M0010515C

SANMOTION

AC SERVO SYSTEMS

R ADVANCED MODEL

TYPE M

With EtherCAT® Interface Type H

For Rotary Motor, Linear Motor

Instruction Manual

SANYO DENKI

The third edition (C)

- p. 1-5
  - 37kW is added to the table of main circuit capacity in power unit model number.
  - Series name of amplifier units and power units are changed to RM3.
  - DB resistor information is added to main circuit capacity table.

- p. 1-6
  - 300A and 600A are added to the table of main circuit capacity for 560VDC in amplifier unit model number.

- p. 4-137, 4-138
  - 400V/100A input type motors are deleted.
  - Motor model numbers below are added to motor code table.
    Rotary motor (200V)
    R2AA18350A, R2AA18350E, R2AA18350V, R2AA18750A, R2AA2220KB, R1AA13300H, R1AA13500H, R1AA13600H, R2AA18350V
    Rotary motor (400V)
    R2CA18350D, R2CA18350R, R2CA2220KM, R2CA2220KB, R2CA2220KV, R2CA2830KV, R2CA2837KB, R1CA2220KV, R1CA2225KL

- p. 5-9
  - Item below is added to the table of inrush current prevention time for 400VAC input.
    400 AC -300A, 600A

- p. 8-4, 8-6, 8-8, 8-9
  - Description for alarm code 21 and 2F is corrected.

- p. 8-12
  - Item 6 is added to corrective actions of alarm code 51.

- p. 8-13
  - Alarm code 54 is deleted.

- p. 8-14
  - Alarm code 56 is deleted.

- p. 8-8, 8-9, 8-12
  - Description for alarm code 21, 2F and 51 is added into troubleshooting.

- p. 9-6
  - Connector CN6 layout is added.

- p. 10-1
  - Standards conformity is updated.

- p. 13-3
  - Manufacturer model number of connectors for general I/O signal and for emergency stop input is changed.

Safety Precautions — Make sure to follow

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

■ Warning Symbol

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

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

■ Prohibited, Mandatory Symbols

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

■ Attention in use

⚠ Warning

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

◆ Do not use this device in explosive environment.
Injury or fire could otherwise result.

◆ Do not perform any wiring, maintenance or inspection when the device is hot-wired. After switching the power off, wait at least 15 minutes before performing these tasks.
Electric shock or damage could otherwise result.

◆ The protective ground terminal (⏚) should always be grounded to the unit or control board. The ground terminal of the motor should always be connected to the protective ground terminal (⏚) of the amplifier.
Electric shock could otherwise result.

◆ Do not touch the inside of the amplifier.
Electric shock could otherwise result.

◆ Do not damage the cable, do not apply unreasonable stress to it, do not place heavy items on it, and do not insert it in between objects.
Electric shock could otherwise result.

◆ Do not touch the rotating part of the motor during operation.
Bodily injury could otherwise result.

⚠ Caution

◆ Use the amplifier and motor together in the specified combination.
Fire or damage to the device could otherwise result.

◆ Only technically qualified personnel should transport, install, wire, operate, or perform maintenance and inspection on this device.
Electric shock, injury or fire could otherwise result.

◆ Do not expose the device to water, corrosive or flammable gases, or any flammable material.
Fire or damage to the device could otherwise result.

◆ Be careful of the high temperatures generated by the amplifier/motor and the peripherals.
Burn could otherwise result.

◆ Do not touch the radiation fin of the amplifier, the regenerative resistor, or the motor while the device is powered up, or immediately after switching the power off, as these parts generate excessive heat.
Burn could otherwise result.

◆ In terms of designing safety systems using the Safe Torque Off function, personnel who have expertise of relevant safety standard are supposed to do that job with good understanding of this instruction manual.
Injury or damage to the device could otherwise result.

◆ Please read the User Manual carefully before installation, operation, maintenance or inspection, and perform these tasks according to the instructions.
Electric shock, injury or fire could otherwise result.

◆ Do not use the amplifier or the motor outside their specifications.
Electric shock, injury or damage to the device could otherwise result.

◆ Regenerative resistor has instantaneous capacity. Contact our offices if the instantaneous regenerative power could be high as the result of high-inertia load or high-velocity rotation.

■ Storage

Prohibited

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

Mandatory

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

■ Maintenance･Inspection

Caution

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

Prohibited

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

■ Disposal

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

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

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

1. Preface

2 Interface

3. Data Link Layer

4. Object Dictionary

5. Operations

6. Adjustments

7. Digital Operator

8. Maintenance

9. Wiring

10. Safe Torque Off function

11. Full-Closed control

12. Linear motor

13. Appendixes

1.

1. Preface

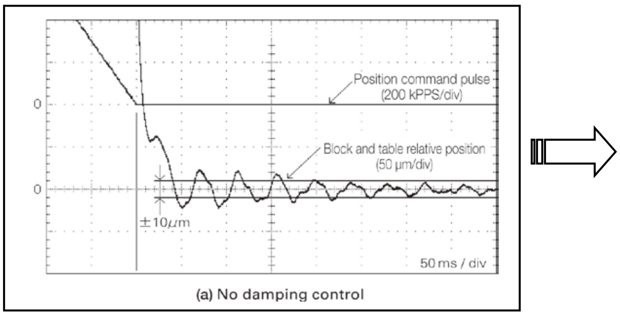
1.1 Introduction

The SANMOTION R multi-axis servo amplifier RM series provide one control unit, four kinds power unit/ six kinds amplifier unit for 200VAC input, and one power unit/ four kinds amplifier unit.
The servo motor corresponds to the rotary motor of R series.
For motor encoder, rotary motor can use serial encoder and pulse encoder, linear motor can use pulse encoder. Also, it can apply to external pulse encoder for full-closed system. Backup batteries for motor encoder can be supplied via servo amplifier dedicated connector. In addition, connectors for EtherCAT communication, PC connection and encoder are equipped.

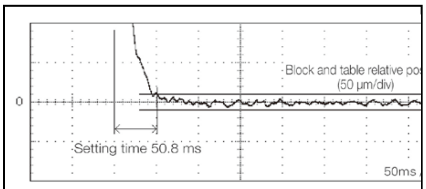
1) SANMOTION R multi-axis servo amplifier RM series features

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

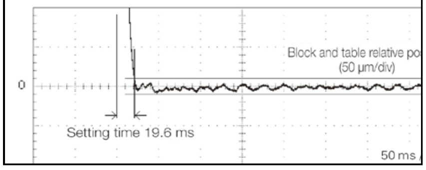
We have shortened the positioning time to 1/2 the current use, which improves the throughput of the machine using a high-response model following control and using model following vibration suppression control and feed forward vibration suppression control simultaneously.
Furthermore, external disturbance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



(a) No damping control



(b) Feed-forward damping control



- Noise reduction

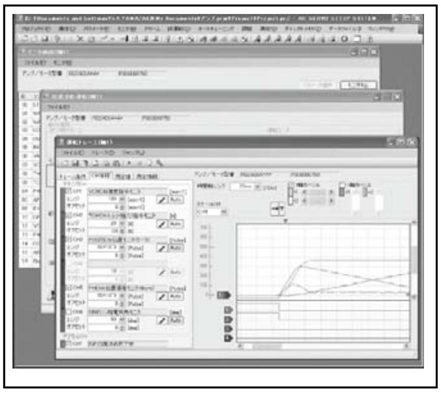
Using “model following vibration control” and “feed forward vibration control” the entire machinery system vibration is suppressed with an added bonus of cutbacks in energy expenditure.

- 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.

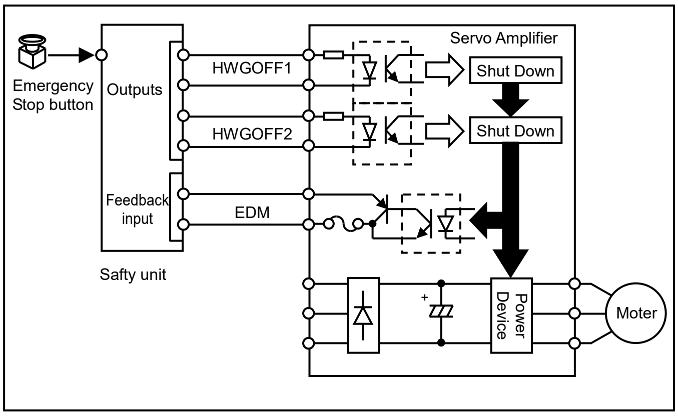


- Alarm display function

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 SANMOTION R multi-axis servo amplifier RM series as follows:

1) Contents

- ■ Chapter 1 Preface
  Describes product outline, model number, names of components.
- ■ Chapter 2 EtherCAT interface
  Describes EtherCAT interface outline.
- ■ Chapter 3 EtherCAT datalink
  Describes EtherCAT slave controller (ESC).
- ■ Chapter 4 Object Dictionary
  Describes EtherCAT Interface Object Dictionary.
- ■ Chapter 5 Operations
  Describes explanation of operation sequence, test operations and parameters.
- ■ Chapter 6 Adjustments
  Describes explanation of auto tuning, manual servo tuning, etc.
- ■ Chapter 7 Digital Operator
  Describes LED display and how to use the Digital Operator.
- ■ Chapter 8 Maintenance
  Describes explanation of troubleshooting when alarms occur and inspection
- ■ Chapter 9 Wiring
  Describes illustrations and explanations of wiring.
- ■ Chapter 10 Safe Torque Off Function
  Describes explanation of safe torque off function and how to use it.
- ■ Chapter 11 Full-closed Function
  Explanation of full-closed function and how to use it.
- ■ Chapter 12 Linear Motor
  Describes how to use when linear motor connected.
- ■ Chapter 13 Appendix
  Describes international standards, outline drawing, and explanation of EtherCAT terminology.

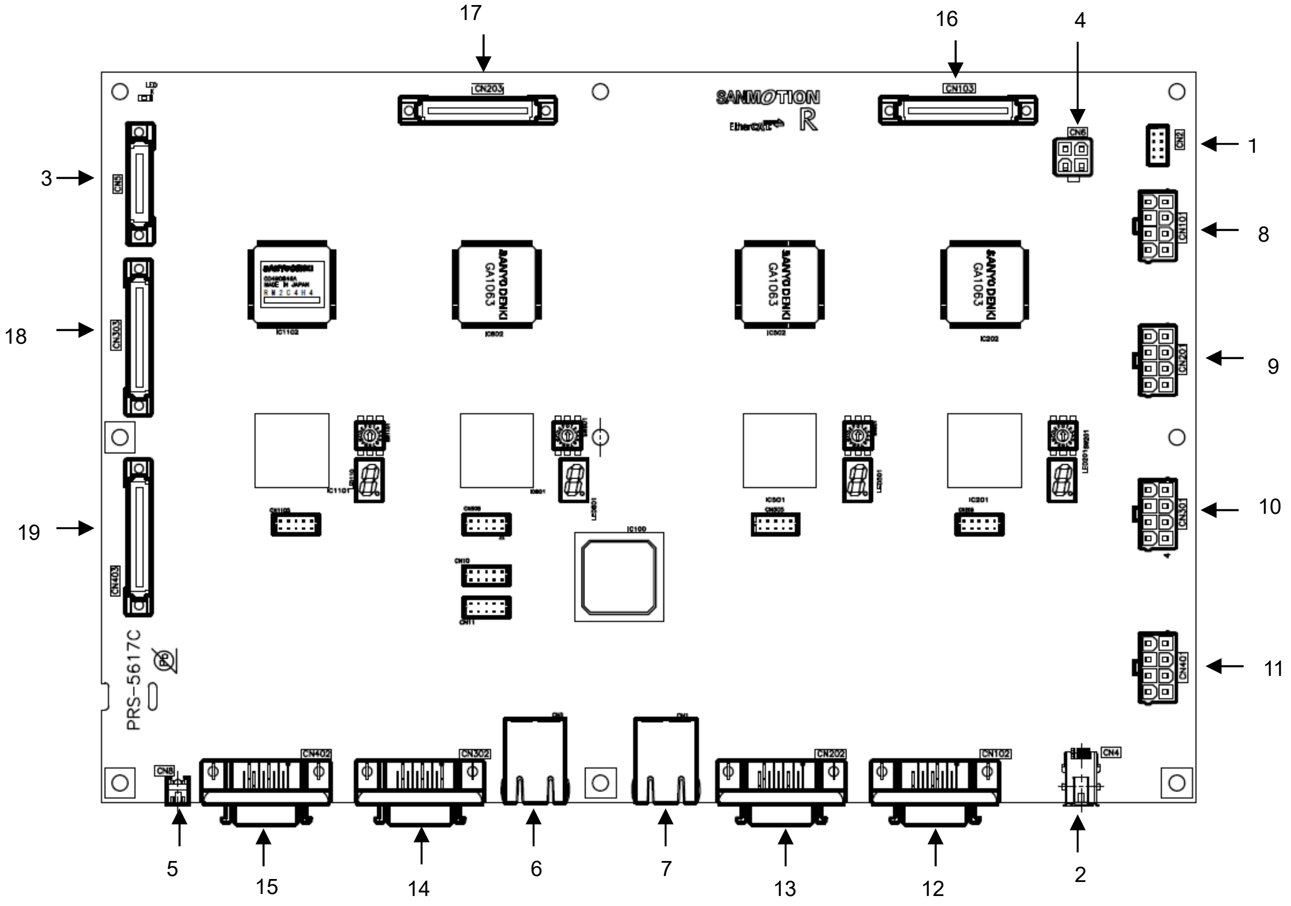
2) Precautions related to these Instructions

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

1.3 Product Part Names

1) Control board

Below shows name and description for each part of control board.



1. CN2
   Connector for PC communication.
2. CN4
   Connector for safety device connection.
3. CN5
   Connector for connection with power unit.
4. CN6
   Connector for emergency stop.
5. CN8
   Connector for battery connection.
6. IN
   Connector for EtherCAT communication.
7. OUT
   Connector for EtherCAT communication.
8. CN101
   Connector for general I/O signal (1st axis).
9. CN201
   Connector for general I/O signal (2nd axis).
10. CN301
    Connector for general I/O signal (3rd axis).
11. CN401
    Connector for general I/O signal (4th axis).
12. CN102
    Connector for sensor signal of servo motor (1st axis).
13. CN202
    Connector for sensor signal of servo motor (2nd axis).
14. CN302
    Connector for sensor signal of servo motor (3rd axis).
15. CN402
    Connector for sensor signal of servo motor (4th axis).
16. CN103
    Connector for connection with amplifier unit (1st axis).
17. CN203
    Connector for connection with amplifier unit (2nd axis).
18. CN303
    Connector for connection with amplifier unit (3rd axis).
19. CN403
    Connector for connection with amplifier unit (4th axis).

1.4 Model Number Structure

1) Control board model number

RM2 C 4 H 4 △△△

Series name
RM2･･･SANMOTION R ADVANCED MODEL
Multi-axis EtherCAT control board

Unit name
C･･･Control board

Axes number
4･･･4 axes

Interface type
H･･･EtherCAT interface (RM2 series amplifier unit, power unit connection)

Safety hardware

	Safe Torque Off function
4	Available (with delay circuit)

Individual specification

2) Power unit model number

RM3 P □ ▽ ◇◇◇ △△△

Series name
RM3･･･RM3 series

Unit name
P･･･Power unit (power)

Input power supply voltage
A･･･200 V AC for main circuit/ 200 V AC for control
C･･･400 V AC for main circuit/ 24 V AC for control

Regenerative resistor
A･･･External type B･･･Built-in type

Main circuit capacity

	Main circuit capacity of 200V AC input type
7R8	7.8kW
120	12kW
160	16kW
270	27kW
370	37kW

	Main circuit capacity of 400V AC input type
160	16kW
370	37kW

Individual specification

3) Amplifier unit model number

RM3 D □ ◇◇◇ △△△

Series name
RM3･･･RM3 series

Unit name
D･･･Amplifier unit (Drive)

Input power supply voltage
A･･･280 V DC for main circuit/ 280 V DC for control
C･･･560 V DC for main circuit/ 24V DC for control

Main circuit capacity

	Amplifier capacity of 200V AC input type	DB resistor
050	50A	Built-in
100	100A	Built-in
150	150A	Built-in
300	300A	Built-in
600	600A	Without
900	900A	Without

	Amplifier capacity of 400V AC input type	DB resistor
025	25A	Built-in
050	50A	Built-in
075	75A	Built-in
150	150A	Built-in
300	300A	Without
600	600A	Without

Individual specification

- * Above is the model numbers for standard specification. Model number with the specification undescribed in manual will different. Contact us for the detail.
- * "Standard setting value" is set to a control board at factory setting.
  "System parameters" and "General parameters" have to change as fit to the followings: servo amplifier/motor combination in customer use, customer application spec, etc.

2.

2. Interface

2.1 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).

2.2 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.

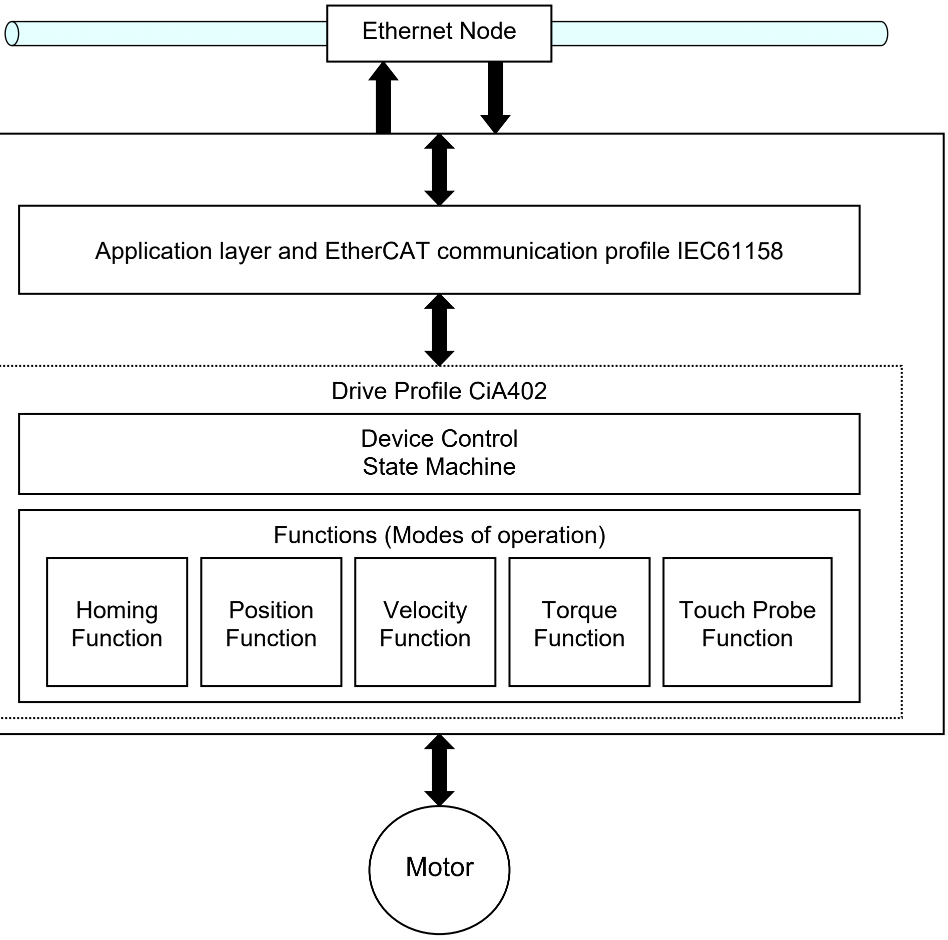
- ■ Layer 4 (Transport layer)
  Performs data compression, error correction and resends data delivery controls absolutely and efficiently.

- ■ 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

2.3 Settings

1) Node ID

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

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

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

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

2) Physical Communication Specifications

Physical Communication Specifications

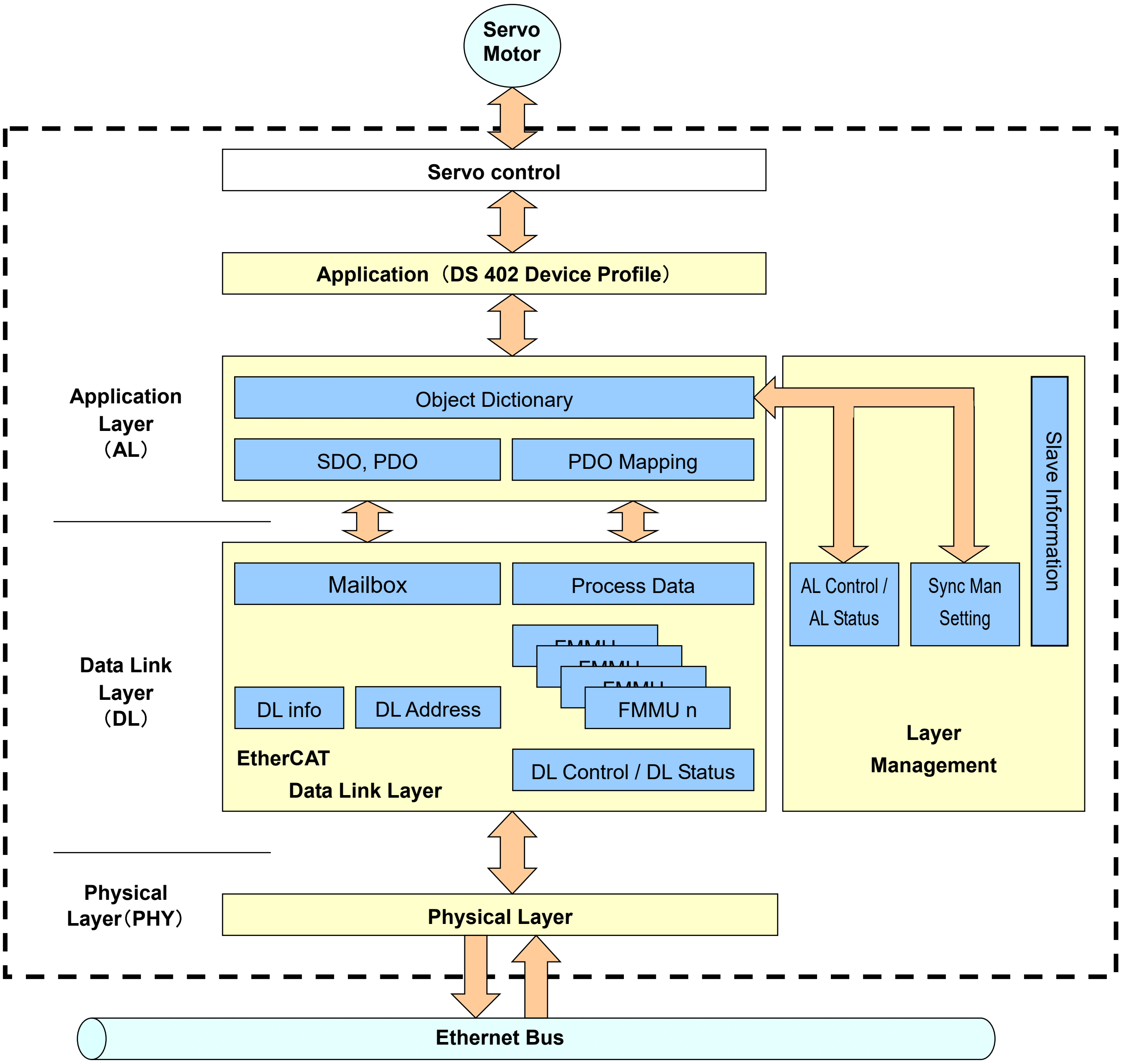
Item	Specifications	Notes
Topology	Line	
Data flow	Line: From the master to the first slave and then on to the last slave, shuttling back and forth.	
Communication media	Twisted pair cable	
Communication rate	100 Mbit/s	
Communication parameter settings	Auto-negotiation function with ISO/IEC 8802-3 Auto-crossover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

2.4 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:

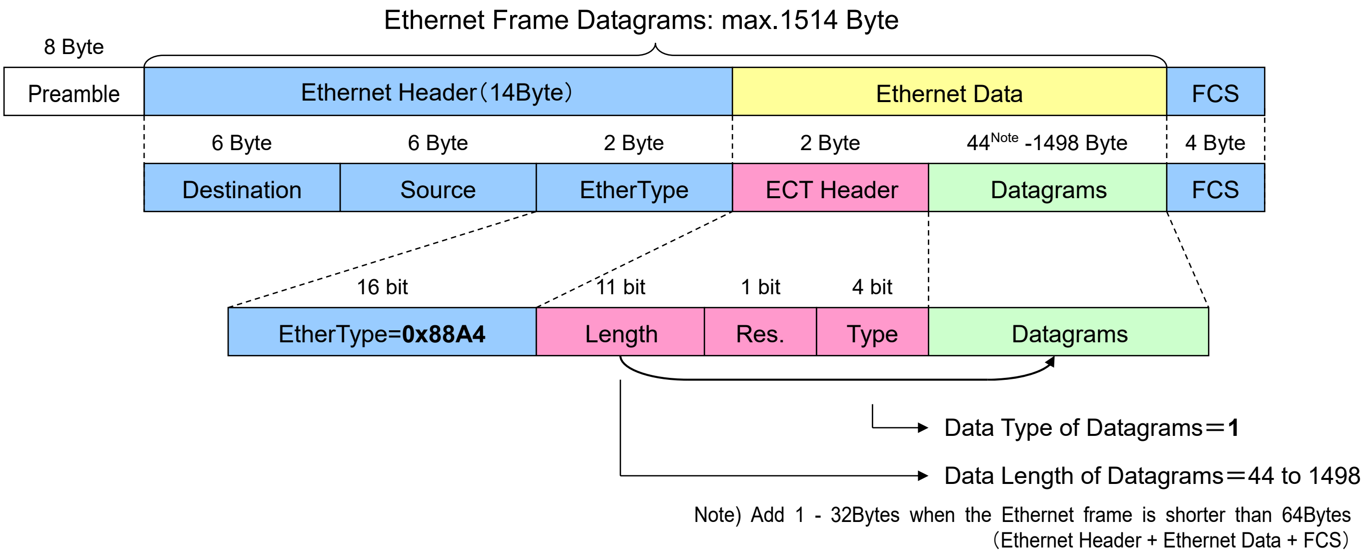
Object Index Assignment

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**

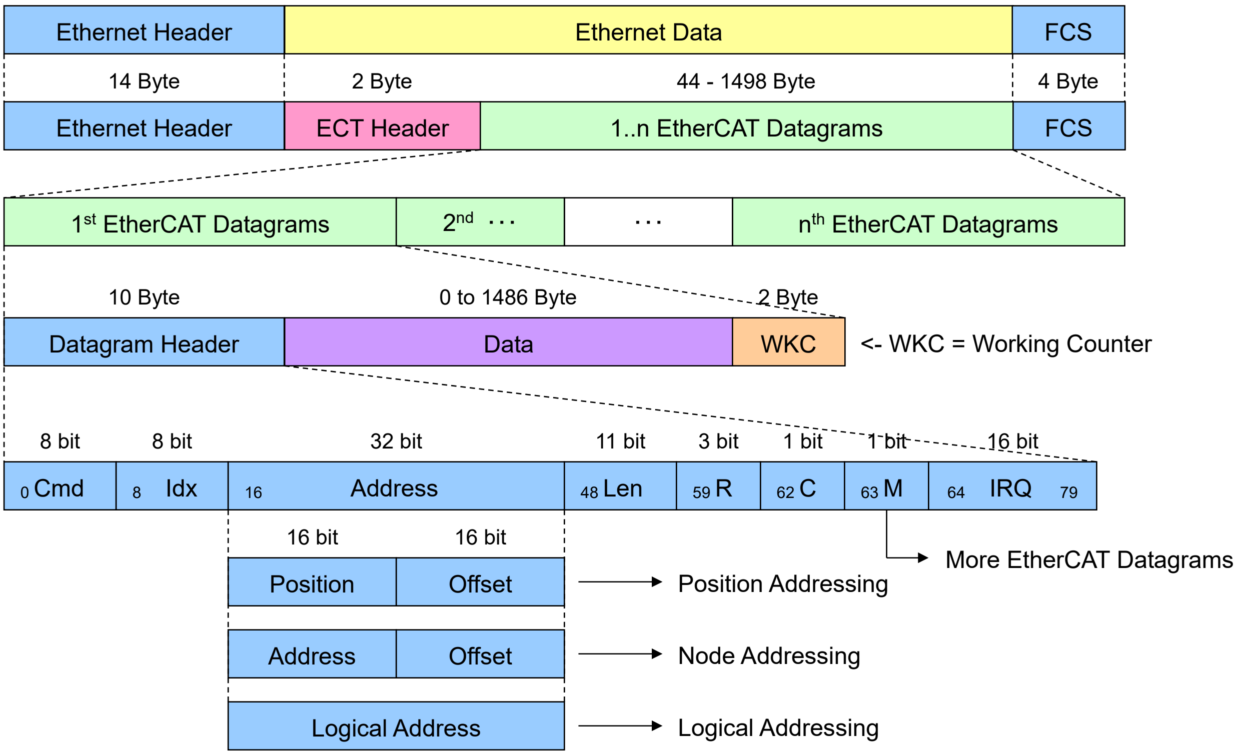
Since EtherCAT is adopting IEEE 802.3 as its standard Ethernet frame, a standard network controller can be used.
Therefore, system construction is possible on the master side without designing specific hardware.
“0x88A4” is reserved for the Ether type of EtherCAT and is distinguished from the other Ethernet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

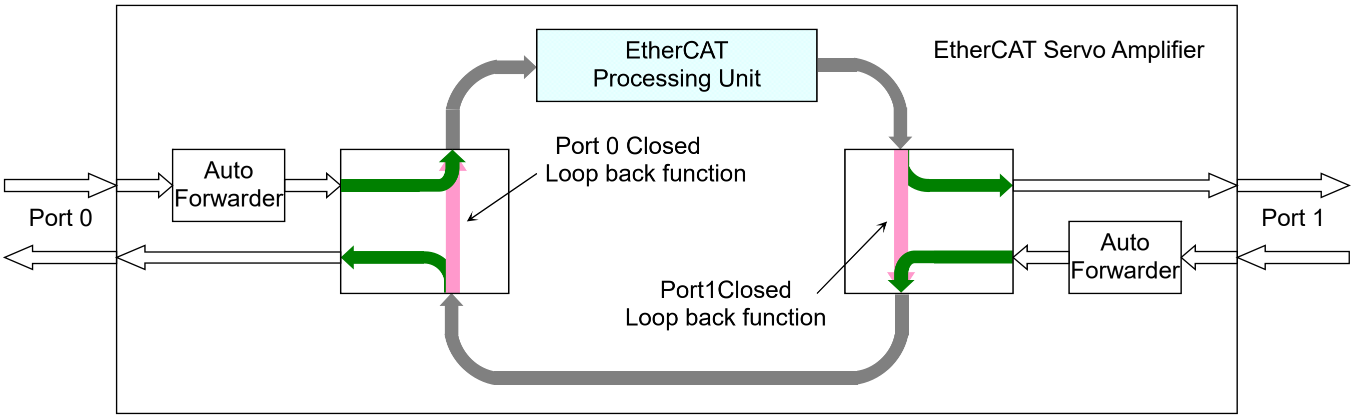
7) Frame Processing

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”.

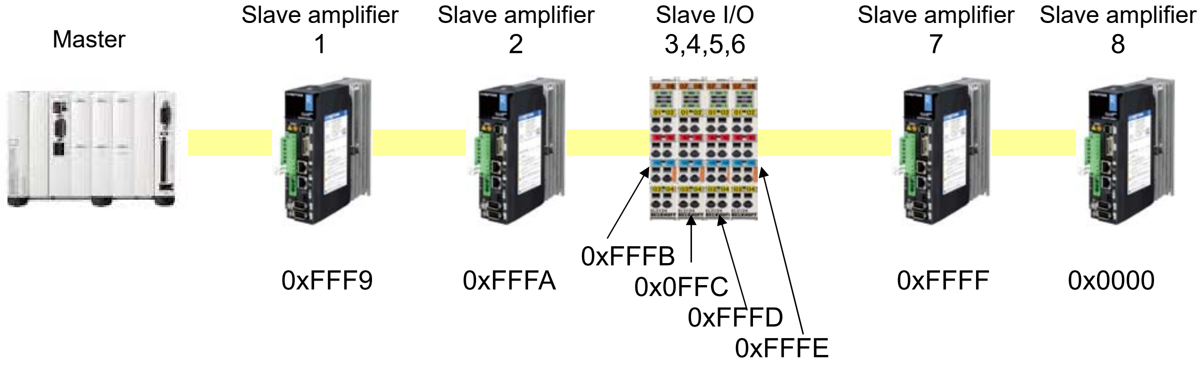


Frame Processing of R-ADVANCED EtherCAT Amplifier

2.5 Addressing Image

1) Position Addressing (Auto-Increment Addressing)

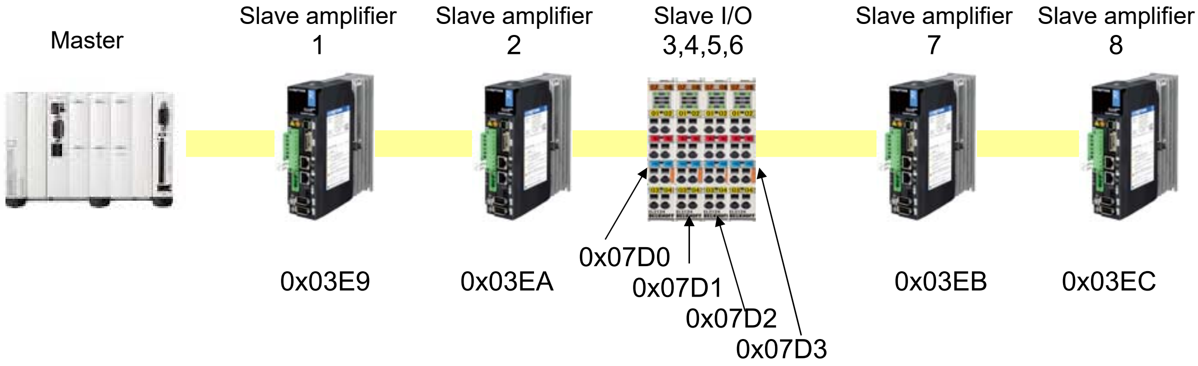
Position addressing is a command to access slaves from the master according to the connection order (physical position).
Each slave device provides one (1) 16-bit address field every time datagrams pass through and a slave “0x0000”will be addressed and will respond when receiving the address field.
Position 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.

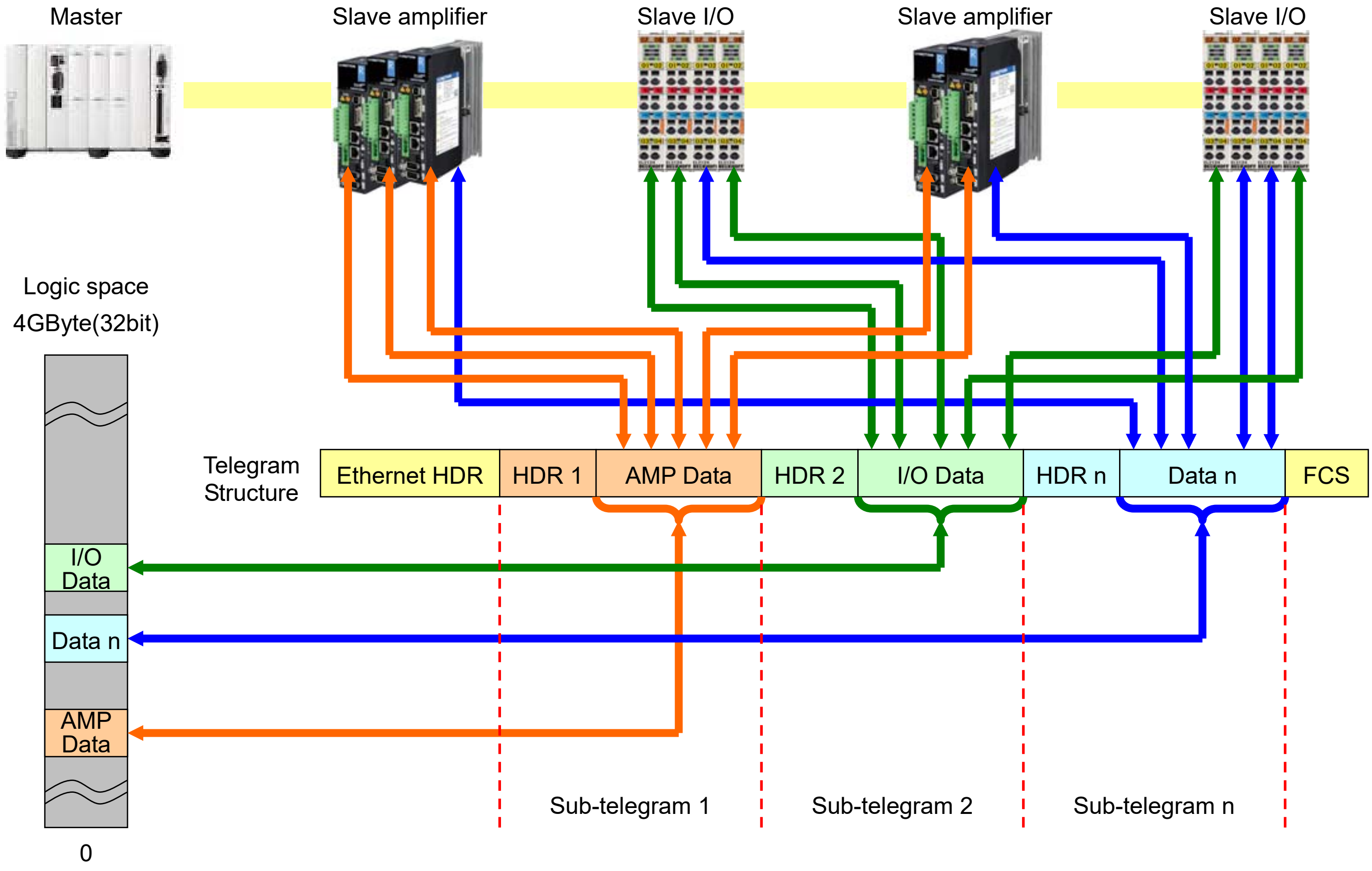


Node Addressing Image

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 (Sync Manager)

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.

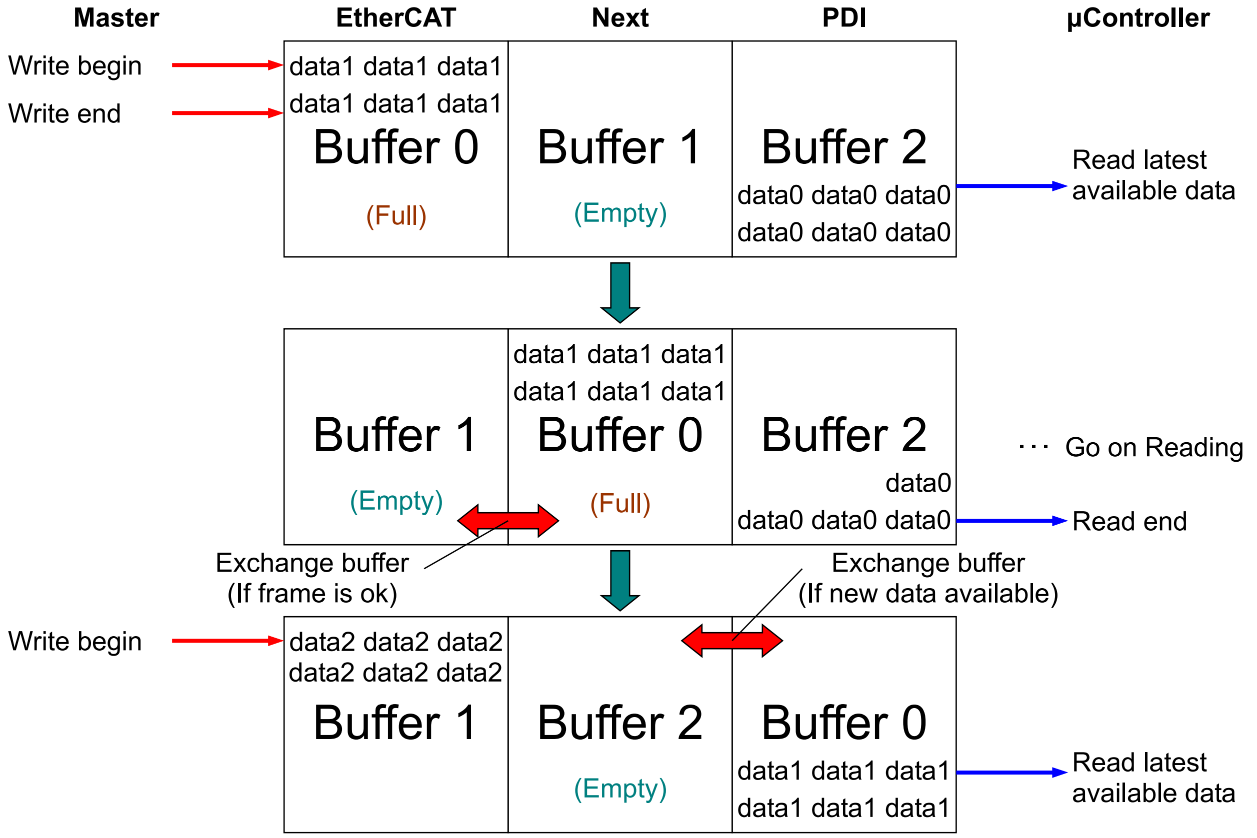
Generally, one buffer among the three is for Write use, one for Read use and another is reserved for Write use.

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



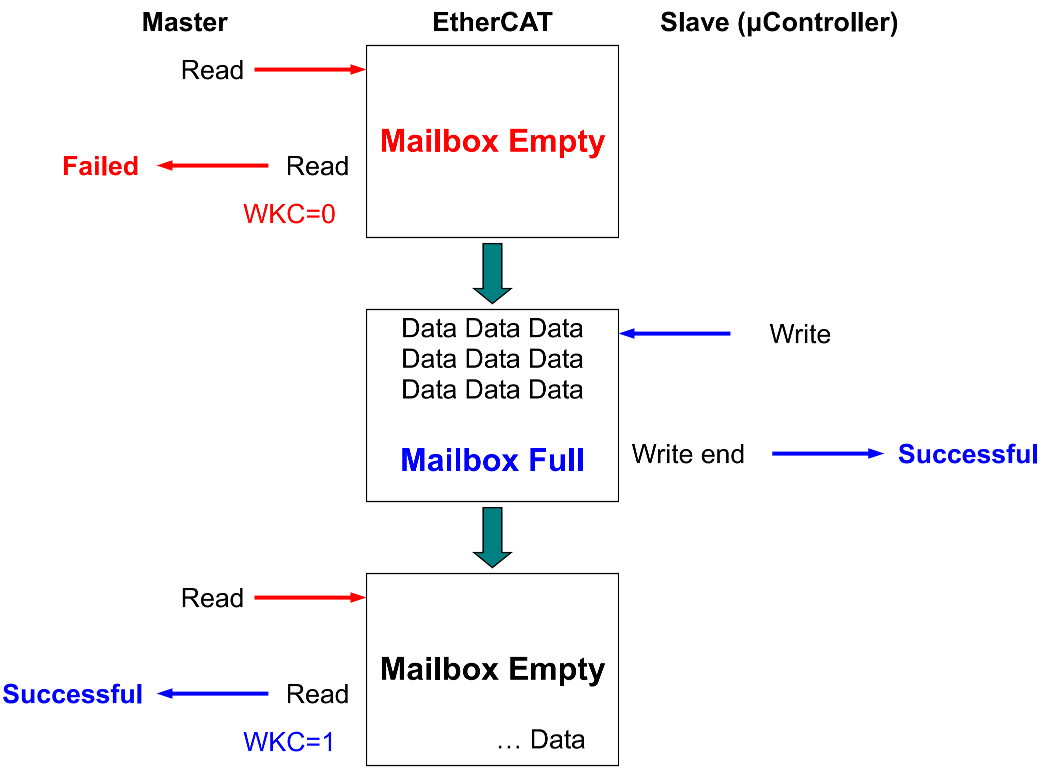
Conversion example of SyncManager Buffer Mode (Master => Slave)

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)

2.6 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)

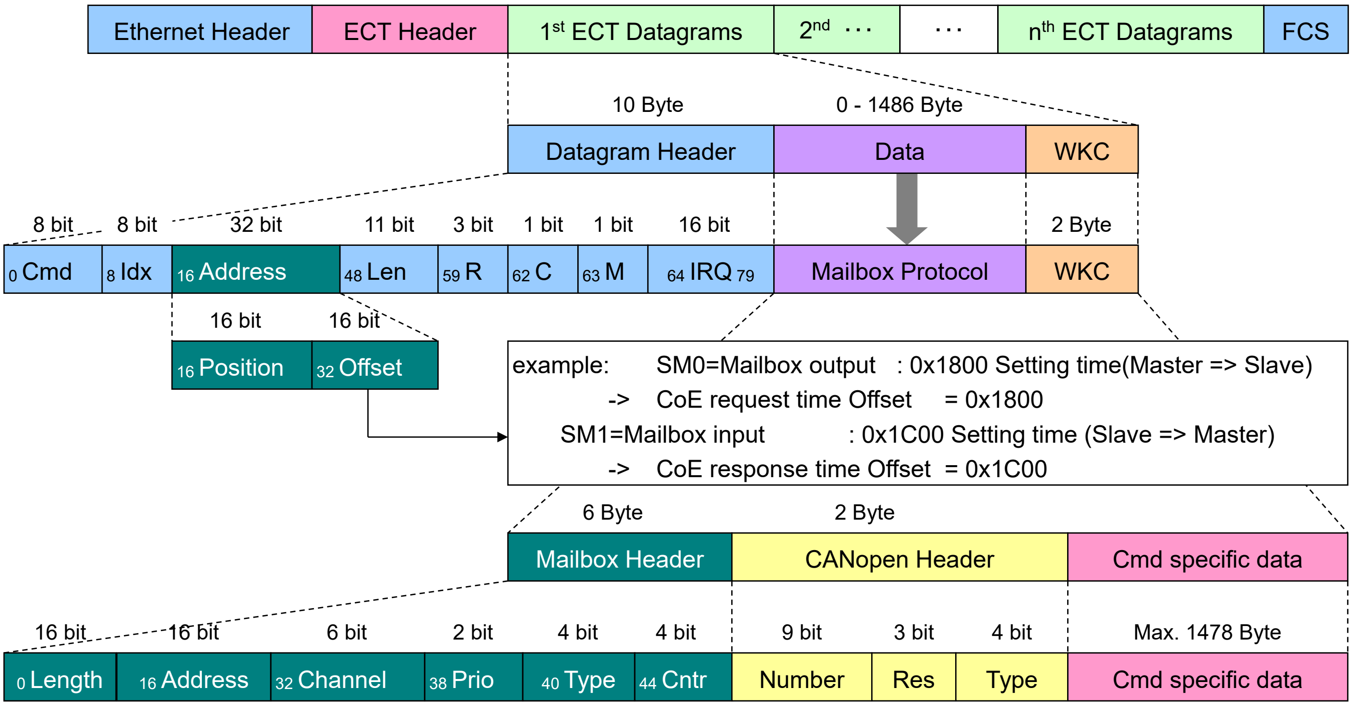
1) Service Data Object (SDO)

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

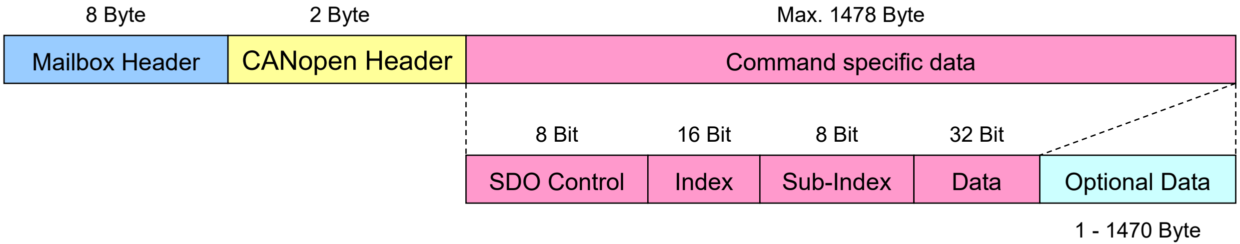
"CANopen Header" is configured with a 2Byte identifier composed of "Number" and "Type".
"CANopen Header" configuration is shown below.

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
$_{2}$ Data Set Size : $_{2}$ D S
$_{5}$ Command Specific : $_{5}$ C S
$_{8}$ Index : $_{8}$ Idx
$_{32}$Complet Size : $_{32}$ Cmp S

$_{1}$ Transfer Type : $_{1}$ T T
$_{4}$ Complete Access : $_{4}$ C A
$_{0}$SDO Control : $_{0}$ SDO
$_{24}$ Sub-Index : $_{24}$ Sub

- SDO Download Expedited Request

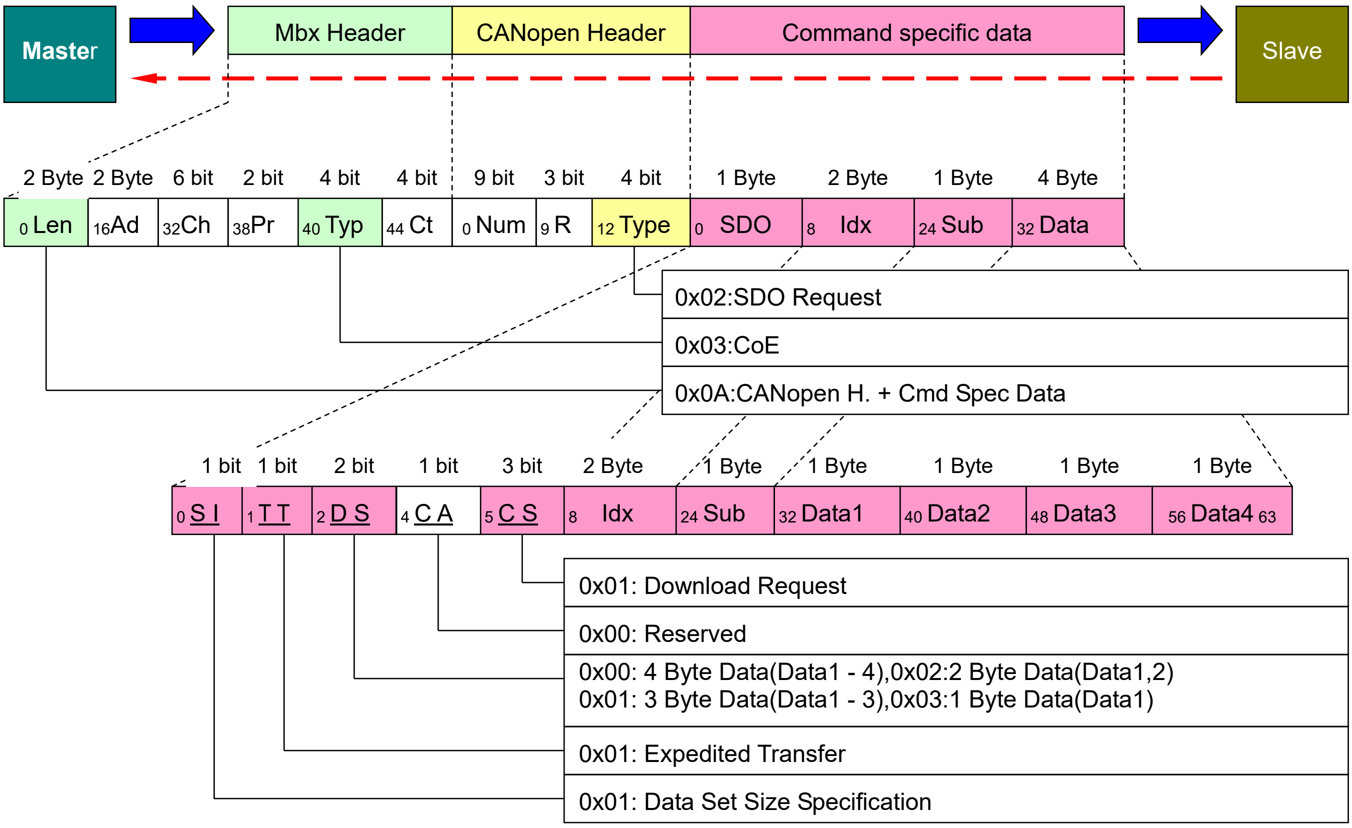


Diagram 1 : SDO Download Expedited Request

- SDO Download Expedited Response

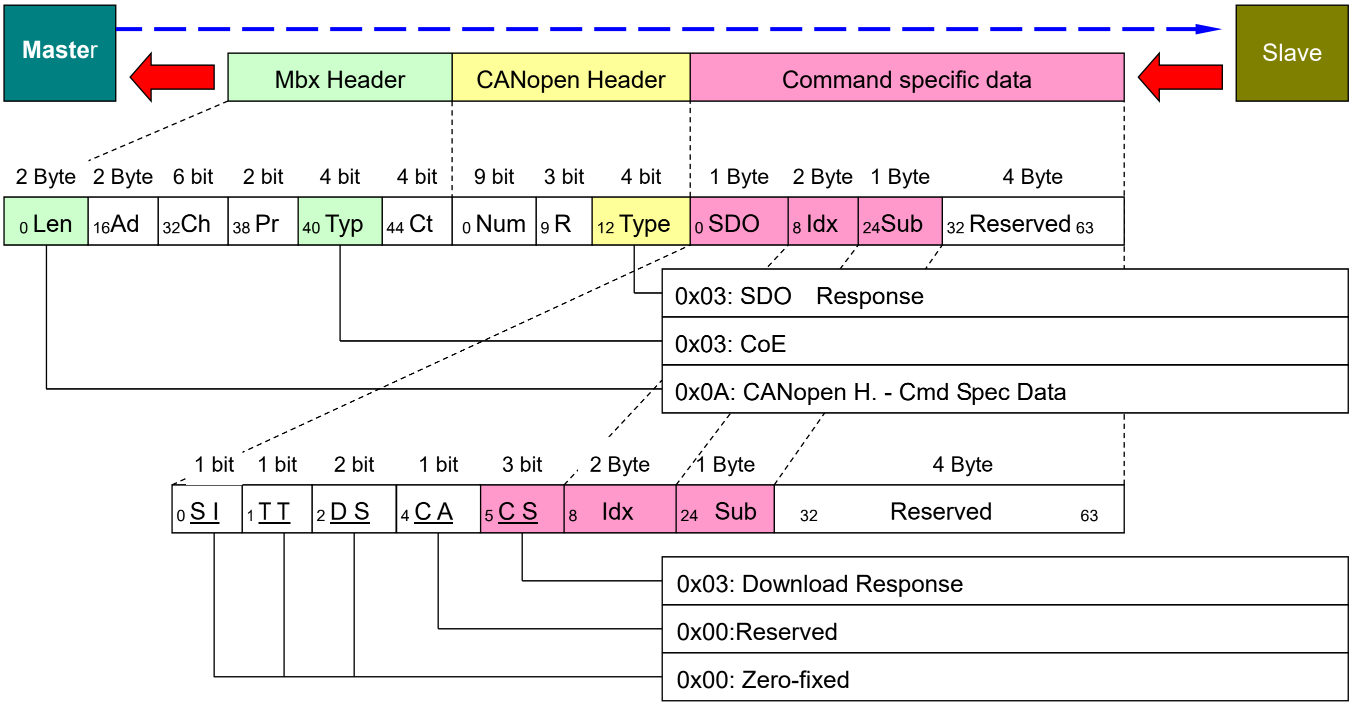


Diagram 2 : SDO Download Expedited Response

- SDO Upload Expedited Request

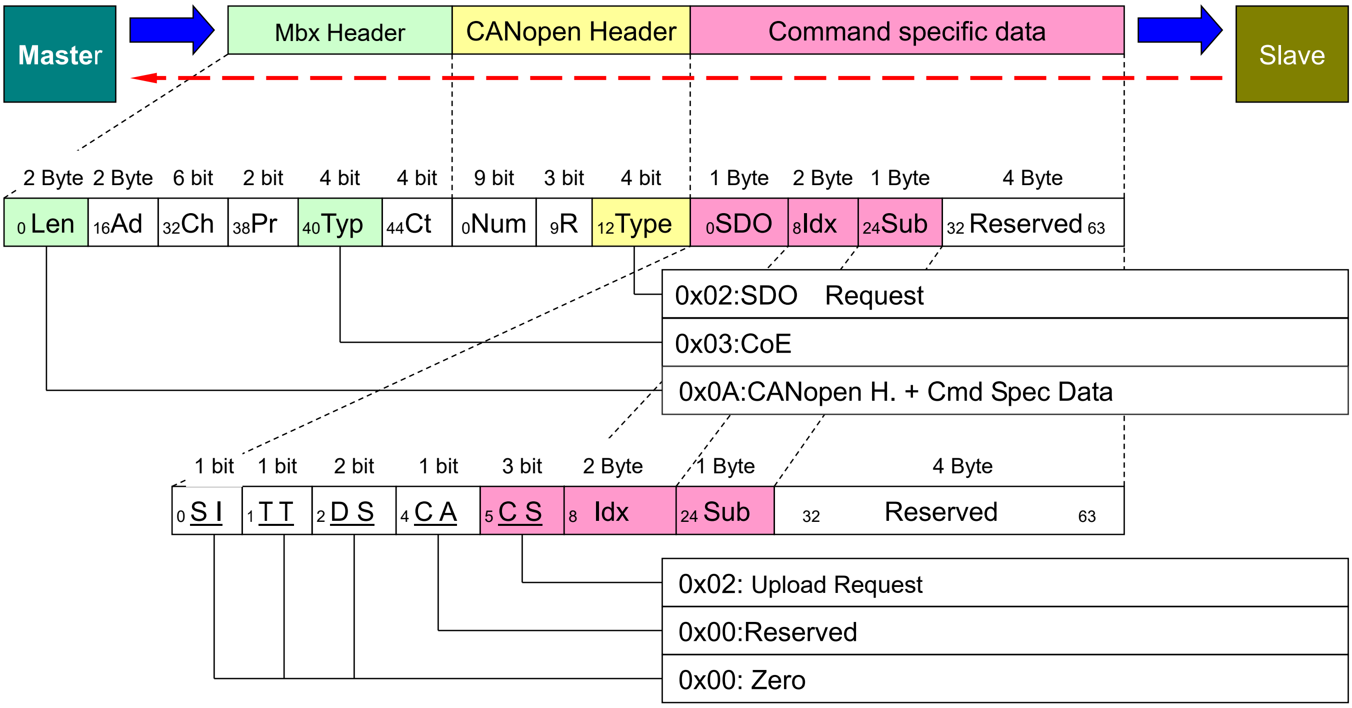


Diagram 3 : SDO Upload Expedited Request

- SDO Upload Expedited Response

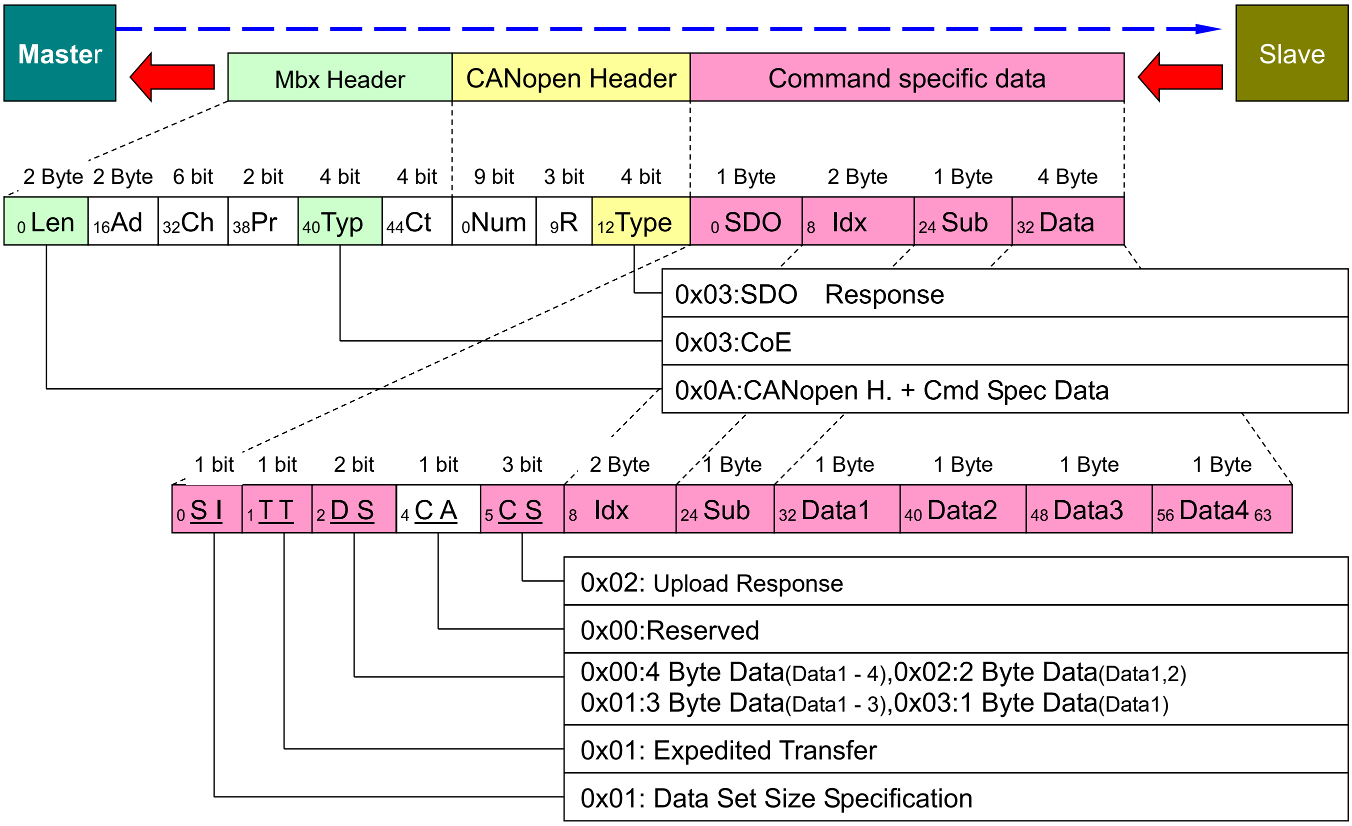


Diagram 4 : SDO Upload Expedited Response

- SDO Download Normal Request

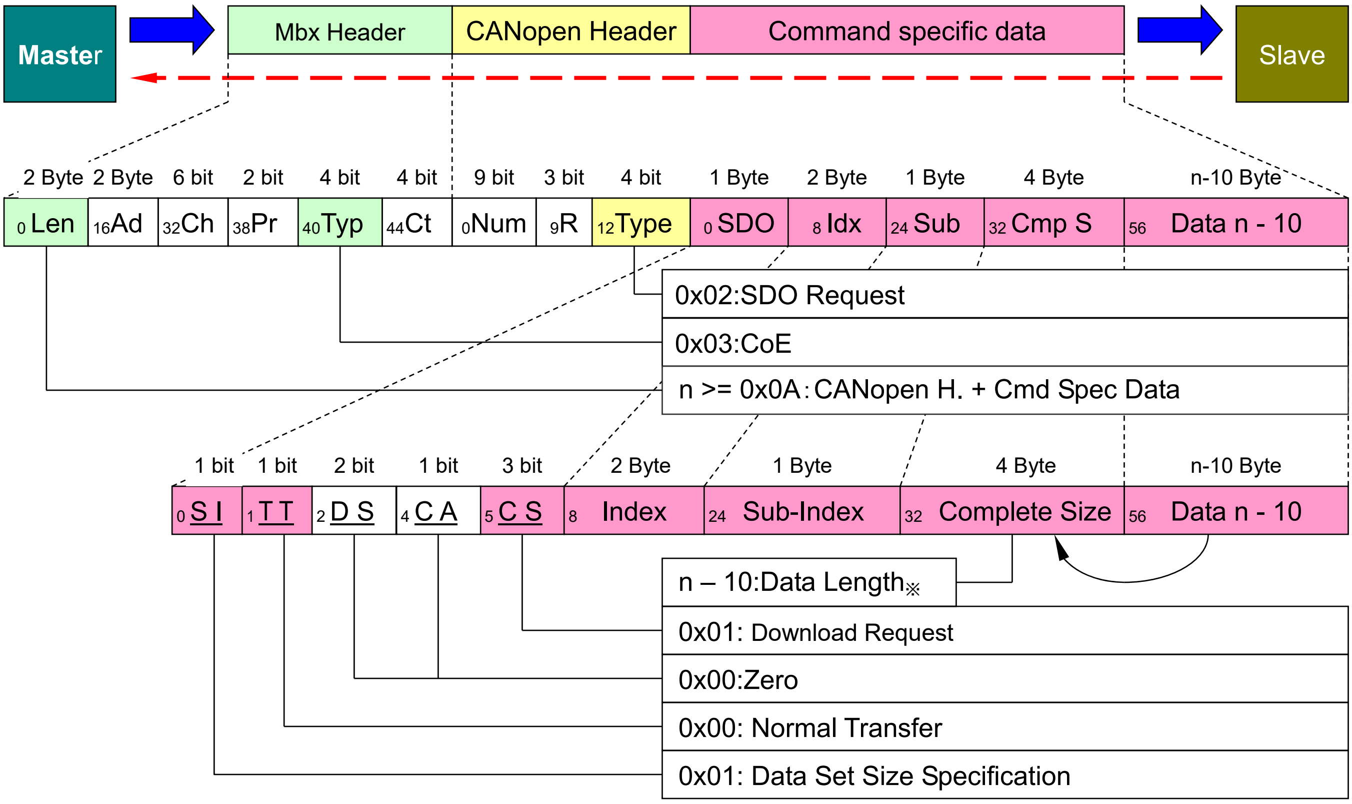


Diagram 5 : SDO Download Normal Request

- 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

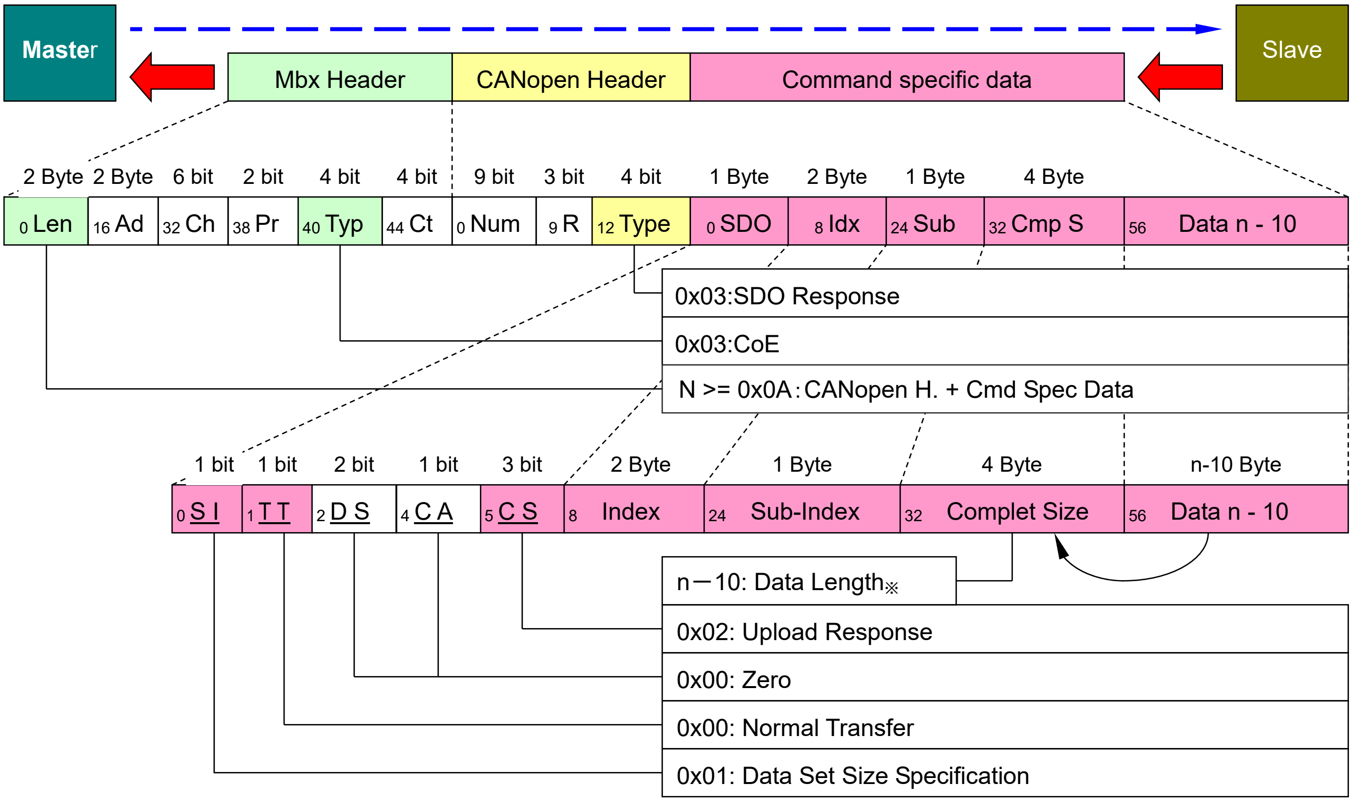


Diagram 6 : SDO Upload Normal Response

- 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:

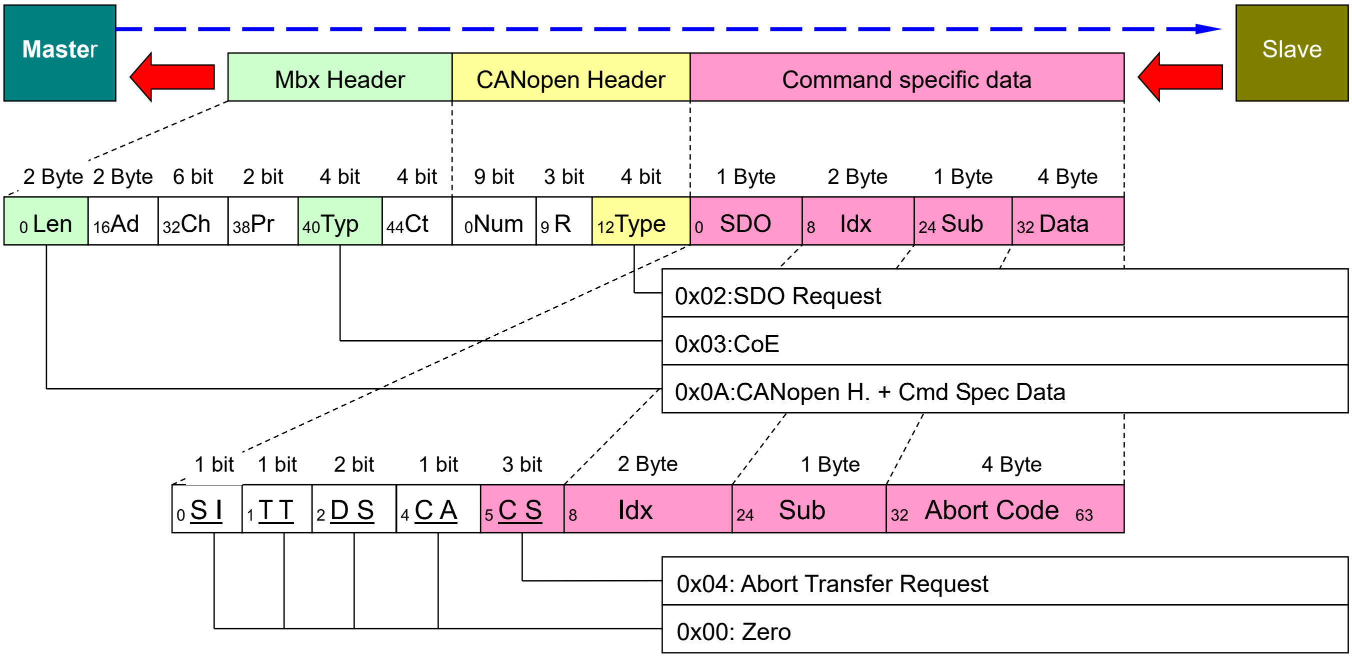


Diagram 7 : Abort SDO Transfer Request

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.

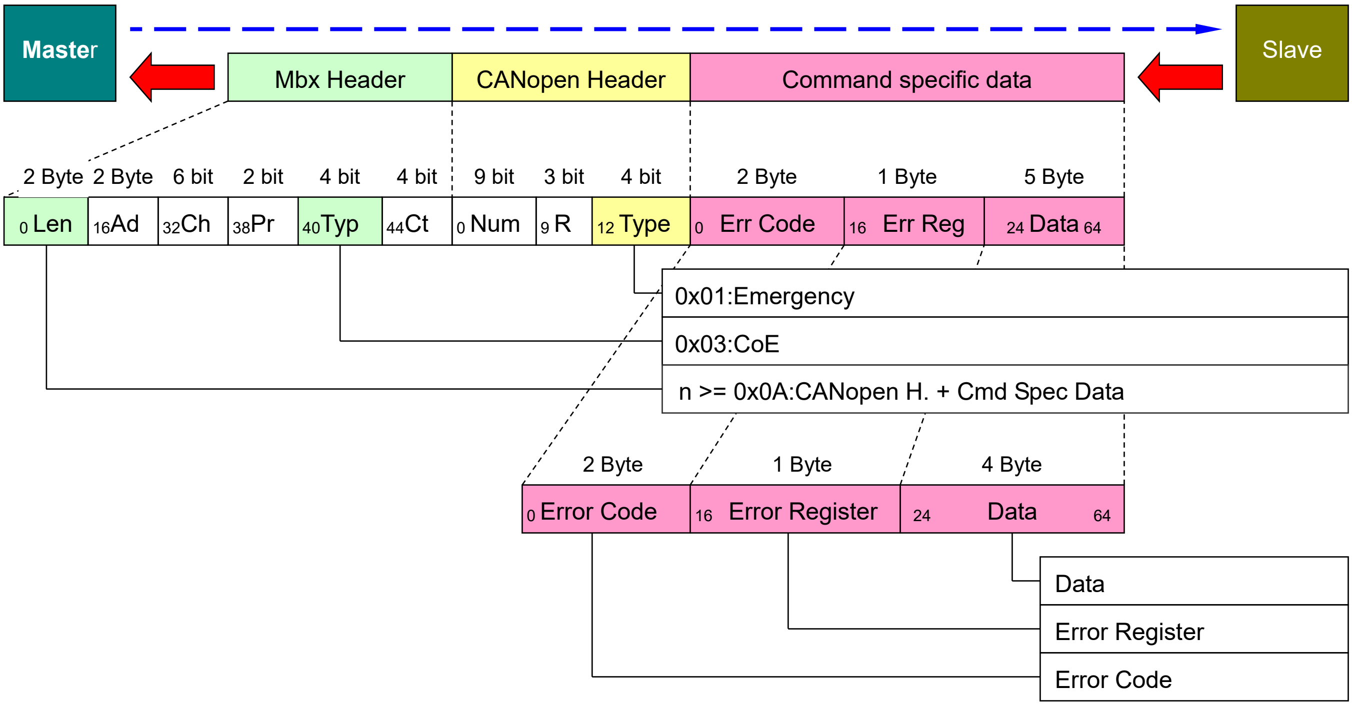


Diagram 8 : EMCY Emergency

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

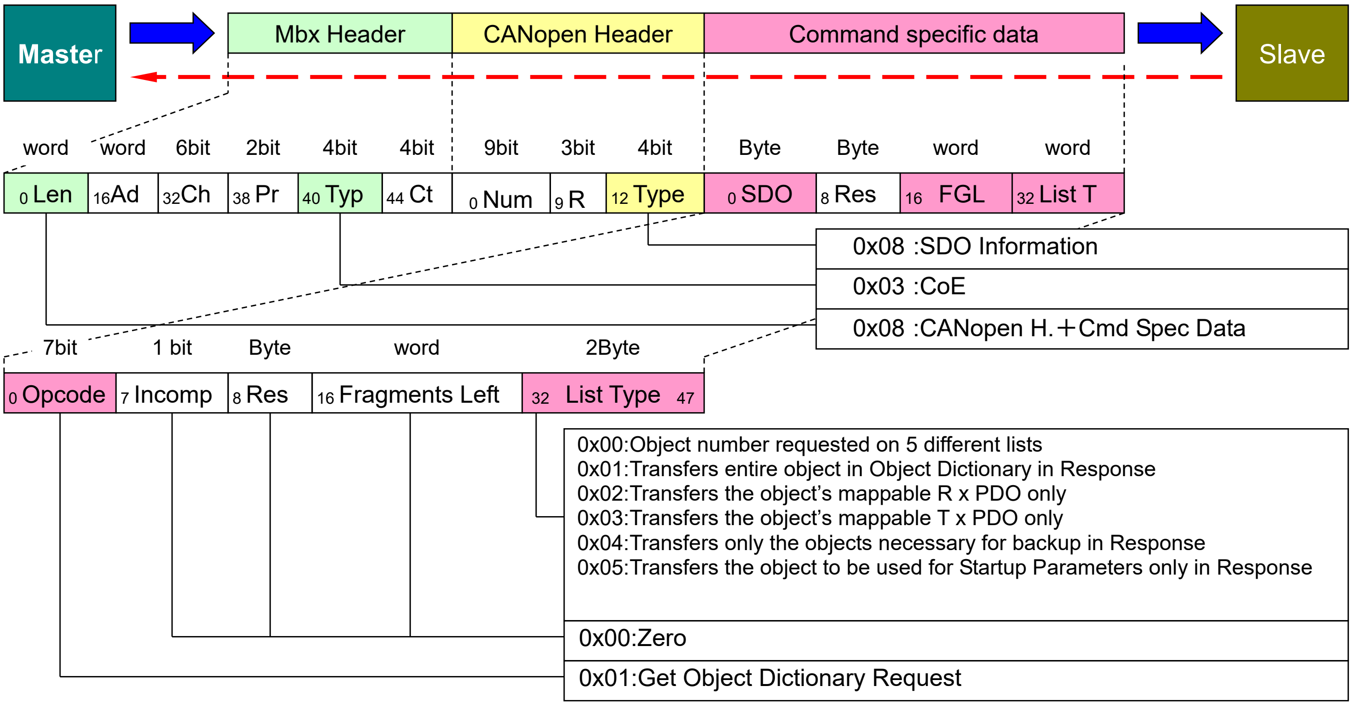


Diagram 9 : Get OD List Request (Object Dictionary Request)

◆ Object List Response (Object List Segment Response)

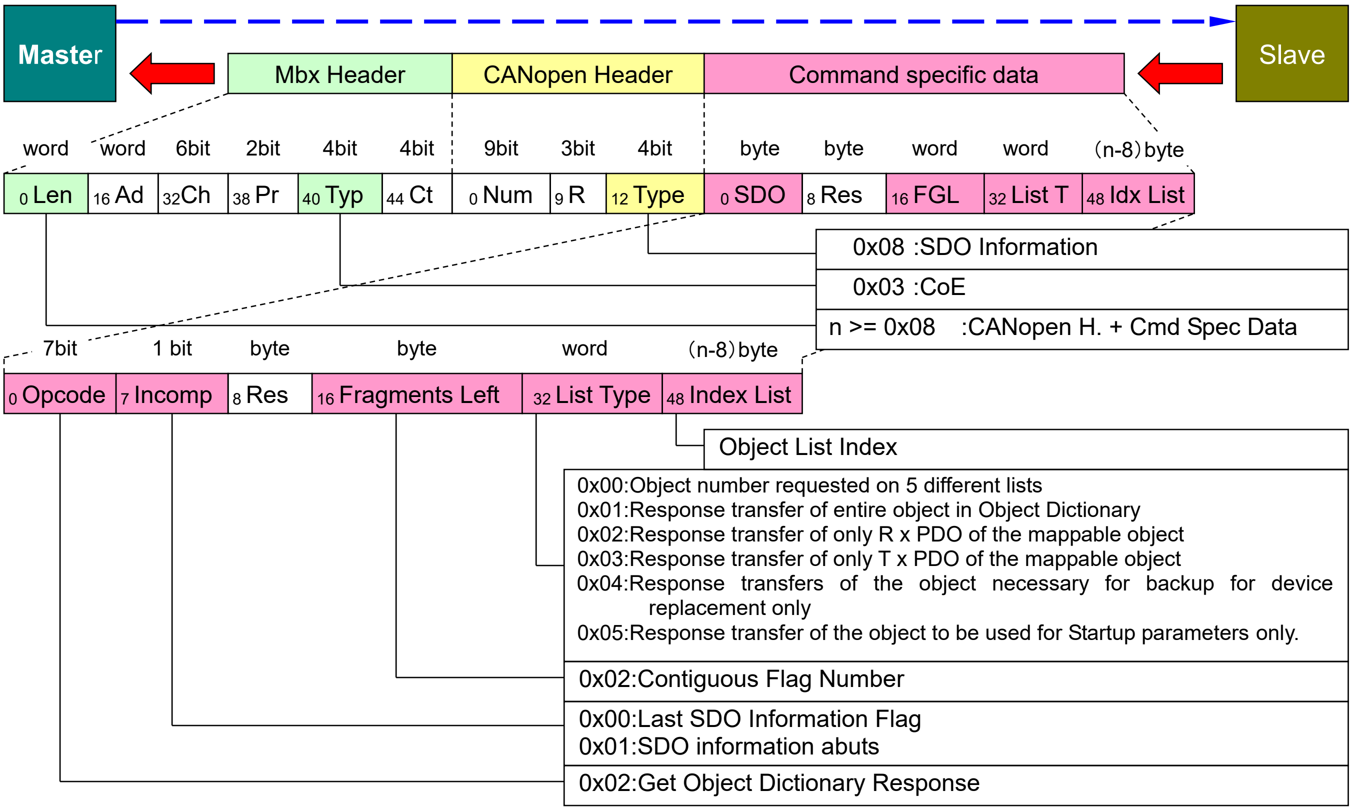


Diagram 10 : Get OD List Response (Object Dictionary Response)

◆ Object Dictionary Request

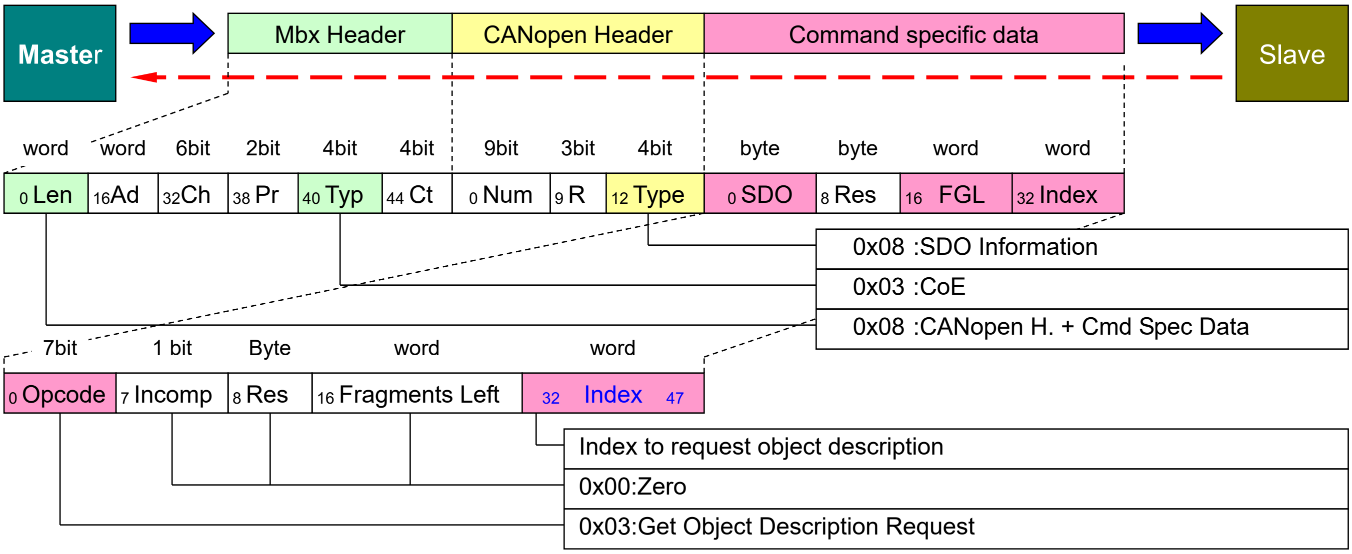


Diagram 11 : Get Object Description Request (Object Description Request)

◆ Object Description Response

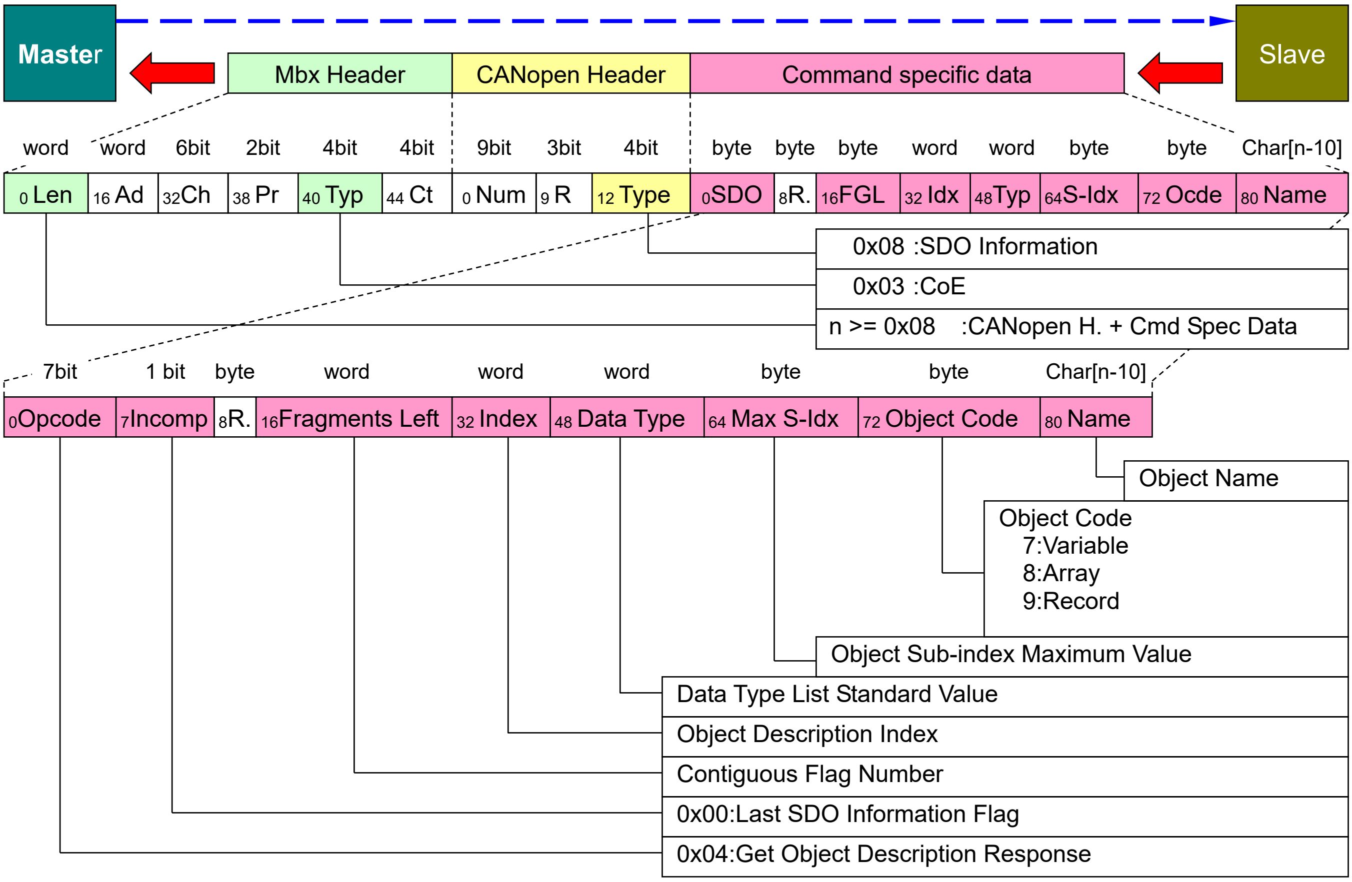


Diagram 12 : Get Object Description Response (Object Dictionary Response)

- Entry Description Request

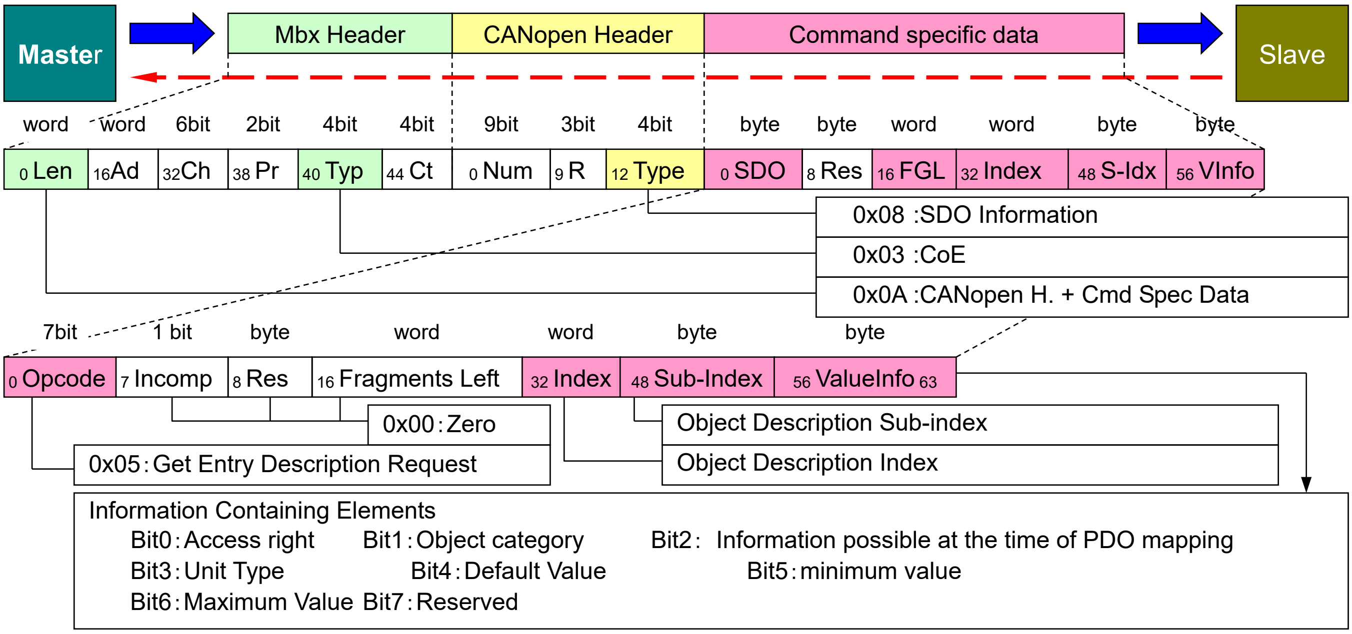


Diagram 13 : Get Entry Description Request (Object Description Request)

- Entry Description Response (Entry Description Segment)

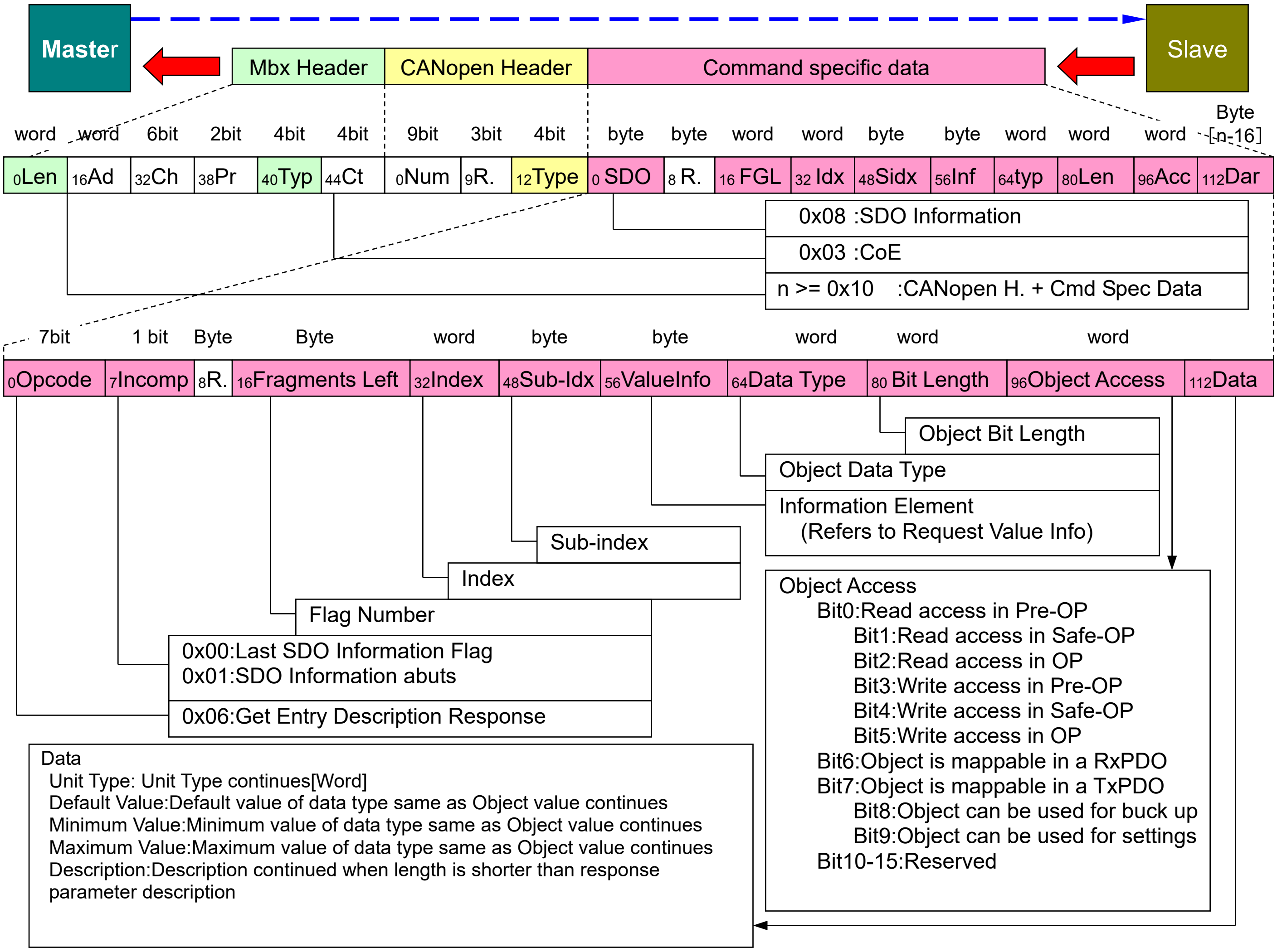


Diagram 14 : Get Entry Description Response (Object Dictionary Response)

- SDO information Error Request

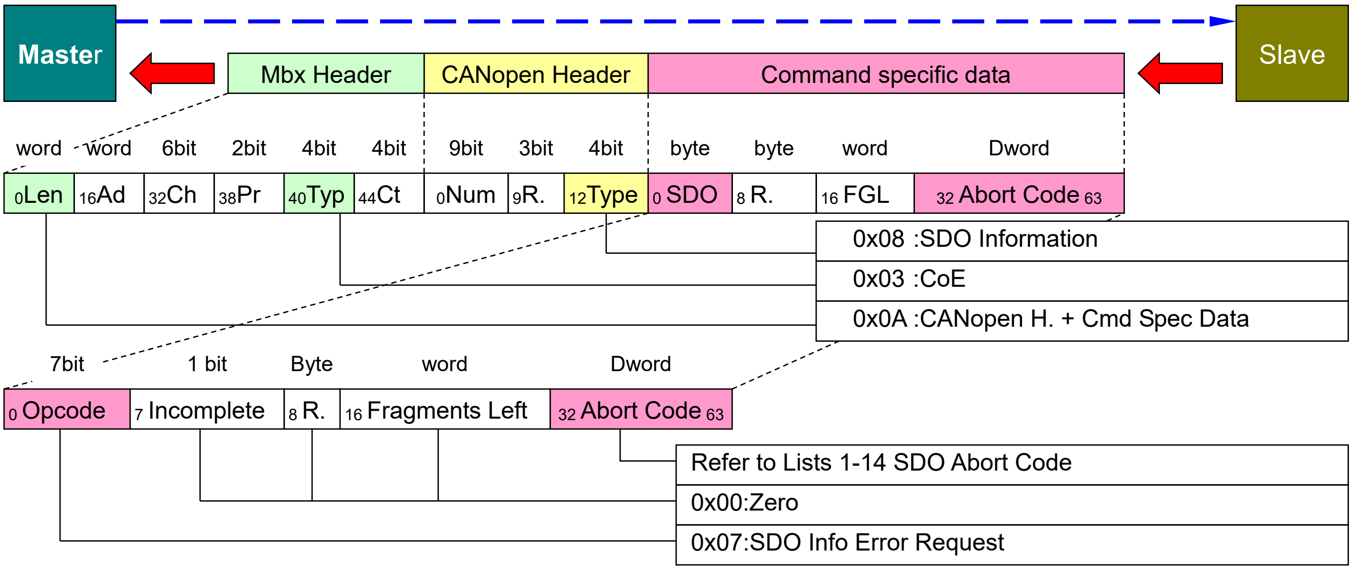


Diagram 15 : Error Request (SDO Information Error Request)

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.

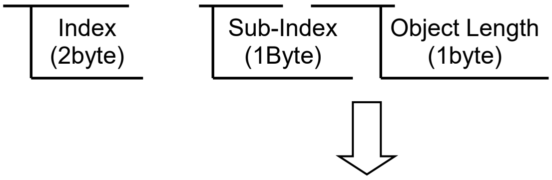
- PDO Mapping

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



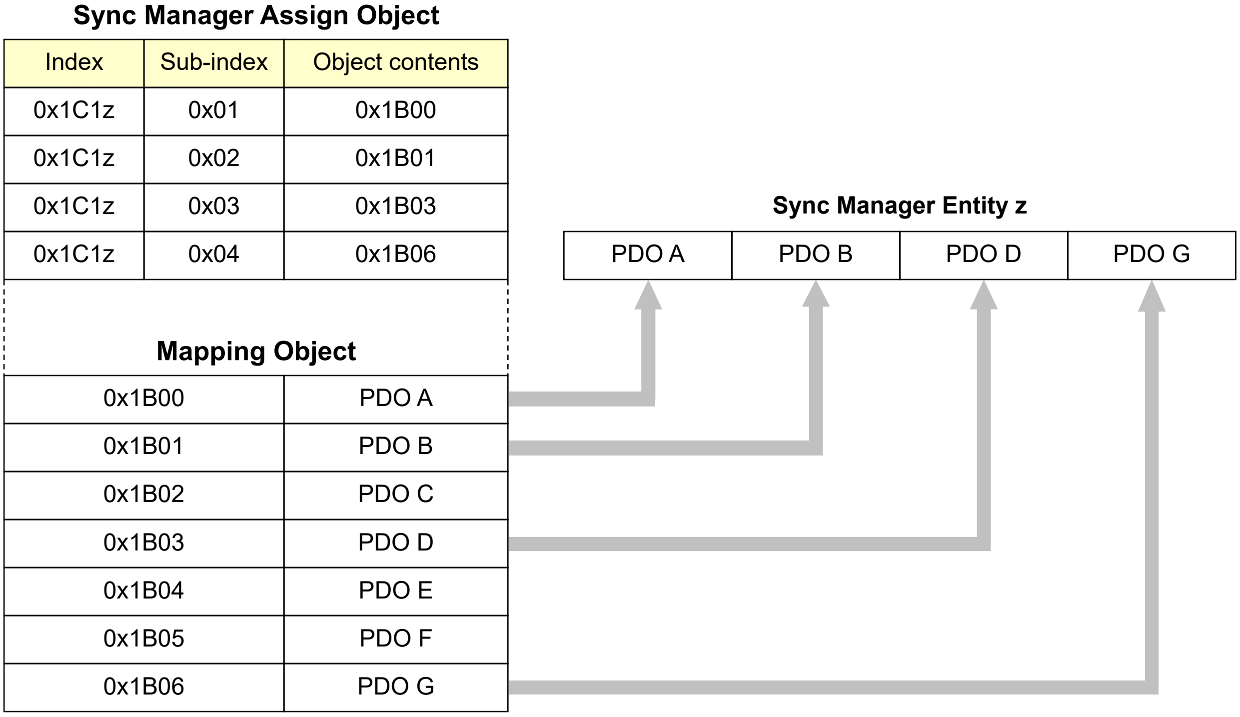
Byte	0	1	2	3	4	5	6	7	8	9
PDO “0x1B0y”	0x6064:00				0x6077:00		0x6061:00	Reserved	0x6041:00	

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 RM2 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).

2.7 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

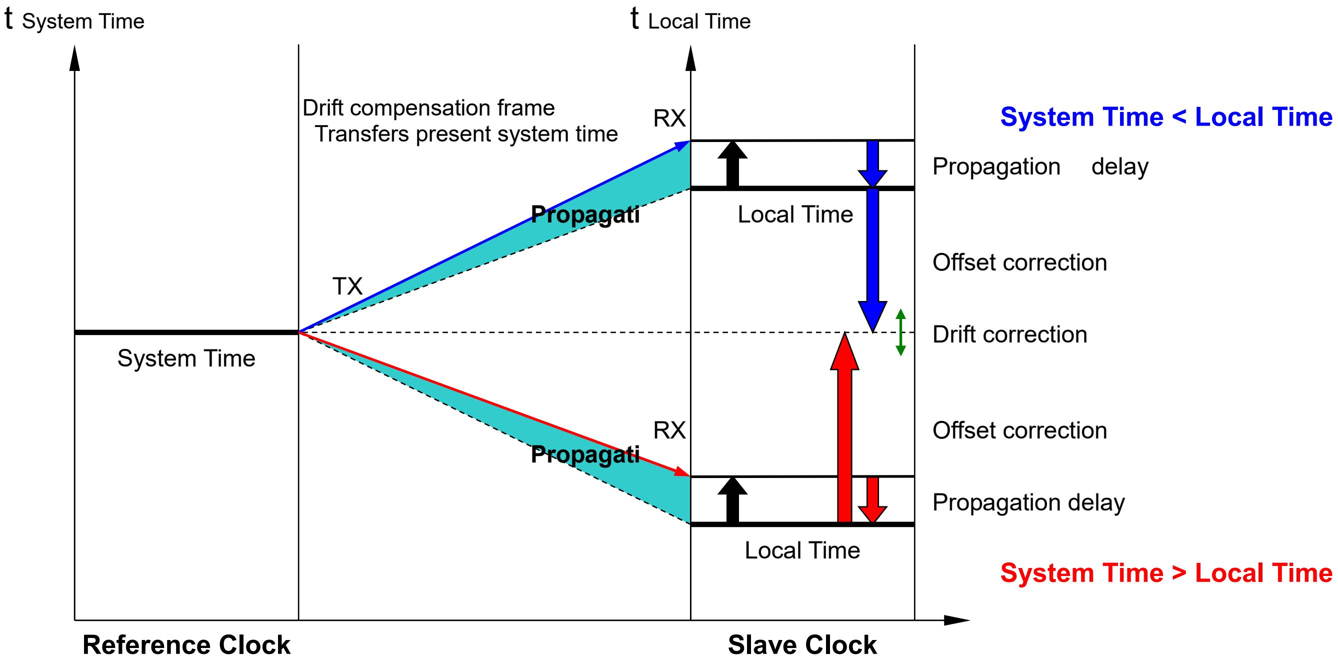
The clock synchronization process consists of three (3) steps.

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).

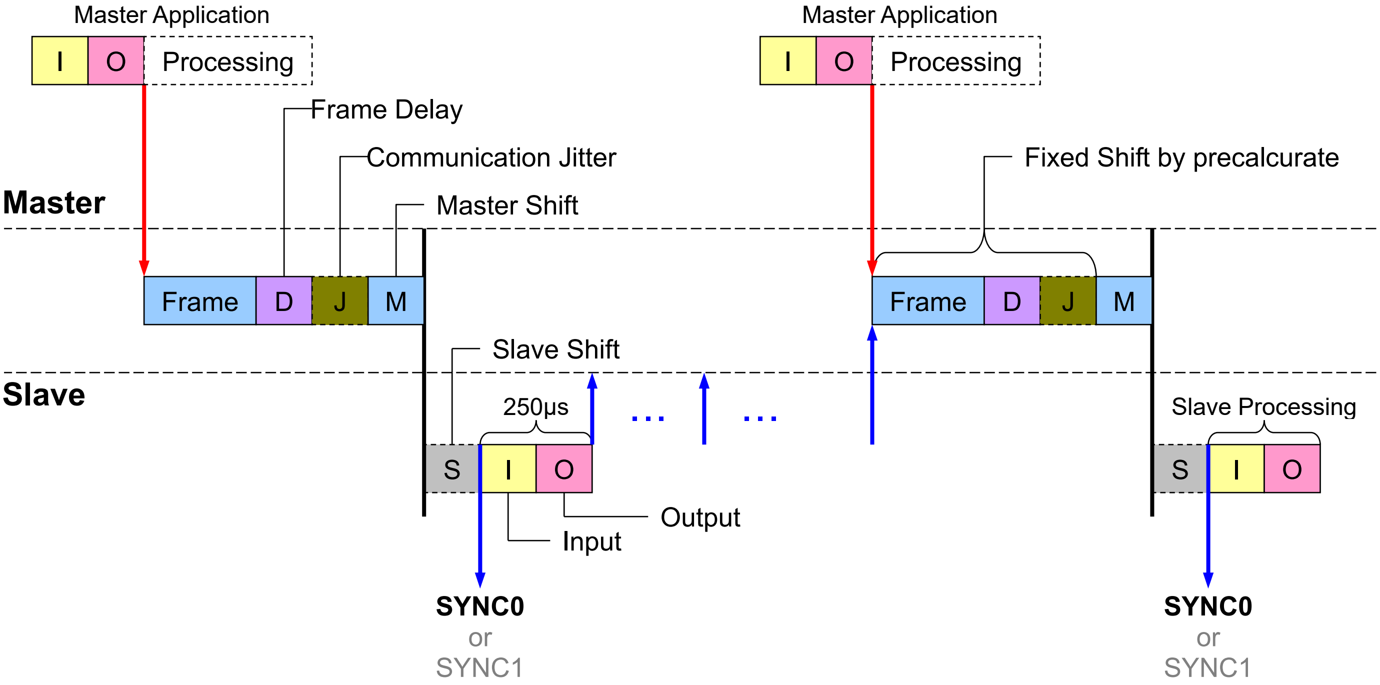
Synchronizing unit stands by until the first SYNC 0 pulse is output.
Cycle motion start time register and the next SYNC 1 pulse register can be read to acquire the next output event time.

2.8 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.)

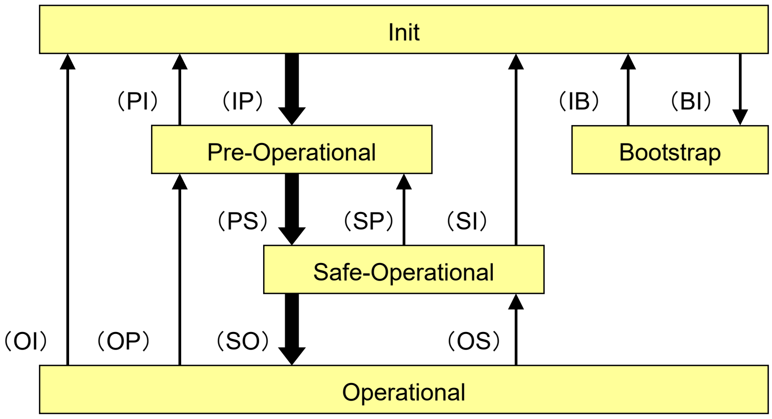
2.9 EtherCAT State Machine (ESM)

ESM contains states defined by EtherCAT.

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

1) ESM

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



ESM Diagram

State Transition and Local Management Service

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

2) State

- Init State

  “Init” state defines basic communication relations between the master and slaves in the application layer.
  Direct communication between the master and slaves is not possible in the application layer.
  The master uses the “Init” state to initialize the setting for the configuration of the slaves.
  When the slaves support the mailbox service, the corresponding SM settings will also be executed in “Init” state.

- Pre - Operational State

  The mailbox communication can be performed in the “Pre - Operational” state when the slaves support the optional mailbox.
  Both master and slaves can use the mailbox to initialize application specifications and to change parameters.
  Process data communication cannot be executed in this state.

- Safe - Operational State

  In “Safe - Operational” state, slave applications transfer the actual input data, but not the output data that may not be available for processing. The output must be set in Safe state.

- Operational State

  In “Operational” state slave applications transfer the actual input data and the master application transfers the actual output data.

- Bootstrap State

  In the "Bootstrap" state, slave applications can receive new firmware and servo amplifire parameter downloaded by FoE (File access Over EtherCAT) protocol.

3.

3. Data Link Layer

3.1 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 RM2 EtherCAT slave amplifier has a 14 bit local address space.
The address range 0x0000:0x0FFF is dedicated to EtherCAT registers and address range 0x1000:0x2FFF is used as process memory, which is addressed via a 16 bit Offset address field belonging to the EtherCAT datagram.
The process memory space is used communication applications such as PDO interface and SDO (mailbox) interface.

2） Shadow Buffer for Register Write Operations

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

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

3） EtherCAT Slave Controller Function Blocks

■ EtherCAT Interface (Ethernet/EBUS)

The EtherCAT interfaces or ports connect the ESC to other EtherCAT slaves and the master.
The MAC layer is integral part of the ESC. The physical layer may be Ethernet or EBUS.
The physical layer for EBUS is fully integrated into the ASICs. For Ethernet ports, external Ethernet PHYs connect to the MII/RMII ports of the ESC. Transmission speed for EtherCAT is fixed to 100 Mbit/s with Full Duplex communication. Link state and communication status are reported to the Monitoring device.
RM2 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.

3.2 Address Space

RM2 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.
RM2 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/-	2Byte	0x0000

Configured Station Alias

Address	bit	Description	Master	Slave	Length	Rest Value
0x0012 - 0x0013	3:0	Read value of 1st axis-rotary switch	R/-	R/W	2Byte	0x0000
	7:4	Read value of 2nd axis-rotary switch				
	11:8	Read value of 3rd axis-rotary switch				
	15:12	Read value of 4th axis-rotary switch				

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 RM2 EtherCAT slave amplifier is capable of issuing a hardware reset from the EtherCAT master. Three special sequences and consecutive frames have to be sent to the ESC reset register (0x0040) in a slave. Afterwards, the slave is reset if transmission is complete correctly.
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 ESM.
The AL Status register (0x0130:0x0131) reflects the current state of the slave.

■ Device Emulation

Simple devices without microcontroller cannot perform transition of ESM by itself. So, copy directly the AL Control register set value to the AL Status register, by setting "1" to the device emulation (0x0140.8).
In that setting, the master should not set the Error Indication Acknowledge bit as "1", because it would reflect as the Error Indication bit even if no error occurred in aslave.
The device emulation (0x0140.8) is zero in the RM2 EtherCAT slave amplifier.

AL Control

Address	bit	Description		Master	Slave	Length	Rest Value
0x0120 - 0x0121	3:0	Initiate State Transition of the EMS:	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 EMS:	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 high11: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				

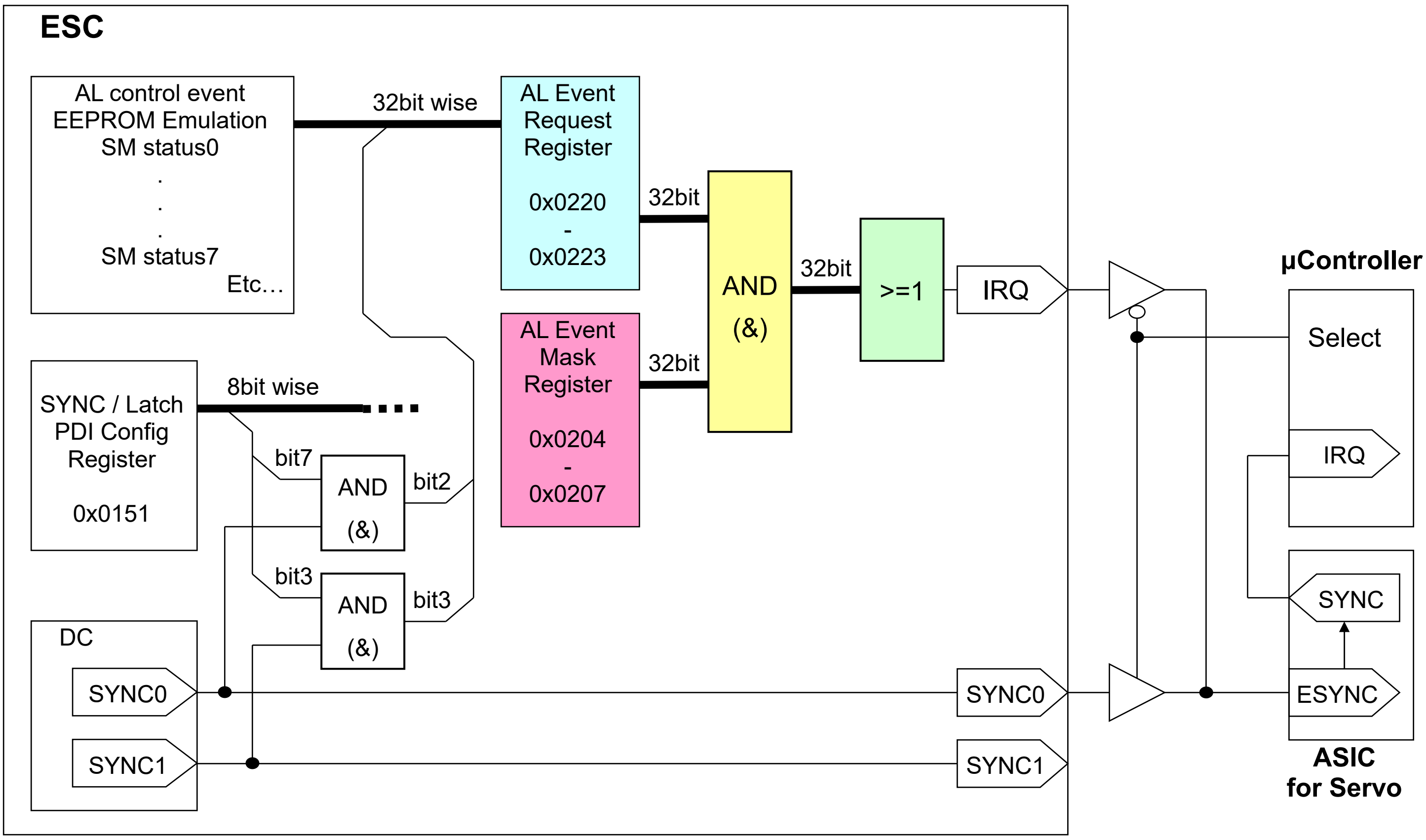
Note) Reset Value is "0". After that, depends on configuration EEPROM ADR 0x0003.

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

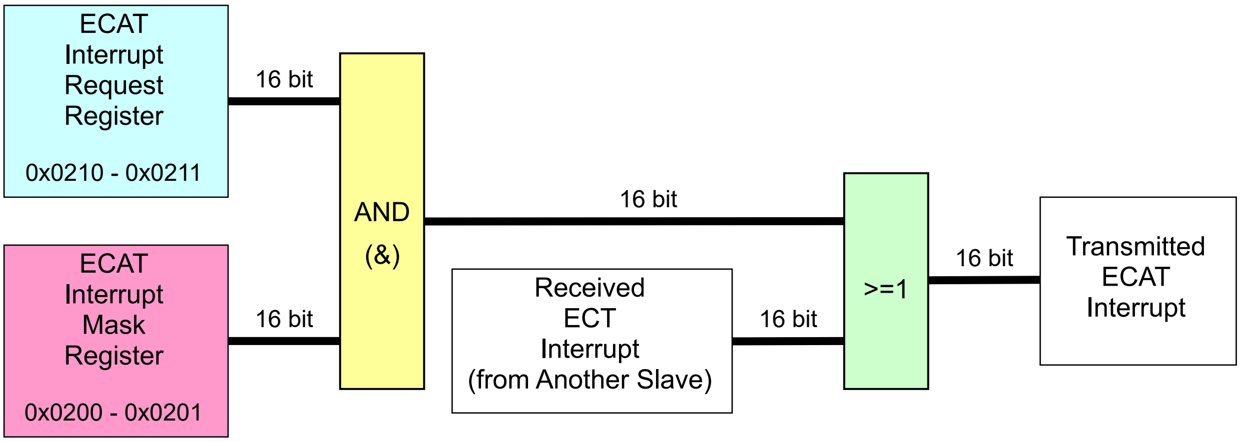
Register Address	Name	Description
0x0150	PDI Configuration	IRQ driver characteristics, depending on PDI
0x0151	SYNC/LATCH PDI Configuration	Mapping DC Sync Signals to Interrupts
0x0204:0x0207	AL Event Mask	Mask register
0x0220:0x0223	AL Event Request	Pending Interrupts
0x0804+N*8	Sync Manager Control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

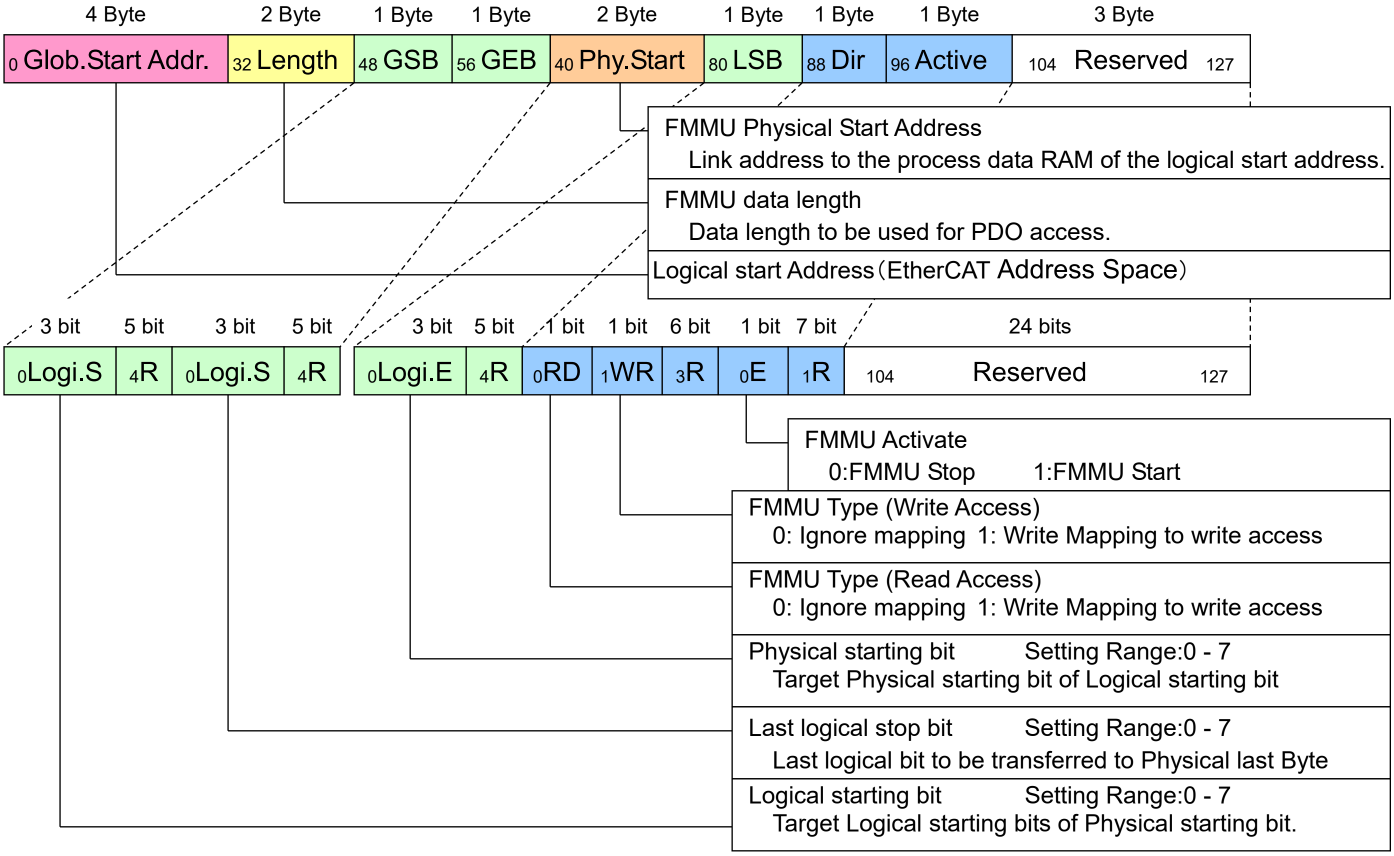
* R/(W): write access depends on assignment of MI (ECAT/PDI).

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

Each FMMU entry is described in 16 Bytes from 0x0600:0x060F to 0x0670:0x067F.
RM2 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

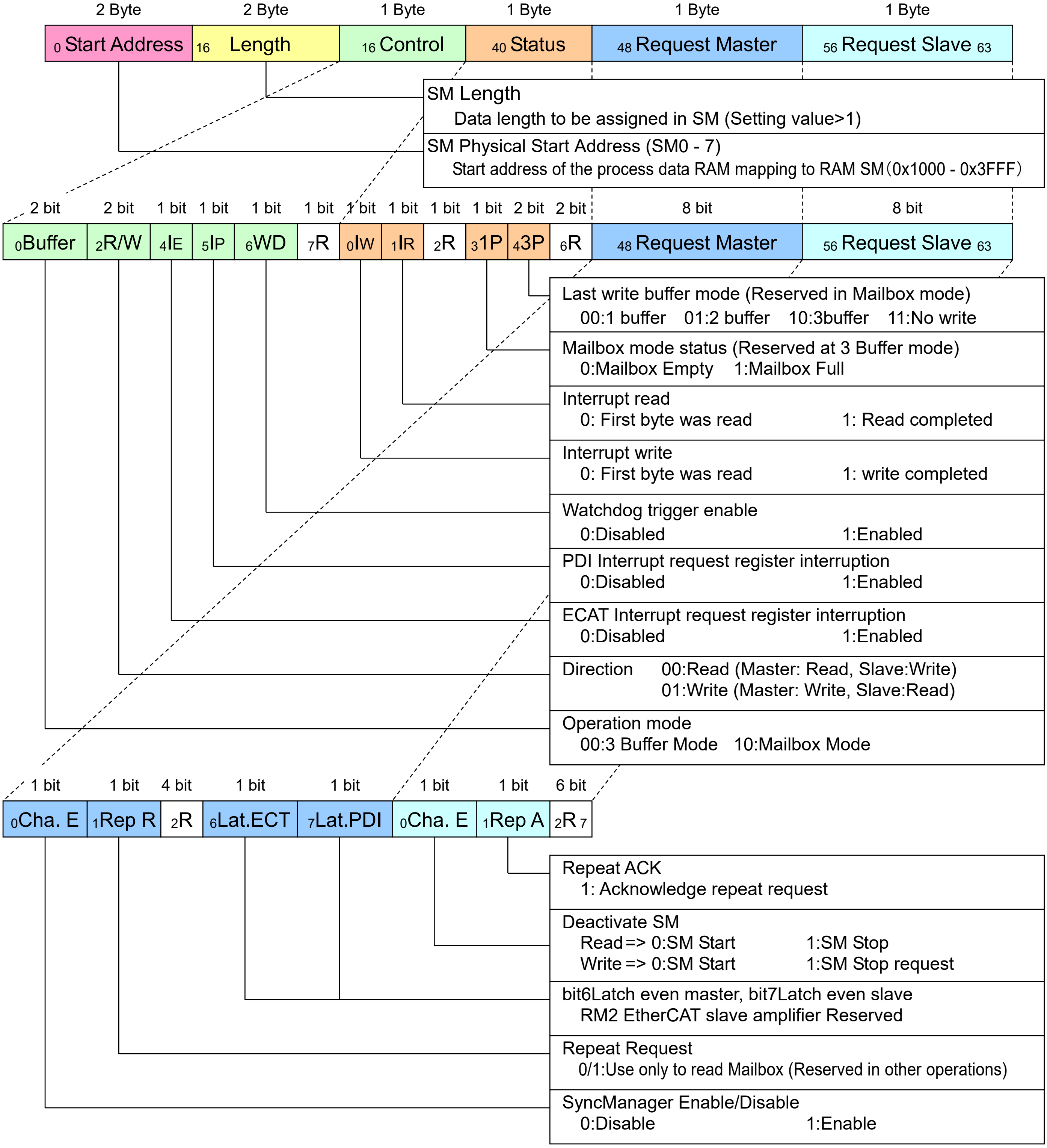
Address	bit	Description	Master	Slave	Length	Rest Value
0x06yC - 0x06yF	0	0:FMMU deactivated 1:FMMU activated. FMMU checks logical addressed blocks to be mapped according to mapping configured	R/W	R/-	4 Bytes	0x00000000
	31:1	Reserved, write 0	R/-	R/-		

13）SyncManager (sm [7:0])

SyncManager registers are mapped from 0x0800:0x0807 to 0x0838:0x083F.
The RM2 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.



SM Length
Data length to be assigned in SM (Setting value>1)

SM Physical Start Address (SM0 - 7)
Start address of the process data RAM mapping to RAM SM（0x1000 - 0x3FFF）

Last write buffer mode (Reserved in Mailbox mode)
00:1 buffer 01:2 buffer 10:3buffer 11:No write

Mailbox mode status (Reserved at 3 Buffer mode)
0:Mailbox Empty 1:Mailbox Full

Interrupt read
0: First byte was read 1: Read completed

Interrupt write
0: First byte was read 1: write completed

Watchdog trigger enable
0:Disabled 1:Enabled

PDI Interrupt request register interruption
0:Disabled 1:Enabled

ECAT Interrupt request register interruption
0:Disabled 1:Enabled

Direction 00:Read (Master: Read, Slave:Write)
01:Write (Master: Write, Slave:Read)

Operation mode
00:3 Buffer Mode 10:Mailbox Mode

Repeat ACK
1: Acknowledge repeat request

Deactivate SM
Read => 0:SM Start 1:SM Stop
Write => 0:SM Start 1:SM Stop request

bit6Latch even master, bit7Latch even slave
RM2 EtherCAT slave amplifier Reserved

Repeat Request
0/1:Use only to read Mailbox (Reserved in other operations)

SyncManager Enable/Disable
0:Disable 1:Enable

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).

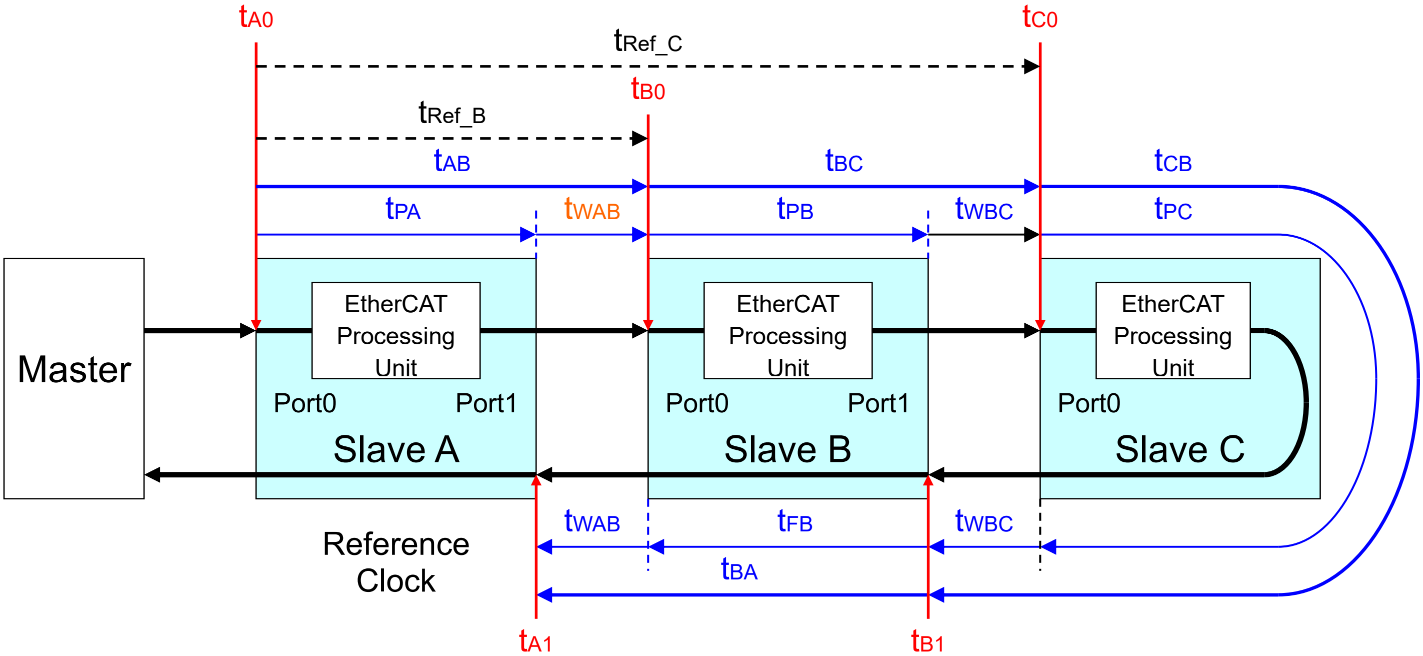
The receive time registers are used to sample the receive time of a specific frame (a broadcast write to Receive Time Port 0 register).
The clocks must not be synchronized for the delay measurement, only local clock values are used.
Since the local clocks of the slaves are not synchronized, there is 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 Forwarding Delay)
tAB, tBC, tCB, tBA	Propagation delay from slave to slave
tWAB, tWBC, tWCB, tWBA	Wire propagation delay between slaves (assumed to be symmetrical in both directions)
tA0, tB0, tC0, tA1, tB1	Receive Time Port 0/1 values of slave (time when first preamble bit is detected)
tP	Processing delay (EtherCAT Processing) if all slaves are identical
tF	Forwarding delay (EtherCAT Forwarding) if all slaves are identical
tDiff	Difference between Processing delay and forwarding delay tDiff = tP - tF if all slaves are identical. Note)TDiff of the RM2 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:

tLocal copy of System Time = tLocal time + tOffset

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:

Δt = (tLocal time + tOffset-tPropagation delay) - tReceived 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

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

System Time Difference Filter Depth

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

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

Speed Counter Filter Depth

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

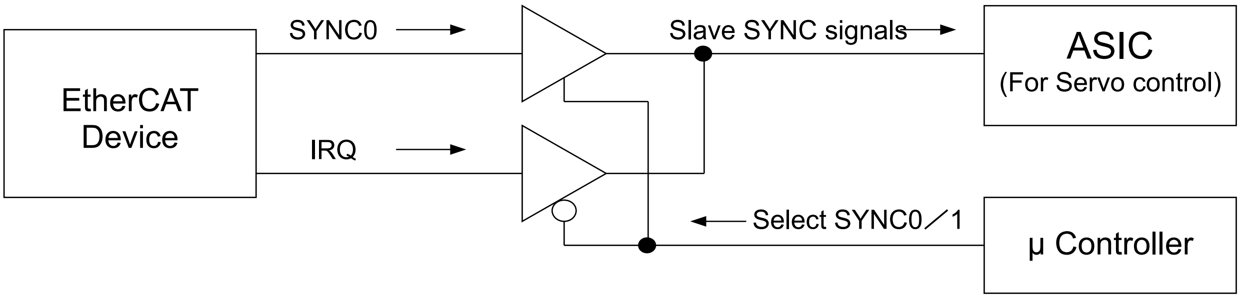
* Usable when 0x0140.10=1 or 0x0140.11=1. Reset control loop by writing the speed counter start (0x0930:0x0931) after this value has been changed.

■ DC-Cycle Unit Control

1. Synchronize Signal

RM2 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).



RM2 **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 RM2 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

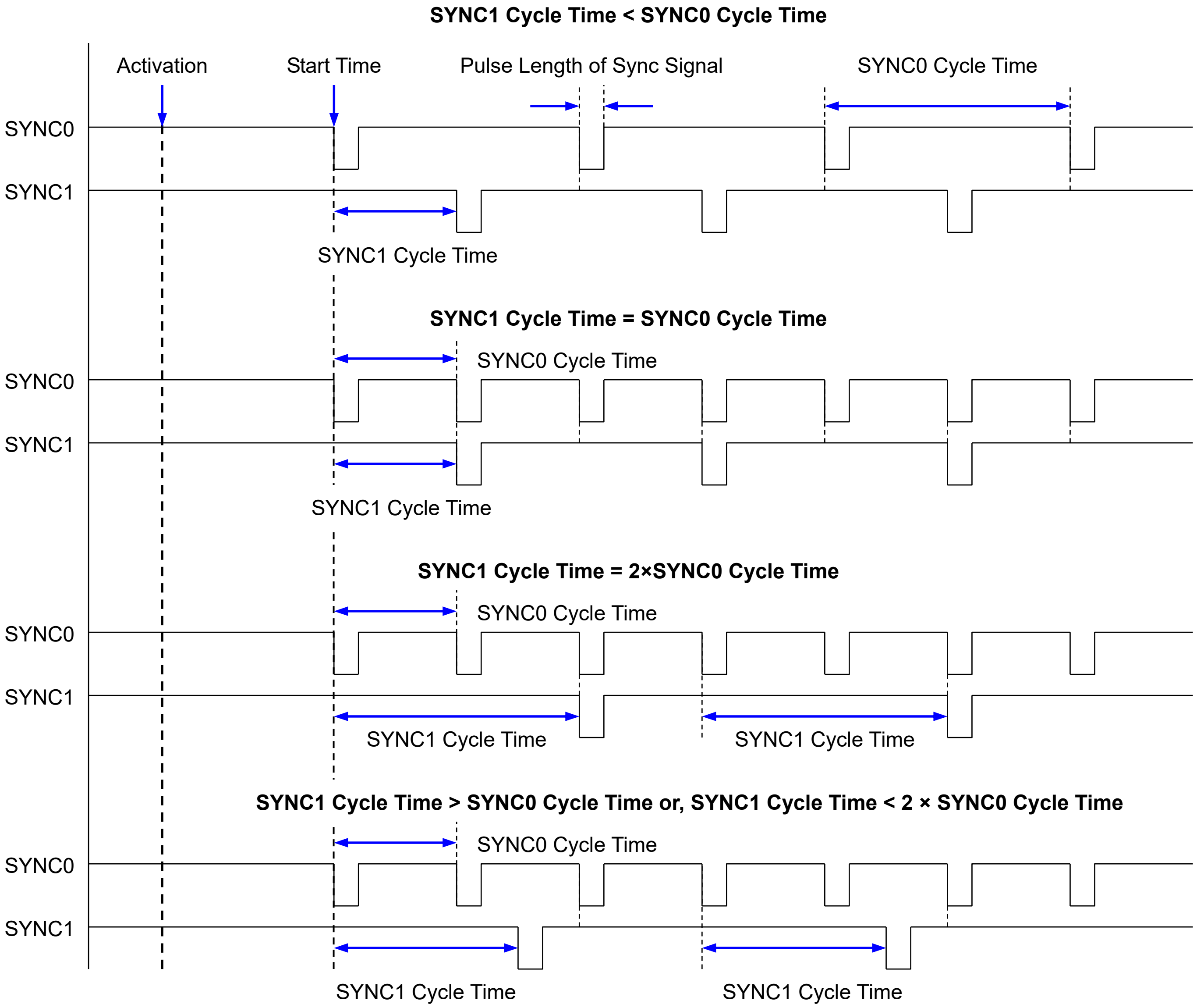
* Some of these registers are set via EEPROM at the time of power ON.

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.



SYNC1 Cycle Time < SYNC0 Cycle Time

SYNC1 Cycle Time = SYNC0 Cycle Time

SYNC1 Cycle Time = 2×SYNC0 Cycle Time

SYNC1 Cycle Time > SYNC0 Cycle Time or, SYNC1 Cycle Time < 2 × SYNC0 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 RM2 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

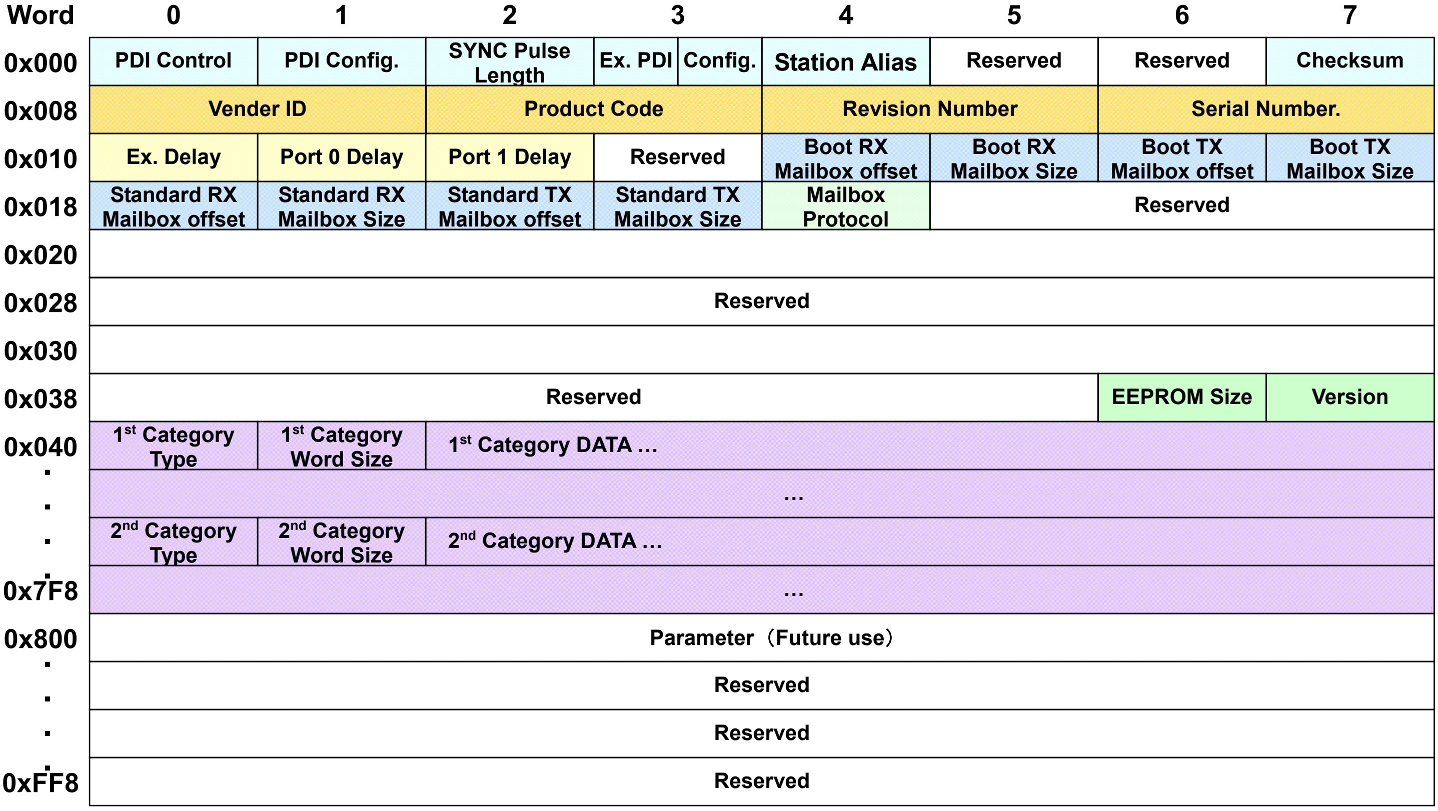
Address	Byte	Description	Master	Slave	Length	Rest Value
0x1000 - 0x2FFF	0x2000	Process Data RAM Note) (r/w): Process Data RAM is only accessible if EEPROM was correctly loaded (register 0x0110.0 = 1).	(R/W)	(R/W)	8,192 Bytes	Undefined

3.3 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 RM2 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	Unsupported	Unsupported	-

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	Unsupported	Unsupported	-

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

4

4. Object Dictionary

4.1 Object Dictionary summary

1) Structure of Object Dictionary

Each object is addressed using a 16-bit index displaying 4 digits hexadecimal, assigned to each group in the object dictionary. RM2 multi axis EtherCAT amplifier accepts the objects of 4 axes by single ESC, so, the numbering of object from 2nd to 4th axis differ from 1st axis.
Structure of the Object Dictionary of CoE (CANopen over EtherCAT) comply with CiA draft standard proposal 402 is shown as below.

Structure of Object Dictionary

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

2) Access types

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

Access Attributes for Data Objects

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

4.2 CoE Communication Area

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

Communication Area

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

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

1) Parameter Details of Object Group from 0x1000

0x1000: Device Type

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

MSB LSB

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

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

0x1001: Error Register

Index	0x1001	Indicates error state of slave. Refer to (Error Field Definition) for the details of error.		Object Code		VAR
Sub-Idx	Name/Description		Data Type	Access	PDO	Initial Value
0x00	Error Register [ERRREG]		Unsigned8	RO	Possible	0x00

Bit7:Maker Definition Error	Bit3:Temperature Error
Bit6:Reserved	Bit2:Voltage Error
Bit5:Device Profile Definition Error	Bit1:Current Error
Bit4:Communication Error	Bit0:Generic error

0x1008: Device Name

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

RM2 K 2 4 A 0 H L 5

✔ Refer to secton 1.3, Servo amplifier model number, for model number structure details.

0x1009: Hardware Version

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

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 4 0 0 . 0 . 5 5 2 5						

Byte10, 11 : Date of firmware compiled 1 : 1st, 2 : 2nd ･･･ 30 : 30th, 31 : 31th
Byte 9 : Month of firmware compiled 1 : Jan., 2 : Feb. ･･･ A : Oct., B : Nov., C : Dec.
Byte 8 : Year of firmware compiled 5 : in 2015 ･･･ A : in 2020 ･･･ F : in 2025 ･･･
Byte 6 : Manufacturer specific profile revision SANYO DENKI-conroled number: “0,1･･･9, A･･･Y, Z”
Byte 3, 4 : Amplifier revision 1 : Revision “B” 2 : Revision "C”･･･
Byte1, 2 : Series name 84: RM2 EtherCAT Interface

0x1010:Store Parameters

<table>
<tr><td>Index</td><td>0x1010 Store current amplifier parameters to non-volatile memory</td><td></td><td colspan="2">Object Code</td><td>ARRAY</td></tr>
<tr><td>Sub-Idx</td><td>Name/Description</td><td>Data Type</td><td>Access</td><td>PDO</td><td>Initial value</td></tr>
<tr><td>0x00</td><td>Number of Entry</td><td>Unsigned8</td><td>RO</td><td>No</td><td>0x0C</td></tr>
<tr><td>0x01</td><td>Store all parameters of AX1 [PARASAVE]
Store all storable parameters of axis 1, in a lump.</td><td>Unsigned32</td><td>RW</td><td>No</td><td>0x0000 0001</td></tr>
<tr><td></td><td colspan="5">In order to avoid storage of parameters by misstate, storage is only executed when a specific signature is written to the "Sub-index 0x01". The signature is "save".
&Write-access Sequence
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 service (abort code: 0800 0020h).

&Read-access Sequence
Slave provides information on parameter storing function in the following formats.
<table>
<tr><td>Bit</td><td>Value</td><td>Description</td></tr>
<tr><td>31-2: Reserved</td><td>0</td><td>Reserved</td></tr>
<tr><td>1: Auto</td><td>0</td><td>Slave does not store parameters on an autonomous basis.</td></tr>
<tr><td>0: Cmd</td><td>1</td><td>Slave stores parameters when commanded via the above write -access.</td></tr>
</table>
✔ If NVRAM is Yes at each area of object list , paramaters will be store by this command.</td></tr>
<tr><td>0x02</td><td>Not supported [Save communication parameter]</td><td>Unsigned32</td><td>RW</td><td>No</td><td>0x0000 0000</td></tr>
<tr><td>0x03</td><td>Not supported [Save application parameter]</td><td>Unsigned32</td><td>RW</td><td>No</td><td>0x0000 0000</td></tr>
<tr><td>0x04</td><td>Store all parameters of AX2 [PARASAVE]
Store all storable parameters of axis 2, in a lump.
✔Parameter description is same as Sub-Index 0x01.</td><td>Unsigned32</td><td>RW</td><td>No</td><td>0x0000 0001</td></tr>
<tr><td>0x05</td><td>Not supported [Save communication parameter]</td><td>Unsigned32</td><td>RW</td><td>No</td><td>0x0000 0000</td></tr>
<tr><td>0x06</td><td>Not supported [Save application parameter]</td><td>Unsigned32</td><td>RW</td><td>No</td><td>0x0000 0000</td></tr>
<tr><td>0x07</td><td>Store all parameters of AX [PARASAVE]
Store all storable parameters of axis 3, in a lump.
✔Parameter description is same as Sub-Index 0x01.</td><td>Unsigned32</td><td>RW</td><td>No</td><td>0x0000 0001</td></tr>
<tr><td>0x08</td><td>Not supported [Save communication parameter]</td><td>Unsigned32</td><td>RW</td><td>No</td><td>0x0000 0000</td></tr>
<tr><td>0x09</td><td>Not supported [Save application parameter]</td><td>Unsigned32</td><td>RW</td><td>No</td><td>0x0000 0000</td></tr>
<tr><td>0x0A</td><td>Store all parameters of AX4 [PARASAVE]
Store all storable parameters of axis 4, in a lump.
✔Parameter description is same as Sub-Index 0x01.</td><td>Unsigned32</td><td>RW</td><td>No</td><td>0x0000 0001</td></tr>
<tr><td>0x0B</td><td>Not supported [Save communication parameter]</td><td>Unsigned32</td><td>RW</td><td>No</td><td>0x0000 0000</td></tr>
<tr><td>0x0C</td><td>Not supported [Save application parameter]</td><td>Unsigned32</td><td>RW</td><td>No</td><td>0x0000 0000</td></tr>
</table>

0x10F0:Back up parameter

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

0x1018:Identity Object

Index	0x1018 Indicates information of salve device.		Object Code		RECORD
Sub-Idx	Name/Description	Data Type	Access	PDO	Value
0x00	Number of Entry	Unsigned8	RO	No	0x04
0x01	Vender ID [VENDOR] Vender ID registered in ETG	Unsigned32	RO	Possible	0x0000 01B9
0x02	Product Code [PRODUCT] Product Code of Production	Unsigned32	RO	No	0x00000008
0x03	Revision No. [AMPREV] Revision Number of Product (Not used: fixed value 0)	Unsigned32	RO	No	(-)
0x04	Serial No. [SERIAL] Serial Number of Product (Not used: fixed value 3)	Unsigned32	RO	No	(-)

1) Synchronous Setup

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

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

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

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

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

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

2) PDO Mapping

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

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

Perform mapping in the following procedures.

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

■ Restrictions on PDO-mapping

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

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

0x1600:Reception PDO Mapping 1

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

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

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

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

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

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

0x1A00: TxPDO Mapping 1 (TxPDO 1)

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

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

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

0x1C00:SM (Sync Manager) Communication Type

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

SM (Sync Manager) PDO Assignment

0x1C10:SM Channel 0(Mailbox Receive)

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

0x1C11:SM Channel 1(Mailbox Send)

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

0x1C12:SM Channel 2(Process Data Output)

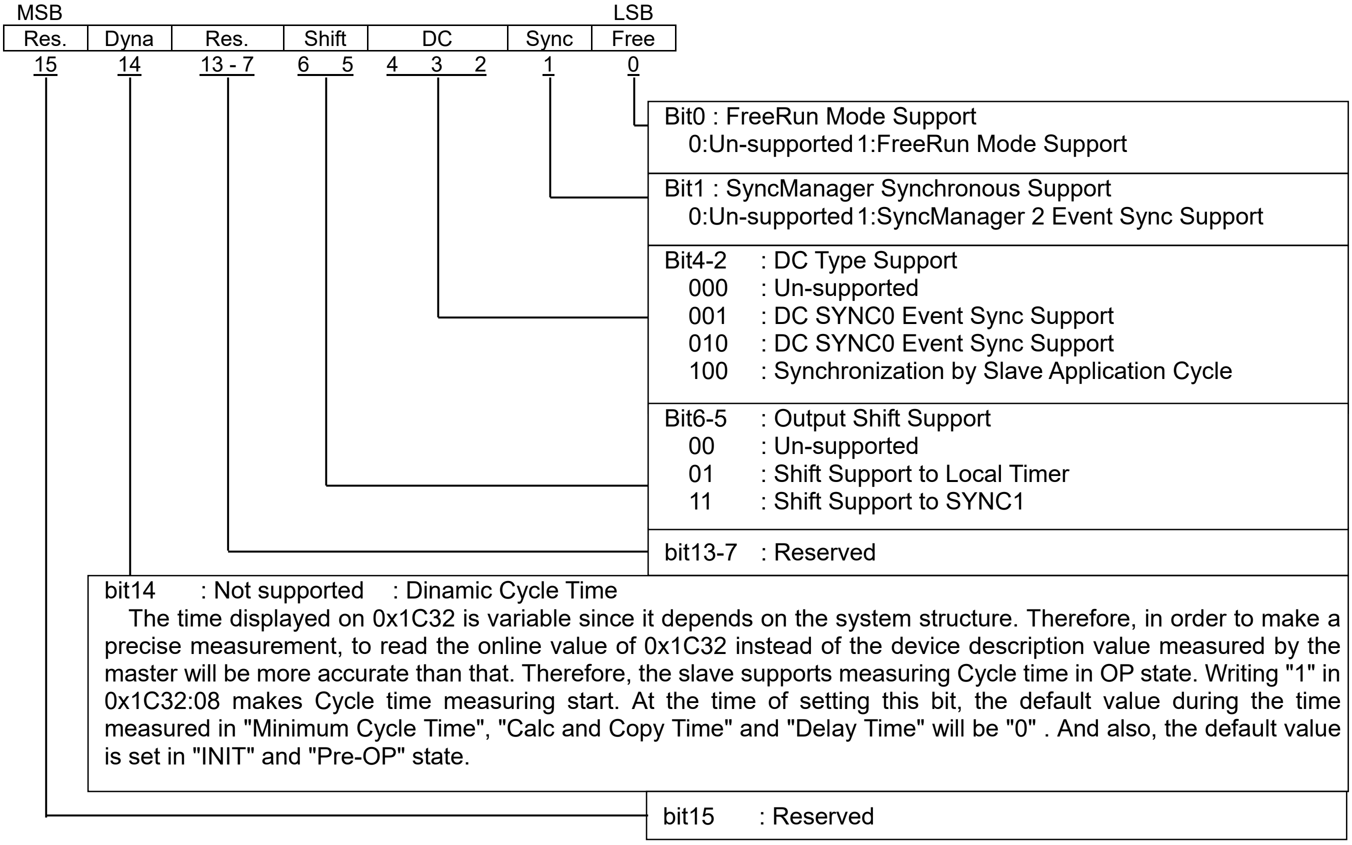
Index	0x1C12	Indicates the object assigned to SM2 as PDO.		Object Code	ARRAY
Sub-Idx	Description	Data Type	Access	PDO	Range
0x00	n [several] number of object assigned to RxPDO	Unsigned8	RW	No	0x00 to 0x04
0x01 - 4	Index of the PDO object assigned to RxPDO	Unsigned16	RW	No	0x1600:RxPDO 1 ... 0x1603:RxPDO 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 - 4	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.	Unsigned16	RW	No	0x0002
		Setting Range	0x0000-0x0003		
	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) ✔ This is the storing parameter into non volatile memory. RM2 multi axes amplifier is controlled with Axis 1 setting, even though 4 axes are there and each axis has this parameter.				
0x02	Cycle Time : Unit(ns) [SM2SYC] Sets up communication cycle between master and slave. Set Value: When T (ns) =125000x2^{Y} (ns), it is in the range of Y= 1 to 7.	Unsigned32	RW	No	0x0007A120 （500μs）
		Setting Range	0x0001E848 - 0x00F42400 (0.125 - 16ms)		
	Free Run (Synchronization Type=0x0) : Local Timer Event Cycle of Slave DC SYNC0 (Synchronization Type=0x02) : SYNC0 Cycle Time (0x09A0 - 0x09A3) DC SYNC1 (Synchronization Type=0x03) : SYNC0 Cycle Time (0x09A0 - 0x09A3) Possible Setting Value:T$_{(ns)}$ 125us :0x0001E848 250us :0x0003D090 500us :0x0007A120 1ms :0x000F4240 2ms :0x001E8480 4ms :0x003D0900 8ms :0x007A1200 16ms :0x00F42400 ✔ Error is returned when the value is set except the value that can be set as above. ✔ Synchronizes with Interpolation time period (0x60C2) by the setting of Special Function Selection (0x20F7). ✔ This is the storing parameter into non volatile memory. RM2 multi axes amplifier is controlled with Axis 1 setting, even though 4 axes are there and each axis has this parameter.				
0x03	Shift Time : Unit (ns) Time between Hardware Output Effective Operation and Related Event	Unsigned32	RO	No	0x0
0x04	Synchronization Type Supported	Unsigned16	RO	No	0x4007



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) The minimum cycle time is supported by slave. (Maximum time of local cycle)	Unsigned32	RO	No	0x0001E848 （125μs）
0x06	Copy and Operation Time (Calc and Copy Time) Unit (ns) Time required of micro controller in order to copy process data to local memory from SyncManager. Operation is processed, if required before data's transmitting to process.	Unsigned32	RO	No	0x0000F424 （62.5μs）
0x07	Reserved	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 It is time during trigger reception of SYNC0 or SYNC1 event to be effective in order to do output drive of the value by the hardware delay time of slave, *Only the synchronous type 0x02, or DC SYNC0/1 of 0x03	Unsigned32	RO	No	0x00007530 （30μs）
0x0A	Not supported : Sync0 Cycle Time When SYNC0 fixed cycle time is required of application, it is the time between two Sync0 signals. *Synchronous Time = Only DC SYNC0 of 0x03, and local cycle control	Unsigned32	RW	No	-
0x0B	Cycle Time Too Small This error counter is incremented when cycle time is too short as local cycle cannot be completed or input data cannot prepare by the next SM event.	Unsigned16	RO	No	-
0x0C	SM-Event Missed This error counter is incremented when application demands SM event and cannot receive it. As a result, data may be unable to be copied any more.	Unsigned16	RO	No	-
0x0D	Shift Time Too Short This error counter is incremented when the time interval of SYNC0 trigger and an output is too short, by the fact that shift time or SYNC1 cycle time is too short.	Unsigned16	RO	No	-
0x0E	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	Not supported : Sync Error TxPDO mapping is possible at the time of SM-Event Missed or Shift Time Too Short Counter support. 0: Not Sync. Error or unsupported Sync.Error 1: Sync. Error	BOOL	RO		

0x1C33:SM3 Synchronization (Input SyncManager Parameter)

Index	0x1C33	SM3 Synchronization	Object Code		RECORD
Sub-Idx	Name/Description	Data Type	Access	PDO	Initial Value
0x00	Number of Synchronization Parameter	Unsigned8	RO	No	0x20
0x01	Synchronization Type [SM3TYP]	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) ✔ This is the storing parameter into non volatile memory. RM2 multi axes amplifier is controlled with Axis 1 setting, even though 4 axes are there and each axis has this parameter.				
0x02	Cycle Time : Unit (ns) [SM3CYC]	Unsigned32	RO	No	0x0007A120 （500μs）
	Free Run (Synchronous Type=0x00) : Local Timer Event Cycle of Slave DC SYNC0 (Synchronous Type=0x02) : SYNC0 Cycle Time (0x09A0 - 0x09A3) DC SYNC1 (Synchronous Type=0x03) : SYNC0 Cycle Time (0x09A0 - 0x09A3) ✔ The value shall be the same as Index:0x1C32,Sub-index2.				
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	0x0001E848 （125μs）
0x06	Copy and Operation Time (Calc and Copy Time) Unit (ns) Time required from Input Latch through minimum cycle time.	Unsigned32	RO	No	0x0001E848 （125μs）
0x07	Reserved	-	-	-	-
0x08	Get Cycle Time 0:Stops local cycle time measurement. 1:Starts local cycle time measurement. *Measurement value is reset when written into again.	Unsigned16	RW	No	-
0x09	Delay Time Hardware delay time of a slave, period from trigger reception of SYNC0 or SYNC1 event until latching input value. *Only the synchronous type 0x02, or DC SYNC0/1 of 0x03	Unsigned32	RO	No	-
0x0A	Not supported : Sync0 Cycle Time When SYNC0 fixed cycle time is required of application, it is the time between two Sync0 signals. *Synchronous Time = Only DC SYNC0 of 0x03, and local cycle control	Unsigned32	RW	No	-
0x0B	Cycle Time Too Small This error counter is incremented when cycle time is too short as local cycle cannot be completed or input data cannot prepare by the next SM event.	Unsigned16	RO	No	-
0x0C	SM-Event Missed This error counter is incremented when application demands SM event and cannot receive it. As a result, data may be unable to be copied any more.	Unsigned16	RO	No	-
0x0D	Shift Time Too Short This error counter is incremented when the time interval of SYNC0 trigger and an output is too short, by the fact that shift time or SYNC1 cycle time is too short.	Unsigned16	RO	No	-
0x0E	Not supported : RxPDO Toggle Failed This error counter is incremented when slave supports a RxPDO toggle and then new RxPDO data cannot be received from a master. (When RxPDO toggle is set to TRUE.)	Unsigned16	RO	No	-
0x0F:0x1F	Reserved	-	-	-	-
0x20	Not supported (Sync Error) TxPDO mapping is possible at the time of SM-Event Missed or Shift Time Too Short Counter support. 0: Not Sync. Error or unsupported Sync-Error 1: Sync. Error	BOOL	RO		

3) Communication Timing

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

Copy and Prepare Outputs

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

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

Get and Copy Inputs

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

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

Outputs Valid

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

Start Driving Outputs

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

Start Latch

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

Input Latch

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

User Shift Time

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

SYNC1 Cycle Time

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

Shift Time

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

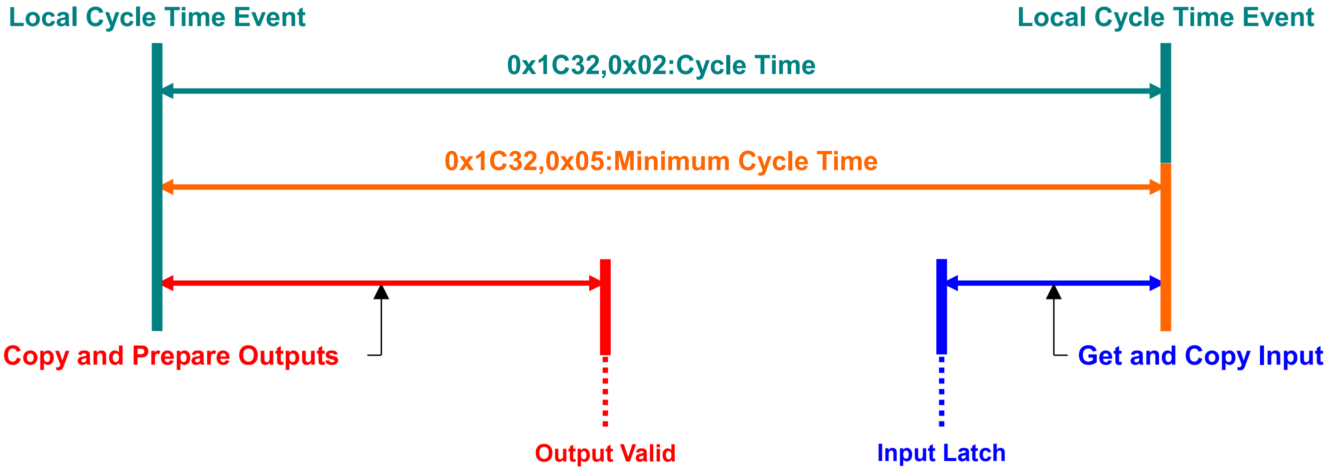
The synchronous mode supported to this servo amplifier is shown the following.

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

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

Parameter of Free Run Mode List

Index	Sub-Index	Dir	Name	Remarks
0x1C32	0x01	RW	Synchronization Type	0x00:Free Run Support
	0x02	RO	Cycle Time	Control Cycle Time of Slave
	0x04	RO	Synchronization Type Supported	Bit0=1:FreeRun Support
	0x05	RO	Minimum Cycle Time	RM2-EtherCAT(s) are the same setup to 0x1C32:0x02.
0x1C33	0x01	RW	Synchronization Type	0x00:Free Run Support
	0x02	RO	Cycle Time	Same setup to 0x1C32:0x02
	0x04	RO	Synchronization Type Supported	Same setup to 0x1C32:0x04
	0x05	RO	Minimum Cycle Time	Same setup to 0x1C32:0x05



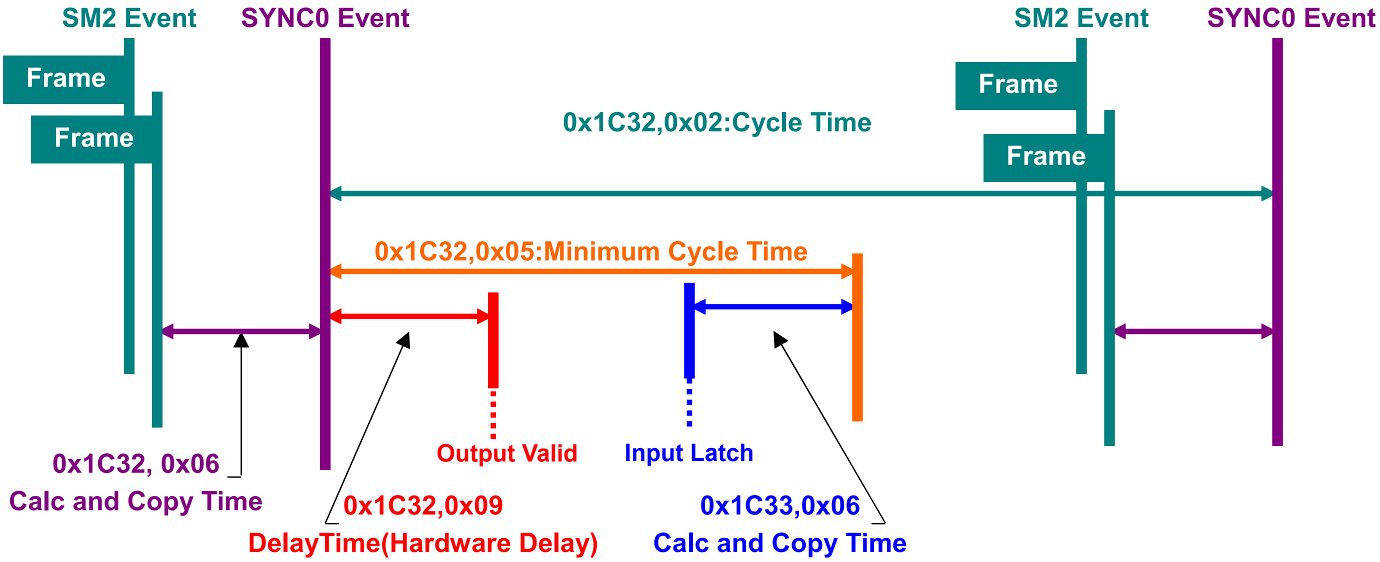
Communication Timing of Free Run Mode

5) DC Mode (SYNC0 Event Synchronization)

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

Parameter of DC Mode (SYNC0 Event Synchronization)

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



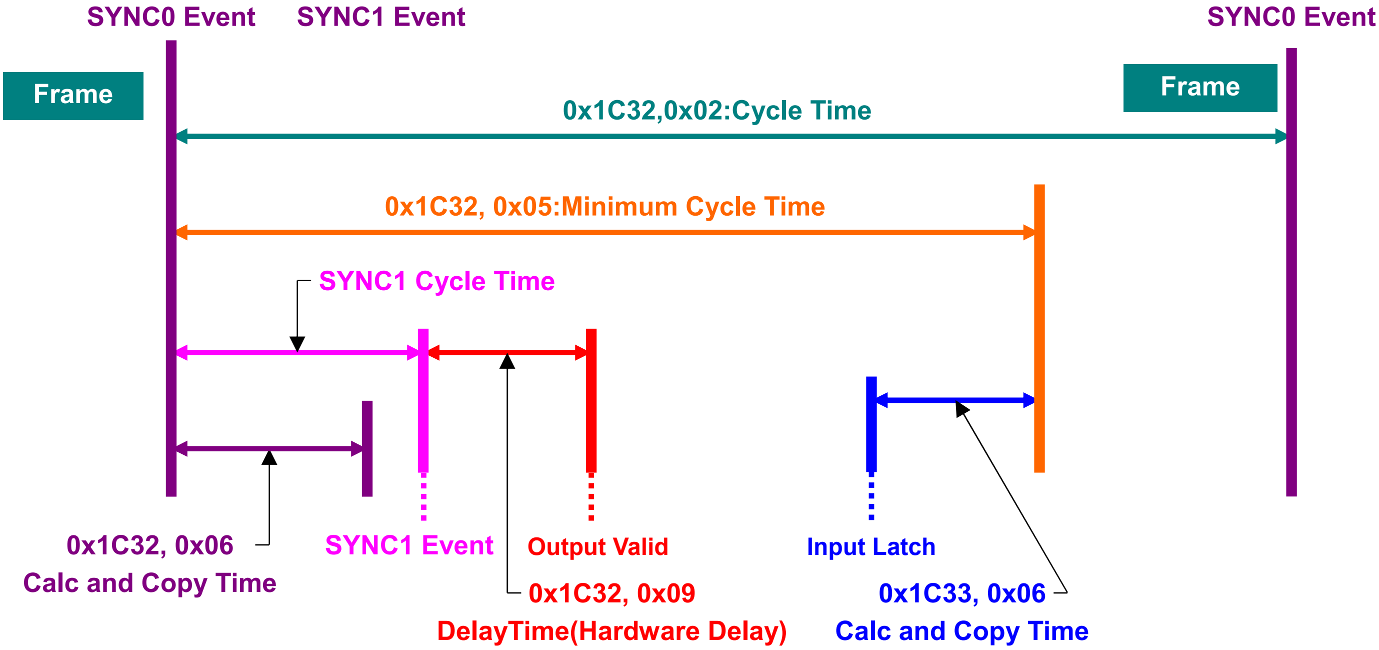
Communication Timing of DC Synchronization Mode (SYNC0)

6) DC Mode (SYNC1 Event Synchronization)

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

Parameter of DC Mode (SYNC1 Event Synchronization)

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

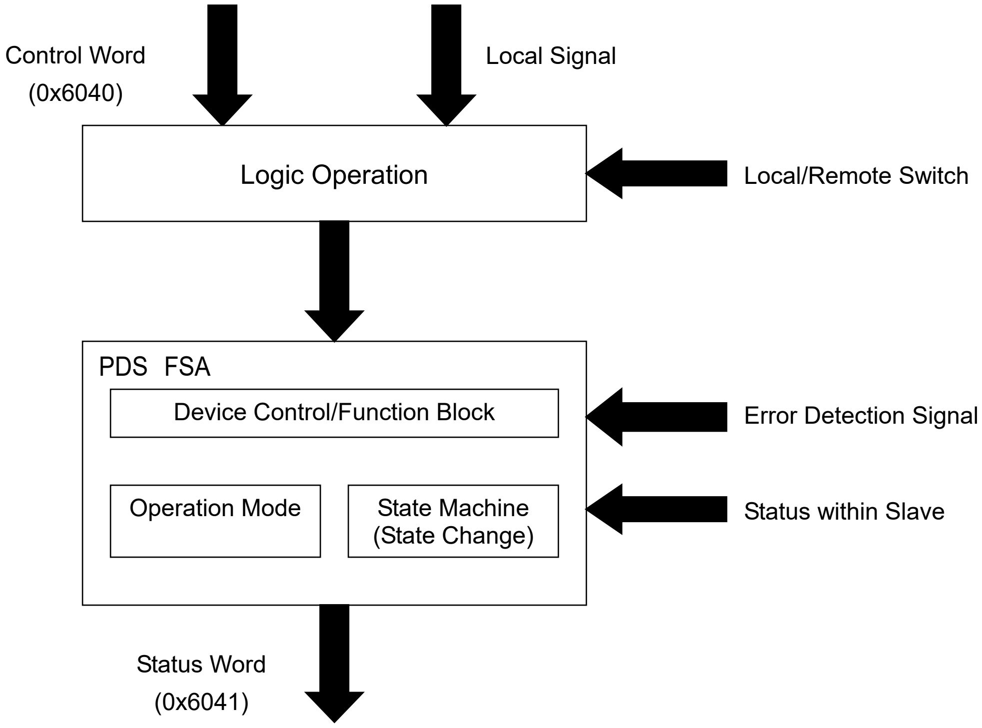


Communication Timing of DC Synchronization Mode(SYNC0)

4.3 PDS FSA

1) Abstract

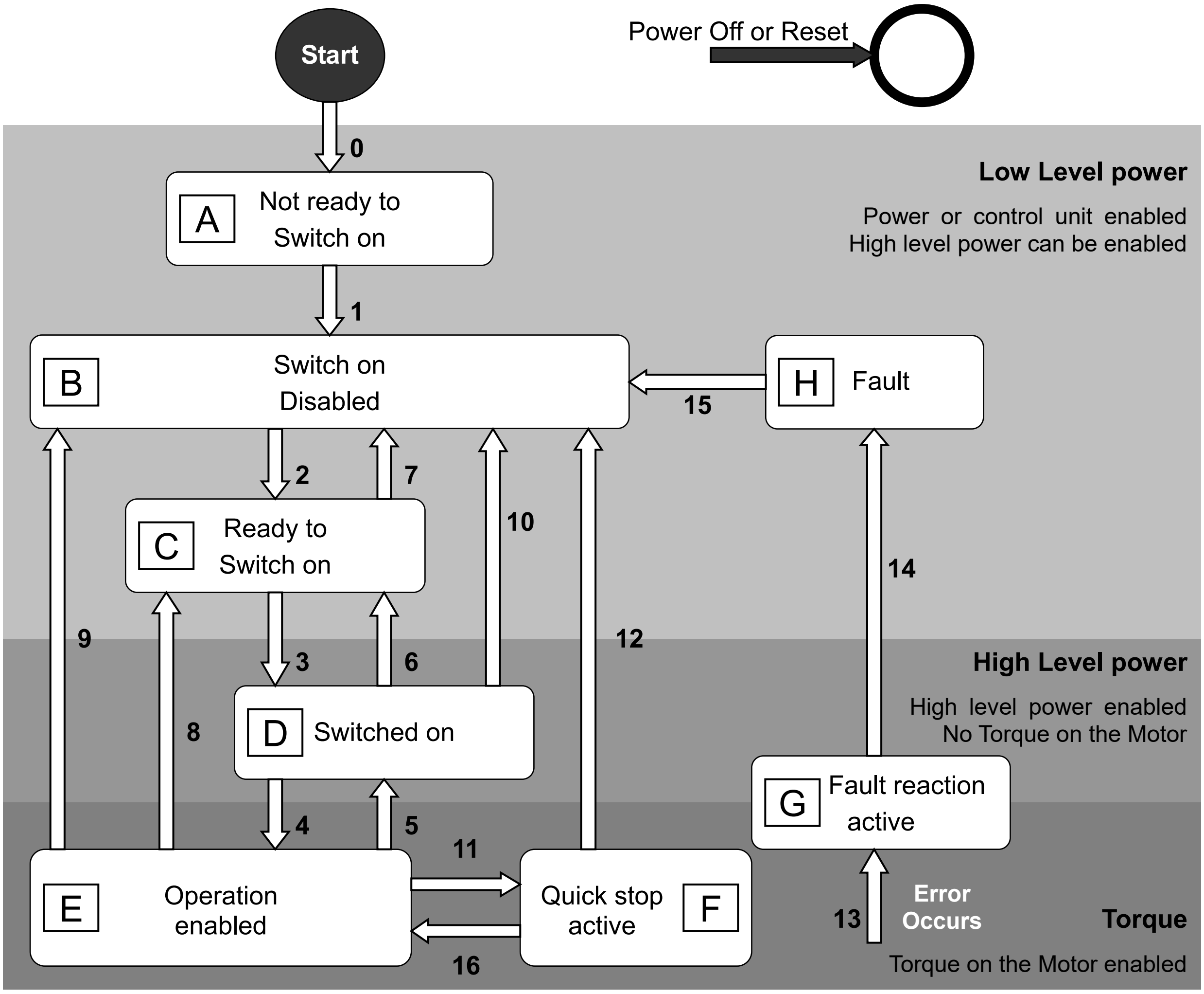
PDS (Power System Device) FSA (Finite States Automaton)of this servo amplifier is an abstract concept which defines the state of the control device stays or passes, operation with the Black Box. It defines the slave's application operating. Slave controls State Device, Mode, and State Change with Object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



Control Word / Status Word Concept of Slave

2) FSA (Finite States Automaton)

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



FSA of EtherCAT Amplifier

Low Level power Area
: The control source is established and the state can switch on main circuit power supply.
High Level Power Area
: Main circuit power supply is in SwithOn state. However, motor is in servo-off (torque(force)-off) state, and when the main circuit is not established, Shift 3 is canceled by slave. Target and set point value are invalid.
Torque Area
: After slave completes servo-on (torque(force)-on) preparation, excited by motor with SwithOn. Motor is operated by target or set point value.
FSA and FSA state describes the state transitions.

FSA State Definition

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

State Shift of FSA

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

3) Control Word

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

Allotment for Each Bit of Control Word

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

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

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

0x6040:Control Word (Intersection)

Index Ax1 0x6040 Ax2 0x6840 Ax3 0x7040 Ax4 0x7840	Indicates reception command of FSA (State Machine) that PDS (Power Device System) is controlled.		Object Code		Variable
Sub-Idx	Description	Data Type	Access	PDO	Initial Value
0x00	Control Word [CWORD] 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 Specific	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 (Manufacturer Specification)		Reserved (Operation Mode Specification)	Target Value Ignored	Internal Limit Active	Target Reached	Remote	Reserved (Manufacturer 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	Indicates status of FSA (State Machine) that PDS (Power Device System) is controlled.		Object Code		Variable
Ax1 0x6041 Ax2 0x6841 Ax3 0x7041 Ax4 0x7841					
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		

MSB LSB

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

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

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

Bit4 :Voltage Enabled (Main Circuit Bit 14 : Voltage Enabled (Main Circuit Establishment Status)
Means that main circuit power supply is impressed at the time of "1."

Bit5 :Quick Stop (Quick Stop)
Shows that it is under operation by Quick Stop Request at the time of "0"

Bit7 :Warning(Warning Status)
It is set to "1" when warning is occurring in slave. This bit is not cleared even if warning factor is lost.

Bit9 :Remote(Control Word Remote)
Operation through EtherCAT communication enabled at the time of "1".
Operation through EtherCAT communication disabled at the time of "0" although setup software enabled.

Bit10:Target reached
It is set to "1" when an operation mode is changed.
It is set to "1" when Quick stop operation is finished and motor stops with Quick stop Option Code;-2,5 to7
Besides, when Bit10 (Target reached) of status word is "1", Indicates that the motor reached the preset value.
Then cleared to "0" when target position is changed. (Only Profile Position (pp):Reserved)

Bit11:Internal Limit Active
When target position is outside of range, and at invalid, soft limit, and forward/backward side limit, it is set to "1".
Setting range is based on specification.

Bit12:Target value ignored Inposition(csp),Velocity Attainment(csv),Torque (force) Limit(cst)
When Target value ignored bit is in Position (csp), Velocity (csv), and Torque (force) (cst) mode, the update of the command becomes permission "1" with command update permission monitor within servo amplifier. Other than this (when command is prohibited), is set to "0."
* At SOFF -> SON, holding brake operation open time after motor excitation is set up, and it becomes "1"after BOFDRY passes.

Bit13 and 8 are based on operation mode specifications, and Bit15 and 14 are maker specifications.

5) Manufacturer specific area

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

Allocation for control words (manufacturer specific area)

bit15	bit14	bit13	bit12	bit11
Cseten	Reserved	Reserved	Eclr	Reserved

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

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

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

MSB LSB

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

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

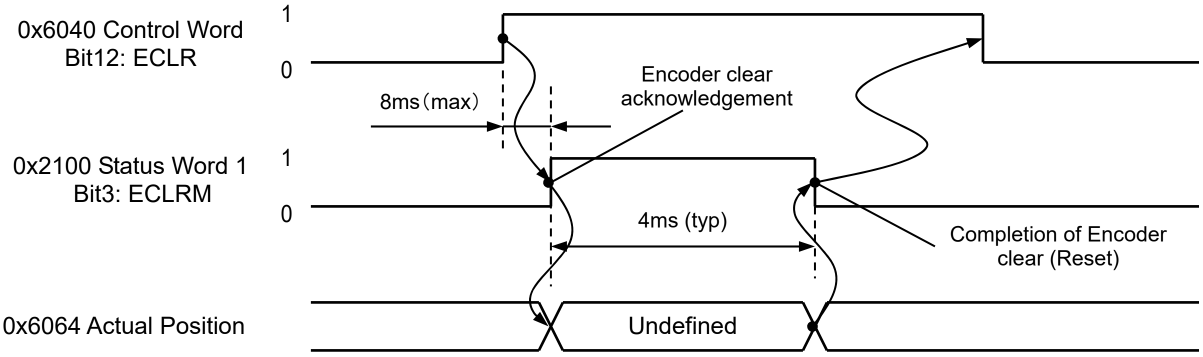
bit15：Magnetic pole position estimation enabled ［CSET］
Magnetic pole position estimation command when using linear motor without hall effect sensor input.
"0": Magnetic pole position estimation disabled
"1": Magnetic pole position estimation enabled

Bit 12: Encoder clear enabled

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

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

Encoder clear (Reset encoder) sequence is shown below.



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

Layout for control words (manufacturer specific area)

bit15	bit14	bit8
Csetfix	Csetpro	Reserved

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

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

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

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Status words ［STSWORD］ *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

4.4 Profile Area

The followings are shown in Table ; profile area of CoE (CANopen over EtherCAT) object list, RM2-EtherCAT Supported / Un-supported, Data length, Access (Dir), PDO Mapping, and parameter effective timing (updating).
#=immediately, $=ESM change required, and &=controlpower cycle required.

Profile Area (No.1)

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

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

Profile Area (No.2)

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

1) Error Code and Error Operation

0x6007: Abort Connection Option Code

<table>
<tr><td>Index Ax1 0x6007
Ax2 0x6807
Ax3 0x7007
Ax4 0x7807</td><td colspan="3">When an abnormality occurs in the communication system (Ex. communication timeout, Link lost, Crc error etc..), This object indicates how the servo amplifier to behave.</td><td>Object Code</td><td>Variable</td></tr>
<tr><td>Sub-Idx</td><td>Description</td><td>Data Type</td><td>Access</td><td>PDO</td><td>Initial Value</td></tr>
<tr><td rowspan="3">0x00</td><td rowspan="2">Abort Connection Option Code</td><td>Integer16</td><td>RW</td><td>No</td><td>0x0001</td></tr>
<tr><td>Setting Range</td><td colspan="3">0x0000-0x0003</td></tr>
<tr><td colspan="5">0 : No Action
1 : Fault Signal
2 : Desable Voltage Command
3 : Even if it is the setting of the Quick Stop Active state, shifts to Switch On Disabled after a stop by Quick Stop Command (quick stop setting (0x605A).</td></tr>
</table>

0x603F: Error code

<table>
<tr><td>Index Ax1 0x603F
Ax2 0x683F
Ax3 0x703F
Ax4 0x783F</td><td colspan="3">Displays codes of errors occurred in the servo amplifier.</td><td>Object code</td><td>Variable</td></tr>
<tr><td>Sub-Idx</td><td>Description</td><td>Data Type</td><td>Access</td><td>PDO</td><td>Initial value</td></tr>
<tr><td rowspan="3">0x00</td><td rowspan="2">Error codes [ERRCODE]
For the list of error codes, please refer to the list of alarm codes in chanpter 11.3.</td><td>Unsigned16</td><td>RO</td><td>Possible</td><td>0x0000</td></tr>
<tr><td>Display range</td><td colspan="3">0x0000 - 0xFFFF</td></tr>
<tr><td colspan="5">✔Represents the same information as lower 16-bit of Sub-index 0x01 in pre-defined errorfield 0x1003 in CANopen communication method.</td></tr>
</table>

0x605A: Quick Stop Option Code (EMR)

<table>
<tr><td>Index Ax1 0x605A
Ax2 0x685A
Ax3 0x705A
Ax4 0x785A</td><td colspan="2">When quick stop (EMR) command is inputted, it is set up by which action motor is stopped.</td><td colspan="2">Object Code</td><td>Variable</td></tr>
<tr><td>Sub-Idx</td><td>Description</td><td>Data Type</td><td>Access</td><td>PDO</td><td>Initial Value</td></tr>
<tr><td rowspan="3">0x00</td><td rowspan="2">Quick Stop Option Code [QSTOP]
By Control mode, treated in the amplifier internally as shown below.</td><td>Integer16</td><td>RW</td><td>No</td><td>0x0002</td></tr>
<tr><td>Setting Range</td><td colspan="3">0x0000-0x0007
(0 - 7)</td></tr>
<tr><td colspan="5">-128 to-1,4,8 to 127 are reserved. Not possible to be set.
Profile position (pp), Cyclic sync position(csp), Interpolated Position (ip) mode
Cyclic sync velocity mode (csv), Profile velocity (pv), Homing mode (hm)
0 : Drive function is Disabled. (To Switch On Disabled after motor stop by dynamic brake operation)
1 : To Switch On Disabled after stop at slowdown deceleration (0x6084)
2 : To Switch On Disabled after stop at quick stop deceleration (0x6085)
3 : To Switch On Disabled after stop by Current Limit
5 : Quick Stop Active state after stop at slowdown deceleration (0x6084)
6 : Quick Stop Active state after stop at quick stop deceleration (0x6085)
7 : Quick Stop Active state after stop by Current Limit

Cyclic sync torque (force) mode (cst), Torque (force) profile mode (tq)
0 : Drive function is disabled (After a motor stops by dynamic brake operation, Switch On Disabled)
1, 2 : Switch On Disabled after Stops by 0x6087(Torque (force) Slope)
3 : To Switch On Disabled after stop by Current Zero
5, 6 : Quick Stop Active state after Stops by 0x6087(Torque (force) Slope)
7 : Quick Stop Active state after stop by Current Zero

*When Quick Stop Operation, not only Maximum torque (force) (0x6072), Clock wise side torque (force) limit (0x60E0), Counter clockwise torque (force) limit (0x60E1), but also Sequence current limit value (0x201E) are limited.
When external EMR signal is input through I/O, it will be "Switch On Disable" even if "Quick Stop Active" is set.</td></tr>
</table>

0x605B: Shutdown Option Code

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

Sub-Idx	Description	Data Type	Access	PDO	Initial Value
0x00	Shutdown Option Code	Integer16	RW	No	0x0000
		Setting Range	0x0000 - 0x0001 (0 to 1)		
	# Profile position (pp), Cyclic sync position(csp), Interpolated Position (ip) mode # Cyclic sync velocity mode (csv), Profile velocity (pv), Homing mode 0 : Disable Drive: Servo-Off(Switch OFF Drive Power Stage 1 : Slow down with slow down ramp; Disable of the drive function # Cyclic sync torque (force) mode (cst), Torque (force) profile mode (tq) 0 : Disable Drive: Servo-Off(Switch OFF Drive Power Stage 1 : Stop at 0x6087 Torque (thrust force) slop				

0x605C:Disable Operation Option Code

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

Sub-Idx	Description	Data Type	Access	PDO	Initial Value
0x00	Disable Operation Option Code [DISOP]	Integer16	RW	No	0x0000
		Setting Range	0x0000 - 0x0001 (0 to 1)		
	Set how to stop a motor at shifts from servo-on to servo-off. # Profile position (pp), Cyclic sync position(csp), Interpolated Position (ip) mode # Cyclic sync velocity mode (csv), Profile velocity (pv), Homing mode 0 : Disable Drive function Switch OFF srive power stage. 1 : Slow down with slow down ramp; disable of drive function # Cyclic sync torque (force) mode (cst), Torque (force) profile mode (tq) 0 : Disable Drive: Servo-Off(Switch OFF Drive Power Stage 1 : Stop at 0x6087 Torque (thrust force) slop ✔When main power is shut down, it will be dynamic brake operation regardless of the setting. However, RM2 series servo amplifier does not have dynamic brake circuit. So, it will be Free Run Stop if set value is zero.				

0x605D:Halt option code

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

Sub-Idx	Name/Description	Data Type	Access	PDO	Initial Value
0x00	Halt option code By Control mode, treated in the amplifier internally as shown below. -128 to -1, 4 to 127 are reserved. Not possible to be set up.	Integer16	RW	No	0x0001
		Setting Range	0x0001 - 0x0003(1-3)		
	# Profile position (pp), Cyclic sync velocity mode (csv), Profile velocity (pv), Homing mode 1 : Operation enabled state after Stop at slowdown deceleration (0x6084). 2 : Operation enabled state after stop at quick stop deceleration (0x6085) 3 : To Switch On Disabled after stop by Current Limit # Cyclic sync position mode (csp) ,Interpolated Position (ip) mode 1, 2, 3 : Operation enabled state after stop by Current Limit # Cyclic sync torque (force) mode (cst), Torque (force) profile mode (tq) 1, 2 : Operation enabled state after Stops by 0x6087(Torque (force) Slope) 3 : Operation enabled state after stop by Current Zero. ✔For being servo OFF after stop by halt state, perform servo OFF with the state of setting a halt bit of the control word.				

0x605E: Fault Reaction Option Code

Index Ax1 0x605E Ax2 0x685E Ax3 0x705E Ax4 0x785E	When alarm is generated with servo amplifier, determined how it operates.		Object Code		Variable
Sub-Idx	**Description**	**Data Type**	**Access**	**PDO**	**Initial Value**
0x00	Fault Reaction Option Code	Integer16	RW	No	0x0002
		Setting Range	0x0000 to 0x0003 （0 to 3）		

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

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

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

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

2) Operation Mode

EtherCAT-CoE specification has modes of operation shown in operation mode list.
Profiles applicable to RM2 EtherCAT-CoE slave amplifier are listed in the following Operation Mode List.
Besides, operation mode supported can check at "Supported Drive Mode:0x6502."

Operation Mode List

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

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

Unique Mode Bit Assigned to Control Word

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

Manufacturer own Bit Assigned to Status Word

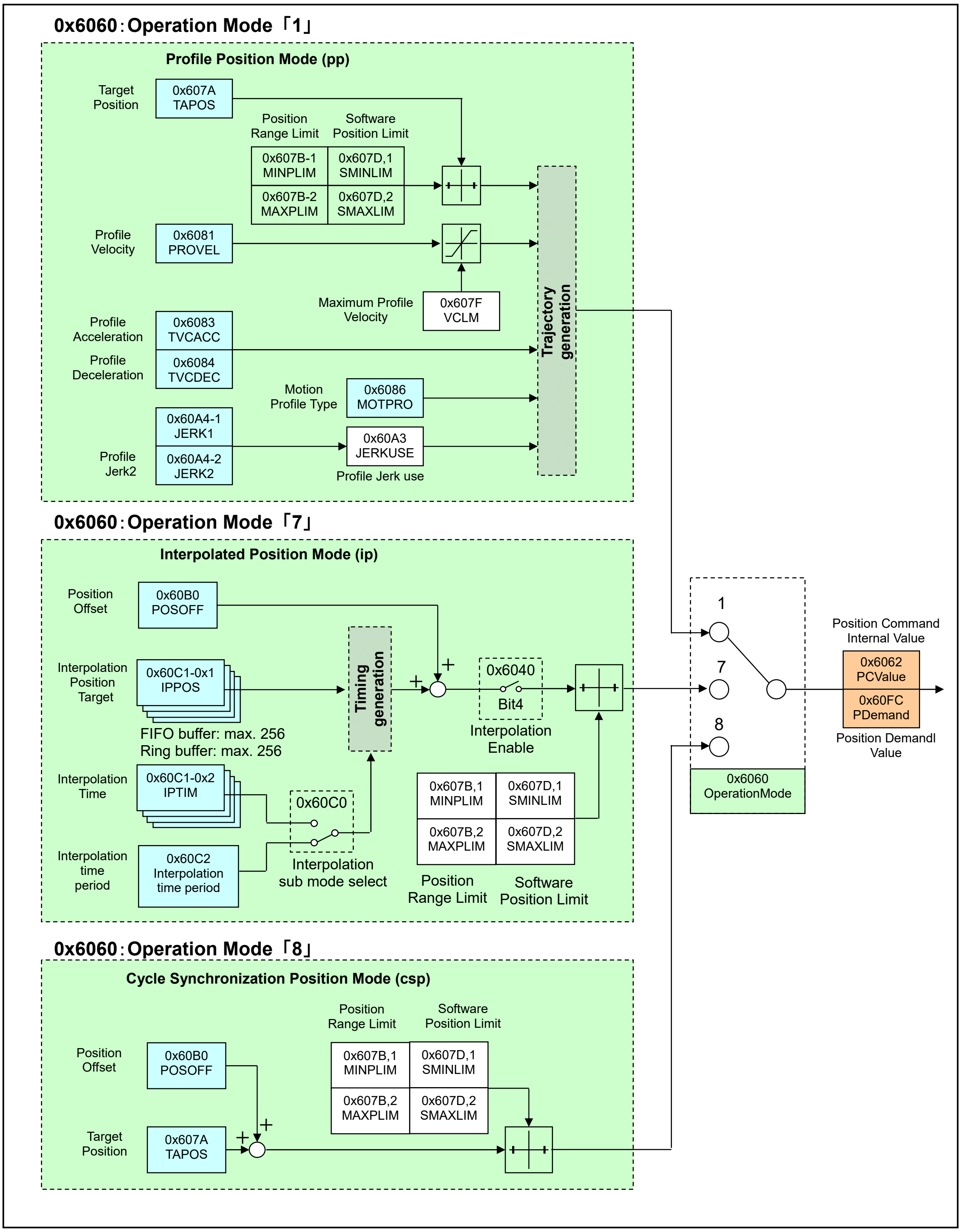
Operation Mode		bit13	bit12	bit10
pp	Profile Position Mode	Following error	Set-point Acknowledge	Target reached Quick Stop Finished Operation Change Finished Halt Active
csp	Cycle Sync. Position Mode	Following error	Target Position ignore	
ip	Interpolated position	Reserved	Interpolation active	
csv	Cycle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

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

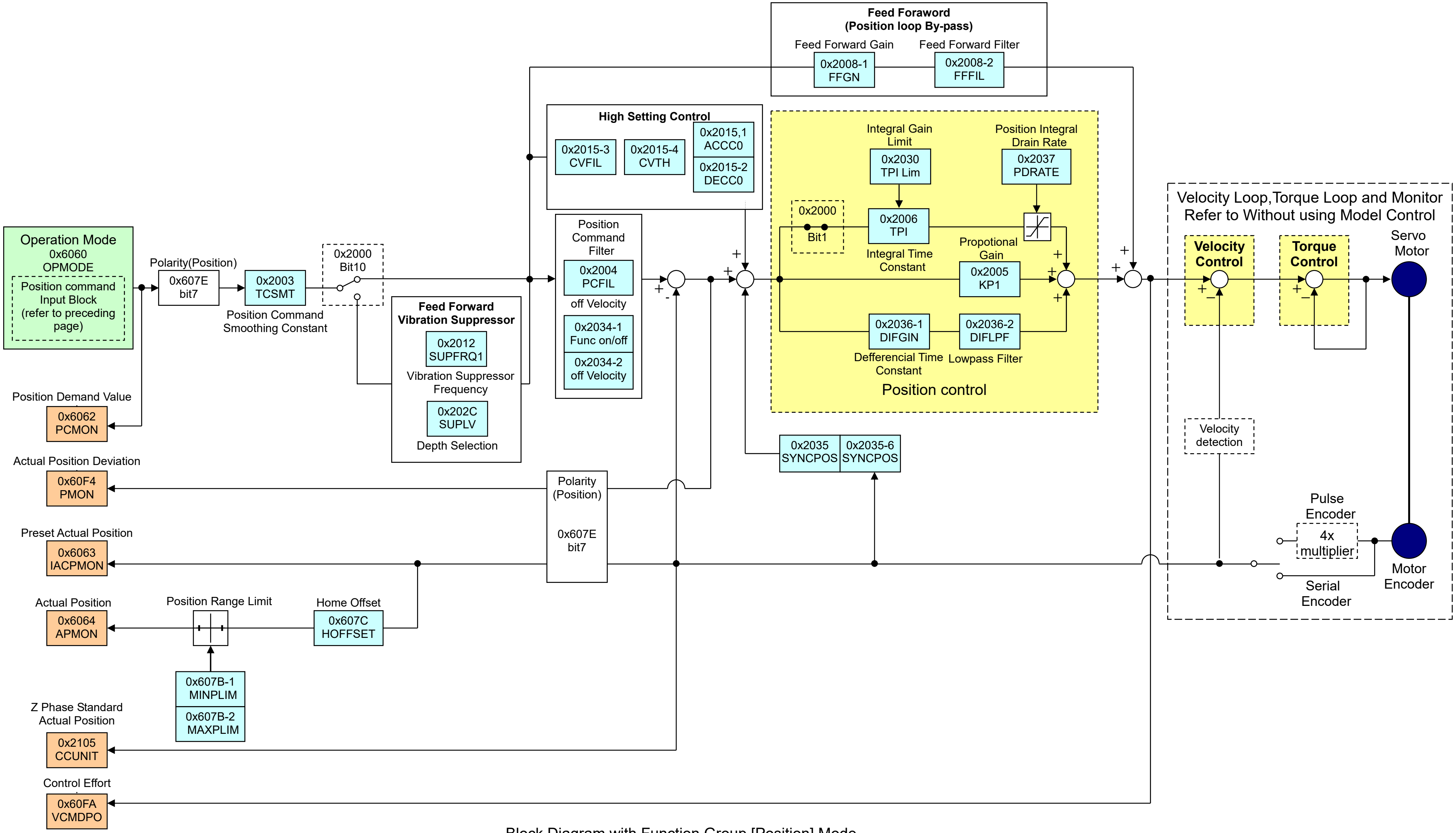
3) Function Group “Position” Mode

Abstract of Function Group “Position” Mode

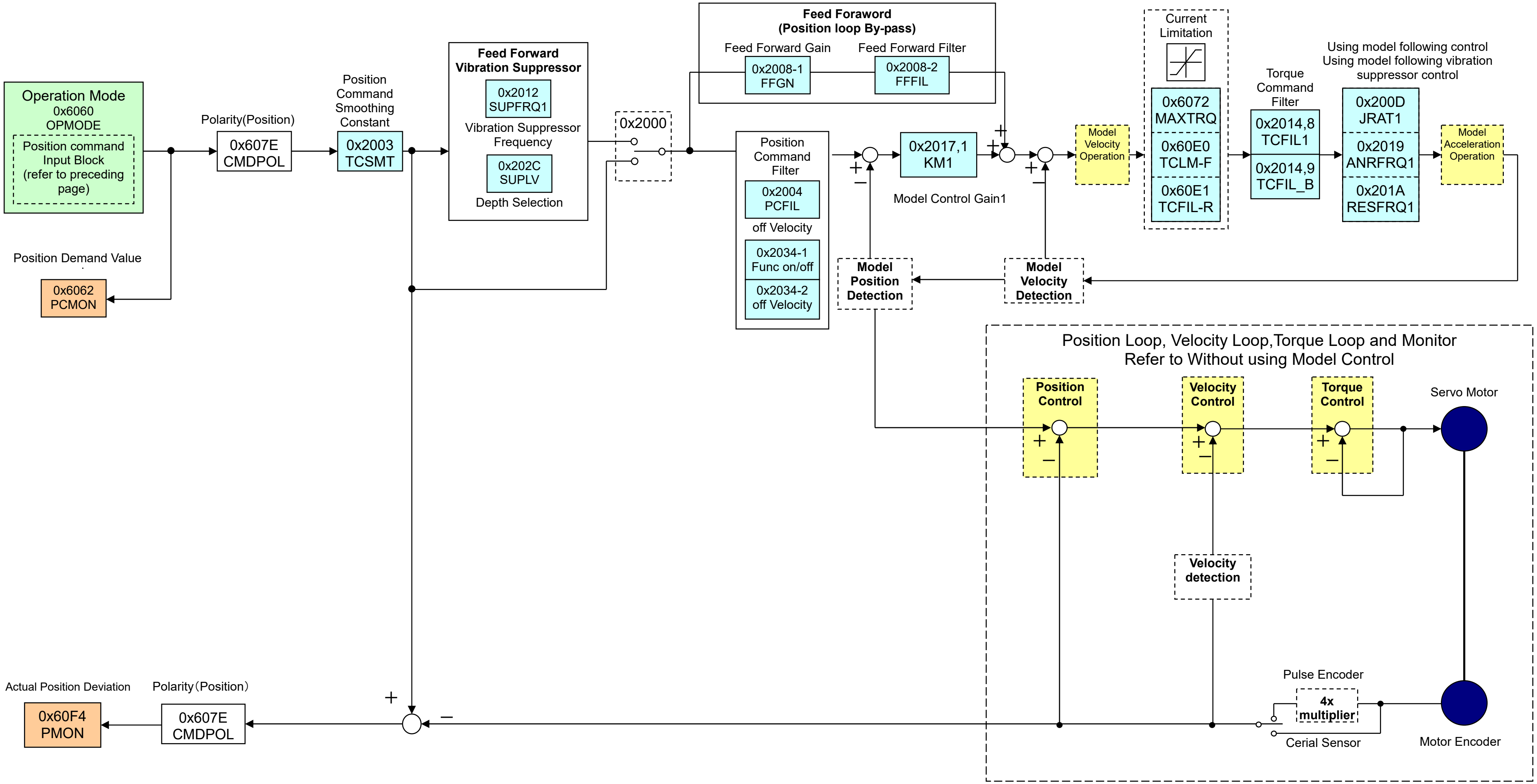
As for function group “Position” operation mode, “Profile position Mode” , “Cyclic Synchronous Position Mode” and “Interpolated Position Mode”are supported. 0x6060: Operate “Profile Position Mode” by setting “1” in operation mode, “Cyclic Synchronous Position Mode” by setting “8” and “Interpolated Position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



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



Block Diagram with Function Group [Position] Mode



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

4) Profile Position Mode

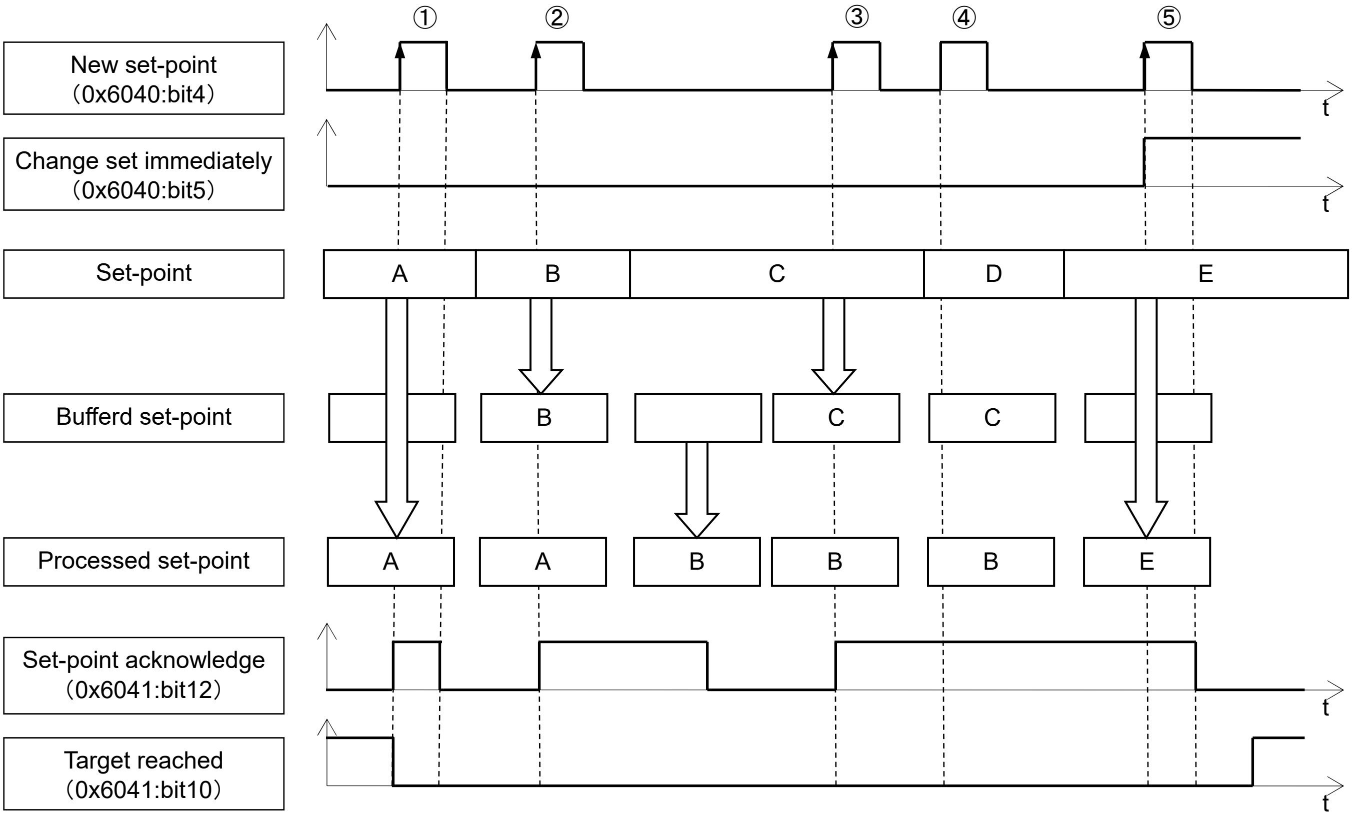
0x6060：When Operation Mode is set “1”, “Profile Position Mode” shall be operated.
The master sends “Target Position（0x607A）”, “Profile Velocity (0x6081), “Profile Acceleration and Deceleration（0x6083，0x6084）.
The slave (servo amplifier) executes trajectory generation and starts to move to the target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

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

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

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

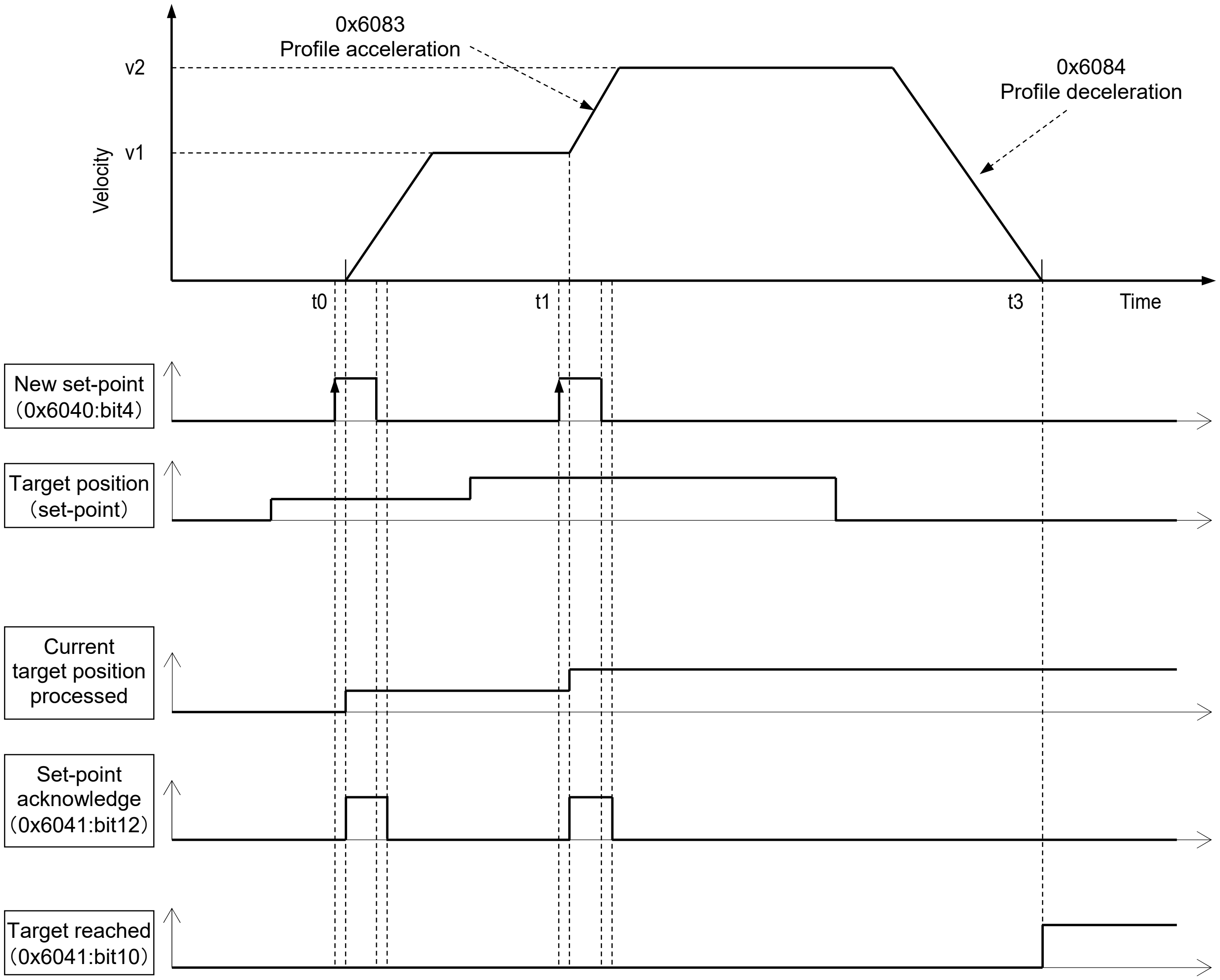
The master controller switches the two modes mentioned above by the timing of the following bits;
“New set-point（bit4）”, ”Change set immediately（bit5）”, ”Change of set-point（bit9）” in the Control Word（0x6040）and “Set-point acknowledge（bit12）” in the Status Word（0x6041）.
These bits allow to set up a request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



Sequence Diagram for Profile Position Mode

& Single set-point

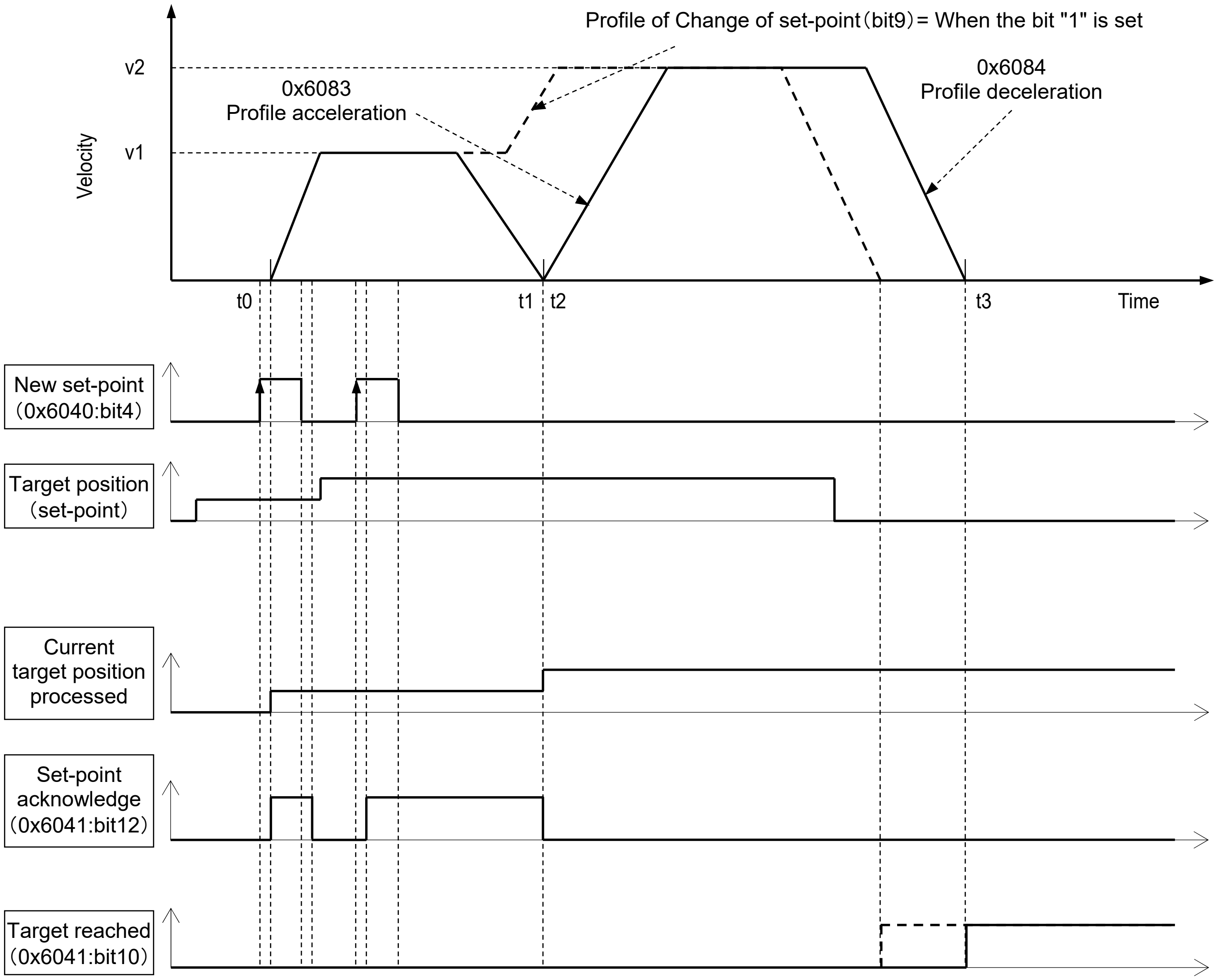
(1) If the bit "Change set immediately（bit5）" is "1", a single set point is executed by the servo amplifier.
(2) After a set point is applied to a servo amplifier, the master sets "new set-point (bit4)" in Control word to "1" in order to notify completion of the set point to the slave(servo amplifier).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



Single set-point (Update a set point immediately)

& Set of set-points

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



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

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

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

MSB LSB

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

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

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

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

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

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

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

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

Index Ax1 0x6041 Ax2 0x6841 Ax3 0x7041 Ax4 0x7841	This object indicates Operation Mode Specific bit and Manufacturer Specific bit of the Profile Position mode (pp).		Object code		Variable
Sub-Idx	Discription	Data Type	Access	PDO	Initial value
0x00	Status Word [STSWORD] * See the Pattern Status table for"Status word bit pattern (Bit 6,5, 3,2,1,0,)	Unsigned16	RO	Possible	0x0000
		Range	0x0000-0xFFFF		

MSB LSB

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

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

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

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

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

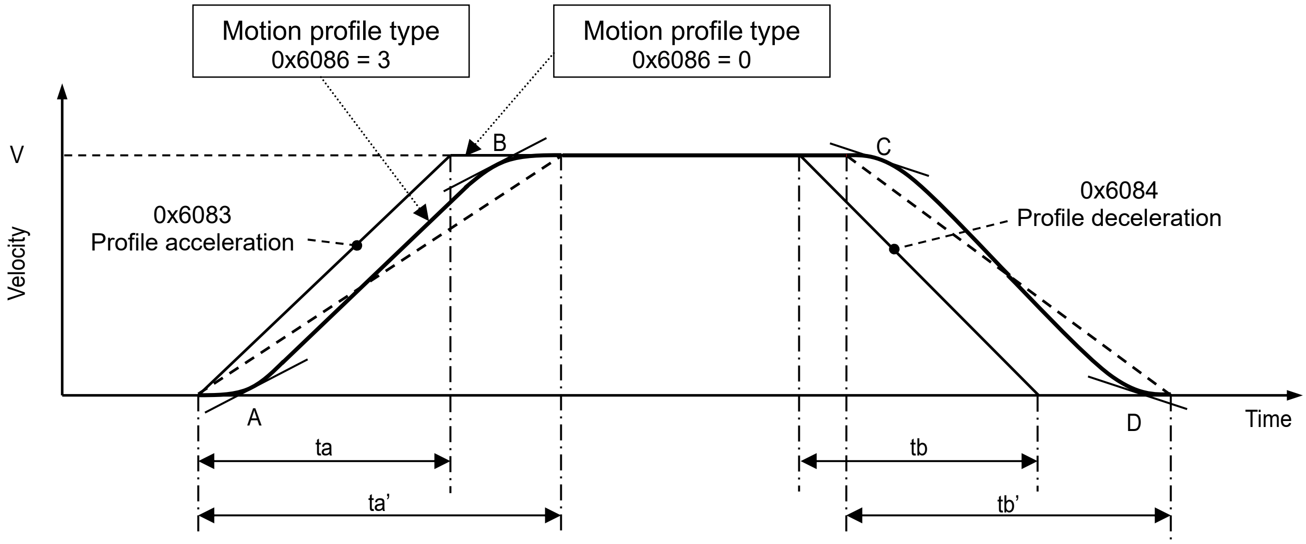
bit11：Internal limit active [Internal Limit active]
0：In normal operation, or standby state after previous normal profiling.
1：Set in the following cases.
・When relative position command selected and wrap around inactivated, the value oversteps the coordinate from positive (present position ≦ 0x7FFFFFFF)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

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

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

& Motion Profile

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



Motion profile operation

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

0x6086: Motion Profile Type

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

0x60A3: Profile Jerk Use

Index		Profile Jerk Use		Object Code		Variable
Ax1 0x60A3 Ax2 0x68A3 Ax3 0x70A3 Ax4 0x78A3						
Sub-Idx	Description		Data Type	Access	PDO	Initial Value
0x00	Profile Jerk Use		Unsigned8	RW	No	0x01
			Setting Range	0x01-0x02 (1 or 2)		
	Sets up combinations of sub index numbers of profile jerk object (0x60A4) for jerk profile operation.					

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

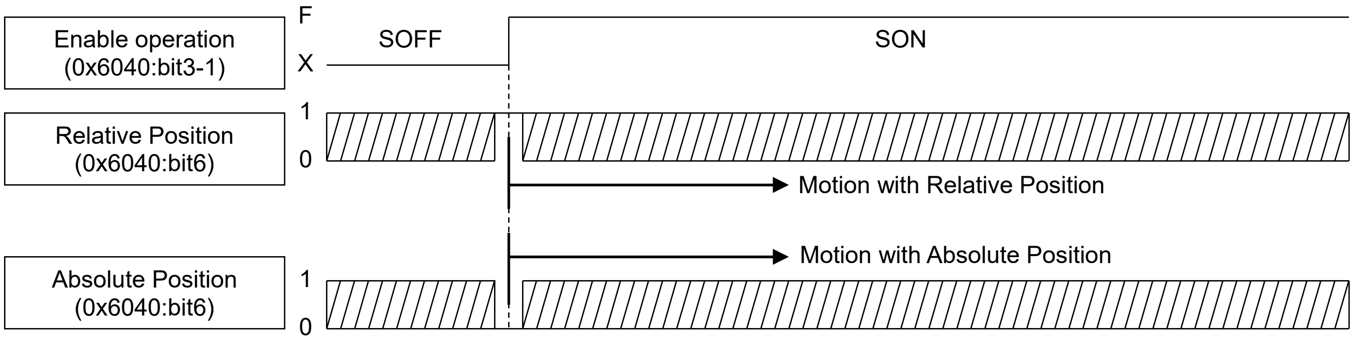
0x60A4: Profile Jerk

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

* Refer M0011028 for setting of jerk function.

5) Cycle Synchronization Position Mode

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



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

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

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

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

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

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

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

MSB LSB

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

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

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

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

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

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

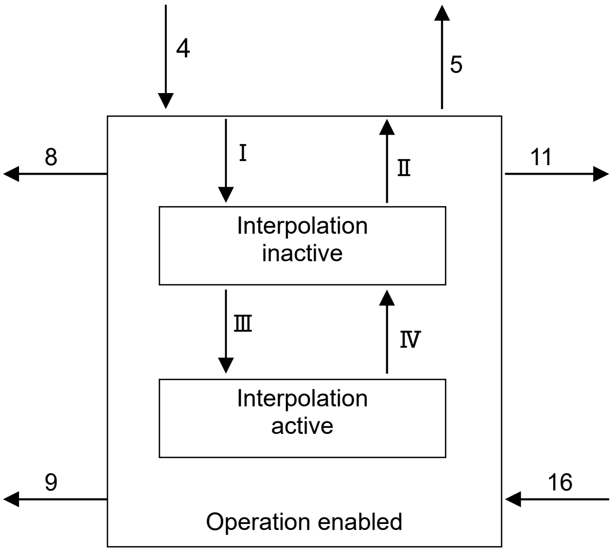
bit12:Target value ignored [Target value ignored]
(Command acceptance prohibition)
0:Target position shall be used as input to position control loop.
1:Target position ignored.

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

6) Interpolated Position Mode

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

State Change ofInterpolated position mode



FSA status and FSAstate change

FSA status definition

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

FSA state change

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

&Interpolation sub mode select (0x60C0)

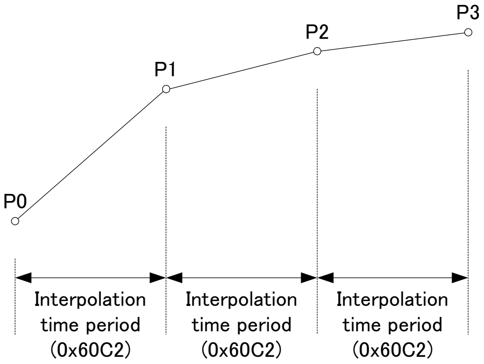
This servo amplifier corresponds to two kinds of interpolation methods. Select by using interpolation sub mode select (0x60C0).

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

・Linear Interpolation (fixation time)

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

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

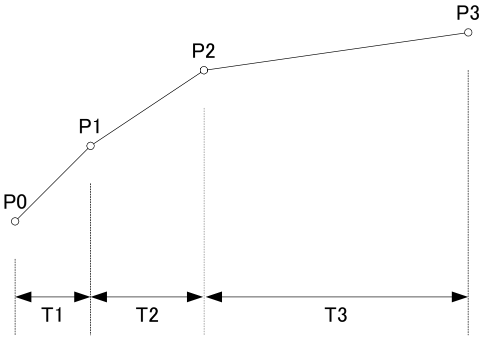


Buffer	
Interpolation Position Target 0x60C1-1	Interpolation Time 0x60C1-2
P0	-
P1	-
P2	-
P3	-

・Linear Interpolation (variable time)

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

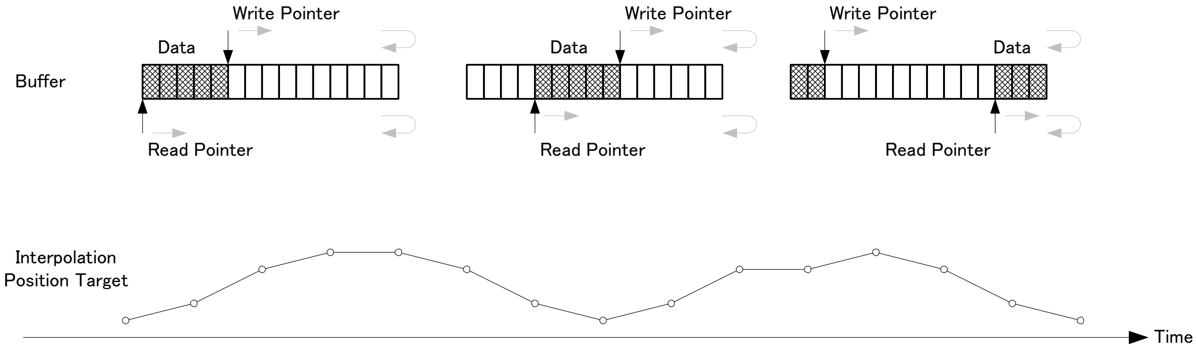
Sets interpolation position target (0x60C1-1) and interpolation time (0x60C1-2). Interpolation time period (0x60C2) is not used.



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

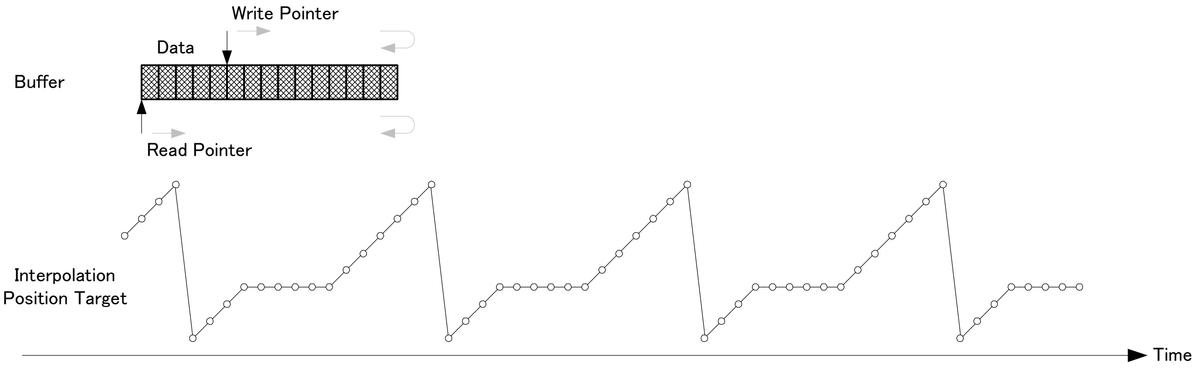
&Usage when buffer format is set to FIFO

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



&Usage when buffer format is set to Ring

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



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

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

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

MSB　LSB

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

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

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

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

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

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Status word ［STSWORD］	Unsigned16	RO	Possible	0x0000
	*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)	Range	0x0000 - 0xFFFF		

MSB　LSB

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

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

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

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

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

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

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

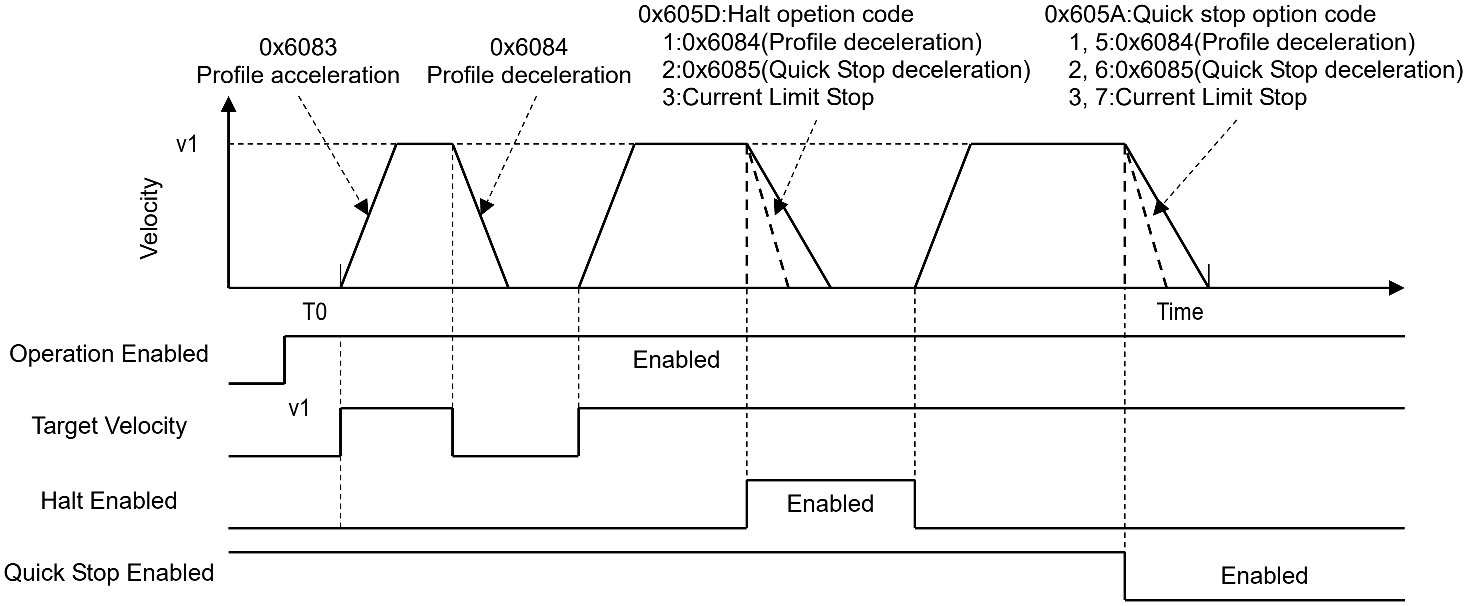
bit13：Following error　［Following error］
0: No following error　1: Following error

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

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

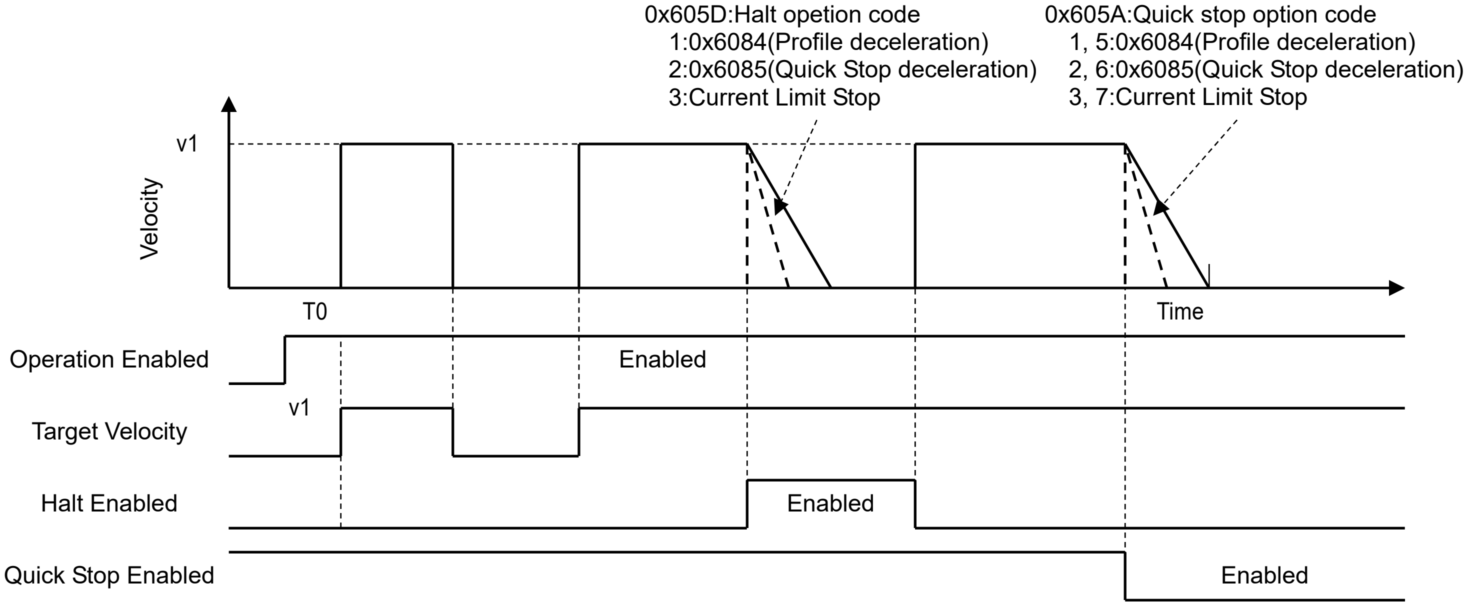
8) Profile Velocity Mode

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

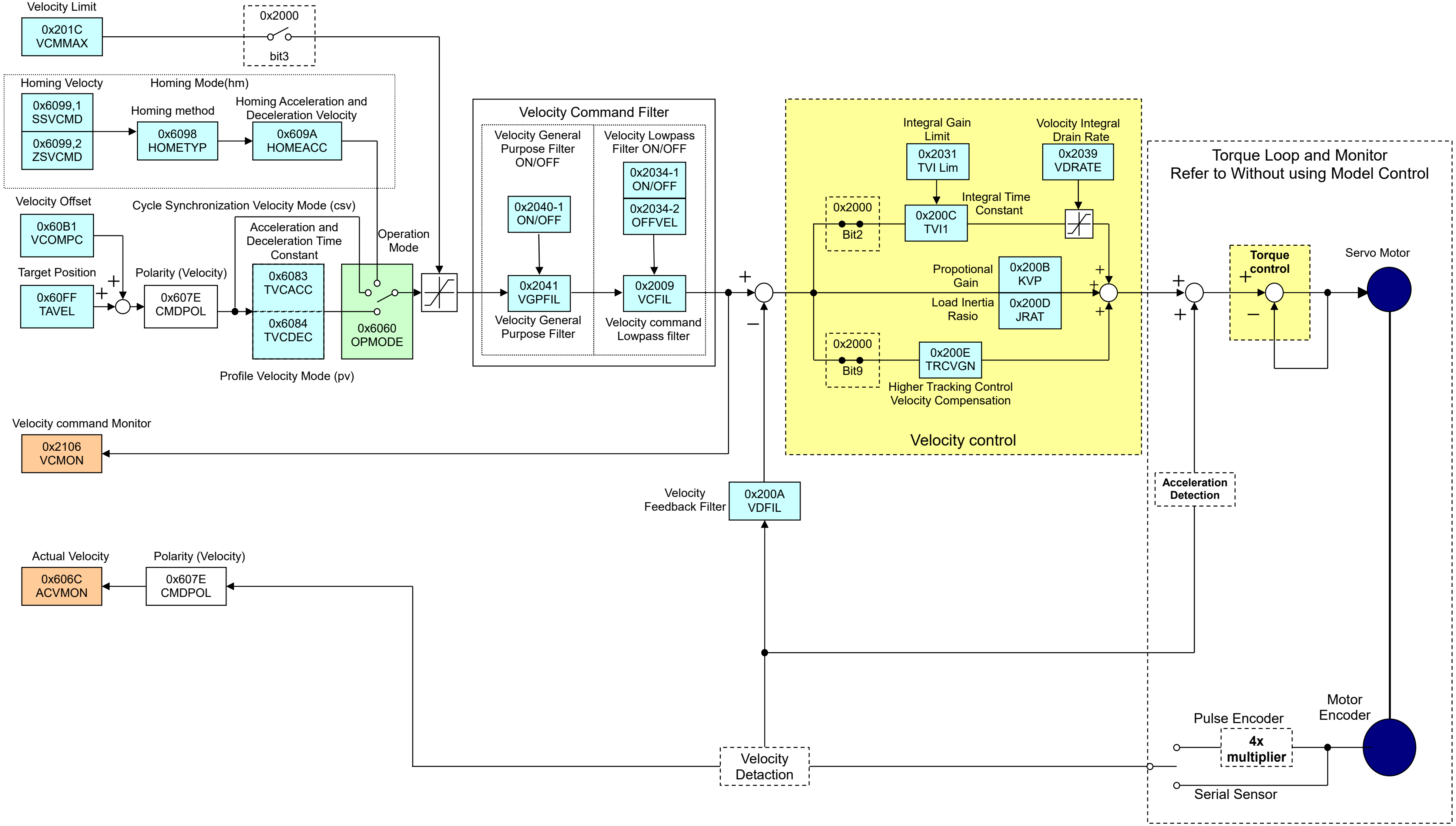


9) Cyclic Synchronous Velocity Mode

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



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



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

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

Index Ax1 0x6040 Ax2 0x6840 Ax3 0x7040 Ax4 0x7840	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: Acceptpt Velocity Command(Enable bit4)
1:Stop axle with halt option code(0x605D)

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

Index 0x6041	This object indicates Operation mode specific bits and Manufacturer 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	Speed	Internal Limit active	Tr	Rm	Res	W	Sod*	Qs*	Ve	F*	Oe*	So*	Rtso*
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

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

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

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

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

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

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

10) Homing Mode

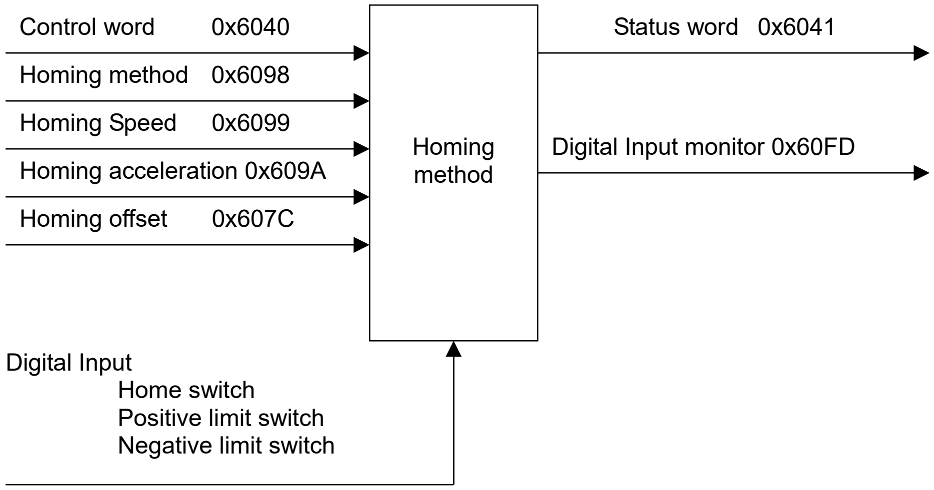
This clause describes the method by which a drive seeks the home position (also called, the datum, reference point or zero point)
Input objects are defined as well as the output objects. The user may specify the speed, acceleration and the method of homing. There is a further object home offset, which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

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

Here is the Objects list in the Homing mode.

List of Homing Mode Object

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



Homing mode function

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

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

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

Homing Method

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

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

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

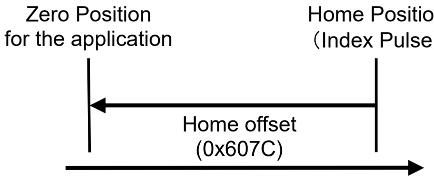
The position actual value (0x6064) is the current software position in the amplifier. It is based on the unprocessed position encoder information (single or multi turn encoder).

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

Settings of actual position calculation method”.

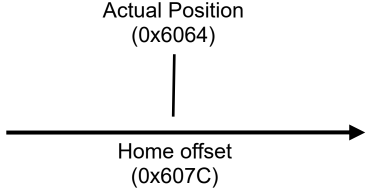
The actual position (0x6064) in home position during homing is as follows:

Without Homing Method 35,37



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

Homing Method 35,37

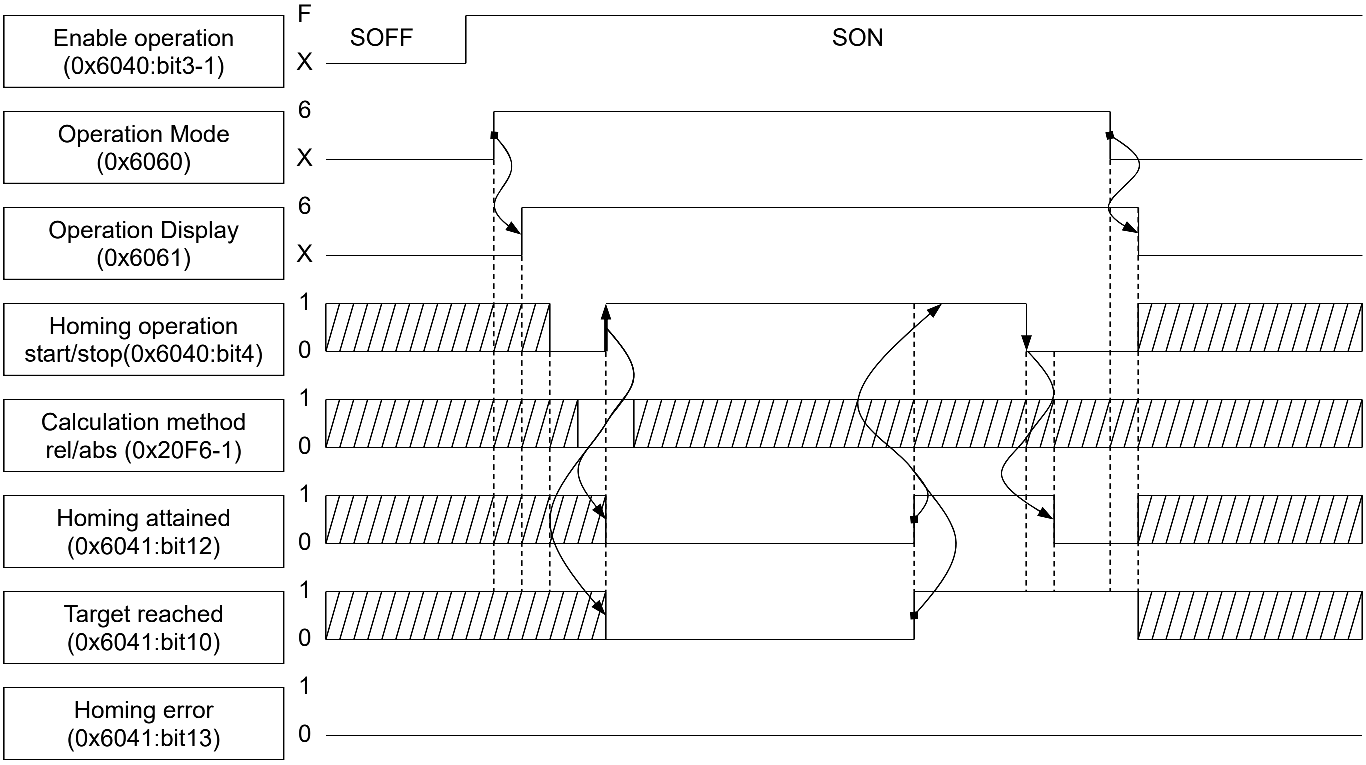


Actual Position(0x6064) = Home offset (0x607C)

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

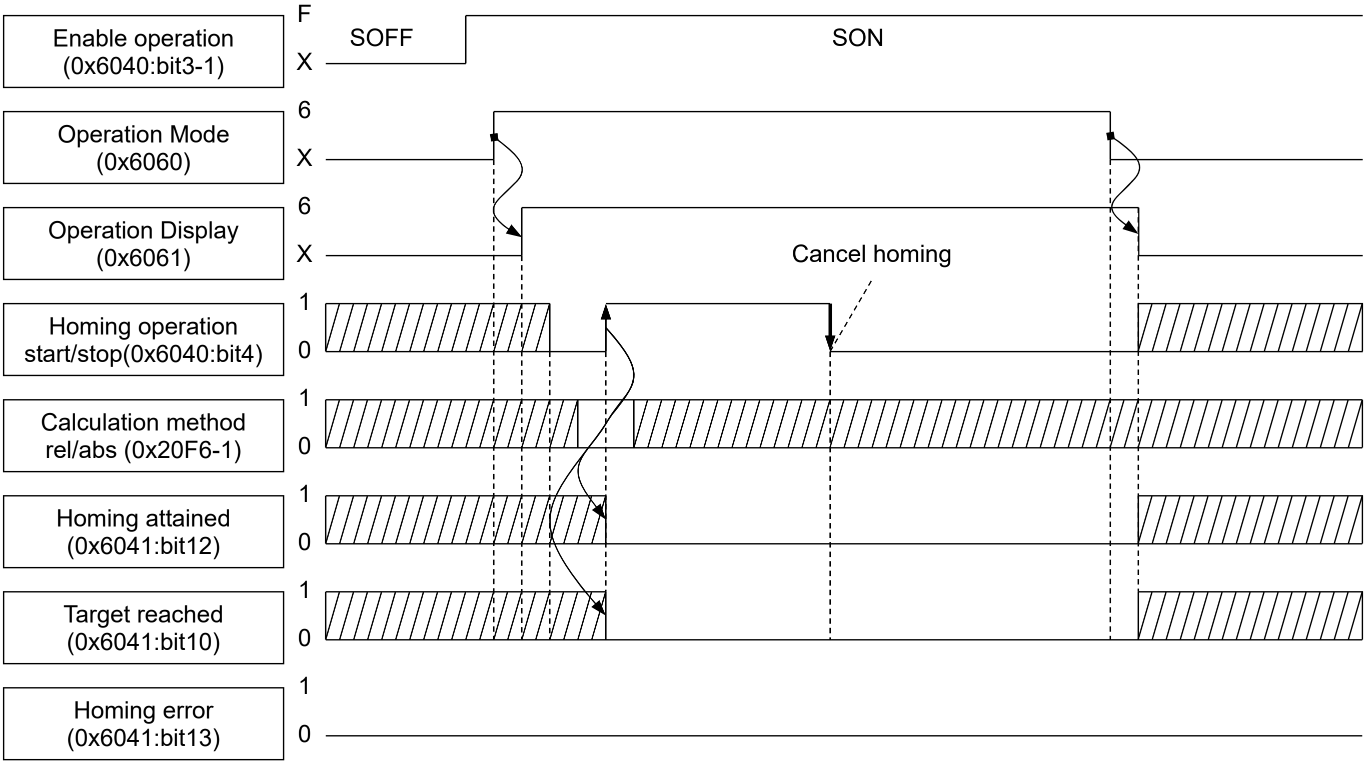
The following sequence shows homing modes corresponding to the Amplifier of Servo Amplifier

1) Start and completion sequence of homing mode



Homing sequence

2) Cancel before homing completion



Homing Cancel sequence

Definitions of general purpose input signals in the homing mode

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

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

Homing mode which cannot use with multiple axis

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

Operation direction by homing method

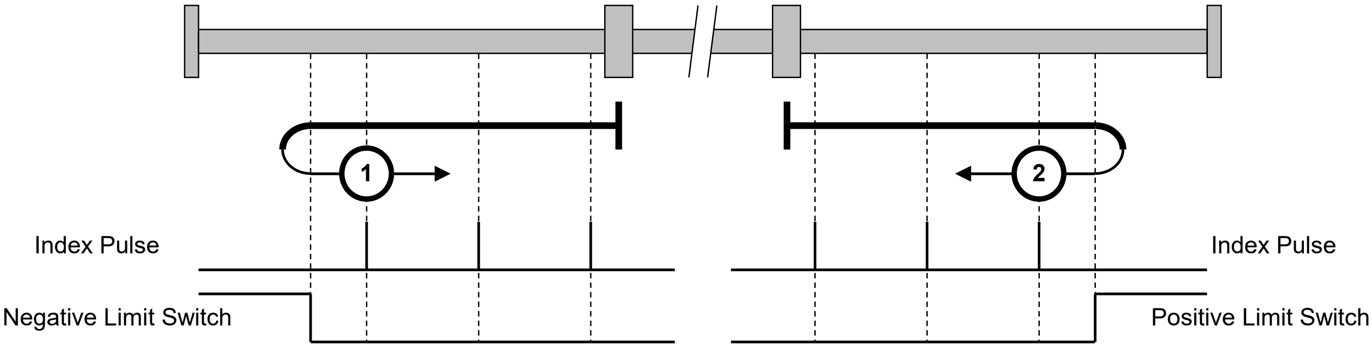
Move direction in each homing drawing and rotation direction are depending on 0x607E: Polarity.
Move direction in drawing and motor rotation direction are shown below.

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

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

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

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



[1]Homing on negative limit switch and index pulse

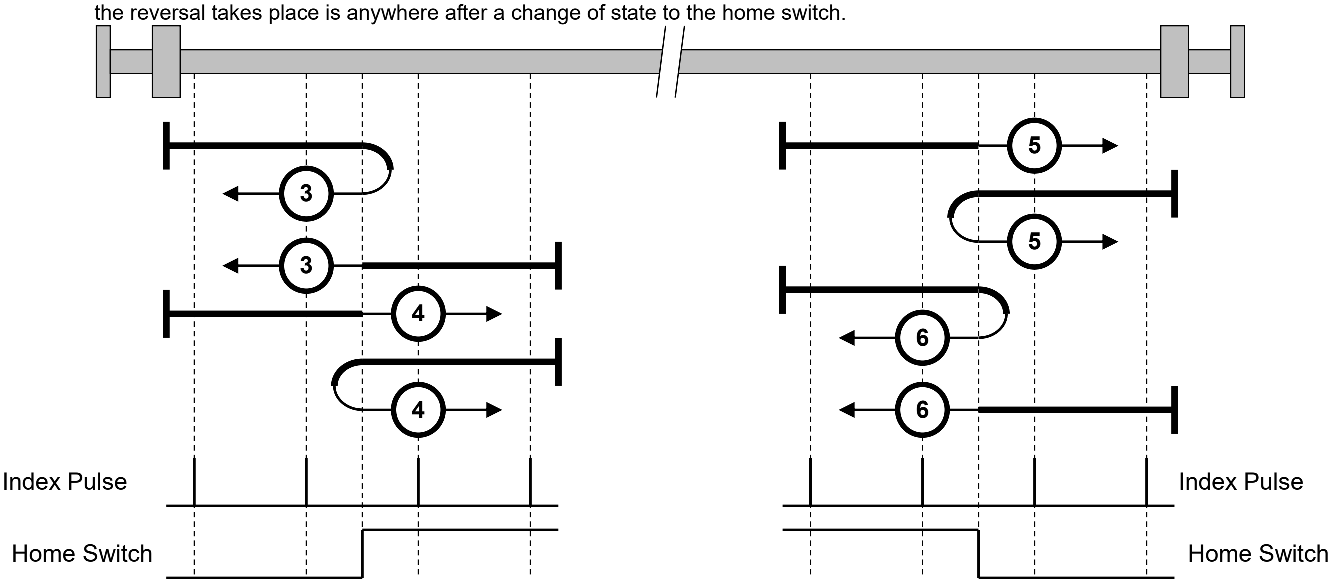
[2] Homing on positive limit switch and index pulse

0x6099, 0x01: Speed during search for switch ━━━

0x6099, 0x02 : Speed during search for zero ⟶

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

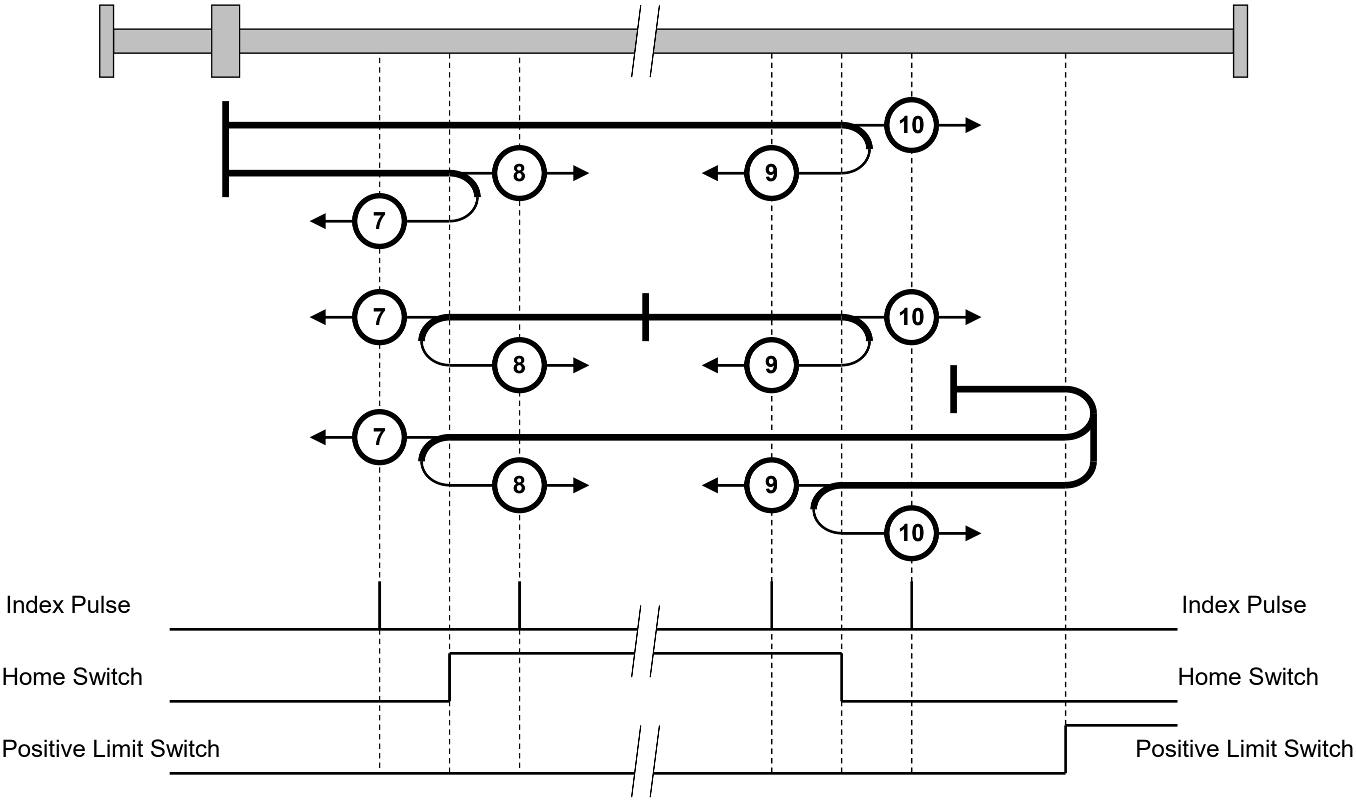
Using these methods as shown in the below figure, the initial direction of movement shall be dependent on the state of the home switch input. In the method [3] and [6], the home position shall be at the left position where the home switch changes state, and in the method [4] and [5], the home position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



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

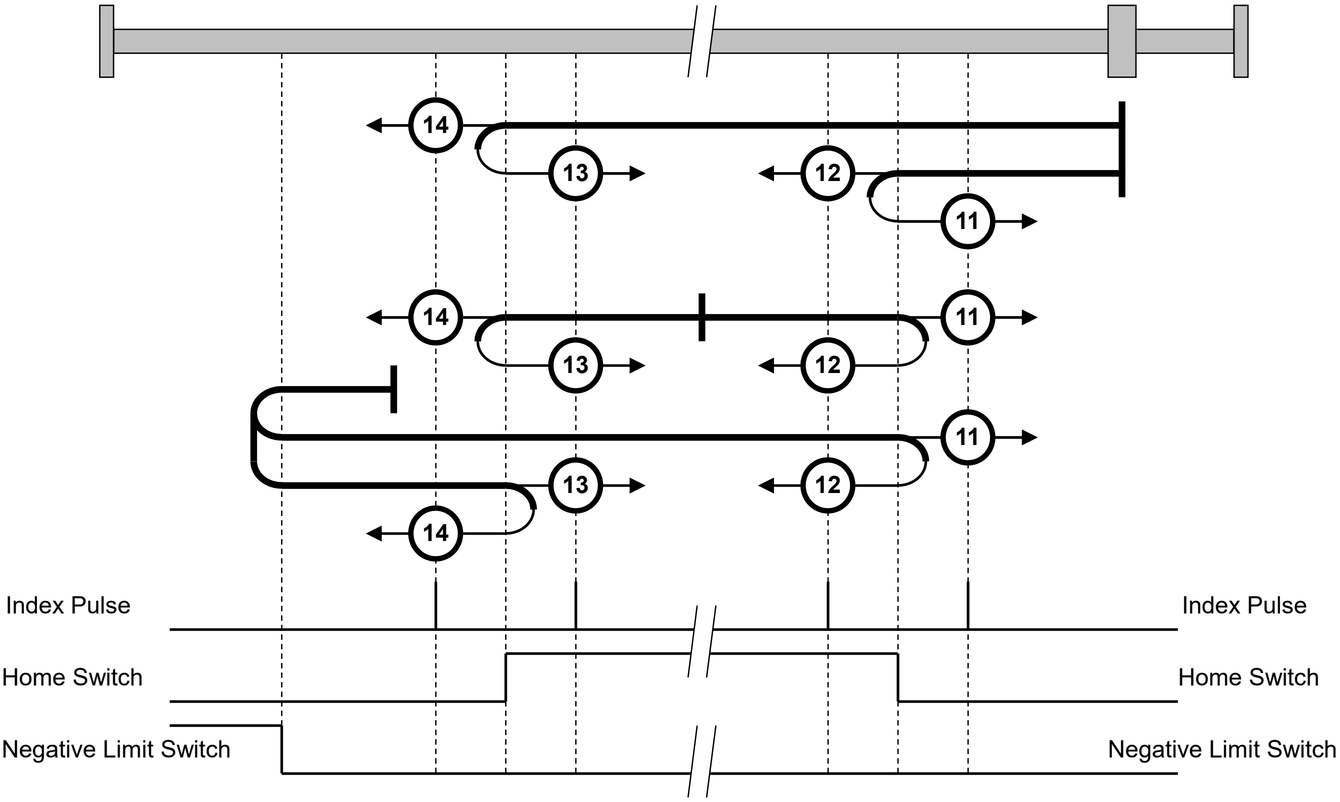
[5] Homing on negative home switch and index pulse (Pos)
[6] Homing on negative home switch and index pulse (Neg)

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)

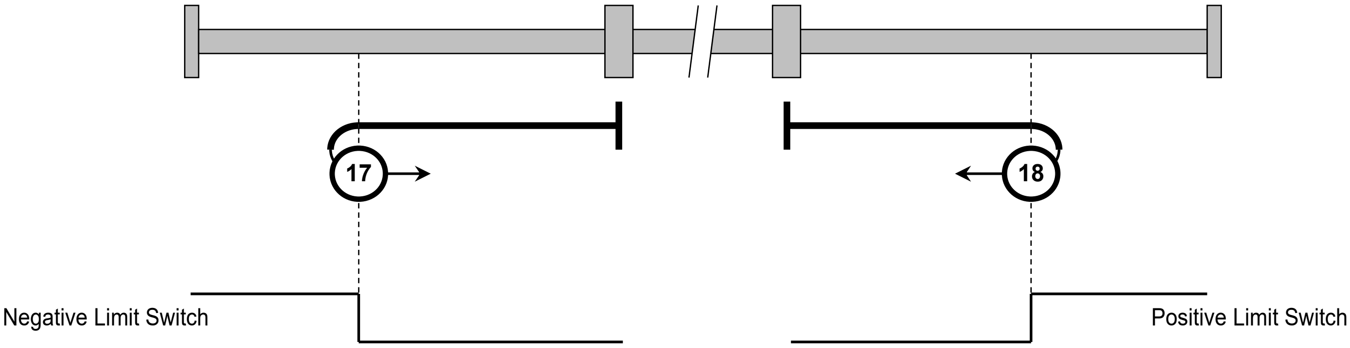
Homing Method [11][12][13][14]: Homing on negative home switch, home switch and index Pulse



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

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

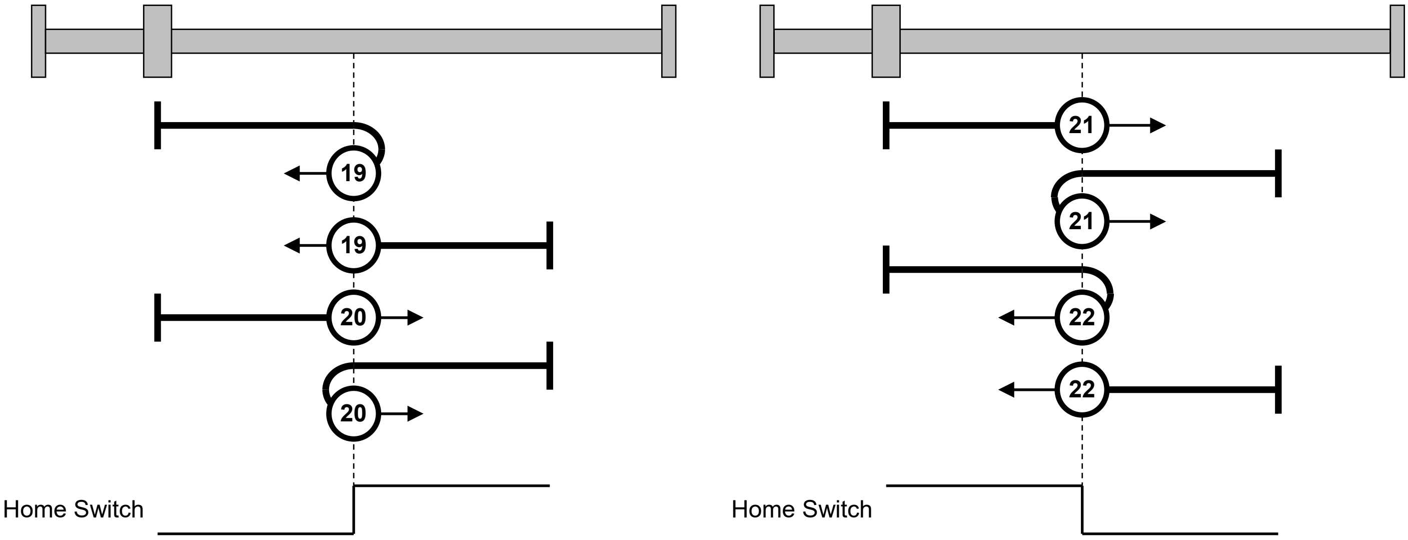
In the method [17], the initial direction of movement shall be leftward (Negative rotation) if the negative limit switch is inactive. The home position shall be at the potision by the negative limit switch becomes active.
And using the method [18] , the initial direction of movement shall be rightward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



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

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

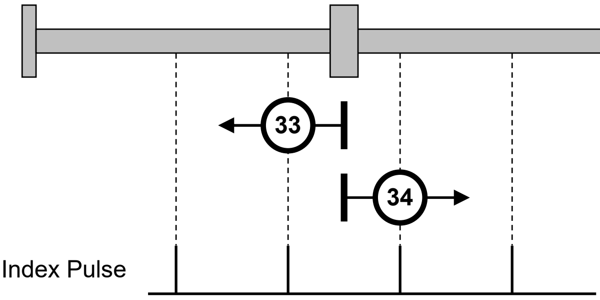
There methods are similar to methods 3 to 6 that the home position is not dependent on the index pulse but only depend on the relevant home or limit switch transitions. The initial move direction depending on state of home switch and the move direction at home switch change are matched as follows: [3]=[19],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



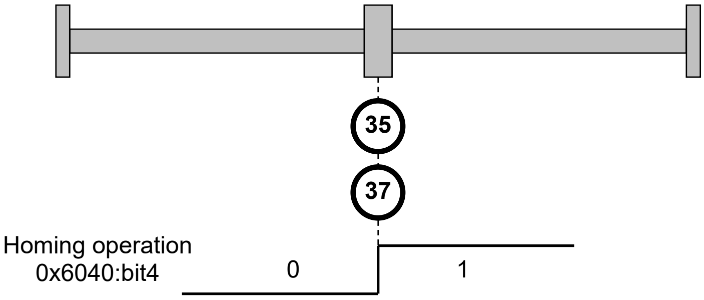
[19] Homing on positive home switch (negative direction stop)
[20] Homing on positive home switch (positive direction stop)
[21] Homing on negative home switch (positive direction stop)
[22] Homing on negative home switch (negative direction stop)

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

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



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

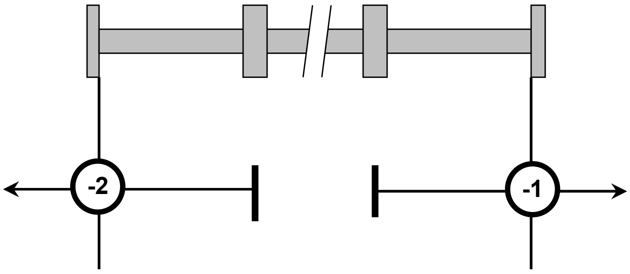


[35][37]Homing on Current position Note)

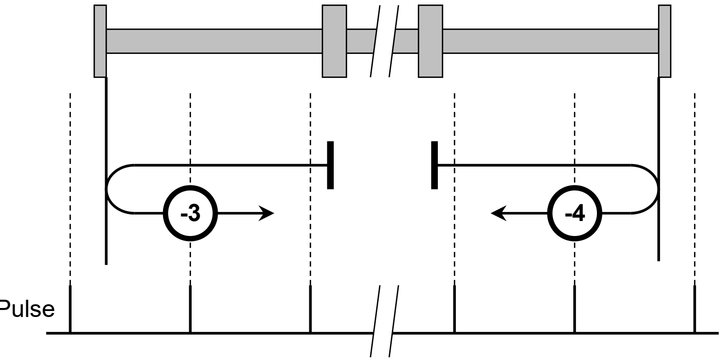
Note) Homing method [35]: Homing on current position is void at CiA402 Work Draft CANopen Drive and motion control device profile part2 Version：3.0.1.13 (26 April 2012)

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

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



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



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

& Home position retention function when using absolute system

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

Step 1 Preparation of homing
OD: 0x6098 Set homing method to "35 (0x23): Homing to present position."
OD: 0x607C Setting of home offset (When using "0: Absolute homing," set the position you want to set to "detection reference position,"when using"1: Relative position homing," set to zero.)
OD：0x6060 Change operation mode to "6: Homing mode."
Step 2 Homing start
OD: 0x6040 Set "Control word, Bit4＝1 (0x0010): Homing start."
Step 3 Confirmation of reference position detection
OD: 0x6041 Monitor "Status word, Bit12＝1: Homing completed."
When performing "0: Absolute homing," proceed to step 5, when performing "1: Relative homing," proceed to step 4.
Step 4 Setting of home offset
OD: 0x210C Calculate "OD: 0x607C Home offset" value from home index position to set.
Home offset (0x607C) = Origin coordinate after homing completed - Home index (0x210C)

Step 5 Homing completion
Exit "OD: 0x6040 Control word, Bit4 = 0 (0x0000): Homing," and then change the control mode back to the one using "OD: 0x6060 Operation mode."
Step 6 Storage of origin coordinate
Write "0x65766173" in "Sub-Idx01: All parameters storage" of "OD: 0x1010 Parameter storage."
Step 7 Confirmation of storage completion
Storing is completed by turing back to "Sub-Idx01=1" of "OD：0x1010 Parameter storage."
(0: Now in storing)

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

0x6040:Control Word (Homing Mode: hm)

Index		This object indicates the Operation Mode Specific bit and Manufacturer Specific bit in Homing Mode.		Object code		Variable
Ax1 0x6040 Ax2 0x6840 Ax3 0x7040 Ax4 0x7840						
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

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

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

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

0x6041:Status Word(Homing Mode: hm)

Index Ax1 0x6041 Ax2 0x6841 Ax3 0x7041 Ax4 0x7841	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.	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	[Voltage Enabled]
0:Voltage disenabled	1:Voltage enabled
bit7:warning	[warning]
0:No warning	1:warning condition
bit9:remote	[remote]
0: Control word is not processed 1: Being processed by control word	
bit11:Internal Limit active	[Internal Limit active]
0:nomal operation 1:Software Position limit ,CW limit/CCW limit	

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

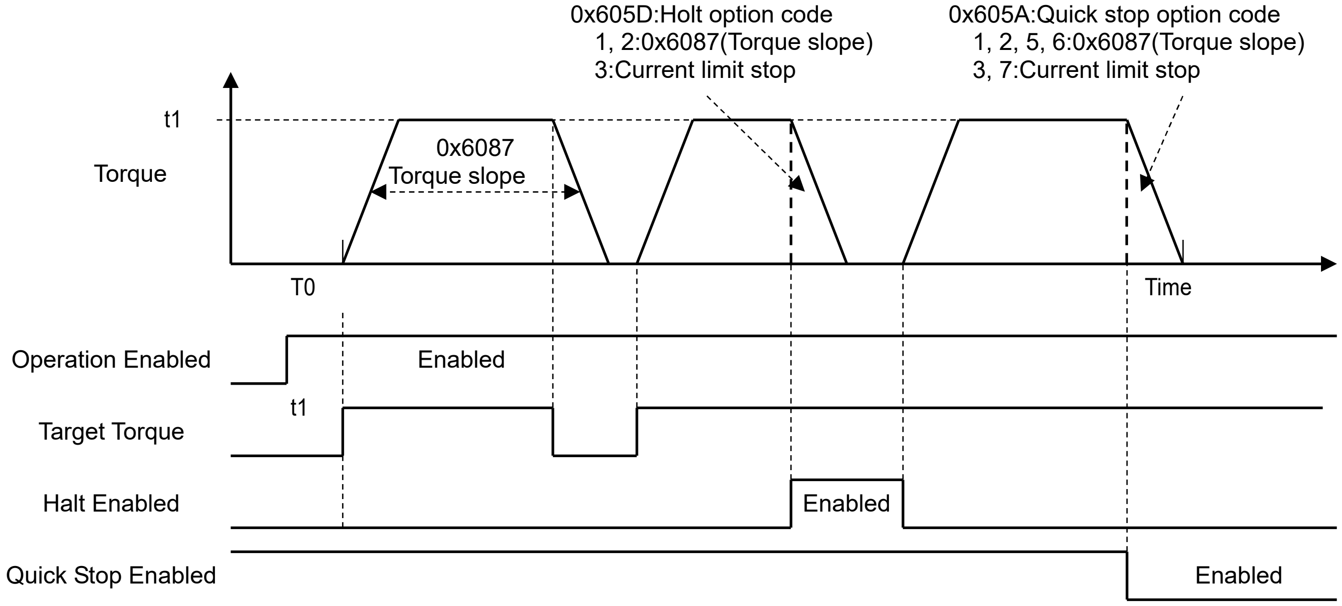
11) Function Group “Torque (force)”

Abstract of Function Group “Torque (force)”

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

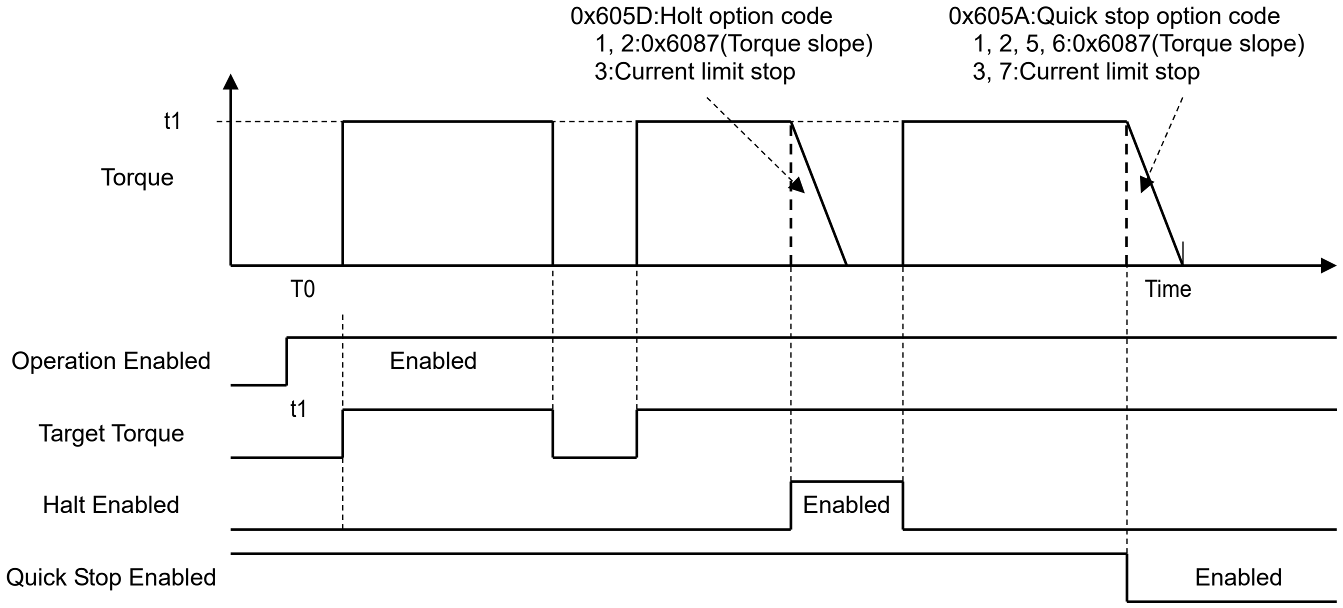
12) Profile torque (force) mode

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

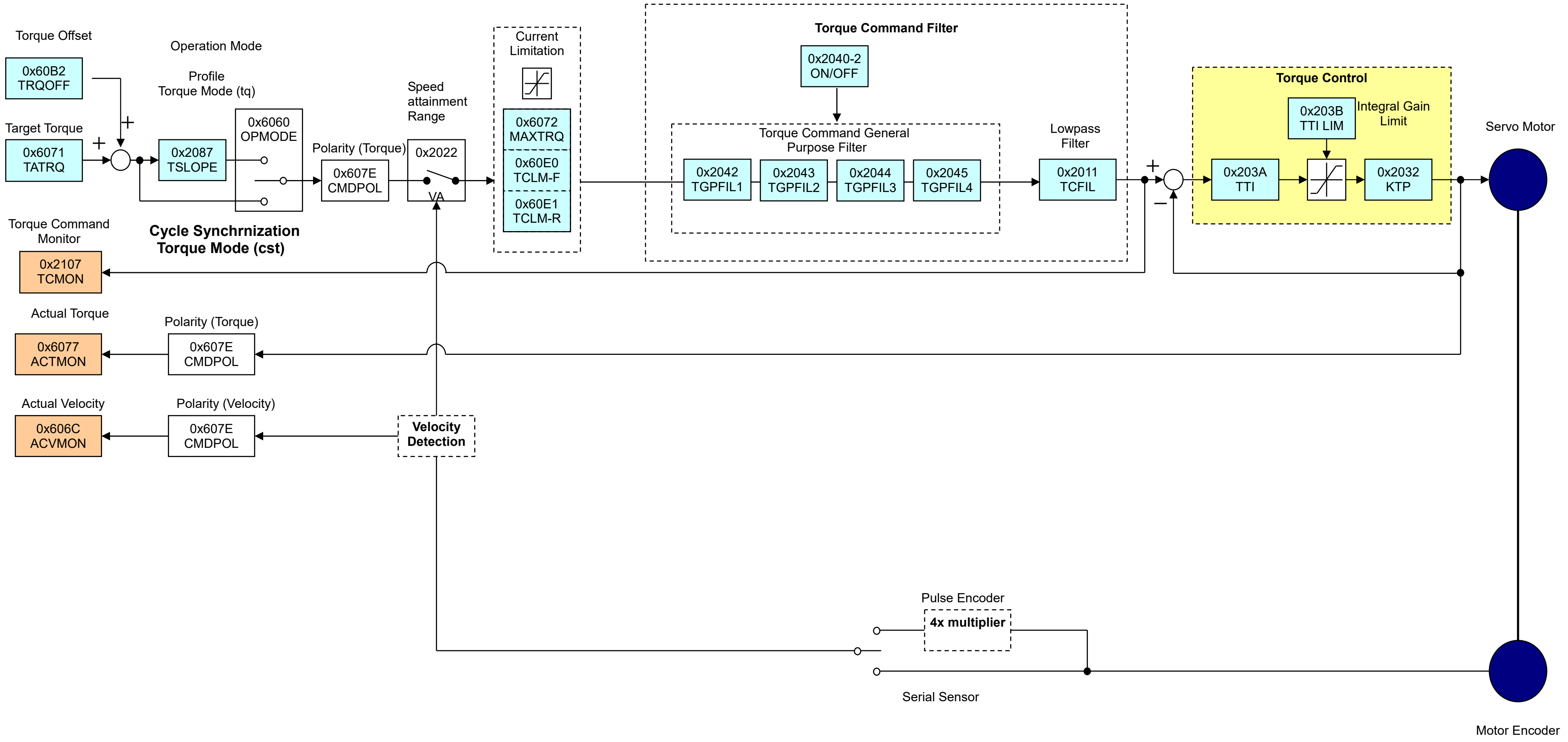


13) Cyclic Synchronous torque (force) mode

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



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



Block Diagram with Function Torque Mode

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

<table>
<tr><td>Index Ax1 0x6040
Ax2 0x6840
Ax3 0x7040
Ax4 0x7840</td><td colspan="2">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)</td><td colspan="2">Object code</td><td>Variable</td></tr>
<tr><td>Sub-Idx</td><td>Description</td><td>Data Type</td><td>Access</td><td>PDO</td><td>Initial value</td></tr>
<tr><td rowspan="2">0x00</td><td rowspan="2">Control word [CWORD]
* See the Command table for “Control word bit pattern (Bit 7, 3, 2,1, 0,) command</td><td>Unsigned16</td><td>RW</td><td>Possible</td><td>0x0000</td></tr>
<tr><td>Range</td><td colspan="3">0x0000-0xFFFF</td></tr>
</table>

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

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

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

MSB LSB

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

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

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

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

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

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

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

14) Function Group “Touch Probe”

Abstract of Touch Probe

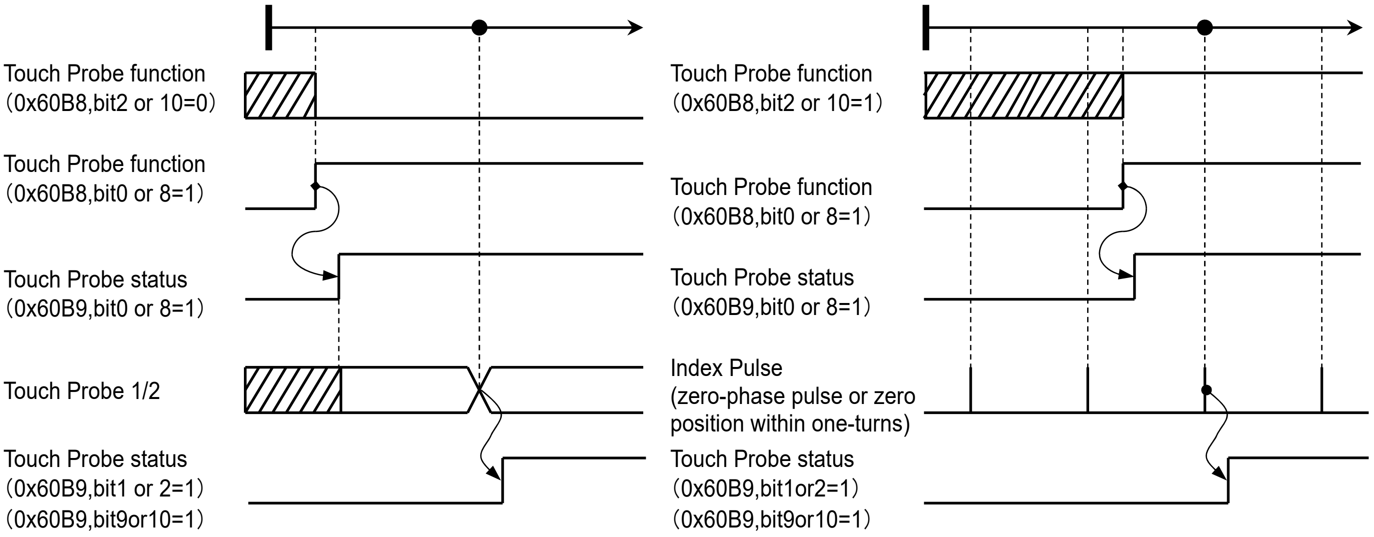
“Touch Probe function” is a latching function to latch the edge-triggered encoder position by digital input.
”Touch Probe in the event” is independent from NC cycle time function since it
latches the sensor position in the hardware of the slave, therefore, it enables capture it more precisely.
This amplifier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

Object Lists of Touch Probe

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

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

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


The position feedback value latched at Touch Probe 1/2

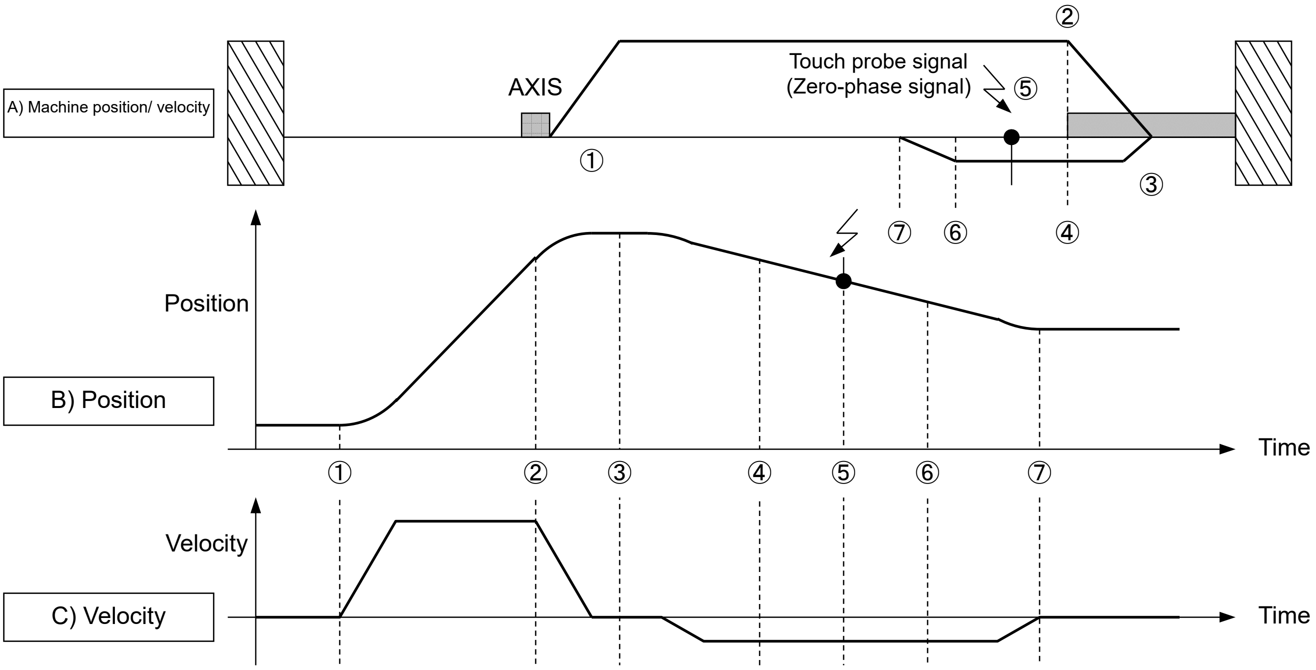
The position feedback value latched at Touch Probe 1 with Index Pulse.

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

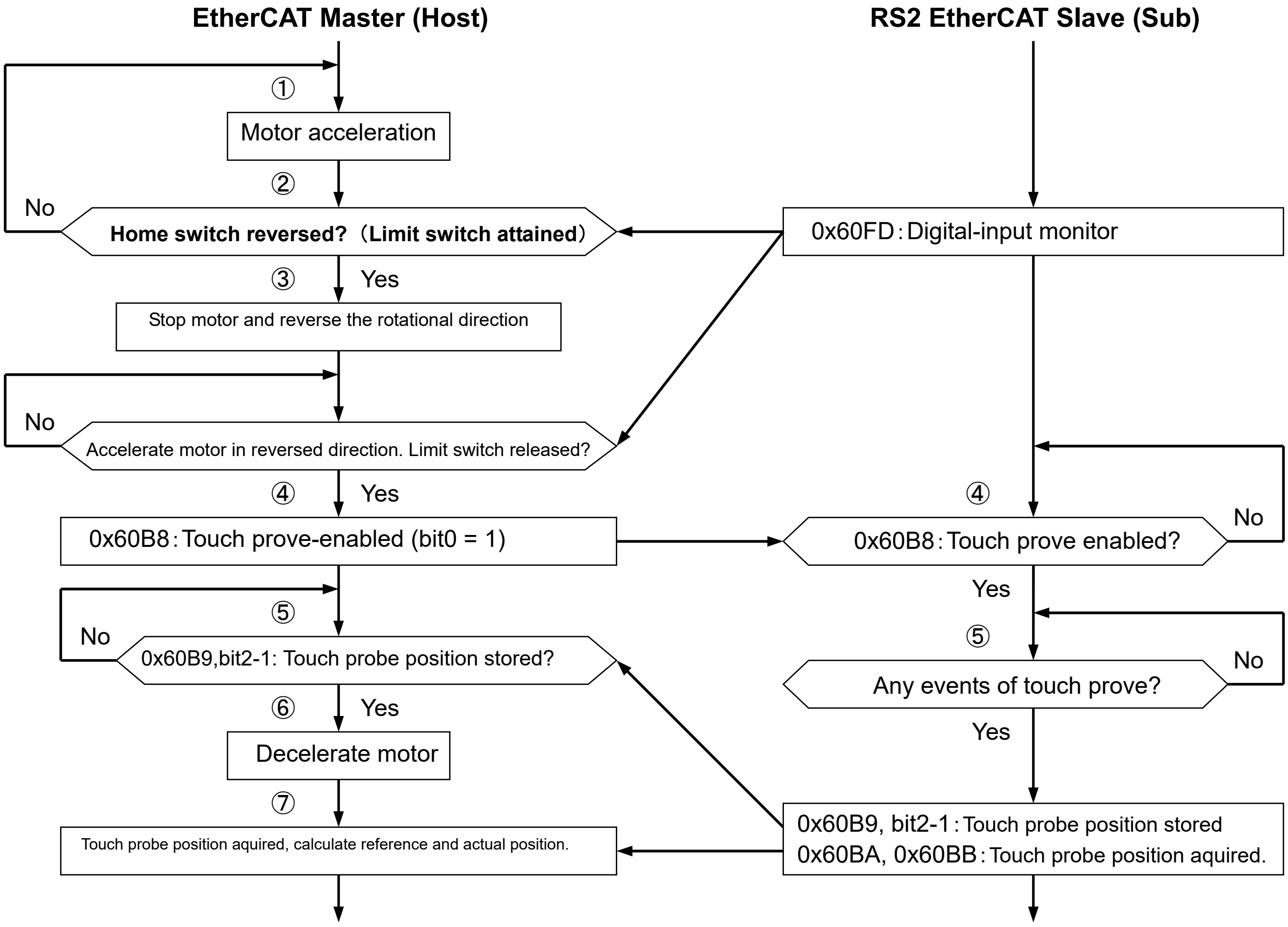
The position value latched by Touch Probe function

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

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



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



Example of touch prove homing procesure

15) Operation Mode Parameter (Profile Area)

0x6060:Operation Mode

Index	Indicates requested operation mode.	Object Code	Variable
Ax1 0x6060 Ax2 0x6860 Ax3 0x7060 Ax4 0x7860			

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 :(ip) Interpolated position mode 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).

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

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

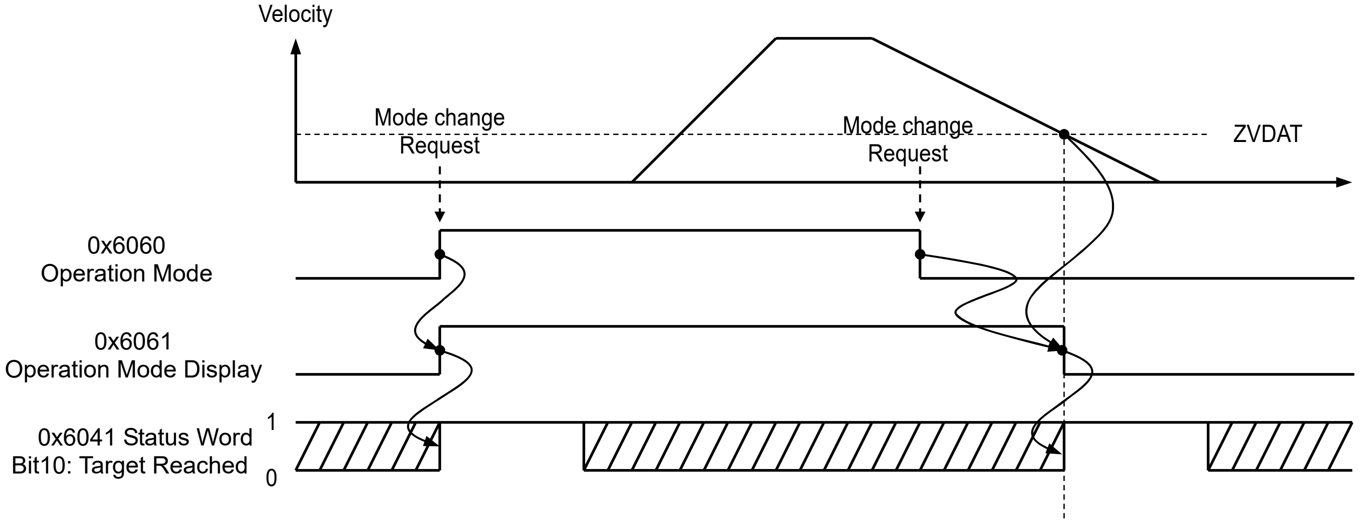
* Servo ON is not available when operation Mode is set “0”.

0x6061:Operation Mode Display

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

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 : Reserved 6 :(hm) Homing Mode 7 :(ip) Interpolated position mode 8 :(csp) Cycle Sync. Position Mode 9 :(csv) Cycle Sync. Velocity Mode 10 :(cst) Cycle Sync. Torque (force) Mode	Integer8	RO	Possible	0x00
		Display Range	0x00 - 0x0A (0 to 10)		

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



0x6062: Position Demand Value

Index				
Index	Ax1 0x6062 Ax2 0x6862 Ax3 0x7062 Ax4 0x7862	Indicates the internal target position.	Object Code	Variable

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

0x6063: Internal Actual Position

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

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

0x6064: Position Actual Value

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

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

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

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

Sub-Idx	Description	Data Type	Access	PDO	Initial Value
0x00	Position Deviation Window [OFLV] 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		

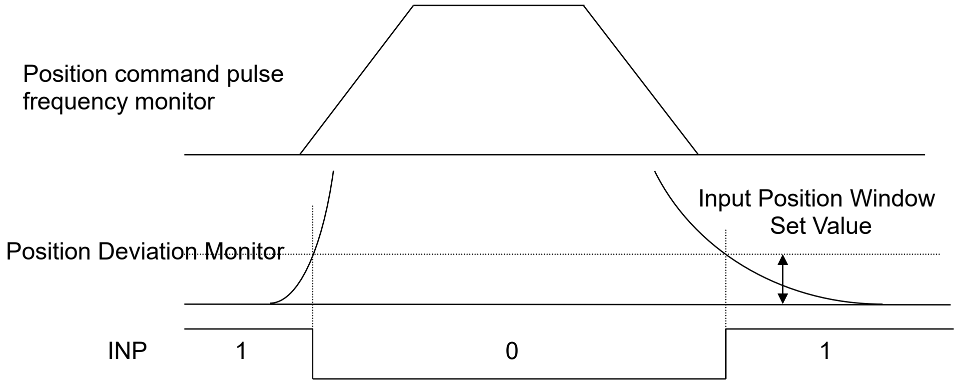
0x6066:Position Deviation Time-out

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

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

0x6067:Position Window (Input Position Window)

Index Ax1 0x6067 Ax2 0x6867 Ax3 0x7067 Ax4 0x7867	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		
	*In the case of incremental encoder, 4 times of the number of encoder pulses are standard. *In the case of absolute encoder (except for incremental output), absolute value is standard. 				

0x6068:Position Window Time

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

Sub-Idx	Description	Data Type	Access	PDO	Initial Value
0x00	Position Window Time This servo amplifier is outputted immediately after arriving in setting range.	Unsigned16	RW	No	0x0000
		Setting Range	0x0000 - 0x0000		
		Unit	ms		

0x6069:Actual Sensor Velocity

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

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

0x606A:Sensor Selection Code

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

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

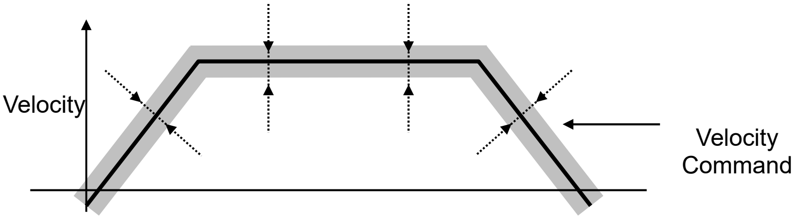
0x606C: Velocity Actual Value

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

Sub-Idx	Description	Data Type	Access	PDO	Initial Value
0x00	Velocity Actual Value [ACVMON] *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: Rotation Speed Setup)

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

Sub-Idx	Description	Data Type	Access	PDO	Initial Value
0x00	Velocity Window When the actual velocity remains within the range of the target velocity during the time period set in velocity window time shown in 0x605E, the status word “TargetReached” is set. This is enabled in profile velocity mode.	Unsigned16	RW	No	0x32 （50 min^{-1}）
		Display Range	0x0000 to 0xFFFF （0 to 65535min^{-1}）		
		Unit	min^{-1}		
	 ✔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 selection of rotation speed setup, the condition under this setting value can be monitored with the status word (0x6040) bit 10: Target matching monitor.				

0x606E: Velocity Window Time

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

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

0x606F: Velocity Threshold (Speed Zero Setting)

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

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

0x6070: Velocity Threshold Time

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

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

0x6071： Target Torque (force)

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

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

0x6072: Maximum Torque (force)

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

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

0x6076: Rated torque

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

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

6077: Actual Torque (force) Value

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

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

0x6078: Actual Current Value

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

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

0x6079： DC link circuit voltage

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

Sub-Idx	Description	Data Type	Access	PDO	Initial Value
0x00	DC link circuit voltage ✔For AC100V, AC200V DC24V, DC48V Rotary, Linear , Direct Drive Motor (RS2E TypeH, RS2A TypeH, RS2J TypeH, RS2K TypeH, RM2)	Unsigned32	RO	Possible	–
		Display Range	0x00000000 to 0xFFFFFFFF		
		Unit	mV		
	This monitor is simplified. This shows 280,000mV at 200VAC input, 140,000mV at 100VAC input, 48,000mV at 48VDC input, 24,000mV at 24VDC input and 0V at POFF state. ✔For AC400V Rotary, Linear , Direct Drive, Induction Motor AC200V input type (SS1A typeH, RS2C typeH) It displays the actual DC voltage by detected internal circuit.				

0x607A:Target Position

Index Ax1 0x607A Ax2 0x687A Ax3 0x707A Ax4 0x787A	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 Ax1 0x607B Ax2 0x687B Ax3 0x707B Ax4 0x787B	At position command type motion mode, set the range of position coordinates able to be set (able to be assigned). Both controller (position command) and driver (actual position) communicate position data within the range of position coordinates set here.	Object Code Array

Sub-Idx	Name/Description	Data Type	Access	PDO	Range (Initial Value)
0x00	Number of Entry	-	RO	No	0x2
0x01	Min position range limit [MINPLIM]	Unsigned8	RW	Possible	0x80000000
		Setting value	0x80000000−0x7FFFFFFF		
0x02	Max position range limit [MAXPLIM]	Integer32	RW	Possible	0x7FFFFFFF
		Setting value	0x80000000-0x7FFFFFFF		
Refer to the next page for details.					

< About Setting Value >

- Unit is the same user definition as target position, and in this servo amplifier, the unit is 1 Pulse/LSB.
- When minimum position range limit= 0x00000000 and maximum position range limit = 0x00000000 are set, or when minimum position range limit = 0x80000000 and maximum position range limit = 0x7FFFFFFF are set, the position coordinate is recognized as "Linear coordinate".
- When setting is other than the above, position coordinate indicates "Modulo coordinate". In this case, although the setting value can be any value, set actual range of motion at no more than the positive maximum value (0x7FFFFFFF) of 32bit

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

< Linear coordinate(Straight Axis) >

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

< Modulo Coordinate (Rotation Axis) >

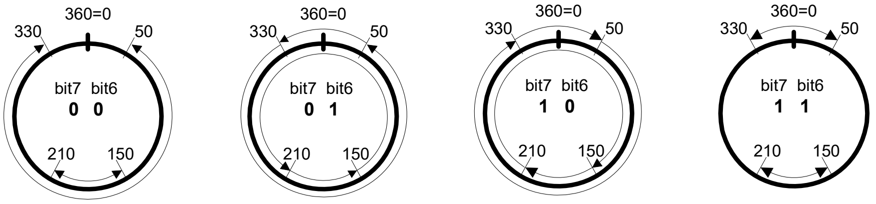
- When the current position reaches the maximum position range limit in the direction of coordinate increase, the following coordinate value will indicate the setting value of minimum position range limit.
- In the opposite situation, when the current position reaches the minimum position range limit in the direction of coordinate decrease, the following coordinate value will indicate the setting value of maximum position range limit.
- Except for the motion modes listed below in brackets, all position information set by the controllers should be modulo coordinates.
  (In the following case, in the setting of "Standard positioning same as straight axis," for example, if you wish to move from current position by a value of 90°, the following commands are possible:

"positioning to absolute displacement 630° = 360° (1 revolution) + 270° (in this case, relative displacement of 540°",
"positioning to relative displacement 500° = 360° (1 revolution) + relative displacement of 140 (in the result, positioning to 230°)"

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

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

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



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

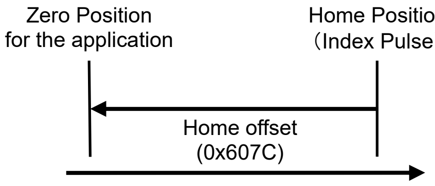
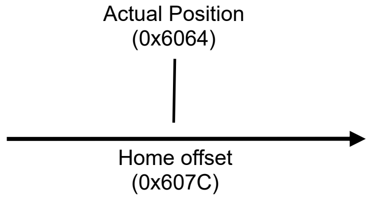
Example of Positioning at Rotation Axis

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

- In the case that the previously set position range limit value has been written in the nonvolatile memory of the servo amplifier
  ⇒ Immediately after control power is On, the setting value of the position range limit will be reflected on position information.
- In the case that setting of position range limit is changed when ESM is in Pre-Operational status.
  ⇒ The changed setting value will be reflected when ESM is shifted from Pre-Operational to Safe-Operational.
- In the case that ESM changes setting of position range limit in another status than that of Pre-Operational
  ⇒ Because the changed setting value will be reflected when ESM is shifted from Pre-Operational to Safe-Operational, temporarily lower ESM to Pre-Operational and increase ESM again.

0x607C: Home offset (homing mode)

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

Sub-Idx	Description	Data Type	Access	PDO	Initial Value
0x00	Home offset [HOFFSET] &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.	Integer32	RW	Possible	0x00000000 (0 pulse)
		Setting Range	0x80000000-0x7FFFFFFF (-2147483648-2147483647 Pulse)		
		Unit	Pulse		
	The actual position（0x6064）using homing position during homing is calculated as follows: Without Homing Method 35,37  Zero Position = Home Position +Home offset (0x607C) Homing Method 35,37  Actual Position(0x6064) = Home offset (0x607C) ✔If not Homing Method 35 or 37 and ZeroPosition＝Home Offset Homing need to sets 0x20F6-1 = 1.				

0x607D:Software Position Limit

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

Sub-Idx	Name/Description	Data Type	Access	PDO	Range (Initial Value)
0x00	Number of Entry	-	RO	No	0x2
0x01	Minimum Position Limit [SMINLIM] Unit is 1 pulse/LSB with RS2EtherCAT amplifier in the same user definition as a target position.	Integer32	RW	Possible	0x80000000 - 0x7FFFFFFF (0)
0x02	Maximum Position Limit [SMAXLIM] Unit is 1 pulse/LSB with RS2EtherCAT amplifier in the same user definition as a target position.	Integer32	RW	Possible	0x80000000 - 0x7FFFFFFF (0)
	Since the actually used limit value includes Home Offset (0x607C), it is normalized internally before being compared with target position. Minimum Position Limit for Normalization = Minimum Position Limit - Home Offset Maximum Position Limit for Normalization = Maximum Position Limit - Home Offset *Function is invalid when the Minimum Position Limit >= Maximum Position Limit.				

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

Index				
Index	Ax1 0x607E Ax2 0x687E Ax3 0x707E Ax4 0x787E	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] Selects the combination of each command polarity over position command, velocity command, torque (force) command input, position offset, velocity offset (velocity addition), and torque (force) offset (torque (force) addition) from the following contents.	Unsigned8	RW	Possible	0x00
		Setting Range	0x00 - 0xE0		

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

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

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

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

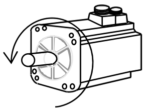
Bit5 : Torque (force) Polarity "0": Command is multiplied by +1. "1": Multiplied by -1.

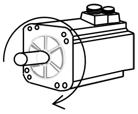
- In Cycle sync. position mode (csp) , Interpolated position mode (ip) and Cycle sync. velocity mode(csv),0x60B2 Torque (force) offset input value as torque (force) compensation is multiplied by -1 with ”1”, and then compensation command polarity is reversed.
- In Cycle sync. torque (force) mode(cst),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

Bit4 - 0: Reserved

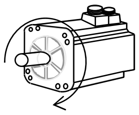
*Direction with positive (+) polarity command supply according to the setting value is shown below.

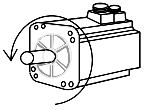
*When command input polarity is standard set value "Bit7=0, Bit6=0, Bit5=0",
rotates to positive direction (CCW)by command polarity + / to negative direction (CW) by -.





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





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

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

✔When OT is used, set 0x00 or 0xE0.

0x607F: Maximum Profile Velocity (Velocity Limit Command)

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

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

0x6080: Maximum motor velocity

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

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

0x6081: Profile Velocity

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

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

0x6082: End velocity

Index Ax1 0x6082 Ax2 0x6882 Ax3 0x7082 Ax4 0x7882	Sets end velocity.	Object Code	Variable

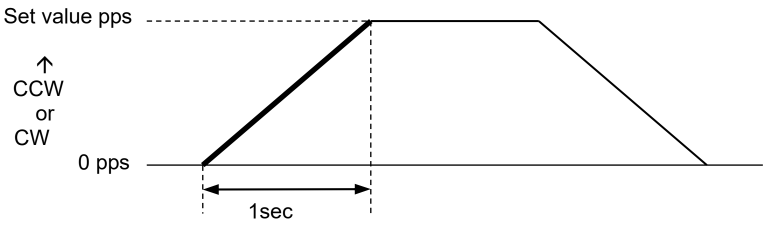
Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	End velocity Sets the end velocity in position mode at the time of reaching the target. This servo amplifier does not support this function.	Unsigned32	RW	Possible	0x00000000
		Setting range	0x00000000-0xFFFFFFFF		
		Unit	Pulse/sec		

0x6083: Profile acceleration

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

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Profile acceleration [TVCACC] 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."

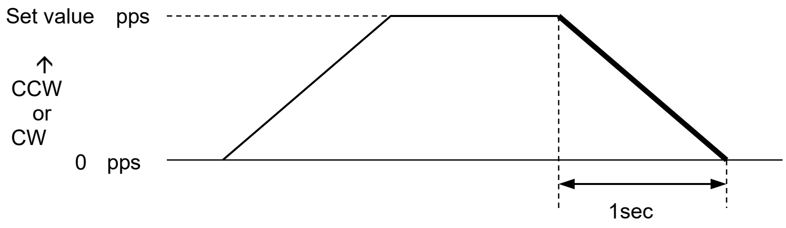
* At the pv mode, upper limit value will be kept at 16,000msec if the value exceeding 16,000msec is set with conversion per 1,000min-1.

0x6084: Profile Deceleration

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

Sub-Idx	Description	Data Type	Access	PDO	Initial Value
0x00	Profile Deceleration [TVCDEC] 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 pps^2)		
		Unit	Pulse/sec^2		

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



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

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

0x6085: Quick Stop Deceleration

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

Sub-Idx	Description	Data Type	Access	PDO	Initial Value
0x00	Quick Stop Deceleration [QSDEC] Value serves as the same unit as a Profile acceleration object (0x6083). Note) If value is set to “0”, the amplifier proceeds it as "1."	Unsigned32	RW	Possible	0xFFFFFFFF
		Setting Range	0x00000000-0xFFFFFFFF (0-4294967295 pps^2)		
		Unit	Pulse/sec^2		

0x6087: Torque (force) slope

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

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

0x6088: Torque Profile Type

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

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

0x608F: Position Encoder Resolution

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

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

0x6091: Gear Ratio

Index Ax1 0x6091 Ax2 0x6891 Ax3 0x7091 Ax4 0x7891	Sets the gear ratio of the motor shaft and the output shaft.	Object Code	Variable

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

0x6092: Feed Constant

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

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

0x6098: Homing method

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

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Homing method [HOMETYP] Configured homing method (Origin return method)	Integer8	RW	Possible	0x23 (35)
		Setting range	0xFC to 0x25 (-4 to 37)		
	－4 (0xFC) : Homing on positive hard stop and index pulse －3 (0xFD) : Homing on negative hard stop and index pulse －2 (0xFE) : Homing on negative hard stop －1 (0xFF) : Homing on positive hard stop 0 (0x00) : No Homing method 1 (0x01) : Homing on negative limit and index pulse 2 (0x02) : Homing on positive limit and index pulse 3 (0x03) : Homing on positive home switch and index pulse 4 (0x04) : Homing on positive home switch and index pulse 5 (0x05) : Homing on negative home switch and index pulse 6 (0x06) : Homing on negative home switch and index pulse 7 (0x07) : Homing on positive limit switch, homing on positive home switch and index pulse 8 (0x08) : Homing on positive limit switch, homing on positive home switch and index pulse 9 (0x09) : Homing on positive limit switch, homing on negative home switch and index pulse 10 (0x0A) : Homing on positive limit switch, homing on negative home switch and index pulse 11 (0x0B) : Homing on negative limit switch, homing on positive home switch and index pulse 12 (0x0C) : Homing on negative limit switch, homing on positive home switch and index pulse 13 (0x0D) : Homing on negative limit switch, homing on negative home switch and index pulse 14 (0x0E) : Homing on negative limit switch, homing on negative home switch and index pulse 17 (0x11) : Homing on negative limit switch 18 (0x12) : Homing on positive limit switch 19 (0x13) : Homing on positive home switch 20 (0x14) : Homing on positive home switch 21 (0x15) : Homing on negative home switch 22 (0x16) : Homing on negative home switch 33 (0x21) : Homing on negative index pulse 34 (0x22) : Homing on positive index pulse 35 (0x23) : Homing on the current position 37 (0x25) : Homing on the current position －5 to －128(0xFB-0x80),15（0x0F）,16（0x10）23 to 32（0x17-0x20）,36（0x24）,38 to 127（0x26-0x7F）:Reserved				

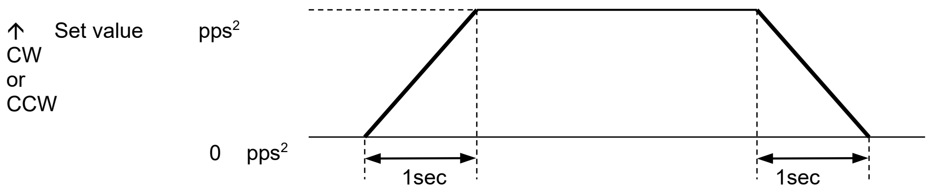
0x6099: Homing Velocity

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

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Number of entry	Unsigned8	RO	No	0x02
0x01	Switch search speed [SSVCMD] 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 Ax1 0x609A Ax2 0x689A Ax3 0x709A Ax4 0x789A	This object is the parameters that define the velocity slope of the acceleration and deceleration ramp on homing mode.	Object code	Variable

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Homing acceleration ad deceleration [HOMEACC] The parameters to Homing velocity that restrain velocity slope of the acceleration and deceleration ramp during acceleration, zero speed, direction change Note) This parameter is effective only during Homing mode (hm)	Unsigned32	RW	Possible	0xFFFFFFFF
		Setting range	0x00000000-0xFFFFFFFF (0-4294967295 pps^2) *		
		Unit	Pulse/sec^2		
					
	Note) If value is set “0”, the amplifier proceeds it as "1." * At the hm mode, upper limit value will be kept at 16,000msec if the value exceeding 16,000msec is set with conversion per 1,000min^{-1}.				

0x60B0: Position Offset

Index Ax1 0x60B0 Ax2 0x68B0 Ax3 0x70B0 Ax4 0x78B0	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 Ax1 0x60B1 Ax2 0x68B1 Ax3 0x70B1 Ax4 0x78B1	Offset is given to Velocity command.	Object Code	Variable

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

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

Index Ax1 0x60B2 Ax2 0x68B2 Ax3 0x70B2 Ax4 0x78B2	In cst Mode, object gives Offset to Target torque (force). In csp, ip and csv Mode, Feed forward function to Torque (force) control system as a Torque (force) compensation function.	Object Code		Variable	
Sub-Idx	Description	Data Type	Access	PDO	Initial Value
0x00	Torque (force) Offset (Torque (force) Compensation) [TRQOFF] *In Cycle sync. Position / Velocity mode (csp, csv), Interpolated position mode (ip) Torque (force) compensation value is added to Torque (force) command when torque (force) compensation enable [ICMPEN] Bit4=1 of the Control word 1 (0x2000). *In Cycle sync. Torque (force) mode (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%		

0x60B8:Touch probe function

Index Ax1 0x60B8 Ax2 0x68B8 Ax3 0x70B8 Ax4 0x78B8	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 encoder 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 encoder 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
bit15, 14, 11, 7, 6, 3: Reserved

◆When using absolute encoder, index pulse is position data at 0 within single-turn.
When using "Modulo coordination", be sure to set bit2 and bit10 to "0: Trigger with touch probe 1 and 2 input".

0x60B9:Touch probe status

Index Ax1 0x60B9 Ax2 0x68B9 Ax3 0x70B9 Ax4 0x78B9	Displays the status of the touch probe		Object Code		Variable
Sub-Idx	Description	Data Type	Access	PDO	Initial Value
0x00	Touch probe status [TPSTS] Displays the status of the touch probe	Unsigned16	RO	Possible	0x0000
		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 encoder 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 encoder 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) bit13 to 11, 5 to 3：Reserved				

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

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

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

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

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

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

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

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

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

0x60C0: Interpolation sub mode select

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

0x60C1: Interpolation data record

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

0x60C2: Interpolation time period

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

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

Setting Example:

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

0x60C4: Interpolation data configuration

Index Ax1 0x60C4 Ax2 0x68C4 Ax3 0x70C4 Ax4 0x78C4	The format of interpolation data.	Object code	RECORD

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

0x60C5：Maximum deceleration

Index Ax1 0x60C5 Ax2 0x68C5 Ax3 0x70C5 Ax4 0x78C5	Sets the limit value of deceleration	Object Code	Variable

Sub-Idx	Description	Data Type	Access	PDO	Initial Value
0x00	Deceleration limit value Limits the deceleration set value by this parameter if the deceleration setting of 0x6084 exceeds this value. Invalid when the set value is 0.	Unsigned32	RW	Possible	0xFFFFFFFF
		Setting Range	0x00000000 to 0xFFFFFFFF (0 to 4294967295 pps^2)		
		Unit	Pulse/sec^2		
	✔Valid for PV mode only.				

0x60C6：Maximum acceleration

Index Ax1 0x60C6 Ax2 0x68C6 Ax3 0x70C6 Ax4 0x78C6	Sets the limit value of acceleration	Object Code	Variable

Sub-Idx	Description	Data Type	Access	PDO	Initial Value
0x00	Acceleration limit value Limits the acceleration set value by this parameter if the acceleration setting of 0x6083 exceeds this value. Invalid when the set value is 0.	Unsigned32	RW	Possible	0xFFFFFFFF
		Setting Range	0x00000000 to 0xFFFFFFFF (0 to 4294967295 pps^2)		
		Unit	Pulse/sec^2		
	✔Valid for PV mode only.				

0x60E0: Forward Direction Torque (force) Limit Value

Index Ax1 0x60E0 Ax2 0x68E0 Ax3 0x70E0 Ax4 0x78E0	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%		
	*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.				

0x60E1: Reverse Direction Torque (force) Limit Value

Index Ax1 0x60E1 Ax2 0x68E1 Ax3 0x70E1 Ax4 0x78E1	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.	Unsigned16	RW	Possible	0x1388 (500.0%)
		Setting Range	0x0000 - 0x1388 (0 - 500.0 %)		
		Unit	0.1%		
	*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.				

0x60E3: Support homing method

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

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

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

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

0x60F2: Positioning option code

Index	Ax1 0x60F2 Ax2 0x68F2 Ax3 0x70F2 Ax4 0x78F2	Set the behavior of positioning.	Object Code	Variable

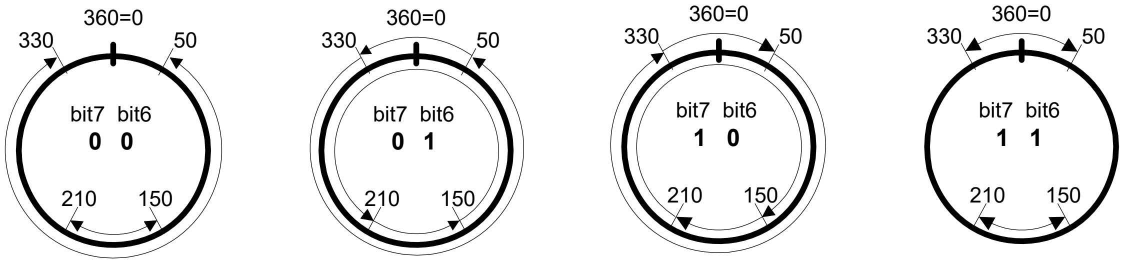
Sub-Idx	Description	Data Type	Access	PDO	Initial Value
0x00	Positioning option code ［POSOP］ See table below for definition of bit 7 and 6. Set 0 except bit 7 and 6.	Unsigned16	RW	Possible	0x0000
		Setting Range	0x0000-0xFFFF		

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.

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



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

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

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

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

0x60FA: Control effort

Index	Ax1 0x60FA Ax2 0x68FA Ax3 0x70FA Ax4 0x78FA	Indication of the target value after positioning.	Object code	Variable

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Indicatevelocity command value after positioning. This object indicate value at Profile position and Cycle position mode only.	Integer32	RO	Possible	0x00000000
		Setting range	0x80000000-0x7FFFFFFF (-2147483648-2147483647 Pulse)		
		Unit	PPS		

0x60FC: Position Demand Internal Value

<table>
<tr><td>Index Ax1 0x60FC
Ax2 0x68FC
Ax3 0x70FC
Ax4 0x78FC</td><td colspan="2">Indicates the internal target position.</td><td colspan="2">Object Code</td><td>Variable</td></tr>
<tr><td>Sub-Idx</td><td>Description</td><td>Data Type</td><td>Access</td><td>PDO</td><td>Initial Value</td></tr>
<tr><td rowspan="3">0x00</td><td rowspan="3">Internal Target Position
Displays internal target position command in profile position mode.
This value same as Position Demand Value(0x6062) as measured by the control cycle unit（125μs）.
✔Other modes
Values are not displayed. (always displayed as 0)</td><td>Integer32</td><td>RO</td><td>Possible</td><td>—</td></tr>
<tr><td>Display Range</td><td colspan="3">0x80000000-0x7FFFFFFF
(-2147483648-2147483647 Pulse)</td></tr>
<tr><td>Unit</td><td colspan="3">Pulse</td></tr>
</table>

0x60FD: Digital inputs

<table>
<tr><td>Index Ax1 0x60FD
Ax2 0x68FD
Ax3 0x70FD
Ax4 0x78FD</td><td colspan="2">This object shall monitor the status of general-purpose input, output and hardware gate off.</td><td colspan="2">Object code</td><td>Record</td></tr>
<tr><td>Sub-Idx</td><td>Description</td><td>Data Type</td><td>Access</td><td>PDO</td><td>Initial value</td></tr>
<tr><td rowspan="2">0x00</td><td rowspan="2">Digital input monitor [DINPUT]
Monitor the state of general input: CONT1 to 8.
1: Photocoupler is on.
* For hardware detection, digital input has about 4msec delay.</td><td>Unsigned32</td><td>RO</td><td>Possible</td><td>-</td></tr>
<tr><td>Display range</td><td colspan="3">0x00000000-0xFFFFFFFF</td></tr>
</table>

MSB													LSB
Res	CONT8	CONT7	CONT6	CONT5	CONT4	CONT3	CONT2	CONT1	Res	EMR	Home	Positive limit	Negative limit
31··24	23	22	21	20	19	18	17	16	15··4	3	2	1	0

0x60FE: Digital output

<table>
<tr><td>Index Ax1 0x60FE
Ax2 0x68FE
Ax3 0x70FE
Ax4 0x78FE</td><td colspan="3">This object sets output of holding brake timing output monitor and general-purpose output OUT1 and OUT2</td><td>Object Code</td><td>Record</td></tr>
<tr><td>Sub-Idx</td><td>Description</td><td>Data Type</td><td>Access</td><td>PDO</td><td>Initial Value</td></tr>
<tr><td>0x00</td><td>Number of entry</td><td>Unsigned8</td><td>RO</td><td>No</td><td>0x0</td></tr>
<tr><td rowspan="2">0x01</td><td rowspan="2">Physical output [DOUTPUT]
Bit 0: Monitoring Holding brake output timing

Bit17-16: Enables control output OUT1 and OUT2 when it is set 0x42 through 0x45 for “Controls by EtherCAT communication”.
* For hardware detection, digital output has about 4msec delay.
<table><tr><td colspan="4">MSB</td><td>LSB</td></tr><tr><td>Reserved</td><td>FOUT2</td><td>FOUT1</td><td>Reserved</td><td>Set brake</td></tr><tr><td>31 - 18</td><td>17</td><td>16</td><td>15...3</td><td>0</td></tr></table></td><td>Unsigned32</td><td>RW</td><td>Possible</td><td>-</td></tr>
<tr><td>Display range</td><td colspan="3">0x000000-0xFFFFFFFF</td></tr>
<tr><td rowspan="3">0x02</td><td rowspan="2">Bit mask
bit0: Disabled
bit17-16 mask the bits corresponding to physical output</td><td>Unsigned32</td><td>RW</td><td>Possible</td><td>0xFFFFFFFF</td></tr>
<tr><td>Setting Range</td><td colspan="3">0x000000 to 0xFFFFFFFF</td></tr>
<tr><td colspan="5">When the setting of General Purpose Output setting is set by any of “Controls by EtherCAT communication”, if the mask of the setting bit is set, output of OUT1.2 will be disabled.
When the bit mask is set to “1”, it is Enable OUTPUT and the bit mask is set to “0”, it is Disable OUTPUT.</td></tr>
</table>

0x60FF: Target Velocity

Index	Ax1	0x60FF	Indicates to set Target velocity, and used for inputting trajectory generator.	Object Code	Variable
	Ax2	0x68FF			
	Ax3	0x70FF			
	Ax4	0x78FF			

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 to 2147483647 pps)		
		Unit	Pulse/sec		

0x6402: Motor Type

Index	Ax1	0x6402	Select running motor type.	Object Code	VAR
	Ax2	0x6C02			
	Ax3	0x7402			
	Ax4	0x7C02			

Sub-Idx	Name/Description	Data Type	Access	PDO	Value
0x00	Motor Type This product does not support any motor other than AC motor.	Unsigned16	RW	Possible	0x000C

0x6403: Motor Catalog Number

Index	Ax1	0x6403	Indicates setting motor model number.	Object Code	VAR
	Ax2	0x6C03			
	Ax3	0x7403			
	Ax4	0x7C03			

Sub-Idx	Name/Description	Data Type	Access	PDO	Value
0x00	Motor Model Number Setting Motor Model Number (ASCIICode)	Visible String	RO	No	Character String (－)

R2 A A 0 4 00 3 F ✔ Please refer to chapter 1.4 "Motor model number" for the detail of motor model number.

※ Only the Sanyo Denki R series are supported. Non supported motors are indicated as Not Supported.

0x6404:Motor Manufacturer

Index	Ax1	0x6404	Indicates manufacturer of setting motor.	Object Code	VAR
	Ax2	0x6C04			
	Ax3	0x7404			
	Ax4	0x7C04			

Sub-Idx	Name/Description	Data Type	Access	PDO	Value
0x00	Manufacturer Manufacturer of setting motor (ASCII code)	Visible String	RO	No	Character String (－)

※ It is indicated as SANYO DENKI Co., LTD because Sanyo Denki motors are recommended.

0x6405: Motor Catalog Address of our Home Page

Index				
Index	Ax1 0x6405 Ax2 0x6C05 Ax3 0x7405 Ax4 0x7C05	Indicates catalog address of selected motor.	Object Code	VAR

Sub-Idx	Name/Description	Data Type	Access	PDO	Value
0x00	Home Page Address Home Page Address of setting motor (ASCIICode)	Visible String	RO	No	Character String (－)
※ SANYO DENKI's home page address is indicated because Sanyo Denki motors are recommended.					

0x6502:Supported Drive mode

Index	Ax1 0x6502 Ax2 0x6D02 Ax3 0x7502 Ax4 0x7D02	This object shall provide information on the supported drive modes by the servo amplifier.	Object code	Variable

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Support drive mode [SUPMODE] 0:Not supported 1: Supported	Unsigned32	RO	Possible	0x03ED
		Display range	0x03ED to 0x03ED		

MSB LSB

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

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

0x6503：Drive Catalog No.

Index	Ax1 0x6503 Ax2 0x6D03 Ax3 0x7503 Ax4 0x7D03	Indicates Catalog No. of this product.	Object Code	VAR

Sub-Idx	Name/Description	Data Type	Access	PDO	Value
0x00	Catalog No. The Catalog No. of this product is indicated.	Visible String	RO	No	Character String (－)
Indicates the bookbinding Catalog No. of this product (944-1 or 946-2)					

0x6505：http Drive Catalog Address

Index	0x6505	Indicates the website address of the catalog for this product.	Object Code	VAR

Sub-Idx	Name/Description	Data Type	Access	PDO	Value
0x00	Website address The address of the website catalog for this Product. (ASCII Code)	Visible String	RO	No	Character String (－)
※Indicates the address of the catalog of servo amplifiers on the Sanyo Denki website.					

4.5 Manufacturer Specific Area

1) Object Group (0x2000-)

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

Manufacturer Specific Area (No.1)

Index	S-Idx	FP	FV	FT	FH	Name	Data Type	Dir	PDO Mapping	Update	NVRAM
0x2000	0x00	○	○	○	○	Control Word 1	Unsigned16	RW	Possible	#	Yes
0x2001	0x00	○	○	○	○	Parameter Select	Unsigned16	RW	Possible	#	-
0x2002	0x00	-	-	-	-	Auto-tuning settings	Unsigned8	RO	No	-	-
↑	0x01	○	○	○	○	Auto-Tuning Mode	Unsigned8	RW	No	#	Yes
↑	0x02	○	○	○	○	Auto-Tuning Characteristic	Unsigned8	RW	No	#	Yes
↑	0x03	○	○	○	○	Auto-Tuning Response	Unsigned8	RW	No	#	Yes
↑	0x04	○	○	○	○	Running tune	Unsigned8	RW	No	-	-
↑	0x05	○	○	○	○	Monitoring on tune	Unsigned8	RO	No	-	-
↑	0x06	○	○	○	○	Tune result saving parameter selection	Unsigned8	RW	No	-	-
0x2003	0x00	○	×	×	×	Position Command Smoothing Constant	Unsigned16	RW	Possible	#	Yes
0x2004	0x00	○	×	×	×	Position Command Filter	Unsigned16	RW	No	#	Yes
0x2005	0x00	-	-	-	-	Position Loop Proportional Gain	Unsigned8	RO	No	-	-
↑	0x01	○	×	×	×	Position Loop Proportional Gain 1	Unsigned16	RW	Possible	#	Yes
↑	0x02-0x04	○	×	×	×	Position Loop Proportional Gain 2 - 4	Unsigned16	RW	No	#	Yes
0x2006	0x00	-	-	-	-	Position Integral Time Constant	Unsigned8	RO	No	-	-
↑	0x01	○	×	×	×	Position Integral Time Constant 1	Unsigned16	RW	Possible	#	Yes
↑	0x02-0x04	○	×	×	×	Position Integral Time Constant 2 - 4	Unsigned16	RW	No	#	Yes
0x2007	0x00	○	×	×	×	Higher Tracking Control Position Compensation Gain	Unsigned16	RW	No	#	Yes
0x2008	0x00	-	-	-	-	Feed forward compensation parameter	Unsigned8	RO	No	-	-
↑	0x01	○	×	×	×	Feed Forward Gain	Unsigned16	RW	Possible	#	Yes
↑	0x02	○	×	×	×	Feed Forward Filter	Unsigned16	RW	No	#	Yes
0x2009	0x00	-	-	-	-	Velocity Command Filter Settings	Unsigned8	RO	No	-	Yes
0x200A	0x00	○	○	×	○	Velocity Feedback Filter	Unsigned16	RW	No	#	Yes
0x200B	0x00	-	-	-	-	Velocity Loop Proportional Gain	Unsigned8	RO	No	-	-
↑	0x01	○	○	×	○	Velocity Loop Proportional Gain 1	Unsigned16	RW	Possible	#	Yes
↑	0x02-0x04	○	○	×	○	Velocity Loop Proportional Gain 2 - 4	Unsigned16	RW	No	#	Yes
0x200C	0x00	-	-	-	-	Velocity Loop Integral Time Constant	Unsigned8	RO	No	-	-
↑	0x01	○	○	×	○	Velocity Loop Integral Time Constant 1	Unsigned16	RW	Possible	#	Yes
↑	0x02-0x04	○	○	×	○	Velocity Loop Integral Time Constant 2 - 4	Unsigned16	RW	No	#	Yes
0x200D	0x00	-	-	-	-	Load Inertia Moment Ratio	Unsigned8	RO	No	-	-
↑	0x01	○	○	○	○	Load Inertia Moment Ratio 1	Unsigned16	RW	Possible	#	Yes
↑	0x02-0x04	○	○	○	○	Load Inertia Moment Ratio 2 - 4	Unsigned16	RW	No	#	Yes
0x200E	0x00	○	○	×	○	Higher Tracking Control Velocity Compensation Gain	Unsigned16	RW	No	#	Yes
0x200F	0x00	-	-	-	-	Acceleration Feedback Compensation	Unsigned8	RO	No	-	-
↑	0x01	○	○	×	○	Acceleration Feedback Gain	Integer16	RW	No	#	Yes
↑	0x02	○	○	×	○	Acceleration Feedback Filter	Unsigned16	RW	No	#	Yes
0x2011	0x00	-	-	-	-	Command Filter	Unsigned8	RO	No	-	-
↑	0x01	○	○	○	○	Torque (force) Command Filter 1	Unsigned16	RW	Possible	#	Yes
↑	0x02-0x04	○	○	○	○	Torque (force) Command Filter 2 - 4	Unsigned16	RW	Possible	#	Yes
0x2012	0x00	-	-	-	-	FF Vibration Suppressor Frequency	Unsigned8	RO	No	-	-
↑	0x01	○	×	×	×	FF Vibration Suppressor Frequency 1	Unsigned16	RW	Possible	#	Yes
↑	0x02-0x04	○	×	×	×	FF Vibration Suppressor Frequency 2 - 4	Unsigned16	RW	No	#	Yes
0x2015	0x00	-	-	-	-	High setting control settings	Unsigned8	RO	No	-	-
↑	0x01	○	×	×	×	Acceleration Compensation	Integer16	RW	No	#	Yes
↑	0x02	○	×	×	×	Deceleration Compensation	Integer16	RW	No	#	Yes
↑	0x03	○	×	×	×	Command Velocity Low-pass Filter	Unsigned16	RW	No	#	Yes
↑	0x04	○	×	×	×	Command Velocity Threshold	Unsigned16	RW	No	#	Yes

○: Supported, ×: Not supported

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

Manufacturer Specific Area (No.2)

Index	S-Idx	FP	FV	FT	FH	Name	Data Type	Dir	PDO Mapping	Update	NVRAM
0x2016	0x00	-	-	-	-	Observer Parameter	Unsigned8	RO	No	-	-
↑	0x01	○	○	×	○	Observer Characteristic	Unsigned8	RW	No	#	Yes
↑	0x02	○	○	×	○	Observer Compensation Gain	Unsigned16	RW	No	#	Yes
↑	0x03	○	○	×	○	Observer Output Filter	Unsigned16	RW	No	#	Yes
↑	0x04	○	○	×	○	Observer Notch Filter	Unsigned16	RW	No	#	Yes
↑	0x05	○	○	×	○	Observer Load Inertia Ratio	Unsigned16	RW	No	#	Yes
↑	0x06	○	○	×	○	Observer Loop Proportional Gain	Unsigned16	RW	No	#	Yes
↑	0x07	○	○	×	○	Load Torque (force) Filter	Unsigned16	RW	No	#	Yes
0x2017	0x00	-	-	-	-	Model Control Gain	Unsigned8	RO	No	-	-
↑	0x01	○	×	×	×	Model Control Gain 1	Unsigned16	RW	Possible	#	Yes
↑	0x02-0x04	○	×	×	×	Model Control Gain 2 - 4	Unsigned16	RW	No	#	Yes
0x2018	0x00	○	×	×	×	Overshoot Suppressor Filter	Unsigned16	RW	No	#	Yes
0x2019	0x00	-	-	-	-	Model Control Antiresonance Frequency	Unsigned8	RO	No	-	-
↑	0x01	○	×	×	×	Model Control Antiresonance Frequency 1	Unsigned16	RW	Possible	#	Yes
↑	0x02-0x04	○	×	×	×	Model Control Antiresonance Frequency 2 - 4	Unsigned16	RW	No	#	Yes
0x201A	0x00	-	-	-	-	Model Control Resonance Frequency	Unsigned8	RO	No	-	-
↑	0x01	○	×	×	×	Model Control Resonance Frequency 1	Unsigned16	RW	Possible	#	Yes
↑	0x02-0x04	○	×	×	×	Model Control Resonance Frequency 2 - 4	Unsigned16	RW	No	#	Yes
0x201B	0x00	○	○	×	○	Gain Switching Filter	Unsigned16	RW	No	#	Yes
0x201C	0x00	○	○	×	○	Internal Velocity Command limit	Unsigned16	RW	No	#	Yes
0x201D	0x00	○	×	×	×	Position Command error 1 level	Unsigned32	RW	No	#	Yes
0x201E	0x00	○	○	×	○	Sequence Operation Torque (force) Limit Value	Unsigned16	RW	No	#	Yes
0x201F	0x00	○	×	×	×	Near Range	Unsigned32	RW	No	#	Yes
0x2020	0x00	○	○	×	○	Speed Zero Range	Unsigned16	RW	No	#	Yes
0x2021	0x00	○	○	×	○	Low Speed Range	Unsigned16	RW	No	#	Yes
0x2022	0x00	○	○	×	○	Speed Attainment Setting (high-speed setting)	Unsigned16	RW	No	#	Yes
0x2023	0x00	-	-	-	-	Analog Monitor Select Output	Unsigned8	RO	No	-	-
↑	0x01,0x02	○	○	○	○	Analog Monitor Select Output 1 ,2	Unsigned8	RW	No	#	Yes
↑	0x03	○	○	○	○	Analog Monitor Output Polarity	Unsigned8	RW	No	#	Yes
0x2024	0x00	○	○	○	○	Delay Time of Engaging Holding Brake (Holding Brake Holding Delay Time)	Unsigned16	RW	Possible	#	Yes
0x2025	0x00	○	○	○	○	Delay Time of Releasing Holding Brake (Holding Brake Release Delay Time)	Unsigned16	RW	No	#	Yes
0x2026	0x00	○	○	○	○	Brake Operation Beginning Time	Unsigned16	RW	Possible	#	Yes
0x2027	0x00	○	○	○	○	Power Failure Detection Delay Time	Unsigned16	RW	No	#	Yes
0x2028	0x00	○	×	×	×	Excessive Deviation Warning Level	Unsigned32	RW	No	#	Yes
0x2029	0x00	○	○	○	○	Overload Warning Level	Unsigned16	RW	No	#	Yes
0x202A	0x00	○	○	○	○	Speed Matching Width	Unsigned16	RW	No	#	Yes
0x202B	0x00	○	○	○	○	Torque (force)Command Filter Characteristic	Unsigned8	RW	No	#	Yes
0x202C	0x00	○	×	×	×	Feed Forward Filter, Depth Selection	Unsigned8	RW	No	#	Yes
0x202E	0x00	○	○	○	○	Torque attainement setting	Unsigned16	RW	No	#	Yes
0x202F	0x00	○	○	○	○	Brake Activation Speed	Unsigned16	RW	Possible	#	Yes
0x2030	0x00	○	○	○	×	Position Loop Integral Gain Limit	Unsigned16	RW	Possible	#	Yes
0x2031	0x00	×	○	○	×	Velocity Control Integral Gain Limit	Unsigned16	RW	Possible	#	Yes
0x2032	0x00	×	×	○	×	Torque (force) Control Proportional Gain	Unsigned8	RW	Possible	#	Yes
0x2034	0x00	-	-	-	-	Command Filter off Speed	Unsigned8	RO	No	#	
↑	0x01	○	○	○	○	Position / Velocity Command Filter off Speed selection	Unsigned8	RW	Possible	#	Yes
↑	0x02	○	○	○	○	Position / Velocity Command Filter off Speed	Unsigned16	RW	Possible	#	Yes
0x2035	0x00	-	-	-	-	Assist-Function Parameter	Unsigned8	RO	No		
↑	0x01	○	-	-	-	Correction Proportional Gain	Unsigned8	RW	No		Yes
↑	0x02	○	-	-	-	Correction Integral Time Constant	Unsigned16	RW	No		Yes
↑	0x03	○	-	-	-	Correction Low-pass Filter	Unsigned16	RW	No		Yes
↑	0x04	○	-	-	-	Excessive Position Synchronization Deviation Level	Unsigned32	RW	No		Yes
↑	0x05	○	-	-	-	Position Synchronization Deviation Warning Level	Unsigned32	RW	No		Yes
↑	0x06	○	-	-	-	Position Deviation Polarity Selection	Unsigned8	RW	No		Yes
↑	0x07	○	○	○	—	Assist-target axis address	Unsigned8	RW	No	#	Yes
↑	0x08	○	○	○	—	Assist-function selection	Unsigned8	RW	No	#	Yes
↑	0x09	—	—	○	—	Torque assisting rate	Unsigned16	RW	Possible	-	Yes
0x2036	0x00	-	-	-	-	Position Differential Gain setting	Unsigned8	RO	No	-	-
↑	0x01	○	×	×	×	Position differential time constant	Unsigned16	RW	Possible	#	Yes
↑	0x02	○	×	×	×	Position differential filter	Unsigned16	RW	Possible	#	Yes
0x2037	0x00	○	×	×	×	Position Drain Ratio	Unsigned32	RW	Possible	#	Yes
0x2038	0x00	○	×	×	×	Velocity Control Bypass Setting	Unsigned16	RW	Possible	#	Yes
0x2039	0x00	○	○	×	×	Verifications Drain Ratio	Unsigned16	RW	Possible	#	Yes
0x203A	0x00	○	○	○	○	Torque (force) Control Integral Gain Setting	Unsigned8	RW	Possible	#	Yes
0x203B	0x00	○	○	○	○	Torque (force) Control Integral Gain Limit Setting	Unsigned8	RW	Possible	#	Yes
0x203C	0x00	○	×	×	×	Software Deceleration Limit	Unsigned32	RW	No	#	Yes
0x203D	0x00	—	—	—	—	Amplifier temperature warning level	Unsigned8	RO	No	-	
↑	0x01	○	○	○	○	Amplifier temperature warning high level setting	Integer16	RW	No	#	Yes
↑	0x02	○	○	○	○	Amplifier temperature warning low level setting	Integer16	RW	No	#	Yes

○: Supported, ×: Not supported

Manufacturer Specific Area (No.3)

Index	S-Idx	FP	FV	FT	FH	Name	Data Type	Dir	PDO Mapping	Update	NVRAM
0x2040	0x00	—	—	—	—	Command Filter Setting	Unsigned8	RO	No	—	-
↑	0x01	○	○	×	○	Velocity Command Filter	Unsigned8	RW	Possible	#	Yes
↑	0x02	○	○	○	○	Torque（force）Command Filter	Unsigned8	RW	Possible	#	Yes
0x2041 0x2042- 0x2045	0x00	—	—	—	—	Velocity Command Filter Setting Torque（force）Command Filter1 – 4 Setting	Unsigned8	-	-	-	Yes
↑	0x01	○	○	×	○	Filter ON/OFF	Integer8	RW	Possible	#	Yes
↑	0x02	○	○	×	○	Filter Type	Integer8	RW	Possible	#	Yes
↑	0x03	○	○	×	○	Low Pass Filter Cutoff frequency	Unsigned16	RW	Possible	#	Yes
↑	0x04	○	○	×	○	High Pass Filter Cutoff frequency	Unsigned16	RW	Possible	#	Yes
↑	0x05	○	○	×	○	Band PassFilter Cutoff frequency	Unsigned16	RW	Possible	#	Yes
↑	0x06	○	○	×	○	Band width of Band Pass Filter	Unsigned16	RW	Possible	#	Yes
↑	0x07	○	○	×	○	Center frequency of Notch Filter	Unsigned16	RW	Possible	#	Yes
↑	0x08	○	○	×	○	Band width of Notch Filter	Unsigned16	RW	Possible	#	Yes
↑	0x09	○	○	×	○	Bi-quad Filter a1	Float32	RW	Possible	#	Yes
↑	0x0A	○	○	×	○	Bi-quad Filter a2	Float32	RW	Possible	#	Yes
↑	0x0B	○	○	×	○	Bi-quad Filter b0	Float32	RW	Possible	#	Yes
↑	0x0C	○	○	×	○	Bi-quad Filter b1	Float32	RW	Possible	#	Yes
↑	0x0D	○	○	×	○	Bi-quad Filter b2	Float32	RW	Possible	#	Yes
0x2050	0x00	—	—	—	—	Quadrant Glitch Compensation function	Unsigned8	RO	No	—	—
↑	0x01	○	○	○	○	Effective condition selection	Unsigned8	RW	Possible	#	Yes
↑	0x02	○	○	○	○	Effective velocity	Unsigned16	RW	Possible	#	Yes
↑	0x03	○	○	○	○	Keeping time	Unsigned16	RW	Possible	#	Yes
↑	0x04	○	○	○	○	Velocity Loop Integral Time Constant	Unsigned16	RW	Possible	#	Yes
0x2051	0x00	○	○	○	○	Micro Vibration Suppression function	Unsigned8	RW	Possible	#	Yes
0x2060	0x00	○	○	○	○	Control Word 2	Unsigned16	RW	Possible	#	Yes
0x2064	0x00	—	—	—	—	High-precision sync function parameter	Unsigned8	RO	No	—	—
↑	0x01	○	○	×	×	High-precision sync position compensation proportional gain	Unsigned16	RW	No	#	Yes
↑	0x05	○	○	×	×	LPF of acceleration FB velocity variation limit	Unsigned16	RW	No	#	Yes
↑	0x06	○	○	×	×	High-precision sync compensation input polarity selection	Unsigned8	RW	No	#	Yes
↑	0x07	○	○	×	×	High-precision sync position error warning level	Unsigned32	RW	No	#	Yes
↑	0x08	○	○	×	×	High-precision sync excessive position error value	Unsigned32	RW	No	#	Yes
↑	0x09	○	○	×	×	High-precision sync velocity error warning level	Unsigned16	RW	No	#	Yes
↑	0x0A	○	○	×	×	High-precision sync excessive velocity error value	Unsigned16	RW	No	#	Yes
↑	0x0B	○	○	×	×	High-precision sync acceleration error warning level	Unsigned32	RW	No	#	Yes
↑	0x0C	○	○	×	×	High-precision sync excessive accleration error value	Unsigned32	RW	No	#	Yes
↑	0x0D	○	○	×	×	High-precision sync compensation gain 1	Unsigned16	RW	No	#	Yes
↑	0x0E	○	○	×	×	High-precision sync compensation gain 2	Unsigned16	RW	No	#	Yes
↑	0x0F	○	○	×	×	High-precision sync excessive position error value (at automatic recovery)	Unsigned32	RW	No	#	Yes
↑	0x10	○	○	×	×	High-precision sync excessive velocity error value (at automatic recovery)	Unsigned16	RW	No	#	Yes
↑	0x11	○	○	×	×	High-precision sync excessive acceleration error value (at automatic recovery)	Unsigned32	RW	No	#	Yes
0x2065	0x00	○	○	×	×	Torque Feed Forward Gain	Unsigned16	RW	No	#	Yes
0x5080	0x00	○	-	-	-	Correction Table Control	Unsigned8	RW	No	#	Yes
0x5081	0x00	○	-	-	-	Correction Table Interpolation Method	Unsigned8	RW	No	#	Yes
0x5082	0x00	○	-	-	-	Correction Table Extrapolation Method	Unsigned8	RW	No	#	Yes
0x5083	0x00	-	-	-	-	Correction Table, Number of Entry	Unsigned8	RW	No	&	Yes
↑	0x01-0x40	○	-	-	-	Correction Position	Unsigned32	RW	No	#	Yes
0x5084	0x00	-	-	-	-	Correction Table, Number of Entry	Unsigned8	RW	No	&	Yes
↑	0x01-0x40	○	-	-	-	Offset	Integer32	RW	No	#	Yes
0x5090	0x00	○	×	×	×	Selection of Backlash Correction Function	Unsigned8	RW	No	#	Yes
0x5091	0x00	○	×	×	×	Correction amount of Backlash	Unsigned32	RW	No	#	Yes
0x5092	0x00	○	×	×	×	Correction direction of Backlash	Unsigned8	RW	No	#	Yes

○: Supported, ×: Not supported

Manufacturer Specific Area (No.4)

Index	S-Idx	FP	FV	FT	FH	Name	Data Type	Dir	PDO Mapping	Update	NVRAM
0x20F0	0x00	-	-	-	-	Amplifier Function Selection	Unsigned8	RO	No	-	-
↑	0x01	○	○	○	○	Limit behavior	Unsigned8	RW	No	#	Yes
↑	0x02	○	×	×	×	Positioning Method	Unsigned8	RW	No	&	Yes
↑	0x03	○	×	×	×	In position / Position deviation monitor	Unsigned8	RW	No	#	Yes
↑	0x04	○	○	○	○	Velocity Window Unit Output	Unsigned8	RW	No	#	Yes
↑	0x05	○	×	×	×	Deviation Clear	Unsigned8	RW	No	#	Yes
↑	0x06	○	○	○	○	Torque (force) attainment function selection	Unsigned8	RW	No	#	Yes
0x20F1	0x00	-	-	-	-	Encoder Function Selection	Unsigned8	RO	No	-	-
↑	0x01	○	○	○	○	Serial Encoder Clear Function	Unsigned8	RW	No	#	Yes
↑	0x02	○	○	○	○	Incremental Encoder, Digital Filter	Unsigned8	RW	No	#	Yes
↑	0x03	○	×	×	×	External Pulse Encoder, Digital Filter	Unsigned8	RW	No	#	Yes
↑	0x04	○	×	×	×	External Pulse Encoder Polarity	Unsigned8	RW	No	&	Yes
↑	0x05	○	○	○	○	CS offset onlinear encoder	Unsigned16	RW	No	&	Yes
↑	0x06	○	○	○	○	CS normalization offset of phase Z on linear encoder	Unsigned16	RW	No	&	Yes
↑	0x07	○	○	○	○	Polarity selection on linear encoder	Unsigned8	RW	No	&	Yes
↑	0x08	○	○	○	○	Magnetic pole position detecting frequency	Unsigned16	RW	No	&	Yes
↑	0x09	○	○	○	○	Magnetic Pole Position Estimation Mode Selection	Unsigned8	RW	No	&	Yes
0x20F2	0x00	-	-	-	-	Amplifier Alarm Detect Selection	Unsigned8	RO	No	-	-
↑	0x01	○	○	○	○	Main Circuit Under-voltage Detection	Unsigned8	RW	No	#	Yes
↑	0x02	○	○	○	○	Velocity Control Alarm Detection	Unsigned8	RW	No	#	Yes
↑	0x03	○	○	○	○	Velocity Feedback Alarm Detection	Unsigned8	RW	No	#	Yes
↑	0x04	○	○	○	○	Communication Frame Error Detection	Unsigned8	RW	No	#	Yes
↑	0x05	○	○	○	○	Communication Timeout Detection	Unsigned8	RW	No	#	Yes
0x20F3	0x00	-	-	-	-	Position Control Selection	Unsigned8	RO	No	-	-
↑	0x01	○	×	×	×	Model Control Characteristic	Unsigned8	RW	No	&	Yes
↑	0x02	○	×	×	×	Position Loop Encoder Selection	Unsigned8	RW	No	&	Yes
0x20F4	0x00	○	○	○	○	Servo Loop Delay Time	Unsigned8	RW	No	&	Yes
0x20F5	0x00	○	○	○	○	Torque (force) Limit at Power Supply Shortage	Unsigned8	RW	No	#	Yes
0x20F6	0x00	—	—	—	—	Manufacturer Homing Function Selection	Unsigned8	RO	No	—	-
↑	0x01	×	×	×	○	Actual Position Calculation Method	Unsigned8	RW	No	#	Yes
↑	0x02	×	×	×	○	Hard Stop Torque Limit	Unsigned16	RW	No	#	Yes
↑	0x03	×	×	×	○	Hard Stop Detection Time	Unsigned16	RW	No	#	Yes
0x20F7	0x00	○	○	○	○	Amplifier special setting	Unsigned16	RW	No	#	Yes
0x20F8	0x00	-	-	-	-	General Purpose Input Setting	Unsigned8	RO	No	-	-
↑	0x01	○	○	○	○	Positive Limit Switch Function (Positive Over-Travel)	Unsigned8	RW	No	#	Yes
↑	0x02	○	○	○	○	Negative Limit Switch Function (Negative Over-Travel)	Unsigned8	RW	No	#	Yes
↑	0x03	○	○	○	○	External Error Input Function	Unsigned8	RW	No	#	Yes
↑	0x04	○	○	○	○	Main Power Discharge Function	Unsigned8	RW	No	#	Yes
↑	0x05	○	○	○	○	Emergency Sop Function	Unsigned8	RW	No	#	Yes
↑	0x06	○	○	○	○	Detecton function of magnetic pole position	Unsigned8	RW	No	#	Yes
0x20F9	0x00	-	-	-	-	General Purpose Output Setting	Unsigned8	RO	No	-	-
↑	0x01 0x02	○	○	○	○	General Purpose Output 1 – 2	Unsigned8	RW	No	#	Yes
0x20FA	0x00	-	-	-	-	Extend Station Alias	Unsigned8	RO	No	-	-
↑	0x01	○	○	○	○	Extended Alias Number	Unsigned8	RW	No	#	Yes
↑	0x02	○	○	○	○	Station Alias Selection	Unsigned8	RW	No	#	Yes
0x20FD	0x00	-	-	-	-	Amplifier System Selection	Unsigned8	RO	No	-	-
↑	0x01	○	○	○	○	Main power input type	Unsigned8	RW	No	&	Yes
↑	0x02	○	○	○	○	Regenerative Resistor Selection	Unsigned8	RW	No	&	Yes
↑	0x03	○	○	○	○	Setup Communication Baud Rate	Unsigned8	RW	No	&	Yes
↑	0x04	○	○	○	○	Main circuit power input voltage	Unsigned8	RW	No	&	Yes
0x20FE	0x00	○	○	○	○	Combination Motor Code	Unsigned16	RW	No	&	Yes
0x20FF	0x00	○	○	○	○	Combination Encoder Selection	Unsigned8	RO	No	-	-
↑	0x01	○	○	○	○	Encoder Resolution Setting	Unsigned16	RW	No	&	Yes
↑	0x02	○	○	○	○	Encoder Type	Unsigned16	RW	No	&	Yes
↑	0x03	○	×	×	×	External Encoder Resolution	Unsigned32	RW	No	&	Yes

○: Supported, ×: Not supported

Manufacturer Specific Area (No.5)

Index	S-Idx	FP	FV	FT	FH	Name	Data Type	Dir	PDO Mapping	Update	NVRAM
0x2100	0x00	○	○	○	○	Status Word 1	Unsigned16	RO	Possible	-	-
0x2101	0x00	-	-	-	-	Amplifier error field	Unsigned8	RO	No	-	-
↑	0x01-0x04	○	○	○	○	Alarm actual 1 – 4	Unsigned8	RO	Possible	-	-
0x2102	0x00	-	-	-	-	Description of Alarm Trace	Unsigned8	RO	No	-	-
↑	0x01	○	○	○	○	Now Status	Unsigned32	RO	Possible	-	-
↑	0x02-0x08	○	○	○	○	1st - 7th Latest Alarm	Unsigned16	RO	Possible	-	-
0x2103	0x00	-	-	-	-	Warning Status	Unsigned8	RO	No	-	-
↑	0x01	○	○	○	○	Warning Monitor	Unsigned16	RO	Possible	-	-
↑	0x02	○	○	○	○	Warning mask Selection	Unsigned16	RW	No	#	Yes
0x2104	0x00	-	-	-	-	Actual Gain Value Monitor	Unsigned8	RO	No	-	-
↑	0x01	○	-	-	-	Actual Position Loop Proportional Gain	Unsigned16	RO	Possible	-	-
↑	0x02	○	-	-	-	Actual Position Integral Time Constant	Unsigned16	RO	Possible	-	-
↑	0x03	○	○	○	○	Actual Velocity Loop Proportional Gain	Unsigned16	RO	Possible	-	-
↑	0x04	○	○	-	○	Actual Velocity Loop Integral Time Constant 1	Unsigned16	RO	Possible	-	-
↑	0x05	○	○	-	○	Actual Load Inertia Moment Ratio	Unsigned16	RO	Possible	-	-
↑	0x06	○	○	○	○	Actual Torque (force) Command Filter	Unsigned16	RO	Possible	-	-
↑	0x07	-	-	-	-	Actual Model Control Gain	Unsigned16	RO	Possible	-	-
0x2105	0x00	○	○	○	○	Z-phase Signal Base Actual Position	Unsigned32	RO	Possible	-	-
0x2106	0x00	○	○	×	○	Internal Velocity Command Monitor	Integer32	RO	Possible	-	-
0x2107	0x00	○	○	○	○	Internal Torque (force) Command Monitor	Integer16	RO	Possible	-	-
0x2108	0x00	-	-	-	-	Effective Torque (force) Monitor	Unsigned8	RO	No	-	-
↑	0x01	○	○	○	○	Effective Torque (force) Estimated Value	Unsigned16	RO	Possible	-	-
↑	0x02	○	○	○	○	Fast Effective Torque (force) Estimate Value	Unsigned16	RO	Possible	-	-
0x2109	0x00	○	○	○	○	Temperature inside the servo amplifier	Integer16	RO	Possible	-	-
0x210A	0x00	○	○	○	○	Regenerative Resistor Operation Percentage Monitor	Unsigned16	RO	Possible	-	-
0x210B	0x00	○	○	○	○	Encoder Temperature Monitor	Integer16	RO	Possible	-	-
0x210C	0x00	○	○	○	○	Home Index Position Detection Value	Integer32	RO	Possible	-	-
0x210D	0x00	○	—	—	—	Position Synchronization Deviation Monitor	Integer32	RO	Possible	—	-
0x210E	0x00	—	—	—	—	Power Consumption Monitor	Unsigned8	RO	No	—	-
↑	0x01	○	○	○	○	Average Power Monitor	Integer32	RO	Possible	—	-
↑	0x02	○	○	○	○	Maximum Power Monitor	Integer32	RO	Possible	—	-
↑	0x03	○	○	○	○	Integrated Average Power Monitor	Unsigned32	RO	Possible	—	-
0x2110	0x00	-	-	-	-	Internal Control Cycle Position Actual Value	Unsigned8	RO	No	-	-
↑	0x01-0x07	○	○	○	○	Internal Control Cycle Actual Position 1 –7 (125us Latest)	Integer32	RO	Possible	-	-
0x2111	0x00	-	-	-	-	Internal Control Cycle Actual Velocity	Unsigned8	RO	No	-	-
↑	0x01-0x07	○	○	○	○	Internal Control Cycle Actual Velocity 1 – 7 (125us Latest)	Integer32	RO	Possible	-	-
0x2112	0x00	-	-	-	-	Internal Control Cycle Actual Torque (force)	Unsigned8	RO	No	-	-
↑	0x01-0x07	○	○	○	○	Internal Control Cycle Actual Torque (force) 1 – 7 (125us Latest)	Integer16	RO	Possible	-	-
0x2116	0x00	○	○	○	○	Actual Velocity Value (Velocity Monitor) 2	Integer32	RO	Possible	—	-
0x2117	0x00	○	○	○	○	Actual Position Value (Position Monitor) 2	Integer32	RO	Possible	—	-
0x2120	0x00	—	—	—	—	Amplifier Parameter	Unsigned8	RO	—	—	-
↑	0x01	○	○	○	○	Alarm Mask monitor	Unsigned32	RO	Possible	—	-
↑	0x02	○	○	○	○	Amplifier Control Status	Unsigned8	RW	—	#	-
↑	0x03	○	○	○	○	Amplifier Operation Time	Unsigned32	RO	—	—	-
↑	0x04	○	○	○	○	External Regenerative Resistor Value	Unsigned32	RW	Possible	#	-
0x2151	0x00	○	○	○	○	Error Register	Unsigned8	RO	Possible	—	-
0x2152	0x00	○	○	○	○	Device Name	Visible String	RO	No	—	-
0x2153	0x00	○	○	○	○	FPGA Hardware Version	Visible String	RO	No	—	-
0x2154	0x00	○	○	○	○	Communication Software Version	Visible String	RO	No	—	-
0x2155	0x00	○	○	○	○	Servo Software Version	Visible String	RO	No	—	-
0x2156	0x00	—	—	—	—	Alarm Estimation Cause code	Unsigned8	RO	No	—	-
↑	0x01-0x08	○	○	○	○	Alarm cause estimation code 1-8	Unsigned16	RO	No	—	-
0x2157	0x00	○	○	○	○	FPGA Initialization error	Unsigned16	RO	No	—	-
0x2158	0x00	—	—	—	—	High-precision Sync Monitor	Unsigned8	RO	No	—	-
↑	0x01	○	○	×	×	High-precision Sync Position Error Monitor	Integer32	RO	Possible	—	-
↑	0x02	○	○	×	×	High-precision Sync Velocity Error Monitor	Integer32	RO	Possible	—	-
↑	0x03	○	○	×	×	High-precision Sync Acceleration Error Monitor	Integer32	RO	Possible	—	-
0x2159	0x00	—	—	—	—	Warning Status 2	Unsigned8	RO	No	—	-
↑	0x01	○	○	○	○	Warning Monitor 2	Unsigned16	RO	Possible	—	-
↑	0x02	○	○	○	○	Warning Mask 2	Unsigned16	RW	No	#	Yes
0x5010	0x00	—	—	—	—	Motor Data	Unsigned8	RO	No	-	-
↑	0x01	○	○	○	○	Number of motor pole	Unsigned8	RO	Possible	-	-
↑	0x02	○	○	○	○	Phase resistance	Unsigned16	RO	Possible	-	-
↑	0x03	○	○	○	○	Phase inductance	Unsigned16	RO	Possible	-	-
↑	0x04	○	○	○	○	Moment of inertia	Unsigned32	RO	Possible	-	-
↑	0x05	○	○	○	○	Voltage constant for each phase	Unsigned32	RO	Possible	-	-
↑	0x06	○	○	○	○	Rated torque	Unsigned16	RO	Possible	-	-

○: Supported, ×: Not supported

Manufacturer Specific Area (No.6)

Index	S-Idx	FP	FV	FT	FH	Name	Data Type	Dir	PDO Mapping	Update	NVRAM
0x5040 0x5041 0x5042	0x00	–	–	–	–	Position unit system Velocity unit system Acceleration unit system	Unsigned8	RO	No	-	-
↑	0x01	○	○	○	○	100% Full-scale Software Resolution	Unsigned8	RO	Possible	-	-
↑	0x02	○	○	○	○	Full-scale Unit	Unsigned16	RO	Possible	-	-
↑	0x03	○	○	○	○	Full-scale Data Type	Unsigned16	RO	Possible	-	-
↑	0x04	○	○	○	○	Full-scale Value	Unsigned32	RO	Possible	-	-

○: Supported, ×: Not supported

2) Control Command Parameter

0x2000: Control Word 1

<table>
<tr><td colspan="2">Index Ax1 0x2000
Ax2 0x2200
Ax3 0x2400
Ax4 0x2600</td><td>Manufacturer-specific object for the servo amplifier control.</td><td colspan="2">Object Code</td><td>Variable</td></tr>
<tr><td>Sub-Idx</td><td colspan="2">Description</td><td>Data Type</td><td>Access</td><td>PDO</td><td>Initial value</td></tr>
<tr><td>0x00</td><td colspan="2">Control Woad1 [CWORD1]
Enables various functions.
0:disabled 1:enabled</td><td>Unsigned16</td><td>RW</td><td>Possible</td><td>-</td></tr>
</table>

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

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

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

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

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

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

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

bit6:location-complement disabled(csp only) [INTPODI]
When position commands cannot be received cyclically(SM2 event not received), keep operating at “1” using the previous amount of travel.
“0”: Disabled. “1”: Enabled.

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

MSB							LSB
psce	pscme	ETMPDIS	loscon	obscon	vibcon	htrv	htrp
15	14	13	12	11	10	9	8

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

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

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

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

bit12:
Reserved.

bit13:encoder temperature monitor [ETMPDIS]
Encoder temperature detection is disabled at “1.”

bit14:
Reserved.

bit15: Synchronizing function enabled
[SYCON]
Synchronization function is enabled at “1”.

0x2001: Parameter Select

Index Ax1 0x2001 Ax2 0x2201 Ax3 0x2401 Ax4 0x2601	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 *1 [MDLFSEL]
Under the model control, resonance/anti-resonance frequency 1-4 to be used is selected.
Use the setting: bit1, 0=0, 0 frequency 1 Sub-Index:0x01.
Use the setting: bit1, 0=0,1 frequency 2 Sub-Index:0x02.
Use the setting: bit1, 0=1, 0 frequency 3 Sub-Index:0x02.
Use the setting: bit1, 0=1, 1 frequency 4 Sub-Index:0x04.

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

bit5-4：Gain change selection *2 ［GC］
The value to be used is selected by various gain settings from Sub-Index 1-4.
Use the setting bit5, 4=0, 0 gain1 Sub-Index:0x01.
Use the setting bit5, 4=0, 1 gain2 Sub-Index:0x02.
Use the setting bit5, 4=1, 0 gain3 Sub-Index:0x03.
Use the setting bit5, 4=1, 1 gain4 Sub-Index:0x04.

bit7-6:
Reserved

*1 Model control gains 1-4 are switched by bit5-4: gain switching selection, and bit1-0 is a parameter to switch model control anti-resonance frequency 1-4 and model control resonance frequency 1-4.

*2 The parameter of switching by the Gain change selection is below.
Position loop proportional gain (0x2005), Position integral time constant (0x2006), Velocity loop proportional gain (0x200B), Velocity loop integral time constant (0x200C), Load inertia moment ratio (0x200D), Command filter (0x2011)
Also, for use of this function, please enable Torque low pass filter setting at the Special Function Selection Setting.

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

bit15-8：
Reserved

3) Auto-Tuning Parameter

0x2002: Auto-tuning

Index Ax1 0x2002 Ax2 0x2202 Ax3 0x2402 Ax4 0x2602	Auto-tuning settings	Object Code	Array

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Number of entry	Unsigned8	RO	No	0x06
0x01	Auto-tuning Mode [TUNEMODE] Set the validity, invalidity of Auto-tuning, and Load inertia moment rate estimation.	Unsigned8	RW	No	0x02
		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] Selects the tuning characteristic.	Unsigned8	RW	No	0x00
		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 load inertia vary during the operation. * When the estimation accuracy of the Load Inertia moment ratio is low or cannot be obtained due to operation patterns or machine characteristics. *[Positioning Control 5] * When you want to adjust forward gain in case of the horizontal axis without external forces. *[Trajectory Control 1] * When there is no need to follow position commands and coordination with other axes (such as in cutting operations.) *[Trajectory Control 2] * For coordination with other axes (please adjust KPPGIN.) * For following position commands. Do not use at “model following vibration suppressor control.” At Model following vibration suppressor control, trajectory will be out of alignment. *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.				
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)		

0x04	Save Notch/FF Vibration Suppression frequency/ Auto-Tuning data	Unsigned8	RW	No	0x00
	◆Result of above tuning data can save by EtherCAT communication network.	Setting range	0x00 to 0x05 (0 to 5)		

◆Selects thecommand
0x00： Disable tuning
0x01： Execute Auto- Notch Filter tuning
0x02： Execute Auto FF Vibration Suppression tuning
0x03： Save result of Auto-tuning
0x04： Stop Auto Notch Filter tuning / Auto FF Vibration Suppression tuning
0x05： Stop save result of Auto-tuning

◆Make sure of motor stop before start to Auto-tuning.
Auto-tuning will get wrong value when it runs with rotating motor.
When Auto-tuning is working, command relate to motor operation and the other tuning will not be accept.
When motor is rotating, Auto-tuning command from master will not be accepted. Command will ignored and terminated abnormally.
◆Master will not able to run Auto-tuning while run by Setup software.
◆Setup software will not able to run Auto-tuning while run by master.

◆When Auto-tuning is working, master can be stop Auto-tuning.
◆Slave could receive a execute command then slave will continue to Auto-tuning even if communication error by some reason. If alarm occur by communication error then slave will stop Auto-tuning.

◆Auto Notch Filter tuning
When Auto Notch Filter tuning is working, need to follow below.
≫Don`t change 0x2040.2, 0x2042.1 and 0x2042.2.
≫Tuning result need to save Torque Command Notch Filter frequency.

◆Tuning result of Auto FF Vibration Suppression need to save 0x2012.

◆When execute Auto-tuning result save, save parameter will follow selected sub index (0x06).
。There are 6 kind of save parameter.、Each save parameter has 5 sub index（0x06）
≫Load inertia 1(0x200D.1)
≫Position Loop Proportional Gain 1(0x2005.1)
≫Velocity Loop Proportional Gain 1(0x200B.1)
≫Velocity Loop Integral Time Constant 1(0x200C.1)
≫Torque Command Filter 1(0x2011.1)
Don`t change 0x20F7 bit1.
≫ModelFollowing Control Gain 1(0x2017.1)

◆Result of Auto Notch filter tuning and Auto FF Vibration Suppression tuning can not save at the same time.

0x05	Notch /FF Vibration Suppression frequency/ Monitor of save tuning result.	Unsigned8	RO	No	0x01
	◆Indicate state of Notch Filter,FF Vibration Suppression frequency and tuning result.	Setting range	0x00 to 0x02 (0 to 2)		

0x00： Running tuning
0x01： Completion
0x02： Abnormal termination
If finish tuning, 0x01 or 0x02 will indicate.

0x06	Parameter setting of save Auto-tuning result	Unsigned8	RW	No	0x00
	◆Setting of save parameter	Setting range	0x00-0x04 (0-5)		

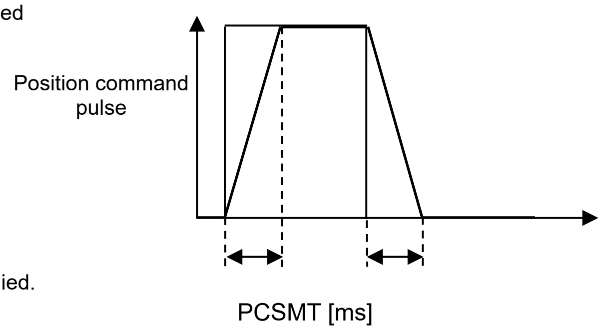
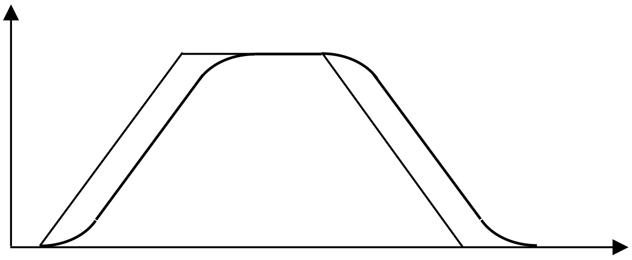
◆Description

Setting value	Load inertia	Position Proportional Gain	Velocity Proportional Gain	Velocity Integral Constant	Torque Command Filter	Model Control Gain
0	Save	Save	Save	Save	Save	Save
1	Save	Not save	Save	Save	Save	Not save
2	Save	Not save	Not save	Not save	Not save	Not save
3	Not save	Save	Save	Save	Save	Save
4	Not save	Not save	Save	Save	Save	Not save

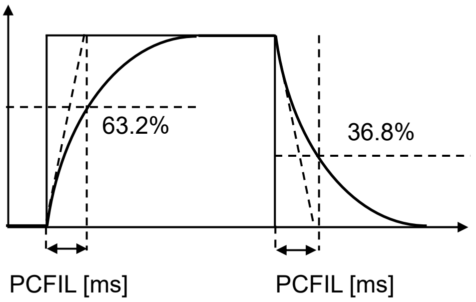
4) Basic Control Parameter

0x2003: Position Command Smoothing Constant

<table>
<tr><td>Index Ax1 0x2003
Ax2 0x2203
Ax3 0x2403
Ax4 0x2603</td><td colspan="2">This moving low-pass filter smoothes the position command pulse. Sets time constants.</td><td colspan="2">Object Code</td><td>Variable</td></tr>
<tr><td>Sub-Idx</td><td>Description</td><td>Data Type</td><td>Access</td><td>PDO</td><td>Initial value</td></tr>
<tr><td rowspan="4">0x00</td><td rowspan="3">Position Command Smoothing Constant [PCSMT]
*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.</td><td>Unsigned16</td><td>RW</td><td>Possible</td><td>0x0005
(0.5 ms)</td></tr>
<tr><td>Setting range</td><td colspan="3">0x0000-0x1388
(0.0-500.0 ms)</td></tr>
<tr><td>Unit</td><td colspan="3">0.1 ms</td></tr>
<tr><td colspan="5">(This may decrease the operating noise of the servo motor.)
*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 with lamp condition applied.
</td></tr>
</table>

0x2004: Position Command Filter

<table>
<tr><td>Index Ax1 0x2004
Ax2 0x2204
Ax3 0x2404
Ax4 0x2604</td><td colspan="2">This low-pass filter suppresses any sudden change of the position control pulse. Sets time constants.</td><td colspan="2">Object Code</td><td>Variable</td></tr>
<tr><td>Sub-Idx</td><td>Description</td><td>Data Type</td><td>Access</td><td>PDO</td><td>Initial value</td></tr>
<tr><td rowspan="4">0x00</td><td rowspan="3">Position Command Filter [PCFIL]
Time constant for the filter will be set.
Filter will be invalid at the set value 0.0 ms.
Does not influence Feed Forward.</td><td>Unsigned16</td><td>RW</td><td>No</td><td>0x0000
(0.0 ms)</td></tr>
<tr><td>Setting range</td><td colspan="3">0x0000-0x4E20
(0.0-2000.0 ms)</td></tr>
<tr><td>Unit</td><td colspan="3">0.1 ms</td></tr>
<tr><td colspan="5">*This parameter setting is valid when the value of Higher Tracking Control Position Compensation Gain is set at 0%.
*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.
 </td></tr>
</table>

0x2005: Position Loop Gain

Index Ax1 0x2005 Ax2 0x2205 Ax3 0x2405 Ax4 0x2605	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 Ax1 0x2006 Ax2 0x2206 Ax3 0x2406 Ax4 0x2606	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 Ax1 0x2007 Ax2 0x2207 Ax3 0x2407 Ax4 0x2607	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. KFGN [%] = 0.9 × Setting value [%]	Unsigned16	RW	No	0x0000 (0 %)
		Setting range	0x0000-0x0064 (0-100 %)		
		Unit	1 %		
	PCFIL [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.				

0x2008: Feed Forward compensation parameter

Index Ax1 0x2008 Ax2 0x2208 Ax3 0x2408 Ax4 0x2608	Sets parameters regarding Feed Forward compensation functions.		Object Code		Array
Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Number of entry	Unsigned8	RO	No	0x0002
0x01	Feed Forward Gain [FFGN] 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.	Unsigned16	RW	Possible	0x0000 (0 %)
		Setting range	0x0000-0x0064 (0-100 %)		
		Unit	1 %		
	*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				
0x02	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.”	Unsigned16	RW	No	0x0FA0 (4000Hz) Invalid
		Setting range	0x0001-0x0FA0 (1-4000Hz)		
		Unit	1 Hz		
	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				

0x2009: Command Filter Settings

Index Ax1 0x2009 Ax2 0x2209 Ax3 0x2409 Ax4 0x2609	Sets primary low pass filter regarding velocity command.		Object Code		Variable
Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Velocity Command Filter ［VCFIL］ This primary low pass filter to suppress the sudden changes of the velocity command. Sets the cutoff frequency. When sets over 2000Hz（0x07D0）then setting become disable.	Unsigned16	RW	No	0x0FA0 (4000 Hz) Invalid
		Setting Range	0x0001 to 0x0FA0 (1 to 4000 Hz)		
		Unit	1 Hz		

0x200A: Velocity Feedback Filter

Index Ax1 0x200A Ax2 0x220A Ax3 0x240A Ax4 0x260A	Parameter to switch on the primary low-pass filter in response to velocity feedback.	Object Code	Variable

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Velocity Feedback Filter [VDFIL] First low-pass filter to eliminate ripples caused by encoder pulse included in the velocity control system feedback. Sets the cutoff frequency. Setting value: the filter will be disabled at 2000Hz(0x07D0) or greater.	Unsigned16	RW	No	0x05DC (1500 Hz)
		Setting range	0x0001-0x0FA0 (1-4000 Hz)		
		Unit	1 Hz		
	*When the encoder resolution is low, lowering the setting value and suppressor the ripples can suppress motor drive noise. In addition, when the encoder resolution is high, raising the setting value may improve the response of the velocity control system. For general use, set at the Standard value.				

0x200B: Velocity Loop Proportional Gain

Index Ax1 0x200B Ax2 0x220B Ax3 0x240B Ax4 0x260B	Proportional gain of velocity controller. By setting bit5, 4, gain change selection (GC), in the parameter selection (0x2001), the Position Loop Proportional Gain to be used is selected.	Object Code	Array

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Number of entry	Unsigned8	RO	No	0x04
0x01	Velocity Loop Proportional Gain 1 [KVP1] ∗Automatically saved by Auto-tuning result saving.	Unsigned16	RW	Possible	0x0032 (50Hz)
	*When Auto-tuning function is valid, this setting value is not applied. *When the Gain switching function is valid, select gain 1 and this setting value is applied. *When gain 1(bit5, 4=0, 0) is selected, in the Gain Switching function, it operates at this setting value.				
0x02	Velocity Loop Proportional Gain 2 [KVP2] *When gain 2(bit5, 4=0, 1) is selected, in the Gain Switching function, it operates at this setting value.	Unsigned16	RW	No	0x0032 (50Hz)
0x03	Velocity Loop Proportional Gain 3 [KVP3] *When gain 3(bit5, 4=1, 0) is selected, in the Gain Switching function, it operates at this setting value.	Unsigned16	RW	No	0x0032 (50Hz)
0x04	Velocity Loop Proportional Gain 4 [KVP4] *When gain 4(bit5, 4=1, 1) is selected, in the Gain Switching function, it operates at this setting value.	Unsigned16	RW	No	0x0032 (50Hz)
		Setting range	0x0001-0x07D0 (1-2000 Hz)		
		Unit	1Hz		

0x200C: Velocity Loop Integral Time Constant

Index Ax1 0x200C Ax2 0x220C Ax3 0x240C Ax4 0x260C	Integral time constant of velocity controller. Selects Velocity Loop Integral Time Constant to use by Gain change selection (GC) (Parameter Select: 0x2001 bit5, 4). Integral term is invalid (proportional control) with the setting value of 1000ms (0x2710).	Object Code	Array

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Number of entry	Unsigned8	RO	No	0x04
0x01	Velocity Loop Integral Time Constant 1 [TVI1] ∗Automatically saved by Auto-tuning result saving.	Unsigned16	RW	Possible	0x00C8 (20ms)
	*When Auto-tuning function is valid, this setting value is not applied. *When Gain switching function is valid, select gain 1 and this setting value is applied. *When gain 1(bit5, 4=0, 0) is selected, in the Gain Switching function, it operates at this setting value.				
0x02	Velocity Loop Integral Time Constant 2 [TVI2] * When gain 2(bit5, 4=0, 1) is selected, in the Gain Switching function, it operates at this setting value.	Unsigned16	RW	No	0x00C8 (20ms)
0x03	Velocity Loop Integral Time Constant 3 [TVI3] * When gain 3(bit5, 4=1, 0) is selected, in the Gain Switching function, it operates at this setting value.	Unsigned16	RW	No	0x00C8 (20ms)
0x04	Velocity Loop Integral Time Constant 4 [TVI4] * When gain 4(bit5, 4=1, 1) is selected, in the Gain Switching function, it operates at this setting value.	Unsigned16	RW	No	0x00C8 (20ms)
		Setting range	0x0003-0x2710 (0.3-1000 ms)		
		Unit	0.1ms		

0x200D: Load Inertia Moment Ratio

Index Ax1 0x200D Ax2 0x220D Ax3 0x240D Ax4 0x260D	Sets inertia moment of the loading device to the servo motor roter inertia. Setting value=$J_L/J_M \times 100\%$ (J_L: Load inertia, J_M: Motor roter inertia) By setting bit5, 4, gain change selection (GC) in the parameter selection (0x2001), the Load Inertia Moment Ratio to be used is selected.	Object Code	Array

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Number of entry	Unsigned8	RO	No	0x04
0x01	Load Inertia Moment Ratio 1 [JRAT1] *For velocity control parameters. *Automatically saved by Auto-tuning result saving. *When Auto-tuning function is valid, this setting value not applied. *When Gain switching function is valid, select gain 1 and this setting value is applied. *When gain 1(bit5, 4=0, 0) is selected, in the Gain Switching function, it operates at this setting value.	Unsigned16	RW	Possible	0x0064 (100%)
0x02	Load Inertia Moment Ratio 2 [JRAT2] *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 Ax1 0x200E Ax2 0x220E Ax3 0x240E Ax4 0x260E	Parameter to adjust command following prerformance of velocity control.	Object Code	Variable

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Higher Tracking Control Velocity Compensation Gain [TRCVGN] *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 Ax1 0x200F Ax2 0x220F Ax3 0x240F Ax4 0x260F	Sets acceleration feedback compensation gain to make the velocity loop stable. Sets the cutoff frequency.	Object Code	Array

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Number of entry	Unsigned8	RO	No	0x02
0x01	Acceleration Feedback Gain [AFBK] 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.	Integer16	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 Command Filter

Index Ax1 0x2011 Ax2 0x2211 Ax3 0x2411 Ax4 0x2611	Low-pass filter to eliminate high frequency component included in the torque (force) command. Sets cutoff frequency. By setting bit5, 4 gain, change selection (GC) in the parameter selection (0x2001), the Torque (force) Command Filter to be used is selected.		Object Code		Array
Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Number of entry	Unsigned8	RO	No	0x04
0x01	Torque(force) command filter 1 ［TCFIL1］ * This setting update when save Auto-Tuning data.	Unsigned16	RW	Possible	0x0258 （600Hz）
	* When Auto-Tuning activate , this setting invalid. * When Auto-Tuning activate and System analysis activate, this setting valid. * When Gain Switching activate and select gain 1（bit5,4＝0,0）, this setting enable.				
0x02	Torque (force) Command Filter 2 [TCFIL2] *When the gain permission is enabled and gain 2 (bit5,4 = 0,1) is selected in the Gain Switching function, it operates at this setting value.	Unsigned16	RW	No	0x0258 (600Hz)
0x03	Torque (force) Command Filter 3 [TCFIL3] * When the gain permission is enabled and gain 3 (bit5,4 = 1,0) is selected in the Gain Switching function, it operates at this setting value.	Unsigned16	RW	No	0x0258 (600Hz)
0x04	Torque (force) Command Filter 4 [TCFIL4] * When the gain permission is enabled and gain 4 (bit5,4 = 1,1) is selected in the Gain Switching function, it operates at this setting value.	Unsigned16	RW	No	0x0258 (600Hz)
		Setting value	0x0001 - 0x0FA0 (1 - 4000 Hz)		
		Unit	Hz		

5) Feed Forward vibration suppressor control / Notch filter Parameter

0x2012: FF Vibration Suppressor Frequency

Index Ax1 0x2012 Ax2 0x2212 Ax3 0x2412 Ax4 0x2612	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 1 (bit 3, 2=0, 0) 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		

6) High stabilized control settings

0x2015: High stabilized control settings

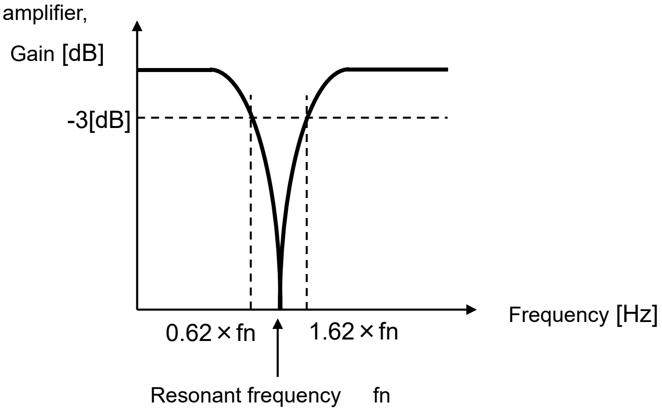
Index Ax1 0x2015 Ax2 0x2215 Ax3 0x2415 Ax4 0x2615	Parameter setting to implement high setting control by adding position deviation to Acceleration and Deceleration Compensation Values.	Object Code	Array

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Number of entry	Unsigned8	RO	No	0x04
0x01	Acceleration Compensation [ACCC0] 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.	Indeger16	RW	No	0x0 (0 Pulse)
		Setting range	0xD8F1-0x270F (-9999-+9999×50 Pulse)		
		Unit	×50 Pulse		
	*Greater setting values result in increased compensation. *Greater accelerations converted from the Position Command Pulse result in increased compensation. *Greater Load inertia result in increased compensation. *High Stabilized Control results in Position Deviation. *In case of model following control or model following anti-resonance control, this setting value is not reflected.				
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.	Indeger16	RW	No	0x0 (0 Pulse)
		Setting range	0xD8F1-0x270F (-9999-+9999×50 Pulse)		
		Unit	×50 Pulse		
	✔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 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.				
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		Description	Object Code	
Ax1 Ax2 Ax3 Ax4	0x2016 0x2216 0x2416 0x2616	Sets various parameters in the disturbance suppression observer. Observer compensation operates with control word 1 (0x2000) bit 11: disturbance Observer compensation enable [OBCON]="1"	Object Code	Record

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Number of entry	Unsigned8	RO	No	0x07
0x01	Observer Characteristic [OBCHA]	Unsigned8	RW	No	0x00
		Setting range	0x00-0x02		
	0x00: Low For Low Frequency 0x01: Middle For Middle Frequency 0x02: High For High Frequency 0x03-0xFF: Reserved *Select "00 Low, Low Frequency Disturbance Observer Suppressor" for Load torque (force) monitor (estimate value). *Select 02 High, High Frequency Disturbance Observer Suppressor, when the encoder resolution is over 1048576P/R (20bit).				
0x02	Compensation gain for Disturbance Observer.[OBG] Observer Compensation gain in response to the Torque (force)command. *The larger the value, the higher the suppression performance. By making this too large to oscillate, the disturbance suppression characteristics improve.	Unsigned16	RW	No	0x0000 (0 %)
		Setting range	0x0000-0x0064 (0-100 %)		
		Unit	1 %		
0x03	Observer Output Filter [OBLPF] First low-pass filter to eliminate high frequency elements included in the observer compensation. Sets the cutoff frequency. *Filter is invalid at the setting value more than 2000Hz.	Unsigned16	RW	No	0x032 (50 Hz)
		Setting range	0x0001-0x0FA0 (1-4000 Hz)		
		Unit	Hz		
	*The larger the value is, the faster the response of disturbance observer suppression. However, it may cause a louder driving sound depending on the ripple components included in disturbance observer output. *Filter is invalid when observer characteristic is set to [01 Middle, For Middle Frequency], or [02 High, For High Frequency].				
0x04	Observer Notch Filter [OBNFIL] 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.	Unsigned16	RW	No	0x0FA0 (4000 Hz)
		Setting range	0x0001-0x0FA0 (1-4000 Hz)		
		Unit	Hz		
	*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 				
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, JM: Motor rotor inertia) * Selection of disturbance suppression observer characteristics: JRAT 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 Ax1 0x2017 Ax2 0x2217 Ax3 0x2417 Ax4 0x2617	Proportional gain of the Model Following Control Position Controller.		Object Code		Array
Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Number of entry	Unsigned8	RO	No	0x04
0x01	Model Control Gain 1 [KM1] *Automatically saved by Auto-tuning result saving.	Unsigned16	RW	Possible	0x001E (30 /s)
	*When gain 1(bit5, 4=0, 0) is selected, in the Gain Switching function, it operates at this setting value.				
0x02	Model Control Gain 2 [KM2] *When gain 2(bit5, 4=0, 1) is selected, in the Gain Switching function, it operates at this setting value.	Unsigned16	RW	No	0x001E (30 /s)
0x03	Model Control Gain 3 [KM3] *When gain 3(bit5, 4=1, 0) is selected, in the Gain Switching function, it operates at this setting value.	Unsigned16	RW	No	0x001E (30 /s)
0x04	Model Control Gain 4 [KM4] *When gain 4(bit5, 4=1, 1) is selected, in the Gain Switching function, it operates at this setting value.	Unsigned16	RW	No	0x001E (30 /s)
	Depends on the setting value of Position control selection (0x20F3:01), the range is different. 01: Model Following Control 0x0001-0x0BB8 (1-3000 /s) 02: Condition Feedback Model Following Vibration Suppress Control 0x000F-0x013B (15-315 /s)	Setting range	0x0001-0x0BB8 (1-3000 /s)		
		Unit	1/s		
	* 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.				

0x2018: Overshoot Suppressor Filter

Index Ax1 0x2018 Ax2 0x2218 Ax3 0x2418 Ax4 0x2618	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

Index Ax1 0x2019 Ax2 0x2219 Ax3 0x2419 Ax4 0x2619	Sets antiresonance frequency to the mechanical device with Model following vibration suppressor control. Sets actual antiresonance frequency value of the mechanical system by using System Analysis function of the Software Setup.		Object Code		Array
Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Number of entry	Unsigned8	RO	No	0x04
0x01	Model Control Antiresonance Frequency 1 [ANRFRQ1] *When frequency 1(bit1, 0=0, 0) is selected in the model anti-resonance frequency switch at 0x2001, it operates at this setting value.	Unsigned16	RW	Possible	0x0320 (80.0 Hz) proportional control
0x02	Model Control Antiresonance Frequency 2 [ANRFRQ2] *When frequency 2(bit1, 0=0, 1) is selected in the model anti-resonance frequency switch at 0x2001, it operates at this setting value.	Unsigned16	RW	No	0x0320 (80.0 Hz) proportional control
0x03	Model Control Antiresonance Frequency 3 [ANRFRQ3] *When frequency 3(bit1, 0=1, 0) is selected in the model anti-resonance frequency switch at 0x2001, it operates at this setting value.	Unsigned16	RW	No	0x0320 (80.0 Hz) proportional control
0x04	Model Control Antiresonance Frequency 4 [ANRFRQ4] *When frequency 4(bit1, 0=1, 1) is selected in the model anti-resonance frequency switch at 0x2001, it operates at this setting value.	Unsigned16	RW	No	0x0320 (80.0 Hz) proportional control
■Setting value is invalid with following control. ■If the sitting value is over the Model Control Resonance Frequency, vibration suppressor control is invalid. ■If “Model Control Anti-resonance Frequency 2-4” are selected in the “Model vibration suppressor frequency switching function”, it operates at this setting value. ■Change value while the servo motor is OFF.			Setting range	0x0064-0x0320 (10.0-80.0 Hz)	
			Unit	0.1 Hz	

0x201A: Model Control Resonance Frequency

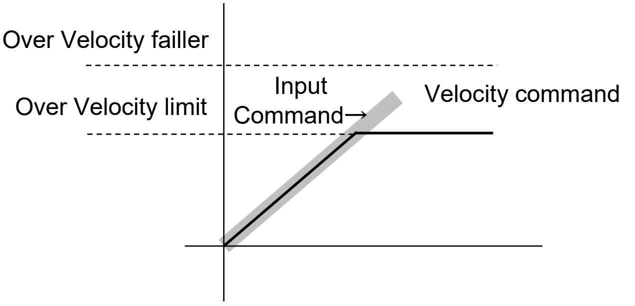
Index Ax1 0x201A Ax2 0x221A Ax3 0x241A Ax4 0x261A	Sets resonance frequency of the mechanical device with Model following vibration suppressor control. Sets actual resonance frequency value of the mechanical system by using System Analysis function of the Software Setup.		Object Code		Array
Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Number of entry	Unsigned8	RO	No	0x04
0x01	Model Control Resonance Frequency 1 [RESFRQ1] *When frequency 1(bit1, 0=0, 0) is selected in the model anti-resonance frequency switch at 0x2001, it operates at this setting value.	Unsigned16	RW	Possible	0x0320 (80.0 Hz) proportional control
0x02	Model Control Resonance Frequency 2 [RESFRQ2] *When frequency 2(bit1, 0=0, 1) is selected in the model anti-resonance frequency switch at 0x2001, it operates at this setting value.	Unsigned16	RW	No	0x0320 (80.0 Hz) proportional control
0x03	Model Control Resonance Frequency 3 [RESFRQ3] *When frequency 3(bit1, 0=1, 0) is selected in the model anti-resonance frequency switch at 0x2001, it operates at this setting value.	Unsigned16	RW	No	0x0320 (80.0 Hz) proportional control
0x04	Model Control Resonance Frequency 4 [RESFRQ4] *When frequency 1(bit1, 0=1, 1) is selected in the model anti-resonance frequency switch at 0x2001, it operates at this setting value.	Unsigned16	RW	No	0x0320 (80.0 Hz) proportional control
* Setting value is invalid with Model following control. * The filter is disabled by setting value 0x320(80Hz) or more. * If Model Control Antiresonance Frequency 2-4 selected in Model vibration suppressor frequency switching setting, it works in this setting. * Change value while the servo motor is OFF.		Setting range	0x0064-0x0320 (10.0-80.0 Hz)		
		Unit	0.1 Hz		

0x201B: Gain Switching Filter

Index Ax1 0x201B Ax2 0x221B Ax3 0x241B Ax4 0x261B	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 Ax1 0x201C
Ax2 0x221C
Ax3 0x241C
Ax4 0x261C</td><td colspan="2">Sets the allowable velocity in response to the Internal Velocity Command.</td><td colspan="2">Object Code</td><td>Variable</td></tr>
<tr><td>Sub-Idx</td><td>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">Internal Velocity Command limit [VCMMAX]
In the cycle synchronous position (csp) or the profile position (pp) mode, Interpolated position (ip) the internal velocity command is limited.
In the cycle synchronous velocity (csv) or the profile velocity (pv) mode, it is clamped at the setting value in response to the velocity command. Moreover, when
Setting value = |Velocity Command|
velocity-limit warning bit is set.</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>
<tr><td colspan="5">■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).
* It works at the state that bit3 of control word (0x2000) is valid.
✍The rotary motor differs from linear motor in unit.
 </td></tr>
</table>

0x201D: Position Command error 1 level

<table>
<tr><td>Index Ax1 0x201D
Ax2 0x221D
Ax3 0x241D
Ax4 0x261D</td><td colspan="2">Position Command error 1 alarm detection level is set.</td><td colspan="2">Object Code</td><td>Variable</td></tr>
<tr><td>Sub-Idx</td><td>Description</td><td>Data Type</td><td>Access</td><td>PDO</td><td>Initial value</td></tr>
<tr><td rowspan="4">0x00</td><td rowspan="3">Position Command error 1 level [OVFSET]
* Profile Position mode (pp)
When the velocity-converted value of trajectory generation distance exceeds the setting value, alarm “D2” is detected.</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>
<tr><td colspan="5">* Cycle synchronous position mode (csp), Interpolated position mode (ip)
When the velocity-converted value of position command variation (the previous target position – the target position) exceeds the setting value, alarm “D2” is detected.

* The weight treated inside the amplifier is set by the servo control cycle 125μs steps; therefore, please set it according to the following equation indicating the resulting value:
Internal Unit [LSB] = 480000÷1 rotary resolution [Pulse/sec]</td></tr>
</table>

0x201E: Sequence Operation Torque (force) Limit Value

<table>
<tr><td>Index Ax1 0x201E
Ax2 0x221E
Ax3 0x241E
Ax4 0x261E</td><td colspan="2">Parameter to set the output torque (force) in Sequence Operation.</td><td colspan="2">Object Code</td><td>Variable</td></tr>
<tr><td>Sub-Idx</td><td>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">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.</td><td>Unsigned16</td><td>RW</td><td>No</td><td>0x04B0
(120.0 %)</td></tr>
<tr><td>Setting range</td><td colspan="3">0x0064-0x1388
(10.0-500.0 %)</td></tr>
<tr><td>Unit</td><td colspan="3">0.1 %</td></tr>
<tr><td colspan="5">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.</td></tr>
</table>

0x201F: Near Range

Index Ax1 Ax2 Ax3 Ax4	0x201F 0x221F 0x241F 0x261F	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 less than the setting value, it is output from near range completion monitor (NEAR monitor.)				

0x2020: Speed Zero Range

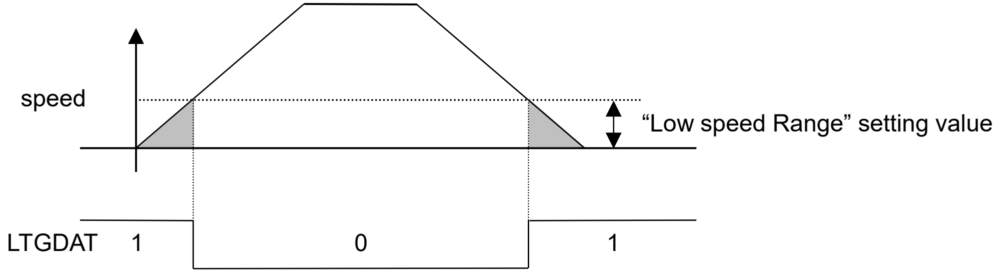
Index Ax1 Ax2 Ax3 Ax4	0x2020 0x2220 0x2420 0x2620	Setting value for detecting Zero-speed status (motor stop). Sets the allowable range at Zero-speed.	Object Code	Variable

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

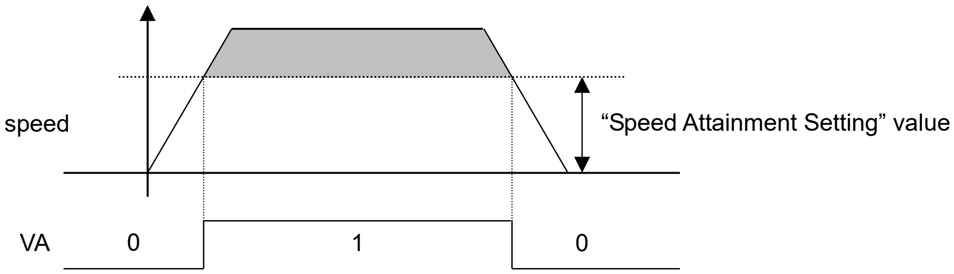
Index Ax1 Ax2 Ax3 Ax4	0x2021 0x2221 0x2421 0x2621	Sets the acceptable Low Speed Range of the motor rotation speed.	Object Code	Variable

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)

<table>
<tr><td>Index Ax1
Ax2
Ax3
Ax4</td><td>0x2022
0x2222
0x2422
0x2622</td><td colspan="2">Sets the speed attainment level of the motor rotation speed.</td><td colspan="2">Object Code</td><td>Variable</td></tr>
<tr><td>Sub-Idx</td><td 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">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.</td><td>Unsigned16</td><td>RW</td><td>No</td><td>0x03E8
(1000min^{-1})
[1000mm/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>
<tr><td colspan="6">

■ 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.</td></tr>
</table>

0x2023: Analog Monitor Select Output

Index				
Index Ax1 0x2023 Ax2 0x2223 Ax3 0x2423 Ax4 0x2623	Selects the output selection and the polarization character of Analog Monitor 1, 2.	Object Code	Record	

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Number of entry	Unsigned8	RO	No	0x03
0x01	Analog Monitor Select Output 1 [MON1] Select data to output from Analog Monitor 1.	Unsigned8	RW	No	0x05
		Setting range	0x01-0x24		

& Rotary motor

0x00：	Reserved（For maintenance by manufacturer）	
0x01：	Torque（force） monitor	2V／ratedTorque（force）
0x02：	Torque（force） command monitor	2V／ratedTorque（force）
0x03：	Velocity monitor	0.2mV／min^{-1}
0x04：	Velocity monitor	1mV／min^{-1}
0x05：	Velocity monitor	2mV／min^{-1}
0x06：	Velocity monitor	3mV／min^{-1}
0x07：	Velocity command monitor	0.2mV／min^{-1}
0x08：	Velocity command monitor	1mV／min^{-1}
0x09：	Velocity command monitor	2mV／min^{-1}
0x0A：	Velocity command monitor	3mV／min^{-1}
0x0B：	Position deviation monitor	0.01mV／Pulse
0x0C：	Position deviation monitor	0.1mV／Pulse
0x0D：	Position deviation monitor	1mV／Pulse
0x0E：	Position deviation monitor	10mV／Pulse
0x0F：	Position deviation monitor	20mV／Pulse
0x10：	Position deviation monitor	50mV／Pulse
0x11：	Position command monitor1	2mV／kPulse／sec
0x12：	Position command monitor1	10mV／kPulse／s
0x13：	Position command monitor2	0.05mV／kPulse／s
0x14：	Position command monitor2	0.5mV／kPulse／s
0x15：	Position command monitor2	2mV／kPulse／s
0x16：	Position command monitor2	10mV／kPulse／s
0x17：	Load Torque（force）monitor	2V／ratedTorque（force）
0x18：	Phase U electrical angle monitor	8Vpeak
0x19：	Position command monitor1	0.05mV／kPulse／sec
0x1A：	Position command monitor1	0.5mV／kPulse／sec
0x1B：	Acceleration monitor	0.01mV／rad／sec^2
0x1C：	Acceleration monitor	0.1mV／rad／sec^2
0x1D：	Acceleration monitor	1mV／rad／sec^2
0x1E：	Acceleration monitor	10mV／rad／sec^2
0x1F to 0xFF：reserved		
0x1F:	Position Synchronization Deviation Monitor	0.01mV/Pulse
0x20:	Position Synchronization Deviation Monitor	0.1mV/Pulse
0x21:	Position Synchronization Deviation Monitor	1mV/Pulse
0x22:	Position Synchronization Deviation Monitor	10mV/Pulse
0x23:	Position Synchronization Deviation Monitor	20mV/Pulse
0x24:	Position Synchronization Deviation Monitor	50mV/Pulse
0x25 to 0xFF: Reserved		

& Linear motor

0x00：	Reserved （For maintenance by manufacturer）	
0x01：	Torque（force）monitor	2V／ratedTorque（force）
0x02：	Torque（force）monitor	2V／ratedTorque（force）
0x03：	Velocity monitor	0.2mV／mm／sec
0x04：	Velocity monitor	1mV／mm ／sec
0x05：	Velocity monitor	2mV／mm ／sec
0x06：	Velocity monitor	3mV／mm ／sec
0x07：	Velocity command monitor	0.2mV／mm／sec
0x08：	Velocity command monitor	1mV／mm／sec
0x09：	Velocity command monitor	2mV／mm／sec
0x0A：	Velocity command monitor	3mV／mm／sec
0x0B：	Position deviation monitor	0.01mV／Pulse
0x0C：	Position deviation monitor	0.1mV／Pulse
0x0D：	Position deviation monitor	1mV／Pulse
0x0E：	Position deviation monitor	10mV／Pulse
0x0F：	Position deviation monitor	20mV／Pulse
0x10：	Position deviation monitor	50mV／Pulse
0x11：	Position command monitor1	2mV／kPulse／sec
0x12：	Position command monitor1	10mV／kPulse／s
0x13：	Position command monitor2	0.05mV／kPulse／s
0x14：	Position command monitor2	0.5mV／kPulse／s
0x15：	Position command monitor2	2mV／kPulse／s
0x16：	Position command monitor2	10mV／kPulse／s
0x17：	Load Torque（force）monitor	2V／ratedTorque（force）
0x18：	Phase U electrical angle monitor	8Vpeak
0x19：	Position command monitor1	0.05mV／kPulse／sec
0x1A：	Position command monitor1	0.5mV／kPulse／sec
0x1B：	Acceleration monitor	0.01mV／mm／sec^2
0x1C：	Acceleration monitor	0.1mV／mm／sec^2
0x1D：	Acceleration monitor	1mV／mm／sec^2
0x1E：	Acceleration monitor	10mV／mm／sec^2
0x1F to 0xFF：reserved		
0x1F:	Position Synchronization Deviation Monitor	0.01mV/Pulse
0x20:	Position Synchronization Deviation Monitor	0.1mV/Pulse
0x21:	Position Synchronization Deviation Monitor	1mV/Pulse
0x22:	Position Synchronization Deviation Monitor	10mV/Pulse
0x23:	Position Synchronization Deviation Monitor	20mV/Pulse
0x24:	Position Synchronization Deviation Monitor	50mV/Pulse
0x25 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 0x24 (Rotary) 0x01 to 0x1E (Linear)		
0x03	Analog Monitor Output Polarity Selection [MONPOL] Selects the output polarity of analog monitor 1/2.	Unsigned8	RW	No	0x00
		Setting range	0x00-0x08		

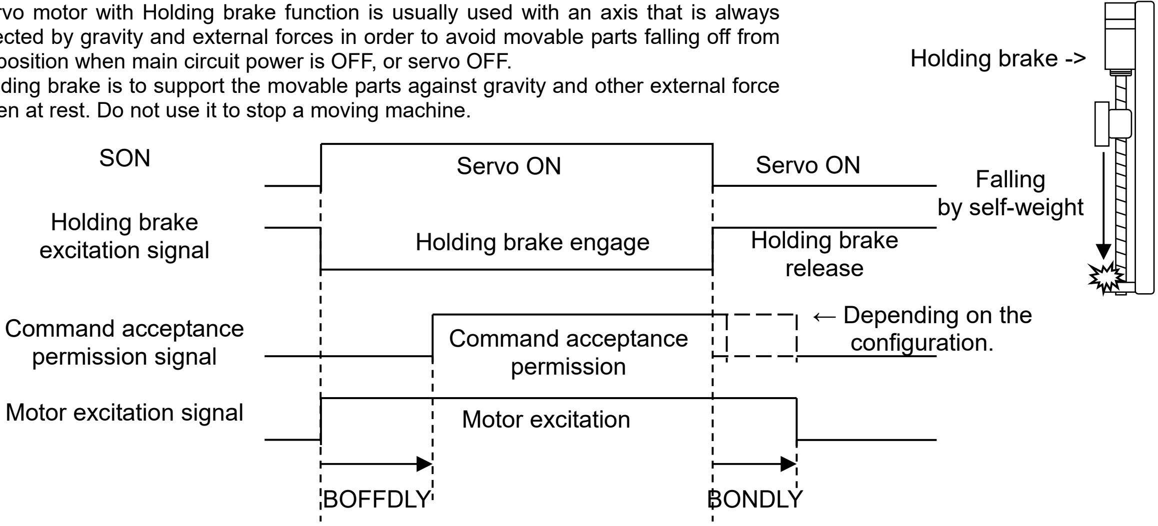
*For both MON1 and MON2, set from any of the followings: +No Polarity Rotation, - Polarity Rotation, ABS Absolute Value Output

0x00:AMON1/AMON2	at positive rotation+voltage output/at positive rotation+output
0x01:AMON1/AMON2	at positive rotation-voltage output/at positive rotation+output
0x02:AMON1/AMON2	at positive rotation+voltage output/at positive rotation-output
0x03:AMON1/AMON2	at positive rotation-voltage output/at positive rotation-output
0x04:AMON1/AMON2	at positive/reverse rotations+voltage output(absolute value)/at positive rotation+output
0x05:AMON1/AMON2	at positive/reverse rotations+voltage output (absolute value)/at positive rotation-output
0x06:AMON1/AMON2	at positive rotation+output/at positive/reverse rotations+voltage output (absolute value)
0x07:AMON1/AMON2	at positive rotation-output/at positive/reverse rotations+voltage output (absolute value)
0x08:AMON1/AMON2	at positive/reverse rotations+voltage output (absolute value/at positive/reverse rotations+voltage output (absolute value)
0x09-0xFF:Reserved	

About Holding Brake

Servo motor with Holding brake function is usually used with an axis that is always affected by gravity and external forces in order to avoid movable parts falling off from its position when main circuit power is OFF, or servo OFF.

Holding brake is to support the movable parts against gravity and other external force when at rest. Do not use it to stop a moving machine.



0x2024: Delay Time of Engaging Holding Brake

<table>
<tr><td>Index Ax1 0x2024
Ax2 0x2224
Ax3 0x2424
Ax4 0x2624</td><td colspan="2">Sets holding-brake-activation delay time from when power distribution to holding brake stopped till when holding torque generated.</td><td colspan="2">Object Code</td><td>Variable</td></tr>
<tr><td>Sub-Idx</td><td>Description</td><td>Data Type</td><td>Access</td><td>PDO</td><td>Initial value</td></tr>
<tr><td rowspan="4">0x00</td><td rowspan="3">Delay Time of Engaging Holding Brake [BONDLY]
* While shifting from servo ON to servo OFF, during the setting time, Excitation command 0 is given to servo motor. (Even when servo is turned OFF, power is supplied to the motor until the setting time is over.)</td><td>Unsigned16</td><td>RW</td><td>Possible</td><td>0x01C2
(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 Ax1 0x2025
Ax2 0x2225
Ax3 0x2425
Ax4 0x2625</td><td colspan="2">Sets holding-brake-release delay time from when power distribution to holding brake started till when holding torque disappeared.</td><td colspan="2">Object Code</td><td>Variable</td></tr>
<tr><td>Sub-Idx</td><td>Description</td><td>Data Type</td><td>Access</td><td>PDO</td><td>Initial value</td></tr>
<tr><td rowspan="4">0x00</td><td rowspan="3">Delay Time of Releasing Holding Brake [BOFFDLY]
* 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 Ax1 Ax2 Ax3 Ax4	0x2026 0x2226 0x2426 0x2626	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 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 below 0x202F Brake Activation Speed within the set 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.	Unsigned16	RW	Possible	0x2710 (10sec)
		Setting range	0x0000-0xFFFF (0-65535ms)		
		Unit	ms		

0x2027: Power Failure Detection Delay Time

Index Ax1 Ax2 Ax3 Ax4	0x2027 0x2227 0x2427 0x2627	Sets the delay time from Control power OFF to Control power error detection.	Object Code	Variable

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Power Failure Detection Delay Time [PFDDLY] * By making the setting value greater, delay in alarm detection time is possible. However, this does not guarantee the retention of Control power until the setting time. * When power source of the control logic expires, it operates the same as when Control power is interrupted. When the Main circuit power reaches a lower point than Control power, other alarms may occur. * In case of power failure of Internal logic circuit, operation is same as when Control power is turned ON again. In case of energy shortage of Main circuit power, other errors such as Main circuit power loss may be detected. * In this setting, actual detection delay time varies by -12ms - +6ms.	Unsigned16	RW	No	0x0020 (32ms)
		Setting range	0x0014-0x03E8 (20-1000ms)		
		Unit	ms		

0x2028: Excessive Deviation Warning Level

Index Ax1 Ax2 Ax3 Ax4	0x2028 0x2228 0x2428 0x2628	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	0x00000001 to 0x7FFFFFFF (1-2147483647 Pulse)			
	Unit	Pulse			

Positioning completion range -> See Position Deviation Window (0x6065 of the function group “position”.)

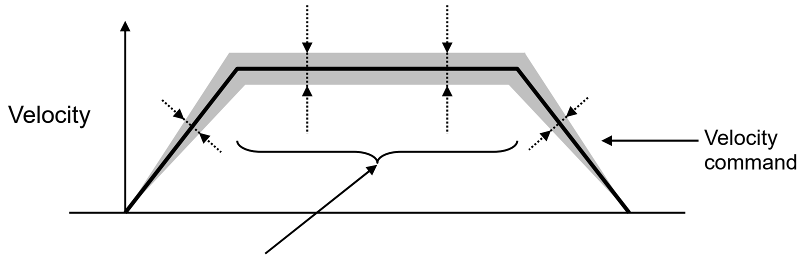
0x2029: Overload Warning Level

Index Ax1 Ax2 Ax3 Ax4	0x2029 0x2229 0x2429 0x2629	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 When set to 100%, Overload warning and Overload alarm are output at one time. * Overload detection is assumed and set as 75%, of a rated load when Control power is turned ON (hot start). This is to prevent motor damage due to the estimation value reset by power re-closing and operation resumption immediately after the occurrence of Overload alarm when it is set at 0%. Therefore, when Overload warning level is set at 75% or less, Overload warning may be output when Control power is turned ON.	Unsigned16	RW	No	0x005A (90%)
		Setting range	0x0014-0x0064 (20-100 %)		
		Unit	%		

0x202A: Speed Matching Width (Velocity matching range rate)

Index Ax1 0x202A Ax2 0x222A Ax3 0x242A Ax4 0x262A	Sets the ratio [%] of the range regarded as velocity matching against velocity commands. This value setting is used when “Speed Matching unit selection” is “0x01_Percent.”	Object Code	Variable

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Speed Matching Width [VCMPR] Velocity matching is output when the Velocity deviation (difference between the velocity command and actual velocity) is within this setting range. |Actual Velocity| <= Setting value then VCMP monitor is set.	Unsigned16	RW	No	0x0032 (5.0 %)
		Setting range	0x0000-0x03E8 (0-100%)		
		Unit	0.1 %		
	 Output ETGDAT=1 during the setting width of the Velocity matching range. *The Velocity matching output is switched by the setting of rotation speed (min^{-1}) and ratio (%) at Velocity matching unit output selection (0x20F0.4). At ratio selection, the condition under this setting value can be monitored with the status word 1(0x2100) bit 10: Velocity matching monitor.				

0x202B: Torque (force) Command Filter Characteristic

Index Ax1 0x202B Ax2 0x222B Ax3 0x242B Ax4 0x262B	The filter order is set at Torque (force)command filter	Object Code	Variable

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Torque (force) Command Filter Characteristic [TCFILOR] If the cutoff frequency of the torque (force) order filter is switched with the gain switch, the order is fixed at this setting value.	Unsigned8	RW	No	0x02
		Setting range	0x01-0x03		
	0x01: primary Filter 0x02: secondary Filter 0x03: tertiary Filter 0x00, 0x04-0xFF: Reserved				

0x202C:Feed Forward Filter, Depth Selection (FF Vibration Suppressor Level Selection)

Index Ax1 0x202C Ax2 0x222C Ax3 0x242C Ax4 0x262C	Sets the characteristics of 0x2012 Feed Forward vibration suppressor frequency in operation.	Object Code	Variable

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Feed Forward Filter, Depth Selection [SUPLV] Parameter to set the magnitude of the vibration suppressor frequency effect.	Unsigned8	RW	No	0x00
		Setting range	0x00-0x03		
	* Change while servo motor is OFF. * 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				

0x202E: Torque (force) attainment setting

Index		Description	Object Code	Variable
Ax1 Ax2 Ax3 Ax4	0x202E 0x222E 0x242E 0x262E	Sets detection level of torque attainment monitor (a function to detect that commanded internal torque value exceeds set value).	Object Code	Variable

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Torque (force) attainment setting [TA] 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	Unsigned16	RW	No	0x03E8 (100%)
		Setting range	0x0000 - 0x1388 (0.0 - 500.0%)		
		Unit	0.1 %		

✔ Torque (force) attainment output switches between maximum motor torque ratio and limited torque ratio depending on function selection of torque (force) attainment (0x20F0.6).

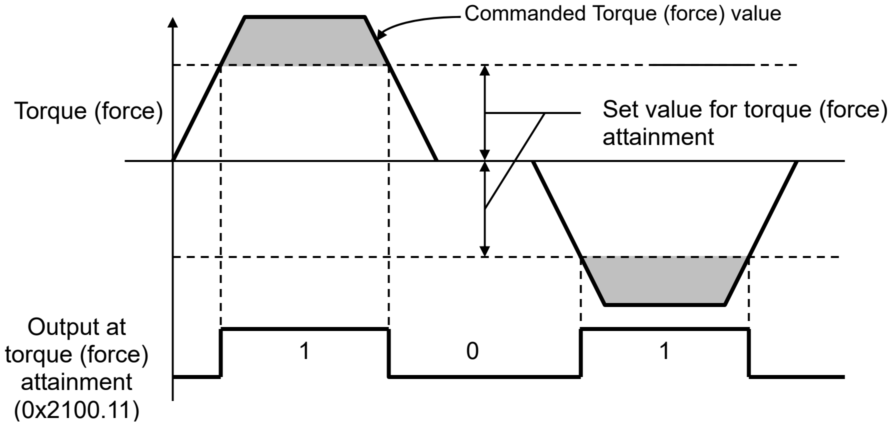
◆ Function selection of torque (force) attainment (0x20F0.6): In the case of 0x00

Sets the ratio of torque (force) attainment level by using the ratio to motor rated torque (force).

"100.0% = rated torque (force)"

Torque (force) attainment level is the same value in both forward and reverse direction.

Bit 11, output at torque (force) attainment OD:2100 is set to "1" when torque (force) command exceeds torque (force) attainment level.



◆ Function selection of torque (force) attainment (0x20F0.6): In the case of 0x01

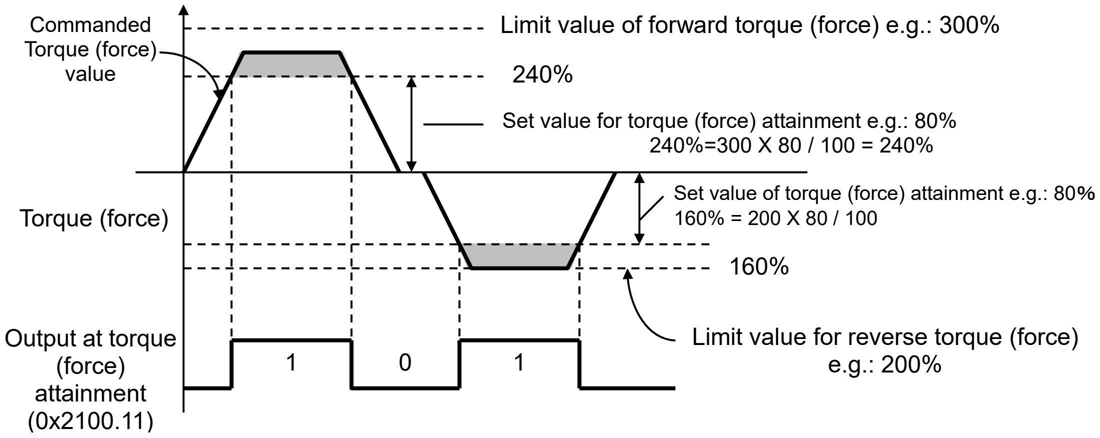
Sets the ratio of torque (force) attainment level by using the ratio to limited torque (force) value.

"100.0% = rated torque (force)"

Torque (force) attainment level is also independently calculated for both forward and reverse direction respectively in amplifier, as limited torque (force) value is independent in both directions respectively.

Forward torque (force) attainment level = Limited forward torque (force) value X set value /100.0 [%]

Reverse torque (force) attainment level = Limited reverse torque (force) value X set value /100.0 [%]



Detection shall be independently performed in both forward and reverse direction, and if the first one commanded torque (force) value in either direction exceeds torque (force) attainment level, Bit11, output at torque (force) attainment OD:2100, is set to "1."

0x202F: Brake activation speed

Index Ax1 0x202F Ax2 0x222F Ax3 0x242F Ax4 0x262F	Set the brake activation speed when decelerating motor. It works while running servo-brake.	Object Code	Variable

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Brake activation speed ［ZVDAT］ Motor brake works at lower rotation speed than set value with condition below. Quick Stop, Alarm, Emergency Stop. Motor stop will detect when relation below continued 1 msec or more. Absolute value of actual speed ≦Set value Holding brake signal will provide after detecting motor stop.	Unsigned16	RW	Possible	0x32 （50min^{-1}）
		Setting range	0x000A to 0x01F4 （10 to 500min^{-1}）		
		Unit	min^{-1}		
	✔ DDM（Direct Drive Motor）has different setting range conversion below. 0x000A to 0x01F4 --> 1 to 50.0min^{-1} (0.1min^{-1}/lsb）				

0x2030: Position Loop Integral Gain Limit

Index Ax1 0x2030 Ax2 0x2230 Ax3 0x2430 Ax4 0x2630	Set the limit of Position Loop Integral Gain	Object Code	Variable

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Limit value of position integral time constant 1 (TPI1). If setting value of position integral time constant is lower than this setting value. Position integral time constant use this setting value.	Unsigned16	RW	Possible	0x2710
		Setting range	0x0003 to 0x2710 (0.3 to 1000)		
		Unit	0.1ms		

0x2031: Velocity Control Integral Gain Limit

Index Ax1 0x2031 Ax2 0x2231 Ax3 0x2431 Ax4 0x2631	Set the Velocity Control Integral Gain Limit.	Object Code	Variable

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Limit value of velocity integral time constant 1 (TVI1). If setting value of velocity integral time constant is lower than this setting value. Velocity integral time constant use this setting value.	Unsigned16	RW	Possible	0x0003
		Setting range	0x0003 to 0x2710 (0.3 to 1000)		
		Unit	0.1ms		

0x2032: Torque (force) control proportional gain

Index Ax1 0x2032 Ax2 0x2232 Ax3 0x2432 Ax4 0x2632	Set the Torque (force) control proportional gain.	Object Code	Variable

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Proportional gain of Torque (force) control mode. Torque (force) control proportional gain is set from desired percentage of default torque gain. Setting range is from 50 to 140%, and higher the set value increase the proportional gain.	Unsigned8	RW	No	0x64
		Setting range	0x32 to 0x8C （50 to 140）		
		Unit	%		

0x2034: Low Pass Filter OFF Velocity for Position loop / Velocity loop command.

Index Ax1 0x2034 Ax2 0x2234 Ax3 0x2434 Ax4 0x2634	Set the Low Pass Filter OFF Velocity.	Object Code	Array

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Number of entry	Unsigned8	RO	No	0x02
0x01	Switch ON / OFF of the object. This object become active by setting 1 to Sub-Idx :0x01.	Unsigned8	RW	Possible	0x00
		Setting range	0x00-0x01		
0x02	Low Pass Filter OFF Velocity Disable low pass filter at less than this velocity. Setting range is from 0 to 50 rpm.	Unsigned16	RW	Possible	0x0000
		Setting range	0x0000-0x0032		
		Unit	min^{-1}		
Disable low pass filter for Position/ Velocity command at less than the value set at Sub-Idx2. Cutting off is performed with the value in 0x2004 or 0x2009, while position/velocity command low pass filter is effective.					

0x2035: Assist-Function Parameter

Index		Description	Object Code	
Ax1 Ax2 Ax3 Ax4	0x2035 0x2235 0x2435 0x2635	The parameter which sets for use of assist function between amplifier 1 to 4.	Object Code	Record

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Number of entry	Unsigned8	RO	No	0x06
0x01	Correction Proportional Gain [KSCP] When the position-assist correction is enabled and the set value is 100%, add the same value as assist deviation value (error pulse volume) to the position command. Correction will be invalid at the set value 0%. ✔If the value is too large, a vibration may oocur.	Unsigned8	RW	No	0x0064 (100%)
		Setting Range	0x0000 to 0x03E8 (0-1000%)		
		Unit	%		
0x02	Correction Integral Time Constant [TSCI] Sets integral time constant of position-assist controller. When the set value is 1000.0ms, the proportional control (without integral compensation) is activated. ✔If the value is too small, a vibration may oocur. ✔When 2 sets of amplifiers are mutually corrected their synchronizations, set correction integral time constant at 1000ms (invalid).	Unsigned16	RW	No	0x2710 (1000ms) Propotional Control
		Setting Range	0x0005-0x2710 (0.5-1000.0ms)		
		Unit	0.1ms		
0x03	Correction Low-pass Filter [PSYNLPF] Sets time constant of the first low-pass filter which suppresses any sudden change in the correction command pulses. Filter will be invalid at the set value 0.0 ms.	Unsigned16	RW	No	0x0000(0.0 ms) Invalid Filter
		Setting Range	0x0000-0x2710 (0.0-1000.0 ms)		
		Unit	0.1 ms		
0x04	Excessive Position-assist Deviation Level [PSDEVAL] Sets acceptable error range for error pulse quntity (synchronization deviation) of 2 amplifiers. When the actual synchronization position deviation exceeds the set value, a position synchronization deviation alarm is issued. Setup Value ≦ ｜Synchronization Error Pulse Quntity｜	Unsigned32	RW	No	0x7FFFFFFF(2147483647)
		Setting Range	0x00000001-0x7FFFFFFF (1-2147483647 Pulse)		
		Unit	Pulse		
0x05	Position-assist Deviation Warning Level [PSDEVWN] Sets Warning output level before Excessive position-assist deviation alarm is issued. When the actual synchronization position deviation exceeds the set value, position synchronization deviation warning is issued. Setup Value ≦ ｜Synchronization Error Pulse Quntity｜	Unsigned32	RW	No	0x7FFFFFFF (2147483647)
		Setting Range	0x00000001-0x7FFFFFFF (1-2147483647 Pulse)		
		Unit	Pulse		
0x06	Position Deviation Polarity Slection [SDEVPOR] Selects polarity of position deviation signal which is sent to another amplifier for position-assist. ✔Regarding command polarity and motor installation angle, set position deviation polarity selection in order to have the same output deviation polarity. ✍**It will be valid with control-power-source re-input.**	Unsigned8	RW	No	0x00
		Setting Range	0x00-0x01 0:Without Position Deviation Polarity Reversal 1:With Position Deviation Polarity Reversal		
0x07	Assist-target axis address [MSTERID] Set the address of target axis if sync compensation function is used. ✍**It will be valid with control-power-source re-input.**	Unsigned16	RW	No	0x0001
		Setting Range	0x0001-0x0004		
0x08	Assist-function selection [ASSEL] 0x00: Without sync. 0x01: Mutual assisting correction mode, Master mode (Position-assist function : Position control) 0x02: Mutual assisting correction mode, Slave mode (Position-assist function : Position control) 0x03: Master amplifier mode (Position-assist function, Master : Position control) 0x04: Slave amplifier mode (Position-assist function, Slave : Position control) 0x05: Master amplifier mode (Torque-assist function : Position control, Velocity control) 0x06: Slave amplifier mode (Torque-assist function : Torque control) 0x08: Master amplifier mode (High-precision sync function : Position control, Velocity control) 0x09: Slave amplifier mode (High-precision sync function : Position control) ✔ For use of 0x08 or 0x09, set 0x2064: High-precision sync function parameter. ✍**It will be valid with control-power-source re-input.**	Unsigned8	RW	No	0x00
		Setting Range	0x00-0x06		
		Unit	–		
0x09	Torque assisting rate [TSCP] When the torque-assist function is enabled and the set value is 100%, add the same value of torque command. Torque-assist will be invalid at the set value 0%.	Unsigned16	RW	Possible	0x0064 (100%)
		Setting Range	0x0000-0x0064 (0-100%)		
		Unit	%		

0x2036: Position Differential Gain

Index Ax1 0x2036 Ax2 0x2236 Ax3 0x2436 Ax4 0x2636	Sets the differential time constant of the position controller.	Object Code	Variable

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Number of entry	Unsigned8	RO	No	0x02
0x01	Position Controller Differential Time Constant The position control characteristic is improved by multiplying the difference of the position differential by the gain equivalent to the derivation time constant. This function will be disabled during auto-tuning.	Unsigned16	RW	Possible	0x0000 （0）
		Setting Range	0x0000 to 0x2710 （0.0 to 1000.0）		
		Unit	0.1ms		
0x02	Position Controller Derivative Compensation LPF LPF to be applied to the command value after setting the position differential time constant. Improves the position differential command value. This function will be disabled during auto-tuning.	Unsigned16	RW	Possible	0x0FA0 （4000）
		Setting Range	0x0001 to 0x0FA0 (1 to 4000)		
		Unit	Hz		

0x2037: Position Integral Time Constant Limit

Index Ax1 0x2037 Ax2 0x2237 Ax3 0x2437 Ax4 0x2637	Sets the velocity to limit the integral output of the position controller.	Object Code	Variable

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Output limit of the position controller Disables the integral time constant of the position controller. When the motor velocity exceeds the setting value, it disables the position integral time constant. This function will be disabled during auto-tuning.	Unsigned32	RW	Possible	0x3FFFFFFF （1073741823）
		Setting range	0x00000000 to 0x7FFFFFFF (0 to 2147483647)		
		Unit	pulse		

0x2038: Velocity Control Bypass Setting

Index Ax1 0x2038 Ax2 0x2238 Ax3 0x2438 Ax4 0x2638	Bypasses the velocity controller during position control.	Object Code	Variable

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Bypass of Velocity Controller Transmits the command from the position controller to the torque (force) control without the velocity controller.	Unsigned8	RW	Possible	0x00
		Setting range	0x00-0x01		
	The setting value 0 disables the function. The setting value 1 enables the function.				

0x2039: Velocity Integral Time Constant Limit

Index Ax1 0x2039 Ax2 0x2239 Ax3 0x2439 Ax4 0x2639	Sets the torque (force) to limit the integral output of the velocity controller.	Object Code	Variable

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Output limit of the velocity controller Disables the integral time constant of the velocity controller. When the motor torque (force) exceeds the setting value or more, it disables the position integral time constant. This function will be disabled during auto-tuning.	Unsigned16	RW	Possible	0xFFFF （65535）
		Setting range	0x0000 to 0xFFFF （0 to 65535）		
		Unit	min-1		

0x203A: Torque (force) Integral Gain

Index Ax1 0x203A Ax2 0x223A Ax3 0x243A Ax4 0x263A	Sets the integral gain of the torque (force) controller.	Object Code	Variable

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Torque (force) Control Integral Gain Sets the integral gain of the torque (force) control by using the ratio. Against the integral gain output by each motors is 100%, it can be adjusted within the range of 50% - 200%. This function will be disabled during auto-tuning.	Unsigned8	RW	Possible	0x64
		Setting range	0x32 to 0xC8 （50 to 200）		
		Unit	%		

0x203B: Torque (force) Integral Gain limit

<table>
<tr><td>Index Ax1 0x203B
Ax2 0x223B
Ax3 0x243B
Ax4 0x263B</td><td>Sets the limit value of the integral gain of the torque (force) controller.</td><td>Object Code</td><td>Variable</td></tr>
</table>

<table>
<tr><th>Sub-Idx</th><th>Description</th><th>Data Type</th><th>Access</th><th>PDO</th><th>Initial value</th></tr>
<tr><td rowspan="3">0x00</td><td rowspan="3">Torque (force) Control Integral Gain Limit
Limits the setting of gain within the range of 50% - 200% against the value of the object 0x203A.
Cuts the large value of the setting by the limit value.</td><td>Unsigned8</td><td>RW</td><td>Possible</td><td>0xC8
（200）</td></tr>
<tr><td>Setting range</td><td colspan="3">0x32 to 0xC8
（50 to 200）</td></tr>
<tr><td>Unit</td><td colspan="3">%</td></tr>
</table>

0x203C: Software limit Deceleration

<table>
<tr><td>Index Ax1 0x203C
Ax2 0x223C
Ax3 0x243C
Ax4 0x263C</td><td>Sets the deceleration in the case that it reaches the software limit switch in CSP, IP mode.</td><td>Object Code</td><td>Variable</td></tr>
</table>

<table>
<tr><th>Sub-Idx</th><th>Description</th><th>Data Type</th><th>Access</th><th>PDO</th><th>Initial value</th></tr>
<tr><td rowspan="2">0x00</td><td rowspan="2">Software Limit Deceleration ［SLTDEC］
When it reaches the software position limit of 0x607D, the motor will perform a deceleration stop.
This parameter sets the deceleration.</td><td>Unsigned32</td><td>RW</td><td>No</td><td>0xFFFFFFFF</td></tr>
<tr><td>Setting range</td><td colspan="3">0x00000000 to 0xFFFFFFFF</td></tr>
</table>

0x203D: Amplifier temperature warning level

<table>
<tr><td>Index Ax1 0x203D
Ax2 0x223D
Ax3 0x243D
Ax4 0x263D</td><td>Sets the warning output level which is issuing before the amplifier temperature error.</td></tr>
</table>

<table>
<tr><th>Sub-Idx</th><th>Description</th><th>Data Type</th><th>Access</th><th>PDO</th><th>Initial value</th></tr>
<tr><td rowspan="4">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>

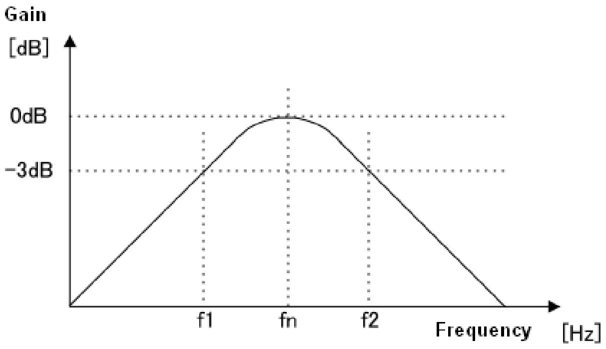
0x2040 Command Filter Setting

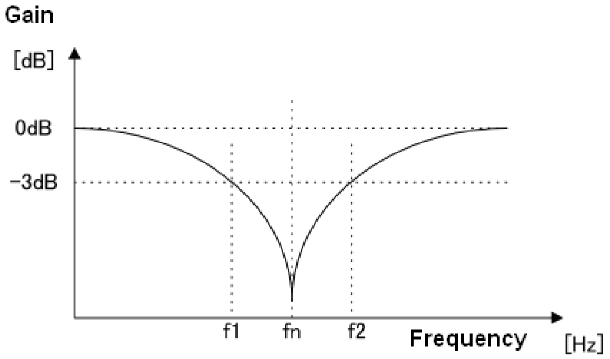
Index				
Ax1 Ax2 Ax3 Ax4	0x2040 0x2240 0x2440 0x2640	Sets Velocity Command Filter and Torque（force）Command Filter1 to 4 functions.	Object Code	Variable

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Number of entry	Unsigned8	RO	No	0x02
0x01	Sets Velocity Command Filter Sets Velocity Command Filter object 0x2041 valid or invalid. When valid filter work by 0x2041setting.	Unsigned8	RW	Possible	0x00
		Setting range	0x00 to 0x01		
	0：Velocity Command Filter disabled 1：Velocity Command Filter enabled				
0x02	Torque（force）Command Filter Sets Torque（force）Command Filter object 0x2042 to 0x2045 valid or invalid. When valid filter work by 0x2041 to 0x2045setting.	Unsigned8	RW	Possible	0x01
		Setting range	0x00 to 0x01		
	0：Torque（force）Command Filter1 to 4 disabled 1：Torque（force）Command Filter1 to 4 enabled				

0x2041： Velocity Command Filter Setting, 0x2042-0x2045： Torque（force）Command Filter1 – 4 Setting

Index				
Ax1 Ax2 Ax3 Ax4	0x2040-0x2045 0x2240-0x2245 0x2440-0x2445 0x2640-0x2645	Sets Velocity Command Filter［VCNFIL］, Torque（force）Command Filter.	Object Code	Array

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Number of entry	Unsigned8	RO	No	0x10
0x01	Filter ON/OFF Sets filter ON or OFF. The initial value of 0x2045 is effective.	Integer8	RW	Possible	0x00（0x01）
		Setting range	0x00-0x01		
0x02	FilterType Sets type of filter The initial value of 0x2045 is 0x01:Low Pass Filter.	Integer8	RW	Possible	0x04（0x01）
		Setting range	0x01-0x05		
	0x01:Low Pass Filter 0x02:High Pass Filter 0x03:Band Pass Filter 0x04:Notch Filter 0x05:Bi-quad Filter 0x06-0xFF:Reserved				
0x03	Low Pass Filter cutoff frequency When filter type（Sub-Idx2）stes Low Pass Filter（0x01）, Low Pass Filter work by this cutoff frequency. ✔When sets over 2000Hz（0x07D0）then setting become disable.	Unsigned16	RW	Possible	0x0258 （600Hz）
		Setting range	0x000A-0x07D0 （10-2000Hz）		
0x04	High Pass Filter cutoff frequency When filter type（Sub-Idx2）sets High Pass Filter（0x02）, High Pass Filter work by this cutoff frequency. ✔When sets over 2000Hz（0x07D0）then setting become disable.	Unsigned16	RW	Possible	0x07D0 （invalid）
		Setting range	0x000A-0x07D0 （10-2000Hz）		
0x05	Center frequency of Band Pass Filter When filter type（Sub-Idx2）sets Band Pass Filter（0x03）, Band Pass Filter work by this center frequency. When sets over 2000Hz（0x07D0）then setting become disable.	Unsigned16	RW	Possible	0x07D0 （2000Hz）
		Setting range	0x000A-0x07D0 （10-2000Hz）		
0x06	Band width of Band Pass Filter When filter type（Sub-Idx2）sets Band Pass Filter（0x03）, Band Pass Filter work by this band width. Setting value small become band width narrow. 	Unsigned16	RW	Possible	0x0005
		Setting Range	0x0001 to 0x01F4 （0.1-50）		
		Setting Value	f1		f2
		0.1	fn × 0.91		fn × 1.10
		0.2	fn × 0.82		fn × 1.22
		0.3	fn × 0.75		fn × 1.34
		0.4	fn × 0.68		fn × 1.47
		0.5	fn × 0.62		fn × 1.61
		0.6	fn × 0.57		fn × 1.75
		0.7	fn × 0.52		fn × 1.91
		0.8	fn × 0.48		fn × 2.07
		0.9	fn × 0.45		fn × 2.23
		1.0	fn × 0.42		fn × 2.39
		Example of setting value vs band width. Magnification from center frequency(fn)			

0x07	Center frequency of Notch Filter When filter type（Sub-Idx2）sets Notch Filter（0x04）, Notch Filter work by this center frequency.. ✔When sets over 2000Hz(0x07D0), then setting become invalid.	Unsigned16	RW	Possible	0x07D0 （2000Hz）
		Setting range	0x000A-0x07D0 （10-2000Hz）		
0x08	Band width of Notch Filter When filter type（Sub-Idx2）sets Notch Filter（0x04）, Notch Filter work by this Band width. Setting value small become band width narrow. 	Unsigned16	RW	Possible	0x0010
		Setting range	0x0001-0x01F4（0.1-50） 0.1 / LSB		
		Setting value	f1	f2	
		0.1	fn × 0.95	fn × 1.05	
		0.2	fn × 0.90	fn × 1.11	
		0.4	fn × 0.82	fn × 1.22	
		0.6	fn × 0.74	fn × 1.35	
		0.8	fn × 0.67	fn × 1.49	
		1.0	fn × 0.62	fn × 1.63	
		1.2	fn × 0.57	fn × 1.77	
		1.4	fn × 0.52	fn × 1.94	
		1.6	fn × 0.48	fn × 2.08	
		1.8	fn × 0.44	fn × 2.25	
		2.0	fn × 0.41	fn × 2.42	
		5.0	fn ×0.19	fn × 5.18	
		10.0	fn × 0.098	fn × 9.66	
		20.0	fn × 0.050	fn × 17.1	
		30.0	fn × 0.033	fn × 22.2	
		40.0	fn × 0.025	fn × 25.6	
		50.0	fn × 0.020	fn × 28.1	
		Example of setting value vs band width. Magnification from center frequency(fn)			
0x09	Bi-quad Filter a1 When filter type（Sub-Idx2）sets Bi-quad Filter（0x05）, Bi-quad Filter work by this a1.	Float32	RW	Possible	0.0
		Setting range	-3.402823e38 to 3.402823e38		
0x0A	Bi-quad Filter a2 When filter type（Sub-Idx2）sets Bi-quad Filter（0x05）, Bi-quad Filter work by this a2.	Float32	RW	Possible	0.187561
		Setting range	-3.402823e38 to 3.402823e38		
0x0B	Bi-quad Filter b0 When filter type（Sub-Idx2）sets Bi-quad Filter（0x05）, Bi-quad Filter work by this b0.	Float32	RW	Possible	0.296890
		Setting range	-3.402823e38 to 3.402823e38		
0x0C	Bi-quad Filter b1 When filter type（Sub-Idx2）sets Bi-quad Filter（0x05）, Bi-quad Filter work by this b1.	Float32	RW	Possible	0.593780
		Setting range	-3.402823e38 to 3.402823e38		
0x0D	Bi-quad Filter b2 When filter type（Sub-Idx2）sets Bi-quad Filter（0x05）, Bi-quad Filter work by this b2.	Float32	RW	Possible	0.296890
		Setting range	-3.402823e38 to 3.402823e38		

0x2050 Stick Motion compensation

Index Ax1 0x2050 Ax2 0x2250 Ax3 0x2450 Ax4 0x2650	Setting of Stick Motion compensation	Object Code	Variable

Sub-Idx	Description	Data Type	Access	PDO	Initial Value
0x00	Number of entry	Unsigned8	RO	No	0x04
0x01	Set the validity of Stick Motion compensation [STC]	Unsigned8	RW	Possible	0x00
		Setting range	0x00-0x27		
	◆ Setting validity condition of Stick Motion compensation Stick Motion compensation is enable when STC is enable. ◆ Setting range of Stick Motion compensation will follow 0x00 to 0x27.				
0x02	Valid speed of Stick Motion compensation [STV]	Unsigned16	RW	Possible	10.0
		Setting range	0.1-128.0		
		Unit	min^{-1}		
	◆Stick Motion compensation will work when setting value is less than internal velocity command.				
0x03	Valid time of Stick Motion compensation [STHLD]	Unsigned16	RW	Possible	20
		Setting range	1-500		
		Unit	ms		
	◆Stick Motion compensation will work until this setting time, even if internal velocity command is over speed. ◆If velocity loop response is low , set the this time longer.				
0x04	Set the integral constant of Stick Motion compensation [STTVI]	Unsigned16	RW	Possible	0.3
		Setting range	0.3-1000.0		
		Unit	ms		
	◆Vaild velocity loop integral constant when Stick Motion compensation is activating. ◆Velocity loop integral constant of Stick Motion compensation should set lower than normal setting. If set higher than normal value, efficiency will low. ◆Stick Motion compensation will disable when velocity loop is proportional control.				

0x2051: Micro Vibration Suppression

Index Ax1 0x2051 Ax2 0x2251 Ax3 0x2451 Ax4 0x2651	Suppress mechanical micro vibration by moving encoder pulse when motor stop.	Object Code	Variable

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Set the validity of Micro Vibration Suppression ［FBHYST］	Unsigned8	RW	No	0x00
		Setting range	0x00-0x27		
	◆ Suppress mechanical micro vibration when motor stop and encoder pulse moving ±1pulse ◆ Micro Vibration Suppression will valid when FBHYST is valid. ◆ Setting range of Micro Vibration Suppression will follow 0x00 to 0x27.				

0x2060: Control Word 2

Index Ax1 0x2060 Ax2 0x2260 Ax3 0x2460 Ax4 0x2660	Manufacturer-specific object for the servo amplifier control.	Object Code	Variable

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Control Word 2 ［CWORD2］ Enables various functions. 0:disabled 1:enabled	Unsigned16	RW	Possible	–

MSB LSB

cere	–	HPEN	mssel	sladj	mscmp	ntl	ptl
7	6	5	4	3	2	1	0

bit5:High-precision Sync Function [HPEN]
It is enabled at "1".

0x2064： High-precision sync function parameter

Index Ax1 Ax2 Ax3 Ax4	0x2064 0x2264 0x2464 0x2664	The parameters to be set for use of High-precision sync function parameter.	Object Code	Record

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Number of entry	Unsigned8	RO	No	0x0C
0x01	High-precision sync position compensation proportional gain [PKHASPGN] Sets the proportional gain of high-precision sync position compensation.	Unsigned16	RW	No	0x0000
		Setting range	0x0000 to 0x0BB8 (0 to 3000)		
		Unit	1/s		
0x02-04	RESERVED	—	—	—	—
		Setting range	—		
		Unit	—		
0x05	LPF of acceleration FB velocity variation limit [VDAFBFIL] Low-pass filter eliminating high-frequency component included to acceleration feedback. Sets the cutoff frequency.	Unsigned16	RW	No	0x0000
		Setting range	0x0000 to 0x07D0 (0 to 2000Hz)		
		Unit	1Hz		
0x06	High-precision sync compensation input polarity selection [HASCDIR] Selects polarity against master axis. 0x00: Without reversal 0x01: With reversal	Unsigned8	RW	No	0x00 (Without reversal)
		Setting range	0x00 to 0x01		
		Unit	—		
0x07	High-precision sync position error warning level [PHASDEVW] Warning is issued when position error between self axis and target axis exceeds this set value. Use as warning before issuing high-precision sync excessive position error alarm.	Unsigned32	RW	No	0x7FFFFFFF (2147483647Pulse)
		Setting range	0x00000001 to 0x7FFFFFFF （1 to 2147483647Pulse）		
		Unit	Pulse		
0x08	High-precision sync excessive position error value [PHASDEVA] High-precision sync excessive position error alarm is issued when positionerror between self axis and target axis exceeds this set value.	Unsigned32	RW	No	0x004C4B40 (5000000Pulse)
		Setting range	0x00000001 to 0x7FFFFFFF （1 to 2147483647Pulse）		
		Unit	Pulse		
0x09	High-precision sync velocity error warning level [VHASDEVW] Warning is issued when velocity error between self axis and target axis exceeds this set value. Use as warning before issuing high-precision sync excessive velocity error alarm.	Unsigned16	RW	No	0xFFFF （6553.5min^{-1}）
		Setting range	0x0001 to 0xFFFF (1 to 6553.5min^{-1})		
		Unit	0.1min^{-1}		
0x0A	High-precision sync excessive velocity error value [VHASDEVA] High-precision sync excessive velocity error alarm is issued when velocity error between self axis and target axis exceeds this set value.	Unsigned16	RW	No	0x2710 (1000.0min^{-1})
		Setting range	0x0001 to 0xFFFF (1 to 6553.5min^{-1})		
		Unit	0.1min^{-1}		
0x0B	High-precision sync acceleration error warning level [AHASDEVW] Warning is issued when acceleration error between self axis and target axis exceeds this set value. Use as warning before issuing high-precision sync excessive acceleration error alarm.	Unsigned32	RW	No	0x80000000 (134217728)
		Setting range	0x00000001 to 0x80000000 (0.0625 to 134217728rad/s^2)		
		Unit	0.0625rad/s^2		
0x0C	High-precision sync excessive acceleration error value [AHASDEVA] High-precision sync excessive acceleration error alarm is issued when acceleration error between self axis and target axis exceeds this set value.	Unsigned32	RW	No	0x00000540 (84)
		Setting range	0x00000001 to 0x80000000 (0.0625 to 134217728rad/s^2)		
		Unit	0.0625rad/s^2		

0x0D	High-precision sync compensation gain 1 [HASCG1] Sets gain of high-precision sync compensation. Synchronization error will be reduced with higher setting value. But oscillation occurs by too much higher setting value.	Unsigned16	RW	No	0x0000
		Setting range	0x0000 to 0xFFFF(0 to 65535)		
		Unit	-		
0x0E	High-precision sync velocity compensation integral time constant [VTHASIGN] Synchronization error will be reduced with lower setting value. But oscillation occurs by too much lower setting value. (from 0x2710 to0x000A	Unsigned16	RW	No	0x2710
		Setting range	0x0000 to 0xFFFF(0 to 65535)		
		Unit	-		
0x0F	High-precision sync excessive position error value (at automatic recovery) [PHASDEVAA] After automatic recovery, high-precision sync excessive position error alarm is issued when position error between self axis and target axis exceeds this set value.	Unsigned32	RW	No	0x004C4B40 (5000000Pulse)
		Setting range	0x00000001 to 0x7FFFFFFF (1 to 2147483647Pulse)		
		Unit	Pulse		
0x10	High-precision sync excessive velocity error value (at automatic recovery) [VHASDEVAA] After automatic recovery, high-precision sync excessive velocity error alarm is issued when velocity error between self axis and target axis exceeds this set value.	Unsigned16	RW	No	0x2710 (1000.0min^{-1})
		Setting range	0x0001 to 0xFFFF (1 to 6553.5min^{-1})		
		Unit	0.1min^{-1}		
0x11	High-precision sync excessive acceleration error value (at automatic recovery) [AHASDEVAA] After automatic recovery, high-precision sync excessive acceleration error alarm is issued when acceleration error between self axis and target axis exceeds this set value.	Unsigned32	RW	No	0x00000540 (84)
		Setting range	0x00000001 to 0x80000000 (0.0625 to 134217728rad/s^2)		
		Unit	0.0625rad/s^2		

0x2065： Torque Feed Forward Gain

Index	0x2065 0x2265 0x2465 0x2665	Sets gain of Torque Feed Forward.	Object Code	Record	
Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Torque Feed Forward Gain [TFFK] Sets a rate of Torque Feed Forward which improves a command responsiveness of velocity loop.	Unsigned16	RW	No	0x0000 (0%)
		Setting range	0x0000 to 0x0064 (0 to 100%)		
		Unit	%		

0x5080: Correction Table Control

Index Ax1 0x5080 Ax2 0x5280 Ax3 0x5480 Ax4 0x5680	Enables/disables the correction table function.	Object Code	Variable

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Correction Table Control ［COTBLEN］	Unsigned8	RW	No	0x00
	Enables/disables the correction table function.	Setting range	0x00-0x01		
	0x00: Disabled 0x01: Enabled 0x02 - 0xFF: Reserved				

0x5081: Correction Table Interpolation Method

Index Ax1 0x5081 Ax2 0x5281 Ax3 0x5481 Ax4 0x5681	Sets the interpolation method of the correction table.	Object Code	Variable

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Correction Table Interpolation Method ［COTBLINTP］	Unsigned8	RW	No	0x00
	Sets the interpolation method of the correction table.	Setting range	0x00-0x02		
	0x00: Linear 0x01: Polynomial 0x02: Spline 0x03 - 0xFF: Reserved				

0x5082: Correction Table Extrapolation Method

Index Ax1 0x5082 Ax2 0x5282 Ax3 0x5482 Ax4 0x5682	Sets the extrapolation method of the correction table.	Object Code	Variable

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Correction Table Extrapolation Method ［COTBLEXTP］	Unsigned8	RW	No	0x00
	Sets the extrapolation method of the correction table. 0x00: Linear 0x01: Polynomial 0x02: Spline 0x03 - 0xFF: Reserved	Setting range	0x00-0x02		

0x5083: Correction Table Position

Index Ax1 0x5083 Ax2 0x5283 Ax3 0x5483 Ax4 0x5683	Correction Table Position	Object Code	Record

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Number of entry	Unsigned8	RW	No	0x00
	✔This becomes valid by re-closing the control source.	Setting range	0x00-0x40		
0x01	Entry 1 Correction Position 1	Unsigned32	RW	No	0x00000000
		Setting range	0x00000000-0xFFFFFFFF		
		Unit	Pulse		
	✔ If correction posotion over the coordinate axes（-1⇔0），0x5083 correction position 1 and 0x5084 No1 offset value need to set 0. Caution, if not 0, the machine may oscillate at the correction posotion over the coordinate axes. ✔This becomes valid by re-closing the control source.				
0x02 to n	Entry 2 to n Correction Position 2 to n -	Unsigned32	RW	No	0x00000000
		Setting range	0x00000000-0xFFFFFFFF		
		Unit	Pulse		
	✔"n" is up to 0x40 in maximum. ✔Please set so as to ensure that the correction position n-1 < the correction position n. (n=2-64) If not correction position n-1< correction position n at the power on and initial state then it indicates warning of 0x2013,Bit9. Correction position need to correction and then re-turn on control power. ✔ If correction posotion over the coordinate axes（0x7FFFFFFF⇔0x80000000），0x5083 correction position n=0x7FFFFFFF and 0x5084 Number n offset value need to set 0. Caution, if not 0, the machine may oscillate at the correction posotion over the coordinate axes. ✔This becomes valid by re-closing the control source.				
✔ When the symbol of the actual position (0x6064) is negative, it refers to the table after translating the actual position to the absolute value. After reversing the plus and minus signs of the offset retrieved from the table, use for control.					

0x5084: Correction Table Offset

Index Ax1 0x5084 Ax2 0x5284 Ax3 0x5484 Ax4 0x5684	Correction Table Offset	Object Code	Record

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Number of entry ✔This becomes valid by re-closing the control source.	Unsigned8	RW	No	0x00
		Setting range	0x00 to 0x40		
0x01	Entry 1 Offset 1	Integer32	RW	No	0x00000000
		Setting range	0x80000000-0x7FFFFFFF		
		Unit	Pulse		
	✔ If correction posotion over the coordinate axes（-1⇔0）, 0x5083 correction position 1 and 0x5084 No1 offset value need to set 0. Caution, if not 0, the machine may oscillate at the correction posotion over the coordinate axes.				
0x02 to n	Entry 2 - Entry n Offset 2 - Offset n	Integer32	RW	No	0x00000000
		Setting range	0x80000000-0x7FFFFFFF		
		Unit	Pulse		
	✔"n" is up to 0x40 in maximum. ✔ If correction posotion over the coordinate axes（0x7FFFFFFF⇔0x80000000）, 0x5083 correction position n=0x7FFFFFFF and 0x5084 Number n offset value need to set 0. Caution, if not 0, the machine may oscillate at the correction posotion over the coordinate axes.				

0x5090: Backlash correction function selection

Index Ax1 0x5090 Ax2 0x5290 Ax3 0x5490 Ax4 0x5690	Set the Backlash correction function on / off.	Object Code	Variable

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Backlash correction function ［BLCEN］ Set the Backlash correction function on / off. 0x00: Disabled 0x01: Enabled 0x02 - 0xFF: Reserved	Unsigned8	RW	No	0x00
		Setting range	0x00-0x01		

0x5091: Backlash correction value

Index Ax1 0x5091 Ax2 0x5291 Ax3 0x5491 Ax4 0x5691	Set the backlash correction value.	Object Code	Variable

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Backlash correction value. ［BLCVAL］ Set the Backlash correction value.	Unsigned32	RW	No	0x00000000
		Setting range	0x00000000-0x7FFFFFFF （0 - 2147483647）		
		Unit	Pulse		
	◆0 is set to bit 6 of Control Word. (Target position is treated as absolute value.) Backlash correction value is incremented from target position when position command had increased target position. Backlash correction value is not incremented from target position when position command had decreased target position. ◆1 is set to bit 6 of Control Word. (Target position is treated as relative value.) Backlash correction value is decremented from target position when target position polarity had changed from positive to negative. Backlash correction value is incremented from target position when target position polarity had changed from negative to positive.				

0x5092: Correction direction of Backlash

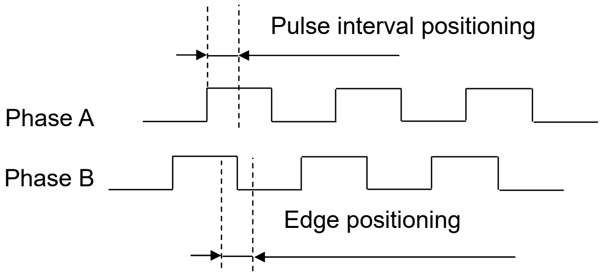
Index Ax1 0x5092 Ax2 0x5292 Ax3 0x5492 Ax4 0x5692	Sets the correction direction of Backlash	Object Code	Variable

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Correction direction of Backlash ［BLCDIR］ Sets the command direction of Backlash correction. 0x00: Positive direction 0x01: Negative direction 0x02-0xFF: Reserved	Unsigned8	RW	No	0x00
		Setting range	0x00-0x01		

10) System Parameter

0x20F0: Amplifier Function Selection

Index Ax1 0x20F0 Ax2 0x22F0 Ax3 0x24F0 Ax4 0x26F0	Set the Sequence function.	Object Code	Record

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Number of entry	Unsigned8	RO	No	0x06
0x01	Limit behavior Selection [ACTOT] Selects the operation when the positive direction limit switch (normal rotation over travel) or the negative direction limit switch (reverse rotation over travel) is on.	Unsigned8	RW	No	0x06
		Setting range	0x00-0x06		
	* Profile Position (PP), Profile Velocity (PV), Cycle synchronous position (CSP), Interpolated position（ip）, 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 0x07-0xFF:Reserved * Profile torque (force) (TQ), Cycle synchronous torque (force) (CST) 0x00 - 0x02, 0x06: 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) 0x07-0xFF:Reserved *1 The Sequence Operational Torque(force) limit value(0x201E) is valid with power running direction. *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 0x02-0xFF: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. 				

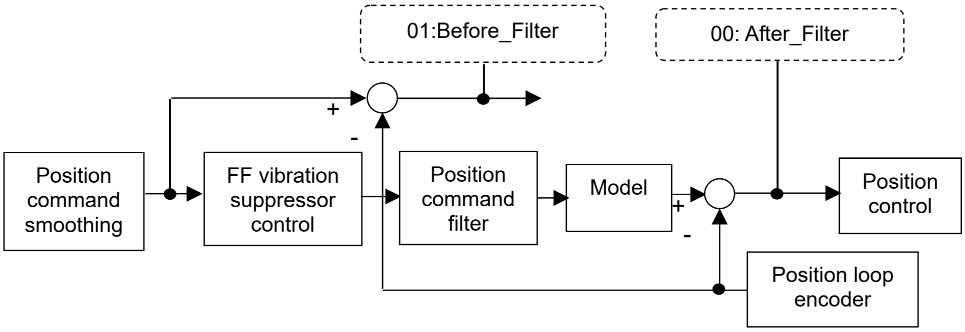
Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x03	In-Position Signal/ Position Deviation Monitor [PDEVMON] Select in-position signal (INP) and Position deviation monitor output before and after passing through the Position Command Filter.	Unsigned8 Setting range: 0x00-0x01	RW	No	0x00

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 Setting range: 0x00-0x01	RW	No	0x00

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 Setting range: 0x00-0x03	RW	No	0x00

* 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.

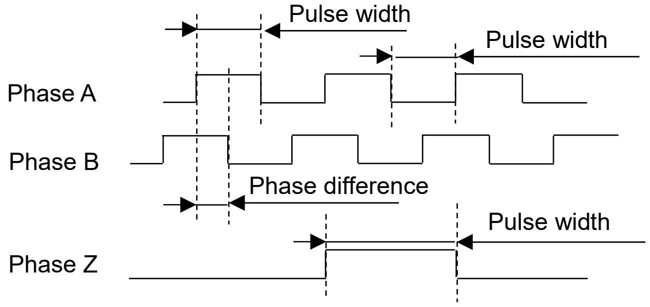
Selection		Contents	
0x00	Type1	When Servo OFF -> Clear Deviation Deviation Clear Input =Level Detection	During servo OFF, Deviation clear is always executed. While Deviation clear input is ON, Deviation clear is always executed.
0x01	Type2	When Servo OFF -> Clear Deviation Deviation Clear Input =Edge 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 Setting range: 0x00 - 0x01	RW	No	0x00

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: Encoder Function Selection

Index Ax1 0x20F1 Ax2 0x22F1 Ax3 0x24F1 Ax4 0x26F1	Sets the Encoder Function.		Object Code		Record
Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Number of entry	Unsigned8	RO	No	0x09
0x01	Serial encoder Clear Function Selection [ECLRFUNC] Selects the encoder clear method.	Unsigned8	RW	No	0x00
		Setting range	0x00-0x01		
	* Use to clear Serial encoder warning when the warning is not automatically restored. * 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. 0x00: Clear Encoder Status (Alarm and Warning) and Multi Turn Data 0x01: Clear Only Encoder Status (Alarm and Warning) * 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] Thie parameter can be set only when using pulse encoder. This sets digital filter of motor pulse encoder.	Unsigned8	RW	No	0x01
		Setting range	0x00-0x07		
	* It is possible to set the value of incremental pulse digital filter for using incremental encoder. 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. 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 Pulse encoder. 				
0x03	Reserved [ENPOL]	Unsigned8			
		Setting range			
0x04	Reserved [ENPOL]	Unsigned8			
		Setting range			

0x05 [Linear]	CS offset ［CSOF］ Sets electrical degree of the motor. For rotary motor use Must set it 0 degree. For linear motor and Direct Drive Motor use In case with hall effect sensor, sets an offset value with electrical angle conversion between 0 degree of U phase electrical angle and hall sensor output signal edge of U phase. ✔ 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.	Unsigned16	RW	No	0x0000 （0deg）
		Setting range	0x0000 - 0x0167 （0 - 359deg）		
0x06 [Linear]	CS normalization offset of phase Z ［ZPHOF］ Sets offset of phase Z signal to electrical degree of the motor. For rotary motor use Must set it 0 degree. For linear motor and Direct Drive Motor use This function is valid when performing CS normalization with use of phase Z signal. Sets an offset value with electrical angle conversion between 0 degree of U phase electrical angle and Z phase signal output position. ✍ This function becomes effective after re-turning the control power supply on.	Unsigned16	RW	No	0x0000 （0deg）
		Setting range	0x0000 - 0x0167 （0 - 359deg）		
0x07 [Linear]	Polarity selection on linear encoder ［ENCDIR］ Select linear encoder signal polarity EN1. You can select phase A and B signal polarity. Phase U and V signal polarity shall not be changed in case of omitted wiring incremental encoder.) ✍ This function becomes effective after re-turning the control power supply on.	Unsigned8	RW	No	0x00
		Setting range	0x00 - 0x01		
0x08 [Linear]	Magnetic pole position estimation frequency ［EMPFREQ］ Sets frequency for torque (force) command that is applied to estimate magnetic pole position. ✔Change excitation frequency if amplifier hardware magnetic pole position estiation cannot be normally completed due to resonance of equipment. ✍This function becomes effective after re-turning the control power supply on.	Unsigned16	RW	No	0x0032 （50Hz）
		Setting range	0x05 - 0x0064 （5 - 100Hz）		
0x09 [Linear]	Magnetic pole position estimation selection ［CSETMD］ Select the Magnetic pole position estimationmode. ✔This object is valid when 0x0850 is set to 0x20FF_0x02. 0x00: Follow the setting of 0x20F8. 6. 0x01: Magnetic pole position estimation will run at once only after turn on main power. ✍Change is valid after control power-cycle.	Unsigned8	RW	No	0x00
		Setting range	0x00 to 0x01		

0x20F2: Amplifier Alarm Detect Selection

Index Ax1	0x20F2	Sets the Sequence function.	Object Code	Record
Ax2	0x22F2			
Ax3	0x24F2			
Ax4	0x26F2			

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Number of entry	Unsigned8	RO	No	0x05
0x01	Main Circuit Under-voltage (ALM_62) Detection [MPESEL]	Unsigned8	RW	No	0x01
		Setting range	0x00-0x01		
	When DC input power specification is selected, select whether the Main Circuit Under-voltage alarm should be detected or not. 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] Select valid / invalid from the velocity control trouble detection.	Unsigned8	RW	No	0x00
		Setting range	0x00-0x01		
	Trouble can be detected in operation patterns where the motor results in overshooting in response to commands; in these systems, please set as “invalid.” 0x00: invalid 0x01: valid				
0x03	Velocity Feedback Alarm (ALM_C3) Detection [FBKEEN] 0x00:invalid 0x01:valid	Unsigned8	RW	No	0x01
		Setting range	0x00-0x01		
	Select valid / invalid for the velocity feedback trouble detection.				
0x04	Communication Frame Error (ALM_10-15) Detection [CRCSET] 0x00-0x02:invalid 0x03: valid (error detected three times in row)	Unsigned8	RW	No	0x00
		Setting range	0x00-0x08		
	0x04: valid (error detected four times in row) ... 0x08: valid (error detected eight times in row) 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] 0x00, 0x01: invalid	Unsigned8	RW	No	0x00
		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 Ax1	0x20F3	Selects Position control Compensation and encoder to use to control the position loop in PP, CSP, IP modes.	Object Code	Record
Ax2	0x22F3			
Ax3	0x24F3			
Ax4	0x26F3			

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Number of entry	Unsigned8	RO	No	0x02
0x01	Position Control Selection [PCNTSEL]	Unsigned8	RW	No	0x00
		Setting range	0x00-0x02		
	Selects the model following control form and presence/absence. 0x00: Normal Control (Model Following Position Control detached) 0x01: Model Following Position Control (rigid body model) 0x02: Model Following Position Control (base vibration model) 0x03 - 0xFF: Reserved *The setting value is switched by re-closing. *The function becomes valid through control source re-closing.				
0x02	Position Loop Control, Encoder Selection [PLMODE] Selects the encoder that the servo amplifier uses for Position Loop Control.	Unsigned8	RW	No	0x00
		Setting range	0x00-0x01		
	0x00: Semi-closed Control (motor encoder used) 0x01: Full-closed Control (external encoder used) *The function becomes valid through control source re-closing.				

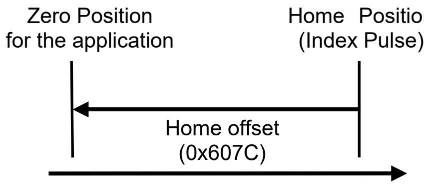
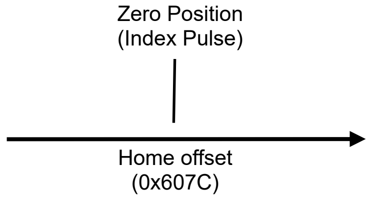
0x20F4: Servo Loop Delay Time

Index				Object Code	Variable
Ax1 0x20F4 Ax2 0x22F4 Ax3 0x24F4 Ax4 0x26F4	In SM2 SYNC, set the delay time from IRQ interruption to the beginning of the computation of the servo amplifier control loop.				
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				Object Code	Variable
Ax1 0x20F5 Ax2 0x22F5 Ax3 0x24F5 Ax4 0x26F5	When a power supply shortage is detected, select whether the normal limit value or the sequence operation torque (force) limit of the motor output current is used. Provided as a SEMI F47support function.				
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."				

0x20F6: Manufacturer Homing Parameter

Index				Object Code	Record
Ax1 0x20F6 Ax2 0x22F6 Ax3 0x24F6 Ax4 0x26F6	In the homing mode (hm), set the parameter that maker decided.				
Sub-Idx	**Description**	**Data Type**	**Access**	**PDO**	**Initial value**
0x00	Number of entry	Unsigned8	RO	No	0x03
0x01	Actual position calculation method ［HMPSEL］	Unsigned8	RW	No	0x00
	At homing process, define calculation of actual position (0x6064).	Setting range	0x00 to 0x01		
	0x20F6-1=0 ： Calculation method 1  Except for homing method 35,37. Zero Position = Home Position +Home offset (0x606C) 0x20F6 - 1 = 1 : Calculation method 2  Except for homing method 35,37. Zero Position = Home offset (0x606C) Homing Method 35,37 Actual Position(0x6064) = Home offset (0x606C) ✔ When homing method 35 or 37 and 0x20F6-1=0 ,calculation is calculation method 2.				
0x02	Hard stop torque (force) limit ［HSTRQ］ In the Hard stop homing (0x6098：from -4 to -1), this value is torque (force) limitation when reaching hard stop. Hard stop is detected with this value.	Unsigned16	RW	No	0x03E8 (100.0%)
		Setting range	0x0000 to 0x1388 (0 to 500.0%)		
		Unit	0.1 %		
0x03	Hard stop detection time ［HSTIM］ In the Hard stop homing (0x6098：from -4 to -1), hard stop is detected after spending this time with torque value beyond above. After hard stop detection, state will change by homing method as below.	Unsigned16	RW	No	0x000A (10ms)
		Setting range	0x000A to 0xFFFF (10 to 65535ms)		
		Unit	ms		
	Homing method (0x6098) -1, -2 --> Home position detected. (Finished homing.) -3, -4 --> Go reverse to find index position. (Continuing homing.)				

0x20F7: Special Function Selection Setting

Index Ax1 0x20F7 Ax2 0x22F7 Ax3 0x24F7 Ax4 0x26F7	Sets whether or not the special function of the servo amplifier is usable.	Object Code	Variable

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Bit0: Independent setting of SM2 synchronization and interpolated synchronization Sets whether or not the synchronized time in the interpolation mode is synchronized. The interpolation synchronized time is synchronized to SM2 synchronization at the setting value 0. The interpolation synchronized time is independently set from SM2 synchronization at the setting value 1. ✔ When using the SANMotionC, please make sure to use it under the conditions synchronizing to SM2 synchronization. Bit1: Torque low pass filter setting Sets torque command filter（0x2011）. 0: Torque command filter（0x2011） disable. 1: Torque command filter（0x2011） enable. Bit2：Reserved Bit3:Reserved Bit4: Shutdown command state selection In the FSA status transition, selects the amplifier state at the time of shutdown command inputting. Emergency stop state can set every time at the time of shutdown command inputting. 0: Not to be an emergency stop state at the time of shutdown command inputting. However, transition from Operation state, it is to be an emergency stop state. 1: To be an emergency stop state at the time of shutdown command inputting. Bit5 to 15: Reserved	Unsigned16	RW	No	0x0000
		Setting Range	0x0000-0xFFFF		

0x20F8: General Purpose Input Setting

Index	Description		
Index Ax1 0x20F8 Ax2 0x22F8 Ax3 0x24F8 Ax4 0x26F8	Select the function of General Purpose input 1, 2(CONT1, CONT2). Input time until all the function become enabled is 8ms.	Object Code	Record

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Number of entry	Unsigned8	RO	No	0x06
0x01	Positive Limit Switch Function [PLIMSW] Select the valid condition of the positive direction limit switch function.	Unsigned8	RW	No	0x00
		Setting range	0x00 to 0x11		
	00：Always_Disable Always function disabled. 01：Always_Enable Always function enabled. 02：CONT1_ON Function enabled when versatile input CONT1 is ON. 03：CONT1_OFF Function enabled when versatile input CONT1 is OFF. 04：CONT2_ON Function enabled when versatile input CONT2 is ON. 05：CONT2_OFF Function enabled when versatile input CONT2 is OFF. 06：CONT3_ON Function enabled when versatile input CONT3 is ON. 07：CONT3_OFF Function enabled when versatile input CONT3 is OFF. 08：CONT4_ON Function enabled when versatile input CONT4 is ON. 09：CONT4_OFF Function enabled when versatile input CONT4 is OFF. 0A：CONT5_ON Function enabled when versatile input CONT5 is ON. 0B：CONT5_OFF Function enabled when versatile input CONT5 is OFF. 0C：CONT6_ON Function enabled when versatile input CONT6 is ON. 0D：CONT6_OFF Function enabled when versatile input CONT6 is OFF. 0E：CONT7_ON Function enabled when versatile input CONT7 is ON. 0F：CONT7_OFF Function enabled when versatile input CONT7 is OFF. 10：CONT8_ON Function enabled when versatile input CONT8 is ON. 11：CONT8_OFF Function enabled when versatile input CONT8 is OFF.				
0x02	Negative Limit Switch Function [NLIMSW] Select the valid condition of the negative direction limit switch function	Unsigned8	RW	No	0x00
		Setting range	0x00 to 0x11		
	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 to 0x11		
	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 to 0x11		
	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 to 0x11		
	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 to 0x11		
	Sets valid condition for inputting fixed magnetic pole position estimation function on the linear motor without hall efefct sensor output. This selection functions the same way as SubIndex：01 (limit switch function in positive direction).				

0x20F9: General Purpose Output Setting

Index					
Ax1 0x20F9 Ax2 0x22F9 Ax3 0x24F9 Ax4 0x26F9	Selects General Output 1, 2(OUT1, OUT2) function		Object Code		Record
Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Number of entry	Unsigned8	RO	No	0x02
0x01	General Purpose Output 1 [OUT1] Selects the Output signal for General Purpose Output 1. For a detailed list, see the General Purpose Output Parameters list.	Unsigned8	RW	No	0x42
		Setting range	0x00-0x5F (Initial value: 42:FOUT1_ON)		
0x02	General Purpose Output 2 [OUT2] Selects the Output signal for General Purpose Output 2. For a detailed list, see the General Purpose Output Parameters list.	Unsigned8	RW	No	0x44
		Setting range	0x00-0x55 (Initial value: 44: FOUT2_ON)		

■ To control from EtherCAT communication

Physical output 0x60FE, 0x01:bit16 setting	42:FOUT1_ON	43:FOUT1_OFF
Physical output 0x60FE, 0x01:bit17 setting	44:FOUT2_ON	45:FOUT2_OFF

■ When Generic input signal status it to be Output.

General Input, CONT1 is ON	3A:CONT1_ON	3B:CONT1_OFF
General Input, CONT2 is ON	3C:CONT2_ON	3D:CONT2_OFF
General Input, CONT3 is ON	3E:CONT3_ON	3F:CONT3_OFF
General Input, CONT4 is ON	40:CONT4_ON	41:CONT4_OFF

■ When Servo amplifier Preset status is to be output.

While Servo Ready Complete	02:S-RDY_ON	03:S-RDY_OFF
	50:S-RDY2_ON	51:S-RDY2_OFF
While Power Supply ON	04:P-ON_ON	05:P-ON_OFF
While Power Supply ON Permission	06:A-RDY_ON	07:A-RDY_OFF
While Motor Excitation	08:S-ON_ON	09:S-ON_OFF
While Holding Brake Excitation Signal Output	0A:MBR-ON_ON	0B:MBR-ON_OFF
While Torque (force) Limiting	0C:TLC_ON	0D:TLC_OFF
While Velocity Limiting	0E:VLC_ON	0F:VLC_OFF
While Low Speed Status	10:LOWV_ON	11:LOWV_OFF
While Speed Attainment Status	12:VA_ON	13:VA_OFF
While Speed Matching Status	14:VCMP_ON	15:VCMP_OFF
While Speed Zero Status	16:ZV_ON	17:ZV_OFF
While Command Acceptance Permission Status	1C:CMD-ACK_ON	1D:CMD-ACK_OFF
While Gain Switching Status	1E:GC-ACK_ON	1F:GC-ACK_OFF
While Velocity Loop Proportional Control Switching Status	20:PCON-ACK_ON	21:PCON-ACK_OFF
While Control Mode Switching Status	24:MS-ACK_ON	25:MS-ACK_OFF
While in positive direction limit condition	26:F-OT_ON	27:F-OT_OFF
While in negative direction limit condition	28:R-OT_ON	29:R-OT_OFF
While Main Circuit Power Supply Charging	4A:CHARGE_ON	4B:CHARGE_OFF
While Dynamic Braking	4C:DB_OFF	4D:DB_ON
While in Alarm Status	38:ALM_ON	39:ALM_OFF

■ When Positioning signal is to be output

While In-Position Status	18:INP_ON	19:INP_OFF
While Near Range Status	1A:NEAR_ON	1B:NEAR_OFF
While In-Position with Position Command 0 Status	52:INPZ_ON	53:INPZ_OFF

*All codes not on the list are Reserved and indeterminate.

■ 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：Extend Station Alias

Index	0x20FA	Sets the rotary switch for Station of Alias to use more than 0 to 256 points rotary switch. This amplifier has single ESC. So, this is single object, also.	Object Code	Variable

Sub-Idx	Description	Data Type	Access	PDO	Initial Value
0x00	Number of entry	Unsigned8	RO	No	0x02
0x01	Extended Alias Number ［EXALIAS］	Unsigned8	RW	No	0x00
	Sets the Inherent Slave address（Station Alias Reg：0x0012，0x0013）to bit15-8	Setting range	0x00 to 0xFF		
	bit7-0 Rotary switch of amplifier front panel ,bit15-8 This setting value at initialization If 0x20FA.02＝0x00 then logical add will write to station alias Reg：0x0012,0x0013 *The function becomes valid through control source re-closing.				
0x02	Station Alias Selection ［ALIASEL］	Unsigned8	RW	No	0x00
	Sets the station alias Reg：0x0012,0x0013	Setting range	0x00 to 0x01		
	0x00：Use value of rotary switch of amplifier front panel（bit7-0）and extended alias number(bit15-8) 0x01：Use value of EEPROM address 0x04 *The function becomes valid through control source re-closing.				

0x20FD: Amplifier System Selection

Index Ax1 0x20FD Ax2 0x22FD Ax3 0x24FD Ax4 0x26FD	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. 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.	Unsigned8	RW	No	0x02
		Setting range	0x00-0x02		
0x02	Regenerative Resistor Selection [RGKIND] Selects the presence/absence of regenerative resistance and the connection forms. 0x00:regenerative resistance disconnected 0x01:built-in regenerative resistor used 0x02:external regenerative resistor used 0x03 - 0xFF:Reserved *The function becomes valid through control source re-closing.	Unsigned8	RW	No	0x02
		Setting range	0x00-0x02		
0x03	Setup Communication Baud Rate [COMBAUD] Selects the baud rate when PC communication is performed by the setup software. 0x03 : 9600bps 0x04 : 19200bps 0x05 : 38400bps 0x06 : 57600bps 0x00-0x02,0x07-0xFF:Reserved *The function becomes valid through control source re-closing.	Unsigned8	RW	No	0x05
		Setting range	0x03-0x06		
0x04	Main circuit power input voltage [MPWRVL] Selects a main circuit power input voltage. 0x00: AC200V 0x01 to 0xFF: Reserved *The function becomes valid through control source re-closing.	Unsigned8	RW	No	0x03
		Setting range	0x03-0x04		

0x20FE: Motor code

Index Ax1 0x20FE Ax2 0x22FE Ax3 0x24FE Ax4 0x26FE	Sets the code of the drive motor.		Object Code		Variable
Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Combination Motor code [MOCODE] Sets the combination motor code.	Unsigned16	RW	No	0xFFFF
		Setting range	0x0000-0xFFFF		

■ Rotary motor (200V)

Series	Motor code	Servo motor model number	Input type	Amplifier capacity	Flange size	Output	Maximum speed
R2 Series	0x01B1	R2AAB8075F	AC200V	50A	86mm sq.	750W	6,000 min^{-1}
	0x0193	R2AAB8100F	AC200V	50A	86mm sq.	1.0kW	6,000 min^{-1}
	0x019E	R2AA10100F	AC200V	50A	100mm sq.	1.0kW	6,000 min^{-1}
	0x018D	R2AA13120D	AC200V	50A	130mm sq.	1.2kW	5,000 min^{-1}
	0x018E	R2AA13120L	AC200V	50A	130mm sq.	1.2kW	3,000 min^{-1}
	0x01B6	R2AA13180H	AC200V	50A	130mm sq.	1.8kW	3,500 min^{-1}
	0x0192	R2AA13200L	AC200V	50A	130mm sq.	2.0kW	3,000 min^{-1}
	0x04E5	R2AA18350A	AC200V	50A	180mm sq.	3.5kW	1,250 min^{-1}
	0x011B	R2AA13180D	AC200V	100A	130mm sq.	1.8kW	5,000 min^{-1}
	0x0190	R2AA13200D	AC200V	100A	130mm sq.	2.0kW	5,000 min^{-1}
	0x011C	R2AA18350L	AC200V	100A	180mm sq.	3.5kW	3,000 min^{-1}
	0x04EF	R2AA18350E	AC200V	100A	180mm sq.	3.5kW	2,000 min^{-1}
	0x04FD	R2AA18350V	AC200V	100A	180mm sq.	3.5kW	3,000 min^{-1}
	0x011D	R2AA18350D	AC200V	150A	180mm sq.	3.5kW	4,000 min^{-1}
	0x011E	R2AA18450H	AC200V	150A	180mm sq.	4.5kW	3,500 min^{-1}
	0x01B8	R2AA18550R	AC200V	150A	180mm sq.	5.5kW	2,500 min^{-1}
	0x01BA	R2AA18750A	AC200V	150A	180mm sq.	6.4kW	1,300 min^{-1}
	0x0195	R2AA22500L	AC200V	150A	220mm sq.	5.0kW	4,000 min^{-1}
	0x011F	R2AA18550H	AC200V	300A	180mm sq.	5.5kW	3,000 min^{-1}
	0x01B9	R2AA18750H	AC200V	300A	180mm sq.	7.5kW	3,000 min^{-1}
	0x0120	R2AA1811KR	AC200V	300A	180mm sq.	11kW	2,500 min^{-1}
	0x0483	R2AA2211KB	AC200V	300A	220mm sq.	11kW	2,000 min^{-1}
	0x0117	R2AA2215KB	AC200V	300A	220mm sq.	15kW	2,000 min^{-1}
	0x02BD	R2AA2220KB	AC200V	600A	220mm sq.	20kW	2,000 min^{-1}
	0x52BD	R2AA2220KB	AC200V	600A	220mm sq.	20kW	3,000 min^{-1}
	0x0112	R2AA2225KB	AC200V	600A	220mm sq.	22.5kW	2,000 min^{-1}
	0x0499	R2AA2830KV	AC200V	600A	280mm sq.	30kW	2,000 min^{-1}

■ Rotary motor (200V)

Series	Motor code	Servo motor model number	Input type	Amplifier capacity	Flange size	Output	Maximum speed
R1 Series	0x0511	R1AA13300H	AC200V	100A	130mm sq.	3.0kW	3,000 min^{-1}
	0x050E	R1AA13500H	AC200V	100A	130mm sq.	5.0kW	3,000 min^{-1}
	0x050C	R1AA13600H	AC200V	150A	130mm sq.	6.0kW	3,000 min^{-1}
	0x0109	R1AA18550H	AC200V	300A	180mm sq.	5.5kW	3,000 min^{-1}
	0x010F	R1AA18750L	AC200V	300A	180mm sq.	7.5kW	3,000 min^{-1}
	0x010D	R1AA1811KR	AC200V	300A	180mm sq.	11kW	2,500 min^{-1}
	0x010E	R1AA1815KB	AC200V	300A	180mm sq.	15kW	2,000 min^{-1}
	0x010B	R1AA2220KV	AC200V	600A	220mm sq.	21kW	2,000 min^{-1}

■ Rotary motor (400V)

Series	Motor code	Servo motor model number	Input type	Amplifier capacity	Flange size	Output	Maximum speed
R2 Series	0x04EC	R2CA10075F	AC400V	25A	100mm sq.	750W	6,000 min^{-1}
	0x012D	R2CA13050D	AC400V	25A	130mm sq.	550W	5,000 min^{-1}
	0x012F	R2CA13120R	AC400V	25A	130mm sq.	1.2kW	3,000 min^{-1}
	0x0130	R2CA13180H	AC400V	25A	130mm sq.	1.8kW	3,500 min^{-1}
	0x0133	R2CA13200L	AC400V	25A	130mm sq.	2.0kW	3,000 min^{-1}
	0x04ED	R2CA10100F	AC400V	50A	100mm sq.	1.0kW	6,000 min^{-1}
	0x012E	R2CA13120F	AC400V	50A	130mm sq.	1.2kW	5,000 min^{-1}
	0x0521	R2CA13180D	AC400V	50A	130mm sq.	1.8kW	5,000 min^{-1}
	0x0135	R2CA13200H	AC400V	50A	130mm sq.	2.0kW	5,000 min^{-1}
	0x051E	R2CA18350L	AC400V	50A	180mm sq.	3.5kW	3,000 min^{-1}
	0x053A	R2CA18350C	AC400V	75A	180mm sq.	3.5kW	4,000 min^{-1}
	0x052E	R2CA18450H	AC400V	75A	180mm sq.	4.5kW	3,000 min^{-1}
	0x0537	R2CA18550V	AC400V	75A	180mm sq.	5.5kW	2,500 min^{-1}
	0x05BF	R2CA18350D	AC400V	150A	180mm sq.	3.5kW	4,000 min^{-1}
	0x05C0	R2CA18550R	AC400V	150A	180mm sq.	5.5kW	3,000 min^{-1}
	0x053C	R2CA18550H	AC400V	150A	180mm sq.	5.5kW	3,000 min^{-1}
	0x013F	R2CA18750H	AC400V	150A	180mm sq.	7.5kW	3,000 min^{-1}
	0x04E4	R2CA2211KB	AC400V	150A	220mm sq.	11kW	2,000 min^{-1}
	0x0140	R2CA2215KV	AC400V	150A	220mm sq.	15kW	2,500 min^{-1}
	0x05A7	R2CA2220KM	AC400V	150A	220mm sq.	20kW	1,500 min^{-1}
	0x013A	R2CA2220KB	AC400V	300A	220mm sq.	20kW	2,300 min^{-1}
	0x056E	R2CA2220KV	AC400V	300A	220mm sq.	20kW	2,000 min^{-1}
	0x056A	R2CA2830KV	AC400V	300A	275mm sq.	30kW	2,000 min^{-1}
	0x05A6	R2CA2837KB	AC400V	600A	275mm sq.	37kW	2,000 min^{-1}
	0x55A6	R2CA2837KB	AC400V	600A	275mm sq.	37kW	2,500 min^{-1}

■Rotary motor (400V)

Series	Motor code	Servo motor model number	Input type	Amplifier capacity	Flange size	Output	Maximum speed
R1 Series	0x04BC	R1CA10150V	AC400V	25A	100mm sq.	1.5kW	5,000 min^{-1}
	0x04BD	R1CA10200V	AC400V	50A	100mm sq.	2.0kW	5,000 min^{-1}
	0x04E7	R1CA13300V	AC400V	50A	130mm sq.	3.0kW	5,000 min^{-1}
	0x053F	R1CA18550H	AC400V	150A	180mm sq.	5.5kW	3,000 min^{-1}
	0x0540	R1CA18750L	AC400V	150A	180mm sq.	7.5kW	3,000 min^{-1}
	0x0561	R1CA1811KR	AC400V	150A	180mm sq.	11kW	2,500 min^{-1}
	0x0562	R1CA1815KB	AC400V	150A	180mm sq.	15kW	2,000 min^{-1}
	0x056D	R1CA2220KV	AC400V	300A	220mm sq.	20kW	2,000 min^{-1}
	0x556D	R1CA2220KV	AC400V	300A	220mm sq.	20kW	2,500 min^{-1}
	0x05A5	R1CA2225KL	AC400V	600A	220mm sq.	25kW	2,500 min^{-1}

■ 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), encoder division number code (0x20FF: 0x01), or encoder type code (0x20FF: 0x02). After that the three values are updated automatically.

0x20FF: Combination Encoder Selection

Index Ax1 0x20FF Ax2 0x22FF Ax3 0x24FF Ax4 0x26FF	Selects the motor encoder specifications and functions driven by combination. * Reactivate the control power after changing the setting this will reset the setting.		Object Code		Record
Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Number of entry	Unsigned8	RO	No	0x03
0x01	Encoder Resolution setting [ENCODE] Sets the division number of the motor encoder.	Unsigned16	RW	No	0xFFFF
		Setting range	0x0000-0x000F		

■ When the incremental encoder is used	■ When the absolute encoder is used	■ when linear scale encoder is used.
0x0000 : 500P/R	0x0000 : 2,048FMT	0x0000 : 5µm [200P/mm]
0x0001 : 512P/R	0x0001 : 4,096FMT	0x0001 : 2.5µm [400P/mm]
0x0002 : 1,000P/R	0x0002 : 8,192FMT	0x0002 : 2µm [500P/mm]
0x0003 : 1,024P/R	0x0003 : 16,384FMT	0x0003 : 1.25µm [800P/mm]
0x0004 : 1,500P/R	0x0004 : 32,768FMT	0x0004 : 1µm [1,000P/mm]
0x0005 : 2,000P/R	0x0005 : 65,536FMT	0x0005 : 0.5µm [2,000P/mm]
0x0006 : 2,048P/R	0x0006 : 131,072FMT	0x0006 : 0.25µm [4,000P/mm]
0x0007 : 2,500P/R	0x0007 : 262,144FMT	0x0007 : 0.125µm [8,000P/mm]
0x0008 : 3,000P/R	0x0008 : 524,288FMT	0x0008 : 0.1µm [10,000P/mm]
0x0009 : 4,000P/R	0x0009 : 1,048,576FMT	0x0009 : 0.05µm [20,000P/mm]
0x000A : 4,096P/R		
0x000B : 5,000P/R		
0x000C : 6,000P/R		
0x000D : 8,192P/R		
0x000E : 16,384P/R		
0x000F : 32,768P/R		
0x0010 : 10,000P/R		

0x8000: Auto setting of motor parameter (When connected to applicable motor.)
0xFFFF: Depends on division number setting (EEPROM setting value) of the MOTOR Setup software.

Initialized by the encoder resolution number set in EEPROM at the turn-on state.
When the encoder resolution number set parameter is different from the EEPROM value set, the function will be enabled by control source re-closing. After the new value is set in EEPROM, alarm ”DE: parameter change completed” occurs, then re-close control source.

✍ Automatic setting of motor parameter is performed when re-turning on the power supply after 0x8000 is set to any of motor code (0x20FE: 0x00), encoder division number code (0x20FF: 0x01), or encoder type code (0x20FF: 0x02). After that the three values are updated automatically.

■ Automatic setting of motor parameter

There are two ways to perform automatic setting of motor parameter.

(1) 0x8000 is set to any of motor code (0x20FE: 0x00), encoder division number code (0x20FF: 0x01), or encoder type code (0x20FF: 0x02). After that all the three values are read out automatically from encoder on re-turning on the control power.

(2) When using sutomatic setting button on parameter setting display of MOTOR setup software, the procedure is as follow:
  (a) Click automatic setting button on parameter setting display.
  (b) Click OK-buton if normally completed.
  (c) Set motor code of system parameter tub to 0xFFFF.
  (d) Re-turn on the control power.

✔ Refer to separate document, M0010842 for the details.

In the following cases, automatic setting of motor parameter function is not available.

✔ When alarm activated, in servo-on state, when encode-clear being performed.
✔ Connected to the motor which is not supported by automatic setting.
✔ Connected to the motor which is improper combination with the amplifier (motor size, encoder baud rate).

0x02	Encoder type [ENTYPE] Selects the type of motor encoder.	Unsigned16	RW	No	0xFFFF
		Setting range	0x0000-0xFFFF		

■ Incremental system (Wire-saving incremental encoder: 4pairs)
0x0000: Wire-saving incremental encoder
0x0002: Incremental encoder: CS normalization/ software setting (Magnetic pole position estimation)

■ Incremental System (Absolute encoder for incremental system)
0x0101:asynchronous encoder 2.5MHz(without multiple rotation output)
0x0201:asynchronous encoder 4.0MHz(without multiple rotation output)
*Used when the position at the turn-on state is zero.

■absolute system (multiple rotation backup system)
0x0300:optical asynchronous encoder 2.5MHz(with multiple rotation output)
0x0400:optical asynchronous encoder 4.0MHz(with multiple rotation output)
0x0600:resolver asynchronous encoder 2.5MHz(with multiple rotation output)
0x0600:resolver asynchronous encoder 4.0MHz(with multiple rotation output)

■Incremental system (multiple rotation output system)
0x0301:optical asynchronous encoder 2.5MHz(with multiple rotation output)
0x0401:optical asynchronous encoder 4.0MHz(with multiple rotation output)
0x0501:resolver asynchronous encoder 2.5MHz(with multiple rotation output)
0x0601:resolver asynchronous encoder 4.0MHz(with multiple rotation output)
*When the absolute encoder is used in the Incremental system, it is used when the turn-on state position is zero.
In this setting, battery trouble and battery warnings are not detected.

■Incremental system (Clearing multiple rotation at initialization: +/- 1 turn or less)
0x0302:optical asynchronous encoder 2.5MHz(with multiple rotation output. +/- 1 turn or less at initialization)
0x0402:optical asynchronous encoder 4.0MHz(with multiple rotation output. +/- 1 turn or less at initialization)
0x0502:resolver asynchronous encoder 2.5MHz(with multiple rotation output. +/- 1 turn or less at initialization)
0x0602:resolver asynchronous encoder 4.0MHz(with multiple rotation output. +/- 1 turn or less at initialization)
*Performing encoder clearing by initialization when power turns on.
In this setting, battery trouble and battery warnings are not detected.

■Linear scale encoder (Only when using linear motor)
0x0850:signal/ limited to A,B, and Z :CS normalization/ software setting (Magnetic pole position estimation)
0x0860:signal/ limited to A,B, and Z :CS normalization/ software setting (forced setting)

■Setting with the Setup software configuration
0x8000: Auto setting of motor parameter (When connected to applicable motor.)
0xFFFF: R ADVANCED – with the encoder setting (EEPROM setting value) set in Setup software

✍ Initialized by the encoder variety code set in EEPROM at the turn-on state.
When the encoder variety set parameter is different from the EEPROM value set, the function will be enabled by control source re-closing. After the new value is set in EEPROM, alarm "DE: parameter change completed" occurs, then re-close control source.
✍ Automatic setting of motor parameter is performed when re-turning on the power supply after 0x8000 is set to any of motor code (0x20FE: 0x00), encoder division number code (0x20FF: 0x01), or encoder type code (0x20FF: 0x02). After that the three values are updated automatically.

11) Monitor Parameter

0x2100: Status Word 1

Index Ax1 0x2100 Ax2 0x2300 Ax3 0x2500 Ax4 0x2700	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 and ip.)

bit1:Near Range Monitor [NEAR]
Set to “1” when the actual position is within the near range (0x201F) (Indefinite except for csp and ip.)

bit2: encoder C phase monitor [ECSM]
Set to “1” when the C signal(Z) of the incremental encoder is input. (indefinite except for INC-E.)

bit3:Encoder Clear Monitor [ECLRM]
Set to “1” during encoder clearance.

bit4: Brake Control [BCNT]
This is a holding brake release timing output.
Set to “1” while the brake is released.

bit5: Actual position effective monitor [EACT]
Set to “1” when encoder signal can be read.

bit6: Command reception-enable monitor ［SACT］
Set to”1” when command reception enabled.

bit7:Speed Zero Monitor [ZV]
Set to “1” when the actual velocity is within zero velocity range (0x2020) for 1ms or more.

MSB						LSB
pse	psr	Gests	Ta	vcmp	vp	ltg
15	14	13-12	11	10	9	8

bit8:Low Speed Monitor [LTG]
When the actual velocity is in the low velocity range or less (0x2021), set at “1.”

bit9:Speed Attainment Monitor [VA]
When the actual velocity is in the speed attainment range or greater (0x2002), set at “1.”

bit10:Speed Matching Monitor [VCMP]
When the actual velocity is within the set rotation set by 0x20F0.3 velocity window (velocity consistent) unit output selection, set at “1.”
*When the velocity window (0x606D) selected: compare with the rotation number setting (min-1).
* When the velocity window (0x606D) selected: compare with the proportion setting (%).

Bit11: Torque (force) attainment monitor ［TA］
Set to “1” when internal velocity command is over Torque (force) attainment (0x202E).

bit13,12:PP trajectory generation status monitor ［GESTS］
The status of trajectory generator is shown.
Bit13,12 = 0,0 : Stop
Bit13,12 = 0,1 : In acceleration
Bit13,12 = 1,0 : In constant velocity
Bit13,12 = 1,1 : In deceleration

bit15-14: Position sync compensation status monitor [PSE,PSR]
Monitors the status of position sync compensation.
Bit14 = 1 : In position sync compensation
Bit15 = 1 : In position deviation data receiving

0x2101: Amplifier Error Field

Index Ax1 0x2101 Ax2 0x2301 Ax3 0x2501 Ax4 0x2701	Indicates the alarm occurring in the servo amplifier. Sub-Index 0x00 indicates the number of alarms that are currently occurring, and Sub-Index 0x01-0x04 indicates the contents of alarms and Amplifier Status when the alarms occur up to four. Resets the alarm by setting Alarm reset in Control Word (0x6040.7).					Object Code Array
Sub-Idx	Name	Description	Data Type	Access	PDO	Initial value
0x00	Number of entry		Unsigned8	RO	No	0x04
0x01	Error 1	: Alarm 1 [ALMACT1]	Unsigned8	RO	Possible	0x00
0x02	Error 2	: Alarm 2 [ALMACT2]	Unsigned8	RO	Possible	0x00
0x03	Error 3	: Alarm 3 [ALMACT3]	Unsigned8	RO	Possible	0x00
0x04	Error 4	: Alarm 4 [ALMACT4]	Unsigned8	RO	Possible	0x00

MSB LSB

ALMCODE
7 6 5 4 3 2 1 0

bit7-0:Alarm Code defined by this servo amplifier
See the Alarm Code list.

0x2102: Description of Alarm Trace

Index Ax1 0x2102 Ax2 0x2302 Ax3 0x2502 Ax4 0x2702	Indicates the Alarm history of the servo amplifier occurring now or previously.		Object Code		Array
Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Number of entry	Unsigned8	RO	No	0x08
0x01	Now Status [NOWALM] *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-0x0E
Power ON 4	0x06	Initial State	0x0F

0x2103: Warning Status

Index Ax1 0x2103 Ax2 0x2303 Ax3 0x2503 Ax4 0x2703	Indicates the warnings and limitation status of the servo amplifier.	Object Code	Record

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Number of entry	Unsigned8	RO	No	0x02
0x01	Warning monitor [WARMON] 0:no warning (without limitation) 1:during warning (under limitation)	Unsigned16	RO	Possible	0x0000

MSB							LSB
tlw	-	vlw	tlw	rolw	olw	modw	tpw
7	6	5	4	3	2	1	0

- bit0:Temperature Warning
- bit1:Modulo initialization warning
- bit2:While Overload Warning
- bit3:While Regenerative Overload Warning
- bit4:Torque controlled
- bit5:Velocity command controlled
- bit6: Position Synchronization Deviation
- bit7:Position deviation Warning

MSB							LSB
cpew	btw	maxw	minw	hlw	llw	-	pow
15	14	13	12	11	10	9	8

- bit8: Main circuit power being charged
- bit9: Correction Table Data Warning
- bit10:Forward direction Over-travel(positive direction)
- bit11:Reverse direction Over-travel(negative direction)
- bit12: While the minimum position is limited
- bit13: While the maximum position is limited
- bit14:While Battery Warning
- bit15: Control electricity and voltage decrease warning

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x02	Warning mask Selection [WARMSK] Sets the condition to set status word (0x6041) bit7: warning status. Clears the corresponding bits for warning monitors to get rid of from the warning status condition. After the AND operation of the Warning Monitor/ Mask, if flags are set, sets Warning status.	Unsigned16	RW	No	0x4E8D

0x2104: Actual Gain Monitor

Index Ax1 0x2104 Ax2 0x2304 Ax3 0x2504 Ax4 0x2704	Indicates the actual setting value of the gain parameter to switch to real time various gain parameters through auto-tuning or gain switching selection.	Object Code	Array

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Number of entry	Unsigned8	RO	No	0x07
0x01	Actual Position Loop Proportional Gain [KPMON] Outputs the value of the position loop gain (0x2005) that is switched in auto-tuning mode (0x2002) or the gain switching selection (0x2001, bit 5-4), and is currently used for the servo control.	Unsigned16	RO	Possible	0x001E (30 /s)
		Setting range	0x0001-0x0BB8 (1-3000 /s)		
		Unit	1/s		
0x02	Actual Position Integral Time Constant [TPIMON] Outputs the value of the position integral time constant (0x2006) that is switched in auto-tuning mode (0x2002) or the gain switching selection (0x2001, bit 5-4), and is currently used for the servo control.	Unsigned16	RO	Possible	0x2710 (1000ms) proportional control
		Setting range	0x0003-0x2710 (0.3-1000 ms)		
		Unit	0.1ms		
0x03	Actual Velocity Loop Proportional Gain [KVPMON] Outputs the value of the velocity loop proportional gain (0x200B) that is switched in auto-tuning mode (0x2002) or the gain switching selection (0x2001, bit 5-4), and is currently used for the servo control.	Unsigned16	RO	Possible	0x0032 (50Hz)
		Setting range	0x0001-0x07D0 (1-2000 Hz)		
		Unit	Hz		
0x04	Actual Velocity Loop Integral Time Constant [TVIMON] Outputs the value of the velocity loop integral time constant (0x200C) that is switched in auto-tuning mode (0x2002) or the gain switching selection (0x2001, bit 5-4), and is currently used for the servo control.	Unsigned16	RO	Possible	0x00C8 (20ms)
		Setting range	0x0003-0x2710 (0.3-1000 ms)		
		Unit	0.1ms		
0x05	Actual Load Inertia Moment Ratio [JRATMON] Outputs the value of the load inertia moment ratio (0x200D) that is switched in auto-tuning mode (0x2002) or the gain switching selection (0x2001, bit 5-4), and is currently used for the servo control.	Unsigned16	RO	Possible	0x0064 (100%)
		Setting range	0x0000-0x3A98 (0-15000%)		
		Unit	%		
0x06	Actual Torque (force) Command Filter [TCFILMON] Outputs the value of the torque command filter (0x2011) that is switched in auto-tuning mode (0x2002) or the gain switching selection (0x2001, bit 5-4), and is currently used for the servo control.	Unsigned16	RO	Possible	0x0258 (600Hz)
		Setting range	0x0001-0x07D0 (1-2000 Hz)		
		Unit	Hz		
0x07	Actual Model Control Gain [MKPMON] Outputs the value of the model control gain (0x2017) that is switched in auto-tuning mode (0x2002) or the gain switching selection (0x2001, bit 5-4), and is currently used for the servo control.	Unsigned16	RO	Possible	0x001E (30 /s)
		Setting range	0x0001-0x0BB8 (1-3000 /s)		
		Unit	1/s		

0x2105: Z-phase Signal Base Actual Position

Index Ax1 0x2105 Ax2 0x2305 Ax3 0x2505 Ax4 0x2705	Indicates the Actual Position from Zero-phase.	Object Code	Variable

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Z-phase Signal Base Actual Position [CCUNIT] *In the incremental encoder indicates the position within one rotation based on C phase. The location increases to the direction of CCW seen head-on. The unit is 1 Pulse/LSB, four-fold value of A･B phases. It is indefinite after the turning-on until C phase is detected. (Example: At the 1024P/Re encoder, 0 - 4095Pulse indicated) *In the Absolute Encoder, indicates the position within one rotation based on Absolute Positon.	Integer32	RO	Possible	-
		Setting range	0x00000000-0xFFFFFFFF (0-4294967295 Pulse)		
		Unit	Pulse		

0x2106: Internal Velocity Command Monitor

Index Ax1 0x2106 Ax2 0x2306 Ax3 0x2506 Ax4 0x2706	Has the actual velocity value calculated from the position encoder The value is provided by the user-defined velocity unit.	Object Code	Variable

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Internal Velocity Command Monitor [VCMON] An Internal Velocity Command Value after passing the Velocity Command low-pass filter.	Integer32	RO	Possible	-
		Setting range	0x80000000-0x7FFFFFFF (-2147483648-2147483647 pps)		
		Unit	Pulse/sec		

0x2107: Internal Torque (force) Command Monitor

Index Ax1 0x2107 Ax2 0x2307 Ax3 0x2507 Ax4 0x2707	Indicates the torque (force) indication monitor inside the servo amplifier.	Object Code	Variable

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Internal Torque Command Monitor [TCMON] 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 Ax1 0x2108 Ax2 0x2308 Ax3 0x2508 Ax4 0x2708	Indicates the estimation value of the Effective Motor Torque (force).	Object Code	Variable

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Number of entry	Unsigned8	RO	No	0x02
0x01	Effective Torque (force) Estimated Value [TRMS] Indicates the Effective Motor Torque (force) against the motor rated torque (force). * The exact value is indicated, but in some operation patterns, it may take several hours to stabilize the figure.	Unsigned16	RO	Possible	-
		Setting range	0x0000-0xFFFF (0-65535 %)		
		Unit	%		
0x02	Fast Effective Torque (force) Estimate Value [ETRMS] Indicates the Effective Motor Torque (force) of time constant (1/16) against TRMS. * Quick estimation is possible in applications where short-cycle operation patterns are repeated.	Unsigned16	RO	Possible	-
		Setting range	0x0000-0xFFFF (0-65535 %)		
		Unit	%		

0x2109: Temperature inside the servo amplifier

Index Ax1 0x2109 Ax2 0x2309 Ax3 0x2509 Ax4 0x2709	Indicates the temperature inside the servo amplifier.	Object Code	Variable

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Temperature inside the servo amplifier [ATEMP] 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. This amplifier has single ESC. So, this is single object, also.	Object Code	Variable

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Regenerative resistor operation percentage monitor [REGP] 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 %		
	For DC48V input: PM (W)=60^2(V)/regenerative resistance value (ohm)×Regenerative resistor operation percentage (%)/100(%) For DC24V input: PM (W)=30^2(V)/regenerative resistance value (ohm)×Regenerative resistor operation percentage (%)/100(%)				

0x210B: Encoder Temperature Monitor

Index Ax1 0x210B Ax2 0x230B Ax3 0x250B Ax4 0x270B	The temperature of an encoder is displayed.	Object Code	Variable

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Encoder Temperature Monitor ［ETEMP］ The monitor value of the temperature of the encoder control board, shown in the unit of ℃ Celsius/LSB.	Integer16	RO	Possible	—
		Setting range	0xFF80-0x007F （－128-127 ℃）		
		Unit	℃		
	✔The encoder temperature is detected at the time that the servo amplifier stops. If the stop status continues, the encoder temperature monitor continuously and repeatedly detects the temperature of the encoder each 1s cycle. ✔When the encoder temperature detection is set to disable (0x2000 bit13 = 1), it will not detect the temperature.				

0x210C: Home Index Position Detection Value

Index Ax1 0x210C Ax2 0x230C Ax3 0x250C Ax4 0x270C	Home Index Positions latched by various systems of homing modes.	Object Code	Variable

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Home Index Position Detection Value [HOMEIDX] When homing activate and latched home index then indicates Internal position. *Incremental system Internal position is based on counter value when control power on. *Absolute system Internal position is based on absolute encoder value.	Integer32	RO	Possible	-
		Setting range	0x80000000-0x7FFFFFFF (-2147483648-2147483647Pulse)		
		Unit	Pulse		

0x210D: Position Synchronization Deviation Monitor

Index Ax1 0x210D Ax2 0x230D Ax3 0x250D Ax4 0x270D	Position deviation between two synchronous connected axes is monitored.	Object Code	Variable

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Position Synchronization Deviation Monitor [PSYNDEV] When positon synchronization correction function is valid, the monitor indicates error pulse quantity from position deviation of amplifiers which are subject to synchronization. ✔This is valid when 0x01 - 0x04 in 0x2035-8 Assist-function selection is set.	Integer32	RO	Possible	—
		Setting range	0x80000000-0x7FFFFFFF (−2147483648-2147483647 pulse)		
		Unit	Pulse		

0x210E: Power Consumption Monitor

Index Ax1 0x210E Ax2 0x230E Ax3 0x250E Ax4 0x270E	Power consumption of servo amplifier is monitored.	Object Code	Record

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Number of entry	Unsigned8	RO	No	0x02
0x01	Average Power Monitor [MAVEPOW] It shows measurement result every 1 minute.	Integer32	RO	Possible	-
		Setting range	-2147483520 to 2147483520		
		Unit	mW		
0x02	Maximum Power Monitor [MMAXPOW] It shows measurement result every 1 minute.	Integer32	RO	Possible	-
		Setting range	0 to 2147483520		
		Unit	mW		
0x03	Integrated Average Power Monitor [POWCONSUMP] It shows integrated result of average power. "0x210E-1: Average Power Monitor" is integrated.	Unsigned32	RO	Possible	-
		Setting range	0x00000000 to 0xFFFFFFFF (0 to 4294967295)		
		Unit	0.01Wh		
	✓ Not shown with the motor except R series. ✓ When 3-phase 200V AC is used to the 200V AC input type, accuracy will be ±25% (at the accel/decel operation with 100% effective torque). ✓ When single-phase 200V AC is used to the 200V AC input type, accuracy will be ±30% (at the accel/decel operation with 100% effective torque). ✓ For the 100V AC input type, accuracy will be ±30% (at the accel/decel operation with 100% effective torque). (Accuracy may be worse when it is used at the instantaneous area of Velocity-torque characteristics.)				

0x2110: Internal Control Cycle Position Actual Value

Index		Description	Object Code	Array
Index Ax1 Ax2 Ax3 Ax4	0x2110 0x2310 0x2510 0x2710	Returns the Actual Position value latched every control cycle (125μs). Monitor unit is expressed by the resolution of the motor encoder used.	Object Code	Array

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Number of entry	Unsigned8	RO	No	0x07
0x01	Internal Control Cycle Actual Position 1 Actual position of 0x6064, 125μs ago.	Integer32	RO	Possible	-
0x02	Internal Control Cycle Actual Position 2 Actual position of 0x6064, 250μs ago.	Integer32	RO	Possible	-
0x03	Internal Control Cycle Actual Position 3 Actual position of 0x6064, 375μs ago.	Integer32	RO	Possible	-
0x04	Internal Control Cycle Actual Position 4 Actual position of 0x6064, 500μs ago.	Integer32	RO	Possible	-
0x05	Internal Control Cycle Actual Position 5 Actual position of 0x6064, 625μs ago.	Integer32	RO	Possible	-
0x06	Internal Control Cycle Actual Position 6 Actual position of 0x6064, 750μs ago.	Integer32	RO	Possible	-
0x07	Internal Control Cycle Actual Position 7 Actual position of 0x6064, 875μs ago.	Integer32	RO	Possible	-
		Setting range	0x80000000-0x7FFFFFFF (-2147483648-2147483647 Pulse)		
		Unit	Pulse		

0x2111: Internal Control Cycle Actual Velocity

Index Ax1 0x2111 Ax2 0x2311 Ax3 0x2511 Ax4 0x2711	Returns the Actual Velocity value latched every control cycle (125µs).		Object Code		Array
Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Number of entry	Unsigned8	RO	No	0x07
0x01	Internal Control Cycle Actual Velocity 1 Actual velocity of 0x606C, 125µs ago.	Integer32	RO	Possible	-
0x02	Internal Control Cycle Actual Velocity 2 Actual velocity of 0x606C, 250µs ago.	Integer32	RO	Possible	-
0x03	Internal Control Cycle Actual Velocity 3 Actual velocity of 0x606C, 375µs ago.	Integer32	RO	Possible	-
0x04	Internal Control Cycle Actual Velocity 4 Actual velocity of 0x606C, 500µs ago.	Integer32	RO	Possible	-
0x05	Internal Control Cycle Actual Velocity 5 Actual velocity of 0x606C, 625µs ago.	Integer32	RO	Possible	-
0x06	Internal Control Cycle Actual Velocity 6 Actual velocity of 0x606C, 750µs ago.	Integer32	RO	Possible	-
0x07	Internal Control Cycle Actual Velocity 7 Actual velocity of 0x606C, 875µs ago.	Integer32	RO	Possible	-
*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 Ax1 0x2112 Ax2 0x2312 Ax3 0x2512 Ax4 0x2712	Returns the Actual Torque (force) value latched every control cycle (125µs).		Object Code		Array
Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Number of entry	Unsigned8	RO	No	0x03
0x01	Internal Control Cycle Actual Torque (force) 1 Actual torque(force)position of 0x6077, 125µs ago.	Integer16	RO	Possible	-
0x02	Internal Control Cycle Actual Torque (force) 2 Actual torque(force) of 0x6077, 250µs ago.	Integer16	RO	Possible	-
0x03	Internal Control Cycle Actual Torque (force) 3 Actual torque(force) of 0x6077, 375µs ago.	Integer16	RO	Possible	-
0x04	Internal Control Cycle Actual Torque (force) 4 Actual torque(force) of 0x6077, 500µs ago.	Integer16	RO	Possible	-
0x05	Internal Control Cycle Actual Torque (force) 5 Actual torque(force) of 0x6077, 625µs ago.	Integer16	RO	Possible	-
0x06	Internal Control Cycle Actual Torque (force) 6 Actual torque(force) of 0x6077, 750µs ago.	Integer16	RO	Possible	-
0x07	Internal Control Cycle Actual Torque (force) 7 Actual torque(force) of 0x6077, 875µs ago.	Integer16	RO	Possible	-
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 Ax1 0x2116 Ax2 0x2316 Ax3 0x2516 Ax4 0x2716	Has actual velocity value caluculated from position encoder. Value shall be given in the velocity unit of user definition.	Object Code	Variable

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Actual Velocity ［ACVMON2］ ✔Filter is processed data, and cutoff frequency is 20Hz	Integer32	RO	Possible	—
		Setting range	0x80000000-0x7FFFFFFF （−2147483648-2147483647 pps）		
		Unit	Pulse/sec		

0x2117: Position Actual Value 2

Index Ax1 0x2117 Ax2 0x2317 Ax3 0x2517 Ax4 0x2717	Indicates the actual position without backlash correction value.	Object Code	Variable

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Position Actual Value 2 ［APMON2］ Indicates the actual position without backlash correction value.	Integer32	RO	Possible	—
		Setting range	0x80000000-0x7FFFFFFF （−2147483648-2147483647）		
		Unit	Pulse		
	◆With backlash correction Position Actual Value 2 ＝Position Actual Value (0x6064) - Backlash correction value (0x5091) ◆Without backlash correction Position Actual Value 2 ＝Position Actual Value				

0x2120： Amplifier Parameter Information

Index Ax1 0x2120 Ax2 0x2320 Ax3 0x2520 Ax4 0x2720	Indicate servo amplifier status.	Object Code	Array

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Number of entry	Unsigned8	RO	No	0x04
0x01	Indicate status of alarm masking. Each bit fit to alarm below.	Unsigned32	RO	Possible	0x00000000

	Alarm		Alarm
Bit31	EEPE2	Bit15	PARE
Bit30	MPARA	Bit14	OVC
Bit29	VCCE	Bit13	OVF
Bit28	IPMOH	Bit12	All of encoder alarm
Bit27	RSOH	Bit11	All of communication alarm
Bit26	HWBBE1,2	Bit10	RGOL
Bit25	Reserved	Bit9	IFBE1 - 3
Bit24	SOL	Bit8	IPME
Bit23	Main Circuit Under-voltage alarm	Bit7	EXOH
Bit22	DBOH	Bit6	RGOH
Bit21	TSKE	Bit5	AOH
Bit20	ADBUSE	Bit4	OVC
Bit19	RAME	Bit3	OL
Bit18	PE	Bit2	OS
Bit17	CPE	Bit1	FP
Bit16	OVE	Bit0	MPE

Alarm is masked by setting 1 to each bit.

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x02	Control status Indicate control by Since this amplifier is controlled by only the EtherCAT communication, values other than 1 cannot be set.	Unsigned8	RW	No	0x01
0x03	Amplifier running time Indicate total power on time after shipping from factory in increments of 2 hours.	Unsigned32	RO	No	—
		Unit	2 hour		
0x04	External regenerative resistance Indicate recommended value of minimum external regenerative resistance.	Unsigned32	RW	Possible	※
		Setting range	0x00000000-0xFFFFFFFF		
		Unit	mΩ		

※) Initial value varies addording to amplifier capacity.

0x2151: Error Register

Index Ax1 Ax2 Ax3 Ax4	0x2151 0x2351 0x2551 0x2751	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 Register ［ERRREG］ 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 ✔Index 0x2151 is same as Index 0x1001.	Unsigned8	RO	Possible	0x00

0x2152: Device Name

Index Ax1 Ax2 Ax3 Ax4	0x2152 0x2352 0x2552 0x2752	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) ✔Index 0x2152 is same as Index 0x1008.	Visible String	RO	No	Character String (-)
RM2					

0x2153: FPGA Hardware Version

Index	0x2153	Indicates FPGA hardware version.	Object Code	VAR

Sub-Idx	Name/Description	Data Type	Access	PDO	Value
0x00	Hardware Version ［HARDVER］ Hardware Version of Device	Visible String （Unsigned32）	RO	No	Character String (-)

0x2154: Communication Software Version

Index	0x2154	Indicates product software version.	Object Code	VAR

Sub-Idx	Name/Description	Data Type	Access	PDO	Value
0x00	Software Version [SOFTVER] Communication Software Version of Device	Visible String （Unsigned32）	RO	No	Character String (-)
8 E 0 0 . 0 . 5 7 2 0					

Byte 10, 11: Date of firmware compiled
1: 1st, 2: 2nd ･･･ 30: 30th, 31: 31th

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

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

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

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

Byte 1, 2: Series Name
8E: RM2-EtherCAT Interface

0x2155: Servo Software Version

Index Ax1 Ax2 Ax3 AX4	0x2155 0x2355 0x2555 0x2755	Indicates product software version.	Object Code	VAR

Sub-Idx	Name/Description	Data Type	Access	PDO	Value
0x00	Software Version [SOFTVER] Servo Software Version of Device ✔Index 0x2155 is nearly same as Index 0x100A.	Visible String （Unsigned32）	RO	No	Character String (-)
8 4 0 0 . 0 . 0 7 2 0					

Byte 10,11: Date of firmware compiled
1: 1st, 2: 2nd ･･･ 30: 30th, 31: 31th

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

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

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

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

Byte 1, 2: Series Name
84: RM2-EtherCAT Interface

0x2156: Alarm Estimation Cause Code

Index				
Ax1 Ax2 Ax3 Ax4	0x2156 0x2356 0x2556 0x2756	Indicates estimated cause code for alarm occurrence. Amount of indicating estimated cause code differs depending on kinds of occurred alarm.	Object Code	Variable

Sub-Idx	Description	Data Type	Access	PDO	Initial Value
0x00	Number of entry	Unsigned8	RO	No	0x08
0x01	Alarm Estimation Cause Code 1 ［ALMCAUSE1］	Unsigned16	RO	No	0x0000
0x02	Alarm Estimation Cause Code 2 ［ALMCAUSE2］	Unsigned16	RO	No	0x0000
0x03	Alarm Estimation Cause Code 3 ［ALMCAUSE3］	Unsigned16	RO	No	0x0000
0x04	Alarm Estimation Cause Code 4 ［ALMCAUSE4］	Unsigned16	RO	No	0x0000
0x05	Alarm Estimation Cause Code 5 ［ALMCAUSE5］	Unsigned16	RO	No	0x0000
0x06	Alarm Estimation Cause Code 6 ［ALMCAUSE6］	Unsigned16	RO	No	0x0000
0x07	Alarm Estimation Cause Code 7 ［ALMCAUSE7］	Unsigned16	RO	No	0x0000
0x08	Alarm Estimation Cause Code 8 ［ALMCAUSE8］	Unsigned16	RO	No	0x0000
		Display Range	0x0000-0xFFFF		

✔It will be 0x0000 if there is no estimated cause.

0x2157: FPGA Initialization error

Index	0x2157	Indicates state of FPGA initialization.	Object Code	VAR

Sub-Idx	Name/Description	Data Type	Access	PDO	Initial Value
0x00	FPGA Initialization error ［FPGAINIERR］ bit7-15: Reserved bit6: SRAM error bit5: Internal RAM2 error bit4: Internal RAM1 error bit3: DPRAM error for AX4 bit2: DPRAM error for AX3 bit1: DPRAM error for AX2 bit0: DPRAM error for AX1	Unsigned16	RO	No	0x0000

0x2158: High-precision Sync Monitor

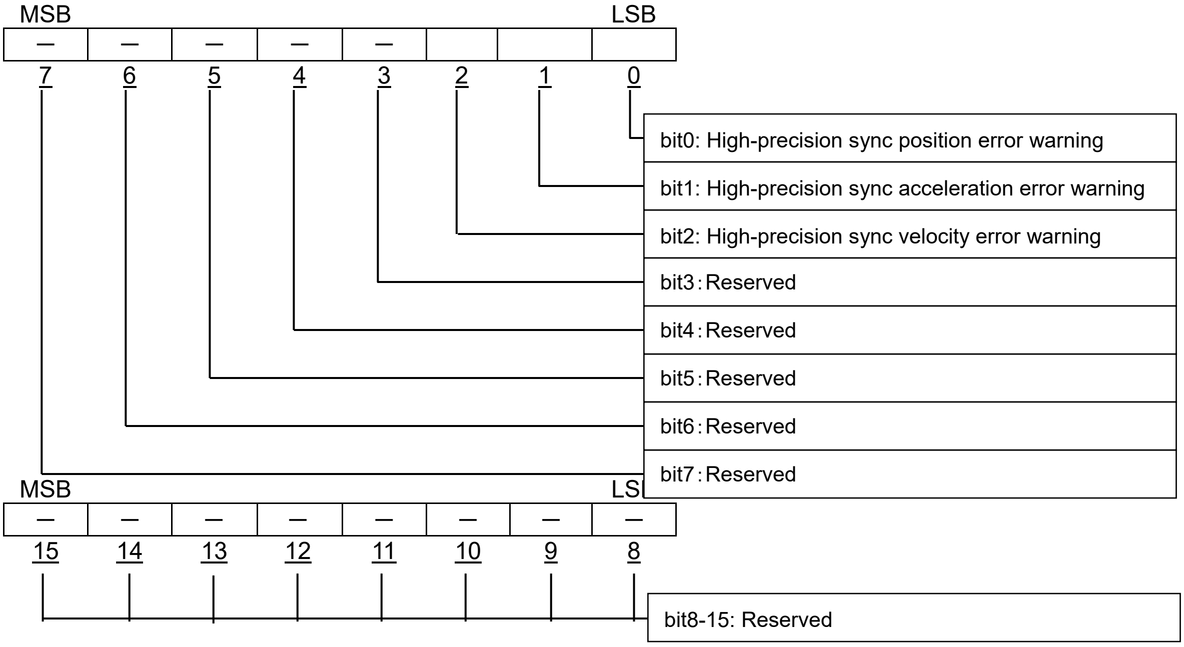
Index	0x2158 0x2358 0x2558 0x2758	Each monitors of high-precision synchronization.	Object Code	Record

Sub-Idx	Description	Data Type	Access	PDO	Initial Value
0x00	Number of entry	Unsigned8	RO	No	0x03
0x01	High-precision Sync Position Error Monitor [PHASERR] It shows position error amount against synchronization target axis, when high-precision sync valid.	Integer32	RO	Possible	-
		Display range	-2147483648 to 2147483647		
		Unit	Pulse		
0x02	High-precision Sync Velocity Error Monitor [VHASERR] It shows velocity error amount against synchronization target axis, when high-precision sync valid.	Integer32	RO	Possible	-
		Display range	-2147483648 to 2147483647		
		Unit	2^{-15}min^{-1}		
0x03	High-precision Sync Acceleration Error Monitor [AHASERR] It shows acceleration error amount against synchronization target axis, when high-precision sync valid.	Integer32	RO	Possible	-
		Display range	-2147483648 to 2147483647		
		Unit	2^{-4}rad/s^2		

0x2159: Warning Status 2

Index Ax1 0x2159 Ax2 0x2359 Ax3 0x2559 Ax4 0x2759	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 2 [WARMON2] 0:no warning (without limitation) 1:during warning (under limitation)	Unsigned16	RO	Possible	0x0000



bit0: High-precision sync position error warning

bit1: High-precision sync acceleration error warning

bit2: High-precision sync velocity error warning

bit3 : Reserved

bit4 : Reserved

bit5 : Reserved

bit6 : Reserved

bit7 : Reserved

bit8-15: Reserved

Sub-Idx	Description	Data Type	Access	PDO	Initial Value
0x02	Warning Mask 2 [WARMSK2] 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	0x0007

0x5010：Motor data

Index Ax1 0x5010 Ax2 0x5210 Ax3 0x5410 Ax4 0x5610	Indicate selected motor data.	Object Code	Array

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Number of entry	Unsigned8	RO	No	0x07
0x01	Number of motor pole	Unsigned8	RO	Possible	0x00
		Unit	Pole		
0x02	Phase resistance	Unsigned16	RO	Possible	0x0000
		Unit	mΩ		
0x03	Phaseinductance	Unsigned16	RO	Possible	0x0000
		Unit	μH		
0x04	Moment of inertia	Unsigned16	RO	Possible	0x0000
		Unit	gmm^2		
0x05	Voltage constant for each phase	Unsigned32	RO	Possible	0x0000
		Unit	μVrms/min-1		
0x06	Rated torque	Unsigned16	RO	Possible	0x0000
		Unit	mN･m/Arms		
Support R series motor only. Disabled to Q series or previous motor.					

0x5040: Position Unit System

Index Ax1 0x5040 Ax2 0x5240 Ax3 0x5440 Ax4 0x5640	Indicates the unit system of the position.	Object Code	Array

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Number of entry	Unsigned8	RO	No	0x05
0x01	Software expression in 100% of full scale 100% of full scale expression is applied in the value of the software. The display value is 1 (1bit) fixed.	Unsigned8	RO	Possible	0x01
0x02	Full-scale Unit Unit of full scale value. The display value is 1 (Encoder Count) fixed.	Unsigned16	RO	Possible	0x0001
0x03	Full-scale Data Type Indicates the data type to be used in the full scale value. The display value is 1 (Integer Type 32bit) fixed.	Unsigned16	RO	Possible	0x0001
0x04	Full-scale Unit Transforms into the actual unit. The display value is 1 (1bit) fixed.	Unsigned16	RO	Possible	0x0001

0x5041: Velocity Unit System

Index Ax1 0x5041 Ax2 0x5241 Ax3 0x5441 Ax4 0x5641	Indicates the unit system of velocity.	Object Code	Array

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Number of entry	Unsigned8	RO	No	0x05
0x01	Software expression in 100% of full scale 100% of full scale expression is applied in the value of the software. The display value is 1 (pps) fixed.	Unsigned8	RO	Possible	0x01
0x02	Full-scale Unit Unit of full scale value. The display value is 1 (pps) fixed.	Unsigned16	RO	Possible	0x0001
0x03	Full-scale Data Type Indicates the data type to be used in the full scale value. The display value is 1 (Integer Type 32bit) fixed.	Unsigned16	RO	Possible	0x0001
0x04	Full-scale Value Transforms into the actual unit. The display value is 1 (pps) fixed.	Unsigned16	RO	Possible	0x0001

0x5042: Acceleration Unit System

Index Ax1 0x5042 Ax2 0x5242 Ax3 0x5442 Ax4 0x5642	Indicates the unit system of velocity.	Object Code	Array

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Number of entry	Unsigned8	RO	No	0x05
0x01	Software expression in 100% of full scale 100% of full scale expression is applied in the value of the software. The display value is 1 (pps^2) fixed.	Unsigned8	RO	Possible	0x01
0x02	Full-scale Unit Unit of full scale value. The display value is 1 (pps^2) fixed.	Unsigned16	RO	Possible	0x0001
0x03	Full-scale Data Type Indicates the data type to be used in the full scale value. The display value is 1 (Integer Type 32bit) fixed.	Unsigned16	RO	Possible	0x0001
0x04	Full-scale Value Transforms into the actual unit. The display value is 1 (pps^2) fixed.	Unsigned16	RO	Possible	0x0001

5.

5. Operations

5.1 Test operation

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 IN (Port 0) / OUT (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

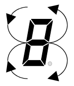
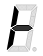
When using a product that corresponds to the Safe Torque OFF function, please check the function followed with a Confirmation Test (Chapter 13) to verify normal operation.

3) Movement Confirmation

Perform JOG operations using Setup Software or Digital Operator.

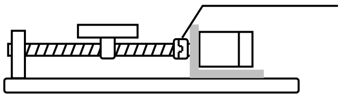
<table>
<tr><th>Process</th><th>Items and Contents</th></tr>
<tr><td rowspan="2">1</td><td>Input signal check: Generic Input signals (CN101, 201, 301,401)</td></tr>
<tr><td>■ Select Input signals to be used from General parameter Group9 and assign in CONT1, and CONT2.
<table>
<tr><th></th><th></th><th>Factory Shipment Setting Value</th></tr>
<tr><td>Input Signal</td><td>CN*01 Pin No.</td><td>Setting Value</td></tr>
<tr><td>CONT1</td><td>1, 5</td><td>00:Always_Disable</td></tr>
<tr><td>CONT2</td><td>2, 6</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 (CN101, 201, 301,401)</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><td>Output Signal</td><td>CN*01 Pin No</td><td>Setting Value</td><td>Object: Index, Sub-index</td></tr>
<tr><td>OUT1</td><td>3, 7</td><td>42:FOUT1_ON</td><td>0x20F9,0x01 (OUT1)</td></tr>
<tr><td>OUT2</td><td>4, 8</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 manual M0010842 for Setup Software operations.
◆ When checking with “Digital Operator” Refer to “Section 10.6 Trial operation for digital opeartot operation method.</td></tr>
</table>

<table>
<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 M0010842 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 the motor is excited and "8" is drawn continuously by 7-segment LED of the control unit.

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.

Connect servo 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>

5.2 ESC Power ON Sequence

Shows RM2 EtherCAT slave amplifier power ON sequence at input of control power supply.

1. Power ON : Control voltage reaches operational voltage of ESC

⇩

2. PLL Clock : Output PLL clock

⇩

3. Reset Cancel: Starts ESC operation. Prohibits memory access until ESI EEPROM is loaded.
Access enabled for μ controller after reset cancellation.

⇩

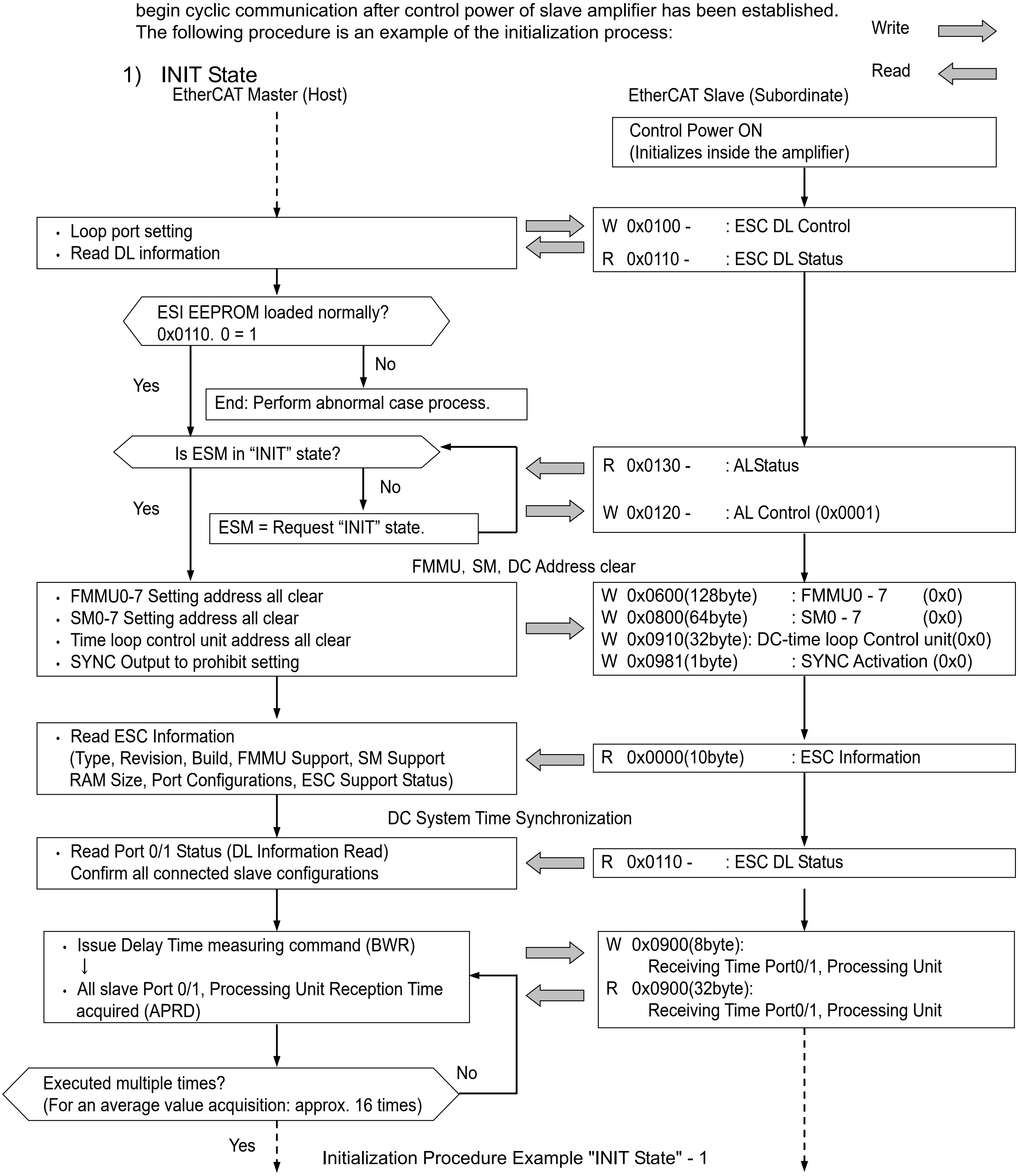
4. Establish Link : Starts EtherCAT communication. Accessible to master.
(Setting data for μ controller inside ESC also prohibits access.)
EEPROM load : Access will be enabled only when EEPROM load to ESC success.
・ESC setting register initialization completed
・μ controller starts operation
・Changes to 0x0110.1=1
・Process data RAM enabled
・ESM of ESC reaches ”Init” state

ESC Power ON Sequence

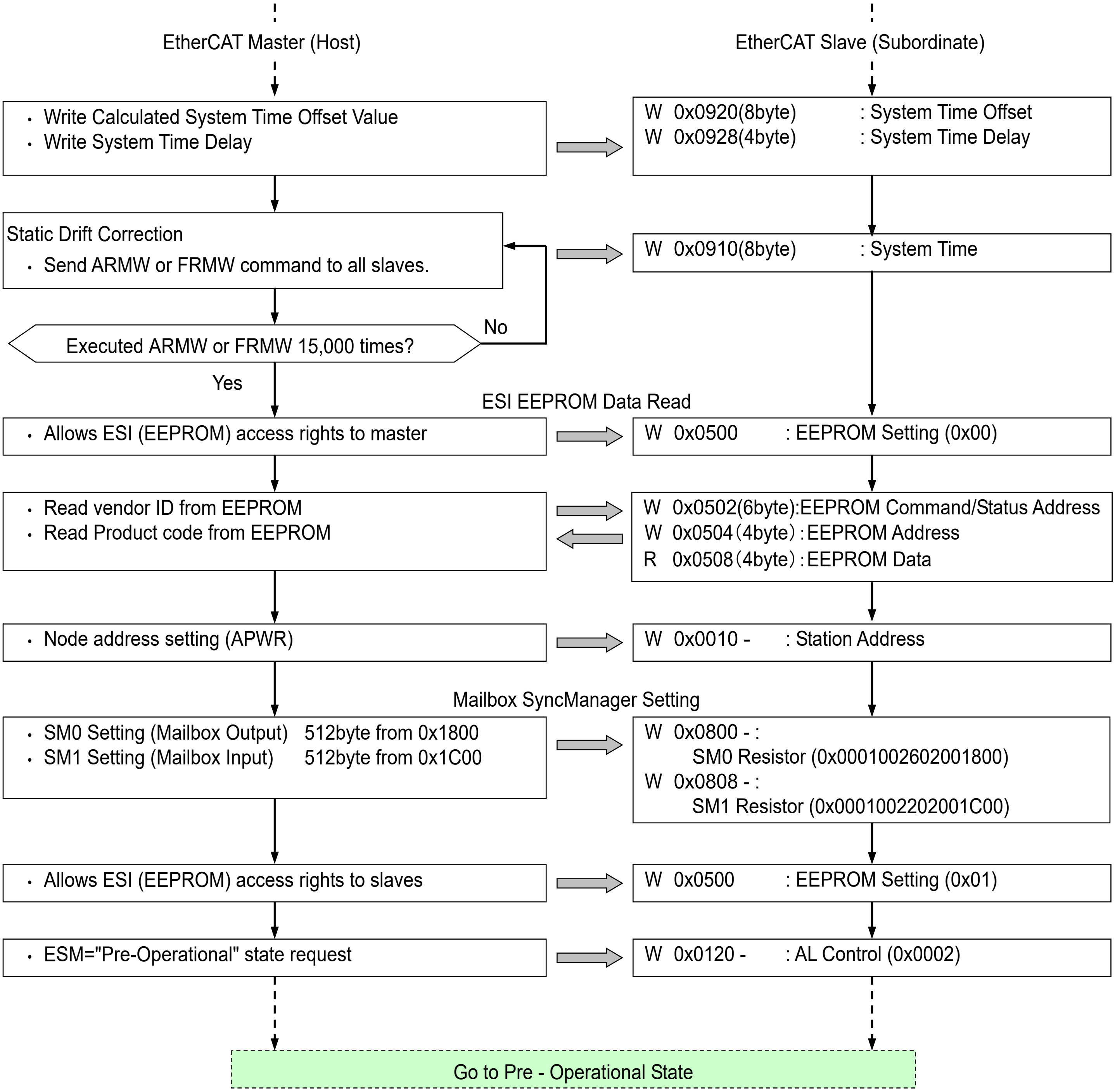
5.3 EtherCAT Initialization Process

Various parameter settings from master to slave datalink layer and application layer are required to begin cyclic communication after control power of slave amplifier has been established.
The following procedure is an example of the initialization process:

1) INIT State

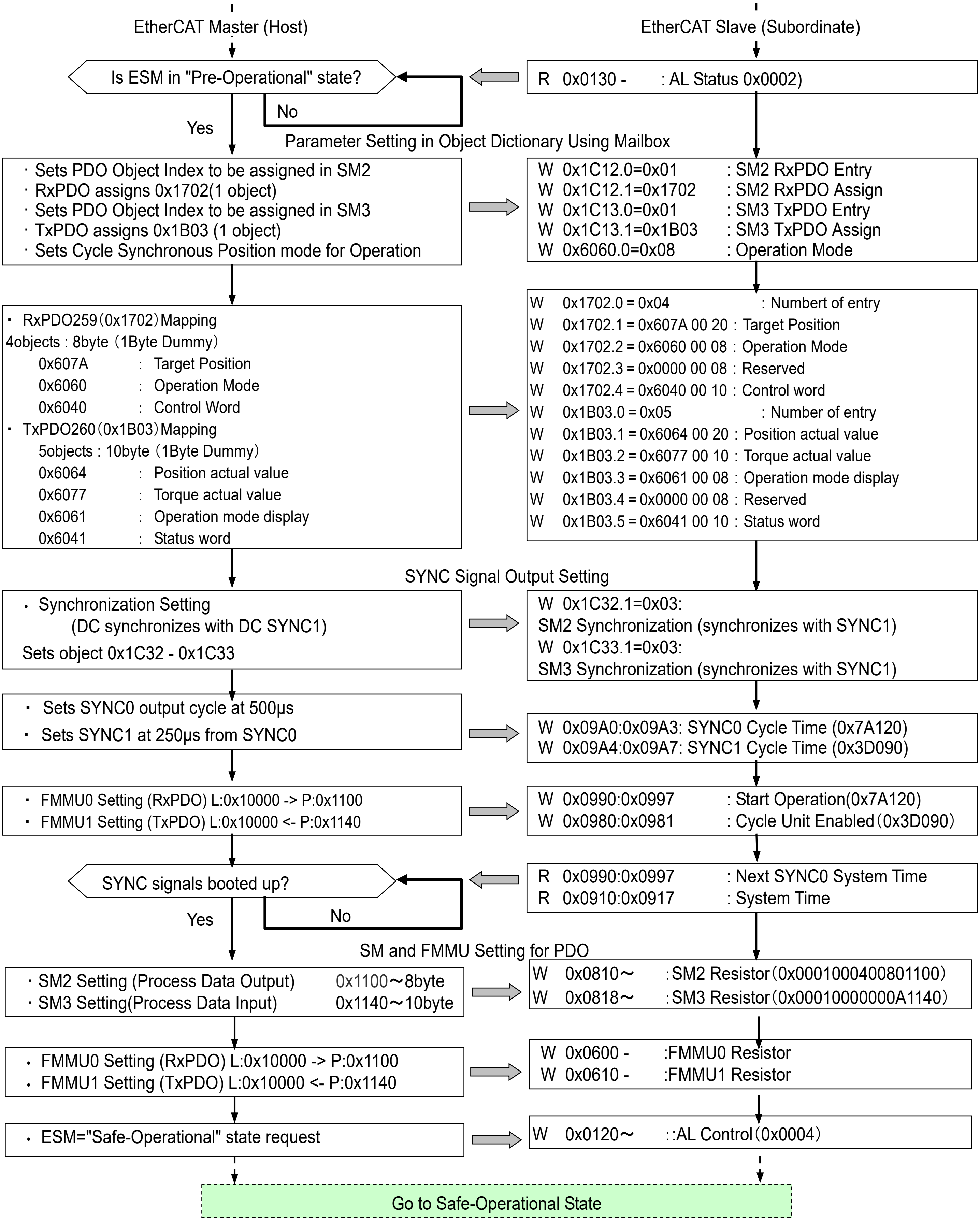


Initialization Procedure Example "INIT State" - 1



Initialization Procedure Example "INIT State" -2

2) Pre-Operational State



R 0x0130 - : AL Status 0x0002)

- Sets PDO Object Index to be assigned in SM2
- RxPDO assigns 0x1702(1 object)
- Sets PDO Object Index to be assigned in SM3
- TxPDO assigns 0x1B03 (1 object)
- Sets Cycle Synchronous Position mode for Operation

W 0x1C12.0=0x01 : SM2 RxPDO Entry
W 0x1C12.1=0x1702 : SM2 RxPDO Assign
W 0x1C13.0=0x01 : SM3 TxPDO Entry
W 0x1C13.1=0x1B03 : SM3 TxPDO Assign
W 0x6060.0=0x08 : Operation Mode

- RxPDO259(0x1702)Mapping
4objects : 8byte（1Byte Dummy）
0x6040 : Target Position
0x6060 : Operation Mode
0x6040 : Control Word
- TxPDO260(0x1B03)Mapping
5objects : 10byte（1Byte Dummy）
0x6064 : Position actual value
0x6077 : Torque actual value
0x6061 : Operation mode display
0x6041 : Status word

W 0x1702.0 = 0x04 : Numbert of entry
W 0x1702.1 = 0x607A 00 20 : Target Position
W 0x1702.2 = 0x6060 00 08 : Operation Mode
W 0x1702.3 = 0x0000 00 08 : Reserved
W 0x1702.4 = 0x6040 00 10 : Control word
W 0x1B03.0 = 0x05 : Number of entry
W 0x1B03.1 = 0x6064 00 20 : Position actual value
W 0x1B03.2 = 0x6077 00 10 : Torque actual value
W 0x1B03.3 = 0x6061 00 08 : Operation mode display
W 0x1B03.4 = 0x0000 00 08 : Reserved
W 0x1B03.5 = 0x6041 00 10 : Status word

- Synchronization Setting
(DC synchronizes with DC SYNC1)
Sets object 0x1C32 - 0x1C33

W 0x1C32.1=0x03:
SM2 Synchronization (synchronizes with SYNC1)
W 0x1C33.1=0x03:
SM3 Synchronization (synchronizes with SYNC1)

- Sets SYNC0 output cycle at 500μs
- Sets SYNC1 at 250μs from SYNC0

W 0x09A0:0x09A3: SYNC0 Cycle Time (0x7A120)
W 0x09A4:0x09A7: SYNC1 Cycle Time (0x3D090)

- FMMU0 Setting (RxPDO) L:0x10000 -> P:0x1100
- FMMU1 Setting (TxPDO) L:0x10000 <- P:0x1140

W 0x0990:0x0997 : Start Operation(0x7A120)
W 0x0980:0x0981 : Cycle Unit Enabled（0x3D090）

R 0x0990:0x0997 : Next SYNC0 System Time
R 0x0910:0x0917 : System Time

- SM2 Setting (Process Data Output) 0x1100～8byte
- SM3 Setting(Process Data Input) 0x1140～10byte

W 0x0810～ :SM2 Resistor（0x0001000400801100）
W 0x0818～ :SM3 Resistor（0x00010000000A1140）

- FMMU0 Setting (RxPDO) L:0x10000 -> P:0x1100
- FMMU1 Setting (TxPDO) L:0x10000 <- P:0x1140

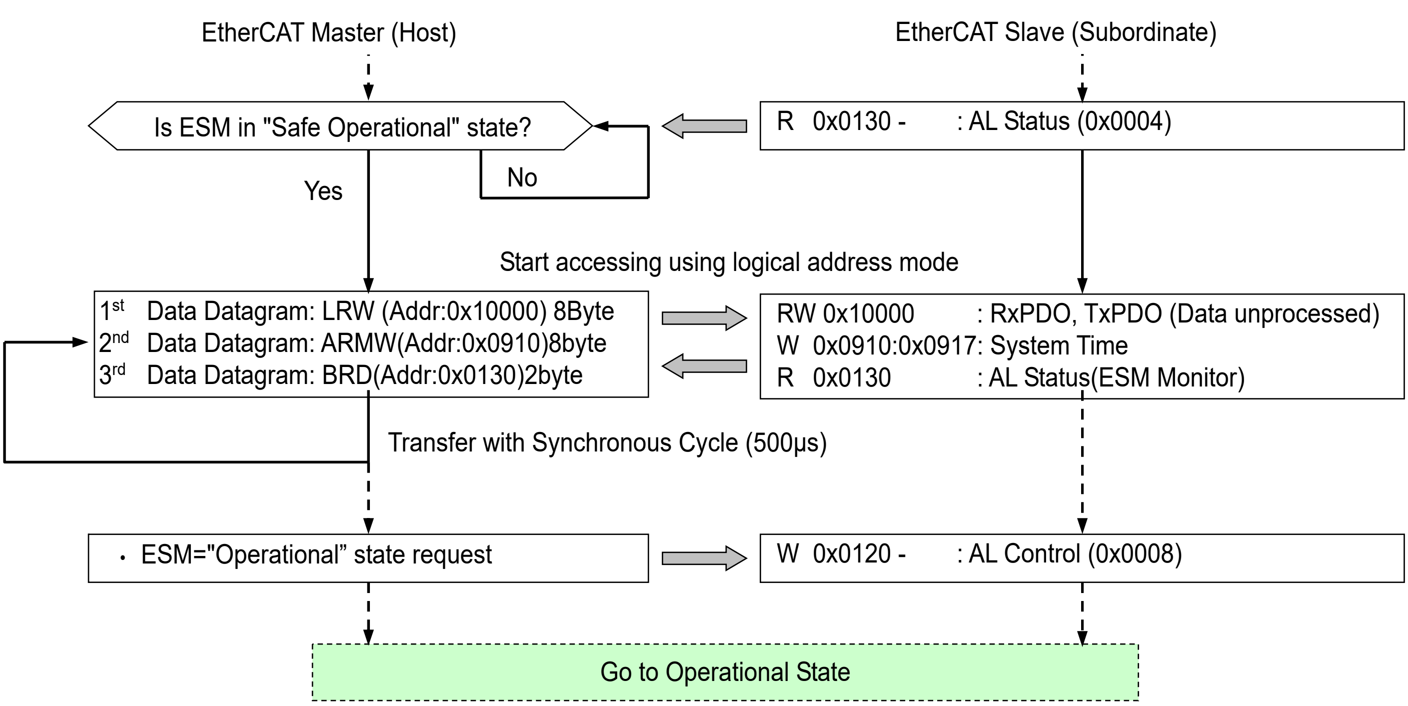
W 0x0600 - :FMMU0 Resistor
W 0x0610 - :FMMU1 Resistor

- ESM="Safe-Operational" state request

W 0x0120～ ::AL Control（0x0004）

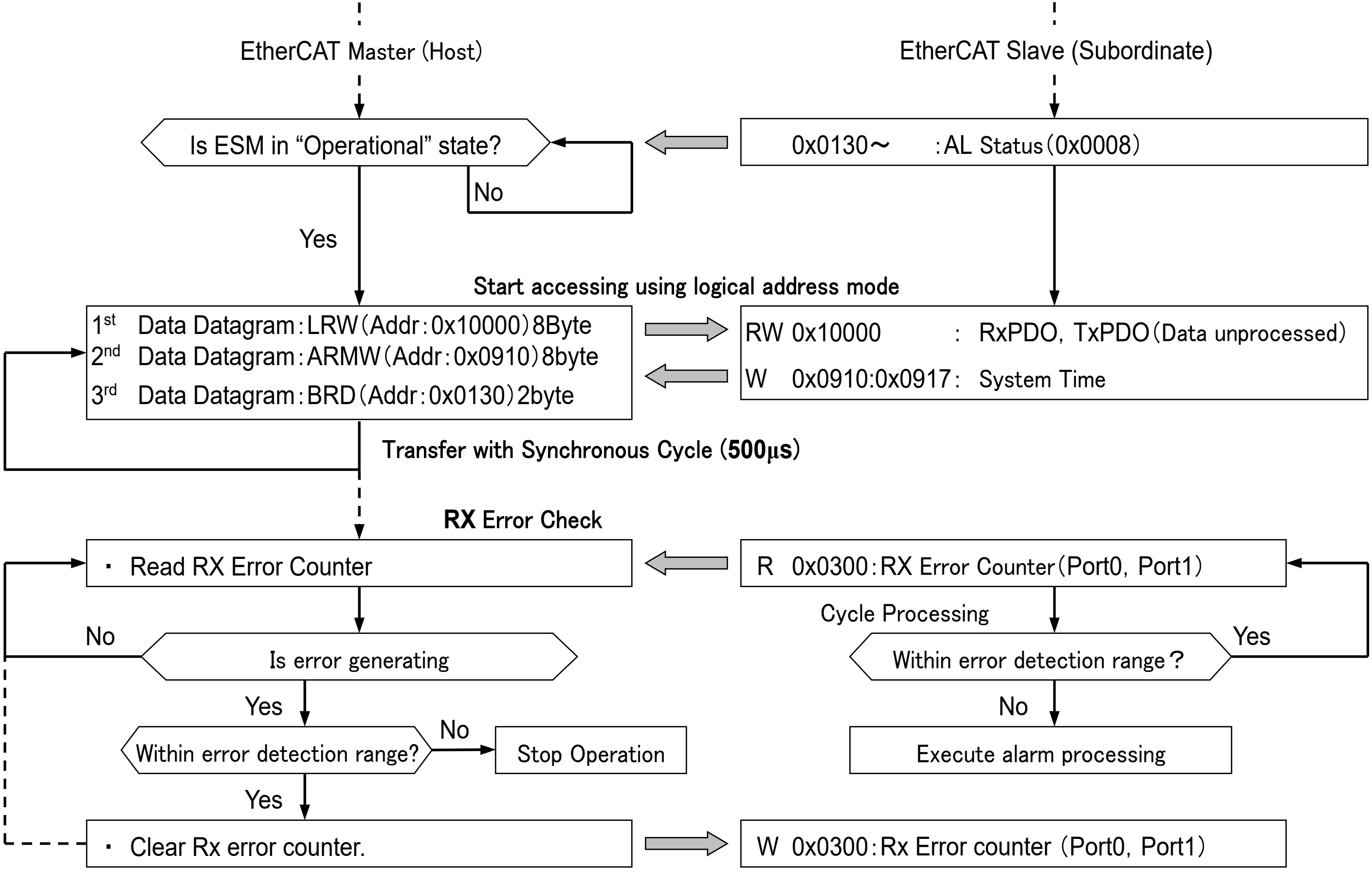
Initialization Procedure Example (Pre-Operational State)

3) Safe-Operational State



Initialization Procedure Example (Safe-Operational State)

4) Operational State

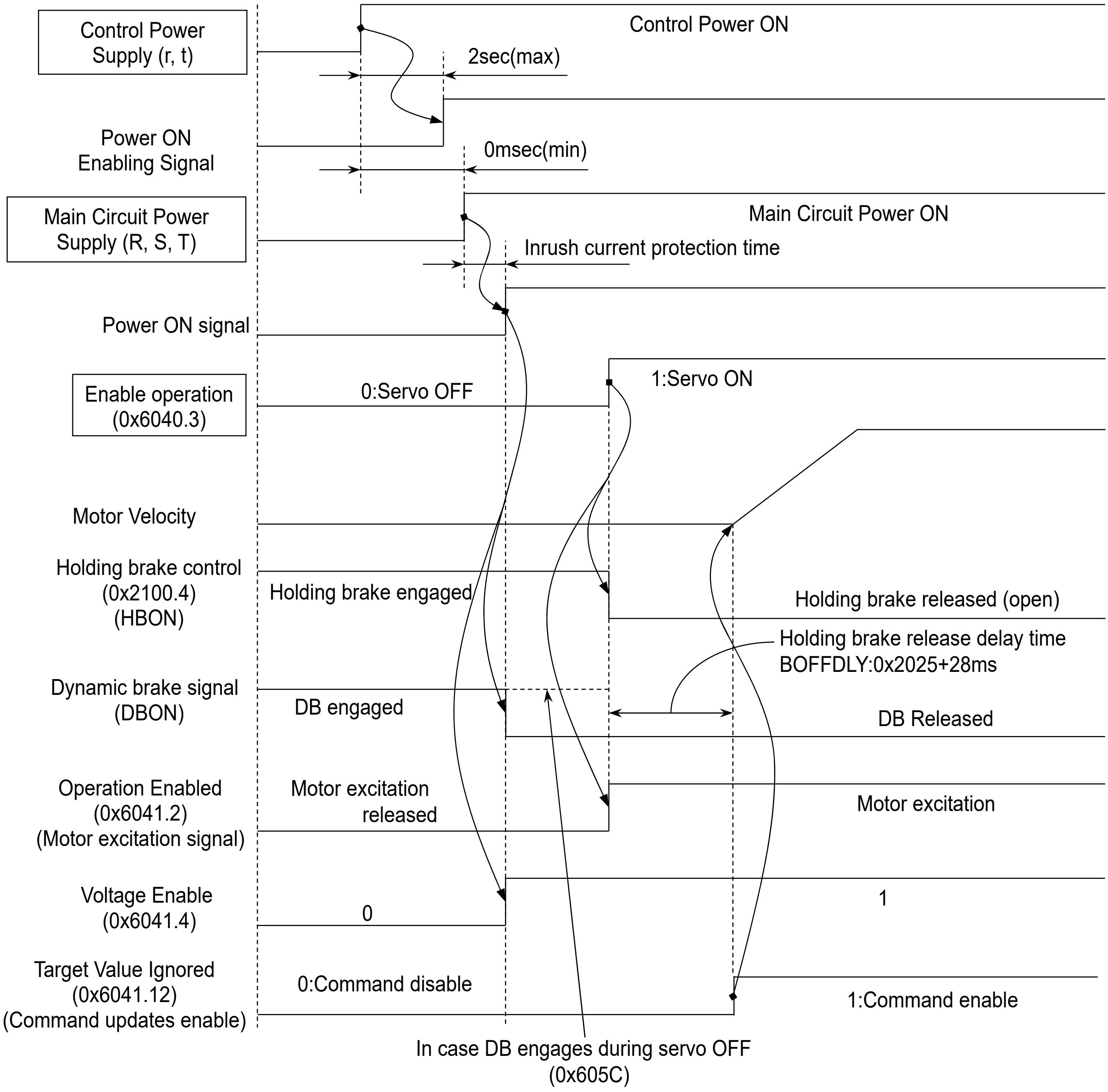


Initialization Procedure Example(Operational State)

5.4 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 prevention times of each servo amplifier capacity are as follows:

■ 200V AC input

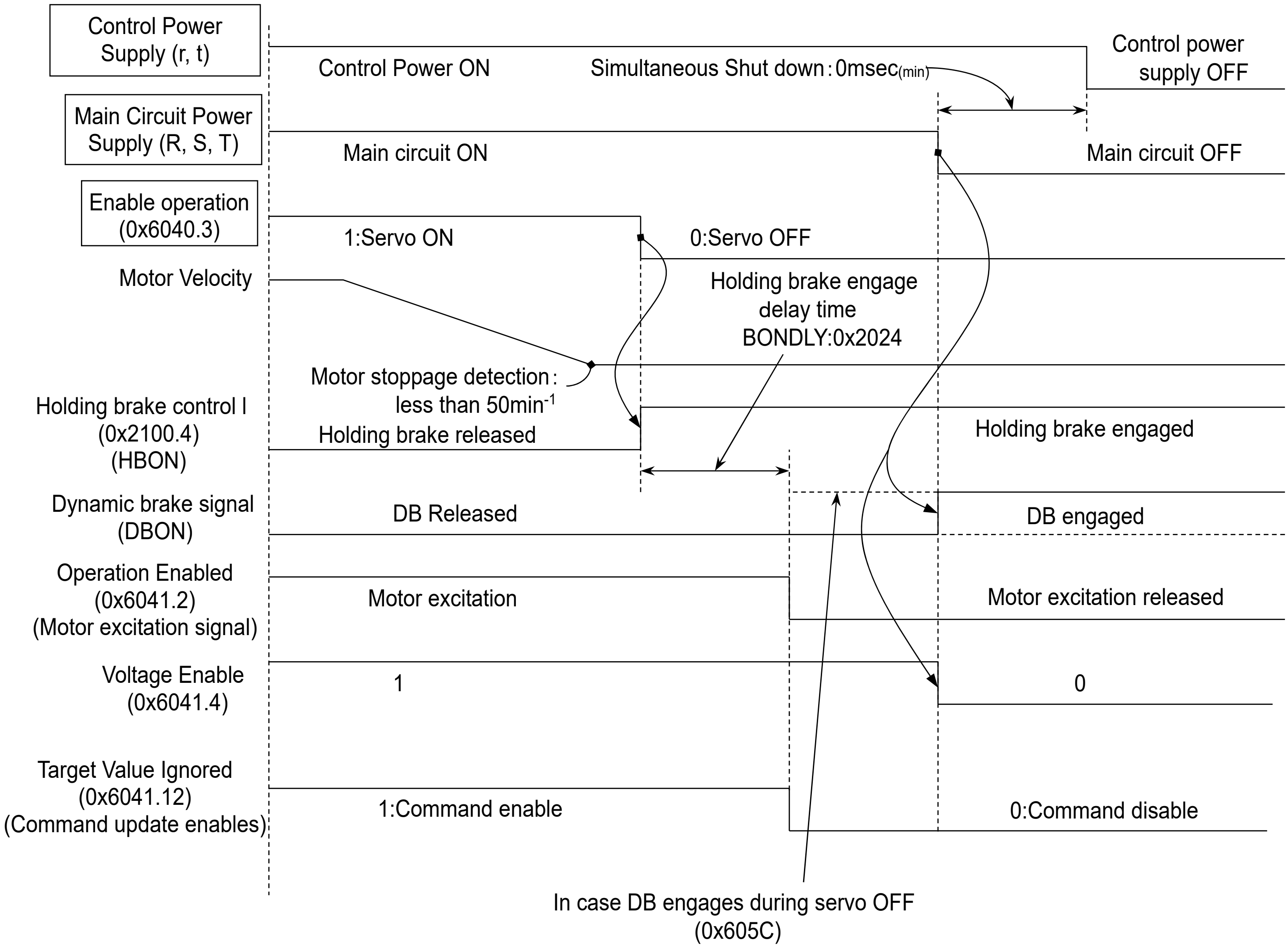
Servo amplifier capacity	Inrush current prevention time
	Three-phase
RM3DA*050#	1200 [ms]
RM3DA*100#	1200 [ms]
RM3DA*150#	1200 [ms]
RM3DA*300#	1200 [ms]
RM3DA*600#	1200 [ms]
RM3DA*900#	1200 [ms]

■ 400V ACinput

Servo amplifier capacity	Inrush current prevention time
	Three-phase
RM3DC*025#	1200 [ms]
RM3DC*050#	1200 [ms]
RM3DC*075#	1200 [ms]
RM3DC*150#	1200 [ms]
RM3DC*300#	1200 [ms]
RM3DC*600#	1200 [ms]

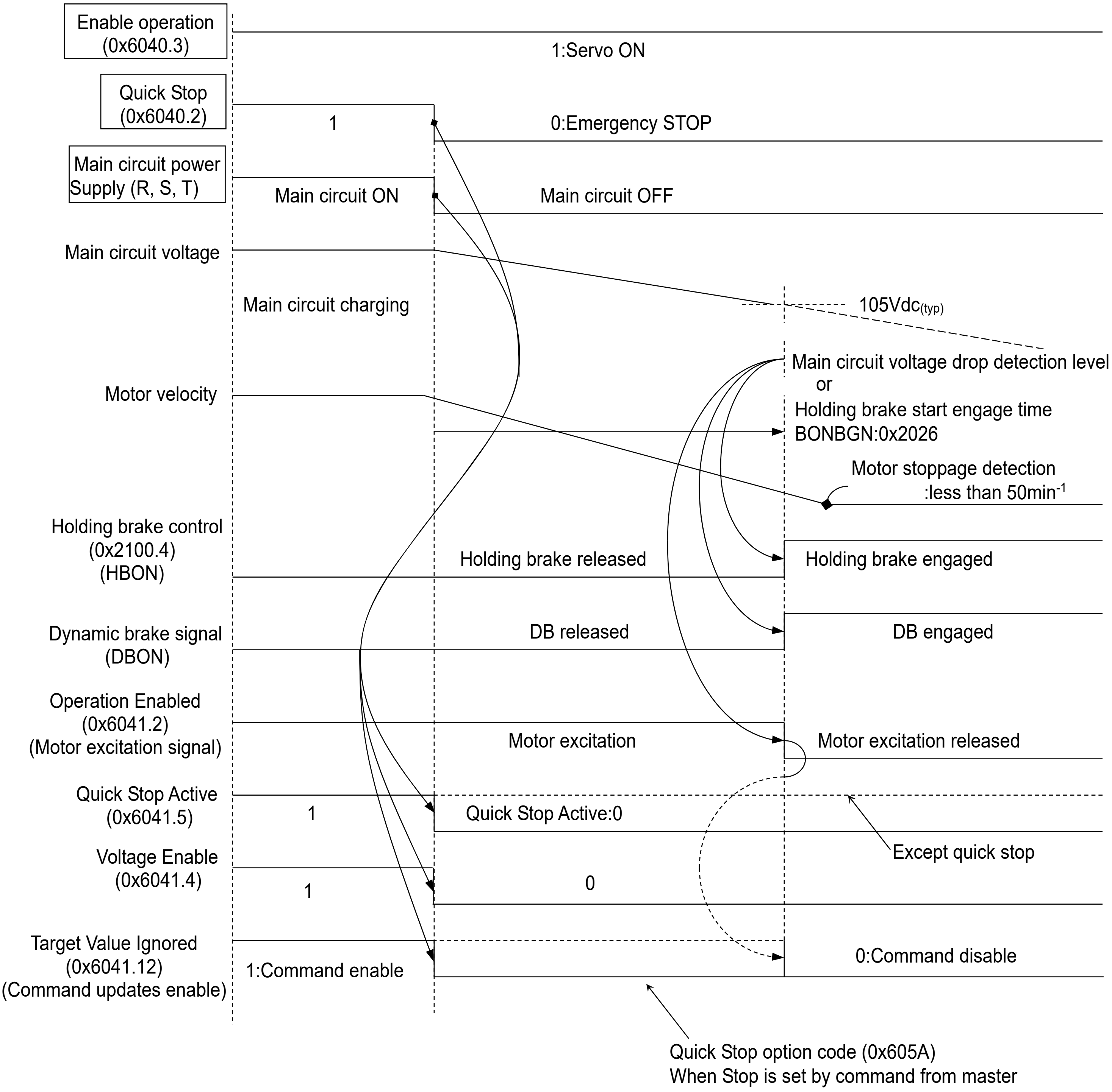
■ Servo OFF → Power OFF

Sequence in case of Servo OFF during motor rotation depends on Disable Option Code (0x605C) setting.



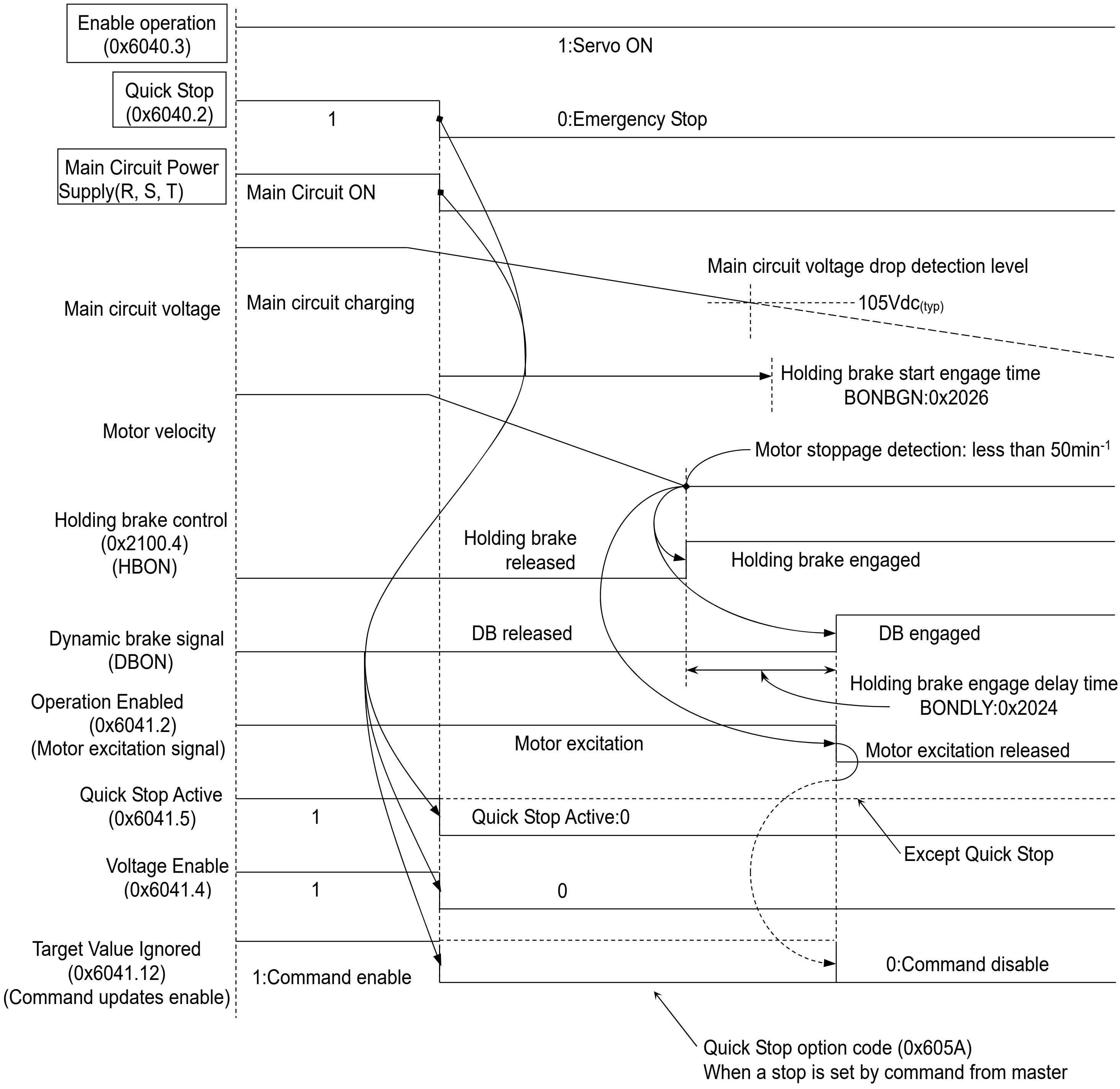
■ Main Circuit OFF, Quick STOP (Emergency STOP) Sequence

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

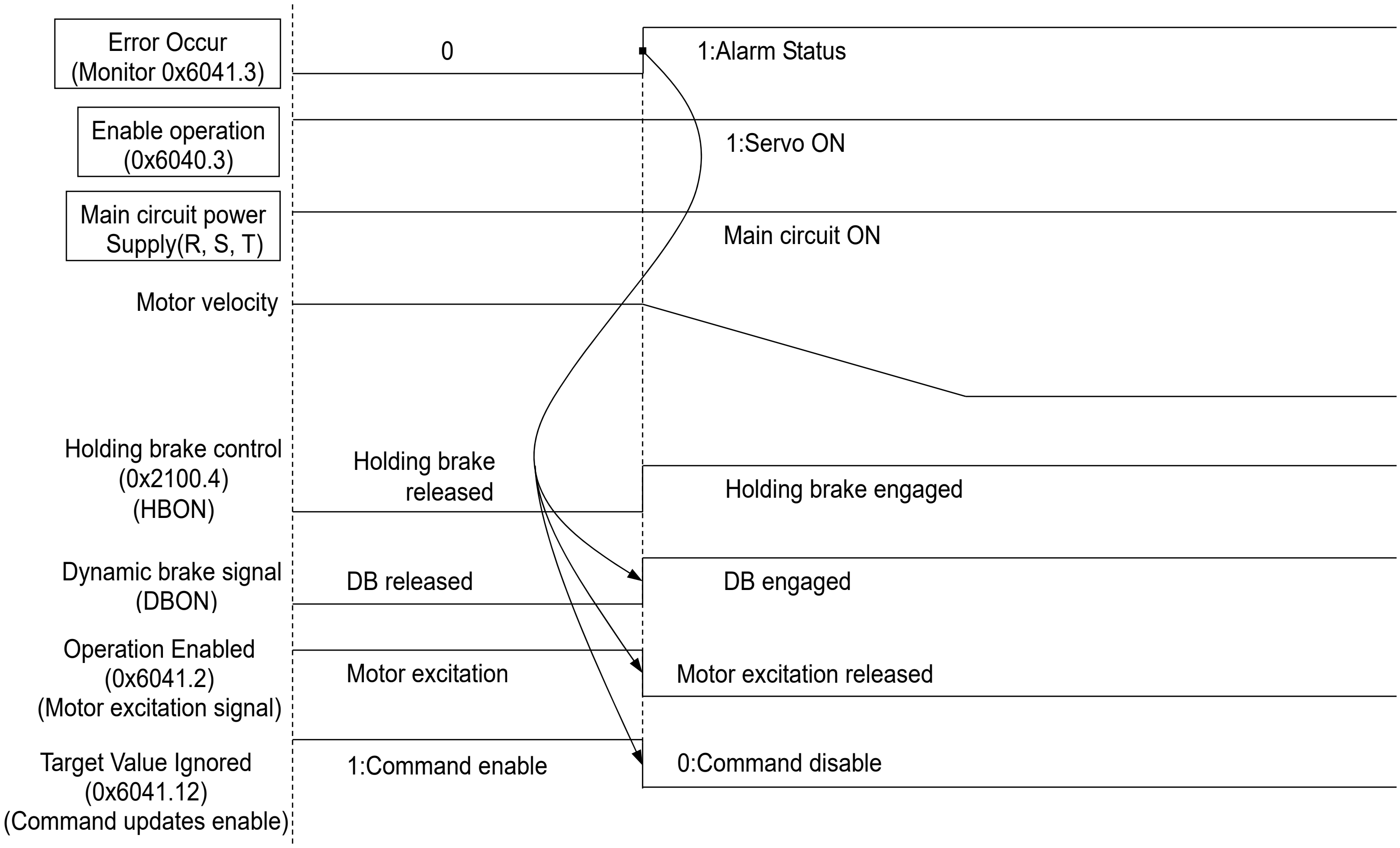
2. When motor is stopped within holding brake start engage time or before main circuit voltage drop detection



2) Alarm Occurrence Stop Sequence

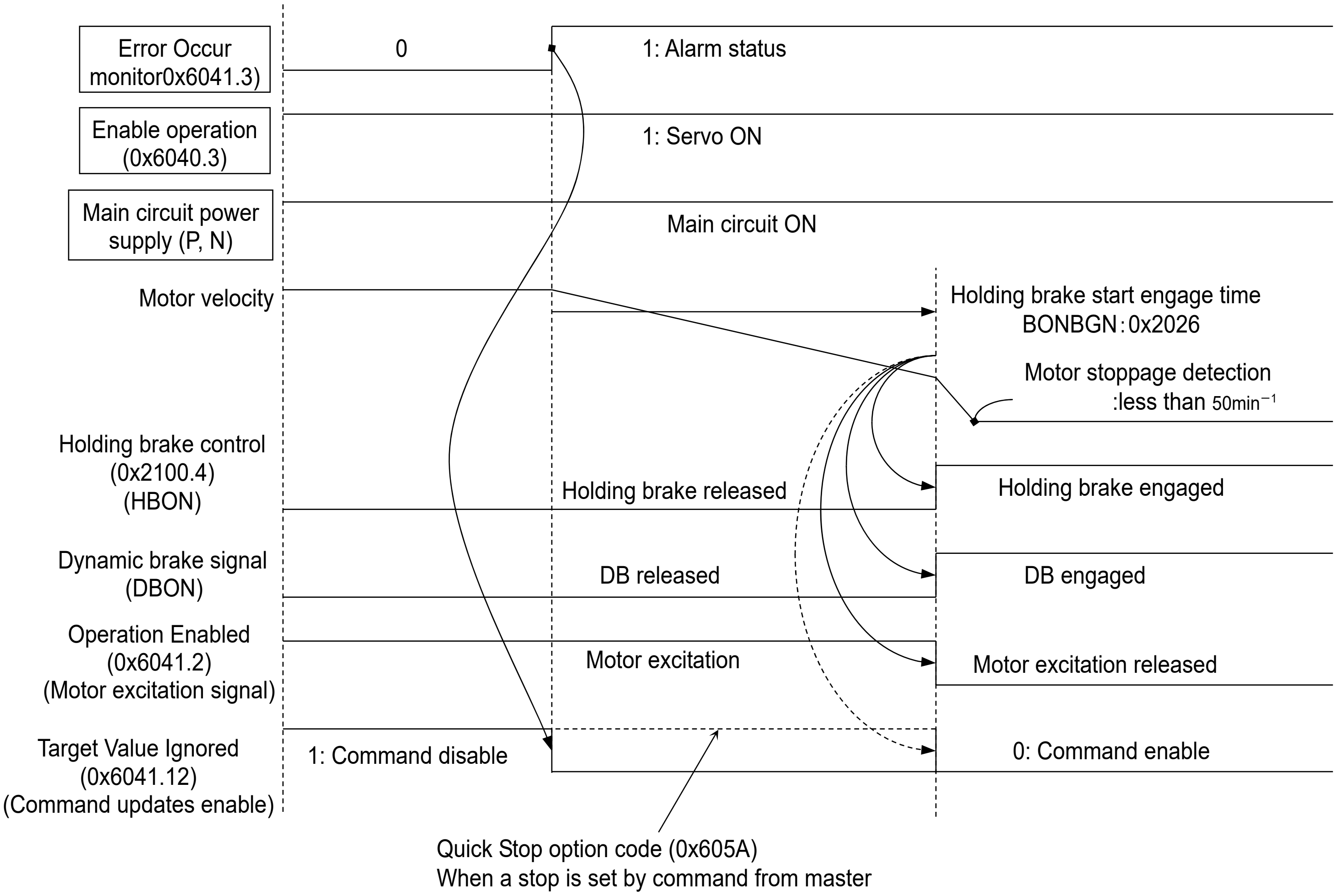
Servo motor is stopped by dynamic brake or servo brake with alarm occurrence. To stop either with dynamic brake or servo brake, please refer to “Movement of SB, DB at the time of Alarm detection” in the alarm code list. (SB: Servo brake Stop, DB: Dynamic brake Stop)
The stop method can be selected with 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 at Alarm Occurrence



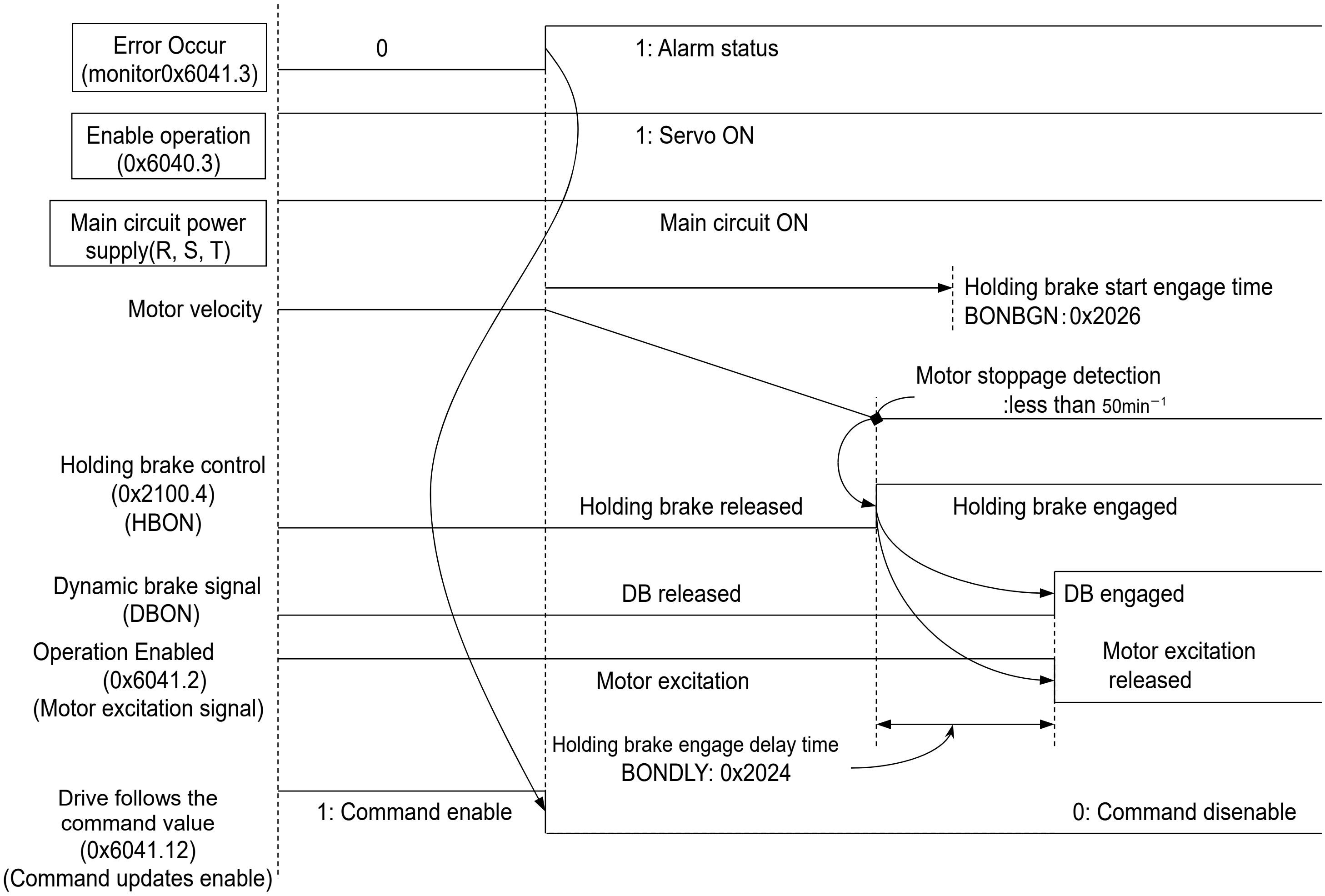
■ Stop Sequence with Servo Stop (Quick Stop option code) at Alarm Occurrence

1. When a motor does not stop with the setting value of holding brake engage start time



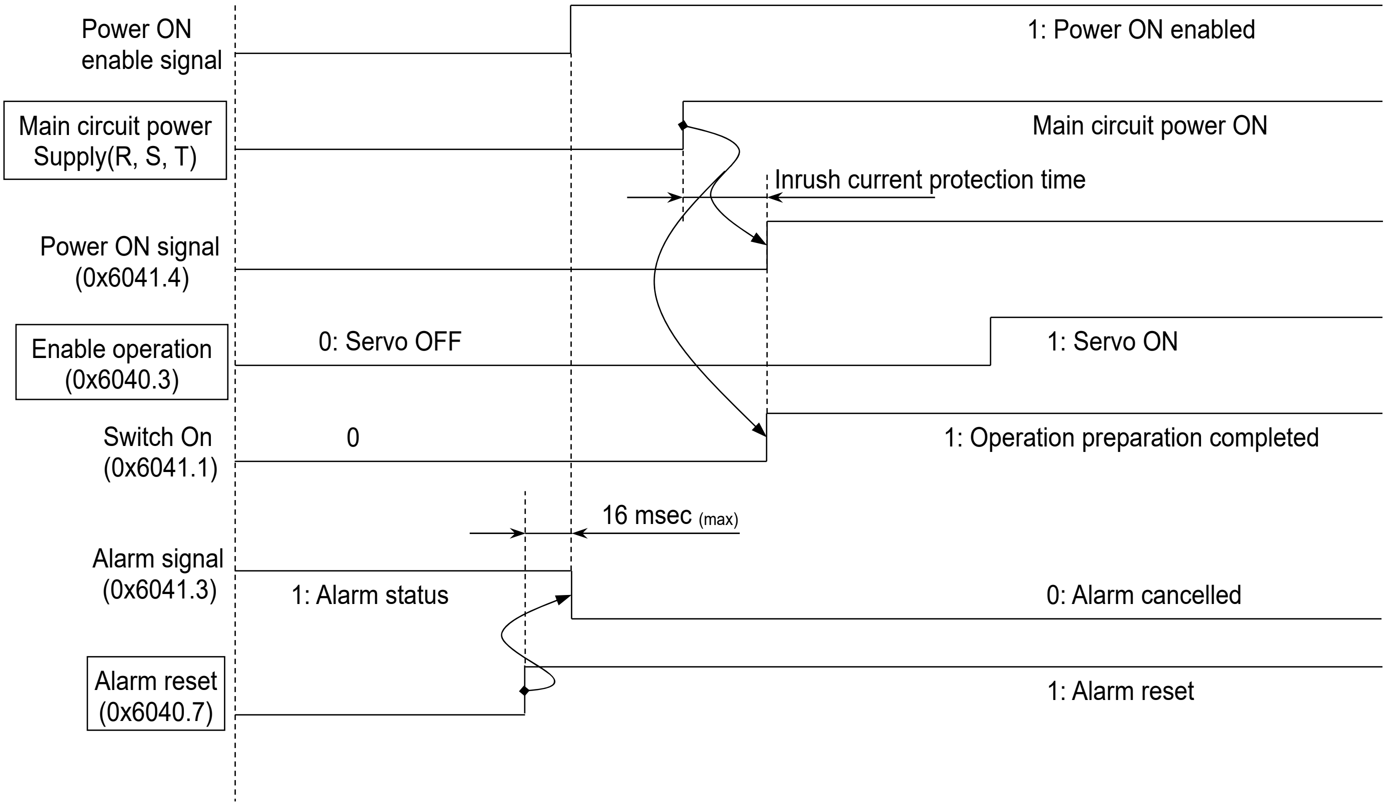
■ Stop Sequence with Servo Stop (Quick Stop option code) at Alarm Occurrence

2. When a motor has stopped with the setting value of holding brake engage start time



3) Alarm Reset Sequence

Alarm can be reset by inputting alarm reset signal from generic input signals.



* Power reset (Turn off power once and re-input) or encoder clear is required for the alarm reset depending on alarm type. Refer to “Alarm Display List (11-3)” for details.

5.5 SEMI F47 Support Functions

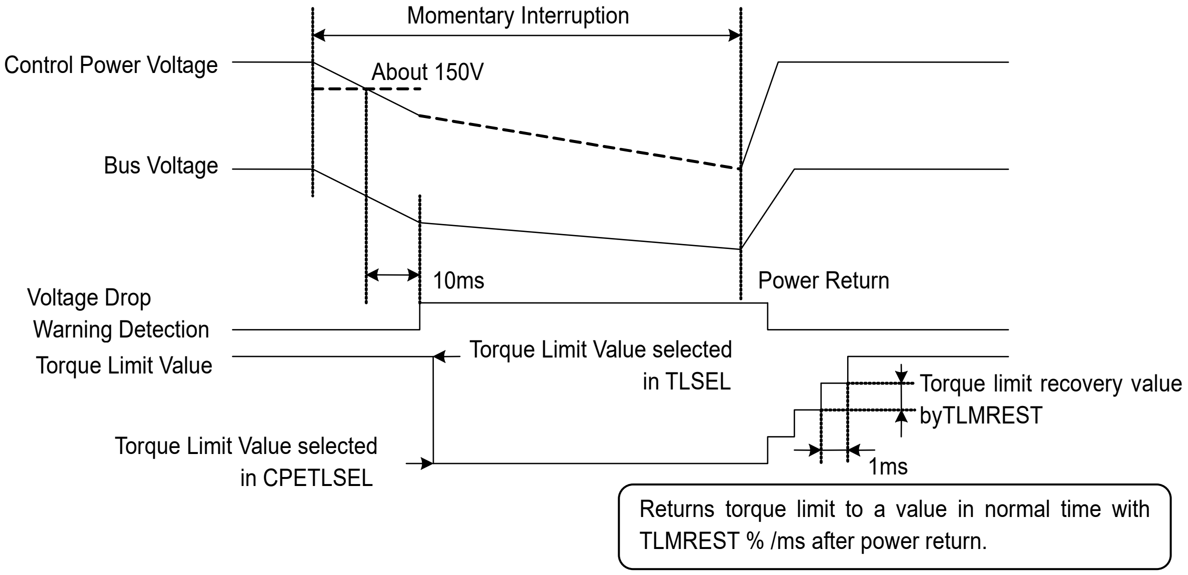
This is a function used to limit motor output current by detecting control power sag warning when momentary power interruptions of the control power supply (drop to AC135V - AC152V)are detected.
This is provided as a support function of “SEMI F47 Standard” required for semiconductor manufacturing equipment.
Stoppage by alarm at the time of momentary power interruptions can be avoided and operation can continue by combining with 0x2027:Power failure detection delay time.

1. Parameters to be set

Index	Symbol	Name	Unit	Setting range
0x20F5	CPETLSEL	Torque limit selection at the time of power drop	-	00 - 01
-	TLMREST	Torque limit recovery value at the time of power return.	%	0.0 - 500.0

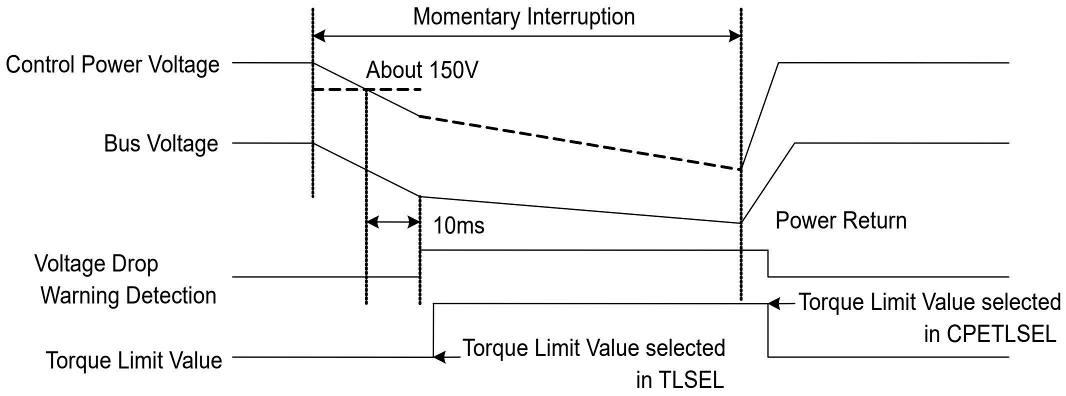
2. Operation sequence

Shows the sequence from the control power drop warning detection until the power return.



3. Remarks

Torque limit value at the time of control power drop warning must be less than the value in normal operation. Torque will be limited by selected value at the time of the power drop even if the torque limit value is larger than the value under normal operation.
Returns to torque limit value in normal operation immediately after power returns.



* This function is to limit torque under power failure and is not a function corresponding to all kinds of load conditions or operational conditions.
Please make sure to use after the operation is confirmed with actual equipment.

6.

6. Adjustments

6.1 Servo Tuning Functions and Basic Adjustment Procedure

To operate the servo motor (and machine) using the servo amplifier, adjustments of the servo gain and its control system is necessary. Generally, the higher setting value of the servo gain increases the machine response. However, if the servo gain is too high, in a lower rigidity machine, vibration may result and the machine response will not increase. The servo gain and its control system need to be appropriately adjusted according to the operating servo motor and the mechanical system and this adjustment method is called Servo tuning. Following is an explanation of the Servo tuning procedure:

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

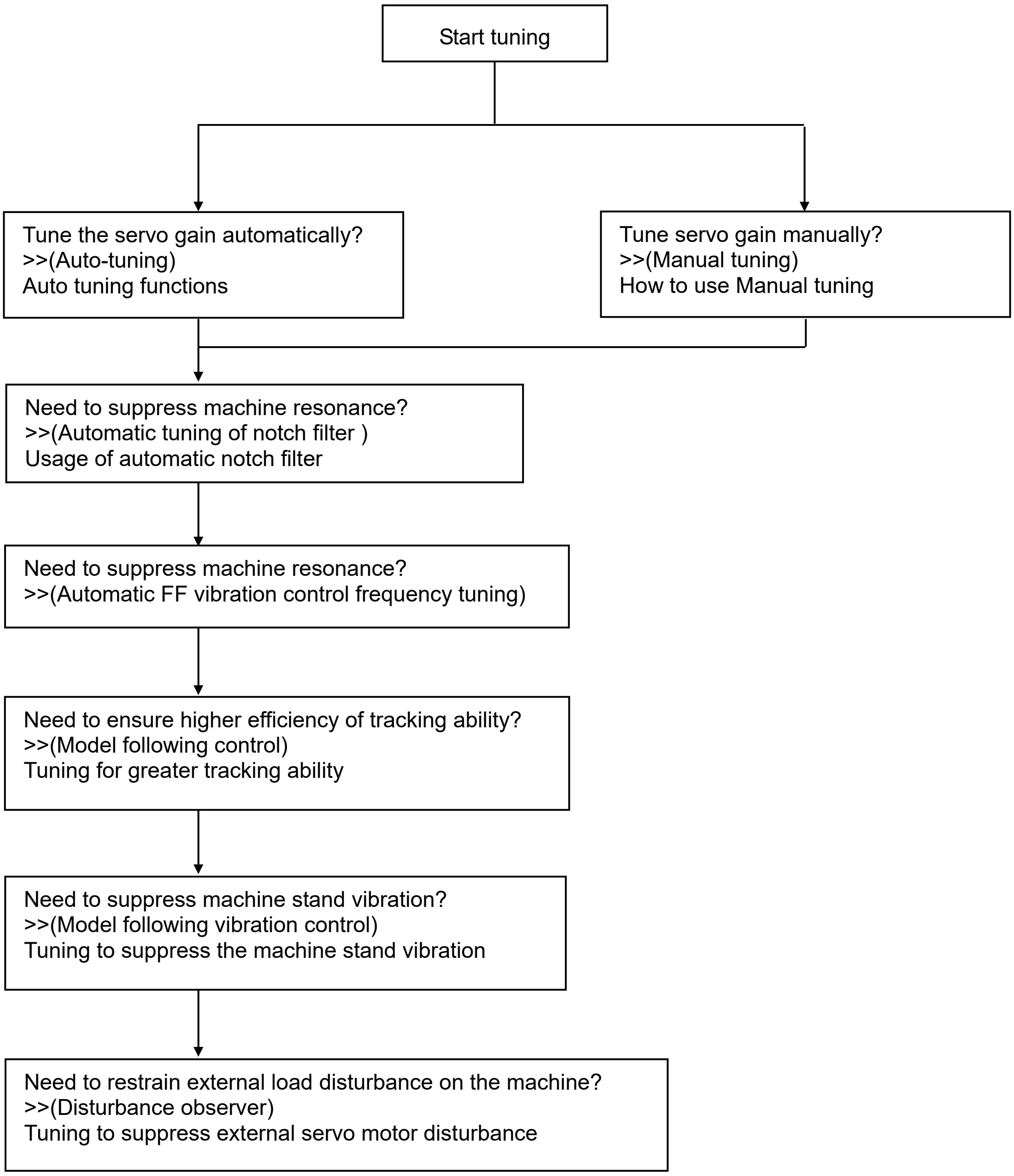
  Model following control is a control method that ensures a higher detection response by composing a model control system including the mechanical system in a servo amplifier to operate the actual servo motor in order to follow the model control system.

  - 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.

6.2 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></td><td></td><td>Auto-Tuning Characteristic [ATCHA]</td></tr>
<tr><td>01</td><td>0x2002, 0x02</td><td>
■ 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, 0x02</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>0x2002, 0x03</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	
1A	0x2011, 0x01	TCFIL1	Torque (force) Command Filter 1	

Note 1) Manual setting is available on Trajectory Control 2 (KP, FFGN Manual Setting).

Note 2) Manual setting is available on Positioning Control 3 (High Response, FFGN Manual Setting).
Manual setting is available on Positioning Control 5 (High Response, Horizontal Axis Limited, FFGN Manual Setting).
Manual setting is available on Trajectory Control 2 (KP,FFGN Manual Setting).

Note 3) Manual is available on auto-tuning [JRAT manual setting].

3) Adjustable parameters during auto-tuning

The following parameters are adjustable during auto-tuning:

■ General parameters Group1 [Basic control parameter settings]

ID	CoE Object ID	Symbol	Name
00	0x2003, 0x00	PCSMT	Position Command Smoothing Constant
01	0x2004, 0x00	PCFIL	Position Command Filter
06	0x2008, 0x02	FFFIL	Feed Forward Filter
10	0x2009, 0x00	VCFIL	Velocity Command Filter
11	0x200A, 0x00	VDFIL	Velocity Feedback Filter
21	0x202B, 0x00	TCFILOR	Torque (force) Command Filter Order

■ General parameters Group2 [FF vibration suppressor control/ Notch filter/ Disturbance observer settings]

ID	CoE Object ID	Symbol	Name
00	0x2012, 0x01	SUPFRQ1	FF Vibration Suppressor Frequency 1
01	0x202C, 0x00	SUPLV	FF Vibration Suppressor Level Selection
02	0x2040, 0x01	VCFIL_SET	Velocity Command Filter Setting
03	0x2041, 0x01	VCGFIL_SET	Velocity Command Filter Setting
04	0x2041, 0x02	VCGFIL_TYP	Type of Velocity Filter
05	0x2041, 0x03	VCGFIL_LPF	Velocity Low Pass Filter cutoff frequency *
06	0x2041, 0x04	VCGFIL_HPF	Cutoff frequency of Velocity Bypass Filter *
07	0x2041, 0x05	VCGFIL_BPFC	Center frequency of Velocity Band Pass Filter *
08	0x2041, 0x06	VCGFIL_BPFW	Band width of Velocity Band Pass Filter
09	0x2041, 0x07	VCGFIL_NCFC	Center frequency of Velocity Notch Filter *
0A	0x2041, 0x08	VCGFIL_NCFW	Band width of Velocity Notch Filter *
10	0x2040, 0x02	TCFIL_SET	Torque Command Filter Setting
11 - 30 **	0x204n, 0x01	TCGFILn_SET	General Torque Command Filter Setting n **
	0x204n, 0x02	TCGFILn_TYP	Type of Torque Filter
	0x204n, 0x03	TCGFILn_LPF	Cutoff frequency of Torque Low Pass Filter n **
	0x204n, 0x04	TCGFILn_HPF	Cutoff frequency of Torque High Pass Filter n **
	0x204n, 0x05	TCGFILn_BPFC	Cutoff frequency of Torque Band Pass Filter n **
	0x204n, 0x06	TCGFILn_BPFW	Band width of Torque Band Pass Filter n **
	0x204n, 0x07	TCGFILn_NCFC	Center frequency of Torque Notch Filter n **
	0x204n, 0x08	TCGFILn_NCFW	Band width of Torque Notch Filter n **
31	0x2016, 0x01	OBCHA	Observer Characteristic
32	0x2016, 0x02	OBG	Observer Compensation Gain
33	0x2016, 0x03	OBLPF	Observer Output Low-pass Filter
34	0x2016, 0x04	OBNFIL	Observer Output Notch Filter
35	0x2034, 0x01	PVLPFset	(Position/Velocity) command Low Pass Filter On/Off
36	0x2034, 0x02	LPF_OFF_V	Off velocity of (Position/Velocity) command Low Pass Filter

* Setting value is valid when filter on, setting type and values are correct.

** General torque filter has 1 to 4.

■ General parameters Group4 [Gain switching control/Vibration suppressor frequency switching settings]

ID	CoE Object ID	Symbol	Name
40	0x2012, 0x02	SUPFRQ2	FF Vibration Suppressor Frequency 2
41	0x2013, 0x03	SUPFRQ3	FF Vibration Suppressor Frequency 3
42	0x2013, 0x04	SUPFRQ4	FF Vibration Suppressor Frequency 4

■ General parameters Group5 [High setting control setting]

ID	CoE Object ID	Symbol	Name
00	0x2015, 0x01	CVFIL	Command Velocity Low-pass Filter
01	0x2015, 0x02	CVTH	Command Velocity Threshold
02	0x2015, 0x03	ACCC0	Acceleration Compensation
03	0x2015, 0x04	DFCC0	Deceleration Compensation

4) Unstable functions during auto-tuning

The following functions cannot be used during auto-tuning:

■ General parameters Group1 [Basic control parameter setting]

ID	CoE Object ID	Symbol	Name
04	0x2007, 0x00	TRCPGN	Higher Tracking Control Position Compensation Gain
16	0x200E, 0x00	AFBK	Acceleration Feedback Gain

* [Disturbance observer] cannot be used together with auto-tuning.
Render [Disturbance observer] function invalid when auto-tuning is used.

■ Parameter characteristics for EtherCAT objects

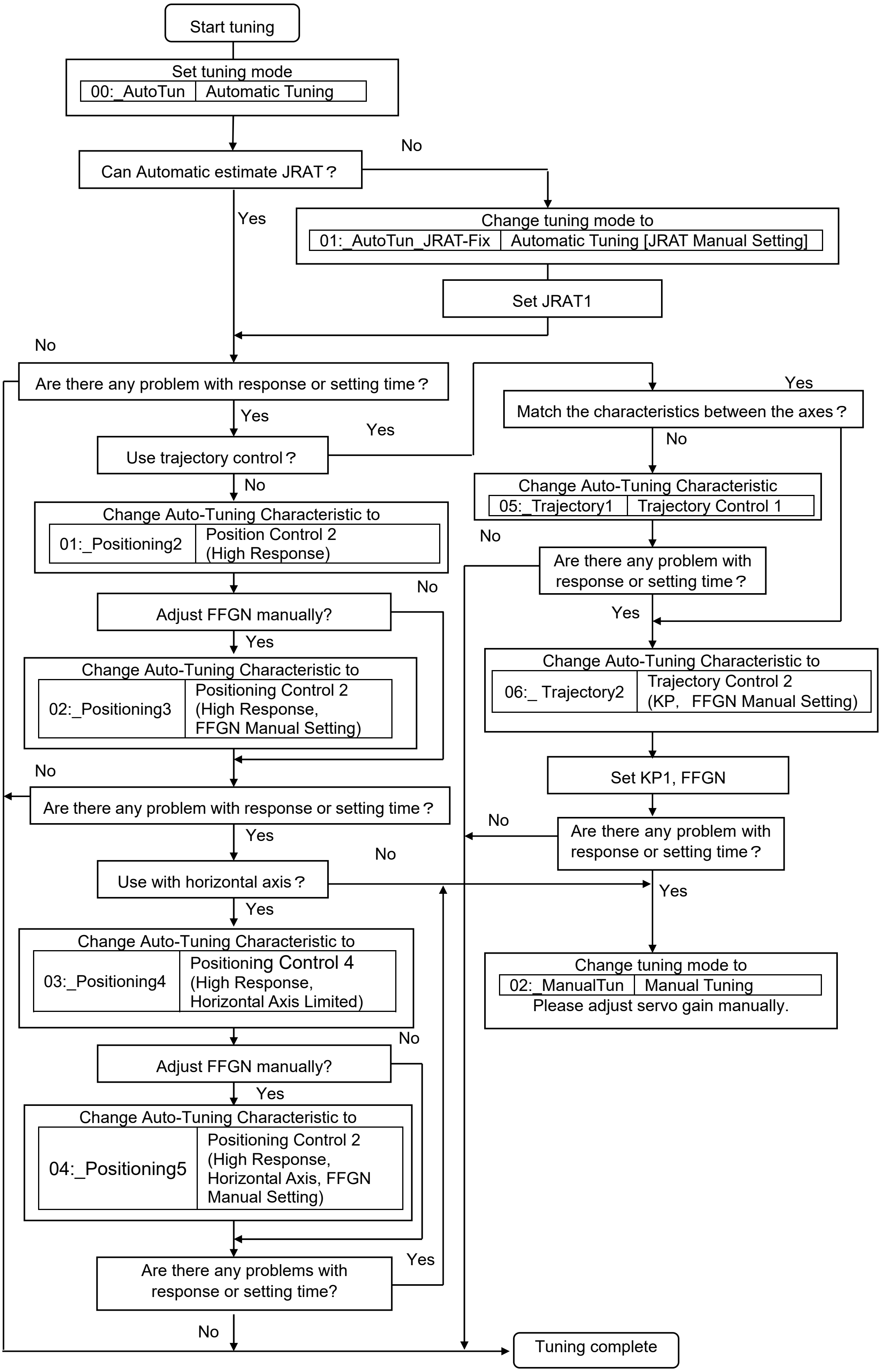
ID	CoE Object ID	Symbol	Name
-	0x2001, 0x00 bit5-4	GC	Gain Switching Selection
-	0x2000, 0x00 bit1	PPCON	Position Loop Proportional Control Switching Function
-	0x2000, 0x00 bit2	PCON	Velocity Loop Proportional Control Switching Function

5) Adjustment method for auto-tuning

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

Procedure 1	■ 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	%
1A	0x2011, 0x01	TCFIL1	Torque (force) Command Filter 1	Hz

◆ General parameters Group3 [Model following control settings]

ID	CoE Object ID	Symbol	Name	Unit
00	0x2017, 0x01	KM1	Model Control Gain 1	1 / s

6.3 Automatic tuning of notch filter

Automatic notch filter can suppress high frequency resonance resulting from coupling and rigidity from the device mechanism.
With short periods of operation of servo amplifier and servo motor, the mechanical resonance frequency can be found easily.

1) Operation method

- ■ Operate from Auto-tuning mode in Software Setup.
- ■ The tuning results are saved automatically in [Group2 ID17: Center frequency of Torque (force) Notch Filter1.
  - * Torque (force) command notch filter function can be used together with Auto-tuning.
  - * Holding torque (force) falls while auto notch filter is running. Do not use as a gravity axis.
- ■ When resonance of the device does not stop even after using Automatic tuning of notch filter, there may be two or more resonance points.
  In this case, inquire about the resonance frequency using the system analysis function and insert Notch filter 2, 3, 4 (Manual setting) to suppress each resonance. If resonance is still not suppressed, there is a possibility that auto-tuning response or gain control is too high. Lower the Auto-Tuning Response or control gain.

2) Setting parameters

■ Torque (force) command value for notch filter tuning
Setting the Torque (force) command value to the motor at the time of Automatic tuning of notch filter:

◆ General parameters Group0 [Auto-tuning settings]

ID	CoE Object ID	Symbol	Name	Unit	Setting range
10	—	ANFILTC	Automatic tuning of notch filter Torque (force) Command	%	10.0 - 100.0

* As the value increases so does tuning accuracy. However, machine movement will increase as well. Please monitor it closely.

■ Automatically saving parameters with Automatic tuning of notch filter

◆ General parameters Group2 [FF vibration suppressor control/Notch filter/ Disturbance observer settings]

ID	CoE Object ID	Symbol	Name	Unit	Setting range
13	0x2042，0x03	TCGFIL1_LPF	Cutoff frequency of Torque Low Pass Filter n **	Hz	10 - 2000

* The above parameter is saved automatically with Automatic tuning of notch filter

6.4 Automatic tuning of FF Vibration Suppression Frequency

Set FF vibration suppressor frequency to suppress low frequency vibration at the tip or body of the machine. Automatic tuning of FF Vibration suppression frequency simply enables the frequency tune in minimal motion cycle time between the servo amplifier and the servo motor.

1) Operation method

■ Operate from Auto-tuning mode in Software Setup.

■ The tuning result is automatically saved in Group2 ID00: FF Vibration suppressor frequency 1 ［SUPFREQ1］.

■ FF vibration suppressor frequency is obtained by executing auto-tuning of vibration suppressor frequency or by calculating vibration frequency from the mechanical vibration period at the time of positioning.

* When vibration does not stop with FF vibration suppressor frequency, there is a possibility that the gain for control system may be too high. In this case, lower the control system gain.

* When used together with Higher Tracking Control Velocity Compensation Gain, vibration- suppressor effect may be improved.

* FF vibration suppressor control function can be used with auto-tuning.

* Holding torque (force) falls while Automatic tuning of FF Vibration Suppression Frequency is executing. Do not use as gravity axis.

2) Setting parameters

■ Torque (force) command value of Auto-FF vibration suppressor frequency
Sets torque (force) command value to servo motor at the time of Automatic tuning of FF Vibration Suppression Frequency execution.

◆ General parameters Group0 [Auto-tuning setup]

ID	CoE Object ID	Symbol	Name	Unit	Setting range
11	-	ASUPTC	Automatic tuning of FF Vibration Suppression Frequency Friction torque (force) Compensation Value	%	10.0 - 100.0

* As the value increases so does tuning accuracy. However, machine movement will increase as well. Please monitor it closely.

■ Friction torque (force) compensation amount during Automatic tuning of FF Vibration Suppression Frequency.
Sets additional frictional torque (force) compensation amount when Automatic tuning of FF Vibration Suppression Frequency is executed.
By setting the value close to the actual friction torque (force), the accuracy of Automatic tuning of FF Vibration Suppression Frequency can be improved.

◆ General parameters Group0 [Auto-tuning setup]

ID	CoE Object ID	Symbol	Name	Unit	Setting range
12	-	ASUPFC	Automatic tuning of FF Vibration Suppression Frequency Friction torque (force) Compensation Value	%	0.0 - 50.0

■ Automatically saved parameter of Automatic tuning of FF Vibration Suppression Frequency.

◆ General parameters Group2 [FF vibration suppressor control/Notch filter/ Disturbance observer settings]

ID	CoE Object ID	Symbol	Name	Unit	Setting range
00	0x2012, 0x01	SUPFRQ1	FF Vibration Suppressor Frequency 1	Hz	5 - 500

6.5 Using Manual Tuning

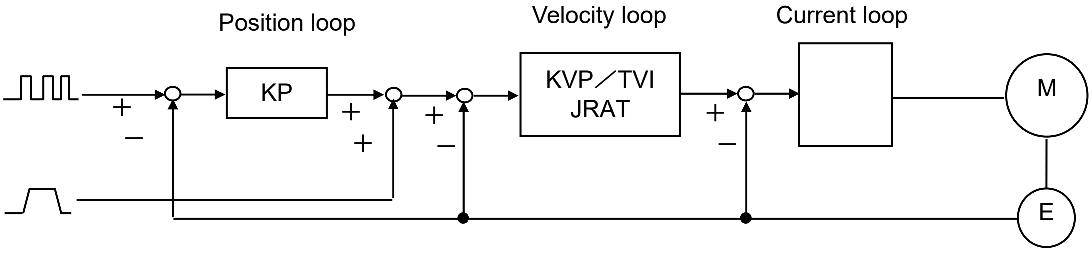
All gain is adjustable manually using manual tuning mode when characteristics in auto-tuning are insufficient.
Sets the Tuning Mode to Manual tuning.

■ General parameters Group0 ID00: Tuning Mode Index:0x2002, Sub-Index:0x01 [TUNMOD]

02:_ManualTun	Manual Tuning

1) Servo system structure and servo adjustment parameters

The servo system consists of three (3) subsystems: Position loop, Velocity loop and Current loop.
Higher response is required for internal loops. If this structure is compromised, it could result in instability, low response, vibration or oscillation.



Explains each servo parameter (Group 1) below

■ Position Command Smoothing Constant Index:0x2003, 0x00 [PCSMT]
This moving low-pass filter smoothes the position command pulse. Sets time constants.
The position command pulse will become smoother by setting this parameter when the communication cycle is long.

■ Position Command Filter Index:0x2004, 0x00 [PCFIL]
When the position command resolution is low, set this parameter to suppress the ripples contained in the position command. A larger value of this parameter will cause a greater ripple suppressing effect; however, delay will be increased.

* When Higher Tracking Control Position Compensation Gain is set to other than 0%, this parameter is automatically set.

■ Position Loop Proportional Gain Index:0x2005, 0x01 - 0x04 [KP]
Sets the response of Position control.
Set this to: $KP_{[1/S]} = KVP_{[Hz]} / 4 \cdot 2\pi$

■ Higher Tracking Control Position Compensation Gain Index:0x2007, 0x00 [TRCPGN]
When the tracking effect needs to be improved under high resolution of position command, increase this parameter after adjustment of Higher Tracking Control Velocity Compensation Gain.

■ Feed Forward Gain Index:0x2008, 0x01 [FFGN]
The tracking effect of position command can be improved by increasing this gain. Under positioning control, set this to approximately 30 - 40% as the standard.
* When Higher Tracking Control Position Compensation Gain is set to other than 0%, this parameter is automatically set.

■ Feed Forward Filter Index:0x2008, 0x02 [FFFIL]
When position command resolution is low, set this parameter to suppress ripples.

■ Velocity Loop Proportional Gain Index:0x200B, 0x01 - 0x04 [KVP]
Sets the response of Velocity control. Set this parameter as high as possible within a stable operating range that does not cause vibration or oscillation.
If JRAT is accurately set, the set value of KVP becomes the Velocity loop response zone.

■ Velocity Loop Integral Time Constant Index:0x200C, 0x01 - 0x04 [TVI]
Set this to: $TVI_{[ms]}=1000 / (KVP_{[Hz]})$

- ■ Load inertia moment ratio Index:0x200D, 0x01 - 0x04 [JRAT]
  Set this value to the calculation shown below:

$$\text{JRAT} = \frac{\text{Motor axis converted load inertia } (J_L)}{\text{Motor rotor inertia } (J_M)} \times 100\%$$

- ■ Higher Tracking Control Velocity Compensation Gain Index:0x2007, 0x00 [TRCVGN]
  Tracking effect can be improved by increasing compensation gain.
  Adjust this to shorten the position setting time.
  - * Set the value of JRAT properly to use this function.
  - * Set 0% when you use [Velocity Loop Proportional Control Switching Function] during operation.
  - * Set at 100% to equal Q-series servo amplifier.

- ■ Torque (force) Command Filter Index:0x2011, 0x01
  When rigidity of the mechanical device is high, set this value high and the Velocit0 Loop Proportional Gain can also be set higher. When the rigidity of the mechanical device is low, set this value low and resonance in the high frequency zone as well as abnormal sound can be suppressed. For normal usage, set this below 1200Hz.

2) Basic manual tuning method for velocity control

- ■ Set Velocity Loop Proportional Gain(0x200B, 0x01) (KVP1) as high as possible within the range that allows the mechanical device to maintain stability without causing vibration or oscillation.
  If vibration increases, lower the value.

- ■ Set Velocity Loop Integral Time Constant (0x200C, 0x01) (TV1) to: TVI [ms]=1000/(KVP[Hz])
  - * When you cannot increase the gain because of mechanical resonance, etc., and the response is insufficient (after using the Torque notch filter and/or FF vibration suppressor frequency to suppress resonance) try the procedure again.

3) Basic manual tuning method for position control

- ■ Set Velocity Loop Proportional Gain (0x200B, 0x01)(KVP1) as high as possible within the range that allows the mechanical device to maintain stability without causing vibration or oscillation.
  If vibration increases, lower the value.
- ■ Set Velocity Loop Integral Time Constant (0x200C, 0x01)(TVI1) to: $\text{TVI}_{[ms]}=1000 / (\text{KVP}_{[Hz]})$
- ■ Position Loop Proportional Gain (0x2005, 0x01)(KP1) to: $\text{KP}_{[1/S]} = \text{KVP}_{[H]}/4 \cdot 2\pi$
  In case vibration occurs, lower the value.
  - * When you cannot increase the gain because of mechanical resonance, etc., and the response is insufficient (after using the Torque notch filter and/or FF vibration suppressor frequency to suppress resonance) try the procedure again.

6.6 Model Following Control

Model following control is a method used to obtain a higher response. Model control systems include mechanical devices in a servo amplifier and run a servo motor in order to track the Model control system.
Select [Position control form] in [Control mode]
Select [Model following control] in [Position control selection]

<table>
<tr><th>ID</th><th>CoE Object ID</th><th>Content</th></tr>
<tr><td rowspan="2">0A</td><td rowspan="2">0x20F3, 0x01</td><td>Position Control Selection</td></tr>
<tr><td><table><tr><th colspan="2">Select value</th><th>Content</th></tr><tr><td>01</td><td>Model1</td><td>Model following control</td></tr></table></td></tr>
</table>

- * Model following control cannot be used when in velocity control mode or torque (force) control mode.
- * Model following control can be used with auto-tuning.
- * Model following control can be used with full-closed control.

1) Automatic tuning method for Model following control

The Model following control can be used in conjunction with the Auto-tuning.
Follow the tuning procedure shown in [Adjustment method for auto-tuning].
Model Control Gain 1 is tuned in addition to tuning the parameter at Standard position control.

■ Automatically adjust parameters using Model following control auto-tuning.

◆ General parameters Group1 [Basic control parameter settings]

ID	CoE Object ID	Symbol	Name	Notes
02	0x2005, 0x01	KP1	Position Loop Proportional Gain 1	Note 1)
12	0x200B, 0x01	KVP1	Velocity Loop Proportional Gain 1	
13	0x200C, 0x01	TVI1	Velocity Loop Integral Time Constant 1	
14	0x200D, 0x01	JRAT1	Load Inertia Moment Ratio 1	Note 2)
1A	0x2011, 0x01	TCFIL1	Torque (force) Command Filter 1	

Note 1) Manual setting is available in Trajectory Control 2 [KP, FFGN manual setting]
Note 2) Manual setting is available in Automatic Tuning [JRAT Manual Setting]

◆ General parameters Group3 [Model following control settings]

ID	CoE Object ID	Symbol	Name	Notes
00	0x2017, 0x01	KM1	Model Control Gain 1	Note 3)

Note 3) KP1 setting value is set in Trajectory Control 2 [KP, FFGN Manual Setting]

* Parameters automatically adjusted by the servo amplifier vary according to selected Auto-Tuning Characteristic.

2) Manual tuning method for Model following control

- Set Velocity Loop Proportional Gain (0x2005, 0x01)(KVP1) at as high a value as possible within a stable range that will not cause vibration or oscillation. If vibration increases, lower the value.
- Set Velocity Loop Integral Time Constant (0x200C, 0x01)(TVI1) to: $TVI_{[ms]}=1000/(KVP_{[Hz]})$.
- Set Position Loop Proportional Gain (0x2005, 0x01)(KP1) to: $KP_{[1/S]}=KVP_{[Hz]} / 4 \cdot 2\pi$.
- 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.

6.7 Tuning to Suppress Vibration

1) FF vibration suppressor control

FF vibration suppressor control can be used as a method of suppressing the vibration of the mechanical tip.

- ■ Adjust this gain by using the same basic tuning procedures from Position control.
- ■ When vibration rises on the machine tip during operation, use [Auto-FF vibration suppressor frequency tuning] or calculate the vibration frequency from the vibration period and set the vibration frequency to [FF vibration suppressor frequency (SUPFRQ1)].

◆ General parameters Group2 [FF vibration suppressor control/Notch filter/ Disturbance observer settings]

ID	CoE Object ID	Symbol	Name	Unit	Setting range
00	0x2012, 0x01	SUPFRQ1	FF Vibration Suppressor Frequency 1	Hz	5 - 500

* If the machine tip vibration does not stop after taking the above steps, there is a possibility the gain for the control system could be too high. In this case, lower the Control system gain.

* Do not change the Setting value when the motor is running.

2) Model tracking vibration suppressor control

When you use the servo motor to drive tables on a machine stand, the stand itself may vibrate as a reciprocal reactor of the motor.
When the machine stand vibrates, the vibration may cause a reaction with the Positioning stabilizing time of the table working on the stand.
Model following vibration suppressor control suppresses this type of machine stand vibration and improves Position stabilization time and response.

- ■ When you use Model following vibration suppressor control, select Position control at Control Mode Selection and Model following vibration suppressor control at Position Control Selection at System parameters.
You can run the servo motor under the condition that the machine stand vibration is suppressed using Model control system.

<table>
<tr><th>ID</th><th>CoE Object ID</th><th>Contents</th></tr>
<tr><td rowspan="2">0A</td><td rowspan="2">0x20F3, 0x01</td><td>Position Control Selection</td></tr>
<tr><td><table><tr><th colspan="2">Select value</th><th>Contents</th></tr><tr><td>02</td><td>Model2</td><td>Model Following Vibration Suppress Control</td></tr></table></td></tr>
</table>

* Do not use Auto-tuning with Model following vibration suppressor control.

* Full-closed control cannot be used with Model following vibration suppressor control.

* Model following vibration suppressor control cannot be used when in Velocity control mode or Torque (force) control mode.

■ Adjustable parameters in Model following vibration suppressor control

◆ General parameters Group3 [Model following control settings]

ID	CoE Object ID	Symbol	Name	Unit	Setting range
00	0x2017, 0x01	KM1	Model Control Gain 1	1 / s	15 - 315
01	0x2018, 0x01	OSSFIL	Overshoot Suppressor Filter	Hz	1 - 4000
02	0x2019, 0x01	ANRFRQ1	Model Control Antiresonance Frequency 1	Hz	10.0 - 80.0
03	0x201A, 0x01	RESFRQ1	Model Control Resonance Frequency 1	Hz	10.0 - 80.0

◆ Model Control Gain 1 Index:0x2017, 0x01 [KM1]
This is the proportional gain of the Model following controlling position controller and set response for Model control system.

◆ Overshoot Suppressor Filter Index:0x2018, 0x01 [OSSFIL]
This parameter is to set the cutoff frequency of the Overshoot suppressor filter in Model following vibration suppressor control. If overshoot occurred on a position deviation, lower the setting value.

◆ Model Control Antiresonance Frequency 1 Index:0x2019, 0x01 [ANRFRQ1]
This is to set the Anti-resonance frequency of the machine using Model following vibration suppressor control.
When the value is set higher than Model Control Resonance Frequency, vibration suppressor control will be invalid.

◆ Model Control Resonance Frequency 1 Index:0x201A, 0x01 [RESFRQ1]
This is to set the Resonance frequency of the machine model using Model following vibration suppressor control.
Vibration suppressor control will be invalid at 80.0Hz.

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

■ Parameter setting range for Model following vibration suppressor control
Setting ranges for the following parameters are restricted:

◆ General parameters Group1 [Basic control parameter settings]

ID	CoE Object ID	Symbol	Name	Unit	Setting Range
14	0x200D, 0x01	JRAT1	Load Inertia Moment Ratio 1	%	100 - 3000
1A	0x2011, 0x01	TCFIL1	Torque (force) Command Filter 1	Hz	10-600

◆ General parameters Group3 [Model following control settings]

ID	CoE Object ID	Symbol	Name	Unit	Setting Range
00	0x2017, 0x01	KM1	Model Control Gain1	1 / s	15 - 315

3) Tuning methods

- First, execute Model following control auto-tuning by selecting [01:_Model following control] in [Position Control Selection(0x20F3, 0x01)(ID07)] at System parameters and tune the machine with the best servo gain.
  Refer to Auto-tuning method in Model following control for instructions on tuning.

  * When the best servo gain for the machine has been selected, ignore this step.

- When servo gain tuning is completed, please change tuning mode to manual tuning after performing an auto tuning result storing function.

- After completing servo gain tuning, set the Resonance frequency and Anti-resonance frequency of the mechanical device using [02:_ Model following vibration suppressor control] in [Position Control Selection (0x20F3, 0x01)(ID07)] at System parameters.
  When anti-resonance and resonance frequencies are already known, set the values. When these values are unknown, these frequencies can be measured using System analysis.

  * Refer to MOTOR Setup Software Instruction manual M0010842 for instructions on using System analysis.
  * When you measure the anti-resonance and resonance frequencies using System analysis, set the [Frequency range selection] in the low range.
    If you set the range in a high range, the ant-resonance and resonance frequencies in suppressible ranges created by the Model following vibration suppressor control may not be measured.
    1 - 125Hz for [Frequency range selection] is recommended.
  * When the mass of the drive motor is smaller than the machine stand mass, the anti-resonance and resonance frequencies may not be measured in system analysis. In this case, obtain the vibration frequency (Model anti-resonance frequency) by calculating the machine vibration period of the vibrating point at positioning and its reciprocal and set the model resonance frequency 1.05 - 1.2 times the anti-resonance frequency.

- Set the Velocity Loop Proportional Gain (0x200B,0x01)(KVP1) as high as possible within stable range without causing vibration or oscillation. If vibration increases, lower the value.
- Set the Velocity Loop Integral Time Constant (0x200C, 0x01)(TVI1) to: $TVI_{[ms]}=1000/(KVP_{[Hz]})$.
- Set the Position Loop Proportional Gain (0x2005, 0x01)(KP1) to: $KP_{[1/S]}=KVP_{[Hz]}/4\cdot 2\pi$.
- Set the Model Control Gain (0x2017, 0x01)(KM1) to: $KM \fallingdotseq KP$. If vibration increases, lower the value.
- Set the Model Control Gain (0x2017, 0x01)(KM1) value to: 1.1 - 1.2times when the response is low.
- Depending on the mechanical system, there may be two or more frequency vibrations aside from anti-resonance and resonance frequencies that have already been set.
  In this case, the vibration can be suppressed using FF vibration suppressor controls together. Set the vibration frequency to: [Group02 ID00 : FF vibration suppressor frequency 1(0x2012, 0x01)(SUPFRQ1)] by calculating the frequency from the vibration period.
- In case you cannot increase the gain because of mechanical resonance, etc., and response is insufficient, use Torque (force) command notch filter and FF vibration suppressor frequency to suppress the resonance, and then try again.

6.8 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.

7.

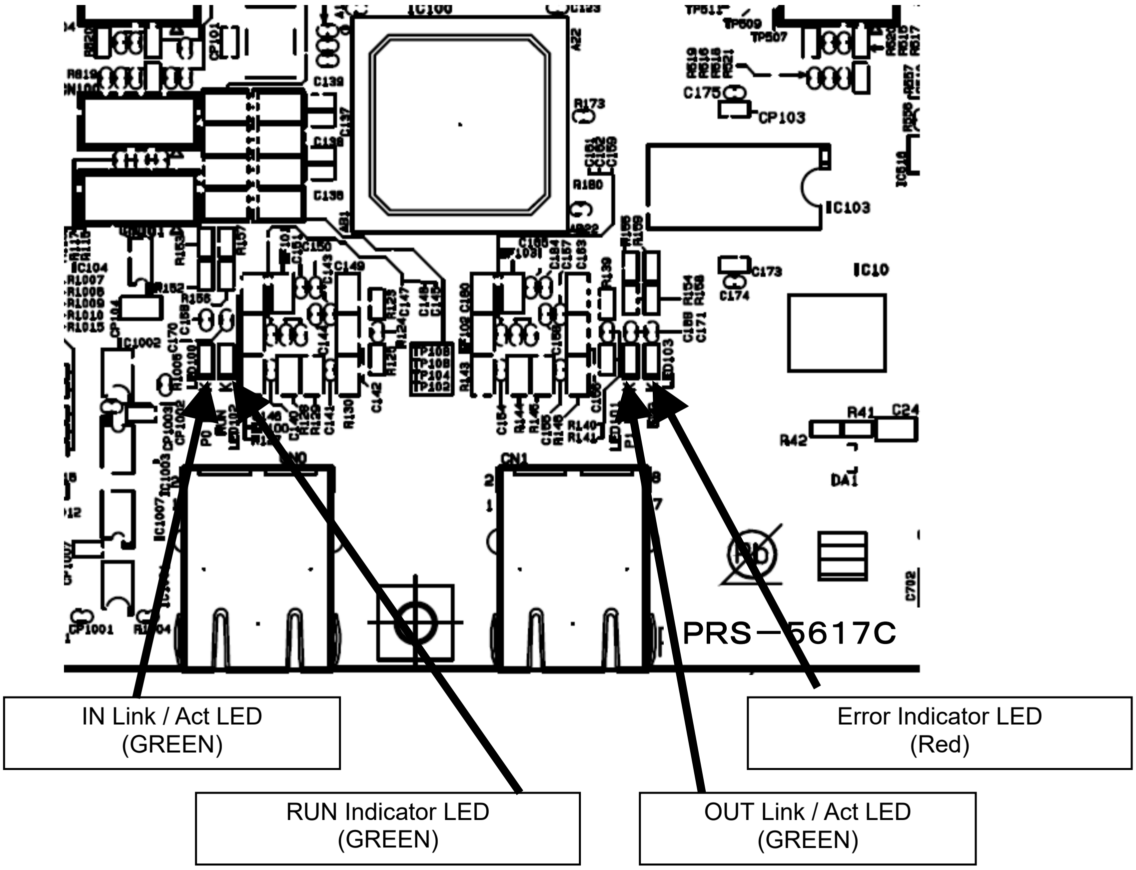
7. Digital Operator

7.1 EtherCAT Indicator

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

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

■ Names



EtherCAT Status LED

1) IN/OUT Link / Activity Indicator Code: IN L/A, OUT L/A

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

Link / Activity Indicator

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

2) RUN Indicator Code：RUN

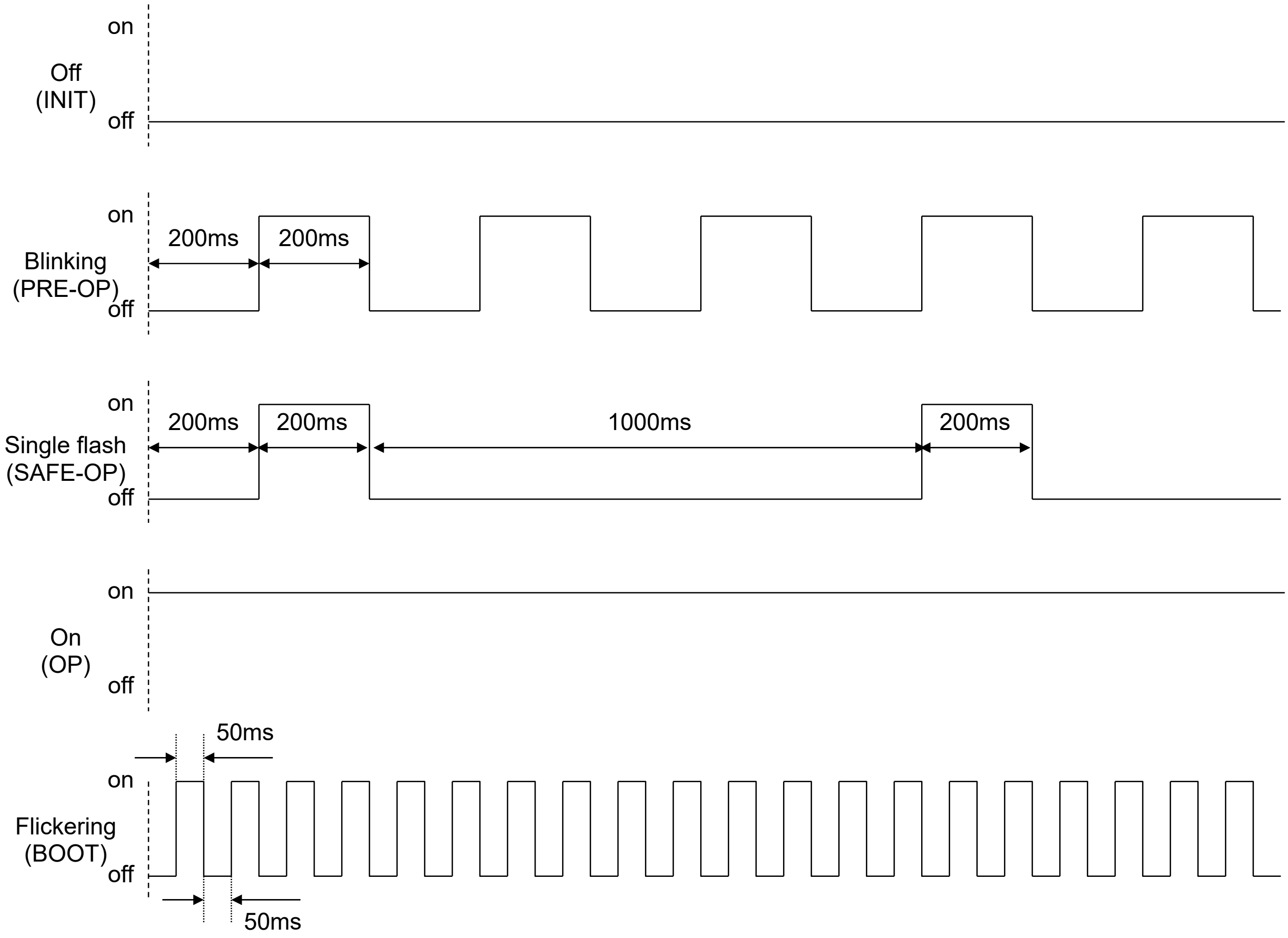
RUN indicator (Green LED) displays EtherCAT communication State machine status with Lighting /Extinguishing/ Flickering of the LED. Explains the RUN indicator below.

RUN Indicator explanation

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

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

RUN LED display state and Flickering Cycle



3) Error Indicator Code：ERR

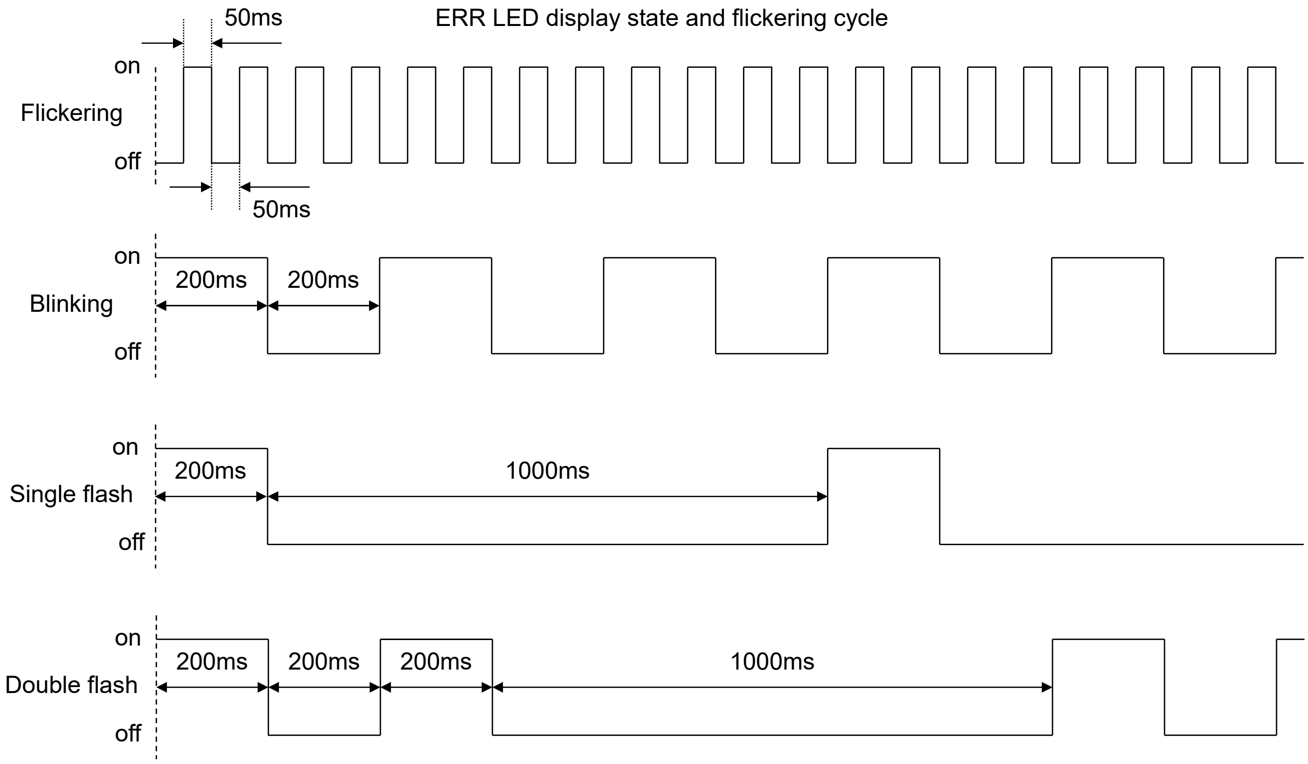
Error Indicator (Red LED) displays invalid state machine (ESM) change and/or watchdog error with an ON/OFF flickering of the LED.

Explains the Error Indicator status below.

Error Indicator Explanation

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

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



7.2 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×1(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) of the power unit 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.

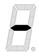
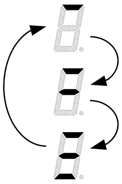
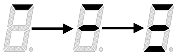
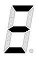
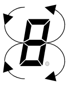
2) Control Power Supply Establish Indicator

Control Power Supply Establish Indicator (Blue LED) of the control unit 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.

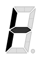
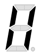
7.3 Digital Operator Indicator

Status indication is able to confirm by single digit 7-segment LED of the control unit.

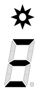
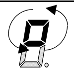
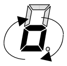
1) Servo Amplifier Status Display

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” “Ready to Switch ON” or “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”

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: 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.

7.4 Analog monitor

■ Selection of Output signal

Output signals to be used can be selected and changed from the following parameters:

Digital monitor1[DM1*]	Not available	Not available
Digital monitor2[DM2*]	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

8.

8. Maintenance

8.1 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.	■ Change the settings and turn ON the power again.
Check a setup of encoder resolution. (System parameter)	

* When performing the work for correction processing, be sure to intercept power supply.

- ■ Servo motor hangs up.

Investigation	Assumed causes and corrective actions
Check motor power line.	■ Phase order of servo motor power line is wrong.
Check the wiring of encoder cable.	■ Wiring of the encoder is incorrect.

* When performing the work for correction processing, be sure to intercept power supply.

- ■ Servo motor is vibrating.

Investigation	Assumed causes and corrective actions
Motor is vibrating with frequency above 200 Hz.	■ Reduce the loop gain speed. Set the torque (force) command low-pass filter and torque (force) command notch filter.

- ■ Occurs over shoot/ under shoot during starting / stopping.

Assumed causes and corrective actions
■ 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.

8.2 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

8.3 Alarm Display

1) Alarm Display Overview

Displays a 2-digit alarm code on alarm occurrence as defined by this servo amplifier.
Alarms shall be diplayed with Error Register (0x1001), Error code (0x603F) read via EtherCAT communication when alarm activated, and servo amplifier definition（0x2001, 0x2002）code list is shown in 2).

Operation at detecting: "DB" performs the slowdown stop of the servo motor in dynamic brake operation when the alarm generating
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	7-segment display	Alarm name	Alarm contents	Detection Operations	Alarm Reset
Bit4	0x7510	0x10	n	IN Rx Invalidity Frame Error	* Received invalid frame successively at Port 0	SB	Yes
		0x11	n	OUT Rx Invalidity Frame Error	* Received invalid frame successively at Port 1	SB	Yes
		0x12	n	IN Rx CRC Error	* Port 0 Successive Rx error	SB	Yes
		0x13	n	OUT Rx CRC Error	* Port 1 Rx occurrence error	SB	Yes
		0x14	n	IN Tx Error	* Port 0　Successive TX error	SB	Yes
		0x15	n	OUT Tx Error	* Port 1 TX occurrence error	SB	Yes
	0x7520	0x18	n	IN Lost link	* Port 0/1 cable was disconnected or unplugged in servo-on state. Host power supply was shutdown.	SB	Yes
		0x19	n	OUT Lost link		SB	Yes
	0x7510	0x1A	n	Communication time out	* Did not receive output data within regulated cycle time	SB	Yes
	0x7510	0x1E	n	Position Synchronization Communication Time-Out	* Position sync communication is not able to receive correctly.	SB	Yes
Bit1	0x5400	0x21	1	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	1	Current Detection Error 0	* Abnormality of electric current detection value	DB	Yes
		0x23	1	Current Detection Error 1	* Abnormality of Electric current detection circuit	DB	Yes
		0x24	1	Current Detection Error 2	* Abnormality in communication with Electric current detection circuit	DB	Yes
	0x8312	0x25	1	Safe Torque (force) Off Error 1	* Timing error of safe torque (force) off input	DB	No
		0x26	1	Safe Torque (force) Off Error 2	* Failure of safe torque (force) off circuit	SB, (DB)	No
	0x5400	0x2F	1	Main Circuit Power Device Error Note10)	・ Over current of drive module	DB	No
Bit1	0x8311	0x41	2	Overload 1	* Failure of safe torque (force) off circuit	SB	Yes
	0x2220	0x42	2	Overload 2	* Stall over load	DB	Yes
	0x3212	0x43	2	Regenerative Overload	* Regeneration load ratio exorbitance	DB	Yes
	0x7300	0x44	2	Magnetic Pole Position Detection Error	* CS detection error	—	Yes
	0x8400	0x45	2	Average continuous over speed	* Over speed in average rotational speed	SB	Yes
Bit3	0x4110	0x51	H	Servo Amplifier Temperature Error	* Overheating detection of amplifier ambient temperature	SB	Yes
	0x4210	0x52	H	RS Overheat	* Detection of in-rush prevention resistance overheating	SB	Yes
		0x53	H	Dynamic Brake Resistance Overheat	* Overheating detection of dynamic brake resistor	SB	Yes
	0x4310	0x55	E	External Error	* Abnormality of external regenerative resistor, etc.	SB	Yes
	0x7120	0x57	H	Motor Overheat　※11）	* Overheating detection of motor	DB	Yes
Bit2	0x3211	0x61	5	Over-voltage	* DC Excess voltage of main circuit	DB	Yes
	0x3220	0x62	9	Main Circuit Under-voltage Note 1)	* DC Main circuit low voltage	DB	Yes
	0x3130	0x63	A	Main Power Supply Fail Phase Note 1)	* 1 phase of the 3 phase main circuit power supply disconnected	SB	Yes
Bit2	0x5114	0x71	7	Control Power Supply Under-voltage Note 2)	* Control power supply low voltage or instantaneous stoppage occurred	DB	Yes Note3
	0x5115	0x72	7	Control Power Supply Under-voltage 1	* Under voltage of ±12V of control switching power supply	SB	Yes
	0x5113	0x73	7	Control Power Supply Under-voltage 2	* Under voltage of ±5V of control switching power supply	DB	Yes
Bit0	0x7305	0x81	8	Encoder Connector 1 Disconnection	* Incremental encoder (A, B, Z) signal line break * Power supply cable break	DB	No
	0x7306	0x83	8	Encoder Connector 2 Disconnection	* Full close encoder (A, B, Z) signal line break * Power supply cable break	DB	Yes Note4
	0x7300	0x84	8	Serial Encoder Communication Error	* CRC, SYNC, FORM, Command error occurrence in communication with sensor	DB	No
		0x85	8	Encoder Initial Process Error	* CS data read failure of Incremental encoder * Initial processing abnormality of Absolute encoder * Cable break	-	No
		0x86	8	CS error	* Position skip of CS data	DB	No
		0x87	8	CS Signal Disconnection	* CS signal line break	DB	No

Note 1) When the main power voltage increases or decreases gradually or is suspended, main circuit low voltage or main power failed phase may be detected.

Note 2) Control power supply under-voltage or servo ready OFF is detected during instantaneous break of 1.5 to 2 cycles. Detection of control power supply under-voltage and servo ready OFF can be delayed by setting larger value of PFDDLY (GroupB ID16).

Note3) When moment cutting of a control power source is long, it regards in power supply interception and re-input, and does not leave detected control power supply under-voltage to an alarm history.
(If cutting exceeds 1 second at the moment, it will be certainly judged as power supply interception.)

Alarm code list 2/2

0x1001 Error Resister	0x603F Error Code	0x2001 0x2002 Code	7-segment display	Alarm name	Alarm contents	Detection Operations	Alarm Reset
Bit0	0x7300	0xA0	U	Serial Encoder Internal Error 0	* Absolute encoder rotation overflow * Frequent rotation counter overflow	DB	No
		0xA1	U	Serial Encoder Internal Error 1	* Multi-turn error * Battery low voltage	DB	Yes
	0x7310	0xA2	8	Serial Encoder Internal Error 2	* Accelerate error	DB	Note 5
	0x7310	0xA3	8	Serial Encoder Internal Error 3	* Over-speed error	DB	Note 5
	0x7300	0xA4	8	Serial Encoder Internal Error 4	* Access error of Encoder internal EEPROM	DB	Note 5
		0xA5	8	Serial Encoder Internal Error 5	* Detection of single rotation coefficient incorrect	DB	Note 5
		0xA6	8	Serial Encoder Internal Error 6	* Detection of multiple rotation coefficient incorrect	DB	Note 5
		0xA9	8	Serial Encoder Internal Error 9	* Overheating of encoder with built-in servo motor	DB	Note 5
	0x7320	0xAA	8	Serial Encoder Internal Error 10	* Incremental error（Position data error）	DB	Note 5
	0x7300	0xAB	8	Serial Encoder Internal Error 11	* Encoder error	DB	Note 5
		0xAC	8	Serial Encoder Internal Error 12	* Multi-rotation error generation	DB	Note 5
		0xAD	8	Serial Encoder Internal Error 13	* Encoder built-in EEPROM data is not set	DB	Note 5
	0x7303	0xAE	8	Serial Encoder Internal Error 14	* Resolver output abnormality	DB	Note 5
	0x7304	0xAF	8	Serial Encoder Internal Error 15	* Resolver disconnection	DB	Note 5
Bit0	0x8400	0xC1	6	Over-speed	* Motor rotation speed is 120 % more than the highest speed limit	DB	Yes
		0xC2	6	Velocity SControl Error	* Nonconformity of electrical current command and acceleration signs	DB	Yes
	0x7122	0xC3	6	Velocity Feedback Error	* Servo motor power disconnection Note 6	DB	Yes
	0x8500	0xC5	6	Model tracking vibration suppression control error	* Machine cycle time is not mach with model tracking vibration suppression control.	DB	Yes
	0x8400	0xC7	6	High-precision sync excessive velocity error	* Velocity difference between master axis and slave axis exceeds the high-precision sync excessive velocity error value.	DB	Yes
	0x8400	0xC8	6	High-precision sync excessive acceleration error	* Acceleration difference between master axis and slave axis exceeds the high-precision sync excessive acceleration error value.	DB	Yes
Bit0	0x8611	0xD1	D	Excessive Position Deviation	* Position Deviation exceeds setup value.	DB	Yes
	0x8500	0xD2	D	Position Command Error 1	* Position command exceeded setting range 0x201D	SB	Yes
		0xD3	D	Position Command Error 2	* Position command input exceeded processing range	SB	Yes
	0x8611	0xD4	D	Excessive Position Synchronization Deviation	・Position Synchronization Deviation exceeds setup value	DB	Yes
		0xD5	D	High-precision sync excessive position error	* Position difference between master axis and slave axis exceeds the high-precision sync excessive position error value.	DB	Yes
	0xFF01	0xDE	D	Parameter change completion Note7	* Parameter change of motor and sensor codes is complete	—	No
	0xFF00	0xDF	D	Test Run Close Note 7	* Detection in 'Test mode end' status	DB	Yes
Bit7	0x5530	0xE1	P	EEPROM Error	* Abnormality of amplifier with built-in EEPROM	DB	No
	0x6310	0xE2	P	EEPROM Check Sum Error	* Access error in CPU built in RAM EPROM (entire area)	—	No
	0x5510	0xE3	P	Memory Error 1	* Access error in CPU built in RAM	—	No
	Note7	0xE4	P	Memory Error 2 Note7	* Error in check sum of Flash memory	—	No
	0x6320	0xE5	P	System Parameter Error 1	* System parameter is outside a setting range.	—	No
		0xE6	P	System Parameter Error 2	* Combination of a system parameter is abnormal. * System parameter and amplifier mismatch	—	No
		0xE7	P	Motor Parameter Error	* Check sum of a motor parameter is abnormal.	—	No
	0x5220	0xE8	F	CPU Circumference Circuit Error	* Abnormal access to CPU and peripheral devices	—	No
		0xE9	F	System Code Error	* Control board code and sensor setting mismatch	—	No
	0x6320	0xEA	8	Motor code setting Error	* Motor code is outside a setting range.	—	No
		0xEB	8	Sensor code setting Error	* Sensor code is outside a setting range.	—	No
		0xEE	8	Motor parameter automatic setting error 1	* Motor parameter automatic setting disabled.	—	No
		0xEF	8	Motor parameter automatic setting error 2	* The result of motor parameter automatic setting has an abonormality.	—	No
Bit7	0x8700	0xF1	F	Task Process Error	* Error in interruption process of CPU	DB	No
	0x6010	0xF2	F	Initial Process Time-Out	* Initial process does not end within initial process time	—	No
— Note9	— Note8	0xFF	F	Self flash timeout Note7	* Self-flash re-writing procedure is completed within the sepecifed time.	—	No

Note 4) It can not reset, depens on the kinds of encorder.

Note 5) Detecting only Synchronization encoder.
Due to abnormality in encoder main body, encoder clear may sometimes be needed. “An encoder clear and the alarm reset method" change with motor encoders in use. Please refer to "Encoder clear and the alarm reset method."

Note 6) When there is a rapid motor slow down simultaneous with servo ON, there is a possibility that a break in the motor’s power line cannot be detected.

Note 7) Alarm activated at test mode completeion, 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) In use with RM3DCB300, RM3DCB600 (400VAC input 300A, 600A amplifier unit), alarm 2FH is used instead of 21H.

Note 11) Just for 400VAC input 300A, 600A amplifier unit connection and 200VAC input 600A, 900A amplifier unit connection.

8.4 Trouble shooting When Alarm Occurs

Note) V means the cause number with possibility.

- Alarm code 10 (IN Rx Invalid Frame Error)
- Alarm code 11 (OUT Rx Invalid Frame Error)
- Alarm code 12 (IN Rx CRC Error)
- Alarm code 13 (OUT Rx CRC Error)
- Alarm code 14 (IN Tx Error)
- Alarm code 15 (OUT Tx Error)

Status at the time of alarm	Cause		
	1	2	3
Issued when control power is turned ON.	V	V	V
Issued during operation of servo motor	V	V	V

Corrective actions

Cause		Investigative and Corrective Actions
1	■ Defect of communications cable	■ Check if there is contact failure in the communication cable wiring system
2	■ Malfunction due to noise	■ Confirm proper grounding of the amplifier. ■ 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 (IN Lost link)
- Alarm code 19 (OUT Lost link)

Status at the time of alarm	Cause	
	1	2
The cable was unplugged.	V	
Issued during operation.		V

Corrective actions

Cause		Investigative and Corrective Actions
1	■ Cable unplugged when motor was in operation.	■ Plug in / unplug cable in servo-off or below Pre-OP state.
2	■ Communication cable break. ■ 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 1E (Corrected Position Synchronization Communication Time-Out）

Status at the time of alarm	Cause	
	1	2
Issued before use.	V	V
Issued during operation.		V

Corrective actions

Cause		Investigation and corrective actions
1	■ After enabling position synchronization, data transmission from amplifier for synchronization does not start. (After enabling, 4sec passed but data could not be recieved.)	■ Confirm that the communication cable is connected through CN4 in another amplifier for synchronization. ■ Check cable wiring, and review.
2	■ Malfunction due to noise. (Data from amplifier for synchronization could not be received for consecutive 4ms.)	■ Confirm proper grounding of the amplifier. ■ Check communication cable shield. ■ 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	5
Issued when control power is turned ON.	V		V	V	V
Issued at input of servo ON.	V	V	V		V
Issued while starting and stopping the servo motor.	V	V	V		
Issued after extended operating time.	V	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
5	■ 24V wiring of amplifier unit has disconnected (with 400VAC input type only).	■ Check the wiring of 24V connector.

■ Alarm code 22 (Current Detection Error 0)

Status at the time of alarm	Cause	
	1	2
Issued when servo is turned ON.	V	V

Corrective actions

Cause		Investigation and corrective actions
1	■ Defect in internal circuit of servo amplifier.	■ Replace the servo amplifier.
2	■ Servo amplifier and motor are not combined properly. Electric current has exceeded maximum current (IP) of combined motor. (MOC: Motor Overcurrent)	■ Confirm that the proper codes (per the specified Motor Codes) have been used for the servo motor; if not, replace the servo motor.

■ Alarm code 23 (Current Detection Error 1)

Status at the time of alarm	Cause	
	1	2
Issued at input of servo ON.	V	
Issued during operation.	V	V

Corrective actions

Cause		Investigation and corrective actions
1	■ Defect in internal circuit of servo amplifier. Data from electric current detector is always fixed.	■ Replace the servo amplifier.
2	■ Malfunction due to noise	■ Confirm proper grounding of the amplifier. ■ Add ferrite core or similar countermeasures against noise.

■ Alarm code 24 (Current Detection Error 2)

Status at the time of alarm	Cause	
	1	2
Issued at input of servo ON.	V	
Issued during operation.	V	V

Corrective actions

Cause		Investigation and corrective actions
1	■ Defect in internal circuit of servo amplifier. Cannot get data from electric current detector.	■ Replace the servo amplifier.
2	■ Malfunction due to noise	■ Confirm proper grounding of the amplifier. ■ Add ferrite core or similar countermeasures against noise.

- Alarm code 25 (Safe Torque (force) Off error 1)

Status at the time of alarm	Cause	
	1	2
Occurred in about 10 sec. after control power turned on	V	V
Issued during operation.	V	

Corrective actions

	Cause	Investigation and corrective actions
1	■ Input logic of Safe Torque (force) Off 1 and Safe Torque (force) Off 2 are mismatched	■ Match Input logic of SAFETOFF1/2 ■ 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	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 2F (Main Circuit Power Device Error)
(Just for 400VAC input 300A, 600A amplifier unit connection)

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	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	■ Short circuit is there at U/V/W-phases of amplifier unit, or wiring between amplifier unit and motor. Otherwise, U/V/W-phases are grounded to the earth.	■ Check the wiring conditions and correct it if improper.
2	■ Short circuit or earth fault in U/V/W phases on servo motor side.	■ Replace the servo motor.
3	■ Defect in internal circuit of amplifier unit.	■ Replace the amplifier unit.
4	■ 24V wiring of amplifier unit has disconnected (with 400VAC input type only).	■ Check the wiring of 24V connector.

■ 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.							V	
Issued when power supply of main circuit is turned ON.		V	V	V		V	V	V
Issued during operation.	V	V	V	V	V		V	

Corrective actions

Cause		Investigation and corrective actions
1	■ Exceeded permitted value of regenerating power in built-in regenerative resistance specifications. ■ 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.		V
Occurred during magnetic pole position error detection.	V	

Corrective action

	Cause	Investigation and corrective actions
1	■ Magnetic pole position detection frequency and mechanical resonance point are matched. ■ 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	6
Issued when power supply control is turned ON.	V		V	V		V
Issued during operation.	V	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.
6	■ Overheat detection of main circuit power device worked. (Just for RM3DCB300, RM3DCB600)	■ Confirm temperature in cabinet (or ambient of the amplifier unit), then refine installation method of the servo amplifier and ventilation of the cabinet to keep 55℃ or less.

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 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 57 (Motor Overheat)

Status at the time of alarm	Cause					
	1	2	3	4	5	6
Issued when control power is turned ON.	V	V		V	V	V
Issued during operation.	V	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	■ 3 and 4 pin for servo amplifier EXT.TH is opened.	■ Perform short circuit or wiring of thermal detection of servo motor.
3	■ Thermal detection element failure of servo motor	■ Replace the servo motor.
4	■ Ambient temperature of servo motor is high.	■ Review the cooling method to keep ambient temperature below 40°C.
5	■ Cooling fan of servo motor is stopped.	■ Check that the cooling fan motor is running; if not, replace the cooling fan motor.
6	■ Malfunction due to noise	■ Add ferrite core or similar countermeasures against noise.

■ Alarm Code 61 (Over-Voltage)

Status at the time of alarm	Cause			
	1	2	3	4
Issued when power supply control is turned ON.	V			
Issued when power supply of main circuit is turned ON.	V	V		
Issued while decelerating the servo motor.		V	V	V

Corrective actions

Cause		Investigation and corrective actions
1	■ Defect in internal circuit of servo amplifier.	■ Replace the servo amplifier.
2	■ The power supply voltage of main circuit is out of the specification.	■ Reduce the power supply voltage to within the specified range.
3	■ Excessive load inertia.	■ Reduce the load inertia to within the specified range.
4	■ Incorrect wiring for regeneration resistance. ■ 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	2	3	4	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	2	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
Issued when motor was in operation.	V

Corrective action

Cause		Investigation and corrective actions
1	■ Malfunction due to noise occurred in linear sensor and Hall effect 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 C7 (High-precision sync excessive velocity error)

Status at the time of alarm	Cause
	1
Issued when motor was in operation.	V

Corrective actions

Cause		Investigation and corrective actions
1	■ Set value of 0x2064-0A is too small.	■ Set larger the High-precision sync excessive velocity error value.

■ Alarm Code C8 (High-precision sync excessive acceleration error)

Status at the time of alarm	Cause
	1
Issued when motor was in operation.	V

Corrective actions

Cause		Investigation and corrective actions
1	■ Set value of 0x2064-0C is toosmall.	■ Set larger the High-precision sync excessive acceleration error value.

■ 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 command input travel distance.
2	■ In cases where Position command cannot be received due to CRC error generation.	■ Add ferrite core or similar countermeasures against noise.

Note) Alarm “D2” must reset after deviation clear.

- Alarm Code D3 (Position Command Error 2)

Status at the time of alarm	Cause	
	1	2
Issued after entering position command	V	V

Corrective actions

Cause		Investigation and corrective actions
1	■ Excessive difference of recent command compared to previous Position command	■ Lower command input travel distance.
2	■ In cases where Position command cannot be received due to CRC error generation.	■ Add ferrite core or similar countermeasures against noise.

Note) Alarm "D3" must reset after deviation clear.

- Alarm Code D4 (Excessive Position Synchronization Deviation)

Status at the time of alarm	Cause				
	1	2	3	4	5
Issued immediately after entering the command.	V	V	V	V	V
Issued during starting or stopping at high speed.	V	V			V
Issued during long run.	V	V			V

Corrective actions

Cause		Investigation and corrective actions
1	■ 2-axis position loop control parameters are not appropriate. ■ Response setting of corrected position synchronization is too high. ■ Parameters setting for corrected position synchronization are not appropriate.	■ In mutual synchronization correction mode, disable integral compensation. Also, set the parameter at the same setting. ■ In master-slave mode position synchronization correction, ■ Turn on mutual synchronization correction mode.
2	■ 2-axis load inertia balance is not appropriate.	■ Review the load condition, or perform countermeasures such as increasing the capacity of servomotor.
3	■ Valid torque (force) limit command is entered by the controller, and the torque (force) limit setting is too low. ■ Setting of Velocity Limit Command is too low. ■ No. of pulses of 2-axis sensor is not appropriate.	■ Increase the torque (force) limit value. Or disable the torque (force) limit. ■ Increase the Velocity Limit Command. ■ Replace the motor which has same No. of sensor pulses.
4	■ Holding brake does not release. ■ Servo motor is mechanically locked or machine has a collision.	■ Check the wiring, and correct the wiring if needed. If the specified voltage is applied, replace the servo motor. ■ Check if the machinery system is mechanically locked.
5	■ Setting of Position Synchronization Deviation is too low.	■ Increase setting of Position Synchronization Deviation.

- Alarm Code D5 (High-precision sync excessive position error)

Status at the time of alarm	Cause
	1
Issued when motor was in operation.	V

Corrective actions

Cause		Investigation and corrective actions
1	■ Setup of model control gain is high.	■ Set larger the High-precision sync excessive position error value.

- ■ 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. Motor code or encoder code change has detected. (The change above needs control power-cycle.)	■ Shut down control power supply and restart servo amplifier.

- ■ Alarm Code DF (Test Run Close)

Status at the time of alarm	Cause
	1
Occurred after execution of test mode.	V

Corrective actions

	Cause	Investigation and corrective actions
1	■ Normal operation of alarm in test mode completion. (After completion of test mode, to confirm any deviation in the controller).	■ Clear the alarm and restore operation.

* Alarm will not be issued by marking the checkmark in “(Disabling support function completion alarm) at completion time” in test mode operation screen.

- ■ Alarm Code E1 (EEPROM Error)

Status at the time of alarm	Cause
	1
Issued during parameter change in Setup Software	V

Corrective actions

	Cause	Investigation and corrective actions
1	■ Defect in internal circuit of servo amplifier. ■ 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 encoder on servo amplifier control board and encoder setting value do not match. (Defect in control circuit board of servo amplifier.)	■ Replace the servo amplifier.

■ Alarm Code EA (Motor code setting Error)

Status at the time of alarm	Cause
	1
Issued during amplifier initialization.	V

Corrective actions

Cause		Investigation and corrective actions
1	■ Motor code transferred to 0x20FE is out of combination range.	■ Combinable motor code of amplifier capacity is not set. ■ 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.	V	V	V

Corrective actions

Cause		Investigation and corrective actions
1	■ Encoder being connected is not supported by motor parameter automatic setting function.	■ Replace with supported servo motor.
2	■ Servo motor being connected is not supported by motor parameter automatic setting function.	■ The servo motor you use cannot be supported by this function, so please download motor parameters from setup software.
3	■ Failure in internal circuit of motor encoder.	■ Replace the servo motor.

■ Alarm Code EF (Motor Parameter Automatic Setting Error 2)

Status at the time of alarm	Cause	
	1	2
Occurred after motor parameter automatic setting functional performed.	V	V

Corrective actions

Cause		Investigation and corrective actions
1	■ Combination of servo amplifier and motor is incorrect.	■ Check the model number of servo amplifier and servo motor, and correct the combination.
2	■ Failure in internal circuit of motor encoder.	■ Replace the servo motor.

■ Alarm Code F1 (Task Process Error)

Status at the time of alarm	Cause
	1
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.
3	■ Excesive number of PDO mappings	■ Revise No. of mappings.

■ Alarm Code F2 (Initial Process Time-Out)

Status at the time of alarm	Cause	
	1	2
Issued when control power supply is turned ON.	V	V

Corrective actions

	Cause	Investigation and corrective actions
1	■ Defect in internal circuit of servo amplifier.	■ Replace the servo amplifier.
2	■ Malfunction due to noise.	■ Confirm proper grounding of the servo amplifier. ■ 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.

8.5 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	・ Perform “Power-cycle”. Then perform "Alarm reset" 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.

- Alarm code A4 (Serial Encoder Internal Error 4)
  - Motor encoder model and method of encoder clearing/alarm resetting, in use

Model	Method
PA035S	"Alarm resetting after encoder clearing", or "Control power cycle"
PA035C	
RA035C	

- Alarm code A5 (Serial Encoder Internal Error 5)
  - Motor encoder model and method of encoder clearing/alarm resetting, in use

Model	Method
PA035S	"Control power cycle"
PA035C	
RA035C	

- Alarm code A6 (Serial Encoder Internal Error 6)
  - Motor encoder model and method of encoder clearing/alarm resetting, in use

Model	Method
PA035S	"Control power cycle"
PA035C	
RA035C	

- Alarm code A9 (Serial Encoder Internal Error 9)
  - Motor encoder model and method of encoder clearing/alarm resetting, in use

Model	Method
PA035S	"Alarm resetting"
PA035C	
RA035C	

- Alarm code AA～AF (Serial Encoder Internal Error 10 - 15)
  - Motor encoder model and method of encoder clearing/alarm resetting, in use

Model	Method
PA035S	"Control power cycle"
PA035C	
RA035C	

8.6 Inspection

1) Corrective Actions for Problems During Operation

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.

8.7 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 model: RM3DA#600, RM3DA#900, RM23PAA270 and RM3PAA370 have a built-in cooling fan; therefore make sure to maintain a space of 50mm on the upper and lower side of the amplifier for airflow. Installation in a narrow space may cause damage due to a reduction in the static pressure of the cooling fan and/or degradation of electronic parts. Replacement is necessary if abnormal noise occurs, or oil or dust is observed on the parts. Also, at an average temperature of 40°C year-round, the life expectancy is 5 years.

■ Lithium battery for serial encoder

- ◆ The standard replacement period recommended by our company is the life expectancy of lithium battery based on normal usage conditions. However, if there is high frequency of turning the power ON/OFF, or the motor is not used for a long period, then the life of lithium battery is reduced. If the battery power is less than 3.6 V during inspection, replace it with new one.

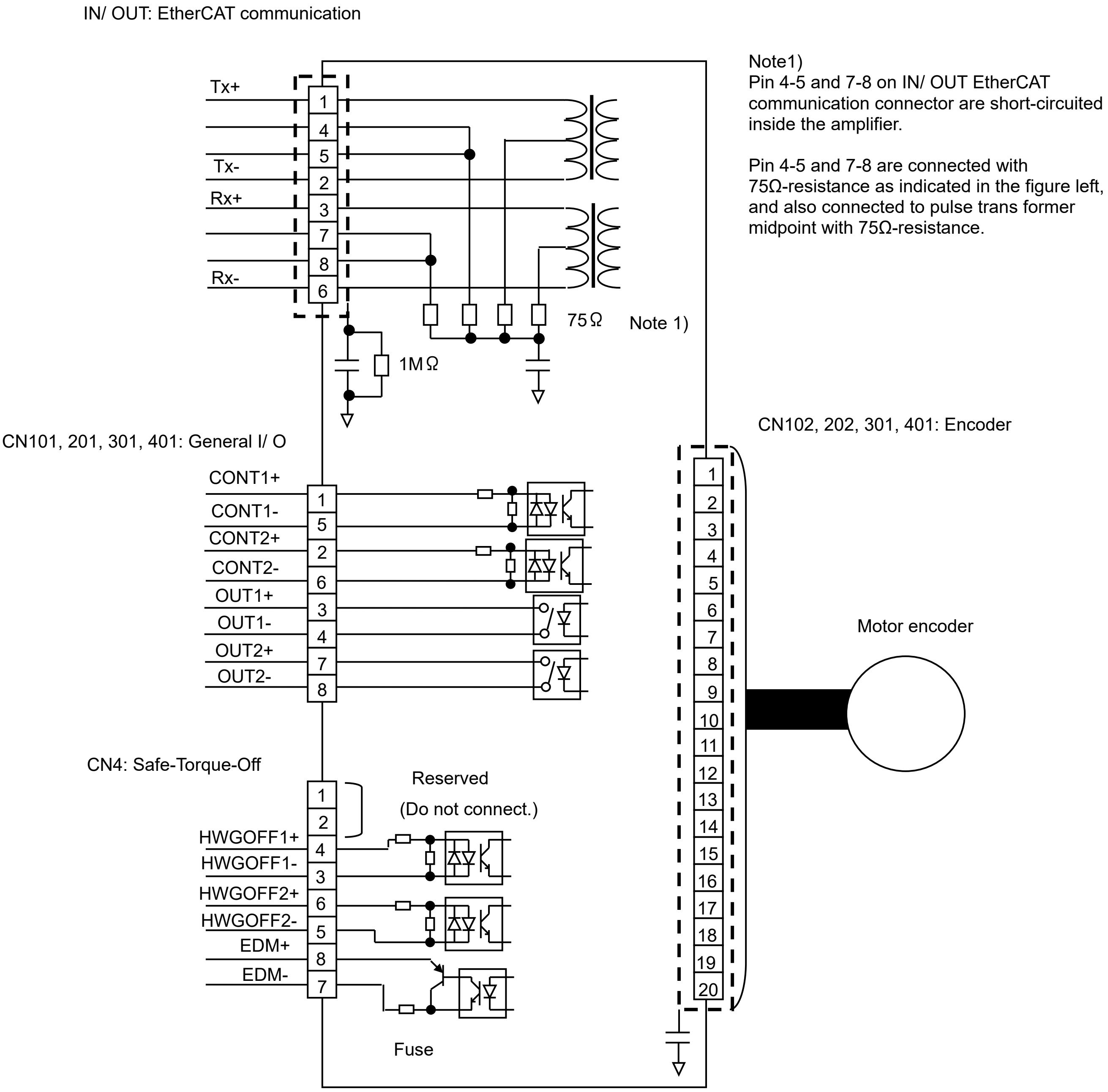
■ At SANYO DENKI, the overhauled servo amplifier is shipped with the same parameters as the ones before overhauling, however, be sure to confirm the parameters before use.

9.

9. Wiring

9.1 Wiring with Host Unit

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



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

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

2) IN, OUT connector disposition

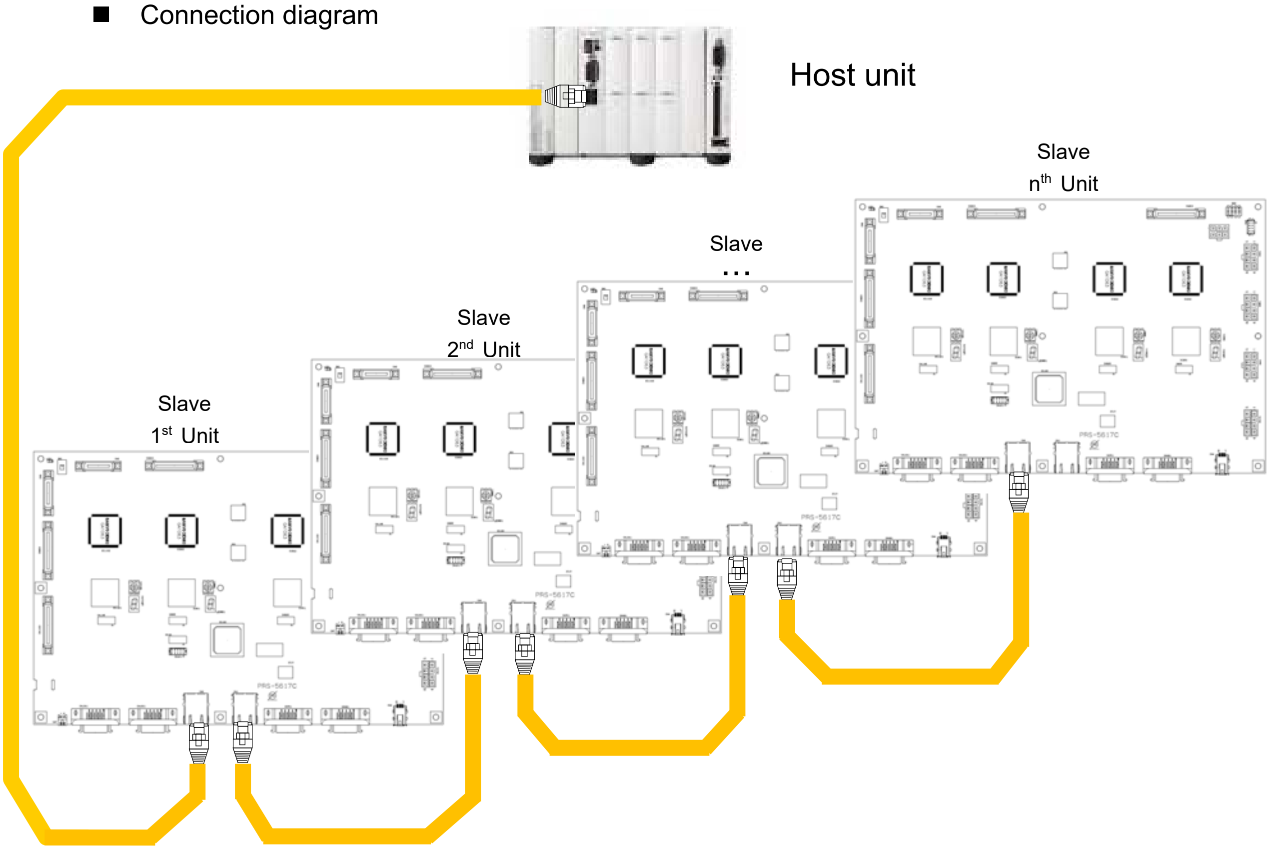
- Pin assignment

Port IN/ OUT 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 IN Port 0) to the higher-level device and OUT 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.

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

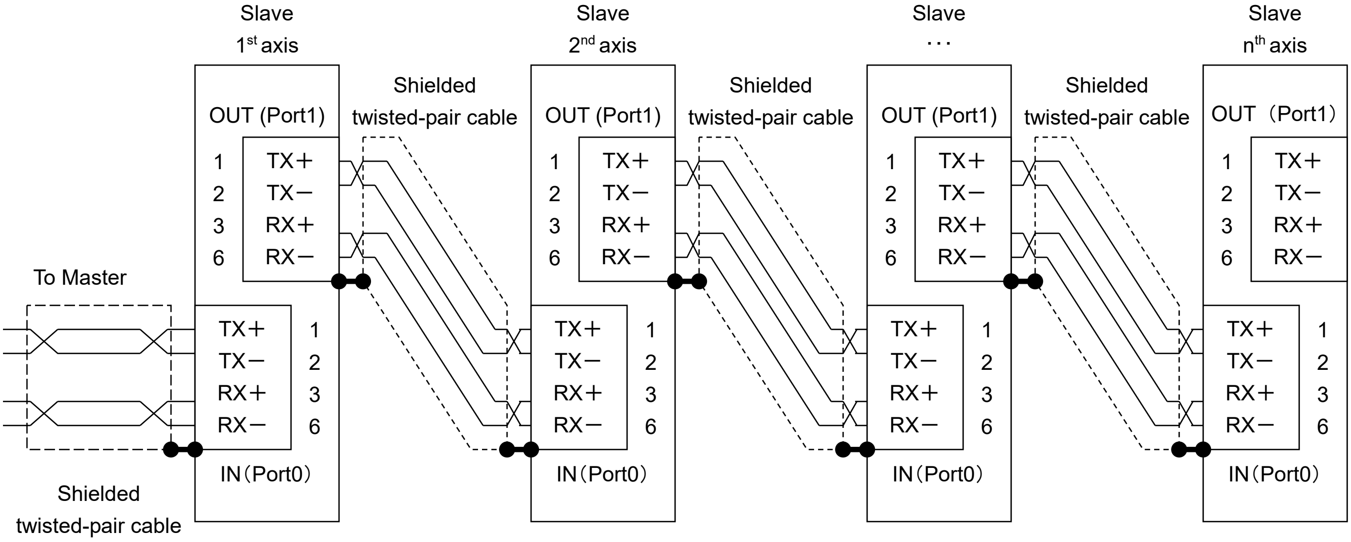
* Refer to “Control signal and pin number (wiring with host unit)” on the previous page for electrical connection of IN and OUT. Pins 4 and 5 and pins 7 and 8 are shorted inside the amplifier and connected with 150Ω to the midpoint of the pulse transmission between pin 4/5 and 7/8.

- Connection diagram



✔ Connect Master (host) cable to the left side connector IN (Port0), and then connect cable of the right side connector OUT (Port1) to the next Slave.

- Wiring diagram



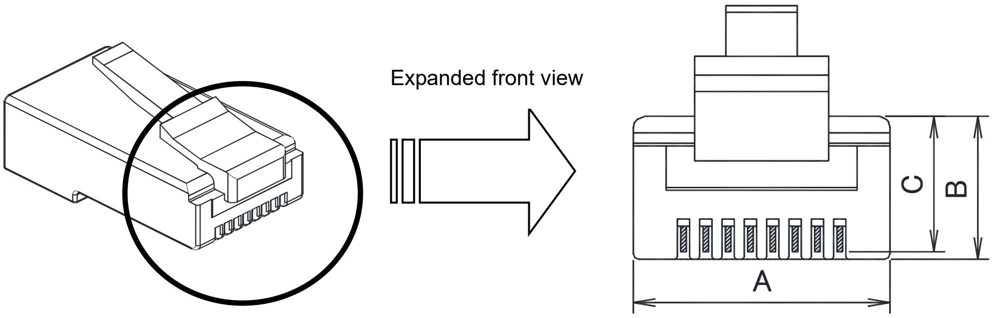
* R-ADVANCED EtherCAT amplifier is twisted-pair cable and daisy-chain topology-compliant model, and port0（IN）/ 1（OUT）are Ethernet connection.

* Ethernet port-to-port connection can use both straight and cross cable as the model has auto crossover function for slave amplifier. Connecting cable shall be Category 5e cable.

- Caution for RJ-45 modular connector selection

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

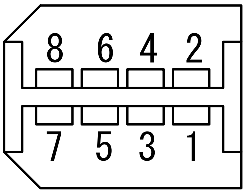
・ Especially, when the connector (ready-made/ modified product) which has out-of-range dimension at C (from top end of connector housing to lower side of terminal) is used, it gives excessive stress to mating connector and may cause a damage of terminal or connector, and a communication error by contact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



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

3) CN4 connector disposition

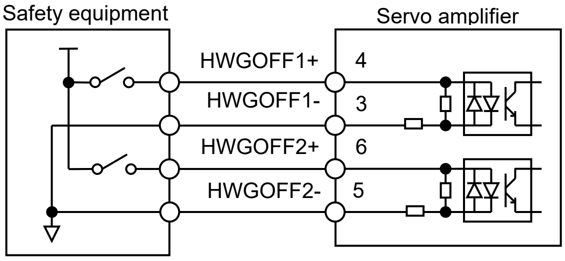
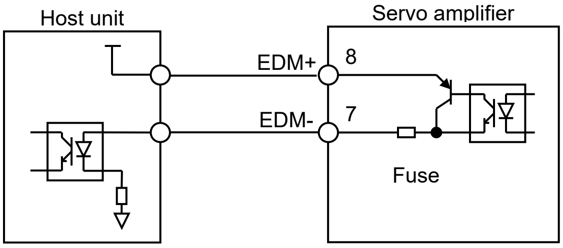
- 2013595－3 (*The figure below is viewed from connector’s soldered side.)



◆ Signal name and its function

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

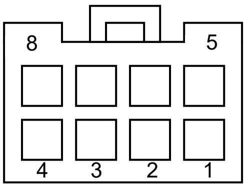
◆ Signal names and functions

Signal name	Terminal NO.	Symbol	Description
Reserved	1	Terminal for maintenance	This is a connection terminal when the function is not used. Do not use this terminal.
Reserved	2		
Safety input 1	3	HWGOFF1-	This is an input signal to control Safe-Torque-Off state. Connection circuit Connected to a relay or open collector transistor circuit. Power supply voltage range: DC24V±10% Internal impedance: 2.2kΩ 
	4	HWGOFF1+	
Safety input 2	5	HWGOFF2-	
	6	HWGOFF2+	
Error detection monitor	7	EDM-	This is a signal to monitor errors of Safe-Torque-Off function. Connection circuit Connected to a photo coupler or relay circuit. Power supply voltage range（Uext）: DC24V±10% Maximum current value: 50mA Output voltage: Uext-0.5 to Uext 
	8	EDM+	

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

4) CN101, 201, 301, 401 General input-output connector layout

- ■ 5557-08R (View from connector crimped side.)



◆ Signal name and its function

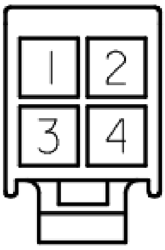
Terminal No.	Signal name	Description
1	CONT1+	General-purpose input 1(+)
5	CONT1-	General-purpose input 1(-)
2	CONT2+	General-purpose input 2(+)
6	CONT2-	General-purpose input 2(-)
3	OUT1+	General-purpose output 1(+)
7	OUT1-	General-purpose output 1(-)
4	OUT2+	General-purpose output 2(+)
8	OUT2-	General-purpose output 2(-)

◆ Terminal connection circuit

Terminal NO.	Symbol	Name	Description
1	CONT1+	General-purpose input 1(+)	■ Connect the general-purpose input circuit to a relay or open collector transistor circuit. Power supply voltage range: DC5V±5%/DC12V to 24V±10% Current capacity: 100mA or more (DC24V)
5	CONT1-	General-purpose input 1 (-)	
2	CONT2+	General-purpose input 2(+)	
6	CONT2-	General-purpose input 2(-)	
3	OUT1+	General-purpose output 1(+)	■ Connect the general output circuit to a photocoupler or relay circuit. Power supply voltage range: DC5V±5% Maximum current value: 50mA Power supply voltage range: DC12V to 15V±10% Maximum current value: 50mA Power supply voltage range: DC24V±10% Maximum current value: 50mA * When host unit input circuit is a TTL or CMOS-input, the maximum current value shall be 20mA or less.
7	OUT1-	General-purpose output 1(-)	
4	OUT2+	General-purpose output 2(+)	
8	OUT2-	General-purpose output 2(-)	

5) CN6 EMR canceling connector layout

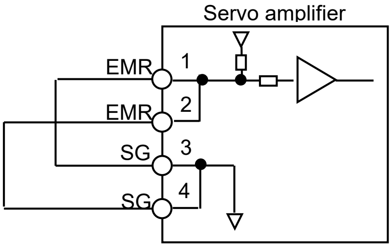
- 5557-04R (View from connector crimped side.)



◆ Signal name and its function

Terminal No.	Signal name	Description
1	EMR	Emergency stop input
2	EMR	Emergency stop input
3	SG	Signal ground common
4	SG	Signal ground common

In case that EMR is not used, short circuit pin 1 and 3, pin 2 and 4.



9.2 Wiring of Motor Encoder

1) CN102, 202, 302, 402 connector name and its function

- Battery backup absolute encoder

Servo Amplifier CN102,202,302,402 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	BAT+	8 (Pink)	T	Battery	Twisted pair
2	BAT-	4 (Purple)	S		
3	(NC)	-	-	Unconnected	-
4	(NC)	-	-	Unconnected	-
5	(NC)	-	-	Unconnected	-
6	(NC)	-	-	Unconnected	-
7	(NC)	-	-	Unconnected	-
8	(NC)	-	-	Unconnected	-
9	ES+	1 (Brown)	E	Serial data signal	Twisted pair
10	ES-	2 (Blue)	F		
11	(NC)	-	-	Unconnected	-
12	(NC)	-	-	Unconnected	-
13	(NC)	-	-	Unconnected	-
14	(NC)	-	-	Unconnected	-
15	-	-	-	-	-
16	SG	10 (Black)	G	Power supply common	Twisted pair (Recommended)
17	5V	9 (Red)	H	Power supply	
18	-	-	-	-	-
19	-	-	-	-	-
20	-	-	-	-	-
Note 2)	Earth	7 (Shielded)	J	Shielded	-

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 (CN*02). 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 CN102,202,302,402 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	(NC)	-	-	Unconnected	-
2	(NC)	-	-	Unconnected	-
3	(NC)	-	-	Unconnected	-
4	(NC)	-	-	Unconnected	-
5	(NC)	-	-	Unconnected	-
6	(NC)	-	-	Unconnected	-
7	(NC)	-	-	Unconnected	-
8	(NC)	-	-	Unconnected	-
9	ES+	1 (Blown)	E	Serial data signal	Twisted pair
10	ES-	2 (Blue)	F		
11	(NC)	-	-	Unconnected	-
12	(NC)	-	-	Unconnected	-
13	(NC)	-	-	Unconnected	-
14	(NC)	-	-	Unconnected	-
15	(NC)	-	-	Unconnected	-
16	SG	10 (Black)	G	Power supply common	Twisted pair (Recommended)
17	5V	9 (Red)	H	Power supply	
18	-	-	-	-	-
19	-	-	-	-	-
20	-	-	-	-	-
Note 2)	Earth	7 (Shielded)	J	Shielded	-

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 (CN*02). 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 CN102,202,302,402 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	(NC)	-	-	Unconnected	-
2	(NC)	-	-	Unconnected	-
3	(NC)	-	-	Unconnected	-
4	(NC)	-	-	Unconnected	-
5	(NC)	-	-	Unconnected	-
6	(NC)	-	-	Unconnected	-
7	(NC)	-	-	Unconnected	-
8	(NC)	-	-	Unconnected	-
9	ES+	1 (Blown)	E	Serial data signal	Twisted pair
10	ES-	2 (Blue)	F		
11	(NC)	-	-	Unconnected	-
12	(NC)	-	-	Unconnected	-
13	(NC)	-	-	Unconnected	-
14	(NC)	-	-	Unconnected	-
15	(NC)	-	-	Unconnected	-
16	SG	10 (Black)	G	Power supply common	Twisted pair (Recommended)
17	5V	9 (Red)	H	Power supply	
18	-	-	-	-	-
19	-	-	-	-	-
20	-	-	-	-	-
Note 2)	Earth	7 (Shield)	J	Shield	-

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

Note 2) Connect the shielded cable to the metal case (ground) on CN*02 side and connect the ground to the motor encoder side.

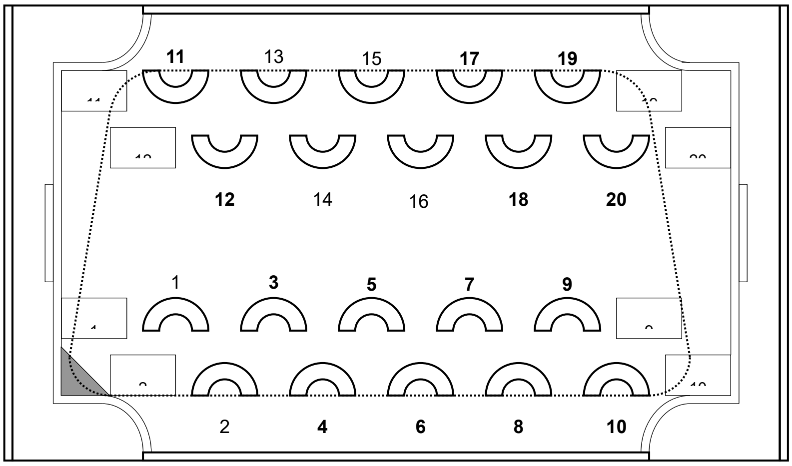
- Pulse encoder

Servo Amplifier CN102,202,302,402 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	(NC)	-	-	Unconnected	-
2	(NC)	-	-	Unconnected	-
3	A	1 (Blue)	A	A-phase pulse output	Twisted pair
4	/A	4 (Brown)	D		
5	B	2 (Green)	B	B-phase pulse output	Twisted pair
6	/B	5 (Purple)	E		
7	Z	3 (White)	F	Z-phase pulse output	Twisted pair
8	/Z	6 (Yellow)	G		
9	(NC)	-	-	Unconnected	-
10	(NC)	-	-	Unconnected	-
11	(NC)	-	-	Unconnected	-
12	(NC)	-	-	Unconnected	-
13	(NC)	-	-	Unconnected	-
14	(NC)	-	-	Unconnected	-
15	(NC)	-	-	Unconnected	-
16	SG	10 (Black)	G	Power supply common	Twisted pair (Recommended)
17	5V	9 (Red)	H	Power supply	
18	-	-	-	-	-
19	-	-	-	-	-
20	-	-	-	-	-
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 CN*02 side and connect the ground to the motor encoder side.

2) Terminal number



View from 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	10120-3000VE	AWG24 or more	-

3) Connector model number for motor encoder

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

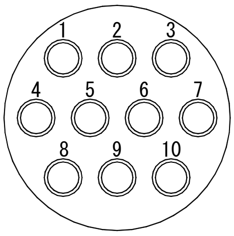
Motor model number	Motor encoder plug model number	Connector type	Applicable cable diameter
R2AAB8100 R2AA10100	(Specification for lead locating)	-	-
R2AA13050 R2AA13120 R2AA13180 R2AA13200 R2AA18350 R2AA18450 R2AA18550 R2AA18750 R2AA1811K R2AA22500	JN2DS10SL1-R	Straight	ϕ5.7 toϕ7.3
	JN2FS10SL1-R	Angle	
	JN2DS10SL2-R	Straight	ϕ6.5 toϕ8.0
	JN2FS10SL2-R	Angle	
	JN2DS10SL3-R	Straight	ϕ3.5 to ϕ5.0
	JN2FS10SL3-R	Angle	
R2AAB8100	(Specification for lead locating)	-	-

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

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

Type	Model number	Qty.	Applicable wire size
Manual crimping type	JN1-22-20S-R-PKG100	Note1)	AWG20
	JN1-22-22S-PKG100	Note1)	AWG21 to 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).



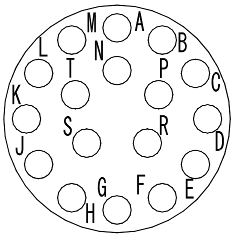
R-series servo motor
Encoder canon plug
Pin assignment
(Viewed from motor)

■ 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 to φ7.3
JN2FS10SL1-R	Angle	
JN2DS10SL2-R	Straight	φ6.5 to φ8.0
JN2FS10SL2-R	Angle	
JN2DS10SL3-R	Straight	φ3.5 to 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.

10.

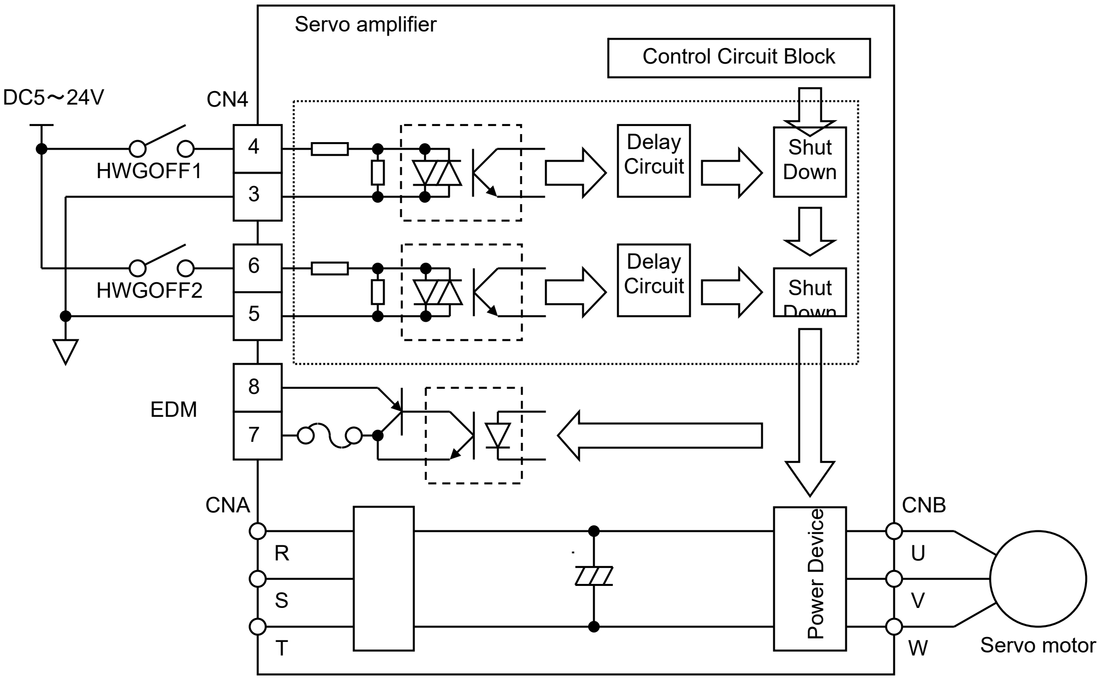
10 Safe Torque Off (STO) Function

10.1 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 / EN61800-5-2
Safety Standard	■ IEC61508(2nd), SIL3, HFT=1, type B / EN61508 ■ IEC62061, SILCL3, HFT=1, type B / EN62061 ■ ISO13849-1:2015, Cat3, PL = e (In case of performing error detection with EDM using.) / EN ISO13849-1/AC: 2015 ■ ISO13849-1:2006, Cat3, PL = c (In case without error detection.) / EN ISO13849-1/AC: 2015

* PFH (Probability of a dangerous Failure per Hour) of this function (Safe Torque Off circuit) achieves less than 25% of required level of SIL3 and 2% of required level of SIL2.

* To suffice ISO13849-1:2015, Cat3, PL=e, you need to design machine safety system so as to detect failure of STO circuit by surely using Error Detection Monitor (EDM).

* The Mean Time to Dangerous Failure "S" (MTTFd) for this function is a hundred year.
The Diagnostic Coverage (DC) for this function with use of Error Detection Monitor (EDM) is 92%.

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.

Control unit model number	Delay Circuit (Max. delay time)
RM2C#H4	With (Max.500ms)

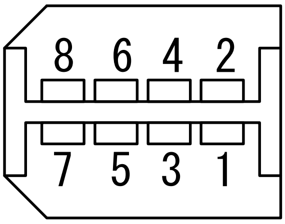
* Even the hardware without delay circuit, there are still max. 20ms of delay until the safe torque off function works due to the delay in the input circuit.

* Holding brake excitation signal and servo motor holding brake are not safety related parts.

10.2 Wiring

1) CN4 connector disposition

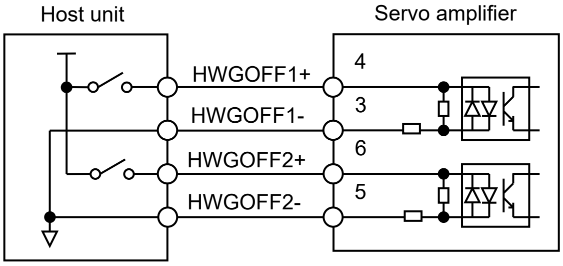
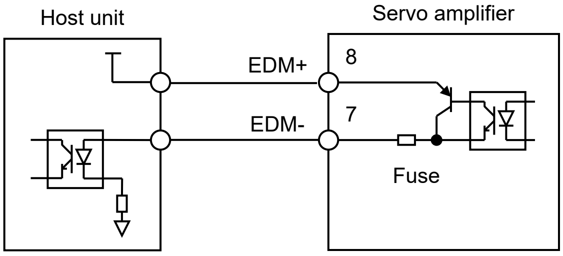
■ 2013595－3 (*The figure below is viewed from connector's soldered side.)



◆ Signal name and its function

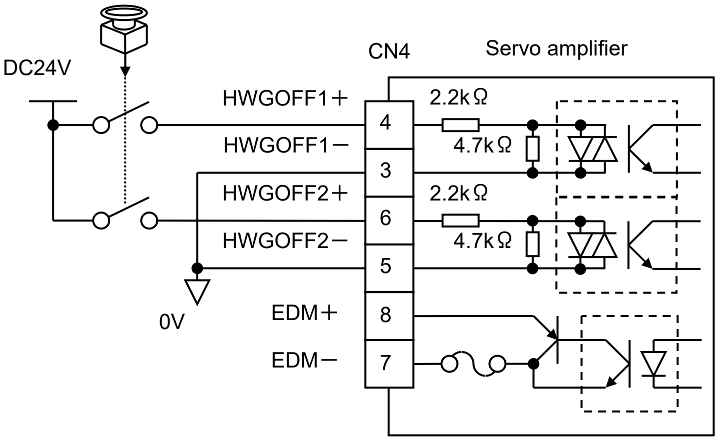
Terminal number	Signal name	Description
1	Reserve	Do not use.
2	Reserve	Do not use.
3	HWGOFF1-	Signal input 1(-), for safety function
4	HWGOFF1+	Signal input 1(+), for safety function
5	HWGOFF2-	Signal input 2(-), for safety function
6	HWGOFF2+	Signal input 2(+), for safety function
7	EDM -	Monitor (-),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

◆ Signal name and its function

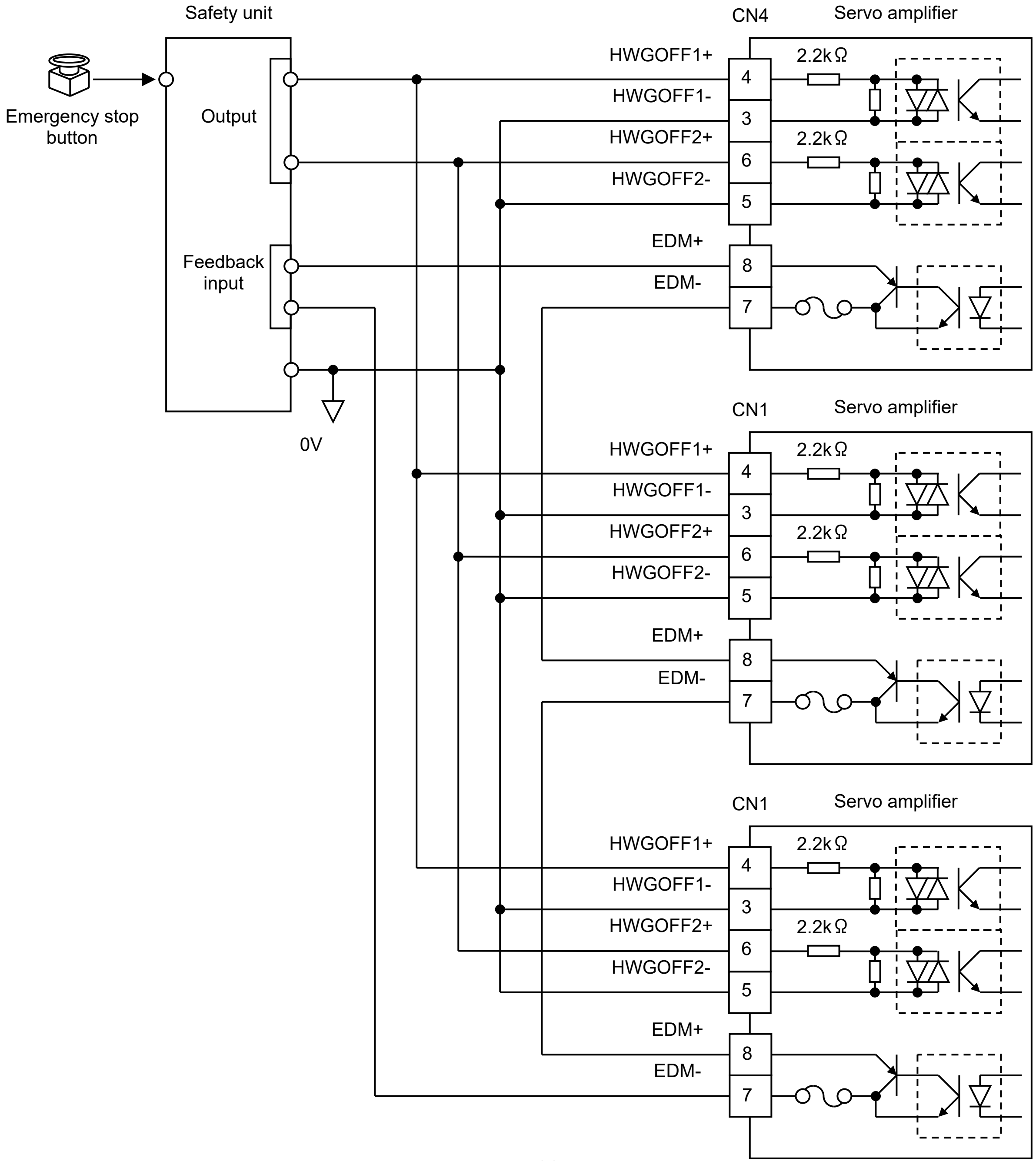
signal name	Terminal number	Symbol	Description
Reserved	1	Terminal for maintenance	This is a connecting terminal when function is not used. Do not use this terminal.
Reserved	2		
Safety input 1	3	HWGOFF1-	Input signal to control Safe-Torque-Off state. Connection circuit Connected to a relay or open collector transistor circuit. Power supply voltage range : DC24V±10% Internal impedance : 2.2kΩ 
	4	HWGOFF1+	
Safety input 2	5	HWGOFF2-	
	6	HWGOFF2+	
Error detection monitor	7	EDM-	Signal to monitor of Safe-Torque-Off function error. Connection circuit Connected to a photo coupler or relay circuit. Power supply voltage range (Uext) : DC24V±10% Maximum current value : 50mA Output voltage : Uext-0.5 to Uext 
	8	EDM+	

2) Example of wiring

Example of wiring to safety switch (in use of single control unit) (In case of Performance Level: PL=C)

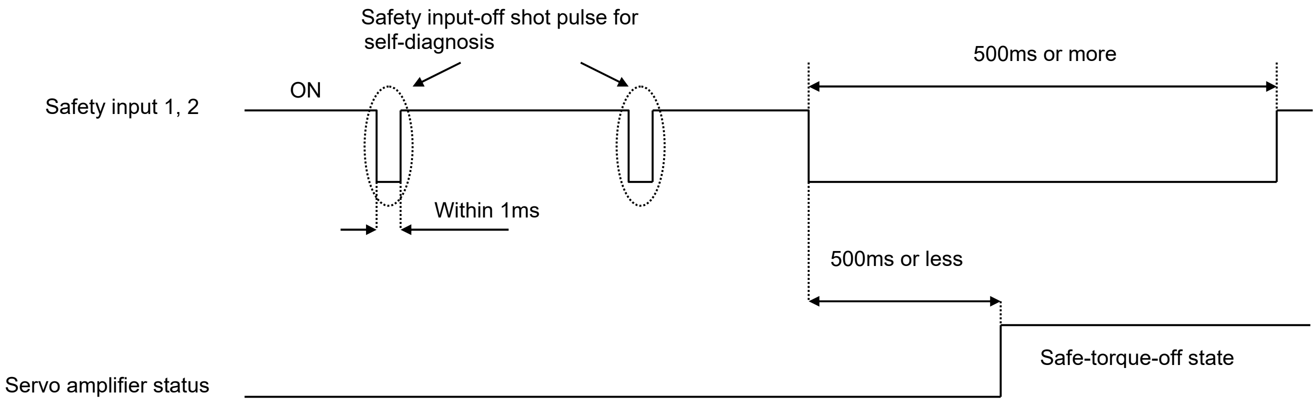


Example of wiring to safety unit (in use of multiple control unit) (In case of Performance Level: PL=D)



3) Safety input-off shot pulse for safety device self-diagnosis

When you connect safety device supplied with safety input-off shot pulse signal for self-diagnosis added to safety output signal, such as safety unit or safety sensor, use safety device whose safety input-off shot pulse signal is 1ms or less. Safe-torque-off function is not activated when the period of safety input signal (HWGOFF1, HWGOFF2)-OFF is 1ms or less.
In order to surely fulfill the safe-torque-off function, turn off safety input signal for 500ms or more.



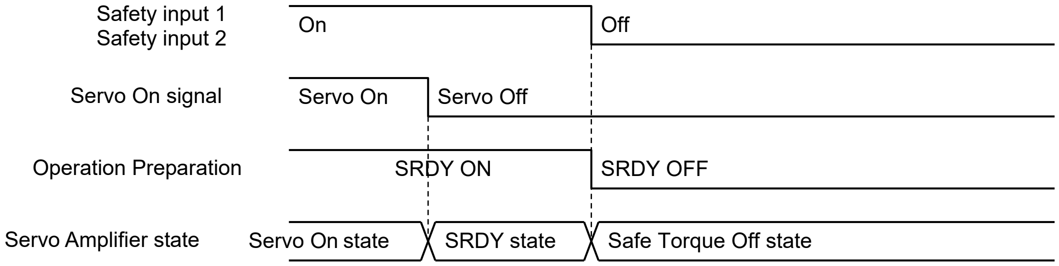
10.3 Safe Torque Off Operations

1) Safe Torque Off active state

The safe torque off is active when the safety input 1(HWGOFF1) or safety input 2(HWGOFF2) signal is Off (see the table below). In the safe torque off active state, the Servo Ready signal is Off. The Servo On signal will not be accepted in this state.

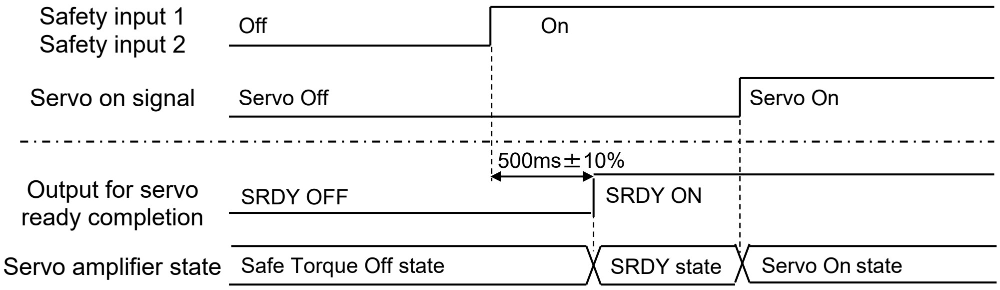
Signal	Input condition	Servo Amplifier condition
Safety input 1(HWGOFF1)	On	Normal state
	Off	Safe torque off active state
Safety input 2(HWGOFF2)	On	Normal state
	Off	Safe torque off active state

* Off: Electric current will not flow (contact open).
* On: Electric current will flow (contact closed).

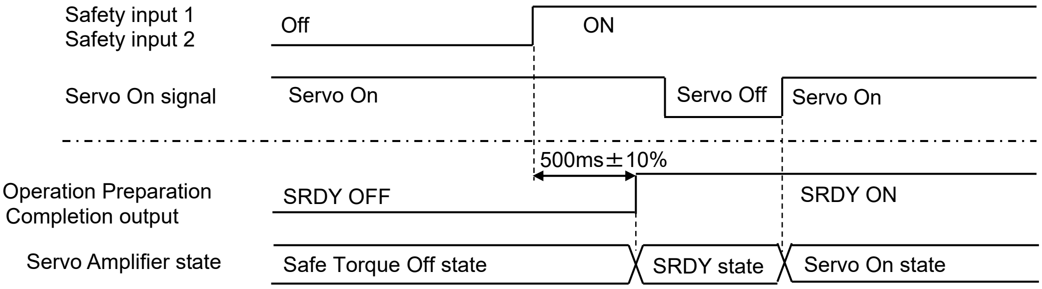


2) Recovery from Safe Torque Off active state

While servo-off signal is input as described in 1), turning on the safety input 1 or safety input 2 signal activates SRDY state. Operations may resume when servo-on signal is input. (The time to transit to SRDY state is maximum 550ms.)



While servo-on signal is input, it will transited to SRDY state if safety input 1 or safety input 2 signal is turned on. To re-start the operation, input the servo-off signal, and then input the servo-on signal again.



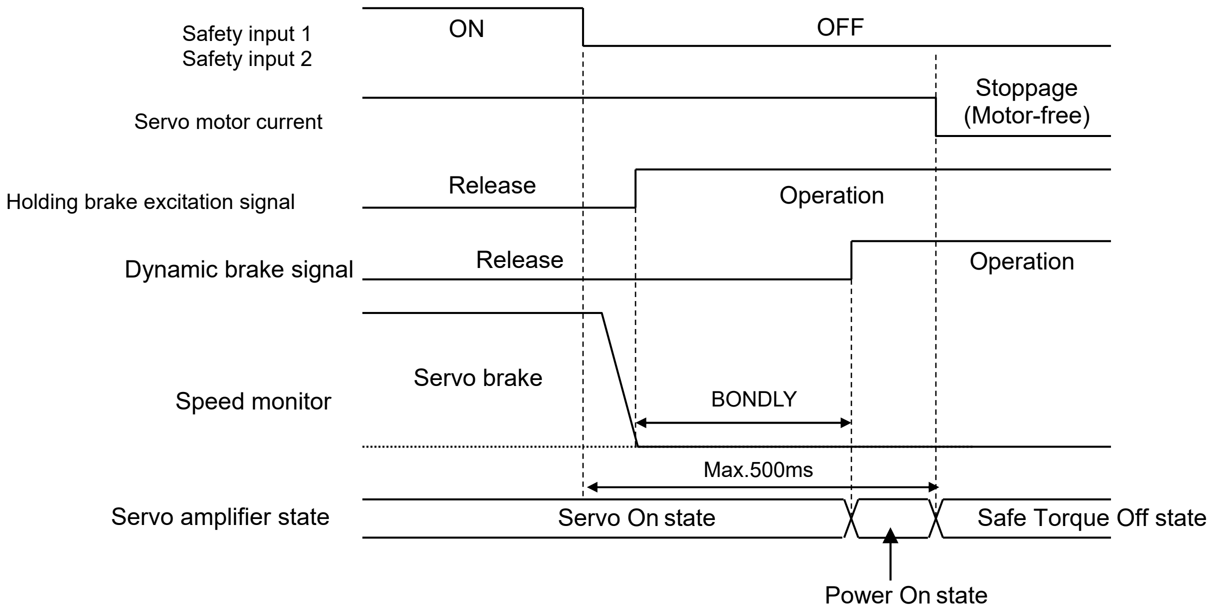
* Group9 ID06: Setting the Servo-ON Function parameter to "01: Always On" disables resets from the safe torque off state. Avoid this setting when using the safe torque off function.

3) Safe Torque Off while Servo Motor Running

Depending on setting of quick stop option code (0x605A, 0x00:[QSTOP]), it will be vary how the motor stops.

- ■ In case the setting value is either 3 or 7(motor stops with servo brake when servo off)

If either safety input 1 or safety input 2 input is off, motor stops with servo brake.

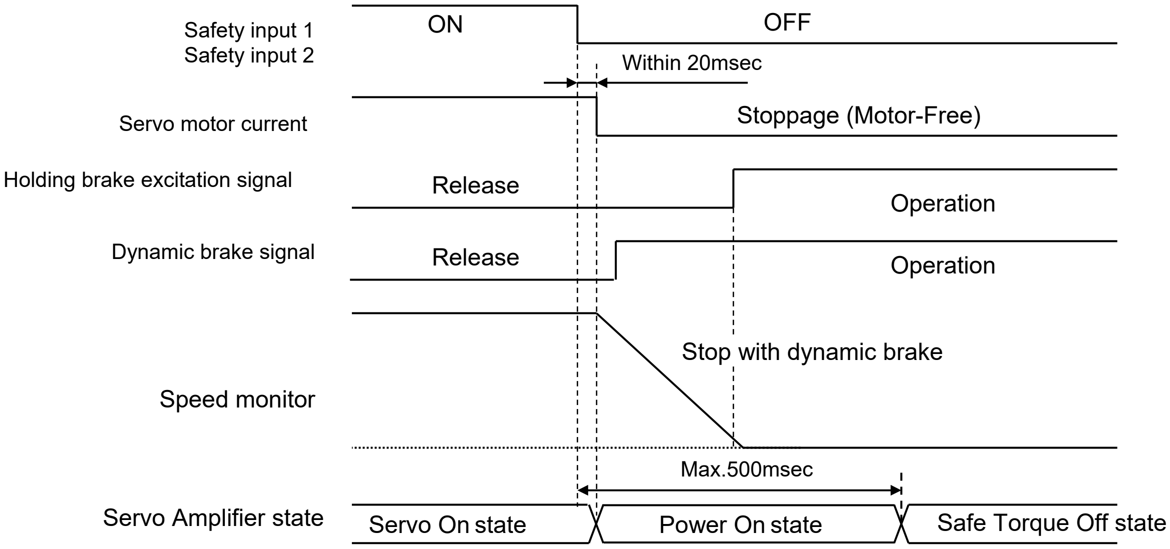


* When set value of BONDLY (holding brake activation delay time OD: 0x2024) is more than safe-torque-off delay time (500msec max.), the states comes to be motor-free after period of safe-torque-off delay time. Please note that recommended set value for BONDLY is less than 500msec.

* Servo brake circuit, dynamic brake circuit, and holding brake excitation signal are not safety-related sections.

- In case the setting value is 0

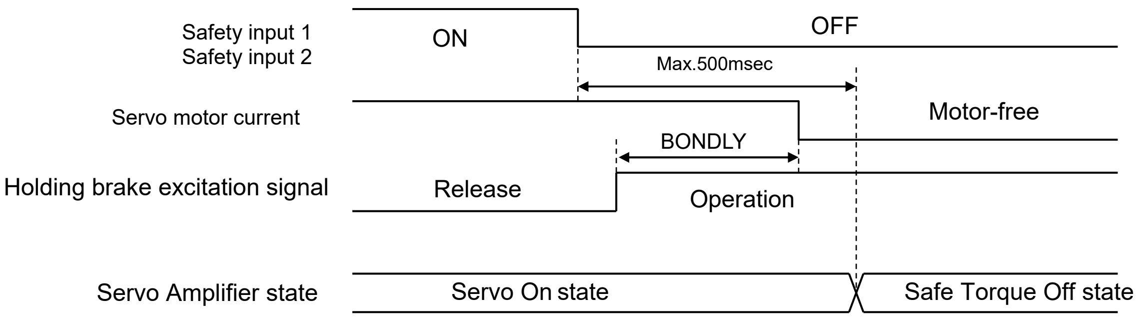
When either safety input 1 or safety input 2 is off, the current to servo motor is shut down, then the motor stops by dynamic brake after moving to safe-torque-off state. After turning off safety input and elapsing delay time (Max.500ms), the state moves to safe-torque-off state.
Dynamic brake is activated on turning off safety input.



* Dynamic brake circuit and holding brake excitation signal are not safety-related sections.

4) Safe Torque Off while Servo Motor stoppage

Turning Off safety input 1 or safety input 2 input causes the holding brake signal to issue notification of the operating status. However, since this interrupts current supply to the servo motor, the "holding brake delay time" setting is disabled. This means the servo motor is subject to and may be moved by external forces during the interval from the output of the operating status via the holding brake signal to actual operation of the holding brake.



* Set below 500msec in BONDLY (Delay Time of Engaging Holding Brake OD:0x2024)

5) Deviation clear

Note the following if the Deviation Clear Selection parameter (0x20F0,0x05:[CLR]) is set to Type 3 or Type 4 (do not clear deviations when Servo Off).

As long as positioning commands are being issued during position control, activating the safe torque off function will trigger the excessive cumulative positional deviation error (alarm D1). If the Servo On signal is input once again before this alarm is issued, the servo motor will continue to operate according to cumulative positional deviations. To keep this from happening, stop issuing positioning commands as soon as the safe torque off function is activated and clear any positional deviations.

(If the Deviation Clear Selection parameter (0x20F0,0x05[CLR]) is set to Type 1 or Type 2 (clear deviation when Servo On), any positional deviation is automatically cleared when the Servo Off signal is transmitted.

6) Detecting HWGOFF signal errors

■ Safe Torque Off function error 1 (alarm 25)
After the safety input 1 or safety input 2 signal is turned Off, this alarm is issued if the other signal does not turn Off within 10 seconds. This enables detection of a broken wire or disconnected HWGOFF signals.

■ Safe Torque Off function error 2 (alarm 26)
This alarm is issued when an internal circuit failure is detected based on the safety signal input status and internal status. This enables detection of circuit problems that interrupt control signals to the power module based on the safety signal input.

10.4 Error Detection Monitor (EDM)

1) Specifications

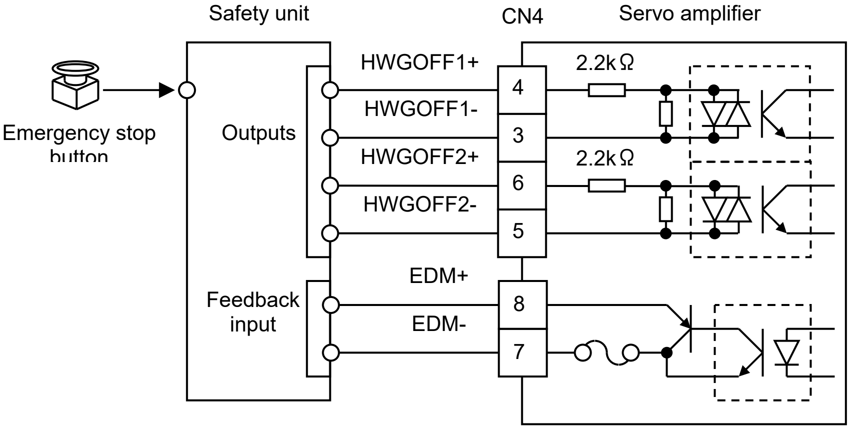
The EDM output signals monitor errors in the safe torque off circuit, /HWGOFF1 wire, or /HWGOFF2 wire. The following table shows the relationships among /HWGOFF1 input, /HWGOFF2 input, and EDM output.

Signal	State			
Safety input 1 (HWGOFF1)	On	On	Off	Off
Safety input 2 (HWGOFF2)	On	Off	On	Off
Error detection monitor (EDM)	Off	Off	Off	On

* If the above relationships are not satisfied, the Safe Torque Off circuit or EDM output circuit shall be malfunctions.

2) Connection example

The following is a connection example. This example uses a safety unit and activates the Safe Torque Off function when the operator presses the Emergency Stop button.



Connect safety unit output signal to safety input1 (HWGOFF1) and safety input 2 (HWGOFF2) respectively, and then connect error detection monitor (EDM) from servo amplifier to feedback input of safety unit.
Under normal conditions, pressing emergency stop button turns off both of safety inputs and on EDM output.
Once the emergency stop button is cancelled, as EDM output is on, the feedback circuit of safety unit is reset, and both safety inputs are turned on, which resumes the operation.

* In case such a malfunction occurs that EDM will not be turned on despite both the safety input being off, even if the emergency stop button is cancelled, the operation will not resume as the feedback circuit has not been reset yet. (The amplifier keeps Safety Torque Off state).

3) Error detection method

When any failures occurred with any of safety inputs remained ON inside the servo amplifier, EDM output will not be turned on, and EDM signal will remain OFF even if emergency stop button pressed.
Errors can be detected by system configuration with safety unit detecting the condition that relationship between safety input and EDM output in the above table is not effective.

* In case you need to meet requirements of ISO13849-1, PL=e, make sure to perform testing of failure detection by using EDM output once a month or more frequently.
* For discussions on connecting and operating the safety unit, please refer to the manual provided with your safety unit.
* The EDM signal is not safety output. Do not use EDM signal for any purpose other than malfunction monitoring.

10.5 Confirmation Test

For use of the Safe Torque Off function, you must confirm that the safe torque off function operating correctly during machine startup, servo amp replacement and test operation.
Even if it is not fit to the case above, strongly recommended that confirmation of function operation at least once every three months.

1) Preparations

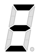
Before performing the confirmation test, perform a test operation to confirm that the equipment operates properly and that there are no problems in the servo amp, servo motor installation, or wire connections.
For a discussion of installation, wiring, and test operations, see "3. Installation", "4. Wiring” 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

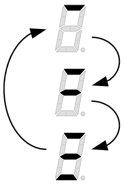
Confirmation procedure 2 to 4, confirm the states listed below.
Procedure 2, make sure that the EDM output and LED indication are as follows:

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	

10.6 Safety Precautions

As for Safe Torque Off function, strictly adhere to the following safety precautions.
Incorrect use of this function can result in physical injury and damage to people and/or machinery.

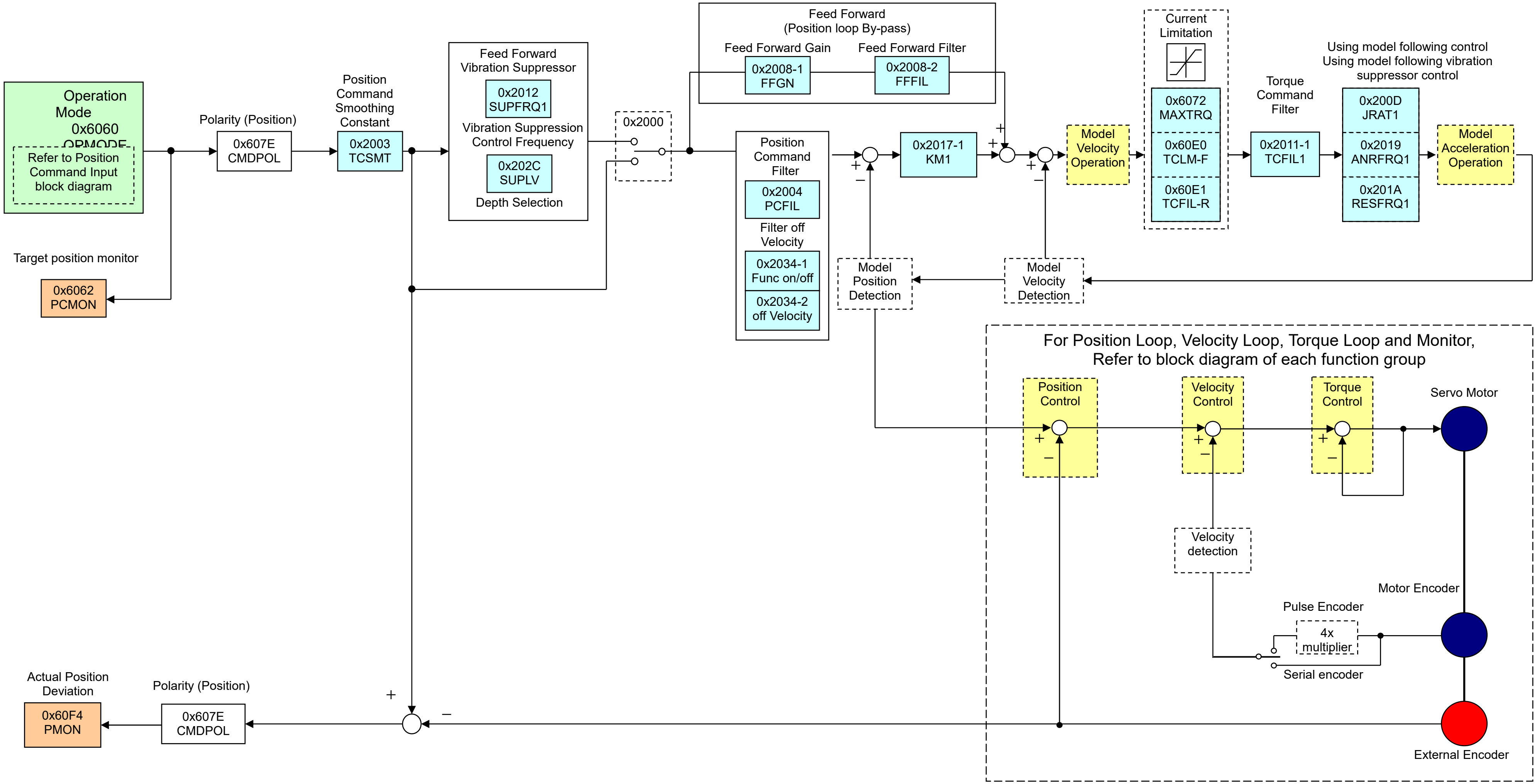
- ✓ The person who designs a system using the safety function (STO function) must have full knowledge of the related safety standards and full understanding of the instructions in this manual.
- ✓ Ensure performing Risk assessment when designing safety system using this function.
- ✓ When STO function is activated while servo motor running, the power supply to the motor is shut down, however, the motor continues to run a while through inertia. Make sure to design safety system to prevent any danger until the motor stops completely.
- ✓ When in vertical axes and the like, the motor rotates because of gravity loads. Take measures to hold the motor shaft with mechanical brake etc. Incidentally, dynamic brake of servo amplifier, holding brake excitation signal or holding brake of servo motor are not safety related parts.
- ✓ The motor may rotate within the electric angle of 180 degrees keeping motor excitation in case of servo motor between phases short-circuit due to the power device failure, etc. Use the function only in the applications where you can judge the above behavior will not lead to dangerous condition.
- ✓ Be sure to check if this function works properly when the machine is operated for the first time or servo amplifier is replaced. If the servo amplifier is incorrectly used due to faulty wiring of input / output signals, this function will not work properly, which may incur danger.
- ✓ For the time of Safe Torque Off function working and the cause concerning information, recommended that recording as error log at user device.
- ✓ At inspection and maintenance for servo amplifier, strongly recommended that recording and storing a detail of inspection and maintenance.

11.

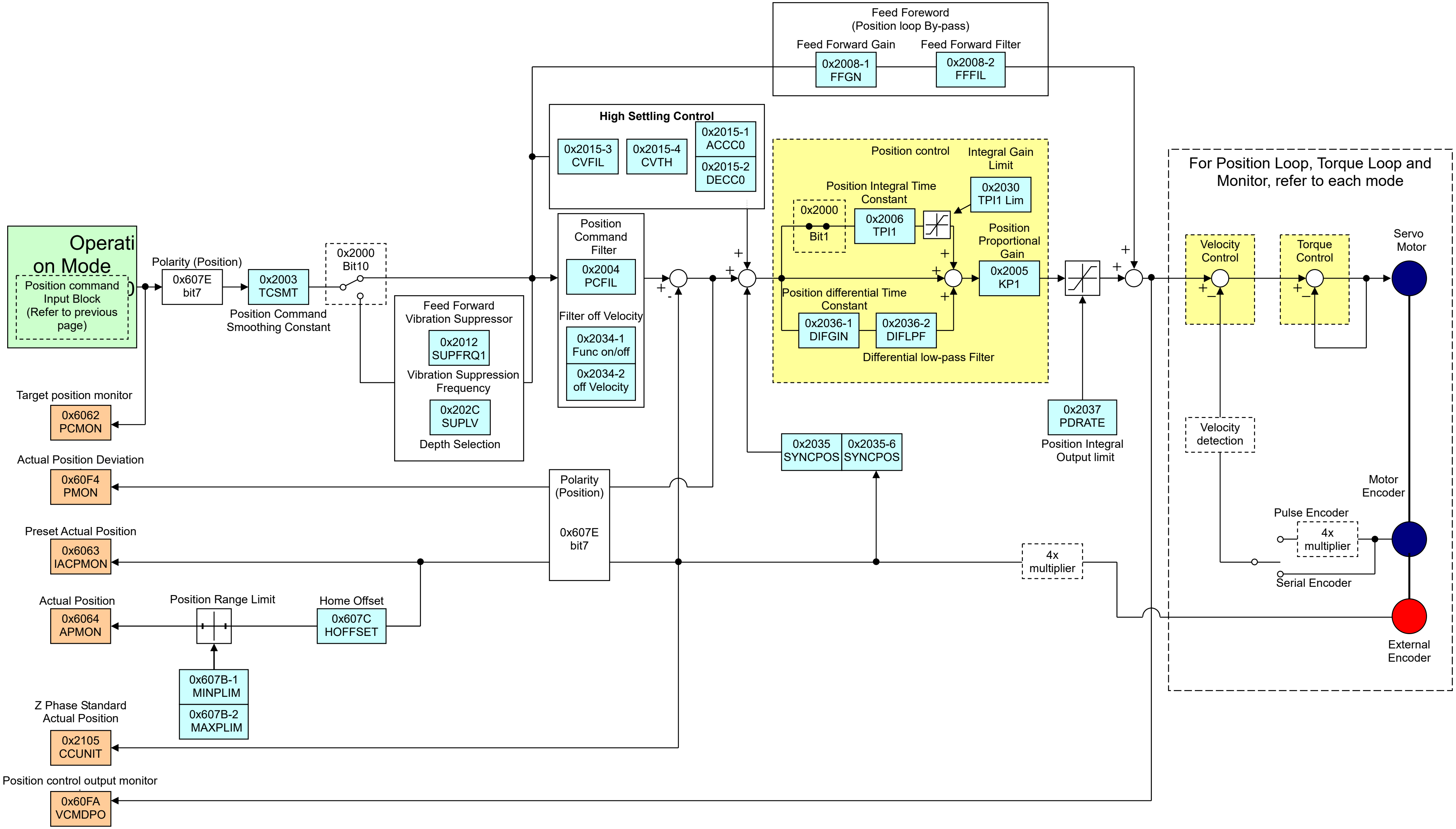
11. Fully-closed control

11.1 Internal Block Diagram

1) Block Diagram with Model Following Control



2) Block Diagram at no use of Model Following Control



11.2 Wiring

1) Connector name and function

Terminal number and signal name of CN102/202/302/402 for external encoder are shown below.

■ CN102/202/302/402 external encoder

External encoder Terminal No.	Signal name	Description	Note 1)
1	-	-	-
2	-	-	-
3	-	-	-
4	-	-	-
5	-	-	-
6	-	-	-
7	-	-	-
8	-	-	-
9	A	A-phase pulse output	Twisted pair
10	/A		
11	B	B-phase pulse output	Twisted pair
12	/B		
13	Z	Z-phase pulse output	Twisted pair
14	/Z		
15	-	-	-
16	SG	Power supply common Note 4)	-
17	-	-	-
18	SG	Power supply common Note 4)	-
19	-	-	-
20	SG	Power supply common Note 4)	-

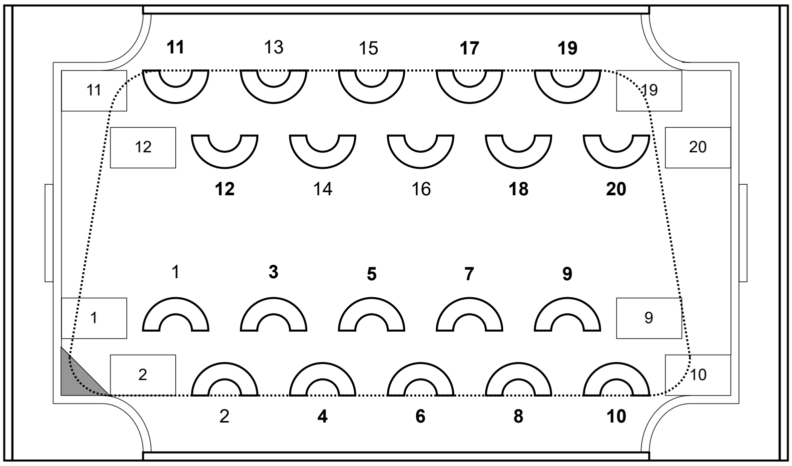
Note 1) Use an exterior covering shielded cable by a twisted pair.

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 on servo amplifier



Soldered side

11.3 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.

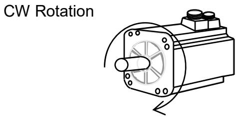
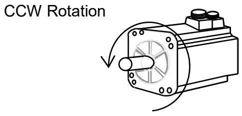
<table>
<tr><th>Group
ID</th><th>CoE
Object ID</th><th>Contents</th></tr>
<tr><td>System
ID06</td><td>0x6060, 0x00
OPMODE</td><td>Operation mode
■ Setup Operation mode to the servo amplifier being used Set below.
<table>
<tr><th colspan="2">Selection Value</th><th>Contents</th></tr>
<tr><td>01</td><td>PP</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>

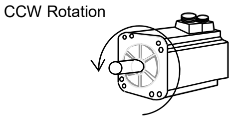
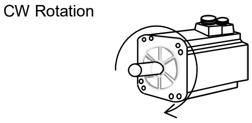
2) Rotation direction setting for the servo motor

Rotation of the servo motor in Full-closed control is determined by Command polarity and External pulse encoder polarity.

■ Setting of Command input polarity

Group ID	CoE Object ID	Polarity
Group8 ID00	0x607E, 0x00 CMDPOL	■ 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.

Selection Value		Position command positive	Position command negative
00	PC+_VC+_TC+		
20	PC+_VC+_TC-		
40	PC+_VC-_TC+		
60	PC+_VC-_TC-		
“APMON”		Current position monitor value decrease	Current position monitor value increase

Selection Value		Position command positive	Position command negative
80	PC-_VC+_TC+		
A0	PC-_VC+_TC-		
C0	PC-_VC-_TC+		
E0	PC-_VC-_TC-		
”APMON”		Current position monitor value increase	Current position monitor value decrease

■ Setting of External Encoder input polarity

Group ID	CoE Object ID	External Encoder Polarity Selection
GroupC ID03	0x20F1, 0x04 EX-ENPOL	■ Setup Signal polarity of External pulse encoder 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.

Selection Value		Contents		
00	Type1	EX-Z/ No inversion	EX-B/ No inversion	EX-A/ No inversion
01	Type2	EX-Z/ No inversion	EX-B/ No inversion	EX-A/ Inversion

3) Setting for external encoder resolution

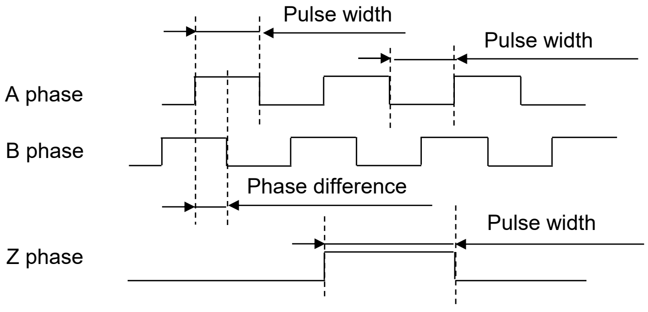
- Setting of External Encoder input pulse number

<table>
<tr><th>Group
ID</th><th>CoE
Object ID</th><th>External Encoder Division Setting Number</th></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><th>Setting range</th><th>Unit</th></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><th>Group
ID</th><th>CoE
Object ID</th><th>External Pulse Encoder Digital Filter</th></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><th colspan="2">Selection Value</th><th>Contents</th></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>

11.4 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.

12.

12.Linear motor

12.1 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.

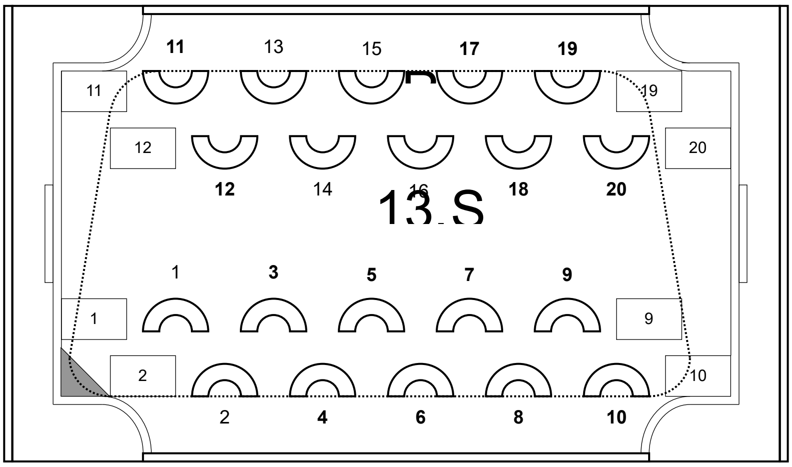
2) Encoder cable length

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 (Product of 3M Japan Limited)

	Model number	Applicable wire size	Applicable cable outer diameter
Connector	10120-3000VE	AWG24 or more	-

4) Connector names and functions

The following shows terminal numbers and signal names of linear scale sensor.

■ Linear sensor (incremental differential output)

Terminal number	Signal name	Description	Remarks Note1)
1	-	-	
2	-	-	
3	A	Phase A position signal pulse output	Twisted-pair
4	/A		
5	B	Phase B position signal pulse output	Twisted-pair
6	/B		
7	Z	Phase Z position signal pulse output	Twisted-pair
8	/Z		
9	-		
10	-		
11	-	-	
12	-	-	
13	-	-	
14	-	-	
15	-	-	
16	SG	Power supply common Note4)	Twisted-pair
17	5V	Note3)	
18	SG	Power supply common Note4)	Twisted-pair
19	5V	Note3)	
20	SG	Power supply common Note4)	
Note2)	Ground	Shielded	-

* Shows terminal numbers and signal names of Hall effect sensor.

■ Hall effect sensor (differential output)

Terminal number	Signal name	Description	Remarks Note1)
1	-	-	
2	-	-	
3	-	-	
4	-	-	
5	-	-	
6	-	-	
7	-	-	
8	-	-	
9	S1	Phase V signal output	Twisted-pair
10	/S1		
11	S2	Phase U signal output	Twisted-pair
12	/S2		
13	S3	Phase W signal output	Twisted-pair
14	/S3		
15	-	-	
16	SG	Power supply common Note4)	Twisted-pair
17	5V	Note3)	
18	SG	Power supply common Note4)	Twisted-pair
19	5V	Note3)	
20	SG	Power supply common Note4)	
Note2)	Ground	Shielded	-

■ Hall effect sensor (Open collector output)

Terminal number	Signal name	Description	Remarks Note1)
1	-	-	
2	-	-	
3	-	-	
4	-	-	
5	-	-	
6	-	-	
7	-	-	
8	-	-	
9	S1	Phase U signal output	-
10	-	-	NC
11	S2	Phase V signal output	-
12	-	-	NC
13	S3	Phase W signal output	-
14	-	-	NC
15	-	-	
16	SG	Power supply common Note4)	Twisted-pair
17	5V	Note3)	
18	SG	Power supply common Note4)	Twisted-pair
19	5V	Note3)	
20	SG	Power supply common Note4)	
Note2)	Earth	Shielded	-

Note1) Use shielded twisted-pair cable.

Note2) Connect the shielded cable to the metal case (ground) on control board side and connect the ground to the external pulse encoder side.

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.

12.2 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 : 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]
✍ System parameter becomes effective on re-power on.</td></tr>
<tr><td>System
ID04</td><td>0x20FF, 0x02
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>GroupC
ID01</td><td>0x20F1, 0x02
ENFIL</td><td>Encoder digital filter selection（EN1）
■ Set digital filter for motor pulse encoder pulse signal, which is contained in pulse output encoder. Digital filter value of incremental pulse from the linear scale sensor you use can be set. When noises superimposed on incremental encoder, pulse under the set value shall be eliminated as noise. Set the value in consideration of encoder resolution and operational maximum velocity of servo motor you use. Use the value under a quarter of encoder pulse width at maximum rotational velocity as a guide.
<table>
<tr><th>Value to select</th><th>Contents</th></tr>
<tr><td>00：_110nsec</td><td>Minimum pulse width ＝110ns（Minimum phase difference37.5ns）</td></tr>
<tr><td>01：_220nsec</td><td>Minimum pulse width ＝220ns（Minimum phase difference75ns）</td></tr>
<tr><td>02：_440nsec</td><td>Minimum pulse width ＝440ns（Minimum phase difference150ns）</td></tr>
<tr><td>03：_880nsec</td><td>Minimum pulse width ＝880ns（Minimum phase difference300ns）</td></tr>
<tr><td>04：_ 75nsec</td><td>Minimum pulse width ＝ 75ns（Minimum phase difference37.5ns）</td></tr>
<tr><td>05：_150nsec</td><td>Minimum pulse width ＝150ns（Minimum phase difference75ns）</td></tr>
<tr><td>06：_300nsec</td><td>Minimum pulse width ＝300ns（Minimum phase difference150ns）</td></tr>
<tr><td>07：_600nsec</td><td>Minimum pulse width ＝600ns（Minimum phase difference300ns）</td></tr>
</table>
</td></tr>
<tr><td>GroupC
ID0A</td><td>0x20F1, 0x07
ENCDIR</td><td>Linear sensor polarity selection（EN1）
■ ﾘ 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, 0x02 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 effect sensor digital filter selection (External encoder digital filter selection)
■ Set digital filter of Hall effect sensor input signal.
When noises are superimposed on Hall effect sensor signal, pulse under the set value shall be removed as noise.
<table>
<tr><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 effect sensor polarity selection (External encoder polarity selection)
■ Set polarity of Hall effect 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 effect sensor, offset from phase U electrical angle 0 degree to phase U Hall effect sensor output edge shall be set in electrical angle.
Setting range ：0 to 359deg
Initial value ：330deg
✔Sensor type code: 0x20FF, 02＝0x0800, 0x0810, 0x0820, 0x0830, 0x0840, 0x0850 and 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,02＝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>–</td><td>0x20F1, 0x09
CSETMD</td><td>Magnetic pole position estimation mode selection
■ Set the magnetic pole position estimation run mode.
<table>
<tr><th>Value to select</th><th>Contents</th></tr>
<tr><td>00</td><td>Follow the setting of the valid condition of magnetic pole position pointing function.</td></tr>
<tr><td>01</td><td>Magnetic pole position estimation will run one time automatically only after turning on the main power.</td></tr>
</table>
✔Sensor Classification Cord:0x20FF, Function will be enabled by setting 02=0x0850.
✍ 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 effect 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>
<tr><td>0E:_CONT7_ON</td><td>Function enabled when general input CONT7 is ON. Note1)</td></tr>
<tr><td>0F:_CONT7_OFF</td><td>Function enabled when general input CONT7 is OFF. Note1)</td></tr>
<tr><td>10:_CONT8_ON</td><td>Function enabled when general input CONT8 is ON. Note1)</td></tr>
<tr><td>11:_CONT8_OFF</td><td>Function enabled when general input CONT8 is OFF. Note1)</td></tr>
</table>
✔ Input time to become al l the function enabled is 8ms.</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.</td></tr>
</table>

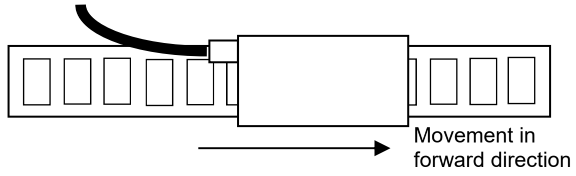
4) Setting of moving direction

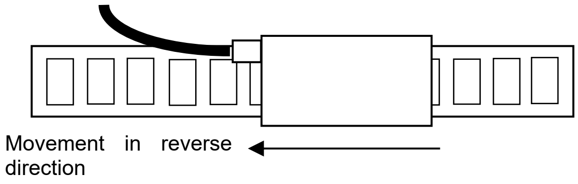
Moving direction of linear motor depends on polarity of command and linear scale sensor.

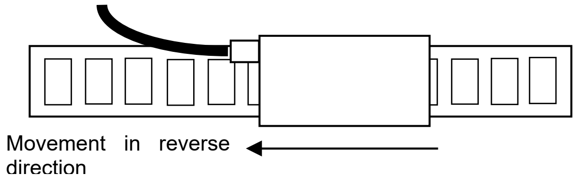
- Setting of command-input polarity

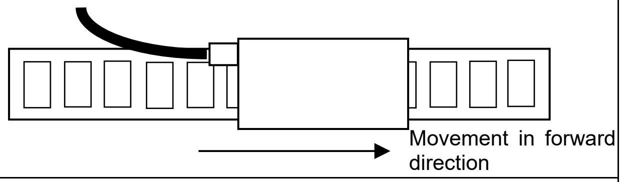
<table>
<tr><th>Group ID</th><th>CoE Object ID</th><th>Contents</th></tr>
<tr><td rowspan="2">Group8
ID00</td><td rowspan="2">0x607E, 0x00
CMDPOL</td><td>Polarity</td></tr>
<tr><td>

■ 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>

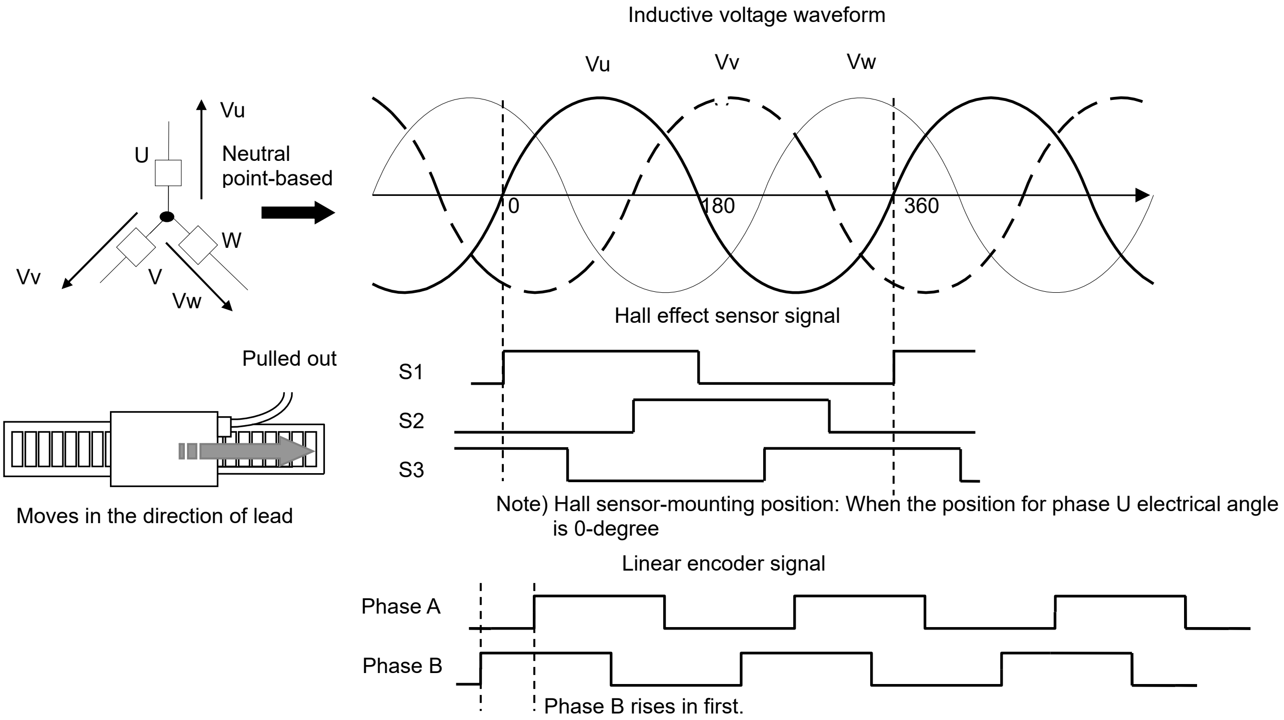
12.3 Precautions

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 effect 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.



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

- “Linear encoder resolution” is set to 1μm (multiplier ratio 1:4) 1000P/mm at factory setting. So select and set the linear encoder resolution you use from " System ID03” or “OD：0x20FF, 0x01 ENCODE.”

- When using “motor thermal,” connect motor thermal wire to any of CONT1 through CONT6, and then setting condition “Group 9, ID02 or 0x20F8, 0x03 EXT-E” of the connected “CONT*” to “external trip function.”

- When using Hall effect sensor, set the mounting position of Hall effect sensor to phase U electrical angle to System ID16 or “CS offset of0x20F1, 0x05 CSOF.”

3) Automatic Magnetic Pole Position Estimation Function

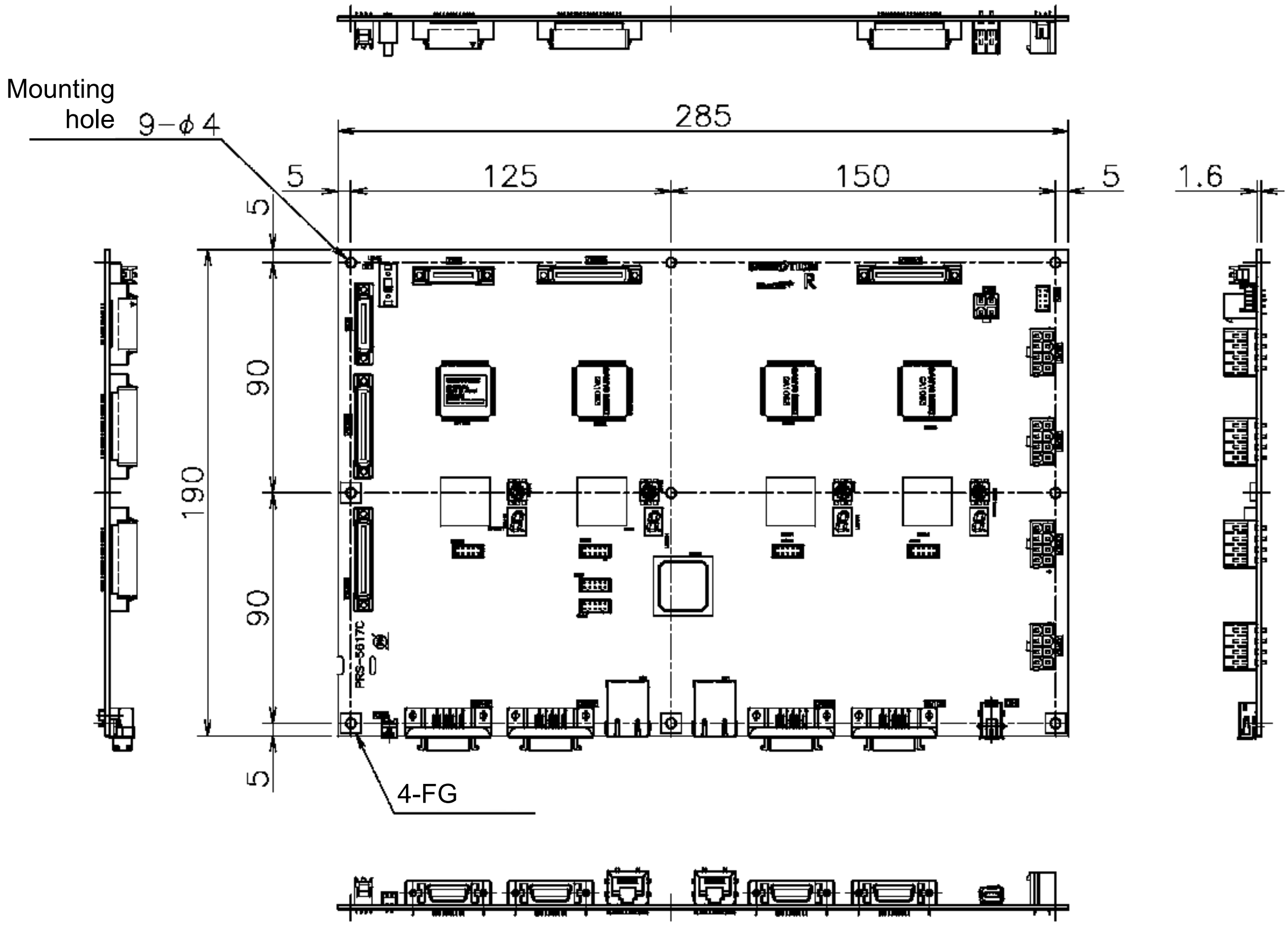
- After power on, if moving to preparation status of magnetic pole position estimation (3 seven-segment LEDs blink) because of an alarm/emergency stop etc., start running automatic execution after deactivating alarm/emergency stop.
- At the time of moving to preparation status of magnetic pole position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

13.

13 Appendixes

13.1 Control Board Dimensions

■ RM2C4H4

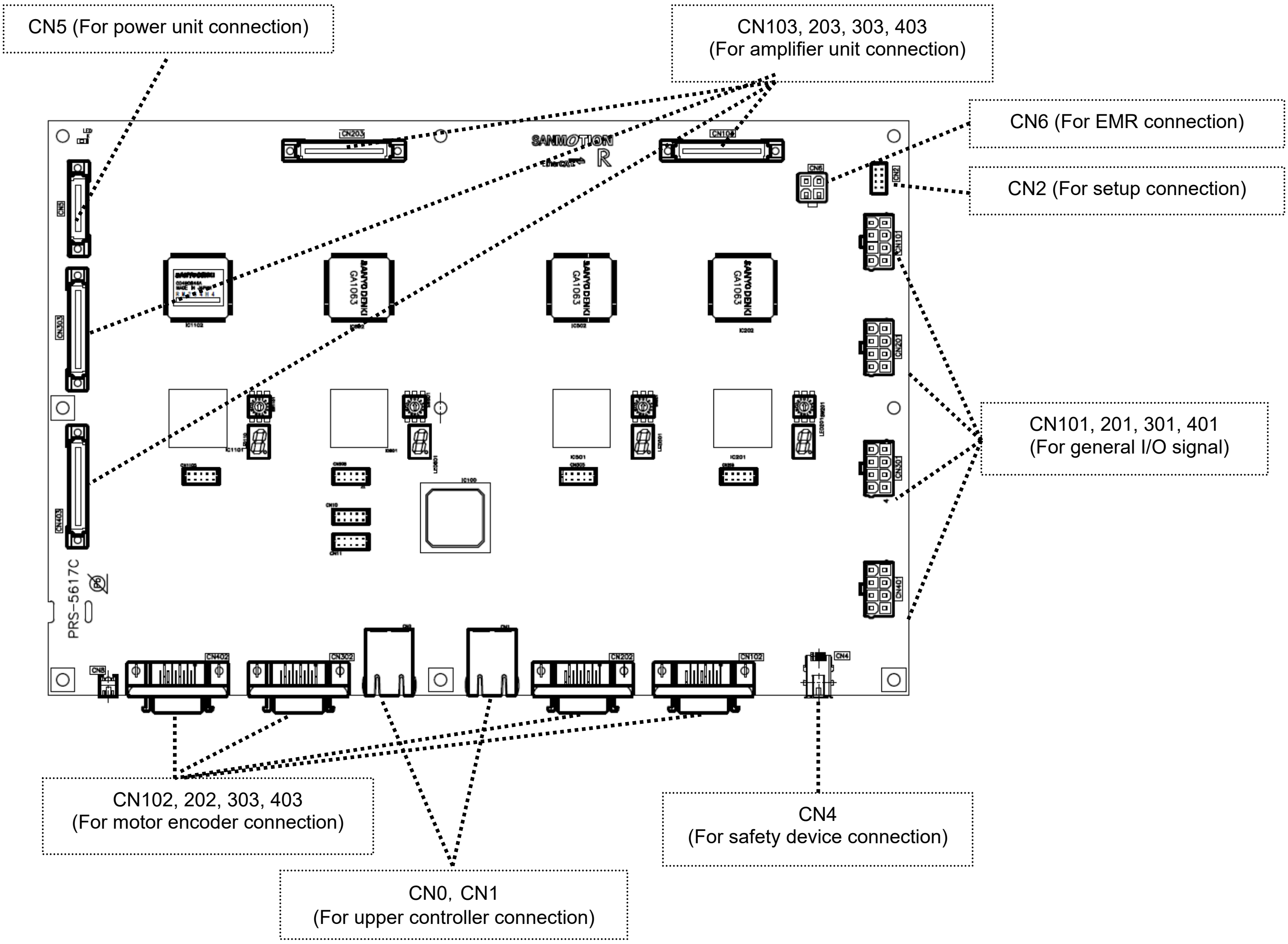


13.2 Optional Parts

1) Connector arrangement

We prepare the following option products.

Control Unit: RM2C4H4



2) Connector Model Numbers for control board

■ Our model number for connecter as single item

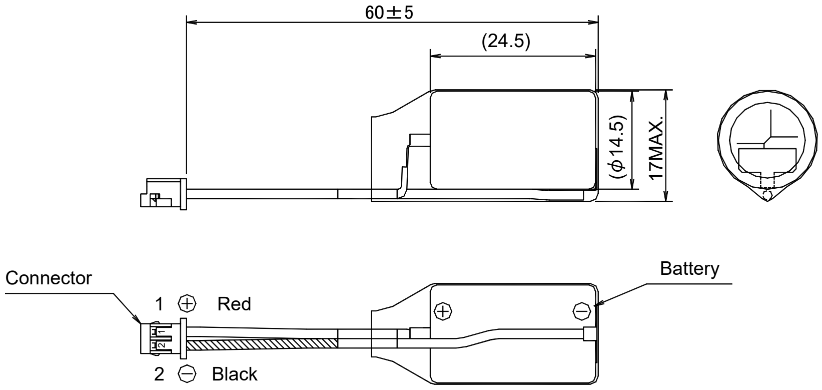
Connector No.	Contents	SANYO DENKI model No.	Manufacturer's model No.	Manufacturer name
CN0, CN1	Ethernet For host unit connection	Not provided by our company. Please use shielded type modular plug (RJ-45) corresponding to the CAT5e standard.		
CN102, CN202, CN302, CN402	For encoder Connection	AL-00385596	10120-3000PE	3M Japan Limited
CN101, CN201, CN301, CN401	For general I/O signal	AL-00922656	5557-08R_NATURAL x 1 pcs 5556TL x 8pcs	Molex Japan LLC
CN3	For emergency stop input	AL-00922660	5557-04R_ NATURAL x 1 pcs 5556TL x 4 pcs	Molex Japan LLC
CN4 Note 1)	For safety device connection (Short-circuiting)	AL-00849548-02	1971153-2	Tyco Electronics Japan G.K.
CN4	For safety device connection (Wiring)	AL-00718252-01	2013595-3	

Note 1) If no wiring to CN4, short-circuiting connector shall be connected to CN4 of servo amplifier.

3) Battery-backup absolute encoder battery related parts

Name	Contents	QTY.	SANYO DENKI model NO.
Battery (lithium battery)	Lithium battery: ER3VLY TOSHIBA LIFESTYLE PRODUCTS & SERVICES CORPORATION	1	AL-00697958-01

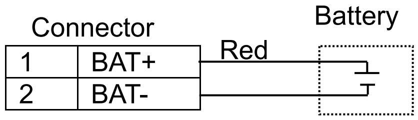
■Outline dimensional drawing of battery unit (Model No.: AL-00697958-01)



1. Battery and Connector Specifications

Lithium battery	Thionyl Chloride Lithium Battery ER3VLY (TOSHIBA LIFESTYLE PRODUCTS & SERVICES CORPORATION) Nominal Voltage: 3.6V Nominal Capacity: 1000mAh Lithium metal weight as standard: 0.31g
Connector	DF3-2S-2C; Socket Housing (HIROSE) DF3-2428SCFC; Contact (HIROSE)

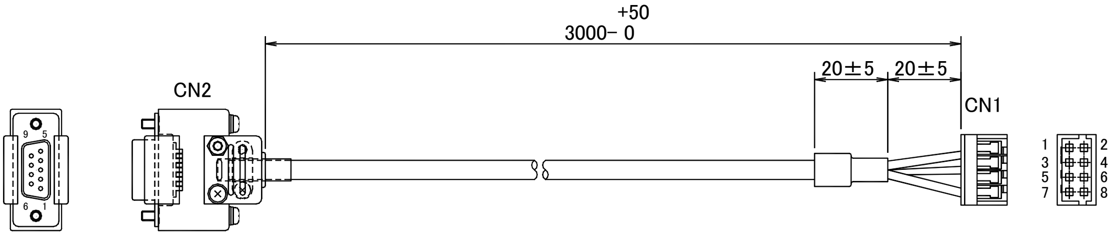
2. Wiring diagram



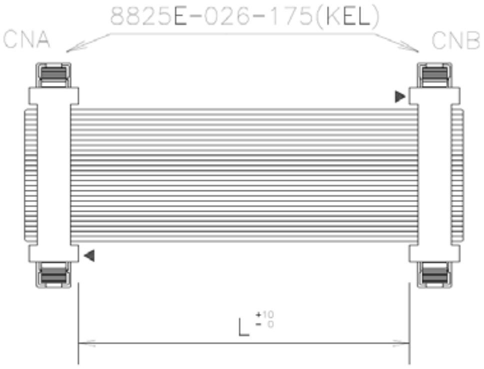
4) Setup software and serial communication-related parts

Connector number	Name	Contents	QTY	SANYO DENKI model NO.
CN2	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)



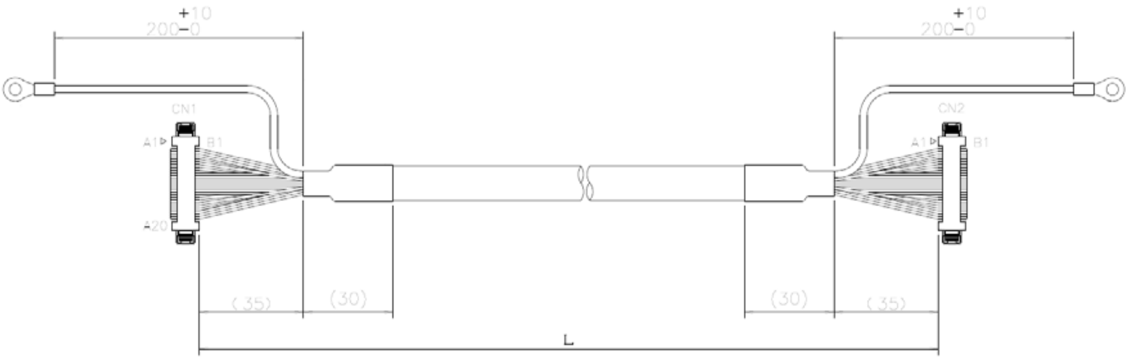
5) Connection cable between Power unit and Control unit



* Maximum cable length between Power unit and Control unit shall be 1 m.

Connector number		L [mm]	SANYO DENKI model No.
Power unit	Control unit		
CN2	CN5, CN6	200	AL-00397730-01
		250	AL-00397730-02
		300	AL-00397730-03
		350	AL-00397730-04
		500	AL-00397730-05

6) Connection cable between Amplifier unit and Control unit



* Maximum cable length between Amplifier unit and Control unit shall be 2.5 m.

Connector number		L [mm]	SANYO DENKI model No.
Power unit	Control unit		
CN2	CN103,203, 303,403	500	AL-00510001-01
		750	AL-00510001-02
		1000	AL-00510001-03

13.3 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 µController
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	
Revision A	Apr. 2016
Revision B	Jul. 2018
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■ECO PRODUCTS

Sanyo Denki's ECO PRODUCTS are designed with the concept of lessening impact on the environment in the process from product development to waste. The product units and packaging materials are designed for reduced environmental impact.

We have established our own assessment criteria on the environmental impacts applicable to all processes, ranging from design to manufacture.

■Precautions For Adoption

Failure to follow the precautions on the right may cause moderate injury and property damage, or in some circumstances, could lead to a serious accident.

Always follow all listed precautions.

⚠ Cautions

- Read the accompanying Instruction Manual carefully prior to using the product.
- If applying to medical devices and other equipment affecting people's lives please contact us beforehand and take appropriate safety measures.
- If applying to equipment that can have significant effects on society and the general public, please contact us beforehand.
- Do not use this product in an environment where vibration is present, such as in a moving vehicle or shipping vessel.
- Do not perform any retrofitting, re-engineering, or modification to this equipment.
- The Products presented in this Instruction Manual are meant to be used for general industrial applications. If using for special applications related to aviation and space, nuclear power, electric power, submarine repeaters, etc., please contact us beforehand.

* For any question or inquiry regarding the above, contact our Sales Department.

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Translated version of the original instructions