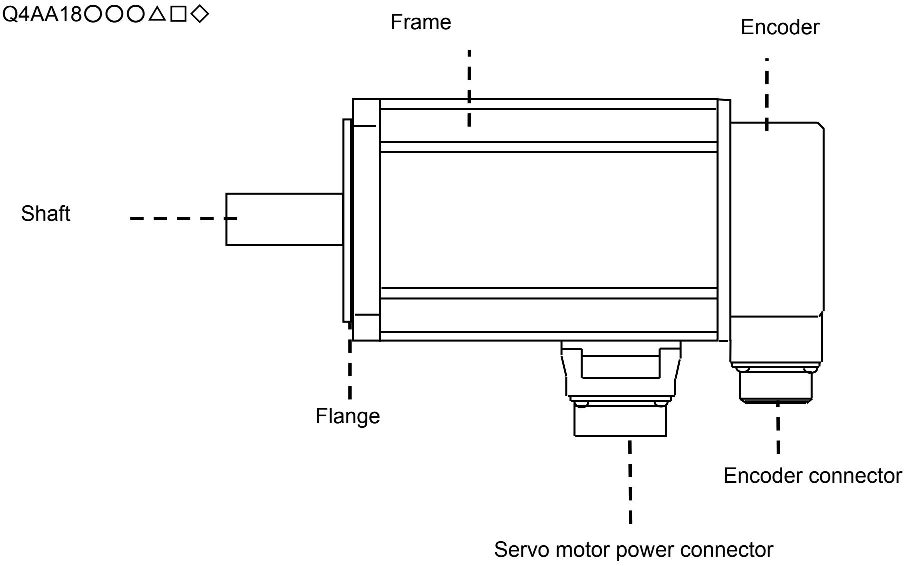
2) Rotary motor

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



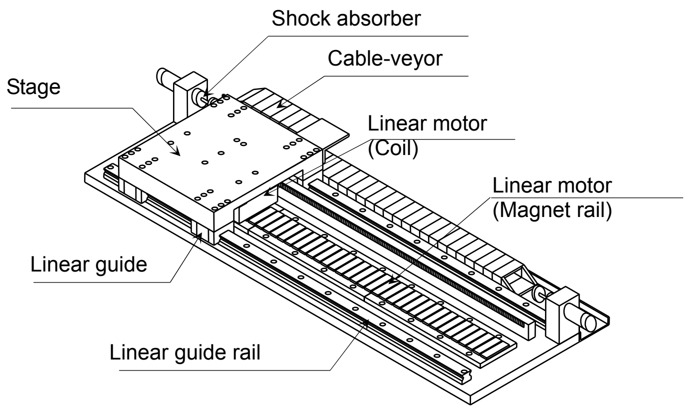
■ Connector Type

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

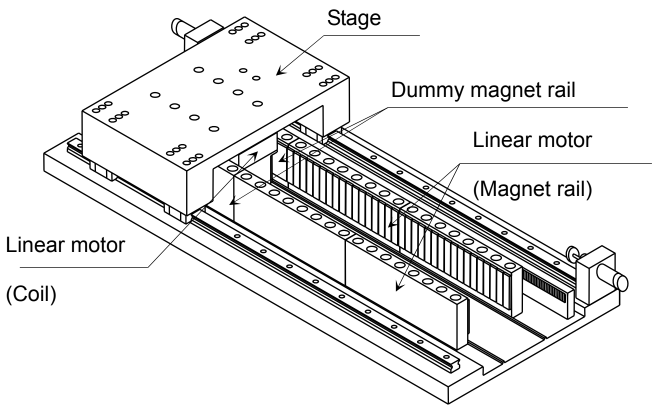


3) Linear motor

■ Single magnet core type
DS030□△○○
DS050□△○○
DS075□△○○
DS100□△○○
DS150□△○○



■ Dual magnet core type
DD030□△○○
DD050□△○○
DD075□△○○



1.6 Combination

1) Combination motor list

■ Rotary motor (AC200V-input)

Combination amplifier model number	Motor model number	Motor code (OD：0x20FE)	Combination amplifier model number	Motor model number	Motor code (OD：0x20FE)
RS2A01A#K##	R2AA04003F	0x0181	RS2A01A#K##	P50B05020D	0x0286
RS2A03A#K##	R2AA04003F	0x7181	RS2A01A#K##	P50BA2004D	0x027C
RS2A01A#K##	R2AA04005F	0x0182	RS2A05A#K##	P50B05030K	0x0273
RS2A01A#K##	R2AA04010F	0x0183	RS2A01A#K##	P50B07030D	0x01F1
RS2A01A#K##	R2AA06010F	0x0184	RS2A03A#K##	P50B08100D	0x0217
RS2A01A#K##	R2AA06020F	0x0185	RS2A03A#K##	P50B07040D	0x028A
RS2A03A#K##	R2AA06020F	0x7185	RS2A03A#K##	P50B08050D	0x028C
RS2A03A#K##	R2AA06040F	0x0186	RS2A03A#K##	P60B13100H	0x0312
RS2A01A#K##	R2AA06040F	0x1186	RS2A05A#K##	P60B13100H	0x02C1
RS2A03A#K##	R2AA08075F	0x0187	RS2A05A#K##	P60B13150H	0x02C2
RS2A05A#K##	R2AA08075F	0x01B1	RS2A05A#K##	P60B18350M	0x02CF
RS2A10A#K##	R2AA13180D	0x01B6	RS2A05A#K##	P60B13200B	0x02D2
RS2A03A#K##	R2AA08040F	0x0188	RS2A05A#K##	P60B18200B	0x02D7
RS2A01A#K##	R2AA06040H	0x0189	RS2A30A#K##	P60B2215KB	0x02DE
RS2A01A#K##	R2AA08020F	0x018A	RS2A05A#K##	P60B13150B	0x02DF
RS2A03A#K##	R2AA13050D	0x018C	RS2A03A#K##	P60B13150B	0x0310
RS2A05A#K##	R2AA13120D	0x018D	RS2A10A#K##	P80B22250H	0x02E4
RS2A05A#K##	R2AA13120L	0x018E	RS2A01A#K##	P80C18050B	0x32F3
RS2A03A#K##	R2AA13120L	0x118E	RS2A10A#K##	P80B22350R	0x02E9
RS2A03A#K##	R2AA13050H	0x018F	RS2A03A#K##	Q1AA07075D	0x0046
RS2A05A#K##	R2AA13050H	0x718F	RS2A05A#K##	Q1AA10150D	0x0048
RS2A10A#K##	R2AA13200D	0x0190	RS2A10A#K##	Q1AA10200D	0x0049
RS2A03A#K##	R2AA13120B	0x0191	RS2A10A#K##	Q1AA10250D	0x004A
RS2A05A#K##	R2AA13180M	0x0119	RS2A10A#K##	Q1AA12200D	0x004C
RS2A10A#K##	R2AA13200F	0x11B2	RS2A10A#K##	Q1AA12300D	0x004D
RS2A05A#K##	R2AA13200L	0x0192	RS2A10A#K##	Q1AA13300D	0x504E
RS2A05A#K##	R2AAB8100F	0x0193	RS2A15A#K##	Q1AA13400D	0x004F
RS2A03A#K##	R2AAB8100H	0x0194	RS2A15A#K##	Q1AA13500D	0x0050
RS2A15A#K##	R2AA22500L	0x0195	RS2A15A#K##	Q1AA18450M	0x0051
RS2A10A#K##	R2AA22500L	0x1195	RS2A30A#K##	Q1AA18750H	0x0052
RS2A05A#K##	R2AA10100F	0x019E	RS2A15A#K##	Q1AA13500H	0x0058
RS2A03A#K##	R2AA10075F	0x019F	RS2A01A#K##	Q1AA04010D	0x0043
RS2A05A#K##	R2AA13180H	0x01B6	RS2A01A#K##	Q1AA06020D	0x0044
RS2A15A#K##	R2AA18550R	0x01B8	RS2A05A#K##	Q1AA10100D	0x0047
RS2A05A#K##	R2AA13180D	0x011B	RS2A03A#K##	Q1AC06040V	0x00A8
RS2A10A#K##	R2AA18350L	0x011C	RS2A05A#K##	Q2AA13100H	0x0070
RS2A15A#K##	R2AA18350D	0x011D	RS2A01A#K##	Q2AA04006D	0x0061
RS2A15A#K##	R2AA18450H	0x011E	RS2A01A#K##	Q2AA04010D	0x0062
RS2A30A#K##	R2AA18550H	0x011F	RS2A01A#K##	Q2AA05020D	0x0065
RS2A30A#K##	R2AA1811KR	0x0120	RS2A03A#K##	Q2AA08050D	0x006A
RS2A30A#K##	R2AA18750H	0x01B9	RS2A05A#K##	Q2AA08075D	0x006B
RS2A30A#K##	R2AA18750H	0x51B9	RS2A03A#K##	Q2AA08100D	0x106C
RS2A15A#K##	R2AA18750H	0x01BA	RS2A05A#K##	Q2AA08100D	0x006C
RS2A03A#K##	R2AA04010F	0x7183	RS2A05A#K##	Q2AA10100H	0x006D
RS2A30A#K##	R2AA2215KR	0x02BC	RS2A05A#K##	Q2AA10150V	0x00B3
RS2A30A#K##	R1AA1815KB	0x010E	RS2A03A#K##	Q2AA10150H	0x00DD
RS2A30A#K##	R1AA18750L	0x010F	RS2A03A#K##	Q2AA13050H	0x006F
RS2A03A#K##	R5AA08075D	0x02BA	RS2A05A#K##	Q2AA13150H	0x0071
RS2A01A#K##	R5AA06020F	0x049E	RS2A10A#K##	Q2AA13200H	0x0072
RS2A01A#K##	R5AA06020H	0x049D	RS2A10A#K##	Q2AA13300B	0x00E0
RS2A01A#K##	R5AA06040H	0x049F	RS2A10A#K##	Q2AA18200H	0x0073
RS2A03A#K##	R5AA06040F	0x02BB	RS2A15A#K##	Q2AA18350H	0x0074
RS2A03A#K##	R5AA08075F	0x04A0	RS2A15A#K##	Q2AA18450H	0x0075
RS2A03A#K##	P10B13150B	0x100C	RS2A15A#K##	Q2AA18550R	0x0076
RS2A05A#K##	P10B18200B	0x000D	RS2A15A#K##	Q2AA22550B	0x007A
RS2A10A#K##	P20B13400H	0x002D	RS2A15A#K##	Q2AA22700S	0x007B
RS2A01A#K##	P30B06008D	0x020A	RS2A03A#K##	Q2AA08075H	0x00CA
RS2A03A#K##	P30B08040D	0x02B0	RS2A30A#K##	Q2AA18550H	0x00D5
RS2A01A#K##	P50B02001D	0x021C	RS2A30A#K##	Q2AA18750L	0x00D6
RS2A01A#K##	P50B02002D	0x0278	RS2A30A#K##	Q2AA2211KV	0x00D8
RS2A01A#K##	P50B04006D	0x0282	RS2A30A#K##	Q2AA2215KV	0x00D9
RS2A01A#K##	P50B04010D	0x0283	RS2A30A#K##	Q4AA1811KB	0x0121
RS2A01A#K##	P50B05008D	0x0208			

■ Rotary motor(AC100V-input)

Combination amplifier model number	Motor model number	Motor code (OD：0x20FE)	Combination amplifier model number	Motor model number	Motor code (OD：0x20FE)
RS2E01A#K##	R2EA04003F	0x0197	RS2E01A#K##	Q2EA07020D	0x00C1
RS2E01A#K##	R2EA04005F	0x0198	—	—	—
RS2E01A#K##	R2EA06010F	0x019A	—	—	—
RS2E03A#K##	R2EA06020F	0x019B	—	—	—
RS2E01A#K##	R2EA06008F	0x019C	—	—	—
RS2E01A#K##	R2EA04008F	0x019D	—	—	—

■ Linear motor (AC200V-input)

Combination amplifier model number	Motor model number	Motor code (OD：0x20FE)	Combination amplifier model number	Motor model number	Motor code (OD：0x20FE)
RS2A03L#K##	DS030C1N2E	0x0343	RS2A10L#K##	DS150C2N2E	0x0354
RS2A05L#K##	DS030C2N2E	0x0344	RS2A15L#K##	DS150C3N2E	0x034D
RS2A10L#K##	DS030C3N2E	0x0346	RS2A05L#K##	DD030C1Y4E	0x03D2
RS2A03L#K##	DS050C1N2E	0x0347	RS2A10L#K##	DD030C2Y4E	0x03D3
RS2A05L#K##	DS050C2N2E	0x0348	RS2A10L#K##	DD030C3Y4E	0x03D4
RS2A10L#K##	DS050C3N2E	0x034A	RS2A10L#K##	DD050C1Y2E	0x03D5
RS2A03L#K##	DS075C1N2E	0x034C	RS2A15L#K##	DD050C2Y2E	0x03D6
RS2A05L#K##	DS075C2N2E	0x034F	RS2A30L#K##	DD050C3Y2E	0x03D9
RS2A10L#K##	DS075C3N2E	0x0349	RS2A10L#K##	DD075C1Y2E	0x03DA
RS2A05L#K##	DS100C1N2E	0x0350	RS2A15L#K##	DD075C2Y2E	0x03DB
RS2A10L#K##	DS100C2N2E	0x0351	RS2A30L#K##	DD075C3Y2E	0x03DC
RS2A15L#K##	DS100C3N2E	0x0352	RS2A30L#K##	DD075C4Y2E	0x03DD
RS2A05L#K##	DS150C1N2E	0x0353	***RS2A03L#K##***	***ACC10060***	***0x03D7***

2) Combination encoder list

■ Encoder division number

Combination amplifier model number RS2###A8K## RS2###AAK##	Combination amplifier model number RS2###A0K## RS2###A2K##	Combination amplifier model number RS2###L8K## RS2###LAK## RS2###LBK##	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 number Encoder type	Remarks (Description)
0x0000	Incremental encoder (Wire-saving incremental)	4 pairs	8, A	S	Set when motor encoder is wire-saving incremental encoder.
0x0101	Asynchronous encoder (Incremental system)	2.5MHz No multiple rotation output	0, 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 No multiple rotation output			
0x0301	Optical asynchronous encoder	2.5MHz Multiple rotation output	0, 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 Multiple rotation output			
0x0501	Resolver type asynchronous encoder	2.5MHz Multiple rotation output	0, 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 Multiple rotation output			
0x0300	Optical asynchronous encoder	2.5MHz Multiple rotation output	0, 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 Multiple rotation output			
0x0500	Revolver type asynchronous encoder	2.5MHz Multiple rotation output	0, 2	W	Set to use in absolute system. Multiple rotations is mechanical backup system, no battery cell is needed to connect.
0x0600		4.0MHz Multiple rotation output			

■ Encoder type (Linear scale encoder hall sensor)

Encoder code OD：0x20FE，2	Linear scale encoder (Incremental)	Hall sensor	CS-normalization (CS-reset method)	Amplifier model number Encoder type	Remarks (Description)
0x0800	Phase A, B, Z	Yes	Hall sensor Phase U	A, B Note1)	Set to perform CS-normalization with phase U signal of hall 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 sensor performs CS-normalization, but set when CS-normalization not performed.
0x0830	Incremental encoder (Wire-saving incremental)	Yes	Incremental Phase Z	8, A, B	System using hall 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	8, A, B	System using hall 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)	8, A, B Note2)	System not using hall sensor. Set to perform magnetic pole position estimation process.
0x0860	Phase A, B, Z	No	Software setting (Forced setting)	8, A, B Note2)	System not using hall sensor. Set when CS-normalization not performed.

Note1） When specification for hall sensor output is for line driver, select encoder type “A” of amplifier model number.
When specification for hall sensor output is for open collector, select encoder type “B of amplifier model number.

Note2） Both encoder type “A” and “B” can be used, however, select amplifier “8” when hall sensor not used.

2

2 Specifications

2.1 Servo Motor

1) General Specifications

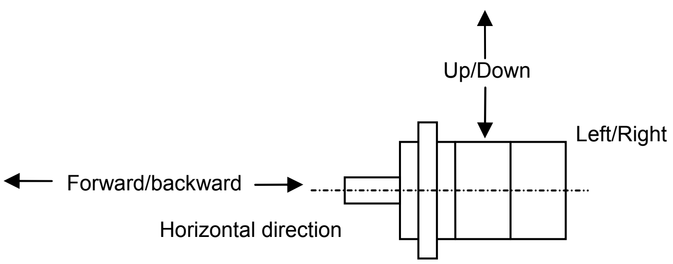
Series name	R2, Q1, Q2, Q4
Time rating	Continuous
Insulation classification	Type F
Voltage/Dielectric strength	AC1500V 1 minute
Insulation resistance	DC500V, greater than 10MΩ
Protection method	Fully closed, Auto cooling Motor flange angle: 86 or less: IP67 Motor flange angle: 130 or over: IP65 However, 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 / Weight

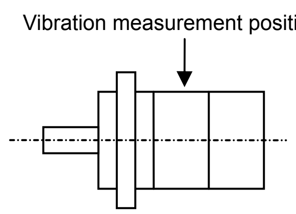
Refer to [Servo Motor Dimension (Section 16)]
Refer to [Servo Motor Data Sheet (Section 16)]

3) Mechanical Specifications / Mechanical Strength / Working Accuracy

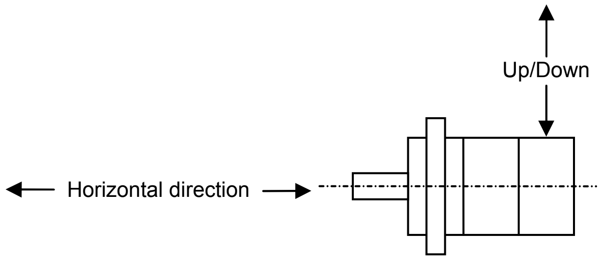
■ Vibration Resistance
Install the servo motor horizontally (shown in the figure below), so when vibration occurs in any of three (3) directions (up/down, backward/forward, left/right) the motor will withstand vibration acceleration up to $24.5m/s^2$.



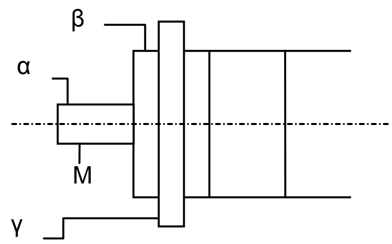
■ Vibration Classification
The vibration classification of the servo motor is V15 or less at maximum rotation speed for a single servo motor unit and is measured as indicated in the figure below.



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



- **Mechanical Strength**
  The axis strength of the servo motor can withstand instantaneous maximum torque.
- **Working Accuracy**
  The following table shows the accuracy and precision of the servo motor output shaft (Total Indicator Reading) of the parts surrounding the shaft.

Items	T.I.R.	Reference Figure
Vibration of output shaft terminal: α	0.02	
	0.03 (220)	
Eccentricity of external diameter of flange on output shaft M: β	0.06 (below 80)	
	0.08 (above 100)	
Perpendicularity of flange face to output shaft M: γ	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.

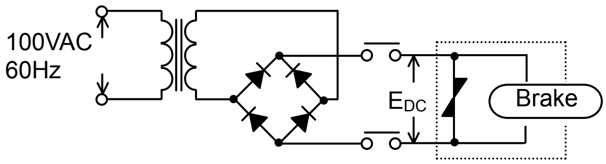
Servo motor model number	Oil seal type
R2□A04○○○□	Standard: N/A Optional: G-Type
R2□A06○○○□/R2□A□8○○○□	Standard: N/A Optional: S-Type
R2□A10○○○□	Standard: N/A Optional: S-Type
R2□A13○○○□	Standard: Double Lip seal type
R2AA18○○○□	Standard: S-Type
R2□A22○○○□	Standard: Double Lip seal type
R5AA06○○○□	Standard: N/A Optional: S-Type
R5AA08○○○□	Standard: N/A Optional: S-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

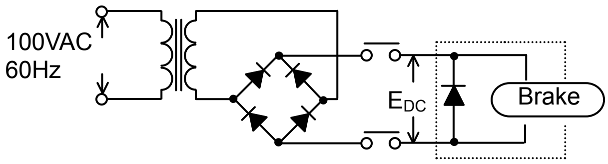
An optional Holding Brake is available for the servo motor. Since the primary use of this brake is for holding, it should never be used for braking, except in emergency situations.
Turn the brake excitation On or Off using the “holding brake timing signal output”. When using this signal, set the command for brake release time to 0min^{-1} for the servo amplifier.
To externally control the holding brake, a response time (as in the table below) is required.
When using a motor with the brake, determine a time sequence that accounts for this delay.

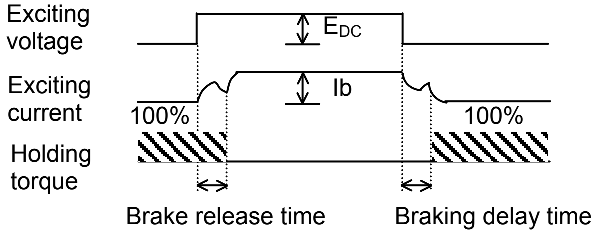
<table>
<tr><th colspan="2" rowspan="2">Servo motor model number</th><th rowspan="2">Static friction torque
N·m</th><th rowspan="2">Release time
ms</th><th colspan="2">Braking delay time ms</th></tr>
<tr><th>Varistor</th><th>Diode</th></tr>
<tr><td rowspan="29">R2</td><td>R2AA04003F</td><td>0.32</td><td rowspan="3">25</td><td rowspan="3">15</td><td rowspan="3">100</td></tr>
<tr><td>R2AA04005F</td><td>0.32</td></tr>
<tr><td>R2AA04010F</td><td>0.32</td></tr>
<tr><td>R2AA06010F</td><td>0.36</td><td rowspan="2">30</td><td rowspan="2">20</td><td rowspan="2">120</td></tr>
<tr><td>R2AA06020F</td><td>1.37</td></tr>
<tr><td>R2AA08020F</td><td>2.55</td><td>40</td><td>20</td><td>200</td></tr>
<tr><td>R2AA06040□</td><td>1.37</td><td>30</td><td>20</td><td>120</td></tr>
<tr><td>R2AA08040F</td><td>2.55</td><td rowspan="2">40</td><td rowspan="2">20</td><td rowspan="2">200</td></tr>
<tr><td>R2AA08075F</td><td>2.55</td></tr>
<tr><td>R2AAB8075F</td><td>3.92</td><td>40</td><td>20</td><td>200</td></tr>
<tr><td>R2AAB8100□</td><td>3.92</td><td>40</td><td>20</td><td>200</td></tr>
<tr><td>R2AAB8100F</td><td>3.92</td><td>40</td><td>20</td><td>200</td></tr>
<tr><td>R2AA10075F</td><td>3.92</td><td>40</td><td>20</td><td>200</td></tr>
<tr><td>R2AA10100F</td><td>3.92</td><td>40</td><td>20</td><td>200</td></tr>
<tr><td>R2AA13050□</td><td>3.50</td><td>40</td><td>30</td><td>120</td></tr>
<tr><td>R2AA13120□</td><td>9.0</td><td>100</td><td>30</td><td>130</td></tr>
<tr><td>R2AA13180□</td><td>9.0</td><td>100</td><td>30</td><td>130</td></tr>
<tr><td>R2AA13200□</td><td>12.0</td><td>100</td><td>30</td><td>140</td></tr>
<tr><td>R2AA18350□</td><td>22.0</td><td>120</td><td>50</td><td>150</td></tr>
<tr><td>R2AA18450H</td><td>32.0</td><td>150</td><td>60</td><td>250</td></tr>
<tr><td>R2AA18550□</td><td>42.0</td><td>150</td><td>60</td><td>250</td></tr>
<tr><td>R2AA18750H</td><td>54.9</td><td>300</td><td>140</td><td>400</td></tr>
<tr><td>R2AA1811KR</td><td>100</td><td>300</td><td>140</td><td>400</td></tr>
<tr><td>R2AA22500L</td><td>42</td><td>150</td><td>60</td><td>250</td></tr>
<tr><td>R2EA04003F</td><td>0.32</td><td rowspan="3">25</td><td rowspan="3">15</td><td rowspan="3">100</td></tr>
<tr><td>R2EA04005F</td><td>0.32</td></tr>
<tr><td>R2EA04008F</td><td>0.32</td></tr>
<tr><td>R2EA06010F</td><td>0.36</td><td rowspan="2">30</td><td rowspan="2">20</td><td rowspan="2">120</td></tr>
<tr><td>R2EA06020F</td><td>1.37</td></tr>
<tr><td rowspan="6">R5</td><td>R5AA06020H</td><td>1.37</td><td>30</td><td>20</td><td>120</td></tr>
<tr><td>R5AA06020F</td><td>1.37</td><td>30</td><td>20</td><td>120</td></tr>
<tr><td>R5AA06040H</td><td>1.37</td><td>30</td><td>20</td><td>120</td></tr>
<tr><td>R5AA06040F</td><td>1.37</td><td>30</td><td>20</td><td>120</td></tr>
<tr><td>R5AA08075D</td><td>2.55</td><td>40</td><td>20</td><td>200</td></tr>
<tr><td>R5AA08075F</td><td>2.55</td><td>40</td><td>20</td><td>200</td></tr>
<tr><td rowspan="8">Q1</td><td>Q1AA10200D</td><td>7.84</td><td>100</td><td>30</td><td>140</td></tr>
<tr><td>Q1AA10250D</td><td>9.80</td><td>100</td><td>30</td><td>140</td></tr>
<tr><td>Q1AA12200D</td><td>7.84</td><td>100</td><td>30</td><td>140</td></tr>
<tr><td>Q1AA12300D</td><td>11.8</td><td>100</td><td>30</td><td>140</td></tr>
<tr><td>Q1AA13400D</td><td>19.6</td><td rowspan="2">120</td><td rowspan="2">50</td><td rowspan="2">150</td></tr>
<tr><td>Q1AA13500D</td><td>19.6</td></tr>
<tr><td>Q1AA18450M</td><td>32.0</td><td>150</td><td>40</td><td>250</td></tr>
<tr><td>Q1AA18750H</td><td>54.9</td><td>300</td><td>140</td><td>400</td></tr>
<tr><td rowspan="11">Q2</td><td>Q2AA13200H</td><td>12.0</td><td>100</td><td>30</td><td>140</td></tr>
<tr><td>Q2AA18200H</td><td>12.0</td><td>100</td><td>30</td><td>140</td></tr>
<tr><td>Q2AA18350H</td><td>32.0</td><td>120</td><td>40</td><td>150</td></tr>
<tr><td>Q2AA18450H</td><td>32.0</td><td>150</td><td>40</td><td>250</td></tr>
<tr><td>Q2AA18550R</td><td rowspan="3">54.9</td><td rowspan="3">300</td><td rowspan="3">140</td><td rowspan="3">400</td></tr>
<tr><td>Q2AA18550H</td></tr>
<tr><td>Q2AA18750L</td></tr>
<tr><td>Q2AA22550B</td><td>90.0</td><td>300</td><td>140</td><td>400</td></tr>
<tr><td>Q2AA22700S</td><td rowspan="3">90.0</td><td rowspan="3">300</td><td rowspan="3">140</td><td rowspan="3">400</td></tr>
<tr><td>Q2AA2211KV</td></tr>
<tr><td>Q2AA2215KV</td></tr>
</table>

- 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 R2AA 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

	R2AA04005F	R2AA04010F	R2AA06040F	R2AA08075F	R2EA04005F
Degree of decrease rating 1	-	90%	90%	-	-
Degree of decrease rating 2	90%	85%	80%	90%	90%

2.2 Motor Encoder

1) Serial Encoder Specifications

■ Absolute Encoder for Incremental System

Model	Resolution	Multiple rotations	Synchronization method	Transmission method	Baud rate
PA035S	131072 division (17bits)	None	Asynchronous	Half duplex serial communication	2.5Mbps

Model number example: R2-series, square type: 40mm, 200W-model
R2AA06020FCH00

■ Battery Backup Method Absolute Encoder

Model	Resolution	Multiple rotations	Synchronization method	Transmission method	Baud rate
PA035C	131072 division (17bit)	65536 (16bit)	Asynchronous	Half duplex serial communication	2.5Mbps
	131072 division (17bit)	65536 (16bit)	Asynchronous	Half duplex serial communication	4.0Mbps

Model number example: R2-series, square type: 40mm, 200W-model R2AA06020FCP00

■ Battery-less Absolute Encoder

Model	Resolution	Multiple rotations	Synchronization method	Transmission method	Baud rate
RA035C	131072 division (17bit)	65536 (16bit)	Asynchronous	Half duplex serial communication	2.5Mbps

Model number example: R2-series, square type: 40mm, 200W-model
R2AA06020FCW00

2) Pulse Encoder Specifications

■ Wire-saving incremental encoder

Model	Resolution	Conform to motor flange angle
PP031	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

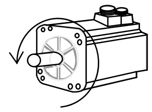
Model number example: R2-series, square type: 40mm, 200W-model R2AA06020FCS00

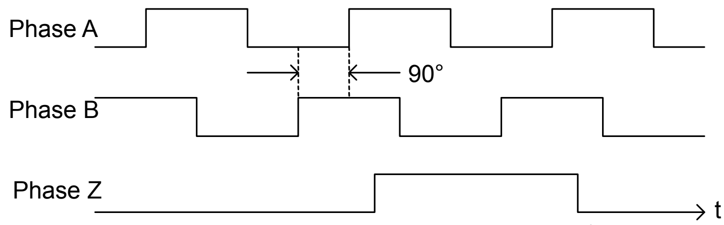
2.3 Servo motor rotational and moving direction

1) Rotary motor rotational direction

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

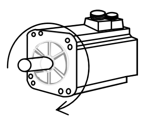
Servo motor rotation direction
[CCW]

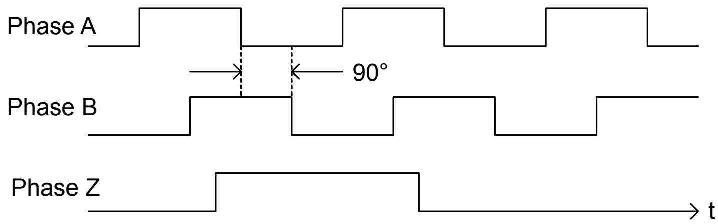




Phase B is behind Phase A 90°.

Servo motor rotation direction
[CW]

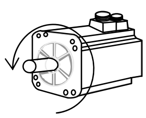




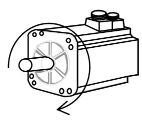
Phase B is behind Phase A 90°

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

■ Serial Encoder
Servo motor rotation direction :Counterclockwise rotation from the load side "CCW"
･･･Note : Position signal output : Increase



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



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

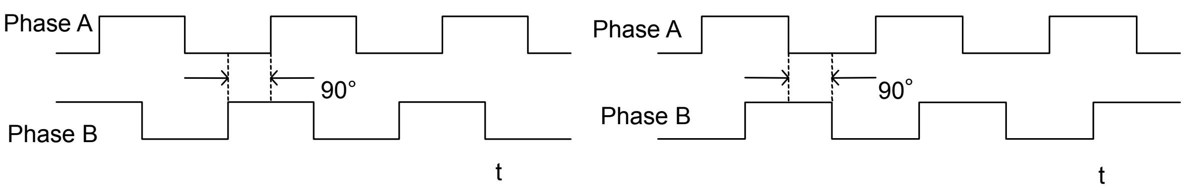
2) Battery Specification

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

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.

<Forward> <Reverse>

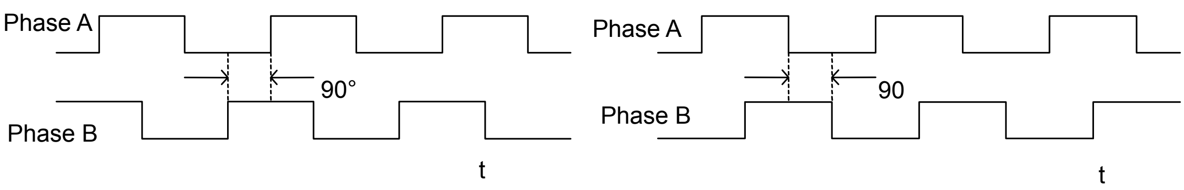


Phase B is ahead of phase A by 90°

Phase B is behind Phase A by 90°

- Linear sensor signal phase

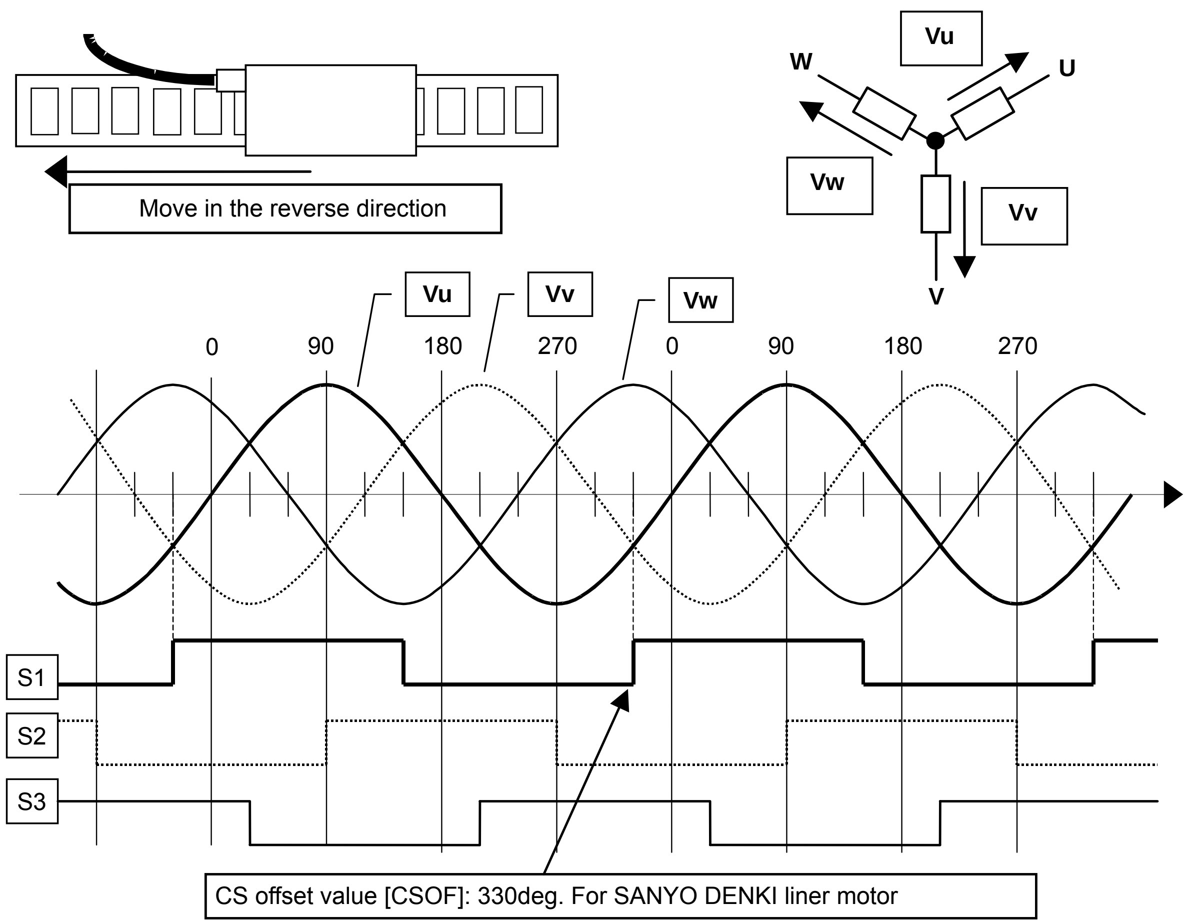
<Forward> <Reverse>



Phase B is ahead of phase A by 90°.

Phase B is behind Phase A by 90°.

- 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					
Main Circuit Power Note 1)		Three-phase : AC200 - 230V+10, -15% , 50/60Hz±3Hz Single-phrase : AC200 - 230V+10, -15% , 50/60Hz±3Hz Note 2) Single-phrase : AC100 - 115V+10, -15% , 50/60Hz±3Hz Note 3)					
Control Power Note 1)		Single-phase:AC200 - 230V+10, -15% ,50/60Hz±3Hz Single-phase:AC100 - 115V+10, -15% ,50/60Hz±3Hz Note 3)					
Environment	Ambient temperature	0 - 55°C					
	Storage temperature	-20 - +65°C					
	Operation/ Storage humidity	Below 90%RH (no condensation)					
	Elevation	Below 1000m					
	Vibration	$5m/s^2$ Frequency range 10 - 55Hz tested for 2H in each direction X.Y.Z					
	Shock	$20m/s^2$					
Structure		Built-in tray type power supply					
Servo amplifier model number		RS2#01A#KA# RS2#01A#KL#	RS2#03A#KA# RS2#03A#KL#	RS2#05A#KA# RS2#05A#KL#	RS2A10A##A# RS2A10A##L#	RS2A15A##A# RS2A15A##L#	RS2A30A##L#
External dimensions (H×W×D)		40×160×130	50×160×130	85×160×130	205(235) ×100×220	205(235) ×120×220	205(235) ×220×220
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
	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

Note 1) Power source voltage should be within the specified range AC200V Power input type:
Specified power supply range = AC170V - AC253V
AC100VPower input type: Specified power supply range = AC85V - AC127V

Note 2) AC200V-single-phase input type corresponds only to RS2☐01/RS2☐03/RS2☐05.

Note 3) AC100Vsingle-phase input type corresponds only to, RS2*01/RS2*03

■ Performance

Speed control range	1 : 5000
Frequency characteristics	800Hz

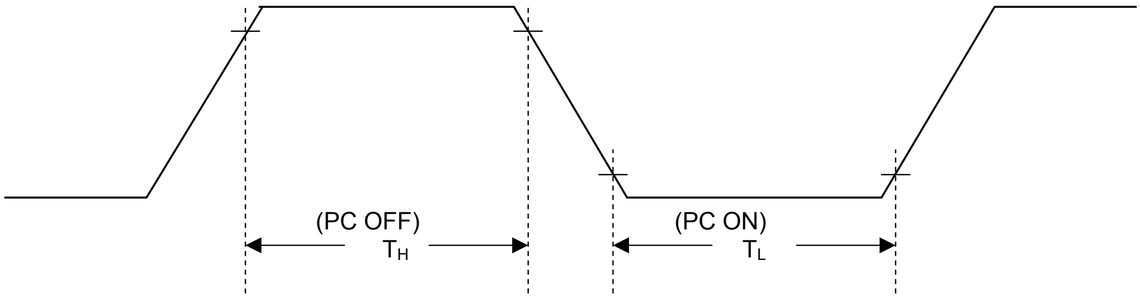
■ Built-in functions

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 $1000min^{-1}$)
	Torque (Thrust) (TCMON)	2.0V±10% (at 100%)

2) General Input/Output

■ General input signals

Sequence input signals	Interactive photo coupler (sink, source connection):×2 input
	Input power voltage range: DC5V ±5%/ DC12V - DC24V±10%,100mA or over (DC24V)
	Forward direction limit switch, Reverse direction limit switch, External trip, Forced discharge, Emergency stop. Refer to [Index: 0x20F8 General input function selection (Section 7)]



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

General input functions	Photo coupler ON Hold time (T_L)	Photo coupler OFF Hold time (T_H)
Emergency stop function (Emergency Stop)	Min.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	Photorelay output (SYNC, Source connection) x 2 outputs
	External power supply voltage:DC5V±5% / DC12V～DC24V±10%, 20mA or over
	Circuit power for output signal:DC5V±5% / Maximum current value 10mA(per 1 output) Circuit power for output signal:DC12V - DC15V±10% / Maximum current value 30mA (per 1 output) Circuit power for output signal:DC24V - DC15V±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)
AC200V	RS2A01#	R2AA04003F	30	0.2	40
		R2AA04005F	50	0.2	
		R2AA04010F	100	0.3	
		R2AA06010F	100	0.3	
		R2AA06020F	200	0.6	
		R2AA06040H	200	1.0	
		R2AA08020F	200	0.6	
		R5AA06020H	200	0.6	
		R5AA06020F	200	0.6	
		R5AA06040H	400	1.0	
	RS2A03#	R2AA06040F	400	1.0	
		R2AA08040F	400	1.0	
		R2AA08075F	750	1.6	
		R2AAB8100H	1000	2.0	
		R2AA10075F	750	1.7	
		R2AA13050H	550	1.2	
		R2AA13050D	550	1.2	
		R2AA13120B	1200	2.2	
		R5AA06040F	400	1.0	
		R5AA08075D	750	1.6	
		R5AA08075F	750	1.6	
	RS2A05#	R2AAB8075F	750	1.6	
		R2AAB8100F	1000	2.3	
		R2AA10100F	1000	2.3	
		R2AA13120D	1200	2.8	
		R2AA13120L	1200	2.8	
		R2AA13180H	1800	3.6	
		R2AA13200L	2000	4.0	
	RS2A10#	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	
	RS2A15#	R2AA18350D	3500	7.0	
		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	
	RS2A30#	R2AA18550H	5500	9.3	
		R2AA18750H	7500	11.6	
		R2AA1811KR	11000	16.0	
		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

■ 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)
AC100V	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

■ 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)
AC200V	RS2A03L	DS030C1N2	160	1.4	40
		DS050C1N2	260	1.4	
		DS075C1N2	400	1.5	
	RS2A05L	DS030C2N2	320	2.7	
		DS050C2N2	520	2.7	
		DS075C2N2	800	3.0	
		DS100C1N2	540	3.2	
		DS150C1N2	800	3.2	
		DD030C1Y4	430	2.7	
	RS2A10L	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	
		DD075C1Y2	1050	4.8	
	RS2A15L	DS100C3N2	1620	8.2	
		DS150C3N2	2400	8.2	
		DD050C2Y2	1400	8.8	
		DD075C2Y2	2100	9.5	
	RS2A30L	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

<table>
<tr><th>Input Voltage</th><th>Servo amplifier capacity</th><th>Control power
(Maximum value between1ms after input)</th><th>Main circuit power
(Maximum value between 1.2seconds after input)</th></tr>
<tr><td rowspan="6">AC200V</td><td>RS2A01#</td><td rowspan="6">40A (O-P)</td><td rowspan="3">22A (O-P)</td></tr>
<tr><td>RS2A03#</td></tr>
<tr><td>RS2A05#</td></tr>
<tr><td>RS2A10#</td><td rowspan="3">17A(O-P)</td></tr>
<tr><td>RS2A15#</td></tr>
<tr><td>RS2A30#</td></tr>
<tr><td rowspan="2">AC100V</td><td>RS2E01#</td><td rowspan="2">20A (O-P)</td><td rowspan="2">11A (O-P)</td></tr>
<tr><td>RS2E03#</td></tr>
</table>

* # = Optional alphabetical letter
* Using thermistor for incoming prevention circuit of control power supply. This is the maximum current value under normal temperature conditions when AC230V or AC115V is supplied.
* Incoming current value is the value when AC230V or AC115V 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

* # = 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)
AC200V	RS2A01A	R2AA04003F	13
		R2AA04005F	14
		R2AA04010F	15
		R2AA06010F	15
		R2AA06020F	20
		R2AA06040H	22
		R2AA08020F	20
		R5AA06020H	20
		R5AA06020F	20
		R5AA06040H	22
	RS2A03A	R2AA06040F	31
		R2AA08040F	30
		R2AA08075F	43
		R2AAB8100H	45
		R2AA10075F	43
		R2AA13050H	40
		R2AA13050D	44
		R2AA13120B	50
		R5AA06040F	31
		R5AA08075D	43
		R5AA08075F	43
	RS2A05A	R2AAB8075F	45
		R2AAB8100F	52
		R2AA10100F	50
		R2AA13120D	68
		R2AA13120L	60
		R2AA13180H	87
		R2AA13200L	87
	RS2A10A	R2AA13180D	92
		R2AA13200D	100
		R2AA18350L	148
		Q1AA10200D	112
		Q1AA10250D	118
		Q1AA12200D	104
		Q1AA12300D	125
		Q1AA13300D	127
		Q2AA13200H	98
		Q2AA18200H	108
AC200V	RS2A15A	R2AA18350D	148
		R2AA18450H	163
		R2AA18550R	213
		R2AA22500L	164
		Q1AA13400D	157
		Q1AA13500D	180
		Q1AA18450M	150
		Q2AA18350H	148
		Q2AA18450H	163
		Q2AA18550R	213
		Q2AA22550B	200
		Q2AA22700S	235
	RS2A30A	R2AA18550H	315
		R2AA18750H	365
		R2AA1811KR	430
		Q1AA18750H	380
		Q2AA18550H	315
		Q2AA18750L	365
		Q2AA2211KV	440
		Q2AA2215KV	450
		Q4AA1811KB	430
		Q4AA1815KB	450
AC100V	RS2E01A	R2EA04003F	13
		R2EA04005F	15
		R2EA04008F	16
		R2EA06010F	17
	RS2E03A	R2EA06020F	26

* 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 (Installation Servo amplifier (3-1).)
* Values are rated speed and rated torque.

■Linear motor

Input voltage	Servo amplifier capacity	Servo motor model number	Servo amplifier total calorific value (W)
AC200V	RS2A03L	DS030C1N2	41
		DS050C1N2	41
		DS075C1N2	42
	RS2A05L	DS030C2N2	68
		DS050C2N2	68
		DS075C2N2	69
		DS100C1N2	70
		DS150C1N2	70
		DD030C1Y4	65
	RS2A10L	DS030C3N2	91
		DS050C3N2	91
		DS075C3N2	93
		DS100C2N2	135
		DS150C2N2	135
		DD030C2Y4	110
AC200V	RS2A10L	DD030C3Y4	138
		DD050C1Y2	110
		DD075C1Y2	110
	RS2A15L	DS100C3N2	185
		DS150C3N2	185
		DD050C2Y2	210
		DD075C2Y2	210
	RS2A30L	DD050C3Y2	270
		DD075C3Y2	275
		DD075C4Y2	380

* 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 (Installation Servo amplifier (3-1).)
* Values 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 ($kg \cdot m^2$)
  - ◆ J_L :Load inertia ($kg \cdot m^2$)
  - ◆ N1, N2 :Rotational speed of motor (min^{-1})
  - ◆ T_P :Instantaneous maximum stall torque ($N \cdot m$)
  - ◆ T_L :Load torque ($N \cdot m$)

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

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

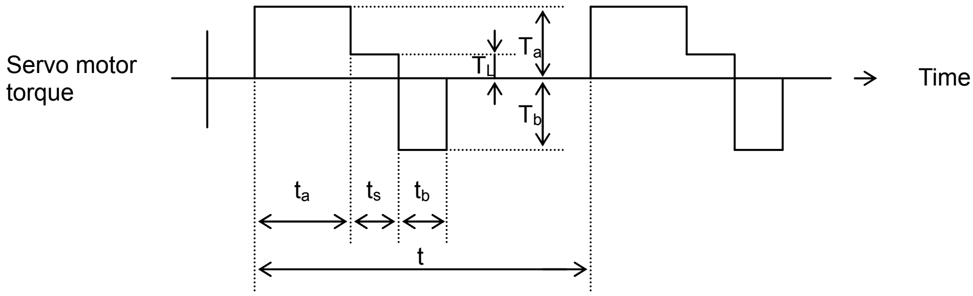
■ Frequency of permitted repetitions for the servo amplifier
When Start/Stop sequences are repeated frequently, confirm in advance that the frequency of repetitions are within tolerance range. Allowed repetitions differ depending on the type, capacity, load inertia, adjustable speed current value and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

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

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

■ When the motor repeats continuous speed status and stop status

In operating status (shown below) the motor should be used at a frequency in which its effective torque is less than the rated torque T_{R}.



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

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

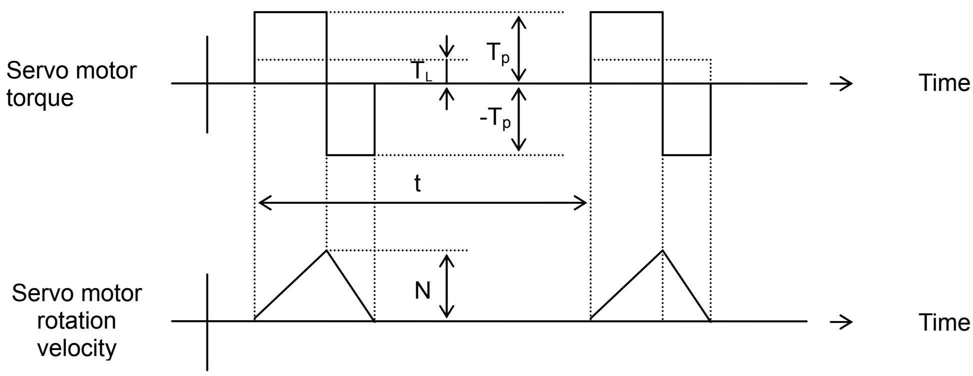
T_a : Acceleration torque
T_b : Deceleration torque
T_L : Load torque
T_{rms} : Effective torque
T_R : Rated torque
t_s : constant speed time [s]

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

* When actually determining the system drive mode, it is recommended to calculate the load margin and suppress it to Trms < 0.9T_R.

■ When the motor repeats acceleration, deceleration and stop status

In operating status (shown below) the value of permitted repetitions n (times/minutes) is found with the following equation:

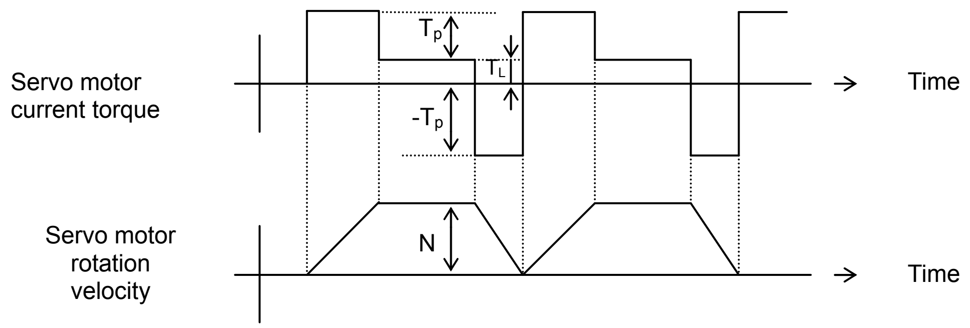


$$N = 2.86 \times 10^2 \times \frac{1}{N\,(J_M+J_L)} \times \frac{T_P^{2}-T_L^{2}}{T_P^{3}} \times T_R^{2} \qquad [\text{times/min}]$$

T_R : Rated torque

■ When the motor repeats acceleration – constant speed operation – deceleration status

For the operating status shown below, the value of permitted repetitions n (times/min) is found in the following equation:



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

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)
  - V1,V2 : Speed of motor (m/s)
  - F_P : Maximum thrust (N)
  - F_L : Load thrust (N)

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

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

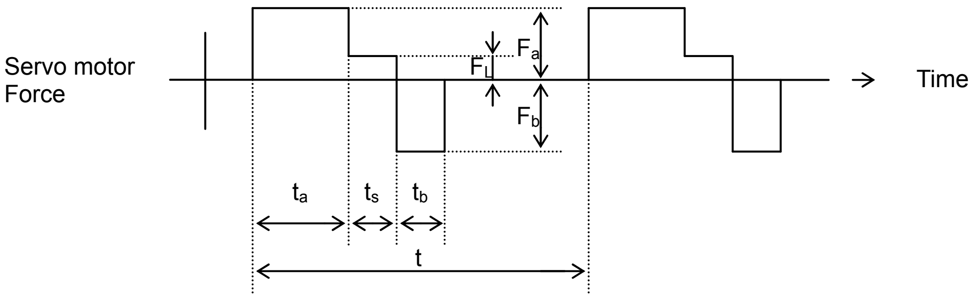
- Frequency of permitted repetitions for the servo amplifier
  When Start/Stop sequences are repeated frequently, confirm in advance that the frequency of repetitions are within tolerance range. Allowed repetitions differ depending on the type, capacity, and load mass, adjustable speed current value and motor velocity of the motor in use. If the load mass = motor coil mass x m-times, and when the permitted Start/Stop repetitions (up to the maximum rotation speed) exceed the following value, please contact us for assistance, as precise calculation of execution force and regenerating power is critical.

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

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

■ When the motor repeats continuous speed status and stop status

In operating status (shown below) the motor should be used at a frequency in which its execution force is less than the rated force F_R.



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

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

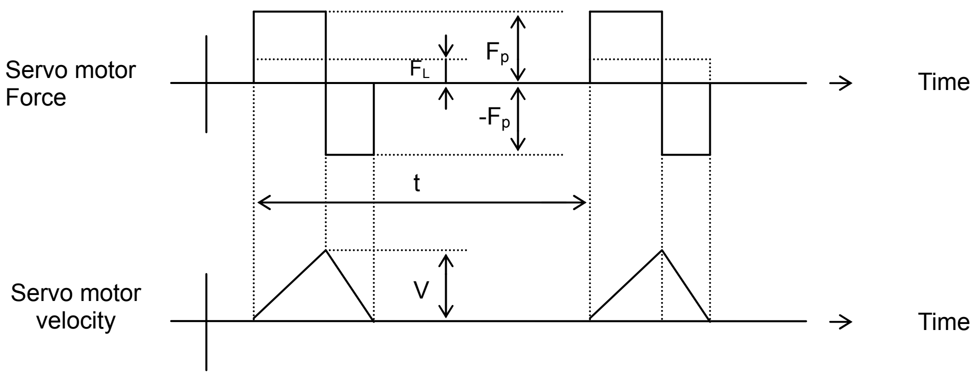
F_a : Acceleration force
F_b : Deceleration force
F_L : Load force
F_{rms} : Effective force
F_R : Rated force
t_s : constant speed time [s]

◆ When the cycle time (t) is predetermined Fa, Fb, t_a, t_b appropriate in the above formula are required.

* When actually determining the system drive mode, it is recommended to calculate the load margin and suppress it to Frms < $0.9F_R$.

■ When the motor repeats acceleration, deceleration and stop status

In operating status (shown below) the value of permitted repetitions n (times/minutes) is found with the following equation:

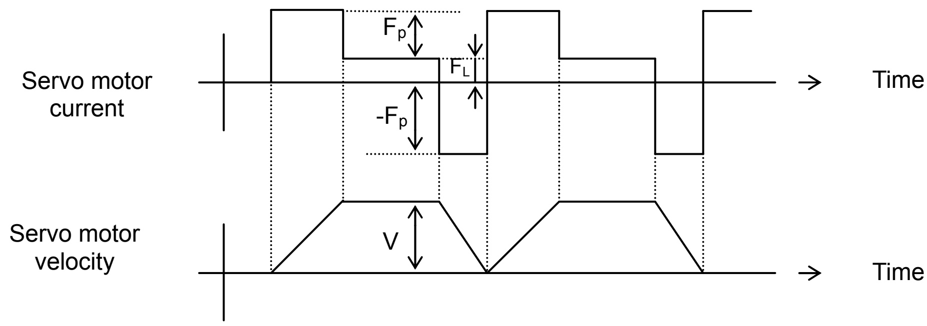


$$n = 30 \times \frac{1}{V\,(M_C+M_L)} \times \frac{F_P^2 - F_L^2}{F_P^3} \times F_R^2 \quad [\text{times/min}]$$

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.

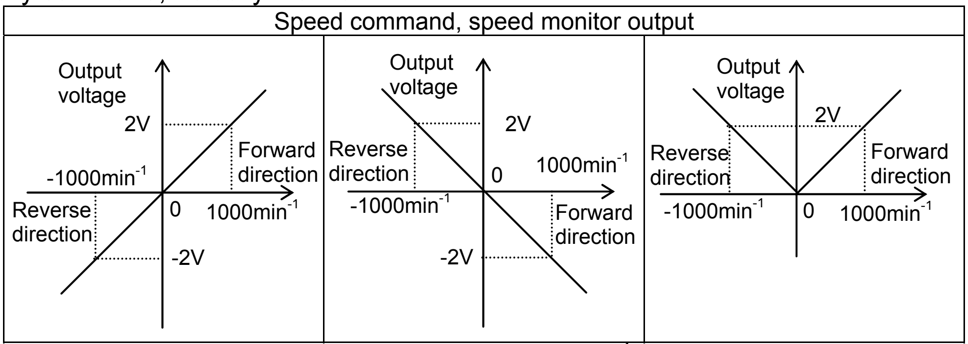
- ◆ Reduce the force limit
- ◆ Extend the acceleration and deceleration times (slow down)
- ◆ Reduce the maximum speed
- ◆ Re-examine regenerative resistance

2.7 Specifications for Analog Monitor

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

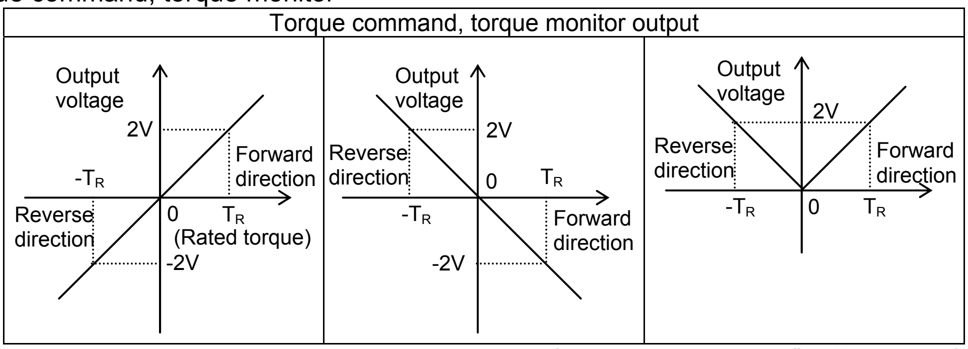
* Monitor output is indefinite at the time of power ON/OFF and may output DC12V+/- around 10%.

- ■ Velocity command, Velocity monitor



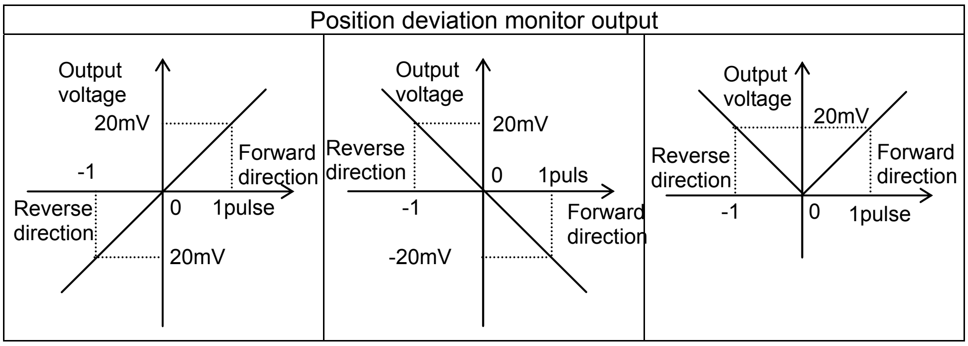
* Horizontal unit when suing linear motor is changed from “min^{-1}” to “mm/s.”

- ■ 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:

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

■ If/When the load inertia (J_L) 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_{RD} by dynamic brake resistance in one dynamic brake operation is as follows:

■ Rotary motor

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

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

■ Linear motor

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

Rφ :Servo motor phase winding resistance (Ω)
M :Moving part mass (kg)
V :Velocity just before deceleration (m/s)

■ Instantaneous tolerance of dynamic brake

Servo amplifier Model number	E_{RD} (J)
RS2#01A##A#, RS2#01A##L#	360
RS2#03A##A#, RS2#03A##L#	360
RS2#05A##A#, RS2#05A##L#	1800
RS2#10A##A#, RS2#10A##L#	2450
RS2#15A##A#, RS2#15A##L#	2450
RS2#30A##L#	9384

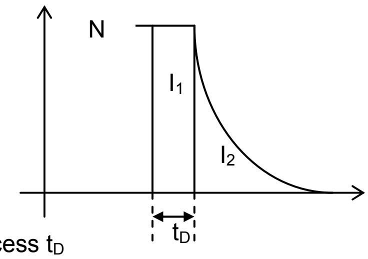
* # = Optional number or alphabetical letter.

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 :Inertia of servo motor (kg·m^2)
J_L :Load inertia (motor axis conversion)(kg·m^2)
N :Servo motor rotation speed (min^{-1})
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]
α·β :Constants for dynamic brake

α·β:

Servo amplifier apacity	Servo motor model number	α	β	J_M(kg·m2)
RS2A01	R2AA04003F	227	4.29×10^{-6}	0.0247×10^{-4}
	R2AA04005F	119	2.96×10^{-6}	0.0376×10^{-4}
	R2AA04010F	41.2	1.56×10^{-6}	0.0627×10^{-4}
	R2AA06010F	32.6	5.04×10^{-6}	0.117×10^{-4}
	R2AA06020F	14.5	2.46×10^{-6}	0.219×10^{-4}
	R2AA06040H	5.47	1.61×10^{-6}	0.412×10^{-4}
	R2AA08020F	11.3	1.13×10^{-6}	0.52×10^{-4}
	R5AA06020H	11.7	3.76×10^{-6}	0.2×10^{-4}
	R5AA06020F	15.36	2.92×10^{-6}	0.2×10^{-4}
	R5AA06040H	6.09	2.3×10^{-6}	0.416×10^{-4}
RS2A03	R2AA06040F	8.82	1.00×10^{-6}	0.412×10^{-4}
	R2AA08040F	6.91	4.25×10^{-6}	1.04×10^{-4}
	R2AA08075F	5.84	9.10×10^{-8}	1.82×10^{-4}
	R2AAB8100H	3.09	3.83×10^{-7}	2.38×10^{-4}
	R2AA10075F	6.04	1.2×10^{-6}	2.0×10^{-4}
	R2AA13050H	4.37	3.55×10^{-6}	3.1×10^{-4}
	R2AA13050D	6.46	2.14×10^{-6}	3.1×10^{-4}
	R2AA13120B	1.68	1.56×10^{-6}	6×10^{-4}
	R5AA06040F	10.11	1.55×10^{-6}	0.416×10^{-4}
	R5AA08075D	4.67	1.67×10^{-6}	1.65×10^{-4}
	R5AA08075F	6.45	2.75×10^{-6}	1.65×10^{-4}
RS2A05	R2AAB8075F	6.55	4.16×10^{-7}	1.64×10^{-4}
	R2AAB8100F	5.46	2.08×10^{-7}	2.38×10^{-4}
	R2AA10100F	5.35	4.86×10^{-7}	3.5×10^{-4}
	R2AA13120D	4.06	6.45×10^{-7}	6.3×10^{-4}
	R2AA13120L	2.99	1.21×10^{-6}	6×10^{-4}
	R2AA13180H	2.17	4.66×10^{-7}	9.0×10^{-4}
	R2AA13200L	1.83	3.1×10^{-7}	12.2×10^{-4}
RS2A10	R2AA13180D	2.12	1.23×10^{-7}	9.0×10^{-4}
	R2AA13200D	1.69	0.91×10^{-7}	12.2×10^{-4}
	R2AA18350L	0.82	1.6×10^{-8}	40×10^{-4}
	Q1AA10200D	4.19	0.47×10^{-7}	2.15×10^{-4}
	Q1AA10250D	2.70	0.46×10^{-7}	2.65×10^{-4}
	Q1AA12200D	2.85	0.33×10^{-7}	4.37×10^{-4}
	Q1AA12300D	1.53	0.27×10^{-7}	6.40×10^{-4}
	Q1AA13300D	1.78	0.53×10^{-7}	4.92×10^{-4}
	Q2AA13200H	1.23	0.48×10^{-7}	12×10^{-4}
	Q2AA18200H	1.49	0.36×10^{-7}	20×10^{-4}

Servo amplifier capacity	Servo motor model number	α	β	$J_M(kg\cdot m^2)$
RS2A15	R2AA18350D	1.05	1.3×10^{-8}	40×10^{-4}
	R2AA18450H	0.67	1.2×10^{-8}	50×10^{-4}
	R2AA18550R	0.53	7×10^{-9}	68×10^{-4}
	R2AA22500L	0.8	0.41×10^{-7}	55×10^{-4}
	Q1AA13400D	2.13	0.25×10^{-7}	6.43×10^{-4}
	Q1AA13500D	1.52	0.20×10^{-7}	8.47×10^{-4}
	Q1AA18450M	0.43	0.35×10^{-7}	27.5×10^{-4}
	Q2AA18350H	1.14	0.09×10^{-7}	38×10^{-4}
	Q2AA18450H	0.74	0.09×10^{-7}	55×10^{-4}
	Q2AA18550R	0.52	0.05×10^{-7}	72.65×10^{-4}
	Q2AA22550B	0.46	0.11×10^{-7}	95×10^{-4}
	Q2AA22700S	0.18	0.10×10^{-7}	185×10^{-4}
RS2A30	R2AA18550H	1.13	4×10^{-9}	68×10^{-4}
	R2AA18750H	0.72	2×10^{-9}	98×10^{-4}
	R2AA1811KR	0.51	3×10^{-9}	110×10^{-4}
	Q1AA18750H	0.92	4.97×10^{-9}	52×10^{-4}
	Q2AA18550H	1.1	2.38×10^{-9}	73×10^{-4}
	Q2AA18750L	0.7	2.40×10^{-9}	95×10^{-4}
	Q2AA2211KV	0.46	2.58×10^{-9}	186×10^{-4}
	Q2AA2215KV	0.32	2.04×10^{-9}	255×10^{-4}
	Q4AA1811KB	0.38	2.27×10^{-9}	63×10^{-4}
	Q4AA1815KB	0.25	2.62×10^{-9}	85×10^{-4}

Servo amplifier capacity	Servo motor model number	α	β	$J_M(kg\cdot m^2)$
RS2E01A	R2EA04003F	305	3.19×10^{-6}	0.0247×10^{-4}
	R2EA04005F	171	2.06×10^{-6}	0.0376×10^{-4}
	R2EA04008F	69.7	1.06×10^{-6}	0.0627×10^{-4}
	R2EA06010F	59.1	2.84×10^{-6}	0.117×10^{-4}
RS2E03A	R2EA06020F	38.8	9.10×10^{-7}	0.219×10^{-4}

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

Brake operation delay time : t_D

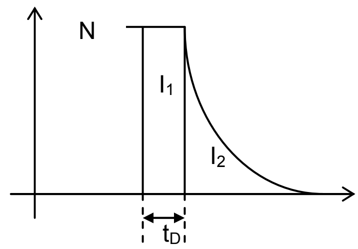
Servo amplifier model number	Delay time tD(S)
RS2#01A##A#, RS2#01A##L#	10×10^{-3}
RS2#03A##A#, RS2#03A##L#	10×10^{-3}
RS2#05A##A#, RS2#05A##L#	10×10^{-3}
RS2#10A##A#, RS2#10A##L#	24×10^{-3}
RS2#15A##A#, RS2#15A##L#	24×10^{-3}
RS2#30A##L#	42×10^{-3}

■ 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_D :Brake operation delay time [s]
t_D is the same constant as the one for rotary motor.
M :Moving part mass=Mc + ML [kg]
(MC: Coil mass [Kg],ML: Load mass [Kg])
α,β :Constants for dynamic brake



α･β:

Servo amplifier capacity	Servo motor model number	α	β	M (kg)
RS2A03L	DS030C1N2	6.88×10^{-3}	1.59×10^{-3}	2.8
	DS050C1N2	3.05×10^{-3}	1.27×10^{-3}	3.8
	DS075C1N2	1.75×10^{-3}	1.03×10^{-3}	5.2
RS2A05L	DS030C2N2	5.42×10^{-3}	5.04×10^{-4}	5.4
	DS050C2N2	2.27×10^{-3}	4.26×10^{-4}	7.4
	DS075C2N2	1.23×10^{-3}	3.64×10^{-4}	10
	DS100C1N2	2.65×10^{-3}	4.05×10^{-4}	6.6
	DS150C1N2	1.30×10^{-3}	3.49×10^{-4}	9.4
	DD030C1Y4	3.98×10^{-3}	1.08×10^{-3}	8.3
RS2A10L	DS030C3N2	4.46×10^{-3}	6.83×10^{-5}	7.8
	DS050C3N2	1.75×10^{-3}	6.17×10^{-5}	10.9
	DS075C3N2	8.91×10^{-4}	5.59×10^{-5}	14.8
	DS100C2N2	2.09×10^{-3}	3.21×10^{-5}	12.6
	DS150C2N2	9.60×10^{-4}	2.96×10^{-5}	17.8
	DD030C2Y4	2.21×10^{-3}	1.22×10^{-4}	15.0

Servo amplifier capacity	Servo motor model number	α	β	M (kg)
RS2A10L	DD030C3Y4	2.02×10^{-3}	5.92×10^{-5}	21.6
	DD050C1Y2	3.25×10^{-3}	1.09×10^{-4}	11.2
	DD075C1Y2	1.63×10^{-3}	9.95×10^{-5}	14.7
RS2A15L	DS100C3N2	2.03×10^{-3}	1.47×10^{-5}	18.6
	DS150C3N2	9.23×10^{-4}	1.37×10^{-5}	26.2
	DD050C2Y2	2.93×10^{-3}	3.01×10^{-5}	21.2
	DD075C2Y2	1.43×10^{-3}	2.83×10^{-5}	26.5
RS2A30L	DD050C3Y2	2.83×10^{-3}	1.39×10^{-5}	29.0
	DD075C3Y2	1.37×10^{-3}	1.32×10^{-5}	38.1
	DD075C4Y2	1.33×10^{-3}	7.60×10^{-6}	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 [Capacity Selection of Regenerative Resistor (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##A#	50Ω
RS2#03A##A#	50Ω
RS2#05A##A#	17Ω
RS2A10A##A#	10Ω
RS2A15A##A#	6Ω

* # = 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##A# RS2#01A##L#	5W	220W
RS2#03A##A# RS2#03A##L#	5W	220W
RS2#05A##A# RS2#05A##L#	20W	500W
RS2A10A##A# RS2A10A##L#	90W	500W
RS2A15A##A# RS2A15A##L#	120W	500W
RS2A30A##L#	-	500W

* # = Optional number or alphabetical letter.

3

3. Installation

3.1 Servo Amplifier

1) Servo Amplifier

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

■ Various precautions

The device should be installed on non-flammable surfaces only. Installation on or near flammable materials can cause fire.
Do not stand, and put heavy items on the servo amplifier.
Operate the device within the specified environmental conditions.
Do not drop the device or subject it to excessive shock.
Make sure no screws or other conductive or flammable materials get inside the servo amplifier.
Do not obstruct the air intake and exhaust vents. 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

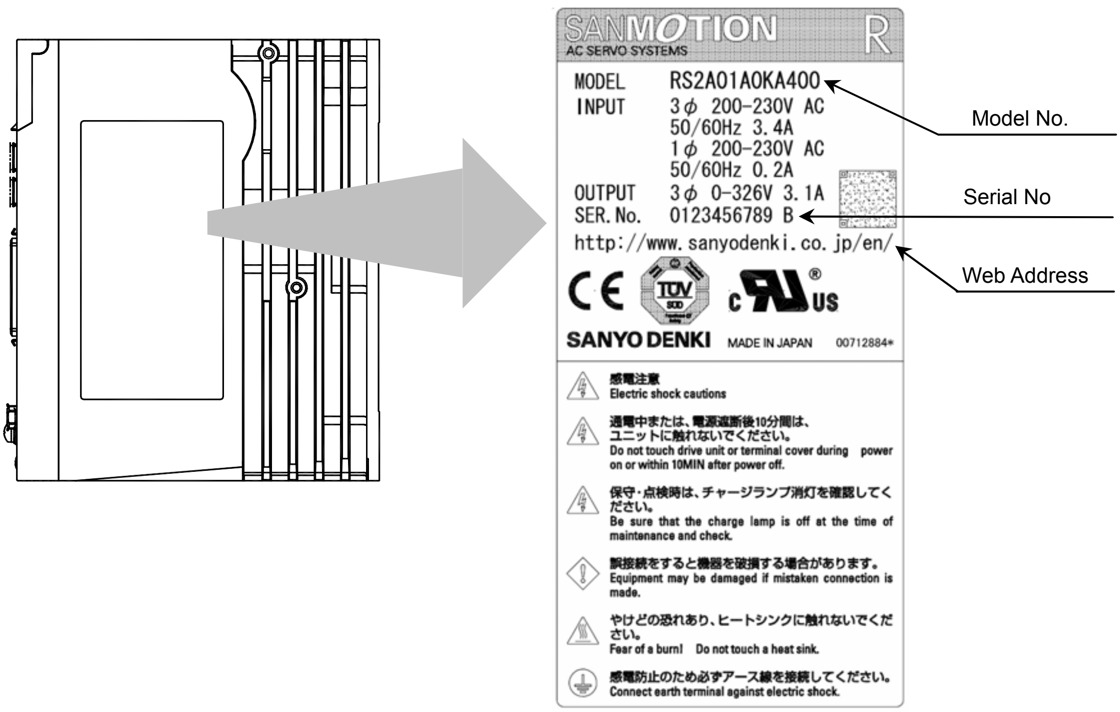
If inductive noise enters the input signals or the power circuit, it can cause a malfunction. If there is a possibility of noise, inspect the line wiring and take appropriate noise prevention measures. A noise filter should be installed to protect the servo amplifier.

2) Open package

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

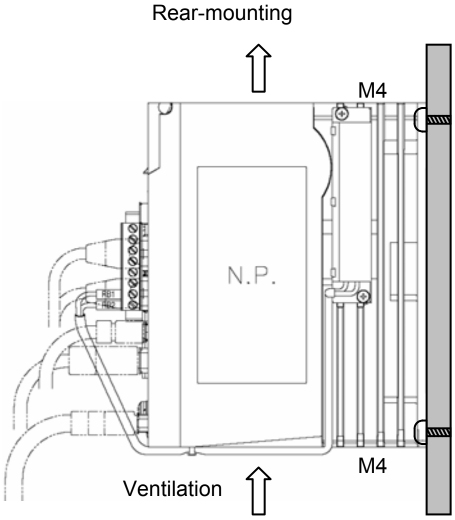
- ■ Verify that the model number of the servo motor or servo amplifier is the same as ordered.
  The model number is located on the main nameplate, following the word "MODEL".
- ■ Verify that there is no problem in the appearance of servo amplifier.
- ■ Verify that there are no loose screws on the servo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

Servo amplifier Servo amp main nameplate



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

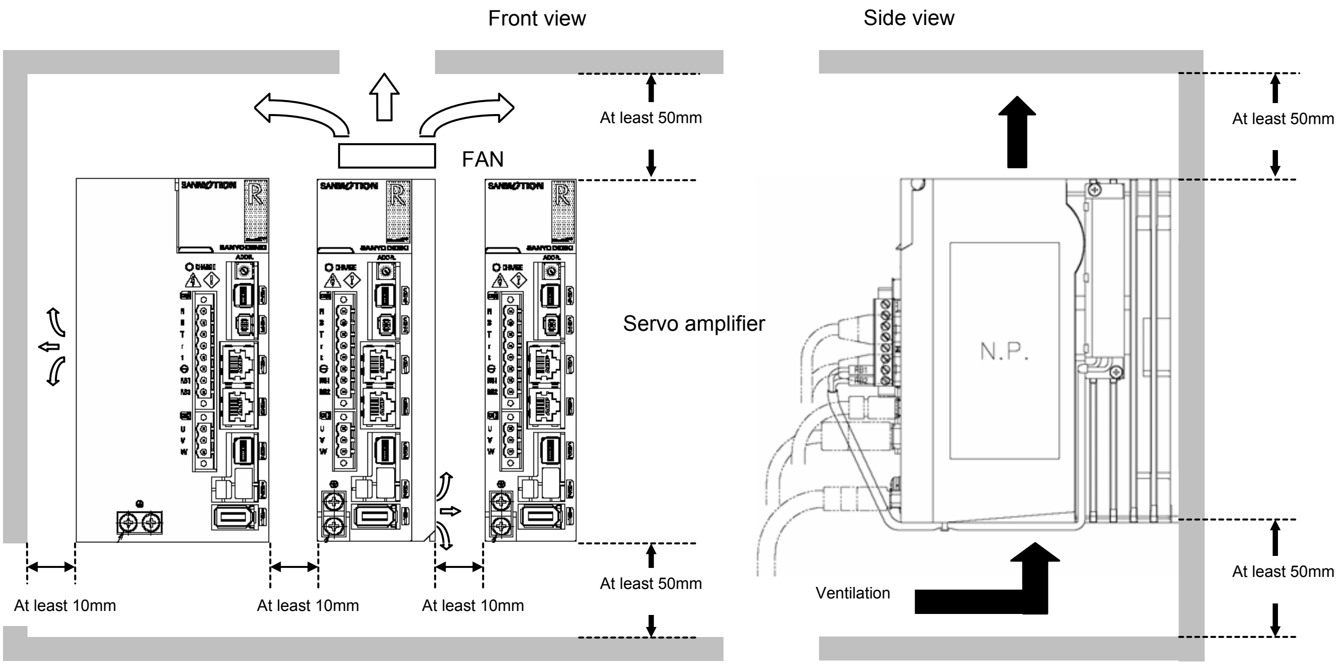
3) Mounting direction and location



* 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.



3.2 Rotary Motor

1) Precautions

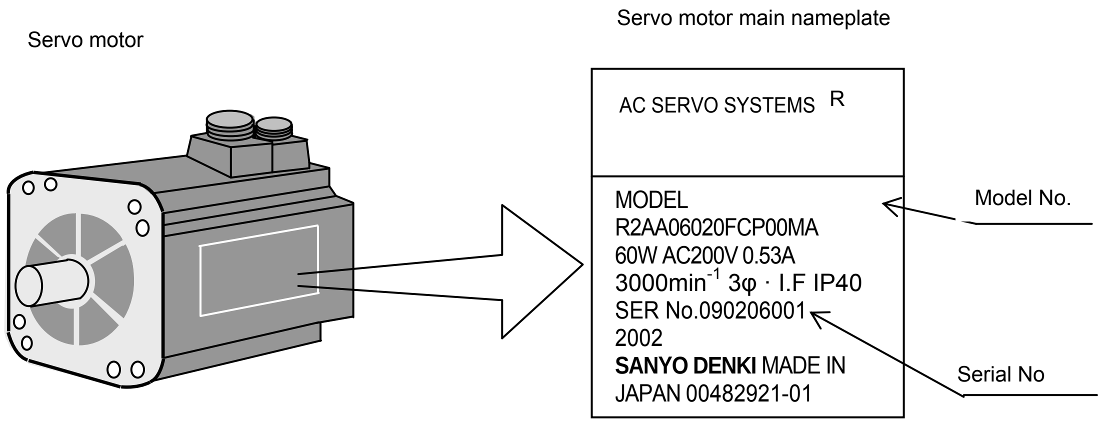
■ Various precautions

The device should be installed on non-flammable surfaces only. Installation on or near flammable materials can cause fire.
Do not stand, and put heavy items on the servo amplifier.
Operate the device within the specified environmental conditions.
Do not drop the device or subject it to excessive shock.
The attachment direction should be observed strictly.
The thing that damage and mounting parts have damaged should fix by returning to our company immediately.

2) Open package

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

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



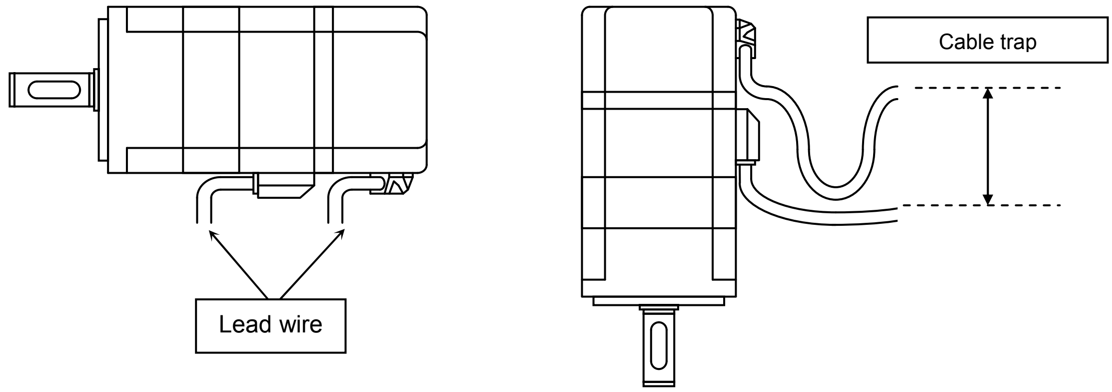
3) Installation

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

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.

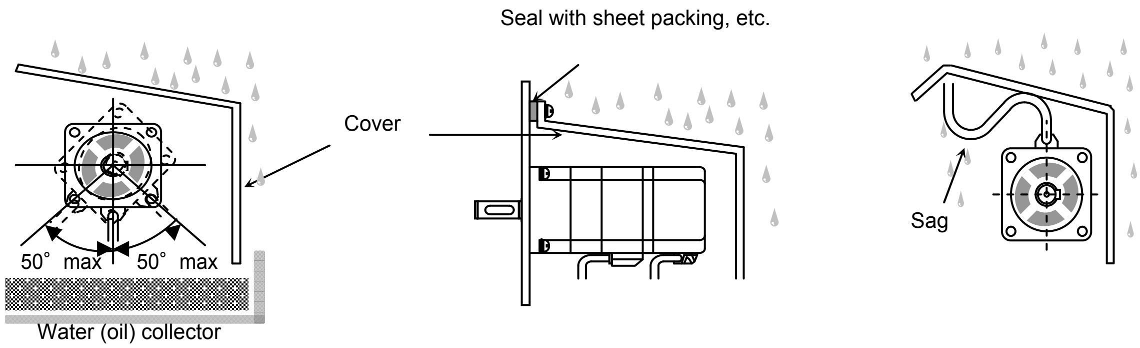


5) Waterproofing and dust proofing

- 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.

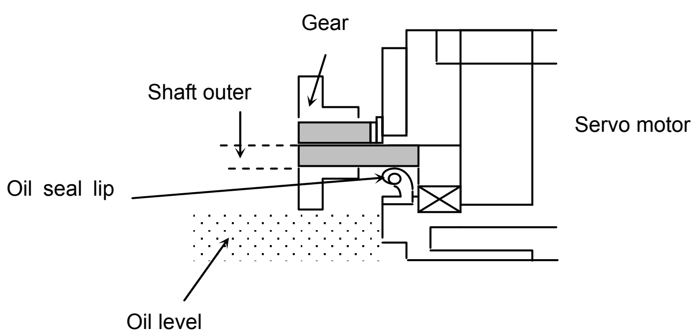
6) Protective cover installation

- 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.

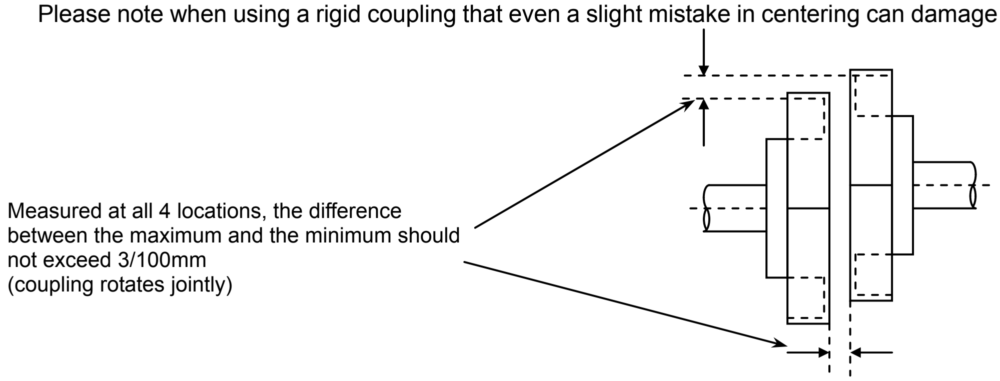


7) Gear installation and Integration with the target machinery

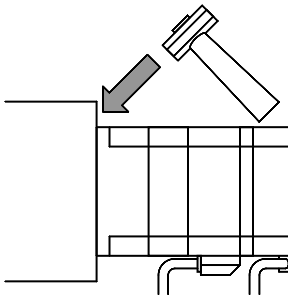
- The oil level of the gear box should be below the oil seal lip, for a slight spraying effect on the lip.
- Create a hole to prevent pressure build-up inside the gear box, as pressure can cause water or oil to penetrate the oil seal and enter inside the motor
- If the motor is used with the shaft facing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

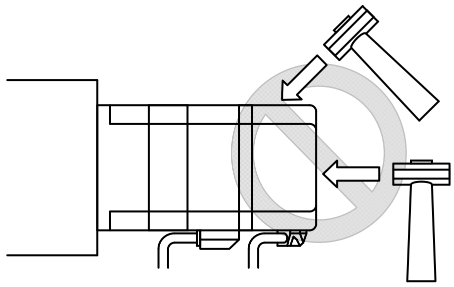


- ■ Refer to the drawing below for correct centering of the motor shaft and the target machinery.
  Please note when using a rigid coupling that even a slight mistake in centering can damage the output shaft.



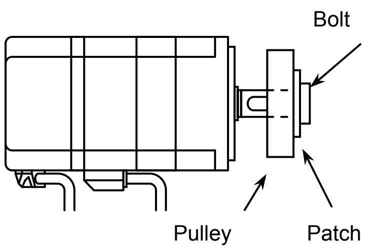
- ■ Do not subject the servo motor shaft to shock, as the precision encoder is directly connected to it.
  If it is absolutely necessary to hit the motor for position adjustment or other reasons, use a rubber or plastic hammer and hit the front flange area.

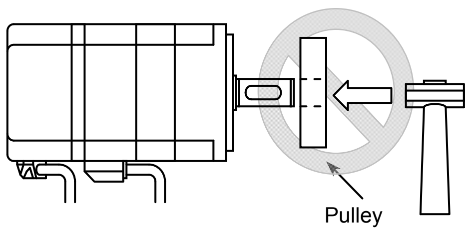




- ■ If mounting to a machine, create enough mounting holes for smooth coupling of the motor flange rabbet. The mounting surface should be flat, otherwise damage to the shaft or the load may occur.

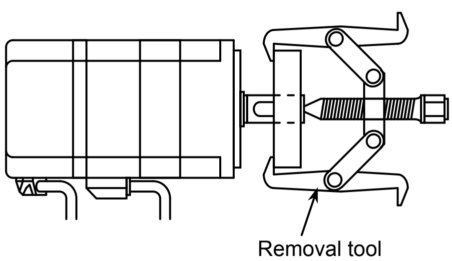
- ■ Use the screw at the end of the shaft for installing parts such as the gear, pulley, or coupling, to avoid shock.

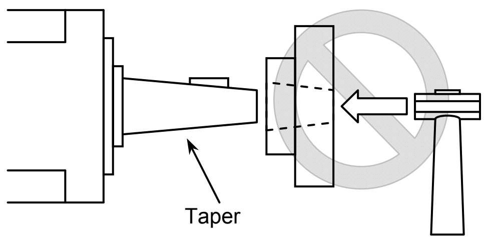




- ■ Tapered servo motor shafts transmit the torque via the tapered surface. Make sure the key fits without rattling. The tapered surface contact should be no less than 70%.

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

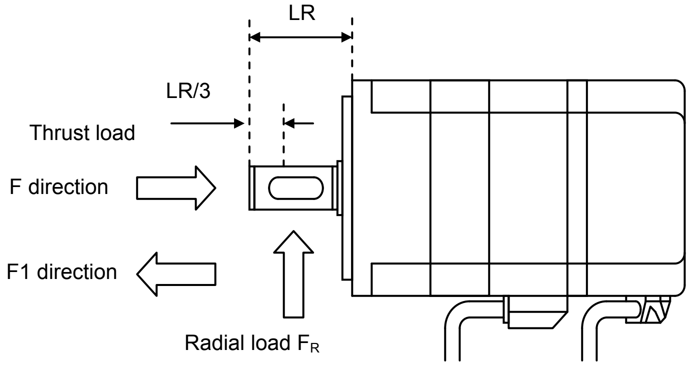




8) Allowable bearing load

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

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



	Servo motor model number	Assembly			Operation		
		Radial load (N)	Thrust load (N)		Radial load (N)	Thrust load (N)	
		FR	Direction F	Direction F1	FR	Direction F	Direction F1
R2	R2□A04003	98	78	78	49	29	29
	R2□A04005	150	98	98	98	29	29
	R2EA04008	150	98	98	98	29	29
	R2AA04010	150	98	98	98	29	29
	R2□A06010	150	98	98	98	29	29
	R2□A06020	390	200	200	200	68	68
	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
	R2AAB8075	590	780	290	340	200	200
	R2AAB8100	590	780	290	340	200	200
	R2AA10075	590	780	290	340	200	200
	R2AA10100	590	780	290	340	200	200
	R2AA13050	980	1400	1400	640	490	490
	R2AA13120	1700	1900	1900	640	490	490
	R2AA13180	1700	1900	1900	640	490	490
	R2AA13200	1700	1900	1900	640	490	490
	R2AA18350	2300	1900	1900	1500	290	290
	R2AA18450	2300	1900	1900	1500	290	290
	R2AA18550	3900	2000	2000	1800	590	590
	R2AA18750	3900	2000	2000	1800	590	590
	R2AA1811K	3900	2000	2000	1800	590	590
	R2AA22500	2300	1900	1900	1500	490	490

	Servo motor model number	Assembly			Operation		
		Radial load (N)	Thrust load (N)		Radial load (N)	Thrust load (N)	
		FR	Direction F	Direction F1	FR	Direction F	Direction F1
R5	R5AA06020	390	200	200	200	68	68
	R5AA06040	390	200	200	250	68	68
	R5AA08075	590	390	390	340	200	200
Q1	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	Q2AA13200	1700	1300	1300	690	290	290
	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

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.

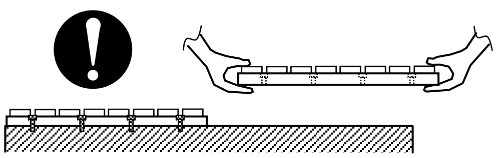
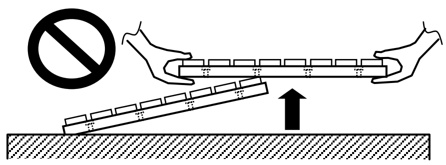
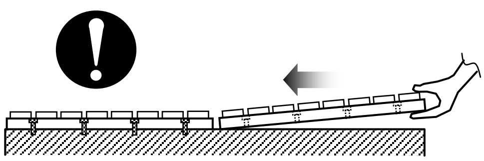
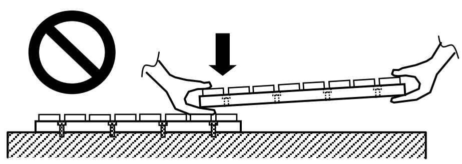
3.3 Linear motor

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.

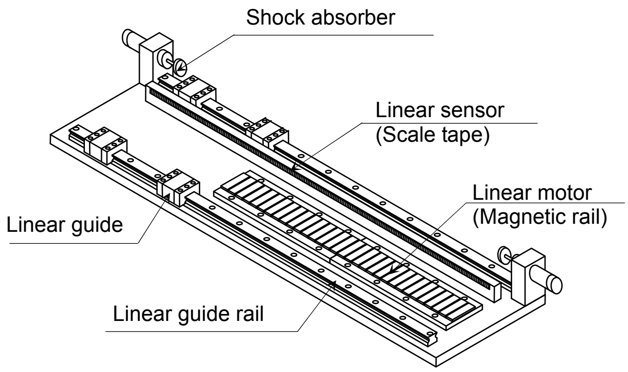
2) Installation of single magnet core-type linear motor

■ Installation of magnetic rails

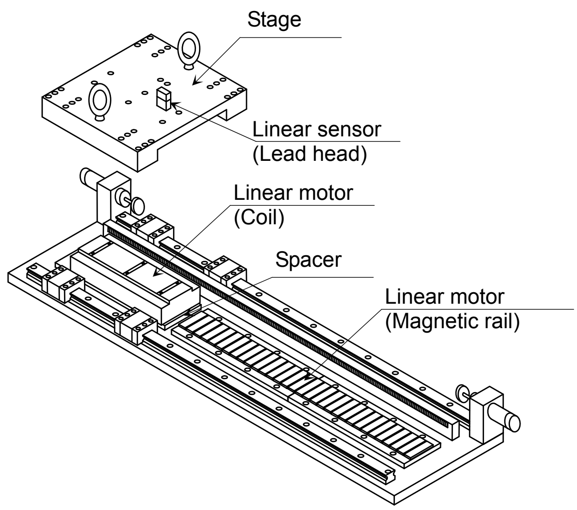
Step	Description
1	Strong magnet is set in the surface of the magnetic rail. High magnetic attraction force exists between themselves and between the rails and the motor coil or tools made of iron. Take care not to have your hands caught
2	Attraction force between the motor coil and the magnetic rail 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	All the pinholes of the magnetic rails must be facing the same direction.
5	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.
6	Position pinholes of the magnetic rails (ϕ5.1) must be all on the same side. If not, polarity order of the magnetic rails is inappropriate and there is a danger of runaway.
7	Install the magnetic rails one by one using all the installing screws. Tightening torque of the installing screws M6 is 13.6N・m or more (recommended: screw strength class 10.9, and non-magnetic screws), their engagement length is 9mm or longer and apply fixatives. 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.  
8	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. >

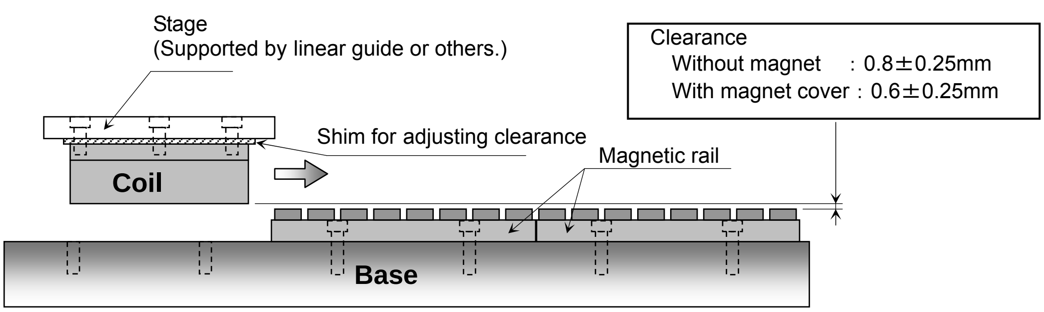
<table>
<tr><th>Step</th><th>Description</th></tr>
<tr><td rowspan="2">1</td><td>Install the magnetic rail at only the half of the whole stroke, and confirm that each area with and without magnetic rail is longer than the coil length by 50mm minimum.</td></tr>
<tr><td>



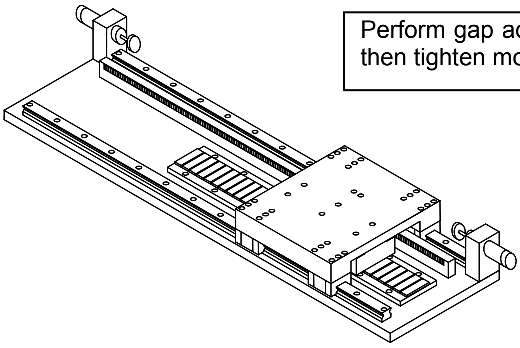
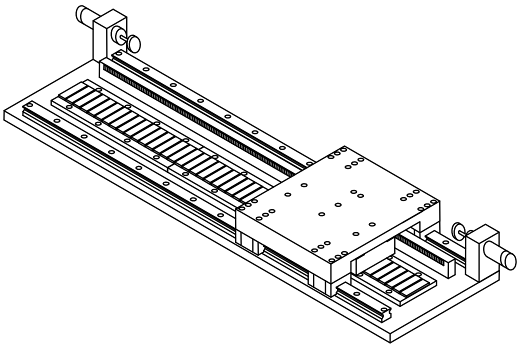
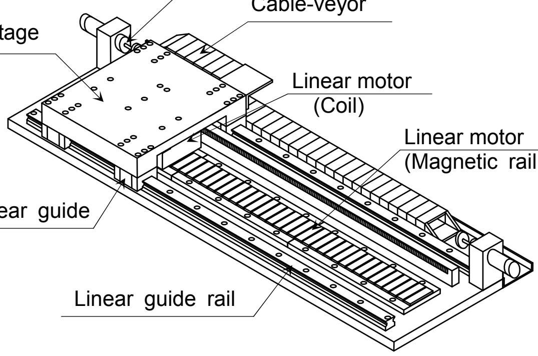
</td></tr>
<tr><td rowspan="2">2</td><td>Place the coil on the base where there is no magnetic rail using a spacer. Use a spacer of appropriate material which does not damage the base and the coil. Take care not to have your fingers caught in between the coil and the base. Use a spacer which is a little thinner than the magnetic rails.</td></tr>
<tr><td>



</td></tr>
<tr><td rowspan="2">3</td><td>All the M5 taps for installing the coil must be used. Tightening torque is 8.0N・m or more (screw strength class 10.9 or more), engagement length is longer than 6mm and shorter than 8mm. Apply fixatives. 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.
・Without magnet cover：0.8±0.25mm
・With magnet cover ：0.6±0.25mm</td></tr>
<tr><td>

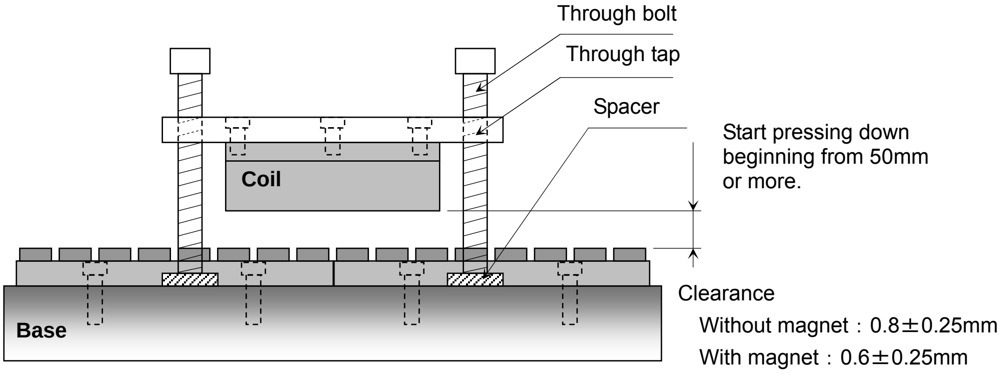


</td></tr>
</table>

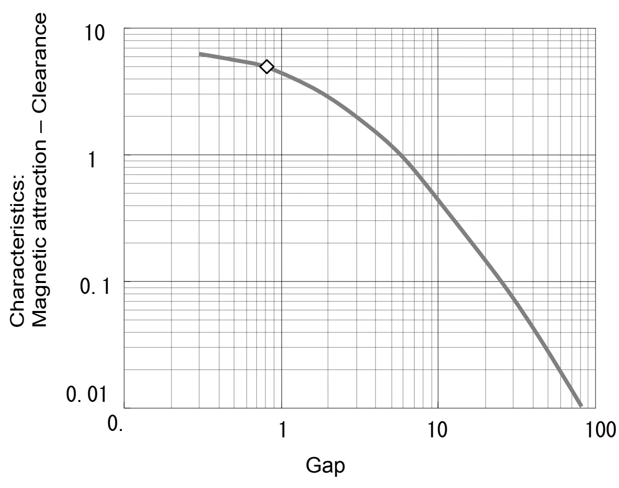
4	Slide the movable stage which has the coil installed onto the magnetic rails which have been fixed by screws. Magnetic force by which the coil is drawn toward the magnet surface is shown in the table below. When the whole coil is on the magnetic rail, attraction force no longer exists.  Perform gap adjust between the motor coil and magnetic rail, and then tighten mounting bolts.
5	Install the remaining magnetic rails. 
6	Installation is complete when the motor has been installed. Then conduct wiring. 

■ 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 shape and number of the taps 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.



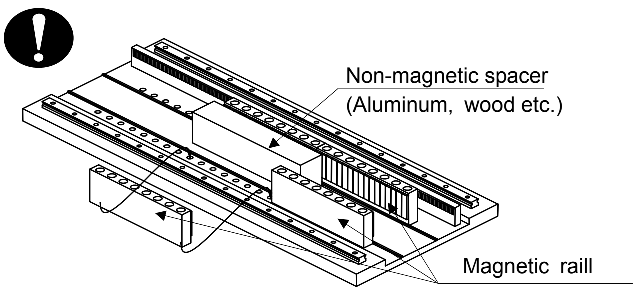
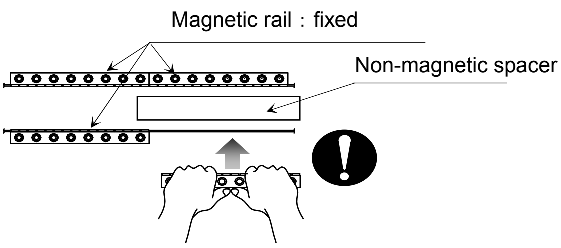
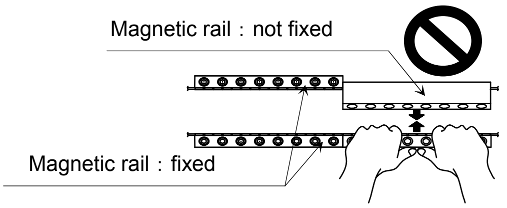
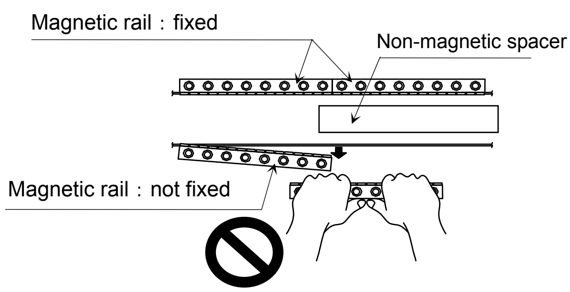
Characteristics of Magnetic Force

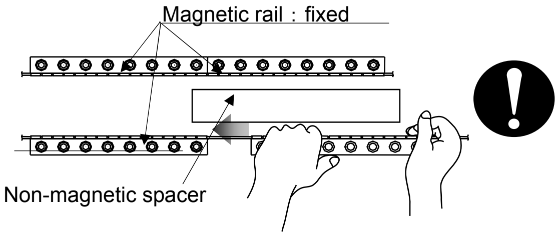
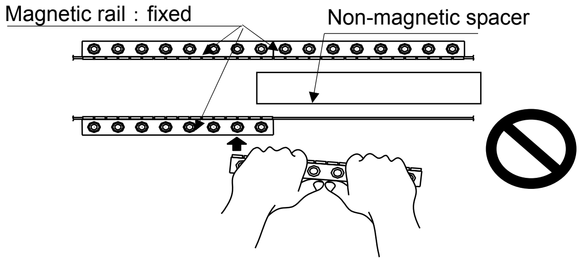


Keep 50mm or more for security reasons.

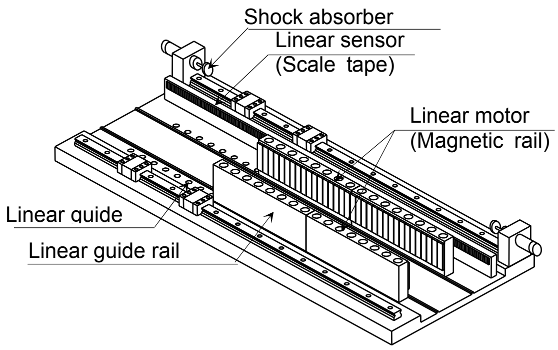
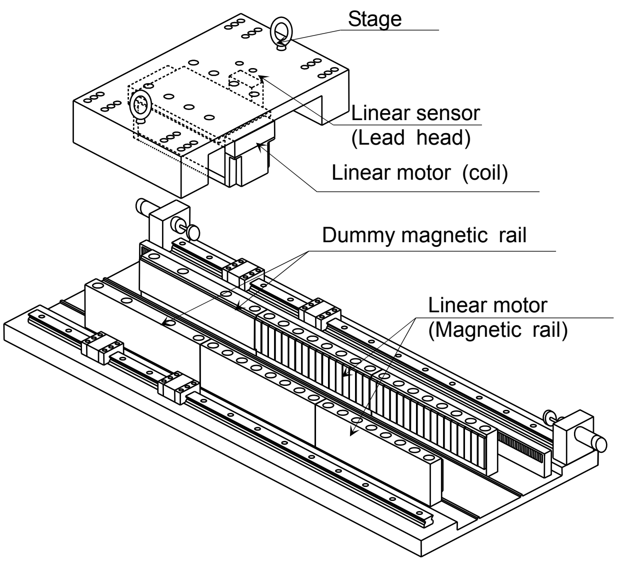
3) Installation of dual magnet core-type linear motor

■ 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 form attaching. Take care to keep the surface of the magnetic rails clean.
4	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. 
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	Install the magnetic rails one by one using all the installing bolts. Tightening torque of the installing bolts M10 is 66 N･m or more (recommended: bolt strength class 12.9), their engagement length is 15mm or longer and apply anti-loosening agent. 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.   

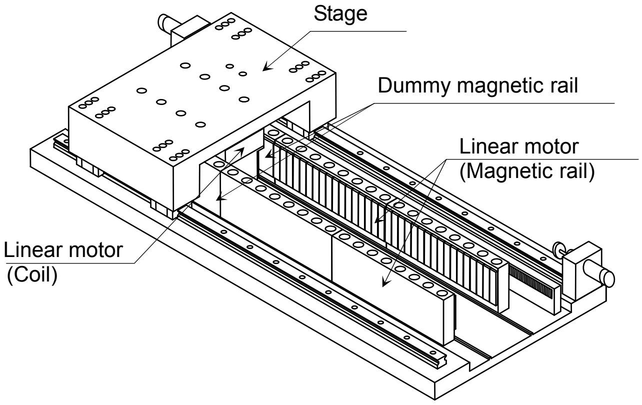
7	Install the magnetic rails in order from end. When installing one magnetic rail next to the one already fixed, do not place the former from the side of the latter but place it from front or back of the latter. Otherwise, magnetic force will be generated and may cause injury or breakage.  

■ Installation of coil

Step	Description
1	Install the magnetic rail at only the half of the whole stroke, and confirm that each area with and without magnetic rail is longer than the coil length by 50mm minimum.  Install the magnetic rail except for the motor coil length.
2	Install a dummy magnetic rail on the stroke without magnetic rails and insert the motor coil onto 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".) 

3

Temporarily fix the motor coil and the stage using installing bolts and adjust the gap between the dummy magnetic rail and the coil. Appropriate length of the gap is 1.3±0.2mm for the one without magnet cover, 1.1±0.2mm for the one with magnet cover. It is recommended that the difference of gaps at two points be 0.2mm maximum. After adjusting the gap, tighten the installing bolts for the motor coil and the stage. All the M8 taps for installing the motor coil must be used. Tightening torque is 38N・m (bolt strength class 12.9), engagement length is 8mm to 12mm. Apply fixatives.

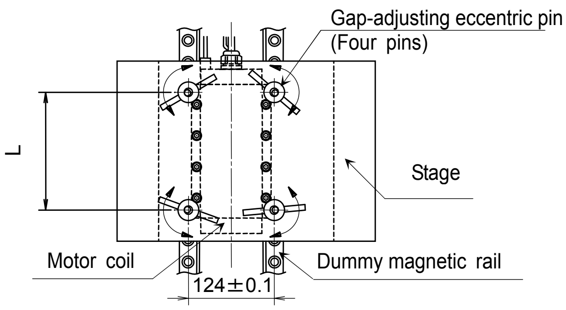


How to adjust the gap

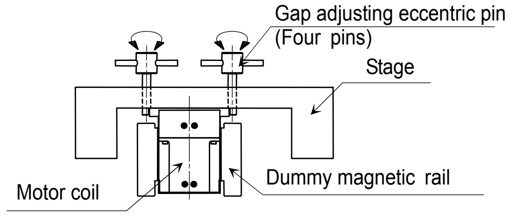
Make sure to perform gap adjustment on the area where the motor coil is facing dummy magneticrail. If adjustment is performed on the area with magnetic rails, injury or breakage may occur, because high magnetic attraction force exists on the motor coil. Never adjust the gap on the area with the magnetic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

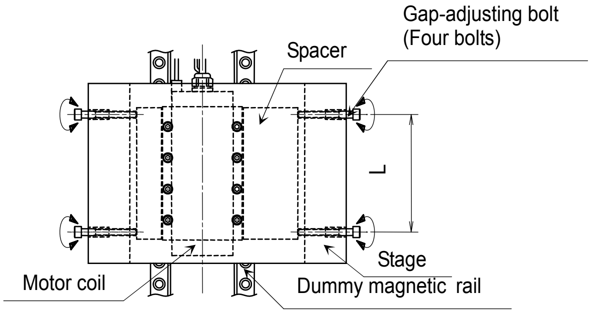
When eccentric pins are used.

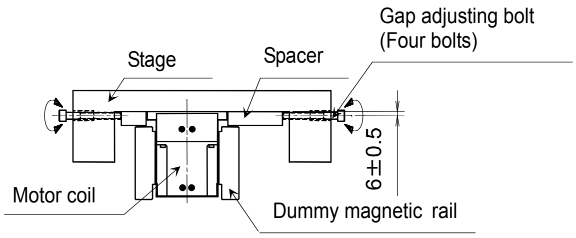
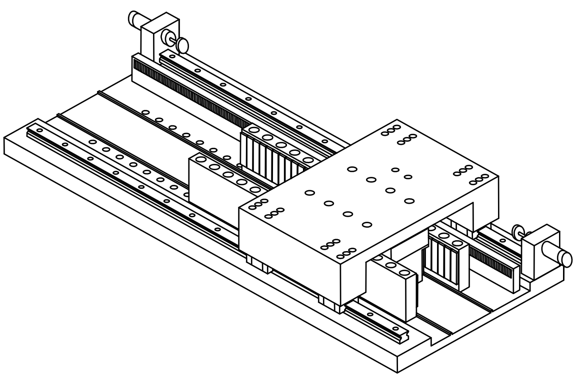
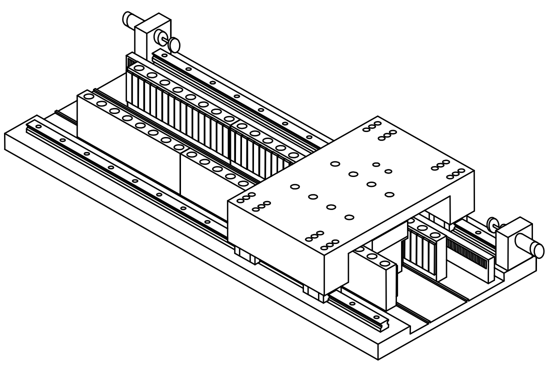
When eccentric pins are used, adjust the gap from top of the stage.
Make four or more holes for eccentric pins on top of the stage. The hole location must be determined so that the eccentric pins touch the upper plate of the motor coil. If the eccentric pins stress other point than the upper plate, the 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.

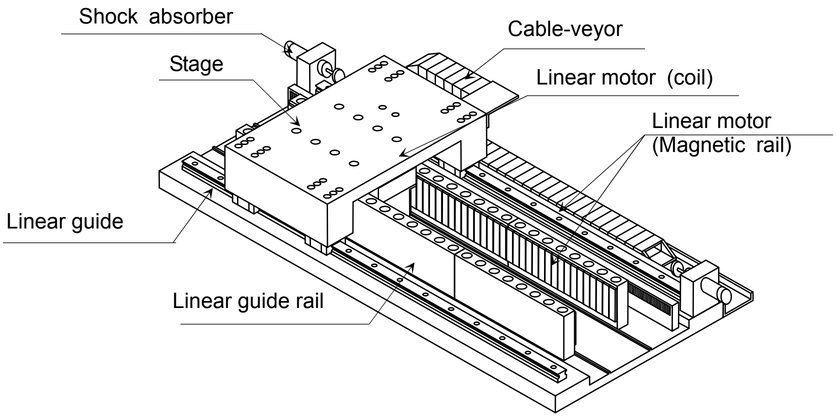


(Recommended location value of gap adjusting eccentric pin)



<table>
<tr><td rowspan="2">3</td><td>When bolts are used.</td></tr>
<tr><td>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.



</td></tr>
<tr><td rowspan="2">4</td><td>Slide the movable stage with the motor coil installed towards the magnetic rail side which was fixed with screws. At this time, the motor coil is drawn towards the magnetic rail side by the force of approx. ±300N. When the motor coil is completely inside the magnetic rail, the force no longer exists.</td></tr>
<tr><td></td></tr>
<tr><td rowspan="2">5</td><td>Remove the dummy magnetic rail and install the remaining magnetic rail.</td></tr>
<tr><td></td></tr>
</table>

6	When the motor has been installed, perform wiring. 

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

4. Wiring

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

1) Name and its function

Terminal name	Connector marking	Remarks	
Main circuit power supply	R・T or R・S・T	Single-phase AC100 - 115V +10%,-15% 50/60Hz ±3%	
		Single-phase AC200 - 230V +10%,-15% 50/60Hz ±3%	
		Three-phase AC200 - 230V +10%,-15% 50/60Hz ±3%	
Control power supply	r・t	Single-phase AC100 - 115V +10%,-15% 50/60Hz ±3%	
		Single-phase AC200 - 230V +10%,-15% 50/60Hz ±3%	
Servo motor connector	U・V・W	Connected with servo motor	
Safeguard connector	⏚	Connected with grounding wire of power supply and of servo motor.	
Regeneration resistance connector	RB1・RB2 RB4	RS2#01 RS2#03 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.

3) Wire diameter - Permissible current

<table>
<tr><th rowspan="2">AWG sides</th><th rowspan="2">Nominal cross-sectional area [mm²]</th><th rowspan="2">Conductor resistance [Ω/km]</th><th colspan="3">Permissible current over ambient temperature [A]</th></tr>
<tr><th>30°C</th><th>40°C</th><th>55°C</th></tr>
<tr><td>20</td><td>0.5</td><td>39.5</td><td>6.6</td><td>5.6</td><td>4.2</td></tr>
<tr><td>19</td><td>0.75</td><td>26.0</td><td>8.8</td><td>7.0</td><td>5.4</td></tr>
<tr><td>18</td><td>0.9</td><td>24.4</td><td>9.0</td><td>7.7</td><td>5.8</td></tr>
<tr><td>16</td><td>1.25</td><td>15.6</td><td>12.0</td><td>11.0</td><td>8.3</td></tr>
<tr><td>14</td><td>2.0</td><td>9.53</td><td>23.0</td><td>20.0</td><td>15.0</td></tr>
<tr><td>12</td><td>3.5</td><td>5.41</td><td>33.0</td><td>29.0</td><td>21.8</td></tr>
<tr><td>10</td><td>5.5</td><td>3.47</td><td>43.0</td><td>38.0</td><td>28.5</td></tr>
<tr><td>8</td><td>8.0</td><td>2.41</td><td>55.0</td><td>49.0</td><td>36.8</td></tr>
<tr><td>6</td><td>14.0</td><td>1.35</td><td>79.0</td><td>70.0</td><td>52.5</td></tr>
</table>

* 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 AC200V (R-series)

<table>
<tr><th rowspan="2">Servo motor model No.</th><th colspan="2">Motor power (U·V·W·⏚)</th><th rowspan="2">Servo amplifier to be combined</th><th colspan="2">Main circuit power supply (R·S·T⏚)</th><th colspan="2">Control power supply</th><th colspan="2">Regeneration resistance</th><th colspan="2">⏚</th></tr>
<tr><th>mm²</th><th>AWG No</th><th>mm²</th><th>AWG No</th><th colspan="2">mm²</th><th colspan="2">AWG No</th><th>mm²</th><th>AWG No</th></tr>
<tr><td>R2AA04003F</td><td rowspan="4">0.5</td><td rowspan="4">20</td><td rowspan="10">RS2#01#</td><td rowspan="10">1.25</td><td rowspan="10">16</td><td rowspan="39">1.25</td><td rowspan="39">16</td><td rowspan="10">1.25</td><td rowspan="10">16</td><td rowspan="29">2.0</td><td rowspan="29">14</td></tr>
<tr><td>R2AA04005F</td></tr>
<tr><td>R2AA04010F</td></tr>
<tr><td>R2AA06010F</td></tr>
<tr><td>R2AA06020F</td><td rowspan="6">0.75</td><td rowspan="6">19</td></tr>
<tr><td>R2AA06040H</td></tr>
<tr><td>R2AA08020F</td></tr>
<tr><td>R5AA06020H</td></tr>
<tr><td>R5AA06020F</td></tr>
<tr><td>R5AA06040H</td></tr>
<tr><td>R2AA06040F</td><td rowspan="12">0.75</td><td rowspan="12">19</td><td rowspan="12">RS2#03#</td><td rowspan="12">2.0</td><td rowspan="12">14</td><td rowspan="19">2.0</td><td rowspan="19">14</td></tr>
<tr><td>R2AA08040F</td></tr>
<tr><td>R2AA08075F</td></tr>
<tr><td>R2AAB8100H</td></tr>
<tr><td>R2AA10075F</td></tr>
<tr><td>R2AA13050D</td></tr>
<tr><td>R2AA13050H</td></tr>
<tr><td>R2AA13120B</td></tr>
<tr><td>R5AA08075D</td></tr>
<tr><td>R5AA06040F</td></tr>
<tr><td>R5AA08075D</td></tr>
<tr><td>R5AA08075F</td></tr>
<tr><td>R2AAB8075F</td><td rowspan="7">2.0</td><td rowspan="7">14</td><td rowspan="7">RS2#05#</td><td rowspan="7">2.0</td><td rowspan="7">14</td></tr>
<tr><td>R2AAB8100F</td></tr>
<tr><td>R2AA10100F</td></tr>
<tr><td>R2AA13120D</td></tr>
<tr><td>R2AA13120L</td></tr>
<tr><td>R2AA13180H</td></tr>
<tr><td>R2AA13200L</td></tr>
<tr><td>R2AA13200D</td><td rowspan="5">5.5</td><td rowspan="5">10</td><td rowspan="3">RS2#10#</td><td rowspan="3">5.5</td><td rowspan="3">10</td><td rowspan="3">5.5</td><td rowspan="3">10</td><td rowspan="3">5.5</td><td rowspan="3">10</td></tr>
<tr><td>R2AA13180D</td></tr>
<tr><td>R2AA18350L</td></tr>
<tr><td>R2AA18350D</td><td rowspan="3">RS2#15#</td><td rowspan="3">8.0</td><td rowspan="3">8</td><td rowspan="3">8.0</td><td rowspan="3">8</td><td rowspan="3">8.0</td><td rowspan="3">8</td></tr>
<tr><td>R2AA18450H</td></tr>
<tr><td>R2AA22500L</td><td>8.0</td><td>8</td></tr>
<tr><td>R2AA18550R</td><td rowspan="4">14.0</td><td rowspan="4">6</td><td rowspan="4">RS2#30#</td><td rowspan="4">14.0</td><td rowspan="4">6</td><td rowspan="4">8.0</td><td rowspan="4">8</td><td rowspan="4">14.0</td><td rowspan="4">6</td></tr>
<tr><td>R2AA18550H</td></tr>
<tr><td>R2AA18750H</td></tr>
<tr><td>R2AA1811KR</td></tr>
</table>

* Mark “#” shows optional number or alphabetical letter.

■ Input voltage AC200V (R-series)

<table>
<tr><th rowspan="2">Servo motor model No.</th><th colspan="2">Motor power (U·V·W·⏚)</th><th rowspan="2">Servo amplifier to be combined</th><th colspan="2">Main circuit power supply (R·S·T·⏚)</th><th colspan="2">Control power supply</th><th colspan="2">Regeneration resistance</th><th colspan="2">⏚</th></tr>
<tr><th>Mm²</th><th>AWG No</th><th>mm²</th><th>AWG No</th><th colspan="2">mm²</th><th colspan="2">AWG No</th><th>mm²</th><th>AWG No</th></tr>
<tr><td>Q1AA10200D</td><td rowspan="2">3.5</td><td rowspan="2">12</td><td rowspan="5">RS2#10#</td><td rowspan="5">5.5</td><td rowspan="5">10</td><td rowspan="22">1.25</td><td rowspan="22">16</td><td rowspan="5">5.5</td><td rowspan="5">10</td><td rowspan="5">5.5</td><td rowspan="5">10</td></tr>
<tr><td>Q1AA10250D</td></tr>
<tr><td>Q1AA12200D</td><td rowspan="6">5.5</td><td rowspan="6">10</td></tr>
<tr><td>Q1AA12300D</td></tr>
<tr><td>Q1AA13300D</td></tr>
<tr><td>Q1AA13400D</td><td rowspan="3">RS2#15#</td><td rowspan="3">8.0</td><td rowspan="3">8</td><td rowspan="3">8.0</td><td rowspan="3">8</td><td rowspan="3">8.0</td><td rowspan="3">8</td></tr>
<tr><td>Q1AA13500D</td></tr>
<tr><td>Q1AA18450M</td></tr>
<tr><td>Q1AA18750H</td><td>14.0</td><td>6</td><td>RS2#30#</td><td>14.0</td><td>6</td><td>8</td><td>8</td><td>14.0</td><td>6</td></tr>
<tr><td>Q2AA13200H</td><td rowspan="4">5.5</td><td rowspan="4">10</td><td rowspan="2">RS2#10#</td><td rowspan="2">5.5</td><td rowspan="2">10</td><td rowspan="2">5.5</td><td rowspan="2">10</td><td rowspan="2">5.5</td><td rowspan="2">10</td></tr>
<tr><td>Q2AA18200H</td></tr>
<tr><td>Q2AA18350H</td><td rowspan="5">RS2#15#</td><td rowspan="5">8.0</td><td rowspan="5">8</td><td rowspan="5">8.0</td><td rowspan="5">8</td><td rowspan="5">8.0</td><td rowspan="5">8</td></tr>
<tr><td>Q2AA18450H</td></tr>
<tr><td>Q2AA18550R</td><td rowspan="3">8.0</td><td rowspan="3">8</td></tr>
<tr><td>Q2AA22550B</td></tr>
<tr><td>Q2AA22700S</td></tr>
<tr><td>Q2AA18550H</td><td rowspan="6">14.0</td><td rowspan="6">6</td><td rowspan="6">RS2#30#</td><td rowspan="6">14.0</td><td rowspan="6">6</td><td rowspan="6">8</td><td rowspan="6">8</td><td rowspan="6">14.0</td><td rowspan="6">6</td></tr>
<tr><td>Q2AA18750L</td></tr>
<tr><td>Q2AA2211KV</td></tr>
<tr><td>Q2AA2215KV</td></tr>
<tr><td>Q4AA1811KB</td></tr>
<tr><td>Q4AA1815KB</td></tr>
</table>

■ Input voltage AC100V (R-series)

<table>
<tr><th rowspan="2">Servo motor model No.</th><th colspan="2">Motor power (U・V・W・⏚)</th><th rowspan="2">Servo amplifier to be combined</th><th colspan="2">Main circuit power supply (R・S・T・⏚)</th><th colspan="2">Control power supply</th><th colspan="2">Regeneration resistance</th><th colspan="2">⏚</th></tr>
<tr><th>mm²</th><th>AWG No</th><th>mm²</th><th>AWG No</th><th>mm²</th><th>AWG No</th><th>mm²</th><th>AWG No</th><th>mm²</th><th>AWG No</th></tr>
<tr><td>R2EA04003F</td><td rowspan="4">0.5</td><td rowspan="4">20</td><td rowspan="4">RS2#01A</td><td rowspan="4">1.25</td><td rowspan="4">16</td><td rowspan="5">1.25</td><td rowspan="5">16</td><td rowspan="4">1.</td><td rowspan="4">16</td><td rowspan="5">2.0</td><td rowspan="5">14</td></tr>
<tr><td>R2EA04005F</td></tr>
<tr><td>R2EA04008F</td></tr>
<tr><td>R2EA06010F</td></tr>
<tr><td>R2EA06020F</td><td>0.75</td><td>19</td><td>RS2#03A</td><td>2.0</td><td>14</td><td>2.</td><td>14</td></tr>
</table>

* # = 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.

5) Recommended wire diameter (Linear motor)

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

■ Input voltage AC200V (DS-series: Linear motor)

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		⏚	
	mm²	AWG No		mm²	AWG No	mm²	AWG No	mm²	AWG No	mm²	AWG No
DS030C1N2											
DS050C1N2	0.75	19	RS2#03L	2.0	14						
DS075C1N2											
DS030C2N2								2.0	14	2.0	14
DS050C2N2											
DS075C2N2	20	14	RS2#05L	2.0	8						
DS100C1N2											
DS150C1N2						1.25	16				
DS030C3N2											
DS050C3N2											
DS075C3N2	5.5	10	RS2#10L	5.5	10			5.5	10	5.5	10
DS100C2N2											
DS150C2N2											
DS100C3N2	8.0	8	RS2#15L	8.0	8			8.0	8	8.0	8
DS150C3N2											

■ Input voltage AC200V (DD-series: Linear motor)

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		⏚	
	mm²	AWG No		mm²	AWG No	mm²	AWG No	mm²	AWG No	mm²	AWG No
DS030C1Y4	2.0	14	RS2#05L	2.0	14	1.25	16	5.5	14	2.0	14
DS030C2Y4											
DS030C3Y4	5.5	10	RS2#10L	5.5	10			5.5	10	5.5	10
DS050C1Y2											
DS075C1Y2											
DS050C2Y2	8.0	8	RS2#15L	8.0	8	1.25	16	8.0	8	8.0	8
DS075C2Y2											
DS050C3Y2											
DS075C3Y2	14.0	6	RS2#30L	14.0	6			14.0	6	14.0	6
DS050C4Y2											

* # = 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 powering and braking line (Cable clamp) [Plug + clamp model number]		Plug for braking line (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				

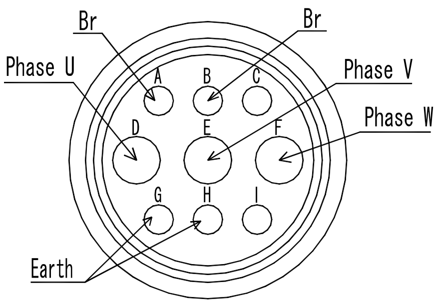
Note1) Plug for braking line is used in common with powering line.

* 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)
Yellow	B	Brake	Power for brake (24V)
-	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	⏚	-

* No polarity on terminal for brake power.



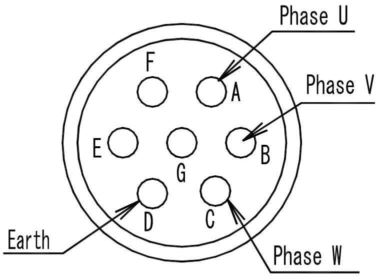
R-series servo motor
Canon plug for power line
Pin assignment (Viewed from motor)

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

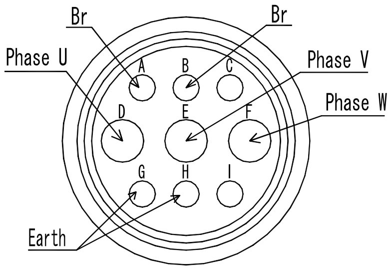
<table>
<tr><th rowspan="2">Servo motor model number</th><th colspan="2">Plug for power (Cable clamp)
【Plug + clamp model number】</th><th colspan="2">Plug for power (Cable clamp)
【Plug + clamp model number】</th><th rowspan="2">Remarks</th></tr>
<tr><th>Straight</th><th>Angle</th><th>Straight</th><th>Angle</th></tr>
<tr><td>Q1AA10200D
Q1AA10250D</td><td>N/MS3106B20-15S
(N/MS3057-12A)
【MS06B20-15S-12】</td><td>N/MS3108B20-15S
(N/MS3057-12A)
【MS08B20-15S-12】</td><td>JL04V-6A10SL-3SE-EB
(JL04-1012CK (50))
【332706×1】</td><td>JL04V-8A10SL-3SE-EB
(JL04-1012CK (50))
【332707×1】</td><td></td></tr>
<tr><td>Q1AA12200D
Q1AA12300D</td><td rowspan="2">N/MS3106B24-11S
(N/MS3057-16A)
【MS06B24-11S-16】</td><td rowspan="2">N/MS3108B24-11S
(N/MS3057-16A)
【MS08B24-11S-16】</td><td>JL04V-6A10SL-3SE-EB
(JL04-1012CK (50))
【332706×1】</td><td>JL04V-8A10SL-3SE-EB
(JL04-1012CK (50))
【332707×1】</td><td></td></tr>
<tr><td>Q1AA13300D
Q1AA13400D
Q1AA13500D
Q1AA18450M</td><td>Note 1</td><td>Note 1</td><td></td></tr>
<tr><td>Q1AA18750H</td><td>N/MS3106B32-17S
(N/MS3057-20A)
【MS06B32-17S-20】</td><td>N/MS3108B32-17S
(N/MS3057-20A)
【MS08B32-17S-20】</td><td>JL04V-6A10SL-3SE-EB
(JL04-1012CK (50))
【332706×1】</td><td>JL04V-8A10SL-3SE-EB
(JL04-1012CK (50))
【332706×1】</td><td></td></tr>
<tr><td>Q2AA13200H
Q2AA18200H
Q2AA18350H
Q2AA18450H</td><td>N/MS3106B24-11S
(N/MS3057-16A)
【MS06B24-11S-16】</td><td>N/MS3108B24-11S
(N/MS3057-16A)
【MS08B24-11S-16】</td><td>Note 1</td><td>Note 1</td><td></td></tr>
<tr><td>Q2AA18550R
Q2AA18550H
Q2AA18750L</td><td>N/MS3106B32-17S
(N/MS3057-20A)
【MS06B32-17S-20】</td><td>N/MS3108B32-17S
(N/MS3057-20A)
【MS08B32-17S-20】</td><td rowspan="3">JL04V-6A10SL-3SE-EB
(JL04-1012CK (50))
【332706×1】</td><td rowspan="3">JL04V-8A10SL-3SE-EB
(JL04-1012CK (50))
【332707×1】</td><td></td></tr>
<tr><td>Q2AA22550B
Q2AA22700S</td><td>N/MS3106B24-11S
(N/MS3057-16A)
【MS06B24-11S-16】</td><td>N/MS3108B24-11S
(N/MS3057-16A)
【MS08B24-11S-16】</td><td></td></tr>
<tr><td>Q2AA2211KV
Q2AA2215KV</td><td rowspan="2">N/MS3106B32-17S
(N/MS3057-20A)
【MS06B32-17S-20】</td><td rowspan="2">N/MS3108B32-17S
(N/MS3057-20A)
【MS08B32-17S-20】</td><td></td></tr>
<tr><td>Q4AA1811KB
Q4AA1815KB</td><td></td><td></td><td></td></tr>
</table>

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.

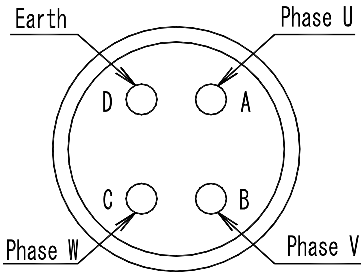
* Please contact us for waterproofing specifications and TÜV-compliant products.
Please place your order by【plug + clamp model number】, our exclusive model numbers.



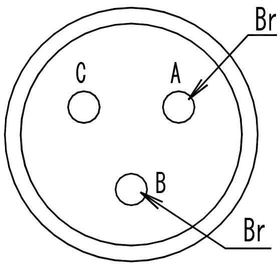
Q-series servo motor
Canon plug for power line
(For N/MS3106 (8)B20-15S)
Pin assignment (Viewed from motor)



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)



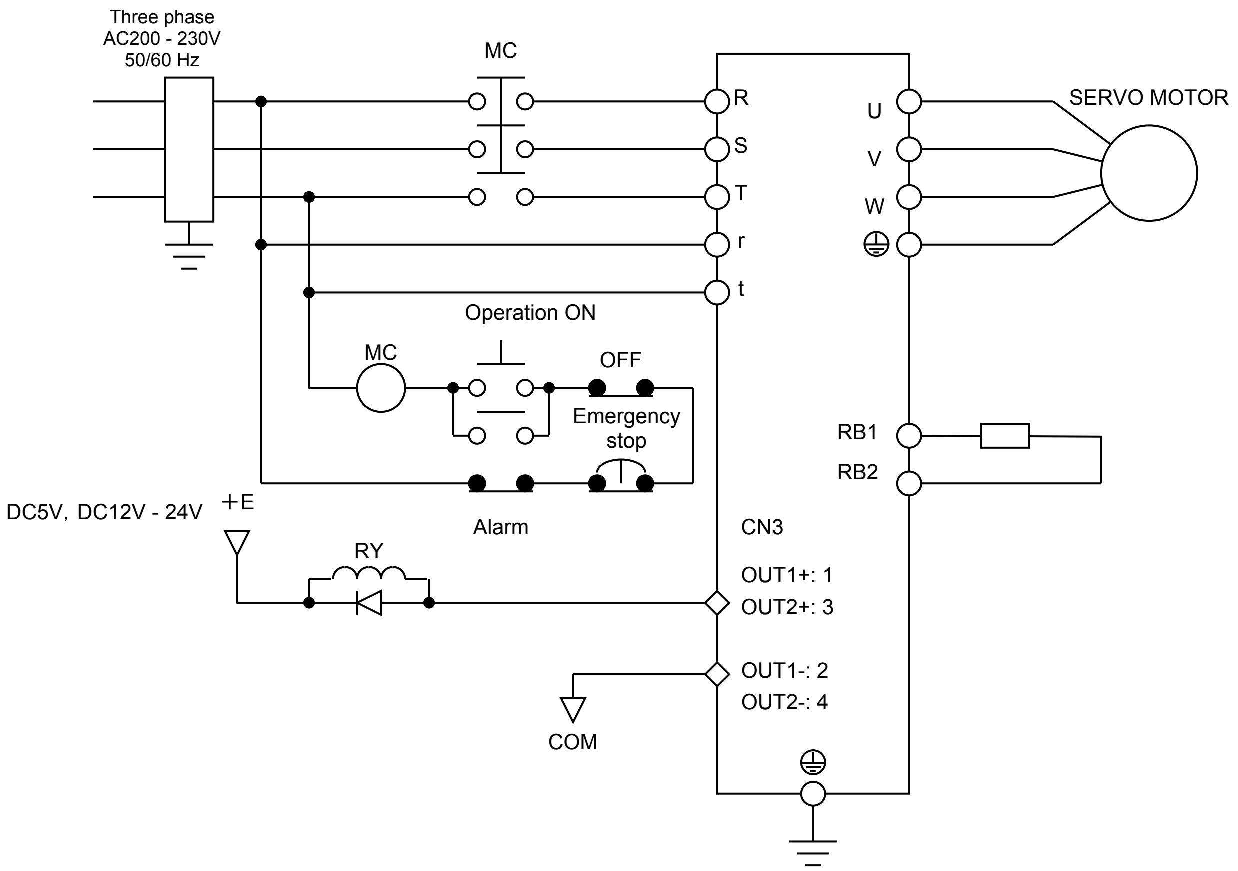
Q-series servo motor
Canon plug for brake line
(For JL04V-6 (8)A10SL-3SE-EB)
Pin assignment (Viewed from motor)

7) Wiring Example

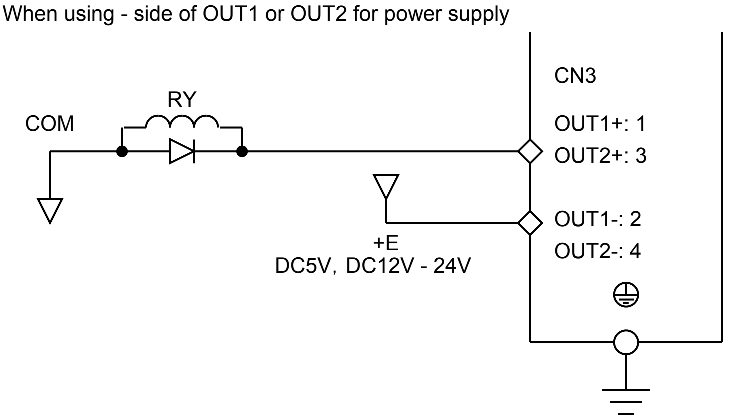
Even if it turns off power supply, high-pressure voltage may remain in servo amplifier. Therefore, do not touch a power supply terminal for 15 minutes for the prevention from an electric shock. Completion of electric discharge turns off the lamp of CHARGE. Please do connection check work after checking putting out lights.

■ Three phase AC200V [Generic output]

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



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

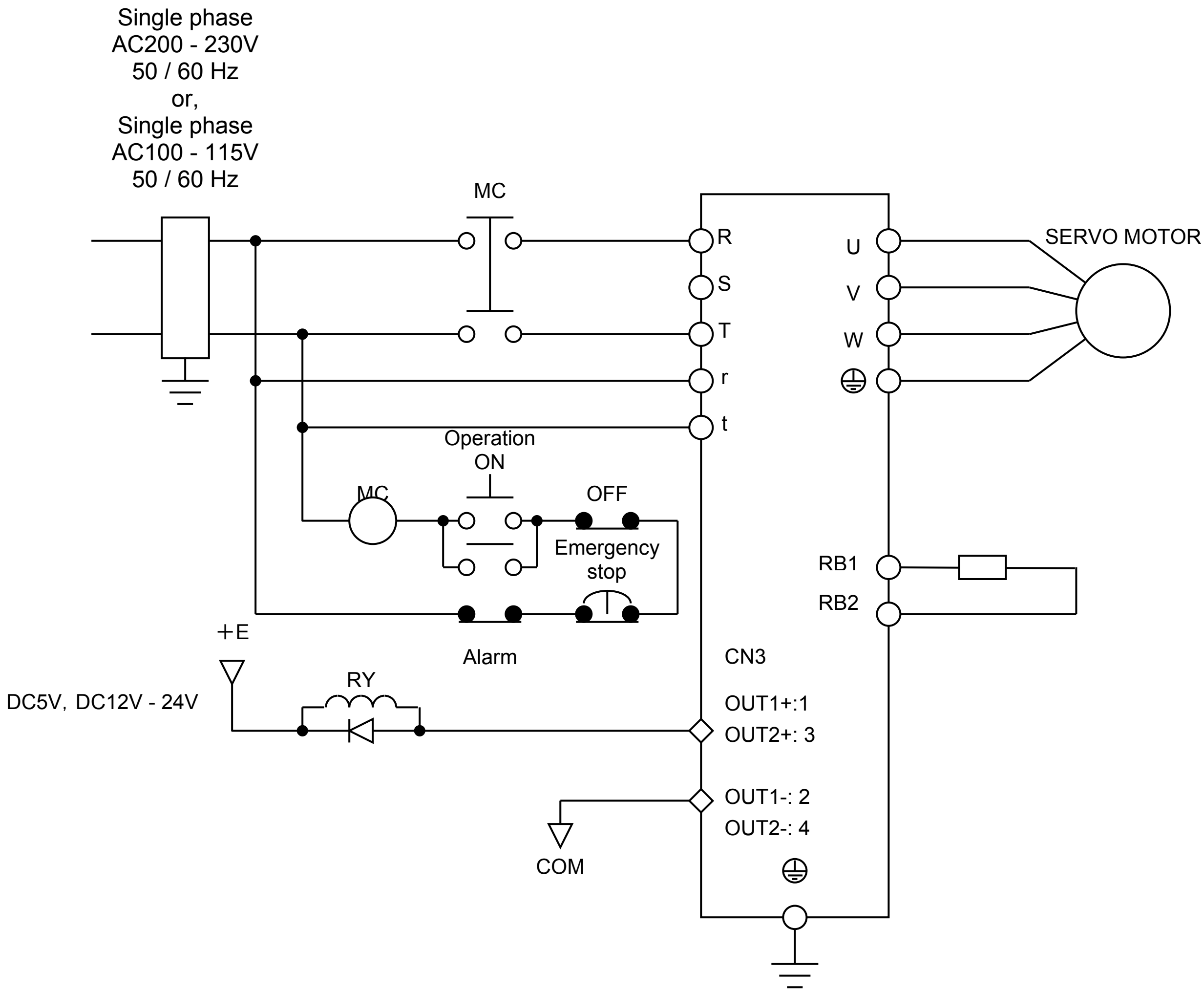


* Use one of the CN3 1 - 4(OUT1, OUT2) outputs, and set either during ALM status output ON or during ALM status output OFF with the selection setting of “Index:0x20F9 General output function selection”.

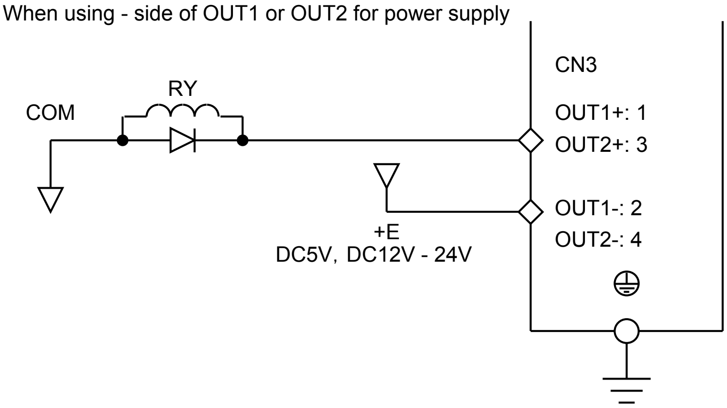
* Make sure to install diode as a surge absorber when connecting induction load, such as relay, to output 1-4 on CN3(OUT1,OUT2).Please carefully install diode so as not to connect polarity of diode. Failure to do this couses servo amplifier malfunction.

■ Single phase AC200V, Single phase AC100V [Generic output]

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



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

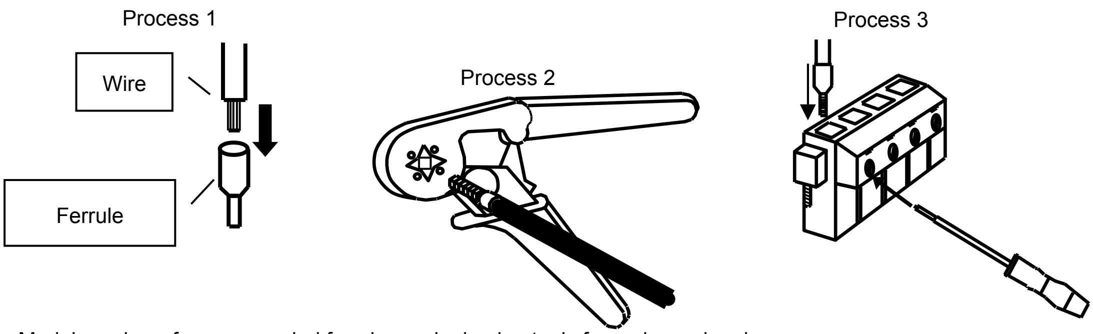


* Use one of the CN3 1 - 4(OUT1, OUT2) outputs, and set either during ALM status output ON or during ALM status output OFF with the selection setting of “Index:0x20F9 General output function selection”.

* Make sure to install diode as a surge absorber when connecting induction load, such as relay, to output 1-4 on CN3(OUT1,OUT2).Please carefully install diode so as not to connect polarity of diode. Failure to do this couses servo amplifier malfunction.

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^2	AWG	Model number		
		1Pcs / Pkt	1000Pcs / Pkt	Taped components
0.75 mm^2	18	AI0.75 - 8GY	AI0.75 - 8GY - 1000	AI0.75-8GY-B (1000Pcs/Pkt)
1.0 mm^2	18	AI1 - 8RD	AI1 - 8RD - 1000	AI1-8RD-B (1000Pcs/Pkt)
1.5 mm^2	16	AI1.5 - 8BK	AI1.5 - 8BK - 1000	AI1.5-8BK-B (1000Pcs/Pkt)
2.5 mm^2	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^2 - 6mm^2: CRIMPFOX UD 6-4,
0.75mm^2 - 10mm^2: CRIMPFOX UD 10-4GY
* Manufactured by Phoenix Contact.

9) High voltage circuit terminal; tightening torque

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

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

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

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

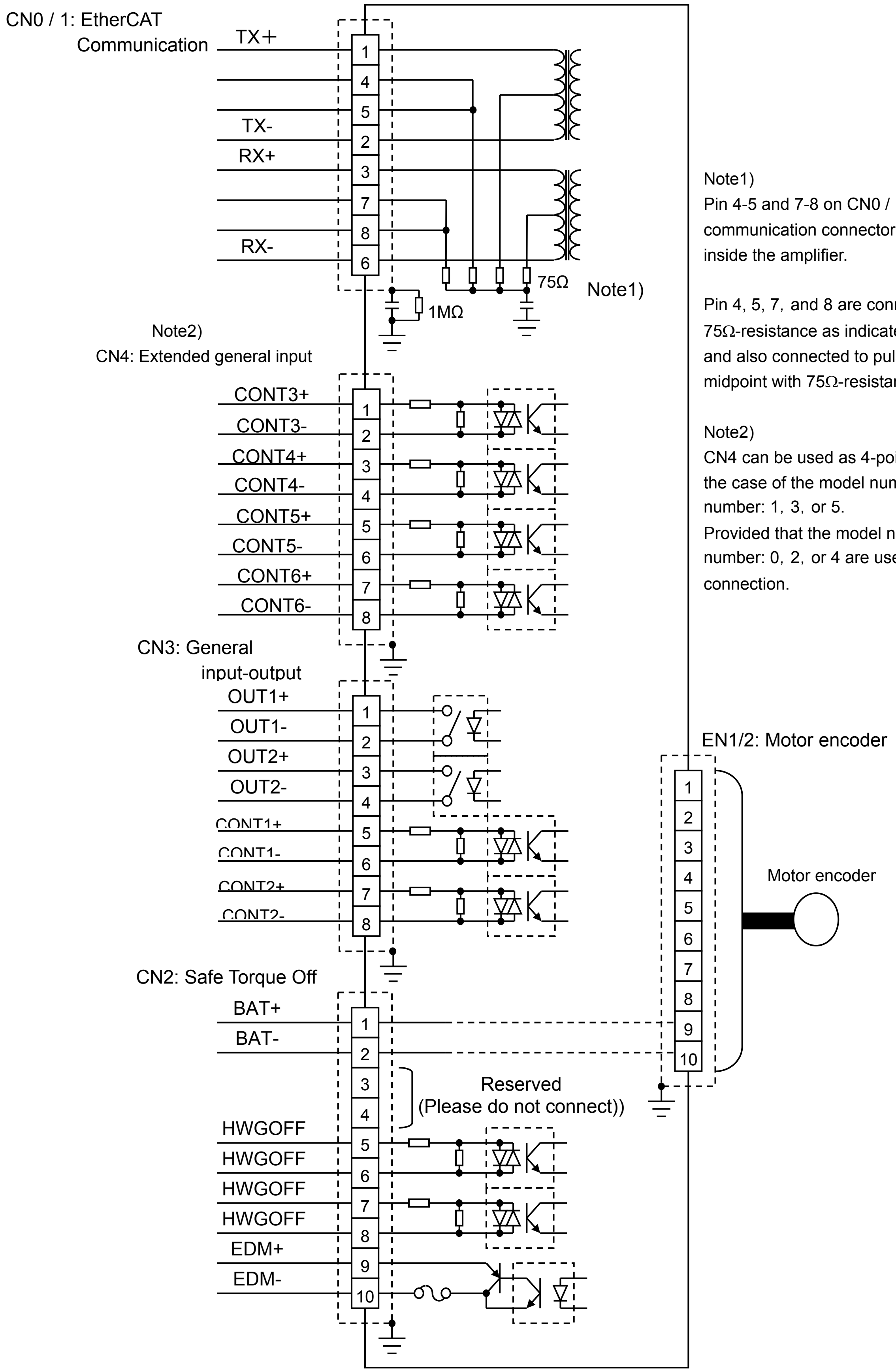
10) Wiring of the canon connector for servo motors

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 earth terminal
H	⏚	Protective earth terminal

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

4.2 Wiring with Host Unit

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



Note1)
Pin 4-5 and 7-8 on CN0 / 1EtherCAT communication connector are short-circuited inside the amplifier.

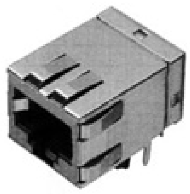
Pin 4, 5, 7, and 8 are connected with 75Ω-resistance as indicated in the left figure, and also connected to pulse trans former midpoint with 75Ω-resistance.

Note2)
CN4 can be used as 4-point general input in the case of the model numbers whose final number: 1, 3, or 5.
Provided that the model numbers whose final number: 0, 2, or 4 are used for setup connection.

2) CN0, CN1 connector disposition

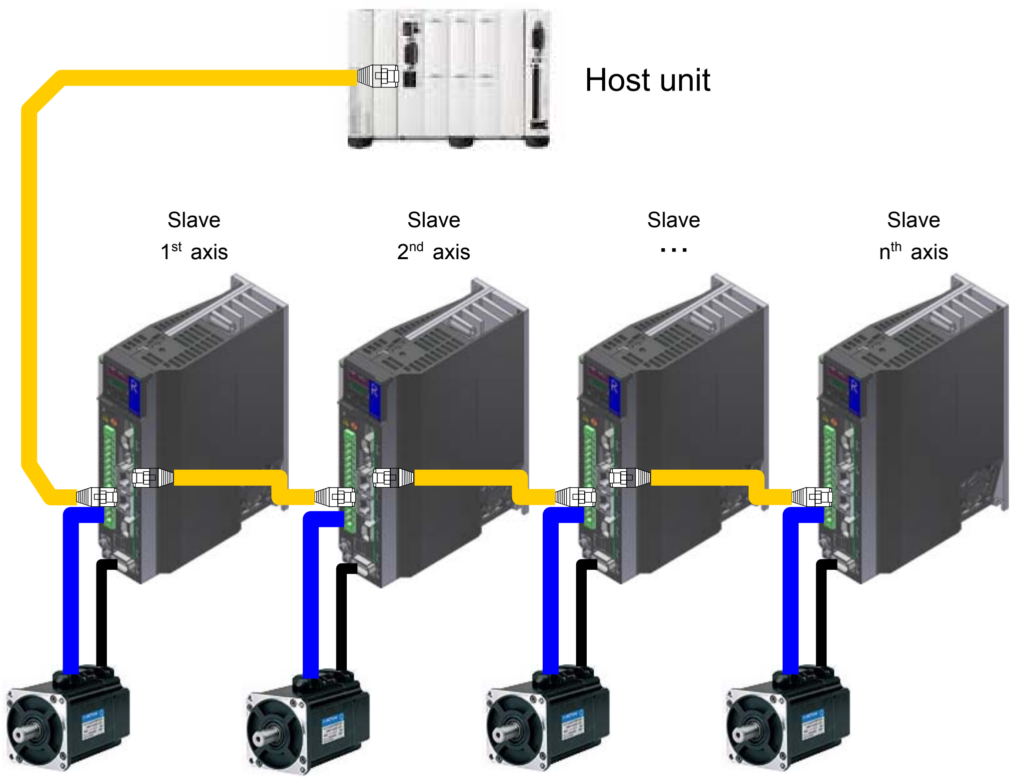
■ Pin assignment

Two (Port 0/1) standard Ethernet connectionRJ-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 CN0 (Port 0) to the higher-level device and CN1 to the next slave.
Use twisted-pair cables that satisfy at leas “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.

CN0 (Port0), CN1 (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

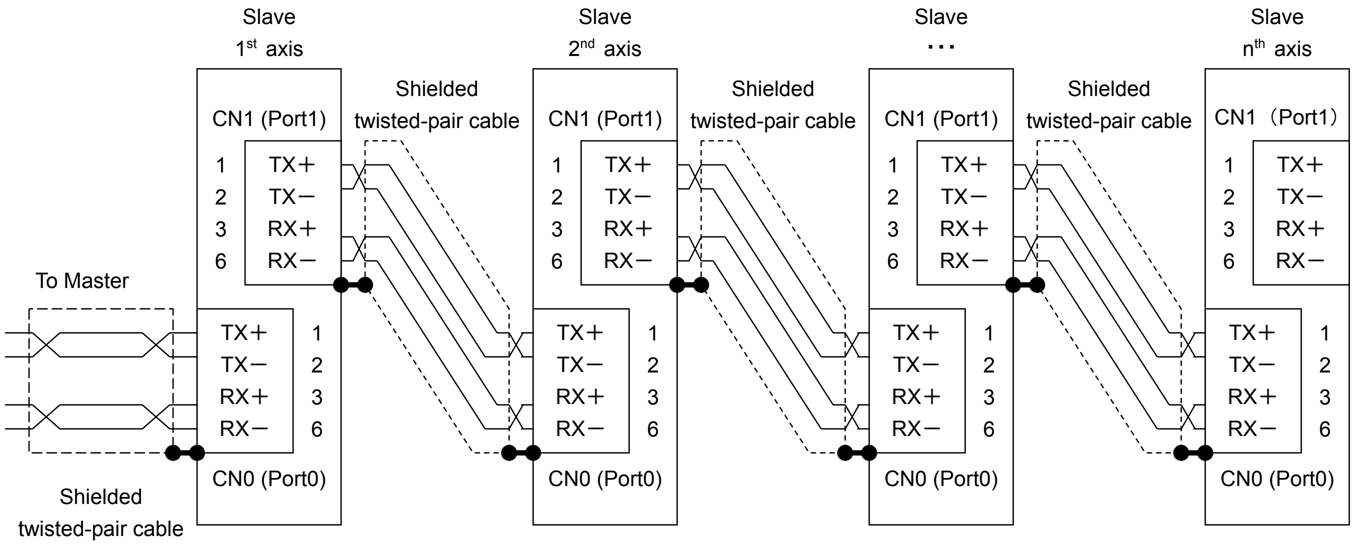
* Refer to “Control signal and pin number (wiring with host unit)” on the previous page for electrical connection of CN0 and CN1. Pins 4 and 5 and pins 7 and 8 are shorted inside the amplifier and connected with 150Ω to the midpoint of the pulse transmission between pin 4/5 and 7/8.

■ Connection diagram



✔ Connect Master (host) cable to the lower connector CN0 (Port0), and then connect cable of the upper connector CN1 (Port1) to the next Slave.

■ Wiring diagram

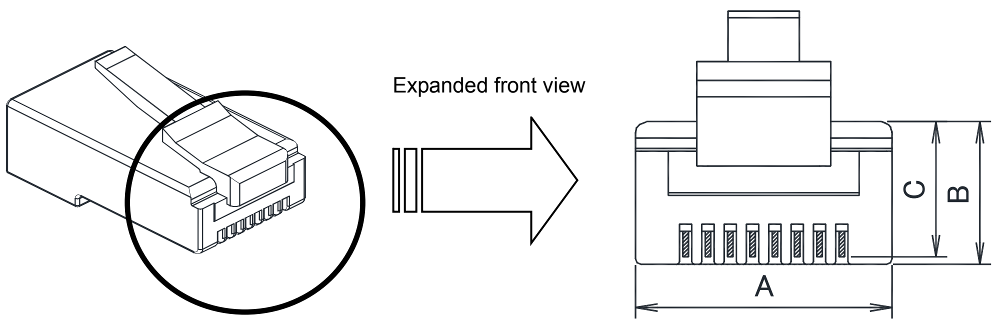


✔ R-ADVANCED EtherCAT amplifier is twisted-pair cable and daisy-chain topology-compliant model, and port0 (CN0)/(CN1) are Ethernet connection.

✔ 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

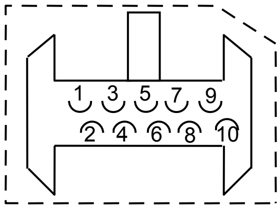
- For the modular connector selection and modification, please confirm the standards dimension below (Standards: TIA-968-A).
- Especially, when the connector (ready-made/ modified product) which has out-of-range dimension at C (from top end of connector housing to lower side of terminal) is used, it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



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

3) CN2 connector disposition

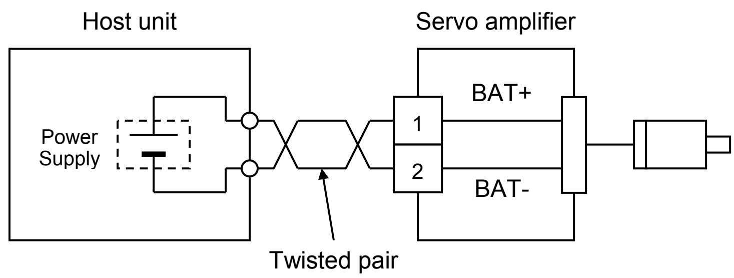
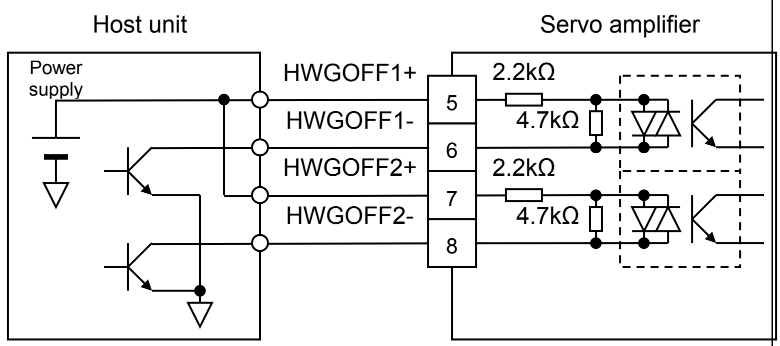
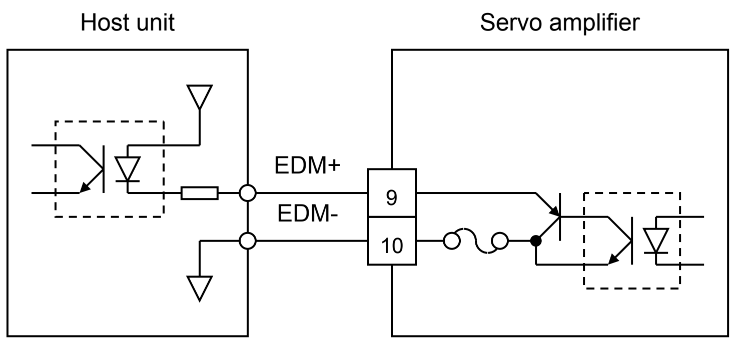
■ MUF-PK10K-X (Note: A view of the connector's soldered side.)



◆ Signal name and its function

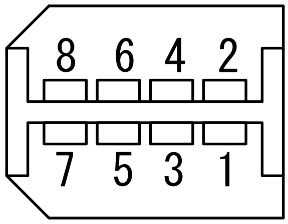
Terminal number	Signal name	Description
1	BAT +	Battery (+)
2	BAT -	Battery (-)
3	Reserve	Do not use
4	Reserve	Do not use
5	HWGOFF1+	Signal-input for safety function 1(+)
6	HWGOFF1-	Signal-input for safety function 1(-)
7	HWGOFF2+	Signal-input for safety function 2(+)
8	HWGOFF2-	Signal-input for safety function 2(-)
9	EDM +	Monitor for safety function (+)
10	EDM -	Monitor for safety function (-)

◆ Terminal connection circuit

Terminal No.	Symbol	Name	Description
1	BAT+	Battery (+)	When using a Battery Backup Method Absolute Encoder, the battery for backup can be mounted in the host unit side, and it can connect via servo amplifier. When it mounts a battery between servo amplifier and a servo motor, it is not necessary to connect. 
2	BAT-	Battery (-)	
3	Reserved	Terminal for maintenance	Connecting terminal when Safe Torque Off funciton not used. When you do not use Safe Torque Off function, short circuit terminal “3 and 5/7,” “4 and 6/8.”
4	Reserved		
5	HWGOFF1+	Safety Function Signal input 1 (+)	Input signals to control safe torque Off state Power supply voltage range: DC24V±10% Internal impedance: 2.2kΩ Signals under 8ms cannot be recognized 
6	HWGOFF1-	Safety Function Signal input 1 (-)	
7	HWGOFF2+	Safety Function Signal input 2 (+)	
8	HWGOFF2-	Safety Function Signal input 2 (-)	
9	EDM+	Safety Function Monitor (+)	The signal monitors the system for Safe Torque Off function failures. Power supply voltage range (Uext): DC24V±10% Maximum operational electric current: 50 mA Output voltage: Uext-0.5 - Uext Monitor output reverts to ON when safety function signal input 1 and 2 are OFF. 
10	EDM-	Safety Function Monitor (-)	

4) CN3 General input-output connector disposition

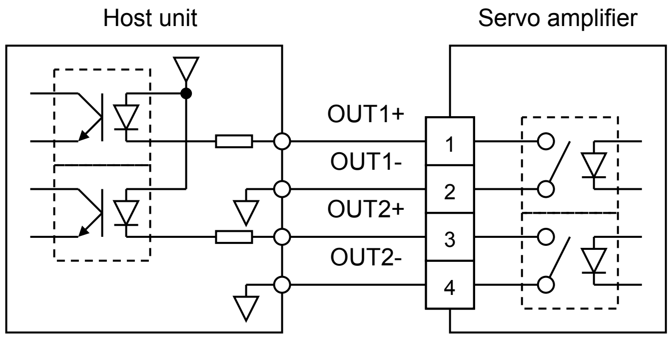
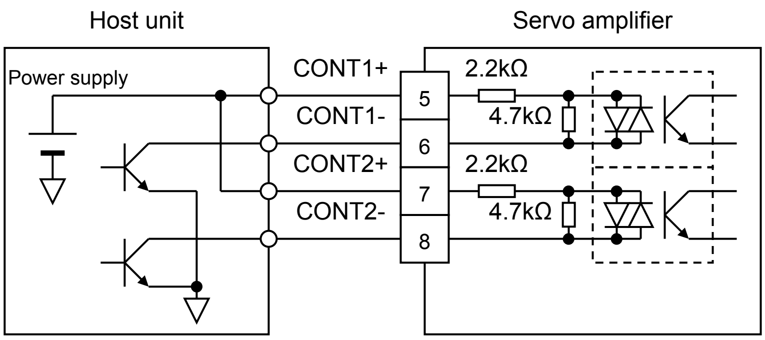
■ 2013595-3 (Note: A view of the connector’s soldered side)



◆ Signal name and its function

Terminal number	Signal name	Description
1	OUT1+	General output 1 (+)
2	OUT1-	General output 1 (-)
3	OUT2+	General output 2 (+)
4	OUT2-	General output 2 (-)
5	CONT1+	General input 1 (+)
6	CONT1-	General input 1 (-)
7	CONT2+	General input 2 (+)
8	CONT2-	General input 2 (-)

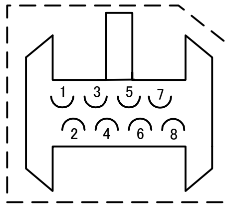
◆ Terminal connection circuit

<table>
<tr><th>Terminal No.</th><th>Symbol</th><th>Name</th><th>Description</th></tr>
<tr><td>1</td><td>OUT1+</td><td>General output 1 (+)</td><td rowspan="4">General output circuit is connected with a photo-coupler or a relay circuit.
Power supply voltage range: DC5V±5%
Maximum current: 100mA
Power supply voltage range: DC12V - 15V±10%
Maximum current: 100mA
Power supply voltage range: DC24V±10%
Maximum current: 100Ma
Maximum current should be below 20mA when input circuit of host unit side is from TTL or CMOS.

</td></tr>
<tr><td>2</td><td>OUT1-</td><td>General output 1 (-)</td></tr>
<tr><td>3</td><td>OUT2+</td><td>General output 2 (+)</td></tr>
<tr><td>4</td><td>OUT2-</td><td>General output 2 (-)</td></tr>
<tr><td>5</td><td>CONT1+</td><td>General input 1 (+)</td><td rowspan="4">General input circuit is connected with the transistor circuit of a relay or an open collector.
Power supply voltage: DC5V±5%/DC12V - 24V±10%
Minimum current: 100mA (DC24V)

</td></tr>
<tr><td>6</td><td>CONT1-</td><td>General input 1(-)</td></tr>
<tr><td>7</td><td>CONT2+</td><td>General input 2 (+)</td></tr>
<tr><td>8</td><td>CONT2-</td><td>General input 2 (-)</td></tr>
</table>

✔ Make sure to install diode as a surge absorber when connecting induction load, such as relay, to general (-purpose) output. Please carefully install diode so as not to connect polarity of diode. Failure to do this causes servo amplifier malfunction.

5) CN4 General input connector disposition

*Applicabel to RS2#####K#1, RS2#####K3, and RS2#####K5.

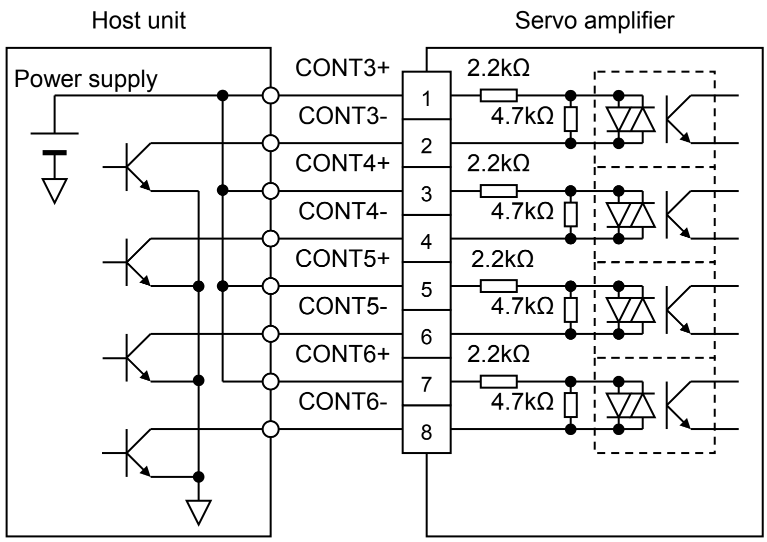


■ MUF-PK8K-X (Note: A view of the connector's soldered side)

◆ Signal name and its function

Terminal number	Signal name	Description	Default setting
1	CONT3+	General input 3 (+)	Limit switch function in positive direction
2	CONT3-	General input 3 (-)	
3	CONT4+	General input 4 (+)	Limit switch function in negative direction
4	CONT4-	General input 4 (-)	
5	CONT5+	General input 5 (+)	Emergency stop function
6	CONT5-	General input 5 (-)	
7	CONT6+	General input 6 (+)	–
8	CONT6-	General input 6 (-)	

◆ Terminal connection circuit

Terminal No.	Symbol	Name	Description
1	CONT3+	General input 3 (+)	General input circuit is connected with the transistor circuit of a relay or an open collector. Power supply voltage: DC5V±5%/DC12V - 24V±10% Minimum current: 100mA (DC24V) 
2	CONT3-	General input 3 (-)	
3	CONT4+	General input 4 (+)	
4	CONT4-	General input 4 (-)	
5	CONT5+	General input 5 (+)	
6	CONT5-	General input 5 (-)	
7	CONT6+	General input 6 (+)	
8	CONT6-	General input 6 (-)	

4.3 Wiring of Motor Encoder

1) EN1connector 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)	Earth	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 (earth) 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.

■ Absolute encoder for incremental system

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	Unconnected	-
10	BAT-	4 (Purple)	S	Unconnected	-
Note 2)	Earth	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 (earth) 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)	Earth	7 (Shielded)	J	Shield	-

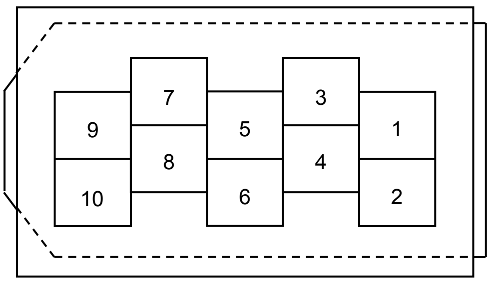
Note 1) Use shielded cable and perform twisted-pair wiring.
Note 2) Connect the shielded cable to the metal case (ground) on EN1 side and connect the ground to the motor encoder side.

- Pulse 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)	Earth	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 Limited.)

	Model Number	Application wire size	Application cable diameter
Connector	36210-0100PL	AWG30 - AWG18	-
Shell kit	36310-3200-008	-	φ7 - φ9

3) Connector model number for motor encoder

■ R-series servo motor encoder Connector model numbers

(Products of Japan Aviation Electronics Industry, Limited)

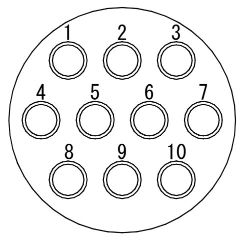
Motor model number	Motor encoder plug model number	Connector type	Applicable cable diameter
R2#A04003 R2#A04005 R2EA04008 R2#A04010 R2#A06010 R2#A06020 R2AA08020 R2AA06040 R2AA08040 R2AA08075 R2AAB8075 R2AAB8100 R2AA10075 R2AA10100 R5AA08075	(Specification for lead locating)	-	-
R2AA13050 R2AA13120 R2AA13180 R2AA13200 R2AA18350 R2AA18450 R2AA18550 R2AA18750 R2AA1811K R2AA22500	JN2DS10SL1-R	Straight	Φ5.7 to Φ7.3
	JN2FS10SL1-R	Angle	
	JN2DS10SL2-R	Straight	Φ6.5 toΦ8.0
	JN2FS10SL2-R	Angle	
	JN2DS10SL3-R	Straight	Φ3.5 toΦ5.0
	JN2FS10SL3-R	Angle	

* 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 AWG25
	JN1-22-26S-PKG100	Note1)	AWG26 to AWG28
Soldering type	JN1-22-22F-PKG100	Note1)	AWG20 max.

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).



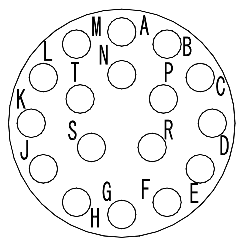
R-series servo motor
Encoder canon plugg
Pin assignment
(Viewed from motor)

■ 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	φ5.7 - φ7.3
JN2FS10SL1-R	Angle	
JN2DS10SL2-R	Straight	φ6.5 - φ8.0
JN2FS10SL2-R	Angle	
JN2DS10SL3-R	Straight	φ3.5 - φ5.0
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 - AWG25
JN1-22-26S-PKG100	AWG26 - AWG28

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 - AWG18
SQ (mm^2)	0.15 - 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^2)	0.15	150 or less	5
	0.2	100 or less	10
	0.3	65 or less	15
	0.5	40 or less	25
	0.75	28 or less	35

* Conductor resistance is different by conductor specifications.

4.4 Peripherals

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

■ AC200V input

Input voltage	Servo amplifier capacity	Servo motor model No.	Main circuit power supply rating (kVA)	Molded case circuit breaker (MCCB)	Noise filter	Magnetic contact	Surge absorber
AC200V	RS2#01#	R2AA04003F	0.2	Model NF30 10A MITSUBISHI ELECTRIC	HF3030C-UQA SOSHIN ELECTRIC Co., Ltd.	S-N10 MITSUBISHI ELECTRIC	LT-C32G801WS SOSHIN ELECTRIC Co., Ltd.
		R2AA04005F	0.2				
		R2AA04010F	0.3				
		R2AA06010F	0.3				
		R2AA06020F	0.6				
		R2AA06040H	1.0				
		R2AA08020F	0.6				
		R5AA06020H	0.6				
		R5AA06020F	0.6				
		R5AA06040H	1.0				
	RS2#03#	R2AA06040F	1.0				
		R2AA08040F	1.0				
		R2AA08075F	1.6				
		R2AAB8100H	2.0				
		R2AA10075F	1.7				
		R2AA13050H	1.2				
		R2AA13050D	1.2				
		R2AA13120B	2.2				
		R5AA06040F	1.0				
		R5AA08075D	1.6				
		R5AA08075F	1.6				
	RS2#05#	R2AAB8075F	1.6	Model NF30 15A MITSUBISHI ELECTRIC			
		R2AAB8100F	2.3				
		R2AA10100F	2.3				
		R2AA13120D	2.8				
		R2AA13120L	2.8				
		R2AA13180H	3.6				
		R2AA13200L	4.0				
	RS2#10#	R2AA13180D	4.0	Model NF50 30A MITSUBISHI ELECTRIC		S-N18 MITSUBISHI ELECTRIC	
		R2AA13200D	5.0				
		R2AA18350L	6.0				
		Q1AA10200D	4.0				
		Q1AA10250D	4.2				
		Q1AA12200D	4.0				
		Q1AA12300D	5.0				
		Q1AA13300D	5.0				
		Q2AA13200H	4.0				
		Q2AA18200H	4.0				
	RS2#15#	R2AA18350D	7.0	Model NF50 50A MITSUBISHI ELECTRIC		S-N35 MITSUBISHI ELECTRIC	
		R2AA18450H	7.4				
		R2AA18550R	8.4				
		R2AA22500L	9.6				
		Q1AA13400D	6.7	Model NF50 50A MITSUBISHI ELECTRIC		S-N35 MITSUBISHI ELECTRIC	
		Q1AA13500D	8.3				
		Q1AA18450M	7.4				
		Q2AA18350H	6.9				
		Q2AA18450H	7.4				
		Q2AA18550R	8.4				
		Q2AA22550B	10.0				
		Q2AA22700S	12.2	Model NF100 75A MITSUBISHI ELECTRIC	HF3050C-UQA	S-N50 MITSUBISHI ELECTRIC	
	RS2#30#	R2AA18550H	9.3	Model NF100 100A MITSUBISHI ELECTRIC	HF3080C-UQA SOSHIN ELECTRIC Co., Ltd.	S-N65 MITSUBISHI ELECTRIC	
		R2AA18750H	11.6				
		R2AA1811KR	16.0				
		Q1AA18750H	12.6				
		Q2AA18550H	10.0				
		Q2AA18750L	12.6				
		Q2AA2211KV	16.0				
		Q2AA2215KV	21.4				
		Q4AA1811KB	15.7				
		Q4AA1815KB	21.4				

■ AC100V input

Input voltage	Servo amplifier capacity	Servo motor model No.	Main circuit power supply rating (KVA)	Circuit breaker	Noise filter	Magnetic contact	Surge absorber
AC 100V	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.

1. Please install surge absorber at the input part of servo amplifier when overvoltage such as lightning surge is applied to servo amplifier.

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

■ AC200V input

Input voltage	Servo amplifier capacity	Servo motor model No.	Main circuit power supply rating (KVA)	Circuit breaker	Noise filter	Magnetic contact	Surge absorber
AC200V	RS2#03L	DS030C1N2	1.4	Model NF30 10A MITSUBISHI ELECTRIC	HF3030C-UQA SOSHIN ELECTRIC Co., Ltd.	S-N10 MITSUBISHI ELECTRIC	LT-C32G801WS SOSHIN ELECTRIC Co., Ltd.
		DS050C1N2	1.4				
		DS075C1N2	1.5				
	RS2#05L	DS030C2N2	2.7	Model NF30 15A MITSUBISHI ELECTRIC			
		DS050C2N2	2.7				
		DS075C2N2	3.0				
		DS030C1Y4	2.7				
		DS100C1N2	3.2	Model NF50 30A MITSUBISHI ELECTRIC		S-N18 MITSUBISHI ELECTRIC	
		DS150C1N2	3.2				
	RS2#10L	DS030C3N2	3.5				
		DS050C3N2	3.5				
		DS075C3N2	3.8				
		DS100C2N2	5.5				
		DS150C2N2	5.5				
		DS030C2Y4	4.5				
		DS050C1Y2	4.4				
		DS075C1Y2	4.8				
		DS030C3Y4	6.8	Model NF50 50A MITSUBISHI ELECTRIC		S-N35 MITSUBISHI ELECTRIC	
	RS2#15L	DS100C3N2	8.2				
		DS150C3N2	8.2				
		DS050C2Y2	8.8				
		DS075C2Y2	9.5				
	RS2#30L	DS050C3Y2	12.2	Model NF100 75A MITSUBISHI ELECTRIC	HF3050C-UQA	S-N50 MITSUBISHI ELECTRIC	
		DS075C3Y2	13.2	Model NF100 100A MITSUBISHI ELECTRIC	HF3080C-UQA SOSHIN ELECTRIC Co., Ltd.	S-N65 MITSUBISHI ELECTRIC	
		DS050C4Y2	8.2				

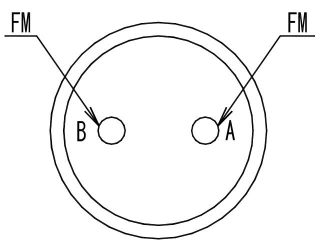
* Mark "#" is optional number or alphabetical letter.

* Please install surge absorber at the input part of servo amplifier when overvoltage such as lightning surge is applied to servo amplifier.

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 AC200V±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)

5

5. Interface

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 IEEE802.3maintained 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 mapps 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.
Section1defines 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.

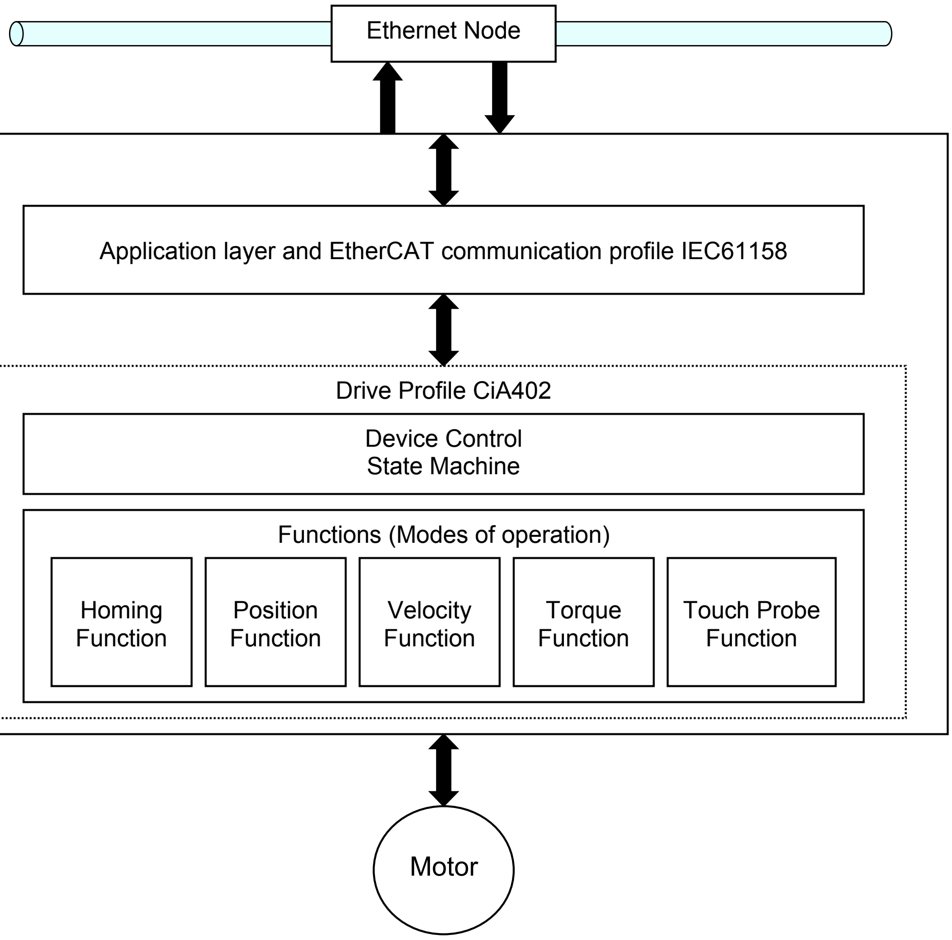
■ Layer 4 (Transport layer)
Performs data compression, error correction and resends data delivery controls absolutely and efficiently.

■ 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



Communication 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 4 bit rotary switch (0x0 - 0xF:bit 3 - 0) at the front of the amplifier and with a set value of bit 15 – 4, 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

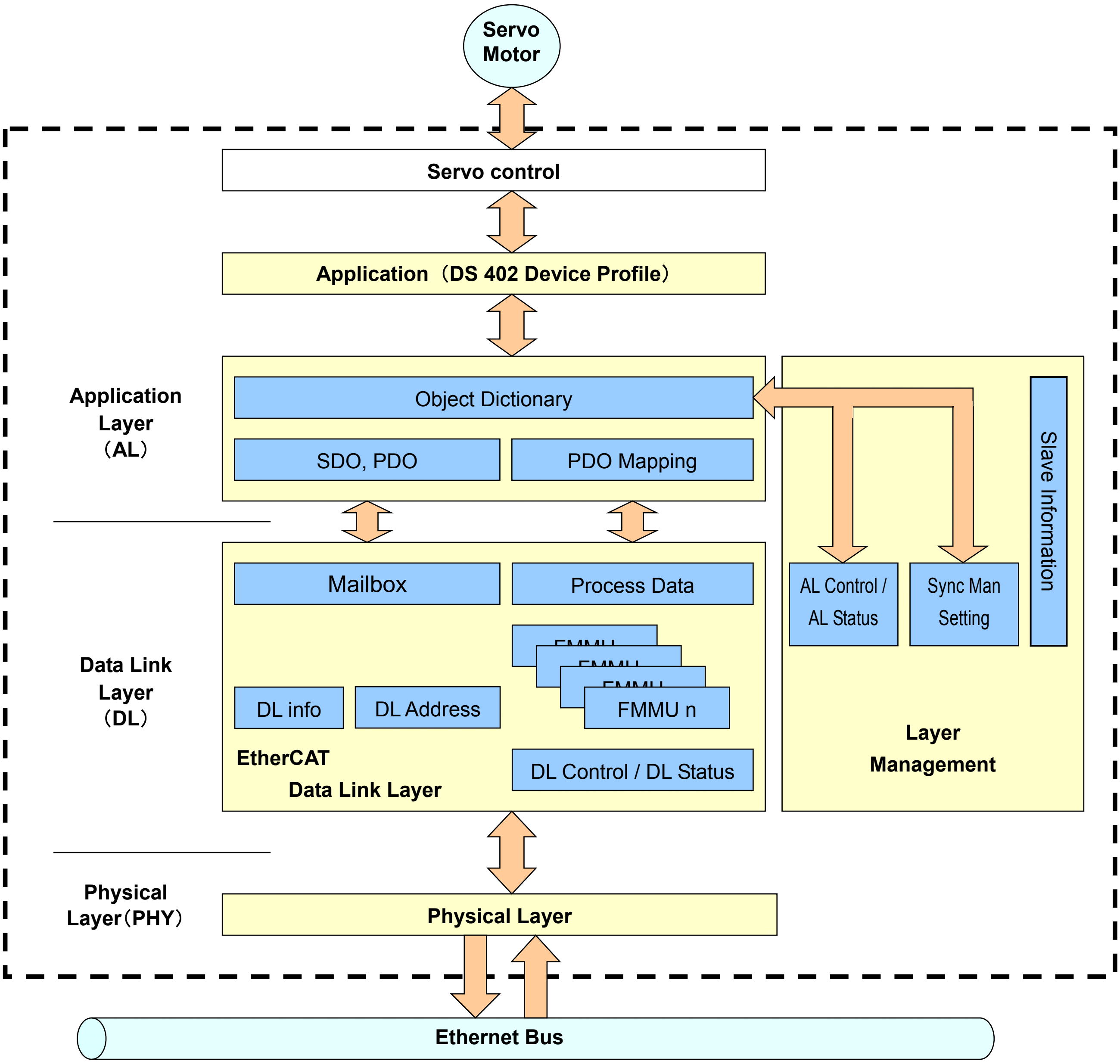
Item	Specifications	Notes
Topology	Line	
Data flow	Line: From the master to the first slave and then on to the last slave, shuttling back and forth.	
Communication media	Twisted pair cable	
Communication rate	100 Mbit/s	
Communication parameter settings	Auto-negotiation function with ISO/IEC 8802-3 Auto-crossover 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

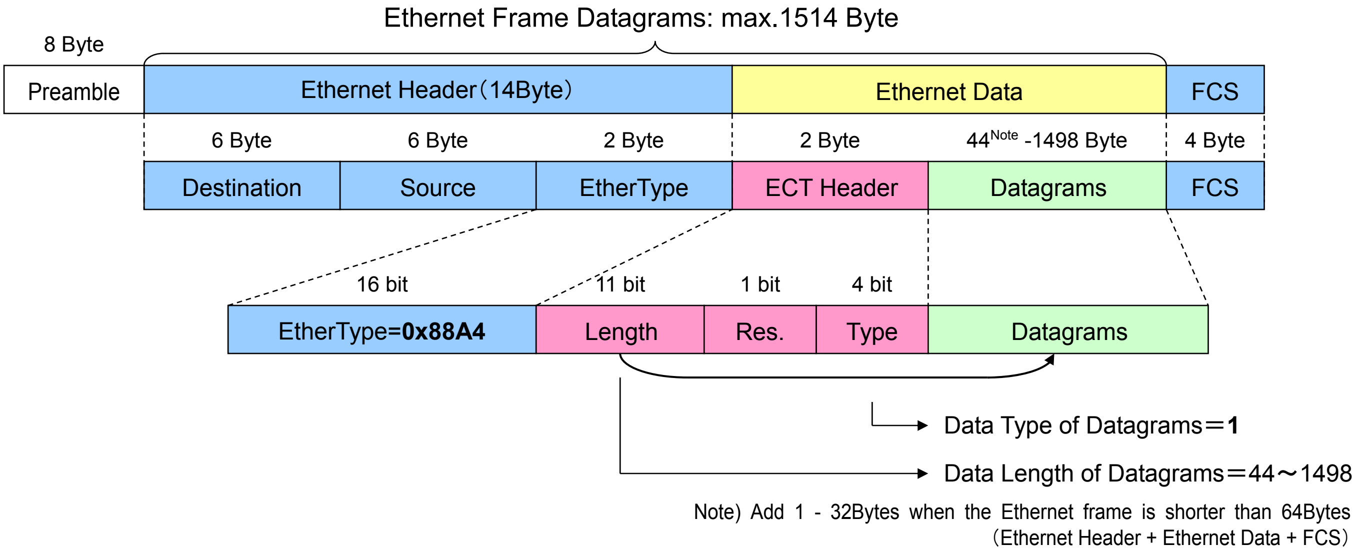
■ Object Index
All objects are addressed with a 16-bit index using a 4-digit hexadecimal number.
Objects are assigned in the Object Dictionary by individual groups.
The Object Dictionary outline prescribed in CoE is as follows:

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

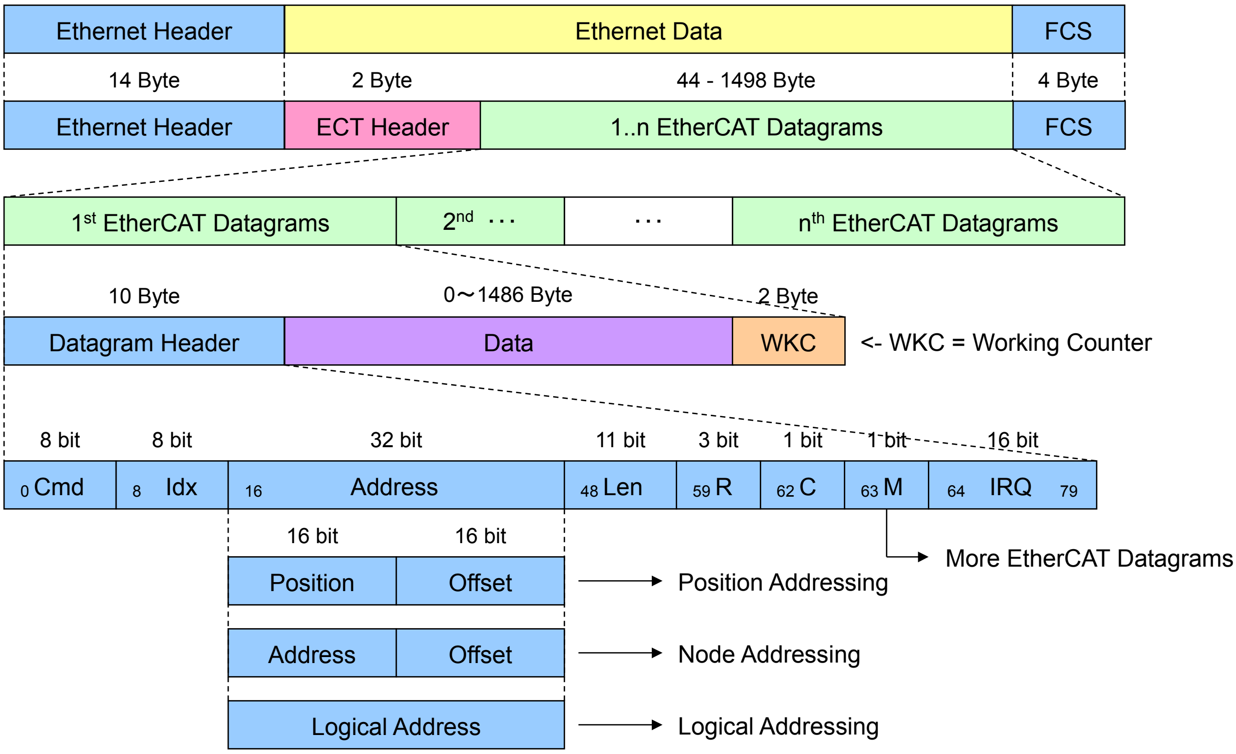
■ Ethernet Protocol
Since EtherCAT is adopting IEEE 802.3 as its standard Ethernet frame, a standard network controller can be used.
Therefore, system construction is possible on the master side without designing specific hardware.
"0x88A4" is reserved for the Ether type of EtherCAT and is distinguished 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.



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 (nth EtherCAT Datagrams) 1 : EtherCAT provide further contiguity (Example:2nd EtherCAT Datagrams will abut the 1st 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 he 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

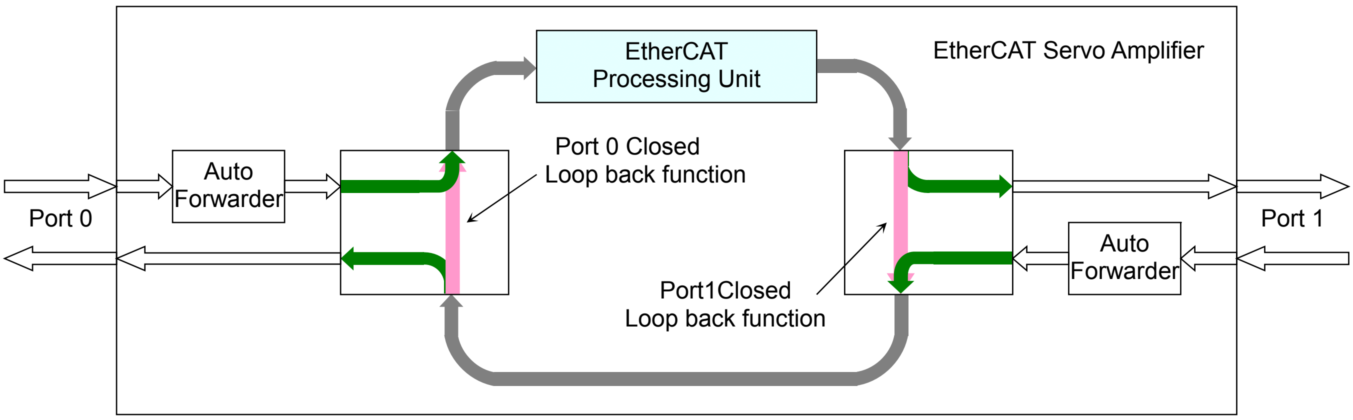
7) Frame Processing

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

Frame Processing Order

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

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

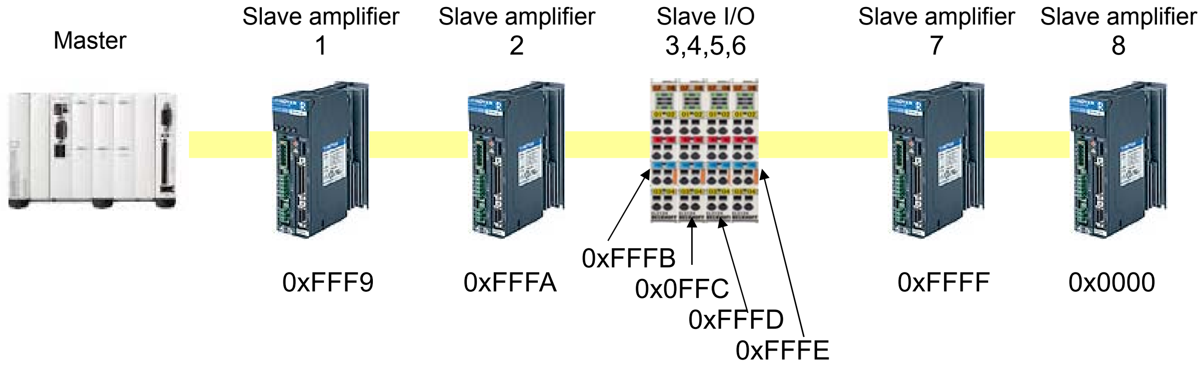


Frame Processing of R-ADVANCED EtherCAT Amplifier

5.5 Addressing Image

1) Position Addressing (Auto-Increment Addressing)

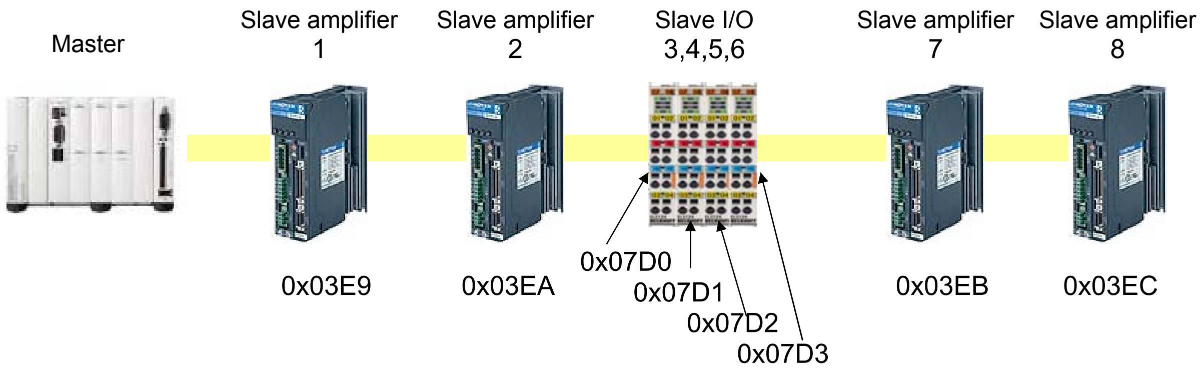
Position addressing is a command to access slaves from the master according to the connection order (physical position).
Each slave device provides one (1) 16-bit address field every time datagrams pass through and a slave “0x0000”will be addressed and will respond when receiving the address field.
Position addressing image is as follows: Frame must be transmitted under the position setting of “0x0000” when addressing the 1st axis and “0xFFF9” when addressing the 8th axis.



Position Addressing Image (Example: Addressing the 8th 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.

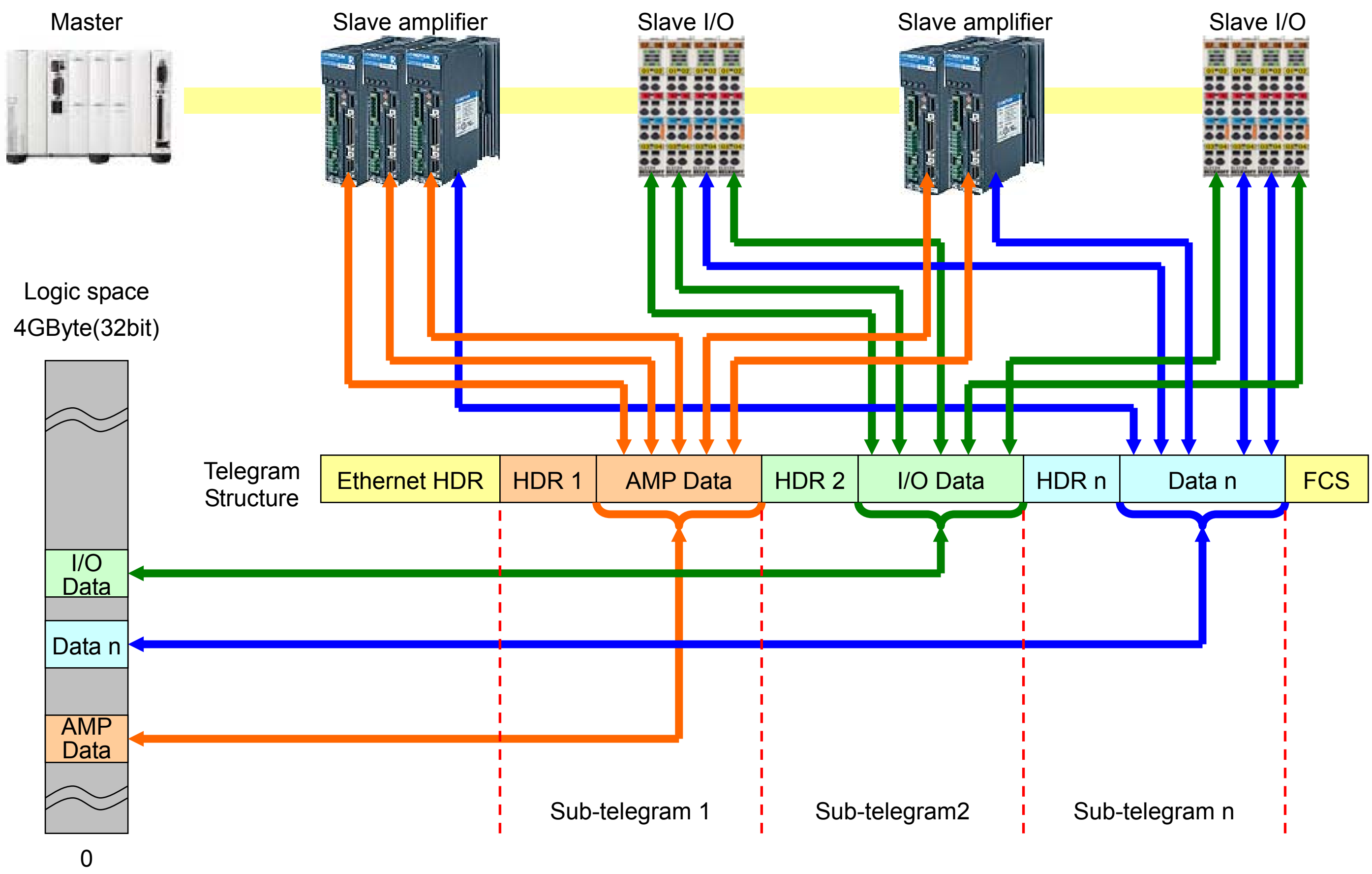


Node Addressing Image

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.

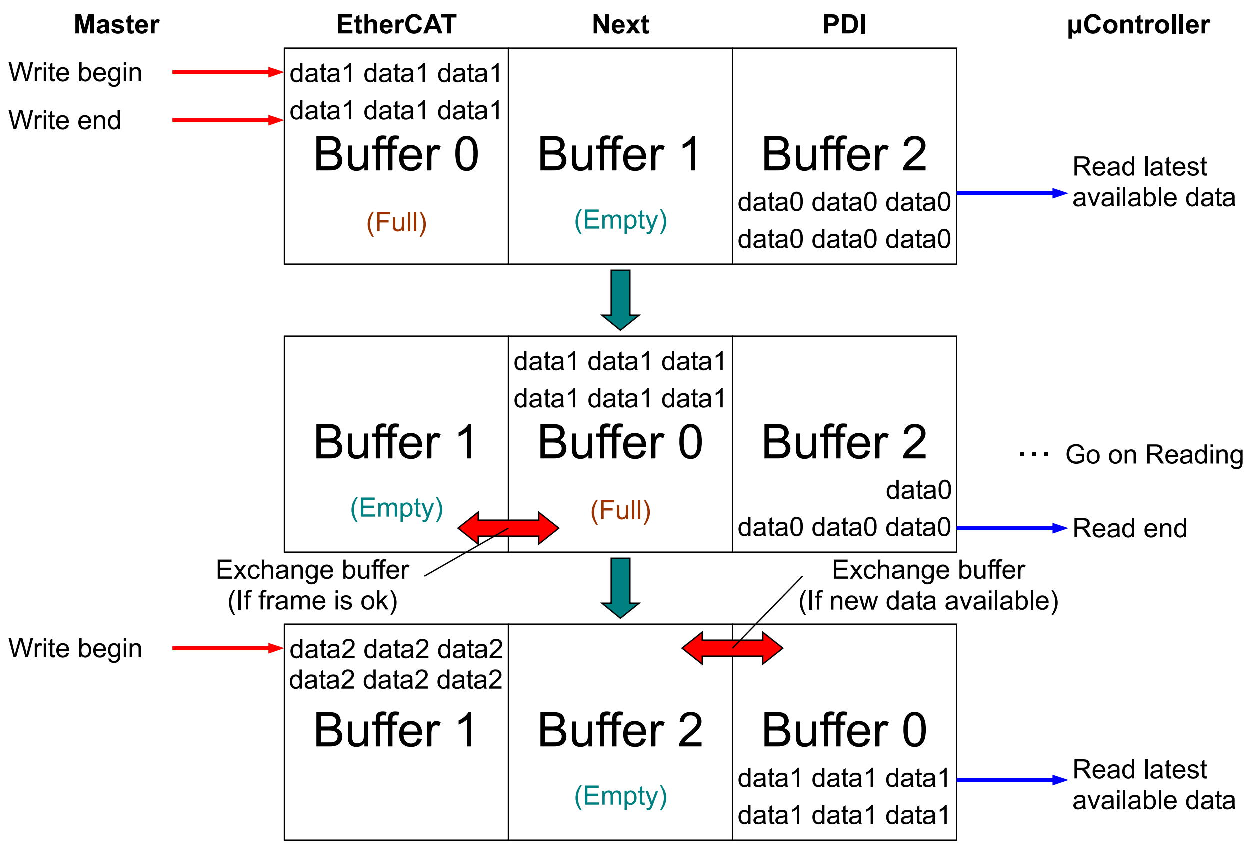
Generally, one buffer among the three is for Write use, one for Read use and another is reserved for Write use.

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



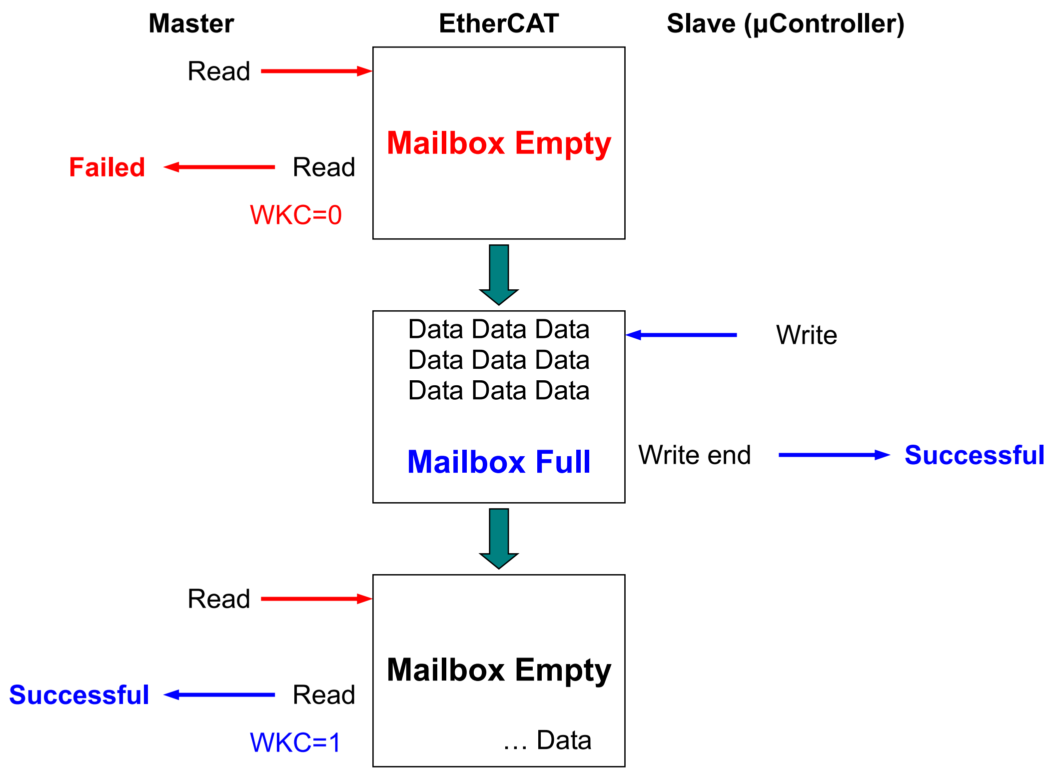
Conversion example of SyncManager Buffer Mode (Master => Slave)

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)

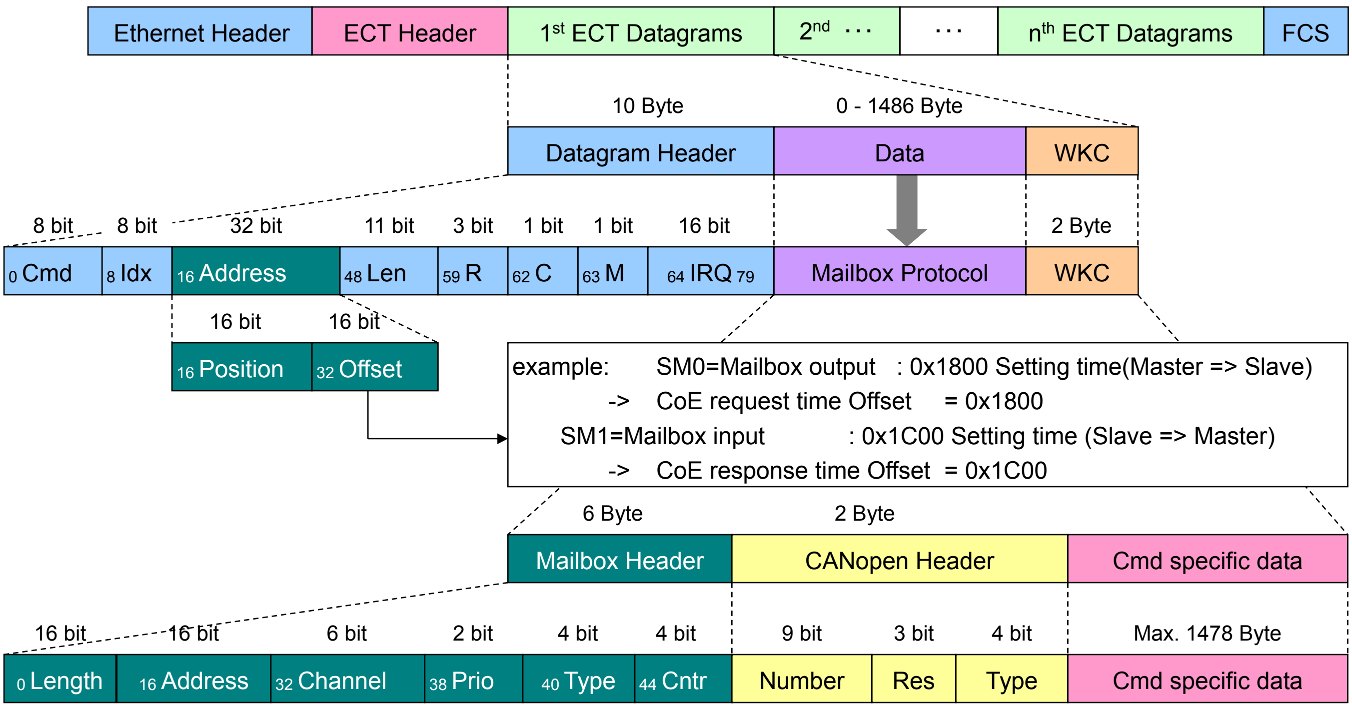
1) Service Data Object (SDO)

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

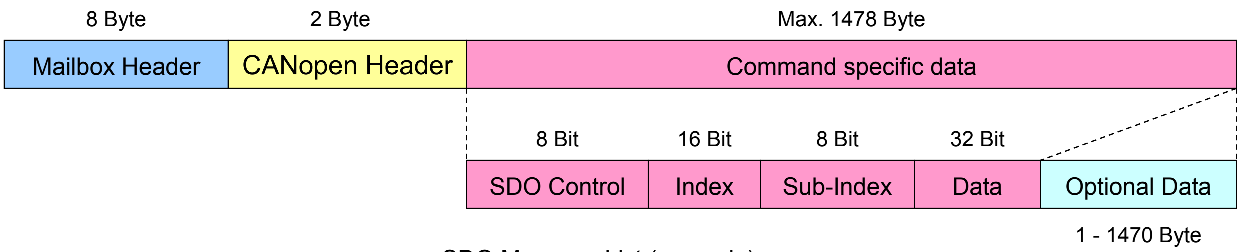
"CANopen Header" is configured with a 2Byte identifier composed of "Number" and "Type".
"CANopen Header" configuration is shown below.

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 List (example)

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	Diagram1	
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
$_{32}$ Complet Size	:	$_{32}$ Cmp S			

■ SDO Download Expedited Request

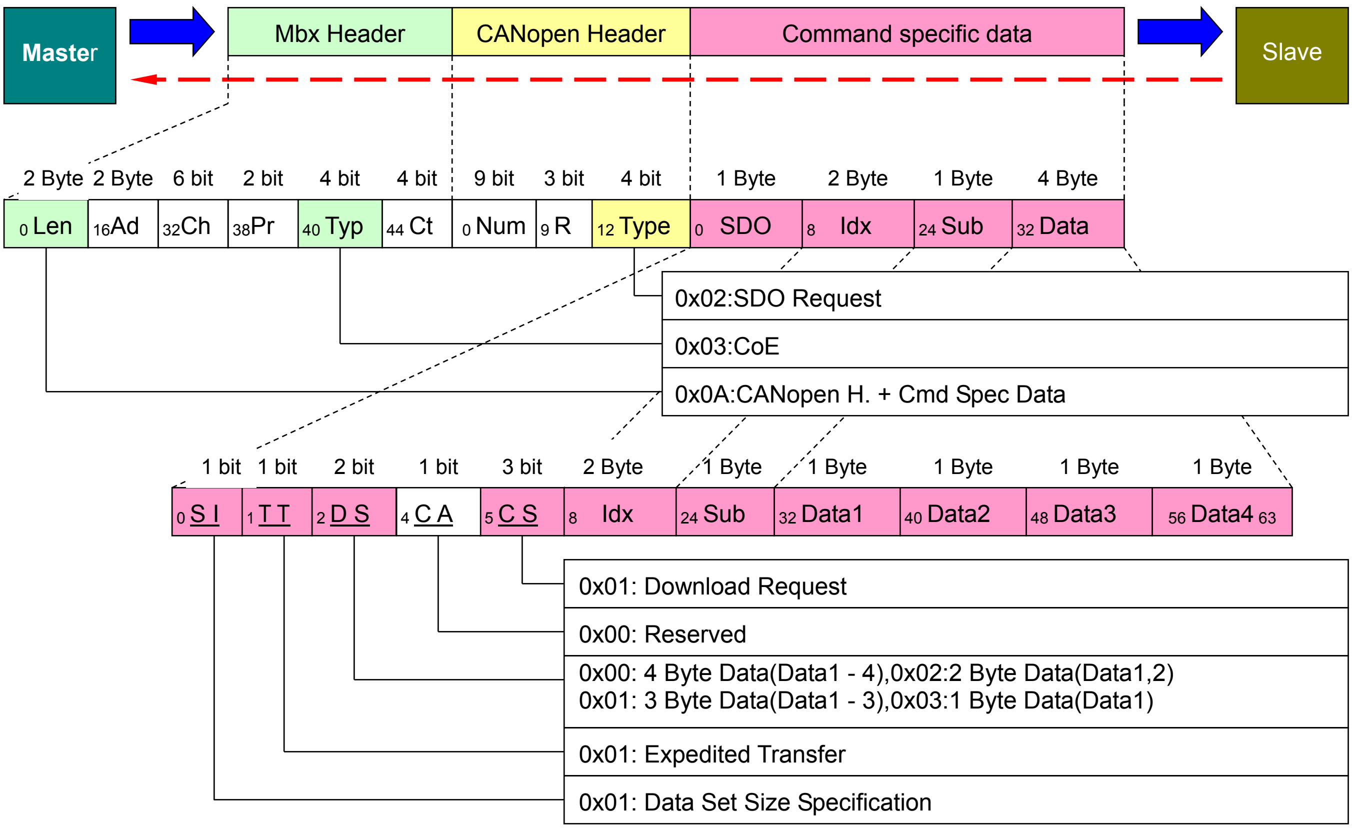


Diagram 1 : SDO Download Expedited Request

■ SDO Download Expedited Response

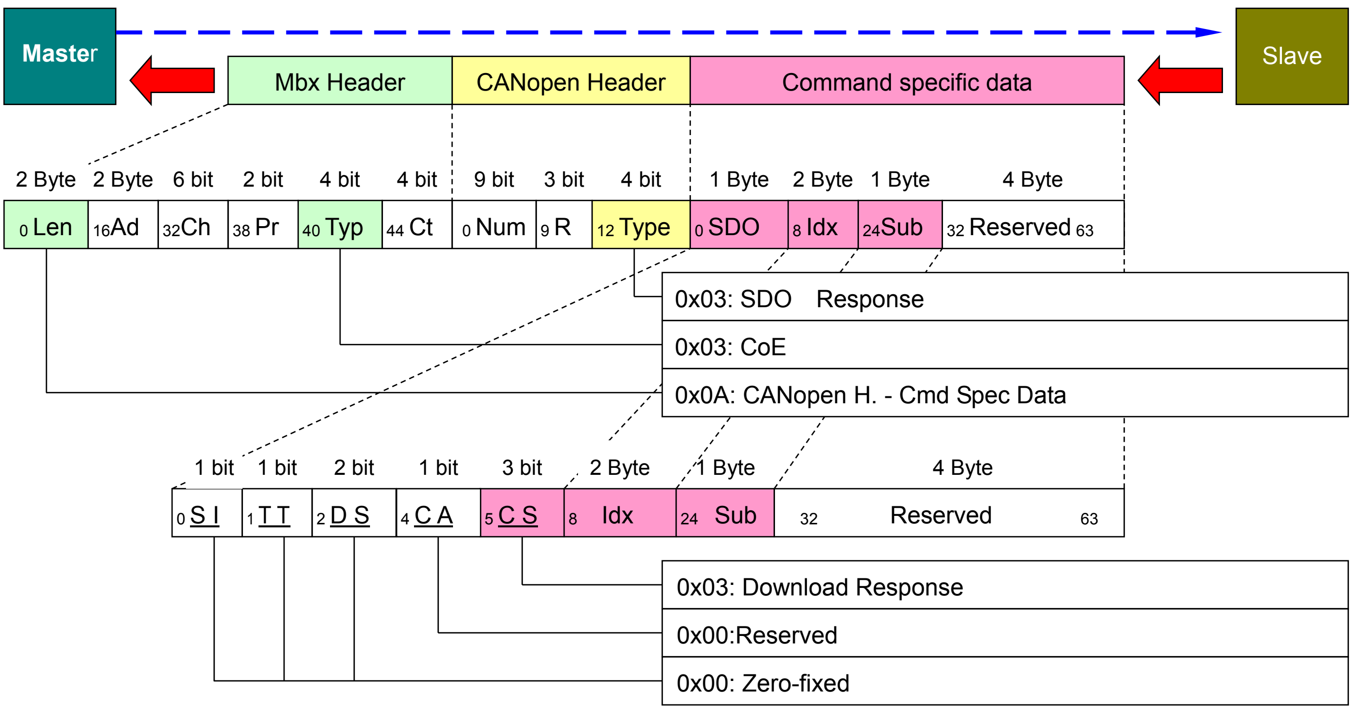


Diagram 2 : SDO Download Expedited Response

■ SDO Upload Expedited Request

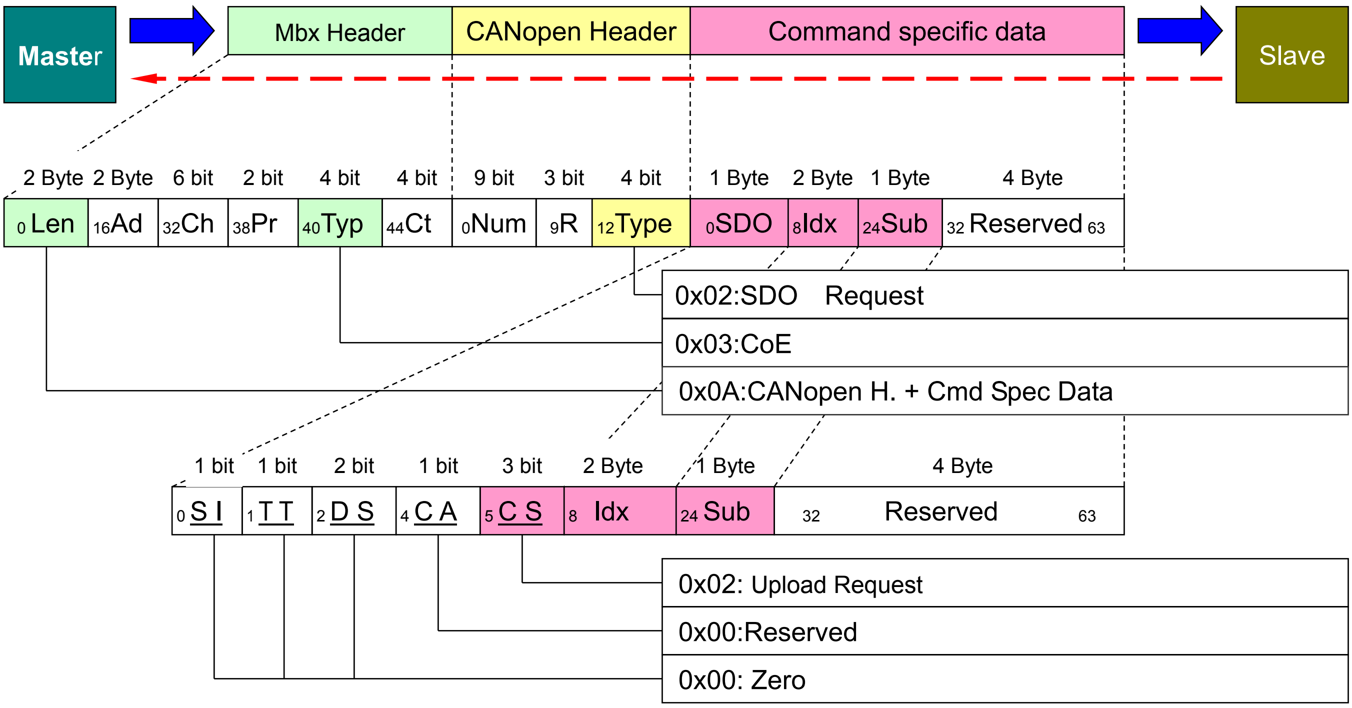


Diagram 3 : SDO Upload Expedited Request

■ SDO Upload Expedited Response

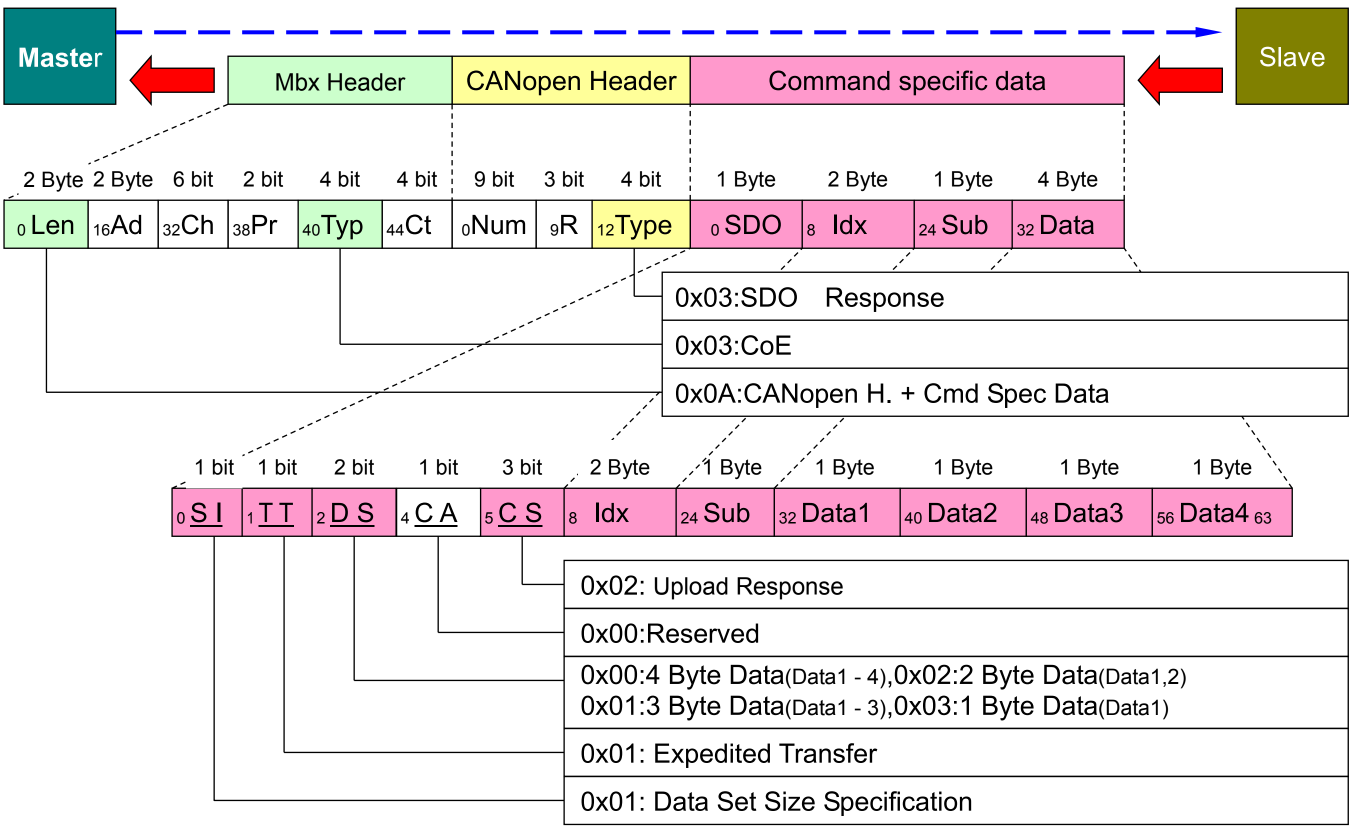


Diagram 4 : SDO Upload Expedited Response

■ SDO Download Normal Request

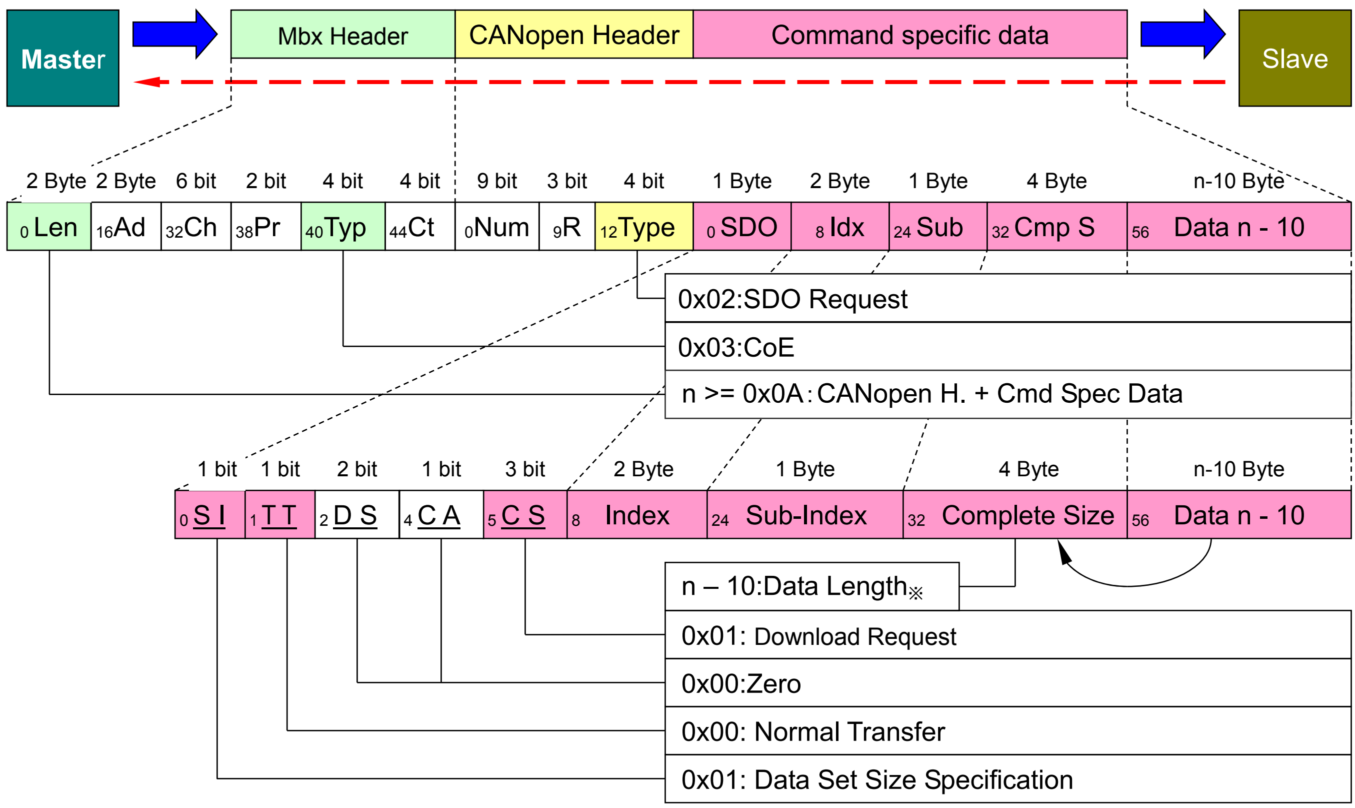


Diagram 5 : SDO Download Normal Request

■ 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

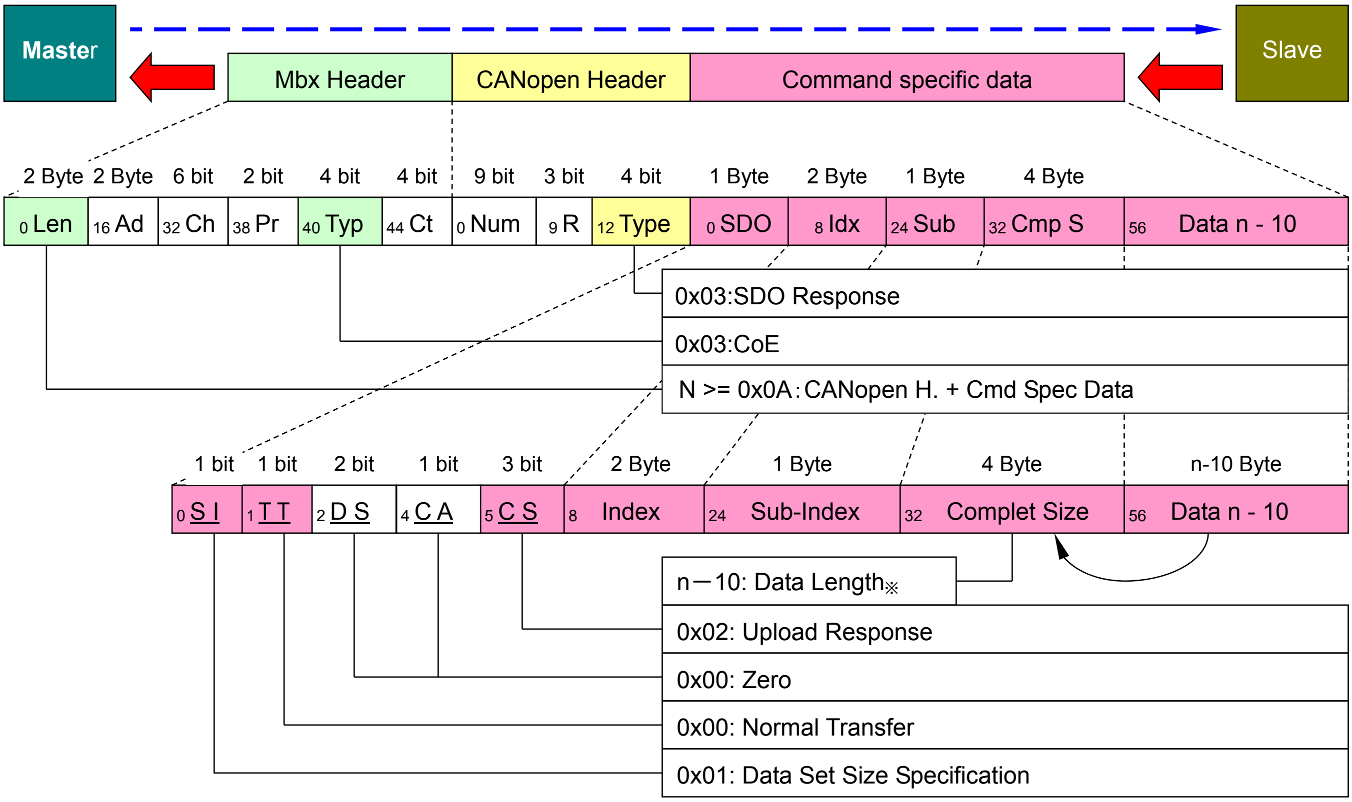


Diagram 6 : SDO Upload Normal Response

■ 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:

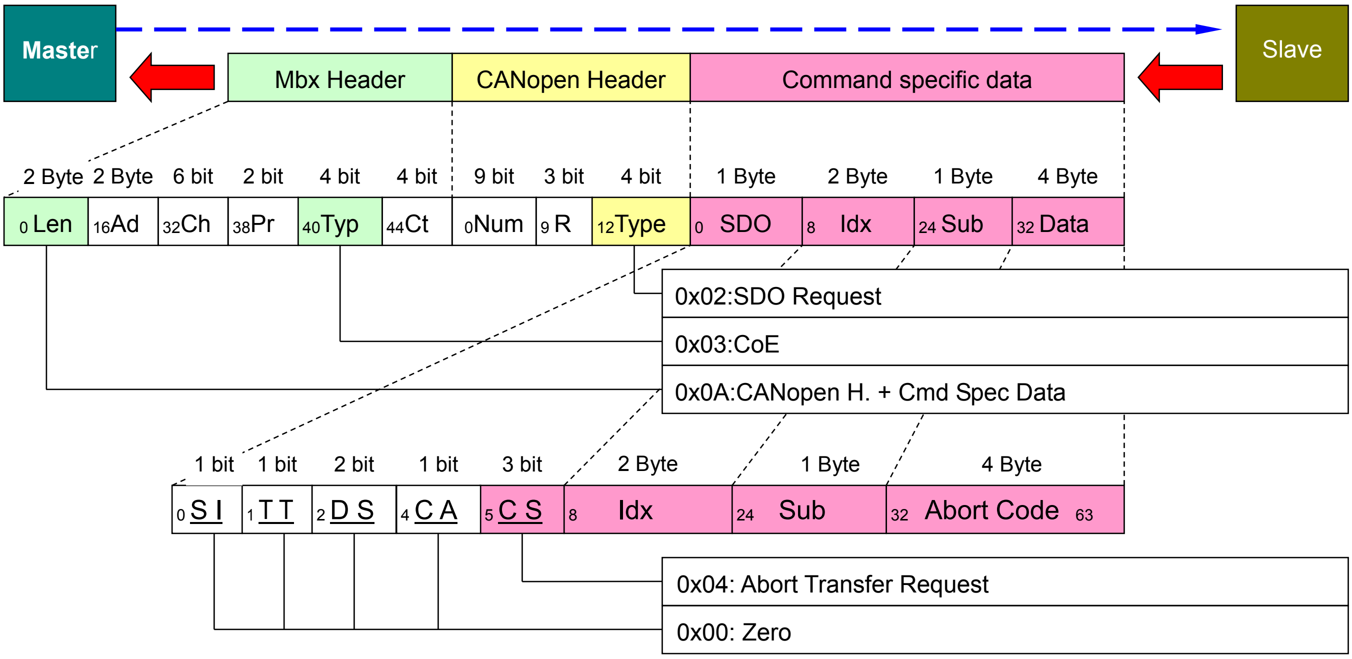


Diagram7 : Abort SDO Transfer Request

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
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.

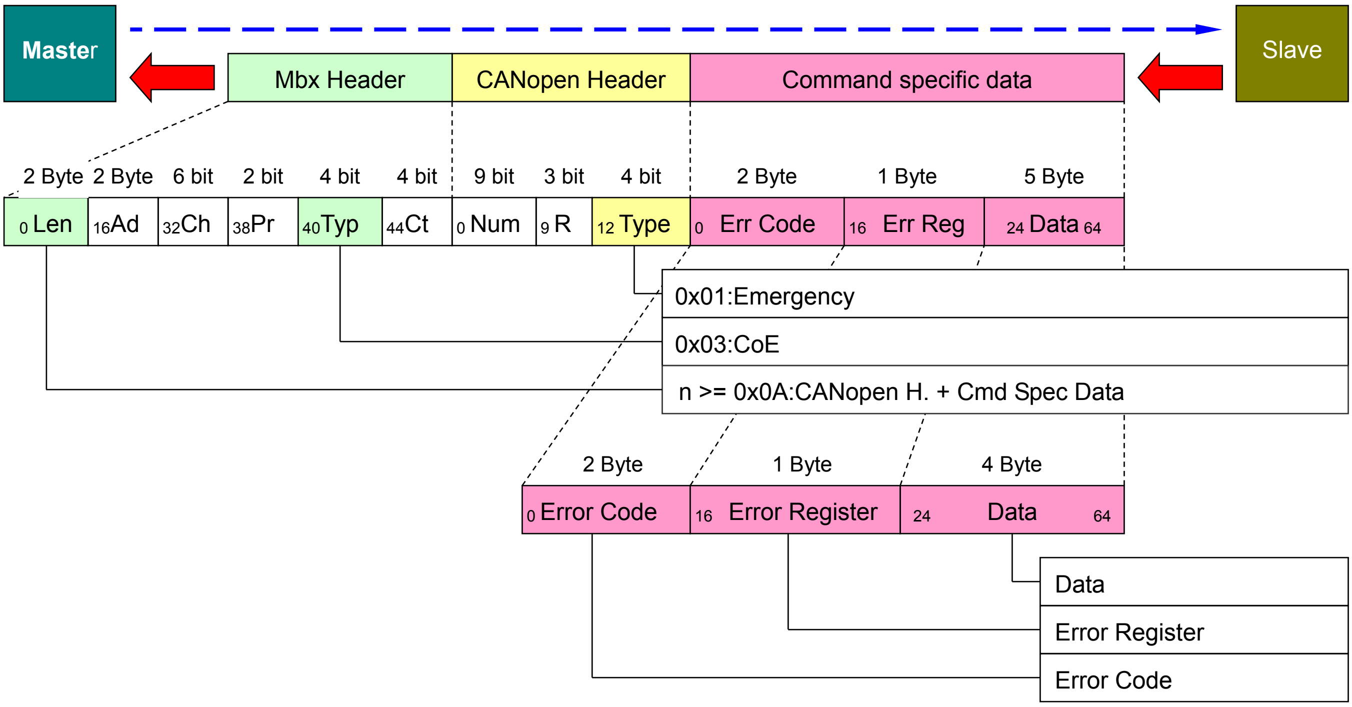


Diagram 8：EMCY Emergency

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

- **SDO Information**
  - Object List Request

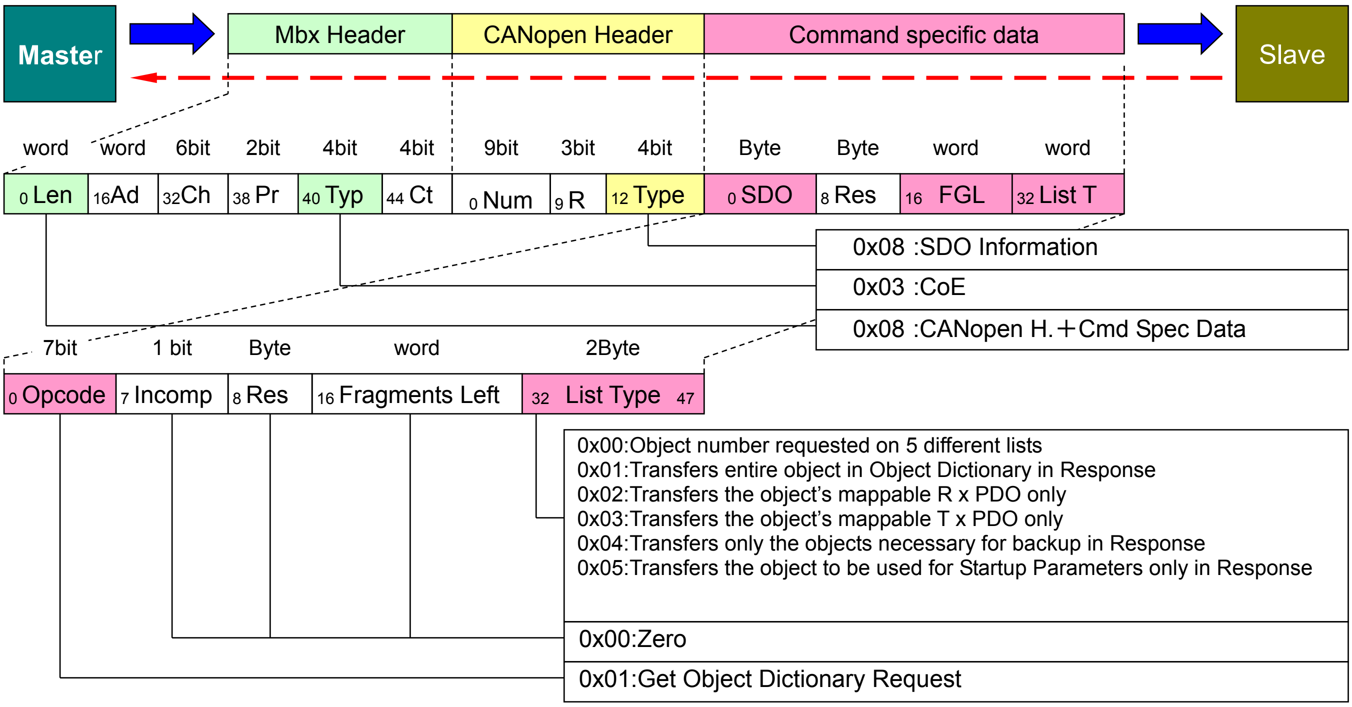


Diagram 9 : Get OD List Request (Object Dictionary Request)

- Object List Response (Object List Segment Response)

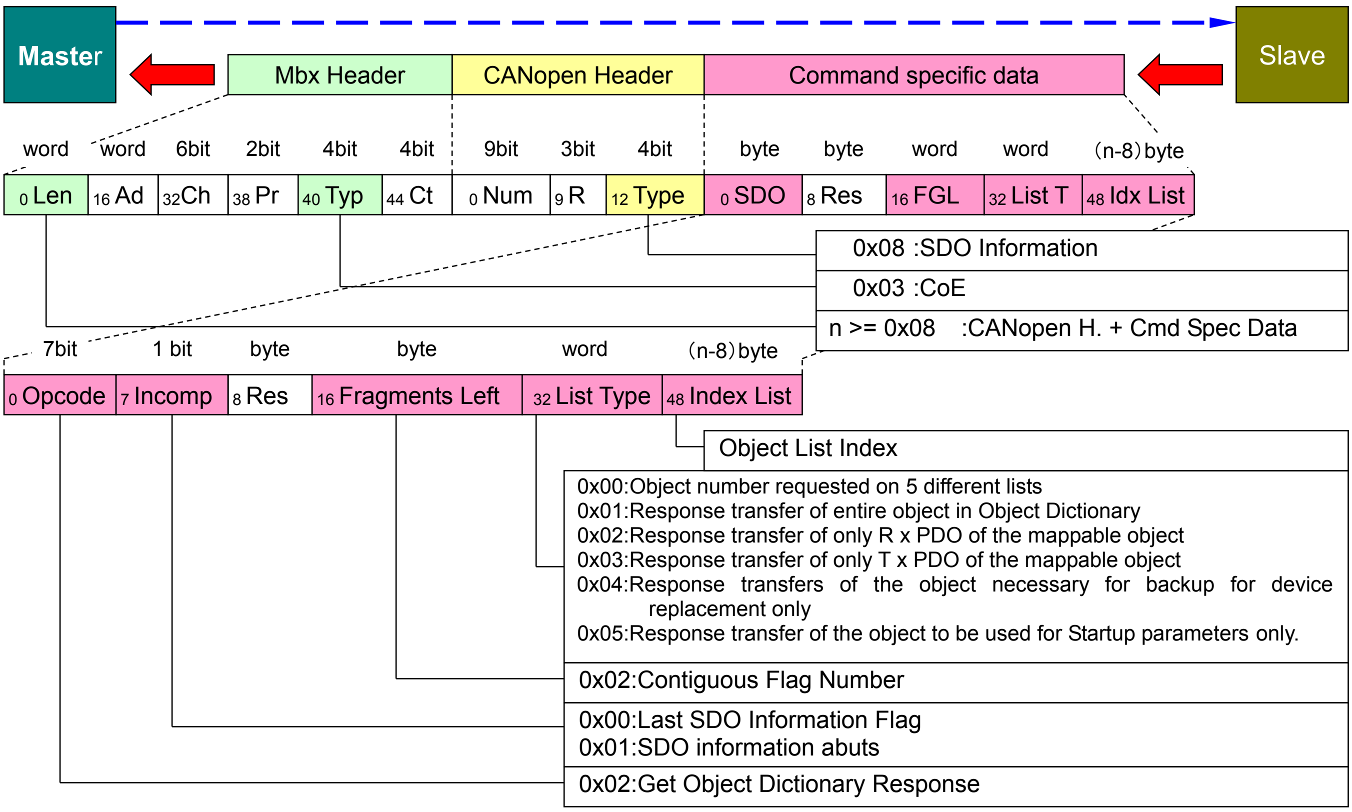


Diagram 10 : Get OD List Response (Object Dictionary Response)

◆ Object Dictionary Request

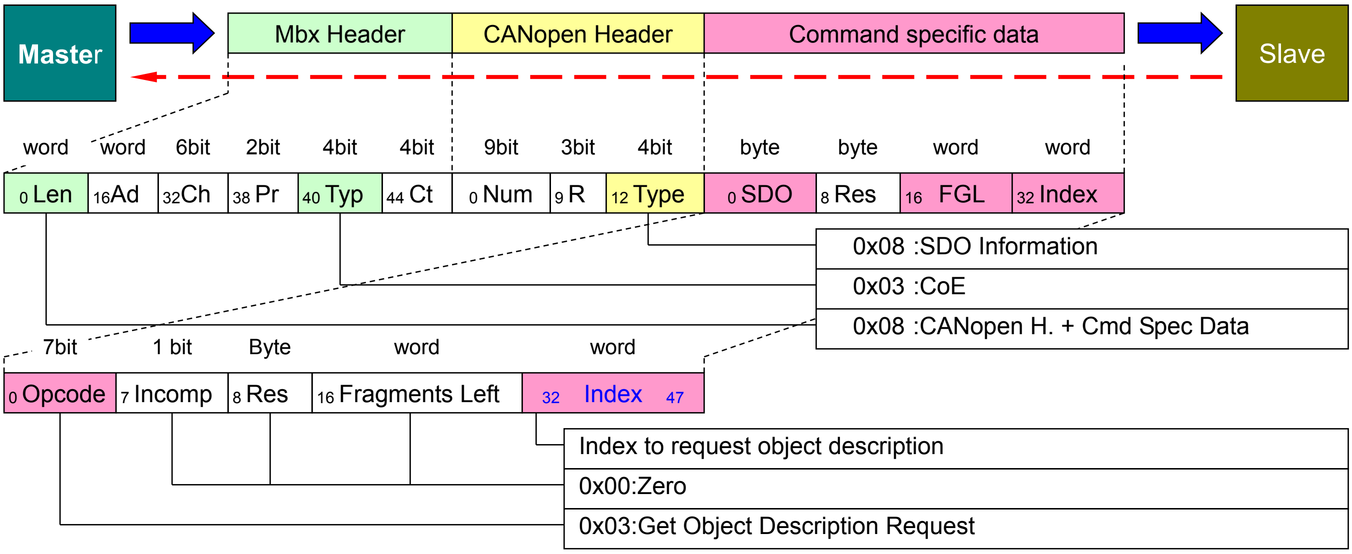


Diagram 11 : Get Object Description Request (Object Description Request)

◆ Object Description Response

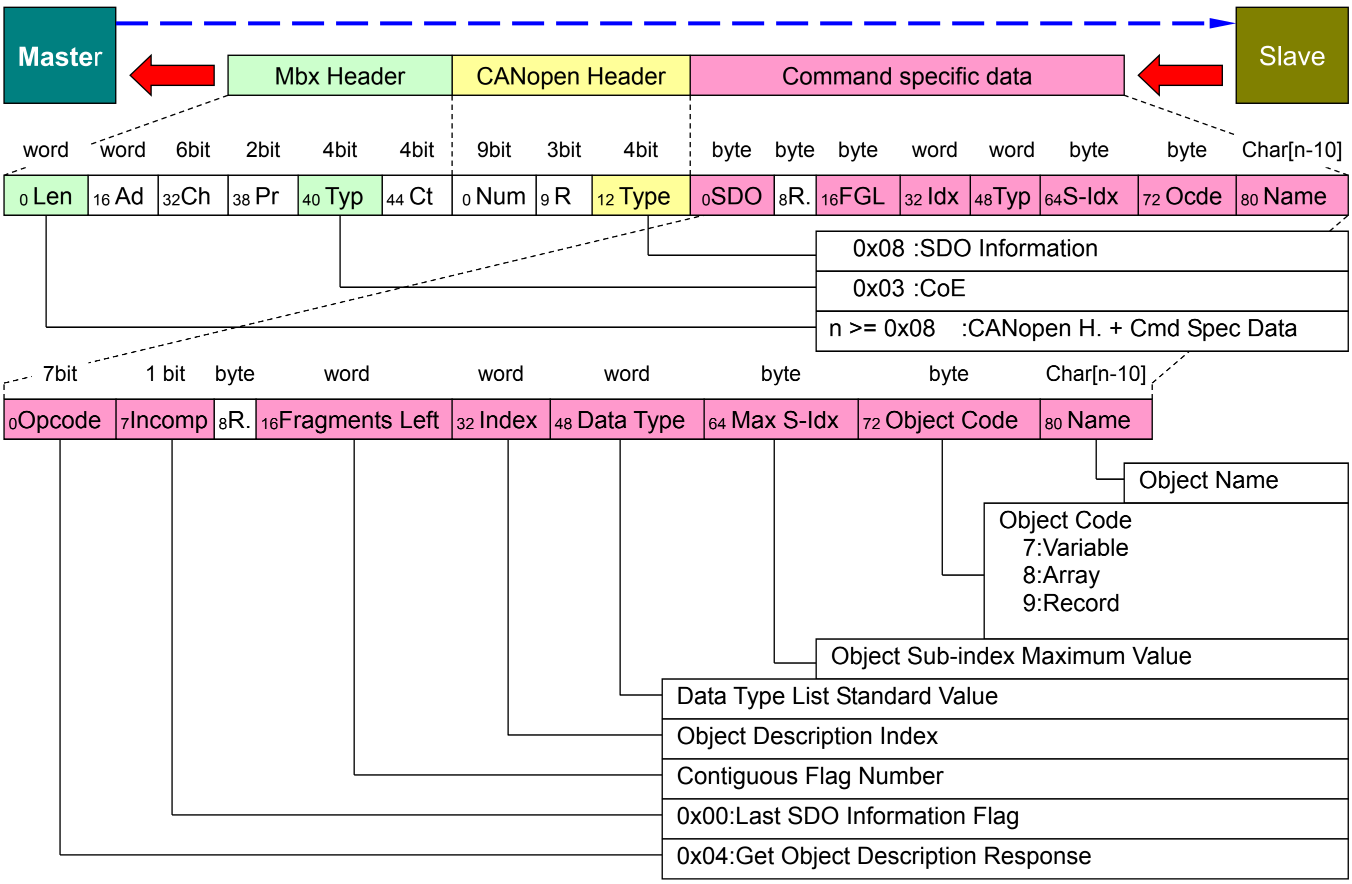


Diagram 12 : Get Object Description Response (Object Dictionary Response)

- Entry Description Request

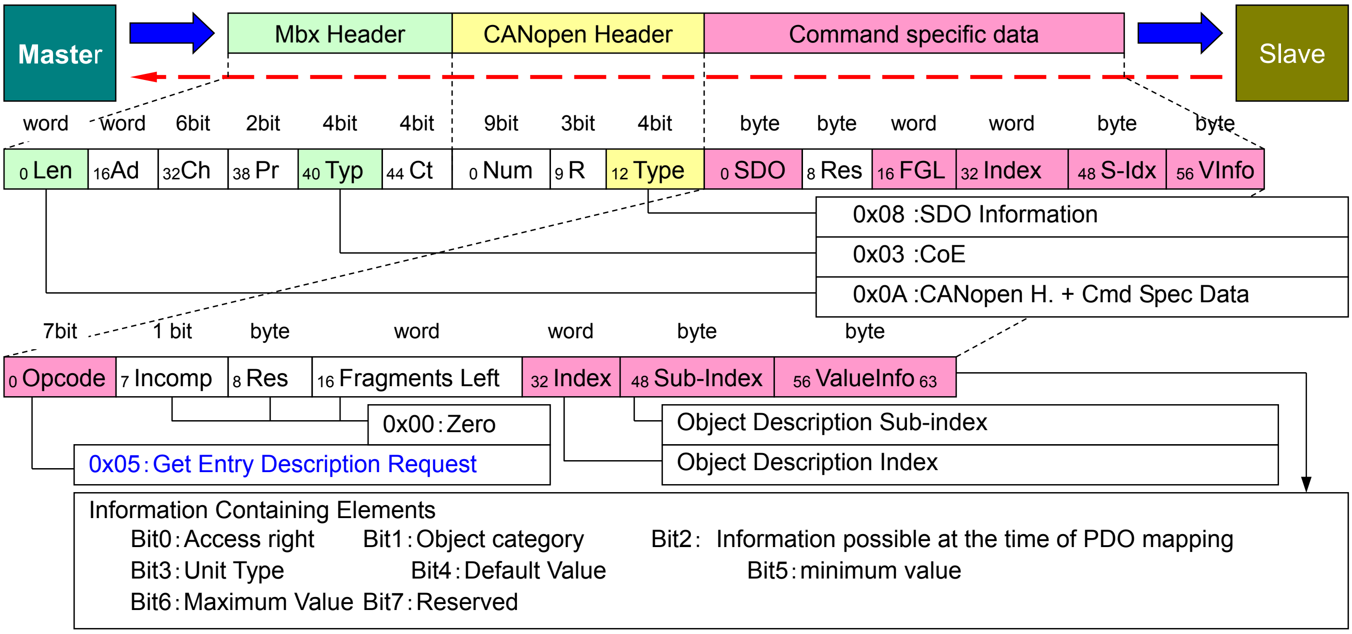


Diagram 13 : Get Entry Description Request (Object Description Request)

- Entry Description Response (Entry Description Segment)

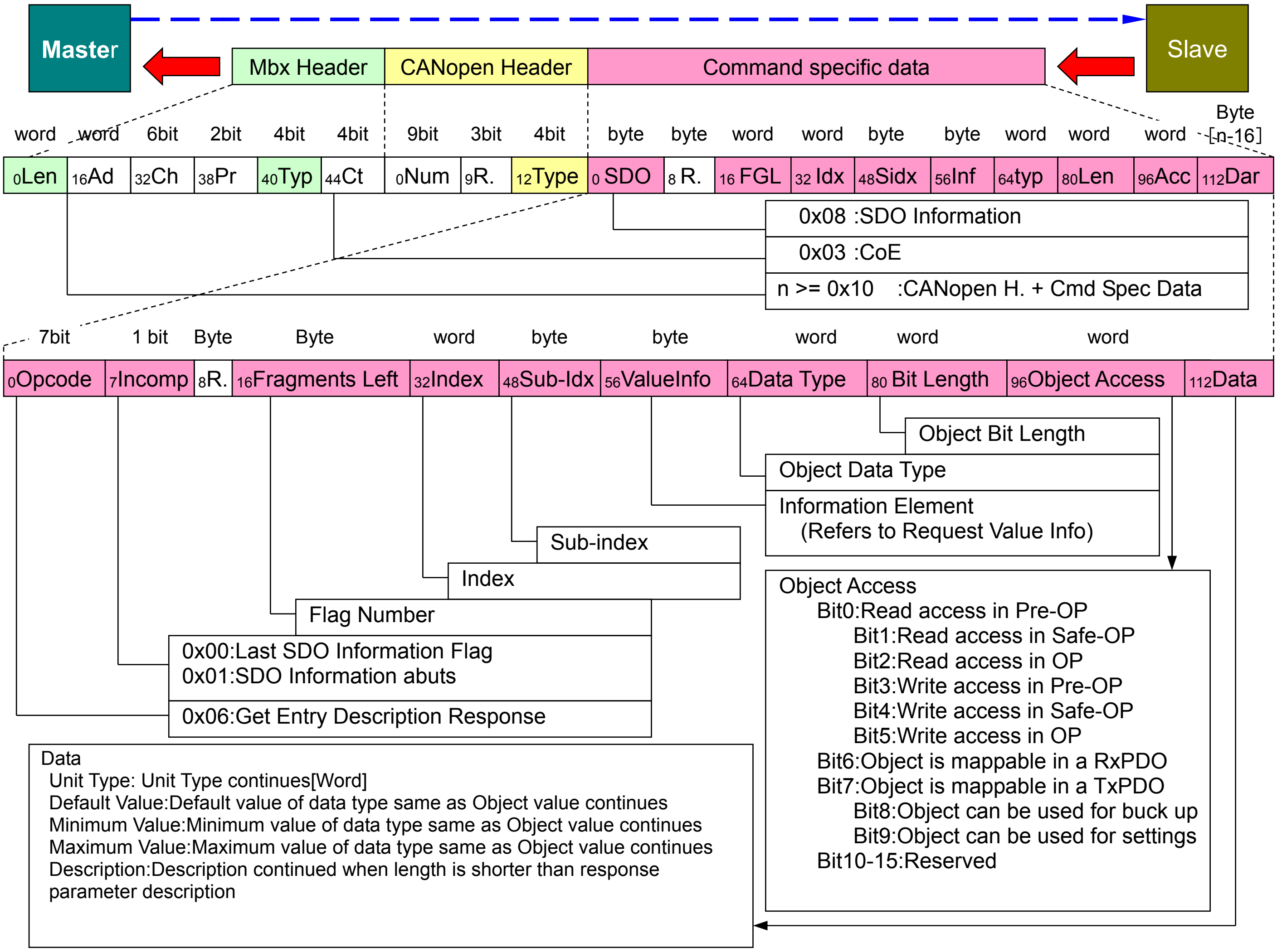


Diagram 14 : Get Entry Description Response (Object Dictionary Response)

◆ SDO information Error Request

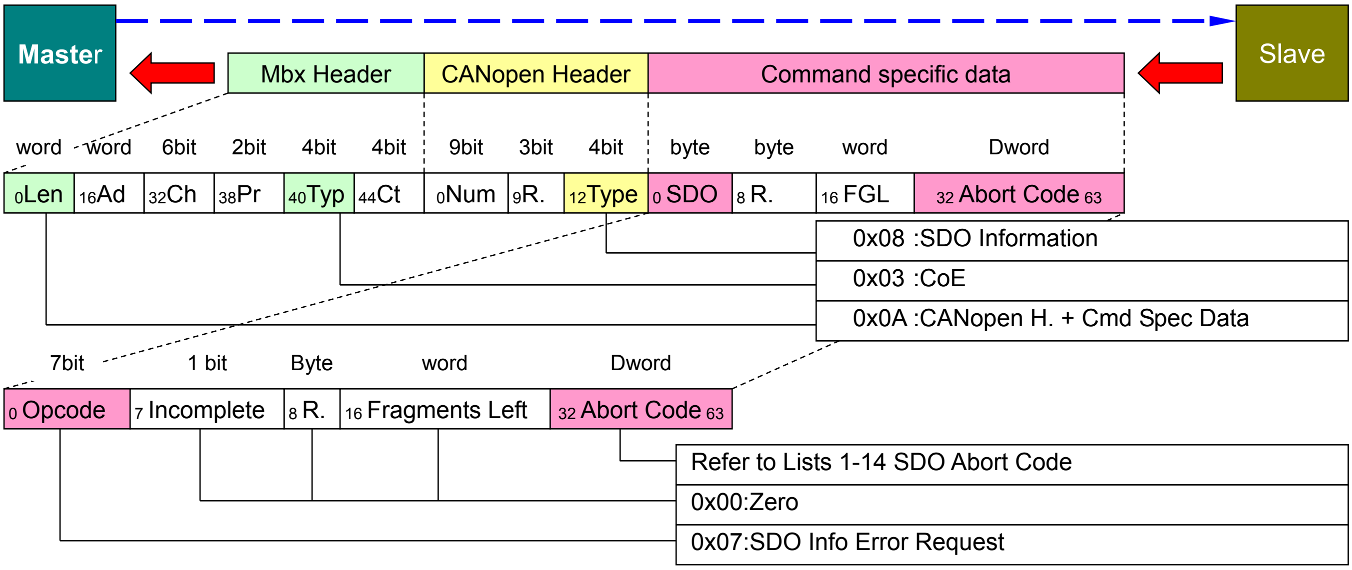


Diagram 15 : Error Request (SDO Information Error Request)

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

Index (2byte) Sub-Index (1Byte) Object Length (1byte)

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

PDO A	PDO B	PDO D	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 fins 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 withi 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

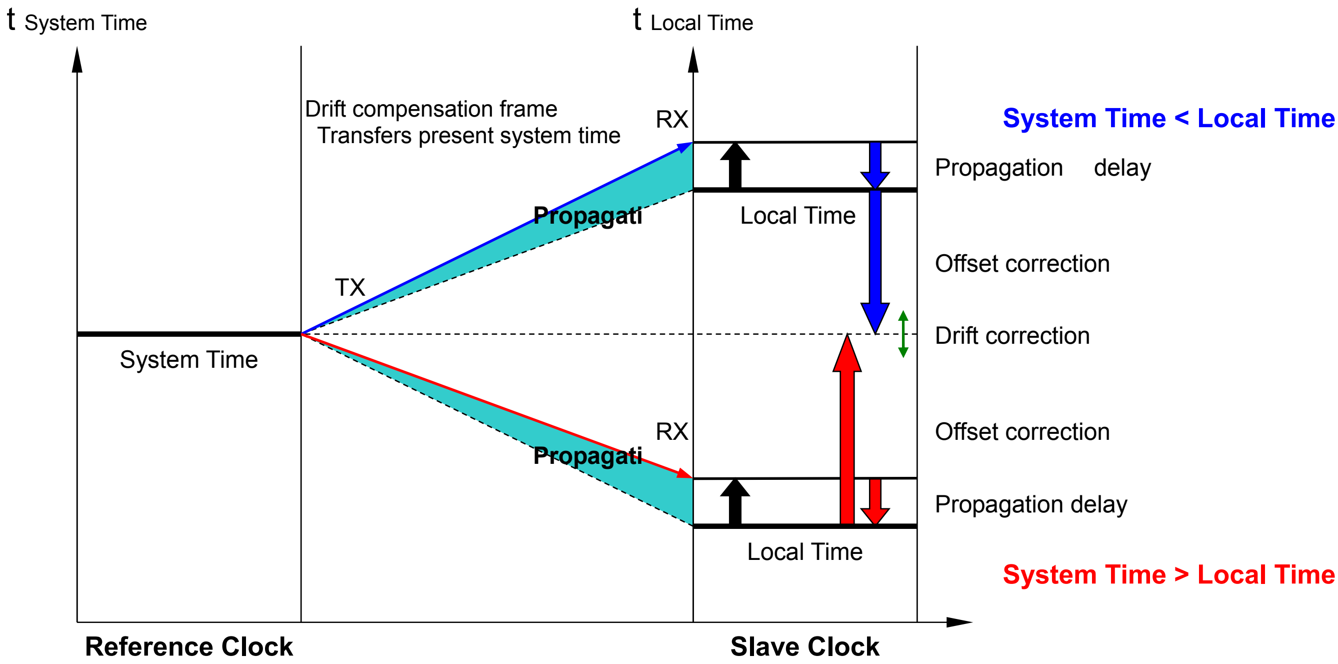
The clock synchronization process consists of three (3) steps.

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 2nd 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).

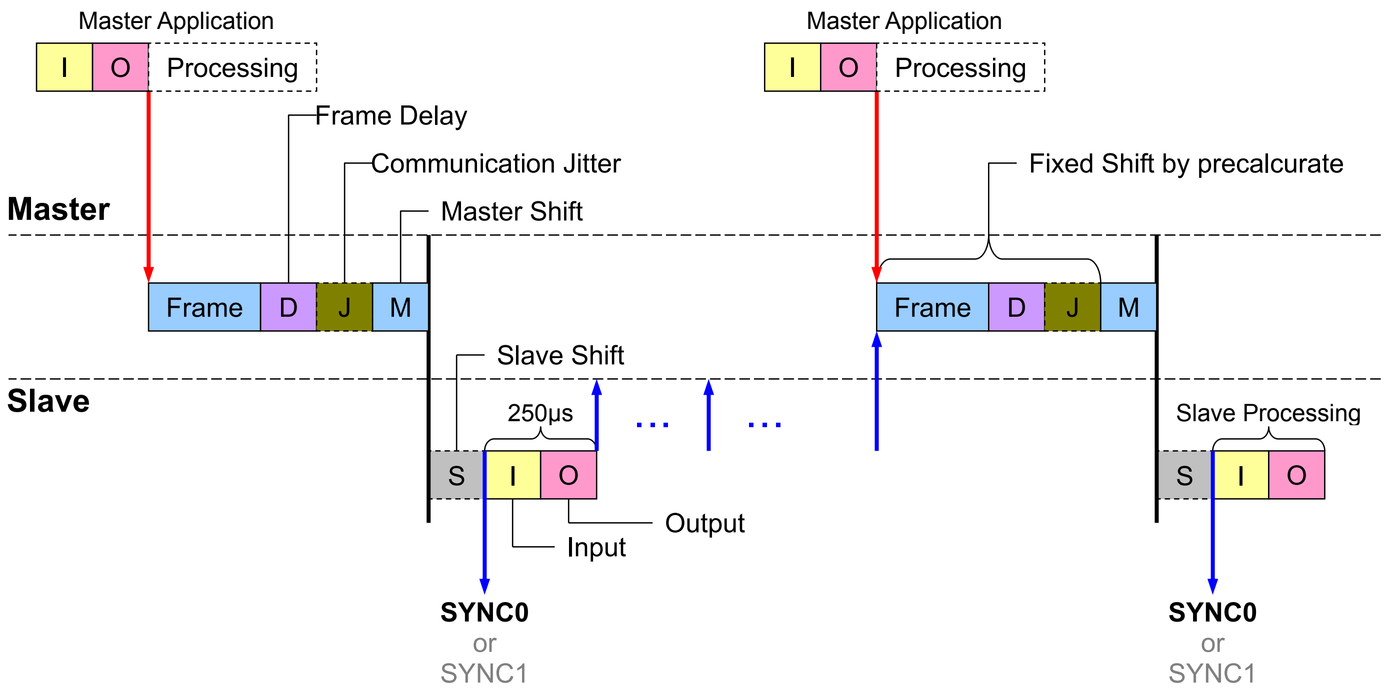
Synchronizing unit stands by until the first SYNC 0 pulse is output.
Cycle motion start time register and the next SYNC 1 pulse register can be read to acquire the next output event time.

5.8 Communication Timing

EtherCAT synchronous handling works independently from the EtherCAT device inside the master and slaves. The following three (3) communication methods are standard for synchronous modes:

1) Free-run Mode
   The slave application does not synchronize with the EtherCAT synchronous signal (non-synchronous mode).
2) SM Event Synchronous Mode
   The slave application synchronizes with an SM2 event when cycle output is transmitted. Also, the application synchronizes with an SM3 event (Note) only when cycle input is transmitted.
   Note) Synchronizing with an SM3 event is not supported in this amplifier.
3) SYNC Event Synchronous Mode
   The slave application synchronizes with a SYNC 0 or SYNC 1 event.

The differences between the synchronous type modes can be identified by the Sub-index combination sin the CoE Object Dictionary 0x1C32 and 0x1033.
An example of communication timing with DC is shown below.



Communication with DC Timing

- Frame
  Communication frame and frame transfer time (80ns / Byte+5μs)
- Frame Delay (Communication Delay)
  Delay time of the EtherCAT slaves for data transfer (approx. 5ns/m cable delay,approx. 1μs 100BASE-TX)
- Jitter (Communication Jitter)
  Frame transmission start jitter (Cycle Time Jitter) is generally influenced by the master's efficiency.
- Cycle Time Jitter
  Cycle time jitter, an application specification, depends on the slave and master system hardware. In this example, 10% of the cycle time is reserved for jitter
- Master Shift (Communication Master)
  Adjusting shift time inside the master also adjusts the necessary processing time in the mater.
- Slave Shift
  Delay time at the start of processing in the EtherCAT slaves (= 0 in R-ADVANCED EtherCAT amplifier).
- Input or Output of the Slave
  Input is for R x PDO import and processing. Output is for T x PDO output.
  (The input / output processing time of R-ADVANCED EtherCAT amplifier is 250μs fixed.)

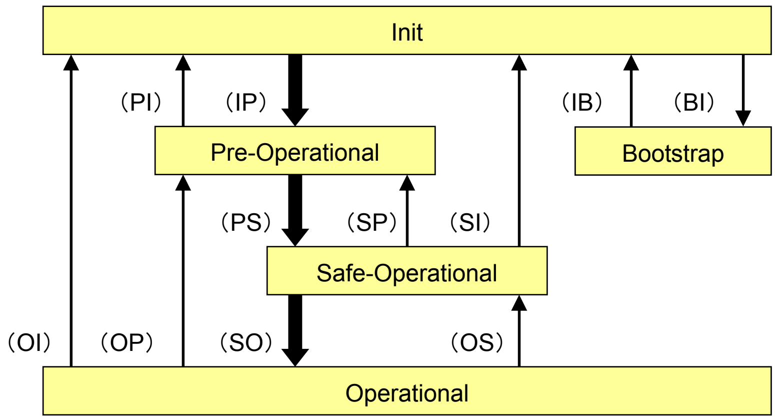
5.9 EtherCAT State Machine (ESM)

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 Firmware Update (FoE), Start Bootstrap Mode
BI	BOOT TO INIT	Start Firmware Update (FoE), Restart Device

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 downloaded to the FoE (File access Over EtherCAT) protocol.

5.10 Bootstrap state

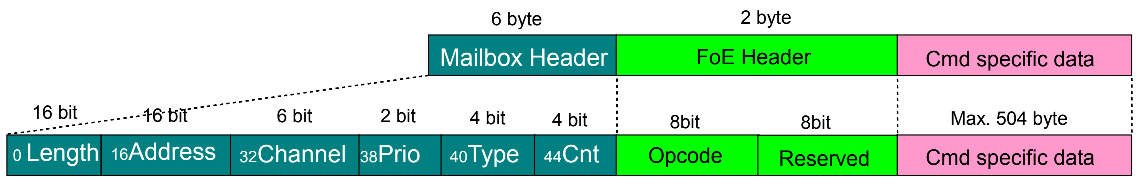
In the Bootstrap state, servo amplifier firmware can be downloaded to servo amplifier by using FoE（File access over EtherCAT）protocol.Re-wrinting of servoamplifier firmware is perfomed by changing “Bootstrap state” to “Init state” in the consideration that firmware re-writing has no risks, after the firmware downloaded completely. In line with this, the downloaded firmware is written in CPU flash. The time to write is several seconds.

The conditions consided 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.

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

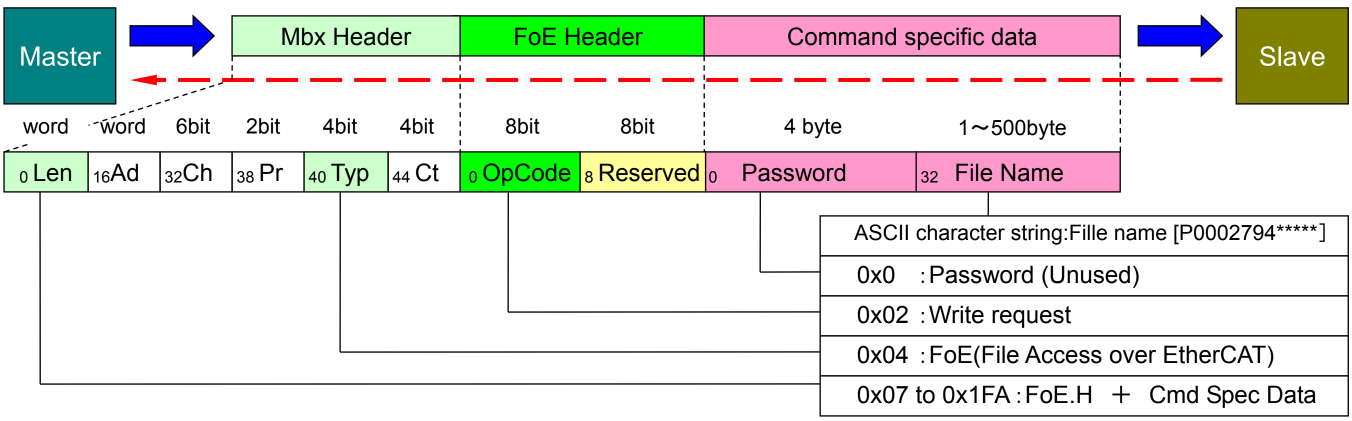
Code (Abbrev.)	Data length	Description
Opcode	8 bit	FoE commnad 0x01 : Reserved (Read request) 0x02 : Write request 0x03 : Data request 0x04 : Ack request 0x05 : Error request 0x06 : Reserved (Busy request)
Reserved	8 bit	0x00

3) FoE command

Firmware downloading 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 firmware data. Slave returns "Ack request" to Master only when the request from Master normally recived. "Data request" and "Ack request" are repeatedly tramsmitted and received until the firmware data sent from Master runs out.
When Slave does not judge the firmware data is valid, Slave returns "Error request," an error meddage to Master. (Refer to FoE error code.)

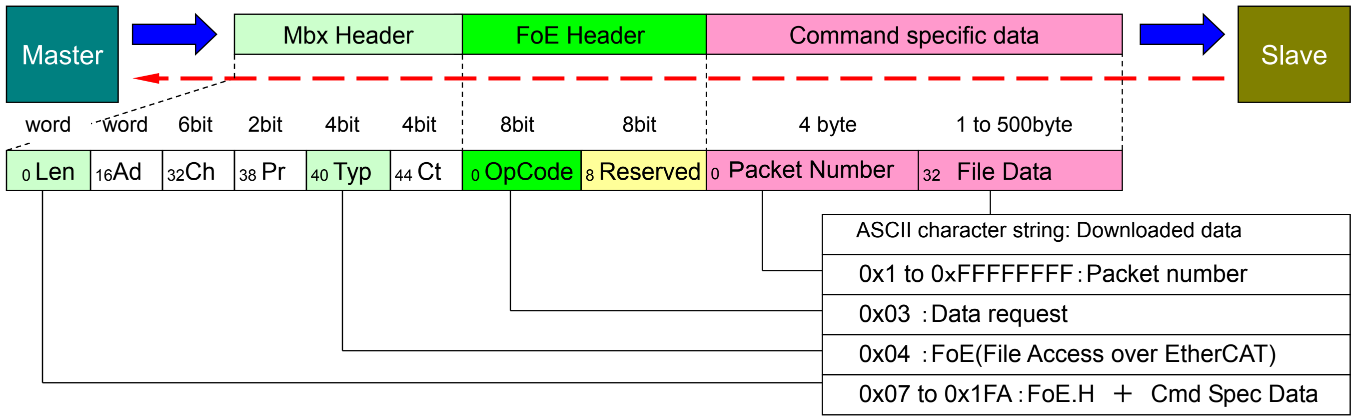
Note) Password *1: Password identification function for R-ADVANCED EtherCAT amplifier is disabled.

■ Write request



Write request

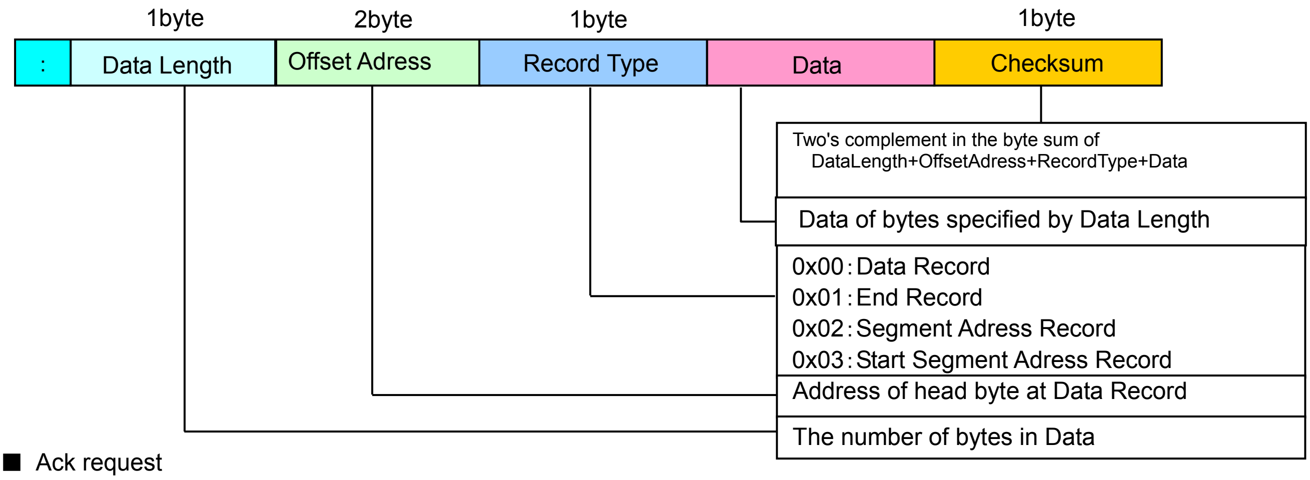
■ Data request



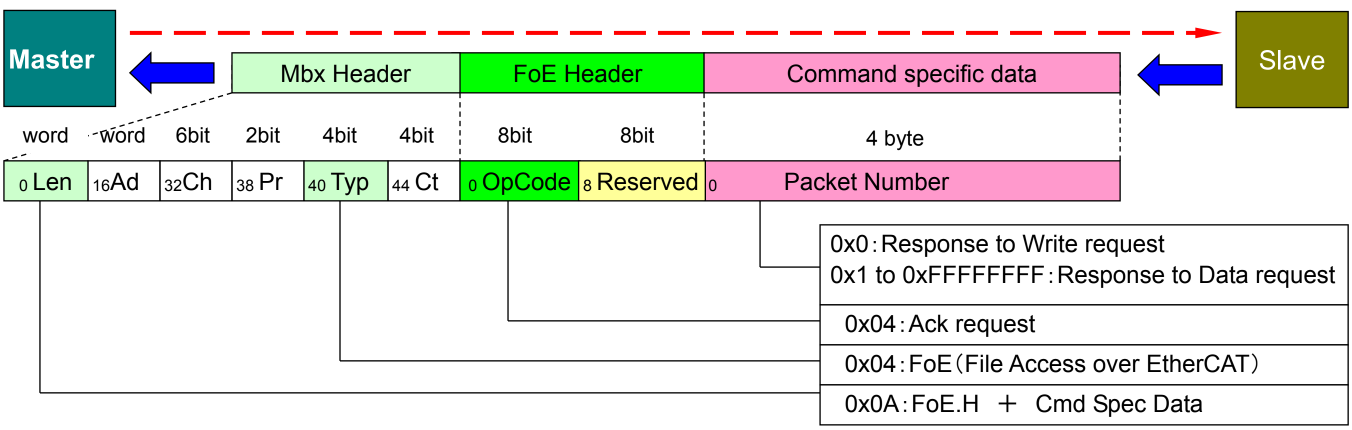
Data request

※ 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］

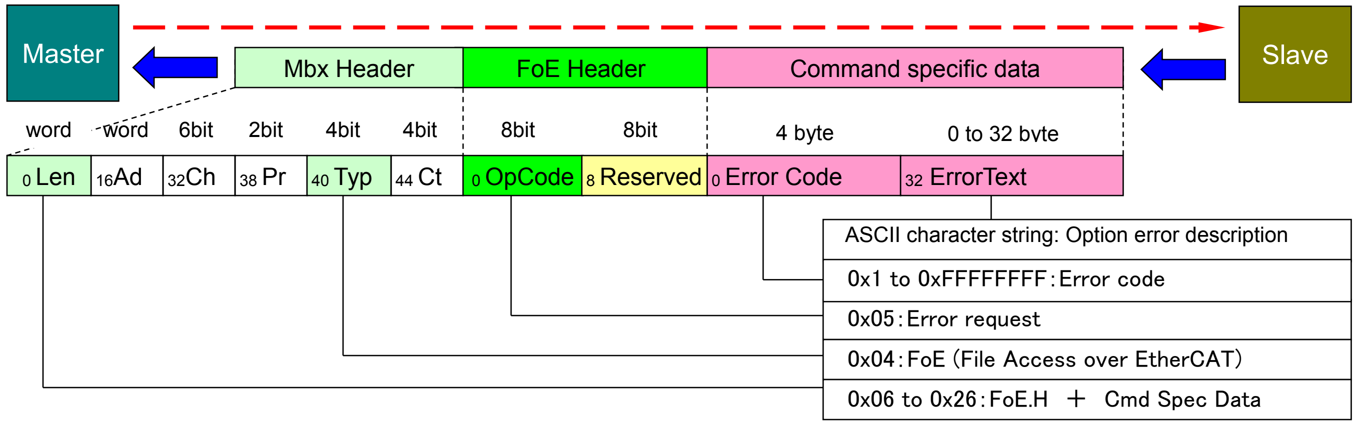


■ Ack request



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.
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

6. Data Link Layer

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 EhterCAT 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.

6.2 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 0x1000to 0x2FFF

The address space list is shown below.

Table 1: ESC address space

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

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

Table 2: ESC address space

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

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

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	Port configuration: 00:Not implemented, 10:EBUS, 11:MII	R/-	R/-	1Byte	0x0F
	3:2	Port 1					
	7:4	Reserved					

ESC Features supported

Address	bit	Description		Master	Slave	Length	Rest Value
0x0008 - 0x0009	0	FMMU Operation	0:Bit oriented, 1:Byte oriented	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					

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.

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				

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/-		0x00
	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				
	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:defaul , 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

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).

■ 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.

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	O		S + E	
	0x0030	Invalid DC SYNCH 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） Process data interface(PDI)

PDI Control

Address	bit	Description	Master	Slave	Length	Rest Value
0x0140 - 0x0141	7:0	Process data interface: 8:16 Bit asynchronous microcontroller interface	R/-	R/-	2 Byte	0x08 Note)
	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 micro**controller 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 - 0x0153	0	Read BUSY delay: 0:Normal read BUSY output 1:Delayed read BUSY output	R/-	R/-	2 Bytes	0x0000 Note)
	15:1	Reserved, set EEPROM value 0				

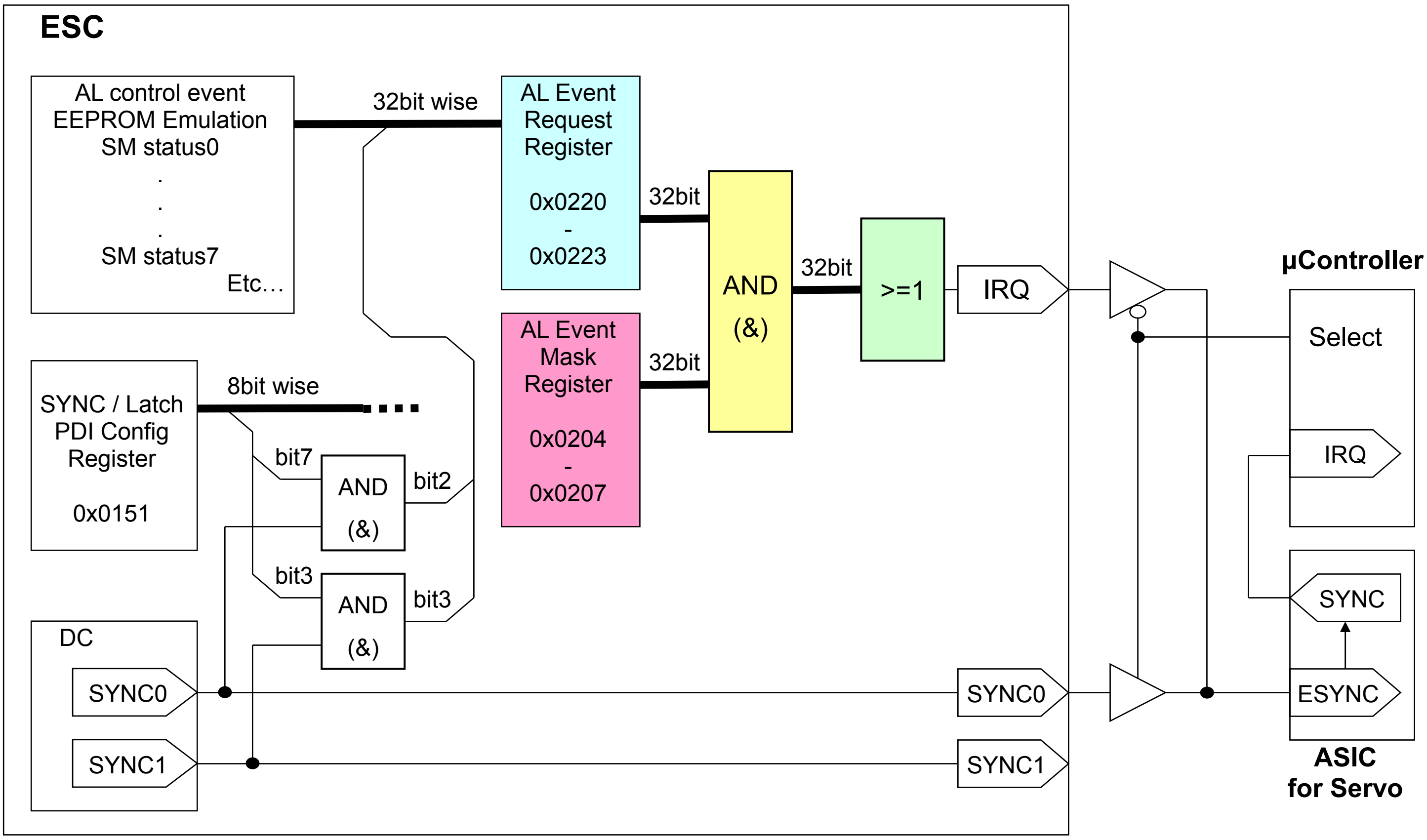
Note) Reset Value is “0”. After that, depends on configuration EEPROM ADR 0x0003.

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).

Registers used for AL event requests are described:

Registers for AL Event Requests

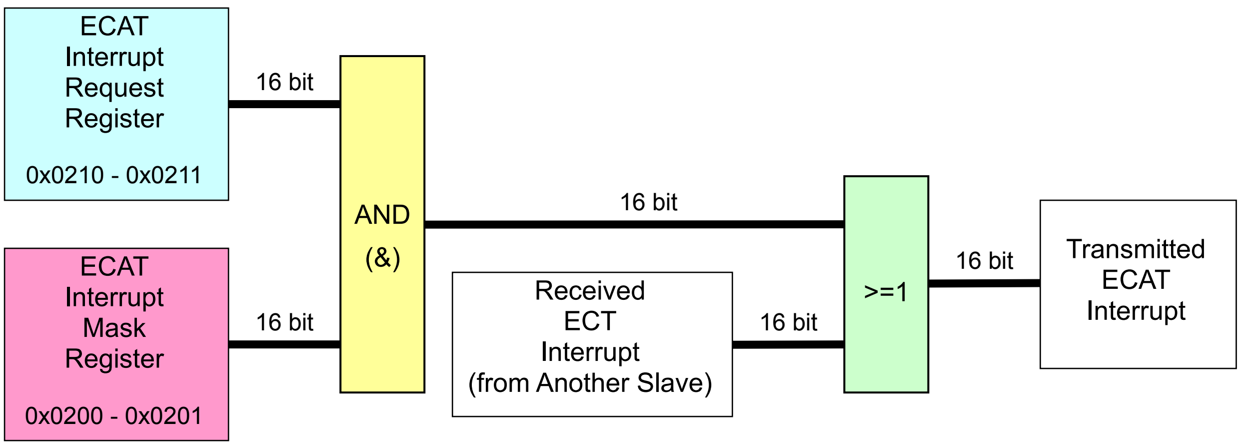
Register Address	Name	Description
0x0150	PDI Configuration	IRQ driver characteristics, depending on PDI
0x0151	SYNC/LATCH PDI Configuration	Mapping DC Sync Signals to Interrupts
0x0204:0x0207	AL Event Mask	Mask register
0x0220:0x0223	AL Event Request	Pending Interrupts
0x0804+N*8	Sync Manager Control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

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				

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 - 0x0307	7:0	Invalid frame counter of Port 0 (counting is stopped when 0xFF is reached). Note)	R/W (clr)	R/-	8 Bytes	0x00
	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 - 0x030B	7:0	Forwarded error counter of Port 0 (counting is stopped when 0xFF is reached). Note)	R/W (clr)	R/-	4 Bytes	0x00
	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 - 0x0313	7:0	Lost Link counter of Port 0 (counting is stopped when 0xff is reached). Note)	R/W (clr)	R/-	4 Bytes	0x00
	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.

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 100μs = 2,500-2 = 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 100μs 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 100μs 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)	0: Watchdog Process Data expired 1: Watchdog Process Data is active or disabled	R/-	R/-	2 Bytes	0x0000
	15:1	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.

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	0: EtherCAT (Master) 1: PDI (Slave)	R/W	R/-	1 Byte	0x00
	1	Force ECAT access	0: Do not change Bit 501.0 1: Reset Bit 501.0 to 0				
	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)	0: PDI releases EEPROM access 1: PDI takes EEPROM access (PDI has EEPROM control)	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 Note1)	0: Write requests are disabled 1: Write requests are enabled This bit is always 1 if PDI has EEPROM control.	R/(W)	R/-	2 Bytes	0xC0
	4:1	Reserved, write 0		R/-	R/-		
	5	EEPROM emulation	0: Normal operation (I²C interface used) 1: PDI emulates EEPROM (I²C 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 Note1)	Write: 0:No Action 1: Begin read access Read: 0:No read 1: Read processing	R/(W)	R/(W)		0x00
	9	EEPROM Write Commands Note1)	Write: 0:No Action 1: Begin write access Read: 0:No write 1: Write processing				
	10	EEPROM Reload Commands Note1)	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	R/-	R/-		
	12	EEPROM loading status	0: EEPROM loaded, device information ok 1: EEPROM not loaded, device information not available				
	13	Error Acknowledge/ Commands Note1)	0: No error 1: Missing EEPROM acknowledge or invalid command				
	14	Error Write Enable Note2)	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).

Note1) 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).

Note2) Error bits are cleared by writing “000” (or any valid command) to Command Register Bits [10:8].

EEPROM Address

Address	bit	Description	Master	Slave	Length	Rest Value
0x0504 - 0x0507	15:0	EEPROM Address, to be read or written Lower Word(=16bit)	R/(W)	R/(W)	4 Bytes	0x00000000
	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 - 0x050F	15:0	EEPROM Write data / Read data (lower bytes : 2Byte)	R/(W)	R/(W)	8 Bytes	0x0000
	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

MII Management Control/Status

Address	bit	Description		Master	Slave	Length	Rest Value
0x0510 - 0x0511	0	Write enable Note)	0: Write disabled 1: Write enabled	R/(W)	R/(W)	2 Bytes	0x00
	1	Management Interface can be controlled by PDI (registers 0x0516-0x0517)	0: Only ECAT control 1: PDI control possible	R/-	R/-		
	2	MI link detection(0x0518:0x051B)	link configuration, link detection 0: Not available 1: MI link detection active				
	7:3	PHY address offset	00000:offset ”0”				
	9:8	Command register	Write: Initiate command. Read: Currently executed command Commands: 00: No command/MI idle (clear error bits) 01: Read 10: Write Others: Reserved/invalid commands (do not issue)	R/(W)	R/(W)		0x00
	12:10	Reserved, write 0		R/-	R/-		
	13	Read error	0: No read error 1: Read error occurred (PHY or register not available) Cleared by writing to this register.	R/(W)	R/(W)		
	14	Command error	0: Last Command was successful 1: Invalid command or write command without Write Enable Cleared with a valid command or by writing “00” to Command register bits [9:8].				
	15	Busy	0: MI control state machine is idle 1: MI control state machine is active				

* 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).

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 Note)	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/-		0x00
	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 Note)	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/-		

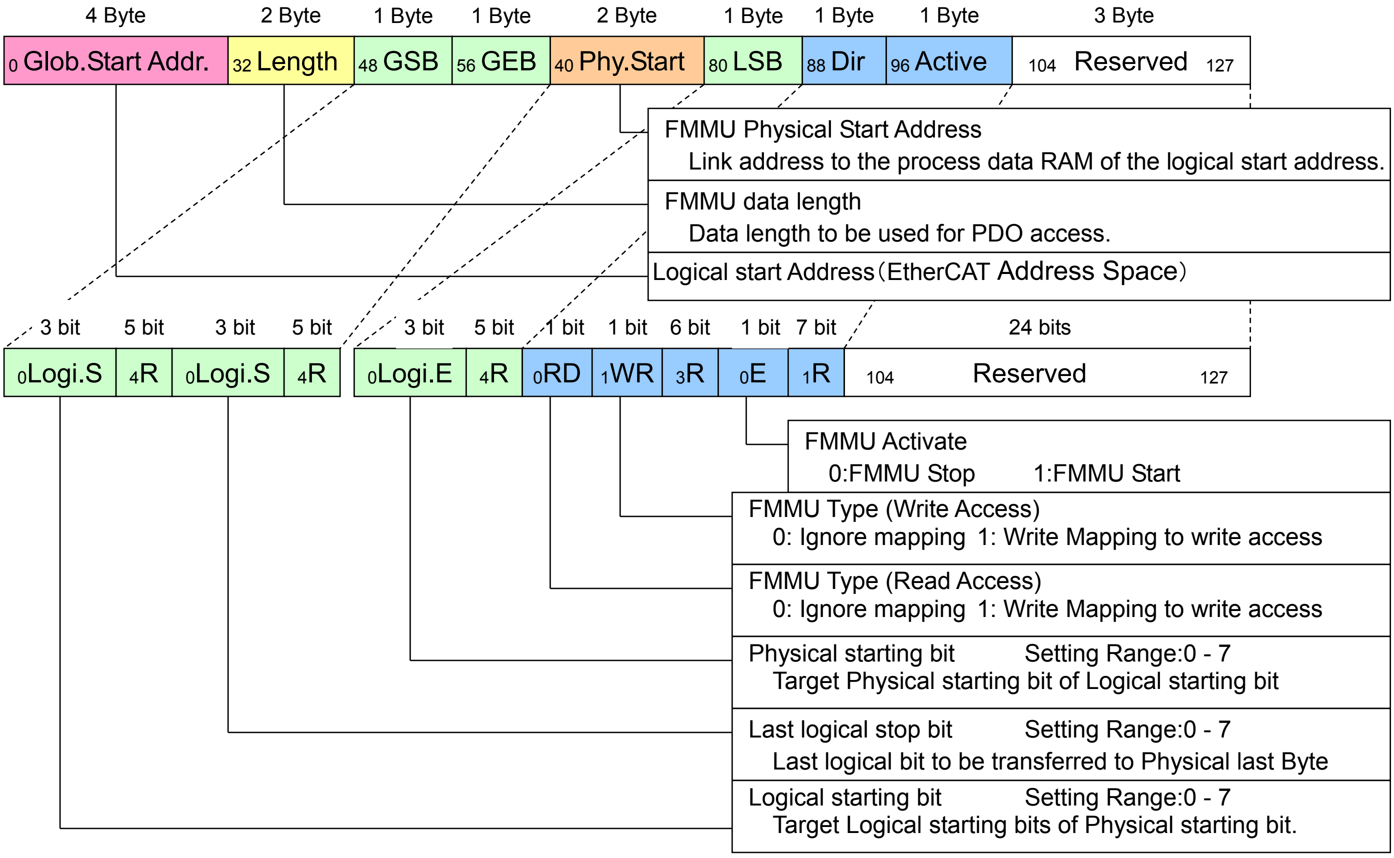
Note) Cleared by writing any value to at least one of the PHY Status Port 0 registers.
* r/ (w): write access depends on assignment of MI (ECAT/PDI).

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.

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

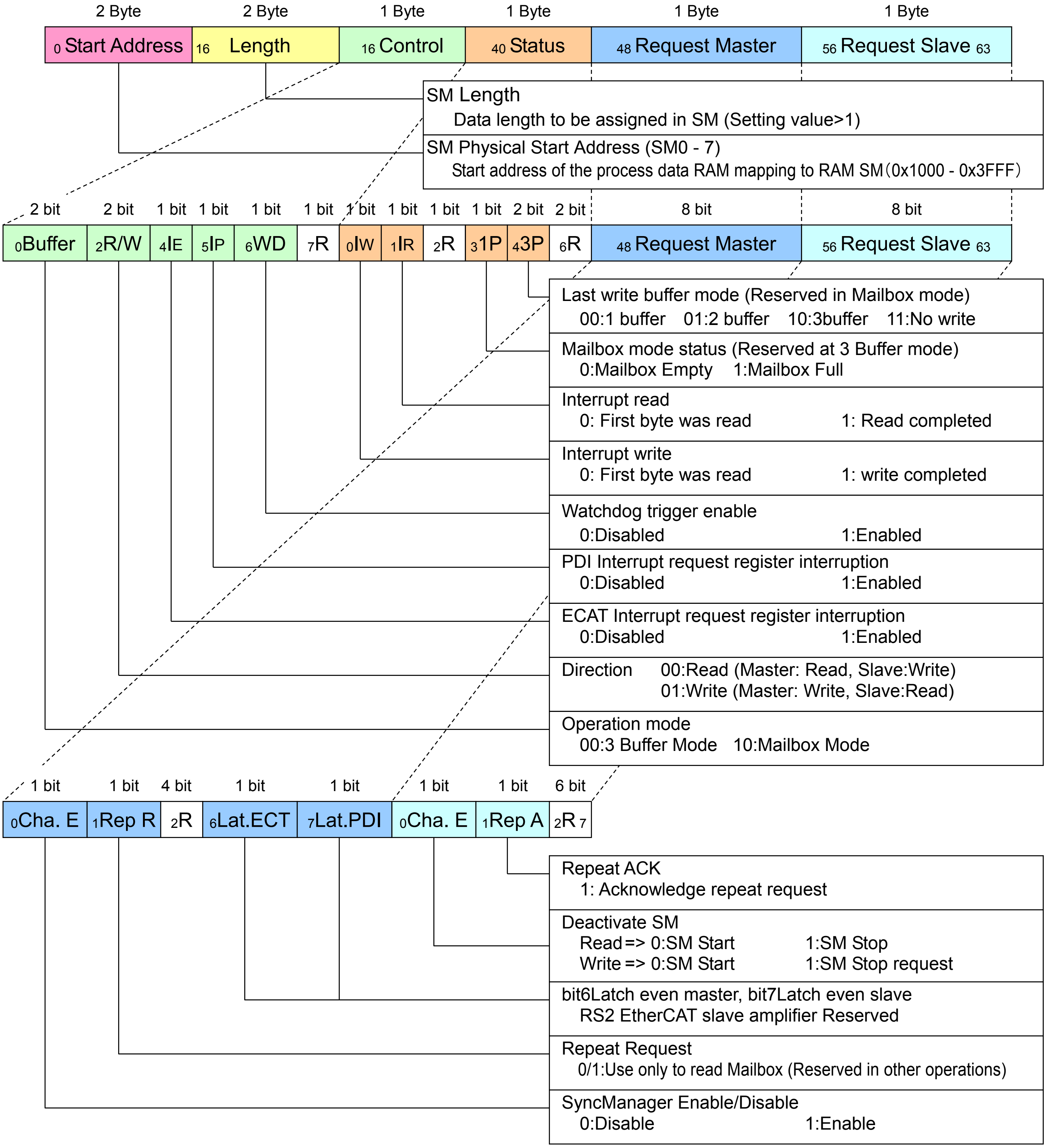
Address	bit	Description	Master	Slave	Length	Rest Value
0x06yC - 0x06yF	0	0:FMMU deactivated 1:FMMU activated. FMMU checks logical addressed blocks to be mapped according to mapping configured	R/W	R/-	4 Bytes	0x00000000
	31:1	Reserved, write 0	R/-	R/-		

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

Physical Start Address SyncManager y

Address	bit	Description	Master	Slave	Length	Rest Value
0x0800+y^{x8} - 0x0801+y^{x8}	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^{x8} - 0x0803+y^{x8}	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^{x8} SM0 0x0804 SM1 0x080C SM2 0x0814 SM3 0x081C	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				
	4	Interrupt in ECAT Event Request Register	0: Disabled 1: Enabled				
	5	Interrupt in PDI Event Request Register	0: Disabled 1: Enabled				
	6	Watchdog Trigger Enable Note)	0: Disabled 1: Enabled				
	7	Reserved, write 0		R/-	R/-		

* 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.

Status Register SyncManager y

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

Activate SyncManager y

Address	bit	Description		Master	Slave	Length	Rest Value
0x0806 $+y^{x8}$ SM0 0x0806 SM1 0x080E SM2 0x0816 SM3 0x081E	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)				
	5:2	Reserved, write 0		R/-	R/-		
	6	Latch Event ECAT	0: No 1: Generate Latch event if EtherCAT master issues a buffer exchange	R/W	R/-		
	7	Latch Event PDI	0: No 1: Generate Latch events if PDI issues a buffer exchange or if PDI accesses buffer start address				

PDI Control SyncManager y

Address	bit	Description		Master	Slave	Length	Rest Value
0x0807 $+y^{x8}$ SM0 0x0807 SM1 0x080F SM2 0x0817 SM3 0x081F	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
	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.				
	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).

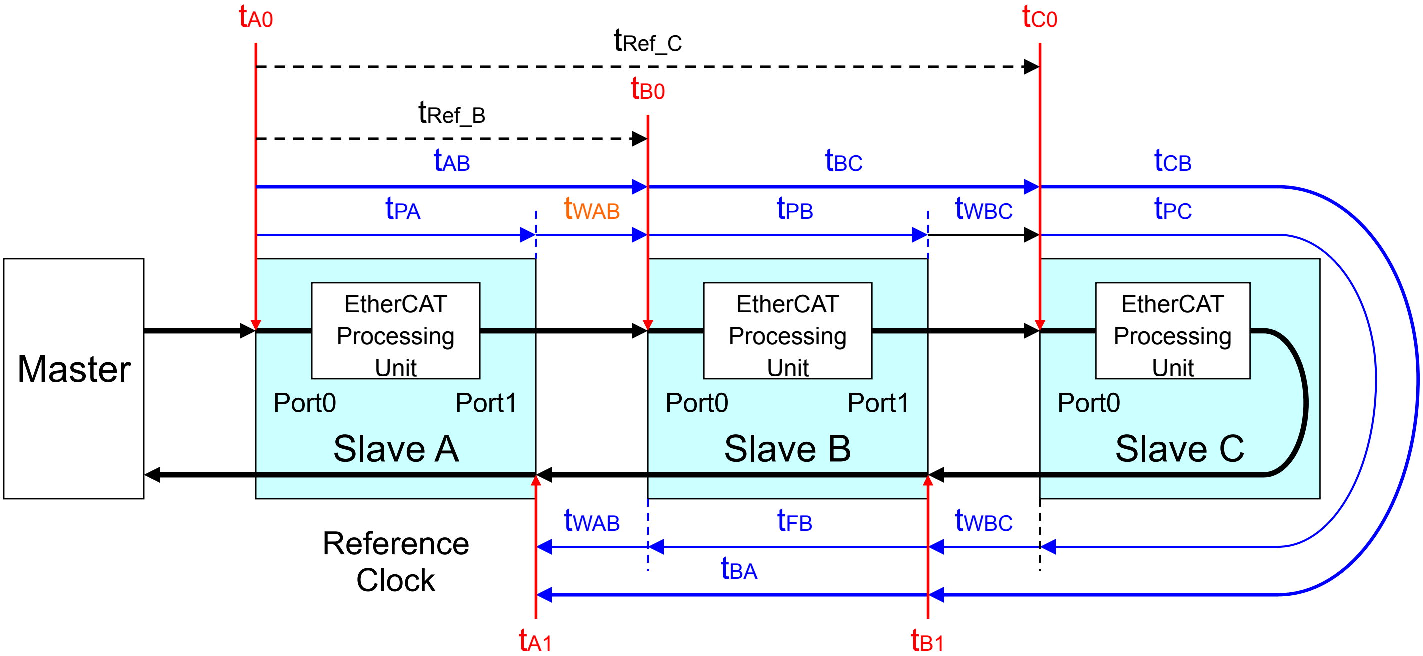
The receive time registers are used to sample the receive time of a specific frame (a broadcast write to Receive Time Port 0 register).
The clocks must not be synchronized for the delay measurement, only local clock values are used.
Since the local clocks of the slaves are not synchronized, there is 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.



Propagation Delay Calculation

Parameters for Propagation Delay Calculation

Parameter	Description
tPA, tPB, tPC	Processing delay of slave (EtherCAT Processing Delay)
tFB	Forwarding delay of slave (EtherCAT FoR/Warding 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 (through EtherCAT Processing Unit) if all slaves are identical
tF	Forwarding delay (alongside EtherCAT Processing Unit) 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 , 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, 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 = tPB - tFB :

TAB = tP + tWAB, 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 × 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

■ **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 Δt is positive, the local time is running faster than the System time, and has to be slowed down. If Δt 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.

Receive Time Port 0

Address	bit	Description	Master	Slave	Length	Rest Value
0x0900 - 0x0903	31:0	[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 [Read access] Local time of the beginning of the last receive frame containing a write access to this register. Note) The time stamps cannot be read in the same frame in which this register was written.	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

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 (Δt). 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	[ead 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

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

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

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/-		

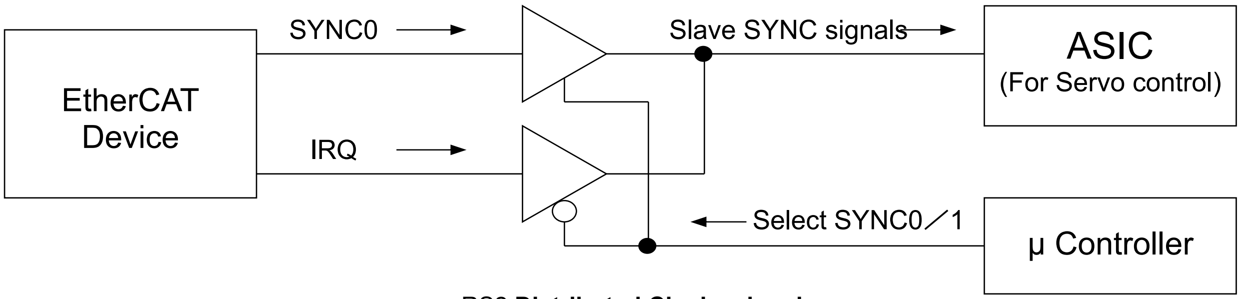
* Usable when 0x0140.10=1 or 0x0140.11=1. Reset control loop by writing the speed counter start (0x0930:0x0931) after this value has been changed.

■ 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 orSYNC1, 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).



RS2 **Distributed Clocks signals**

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
0x09A:0x09A3	SYNC0 Cycle Time	Cycle Time of SYNC0
0x09A4:0x09A7	SYNC1Cycle Time	Cycle Time of SYNC1

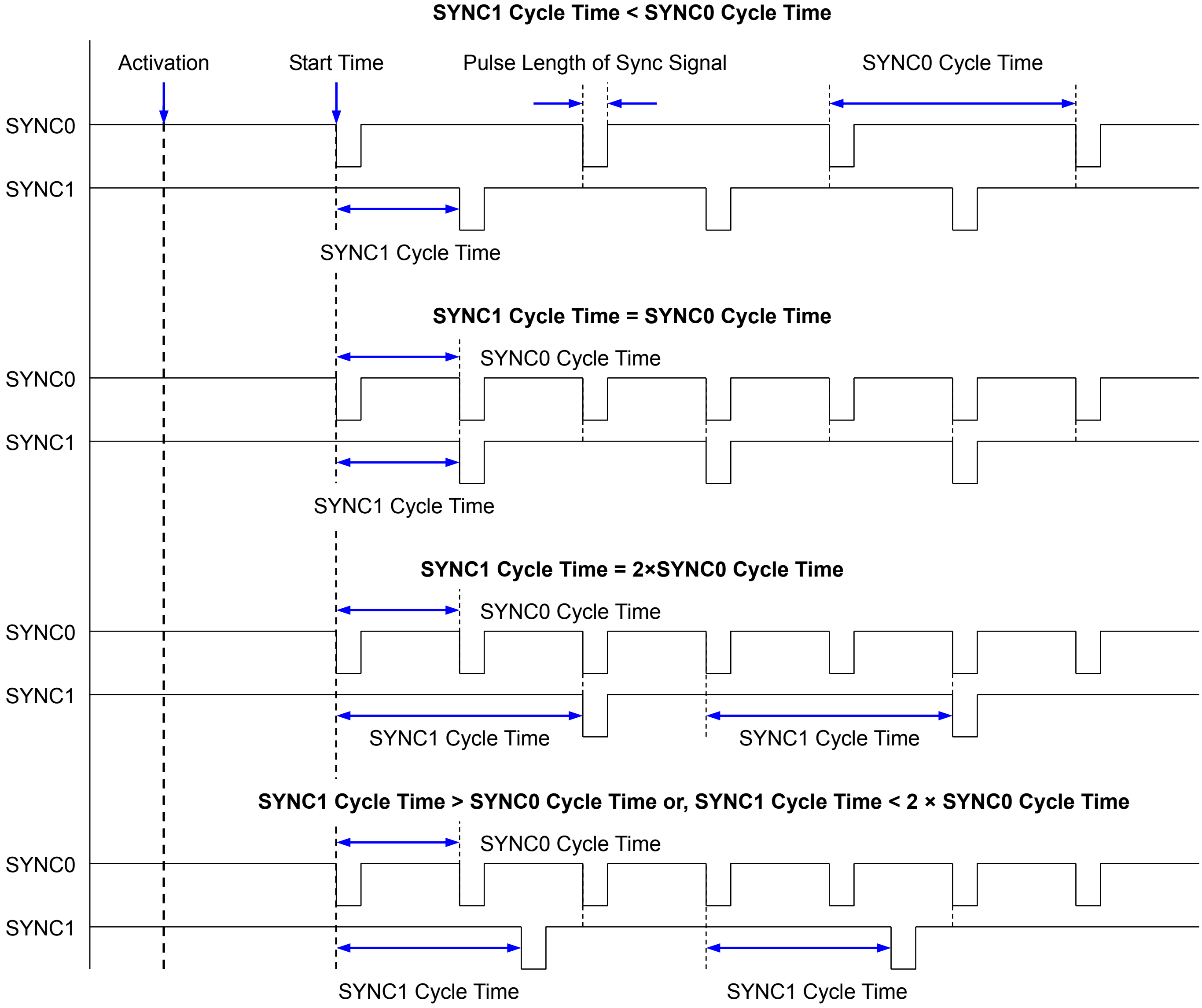
* Some of these registers are set via EEPROM at the time of power ON.

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.



SYNC0/1 Cycle Time Examples

If the SYNC1 cycle time is greater than the SYNC0 cycle time, the SYNC1pulse will be output with the timing shown in the lower of the two.

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)				
	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

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

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

16) ESC specific registers

Power-On Values

Address	bit	Description		Master	Slave	Length	Rest Value
0x0E00 - 0x0E01	1:0	Port mode (P_MODE)	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	R/-	R/-	2 Bytes	0x8C
	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

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 0x0410:0x0411	Watchdog divider writeable and Watchdog PDI	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 μController		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	1:1st slave				
	1	1:2nd slave				
	2	1:3rd slave				
	…	…				
	510	1:511th slave				
	511	1:512th 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

6.3 EEPROM Mapping

1） Address Space Overview

64kbit I^{2}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	1st Category Type	1st Category Word Size	1st Category DATA …					
·	…							
·	2nd Category Type	2nd Category Word Size	2nd 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.

■ 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		

Configured Station Alias

Address 0x0004	Alias Address used for node addressing		Length 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 0x0007	For debug. Can be disabled by checking the checksum with a value of 0x88A4		Length 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	-

Vender ID

Address 0x0008	Vendor ID for our EtherCAT products registered in ETG. CoE Object Index:0x1018　Sub index:0x01		Length 2 word
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 0x000A	Product code for our EtherCAT products: CoE Object Index:0x1018　Sub index:0x02		Length 2 word
bit	Description	Value	Register
31:0	Product code is “2” for EtherCAT amplifier.	0x00000002	-

Revision Number

Address 0x000C	Revision number for the servo amplifier: CoE Object Index:0x1018　Sub index:0x03		Length 2 word
bit	Description	Value	Register
31:0	Revision number to identify the revised contents in both the hardware and the software of the servo amplifier. It is the same as the alphabet character followed by the serial number on the main nameplate. These values:0x1->Main nameplate :A,0x2->B・・・0x1A->Y,0x1B->Z(0x9->I,0xF->O are not used)	Depends on product revision	-

Serial Number

Address 0x000E	Serial number for servo amplifier: CoE Object Index:0x1018　Sub index:0x04		Length 2 word
bit	Description	Value	Register
31:0	Serial number noting the manufacturing date of the product. Create decimal data from hexadecimal data using 10 digits as shown below and this will be the same as the serial number on the amplifier main nameplate. Month (2 digits)+Last 2 digits of the Year (2 digits)+Date (2 digits)+ Manufacturer’s serial number (4 digits)	Depends on respective product	-

Execution Delay

Address 0x0010	Correction factor for line Delay in 100ps to be added if this is the last station		Length 1 word
bit	Description	Rest Value	Register
15:0	Unit: 100ps	0x0000	-

Port0 Delay

Address 0x0011	Correction factor for line Delay in 100ps to be added if Master is behind Port 0		Length 1 word
bit	Description	Rest Value	Register
15:0	Unit: 100ps / LSB, Integer	0x0000	-

Port1 Delay

Address 0x0012	Correction factor for line Delay in 100ps to be added if Master is behind Port 1		Length 1 word
bit	Description	Rest Value	Register
15:0	Unit: 100ps / LSB, Integer	0x0000	-

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 www.beckhoff.com)	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		

Port0 Tx Delay

Address 0x0020	Correction factor for line delay of Port 0 transmission time.		Length 1 word
bit	Description	Rest Value	Register
15:0	Unit: 100ps / LSB, Unsigned16	0x0000	-

Port1 Tx Delay

Address 0x0021	Correction factor for line delay of Port 1 transmission time		Length 1 word
bit	Description	Rest Value	Register
15:0	Unit: 100ps / LSB, Unsigned16	0x0000	-

Port0 Rx Delay

Address 0x0024	Correction factor for line delay of Port 0 receiving time		Length 1 word
bit	Description	Rest Value	Register
15:0	Unit: 100ps/ LSB, Unsigned16	0x0000	-

Port1 Rx Delay

Address 0x0025	Correction factor for line delay of Port 1 receiving time		Length 1 word
bit	Description	Rest Value	Register
15:0	Unit: 100ps / LSB, Unsigned16	0x0000	-

Port 0 transfer to the next port

Address 0x0028	Correction factor between PhL reception of Port and 0 PhL transmission to the next port		Length 1 word
bit	Description	Rest Value	Register
15:0	Unit: 100ps / LSB, Unsigned16	0x0000	-

Transfer to the next port except Port 0

Address 0x0029	Correction factor between PhL reception of Port and 0 PhL transmission to the next port except Port 0		Length 1 word
bit	Description	Rest Value	Register
15:0	Unit: 100ps / LSB, Integer	0x0000	-

Closed port additional transfer time

Address 0x002A	Additional correction factor between port and BAT WAN port		Length 1 word
bit	Description	Rest Value	Register
15:0	Unit:100ps / LSB, Integer	0x0000	-

EEPROM Size

Address 0x003E	size of E2PROM in KBit-1		Length 1 word
bit	Description	Rest Value	Register
15:0	The EEPROM capacity loaded on this amplifier is 32kbit [32kbit-1:0x1F]	0x001F	-

Version

Address 0x003F	Version		Length 1 word
bit	Description	Rest Value	Register
15:0	This Version is 1	0x0001	-

3） Slave information Interface Categories

1stCategory 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.

1stCategory Word Size

Address 0x0041	1st Word data size following the address of the 1st category.		Length 1 word
bit	Description	Rest Value	Register
15:0	Word size	Depends on setting	-

1stCategory Data

Address 0x0042:	1st Category Data		Length 1 word
bit	Description	Rest Value	Register
15:0	1st 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

Category Summary Configuration

Parameter	Address	Data Type	Value / Description	
GroupeIdx	0x0000	Unsigned8	(Vendor Specification) Group information: Shown with character strings	
ImgIdx	0x0001	Unsigned8	(Vendor Specification) Image name: Shown with character strings	
OderIdex	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 1:100BASE-TX 2:100BASE-FX	
Physical layer Port1		Unsigned2		
Physical layer Port2		Unsigned2		
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 2:FMMU0 is for Input 3:FMMU0 is for SyncManagerStatus (Read Mailbox)
	0x0001	Byte	1:FMMU1 Output 2:FMMU1 is for Input 3:FMMU1 is for SyncManagerStatus (Read Mailbox)
	…		
	0x0007	Byte	1:FMMU7 Output 2:FMMU7 is for Input 3:FMMU7 is for SyncManagerStatus (Read Mailbox)

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’ care
Activate	0x0006	Byte	Enable SyncManager
PDI CTRL	0x0007	Byte	Don’ care

RXPDO & TXPDO Category Configuration (each element)

Parameter	Address	Data Type	Value / Description
PDO Index	0x0000	Word	RxPDO : 0x1600 - 0x1603, 0x1700 - 0x1703 TxPDO : 0x1A00 - 0x1A00, 0x1b00 - 0x1B03
nEntry	0x0002	Byte	Entry number
SyncM	0x0003	Byte	SyncManager Association 0x02 : Associate to SM2, 0x03 : Associate to SM3 0xFF : No association
Synchronization	0x0004	Byte	Standard value for DC Synch
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

7

7. Object Dictionary

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.

Structure of Object Dictionary

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 types

Object code definition entries are organized as follows.

Object Dictionary Object Definitions

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.

Access Attributes for Data Objects

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

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	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 (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 in Table 3-6; 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	Up-date
0x1000	0x00	VAR	Device Type	Unsigned32	RO	No	-
0x1001	0x00	VAR	Error Resistor	Unsigned8	RO	No	-
0x1008	0x00	VAR	Device Name of Manufacture	VisibleString	RO	No	-
0x1009	0x00	VAR	Hardware Version of Manufacture	VisibleString	RO	No	-
0x100A	0x00	VAR	Software Version of Manufacture	VisibleString	RO	No	-
0x1010	-	ARRAY	Store Parameters	-	-	-	-
	0x00	-	Number of entry	Unsigned8	RO	No	-
	0x01	-	Save all parameters	Unsigned32	RW	No	#
0x1018	-	RECORD	Identity Object	-	-	-	-
	0x00	-	Number of Entry	Unsigned8	RO	No	-
	0x01	-	Vender ID	Unsigned32	RO	No	-
	0x02	-	Product Code	Unsigned32	RO	No	-
	0x03	-	Revision Number	Unsigned32	RO	No	-
	0x04	-	Serial Number	Unsigned32	RO	No	-
0x1400 - 0x1403 0x1500 - 0x1503	-	RECORD	RxPDO Parameter	-	-	-	-
	0x00	-	Number of Entry	Unsigned8	RO	No	-
	0x01 - 0x05	-	Reserved	Unsigned32	RW	No	$
	0x06	-	RxPDO exception PDO	Octet-String	RW	No	$
	0x07	-	RxPDO State	BOOLEAN	RO	Possible	-
	0x08	-	RxPDO Control	BOOLEAN	RW	Possible	#
	0x09	-	RxPDO Toggle	BOOLEAN	RW	Possible	#
0x1600 - 0x1603 0x1700 - 0x1703	-	RECORD	1st to 4th,257th to 260th Reception PDO	PDO Mapping	-	-	-
	0x00	-	Number of Entry to RxPDO	Unsigned8	RW	No	$
	0x01 - n	-	Object mapped in the 1st ... Object mapped in the n-th	Unsigned32	RW	No	$
0x1800 - 0x1803 0x1900 - 0x1903	-	RECORD	TxPDO Parameter	-	-	-	-
	0x00	-	Number of Entry	Unsigned8	RO	No	-
	0x01 - 0x05	-	Reserved	Unsigned32	RW	No	$
	0x06	-	TxPDO exception PDO	Octet-String	RW	No	$
	0x07	-	TxPDO State	BOOLEAN	RO	Possible	-
	0x08	-	Reserved	BOOLEAN	-	-	-
	0x09	-	TxPDO Toggle	BOOLEAN	RO	Possible	-
0x1A00 - 0x1BFF	-	RECORD	1st to 512th Reception PDO Mapping	PDO Mapping	-	-	-
	0x00	-	Number of Entry to TxPDO	Unsigned8	RW	No	$
	0x01 - n	-	Object mapped in the 1st ... Object mapped in the n-th	Unsigned32	RW	No	$

Communication Area (No.2)

Index	Sub-Index	Object Type	Name	Data Length	Access	PDO Mapping	Up-date
0x1C00	-	ARRAY	SM(Sync Manager) Communication Type	-	-	-	-
	0x00	-	Number of Entry	Unsigned8	RO	No	-
	0x01 - 0x07	-	Communication Type of SM0 … Communication Type of SM7	Unsigned32	RO	No	$
0x1C10 - 0x1C13	-	ARRAY	PDO Assignment of SM 0 to SM3	-	-	-	-
	0x00	-	Number of Objects PDO assigned	Unsigned8	RW (RO)	No	$
0x1C32 - 0x1C33	-	RECORD	SM 0 to SM7 Synchronization	-	-	-	-
	0x00	-	Number of Synchronous Parameter	Unsigned8	RO	No	-
	0x01	-	Synchronous Type	Unsigned32	RW (RO)	No	$
	0x02	-	Cycle Time	Unsigned32	RW (RO)	No	-
	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 (RO)	No	-
	0x09	-	Delay Time	Unsigned32	RO	No	-
	0x0A	-	Sync0 Cycle Time	Unsigned32	RW (RO)	No	-
	0x0B	-	Cycle Time Too Small	Unsigned32	RO	No	-
	0x0C	-	SM-Event Missed	Unsigned32	RO	No	-
	0x0D	-	Shift Time Too Short	Unsigned32	RO	No	-
	0x0E	-	RxPDO Toggle Failed	Unsigned32	RO	No	-
	0x0F - 0x1F		Reserved	-	-	-	-
	0x20	-	Sync Error	BOOL	RO	No	-

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

1) Parameter Details of Object Group from 0x1000

0x1000:Device Type

Index	0x1000	Indicates type and profile function of device		Object Code		VAR
Sub-Idx	Name		Data Type	Access	PDO	Value
0x00	Device Type [DEVICE] Displays device type for EtherCAT servo drive.		Unsigned32	RO	No	0x00020192

MSB LSB

Mode Bit	Type	Number of Device Profile
31 24	23 16	15 0

0x0192	Device Profile(DS402d)
0x02	Servo Drive
0x00	Manufacture Definition (Standard Specification)

0x1001:Error Resistor

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

0x1008:Device Name

Index	0x1008	Indicates product device name.		Object Code		VAR
Sub-Idx	Name/Description		Data Type	Access	PDO	Value
0x00	Device Name [DEVICE] Product Device Name (ASCII Code)		Visible String (Unsigned32)	RO	No	Character String (-)

RS2 A 0 1 A 0 K A 4

✔ Refer to secton 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		Data Type	Access	PDO	Value
0x00	Hardware Version[HARDVER] Hardware Version of Device		Visible String (Unsigned32)	RO	No	Character String (-)

RS2 A 0 1 A 0 K A 4

✔ Refer to section1.4, Servo molifier model numer for the details of model number.

0x100A:Software Version

Index	0x100A	Indicates product software version.		Object Code		VAR
Sub-Idx	Name/Description		Data Type	Access	PDO	Value
0x00	Software Version [SOFTVER] Software Version of Device		Visible String (Unsigned32)	RO	No	Character String (-)
8 0 0 2 . 0 . 0 7 2 0						

Byte10, 11: Date of firmware compiled	1: 1st, 2: 2nd ･･･ 30: 30th, 31: 31th
Byte 9: Month of firmware compiled	1: Jan., 2: Feb. ･･･ A: Oct., B: Nov., C: Dec.
Byte 8: Year of firmware compiled	0: in 2010 ･･･ A: in 2020 ･･･ F: in 2025 ･･･
Byte 6: Manufacturer specific profile revision	SANYO DENKI-conroled number: “0,1･･･9, A･･･Y, Z”
Byte 3, 4: Amplifier revision	2: Revision “B” 3: Revision ”C”･･･
Byte1,2: Series name	80: EtherCAT-interafced

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

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”

■Sequence

■Write-access

1) Master writes ”0x65 76 61 73” (ASCII：s：73, a：61, v：76, e：65) in “Sub-index 01.”

↓

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.

↓

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).

■Read-access

Slave provides information on parameter storing function in the following formats.

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.

The objects can be stored as shown in the following table.

\# The following is the table of objects saved in 0x1010:Store Parameters.

Profile / Communication Area

Index	S-Idx	Name	Index	S-Idx	Name
0x1C32	0x01	Synchronization Type (SM2)	0x607E	0x00	Polarity
0x1C32	0x02	Cycle Time (SM2)	0x607F	0x00	Max profile velocity
0x1C33	0x01	Synchronization Type (SM3)	0x6081	0x00	Profile velocity
0x605A	0x00	Quick stop option code	0x6083	0x00	Profile acceleration
0x605C	0x00	Disable operation option code	0x6084	0x00	Profile deceleration
0x605D	0x00	Halt option code	0x6085	0x00	Quick stop deceleration
0x6060	0x00	Modes of operation	0x6087	0x00	Torque (force) slope
0x6065	0x00	Following error window	0x6098	0x00	Homing method
0x6067	0x00	Position window	0x6099	0x01	Speed during search for switch
0x606D	0x00	Velocity window	↑	0x02	Speed during search for zero
0x6072	0x00	Max torque (force)	0x609A	0x00	Homing acceleration
0x607B	0x01	Home offset	0x60E0	0x00	Positive direction torque (force) limit
↑	0x02	Min position range limit	0x60E1	0x00	Negative direction torque(force) limit
0x607C	0x00	Max position range limit	0x60E6	0x00	Actual position calculation method
0x607D	0x01	Synchronization Type (SM2)	-	-	-
↑	0x02	Cycle Time (SM2)	-	-	-

Manufacturer Specific Profile Area

Index	S-Idx	Name	Index	S-Idx	Name
0x2002	0x01	Auto Tuning Mode	0x2029	0x00	Overload Warning Level
↑	0x02	Auto Tuning Characteristic	0x202A	0x00	Velocity Window (Speed Matching Width)
↑	0x03	Auto Tuning Response	0x202B	0x00	Torque (force) Command Filter
0x2003	0x00	Position Command Smoothing Constant	0x202C	0x00	Feed Forward Vibration Suppressor , Depth Selection
0x2004	0x00	Position Command Filter	0x202D	0x01	Torque (force) Command Notch Filter (A) Low Frequency Phase Delay Improvement
0x2005	0x01 to 0x04	Position Loop Proportional Gain 1-4	↑	0x02 to 0x04	Torque (force) Command Notch Filter (B) - (D) Selection Depth Selection
0x2006	0x01 to 0x04	Position Loop Integral Time Constant 1-4	0x202E	0x00	Torque (force) attainment selection
0x2007	0x00	Higher Tracking Control Position Compensation Gain	0x203D	0x01	Amplifier temperature warning high level setting
0x2008	0x01	Feed Forward Gain	↑	0x02	Amplifier temperature warning low level setting
↑	0x02	Feed Forward Filter	0x20F0	0x01	Limit Action
0x2009	0x00	Velocity Command Filter	↑	0x02	Positioning Methods
0x200A	0x00	Velocity Feedback Filter	↑	0x03	In-Position Signal / Position Deviation Monitor
0x200B	0x01 to 0x04	Velocity Loop Proportional Gain 1-4	↑	0x04	Speed Matching Unit Selection
0x200C	0x01 to 0x04	Velocity Loop Integral Time Constant 1-4	↑	0x05	Deviation Clear Selection
0x200D	0x01 to 0x04	Load Inertia Moment Ratio 1-4	↑	0x06	Torque (force) attainment selection
0x200E	0x00	Higher Tracking Control Velocity Compensation Gain	0x20F1	0x01	Encoder Clear Function Selection
0x200F	0x01	Acceleration feedback gain	↑	0x02	Motor Pulse Encoder Digital Filter
↑	0x02	Acceleration feedback filter	↑	0x03	External Pulse Encoder Digital Filter
0x2011	0x01 to 0x04	Torque (force) Command Filter 1-4	↑	0x04	External Pulse Encoder Polarity Selection
0x2012	0x01 to 0x04	FF Vibration Suppressor Frequency 1-4	↑	0x05	CS offset onlinear encoder
0x2013	0x00	Velocity Command Notch Filter	↑	0x06	CS normalization offset of phase Z on linear encoder
0x2014	0x01 to 0x04	Torque (force) Command Notch Filter A-D	↑	0x07	Polarity selection on linear encoder
0x2015	0x01	Acceleration Compensation	↑	0x08	Frequency for detecting magnetic pole position
↑	0x02	Deceleration Compensation	0x20F2	0x01	Main Circuit Under-voltage (ALM_62) Detection
↑	0x03	Command Velocity, Low Pass Filter	↑	0x02	Velocity Control Alarm (ALM_C2) Detection
↑	0x04	Command Velocity, Threshold	↑	0x03	Velocity Feedback Alarm (ALM_C3) Detection
0x2016	0x01	Observer Characteristic	↑	0x04	Communication Frame Error Detection
↑	0x02	Observer Compensation Gain	↑	0x05	Communication Timeout Detection
↑	0x03	Observer Output, Low Pass Filter	0x20F3	0x01	Control Mode Selection
↑	0x04	Observer Output, Notch Filter	↑	0x02	Position Loop Control Encoder Selection
↑	0x05	Observer Load Inertia Moment Ratio	0x20F4	0x00	Servo Loop Delay Time
↑	0x06	Observer Proportional Gain	0x20F5	0x00	Selection of Torque (force) Limit Input Under Voltage Sag
↑	0x07	Low-pass filter for the estimated load torque (force)	0x20F8	0x01	Positive Limit Switch Function
0x2017	0x01 to 0x04	Model Control Gain 1-4	↑	0x02	Negative Limit Switch Function
0x2018	0x00	Overshoot Suppressor Filter	↑	0x03	External Trip Input Function
0x2019	0x01～0x04	Model Control Antiresonance Frequency 1-4	↑	0x04	Main Power Discharge Function
0x201A	0x01～0x04	Model Control Resonance Frequency 1-4	↑	0x05	Emergency Stop function
0x201B	0x00	Gain Switch Filter	↑	0x06	Detection function of magnetic pole position
0x201C	0x00	Speed limit	0x20F9	0x01	General Purpose Output 1
0x201D	0x00	Position Command Error 1 setting	↑	0x02	General Purpose Output 2
0x201E	0x00	Torque (force) Limit at Sequence Operation	0x20FA	0x01	Extended unit address
0x201F	0x00	In-position Near Range	↑	0x02	Extend Station Alias Number
0x2020	0x00	Speed Zero Range	0x20FB	0x00	Torque command addition during servo-on
0x2021	0x00	Low Speed Range	0x20FD	0x01	Main Power, Input Type
0x2022	0x00	Speed Attainment Setting	↑	0x02	Regenerative Resistor Selection
0x2023	0x01 to 0x02	Analog Monitor1, 2 Output Signal Selection	↑	0x03	Setup Software Communication Baud Rate
↑	0x03	Analog Monitor Output Polarity	0x20FE	0x00	Motor Code
0x2024	0x00	Operating delay time of holding brake	0x20FF	0x01	Encoder Resolution Setting Code
0x2025	0x00	Operating delay time of holding brake	↑	0x02	Motor Encoder Type
0x2026	0x00	Operating delay time of holding brake	↑	0x03	External Pulse Encoder Resolution
0x2027	0x00	Power Failure Detection Delay Time	0x2103	0x02	Warning Mask
0x2028	0x00	Following Error Warning Level			

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	No	0x0000 01B9
0x02	Product Code [PRODUCT] Product Code of Production		Unsigned32	RO	No	0x00000002
0x03	Revision No. [AMPREV] Revision Number of Product		Unsigned32	RO	No	(-)
0x04	Serial No. [SERIAL] Serial Number of Product		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 Includes the index of object mapping RxPDO which was not able to assign in this RxPDO.		Octet-String	RW	No	-
0x07	Not supported : RxPDO State When output data of this RxPDO were not arranged to hardware, slave sets it to TRUE =1.		BOOLEAN	RO	Possible	-
0x08	Not supported : RxPDO Control When output of this RxPDO does not have an effective value, master sets it to TRUE =1.		BOOLEAN	RW	Possible	-
0x09	Not supported : RxPDO Toggle Toggles every update of supporting RxPDO to be written by master.		BOOLEAN	RW	Possible	-

2) PDO Mapping

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

The change of the RxPDO mapping uses reception of PDO mapping parameter (0x1600 - 0x1603, 0x1700 - 0x1703) with 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 can be mapped within 16-bit range continued from 16-bit boundary.
- Byte-type object can be mapped at the boundary of 8-bit, and allocated in both odd and even address.
  Map the items below surely from the boundary of 8-bit or 16-bit.
  [The case byte-type object is mapped in the next to BOOLEAN-type]
  Allocate objects after padding out “Padding object (OD:0x0000 SI:0)” for the amount of bit that are reached at the boundary of 8-bit and 16-bit.
- Objects more than half-word can be mapped at the boundary of 16-bit, and allocated in even address.
  Make sure to peform mapping for the following cases only after allocating them in even address.
  [The case object more than half-word is mapped in the next to BOOLEAN-type]
  Allocate objects after padding out for the amount of bit that are reached at the boundary of the next 16-bit.
  [The case object more than half-waord is mapped from odd address]
  Allocate objects after padding out for the amount of 8-bit.

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 Object Mapped in the 2nd - RxPDO1 ... Entry-n Object Mapped in the n-th - 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 Object Mapped in the 1st - RxPDOx ... Entry n Object Mapped in the n-th - 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 Object Mapped in the 2nd to TxPDO2 ... Entry n Object Mapped in the n-th to 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 Object Mapped in the 1st to TxPDO1 ... Entry n Object Mapped in the n-th to 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

0x1C32:SM2 Synchronization (Output Sync Manager Parameter)

Index	0x1C32	SM2 synchronization setup		Object Code		RECORD
Sub-Idx	Name/Description		Data Type	Access	PDO	Range
0x00	Number of synchronization parameter		Unsigned8	RO	No	0x20
0x01	Synchronization Type [SM2TYP] Sets up synchronous mode. 0x00:Not Synchronized (Free Run) 0x01:Synchron SM2 Event Synchronization (AL Event Synchronization of SM2) 0x02:DC Sync0 SYNC0 Event Synchronization (Synchronized with SYNC0 Hardware Signal) 0x03:DC Sync1 SYNC1 Event Synchronization (Synchronized with SYNC1 Hardware Signal)		Unsigned16 Setting Range	RW 0x0000-0x0003	No	0x0002
0x02	Cycle Time : Unit(ns) [SM2SYC] Sets up communication cycle between master and slave. Set Value: When T (ns) =500000x2^{Y} (ns),it is in the range of Y= 1 to 7 Free Run (Synchronization Type=0x0) : Local Timer Event Cycle of Slave SM2 Synchron (Synchronization Type=0x01) : SM2 Event Cycle (Minimum Time) DC SYNC0 (Synchronization Type=0x02) : SYNC0 Cycle Time (0x09A0 - 0x09A3) DC SYNC1 (Synchronization Type=0x03) : SYNC0 Cycle Time (0x09A0 - 0x09A3) Possible Setting Value:T(ns) 0.5ms:0x0007A120 1ms:0x000F4240 2ms:0x001E8480 4ms:0x003D0900 8ms:0x007A1200 16ms:0x00F42400 32ms:0x01E84800 64ms:0x03D09000 * Error is returned when the value is set except the value that can be set as above.		Unsigned32 Setting Range	RW 0x0007A120 - 0x03D09000 (0.5 - 64ms)	No	0x0007A120 (500μs)
0x03	Shift Time : Unit (ns) Time between Hardware Output Effective Operation and Related Event		Unsigned32	RO	No	0x0
0x04	Synchronization Type Supported		Unsigned16	RO	No	0x4007

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

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

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

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

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

bit13-7 : Reserved

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

bit15 : Reserved

Sub-Idx	Name/Description	Data Type	Access	PDO	Range
0x05	Minimum Cycle Time : Unit(ns)	Unsigned32	RO	No	0x0007A120 (500 µs)
	The minimum cycle time is supported by slave. (Maximum time of local cycle)				
0x06	Copy and Operation Time (Calc and Copy Time) Unit (ns)	Unsigned32	RO	No	0x0000F424 (62.5 µs)
	Time required of micro controller in order to copy process data to local memory from SyncManager. Operation is processed, if required before data's transmitting to process.				
0x07	Reserved	Unsigned32	-	-	-
0x08	Get Cycle Time 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	Unsigned32	RO	No	0x00007530 (30 µs)
	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				
0x0A	Not supported : Sync0 Cycle Time	Unsigned32	RW	No	-
	When SYNC0 fixed cycle time is required of application, it is the time between two Sync0 signals. *Synchronous Time = Only DC SYNC0 of 0x03, and local cycle control				
0x0B	Cycle Time Too Small	Unsigned16	RO	No	-
	This error counter is incremented when cycle time is too short as local cycle cannot be completed or input data cannot prepare by the next SM event.				
0x0C	SM-Event Missed	Unsigned16	RO	No	-
	This error counter is incremented when application demands SM event and cannot receive it. As a result, data may be unable to be copied any more.				
0x0D	Shift Time Too Short	Unsigned16	RO	No	-
	This error counter is incremented when the time interval of SYNC0 trigger and an output is too short, by the fact that shift time or SYNC1 cycle time is too short.				
0x0E	RxPDO Toggle Failed	Unsigned16	RO	No	-
	This error counter is incremented when slave supports a RxPDO toggle and then new RxPDO data cannot be received from a master. (When RxPDO toggle is set to TRUE.)				
0x0F:0x1F	Reserved	-	-	-	-
0x20	Not supported : Sync Error	BOOL	RO		
	TxPDO mapping is possible at the time of SM-Event Missed or Shift Time Too Short Counter support. 0: Not Sync. Error or unsupported Sync.Error 1: Sync. Error				

0x1C33:SM3 Synchronization (Input SyncManager Parameter)

Index	0x1C33	SM3 Synchronization	Object Code		RECORD
Sub-Idx	Name/Description	Data Type	Access	PDO	Initial Value
0x00	Number of Synchronization Parameter	Unsigned8	RW	No	0x20
0x01	Synchronization Type [SM3TYP]	Unsigned16	RW	No	0x0002
		Setting Range	0x00, 0x02, 0x03, 0x22		
	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 0x22:Synchron SM2 Event Synchronization (When Output is transmitted by Safe-Ope and OP)				
0x02	Cycle Time : Unit (ns) [SM3CYC]	Unsigned32	RO	No	0x0007A120 (500 μs)
	Free Run (Synchronous Type=0x00) : Local Timer Event Cycle of Slave SM2 Sync (Synchronous Type=0x01) : SM2 Event Cycle (Minimum Time) 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.				
0x03	Shift Time : Unit(ns)	Unsigned32	RO	No	0x0-
	Time between Input Latch Operation from Hardware and Related Operation ✔ The value shall be the same as Index:0x1C32,Sub-index2.				
0x04	Synchronous Type Support	Unsigned16	Ro	No	0x4007

MSB LSB

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

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

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

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

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

Bit13-7 : Reserved

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

Bit15 : Reserved

Sub-Idx	Name/Description	Data Type	Access	PDO	Range
0x05	Minimum Cycle Time : Unit (ns) 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	0x0007A120 （500 µs）
0x06	Copy and Operation Time (Calc and Copy Time) Unit (ns) Time required from Input Latch through minimum cycle time.	Unsigned32	RO	No	0x00065518 （415 µs）
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	-
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. 0: Not Sync. Error or unsupported Sync-Error 1: Sync. Error	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: 0x1C32,0x1C33.

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 sensor 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 sensor.
However, when position cannot be received more correctly than sensor (serial sensor), 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".

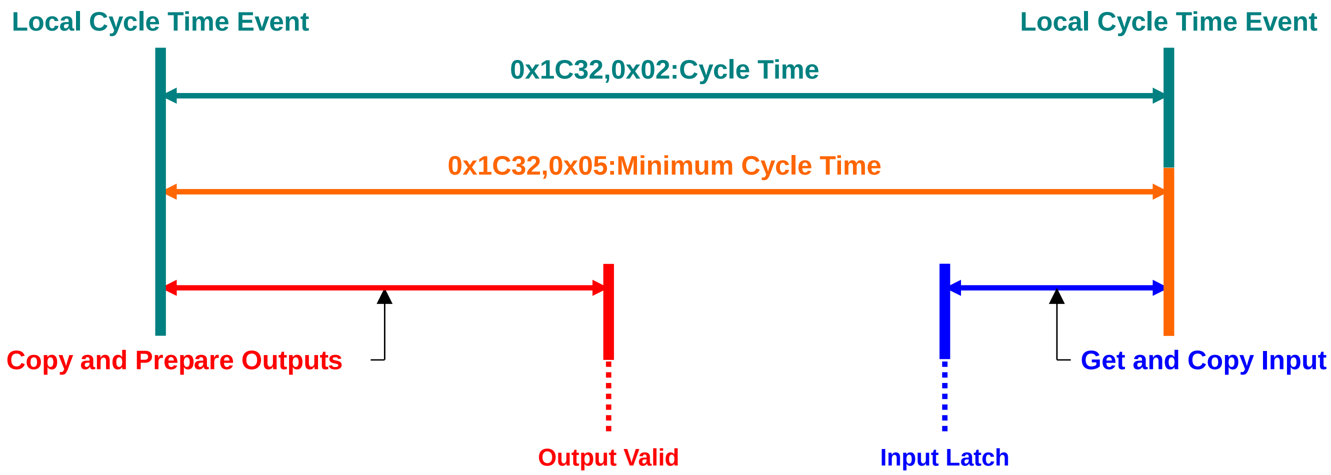
The synchronous mode supported to RS2-EtherCAT amplifier is shown the following.

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



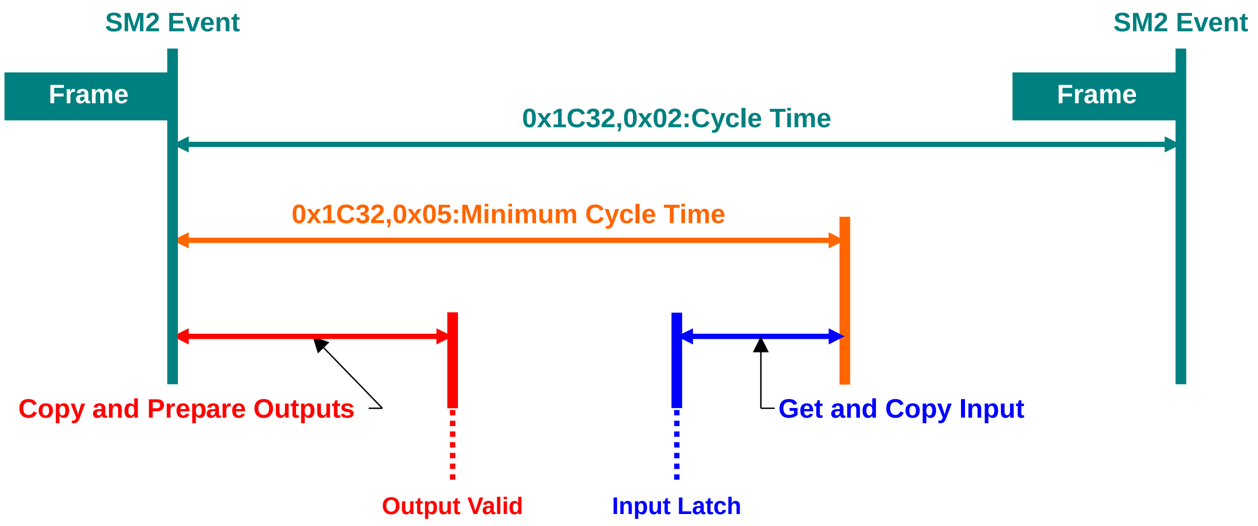
Communication Timing of Free Run Mode

5) SM2 Event Synchronization Mode (Synchronous with SM2 Event)

Since slave process is started to SM2 event cycle, always synchronizes with SM2 event.
Operated in local cycle time until receiving SM2 event.
With RS2-EtherCAT amplifier, since Output is always effective, SM3 event synchronization cannot be performed.

SM2 Set Parameter of Event Synchronization Mode

Index	Sub-Index	Dir	Name	Remarks
0x1C32	0x01	RW	Synchronization Type	Synchronized with 0x01:SM2 Event
	0x02	RW	Cycle Time	Communication Cycle
	0x04	RO	Synchronization Type Supported	Bit1=1:Synchronization Supported
	0x05	RO	Minimum Cycle Time	
	0x08	RW	Cycle Time Acquisition	
	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 0x22:SM2
	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
	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



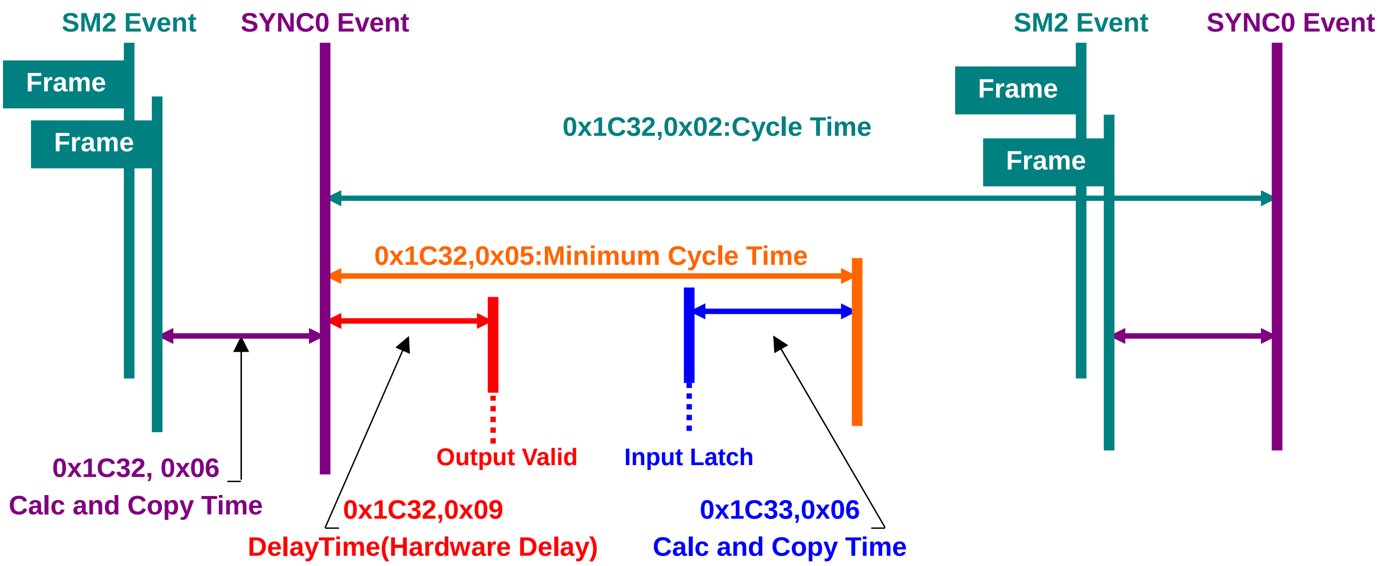
Communication Timing of SM2 Synchronization Mode

6) 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



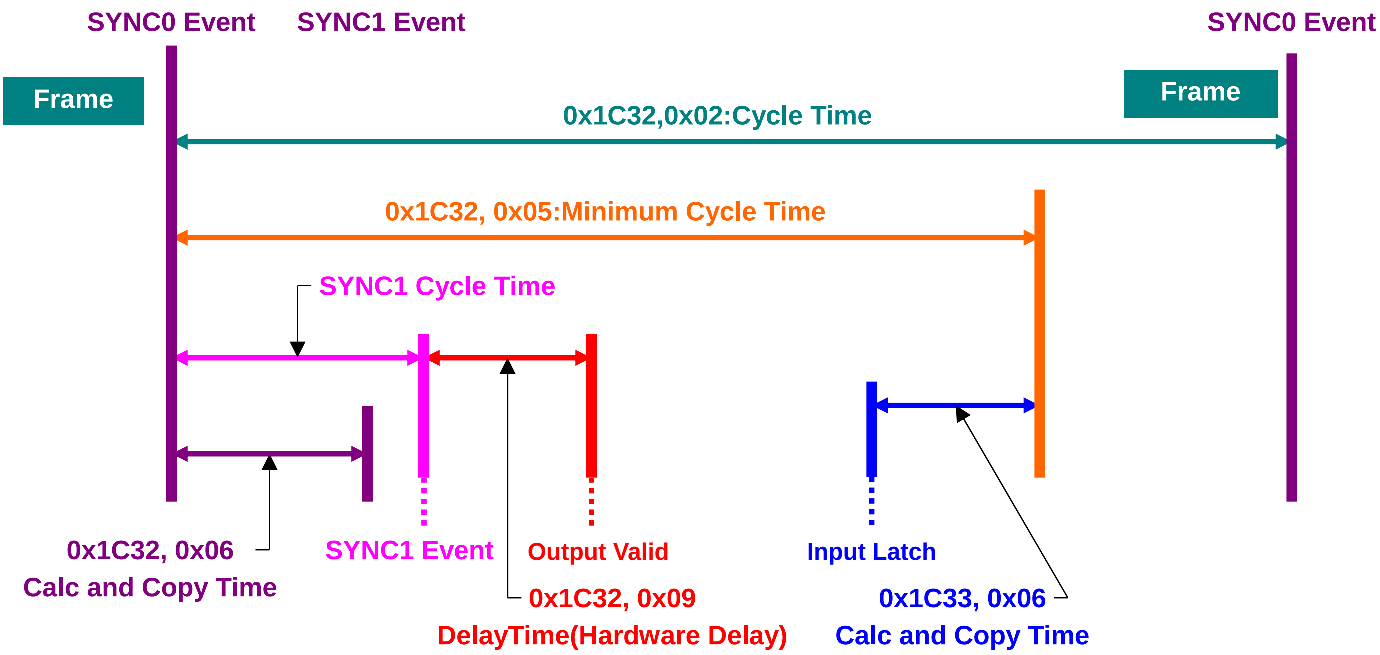
Communication Timing of DC Synchronization Mode (SYNC0)

7) 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



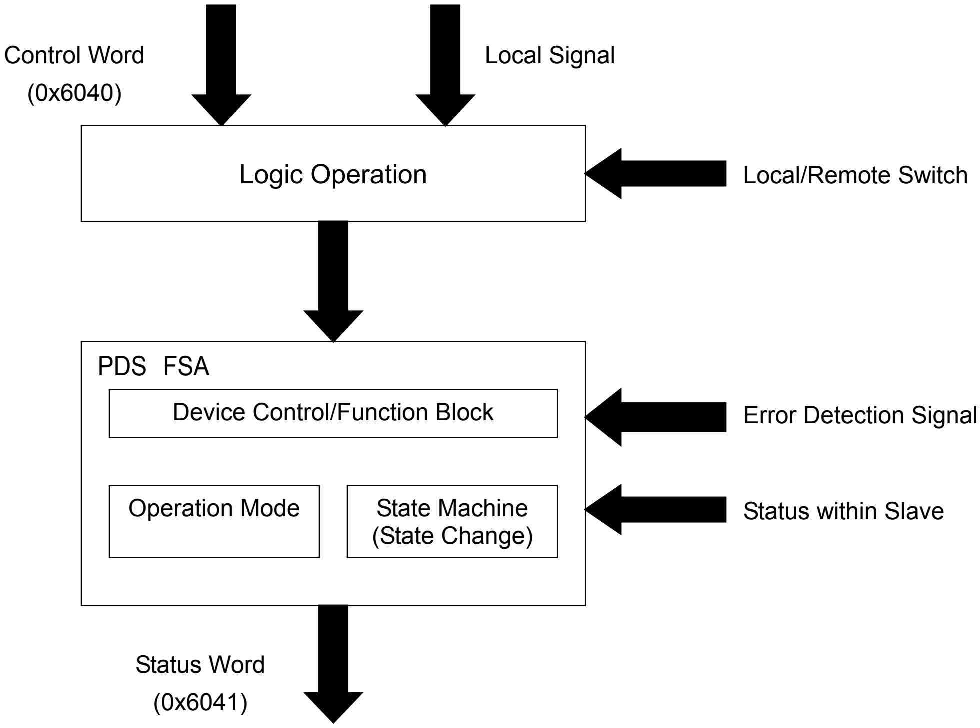
Communication Timing of DC Synchronization Mode(SYNC0)

7.3 PDS FSA

(Power Device System Finite State Automaton)

1) Abstract

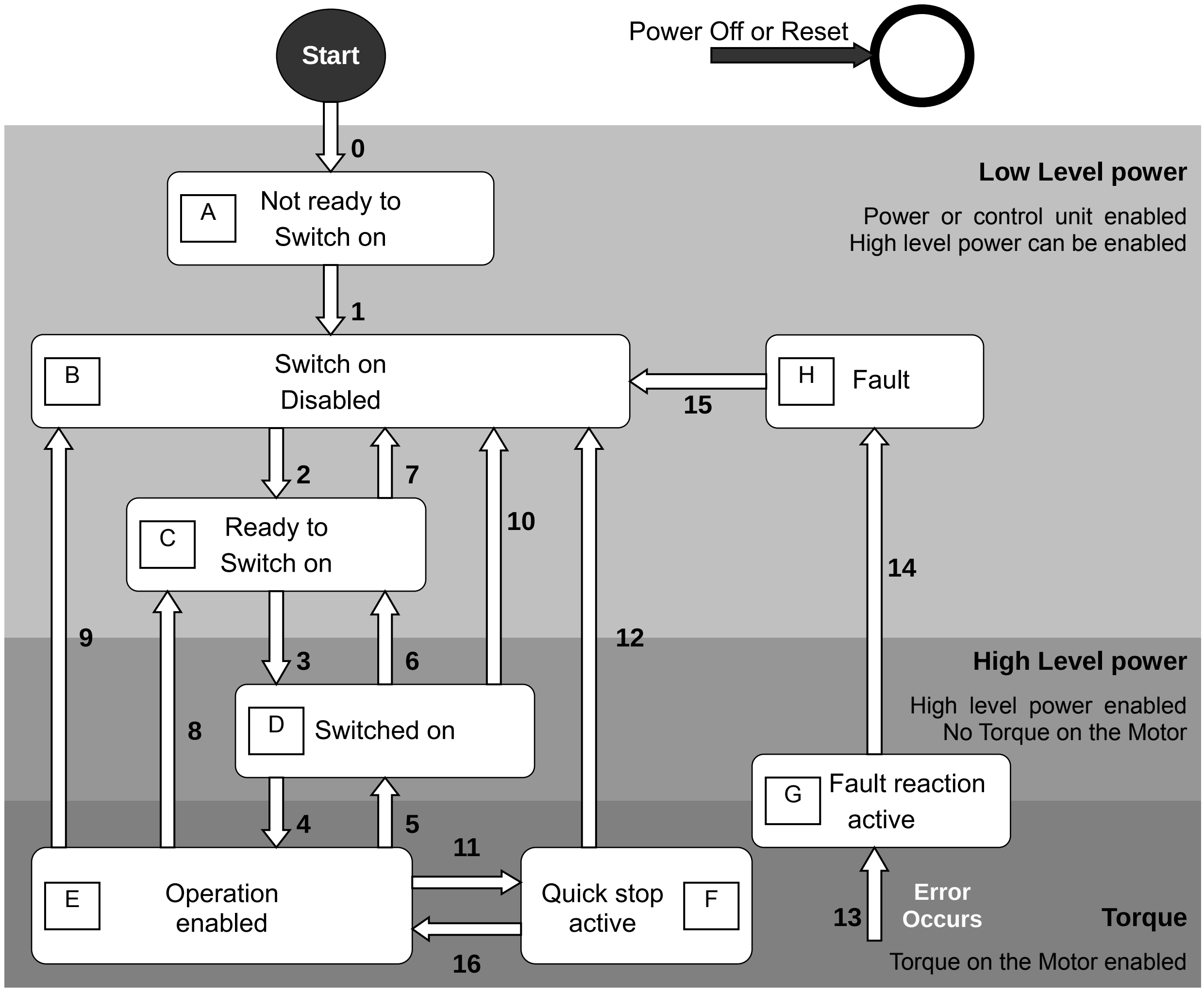
PDS (Power System Device) FSA (Finite States Automaton)of the EtherCAT slave amplifier is an abstract concept which defines the state of the control device stays or passes, operation with the Black Box. It defines the slave's application operating. Slave controls State Device, Mode, and State Change 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.



Control Word / Status Word Concept of Slave

2) FSA (Finite States Automaton)

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



FSA of 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 SwithOn state. However, motor is in servo-off (torque(force)-off) state, and when the main circuit is not established, Shift 3 is canceled by slave. Target and set point value are invalid.

Torque Area

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

FSA and FSA state describes the state transitions.

FSA State Definition

No.	State	Description
[A]	Not Ready to Switch on	The control source is provided to the slave and established. 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 switch-on preparation. Parameter to slave can be set.
[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-OFF.
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.

Allotment for Each Bit of Control Word

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

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

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

0x6040:Control Word (Intersection)

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

MSB LSB

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

Control word bit pattern command

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

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

4) Status Word

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

Allotment for Bit of Status Word

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

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

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

0x6041:Status Word (Intersection)

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

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

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

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

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

5) Manufacture specific area

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

Allocation for control words (manufacture specific area)

bit15	bit14	bit13	bit12	bit11
Cseten	Reserved	Reserved	Eclr	Reserved

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

Index	0x6040	Indicates status of FSA (State Machine) that PDS (Power Device System) is controlled.	Object code		Variable
Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Control words [CWORD] *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		

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

bit12: Encoder clear enable [ECLR]
Clear absolute sensor battery malfunction or multiple rotating positions.
Clear in case state "1" lasted for 112ms.
"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

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

Layout for control words (manufacture specific area)

bit15	bit14	bit8
Csetfix	Csetpro	Reserved

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

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

Index	0x6041	Indicates status of FSA (State Machine) that PDS (Power Device System) is controlled.	Object code		Variable
Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Status words [STSWORD] *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
0x6007	0x00	□	□	□	□	Abort Connection Option Code	Integer16	RW	No	-
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	#
0x605B	0x00	□	□	□	□	Shutdown Option Code	Integer16	RW	No	-
0x605C	0x00	○	○	○	×	Disable Operation Option Code	Integer16	RW	No	#
0x605D	0x00	○	○	○	○	Halt Option Code	Integer16	RW	No	#
0x605E	0x00	□	□	□	□	Fault Reaction Option Code	Integer16	RW	No	-
0x6060	0x00	○	○	○	○	Operation Mode	Integer8	RW	Possible	#
0x6061	0x00	○	○	○	○	Operation Display	Integer8	RO	Possible	-
0x6062	0x00	×	×	×	×	Position Demand Value	-	-	-	-
0x6063	0x00	○	○	○	○	Internal Actual Position	Integer32	RO	Possible	-
0x6064	0x00	○	○	○	○	Real Position	Integer32	RO	Possible	-
0x6065	0x00	○	×	×	×	Excessive Position Deviation Value	Unsigned32	RW	Possible	-
0x6066	0x00	□	×	×	×	Excessive Position Deviation Time-out	Unsigned16	RW	No	-
0x6067	0x00	○	×	×	×	Position Window (Positioning complete range)	Unsigned32	RW	No	#
0x6068	0x00	□	×	×	×	Position Window Time	Unsigned16	RW	No	-
0x6069	0x00	×	×	×	×	Real Velocity Sensor Value	-	-	-	-
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 coincidence range)	Unsigned16	RW	No	#
0x606E	0x00	□	□	□	□	Velocity Window Time	Unsigned16	RW	No	-
0x606F	0x00	×	×	×	×	Velocity Threshold	-	-	-	-
0x6070	0x00	×	×	×	×	Velocity Threshold Time	-	-	-	-
0x6071	0x00	×	×	○	×	Target Torque (force) (Torque (force) Command)	Integer16	RW	Possible	#
0x6072	0x00	○	○	○	○	Maximum Torque (force) (Torque (force) Limit)	Unsigned16	RW	Possible	#
0x6073	0x00	×	×	×	×	Maximum Current	-	-	-	-
0x6074	0x00	×	×	×	×	Torque (force) Demand	-	-	-	-
0x6075	0x00	×	×	×	×	Motor Rating Current	-	-	-	-
0x6076	0x00	×	×	×	×	Motor Rating Torque (force)	-	-	-	-
0x6077	0x00	○	○	○	○	Real Torque (force) Value (Torque (force) Monitor)	Integer16	RO	Possible	-
0x6078	0x00	×	×	×	×	Real Current Value	-	-	-	-
0x6079	0x00	×	×	×	×	DC Link Circuit Voltage	-	-	-	-
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	$
↑	0x02	○	×	×	×	Maximum Position Limit	Integer32	RW	Possible	$
0x607C	0x00	○	○	○	○	Coordinates Offset (Homing Offset)	Integer32	RW	Possible	#
0x607D	0x00	-	-	-	-	Software Position Limit	Unsigned8	RO	No	-
↑	0x01	○	×	×	×	Software Mimi nun Position Limit	Integer32	RW	No	#
↑	0x02	○	×	×	×	Software Maximum Position Limit	Integer32	RW	No	#
0x607E	0x00	○	○	○	○	Polarity	Unsigned8	RW	No	$
0x607F	0x00	○	×	×	×	Max. Profile Velocity (Velocity Control Command)	Unsigned32	RW	No	#
0x6080	0x00	×	×	×	×	Maximum Motor Speed	-	-	-	-
0x6081	0x00	○	○	×	×	Profile Velocity	Unsigned32	RW	No	#
0x6082	0x00	×	×	×	×	End Velocity	-	-	-	-
0x6083	0x00	○	○	×	×	Profile Acceleration (Accelerating Constant)	Unsigned32	RW	No	#

Profile Area (No.2)

Index	S-Idx	FP	FV	FT	FH	Name	Data Type	Dir	PDO_M	Update
0x6084	0x00	○	○	×	×	Profile Deceleration (Decelerating Constant)	Unsigned32	RW	No	#
0x6085	0x00	○	○	○	○	Quick Stop Deceleration	Unsigned32	RW	No	#
0x6086	0x00	□	□	□	□	Motion Profile Type	Integer16	RW	No	-
0x6087	0x00	×	×	○	×	Torque (force) Slope	Unsigned32	RW	No	#
0x6088	0x00	×	×	×	×	Torque (force) Profile Type	-	-	-	-
0x608F	0x00	×	×	×	×	Position Encoder Resolution (Sensor Resolution)	-	-	-	-
0x6090	0x00	×	×	×	×	Velocity Encoder Resolution	-	-	-	-
0x6091	0x00	×	×	×	×	Gear Ratio	-	-	-	-
0x6092	0x00	×	×	×	×	Feed Constant	-	-	-	-
0x6098	0x00	×	×	×	○	Homing Method	Integer8	RW	No	#
0x6099	0x00	-	-	-	-	Homing Speed	-	-	-	-
↑	0x01	×	×	×	○	Speed during search for switch	Unsigned32	RW	Possible	#
↑	0x02	×	×	×	○	Speed during search for Zero	Unsigned32	RW	Possible	#
0x609A	0x00	×	×	×	○	Homing Acceleration	Unsigned32	RW	No	#
0x60A3	0x00	×	×	×	×	Profile Jerk Use	-	-	-	-
0x60A4	0x00	×	×	×	×	Profile Jerk	-	-	-	-
0x60B0	0x00	○	×	×	×	Position Offset (Position Addition)	Integer32	RW	Possible	#
0x60B1	0x00	○	○	-	×	Speed Offset (Speed Addition)	Integer32	RW	Possible	#
0x60B2	0x00	○	○	○	×	Torque (force) Offset (Torque (force) Addition)	Integer16	RW	Possible	#
0x60B8	0x00	×	×	×	○	Touch probe mode	Unsigned16	RW	Possible	#
0x60B9	0x00	×	×	×	○	Touch probe state	Unsigned16	RO	Possible	#
0x60BA	0x00	×	×	×	○	Touch probe1 positive edge position stored	Integer32	RO	Possible	#
0x60BB	0x00	×	×	×	○	Touch probe1 negative edge position stored	Integer32	RO	Possible	#
0x60BC	0x00	×	×	×	×	Touch probe1 positive edge position stored	Integer32	RO	Possible	#
0x60BD	0x00	×	×	×	×	Touch probe1 negative edge position stored	Integer32	RO	Possible	#
0x60C0	0x00	×	×	×	×	Complement Sub-Mode Select	-	-	-	-
0x60C1	0x00	×	×	×	×	Complement Data Record	-	-	-	-
0x60C2	0x00	-	-	-	-	Complement Time Cycle	Unsigned8	RO	No	-
↑	0x01	○	○	○	○	Complement Time Unit	Unsigned8	RW	No	#
↑	0x02	○	○	○	○	Complement Time Exponent	Integer8	RW	No	#
0x60C4	0x00	×	×	×	×	Complement Data Set	-	-	-	-
0x60C5	0x00	×	×	×	×	Maximum Acceleration	-	-	-	-
0x60C6	0x00	×	×	×	×	Maximum Deceleration	-	-	-	-
0x60E0	0x00	○	○	○	○	Forward Torque (force) Limit Value	Unsigned16	RW	Possible	#
0x60E1	0x00	○	○	○	○	Backward Torque (force) Limit Value	Unsigned16	RW	Possible	#
0x60E2	0x00	×	×	×	×	Modulo Value	-	-	-	-

Profile Area (No.3)

Index	S-Idx	FP	FV	FT	FH	Name	Data Type	Dir	PDO_M	Update
0x60E3	0x00	-	-	-	-	Support Homing Method	-	-	-	-
↑	0x01	×	×	×	○	Support Homing Method 1	Unsigned16	RO	No	-
↑	0x02	×	×	×	○	Support Homing Method 2	Unsigned16	RO	No	-
↑	0x03	×	×	×	○	Support Homing Method 3	Unsigned16	RO	No	-
↑	0x04	×	×	×	○	Support Homing Method 4	Unsigned16	RO	No	-
↑	0x05	×	×	×	○	Support Homing Method 5	Unsigned16	RO	No	-
↑	0x06	×	×	×	○	Support Homing Method 6	Unsigned16	RO	No	-
↑	0x07	×	×	×	○	Support Homing Method 7	Unsigned16	RO	No	-
↑	0x08	×	×	×	○	Support Homing Method 8	Unsigned16	RO	No	-
↑	0x09	×	×	×	○	Support Homing Method 9	Unsigned16	RO	No	-
↑	0x0A	×	×	×	○	Support Homing Method 10	Unsigned16	RO	No	-
↑	0x0B	×	×	×	○	Support Homing Method 11	Unsigned16	RO	No	-
↑	0x0C	×	×	×	○	Support Homing Method 12	Unsigned16	RO	No	-
↑	0x0D	×	×	×	○	Support Homing Method13	Unsigned16	RO	No	-
↑	0x0E	×	×	×	○	Support Homing Method 14	Unsigned16	RO	No	-
↑	0x0F	×	×	×	○	Support Homing Method 15	Unsigned16	RO	No	-
↑	0x10	×	×	×	○	Support Homing Method 16	Unsigned16	RO	No	-
↑	0x11	×	×	×	○	Support Homing Method 17	Unsigned16	RO	No	-
↑	0x12	×	×	×	○	Support Homing Method 18	Unsigned16	RO	No	-
↑	0x13	×	×	×	○	Support Homing Method 19	Unsigned16	RO	No	-
↑	0x14	×	×	×	○	Support Homing Method 20	Unsigned16	RO	No	-
↑	0x15	×	×	×	○	Support Homing Method 21	Unsigned16	RO	No	-
↑	0x16	×	×	×	○	Support Homing Method 22	Unsigned16	RO	No	-
↑	0x17	×	×	×	○	Support Homing Method 23	Unsigned16	RO	No	-
0x60E6	0x00	x	x	x	○	Actual position calculation method	Unsigned8	RW	Possible	#
0x60F2	0x00	○	×	×	×	Position Option Code	Unsigned16	RW	Possible	#
0x60F4	0x00	○	×	×	×	Actual Position Deviation (Following Error Actual Value)	Integer32	RO	Possibl e	-
0x60F8	0x00	×	×	×	×	Maximum Deviation (Amount of Max. Gaps)	-	-	-	-
0x60FA	0x00	×	×	×	×	Control Effort	-	-	-	-
0x60FC	0x00	×	×	×	×	Internal Position Command Value	-	-	-	-
0x60FD	0x00	○	○	○	○	Digital Input	Unsigned32	RO	Possible	-
0x60FE	0x00	○	○	○	○	Digital Output	Unsigned32	RW	Possible	#
0x60FF	0x00	×	○	×	×	Target Velocity (Velocity Command)	Integer32	RW	Possible	#
0x6402	0x00	×	×	×	×	Motor Type	-	-	-	-
0x6403	0x00	×	×	×	×	Motor Catalog No.	-	-	-	-
0x6404	0x00	×	×	×	×	Motor Manufacture	-	-	-	-
0x6405	0x00	×	×	×	×	http Motor Catalog Address	-	-	-	-
0x6406	0x00	×	×	×	×	Motor Calibration date	-	-	-	-
0x6407	0x00	×	×	×	×	Motor Service Period	-	-	-	-
0x6502	0x00	○	○	○	○	Support Drive Mode	Unsigned32	RO	No	-
0x6503	0x00	×	×	×	×	Drive Catalog No.	-	-	-	-
0x6505	0x00	×	×	×	×	http Drive Catalog Address	-	-	-	-

1) Error Code and Error Operation

0x6007: Abort Connection Option Code

Index	0x6007	When main circuit power supply turns off or reset application event occurs, sets up which operation is performed.		Object Code	Variable
Sub-Idx	Description	Data Type	Access	PDO	Initial Value
0x00	Abort Connection Option Code 0:Reserved (No Action)	Integer16	RW	No	0x0003
		Setting Range	0x0003-0x0003		
	1:Reserves (Fault Signal) 2:Reserved (Voltage-Off 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 codes [ERRCODE] For the list of error codes, please refer to the list of alarm codes in chanpter 11.3.	Integer16	RO	No	0x0000
		Display range	0x0000 - 0xFFFF		
	✔Represents the same information as lower 16-bit of Sub-index 0x01 in pre-defined errorfield 0x1003 in CANopen communication method.				

0x605A: Quick Stop Option Code (EMR)

Index	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.	Integer16	RW	No	0x0002
		Setting Range	0xFFFE-0x0007 (-2 - 7)		

-128 to-3,4,8 to 127 are reserved. Not possible to be set.

Profile position (pp) mode
- -2 :Quick Stop Active state after stop by the command from master
- -1 :To Switch On Disabled after stop by the command from master
- 0 :Drive function is Disabled. (To Switch On Disabled after motor stop by dynamic brake operation)
- 1 :To Switch On Disabled after stop by profile deceleration (0x6084).
- 2 :To Switch On Disabled after stop by quick stop deceleration (0x6085)
- 3 :To Switch On Disabled after stop by Current Limit
- 5 :Quick Stop Active state after stop by profile deceleration (0x6084)
- 6 :Quick Stop Active state after stop by quick stop deceleration (0x6085)
- 7 :Quick Stop Active state after stop by Current Limit

Cyclic sync position mode (csp)
- -2 :To Quick Stop Active state after stop by the command from master
- -1 :To Switch on disabled after stop by the command from master
- 0 :Drive function is disabled by Dynamic brake operation after motor stop, Switch On Disabled.
- 1, 2, 3 :To Switch On Disabled after stop by Current Limit
- 5, 6, 7 :Quick Stop Active state after stop by Current Limit.

Cyclic sync velocity mode (csv), Profile velocity (pv), Homing mode (hm)
- -2 :Quick Stop Active state after stop by the command from master
- -1 :To Switch on disabled after stop by the command from master
- 0 :Drive function is disabled (after a motor stops by dynamic brake operation, Switch On Disabled)
- 1 :To Switch On Disabled (Stops at profile deceleration (0x6084).)
- 2 :To Switch On Disabled after stop by quick stop deceleration (0x6085)
- 3 :To Switch On Disabled after stop by Current Limit
- 5 :Quick Stop Active state after stop by profile deceleration (0x6084)
- 6 :Quick Stop Active state after stop by quick stop deceleration (0x6085)
- 7 :To Switch On Disabled after stop by Current Limit

Cyclic sync torque (force) mode (cst), Torque (force) profile mode (tq)
- -2 :To Quick Stop Active state after stop by the command from master
- -1 :To Switch on disabled after stop by the command from master
- 0 :Drive function is disabled (After a motor stops by dynamic brake operation, Switch On Disabled)
- 1, 2 :Switch On Disabled after stop 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.

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	0xFFFF
			Setting Range	0xFFFF - 0xFFFF (-1 to -1)		
	-1: Transits to the "Switch On Disabled" after a stop by Disable Operation Option Code setting (0x605C). 0: Reserved (Disable Drive: Servo-Off) 1: Reserved (Servo-off after slowdown with slowdown ramp)					

0x605C:Disable Operation Option Code (Dynamic Brake Operation)

Index	0x605C	When shifts from Operation Enabled to the Switch On State, determined how it operates. (Dynamic Brake Operation Setup)		Object Code		Variable
Sub-Idx	Description		Data Type	Access	PDO	Initial Value
0x00	Disable Operation Option Code[DISOP]		Integer16	RW	No	0x0000
			Setting Range	0xFFFB - 0x0000 (-5 to 0)		
	When shifts from servo-on to servo-off and during servo-off, dynamic brake operation is set up. -5: Dynamic brake operates after motor stop by Current Limit. -4: Motor-free after motor stop by Current Limit. -3: Dynamic brake operates after motor stop by Dynamic Brake Operation. -2: Motor-free after motor stop by Dynamic Brake Operation. -1: Dynamic brake operates after motor stop by Free Run Operation. 0: Motor-free (Disable Drive) after motor stop by Free Run Operation. 1: Reserved (Slowdown with slowdown ramp). *When main circuit power supply is intercepted, regardless of a setup, it becomes dynamic brake operation.					

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-3, 4, 8 to 127 are reserved. Not possible to be set up.		Setting Range	0x0001 - 0x0003(1-3)		
	# Profile position (pp) mode 1:Operation enabled state after stop by profile deceleration (0x6084). 2:Operation enabled state after stop by quick stop deceleration (0x6085) 3:To Switch On Disabled after stop by Current Limit # Cyclic sync position mode (csp) 1.2.3.:Operation enabled state after stop by Current Limit # Cyclic sync velocity mode (csv), Profile velocity (pv), Homing mode 1:Operation enabled state after stop by profile deceleration (0x6084). 2:Operation enabled state after stop by quick stop deceleration (0x6085) 3.:Operation enabled state after stop by Current Limit # Cyclic sync torque (force) mode (cst), Torque (force) profile mode (tq) 1. 2.:Operation enabled state after Stops by 0x6087(Torque (force) Slope) 3.:Operation enabled state after stop by Current Zero.					

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	0xFFFF
			Setting Range	0xFFFF - 0xFFFF (-1 to -1)		
	-1: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). 0:Reserved (Motor-free (Disable Drive) after motor stop by Free Run Operation.) 1:Reserved (Stops at profile deceleration (0x6084).) 2:Reserved (Stops at quick stop deceleration (0x6085).) 3:Reserved (Stops by Current Limit.) *At the time of the alarm detection, limited to the alarm that servo brake stop (SB) is possible. Dynamic brake stop (DB) alarm is stop in dynamic brake operation of "-1."					

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	No
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

<table>
<tr><th colspan="2">Operation Mode</th><th>bit8</th><th>bit6</th><th>bit5</th><th>bit4</th></tr>
<tr><td>pp</td><td>Profile Position Mode</td><td rowspan="7">Halt</td><td rowspan="2">Absolute / Relative Position</td><td>Change set immediately</td><td>New set point</td></tr>
<tr><td>csp</td><td>Cycle Sync. Position Mode</td><td>Reserved</td><td>Reserved</td></tr>
<tr><td>csv</td><td>Cycle Sync. Velocity Mode</td><td>Reserved</td><td>Reserved</td><td>Reserved</td></tr>
<tr><td>pv</td><td>Profile Velocity Mode</td><td>Reserved</td><td>Reserved</td><td>Reserved</td></tr>
<tr><td>cst</td><td>Cycle Sync. Torque (force) Mode</td><td rowspan="3">Homing offset Active</td><td rowspan="3">Reserved</td><td rowspan="3">Homing Enable</td></tr>
<tr><td>tq</td><td>Torque (force) Mode</td></tr>
<tr><td>hm</td><td>Homing Mode</td></tr>
</table>

Manufacturer own Bit Assigned to Status Word

<table>
<tr><th colspan="2">Operation Mode</th><th>bit13</th><th>bit12</th><th>bit10</th></tr>
<tr><td>pp</td><td>Profile Position Mode</td><td>Following error</td><td>Set-point Acknowledge</td><td rowspan="7">Target reached
Quick Stop Finished
Operation Change Finished
Halt Active</td></tr>
<tr><td>csp</td><td>Cycle Sync. Position Mode</td><td>Following error</td><td>Target Position ignore</td></tr>
<tr><td>csv</td><td>Cycle Sync. Velocity Mode</td><td rowspan="2">Reserved</td><td rowspan="2">Target velocity ignore</td></tr>
<tr><td>pv</td><td>Profile Velocity Mode</td></tr>
<tr><td>cst</td><td>Cycle Sync. Torque (force) Mode</td><td rowspan="2">Reserved</td><td rowspan="2">Target torque (force) ignore</td></tr>
<tr><td>tq</td><td>Torque (force) Mode</td></tr>
<tr><td>hm</td><td>Homing Mode</td><td>Homing error</td><td>Homing attained</td></tr>
</table>

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” and “Cyclic Synchronous Position Mode” are supported.
0x6060: Operate “Profile Position Mode” by setting “1” in operation mode, and “Cyclic Synchronous Position Mode” by setting “8”.
Here is the main object list for the function group “Profile Position Mode”

List of Position Mode Object (Manufacturer Specific Profile Area)

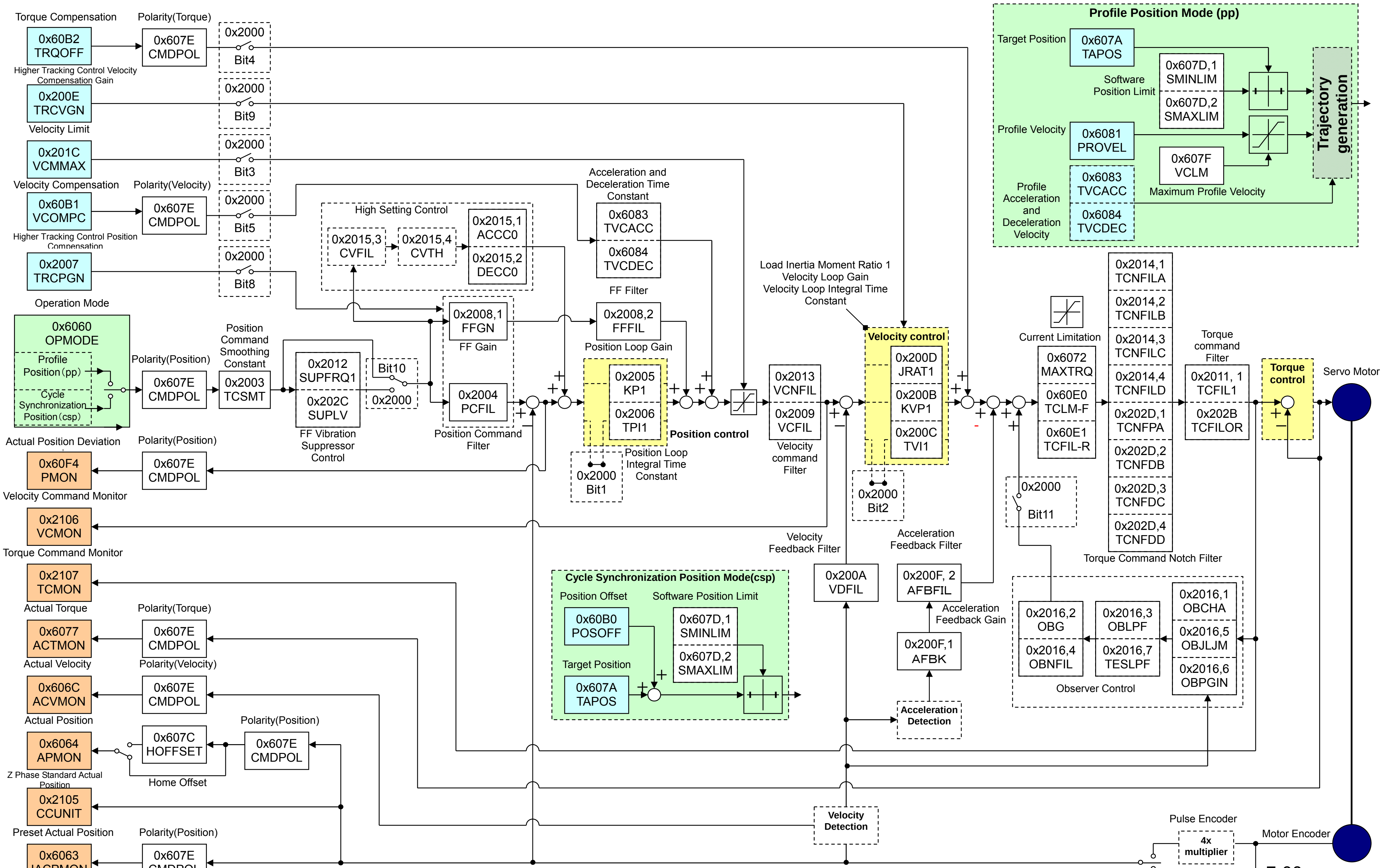
Index	Sub-Index	Name	PDO Mapping	0x6060 Mode
0x2003	0x00	Position Command Smoothing Constant	No	csp, pp
0x2004	0x00	Position Command Filter	No	csp, pp
0x2005	0x01	Position Loop Proportional Gain 1	Possible	csp, pp
0x2006	0x01	Position Loop Integral Time Constant 1	Possible	csp, pp
0x2007	0x00	Higher Tracking Control Position Compensation Gain	No	csp, pp
0x2008	0x01	Feed Forward Gain	Possible	csp, pp
0x2008	0x02	Feed Forward Filter	No	csp, pp
0x2009	0x00	Velocity Command Filter	No	csp, pp
0x200A	0x00	Velocity Feedback Filter	No	csp, pp
0x200B	0x01	Velocity Loop Proportional Gain 1	Possible	csp, pp
0x200C	0x01	Velocity Loop Integral Time Constant 1	Possible	csp, pp
0x200D	0x01	Load Inertia Moment Ratio 1	Possible	csp, pp
0x200E	0x00	Higher Tracking Control Velocity Compensation Gain	No	csp, pp
0x200F	0x01-0x02	Acceleration feedback compensation gain	No	csp, pp
0x2011	0x00	Torque (force) Command Filter 1	No	csp, pp
0x2012	0x01	FF Vibration Suppressor Frequency 1	Possible	csp, pp
0x2013	0x00	Velocity Command Notch Filter	No	csp, pp
0x2014	0x01-0x04	Torque (force) Command Notch Filter A-D	No	csp, pp
0x2015	0x01-0x04	Highly Configurable settings	No	csp, pp
0x2016	0x01-0x07	Disturbance observer settings	No	csp, pp
0x2017	0x01	Model Control Gain 1	No	csp, pp
0x2019	0x01	Model Control Antiresonance Frequency 1	No	csp, pp
0x201A	0x01	Model Control Resonance Frequency 1	No	csp, pp
0x201C	0x00	Speed limit	No	csp, pp
0x202B	0x00	Torque (force) Command Filter	No	csp, pp
0x202C	0x00	Feed Forward Vibration Suppressor, Depth Selection	No	csp, pp
0x202D	0x01-0x04	Torque (force) Command Notch Filter Selection A-D	No	csp, pp
0x2106	0x00	Preset velocity Command monitor	Possible	csp, pp
0x2107	0x00	Preset torque (force) Command monitor	Possible	csp, pp

List of Position Mode Object (Standardized Device Profile Area)

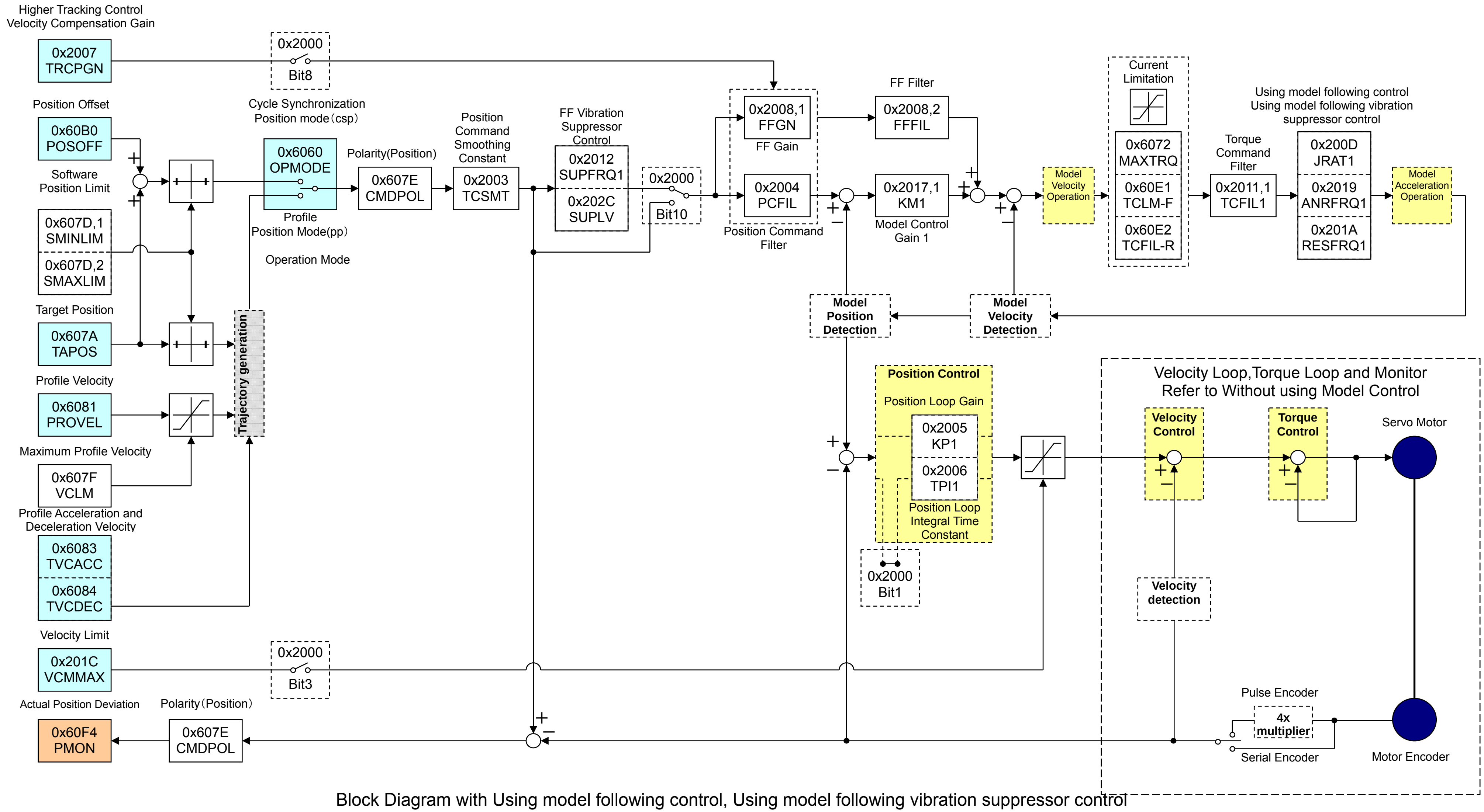
Index	Sub-Index	Name	PDO Mapping	0x6060 Mode
0x6040	0x00	Control Word	Possible	csp, pp
0x6041	0x00	Status Word	Possible	csp, pp
0x605A	0x00	Quick stop option code	No	csp, pp
0x6063	0x00	Position actual value *(Internal)	Possible	csp, pp
0x6064	0x00	Position actual value	Possible	csp, pp
0x6065	0x00	Following error window	No	csp, pp
0x6067	0x00	Position window	No	csp, pp
0x606C	0x00	Velocity Actual Value	Possible	csp, pp
0x6072	0x00	Max torque (force)	Possible	csp, pp
0x6077	0x00	Torque (force) actual value	Possible	csp, pp
0x607A	0x00	Target Position	Possible	csp, pp
0x607B	0x00-0x02	Position range Limit	No	pp
0x607C	0x00	Home offset	Possible	csp, pp
0x607D	0x00-0x02	Software Position Limit	No	csp, pp
0x607E	0x00	Polarity	No	csp, pp
0x607F	0x00	Max Profile Velocity	No	pp
0x6081	0x00	Profile Velocity	Possible	pp
0x6083	0x00	Profile Acceleration	Possible	pp(csp*)
0x6084	0x00	Profile Deceleration	Possible	pp(csp*)
0x60B0	0x00	Position offset	Possible	csp
0x60B1	0x00	Velocity offset	Possible	csp, pp
0x60B2	0x00	Torque (force) addition Torque (force) offset	Possible	csp, pp
0x60E0	0x00	Positive torque (force) limit value	Possible	csp, pp
0x60E1	0x00	Negative torque (force) limit value	Possible	csp, pp
0x60F4	0x00	Following error actual value	Possible	csp, pp

*(csp) the parameters are effective for only Halt Active and Quick stop enabled.

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



Block Diagram with Function Group [Position] Mode



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

4) Profile Position Mode

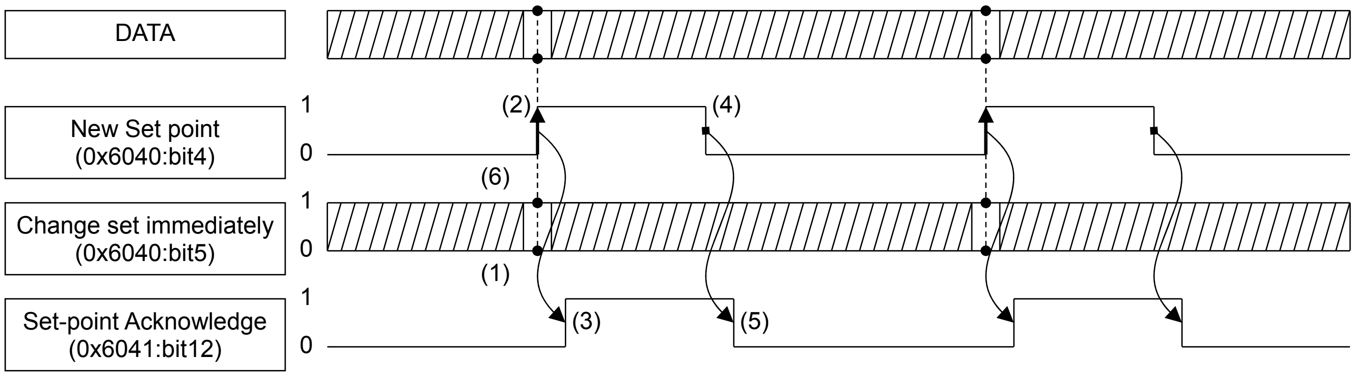
0x6060: When Operation Mode is set “1”, “Profile Position Mode” shall be operated.
The master sends “Target Position (0x607A)”, “Profile Velocity (0x6081), “Profile Acceleration and Deceleration (0x6083, 0x6084).
The slave (Drive device) executes trajectory generation and reaches to the target position by setting Bit4=1:New setpoint of Control word 0x6040.
The slave (Drive device) 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.

Two different ways to apply target positions to a drive are supported by this device profile.

1. Set of set points:
   After reaching the target position the drive unit immediately processes the next target position, which results in a move where the velocity of the drive normally is not reduced to zero after achieving a set point.

2. Single set point:
   After reaching the target position the drive unit signals this status to the master and then receives a new set point. After reaching a target position the velocity normally is reduced to zero before starting a move to the next set point.

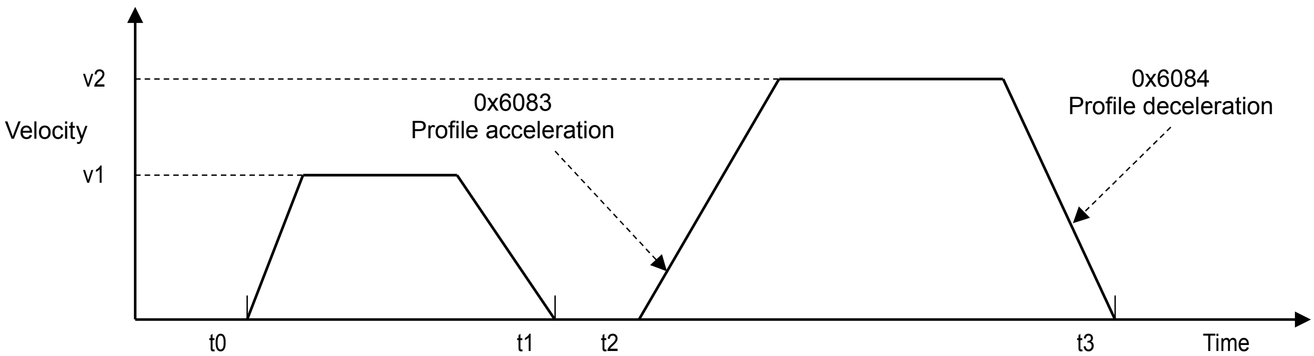
   The timing of the bits ‘new set-point’ and ‘change set immediately’ in the Control Word and ‘set-point acknowledge’ in the Status Word controls the two modes. These bits allow to set up a request response mechanism in order to prepare a set of set-points while another set still is processed in the drive unit.
   This minimizes reaction times within a control program on the master.



Sequence Diagram for Profile Position Mode

(1) If the bit ‘change set immediately’ is "0" a single set point is expected by the drive.
(2) After data is applied to the drive, a host signals that the data is valid by changing the bit ‘new set-point’ to "1" in the Control Word.
(3) The drive responds with ‘set-point acknowledge’ set to "1" in the Status Word.
(4) After it recognized and buffered the new valid data. Now the host may release ‘new set-point’

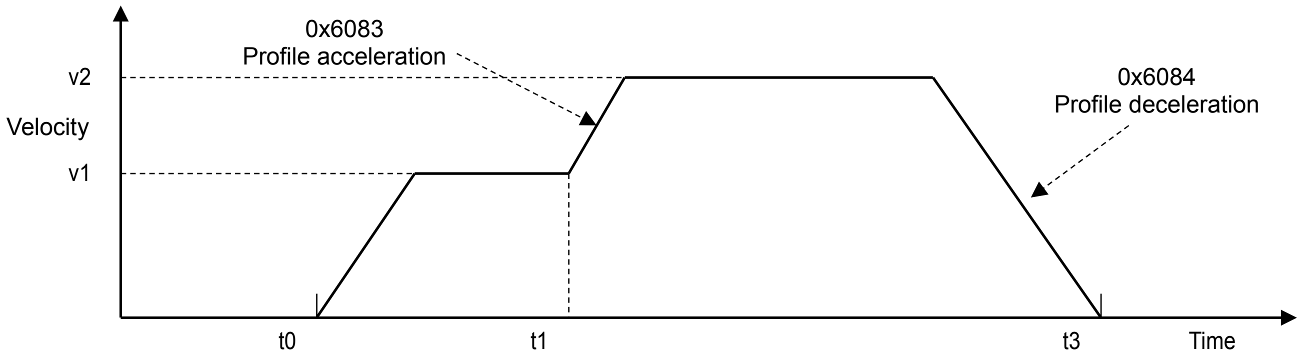
This mechanism results in a velocity of zero after ramping down in order to reach a target position x1.at t1.
After signaling to the host, that the set point is reached like described above, the next target position x2 is processed at t2 and reached at t3.



Profile Position mode (Single set point)

If the bit ‘change set immediately’ is "1" the new target position will be active immediately.
The drive receives the first target position at t0. At the time point t1 the drive receives a second target position.

(6) The drive readapts the actual move to the new target position immediately.



Profile Position Mode (Change set immediately)

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]		Unsigned16	RW	Possible	0x0000
	* See the Command table for “Control word bit pattern (Bit 7, 3, 2,1, 0,)		Range	0x0000-0xFFFF		

MSB LSB

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

bit4:New setpoint [New setpoint]
0:Does not assume target position
1:Assume target position
While 0x2100 statusword1 : bit6 Command reception-enable monitor is set to "1", set 0x6040 controlword : bit4 new setpoint to "1."

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

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

bit8:HALT [HALT]
1:Stop axle with halt option code(0x605D)

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

MSB LSB

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

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

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

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

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

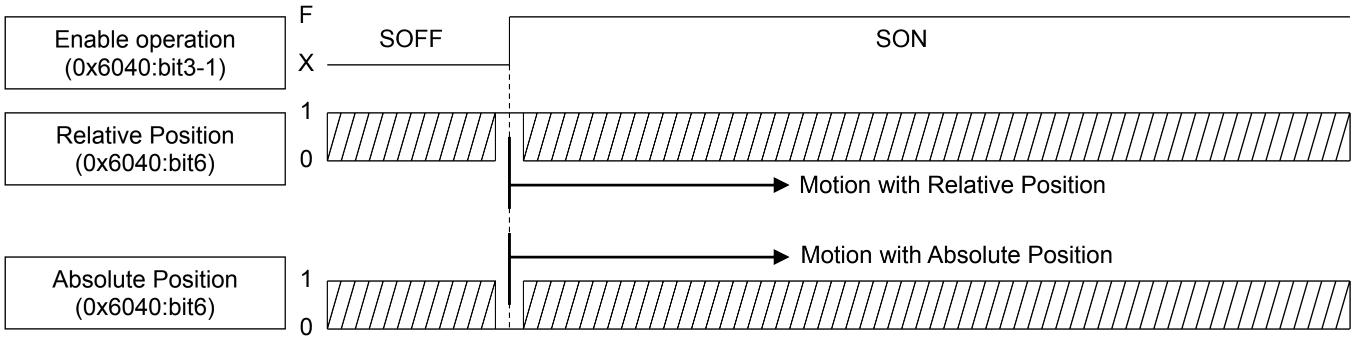
bit11：Internal limit active [Internal Limit active]
0：In normal operation, or standby state after previous normal profiling.
1：Set in the following cases.
・When relative position command selected and wrap around inactivated, the value oversteps the coordinate from positive (present position ≦ 0x7FFFFFFF)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

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

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

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	RW	Possible	0x0000
			Range	0x0000-0xFFFF		

MSB … LSB

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

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

bit8:HALT [HALT]
0:Permission of homing function (Enable bit4 for homing)
1:Stop axle with halt option code(0x605D)

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		Data Type	Access	PDO	Initial value
0x00	Status Word [STSWORD] *See the Pattern status table for “Status word bit” (Bit6,5, 3,2,1,0)		Unsigned16	RO	Possible	0x0000
			Range	0x0000-0xFFFF		

MSB LSB

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

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

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

bit9:remote [remote]
0:controlword is not processed 1:controlword is processed

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

bit11:Internal Limit active [Internal Limit active]
0: In normal operation
1:At the software limit,forward rotation limit/ reverse rotation limit

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

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

6) Function Group “Velocity”, ”Homing mode”

■ Abstract of Function Group “Velocity”, ”Homing mode”

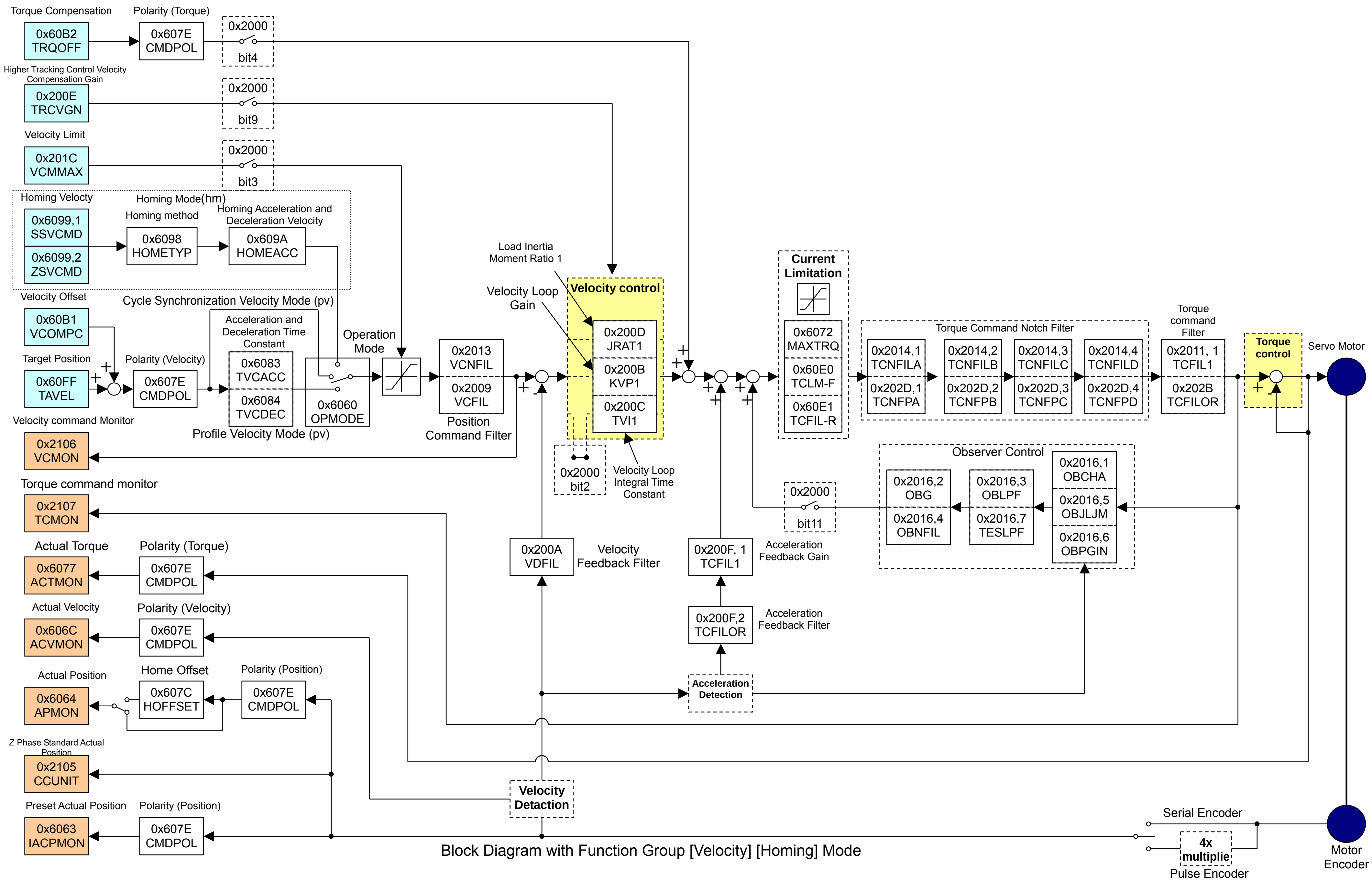
In Function Group "Velocity" the operation mode, “Profile Velocity mode” and "Cyclic Synchronous Velocity Mode" shall be supported.
0x6060:When the bit is set “3” in Operation Mode it is operated profile Velocity Mode, and when the bit is set “9”, it is operated by Cyclic Synchronous Velocity Mode.
And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

List of Position Mode Object

Index	Sub-Index	Name	PDO Mapping	0x6060 Mode
0x2009	0x00	Velocity Command Filter	No	csv, pv, hm
0x200A	0x00	Velocity Feedback Filter	No	csv, pv, hm
0x200B	0x01	Velocity Loop Proportional Gain 1	Possible	csv, pv, hm
0x200C	0x01	Velocity Loop Integral Time Constant 1	Possible	csv, pv, hm
0x200D	0x01	Load Inertia Moment Ratio 1	Possible	csv, pv, hm
0x200E	0x00	Higher Tracking Control Velocity Compensation Gain	No	csv, pv, hm
0x200F	0x01-0x02	Acceleration feedback Compensation	No	csv, pv, hm
0x2011	0x00	Torque (force) Command Filter	No	csv, pv, hm
0x2013	0x00	Velocity Command Notch Filter	No	csv, pv, hm
0x2014	0x01-0x04	Torque (force) Command Notch Filter A-D	No	csv, pv, hm
0x2016	0x01-0x07	Observer Characteristic	No	csv, pv, hm
0x201C	0x00	Speed limit	No	csv, pv, hm
0x202B	0x00	Torque (force) Command Filter	No	csv, pv, hm
0x202D	0x01-0x04	Torque (force) Command Notch Filter (A) Low Frequency Phase Delay Improvement	No	csv, pv, hm
0x2106	0x00	Preset Velocity Command Monitor	Possible	csv, pv, hm
0x2107	0x00	Preset Torque (force) Command Monitor	Possible	csv, pv, hm
0x6040	0x00	Controlword	Possible	csv, pv, hm
0x6041	0x00	Statusword	Possible	csv, pv, hm
0x605A	0x00	Quick stop option code	No	csv, pv, hm
0x6063	0x00	Position actual internal value	Possible	csv, pv, hm
0x6064	0x00	Position actual value	Possible	csv, pv, hm
0x606C	0x00	Velocity actual value	Possible	csv, pv, hm
0x6072	0x00	Max torque (force)	Possible	csv, pv, hm
0x6077	0x00	Torque (force) actual value	Possible	csv, pv, hm
0x607C	0x00	Home offset	Possible	csv, pv, hm
0x607E	0x00	Polarity	No	csv, pv, hm
0x6083	0x00	Profile acceleration	Possible	pv (csv, hm*)
0x6084	0x00	Profile deceleration	Possible	pv (csv, hm*)
0x6098	0x00	Homing method	No	hm
0x6099	0x01-0x02	Homing Speed	Possible	hm
0x609A	0x00	Homing acceleration	No	hm
0x60B1	0x00	Velocity offset	Possible	csv, pv, hm
0x60B2	0x00	Torque (force) addition　Torque (force) offset	Possible	csv, pv, hm
0x60E0	0x00	Positive Direction Torque (force) limit	Possible	csv, pv, hm
0x60E1	0x00	Negative Direction Torque (force) limit	Possible	csv, pv, hm
0x60FF	0x00	Target velocity	Possible	csv, pv, hm

*“csv” and “cst” are valid only for “Halt and Quick stop” enabled.

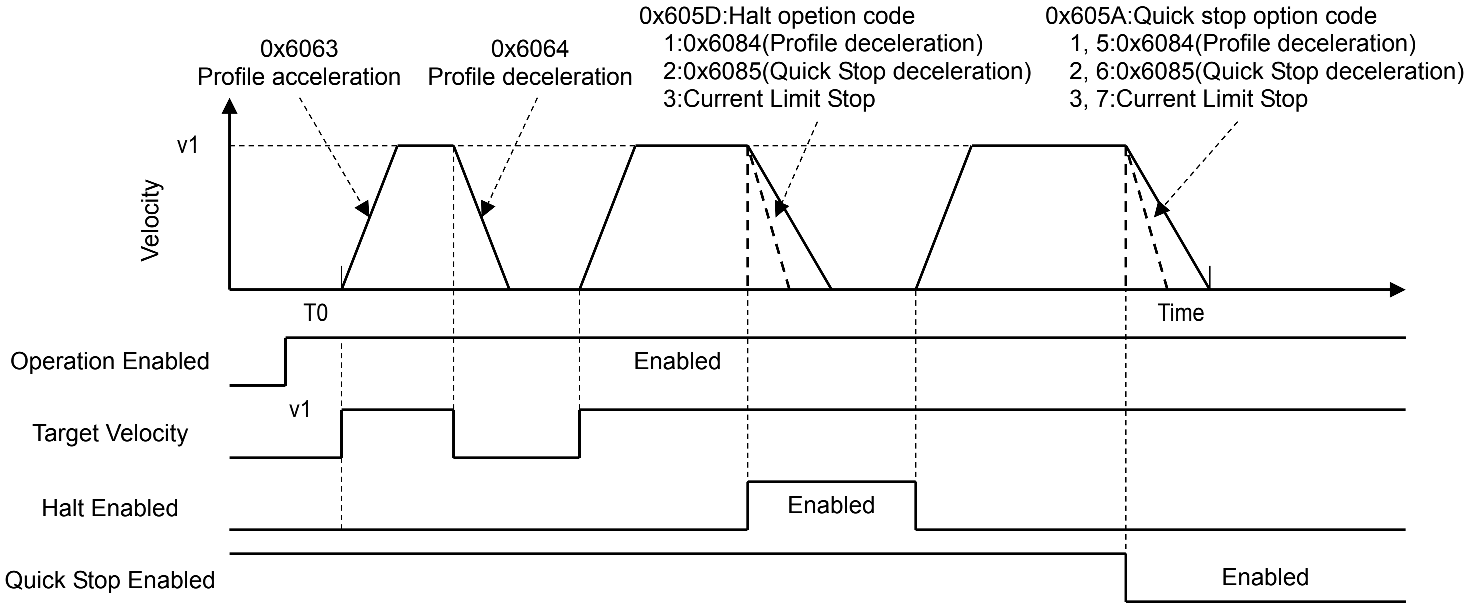
Block diagrams of Function Group “Velocity” “Homing” mode are indicated in the following pages.



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

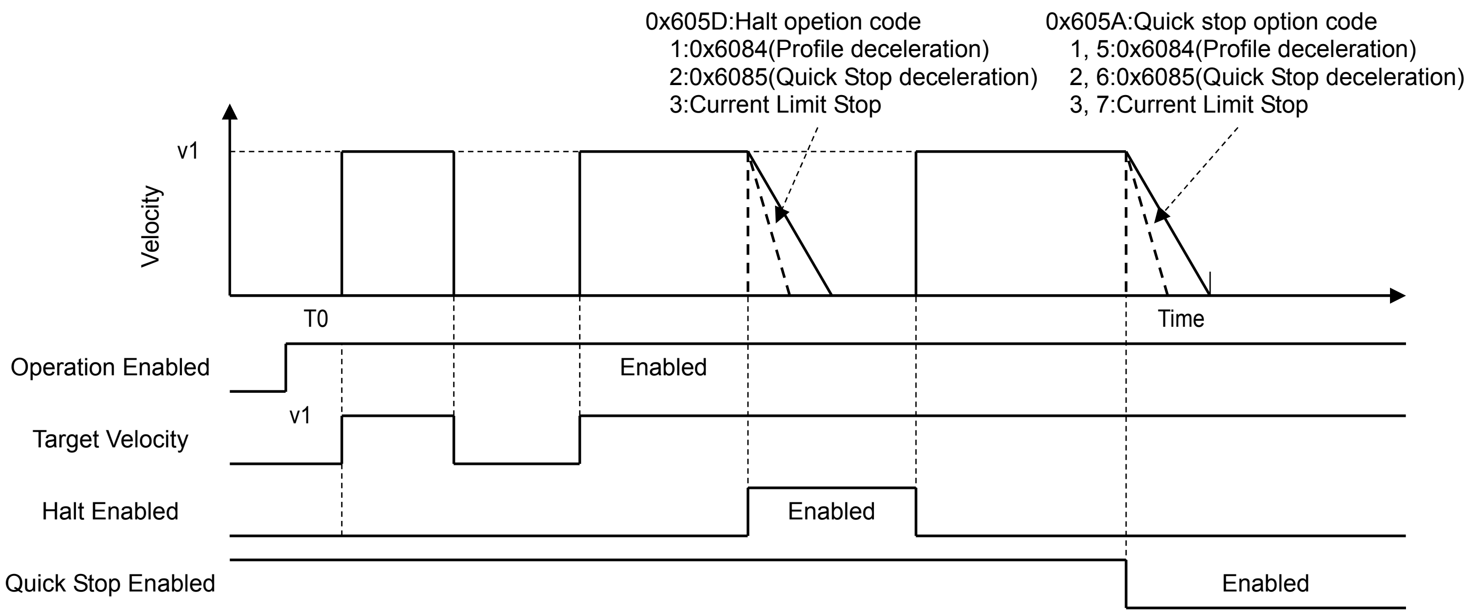
7) Profile Velocity Mode

In this Profile torque mode, the master (Control Device) generates trajectory and transmits 0x60FF:Target velocity to the slave to make control velocity and torque (force) by Cyclic mode or Non-Cyclic mode.
When the Profile acceleration and deceleration 0x60083, 0x6084 are used, an inclination is given to target velocity.



8) Cyclic Synchronous Velocity Mode

In this Cyclic Synchronous Velocity Mode, the master (Control Device) generates trajectory and transmits Target velocity (0x60FF) to the slave to make control velocity and torque (force) by Cyclic mode .
When the Profile acceleration and deceleration 0x60083, 0x6084 are used, they function only for Halt and Quick stop operations.



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	Description		Data Type	Access	PDO	Initial value
0x00	Control word [CWORD] * See the bit patter command list for the detail on Bit 7, 3, 2, 1, 0		Unsigned16	RW	Possible	0x0000
			Range	0x0000-0xFFFF		

MSB LSB

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

bit8:HALT [HALT]
0:permission of homing function (Enable bit4 for homing)
1:Stop axle with halt option code(0x605D)

bit12: Encoder Clear Enable [ECLR]
It will clear Absolute encoder battery error or position of multi-rotation. They shall be cleared when 112ms goes by since bit "1" is set.

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

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

MSB LSB

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

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

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

bit9:remote [remote]
0:controlword is not processed 1:controlword is processed

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

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

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

9) Homing Mode

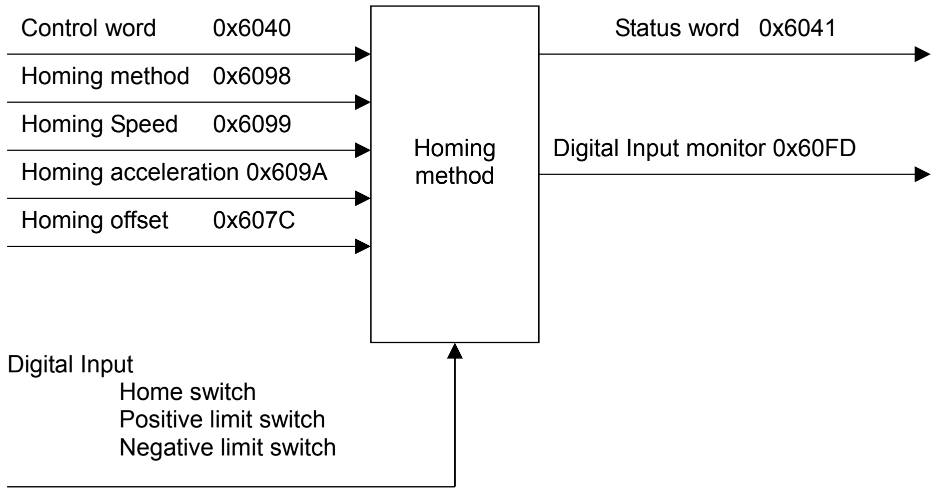
This clause describes the method by which a drive seeks the home position (also called, the datum, reference point or zero point)
Input objects are defined as well as the output objects. The user may specify the speed, acceleration and the method of homing. There is a further object home offset, which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

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

Here is the Objects list in the Homing mode.

List of Homing Mode Object

Index	Sub-Index	Name	PDO Mapping
0x607C	0x00	Home offset	Possible
0x6098	0x00	Homing method	No
0x6099	0x00	Homing speeds	Possible
0x609A	0x00	Homing acceleration	No
0x60E3	0x00	Support Homing Method	No
0x60E6	0x00	Actual position calculation method	No
0x60FD	0x00	Digital Input	Possible



Homing mode function

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

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

The below shows the Homing Methods list.

Homing Method

Method	Homing Mode	Stop direction	Function
-128 to 0	Reserved	-	-
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
15, 16	Reserved	-	-
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
31, 32	Reserved	-	-
33	Homing on the index pulse	negative	Supported
34	Homing on the index pulse	positive	Supported
35	Homing on the current position	-	Supported
36	Homing with touch-probe	-	Not Supported
38-127	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 sensor information (single or multi turn sensor).
For a single turn sensor the single turn information represents the position actual value. For a multi turn sensor the multi turn information represents the position actual value.
Setting of relative value homing/ absolute position homing are depending on “0x60E6: Setting of actual position calculation method.” The actual position (0x6064) in home position during homing is as follows:

A) Absolue value homing: 0x60E6＝0 (Absolue homing)
Actual position information is not used in home position (Calculated excluding present position.)

Actual position（0x6064）＝ Homing offset（0x607C）

B) Relative value homing : 0x60E6＝1（Relative homing）
Actual position information is used.（Including present position.）

Actual position（0x6064）＝ Present position ＋ Homing offset（0x607C）

✔ Homing mode cannot be used in the modes other than incremental system.（Except for homing method [35].）
Applicable sensor code (OD：0x20FE S-Idx 2): 0x0000, 0x0101, 0x0201, 0x0301, 0x0401, 0x0501, and 0x0601
✔ Homing method [35] can be performed with all the sensor code.

Usage of absolute sensors and repeated homing

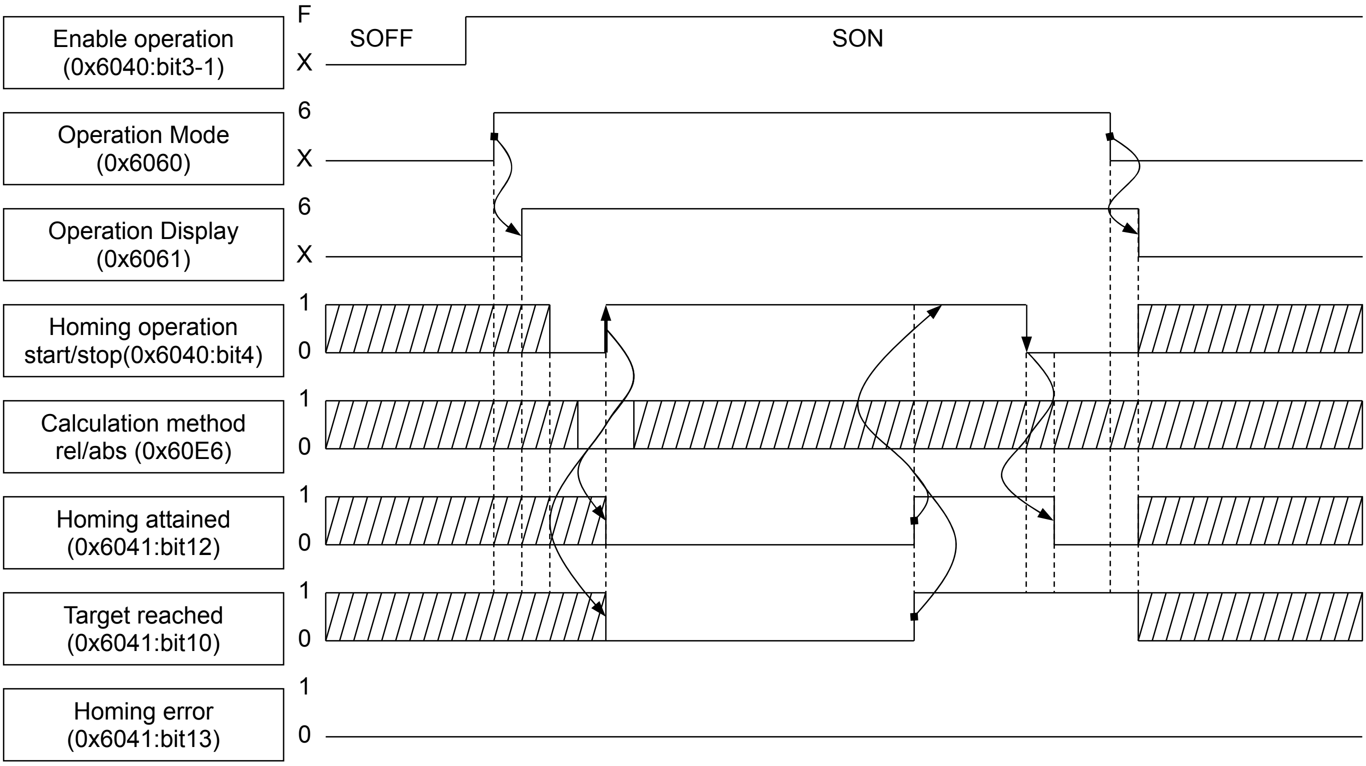
1) Single turn sensor
In a system with a single turn sensor the position actual value is identical with the sensor position (single turn information).
During homing, the homing offset will be calculated relative or absolute.
Position information of an axis that are already accumulated before homing are discarded. Always the position actual value and the homing offset will be used as the reference position. Because the single turn information of the sensor is used there will be no drift in the position when repeating the homing with a set homing offset.

2) Multi turn sensor
In a system with a Multi turn sensor the position actual value is identical with the sensor position.
During homing the honing offset will be calculated relative or absolute. The position actual value is set as position information.
A repeated homing does not lead to a drift, because the multi turn information of the sensor (the position actual value) is always used.
The position actual value in the drive is not set to zero because of the homing.

The change of the operation mode to the honing mode and back in the object 0x6060 is included.
The following figures show sequences in the homing mode of Control word (0x6040), Operation mode (0x6060) and Operation display (0x6061).

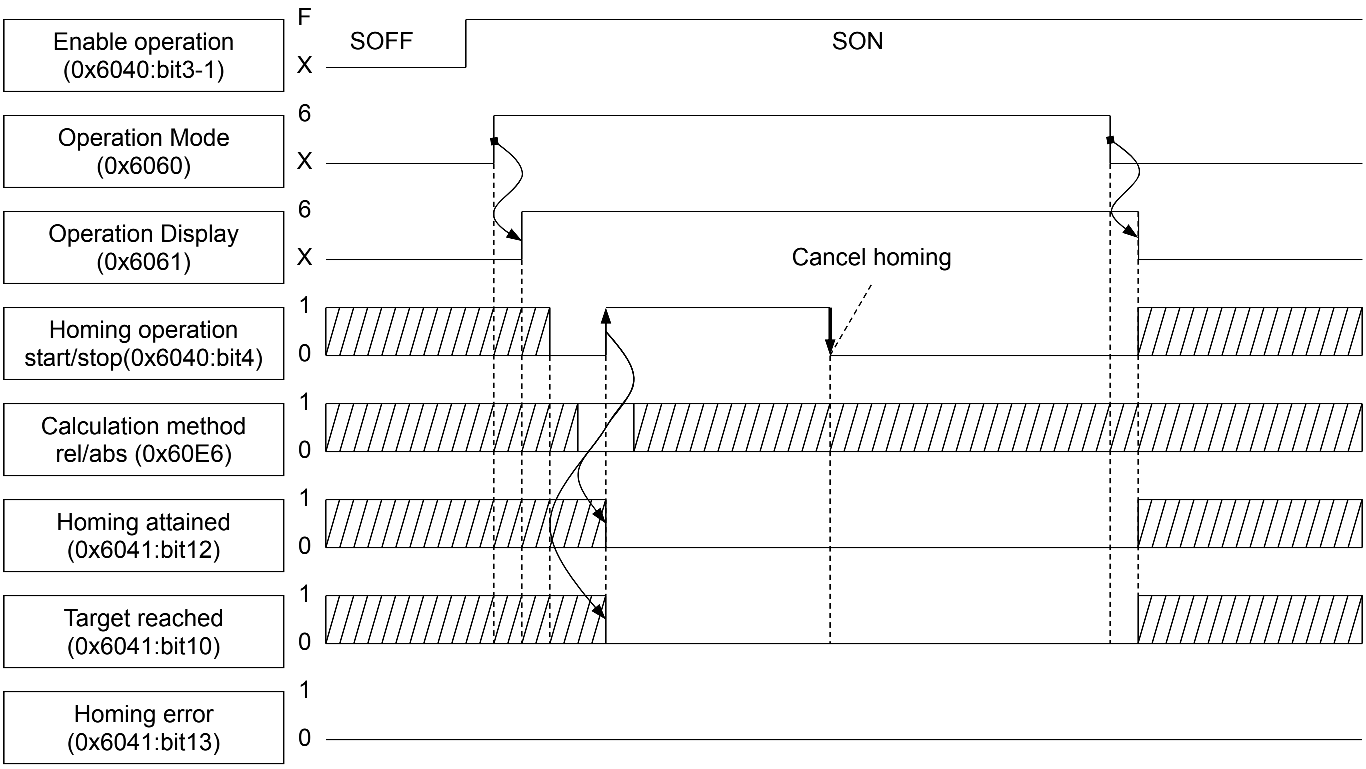
The following sequence shows homing modes corresponding to the Amplifier of Servo Amplifier

1) Start and completion sequence of homing mode



Homing sequence

2) Cancel before homing completion



Homing Cancel sequence

Definitions of general purpose input signals in the homing mode

1) In the homing mode, input allocation and sequence of positive limit switch (CC:OT) and negative limit switch (CCW:OT) are determined by setting of 0x01:Positive limit switch and 0x02:negative limit switch in 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 “00: Always no function”.
* 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

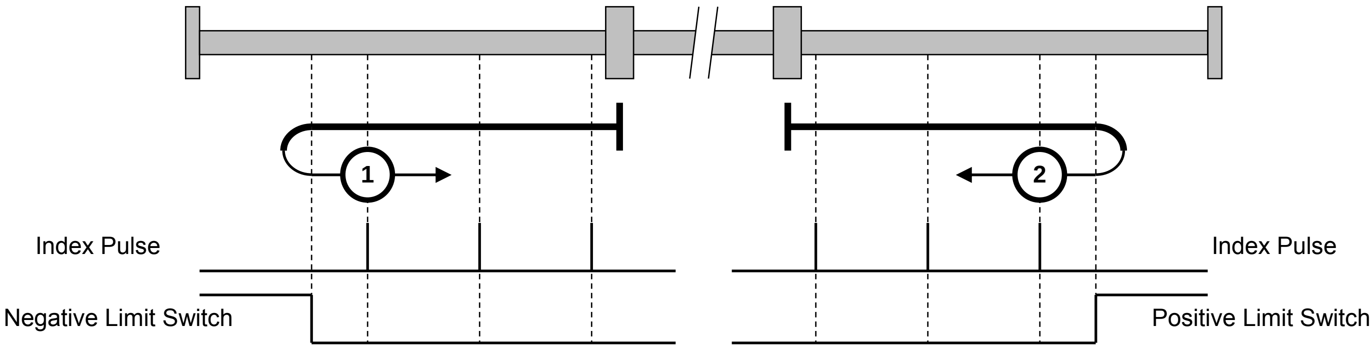
#Operating direction of homing method

The move direction in each homing drawing and the rotation direction (see from motor shaft) are depending on 0x607E: Polarity.
The move direction in drawing and the motor rotation direction are shown below.

0x607E Polarity	Move to right/ Positive rotation (Actual position increasing)	Move to left/ Negative rotation (Actual position decreasing)
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 (Positive rotation) if the positive limit switch is inactive The position of home shall be at the first index pulse to the left of the position (Negative side) where the positive limit switch becomes inactive.

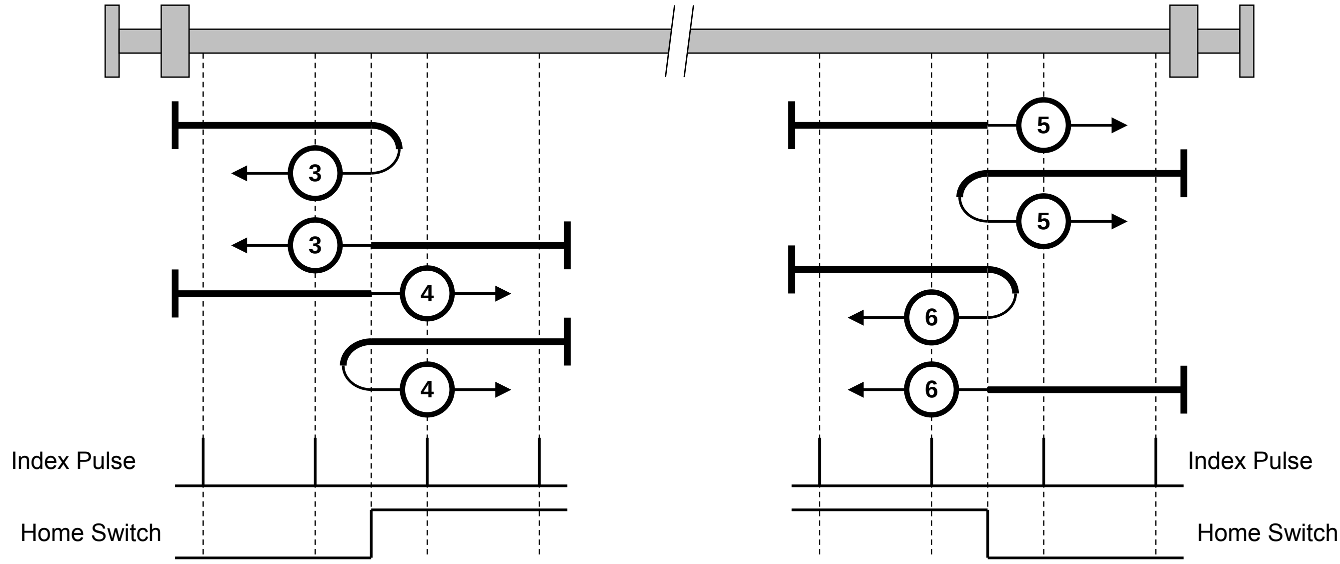


[1]Homing on negative limit switch and index pulse   [2] Homing on positive limit switch and index pulse

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

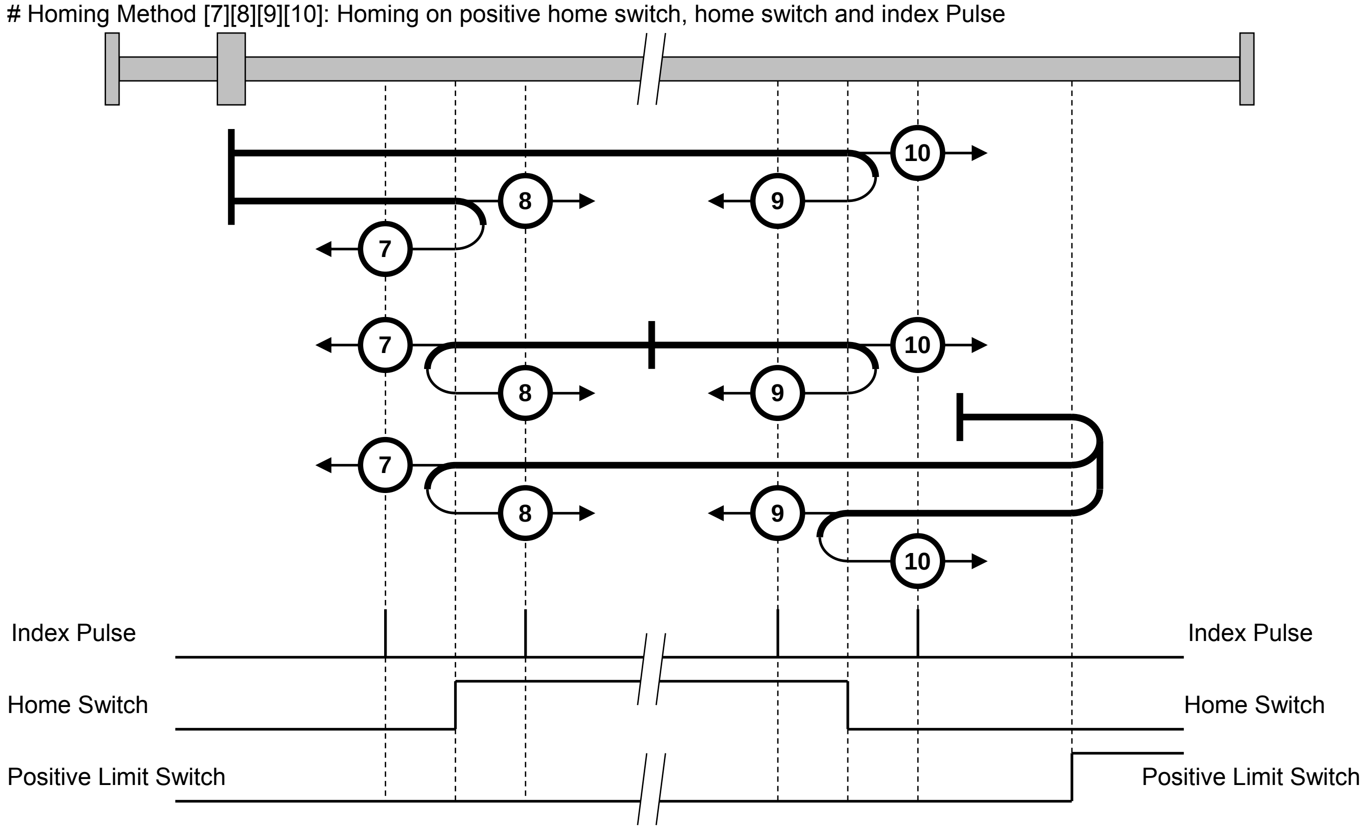
Homing Method [3][4]: Homing on positive home switch and index Pulse
Homing Method [5][6]: Homing on positive home switch and index Pulse

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



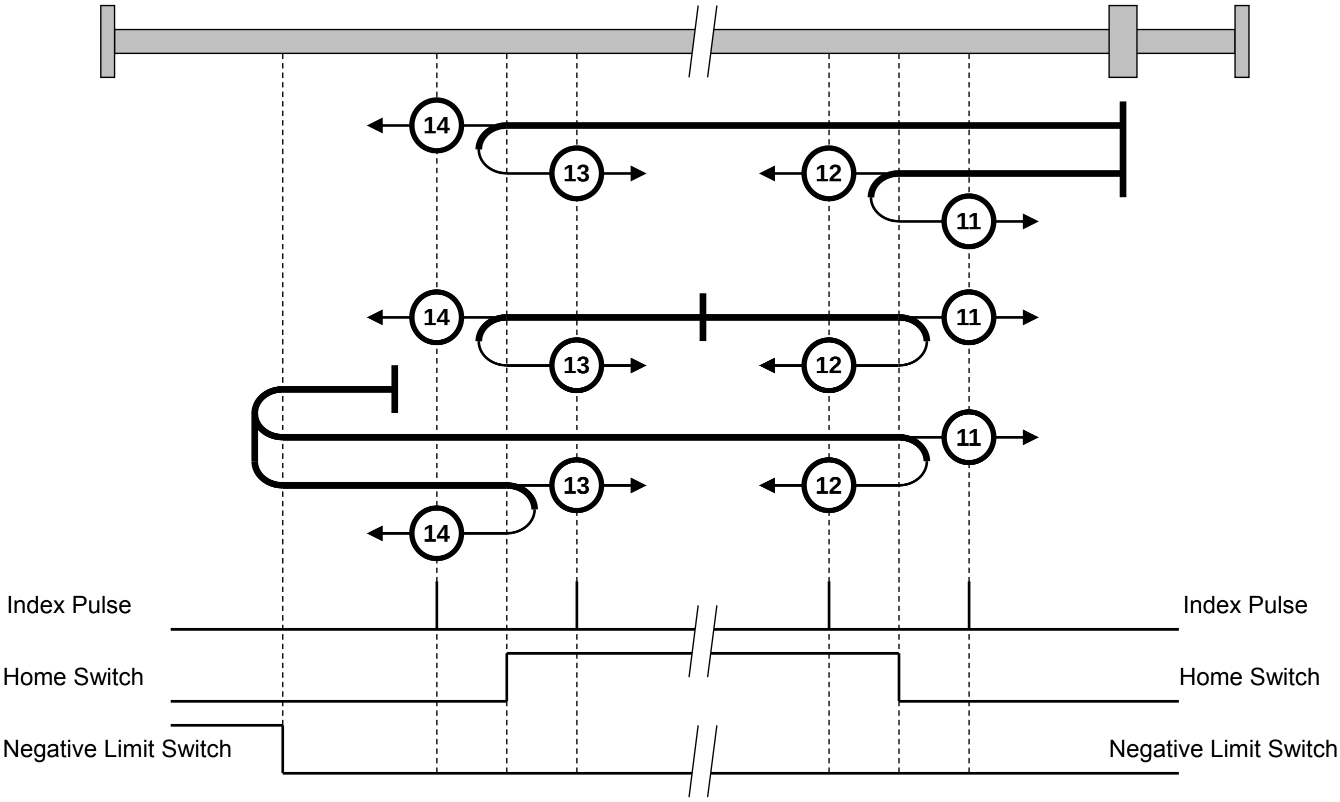
[3] Homing on positive home switch and index pulse (Neg) [5] Homing on positive home switch and index pulse (Pos)[4] Homing on positive home switch and index pulse (Pos) [6] Homing on positive home switch and index pulse (Neg)

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



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

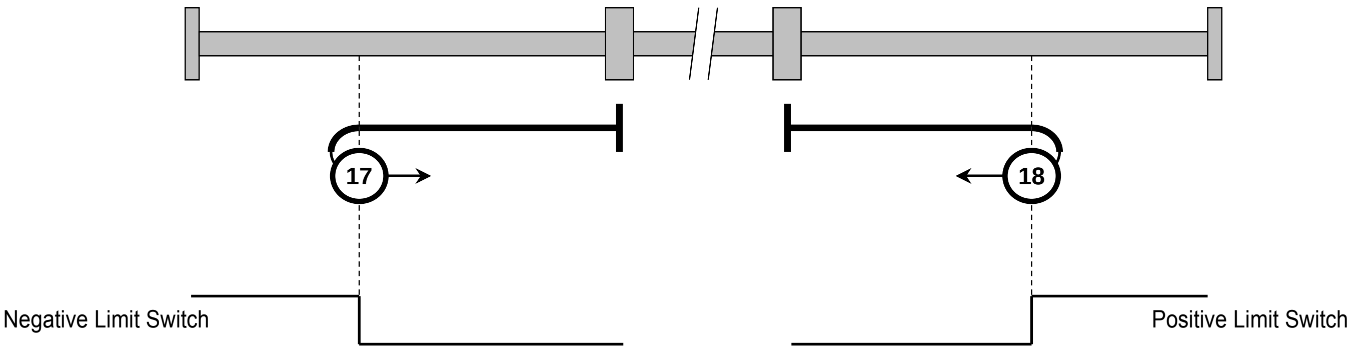
Homing Method [11][12][13][14]: Homing on negative home switch, home switch and index Pulse



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

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

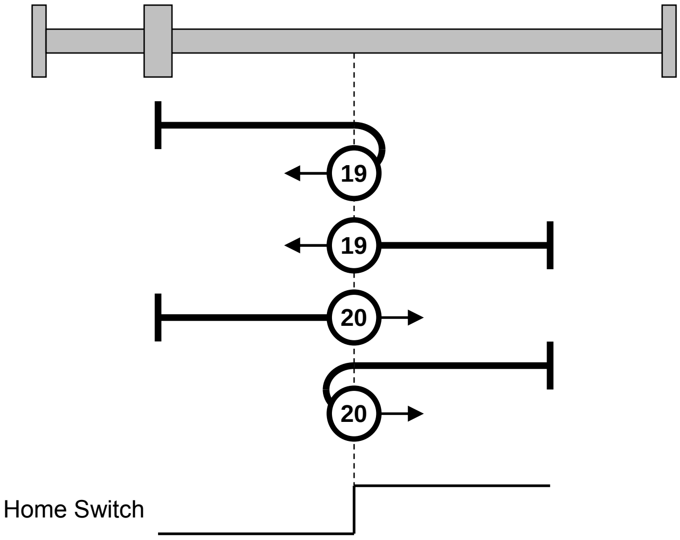
In the method [17], the initial direction of movement shall be leftward (Negative rotation) if the negative limit switch (Reverse rotation OT) is inactive. The home position shall be at the potision by the negative limit switch becomes active.
And using the method [18] , the initial direction of movement shall be rightward (Positive rotation) if the positive limit switch (Forward rotation OT) is inactive The position of home shall be at the position by the positive limit switch becomes inactive.
Positive Limit Switcha and Negative Limit Switch used in homing method [17] and [18] cannot be used for the inputs other than the following versatilw input.
The end number of amplifier model number: 0 or 4 CONT1, CONT2
The end number of amplifier model number: 1or 5 CONT1, CONT2, CONT3



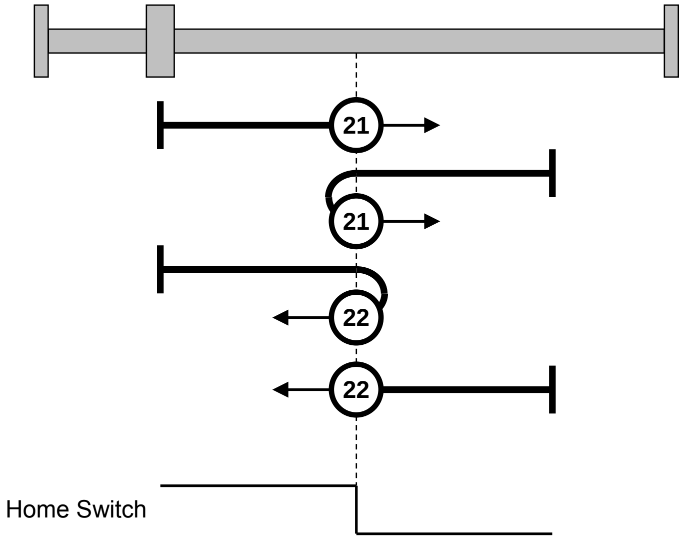
[17] Homing on negative limit switch [18] Homing on positive limit switch

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

Homing without index pulse
There methods are similar to methods 3 to 6 that the home position is not dependent on the index pulse but only depend on the relevant home or limit switch transitions. The home position is found by the homing switches and Index pulses. Methods 19 to 21 stop by the homing position only.



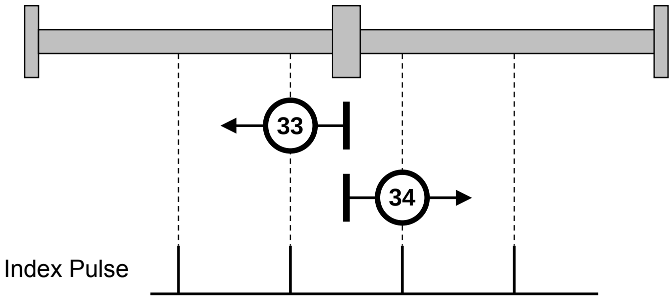
[19] Homing on positive home switch (Negative stop)
[20] Homing on positive home switch (Positive stop)



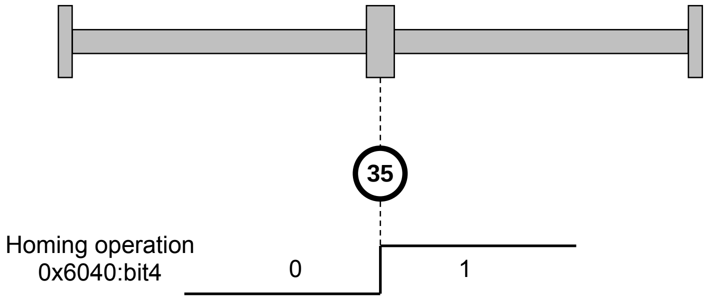
[21] Homing on negative home switch (Positive stop)
[22] Homing on negative home switch (Negative stop)

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

Using these methods, the direction of homing is negative (CW) or positive (CCW) respectively. The home position shall be at the nearest index pulse that is found in the selected direction.
In homing method [35], 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).



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



[35] Homing on Current position

■ Home position retention function when using absolute system

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

Step (1) Preparation of homing
OD: 0x6098 Set homing method to “35 (0x23): Homing to present position.”
OD: 0x60E6 Select actual position calculation method (0: Absolute homing
1: Relative position homing)
OD: 0x607C Setting of home offset (When using ”0: Absolute homing,” set the position you want to set to “detection reference position,“when using”1: Relative position homing,” set to zero.)
OD：0x6060 Change operation mode to ”6: Homing mode.”

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

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

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

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

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

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

✔ If you use absolute system, you can not use any homing methods other than Homing method: 35 (0x23).
✔ To clear stored “origin coordinate after homing completed,” perform encoder clear, and then re-perform parameter retension procedure (step 6 and 7).

0x6040:Control Word (Homing Mode: hm)

Index	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] *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

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

bit6:Homing offset Selection [absolute / relative]
0:After homing finishes, position Actual value is absolute value
1:After homing finishes, position Actual value is relative value

bit8:HALT [HALT]
This function has been change in accordance with “EtherCAT Implement Guideline for CiA402 V0.2.4.”
(Document No.ETG.6010G(D)V0.2.4)
This function is defined by “OD: 0x60E6 Actual position calculation methid.”

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	Initial value
0x00	Status Word [STSWORD] *For details on Bit 6, 5, 3, 2, 1 and 0, see the Status Word List Bit Pattern (Bit 6,5,3,2,1,0)		Unsigned16	RO	Possible	0x0000
			Range	0x0000-0xFFFF		

MSB LSB

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

bit4:Voltage Enabled 0:Voltage disenabled	[Voltage Enabled] 1:Voltage enabled
bit7:warning 0:No warning	[warning] 1:warning condition
bit9:remote 0:No warning	[remote] 1:warning condition
bit11:Internal Limit active 0:nomal operation 1:Software Position limit ,CW limit/CCW limit	[Internal Limit active]

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

10) 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.

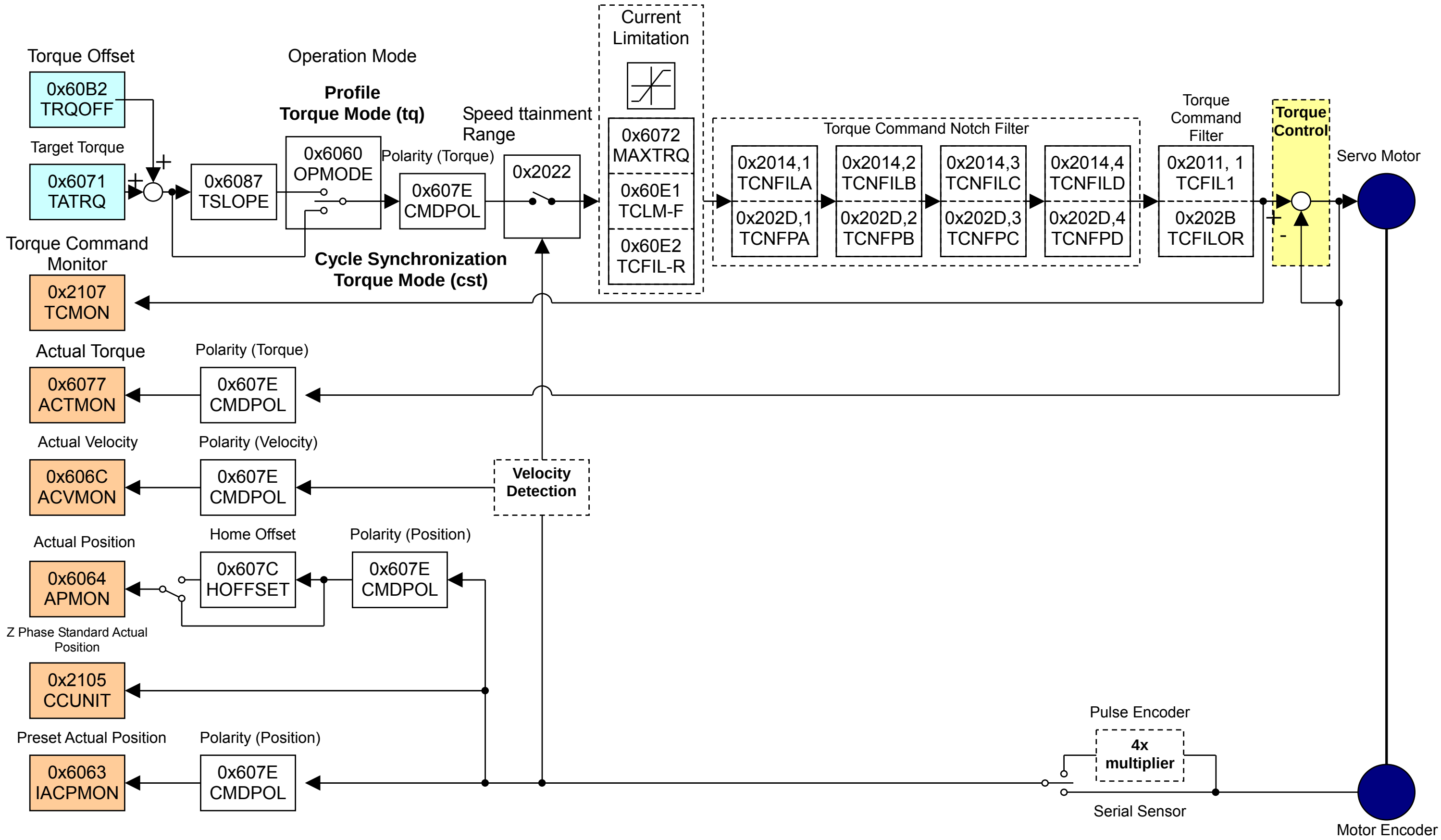
0x6060: If Operation Mode is set “4”, it is operated by Profile torque (force) mode. If it is set “10”, Cyclic synchronous torque (force) mode is operated. The below list indicates the main Objects as for function group “Torque (force)”.

Object List of Cycle Synchronization Torque (force) Mode

Index	Sub-Index	Name	PDO Mapping	0x6060 Mode
0x2011	0x00	Torque (force) Command Filter	No	cst,tq
0x2014	0x01-0x04	Torque (force) Command Notch Filter A-D	No	cst,tq
0x2022	0x00	Speed Attainment Setting	No	cst,tq
0x202B	0x00	Torque (force) Command Filter Characteristic	No	cst,tq
0x202D	0x01-0x04	Torque (force) Command Notch Filter Selection A-D	No	cst,tq
0x2107	0x00	Torque (force) Command monitor	Possible	cst,tq
0x6040	0x00	Control Word	Possible	cst,tq
0x6041	0x00	Status Word	Possible	cst,tq
0x6063	0x00	Internal Real Position	Possible	cst,tq
0x6064	0x00	Real Position	Possible	cst,tq
0x606C	0x00	Real Position	Possible	cst,tq
0x6071	0x00	Target Torque (force)	Possible	cst,tq
0x6072	0x00	Maximum Torque (force)	Possible	cst,tq
0x6077	0x00	Real Torque (force)	Possible	cst,tq
0x607E	0x00	Polarity	No	cst,tq
0x6087	0x00	Torque (force) slope	Possible	tq(cst*)
0x60B2	0x00	Torque (force) Offset	Possible	cst,tq
0x60E0	0x00	Forward Torque (force) Limit Value	Possible	cst,tq
0x60E1	0x00	Reverse Torque (force) Limit Value	Possible	cst,tq

*(cst) is the parameter that is enable only for the command “Halt” and “Quick stop enable”.

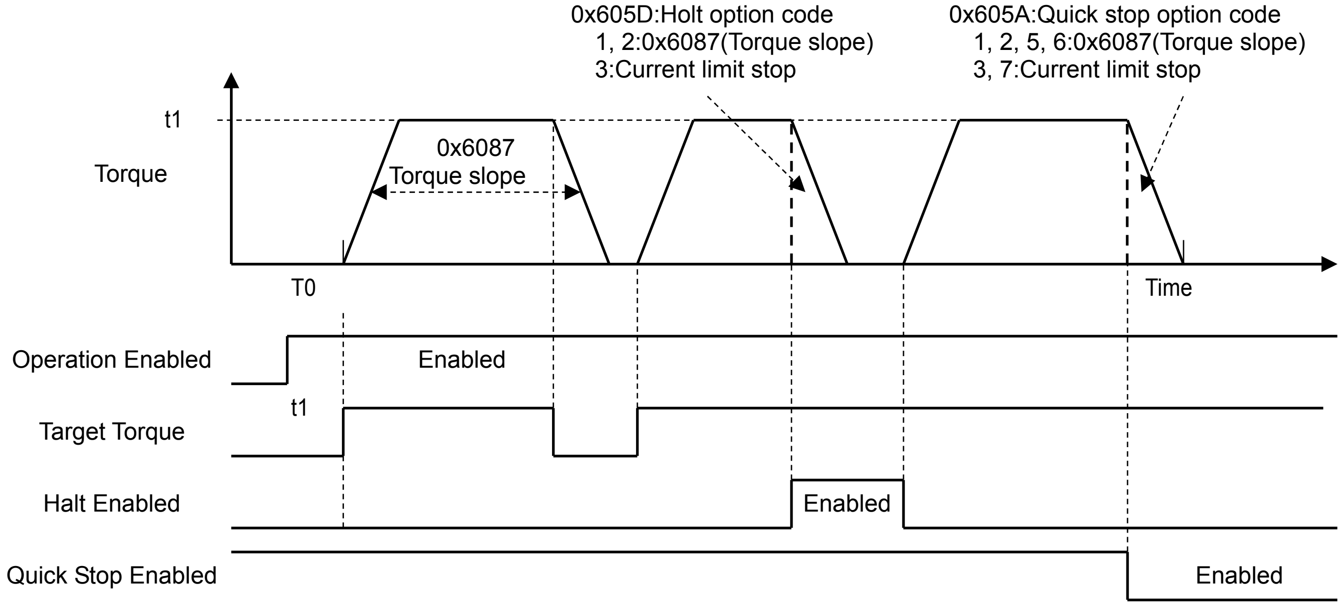
Block diagrams of Function Group “Torque” mode are indicated in the following pages.



Block Diagram with Function Torque Mode

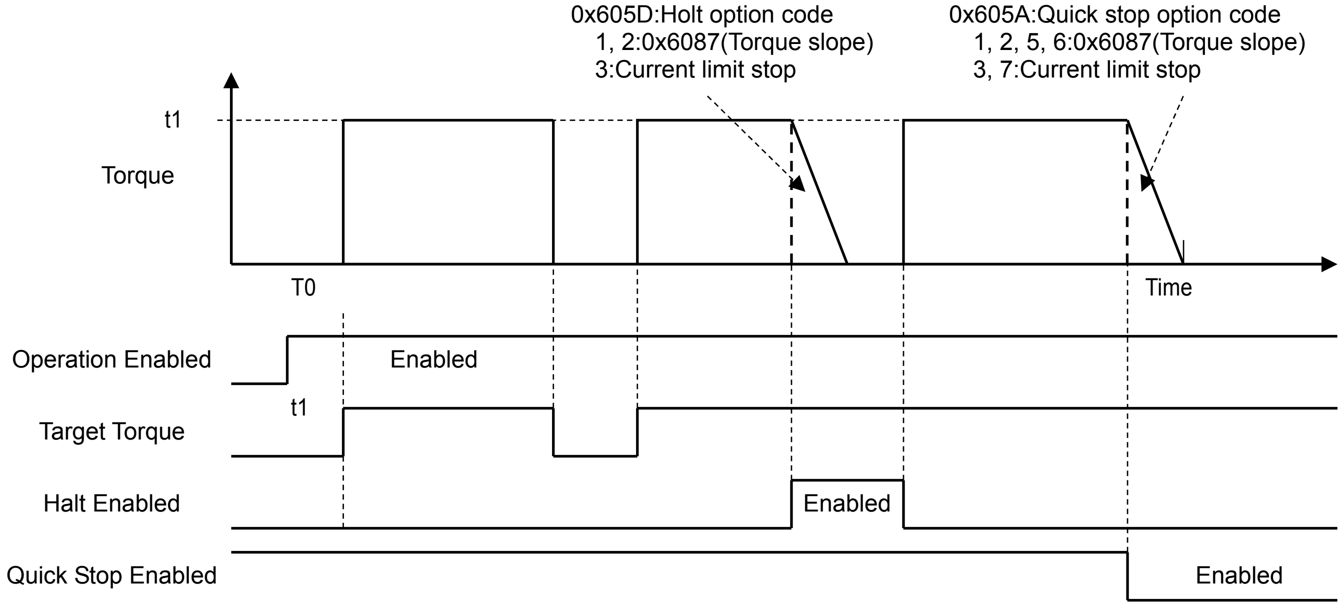
11) Profile torque (force) mode

In this Profile torque mode, the master (Control Device) generates trajectory and transmits Target torque (force) (0x6071) to the slave to make control torque (force) by Cyclic mode or Non-Cyclic mode.
And also, enable to slope the target torque (force) by setting 0x6087:Torque slope.



12) Cyclic Synchronous torque (force) mode

In this Cyclic Synchronous torque mode, the master (Control Device) generates trajectory and transmits Target torque (force) (0x6071) to the slave continuously to make control torque (force) by cyclic mode.
0x6087 Torque (force) slope functions only in Holt or Quick stop operation.



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] * See the Command table for "Control word bit pattern (Bit 7, 3, 2,1, 0,) command		Unsigned16	RW	Possible	0x0000
			Range	0x0000-0xFFFF		

MSB / LSB

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

bit8:HALT [HALT]
0:homing function enable (Enable 0x6040: bit4)
1:Stop axis according to halt option code (0x605D)

bit12:Encoder clear enable [ECLR]
It will clear the Battery error of the Absolute sensor, or the postion of multiple-rotation. They shall be cleared when 112 ms goes by since Bit " 1" is set.

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] * See the Pattern Status table for "Status word bit pattern (Bit 6,5, 3,2,1,0,)		Unsigned16	RO	Possible	0x0000
			Range	0x0000-0xFFFF		

MSB / LSB

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

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

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

bit9:remote [remote]
0:controlword is not processed 1:controlword is processed

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

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

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

13) Function Group “Touch Probe”

■ Abstract of Touch Probe

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

Object Lists of Touch Probe

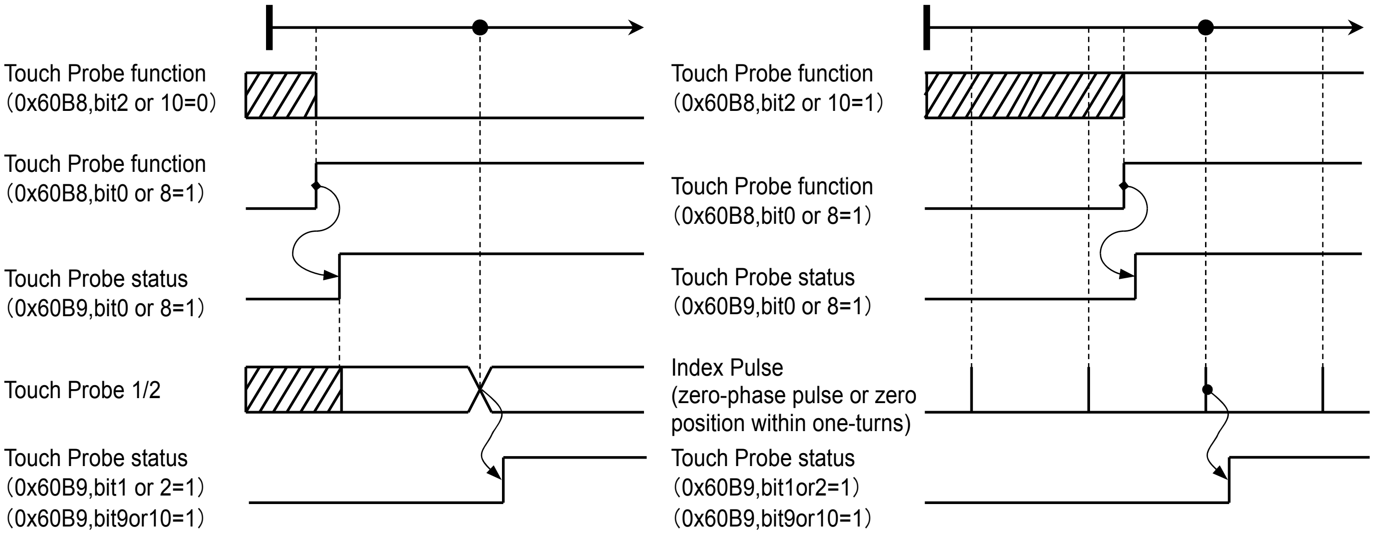
Index	Sub-Index	Name	PDO Mapping
0x60B8	0x00	Touch Probe Function	Possible
0x60B9	0x00	Touch Probe Status	Possible
0x60BA	0x00	Touch probe pos 1 pos value (positive edge)	Possible
0x60BB	0x00	Touch probe pos 1 neg value (negative edge)	Possible
0x60BC	0x00	Touch probe pos 2 pos value (positive edge)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

- Touch prove 1 (CONT1) signal can be triggered with “touch prove 1 input or position sensor index pulse [Note 1]” by “0x60B8, bit 2: Trigger selection.”
- Touch prove 2 (CONT2) signal can be triggered with “touch prove 2 input or position sensor index pulse [Note 1]” by “0x60B8, bit 10: Trigger selection.”

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

The position feedback value latched at Touch Probe 1/2

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

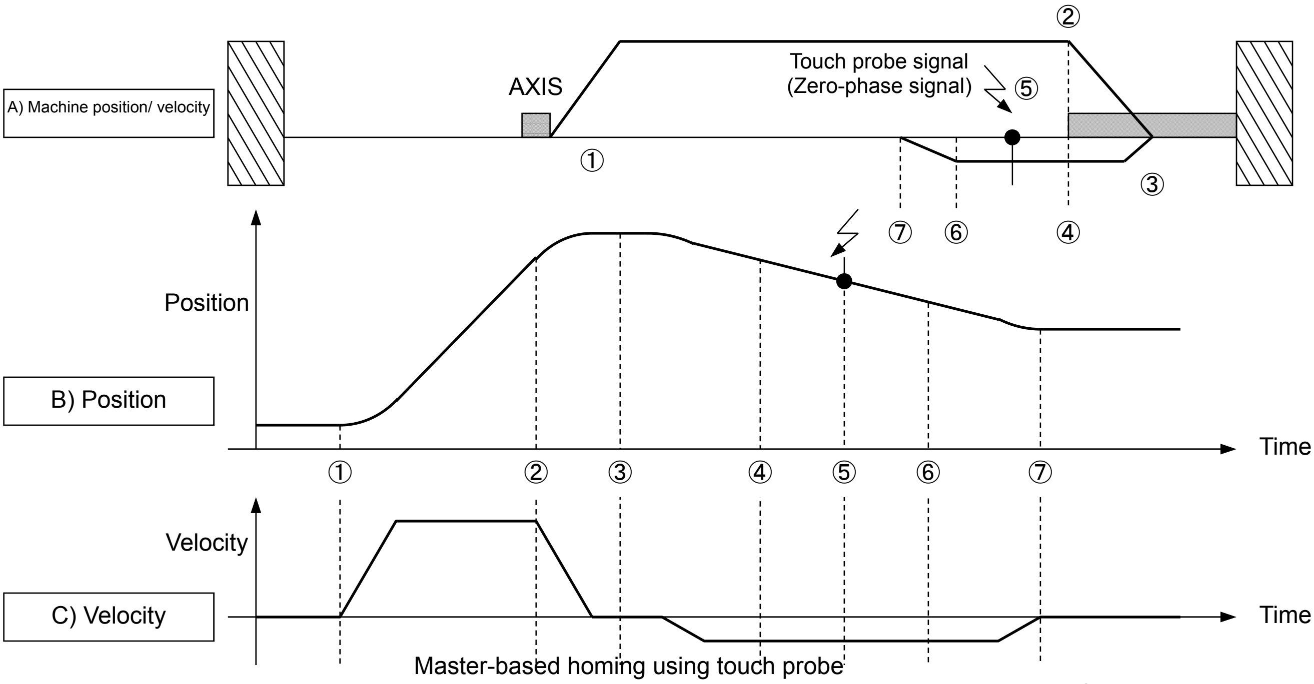


The position value of positive edge latched at Touch Probe 1 (position sensor index pulse) is stored in 0x60BA
The position value of negative edge latched at Touch Probe 1 (position sensor index pulse) is stored in 0x60BB
The position value of positive edge latched at Touch Probe 2 (position sensor index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

The position value latched by Touch Probe function

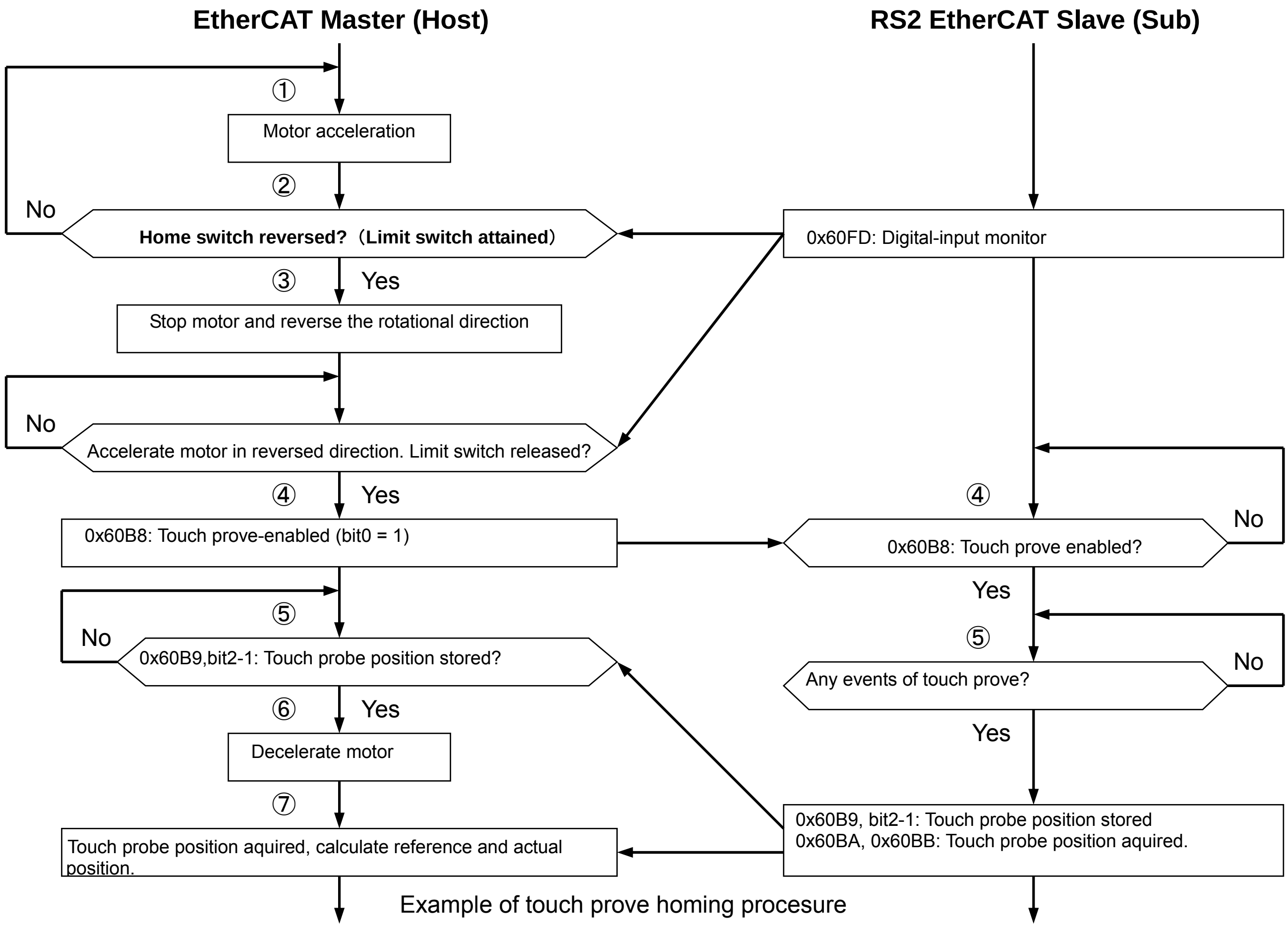
■ Master-led homing (Touch probe homing method)：Homing with touch-probe (without Limit Switch)

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



Master-based homing using touch probe

*A) shows machine axis position, the red line shows velocity, B) shows motor position chart, and C) shows motor velocity chart.



Example of touch prove homing procesure

14) Operation Mode Parameter (Profile Area)

0x6060:Operation Mode

Index	0x6060	Indicates requested operation mode.		Object Code		Variable
Sub-Idx	Description		Data Type	Access	PDO	Initial Value
0x00	Operation Mode [OPMODE] 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 :Reserved 6 :(hm) Homing Mode 7 :Reserved 8 :(csp) Cycle Sync. Position Mode 9 :(csv) Cycle Sync. Velocity Mode 10 :(cst) Cycle Sync. Torque (force) Mode		Integer8	RW	Possible	0x00
			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).
* The mode change at the time of motor rotation is dangerous. Make sure to change at the time of the main power supply OFF, Servo-off, or motor stop.

0x6061:Operation Mode Display

Index	0x6061	Indicates actual operation mode. Definition is the same as 0x6060: Operation Mode.		Object Code		Variable
Sub-Idx	Description		Data Type	Access	PDO	Initial Value
0x00	Operation Mode Display [OPDISP] 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 to 7 :Reserved 8 :(csp) Cycle Sync. Position Mode 9 :(csv) Cycle Sync. Velocity Mode 10 :(cst) Cycle Sync. Torque (force) Mode		Integer8	RO	Possible	0x00
			Display Range	0x00 - 0x0A (0 to 10)		

0x6063: Internal Actual Position

Index	0x6063	Indicates real position of motor sensor.	Object Code		Variable
Sub-Idx	**Description**	**Data Type**	**Access**	**PDO**	**Initial Value**
0x00	Internal Actual Position [IACPMON] Real position acquired from the sensor. Monitor unit is indicated with the resolution of motor sensor to be used. *Sensor combination: In the case of Absolute Sensor	Integer32	RO	Possible	-
		Display Range	0x80000000 - 0x7FFFFFFF (-2147483648 to 2147483647 Pulse)		
		Unit	1 pulse		
	Effective bit length=Multiply 1 rotation resolution by multiple-rotation bit, effective bit length become ”x” unfixed. *Sensor combination: In the case of Incremental Sensor 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).				

0x6064: Position Actual Value

Index	0x6064	Indicates after offset process or the actual position of motor sensor.	Object Code		Variable
Sub-Idx	**Description**	**Data Type**	**Access**	**PDO**	**Initial Value**
0x00	Position Actual Value [APMON] Position data disposed such as offset process, 1 rotation specification, modulo process in Position actual internal value. *Sensor combination: In the case of Absolute Sensor	Integer32	RO	Possible	-
		Display Range	0x80000000 - 0x7FFFFFFF (-2147483648 to 2147483647 Pulse)		
		Unit	Pulse		
	Effective bit length= Multiply 1 rotation resolution by multiple-rotation bit, effective bit length become ”x” unfixed. *Sensor combination: In the case of Incremental Sensor 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 CW direction *When the position polarity of 0x607E is reversed, the value increases in the CCW direction.				

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		

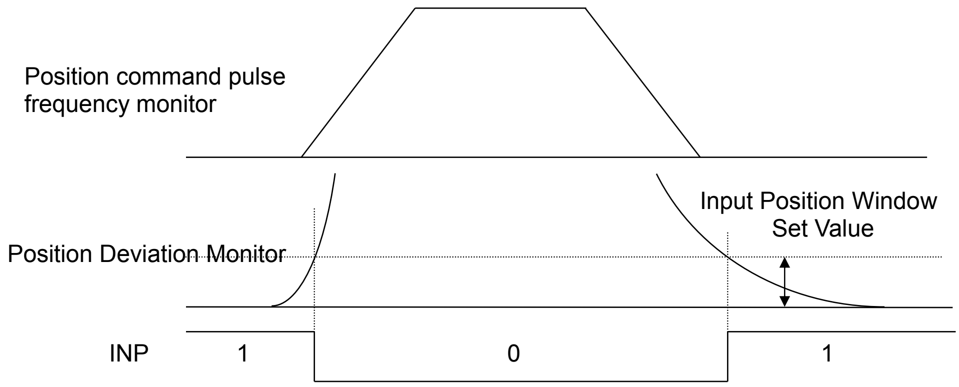
0x6066:Position Deviation Time-out

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		

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).	Unsigned32	RW	No	0x64 (100Pulse)
		Setting Range	0x00000000 - 0x7FFFFFFF (0 to 2147483647 Pulse)		
		Unit	pulse		

*When preset value is 0xFFFFFFFF, position window function is OFF.
*In the case of incremental encoder, 4 times of the number of encoder pulses are standard.
*In the case of absolute encoder (except for incremental output), absolute value is standard.



0x6068:Position Window Time

Index	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		

0x606A:Sensor Selection Code

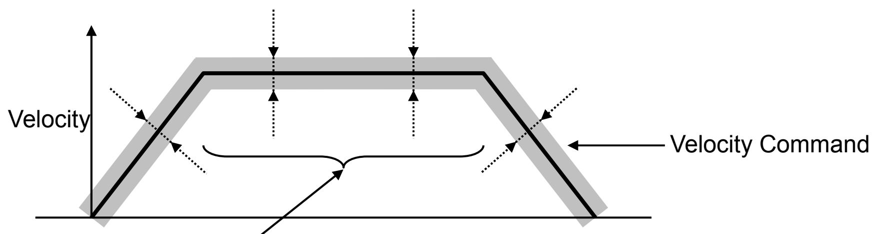
Index	0x606A	With the object provide the source of velocity sensor actual value. It determines whether a differentiated position signal or the signal from a separate velocity sensor evaluated.	Object Code		Variable
Sub-Idx	**Description**	**Data Type**	**Access**	**PDO**	**Initial Value**
0x00	Sensor Selection Code 0:Actual velocity from position encoder 1:Actual velocity from velocity encoder This amplifier is "0" fixation.	Integer16	RW	No	0x0000
			0x0000 - 0x0000		

0x606C: Velocity Actual Value

Index	0x606C	Has actual velocity value calculated from position sensor. 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	

0x606D: Velocity Window (Velocity Matching: Number-of-rotations Setup)

Index	0x606D	Sets the range regarded as Velocity matching range by the unit [min^{-1}]. Use this setting when "Velocity Matching Selection" is "0x00_min-1".	Object Code		Variable
Sub-Idx	Description		Data Type	Access / PDO	Initial Value
0x00	Velocity Window [VCMP] Velocity matching is output when the Velocity deviation (difference between the Velocity command and Actual velocity) is within this setting range. VCMP monitor is set when Actual velocity≦Set value.		Unsigned16	WR / No	0x32 (50 min^{-1})
			Display Range	0x0000 - 0xFFFF (0 to 65535min^{-1})	
			Unit	min^{-1}	



Outputs STGDAT=1 within the setting range of the velocity matching one.

*Velocity matching output changes by a number-of-rotations (min-1) setup and ratio (%) setup with Velocity Matching Unit Selection (0x20F0.4).
Bit10: Velocity matching monitor of Status word 1 (0x2100) can monitor the state by this preset value during number-of-rotations setting selection.

0x606E: Velocity Window Time

Index	0x606E	After velocity attainment, sets up Time (timer) to be outputted VCMP monitor.	Object Code		Variable
Sub-Idx	Description		Data Type	Access / PDO	Initial Value
0x00	Velocity Window Time RS2-EtherCAT slave amplifier is applied immediately after arriving setting range.		Unsigned16	RW / No	0x0000
			Setting Range	0x0000 - 0x0000	
			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 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
			Setting Range	0x8000 - 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 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%		

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%		

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	0x80000000 - 0x7FFFFFFF		
			Unit	pulse		

0x607B:Position range Limit (Modulo value)

Index	0x607B	This value sets the range of position coordinates which can be put into effect in the position related operating mode. Both controller (position command) and driver (actual position) exchage the position data within the set range of coordinates.			Object Code Array	
Sub-Idx	Name/Description		Data Type	Access	PDO	Range (Initial Value)
0x00	Number of Entry		-	RO	No	0x2
0x01	Min position range limit [MINPLIM]		Integer32	RW	Possible	0x80000000
			Setting value	0x80000000−0x7FFFFFFF		
0x02	Max position range limit [MAXPLIM]		Integer32	RW	Possible	0x7FFFFFFF
			Setting value	0x80000000-0x7FFFFFFF		
Refer to the subsequent page for details.						

<Explanations for setting value>

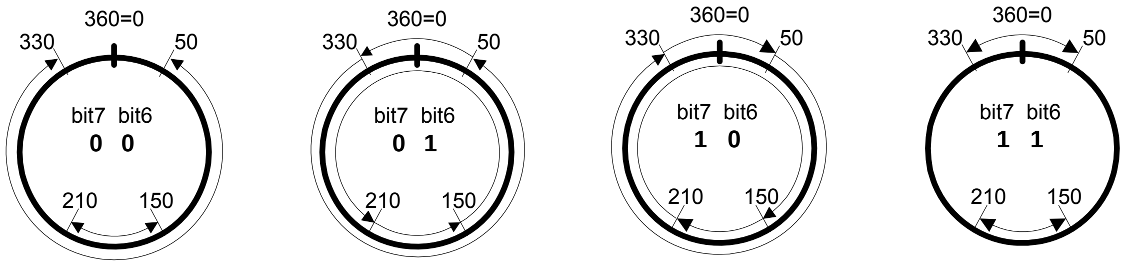
- It is a user-defined unit same as Target Position. In this servo amplifier this unit is 1 Pulse/LSB.
- In case Minimum position range limit = 0x00000000 and Maximum position range limit = 0x00000000, or Minimum position range limit = 0x80000000 and Maximum position range limit = 0x7FFFFFFF are set, position coordinate is recognized as “Linear coordinate”.
- When the setting doesn’t apply to the above-mentioned, position coordinate is recognized as “Modulo coordinate”. In this case, please set these value within the following range.
  (『Maximum position range limit』 − 『Minimum position range limit』 ≦ 2147483647 (0x7FFFFFFF))

<Linear coordinates (Linear axis)>

- The range of coordinates are …. Minimum value = 0x80000000, Maximum value = 0x7FFFFFFF. Please set software positional limit (0x607D) appropriately when you want to install the limitation in the range of movement within the range.

<Modulo coordinates (Rotary axis)>

- On reaching or exceeding maximum position range limit in positive rotation, the next coordinate value becomes the same value as minimum position range limit.
- On reaching or exceeding minimum position range limit in negative rotation, the next coordinate value becomes the same value as maximum position range limit.
- All position information that the controller sets should be modulo coordinates excluding in following operation mode. (Larger value than modulo can be set in “normal positioning mode” in the following figure.
  For example, as the move command from the actual position = 90° ,
  『Absolute move 630° = 360° (1 rotation) + positioning to 270° (result in relative move of 540°)』
  『Relative move 500° = 360° (1 rotation) + more 140° (result in positioning to 230° point)』
  However, actual position information is “Moduloed” value by 360° all the time.
- In modulo mode, bit 7 and 6 of object 0x60F2 defines the rotation direction of “Profile Position Mode”. Following figure shows the image of modulo coordinates in case Minimum position range limit = 0 and Maximum position range limit = 359.



normal (similar to linear axis)	only negative direction	only positive direction	optimized (shortest way)

Positioning example at the rotary axis

<Timing for which the set parameter is reflected in actual coordinates>

- In case the position range limit value set before has already beed stored in non-volatilememory of the servo amplifier.
  ⇒ Values are reflected in the position information immediately after the control power is turned ON.
- If the position range limit values are changed in the ESM state of Pre-operational.
  ⇒ Values are reflected when the ESM state is chaned from Pre-Operational to Safe-Operational.
- If the position range limit values are changed in the ESM state other than Pre-operational.
  ⇒ Because the values are reflected when the ESM state is chaned from Pre-Operational to Safe-Operational, please get down the ESM state to Pre-Operational once, then go up the state agein.

<Modulo value at the time of power activation>

- When you use a serial encoder by an absolute system, please use a modulo value by setup of the exponentiation of 2 of an encoder division number. In other setup, when it continues operating a servo motor in the fixed direction, a modulo value may be changed by control power re-injection .

0x607C: Home offset (homing mode)

<table>
<tr><td>Index</td><td>0x607C</td><td colspan="2">Normalizes homing position (mechanical origin) detected in homing mode by homing offset value.</td><td colspan="2">Object code</td><td>Variable</td></tr>
<tr><td>Sub-Idx</td><td colspan="2">Description</td><td>Data Type</td><td>Access</td><td>PDO</td><td>Initial Value</td></tr>
<tr><td rowspan="4">0x00</td><td colspan="2" rowspan="3">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.</td><td>Integer32</td><td>RW</td><td>Possible</td><td>0x00000000
(0 pulse)</td></tr>
<tr><td>Setting Range</td><td colspan="3">0x80000000-0x7FFFFFFF
(-2147483648-2147483647 Pulse)</td></tr>
<tr><td>Unit</td><td colspan="3">Pulse</td></tr>
<tr><td colspan="6">The actual position (0x6064) using homing position during homing is calculated as follows:

A） Actual position information is not used in homing position. (Calculated excluding present position.)
0x60E6＝0 (Absolute homing)

Actual position (0x6064) ＝ Homing offset (0x607C)

B）Actual position information is used. (Calculated including present position.)
0x60E6＝1 (Relative homing)

Actual position (0x6064) ＝ Present position ＋ Homing offset (0x607C)

✔ Homing mode cannot be used in the modes other than incremental system. (Except for homing method [35].) Applicable sensor code (OD：0x20FE S-Idx 2): 0x0000, 0x0101, 0x0201, 0x0301, 0x0401, 0x0501, and 0x0601
✔ Homing method [35] can be performed with all the sensor code.</td></tr>
</table>

0x607D:Software Position Limit

<table>
<tr><td>Index</td><td>0x607D</td><td colspan="4">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.</td><td>Object Code
Array</td></tr>
<tr><td>Sub-Idx</td><td colspan="2">Name/Description</td><td>Data Type</td><td>Access</td><td>PDO</td><td>Range
(Initial Value)</td></tr>
<tr><td>0x00</td><td colspan="2">Number of Entry</td><td>-</td><td>RO</td><td>No</td><td>0x2</td></tr>
<tr><td>0x01</td><td colspan="2">Minimum Position Limit [SMINLIM]
Unit is 1 pulse/LSB with RS2EtherCAT amplifier in the same user definition as a target position.</td><td>Integer32</td><td>RW</td><td>No</td><td>0x80000000
-
0x7FFFFFFF
(0)</td></tr>
<tr><td>0x02</td><td colspan="2">Maximum Position Limit [SMAXLIM]
Unit is 1 pulse/LSB with RS2EtherCAT amplifier in the same user definition as a target position.</td><td>Integer32</td><td>RW</td><td>No</td><td>0x80000000
-
0x7FFFFFFF
(0)</td></tr>
<tr><td></td><td colspan="6">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.</td></tr>
</table>

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	No	0x00
	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.	Setting Range	0x00 - 0xE0		

Bit7 : Position Polarity “0”: Command is multiplied by +1. “1”: Multiplied by -1. (only csp enable)

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

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

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

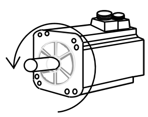
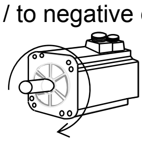
Bit5 : Torque (force) Polarity “0”: Command is multiplied by +1. “1”: Multiplied by -1.

- In Cycle sync. position mode (csp) 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),0x60FF Target velocity and 0x60B1 Velocity offset input value are multiplied by -1 with ”1”, and then command polarity is reversed.

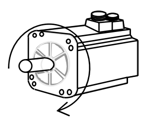
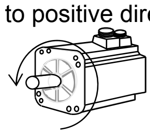
Bit4 - 0: Reserved

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

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

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

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

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

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	No	0xFFFF
		Setting Range	0x00000000 - 0x0000FFFF (0-4294967295 pps)		
		Unit	Pulse/sec		

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

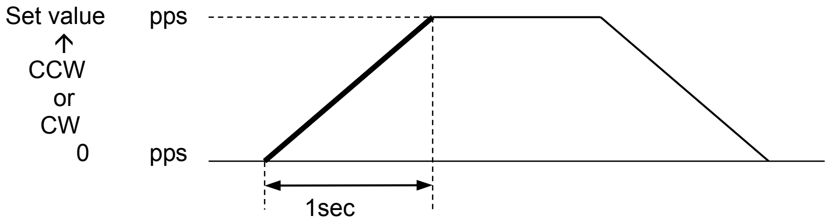
Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Profile velocity [PROVEL] The value is effective for both of CW and CCW.	Unsigned32	RW	Possible	0xFFFFFFFF
		Display range	0x00000000-0xFFFFFFFF (0-4294967295 pps)		
		unit	Pulse/sec		

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 [TVCACC] The parameters to give acceleration incline against preset velocity command, and set the rate of velocity per second.	Unsigned32	RW	Possible	0xFFFFFFFF
		Setting Range	0x00000000-0xFFFFFFFF (0-4294967295 pps^2)		
		Unit	Pulse/sec^2		

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



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

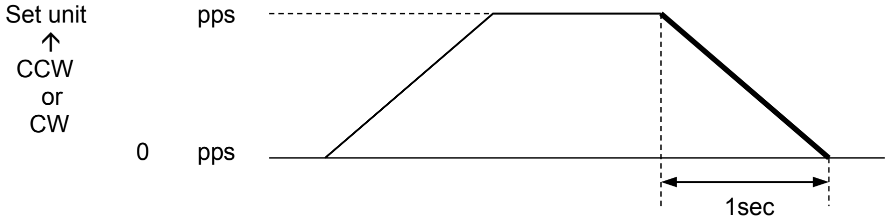
* At PV mode, with conversion of acceleration time constant per 1000min^{-1}, the value will be limited to 16000msec even if exceeded value is set.

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 [TVCDEC] The parameters to give deceleration incline against preset velocity command, and set the rate of velocity per second.	Unsigned32	RW	Possible	0xFFFFFFFF
		Setting Range	0x00000000-0xFFFFFFFF (0-4294967295 pps2)		
		Unit	Pulse/sec2		

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



Note) If value is set to “0”, the amplifier proceeds it as "1."
* At PV mode, with conversion of deceleration time constant per 1000min^{-1}, the value will be limited to 16000msec even if exceeded value is set.

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	No	0xFFFFFFFF
		Setting Range	0x00000000-0xFFFFFFFF (0-4294967295 pps2)		
		Unit	Pulse/sec2		

0x6086: Motion Profile Type

Index	0x6086	Indicates the setting type of Motion profile used for operating trajectory execution.	Object Code	Variable

Sub-Idx	Description	Data Type	Access	PDO	Initial Value
0x00	Motion Profile Type 0:Liner ramp (trapezoidal profile) 1:Not supported Sin^2 gradient 2:Not supported Jerk-free gradient 3:Not supported Jerk-limited gradient	Integer16	RW	No	0x0000
		Setting Range	0x0000-0x0000		

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. Also, if the bit is set to "0", the amplifier proceeds it as "1".		Unsigned32	RW	Possible	0xFFFFFFFF
			Setting range	0.1%-0xFFFFFFFF		
			Unit	0.1%/sec		

0x6098: Homing method

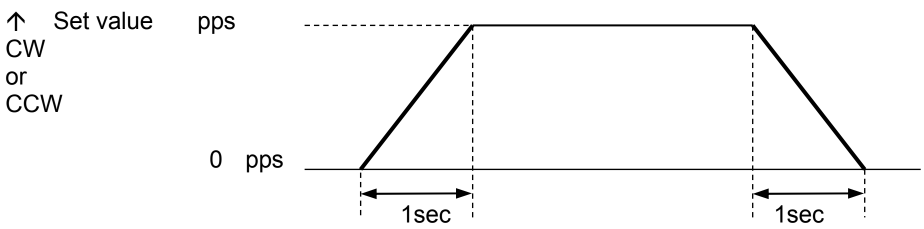
Index	0x6098	This object shall set the homing method that shall be used.		Object code		Variable
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Homing method [HOMETYP] Configured homing method (Origin return method) -128(0x80)-0(0x00) : Reserved 1 (0x01) : Homing on negative limit and index 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 15,16 (0x0F-0x10) : Reserved 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 23-32 (0x17-0x20) : Reserved 33 (0x21) : Homing on negative index pulse 34 (0x22) : Homing on positive index pulse 35 (0x23) : Homing on the current position 37-128 (0x25-0x7F) : Reserved		Integer8	RW	No	0x23 (35)
			Setting range	0x01-0x23 (1-35)		

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 (0-4294967295 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 (0-4294967295 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	No	0xFFFFFFFF
		Setting range	0x00000000-0xFFFFFFFF (0-4294967295 pps2)		
		Unit	Pulse/sec2		



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

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), 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	RO	Possible	0
		Display Range	0x80000000 - 0x7FFFFFFF (-2147483648-2147483647 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 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), 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 (csv), gives Offset to Torque (force) demand value.		Integer16	RW	Possible	0x0000 (0 %)
			Setting Range	0xEC78 - 0x1388 (-500.0 to 500.0 %)		
			Unit	0.1%/LSB		

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		
	bit0: Touch probe 1 switch enable 0: Switch off touch probe 1 1:Enable touch probe 1 bit1: Touch probe 1 Trigger operation 0:Trigger first event 1:continous bit2: Touch probe 1 Trigger selection 0:Trigger with touch probe 1 input 1:Trigger with position sensor index pulse bit4: Touch probe 1 positive edge enable 0:Switch off sampling at positive edge of touch probe 1 1:Enable sampling at positive edge of touch probe 1 bit5: Touch probe 1 negative edge enable 0:Switch off sampling at negative edge of touch probe 1 1:Enable sampling at negative edge of touch probe 1 bit8: Touch probe 2 switch enable 0: Switch off touch probe 2 1:Enable touch probe 2 bit9: Touch probe 2 Trigger operation 0:Trigger first event 1:continous bit10: Touch probe 2 Trigger selection 0:Trigger with touch probe 2 input 1:Trigger with position sensor index pulse※ bit12: Touch probe 2 positive edge enable 0:Switch off sampling at positive edge of touch probe 2 1:Enable sampling at positive edge of touch probe 2 bit13: Touch probe 2 negative edge enable 0:Switch off sampling at negative edge of touch probe 2 1:Enable sampling at negative edge of touch probe 2 ◆When using absolute sensor, the position data within single-turn shall be index pulse. Choose a trigger in bit2, and bit10 = 0:touch probe 1 / 2 input in the case of modulo mode.					

* Touch Probe 1 and Index Pulse Trigger Mode can be selected only when using incremental encoder.

0x60B9:Touch probe status

Index	0x60B9	Displays the status of the touch probe		Object Code		Variable
Sub-Idx	Description		Data Type	Access	PDO	Initial Value
0x00	Touch probe status [TPSTS]		Unsigned16	RW	Possible	0x0000
	Displays the status of the touch probe		Setting Range	0x0000-0xFFFF		
	bit0: Touch probe 1 switch enable monitor 0:Touch probe 1 is switched off 1:Touch probe 1 is enabled bit1: Touch probe 1 positive edge value stored monitor 0:Touch probe 1 no positive edge value stored 1:Touch probe 1 positive edge position stored bit2: Touch probe 1 negative edge value stored monitor 0:Touch probe 1 no negative edge value stored 1:Touch probe 1 negative edge position stored bit6: Touch probe 1 Trigger selection monitor (User-defined : for testing) 0:Trigger with touch probe 1 input mode 1:Position sensor index pulse trigger mode Bit7:Touch probe 1input monitor (User-defined : for testing) 0:Photocoupler is off (CONT1:OFF) 1:Photocoupler is on (CONT1:ON) bit8: Touch probe 2 switch enable monitor 0:Touch probe 2 is switched off 1:Touch probe 2 is enabled bit9: Touch probe 2 positive edge value stored monitor 0:Touch probe 2 no positive edge value stored 1:Touch probe 2 positive edge position stored bit10: Touch probe 2 negative edge value stored monitor 0:Touch probe 2 no negative edge value stored 1:Touch probe 2 negative edge position stored bit14: Touch probe 2 Trigger selection monitor (User-defined: for testing) 0:Trigger with touch probe 1 input mode 1:Position sensor index pulse trigger mode bit15: Touch probe 2input monitor (User-defined : for testing) 0:Photocoupler is off (CONT2:OFF) 1:Photocoupler is on (CONT2:ON)						

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

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

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

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

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

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

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

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

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

0x60C2: Complement Time Cycle

Index	0x60C2	The interpolation time period (sub-index 01) value shall be given in 10(interpolation time index) s(econd). The interpolation time index (sub-index 02) shall be dimensionless. Forther more this parametor is also written to Cycle Time Unit (sub-index 02 of Index 0x1C32)	Object Code	RECORD

Sub-Idx	Name/Description	Data Type	Access	PDO	Range (Initial Value)
0x00	Number of Entry	Unsigned8	RO	No	0x02
0x01	Complement Time Cycle Value Indicates the value of the time interval used for complement. Value makes a degree decision by 10^(complement time exponent) sec of S-Idx:0x02.	Unsigned8	RW	No	0x1 - 0xFA (1 - 250)
0x02	Complement Time Exponent Indicates the degree (what multiplies) of complement time. Examlple:Setting value 0xFC(-4) means 100μsec.	Integer8	RW	No	0xFA - 0xFD (10^{-6} – 10^{-3})

Setting Example:

Cycle Time (Index 0x1C32, Sub-Index 02)	Dir	Complement Time Cycle Value (Index 0x60C2,Sub-Index 01)	Complement Time Exponent (Index 0x60C2,Sub-Index 02)
0x0007A120 (500us)	←	50(0x32)	-5(0xFC)
	←→	5(0x05)	-4(0xFC)
0x000F4240 (1ms)	←→	1(0x01)	-3(0xFD)
	←	10(0x0A)	-4(0xFD)
	←	100(0x64)	-5(0xFD)
0x001E8480 (2ms)	←→	2(0x02)	-3(0xFD)
	←	20(0x14)	-4(0xFD)
	←	200(0xC8)	-5(0xFD)
0x003D0900 (4ms)	←→	4(0x04)	-3(0xFD)
	←	40(0x28)	-4(0xFC)
0x007A01200 (8ms)	←→	8(0x08)	-3(0xFD)
	←	80(0x50)	-4(0xFC)
0x00F42400 (16ms)	←→	16(0x10)	-3(0xFD)
	←	160(0xA0)	-4(0xFC)
0x01E8480(32ms)	←→	32(0x20)	-3(0xFD)
0x03D09000(64ms)	←→	64(0x40)	-3(0xFD)

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.	Unsigned16	RW	Possible	0x1388 (500.0%)
		Setting Range	0x0000 - 0x1388 (0 - 500.0%)		
		Unit	0.1%/LSB		
	*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.				

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 - 500.0 %)		
			Unit	0.1%/LSB		

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	0x15
0x01	Support homing method 1 [HSUP01] Supports Homing method 1 “Homing on negative limit switch and index pulse”	Unsigned16	RO	No	0x0301
0x02	Support homing method 2 [HSUP02] Supports Homing method 2” Homing on positive limit switch and negative index pulse”	Unsigned16	RO	No	0x0302
0x03	Support homing method 3 [HSUP03] Supports Homing method 3” Homing on positive home switch and negative index pulse”	Unsigned16	RO	No	0x0303
0x04	Support homing method 4 [HSUP04] Supports Homing method 4” Homing on positive home switch and positive index pulse”	Unsigned16	RO	No	0x0304
0x05	Support homing method 5 [HSUP05] Supports Homing method 5” Homing on negative home switch and positive index pulse”	Unsigned16	RO	No	0x0305
0x06	Support homing method 6 [HSUP06] Supports Homing method 6” Homing on negative home switch and negative index pulse”	Unsigned16	RO	No	0x0306
0x07	Support homing method 7 [HSUP07] Supports Homing method 7 “Homing on positive limit switch, homing on positive home switch and negative index pulse	Unsigned16	RO	No	0x0307
0x08	Support homing method 8 [HSUP08] Supports Homing method 8 “Homing on positive limit switch, homing on positive home switch and positive index pulse”	Unsigned16	RO	No	0x0308
0x09	Support homing method 9 [HSUP09] Supports Homing method 9 “Homing on positive limit switch, homing on negative home switch and negative index pulse”	Unsigned16	RO	No	0x0309
0x0A	Support homing method 10 [HSUP0A] Supports Homing method 10 “Homing on positive limit switch, homing on negative home switch and positive index pulse”	Unsigned16	RO	No	0x030A
0x0B	Support homing method 11 [HSUP0B] Supports Homing method 11” Homing on negative limit switch, homing on positive home switch and positive index pulse”	Unsigned16	RO	No	0x030B
0x0C	Support homing method 12 [HSUP0C] Supports Homing method 12 ” Homing on negative limit switch, homing on positive home switch and negative index pulse”	Unsigned16	RO	No	0x030C
0x0D	Support homing method13 [HSUP0D] Supports Homing method 13 ” Homing on negative limit switch, homing on negative home switch and positive index pulse”	Unsigned16	RO	No	0x030D
0x0E	Support homing method 14 [HSUP0E] Supports Homing method 14 ” Homing on negative limit switch, homing on negative home switch and negative index pulse”	Unsigned16	RO	No	0x030E

0x0F	Support homing method 15 [HSUP0F] Supports Homing method 17” Homing on negative limit switch.”	Unsigned16	RO	No	0x0311
0x10	Support homing method 16 [HSUP10] Supports Homing method 18 “Homing on positive limit switch.”	Unsigned16	RO	No	0x0312
0x11	Support homing method 17 [HSUP11] Supports Homing method 19” Homing on home switch (positive logic), stop in positive direction.”	Unsigned16	RO	No	0x0313
0x12	Support homing method 18 [HSUP12] Supports Homing method 20” Homing on home switch (positive logic), stop in negative direction.”	Unsigned16	RO	No	0x0314
0x13	Support homing method 19 [HSUP13] Supports Homing method 21 ”Homing on home switch (negative logic), stop in positive direction.”	Unsigned16	RW	No	0x0315
0x14	Support homing method 20 [HSUP14] Supports Homing method 22 ” Homing on home switch (negative logic), stop in negative direction.”	Unsigned16	RW	No	0x0316
0x15	Support homing method 21 [HSUP15] Supports Homing method 33 ” Homing on index pulse in negative direction.”	Unsigned16	RW	No	0x0321
0x16	Support homing method 22 [HSUP16] Supports Homing method 34 ” Homing on index pulse in positive direction.”	Unsigned16	RW	No	0x0322
0x17	Support homing method 23 [HSUP17] Support Honing method 35 ”Homing position on actual position”	Unsigned16	RW	No	0x0323

MSB			LSB
Reserved	absolute support	relative support	Supported homing method
15...10	9	8	7...0

Bit9: Absolute homing method support
0:Unsupported 1: Supported

Bit8: Relative value homing support
0:Unsupported 1: Supported

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

0x60E6: Actual position calculation method

Index	0x60E6	Defines actual position (0x6064) calculation method in homing procedure.	Object code		Variable
Sub-Idx	Description		Data Type	Access	PDO	Initial value

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Actual position calculation method [PMON]	Unsigned8	RW	No	0x00
	0: Clculates excluding present position. (Present position information is not usedin home position.)	Setting range	0x00 - 0x01		
	Actual position (0x6064) = Homing offset (0x607C) 1: Calculates including present position. (Present position information is used. Actual position (0x6064) = Present position + Homing offset (0x607C) 2 to 255: Reserved				

0x60F2: Positioning option code

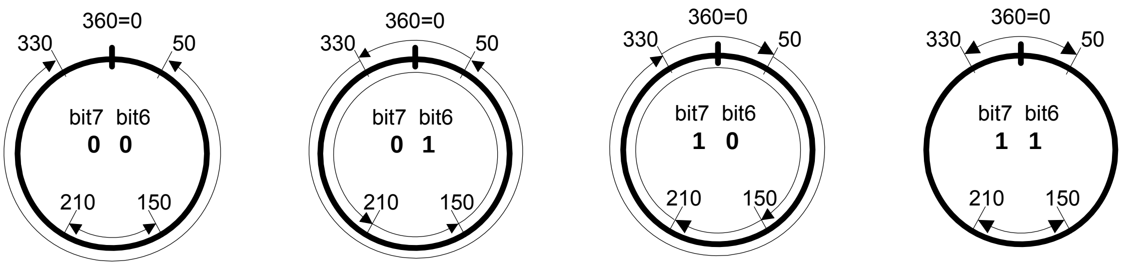
Index	0x60F2	Set the behavior of positioning.			Object Code		Variable
Sub-Idx	Description			Data Type	Access	PDO	Initial Value
0x00	Positioning option code ［POSOP］ See table below for definition of bit 7 and 6. Set 0 except bit 7 and 6.			Unsigned16	RW	Possible	0x0000
				Setting Range	0x0000～0xFFFF		

MSB LSB

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

bit7	bit6	Rotation direction definition on rotation axis
0	0	Standard positioning same as straight axis: 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.

Image of modulo coordinate in case Minimum position range limit = 0 and Maximum position range limit = 359



normal (similar to linear axis)

only negative direction

only positive direction

optimized (shortest way)

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

Index	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		

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, 2 and HWGOFF1. 1: Photocoupler is on. * Reflection to digital input has about 4msec delay from hardware input.	Unsigned32	RO	Possible	-
		Display range	0x00000000-0xFFFFFFFF		

MSB ■ 2-versatile input LSB

Reserved	HWGOFF2 (※CONT4)	HWGOFF1 (※CONT3)	CONT2	CONT1	Reserved	EMR	Home	Positive limit	Negative limit
31･･･20	19	18	17	16	15･･･4	3	2	1	0

MSB ■6-versatile input LSB

Res	HWGOFF2 (※CONT8)	HWGOFF1 (※CONT7)	CONT6	CONT5	CONT4	CONT3	CONT2	CONT1	Res	EMR	Home	Positive limit	Negative limit
31･･24	23	22	21	20	19	18	17	16	15･･4	3	2	1	0

Note) CONT4 is available only for the amplifier that is unsupported “Hardware Gate Off”

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	Unsigned32	RW	Possible	-
		Display range	0x000000-0xFFFFFFFF		
	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.				

MSB LSB

Reserved	FOUT2	FOUT1	Reserved	Set brake
31 - 18	17	16	15...3	0

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		

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	RO	No	0x103AD
			Display range	0x103AD-0x103AD		

MSB LSB

-	-	cst	csv	csp	ip	hm	-	tq	pv	vl	pp
31 - 16	15 - 10	9	8	7	6	5	4	3	2	1	0

bit0:pp	Profile Position mode
bit1:vl	Velocity mode
bit2:pv	Profile Velocity mode
bit3:tq	Torque profile mode
bit5:hm	Homing mode
bit6:ip	Interpolated position mode
bit7:csp	Cycle synchronous Position Mode
bit8:csv	Cycle synchronous Velocity Mode
bit9 :cst	Cycle synchronous Torque Mode

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
0x2000	0x00	○	○	○	○	Control Word 1	Unsigned16	RW	Possible	#
0x2001	0x00	○	○	○	○	Parameter Select	Unsigned16	RW	Possible	#
0x2002	0x00	-	-	-	-	Auto-tuning settings	Unsigned8	RO	No	-
↑	0x01	○	○	○	○	Auto-Tuning Mode	Unsigned8	RW	No	#
↑	0x02	○	○	○	○	Auto-Tuning Characteristic	Unsigned8	RW	No	#
↑	0x03	○	○	○	○	Auto-Tuning Response	Unsigned8	RW	No	#
0x2003	0x00	○	×	×	×	Position Command Smoothing Constant	Unsigned16	RW	No	#
0x2004	0x00	○	×	×	×	Position Command Filter	Unsigned16	RW	No	#
0x2005	0x00	-	-	-	-	Position Loop Proportional Gain 1	Unsigned8	RO	No	-
↑	0x01	○	×	×	×	Position Loop Proportional Gain 1	Unsigned16	RW	Possible	#
↑	0x02	○	×	×	×	Position Loop Proportional Gain 2	Unsigned16	RW	No	#
↑	0x03	○	×	×	×	Position Loop Proportional Gain 3	Unsigned16	RW	No	#
↑	0x04	○	×	×	×	Position Loop Proportional Gain 4	Unsigned16	RW	No	#
0x2006	0x00	-	-	-	-	Position Integral Time Constant	Unsigned8	RO	No	-
↑	0x01	○	×	×	×	Position Integral Time Constant 1	Unsigned16	RW	Possible	#
↑	0x02	○	×	×	×	Position Integral Time Constant 2	Unsigned16	RW	No	#
↑	0x03	○	×	×	×	Position Integral Time Constant 3	Unsigned16	RW	No	#
↑	0x04	○	×	×	×	Position Integral Time Constant 4	Unsigned16	RW	No	#
0x2007	0x00	○	×	×	×	Higher Tracking Control Position Compensation Gain	Unsigned16	RW	No	#
0x2008	0x00	-	-	-	-	Feed forward compensation parameter	Unsigned8	RO	No	-
↑	0x01	○	×	×	×	Feed Forward Gain	Unsigned16	RW	Possible	#
↑	0x02	○	×	×	×	Feed Forward Filter	Unsigned16	RW	No	#
0x2009	0x00	○	○	×	○	Velocity Command Filter	Unsigned16	RW	No	#
0x200A	0x00	○	○	×	○	Velocity Feedback Filter	Unsigned16	RW	No	#
0x200B	0x00	-	-	-	-	Velocity Loop Proportional Gain	Unsigned8	RO	No	-
↑	0x01	○	○	×	○	Velocity Loop Proportional Gain 1	Unsigned16	RW	Possible	#
↑	0x02	○	○	×	○	Velocity Loop Proportional Gain 2	Unsigned16	RW	No	#
↑	0x03	○	○	×	○	Velocity Loop Proportional Gain 3	Unsigned16	RW	No	#
↑	0x04	○	○	×	○	Velocity Loop Proportional Gain 4	Unsigned16	RW	No	#
0x200C	0x00	-	-	-	-	Velocity Loop Integral Time Constant	Unsigned8	RO	No	-
↑	0x01	○	○	×	○	Velocity Loop Integral Time Constant 1	Unsigned16	RW	Possible	#
↑	0x02	○	○	×	○	Velocity Loop Integral Time Constant 2	Unsigned16	RW	No	#
↑	0x03	○	○	×	○	Velocity Loop Integral Time Constant 3	Unsigned16	RW	No	#
↑	0x04	○	○	×	○	Velocity Loop Integral Time Constant 4	Unsigned16	RW	No	#
0x200D	0x00	-	-	-	-	Load Inertia Moment Ratio	Unsigned8	RO	No	-
↑	0x01	○	○	○	○	Load Inertia Moment Ratio 1	Unsigned16	RW	Possible	#
↑	0x02	○	○	○	○	Load Inertia Moment Ratio 2	Unsigned16	RW	No	#
↑	0x03	○	○	○	○	Load Inertia Moment Ratio 3	Unsigned16	RW	No	#
↑	0x04	○	○	○	○	Load Inertia Moment Ratio 4	Unsigned16	RW	No	#

○: Supported, ×: Not supported

FP: Function Group “Position” FV: Function Group “ Velocity “ FT: Function Group ” Torque (force) ”
FH: Function Group ”Homing mode”

Manufacturer Specific Area (No.2)

Index	S-Idx	FP	FV	FT	FH	Name	Data Type	Dir	PDO Mapping	Update
0x200E	0x00	○	○	×	○	Higher Tracking Control Velocity Compensation Gain	Unsigned16	RW	No	#
0x200F	0x00	-	-	-	-	Acceleration Feedback Compensation	Unsigned8	RO	No	-
↑	0x01	○	○	×	○	Acceleration Feedback Gain	Integer16	RW	No	#
↑	0x02	○	○	×	○	Acceleration Feedback Filter	Unsigned16	RW	No	#
0x2011	0x00	-	-	-	-	Torque (force) Command Filter	Unsigned8	RO	No	-
↑	0x01	○	○	○	○	Torque (force) Command Filter 1	Unsigned16	RW	Possible	#
↑	0x02	○	○	○	○	Torque (force) Command Filter 2	Unsigned16	RW	No	#
↑	0x03	○	○	○	○	Torque (force) Command Filter 3	Unsigned16	RW	No	#
↑	0x04	○	○	○	○	Torque (force) Command Filter 4	Unsigned16	RW	No	#
0x2012	0x00	-	-	-	-	FF Vibration Suppressor Frequency	Unsigned8	RO	No	-
↑	0x01	○	×	×	×	FF Vibration Suppressor Frequency 1	Unsigned16	RW	Possible	#
↑	0x02	○	×	×	×	FF Vibration Suppressor Frequency 2	Unsigned16	RW	No	#
↑	0x03	○	×	×	×	FF Vibration Suppressor Frequency 3	Unsigned16	RW	No	#
↑	0x04	○	×	×	×	FF Vibration Suppressor Frequency 4	Unsigned16	RW	No	#
0x2013	0x00	○	○	×	○	Velocity Command Notch Filter	Unsigned16	RW	No	#
0x2014	0x00	-	-	-	-	Torque (force) Command Notch Filter	Unsigned8	RO	No	-
↑	0x01	○	○	○	○	Torque (force) Command Notch Filter A	Unsigned16	RW	No	#
↑	0x02	○	○	○	○	Torque (force) Command Notch Filter B	Unsigned16	RW	No	#
↑	0x03	○	○	○	○	Torque (force) Command Notch Filter C	Unsigned16	RW	No	#
↑	0x04	○	○	○	○	Torque (force) Command Notch Filter D	Unsigned16	RW	No	#
↑	0x05	○	○	○	○	Torque (force) Command Notch Filter E	Unsigned16	RW	No	#
0x2015	0x00	-	-	-	-	High setting control settings	Unsigned8	RO	No	-
↑	0x01	○	×	×	×	Acceleration Compensation	Unsigned16	RW	No	#
↑	0x02	○	×	×	×	Deceleration Compensation	Unsigned16	RW	No	#
↑	0x03	○	×	×	×	Command Velocity Low-pass Filter	Unsigned16	RW	No	#
↑	0x04	○	×	×	×	Command Velocity Threshold	Unsigned16	RW	No	#
0x2016	0x00	-	-	-	-	Observer Parameter	Unsigned8	RO	No	-
↑	0x01	○	○	×	○	Observer Characteristic	Unsigned8	RW	No	#
↑	0x02	○	○	×	○	Observer Compensation Gain	Unsigned16	RW	No	#
↑	0x03	○	○	×	○	Observer Output Filter	Unsigned16	RW	No	#
↑	0x04	○	○	×	○	Observer Notch Filter	Unsigned16	RW	No	#
↑	0x05	○	○	×	○	Observer Load Inertia Ratio	Unsigned16	RW	No	#
↑	0x06	○	○	×	○	Observer Loop Proportional Gain	Unsigned16	RW	No	#
↑	0x07	○	○	×	○	Observer Load Torque (force) Filter	Unsigned16	RW	No	#
0x2017	0x00	-	-	-	-	Model Control Gain	Unsigned8	RO	No	-
↑	0x01	○	×	×	×	Model Control Gain 1	Unsigned16	RW	Possible	#
↑	0x02	○	×	×	×	Model Control Gain 2	Unsigned16	RW	No	#
↑	0x03	○	×	×	×	Model Control Gain 3	Unsigned16	RW	No	#
↑	0x04	○	×	×	×	Model Control Gain 4	Unsigned16	RW	No	#
0x2018	0x00	○	×	×	×	Overshoot Suppressor Filter	Unsigned16	RW	No	#
0x2019	0x00	-	-	-	-	Model Control Antiresonance Frequency	Unsigned8	RO	No	-
↑	0x01	○	×	×	×	Model Control Antiresonance Frequency 1	Unsigned16	RW	Possible	#
↑	0x02	○	×	×	×	Model Control Antiresonance Frequency 2	Unsigned16	RW	No	#
↑	0x03	○	×	×	×	Model Control Antiresonance Frequency 3	Unsigned16	RW	No	#
↑	0x04	○	×	×	×	Model Control Antiresonance Frequency 4	Unsigned16	RW	No	#
0x201A	0x00	-	-	-	-	Model Control Resonance Frequency	Unsigned8	RO	No	-
↑	0x01	○	×	×	×	Model Control Resonance Frequency 1	Unsigned16	RW	Possible	#
↑	0x02	○	×	×	×	Model Control Resonance Frequency 2	Unsigned16	RW	No	#
↑	0x03	○	×	×	×	Model Control Resonance Frequency 3	Unsigned16	RW	No	#
↑	0x04	○	×	×	×	Model Control Resonance Frequency 4	Unsigned16	RW	No	#
0x201B	0x00	○	○	×	○	Gain Switching Filter	Unsigned16	RW	No	#

○: Supported, ×: Not supported

Manufacturer Specific Area (No.3)

Index	S-Idx	FP	FV	FT	FH	Name	Data Type	Dir	PDO Mapping	Update
0x201C	0x00	○	○	×	○	Internal Velocity Command limit	Unsigned32	RW	No	#
0x201D	0x00	○	×	×	×	Position Command error 1 level	Unsigned32	RW	No	#
0x201E	0x00	○	○	×	○	Sequence Operation Torque (force) Limit Value	Unsigned16	RW	No	#
0x201F	0x00	○	×	×	×	Near Range	Unsigned32	RW	No	#
0x2020	0x00	○	○	×	○	Speed Zero Range	Unsigned16	RW	No	#
0x2021	0x00	○	○	×	○	Low Speed Range	Unsigned16	RW	No	#
0x2022	0x00	○	○	×	○	Speed Attainment Setting (high-speed setting)	Unsigned16	RW	No	#
0x2023	0x00	-	-	-	-	Analog Monitor Select Output	Unsigned8	RO	No	-
↑	0x01	○	○	○	○	Analog Monitor Select Output 1	Unsigned8	RW	No	#
↑	0x02	○	○	○	○	Analog Monitor Select Output 2	Unsigned8	RW	No	#
↑	0x03	○	○	○	○	Analog Monitor Output Polarity	Unsigned8	RW	No	#
0x2024	0x00	○	○	○	○	Delay Time of Engaging Holding Brake (Holding Brake Holding Delay Time)	Unsigned16	RW	No	#
0x2025	0x00	○	○	○	○	Delay Time of Releasing Holding Brake (Holding Brake Release Delay Time)	Unsigned16	RW	No	#
0x2026	0x00	○	○	○	○	Brake Operation Beginning Time	Unsigned16	RW	No	#
0x2027	0x00	○	○	○	○	Power Failure Detection Delay Time	Unsigned16	RW	No	#
0x2028	0x00	○	×	×	×	Excessive Deviation Warning Level	Unsigned16	RW	No	#
0x2029	0x00	○	○	○	○	Overload Warning Level	Unsigned16	RW	No	#
0x202A	0x00	○	○	○	○	Speed Matching Width	Unsigned16	RW	No	#
0x202B	0x00	○	○	○	○	Torque (force)Command Filter Characteristic	Unsigned8	RW	No	#
0x202C	0x00	○	×	×	×	Feed Forward Filter, Depth Selection	Unsigned8	RW	No	#
0x202D	0x00	-	-	-	-	Torque (force) Command, Notch Filter Feature	Unsigned8	RW	No	-
↑	0x01	○	○	○	○	TCNFILA, Low Frequency Phase Delay Improvement	Unsigned8	RO	No	#
↑	0x02	○	○	○	○	T (force)CNFILB, Depth Selection	Unsigned8	RW	No	#
↑	0x03	○	○	○	○	T (force)CNFILC, Depth Selection	Unsigned8	RW	No	#
↑	0x04	○	○	○	○	T (force)CNFILD, Depth Selection	Unsigned8	RW	No	#
↑	0x05	○	○	○	○	T (force)CNFILE, Depth Selection	Unsigned8	RW	No	#
0x202E	0x00	○	○	○	○	Torque attainement setting	Unsigned16	RW	No	#
0x203D	0x00	-	-	-	-	Amplifier temperature warning level	Unsigned8	RO	No	-
↑	0x01	○	○	○	○	Amplifier temperature warning high level setting	Integer16	RW	No	#
↑	0x02	○	○	○	○	Amplifier temperature warning low level setting	Integer16	RW	No	#

○: Supported, ×: Not supported

Manufacturer Specific Area (No.4)

Index	S-Idx	FP	FV	FT	FH	Name	Data Type	Dir	PDO Mapping	Update
0x20F0	0x00	-	-	-	-	Amplifier Function Selection	Unsigned8	RO	No	-
↑	0x01	○	○	○	○	Limit behavior	Unsigned8	RW	No	#
↑	0x02	○	×	×	×	Positioning Method	Unsigned8	RW	No	&
↑	0x03	○	×	×	×	In position / Position deviation monitor	Unsigned8	RW	No	#
↑	0x04	○	○	○	○	Velocity Window Unit Output	Unsigned8	RW	No	#
↑	0x05	○	×	×	×	Deviation Clear	Unsigned8	RW	No	#
↑	0x06	○	○	○	○	Torque (force) attainment function selection	Unsigned8	RW	No	●
0x20F1	0x00	-	-	-	-	Sensor Function Selection	Unsigned8	RO	No	-
↑	0x01	○	○	○	○	Serial Encoder Clear Function	Unsigned8	RW	No	#
↑	0x02	○	○	○	○	Incremental Encoder, Digital Filter	Unsigned8	RW	No	#
↑	0x03	○	×	×	×	External Pulse Encoder, Digital Filter	Unsigned8	RW	No	#
↑	0x04	○	×	×	×	External Pulse Encoder Polarity	Unsigned8	RW	No	&
↑	0x05	○	○	○	○	CS offset onlinear encoder	Unsigned16	RW	No	■
↑	0x06	○	○	○	○	CS normalization offset of phase Z on linear encoder	Unsigned16	RW	No	■
↑	0x07	○	○	○	○	Polarity selection on linear encoder	Unsigned8	RW	No	■
↑	0x08	○	○	○	○	Magnetic pole position detecting frequency	Unsigned16	RW	No	■
0x20F2	0x00	-	-	-	-	Amplifier Alarm Detect Selection	Unsigned8	RO	No	-
↑	0x01	○	○	○	○	Main Circuit Under-voltage Detection	Unsigned8	RW	No	#
↑	0x02	○	○	○	○	Velocity Control Alarm Detection	Unsigned8	RW	No	#
↑	0x03	○	○	○	○	Velocity Feedback Alarm Detection	Unsigned8	RW	No	#
↑	0x04	○	○	○	○	Communication Frame Error Detection	Unsigned8	RW	No	#
↑	0x05	○	○	○	○	Communication Timeout Detection	Unsigned8	RW	No	#
0x20F3	0x00	-	-	-	-	Position Control Selection	Unsigned8	RW	No	&
↑	0x01	○	×	×	×	Model Control Characteristic	Unsigned8	RW	No	&
↑	0x02	○	×	×	×	Position Loop Encoder Selection	Unsigned8	RW	No	&
0x20F4	0x00	○	○	○	○	Servo Loop Delay Time	Unsigned8	RW	No	&
0x20F5	0x00	○	○	○	○	Torque (force) Limit at Power Supply Shortage	Unsigned8	RW	No	#
0x20F8	0x00	-	-	-	-	General Purpose Input Setting	Unsigned8	RO	No	-
↑	0x01	○	○	○	○	Positive Limit Switch Function (Positive Over-Travel)	Unsigned8	RW	No	#
↑	0x02	○	○	○	○	Negative Limit Switch Function (Negative Over-Travel)	Unsigned8	RW	No	#
↑	0x03	○	○	○	○	External Error Input Function	Unsigned8	RW	No	#
↑	0x04	○	○	○	○	Main Power Discharge Function	Unsigned8	RW	No	#
↑	0x05	○	○	○	○	Emergency Sop Function	Unsigned8	RW	No	#
↑	0x06	○	○	○	○	Detecton function of magnetic pole position	Unsigned8	RW	No	●
0x20F9	0x00	-	-	-	-	General Purpose Output Setting	Unsigned8	RO	No	-
↑	0x01	○	○	○	○	General Purpose Output 1	Unsigned8	RW	No	#
↑	0x02	○	○	○	○	General Purpose Output 2	Unsigned8	RW	No	#
0x20FA	0x00	○	○	○	○	Extend Station Alias	Unsigned8	RO	No	-
↑	0x01	○	○	○	○	Extended unit address	Unsigned8	RW	No	●
↑	0x02	○	○	○	○	Extended Alias Number	Unsigned8	RW	No	●
0x20FB	0x00	○	○	○	○	Torque command addition during servo-on	Signed16	RW	No	&
0x20FD	0x00	-	-	-	-	Amplifier System Selection	Unsigned8	RO	No	-
↑	0x01	○	○	○	○	Main power input type	Unsigned8	RW	No	&
↑	0x02	○	○	○	○	Regenerative Resistor Selection	Unsigned8	RW	No	&
↑	0x03	○	○	○	○	Setup Communication Baud Rate	Unsigned8	RW	No	&
0x20FE	0x00	○	○	○	○	Combination Motor Code	Unsigned16	RW	No	&
0x20FF	0x00	○	○	○	○	Combination Encoder Selection	Unsigned8	RO	No	-
↑	0x01	○	○	○	○	Encoder Resolution Setting	Unsigned16	RW	No	&
↑	0x02	○	○	○	○	Encoder Type	Unsigned16	RW	No	&
↑	0x03	○	×	×	×	External Encoder Resolution	Unsigned32	RW	No	&

○: Supported, ×: Not supported

Manufacturer Specific Area (No.5)

Index	S-Idx	FP	FV	FT	FH	Name	Data Type	Dir	PDO Mapping	Update
0x2100	0x00	○	○	○	○	Status Word 1	Unsigned16	RO	Possible	-
0x2101	0x00	-	-	-	-	Amplifier error field	Unsigned8	RO	No	-
↑	0x01	○	○	○	○	Alarm actual 1	Unsigned8	RO	Possible	-
↑	0x02	○	○	○	○	Alarm actual 2	Unsigned8	RO	Possible	-
↑	0x03	○	○	○	○	Alarm actual 3	Unsigned8	RO	Possible	-
↑	0x04	○	○	○	○	Alarm actual 4	Unsigned8	RO	Possible	-
0x2102	0x00	-	-	-	-	Description of Alarm Trace	Unsigned8	RO	No	-
↑	0x01	○	○	○	○	Now Status	Unsigned16	RO	Possible	-
↑	0x02	○	○	○	○	1st Latest Alarm	Unsigned16	RO	Possible	-
↑	0x03	○	○	○	○	2nd Latest Alarm	Unsigned16	RO	Possible	-
↑	0x04	○	○	○	○	3rd Latest Alarm	Unsigned16	RO	Possible	-
↑	0x05	○	○	○	○	4th Latest Alarm	Unsigned16	RO	Possible	-
↑	0x06	○	○	○	○	5th Latest Alarm	Unsigned16	RO	Possible	-
↑	0x07	○	○	○	○	6th Latest Alarm	Unsigned16	RO	Possible	-
↑	0x08	○	○	○	○	7th Latest Alarm	Unsigned16	RO	Possible	-
0x2103	0x00	-	-	-	-	Warning Status	Unsigned8	RO	No	-
↑	0x01	○	○	○	○	Warning Monitor	Unsigned16	RO	Possible	-
↑	0x02	○	○	○	○	Warning mask Selection	Unsigned16	RO	No	#
0x2104	0x00	-	-	-	-	Actual Gain Value Monitor	Unsigned18	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	-
0x210C	0x00	○	○	○	○	Home Index Position Detection Value	Integer32	RO	Possible	-

○: Supported, ×: Not supported

Manufacturer Specific Area (No.6)

Index	S-Idx	FP	FV	FT	FH	Name	Data Type	Dir	PDO Mapping	Update
0x2110	0x00	-	-	-	-	Internal Control Cycle Position Actual Value	Unsigned8	RO	No	-
↑	0x01	○	○	○	○	Internal Control Cycle Actual Position 1 (125us Latest)	Integer32	RO	Possible	-
↑	0x02	○	○	○	○	Internal Control Cycle Actual Position 2 (250us Latest)	Integer32	RO	Possible	-
↑	0x03	○	○	○	○	Internal Control Cycle Actual Position 3 (375us Latest)	Integer32	RO	Possible	-
0x2111	0x00	-	-	-	-	Internal Control Cycle Actual Velocity	Unsigned8	RO	No	-
↑	0x01	○	○	○	○	Internal Control Cycle Actual Velocity 1 (125us Latest)	Integer32	RO	Possible	-
↑	0x02	○	○	○	○	Internal Control Cycle Actual Velocity 2 (250us Latest)	Integer32	RO	Possible	-
↑	0x03	○	○	○	○	Internal Control Cycle Actual Velocity 3 (375us Latest)	Integer32	RO	Possible	-
0x2112	0x00	-	-	-	-	Internal Control Cycle Actual Torque (force)	Unsigned8	RO	No	-
↑	0x01	○	○	○	○	Internal Control Cycle Actual Torque (force) 1 (125us Latest)	Integer16	RO	Possible	-
↑	0x02	○	○	○	○	Internal Control Cycle Actual Torque (force) 2 (250us Latest)	Integer16	RO	Possible	-
↑	0x03	○	○	○	○	Internal Control Cycle Actual Torque (force) 3 (375us Latest)	Integer16	RO	Possible	-
0x2113	0x00	-	-	-	-	Minimum Communication Cycle Actual Position	Unsigned8	RO	No	-
↑	0x01	○	○	○	○	Minimum Communication Cycle Actual Position 1 (0.5ms Latest)	Integer32	RO	Possible	-
↑	0x02	○	○	○	○	Minimum Communication Cycle Actual Position 2 (1ms Latest)	Integer32	RO	Possible	-
↑	0x03	○	○	○	○	Minimum Communication Cycle Actual Position 3 (1.5ms Latest)	Integer32	RO	Possible	-
0x2114	0x00	-	-	-	-	Minimum Communication Cycle Actual Velocity	Unsigned8	RO	No	-
↑	0x01	○	○	○	○	Minimum Communication Cycle Actual Velocity 1 (0.5ms Latest)	Integer32	RO	Possible	-
↑	0x02	○	○	○	○	Minimum Communication Cycle Actual Velocity 2 (1ms Latest)	Integer32	RO	Possible	-
↑	0x03	○	○	○	○	Minimum Communication Cycle Actual Velocity 3 (1.5ms Latest)	Integer32	RO	Possible	-
0x2115	0x00	-	-	-	-	Minimum Communication Cycle Actual Torque (force)	Unsigned8	RO	No	-
↑	0x01	○	○	○	○	Minimum Communication Cycle Actual Torque (force) 1 (0.5ms Latest)	Integer16	RO	Possible	-
↑	0x02	○	○	○	○	Minimum Communication Cycle Actual Torque (force) 2 (1ms Latest)	Integer16	RO	Possible	-
↑	0x03	○	○	○	○	Minimum Communication Cycle Actual Torque (force) 3 (1.5ms Latest)	Integer16	RO	Possible	-
0x2116	0x00	○	○	○	○	Actual Velocity Value (Velocity Monitor) 2	Integer32	RO	Possible	-
0x211F	0x00	○	○	○	○	Digital inputs 2	Unsigned16	RO	Possible	-
0x21FD	0x00	○	○	○	○	Firmware Identify Number	Unsigned64	RO	No	—
0x21FE	0x00	○	○	○	○	Combination Motor Code Monitor	Unsigned16	RO	No	—
0x21FF	0x00	—	—	—	—	Combination Encoder Selection Monitor	Unsigned8	RO	No	—
↑	0x01	○	○	○	○	Encoder Resolution Setting Monitor	Unsigned16	RO	No	—
↑	0x02	○	○	○	○	Encoder Type Monitor	Unsigned16	RO	No	—

○: Supported, ×: Not supported

2) Control Command Parameter

0x2000: Control Word 1

Index	0x2000	Manufacturer-specific object for the servo amplifier control.		Object Code		Variable
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Control Woad1 [CWORD1] Enables various functions. 0:disabled 1:enabled		Unsigned16	RW	Possible	-

MSB LSB

discen	intpodi	vcmpen	icmpen	vcmlim	pcon	ppcon	pclr
7	6	5	4	3	2	1	0

bit0:clearance of location deviation enabled [PCLR]
Clear the location deviation.

bit1:proportional positioning control enabled [PPCON]
Clear the integral terms of the positioning controller. It is enabled at "1" and proportionally controlled.

bit2:proportional-speed control enabled [PCON]
Clear the integral terms of the positioning controller. It is enabled at "1" and proportionally controlled.

Bit3：Velocity Limit Command ［VCMLIM］
Limit the internal speed command at the velocity limit command value.

bit4:torque addition enabled [ICMPEN]
Add the torque addition value to the torque command. Enabled at “1".

bit5:speed addition enabled [VCMPEN]
Add the speed addition value to the command. Enabled at “1".

bit6:Position-complement disabled(csp only) [INTPODI]
At the enabled setting, when position commands cannot be received cyclically(SM2 event not received), keep operating using the previous amount of travel.

bit7:compulsory discharge enabled [DISCEN]
When the main circuit is off, the main circuit charged voltage is compulsorily discharged at “1”.

MSB LSB

Trqadd	Res	Res	Res	obscon	vibcon	htrv	htrp
15	14	13	12	11	10	9	8

bit8:highly compliant position compensation enabled [HTRP]
Highly compliant position compensation is performed at “1.”

bit9:highly compliant speed compensation enabled [HTRV]
Highly compliant speed compensation is performed at “1.”

bit10:FF vibration control enabled [VIBCON]
Vibration control is performed at “1.”

bit11:disturbance observer compensation enabled[OBSCON]
Observer compensation is performed at “1.”

bit12:
Reserved

bit13:
Reserved

bit14:
Reserved

bit15： [Trqadd]
Real time setting enabled at the torque command addition during servo-on
SDO set value will be valid with real time, at "1".

* The initial value is set as "0x0040" for the end of the part number "5."

0x2001: Parameter Select

Index	0x2001	Controls the selection of various parameters.		Object Code		Variable
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Parameter Select [PARSEL] Enables various functions.		Unsigned16	RW	Possible	-

MSB / LSB

-	gc	supfsel	mdlfsl
7 6	5 4	3 2	1 0

bit1-0:model suppression frequency switch selection* [MDLFSEL]
Under the model control, resonance/anti-resonance frequency 1-4 to be used is selected.
Use the setting: bit1, 0=0, 0 frequency 1 Sub-Index:0x01.
Use the setting: bit1, 0=0,1 frequency 2 Sub-Index:0x02.
Use the setting: bit1, 0=1, 0 frequency 3 Sub-Index:0x02.
Use the setting: bit1, 0=1, 1 frequency 4 Sub-Index:0x04.

bit3-2:FF suppression frequency selection [SUPFSEL]
The suppression frequency value to be used is selected from sub-Index 1-4.
Use the setting: bit3, 2=0, 0 frequency 1 Sub-Index:0x01.
Use the setting: bit3, 2=0, 1 frequency 2 Sub-Index:0x02.
Use the setting: bit3, 2=1, 0 frequency 3 Sub-Index:0x02.
Use the setting: bit3, 2=1, 1 frequency 4 Sub-Index:0x04.

bit5-4：Gain change selection ［GC］
The value to be used is selected by various gain settings from Sub-Index 1-4.
Use the setting bit5, 4=0, 0 gain1 Sub-Index:0x01.
Use the setting bit5, 4=0, 1 gain2 Sub-Index:0x02.
Use the setting bit5, 4=1, 0 gain3 Sub-Index:0x03.
Use the setting bit5, 4=1, 1 gain4 Sub-Index:0x04.

bit7-6:
Reserved

* Switching of model control gains 1-4
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.

MSB / LSB

Orgtc	Res	Res	Res
15 14	13 12	11 10	9 8

bit13-8:
Reserved

bit15-14: Reserved

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	0x04
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		
	0x00:_AutoTun (Automatic Tuning) 0x01:_AutoTun_JRAT-Fix (Automatic Tuning JRAT Manual Setting) 0x02:_ManualTun (Manual Tuning) *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 intertia moment ratio of machines applied large disturbance torque (force), machine with majour backlash, and machine whose moving part vibrate partially can not correctly estimetd. *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.				
0x02	Auto-Tuning Characteristic [ATCHA]	Unsigned8	RW	No	0x00
	Selects the tuning characteristic.	Setting range	0x00-0x06		
	0x00:_Positioning1 Positioning Control 1 (General Purpose) 0x01:_Positioning2 Positioning Control 2 (High Response) 0x02:_Positioning3 Positioning Control 3 (High Response, FFGN Manual Setting) 0x03:_Positioning4 Positioning Control 4 (High Response, Horizontal Axis Limited) 0x04:_Positioning5 Positioning Control 5 (High Response, Horizontal Axis Limited) 0x05:_Trajectory1 Trajectory Control 1 0x06:_Trajectory2 Trajectory Control 2 (KP,FFGN Manual Setting) *[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 moments of inertia of the load vary during the operation. * When the estimation accuracy of the Inertial moment ratio of the load 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. *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.				

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x03	Sets the Auto-Tuning Response [ATRES] *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.	Unsigned8	RW	No	0x05
		Setting range	0x01-0x1E (1-30)		

4) Basic Control Parameter

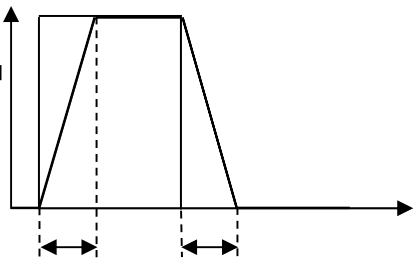
0x2003: Position Command Smoothing Constant

Index	0x2003	This moving low-pass filter smoothes the position command pulse. Sets time constants.	Object Code	Variable	
Sub-Idx	**Description**	**Data Type**	**Access**	**PDO**	**Initial value**
0x00	Position Command Smoothing Constant [TCSMT] *Applies gradient to the step condition positioning pulse. *Applies S curve to the lamp condition position command pulse. *When position command differences in each communication cycle are large, position command will be smoothed.	Unsigned16	RW	No	0x0005 (0.5 ms)
		Setting range	0x0000-0x1388 (0.0-500.0 ms)		
		Unit	0.1 ms		

(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.)

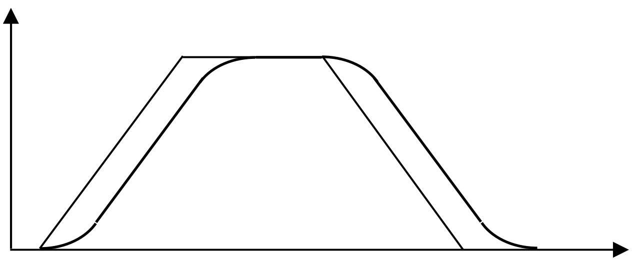
* Position command pulse with step condition applied

Position command pulse



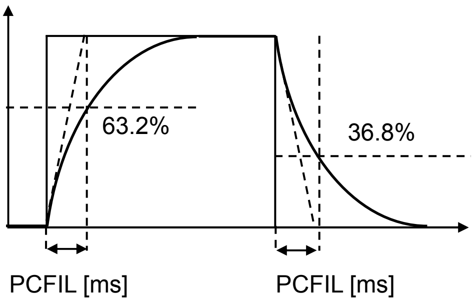
* Position command pulse with lamp condition applied.

PCSMT [ms]



0x2004: Position Command Filter

Index	0x2004	This low-pass filter suppresses any sudden change of the position control pulse. Sets time constants.	Object Code		Variable
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	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 (0.0-2000.0 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.					



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] *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.	Unsigned16	RW	Possible	0x001E (30 /s)
0x02	Position Loop Gain 2 [KP2] * 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	Position Loop Gain 3 [KP3] * 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	Position Loop Gain 4 [KP4] * 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)
		Setting range	0x0001-0x0BB8 (1-3000 /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] * 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.		Unsigned16	RW	Possible	0x2710 (1000ms) proportional control
0x02	Position Integral Time Constant 2 [TPI2] *When gain 2(bit5, 4=0, 1) is selected, in the Gain Switching function, it operates at this setting value.		Unsigned16	RW	No	0x2710 (1000ms) proportional control
0x03	Position Integral Time Constant 3 [TPI3] *When gain 3(bit5, 4=1, 0) is selected, in the Gain Switching function, it operates at this setting value.		Unsigned16	RW	No	0x2710 (1000ms) proportional control
0x04	Position Integral Time Constant 4 [TPI4] *When gain 4(bit5, 4=1, 1) is selected, in the Gain Switching function, it operates at this setting value.		Unsigned16	RW	No	0x2710 (1000ms) proportional control
			Setting range	0x0003-0x2710 (0.3-1000 ms)		
			Unit	0.1ms		

0x2007:Higher Tracking Control Position Compensation Gain

Index	0x2007	Improves the Command Tractability using Compensation Gain Parameter to the position system. The larger value can raise command tracking performance.		Object Code		Variable
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Higher Tracking Control Position Compensation Gain [TRCPGN] When higher tracking control position compensation bit is enabled, Feed Forward Gain (FFGN), Position Command Filter Time Constant (PCFIL) will be automatically set to the intended proportion. KVFF [%]=0.9×Setting value [%] PCLPF [Hz]=Velocity Loop Proportional Gain/Setting value [%]/100 When the value is greater, Command Track ability will be improved. ■ When a value other than 0% is set, Position Command Filter and Feed Forward Gain are automatically set in the servo amplifier. ■ When Auto-tuning function is valid, this setting value not applied.		Unsigned16	RW	No	0x0000 (0 %)
			Setting range	0x0000-0x0064 (0-100 %)		
			Unit	1 %		

0x2008: Feed Forward compensation parameter

<table>
<tr><td>Index</td><td>0x2008</td><td colspan="2">Sets parameters regarding Feed Forward compensation functions.</td><td>Object Code</td><td></td><td>Array</td></tr>
<tr><td>Sub-Idx</td><td colspan="2">Description</td><td>Data Type</td><td>Access</td><td>PDO</td><td>Initial value</td></tr>
<tr><td>0x00</td><td colspan="2">Number of entry</td><td>Unsigned8</td><td>RO</td><td>No</td><td>0x0002</td></tr>
<tr><td rowspan="4">0x01</td><td colspan="2" rowspan="3">Feed Forward Gain [FFGN]
Sets feed forward compensation gain to position control system.
Model control system compensates for feed forward to Model following system when Position Control Selection is at Model following control.</td><td>Unsigned16</td><td>RW</td><td>Possible</td><td>0x0000
(0 %)</td></tr>
<tr><td>Setting range</td><td colspan="3">0x0000-0x0064
(0-100 %)</td></tr>
<tr><td>Unit</td><td colspan="3">1 %</td></tr>
<tr><td colspan="6">*Valid when Higher Tracking Control Position Compensation Gain is set at 0%.
*The setting value is not applied when using the Auto-Tuning Characteristics listed below.

Positioning1 Positioning Control 1 (General Purpose)
Positioning2 Positioning Control 2 (High Response)
Positioning4 Positioning Control 4 (High Response, Horizontal Axis Limited)
Trajectory1 Trajectory Control 1</td></tr>
<tr><td rowspan="4">0x02</td><td colspan="2" rowspan="3">Feed Forward Filter [FFFIL]
First low-pass filter to eliminate pulsed ripple caused by the position command pulse included in the feed forward command. Sets the cutoff frequency.
* Sets values to disable the filter differ according to the setting of “position control selection.”</td><td>Unsigned16</td><td>RW</td><td>No</td><td>0x0FA0
(4000Hz)
Invalid</td></tr>
<tr><td>Setting range</td><td colspan="3">0x0001-0x0FA0
(1-4000Hz)</td></tr>
<tr><td>Unit</td><td colspan="3">1 Hz</td></tr>
<tr><td colspan="6">Position Control Selection — Value when the filter is invalid
00:Standard Standard — 2000Hz or more
01:Model1 Model 1 Model Following Control — 500Hz or more
02:Model2 Model 2 Model Flowing Vibration Suppress Control — 500Hz or more</td></tr>
</table>

0x2009: Velocity Command Filter

<table>
<tr><td>Index</td><td>0x2009</td><td colspan="2">Parameter to switch on the primary low-pass filter in response to velocity command.</td><td>Object Code</td><td></td><td>Variable</td></tr>
<tr><td>Sub-Idx</td><td colspan="2">Description</td><td>Data Type</td><td>Access</td><td>PDO</td><td>Initial value</td></tr>
<tr><td rowspan="3">0x00</td><td colspan="2" rowspan="3">Velocity Command Filter [VCFIL]
First low-pass filter to suppress sudden change of velocity command. Sets the cutoff frequency.
Setting value: the filter will be disabled at 2000Hz(0x07D0) or greater.</td><td>Unsigned16</td><td>RW</td><td>No</td><td>0x0FA0
(4000 Hz)
Invalid</td></tr>
<tr><td>Setting range</td><td colspan="3">0x0001-0x0FA0
(1-4000 Hz)</td></tr>
<tr><td>Unit</td><td colspan="3">1 Hz</td></tr>
</table>

0x200A: Velocity Feedback Filter

<table>
<tr><td>Index</td><td>0x200A</td><td colspan="2">Parameter to switch on the primary low-pass filter in response to velocity feedback.</td><td>Object Code</td><td></td><td>Variable</td></tr>
<tr><td>Sub-Idx</td><td colspan="2">Description</td><td>Data Type</td><td>Access</td><td>PDO</td><td>Initial value</td></tr>
<tr><td rowspan="4">0x00</td><td colspan="2" rowspan="3">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.</td><td>Unsigned16</td><td>RW</td><td>No</td><td>0x05DC
(1500 Hz)</td></tr>
<tr><td>Setting range</td><td colspan="3">0x0001-0x0FA0
(1-4000 Hz)</td></tr>
<tr><td>Unit</td><td colspan="3">1 Hz</td></tr>
<tr><td colspan="6">*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.</td></tr>
</table>

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. *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.	Unsigned16	RW	Possible	0x0032 (50Hz)
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 (1-2000 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. *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.	Unsigned16	RW	Possible	0x00C8 (20ms)
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 (0.3-1000 ms)		
		Unit	0.1ms		

0x200D: Load Inertia Moment Ratio

Index	0x200D	Sets inertia moment of the loading device to the servo motor inertia moment. Setting value=$J_L/J_M\times100\%$ (J_L: Load inertia moment, JM: Motor inertia moment) 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] *When gain 2(bit5, 4=0, 1) is selected, in the Gain Switching function, it operates at this setting value.		Unsigned16	RW	No	0x0064 (100%)
0x03	Load Inertia Moment Ratio 3 [JRAT3] *When gain 3(bit5, 4=1, 0) is selected, in the Gain Switching function, it operates at this setting value.		Unsigned16	RW	No	0x0064 (100%)
0x04	Load Inertia Moment Ratio 4 [JRAT4] *When gain 4(bit5, 4=1, 1) is selected, in the Gain Switching function, it operates at this setting value.		Unsigned16	RW	No	0x0064 (100%)
			Setting range	0x0000-0x3A98 (0-15000%)		
			Unit	1%		

0x200E: Higher Tracking Control Velocity Compensation Gain

Index	0x200E	Parameter to adjust command following prerformance of velocity control.	Object Code		Variable
Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Higher Tracking Control Velocity Compensation Gain [TRCVGN] *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 (0-100 %)		
		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 ±15.0% for general use.	Indeger16	RW	No	0x0000 (0.0 %)
		Setting range	0xFC18-0x03E8 (-100.0-+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 (1-4000Hz)		
		Unit	Hz		

0x2011: Torque (force) Command Filter

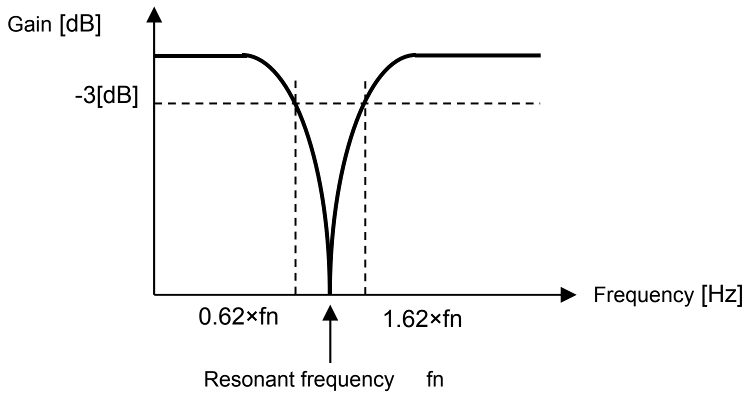
Index	0x2011	Low-pass filter to eliminate high frequency component included in the torque (force) command. Sets cutoff frequency. By setting bit5, 4 gain, change selection (GC) in the parameter selection (0x2001), the Torque (force) Command Filter to be used is selected.	Object Code		Array
Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Number of entry	Unsigned8	RO	No	0x04
0x01	Torque (force) Command Filter 1 [TCFIL1] *Automatically saved by Auto-tuning result saving. *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 Auto-tuning is valid, while system analysis function is active, this 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	0x0258 (600Hz)
0x02	Torque (force) Command Filter 2 [TCFIL2] *When 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 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 gain 4(bit5, 4=1, 1) is selected, in the Gain Switching function, it operates at this setting value.	Unsigned16	RW	No	0x0258 (600Hz)
		Setting value	0x0001 - 0x0FA0 (1 - 4000 Hz)		
		Unit	Hz		

5) Feed Forward vibration suppressor control / Notch filter Parameter

0x2012: FF Vibration Suppressor Frequency

Index	0x2012	Sets the frequency of the machine vibration to be suppressed by FF vibration suppressor function. Change this while the servo motor is OFF. 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). By setting bit3, 2 FF Vibration Suppressor Frequency switch selection (supfsel) in parameter selection (0x2001), the notch 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	FF Vibration Suppressor Frequency 1 [SUPFRQ1] *This parameter is automatically saved by executing FF vibration suppressor frequency tuning. *Tuning result will be automatically saved in this parameter. *When frequency 2 (bit 3, 2=0, 1) is selected in the vibration suppressor frequency selection function, it will operate at this setting value.	Unsigned16	RW	Possible	0x01F4 (500 Hz) proportional control
0x02	FF Vibration Suppressor Frequency 2 [SUPFRQ2] *When frequency 2 (bit 3, 2=0, 1) is selected in the vibration suppressor frequency selection function, it will operate at this setting value.	Unsigned16	RW	No	0x01F4 (500 Hz) proportional control
0x03	FF Vibration Suppressor Frequency 3 [SUPFRQ3] *When frequency 3 (bit 3, 2=1, 0) is selected in the vibration suppressor frequency selection function, it will operate at this setting value.	Unsigned16	RW	No	0x01F4 (500 Hz) proportional control
0x04	FF Vibration Suppressor Frequency 4 [SUPFRQ4] *When frequency 4 (bit 3, 2=1, 1) is selected in the vibration suppressor frequency selection function, it will operate at this setting value.	Unsigned16	RW	No	0x01F4 (500 Hz) proportional control
	*Setting value can be input by 1Hz; inside the servo amplifier, the units listed below are used. Setting range Unit value inside servo amplifier 5-99Hz Valid by 1Hz 100-499Hz Valid by 5Hz and drop less than 5 *Setting value: FF vibration suppressor control is invalid *Do not use while synchronizing with other axis such as controlling XY table trajectory for cutting operation.	Setting range	0x0005-0x01F4 (5-500Hz)		
		Unit	Hz		

0x2013: Velocity Command Notch Filter

<table>
<tr><td>Index</td><td>0x2013</td><td colspan="2">Notch filter to eliminate frequency element arbitrarily set from velocity command.
Sets the center frequency of the filter. When sympathetic vibration occurs in velocity control system, the gain is raised by setting the resonance frequency.</td><td colspan="2">Object Code</td><td>Variable</td></tr>
<tr><td>Sub-Idx</td><td colspan="2">Description</td><td>Data Type</td><td>Access</td><td>PDO</td><td>Initial value</td></tr>
<tr><td rowspan="3">0x00</td><td colspan="2" rowspan="3">Velocity Command Notch Filter [VCNFIL]
*Specified in increment of HZ, but inside the servo amplifier, in increment of HZ between 50-99HZ and in increment of 5HZ between 100-1000HZ
(Rounded off to the 5Hz.)
*Setting value: the setting will be disabled at setting value 500Hz (0x01F4).</td><td>Unsigned16</td><td>RW</td><td>No</td><td>0x03E8
(1000Hz)</td></tr>
<tr><td>Setting range</td><td colspan="3">0x0032-0x03E8
(50-1000Hz)</td></tr>
<tr><td>Unit</td><td colspan="3">1Hz</td></tr>
<tr><td></td><td colspan="6">The depth of the filter can also be selected with the selection of the vibration control level.
*Do not use while synchronizing with other axis such as controlling XY table trajectory for cutting operation.

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

0x2014: Torque (force) Command Notch Filter

Index	0x2014	Notch filter to eliminate sympathetic vibration element included in torque (force) command. Set the center frequency of the notch filter. Inputs increment uses HZ/LSB steps, but in the servo amplifier, the setting will be enabled by 10 HZ steps.		Object Code		Array
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Number of entry		Unsigned8	RO	No	0x04
0x01	Torque (force) Command Notch Filter A [TCNFILA] The center frequency of the first notch filter is in response to the Torque (force) Command. * When Auto Notch Filter Tuning is implemented, the tuning result will be saved in this parameter automatically. Setting value: the filter will be disabled at 2000Hz(0x07D0) or greater.		Unsigned16	RW	No	0x0FA0 (4000Hz)
			Setting range	0x0064-0x0FA0 (100-4000Hz)		
			Unit	Hz		
0x02	Torque (force) Command Notch Filter B [TCNFILB] The center frequency of the 2nd notch filter is in response to the Torque (force) Command. Setting value: the filter will be disabled at 2000Hz(0x07D0) or greater.		Unsigned16	RW	No	0x0FA0 (4000Hz)
			Setting range	0x0064-0x0FA0 (100-4000Hz)		
			Unit	Hz		
0x03	Torque (force) Command Notch Filter C [TCNFILC] The center frequency of the 3rd notch filter is in response to the Torque (force) Command. Setting value: the filter will be disabled at 2000Hz(0x07D0) or greater.		Unsigned16	RW	No	0x0FA0 (4000Hz)
			Setting range	0x0064-0x0FA0 (100-4000Hz)		
			Unit	Hz		
0x04	Torque (force) Command Notch Filter D [TCNFILD] The center frequency of the 4th notch filter is in response to the Torque (force) Command. Setting value: the filter will be disabled at 2000Hz(0x07D0) or greater.		Unsigned16	RW	No	0x0FA0 (4000Hz)
			Setting range	0x0064-0x0FA0 (100-4000Hz)		
			Unit	Hz		

6) High setting control settings

0x2015:High setting control settings

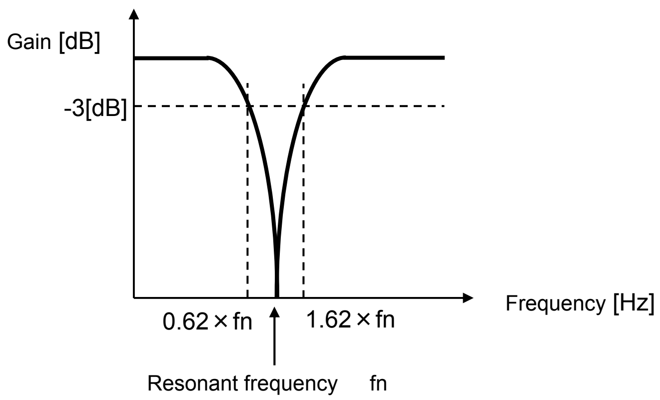
Index	0x2015 Parameter setting to implement high setting control by adding position deviation to Acceleration and Deceleration Compensation Values.	Object Code		Array	
Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Number of entry	Unsigned8	RO	No	0x04
0x01	Acceleration Compensation [ACCC0] 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 moments 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	0x0064-0x0FA0 (-9999-+9999×50 Pulse)		
		Unit	×50 Pulse		
0x02	Deceleration Compensation [DECC0] 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 higer the acceleration converterted from position command pulse, the more the compensation increases. ✔The higher the load inertia moment 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-+9999×50 Pulse)		
		Unit	×50 Pulse		
0x03	Command Velocity Low-pass Filter [CVFIL] Sets the cutoff frequency of the primary low-pass filter to eliminate high-frequency component (ripples etc.,) included in the Velocity (Command Velocity) calculated from the position command inside the higher established control. * 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 (1-4000Hz)		
		Unit	Hz		
0x04	Command Velocity Threshold [CVTH] Sets the Velocity Threshold to validate the Acceleration and Deceleration Compensation Values in the higher established 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^{-1}) [20mm/s]
		Setting range	0x0000-0xFFFF (0-65536)		
		Unit	Rotary : min^{-1} [Linear : mm/s]		

7) Observer Parameter

0x2016: Observer Parameter

Index	0x2016	Description	Object Code	Record
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] 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).	Unsigned8 Setting range: 0x00-0x02	RW	No	0x00
0x02	Compensation gain for Disturbance Observer.[OBG] Observer Compensation gain in response to the Torque (force)command. *The larger the value, the higher the suppression performance. By making this too large to oscillate, the disturbance suppression characteristics improve.	Unsigned16 Setting range: 0x0000-0x0064 (0-100 %) Unit: 1 %	RW	No	0x0000 (0 %)
0x03	Observer Output Filter [OBLPF] First low-pass filter to eliminate high frequency elements included in the observer compensation. Sets the cutoff frequency. *Filter is invalid at the setting value more than 2000Hz. *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].	Unsigned16 Setting range: 0x0001-0x0FA0 (1-4000 Hz) Unit: Hz	RW	No	0x032 (50 Hz)
0x04	Observer Notch Filter [OBNFIL] Notch filter to eliminate arbitrarily selected frequency from observer compensation. Set the center frequency of the filter. *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 value — Unit value inside servo amplifier 100-1999Hz — Valid by 10Hz and drop less than 10 2000-4000Hz — Filter invalid	Unsigned16 Setting range: 0x0001-0x0FA0 (1-4000 Hz) Unit: Hz	RW	No	0x0FA0 (4000 Hz)



Sub-Idx	Description	Data Type	Access	PDO	Initial value
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%	Unsigned16	RW	No	0x0064 (100%)
		Setting range	0x0000-0x1388 (0-5000%)		
		Unit	%		
	(JL: Load inertia moment, JM: Motor inertia moment) * Selection of disturbance suppression observer characteristics: JLAT 1-4 are used when frequency setting is made.				
0x06	Observer Loop Proportional Gain [OBPGIN] Proportional gain of the observer control.	Unsigned16	RW	No	0x012C (300Hz)
		Setting range	0x0001-0x07D0 (1-2000Hz)		
		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. Sets the cutoff frequency. Setting value: the filter will be disabled at 2000Hz(0x07D0) or greater.	Unsigned16	RW	No	0x0032 (50 Hz)
		Setting range	0x0001-0x07D0 (1-2000Hz)		
		Unit	Hz		

8) Model Following Control Settings Parameter

A note of caution in using Model Following Control
* If oscillation is restrained when using Model Following Vibration Suppressor Control, the vibration suppression effect disappears when the alarm occurs.
* When the Gain Switching Function is used, please stop the servo motor.
* When the Model Vibration Suppressor Frequency switching is used, please stop the servo motor.
* If the alarm “AL.C5 Model Following Vibration Suppressor Control trouble” occurs during the operation, please lower the “KM Model Control Gain” or change the operation pattern so that the acceleration and deceleration will be slowed.
* In the JOG operation, Model Following Vibration Suppressor Control function does not operate.

0x2017: Model Control Gain

Index	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 * In case of operating at Model following anti-resonance control, use in the range of 15 - 315/s. * Change value while the servo motor is OFF.	Setting range	0x0001-0x0BB8 (1-3000 /s)		
		Unit	1/s		

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 (1-4000 Hz)		
		Unit	Hz		

0x2019: Model Control Antiresonance Frequency

<table>
<tr><td>Index</td><td>0x2019</td><td colspan="2">Sets antiresonance frequency to the mechanical device with Model following vibration suppressor control. Sets actual antiresonance frequency value of the mechanical system by using System Analysis function of the Software Setup.
Control Word 1(0x2000) bit10 : Enable vibration suppression control.
Makes Compensation of vibration suppression control with [VIBCON]="1"</td><td colspan="2">Object Code</td><td>Array</td></tr>
<tr><td>Sub-Idx</td><td colspan="2">Description</td><td>Data Type</td><td>Access</td><td>PDO</td><td>Initial value</td></tr>
<tr><td>0x00</td><td colspan="2">Number of entry</td><td>Unsigned8</td><td>RO</td><td>No</td><td>0x04</td></tr>
<tr><td>0x01</td><td colspan="2">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.</td><td>Unsigned16</td><td>RW</td><td>Possible</td><td>0x0320
(80.0 Hz)
proportional control</td></tr>
<tr><td>0x02</td><td colspan="2">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.</td><td>Unsigned16</td><td>RW</td><td>No</td><td>0x0320
(80.0 Hz)
proportional control</td></tr>
<tr><td>0x03</td><td colspan="2">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.</td><td>Unsigned16</td><td>RW</td><td>No</td><td>0x0320
(80.0 Hz)
proportional control</td></tr>
<tr><td>0x04</td><td colspan="2">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.</td><td>Unsigned16</td><td>RW</td><td>No</td><td>0x0320
(80.0 Hz)
proportional control</td></tr>
<tr><td colspan="4" rowspan="2">■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.</td><td>Setting range</td><td colspan="2">0x0064-0x0320
(10.0-80.0 Hz)</td></tr>
<tr><td>Unit</td><td colspan="2">0.1 Hz</td></tr>
</table>

0x201A: Model Control Resonance Frequency

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. Control Word 1(0x2000) bit10：Enable vibration suppression control. Makes Compensation of vibration suppression control with [VIBCON]="1"	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 (10.0-80.0 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.	Unsigned16	RW	No	0x0000 (0 ms)
		Setting range	0x0000-0x064 (0-100ms)		
		Setting Unit	ms		
	* When the mechanical system is shocked by the change of gain resulted from gain switching, making a moderate gain change will modify the shock.				

9) Amplifier Function Parameter

0x201C: Internal Velocity Command limit

<table>
<tr><td>Index</td><td>0x201C</td><td colspan="2">Sets the allowable velocity in response to the Internal Velocity Command.</td><td colspan="2">Object Code</td><td>Variable</td></tr>
<tr><td>Sub-Idx</td><td colspan="3">Description</td><td>Data Type</td><td>Access</td><td>PDO</td><td>Initial value</td></tr>
<tr><td rowspan="3">0x00</td><td colspan="3" rowspan="3">Internal Velocity Command limit [VCMMAX]
In the cycle synchronous position (csp) or the profile osition (pp) mode, 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.

■When the setting value is 0 min^{-1} , or 50000 min^{-1} or more, 0 min^{-1} it is limited at 1.1 fold the highest rotation velocity of the motor (combining the velocity commands).

■ The function becomes valid when 1 is set to bit3 of the control word (0x2000).

✍The rotary motor differs from linear motor in unit.</td><td>Unsigned16</td><td>RW</td><td>No</td><td>0xFFFF
(65535min^{-1})
[65535mm/s]</td></tr>
<tr><td>Setting range</td><td colspan="3">0x0000 - 0xFFFF
(0 - 65535min^{-1})
[0 - 65535mm/s]</td></tr>
<tr><td>Unit</td><td colspan="3">Rotary : min^{-1}
[Linear : mm/s]</td></tr>
</table>

0x201D: Position Command error 1 level

<table>
<tr><td>Index</td><td>0x201D</td><td colspan="2">Position Command error 1 alarm detection level is set.</td><td colspan="2">Object Code</td><td>Variable</td></tr>
<tr><td>Sub-Idx</td><td colspan="3">Description</td><td>Data Type</td><td>Access</td><td>PDO</td><td>Initial value</td></tr>
<tr><td rowspan="3">0x00</td><td colspan="3" rowspan="3">Position Command error 1 level [OVFSET]
* Profile Position mode (pp)
When the velocity-converted value of the operated and generated amount of travel exceeds the setting value, alarm “D2” is detected.

* Cycle synchronous position mode (csp)
When the 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]</td><td>Unsigned32</td><td>RW</td><td>No</td><td>0xFFFFFFFF</td></tr>
<tr><td>Setting range</td><td colspan="3">0x1-0xFFFFFFFF
(1 - 4294967295 p/s)</td></tr>
<tr><td>Unit</td><td colspan="3">Pulse/sec</td></tr>
</table>

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 [SQTCLM] This is Torque (force) Limit Value for the following sequence controls. *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.		Unsigned16	RW	No	0x04B0 (120.0 %)
			Setting range	0x0064-0x1388 (10.0-500.0 %)		
			Unit	0.1 %		
	Moreover, when power lowering torque (force) limit selection (0x20F5) is “0x01,” electric current is limited including this setting value. * 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_P) of the combining servo motor, it is limited by the Maximum instant stall torque (force) (T_P) 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

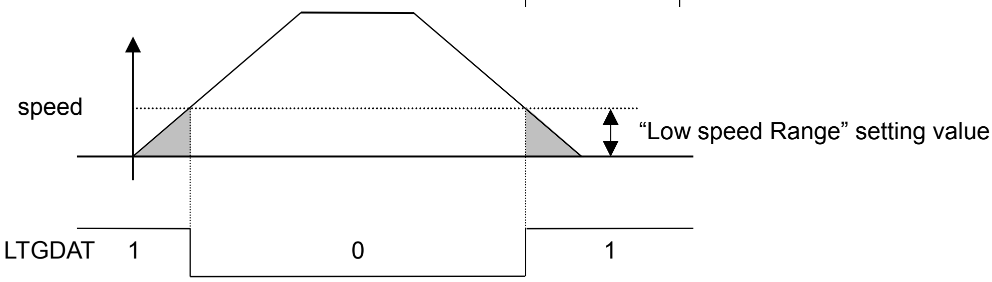
Index	0x201F	A position range variation counter for positioning completion/ near range completion monitoring.		Object Code		Variable
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Near Range [NEAR] * Outputs Near range signal when the Position deviation counter is set lower that this set value. * Sets at the resolution of the encoder pulse |Following Error Actual Value| <= Setting value		Unsigned32	RW	No	0x01F4 (500 pulse)
			Setting range	0x00000000-0x7FFFFFFF (0-2147483647 Pulse)		
			Unit	1 Pulse		
	When the actual position variation is greater than the setting value, it is output from near range completion monitor (NEAR monitor.)					

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	Initial value
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	0x0032 (50min^{-1}) [50mm/s]
			Setting range	0x0005 - 0x01F4 (5 - 500min^{-1}) [5 - 500mm/s]		
			Unit	Rotary : min^{-1} [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	Initial value
0x00	Low Speed Range [LOWV] When the speed is lower than this value, Low speed range is output. |Actual Velocity|<= Setting value then LTG flag is set.	Unsigned16	RW	No	0x0032 ($50min^{-1}$) [50mm/s]
		Setting range	0x0000 - 0xFFFF ($0 - 65535min^{-1}$) [0 - 65535mm/s]		
		Unit	Rotary : min^{-1} [Linear : mm/s]		

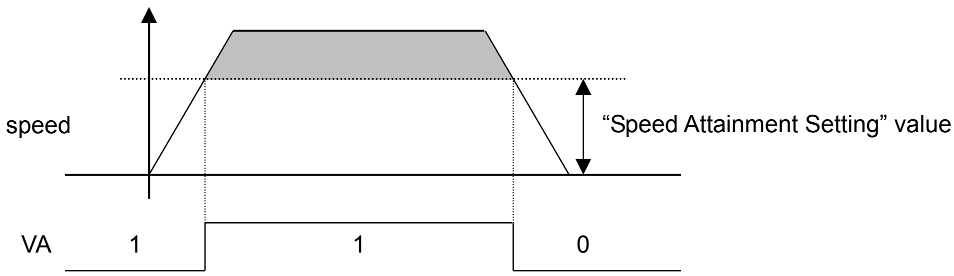


■ If Auto Tuning Mode setting is 0x01 and Auto Tuning Characteristics setting is 0x02, 50min-1 will be set automatically.

✍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	Initial value
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	0x03E8 ($1000min^{-1}$) [1000mm/s]
		Setting range	0x0000 - 0xFFFF ($0 - 65535min^{-1}$) [0 - 65535mm/s]		
		Unit	Rotary : min^{-1} [Linear : mm/s]		



■ 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.

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	0x01-0x1A	

■ Rotary motor

Value	Monitor	Unit
0x00	Reserved (For maintenance by manufacturer)	
0x01	Torque(force) monitor	2V/ratedTorque(force)
0x02	Torque(force)monitor	2V/ratedTorque(force)
0x03	Velocity monitor	0.2mV/min^{-1}
0x04	Velocity monitor	1mV/min^{-1}
0x05	Velocity monitor	2mV/min^{-1}
0x06	Velocity monitor	3mV/min^{-1}
0x07	Velocity command monitor	0.2mV/min^{-1}
0x08	Velocity command monitor	1mV/min^{-1}
0x09	Velocity command monitor	2mV/min^{-1}
0x0A	Velocity command monitor	3mV/min^{-1}
0x0B	Position deviation monitor	0.01mV/Pulse
0x0C	Position deviation monitor	0.1mV/Pulse
0x0D	Position deviation monitor	1mV/Pulse
0x0E	Position deviation monitor	10mV/Pulse
0x0F	Position deviation monitor	20mV/Pulse
0x10	Position deviation monitor	50mV/Pulse
0x11	Position command monitor1	2mV/kPulse/sec
0x12	Position command monitor1	10mV/kPulse/s
0x13	Position command monitor2	0.05mV/kPulse/s
0x14	Position command monitor2	0.5mV/kPulse/s
0x15	Position command monitor2	2mV/kPulse/s
0x16	Position command monitor2	10mV/kPulse/s
0x17	Load Torque(force)monitor	2V/ratedTorque(force)
0x18	Phase U electrical angle monitor	8Vpeak
0x19	Position command monitor1	0.05mV/kPulse/sec
0x1A	Position command monitor1	0.5mV/kPulse/sec
0x1B	Acceleration monitor	0.01mV/rad/sec^2
0x1C	Acceleration monitor	0.1mV/rad/sec^2
0x1D	Acceleration monitor	1mV/rad/sec^2
0x1E	Acceleration monitor	10mV/rad/sec^2
0x1F to 0xFF	reserved	

■ Linear motor

Value	Monitor	Unit
0x00	Reserved (For maintenance by manufacturer)	
0x01	Torque(force)monitor	2V/ratedTorque(force)
0x02	Torque(force)monitor	2V/ratedTorque(force)
0x03	Velocity monitor	0.2mV/mm/sec
0x04	Velocity monitor	1mV/mm /sec
0x05	Velocity monitor	2mV/mm /sec
0x06	Velocity monitor	3mV/mm /sec
0x07	Velocity command monitor	0.2mV/mm/sec
0x08	Velocity command monitor	1mV/mm/sec
0x09	Velocity command monitor	2mV/mm/sec
0x0A	Velocity command monitor	3mV/mm/sec
0x0B	Position deviation monitor	0.01mV/Pulse
0x0C	Position deviation monitor	0.1mV/Pulse
0x0D	Position deviation monitor	1mV/Pulse
0x0E	Position deviation monitor	10mV/Pulse
0x0F	Position deviation monitor	20mV/Pulse
0x10	Position deviation monitor	50mV/Pulse
0x11	Position command monitor1	2mV/kPulse/sec
0x12	Position command monitor1	10mV/kPulse/s
0x13	Position command monitor2	0.05mV/kPulse/s
0x14	Position command monitor2	0.5mV/kPulse/s
0x15	Position command monitor2	2mV/kPulse/s
0x16	Position command monitor2	10mV/kPulse/s
0x17	Load Torque(force)monitor	2V/ratedTorque(force)
0x18	Phase U electrical angle monitor	8Vpeak
0x19	Position command monitor1	0.05mV/kPulse/sec
0x1A	Position command monitor1	0.5mV/kPulse/sec
0x1B	Acceleration monitor	0.01mV/mm/sec^2
0x1C	Acceleration monitor	0.1mV/mm/sec^2
0x1D	Acceleration monitor	1mV/mm/sec^2
0x1E	Acceleration monitor	10mV/mm/sec^2
0x1F to 0xFF	reserved	

◆Position command monitor1 monitors position command pulse before position somoothing passing.
◆Position command monitor2 monitors position command pulse after position somoothing passing.

✔Position command pulse frequency monitor1 and 2 are output in the form of pulse when command pulsefrequency is 10kHz or less.
Average the frequency when convering to position command frequency.

◆Torque(force)monitor, velocity monitor, and load torque monitor are placed the following low-path filters.

Torque(force)monitor	250Hz
Velocity monitor	250Hz
Load torque monitor	20Hz

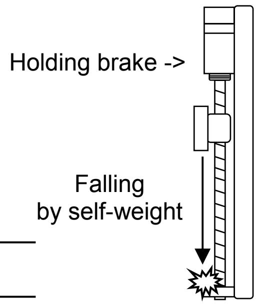
Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x02	Analog Monitor Select Output 2 [MON2] Selects the data to output from Analog Monitor 2. The setting value is the same as in Analog Monitor output selection 1.	Unsigned8	RW	No	0x02
		Setting range	0x01 to 0x1E		

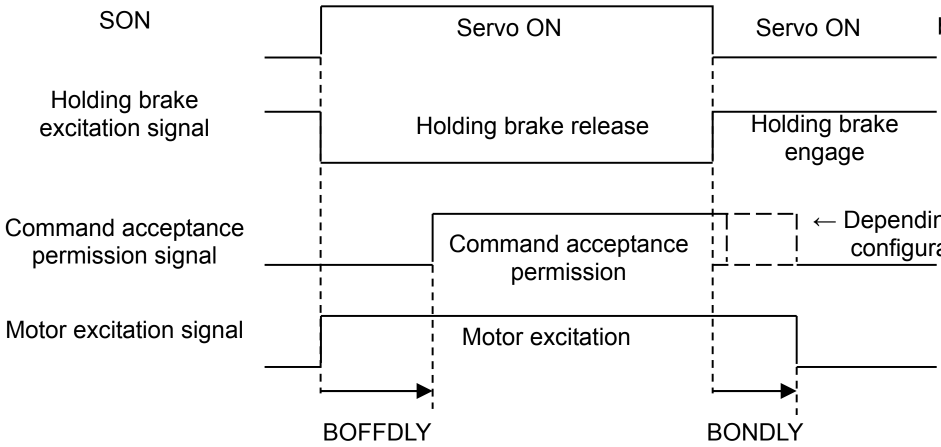
<table>
<tr><td rowspan="3">0x03</td><td rowspan="2">Analog Monitor Output Polarity Selection [MONPOL]
Selects the output polarity of analog monitor 1/2.</td><td>Unsigned8</td><td>RW</td><td>No</td><td>0x00</td></tr>
<tr><td>Setting range</td><td colspan="3">0x00-0x08</td></tr>
<tr><td colspan="5">*For 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</td></tr>
</table>

About Holding Brake

Servo motor with Holding brake function is usually used with an axis that is always affected by gravity and external forces in order to avoid movable parts falling off from its position when main circuit power is OFF, or servo OFF.
Holding brake is to support the movable parts against gravity and other external force when at rest. Do not use it to stop a moving machine.





0x2024: Delay Time of Engaging Holding Brake

<table>
<tr><td>Index</td><td>0x2024</td><td>Sets holding-brake-activation delay time from when power distribution to holding brake stopped till when holding torque generated.</td><td colspan="2">Object Code</td><td>Variable</td></tr>
<tr><td>Sub-Idx</td><td>Description</td><td>Data Type</td><td>Access</td><td>PDO</td><td>Initial value</td></tr>
<tr><td rowspan="4">0x00</td><td rowspan="3">Delay Time of Engaging Holding Brake [BONDLY]
* While shifting from servo ON to servo OFF, during the setting time, Excitation command 0 is given to servo motor. (Even when servo is turned OFF, power is supplied to the motor until the setting time is over.)</td><td>Unsigned16</td><td>RW</td><td>No</td><td>0x01C2
(300ms)</td></tr>
<tr><td>Setting range</td><td colspan="3">0x0000-0x03E8
(0-1000ms)</td></tr>
<tr><td>Unit</td><td colspan="3">ms</td></tr>
<tr><td colspan="5">By this, until Holding brake functions, servo motor generates Holding torque (force).
* 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.)
* When the setting value is 0ms, after servo OFF, command is invalid (command 0) for approximately 4ms.
* Because the setting unit is valid in 4ms steps, the remainder, divided by 4, is cut off inside the amplifier.</td></tr>
</table>

0x2025: Delay Time of Releasing Holding Brake (Holding Brake Releasing Delay time)

<table>
<tr><td>Index</td><td>0x2025</td><td>Sets holding-brake-release delay time from when power distribution to holding brake started till when holding torque disappeared.</td><td colspan="2">Object Code</td><td>Variable</td></tr>
<tr><td>Sub-Idx</td><td>Description</td><td>Data Type</td><td>Access</td><td>PDO</td><td>Initial value</td></tr>
<tr><td rowspan="4">0x00</td><td rowspan="3">Delay Time of Releasing Holding Brake [BOFFDLY]
* While shifting from servo OFF to servo ON, during the setting time, Excitation command 0 is given to servo motor.</td><td>Unsigned16</td><td>RW</td><td>No</td><td>0x01C2
(300ms)</td></tr>
<tr><td>Setting range</td><td colspan="3">0x0000-0x03E8
(0-1000ms)</td></tr>
<tr><td>Unit</td><td colspan="3">ms</td></tr>
<tr><td colspan="5">(Even when servo is turned ON, command is not accepted until the setting time is complete.)
* Therefore, until Holding brake is released, servo motor does not operate.
* When the setting value is 0ms, after servo ON, command is invalid (command 0) for approximately 4ms.
* Because the setting unit is valid in 4ms steps, the remainder, divided by 4, is cut off inside the amplifier.</td></tr>
</table>

0X2026: BRAKE OPERATION BEGINNING TIME

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. * At the time of Quick Stop operation, Emergency Stop (EMR), Servo brake stop alarm occurrence, if motor velocity does not reach less than 50min^{-1}, it signals the Dynamic		Unsigned16	RW	No	0x2710 (10sec)
			Setting range	0x0000-0xFFFF (0-65535ms)		
			Unit	ms		
	brake operation and the Holding brake operation that are then output and motor excitation is discharged. * 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. * If the servo motor velocity reaches zero velocity (50min-1) or less within the setting time, this function does not operate. * 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.					

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. * This becomes valid by re-closing the control source.		Unsigned16	RW	No	0x0020 (32ms)
			Setting range	0x0014-0x03E8 (20-1000ms)		
			Unit	ms		
	* 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.					

0x2028: Excessive Deviation Warning Level

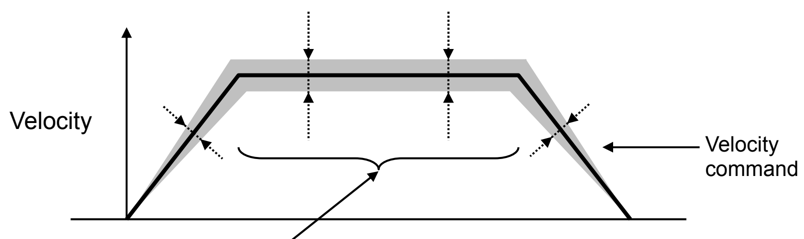
Index	0x2028	Sets Warning output level before Excessive position deviation alarm is output.		Object Code	Variable
Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Excessive Deviation Warning Level [OFWLV] When the actual deviation exceeds the setting value, within the range relatively regarded as warning against the position, Excessive Deviation Warning engages. |Following Error Actual Value| >= Setting value	Unsigned32	RW	No	0x7FFFFFFF (2147483647Pulse)
		Setting range	1-0x7FFFFFFF (0-2147483647 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 [OLWLV] * the allowable setting Level range is as follows (the Overload warning level =100%;) Setting value < 20% or 100% >= Setting value		Unsigned16	RW	No	0x005A (90%)
			Setting range	0x0014-0x0064 (20-100 %)		
			Unit	%		
	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.					

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 [VCMPR] 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	WR	No	0x0032 (5.0 %)
			Setting range	0x0000-0x03E8 (0-100%)		
			Unit	0.1 %		
	 Output ETGDAT=1 during the setting width of the Velocity matching range. *The Velocity matching output is switched by the setting of rotation speed (min^{-1}) and ratio (%) at Velocity matching unit output selection (0x20F0.4). At ratio selection, the condition under this setting value can be monitored with the status word 1(0x2100) bit 10: Velocity matching monitor.					

0x202B: Torque (force) Command Filter Characteristic

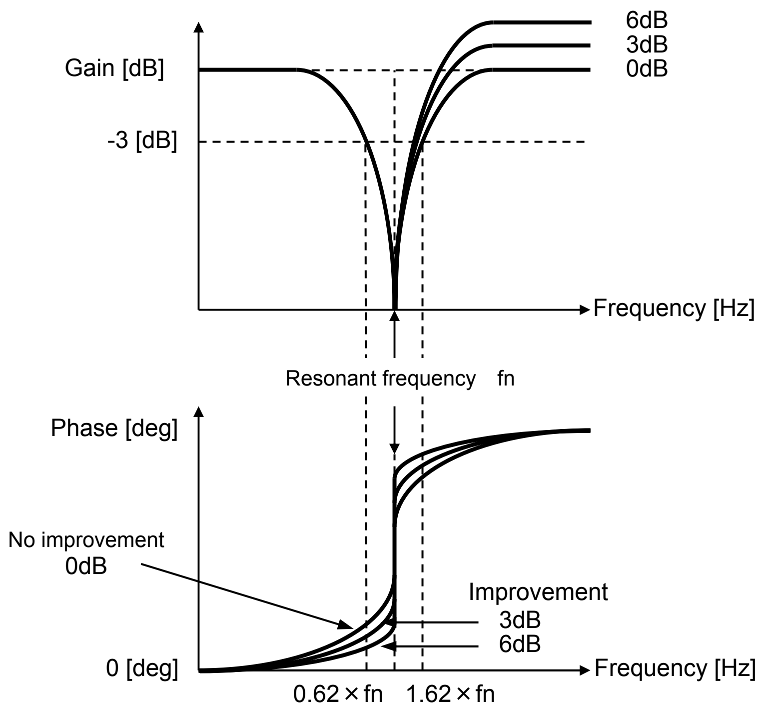
Index	0x202B	The filter order is set at the operation of Torque (force) Command Filter.		Object Code		Variable
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Torque (force) Command Filter Characteristic [TCFILOR]		Unsigned8	RW	No	0x02
	If the cutoff frequency of the torque (force) order filter is switched with the gain switch, the order is fixed at this setting value.		Setting range	0x01-0x03		
	0x01: primary Filter 0x02: secondary Filter 0x03: tertiary Filter 0x00, 0x04-0xFF: Reserved					

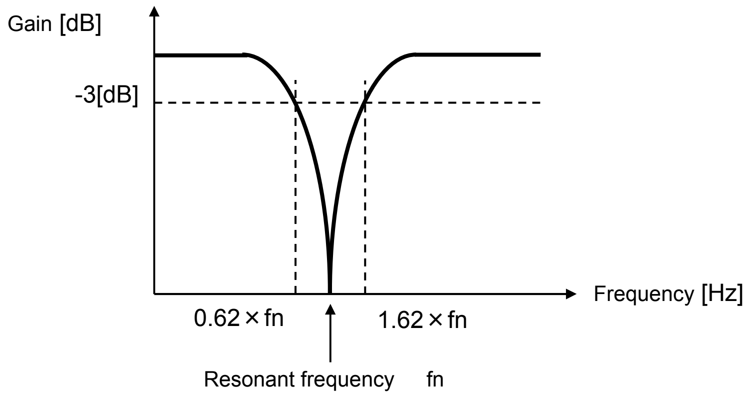
0x202C:Feed Forward Filter, Depth Selection (FF Vibration Suppressor Level Selection)

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. * 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. 0x00: -∞ 0x01: -30dB 0x02: -20dB 0x03: -10dB 0x04-0xFF: Reserved		Setting range	0x00-0x03		

0x202D: Torque (force) Command Notch Filter Characteristic

Index	0x202D	0x2014, 0x01: Parameter to improve the phase lapse of center and lower frequency settings for Torque (force) Command Notch Filter A.		Object Code		Record
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Number of entry		Unsigned8	RO	No	0x05
0x01	T (force) CNFILA, Low Frequency Phase Delay Improvement [TCNFPA] * When the value increases, the phase lapse of the center and lower frequency settings for Torque (force) Command Notch Filter A are diminished. * Characteristic is same as the standard notch filter at the setting value 0. * In settings “1” and “2” please be careful of the amplification effect of the response to center and higher frequency elements. 0x00: 0dB 0x01: 3dB 0x02: 6dB 0x03-0xFF:Reserved		Unsigned8	RW	No	0x00
			Setting range	0x00-0x02		



Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x02	Torque (force) Command Notch Filter B Depth Selection [TCNFDB] Selects the depth of the Torque (force) Command Notch Filter B. * The larger the value is, the shallower the depth. 0x00:-∞ 0x01:-30dB 0x02:-20dB 0x03:-10dB 0x04-0xFF: Reserved	Unsigned8 Setting range	RW 0x00-0x03	No	0x00
0x03	Torque (force) Command Notch Filter C Depth Selection [TCNFDC] Selects the depth of the Torque (force) Command Notch Filter C. * The larger the value is, the shallower the depth. 0x00:-∞ 0x01:-30dB 0x02:-20dB 0x03:-10dB 0x04-0xFF: Reserved	Unsigned8 Setting range	RW 0x00-0x03	No	0x00
0x04	Torque (force) Command Notch Filter D Depth Selection [TCNFDD] Selects the depth of the Torque (force) Command Notch Filter D. * The larger the value is, the shallower the depth. 0x00:-∞ 0x01:-30dB 0x02:-20dB 0x03:-10dB 0x04-0xFF: Reserved	Unsigned8 Setting range	RW 0x00-0x03	No	0x00
	The Depth characteristics of the Torque (force) Command Notch Filter B-D are shown on the right. 				

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]	Unsigned16	RW	No	0x064 (100%)
		Setting range	0x0000 - 0x1388 (0.0 - 500.0%)		
		Unit	%		

Torque (force) attainment setting [TA]

Sets the ratio of torque (force) attainment.

Data subjected to the ratio set by this paramenter 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).

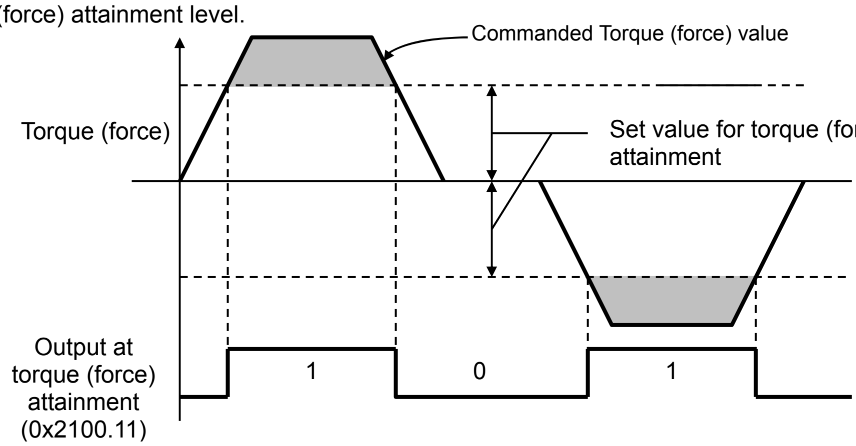
◆ Function selection of torque (force) attainment (0x20F0.6): In the case of 0x00

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.



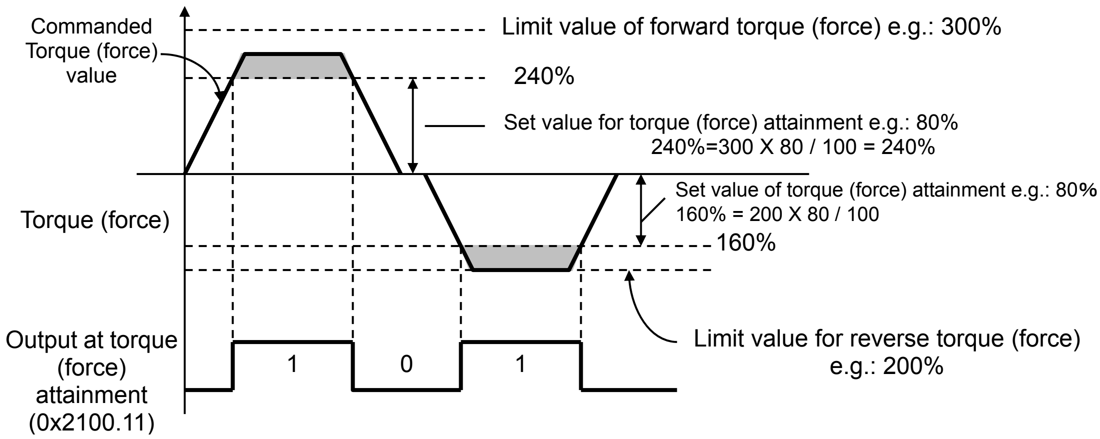
◆ Function selection of torque (force) attainment (0x20F0.6): In the case of 0x01

Sets the ratio of torque (force) attainment level by using the ratio to limited torque (force) value.

"100.0% = rated torque (force)"

Torque (force) attainment level is also independently calculated for both forward and reverse direction respectively in amplifier, as limited torque (force) value is independent in both directions respectively.

Forward torque (force) attainment level = Limited forward torque (force) value X set value /100.0 [%]
Reverse torque (force) attainment level = Limited reverse torque (force) value X set value /100.0 [%]



Detection shall be independently performed in both forward and reverse direction, and if the first one commanded torque (force) value in either direction exceeds torque (force) attainment level, Bit11, output at torque (force) attainment OD:2100, is set to "1."

0x203D: Amplifier temperature warning level

<table>
<tr><td>Index</td><td>0x203D</td><td colspan="4">Sets the warning output level which is issuing before the amplifier temperature error.</td></tr>
<tr><td>Sub-Idx</td><td>Description</td><td>Data Type</td><td>Access</td><td>PDO</td><td>Initial value</td></tr>
<tr><td rowspan="4">0x01</td><td rowspan="3">Amplifier temperature warning high level setting
[DEGWHL]
Sets high level of the amplifier temperature warning detection.</td><td>Signed16</td><td>RW</td><td>No</td><td>0x4B（75℃）</td></tr>
<tr><td>Display range</td><td colspan="3">0x038 to 0x005F (56 to 95℃)</td></tr>
<tr><td>Unit</td><td colspan="3">℃</td></tr>
<tr><td colspan="5">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” ≦ 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℃, amplifier temperature warning will issue at same timing of amplifier temperature error.</td></tr>
<tr><td rowspan="4">0x02</td><td rowspan="3">Amplifier temperature warning low level setting
[DEGWLL]
Sets low level of the amplifier temperature warning detection.</td><td>Signed16</td><td>RW</td><td>No</td><td>0xFFF6（-10℃）</td></tr>
<tr><td>Display range</td><td colspan="3">0xFFFF to 0xFFF1（-1 to -15℃）</td></tr>
<tr><td>Unit</td><td colspan="3">℃</td></tr>
<tr><td colspan="5">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.

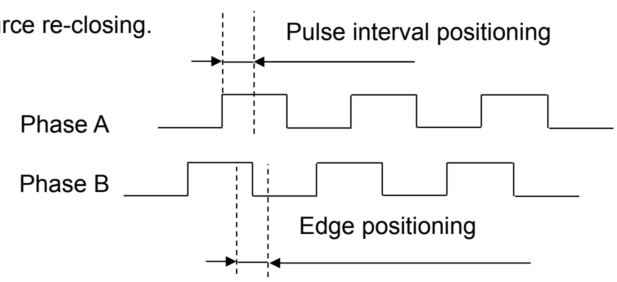
0x203D-01 “Amplifier temperature warning low level setting” ≧ 0x2109 “Temperature inside the servo amplifier”

✔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℃, amplifier temperature warning will issue at same timing of amplifier temperature error.</td></tr>
</table>

10) System Parameter

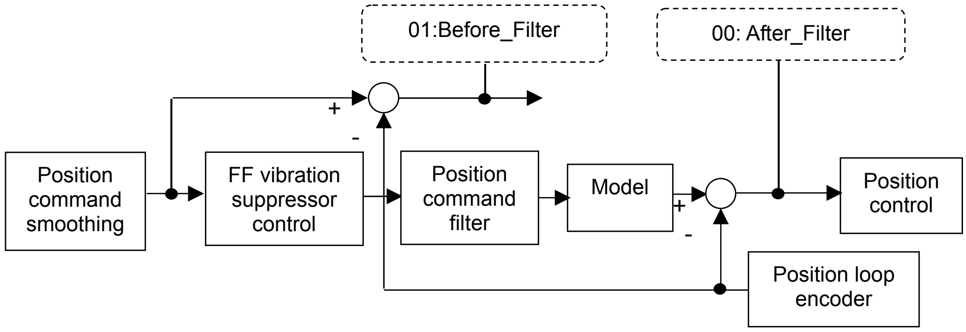
0x20F0: Amplifier Function Selection

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	0x05
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		
	* Profile Position (PP), Profile Velocity (PV), Cycle synchronous position (CSP), Cycle synchronous velocity (CSV) 0x00:Command entry disabled, after the motor stops with the servo brake, servo ON ※1 0x01:Command entry disabled, after the motor stops with the dynamic brake, servo ON 0x02:Command entry disabled, after the motor stops with free run, servo ON 0x03:Command entry disabled, after the motor stops with the servo brake, servo OFF ※1 0x04:Command entry disabled, after the motor stops with the dynamic brake, servo OFF 0x05:Command entry disabled, after the motor stops with free run, servo OFF 0x06:Command entry enabled, after servo motor stops without internal velocity limit command, servo ON 0x07:Reserved 0x08:Command entry disabled, after the motor stops with the servo brake, servo ON ※1 For the Torque (force) limit value stopping a servo motor, the Sequence Operational Torque (force) limit value has priority. 0x09-0xFF:Reserved * Profile torque (force) (TQ), Cycle synchronous torque (force) (CST) 0x00 - 0x02, 0x06, 0x08:Limit the Torque (force) command with Sequence Torque (force) limit (servo ON)※1,2 0x03, 0x04: After servo Off, the motor stops with dynamic brake (servo Off) 0x05: After servo Off, the motor stops with free run (servo Off) 0x07:Reserved 0x09-0xFF:Reserved ※1 The Sequence Operational Torque (force) limit value (0x201E) is valid with power running direction. However, if Maximum torque (force) (0x6072), Positive torque (force) (0x60E0) and Negative torque (force) (0x60E1) are smaller than the value (0x201E), the value (0x201E) doesn't have priority. ※2 When the Torque (force) Command is smaller than sequence operational torque limit value, it is limited by the Target Torque (force).				
0x02	Positioning Methods selection [EDGEPOS] Select the Encoder pulse positioning.	Unsigned8	RW	No	0x00
		Setting range	0x00-0x01		
	0x00 :Specify Pulse Interval 0x01 :Specify Pulse Edge 0x07-0xFF:Reserved ■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. ■Select standard value for usual operation. *The function becomes valid through control source re-closing.				



Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x03	In-Position Signal/ Position Deviation Monitor [PDEVMON] Select in-position signal (INP) and Position deviation monitor output before and after passing through the Position Command Filter.	Unsigned8	RW	No	0x00
		Setting range	0x00-0x01		

0x00:After Filter Compare Position command value with Feedback value after passing through the filter.
0x01:Before Filter Compare Position command value with Feedback value before passing through the filter.
■For 00 After_Filter, use the Position deviation value of the Position controller.
■For 01 Before_Filter, use the Position deviation value based on Position command before FF vibration suppressor control.
■With system parameter ID0A Position Control Selection at 01 Model 1 Model Following Control, or 02 Model 2 Model Following Vibration Suppress Control, 01:Before_Filter always operates no matter the selection.



Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x04	Velocity Window Unit Output Selection [VCMPUS] Sets the comparison method of the Velocity matching output.	Unsigned8	RW	No	0x00
		Setting range	0x00-0x01		

0x00:min-1 0x606D(rotation frequency setting:min^{-1})compare with setting value.
0x01:percent 0x202A(proportion setting:%)compare with setting value.
*The function becomes valid through control source re-closing.

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x05	Deviation Clear Selection [CLR] Sets ON/OFF of position deviation clear during servo OFF, and deviation clear signal treatment.	Unsigned8	RW	No	0x00
		Setting range	0x00-0x03		

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

Selection		Contents	
0x00	Type1	When Servo OFF -> Clear Deviation Deviation Clear Input =Level Detection	During servo OFF, Deviation clear is always executed. While Deviation clear input is ON, Deviation clear is always executed.
0x01	Type2	When Servo OFF -> Clear Deviation Deviation Clear Input =Edge Detection	At the edge of OFF->ON of Deviation clear input, Deviation clear is executed.
0x02	Type3	When Servo OFF -> NOT Clear Deviation Deviation Clear Input =Level Detection	During servo OFF, Deviation clear is not executed. (After servo ON, the motor may operate suddenly.)
0x03	Type4	When Servo OFF -> NOT Clear Deviation Deviation Clear Input =Edge Detection	During servo OFF, Deviation clear is not executed. (After servo ON, the motor may operate suddenly.)

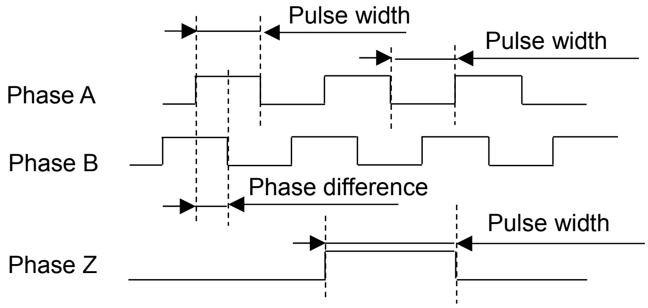
* Used, for example, to force the position variation counter inside the servo amplifier to zero from higher-level devices.

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x06	Torque (force) attainment function selection [TASEL] Sets detection method of torque (force) attainment setting (0X202E).	Unsigned8	RW	No	0x00
		Setting range	0x00 - 0x01		

Selection		Contents
00	TA/TZR	Sets by using the ratio of rated torque (force) of the motor. (100%= rated torque (force))
01	TA/TCOM	Sets by using the ratio of limit value of torque(force). (100%=limit value of torque (force))

0x20F1: Sensor Function Selection

Index	0x20F1 Sets the Sensor Function.		Object Code		Record
Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Number of entry	Unsigned8	RO	No	0x04
0x01	Serial encoder Clear Function Selection [ECLRFUNC]	Unsigned8	RW	No	0x00
	Selects the encoder clear method.	Setting range	0x00-0x01		
	* Use to clear Serial encoder warning when the warning is not automatically restored. * Valid when using with Battery Backup Method Absolute Encoder and Battery-less Absolute Encoder. * When used with Absolute Encoder for Incremental System, even 01:_Status_MultiTurn is selected; it works as the selection, Clear only encoder status. <u>0x00: Clear Encoder Status (Alarm and Warning) and Multi Turn Data</u> <u>0x01: Clear Only Encoder Status (Alarm and Warning)</u> * Parameter set when amplifier hardware matches to Serial Encoder. * Valid when Battery backup system absolute encoder, or Battery less absolute encoder is used.				
0x02	Encoder Digital Filter selection [ENFIL]	Unsigned8	RW	No	0x01
	This parameter can be set only when using pulse encoder. This sets digital filter of motor pulse encoder.	Setting range	0x00-0x07		
	* 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. * 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. <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> * This parameter can be set when amplifier hardware supports Pulse encoder.				



0x03	External Encoder Digital Filter selection [EX-ENFIL]	Unsigned8	RW	No	0x01
	This parameter can be set only when using fully closed controlfunciton.	Setting range	0x00-0x07		
[Full Close] [Linear]	■Pulse lower than the set value is eliminated as noise when noise superposition occurred in encoder signals. ■Consider Encoder resolution and Maximum rotation velocity of the servo motor in operation when selecting value. Set the value roughly less than 1/4 of the Encoder pulse width at Maximum rotation velocity. 0x00:Minimum Pulse Width=110ns(Minimum pulse Phase Difference 37.5ns) 0x01:Minimum Pulse Width=220ns(Minimum pulse Phase Difference 75ns) 0x02:Minimum Pulse Width=440ns(Minimum pulse Phase Difference 150ns) 0x03:Minimum Pulse Width=880ns(Minimum pulse Phase Difference 300ns) 0x04:Minimum Pulse Width= 75ns(Minimum pulse Phase Difference 37.5ns) 0x05:Minimum Pulse Width=150ns(Minimum pulse Phase Difference 75ns) 0x06:Minimum Pulse Width=300ns(Minimum pulse Phase Difference 150ns) 0x07:Minimum Pulse Width=600ns(Minimum pulse Phase Difference 300ns) 0x08-0x0F:Reserved *This parameter can be set when amplifier hardware supports Full-closed option.				
0x04	External Encoder Polarity Selection [EX-ENPOL]	Unsigned8	RW	No	0x00
	This parameter can be set only when using fully closed controlfunciton. Selects External pulse encoder signal polarity.	Setting range	0x00-0x07		
[Full Close] [Linear]	*This parameter can be used when amplifier hardware supports Full-closed option. 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 0x08-0x0F:Reserved *The function becomes valid through control source re-closing.				
0x05	CS offset ［CSOF］ Sets electrical degree of the motor.	Unsigned16	RW	No	0x0000 （0deg）
[Linear]	The Unit with hole sensor sets offset from phase U electrical degree through output edge of phase U hall effect sensor in terms of electrical degree.	Setting range	0x0000 - 0x0167 （0 - 359deg）		
	✔ This parameter is settable only under condition that amplifier hardware can support hall effect sensor input option. ✍ This function becomes effective after re-turning the control power supply on.				
0x06	CS normalization offset of phase Z ［ZPHOF］ Sets offset of phase Z signal to electrical degree of	Unsigned16	RW	No	0x0000 （0deg）
[Linear]	the motor. This function is valid when performing CS normalization with use of phase Z signal. Sets offset from phase U electrical degree 0 through the position of Z signal output in terms of electrical degree.	Setting range	0x0000 - 0x0167 （0 - 359deg）		
	✍ This function becomes effective after re-turning the control power supply on.				
0x07	Polarity selection on linear encoder ［ENCDIR］	Unsigned8	RW	No	0x00
[Linear]	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.)	Setting range	0x00 - 0x01		
	✍ This function becomes effective after re-turning the control power supply on.				
0x08	Magnetic pole position estimation frequency ［EMPFREQ］ Sets frequency for torque (force) command that is applied to	Unsigned16	RW	No	0x0032 （50Hz）
[Linear]	estimate magnetic pole position. ✔Change excitation frequency if amplifier hardware magnetic pole position estiation cannot be normally completed due to resonance of equipment.	Setting range	0x05 - 0x0064 （5 - 100Hz）		
	✍This function becomes effective after re-turning the control power supply on.				

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	0x03
0x01	Main Circuit Under-voltage (ALM_62) Detection [MPESEL]	Unsigned8	RW	No	0x01
		Setting range	0x00-0x01		
	When DC input power specification is selected, select whether the Main Circuit Under-voltage alarm should be detected or not. 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
	Select valid / invalid from the velocity control trouble detection.	Setting range	0x00-0x01		
	Trouble can be detected in operation patterns where the motor results in overshooting in response to commands; in these systems, please set as “invalid.” 0x00: invalid 0x01:valid				
0x03	Velocity Feedback Alarm (ALM_C3) Detection [FBKEEN]	Unsigned8	RW	No	0x01
	0x00:invalid 0x01:valid	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
	0x00-0x02:invalid 0x03: valid (error detected three times in row)	Setting range	0x00-0x08		
	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
	0x00, 0x01: invalid	Setting range	0x00-0xFF		
	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.				

0x20F3: Position Control Selection

Index	0x20F3	Selects the control characteristics and the control encoder in Cyclic SYNC Position mode (CSP) and Profile position operation 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
	Selects the model following control form and presence/absence. 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.		Setting range	0x00-0x02		
0x02	Position Loop Control, Encoder Selection [PLMODE]		Unsigned8	RW	No	0x00
	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.		Setting range	0x00-0x01		

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.		Unsigned8	RW	No	0xEF (120μs)
			Setting range	0x00-0xEF (0.5-120μs)		
			Unit	0.5μs		
	Delay Time (usec) = (Setting value + 1) / 2 "Example : 62.5us = 62.5 * 2 – 1 = 124 =Setting value:0x7C" *Adjust to the last slave axis.					

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 F47support 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).		Unsigned8	RW	No	0x00
			Setting range	0x00-0x01		
	0x00:Limit to minimum value of 0x6072, 0x60E0, 0x60E1(By normal torque limit method) 0x01:0x201E:Limit to minimum value of the Sequence Torque Operation Torque limit and the minimum value of 0x6072, 0x60E0, and 0x60E1. *For the operation sequence, see chapter 8, “SEMI F47 support function.”					

0x20F8: General Purpose Input Setting

Index	0x20F8	Select the function of General Purpose input 1, 2(CONT1, CONT2). Input time until all the function become enabled is 8ms.		Object Code		Record
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Number of entry		Unsigned8	RO	No	0x04
0x01	Positive Limit Switch Function [PLIMSW] Select the valid condition of the positive direction limit switch function.		Unsigned8	RW	No	0x00
			Setting range	0x00-0x05		
	■2-input amplifier (CONT1-2) The end number of amplifier model number: 0, 2, and 4 00: Always_Disable This function is always disabled. 01: Always_Enable This function is always enabled. 02: CONT1_ON This function is enabled when General Purpose Input CONT1 is ON. 03: CONT1_OFF This function is enabled when General Purpose Input CONT1 is OFF. 04: CONT2_ON This function is enabled when General Purpose Input CONT2 is ON. 05: CONT2_OFF This function is enabled when General Purpose Input CONT2 is OFF. 06: CONT3_ON (HWGOFF1)* This function is enabled when General Purpose Input CONT3 is ON. 07: CONT3_OFF (HWGOFF1)* This function is enabled when General Purpose Input CONT3 is OFF. 08: CONT4_ON (HWGOFF2)* This function is enabled when General Purpose Input CONT4 is ON. 09: CONT4_OFF (HWGOFF2)* This function is enabled when General Purpose Input CONT4 is OFF. *CONT3 and 4 are dedicated input for hardware gate off function. ■6-input amplifier（CONT1-6） The end number of amplifier model number: 1, 3, and 5 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. 08：CONT6_ON Function enabled when versatile input CONT6 is ON. 09：CONT6_OFF Function enabled when versatile input CONT6 is OFF. 06：CONT7_ON (HWGOFF1)* Function enabled when versatile input CONT7 is ON. 07：CONT7_OFF (HWGOFF1)* Function enabled when versatile input CONT7 is OFF. 08：CONT8_ON (HWGOFF2)* Function enabled when versatile input CONT8 is ON. 09：CONT8_OFF (HWGOFF2)* Function enabled when versatile input CONT8 is OFF. *CONT7 and 8 are dedicated input for hardware gate off function.					

0x02	Negative Limit Switch Function [NLIMSW] Select the valid condition of the negative direction limit switch function	Unsigned8	RW	No	0x00
		Setting range	0x00-0x09		
	The same as Sub Index:01(positive direction limit switch function.)				
0x03	External Trip Input Function [EXT-E] Sets the trip valid condition the same as the trip input of the external regenerative resistance.	Unsigned8	RW	No	0x00
		Setting range	0x00-0x09		
	The same as Sub Index:01(positive direction limit switch function.)				
0x04	Main Power Discharge Function [DISCHRGE] Sets the valid condition of the discharge function in case of main circuit power shutdown.	Unsigned8	RW	No	0x00
		Setting range	0x00-0x09		
	The same as Sub Index:01(positive direction limit switch function.)				
0x05	Emergency Stop Function [EMR] Sets the valid condition of the input function in case of emergency stop.	Unsigned8	RW	No	0x00
		Setting range	0x00-0x09		
	The same as Sub Index:01(positive direction limit switch function.)				
0x06 [Linear]	Detetion function of magnetic pole position ［CSET］ Sets valid condition for inputting fixed excitation operation on the linear motor without hall efefct sensor output.	Unsigned8	RW	No	0x00
		Setting range	0x00～0x0D		
	This selection functions the same way as SubIndex：01 (limit switch function in positive direction).				

* In the safety function mounted amplifier, this cannot be used as a general purpose input signal.
It will be exclusively the hardware gate off function input.

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	0x00-0x55 (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.

General output parameter list

Item	Setting value	Item	Setting value
The output is always OFF.	00:Always_OFF	The output is always ON.	01:Always_ON
The output is ON during Servo Ready complete.	02:S-RDY_ON	The output is OFF during Servo Ready complete.	03:S-RDY_OFF
The output is ON while the main power supply is turned on.	04:P-ON_ON	The output is OFF while the main power supply is turned on.	05:P-ON_OFF
The output is ON during the main power supply ON permission.	06:A-RDY_ON	The output is OFF during the main power supply ON permission.	07:A-RDY_OFF
The output is ON during motor excitation.	08:S-ON_ON	The output is OFF during motor excitation.	09:S-ON_OFF
The output is ON while holding brake excitation signal outputs.	0A:MBR-ON_ON	The output is OFF while holding brake excitation signal outputs.	0B:MBR-ON_OFF
The output is ON during torque (force) limiting.	0C:TLC_ON	The output is OFF during torque (force) limiting.	0D:TLC_OFF
The output is ON during velocity limiting.	0E:VLC_ON	The output is OFF during velocity limiting.	0F:VLC_OFF
The output is ON during low speed status.	10:LOWV_ON	The output is OFF during low speed status.	11:LOWV_OFF
The output is ON during speed attainment status.	12:VA_ON	The output is OFF during speed attainment status.	13:VA_OFF
The output is ON during speed matching status.	14:VCMP_ON	The output is OFF during speed matching status.	15:VCMP_OFF
The output is ON during zero speed status.	16:ZV_ON	The output is OFF during zero speed status.	17:ZV_OFF
The output is ON during In-Position status.	18:INP_ON	The output is OFF during In-Position status.	19:INP_OFF
The output is ON during In-Position Near status.	1A:NEAR_ON	The output is OFF during In-Position Near status.	1B:NEAR_OFF
The output is ON while command can be accepted.	1C:CMD-ACK_ON	The output is OFF while command can be accepted.	1D:CMD-ACK_OFF
The output is ON during gain switching.	1E:GC-ACK_ON	The output is OFF during gain switching.	1F:GC-ACK_OFF
The output is ON during velocity loop proportional control switching.	20:PCON-ACK_ON	The output is OFF during velocity loop proportional control switching.	21:PCON-ACK_OFF
The output is ON during control mode switching.	24:MS-ACK_ON	The output is OFF during control mode switching.	25:MS-ACK_OFF
The output is ON during positive over-travel status.	26:F-OT_ON	The output is OFF during positive over-travel status.	27:F-OT_OFF
The output is ON during negative over-travel status.	28:R-OT_ON	The output is OFF during negative over-travel status.	29:R-OT_OFF
The output is ON during excessive deviation warning status.	2A:WNG-OFW_ON	The output is OFF during excessive deviation warning status.	2B:WNG-OFW_OFF
The output is ON during over-load warning status.	2C:WNG-OLW_ON	The output is OFF during over-load warning status.	2D:WNG-OLW_OFF
The output is ON during regenerative over-load warning status.	2E:WNG-ROLW_ON	The output is OFF during regenerative over-load warning status.	2F:WNG-ROLW_OFF
The output is ON during battery warning.	30:WNG-BAT_ON	The output is OFF during battery warning.	31:WNG-BAT_OFF
The output is alarm Code Bit 5 (positive logic).	32:ALM5_ON	The output is alarm Code Bit 5 (negative logic).	33:ALM5_OFF
The output is alarm Code Bit 6 (positive logic).	34:ALM6_ON	The output is alarm Code Bit 6 (negative logic).	35:ALM6_OFF
The output is alarm Code Bit 7 (positive logic).	36:ALM7_ON	The output is alarm Code Bit 7 (negative logic).	37:ALM7_OFF
The output is ON during alarm status.	38:ALM_ON	The output is OFF during alarm status.	39:ALM_OFF
The output is ON during generic input CONT1 is ON.	3A:CONT1_ON	The output is OFF during generic input CONT1 is ON.	3B:CONT1_OFF
The output is ON during generic input CONT2 is ON.	3C:CONT2_ON	The output is OFF during generic input CONT2 is ON.	3D:CONT2_OFF
The output is ON during generic input CONT3 is ON.	3E:CONT3_ON	The output is OFF during generic input CONT3 is ON.	3F:CONT3_OFF
The output is ON during generic input CONT4 is ON.	40:CONT4_ON	The output is OFF during generic input CONT4 is ON.	41:CONT4_OFF
The output is ON during physical output is “0x60FE, 1:bit16=1”.	42:FOUT1_ON	The output is OFF during physical output is “0x60FE, 1:bit16=1”.	43:FOUT1_OFF
The output is ON during physical output is “0x60FE, 1:bit17=1”.	44:FOUT2_ON	The output is OFF during physical output is “0x60FE, 1:bit17=1”.	45:FOUT2_OFF
The output is always OFF.	46:Always_OFF	The output is always OFF.	47:Always_OFF
The output is always OFF.	48:Always_OFF	The output is always OFF.	48:Always_OFF
The output is ON during main circuit power is charging,	4A:CHARGE_ON	The output is OFF during main circuit power is charging,	4B:CHARGE_OFF
The output is OFF during dynamic brake is operating.	4C:DB_OFF	The output is ON during dynamic brake is operating.	4D:DB_ON
The output is ON during magnetic pole position estimation is finished.	4E:CRDY_ON	The output is OFF during magnetic pole position estimation is finished.	4F:CRDY_OFF
The output is ON during Servo Ready 2 complete.	50:S-RDY2_ON	The output is OFF during Servo Ready 2 complete.	51:S-RDY2_OFF
The output is ON during PCMD=0 and In-position Status.	52:INPZ_ON	The output is OFF during PCMD=0 and In-position Status.	53:INPZ_OFF
The output is ON during power supply shortage warning.	54:PEWNG_ON	The output is OFF during power supply shortage warning.	55:PEWNG_OFF
The ourput is ON in during detecting torque (force) attainment.	56:TA_ON	The ourput is OFF in during detecting torque (force) attainment.	57：TA_OFF
When versatile input CONT5 is ON, output is ON	58:CONT5_ON	When versatile input CONT5 is ON, output is OFF	59:CONT5_OFF
When versatile input CONT6 is ON, output is ON	5A:CONT6_ON	When versatile input CONT6 is ON, output is OFF	5B:CONT6_OFF
When versatile input CONT7 is ON, output is ON	5C:CONT7_ON	When versatile input CONT7 is ON, output is OFF	5D:CONT7_OFF
When versatile input CONT8 is ON, output is ON	5E:CONT8_ON	When versatile input CONT8 is ON, output is OFF	5F:CONT8_OFF
Reserved	FF: RESERVE	-	-

0x20FA: Extended Station Alias

Index	0x20FA	Extended parameter to set the Station Alias 0xF.	Object Code	Variable

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Number of entry	Unsigned8	RO	No	0x02
0x01	Extended unit address ［EXUNITS］	Unsigned8	RW	No	0x00
		Setting range	0x00～0xFF		
	Parameter to set address 256-65535 in the intrinsic slave Station Alias Reg:0x0012, 0x0013. When the amplifier is initialized, the Station Alias value is calculated by adding the rotary switch setting value: bit3 - 0(0x0 - 0xF) and 0x20FA.02 EXALIAS（bit7～4）to this Address value. *The function becomes valid through control source re-closing.				
0x02	Extended Alias Number ［EXALIAS］	Unsigned8	RW	No	0x00
		Setting range	0x00～0x0F		
	Parameter to set address（bit7～4）in the intrinsic slave Station Alias Reg:0x0012, 0x0013. When the amplifier is initialized, the Station Alias value is calculated by adding the rotary switch setting value: bit3 - 0(0x0 - 0xF) and 0x20FA.01 EXUNITS（256-65535）to this Address value. *The function becomes valid through control source re-closing.				

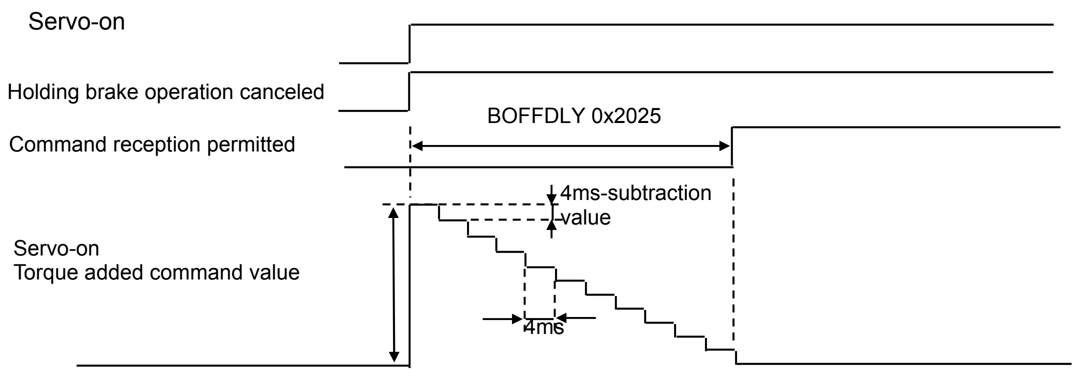
0x20FB: Torque command addition during servo-on

Index	0x20FB	Function to add torque command value to prevent equipment-self weight fall during the servo-on period of holding brake operation cancelation delay (delay time from motor excitation to command enabled).	Object Code	Variable

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Torque command addition during servo-on ［SONTCSET］	Signed16	RW	No	0x0000
	Torque additional value is decreased every 4 ms so that torque addition instructions may be 0.0% after the servo-on period of holding brake operation cancellation delay progress.	Setting range	0xFC18～0x03E8 （-100.0～100.0%）		

✍For the setting of 0x2000 bit15=0, parameter change is saved to EEPROM, and changed parameter will be valid after control power cycle.

For the setting of 0x2000 bit15=1, parameter change is not saved to EEPROM, and SDO value will be valid in real time.



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
		Setting range	0x00-0x02		
	0x00:3φAC(three-phase AC input) 0x01:1φAC(single phase AC input) 0x02:DC (DC power source input) supplied from the power supply unit 0x03 - 0xFF:Reserved *The function becomes valid through control source re-closing.				
0x02	Regenerative Resistor Selection [RGKIND] Selects the presence/absence of regenerative resistance and the connection forms.	Unsigned8	RW	No	-
		Setting range	0x00-0x02		
	0x00:regenerative resistance disconnected 0x01:embedded regenerative resistance used (used as discharge resistance in the power regenerating unit) 0x02:external regenerative resistance used (used as discharge resistance in the power regenerating unit) 0x03 - 0xFF:Reserved *The function becomes valid through control source re-closing.				
0x03	Setup Communication Baud Rate [COMBAUD] Selects the baud rate when PC communication is performed by the setup software.	Unsigned8	RW	No	0x05
		Setting range	0x03-0x06		
	0x03 : 9600bps 0x04 : 19200bps 0x05 : 38400bps 0x06 : 57600bps 0x00-0x02,0x07-0xFF:Reserved *The function becomes valid through control source re-closing.				

0x20FE: Motor code

Index	0x20FE	Sets the code of the drive motor.		Object Code		Variable
Sub-Idx	Description		Data Type	Access	PDO	Sub-Idx
0x00	Combination Motor code [MOCODE]		Unsigned16	RW	No	0x00
	Sets the combination motor code. The motor code list can be set via communication.		Setting range	0x0000-0xFFFF		

■Rotary motor (200V)

Series	Motor code	Servo motor model number	Input type	Amplifier capacity	Flange size	Output	Maximum speed
P Series	0x100C	P10B13150B	AC200V	30A	□130mm	1.5kW	2,000 min^{-1}
	0x000D	P10B18200B	AC200V	50A	□180mm	2.0kW	2,000 min^{-1}
	0x002D	P20B13400H	AC200V	100A	□130mm	4.0kW	3,000 min^{-1}
	0x020A	P30B06008D	AC200V	15A	□60mm	80W	5,000 min^{-1}
	0x02B0	P30B08040D	AC200V	30A	□80mm	400W	4,500 min^{-1}
	0x021C	P50B02001D	AC200V	15A	□20mm	10W	5,000 min^{-1}
	0x0278	P50B02002D	AC200V	15A	□20mm	20W	5,000 min^{-1}
	0x0282	P50B04006D	AC200V	15A	□42mm	60W	4,500 min^{-1}
	0x0283	P50B04010D	AC200V	15A	□42mm	100W	4,500 min^{-1}
	0x0208	P50B05008D	AC200V	15A	□54mm	80W	4,500 min^{-1}
	0x0286	P50B05020D	AC200V	15A	□54mm	200W	4,500 min^{-1}
	0x027C	P50BA2004D	AC200V	15A	□28mm	40W	5,000 min^{-1}
	0x0273	P50B05030K	AC200V	50A	□50mm	370W	10,000 min^{-1}
	0x01F1	P50B07030D	AC200V	15A	□76mm	300W	4,500 min^{-1}
	0x028A	P50B07040D	AC200V	30A	□76mm	400W	4,500 min^{-1}
	0x0217	P50B08100D	AC200V	30A	□86mm	1kW	4,500 min^{-1}
	0x028C	P50B08050D	AC200V	30A	□86mm	500W	4,500 min^{-1}
	0x0312	P60B13100H	AC200V	30A	□130mm	1.0kW	3,000 min^{-1}
	0x02C1	P60B13100H	AC200V	50A	□130mm	1.0kW	3,000 min^{-1}
	0x02C2	P60B13150H	AC200V	50A	□130mm	1.5kW	3,000 min^{-1}
	0x02D2	P60B13200B	AC200V	50A	□130mm	2.0kW	2,000 min^{-1}
	0x02D7	P60B18200B	AC200V	50A	□180mm	2.0kW	2,000 min^{-1}
	0x72C5	P60B18200H	AC200V	150A	□180mm	2.0kW	3,000 min^{-1}
	0x02DE	P60B2215KB	AC200V	300A	□220mm	15.0kW	2,000 min^{-1}
	0x02DF	P60B13150B	AC200V	50A	□130mm	1.5kW	2,000 min^{-1}
	0x0310	P60B13150B	AC200V	30A	□130mm	1.5kW	2,000 min^{-1}
	0x02CF	P60B18350M	AC200V	50A	□180mm	2.7kW	1,500 min^{-1}
	0x030A	P60B22700M	AC200V	150A	□220mm	7.0kW	1,500 min^{-1}
	0x02E4	P80B22250H	AC200V	100A	□220mm	2.5kW	3,000 min^{-1}
	0X02E9	P80B22350R	AC200V	100A	□220mm	3.5kW	2,500 min^{-1}
	0x32F3	P80C18050B	AC200V	15A	□180mm	270W	2,000 min^{-1}
Q1 Series	0x0043	Q1AA04010D	AC200V	15A	□40mm	100W	5,000 min^{-1}
	0x0044	Q1AA06020D	AC200V	15A	□60mm	200W	5,000 min^{-1}
	0x0046	Q1AA07075D	AC200V	30A	□76mm	750W	5,000 min^{-1}
	0x0047	Q1AA10100D	AC200V	50A	□100mm	1kW	5,000 min^{-1}
	0x0048	Q1AA10150D	AC200V	50A	□100mm	1.5kW	4,500 min^{-1}
	0x0049	Q1AA10200D	AC200V	100A	□100mm	2.0kW	5,000 min^{-1}
	0x004A	Q1AA10250D	AC200V	100A	□100mm	2.5kW	5,000 min^{-1}
	0x004C	Q1AA12200D	AC200V	100A	□120mm	2.0kW	5,000 min^{-1}
	0x004D	Q1AA12300D	AC200V	100A	□120mm	3.0kW	5,000 min^{-1}
	0x504E	Q1AA13300D	AC200V	100A	□130mm	3.0kW	4,500 min^{-1}
	0x004F	Q1AA13400D	AC200V	150A	□130mm	4.0kW	4,500 min^{-1}
	0x0050	Q1AA13500D	AC200V	150A	□130mm	5.0kW	4,500 min^{-1}
	0x0051	Q1AA18450M	AC200V	150A	□180mm	4.5kW	1,500 min^{-1}
	0x0052	Q1AA18750H	AC200V	300A	□180mm	7.5kW	3,000 min^{-1}
	0x0058	Q1AA13500H	AC200V	150A	□130mm	5.0kW	3,000 min^{-1}
	0x00A8	Q1AC06040V	AC200V	30A	□60mm	400W	8,000 min^{-1}

Series	Motor code	Servo motor model number	Input type	Amplifier capacity	Flange size	Output	Maximum speed
Q2 Series	0x0061	Q2AA04006D	AC200V	15A	□42mm	60W	5,000 min^{-1}
	0x0062	Q2AA04010D	AC200V	15A	□42mm	100W	5,000 min^{-1}
	0x0065	Q2AA05020D	AC200V	15A	□54mm	200W	5,000 min^{-1}
	0x006A	Q2AA08050D	AC200V	30A	□86mm	500W	5,000 min^{-1}
	0x006B	Q2AA08075D	AC200V	50A	□86mm	750W	5,000 min^{-1}
	0x106C	Q2AA08100D	AC200V	30A	□86mm	1.0kW	5,000 min^{-1}
	0x006C	Q2AA08100D	AC200V	50A	□86mm	1.0kW	5,000 min^{-1}
	0x006D	Q2AA10100H	AC200V	50A	□100mm	1.0kW	3,500 min^{-1}
	0x00B3	Q2AA10150V	AC200V	50A	□100mm	1.5kW	3,400 min^{-1}
	0x00DD	Q2AA10150B	AC200V	30A	□100mm	1.5kW	3,000 min^{-1}
	0x006F	Q2AA13050H	AC200V	30A	□130mm	500W	3,500 min^{-1}
	0x0070	Q2AA13100H	AC200V	50A	□130mm	1.0kW	3,000 min^{-1}
	0x0071	Q2AA13150H	AC200V	50A	□130mm	1.5kW	3,500 min^{-1}
	0x0072	Q2AA13200H	AC200V	100A	□130mm	2.0kW	3,500 min^{-1}
	0x00E0	Q2AA13300B	AC200V	100A	□130mm	3.0kW	2,000 min^{-1}
	0x0073	Q2AA18200H	AC200V	100A	□180mm	2.0kW	3,000 min^{-1}
	0x0074	Q2AA18350H	AC200V	150A	□180mm	3.5kW	3,500 min^{-1}
	0x0075	Q2AA18450H	AC200V	150A	□180mm	4.5kW	3,000 min^{-1}
	0x0076	Q2AA18550R	AC200V	150A	□180mm	5.5kW	2,500 min^{-1}
	0x007A	Q2AA22550B	AC200V	150A	□220mm	5.5kW	2,000 min^{-1}
	0x007B	Q2AA22700S	AC200V	150A	□220mm	7.0kW	1,000 min^{-1}
	0x00CA	Q2AA08075H	AC200V	30A	□86mm	750W	3,000 min^{-1}
	0x00D5	Q2AA18550H	AC200V	300A	□180mm	5.5kW	3,000 min^{-1}
	0x00D6	Q2AA18750L	AC200V	300A	□180mm	7.5kW	3,000 min^{-1}
	0x00D8	Q2AA2211KV	AC200V	300A	□220mm	11.0kW	2,000 min^{-1}
	0x00D9	Q2AA2215KV	AC200V	300A	□220mm	13kW	2,000 min^{-1}
Q4 Series	0x0121	Q4AA1811KB	AC200V	300A	□180mm	11kW	2,000 min^{-1}
	—	—	—	—	—	—	—
R1 Series	0x0109	R1AA18550H	AC200V	300A	□180mm	5.5kW	3,000 min^{-1}
	0x010D	R1AA1811KR	AC200V	300A	□180mm	11kW	2,500 min^{-1}
	0x010E	R1AA1815KB	AC200V	300A	□180mm	15kW	2,000 min^{-1}
	0x010F	R1AA18750L	AC200V	300A	□180mm	7.5kW	3,000 min^{-1}

Series	Motor code	Servo motor model number	Input type	Amplifier capacity	Flange size	Output	Maximum speed
R2 Series	0x0111	R2AA18750M	AC200V	150A	□180mm	7.5kW	1,500 min^{-1}
	0x0181	R2AA04003F	AC200V	15A	□40mm	30W	6,000 min^{-1}
	0x7181	R2AA04003F	AC200V	30A	□40mm	30W	6,000 min^{-1}
	0x0182	R2AA04005F	AC200V	15A	□40mm	50W	6,000 min^{-1}
	0x0183	R2AA04010F	AC200V	15A	□40mm	100W	6,000 min^{-1}
	0x7183	R2AA04010F	AC200V	30A	□40mm	100W	6,000 min^{-1}
	0x0184	R2AA06010F	AC200V	15A	□60mm	100W	6,000 min^{-1}
	0x0185	R2AA06020F	AC200V	15A	□60mm	200W	6,000 min^{-1}
	0x7185	R2AA06020F	AC200V	30A	□60mm	200W	6,000 min^{-1}
	0x0186	R2AA06040F	AC200V	30A	□60mm	400W	6,000 min^{-1}
	0x1186	R2AA06040F	AC200V	15A	□60mm	400W	6,000 min^{-1}
	0x0187	R2AA08075F	AC200V	30A	□80mm	750W	6,000 min^{-1}
	0x01B1	R2AA08075F	AC200V	50A	□80mm	750W	6,000 min^{-1}
	0x0188	R2AA08040F	AC200V	30A	□80mm	400W	6,000 min^{-1}
	0x0189	R2AA06040H	AC200V	15A	□60mm	400W	3,000 min^{-1}
	0x018A	R2AA08020F	AC200V	15A	□80mm	200W	6,000 min^{-1}
	0x018C	R2AA13050D	AC200V	30A	□130mm	500W	5,000 min^{-1}
	0x018D	R2AA13120D	AC200V	50A	□130mm	1.2kW	5,000 min^{-1}
	0x018E	R2AA13120L	AC200V	50A	□130mm	1.2kW	5,000 min^{-1}
	0x118E	R2AA13120L	AC200V	30A	□130mm	1.2kW	3,000 min^{-1}
	0x018F	R2AA13050H	AC200V	30A	□130mm	550W	3,500 min^{-1}
	0x718F	R2AA13050H	AC200V	50A	□130mm	550W	3,500 min^{-1}
	0X0190	R2AA13200D	AC200V	100A	□130mm	2.0kW	5,000 min^{-1}
	0x0191	R2AA13120B	AC200V	30A	□130mm	1.2kW	2,000 min^{-1}
	0x0119	R2AA13180M	AC200V	50A	□130mm	1.8kW	4,000 min^{-1}
	0x11B2	R2AA13200F	AC200V	100A	□130mm	2.0kW	4,500 min^{-1}
	0x0192	R2AA13200L	AC200V	50A	□130mm	2.0kW	3,000 min^{-1}
	0x0193	R2AAB8100F	AC200V	50A	□86mm	1.0kW	6,000 min^{-1}
	0x0194	R2AAB8100H	AC200V	30A	□86mm	1.0kW	3,000 min^{-1}
	0x0195	R2AA22500L	AC200V	150A	□220mm	5.0kW	4,000 min^{-1}
	0x1195	R2AA22500L	AC200V	100A	□220mm	5.0kW	4,000 min^{-1}
	0x019F	R2AA10075F	AC200V	30A	□100mm	750W	6,000 min^{-1}
	0x019E	R2AA10100F	AC200V	50A	□100mm	1.0Kw	6,000 min^{-1}
	0x01B6	R2AA13180H	AC200V	50A	□130mm	1.8kW	3,500 min^{-1}
	0x01B7	R2AAB8075H	AC200V	30A	□86mm	750W	3,000 min^{-1}
	0x01B8	R2AA18550R	AC200V	150A	□180mm	5.5kW	2,500 min^{-1}
	0x01BA	R2AA18750A	AC200V	150A	□180mm	6.4kW	1,300 min^{-1}
	0x01BC	R2AA18350M	AC200V	50A	□180mm	2.7kW	1,500 min^{-1}
	0x011B	R2AA13180D	AC200V	100A	□130mm	1.8kW	5,000 min^{-1}
	0x0120	R2AA1811KR	AC200V	300A	□180mm	11kW	2,500 min^{-1}
	0x011C	R2AA18350L	AC200V	100A	□180mm	3.5kW	3,000 min^{-1}
	0x011D	R2AA18350D	AC200V	150A	□180mm	3.5kW	4,000 min^{-1}
	0x011E	R2AA18450H	AC200V	150A	□180mm	4.5kW	3,500 min^{-1}
	0x011F	R2AA18550H	AC200V	300A	□180mm	5.5kW	3,000 min^{-1}
	0x02BC	R2AA2215KR	AC200V	300A	□220mm	15kW	2,000 min^{-1}
	0x01B9	R2AA18750H	AC200V	300A	□180mm	7.5kW	3,000 min^{-1}
	0x0484	R2AA22700S	AC200V	150A	□220mm	7.0kW	1,000 min^{-1}
	0x0493	R2AA18550M	AC200V	100A	□180mm	5.5kW	1,500 min^{-1}
	0x04A8	R2AAB8100B	AC200V	50A	□86mm	0.82kW	2,000 min^{-1}
	0x51B9	R2AA18750H	AC200V	300A	□180mm	7.5kW	4,000 min^{-1}
R5 Series	0x049D	R5AA06020H	AC200V	15A	□60mm	200W	3,000 min^{-1}
	0x049E	R5AA06020F	AC200V	15A	□60mm	200W	6,000 min^{-1}
	0x049F	R5AA06040H	AC200V	15A	□60mm	200W	3,000 min^{-1}
	0x02BA	R5AA08075D	AC200V	30A	□80mm	750W	5,000 min^{-1}
	0x02BB	R5AA06040F	AC200V	30A	□60mm	400W	6,000 min^{-1}
	0x04A0	R5AA08075F	AC200V	30A	□80mm	750W	6,000 min^{-1}

Series							
Series	Motor code	Servo motor model number	Input type	Amplifier capacity	Flange size	Output	Maximum speed
Q2 Series	0x00C1	Q2EA07020D	AC100V	30A	□76mm	200W	5,000 min^{-1}
	—	—	—	—	—	—	—
R2 Series	0x0197	R2EA04003F	AC100V	15A	□40mm	30W	6,000 min^{-1}
	0x0198	R2EA04005F	AC100V	15A	□40mm	50W	6,000 min^{-1}
	0x019A	R2EA06010F	AC100V	15A	□60mm	100W	6,000 min^{-1}
	0x019B	R2EA06020F	AC100V	30A	□60mm	200W	6,000 min^{-1}
	0x019C	R2EA06008F	AC100V	15A	□60mm	80W	6,000 min^{-1}
	0x019D	R2EA04008F	AC100V	15A	□40mm	80W	6,000 min^{-1}
■Linear motor (200V)							
Series	Motor code	Servo motor model number	Input type	Amplifier capacity	Magnet width	Output	Maximum speed
Linear motor	0x0343	DS030C1N2E	AC200V	30A	30mm	160N	5.5 m/s
	0x0344	DS030C2N2E	AC200V	50A	30mm	320N	5.5 m/s
	0x0346	DS030C3N2E	AC200V	100A	30mm	480N	5.5 m/s
	0x0347	DS050C1N2E	AC200V	30A	50mm	260N	3.5 m/s
	0x0348	DS050C2N2E	AC200V	50A	50mm	520N	3.5 m/s
	0x034A	DS050C3N2E	AC200V	100A	50mm	780N	3.5 m/s
	0x034C	DS075C1N2E	AC200V	30A	75mm	400N	2.4 m/s
	0x034F	DS075C2N2E	AC200V	50A	75mm	800N	2.4 m/s
	0x0349	DS075C3N2E	AC200V	100A	75mm	1200N	2.4 m/s
	0x0350	DS100C1N2E	AC200V	50A	100mm	540N	4.0 m/s
	0x0351	DS100C2N2E	AC200V	100A	100mm	1080N	4.0 m/s
	0x0352	DS100C3N2E	AC200V	150A	100mm	1620N	4.0 m/s
	0x0353	DS150C1N2E	AC200V	50A	150mm	800N	2.6 m/s
	0x0354	DS150C2N2E	AC200V	100A	150mm	1600N	2.6 m/s
	0x034D	DS150C3N2E	AC200V	150A	150mm	2400N	2.6 m/s
	0x03D2	DD030C1Y4E	AC200V	50A	30mm	630N	3.0 m/s
	0x03D3	DD030C2Y4E	AC200V	100A	30mm	1260N	3.0 m/s
	0x03D4	DD030C3Y4E	AC200V	100A	30mm	1890N	3.0 m/s
	0x03D5	DD050C1Y2E	AC200V	100A	50mm	1050N	3.0 m/s
	0x03D6	DD050C2Y2E	AC200V	150A	50mm	2100N	3.0 m/s
	0x03D9	DD050C3Y2E	AC200V	300A	50mm	3150N	3.0 m/s
	0x03DA	DD075C1Y2E	AC200V	100A	75mm	1600N	3.0 m/s
	0x03DB	DD075C2Y2E	AC200V	150A	75mm	3200N	3.0 m/s
	0x03DC	DD075C3Y2E	AC200V	300A	75mm	4800N	3.0 m/s
	0x03DD	DD075C4Y2E	AC200V	300A	75mm	6400N	3.0 m/s
	0x03D7	***ACC10060***	***AC200V***	***30A***	***—***	***270N***	***2.0 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.					

✍ To be Initialized by motor code set on EEPROM at power-on.
When the motor code whose set parameter is differenet from EEPROM value, function becomes enabled when control power is re-turned on.
Re-turn on control power since alram “DE: parameter change completed” becomes active after new value is set to EEPROM.

✍ Automatic setting of motor parameter is performed when re-turning on the power supply after 0x8000 is set to any of motor code (0x20FE: 0x00), sensor division number code (0x20FF: 0x01), or sensor type code (0x20FF: 0x02). After that the three values are updated automatically.

0x20FF: Combination Encoder Selection

Index	0x20FF	Selects the motor sensor 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]		Unsigned16	RW	No	0xFFFF
	Sets the division number of the motor sensor.		Setting range	0x0000-0x000F		

When the incremental encoder is used

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

When the absolute sensor is used

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

when linear scale sensor is used.

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]

0x8000: Auto setting of motor parameter (When connected to applicable motor.)
0xFFFF: R ADVANCED - by division number setting (EEPROM setting value) of the Setup software.

Initialized by the encoder resolution number set in EEPROM at the turn-on state.
When the encoder resolution number set parameter is different from the EEPROM value set, the function will be enabled by control source re-closing. After the new value is set in EEPROM, alarm ”DE: parameter change completed” occurs, then re-close control source.

✍ Automatic setting of motor parameter is performed when re-turning on the power supply after 0x8000 is set to any of motor code (0x20FE: 0x00), sensor division number code (0x20FF: 0x01), or sensor type code (0x20FF: 0x02). After that the three values are updated automatically.

■ Automatic setting of motor parameter

There are two ways to perform automatic setting of motor parameter.

(1) 0x8000 is set to any of motor code (0x20FE: 0x00), sensor division number code (0x20FF: 0x01), or sensor type code (0x20FF: 0x02). After that all the three values are read out automatically from sensor on re-turning on the control power.

(2) When using sutomatic setting button on parameter setting display of R ADVANCED - setup software, the procedure is as follow:
  (a) Click automatic setting button on parameter setting display.
  (b) Click OK-buton if normally completed.
  (c) Set motor code of system parameter tub to 0xFFFF.
  (d) Re-turn on the control power.

✔ Refer to separate document, M0008363 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).

<table>
<tr><td rowspan="2">0x02</td><td>Encoder type [ENTYPE]
Selects the type of motor sensor.</td><td>Unsigned16
Setting range</td><td>RW</td><td>No</td><td>0xFFFF</td></tr>
<tr><td colspan="5">0x0000-0x0601 (Setting range)

Incremental system (Wire-saving incremental encoder: 4pairs)
0x0000: Wire-saving incremental encoder

Incremental System (Absolute encoder for incremental system)
0x0101:asynchronous encoder 2.5MHz(without multiple rotation output)
0x0201:asynchronous encoder 4.0MHz(without multiple rotation output)
*Used when the position at the turn-on state is zero.

■absolute system (multiple rotation backup system)
0x0300:optical asynchronous encoder 2.5MHz(with multiple rotation output)
0x0400:optical asynchronous encoder 4.0MHz(with multiple rotation output)
0x0600:resolver asynchronous encoder 2.5MHz(with multiple rotation output)
0x0600:resolver asynchronous encoder 4.0MHz(with multiple rotation output)

■Incremental system (multiple rotation output system)
0x0301:optical asynchronous encoder 2.5MHz(with multiple rotation output)
0x0401:optical asynchronous encoder 4.0MHz(with multiple rotation output)
0x0501:resolver asynchronous encoder 2.5MHz(with multiple rotation output)
0x0601:resolver asynchronous encoder 4.0MHz(with multiple rotation output)
*When the absolute sensor is used in the Incremental system, it is used when the turn-on state position is zero.
In this setting, battery trouble and battery warnings are not detected.

■Linear scale sensor (Only when using linear motor)
0x0800:signal/ A,B,Z ＋ S1･S2･S3 :CS normalization/ EU
0x0810:signal/ A,B,Z ＋ S1･S2･S3 :CS normalization/ phase Z
0x0820:signal/ A,B,Z ＋ S1･S2･S3 :CS normalization/ none
0x0830:signal/ omitted wiring incremental encoder :CS normalization/ phase Z
0x0830:signal/ limited to A,B, and Z :CS normalization/ phase Z
0x0850:signal/ limited to A,B, and Z :CS normalization/ software setting (Magnetic pole position estimation)
0x0860:signal/ limited to A,B, and Z :CS normalization/ software setting (forced setting)

■Setting with the Setup software configuration
0x8000: Auto setting of motor parameter (When connected to applicable motor.)
0xFFFF: R ADVANCED – with the sensor setting (EEPROM setting value) set in Setup software

Initialized by the sensor variety code set in EEPROM at the turn-on state.
When the sensor variety set parameter is different from the EEPROM value set, the function will be enabled by control source re-closing. After the new value is set in EEPROM, alarm ”DE: parameter change completed” occurs, then re-close control source.
✍Automatic setting of motor parameter is performed when re-turning on the power supply after 0x8000 is set to any of motor code (0x20FE: 0x00), sensor division number code (0x20FF: 0x01), or sensor type code (0x20FF: 0x02). After that the three values are updated automatically.</td></tr>
<tr><td rowspan="2">0x03

[Full Close]</td><td>External Encoder Resolution [EXPENRES]
Sets the external pulse encoder resolution used for full close control.</td><td>Unsigned32
Setting range
Unit</td><td>RW
0x000001F4-0x0001869F
Pulse</td><td>No</td><td>0x000007D0
(2,000P/R)</td></tr>
<tr><td colspan="5">Sets the (1 fold) pulse converted to one turn of the motor axis.
The position command is the division number of the 4-fold one turn pulse.
* The external encoder does not correspond to the absolute sensor.

Initialized by the encoder resolution number set in EEPROM at the turn-on state.
When the encoder resolution number set parameter is different from the EEPROM value set, the function will be enabled by control source re-closing. After the new value is set in EEPROM, alarm ”DE: parameter change completed” occurs, then re-close control source.</td></tr>
</table>

11) Monitor Parameter

0x2100: Status Word 1

Index	0x2100	Indicates servo amplifier status.		Object Code		Variable
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Status Word 1 Indicates various internal statuses of the amplifier.		Unsigned16	RO	Possible	-

MSB / LSB

zv	sact	eact	bcnt	eclrm	ecsm	near	inps
7	6	5	4	3	2	1	0

bit0:In-Position Monitor [INPS]
Set to "1" when the actual position is within the position window (0x6067) (indefinite except for csp.)

bit1:Near Range Monitor [NEAR]
SET TO "1" WHEN THE ACTUAL POSITION IS WITHIN THE NEAR RANGE (0X201F) (INDEFINITE EXCEPT FOR CSP.)

bit2: Encoder C phase monitor [ECSM]
Set to "1" when the C signal(Z) of the incremental encoder is input. (indefinite except for INC-E.)

bit3:Encoder Clear Monitor [ECLRM]
Set to "1" during encoder clearance.

bit4: Brake Control [BCNT]
This is a holding brake release timing output.
Set to "1" while the brake is released.

bit5: Actual position effective monitor [EACT]
Set to "1" when encoder signal can be read.

bit6: Command reception-enable monitor ［SACT］
Set to"1" when command reception enabled. This is the same value as Bit12 of control word except for profile position mode (PP).

bit7:Speed Zero Monitor [ZV]
Set to "1" when the actual velocity is within zero velocity range (0x2020) for 1ms or more.

MSB / LSB

-	-	-	-	Ta	vcmp	vp	ltg
15	14	13	12	11	10	9	8

bit8:Low Speed Monitor [LTG]
When the actual velocity is in the low velocity range or less (0x2021), set at "1."

bit9:Speed Attainment Monitor [VA]
When the actual velocity is in the speed attainment range or greater (0x2002), set at "1."

bit10:Speed Matching Monitor [VCMP]
When the actual velocity is within the set rotation set by 0x20F0.3 velocity window (velocity consistent) unit output selection, set at "1."
*When the velocity window (0x606D) selected: compare with the rotation number setting (min-1).
* When the velocity window (0x606D) selected: compare with the proportion setting (%).

Bit11: Torque (force) attainment monitor ［TA］
Set to "1" when internal velocity command is over Torque (force) attainment (0x202E).

bit15-12:
Reserved

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

MSB LSB

ALMCODE
7 6 5 4 3 2 1 0

bit7-0:Alarm Code defined by this servo amplifier
See the Alarm Code list.

0x2102: Description of Alarm Trace

Index	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	1st Latest Alarm [LASTAL1]	Unsigned32	RO	Possible	0x00000000
0x03	2nd Latest Alarm [LASTAL2]	Unsigned32	RO	Possible	0x00000000
0x04	3rd Latest Alarm [LASTAL3]	Unsigned32	RO	Possible	0x00000000
0x05	4th Latest Alarm [LASTAL4]	Unsigned32	RO	Possible	0x00000000
0x06	5th Latest Alarm [LASTAL5]	Unsigned32	RO	Possible	0x00000000
0x07	6th Latest Alarm [LASTAL6]	Unsigned32	RO	Possible	0x00000000
0x08	7th Latest Alarm [LASTAL7]	Unsigned32	RO	Possible	0x00000000

MSB LSB

ALMRUNTIME	ALMSTS	ALMCODE
31 - 16	15 - 8	7 - 0

bit7-0: Ararm Code defined by this servo amplifier
See the Ararm Code list.

bit15-8: Status when an alarm occurs
See the Status list.

bit32-16: Cumulative operating times when an alarm occurs
(The value at the time of shipment : 0H)
The cumulative operation times when an alarm occurs (2 Hour / LSB units)
Increments every two hours after control power on.
* Please use as a guide by the hour increments.

Status (ALMSTS) function

Status Display	ALMSTS	Status Display	ALMSTS
Power OFF	0x00	Servo ON 1(Reprocessing the electric current detector)	0x07
Power ON 1 (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 (Emergency Stop status)	0x0A
Servo ready	0x04	Emergency stop 2(CNOTRDY)	0x0B
Prepared for magnetic pole position detection (Reserved)	0x05	Reserved	0x0C-0x3F
Power ON 4	0x06		

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

MSB / LSB

tlw	-	vlw	tlw	rolw	olw	-	tpw
7	6	5	4	3	2	1	0

- bit0:Temperature Warning
- bit1:Reserved
- bit2:While Overload Warning
- bit3:While Regenerative Overload Warning
- bit4:Torque controlled
- bit5:Velocity command controlled
- bit6:Reserved
- bit7:Position deviation Warning

MSB / LSB

cpew	btw	maxw	minw	hlw	llw	-	pow
15	14	13	12	11	10	9	8

- bit8: Main circuit power being charged
- bit10:Forward direction Over-travel(positive direction)
- bit11:Reverse direction Over-travel(negative direction)
- bit12: While the minimum position is limited
- bit13: While the maximum position is limited
- bit14:While Battery Warning
- bit15: Control electricity and voltage decrease warning

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x02	Warning mask Selection [WARMSK] 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	0x4C8D

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	RW	Possible	0x001E (30 /s)
			Setting range	0x0001-0x0BB8 (1-3000 /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	RW	Possible	0x2710 (1000ms) proportional control
			Setting range	0x0003-0x2710 (0.3-1000 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	RW	Possible	0x0032 (50Hz)
			Setting range	0x0001-0x07D0 (1-2000 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	RW	Possible	0x00C8 (20ms)
			Setting range	0x0003-0x2710 (0.3-1000 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	RW	Possible	0x0064 (100%)
			Setting range	0x0000-0x3A98 (0-15000%)		
			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	RW	Possible	0x0258 (600Hz)
			Setting range	0x0001-0x07D0 (1-2000 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	RW	Possible	0x001E (30 /s)
			Setting range	0x0001-0x0BB8 (1-3000 /s)		
			Unit	1/s		

0x2105: Z-phase Signal Base Actual Position

Index	0x2105	Indicates the Actual Position from C 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)	Integer32	RO	Possible	-
		Setting range	0x00000000-0xFFFFFFFF (0-4294967295 Pulse)		
		Unit	Pulse		

0x2106: Internal Velocity Command Monitor

Index	0x2106	Has the actual velocity value calculated from the position censor. 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 (-2147483648-2147483647 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 (-3276.8-3276.7 %)		
		Unit	0.1 %		

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	0x0000～0x01F3 （0～499 %）		
		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	0x0000～0x01F3 （0～499 %）		
		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 (-32768-32767 °C)		
			Unit	°C		
	If Monitor value <= -10˚C, +75˚C <= Monitor value, it indicates temperature warning. 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.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.		Unsigned16	RO	Possible	0x0000 (0%)
			Setting range	0x0000-0xFFFF (0-655.35%)		
			Unit	0.01 %		
	PM (W)=400^2(V)/regenerative resistance value (ohm)×Regenerative resistor operation percentage (%)/100(%)					

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 actual position calculation method of 0x60E6 is absolute position mode (bit0 = 0), the following values are offsets to mechanical original point calculated by servo amplifier.		Integer32	RO	Possible	-
			Setting range	0x80000000-0x7FFFFFFF (-2147483648-2147483647Pulse)		
			Unit	Pulse		
	Coordinate offset (amplifier-calculated value) = Home offset (0x607C) - Home index position (0x210C) Master needs to calculate origin coordinate according to the value when actual position calculation method of 0x60E6 is in relative mode (bit0 = 1). ✔When calculation method 0x60E6 is in relative mode (bit0 = 1), home index of actual position (0x6064) can be set to zero by setting reversal value of the above value to Home offset (0x607C).					

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 sensor used.		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 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	-
			Setting range	0x80000000-0x7FFFFFFF (-2147483648-2147483647 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	0x03
0x01	Internal Control Cycle Actual Velocity 1 Actual position of 0x606C, 125μs ago.		Integer32	RO	Possible	-
0x02	Internal Control Cycle Actual Velocity 2 Actual position of 0x606C, 250μs ago.		Integer32	RO	Possible	-
0x02	Internal Control Cycle Actual Velocity 3 Actual position of 0x606C, 375μs ago.		Integer32	RO	Possible	-
The unit is the weight of Pulse/sec. *Data is filtered and the cutoff frequency is 250Hz.			Setting range	0x80000000-0x7FFFFFFF (-2147483648-2147483647 pps)		
			Unit	Pulse/sec		

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 position of 0x6077, 125μs ago.		Integer16	RO	Possible	-
0x02	Internal Control Cycle Actual Torque (force) 2 Actual position of 0x6077, 250μs ago.		Integer16	RO	Possible	-
0x03	Internal Control Cycle Actual Torque (force) 3 Actual position of 0x6077, 375μs ago.		Integer16	RO	Possible	-
Monitor unit is the 1/1000 units of the rated torque (force) and 0.1% / LSB.			Setting range	0x8000-0x7FFF (-3276.8-3276.7%)		
			Unit	0.1%		

0x2113: Minimum Communication Cycle Actual Position

Index	0x2113	Returns the Actual Position value latched every minimum communication cycle (500μs). Monitor unit is expressed by the resolution of the motor sensor used.		Object Code		Array
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Number of entry		Unsigned8	RO	No	0x03
0x01	Minimum Communication Cycle Actual Position 1 Actual position of 0x6064, 1 cycle ago (500μs ago).		Integer32	RO	Possible	-
0x02	Minimum Communication Cycle Actual Position 2 Actual position of 0x6064, 2 cycles ago (1ms ago).		Integer32	RO	Possible	-
0x03	Minimum Communication Cycle Actual Position 3 Actual position of 0x6064, 3 cycles ago (1.5ms ago).		Integer32	RO	Possible	-
			Setting range	0x80000000-0x7FFFFFFF (-2147483648-2147483647 Pulse)		
			Unit	Pulse		

0x2114: Minimum Communication Cycle Actual Velocity

Index	0x2114	Returns the Actual Velocity value latched every minimum communication cycle (500μs).		Object Code		Array
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Number of entry		Unsigned8	RO	No	0x03
0x01	Minimum Communication Cycle Actual Velocity 1 Actual velocity of 0x606C, 1 cycle ago (500μs ago).		Integer32	RO	Possible	-
0x02	Minimum Communication Cycle Actual Velocity 2 Actual velocity of 0x606C, 2 cycles ago (1ms ago).		Integer32	RO	Possible	-
0x03	Minimum Communication Cycle Actual Velocity 3 Actual velocity of 0x606C, 3 cycles ago (1.5ms ago).		Integer32	RO	Possible	-
The unit is the weight of Pulse/sec. *Data is filtered and the cutoff frequency is 250Hz.			Setting range	0x80000000-0x7FFFFFFF (-2147483648-2147483647 pps)		
			Unit	Pulse/sec		

0x2115: Minimum Communication Cycle Actual Torque (force)

Index	0x2115	Returns the Actual Torque (force) value latched every minimum communication cycle (500μs).		Object Code		Array
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Number of entry		Unsigned8	RO	No	0x03
0x01	Minimum Communication Cycle Actual Torque (force) 1 Actual torque of 0x6077, 1 cycle ago (500μs ago).		Integer16	RO	Possible	-
0x02	Minimum Communication Cycle Actual Torque (force) 2 Actual torque of 0x6077, 2 cycles ago (1ms ago).		Integer16	RO	Possible	-
0x03	Minimum Communication Cycle Actual Torque (force) 3 Actual torque of 0x6077, 3 cycles ago (1.5ms ago).		Integer16	RO	Possible	-
Monitor unit is the 1/1000 units of the rated torque (force) and 0.1% / LSB.			Setting range	0x8000-0x7FFF (-3276.8-3276.7%)		
			Unit	0.1 %		

0x2116： Actual Velocity 2

Index	0x2116	Has actual velocity value caluculated from position sensor. 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］ ✔Filter is processed data, and cutoff frequency is 20Hz	Integer32	RO	Possible	—
		Setting range	0x80000000～0x7FFFFFFF （－2147483648～2147483647 pps）		
		Unit	Pulse／sec		

0x211F: Digital inputs 2

Index	0x211F	This object monitors 16 bits of low ranks of 0x60FD.	Object code		Record
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Digital input monitor [DINPUTU16] Monitor general-purpose input. 1: Photocoupler is on.		Unsigned16	RO	Possible	-
			Display range	0x0000-0xFFFF		

MSB				LSB
Reserved	EMR	Home	Positive limit	Negative limit
15･･･4	3	2	1	0

0x21FD: Firmware Identify Number

Index	0x21FD	Indicates the reserved word that identifies a firmware of servo amplifier.	Object code		Variable
Sub-Idx	Description	Data Type	Access	PDO	Value
0x00	Firmware Identify Number ［FIRMID］ Indicates first 8 characters of firmware filename.	Visible String (Unsigned64)	RO	No	Character String (-)
	To avoid downloading irregular firmware file, slave application confirms that first 8 characters of servo amplifier firmware filename matches to the reserved word written in this function. ✔When downloading a firmware through FoE protocol in the Bootstrap state, please confirm that the first 8 characters of servo amplifier firmware filename matches to the reserved word written in this function.				

	LSB							MSB
	P	0	0	0	2	7	9	4
Byte	1	2	3	4	5	5	7	8

0x21FE: Combination Motor Code Monitor

<table>
<tr><td>Index</td><td>0x21FE</td><td colspan="2">Indicates the motor code used in servo amplifier.</td><td colspan="2">Object code</td><td>Variable</td></tr>
<tr><td>Sub-Idx</td><td colspan="2">Description</td><td>Data Type</td><td>Access</td><td>PDO</td><td>Initial value</td></tr>
<tr><td rowspan="2">0x00</td><td colspan="2" rowspan="2">Motor Code Monitor
[MOCODEMON]
Indicates the motor code set in servo amplifier.

■When automatic setting of motor parameter is NOT used
It becomes same with the value set to the Motor Code (0x20FE: 0x00) at the time of control power turned on.
It is not reflected until after control power cycle even if rewrite the set value of Motor Code (0x20FE: 0x00).

■When automatic setting of motor parameter is used
It becomes the value read from encoder at the time of control power turned on.
It is not reflected until after control power cycle even if rewrite the set value of Motor Code (0x20FE: 0x00).

✔For the motor code, refer the table in 0x20FE.</td><td>Unsigned16</td><td>RO</td><td>No</td><td>—</td></tr>
<tr><td>Display range</td><td colspan="3">0x0000-0xFFFF</td></tr>
</table>

0x21FF: Combination Encoder Selection Monitor

<table>
<tr><td>Index</td><td>0x21FF</td><td colspan="2">Indicates the encoder resolution code/encoder type code used in servo amplifier.</td><td colspan="2">Object code</td><td>Array</td></tr>
<tr><td>Sub-Idx</td><td colspan="2">Description</td><td>Data Type</td><td>Access</td><td>PDO</td><td>Initial value</td></tr>
<tr><td>0x00</td><td colspan="2">Number of entry</td><td>Unsigned8</td><td>RO</td><td>No</td><td>0x02</td></tr>
<tr><td rowspan="2">0x01</td><td colspan="2" rowspan="2">Encoder Resolution Setting Monitor
[ENCODEMON]
Indicates the encoder resolution code set in servo amplifier.

■When automatic setting of motor parameter is NOT used
It becomes same with the value set to the Encoder Resolution Setting (0x20FF: 0x01) at the time of control power turned on.
It is not reflected until after control power cycle even if rewrite the set value of Encoder Resolution Setting (0x20FF: 0x01).

■When automatic setting of motor parameter is used
It becomes the value read from encoder at the time of control power turned on.
It is not reflected until after control power cycle even if rewrite the set value of Encoder Resolution Setting (0x20FF: 0x01).

✔For the encoder resolution code, refer the table in 0x20FF: 0x01.</td><td>Unsigned16</td><td>RO</td><td>No</td><td>—</td></tr>
<tr><td>Display range</td><td colspan="3">0x0000-0xFFFF</td></tr>
<tr><td rowspan="2">0x02</td><td colspan="2" rowspan="2">Encoder Type Monitor
[ENTYPEMON]
Indicates the encoder type code set in servo amplifier.

■When automatic setting of motor parameter is NOT used
It becomes same with the value set to the Encoder Type (0x20FF: 0x02) at the time of control power turned on.
It is not reflected until after control power cycle even if rewrite the set value of Encoder Type (0x20FF: 0x02).

■When automatic setting of motor parameter is used
It becomes the value read from encoder at the time of control power turned on.
It is not reflected until after control power cycle even if rewrite the set value of Encoder Type (0x20FF: 0x02).

✔For the encoder type code, refer the table in 0x20FF: 0x02.</td><td>Unsigned16</td><td>RO</td><td>No</td><td>—</td></tr>
<tr><td>Display range</td><td colspan="3">0x0000-0xFFFF</td></tr>
</table>

8

8. Operation

8.1 Standard setting value upon shipment

The system parameters setting value upon shipment from the factory is shown below.

■ Servo Amplifier Model Number:RS2○##A■K□

ID	Name	Code	Setting Value		Object
00	Main Circuit Power Input Classification	○ : A ○ : E	200V-input 100V-input	00 : _AC_3-Phase 01 : _AC_Single-Phase	0x20FD.1: MPWRIN
01	Regenerative Resistance Selection	□ : A □ : L	With resistence No istence	01 : Built-in_R 02 : External_R	0x20FD.2: RGKIND
02	Motor Code	## : 01 ## : 03 ## : 05 ## : 10 ## : 15 ## : 30	200V-input	015A : 0x0181 (R2AA04003F) 030A : 0x0186 (R2AA06040F) 050A : 0x018D (R2AA13120D) 100A : 0x0190 (R2AA13200D) 150A : 0x004F (Q1AA13400D) 300A : 0x00D5 (Q2AA18550H)	0x20FE.0: MOCODE
		## : 01 ## : 03	100V-input	015A : 0x0198 (R2AA04005F) 030A : 0x019B (R2AA06020F)	
03	Sensor Division Number Code	■ : 0 ■ : 8	Absolute : 0x0006 (131,072FMT) Incremental : 0x0005 (2,000P/R)		0x20FF.1: ENCODE
04	Sensor Classification Code	■ : 0 ■ : 8	Absolute : 0x0300 (Synchronous Communication 2.5Mhz High-rotation backup method) Incremental : 0x0000 (Wiring-saving Incremental Encoder)		0x20FF.2: ENTYPE
05	Extension Station Alias	-	00:PA_S_2.5M		0x20FA.0: EXALOAS
06	Operation Mode	-	0x00 (No Mode, No Mode Definitions)		0x6060.0: OPMODE
07	Position Control Selection	-	00:Standard		0x20F3.0: PCNTSEL

* Please confirm with separate volume M0008363 for operation methods of Setup Software

8.2 Test opeartion

1) Installation and Wiring

Confirm the installation and wiring of the servo amplifier and servo motor.

Process	Items and Contents
1	Installation ■ Install servo amplifier and servo motor according to “Installation 3-1”. Servo motor shaft should be in disengaged state and machine should not be connected. 
2	Wiring / Connecting → Input Power ■ Power supply wire, servo motor and host device, however, do not connect CN0 (Port 0) / CN1 (Port 1) to servo amplifier after wiring. ■ 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)”. ■ When 7 segment LED does not light “≡” through main circuit power input, take appropriate measures based on “Troubleshooting (Chapter 11)”.

2) Safe Torque OFF Function

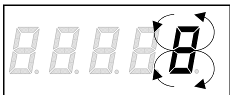
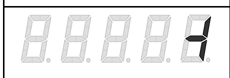
When using a product that corresponds to the Safe Torque OFF function, please check the function followed with a Confirmation Test (Chapter 13) to verify normal operation.

3) Movement Confirmation

Perform JOG operations using Setup Software or Digital Operator.

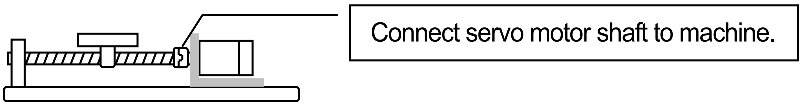
<table>
<tr><th>Process</th><th>Items and Contents</th></tr>
<tr><td rowspan="2">1</td><td>Input signal check: Generic Input signals (CN3)</td></tr>
<tr><td>Select Input signals to be used from General parameter Group9 and assign in CONT1, and CONT2.
<table>
<tr><th></th><th></th><th>Factory Shipment Setting Value</th></tr>
<tr><th>Input Signal</th><th>CN3 Pin No.</th><th>Setting Value</th></tr>
<tr><td>CONT1</td><td>5, 6</td><td>00:Always_Disable</td></tr>
<tr><td>CONT2</td><td>7, 8</td><td>00:Always_Disable</td></tr>
</table>
* The factory default gives no assignment function to the general signal.</td></tr>
<tr><td rowspan="2">2</td><td>Output signal check: Generic Output signals (CN3)</td></tr>
<tr><td>■ Select Output signals to be used from General parameter Group9 and assign in OUT1, and OUT2.
<table>
<tr><th></th><th></th><th colspan="2">Factory Shipment Setting Value</th></tr>
<tr><th>Output Signal</th><th>CN3 Pin No</th><th>Setting Value</th><th>Object: Index, Sub-index</th></tr>
<tr><td>OUT1</td><td>1, 2</td><td>42:FOUT1_ON</td><td>0x20F9,0x01 (OUT1)</td></tr>
<tr><td>OUT2</td><td>3, 4</td><td>44:FOUT2_ON</td><td>0x20F9,0x01 (OUT2)</td></tr>
</table></td></tr>
<tr><td rowspan="2">3</td><td>Input/Output Signal Check</td></tr>
<tr><td>■ Check that the set Input/Output signals are functioning normally with the monitor. Refer to “Monitor Functions (chapter 10)” for monitor explanation.

◆ Check using Setup Software with monitor in menu.
Read separate manualM0008363 for Setup Software operations.
◆ When checking with “Digital Operator”
Refer to “Section 10.6 Trial operation for digital opeartot operation method.</td></tr>
<tr><td rowspan="3">4</td><td>JOG Operation (Input Servo ON signal)</td></tr>
<tr><td>■ Performs JOG operation without connection motor shaft to machine under disengaged condition.
■ Check that servo motor rotates in both Forward and Inverse directions.
■ Rotaion direction of JOG operation is reverse to the one if communication on EtherCAT.
◆ Operating with “Setup Software”
Select JOG operation from Test Run in menu. Read separate manual M0008363 for Setup Software operations.
◆ Checking and Setting method with “Digital Operator”
Refer to “Section 10.6 Test operation for digital opeartot operation method.</td></tr>
<tr><td>■ Input Servo ON signal. Confirm that motor excitation and Digital Operator display on the front of the servo amplifier shows the “8” shape.

The following display indicates servo-on state.
<table>
<tr><td></td><td>・Servo-on state
“8” is indicated continuously.</td></tr>
</table>
The following display indicates forward/ reverse rotation limit state.
<table>
<tr><td></td><td>Forward rotation side limit state. Forward rotation side over travel state in position and velocity control form.</td></tr>
<tr><td></td><td>Inverse rotation side limit state. Inverse rotation side overt ravel state in position and velocity control form.</td></tr>
</table>
■ Setting for the limit switch function can be changed in general parameter Group9 ID00, ID01.</td></tr>
</table>

4) Machine Movement Check

Connect servo motor shaft to machine and check movement.

<table>
<tr><th>Process</th><th colspan="2">Items and Contents</th></tr>
<tr><td rowspan="2">1</td><td colspan="2">Connect to machine</td></tr>
<tr><td colspan="2">■ Connect motor shaft to machine.


■ 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.
■ Be prepared to stop immediately in case of abnormal movement.</td></tr>
<tr><td rowspan="2">2</td><td colspan="2">Operation</td></tr>
<tr><td colspan="2">■ Input commands of actual operation patterns and operate machine.
■ 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.</td></tr>
<tr><td>3</td><td>Power OFF</td><td>Turn OFF power after turning OFF Servo ON signal.</td></tr>
</table>

8.3 ESC Power ON Sequence

Shows RS2 EtherCAT slave amplifier power ON sequence at input of control power supply.

1 Power ON : Control voltage reaches operational voltage of ESC

⇩

2 PLL Clock : Output PLL clock

⇩

3 Reset Cancel: Starts ESC operation. Prohibits memory access until SII EEPROM is loaded .
Access enabled for μ controller after reset cancellation.

⇩

4 Establish Link : Starts EtherCAT communication. Accessible to master.
(Setting data for μ controller inside ESC also prohibits access.)
EEPROM load : Access will be enabled only when EEPROM load to ESC success.
- ESC setting register initialization completed
- μ controller starts operation
- Changes to 0x0110.1=1
- Process data RAM enabled
- ESM of ESC reaches "Init" state

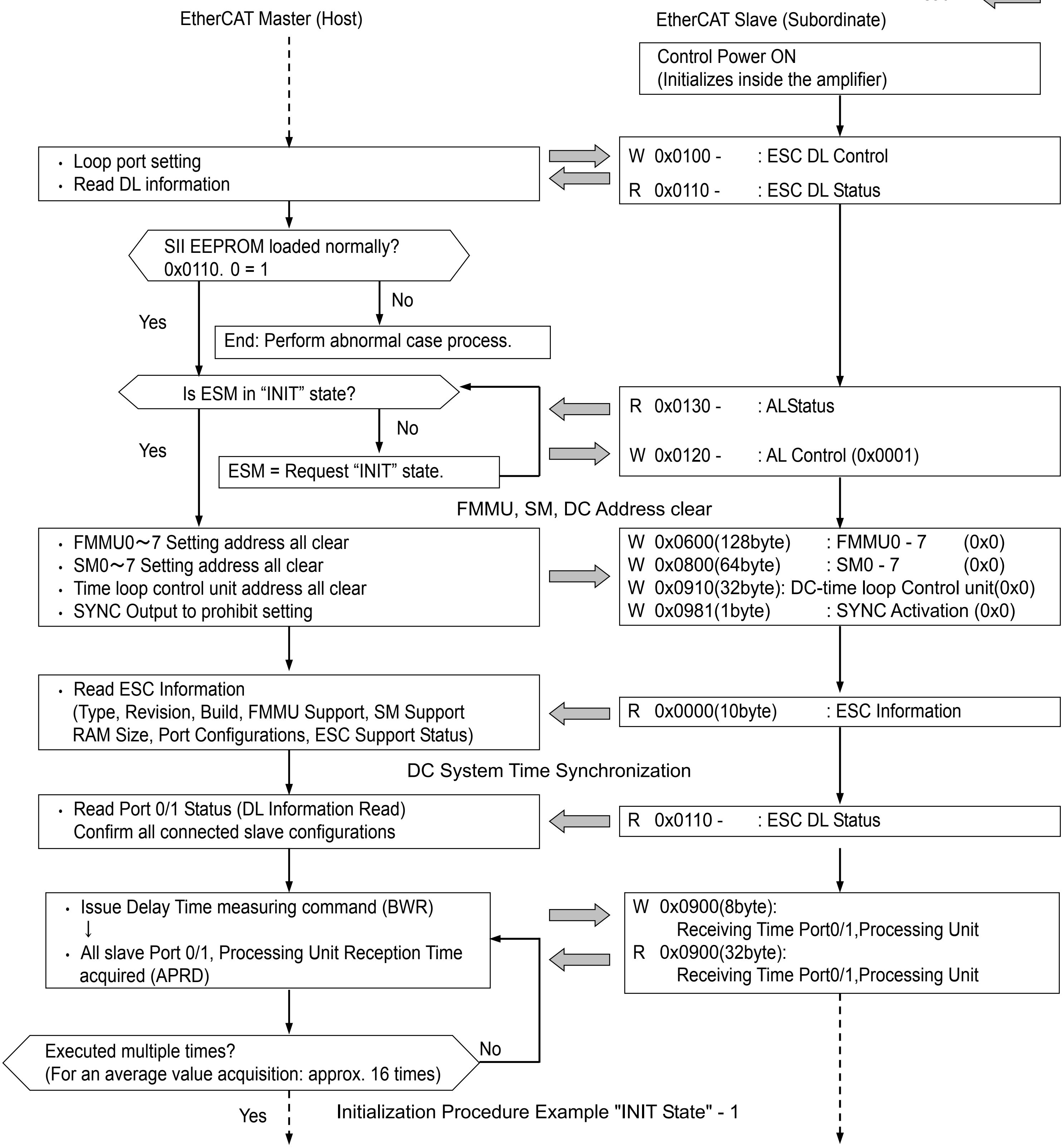
ESC Power ON Sequence

8.4 EtherCAT Initialization Process

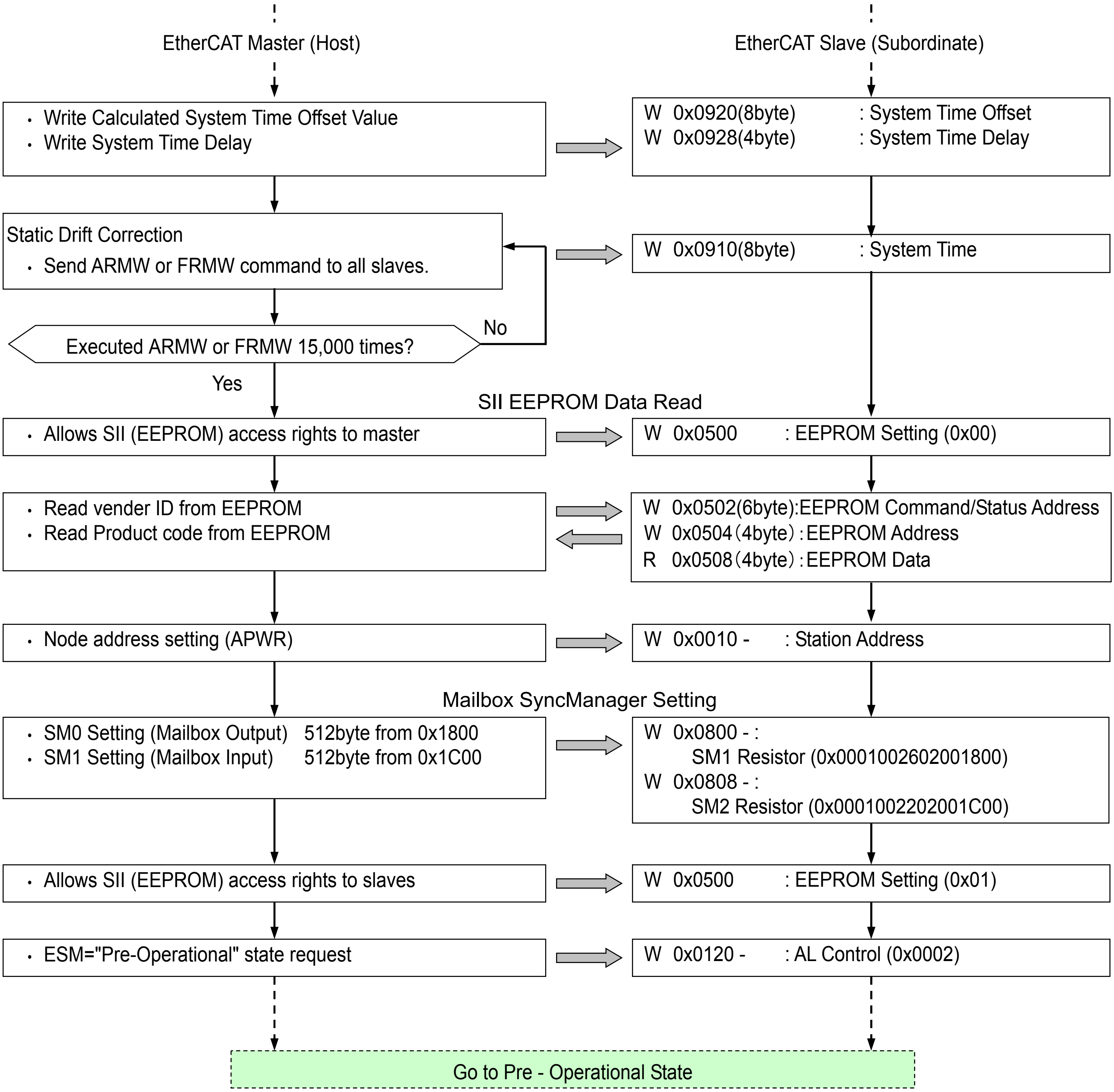
Various parameter settings from master to slave datalink layer and application layer are required to begin cyclic communication after control power of slave amplifier has been established.
The following procedure is an example of the initialization process:

Write
Read

1) INIT State



Initialization Procedure Example "INIT State" - 1



Initialization Procedure Example "INIT State" -2

2) Pre-Operational State

EtherCAT Master (Host)

EtherCAT Slave (Subordinate)

Is ESM in "Pre-Operational" state?

R 0x0130 - : AL Status 0x0002)

No

Yes

Parameter Setting in Object Dictionary Using Mailbox

- Sets PDO Object Index to be assigned in SM2
- RxPDO assigns 0x1700(1 object)
- Sets PDO Object Index to be assigned in SM3
- TxPDO assigns 0x1B00 (1 object)
- Sets Cycle Synchronous Position mode for Operation

W 0x1C12.0=0x01 : SM2 RxPDO Entry
W 0x1C12.1=0x1700 : SM2 RxPDO Assign
W 0x1C13.0=0x01 : SM3 TxPDO Entry
W 0x1C13.1=0x1B00 : SM3 TxPDO Assign
W 0x6060.0=0x08 : Operation Mode

- RxPDO257 (0x1700) Mapping (For Example)
  9 objects: 26-byte (1-byte Dummy)

0x6040	: Control word	(2-byte)
0x607A	: Target Position	(4-byte)
0x6081	: Profile velocity	(4-byte)
0x6083	: Profile acceleration	(4-byte)
0x6084	: Profile deceleration	(4-byte)
0x60FF	: Target velocity	(4-byte)
0x6071	: Target torque	(2-byte)
0x6060	: Operation Mode	(1-byte)
0x0000	: Dummy	(1-byte)

- TxPDO257 (0x1B00) Mapping
  7 objects: 18byte (1Byte Dummy)

0x6041	: Status word	(2-byte)
0x6064	: Position actual value	(4-byte)
0x606C	: Velocity actual value	(4-byte)
0x6077	: Torque actual value	(2-byte)
0x60F4	: Following error actual value	(4-byte)
0x6061	: Operation mode display	(1-byte)
0x0000	: Dummy	(1-byte)

W 0x1700.0=0x09 :Numbert of entry
W 0x1700.1=0x6040 00 10:Control word
W 0x1700.2=0x607A 00 20:Target position
W 0x1700.3=0x6081 00 20:Profile velocity
W 0x1700.4=0x6083 00 20:Profile acceleration
W 0x1700.5=0x6084 00 20:Profile deceleration
W 0x1700.6=0x60FF 00 20:Target velocity
W 0x1700.7=0x6071 00 10:Target torque
W 0x1700.8=0x6060 00 08:Operation mode
W 0x1700.3=0x0000 00 08:Reserved *Note
W 0x1B00.0=0x07 :Number of entry
W 0x1B00.1=0x6041 00 10:Status word
W 0x1B00.2=0x6064 00 20:Position actual value
W 0x1B00.3=0x606C 00 20:Velocity actual value
W 0x1B00.4=0x6077 00 10:Torque actual value
W 0x1B00.5=0x60F4 00 20:Following error actualvalue
W 0x1B00.6=0x6061 00 08:Operation mode display
W 0x1B00.7=0x0000 00 08:Reserved *Note

*Note: Pdo data length needs to even byte length.
If the data length is odd, It must be added the putting bytes.

SYNC Signal Output Setting

- Synchronization Setting
  (DC synchronizes with DC SYNC0)

W 0x1C32.1=0x02:SM2
Synchronization (synchronizes with SYNC0)
W 0x1C33.1=0x02:
SM3 Synchronization (synchronizes with SYNC0)

- Sets SYNC0 output cycle at 500μs

W 0x09A0:0x09A3: SYNC0 Cycle Time (0x7A120)

- FMMU0 Setting (RxPDO) L:0x10000 -> P:0x1100
- FMMU1 Setting (TxPDO) L:0x10000 <- P:0x1140

W 0x0990:0x0997 : Start Operation
W 0x0980:0x0981 : Cycle Unit Enabled(0x0300)

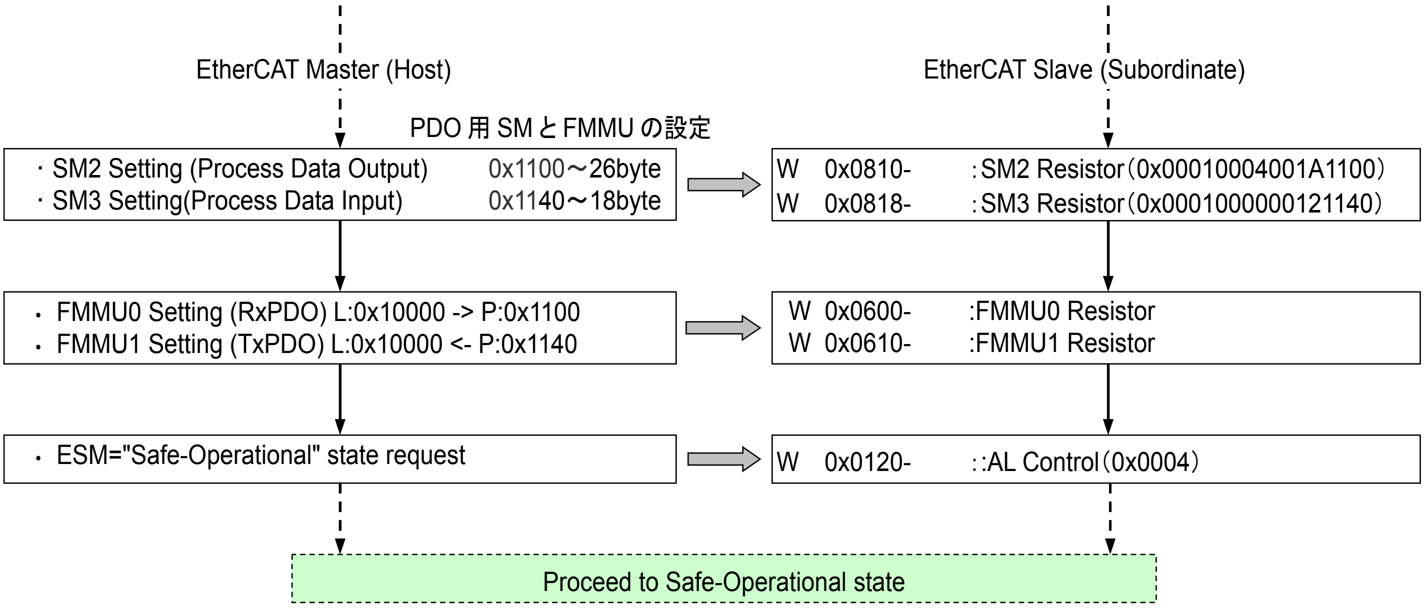
SYNC signals booted up?

R 0x0990:0x0997 : Next SYNC0 System Time
R 0x0910:0x0917 : System Time

No

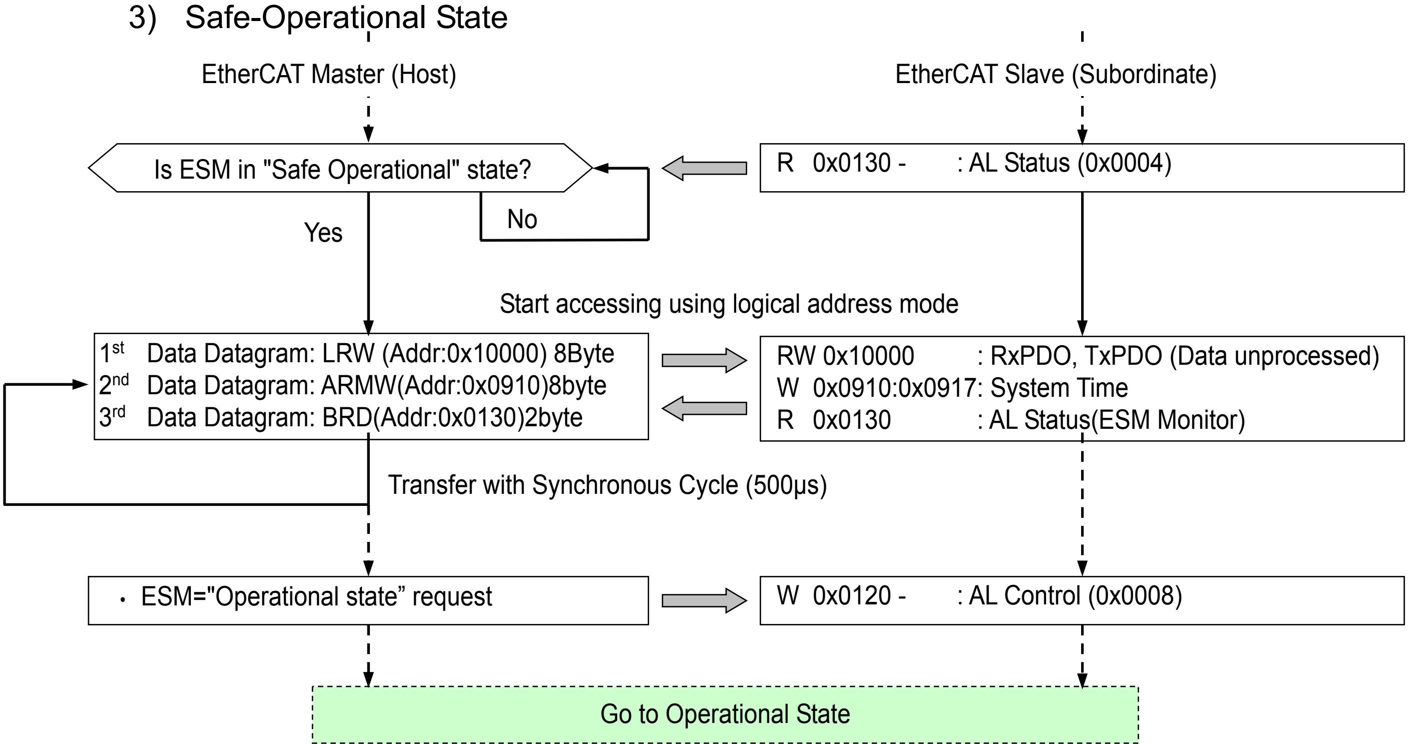
Yes

Initialization Procedure Example (Pre-Operational State-1)



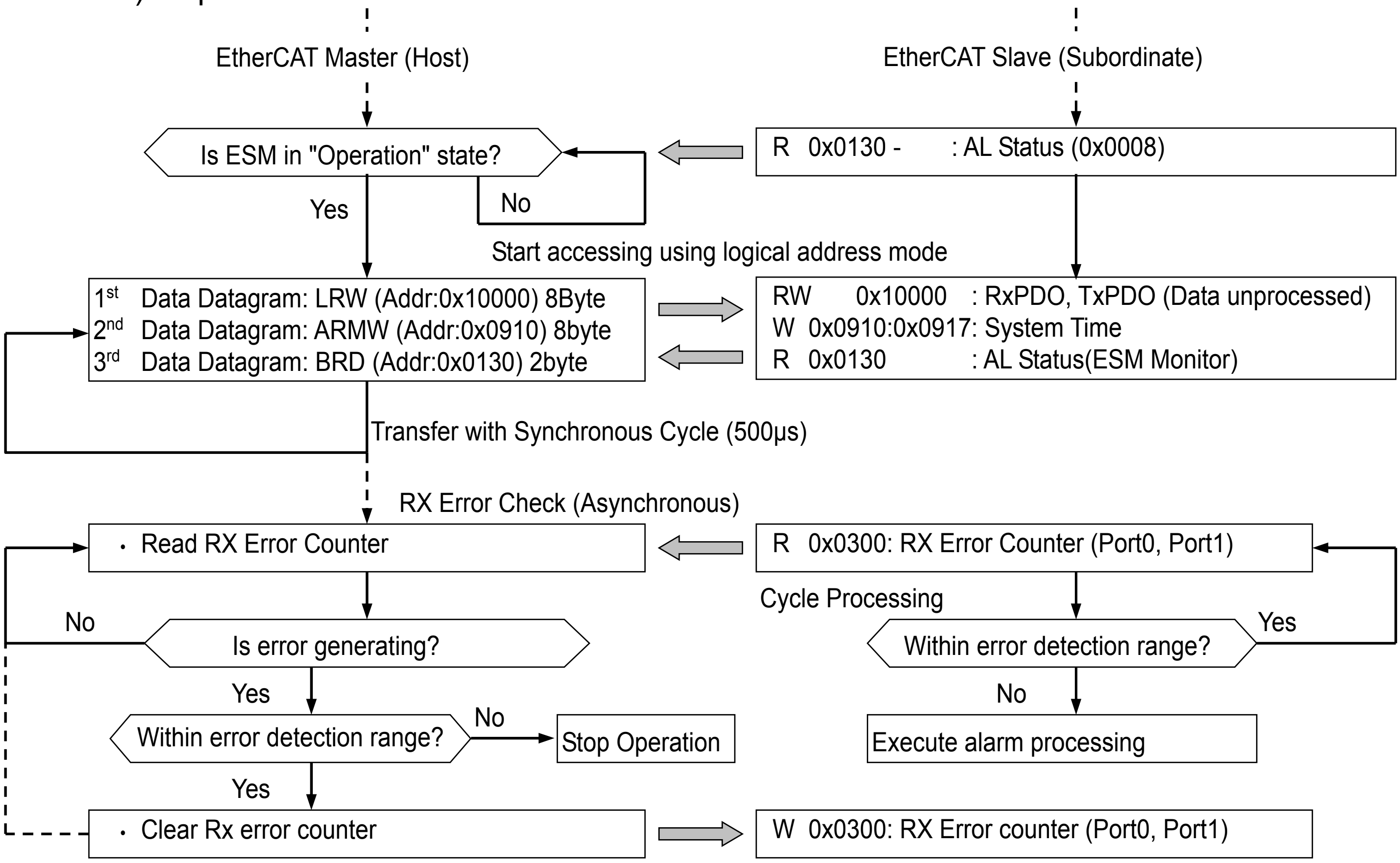
Initialization Procedure Example (Pre-Operational State -2)

3) Safe-Operational State



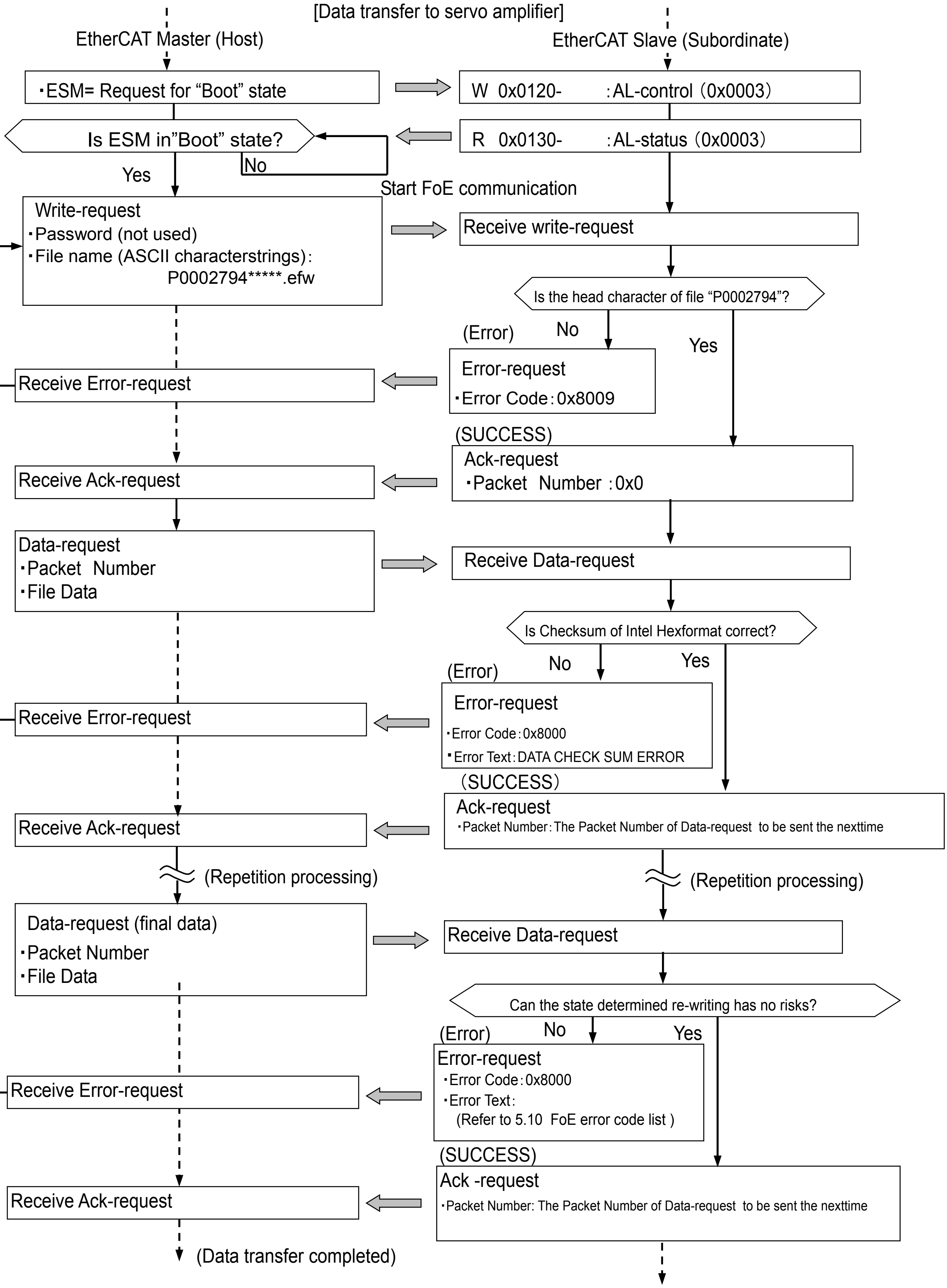
Initialization Procedure Example (Safe-Operational State)

4) Operational State

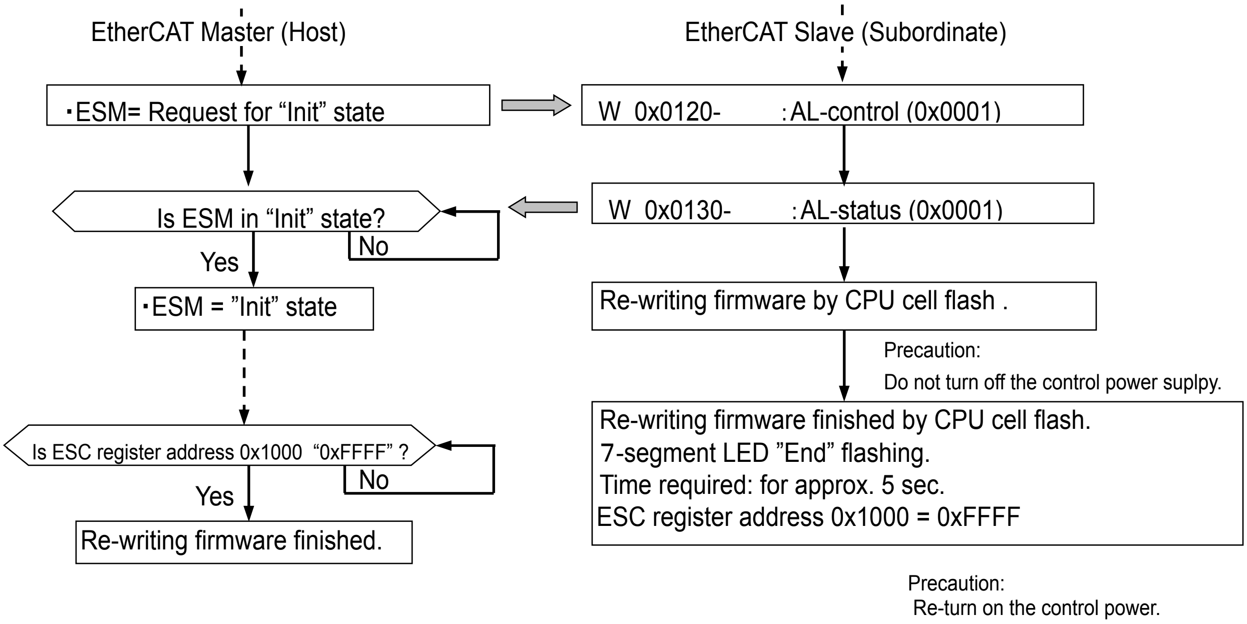


Initialization Procedure Example (Operational State)

5) Boot Strap state

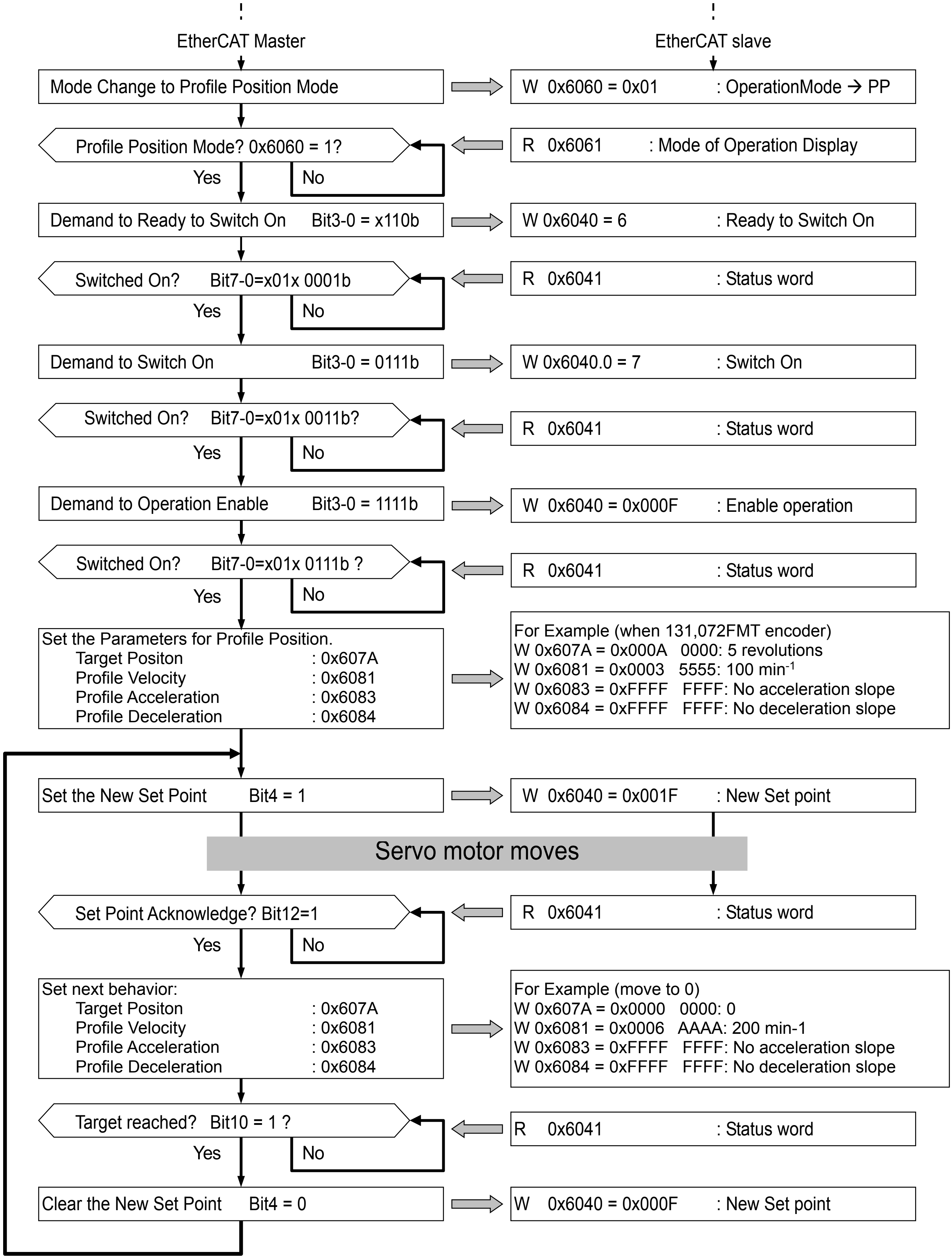


[Writing procedure to CPU flash after data transfer]



Procedure Example (Bootstarp State)

6) CoE Operation (Profile Position Mode: When CiA402 Ver.2)

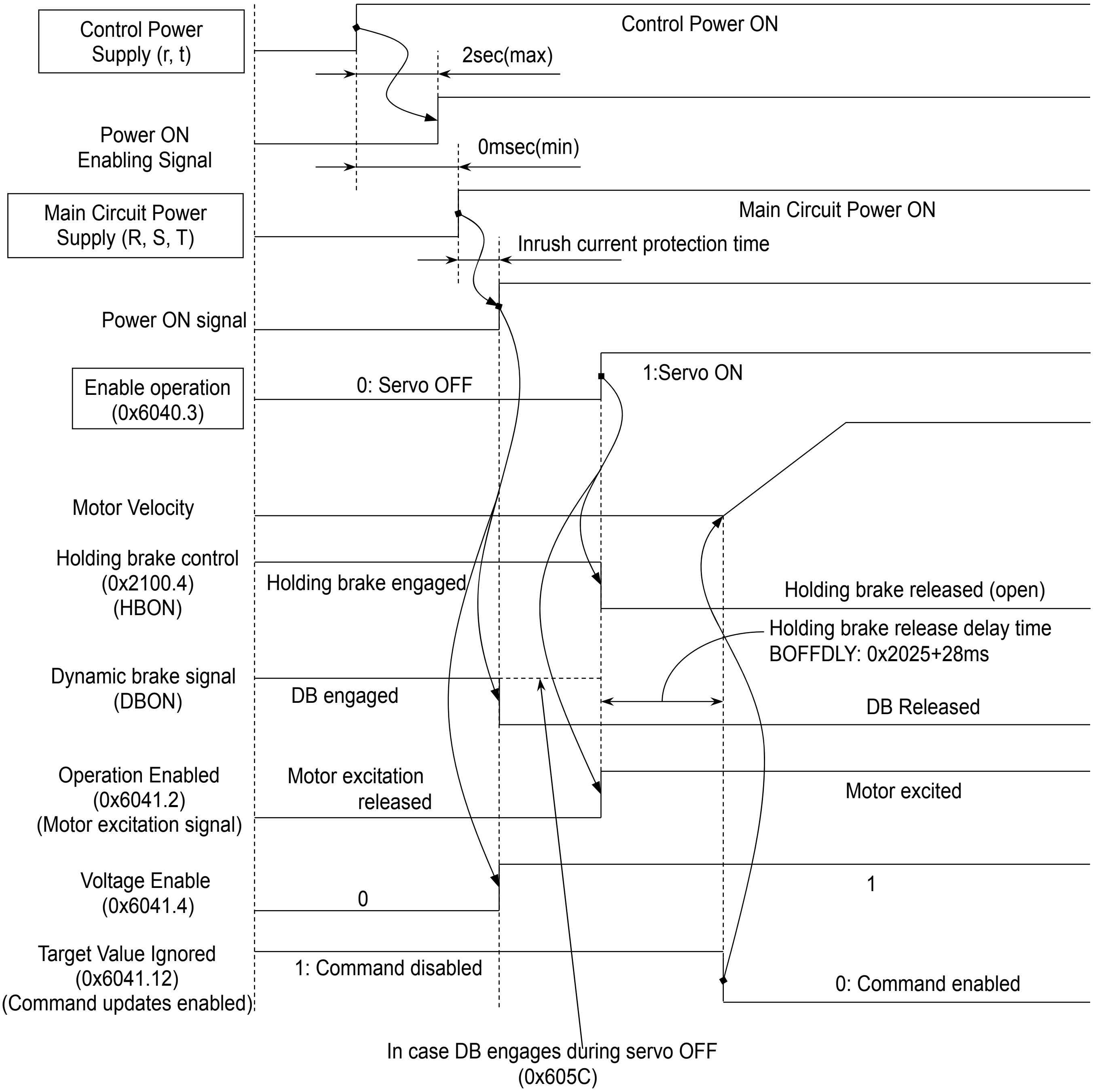


Profile Position Mode Operating Procedure Example(PP)

8.5 Operation Sequence

1) Operation Sequence from Power ON to Power OFF

■ Power ON → Servo ON

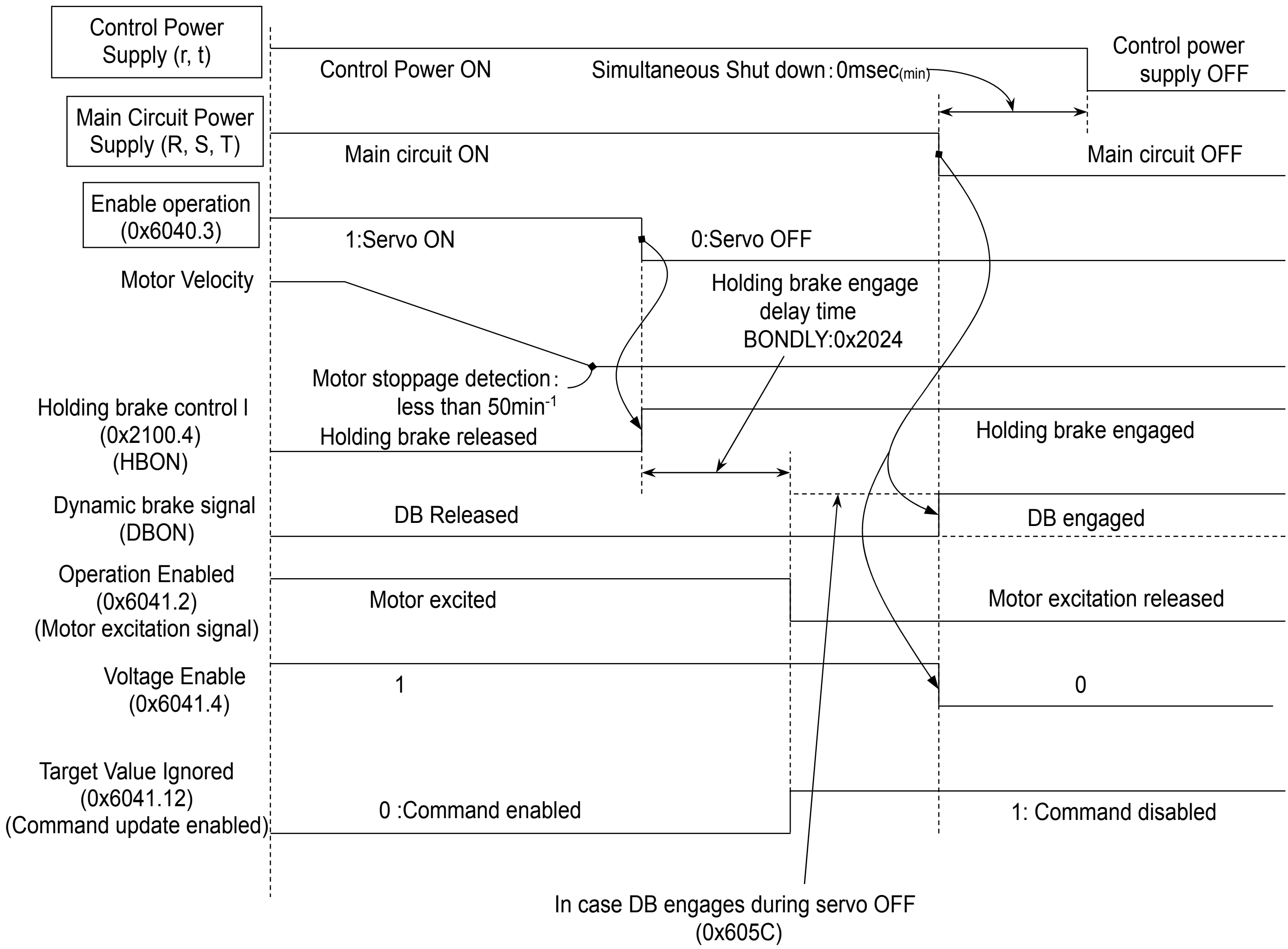


* The frequency of powering the servo amplifier ON/OFF must be less than 5 times/H and 30 times/day. In addition, the intervals between Power ON/OFF must be longer than 10 minutes. Inrush current suppression times of each servo amplifier size are as follows:

Servo amplifier size	Inrush current suppression time
RS2A01#	900[ms]
RS2A03#	900[ms]
RS2A05#	900[ms]
RS2A10#	1400[ms]
RS2A15#	1400[ms]
RS2A30#	1900[ms]

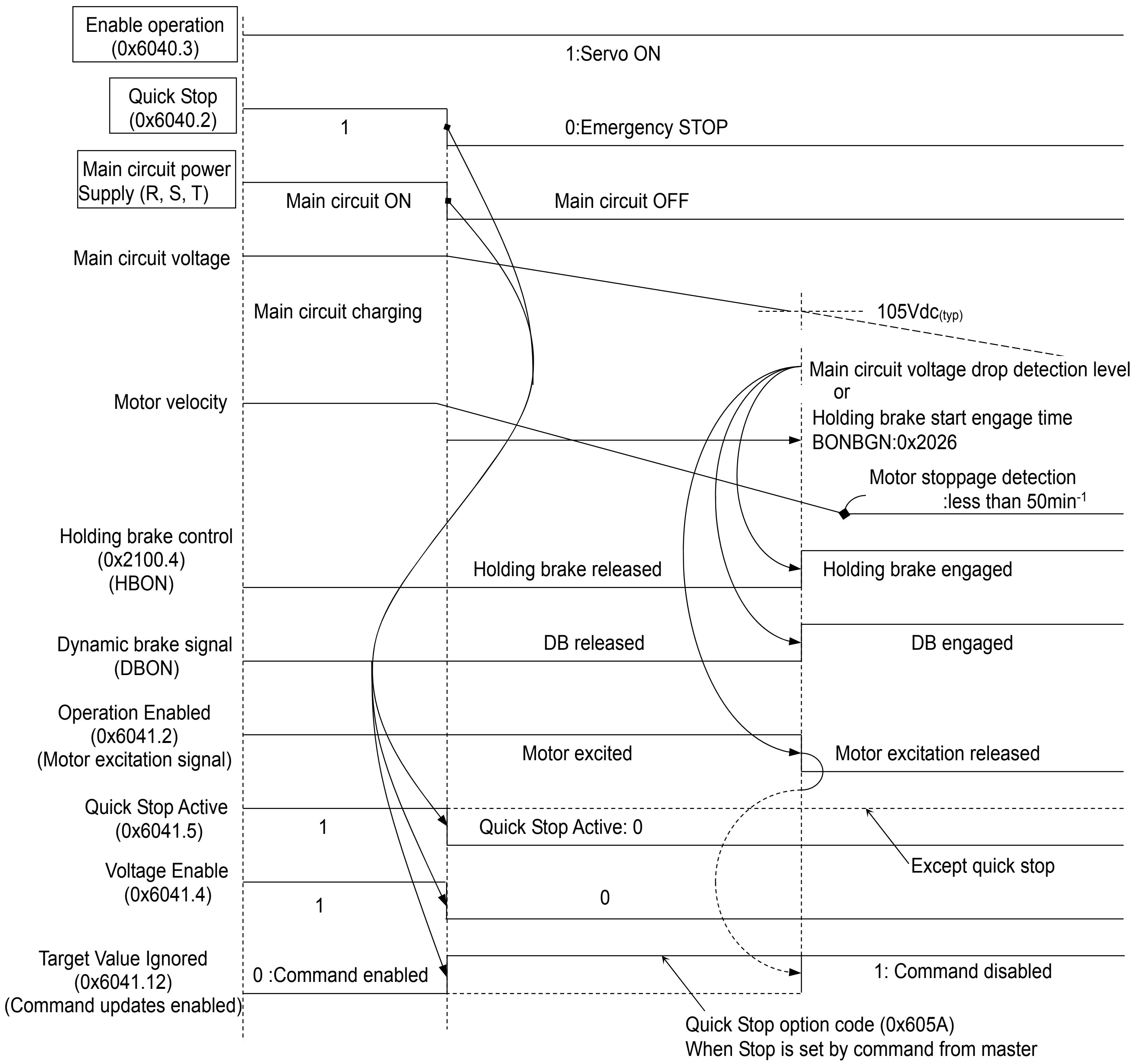
■ Servo OFF → Power OFF

Sequence in case of Servo OFF during motor rotation depends on Disable Option Code (0x605C) setting.



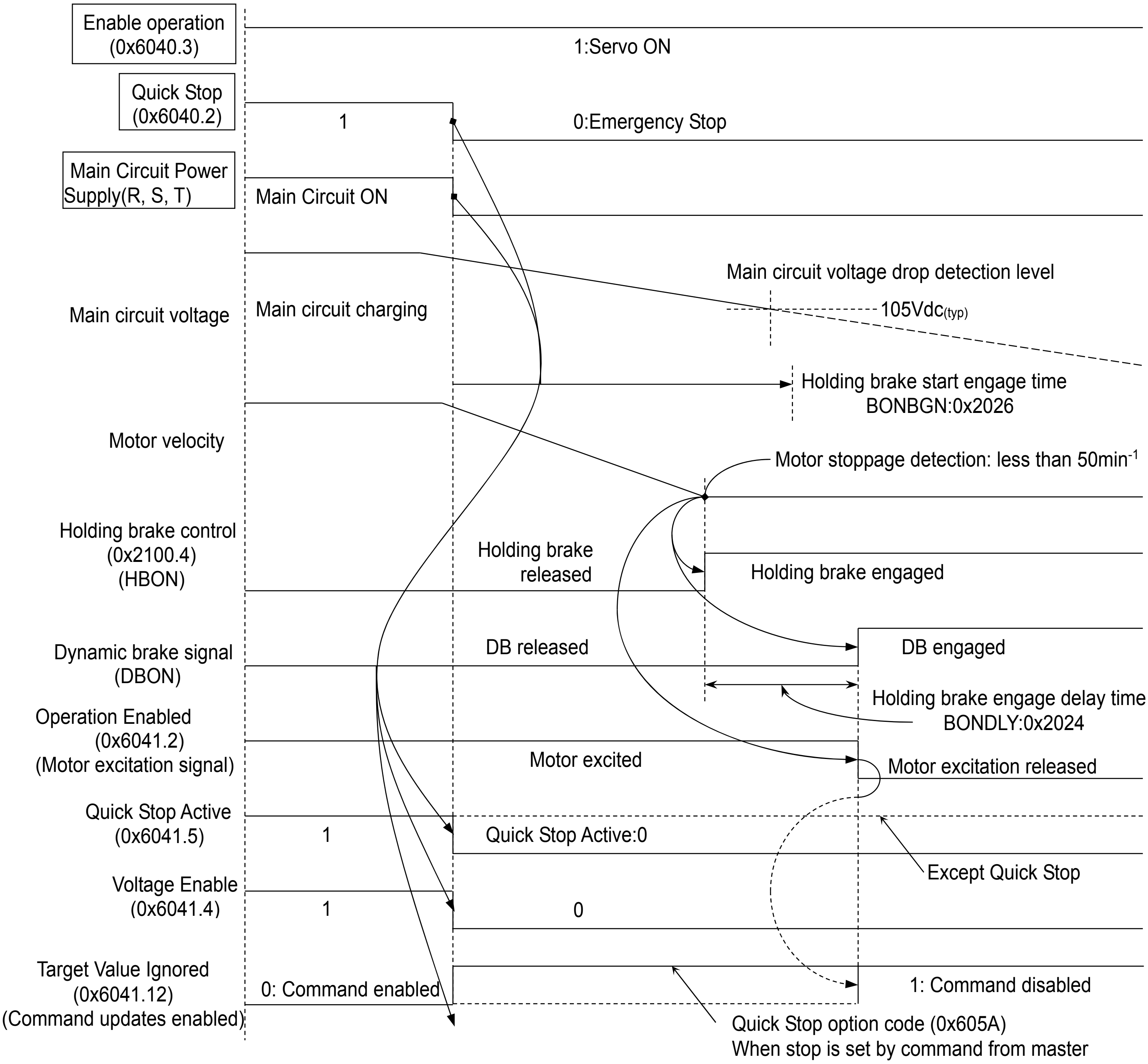
■ Main Circuit OFF, Quick STOP (Emergency STOP) Sequence

(1) When motor did not stop with the setting value of the holding brake engage starting time, or main circuit voltage drop is detected



■ Main Circuit OFF, Quick STOP (Emergency STOP) Sequence

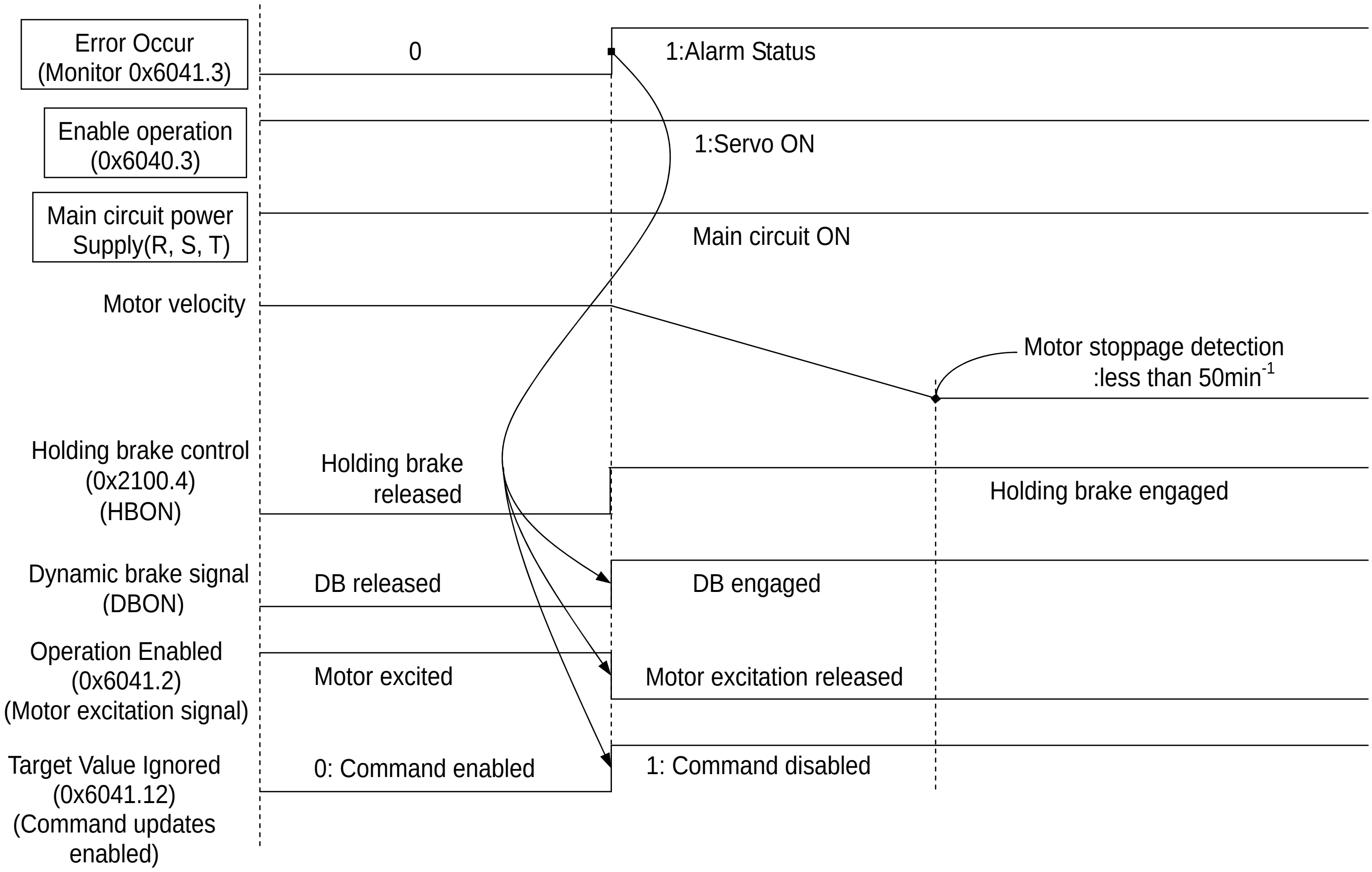
(2) When motor is stopped within holding brake start engage time or before main circuit voltage drop detection



2) Alarm Occurrence Stop Sequence

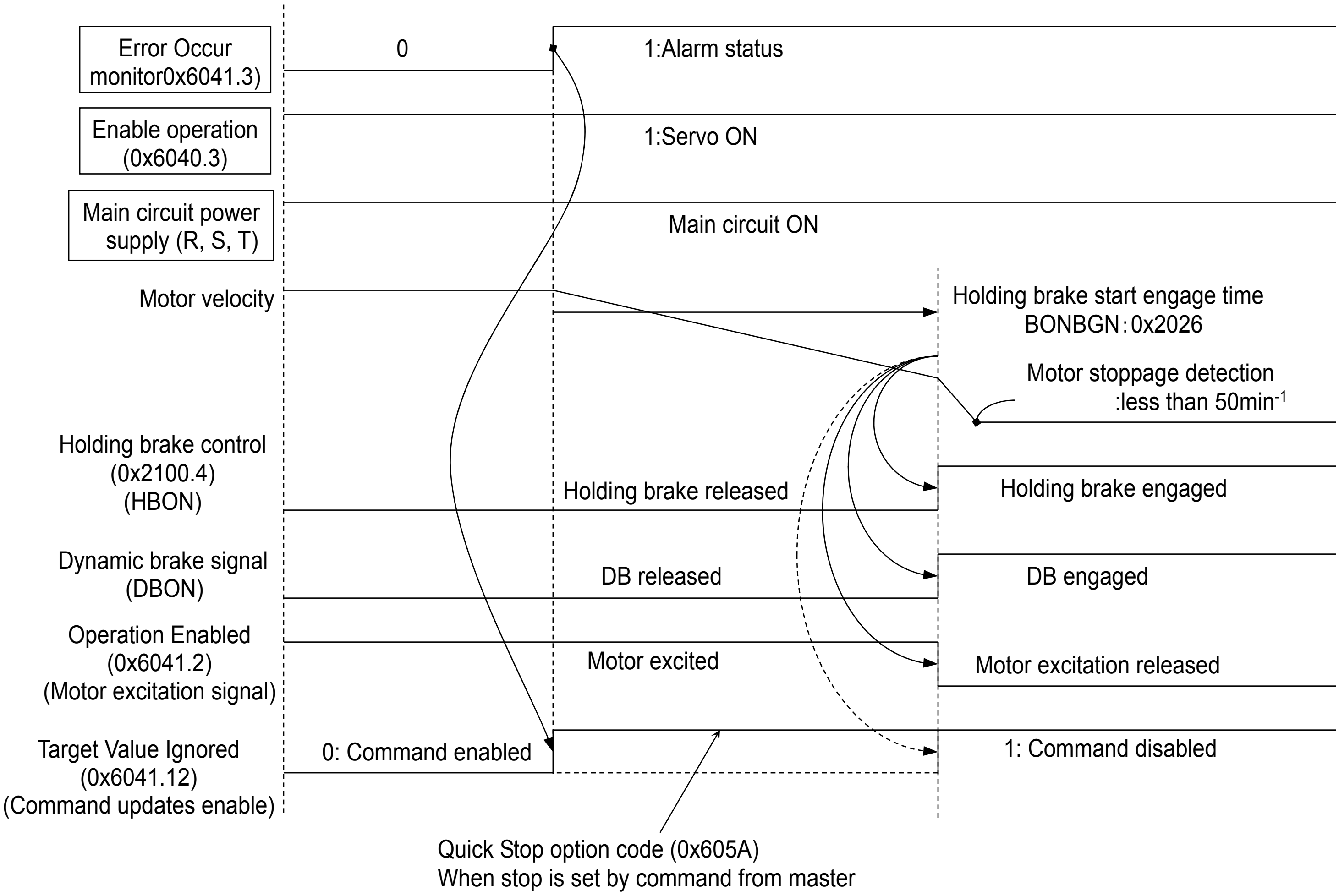
Servo motor is stopped by dynamic brake or servo brake with alarm occurrence. To stop either with dynamic brake or servo brake, please refer to “Movement of SB, DB at the time of Alarm detection” in the alarm code list. (SB: Servo brake Stop, DB: Dynamic brake Stop)
The stop method can be selected with Quick Stop option code (0x605A) for alarms that can be stopped with the servo brake. Please refer to “Alarm Display List (11-3)” for details.

■ Stop Sequence with Dynamic brake when alarm activated



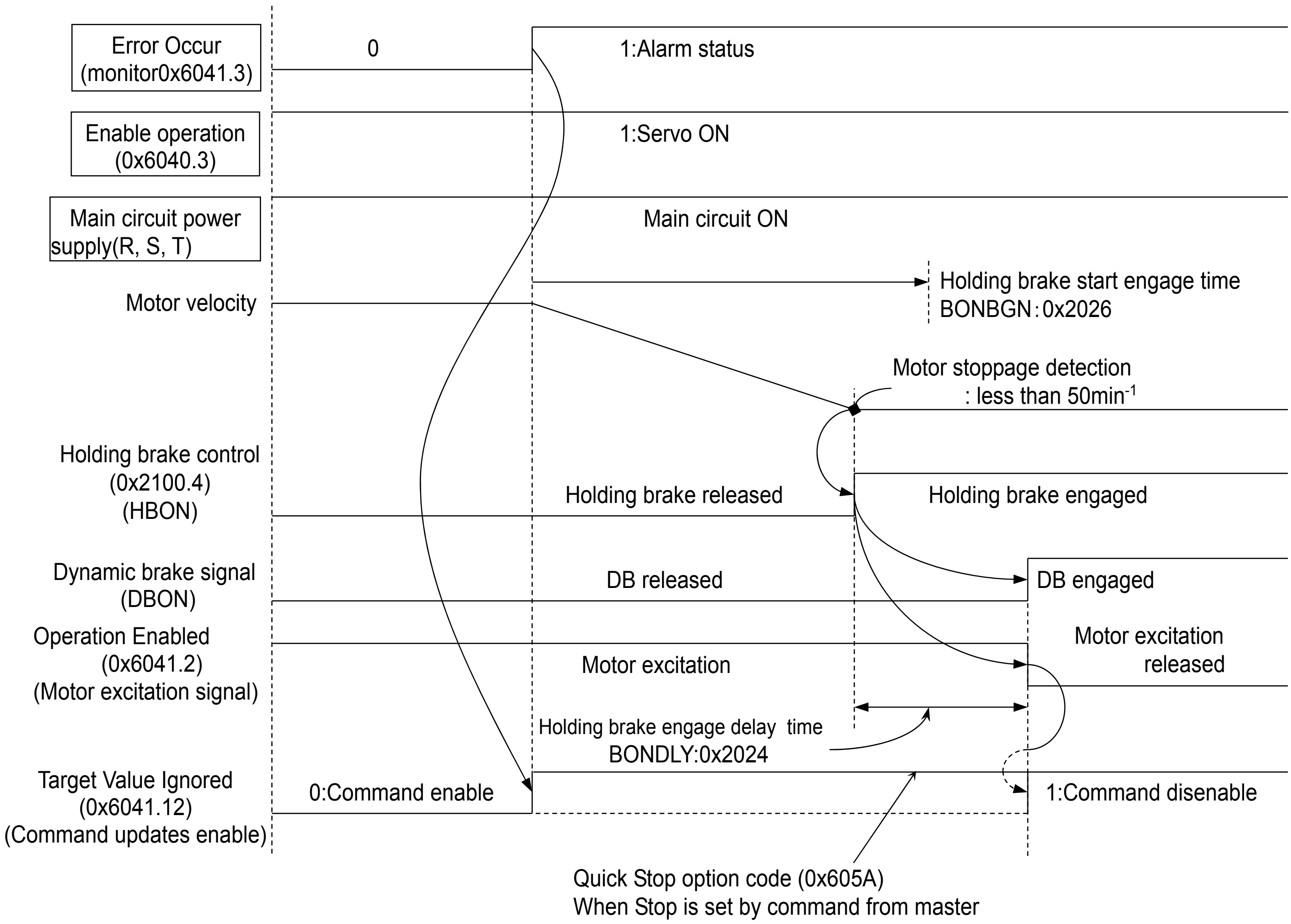
■ Stop Sequence with Servo Stop (Quick Stop option code) when alarm activated

(1) When a motor does not stop with the setting value of holding brake engage start time



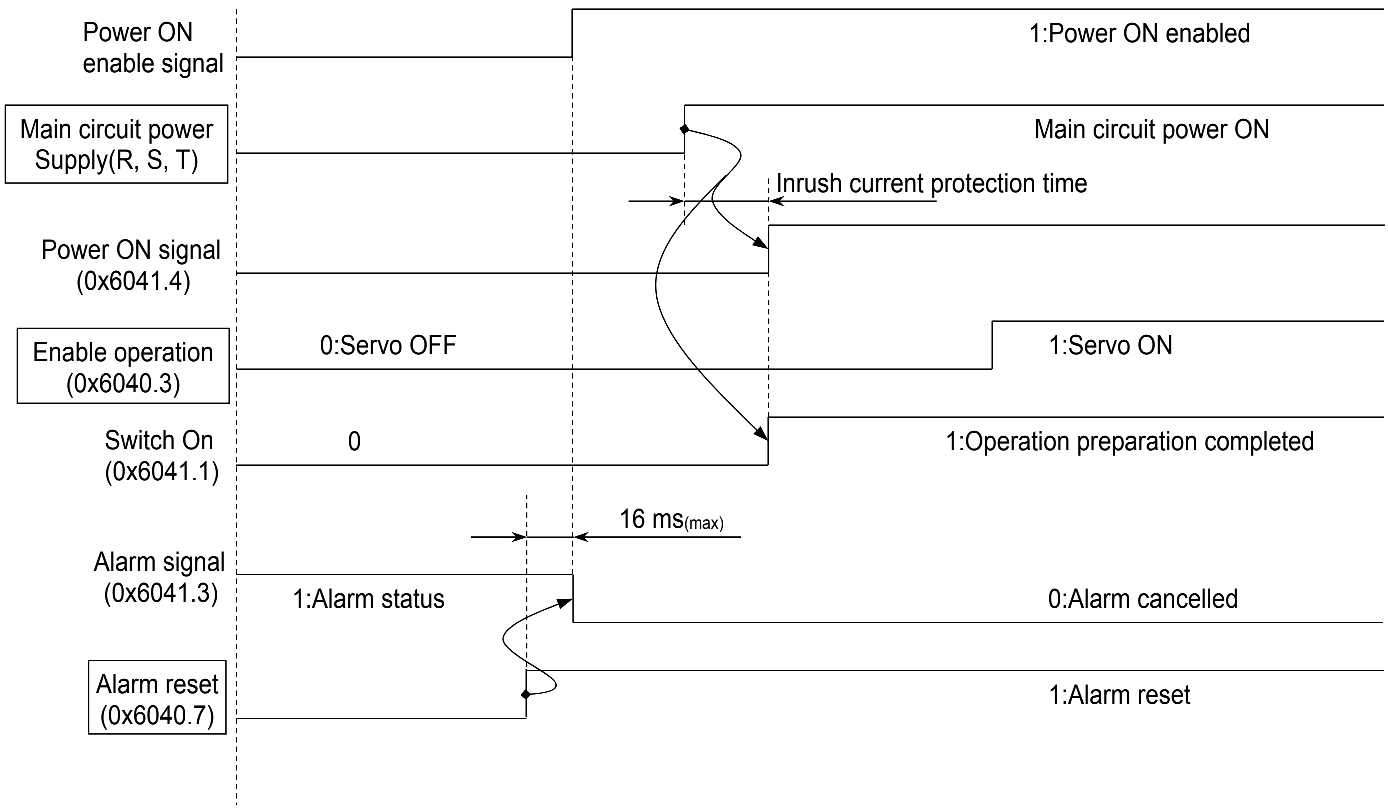
■ Stop Sequence with Servo Stop (Quick Stop option code) when alarm activated

(2) When a motor has stopped with the setting value of holding brake engage start time



3) Alarm Reset Sequence

Alarm can be reset by inputting alarm reset signal from generic input signals.



* Power reset (Turn off power once and re-input) or encoder clear is required for the alarm reset depending on alarm type. Refer to “Alarm Display List (11-3)” for details.

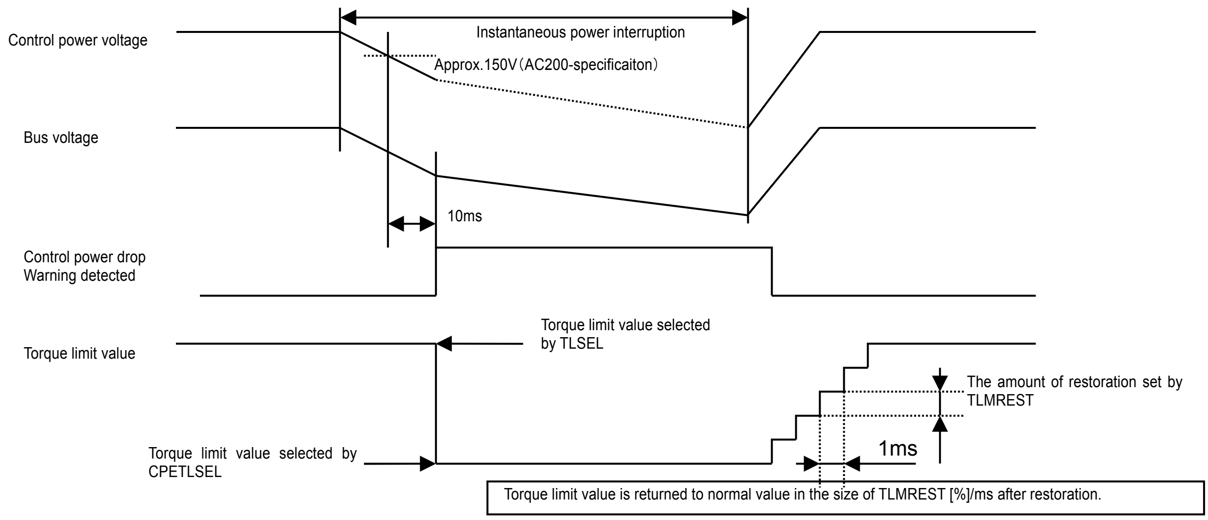
8.6 SEMI F47 Support Functions

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.

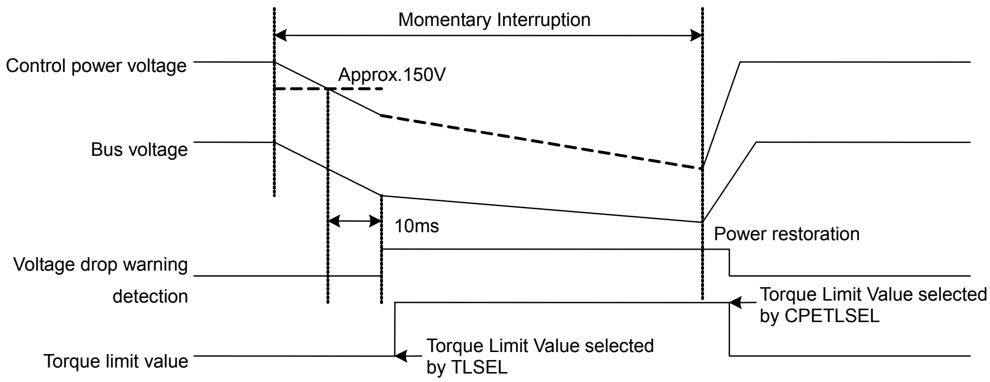
1. Parameters to be set

Setup software	Index	Symbol	Name	Unit	Setting range
GroupB_ID08	0x20F5	CPETLSEL	Torque limit selection at the time of power drop.	—	00～01
Group8_ID3D	—	TLMREST	The amounts of torque limit value restoration when power restored.	%	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

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

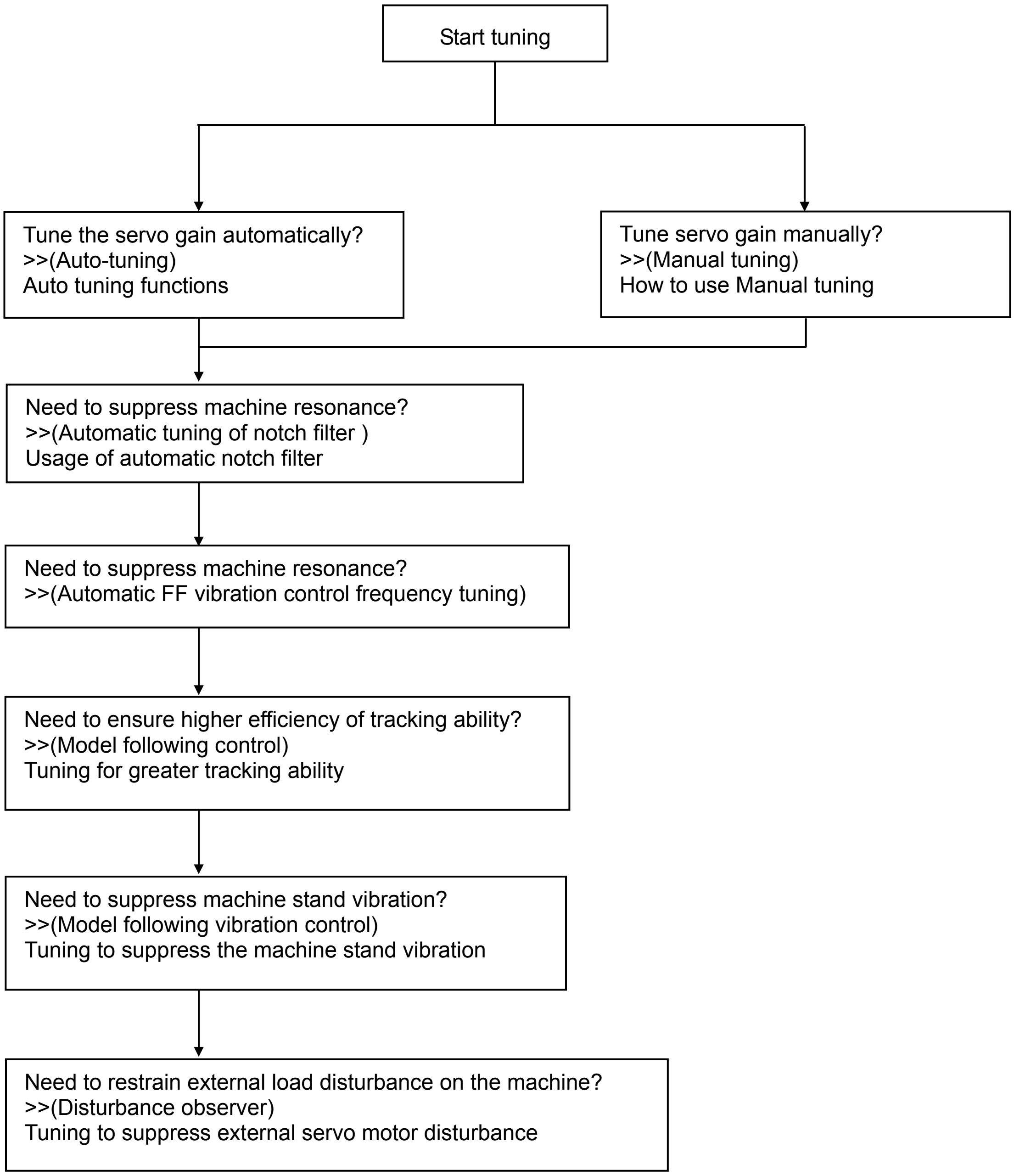
  Model following control is a control method that ensures a higher detection response by composing a model control system including the mechanical system in a servo amplifier to operate the actual servo motor in order to follow the model control system.

  - 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.

<table>
<tr><th>ID</th><th>CoE
Object ID</th><th>Contents</th></tr>
<tr><td rowspan="2">00</td><td rowspan="2">0x2002, 0x01</td><td>Tuning Mode [TUNMODE]</td></tr>
<tr><td>
<table>
<tr><th colspan="2">Selection</th><th>Meaning</th></tr>
<tr><td>00</td><td>AutoTun</td><td>Automatic Tuning</td></tr>
</table>
◆ Servo amplifier estimates Load inertia moment ratio of the machine or equipment during real time and automatically tunes the servo gain.
◆ Parameters for the servo amplifier to automatically tune vary depending on selected auto-tuning characteristics.
◆ 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.
[01 :_AutoTun_JRAT-Fix Automatic Tuning [JRAT Manual Setting]
<table>
<tr><th colspan="2">Selection</th><th>Meaning</th></tr>
<tr><td>01</td><td>AutoTun_JRAT-Fix</td><td>Automatic Tuning [JRAT manual setting]</td></tr>
</table>
◆ Based on the Load inertia moment ratio (JRAT1) [Group1 ID14], which has to be set, the servo amplifier automatically tunes to the best servo gain.
◆ Parameters for the servo amplifier to automatically tune will vary depending on the selected auto-tuning characteristics.
<table>
<tr><th colspan="2">Selection</th><th>Meaning</th></tr>
<tr><td>02</td><td>ManualTun</td><td>Manual Tuning</td></tr>
</table>
◆ This mode is used in order to adjust the servo gain to the machine or equipment to ensure maximum response as well as when characteristics in auto-tuning are insufficient.
</td></tr>
</table>

<table>
<tr><th>ID</th><th>CoE
Object ID</th><th>Contents</th></tr>
<tr><td>01</td><td>0x2002, 0x02</td><td>Auto-Tuning Characteristic [ATCHA]
■ Auto-Tuning Characteristic to fit the mechanical requirements and movements are provided.
Parameters that can be adjusted vary depending on each auto-tuning characteristic. Set the parameters based on the situation.
■ [Positioning control (Positioning)]
Positioning control is a control method used to reach the servo motor quickly to target a position from the present position by disregarding the trajectory between the positions. Select this mode when positioning point by point is necessary.

■ [Trajectory control (Trajectory)]
Trajectory control is a method used to move the servo motor to the target position from the present position while considering the trajectory between the positions. Select this mode when the Position command corresponding trajectory control is needed such as in processing work.

<table><tr><th colspan="2">Selection</th><th>Meaning</th></tr><tr><td>00</td><td>Positioning1</td><td>Positioning Control 1(General)</td></tr></table>
◆ Select for general positioning purposes.
◆ Parameters shown in table 2 cannot be adjusted manually.

<table><tr><th colspan="2">Selection</th><th>Meaning</th></tr><tr><td>01</td><td>Positioning2</td><td>Positioning Control 2(High Response)</td></tr></table>
◆ Select for high response positioning.
◆ Parameters shown in table 2 cannot be adjusted manually.

<table><tr><th colspan="2">Selection</th><th>Meaning</th></tr><tr><td>02</td><td>Positioning3</td><td>Positioning control 3(High Response, FFGN Manual Setting)</td></tr></table>
◆ Select this mode to adjust FFGN manually.
◆ The following parameter adjustment is made manually:
General parameters GROUP1 [Basic control parameter settings]

<table><tr><th>ID</th><th>Symbol</th><th>Name</th></tr><tr><td>05</td><td>FFGN</td><td>Feed Forward Gain</td></tr></table>
</td></tr>
</table>

<table>
<tr><th>ID</th><th>CoE
Object ID</th><th>Contents</th></tr>
<tr><td>01</td><td>0x2002, 0x03</td><td>
Auto-Tuning Characteristic [ATCHA]
<table>
<tr><th colspan="2">Selection</th><th>Meaning</th></tr>
<tr><td>03</td><td>Positioning4</td><td>Positioning control 4
(High Response, Horizontal Axis Limited)</td></tr>
</table>
◆ Select this mode when the machine movement is on a horizontal axis and receives no disturbing influence from external sources.
◆ Positioning time may be shortened compared to “Positioning Control 2”.
◆ Parameters shown in table 2 cannot be adjusted manually.
<table>
<tr><th colspan="2">Selection</th><th>Meaning</th></tr>
<tr><td>04</td><td>Positioning5</td><td>Positioning control 5
(for high response, horizontal axis only,
FFGN manual setting)</td></tr>
</table>
◆ Select this mode when the machine movement is on a horizontal axis and receives no disturbing influence from external sources or when you want to adjust FFGN manually.
◆ Positioning time may be shortened compared to “Positioning control 2”.
◆ The following parameter adjustment is done manually.
General parameters GROUP1 [Basic Control Parameter Settings]
<table>
<tr><th>ID</th><th>Symbol</th><th>Name</th></tr>
<tr><td>05</td><td>FFGN</td><td>Feed Forward Gain</td></tr>
</table>
<table>
<tr><th colspan="2">Selection</th><th>Meaning</th></tr>
<tr><td>05</td><td>Trajectory1</td><td>Trajectory Control 1</td></tr>
</table>
◆ Select this mode for single axis use. The response of each axis can be different.
◆ Parameters shown in table 2 cannot be adjusted manually.
<table>
<tr><th colspan="2">Selection</th><th>Meaning</th></tr>
<tr><td>06</td><td>Trajectory2</td><td>Trajectory Control 2
(KP, FFGN Manual Setting)</td></tr>
</table>
◆ Select this mode when you need equal responses from multiple axes, respectively. Adjust KP, FFGN.
◆ The following parameter adjustment is done manually.
General parameters GROUP1 [Basic control parameter settings]
<table>
<tr><th>ID</th><th>Symbol</th><th>Name</th></tr>
<tr><td>02</td><td>KP1</td><td>Position Loop Proportional Gain 1</td></tr>
<tr><td>05</td><td>FFGN</td><td>Feed Forward Gain</td></tr>
</table>
</td></tr>
<tr><td>02</td><td>(-)</td><td>
Auto-Tuning Response [ATRES]
■ Select this mode when Auto-tuning and Auto-tuning [JRAT manual setting] are used.
■ As the setting value rises, the response increases.
Set the value suitable for equipment rigidity.
■ This does not function for manual tuning.
</td></tr>
<tr><td>03</td><td>(-)</td><td>
Auto-Tuning Automatic Parameter Saving [ATSAVE]
■ Load inertia moment ratio obtained from the result of auto-tuning is automatically saved in parameter JRAT1 every two (2) hours.
■ The value is effective when auto-tuning is used.
This does not function for [JRAT manual setting].
</td></tr>
</table>

2) Automatically adjusted parameters in auto-tuning

The following parameters are automatically adjusted at the time of auto-tuning. These parameters will not reflect on motor movements by changing or overriding those values. However, some of them can be adjusted manually depending on selected [Tuning Mode] and [Auto-Tuning Characteristic].

■ General parameters Group1 [Basic control parameter settings]

ID	CoE Object ID	Symbol	Name	Notes
02	0x2005, 0x01	KP1	Position Loop Proportional Gain 1	Note 1)
05	0x2008, 0x01	FFGN	Feed Forward Gain	Note 1) 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	
20	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
10	0x2013, 0x00	VCNFIL	Velocity Command Notch Filter
20	0x2014, 0x01	TCNFILA	Torque (force) Command Notch Filter A
21	0x202D, 0x01	TCNFPA	T (force) CNFILA, Low Frequency Phase Delay Improvement
22	0x2014, 0x02	TCNFILB	Torque (force) Command Notch Filter B
23	0x202D, 0x02	TCNFDB	T (force) CNFILB, Depth Selection
24	0x2014, 0x03	TCNFILC	Torque (force) Command Notch Filter C
25	0x202D, 0x03	TCNFDC	T (force) CNFILC, Depth Selection
26	0x2014, 0x04	TCNFILD	Torque (force) Command Notch Filter D
27	0x202D, 0x04	TCNFDD	T(force) CNFILD, Depth Selection
30	0x2016, 0x01	OBCHA	Observer Characteristic
31	0x2016, 0x02	OBG	Observer Compensation Gain
32	0x2016, 0x03	OBLPF	Observer Output Low-pass Filter
33	0x2016, 0x04	OBNFIL	Observer Output Notch Filter

■ General parameters Group4 [Gain switching control/Vibration suppressor frequency switching settings]

ID	CoE Object ID	Symbol	Name
40	0x2012, 0x02	SUPFRQ2	FF Vibration Suppressor Frequency 2
41	0x2013, 0x03	SUPFRQ3	FF Vibration Suppressor Frequency 3
42	0x2013, 0x04	SUPFRQ4	FF Vibration Suppressor Frequency 4

■ General parameters Group5 [High setting control setting]

ID	CoE Object ID	Symbol	Name
00	0x2015, 0x01	CVFIL	Command Velocity Low-pass Filter
01	0x2015, 0x02	CVTH	Command Velocity Threshold
02	0x2015, 0x03	ACCC0	Acceleration Compensation
03	0x2015, 0x04	DFCC0	Deceleration Compensation

4) Unstable functions during auto-tuning

The following functions cannot be used during auto-tuning:

■ General parameters Group1 [Basic control parameter setting]

ID	CoE Object ID	Symbol	Name
04	0x2007, 0x00	TRCPGN	Higher Tracking Control Position Compensation Gain
16	0x200E, 0x00	AFBK	Acceleration Feedback Gain

* [Disturbance observer] cannot be used together with auto-tuning.
Render [Disturbance observer] function invalid when auto-tuning is used.

■ Parameter characteristics for EtherCAT objects

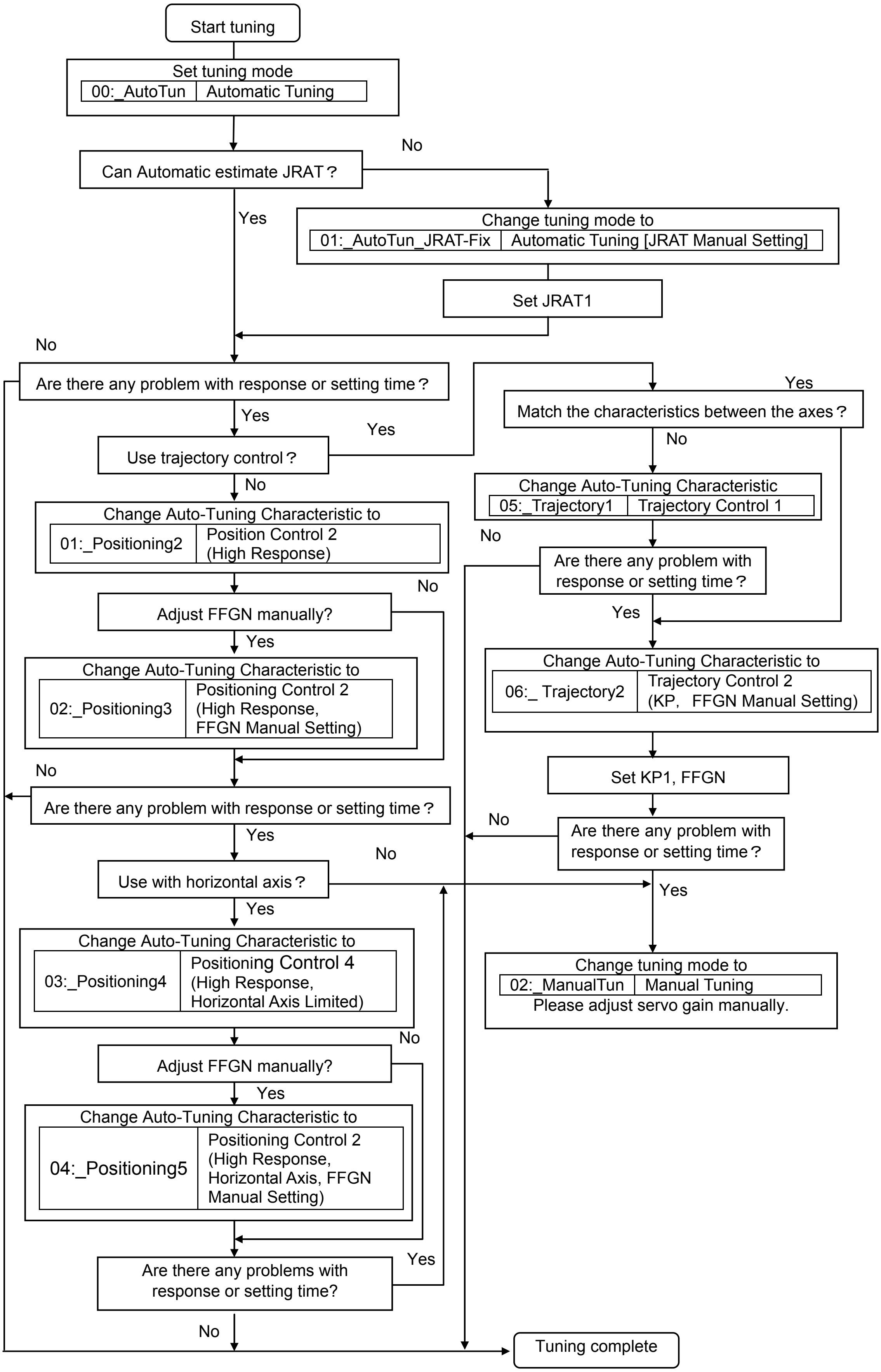
ID	CoE Object ID	Symbol	Name
-	0x2001, 0x00 bit5-4	GC	Gain Switching Selection
-	0x2000, 0x00 bit1	PPCON	Position Loop Proportional Control Switching Function
-	0x2000, 0x00 bit2	PCON	Velocity Loop Proportional Control Switching Function

5) Adjustment method for auto-tuning

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

Procedure 1	■ Estimate the load inertia ratio with the servo amplifier in real time and adjust the servo gain automatically >> [Tuning Mode] to 00:_AutoTun Automatic Tuning] When automatically tuned, the best servo gain based on the previous manual setting load inertia ratio (JRAT1) >> Set [Tuning Mode] to 01:_AutoTun_JRAT-Fix Automatic Tuning [JRAT Manual Setting].
Procedure 2	■ After setting [Tuning Mode] select [Auto-Tuning Characteristic] for the machine or equipment.
Procedure 3	■ Next, boot the servo motor and adjust [Auto-Tuning Response] according to equipment rigidity. ◆ 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. ◆ 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. ◆ If increasing the response has caused the machine to develop vibration, lower the value of the [Auto-Tuning Response] slightly. * 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]. * Tuning methods are the same in [01:_AutoTun_JRAT-Fix [JRAT Manual Setting].

6) Auto-Tuning Characteristic selection flowchart



7) Monitoring servo gain adjustment parameters

The following parameters can be monitored with Digital Operator and Software Setup when auto-tuning is used.
Refer to [See Section 10] for use of Digital Operator.

ID	CoE Object ID	Symbol	Name	Unit
1D	0x2104, 0x05	JRAT MON	Load Inertia Moment Ratio monitor	%
1E	0x2104, 0x01	KP MON	Position Loop Proportional Gain monitor	1 / s
1F	0x2104, 0x02	TPI MON	Position Loop Integral Time Constant monitor	Mss
20	0x2104, 0x03	KVP MON	Velocity Loop Proportional Gain monitor	Hz
21	0x2104, 0x04	TVI MON	Velocity Loop Integral Time Constant monitor	ms
22	0x2104, 0x06	TCFIL MON	Torque (force) Command Filter monitor	Hz
23	0x2104, 0x07	MKP MON	Model Control Gain monitor	1 / s

8) Manual tuning method using auto-tuning results

Save auto-tuning results as a batch, and it can be utilized in manual tuning.
For Software Setup, use Auto-tuning >> Auto-tuning result saving.

■ Saving parameters

◆ General parameters Group1 [Basic control parameter settings]

ID	CoE Object ID	Symbol	Name	Unit
02	0x2005, 0x01	KP1	Position Loop Proportional Gain 1	1 / s
12	0x200B, 0x01	KVP1	Velocity Loop Proportional Gain 1	Hz
13	0x200C, 0x01	TVI1	Velocity Loop Integral Time Constant 1	ms
14	0x200D, 0x01	JRAT1	Load Inertia Moment Ratio 1	%
20	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 ID20: Torque (force) Command Notch Filter A (TCNFILA)].
  - * 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 B, C, D (Manual setting) to suppress each resonance. If resonance is still not suppressed, there is a possibility that auto-tuning response or gain control is too high. Lower the Auto-Tuning Response or control gain.

2) Setting parameters

- ■ Torque (force) command value for notch filter tuning
  Setting the Torque (force) command value to the motor at the time of Automatic tuning of notch filter:

◆ General parameters Group0 [Auto-tuning settings]

ID	CoE Object ID	Symbol	Name	Unit	Setting range
10	—	ANFILTC	Automatic tuning of notch filter Torque (force) Command	%	10.0 - 100.0

* As the value increases so does tuning accuracy. However, machine movement will increase as well. Please monitor it closely.

- ■ Automatically saving parameters with Automatic tuning of notch filter

◆ General parameters Group2 [FF vibration suppressor control/Notch filter/ Disturbance observer settings]

ID	CoE Object ID	Symbol	Name	Unit	Setting range
20	0x2014, 0x01	TCNFILA	Torque (force) Command Notch Filter A	Hz	100 - 4000

* 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 or Digital Operator.
- ■ The tuning result is automatically saved in Group2 ID00: FF Vibration suppressor frequency 1 [SUPFREQ1].
- ■ FF vibration suppressor frequency is obtained by executing auto-tuning of vibration suppressor frequency or by calculating vibration frequency from the mechanical vibration period at the time of positioning.

* When vibration does not stop with FF vibration suppressor frequency, there is a possibility that the gain for control system may be too high. In this case, lower the control system gain.

* When used together with Higher Tracking Control Velocity Compensation Gain, vibration- suppressor effect may be improved.

* FF vibration suppressor control function can be used with auto-tuning.

* Holding torque (force) falls while Automatic tuning of FF Vibration Suppression Frequency is executing. Do not use as gravity axis.

2) Setting parameters

■ Torque (force) command value of Auto-FF vibration suppressor frequency
Sets torque (force) command value to servo motor at the time of Automatic tuning of FF Vibration Suppression Frequency execution.

◆ General parameters Group0 [Auto-tuning setup]

ID	CoE Object ID	Symbol	Name	Unit	Setting range
11	-	ASUPTC	Automatic tuning of FF Vibration Suppression Frequency Friction torque (force) Compensation Value	%	10.0 - 100.0

* As the value increases so does tuning accuracy. However, machine movement will increase as well. Please monitor it closely.

■ Friction torque (force) compensation amount during Automatic tuning of FF Vibration Suppression Frequency.
Sets additional frictional torque (force) compensation amount when Automatic tuning of FF Vibration Suppression Frequency is executed.
By setting the value close to the actual friction torque (force), the accuracy of Automatic tuning of FF Vibration Suppression Frequency can be improved.

◆ General parameters Group0 [Auto-tuning setup]

ID	CoE Object ID	Symbol	Name	Unit	Setting range
12	-	ASUPFC	Automatic tuning of FF Vibration Suppression Frequency Friction torque (force) Compensation Value	%	0.0 - 50.0

■ Automatically saved parameter of Automatic tuning of FF Vibration Suppression Frequency.

◆ General parameters Group2 [FF vibration suppressor control/Notch filter/ Disturbance observer settings]

ID	CoE Object ID	Symbol	Name	Unit	Setting range
00	0x2012, 0x01	SUPFRQ1	FF Vibration Suppressor Frequency 1	Hz	5 - 500

9.5 Using Manual Tuning

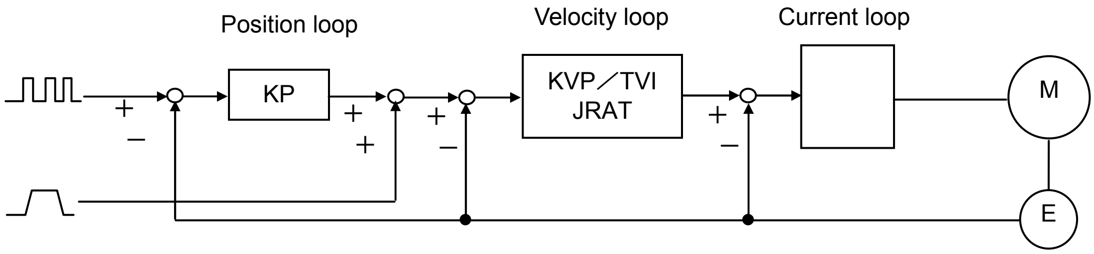
All gain is adjustable manually using manual tuning mode when characteristics in auto-tuning are insufficient.
Sets the Tuning Mode to Manual tuning.

■ 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:

$$JRAT = \frac{\text{Motor axis converted load inertia moment } (J_L)}{\text{Motor inertia moment } (J_M)} \times 100\%$$

■ 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 1 Index:0x2011, 0x01 - 0x04 [TCFIL1]
When rigidity of the mechanical device is high, set this value high and the Velocit0 Loop Proportional Gain can also be set higher. When the rigidity of the mechanical device is low, set this value low and resonance in the high frequency zone as well as abnormal sound can be suppressed. For normal usage, set this below 1200Hz.

2) Basic manual tuning method for velocity control

■ Set Velocity Loop Proportional Gain(0x200B, 0x01) (KVP1) as high as possible within the range that allows the mechanical device to maintain stability without causing vibration or oscillation.
If vibration increases, lower the value.

■ Set Velocity Loop Integral Time Constant (0x200C, 0x01) (TV1) to: TVI [ms]=1000/(KVP[Hz])
* When you cannot increase the gain because of mechanical resonance, etc., and the response is insufficient (after using the Torque notch filter and/or FF vibration suppressor frequency to suppress resonance) try the procedure again.

3) Basic manual tuning method for position control

■ Set Velocity Loop Proportional Gain (0x200B, 0x01)(KVP1) as high as possible within the range that allows the mechanical device to maintain stability without causing vibration or oscillation.
If vibration increases, lower the value.
■ Set Velocity Loop Integral Time Constant (0x200C, 0x01)(TVI1) to: $TVI_{[ms]}=1000 / (KVP_{[Hz]})$
■ Position Loop Proportional Gain (0x2005, 0x01)(KP1) to: $KP_{[1/S]} = KVP_{[HZ]}/4 \cdot 2\pi$
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 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)
20	0x2011, 0x01	TCFIL1	Torque (force) Command Filter 1	

Note 1) Manual setting is available in Trajectory Control 2 [KP, FFGN manual setting]
Note 2) Manual setting is available in Automatic Tuning [JRAT Manual Setting]

◆ General parameters Group3 [Model following control settings]

ID	CoE Object ID	Symbol	Name	Notes
00	0x2017, 0x01	KM1	Model Control Gain 1	Note 3)

Note 3) KP1 setting value is set in Trajectory Control 2 [KP, FFGN Manual Setting]

* Parameters automatically adjusted by the servo amplifier vary according to selected Auto-Tuning Characteristic.

2) Manual tuning method for Model following control

- ■ Set Velocity Loop Proportional Gain (0x2005, 0x01)(KVP1) at as high a value as possible within a stable range that will not cause vibration or oscillation. If vibration increases, lower the value.
- ■ Set Velocity Loop Integral Time Constant (0x200C, 0x01)(TVI1) to: $TVI_{[ms]}=1000/(KVP_{[Hz]})$.
- ■ Set Position Loop Proportional Gain (0x2005, 0x01)(KP1) to: $KP_{[1/S]}=KVP_{[Hz]} / 4 \cdot 2\pi$.
- ■ Set Model Control Gain (0x2017, 0x01)(KM1) to: KM≒KP. If vibration increases, lower the value.
- ■ When response is low, set the value of KM to: approximately 1.1 - 1.2 times.

* When the gain cannot rise because of mechanical vibration, etc., and the response time is insufficient, use Torque notch filter and/or FF Vibration suppressor frequency to suppress resonance and attempt it again.

- ■ Adjustable parameters in Model following control

In addition to the parameters in Standard position control, the following parameters are also adjustable:

◆ General parameters Group3 [Model following control settings]

ID	CoE Object ID	Symbol	Name
00	0x2017, 0x01	KM1	Model Control Gain 1
01	0x2018, 0x01	OSSFIL	Overshoot Suppressor Filter

◆ Model Control Gain 1 Index：0x2017, 0x01 [KM1]

Proportional gain fro Model following control position controller. Adjust this to: KM≒KP.

◆ Overshoot Suppressor Filter index：0x2019, 0x01 [OSSFIL]

Set cutoff frequency of overshoot suppressor filter in Model following control.
If overshoot occurred on a position deviation, lower the setting value.

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.

<table>
<tr><th>ID</th><th>CoE Object ID</th><th>Contents</th></tr>
<tr><td rowspan="2">0A</td><td rowspan="2">0x20F3, 0x01</td><td>Position Control Selection</td></tr>
<tr><td><table><tr><th colspan="2">Select value</th><th>Contents</th></tr><tr><td>02</td><td>Model2</td><td>Model Following Vibration Suppress Control</td></tr></table></td></tr>
</table>

* Do not use Auto-tuning with Model following vibration suppressor control.
* Full-closed control cannot be used with Model following vibration suppressor control.
* Model following vibration suppressor control cannot be used when in Velocity control mode or Torque (force) control mode.

■ Adjustable parameters in Model following vibration suppressor control

◆ General parameters Group3 [Model following control settings]

ID	CoE Object ID	Symbol	Name	Unit	Setting range
00	0x2017, 0x01	KM1	Model Control Gain 1	1 / s	15 - 315
01	0x2018, 0x01	OSSFIL	Overshoot Suppressor Filter	Hz	1 - 4000
02	0x2019, 0x01	ANRFRQ1	Model Control Antiresonance Frequency 1	Hz	10.0 - 80.0
03	0x201A, 0x01	RESFRQ1	Model Control Resonance Frequency 1	Hz	10.0 - 80.0

◆ Model Control Gain 1 Index:0x2017, 0x01 [KM1]
This is the proportional gain of the Model following controlling position controller and set response for Model control system.

◆ Overshoot Suppressor Filter Index:0x2018, 0x01 [OSSFIL]
This parameter is to set the cutoff frequency of the Overshoot suppressor filter in Model following vibration suppressor control. If overshoot occurred on a position deviation, lower the setting value.

◆ Model Control Antiresonance Frequency 1 Index:0x2019, 0x01 [ANRFRQ1]
This is to set the Anti-resonance frequency of the machine using Model following vibration suppressor control.
When the value is set higher than Model Control Resonance Frequency, vibration suppressor control will be invalid.

◆ Model Control Resonance Frequency 1 Index:0x201A, 0x01 [RESFRQ1]
This is to set the Resonance frequency of the machine model using Model following vibration suppressor control.
Vibration suppressor control will be invalid at 80.0Hz.

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

■ Parameter setting range for Model following vibration suppressor control
Setting ranges for the following parameters are restricted:

◆ General parameters Group1 [Basic control parameter settings]

ID	CoE Object ID	Symbol	Name	Unit	Setting Range
14	0x200D, 0x01	JRAT1	Load Inertia Moment Ratio 1	%	100 - 3000
20	0x2011, 0x01	TCFIL1	Torque (force) Command Filter 1	Hz	100 - 1000

◆ General parameters Group3 [Model following control settings]

ID	CoE Object ID	Symbol	Name	Unit	Setting Range
00	0x2017, 0x01	KM1	Model Control Gain1	1 / s	15 - 315

3) Tuning methods

- First, execute Model following control auto-tuning by selecting [01:_Model following control] in [Position Control Selection(0x20F3, 0x01)(ID07)] at System parameters and tune the machine with the best servo gain.
  Refer to Auto-tuning method in Model following control for instructions on tuning.

  * When the best servo gain for the machine has been selected, ignore this step.

- When servo gain tuning is completed, please change tuning mode to manual tuning after performing an auto tuning result storing function.

- After completing servo gain tuning, set the Resonance frequency and Anti-resonance frequency of the mechanical device using [02:_ Model following vibration suppressor control] in [Position Control Selection (0x20F3, 0x01)(ID07)] at System parameters.
  When anti-resonance and resonance frequencies are already known, set the values. When these values are unknown, these frequencies can be measured using System analysis.

  * Refer to Software Setup Instruction manual M0008363 for instructions on using System analysis.
  * When you measure the anti-resonance and resonance frequencies using System analysis, set the [Frequency range selection] in the low range.
    If you set the range in a high range, the ant-resonance and resonance frequencies in suppressible ranges created by the Model following vibration suppressor control may not be measured.
    1 - 125Hz for [Frequency range selection] is recommended.
  * When the mass of the drive motor is smaller than the machine stand mass, the anti-resonance and resonance frequencies may not be measured in system analysis. In this case, obtain the vibration frequency (Model anti-resonance frequency) by calculating the machine vibration period of the vibrating point at positioning and its reciprocal and set the model resonance frequency 1.05 - 1.2 times the anti-resonance frequency.

- Set the Velocity Loop Proportional Gain (0x200B,0x01)(KVP1) as high as possible within stable range without causing vibration or oscillation. If vibration increases, lower the value.
- Set the Velocity Loop Integral Time Constant (0x200C, 0x01)(TVI1) to: $TVI_{[ms]}=1000/(KVP_{[Hz]})$.
- Set the Position Loop Proportional Gain (0x2005, 0x01)(KP1) to: $KP_{[1/S]}=KVP_{[Hz]}/4\cdot 2\pi$.
- Set the Model Control Gain (0x2017, 0x01)(KM1) to: $KM \fallingdotseq KP$. If vibration increases, lower the value.
- Set the Model Control Gain (0x2017, 0x01)(KM1) value to: 1.1 - 1.2times when the response is low.
- Depending on the mechanical system, there may be two or more frequency vibrations aside from anti-resonance and resonance frequencies that have already been set.
  In this case, the vibration can be suppressed using FF vibration suppressor controls together. Set the vibration frequency to: [Group02 ID00 : FF vibration suppressor frequency 1(0x2012, 0x01)(SUPFRQ1)] by calculating the frequency from the vibration period.
- In case you cannot increase the gain because of mechanical resonance, etc., and response is insufficient, use Torque (force) command notch filter and FF vibration suppressor frequency to suppress the resonance, and then try again.

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.

10

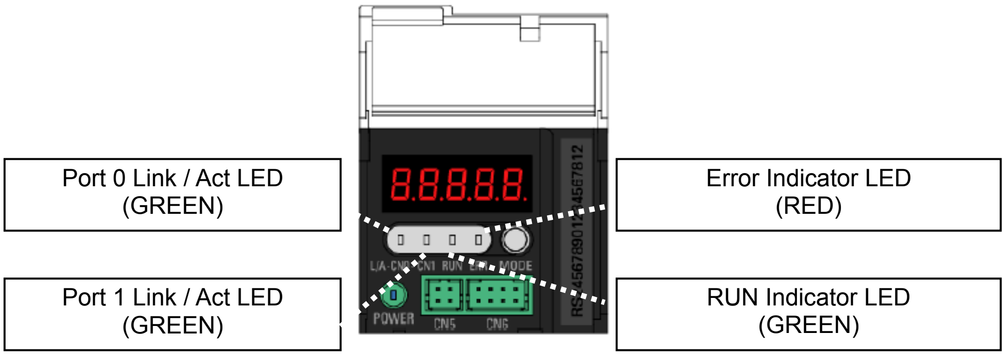
10. Digital Operator

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.

* PORT0 Link/Activity indicator	: LED (GREEN)
* PORT1 Link/Activity indicator	: LED (GREEN)
* RUN indicator	: LED (GREEN)
* ERR indicator	: LED (RED)

■ Names



EtherCAT Status LED

1) PORT0/1 Link / Activity Indicator Code: P0 L/A, P1 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

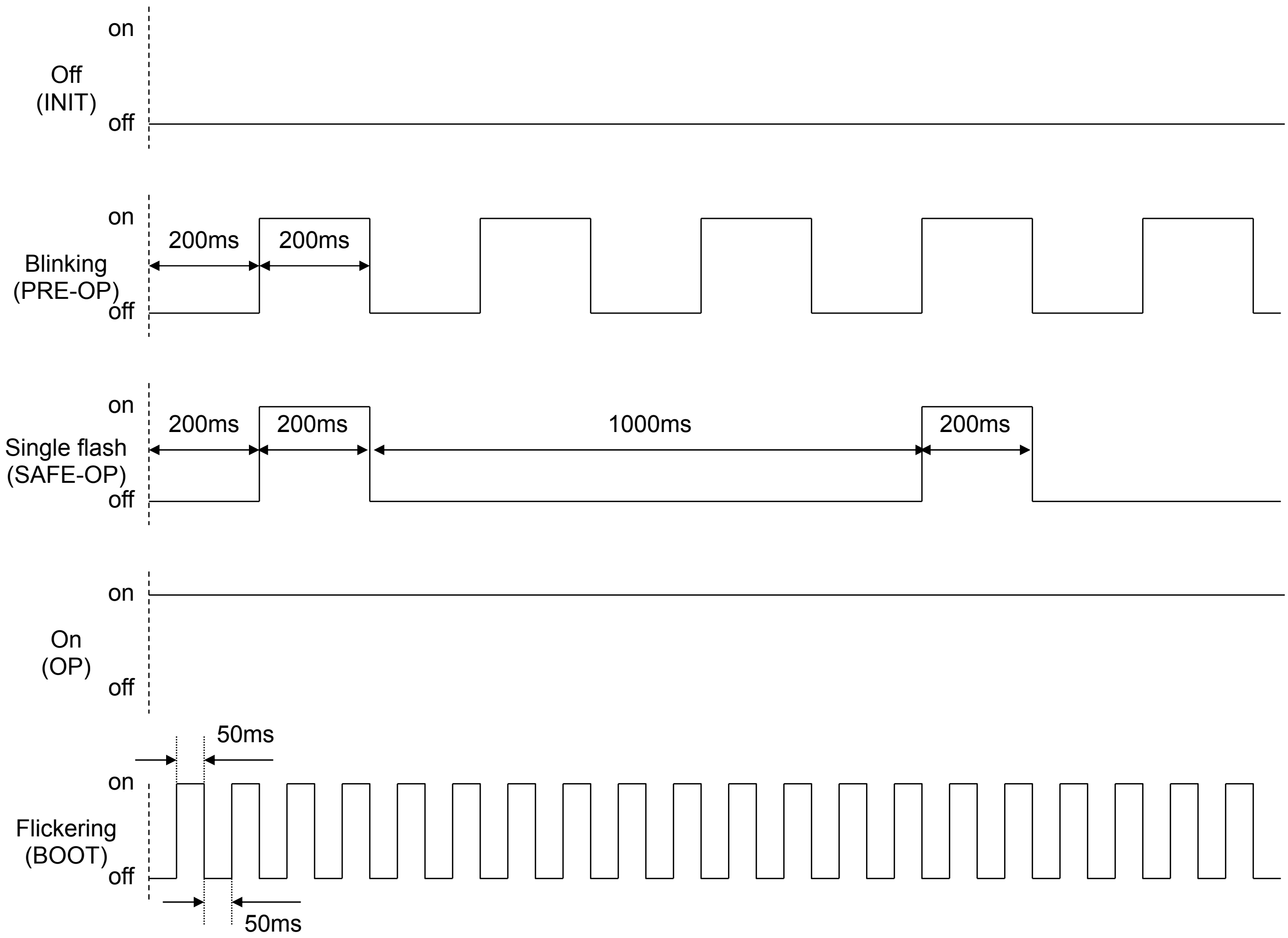
RUN indicator (Green LED) displays EtherCAT communication State machine status with Lighting /Extinguishing/ Flickering of the LED. Explains the RUN indicator below.

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

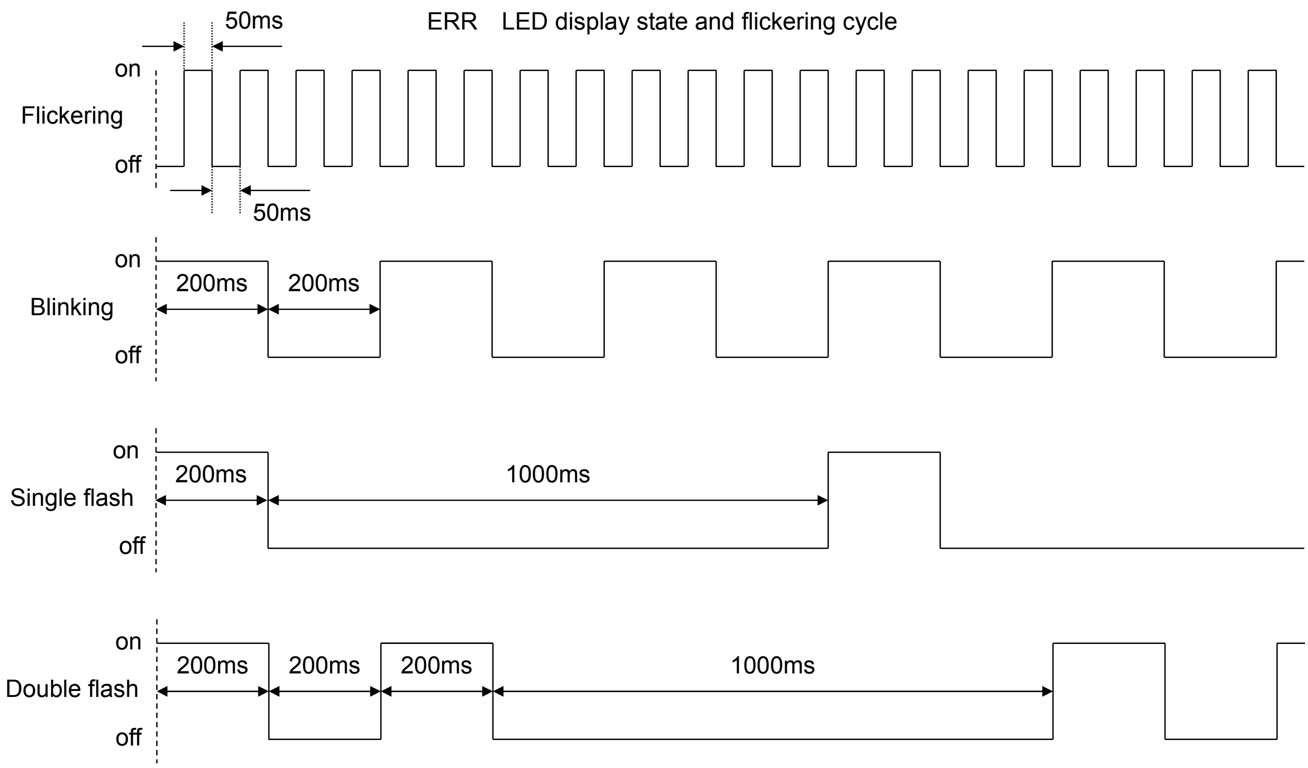
Error Indicator (Red LED) displays invalid state machine (ESM) change and/or watchdog error with an ON/OFF flickering of the LED.

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

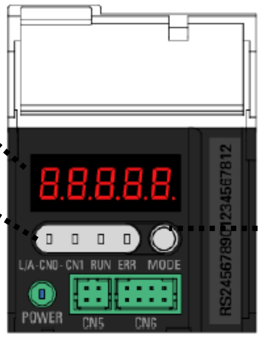
Status display, Alarm history and Monitor can be confirmed with the 5-digit, 7-segment Red LED on the upper front of the servo amplifier.

■ Names

5-digit display 7 segment

EtherCAT status LED (from left)

Port 0 Link / Act LED (GREEN)
Port 1 Link / Act LED (GREEN)
RUN Indicator LED (GREEN)
Error Indicator LED (RED)



Digital Operator Operation

■ 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	ON (Once) :Keep ON for more than 100ms and less than 1s, then turn it OFF.
2 [WR]	MODE / Page Data Determination	ON (Twice) :Repeat ON (1) within 600ms from 1
3 [INC]	Increment value	Long Push (Once) :Causes page increment with a longer push (ON) of more than 1s.
4 [DEC]	Decrement value	Long Push (Second time) :Causes page decrement with a longer push (ON) for more than 1s within 600ms after 1

2) Mode changes

MODE Change is performed by "MODE" operation of the Push Button Switch

Status Display MODE → Test operation MODE → Alarm history display MODE → Monitor display MODE → Status Display MODE

MODE Switching Order

■ Status Display MODE
Displays the establishment of control or main power supply, Servo ON, over-travel, warning and alarm status.
Also performs Alarm Reset.

■ Test operation MODE
JOG Operation, Auto-Tuning Result Writing and Encoder Clear can be executed.

■ Alarm history display MODE
Alarm history for the previous 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	0	Position of 1 display	0 - 9
Plus	10	Position of 10 display	10 - 99
Plus	100	Position of 100 display	100 - 999
Plus	1000	Position of 1000 display	1000 - 9999
Plus	10000	Position of 10000 display	10000 - 99999

■ Data of –9999 to +9999

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

Note) Left end - expresses minus.

■ Data of 0 to ＋41999999999

Symbol	Digital operator display	Range of a digit display	
Plus	1000	Low position of 1 to 1000 display	0 - 9999
Plus	1000	Middle position of 10000 to 10000000 display	0 - 9999
Plus	4 19	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	F0	FF to 00
2 byte	F000	FFFF to 0000
8 byte Low	L.F000	FFFF to 0000(Bit31 to Bit0) display
8 byte High	H.F000	FFFF to 0000(Bit63 to Bit32) display

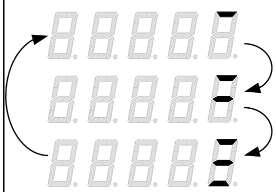
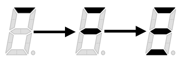
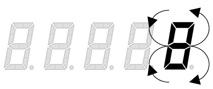
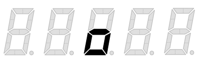
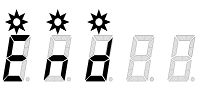
■ Example display of decimal point data

First position of a decimal point	1000.0
Second position of a decimal point	100.00

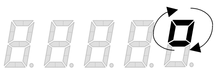
10.5 Status Display Mode

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

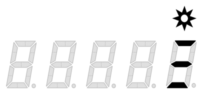
1) Servo Amplifier Status Display

Marking	Servo amplifier status
	・Control power supply established. Control power supply (r, t) is established and amplifier (RDY) is ON. ・EtherCAT FSA “Switch ON Disabled” or “Ready to Switch ON”
	・Main circuit power supply established. Main power supply (R, S, T) is established, but operation preparation completion signal is OFF. ・EtherCAT FSA “Switch ON Disabled” or “Ready to Switch ON”.
	・Safe Torque Off working status. Main Circuit Power Supply (R,S,T) is established and one or both of the Safe Torque OFF Input 1/2 is/are OFF. ・EtherCAT FSA “Switch ON Disabled” “Ready to Switch ON” or “Switch ON” ・Lights as “  ” this order.
	・Operation preparation completion signal established. Main power supply (R, S, T) is established and operation preparation completion signal is ON. ・EtherCAT FSA “Switch ON Disabled” “Ready to Switch ON” or “Switch ON”
	・Servo is ON. Shows ”8” shape continuously ・EtherCAT FSA “Operation Enabled”
	・Progress state firmware being rewritten 1 Shows that the state is in the mode to rewrite amplifier CPU flash ROM.
	・Progress state firmware being rewritten 2 Shows that amplifier CPU flash ROM BOOT program is being rewritten.
	・Progress state firmware being rewritten 3 Shows that amplifier CPU flash ROM application program is being erased.
	・Progress state firmware being rewritten 4 Shows that amplifier CPU flash ROM application program is being rewritten.
	・Progress state firmware being rewritten 5 Shows that amplifier CPU flash ROM application program is being verified.
	・Firmware rewriting completed Shows the state that Shows that amplifier CPU flash ROM rewriting has been completed via firmware downloaded in BOOT mode. (Re-start the control power supply after becoming this state.)

2) Forward/Inverse Limit, Emergency Stop Display

Marking	Servo amplifier status
	･Forward direction limit status Command input of forward direction is disabled by forward direction limit switch input
	･Inverse direction limit status Command input of inverse direction is disabled by inverse direction limit switch input
	･Emergency Stop status Motor is under STOP status by inputting Quick Stop, Shut Down or Emergency Stop
	･Quick Step Active status Under Quick Stop Active status (Quick Stop Code: -2,5 – 7only) after motor stops as a result of inputting Quick Stop or Emergency Stop function (Generic input).

3) Display of linear motor magnetic pole position detecting status

Marking	Servo amplifier status
	・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 competed, after magnetic pole position detection completed via CS-position setting.
	・Magnetic pole position not detected state (CS-position setting being performed) Shows magnetic pole position not detected during CS-position setting.
	・Magnetic pole position detection completed state (CS-position setting being performed) Shows the state magnetic pole position detection completed during CS-position setting.

4) Status Display of Battery Warning, Regenerative Overload Warning, and Overload Warning

Marking	Servo amplifier status
	・Battery Warning status. Replace battery.
	・Regenerative overload Warning status. If operation is kept on, alarm may be issued.
	・Overload Warning status If operation is kept on, alarm may be issued.

5) Alarm Display

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

Marking	Servo amplifier status
AL. 85. 0	Displays Alarm Code with “2 digits” following “AL.” and Status Code at the time of alarm occurrence with “1 digit” after the alarm code. Please take a measure according to the contents of "Maintenance" when alarm occurring.

- AL. : Alarm status
- 85 : Alarm Code
- 0 : Status code of servo amplifier at the time of alarm

Code	State	
0	Power OFF	(P-OFF)
2	Power ON	(P-ON)
4	Servo Ready	(S-RDY)
8	Servo ON	(S-ON)
A	Emergency Stop	(EMR)
F	Initialized	

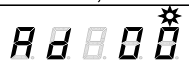
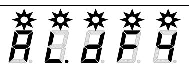
6) How to Reset Alarm When Alarm Occurring

Alarm can be reset with the Digital Operator, except for alarms necessary for re-input of power.

Process	Displayed character, number, code	MODE Key Operation	How to operate
1	AL. 180	Twice ON [WR]	Make the state(Status Display) where the alarm No. is displayed.
2	ALrSt	Twice ON [WR]	Changes to the left display. Alarm will be cleared by pushing “WR” twice again.
3	.r.u.n.	-	Display changes as the left for 2 seconds.
4	-	-	When the cause of alarm is removed, the state of servo amplifier is displayed.
-	ALrSt	Once ON [MODE]	When pushing “MODE” once in the status of Process 2, it will be cancelled and revert to Process 1.

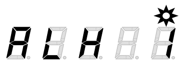
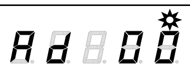
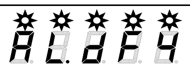
10.6 Trial Run Mode

1) Velocity-controlled JOG Operation

Process	Displayed character, number, code	MODE Key Operation	How to operate
1		Once ON [MODE]	Push Key until it displays the left. Display changes and right end LED blinks.
2		More than 1sec ON [INC]	Push key more than 1 sec to show display on left
3		Twice ON [WR]	Displays “JOG” mode by pushing twice
4		Twice ON [WR]	2Shows “8” shape by pushing twice and powers on servo
5		On long push [INC]	Rotates in CCW direction with one long push. Default value 50min^{-1} Note 1
6		Once ON [MODE]	Push ON once >>>Displays “JOG” in upper digits>>>Returns to Process 3 by pushing once
7		Once ON [MODE]	Ends Process by pushing once and display shows on left

Note 1) The number of rotations can be changed to an arbitrary number with Setup Software Group9 - ID21.

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	Ad 00	Once ON [MODE]	Push Key until it displays the left. Display changes and right end LED blinks.
2	Ad 01	More than 1sec ON [INC]	Push key more than 1 sec to show display on left
3	EnCLr	Twice ON [WR]	Displays "EnCLr" mode by pushing key twice
4	.r.u.n. .	Twice ON [WR]	Display changes to the left and executes Encoder Clear
5	EnCLr		Displays image on left "EnCLr" after normal completion
6	Ad 01	Once ON [MODE]	Returns to Process 2 by pushing key once
7	ALH 1	Once ON [MODE]	Displays Alarm History mode by pushing once

3) Automatic Tuning Result Writing

Process	Displayed character, number, code	MODE Key Operation	How to operate
1	Ad 00	ONCE ON [MODE]	Push Key until it displays the left. Display changes and right end LED blinks.
2	Ad 02	MORE THAN 1SEC ON [INC]	Push key more than 1 sec to show display on left
3	turSL	TWICE ON [WR]	Displays "turSL" mode by pushing key twice
4	.r.u.n. .	TWICE ON [WR]	Display changes to the left and executes Encoder Clear
5	turSL		Displays image on left "turSL" after normal completion
6	Ad 02	ONCE ON [MODE]	Returns to Process 2 by pushing key once
7	ALH 1	ONCE ON [MODE]	Displays Alarm History mode by pushing once

10.7 Alarm History Mode

1) Alarm History Display Mode

Process	Displayed character, number, code	MODE Key Operation	How to operate
1	ALH 1	Once ON [MODE]	Push Key until it displays the left. Display changes and right end LED blinks.
2	ALH 3	More than 1sec ON [INC]	Displays an Alarm History number that requests to be checked. Previous 7 alarms can be checked.
3	AL.85.0	Twice ON [WR]	Displays the previous 3 alarms from the current by pushing twice.
4	_ 1802	Twice ON [WR]	The lower digit displays elapsed time until alarm occurrence by pushing twice.
5	= 0	One long push [INC]	The middle digit displays elapsed time until alarm occurrence by one long push
6	≡ 0	One long push [INC]	The upper digit displays elapsed time until alarm occurrence by one long push
7	AL.85.0	Once ON [MODE]	Returns to Process 3 by pushing key once.
8	ALH 3	Once ON [MODE]	Returns to Process 3.
9	ob	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	ALH.CL	Once ON [MODE]	Displays Clear mode after Alarm History number 7 has been checked.
2	rdY	Twice ON [WR]	Clears preparations screen (as shown on the left) will be displayed by pushing the key until the display changes.
3	.r.u.n.	Twice ON [WR]	Displays as on the left by pushing the key until the display changes and executes Alarm History Clear.
4	ALH 1	-	Returns to History Selection Screen automatically after normal completion.
5	ALH.CL	Once ON [MODE]	Returns to Process 1 by pushing key about 1 sec in Process 3 to cancel
7	ob	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 the key until you see the display on the left. 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 2nd 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	Pulse encoder signal monitor	-
06	VMON	Velocity monitor (CCW: +, CW: -Display)	min^{-1}
07	VCMON	Velocity command monitor (CCW: +, CW: -Display)	min^{-1}
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	Serial 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
0B,0C,0E,10,12,15,16,18,19, 26～30		Reserved	-

2) Monitor Details

ID 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)

ID 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
Bit	7	6	5	4
Function	Excessive deviation	-	Velocity controlled	Torque controlled

ID 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
Bit	7	6	5	4
Function	Detecting a power failure	Low battery voltage	Maximum position limit	Minimum position limit

ID 03

■ General monitor ［CONTMON］

Displays General status. “1” shows input the state of photo coupler-on.

◆ 2-General

Bit	3	2	1	0
Function	SAFETOFF2	SAFETOFF1	CONT2	CONT1
Bit	7	6	5	4
Function	—	—	—	—

◆ 6-General

Bit	3	2	1	0
Function	CONT4	CONT3	CONT2	CONT1
Bit	7	6	5	4
Function	SAFETOFF2	SAFETOFF1	CONT5	CONT4

ID 04

■ General OUT3 - 1 monitor ［OUTMON］

Displays generic output terminal status. 1 = Output Transistor ON

Bit	7-3	2	1	0
Function	Reserved	Reserved (OUT3)	OUT2	OUT1

ID 05

■ Encoder signal monitor [INC-E MON]

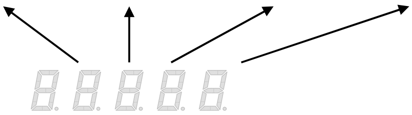
Displays pulse encoder signal status. 1 shows an incoming signal level “H” state.

Bit	3	2	1	0
Function	Reserved	Motor encoder ZERO (Z) phase signal	Motor encoder B phase signal	Motor encoder A phase signal
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

<table>
<tr><td>Bit</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
<tr><td>ON</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>OFF</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>-</td><td colspan="2">LED4</td><td colspan="2">LED3</td><td colspan="2">LED2</td><td colspan="2">LED1</td></tr>
</table>



Digital operator at the front of the servo amplifier

<table>
<tr><th>ID</th><th>Contents</th></tr>
<tr><td>06</td><td>■ Velocity monitor [VMON]
Displays the rotation speed of the servo motor.
<table><tr><th>Display range</th><th>Unit</th></tr><tr><td>- 9999 - 9999</td><td>min^{-1}</td></tr></table></td></tr>
<tr><td>07</td><td>■ Velocity command monitor [VCMON]
Displays the velocity command value.
<table><tr><th>Display range</th><th>Unit</th></tr><tr><td>- 9999 - 9999</td><td>min^{-1}</td></tr></table></td></tr>
<tr><td>08</td><td>■ Torque (force) monitor [TMON]
Displays the output torque.
<table><tr><th>Display range</th><th>Unit</th></tr><tr><td>- 499.9 - 499.9</td><td>%</td></tr></table></td></tr>
<tr><td>09</td><td>■ Torque (force) command monitor [TCMON]
Displays the torque command value.
<table><tr><th>Display range</th><th>Unit</th></tr><tr><td>- 499.9 - 499.9</td><td>%</td></tr></table></td></tr>
<tr><td>0A</td><td>■ Position deviation monitor [PMON]
Displays deviation between the command position and actual position.
<table><tr><th>Display range</th><th>Unit</th></tr><tr><td>- 2147483648 - 2147483647</td><td>Pulse</td></tr></table></td></tr>
<tr><td>0D</td><td>■ 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.
<table><tr><th>Data range</th><th>Display range</th><th>Unit</th></tr><tr><td>Bit31 - Bit0</td><td>H.FFFF - L.0000</td><td>Pulse</td></tr></table></td></tr>
<tr><td>0F</td><td>■ 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.
<table><tr><th>Data range</th><th>Display range</th><th>Unit</th></tr><tr><td>Bit31 to Bit0</td><td>H.FFFF to L.0000</td><td>Pulse</td></tr></table>
* This ID cannot be used in linear motor.</td></tr>
</table>

ID	Contents
11	■ 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. Data range: Bit31 - Bit0 / Display range: H.FFFF - L.0000 / Unit: Pulse
13	■ Position command pulse frequency monitor [FMON1] Displays the input command pulse frequency. Data range: Bit31 to Bit0 / Display range: H.FFFF to L.0000 / Unit: kpulse
14	■ U-phase electric angle monitor [CSU] Display range: 0 - 359 / Unit: deg Displays U-phase electric angle. Always displayed excluding encoder errors.
17	■ Serial encoder PS data [ABSPS] Displays position data of serial encoder. Display range: Bit31 - Bit0 / Display range: H.FFFF - L.0000 / Unit: Pulse In Digital Operator display form, it is displayed in ID17 as hexadecimal (32 bit data). * This ID cannot be used in linear motor.
1A	■ Regenerative resistor operation percentage [RegP] Displays run rate of regenerative resistance. Display range: 0.00 - 99.9 / Unit: %
1B	■Effective torque (force) monitor [TRMS] Displays effective torque. Depending on the operation pattern, it may take some hours to become stable. Display range: 0 - 499 / Unit: % 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)^2×100
1C	■ 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. Display range: 0 - 499 / Unit: % 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）^{2}×100
1D	■ 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.
1E	■ 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.
1F	■ 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.

<table>
<tr><th>ID</th><th>Contents</th></tr>
<tr><td>20</td><td>■ 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.</td></tr>
<tr><td>21</td><td>■ 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.</td></tr>
<tr><td>22</td><td>■ Torque Command Filter monitor [TCFIL MON]
Displays actual Torque Command Filter.
Value can be confirmed when changing gain and at Auto-tuning function.</td></tr>
<tr><td>23</td><td>■ Model Control Gain 1 monitor [KM1 MON]
Displays actual Model Control Gain.
Value can be confirmed when changing gain and at Auto-tuning function.</td></tr>
<tr><td>24</td><td>■ Load Torque(Thrust) monitor (Estimate value) [MTLMON-EST]
Displays estimated value of load torque.
<table><tr><th>Display range</th><th>Unit</th></tr><tr><td>-499.9 - 499.9</td><td>%</td></tr></table></td></tr>
<tr><td>25</td><td>■ Amplifier operation time [OPE-TIM]
Counted during period control power is being turned ON. The time is displayed value x 2 hours.
<table><tr><th>Unit</th></tr><tr><td>×2 hour</td></tr></table></td></tr>
</table>

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 1Selection	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 [Group7 ID06: 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 “Group7 ID06: 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.

11

11. Maintenance

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.	■ If voltage is low, check the power supply. ■ Check that wires and screws are fastened properly.
Red "CHARGE" LED goes out.	■ Internal power circuit of servo amplifier is defective, so replace the servo amplifier.
Over-travel status. Emergency Stop status.	■ Stop the input of Over-travel. ■ Stop the input of Emergency Stop. ■ Check of “Functions enabling condition settings”
Safe Torque (force) Off working status.	■ Turn on /HWGOFF1 and /HWGOFF2 inputs

■ 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)	■ If the value of a monitor is zero, input a command.
Check the servo motor is locked or not.	■ Check that the power line of a servo motor is connected.
Check if torque (force) limit is input.	■ Since torque (force) restrictions are inputted, a servo motor cannot output the torque (force) beyond the load torque (force). ■ Check of “Functions enabling condition settings”
Enter deviation clear to check if process is continued.	■ Stop the input of deviation clear. ■ Check of “Functions enabling condition settings”
Enter encoder clear to check if process is continued.	■ Stop the input of encoder clear. ■ Check of “Functions enabling condition settings”

* When performing the work for correction processing, be sure to intercept power supply.

■ Rotations of servo motor are unstable and less than the specified velocity command.

Investigation	Assumed causes and corrective actions
Check if proportional control is entered.	■ Stop the input of proportional control. ■ Check of “Functions enabling condition settings”
Check if torque (force) limit is input.	■ Stop the input of torque (force) limit. ■ Check of “Functions enabling condition settings”

■ Servo motor rotates only once, and stops.

Investigation	Assumed causes and corrective actions
Check motor power line.	■ The servo motor power line is not connected.
Check a setup of a combination motor. Check a setup of encoder resolution. (System parameter)	■ Change the settings and turn ON the power again.

* 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
■ Adjust the auto tuning “response”. ■ Reduce the loop gain speed. ■ Increase the velocity integral time constant. ■ Simplify the acceleration and declaration command. ■ Use position command low-pass filter.

■ Abnormal sound occurs

Investigation	Assumed causes and corrective actions
Check whether there is any problem in mechanical attachment.	■ Observe by operating one servo motor. ■ Pay attention while coupling and confirm that there is no core shift or unbalance.
Operate at a low speed and check whether abnormal sound has periodicity.	■ Confirm that the twisted pair and shield processing of motor encoder signal line are correct. ■ Confirm that the wiring for motor encoder line and servo motor power line are not installed in the same port. ■ Confirm that the power supply voltage is sufficient.

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	Serial encoder Battery warning	*Battery voltage is below 3.0 V
Control system	0x2103, 0x01, Bit4	Restricting torque (force) command	*While restricting the torque command by torque (force) restriction value.
	0x2103, 0x01, Bit5	Restricting speed command	*While restricting the speed command by speed value.
	0x2103, 0x01, Bit7	Excessive position deviation	*When position deviation warning setup value is outside the proscribed limits
	0x2103, 0x01, Bit10	Restricting position command	*Exceeding position command range

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	Port 0 Rx Invalidity Frame Error	* Received invalid frame successively at Port 0	SB	Yes
		0x11	Port 1 Rx Invalidity Frame Error	* Received invalid frame successively at Port 1	SB	Yes
		0x12	Port 0 Rx CRC Error	* Port 0 Successive Rx error	SB	Yes
		0x13	Port 1 Rx CRC Error	* Port 1 Rx occurrence error	SB	Yes
		0x14	Port 0 Tx Error	* Port 0 Successive TX error	SB	Yes
		0x15	Port 1 Tx Error	* Port 1 TX occurrence error	SB	Yes
	0x7520	0x18	Port 0 Lost link	* Port 0/1 cable was disconnected or unplugged in servo-on state. Host power supply was shutdown.	SB	Yes
		0x19	Port 1 Lost link		SB	Yes
	0x7510	0x1A	Communication time out	* Did not receive output data within regulated cycle time	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	SB	No
		0x26	Safe Torque (force) Off Error 2	* Failure of safe torque (force) off circuit	SB	No
Bit1	0x8311	0x41	Overload 1	* Failure of safe torque (force) off circuit	SB	Yes
	0x2220	0x42	Overload 2	* Stall over load	DB	Yes
	0x3212	0x43	Regenerative Overload	* Regeneration load ratio exorbitance	DB	Yes
	0x7300	0x44	Magnetic pole position detection error	* CS detection error	—	Yes
	0x8400	0x45	Average continuous over speed	* Over speed in average rotational speed	SB	Yes
Bit3	0x4110	0x51	Servo Amplifier Temperature Error	* Overheating detection of amplifier ambient temperature	SB	Yes
	0x4210	0x52	RS Overheat	* Detection of in-rush prevention resistance overheating	SB	Yes
		0x53	Dynamic Brake Resistance Overheat	* Overheating detection of dynamic brake resistor	SB	Yes
	0x4310	0x54	Internal Regenerative Resister Overheat	* Overheating detection of Internal regeneration resistor	DB	Yes
	0x4310	0x55	External Error	* Abnormality of external regenerative resistor, etc.	DB	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 ※1)	* DC Main circuit low voltage	DB	Yes
	0x3130	0x63	Main Power Supply Fail Phase ※1)	* 1 phase of the 3 phase main circuit power supply disconnected	SB	Yes
Bit2	0x5114	0x71	Control Power Supply Under-voltage ※2)	* Control power supply low voltage or instantaneous stoppage occurred	DB	Yes※3)
	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 ※4)	* Incremental encoder (A, B, Z) signal line break * Power supply cable break	DB	No
	0x7306	0x83	Encoder Connector 2 Disconnection ※4)	* Full close encoder (A, B, Z) signal line break * Power supply cable break	DB	Yes
	0x7300	0x84	Serial Encoder Communication Error	* CRC, SYNC, FORM, Command error occurrence in communication with sensor	DB	No
		0x85	Encoder Initial Process Error	* CS data read failure of Incremental encoder * 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.)

Note4) Alarm 0x81 detection becomes invalid with EN1, EN2 input frequency of 100 kHz or more at the time of linear encoder setting.

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	Serial Encoder Internal Error 0	* Absolute encoder rotation overflow * Frequent rotation counter overflow	DB	No
		0xA1	Serial Encoder Internal Error 1	* Multi-turn error * Battery low voltage	DB	Yes
	0x7310	0xA2	Serial Encoder Internal Error 2	* Accelerate error	DB	Note 5
	0x7310	0xA3	Serial Encoder Internal Error 3	* Over-speed error	DB	Note 5
	0x7300	0xA4	Serial Encoder Internal Error 4	* Access error of Encoder internal EEPROM	DB	Note 5
		0xA5	Serial Encoder Internal Error 5	* Detection of single rotation coefficient incorrect	DB	Note 5
		0xA6	Serial Encoder Internal Error 6	* Detection of multiple rotation coefficient incorrect	DB	Note 5
		0xA9	Serial Encoder Internal Error 9	* Overheating of encoder with built-in servo motor	DB	Note 5
	0x7320	0xAA	Serial Encoder Internal Error 10	* Incremental error（Position data error）	DB	Note 5
	0x7300	0xAC	Serial Encoder Internal Error 12	* Multi-rotation error generation	DB	Note 5
		0xAD	Serial Encoder Internal Error 13	* Encoder built-in EEPROM data is not set	DB	Note 5
	0x7303	0xAE	Serial Encoder Internal Error 14	* Resolver output abnormality	DB	Note 5
	0x7304	0xAF	Serial Encoder Internal Error 15	* Resolver disconnection	DB	Note 5
Bit0	0x8400	0xC1	Over-speed	* Motor rotation speed is 120 % more than the highest speed limit	DB	Yes
		0xC2	Velocity Control Error	* Nonconformity of electrical current command and acceleration signs	DB	Yes
	0x7122	0xC3	Velocity Feedback Error	* Servo motor power disconnection ※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
	0xFF01	0xDE	Parameter change completion ※7)	* Parameter change of motor and sensor codes is complete	–	No
	0xFF00	0xDF	Test Run Close ※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
	–※8)	0xE4	Memory Error 2 ※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 Note 10)	–	No
–※9)	–※8)	0xFF	Self flash timeout ※7)	* Self-flash re-writing procedure is completed within the specified time.	–	No

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.”

Note 10) It occurs when the ASIC dedicated for EtherCAT communication is failed to initialization and is not reply to the access from CPU.

11.4 Trouble shooting When Alarm Occurs

Note) V means the cause number with possibility.

- Alarm code 10 (Port 0 Rx Invalid Frame Error)
- Alarm code 11 (Port 1 Rx Invalid Frame Error)
- Alarm code 12 (Port 0 Rx CRC Error)
- Alarm code 13 (Port 1 Rx CRC Error)
- Alarm code 14 (Port 0 Tx Error)
- Alarm code 15 (Port 1 Tx Error)

Status at the time of alarm	Cause		
	1	2	3
Issued when control power is turned ON.	V	V	V
Issued during operation of servo motor	V	V	V

Corrective actions

	Cause	Investigative and Corrective Actions
1	■ Defect of communications cable	■ Check if there is contact failure in the communication cable wiring system
2	■ Malfunction due to noise	■ Confirm proper grounding of the amplifier. ■ Check encoder cable shield ■ Add ferrite core or similar countermeasures against noise.
3	■ Defect of control printed wiring board	■ Replace the servo amplifier.

- Alarm code 18 (Port 0 Lost link)
- Alarm code 19 (Port 1 Lost link)

Status at the time of alarm	Cause	
	1	2
The cable was unplugged.	V	
Issued during operation.		V

Corrective actions

	Cause	Investigative and Corrective Actions
1	■ Cable unplugged when motor was in operation.	■ Plug in / unplug cable in servo-off or below Pre-OP state.
2	■ Communication cable breaks. ■ Contact failure of connector and/or terminal.	■ Check the wiring of motor encoder and servo amplifier, and correct the wiring if needed.

- Alarm code 1A (Communication Time-Out)

Status at the time of alarm	Cause	
	1	2
Issued in Safe-OP or OP status	V	
Issued during operation.		V

Corrective actions

	Cause	Investigation and corrective actions
1	■ Could not receive command within the prescribed time of the Communication Timeout value (SM2 Event: Cannot receive Output data of PDO)	■ Examine if data is being Output by controller communication timing.
2	■ Malfunction due to noise	■ Confirm proper grounding of the amplifier. ■ Check the shielding of the encoder cable. ■ Add ferrite core or similar countermeasures against noise.

■ Alarm code 21 (Main Circuit Power Device Error)

Status at the time of alarm	Cause			
	1	2	3	4
Issued when control power is turned ON.	V		V	V
Issued at input of servo ON.	V	V	V	
Issued while starting and stopping the servo motor.	V	V	V	
Issued after extended operating time.	V	V	V	V

Corrective actions

	Cause	Investigation and corrective actions
1	■ U/V/W-phase of amplifier is short circuited due to the wiring in amplifier and motor. Also, U/V/W-phases are grounded in the earth.	■ Check the wiring conditions and restore if improper.
2	■ Short circuit or fault in U/V/W phases on servo motor side.	■ Replace the servo motor.
3	■ Defect in internal circuit of servo amplifier.	■ Replace the servo amplifier.
4	■ Overheating detection of the main circuit power device functioned.	■ For an amplifier equipped with a cooling fan motor, check that the cooling fan motor is running; if not, replace the servo amplifier. ■ Confirm that the temperature of the control panel (ambient temperature of the servo amplifier) does not exceed 55°C. If in excess of 55(C, check the installation method of the servo amplifier, and confirm that the cooling temperature of the control panel is set to below 55°C

■ Alarm code 22 (Current Detection Error 0)

Status at the time of alarm	Cause	
	1	2
Issued when servo is turned ON.	V	V

Corrective actions

	Cause	Investigation and corrective actions
1	■ Defect in internal circuit of servo amplifier.	■ Replace the servo amplifier.
2	■ Servo amplifier and motor are not combined properly. Electric current has exceeded maximum current (IP) of combined motor. (MOC: Motor Overcurrent)	■ Confirm that the proper codes (per the specified Motor Codes) have been used for the servo motor; if not, replace the servo motor.

■ Alarm code 23 (Current Detection Error 1)

Status at the time of alarm	Cause 1	Cause 2
Issued at input of servo ON.	V	
Issued during operation.	V	V

Corrective actions

	Cause	Investigation and corrective actions
1	■ Defect in internal circuit of servo amplifier. Data from electric current detector is always fixed.	■ Replace the servo amplifier.
2	■ Malfunction due to noise	■ Confirm proper grounding of the amplifier. ■ Add ferrite core or similar countermeasures against noise.

■ Alarm code 24 (Current Detection Error 2)

Status at the time of alarm	Cause 1	Cause 2
Issued at input of servo ON.	V	
Issued during operation.	V	V

Corrective actions

	Cause	Investigation and corrective actions
1	■ Defect in internal circuit of servo amplifier. Cannot get data from electric current detector.	■ Replace the servo amplifier.
2	■ Malfunction due to noise	■ Confirm proper grounding of the amplifier. ■ 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	Cause 2
Occurred in about 10 sec. after control power turned on	V	V
Issued during operation.	V	

Corrective actions

	Cause	Investigation and corrective actions
1	■ Input logic of Safe Torque (force) Off 1 and Safe Torque (force) Off 2 are mismatched	■ Match Input logic of SAFETOFF1/2 ■ Check wiring of SAFETOFF1, SAFETOFF2 and correct if necessary ■ When switching either signal logic of SAFETOFF1or SAFETOFF2 always switch the other one's signal within 10 sec
2	■ Defect in internal circuit of servo amplifier.	■ Replace the servo amplifier.

■ Alarm code 26 (Safe Torque (force) Off error 2)

Status at the time of alarm	Cause 1	Cause 2
Occurred when control power is turned on.	V	V
Issued during operation.		V

Corrective actions

	Cause	Investigation and corrective actions
1	■ Defect in internal circuit of servo amplifier.	■ Replace the servo amplifier.
2	■ Malfunction due to noise	■ Confirm proper grounding of the amplifier. ■ Add ferrite core or similar countermeasures against noise.

■ Alarm code 41 (Overload 1)

Status at the time of alarm	Cause								
	1	2	3	4	5	6	7	8	9
Issued at input of servo ON.	V	V							V
After command input, issued without rotating the motor.		V			V	V	V		V
After command input, brief motor rotation			V	V	V		V	V	

Corrective actions

	Cause	Investigation and corrective actions
1	■ Defect in internal circuit of servo amplifier.	■ Replace the servo amplifier.
2	■ Defect in internal circuit of motor encoder.	■ Replace the servo motor.
3	■ Effective torque (force) exceeds the rated torque (force).	■ Monitor the load status by using execution torque (force) monitor (TRMS), and check if effective torque (force) exceeds the rated value. Then calculate servo motor effective torque (force) according to load and operation conditions. If the effective torque (force) is excessive, check the operating or loading, or replace with large sized servo motor.
4	■ Defect in servo motor-servo amplifier combination.	■ Check if the motor in use matches with the recommended type, and replace if it is improper.
5	■ Holding brake of servo motor does not release.	■ Check that the wiring and voltage of the holding brake are acceptable; if not, repair. If the above are OK, replace the servo motor.
6	■ Wiring of U/V/W –phase between servo amplifier and motor do not match.	■ Check the wiring conditions and restore if improper.
7	■ One or all connections of U/V/W -phase wiring of servo amplifier / motor is disconnected.	■ Check the wiring conditions and restore if improper.
8	■ Machines collided.	■ Check the operating conditions and limit switch.
9	■ Motor encoder pulse number setting does not match with the servo motor.	■ Match the encoder pulse number with the servo motor.

Note) During the alarm caused by conditions in #3 (above), if OFF -> ON of 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.	V	V							V
After command input, issued without rotating the servo motor.		V			V	V	V		V
After command input, brief motor rotation.			V	V	V		V	V	

Corrective actions

Cause		Investigation and corrective actions
1	■ Defect in internal circuit of servo amplifier.	■ Replace the servo amplifier.
2	■ Defect in internal circuit of motor encoder.	■ Replace the servo motor.
3	■ Rotation is less than 50min^{-1} and torque (force) command exceeds approx. 2 times of rated torque (force).	■ Check if torque (force) command exceeds approx. 2 times of the rated torque by torque (force) command monitor (TCMON). Or, calculate the motor effective torque from load conditions and operation conditions. If the effective torque (force) is excessive, check the operating or loading, or replace with large sized servo motor.
4	■ Defect in servo motor-servo amplifier combination	■ Check the motor type setting and the motor in use are matching. If not, correct them.
5	■ Holding brake of servo motor does not release.	■ Check that wirings and voltage for holding brake are correct. If not, repair them. If they are appropriate, replace the servo motor.
6	■ Wiring of U/V/W –phase between servo amplifier and motor do not match.	■ Check the wiring conditions and restore if improper.
7	■ One or all connections of U/V/W -phase wiring of servo amplifier / motor is disconnected.	■ Check the wiring conditions and restore if improper.
8	■ Machines collided.	■ Check the operating conditions and limit switch.
9	■ Motor encoder pulse number setting does not match with the servo motor.	■ Match the encoder pulse number with the servo motor.

■ Alarm code 43 (Regenerative Overload)

Status at the time of alarm	Cause							
	1	2	3	4	5	6	7	8
Issued when 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	■ Magnetic pole position detection frequency and mechanical resonance point are matched. ■ Motor hit the stroke end.	■ Change magnetic pole position detection frequency. ■ Secure the distance to the stroke end.
2	■ Control circuit fault of servo amplifier.	■ Replace servo amplifier.

■ Alarm code 45 (Average continuous over speed)

Status at the time of alarm	Cause
	1
Occurred during operation.	V

Corrective actions

	Cause	Investigation and corrective actions
1	■ The average speed exceeds the maximum speed of continuous rotation speed range.	■ Review the operating conditions. ■ Resize the servo motor.

■ 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.	V		V	V	
Issued during operation.	V	V	V	V	
Issued after emergency stop.					V

Corrective actions

	Cause	Investigation and corrective actions
1	■ Defect in internal circuit of servo amplifier.	■ Replace the servo amplifier.
2	■ Regenerating power exceeded.	■ Check the operating conditions. ■ Use external regeneration resistor.
3	■ Regenerating power is within the specified range but ambient temperature of servo amplifier is out of specified range.	■ Confirm that the cooling method maintains the temperature of control board between 0 to 55°C.
4	■ Regenerating power is within the specified range but built-in cooling fan of servo amplifier is stopped.	■ For an amplifier equipped with a cooling fan motor, check that the cooling fan motor is running; if not, replace the servo amplifier.
5	■ Regeneration energy during emergency stop exceeded.	■ Change the servo amplifier. ■ Check the loading condition.

Note) Abnormalities are detected in the internal temperature of the amplifier regardless of its ambient temperature. When an amplifier temperature warning is issued, please be sure to check the cooling method of the control panel.

■ Alarm Code 52 (In-rush prevention resistance Overheat)

Status at the time of alarm	Cause		
	1	2	3
Issued when power supply control is turned ON.	V		
Issued when main circuit power supply is turned ON.		V	
Issued during operation.			V

Corrective actions

	Cause	Investigation and corrective actions
1	■ Defect in internal circuit of servo amplifier.	■ Replace the servo amplifier.
2	■ Power turning ON is repeated too frequently.	■ Turn ON/OFF the power less frequently.
3	■ Ambient temperature is high.	■ For an amplifier equipped with a cooling fan motor, check that the cooling fan motor is running; if not, replace the servo amplifier. ■ Check if the temperature inside the control board (servo amplifier ambient temperature) exceeds 55°C. If it does, review the servo amplifier installing method and cooling method of control board to make it below 55°C.

■ Alarm Code 53 (Dynamic Brake Resistor Overheat)

Status at the time of alarm	Cause	
	1	2
Issued when power supply control is turned ON.	V	
Issued during operation.	V	V

Corrective actions

	Cause	Investigation and corrective actions
1	■ Defect in internal circuit of servo amplifier.	■ Replace the servo amplifier.
2	■ 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.	V		V
Issued during operation.	V	V	V

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.	V	V

Corrective actions

	Cause	Investigation and corrective actions
1	■ Validity condition for external trip function is set to 'Valid'.	■ Set Generic Input signal to 00:_Always_Disable
2	■ Defect in internal circuit of servo amplifier.	■ Replace the servo amplifier.

◆ When thermal signal of the external regenerative resistor is connected

Status at the time of alarm	Cause		
	1	2	3
Issued when power supply control is turned ON.	V		V
Issued after operation for some time.		V	V

Corrective actions

	Cause	Investigation and corrective actions
1	■ Improper wiring of external regenerative resistance.	■ Check wiring and replace if necessary.
2	■ External regeneration resistor is operating.	■ Check the operating conditions. ■ Increase the capacity of the external regeneration resistor.
3	■ Defect in internal circuit of servo amplifier.	■ Replace the servo amplifier.

Note) When output terminal of upper level device is connected, eliminate the alarm trigger of the host level device.

■ Alarm Code 56 (Main Circuit Power Device Overheat)

Status at the time of alarm	Cause			
	1	2	3	4
Issued when control power is turned ON.	V		V	V
Issued at input of servo ON.	V	V	V	
Issued while starting and stopping the servo motor.	V	V	V	
Issued after operation for some time.	V	V	V	V

Corrective actions

	Cause	Investigation and corrective actions
1	■ U/V/W-phase of amplifier is short circuited due to the wiring in amplifier and motor. Also, U/V/W-phases are grounded in the earth.	■ Check wiring and replace if necessary.
2	■ Short circuit or fault in U/V/W phases on servo motor side.	■ Replace the servo motor.
3	■ Defect in internal circuit of servo amplifier.	■ Replace the servo amplifier.
4	■ Ambient temperature is high.	■ For an amplifier equipped with a cooling fan motor, check that the cooling fan motor is running; if not, replace the servo amplifier. ■ Confirm that the temperature of the control board (ambient temperature of the servo amplifier) does not exceed 55°C. If in excess of 55°C, check the installation method of the servo amplifier, and confirm that the cooling temperature of the control board is set to below 55°C.

■ Alarm Code 61 (Over-Voltage)

Status at the time of alarm	Cause 1	Cause 2	Cause 3	Cause 4
Issued when power supply control is turned ON.	V			
Issued when power supply of main circuit is turned ON.	V	V		
Issued while starting and stopping the servo motor.		V	V	V

Corrective actions

	Cause	Investigation and corrective actions
1	■ Defect in internal circuit of servo amplifier.	■ Replace the servo amplifier.
2	■ The power supply voltage of main circuit is out of the specification.	■ Reduce the power supply voltage to within the specified range.
3	■ Excessive load inertia.	■ Reduce the load inertia to within the specified range.
4	■ Incorrect wiring for regeneration resistance. ■ Built-in regeneration circuit is not functioning.	■ Wire the regeneration resistance correctly. ■ While using the external regenerative resistance, check the wiring and resistance value. ■ Replace the servo amplifier if any abnormality occurs.

■ Alarm Code 62 (Main Circuit Under-voltage)

Status at the time of alarm	Cause 1	Cause 2	Cause 3	Cause 4	Cause 5
Issued when power supply control is turned ON.				V	V
Issued after power supply of main circuit is turned ON.	V	V	V		
Issued during operation.		V	V		

Corrective actions

	Cause	Investigation and corrective actions
1	■ Input power supply voltage is below the specified range.	■ Check the power supply and set it within the specified range.
2	■ Rectifier of main circuit is broken.	■ Replace the servo amplifier.
3	■ Input power supply voltage is reduced and/or blinking.	■ Check the power supply and confirm that there is no blinking or low voltage.
4	■ Low voltage outside of the specified range is supplied to the main circuit (R/S/T).	■ Check the main circuit voltage. Confirm that there is no external power supply to R/S/T when the main circuit is OFF.
5	■ Defect in internal circuit of servo amplifier.	■ Replace the servo amplifier.

■ Alarm Code 63 (Main Power Supply Fail Phase)

Status at the time of alarm	Cause 1	Cause 2	Cause 3
Issued when power supply control is turned ON.		V	
Issued when power supply of main circuit is turned ON.	V		V
Issued during operation.	V		
Alarm issued during single-phase power input selection.			V

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.	V	V	
Issued during operation.	V		V

Corrective actions

	Cause	Investigation and corrective actions
1	■ Defect in internal circuit of servo amplifier.	■ Replace the servo amplifier.
2	■ Input power supply voltage is below the specified range.	■ Confirm that the power supply is set within the specified range.
3	■ Input power supply voltage is fluctuating or blinking.	■ Confirm that the power supply is not going to neither blink nor reduce the power.

■ Alarm Code 72 (Control Circuit Under-voltage 1)

Status at the time of alarm	Cause	
	1	2
Issued when power supply control is turned ON.	V	V

Corrective actions

	Cause	Investigation and corrective actions
1	■ Defect in internal circuit of the servo amplifier.	■ Replace the servo amplifier.
2	■ Defect in external circuit.	■ Restart the power supply after removing the connector; if alarm is not issued, check the external circuit. ■ 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.	V	V

Corrective actions

	Cause	Investigation and corrective actions
1	■ Defect in internal circuit of servo amplifier.	■ Replace the servo amplifier.
2	■ Defect in external circuit.	■ Restart the power supply after removing the connector; if alarm is not issued, check the external circuit.

■ Alarm Code 81 (Encoder Connector Disconnection 1)
■ Alarm Code 83 (Encoder Connector Disconnection 2)
■ Alarm Code 87 (CS Signal Disconnection)

Status at the time of alarm	Cause				
	1	2	3	4	5
Issued when power supply control is turned ON.	V	V	V	V	V
Issued during operation.	V		V	V	

Corrective actions

	Cause	Investigation and corrective actions
1	■ For motor encoder wiring: ◆ Improper wiring. ◆ Connector is removed. ◆ Loose connection. ◆ Encoder cable is too long. ◆ Encoder cable is too thin.	■ Check wiring and replace if necessary. ■ Confirm that the encoder power supply voltage of the motor is above 4.75 V; increase it if below 4.75 V.
2	■ Servo amplifier and motor encoder are not combined properly.	■ Replace with servo motor equipped with proper encoder.
3	■ Defect in internal circuit of servo amplifier.	■ Replace the servo amplifier.
4	■ Defect in internal circuit of motor encoder.	■ Replace the servo motor.
5	■ Parameter set to ‘Full-closed servo system’.	■ Change of system parameter to “Semi-close Control / Motor Encoder” (Only with alarm code 83)

■ Alarm Code 84 (Serial Encoder Communication Error)

Status at the time of alarm	Cause		
	1	2	3
Issued when power supply control is turned ON.	V	V	V

Corrective actions

	Cause	Investigation and corrective actions
1	■ Defect in internal circuit of motor encoder.	■ Replace the servo motor.
2	■ Malfunction due to noise.	■ Confirm proper grounding of the amplifier. ■ Check the shielding of the encoder cable. ■ Add ferrite core or similar countermeasures against noise.
3	■ Motor encoder wiring has abnormalities.	■ Check the wiring of motor encoder and servo amplifier, and correct the wiring if needed.

■ Alarm Code 85 (Encoder Initial Process Error)

Status at the time of alarm	Cause				
	1	2	3	4	5
Issued when power supply control is turned ON.	V	V	V	V	V

Corrective actions

	Cause	Investigation and corrective actions
1	■ For motor encoder wiring:, ◆ Improper wiring. ◆ Connector is removed. ◆ Loose connection. ◆ Encoder cable is too long. ◆ Encoder cable is too thin.	■ Check wiring and replace if necessary. ■ Confirm that the encoder power supply voltage of the motor is above 4.75 V; increase it if below 4.75 V.
2	■ Servo amplifier and motor encoder are not combined properly.	■ Replace with servo motor equipped with proper encoder.
3	■ Defect in internal circuit of servo amplifier.	■ Replace the servo amplifier.
4	■ Defect in internal circuit of motor encoder.	■ Replace the servo motor.
5	■ Initial position data could not be set, as the number of rotations of the motor is more than 250 min^{-1} during power supply.	■ Restart the power supply after motor is stopped. (Only when PA035C and PA035S encoder is used.)

■ Alarm Code 86 (CS Error)

State when alarm activated	Cause
	1
Occurred motor was in operation.	✔

Corrective action

	Cause	Investigation and corrective actions
1	■ Malfunction due to noise occurred in linear sensor and hole sensor wirings.	■ Check to see if ground lead is properly placed. ■ Check shielding of linear sensor cable. ■ Add ferritic core to protect from noise.

:

■ Alarm Code A0 (Serial Encoder Internal Error 0)

Status at the time of alarm	Cause	
	1	2
Issued when power supply control is turned ON.	V	V
Issued while driving the servo motor.	V	V

Corrective actions

Cause		Investigation and corrective actions
1	■ Defect in internal circuit of motor encoder.	■ Turn ON the power supplies again; if not restored, replace the servo motor.
2	■ Malfunction due to noise.	■ Confirm proper grounding of the amplifier. ■ Check the shielding of the encoder cable. ■ Add ferrite core or similar countermeasures against noise.

■ Alarm Code A1 (Serial Encoder Internal Error 1)

Status at the time of alarm	Cause			
	1	2	3	4
Issued when power supply control is turned ON.	V	V		
Issued during operation.			V	V

Corrective actions

Cause		Investigation and corrective actions
1	■ Loose connection of battery cable.	■ Check the battery connector of encoder cable attachment.
2	■ The fall of battery voltage.	■ Check the voltage of battery.
3	■ Loose connection of encoder connector.	■ Check the wiring of motor encoder and servo amplifier, and correct the wiring if needed.
4	■ Defect in internal circuit of motor encoder.	■ Turn ON the power supplies again; if not restored, replace the servo motor.

Note) “Encoder clear and alarm reset methods” vary depending on the motor encoder in use.

■ Alarm Code A2 (Serial Encoder Internal Error 2)

Status at the time of alarm	Cause		
	1	2	3
Issued while stopping the servo motor.	V	V	
Issued while rotating the servo motor.	V	V	V

Corrective actions

Cause		Investigation and corrective actions
1	■ Defect in internal circuit of motor encoder.	■ Turn ON the power supplies again; if not restored, replace the servo motor.
2	■ Malfunction due to noise.	■ Confirm proper grounding of the amplifier. ■ 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 (Serial Encoder Internal Error 3)

Status at the time of alarm	Cause		
	1	2	3
Issued when power supply control is turned ON.	V		V
Issued while stopping the servo motor.	V	V	
Issued while stopping the servo motor.	V	V	V

Corrective actions

Cause		Investigation and corrective actions
1	■ Defect in internal circuit of motor encoder.	■ Turn ON the power supplies again; if not restored, replace the motor.
2	■ Malfunction due to noise.	■ Confirm proper grounding of the amplifier. ■ 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 (Serial Encoder Internal Error 4 - 6)
■ Alarm Code AA～AF (Serial Encoder Internal Error 10 - 15)

Status at the time of alarm	Cause	
	1	2
Issued when power supply control is turned ON.	V	
Issued during operation.	V	V

Corrective actions

Cause		Investigation and corrective actions
1	■ Defect in internal circuit of motor encoder.	■ Turn ON the power supplies again; if not restored, replace the motor.
2	■ Malfunction due to noise.	■ Confirm proper grounding of the amplifier. ■ 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 (Serial Encoder Internal Error 9)

Status at the time of alarm	Cause		
	1	2	3
Issued when control power supply is turned ON.	V	V	
Issued while stopping the servo motor.	V	V	
Issued while rotating the servo motor.		V	V

Corrective actions

Cause		Investigation and corrective actions
1	■ Defect in internal circuit of motor encoder.	■ Turn ON the power supplies again; if not restored, replace the servo motor.
2	■ Servo motor is not generating heat, but encoder ambient temperature is too high.	■ Confirm that the cooling method keeps the motor encoder ambient temperature below 80°C
3	■ Servo motor is overheated.	■ Confirm the cooling procedure of the servo motor.

Note) “Encoder clear and alarm reset methods” vary depending on the motor encoder in use.

■ Alarm Code C1 (Over-speed)

Status at the time of alarm	Cause			
	1	2	3	4
Issued when command is entered after Servo ON.	V	V		
Issued when the servo motor is started.			V	V
Issued other than operating and starting the motor.		V	V	

Corrective actions

Cause		Investigation and corrective actions
1	■ Defect in internal circuit of servo amplifier.	■ Replace the servo amplifier.
2	■ Defect in internal circuit of motor encoder.	■ Replace the servo motor.
3	■ Excessive overshoot while starting.	■ Adjust the servo parameters. ■ Simplify the acceleration and declaration 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.	V		V	
Issued if command is entered.	V	V	V	
Issued while starting and stopping the servo motor				V

Corrective actions

Cause		Investigation and corrective actions
1	■ Wiring of U/V/W -phase between servo amplifier and motor do not match.	■ Check the wiring and repair any irregularities.
2	■ Wiring of A/B -phase of pulse encoder do not match.	■ Check the wiring and repair any irregularities.
3	■ The servo motor is vibrating (oscillating).	■ Adjust the servo parameters so that servo motor will not vibrate (oscillate).
4	■ Excessive overshoot and undershoot.	■ Monitor speed with the analog monitor. ■ Adjust the servo parameters to reduce overshoot and undershoot. ■ Simplify the acceleration and declaration 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.	V	V	V
Generated at the time of control input.		V	

Corrective actions

Cause		Investigation and corrective actions
1	■ Motor is not rotating.	■ Confirm that the power line is properly connected. ■ Replace the servo motor.
2	■ Defect in internal circuit of servo amplifier.	■ Replace the servo amplifier.
3	■ The motor is vibrating (oscillating).	■ Adjust the servo parameter so that servo motor will not vibrate (oscillate).

■ Alarm Code C5 (Model Tracking Vibration Suppression, Control Error)

Status at the time of alarm	Cause		
	1	2	3
Issued after entering position command	V	V	V

Corrective actions

	Cause	Investigation and corrective actions
1	■ Setup of model control gain is high.	■ Lower model control gain.
2	■ The acceleration and deceleration time of a position command is short.	■ Simplify the acceleration and declaration command pattern.
3	■ Torque (force) limiting value is low.	■ Enlarge a torque (force) limiting value or repeal torque (force) restrictions.

* These alarms may be generated if the servo brake performs alarm reset during a slowdown.

■ Alarm Code D1 (Following Error / Excessive Position Deviation)

Status at the time of alarm	Cause											
	1	2	3	4	5	6	7	8	9	10	11	12
Issued when control power supply is turned ON.										V		
Issued when servo ON is stopped.						V					V	
Issued immediately after entering the command.	V	V	V	V	V		V	V	V		V	
Issued during starting or stopping at high speed.	V	V					V	V	V		V	V
Issued during the operations by lengthy command.		V					V	V			V	

Corrective actions

	Cause	Investigation and corrective actions
1	■ Position command changes excessively, or acceleration and declaration time is short.	■ Correct the position command of the controller.
2	■ Excessive initial load or low motor capacity.	■ Correct the load condition or increase the motor capacity.
3	■ Holding brake is not released.	■ Check wiring and replace if necessary. If specified voltage is applied, replace the servo motor.
4	■ Servo motor is mechanically locked or machine is colliding.	■ Check the machinery system.
5	■ One or all phases of U/V/W -phase of the servo amplifier and motor has disconnected.	■ Check wiring and replace if necessary.
6	■ Motor is being rotated by an external force (Gravity, etc.) during stopping (positioning completion).	■ Check the load, and/or increase the servo motor capacity.
7	■ Valid torque (force) limit command is entered by the controller, and the torque (force) limit setting is too much reduced. ■ Setting of a Velocity Limit Command is too little. ■ Number of motor encoder pulses does not match with the servo motor.	■ Increase the torque (force) limit value or disable the torque (force) limit. ■ ■ Enlarge setting of a Velocity Limit Command. ■ Match the number of servo motor encoder pulses.
8	■ Settings of servo parameters (Position Loop Gain, etc.) are not appropriate.	■ Check the servo parameter settings (Raise the position loop gain, etc.).
9	■ Excessive deviation setting value is much reduced.	■ Set a greater value for excessive deviation.
10	■ Defect in internal circuit of servo amplifier.	■ Replace the servo amplifier.
11	■ Defect in internal circuit of motor encoder.	■ Replace the servo motor.
12	■ Power supply voltage is low.	■ Check the power supply voltage.

■ Alarm Code D2 (Position Command Error 1)※

Status at the time of alarm	Cause	
	1	2
Issued after entering position command	V	V

Corrective actions

	Cause	Investigation and corrective actions
1	■ Velocity converted value of Position command exceeds the setting value of Position command error 1. ■ CSP: Converted velocity has exceeded setting level of previous and current position commands. ■ PP : Converted velocity of trajectory generated position command has exceeded setting value.	■ Lower Index 0x201D Position command error 1 setting value command input travel distance.
2	■ In cases where Position command cannot be received due to CRC error generation.	■ Add ferrite core or similar countermeasures against noise.

Note) Alarm “D2” must be cleared after deviation clear.

■ Alarm Code D3 (Position Command Error 2)

Status at the time of alarm	Cause	
	1	2
Issued after entering position command	V	V

Corrective actions

	Cause	Investigation and corrective actions
1	■ Excessive difference of recent command compared to previous Position command	■ Lower command input travel distance.
2	■ In cases where Position command cannot be received due to CRC error generation.	■ Add ferrite core or similar countermeasures against noise.

Note) Alarm “D3” must be cleared after deviation clear.

■ Alarm Code DE (Parameter change completion)

Status at the time of alarm	Cause
	1
Issued after setting initialization (0x20FE, 0x20FF)	V

Corrective actions

	Cause	Investigation and corrective actions
1	■ Normal operation in alarm status. ■ Setting value error. ■ (Enable value by re-inputting control power supply.)	■ Shut down control power supply and restart servo amplifier.

■ Alarm Code DF (Test Run Close)

Status at the time of alarm	Cause
	1
Occurred after execution of test mode.	V

Corrective actions

	Cause	Investigation and corrective actions
1	■ Normal operation of alarm in test mode completion. ■ (After completion of test mode, to confirm any deviation in the controller).	■ Clear the alarm and restore operation.

* Alarm will not be issued by marking the checkmark in “(Disabling support function completion alarm) at completion time” in test mode operation screen.

■ Alarm Code E1 (EEPROM Error)

Status at the time of alarm	Cause
	1
Issued during parameter change in Setup Software	V

Corrective actions

	Cause	Investigation and corrective actions
1	■ Defect in internal circuit of servo amplifier. ■ No response from EEPROM when saving servo parameters. (Defect in amplifier control board)	■ Replace the servo amplifier.

■ Alarm Code E2 (EEPROM Check Sum Error)

Status at the time of alarm	Cause	
	1	2
Issued when control power supply is turned ON.	V	V

Corrective actions

	Cause	Investigation and corrective actions
1	■ Correct value not read by CPU by EEPROM built-in servo amplifier.	■ Replace the servo amplifier.
2	■ Failed to write into the EEPROM during last power supply cutoff.	■ Replace the servo amplifier.

■ Alarm Code E3 (Memory Error 1)

Status at the time of alarm	Cause
	1
Issued when control power supply is turned ON.	V

Corrective actions

	Cause	Investigation and corrective actions
1	■ Proper access failure of CPU internal RAM ■ (Defect in control board of servo amplifier.)	■ Replace the servo amplifier.

■ Alarm Code E4 (Memory Error 2)

Status at the time of alarm	Cause
	1
Issued when control power supply is turned ON.	V

Corrective actions

	Cause	Investigation and corrective actions
1	■ Defect in internal circuit of servo amplifier. ■ (Program check sum of flash memory was incorrect at control power input.) ■ (Firmware defect in amplifier CPU)	■ Replace the servo amplifier.

■ Alarm Code E5 (System Parameter Error 1)

Status at the time of alarm	Cause	
	1	2
Issued when control power supply is turned ON.	V	V

Corrective actions

	Cause	Investigation and corrective actions
1	■ Selected value is outside the specified range for a system parameter.	■ Confirm the model number of the servo amplifier. ■ Turn ON the control power again and confirm that alarm is cleared.
2	■ Defect in internal circuit of servo amplifier.	■ Replace the servo amplifier.

■ Alarm Code E6 (System Parameter Error 2)

Status at the time of alarm	Cause	
	1	2
Issued when control power supply is turned ON.	V	V

Corrective actions

	Cause	Investigation and corrective actions
1	■ Selected values of system parameters and actual hardware do not match. ■ Improper assembly of system parameter settings.	■ Confirm the model number of the servo amplifier. ■ Turn ON the control power again and confirm that alarm is cleared.
2	■ Defect in internal circuit of servo amplifier.	■ Replace the servo amplifier.

■ Alarm Code E7 (Motor Parameter Error)

Status at the time of alarm	Cause	
	1	2
Issued when control power supply is turned ON.	V	V

Corrective actions

	Cause	Investigation and corrective actions
1	■ Correct value not read by CPU by EEPROM built-in servo amplifier.	■ If control power supply is re-switched on and alarm recurs after re-setting a motor parameter, replace servo amplifier.
2	■ Failed to write into the EEPROM when changing motor parameter.	■ If control power supply is re-switched on and alarm recurs after re-setting a motor parameter, replace servo amplifier.

■ Alarm Code E8 (CPU Circumference Circuit Error)

Status at the time of alarm	Cause
	1
Issued when control power supply is turned ON.	V

Corrective actions

	Cause	Investigation and corrective actions
1	■ Access failure of CPU and peripheral devices at initialization. ■ Defect in control circuit board of servo amplifier.	■ Replace the servo amplifier.

■ Alarm Code E9 (System code Error)

Status at the time of alarm	Cause
	1
Issued when control power supply is turned ON.	V

Corrective actions

	Cause	Investigation and corrective actions
1	■ Corresponding sensor on servo amplifier control board and sensor setting value do not match. (Defect in control circuit board of servo amplifier.)	■ Replace the servo amplifier.

■ Alarm Code EA (Motor code setting Error)

Status at the time of alarm	Cause
	1
Issued during amplifier initialization.	V

Corrective actions

	Cause	Investigation and corrective actions
1	■ Motor code transferred to 0x20FE is out of combination range.	■ Combinable motor code of amplifier capacity is not set. ■ Check if a combinable motor is set.

■ Alarm Code EB (Sensor code setting Error)

Status at the time of alarm	Cause
	1
Issued during amplifier initialization.	V

Corrective actions

	Cause	Investigation and corrective actions
1	■ Sensor division number transferred to 0x20FF is out of range or is an unsupported sensor.	■ Sensor classification code or division number cannot be combined. Set combinable sensor code or division number. ■ Change motor sensor to supported amplifier when motor sensor differs from sensor specification of non-responding amplifier.

■ Alarm Code EE (Motor Parameter Automatic Setting Error 1)

Status at the time of alarm	Cause		
	1	2	3
Occurred after motor parameter automatic setting functional performed.	✔	✔	✔

Corrective actions

	Cause	Investigation and corrective actions
1	■ Encoder being connected is not supported by motor parameter automatic setting function.	■ Replace with supported servo motor.
2	■ Servo motor being connected is not supported by motor parameter automatic setting function.	■ The servo motor you use cannot be supported by this function, so please download motor parameters from setup software.
3	■ Failure in internal circuit of motor encoder.	■ Replace the servo motor.

■ Alarm Code EF (Motor Parameter Automatic Setting Error 2)

Status at the time of alarm	Cause	
	1	2
Occurred after motor parameter automatic setting functional performed.	V	V

Corrective actions

	Cause	Investigation and corrective actions
1	■ Combination of servo amplifier and motor is incorrect.	■ Check the model number of servo amplifier and servo motor, and correct the combination.
2	■ Failure in internal circuit of motor encoder.	■ Replace the servo motor.

■ Alarm Code F1 (Task Process Error)

Status at the time of alarm	Cause
	1
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 5us, and transmit the frame exactly.

■ 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. (Initialization failure of the ASIC dedicating for EtherCAT communication)	■ 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 method absolute encoder	Battery-less absolute encoder
A1	—	・ Perform “Alarm reset” after “Encoder clear”	・ Perform “Alarm reset” after “Encoder clear” ・ Power cycle
A3	・ Perform “Alarm reset” after “Encoder clear” ・ Power cycle	・ Perform “Alarm reset” after “Encoder clear” ・ Power cycle	・ Perform “Alarm reset” after “Encoder clear” ・ Power cycle
A4	・ Perform “Alarm reset” after “Encoder clear” ・ Power cycle	・ Perform “Alarm reset” after “Encoder clear” ・ Power cycle	・ Perform “Alarm reset” after “Encoder clear” ・ Power cycle
A5	・ Power cycle	・ Power cycle	・ Perform “Alarm reset” after “Encoder clear” ・ Power cycle
A6	・ Power cycle	・ Power cycle	・ Power cycle after “Encoder clear”
A9	・ Perform “Alarm reset”	・ Perform “Alarm reset”	・ Perform “Alarm reset”
AA	—	—	・ Perform “Alarm reset” after “Encoder clear” ・ Power cycle
AF	—	—	・ Perform “Alarm reset” after “Encoder clear” ・ Power cycle

* When performed encoder clearing, multi turn part of encoder position data is cleared.
Operate after matching an encoder position data and mechanical coordinate.

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	V		Vibration	Check for excessive vibration.	Contact dealer/sales office.
	Daily	V		Sound	Check if there is no abnormal sound as compared to normal sound.	
	Periodic		V	Cleanliness	Check for dirt and dust.	Clean with cloth or air. Note 1)
	Yearly		V	Measure value of insulation resistance	Contact dealer or sales office.	
	5000 hours Note 2)		V	Replacement of oil seal		
Servo amplifier	Periodic		V	Cleaning	Check for dust accumulated in the accessories.	Clean with air. Note 1)
	Yearly		V	Loose screws	Check for loose connections.	Fasten the screws properly.
Battery for serial encoder	Regularly Note 3)		V	Battery voltage	Confirm that battery voltage is more than DC3.6V.	Replace the Battery.
Temperature	Periodic	V		Measure temperature	Ambient temperature 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 serial encoder [ER3V]	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 reduces 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 through out 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.

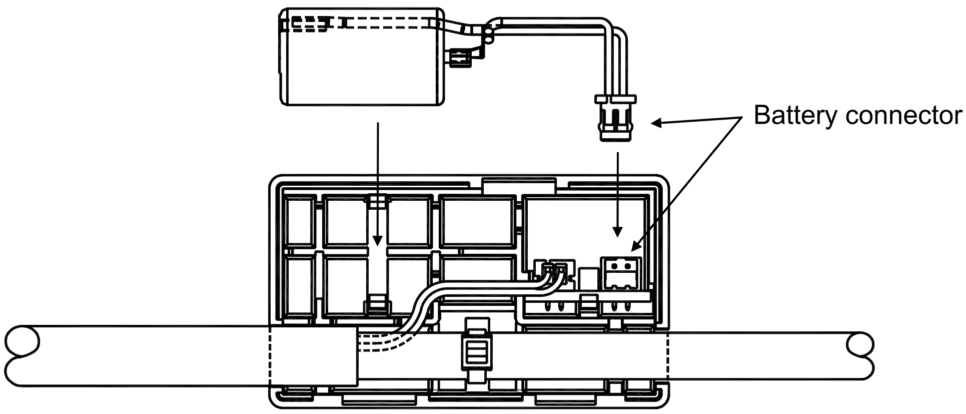
- Lithium battery for serial encoder
  - The standard replacement period recommended by our company is the life expectancy of lithium battery based on normal usage conditions. However, if there is high frequency of turning the power ON/OFF, or the motor is not used for a long period, then the life of lithium battery is reduced. If the battery power is less than 3.6 V during inspection, replace it with new one.

- At SANYO DENKI, the overhauled servo amplifier is shipped with the same parameters as the ones before overhauling, however, be sure to confirm the parameters before use.

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]



Battery case

* 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 (Serial 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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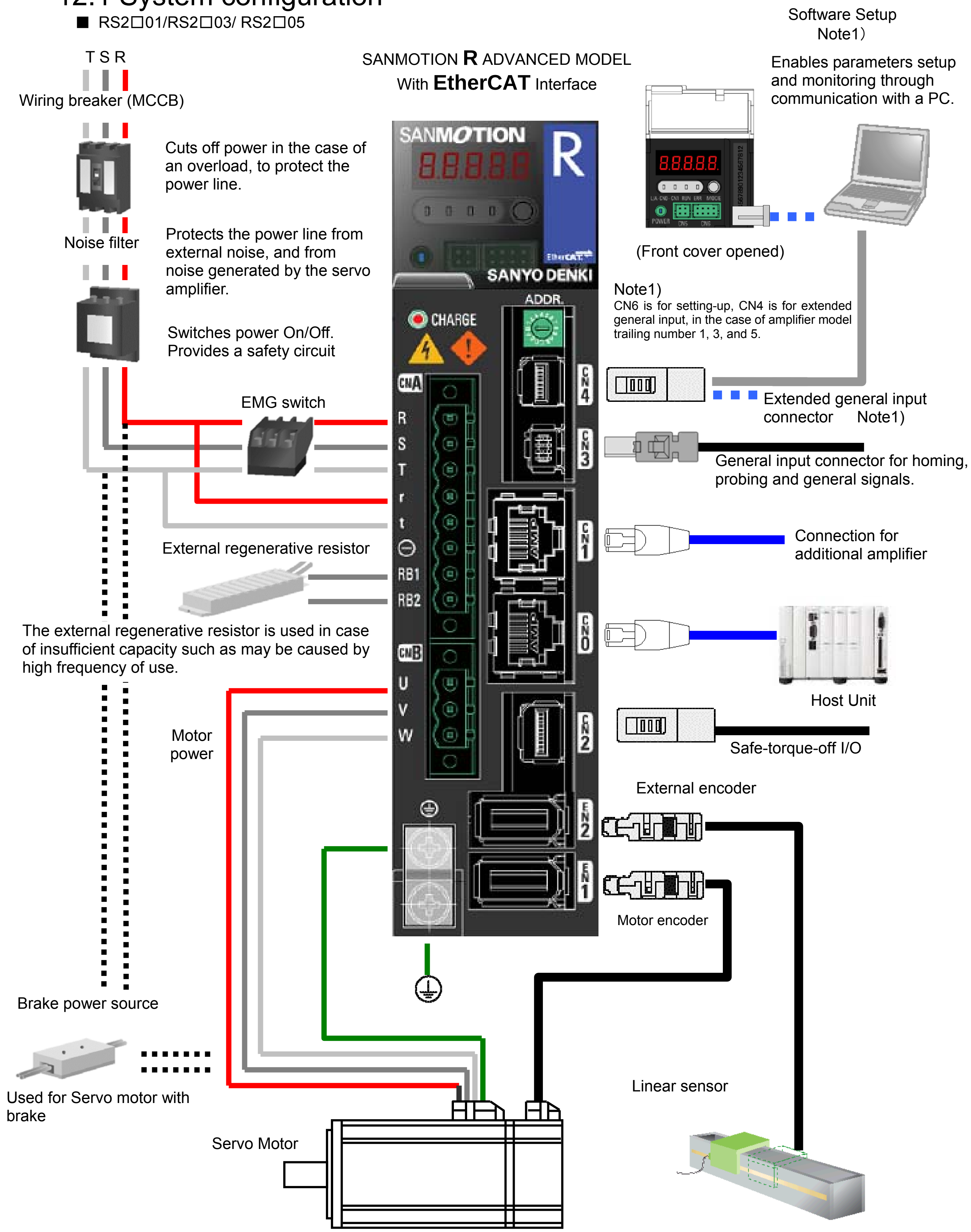
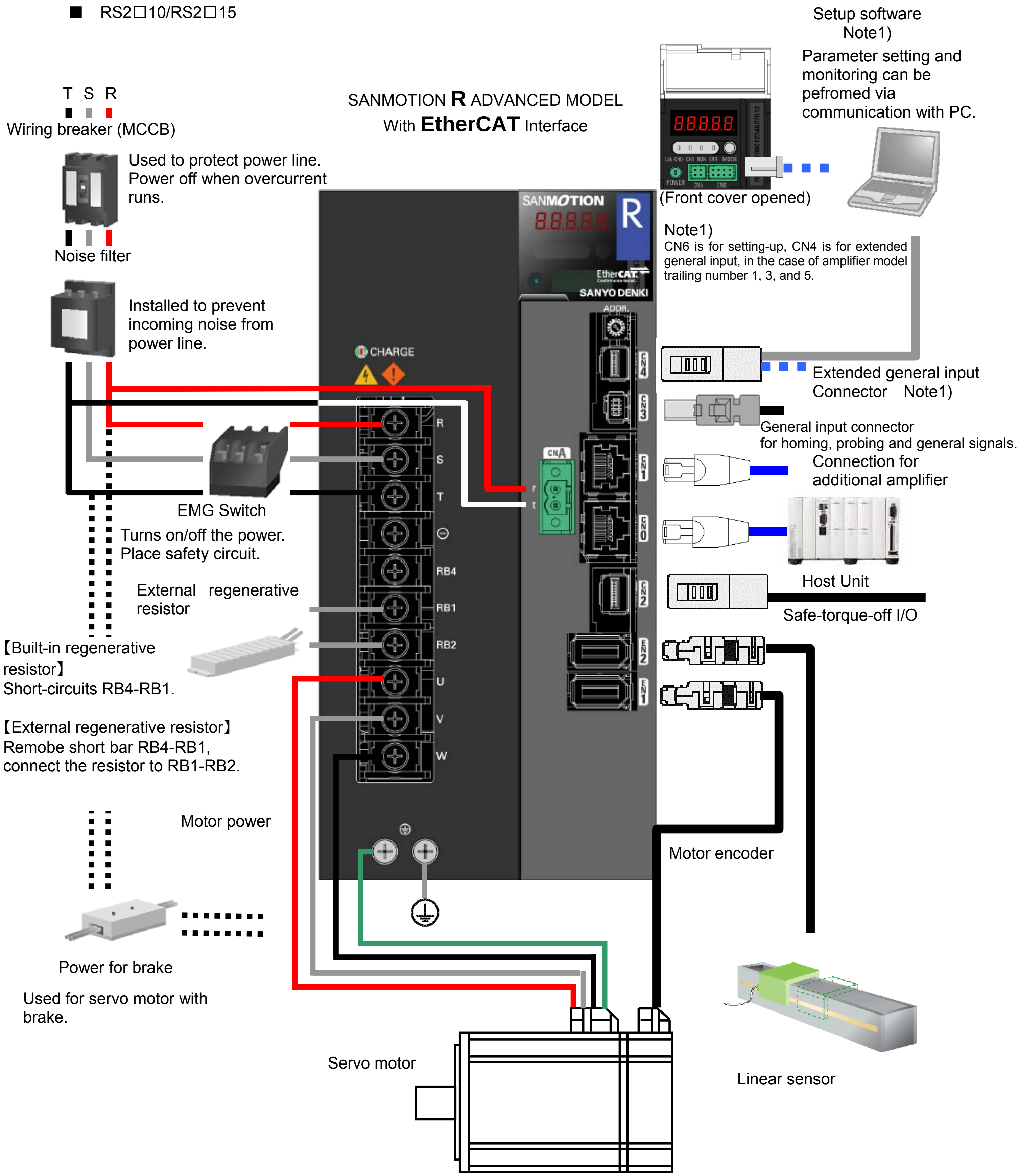
12. Fully-closed control

12.1 System configuration

■ RS2□01/RS2□03/ RS2□05

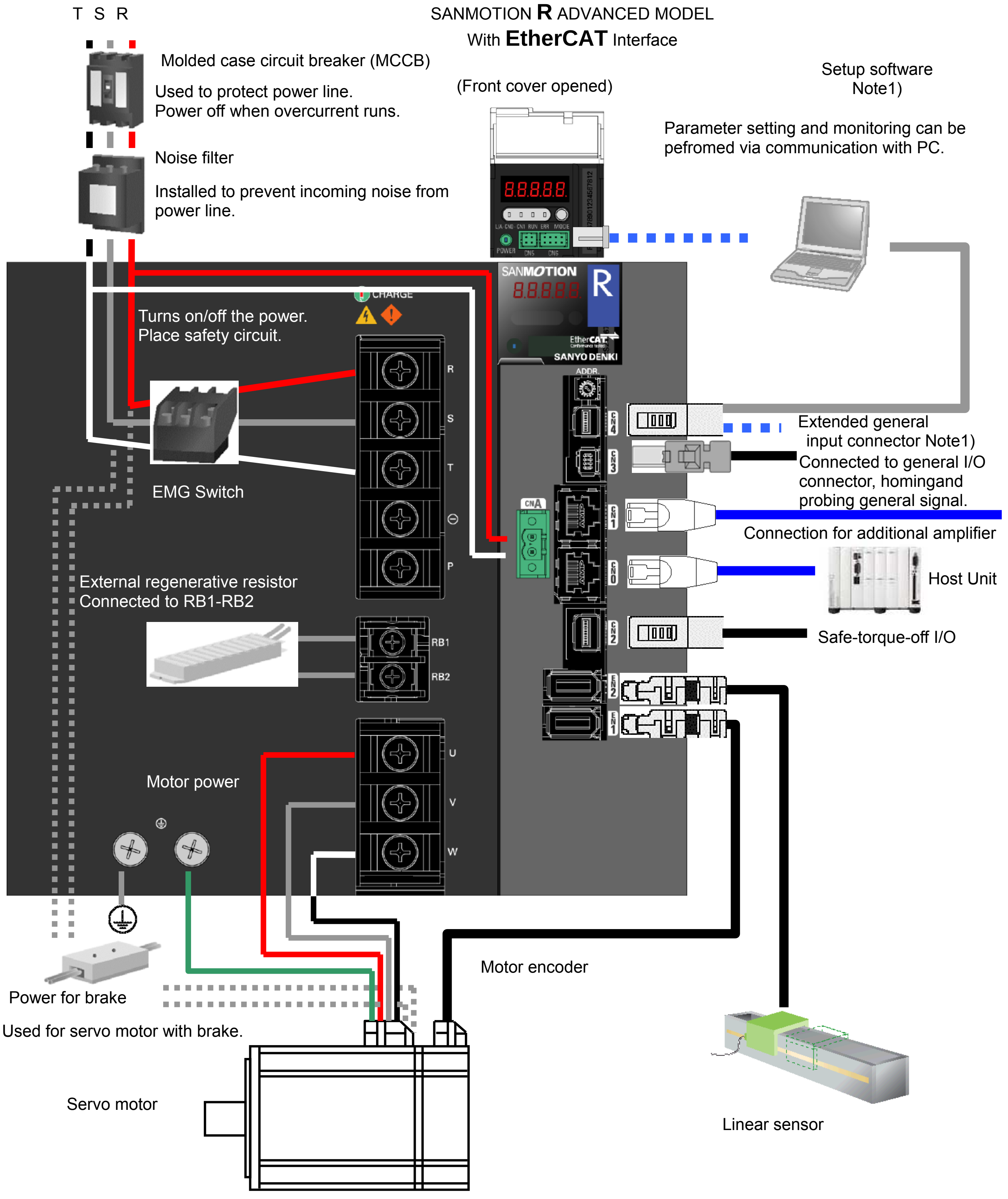


■ RS2□10/RS2□15



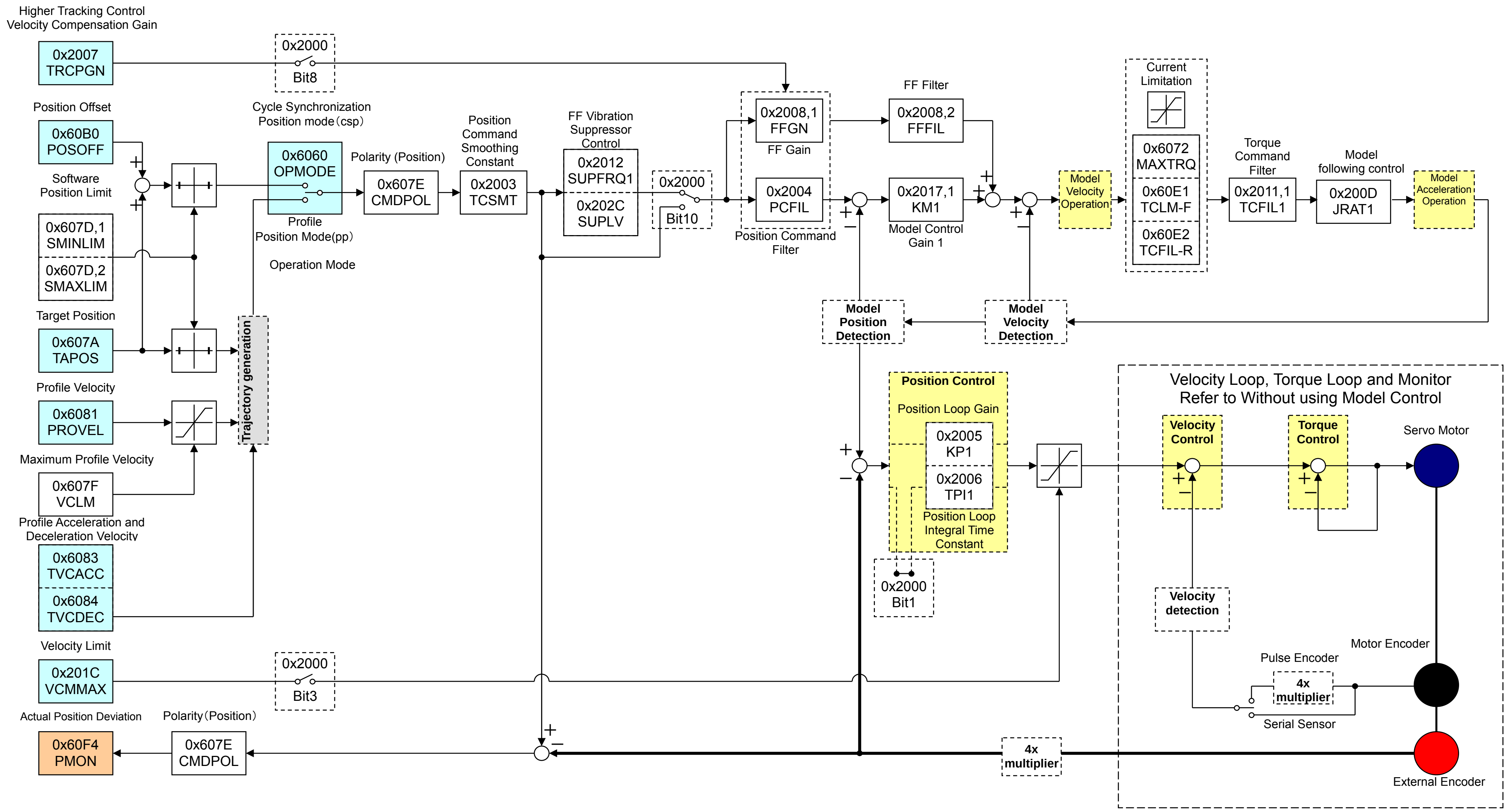
T S R
Wiring breaker (MCCB)
Used to protect power line. Power off when overcurrent runs.
Noise filter
Installed to prevent incoming noise from power line.
SANMOTION R ADVANCED MODEL
With EtherCAT Interface
Setup software
Note1)
Parameter setting and monitoring can be pefromed via communication with PC.
(Front cover opened)
Note1)
CN6 is for setting-up, CN4 is for extended general input, in the case of amplifier model trailing number 1, 3, and 5.
CHARGE
CNA
R
S
T
RB4
RB1
RB2
U
V
W
EMG Switch
Turns on/off the power. Place safety circuit.
External regenerative resistor
【Built-in regenerative resistor】
Short-circuits RB4-RB1.
【External regenerative resistor】
Remobe short bar RB4-RB1, connect the resistor to RB1-RB2.
Extended general input Connector Note1)
General input connector for homing, probing and general signals.
Connection for additional amplifier
Host Unit
Safe-torque-off I/O
Motor power
Motor encoder
Power for brake
Used for servo motor with brake.
Servo motor
Linear sensor

■RS2☐30

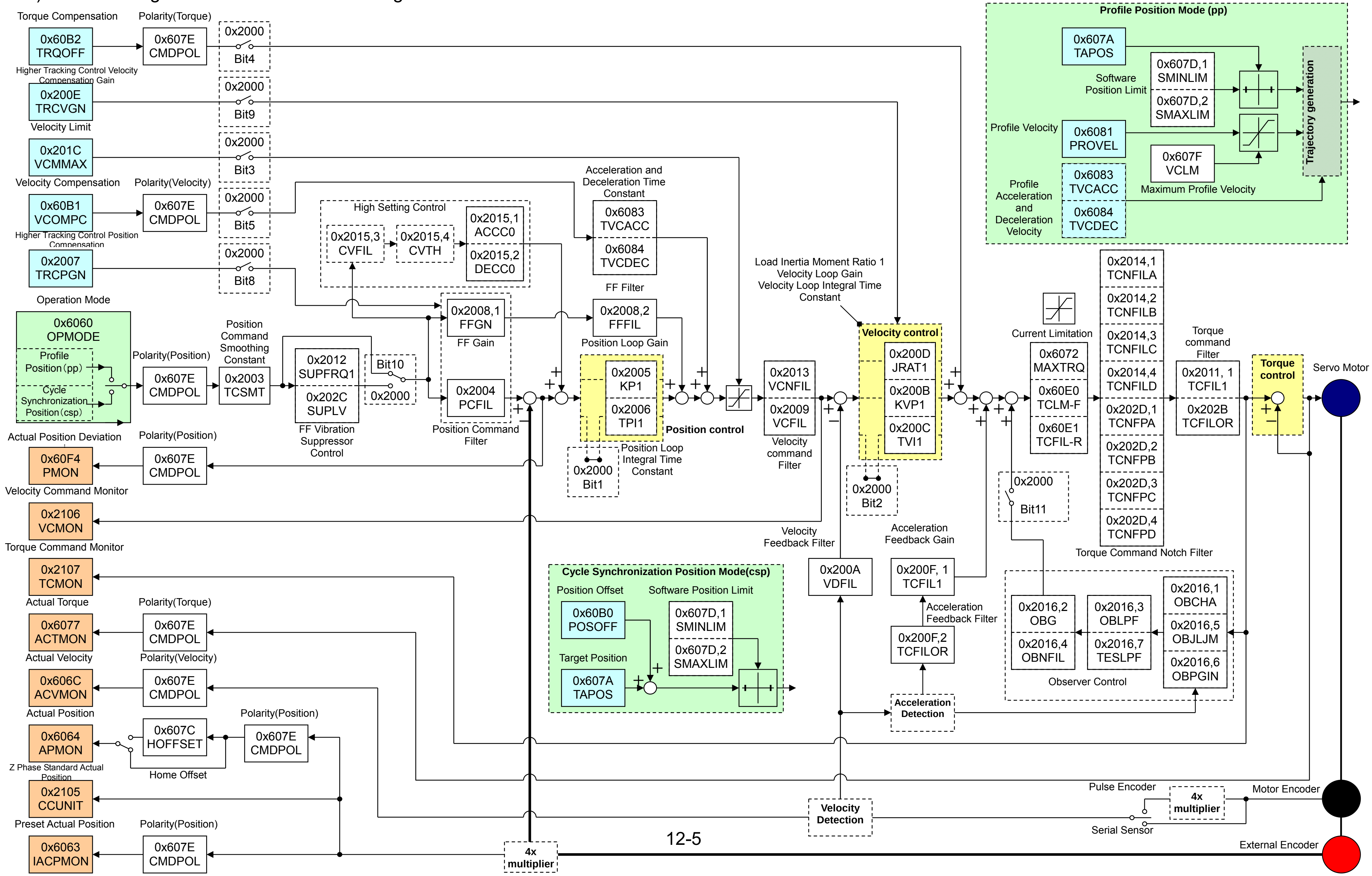

T S R
SANMOTION R ADVANCED MODEL
With EtherCAT Interface
(Front cover opened)
Setup software
Note1)
Parameter setting and monitoring can be pefromed via communication with PC.
Molded case circuit breaker (MCCB)
Used to protect power line.
Power off when overcurrent runs.
Noise filter
Installed to prevent incoming noise from power line.
Turns on/off the power.
Place safety circuit.
CHARGE
EMG Switch
R
S
T
P
External regenerative resistor
Connected to RB1-RB2
RB1
RB2
Motor power
U
V
W
ADDR.
CN4
CN3
CNA
CN1
CN0
CN2
EN2
EN1
Extended general input connector Note1)
Connected to general I/O connector, homingand probing general signal.
Connection for additional amplifier
Host Unit
Safe-torque-off I/O
Power for brake
Used for servo motor with brake.
Motor encoder
Servo motor
Linear sensor

12.2 Internal Block Diagram

1) Block Diagram With Model Following Control



2) Block Diagram Without Model Following Control



12.3 Wiring

1) Connector name and function

EN2 terminal number and signal name for external encoder are shown below.

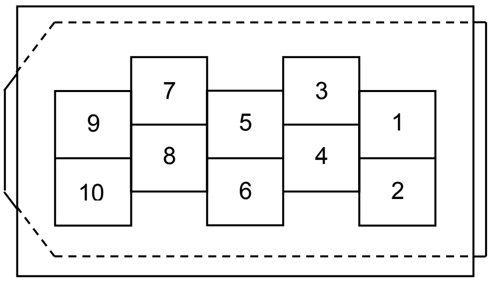
* Refer to 4.3 “Motor Code Wiring” for the connection method of motor encoder (EN1).

■ 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 pulse encoder.
Note 3) The 5 VDC power supply for an external pulse 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

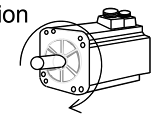
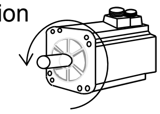
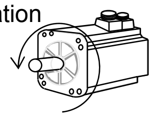
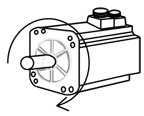
The System parameters have the following restrictions when Full-closed control is used for operation:
Full-closed control becomes valid when the Control mode is in [Positions control]. Full-closed operation is invalid with another Control mode except Positions control.
Only [Standard] and [Model following control] for Position control selection is valid.

<table>
<tr><th>Group ID</th><th>CoE Object ID</th><th>Contents</th></tr>
<tr><td>System
ID06</td><td>0x6060, 0x00
OPMODE</td><td>Operation mode
■ Setup Operation mode to the servo amplifier being used
Set below.
<table>
<tr><th colspan="2">Selection Value</th><th>Contents</th></tr>
<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>
</table></td></tr>
<tr><td>System
ID07</td><td>0x20F3, 0x01
PCNTSEL</td><td>Position Control Selection
■ Select functions of Position control mode
Set below.
<table>
<tr><th colspan="2">Selection Value</th><th>Contents</th></tr>
<tr><td>00</td><td>Standard</td><td>Standard</td></tr>
<tr><td>01</td><td>Model1</td><td>Model following control</td></tr>
</table></td></tr>
<tr><td>System
ID08</td><td>0x20F3, 0x02
PLMODE</td><td>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>
<tr><th colspan="2">Selection Value</th><th>Contents</th></tr>
<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>
</table>
■ Confirm and set below.
<table>
<tr><th>Current set Value</th><th>Contents</th></tr>
<tr><td>01:External-Enc</td><td>Full-closed control/External encoder</td></tr>
</table>
* Changes are not necessary for the system if [Full-closed control] is not used.</td></tr>
<tr><td>System
ID09</td><td>0x20FF, 0x03
EXENCODE</td><td>External Pulse Encoder Division Number
■ Set the external pulse encoder resolution per/pulse to be used for “Full-closed Control”.
Set 1x multiplier number converted in 1 rotation of motor axis.
* Position command becomes 4x multiplier resolution of this setting value.
* External encoder is not corresponding to absolute sensor.
* Changes are not necessary for the system if Full-closed control is not used.</td></tr>
</table>

2) Rotation direction setting for the servo motor

Rotation of the servo motor in Full-closed control is determined by Command polarity and External pulse encoder polarity.

■ Setting of Command input polarity

<table>
<tr><td>Group
ID</td><td>CoE
Object ID</td><td>Polarity</td></tr>
<tr><td>Group8
ID00</td><td>0x607E, 0x00
CMDPOL</td><td>■ 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.
<table>
<tr><td colspan="2">Selection Value</td><td>Position command positive</td><td>Position command negative</td></tr>
<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>
</table>
<table>
<tr><td colspan="2">Selection Value</td><td>Position command positive</td><td>Position command negative</td></tr>
<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>
</table>
</td></tr>
</table>

■ Setting of External Encoder input polarity

<table>
<tr><td>Group
ID</td><td>CoE
Object ID</td><td>External Encoder Polarity Selection</td></tr>
<tr><td>GroupC
ID03</td><td>0x20F1, 0x04
EX-ENPOL</td><td>■ Setup Signal polarity of External pulse encoder
<table>
<tr><td colspan="2">Selection Value</td><td colspan="3">Contents</td></tr>
<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>
</table>
Set: [External pulse 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).

Note) Becomes valid with Control power reactivation.</td></tr>
</table>

3) Setting for external encoder resolution

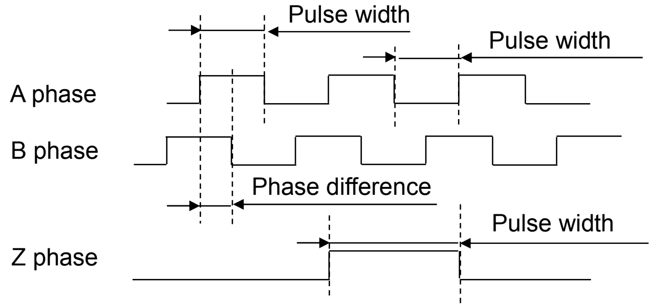
■ Setting of External Encoder input pulse number

<table>
<tr><td>Group ID</td><td>CoE Object ID</td><td>External Encoder Division Setting Number</td></tr>
<tr><td>System ID09</td><td>0x20FF, 0x03
ENPENRES</td><td>
■ Set the external pulse encoder resolution to be used for Full-closed control.
■ Input the pulse number converted in 1 rotation of motor axis.
<table>
<tr><td>Setting range</td><td>Unit</td></tr>
<tr><td>500 - 99999 (1 multiplier)</td><td>P/R</td></tr>
</table>
[Example]
◆ The minimum resolution of the External pulse encoder to be used : 1.0µm
◆ Work moving distance of 1 rotation of the motor axis : 10mm
External pulse encoder minimum resolution: 1.0µm >> converted pulse number per 1mm > >1000P/mm.
Converted pulse number per 1mm from the External pulse encoder’s minimum resolution:
1mm becomes 1000P/mm.
10mm/1R×1000P/mm = 10000P/R (4x multiplier), since the moving distance of work for 1 motor axis is 10 mm.
Set: 10000/4 = 2500P/R (setting value is 1x multiplier) Round off decimals.

Note) Becomes valid with Control power reactivation.
</td></tr>
</table>

4) Digital filter setting

■ Setting of External Encoder input pulse number

<table>
<tr><td>Group ID</td><td>CoE Object ID</td><td>External Pulse Encoder Digital Filter</td></tr>
<tr><td>Group C ID02</td><td>0x20F1, 0x03
EX-ENFIL</td><td>
■ Setting Digital filter of External pulse encoder
When noise is superimposed on the External pulse encoder, the pulse below set value is removed as noise.
Set this value by considering the resolution of the encoder and the maximum rotation speed of the servo motor.
Set the value below ¼ to the Encoder pulse width under peak motor rotation speed as a standard.
<table>
<tr><td colspan="2">Selection Value</td><td>Contents</td></tr>
<tr><td>00</td><td>110nsec</td><td>Minimum pulse width=110nsec
(Minimum phase difference=37.5nsec)</td></tr>
<tr><td>01</td><td>220nsec</td><td>Minimum pulse width =220nsec</td></tr>
<tr><td>02</td><td>440nsec</td><td>Minimum pulse width =440nsec</td></tr>
<tr><td>03</td><td>880nsec</td><td>Minimum pulse width =880nsec</td></tr>
<tr><td>04</td><td>75nsec</td><td>Minimum pulse width=75nsec
(Minimum phase difference=37.5nsec)</td></tr>
<tr><td>05</td><td>150nsec</td><td>Minimum pulse width =150nsec</td></tr>
<tr><td>06</td><td>300nsec</td><td>Minimum pulse width =300nsec</td></tr>
<tr><td>07</td><td>600nsec</td><td>Minimum pulse width =600nsec</td></tr>
</table>


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

12.5 Remarks

1) Input power timing for the external pulse encoder

- Please provide the power supply for the External pulse 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 pulse encoder

- There is a possibility that the servo motor could run out of control under the following conditions: Check the External pulse 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 Pulse Encoder Polarity Selection and set it to the same count direction (increase/decrease)

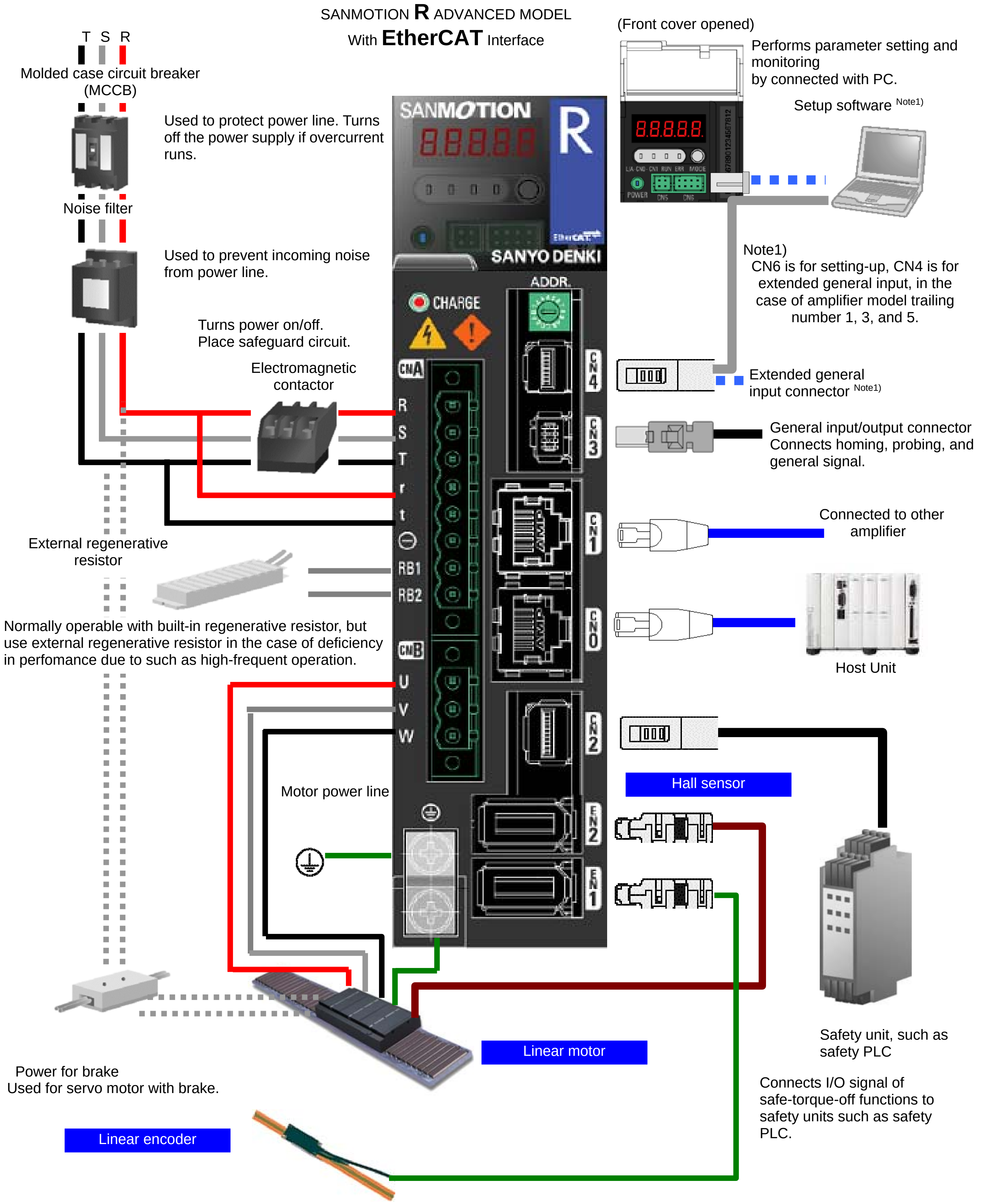
  - When the workings of the External pulse encoder are cut off:
    * Use them under the condition where the external pulse encoder is mechanically connected.

13

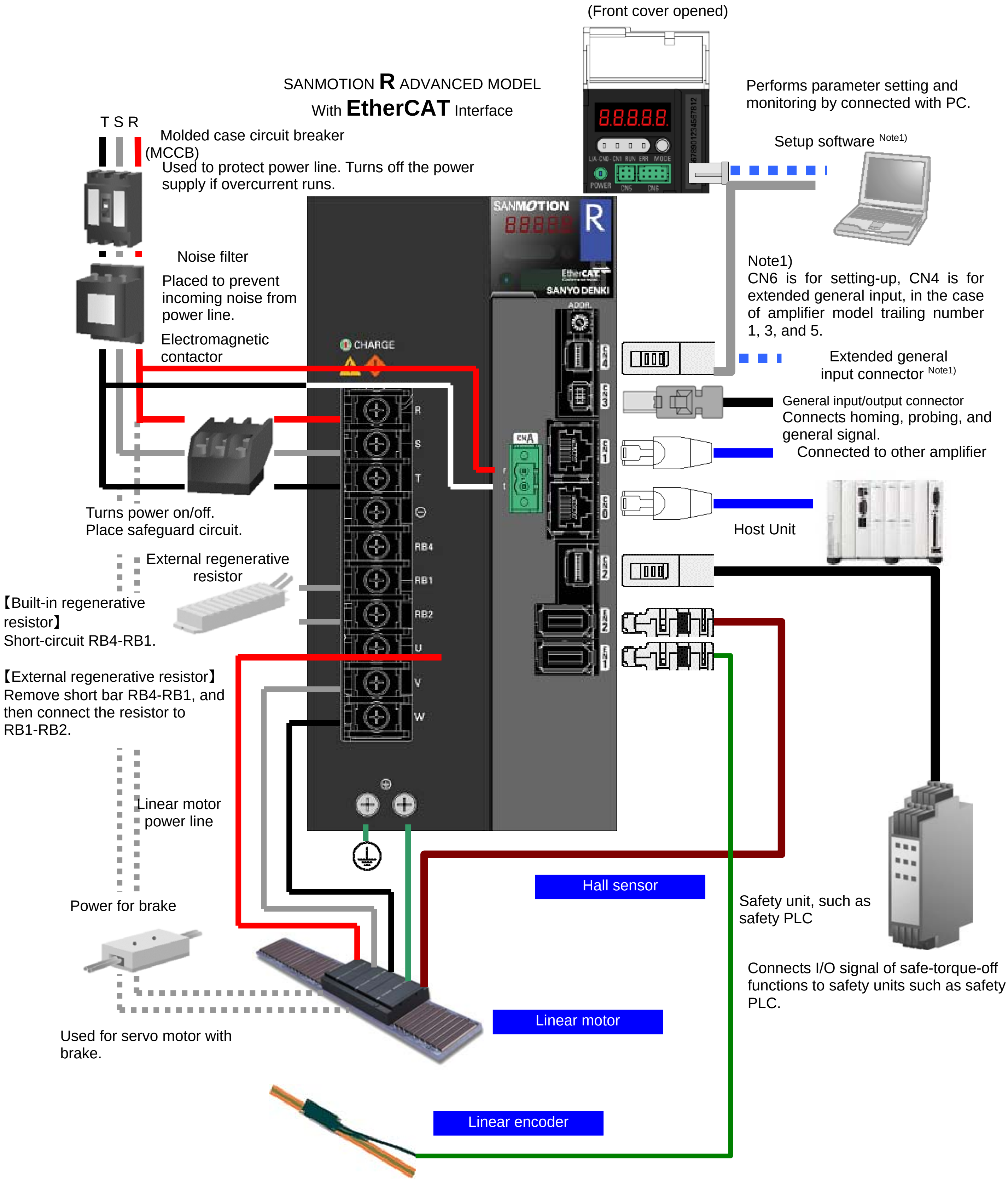
13. Linear motor

13.1 System configuration diagram

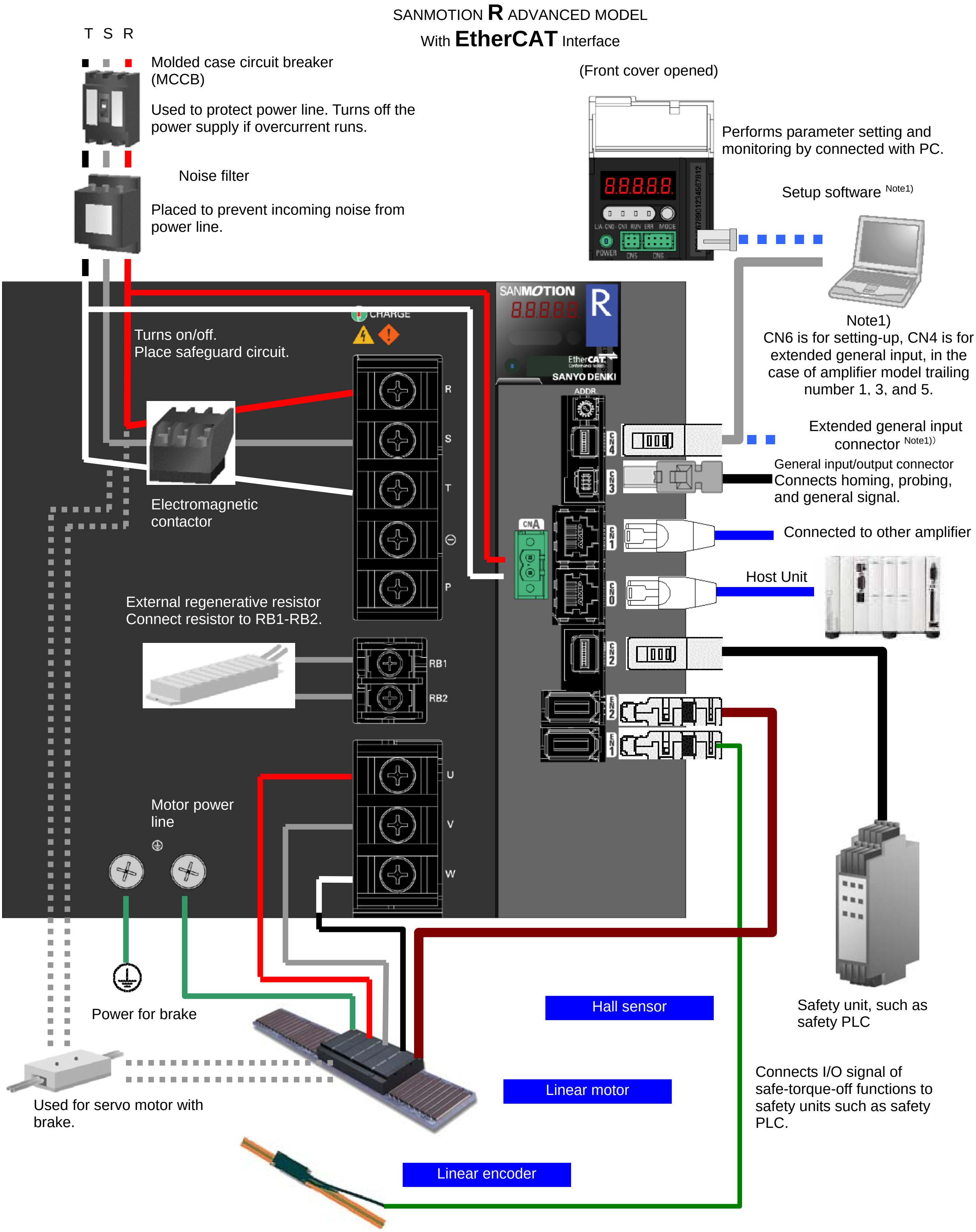
RS2☐01L / RS2☐03L / RS2☐05



■RS2□10L / RS2□15L



■RS2□30L


SANMOTION R ADVANCED MODEL
With EtherCAT Interface
(Front cover opened)
T S R
Molded case circuit breaker (MCCB)
Used to protect power line. Turns off the power supply if overcurrent runs.
Noise filter
Placed to prevent incoming noise from power line.
Performs parameter setting and monitoring by connected with PC.
Setup software Note1)
Turns on/off.
Place safeguard circuit.
CHARGE
Note1)
CN6 is for setting-up, CN4 is for extended general input, in the case of amplifier model trailing number 1, 3, and 5.
Extended general input connector Note1))
General input/output connector
Connects homing, probing, and general signal.
Electromagnetic contactor
Connected to other amplifier
Host Unit
External regenerative resistor
Connect resistor to RB1-RB2.
RB1
RB2
R
S
T
P
U
V
W
Motor power line
Power for brake
Hall sensor
Linear motor
Linear encoder
Safety unit, such as safety PLC
Connects I/O signal of safe-torque-off functions to safety units such as safety PLC.
Used for servo motor with brake.

13.2 Wiring

1) Recommended specification for encoder cable

Shielded many-to-one cable	Cable rating	80℃ 30V
	Conductor resistance value	1Ω or less Note1)
	Conductor size	AWG size: 26 to 18
		SQ(mm^2): 0.15 to 0.75

Note1) Shows conductor resistance value for the conductor length to be actually used.

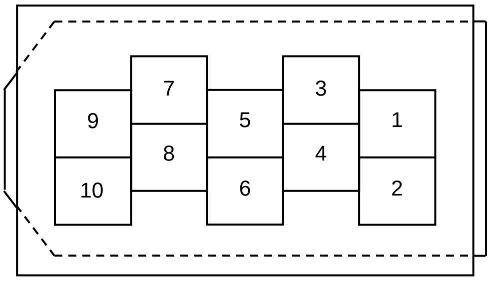
2) Encoder cable length

Maximum cable lengths by conductor size of power (5V, SG) cable

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

Conductor resistance varies depending on conductor specifications.

3) 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 (3M Japan Limited)

	Model number	Applicable wire size	Applicable cable outer diameter
Connector	36210-0100PL	AWG30 to AWG18	-
Shellkit	36310-3200-008	-	ϕ7 to ϕ9

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 pulse encoder.
Note3) Please prepare power supply for external pulse 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

<table>
<tr><th>Group
ID</th><th>CoE
Object ID</th><th>Contents</th></tr>
<tr><td>System
ID02</td><td>0x20FE, 0x00
MOCODE</td><td>Motor code
■ 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."
✔For the case of 0xFFFF whose motor code is specific , make sure to download motor parameters from setup software.
✍ System parameter becomes effective on re-power on.</td></tr>
<tr><td>System
ID03</td><td>0x20FF, 0x01
ENCODE</td><td>Sensor division number code
■ Set division number of linear scale sensor you use.
0x0000 : 5 μm [200P/mm]
0x0001 : 2.5 μm [400P/mm]
0x0002 : 2 μm [500P/mm]
0x0003 : 1.25 μm [800P/mm]
0x0004 : 1 μm [1, 000P/mm]
0x0005 : 0.5 μm [2, 000P/mm]
0x0006 : 0.25 μm [4, 000P/mm]
0x0007 : 0.125 μm [8, 000P/mm]
0x0008 : 0.1 μm [10, 000P/mm]
0x0009 : 0.05 μm [20, 000P/mm]
✍ System parameter becomes effective on re-power on.</td></tr>
<tr><td>System
ID04</td><td>0x20FF, 0x01
ENTYPE</td><td>Sensor type code
■ Set linear sensor and CS-normalization method you use.
0x0800:signal/ A, B, Z + S1·S2·S3 :CS-normalization/ EU
0x0810:signal/ A, B, Z + S1·S2·S3 :CS-normalization/ phase Z
0x0820:signal/ A, B, Z + S1·S2·S3 :CS-normalization/ none
0x0830:signal/ wire-saving incremental encoder :CS-normalization/ phase Z
0x0840:signal/ wire-saving incremental encoder :CS-normalization/ none
0x0850:signal/ A, B, Z only:CS-normalization/ Software setting (Magnetic pole position estimation)
0x0860:signal/ A, B, Z only:CS-normalization/ Software setting (fixed excitation)
✍ System parameter becomes effective on re-power on.</td></tr>
<tr><td>System
ID06</td><td>0x6060, 0x00
OPMODE</td><td>Operational mode
■ Set operational mode for the servo amplifier you use.
Set as follows.
<table>
<tr><th colspan="2">Value to select</th><th>Contents</th></tr>
<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>
</table></td></tr>
<tr><td>System
ID08</td><td>0x20F3, 0x02
PLMODE</td><td>Encoder selection to control position loop
■ Verify the set value is as indicated below.
<table>
<tr><th>Present set value</th><th>Contents</th></tr>
<tr><td>00:External-Enc</td><td>Semi-closed control/ motor encoder</td></tr>
</table></td></tr>
</table>

2) Setting of linear scale sensor

CS-detection method of linear motor varies depending on system parameter "System ID04" or "OD：0x20FF, 0x01 sensor type code." Verify the following parameter settings.

<table>
<tr><th>Group ID</th><th>CoE Object ID</th><th>Contents</th></tr>
<tr><td rowspan="2">GroupC ID01</td><td rowspan="2">0x20F1, 0x02 ENFIL</td><td>Encoder digital filter selection（EN1）</td></tr>
<tr><td>■ Set digital filter for motor pulse encoder pulse signal, which is contained in pulse output encoder. Digital filter value of incremental pulse from the linear scale sensor you use can be set. When noises superimposed on incremental encoder, pulse under the set value shall be eliminated as noise. Set the value in consideration of encoder resolution and operational maximum velocity of servo motor you use. Use the value under a quarter of encoder pulse width at maximum rotational velocity as a guide.
<table>
<tr><th>Value to select</th><th>Contents</th></tr>
<tr><td>00：_110nsec</td><td>Minimum pulse width ＝110ns（Minimum phase difference37.5ns）</td></tr>
<tr><td>01：_220nsec</td><td>Minimum pulse width ＝220ns（Minimum phase difference75ns）</td></tr>
<tr><td>02：_440nsec</td><td>Minimum pulse width ＝440ns（Minimum phase difference150ns）</td></tr>
<tr><td>03：_880nsec</td><td>Minimum pulse width ＝880ns（Minimum phase difference300ns）</td></tr>
<tr><td>04：_ 75nsec</td><td>Minimum pulse width ＝ 75ns（Minimum phase difference37.5ns）</td></tr>
<tr><td>05：_150nsec</td><td>Minimum pulse width ＝150ns（Minimum phase difference75ns）</td></tr>
<tr><td>06：_300nsec</td><td>Minimum pulse width ＝300ns（Minimum phase difference150ns）</td></tr>
<tr><td>07：_600nsec</td><td>Minimum pulse width ＝600ns（Minimum phase difference300ns）</td></tr>
</table></td></tr>
<tr><td rowspan="2">GroupC ID0A</td><td rowspan="2">0x20F1, 0x07 ENCDIR</td><td>Linear sensor polarity selection（EN1）</td></tr>
<tr><td>■ Select linear encoder (EN1) signal polarity. Phase A and B signal polarity are selectable.
<table>
<tr><th colspan="2">Value to select</th><th>Contents</th></tr>
<tr><td>00</td><td>Standard</td><td>Phase B signal rises in first in forward direction operation.</td></tr>
<tr><td>01</td><td>Reversed</td><td>Phase A signal rises in first in forward direction operation.</td></tr>
</table>
✍Function enabled on re-turning control power on.</td></tr>
</table>

3) Setting of magnetic pole position estimation method

CS-detection method of linear motor varies depending on system parameter “System ID04” or “OD：0x20FF, 0x01 sensor type code.” Verify the following parameter settings.

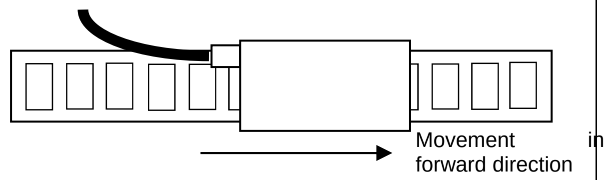
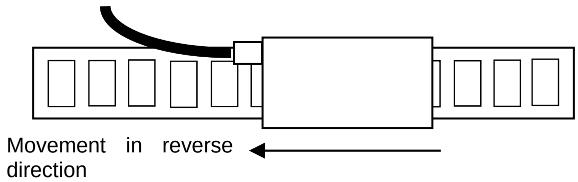
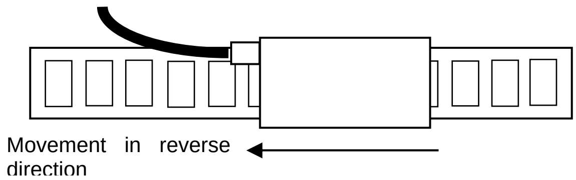
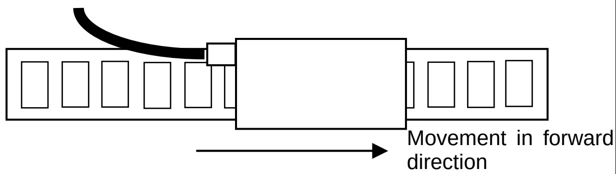
<table>
<tr><th>Group ID</th><th>CoE Object ID</th><th>Contents</th></tr>
<tr><td>GroupC
ID02</td><td>0x20F1, 0x03
EX-ENFIL</td><td>Hall sensor digital filter selection (External encoder digital filter selection)
■ Set digital filter of hall sensor input signal.
When noises are superimposed on hall sensor signal, pulse under the set value shall be removed as noise.
<table>
<tr><th>Value to select</th><th>Contents</th></tr>
<tr><td>00：_110nsec</td><td>Minimum pulse width ＝110ns（Minimum phase difference 37.5ns）</td></tr>
<tr><td>01：_220nsec</td><td>Minimum pulse width ＝220ns（Minimum phase difference 75ns）</td></tr>
<tr><td>02：_440nsec</td><td>Minimum pulse width ＝440ns（Minimum phase difference 150ns）</td></tr>
<tr><td>03：_880nsec</td><td>Minimum pulse width ＝880ns（Minimum phase difference 300ns）</td></tr>
<tr><td>04：_ 75nsec</td><td>Minimum pulse width ＝ 75ns（Minimum phase difference 37.5ns）</td></tr>
<tr><td>05：_150nsec</td><td>Minimum pulse width ＝150ns（Minimum phase difference 75ns）</td></tr>
<tr><td>06：_300nsec</td><td>Minimum pulse width ＝300ns（Minimum phase difference 150ns）</td></tr>
<tr><td>07：_600nsec</td><td>Minimum pulse width ＝600ns（Minimum phase difference 300ns）</td></tr>
</table></td></tr>
<tr><td>Group C
ID03</td><td>0x20F1, 0x04
EX-ENPOL</td><td>Hall sensor polarity selection (External encoder polarity selection)
■ Set polarity of hall sensor input signal.
<table>
<tr><th colspan="2">Value to select</th><th colspan="3">Contents</th></tr>
<tr><td>00</td><td>Type1</td><td>S3/ not reversed</td><td>S2/ not reversed</td><td>S1/ not reversed</td></tr>
<tr><td>01</td><td>Type2</td><td>S3/ not reversed</td><td>S2/ not reversed</td><td>S1/ reversed</td></tr>
<tr><td>02</td><td>Type3</td><td>S3/ not reversed</td><td>S2/ reversed</td><td>S1/ not reversed</td></tr>
<tr><td>03</td><td>Type4</td><td>S3/ not reversed</td><td>S2/ reversed</td><td>S1/ reversed</td></tr>
<tr><td>04</td><td>Type5</td><td>S3/ not reversed</td><td>S2/ not reversed</td><td>S1/ not reversed</td></tr>
<tr><td>05</td><td>Type6</td><td>S3/ reversed</td><td>S2/ not reversed</td><td>S1/ reversed</td></tr>
<tr><td>06</td><td>Type7</td><td>S3/ reversed</td><td>S2/ reversed</td><td>S1/ not reversed</td></tr>
<tr><td>07</td><td>Type8</td><td>S3/ reversed</td><td>S2/ reversed</td><td>S1/ reversed</td></tr>
</table>
✔Sensor type code: 0x20FF, 01＝0x0800, 0x0810, and 0x0820 need to be set.
✍Function enabled on re-turning control power on.</td></tr>
<tr><td>System
ID16</td><td>0x20F1, 0x05
CSOF</td><td>CS-offset
■ 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
✔Sensor type code: 0x20FF, all 01＝0x0800, 0x0810, and 0x0820 0x0830, 0x0840, 0x0850, 0x0860 need to be set.
✍ Function enabled on re-turning control power on.</td></tr>
<tr><td>System
ID17</td><td>0x20F1, 0x06
ZPHOF</td><td>Phase Z CS-normalization offset
■ 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
✔Sensor type code: 0x20FF, 01＝0x0810, 0x0830 need to be set.
✍ Function enabled on re-turning control power on.</td></tr>
</table>

<table>
<tr><th>Group ID</th><th>CoE Object ID</th><th>Contents</th></tr>
<tr><td>GroupB
ID0C</td><td>0x20F1, 0x08
EMPFREQ</td><td>Magnetic pole position estimation frequency
■ Set frequency of torque (force) applied at magnetic pole position estimation.
Setting range :5 to 100Hz
Initial value :50Hz
✔ Change excitation frequency when detection cannot be normally completed due to resonance point of machine, at amplifier hardware magnetic pole position estimation.
✍ Function enabled on re-power on.</td></tr>
<tr><td>Group9
ID22</td><td>0x20F8, 0x06
CSET</td><td>Magnetic pole position pointing function
■ Set valid condition of magnetic pole position estimation, for linear motor without hall sensor output function.
<table>
<tr><th>Value to select</th><th>Contents</th></tr>
<tr><td>02:_CONT1_ON</td><td>Function enabled when general input CONT1 is ON.</td></tr>
<tr><td>03:_CONT1_OFF</td><td>Function enabled when general input CONT1 is OFF.</td></tr>
<tr><td>04:_CONT2_ON</td><td>Function enabled when general input CONT2 is ON.</td></tr>
<tr><td>05:_CONT2_OFF</td><td>Function enabled when general input CONT2 is OFF.</td></tr>
<tr><td>06:_CONT3_ON</td><td>Function enabled when general input CONT3 is ON. Note1)</td></tr>
<tr><td>07:_CONT3_OFF</td><td>Function enabled when general input CONT3 is OFF. Note1)</td></tr>
<tr><td>08:_CONT4_ON</td><td>Function enabled when general input CONT4 is ON. Note1)</td></tr>
<tr><td>09:_CONT4_OFF</td><td>Function enabled when general input CONT4 is OFF. Note1)</td></tr>
<tr><td>0A:_CONT5_ON</td><td>Function enabled when general input CONT5 is ON. Note1)</td></tr>
<tr><td>0B:_CONT5_OFF</td><td>Function enabled when general input CONT5 is OFF. Note1)</td></tr>
<tr><td>0C:_CONT6_ON</td><td>Function enabled when general input CONT6 is ON. Note1)</td></tr>
<tr><td>0D:_CONT6_OFF</td><td>Function enabled when general input CONT6 is OFF. Note1)</td></tr>
</table>
Note1) CONT3 to CONT6 can be used only for general input extended amplifier.
✔ Input time to become al l the function enabled is 8ms.
✍ Function enabled on re-power on.</td></tr>
<tr><td>Group9
ID02</td><td>0x20F8, 0x03
EXT-E</td><td>External trop-input function
Set the condition that trip input becomes effective to use thermal of linear motor.
■ The setting contents are the same as the above magnetic pole position indication function.
✔ Input time to become al l the function enabled is 8ms.
✍ Function enabled on re-power on.</td></tr>
</table>

4) Setting of moving direction

Moving direction of linear motor depends on polarity of command and linear scale sensor.

■ Setting of command-input polarity

<table>
<tr><th>Group ID</th><th>CoE Object ID</th><th>Contents</th></tr>
<tr><td rowspan="2">Group8
ID00</td><td rowspan="2">0x607E, 0x00
CMDPOL</td><td>Polarity</td></tr>
<tr><td>
■ 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.
<table>
<tr><th colspan="2">Value to select</th><th>Position command “plus”</th></tr>
<tr><td>00</td><td>PC+_VC+_TC+</td><td rowspan="4"></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>
</table>
<table>
<tr><th colspan="2">Value to select</th><th>Position command “minus”</th></tr>
<tr><td>00</td><td>PC+_VC+_TC+</td><td rowspan="4"></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 increases.</td></tr>
</table>
<table>
<tr><th colspan="2">Value to select</th><th>Position command “plus”</th></tr>
<tr><td>80</td><td>PC-_VC+_TC+</td><td rowspan="4"></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>
</table>
<table>
<tr><th colspan="2">Value to select</th><th>Position command “minus”</th></tr>
<tr><td>80</td><td>PC-_VC+_TC+</td><td rowspan="4"></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 decreases.</td></tr>
</table>
</td></tr>
</table>

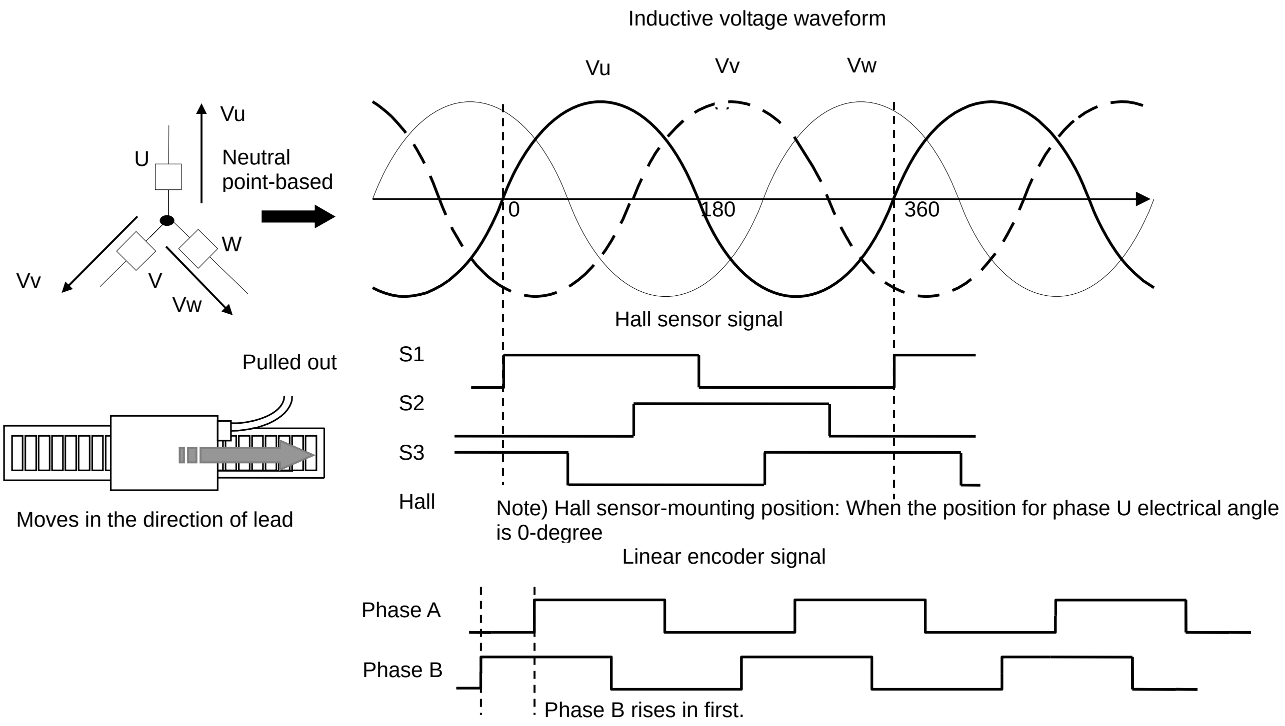
13.4 Precautions

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 us. In this case, we do not conduct any combination tests of servo amplifier and the linear motor, so we assume no responsibility whatsoever for any combination operations and characteristics of the motor. In addition, we assume no responsibility whatsoever for any failures caused by the linear motor.

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 1 µm (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 COMT1 through CON6, and then setting condition “Group 9, ID02 or 0x20F8, 0x03 EXT-E” of the connected “CONT*” to “external trip function.”

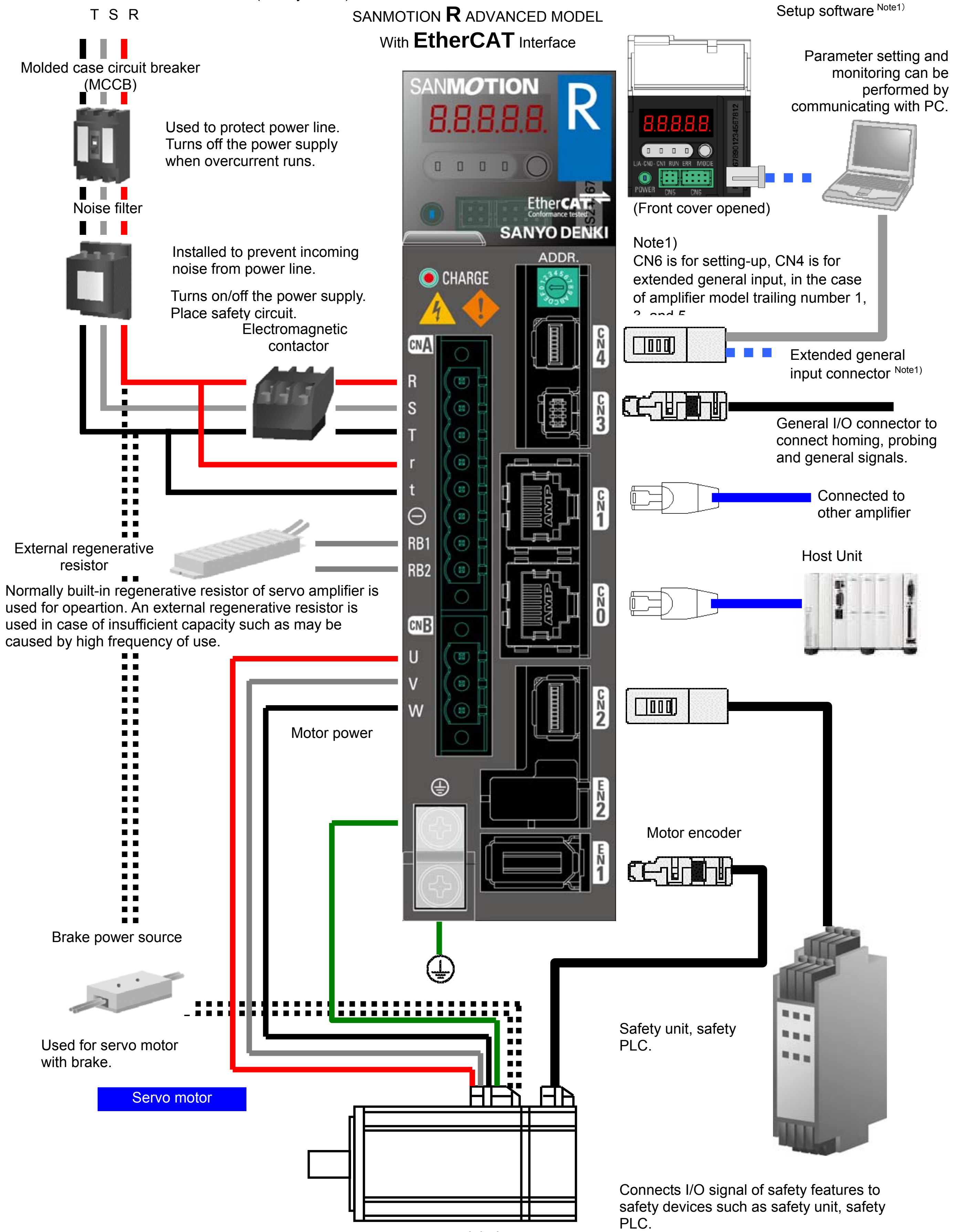
- When using hall sensor, set the mounting position of hall sensor to phase U electrical angle to System ID16 or “CS offset of0x20F1, 0x05 CSOF.”

14

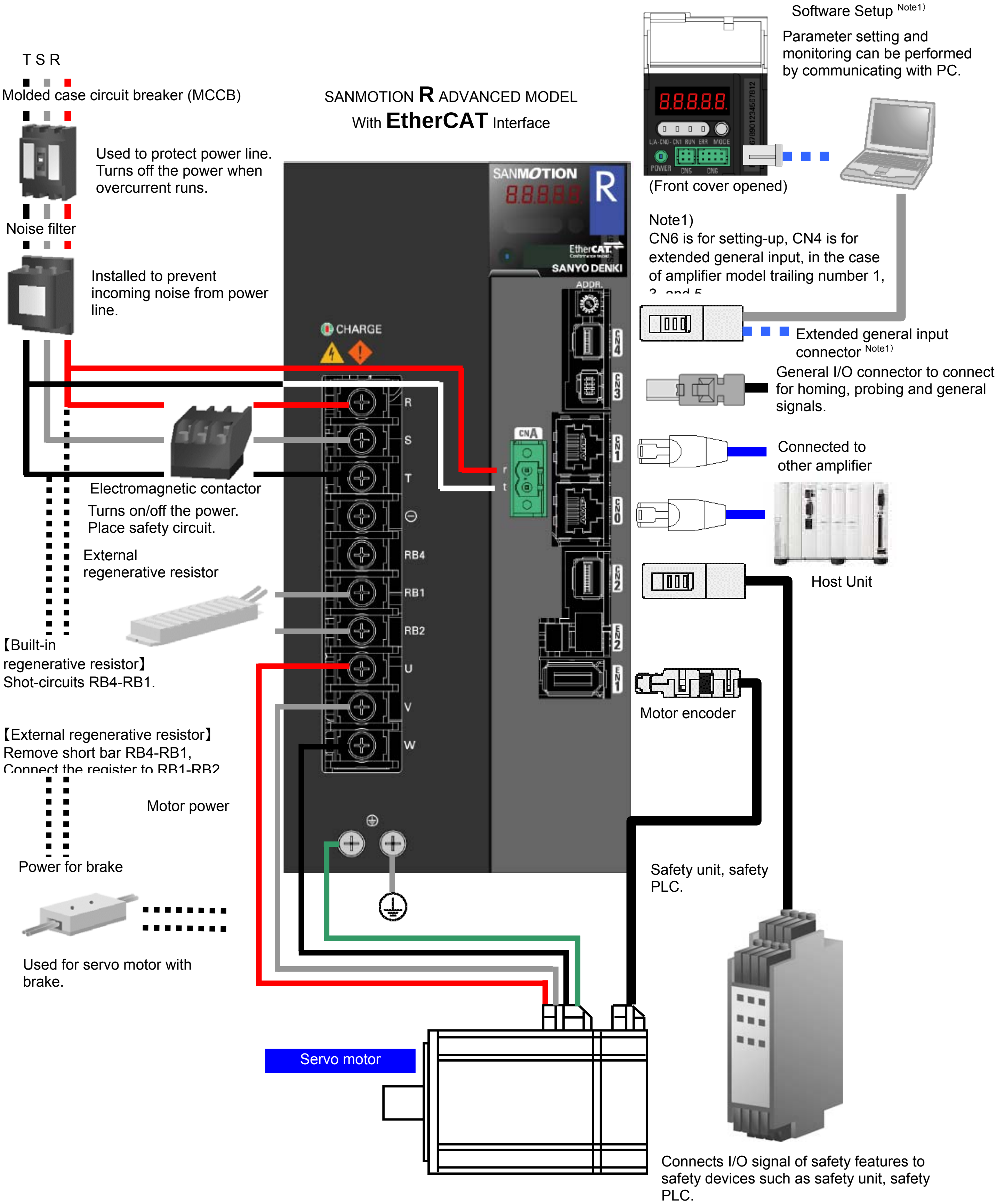
14 Safe Torque Off (STO) Function

14.1 System configuration

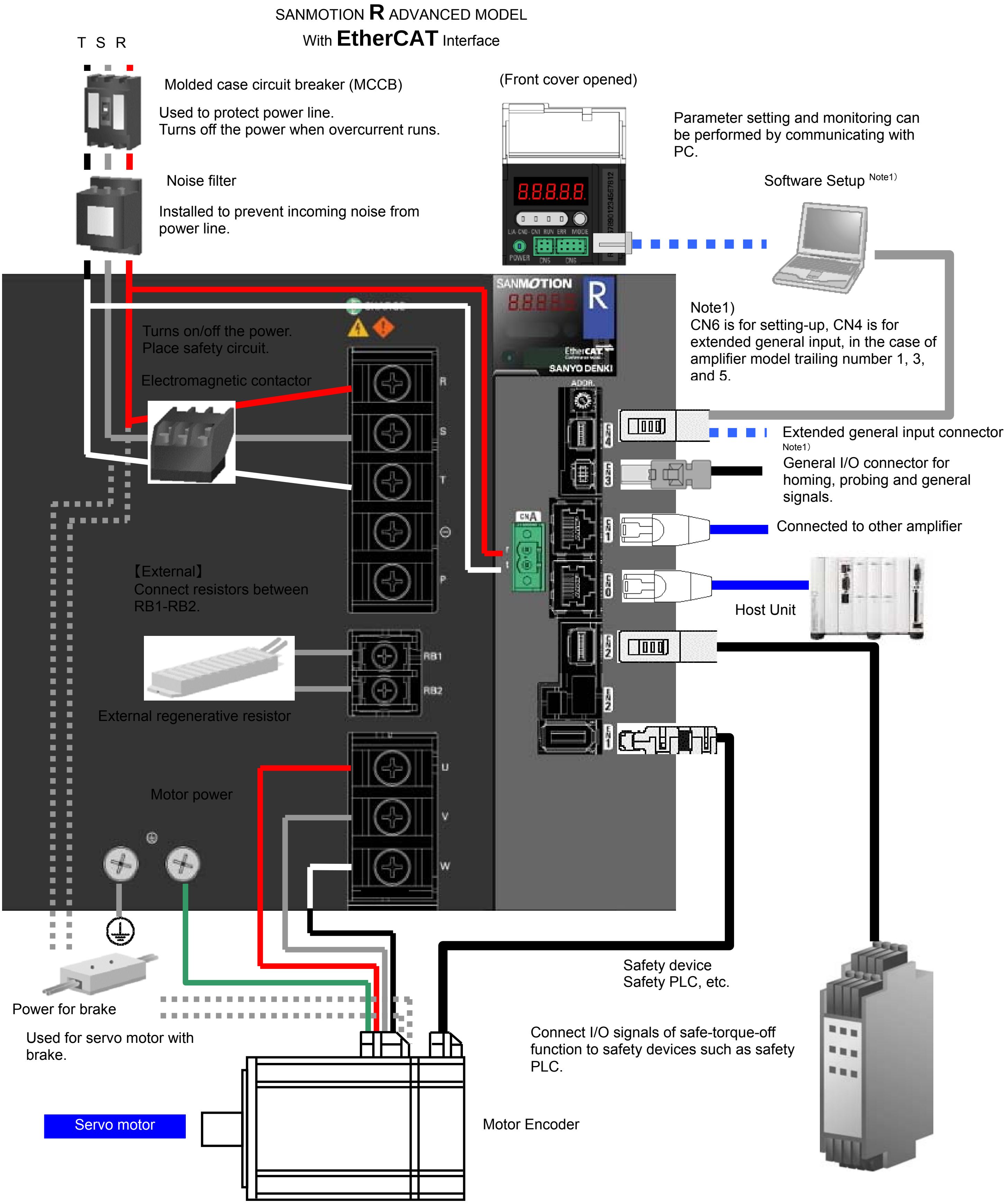
■ RS2□01/RS2□03/ RS2□05 (Rotary motor)



■ RS2□10/RS2□15 (Rotary motor)

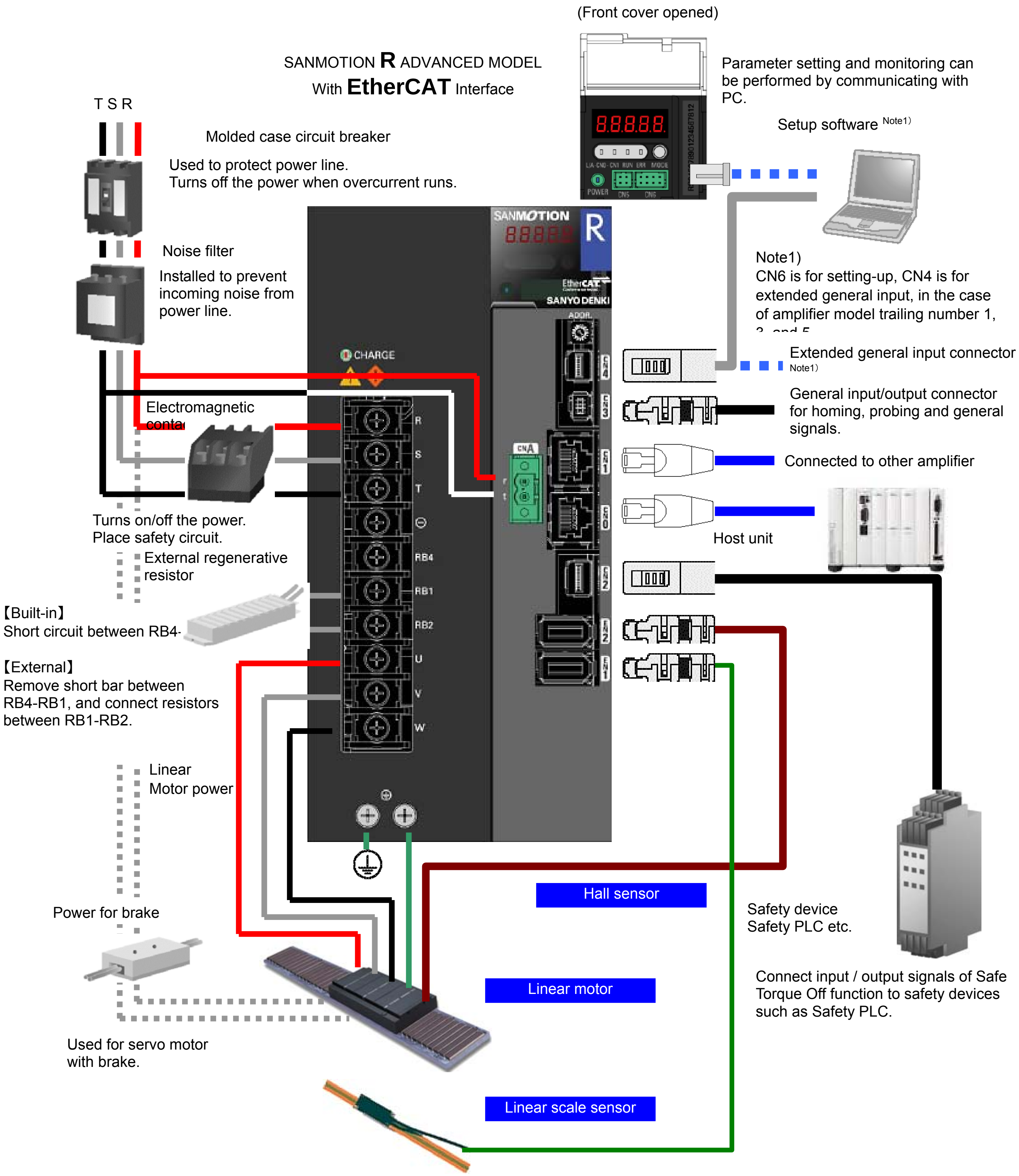


■ RS2☐30 (Rotary motor)



■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.

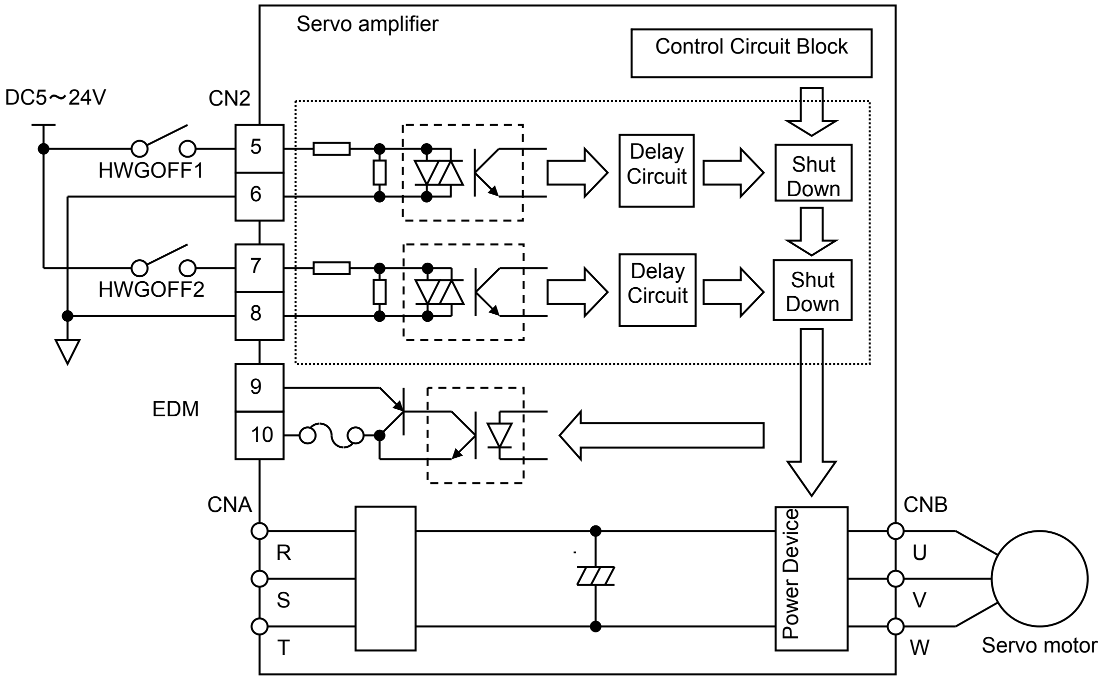


14.2 Safe Torque Off (STO) Function

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	■ IEC61800-5-2, Safe Torque Off ■ IEC60204, Stop Category 0
Safety Standard	■ IEC61508, SIL2 ■ IEC62061, SILCL2 ■ ISO13849-1, PL = d (In case of detecting failure by using EDM) ■ ISO13849-1, PL = c (In case of detecting failure) ■ EN954-1, Cat.3

* 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, PL=d, you need to design machine safety system so as to detect failure of STO circuit by surely using Error Detection Monitor (EDM).

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 (HWGOFF2) signal input circuit and servo motor current control signal blocking circuit (optional). In vertical axis and the like, by choosing the hardware with delay circuit, you can prevent falling of the load by holding motor shaft with holding brake when the safe torque off function is activated.

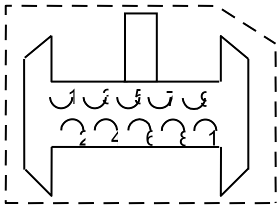
Servo amplifier model number	Delay Circuit (Max. delay time)
RS2#######2 RS2#######3	Without (Max.20ms)
RS2#######4 RS2#######5	With (Max.500ms)

* 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

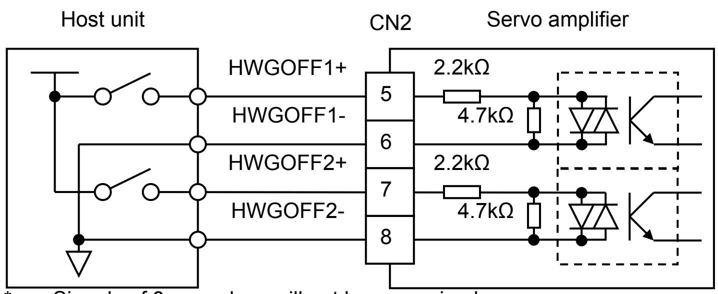
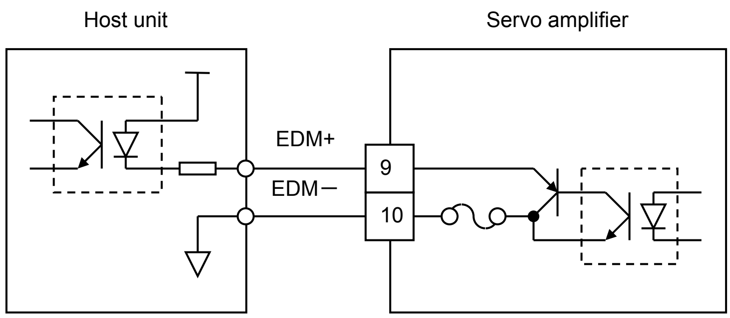
1) CN2 connector disposition

■ MUF-PK10K-X (*View of connecter from soldered direction.)



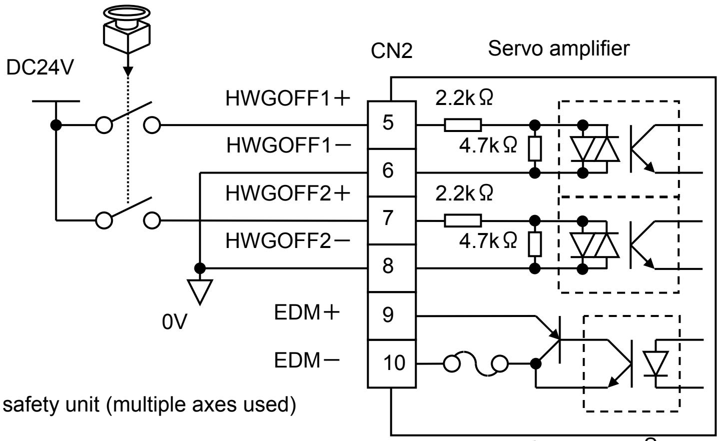
2) Wiring diagram for CN2 terminals

The CN2 pin functions and connected circuits are described below.

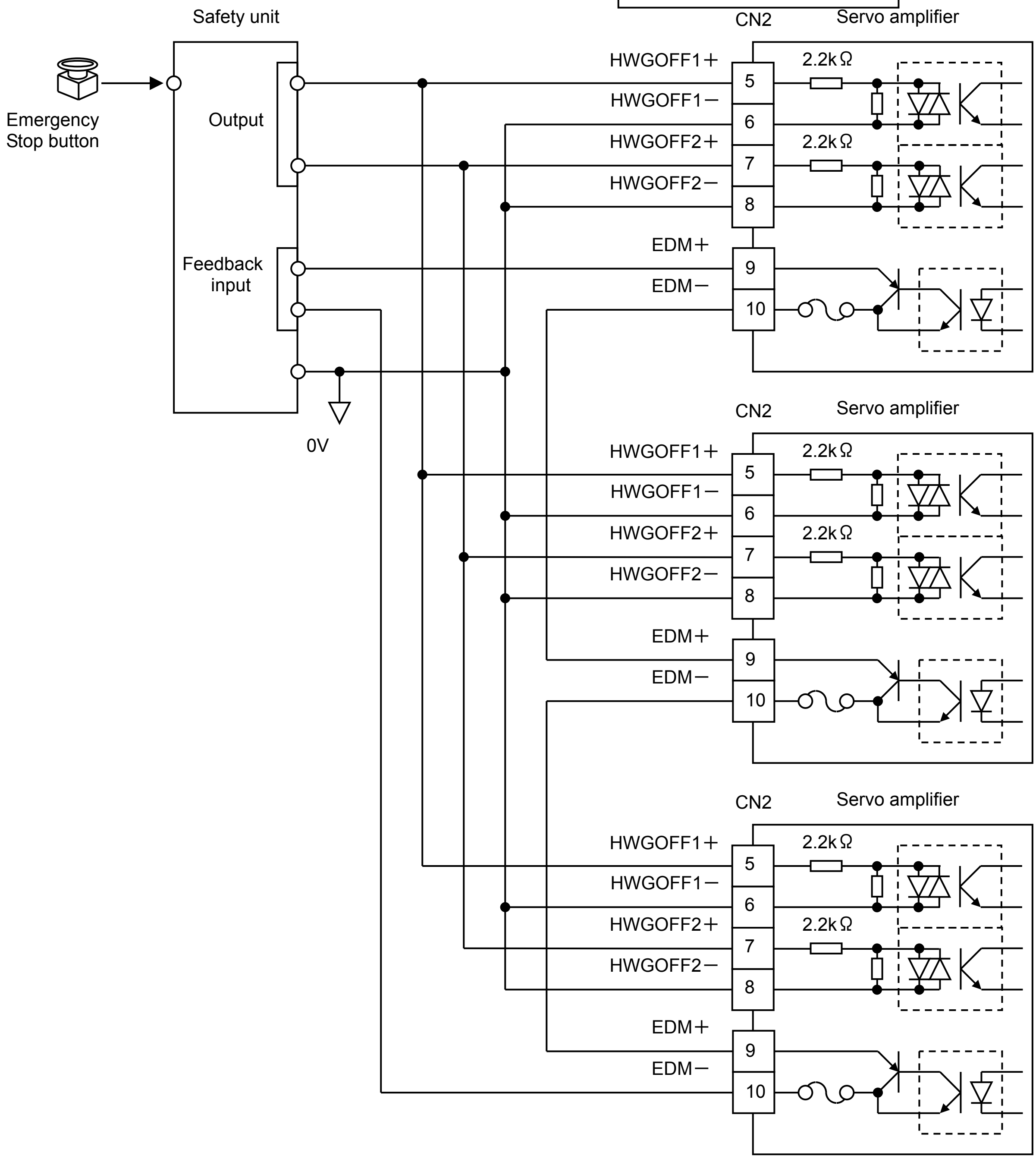
	Pin No.	Symbol	Description
Battery input terminal	1	BAT +	Battery connection terminal (Refer to [Wiring (4)] for details.)
	2	BAT -	
Terminal for maintenance	3	Reserve	These pins are intended for use when the STO function is active. When you do not use this function, connect terminal 3 and 5, 7, and also connect terminal 4 and 6, 8 (short-circuit).
	4	Reserve	
Safety input 1	5	HWGOFF1-	The signal monitors the system for STO function failures. Connected circuit: These pins connect to a photo coupler or relay circuit. Power supply voltage range : DC24V±10% Internal impedance : 2.2kΩ  * Signals of 8 ms or less will not be recognized.
	6	HWGOFF1+	
Safety input 2	7	HWGOFF2-	
	8	HWGOFF2+	
Error detection monitor	9	EDM-	The signal monitors the system for STO function failures. Connected circuit: These pins connect to a photo coupler or relay circuit. Power supply voltage range (Uext) : DC24V±10% Maximum current : 50mA Output voltage : Uext-0.5 - Uext 
	10	EDM+	

3) Example of wiring

Example of wiring to safety switch (1-axis used)

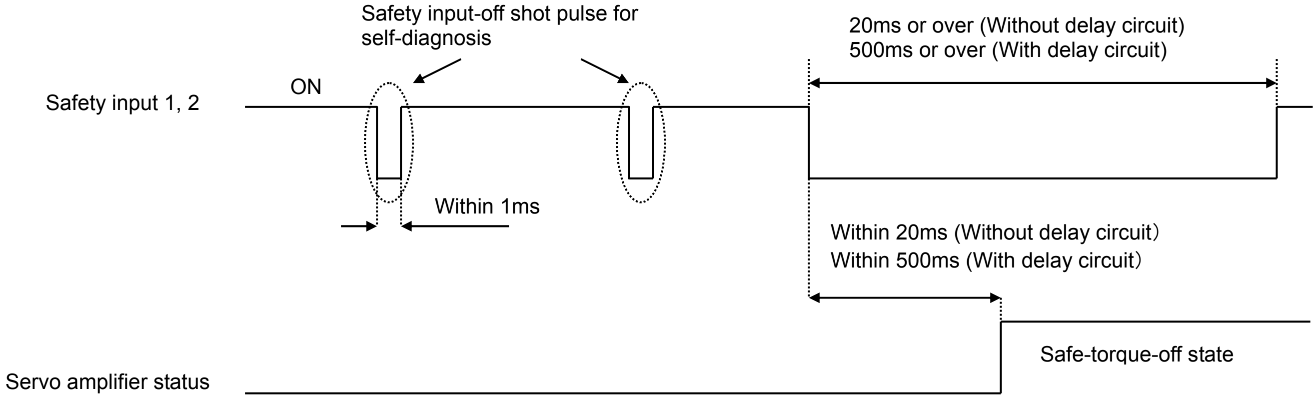


Example of wiring to safety unit (multiple axes used)



4) Safety input-off shot pulse for safety device self-diagnosis

When you connect safety device supplied with safety input-off shot pulse signal for self-diagnosis added to safety output signal, such as safety unit or safety sensor, use safety device whose safety input-off shot pulse signal is 1ms or less. Safe-torque-off function is not activated when the period of safety input signal (HWGOFF1, HWGOFF2)-OFF is 1ms or less. In order to surely fulfill safe-torque-off function, turn off safety input signal for 20ms or more (without delay circuit) or 500ms or more (with delay circuit).



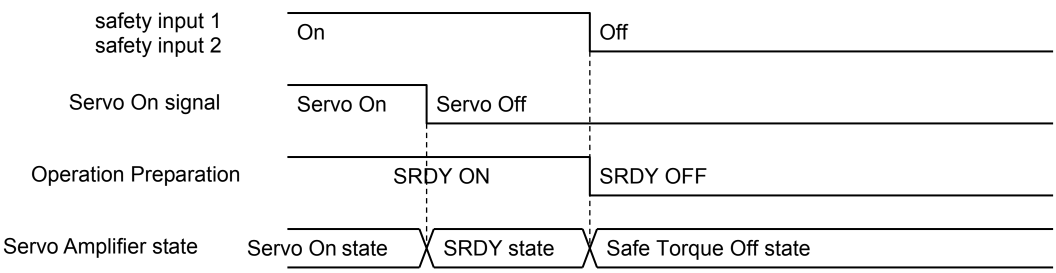
14.4 Safe Torque Off Operations

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.

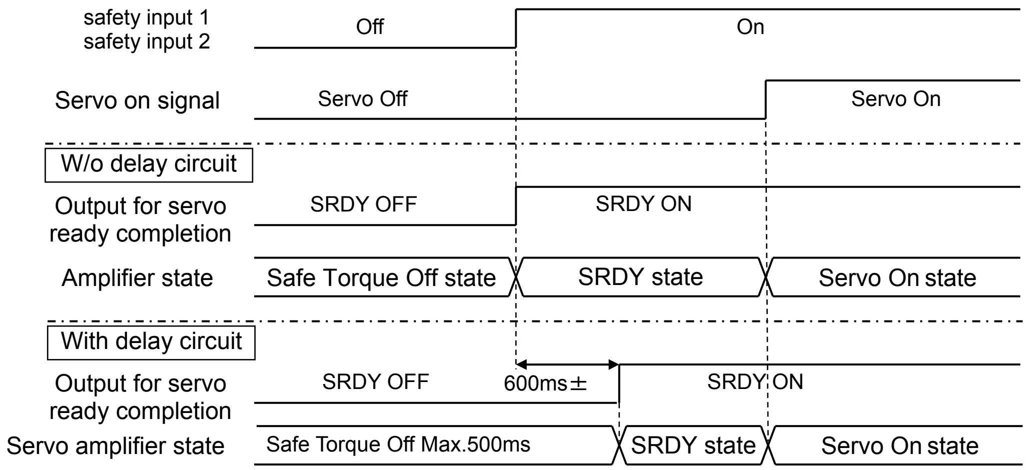
Signal	Input condition	Servo Amplifier condition
Safety input 1(HWGOFF1)	On	Normal state
	Off	Safe torque off active state
Safety input 2(HWGOFF2)	On	Normal state
	Off	Safe torque off active state

* Off: Electric current will not flow (contact open).
* On: Electric current will flow (contact closed).

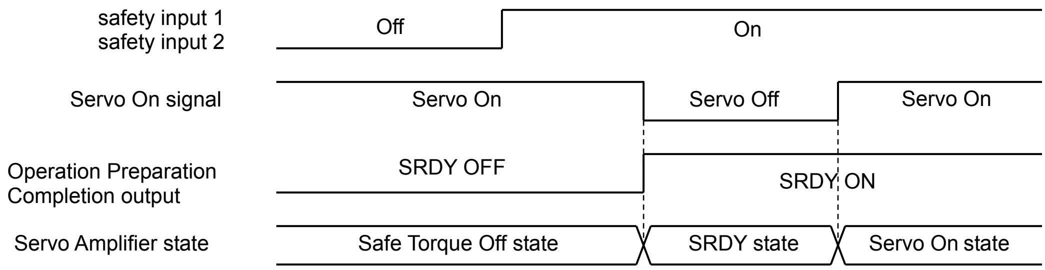


2) Recovery from Safe Torque Off active state

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. (With delay circuit equipped hardware, the time to transit to SRDY state is maximum 600ms.)



While servo-on signal is input, safe-torque-off activated state is maintained even safety input 1 or safety input 2 signal is turned on. To re-start the operation, input servo-off signal first to transit to SRDY state, and then input servo-on signal.



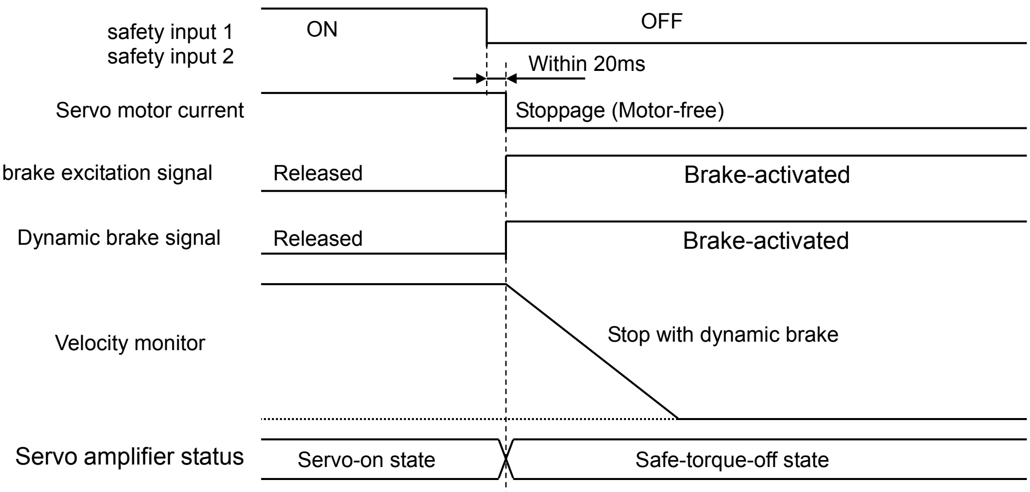
* Group9 ID06: Setting the Servo-ON Function parameter to "01: Always On" disables resets from the safe torque off state. Avoid this setting when using the safe torque off function.

3) Safe Torque Off while Servo Motor Running

Depending on setting of Disabling Operation Option code(0x605C,0x00:[DISOP]),it will be vary how the motor stops.

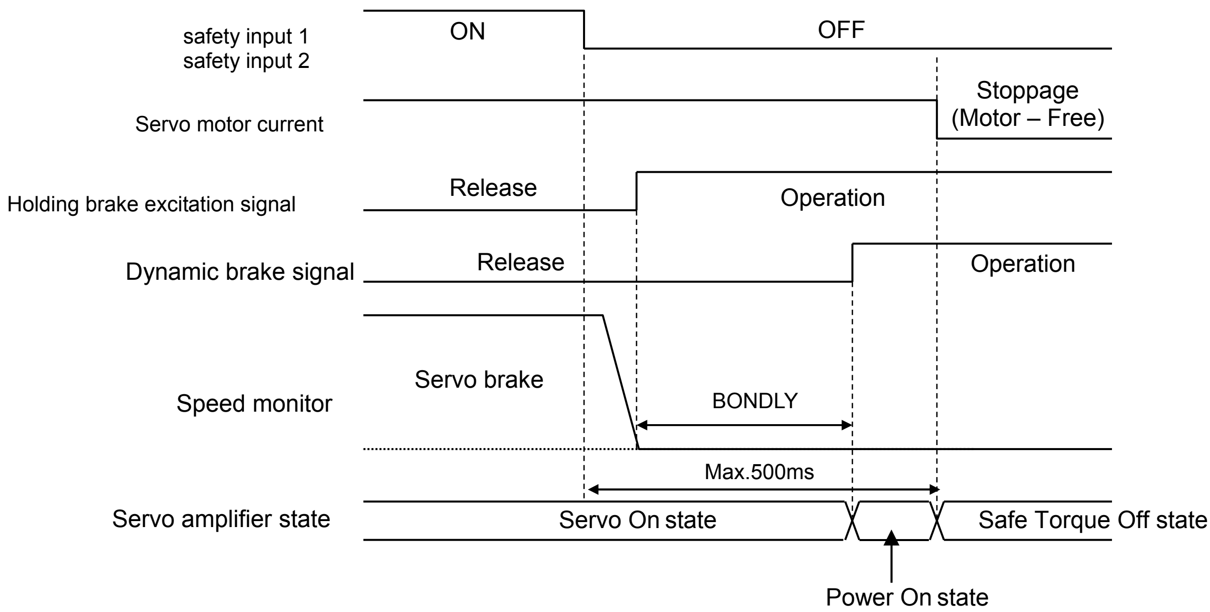
■ In case the setting value is either -4 or -5 (motor stops with servo brake when servo off)
Depending on amplifier part number, it varies how the motor stops.

◆ In case of RS2########2, RS2########3 (without safe torque off delay circuit)
If either safety input 1 or safety input 2 is off, servo motor current is shut down, which does not allow servo brake stop. Therefore, same as in "In case the setting value is either 00 or 01 (motor stops after running freely when servo off)", motor stops after running through inertia.



◆ In case of RS2#######4, RS2#######5 (with safe torque off delay circuit)

If either safety input 1or safety input 2 input is off, motor stops with servo brake.

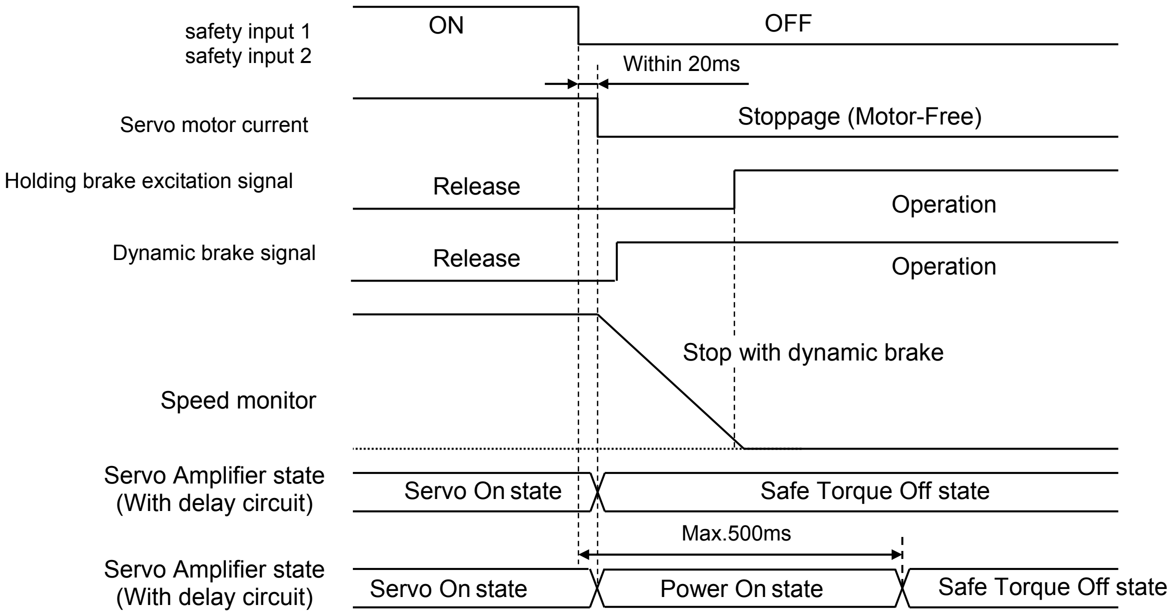


* When set value of BONDLY (holding brake activation delay time: Group B ID13) is more than safe-torque-off delay time (500ms max.), the states comes to be motor-free after period of safe-torque-off delay time. Please note that recommended set value for BONDLY is less than 500ms.
* Servo brake circuit, dynamic brake circuit, and holding brake excitation signal are not safety-related sections.

- In case the setting value is either -2 or -3 (motor stops with dynamic brake when servo off)
  When either safety input 1or safety input 2 input is off, current to servo motor is shut down, then motor stops by dynamic brake.

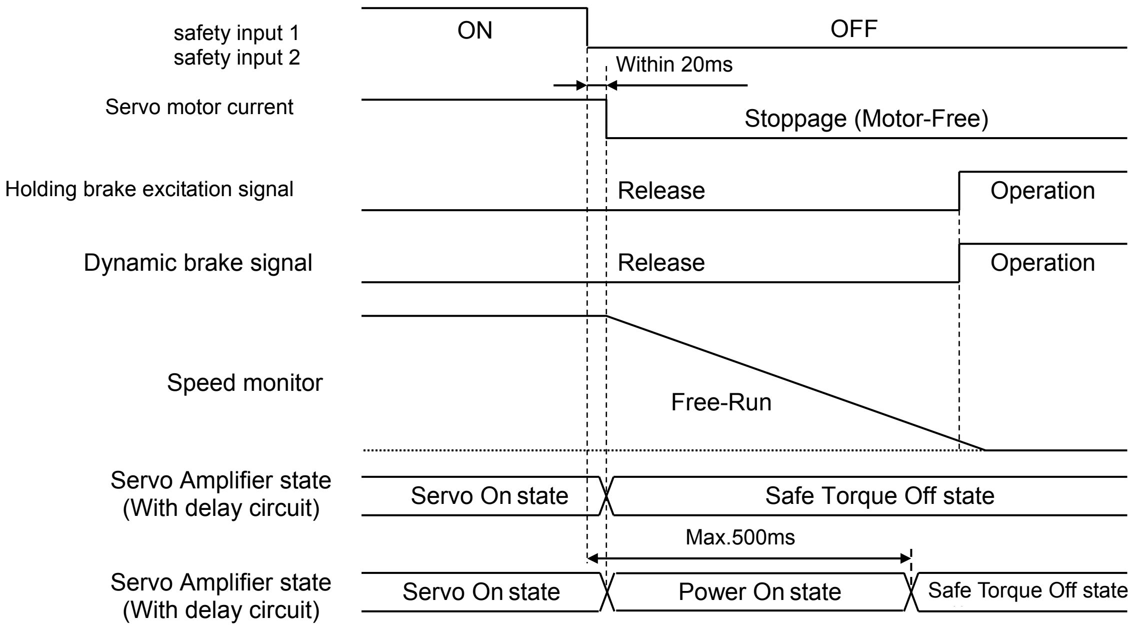
  - RS2########2, RS2########3 (without safe-torque-off delay circuit)
    Safety input is turned off and then the status comes to safe-torque-off state at the same time dynamic brake applied.

  - RS2########4, RS2########5 (with safe-torque-off delay circuit)
    The state moves to safe-torque-off state after period of delay time (500ms max.) from turning off safety input. Dynamic brake is activated on turning off safety input.



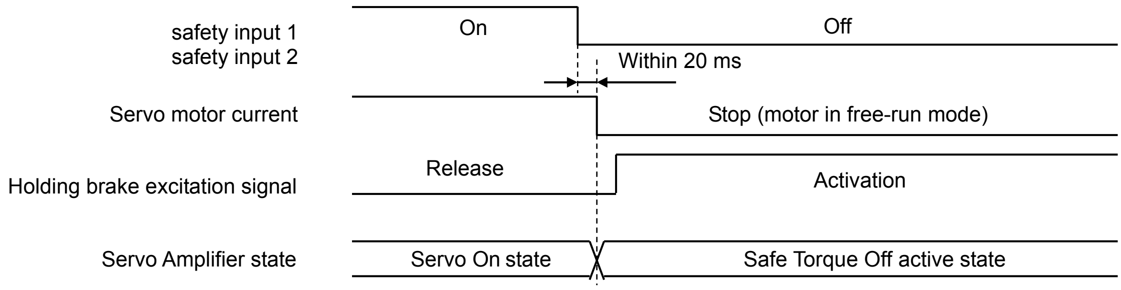
* Dynamic brake circuit and holding brake excitation signal are not safety-related sections.

- In case the setting value is either 0 or -1 (motor stops after running freely when servo off).
  When either /HWGOFF1 or /HWGOFF2 input is off, current to servo motor is shut down, then motor stops after running through inertia.



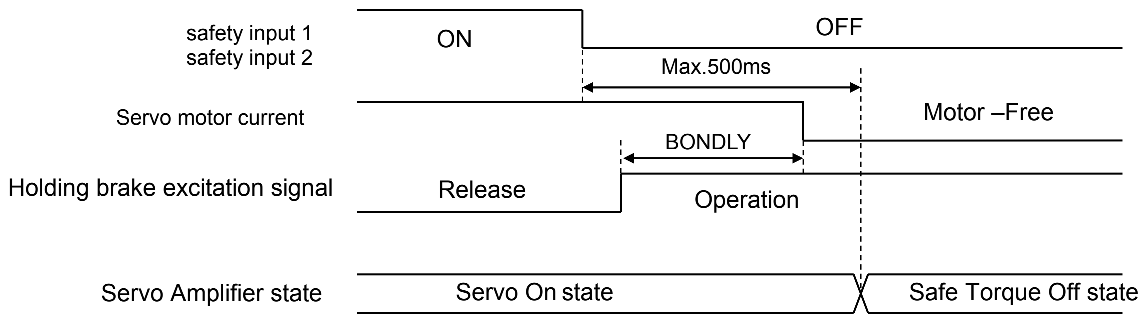
4) Safe Torque Off while Servo Motor stoppage

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.



However, in case the amplifier part number is RS2#######4,RS2#######5 (with delay circuit), there are max. 500ms of delay time from turning off either safety input 1 or safety input 2 input to activating Safe Torque Off function, therefore, you can keep time until holding brake starts working.

When motor is used in gravity axis and the like, choose amplifier part number RS2#######4,RS2#######5.



* 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

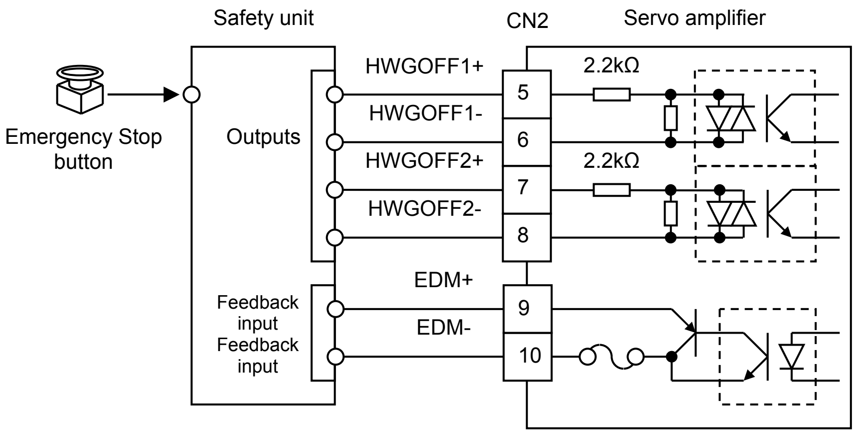
The EDM output signals monitor errors in the safe torque off circuit, /HWGOFF1 wire, or /HWGOFF2 wire. The following table shows the relationships among /HWGOFF1 input, /HWGOFF2 input, and EDM output.

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, 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, you must confirm that the safe torque off operations correctly during machine startup and servo amp replacement.

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

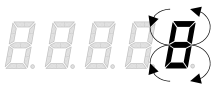
Follow the procedure described below to run an STO function confirmation test:
Procedure 1. Supply control power and main circuit power.
Procedure 2. Turn On both safety input 1and 2 input signals.
Procedure 3. Input the Servo On signal to excite the servo motor.
Procedure 4. Turn Off both the safety input 1and 2 input signals.

3) Acceptance criteria

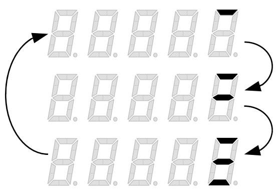
Confirmation procedure 2 to 4, confirm the states listed below.
Procedure 2, make sure that the EDM output and LED indication are as follows:

Confirmation item	State
EDM output	Off
LED indication	

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	

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.

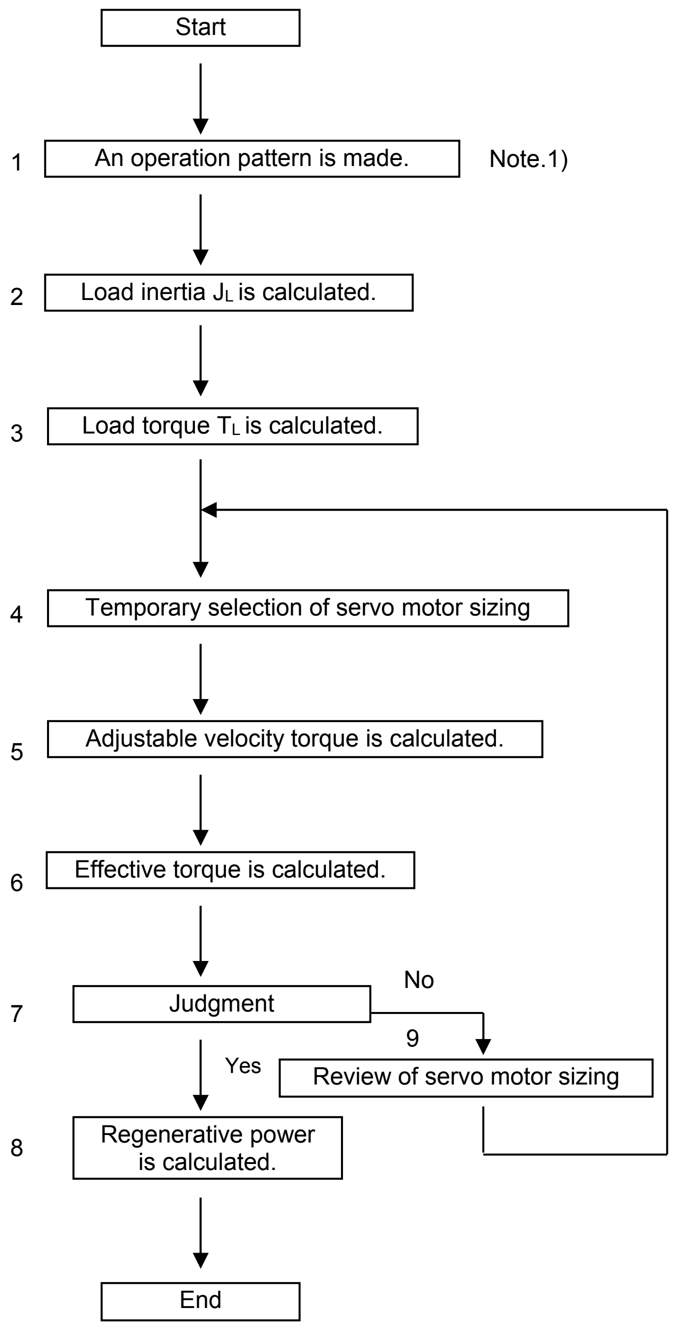
15

15. Selection

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. Select the following motor:
   - Load moment of inertia (J_L) is 10 times or less of servo motor rotor moment of inertia (J_M).
   - The load torque (T_L) is 80% (T_R×0.8) of the motor rated torque or less.

   $J_L \leqq J_M \times 10$

   $T_L \leqq T_R \times 0.8$

5. Calculate the required adjustable velocity torque from an operation pattern.
6. Calculate the effective torque from a torque pattern.
7. Judge whether the followings have been established.

   Adjustable velocity torque (T_a, T_b) is 80% (T_p×0.8) or less of the peak torque at stall (T_p) of servo motor

   The effective torque (Trms) is 80% (T_p×0.8) or less of the rated torque (T_R) of servo motor

   $T_a \leqq T_p \times 0.8$

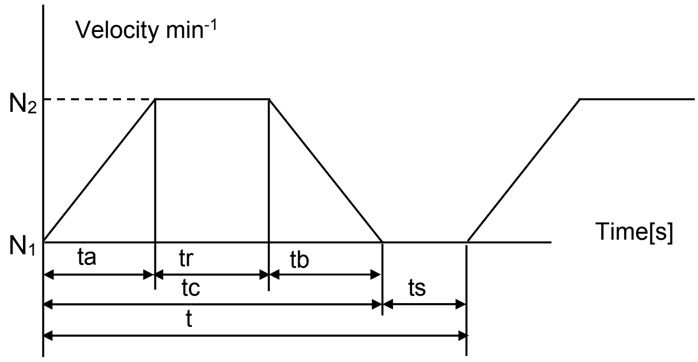
   $T_b \leqq T_p \times 0.8$

   $Trms \leqq T_R \times 0.8$

8. Calculate regeneration electric power, and if required, select an external regeneration resistor.
9. Improve servo motor capacity, such as raising the capacity of a servo motor.

Note1) The operational pattern shall be created so that average motor rotational velocity does not exceed maximum rotational velocity.

2) Make an operation pattern



ta= Acceleration time

tb= Deceleration time

tr= Constant velocity time

ts= Stop time

t=1 cycle

3) Calculate motor axis conversion load moment of inertia (J_L)

■ The inertia moment of a moving part

$$J_L = \left(\frac{1}{G}\right)^2 \times \frac{\pi \times \rho \times D^4 \times L}{32} \quad [\mathrm{kg \cdot m^2}]$$

G: Reduction ratio

ρ : Moving part specific gravity [kg/m^3]

D: Moving part diameter [m]

L: Moving part length [m]

■ Work inertia moment

$$J_L = \left(\frac{1}{G}\right)^2 \times W \times \left(\frac{P}{2\pi}\right)^2 \quad [\mathrm{kg \cdot m^2}]$$

G: Reduction ratio

W: Moving part mass [kg]

P: In the case of a ball screw, is the lead of a ball screw. [m]

In the case of a belt pulley, is an outside diameter of a pulley. [m]

(P=πD)

4) Calculate motor shaft conversion load torque (T_L)

- Ball screw (in horizontal axis)

$$T_L = \frac{(F + \mu W)}{\eta} \times \frac{P}{2\pi} \times \frac{1}{G} \times 9.8 \quad [N \cdot m]$$

- Ball screw (in vertical axis)

When motor drives upward

$$T_L = \frac{(F + (\mu + 1)W)}{\eta} \times \frac{P}{2\pi} \times \frac{1}{G} \times 9.8 \quad [N \cdot m]$$

When motor drives downward

$$T_L = \frac{(F + (\mu - 1)W)}{\eta} \times \frac{P}{2\pi} \times \frac{1}{G} \times 9.8 \quad [N \cdot m]$$

- When ball screw stops (in horizontal axis)

$$T_L = \frac{F}{\eta} \times \frac{P}{2\pi} \times \frac{1}{G} \times 9.8 \quad [N \cdot m]$$

- When ball screw stops (in vertical axis)

$$T_L = \frac{(F + W)}{\eta} \times \frac{P}{2\pi} \times \frac{1}{G} \times 9.8 \quad [N \cdot m]$$

F: External force [kg]

η : Transmission efficiency

μ : Coefficient of friction

W: Moving part mass [kg]

P: Ball screw lead [m]

G: Reduction ratio

■ Belt pulley (Vertical axis)

$$T_L = \frac{(F+(\mu+1)W)}{\eta} \times \frac{D}{2} \times \frac{1}{G} \times 9.8 \quad [\mathrm{N \cdot m}]$$

■ Belt pulley (in vertical axis)

When motor drives upward

$$T_L = \frac{(F+(\mu+1)W)}{\eta} \times \frac{D}{2} \times \frac{1}{G} \times 9.8 \quad [\mathrm{N \cdot m}]$$

When motor drives downward

$$T_L = \frac{(F+(\mu-1)W)}{\eta} \times \frac{D}{2} \times \frac{1}{G} \times 9.8 \quad [\mathrm{N \cdot m}]$$

■ When belt pulley stops (in horizontal axis)

$$T_L = \frac{F}{\eta} \times \frac{D}{2} \times \frac{1}{G} \times 9.8 \quad [\mathrm{N \cdot m}]$$

■ When belt pulley stops (in vertical axis)

$$T_L = \frac{(F+W)}{\eta} \times \frac{D}{2} \times \frac{1}{G} \times 9.8 \quad [\mathrm{N \cdot m}]$$

F: External force [kg]

η : Transmission efficiency

μ : Coefficient of friction

W: Moving part mass [kg]

D: Diameter of a pulley [m]

G: Reduction ratio

5) Calculate acceleration torque (T_a)

$$T_a = \frac{2\pi(N_2 - N_1) \times (J_L + J_M)}{60 \times ta} + T_L \quad [N \cdot m]$$

N_2: Servo motor rotation velocity after acceleration [min^{-1}]

N_1: Servo motor rotation velocity before acceleration [min^{-1}]

J_L: Load inertia moment [$kg \cdot m^2$]

J_M: Rotor inertia moment of servo motor [$kg \cdot m^2$]

6) Calculate deceleration torque (T_b)

$$T_b = \frac{2\pi(N_2 - N_1) \times (J_L + J_M)}{60 \times tb} - T_L \quad [N \cdot m]$$

N_2: Servo motor rotation velocity before deceleration [min^{-1}]

N_1: Servo motor rotation velocity after deceleration [min^{-1}]

J_L: Load inertia moment [$kg \cdot m^2$]

J_M: Rotor inertia moment of servo motor [$kg \cdot m^2$]

7) Calculate effective torque (Trms)

$$Trms = \sqrt{\frac{(T_a^2 \times ta) + (T_L^2 \times tr) + (T_b^2 \times tb)}{t}} \quad [N \cdot m]$$

8) Judgment condition

■ We consider the followings as the standard of the judgment.

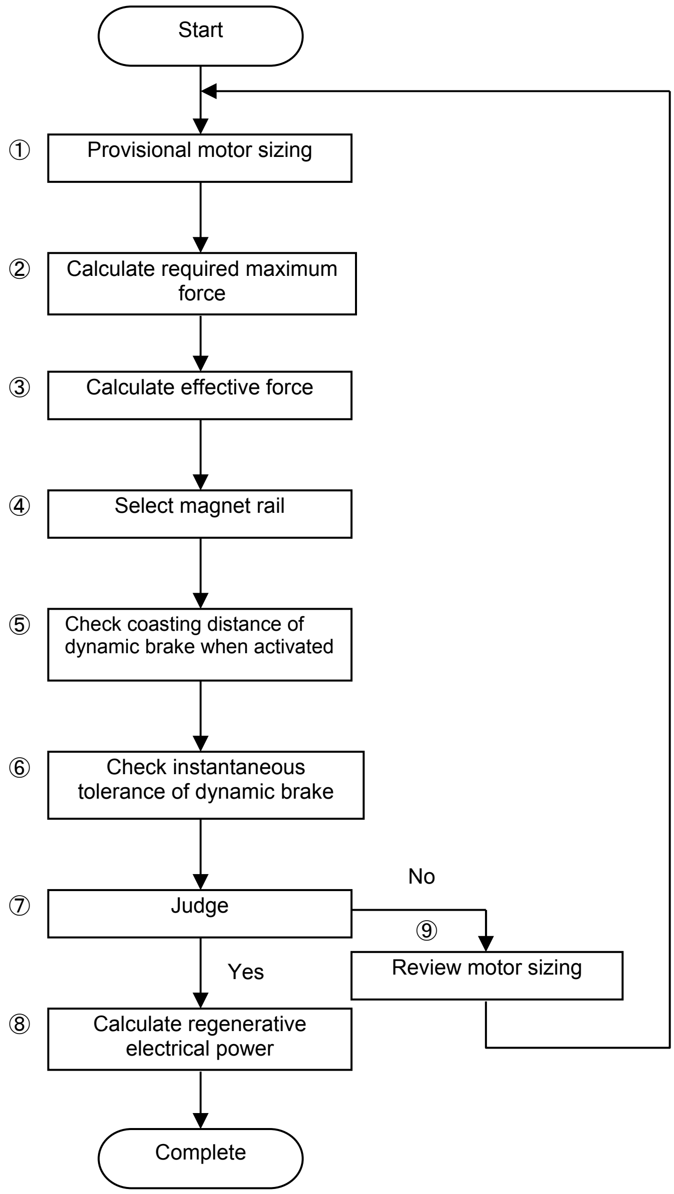
- ◆ Load torque load ratio — $T_L \leqq T_R \times 0.8$ (Load torque is 80% or less of rated torque)
- ◆ Acceleration torque load ratio — $T_a \leqq T_P \times 0.8$ (Acceleration torque is 80% or less of peak torque at stall)
- ◆ Deceleration torque load ratio — $T_b \leqq T_P \times 0.8$ (Deceleration torque is 80% or less of peak torque at stall)
- ◆ Effective torque load ratio — $Trms \leqq T_R \times 0.8$ (The effective torque is 80% or less of rated torque)
- ◆ Inertia moment ratio — $J_L \leqq J_M \times 10$ (Load moment of inertia is 10 times or less of the motor rotor moment of inertia)

In addition, the rise in heat of motor can be suppressed by taking the large degree of margin at torque load ratio. Moreover, when rotating a table mechanism slowly depending on inertia moment ratio, it may be able to control 10 or more times. We recommend you the check by the real machine.

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 maxim force meets the required force in use.
(At least more than "load mass x maximum acceleration+ α" 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.

⑨Review motor size.

2) Required maximum force and effective force

■ Calculate frictional force Ff.

$$Ff = (M \cdot g \cdot \cos\theta + Fatt) \cdot \mu + Fadd \quad [N]$$

Mc	: Coil mass	[kg]	
ML	: Load mass	[kg]	
M	: Moving part mass＝MC + ML	[kg]	
g	: Gravity acceleration＝9.8	[m/s2]	
cos θ	: Angle to horizontal driving surface	[rad]	(When horizontal: cos θ ＝1)
Fatt	: Magnetic attractive force	[N]	
μ	: Coefficient of friction		
Fadd	: Sealing resistance	[N]	(Including dynamic friction and covering friction, and cable routing friction)

■ Calculate the gravity force applied to moving part.

$$Fw = M \cdot g \cdot \sin\theta \quad [N]$$

M	: Moving part mass＝MC + ML	[kg]	
G	: Gravity acceleration＝9.8	[m/s2]	
θ	: Angle to horizontal driving surface	[rad]	(When horizontal: sin θ ＝0)

■ Calculate required maximum force: Fmax, and then verify that “maximum motor force: Fp ＞ required maximum force: Fmax.”

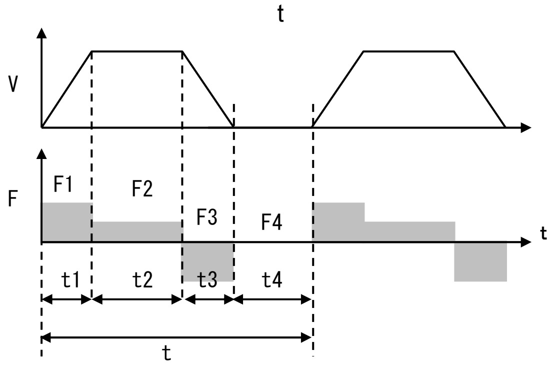
$$Fmax = M \cdot amax + Ff + Fw + Fwork \quad [N]$$

M	:Moving part mass＝ MC + ML	[kg]
Amax	:Maximum acceleration	[m/s2]
Ff	:Frictional force	[N]
Fw	:Gravity	[N]
Fwork	:Processing reactive force	[N]

✍ Margin of 0.9· Fp ≧ Fmax is recommended in consideration of loads change.

■ Motor continuous rated force Fr ＞ Effective force Frms

$$Frms = \frac{\sqrt{(F1^2 \cdot t1 + F2^2 \cdot t2 + F3^2 \cdot t3 + \cdots)}}{t} \quad [N]$$



✍ Margin of 0.9· Fr ≧ Frms is recommended in consideration of loads change.

3) Selection of magnet rail

The following 5 types of length for magnet rail-with core, no core:
64, 128, 256, 512, 1024 [mm]
Determine the length so that "magnet rail length≧ 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.

$$EM = Ehb = \frac{1}{2} \times N \times 3 \cdot Ke\phi \times \frac{Tb}{KT} \times tb - \left[\frac{Tb}{KT}\right]^2 \times 3 \cdot R\phi \times tb$$

EM : Regeneration energy during operations along horizontal axis [J]
Ehb : Regeneration energy during deceleration [J]
$Ke\phi$: Induced voltage constant [Vrms/min^{-1}] (Motor constant)
KT : Torque constant [N·m/Arms] (Motor constant)
N : Motor rotation speed [min^{-1}]
$R\phi$: Armature resistance [Ω] (Motor constant)
tb : Deceleration time [s]
Tb : Torque during deceleration [N·m]

■ Calculate "regeneration effective power" from regeneration energy.

$$PM = \frac{EM}{to}$$

PM : Effective regeneration power [W]
EM : Regeneration energy [J]
to : Cycle time [s]

2) How to find "regeneration effective power (PM)" of the vertical axis drive by a formula（Rotary motor）

■ Calculate regeneration energy.

EM = EVUb + EVD + EVDb

$$= \frac{1}{2} \times N \times 3 \cdot Ke\phi \times \frac{TUb}{KT} \times tUb - \left[\frac{TUb}{KT}\right]^2 \times 3 \cdot R\phi \times tUb$$

$$+ N \times 3 \cdot Ke\phi \times \frac{TD}{KT} \times tD - \left[\frac{TD}{KT}\right]^2 \times 3 \cdot R\phi \times tD$$

$$+ \frac{1}{2} \times N \times 3 \cdot Ke\phi \times \frac{TDb}{KT} \times tDb - \left[\frac{TDb}{KT}\right]^2 \times 3 \cdot R\phi \times tDb$$

$Ke\phi$: Induced voltage constant [Vrms/min^{-1}] (Motor constant)
KT : Torque constant [N·m/Arms] (Motor constant)
N : Motor rotation speed [min^{-1}]
$R\phi$: Armature resistance [Ω] (Motor constant)
EM : Regeneration energy during operations along vertical axis [J]
EVD : Regeneration energy during descending run [J]
Tub : Torque during increased deceleration [N·m]
TD : Torque during descending run [N·m]
tD : Descending run time [s]
TDb : Torque during decreased deceleration [N·m]
tDb : Decreased deceleration time [s]
EVUb: Regeneration energy during increased deceleration [J]
EVDb: Regeneration energy during decreased deceleration [J]
TUb : Increased deceleration time [s]

* When the calculation result of either of **EVUb**, **EVD**, or **EVDb** is negative, calculate **EM** by considering the value of those variabkes as 0.

■ Calculate "regeneration effective power" from regeneration energy.

$$PM = \frac{EM}{to}$$

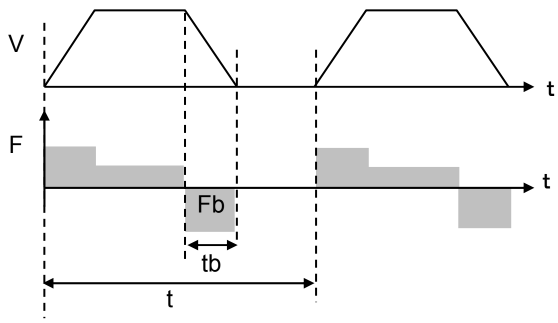
PM : Effective regeneration power [W]
EM : Regeneration energy during deceleration [J]
to : Cycle time [s]

3) How to find "regeneration effective power (PM)" of the vertical axis drive by a formula (Linear motor)

■ Calculate regeneration energy.

$$PM = \left\{ \left(\frac{1}{2 \cdot t} \cdot M \cdot V^2 \right) - \left(\frac{v}{2 \cdot t} \cdot Ff \cdot tb \right) \right\} - \left\{ \left(\frac{3 \cdot R\phi \cdot tb}{t} \right) \times \left(\frac{M \cdot V - Ff \cdot tb}{Kf \cdot tb} \right)^2 \right\} \ [J/s] = [W]$$

PM	: Regenerative electrical power	[W]
M	: Moving part mass	[kg]
V	: Acceleration just before decelerating	[m/s]
t	: Cycle	[s]
tb	: Decelerating time	[s]
Ff	: Frictional force	[N]
Rϕ	: Resistance per 1 motor	[Ω]
Kf	: Force constant	[N/A]



Fb=M·V/tb-Ff

4) Capacity Selection of Regenerative Resistor

Judge whether an internal regenerative resistor can be used from the calculation result. Moreover, when you cannot use it, determine the capacity of an external regeneration resistor.

■ 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#AA0	Less than 5W	50Ω
RS2#03A#AA0	Less than 5W	50Ω
RS2#05A#AA0	Less than 20W	17Ω
RS2#10A#AA0	90W or less	10Ω
RS2#15A#AA0	120W or less	6Ω
RS2#30A#AA0	———	———

■ 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 [PR0]
RS2#01A#AL0	Less than 220W
RS2#03A#AL0	Less than 220W
RS2#05A#AL0	Less than 500W
RS2#10A#AA0	500W or less
RS2#15A#AA0	500W or less
RS2#30A#AA0	500W 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#AL0 RS2#03A#AL0	Resistor Sign	B×1	D×1	F×1	C×2	E×2	F×4	Please contact us.
	Connection Number	Ⅲ	Ⅲ	Ⅲ	Ⅴ	Ⅴ	Ⅵ	

Servo amplifier model number	[PM]	55W or less	125W or less	250W or less	Less than 500W	500W or more
RS2#05A#AL0	Resistor Sign	G×1	H×1	I×2	H×4	Please contact us
	Connection Number	Ⅲ	Ⅲ	Ⅳ	Ⅵ	

Servo amplifier model number	[PM]	125W or less	250W or less	500W Less than	500W or more
RS2#10A#AL0	Resistor Sign	I×1	H×2	I×4	Please contact us
	Connection Number	Ⅲ	Ⅴ	Ⅵ	

Servo amplifier model number	[PM]	125W or less	250W or less	Less than 500W	500W or more
RS2#15A#AL0	Resistor Sign	J×1	K×2	J×4	Please contact us
	Connection Number	Ⅲ	Ⅴ	Ⅵ	

Servo amplifier model number	[PM]	125W or less	250W or less	Less than 500	500W or more
RS2#30A#AL0	Resistor Sign	J×1	L×1	L×2	Please contact us
	Connection Number	Ⅲ	Ⅲ	Ⅴ	

* 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 JI [J] selected according to in the above 4) or less.

$$EM\ [J] \leqq JI\ [J]$$

When regenerative energy exceeds the instantaneous tolerance of resistor you use, select the resistor with large instantaneous tolerance.

* Abnormal regeneration may occurred when vertial axis continously driven, even if the value is under allowable regenerative reistor power " PR0" and allowable instantaneous torelenace "JI "of usable external regenerative resistor.

7) Capacity of External Regenerative Resistor and Resistor Model Name

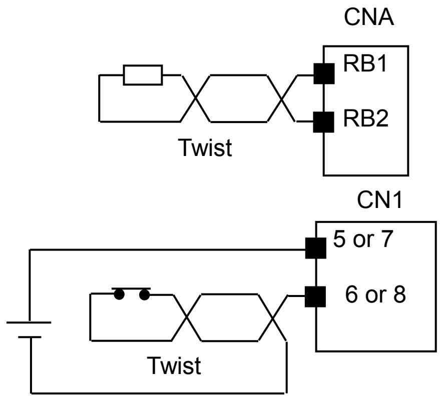
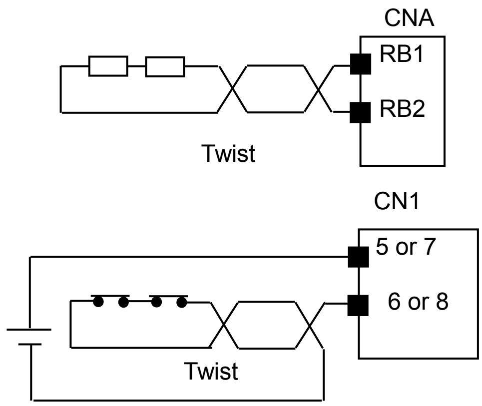
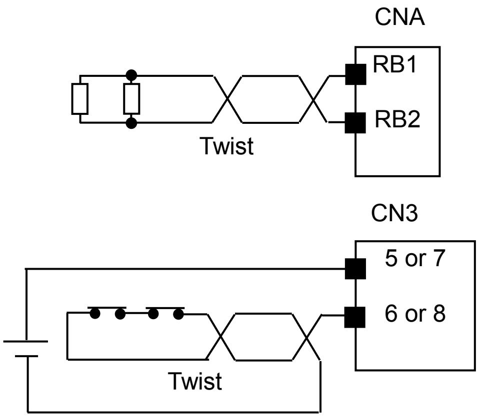
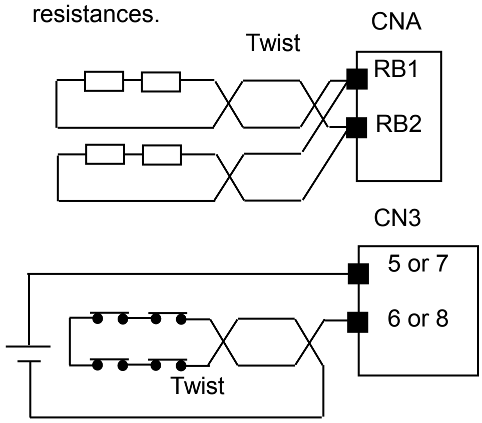
The resistor model name corresponds with the sign of the external regeneration resistor selected for the preceding clause.

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℃±7℃ (Contact b)	10W	35J	0.19kg	"Outline dimensional drawing of regenerative resistor (12-40)"
B	REGIST-080W50B	50Ω		10W	35J		
C	REGIST-120W100B	100Ω		30W	50J	0.24kg	
D	REGIST-120W50B	50Ω		30W	80J		
E	REGIST-220W100B	100Ω		55W	90J	0.44kg	
F	REGIST-220W50B	50Ω		55W	125J		
G	REGIST-220W20B	20Ω		55W	210J		
H	REGIST-500CW0B	20Ω	100℃±5℃ (Contact b)	125W	9700J	1.4kg	
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

Connection Number 3	Connection Number 4
■ One resistance is connected.  Connect a thermostat and thermal to the general input of CN3.	■ Series connection about two resistances.  Connect a thermostat and thermal to the general input of CN3.
Connection Number 5	**Connection Number 6**
■ Parallel connection about two resistances.  Connect a thermostat and thermal to the general input of CN3.	■ Series/parallel connection about four resistances.  Connect a thermostat and thermal to the general input of CN3.

* 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 0.01% - 99.99%.

- The actual regeneration effective power **PM** can be calculated from this monitor value by following equation.
  - ◆ Input Supply Voltage: In case of 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 varys with the voltage fluctuation of the input power supply and changes across the ages of the servo amplifier and the loading device.

* Be sure to opt for selection of regeneration resistance based on the regeneration effective power "PM" found from calculation of a pattern of operation and regeneration power.

* Install the external regeneration resistor on equipment, and measure the temperature of the external regeneration resistor by the operating condition that the regeneration effective power PM becomes the maximum. Then do sufficient mounting check of alarm not being generated. In addition, it takes 1 to 2 hours until the temperature of the external regeneration resistor is saturated.

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. Appendix

16.1 Standards Conformity

Conformance examinations of overseas standards for our products are implemented by certificate authorities, and attestation markings are performed based on the certificates of attestation issued by the authorities.

1) Standards conformity

■ The following overseas standard examinations are implemented for the product.

Model Number	Applicable laws and regulations	Standard Number	Certification Organization
RS2#####K# #	UL/c-UL standard	UL508C	UL (Underwriters Laboratories inc.)
RS2#####K# **0** RS2#####K# **1** (Only without Safe Torque Off function equipped model)	LVD (Low Voltage Directive)	EN61800-5-1	TÜV (TÜV SÜD Japan, Ltd.)
	EMC (Electromagnetic Compatibility)	EN55011 G1 Class A EN61000-6-2 EN61800-3	TÜV (TÜV SÜD Japan, Ltd.)
RS2#####K# **2** RS2#####K# 3 RS2#####K# **4** RS2#####K# 5 (Only with Safe Torque Off function equipped model)	MD (Machinery Directive) FS (Functional Safety)	EN61800-5-1 EN61800-5-2 EN55011 G1 Class A EN61800-3 EN61326-3-1 IEC61508, SIL2 IEC62061, SILCL2 ISO13849-1, Cat.3, PL=d EN954-1, Cat.3	TÜV (TÜV SÜD Japan, Ltd.) (Blue octagon)

■ The servo motor obtained certificates of attestation issued by the authorities.

Standard	Standard Number	Certification Organization
UL standard	UL1004 UL1446	UL (Underwriters Laboratories inc.)
EN standard	IEC-34-1 IEC34-5	TÜV (TÜV SÜD Japan, Ltd.)

* For products conforming to conformity standards, some specifications may differ from the standard product due to prerequisites necessary for obtaining approval. Contact 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 interface, use a DC power supply with reinforced and insulated input and outputs.

■ Make sure to install the servo amplifier in your control panel in an environment where the pollution level specified in EN61800-5-1 and IEC664 is no less than 2 (polution level 1, 2). The protection grade of servo amplifier is IP1X. The control panel installation configuration (under IP54) must exclude exposure to water, oil, carbon, dust, etc.

3) Connection, 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 ground 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.

4) UL File Number

The UL file number of servo amplifier and servo motor is as follows.
You can check from the website of UL.

http://www.ul.com/database/

■ The UL file number of servo amplifier: E179775
■ The UL file number of servo motor: E179832

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.

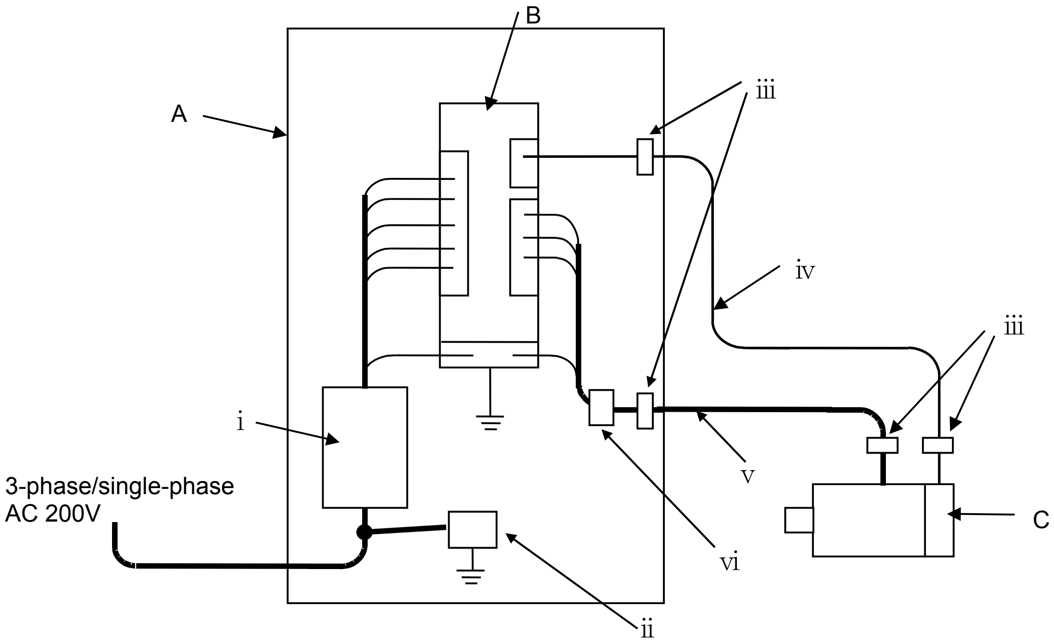
Directive classification	Classification	Test	Test standard
Low voltage Directive (Servo amplifier)	-	-	EN61800-5-1: 2007
Low voltage Directive (Servo motor)	-	Rotating electrical machines-Part1: Rating and performance	IEC-34-1
		Rotating electrical machines-Part5: Classification of degrees of protection provided by enclosures of rotating electrical machines (IP code)	IEC34-5
		Rotating electrical machines-Prat9: Noise limits	IEC34-9
EMC Directive (Servo amplifier/ servo motor)	Emission	Conducted emission	EN55011: A2/2007
		Radiated emission	EN55011: A2/2007
	Immunity	Electrostatic discharge immunity	EN61000-4-2: A2/2001
		Radiated electromagnetic field immunity	EN61000-4-3: A1/2002
		Electrical first transient/ burst immunity	EN61000-4-4: 2004
		Conducted disturbance immunity	EN61000-4-6: A1/2001
		Surge immunity	EN61000-4-5: A1/2001
		Voltage Dips & Interruptions immunity	EN61000-4-11: 2004
		Adjustable speed electrical power drive system	EN61800-3/2004
		Electrical equipment for measurement, control and laboratory use	IEC61326-3-1: 2008 Note1)
		Safety of machinery	EN62061: 2005 (Annex E) Note1)

Note1) Standards applicable only to Safe-Torque-Off function equipped models.

2) EMC Installation Requirements

For the installation requirements, in our company the verification test is implemented by the following installations and measures methods, as machines and configurations differ depending on customers' needs. This servo amplifier has been authorized to display CE marking based on the recognition certificate issued by a certifying authority.

Customers are instructed to perform the final conformity tests for all instruments and devices in use.



No	Name	Remarks
A	Control panel	-
B	Servo amplifier	-
C	Servo motor	-
1	Noise filter (Recommended prevention components) Note1)	RS2*01 to RS2A15: HF3030C-UQA: SOSHIN ELECTRIC Co. Ltd. Rated voltage/ Rated current: Line-Line 480V AC/ 30A RS2A15 (Q2AA22700S-combined case):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
2	Surge-absorber (Recommended prevention components)	LT-C32G801WS: SOSHIN ELECTRIC Co. Ltd.
3	Clamp grounding	-
4	Encoder cable	Shield cable
5	Servo motor power cable	Shield cable
6	Ferrite core	MA070 R-63/38/25A: JFE FERRITE CORPORATION

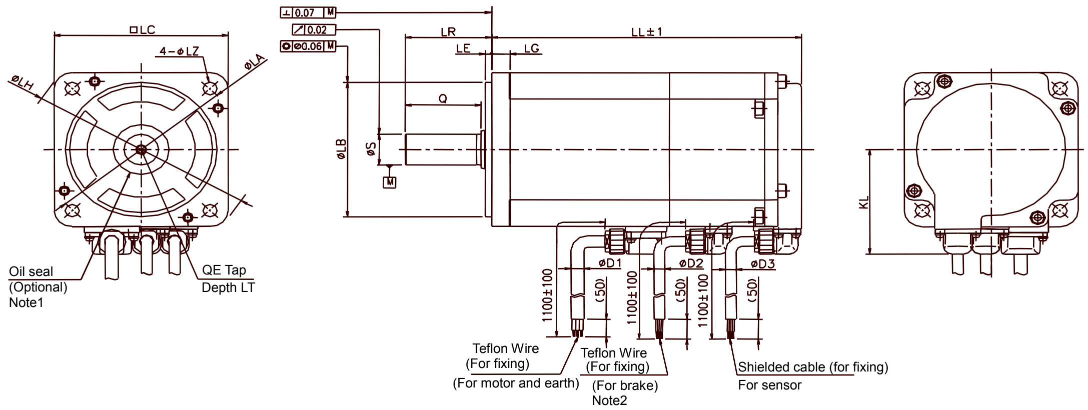
Note1) We also recommend the following noise filters.

- * HF3050C-UQA: SOSHIN ELECTRIC Co. Ltd. Rated voltage / Rated current: Line-Line 480V AC / 50A
- * RF3020-DLC: RASMI ELECTRONICS Ltd. Rated voltage / Rated current: Line-Line 440V –550V AC / 20A
- * RF3030-DLC: RASMI ELECTRONICS Ltd. Rated voltage / Rated current: Line-Line 440V –550V AC / 30A
- * RF3070-DLC: RASMI ELECTRONICS Ltd. Rated voltage / Rated current: Line-Line 440V –550V AC / 70A
- * RF1010-DLC: RASMI ELECTRONICS Ltd. Rated voltage / Rated current: Line-Neutral 250V AC / 35A
- * FS5559-35/33:SCHAFFNER. Rated voltage / Rated current: Line-Line 480V AC / 35A
- * CNW112/10: REO AG. Rated voltage / Rated current: Line-Neutral 250V AC / 6A

* A metallic material must be used for the door and main body of control panel.
* Use an EMI gasket so that there is zero clearance between the door and control panel. Install EMI gasket uniformly to the contact points between door and main body of control panel to confirm their conductivity.
* Ground the noise filter frame to the control panel.
* Use shield cables for the motor power line and encoder cable. Clamp grounding of the shield at the frame of a control panel and equipment.
* Use a conducting metal P clip or U clip to ground and clamp the shield wire, and fix it directly with metal screws. Do not ground by soldering electric wire to the shield wire.
* Wire the servo amplifier at a short distance from the secondary side of noise filter, and wire the primary side and secondary side of the noise filter separately.

16.3 Servo Motor Dimension

1) R2 motor, Flange Size 40mm, 60mm, 80mm, 86mm and 100mm

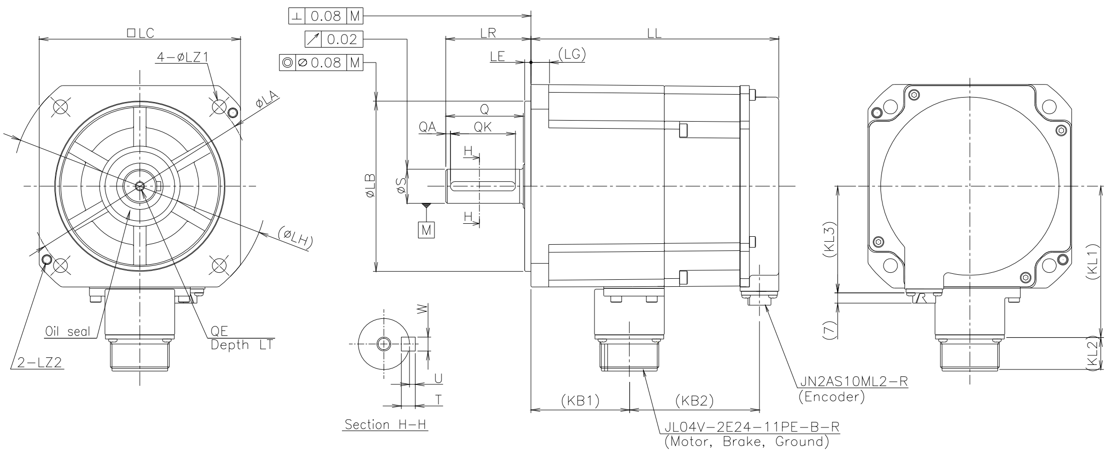


	Without Oil Seal		With Oil Seal										
	Battery backup method absolute encoder Absolute encoder for incremental system												
	Without Brake	With Brake	Without Brake	With Brake									
Servo motor model number	LL	LL	LL	LL	LG	KL	LA	LB	LE	LH	LC	LZ	LR
R2□A04003△□◇	51.5	87.5	56.5	92.5	5	35.4	46	0 30-0.021	2. 5	56	40	2-Φ 4.5	25
R2□A04005△□◇	56.5	92.5	61.5	97.5									
R2EA04008△□◇	72	108	77	113									
R2AA04010△□◇													
R2□A06010△□◇	58.5	82.5	65.5	89.5	6	44.6	70	0 50-0.025	3	82	60	4-Φ 5.5	25
R2□A06020△□◇	69.5	97.5	76.5	104.5									30
R2AA08020△□◇	66.3	102	73.3	109	8	54.4	90	0 70-0.030		108	80	4-Φ 6.6	
R2AA06040△□◇	95.5	123.5	102.5	130.5	6	44.6	70	0 50-0.025		82	60	4-ϕ 5.5	
R2AA08040△□◇	78.3	114	85.3	121	8	54.4	90	0 70-0.030	3	108	80	4-Φ 6.6	
R2AA08075△□◇	107.3	143	114.3	150									40
R2AAB8075△□◇	114.3	140.2	114.3	140.2		59.4	100	0 80-0.03		115. 5	86		35
R2AAB8100△□◇	137	163	137	163									
R2AA10100△□◇	128.3	145.8	128.3	145.8	10	66.8	115	0 95-0.035	3	130	100	4-Φ 9	45
R2AA10075△□◇	111.3	128.8	111.3	128.8									

Servo motor model number	S	Q	QE	LT	D1	D2	D3
R2□A04003△□◇	0 6 -0.008	20	-	-	6	5	5
R2□A04005△□◇	0 8 –0.009						
R2EA04008△□◇							
R2AA04010△□◇							
R2□A06010△□◇	0 8 –0.009		-	-			
R2□A06020△□◇	0 14 –0.011	25	M5	12			
R2AA08020△□◇							
R2AA06040△□◇							
R2AA08040△□◇			M5	12			
R2AA08075△□◇	0 16 –0.011	35					
R2AAB8075△□◇		30					
R2AAB8100△□◇							
R2AA10075△□◇	0 22-0.013	40	M6	20			
R2AA10100△□◇							

* For motor requiring oil seal, the motor whole length differs.
* For motor without brake, no brake connector (or cable) attached.

2) R2 motor, Flange Size 130mm 0.5kW to 1.8kW

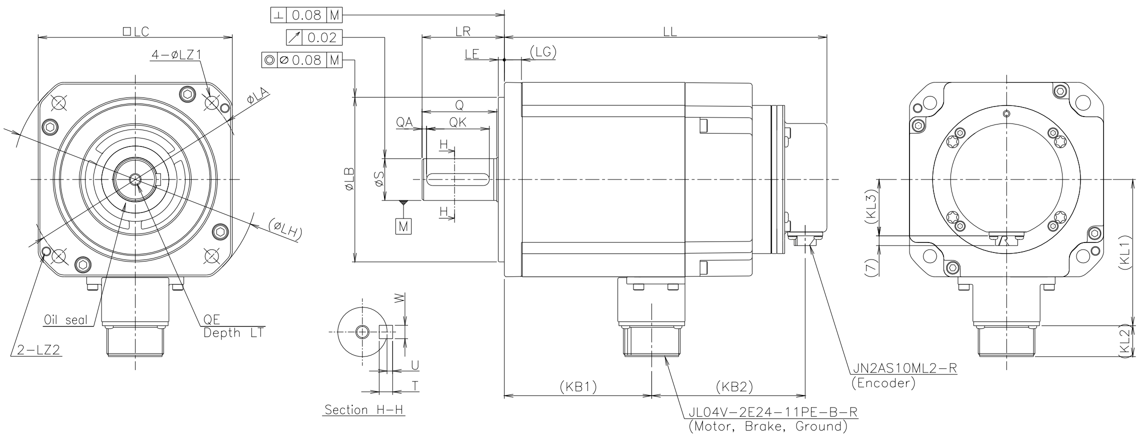


	Battery backup method absolute encoder Absolute encoder for incremental system						Incremental encoder									
	Without Brake			With Brake			Without Brake			With Brake						
Servo motor model number	LL	KB2	KL3	LL	KB2	KL3	LL	KB2	KL3	LL	KB2	KL3	LG	KL1	KL2	LA
R2AA13050△□◇	103			139.5	81		115.5			153.5	93					
R2AA13120△□◇	120.5	44	69	160	84	69	133	57	38	174	96	38	12	98	21	145
R2AA13180△□◇	138			179	86		150.5			192	96					

Servo motor model number	LB	LE	LH	LC	LZ1	LZ2	LR	S	Q	QA	QK	W	T	U	KB1	QE	LT
R2AA13050△□◇															46		
R2AA13120△□◇	0 110-0.035	4	165	130	9	M6	55	0 22-0.013	50	3	42	0 6-0.030	6	2.5	64	M6	20
R2AA13180△□◇															81		

* Please contact us for the dimensions for the encoder below. Battery less absolute encoder [RA035C]

3) R2 motor, Flange Size 130mm 2kW

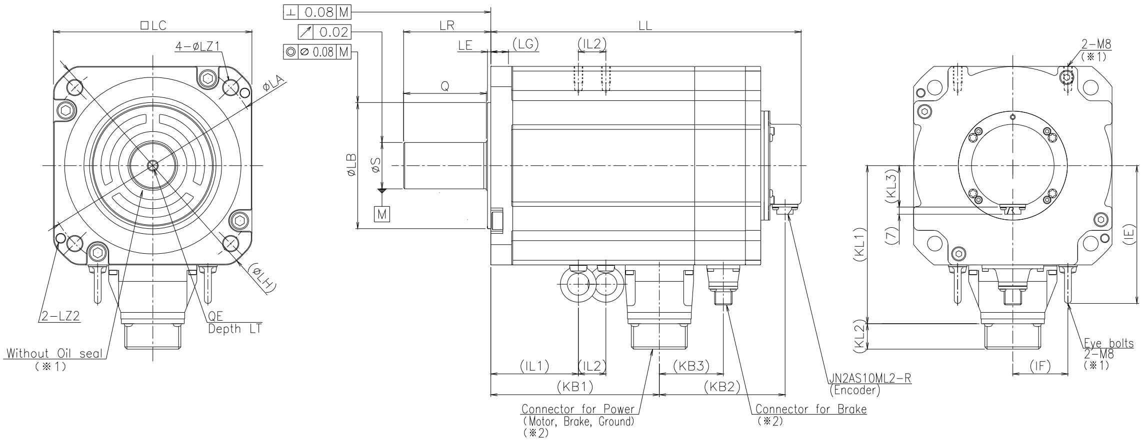


	Battery backup method absolute encoder Absolute encoder for incremental system						Incremental encoder									
	Without Brake			With Brake			Without Brake			With Brake						
Servo motor model number	LL	KB2	KL3	LL	KB2	KL3	LL	KB2	KL3	LL	KB2	KL3	LG	KL1	KL2	LA
R2AA13200△□◇	171	57	38	216	103	38	185	64	65	230	110	65	12	98	21	145

Servo motor model number	LB	LE	LH	LC	LZ1	LZ2	LR	S	Q	QA	QK	W	T	U	KB1	QE	LT
R2AA13200△□◇	0 110-0.035	4	165	130	9	M6	55	0 28-0.013	50	3	42	0 8-0.036	7	3	99	M8	25

* Please contact us for the dimensions for the encoder below. Battery less absolute encoder [RA035C]

4) R2 motor, Flange Size 180mm 3.5kW to 7.5kW



	Battery backup method absolute encoder Absolute encoder for incremental system								Incremental encoder														
	Without Brake				With Brake				Without Brake				With Brake										
Servo motor model number	LL	KB2	KB3	KL3	LL	KB2	KB3	KL3	LL	KB2	KB3	KL3	LL	KB2	KB3	KL3	LG	KL1	KL2	LA	LB	LE	LH
R2AA18350△□◇	155	48	-	38	204	97	-	38	172	59	-	65	221	108	-	65	16	123	21	200	114.3 0 -0.035	3	230
R2AA18450△□◇	172				221				189				238										
R2AA18550△□◇	228	59			281	114	58		242	66			295	121	58		19	144	22				
R2AA18750△□◇	273				336	124	68		287				350	131	68								

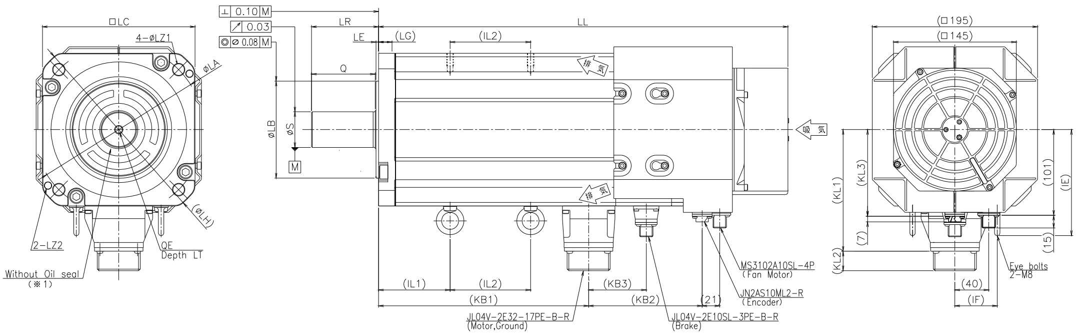
Servo motor model number	LC	LZ1	LZ2	LR	S	Q	KB1	QE	LT	IE	IF	IL1	IL2	Model NO,. of connector for power line	Model NO,. of connector for brake line
R2AA18350△□◇	180	13.5	M8	65	0 35-0.016	60	92	M8	25	123 (1)	50 (1)	50 (1)	20 (1)	JL04V-2E24-11PE-B-R	- (2)
R2AA18450△□◇							109			123	50	57	20		
R2AA18550△□◇				79	0 42-0.016	75	153	M10				63	41	JL04V-2E32-17PE-B-R	JL04V-2E10SL-3PE-B-R
R2AA18750△□◇							198						86		

* Please contact us for the dimensions for the encoder below. Battery less absolute encoder [RA035C]

Note1) No eyebolts are supplied with R2AA18350 motor with no brake.

Note2) Connector for powering line is used in common with braking line.

5) R2 motor, Flange Size 180mm 11kW

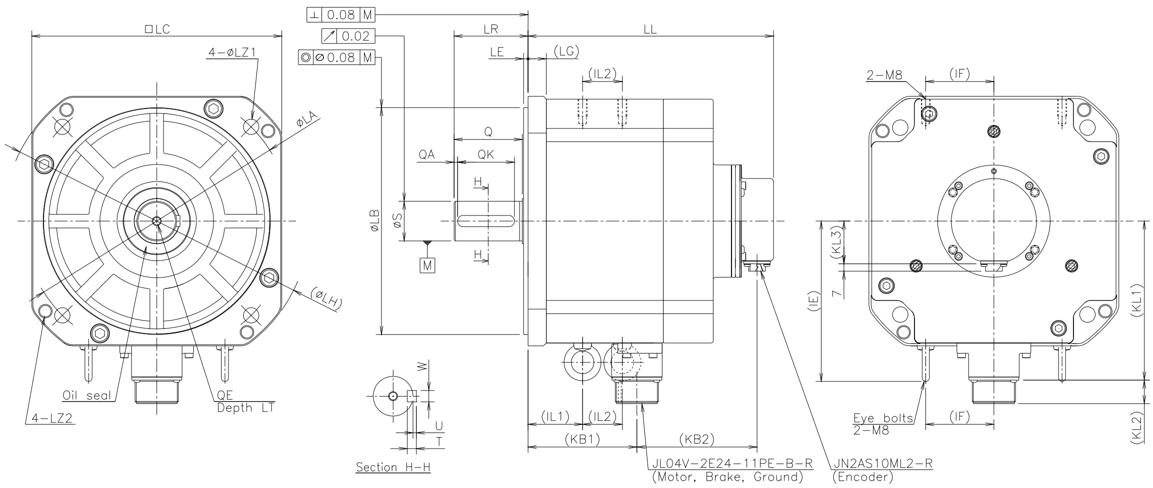


	Battery backup method absolute encoder Absolute encoder for incremental system								Incremental encoder											
	Without Brake				With Brake				Without Brake				With Brake							
Servo motor model number	LL	KB2	KB3	KL3	LL	KB2	KB3	KL3	LL	KB2	KB3	KL3	LL	KB2	KB3	KL3	LG	KL1	KL2	LA
R2AA1811K△□◇	385	59	-	102	478	154	83	102	385	-	66	102	478	161	83	102	19	144	22	200

Servo motor model number	LB	LE	LH	LC	LZ1	LZ2	LR	S	Q	KB1	QE	LT	IE	IF	IL1	IL2
R2AA1811K△□◇	0 114.3-0.035	3	230	180	13.5	M8	79	0 42-0.016	75	223	M10	25	123	50	63	111

* Please contact us for the dimensions for the encoder below. Battery less absolute encoder [RA035C]

6) R2 motor, Flange Size 220mm 3.5kW to 5kW

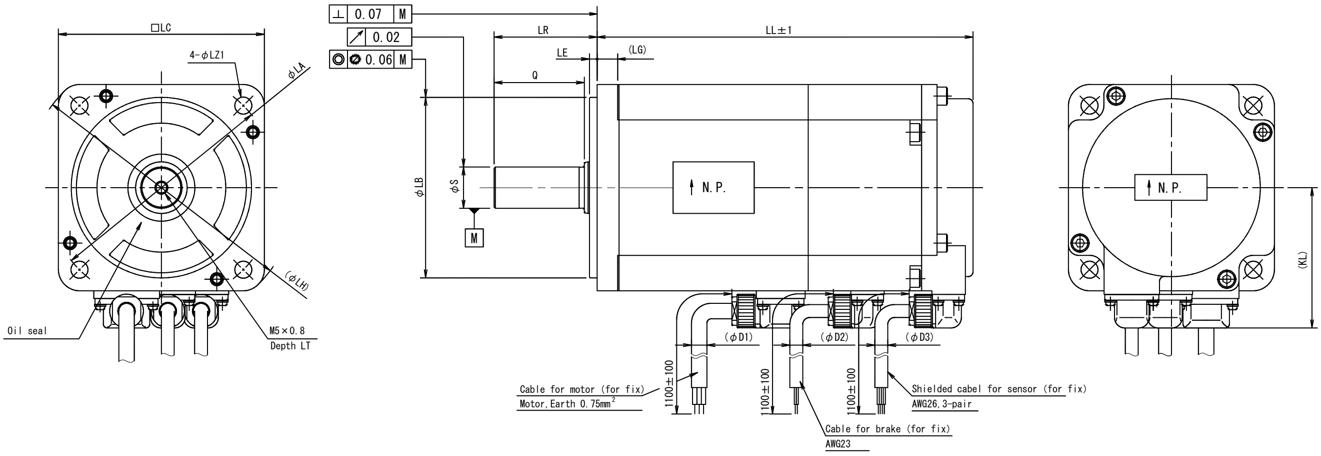


	Battery backup method absolute encoder Absolute encoder for incremental system						Incremental encoder													
	Without Brake			With Brake			Without Brake			With Brake										
Servo motor model number	LL	KB2	KL3	LL	KB2	KL3	LL	KB2	KL3	LL	KB2	KL3	LG	KL1	KL2	KL3	LA	LB	LE	LH
R2AA22500△□◇	163	52	38	216	106	38	177	59	65	230	113	65	16	142	21	38	235	200$^{0}_{-0.046}$	4	270

Servo motor model number	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$^{0}_{-0.016}$	60	3	50	10$^{0}_{-0.036}$	8	3	96	M8	25	142	60	48	35

* Please contact us for the dimensions for the encoder below. Battery less absolute encoder [RA035C]

7) R5 motor, flange size 60mm, 80mm

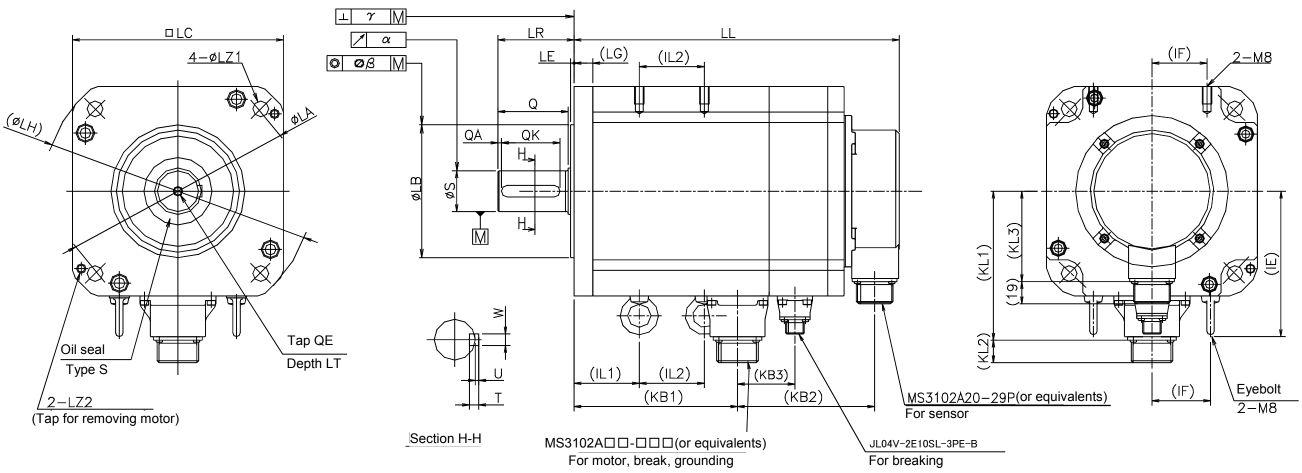


	Without Oil Seal		With Oil Seal										
	Absolute encoder for incremental system												
	Without Brake	With Brake	Without Brake	With Brake									
servo motor model number	LL	LL	LL	LL	LG	KL	LA	LB	LE	LH	LC	LZ	LR
R5AA06020△□◇	72.5	100.5	79.5	107.5	6	44.6	70	0 50-0.025	3	82	60	4-φ 5.5	30
R5AA06040△□◇	98.5	126.5	105.5	133.5									
R5AA08075△□◇	110.3	146	117.3	153	8	54.4	90	0 70-0.03	3	108	80	4-φ 6.6	40

servo motor model number	S	Q	QE	LT	D1	D2	D3
R5AA06020△□◇	0 14 -0.011	25	M5	12	6	5	5
R5AA06040△□◇							
R5AA08075△□◇	0 16 -0.011	35					

* For motor requiring oil seal, the motor whole length differs.
* For motor without brake, no brake connector (or cable) attached.

8) Q1 motor, flange size 100mm, 120mm, 130mm, and 180mm

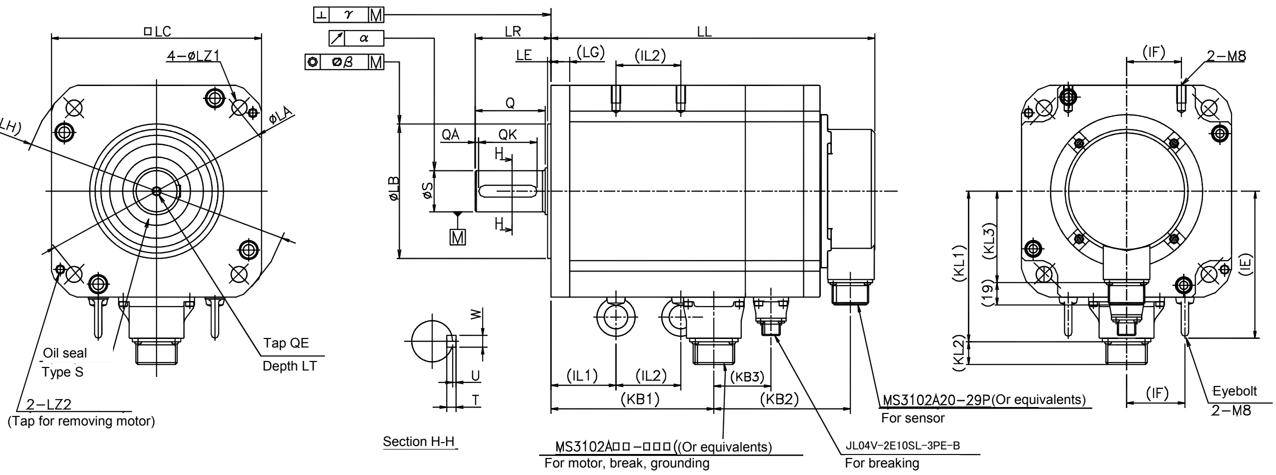


	Wire-saving incremental encoder					Battery backup absolute encoder					Connector, Note1)					[PP062]	[PA035C]		
	No brake		With brake			No brake		With brake			Motor earth	Brake (With brake-motor only, Note2)							
Model number	LL	KB2	LL	KB2	KB3	LL	KB2	LL	KB2	KB3	MS3102A	JL04V-2E	LG	KL1	KL2	KL3	KL3	LA	LB
Q1AA10200△□◇	234	80	269	116	51	243	90	279	125	51	20-15P	10SL-3PEB	10	78	19	63	63	115	0 95-0.035
Q1AA10250△□◇	259		294			268		304											
Q1AA12200△□◇	205	72	241	108	45	220	87	256	123	45	24-11P	10SL-3PE-B	12	93	21	67	63	135/ 145	0 110-0.035
Q1AA12300△□◇	242		278			257		293											
Q1AA13300△□◇	205	67	254	117	-	220	84	270	134	-	24-11P		12	98	21	80	63	145	0 110-0.035
Q1AA13400△□◇	232		281			247		297											
Q1AA13500△□◇	269		318			284		334											
Q1AA18450△□◇	288	67	338	117	-	304	84	354	134	-	24-11P		16	123	21	80	63	200	0 114.3-0.035
Q1AA18750△□◇	384	72	434	122	54	400	89	450	139	54	32-17P	10SL-3PE-B	19	144	22				

Model number	LE	LH	LC	LZ1	LZ2	LR	S	Q	QA	QK	W	T	U	KB1	α	β	γ	QE	LT	IE	IF	IL1	IL2
Q1AA10200△□◇	3	130	100	9	-	45	0 22-0.013	40	3	32	0 6-0.030	6	2.5	134	0.02	0.08	0.08	M6	20	-	-	-	-
Q1AA10250△□◇														159									
Q1AA12200△□◇	3	162	120	9	-	45	0 22-0.013	40	3	32	0 6-0.030	6	2.5	113	0.02	0.08	0.08	M6	20	-	-	-	-
Q1AA12300△□◇						55	0 28-0.013	50	3	42	0 8-0.036	7	3	150				M8	25				
Q1AA13300△□◇	4	165	130	9	M6	55	0 28-0.013	50	3	42	0 8-0.036	7	3	117	0.02	0.08	0.08	M8	25	-	-	-	-
Q1AA13400△□◇														144									
Q1AA13500△□◇														181									
Q1AA18450△□◇	3	230	180	13.5	M8	65	0 35-0.016	60	3	50	0 10-0.036	8	3	200	0.02	0.08	0.08	M8	25	124	50	93	50
Q1AA18750△□◇						79	0 42-0.016	75	3	67	0 12-0.043	8	3	291				M10	25	124	50	85	145

Note1 Use waterproof connector for receptacle plug when compliance with IP67 required, as connector is waterproof when fit.
Note2 All the brake connectors are JL04V-2E70SL-3PE-B, when DC24V-brake conforms to CE.

9) Q2 motor, flange size 130mm, 180mm, and 220mm



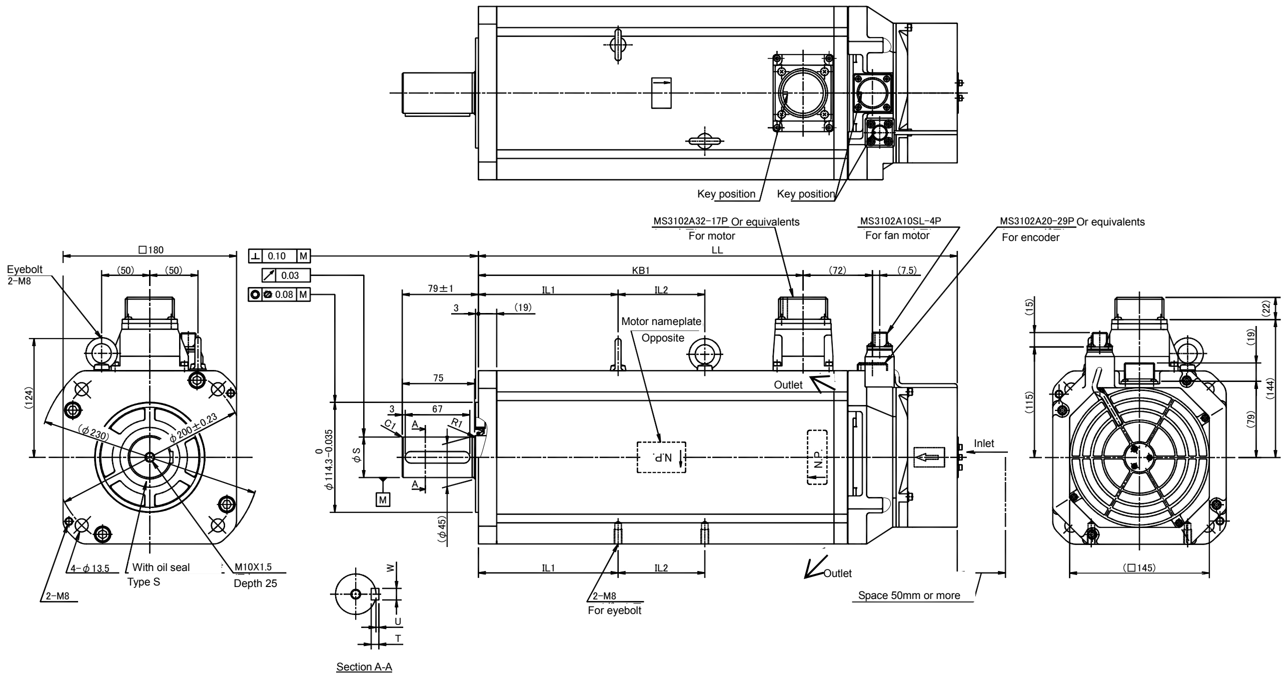
	Wire-saving incremental encoder					Battery backup absolute encoder					Connector, Note1)					[PP031]	[PA035C]		
	No brake		With brake			No brake		With brake			Motor earth	Brake (With brake-motor only, Note2)							
Model number	LL	KB2	LL	KB2	KB3	LL	KB2	LL	KB2	KB3	MS3102A	JL04V-2E	LG	KL1	KL2	KL3	KL3	LA	LB
Q2AA13200△□◇	186	67	226	107	-	201	84	241	124	-	24-11P		12	98	21	80	63	145	0 110-0.035
Q2AA18200△□◇	171	67	221	117	-	186	84	236	134	-	24-11P		16	123	21	80	63	200	0 114.3-0.035
Q2AA18350△□◇	203		253			218		268											
Q2AA18450△□◇	218		268			234		284											
Q2AA18550△□◇	282	72	332	122	54	298	89	348	139	54	32-17P	10SL-3PE-EB	19	144	22	80	63	200	0 114.3-0.035
Q2AA18750△□◇	332		382			348		398											
Q2AA22550△□◇	252	82	309	140	82	265	97	323	155	82	24-11P	10SL-3PE-EB	19	141	21	80	63	235	0 200-0.046
Q2AA22700△□◇	310		368			323		381											
Q2AA2211K△□◇	335	73	393	131	61	355	94	406	145	61	32-17P	10SL-3PE-EB	19	162	22	80	63	235	0 200-0.046
Q2AA2215K△□◇	394		452			414		465											

MODEL	LE	LH	LC	LZ1	LZ2	LR	S	Q	QA	QK	W	T	U	KB1	α	β	γ	QE	LT	IE	IF	IL1	IL2
Q2AA13200△□◇	4	165	130	9	M6	55	0 28-0.013	50	3	42	0 8-0.036	7	3	98	0.02	0.08	0.08	M8	25	-	-	-	-
Q2AA18200△□◇	3	230	180	13.5	M8	65	0 35-0.016	60	3	50	0 10-0.036	8	3	83	0.02	0.08	0.08	M8	25	-	-	-	-
Q2AA18350△□◇														115						124	50	61	20
Q2AA18450△□◇														130									35
Q2AA18550△□◇	3	230	180	13.5	M8	79	0 42-0.016	75	3	67	0 12-0.043	8	3	189	0.02	0.08	0.08	M10	25	124	50	85	50
Q2AA18750△□◇														239									100
Q2AA22550△□◇	4	270	220	13.5	M10	79	0 55-0.019	75	3	67	0 16-0.043	10	4	149	0.03	0.08	0.10	M10	25	142	60	55	50
Q2AA22700△□◇														207									110
Q2AA2211K△□◇	4	270	220	13.5	M10	79	0 55-0.019	75	3	67	0 16-0.043	10	4	241	0.03	0.08	0.10	M10	25	142	60	69	120
Q2AA2215K△□◇														300									180

Note1 Use waterproof connector for receptacle plug when compliance with IP67 required, as connector is waterproof when fit.

Note2 All the brake connectors are JL04V-2E70SL-3PE-B, when DC24V-brake conforms to CE.

10) Q4 motor, flange size 180mm



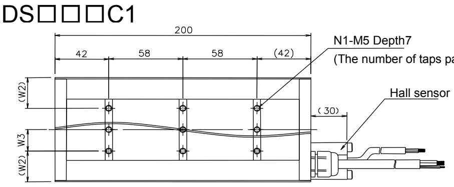
	Wire-saving incremental encoder	Connector, Note1)							
	No brake	Motor earth							
Model number	LL	MS3102A	S	W	T	U	KB1	IL1	IL2
Q4AA1811K△□◇	497	32-17P	0 42-0.016	0 12-0.043	8	3	337	145	90
Q4AA1815K△□◇	587		0 55-0.019	0 16-0.043	10	4	427	155	170

Note1 Use waterproof connector for receptacle plug when compliance with IP67 required, as connector is waterproof when fit.

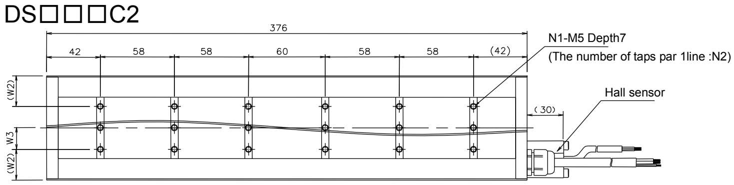
11) Single magnet core type linear servo motor

●Outline dimensional drawing of single magnet core-type linear motor coil

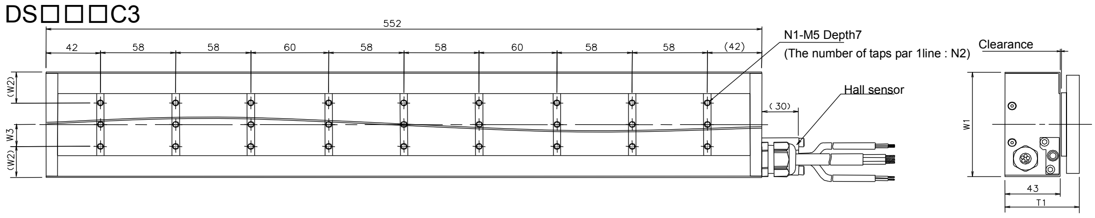
DS□□□C1



DS□□□C2



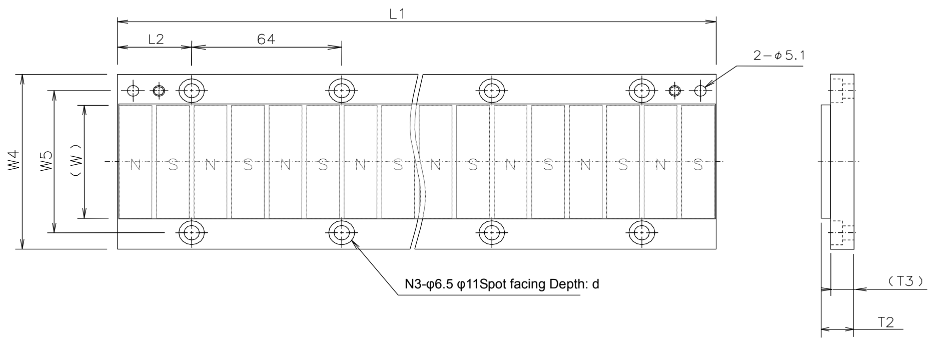
DS□□□C3



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		

- Single magnet core-type, outline dimensional drawing of magnet rail

DS□□□M□□□B00

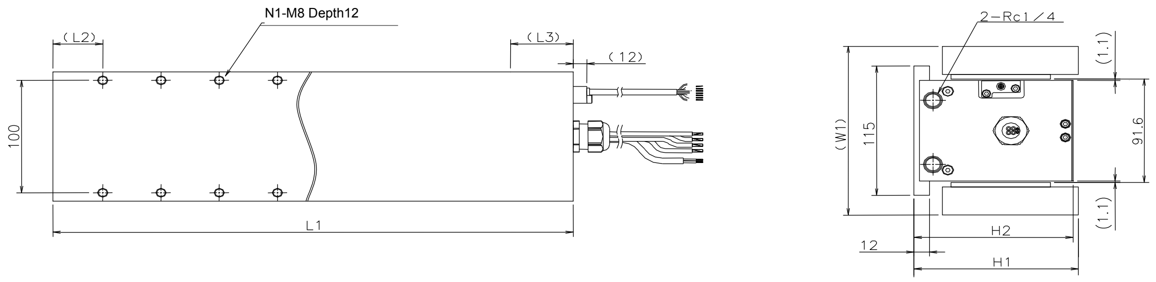


Coil model. no.		Dimension								
		W mm	W4 mm	W5 mm	L1 mm	L2 mm	T2 mm	T3 mm	N3	d mm
DS030	M064B00	30	60	45	63.3	31.65	14.25	10	2	6
	M128B00				127.3				4	
	M256B00				255.3				8	
	M512B00				511.3				16	
DS050	M064B00	50	80	65	63.3	31.65	14.25	10	2	5
	M128B00				127.3				4	
	M256B00				255.3				8	
	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) Dual magnet core type linear servo motor

- Dual magnet core type linear servo motor Coil Dimension

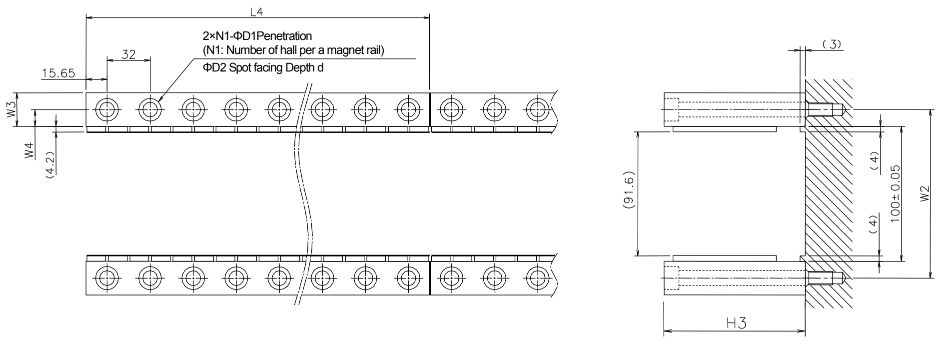
DD□□□C□



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		

- Dual magnet core type linear servo motor Magnet rail Dimension

DD□□□M□□□□B00



Coil 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			

16.4 Servo Motor Data Sheet

1) Characteristics table

■ Specification of R2 motor, AC200V

Servo motor model number R2AA			04003F	04005F	04010F	06010F	06020F	06040H	08020F
Amplifier size combined			RS2A01	RS2A01	RS2A01	RS2A01	RS2A01	RS2A01	RS2A01
*Rated output	P_R	kW	0.03	0.05	0.1	0.1	0.2	0.4	0.2
*Rated velocity	N_R	min^{-1}	3000	3000	3000	3000	3000	3000	3000
*Maximum velocity	N_{max}	min^{-1}	6000	6000	6000	6000	6000	3000	6000
*Rated torque	T_R	N·m	0.098	0.159	0.318	0.318	0.637	1.27	0.637
*Continuous Torque at stall	T_S	N·m	0.108	0.167	0.318	0.353	0.686	1.37	0.686
*Peak Torque at stall	T_P	N·m	0.37	0.59	1.18	1.13	2.2	4.8	2.2
*Rated armature current	I_R	Arms	0.51	0.67	0.81	0.86	1.5	1.7	1.5
*Armature current at stall	I_S	Arms	0.56	0.69	0.81	0.86	1.6	1.8	1.5
*Peak armature current at stall	I_P	Arms	2.15	2.8	3.3	3.5	5.6	7.1	4.8
*Torque constant	K_T	N·m/Arms	0.201	0.246	0.424	0.375	0.476	0.816	0.516
Voltage constant for each phase	$K_{E\Phi}$	mV/min^{-1}	7.0	8.6	14.8	13.1	16.6	28.5	18.0
Phase resistance	R_Φ	Ω	12	9	9.3	4.8	2.7	3.3	2.3
*Rated power rate	Q_R	kW/s	3.9	6.7	16	8.6	19	39	8
Moment of inertia Note1)	J_M	$kg\cdot m^2(GD^2/4)$ $\times10^{-4}$	0.028	0.0409	0.066	0.120	0.222	0.415	0.523
Mass Note1)	WE	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	0.85
Aluminum plate		mm	t6×250	t6×250	t6×250	t6×250	t6×250	t6×250	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_R	kW	0.4	0.4	0.75	0.75	1.0	1.0	0.75
*Rated velocity	N_R	min^{-1}	3000	3000	3000	3000	3000	3000	3000
*Maximum velocity	N_{max}	min^{-1}	6000	6000	6000	6000	3000	6000	6000
*Rated torque	T_R	N·m	1.27	1.27	2.39	2.38	3.18	3.18	2.39
*Continuous Torque at stall	T_S	N·m	1.37	1.37	2.55	2.94	3.92	3.92	2.55
*Peak Torque at stall	T_P	N·m	4.8	4.4	8.5 Note 2)	11.0	11.6	14.3	8.6
*Rated armature current	I_R	Arms	2.8	2.6	4.6	4.7	4.6	6.0	4.4
*Armature current at stall	I_S	Arms	2.8	2.6	4.6	5.5	4.7	6.8	4.6
*Peak armature current at stall	I_P	Arms	10.8	8.9	15.5 Note 2)	23.7	15.5	25.7	15.5
*Torque constant	K_T	N·m/Arms	0.524	0.559	0.559	0.547	0.825	0.582	0.582
Voltage constant for each phase	$K_{E\Phi}$	mV/min^{-1}	18.3	19.5	19.5	19.1	28.8	20.3	20.3
Phase resistance	R_Φ	Ω	1.36	0.93	0.4	0.62	0.85	0.44	0.69
*Rated power rate	Q_R	kW/s	39	16	31	35	42	42	29
Moment of inertia Note1)	J_M	$kg\cdot m^2(GD^2/4)$ $\times10^{-4}$	0.415	1.043	1.823	1.643	2.383	2.383	2.003
Mass Note1)	WE	Kg	1.4	1.7	2.7	2.9	3.5	3.6	3.3
Brake mass	W	kg	0.39	0.89	0.89	0.8	0.8	0.84	0.9
Aluminum plate		mm	t6×250	t6×250	t6×250	t12×305	t12×305	t12×305	t12×305

Note1 Contains battery backup method absolute encoder.

Note2 I 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].

* Constants are values at the time of installing on the aluminum plate in the table. They indicate 'thickness'×' side of square'.
* Items with"*" and Velocity-Torque Characteristics indicate values after temperature rise saturation. The others indicate values at 20°C.
* Each value indicates TYP.

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_R	kW	1.0	0.55	0.55	1.2	1.2	1.2	1.8
*Rated velocity	N_R	min^{-1}	3000	2000	2000	2000	2000	2000	2000
*Maximum velocity	N_{max}	min^{-1}	6000	3500	5000	2000	5000	3000	3000
*Rated torque	T_R	N·m	3.18	2.6	2.6	5.7	5.7	5.7	8.6
*Continuous Torque at stall	T_S	N·m	3.92	3.0	2.6	6.0	6.0	6.0	10.0
*Peak Torque at stall	T_P	N·m	14.3	9.0	7.0	16.0	16.0	20.0	22.0
*Rated armature current	I_R	Arms	5.7	4.2	5.2	5.2	9.1	7.6	11.0
*Armature current at stall	I_S	Arms	6.8	4.6	5.2	5.2	9.3	8.4	11.8
*Peak armature current at stall	I_P	Arms	25.7	15.5	15.5	15.5	25.4	26.5	26.5
*Torque constant	K_T	N·m/Arms	0.584	0.67	0.53	1.09	0.65	0.77	0.89
Voltage constant for each phase	$K_{E\Phi}$	mV/min^{-1}	20.4	23.5	18.5	37.8	22.7	27.0	31.1
Phase resistance	R_Φ	Ω	0.41	0.65	0.39	0.64	0.23	0.35	0.23
*Rated power rate	Q_R	kW/s	29	22	22	54	54	54	81
Moment of inertia Note1)	J_M	$kg\cdot m^2(GD^2/4)$ $x10^{-4}$	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_R	kW	1.8	2.0	2.0	3.5	3.5	4.5	5.5
*Rated velocity	N_R	min^{-1}	2000	2000	2000	2000	2000	2000	1500
*Maximum velocity	N_{max}	min^{-1}	5000	3000	5000	3000	4000	3500	2500
*Rated torque	T_R	N·m	8.6	9.5	9.5	17.0	17.0	21.5	35.0
*Continuous Torque at stall	T_S	N·m	10.0	12.0	12.0	22.0	22.0	30.0	37.3
*Peak Torque at stall	T_P	N·m	25.0	24.0	30.0	49.0	60.0	75.0	90.0
*Rated armature current	I_R	Arms	15.6	11.0	14.3	19.1	21.7	23.7	31.6
*Armature current at stall	I_S	Arms	17.3	12.0	17.5	23.7	27.0	31.7	32.9
*Peak armature current at stall	I_P	Arms	43.0	26.5	45.5	55.0	83.0	83.0	83.0
*Torque constant	K_T	N·m/Arms	0.63	0.97	0.7	1.0	0.88	1.02	1.23
Voltage constant for each phase	$K_{E\Phi}$	mV/min^{-1}	21.8	33.7	24.3	34.8	30.6	35.6	42.8
Phase resistance	R_Φ	Ω	0.14	0.22	0.11	0.085	0.075	0.065	0.059
*Rated power rate	Q_R	kW/s	81	74	74	72	72	92	180
Moment of inertia Note1)	J_M	$kg\cdot m^2(GD^2/4)$ $x10^{-4}$	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 method absolute encoder.

* Constants are values at the time of installing on the aluminum plate in the table. They indicate ‘thickness’×’ side of square’.
* Items with “*” and Velocity-Torque Characteristics indicate values after temperature rise saturation. The others indicate values at 20°C.
* Each value indicates TYP.

Servo motor model number R2AA			18550H	18750H	1811KR	22500L
Amplifier size combined			RS2A30	RS2A30	RS2A30	RS2A15
*Rated output	P_R	kW	5.5	7.5	11	5.0
*Rated velocity	N_R	min^{-1}	1500	1500	1500	2000
*Maximum velocity	N_{max}	min^{-1}	3000	3000	2500	4000
*Rated torque	T_R	N·m	35.0	48.0	70.0	24.0
*Continuous Torque at stall	T_S	N·m	37.5	54.9	80.0	32.0
*Peak Torque at stall	T_P	N·m	107.0	140.0	170.0	75.0
*Rated armature current	I_R	Arms	46.2	51.2	61.9	22.0
*Armature current at stall	I_S	Arms	48.0	56.8	66.0	34.0
*Peak armature current at stall	I_P	Arms	155.0	155.0	155.0	83.0
*Torque constant	K_T	N·m/Arms	0.84	1.04	1.25	1.0
Voltage constant for each phase	$K_{E\Phi}$	mV/min^{-1}	29.3	36.6	43.8	34.9
Phase resistance	R_Φ	Ω	0.03	0.03	0.035	0.047
*Rated power rate	Q_R	kW/s	180	235	445	105
Moment of inertia Note1)	J_M	$kg \cdot m^2(GD^2/4)$ $x10^{-4}$	68	98	110	55
Mass Note1)	WE	Kg	27.7	35.7	40	22.5
Brake mass	W	kg	2.8	4.5	8.9	5.5
Aluminum plate		mm	t20×540	t20×540	t30×610	t20×540

■ Specification of R2 motor, AC100V

Servo motor model number R2EA			04003F	04005F	04008F	06010F	06020F
Amplifier size combined			RS2E01	RS2E01	RS2E01	RS2E01	RS2E03
*Rated output	P_R	kW	0.03	0.05	0.08	0.1	0.2
*Rated velocity	N_R	min^{-1}	3000	3000	3000	3000	3000
*Maximum velocity	N_{max}	min^{-1}	6000	6000	6000	6000	6000
*Rated torque	T_R	N·m	0.098	0.159	0.255	0.318	0.637
*Continuous Torque at stall	T_S	N·m	0.108	0.167	0.255	0.318	0.686
*Peak Torque at stall	T_P	N·m	0.37	0.59	0.86	1.0	2.2
*Rated armature current	I_R	Arms	0.94	1.2	1.3	1.7	3.1
*Armature current at stall	I_S	Arms	1.0	1.3	1.3	1.7	3.2
*Peak armature current at stall	I_P	Arms	3.7	4.9	4.5	5.6	11.9
*Torque constant	K_T	N·m/Arms	0.116	0.142	0.22	0.206	0.224
Voltage constant for each phase	$K_{E\Phi}$	mV/min^{-1}	4.04	4.97	7.7	7.2	7.82
Phase resistance	R_Φ	Ω	4.0	3.0	2.9	1.5	0.6
*Rated power rate	Q_R	kW/s	3.9	6.7	10	8.6	19
Moment of inertia Note1)	J_M	$kg \cdot m^2(GD^2/4)$ $x10^{-4}$	0.028	0.0409	0.066	0.120	0.222
Mass Note1)	WE	Kg	0.23	0.27	0.39	0.59	0.84
Brake mass	W	kg	0.23	0.23	0.23	0.30	0.35
Aluminum plate		mm	t6x250	t6x250	t6x250	t6x250	t6x250

Note1) Contains battery backup method absolute encoder.

* Constants are values at the time of installing on the aluminum plate in the table. They indicate ‘thickness’×’ side of square’.
* Items with “*” and Velocity-Torque Characteristics indicate values after temperature rise saturation. The others indicate values at 20°C.
* Each value indicates TYP.

■ Specification of R5 motor, AC200V

Servo motor model number R5AA			06020H	06020F	06040H	06040F	08075D	08075F
Amplifier size combined			RS2A01	RS2A01	RS2A01	RS2A03	RS2A03	RS2A03
*Rated output	P_R	kW	0.2	0.2	0.4	0.4	0.75	0.75
*Rated velocity	N_R	min^{-1}	3000	3000	3000	3000	3000	3000
*Maximum velocity	N_{max}	min^{-1}	3000	6000	3000	6000	5000	6000
*Rated torque	T_R	N･m	0.637	0.637	1.27	1.27	2.39	2.39
*Continuous Torque at stall	T_S	N･m	0.686	0.686	1.37	1.37	2.55	2.55
*Peak Torque at stall	T_P	N･m	2.2	2.2	4.8	4.8	8.5	7.5
*Rated armature current	I_R	Arms	1.1	1.5	1.8	2.8	3.9	4.5
*Armature current at stall	I_S	Arms	1.1	1.6	1.8	2.8	3.9	4.5
*Peak armature current at stall	I_P	Arms	4.2	5.7	7.0	10.8	14.4	15.5
*Torque constant	K_T	N･m/Arms	0.649	0.476	0.836	0.525	0.763	0.607
Voltage constant for each phase	$K_{E\Phi}$	mV/min^{-1}	21.7	16.1	27.0	17.3	23.2	18.9
Phase resistance	R_{Φ}	Ω	4.8	2.7	3.3	1.36	0.78	0.51
*Rated power rate	Q_R	kW/s	20	20	39	39	35	35
Moment of inertia Note1)	J_M	$kg \cdot m^2 (GD^2/4)$ $x10^{-4}$	0.2	0.2	0.417	0.417	1.653	1.653
Mass Note1)	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

Note1)Absolute encoder for incremental system included.

* Constant in the table above is the value when motor is installed on heat releasing aluminum plate, indicates “thickness” x “length of a side of square.

* Items marked with * and Velocity-Torque Characteristics indicate values after temperature rise saturation. The others indicate values at 20°C.

* Each value indicates TYP.

■ Specification of Q1 motor, AC200V

Servo motor model number Q1AA			10200D	10250D	12200D	12300D	13300D
Amplifier capacity of the servo amplifier to combine			RS2A10	RS2A10	RS2A10	RS2A10	RS2A10
*Rated output	PR	kW	2	2.5	2	3	3
*Rated velocity	NR	min^{-1}	3000	3000	3000	3000	3000
*Maximum velocity	Nmax	min^{-1}	5000	5000	5000	5000	4500
*Rated torque	TR	N･m	6.37	7.97	6.37	9.6	9.5
*Continuous Torque at stall	TS	N･m	7.36	8.82	7.36	11	10.8
*Peak Torque at stall	TP	N･m	19.6	24.4	21	31	28.4
*Rated armature current	IR	Arms	15.9	16.6	14.3	16.2	16.7
*Armature current at stall	IS	Arms	18	17.2	16.2	17.3	17.6
*Peak armature current at stall	IP	Arms	55	55	53	55	55
*Torque constant	KT	N･m/Arms	0.470	0.587	0.534	0.73	0.693
Voltage constant for each phase	KEΦ	mV/min^{-1}	16.4	20.5	18.6	25.4	24.2
Phase resistance	RΦ	Ω	0.0860	0.104	0.07	0.082	0.087
*Rated power rate	QR	kW/s	189	240	93	143	184
Moment of inertia Note1)	JM	kg･m2 (GD2/4) ×10-4	2.15	2.65	4.37	6.4	4.92
Mass Note1)	WE	kg	8.7	9.4	8.7	11.4	11.4
Brake mass	W	kg	1.5	1.5	1.5	1.7	1.7
Aluminum plate		mm	t20×470	t20×470	t20×470	t20×470	t20×470

Servo motor model number Q1AA			13400D	13500D	18450M	18750H
Amplifier capacity of the servo amplifier to combine			RS2A15	RS2A15	RS2A15	RS2A30
*Rated output	PR	kW	4	5	4.5	7.5
*Rated velocity	NR	min^{-1}	3000	3000	1500	1500
*Maximum velocity	Nmax	min^{-1}	4500	4500	1500	3000
*Rated torque	TR	N･m	12.7	15.7	28.5	48
*Continuous Torque at stall	TS	N･m	14.7	18.1	31.6	55
*Peak Torque at stall	TP	N･m	39.2	47.6	105	125
*Rated armature current	IR	Arms	23.4	25.8	20	55
*Armature current at stall	IS	Arms	26.4	27.5	22.2	60
*Peak armature current at stall	IP	Arms	83	83	83	155
*Torque constant	KT	N･m/Arms	0.612	0.724	1.71	0.91
Voltage constant for each phase	KEΦ	mV/min^{-1}	21.4	25.3	59.6	31.7
Phase resistance	RΦ	Ω	0.048	0.0461	0.129	0.021
*Rated power rate	QR	kW/s	251	291	295	443
Moment of inertia Note1)	JM	kg･m2 (GD2/4) ×10-4	6.43	8.47	27.5	52
Mass Note1)	WE	kg	14.4	16.0	21.7	47
Brake mass	W	kg	2.2	2.2	5	6
Aluminum plate		mm	t20×470	t20×540	t20×540	t20×540

Note1) Wire-saving incremental encoder included.

* Constants are values at the time of installing on the aluminum plate in the table. They indicate ‘thickness’×’ side of square’.
* Items marked with“*” and Velocity-Torque Characteristics indicate values after temperature rise saturation. The others indicate values at 20°C.
* Each value indicates TYP.

■ Specification of Q2 motor, AC200V

Servo motor model Q2AA			13200H	18200H	18350H	18450H	18550R	22550B
Amplifier capacity of the servo amplifier to combine			RS2A10	RS2A10	RS2A15	RS2A15	RS2A15	RS2A15
*Rated output	PR	kW	2	2	3.5	4.5	5.5	5.5
*Rated velocity	NR	min^{-1}	2000	2000	2000	2000	1500	1500
*Maximum velocity	Nmax	min^{-1}	3500	3500	3500	3000	2500	2000
*Rated torque	TR	N･m	9.55	9.5	16.7	21.5	35	35
*Continuous Torque at stall	TS	N･m	12	12	21.1	27.1	37.3	42
*Peak Torque at stall	TP	N･m	30.5	31	55	70	88	90
*Rated armature current	IR	Arms	13.1	15	22.6	24	32.2	30
*Armature current at stall	IS	Arms	16.3	18	28	29	33.7	35.1
*Peak armature current at stall	IP	Arms	48	55	83	81	83	79.7
*Torque constant	KT	N･m/Arms	0.822	0.75	0.840	1.04	1.24	1.32
Voltage constant for each phase	KEΦ	mV/min^{-1}	29	25.9	29.3	36.4	43.2	46.0
Phase resistance	RΦ	Ω	0.128	0.075	0.048	0.044	0.039	0.0464
*Rated power rate	QR	kW/s	78	45.7	73	84	180	129
Moment of inertia Note1)	JM	kg･m2 (GD2/4) ×10-4	12	20	38	55	69	95
Mass Note1)	WE	kg	9.8	13.6	17.7	20	30	34.8
Brake mass	W	kg	1.7	5	5	5	6	5.9
Aluminum plate		mm	t20×470	t20×470	t20×470	t20×470	t20×540	t20×540

Servo motor model Q2AA			22700S	18550H	18750L	2211KV	2215KV
Amplifier capacity of the servo amplifier to combine			RS2A15	RS2A30	RS2A30	RS2A30	RS2A30
*Rated output	PR	kW	7	5.5	7.5	11	15
*Rated velocity	NR	min^{-1}	1000	1500	1500	1500	1500
*Maximum velocity	Nmax	min^{-1}	1000	3000	3000	2000	2000
*Rated torque	TR	N･m	67	35	48	70	95.5
*Continuous Torque at stall	TS	N･m	70	37.3	54.9	80	95.5
*Peak Torque at stall	TP	N･m	150	95	137	176	215
*Rated armature current	IR	Arms	34	47	52	60	66
*Armature current at stall	IS	Arms	34	47	57	66	66
*Peak armature current at stall	IP	Arms	83	155	160	155	157
*Torque constant	KT	N･m/Arms	2.13	0.83	1.03	1.29	1.54
Voltage constant for each phase	KEΦ	mV/min^{-1}	74.5	29.0	36.0	45.1	53.6
Phase resistance	RΦ	Ω	0.057	0.018	0.017	0.015	0.016
*Rated power rate	QR	kW/s	243	168	240	260	360
Moment of inertia Note1)	JM	kg･m2 (GD2/4) ×10-4	185	73	95	186	255
Mass Note1)	WE	kg	46	31	40	58	70
Brake mass	W	kg	10.4	6	6	11	11
Aluminum plate		mm	t20×540	t20×540	t20×540	t20×540	t20×540

Note1) Wire-saving incremental encoder included.

* Constants are values at the time of installing on the aluminum plate in the table. They indicate ‘thickness’×’ side of square’.
* Items with“*” and Velocity-Torque Characteristics indicate values after temperature rise saturation. The others indicate values at 20°C.
* Each value indicates TYP.

■ Specification of Q4 motor, AC200V

Servo motor model Q4AA			1811KB	1815KB
Amplifier capacity of the servo amplifier to combine			RS2A30	RS2A30
*Rated output	PR	kW	11	15
*Rated velocity	NR	min^{-1}	1500	1500
*Maximum velocity	Nmax	min^{-1}	2000	2000
*Rated torque	TR	N･m	70	95.5
*Continuous Torque at stall	TS	N･m	70	95.5
*Peak Torque at stall	TP	N･m	190	220
*Rated armature current	IR	Arms	54	61
*Armature current at stall	IS	Arms	53	59
*Peak armature current at stall	IP	Arms	155	155
*Torque constant	KT	N･m/Arms	1.42	1.75
Voltage constant for each phase	KEΦ	mV/min^{-1}	49.7	61.1
Phase resistance	RΦ	Ω	0.025	0.032
*Rated power rate	QR	kW/s	780	1100
Moment of inertia Note1)	JM	kg･m2 (GD2/4) ×10-4	63	85
Mass Note1)	WE	kg	60	75
Brake mass	W	kg	-	-
Aluminum plate		mm	t30×610	t30×610
Characteristic of fan motor		VAC	Single-phase 200	
		Hz	50/60	
		W	39/33	
		A	0.31/0.26	

Note1) Wire-saving incremental encoder included.

* Constants are values at the time of installing on the aluminum plate in the table. They indicate 'thickness'×' side of square'.

* Items marked with "*" and Velocity-Torque Characteristics indicate values after temperature rise saturation. The others indicate values at 20°C.

* Each value indicates TYP.

■ Specification of single magnet core-type, AC200V

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 ratedforce	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	$R_Φ$	Ω	0.92	0.46	0.31	1.32	0.66	0.44
Phase inductance	$L_Φ$	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)	$Ke_Φ$	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 AC200V, 3Φ.

* When the power supply voltage is under AC200V, instantaneous zone decreases

■ Specification of single magnet core-type, AC200V

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	R_Φ	Ω	1.78	0.89	0.59	0.49	0.245	0.163
Phase inductance	L_Φ	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)	Ke_Φ	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 ratedforce	Fr	N	800	1600	2400
* Maximumforce	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	R_Φ	Ω	0.68	0.34	0.23
Phase inductance	L_Φ	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)	Ke_Φ	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 AC200V, 3Φ.
* When the power supply voltage is under AC200V, instantaneous zone decreases.

■ Specification of dual magnet core-type (DD), AC200V

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
* Maximumforce	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)	2τp	mm	32	32	32	32	32	32
Phase resistance	R_Φ	Ω	1.82	0.91	0.61	0.6	0.3	0.20
Phase inductance	L_Φ	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)	Ke_Φ	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		

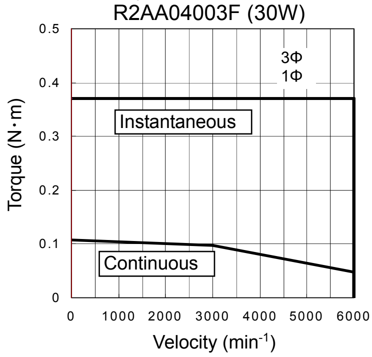
Linear motor model DD			075C1Y2	075C2Y2	075C3Y2	075C4Y2
Amplifier capacity of the servo amplifier to combine			RS2A10L	RS2A15L	RS2A30L	RS2A30L
*Rated output	Pr	kW	2.10	4.20	6.30	8.40
*Continuous ratedforce	Fr	N	1050	2100	3150	4200
* Maximum force	Fp	N	1650	3300	4950	6600
Continuous current	Ir	Arms	16	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)	2τp	mm	32	32	32	32
Phase resistance	R_Φ	Ω	0.8	0.4	0.27	0.20
Phase inductance	L_Φ	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)	Ke_Φ	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 AC200V, 3Φ.
* When the power supply voltage is under AC200V, instantaneous zone decreases.

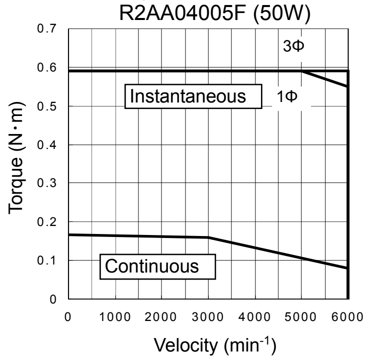
2) Velocity-Torque characteristics

The value of velocity-torque characteristic of R2AA motor shown below is the values when using input power supply AC200V, 3-phase and single-phase. When the voltage is under 200V, instantaneous zone decreases.

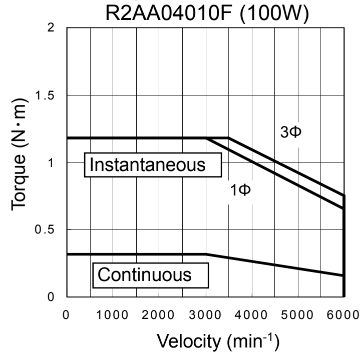
Velocity-torque characteristic
R2AA04003F (30W)



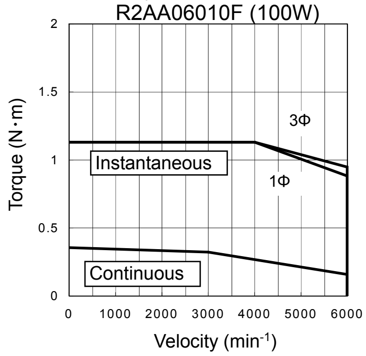
Velocity-torque characteristic
R2AA04005F (50W)



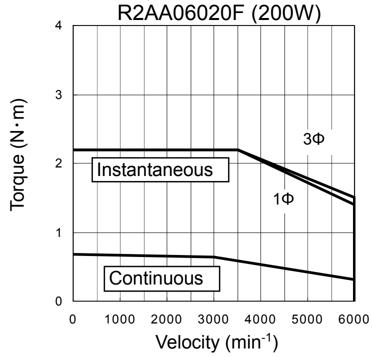
Velocity-torque characteristic
R2AA04010F (100W)



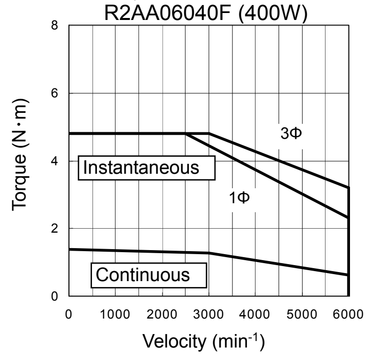
Velocity-torque characteristic
R2AA06010F (100W)



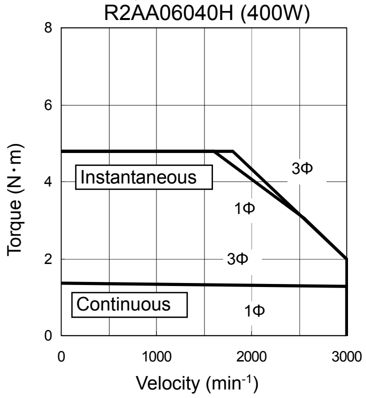
Velocity-torque characteristic
R2AA06020F (200W)



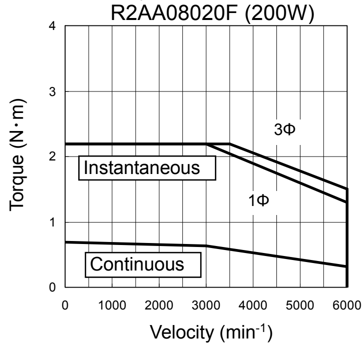
Velocity-torque characteristic
R2AA06040F (400W)



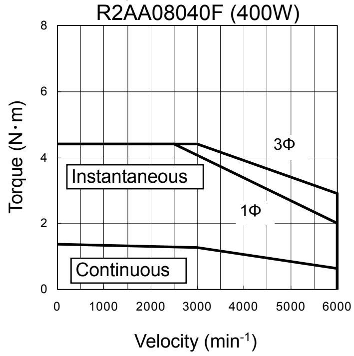
Velocity-torque characteristic
R2AA06040H (400W)



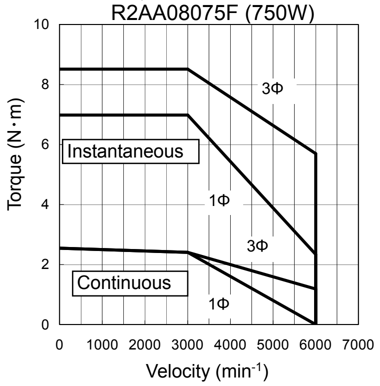
Velocity-torque characteristic
R2AA08020F (200W)



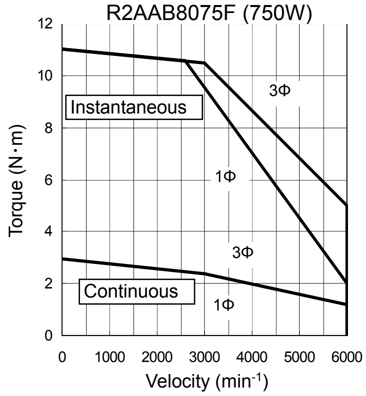
Velocity-torque characteristic
R2AA08040F (400W)



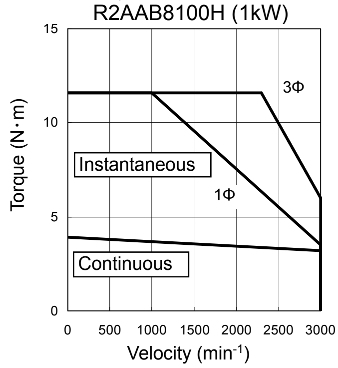
Velocity-torque characteristic
R2AA08075F (750W)



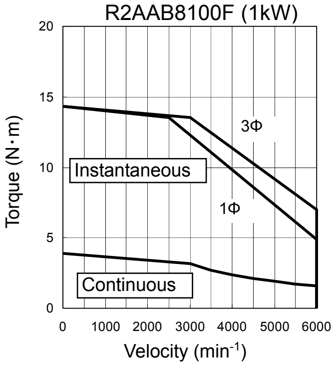
Velocity-torque characteristic
R2AAB8075F (750W)



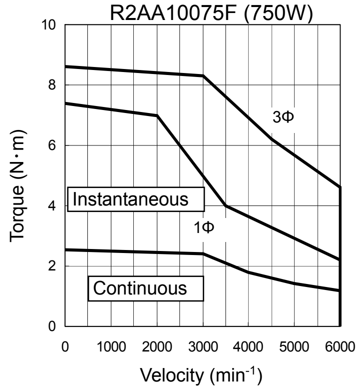
Velocity-torque characteristic
R2AAB8100H (1kW)



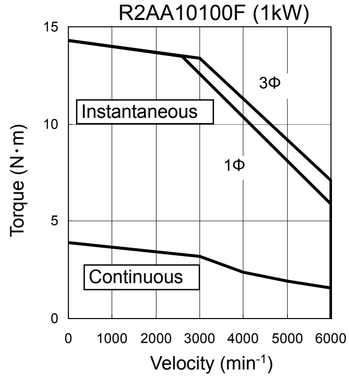
Velocity-torque characteristic
R2AAB8100F (1kW)



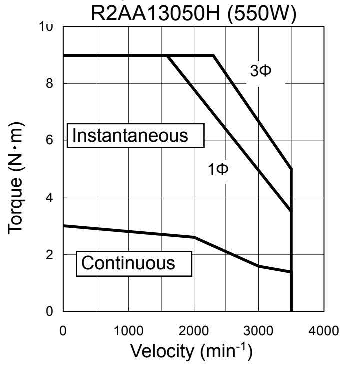
Velocity-torque characteristic
R2AA10075F (750W)



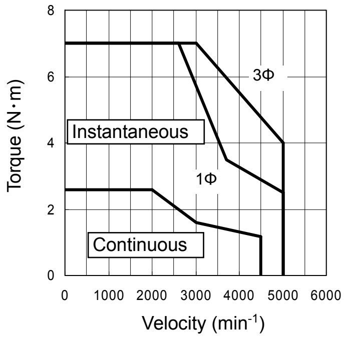
Velocity-torque characteristic
R2AA10100F (1kW)



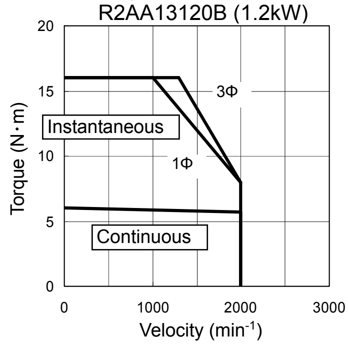
Velocity-torque characteristic
R2AA13050H (550W)



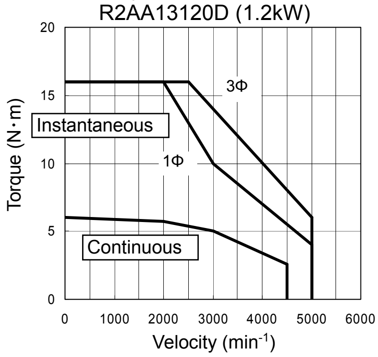
Note1)
Velocity-torque characteristic
R2AA13050D (550W)



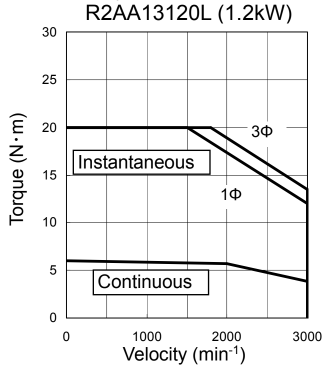
Velocity-torque characteristic
R2AA13120B (1.2kW)



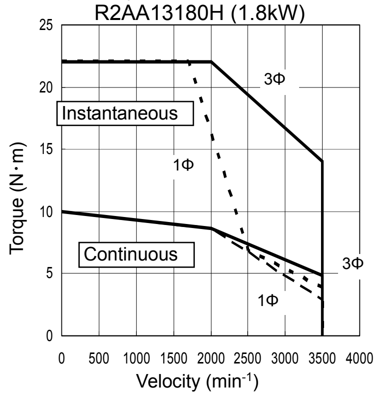
Note)1
Velocity-torque characteristic
R2AA13120D (1.2kW)



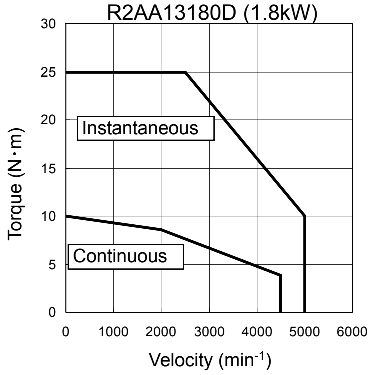
Velocity-torque characteristic
R2AA13120L (1.2kW)



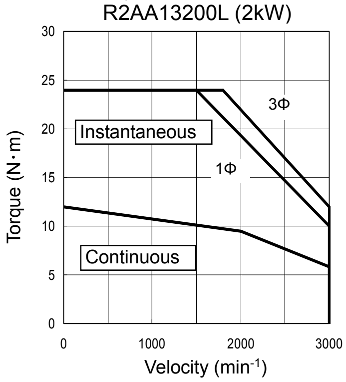
Velocity-torque characteristic
R2AA13180H (1.8kW)



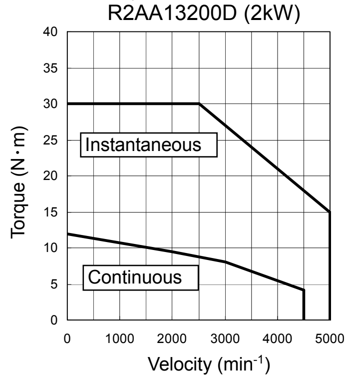
Velocity-torque characteristic
R2AA13180D (1.8kW)



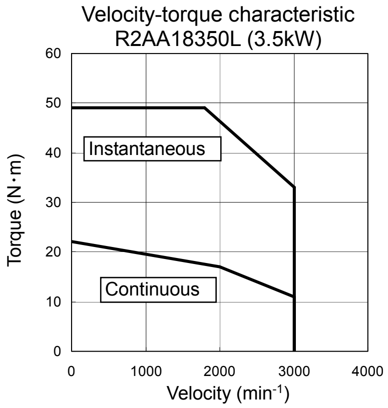
Velocity-torque characteristic
R2AA13200L (2kW)

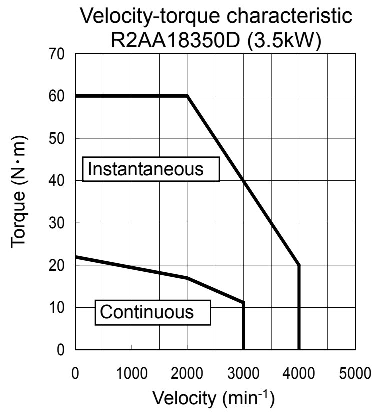


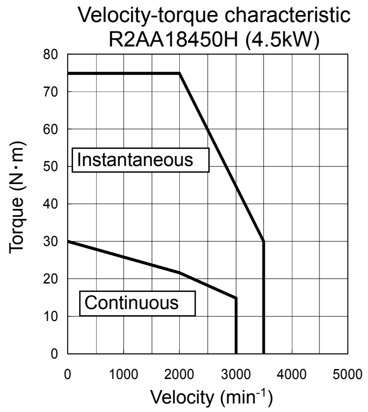
Velocity-torque characteristic
R2AA13200D (2kW)

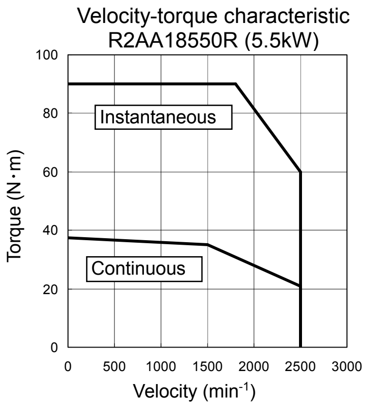


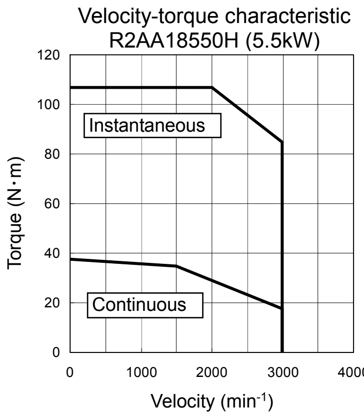
Note1) When you use motor (R2AA13050D, R2AA13120D, R2AA13180D, R2AA13200D, R2AA18450H, R2AA1811KR, or R2AA22500L) whose maximum rotational velocity Nmax and maximum rotational velocity in thecontinuous zone are different, use the motor so that the motor average rotational velocity does not exceed maximum rotational velocity in the continuous zone.

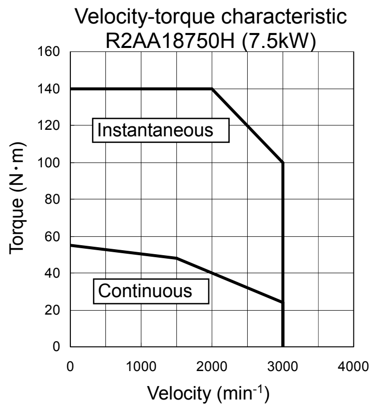


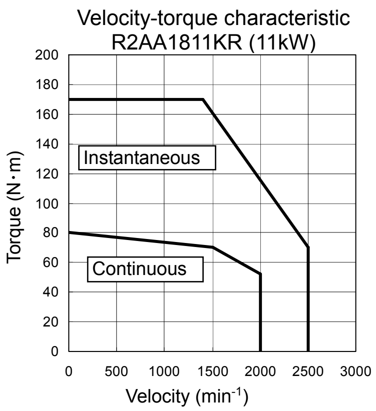


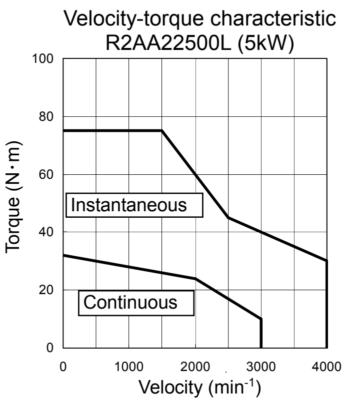






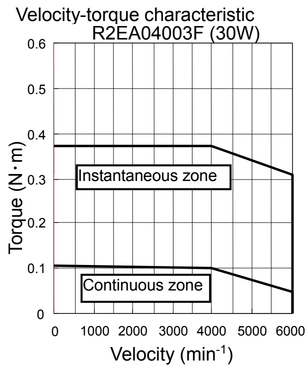


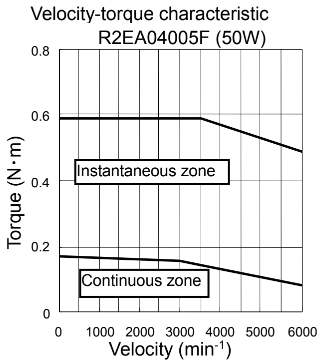


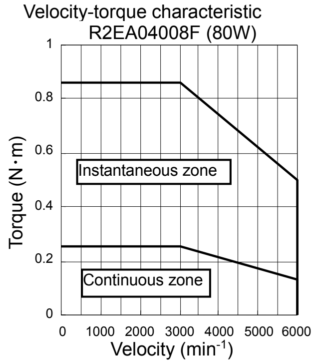


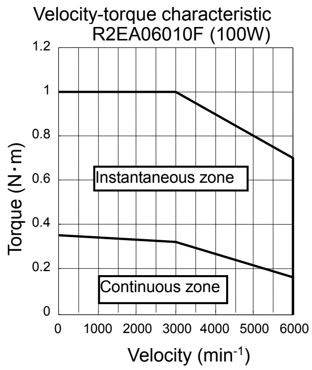
Note1) When you use motor (R2AA13050D, R2AA13120D, R2AA13180D, R2AA13200D, R2AA18450H, R2AA1811KR, or R2AA22500L) whose maximum rotational velocity Nmax and maximum rotational velocity in thecontinuous zone are different, use the motor so that the motor average rotational velocity does not exceed maximum rotational velocity in the continuous zone.

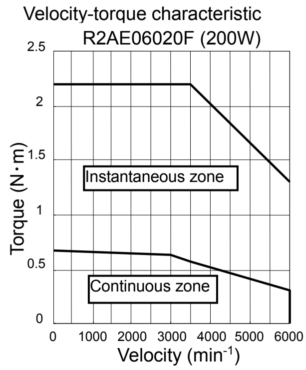
R2EA Motor Velocity-Torque Characteristics indicate the values when amplifier power supply is AC100V.
Instant domain decreases when amplifier power supply is below 100V.











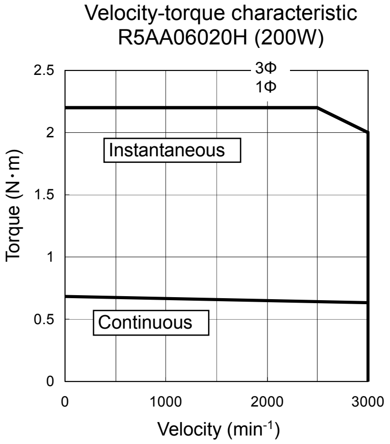
Note2) De-rating ratio of motor with oil seal and brake

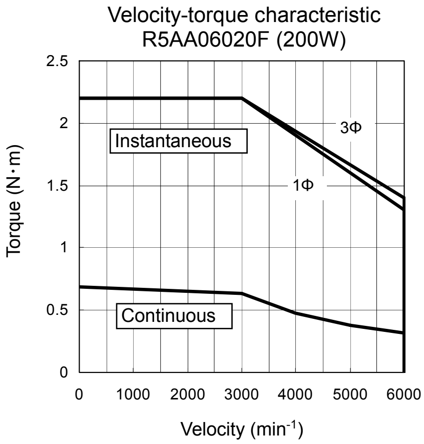
In terms of servomotors with oil-seal and/or brake, the following de-rating ratios have to be applied to the torque characteristic in the continuous speed range.

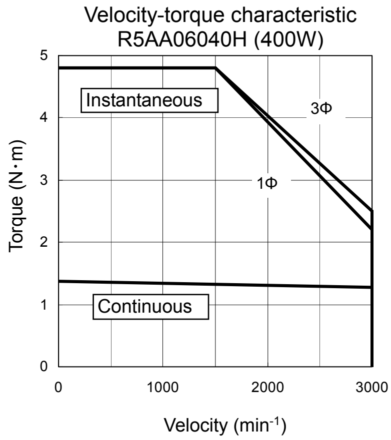
Oil seal / Brake	Without oil seal	With oil seal
Without brake	-	Degree of decrease rating 2
With brake	Degree of decrease rating 1	Degree of decrease rating 2

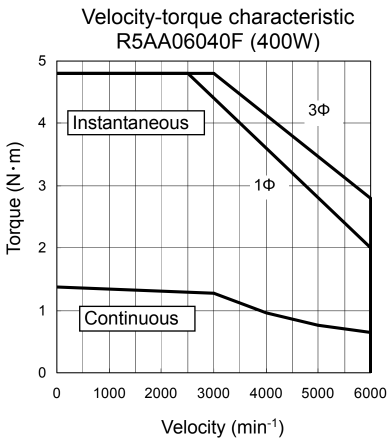
	R2AA04005F	R2AA04010F	R2AA06040F	R2AA08075F	R2EA04005F
Degree of decrease rating 1	-	90%	90%	-	-
Degree of decrease rating 2	90%	85%	80%	90%	90%

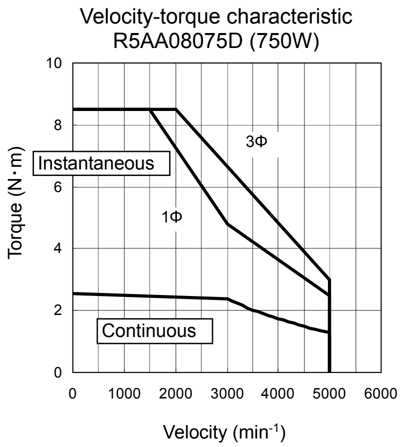
R5AA Motor velocity-torque characteristics indicate the values when amplifier power supply is AC200V. Instantaneous zone decreases when amplifier power supply is below 200V.

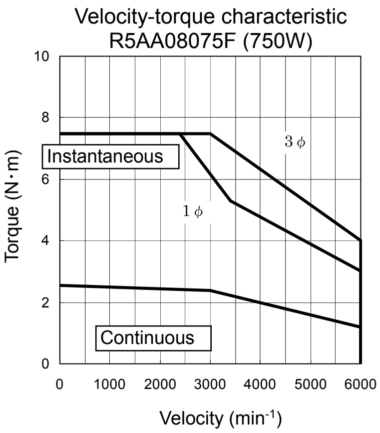




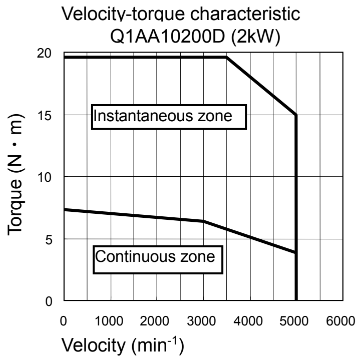


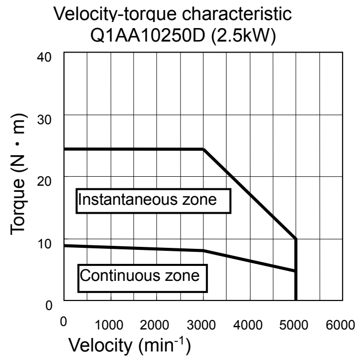


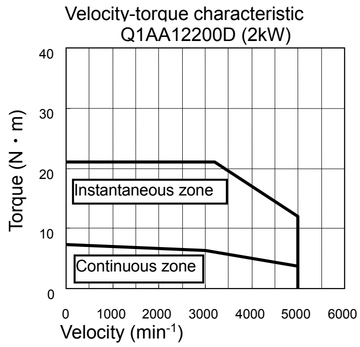


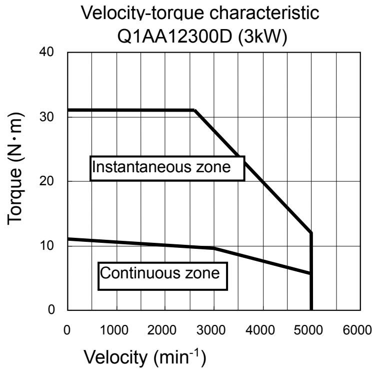


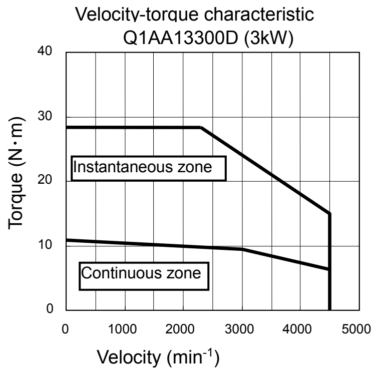
Velocity-torque characteristic of Q1AA motor shows when input power supply is AC200V, 3-phase.
When power voltage is under 200V, instantaneous zone decreases.

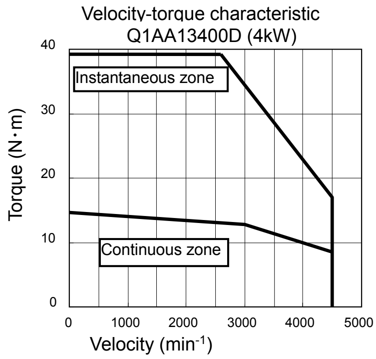


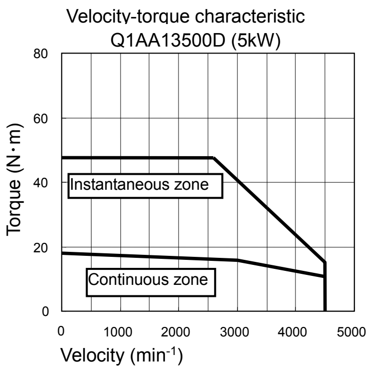


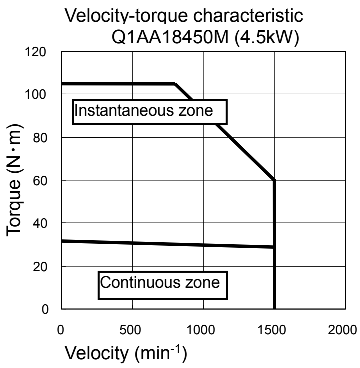


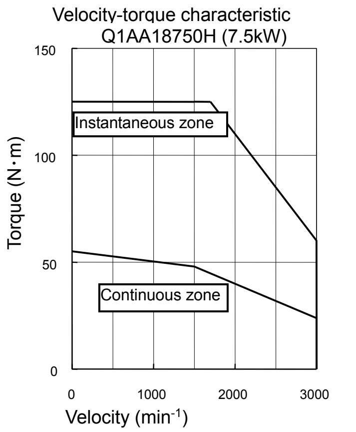




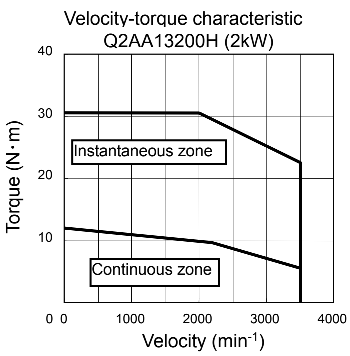


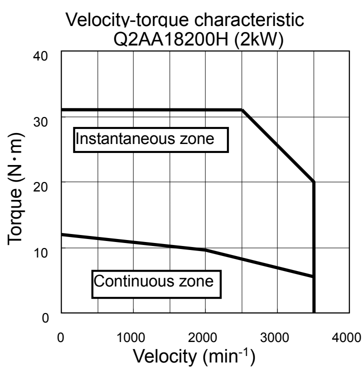


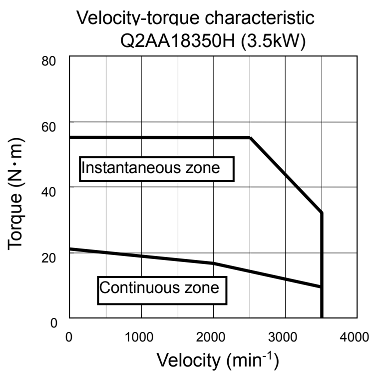




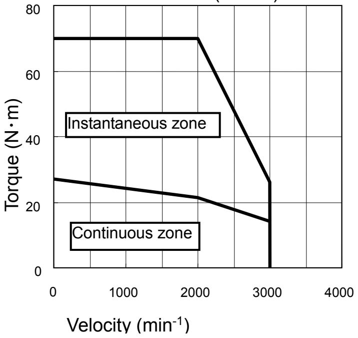
Velocity-torque characteristic of Q2AA motor shows when input power supply is AC200V, 3-phase.
When power voltage is under 200V, instantaneous zone decreases.



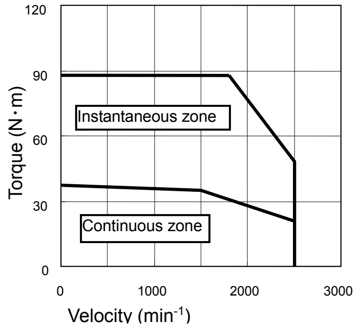




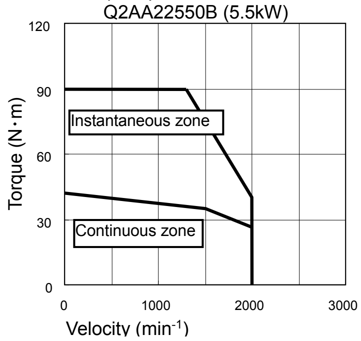
Velocity-torque characteristic
Q2AA18450H (4.5kW)



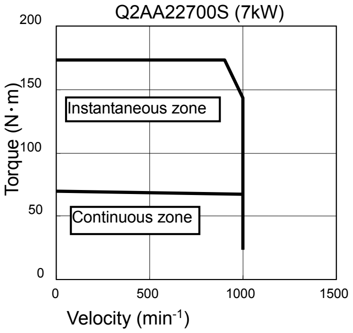
Velocity-torque characteristic
Q2AA18550R (5.5kW)



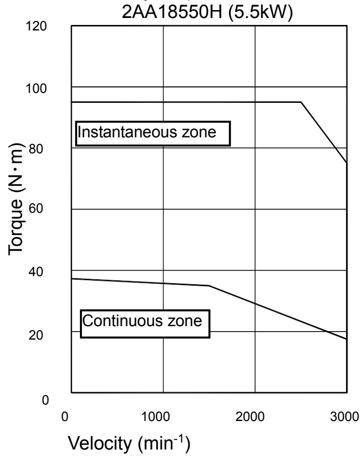
Velocity-torque characteristic
Q2AA22550B (5.5kW)



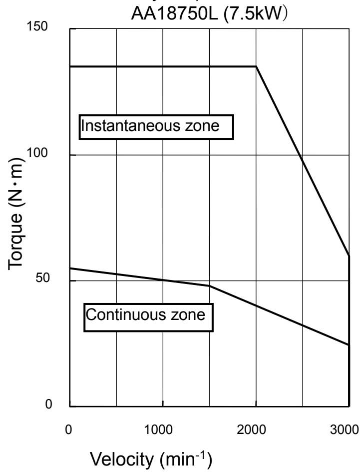
Velocity-torque characteristic
Q2AA22700S (7kW)



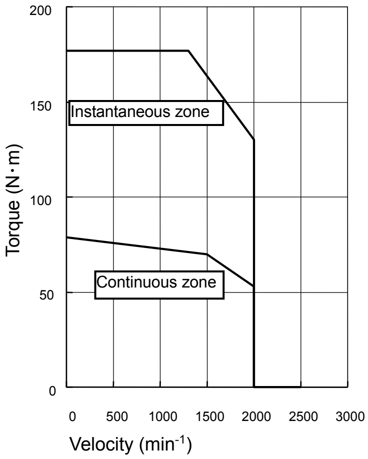
Velocity-torque characteristic
2AA18550H (5.5kW)



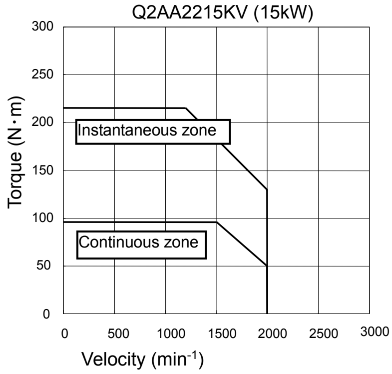
Velocity-torque characteristic
AA18750L (7.5kW)



Velocity-torque characteristic
Q2AA2211KV (11kW)

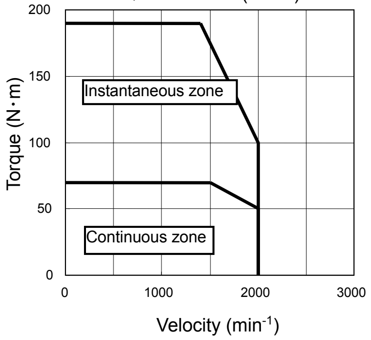


Velocity-torque characteristic
Q2AA2215KV (15kW)

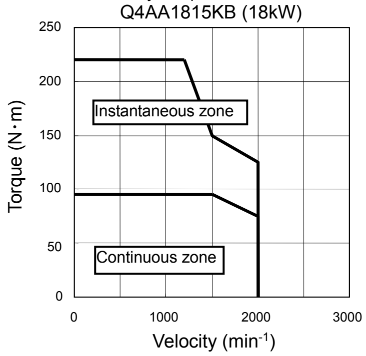


Velocity-torque characteristic of Q4AA motor shows when input power supply is AC200V, 3-phase.
When power voltage is under 200V, instantaneous zone decreases.

Velocity-torque characteristic
Q4AA1811KB (11kW)



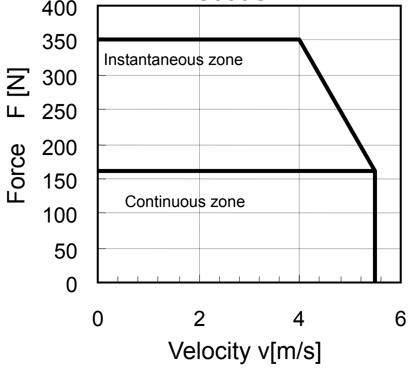
Velocity-torque characteristic
Q4AA1815KB (18kW)



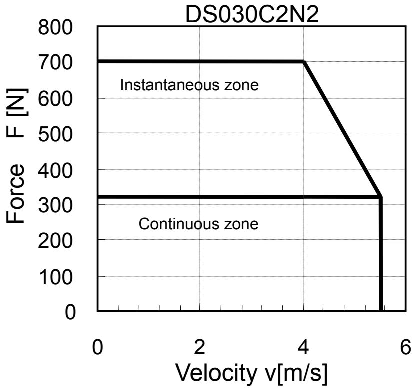
3) Velocity-force characteristics

Velocity-force characteristic of DS linear motor is the value when input power is AC200V, 3-phase.
When the power supply voltage is under 200V, the instantaneous zone decreases.

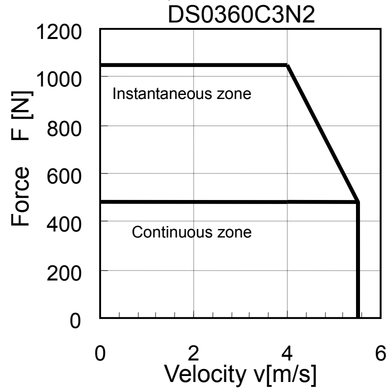
Velocity-force characteristic
DS030C1N2



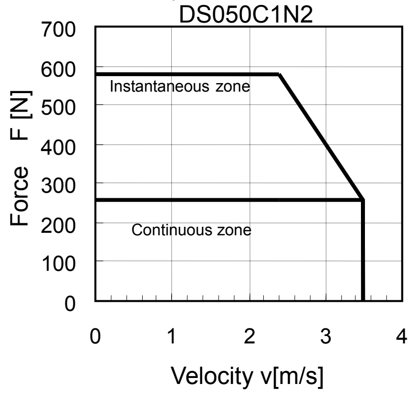
Velocity-force characteristic
DS030C2N2



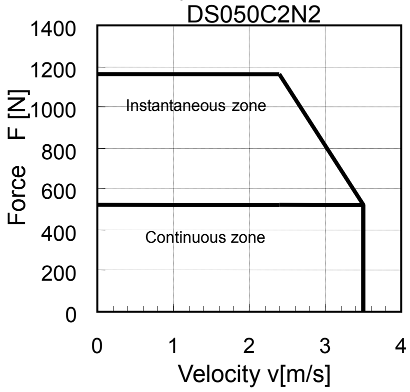
Velocity-force characteristic
DS0360C3N2



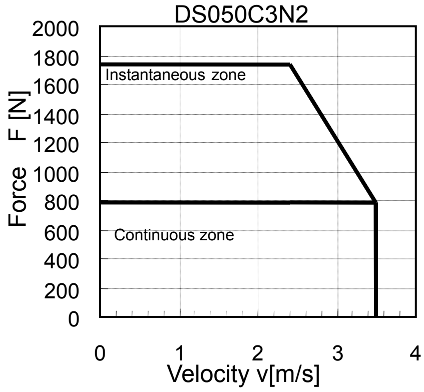
Velocity-force characteristic
DS050C1N2



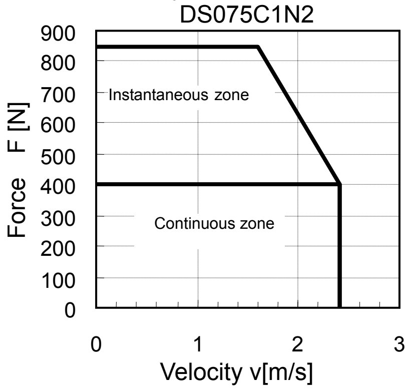
Velocity-force characteristic
DS050C2N2



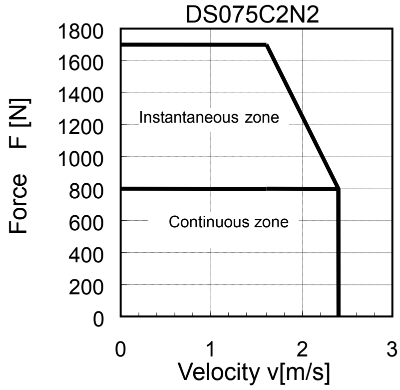
Velocity-force characteristic
DS050C3N2



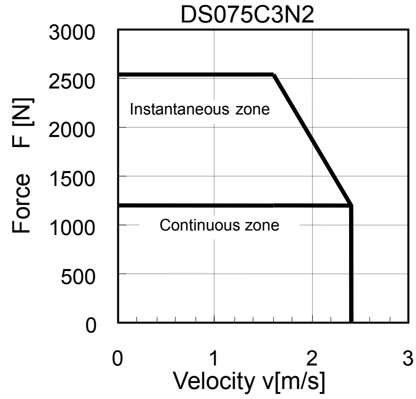
Velocity-force characteristic
DS075C1N2

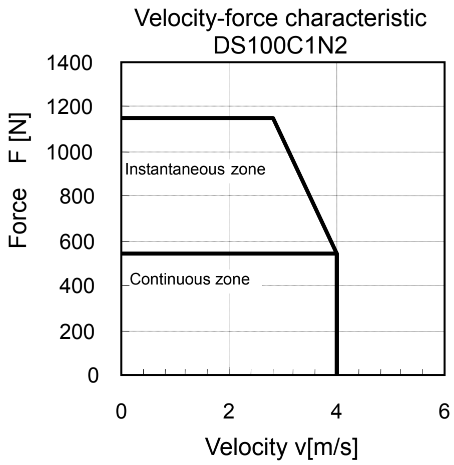


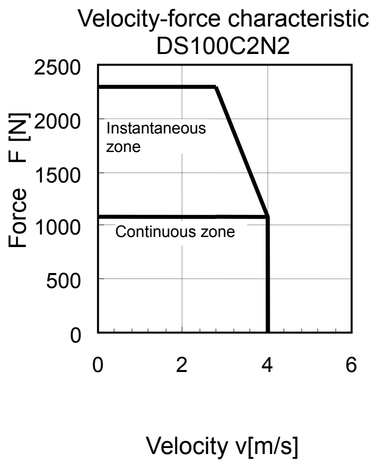
Velocity-force characteristic
DS075C2N2

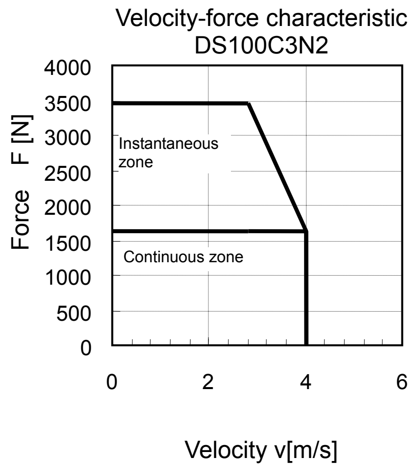


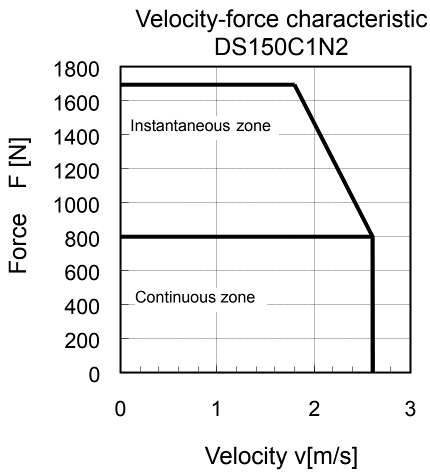
Velocity-force characteristic
DS075C3N2

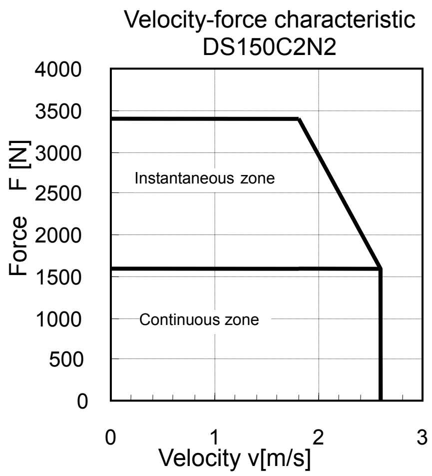


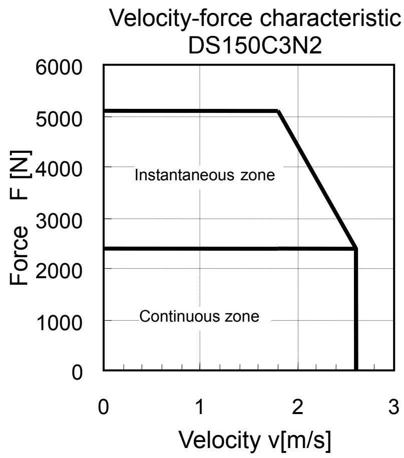

Velocity-force characteristic
DS100C1N2
Force F [N]
1400
1200
1000
800
600
400
200
0
Instantaneous zone
Continuous zone
0
2
4
6
Velocity v[m/s]


Velocity-force characteristic
DS100C2N2
Force F [N]
2500
2000
1500
1000
500
0
Instantaneous zone
Continuous zone
0
2
4
6
Velocity v[m/s]


Velocity-force characteristic
DS100C3N2
Force F [N]
4000
3500
3000
2500
2000
1500
1000
500
0
Instantaneous zone
Continuous zone
0
2
4
6
Velocity v[m/s]

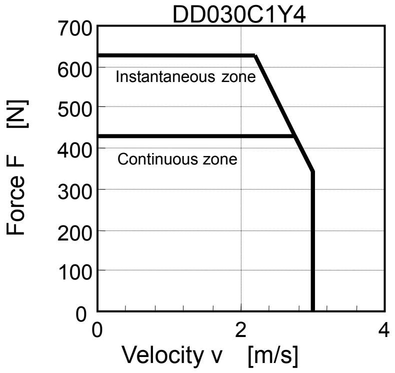

Velocity-force characteristic
DS150C1N2
Force F [N]
1800
1600
1400
1200
1000
800
600
400
200
0
Instantaneous zone
Continuous zone
0
1
2
3
Velocity v[m/s]


Velocity-force characteristic
DS150C2N2
Force F [N]
4000
3500
3000
2500
2000
1500
1000
500
0
Instantaneous zone
Continuous zone
0
1
2
3
Velocity v[m/s]

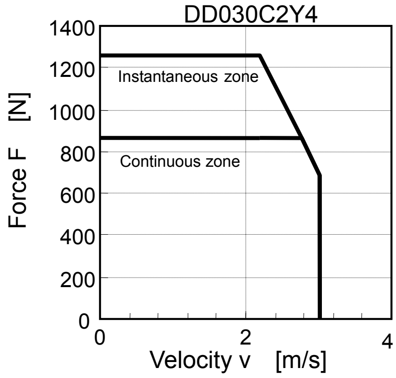

Velocity-force characteristic
DS150C3N2
Force F [N]
6000
5000
4000
3000
2000
1000
0
Instantaneous zone
Continuous zone
0
1
2
3
Velocity v[m/s]

Velocity-force characteristic of DD linear motor is the value when input power is AC200V. 3-phase.
When the power supply voltage is under 200V, the instantaneous zone decreases.

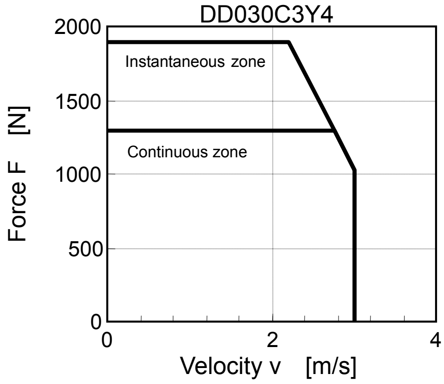
Velocity-force characteristic
DD030C1Y4



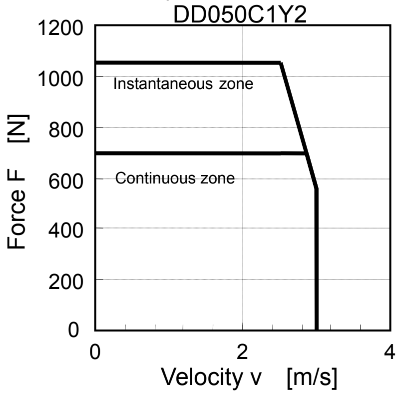
Velocity-force characteristic
DD030C2Y4



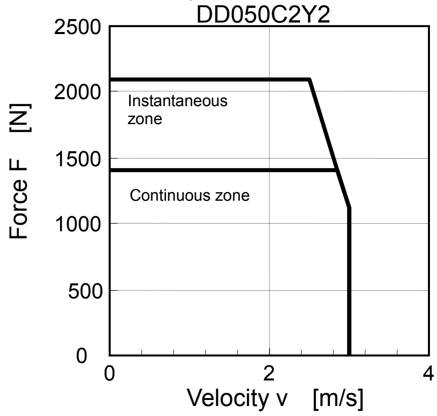
Velocity-force characteristic
DD030C3Y4



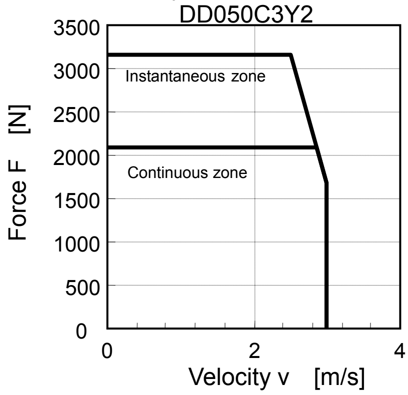
Velocity-force characteristic
DD050C1Y2



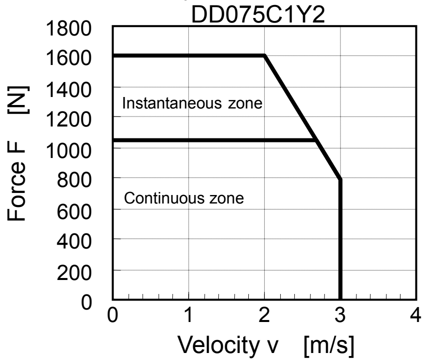
Velocity-force characteristic
DD050C2Y2



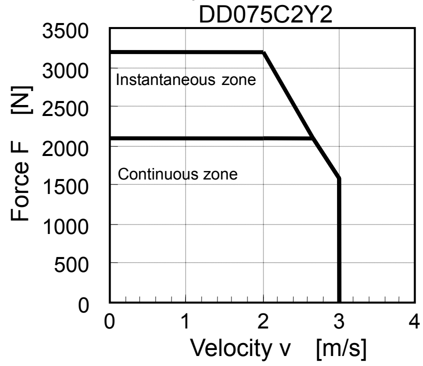
Velocity-force characteristic
DD050C3Y2



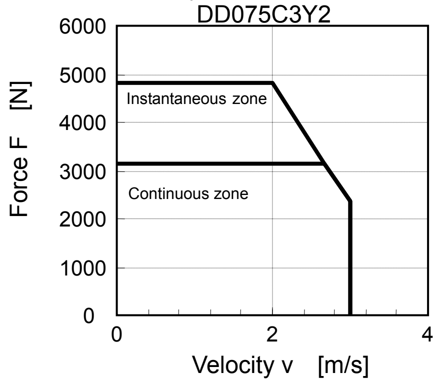
Velocity-force characteristic
DD075C1Y2



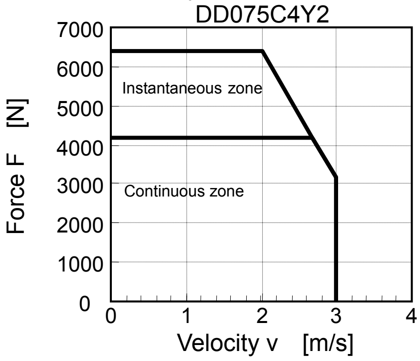
Velocity-force characteristic
DD075C2Y2



Velocity-force characteristic
DD075C3Y2



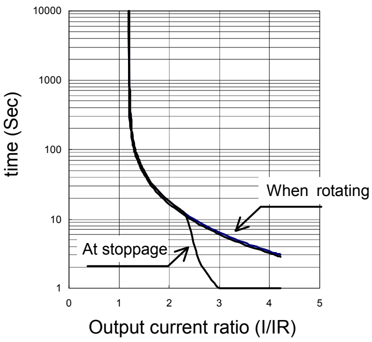
Velocity-force characteristic
DD075C4Y2



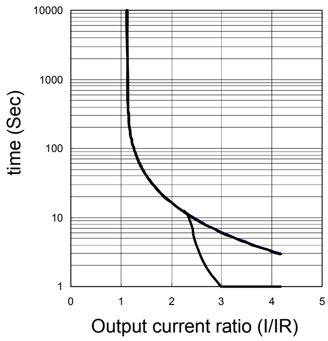
4) Overload characteristics

The following show overload characteristic of R2AA motor.

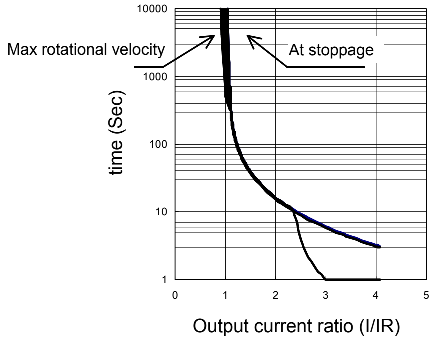
Overload characteristic
R2AA04003F (30W)



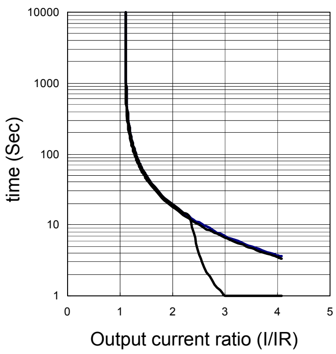
Overload characteristic
R2AA04005F (50W)



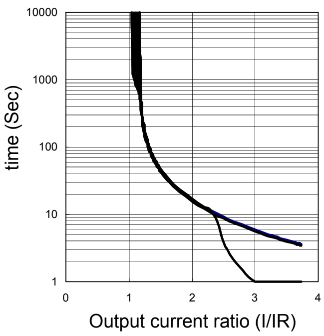
Overload characteristic
R2AA04010F (100W)



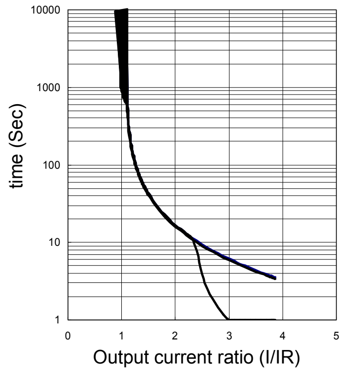
Overload characteristic
R2AA06010F (100W)



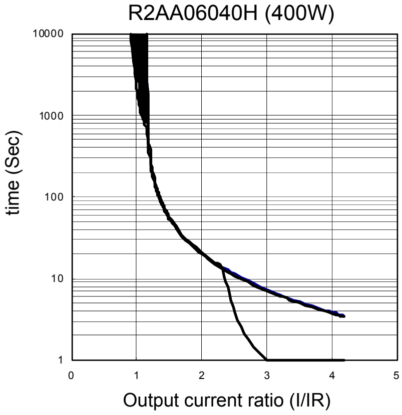
Overload characteristic
R2AA06020F (200W)



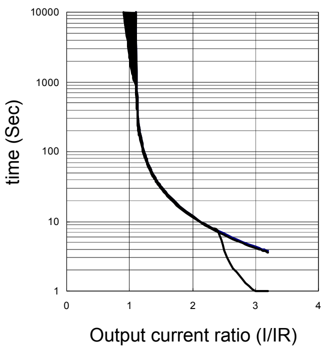
Overload characteristic
R2AA06040F (400W)



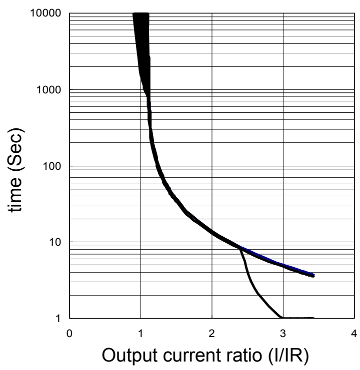
Overload characteristic
R2AA06040H (400W)



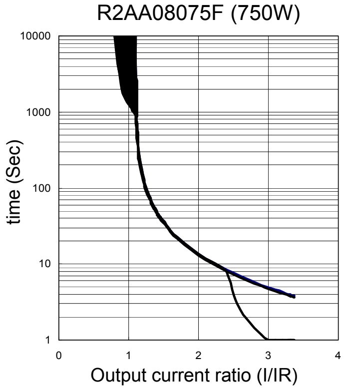
Overload characteristic
R2AA08020F (200W)



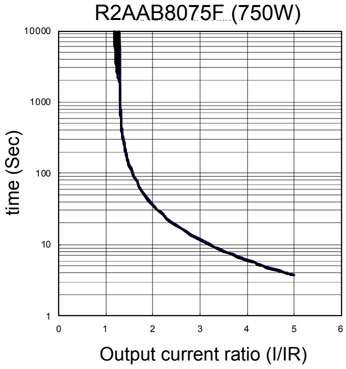
Overload characteristic
R2AA08040F (400W)



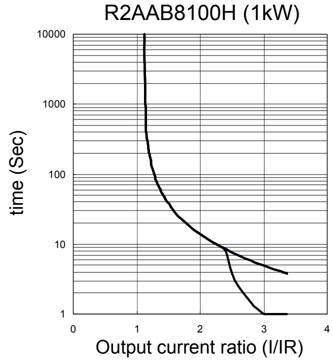
Overload characteristic
R2AA08075F (750W)



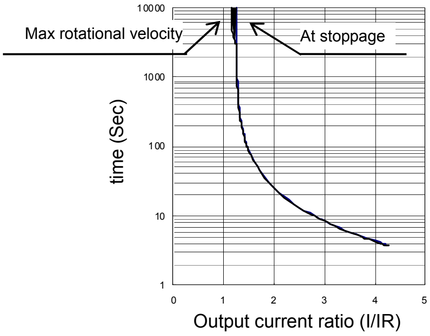
Overload characteristic
R2AAB8075F (750W)



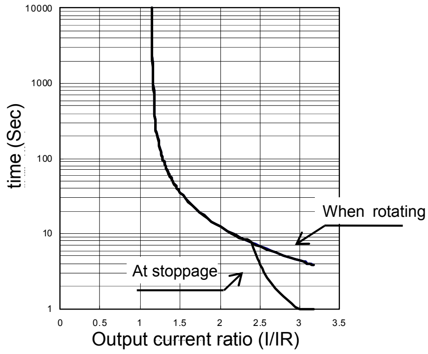
Overload characteristic
R2AAB8100H (1kW)



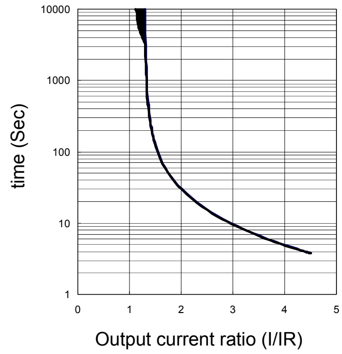
Overload characteristic
R2AAB8100F (1kW)



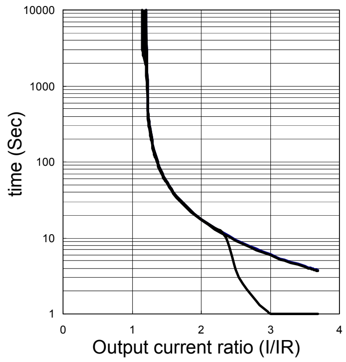
Overload characteristic
R2AA10075F (750W)



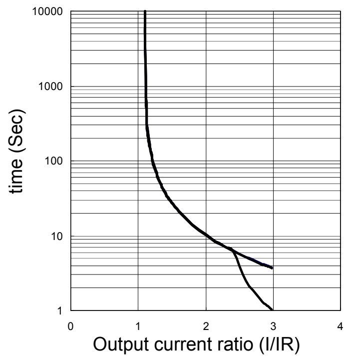
Overload characteristic
R2AA10100F (1kW)



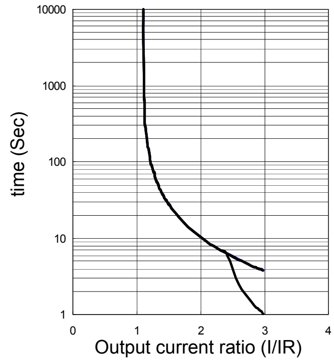
Overload characteristic
R2AA13050H (550W)



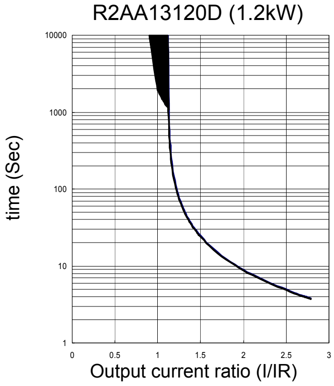
Overload characteristic
R2AA13050D (550W)



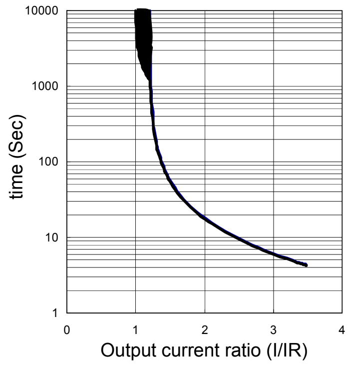
Overload characteristic
R2AA13120B (1.2kW)



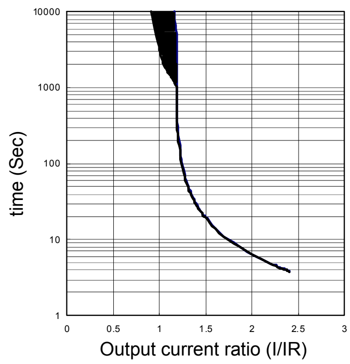
Overload characteristic
R2AA13120D (1.2kW)



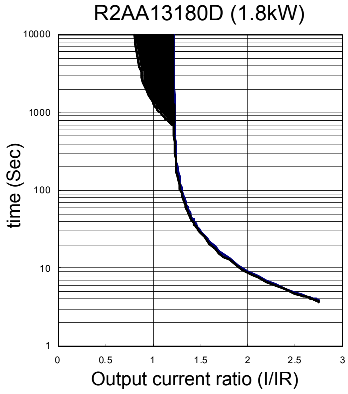
Overload characteristic
R2AA13120L (1.2kW)



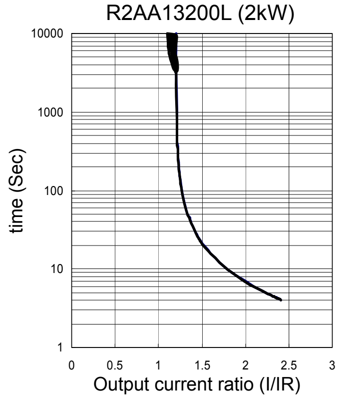
Overload characteristic
R2AA13180H (1.8kW)



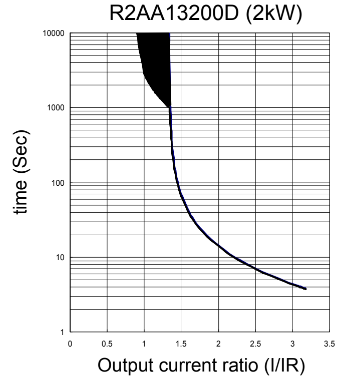
Overload characteristic
R2AA13180D (1.8kW)



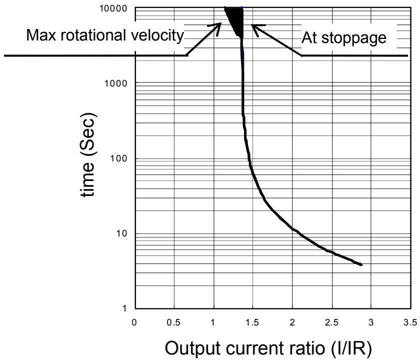
Overload characteristic
R2AA13200L (2kW)



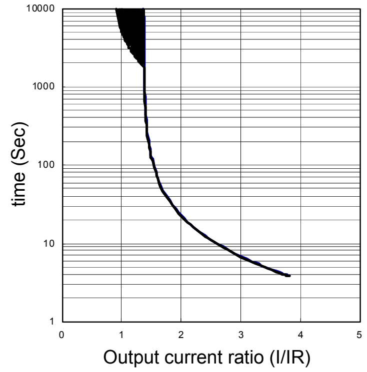
Overload characteristic
R2AA13200D (2kW)



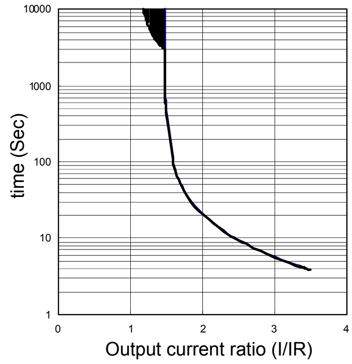
Overload characteristic
R2AA18350L (3.5kW)



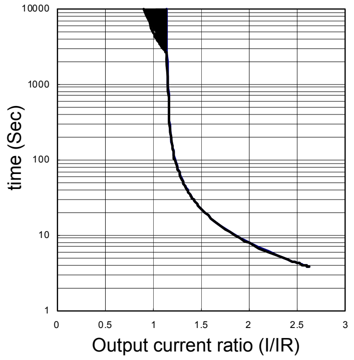
Overload characteristic
R2AA18350D (3.5kW)



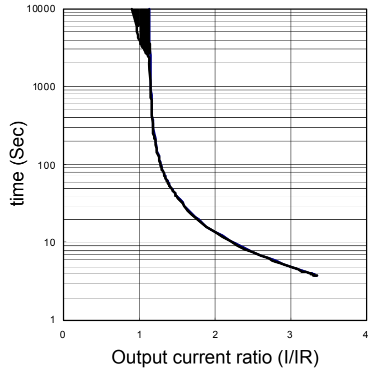
Overload characteristic
R2AA18450H (4.5kW)



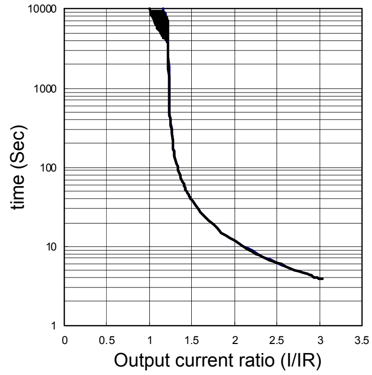
Overload characteristic
R2AA18550R (5.5kW)



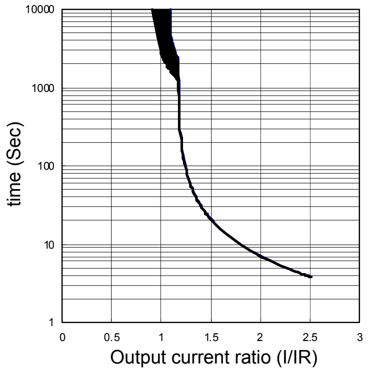
Overload characteristic
R2AA18550H (5.5kW)



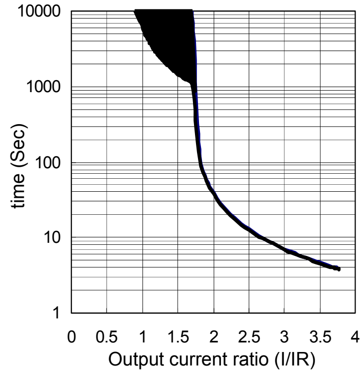
Overload characteristic
R2AA18750H (7.5kW)



Overload characteristic
R2AA1811KR (11kW)

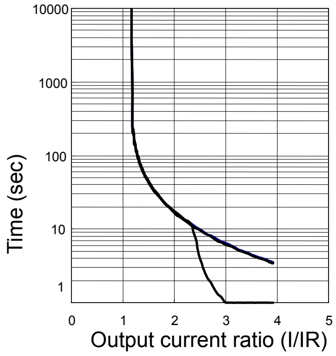


Overload characteristic
R2AA22500L (5kW)

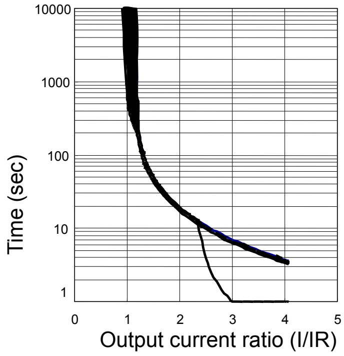


The following show overload characteristic of R2EA motor.

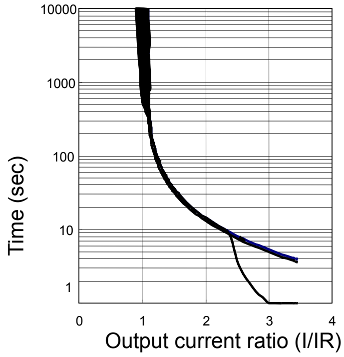
Overload characteristic
R2EA04003F (30W)



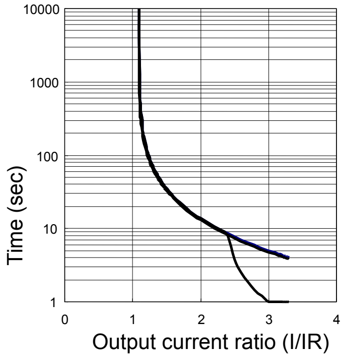
Overload characteristic
R2EA04005F (50W)



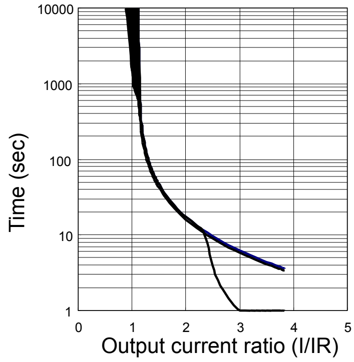
Overload characteristic
R2EA04008F (80W)



Overload characteristic
R2EA06010F (100W)

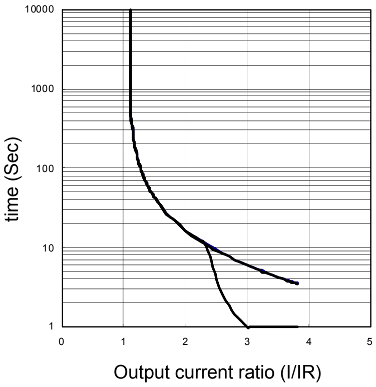


Overload characteristic
R2EA06020F (200W)

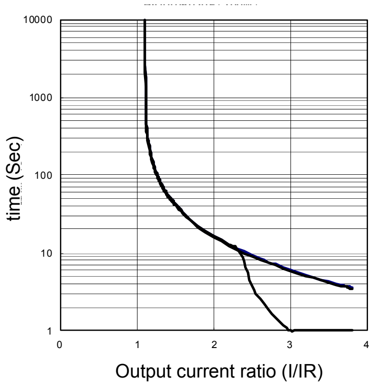


The following show overload characteristic of R5AA motor.

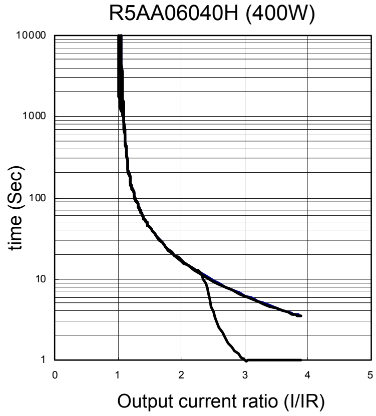
Overload characteristic
R5AA06020H (200W)



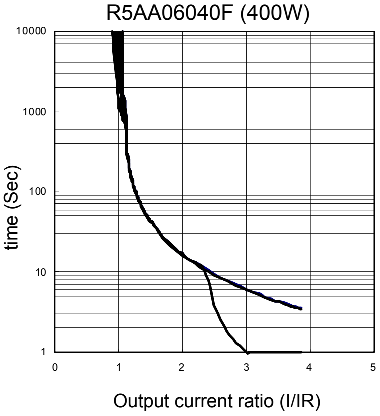
Overload characteristic
R5AA06020F (200W)



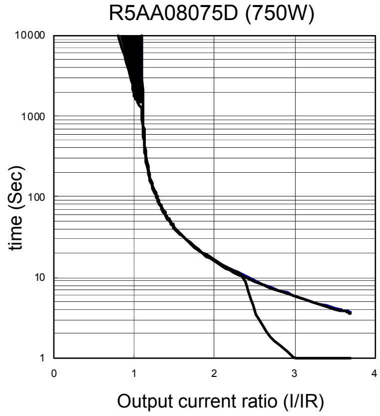
Overload characteristic
R5AA06040H (400W)



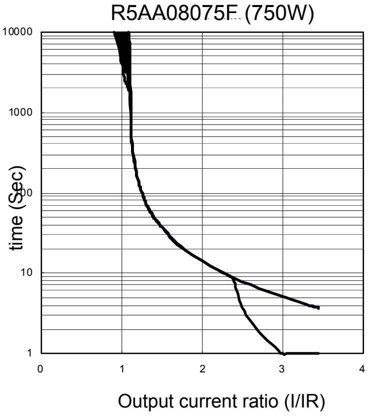
Overload characteristic
R5AA06040F (400W)



Overload characteristic
R5AA08075D (750W)

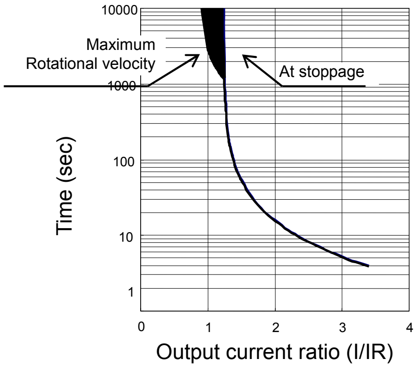


Overload characteristic
R5AA08075F (750W)

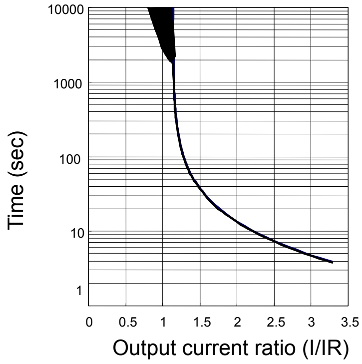


The following show overload characteristic of Q1AA motor.

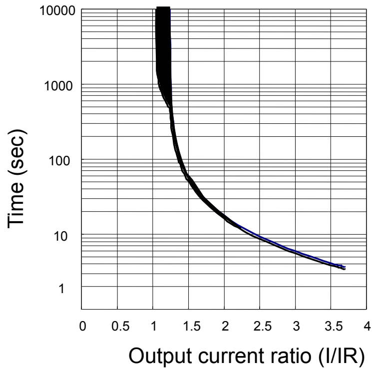
Overload characteristic
Q1AA10200D (2kW)



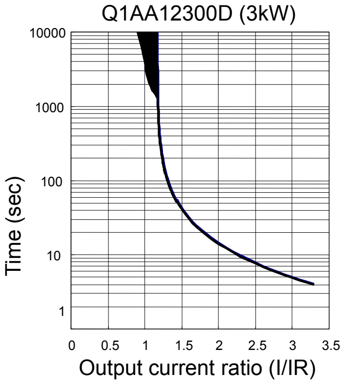
Overload characteristic
Q1AA10250D (2.5kW)



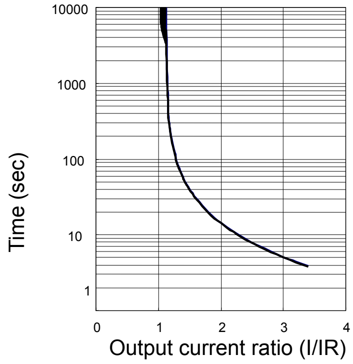
Overload characteristic
Q1AA12200D (2kW)



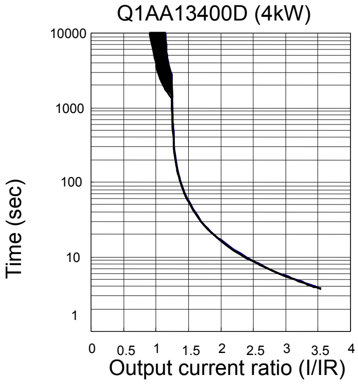
Overload characteristic
Q1AA12300D (3kW)



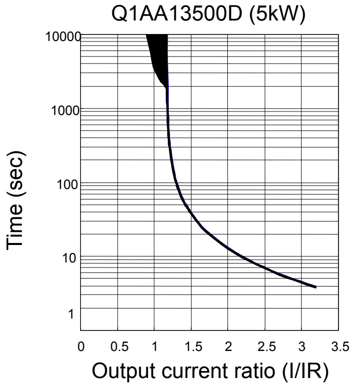
Overload characteristic
Q1AA13300D (3kW)



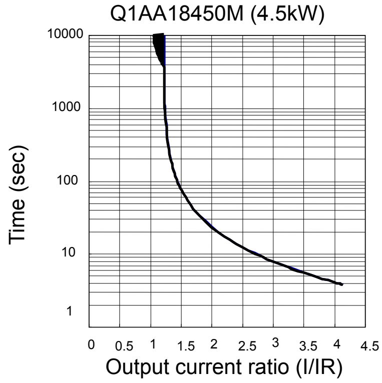
Overload characteristic
Q1AA13400D (4kW)



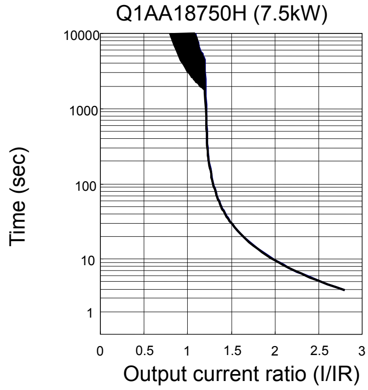
Overload characteristic
Q1AA13500D (5kW)



Overload characteristic
Q1AA18450M (4.5kW)

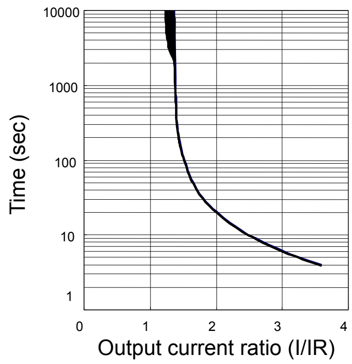


Overload characteristic
Q1AA18750H (7.5kW)

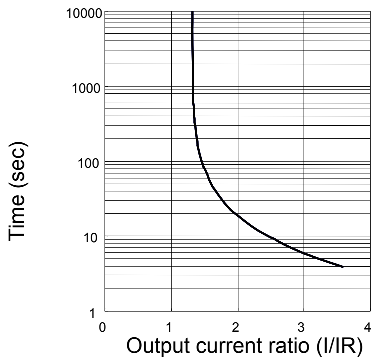


The following show overload characteristic of Q2AA motor.

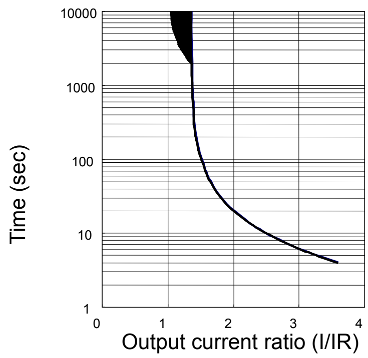
Overload characteristic
Q2AA13200H (2kW)



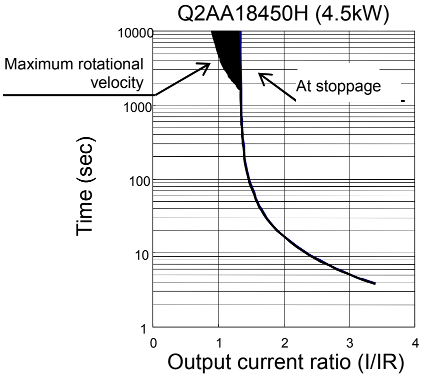
Overload characteristic
Q2AA18200H (2kW)



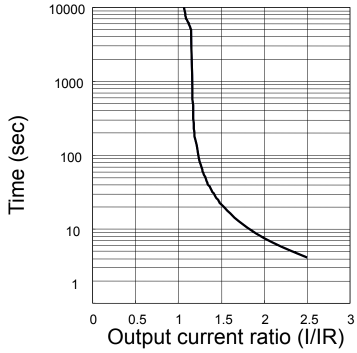
Overload characteristic
Q2AA18350H (3.5kW)



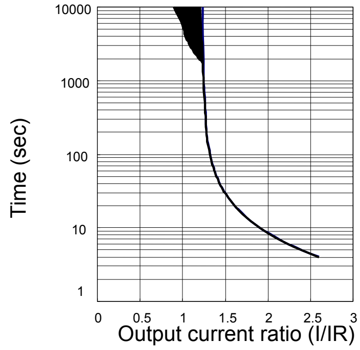
Overload characteristic
Q2AA18450H (4.5kW)



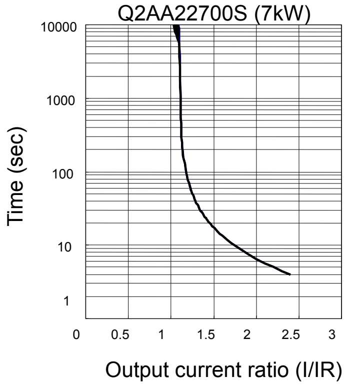
Overload characteristic
Q2AA18550R (5.5kW)



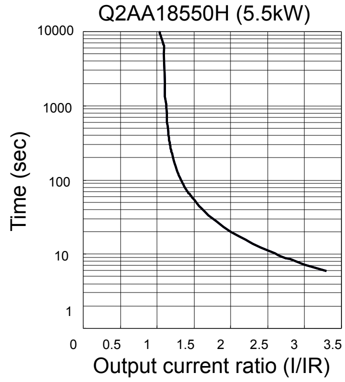
Overload characteristic
Q2AA22550B (5.5kW)



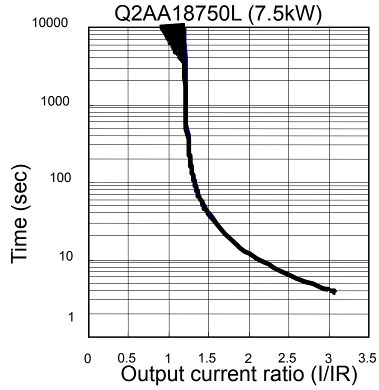
Overload characteristic
Q2AA22700S (7kW)



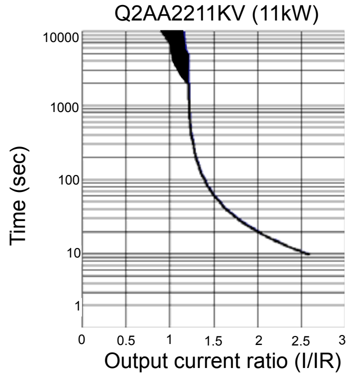
Overload characteristic
Q2AA18550H (5.5kW)



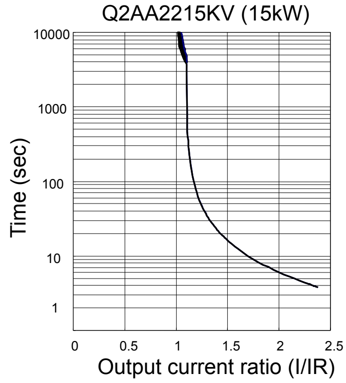
Overload characteristic
Q2AA18750L (7.5kW)



Overload characteristic
Q2AA2211KV (11kW)

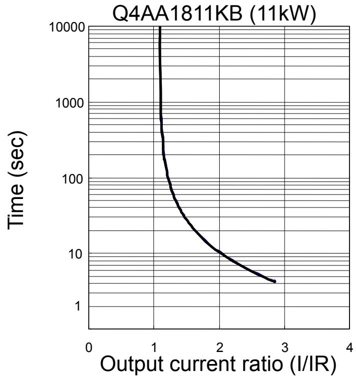


Overload characteristic
Q2AA2215KV (15kW)

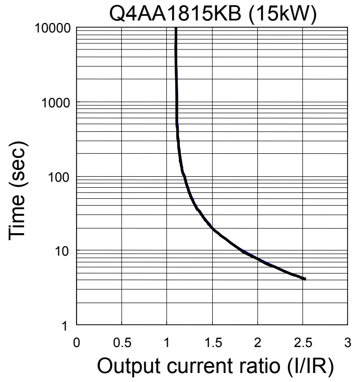


The following show overload characteristic of Q4AA motor.

Overload characteristic
Q4AA1811KB (11kW)

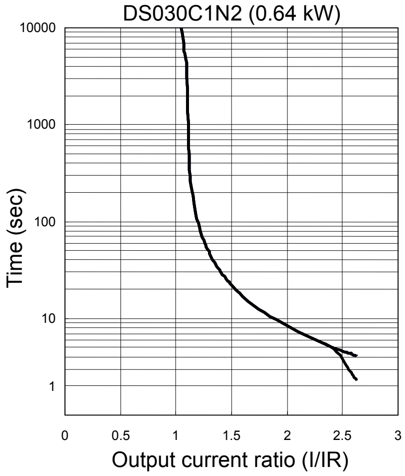


Overload characteristic
Q4AA1815KB (15kW)

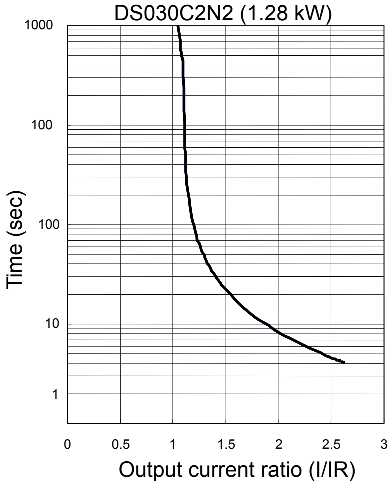


The following show overload characteristic of DS linear motor.

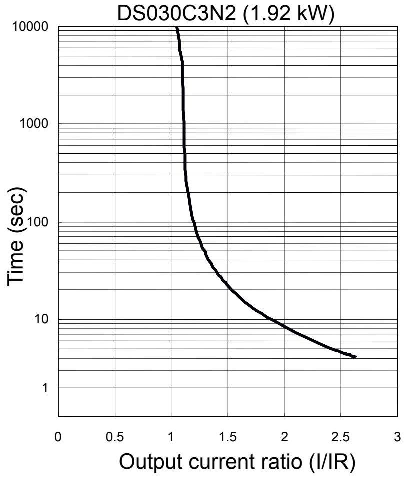
Overload characteristic
DS030C1N2 (0.64 kW)



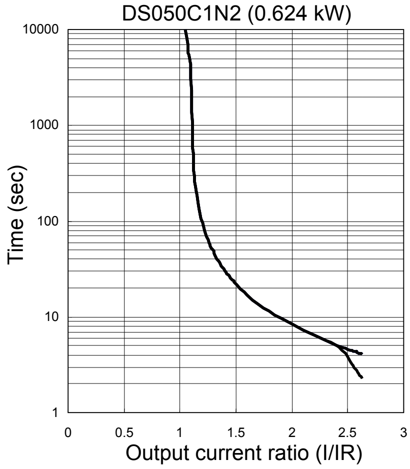
Overload characteristic
DS030C2N2 (1.28 kW)



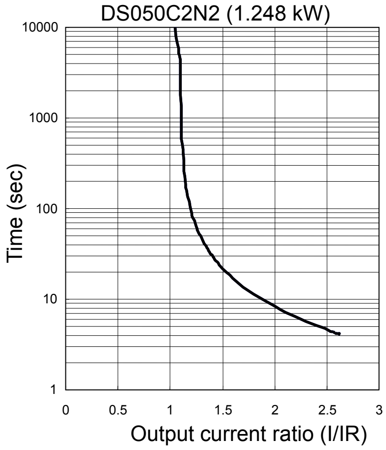
Overload characteristic
DS030C3N2 (1.92 kW)



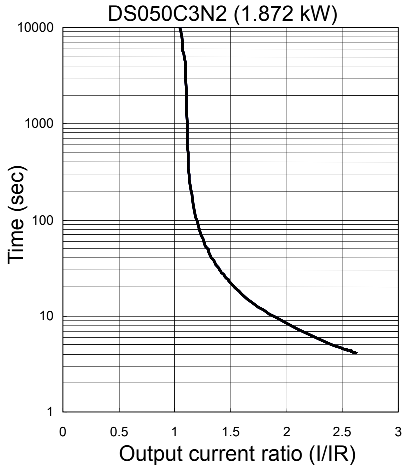
Overload characteristic
DS050C1N2 (0.624 kW)



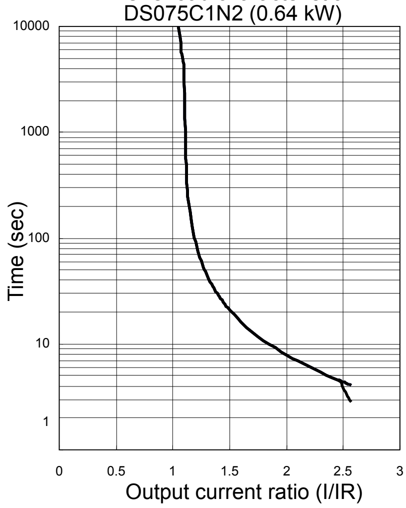
Overload characteristic
DS050C2N2 (1.248 kW)



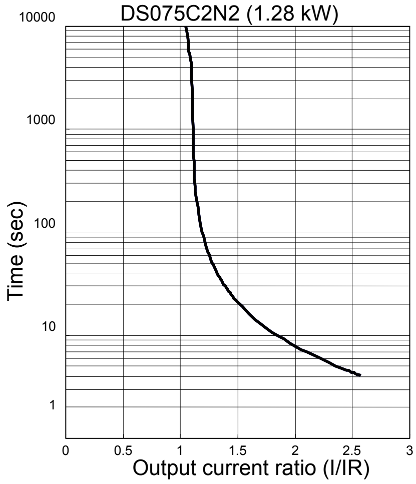
Overload characteristic
DS050C3N2 (1.872 kW)



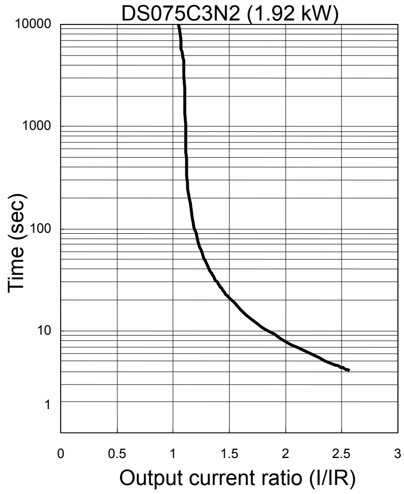
Overload characteristic
DS075C1N2 (0.64 kW)

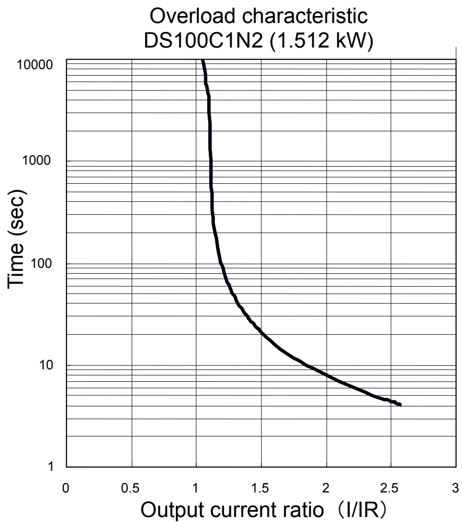


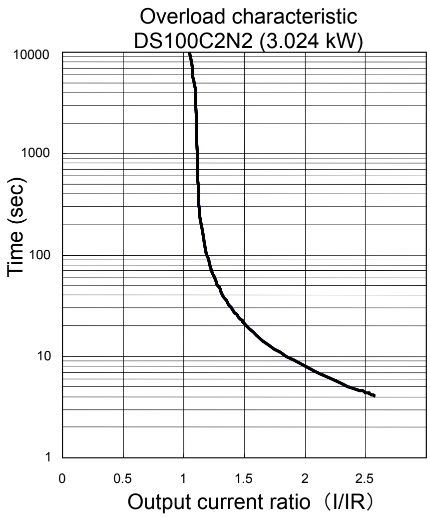
Overload characteristic
DS075C2N2 (1.28 kW)

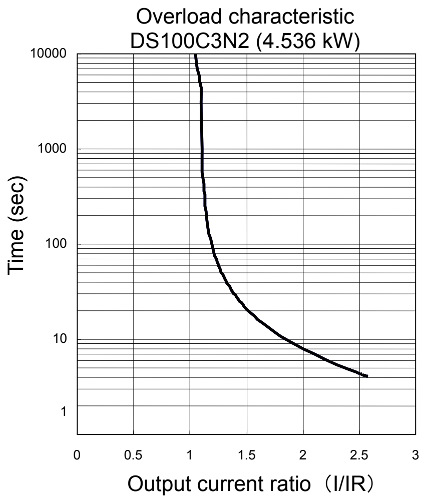


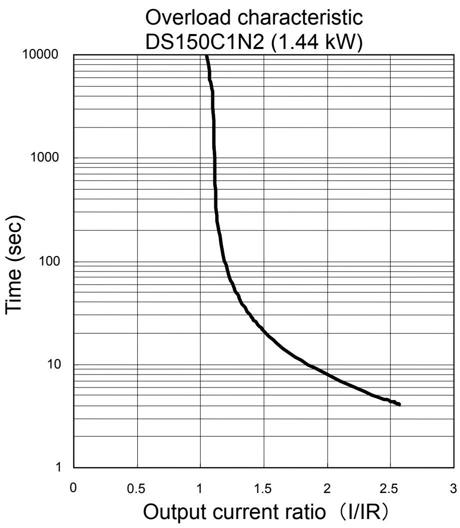
Overload characteristic
DS075C3N2 (1.92 kW)

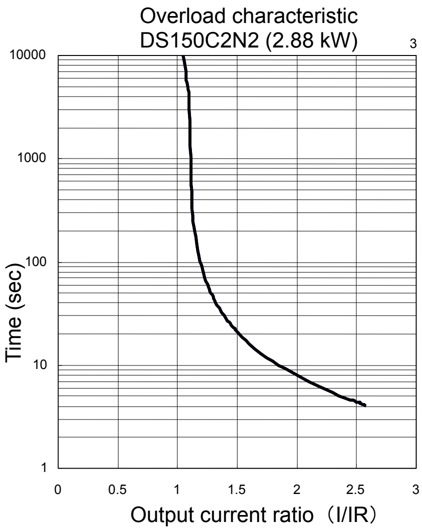


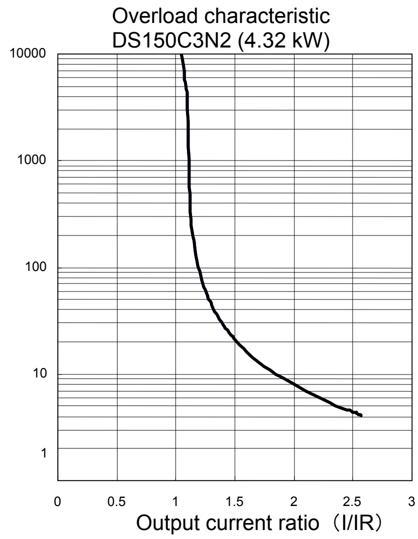

Overload characteristic
DS100C1N2 (1.512 kW)
Time (sec)
Output current ratio（I/IR）


Overload characteristic
DS100C2N2 (3.024 kW)
Time (sec)
Output current ratio（I/IR）


Overload characteristic
DS100C3N2 (4.536 kW)
Time (sec)
Output current ratio（I/IR）

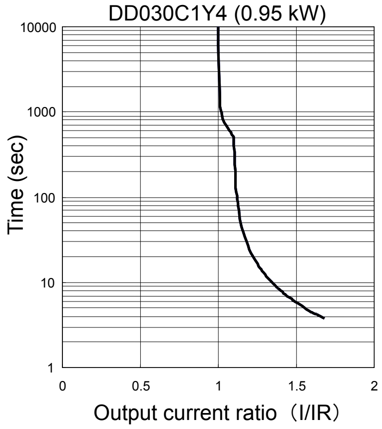

Overload characteristic
DS150C1N2 (1.44 kW)
Time (sec)
Output current ratio（I/IR）


Overload characteristic
DS150C2N2 (2.88 kW)
Time (sec)
Output current ratio（I/IR）

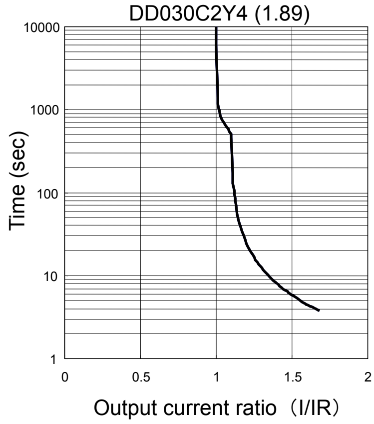

Overload characteristic
DS150C3N2 (4.32 kW)
Output current ratio（I/IR）

The following show overload characteristic of DD linear motor.

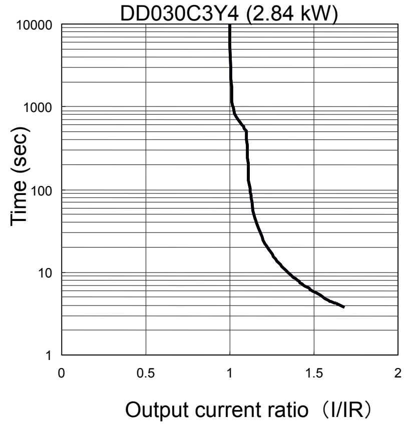
Overload characteristic
DD030C1Y4 (0.95 kW)



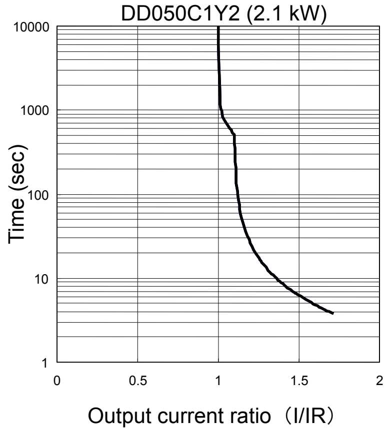
Overload characteristic
DD030C2Y4 (1.89)



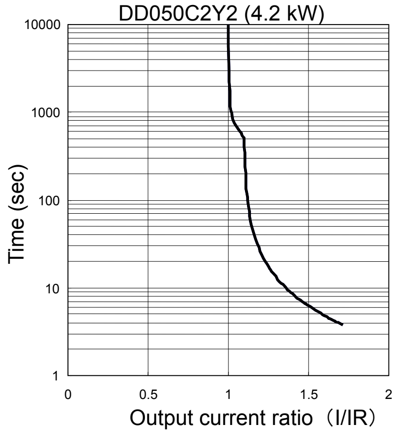
Overload characteristic
DD030C3Y4 (2.84 kW)



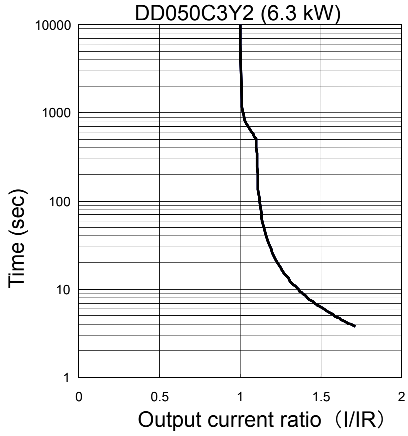
Overload characteristic
DD050C1Y2 (2.1 kW)



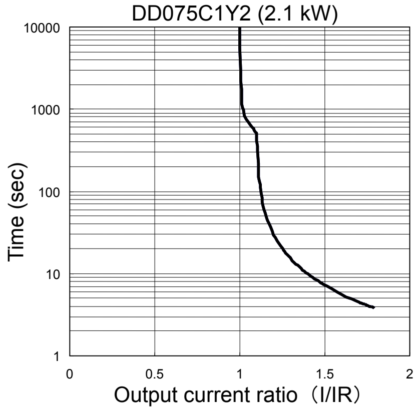
Overload characteristic
DD050C2Y2 (4.2 kW)



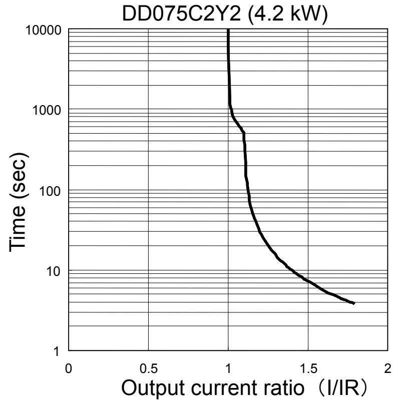
Overload characteristic
DD050C3Y2 (6.3 kW)



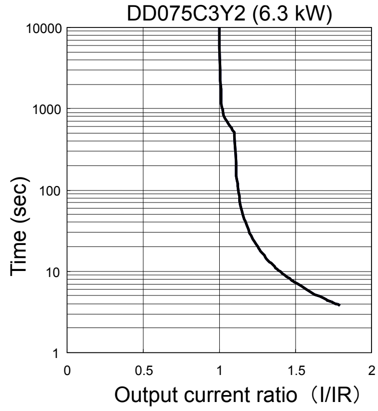
Overload characteristic
DD075C1Y2 (2.1 kW)



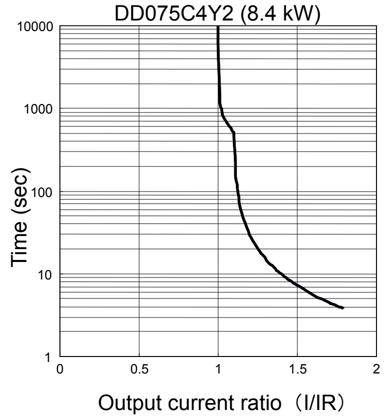
Overload characteristic
DD075C2Y2 (4.2 kW)



Overload characteristic
DD075C3Y2 (6.3 kW)

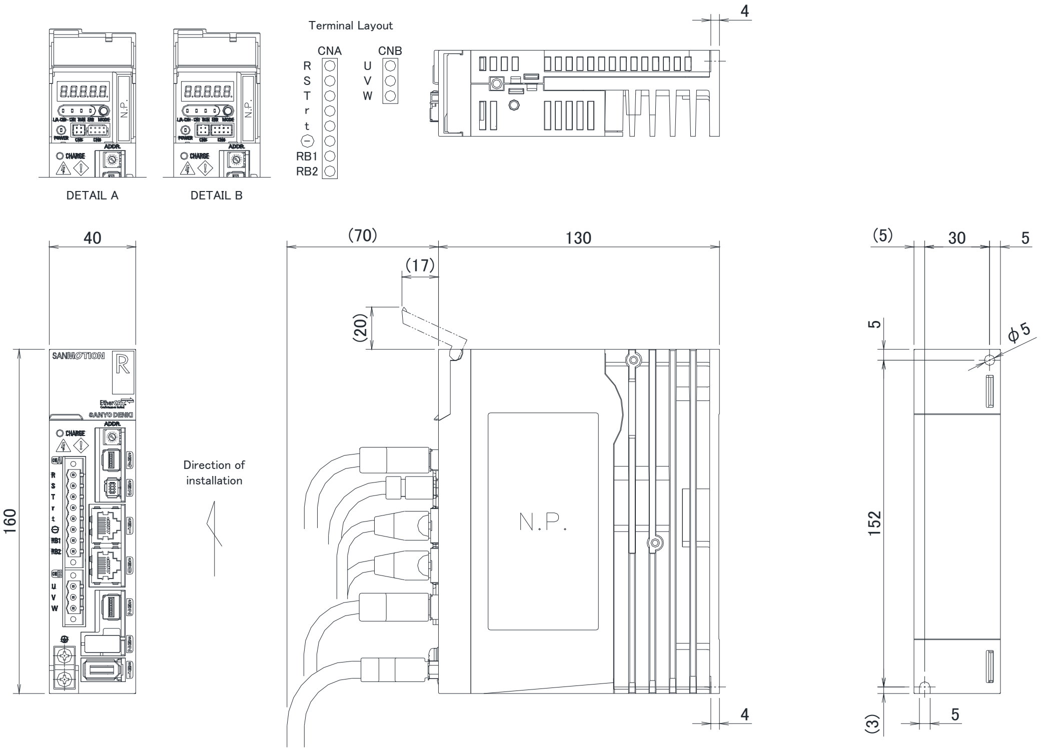


Overload characteristic
DD075C4Y2 (8.4 kW)

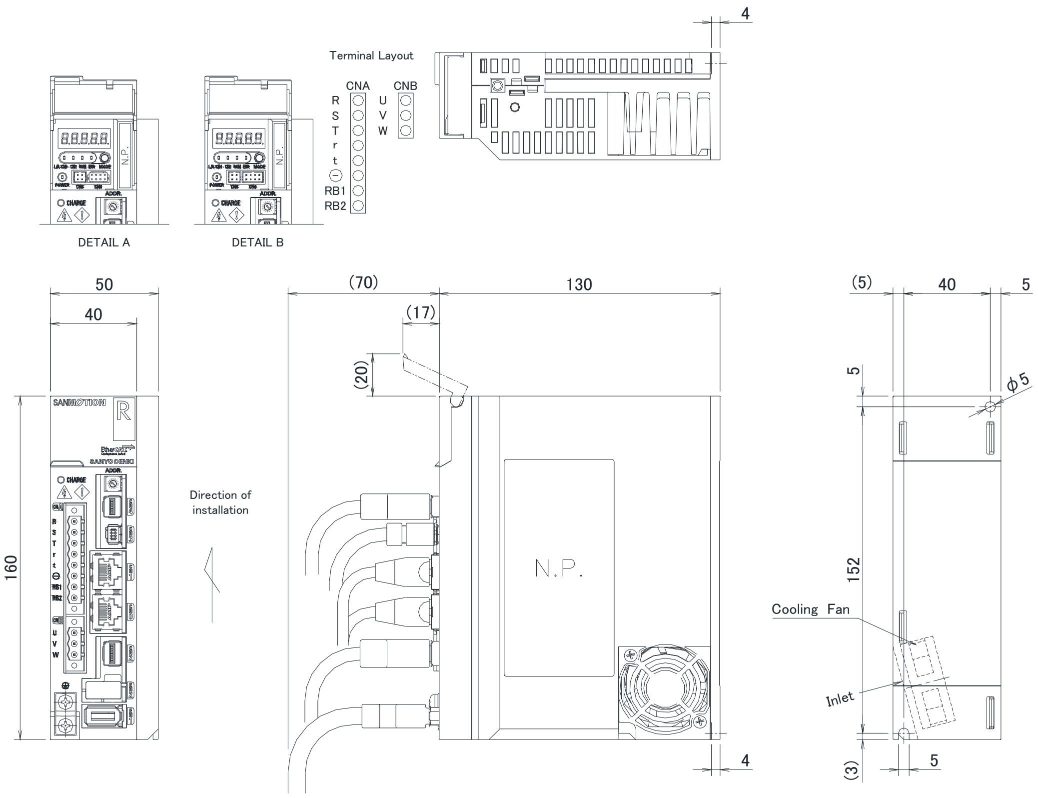


16.5 Servo amplifier dimensions

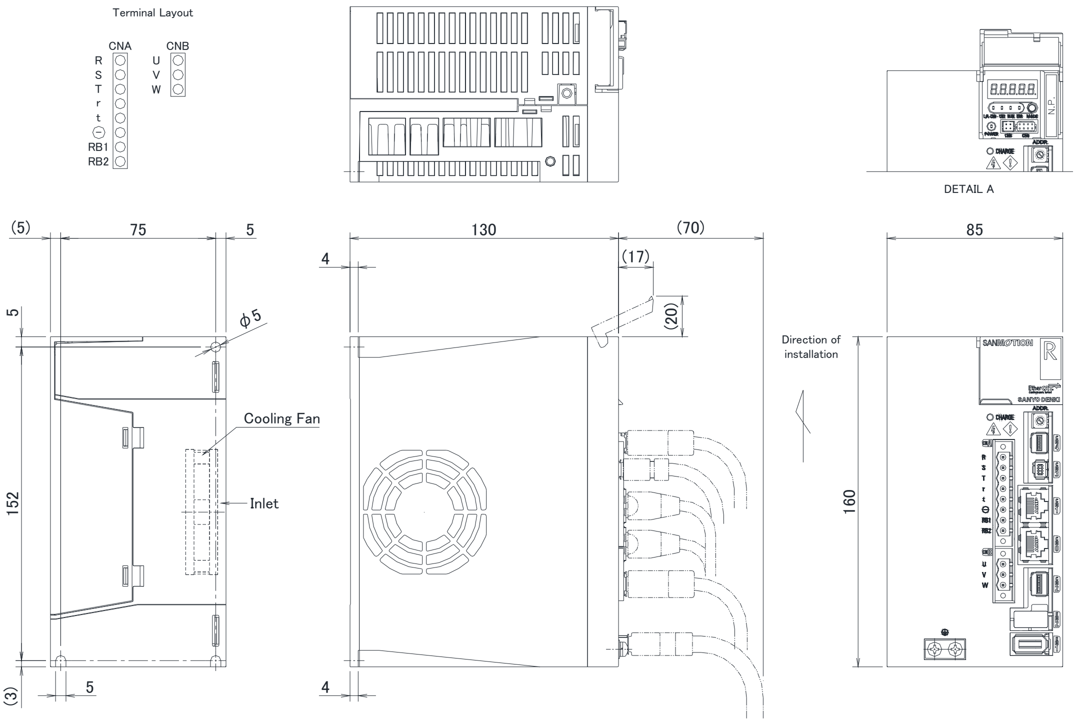
RS2□01A□□L□



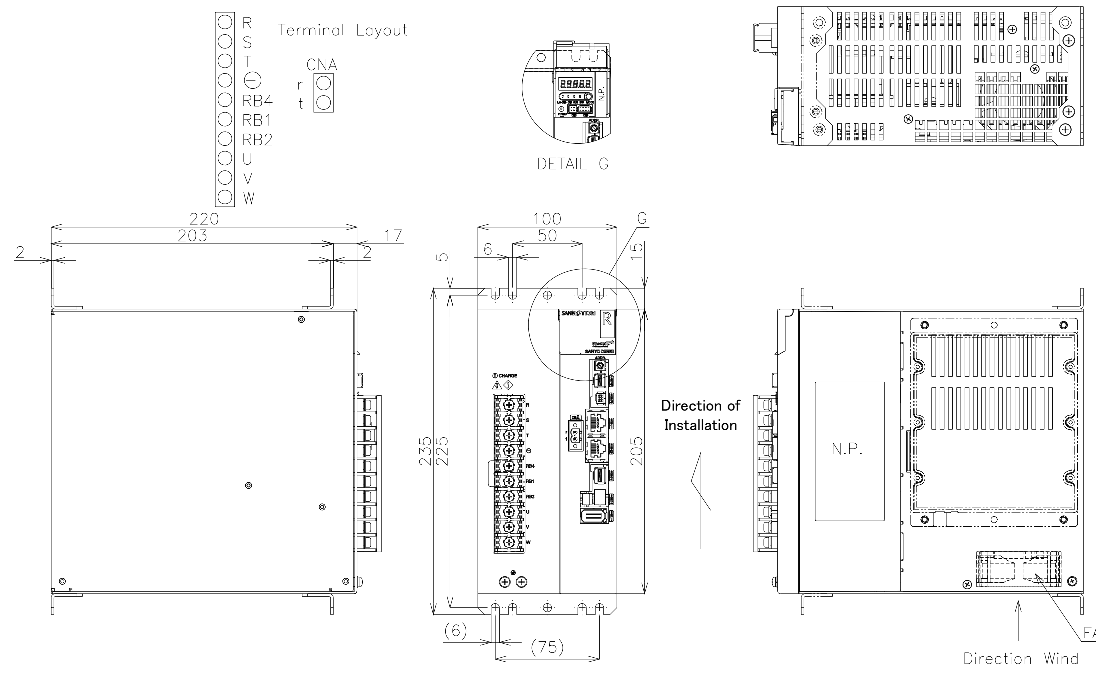
RS2□03A□□L□



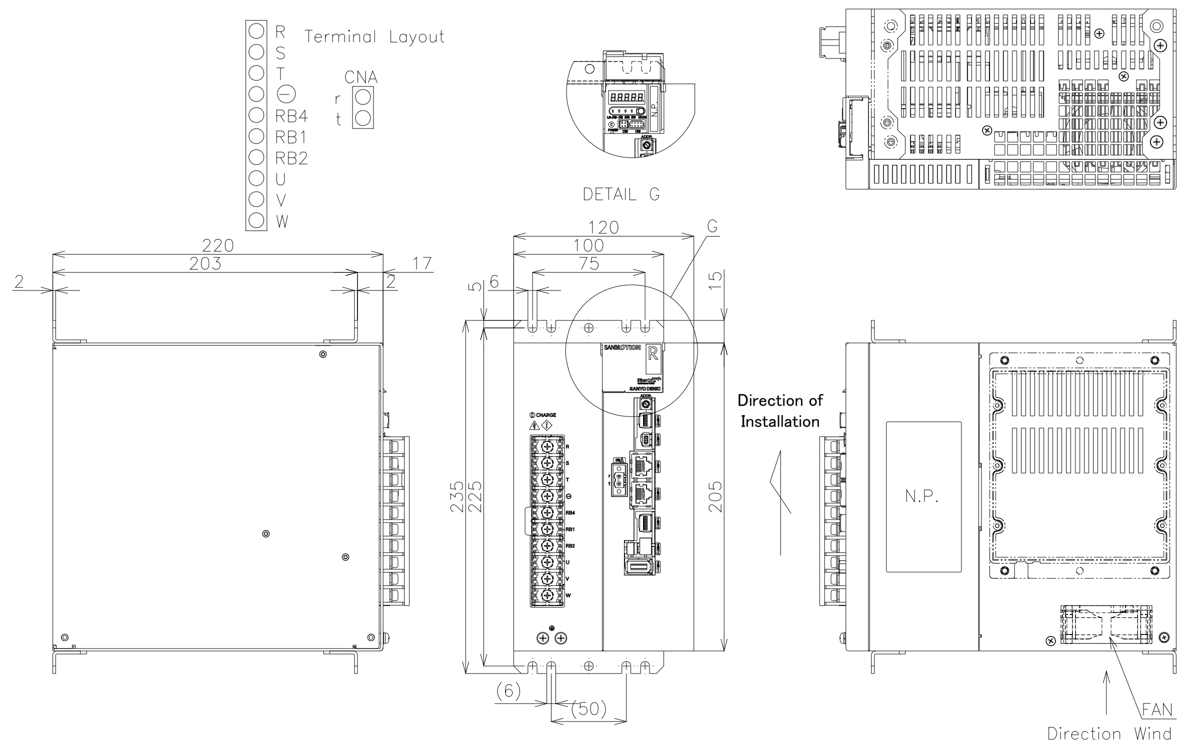
RS2□05A□□L□



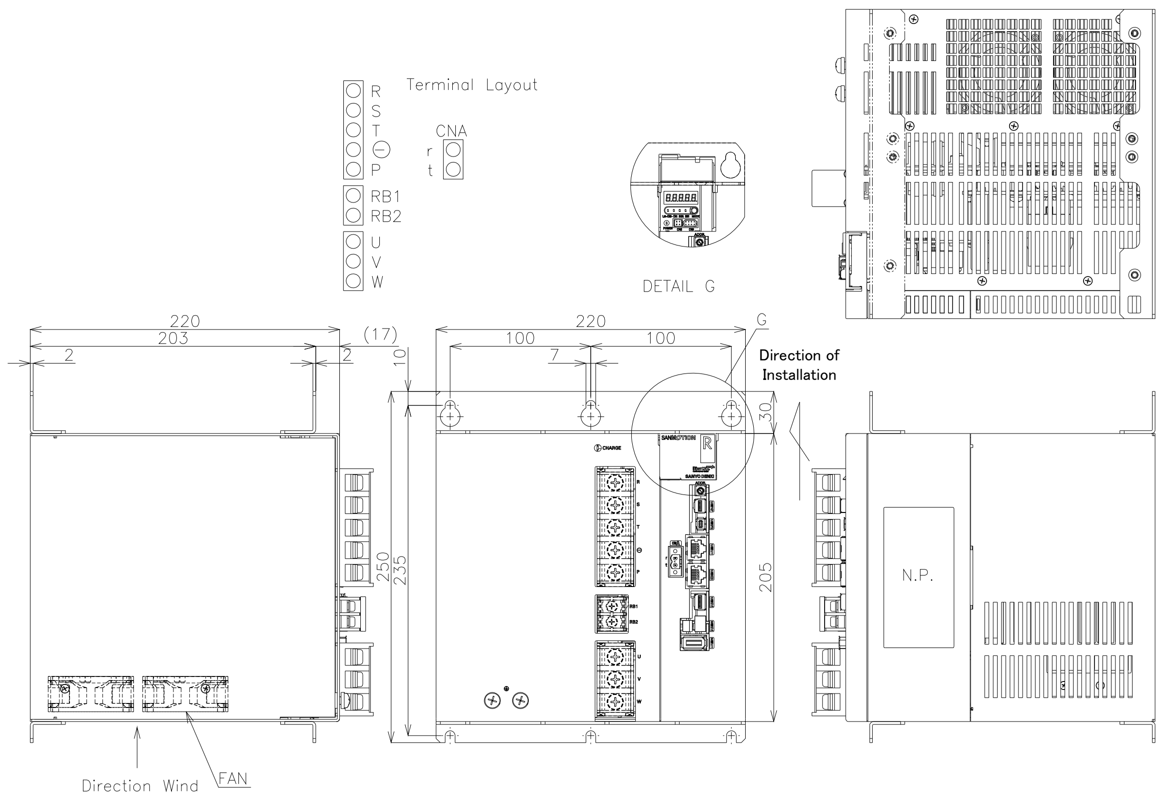
RS2□10A□□A□



RS2□15A□□A□



RS2□30A□□L□



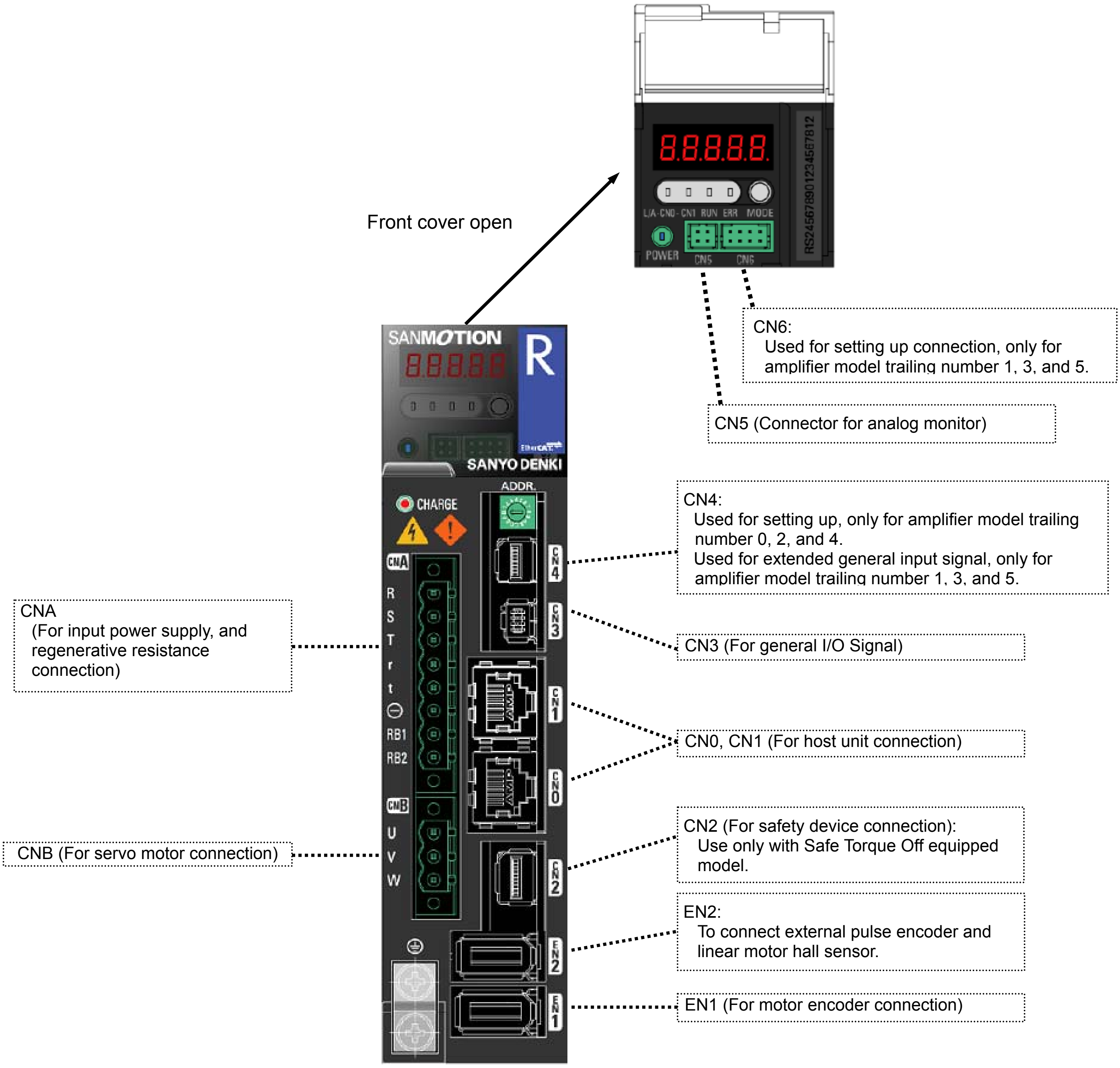
16.6 Optional parts

1) Connectors layout on servo amplifier

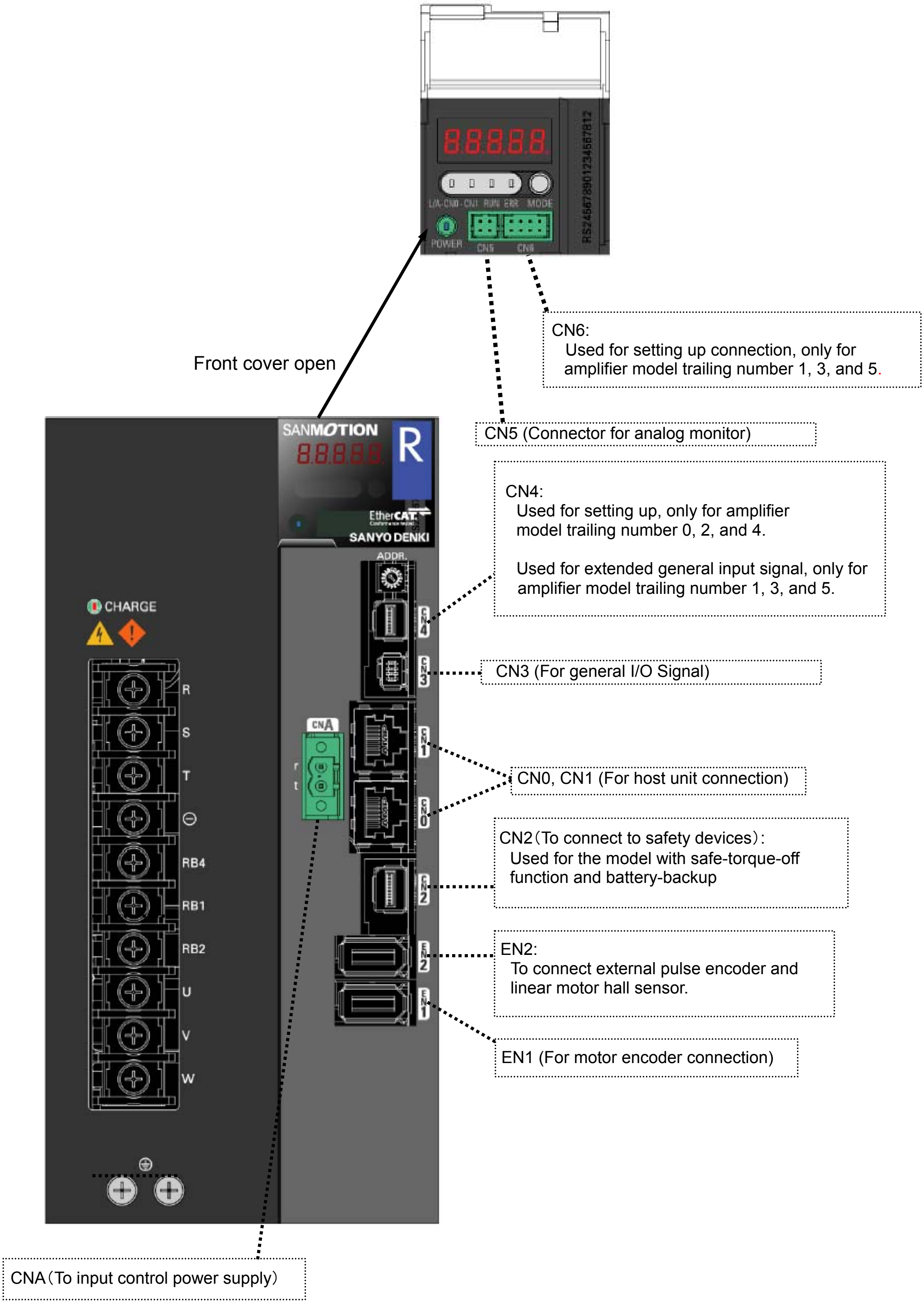
SANYO DENKI offers the following optional parts.

RS2#01, RS2#03, RS2#05

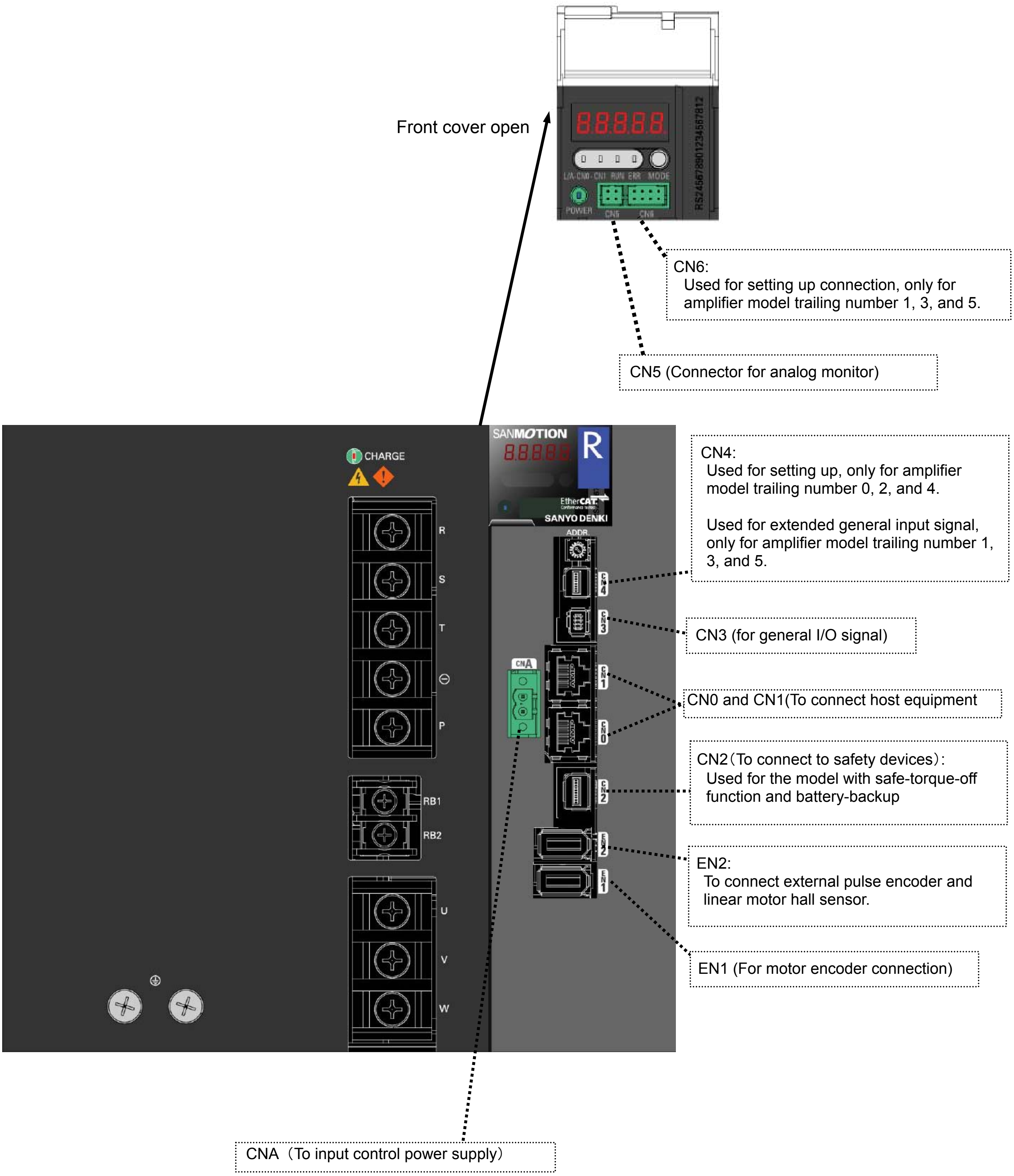
Note1) The following connectors have SANYO DENKI connector model numbers.



RS2#10, RS2#15


Front cover open
CN6:
Used for setting up connection, only for amplifier model trailing number 1, 3, and 5.
CN5 (Connector for analog monitor)
CN4:
Used for setting up, only for amplifier model trailing number 0, 2, and 4.
Used for extended general input signal, only for amplifier model trailing number 1, 3, and 5.
CN3 (For general I/O Signal)
CN0, CN1 (For host unit connection)
CN2（To connect to safety devices）:
Used for the model with safe-torque-off function and battery-backup
EN2:
To connect external pulse encoder and linear motor hall sensor.
EN1 (For motor encoder connection)
CNA（To input control power supply）
SANMOTION
SANYO DENKI
CHARGE
R
S
T
RB4
RB1
RB2
U
V
W

RS2#30


Front cover open
CN6:
Used for setting up connection, only for amplifier model trailing number 1, 3, and 5.
CN5 (Connector for analog monitor)
CN4:
Used for setting up, only for amplifier model trailing number 0, 2, and 4.
Used for extended general input signal, only for amplifier model trailing number 1, 3, and 5.
CN3 (for general I/O signal)
CN0 and CN1(To connect host equipment
CN2（To connect to safety devices）:
Used for the model with safe-torque-off function and battery-backup
EN2:
To connect external pulse encoder and linear motor hall sensor.
EN1 (For motor encoder connection)
CNA（To input control power supply）
CHARGE
R
S
T
P
RB1
RB2
U
V
W
SANMOTION
SANYO DENKI
ADDR.
CNA

2) Connector model numbers

RS2#01, RS2#03, RS2#05

■ SANYO DNEKI model numbers of respective connectors

Connector No.	Item	SANYO DENKI model NO.	Manufacturer model NO.	QTY	Manufacturer
CN0, CN1	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 Limited
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.
CN2	For safety device connection	AL-Y0004290-02	MUF-PK10K-X	1	J.S.T Mfg Co., Ltd.
CN3	For general I/O	AL-00718252-01	2013595-3	1	Tyco Electronics Japan G.K.
CN4	For general input signal [RS2####K#1] [RS2####K#3] [S2####K#5]	AL-Y0004290-01	MUF-PK8K-X	1	J.S.T. Mfg. Co.,Ltd

■ SANYO DNEKI model numbers of respective connector sets

Set connectors	Description	Set QTY	SANYO DENKI model No.
CNA, CNB, EN1, CN2, CN3	For Semi-closed amplifier without built-in regenerative resistance.	1	AL-00734194
CNA, CNB, EN1, EN2, CN2, CN3	For Full-closed amplifier without built-in regenerative resistance. (One EN2 connector is added to Semi-closed amplifier without built-in regenerative resistance.)	1	AL-00734195
CNB, EN1, CN2, CN3	For Semi-closed amplifier with built-in regenerative resistance. (Eliminated CN A connector from Semi-closed amplifier without built-in regenerative resistance.)	1	AL-00734196
CNB, EN1, EN2, CN2, CN3	For Full-closed amplifier with built-in regenerative resistance. (One EN2 connector is added to Semi-closed amplifier without built-in regenerative resistance.)	1	AL-00734197
CNA, CNB, CN2 CN3, CN4, EN1	[RS2####K#1, RS2####K#3, RS2####K#5] For semi-closed system amplifier with no regenerative resistance	1	AL-00752589
CNB, CN2, CN3 CN4, EN1	[RS2####K#1, RS2####K#3, RS2####K#5] For semi-closed system amplifier with no regenerative resistance	1	AL-00752587

RS2#10, RS2#15, RS2#30

■ SANYO DENKI single connector model number

Connector NO.	Intended use	Model number	Manufacturer model number	QTY	Manufacturer
CN0, CN1	EthernetTo To connect to host equipment	Not included. Please use CAT5e standard-compliant shielded modular plug (RJ-45)			
EN1, EN2	To connect encoder	AL-00632607	36210-0100PL and 36310-3200-008	1	3M Japan Limited
CNA	To input control power	AL-Y0005159-01	MSTBT2.5/2-STF-5.08	1	Phoenix Contact.K.K
CN2	To connect safety device (For short-circuiting)	AL-Y0004290-02	MUF-PK10K-X	1	J.S.T. Mfg. Co.,Ltd
CN3	For general I/O	AL-00718252-01	2013595-3	1	Tyco Electronics Japan G.K.
CN4	For general I/O signal [RS2#####K#1] [RS2#####K#3] [RS2#####K#5]	AL-Y0004290-01	MUF-PK8K-X	1	J.S.T. Mfg. Co.,Ltd

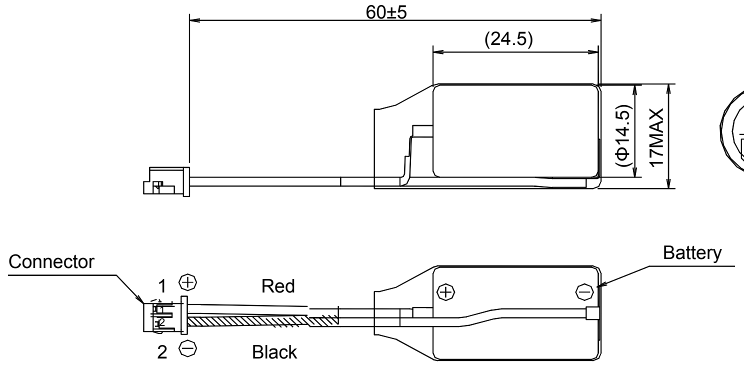
■ SANYO DENKI connector set model number

Set connector	Contents	QTY	SANYO DENKI model NO.
CNA, EN1, CN2, N3	For semi-closed system amplifier	1	AL-00756240
CNA, EN1, EN2, CN2, CN3	For fully-closed system amplifier	1	AL-00756242
EN1, CN2, CN3	Low voltage set	1	AL-00756244
EN1, EN2, CN2, CN3	Low voltage set for fully-closed system amplifier	1	AL-00756246

3) Battery-backup absolute encoder battery related parts

Name	Description	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 - AL-00697960-06
Battery trunk cable with two connectors.	-	1	AL-00731792-01

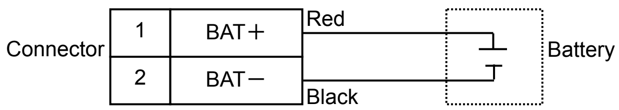
■ Outline dimensional drawing of battery unit (Model No.: AL-00697958-01)



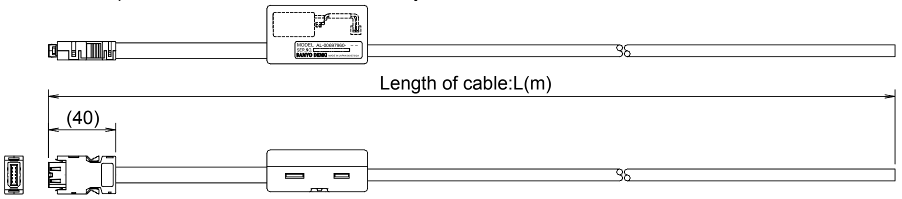
1. Specifications for battery and connector

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



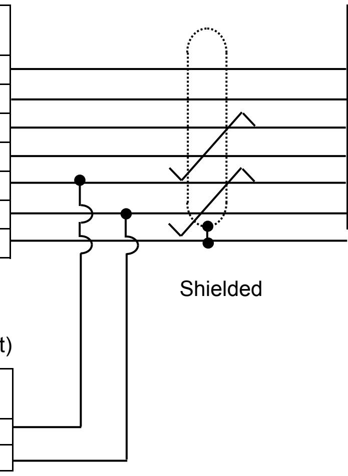
■ Battery trunk cable (Model No.: AL-00697960-☐☐)



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:



Connectors on servo amplifier

Terminal No.	Signal Name
1	5V
2	SG
7	ES+
8	ES-
9	BAT+
10	BAT-
Shell	Earth

Line color	Wire size (AWG) 3 - 15m	Wire size (AWG) 20, 25m
Red	22	20
Black		
Brown	24	24
Blue		
Green		
Purple		

Built-in battery (battery unit)

Terminal No.	Signal Name
1	BAT+
2	BAT-

3. Specification for the connector and the battery unit

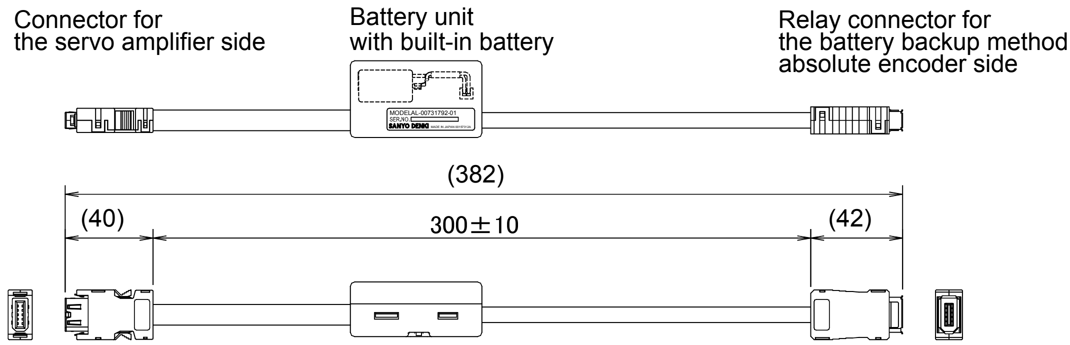
Connector for the servo amplifier side	36210-0100PL; Wiremount Receptacle (3M) 36310-3200-008; Shell Kit (3M)
Battery unit	Built-in battery; ER3VLY (TOSHIBA LIFESTYLE PRODUCTS & SERVICES CORPORATION) Nominal Voltage: 3.6V Nominal Capacity: 1000mAh Metallic weight of lithium: 0.31g

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	

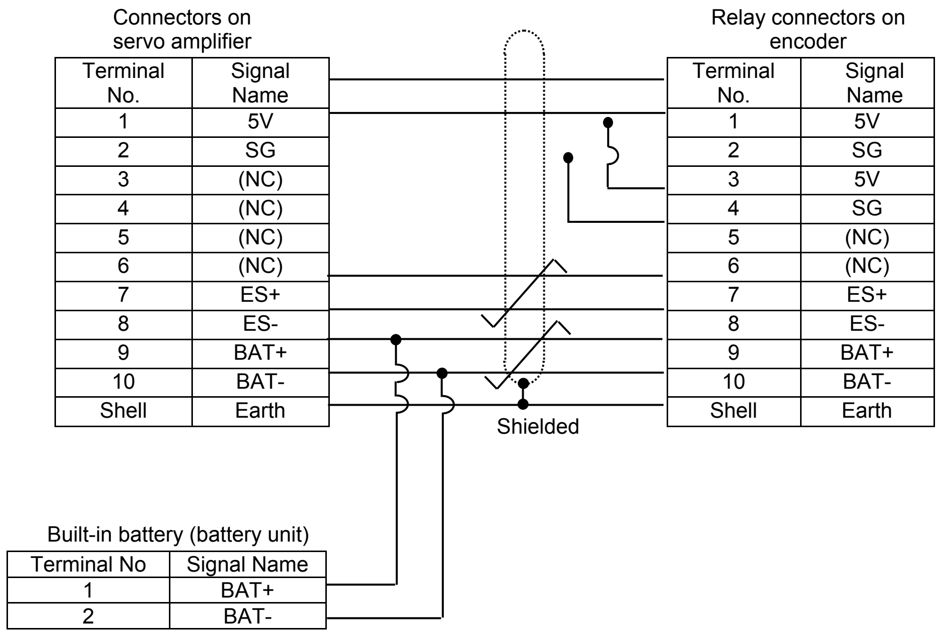
5. Battery model number for exchange: AL-00697958-01

■ 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:



Connectors on servo amplifier

Terminal No.	Signal Name
1	5V
2	SG
3	(NC)
4	(NC)
5	(NC)
6	(NC)
7	ES+
8	ES-
9	BAT+
10	BAT-
Shell	Earth

Relay connectors on encoder

Terminal No.	Signal Name
1	5V
2	SG
3	5V
4	SG
5	(NC)
6	(NC)
7	ES+
8	ES-
9	BAT+
10	BAT-
Shell	Earth

Built-in battery (battery unit)

Terminal No	Signal Name
1	BAT+
2	BAT-

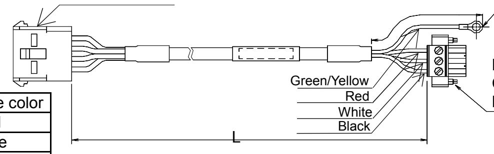
3. Specification for the connector and the battery unit

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	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

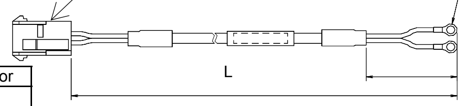
4) Junction cable for servo motor

Power cable



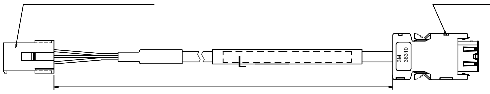
NO.	Lead wire color
1	Red
2	White
3	Black
4	Green/ Yellow

Brake cable



NO.	Lead wire color
1	White
2	Black

Encoder cable



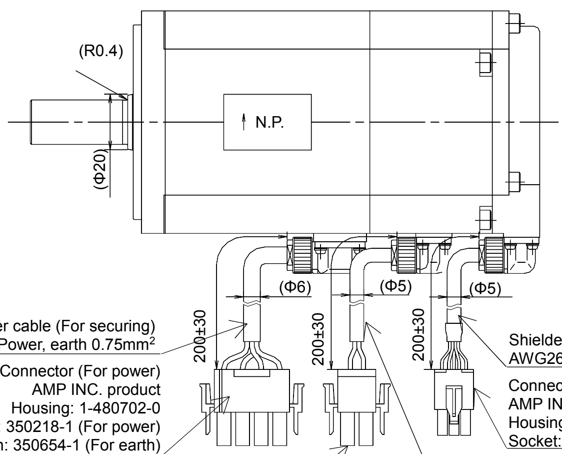
NO.	Lead wire color	Signal name
1	Black	0V
2	Red	+5V
3	Blown	ES+
4	Blue	ES-
5	Green	EBAT+
6	Purple	EBAT-
9	White/Black(Shielded)	Earth

NO.	Lead wire color	Signal name
1	Red	5V
2	Black	0V
7	Blown	ES+
8	Blue	ES-
9	Green	EBAT+
10	Purple	EBAT-

Model Number			Cable length : L(m)
Power cable	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	No holding brake	R2AA04003FXPA0	
30W	□40mm	With holding brake (DC24V)	R2AA04003FCPA0	
50W	□40mm	No holding brake	R2AA04005FXPA0	
50W	□40mm	With holding brake (DC24V)	R2AA04005FCPA0	
100W	□40mm	No holding brake	R2AA04010FXPA0	
90W	□40mm	With holding brake (DC24V)	R2AA04010FCPA0	The rating decreases to 90%
100W	□60mm	No holding brake	R2AA06010FXPA0	
100W	□60mm	With holding brake (DC24V)	R2AA06010FCPA0	
200W	□60mm	No holding brake	R2AA06020FXPA0	
200W	□60mm	With holding brake (DC24V)	R2AA06020FCPA0	
400W	□60mm	No holding brake	R2AA06040FXPA0	
360W	□60mm	With holding brake (DC24V)	R2AA06040FCPA0	The rating decreases to 90%
750W	□80mm	No holding brake	R2AA08075FXPA0	
750W	□80mm	With holding brake (DC24V)	R2AA08075FCPA0	



5) Fixing bracket

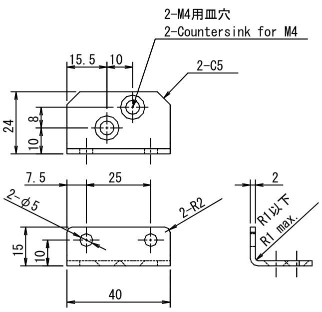
Fixing brackets are supplied with servo amplifier, RS2□01, RS2□03, RS2□05 and RS2□30.

■ List of fixing brackets for RS2□01 through 05, 30.

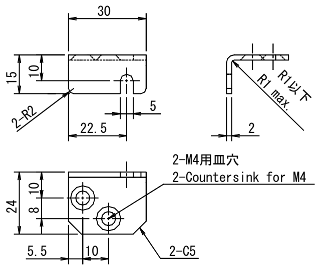
Servo amplifier model number	Bracket fixing position	Model number	Contents
RS2□01 and 03	Front	AL-00736863-01	Fixing bracket (top and bottom set) 1ea, respectively. Tightening screw:: 4ea
RS2□05	Front	AL-00736864-01	Fixing bracket (top and bottom set) 1ea, respectively. Tightening screw: 4ea
RS2□30	Front	AL-00828413-01	Fixing bracket (upper/bottom): 1 ea, respectively Tightening screw: 8 ea

These optional fixing brackets are processed trivalent chromium plating.
(Surface color: Blue-silver/ different from body color.)
RS2□10/15 can be mounted on the front surface of the amplifier after removing rear mounting fixture.

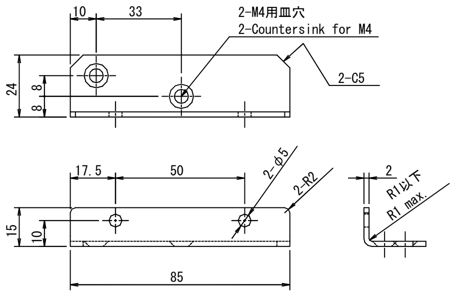
Upper



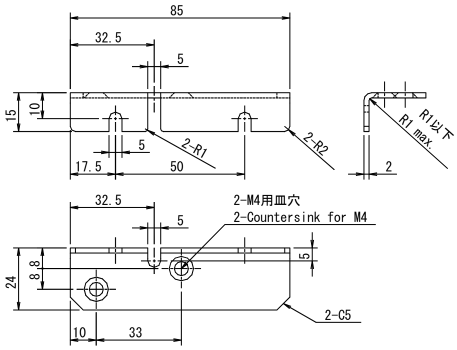
Bottom



Upper

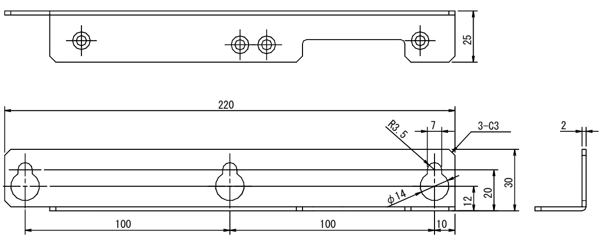


Bottom

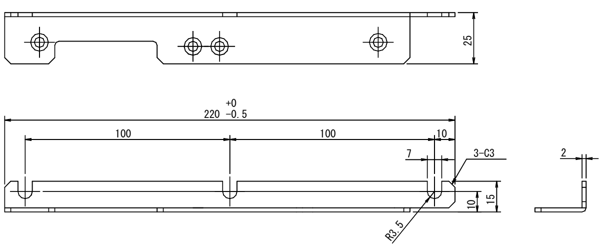


AL-00828413-01

Upper



Bottom

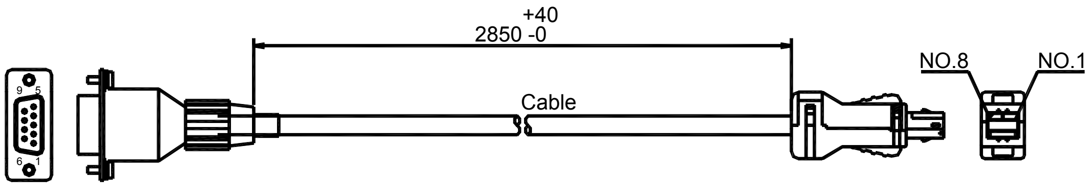


6) Setup software and serial communication-related parts

For RS2#####K#0, RS2#####K#2, and RS2#####K#4

Connector NO.	Name	Description	QTY	SANYO DENKI model NO.
CN4	Cable for communication with PC	PC-servo amplifier	1	AL-00689703-01

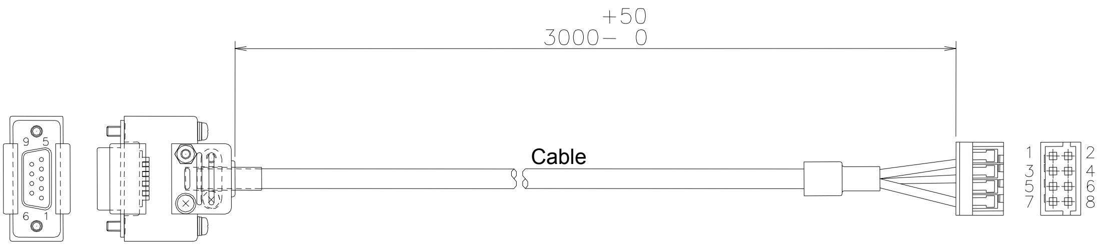
Outline dimensional drawing of cable for communication with PC (Model number: AL-00689703-01)



For RS2#####K#1, RS2#####K#3, and RS2#####K#5

Connector NO.	Name	Description	QTY	SANYO DENKI model NO.
CN6	Cable for communication with PC	PC-servo amplifier	1	AL-00745525-01

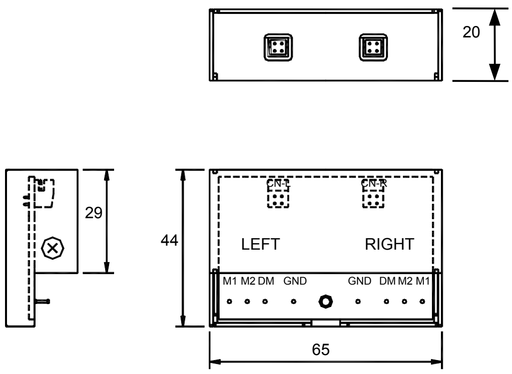
Outline dimensional drawing of cable for communication with PC (Model number: AL-00745525-01）

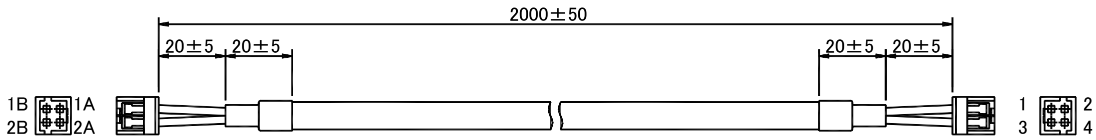


7) Dedicated cable, exclusive to monitor box for analog monitor

Connector NO.	Name	Contents	Set QTY	SANYO DENKI model NO.
CN5	Monitor box	Monitor box unit 2 dedicated cables	1	Q-MON-3
-	Dedicated cable	2 dedicated cables	1	AL-00690525-01

Outline dimensional drawing of monitor box (Model number: Q-MON-3)



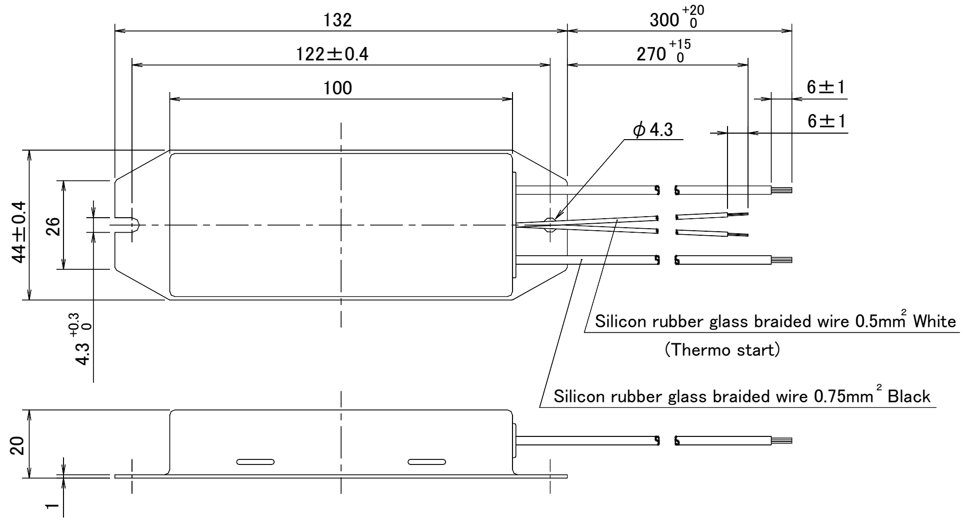


Outline dimensional drawing of dedicated cable (Model number: AL-00690525-01)

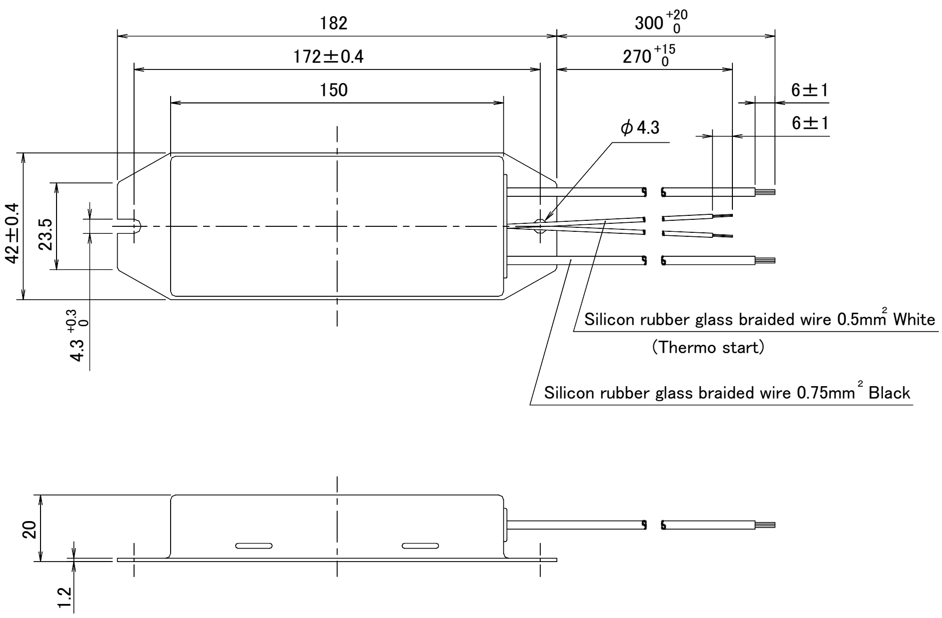
✓ Monitor box is supplied with two dedicated cables (model number: AL-00690525-01 in the above 2), exclusive to monitor box (model number: Q-MON-3).

16.7 Outline dimension of regenerative resistor

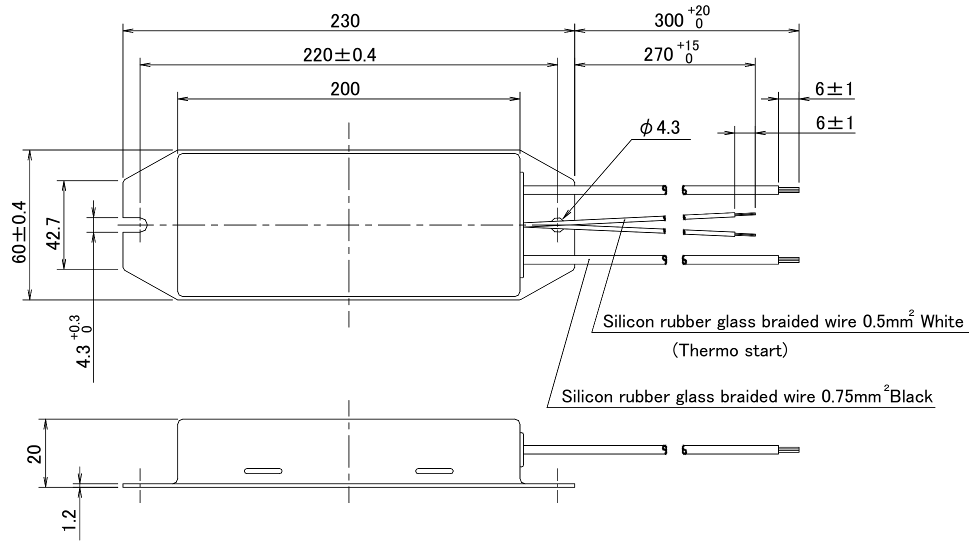
■ REGIST-080W



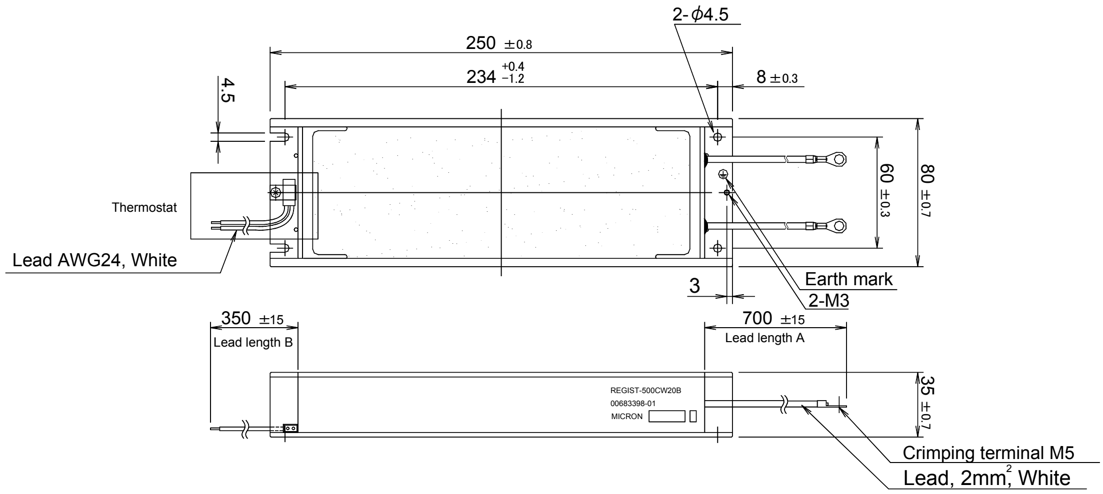
■ REGIST-120W



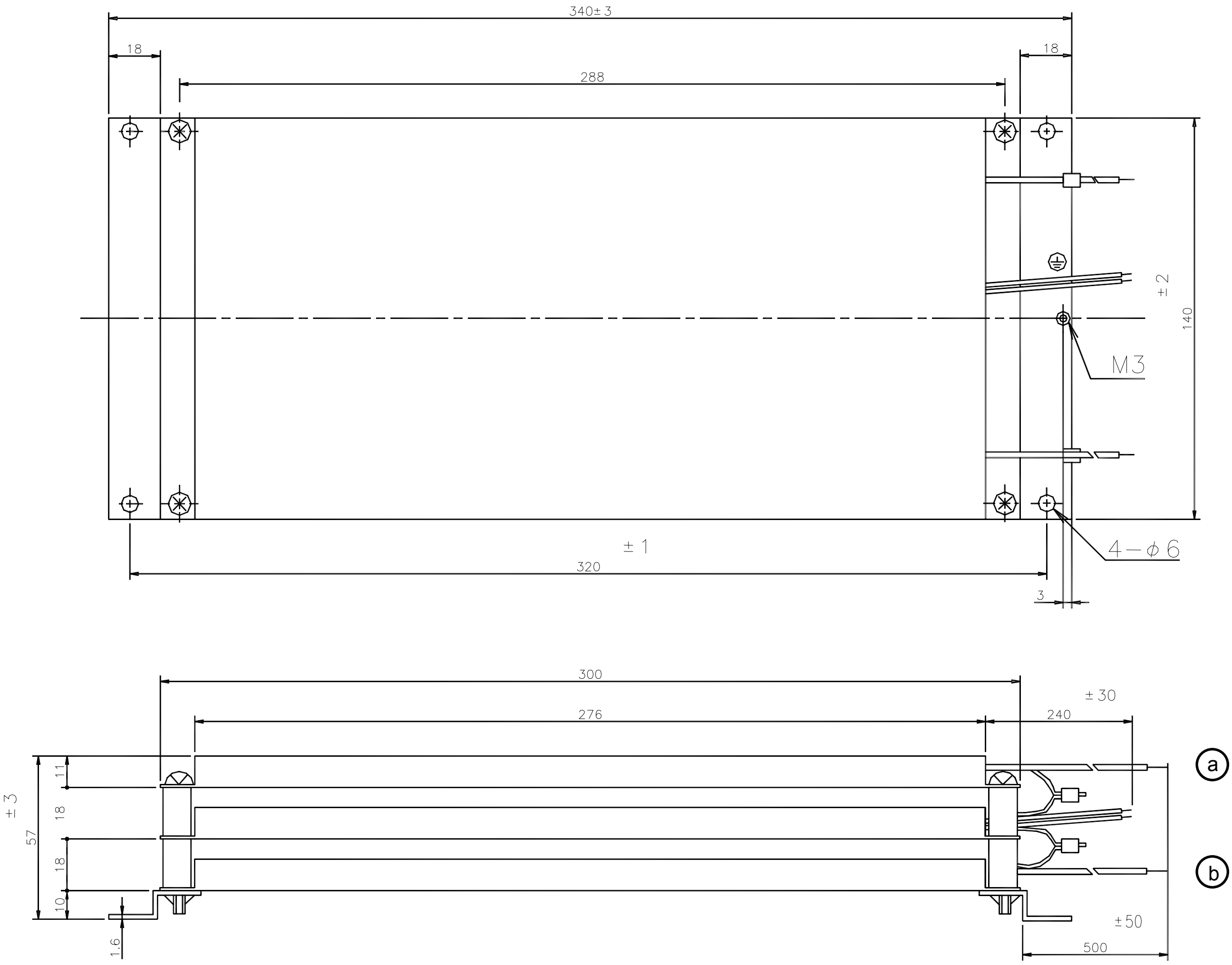
■ REGIST-220W

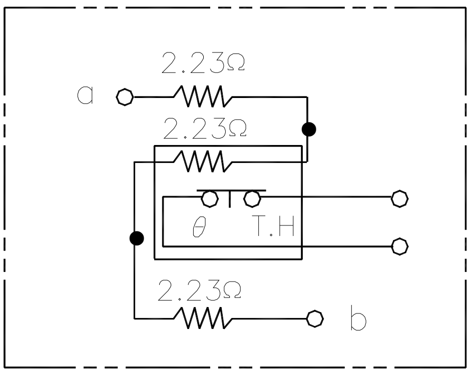


■ REGIST-500CW



■ 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 other 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.

[-E-]

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 (「<http://www.ethercat.org>」)
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.
[-F-]	
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
[-G-]	
Get	Access method used by a client to read data from a device.
GND	Ground
GPI	General Purpose Input
GPO	General Purpose Output
[-H-]	
HW	Hardware
HDR	Header
HNI	Human Machine Interface
[-I-]	
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.
[-L-]	
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
[-M-]	
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 µController.
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 a 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 EtherType 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 www.ietf.org).
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.

	Release	ServoAmplifier revision
Revision A	Nov. 2009	A
Revision B	Sep. 2010	B
Revision C	Mar. 2011	C,D,E,F
Revision D	Jul. 2013	G
Revision E	Jun. 2015	G
Revision F	Nov. 2015	H

■Precautions For Adoption

Failure to follow the precautions on the right may cause moderate injury and property damage, or in some circumstances, could lead to a serious accident.
Always follow all listed precautions.

⚠ Cautions

- Read the accompanying Instruction Manual carefully prior to using the product.
- If applying to medical devices and other equipment affecting people's lives please contact us beforehand and take appropriate safety measures.
- If applying to equipment that can have significant effects on society and the general public, please contact us beforehand.
- Do not use this product in an environment where vibration is present, such as in a moving vehicle or shipping vessel.
- Do not perform any retrofitting, re-engineering, or modification to this equipment.
- The Products presented in this Instruction Manual are meant to be used for general industrial applications. If using for special applications related to aviation and space, nuclear power, electric power, submarine repeaters, etc., please contact us beforehand.

* For any question or inquiry regarding the above, contact our Sales Department.

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