M0011697C

SANMOTION

AC SERVO SYSTEMS

R

3E Model

TYPE S

EtherCAT® Interface

For Rotary Motor, Linear Motor

Communication Manual

SANYO DENKI

The third edition (C)

- Overall
  - Encoder naming is unified.
- p. 2-4
  - Note of node ID setting is added.
- p. 2-15
  - Description is added.
    Table of SDO response time is added.
- p. 2-23
  - SDO Abort Code is updated to latest ETG specifications.
- p. 2-37 to 2-40
  - Description of FoE parameter transferring function is added.
- p. 3-11
  - Error codes added by ETG are added to AL Status Code.
- Chapter 4
  - Writing of "EEPROM" is changed to "non-volatile memory".
- p. 4-3
  - The section describing about unit conversion of linear motor / direct drive motor is added.
- p. 4-7
  - Description for read access in 0x1010 is updated to detail.
- p. 4-18 to 4-22
  - Abort option code description and limitation are added.
  - Disable option code limitation related to torque slope is added.
  - Limitations for each option code are added.
- p. 4-48 to 4-56
  - Object list of manufacturer specific area is updated with correction and new function addition.
- p. 4-64 to 4-68
  - Invalid condition of each filter set value is corrected.
- p. 4-68
  - Change time of FF Vibration Suppression Frequency is added.
- p. 4-69
  - Filtering frequency setting range of velocity/torque notch filter is corrected.
- p. 4-83
  - Description related to assisting function is added.
- p. 4-86
  - Description related to system analysis/POFF detection delay time function is added.

- p. 4-103, 4-108
  - Note is added as below.
    ✓ Alarm DE (Parameter Change Completion) will issued if the value differ from set value is set.

- p. 4-95
  - Description related to Drive recorder function/Initialization timeout waiting time is added.

- p. 4-97 to 4-98
  - Description related to torque scale is added.
  - Deceleration stop special function selection in position control mode/RS3 special function selection setting is added to Extended function selection setting.
  - Description related to FoE Uploading File Selection is added.
  - Description related to Gain Switching Condition is added.

- p. 4-105 to 4-106
  - Description related to Velocity loop proportional control switching function is added to special function selection setting.
  - Torque Limit Switching Condition/Velocity Loop Proportional Control Switching Condition is added to General Purpose Input Setting.

- p. 4-110 to 4-111
  - 9 of R1 series motors are added.

- p. 4-116
  - Description of DE alarm is added to Motor Encoder Input Selection.

- p. 4-140 to 4-141
  - 0x2138 is abolished and 0x2139 is added.
  - 0x213A and 0x213B are added.

- p. 5-12
  - Description related to drive recorder function/system analysis function is added.

- p. 5-35
  - Description related to a recalculated position by "Change set immediately (bit5)" on linear coordinate system exceeds a limit of position range is added.

- p. 5-58
  - Sequence of homing mode is corrected and limitation is added.

- p. 5-63
  - Drawing of homing method 33 is corrected.

- p. 5-67
  - Drawing of touch probe single event trigger behavior is corrected and description is added.

- p. 5-76, 5-77
  - Description of Drive recorder data upload function is added.
  - Description of System analysis data upload function is added.

- p. 5-84, 5-85
  - Deceleration stop special function selection in position control mode is added.

- p. 5-86
  - Restrictions related to deceleration stop in torque control is added.
  - Restrictions related to special function selection in position control is added.

- p. 5-95
  - Description of special function selection setting is added.

Safety Precautions

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

■ Warning Symbol

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

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

■ Prohibited, Mandatory Symbols

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

Safety Precautions

■ Attention in use

⚠ Warning

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

⚠ Caution

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

■ Storage

Prohibited

- Do not store the device where it could be exposed to rain, water, toxic gases or other liquids.
  Damage to the device could otherwise result.

Safety Precautions

Mandatory

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

■ Transportation

Caution

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

Mandatory

- Follow the directions written on the outside box. Excess stacking could result in collapse.
  Bodily injury could otherwise result.
- Use eyebolt of the motor only for transporting itself. Do not use for transportation of machinery combined with the motor.
  Damage to the device or bodily injury could otherwise result.

■ Installation

⚠ Caution

- Do not stand on the device or place heavy objects on top of it.
  Bodily injury could otherwise result.
- Make sure the mounting orientation is correct.
  Fire or damage to the device could otherwise result.
- Do not drop this device or subject it to excessive shock of any kind.
  Damage to the device could otherwise result.
- Do not obstruct the air intake and exhaust vents, and keep them free of debris and foreign matter.
  Fire could otherwise result.
- Consult the User Manual regarding the required distance inside the amplifier disposition.
  Fire or damage to the device could otherwise result.
- Open the box only after checking its top and bottom location.
  Bodily injury could otherwise result.
- Verify that the products correspond to the order sheet/packing list.
  Injury or damage could result.
- Take care of falling or overturning of the device during installation.
  Use eyebolts of the motor if supplied.
  Bodily injury could otherwise result.
- Install the device on a metal or other non-flammable support.
  Fire could otherwise result.
- Make the collision safety device strong enough to resist the maximum output of the system.
  Bodily injury could otherwise result.

■ Wiring

⚠ Caution

- ◆ Wiring connections must be secure.
  Bodily injury could otherwise result.
- ◆ Wiring should be completed based on the Wiring Diagram or the User Manual.
  Electric shock or fire could otherwise result.
- ◆ Wiring should follow electric equipment technical standards and indoor wiring regulations.
  An electrical short or fire could otherwise result.
- ◆ Do not connect a commercial power supply to the U, V or W terminals of the servo motor.
  Fire or damage to the device could otherwise result.
- ◆ Install a safety device such as a breaker to prevent external wiring short-circuits.
  Fire could otherwise result.
- ◆ Do not bind or band the power cable, input/output signal cable and/or encoder cable together or pass through the same duct or conduit.
  This action will cause faulty operation.
- ◆ Must add the surge absorbing diode if inductive load as relay connect to the control signal output of the amplifier. Please take care of polarity of the diode that will be cause of failure.
- ◆ Do not connect 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.
- ◆ Please design a sequence that included braking delay time because the surge-absorbing component for the relay of holding brake of the servo motor gives braking delay time.
  Injury or load falling could otherwise result.

Mandatory

- ◆ Install an external emergency stop circuit that can stop the device and cut off the power instantaneously. Install an external protective circuit to the amplifier to cut off the power from the main circuit in the case of an alarm.
  Motor runaway, bodily injury, burnout, fire and secondary damages could otherwise result.

■ Operation

⚠ 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 holding brake is not to be used as a safety stop for the mechanism. Install a safety stop device on the mechanism.
  Bodily injury could otherwise result.
- In the case of an alarm, first remove the cause of the alarm, and then verify safety. Next, reset the alarm and restart the device.
  Bodily injury could otherwise result.
- Check that input power supply voltage is keeping a specification range.
  Damage to the device could otherwise result.
- Avoid getting close to the device, as a momentary power outage could cause it to suddenly restart (although it is designed to be safe even in the case of a sudden restart).
  Bodily injury could otherwise result.
- Do not use motor or amplifier which is defective or failed and damaged by fire.
  Injury or fire could otherwise result.
- In the case of any irregular operation, stop the device immediately.
  Electric shock, injury or fire could otherwise result.
- When using the servo motor in vertical axis, provide safety devices to prevent falls during the work that will cause an alarm condition.
  Injury or damage could result.

Safety Precautions

Prohibited

- The built-in brake is intended to secure the motor; do not use it for regular control. Damage to the brake could otherwise result.
  Damage to the device could otherwise result.
- Keep the motor's encoder cables away from static electricity and high voltage.
  Damage to the device could otherwise result.
- Standard specification servo amplifiers have a dynamic brake resistor. Do not rotate the motor continuously from the outside when the amplifier is not powered on, because the dynamic brake resistor will heat up, and can be dangerous.
  Fire or burn could otherwise result.
- Absolutely do not apply voltage more than the spec to the amplifier because overvoltage will be cause of part failure.
  Damage to the device or bodily injury could otherwise result.
- Avoid frequent on and off power supply.
  Inner parts might get premature failure in case of repeating ON/OFF of power supply 30 times or more per day, otherwise 5 times or more per hour.

Mandatory

- Install an external emergency stop circuit that can stop the device and cut off the power instantaneously. Install an external protective circuit to the amplifier to cut off the power from the main circuit in the case of an alarm.
  Motor runaway, bodily injury, burnout, fire and secondary damages could otherwise result.
- There is no safeguard on the motor. Use an over-voltage safeguard, short-circuit breaker, overheating safeguard, and emergency stop to ensure safe operation.
  Injury or fire could otherwise result.
- Operate within the specified temperature and humidity range.
  Servo Amplifier
  Temperature 0°C to 55°C
  Humidity below 90% RH (non-condensing).
  Servo Motor
  Temperature 0°C to 40°C
  Humidity below 90% RH (non-condensing).}
  Burnout or damage to the device could otherwise result.

■ Maintenance･Inspection

Caution

- Some parts of the servo amplifier (electrolytic capacitor, cooling fan, lithium battery for encoder, fuse and relay kinds) can deteriorate with long-term use. Please contact our offices for replacements.
  Damage to the device could otherwise result.
- Do not touch or get close to the terminal while the device is powered up.
  Electric shock could otherwise result.
- Be careful during maintenance and inspection, as the body of the amplifier becomes hot.
  Burn could otherwise result.
- Please contact your distributor or sales office if repairs are necessary. Disassembly could render the device inoperative.
  Damage to the device could otherwise result.

Prohibited

- Do not overhaul the device.
  Fire or electric shock could otherwise result.
- Do not measure the insulation resistance and the pressure resistance.
  Damage to the device could otherwise result.
- Absolutely do not unplug the connector while the device is powered up because hot plug will give damaged by surge to component.
  Electric shock or damage could otherwise result.
- Do not remove the nameplate cover attached to the device.

■ Disposal

Mandatory

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

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4. Object Dictionary

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1

Preface

In this chapter, Summary, Positioning, and How to use of this instruction manual are explained.

1. Preface

1.1 Introduction

1.1.1 Product overview

Thank you for purchasing the AC servo system, “SANMOTION R” 3E Model. This instruction manual describes important things to notice to ensure your safety, such as specifications, installation, wiring, operation, functions and maintenance of the system. Please make sure to read this instruction manual before use to operate this AC servo system correctly. After reading, please keep it handy to refer as needed.

■ Summary
This document is a part of instruction manual of R 3E Model EtherCAT servo amplifier issued by SANYO DENKI.
This instruction manual describes technical specification of how to construct EtherCAT network communication, physical parameter adjustment, function activation.
For reading, pertinent knowledge about servo amplifier, motion control, network and EtherCAT etc is required.

■ Related document
Refer another document M0011696, for the information of servo amplifier and especially "Safety precautions".

1.2 Instruction manual

This manual outlines the specifications, installation, wiring, operations, functions, maintenance, etc. of the AC servo amplifier "SANMOTION R" 3E Model EtherCAT interface as follows:

1.2.1 Contents

- Chapter 1 Preface
  Product outline, model number, names of components
- Chapter 2 Interface
  Descriptions for EtherCAT interface.
- Chapter 3 Datalink layer
  Explanation of EtherCAT Slave Controller (ESC)
- Chapter 4 Object dictionary
  Descriptions for object dictionary of EtherCAT interface.
- Chapter 5 Operation
  Explanation of operation sequence and how to use test operation

1.2.2 Precautions related to these instructions

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

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

2
Interface

In this chapter, EtherCAT interface is explained.

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.

2.1.1 Overview

EtherCAT is an abbreviation of Ethernet for Control Automation Technology. EtherCAT is an open network communication between master and slave units using the real time Ethernet developed at BECKHOFF Automation and is controlled by ETG (EtherCAT Technology Group).
Twisted pair or fiber optic cables can be used for the EtherCAT connection and the EtherCAT 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.

2.1.2 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. Inteface

2.2 Model (Reference Model)

2.2.1 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.

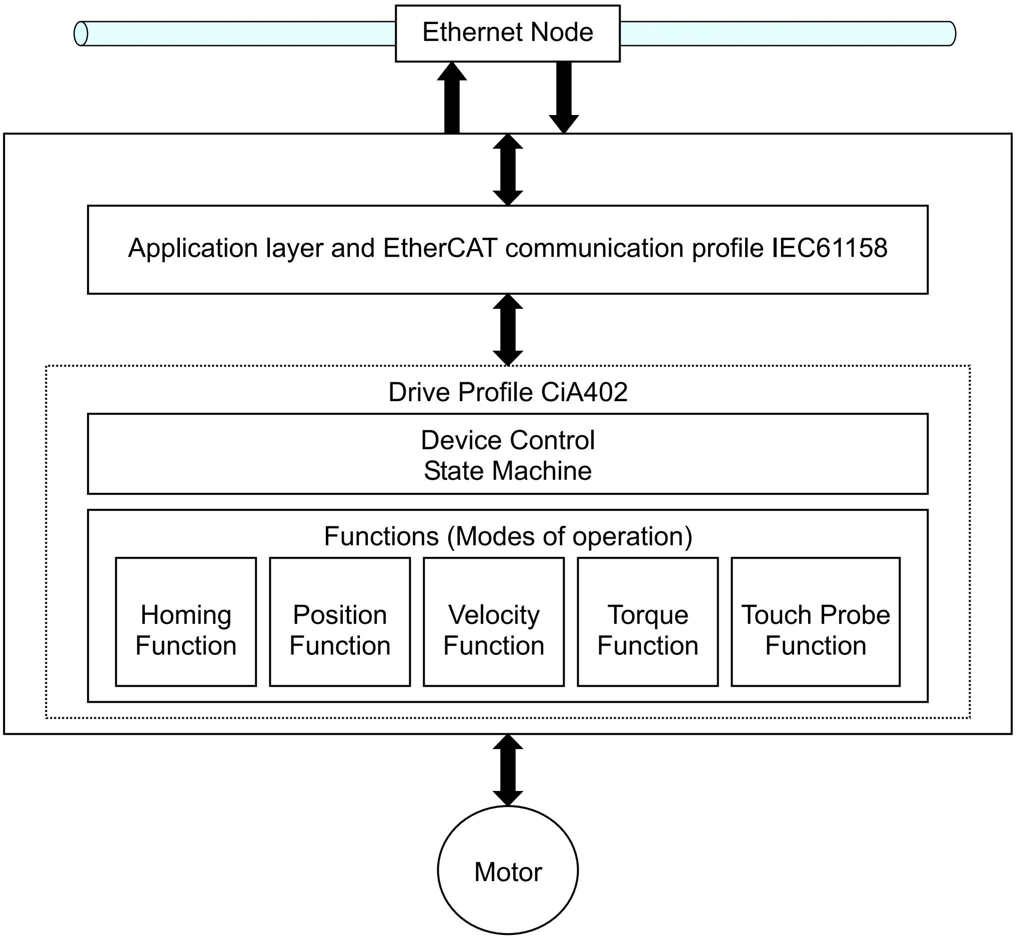
- Layer 4 (Transport layer)
  Performs data compression, error correction and resends data delivery controls absolutely and efficiently.

- 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.

2.2.2 Drive Architecture



Communication architecture

2.3 Settings

2.3.1 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 - 255 axes addresses can be set using the 8bit rotary switch (0x00 to 0xFF: bit 7 to 0) at the front of 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.

Node ID setting method differs due to set value of object 0x20FA-2, as below.

0x20FA-2: Extended station alias selection	Setting method
0x00	Sets a rotary switch value as lower 8 bit, and extended alias number (0x20FA-1) value as higher 8 bit.
0x01	Rotary switch value is zero: Reflects the value defined to address 4 of EEPROM attached to ESC. Rotary switch value is except zero: Reflects the value of rotary switch. (Write zero to address 4 of EEPROM.)

2.3.2 Physical Communication Specifications

Physical Communication Specifications

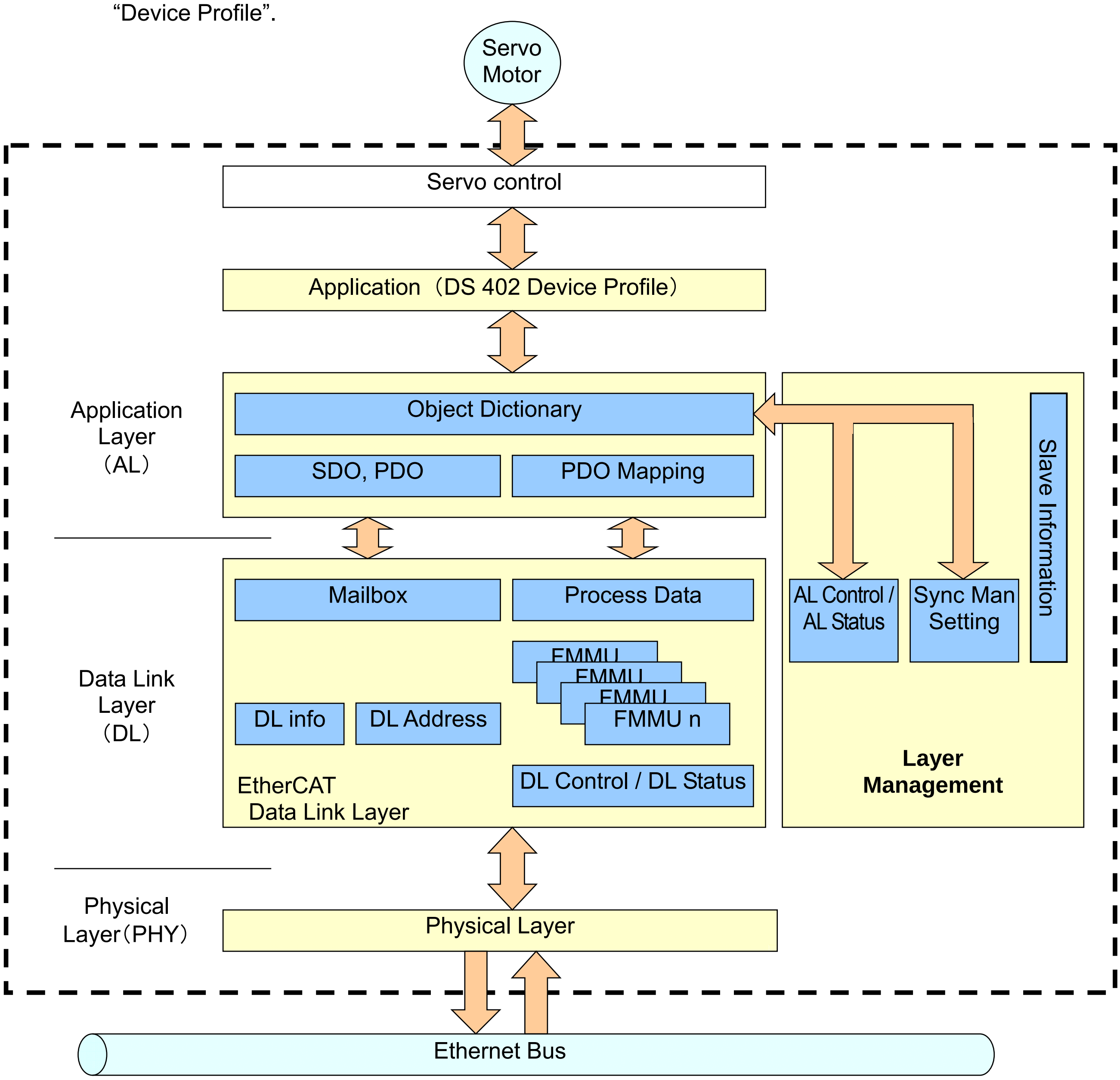
Item	Specifications	Notes
Topology	Line	
Data flow	Line: From the master to the first slave and then on to the last slave, shuttling back and forth.	
Communication media	Twisted pair cable	
Communication rate	100 Mbit/s	
Communication parameter settings	Auto-negotiation function with ISO/IEC 8802-3 Auto-crossover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

2.4.1 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".



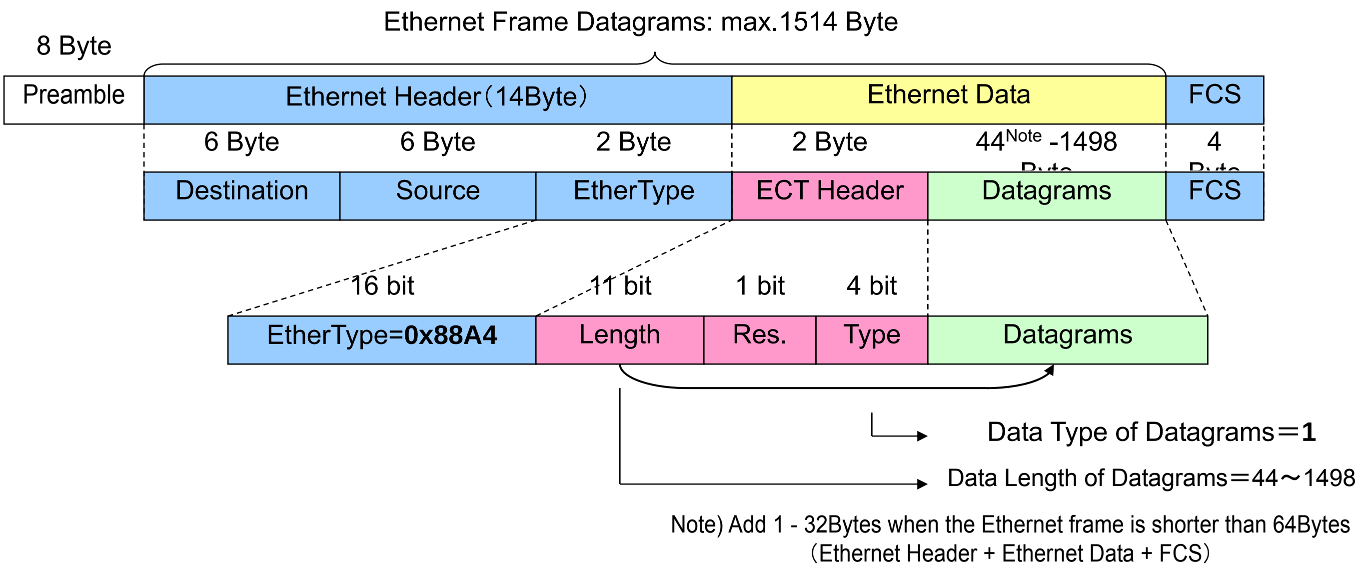
- Object Index
  All objects are addressed with a 16-bit index using a 4-digit hexadecimal number.
  Objects are assigned in the Object Dictionary by individual groups.
  The Object Dictionary outline prescribed in CoE is as follows:

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

2.4.2 Communication

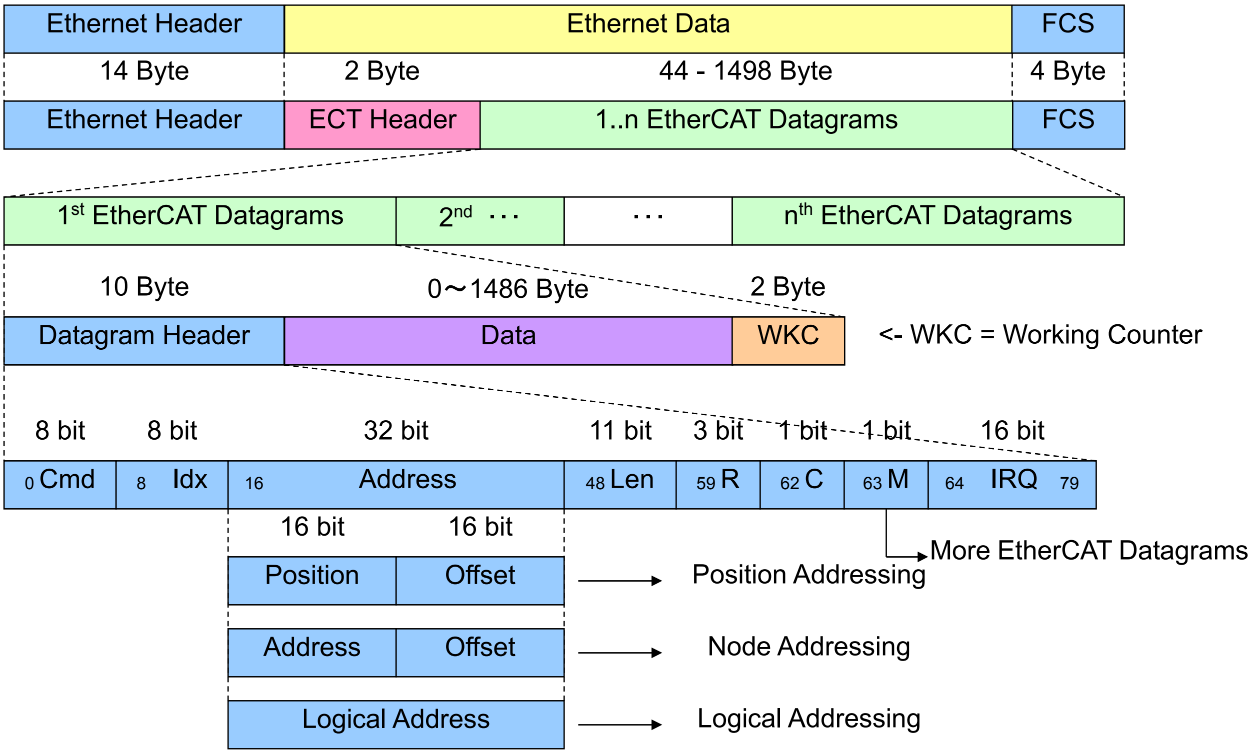
- Ethernet Protocol
  Since EtherCAT is adopting IEEE 802.3 as its standard Ethernet frame, a standard network controller can be used.
  Therefore, system construction is possible on the master side without designing specific hardware.
  "0x88A4" is reserved for the Ether type of EtherCAT and is distinguished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

2.4.3 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

2.4.4 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

2.4.5 Command Type

Address and access method are determined by the 8-bit command at he head of the EtherCAT datagram. EtherCAT command types are listed below.
Read / Write operations and Read operation are executed before Write operation.

EtherCAT Command Types

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

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

EtherCAT Addressing Mode

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

2.4.6 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

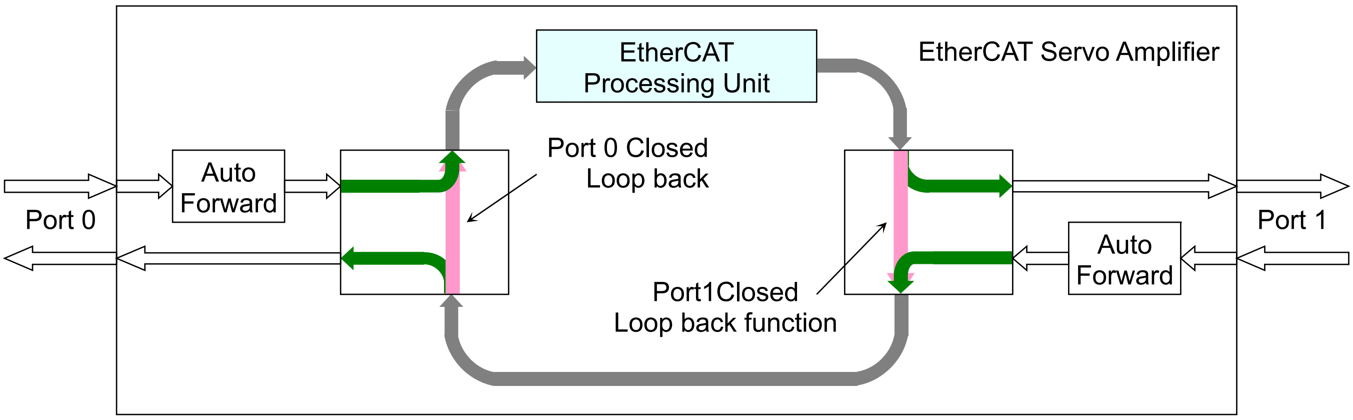
2.4.7 Frame Processing

R 3EModel 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

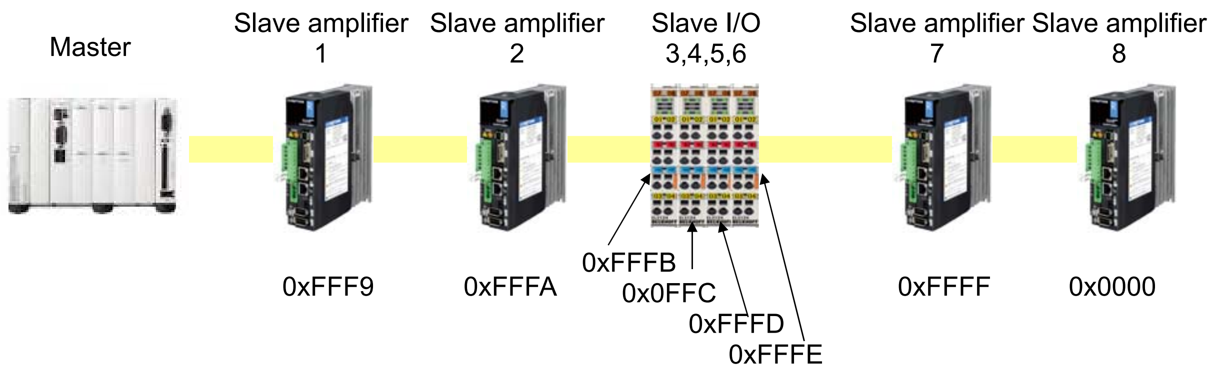
The direction via the EtherCAT processing unit is called “Processing” and the direction that does not pass through the processing unit is called “Forwarding”.



2.5 Addressing Image

2.5.1 Position Addressing (Auto-Increment Addressing)

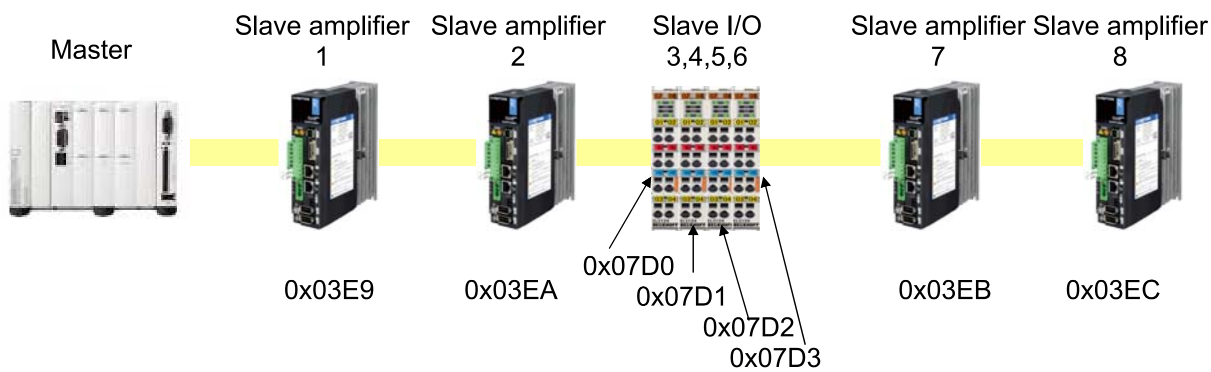
Position addressing is a command to access slaves from the master according to the connection order (physical position).
Each slave device provides one (1) 16-bit address field every time datagrams pass through and a slave “0x0000”will be addressed and will respond when receiving the address field.
Position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

2.5.2 Node Addressing (Fixed Addressing)

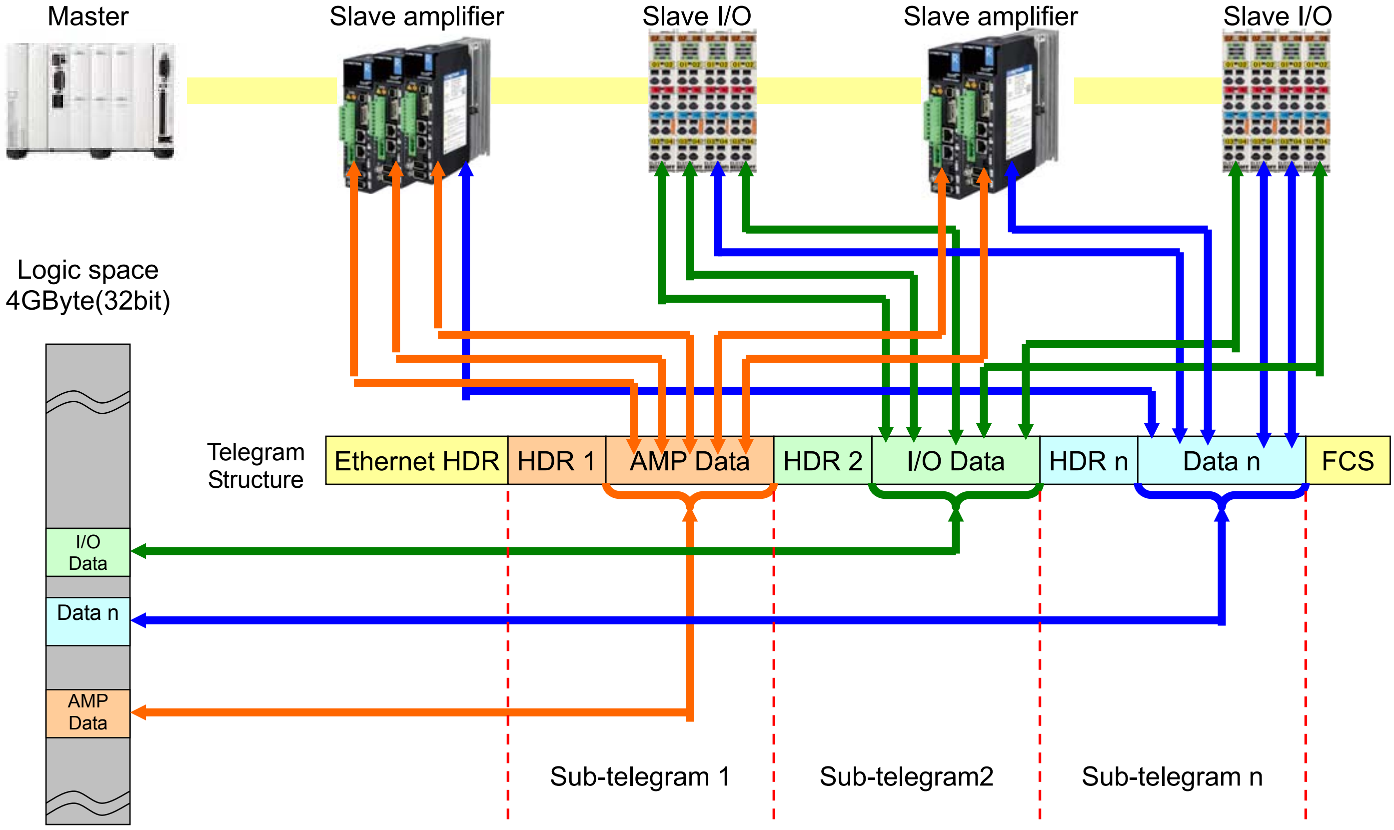
The slave matched to the address set at station register (0x0010) from the master by position addressing is normally addressed in node addressing.
This enables access without fail even when a device is added, the segment topology has changed and/or the slave has been removed.
The respective slave node 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.



2.5.3 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

2.5.4 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”.

2.5.5 SM (SyncManager)

ESC memory can be used for data conversion between the master and the slave microcontroller 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.

2.5.6 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.

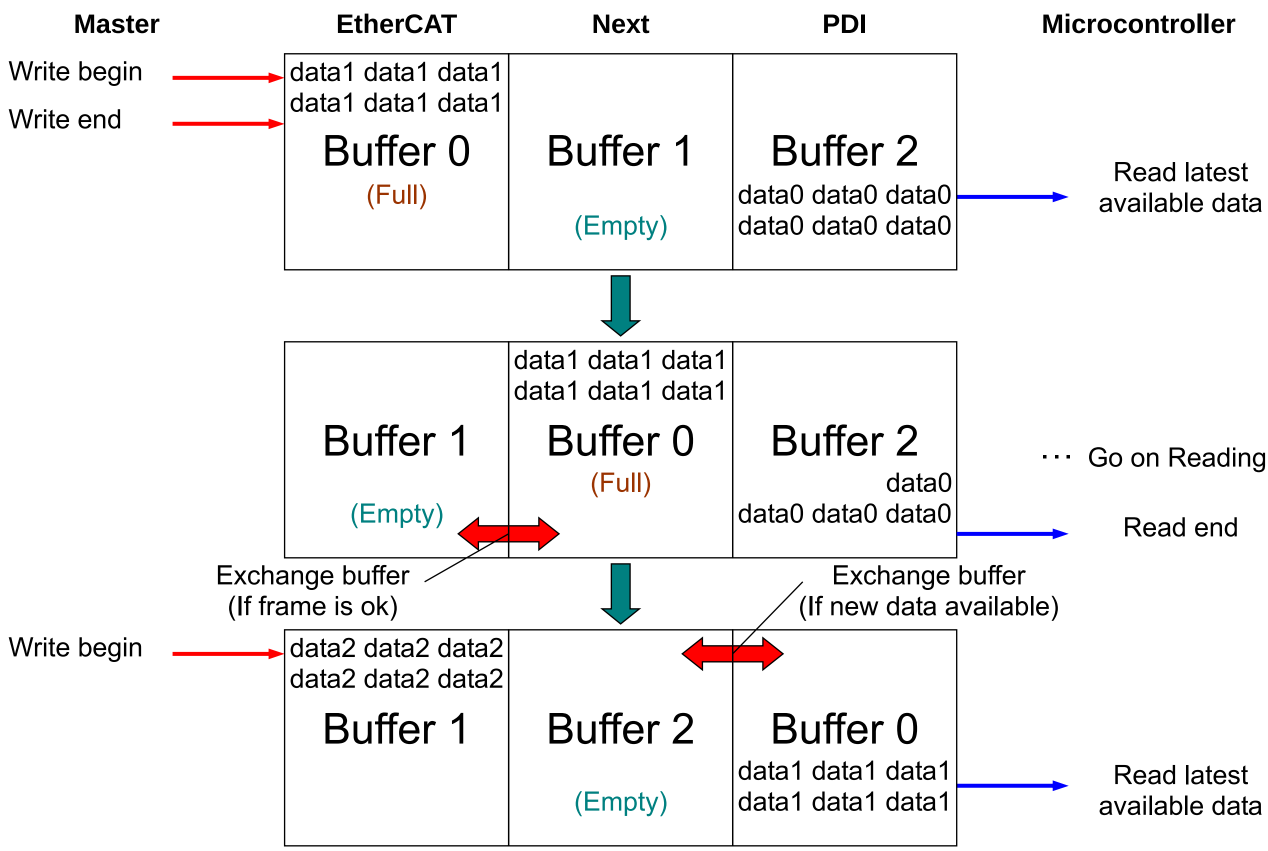
2.5 Addressing Image

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



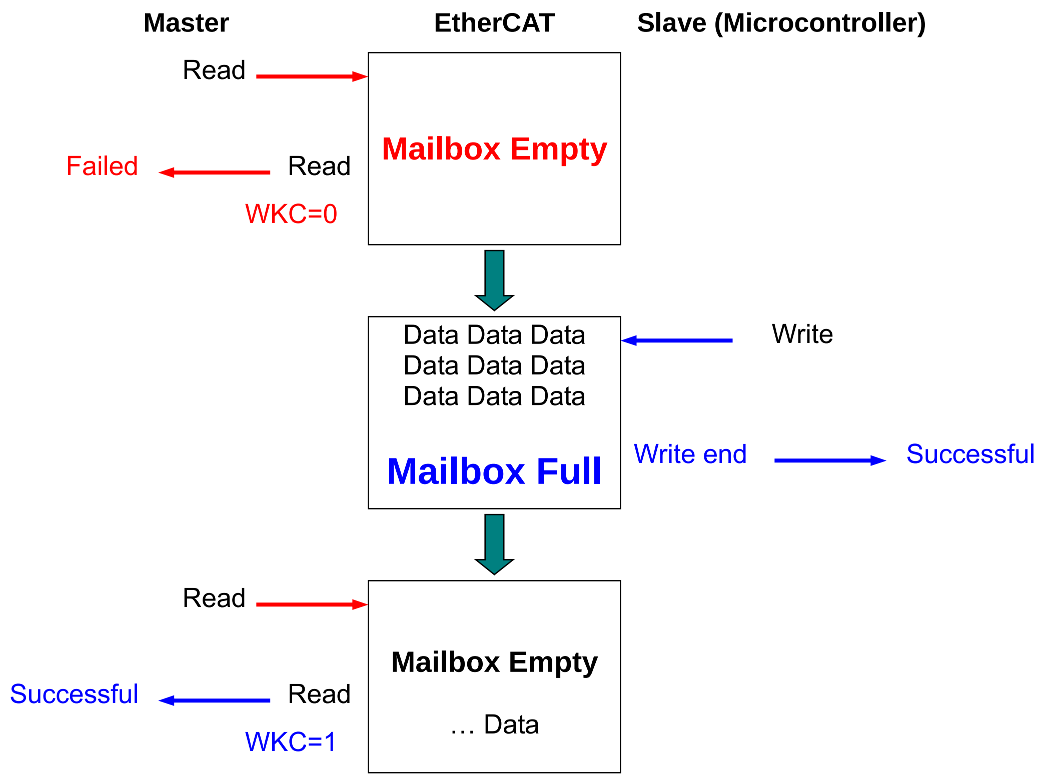
Conversion example of SyncManager Buffer Mode (Master => Slave)

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.

2.5.7 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.



Transferring example of Mailbox Mode (Slave to Master)

2.6 Accessing to Object Dictionary

R3E Model 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)

2.6.1 Service Data Object (SDO)

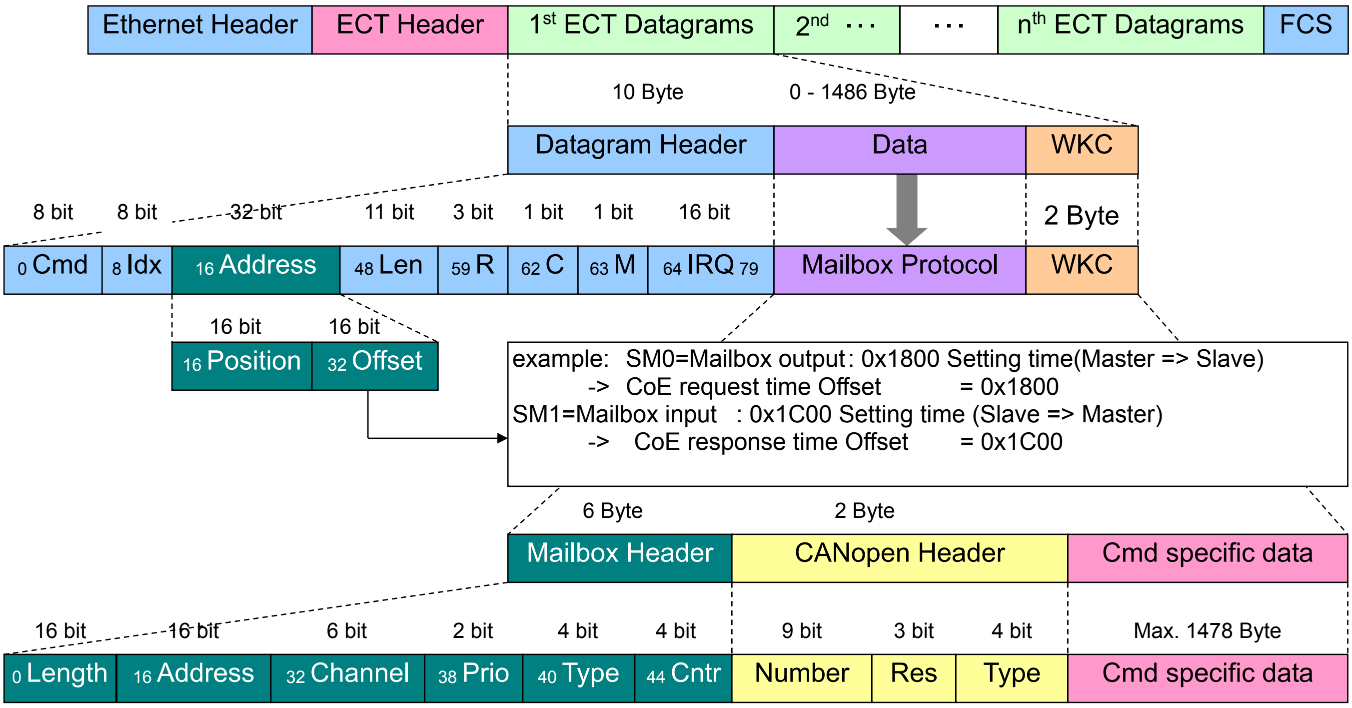
The master can control many of the slave amplifier parameters such as device settings and the monitor, through Read/Write in the Object Dictionary entry, using SDO transfer.
The master, supporting EtherCAT CoE, performs SDO transfer to each slave device.
The data changes and the Read R_SDO is requested by T_SDO and transmitted from the SDO master. When writing to entry of the object dictionary (it has "Yes" at NVRAM column of object list in chapter 4), it saved to non-volatile memory.
Saving to non-volatile memory by SDO requires times around as below according to data size.

Data size	Typical time	Maximum time
2 bytes (including 1 byte)	25 ms	65 ms
4 bytes	35 ms	70 ms
8 bytes	45 ms	80 ms

2.6.2 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)

2.6.3 CANopen Header Protocol

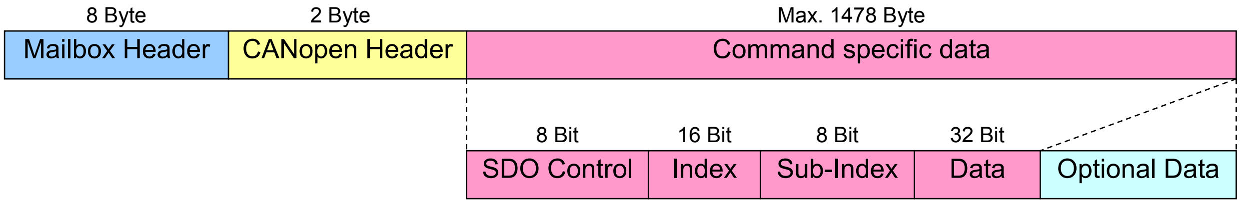
"CANopen Header" is configured with a 2Byte identifier composed of "Number" and "Type".
"CANopen Header" configuration is shown below.

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

2.6.4 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 3E Model EtherCAT CoE amplifier, an expedited SDO transfer is possible.
SDO message configuration is shown below.



SDO Message List (example)

1 - 1470 Byte

SDO Message Configuration

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

■ SDO Command

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

SDO Message List

Command	Page/Diagram	Notes
SDO Download Expedited Request	Diagram1	
SDO Download Expedited Response	Diagram 2	
SDO Upload Expedited Request	Diagram 3	
SDO Upload Expedited Response	Diagram 4	
SDO Download Normal Request	Diagram 5	
SDO Download Normal Response	Diagram 2	Same as Diagram 2
SDO Upload Normal Request	Diagram 3	Same as Diagram 3
SDO Upload Normal Response	Diagram 6	

Command specific Abbreviation Definition List

$_0$ Size Indicator	:	$_0$ S I	$_1$ Transfer Type	:	$_1$ T T
$_2$ Data Set Size	:	$_2$ D S	$_4$ Complete Access	:	$_4$ C A
$_5$ Command Specific	:	$_5$ C S	$_0$ SDO Control	:	$_0$ SDO
$_8$ Index	:	$_8$ Idx	$_{24}$ Sub-Index	:	$_{24}$ Sub
$_{32}$ Complet Size	:	$_{32}$ Cmp S			

■ SDO Download Expedited Request

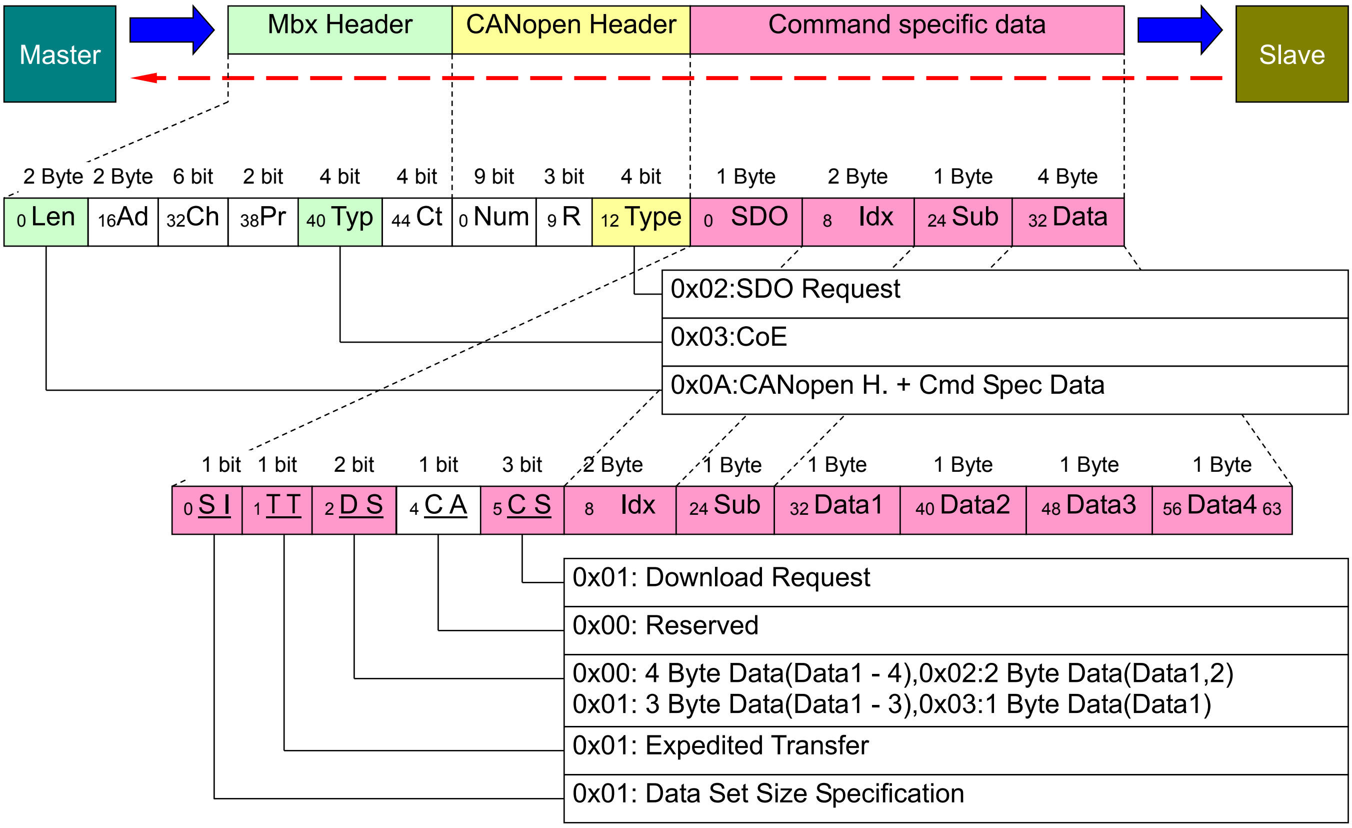


Diagram 1 : SDO Download Expedited Request

■ SDO Download Expedited Response

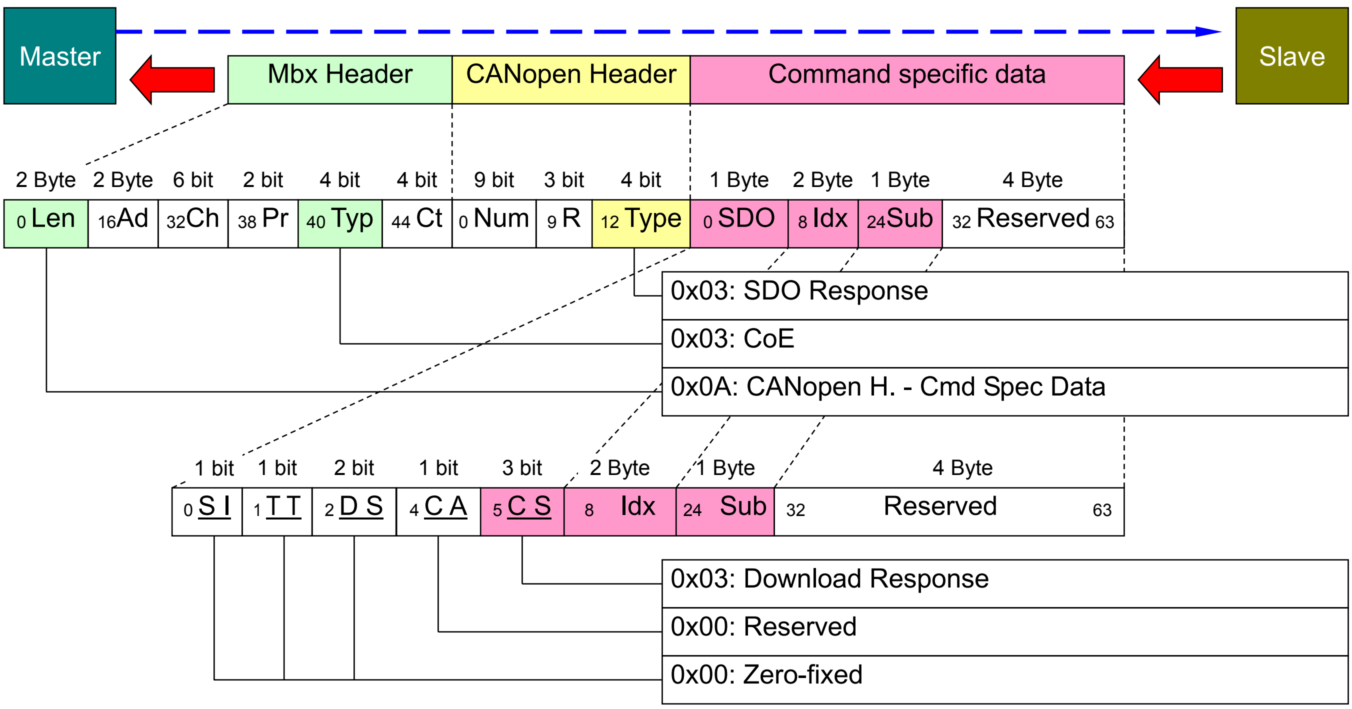


Diagram 2 : SDO Download Expedited Response

2. Inteface

■ SDO Upload Expedited Request

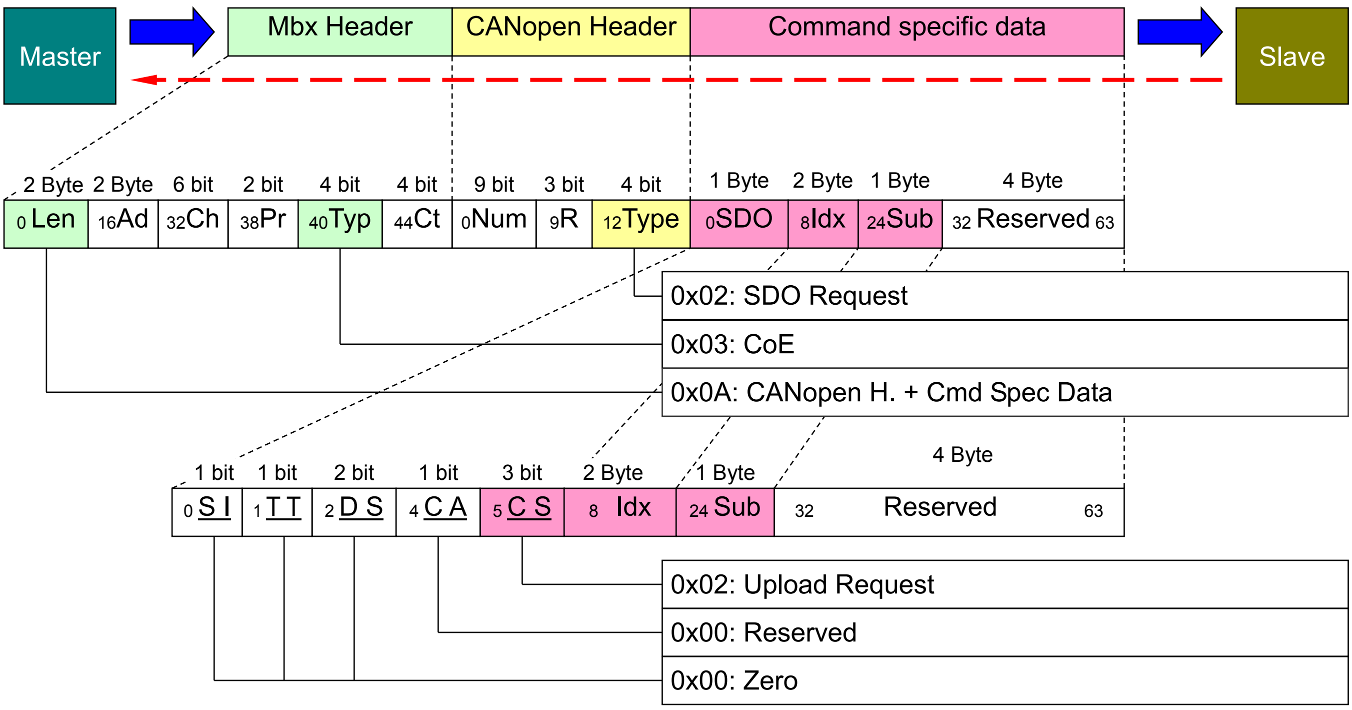


Diagram 3 : SDO Upload Expedited Request

■ SDO Upload Expedited Response

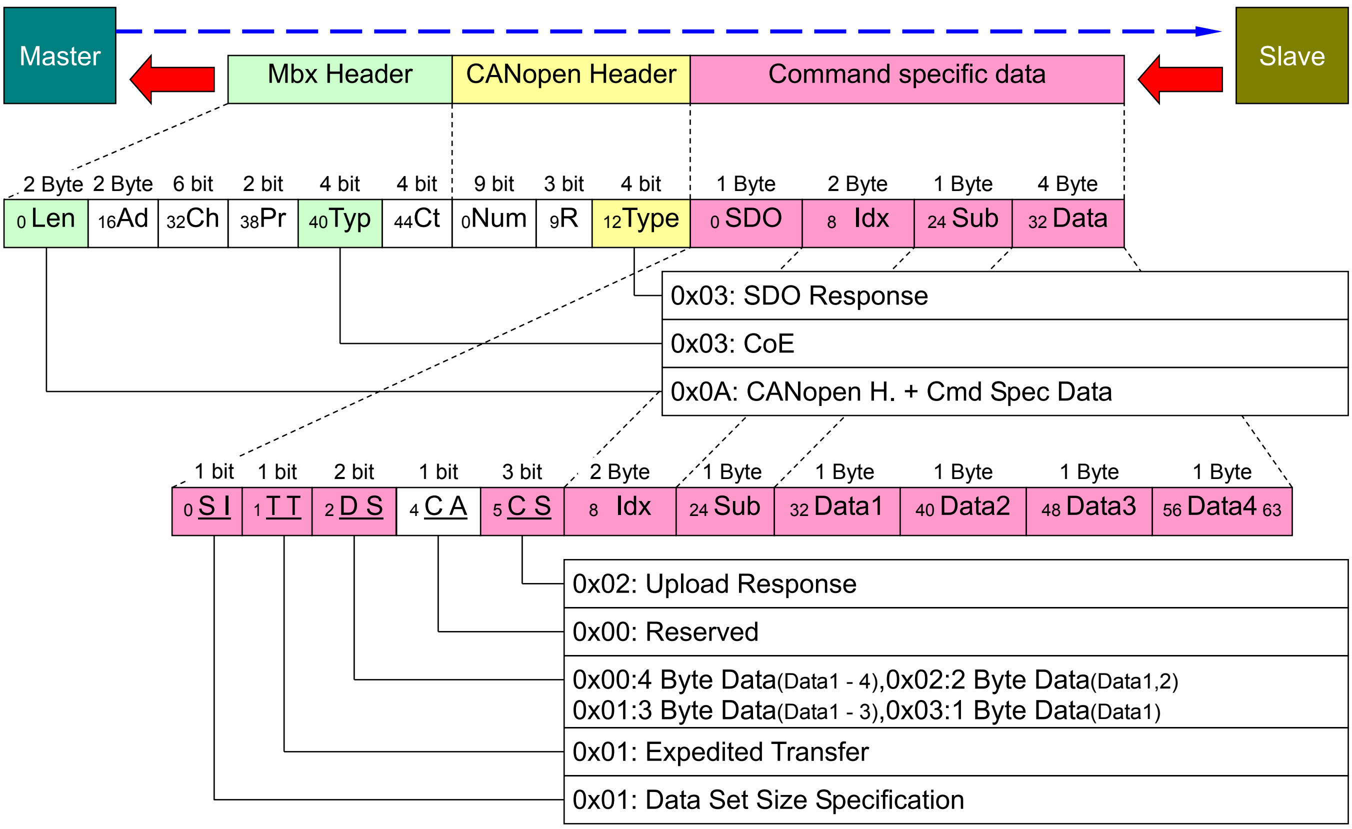


Diagram 4 : SDO Upload Expedited Response

■ SDO Download Normal Request

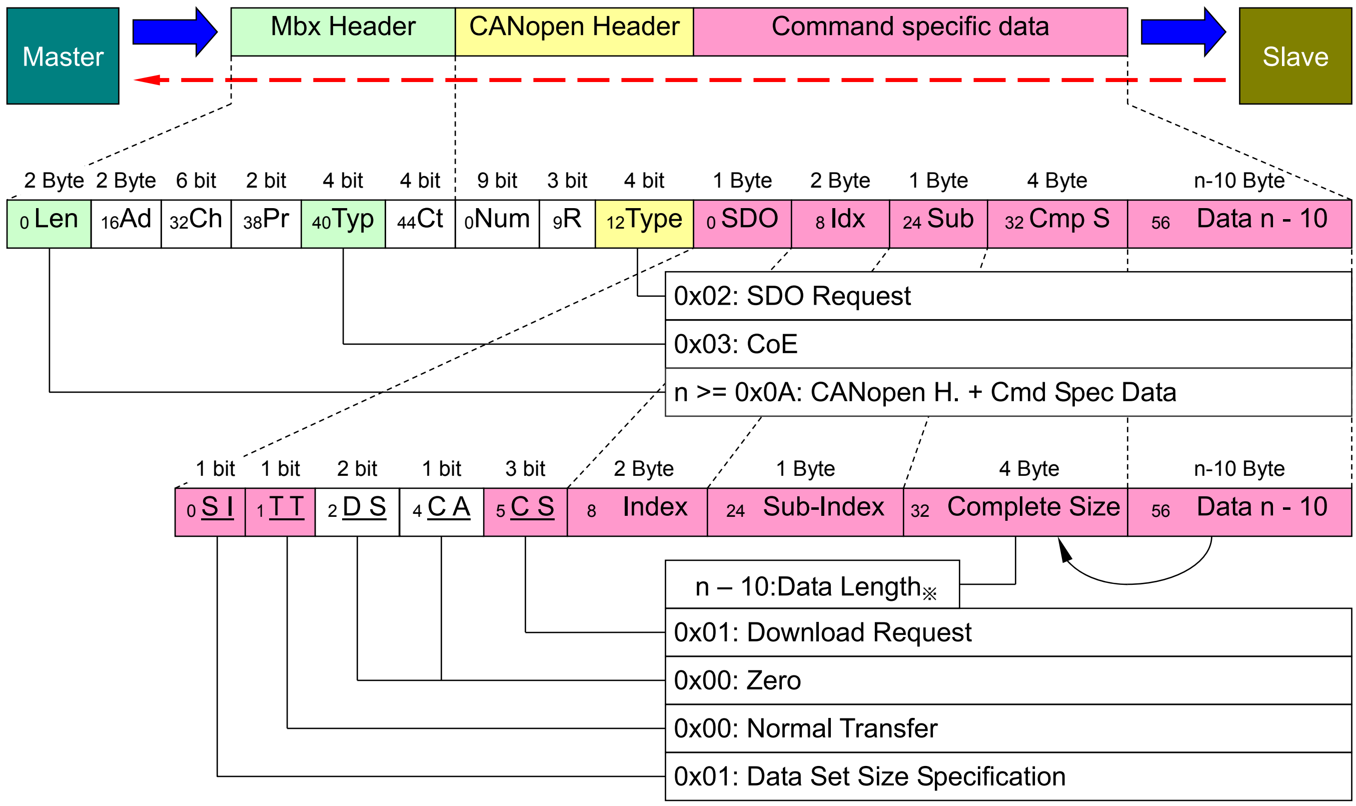


Diagram 5 : SDO Download Normal Request

■ 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

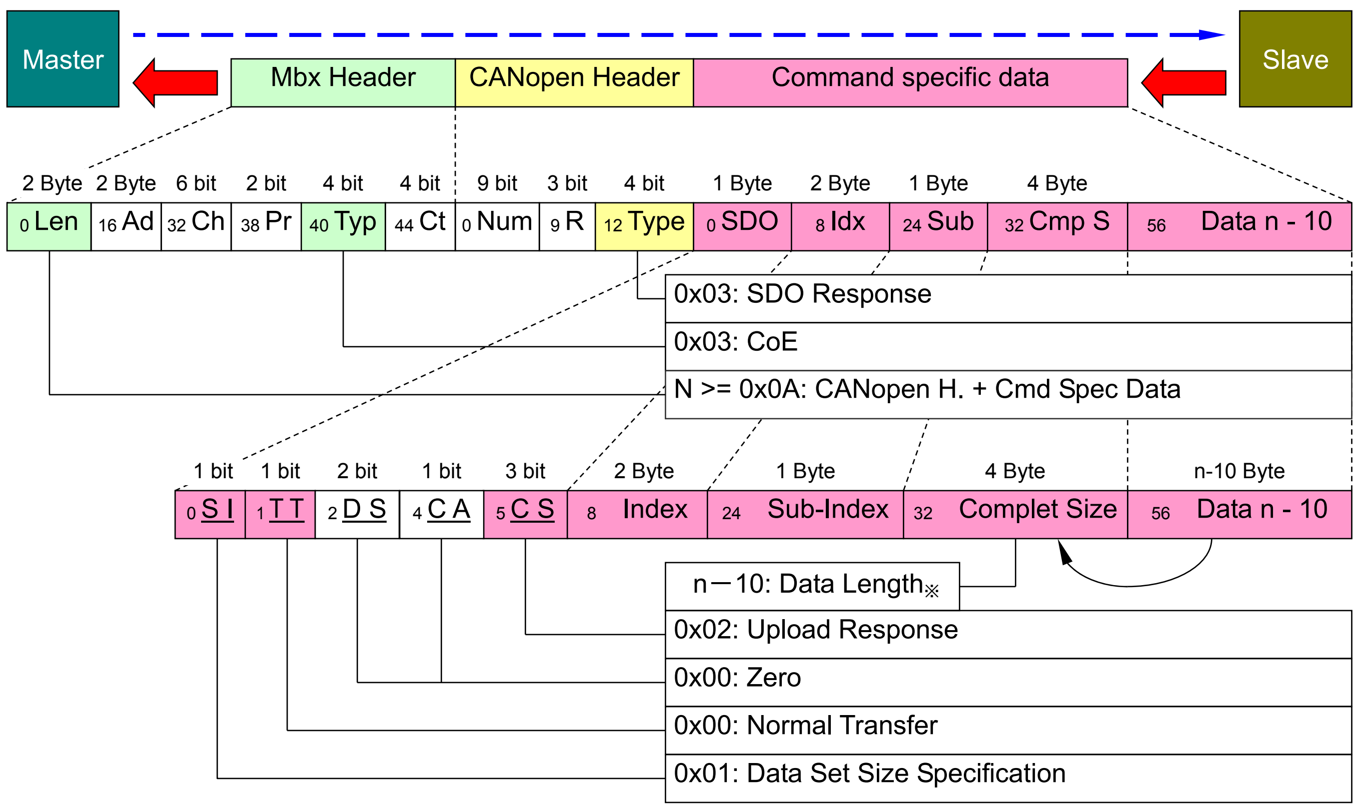


Diagram 6 : SDO Upload Normal Response

2.6 Accessing to Object Dictionary

■ 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:

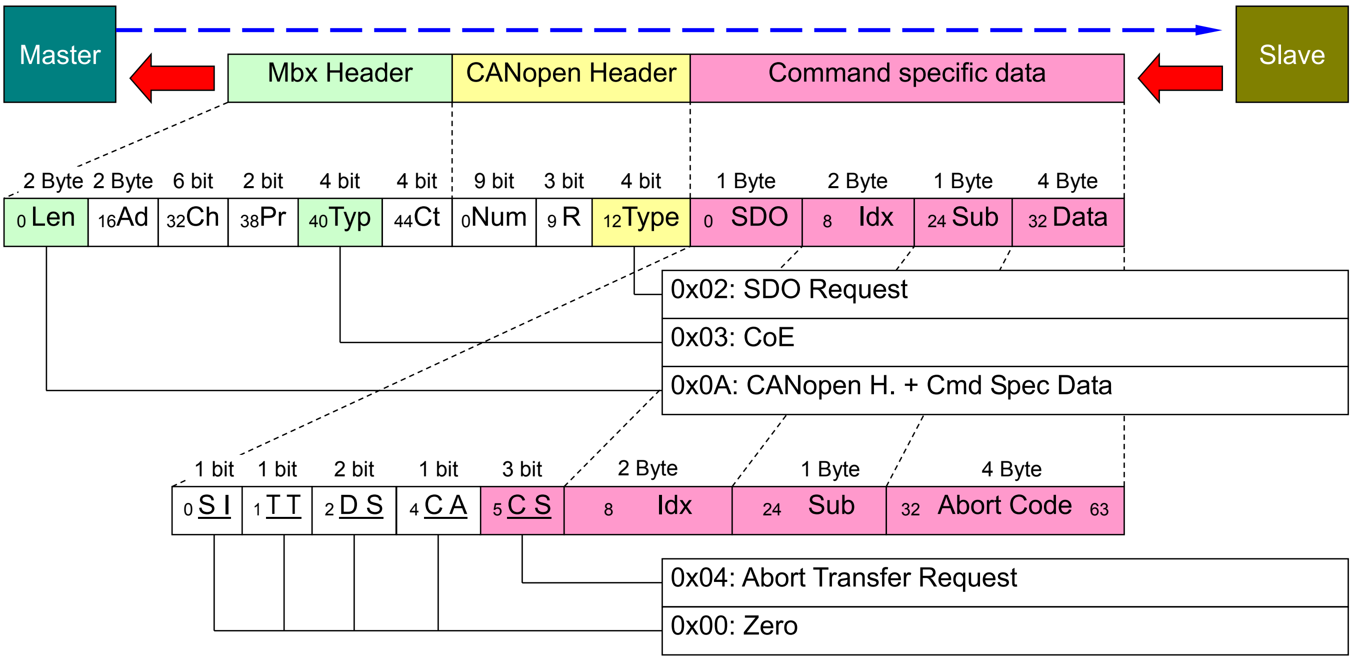


Diagram 7 : Abort SDO Transfer Request

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 01 00 03	Sub index cannot write. It requires clearing of sub index 0 for write access.
0x06 01 00 04	SDO complete access doesn't support variable length object like as ENUM object type.
0x06 01 00 05	Object length exceeds mailbox size.
0x06 01 00 06	SDO download blocked because the object is mapped to RxPDO.
0x06 02 00 00	The object does not exist in the Object Dictionary
0x06 04 00 41	Cannot map the object with PDO
0x06 04 00 42	The number of mapping objects or the data length has exceeded PDO limitation
0x06 04 00 43	Non-compatibility of generic parameters
0x06 04 00 47	Non-compatibility of generic internals of device
0x06 06 00 00	Access failure because of hardware error (Failure by write prohibition setting)
0x06 07 00 10	Data type not coordinated because service parameter length does not match
0x06 07 00 12	Data type not coordinated because service parameter length is too long
0x06 07 00 13	Data type not coordinated because service parameter length is too short
0x06 09 00 11	Sub-index does not exist
0x06 09 00 30	Exceeds the parameter value range (Exclusive for Write access)
0x06 09 00 31	Write parameter is too large
0x06 09 00 32	Write parameter is too small
0x06 09 00 36	The maximum value is smaller than the minimum value
0x08 00 00 00	General error
0x08 00 00 20	Cannot transfer or store data into an application
0x08 00 00 21	Cannot transfer or store data into an application because of local control
0x08 00 00 22	Cannot transfer or store data into an application under present device state
0x08 00 00 23	Object Dictionary does not exist

■ Emergency (EMCY)

Emergency object will be transferred by the master to the request command for mailbox input at the time of error occurrence inside the device.
This object permits transfer only once to one error event.
In other words, an emergency object will not be transferred unless a new error occurs in the device.

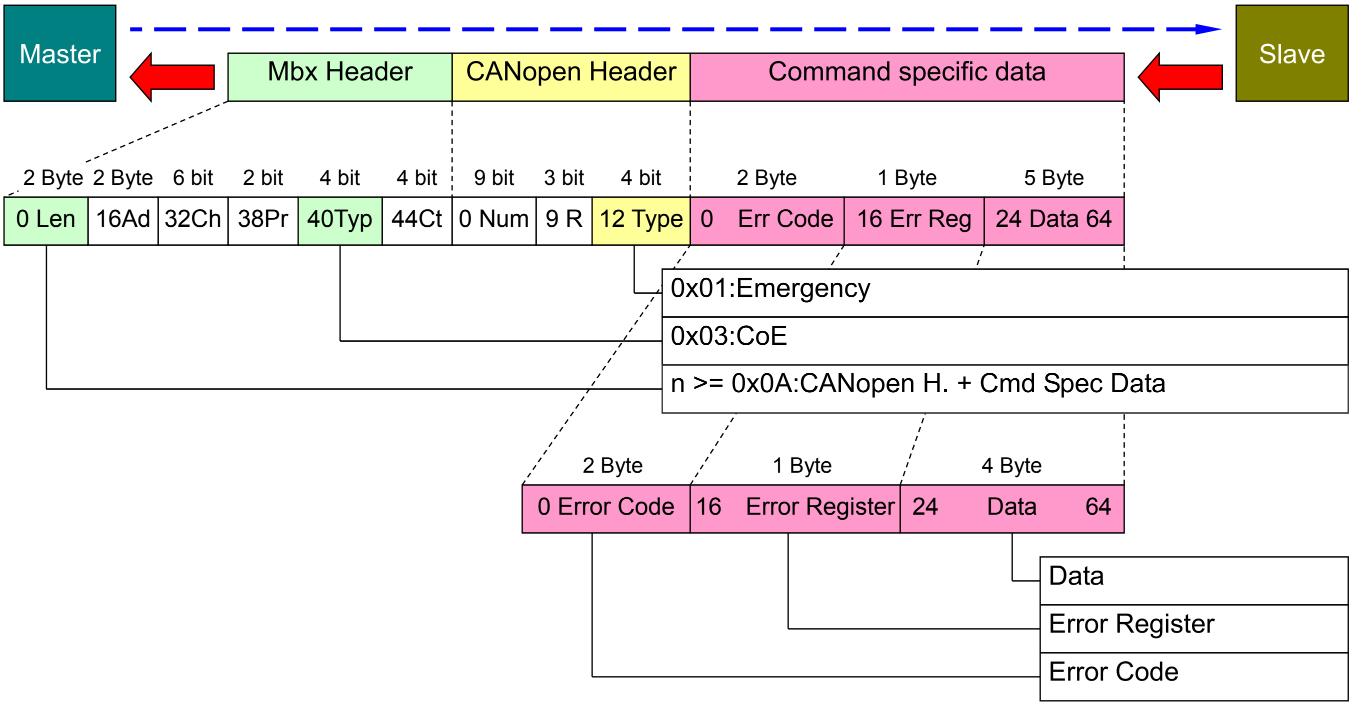


Diagram 8：EMCY Emergency

Error Code List

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

2.6 Accessing to Object Dictionary

■ SDO Information

◆ Object List Request

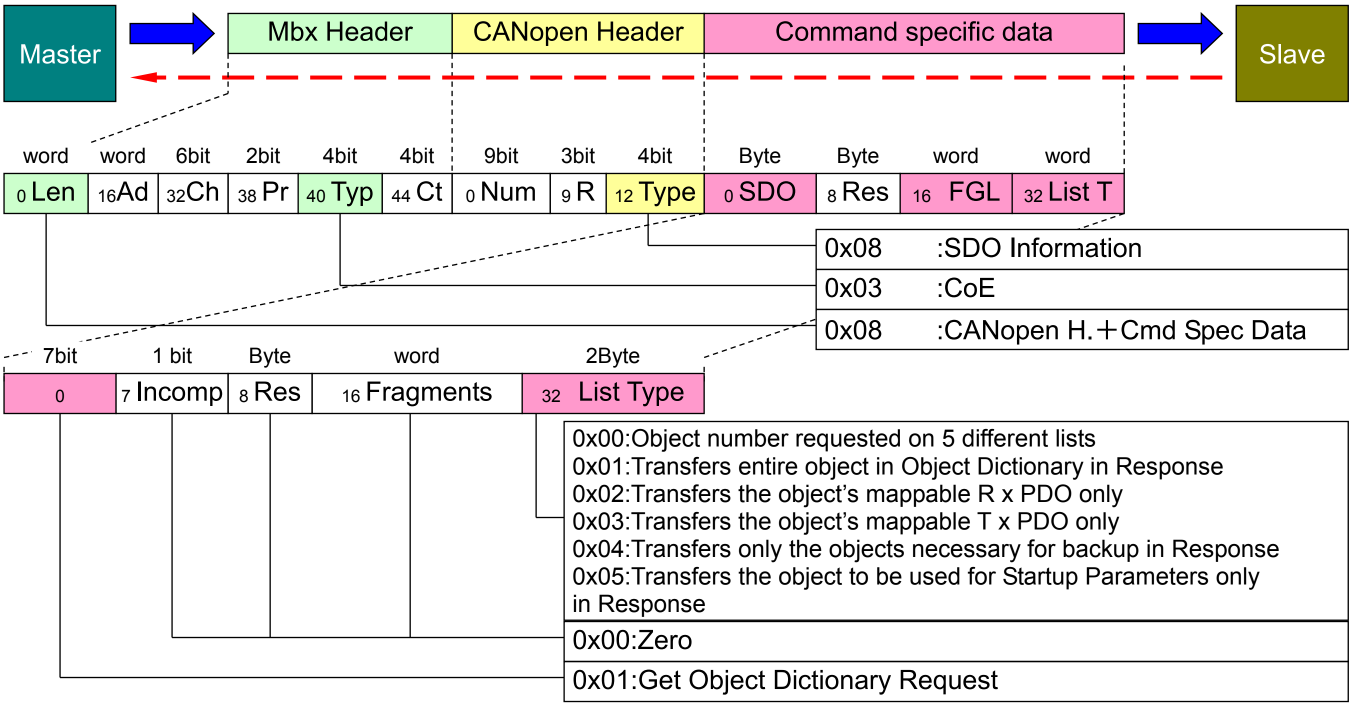


Diagram 9 : Get OD List Request (Object Dictionary Request)

◆ Object List Response (Object List Segment Response)

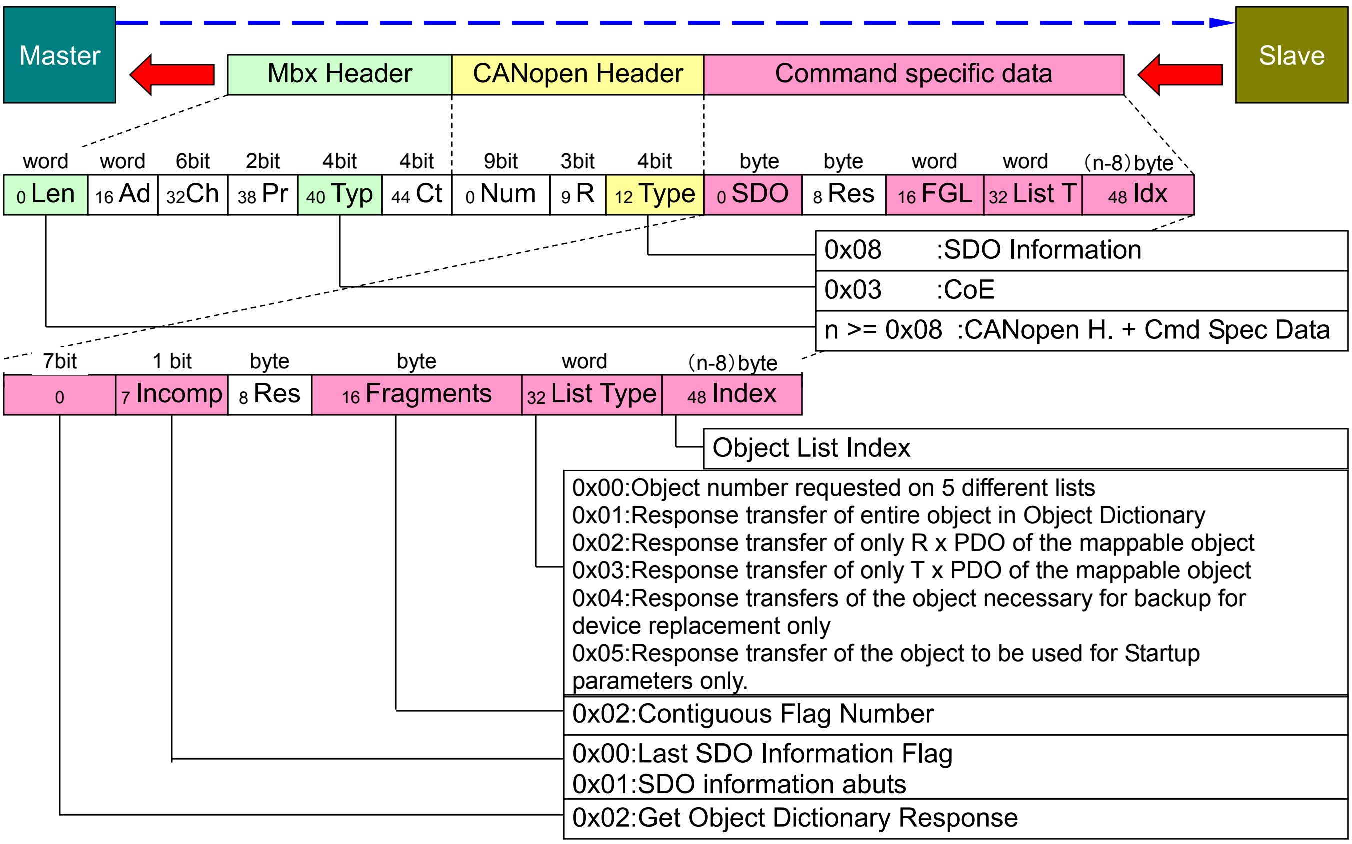


Diagram 10 : Get OD List Response (Object Dictionary Response)

- Object Dictionary Request

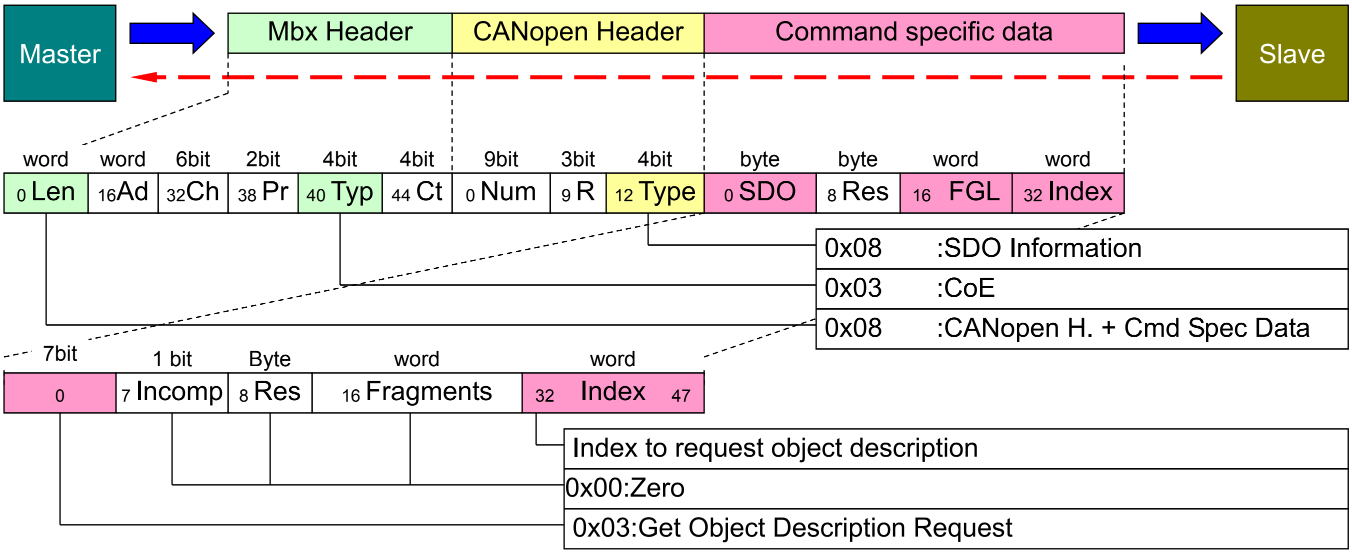


Diagram 11 : Get Object Description Request (Object Description Request)

Object Description Response

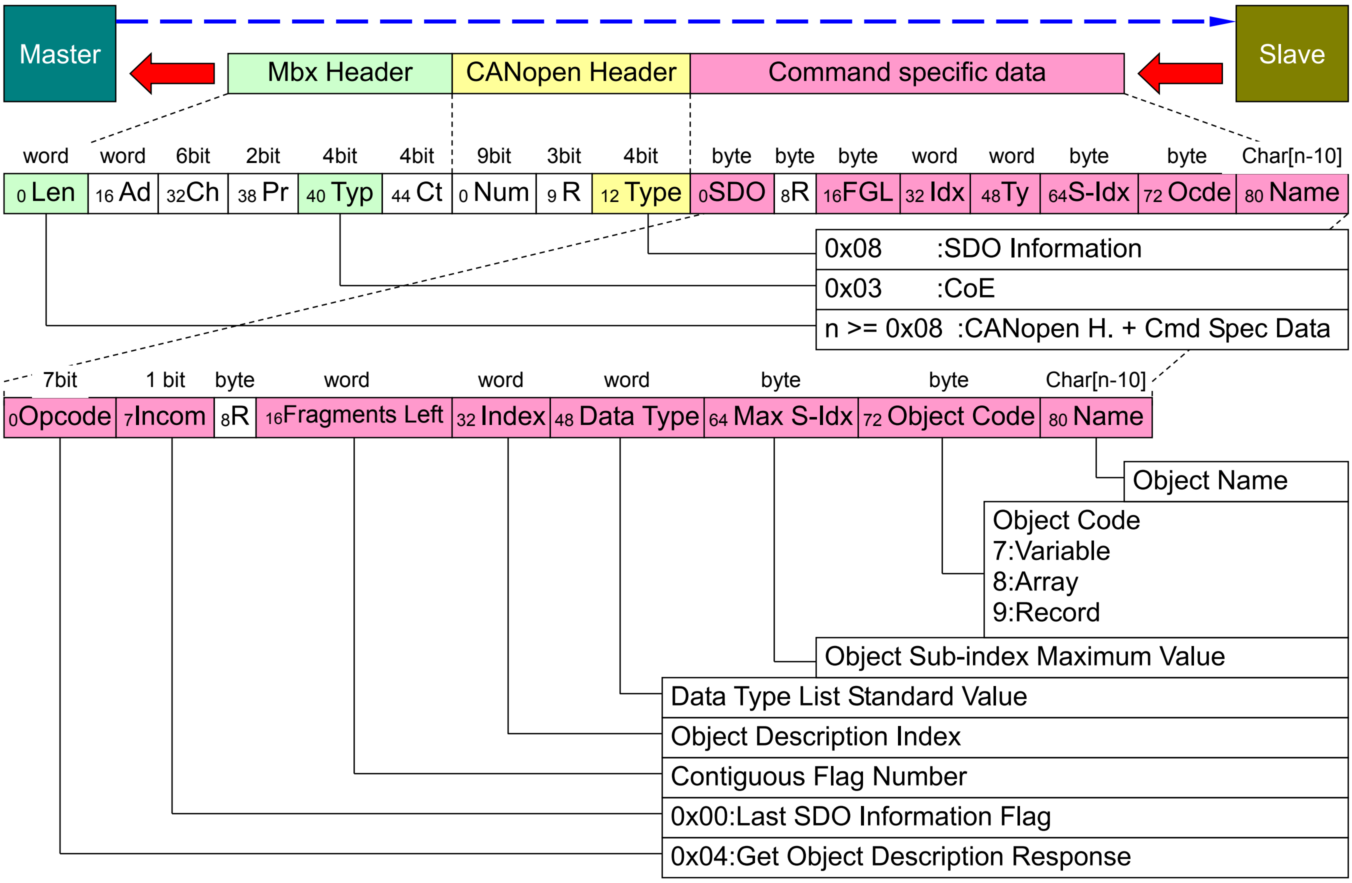


Diagram 12 : Get Object Description Response (Object Dictionary Response)

◆ Entry Description Request

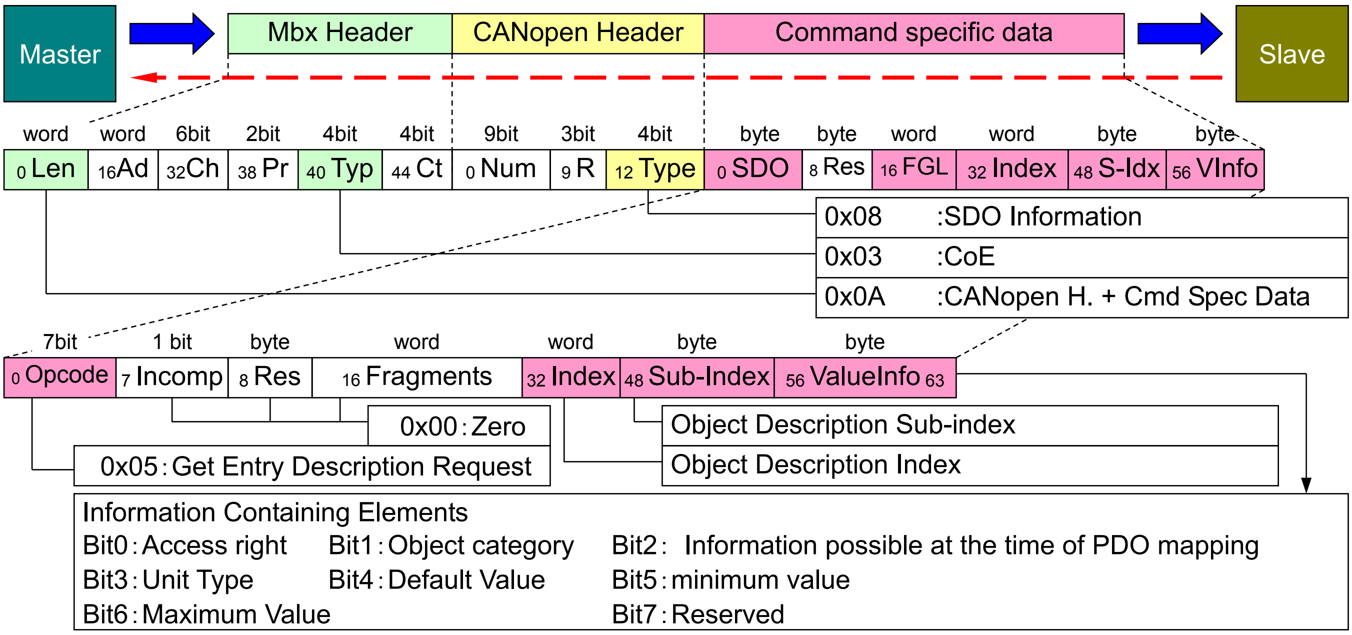


Diagram 13 : Get Entry Description Request (Object Description Request)

◆ Entry Description Response (Entry Description Segment)

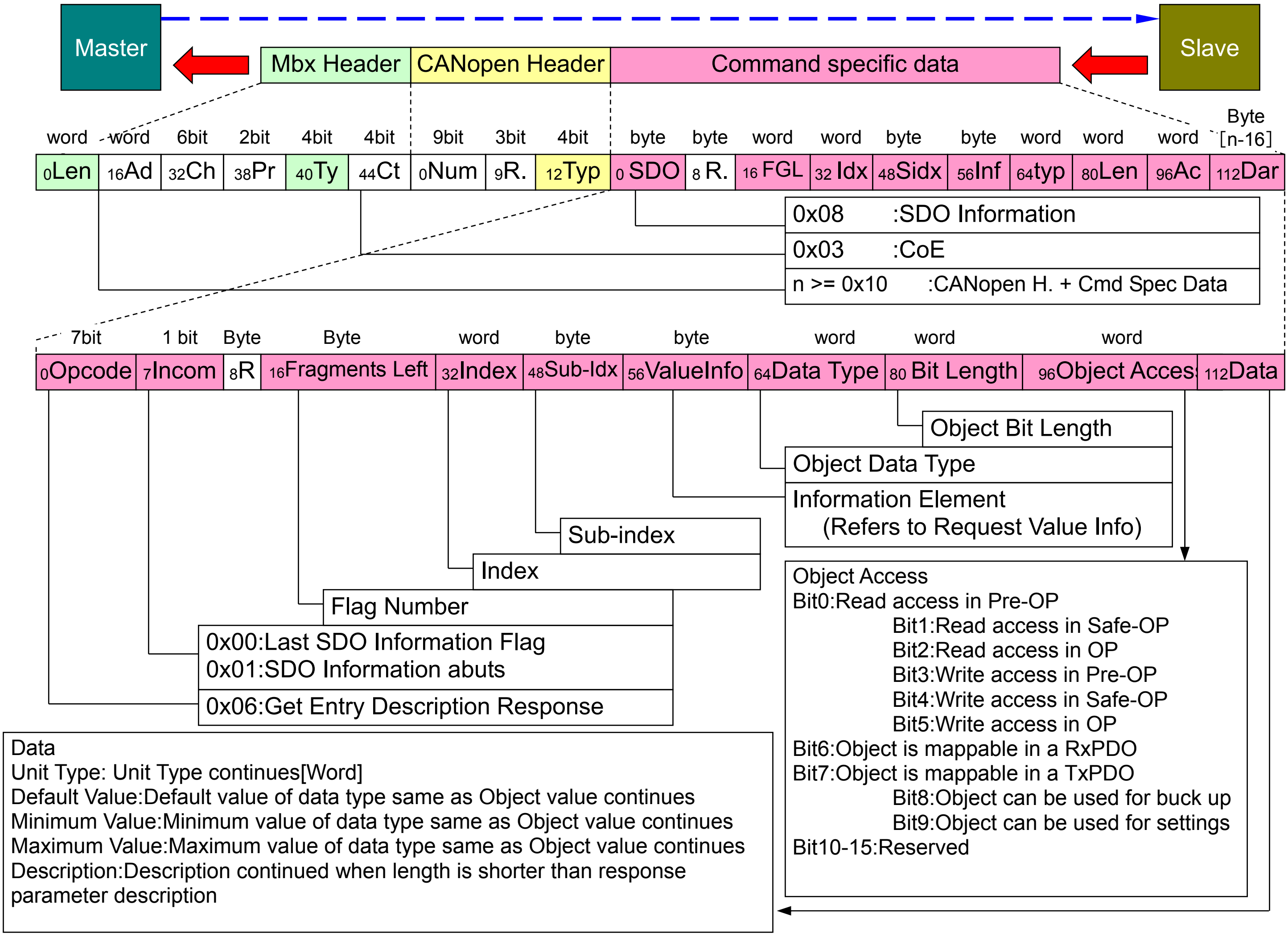


Diagram 14 : Get Entry Description Response (Object Dictionary Response)

■ SDO information Error Request

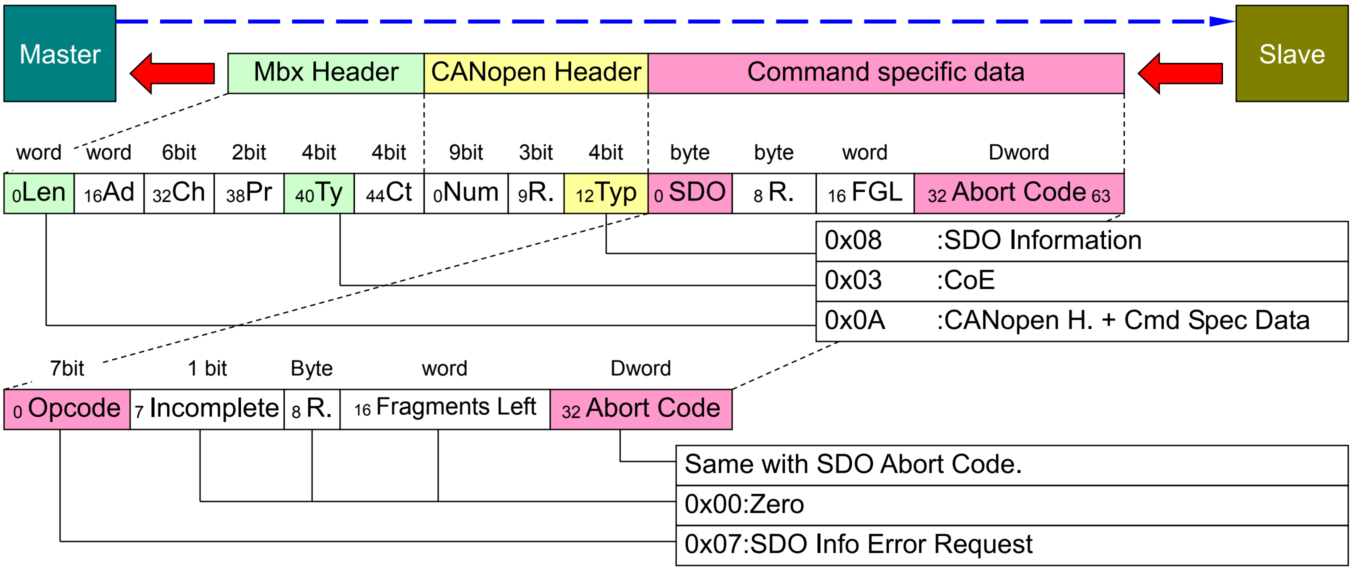


Diagram 15 : Error Request (SDO Information Error Request)

2.6.5 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 3E Model 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 R3E Model EtherCAT is changeable.
Specifically, the EtherCAT CoE Network Manager can change the PDO transfer data freely during operation.
Use "Reception PDO mapping parameters (0x1600 - 0x1603, 0x1700 - 0x1703)" to change R x PDO mapping and "Transmission PDO mapping parameters (0x1A00 - 0x1A03,0x1B00 - 0x1B03)" to change T x DO mapping.
Index, Sub-index and Data length have to be set to each PDO to be transferred.
The data length must match the data length inside the Object Dictionary.

A mapping example of T x PDO is shown below

"0x1B0y" Transmit PDO Mapping (Example)

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

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

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

PDO Mapping (example)

Use the following procedures for mapping:

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

The relation between PDO and SM is defined as Sync Manager PDO Assign in Sync Manager Channel (SM) for processing data objects.
The Sub-index：0x00 in the SM-PDO Assign table will be assigned a PDO number.
Index:0x1C12(SM Channel 2) becomes the Output PDO setting and Index:0x1C13(SM Channel 3 becomes the Input PDO Object Dictionary in the R 3E Model 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 3E Model 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

2.7.1 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.

2.7.2 System Time

The System Time (0x0910 - 0x0918) of R 3E Model EtherCAT amplifier is 8 Byte in length, 1ns/Lsb and will easily cover time up to 500 years. Data "0x0" signifies 0:00 Hour 0 second 000 millisecond 000 n microsecond 000 nanosecond 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 3E Model EtherCAT amplifier fully supports the Distributed Clock (DC) for the reception time stamp, the System Time validity and synchronous signal generation.

2.7.3 Clock Synchronization Process

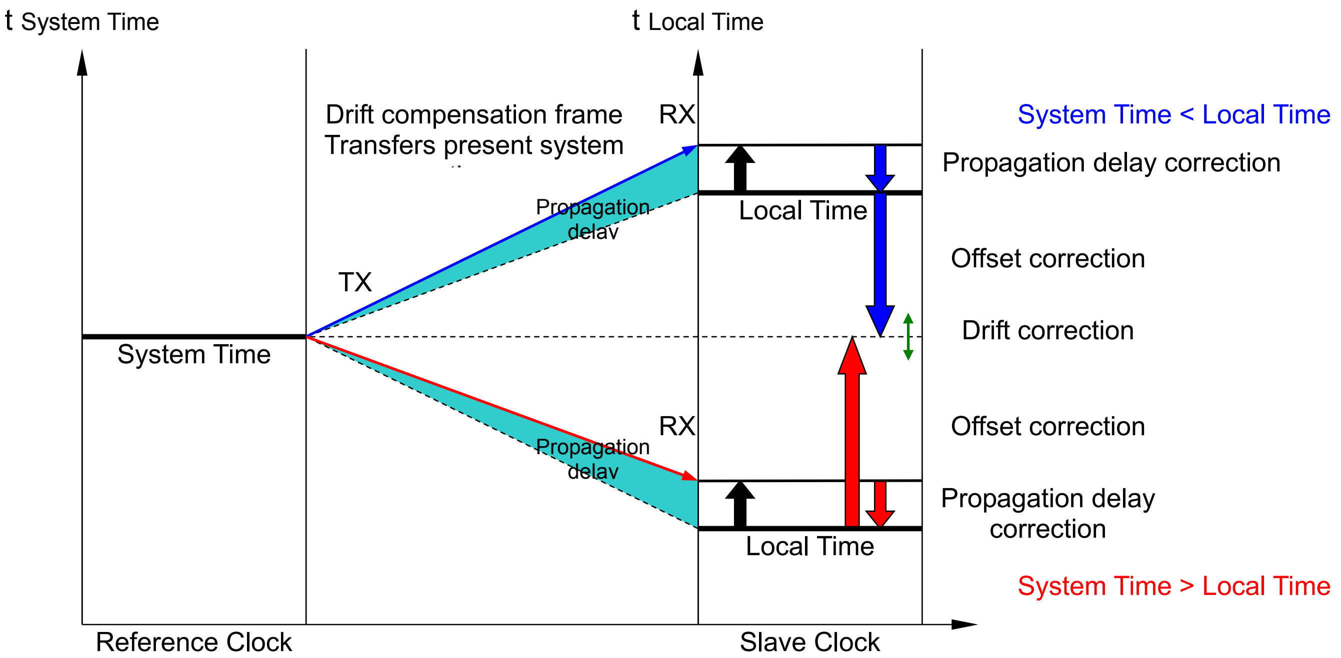
The clock synchronization process consists of three (3) steps.

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.

2.7.4 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.

2.7.5 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).

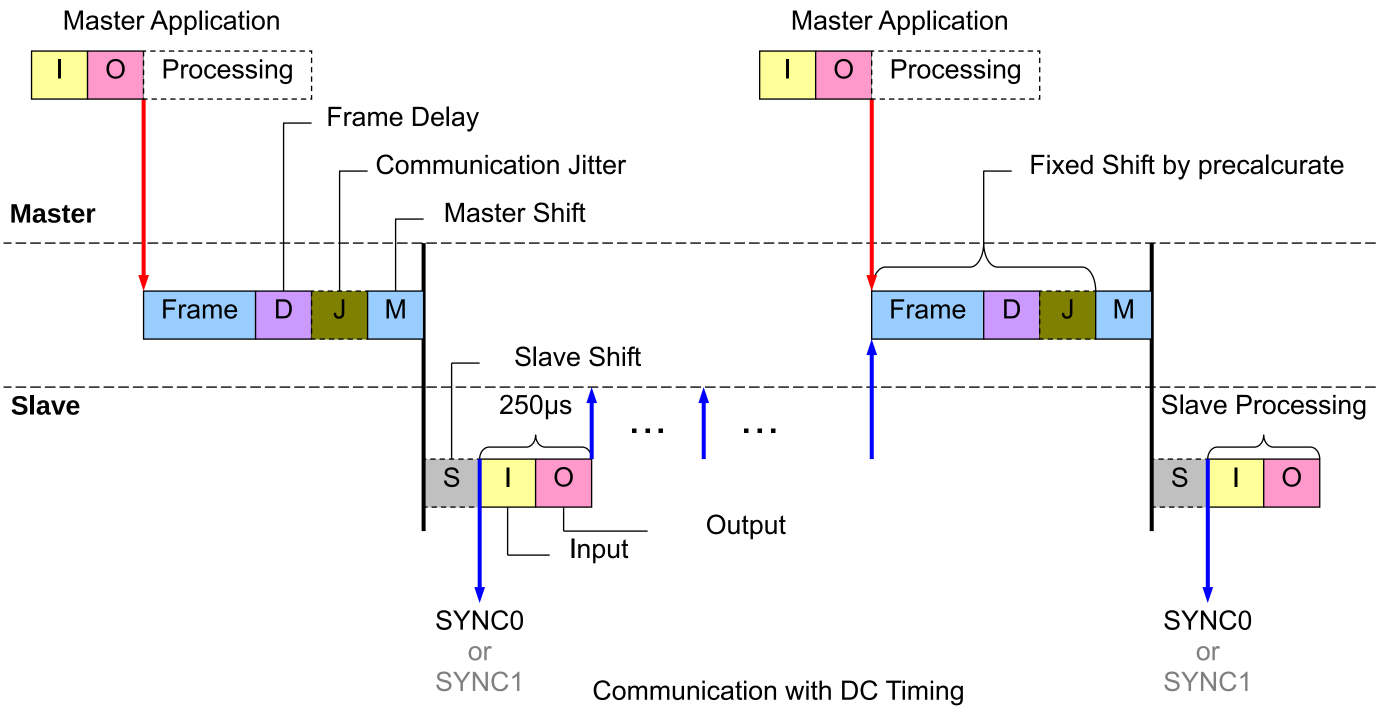
Synchronizing unit stands by until the first SYNC 0 pulse is output.
Cycle motion start time register and the next SYNC 1 pulse register can be read to acquire the next output event time.

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+5 ㎲)
- Frame Delay (Communication Delay)
  Delay time of the EtherCAT slaves for data transfer (approx. 5ns/m cable delay,approx. 1 ㎲ 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 3E Model 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 3E Model EtherCAT amplifier is 250 ㎲ fixed.)

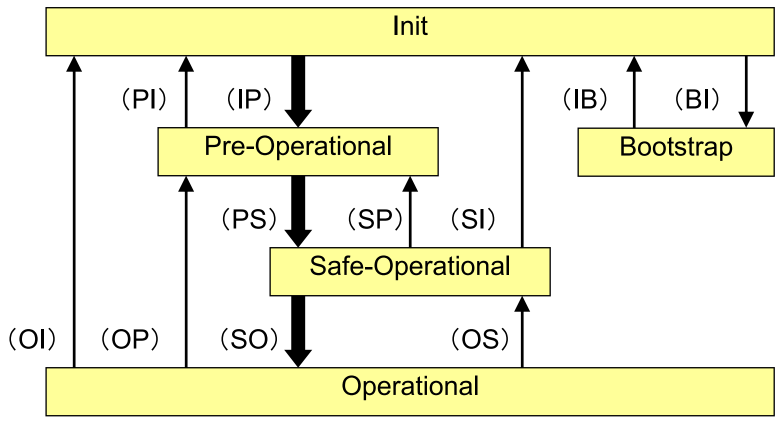
2.9 EtherCAT State Machine (ESM)

ESM contains states defined by EtherCAT.

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

2.9.1 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),

2.9.2 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 update with the firmware downloaded via FoE (File access Over EtherCAT) protocol. It can update amplifier parameter with downloaded parameter file, also. And it can upload parameter information stored by amplifier to controller as a parameter file.

2.10 Bootstrap state

In the Bootstrap state, servo amplifier firmware can be downloaded and upload to servo amplifier by FoE (File access over EtherCAT) protocol. Re-wrinting of servo amplifier firmware is perfomed by changing “Bootstrap state” to “Init state” in the consideration that firmware re-writing has no risks, after the firmware downloaded completely. In line with this, the downloaded firmware is written in CPU flash memory.
Servo amplifier can download the parameter file described with format (.ap1) of the setup software (SANMOTION motor setup) and update a servo amplifier parameter.

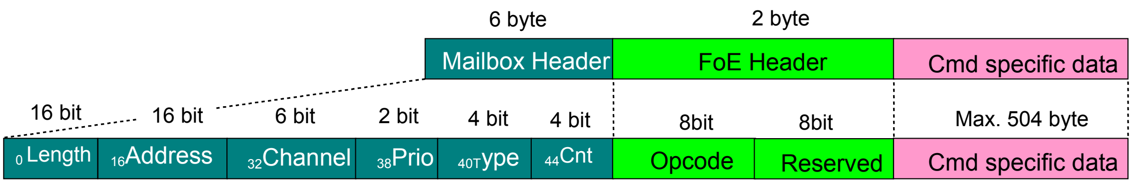
The conditions considered firmware re-writing has no risks are shown below:

- Firmware to be written into servo amplifier has been completely downloaded.
- The result of downloaded firmware checksum is normal.

Servo amplifier can change servo amplifier parameters by download of the file described with parameter file type (.AP1) of the setup software (SANMOTION motor setup). Also, the parameter file generated by servo amplifier can upload.

2.10.1 Mailbox protocol of FoE (File access over EtherCAT)

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



Mailbox interface

Mailbox Header configuration

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

2.10.2 FoE Header protocol

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

FoE Header configuration

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

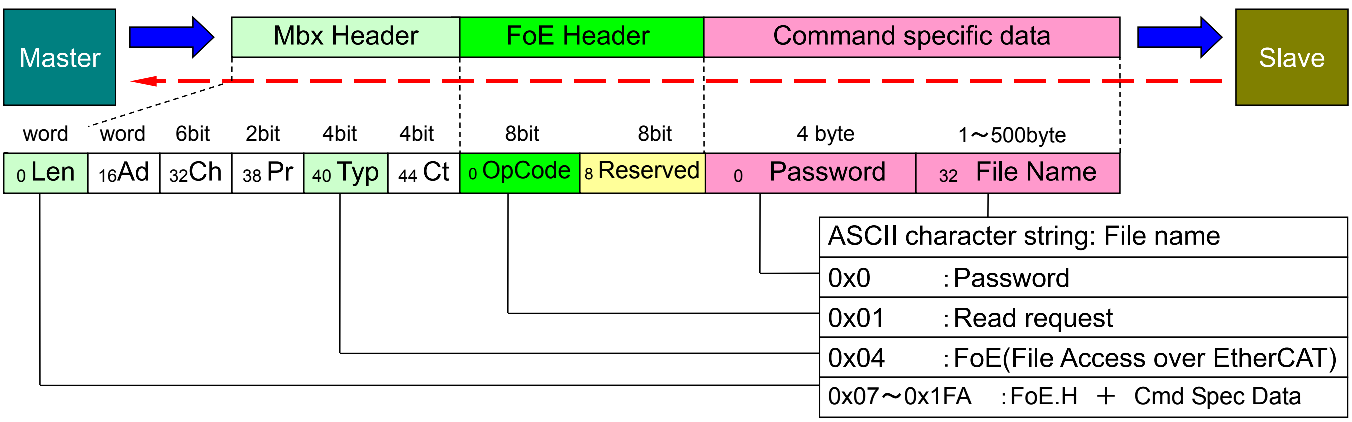
2.10.3 FoE command

Download of the file is started by sending "Write request" from Master to verify password Note 1) with file name. Slave returns "Ack request" to Master only when Slave received data normally and verified file name and password are matched.
Then Master sends "Data request" to send File data. Slave returns "Ack request" to Master only when the request from Master normally recived. "Data request" and "Ack request" are repeatedly tramsmitted and received until the firmware data sent from Master and Slave run out.
When Slave does not judge the File data is valid, Slave returns "Error request," an error message to Master. (Refer to FoE error code.)

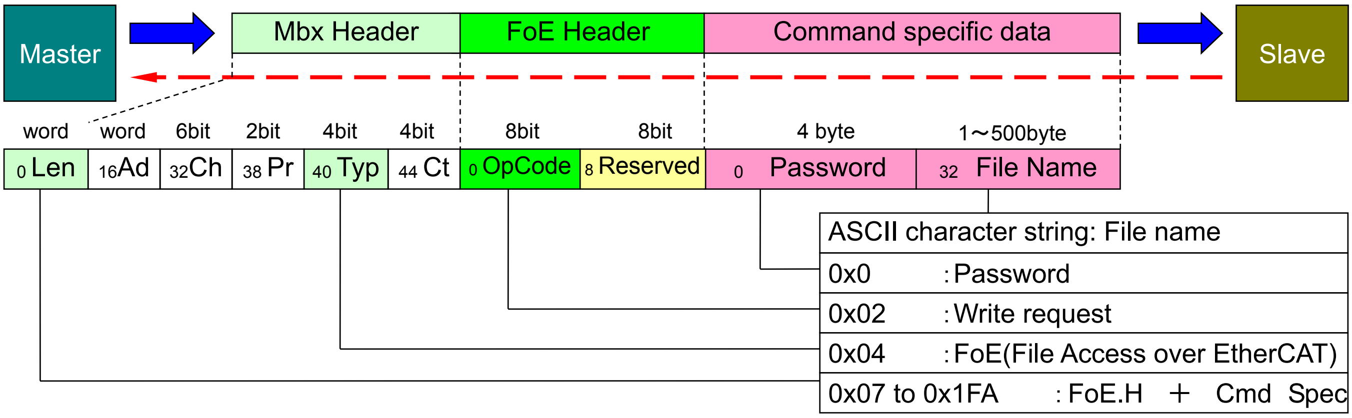
Upload of the file is started by sending "Read request" from Master to verify password Note 2). Slave responces by "Data request" to Master for sending file data when Slave received data normally. Master responses by "Ack request" when data is received normally. Slave will send "Data request" until a data to be send runs out, and Master will send "Ack request".

Note 1) Password is our specified value. Please contact our sales.
Note 2) Password is not used for upload.

■ Read Request

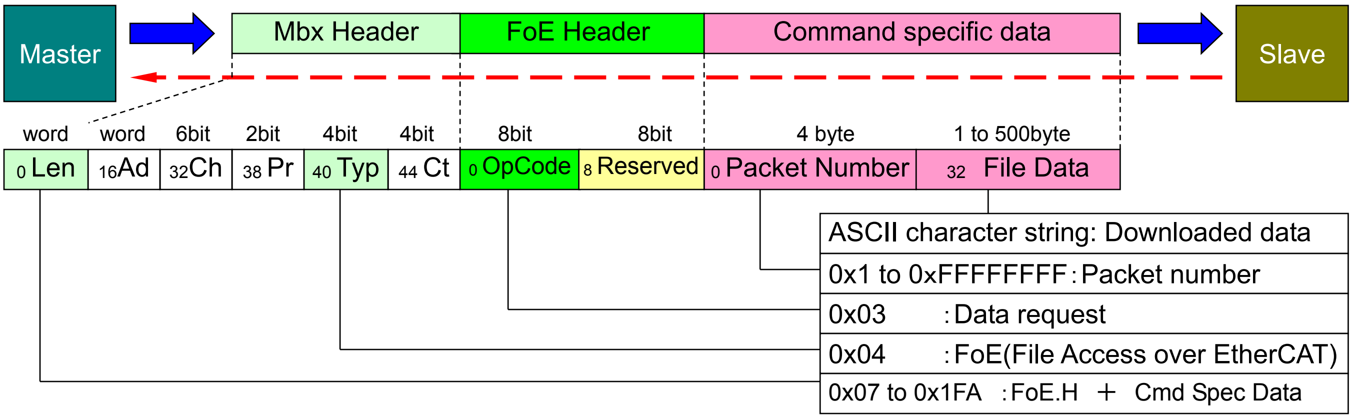


■ Write request



Write request

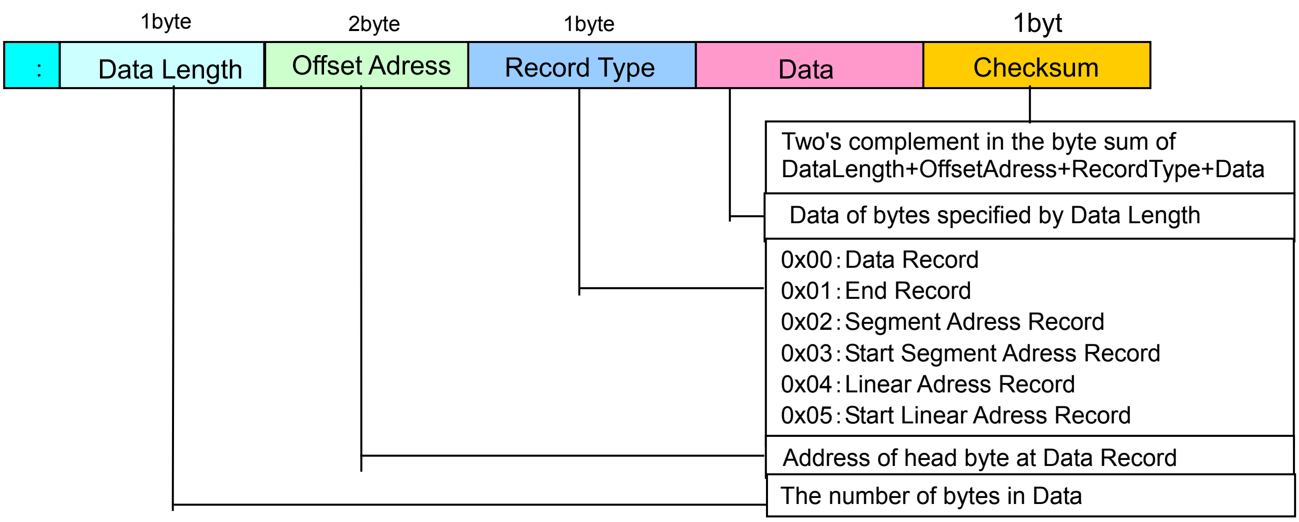
■ Data request



Data request

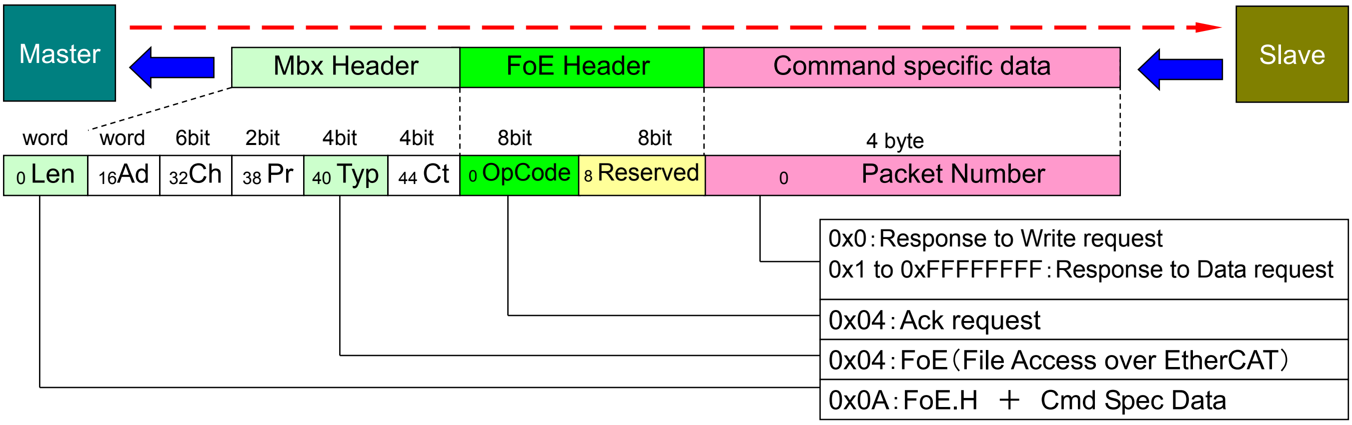
✔ For a firmware update, please use firmware data in Intel Hex format provided by SANYO DENKI.
The following shows the structure of Intel Hex format.

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



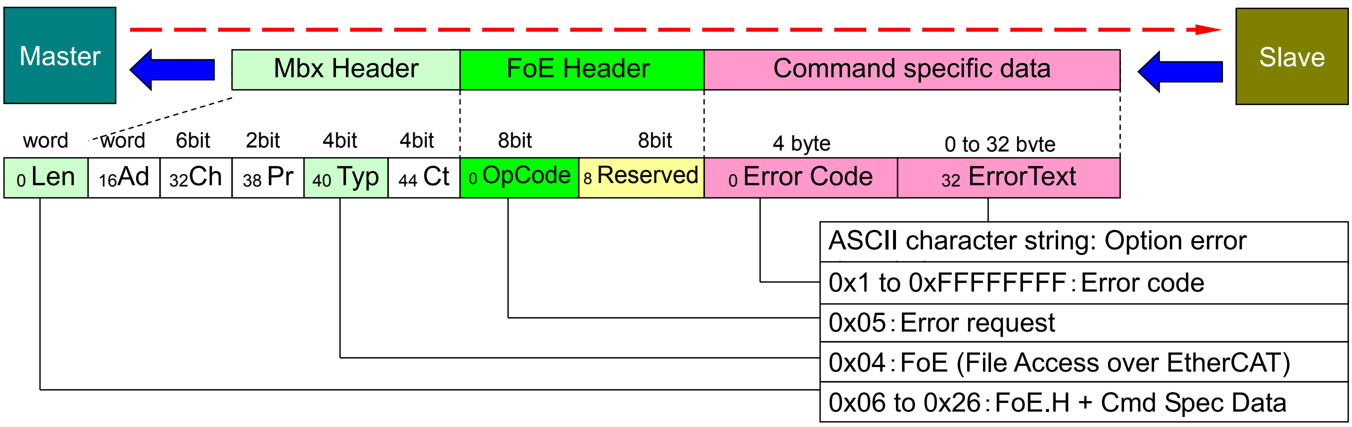
2. Inteface

■ Ack request



◆ For a firmware upload, protocol of Data request and Ack request are reversed at Master/Slave from sequence above.

■ Error request

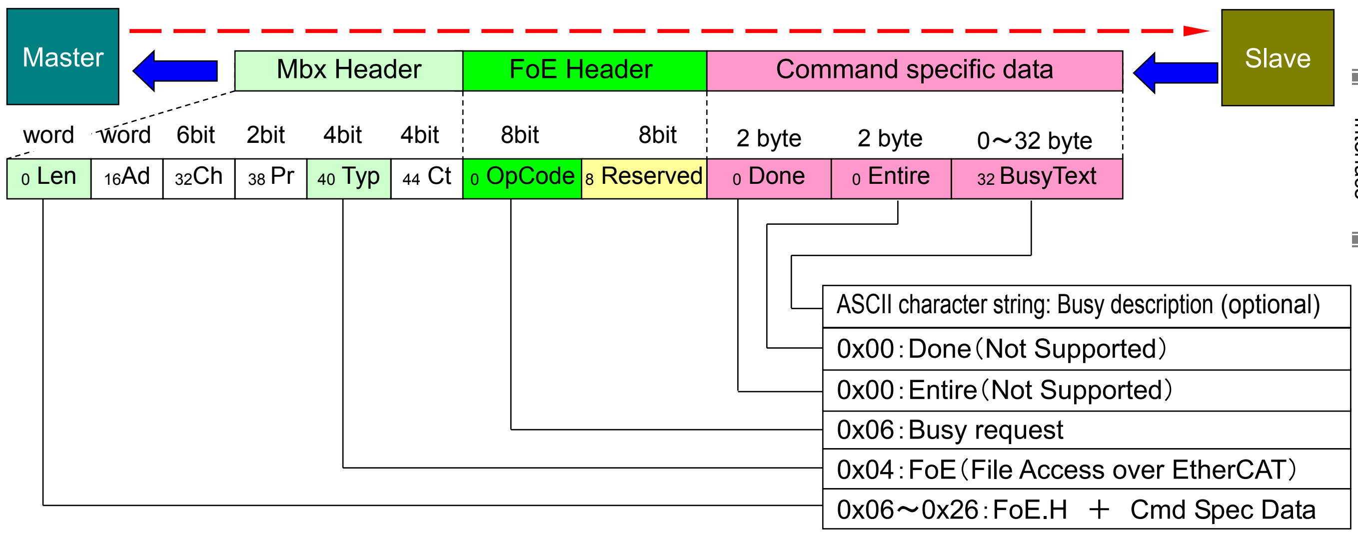


Error request

FoE error code list

Error Code	Description
0x8000 or 0x0000	Undefined error code.
0x8001 or 0x0001	Upload file not found.
0x8002 or 0x0002	Access denied.
0x8003 or 0x0003	Capacity shortage of destination to save.
0x8004 or 0x0004	Disabled to respond to operation.
0x8005 or 0x0005	Incorrect packet number.
0x8006 or 0x0006	Data existing already.
0x8007 or 0x0007	Unusable data.
0x8008 or 0x0008	Not in Bootstrap state.
0x8009 or 0x0009	Incorrect file name.
0x800A or 0x000A	Password unmatched
0x800B or 0x000B	Program error
0x800C or 0x000C	Checksum error
0x800D or 0x000D	Invalid program file
0x800F or 0x000F	No file of readout available

■ Busy request



Busy request

3

EtherCAT Data Link Layer

In this chapter, data link layer as EtherCAT slave controller (ESC) etc is explained.

3. EtherCAT Data Link Layer

3.1 Device Addressing

3.1.1 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 SANMOTION R 3E model EtherCAT servo 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.

3.1.2 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.

3.1.3 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.
SANMOTION R 3E model EtherCAT servo 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. EPU 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

SANMOTION R 3E model 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.
SANMOTION R 3E model EtherCAT servo 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]

Address	Length (Byte)	Description
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

3.2.1 ESC Information

Type

Address	bit	Description	Master	Slave	Length	Rest Value
0x0000	7:0	Type of EtherCAT controller	R/-	R/-	1Byte	0x04

Revision

Address	bit	Description	Master	Slave	Length	Rest Value
0x0001	7:0	Revision of EtherCAT controller	R/-	R/-	1Byte	0x03

Build

Address	bit	Description	Master	Slave	Length	Rest Value
0x0002 - 0x0003	15:0	Actual build of EtherCAT controller	R/-	R/-	2Byte	0x010A

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	0x018C
	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				
	8	Enhanced DC SYNC activation	0:Not available 1:Available				
	9	ECAT LRW command support	0: Supported 1: Not supported				
	10	ECAT read/write command support	0: Supported 1: Not supported				
	11	Fixed FMMU/Sync Manager configuration	0: Variable configuration 1: Fixed configuration				
	15:12	Reserved					

3.2.2 Station Address

Configured Station Address

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

Configured Station Alias

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

3.2.3 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/-			

3.2.4 ESC Data Link Layer

■ ESC Reset
ESC loaded SANMOTION R 3E model EtherCAT servo amplifier is capable of issuing a hardware reset from the EtherCAT master. A special sequence of three independent and consecutive frames/commands has to be sent do the slave (Reset register ECAT 0x0040 or PDI 0x0041). Afterwards, the slave is reset.
It is likely that some transmitting sequence frames will not return to the master because the links will go down with the reset after the normal reception of data.

ESC Reset

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

ESC DL Control

Address	bit	Description	Master	Slave	Length	Rest Value
0x0100 - 0x0103	0	Forwarding rule: 0:EtherCAT frames are processed, Non-EtherCAT frames are forwarded without processing 1:EtherCAT frames are processed, Source MAC Address is changed (SOURCE_MAC [1] is set to 1 - locally administered address), Non-EtherCAT frames are destroyed	R/W	R/-	4 Byte	0x01
	1	Temporary use of settings in Register 0x101: 0:permanent use 1:use for about 1 second, then revert to previous settings	R/W	R/-		
	7:2	Reserved, write 0	R/-	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	R/W	R/-		
	15:12	Reserved, write 0	R/-	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	R/W	R/-		
	23:20	Reserved, write 0	R/-	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/-	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)				

3.2.5 Application layer

■ EtherCAT State Machine (ESM) Registers

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

Registers for the EtherCAT State Machine (ESM)

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

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

■ AL Control and AL Status Register

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

■ Device Emulation

Simple devices (without microcontroller) have the device emulation enabled (0x0140.8=1). The AL Control register is directly copied into the AL Status register by the ESC. The master should not set the Error Indication Acknowledge bit for such slaves at all, because setting this bit would result in setting the Error Indication bit – although no error occurred.
The device emulation is :0x0140.8=0 in the SANMOTION R 3E model EtherCAT servo amplifier.

AL Control

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

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

AL Status

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

* AL Status register is only writable if Device Emulation is off (0x0140.8=0), otherwise AL Status register will reflect AL Control register values.
* Numbers on monitor window of the setup software specifies status above.

■ 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	
	0x0003	Invalid device setting	P→S		P +E	
	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 SYNC Configuration	O, S		S + E	
	0x0031	Invalid DC Latch Configuration	O, S		S + E	
	0x0032	PLL Error	O		S + E	
	0x0033	Invalid DC IO Error	O, S		S + E	
	0x0034	Invalid DC Timeout Error	O, S		S + E	
	0x0035	DC Invalid SYNC CYCLE TIME	P->S		P+ E	
	0x0036	DC SYNC0 CYCLE TIME	P->S		P+ E	
	0x0037	DC SYNC1 CYCLE TIME	P->S		P+ E	
	0x0041	MBX_AOE	B, P, S, O		Current ESM + 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	
	0x0051	EE ERROR	B, P, S, O		Current ESM + E	
	0x0052	External hardware preparation incompletion	P→S		Current ESM + E	
	0x0060	Slave rebooted automatically.	Any ESM		I	
	0x0061	Device identification value update	P->S		P+ E	

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

3.2.6 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 microcontroller configuration

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

Note) EEPROM ADR 0x0001

Sync/Latch PDI Configuration

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

Note) EEPROM ADR 0x0001

Register Asynchronous microcontroller extended Configuration

Address	bit	Description	Master	Slave	Length	Rest Value
0x0152 - 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				

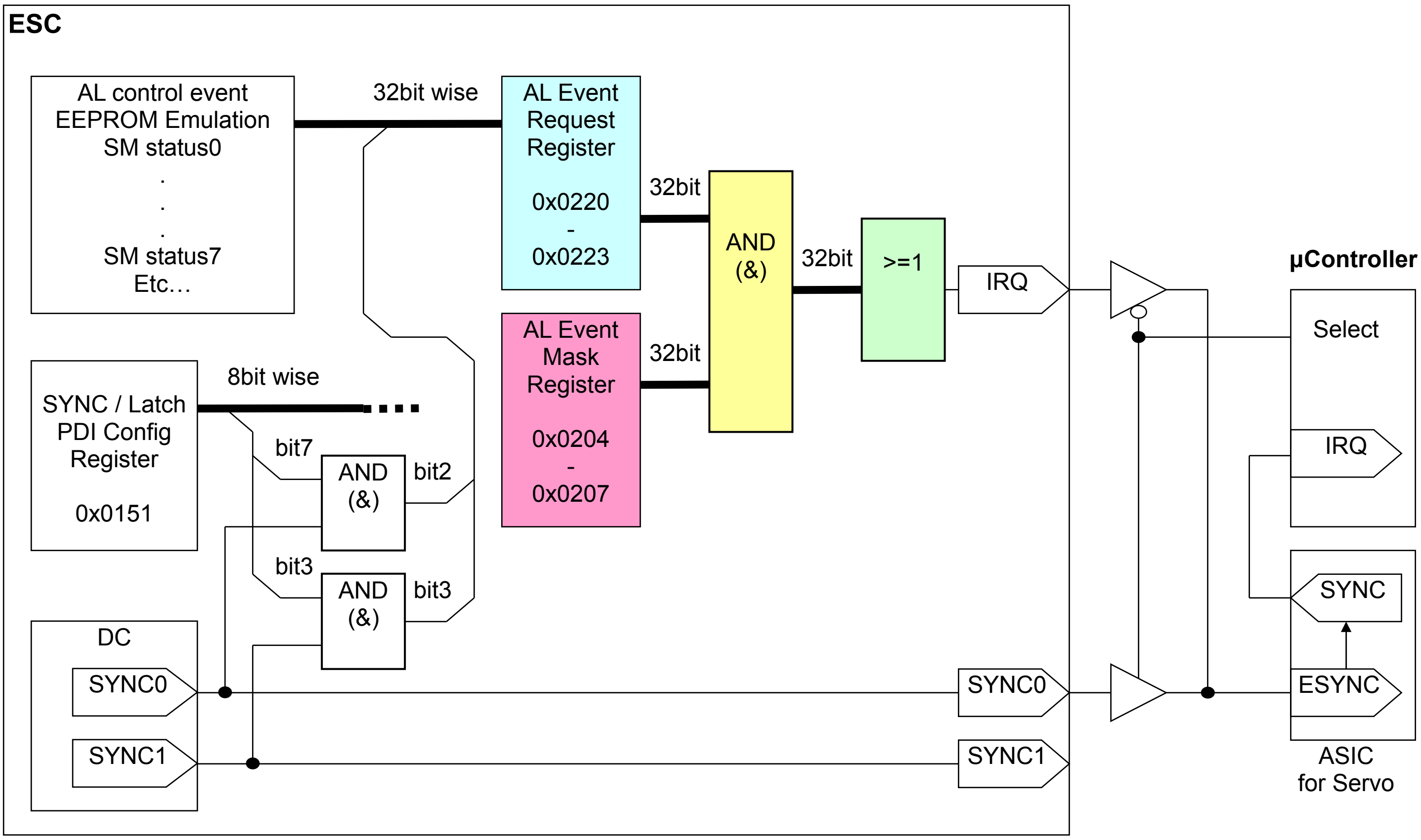
Note) Reset Value is "0". After that, depends on configuration EEPROM ADR 0x0003.

3.2.7 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 microcontroller 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 microcontroller 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

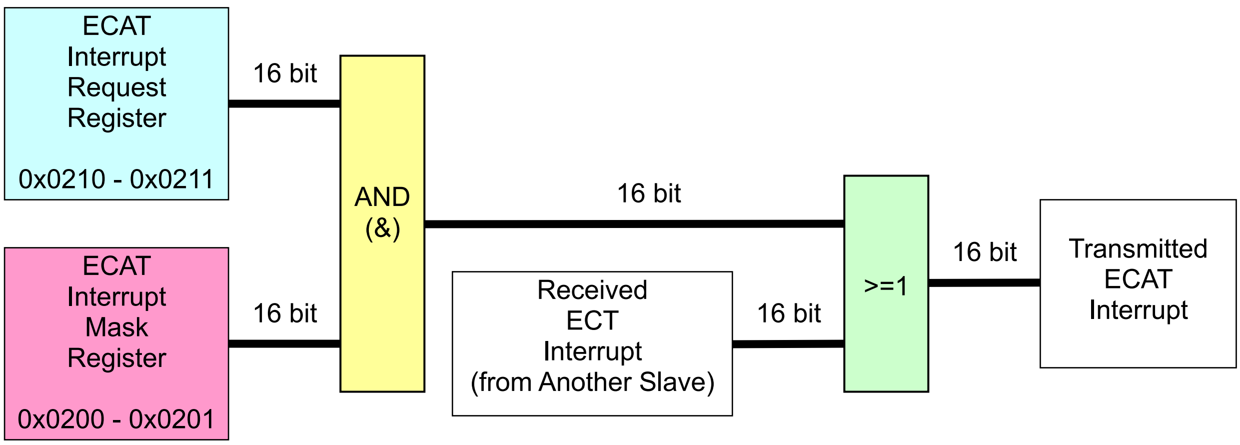
Register Address	Name	Description
0x0150	PDI Configuration	IRQ driver characteristics, depending on PDI
0x0151	SYNC/LATCH PDI Configuration	Mapping DC Sync Signals to Interrupts
0x0204:0x0207	AL Event Mask	Mask register
0x0220:0x0223	AL Event Request	Pending Interrupts
0x0804+N×8	Sync Manager Control	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 cannot 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				

3.2.8 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				0x0000 0000

* 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.

3.2.9 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 function for SyncManager is disabled if Watchdog Time Process Data is set to 0x0420=0. Set zero to Watchdog Trigger Enable of SyncManager y control register (0x0804, 0x080C, 0x0814, 0x081C).

■ 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.

3.2.10 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).

3.2.11 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 0x0516-0 x0517)	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.

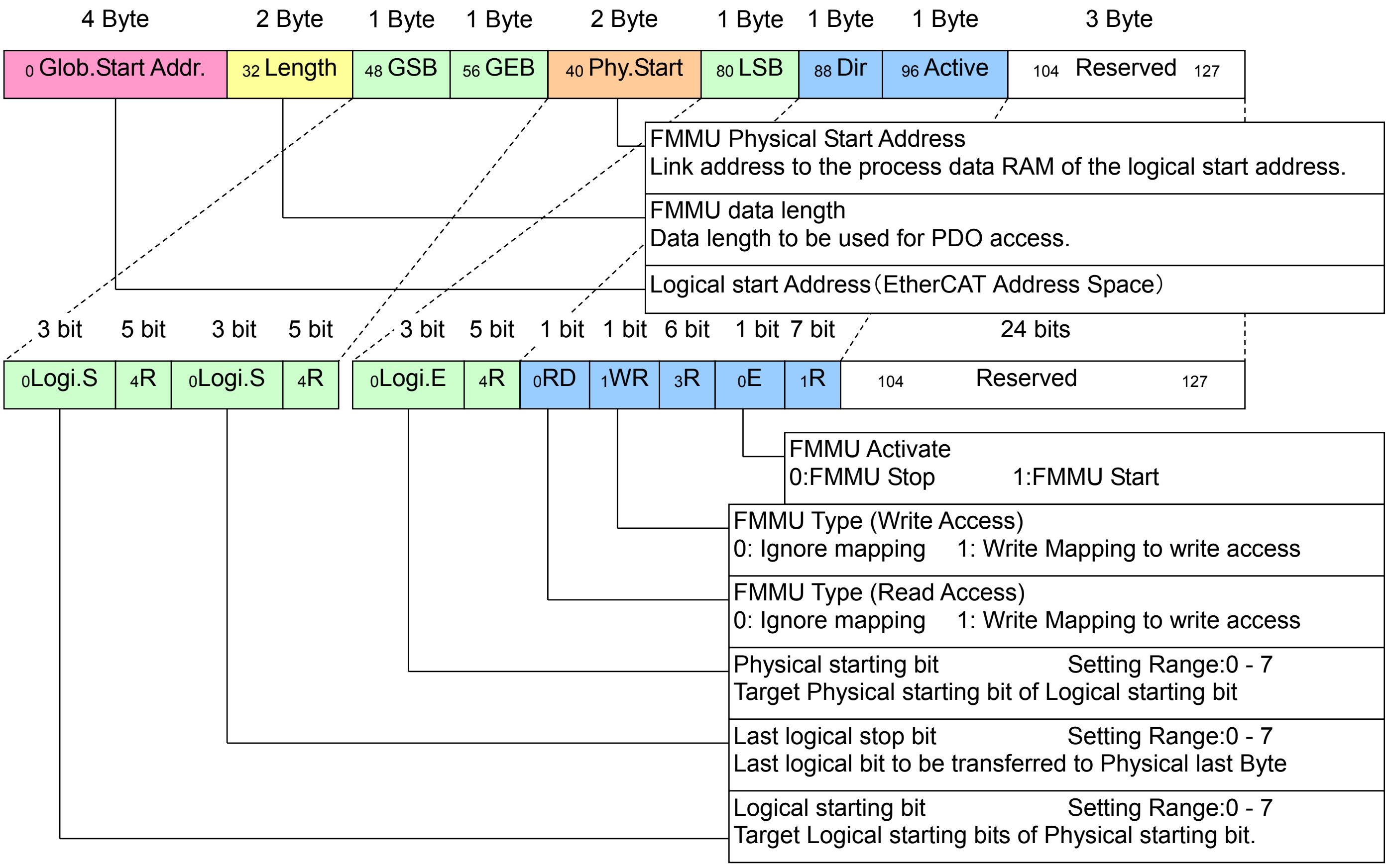
* R/(W): write access depends on assignment of MI (ECAT/PDI).

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

Each FMMU entry is described in 16 Bytes from 0x0600:0x060F to 0x0670:0x067F.
SANMOTION R 3E model EtherCAT servo 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/-		

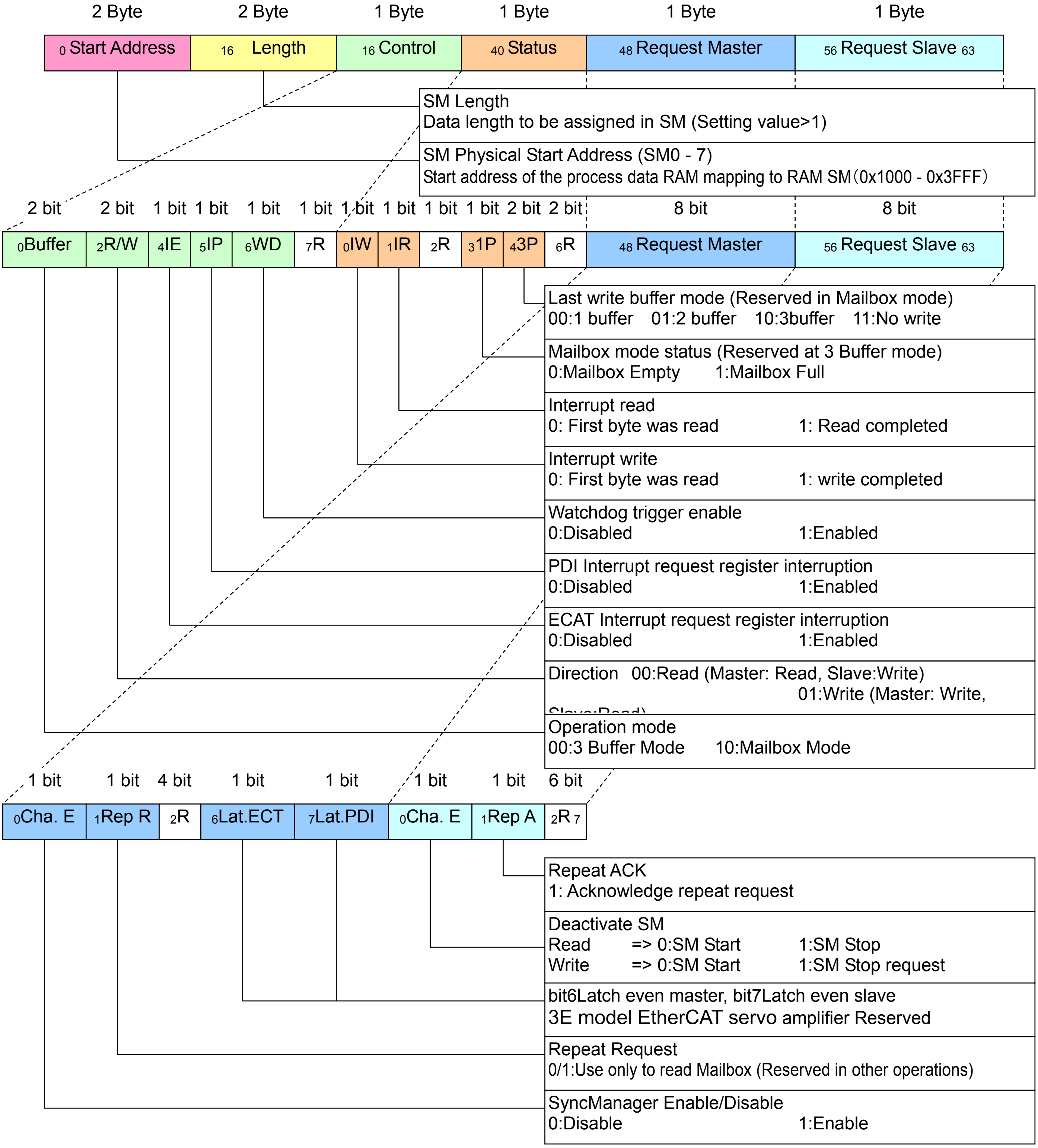
Activate FMMU y

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/-		

3.2.13 SyncManager (sm [7:0])

SyncManager registers are mapped from 0x0800:0x0807 to 0x0838:0x083F.
The SANMOTION R 3E model EtherCAT servo 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.



Physical Start Address SyncManager y

Address	bit	Description	Master	Slave	Length	Rest Value
0x0800+yx8 - 0x0801+yx8	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+yx8 - 0x0803+yx8	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 +yx8	1:0	Operation Mode	00: Buffered (3 buffer mode) 01: Reserved 10: Mailbox (Single buffer mode) 11: Reserved	R/W	R/-	1 Byte	0x00 (0x40 for SM2)
SM0 0x0804	3:2	Direction	00: Read: ECAT read access, PDI write access. 01: Write: ECAT write access, PDI read access. 10: Reserved 11: Reserved				
SM1 0x080C	4	Interrupt in ECAT Event Request Register	0: Disabled 1: Enabled				
SM2 0x0814	5	Interrupt in PDI Event Request Register	0: Disabled 1: Enabled				
	6	Watchdog Trigger Enable Note)	0: Disabled 1: Enabled				
SM3 0x081C	7	Reserved, write 0		R/-	R/-		

* R/(W): Register can only be written if SyncManager is disabled (+0x6.0 = 0).
* When Watchdog Trigger enable bit6=0 (Disabled) is set, 0x0400:Watchdog Divider or 0x0420: Watchdog Time Process Data shall be set zero. SyncManager Watchdog function will be disabled.

Status Register SyncManager y

Address	bit	Description		Master	Slave	Length	Rest Value
0x0805 +yx8 SM0 0x0805 SM1 0x080D SM2 0x0815 SM3 0x081D	0	Interrupt Write	1: Interrupt after buffer was completely and successfully written (0x0804+yx8) 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+yx8) 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 +yx8 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 +yx8 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/-		

3.2.14 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.

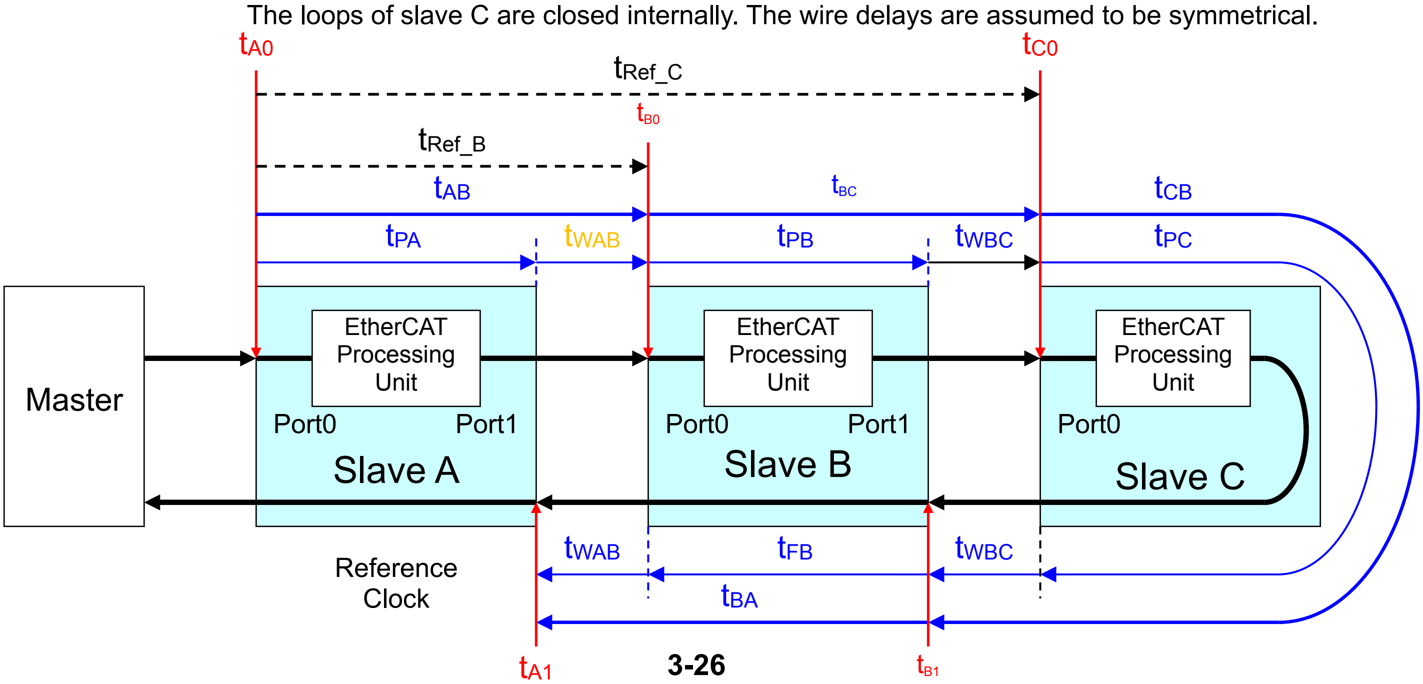
1. For measuring the propagation delay, the master sends a broadcast write to register DC Receive Time Port 0 (at least first byte).
2. Each slave device stores the time of its local clock when the first bit of the Ethernet preamble of the frame was received, separately for each port (Receive Time Port 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.



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 3E model EtherCAT servo 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.
Drift compensation requires time to finish so set time may become longer. Therefore compensation with system time offset is required before starting drift compensation.
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

3.2.15 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	R/-	R/-		

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

Speed Counter Diff

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

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

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

System Time Difference Filter Depth

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

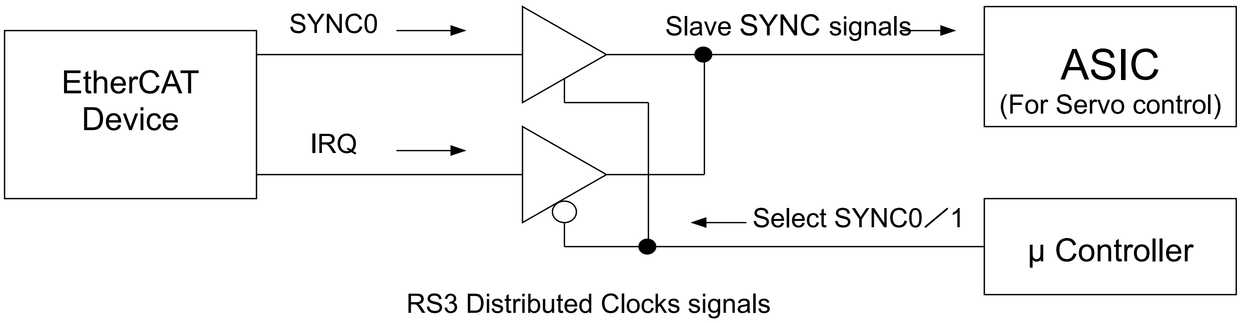
* Usable when 0x0140.10=1 or 0x0140.11=1. Reset control loop by writing the speed counter start (0x0930:0x0931) after this value has been changed.

■ DC-Cycle Unit Control

1. Synchronize Signal

SANMOTION R 3E model EtherCAT servo 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).



RS3 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 SANMOTION R 3E model EtherCAT servo amplifier (the other synchronous outputs are unsupported).
   The Sync Signal mode is selected by Pulse length and SYNC0 cycle time.

SyncSignal Generation Mode Selection

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

The cycle time of the SYNC0 signal is configured in the SYNC0 Cycle Time register (0x09A0:0x09A3), the start time is set in the Start Time Cyclic Operation register (0x0990:0x0997). After the Sync Unit is activated and the output of the SYNC0/1 signals is enabled (DC Activation register 0x0981), the Sync Unit waits until the start time is reached and generates the first SYNC0 pulse.
Internally, the SyncSignals are generated with an update rate of 100 MHz (10 ns update cycle).
The jitter of the internal SyncSignal generation in comparison to the System Time is 12 ns.

Registers for SyncSignal Generation

Register Address	Name	Description
0x0140[11:10]	PDI Control	Enable/Disable DC Units (power saving)
0x0151	Sync/Latch PDI Configuration	Configuration of SYNC/LATCH [1:0] pins
0x0980.0	Unit Cycle Control	Assignment of cyclic function to EtherCAT or PDI
0x0981	Activation	Activation of cyclic function and SYNC pins
0x0982:0x0983	Pulse Length of SYNC Signal	Length of SYNC impulse length
0x098E	SYNC0 Status	Status of SYNC0 signal
0x098F	SYNC1 Status	Status of SYNC1 signal
0x0990:0x0997	SYNC0 Start Time	Start System time of cyclic operation
0x0998:0x099F	Next SYNC1 Pulse	System Time of next Sync1 Pulse
0x09A:0x09A3	SYNC0 Cycle Time	Cycle Time of SYNC0
0x09A4:0x09A7	SYNC1Cycle Time	Cycle Time of SYNC1

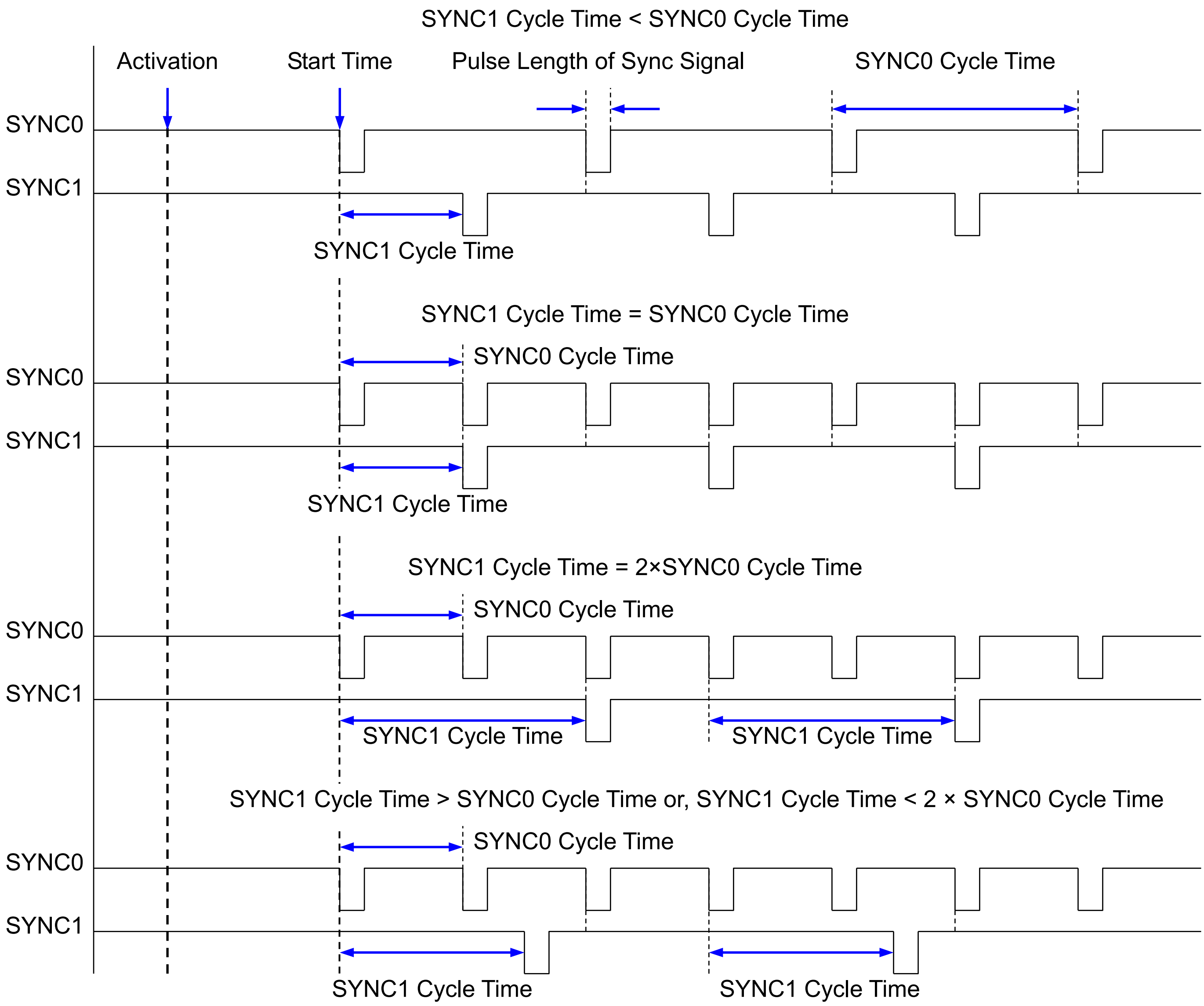
* Some of these registers are set via EEPROM at the time of power ON.

Cyclic Generation (Cyclic Generation)

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

SYNC1 Generation

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



SYNC0/1 Cycle Time Examples

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

Cyclic Unit Control

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

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

DC-SYNC Out Unit

SYNC OUT Unit Activation register

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

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

Pulse Length of SyncSignals

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

* Usable when 0x0140.10=1

SYNC0 Status

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

SYNC1 Status

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

Start Time Cyclic Operation

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

Next SYNC1 Pulse

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

SYNC0 Cycle Time

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

SYNC1 Cycle Time

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

DC-Latch input unit

Latch function is not supported in SANMOTION R 3E model EtherCAT servo 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

3.2.16 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

3.2.17 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 microcontroller		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				

3.2.18 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. EtherCAT Data Link Layer

3.3 EEPROM Mapping

3.3.1 Address Space Overview

64kbit I2C (Inter-Integrated Circuit) Interface EEPROM (Electrically Erasable Programmable Read Only Memory) is loaded in the slave controller of the SANMOTION R 3E model EtherCAT servo 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

3.3.2 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		

SYNC impulse width

Address 0x0002	SYNC impulse with multiples of 10ns		Length 1 word
bit	Description	Rest Value	Register
15:0	Pulse width 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 "0x0000000B" for EtherCAT amplifier.	0x0000000B	-

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	0x0400(1kByte) in size.	0x0400	-

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	0x0400(1kByte) in size。	0x0400	-

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)	0x000C	-
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	-

3.3.3 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't care
Activate	0x0006	Byte	Enable SyncManager
PDI CTRL	0x0007	Byte	Don't care

RXPDO & TXPDO Category Configuration (each element)

Parameter	Address	Data Type	Value / Description
PDO Index	0x0000	Word	RxPDO : 0x1600 - 0x1603, 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 Sync
NameIdx	0x0005	Byte	Object name: Character String Index
Flags	0x0006	Word	Reserved
Entry Index	0x0008	Word	Entry Index
SubIndex	0x000A	Byte	SubIndex
Entry Name Idx	0x000B	Byte	Entry name: Character String Index
Data Type	0x000C	Byte	Entry data type
bitLen	0x000D	Byte	Entry bit length
Flags	0x000E	Word	Reserved
Next Entry	0x0010	8Byte	Next entry….continue to each element

4.

Object Dictionary

In this chapter, EtherCAT object dictionary is explained.

4. Object Dictionary

4.1 Outline of Object Dictionary

4.1.1 Structure of Object Dictionary

Each object is addressed using a 16-bit index displaying 4 digits hexadecimal, assigned to each group in the object dictionary. Structure of the Object Dictionary of CoE (CANopen over EtherCAT) comply with CiA draft standard proposal 402 is shown as below.

Structure of object index

Index(Hex)	Object
0x0000 to 0x0FFF	Data Type Area
0x1000 to 0x1FFF	Communication Profile Area (CoE communication area)
0x2000 to 0x5FFF	Manufacturer Specific Profile Area (Manufacturer spec area)
0x6000 to 0x9FFF	Standardized Device Profile Area (Profile area)
0xA000 to 0xFFFF	Reserved

4.1.2 Object code definition

Object code definition entries are organized as follows.

Object code definition

Object code	Object name	Description
0x0000	NULL	A dictionary entry with no data fields
0x0002	DOMAIN	Large variable amount of data
0x0005	DEFTYPE	Denotes a type definition such as Boolean, Unsigned16 and so on.
0x0006	DEFSTRUCT	Defines a new data record, like as the PDO mapping structure at 0x21.
0x0007	VARIABLE	A single data such as Unsigned8, Boolean, float, Integer16 and visible string.
0x0008	ARRAY	Makes structure with the data which has same basic datatype on each data area. However, Sub-index 0 is Unsigned8 and not ARRAY data.
0x0009	RECORD	Makes structure with the data which has variety basic datatype on each data area. However, Sub-index 0 is Unsigned8 and not RECORD data.

4.1.3 Access types

For each data object, it has access rights as "Attribute".
Meaning of access rights is according to access attribute against data object, and direction of access is from Master to Slave.
Access attribute against data object

Attribute	Description
Rw, RW, rw	Read and write access available
Wo, WO, wo	Write access only available
Ro, RO, ro	Read access only available
Const, CONST	Read access only available (fixed value)

4.1.4 Data Type Area

Data type indicates the data type index of the object contained in Object Dictionary.
Standard data type is assigned to the index: 0x0001-0x001F, and the data type of the special definition is to the index: 0x0020 - 0x07FF.
Below shows Object Dictionary of data type area.

Object Dictionary of Data Type

Index	Object	Name	Index	Object	Name
0x0001	DEFTYPE	BOOLEAN	0x0026		Reserved
0x0002	DEFTYPE	INTEGER8	0x0027	DEFTYPE	PDOCOMPAR
0x0003	DEFTYPE	INTEGER16	0x0028	DEFTYPE	ENUM
0x0004	DEFTYPE	INTEGER32	0x0029	DEFSTRUCT	SYNC_PAR
0x0005	DEFTYPE	UNSIGNED8	0x002A	DEFTYPE	RECORD
0x0006	DEFTYPE	UNSIGNED16	0x002B	DEFTYPE	BACKUP
0x0007	DEFTYPE	UNSIGNED32	0x002C	DEFTYPE	MDP
0x0008	DEFTYPE	FLOAT32(REAL32)	0x002D-02F		Reserved
0x0009	DEFTYPE	VISIBLE_STRING	0x0030	DEFTYPE	BIT1
0x000A	DEFTYPE	OCTET_STRING	0x0031	DEFTYPE	BIT2
0x000B	DEFTYPE	UNICODE_STRING	0x0032	DEFTYPE	BIT3
0x000C	DEFTYPE	TIME_OF_DAY	0x0033	DEFTYPE	BIT4
0x000D	DEFTYPE	TIME_DIFFERENCE	0x0034	DEFTYPE	BIT5
0x000E		Reserved	0x0035	DEFTYPE	BIT6
0x000F	DEFTYPE	DOMAIN	0x0036	DEFTYPE	BIT7
0x0010	DEFTYPE	INTEGER24	0x0037	DEFTYPE	BIT8
0x0011	DEFTYPE	REAL64	0x0038-03F		Reserved
0x0012	DEFTYPE	INTEGER40	0x0040-05F	DEFSTRUCT	Manufacturer Specific Complex Data Type
0x0013	DEFTYPE	INTEGER48	0x0060-07F	DEFTYPE	Device Profile 0 Specific Standard Data Types
0x0014	DEFTYPE	INTEGER56	0x0080-09F	DEFSTRUCT	Device Profile 0 Specific Complex Data Types
0x0015	DEFTYPE	INTEGER64	0x00A0-0BF	DEFTYPE	Device Profile 1 Specific Standard Data Types
0x0016	DEFTYPE	UNSIGNED24	0x00C0-0DF	DEFSTRUCT	Device Profile 1 Specific Complex Data Types
0x0017		Reserved	0x00E0-0FF	DEFTYPE	Device Profile 2 Specific Standard Data Types
0x0018	DEFTYPE	UNSIGNED40	0x0100-11F	DEFSTRUCT	Device Profile 2 Specific Complex Data Types
0x0019	DEFTYPE	UNSIGNED48	0x0120-13F	DEFTYPE	Device Profile 3 Specific Standard Data Types
0x001A	DEFTYPE	UNSIGNED56	0x0140-15F	DEFSTRUCT	Device Profile 3 Specific Complex Data Types
0x001B	DEFTYPE	UNSIGNED64	0x0160-17F	DEFTYPE	Device Profile 4 Specific Standard Data Types
0x001C	DEFTYPE	SAFETY	0x0180-19F	DEFSTRUCT	Device Profile 4 Specific Complex Data Types
0x001D-1F		Reserved	0x01A0-1BF	DEFTYPE	Device Profile 5 Specific Standard Data Types
0x0020		Reserved	0x01C0-1DF	DEFSTRUCT	Device Profile 5 Specific Complex Data Types
0x0021	DEFSTRUCT	PDO_MAPPING	0x01E0-1FF	DEFSTRUCT	Device Profile 6 Specific Standard Data Types
0x0022		Reserved	0x0200-21F	DEFSTRUCT	Device Profile 6 Specific Complex Data Types
0x0023	DEFSTRUCT	IDENTITY	0x0320-23F	DEFTYPE	Device Profile 7 Specific Standard Data Types
0x0024		Reserved	0x0440-25F	DEFSTRUCT	Device Profile 7 Specific Complex Data Types
0x0025	DEFSTRUCT	COMMAND_PAR	0x0260-7FF		Reserved

Also, the Enumerated type data areas are assigned to Index 0x0800 - 0x0FFF.
Each items are the data type which designates occupied bit number (e.g. BIT3 or UNSIGNED16), and there is the type which designates integer value (data type is UNSIGNED32). Character strings are below.

Definition of the Enumerated type data

Sub-Index	Description	Data type	Access	PDO mapping	Values
0x00	Number of entry	UNSIGNED8	RO	No	Numbers of enumerated value "N"
	Padding	UNSIGNED8			0: Even number Padding byte for getting 8bit byte
0x01	Enum 1	OCTET STRING	RO	No	VISIBLE STRING: enumrated character strings UNSIGNED32: integer
・・・					
0xN	Enum N	OCTET STRING	RO	No	

4.1.5 Unit in linear/DD motors

- ✔ For use of linear motor, units in position and velocity are shown below.

Position: mm

Velocity: mm/seconds

- ✔ For use of DDM (Direct Drive Motor), unit in velocity is shown below.

Velocity: 0.1 min^{-1}

4.2 CoE Communication Area

Below shows CoE communication object list, Object type, Data length, Access (Dir), PDO Mapping, and parameter effective timing (updating).
The symbols in the Update column stand for effective timing; #=immediately, $=ESM (EtherCAT State Machine) change required, &=control-power-source re-input.

Communication Area

Index	Sub-Index	Object Type	Name	Data length	Dir	PDO Mapping	Update	NVRAM
0x1000	0x00	VARIABLE	Device Type	Unsigned32	RO	No	—	-
0x1001	0x00	VARIABLE	Error Resistor	Unsigned8	RO	Possible	—	-
0x1008	0x00	VARIABLE	Device Name of Manufacturer	VisibleString	RO	No	—	-
0x1009	0x00	VARIABLE	Hardware Version of Manufacturer	VisibleString	RO	No	—	-
0x100A	0x00	VARIABLE	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 Suported [Serial Number]	Unsigned32	RO	No	—	-
0x1029	0x00	—	Error behavior (reserved)	Unsigned8	RW	No	—	-
0x10F1	—	ARRAY	Error Settings	—	—	—	—	-
	0x00	—	Number of entry	Unsigned8	RO	No	—	-
	0x01	—	Reserved	—	—	—	—	
	0x02	—	Sync error counter limit	Unsigned16	RW	No	#	
0x1400-0x1403 0x1500-0x1503	—	RECORD	RxPDO Parameter	—	—	—	—	-
	0x00	—	Number of Entry	Unsigned8	RO	No	—	-
	0x01-0x05	—	Reserved	Unsigned32	RW	No	$	-
	0x06	—	RxPDO exception PDO	Octet-String	RW	No	$	-
	0x07	—	RxPDO State	BOOLEAN	RO	No	—	-
	0x08	—	RxPDO Control	BOOLEAN	RW	No	#	-
	0x09	—	RxPDO Toggle	BOOLEAN	RW	No	#	-
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	No	—	-
	0x08	—	Reserved	BOOLEAN	—	—	—	-
	0x09	—	TxPDO Toggle	BOOLEAN	RO	No	—	-
0x1A00-0x1A03 0x1B00-0x1B03	—	RECORD	1st to 4th and 257th to 260th Transmission 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	$	-

Index	Sub-Index	Object Type	Name	Data length	Dir	PDO Mapping	Update	NVRAM
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	$	-
	0x02	–	Cycle Time	Unsigned32	RW (RO)	No	–	-
	0x03	–	Shift Time	Unsigned32	RO	No	–	-
	0x04	–	Synchronous Type Support	Unsigned16	RO	No	–	-
	0x05	–	Minimum Cycle Time	Unsigned32	RO	No	–	-
	0x06	–	Calculate and Copy Time	Unsigned32	RO	No	–	-
	0x07	–	Reserved	–	–	–	–	-
	0x08	–	Get Cycle Time	Unsigned16	RW	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 Area.

4.2.1 Parameter Details of Object Group from 0x1000

0x1000: Device Type

Index	0x1000	Indicates type and profile function of device		Object Code		VARIABLE
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 Resistor

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

0x1008: Device Name

Index	0x1008	Indicates product device name.		Object Code		VARIABLE
Sub-Idx	Name/Description		Data Type	Access	PDO	Value
0x00	Device Name [DEVICE] Product Device Name (ASCII Code)		Visible String	RO	No	Character String (-)
RS3 A 0 1 A 2 H A 4 ✓ Refer to M0011696 section 1.4 Servo amplifier model number, for model number structure details.						

0x1009: Hardware Version

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

Manufacturer minor revision Our management number. "01, 02, …, 99"
Manufacturer major revision Our management number. "1, 2, …, 9"
Series information. This indicates 3E Model EtherCAT. Our management number. "30, 31, …, 39"

0x1010: Store Parameters

Index	0x1010	Store current amplifier parameters to non-volatile memory			Object Code	ARRAY
Sub-Idx	Name/Description		Data Type	Access	PDO	Initial value
0x00	Number of Entry		Unsigned8	RO	No	0x01
0x01	Store all parameters [PARASAVE] Store all reservable parameters in a lump.		Unsigned32	RW	No	0x0000 0001 (At read)

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 sets PreOP to ESM and writes "0x65 76 61 73" (ASCII - s: 73, a: 61, v: 76, e: 65) to "Sub-index 01".
  2) Servo amplifier stores storable parameters in non-volatile memory in servo amplifier when received correct signs.
  3) Servo amplifier responds by SDO sending (download-initiating response) after normal storage completion.
     If failed to store, slave responds via SDO abort transfer service (abort code: 0606 0000h).
     If incorrect sign was written, slave responds via SDO abort transfer service (abort code: 0800 0020h).
  4) Servo amplifier makes parameter file for FoE upload in background, after storing parameter to non-volatile memory.
- Read-access Sequence
  Servo amplifier provides information on parameter storing function in the following formats.

Bit	Value	Description
31-2: Reserved	0	Reserved
1: Auto 0: Cmd	11	Servo amplifier stores parameters periodically. Also it stores parameters if the command above is used.
	10	Servo amplifier stores parameters periodically. It cannot store parameters by the command above.
	01	Servo amplifier does not store parameters periodically. It stores parameters if the command above is used.
	00	This function disabled.

✔ If NVRAM column is "Yes" and PDO mapping is available at each area of object list, that parameter is able to store by this command.

✔ It cannot perform when ESM is SafeOP or OP.
During parameter file generation, ESM state cannot transit to OP. (AL status error will be issued.)
Moreover during file generation, it cannot change parameters by SDO or the setup software. (SDO abort error will be issued.)

0x1018: Identity Object

Index	0x1018	Indicates information of salve device.			Object Code	RECORD
Sub-Idx	Name/Description		Data Type	Access	PDO	Value
0x00	Number of Entry		Unsigned8	RO	No	0x04
0x01	Vender ID [VENDOR] Vender ID registered in ETG		Unsigned32	RO	No	0x0000 01B9
0x02	Product Code [PRODUCT] Product Code of Production		Unsigned32	RO	No	0x0000 000B
0x03	Revision No. [AMPREV] Revision Number of Product		Unsigned32	RO	No	0x0000 0001
0x04	Not supported (SerialNo.) [SERIAL] Serial Number of Product (Unused)		Unsigned32	RO	No	(-)

0x10F1: Error Settings

Index	0x10F1	Setting about error		Object Code		RECORD
Sub-Idx	Name/Description		Data Type	Access	PDO	Value
0x00	Number of Entry		Unsigned8	RO	No	0x01
0x01	Reserved		-	-	-	-
0x02	Sync error counter limit	[SyncErrorCounterLimit]	Unsigned16	RW	No	0x0009
	When sync error counter exceeds this set value, 0x001A (Sync error) is set to AL status code and ESM transition occurs to SafeOP. At the time of SYNC0 event happening, sync error count increments 3 if SM2 event is not happened but decrements 1 if SM2 event is happened. Sync error is not detect if this set value is zero.		Set value	0x0000 to 0x000F		

Operating example of sync error counter

SM2 event	1	0	1	0	1	0	1	0	1	0	1
Sync error counter SyncErrorCounterLimit=9	0	3	2	5	4	7	6	9 (Error)	9	9	9

0x1400-0x1403, 0x1500-0x1503: RxPDO Parameter 1-4, 257- 260 (RxPDO)

Index	0x1400-0x1403 0x1500-0x1503	The receiving PDO parameters 1 to 4, 257 to 260 show RxPDO setting/state of a corresponding RxPDO 1 to 4, 257 to 260.	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 (to 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 exception PDO]	Octet-String	RW	No	
0x07	Not supported	[RxPDO State]	BOOLEAN	RO	No	0
0x08	Not supported	[RxPDO Control]	BOOLEAN	RW	No	0
0x09	Not supported	[RxPDO Toggle]	BOOLEAN	RW	No	0

0x1600: Reception PDO Mapping 1

Index	0x1600	Reception PDO Mapping 1	Object Code	RECORD

Sub-Idx	Name/Description	Data Type	Access	PDO	Range (Initial Value)
0x00	Number of Entry : Number of RxPDO1 Object	Unsigned8	RW	No	0x00 to 0x1F
0x01	Entry 1 Object Mapped in the 1st - RxPDO1	Unsigned32	RW	No	0x60400010
0x02 - n	Entry 2 - Entry-n Object Mapped in the 2nd to n of - RxPDO1 ✓ "n" is up to 0x1F in maximum but it may be limited according to communication cycle (in case shorter).	Unsigned32	RW	No	0x00000000 - 0xFFFFFFFF

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

Index	0x1601-0x1603 0x1700-0x1703	Reception PDO Mapping 2 to 4, 257 to 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	0x00-0x1F
0x01 - n	Entry 1 - Entry-n Object Mapped in the 1st to nth of – RxPDO x ✓ "n" is up to 0x1F in maximum but it may be limited according to communication cycle (in case shorter).	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 to 4, 257 to 260 show TxPDO setting/state of a corresponding TxPDO 1 to 4, 257 to 260.	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 TxPDO1 (to 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	
0x07	Not supported [TxPDO State]	BOOLEAN	RO	Possible	0
0x08	Reserved	BOOLEAN	RO	No	0
0x09	Not supported [TxPDO Toggle]	BOOLEAN	RO	No	0

0x1A00: TxPDO Mapping 1 (TxPDO 1)

Index	0x1A00	Transmission PDO Mapping 1	Object Code	RECORD

Sub-Idx	Name/Description	Data Type	Access	PDO	Range (Initial Value)
0x00	Number of Entry: Number of TxPDO1 Object	Unsigned8	RW	No	0x00-0x1F
0x01	Entry 1 Object Mapped in the 1st to TxPDO1	Unsigned32	RW	No	0x60410010
0x02 - n	Entry 2 - Entry-n Object Mapped in the 2nd to n of - TxPDO1 ✓ "n" is up to 0x1F in maximum but it may be limited according to communication cycle (in case shorter).	Unsigned32	RW	No	0x00000000 - 0xFFFFFFFF

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

Index	0x1A01～0x1A03 0x1B00～0x1B03	Transmission PDO Mapping 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 TxPDOx Object	Unsigned8	RW	No	0x00-0x1F
0x01 - n	Entry 1 - Entry-n Object Mapped in the 1st to n of – TxPDO x ✓ "n" is up to 0x1F in maximum but it may be limited according to communication cycle (in case shorter).	Unsigned32	RW	No	0x00000000 - 0xFFFFFFFF

4. Object Dictionary

0x1C00: SM (SyncManager) 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		: Number of SM channels to be used	Unsigned8	RO	No	0x08
0x01	Communication Type SM0		1: Mailbox Reception (from master to slave)	Unsigned8	RO	No	0x01
0x02	Communication Type SM1		2: Mailbox Transmission (from slave to master)	Unsigned8	RO	No	0x02
0x03	Communication Type SM2		3: PD Output (from master to slave)	Unsigned8	RO	No	0x03
0x04	Communication Type SM3		4: PD Input (from slave to master)	Unsigned8	RO	No	0x04
0x05 - 0x08	Communication Type SM4 ... Communication Type SM7		0: Not used 1: Mailbox Reception 2: Mailbox Transmission 3: PD Output 4: PD Input	Unsigned8	RO	No	0x00

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", number of object assigned to RxPDO	Unsigned8	RW	No	0x00-0x04
0x01 - n	Index of the PDO object assigned to RxPDO	Unsigned16	RW	No	0x1600: RxPDO 1 ... 0x1603: RxPDO 4 0x1700: RxPDO257 ... 0x1703: RxPDO260

0x1C13: SM Channel 3 (Process Data Input)

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

0x1C32: SM2 Synchronization (Output Sync Manager Parameter)

Index	0x1C32	SM2 synchronization setup		Object Code		RECORD
Sub-Idx	**Name/Description**		**Data Type**	**Access**	**PDO**	**Range**
0x00	Number of synchronization parameter		Unsigned8	RO	No	0x20
0x01	Synchronization Type	[SM2TYP]	Unsigned16	RW	No	0x0002
	Sets up synchronous mode.		Setting Range	0x0000-0x0003		
	0x00: not synchronized Asynchronized (Free Run) 0x01: Sync Manager2 SM2 Event Synchronization 0x02: DC Sync0 SYNC0 Event Synchronization (Synchronized with SYNC0 Hardware Signal) 0x03: DC Sync1 SYNC1 Event Synchronization (Synchronized with SYNC1 Hardware Signal) ✓ Must set this from controller at communication configuration. ✓ For use of SM2 event sync, communication jitter shall be 6 μs or less.					
0x02	Cycle Time: Unit (ns)	[SM2SYC]	Unsigned32	RW	No	0x0007A120 (500μs)
	Sets up communication cycle between master and slave. Set Value: When T (ns) =125000x2Y (ns), it is in the range of Y= 1 to 7.		Setting Range	0x0000F424 - 0x00F42400 (0.0625 - 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): SYNC1 Cycle Time (0x09A4 - 0x09A7) Possible Setting Value: T (ns) 62.5μs: 0x0000F424 125μs: 0x0001E848 250μs: 0x0003D090 500μs: 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. ✓ When 0x01 is set to Synchronization Type, it must set via a controller, at the time of communication configuration.					
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	0x000F

MSB LSB

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

bit0	: FreeRun Mode Support 1: FreeRun Mode Support
bit1	: SyncManager Synchronous Support 1: SyncManager 2 Event Sync Support
bit4-2	: DC Type Support 000 : Un-supported 001 : DC SYNC0 Event Sync Support 010 : DC SYNC1 Event Sync Support 100 : Un-supported
bit6-5	: Output Shift Support 00 : Un-supported 01 : Un-supported 10 : Un-supported
bit13-7	: Reserved
bit14	: Dynamic Cycle Time 0 : Un-supported
bit15	: Reserved

Sub-Idx	Name/Description	Data Type	Access	PDO	Range
0x05	Minimum Cycle Time : Unit (ns)	Unsigned32	RO	No	0x0000F424 (62.5μs)
	The minimum cycle time is supported by slave. (Maximum time of local cycle)				
0x06	Copy and Operation Time (Calc and Copy Time) : Unit (ns)	Unsigned32	RO	No	0x0000F424 (62.5μs)
	Time required of micro controller in order to copy process data to local memory from SyncManager. Operation is processed, if required before transmitting data to a process.				
0x07	Reserved	Unsigned32	—	—	—
0x08	Get Cycle Time 0: Stops local cycle time measurement. 1: Starts local cycle time measurement. ✓ Measurement value is reset when written into again.	Unsigned16	RW	No	—
0x09	Delay Time	Unsigned32	RO	No	0x00009088 (37μs)
	This is hardware delay time of a slave. It is the time from trigger reception of SYNC0 or SYNC1 event to become effective a value output. ✓ Only for the synchronization type 0x02 (DC Sync0) or 0x03 (DC Sync1).				
0x0A	Not supported ［Sync0 Cycle Time］	Unsigned32	RW	No	—
	This is the time between two Sync0 signals, for the case when SYNC0 fixed cycle time is required of application. ✓ Only the synchronization type 0x02 (SYNC0) or local cycle control.				
0x0B	Cycle Time Too Small	Unsigned16	RO	No	—
	This error counter is incremented when cycle time is too short as local cycle cannot be completed or input data cannot prepare by the next SM event.				
0x0C	SM Event Missed	Unsigned16	RO	No	—
	This error counter is incremented when application demands SM event and cannot receive it. As a result, data may be unable to be copied any more.				
0x0D	Shift Time Too Short	Unsigned16	RO	No	—
	This error counter is incremented if the time interval between SYNC0 trigger and an output is too short according to the fact that shift time or SYNC1 cycle time is too short.				
0x0E	Not supported ［RxPDO Toggle Failed］	Unsigned16	RO	No	—
	This error counter is incremented when slave supports an RxPDO toggle and then new RxPDO data cannot be received from a master. (When RxPDO toggle is set to TRUE.)				
0x0F - 0x1F	Reserved	—	—	—	—
0x20	Not supported ［Sync Error］	BOOL	RO	Possible	
	TxPDO mapping is possible at the time of SM-Event Missed or Shift Time Too Short Counter support. 0: No Sync. Error or unsupported Sync.Error 1: Sync. Error				

0x1C33: SM3 Synchronization (Input SyncManager Parameter)

Index	0x1C33	SM3 Synchronization	Object Code		RECORD
Sub-Idx	**Name/Description**	**Data Type**	**Access**	**PDO**	**Initial Value**
0x00	Number of Synchronization Parameter	Unsigned8	RO	No	0x20
0x01	Synchronization Type [SM3TYP]	Unsigned16	RW	No	0x0002
		Setting Range	0x00, 0x02, 0x03, 0x22		
	0x00: not synchronized — Asynchronized (Free Run) 0x01: Sync Manager2 — SM2 Event Synchronization (In case that Output is not transferred at Safe-OP and OP.) 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 (In case that Output is transferred at Safe-OP and OP.) ✓ Must set this from controller at communication configuration. ✓ For use of SM2 event sync, communication jitter shall be 6 μs or less.				
0x02	Cycle Time: Unit (ns) ［SM3SYC］	Unsigned32	RO	No	0x0007A120 (500μs)
	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): SYNC1 Cycle Time (0x09A4 - 0x09A7) ✓ 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-index3.				
0x04	Synchronization Type Supported	Unsigned16	RO	No	0x000F

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

bit0	: FreeRun Mode Support 1: FreeRun Mode Support
bit1	: SyncManager Synchronous Support 1: SyncManager 2 Event Sync Support
bit4-2	: DC Type Support 000 : Un-supported 001 : DC SYNC0 Event Sync Support 010 : DC SYNC1 Event Sync Support 100 : Un-supported
bit6-5	: Output Shift Support 00 : Un-supported 01 : Un-supported 10 : Un-supported
bit13-7	: Reserved
bit14	: Dinamic Cycle Time 0 : Un-supported
bit15	: Reserved

Sub-Idx	Name/Description	Data Type	Access	PDO	Range
0x05	Minimum Cycle Time : Unit (ns)	Unsigned32	RO	No	0x0000F424 (62.5μs)
	The minimum cycle time is supported by slave. (Maximum time of local cycle) ✓ The value shall be the same as Index: 0x1C32, Sub-index5.				
0x06	Copy and Operation Time (Calc and Copy Time) : Unit (ns)	Unsigned32	RO	No	0x0001E848 (125μs)
	Time required from Input Latch through minimum cycle time.				
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	Unsigned32	RO	No	–
	This is hardware delay time of a slave. It is the time from trigger reception of SYNC0 or SYNC1 event until latching input value. ✓ Only for the synchronization type 0x02 (DC Sync0) or 0x03 (DC Sync1).				
0x0A	Not supported ［Sync0 Cycle Time］	Unsigned32	RW	No	–
	This is the time between two Sync0 signals, for the case when SYNC0 fixed cycle time is required of application. ✓ Only the synchronization type 0x02 (SYNC0) or local cycle control.				
0x0B	Cycle Time Too Small	Unsigned16	RO	No	–
	This error counter is incremented when cycle time is too short as local cycle cannot be completed or input data cannot prepare by the next SM event.				
0x0C	SM-Event Missed	Unsigned16	RO	No	–
	This error counter is incremented when application demands SM event and cannot receive it. As a result, data may be unable to be copied any more.				
0x0D	Shift Time Too Short	Unsigned16	RO	No	–
	This error counter is incremented if the time interval between SYNC0 trigger and an output is too short according to the fact that shift time or SYNC1 cycle time is too short.				
0x0E	Not supported [RxPDO Toggle Failed]	Unsigned16	RO	No	–
	This error counter is incremented when slave supports an RxPDO toggle and then new RxPDO data cannot be received from a master. (When RxPDO toggle is set to TRUE.)				
0x0F：0x1F	Reserved	–	–	–	–
0x20	Not supported [Sync Error]	BOOL	RO	Possible	
	TxPDO mapping is possible at the time of SM-Event Missed or Shift Time Too Short Counter support. 0: No Sync. Error or unsupported Sync.Error 1: Sync. Error				

4.3 Profile Area

The followings are shown in Table; profile area of CoE (CANopen over EtherCAT) object list, 3E Model EtherCAT Supported / Un-supported, Data length, Access (Dir), PDO Mapping, and parameter effective timing (updating).
#=immediately, $=ESM state transition required, and &=effective after control power cycle.

Profile Area (No.1)

○: Support, ●: Support (with limit), □: Support (Not changeable :Fixed Value), ×: Not supported

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	○	○	○	○	Actual Position	Integer32	RO	Possible	—	-
0x6065	0x00	○	×	×	○	Position Deviation Window	Unsigned32	RW	No	#	Yes
0x6067	0x00	○	×	×	○	Position Window (Positioning complete range)	Unsigned32	RW	No	#	Yes
0x6068	0x00	□	×	×	□	Position Window Time	Unsigned16	RW	No	—	-
0x6069	0x00	○	○	×	○	Actual Velocity Sensor Value	Integer32	RO	Possible	—	-
0x606A	0x00	□	□	□	□	Sensor Selection Code	Integer16	RW	No	—	-
0x606C	0x00	○	○	×	○	Actual Velocity Value (Velocity Monitor)	Integer32	RO	Possible	—	-
0x606D	0x00	×	○	×	×	Velocity Window (Velocity matching range)	Unsigned16	RW	No	#	-
0x606E	0x00	×	○	×	×	Velocity Window Time	Unsigned16	RW	No	#	-
0x606F	0x00	×	○	×	×	Velocity Threshold	Unsigned16	RW	No	#	-
0x6070	0x00	×	○	×	×	Velocity Threshold Time	Unsigned16	RW	No	#	-
0x6071	0x00	×	×	○	×	Target Torque (force) (Torque (force) Command)	Integer16	RW	Possible	#	-
0x6072	0x00	○	○	○	○	Maximum Torque (force) (Torque (force) Limit)	Unsigned16	RW	Possible	#	-
0x6076	0x00	○	○	○	○	Motor Rating Torque (force)	Unsigned32	RO	No	—	-
0x6077	0x00	○	○	○	○	Actual Torque (force) Value (Torque (force) Monitor)	Integer16	RO	Possible	—	-
0x6078	0x00	○	○	○	○	Actual 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	○	×	×	○	Minimum Position Limit	Integer32	RW	No	$	Yes
↑	0x02	○	×	×	○	Maximum Position Limit	Integer32	RW	No	$	Yes
0x607C	0x00	○	○	○	○	Coordinates Offset (Homing Offset)	Integer32	RW	Possible	#	Yes
0x607D	0x00	—	—	—	—	Software Position Limit	Unsigned8	RO	No	—	-
↑	0x01	○	×	×	○	Software Minimum Position Limit	Integer32	RW	No	#	Yes
↑	0x02	○	×	×	○	Software Maximum Position Limit	Integer32	RW	No	#	Yes
0x607E	0x00	○	○	○	○	Polarity	Unsigned8	RW	No	$	Yes
0x607F	0x00	○	○	×	×	Max. Profile Velocity	Unsigned32	RW	Possible	#	Yes
0x6081	0x00	○	○	×	×	Profile 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	○	○	○	○	Position Encoder Resolution	Unsigned32	RW	No	$	-
↑	0x02	○	○	○	○	Motor axis rotation number	Unsigned32	RW	No	$	-

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	No	$	-
↑	0x02	○	○	○	○	Drive Shaft Resolution	Unsigned32	RW	No	$	-
0x6092	0x00	—	—	—	—	Feed Constant	Unsigned8	RO	No	—	-
↑	0x01	○	○	×	○	Feed (Travel Distance)	Unsigned32	RW	No	$	-
↑	0x02	○	○	×	○	Feed Shaft Resolution	Unsigned32	RW	No	$	-
0x6098	0x00	×	×	×	○	Homing Method	Integer8	RW	Possible	#	Yes
0x6099	0x00	—	—	—	—	Homing Velocity	Unsigned8	RO	No	—	-
↑	0x01	×	×	×	○	Home Switch Searching Velocity	Unsigned32	RW	Possible	#	Yes
↑	0x02	×	×	×	○	Zero Phase Searching Velocity	Unsigned32	RW	Possible	#	Yes
0x609A	0x00	×	×	×	○	Homing Acceleration	Unsigned32	RW	Possible	#	Yes
0x60A3	0x00	○	×	×	×	Profile Jerk Use	Unsigned8	RW	No	#	-
0x60A4	0x00	—	—	—	—	Profile Jerk	Unsigned8	RO	No	—	-
↑	0x01	○	×	×	×	Profile Jerk 1	Unsigned32	RW	No	#	-
↑	0x02	○	×	×	×	Profile Jerk 2	Unsigned32	RW	No	#	-
0x60A8	0x00	○	×	×	○	SI unit system for position	Unsigned32	RW	No	#	Yes
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 Status	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 probe2 positive edge position stored	Integer32	RO	Possible	#	-
0x60BD	0x00	○	○	○	●	Touch probe2 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	○	×	×	×	Interpolated position command	Integer32	RW	Possible	#	-
↑	0x02	○	×	×	×	Interpolation time	Unsigned8	RW	Possible	#	-
0x60C2	0x00	—	—	—	—	Interpolation time cycle	Unsigned8	RO	No	—	-
↑	0x01	○	×	×	×	Interpolation time unit	Unsigned8	RW	No	#	-
↑	0x02	○	×	×	×	Interpolation time exponent	Integer8	RW	No	#	-
0x60C4	0x00	—	—	—	—	Interpolation data configuration	Unsigned8	RO	No	—	-
↑	0x01	○	×	×	×	Maximum buffer size	Unsigned32	RO	No	—	-
↑	0x02	○	×	×	×	Actual buffer size for interpolation data	Unsigned32	RW	No	#	-
↑	0x03	○	×	×	×	Interpolation data buffer structure	Unsigned8	RW	No	#	-
↑	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	○	○	○	○	Positive Torque (force) Limit Value	Unsigned16	RW	Possible	#	Yes
0x60E1	0x00	○	○	○	○	Negative 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	—	-
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	RO	No	—	-
↑	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	—	-
0x6502	0x00	○	○	○	○	Support Drive Mode	Unsigned32	RO	No	—	-
0x6503	0x00	○	○	○	○	Drive Catalog No.	VisibleString	RO	No	—	-
0x6505	0x00	○	○	○	○	http Drive Catalog Address	VisibleString	RO	No	—	-

4.3.1 Parameter detail of object group following 0x6000

0x6007: Abort Connection Option Code

Index	0x6007	When an abnormality occurs in the communication system (Ex. communication timeout, Link lost etc.), This object indicates how the servo amplifier to behave.	Object Code		VARIABLE
Sub-Idx	**Description**	**Data Type**	**Access**	**PDO**	**Initial Value**
0x00	Abort Connection Option Code	Integer16	RW	No	0x0001
		Setting Range	0x0000-0x0003		
	# Profile Position (pp), Cyclic Sync Position (csp), Interpolated Position (ip) mode # Cyclic Sync Velocity (csv), Profile Velocity (pv), Homing (hm) mode 0: No Action (Current limit stop without alarm) 1: Fault Signal (It stops according to Fault Reaction Option Code) 2: Disable Voltage Command (It stops according to Disable Operation Option Code setting) ※ 3: Setting prohibited # Cyclic Sync Torque (Force) (cst), Torque Profile (tq) mode 0: No Action (Current zero stop without alarm) 1: Fault Signal (It stops according to Fault Reaction Option Code) 2: Disable Voltage Command (It stops according to Disable Operation Option Code setting) ※ 3: Setting prohibited ✓ It may not stop according as settings if communication data changes to unexpected value before detecting communication system error.				

0x603F: Error code

Index	0x603F	Displays codes of errors occurred in the servo amplifier.	Object Code		VARIABLE
Sub-Idx	**Description**	**Data Type**	**Access**	**PDO**	**Initial Value**
0x00	Error codes [ERRCODE]	Unsigned16	RO	Possible	0x0000
		Display range	0x0000-0xFFFF		
	✓ Represents the same information as lower 16-bit of Sub-index 0x01 in pre-defined error field 0x1003 in CANopen communication method.				

4 Object Dictionary

0x6040: Control Word

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

Each bit allocation of Control Word

bit15	bit14	bit13	bit12	bit11	bit10	bit9	bit8
Manufacturer Specific					Reserved	Operation mode Specific	Halt

bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0
Fault Reset	Operation mode Specific			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.

MSB / LSB

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

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.

Allocation of Control Word (manufacturer specific area)

bit15	bit14	bit13	bit12	bit11
Cseten	Reserved	Reserved	Eclr	Reserved

MSB LSB

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

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

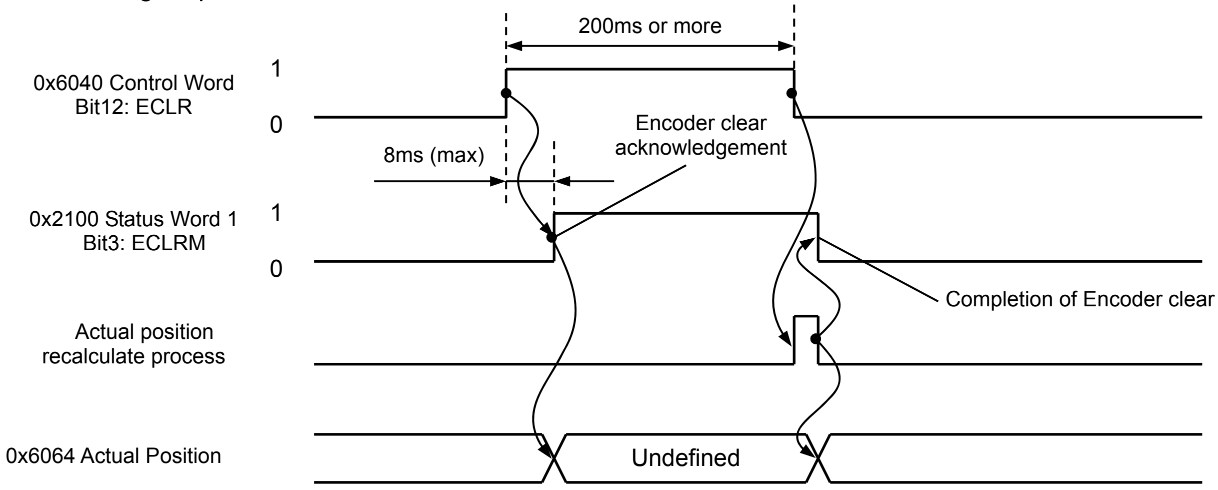
bit15: Magnetic pole position estimation enabled [CSET]
Magnetic pole position estimation command when using linear motor without hall effect sensor input.
"0": Magnetic pole position estimation disabled
"1": Magnetic pole position estimation enabled

bit12: Encoder clear enabled

This Bit 12 performs encoder clearing to absolute encoder. It brings clearing multi-turn info (Multi-turn clear) and Battery malfunction.

Note) When Position Polarity is reversed (0x607E: bit7=0), the actual position will be within minus one rotation.

Encoder clearing sequence is shown below.



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

0x6041: Status Word

Index	0x6041	Indicates status of FSA (State Machine) that PDS (Power Device System) is controlled.		Object code		VARIABLE
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Status Word [STSWORD] Status list for bit pattern (Bit 6, 5, 3, 2, 1, 0) of Control Word		Unsigned16	RO	Possible	0x0000
			Display range	0x0000-0xFFFF		

Bit allocation of Status Word

bit15	bit14	bit13	bit12	bit11	bit10	bit9	bit8
Reserved (Manufacturer Specific)		Reserved (Operation mode Specific)	Target Value Ignored	Internal Limit Active	Target reached	Remote	Reserved (Manufacturer Specific)

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

In each state, it is shown by the bit pattern of Status Word indicating current status.

MSB LSB

Manufac -turer Specific	Operation mode Specific		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

No.	FSA state	Status Word bit					
		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 Established Status) "1" means that main circuit power supply is impressed.
bit5 : Quick Stop (Quick Stop) "0" means it is under operation by Quick Stop Request
bit7 : Warning (Warning Status) It is set to "1" when warning is occurring in slave.
bit9 : Remote (Control Word Remote)
Operation through EtherCAT communication is enabled at the time of "1".
Operation through EtherCAT communication is disabled at the time of "0", caused by JOG operation via the setup software.
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; 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 etc, it is set to "1". Setting range is based on specification.
Bit13 and 12 are based on operation mode specifications, and Bit15, 14 and 8 are maker specifications.

Allocation for Status Word (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.

MSB LSB

Csetfix	Csetpro	Operation mode Specific	Operation mode Specific	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	Bit14	
0	0	: Magnetic pole position estimation disabled
0	1	: Magnetic pole position estimation in process
1	1	: Magnetic pole position estimation completed 了

0x605A: Quick Stop Option Code (EMR)

Index	0x605A	Sets action for stopping motor when quick stop (EMR) command is inputted.	Object Code		VARIABLE
Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Quick Stop Option Code [QSTOP]	Integer16	RW	No	0x0002
	✓ Treates in the amplifier internally as shown below, depending on control mode. -128 to-1, 4, 8 to 127 are reserved. Not possible to be set.	Setting Range	0x0000-0x0007 (0 - 7)		

Profile position (pp), Cyclic sync position(csp), Interpolated Position (ip) mode

Cyclic sync velocity (csv), Profile velocity (pv), Homing (hm) mode

0 : Drive function is Disabled. (To Switch On Disabled after motor stop by dynamic brake operation)
1 : To Switch On Disabled after stop at profile deceleration (0x6084)
2 : To Switch On Disabled after stop at quick stop deceleration (0x6085)
3 : To Switch On Disabled after stop by Current Limit
5-7 : Setting prohibited

Cyclic Sync Velocity (csv), Profile Velocity (pv) mode

0 : Drive function is Disabled. (To Switch On Disabled after motor stop by dynamic brake operation)
1 : To Switch On Disabled after stop at profile 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 : To Quick Stop Active state after stop at profile deceleration (0x6084)
6 : To Quick Stop Active state after stop at quick stop deceleration (0x6085)
7 : To Quick Stop Active state after stop by Current Limit

Cyclic sync torque (force) (cst), Torque (force) profile (tq) mode

0 : Drive function is disabled (After a motor stops by dynamic brake operation, Switch On Disabled)
1, 2, 3 : Setting prohibited
5, 6 : Quick Stop Active state after Stops by 0x6087(Torque (force) Slope)
7 : Quick Stop Active state after stop by Current Zero

✓ At the time of stop by the Quick Stop Deceleration (0x6085), it is limited with the minimum value from within Maximum torque (force) (0x6072), Clockwise side torque (force) limit (0x60E0) and Counterclockwise torque (force) limit (0x60E1).
✓ At the time of stop by Current Limit, it is limited with the Sequence Current Limit Value (0x201E).
✓ When external EMR signal is input through I/O, it will be "Switch On Disable" even if "Quick Stop Active" is set.

0x605B: Shutdown Option Code

Index	0x605B	Sets how it operates when shifts from Operation Enabled to the Ready to Switch On State.	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 – 1)		

Profile position (pp), Cyclic sync position(csp), Interpolated Position (ip) mode

Cyclic sync velocity (csv), Profile velocity (pv), Homing (hm) mode

0 : Disable Drive: Servo OFF (Motor stop with dynamic brake)
1 : Servo OFF after deceleration stop with profile deceleration (0x6084).

Cyclic sync torque (force) (cst), Torque (force) profile (tq) mode

0 : Disable Drive: Servo OFF (Motor stop with dynamic brake)
1 : Servo OFF after deceleration stop with torque (force) slope (0x6087)

0x605C: Disable Operation Option Code

Index	0x605C	Sets how it operates when shifts from Operation Enabled to the Switch On State.	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 – 1)		

Sets 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 (csv), Profile velocity (pv), Homing (hm) mode

<u>0 : Disable Drive (Motor stop with servo brake) (Current limit stop)</u>
<u>1 : Deceleration stop with profile deceleration (0x6084).</u>

Cyclic sync torque (force) (cst), Torque (force) profile (tq) mode

<u>0 : Disable Drive (Motor stop with servo brake) (Current zero stop)</u>
<u>1 : Deceleration stop with torque (force) slope (0x6087)</u>

✓ When main circuit power is shut down, emergency stop (dynamic brake) operation performed regardless of setting.

✓ In case that torque slope is selected at torque control (cst or tq), amplifier internal delay time to servo off will be up to 1 second.
To perform slope stop, slope value shall be decided so as to the time to torque command zero is 1 second or less.
It will be servo off if motor velocity becomes Zero speed range (0x2020) or less when slope stop is used.

✓ In case that zero is set to bit 0 to bit 3 of control word, it stops according to the setting of Disable Option Code.

0x605D: Halt option code

<table>
<tr><td>Index</td><td>0x605D</td><td colspan="2">Sets how it operates when halt bit is set to the control word.</td><td colspan="2">Object Code</td><td>VARIABLE</td></tr>
<tr><td>Sub-Idx</td><td colspan="2">Description</td><td>Data Type</td><td>Access</td><td>PDO</td><td>Initial value</td></tr>
<tr><td rowspan="3">0x00</td><td colspan="2">Halt option code</td><td>Integer16</td><td>RW</td><td>No</td><td>0x0001</td></tr>
<tr><td colspan="2">✓ Treates in the amplifier internally as shown below, depending on control mode.
-128 to-1, 4, 8 to 127 are reserved. Not possible to be set.</td><td>Setting Range</td><td colspan="3">0x0001-0x0003 (1 – 3)</td></tr>
<tr><td colspan="6"># Profile position (pp), Cyclic sync velocity (csv), Profile velocity (pv), Homing (hm) mode
1 : Operation enabled state after Stop at profile deceleration (0x6084)
2 : Operation enabled state after stop at quick stop deceleration (0x6085)
3 : To Switch On Disabled after stop by Current Limit
✓ If in the profile position (pp) mode or homing mode, set a new setpoint at a restarting after halt release, and then set "NewSetpoint".

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

Cyclic sync torque (force) (cst), Torque (force) profile (tq) mode
1, 2 : Operation enabled state after Stops by 0x6087(Torque (force) Slope)
3 : Operation enabled state after stop by Current Zero
✓ If servo OFF is desired after stopping with the halt state, servo OFF with set of halt bit of the control word is required.</td></tr>
</table>

0x605E: Fault Reaction Option Code

<table>
<tr><td>Index</td><td>0x605E</td><td colspan="2">Sets how it operates when alarm is generated with servo amplifier.</td><td colspan="2">Object Code</td><td>VARIABLE</td></tr>
<tr><td>Sub-Idx</td><td colspan="2">Description</td><td>Data Type</td><td>Access</td><td>PDO</td><td>Initial value</td></tr>
<tr><td rowspan="3">0x00</td><td colspan="2" rowspan="2">Fault Reaction Option Code</td><td>Integer16</td><td>RW</td><td>No</td><td>0x0002</td></tr>
<tr><td>Setting Range</td><td colspan="3">0x0000-0x0003 (0-3)</td></tr>
<tr><td colspan="6"># Profile Position (pp), Interpolated Position (ip), Cyclic Sync Position (csp) mode
Profile Velocity (pv), Homing (hm), Cyclic Sync Velocity (csv) mode
0 : Drive function is Disabled. (Motor stop by dynamic brake operation)
1 : Stops at profile deceleration (0x6084)
2 : Stops at quick stop deceleration (0x6085)
3 : Stops by Current Limit

✓ It stops by current limit against dynamic brake overheat alarm.

Torque Profile (tq, Cyclic Sync Torque (cst) mode
0 : Drive function is Disabled. (Motor stop by dynamic brake operation)
1, 2 : Setting prohibited
3 : Current zero stop

✓ It stops by current zero against dynamic brake overheat alarm.
✓ Due to alarm cause, it stops by dynamic brake operation regardless of setting.
Refer to M0011696 chapter 8 Maintenance, for alarm cause of dynamic brake stop.</td></tr>
</table>

If main circuit power is shutdown during operation of any option codes, it stops by emergency stop (dynamic brake) operation regardless of setting.

0x6060: Operation Mode

Index	0x6060	Indicates requested operation mode.	Object Code	VARIABLE

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Operation Mode [OPMODE]	Integer8	RW	Possible	0x00
	0 : No Mode/Mode is not assigned. 1 : (pp) Profile Position mode 2 : Reserved 3 : (pv) Profile Velocity mode 4 : (tq) 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	Setting Range	0x00-0x0A (0 – 10)		

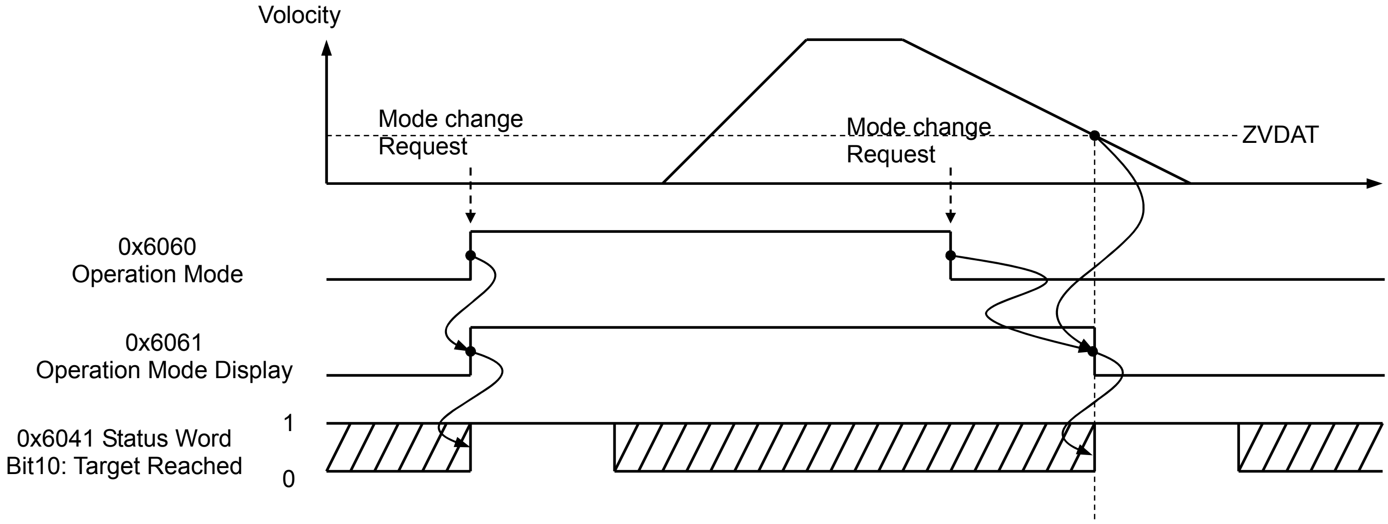
- ✔ When this parameter is read, "operation mode" already set is read out.
  Operation mode while actual operation serves as "Operation Mode Display" (0x6061).
- ✔ Mode change is not available during motor rotation. Change this parameter at the time of the main power supply OFF, Servo-off, or motor stop.
- ✔ Servo ON is not available when Operation Mode is set “0”.

0x6061: Operation Mode Display

Index	0x6061	Indicates actual operation mode. Definition is the same as 0x6060: Operation Mode.	Object Code	VARIABLE

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Operation Mode Display [OPDISP]	Integer8	RO	Possible	0x00
	0 : No Mode/Mode is not assigned. 1 : (pp) Profile Position mode 2 : Reserved 3 : (pv) Profile Velocity mode 4 : (tq) 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	Display Range	0x00-0x0A (0 – 10)		

It is not changed until motor stop even if operation mode changed during motor rotation.



0x6062: Position Demand Value

<table>
<tr><td>Index</td><td colspan="2">0x6062 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">Target position [PDemand]
Indicates the internal position command at position control mode.
This position command updates with the servo control cycle 125μs.</td><td>Integer32</td><td>RO</td><td>Possible</td><td>—</td></tr>
<tr><td>Display Range</td><td colspan="3">0x80000000-0x7FFFFFFF
(-2147483648 to 2147483647)</td></tr>
<tr><td>Unit</td><td colspan="3">UP (User Position unit)</td></tr>
</table>

0x6063: Internal Actual Position

<table>
<tr><td>Index</td><td colspan="2">0x6063 Indicates real position of motor encoder.</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 Actual Position [IACPMON]
Internal actual position data update by the servo control cycle 125μs.
Monitor unit indicates the resolution of motor encoder to be used.</td><td>Integer32</td><td>RO</td><td>Possible</td><td>—</td></tr>
<tr><td>Display Range</td><td colspan="3">0x80000000-0x7FFFFFFF
(-2147483648 to 2147483647)</td></tr>
<tr><td>Unit</td><td colspan="3">Pulse</td></tr>
<tr><td colspan="5">✔Encoder combination: In the case of Absolute encoder
Effective bit length=Multiply single turn resolution by mult-turn bit.
The bit except effective bit length becomes "x" (undefined).
✔Encoder combination: In the case of Incremental encoder
Indicates the value of 4-multiplied A/B signals via 32-bit up/down freerun counter which is to be zero count when control power turns ON.
✓ If the 0x607E position polarity (bit7) = 1, this data is inverted. Therefore, From an anterior view of the motor the value increases in the direction of Counter-Clockwise rotation (CCW).</td></tr>
</table>

0x6064: Position Actual Value

<table>
<tr><td>Index</td><td colspan="2">0x6064 Indicates after offset process or the actual position of motor encoder.</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 Actual Value [APMON]
Indicates present position
In case of synchronization by distributed clock (0x1C32-01 is DC Sync0 or DC Sync1), present position data that is latched by SYNC signal will reply.</td><td>Integer32</td><td>RO</td><td>Possible</td><td>—</td></tr>
<tr><td>Display Range</td><td colspan="3">0x80000000-0x7FFFFFFF
(-2147483648 to 2147483647)</td></tr>
<tr><td>Unit</td><td colspan="3">UP (User Position unit)</td></tr>
<tr><td colspan="5">In case of asynchronization system, latest present position will reply.

✔Encoder combination: In the case of Incremental encoder
Indicates the value of 4-multiplied A/B signals via 32-bit up/down freerun counter which is to be zero count when control power turns ON.
From an anterior view of the motor the value increases in the direction of Clockwise rotation (CW), when positive (+) polarity command.
✔ When the position polarity of 0x607E is reversed, the value increases in the CCW direction.</td></tr>
</table>

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

<table>
<tr><td>Index</td><td colspan="2">0x6065 Permissible position range is set as a position request value relatively to.</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">Position Deviation Window [OFLV]
When position actual value crosses position deviation window, becomes Excessive position deviation alarm.

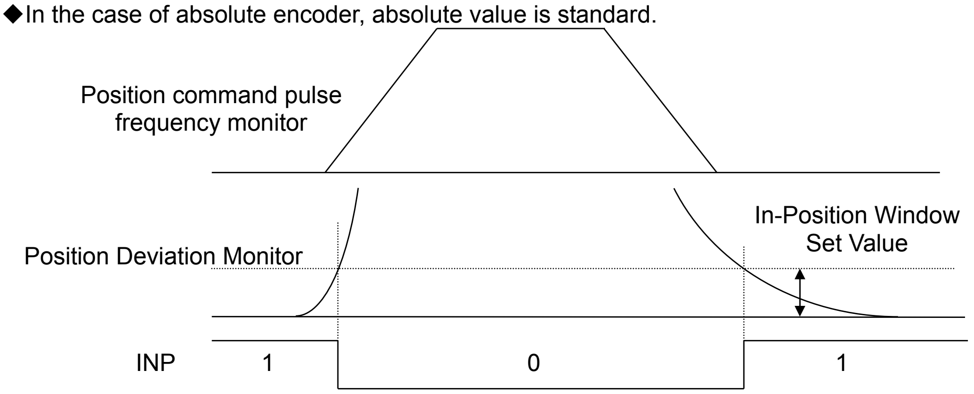
|Position Actual Value Deviation| >= Set Value</td><td>Unsigned32</td><td>RW</td><td>No</td><td>0x4C4B40
(5000000)</td></tr>
<tr><td>Setting Range</td><td colspan="3">0x00000001-0x7FFFFFFF
(1 to 2147483647)</td></tr>
<tr><td>Unit</td><td colspan="3">UP (User Position unit)</td></tr>
</table>

0x6067: Position Window (Positioning completion range)

Index	0x6067	Sets up the range permissible as target position attainment. When position actual value of position encoder is in Position Window, means arriving at target position.	Object Code	VARIABLE

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

◆In the case of incremental encoder, 4 times of the number of encoder pulses are standard.
◆In the case of absolute encoder, absolute value is standard.



0x6068: Position Window Time

Index	0x6068	Sets up time until outputs to INP monitor after arriving in Position Window.	Object Code	VARIABLE

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Position Window Time 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	0x6069	Indicates actual value of velocity sensor.	Object Code	VARIABLE

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Actual Value of Velocity Sensor Indicates actual velocity calucurated by position loop encoder. ✓ Outputs same data with 0x606C.	Integer32	RO	Possible	–
		Display Range	0x80000000-0x7FFFFFFF (-2147483648 to 2147483647)		
		Unit	UP (User Position unit) / s		

0x606A: Sensor Selection Code

Index	0x606A	Selects the source of velocity sensor actual value. It determines whether a differentiated position signal or the signal from a separate velocity sensor.	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	Integer16	RW	No	0x0000
		Setting Range	0x0000-0x0001		
	Position encoder and velocity encoder use the same encoder.				

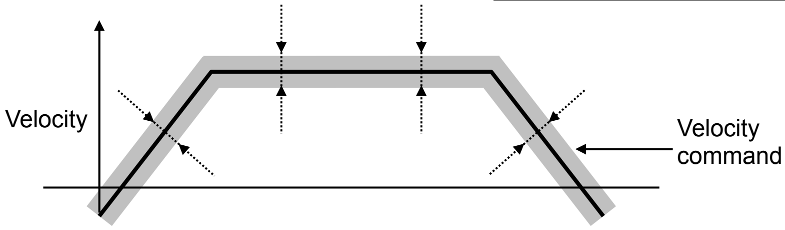
0x606C: Velocity Actual Value

Index	0x606C	It 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 to 2147483647)		
		Unit	UP (User Position unit) /s		

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

Index	0x606D	Sets the range regarded as velocity match. Use this setting when “Velocity Matching Unit Selection” is "0x00_UV".		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 0x606E, "TargetReached" in the status word is set. This is enabled in profile velocity mode.		Unsigned16	RW	No	0x32 (50)
			Setting Range	0x0000-0xFFFF (0 to 65535)		
			Unit	min^{-1}		



✓ The velocity matching output switches the setting of rotation speed UV) and ratio (%) by 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	0x606E	After velocity attainment, sets up time (timer) until the status word “TargetReached” is set.		Object Code		VARIABLE
Sub-Idx	**Description**		**Data Type**	**Access**	**PDO**	**Initial value**
0x00	Velocity Window Time This servo amplifier sets the status word Bit 10: Target matching monitor when the velocity reaches the setting range and remains within the range for a time longer than the setting.		Unsigned16	RW	No	0x0001
			Setting Range	0x0001-0x1388 (1 to 5000)		
			Unit	ms		

0x606F: Velocity Threshold (Speed Zero Setting)

Index	0x606F	Sets the range regarded as speed zero.		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. Set same value with 0x2020 because of same parameter.		Unsigned16	RW	No	0x0032 (50)
			Setting Range	0x0005-0x01F4 (5 to 500)		
			Unit	min^{-1}		

0x6070: Velocity Threshold Time

Index	0x6070	Sets up time (timer) until the status word “Speed zero detection” is canceled.		Object Code		VARIABLE
Sub-Idx	**Description**		**Data Type**	**Access**	**PDO**	**Initial value**
0x00	Velocity Threshold Time When the actual velocity is higher than the threshold velocity for a time longer than the setting, the status word bit 12: Speed zero detection is canceled. This is enabled only in profile velocity mode.		Unsigned16	RW	No	0x0001
			Setting Range	0x0001-0x1388 (1 to 5000)		
			Unit	ms		

0x6071 Target Torque (force)

Index	0x6071	Torque (force) command value set to torque (force) controls in Function Torque (force) Mode.		Object Code		VARIABLE
Sub-Idx	**Description**		**Data Type**	**Access**	**PDO**	**Initial value**
0x00	Target Torque (force) ［TATRQ］ Setting units are defined by Torque scale selection (0x2078).		Integer16	RW	Possible	0x0000
			Setting Range	0x8000-0x7FFF (-32768 to 32767)		
			Unit	UT (User Torque unit)		
	0x2078=0x00 selected: To be unit of 0.1% / LSB. 0x2078=0x01 selected: To be unit of 4096 (0x1000) / TR(100%) However, it is limited by max torque (force) for the value that exceeds the max torque (force) of the motor.					

4. Object Dictionary

0x6072: Maximum Torque (force)

Index	0x6072	Indicates maximum set value of the torque (force) permitted to the motor.		Object Code		VARIABLE
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Maximum Torque (force) ［MAXTRQ］ Setting units are 0.1% LSB in 1/1000 unit of rated torque (force). However, it is limited by max torque (force) for the value that exceeds the max torque (force) of the motor.		Unsigned16	RW	Possible	0x1388 (500.0)
			Setting Range	0x0000-0x1388 (0 to 500.0)		
			Unit	0.1 %		

0x6076: Rated torque

Index	0x6076	Indicates rated torque of selected motor.		Object Code		VARIABLE
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Rated torque Indicates rated torque of selected motor. Only the Sanyo Denki R series motor is accepted.		Unsigned32	RO	No	—
			Display Range	0x00000000-0xFFFFFFFF		
			Unit	m N･m		

0x6077: Actual Torque (force) Value

Index	0x6077	Indicates actual torque (force) value of motor.		Object Code		VARIABLE
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Actual Torque (force) Value [ACTMON] Monitor units are defined by Torque scale selection (0x2078).		Integer16	RO	Possible	—
			Display Range	0x8000-0x7FFF (-32768 to 32767)		
			Unit	UT (User Torque unit)		

0x6078: Actual Current Value

Index	0x6078	Indicates actual current value of motor.		Object Code		VARIABLE
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Actual Current Value Monitor units are defined by Torque scale selection (0x2078).		Integer16	RO	Possible	—
			Display Range	0x8000-0x7FFF (-32768 to 32767)		
			Unit	UT (User Torque unit)		

0x6079: DC link circuit voltage

Index	0x6079	Indicates main circuit DC voltage of amplifier internal circuit.		Object Code		VARIABLE
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	DC link circuit voltage ✓ Indicates main circuit DC voltage.		Unsigned32	RO	Possible	—
			Display Range	0x00000000-0xFFFFFFFF		
			Unit	mV		

0x607A: Target Position

Index	0x607A	Command position of drive moved by setup of motion control parameters, such as velocity, acceleration, deceleration, and motion profile type.		Object Code		VARIABLE
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Target Position [TAPOS] Sets up absolute position command for each communication cycle.		Integer32	RW	Possible	0
			Display Range	0x80000000-0x7FFFFFFF		
			Unit	UP (User Position unit)		

0x607B: Position range Limit (Modulo value)

Index	0x607B	At operation mode of position command inputting system, sets the position coordinates range able to be set. Both controller (position command) and driver (actual position) communicate position data within the range of position coordinates set here.	Object Code Array

Sub-Idx	Name/Description	Data Type	Access	PDO	Initial value
0x00	Number of Entry	Unsigned8	RO	No	0x2
0x01	Position range limit minimum value ［MINPLIM］	Integer32	RW	No	0x80000000
		Setting value	0x80000000-0x00000000		
0x02	Position range limit maximum value ［MAXPLIM］	Integer32	RW	No	0x7FFFFFFF
		Setting value	0x00000000-0x7FFFFFFF		

<Description of set value>

－ Unit is the same user definition as target position. UP (User Position unit)

－ When Position range limit minimum value = 0x00000000 and Position range limit maximum value =0x00000000 are set, or when Position range limit minimum value = 0x80000000 and Position range limit maximum value =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

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

<Linear coordinate (Straight axis)>

－ The limit value of coordinates is the lower limit = 0x80000000, and upper limit = 0x7FFFFFFF. 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. However, wraparound exceeding limit value with absolute value command is not available. For CSP mode, wraparound is always 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 position range limit maximum value in the direction of coordinate increase, the following coordinate value will indicate the setting value of position range limit minimum value

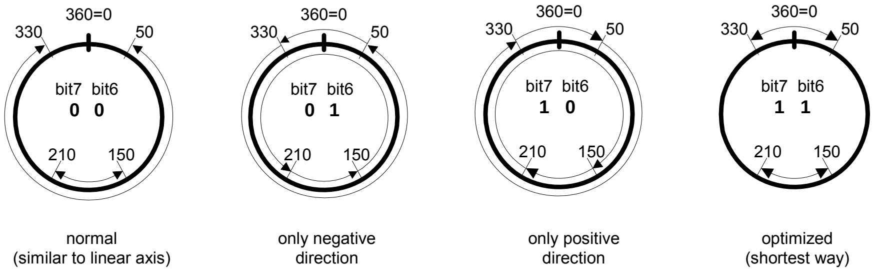
－ In the opposite situation, when the current position reaches the position range limit minimum value in the direction of coordinate decrease, the following coordinate value will indicate the setting value of position range limit maximum value.

－ 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 <u>move from current position by a value of 90°</u>, 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.

Below shows modulo coordinate image of position range limit minimum value=0, and position range limit maximum value=359.



Example of Positioning at Rotation Axis

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

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

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

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

< Regarding Modulo value at power on >

－ In case of "0" set to bit2 of 0x20F7. (Normal process)
⇒Modulo value is the remainder when encoder position (lower 32 bit) is divided by modulo coordinate.
Modulo value after cycled encoder-coordinate will be different between before and after power cycle, if the remainder is existed when encoder coordinate is divided by modulo coordinate.

－ In case of "1" set to bit2 of 0x20F7. (Special process)
⇒ Recording the modulo value to non-volatile memory at control power off. At power on again, absolute position is checked and modulo value is calculated even if motor rotates during control power off. When the motor has rotated over the pulse that calculated with 0x20FC during power off, warning (0x2103-1, bit1=1) will be detected at power on. The modulo value at that time is different from before power off. Do Homing again and reset the coordinate.

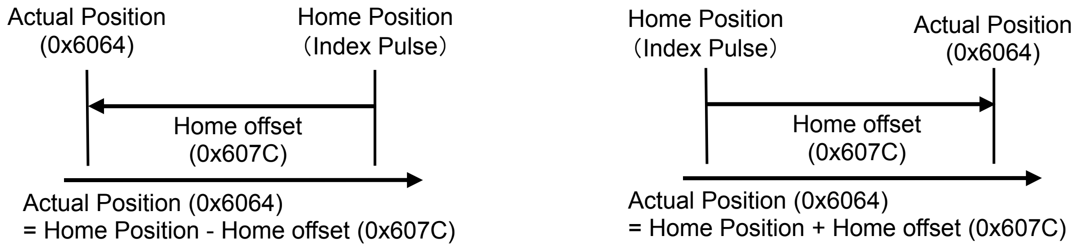
0x607C: Home offset (homing mode)

Index	0x607C	Normalizes homing position (mechanical origin) detected in homing mode by homing offset value.	Object Code	VARIABLE

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Home offset [HOFFSET] # The set homing offset (0x607C) is used to calculate actual position. ✓ Homing offset can be always written, however, is used to recalculate only in homing mode.	Integer32	RW	Possible	0x00000000 (0)
		Setting Range	0x80000000-0x7FFFFFFF (-2147483648 to 2147483647)		
		Unit	UP (User Position unit)		

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

Actual position calculation method (0x20F6-1) = 1 Actual position calculation method (0x20F6-1) = 0



✓ If "ZeroPosition=Home Offset" is required with the other of Homing Method 35 or 37, it shall be set 0x20F6-1 = 1.

0x607D: Software Position Limit

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

Sub-Idx	Name/Description	Data Type	Access	PDO	Initial value
0x00	Number of Entry	—	RO	No	0x2
0x01	Software position limit minimum value [SMINLIM] Unit is the same user definition as target position. UP (User Position unit)	Integer32	RW	No	0x00000000 (0)
		Setting Range	0x80000000-0x7FFFFFFF		
0x02	Software position limit maximum value [SMAXLIM] Unit is the same user definition as target position. UP (User Position unit)	Integer32	RW	No	0x00000000 (0)
		Setting Range	0x80000000-0x7FFFFFFF		

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

Normalized Position Limit Minimum Value = Software Position Limit Minimum Value - Home Offset

Normalized Position Limit Maximum Value = Software Position Limit Maximum Value - Home Offset

✓ Function is invalid when the Software Position Limit Minimum Value >= Software Position Limit Maximum Value.

For PP mode, it denys command and doesn't work when the value exceeding a software position limit is set to target position.

For CSP mode, it stops with command zero at the time target position updated in order is set to out of software position limit range.

Function is invalid except in position control mode.

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

Index	0x607E	Sets an input polarity of command. When Bit=1, the command value is multiplied by -1, and it serves as a reverse command.	Object Code	VARIABLE

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Polarity [CMDPOL]	Unsigned8	RW	No	0x00
		Setting Range	0x00-0xE0		

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.

bit7: Position Polarity "0" : Command is multiplied by +1 "1": Multiplied by -1 (Only csp, ip enable)

- Valid only in Cyclic Sync. Position mode (csp) and Interpolated Position mode (ip). When "1" is set, 0x607A Target position and 0x60B0 Position offset input value are multiplied by -1, and command polarity is reversed.

bit6: Velocity Polarity "0" : Command is multiplied by +1 "1" : Multiplied by -1

- In Cyclic Sync. Position mode (csp) or Interpolated Position mode (ip), when "1" is set, 0x60B0 Velocity offset input value as velocity compensation is multiplied by -1, and compensation polarity is reversed.
- In Cyclic Sync. Velocity mode (csv), when "1" is set, 0x60FF Target velocity and 0x60B1 Velocity offset input value are multiplied by -1, and command polarity is reversed.

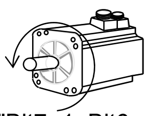
bit5: Torque (force) Polarity "0" : Command is multiplied by +1 "1" : Multiplied by -1

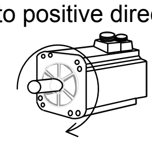
- In Cyclic Sync. Position mode (csp), Interpolated Position mode (ip) or Cyclic Sync. Velocity mode (csv), when "1" is set, 0x60B2 Torque (force) offset input value as torque (force) compensation is multiplied by -1, and compensation command polarity is reversed.
- In Cyclic Sync. Torque (force) mode (cst), when "1" is set, 0x6071 Target torque and 0x6082 Torque offset input value are multiplied by -1, and command polarity is reversed.

bit4 – 0: Reserved

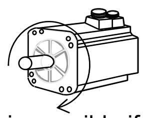
◆Rotation direction varies as below depends on selection values.

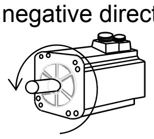
◆ Commad input polarity is set to "Bit7=0, Bit6=0, Bit5=0" as standard,
rotates to negative direction (CCW) by command polarity - / to positive direction (CW) by +.





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





✓ Changeof this parameter will be impossible if ESM is Operational.
Make sure to perform servo OFF and shift to Pre-Operational, before change.
✓ Refer Linear motor control parameter list for the descriprion of linear motor porality.
✓ If OT is used, set 0x00 or 0xE0.

0x607F: Maximum Profile Velocity

Index	0x607F	Sets permissible maximum velocity for Profile Position mode.	Object Code	VARIABLE

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Maximum Profile Velocity [VCLM]	Unsigned32	RW	Possible	0xFFFFFFFF
	Limits maximal allowed profile velocity (0x6081) during a Profile Position (pp) mode.	Setting Range	0x00000001-0xFFFFFFFF (1 to 4294967295)		
	✓ The unit is in user definition as same as 0x6081.	Unit	UP (User Position unit) /s		

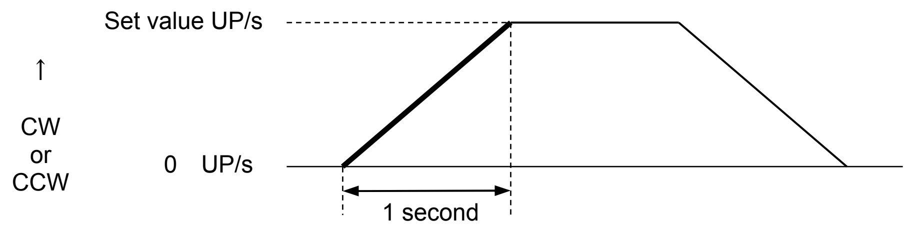
0x6081: Profile Velocity

Index	0x6081	Sets attainment velocity after profile acceleration in Profile Position mode.	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 to 4294967295)		
		Unit	UP (User Position unit) /s		

0x6083: Profile Acceleration

Index	0x6083	Parameters to decide the gradient at the time of motor acceleration during Profile Position, Function Velocity mode.	Object Code		VARIABLE
Sub-Idx	**Description**	**Data Type**	**Access**	**PDO**	**Initial value**
0x00	Profile acceleration [TVCACC] The parameters to give acceleration incline against preset velocity command, and it set the rate of velocity per second.	Unsigned32	RW	Possible	0xFFFFFFFF
		Setting range	0x00000000-0xFFFFFFFF (0 to 4294967295)		
		Unit	UP (User Position unit) /s^2		

✓ This parameter is effective only against Profile Position mode (pp), Profile Velocity mode (pv).

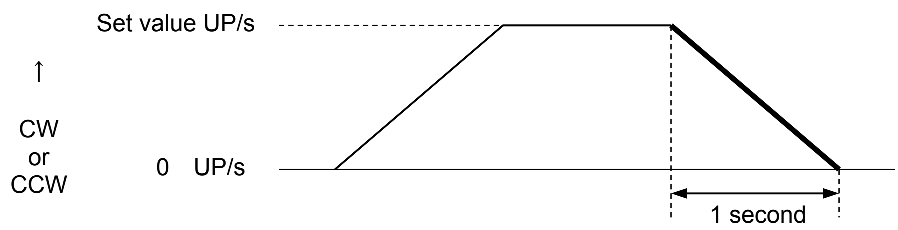


✓ If value is set to “0”, the amplifier proceeds it as "1".

0x6084: Profile Deceleration

Index	0x6084	Parameters to decide the gradient at the time of motor deceleration during Profile Position, Function Velocity mode.	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 it set the rate of velocity per second.	Unsigned32	RW	Possible	0xFFFFFFFF
		Setting range	0x00000000-0xFFFFFFFF (0 to 4294967295)		
		Unit	UP (User Position unit) /s^2		

✓ This parameter is effective only against Profile Position mode (pp), Profile Velocity mode (pv). It also used as deceleration of each option codes for stop.



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

0x6085: Quick Stop Deceleration

Index 0x6085	Slowdown parameter used for motor stop when quick stop function is active and "2" or "6" is set to quick stop code object (0x605A). Used also when Fault reaction code object (0x605E) and the Halt option code object (0x605D) are "2."	Object Code		VARIABLE	
Sub-Idx	**Description**	**Data Type**	**Access**	**PDO**	**Initial value**
0x00	Quick Stop Deceleration [QSDEC] The parameters to give deceleration incline against preset velocity command, and it set the rate of velocity per second. ✓ If value is set to “0”, the amplifier proceeds it as "1".	Unsigned32	RW	Possible	0xFFFFFFFF
		Setting range	0x00000000-0xFFFFFFFF (0-4294967295)		
		Unit	UP (User Position unit) /s^2		

0x6086: Motion Profile Type

Index	0x6086	Motion Profile Type		Object Code		VARIABLE
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Motion Profile Type Sets the type of motion profile operation.		Unsigned32	RW	Possible	0x0000
			Setting range	0x0000, 0x0003 (0 or 3)		
	0x0000: Linear ramp (trapezoid profile) 0x0003: Jerk limited ramp					

0x6087: Torque (force) slope

Index	0x6087	Gives an 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] Set unit is 0.1% per second. ✓ When Torque (force) slope is set the value more than maximum current of the motor, it will be limited to Maximum current.		Unsigned32	RW	Possible	0xFFFFFFFF
			Setting range	0x00000001-0xFFFFFFFF		
			Unit	0.1% /s		

0x6088: Torque Profile Type

Index	0x6088	This is a parameter to set the Torque (force) Profile Type in torque (force) profile mode (tq).		Object Code		VARIABLE
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Torque (force) Profile Type Set unit is fixed to "0 (Linear ramp)".		Integer16	RW	Possible	0x0000
			Setting range	0x0000-0x0000		

0x608F: Position Encoder Resolution

Index	0x608F	Sets the resolution of the output shaft encoder.		Object Code		VARIABLE
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Number of entry		Unsigned8	RO	No	0x02
0x01	Position encoder resolution Sets the number of pulses of position encoder. For the time of readout, set value is readout.		Unsigned32	RW	No	0x01
			Setting range	0x00000001-0xFFFFFFFF		
			Unit	Pulse		
0x02	Rotation speed of motor axis Sets the rotation speed of motor axis. Since this servo amplifier is not compatible with this function, values other than 1 cannot be set.		Unsigned32	RW	No	0x01
			Setting range	0x01-0x01		
			Unit	Rev.		

0x6091: Gear Ratio

Index	0x6091	Sets the gear ratio of the motor shaft and the output shaft.		Object Code		VARIABLE
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Number of entry		Unsigned8	RO	No	0x02
0x01	Motor shaft resolution Sets the rotation speed of motor axis.		Unsigned32	RW	No	0x01
			Setting range	0x00000001-0x00000040 (1 to 64)		
			Unit	-		
0x02	Drive shaft resolution Sets the rotation speed of output axis.		Unsigned32	RW	No	0x01
			Setting range	0x00000001-0x00000040 (1 to 64)		
			Unit	-		

0x6092: Feed Constant

Index	0x6092	Sets the travel distance in one rotation of the motor axis.		Object Code		VARIABLE
Sub-Idx	Description		Data Type	Access		PDO
0x00	Number of entry		Unsigned8	RO	No	0x02
0x00	Feed (Travel distance) Sets the travel distance. This servo amplifier becomes inapplicable of this function if 1 is set, because to have compatibility with existing model.		Unsigned32	RW	No	0x01
			Setting range	0x00000001-0x00989680 (1 to 10,000,000)		
			Unit	UP (User Position unit)		
0x01	Feed shaft resolution Sets the rotation speed of motor axis With this servo amplifier, the rotation speed of the motor shaft is fixed to 1.		Unsigned32	RW	No	0x01
			Setting range	0x01-0x01		
			Unit	Rev.		

0x6098: Homing method

Index	0x6098	This object shall set the homing method that shall be used.		Object Code		VARIABLE
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Homing method [HOMETYP]		Integer8	RW	Possible	0x23 (35)
	Configures homing method (Origin return method)		Setting range	0xFC-0x25 (-4 to 37)		

Value	Hex	Description
-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, positive home switch and index pulse
8	(0x08)	: Homing on positive limit switch, positive home switch and index pulse
9	(0x09)	: Homing on positive limit switch, negative home switch and index pulse
10	(0x0A)	: Homing on positive limit switch, negative home switch and index pulse
11	(0x0B)	: Homing on negative limit switch, positive home switch and index pulse
12	(0x0C)	: Homing on negative limit switch, positive home switch and index pulse
13	(0x0D)	: Homing on negative limit switch, negative home switch and index pulse
14	(0x0E)	: Homing on negative limit switch, 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
23	(0x17)	: Homing on positive limit switch and positive home switch
24	(0x18)	: Homing on positive limit switch and positive home switch
25	(0x19)	: Homing on positive limit switch and negative home switch
26	(0x1A)	: Homing on positive limit switch and negative home switch
27	(0x1B)	: Homing on negative limit switch and positive home switch
28	(0x1C)	: Homing on negative limit switch and positive home switch
29	(0x1D)	: Homing on negative limit switch and negative home switch
30	(0x1E)	: Homing on negative limit switch and 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

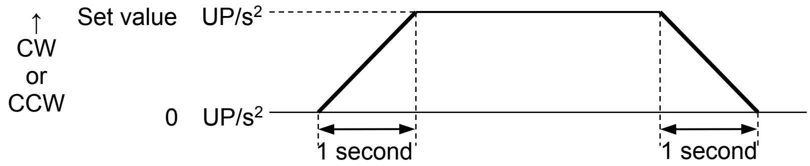
-5 to -128 (0xFB-0x80), 15 (0x0F), 16 (0x10), 31 to 32 (0x1F-0x20), 36 (0x24), 38 to 127 (0x26-0x7F)
: Reserved

0x6099: Homing velocity

Index	0x6099	Sets the velocity used during the "Homing operation".		Object Code		ARRAY
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Number of entry		Unsigned8	RO	No	0x02
0x01	Home Switch Searching Velocity [SSVCMD]		Unsigned32	RW	Possible	0x000A0000
	Sets the motor speed of searching for an end position switch on homing mode.		Setting range	0x0-0xFFFFFFFF (0 to 4294967295)		
			Unit	UP (User Position unit) /s		
0x02	Zero Phase Searching Velocity [ZSVCMD]		Unsigned32	RW	Possible	0x00008000
	Sets the motor speed for the index pulse (zero) detection.		Setting range	0x0-0xFFFFFFFF (0 to 4294967295)		
			Unit	UP (User Position unit) /s		

0x609A: Homing acceleration and deceleration

Index	0x609A	This object is the parameters that define the velocity slope of the acceleration and deceleration ramp on homing mode.	Object Code		VARIABLE
Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Homing acceleration and deceleration [HOMEACC] This parameter limits an acceleration of reaching homing velocity, and a deceleration of reaching zero velocity or direction change. Sets a velocity variation per second. ✓ This parameter is effective for only during Homing mode (hm).	Unsigned32	RW	Possible	0xFFFFFFFF
		Setting range	0x00000000-0xFFFFFFFF (0 to 4294967295)		
		Unit	UP (User Position unit) /s^2		



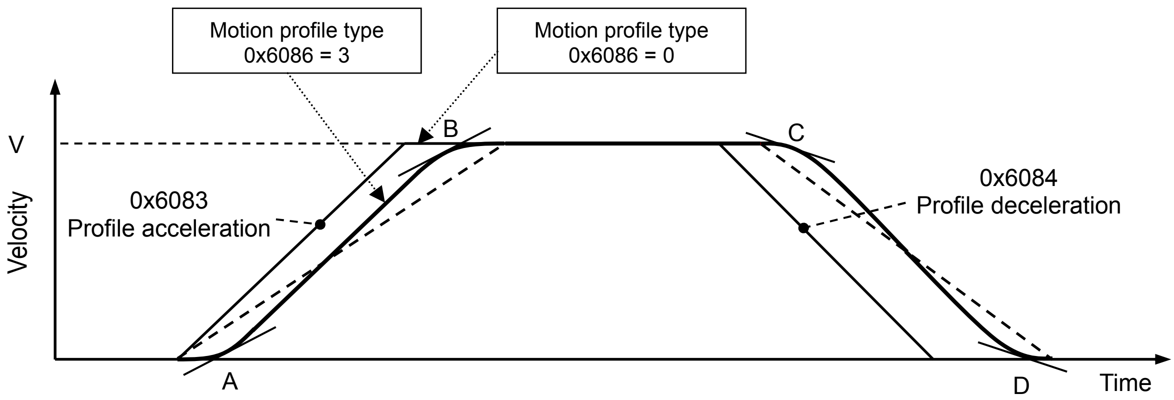
✓ If value is set “0”, the amplifier proceeds it as "1".

0x60A3: Profile Jerk Use

Index	0x60A3	Profile Jerk Use	Object Code		VARIABLE
Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Profile Jerk Use	Unsigned8	RW	No	0x01
		Setting range	0x01-0x02 (1 or 2)		

Sets the combination of 0x60A4 sub-index numbers, for jerk profile operation.

Value in 0x60A3	Jerk assigned value (Sub-index number in 0x60A4)			
	A	B	C	D
0x01	0x01	0x01	0x01	0x01
0x02	0x01	0x01	0x02	0x02



V = Profile velocity
A, B, C and D = Acceleration/deceleration at jerk ramp

0x60A4: Profile Jerk

Index	0x60A4	Profile Jerk	Object Code		Array
Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Number of entry	Unsigned8	RO	No	0x02
0x01	Profile Jerk 1 Sets the value of jerk 1. Acceleration variation per second is set.	Unsigned32	RW	No	0xFFFFFFFF
		Setting range	0x00000000-0xFFFFFFFF (0-4294967295)		
		Unit	pps^3		
0x02	Profile Jerk 2 Sets the value of jerk 2. Acceleration variation per second is set.	Unsigned32	RW	No	0xFFFFFFFF
		Setting range	0x00000000-0xFFFFFFFF (0-4294967295)		
		Unit	pps^3		

0x60A8: SI unit system for position

Index	0x60A8	Indicates unit for position system with user definition.		Object Code		VARIABLE
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Sets a unit of position.		Unsigned32	RW	No	0x00000000
			Setting range	0x00000000～0xFFFF0000		

MSB			LSB
Prefix (exponent)	SI unit, numerator	SI unit, denominator	Reserved (0x00)
31･･･24	23･･･16	15･･･8	7･･･0

31･･･24:
0xF9: (^-7)
0xFA: (^-6)
0xFB: (^-5)
0xFC: (^-4)
0xFD: (^-3)
0xFE: (^-2)
0xFF: (^-1)
0x00: (^0)

23･･･16:
0x00: (pulse)
0x01: (meter)
0xFF: (degree)

15･･･8:
0x00: fixed values

0x60B0: Position Offset

Index	0x60B0	Provides Target position with Offset.	Object Code		VARIABLE
Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Position Offset [POSOFF] Offset value is added to Target position. If this value is not zero, Target position and Actual position shift for the amount of position offset value when motor stop.	Integer32	RW	Possible	0x00000000 (0)
		Display Range	0x80000000-0x7FFFFFFF		
		Unit	UP (User Position unit)		

0x60B1: Velocity Offset (Velocity Compensation Value)

Index	0x60B1	Offset is given to Velocity command.	Object Code		VARIABLE
Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Velocity Offset (Velocity Compensation Value) [VCOMPC] In Cycle sync. Position mode (csp) and Interpolated Position mode (ip), added to internal Velocity Command and valid with Velocity compensation enable bit set. In Cycle sync. Velocity mode (csv), gives Offset to Velocity demand value.	Integer32	RW	Possible	0
		Display Range	0x80000000-0x7FFFFFFF (-2147483648 to 2147483647)		
		Unit	UP (User Position unit) /s		

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

Index	0x60B2	In cst Mode, object gives Offset to Target torque (force). In csp, ip and csv Mode, Feed forward function to Torque (force) control system as a Torque (force) compensation function.	Object Code		VARIABLE
Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Torque (force) Offset (Torque (force) Compensation) [TRQOFF] ◆ In Cycle sync. Position / Velocity mode (csp, csv), Interpolated position mode (ip) Torque (force) compensation value is added to Torque (force) command when torque (force) compensation enable [ICMPEN] Bit4=1 of the Control word 1 (0x2000). ◆In Cycle sync. Torque (force) mode (csv), gives Offset to Torque (force) demand value.	Integer16	RW	Possible	0x0000 (0)
		Setting range	0x8000-0x7FFF (-32768 to 32767)		
		Unit	UT (User Torque unit)		

0x60B8: Touch probe function

Index	0x60B8	Controls the functions of the touch probe.		Object Code		VARIABLE
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Touch probe function [TPFUNC] Indicates definition of touch probe.		Unsigned16	RW	Possible	0x0000
			Display 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: Continuing Note 1)

bit2: Touch probe 1 Trigger selection
- 0: Trigger with touch probe 1 input
- 1: Trigger with position encoder index pulse Note 2), Note 3)

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: Continuing Note 1)

bit10: Touch probe 2 Trigger selection
- 0: Trigger with touch probe 2 input
- 1: Trigger with position encoder index pulse Note 2), Note 3)

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

✓ It cannot use when scale function is used.

Note 1) When "Continuing" is selected, latched position will be cleared by reverse edge of a latching edge.

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

Note 3) When using incremental encoder, it shall be selected that bit4=1 and bit12=1.

0x60B9: Touch probe status

Index	0x60B9	Displays the status of the touch probe		Object Code		VARIABLE
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Touch probe status [TPSTS] Displays the status of the touch probe		Unsigned16	RO	Possible	0x0000
			Display 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 ･･･ 0: Trigger with touch probe 1 input mode
(Manufacturer spec: for testing) 1: Position encoder index pulse trigger mode

bit7: Touch probe 1 input monitor ･･･ 0: Photocoupler is off (CONT1: OFF)
(Manufacturer spec: for testing) 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･･･0:Trigger with touch probe 2 input mode
(Manufacturer spec: for testing) 1: Position encoder index pulse trigger mode

bit15: Touch probe 2input monitor ･･･ 0: Photocoupler is off (CONT2:OFF)
(Manufacturer spec: for testing) 1: Photocoupler is on (CONT2:ON)

bit13 to 11, 5 to 3: Reserved

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

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

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

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

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

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

Index	0x60BC	Position value of the touch probe 2 at positive edge.	Object Code		VARIABLE
Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Touch probe pos2 pos value [TP1PPOS]	Integer32	RO	Possible	—
		Display Range	0x80000000-0x7FFFFFFF (-2147483648 to 2147483647)		
		Unit	UP (User Position unit)		

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

Index	0x60BD	Position value of the touch probe 2 at negative edge.	Object Code		VARIABLE
Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Touch probe pos 2 neg value [TP1NPOS]	Integer32	RO	Possible	—
		Display Range	0x80000000-0x7FFFFFFF (-2147483648 to 2147483647)		
		Unit	UP (User Position unit)		

0x60C0: Interpolation sub mode select

Index	0x60C0	Select algorithm of interpolation		Object Code		VARIABLE
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Interpolation algorithm selection [IPSUBMD] 0: Linear interpolation (Fixation time) −1: Linear interpolation (Variable time)		Integer16	RW	No	0x0000
			Setting range	0xFFFF-0x0000 (-1 to 0)		

0x60C1: Interpolation data record

Index	0x60C1	Interpolation position command data in interpolation algorithm. It is able to buffer according to format in 0x60C4.	Object Code		RECORD
Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Number of entry	Unsigned8	RO	No	0x02
0x01	Interpolation position command value [IPPOS]	Integer32	RW	Possible	0x00000000
		Setting range	0x80000000-0x7FFFFFFF (-2147483648 to 214783647)		
		Unit	UP (User Position unit)		
0x02	Interpolation time [IPTIME]	Unsigned8	RW	Possible	0x00
		Setting range	0x00-0xFF (0 to 255)		
		Unit	ms		

0x60C2: Interpolation time period

Index	0x60C2	The interpolation time period value (sub-index 01) shall be given with unit in second. The interpolation time index (sub-index 02) shall be given with exponent.	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) seconds of S-Idx:0x02.	Unsigned8	RW	No	0x1-0xFA (1 to 250)
0x02	Interpolation time exponent Indicates the degree (exponent) of interpolation time. Example: Setting value 0xFC (-4) means 100μs.	Integer8	RW	No	0xFA-0xFD (10^{-6} to 10^{-3})

Setting Example:

Interpolation time period	Interpolation time period value (Index 0x60C2, Sub-Index 01)	Interpolation time exponent (Index 0x60C2, Sub-Index 02)
125μs	125 (0x7D)	-6 (0xFA)
250μs	250 (0xFA)	-6 (0xFA)
	25 (0x19)	-5 (0xFB)
500μs	50 (0x32)	-5 (0xFB)
	5 (0x05)	-4 (0xFC)
1ms	1 (0x01)	-3 (0xFD)
	10 (0x0A)	-4 (0xFD)
	100 (0x64)	-5 (0xFD)
2ms	2 (0x02)	-3 (0xFD)
	20 (0x14)	-4 (0xFD)
	200 (0xC8)	-5 (0xFD)
4ms	4 (0x04)	-3 (0xFD)
	40 (0x28)	-4 (0xFC)
8ms	8 (0x08)	-3 (0xFD)
	80 (0x50)	-4 (0xFC)
16ms	16 (0x10)	-3 (0xFD)
	160 (0xA0)	-4 (0xFC)

0x60C4: Interpolation data configuration

Index	0x60C4	The format of interpolation data.		Object Code		RECORD
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Number of entry		Unsigned8	RO	No	0x06
0x01	Maximum buffer size ［MAXSIZE］ Show the size of a prepared buffer for interpolation data record.		Unsigned32	RO	No	0x00000100
			Value	0x00000100		
0x02	Interpolation data actual buffer size ［BUFSIZE］ Set the buffer size for use in actual.		Unsigned32	RW	No	0x00000000
			Setting range	0x00000000-0x00000100		
0x03	Interpolation data buffer format ［BUFSTR］ 0x00: FIFO structure 0x01: Ring structure		Unsigned8	RW	No	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 record size ［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 position command value come from upper controller is stored tobuffer.		Unsigned8	WO	Possible	0x00
			Setting range	0x00-0x01		

0x60C5: Maximum acceleration

Index	0x60C5	Sets the limit value of acceleration		Object Code		VARIABLE
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Maximum acceleration Limits the acceleration set value by this parameter if the acceleration setting of 0x6083 exceeds this value. Invalid when the set value is 0. ✓ Valid for PV mode only.		Unsigned32	RW	Possible	0xFFFFFFFF
			Setting range	0x00000000-0xFFFFFFFF (0 to 4294967295)		
			Unit	UP (User Position unit) /s^2		

0x60C6: Maximum deceleration

Index	0x60C6	Sets the limit value of deceleration		Object Code		VARIABLE
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Maximum deceleration Limits the deceleration set value by this parameter if the deceleration setting of 0x6084 exceeds this value. Invalid when the set value is 0. ✓ Valid for PV mode only.		Unsigned32	RW	Possible	0xFFFFFFFF
			Setting range	0x00000000-0xFFFFFFFF (0 to 4294967295)		
			Unit	UP (User Position unit) /s^2		

0x60E0: Positive Torque (force) Limit Value

Index	0x60E0	Sets limit value of motor forward direction maximum torque (force).		Object Code		VARIABLE
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Positive Torque (force) Limit Value ［TCLM-F］ 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. ✓ Set up in consideration of Acceleration / Deceleration time. If setting value is too low, Acceleration / Deceleration torque (force) will be insufficient and normal control cannot be performed.		Unsigned16	RW	Possible	0x1388 (500.0%)
			Setting range	0x0000-0x1388 (0 to 500.0 %)		
			Unit	0.1%		

0x60E1: Negative Torque (force) Limit Value

Index	0x60E1	Sets limit value of motor reverse direction maximum torque (force).		Object Code		VARIABLE
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Negative Torque (force) Limit Value ［TCLM-R］ 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. ✓ Set up in consideration of Acceleration / Deceleration time. If setting value is too low, Acceleration / Deceleration torque (force) will be insufficient and normal control cannot be performed.		Unsigned16	RW	Possible	0x1388 (500.0%)
			Setting range	0x0000-0x1388 (0 to 500.0 %)		
			Unit	0.1%		

0x60E3: Support homing method

Index	0x60E3	Specifies the value definition of homing method supported.	Object Code		ARRAY
Sub-Idx	Description	Data Type	Access	PDO	Value
0x00	Number of entry	Unsigned8	RO	No	0x24
0x01	Support homing method 1 [HSUP01]	Unsigned16	RO	No	0x0001
	Supports Homing method 1 "Homing on negative limit switch and positive 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, 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, 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, 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, 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, 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, positive home switch and negative index pulse".				
0x0D	Support homing method 13 [HSUP0D]	Unsigned16	RO	No	0x000D
	Supports Homing method 13 "Homing on negative limit switch, 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, 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	RO	No	0x0015
	Supports Homing method 21 "Homing on home switch (negative logic), stop in positive direction".				
0x14	Support homing method 20 [HSUP14]	Unsigned16	RO	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	0x0017
	Supports Homing method 23 "Homing on positive limit switch, home switch (positive logic) and stop in positive direction".				
0x16	Support homing method 22 [HSUP16]	Unsigned16	RO	No	0x0018
	Supports Homing method 24 "Homing on positive limit switch, home switch (negative logic) and stop in negative direction".				
0x17	Support homing method 23 [HSUP17]	Unsigned16	RO	No	0x0019
	Supports Homing method 25 "Homing on positive limit switch, home switch (negative logic) and stop in positive direction".				
0x18	Support homing method 24 [HSUP18]	Unsigned16	RO	No	0x001A
	Supports Homing method 26 "Homing on positive limit switch, home switch (negative logic) and stop in negative direction".				

0x60E3: Support homing method (continued)

0x19	Support homing method 25　［HSUP19］	Unsigned16	RO	No	0x001B
	Supports Homing method 27 "Homing on negative limit switch, home switch (positive logic) and stop in positive direction".				
0x1A	Support homing method 26　［HSUP1A］	Unsigned16	RO	No	0x001C
	Supports Homing method 28 "Homing on negative limit switch, home switch (positive logic) and stop in negative direction".				
0x1B	Support homing method 27　［HSUP1B］	Unsigned16	RO	No	0x001D
	Supports Homing method 29 "Homing on negative limit switch, home switch (negative logic) and stop in positive direction".				
0x1C	Support homing method 28　［HSUP1C］	Unsigned16	RO	No	0x001E
	Supports Homing method 30 "Homing on negative limit switch, home switch (negative logic) and stop in negative direction".				
0x1D	Support homing method 29　［HSUP1D］	Unsigned16	RO	No	0x0021
	Supports Homing method 33 "Homing on negative index pulse".				
0x1E	Support homing method 30　［HSUP1E］	Unsigned16	RO	No	0x0022
	Supports Homing method 33 "Homing on positive index pulse".				
0x1F	Support homing method 31　［HSUP1F］	Unsigned16	RO	No	0x0023
	Support Honing method 35 "Homing position on actual position".				
0x20	Support homing method 32　［HSUP20］	Unsigned16	RO	No	0x0025
	Support Honing method 37 "Homing position on actual position".				
0x21	Support homing method 33　［HSUP21］	Unsigned16	RO	No	0x00FF
	Supports homing method -1 "Homing on hard stop (Butt) to the Positive direction".				
0x22	Support homing method 34　［HSUP22］	Unsigned16	RO	No	0x00FE
	Supports homing method -2 "Homing on hard stop (Butt) to the Negative direction".				
0x23	Support homing method 35　［HSUP23］	Unsigned16	RO	No	0x00FD
	Supports homing method -3 "Homing on Negative side hard stop (Butt) and index pulse".				
0x24	Support homing method 36　［HSUP24］	Unsigned16	RO	No	0x00FC
	Suppots homing method -4 "Homing on Positive side hard stop (Butt) and index pulse".				

MSB　　　　　　　　　　　　　　　　　　　　　　　　LSB

Reserved	Reserved	Reserved	Supported homing method
15・・・10	9	8	7・・・0

bit7-0：Support homing method
Index 6098 corresponding to that indicated on homing methods number

0x60F2: Positioning option code

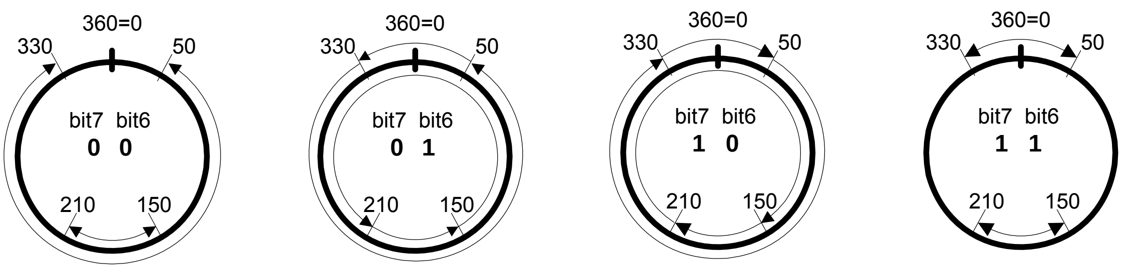
Index	0x60F2	Set the behavior of positioning.		Object Code		VARIABLE
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Positioning option code ［POSOP］ ※See table below for definition of bit 7 and 6. The other bits are undefined, and 0 shall be set.		Unsigned16	RW	Possible	0x0000
			Display 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	0x60F4	This object shall provide the actual value of the following error.		Object Code		VARIABLE
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Actual Position Deviation ［PMON］ Unit is UP (User Position unit)/LSB in the user definition.		Integer32	RO	Possible	0x00000000
			Setting range	0x80000000-0x7FFFFFFF (-2147483648 to 2147483647)		
			Unit	UP (User Position unit)		

0x60FA: Control effort

Index	0x60FA	Indication of the target value after positioning.		Object Code		VARIABLE
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Indicates velocity command value generated by position control, with position control mode. It is valid in Profile position, Cyclic position and Interpolated position mode only.		Integer32	RO	Possible	0x00000000
			Display range	0x80000000-0x7FFFFFFF (-2147483648 to 2147483647)		
			Unit	PPS		

0x60FC: Position Demand Internal Value

Index	0x60FC	Indicates the internal target position.		Object Code		VARIABLE
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Internal Target Position Displays internal target position command in profile position mode. It is a position command updating with amplifier control cycle 125μs. Indicates the value which has translated to pulse unit in amplifier from Position Demand Value (0x6062).		Integer32	RO	Possible	—
			Display Range	0x80000000-0x7FFFFFFF (-2147483648 to 2147483647)		
			Unit	Pulse		
	✓ For the other modes, values are not displayed. (always displayed as 0)					

0x60FD: Digital inputs

Index	0x60FD	This object monitors the status of general-purpose input/output and input of hardware gate off.		Object Code		VARIABLE
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Digital input monitor ［DINPUT］ Monitors input status of the general-purpose input: CONT1 to 7 and HWGOFF1/2. To be 1 when Photocoupler is ON.		Unsigned32	RO	Possible	—
			Display Range	0x00000000-0xFFFFFFFF		
	✓ Digital input has about 4ms delay for reflecting hardware input.					

MSB														LSB
Res	CONT 7	HWGOFF2	HWGOFF1	CONT 6	CONT 5	CONT 4	CONT 3	CONT 2	CONT 1	Res	EMR	Home	Positive limit	Negative limit
31･25	24	23	22	21	20	19	18	17	16	15･･4	3	2	1	0

0x60FE: Digital output

Index	0x60FE	This object sets output of holding brake timing output monitor and general-purpose output OUT1 and OUT2		Object Code		ARRAY
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Number of entry		Unsigned8	RO	No	0x0
0x01	Physical output ［DOUTPUT］ Bit 0: Monitoring Holding brake output timing		Unsigned32	RW	Possible	—
			Display Range	0x00000000-0xFFFFFFFF		
	Bit17-16: Enables control output OUT1 and OUT2 when it is set 0x84 through 0x87 for “Controls by EtherCAT communication”. ✓ For hardware output, digital output has about 4ms delay.					
0x02	Bit mask Bit0: Disabled		Unsigned32	RW	Possible	0xFFFFFFFF
			Display Range	0x00000000-0xFFFFFFFF		
	Bit17-16: Masks the bits corresponding to physical output. When the setting of General Purpose Output setting is set by any of “Controls by EtherCAT communication (0x20F9)”, 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.					

Sub-index 0x01 bit layout:

MSB				LSB
Reserved	FOUT2	FOUT1	Reserved	Set brake
31･･･18	17	16	15･･･3	0

0x60FF: Target Velocity

Index	0x60FF	Indicates to set Target velocity, and used for inputting trajectory generator.		Object Code		VARIABLE
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Target Velocity (Velocity command) ［TAVEL］ Velocity command input for Cyclic Sync. Velocity (csv), Profile Velocity (pv).		Integer32	RW	Possible	—
			Display Range	0x80000000-0x7FFFFFFF (-2147483648 to 2147483647)		
			Unit	UP (User Position unit) /s		

0x6402: Motor Type

Index	0x6402	Selects running motor type.	Object Code		VARIABLE
Sub-Idx	Name/Description		Data Type	Access	PDO	Value
0x00	Motor Type This product does not support any motor other than AC motor.		Unsigned16	RW	Possible	0x000C

0x6403: Motor Catalog Number

Index	0x6403	Indicates setting motor model number.		Object Code		VARIABLE
Sub-Idx	Name/Description		Data Type	Access	PDO	Value
0x00	Motor Model Number Setting Motor Model Number (ASCII code)		Visible String	RO	No	Character String (-)
R2 A A 0 4 00 3 F ※Only the Sanyo Denki R series motors are supported. Non supported motors are indicated as "Not Supported".						

0x6404: Motor Manufacturer

Index	0x6403	Indicates manufacturer of setting motor.		Object Code		VARIABLE
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	0x6405	Indicates catalog address of selected motor.		Object Code		VARIABLE
Sub-Idx	Name/Description		Data Type	Access	PDO	Value
0x00	Home Page Address Home Page Address of setting motor (ASCII code)		Visible String	RO	No	Character String (-)
※It is indicated as SANYO DENKI Co., LTD. because Sanyo Denki motors are recommended.						

0x6502: Supported Drive mode

Index	0x6502	This object shall provide information on the supported drive modes by the servo amplifier.		Object Code		VARIABLE
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Support drive mode ［SUPMODE］ 0: Not supported 1: Supported		Unsigned32	RO	No	0x03ED
			Display Range	0x03ED-0x03ED		

MSB LSB

Res	cst	csv	csp	ip	hm	–	tq	pv	vl	pp
31･･･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	Cyclic Sync Position mode
bit8: csv	Cyclic Sync Velocity mode
bit9: cst	Cyclic Sync Torque mode

0x6503: Drive Catalog No.

Index	0x6503	Indicates Catalog No. of this product.		Object Code		VARIABLE
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.						

0x6505: http Drive Catalog Address

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

4.4 Manufacturer Specific Area

4.4.1 Object Group (0x2000-)

The followings are shown in Table; Manufacturer specific area of CoE (CANopen over EtherCAT) object list, Operation mode Supported / Un-supported, Data length, Access (Dir) and PDO Mapping and parameter effective timing (updating).
#=immediately, $=ESM transition required, and &=valid after control powercycle.

Manufacturer Specific Area (No.1)

Index	S-Idx	FP	FV	FT	FH	Name	Data length	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	○	○	○	○	Tuning Mode	Unsigned8	RW	No	#	Yes
↑	0x02	○	○	○	○	Auto-Tuning Characteristic	Unsigned8	RW	No	#	Yes
↑	0x03	○	○	○	○	Auto-Tuning Responsiveness	Unsigned8	RW	No	#	Yes
↑	0x04	○	○	○	○	Running tune	Unsigned8	RW	No	#	-
↑	0x05	○	○	○	○	Monitoring on tune	Unsigned8	RO	No	-	-
↑	0x06	○	○	○	○	Auto tuning result saving parameter selection	Unsigned8	RW	No	#	-
↑	0x07	○	○	○	○	Auto-Notch Filter Tuning Torque Command	Unsigned16	RW	No	#	Yes
↑	0x08	○	×	×	×	Auto-FF Vibration Suppression Frequency Tuning Torque Command	Unsigned16	RW	No	#	Yes
↑	0x09	○	×	×	×	Auto-FF Vibration Suppression Frequency Tuning Friction Compensation Value	Unsigned16	RW	No	#	Yes
↑	0x0A	○	○	○	○	Auto-Tuning characteristic compatible mode	Unsigned8	RW	No	#	Yes
0x2003	0x00	○	×	×	×	Position Command Smoothing Time 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 Loop Integral Time Constant	Unsigned8	RO	No	-	-
↑	0x01	○	×	×	×	Position Loop Integral Time Constant 1	Unsigned16	RW	Possible	#	Yes
↑	0x02-0x04	○	×	×	×	Position Loop Integral Time Constant 2 - 4	Unsigned16	RW	No	#	Yes
0x2007	0x00	○	×	×	×	Higher Tracking Control Position Compensation Gain	Unsigned16	RW	No	#	Yes
0x2008	0x00	—	—	—	—	Velocity Feedforward Compensation Parameter	Unsigned8	RO	No	-	-
↑	0x01	○	×	×	×	Velocity Feedforward Gain	Unsigned16	RW	Possible	#	Yes
↑	0x02	○	×	×	×	Velocity Feedforward Filter	Unsigned16	RW	No	#	Yes
0x2009	0x00	○	○	×	○	Velocity Command Filter Settings	Unsigned16	RW	Possible	#	Yes
0x200A	0x00	○	○	×	○	Velocity Detection 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

○: Supported, ×: Not supported FP: Function Group "Position", FV: Function Group "Velocity", FT: Function Group "Torque (force)", FH: Function Group "Homing"

Manufacturer Specific Area (No.2)

Index	S-Idx	FP	FV	FT	FH	Name	Data length	Dir	PDO Mapping	Update	NVRAM
0x2010	0x00	—	—	—	—	FF Vibration Suppression Frequency Selection	Unsigned8	RO	No	—	—
↑	0x01	○	×	×	×	FF Vibration Suppression Frequency Selection input A1	Unsigned8	RW	No	#	Yes
↑	0x02	○	×	×	×	FF Vibration Suppression Frequency Selection input A2	Unsigned8	RW	No	#	Yes
↑	0x03	○	×	×	×	FF Vibration Suppression Frequency Selection input B1	Unsigned8	RW	No	#	Yes
↑	0x04	○	×	×	×	FF Vibration Suppression Frequency Selection input B2	Unsigned8	RW	No	#	Yes
0x2011	0x00	—	—	—	—	Torque 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 Suppression Frequency A	Unsigned8	RO	No	-	-
↑	0x01	○	×	×	×	FF Vibration Suppression Frequency A1	Unsigned16	RW	Possible	#	Yes
↑	0x02-0x04	○	×	×	×	FF Vibration Suppression Frequency A2 - A4	Unsigned16	RW	No	#	Yes
↑	0x05	○	×	×	×	FF Vibration Suppression Characteristic Selection B	Unsigned8	RW	No	#	Yes
↑	0x06	○	×	×	×	FF Vibration Suppression Frequency B1	Unsigned16	RW	No	#	Yes
↑	0x07	○	×	×	×	FF Vibration Suppression Frequency B2	Unsigned16	RW	No	#	Yes
↑	0x08	○	×	×	×	FF Vibration Suppression Frequency B3	Unsigned16	RW	No	#	Yes
↑	0x09	○	×	×	×	FF Vibration Suppression Frequency B4	Unsigned16	RW	No	#	Yes
0x2013	0x00	○	×	×	×	Velocity Command Notch Filter	Unsigned16	RW	No	#	Yes
0x2014	0x00	—	—	—	—	Torque (force) Command Notch Filter	Unsigned8	RO	No	-	-
↑	0x01-0x05	○	○	×	○	Torque Notch Filter A - E	Unsigned16	RW	No	#	Yes
0x2015	0x00	—	—	—	—	High settling control settings	Unsigned8	RO	No	-	-
↑	0x01	○	×	×	×	Acceleration Compensation	Integer16	RW	No	#	Yes
↑	0x02	○	×	×	×	Deceleration Compensation	Integer16	RW	No	#	Yes
↑	0x03	○	×	×	×	Command Velocity Low-pass Filter	Unsigned16	RW	No	#	Yes
↑	0x04	○	×	×	×	Command Velocity Threshold	Unsigned16	RW	No	#	Yes
0x2016	0x00	—	—	—	—	Disturbance Observer Function Parameter	Unsigned8	RO	No	-	-
↑	0x01	○	○	×	○	Observer Characteristic	Unsigned8	RW	No	#	Yes
↑	0x02	○	○	×	○	Observer Compensation Gain	Unsigned16	RW	No	#	Yes
↑	0x03	○	○	×	○	Observer Low-pass Filter	Unsigned16	RW	No	#	Yes
↑	0x04	○	○	×	○	Observer Notch Filter	Unsigned16	RW	No	#	Yes
↑	0x05	○	○	×	○	Observer Load Inertia Moment Ratio	Unsigned16	RW	No	#	Yes
↑	0x06	○	○	×	○	Observer Proportional Gain	Unsigned16	RW	No	#	Yes
↑	0x07	○	○	×	○	Observer Load Torque (force) Filter	Unsigned16	RW	No	#	Yes
0x2017	0x00	—	—	—	—	Model Control Gain	Unsigned8	RO	No	-	-
↑	0x01	○	×	×	×	Model Control Gain 1	Unsigned16	RW	Possible	#	Yes
↑	0x02-0x04	○	×	×	×	Model Control Gain 2 - 4	Unsigned16	RW	No	#	Yes
0x2018	0x00	○	×	×	×	Overshoot Suppressor Filter	Unsigned16	RW	No	#	Yes
0x2019	0x00	—	—	—	—	Model Control Antiresonance Frequency	Unsigned8	RO	No	-	-
↑	0x01	○	×	×	×	Model Control Antiresonance Frequency 1	Unsigned16	RW	Possible	#	Yes
↑	0x02-0x04	○	×	×	×	Model Control Antiresonance Frequency 2 - 4	Unsigned16	RW	No	#	Yes
0x201A	0x00	—	—	—	—	Model Control Resonance Frequency	Unsigned8	RO	No	-	-
↑	0x01	○	×	×	×	Model Control Resonance Frequency 1	Unsigned16	RW	Possible	#	Yes
↑	0x02-0x04	○	×	×	×	Model Control Resonance Frequency 2 - 4	Unsigned16	RW	No	#	Yes
0x201B	0x00	○	○	×	○	Gain Switching Filter	Unsigned16	RW	No	#	Yes
0x201C	0x00	○	○	×	○	Internal Velocity Command limit	Unsigned16	RW	No	#	Yes
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

○: Supported, ×: Not supported FP: Function Group "Position", FV: Function Group "Velocity", FT: Function Group "Torque (force)", FH: Function Group "Homing"

Manufacturer Specific Area (No.3)

Index	S-Idx	FP	FV	FT	FH	Name	Data length	Dir	PDO Mapping	Update	NVRAM
0x2023	0x00	—	—	—	—	Analog Monitor Output Selection	Unsigned8	RO	No	-	-
↑	0x01, 0x02	○	○	○	○	Analog Monitor Output Selection 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 Range	Unsigned16	RW	No	#	Yes
0x202B	0x00	○	○	○	○	Torque (force) Command Filter Order	Unsigned8	RW	No	#	Yes
0x202C	0x00	○	×	×	×	FF Vibration SuppressionControl level Selection A	Unsigned8	RW	No	#	Yes
0x202D	0x00	—	—	—	—	Torque (force) Command Notch Filter Characteristics	Unsigned8	RO	No	—	—
↑	0x01	○	○	○	○	Torque (force) Command Notch Filter Characteristics Low Range Phase Delay Improvement	Unsigned8	RW	No	#	Yes
↑	0x02-0x05	○	○	○	○	Torque (force) Command Notch Filter Characteristics 2-5	Unsigned8	RW	No	#	Yes
0x202E	0x00	○	○	○	○	Torque Attainement Setting	Unsigned16	RW	No	#	Yes
0x202F	0x00	○	○	○	○	Brake Activation Speed	Unsigned16	RW	Possible	#	Yes
0x2035	0x00	—	—	—	—	Position Sync compensation Function Parameter	Unsigned8	RO	No	-	-
↑	0x01	○	—	—	—	Axes Sync compensation Proportional Gain	Unsigned16	RW	No	#	Yes
↑	0x02	○	—	—	—	Axes Sync Compensation Integral Time Constant	Unsigned16	RW	No	#	Yes
↑	0x03	○	—	—	—	Axes Sync Compensation Filter	Unsigned16	RW	No	#	Yes
↑	0x04	○	—	—	—	Axes Sync Excessive Error Value	Unsigned32	RW	No	#	Yes
↑	0x05	○	—	—	—	Axes Sync Error Warning Level	Unsigned32	RW	No	#	Yes
↑	0x06	○	—	—	—	Axes Sync Compensation Input Polarity Selection	Unsigned8	RW	No	&	Yes
↑	0x0A	○	—	—	—	Amplifier communication function selection	Unsigned8	RW	No	&	Yes
↑	0x0B	○	—	—	—	Axes Sync Compensation Proportional Control Switching Function	Unsigned8	RW	No	#	Yes
↑	0x0C	○	○	○	×	Assisting Function Selection	Unsigned8	RW	No	&	Yes
↑	0x0D	○	○	○	×	Assisting Rate	Unsigned16	RW	No	#	Yes
0x203C	0x00	○	×	×	×	Software Limit Deceleration	Unsigned32	RW	No	#	Yes
0x2050	0x00	—	—	—	—	Quadrant Glitch Compensation Function	Unsigned8	RO	No	-	-
↑	0x01	○	○	○	○	Quadrant Glitch Compensation Function	Unsigned8	RW	Possible	#	Yes
↑	0x02	○	○	○	○	Quadrant Glitch Compensation Effective Velocity	Unsigned16	RW	Possible	#	Yes
↑	0x03	○	○	○	○	Quadrant Glitch Compensation Kept time	Unsigned16	RW	Possible	#	Yes
↑	0x04	○	○	○	○	Quadrant Glitch Compensation Velocity Loop Integral Time Constant	Unsigned16	RW	Possible	#	Yes
0x2051	0x00	—	—	—	—	Minor Vibration Suppression function	Unsigned8	RO	No	-	-
↑	0x01	○	○	×	○	Minor Vibration Suppression function	Unsigned8	RW	Possible	#	Yes
↑	0x02	○	○	×	○	Minor Vibration Suppression Pulse Compensation Value	Unsigned16	RW	No	#	Yes
↑	0x03	○	○	×	○	Minor Vibration Suppression Pulse Compensation Count	Unsigned16	RW	No	#	Yes
0x2052	0x00	—	—	—	—	Position deviation difference	Unsigned8	RO	No	-	-
↑	0x01	○	×	×	×	Position deviation difference excess warning level	Unsigned32	RW	No	#	Yes
↑	0x02	○	×	×	×	Position deviation difference excess alarm level	Unsigned32	RW	No	#	Yes
↑	0x03	○	×	×	×	Position deviation difference excess detection low-pass filter	Unsigned16	RW	No	#	Yes
↑	0x04	○	×	×	×	Position deviation difference detection continuing time	Unsigned16	RW	No	#	Yes
0x2053	0x00	○	○	○	○	System Analysis Parameter	Unsigned8	RO	No	-	-
↑	0x01	○	○	○	○	Torque Command Value	Unsigned16	RW	No	#	-
↑	0x02	○	○	○	○	Frequency Range Selection	Unsigned8	RW	No	#	-
0x2054	0x00	○	○	○	○	System Analysis Data Measurement	Unsigned8	RO	No	-	-
↑	0x01	○	○	○	○	System Analysis Running Command	Unsigned16	WO	No	-	-
↑	0x02	○	○	○	○	System Analysis Running Status	Unsigned8	RO	No	-	-
↑	0x03	○	○	○	○	System Analysis Running Result	Unsigned8	RO	No	-	-
0x2055	0x00	○	○	○	○	POFF Detection Delay Time	Unsigned16	RW	No	#	Yes
0x2060	0x00	-	-	-	-	Adaptive Notch Filter E	Unsigned8	RO	No	-	-
↑	0x01	○	○	○	○	Adaptive Notch Filter Function E	Unsigned8	RW	No	#	Yes
↑	0x02	○	○	○	○	Adaptive Notch Filter Frequency Upper Limit E	Unsigned16	RW	No	#	Yes
↑	0x03	○	○	○	○	Adaptive Notch Filter Frequency Lower Limit E	Unsigned16	RW	No	#	Yes
↑	0x04	○	○	○	○	Adaptive Notch Filter E Auto Saving	Unsigned8	RW	No	#	Yes
0x2061	0x00	-	-	-	-	Position Loop Phase Lead Compensation	Unsigned8	RO	No	-	-
↑	0x01	○	×	×	×	Position Loop Phase Lead Compensation Gain	Unsigned16	RW	No	#	Yes
↑	0x02	○	×	×	×	Position Loop Phase Lead Compensation Frequency	Unsigned16	RW	No	#	Yes
0x2062	0x00	-	-	-	-	Velocity Loop Phase Lead Compensation	Unsigned8	RO	No	-	-
↑	0x01	○	○	×	×	Velocity Loop Phase Lead Compensation Gain	Unsigned16	RW	No	#	Yes
↑	0x02	○	○	×	×	Velocity Loop Phase Lead Compensation Frequency	Unsigned16	RW	No	#	Yes
0x2063	0x00	-	-	-	-	High Order Integral Control	Unsigned8	RO	No	-	-
↑	0x01	○	○	×	○	High Order Integral Control Gain	Unsigned16	RW	No	#	Yes
↑	0x02	○	○	×	○	High Order Integral Control Frequency	Unsigned16	RW	No	#	Yes

○: Supported, ×: Not supported   FP: Function Group "Position",   FV: Function Group "Velocity",
FT: Function Group "Torque (force)",   FH: Function Group "Homing"

Manufacturer Specific Area (No.4)

Index	S-Idx	FP	FV	FT	FH	Name	Data length	Dir	PDO Mapping	Update	NVRAM
0x2064	0x00	-	-	-	-	Torque Feedforward	Unsigned8	RO	No	-	-
↑	0x01	○	○	○	○	Torque Feedforward Gain	Unsigned16	RW	No	#	Yes
↑	0x02	○	○	○	○	Torque Feedforward Averaging	Unsigned8	RW	No	#	Yes
↑	0x03	○	○	○	○	Torque Feedforward Output Selection	Unsigned8	RW	No	#	Yes
0x2066	0x00	-	-	-	-	Dual Position Feedback	Unsigned8	RO	No	-	-
↑	0x01	○	×	×	×	Dual Position Feedback Gain	Unsigned16	RW	No	#	Yes
↑	0x02	○	×	×	×	Dual Position Feedback Filter	Unsigned16	RW	No	#	Yes
0x2067	0x00	-	-	-	-	CP Vibration Suppression Control	Unsigned8	RO	No	-	-
↑	0x01	○	×	×	×	CP Vibration Suppression Control Frequency	Unsigned16	RW	No	#	Yes
↑	0x02	○	×	×	×	CP Vibration Suppression Control Level	Unsigned8	RW	No	#	Yes
↑	0x03	○	×	×	×	CP Vibration Suppression Control Characteristics Selection	Unsigned8	RW	No	#	Yes
0x2068	0x00	-	-	-	-	Model Control	Unsigned8	RO	No	-	-
↑	0x01	○	×	×	×	Model Control Damping Coefficient	Unsigned16	RW	No	#	Yes
↑	0x02	○	×	×	×	Model Control Feedforward Gain	Unsigned16	RW	No	#	Yes
↑	0x03	○	×	×	×	Model Control Feedforward Integral Time Constant	Unsigned16	RW	No	#	Yes
↑	0x04	○	×	×	×	Model Control Feedforward Filter	Unsigned16	RW	No	#	Yes
0x2069	0x00	○	×	×	×	Time to Judge Position Command Distribution Completion	Unsigned16	RW	No	#	Yes
0x206A	0x00	-	-	-	-	Model Control Selection	Unsigned8	RO	No	-	-
↑	0x01	○	×	×	×	Model Following (Vibration Suppression) Control/Standard Position Control Switching Function	Unsigned8	RW	No	#	Yes
↑	0x02	○	×	×	×	Model Vibration Suppression Frequency Selection Input 1	Unsigned8	RW	No	#	Yes
↑	0x03	○	×	×	×	Model Vibration Suppression Frequency Selection Input 2	Unsigned8	RW	No	#	Yes
0x206B	0x00	-	-	-	-	External Command Effectivity Selection at Holding Brake Operation	Unsigned8	RO	No	-	-
↑	0x01	○	○	×	○	External Command Effectivity Selection at Holding Brake Operation Cancellation Delay Time	Unsigned8	RW	No	#	Yes
↑	0x02	○	○	×	○	External Command Effectivity Selection at Holding Brake Operation Delay Time	Unsigned8	RW	No	#	Yes
0x206C	0x00	-	-	-	-	Dual Position Error	Unsigned8	RO	No	-	-
↑	0x01	○	×	×	×	Dual Position Error Warning Level	Unsigned32	RW	No	#	Yes
↑	0x02	○	×	×	×	Dual Position Error Excess Value	Unsigned32	RW	No	#	Yes
0x206D	0x00	○	○	×	○	Stop Operation with Control Voltage Reduction Alarm	Unsigned8	RW	No	#	Yes
0x2070	0x00	-	-	-	-	Drive Recorder Parameter	Unsigned8	RO	No	-	-
↑	0x01	○	○	○	○	Sampling Interval	Unsigned16	RW	No	#	Yes
↑	0x02	○	○	○	○	Sampling Points	Unsigned8	RW	No	#	Yes
↑	0x03	○	○	○	○	Trigger Edge Selection	Unsigned8	RW	No	#	Yes
↑	0x04	○	○	○	○	Trigger Channel Selection	Unsigned8	RW	No	#	Yes
↑	0x05	○	○	○	○	Trigger Horizontal Position	Unsigned8	RW	No	#	Yes
↑	0x06	○	○	○	○	Trigger Level (Lo)	Unsigned32	RW	No	#	Yes
↑	0x07	○	○	○	○	Trigger Level (Hi)	Unsigned32	RW	No	#	Yes
↑	0x08	○	○	○	○	Analog Channel Selection 1	Unsigned8	RW	No	#	Yes
↑	0x09	○	○	○	○	Analog Channel Selection 2	Unsigned8	RW	No	#	Yes
↑	0x0A	○	○	○	○	Analog Channel Selection 3	Unsigned8	RW	No	#	Yes
↑	0x0B	○	○	○	○	Analog Channel Selection 4	Unsigned8	RW	No	#	Yes
↑	0x0C	○	○	○	○	Analog Channel Selection 5	Unsigned8	RW	No	#	Yes
↑	0x0D	○	○	○	○	Analog Channel Selection 6	Unsigned8	RW	No	#	Yes
↑	0x0E	○	○	○	○	Digital Channel Selection 1	Unsigned8	RW	No	#	Yes
↑	0x0F	○	○	○	○	Digital Channel Selection 2	Unsigned8	RW	No	#	Yes
↑	0x10	○	○	○	○	Digital Channel Selection 3	Unsigned8	RW	No	#	Yes
↑	0x11	○	○	○	○	Digital Channel Selection 4	Unsigned8	RW	No	#	Yes
0x2071	0x00	○	○	○	○	Initialization timeout waiting time	Unsigned8	RW	No	&	Yes
0x2072	0x00	○	○	○	○	The amounts of torque limit value restoration when power restored	Unsigned16	RW	No	#	Yes

Manufacturer Specific Area (No.5)

Index	S-Idx	FP	FV	FT	FH	Name	Data length	Dir	PDO Mapping	Update	NVRAM
0x2073	0x00	-	-	-	-	Drive Recorder Data Clear	Unsigned8	RO	No	-	-
↑	0x01	○	○	○	○	Drive Recorder Clearing Command	Unsigned16	WO	No	-	-
↑	0x02	○	○	○	○	Drive Recorder Clearing Status	Unsigned8	RO	No	-	-
↑	0x03	○	○	○	○	Drive Recorder Clearing Result	Unsigned8	RO	No	-	-
0x2074	0x00	○	×	×	×	External Absolute Encoder Polarity Selection	Unsigned8	RW	No	&	Yes
0x2075	0x00	○	×	×	×	External Encoder Output Pulse Divide Ratio Selection	Unsigned8	RW	No	&	Yes
0x2076	0x00	○	○	○	○	Support Function Torque Limit	Unsigned16	RW	No	#	Yes
0x2077	0x00	○	○	○	○	External Regenerative Resistor Value	Unsigned32	RW	No	&	Yes
0x2078	0x00	—	—	—	○	Torque Scale Selection	Unsigned16	RW	No	#	Yes
0x2079	0x00	—	—	—	—	Extended function selection setting	Unsigned8	RO	No	-	-
↑	0x01	—	—	—	—	Deceleration stop special function selection 1 in torque control mode	Unsigned8	RO	No	-	-
↑	0x02	×	×	○	×	Deceleration stop special function selection 2 in torque control mode	Unsigned8	RW	No	#	Yes
	0x03	○	×	×	×	Deceleration stop special function selection 1 in position control mode	Unsigned8	RW	No	#	Yes
	0x04	○	○	○	○	RS3 special function selection 1	Unsigned32	RW	No	#	Yes
0x207B	0x00	○	○	○	○	FoE Uploading File Selection	Unsigned8	RW	No	#	-
0x20B0	0x00	-	-	-	-	Gain Switching Condition	Unsigned8	RO	No	-	-
↑	0x01	○	○	○	○	Gain Switching Condition 1	Unsigned8	RW	No	#	Yes
↑	0x02	○	○	○	○	Gain Switching Condition 2	Unsigned8	RW	No	#	Yes
0x20F0	0x00	—	—	—	—	Amplifier Function Selection	Unsigned8	RO	No	-	-
↑	0x01	○	○	○	○	Overtravel Operation	Unsigned8	RW	No	#	Yes
↑	0x02	○	—	—	—	Postioning Method	Unsigned8	RW	No	&	Yes
↑	0x03	○	—	—	—	In-Position Signal/Position Deviation Monitor	Unsigned8	RW	No	#	Yes
↑	0x04	○	○	○	○	Speed Matching Width Unit Selection	Unsigned8	RW	No	&	Yes
↑	0x05	○	—	—	—	Deviation Clear Selection	Unsigned8	RW	No	#	Yes
↑	0x06	○	○	○	○	Torque (Force) Attainment Function Selection	Unsigned8	RW	No	#	Yes
0x20F1	0x00	—	—	—	—	Encoder Function Selection	Unsigned8	RO	No	-	-
↑	0x01	○	○	○	○	Encoder Clear Function Selection	Unsigned8	RW	No	#	Yes
↑	0x02	○	○	○	○	Motor Incremental Encoder Digital Filter	Unsigned8	RW	No	#	Yes
↑	0x03	○	×	×	×	External Incremental Encoder Digital Filter	Unsigned8	RW	No	#	Yes
↑	0x04	○	×	×	×	External Encoder Polarity Selection	Unsigned8	RW	No	&	Yes
↑	0x05	○	○	○	○	Linear Encoder CS Offset	Unsigned16	RW	No	&	Yes
↑	0x06	○	○	○	○	Linear Encoder Z-phase CS Normalization Offset	Unsigned16	RW	No	&	Yes
↑	0x07	○	○	○	○	Linear Encoder Polarity Selection	Unsigned8	RW	No	&	Yes
↑	0x08	○	○	○	○	Excitation Command Frequency Setting	Unsigned16	RW	No	&	Yes
↑	0x09	○	○	○	○	Magnetic Pole Position Estimation Mode Selection	Unsigned8	RW	No	&	Yes
↑	0x0A	○	○	○	○	Encoder Clear 2	Unsigned8	RW	No	#	-

○: Supported, ×: Not supported FP: Function Group "Position", FV: Function Group "Velocity",
FT: Function Group "Torque (force)", FH: Function Group "Homing"

Manufacturer Specific Area (No.6)

Index	S-Idx	FP	FV	FT	FH	Name	Data length	Dir	PDO Mapping	Update	NVRAM
0x20F2	0x00	—	—	—	—	Amplifier Alarm Detect Selection	Unsigned8	RO	No	-	-
↑	0x01	○	○	○	○	Main Circuit Voltage Reduction Detection Selection	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 Setting	Unsigned8	RW	No	#	Yes
↑	0x05	○	○	○	○	Communication Timeout Detection Setting	Unsigned8	RW	No	#	Yes
↑	0x06	○	○	○	○	Alarm History Clearing	Unsigned32	RW	No	-	-
↑	0x07	○	○	○	○	Alarm History Clearing Operation Monitor	Unsigned8	RO	No	-	-
0x20F3	0x00	—	—	—	—	Position Control Selection	Unsigned8	RO	No	-	-
↑	0x01	○	×	×	×	Position Control Selection	Unsigned8	RW	No	&	Yes
↑	0x02	○	×	×	×	Position Loop Control/Position Loop Encoder Selection	Unsigned8	RW	No	&	Yes
0x20F5	0x00	○	○	○	○	Torque Limit Input Selection in 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
↑	0x04	×	×	×	○	Position Deviation Excess Value for Hard Stop	Unsigned16	RW	No	#	Yes
0x20F7	0x00	○	○	○	○	Amplifier Special Setting	Unsigned16	RW	No	#	Yes
0x20F8	0x00	—	—	—	—	General Purpose Input Setting	Unsigned8	RO	No	-	-
↑	0x01	○	○	○	○	Positive Over-Travel Function	Unsigned8	RW	No	#	Yes
↑	0x02	○	○	○	○	Negative Over-Travel Function	Unsigned8	RW	No	#	Yes
↑	0x03	○	○	○	○	External Trip Input Function	Unsigned8	RW	No	#	Yes
↑	0x04	○	○	○	○	Main Circuit Power Discharge Selection	Unsigned8	RW	No	&	Yes
↑	0x05	○	○	○	○	Emergency Sop Function	Unsigned8	RW	No	#	Yes
↑	0x06	○	○	○	○	Magnetic Pole Position Detection Command function	Unsigned8	RW	No	#	Yes
↑	0x07	○	○	○	○	Torque Limit Switching Condition	Unsigned8	RW	No	#	Yes
↑	0x08	○	○	×	○	Velocity Loop Proportional Control Switching Condition	Unsigned8	RW	No	#	Yes
0x20F9	0x00	—	—	—	—	General Purpose Output Function Selection	Unsigned8	RO	No	-	-
↑	0x01-0x02	○	○	○	○	General Purpose Output1 - 2	Unsigned8	RW	No	#	Yes
0x20FA	0x00	—	—	—	—	Extended Station Alias	Unsigned8	RO	No	-	-
↑	0x01	○	○	○	○	Extended Alias Number	Unsigned8	RW	No	&	Yes
↑	0x02	○	○	○	○	Station Alias Selection	Unsigned8	RW	No	&	Yes
0x20FB	0x00	○	○	○	○	Torque Addition at Servo ON	Integer16	RW	Possible	#	Yes
0x20FC	0x00	○	○	○	○	Modulo Initialization Warning Setting	Unsigned16	RW	No	&	Yes
0x20FD	0x00	—	—	—	—	Servo Amplifier System Selection	Unsigned8	RO	No	-	-
↑	0x01	○	○	○	○	Main Circuit Power Input Type	Unsigned8	RW	No	&	Yes
↑	0x02	○	○	○	○	Regenerative Resistor Selection	Unsigned8	RW	No	&	Yes
↑	0x03	○	○	○	○	Motor Structure	Unsigned8	RW	No	&	Yes
↑	0x08	●	○	○	●	Control Cycle	Unsigned8	RW	No	&	Yes
0x20FE	0x00	○	○	○	○	Motor Code	Unsigned16	RW	No	&	Yes
0x20FF	0x00	○	○	○	○	Encoder Selection	Unsigned8	RO	No	-	-
↑	0x01	○	○	○	○	Encoder Resolution Code	Unsigned16	RW	No	&	Yes
↑	0x02	○	○	○	○	Encoder Type Code	Unsigned16	RW	No	&	Yes
↑	0x03	○	×	×	×	External Encoder Resolution Code	Unsigned16	RW	No	&	Yes
↑	0x04	○	○	○	○	External Encoder Type Code	Unsigned16	RW	No	&	Yes
↑	0x05	○	○	○	○	Battery Backup Absolute Encoder Function Selection	Unsigned8	RW	No	&	Yes
↑	0x06	○	○	○	○	Absolute Encoder Multi Turn Count	Unsigned8	RW	No	&	Yes
↑	0x07	○	○	○	○	External Absolute Encoder Multi Turn Count	Unsigned8	RW	No	&	Yes
↑	0x08	○	○	○	○	Motor Encoder Input Selection	Unsigned8	RW	No	&	Yes

○: Supported, ×: Not supported FP: Function Group "Position", FV: Function Group "Velocity", FT: Function Group "Torque (force)", FH: Function Group "Homing"

4. Object Dictionary

Manufacturer Specific Area (No.7)

Index	S-Idx	FP	FV	FT	FH	Name	Data length	Dir	PDO Mapping	Update	NVRAM
0x2100	0x00	○	○	○	○	Status Word 1	Unsigned16	RO	Possible	-	-
0x2101	0x00	—	—	—	—	Amplifier Alarm Field	Unsigned8	RO	No	-	-
↑	0x01-0x04	○	○	○	○	Alarm 1 - 4	Unsigned8	RO	Possible	-	-
0x2102	0x00	—	—	—	—	Alarm History	Unsigned8	RO	No	-	-
↑	0x01	○	○	○	○	Present Alarm	Unsigned32	RO	Possible	-	-
↑	0x02- 0x10	○	○	○	○	1st - 15th Past Alarm	Unsigned32	RO	No	-	-
0x2103	0x00	—	—	—	—	Warning Status	Unsigned8	RO	No	-	-
↑	0x01	○	○	○	○	Warning Monitor	Unsigned16	RO	Possible	-	-
↑	0x02	○	○	○	○	Warning Valid	Unsigned16	RW	No	#	Yes
↑	0x03	○	○	○	○	Warning Monitor 2	Unsigned16	RO	Possible	-	-
↑	0x04	○	○	○	○	Warning Valid 2	Unsigned16	RW	No	#	Yes
0x2104	0x00	—	—	—	—	Actual Gain Value Monitor	Unsigned8	RO	No	-	-
↑	0x01	○	—	—	—	Position Loop Proportional Gain Actual Monitor	Unsigned16	RO	Possible	-	-
↑	0x02	○	—	—	—	Position Loop Integral Time Constant Actual Monitor	Unsigned16	RO	Possible	-	-
↑	0x03	○	○	—	○	Velocity Loop Proportional Gain Actual Monitor	Unsigned16	RO	Possible	-	-
↑	0x04	○	○	—	○	Velocity Loop Integral Time Constant Monitor	Unsigned16	RO	Possible	-	-
↑	0x05	○	○	—	○	Load Inertia Moment Ratio Actual Monitor	Unsigned16	RO	Possible	-	-
↑	0x06	○	○	○	○	Torque (force) Command Filter Actual Monitor	Unsigned16	RO	Possible	-	-
↑	0x07	—	—	—	—	Model Control Gain Actual Monitor	Unsigned16	RO	Possible	-	-
↑	0x08	○	○	×	○	Adaptive Notch Filter Monitor	Unsigned16	RO	Possible	-	-
0x2105	0x00	○	○	○	○	Zero-phase Based 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	○	○	○	○	Effective Torque (force) Fast Estimated Value	Unsigned16	RO	Possible	-	-
0x2109	0x00	○	○	○	○	Servo Amplifier Internal Temperature	Integer16	RO	Possible	-	-
0x210A	0x00	○	○	○	○	Regenerative Resistor Operation Percentage Monitor	Unsigned16	RO	Possible	-	-
0x210B	0x01	○	○	○	○	Encoder Temperature Monitor	Integer16	RO	Possible	-	-
↑	0x02	○	○	○	○	External Encoder Temperature Monitor	Integer16	RO	Possible	-	-
0x210C	0x00	○	○	○	○	Home Index Position	Integer32	RO	Possible	-	-
0x210D	0x00	○	—	—	—	Position Synchronization Deviation Monitor	Integer32	RO	Possible	-	-
0x2110	0x00	—	—	—	—	Control Cycle Actual Position	Unsigned8	RO	No	-	-
↑	0x01-0x07	○	○	○	○	Control Cycle Actual Position1 - 7	Integer32	RO	Possible	-	-
0x2111	0x00	—	—	—	—	Control Cycle Actual Velocity	Unsigned8	RO	No	-	-
↑	0x01-0x07	○	○	○	○	Control Cycle Actual Velocity 1 - 7	Integer32	RO	Possible	-	-
0x2112	0x00	—	—	—	—	Control Cycle Actual Torque (force)	Unsigned8	RO	No	-	-
↑	0x01-0x07	○	○	○	○	Control Cycle Actual Torque (force)1 - 7	Integer16	RO	Possible	-	-
0x2116	0x00	○	○	○	○	Actual Velocity Value (Velocity Monitor) 2	Integer32	RO	Possible	-	-
0x2117	0x00	○	○	○	○	Actual Position Value (Position Monitor) 2	Integer32	RO	Possible	-	-
0x2118	0x00	—	—	—	—	Encoder Monitor	Integer32	RO	—	-	-
↑	0x01	○	○	○	○	Motor Encoder Monitor	Integer32	RO	Possible	-	-
↑	0x02	○	×	×	×	External Encoder Monitor	Integer32	RO	Possible	-	-
0x211F	0x00	○	○	○	○	Digital Input Monitor 2	Unsigned16	RO	Possible	-	-

○: Supported, ×: Not supported FP: Function Group "Position", FV: Function Group "Velocity", FT: Function Group "Torque (force)", FH: Function Group "Homing"

Manufacturer Specific Area (No.8)

Index	S-Idx	FP	FV	FT	FH	Name	Data length	Dir	PDO Mapping	Update	NVRAM
0x2121	0x00	○	○	○	○	Production Number	VisibleString	RO	No	-	-
0x2123	0x00	○	○	○	○	Cooling Fan Rotation Speed	Unsigned16	RO	Possible	-	-
0x2124	0x00	○	○	○	○	U-phase Electric Angle Monitor	Unsigned16	RO	Possible	-	-
0x2125	0x00	○	○	○	○	Average Power Monitor	Integer16	RO	Possible	-	-
0x2126	0x00	○	○	○	○	Average Power Monitor	Integer16	RO	Possible	-	-
0x2127	0x00	○	○	○	○	Each Control Status	Unsigned8	RO	No	-	-
↑	0x01	○	○	○	○	Control Status	Unsigned16	RO	No	-	-
↑	0x02	○	○	○	○	Position Control Status	Unsigned16	RO	No	-	-
↑	0x03	○	○	○	○	Velocity Control Status	Unsigned16	RO	No	-	-
↑	0x04	○	○	○	○	Torque Control Status	Unsigned16	RO	No	-	-
↑	0x05	○	○	○	○	Amplifier Management Signal Status	Unsigned8	RO	No	-	-
↑	0x06	○	○	○	○	Alarm Management Status	Unsigned16	RO	No	-	-
↑	0x07	○	○	○	○	Function Management Signal Status	Unsigned16	RO	No	-	-
0x2128	0x00	○	○	○	○	U-phase Current Readout Value	Integer16	RO	No	-	-
0x2129	0x00	○	○	○	○	V-phase Current Readout Value	Integer16	RO	No	-	-
0x212A	0x00	○	○	○	○	Motor Encoder Communication Error Counter	Unsigned32	RO	No	-	-
0x212B	0x00	○	×	×	×	External Encoder Communication Error Counter	Unsigned32	RO	No	-	-
0x212C	0x01	○	○	○	○	Motor Encoder Frequency Monitor	Integer32	RO	Possible	-	-
↑	0x02	○	×	×	×	External Encoder Frequency Monitor	Integer32	RO	Possible	-	-
0x212D	0x00	○	○	○	○	Internal position Offset with Homing	Integer64	RO	No	-	-
0x212E	0x00	○	○	○	○	Amplifier Operation Time	Integer64	RO	No	-	-
0x212F	0x00	○	○	○	○	Overload Detection Temperature Attainment Ratio	Unsigned16	RO	No	-	-
0x2131	0x00	○	○	○	○	Position deviation difference monitor	Integer32	RO	Possible	-	-
0x2134	0x00	○	○	○	○	Life-span monitor	Unsigned8	RO	No	-	-
↑	0x01	○	○	○	○	Remaining life of relay for an inrush current prevention	Unsigned16	RO	Possible	-	-
↑	0x02	○	○	○	○	Remaining life of relay for a dynamic brake	Unsigned16	RO	Possible	-	-
↑	0x03	○	○	○	○	Remaining life of relay for a holding brake	Unsigned16	RO	Possible	-	-
↑	0x04	○	○	○	○	Remaining life of a holding brake	Unsigned16	RO	Possible	-	-
0x2135	0x00	○	○	○	○	Electric power monitor	Unsigned8	RO	No	-	-
↑	0x01	○	○	○	○	Regenerative power monitor	Unsigned32	RO	Possible	-	-
0x2136	0x00	○	○	○	○	Communication quality monitor	Unsigned8	RO	No	-	-
↑	0x01	○	○	○	○	Error rate of motor encoder communication	Unsigned32	RO	Possible	-	-
↑	0x02	○	○	○	○	Error rate of external encoder communication	Unsigned32	RO	Possible	-	-
↑	0x03	○	○	○	○	Error rate of EtherCAT communication	Unsigned32	RO	Possible	-	-
0x2138	0x00	○	○	○	○	Backup file information	Unsigned8	RO	No	-	-
↑	0x01	○	○	○	○	File size	Unsigned32	RO	No	-	-
0x2139	0x00	-	-	-	-	Upload File Information	Unsigned8	RO	No	-	-
↑	0x01	○	○	○	○	AP1 File Size	Unsigned32	RO	No	-	-
↑	0x02	○	○	○	○	Drive Recorder File Size	Unsigned32	RO	No	-	-
↑	0x03	○	○	○	○	System Analysis File Size	Unsigned32	RO	No	-	-
0x213A	0x00	○	○	○	○	Motor Serial Number	VisibleString	RO	No	-	-
0x213B	0x00	-	-	-	-	Motor Information	Unsigned8	RO	No	-	-
↑	0x01	○	○	○	○	Motor Information	Unsigned32	RO	No	-	-
↑	0x02	○	○	○	○	Encoder Information	Unsigned16	RO	No	-	-
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	○	×	×	×	Backlash correction function selection	Unsigned8	RW	No	#	Yes
0x5091	0x00	○	×	×	×	Backlash Correction Value	Unsigned32	RW	No	#	Yes
0x5092	0x00	○	×	×	×	Backlash Correction Direction	Unsigned8	RW	No	#	Yes

○: Supported, ×: Not supported FP: Function Group "Position", FV: Function Group "Velocity", FT: Function Group "Torque (force)", FH: Function Group "Homing"

4.4.2 Parameter detail of object group following 0x2000

0x2000: Function Control Word 1

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

MSB / LSB

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

bit0: Clearing a position deviation enabled [PCLR] Clears a position deviation.
bit1: Proportional position control enabled [PPCON] Clear the integral terms of the positioning controller. It is enabled at "1" and proportionally controlled.
bit2: Proportional velocity control enabled [PCON］ Clear the integral terms of the positioning controller. It is enabled at "1" and proportionally controlled. This function will be valid if bit10 of 0x20F7 is zero.
bit3: Velocity Limit Command [VCMLIM] Limits the internal velocity command at the velocity limit command value. Enabled at "1".
bit4: Torque addition enabled [ICMPEN］ Add the torque addition value to the torque command. Enabled at "1".
bit5: Velocity addition enabled [VCMPEN] Add the velocity addition value to the command. Enabled at "1".
bit6: Position Interpolation Function (csp only) [INTPO] When position commands cannot be received cyclically (SM2 event not received), keep operating at "1" using the previous amount of travel. "1": Valid. "0": Invalid.
bit7: Reserved

MSB / LSB

psce	rsv	rsv	rsv	obscon	rsv	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 velocity compensation enabled [HTRV] Highly compliant velocity compensation is performed at "1".
bit10: Reserved
bit11: Disturbance observer compensation enabled [OBSCON] Observer compensation is performed at "1".
bit12: Reserved
bit13: Reserved
bit14: Reserved
bit15: Position sync compensation enabled [PSCE] Permits and selects mode of the position sync compensation. 0: Position sync compensation disabled. 1: Position sync compensation enabled.

0x2001: Parameter Select

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

MSB			LSB
rsv	gc	rsv	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: Reserved

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.
This function will be valid if bit9 of 0x20F7 is zero.

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)

MSB			LSB
rsv	rsv	rsv	rsv
15 14	13 12	11 10	9 8

bit15-8:
Reserved

0x2002: Auto-tuning

Index	0x2002	Auto-tuning settings		Object Code		RECORD
Sub-Idx	**Description**		**Data Type**	**Access**	**PDO**	**Initial value**
0x00	Number of entry		Unsigned8	RO	No	0x0A
0x01	Tuning Mode [TUNEMODE] Set the validity, invalidity of Auto-tuning, and Load inertia moment ratio estimation. 0x00: AutoTun (Automatic Tuning) 0x01: AutoTun_JRAT-Fix (Automatic Tuning JRAT Manual Setting) 0x02: ManualTun (Manual Tuning) ◆Under the following operating conditions, Load inertia moment ratio 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 suppression control, set "02: Manual tuning". ◆If 00:_AutoTun is selected, vibration suppression control will be disabled though state feedback model following vibration suppression control (base vibration suppression) is selected.		Unsigned8 Setting range	RW 0x00-0x02	No	0x02
0x02	Auto-Tuning Characteristic [ATCHA] Selects characteristic of auto-tuning. 0x00: Positioning1 Positioning Control 1 (General Purpose) 0x01: Positioning2 Positioning Control 2 (High Response) 0x02: Positioning3 Positioning Control 3 (High Response, FFGN Manual Setting) 0x03: Positioning4 Positioning Control 4 (High Response, Horizontal Axis Limited) 0x04: Positioning5 Positioning Control 5 (High Response, Horizontal Axis Limited, FFGN Manual Setting) 0x05: Trajectory1 Trajectory Control 1 0x06: Trajectory2 Trajectory Control 2 (KP, FFGN Manual Setting) ◆[Positioning Control 1] - Use for general-purpose positioning. - For "Velocity control mode" or "Torque control mode", this setting shall be used. - It is available with the axis affected by gravity or external force, also. ◆[Positioning Control 2] - For "Position control mode", this setting shall be used. - For positioning use, it is able to short a settling time by suppressing overshoot. - It is available with the axis affected by gravity or external force, also. ◆[Positioning Control 3] - Use for adjusting FFGN manually. ◆[Positioning Control 4] - It shall be selected when machine works horizontally without external force. - It may be shorten a positioning settling time, against "Positioning Control 2". - For "Position control mode", this setting shall be used. - Must not use with the axis affected by gravity or external force. - It may shock with machine. ◆[Positioning Control 5] - It shall be selected when machine works horizontally without external force, and adjusting FFGN manually. - It may be shorten a positioning settling time, against "Positioning Control 3". - It may shock with machine. ◆[Trajectory Control 1] - This is the setting when following a position command from upper device, such as in cutting operations. - For "Position control mode", this setting shall be used. - It is available with the axis affected by gravity or external force, also. - Use in the condition that single-axis use or allowing different response of each axes. - Use "Trajectory Control 2" for cooperation with the other axis. - Positioning characteristic varies due to position loop gain change caused by estimated inertia moment change. To avoid this change, use "Trajectory Control 2" or manual tuning. ◆[Trajectory Control 2] - This is the setting to be same each axis position loop responses, such as in unison with the other axis. - For "Position control mode", this setting shall be used. - It is available with the axis affected by gravity or external force, also. ✓ Do not set "Model-following vibration suppression control" to the position control selection when using with trajectory control. "Model-following vibration suppression control" will be make trajectory stray. ✓ When "Tuning mode" is set at "02 manual tuning", the set value will not be reflected. ✓ According to the characteristics selected, parameters below 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 Moreover, Higher Tracking Position Compensation Gain and Acceleration Feedback Gain parameters (regardless of selected conditions) are regarded as 0[%] internally.		Unsigned8 Setting range	RW 0x00-0x06	No	0x00
0x03	Auto-Tuning Responsiveness [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 Setting range	RW 0x01-0x28 (1 to 40)	No	0x05

0x04	Save Notch/FF Vibration Suppression frequency/ Auto-Tuning data ◆Performs result saving of auto notch filter/auto FF vibration suppression frequency/ auto tuning, by master via EtherCAT communication. ◆Running commands of each function are below. 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. ◆When Auto FF vibration suppression frequency tuning has performed, the result is saved to 0x2012. ◆When execute Auto-tuning result save, save parameter will follow selected sub index (0x06). There are 6 kind of save parameters as below, and 5 kind of saving pattern. - 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) However, do not change 0x20F7 bit1. - Model Control Gain 1(0x2017.1) ✔ Auto tuning result saving shall be performed after setting "Auto tuning valid" to the tuning mode. ◆Result of Auto Notch filter tuning and Auto FF Vibration Suppression tuning can not save at the same time.	Unsigned8	RW	No	0x00
		Setting range	0x00-0x05 (0 to 5)		
0x05	Execution monitor for Notch /FF vibration suppression frequency/Tuning result saving ◆Indicates state of performing Notch Filter/FF vibration suppression frequency/Tuning result saving. ◆State of tuning execution is below. 0x00: Running Tuning 0x01: Normal completion 0x02: Abnormal termination If finish tuning, 0x01 or 0x02 will indicate.	Unsigned8	RO	No	-
		Setting range	0x00-0x02 (0 to 2)		
0x06	Auto tuning result saving parameter selection ◆Selects parameter combination in tuning result saving.	Unsigned8	RW	No	0x00
		Setting range	0x00-0x04 (0 to 4)		
	◆Parameter combinations are shown below table.				

Setting value	Load inertia moment	Position Proportional Gain	Velocity Proportional Gain	Velocity Integral Time Constant	Torque Command Filter	Model Control Gain
0	✔	✔	✔	✔	✔	✔
1	✔		✔	✔	✔	
2	✔					
3		✔	✔	✔	✔	✔
4			✔	✔	✔	

Object Dictionary 4

0x07	Auto-Notch Filter Tuning Torque Command ［ANFILTC］ Sets the torque value for excite the mechanical system during operation under "Auto-Notch Filter Tuning".	Unsigned16	RW	No	0x01F4 (50.0)
		Setting range	0x0064-0x03E8 (10.0 to 100.0)		
		Unit	0.1 %		
	✓ Larger value makes the tuning more accurate; however, note that it also makes the movement of the machine greater.				
0x08	Auto-FF Vibration Suppression Frequency Tuning Torque Command ［ASUPTC］ Sets the torque value for excite the mechanical system during operation under "Auto-FF Vibration Suppression Frequency Tuning".	Unsigned16	RW	No	0x00FA (25.0)
		Setting range	0x0064-0x03E8 (10.0 to 100.0)		
		Unit	0.1 %		
	✓ Larger value makes the tuning more accurate; however, note that it also makes the movement of the machine greater.				
0x09	Auto-FF Vibration Suppression Frequency Tuning Friction Compensation Value ［ASUPFC］ Sets the friction torque compensation added to the motor torque to excite the mechanical system at the time of Auto-FF Vibration Suppression Frequency Tuning.	Unsigned16	RW	No	0x0032 (5.0)
		Setting range	0x0000-0x01F4 (0.0 to 50.0）		
		Unit	0.1 %		
	◆By setting this value close to actual friction torque, Auto-FF vibration suppression frequency tuning will be more accurate. ✓ When the set value is low, there may be cases that the vibration frequency of the mechanical system cannot be detected, or the wrong value is detected. Raise the value until the detected value settles.				
0x0A	Auto-Tuning characteristic compatible mode ［ATCSEL］	Unsigned8	RW	No	0x00
		Setting range	0x00-0x01		
	◆Set "01: Enable Valid (RS2 compatible)" to set auto-tuning characteristic compatible with RS1/RS2 amplifier. In this case, gain set value will be 30 even if 31 to 40 are set. 0x00: Disable Invalid 0x01: Enable Valid (RS2 compatible)				

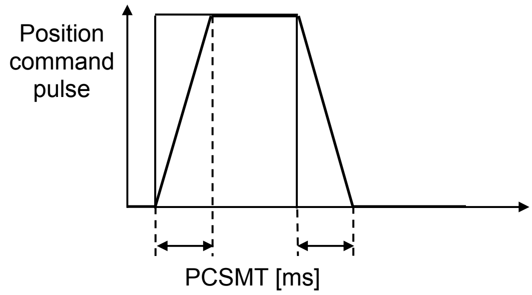
0x2003: Position Command Smoothing Time Constant (Position Demand Moving Average Filter)

Index	0x2003	This moving low-pass filter smoothes the position command pulse. Sets time constants.	Object Code	VARIABLE

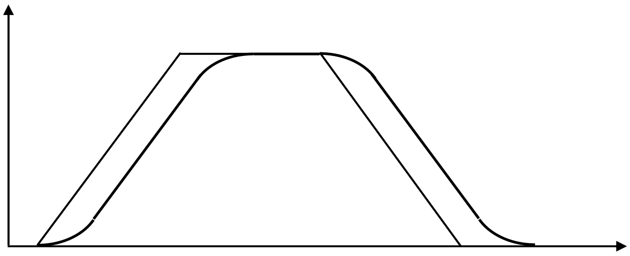
Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Position Command Smoothing Constant ［PCSMT］	Unsigned16	RW	Possible	0x0000 (0.0)
		Setting range	0x0000-0x1388 (0.0 to 500.0)		
		Unit	0.1 ms		

◆Applies gradient to the step condition positioning pulse.
◆Applies S curve to the ramp condition position command pulse.
◆When position command differences in each communication cycle are large, position command will be smoothed. (This may decrease the operating noise of the servo motor.)
◆When this moving-average filter is used, the value is set at “0.3ms and higher”.
◆When the set value is “0.0ms-0.2ms”, this filter is invalid.
◆Set in increments of 0.5ms. (Under the set value “0.4ms and less”, there may be cases where the set value cannot be applied to the operation.)

- Position command pulse with step condition applied



- Position command pulse with ramp condition applied.

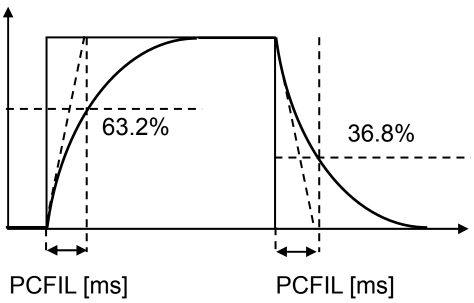


0x2004: Position Command Filter

Index	0x2004	This low-pass filter suppresses any sudden change of the position control pulse. Sets time constants.	Object Code	VARIABLE

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Position Command Filter ［PCFIL］ Time constant for the filter will be set. Filter will be invalid at the set value 0.0 ms. Does not influence Feed Forward.	Unsigned16	RW	No	0x0000 (0.0)
		Setting range	0x0000-0x4E20 (0.0 to 2000.0)		
		Unit	0.1 ms		

✓ This parameter setting is valid when the value of Higher Tracking Control Position Compensation Gain is set at 0%.
✓ When Higher Tracking Control Position Compensation Gain is 0% and this value is set at 0.0ms, the filter becomes invalid.
✓ This filter can suppress overshoot caused by the rise of the feed forward compensation gain.



0x2005: Position Loop Proportional Gain

Index	0x2005	Proportional gain for position controller. By setting of gain change selection (GC), the position loop proportional gain to be used is selected. For a setting method, refer the section 5.18.	Object Code	Array

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Number of entry	Unsigned8	RO	No	0x04
0x01	Position Loop Proportional 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 is selected in the Gain Switching function, it operates at this setting value.	Unsigned16	RW	Possible	0x001E (30)
0x02	Position Loop Proportional Gain 2 ［KP2］ ◆When gain 2 is selected in the Gain Switching function, it operates at this setting value.	Unsigned16	RW	No	0x001E (30)
0x03	Position Loop Proportional Gain 3 ［KP3］ ◆When gain 3 is selected in the Gain Switching function, it operates at this setting value.	Unsigned16	RW	No	0x001E (30)
0x04	Position Loop Proportional Gain 4 ［KP4］ ◆When gain 4 is selected in the Gain Switching function, it operates at this setting value.	Unsigned16	RW	No	0x001E (30)
		Setting range	0x0001-0x0BB8 (1 to 3000)		
		Unit	1 /s		

0x2006: Position Loop Integral Time Constant

Index	0x2006	Integral time constant of position controller. By setting of gain change selection (GC), the position loop integral time constant to be used is selected. For a setting method, refer the section 5.18.	Object Code	Array

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Number of entry	Unsigned8	RO	No	0x04
0x01	Position Loop 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 is selected in the Gain Switching function, it operates at this setting value.	Unsigned16	RW	Possible	0x2710 (1000.0) proportional control
0x02	Position Loop Integral Time Constant 2 ［TPI2］ ◆When gain 2 is selected in the Gain Switching function, it operates at this setting value.	Unsigned16	RW	No	0x2710 (1000.0) proportional control
0x03	Position Loop Integral Time Constant 3 ［TPI3］ ◆When gain 3 is selected in the Gain Switching function, it operates at this setting value.	Unsigned16	RW	No	0x2710 (1000.0) proportional control
0x04	Position Loop Integral Time Constant 4 ［TPI4］ ◆When gain 4 is selected in the Gain Switching function, it operates at this setting value.	Unsigned16	RW	No	0x2710 (1000.0) proportional control
		Setting range	0x0003-0x2710 (0.3 to 1000.0)		
		Unit	0.1ms		

0x2007: Higher Tracking Control Position Compensation Gain

Index	0x2007	Improves the Command Tractability using Compensation Gain Parameter to the position system. The larger value can raise command tracking performance.	Object Code	VARIABLE

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Higher Tracking Control Position Compensation Gain ［TRCPGN］	Unsigned16	RW	No	0x0000 (0)
	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.	Setting range	0x0000-0x0064 (0 to 100)		
	KFGN [%] = 0.9 × Setting value [%]	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: Velocity Feedforward Compensation Parameter

Index	0x2008	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	Velocity Feedforward Compensation Parameter ［FFGN］	Unsigned16	RW	Possible	0x0000 (0)
	This is feedforward compensation gain in position control.	Setting range	0x0000-0x0064 (0 to 100)		
	When Position Control Selection is Model following control, this will be the feedforward compensation against position control in model control system.	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	Velocity Feedforward Filter ［FFFIL］ Primary low-pass filter to eliminate pulsed ripple caused by the position command pulse included in the feed forward command. Sets the cutoff frequency.	Unsigned16	RW	No	0x0FA0 (4000) invalid
	◆It differs the set values to disable the filter differ	Setting range	0x0001-0x0FA0 (1 to 4000)		
	according to the setting of "position control selection".	Unit	1 Hz		
	◆This set value is not reflected if model-following control is valid because model velocity FF filter becomes valid. Filter becomes invalid with set value 2000Hz (0x07D0) or more.				

0x2009: Velocity Command Filter Settings

Index	0x2009	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.	Unsigned16	RW	No	0x0FA0 (4000) invalid
	When sets over 2000Hz (0x07D0) then setting become	Setting range	0x0001-0x0FA0 (1 to 4000)		
	disable. Set range differs due to control cycle selection in system parameter.	Unit	1 Hz		

Control cycle selection	Filter frequency to be invalid
00: Standard sampling mode	2000Hz or more
01: High speed sampling mode	4000Hz or more

4 Object Dictionary

0x200A: Velocity Detection Filter

Index	0x200A	Parameter to switch on the primary low-pass filter in response to velocity feedback.	Object Code	VARIABLE

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Velocity Detection Filter [VDFIL] Primary low-pass filter to eliminate ripples caused by encoder pulse included in the velocity control system feedback. Sets the cutoff frequency.	Unsigned16	RW	No	0x05DC (1500)
		Setting range	0x0001-0x0FA0 (1 to 4000)		
		Unit	1 Hz		
	This filter will be disabled at set value 2000Hz (0x07D0) or greater. Set range differs due to control cycle selection in system parameter.				

Control cycle selection	Filter frequency to be invalid
00: Standard sampling mode	2000Hz or more
01: High speed sampling mode	4000Hz or more

◆When the encoder resolution is low, lowering the setting value and suppressor the ripples can suppress motor drive noise. In addition, when the encoder resolution is high, raising the setting value may improve the response of the velocity control system. For general use, set at the Standard value.

0x200B: Velocity Loop Proportional Gain

Index	0x200B	Sets proportional gain of velocity controller. It will be response frequency of velocity loop if actual load inertia moment ratio is JRATx. By setting of gain change selection (GC), the Velocity Loop Proportional Gain to be used is selected. For a setting method, refer the section 5.18.	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 (50)
	◆When Auto-tuning function is valid, this setting value is not applied. ◆When the Gain switching function is valid, this setting value is applied by select gain 1. ◆When gain 1 is selected in the Gain Switching function, it operates at this setting value.				
0x02	Velocity Loop Proportional Gain 2 [KVP2] ◆When gain 2 is selected in the Gain Switching function, it operates at this setting value.	Unsigned16	RW	No	0x0032 (50)
0x03	Velocity Loop Proportional Gain 3 [KVP3] ◆When gain 3 is selected in the Gain Switching function, it operates at this setting value.	Unsigned16	RW	No	0x0032 (50)
0x04	Velocity Loop Proportional Gain 4 [KVP4] ◆When gain 4 is selected in the Gain Switching function, it operates at this setting value.	Unsigned16	RW	No	0x0032 (50)
		Setting range	0x0001-0x07D0 (1 to 2000)		
		Unit	1Hz		

0x200C: Velocity Loop Integral Time Constant

Index	0x200C	Integral time constant of velocity controller. By setting of gain change selection (GC), the velocity loop integral time constant to be used is selected. Integral term is invalid (proportional control) with the setting value of 1000ms (0x2710). For a setting method, refer the section 5.18.	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 (20.0)
	◆When Auto-tuning function is valid, this setting value is not applied. ◆When the Gain switching function is valid, this setting value is applied by select gain 1. ◆When gain 1 is selected in the Gain Switching function, it operates at this setting value.				
0x02	Velocity Loop Integral Time Constant 2 [TVI2] ◆When gain 2 is selected in the Gain Switching function, it operates at this setting value.	Unsigned16	RW	No	0x00C8 (20.0)
0x03	Velocity Loop Integral Time Constant 3 [TVI3] ◆When gain 3 is selected in the Gain Switching function, it operates at this setting value.	Unsigned16	RW	No	0x00C8 (20.0)
0x04	Velocity Loop Integral Time Constant 4 [TVI4] ◆When gain 4 is selected in the Gain Switching function, it operates at this setting value.	Unsigned16	RW	No	0x00C8 (20.0)
		Setting range	0x0003-0x2710 (0.3 to 1000.0)		
		Unit	0.1ms		

0x200D: Load Inertia Moment Ratio

Index	0x200D	Sets inertia moment of the loading device against the servo motor rotor inertia. Setting value=JL/JM×100% (J_L: Load inertia, J_M: Motor roter inertia) By setting of gain change selection (GC), the Load Inertia Moment Ratio to be used is selected. For a setting method, refer the section 5.18.	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 the Gain switching function is valid, this setting value is applied by select gain 1. ◆When gain 1 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 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 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 is selected in the Gain Switching function, it operates at this setting value.	Unsigned16	RW	No	0x0064 (100)
		Setting range	0x0000-0x3A98 (0 to 15000)		
		Unit	1%		

0x200E: Higher Tracking Control Velocity Compensation Gain

Index	0x200E	Parameter to adjust command following 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 auto-tuning enabled, this setting value is not reflected. ◆The setting value is invalid with Model following control or Model following vibration suppressor control.	Unsigned16	RW	No	0x0000
		Setting range	0x0000-0x0064 (0 to 100)		
		Unit	1 %		

0x200F: Acceleration Feedback Compensation

Index	0x200F	Sets acceleration feedback compensation gain and cutoff frequency to make the velocity loop stable.	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 to +100.0)		
		Unit	0.1 %		
0x02	Acceleration Feedback Filter [AFBFIL] Primary 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.	Unsigned16	RW	No	0x01F4 (500)
		Setting range	0x0001-0x0FA0 (1 to 4000)		
		Unit	Hz		

Set range differs due to control cycle selection in system parameter.

Control cycle selection	Filter frequency to be invalid
00: Standard sampling mode	2000Hz or more
01: High speed sampling mode	4000Hz or more

4 Object Dictionary

0x2010: FF Vibration Suppression Frequency Selection input

Index	0x2010	4 types of FF Vibration Suppression Frequency is able to use with switching.	Object Code			Array
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Number of entry		Unsigned8	RO	No	0x04
0x01	FF Vibration Suppression Frequency Selection input A1 [SUPFSELA1] Selects effective condition of FF Vibration Suppression Frequency Selection input A1.		Unsigned8	RW	No	0x00
			Setting range	0x00-0x29		
0x02	FF Vibration Suppression Frequency Selection input A2 [SUPFSELA2] Selects effective condition of FF Vibration Suppression Frequency Selection input A2.		Unsigned8	RW	No	0x00
			Setting range	0x00-0x29		

◆Allocating conditions to enable FF vibration suppression frequency selecting input.
You can switch FF vibration suppression frequency A1 to A4 by combination of SUPFSELA1 and SUPFSELA2 setting.

SUPFSELA1: FF Vibration Suppression Frequency Selection input A1	Invalid	Valid	Invalid	Valid
SUPFSELA2: FF Vibration Suppression Frequency Selection input A2	Invalid	Invalid	Valid	Valid
	↓	↓	↓	↓
Vibration suppression becoming valid	FF vibration suppression frequency A1 (0x2012.1)	FF vibration suppression frequency A2 (0x2012.2)	FF vibration suppression frequency A3 (0x2012.3)	FF vibration suppression frequency A4 (0x2012.4)

◆Effective condition selecting range of FF Vibration Suppression Frequency Selection input A1, A2 is 0x00 to 0x29 of the function valid condition list.

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x03	FF Vibration Suppression Frequency Selection input B1 [SUPFSELB1] Selects effective condition of FF Vibration Suppression Frequency Selection input B1.	Unsigned8	RW	No	0x00
		Setting range	0x00-0x29		
0x04	FF Vibration Suppression Frequency Selection input B2 [SUPFSELB2] Selects effective condition of FF Vibration Suppression Frequency Selection input B2.	Unsigned8	RW	No	0x00
		Setting range	0x00-0x29		

◆Allocating conditions to enable FF vibration suppression frequency selecting input.
You can switch FF vibration suppression frequency B1 to B4 by combination of SUPFSELB1 and SUPFSELB2 setting.

SUPFSELB1: FF Vibration Suppression Frequency Selection input B1	Invalid	Valid	Invalid	Valid
SUPFSELB2: FF Vibration Suppression Frequency Selection input B2	Invalid	Invalid	Valid	Valid
	↓	↓	↓	↓
Vibration suppression becoming valid	FF vibration suppression frequency B1 (0x2012.6)	FF vibration suppression frequency B2 (0x2012.7)	FF vibration suppression frequency B3 (0x2012.8)	FF vibration suppression frequency B4 (0x2012.9)

◆Effective condition selecting range of FF Vibration Suppression Frequency Selection input B1, B2 is 0x00 to 0x29 of the function valid condition list.

■ Function valid condition list

Item	Set value	Item	Set value
Function is always invalid.	00: Always_Disable	Function is always valid.	01: Always_Enable
Function is valid when general input CONT1 is ON.	02: CONT1_ON	Function is valid when general input CONT1 is OFF.	03: CONT1_OFF
Function is valid when general input CONT2 is ON.	04: CONT2_ON	Function is valid when general input CONT2 is OFF.	05: CONT2_OFF
Function is valid when general input CONT3 is ON.	06: CONT3_ON	Function is valid when general input CONT3 is OFF.	07: CONT3_OFF
Function is valid when general input CONT4 is ON.	08: CONT4_ON	Function is valid when general input CONT4 is OFF.	09: CONT4_OFF
Function is valid when general input CONT5 is ON.	0A: CONT5_ON	Function is valid when general input CONT5 is OFF.	0B: CONT5_OFF
Function is valid when general input CONT6 is ON.	0C: CONT6_ON	Function is valid when general input CONT6 is OFF.	0D: CONT6_OFF
Function is valid when general input CONT7 is ON.	0E: CONT7_ON	Function is valid when general input CONT7 is OFF.	0F: CONT7_OFF
Function is valid while in low speed status ("low speed" is lower than LOWV Setting Value).	12: LOWV_IN	Function is valid while not in low speed status ("low speed" is lower than LOWV Setting Value).	13: LOWV_OUT
Function is valid while in speed attainment status ("speed" is higher than the VA Setting Value).	14: VA_IN	Function is valid while not in speed attainment status ("speed" is higher than the VA Setting Value).	15: VA_OUT
Function is valid while in speed matching status (within command-actual velocity consistent range).	16: VCMP_IN	Function is valid while not in speed matching status (within command-actual velocity consistent range).	17: VCMP_OUT
Function is valid while in zero speed status (speed is lower than the ZV Setting Value).	18: ZV_IN	Function is valid while not in zero speed status (speed is lower than the ZV Setting Value).	19: ZV_OUT
Function is valid while in In-Position status (position deviation < INP)	1A: INP_IN	Function is valid while not in In-Position status (position deviation < INP)	1B: INP_OUT
Function is valid while in torque limit status	1C: TLC_IN	Function is valid while not in torque limit status	1D: TLC_OUT
Function is valid while in velocity limit status	1E: VLC_IN	Function is valid while not in velocity limit status	1F: VLC_OUT
Function is valid while in Near range status	20: NEAR_IN	Function is valid while not in Near range status	21: NEAR_OUT
Function is valid while rotation direction is forward (VMON>+LOWV)	22: VMON > +LV	Function is valid while rotation direction is not forward (VMON≦+LOWV)	23: VMON <= +LV
Function is valid while rotation direction is reverse (VMON<-LOWV)	24: VMON > -LV	Function is valid while rotation direction is not reverse (VMON≧-LOWV)	25: VMON <= -LV
Function is valid while in Position command 0 and In-Position status (position deviation < INP)	26: INPZ_IN	Function is valid while not in Position command 0 and In-Position status (position deviation < INP)	27: INPZ_OUT
Function is valid while in Position command distribution completion (including delay time)	28: TRJCMP_IN	Function is valid while not in Position command distribution completion (including delay time)	29: TRJCMP_OUT

0x2011: Torque Command Filter

Index	0x2011	Low-pass filter to eliminate high frequency component included in the torque (force) command. Sets cutoff frequency. By setting of change selection (GC), the Torque (force) Command Filter to be used is selected. For a setting method, refer the section 5.18.	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］ ◆Overwritten by Auto-tuning result saving. ◆When Auto-tuning function is valid, this setting value is not applied. ◆When the Gain switching function is valid, this setting value is applied by select gain 1. ◆Even if Auto-Tuning activate, this value is used while system analysis activate. ◆When gain 1 is selected in the Gain Switching function, it operates at this setting value.	Unsigned16	RW	Possible	0x0258 (600)
0x02	Torque(force) command filter 2 ［TCFIL2］ ◆When the gain switching permission is valid and gain 2 is selected in the Gain Switching function, it operates at this set value.	Unsigned16	RW	No	0x0258 (600)
0x03	Torque(force) command filter 3 ［TCFIL3］ ◆When the gain switching permission is valid and gain 3 is selected in the Gain Switching function, it operates at this set value.	Unsigned16	RW	No	0x0258 (600)
0x04	Torque(force) command filter 4 ［TCFIL4］ ◆When the gain switching permission is valid and gain 4 is selected in the Gain Switching function, it operates at this set value.	Unsigned16	RW	No	0x0258 (600)
		Setting range	0x0001-0x0FA0 (1 to 4000)		
		Unit	Hz		

0x2012: FF Vibration Suppression Frequency

Index	0x2012	Sets the frequency of the machine vibration to be suppressed by FF vibration suppressor function. Change this while the servo motor is stopping. Shows the center frequency of the notch filter in response to the position command and sets the frequency of the resonance to be constrained (anti-resonance frequency).	Object Code	Array

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Number of entry	Unsigned8	RO	No	0x09
0x01	FF Vibration Suppression Frequency A1［SUPFRQA1］ ◆This parameter is overwritten by executing FF vibration suppressor frequency tuning. ◆Tuning result will be automatically saved in this parameter. ◆Operates with this set value when A1 is valid at FF Vibration Suppression Frequency Selection input (0x2010.1 to 4).	Unsigned16	RW	Possible	0x1388 (500) invalid
0x02	FF Vibration Suppression Frequency A2［SUPFRQA2］ ◆Selects by FF Vibration Suppression Frequency Selection input A1, A2.	Unsigned16	RW	No	0x1388 (500) invalid
0x03	FF Vibration Suppression Frequency A3［SUPFRQA3］ ◆Selects by FF Vibration Suppression Frequency Selection input A1, A2.	Unsigned16	RW	No	0x1388 (500) invalid
0x04	FF Vibration Suppression Frequency A4［SUPFRQA4］ ◆Selects by FF Vibration Suppression Frequency Selection input A1, A2. ◆Setting value can be input by 0.1Hz; inside the servo amplifier, the units listed below are used.	Unsigned16	RW	No	0x1388 (500) invalid
		Setting range	0x000A-0x1388 (1.0 to 500.0)		
		Unit	0.1 Hz		

Setting range	Unit and process inside servo amplifier
1.0 to 9.9Hz	Valid by 0.1Hz.
10.0 to 99.9Hz	Valid by 0.5Hz and drop less than 0.
100.0 to 499.9Hz	Valid by 5.0Hz and drop less than 5.
500.0Hz	FF vibration suppression control is invalid.

◆FF vibration suppression control is invalid with set value 500.0Hz (0x1388). Function becomes valid using a changed frequency after outputting rest of position command pulse stocked internally.
◆Do not use while synchronizing with other axis such as controlling XY table trajectory for cutting operation.
◆In case of changing FF vibration suppression frequency, the time till a changed setting become valid differs as table below, due to frequency setting before change.

Frequency before change	Time till a changed setting become valid
5.0 Hz or more	1 second
3.0 Hz	3 seconds
1.0 Hz	7 seconds

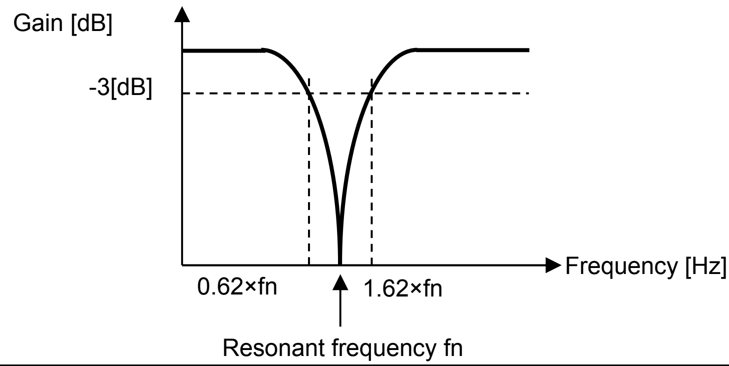
Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x05	FF Vibration Suppression Characteristic Selection B［SUPCRB］	Unsigned8	RW	No	0x00
		Setting range	0x00-0x01		
	◆When 01 is set, vibration suppression frequency range of setting frequency will be narrow.				
0x06	FF Vibration Suppression Frequency B1[SUPFRQB1] ◆This parameter is not set automatically by auto FF vibration suppression frequency tuning. ◆Selects by FF Vibration Suppression Frequency Selection input B1, B2.	Unsigned16	RW	No	0x1388 (500) invalid
0x07	FF Vibration Suppression Frequency B2［SUPFRQB2］ ◆Selects by FF Vibration Suppression Frequency Selection input B1, B2.	Unsigned16	RW	No	0x1388 (500) invalid
0x08	FF Vibration Suppression Frequency B3［SUPFRQB3］ ◆Selects by FF Vibration Suppression Frequency Selection input B1, B2.	Unsigned16	RW	No	0x1388 (500) invalid
0x09	FF Vibration Suppression Frequency B4［SUPFRQB4］ ◆Selects by FF Vibration Suppression Frequency Selection input B1, B2.	Unsigned16	RW	No	0x1388 (500) invalid
	◆Refer FF Vibration Suppression Frequency A.	Setting range	0x000A-0x1388 (1.0 to 500.0)		
		Unit	0.1 Hz		

0x2013: Velocity Command Notch Filter

Index	0x2013	This is notch filter to eliminate frequency element arbitrarily set from velocity command. Sets the resonant frequency.	Object Code	VARIABLE

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Velocity Command Notch Filter ［VCNFIL］ ◆When resonance occurs in velocity control system, the gain will be able to raise by setting the resonance frequency. ◆Do not use while synchronizing with other axis such as controlling XY table trajectory for cutting operation.	Unsigned16	RW	No	0x03E8 (1000)
		Setting range	0x0032-0x03E8 (50 to 1000)		
		Setting unit	Hz		
	◆Set value to be invalid differs due to setting of 0x20FD:0x08 in system parameter. Setting value can be input by 1Hz; inside the servo amplifier, the units listed below are used.				

Setting range		Set value	Unit and process inside servo amplifier
00	Standard sampling mode	50 to 99Hz	Valid by 1 Hz.
		100 to 499Hz	Valid by 5 Hz and drop less than 5.
		500 to 100Hz	Filter invalid.
01	High speed sampling mode	50 to 199Hz	Valid by 1 Hz.
		200 to 999Hz	Valid by 10 Hz and drop less than 5.
		1000Hz	Filter invalid.



0x2014: Torque Command Notch Filter

Index	0x2014	This is notch filter to eliminate sympathetic vibration element included in torque command. Sets the resonant frequency.	Object Code	Array

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Number of entry	Unsigned8	RO	No	0x05
0x01	Torque Command Notch Filter A ［TCNFILA］ ◆Overwritten by auto notch filter tuning.	Unsigned16	RW	No	0x0FA0 (4000)
	◆Set value to be invalid differs due to setting of 0x20FD:0x08 in system parameter.				

Control cycle		Setting range	Unit and process inside servo amplifier
00	Standard sampling mode	100 to 1999Hz	Valid by 1Hz
		2000 to 4000Hz	Filter invalid.
01	High speed sampling mode	100 ～ 3999Hz	Valid by 1 Hz.
		4000Hz	Filter invalid.

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x02	Torque Command Notch Filter B ［TCNFILB］ ◆Filter is invalid with set value 2000Hz (0x07D0) or over.	Unsigned16	RW	No	0x0FA0 (4000)
0x03	Torque Command Notch Filter C ［TCNFILC］ ◆Filter is invalid with set value 2000Hz (0x07D0) or over.	Unsigned16	RW	No	0x0FA0 (4000)
0x04	Torque Command Notch Filter D ［TCNFILD］ ◆Filter is invalid with set value 2000Hz (0x07D0) or over.	Unsigned16	RW	No	0x0FA0 (4000)
0x05	Torque Command Notch Filter E ［TCNFILE］ ◆Filter is invalid with set value 2000Hz (0x07D0) or over.	Unsigned16	RW	No	0x0FA0 (4000)
	◆The value set to Torque Command Notch Filter E will be valid when “00: Adp_Filter Disable Adaptation invalid” is set to 0x2060.1 "Adaptive notch filter function E".	Setting range	0x0064-0x0FA0 (100 to 4000)		
		Unit	Hz		

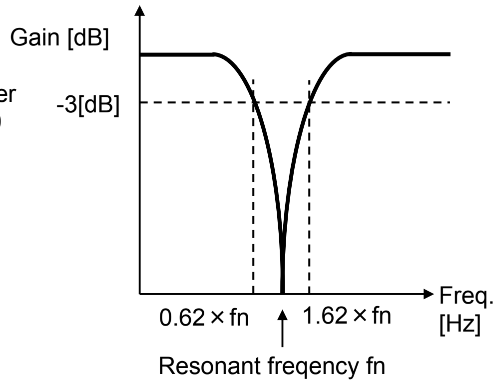
0x2015: High settling control settings

Index	0x2015	Parameter setting to implement high settling control by adding Compensation Values to position deviation at Acceleration and Deceleration.	Object Code	RECORD

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 in high settling control. ✓ Set with the Position Deviation Pulse unit (in case of the incremental encoder, with the quadruple encoder resolution unit.)	Integer16	RW	No	0x0000 (0 Pulse)
		Setting range	0XD8F1-0x270F (-9999 to +9999)		
		Unit	×50 Pulse		
	✓ Compensation is provided in response to position deviation. ✓ Greater setting values result in increased compensation. ✓ Greater accelerations converted from the Position Command Pulse result in increased compensation. ✓ Greater Load inertia result in increased compensation. ✓ High Settling Control reduces in Position Deviation. ✓ In case of model following control or model following vibration suppression control, this setting value is not reflected.				
0x02	Deceleration Compensation ［DECC0］ Sets the deceleration compensation value in high settling control. ✓ Set with the Position Deviation Pulse unit (in case of the incremental encoder, with the quadruple encoder resolution unit.)	Integer16	RW	No	0x0000 (0 Pulse)
		Setting range	0xD8F1-0x270F (-9999 to +9999)		
		Unit	×50 Pulse		
	✓ Compensation is provided in response to position deviation. ✓ Greater setting values result in increased compensation. ✓ Greater accelerations converted from the Position Command Pulse result in increased compensation. ✓ Greater Load inertia result in increased compensation. ✓ High Settling Control reduces in Position Deviation. ✓ In case of model following control or model following vibration suppression control, this setting value is not reflected.				
0x03	Command Velocity Low-pass Filter ［CVFIL］ Primary low-pass filter to eliminate high-frequency component (ripples etc.,) included in the Velocity (Command Velocity) calculated from the position command inside the high settling control. Sets the cutoff frequency. ✓ When the encoder resolution is low, lower the cutoff frequency. ✓ The filter is disabled by setting value 2000Hz or more.	Unsigned16	RW	No	0x03E8 (1000)
		Setting range	0x001-0x0FA0 (1 to 4000)		
		Unit	Hz		
0x04	Command Velocity Threshold ［CVTH］ Sets the Velocity Threshold to validate the Acceleration and Deceleration Compensation Values in the high settling control. ✓ When the velocity (command velocity) converted from the Position Command is higher than this velocity, implements the Acceleration or Deceleration Compensations. ✍ Units for rotary motor and linear motor are different.	Unsigned16	RW	No	0x0014 (20)
		Setting range	0x0000-0xFFFF (0 to 65536)		
		Unit	Rotary : min^{-1} ［Linear : mm/s］		

0x2016: Disturbance Observer Function Parameter

Index	0x2016	Sets various parameters in the disturbance suppression observer. Observer compensation operates with control word 1 (0x2000) bit 11: disturbance Observer compensation enable [OBSCON]="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 "0x00: Low" for use of Load torque (force) monitor (estimate value). ◆Select "0x02: High" when the encoder resolution is over 1048576P/R (20bit).				
0x02	Observer Compensation Gain ［OBG］ Observer Compensation gain in response to the Torque (force) command. ◆ The larger the value, the higher the suppression performance. However, it may oscillate with too higher value. By making this larger with avoiding oscillation, the disturbance suppression characteristics improve.	Unsigned16	RW	No	0x0000 (0)
		Setting range	0x0000-0x0064 (0 to 100)		
		Unit	1 %		
0x03	Observer Low-pass Filter ［OBLPF］ Primary 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)
		Setting range	0x0001-0x0FA0 (1 to 4000)		
		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 "0x01: Middle", or "0x02: High" regardless of set value.				
0x04	Observer Notch Filter ［OBNFIL］ Notch filter to eliminate arbitrarily selected frequency from observer compensation. Set the resonant frequency of the filter. ◆When resonance appears in disturbance observer output, such as resonance with the mechanical system, this notch filter sometimes suppresses the vibration.	Unsigned16	RW	No	0x0FA0 (4000)
		Setting range	0x0064-0x0FA0 (100 to 4000)		
		Unit	Hz		
	◆Setting value can be input by 1Hz; inside the servo amplifier, the units listed below are used. Set value / Unit and process inside servo amplifier 100 to 1999Hz / Valid by 10Hz and drop less than 10 2000 to 4000Hz / Filte invalid 				
0x05	Observer Load Inertia Moment Ratio ［OBJLJM］ Sets the Inertia moment (Load Inertia) of the loading device for the motor inertia moment at the disturbance suppression observer. Set value = JL/JM×100%	Unsigned16	RW	No	0x0064 (100)
		Setting range	0x0000-0x1388 (0 to 5000)		
		Unit	%		
	(JL: Load inertia, JM: Motor rotor inertia) ✓ JRAT 1-4 are used when low frequency is set to the disturbance suppression observer characteristic selection.				
0x06	Observer Proportional Gain ［OBPGIN］ Proportional gain of the observer control.	Unsigned16	RW	No	0x012C (300)
		Setting range	0x0001-0x07D0 (1 to 2000)		
		Unit	Hz		
0x07	Observer 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. Filter is invalid at the set value 2000Hz (0x07D0).	Unsigned16	RW	No	0x0032 (50)
		Setting range	0x0001-0x07D0 (1 to 2000)		
		Unit	Hz		

A note of caution in using Model Following Control

- ✔ Even 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 Suppression 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 Suppression Control function does not operate.

0x2017: Model Control Gain

Index	0x2017	Proportional gain of the Model Following Control Position Controller.	Object Code		Array
Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Number of entry	Unsigned8	RO	No	0x04
0x01	Model Control Gain 1 ［KM1］ ◆Overwritten by Auto-tuning result saving. ◆When gain 1(bit5, 4=0, 0) is selected in the Gain Switching function, it operates at this setting value.	Unsigned16	RW	Possib le	0x001E (30)
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)
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)
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)
	Setting range differs depending on the setting value of Position control selection (0x20F3:01). 01: Model Following Control (Rigid body) 0x0001-0x0BB8 (1 to 3000 /s) 02: Condition Feedback Model Following Vibration Suppression Control (Machine stand vibration suppression) 0x000F-0x013B (15 to 315 /s) ◆In case of operating with Model following vibration suppression control, use in the range of 15 to 315 /s. ◆Change value while the servo motor is OFF.	Setting range	0x0001～0x0BB8 (1 to 3000)		
		Unit	1 /s		

0x2018: Overshoot Suppression Filter

Index	0x2018	Filter to suppress overshoot with Model following control or Model following vibration suppressor control. Sets cutoff frequency.	Object Code		VARIABLE
Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Overshoot Suppression 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)
		Setting range	0x0001-0x0FA0 (1 to 4000)		
		Unit	Hz		

0x2019: Model Control Antiresonance Frequency

Index	0x2019	Sets antiresonance frequency to the mechanical device with Model following vibration suppression control. Sets actual antiresonance frequency value of the mechanical system by using System Analysis function of the Setup Software.	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 control vibration suppression frequency switching at 0x2001, it operates at this setting value.	Unsigned16	RW	Possible	0x0320 (80.0) invalid
0x02	Model Control Antiresonance Frequency 2 ［ANRFRQ2］ ◆When frequency 2 (bit1, 0=0, 1) is selected in the model control vibration suppression frequency switching at 0x2001, it operates at this setting value.	Unsigned16	RW	No	0x0320 (80.0) invalid
0x03	Model Control Antiresonance Frequency 3 ［ANRFRQ3］ ◆When frequency 3 (bit1, 0=1, 0) is selected in the model control vibration suppression frequency switching at 0x2001, it operates at this setting value.	Unsigned16	RW	No	0x0320 (80.0) invalid
0x04	Model Control Antiresonance Frequency 4 ［ANRFRQ4］ ◆When frequency 4 (bit1, 0=1, 1) is selected in the model control vibration suppression frequency switching at 0x2001, it operates at this setting value.	Unsigned16	RW	No	0x0320 (80.0) invalid
◆Setting value is invalid with model following control. ◆If the sitting value is over the Model Control Resonance Frequency, vibration suppression control is invalid. ◆If "Model Control Anti-resonance Frequency 2-4" are selected in the "Model vibration suppression frequency switching function", it operates at this setting value. ◆Change value while the servo motor is OFF.			Setting range Unit	0x0064-0x0320 (10.0 to 80.0) 0.1 Hz	

0x201A: Model Control Resonance Frequency

Index	0x201A	Sets resonance frequency of the mechanical device with Model following vibration suppression control. Sets actual resonance frequency value of the mechanical system by using System Analysis function of the Setup Software.	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 control vibration suppression frequency switching at 0x2001, it operates at this setting value.	Unsigned16	RW	Possible	0x0320 (80.0) invalid
0x02	Model Control Resonance Frequency 2 ［RESFRQ2］ ◆When frequency 2 (bit1, 0=0, 1) is selected in the model control vibration suppression frequency switching at 0x2001, it operates at this setting value.	Unsigned16	RW	No	0x0320 (80.0) invalid
0x03	Model Control Resonance Frequency 3 ［RESFRQ3］ ◆When frequency 3 (bit1, 0=1, 0) is selected in the model control vibration suppression frequency switching at 0x2001, it operates at this setting value.	Unsigned16	RW	No	0x0320 (80.0) invalid
0x04	Model Control Resonance Frequency 4 ［RESFRQ4］ ◆When frequency 4 (bit1, 0=1, 1) is selected in the model control vibration suppression frequency switching at 0x2001, it operates at this setting value.	Unsigned16	RW	No	0x0320 (80.0) invalid
◆Setting value is invalid with model following control. ◆Filter is invalid at the setting value 0x320 (80Hz). ◆If "Model Control Anti-resonance Frequency 2-4" are selected in the "Model vibration suppression frequency switching function", it operates at this setting value. ◆Change value while the servo motor is OFF.		Setting range Unit	0x0064-0x0320 (10.0 to 80.0) 0.1 Hz		

0x201B: Gain Switching Filter

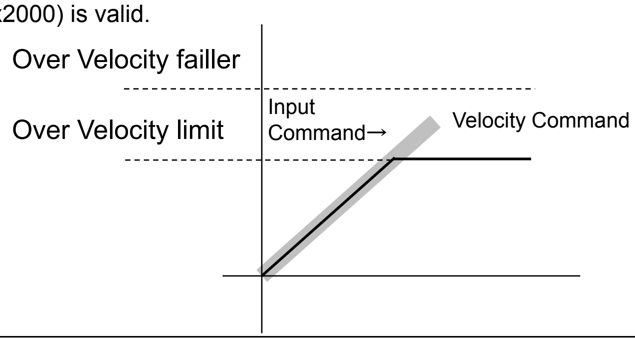
Index	0x201B	Primary low-pass filter to change gain moderately when switching. Sets time constant.	Object Code	VARIABLE

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)
		Setting range	0x0000-0x064 (0 to 100)		
		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.				

0x201C: Internal Velocity Command limit

Index	0x201C	Sets the allowable velocity in response to the Internal Velocity Command.	Object Code	VARIABLE

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Internal Velocity Command limit [VCMMAX] In the cyclic sync position (csp), the profile position (pp) or the Interpolated position (ip) mode, the internal velocity command is limited. In the cyclic sync velocity (csv) or the profile velocity (pv) mode, it is clamped at the setting value in response to the velocity command. Moreover, when Setting value ≧ ｜Velocity Command｜ velocity-limit warning bit is set.	Unsigned16	RW	No	0xFFFF (65535)
		Setting range	0x0000-0xFFFF (0 to 65535)		
		Unit	Rotary : min^{-1} ［Linear : mm/s］		
	◆When the setting value is 0 min^{-1}, or 50000 min^{-1} or more, 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 1 (0x2000) is valid. ✍ The rotary motor differs from linear motor in unit.				



0x201E: Sequence Operation Torque (force) Limit Value

Index	0x201E	Parameter to set the output torque (force) in Sequence Operation.	Object Code	VARIABLE

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Sequence Operation Torque (force) Limit Value ［SQTCLM］ This is Torque (force) Limit Value for the following sequence controls. ◆Sequence Operation Torque (force) Limit is adapted with “Quick stop operation,” “Emergency Stop operation,” as well as “Servo-braking operation,” “JOG operation,” “Forward/Reverse limit operations” at alarm occurrence, and “holding brake down time” when the servo ON.	Unsigned16	RW	No	0x04B0 (120.0)
		Setting range	0x0064-0x1388 (10.0 to 500.0)		
		Unit	0.1 %		
	Moreover, when power lowering torque (force) limit selection (0x20F5) is “0x01,” electric current is limited including this setting value. ◆Sets the limiting torque (force) by the ratio of rated output torque (force). (100.0%=rated torque (force)) ◆When the value is set exceeding the Maximum instant stall torque (force) (TP) of the combining servo motor, it is limited by the Maximum instant stall torque (force) (TP) of the combining servo motor. ✓ When overload 1 alarm occurs, it is limited to 120% in case a value of more than 120% is set.				

0x201F: Near Range

Index	0x201F	A position range variation counter for positioning completion/ near range completion monitoring.	Object Code	VARIABLE

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Near Range ［NEAR］ ◆ Outputs Near range signal when the Position deviation counter is set lower that this set value. ◆Sets at the resolution of the encoder pulse ｜Following Error Actual Value｜ ≦ Set value	Unsigned32	RW	No	0x01F4 (500)
		Setting range	0x00000001-0x7FFFFFFF (1 to 2147483647)		
		Unit	UP (User Position unit)		
	When the actual position variation is greater than the setting value, it is output from near range completion monitor (NEAR monitor.)				

0x2020: Speed Zero Range

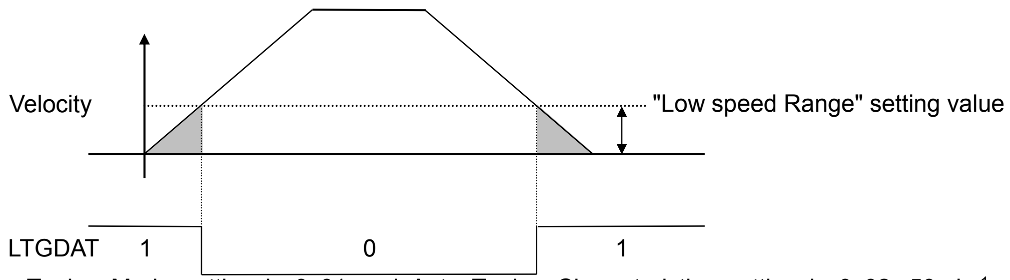
Index	0x2020	Setting value for detecting Zero-speed status (motor stop). Sets the allowable range at Zero-speed.	Object Code	VARIABLE

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Speed Zero Range [ZV] |Actual Velocity| ≦ Set value When the Actual Velocity condition below the Setting value is continuously detected, zero velocity monitor (ZV) is output. Set same value with 0x606F because of same parameter. ✍ The rotary motor differs from linear motor in unit.	Unsigned16	RW	No	0x0032 (50)
		Setting range	0x0005-0x01F4 (5 to 500)		
		Unit	Rotary : min^{-1} [Linear : mm/s]		

0x2021: Low Speed Range

Index	0x2021	Sets the acceptable Low Speed Range of the motor rotation speed.	Object Code	VARIABLE

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Low Speed Range [LOWV] When the speed is lower than this value, Low speed is output. |Actual Velocity| ≦ Set value then LTG flag is set.	Unsigned16	RW	No	0x0032 (50)
		Setting range	0x0000-0xFFFF (0 to 65535)		
		Unit	Rotary : min^{-1} [Linear : mm/s]		



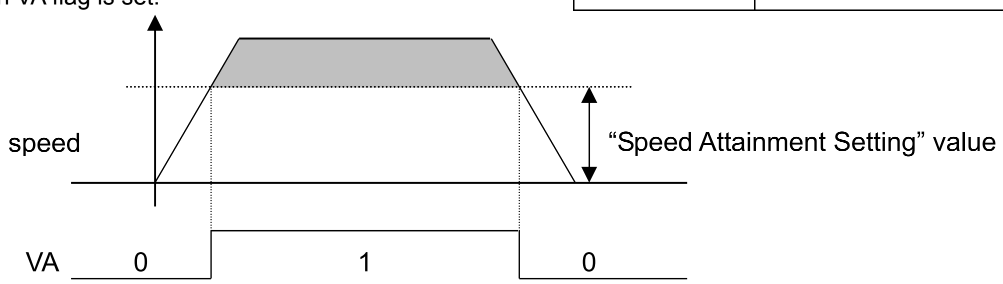
✓ If Auto Tuning Mode setting is 0x01 and Auto Tuning Characteristics setting is 0x02, 50min^{-1} will be set automatically.

✍ The rotary motor differs from linear motor in unit.

0x2022: Speed Attainment Setting (High Speed Range)

Index	0x2022	Sets the speed attainment level of the motor rotation speed.	Object Code	VARIABLE

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Speed Attainment Setting [VA] Used as arrival confirmation in response to a high-speed rotation command; When the speed exceeds this setting value, Speed attainment is output. |Actual Velocity| ≧ Set value, then VA flag is set.	Unsigned16	RW	No	0x03E8 (1000)
		Setting range	0x0000-0xFFFF (0 to 65535)		
		Unit	Rotary : min^{-1} [Linear : mm/s]		



◆While operating with torque (force) control mode, simple velocity control is exercised by this parameter.

✓ When Motor speed exceeds this setting value, as the velocity sets at zero, control of unstable velocity cannot be exercised. Avoid the use of such status to continue.

✍ The rotary motor differs from linear motor in unit.

0x2023: Analog Monitor Output Selection

Index	0x2023	Selects the output selection and the polarity of Analog Monitor 1, 2.	Object Code		Array
Sub-Idx	**Description**		**Data Type**	**Access**	**PDO**
0x00	Number of entry		Unsigned8	RO	No

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Number of entry	Unsigned8	RO	No	0x03
0x01	Analog Monitor Output Selection 1 ［MON1］	Unsigned8	RW	No	0x05
		Setting range	0x01-0x36		
0x02	Analog Monitor Output Selection 2 ［MON2］	Unsigned8	RW	No	0x02
		Setting range	0x01-0x36		
0x03	Analog Monitor Output Polarity ［MONPOL］	Unsigned8	RW	No	0x00
		Setting range	0x00-0x08		

0x01: Analog Monitor Output Selection 1 ［MON1］

Selects data to output from Analog Monitor 1.

\# Rotary motor

0x00：	Reserved（For maintenance by manufacturer）	
0x01：	Torque（force） monitor	2V/rated Torque（force）
0x02：	Torque（force） command monitor	2V/rated Torque (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 pulse frequency 1	2mV/kPulse/s
0x12：	Position command pulse frequency 1	10mV/kPulse/s
0x13：	Position command pulse frequency 2	0.05mV/kPulse/s
0x14：	Position command pulse frequency 2	0.5mV/kPulse/s
0x15：	Position command pulse frequency 2	2mV/kPulse/s
0x16：	Position command pulse frequency 2	10mV/kPulse/s
0x17：	Load Torque（force）monitor	2V／ratedTorque（force）
0x18：	Phase U electrical angle sine	8Vpeak
0x19：	Acceleration monitor	0.01mV/rad/s^2
0x1A：	Acceleration monitor	0.1mV/rad/s^2
0x1B：	Acceleration monitor	1mV/rad/s^2
0x1C：	Acceleration monitor	10mV/rad/s^2
0x1D：	Bus voltage monitor	1V/100V DC
0x1E：	Bus voltage monitor	1V/10V DC
0x1F：	Dual position error monitor	10mV/Pulse
0x20：	Dual position error monitor	0.1mV/Pulse
0x21：	Axes sync error monitor	10mV/Pulse
0x22：	Axes sync error monitor	1mV/Pulse
0x23：	Overload detecting temperature attainment rate	0.5V/%
0x24：	Position command pulse frequency 1	0.01mV/kPulse/s
0x25：	Position command pulse frequency 1	0.05mV/kPulse/s
0x26：	Position command pulse frequency 1	0.5mV/kPulse/s
0x27：	Position command pulse frequency 2	0.01mV/kPulse/s
0x28：	Average power monitor	1V/10W
0x29：	Average power monitor	1V/100W
0x2A：	Average power monitor	1V/1kW
0x2B：	Average power monitor	1V/10kW
0x2C：	Average power monitor	1V/100kW
0x2D：	Torque command monitor (before filter)	2V/rated torque(force)
0x2E：	Position deviation difference monitor	0.01mV/Pulse
0x2F：	Position deviation difference monitor	0.1mV/Pulse
0x30：	Position deviation difference monitor	1mV/Pulse
0x31：	Position deviation difference monitor	10mV/Pulse
0x32：	Position deviation difference monitor	20mV/Pulse
0x33：	Position deviation difference monitor	50mV/Pulse
0x34：	Load inertia moment ratio monitor	10mV/%
0x35：	Load inertia moment ratio monitor	5mV/%
0x36：	Load inertia moment ratio monitor	0.5mV/%

0x37-0xFF： Reserved

◆Position command pulse frequency1 monitors position command pulse before position somoothing passing.

◆Position command pulse frequency2 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

0x02: Analog Monitor Output Selection 2 ［MON2］

Selects the data to output from Analog Monitor 2.
The setting value is the same as in Analog Monitor output selection 1.

0x03: Analog Monitor Output Polarity ［MONPOL］

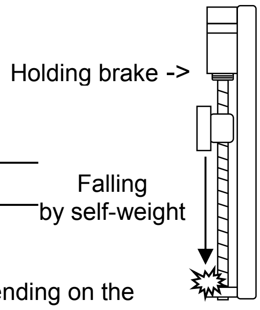
Selects the output polarity of analog monitor 1/2.

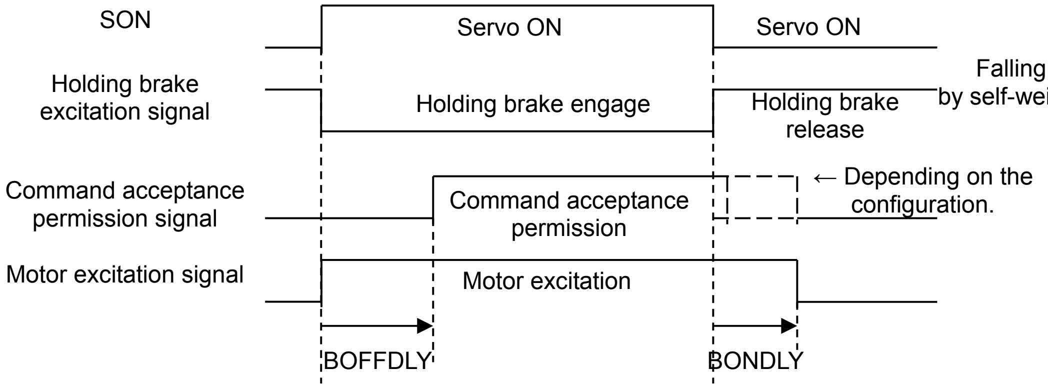
◆For both MON1 and MON2, set from any of the followings:
+No Polarity Rotation, - Polarity Rotation, ABS Absolute Value Output

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

Index	0x2024	Sets holding-brake-activation delay time from when power distribution to holding brake stopped till when holding torque generated.	Object Code	VARIABLE

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Delay Time of Engaging Holding Brake ［BONDLY］ ◆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.)	Unsigned16	RW	Possible	0x012C (300)
		Setting range	0x0000-0x03E8 (0 to 1000)		
		Unit	ms		
	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, command becomes valid for approximately 4ms after servo OFF. ✓ Because the setting unit is valid in 4ms steps, the remainder, divided by 4, is cut off inside the amplifier.				

0x2025: Delay Time of Releasing Holding Brake (Holding Brake Releasing Delay time)

Index	0x2025	Sets holding-brake-release delay time from when power distribution to holding brake started till when holding torque disappeared.	Object Code	VARIABLE

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Delay Time of Releasing Holding Brake ［BOFFDLY］ ◆While shifting from servo OFF to servo ON, during the setting time, Excitation command 0 is given to servo motor.	Unsigned16	RW	No	0x012C (300)
		Setting range	0x0000-0x03E8 (0 to 1000)		
		Unit	ms		
	(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.				

0x2026: Brake Operation Beginning Time

Index	0x2026	Parameter to compulsorily set the time to operate the Dynamic brake and the Holding brake when motor does not stop at Servo OFF and EMR upon entry.	Object Code	VARIABLE

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Brake Operation Beginning Time ［BONBGN］ Sets permissible time from servo OFF until servo motor stop. ◆At the time of Quick Stop operation, Emergency Stop (EMR), Servo brake stop alarm occurrence, if motor velocity does not reach less than 50min^{-1}, it signals the Dynamic brake operation and the Holding brake operation that are then output and motor excitation is discharged.	Unsigned16	RW	Possible	0x2710 (10)
		Setting range	0x0000-0xFFFF (0 to 65535)		
		Unit	ms		
	◆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.				

0x2027: Power Failure Detection Delay Time

Index	0x2027	Sets the delay time from Control power OFF to Control power error detection.		Object Code		VARIABLE
Sub-Idx	**Description**		**Data Type**	**Access**	**PDO**	**Initial value**
0x00	Power Failure Detection Delay Time ［PFDDLY］ ◆By making the setting value greater, delay in alarm detection time is possible. However, this does not guarantee the retention of Control power until the setting time.		Unsigned16	RW	No	0x0020 (32)
			Setting range	0x0014-0x03E8 (20 to 1000)		
			Unit	ms		
	◆When power source of the control logic expires, it operates the same as when Control power is interrupted. When the Main circuit power reaches a lower point than Control power, other alarms may occur. ✓ In this setting, actual detection delay time varies by -12ms - +6ms.					

0x2028: Excessive Deviation Warning Level

Index	0x2028	Sets Warning output level before Excessive position deviation alarm is output.		Object Code		VARIABLE
Sub-Idx	**Description**		**Data Type**	**Access**	**PDO**	**Initial value**
0x00	Excessive Deviation Warning Level ［OFWLV］ When the actual deviation exceeds the setting value, within the range relatively regarded as warning against the position, Excessive Deviation Warning engages. |Following Error Actual Value| ≧ Set value		Unsigned32	RW	No	0x7FFFFFFF (2147483647)
			Setting range	0x00000001 to 0x7FFFFFFF (1 to 2147483647)		
			Unit	UP (User Position unit)		

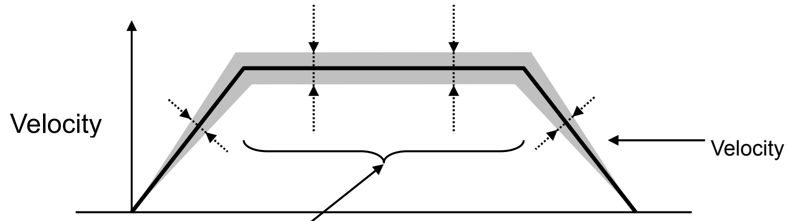
Positioning completion range -> See Position Window (0x6065 of the function group “position”.)

0x2029: Overload Warning Level

Index	0x2029	Parameter to output Warning before detecting the Overload warning.		Object Code		VARIABLE
Sub-Idx	**Description**		**Data Type**	**Access**	**PDO**	**Initial value**
0x00	Overload Warning Level ［OLWLV］ ◆The allowable setting Level range is as follows (the Overload warning level =100%;) <u>Set value < 20% or 100% ≧ Set value</u>		Unsigned16	RW	No	0x005A (90)
			Setting range	0x0014-0x0064 (20 to 100)		
			Unit	%		
	When set to 100%, Overload warning and Overload alarm are output at one time. ✓ Overload detection is assumed and set as 75%, of a rated load when Control power is turned ON (hot start). This is to prevent motor damage due to the estimation value reset by power re-closing and operation resumption immediately after the occurrence of Overload alarm when it is set at 0%. Therefore, when Overload warning level is set at 75% or less, Overload warning may be output when Control power is turned ON.					

0x202A: Speed Matching Range

Index	0x202A	Sets the ratio [%] of the range regarded as velocity matching against velocity commands. This value setting is used when “Speed Matching unit selection” is “0x01_Percent.”		Object Code		VARIABLE
Sub-Idx	**Description**		**Data Type**	**Access**	**PDO**	**Initial value**
0x00	Speed Matching Range ［VCMPR］ Velocity matching is output when the Velocity deviation (difference between the velocity command and actual velocity) is within this setting range. |Actual Velocity| ≦ Set value then VCMP monitor is set.		Unsigned16	RW	No	0x0032 (5.0)
			Display range	0x0000-0x03E8 (0.0 to 100.0)		
			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 Order

Index	0x202B	The filter order is set at Torque (force)command filter		Object Code		VARIABLE
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Torque (force) Command Filter Order ［TCFILOR］		Unsigned8	RW	No	0x02
	If the cutoff frequency of the torque (force) order filter is switched with the gain switch, the order is fixed at this setting value. 0x01: Primary Filter 0x02: Secondary Filter 0x03: Tertiary Filter 0x00, 0x04-0xFF: Reserved		Setting range	0x01-0x03		

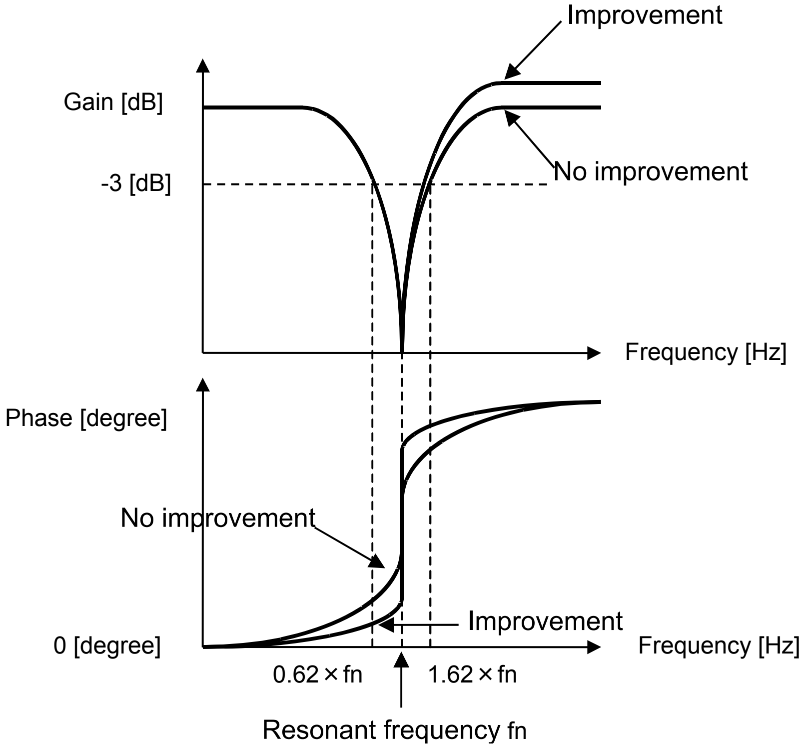
0x202C: FF Vibration SuppressionControl level Selection A

Index	0x202C	Sets the characteristics of 0x2012 FF vibration suppression frequency in operation.		Object Code		VARIABLE
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	FF Vibration SuppressionControl level Selection A ［SUPLV］		Unsigned8	RW	No	0x00
	Parameter to set the magnitude of the vibration suppression frequency effect. ◆Change while servo motor is OFF. ◆The smaller the value, the greater the effect will be. ◆FF vibration suppressor frequency switching function does not affect this. 0x00: -∞ 0x01: -30dB 0x02: -20dB 0x03: -10dB 0x04-0xFF: Reserved		Setting range	0x00-0x03		

0x202D: Torque (force) Command Notch Filter Characteristic

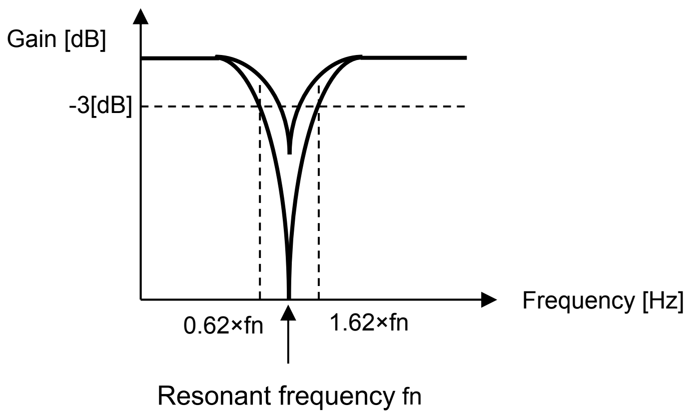
Index	0x202D	Sets characteristic of Torque Command Notch Filter.	Object Code		Array
Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Number of entry	Unsigned8	RO	No	0x05
0x01	TCNFILA, Low Frequency Phase Delay Improvement [TCNFPA]	Unsigned8	RW	No	0x00
	◆Improves phase delay at lower frequency than resonant frequency of the Torque Command Notch Filter A.	Setting range	0x00-0x02 (0 to 2)		

◆The larger the value is, the greater the improvement.
◆Characteristic is same as the standard notch filter when the setting value is 0.
◆Caution, other than the setting value 0, higher frequencies than the resonant frequency will be amplified.



Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x02	TCNFILB, Depth Selection [TCNFDB]	Unsigned8	RW	No	0x00
0x03	TCNFILC, Depth Selection [TCNFDC]	Unsigned8	RW	No	0x00
0x04	TCNFILD, Depth Selection [TCNFDD]	Unsigned8	RW	No	0x00
0x05	TCNFILE, Depth Selection [TCNFDE]	Unsigned8	RW	No	0x00
	◆Parameters to set the depth of each Torque Command Notch Filter (TCNFILB to E). The larger the value is, the shallower the depth.	Setting range	0x00-0x0F (0 to 15)		

◆The value set to TCNFILE, Depth Selection will be valid when “00: Adp_Filter Disable Adaptation invalid” is set to 0x2060.1 “Adaptive notch filter function E”.



4 Object Dictionary

0x202E: Torque (force) attainment setting

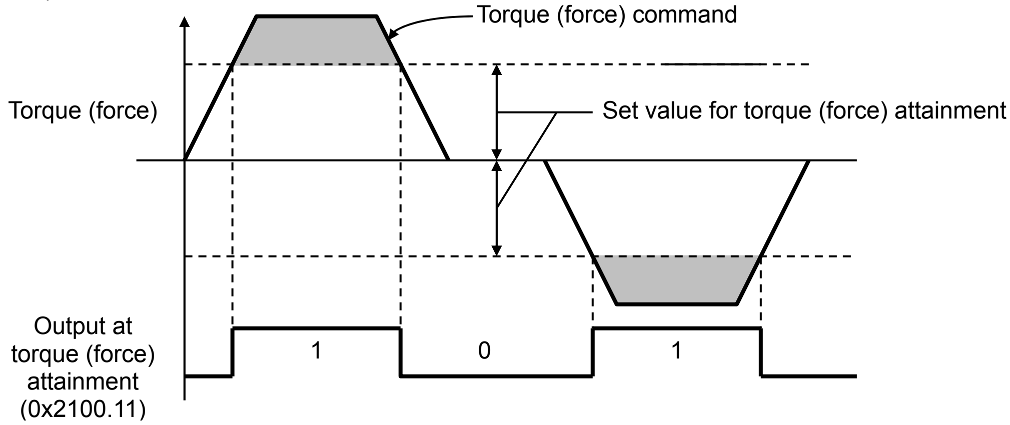
Index	0x202E	Sets detection level of torque attainment monitor (a function to detect that commanded internal torque value exceeds set value).	Object Code	VARIABLE

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Torque (force) attainment setting [TA]	Unsigned16	RW	No	0x03E8 (100.0)
		Setting range	0x0000-0x1388 (0.0 to 500.0)		
		Unit	0.1%		

Sets the ratio of torque (force) attainment. Data subjected to the ratio set by this paramenter vary depending on torque (force) attainment function selection (0x20F4.6).
Sets flag TA (bit11 of 0x2100) in the following case:
|Torque (force) command| ≧ Set value

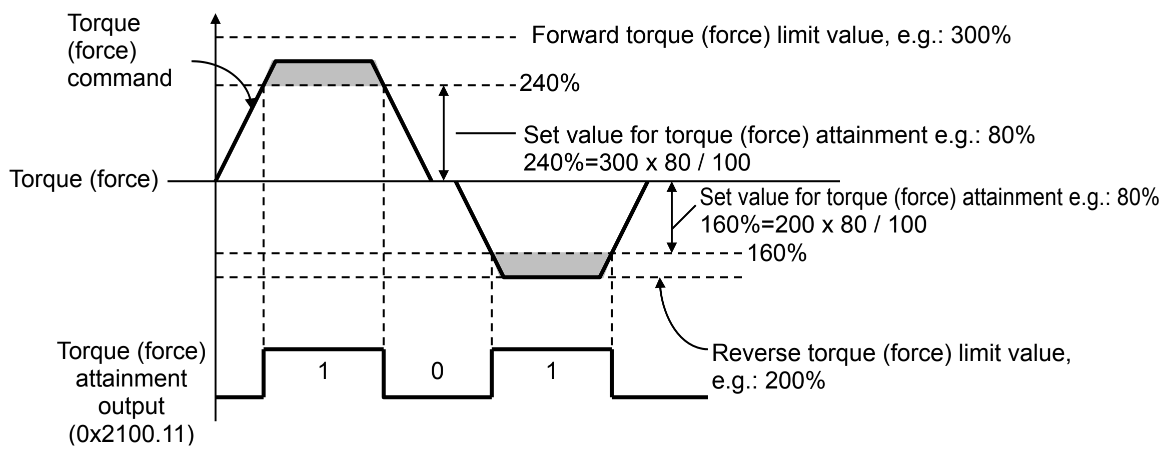
✔ Torque (force) attainment output switches between maximum motor torque ratio and limited torque ratio depending on function selection of torque (force) attainment (0x20F0.6).

◆In the case of 0x00 in Function selection of torque (force) attainment (0x20F0.6).
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.
"1" is set to bit 11 of Index 0x2100: Torque (force) attainment output, when torque (force) command exceeds torque (force) attainment level.



◆In the case of 0x01 in Function selection of torque (force) attainment (0x20F0.6).
Sets the ratio of torque (force) attainment level by using the ratio to torque (force) limit value.
"100.0% = torque (force) limit value"
Torque (force) attainment level is also independently calculated for both forward and reverse direction respectively in amplifier, as torque (force) limit value is independent in both directions respectively.

Forward torque (force) attainment level = Forward torque (force) limit value x set value/ 100.0 [%]
Reverse torque (force) attainment level = Reverse torque (force) limit 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, "1" is set to bit 11 of Index 0x2100: Torque (force) attainment output.

0x202F: Brake activation speed

Index	0x202F	Sets the threshold of brake activation speed when decelerating motor with servo brake according to emergency stop etc.	Object Code	VARIABLE

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Brake activation speed [ZVDAT] Sets the motor stop detection range. Outputs a holding brake signal at lower rotation speed than set value with condition below. Quick Stop, Alarm, Emergency Stop. |Actual Velocity| ≦ Set value It is regarded to motor stop when above condition is detected.	Unsigned16	RW	Possible	0x32 (50)
		Setting range	0x000A-0x01F4 (10 to 500)		
		Unit	min^{-1}		

0x2035: Position Sync Compensation Function Parameter

Index	0x2035	Sets parameters of position synchronization deviation function that control the position deviations of 2 servo amplifiers so that their deviations will be equalized. It is only used at the time of Position control (pp, csp). ✓ For this function, a communication cable should be connected between CN2s which are subject of position synchronization compensation.	Object Code	Record

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Number of entry	Unsigned8	RO	No	0x0B
0x01	Axes Sync Compensation Proportional Gain [KSCP] When the position synchronization compensation is enabled and the set value is 100%, adds the same value as synchronization deviation value (error pulse volume) to the position command. Compensation will be invalid at the set value 0%. ✓ If the value is too large, a vibration may oocur.	Unsigned8	RW	No	0x0000 (0)
		Setting range	0x0000-0x03E8 (0 to 1000)		
		Unit	%		
0x02	Axes Sync Compensation Integral Time Constant [TSCI] Sets integral time constant of position sync 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, please set this parameter to 1000ms (invalid).	Unsigned16	RW	No	0x2710 (1000) Propotional Control
		Setting range	0x0005-0x2710 (0.5 to 1000.0)		
		Unit	0.1ms		
0x03	Axes Sync Compensation Filter [PSYNLPF] Sets time constant of the primary low-pass filter which suppresses any sudden change in the compensation command pulses. Filter will be invalid at the set value 0.0 ms.	Unsigned16	RW	No	0x0000 (0.0) Filter invalid
		Setting range	0x0000-0x2710 (0.0 to 1000.0)		
		Unit	0.1 ms		
0x04	Axes Sync Excessive Error Value [PSDEVAL] Sets acceptable error range for error pulse quantity (sync deviation) of 2 amplifiers. When the actual sync position deviation exceeds the set value, a position sync deviation alarm is issued. Set value ≦ |Sync error pulse quantity|	Unsigned32	RW	No	0x004C4B40 (5000000)
		Setting range	0x00000001-0x7FFFFFFF (1 to 2147483647 Pulse)		
		Unit	Pulse		
0x05	Axes Sync Error Warning Level [PSDEVWN] Sets warning output level which shall be issued before Excessive position sync deviation alarm. When the actual sync position deviation exceeds the set value, position sync deviation warning is issued. Set value ≦ |Sync error pulse quantity|	Unsigned32	RW	No	0x7FFFFFFF (2147483647)
		Setting range	0x00000001-0x7FFFFFFF (1 to 2147483647 Pulse)		
		Unit	Pulse		
0x06	Axes Sync Compensation Input Polarity Selection [SDEVPOR] Selects polarity of position deviation signal which is sent to another servo amplifier for position synchronization. ✓ In consideration of command polarity and motor installation direction, set position deviation polarity which is able to give same output deviation polarities. ✍ It will be valid after control power cycle.	Unsigned8	RW	No	0x00
		Setting range	0x00-0x01 0: Without Polarity Reversal 1: With Polarity Reversal		
0x0A	Servo amplifier communication function selection [AMPIF] Selects the use of communication function (for CN2 connector). ✍ It will be valid after control power cycle.	Unsigned8	RW	No	0x00
		Setting range	0x00-0x01 0: Disabled 1: Tandem		
0x0B	Axes Sync Compensation Proportional Control Switching Function [SYNPCNEN] Able to switch PI control and P control, in the axes-sync compensation function.	Unsigned8	RW	No	0x00
		Setting range	0x00-0x01 0: Disabled 1: Enabled		
	◆ Able to switch when this parameter (SYNPCNEN) is valid. ◆ Assign conditions of becoming valid the axes-sync compensation proportional control switching function. Change to proportional control when SYNPCNEN signal is valid. PI (Proportional-Integral) control: Axes-sync compensation proportional gain (KSCPGN), Axes-sync compensation integral time constant (TSCIGN) P (Proportional) control: Axes-sync compensation proportional gain (KSCPGN) ✓ Servo system will ease to stable when changing to proportional control by reducing axes-sync compensation value. ✓ In the default setting, the axes-sync compensation integral time constant (TSCIGN) is 1000.0ms, so the integral function is invalid.				

✓ If this function is used in PP mode, set the communication cycle setting as DC sync (SYNC0 or SYNC1).

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x0C	Assisting function selection [ASSEL]	Unsigned8	RW	No	0x00
		Setting range	0x00 to 0x02		
		Unit	-		
	0x00: Position assisting function 0x01: Torque assisting function 0x02: Velocity assisting function - Position assisting function is position sync compensation function controlling to be same the position deviations of two servo amplifiers. It performs position compensation by slave axis receiving a position deviation value sent from master axis. Set a position control (CSP or PP) to both of master axis and slave axis. - Torque assisting function performs torque assist by slave axis, receiving a torque command sent from master axis. Master axis uses position or velocity control and sends torque command to slave axis. Set a position control (CSP or PP) or velocity control (CSV or PV) to master axis and a torque control (CST or PT) to slave axis. - Velocity assisting function performs velocity control by slave axis, receiving a velocity command sent from master axis. Master axis sends a velocity command to slave axis. Set a position control (CSP or PP) or velocity control (CSV or PV) to master axis and a velocity control (CSV or PV) to slave axis. For master axis, set invalid (0) to Position sync compensation enabled (0x2000-bit15) in Control Word 1. For slave axis, set valid (1) to Position sync compensation enabled (0x2000-bit15) in Control Word 1. For mutual synchronization, set valid (1) to Position sync compensation enabled (0x2000-bit15) in Control Word 1, in both axes. Mutual synchronization compensation is available just with a position assisting function. ✍ It will be valid after control power cycle.				
0x0D	Assisting rate [ASCP] In case that a torque assisting function set 100 %, torque command is added with 1-multiplied. Torque assist becomes invalid if set 0 %. In case that a velocity assisting function set 100 %, velocity command is added with 1-multiplied. Velocity assist becomes invalid if set 0 %.	Unsigned8	RW	No	0x00
		Setting range	0x0000 to 0x0064 (0 to 100)		
		Unit	%		
✓ To use this function in PP mode, communication sync setting shall be DC sync (SYNC0 or SYNC1).					

Set value of assisting function selection and available operation mode

Assisting function	Assisting function selection 0x2035-0x0C	Master/Slave	Control Word 1 Flag of bit15	Operation mode 0x6060
Position assisting	0	Master	0	CSP, PP
		Mutual	1	CSP, PP
		Slave	1	CSP, PP
Torque assisting	1	Master	0	CSP, PP, CSV, PV
		Slave	1	CST, PT
Velocity assisting	2	Master	0	CSP, PP, CSV, PV
		Slave	1	CSV, PV

0x203C: Software Limit Deceleration

Index	0x203C	Function reserved		Object Code		VARIABLE
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Software Limit Deceleration [SLTDEC]		Unsigned32	RW	No	0xFFFFFFFF
			Setting range	0x00000000-0xFFFFFFFF		
			Unit	UP (User Position unit) /s^2		
	Function reserved					

0x2050: Quadrant Glitch Compensation Function

Index	0x2050	Sets Quadrant Glitch Compensation Function. It compensates trajectory error occurred due to quadrant switching, in use of applications for arc-shape or curved surface process, such as NC machining equipments.	Object Code		Record
Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Number of entry	Unsigned8	RO	No	0x04
0x01	Quadrant Glitch Compensation Function [STC] Set the valid/invalid of Quadrant Glitch Compensation Function.	Unsigned8	RW	Possible	0x00
		Setting range	0x00-0x29		
	◆Sets validity condition of Quadrant Glitch Compensation Function. It is valid when STC signal is enabled. ◆Setting range of this function is 0x00 to 0x29 in the function valid condition list.				
0x02	Quadrant Glitch Compensation Effective Velocity [STV] Sets the velocity for working this function.	Unsigned16	RW	Possible	0x0064 (10.0)
		Setting range	0x0001-0x0500 (0.1 to 128.0)		
		Unit	min^{-1}		
	◆This function will work when setting value is less than amplifier internal velocity command.				
0x03	Quadrant Glitch Compensation Kept time [STHLD] Sets the time for keeping this function.	Unsigned16	RW	Possible	0x0014 (20)
		Setting range	0x0001-0x01F4 (1 to 500)		
		Unit	ms		
	◆This function will work until this setting time, even if servo amplifier internal velocity command exceeds effective velocity. ◆If velocity loop response is low , set the this time longer.				
0x04	Quadrant Glitch Compensation Velocity Loop Integral Time Constant [STTVI] Sets the integral constant of this function.	Unsigned16	RW	Possible	0x001E (3.0)
		Setting range	0x0003-0x2710 (0.3 to 1000.0)		
		Unit	ms		
	◆This value is applied to velocity loop integral constant, during this function is performed. ◆For this parameter, the value smaller than 1 to 4, normally used for velocity loop integral time constant, shall be set. If set higher than normal value, there will be no effect as Quadrant Glitch Compensation. ◆Quadrant Glitch Compensation will disable when velocity loop is proportional control.				

0x2051: Minor Vibration Suppression function

Index	0x2051	Suppress mechanical minor vibration by encoder pulse fluctuation when motor stop.	Object Code		Record

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Number of entry	Unsigned8	RO	No	0x03
0x01	Minor Vibration Suppression function [FBHYST] Sets valid/invalid of Minor Vibration Suppression.	Unsigned8	RW	Possible	0x00
		Setting range	0x00-0x29		
	◆It is able to suppress mechanical system-induced vibration caused by encoder pulse ±1 modulation is enabled when motor stops. ◆The conditions for enabling this sfunction are assigned. This function becomes enabled If the FBHYST signal is valid. ◆Setting range of this function is same as 0x00 to 0x29 of function valid condition list in 0x2010.				
0x02	Minor Vibration Suppression Pulse Compensation Value [FBHPLS] Sets the compensation amount of Minor vibration suppression function for velocity feedback. Unit of set value is 1 pulse of encoder.	Unsigned16	RW	No	1
		Setting range	1 to 100		
		Unit	Pulse		
	◆Sets by multiple of FBHTIM. If not multiple of FBHTIM, the actual Minor vibration suppression pulse compensation frequency will have deviation with FBHTIM.				
0x03	Minor Vibration Suppression Pulse Compensation Count [FBHTIM] Sets the number of Minor vibration suppression.	Unsigned16	RW	No	1
		Setting range	1 to 100		
		Unit	times		
	◆This value will be valid if Minor vibration suppression function is valid.				

0x2052: Position Deviation Difference

Index	0x2052	Sets the position deviation difference setting.	Object Code		Record

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Number of entry	Unsigned8	RO	No	0x04
0x01	Position Deviation Difference Warning Level [PDDWLV] Sets warning output level of position deviation difference.	Unsigned32	RW	No	0x0000
		Setting range	0x00000000 to 0x7FFFFFFF (0 to 2147483647)		
		Unit	Pulse		
	◆Set zero when in model control mode. ◆Position deviation difference warning is not detected when set value is 0 [pulse]. ◆Check that set value of load inertia moment ratio is correct, when this value is not zero [pulse]. ◆Uses as warning output before issuing position deviation difference excess alarm.				
0x02	Position Deviation Difference Excess Alarm Level [PDDALV] Sets the compensation amount of Minor vibration suppression function for velocity feedback. Unit of set value is 1 pulse of encoder.	Unsigned32	RW	No	0x0000
		Setting range	0x00000000 to 0x7FFFFFFF (0 to 2147483647)		
		Unit	Pulse		
	◆Set zero when in model control mode. ◆Position deviation difference alarm is not detected when set value is 0 [pulse]. ◆Check that set value of load inertia moment ratio is correct, when this value is not zero [pulse].				
0x03	Position Deviation Difference Excess Detection LPF [PDDLPF] The set value for adjusting LPF of position deviation difference excess alarm/warning detection.	Unsigned16	RW	No	0x0000
		Setting range	0x0000 to 0x0FA0 (0 to 4000)		
		Unit	Hz		
	◆Set this parameter as reducing the position deviation difference, if LPF adjusting required. ◆The filter is disabled by setting value 0Hz, or 2000Hz or more.				
0x04	Position Deviation Difference Detection Continuing Time [PDDTIM] Alarm or Warning issues when position deviation difference excess level or warning level continues with this setting time.	Unsigned16	RW	No	0x0000
		Setting range	0x0000 to 0x03E8 (0 to 1000)		
		Unit	ms		

0x2053: System Analysis Parameter

Index	0x2053 System Analysis Parameter		Object Code		RECORD
Sub-Idx	Description	Data type	Access	PDO	Initial value
0x00	Number of entry	Unsigned8	RO	No	2
0x01	Torque Command Value	Unsigned16	RW	No	0x01F4 (50.0)
		Setting range	0x0064 to 0x03E8 (10.0 to 100.0)		
		Unit	0.1 %		
0x02	Frequency Range Selection 0:1.0 – 30, 1:1.0-60, 2:1.0-125, 3:1.25 – 250, 4:2.5 - 500, 5:5.0 - 1000, 6:10.0 – 2000	Unsigned8	RW	No	6
		Setting range	0x00 to 0x06		
		Unit	Hz		

0x2054: System Analysis Data Measurement

Index	0x2054 System Analysis Data Measurement		Object Code		RECORD
Sub-Idx	Description	Data type	Access	PDO	Initial value
0x00	Number of entry	Unsigned8	RO	No	3
0x01	System Analysis Running Command Performs system analysis measurement when running command (0x005a) is input.	Unsigned16	WO	No	0
		Setting range	0x0000 to 0xFFFF (0 to 65535)		
0x02	System Analysis Running Status 0: Waiting 1: Running	Unsigned8	RO	No	0
		Display range	0x00 to 0x01		
0x03	System Analysis Running Result 0: Incompletion 1: Normal completion 2: Abnormal completion	Unsigned8	RO	No	0
		Display range	0x00 to 0x02		

0x2055: POFF Detection Delay Time

Index	0x2055	Sets a delay time from main power shutdown to power OFF state detection.	Object Code		VARIABLE
Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	POFF Detection Delay Time [POFFDLY] ◆By making the setting value greater, delay in power OFF detection time is possible.	Unsigned16	RW	No	0x0000 (0)
		Setting range	0x0000 to 0x03E8 (0 to 1000)		
		Unit	ms		
	Heretofore POFF detection has after Power Failure Detection Delay Time (0x2027) passed. This parameter can control POFF detection timing independent of control power shutdown. POFF detection is after Power Failure Detection Delay Time (0x2027) passed if set value is 0 ms. ✔It will be valid after control power cycle.				

4 Object Dictionary

0x2060: Adaptive Notch Filter E

<table>
<tr><td>Index</td><td>0x2060</td><td colspan="2">Sets the function of torque command notch filterE.</td><td colspan="2">Object Code</td><td>Record</td></tr>
<tr><td>Sub-Idx</td><td colspan="2">Description</td><td>Data Type</td><td>Access</td><td>PDO</td><td>Initial value</td></tr>
<tr><td>0x00</td><td colspan="2">Number of entry</td><td>Unsigned8</td><td>RO</td><td>No</td><td>0x04</td></tr>
<tr><td rowspan="3">0x01</td><td colspan="2" rowspan="2">Adaptive Notch Filter Function E ［ADNFE］
This is the parameter which selects function of torque command notch filter E.</td><td>Unsigned8</td><td>RW</td><td>No</td><td>0x00</td></tr>
<tr><td>Setting range</td><td colspan="3">0x00-0x01</td></tr>
<tr><td colspan="6">◆By setting "01: Adp_Filter Enable Adaptation at all times", notch filter E will be adjusted to mechanical resonant frequency automatically.
When adaptive notch filter function is valid, 0x202D.5 will be fixed to 0.
0x2014.5 will work as initial value of adaptive notch filter.
<u>0x00: Adp_Filter Disable Adaptation invalid (TCNFILE manual setting)</u>
<u>0x01: Adp_Filter Enable Adaptation at all times</u></td></tr>
<tr><td rowspan="4">0x02</td><td colspan="2" rowspan="3">Adaptive Notch Filter Frequency Upper Limit E [ADNFUE]
Sets adaptive notch filter frequency upper limit.</td><td>Unsigned16</td><td>RW</td><td>No</td><td>1000</td></tr>
<tr><td>Setting range</td><td colspan="3">100 to 1000</td></tr>
<tr><td>Unit</td><td colspan="3">Hz</td></tr>
<tr><td colspan="6">◆Sets upper limit of mechanical variation.
◆Please set higher value than ADNFLE.</td></tr>
<tr><td rowspan="4">0x03</td><td colspan="2" rowspan="3">Adaptive Notch Filter Frequency Lower Limit E [ADNFLE]
Sets adaptive notch filter frequency lower limit.</td><td>Unsigned16</td><td>RW</td><td>No</td><td>100</td></tr>
<tr><td>Setting range</td><td colspan="3">100 to 1000</td></tr>
<tr><td>Unit</td><td colspan="3">Hz</td></tr>
<tr><td colspan="6">◆Sets lower limit of mechanical variation.
◆Please set lower value than ADNFUE.</td></tr>
<tr><td rowspan="3">0x04</td><td colspan="2" rowspan="2">Adaptive Notch Filter E Auto Saving ［ADNSVE］</td><td>Unsigned8</td><td>RW</td><td>No</td><td>0x00</td></tr>
<tr><td>Setting range</td><td colspan="3">0x00-0x01</td></tr>
<tr><td colspan="6">◆Selects valid/invalid of the function that saves mechanical resonant frequency automatically which is estimated by the servo amplifier to torque command notch filter E set value.
◆This setting is valid when "01: Adp_Filter_Enable" is set to Index 0x2060-1.
◆Estimation result is automatically saved in torque command notch filter E in every 30 minutes.
<u>0x00: Auto_Saving Save automatically</u>
<u>0x01: No_Saving Without save</u></td></tr>
</table>

0x2061: Position Loop Phase Lead Compensation Gain

Index	0x2061	Sets the phase improving value of Position loop phase lead compensation.	Object Code		Array
Sub-Idx	**Description**	**Data Type**	**Access**	**PDO**	**Initial value**
0x00	Number of entry	Unsigned8	RO	No	0x02
0x01	Position Loop Phase Lead Compensation Gain [PLPHLK] Sets the phase improving value of Position loop phase lead compensation.	Unsigned16	RW	No	0x0000 (0)
		Setting range	0x0000-0x0064 (0 to 100)		
		Unit	%		
	◆For position loop, adds the function that shifts phase on phase lead compensation frequency (PLPHLF) as 17 degree by 50% and 35 degree by 100%. Pay attention for the frequency higher than PLPHLF because gain increases in that range. ◆This parameter will be disabled when 0% is set.				
0x02	Position Loop Phase Lead Compensation Frequency [PLPHLF] Sets the frequency that is wanted to improve the phase of position loop.	Unsigned16	RW	No	0x01F4 (500)
		Setting range	0x000A-0x0FA0 (10 to 4000)		
		Unit	Hz		
	◆Set value will limit by 1,000Hz even if 1,000Hz or more is set. ◆This parameter can set in 1 Hz unit, but it will be rounded down to the 10 Hz internally. ✓ Please stop servo motor if change this value.				

0x2062: Velocity Loop Phase Lead Compensation Gain

Index	0x2062	Sets the phase improving value of Velocity loop phase lead compensation.	Object Code		Array
Sub-Idx	**Description**	**Data Type**	**Access**	**PDO**	**Initial value**
0x00	Number of entry	Unsigned8	RO	No	0x02
0x01	Velocity Loop Phase Lead Compensation Gain [VLPHLK] Sets the phase improving value of Velocity loop phase lead compensation.	Unsigned16	RW	No	0x0000 (0)
		Setting range	0x0000-0x0064 (0 to 100)		
		Unit	%		
	◆For velocity loop, adds the function that shifts phase on phase lead compensation frequency (PLPHLF) as 17 degree by 50% and 35 degree by 100%. Pay attention for the frequency higher than PLPHLF because gain increases in that range. ◆This parameter will be disabled when 0% is set.				
0x02	Position Loop Phase Lead Compensation Frequency [VLPHLF] Sets the frequency that is wanted to improve the phase of position loop.	Unsigned16	RW	No	0x01F4 (500)
		Setting range	0x000A-0x0FA0 (10 to 4000)		
		Unit	Hz		
	◆Set value will limit by 1,000Hz even if 1,000Hz or more is set. ◆This parameter can set in 1 Hz unit, but it will be rounded down to the 10 Hz internally. ✓ Please stop servo motor if change this value.				

0x2063: High Order Integral Control

Index	0x2062	Sets the high order integral control setting.	Object Code		Array
Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Number of entry	Unsigned8	RO	No	0x02
0x01	High Order Integral Control Gain [HKVIK] Sets the phase improving value of Velocity integral control.	Unsigned16	RW	No	0x0000 (0)
		Setting range	0x0000-0x0064 (0 to 100)		
		Unit	%		
	◆It is able to shorter the velocity loop integral time constant if larger the set value. ◆This parameter will be disabled when 0% is set.				
0x02	High Order Integral Control Frequency [HKVIF] Set when desired to short the velocity loop integral time constant. The frequency requiring improvment a phase shall be set.	Unsigned16	RW	No	0x01F4 (500)
		Setting range	0x000A-0x0FA0 (10 to 4000)		
		Unit	Hz		
	◆Set value will limit by 1,000Hz even if 1,000Hz or more is set. ◆This parameter can set in 1 Hz unit, but it will be rounded down to the 10 Hz internally. ✓ Please stop servo motor if change this value.				

0x2062: Torque Feedforward

Index	0x2062	Sets the torque feedforward setting.	Object Code		RECORD
Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Number of entry	Unsigned8	RO	No	0x03
0x01	Torque Feedforward Gain [TFFK] Sets the torque feedforward compensation gain against velocity control system.	Unsigned16	RW	No	0x0000 (0)
		Setting range	0x0000-0x0064 (0 to 100)		
		Unit	%		
	◆It will be not refrected when in "model following control" or "model following vibration suppression control" of "position control selection".				
0x02	Torque Feedforward Averaging [TFFAVE] Selects the averaging number of torque feedforward compensation.	Unsigned16	RW	No	0x01F4 (500 Hz)
		Setting range	0x00 to 0x01		
	0x00: 2timesAverage Two times averaging 0x01: 4timesAverage Four times averaging				
0x03	Torque Feedforward Output Selection [TFFOUT] Selects the addition point of torque feedforward compensation.	Unsigned16	RW	No	0x01F4 (500 Hz)
		Setting range	0x00 to 0x01		
	0x00: Before_filter Adding before torque command filter 0x01: After_filter Adding after torque command filter				

0x2066: Dual Position Feedback

Index	0x2066 Sets the dual position feedback compensation gain.		Object Code		Array
Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Number of entry	Unsigned8	RO	No	0x02
0x01	Dual Position Feedback Gain [DFBCG] Sets the dual position feedback compensation gain. The larger value, the higher influence of the dual position feedback compensation.	Unsigned16	RW	No	0x0000 (0)
		Setting range	0x0000-0x0064 (0 to 100)		
		Unit	%		
	◆Become Invalid the dual position feedback gain compensation function when 0% is set.				
0x02	Dual Position Feedback Filter [DFBFIL] Sets a band of the dual position feedback gain compensation. At transient responsiveness, the larger value, the nearer to a semi-closed control.	Unsigned16	RW	No	0x0000 (0.0)
		Setting range	0x0000-0x4E20 (0.0 to 2000.0)		
		Unit	ms		
	◆Become Invalid the dual position feedback gain compensation function when 0% is set.				

0x2067: CP Vibration Suppression Control

Index	0x2067 Sets CP Vibration Suppression Control Frequency		Object Code		Record
Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Number of entry	Unsigned8	RO	No	0x03
0x01	CP Vibration Suppression Control Frequency [CPVSFQ] Sets the vibration frequency of Machine stand.	Unsigned16	RW	No	0x03E8 (100.0)
	◆The filter will invalid if set value is 100.0 Hz or more.	Setting range	0x0064-0x03E8 (10.0 to 100.0)		
	◆This function will valid if in conditions below.	Unit	%		
	・ In case of standard position control. ・ In case of "Model-following / standard position control switching (Model 3)" is set and Standard position control is valid. ・ In case of "Model-following vibration suppression / standard position control switching (Model 4)" is set and Standard position control is valid. ✓ Please stop servo motor if change this value.				
0x02	CP Vibration Suppression Control Level [CPVSLV] This is the parameter which sets impact of CP vibration suppression control.	Unsigned8	RW	No	0x00
		Setting range	0x00-0x03		
	◆The larger value can be impact of CP vibration suppression control big. ✓ Please stop servo motor if change this value.				
0x03	CP Vibration Suppression Control Characteristics Selection [CPVSCR] Sets the effective frequency range of CP vibration suppression control.	Unsigned8	RW	No	0x01
		Setting range	0x00-0x02		
	◆The larger value will be narrower the effective frequency range of CP vibration suppression control. ✓ Please stop servo motor if change this value.				

0x2068: Model Control

Index	0x2068 Sets Model Control.		Object Code		Array
Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Number of entry	Unsigned8	RO	No	0x04
0x01	Model Control Damping Coefficient [MZETA] This is parameter which changes velocity proportional gain of Model following control.	Unsigned16	RW	No	0x0064 (100)
		Setting range	0x0000-0x0064 (0 to 100)		
	◆The parameter value will be ζ=0.866 by the set value 0% and ζ=1.0 by 100%.	Unit	%		
0x02	Model Control Feedforward Gain [MFFGN] This is FF compensation gain for Model position control system.	Unsigned16	RW	No	0x0000 (0)
	◆Automatically overwrite by Auto-tuning result saving. ◆When Auto-tuning function is valid, this setting value is not applied.	Setting range	0x0000-0x0064 (0 to 100)		
		Unit	%		
0x03	Model Control Feedforward Integral Time Constant [MTFFD] This is the parameter which improves command-following capability of Model position control system.	Unsigned16	RW	No	0x0000 (0.00)
	◆The function is invalid when set value is 0.00ms.	Setting range	0x0000-0x03E8 (0.00 to 10.00)		
		Unit	ms		
0x04	Model Control Feedforward Filter [MFFFIL] This is primary low-pass filter to eliminate pulsed ripple caused by the position command pulse included in the feed forward command.	Unsigned16	RW	No	0x0FA0 (4000)
	Sets the cutoff frequency.	Setting range	0x0001-0x0FA0 (1 to 4000)		
	◆The function is Invalid at 1,000Hz or more.	Unit	Hz		

0x2069: Time to Judge Position Command Distribution Completion

Index	0x2069	Sets the time till judging position command distribution completion.	Object Code	VARIABLE		
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Time to Judge Position Command Distribution Completion [PCDLY] Sets an allowable time to stop from servo OFF. ◆Distribution completion is judged if command position does not change (means previous and present command position are same) even if spending this setting time.		Unsigned16	RW	No	0x0000 (0.0)
			Setting range	0x0000-0x2710 (0.0 to 1000.0)		
			Unit	ms		
	◆State will change to "during position command distribution" instantly with no matter to this setting time, when new position command is input during count of position command distribution completion.					

0x206A: Model Control Selection

Index	0x206A	4 types of model vibration suppression frequency can be used by switching them.	Object Code	Array		
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Number of entry		Unsigned8	RO	No	0x03
0x01	Model Following (Vibration Suppression) Control/Standard Position Control Switching Function [MODEL] Enabling Model following (vibration suppression) control.		Unsigned8	RW	No	0x00
			Setting range	0x00-0x0F		
	◆This setting value is valid only when Control mode selection is "03: Velocity / Torque control switching type" or "04: Position / Torque control switching type". ✓ Valid condition is limited to 00 to 0F. ✓ Do not perform switching of the model following (vibration suppression) control and the standard position control, during servo motor operation. Alarm (Model Following Vibration Suppression Control Error (AL.C5)) may occur.					
0x02	Model Vibration Suppression Frequency Selection Input 1 [MDLFSEL1] Selects valid condition of Selection Input 1.		Unsigned8	RW	No	0x00
			Setting range	0x00-0x27		
0x03	Model Vibration Suppression Frequency Selection Input 2 [MDLFSEL2] Selects valid condition of Selection Input 2.		Unsigned8	RW	No	0x00
			Setting range	0x00-0x27		
	◆Allocates conditions to enable model vibration suppression frequency selecting input. You can switch model control antiresonant frequency 1 to 4/ model control antiresonant frequency 1 to 4 by combination of MDLFSEL1 with MDLFSEL2.					

MDLFSEL1: Model Vibration Suppression Frequency Selection Input 1	Invalid	Valid	Invalid	Valid
MDLFSEL2: Model Vibration Suppression Frequency Selection Input 2	Invalid	Invalid	Valid	Valid
	↓	↓	↓	↓
Vibration suppression frequency to be valid	Model control antiresonant frequency 1 (0x2019.1), Model control resonant frequency 1 (0x201A.1)	Model control antiresonant frequency 2 (0x2019.2), Model control resonant frequency 2 (0x201A.2)	Model control antiresonant frequency 3 (0x2019.3), Model control resonant frequency 3 (0x201A.3)	Model control antiresonant frequency 4 (0x2019.4), Model control resonant frequency 4 (0x201A.4)

◆Effective condition selecting range of Model Vibration Suppression Frequency Selection Input 1, 2 is same as 0x00 to 0x27 of function valid condition list in 0x2010.

0x206B: External Command Effectivity Selection at Holding Brake Operation

Index	0x206B	Select valid/invalid of External Command Effectivity Selection at Holding Brake Operation.	Object Code		ARRAY
Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Number of entry	Unsigned8	RO	No	0x02
0x01	External Command Effectivity Selection at Holding Brake Operation Cancellation Delay Time [SONFALL] Selects valid/invalid of external position/velocity command during the holding-brake-release delay time. 0x00: Invalid 0x01: Valid ◆Self weight fall can suppress at servo ON by setting of position/velocity command that corresponded to gravity load or external load. ◆As notes, when the command that exceeds gravity load or external load is given, servo motor will rotate and it may cause of holding-brake failure.	Unsigned8	RW	No	0x00
		Setting range	0x00-0x01		
0x02	External Command Effectivity Selection at Holding Brake Operation Delay Time [SOFFFALL] Selects valid/invalid of external position/velocity command during the holding-brake-activation delay time. 0x00: Invalid 0x01: Valid ◆Self weight fall can suppress at servo OFF by setting of position/velocity command that corresponded to gravity load or external load. ◆As notes, when the command that exceeds gravity load or external load is given, servo motor will rotate and it may cause of holding-brake failure.	Unsigned8	RW	No	0x00
		Setting range	0x00-0x01		

0x206C: Dual Position Error

Index	0x206C	Sets dual posirion error.	Object Code		Array
Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Number of entry	Unsigned8	RO	No	0x02
0x01	Dual Position Error Warning Level ［DFOFWLV］ Warning is output when current position difference between external encoder and motor encoder exceeds this value. Using as warning output before the Dual position error excess alarm occurs. ✓ Sets 4 multiples of external encoder resolution as standards. ✓ Dual position error excess alarm does not detect when set value is 0.	Unsigned32	RW	No	0x7FFFFFFF (2147483647)
		Setting range	0x00000000-0x7FFFFFFF (0 to 2147483647)		
		Unit	Pulse		
0x02	Dual Position Error Excess Value ［DFOFLV］ Outputs the dual position error excess alarm when current position difference between external encoder and motor encoder exceeds this value. ✓ Sets 4 multiples of external encoder resolution as standards. ✓ Dual position error excess alarm does not detect when set value is 0.	Unsigned32	RW	No	0x004C4B40 (5000000)
		Setting range	0x00000000-0x7FFFFFFF (0 to 2147483647)		
		Unit	Pulse		

0x206D: Stop Operation with Voltage Reduction Alarm

Index	0x206D	Selects Stop Operation with Voltage Reduction Alarm.	Object Code		VARIABLE
Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Stop Operation with Voltage Reduction Alarm [CPEOPR] Selects Stop Operation with Voltage Reduction Alarm. 0x00: DYNAMIC-BRAKE Stops motor by dynamic brake operation when alarm occurred. 0x01: SERVO-BRAKE Stops motor by servo brake operation when alarm occurred.	Unsigned8	RW	No	0x00
		Setting range	0x00-0x01		

0x2070: Drive Recorder Parameter

Index	0x2070 Drive Recorder Parameter	Description			RECORD
Sub-Idx	Name/Description	Data type	Access	PDO	Initial value
0x00	Number of entry	Unsigned8	RO	No	17
0x01	Sampling Interval Minimum sampling interval (Ts) is fixed to 125μs. Sets "n" having relation of equation: T=Ts×n. ("T" is sampling interval) Drive recorder stops if "0" is set.	Unsigned16	RW	No	20
		Setting range	0 to 65535		
0x02	Sampling Points Selects amount of points storing in to drive recorder per channel. 0: 256 points, 1: 512 points, 2:1,024 points	Unsigned8	RW	No	0
		Setting range	0x00 to 0x02		
0x03	Trigger Edge Selection Sets a trigger edge condition in drive recorder. 0: Positive edge, 1: Negative edge, 2: Both edge	Unsigned8	RW	No	0
		Setting range	0x00 to 0x02		
0x04	Trigger Channel Selection Sets a channel to be trigger condition in drive recorder. 0x00: Analog CH1 0x05: Analog CH6 0x01: Analog CH2 0x80: Digital CH1 0x02: Analog CH3 0x81: Digital CH2 0x03: Analog CH4 0x82: Digital CH3 0x04: Analog CH5 0x83: Digital CH4	Unsigned8	RW	No	0x83 (131)
		Setting range	0x00 to 0x83 (0 to 131)		
0x05	Trigger Horizontal Position Sets a trigger horizontal position in drive recorder. Sets the rate of the total sampling time and the trigger position from sampling start by.	Unsigned8	RW	No	0x50(80)
		Setting range	0x00 to 0x64 (0 to 100)		
		Unit	%		
0x06	Trigger Level Lo Sets a trigger level (with lower address) in drive recorder. Trigger level is signed 64 bit data.	Unsigned 32	RW	No	0x00000000
		Setting range	0x00000000 to 0xFFFFFFFF (-9223372036854775808 to 9223372036854775807)		
0x07	Trigger Level Hi Sets a trigger level (with upper address) in drive recorder.	Unsigned 32	RW	No	0x00000000
		Setting range	0x00000000 to 0xFFFFFFFF		
0x08	Analog Channel Selection 1	Unsigned8	RW	No	0x08
		Setting range	0x00 to 0x4E		
0x09	Analog Channel Selection 2	Unsigned8	RW	No	0x02
		Setting range	0x00 to 0x4E		
0x0A	Analog Channel Selection 3	Unsigned8	RW	No	0x03
		Setting range	0x00 to 0x4E		
0x0B	Analog Channel Selection 4	Unsigned8	RW	No	0x15
		Setting range	0x00 to 0x4E		
0x0C	Analog Channel Selection 5	Unsigned8	RW	No	0x05
		Setting range	0x00 to 0x4E		
0x0D	Analog Channel Selection 6	Unsigned8	RW	No	0x00
		Setting range	0x00 to 0x4E		
	Selects the data which is measured as Analog channel on the Drive recorder. Refer an analog channel list, for selection value.				
0x0E	Digital Channel Selection 1	Unsigned8	RW	No	0x16
		Setting range	0x00 to 0x55		
0x0F	Digital Channel Selection 2	Unsigned8	RW	No	0x15
		Setting range	0x00 to 0x55		
0x10	Digital Channel Selection 3	Unsigned8	RW	No	0x1B
		Setting range	0x00 to 0x55		
0x11	Digital Channel Selection 4	Unsigned8	RW	No	0x1C
		Setting range	0x00 to 0x55		
	Selects the data which is measured as Digital channel on the Drive recorder. Refer a digital channel list, for selection value.				

Analog channel list

Set value	Measurement data	Set value	Measurement data	Set value	Measurement data
00	Velocity monitor	10	Load Torque (force) monitor (Estimate value)	42	Status word
01	Velocity command monitor	11	U-phase electric angle monitor	43	Status word 1
02	Torque (force) monitor	12	Dual position error monitor	44	Target position
03	Torque (force) command monitor	13	Acceleration monitor	45	Target velocity
04	Position deviation monitor	14	Encoder temperature monitor	46	Target torque
05	Present position monitor (Motor encoder)	15	Main circuit bus voltage monitor	47	Actual position
06	Present position monitor (External encoder)	16	Reaching rate of OL detection level of motor temperature rise estimation value	48	Actual velocity
07	Command position integration value	17	Average power monitor	49	Actual torque
08	Position command pulse frequency monitor 1	18	Torque (force) command filter (before filter)	4A	Actual position deviation
09	Position command pulse frequency monitor 2	19	Axes-sync error monitor	4B	Position command allocation value
0A	Absolute encoder PS data monitor	20	Position deviation difference monitor	4C	EtherCAT state machine
0B	External absolute encoder PS data monitor	21	Regenerative power monitor	4D	EtherCAT status transition
0C	Regenerative resistor operation percentage monitor	22	Error rate of motor encoder communication	4E	EtherCAT communication error rate
0D	Effective torque (force) monitor	23	Error rate of external encoder communication	FF	Function reserved (Manufacturer only) Setting inhibited
0E	Effective torque (force) monitor (Estimated value)	40	Control word		
0F	Load Inertia Moment (mass) Ratio monitor	41	Function control word		

Digital channel list

Set value	Measurement data	Set value	Measurement data	Set value	Measurement data
00	GIN1: General input 1	17	CMD-ACK: While Command Acceptance Permission Status	47	Control word bit 12: Encoder clear
01	GIN2: General input 2	18	PCON-ACK: While Velocity Loop Proportional Control Switching Status	48	Control word bit 15: Magnetic pole position estimation
02	GIN3: General input 3	19	GC-ACK: While Electronic Gear Switching Status	49	Status word bit 3: Fault status
03	GIN4: General input 4	1A	WRG-OVF: While Excessive Deviation Warning Status	4A	Status word bit 7: Warning status
04	GIN5: General input 5	1B	WRG-OL: While Overload Warning Status	4B	Status word bit 10: Operation mode specific 10
05	GIN6: General input 6	1C	ALM: While Alarm Status	4C	Status word bit 11: Internal limit status
06	GIN7: General input 7	1D	WRG-DF: While dual position error excess warning	4D	Status word bit 12: Operation mode specific 12
08	GOUT1: General output 1	1E	TRJCMP: While position command distribution completion status (Delay time included)	4E	Status word bit 13: Operation mode specific 13
09	GOUT2: General output 2	20	WRG-SY: While Axes-sync Error Excess Warning	4F	Digital input bit 0: Negative limit
10	INP: While In-Position Status	40	Control word bit 2: Quick stop	50	Digital input bit 1: Positive limit
11	NEAR: While Near Range Status	41	Control word bit 4: Operation mode specific 4	51	Digital input bit 2: Home
12	VCMP: While Speed Matching Status	42	Control word bit 5: Operation mode specific 5	52	Digital input bit 3: EMR
13	TLIM: While Torque (force) Limiting	43	Control word bit 6: Operation mode specific 6	53	Digital output bit 0: Set brake
14	VLIM: While Velocity Limiting	44	Control word bit 7: Fault reset	54	Digital output bit 16: FOUT1
15	SACT: While Motor Excitation	45	Control word bit 8: Halt	55	Digital output bit 17: FOUT2
16	SRDY: While Servo Ready Status	46	Control word bit 9: Operation mode specific 9	FF	Function reserved (Manufacturer only) Setting inhibited

0x2071: Initialization timeout waiting time

Index	0x2071	Selects a time to initialization completion.		Object Code		VARIABLE
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Initialization timeout waiting time [INTTIM] Selects a time to initialization completion. 0x00: Disable No waiting time 0x01: 1000ms Inserting 1000 ms wait, 0x02: 1400ms Inserting 1400 ms wait 0x03: 1800ms Inserting 1800 ms wait, 0x04: 2000ms Inserting 2000 ms wait 0x05: 3000ms Inserting 3000 ms wait, 0x06: 5000ms Inserting 5000 ms wait 0x07: 10000ms Inserting 10000 ms wait ✔It will be valid after control power cycle.		Unsigned8	RW	No	0x00
			Setting range	0x00 to 0x07		

0x2072: The amounts of torque limit value restoration when power restored

Index	0x2072	Sets the torque-recovering value per 1ms which is used to normal torque from limited torque of power supply drop.		Object Code		Variable
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	The amounts of torque limit value restoration when power restored [TLMREST] ◆Sets the ratio to rated torque. (100.0% = rated torque) ◆When setting "0.0%", operates as 10.0%.		Unsigned16	RW	No	0x0064 (10.0)
			Setting range	0x0000-0x1388 (0.0 to 500.0)		
			Unit	%		

0x2073: Drive Recorder Data Clear

Index	0x2073	Clears a drive recorder data.	Object Code		RECORD
Sub-Idx	Description	Data type	Access	PDO	Initial value
0x00	Number of entry	Unsigned8	RO	No	0x03
0x01	Drive Recorder Clearing Command Clears a drive recorder data. Function runs by input of command (0x00dc).	Unsigned16	WO	No	0x00
		Setting range	0x0000 to 0xFFFF (0 to 65535)		
0x02	Drive Recorder Clearing Status 0: Waiting 1: Running	Unsigned8	RO	No	0x00
		Display range	0x00 to 0x01		
0x03	Drive Recorder Clearing Result 0: Incompletion 1: Normal completion 2: Abnormal completion	Unsigned8	RO	No	0x00
		Display range	0x00 to 0x02		

0x2074: External Absolute Encoder Polarity Selection

Index	0x2074	Selects the count polarity of external encoder against motor rotation direction.		Object Code		VARIABLE
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	External Absolute Encoder Polarity Selection [EX-SENPOL] 0x00: Standard Inverts not an encoder operation direction. 0x01: Reversed Inverts an encoder operation direction. ◆Select the polarity which gives increment/decrement matching of monitors of EX-APMON and APMON. ◆It becomes valid after control power cycle. ◆It is valid when an absolute encoder is used as external encoder.		Unsigned8	RW	No	0x00
			Setting range	0x00-0x01		

0x2075: External Encoder Output Pulse Divide Ratio Selection

Index	0x2075	Selects the encoder output pulse divide ratio when an absolute encoder is used as external encoder.	Object Code	VARIABLE

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	External Encoder Output Pulse Divide Ratio Selection ［EX-PULDIV］	Unsigned8	RW	No	0x00
		Setting range	0x00-0x0B		

◆Selects the external encoder output pulse divide ratio (1/N) when EnDat is used to external encoder.
◆When the external encoder is angle encoder or rotary encoder, select from the range of 1/4(R) to 1/8192(R).
◆When the external encoder is linear encoder, select from the range of 1/4(L) to 1/2000(L).
◆It becomes valid after control power cycle.

Selection		Contents
00	1/4(R)_1/4(L)	Outputs by following calculation according to encoder type.
01	1/8(R)_1/20(L)	For angle encoder or rotary encoder, outputs the pulse as follows: "Single turn resolution" x (1/N). (Use 1/4(R) to 1/8192(R)) For linear encoder, outputs the pulse as follows: "Resolution" / (1/N). (Use 1/4(L) to 1/2000(L))
02	1/16(R)_1/40(L)	
03	1/32(R)_1/80(L)	
04	1/64(R)_1/120(L)	
05	1/128(R)_1/160(L)	
06	1/256(R)_1/200(L)	
07	1/512(R)_1/400(L)	
08	1/1024(R)_1/800(L)	
09	1/2048(R)_1/1200(L)	
0A	1/4096(R)_1/1600(L)	
0B	1/8192(R)_1/2000(L)	

✓ Output is available up to the frequency of 2Mpulse/sec (multiply 1).
Select the divide ratio in the range less than the frequency above.
✓ EnDat (Angle encoder, Rotary encoder)
Divide ratio is limited to be 32768 pulse/rev or more when
""Single turn resolution" x (1/N) < 32768 pulse/rev." is established.
✓ EnDat (Linear encoder)
Use in the range as follows: 231 x Resolution / ((1/N)x4), based on zero position.
(Z-phase output position might shift if a power cycle is performed after moving to out of the range.)

0x2076: Support Function Torque Limit

Index	0x2076	Sets the limit value of torque command at the support function (JOG, positioning and homing) operation.	Object Code	VARIABLE

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Support Function Torque Limit ［TSTTCLM］ ◆This value will be initial setting value of torque command limit for the support function operation in the Setup software.	Unsigned16	RW	No	0x04B0 (120.0)
		Setting range	0x0064-0x1388 (10.0 to 500.0)		
		Unit	%		

0x2077: External Regenerative Resistor Value

Index	0x2077	Sets a resistor value of external regenerative resistor.	Object Code	VARIABLE

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	External Regenerative Resistor Value ［REGVAL］ ◆The value of regenerative resistor shall be set when selecting "02: External R (use external regenerative resistor)". This setting will invalid when selecting except "02: External R (use external regenerative resistor)".	Unsigned16	RW	No	0x01F4 (50.0)
		Setting range	0x000A-0x03E8 (1.0 to 100.0)		
		Unit	ohm		
	✓ If built-in regenerative resistor is selected, it shows the value of built-in regenerative resistor of servo amplifier.				

0x2078: Torque Scale Selection

Index	0x2078	Selects torque scale.		Object Code		VARIABLE
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Torque Scale Selection Sets scale of torque command and torque monitor. 0x0000: 0.1% 0x0001: 4096 (0x1000)/TR (100%) ✔It doesn't apply to torque limit setting value.		Unsigned16	RW	No	0x0000
			Setting range	0x0000-0x0001		

0x2079: Extended function selection setting

Index	0x2079	Sets the extended function setting.		Object Code		RECORD
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Number of entry		Unsigned8	RO	No	0x04
0x01	Deceleration stop special function selection 1 in torque control mode [TDSEL1] Selects valid/invalid of deceleration stop special function in torque control mode. 0x00: Function invalid 0x01: Function valid		Unsigned8	RW	No	0x00
			Setting range	0x00 to 0x01		
0x02	Deceleration stop special function selection 2 in torque control mode [TDSEL2] Selects stop method of aborting. 0x00: Stop according to abort option code, in aborting. 0x01: Stop with special function, in aborting.		Unsigned8	RW	No	0x00
			Setting range	0x00 to 0x01		
0x03	Deceleration stop special function selection 1 in position control mode [PDSEL1] Selects valid/invalid of deceleration stop special function in position control mode. 0x00: Function invalid 0x01: Function valid ✔ In case this function is set valid, it works as deceleration stop special function if 0x0005 or 0x0006 is set to quick option code (0x605A).		Unsigned8	RW	No	0x00
			Setting range	0x00 to 0x01		
0x04	RS3 special function selection 1 [RS3SEL] Selects valid/invalid of RS3 special function. Bit 0: Absolute/relative value selection function switching Selects action due to absolute position (ABS)/relative position (REL) setting in bit 6 of control word. (CSP only) Set value 0: ABS/REL setting becomes always valid. Set value 1: ABS/REL setting is latched when FSA transits to Operation enabled. (It is not reflected even if setting is changed while into Operation enabled state.) Bit1: Operation selection at the setting that 0x06 is set to Overtravel Operation (0x20F0. 1) In case that 0x06 is set to Overtravel Operation, it selects behavior due to overtravel polarity. Set value 0: Velocity limit command against overtravel side is limited to zero when overtravel occurred. (Specification of RS3-H) Set value 1: Position command becomes effective regardless of overtravel polarity when overtravel occurred. (Specification of RS2-H) Bit 2 to bit 31: Reserved		Unsigned32	RW	No	0x0000 0000
			Setting range	0x00000000 to 0xFFFFFFFF		

0x207B: FoE Uploading File Selection

Index	0x207B	Selects a file to be uploaded by FoE uploading.	Object Code		VARIABLE
Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Uploading File Selection Selects a transferring file to be uploaded with FoE protocol. 0x00: AP1 file 0x01: Drive recorder file 0x02: System analysis file	Unsigned8	RW	No	0x00
		Setting range	0x00 to 0x02		

0x20B0: Gain Switching Condition

Index	0x20B0	It can use four preset gains with switching. Assigns a condition to be gain switching condition valid. GAIN 1 to 4 are switched due to GC1/GC2 combination.	Object Code		ARRAY
Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Number of entry	Unsigned8	RO	No	0x02
0x01	Gain switching condition 1 [GC1] Sets the Gain switching condition 1.	Unsigned8	RW	No	0x00
		Setting range	0x00 to 0x29		
0x02	Gain switching condition 2 [GC2] Sets the Gain switching condition 2.	Unsigned8	RW	No	0x00
		Setting range	0x00 to 0x29		

Assigns a condition to be gain switching condition valid. GAIN 1 to 4 are switched due to GC1/GC2 combination.
This function becomes valid if "1" is set to bit 9 of 0x20F7.

GC1: Gain switching condition 1	Invalid	Valid	Invalid	Valid
GC2: Gain switching condition 2	Invalid	Invalid	Valid	Valid
	↓	↓	↓	↓
Effective gain	GAIN1	GAIN2	GAIN3	GAIN4

Valid condition selection range of Gain switching condition 1 and 2 is 0x00 to 0x29 of function valid condition list.

0x20F0: Amplifier Function Selection

Index	0x20F0	Set the Sequence function.		Object Code		ARRAY
Sub-Idx	**Description**		**Data Type**	**Access**	**PDO**	**Initial value**
0x00	Number of entry		Unsigned8	RO	No	0x06
0x01	Overtravel Operation ［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 inputted.		Unsigned8	RW	No	0x06
			Setting range	0x00-0x08		
0x02	Postioning Method ［EDGEPOS］ Selects the positioning method of encoder pulse.		Unsigned8	RW	No	0x00
			Setting range	0x00-0x01		

0x01 (continued):

Profile Position (pp), Profile Velocity (pv), Cycle synchronous position (xsp), Interpolated position（ip）, Cyclic sync velocity (csv)

- 0x00: Command entry disabled, after the motor stops with the servo brake, servo ON Note 1)
- 0x01: Command entry disabled, after the motor stops with the dynamic brake, servo ON Note 3)
- 0x02: Command entry disabled, after the motor stops with the free-run operation, servo ON
- 0x03: Command entry disabled, after the motor stops with the servo brake, servo OFF
- 0x04: Command entry disabled, after the motor stops with the dynamic brake, servo OFF
- 0x05: Command entry disabled, after the motor stops with the free-run operation, servo OFF
- 0x06: Command entry enabled, after servo motor stops with internal velocity limit command, servo ON
- 0x07: Reserved
- 0x08: Command entry disabled, after the motor stops with the servo brake, servo ON
  (For the torque (force) limit value of servo motor stopping, the sequence torque (force) limit is used.)
- 0x09-0xFF: Reserved

✓ In Profile Velocity (pv), it performs deceleration stop with profile deceleration.

Profile torque (force) (tq), Cyclic sync torque (force) (cst)

- 0x00-0x02: Limit the Torque (force) command with Sequence Torque (force) limit (servo ON) Note 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)
- 0x06-0xFF: Reserved

Note 1) The sequence operation torque (force) limit value (0x201E) becomes valid to power running direction.
Note 2) When the Torque (force) Command is smaller than sequence operational torque limit value, it is limited by the Target Torque (force).
Note 3) Setting of the quick stop option code shall be "motor stop by dynamic brake operation".

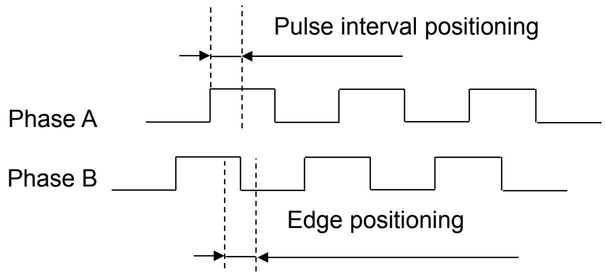
0x02 (continued):

- 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.

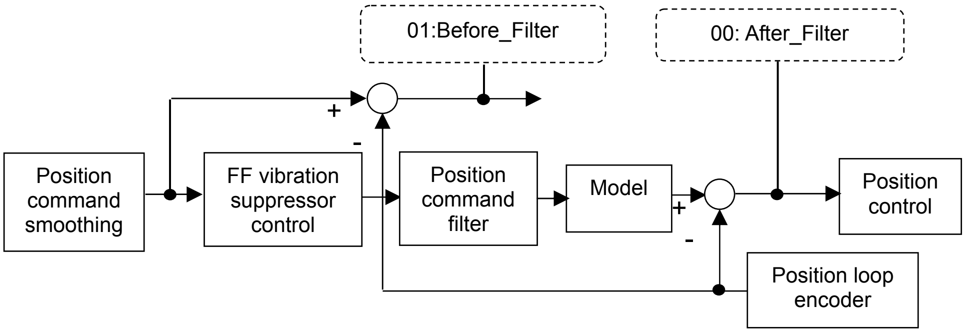
✓ Function becomes valid after control power cycle.



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

0x00: After Filter Compare Position command value with Feedback value after passing through the filter.
0x01: Before Filter Compare Position command value with Feedback value before passing through the filter.

◆For 00 After_Filter, use the Position deviation value of the Position controller.
◆For 01 Before_Filter, use the Position deviation value based on Position command before FF vibration suppression control.
◆In case that Model Following Control or Model Following Vibration Suppression Control is used in Position Control Selection, 0x01:Before_Filter always operates no matter the selection.



Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x04	Speed Matching Width Unit Selection ［VCMPUS］ Sets the comparison method of the velocity matching output.	Unsigned8	RW	No	0x00
		Setting range	0x00-0x01		

0x00: min^{-1} Compare with the setting value in 0x606D (rotation frequency setting: min^{-1})
0x01: percent Compare with the setting value in 0x202A (proportion setting: %)

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x05	Deviation Clear Selection ［CLR］ Sets ON/OFF of position deviation clear during servo OFF, and deviation clear signal treatment.	Unsigned8	RW	No	0x00
		Setting range	0x00-0x03		

◆Selects operation during servo OFF. Deviation clear/ Deviation NOT clear.
◆Selects deviation signal treatment. Level detection /Edge detection.
◆Select proper setting corresponding to above combination from the list below.

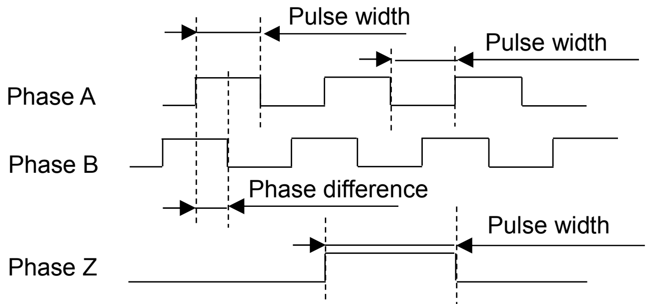
Selection		Contents	
0x00	Type1	When Servo OFF -> Clear Deviation Deviation Clear Input =Level Detection	During servo OFF, Deviation clear is always executed. While Deviation clear input is ON, Deviation clear is always executed.
0x01	Type2	When Servo OFF -> Clear Deviation Deviation Clear Input =Edge Detection	At the edge of OFF->ON of Deviation clear input, Deviation clear is executed.
0x02	Type3	When Servo OFF -> NOT Clear Deviation Deviation Clear Input =Level Detection	During servo OFF, Deviation clear is not executed. (After servo ON, the motor may operate suddenly.)
0x03	Type4	When Servo OFF -> NOT Clear Deviation Deviation Clear Input =Edge Detection	During servo OFF, Deviation clear is not executed. (After servo ON, the motor may operate suddenly.)

◆Used, for example, to force the position deviation counter inside the servo amplifier to zero from higher-level devices.

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x06	Torque (Force) Attainment Function Selection ［TASEL］ Sets detection method of torque (force) attainment setting (0x202E).	Unsigned8	RW	No	0x00
		Setting range	0x00-0x01		

Selection		Contents
00	TA/TR	Sets by using the ratio of rated torque (force) of the combination motor. (100%= rated torque (force))
01	TA/TCLM	Sets by using the ratio of limit value of torque (force). (100%=limit value of torque (force))

0x20F1: Encoder Function Selection

Index	0x20F1	Sets the Encoder Function.	Object Code		RECORD
Sub-Idx	**Description**	**Data Type**	**Access**	**PDO**	**Initial value**
0x00	Number of entry	Unsigned8	RO	No	0x0A
0x01	Encoder Clear Function Selection ［ECLRFUNC］ Selects the encoder clear method.	Unsigned8 Setting range	RW 0x00-0x01	No	0x00
	◆Use to clear an absolute encoder warning when the warning is not automatically restored. ◆Valid when using with Battery Backup Absolute Encoder and Battery-less Absolute Encoder. ◆When Single-turn Absolute Encoder is used, even if "01:_Status_MultiTurn" is selected, it works as "Clear only encoder status". 0x00: Encoder status Clears (Alarm / Warning) and Multi-turn Data 0x01: Encoder status Clears (Alarm / Warning) only ✓ This parameter can be set when amplifier hardware is able to apply Absolute Encoder. ✓ Valid when Battery backup absolute encoder, or Battery-less absolute encoder is used.				
0x02	Motor Incremental Encoder Digital Filter ［ENFIL］ Thie parameter can be set only when using incremental encoder. This sets digital filter of motor incremental encoder.	Unsigned8 Setting range	RW 0x00-0x07	No	0x01
	◆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=110 ns (Minimum Pulse Phase Difference 37.5 ns) 0x01: Minimum Pulse Width=220 ns (Minimum Pulse Phase Difference 75 ns) 0x02: Minimum Pulse Width=440 ns (Minimum Pulse Phase Difference 150 ns) 0x03: Minimum Pulse Width=880 ns (Minimum Pulse Phase Difference 300 ns) 0x04: Minimum Pulse Width= 75 ns (Minimum Pulse Phase Difference 37.5 ns) 0x05: Minimum Pulse Width=150 ns (Minimum Pulse Phase Difference 75 ns) 0x06: Minimum Pulse Width=300 ns (Minimum Pulse Phase Difference 150 ns) 0x07: Minimum Pulse Width=600 ns (Minimum Pulse Phase Difference 300 ns) 0x08-0x0F: Reserved ✓ This parameter can be set when amplifier hardware supports incremental encoder. 				
0x03 [Full Close] [Linear]	External Incremental Encoder Digital Filter ［EX-ENFIL］ This parameter can be set only when using fully closed control function. Sets Digital filter to External Incremental Encoder.	Unsigned8 Setting range	RW 0x00-0x07	No	0x01
	◆Pulse lower than the set value is eliminated as noise when noise superposition occurred in encoder signals. ◆Consider Encoder resolution and Maximum rotation velocity of the servo motor in operation when selecting value. Set the value roughly less than 1/4 of the Encoder pulse width at Maximum rotation velocity. 0x00: Minimum Pulse Width=110ns (Minimum Pulse Phase Difference 37.5ns) 0x01: Minimum Pulse Width=220ns (Minimum Pulse Phase Difference 75ns) 0x02: Minimum Pulse Width=440ns (Minimum Pulse Phase Difference 150ns) 0x03: Minimum Pulse Width=880ns (Minimum Pulse Phase Difference 300ns) 0x04: Minimum Pulse Width= 75ns (Minimum Pulse Phase Difference 37.5ns) 0x05: Minimum Pulse Width=150ns (Minimum Pulse Phase Difference 75ns) 0x06: Minimum Pulse Width=300ns (Minimum Pulse Phase Difference 150ns) 0x07: Minimum Pulse Width=600ns (Minimum Pulse Phase Difference 300ns) 0x08-0x0F: Reserved ✓ This parameter can be set when amplifier hardware supports Full-closed option.				

Index	0x20F1 Sets the Encoder Function.		Object Code		Record
Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x04 [Full Close] [Linear]	External Encoder Polarity Selection [EX-ENPOL] This parameter can be set only when using fully closed controlfunciton. Selects External incremental encoder signal polarity.	Unsigned8	RW	No	0x00
		Setting range	0x00-0x07		
	✓ This parameter can be used when amplifier hardware supports Full-closed option. 0x00: Type1 EX-Z Not Reversed / EX-B Not Reversed / EX-A Not Reversed 0x01: Type2 EX-Z Not Reversed / EX-B Not Reversed / EX-A Reversed 0x02: Type3 EX-Z Not Reversed / EX-B Reversed / EX-A Not Reversed 0x03: Type4 EX-Z Not Reversed / EX-B Reversed / EX-A Reversed 0x04: Type5 EX-Z Reversed / EX-B Not Reversed / EX-A Not Reversed 0x05: Type6 EX-Z Reversed / EX-B Not Reversed / EX-A Reversed 0x06: Type7 EX-Z Reversed / EX-B Reversed / EX-A Not Reversed 0x07: Type8 EX-Z Reversed / EX-B Reversed / EX-A Reversed 0x08-0xFF: Reserved ✍ The function becomes valid after control power cycle.				
0x05 [Linear]	CS Offset [CSOF] Sets electrical angle of the motor. For rotary motor use Must set it 0 degree.	Unsigned16	RW	No	0x0000 (0)
		Setting range	0x0000-0x0167 (0 to 359)		
		Unit	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. ✍ The function becomes valid after control power cycle.				
0x06 [Linear]	Z-phase CS Normalization Offset [ZPHOF] Sets offset of phase Z signal to electrical angle of the motor. For rotary motor use Must set it 0 degree.	Unsigned16	RW	No	0x0000 (0)
		Setting range	0x0000-0x0167 (0 to 359)		
		Unit	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. ✍ The function becomes valid after control power cycle.				
0x07 [Linear]	Linear Encoder Polarity Selection [ENCDIR] Selects linear encoder (EN1) signal polarity. You can select phase A and B signal polarity.	Unsigned8	RW	No	0x00
		Setting range	0x00-0x01		
	(Phase U and V signal polarities are not changed in case of wire saving incremental encoder.) ✍ The function becomes valid after control power cycle.				
0x08 [Linear]	Excitation Command Frequency Setting [EMPFREQ] Sets frequency for torque (force) command that is applied to estimate magnetic pole position. ✓ Change excitation frequency if magnetic pole position estimation cannot be normally completed due to resonance of equipment etc.	Unsigned16	RW	No	0x0032 (50)
		Setting range	0x001E-0x0046 (30 to 70)		
		Unit	Hz		
	✍ The function becomes valid after control power cycle.				
0x09 [Linear]	Magnetic Pole Position Estimation Mode Selection [CSETMD] Select the Magnetic pole position estimation mode. ✓ This object is valid when 0x0850 is set to Encoder Type Code.	Unsigned8	RW	No	0x00
		Setting range	0x00-0x01		
	0x00: Follows the effective condition of 0x20F8. 6. 0x01: Magnetic pole position estimation will run at once only after turn on main power. ✍ The function becomes valid after control power cycle.				
0x0A	Encoder Clear 2 [ECLR2] By setting "1" to this parameter, multi turn part data of absolute encoder will be cleared.	Unsigned8	RW	No	0x00
		Setting range	0x00-0x01		
	The state during clearing is shown to the bit3 of the status word1 (0x2100). ✍ This function will be performed also by the bit12 of the control word, manufacturer specific area.				

4. Object Dictionary

0x20F2: Amplifier Alarm Detect Selection

Index	0x20F2	Sets the Sequence function.		Object Code		Record
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Number of entry		Unsigned8	RO	No	0x07
0x01	Main Circuit Voltage Reduction Detection Selection ［MPESEL］		Unsigned8	RW	No	0x01
			Setting range	0x00-0x01		
	When DC power input model is used, select whether the Main Circuit Under-voltage alarm should be detected or not. 0x00: Do not detect the Main Circuit Under-voltage Alarm. 0x01: Detect the Main Circuit Under-voltage Alarm.					
0x02	Velocity Control Alarm (ALM_C2) Detection ［VCALM］		Unsigned8	RW	No	0x00
	Select valid/invalid of the velocity control trouble detection.		Setting range	0x00-0x01		
	Trouble may detect in operation patterns where the motor results in overshooting in response to commands; in these systems, please set as "Invalid". 0x00: Invalid 0x01: Valid					
0x03	Velocity Feedback Alarm (ALM_C3) Detection ［FBKEEN］		Unsigned8	RW	No	0x01
			Setting range	0x00-0x01		
	0x00: Invalid 0x01: Valid Selects valid/invalid for the velocity feedback trouble detection.					
0x04	Communication Frame Error (ALM_10-15) Detection Setting ［CRCSET］		Unsigned8	RW	No	0x00
			Setting range	0x00-0x08		
	0x00-0x02: Invalid 0x03: Valid (error detected three times in row) 0x04: Valid (error detected four times in row) 0x08: Valid (error detected eight times in row) Monitor the following communication error registers at each communication cycle and set valid/invalid and detection filter for each alarm. 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 Setting ［COTOUT］		Unsigned8	RW	No	0x00
			Setting range	0x00-0xFF		
	0x00, 0x01: Invalid 0x02: Valid (not received twice in row) 0x03: Valid (not received three times in row) 0xFF: Valid (not received 255 times in row) Monitor SM2 event (command receipt) at each communication cycle and set valid/invalid and detection filter for AL_1A.					
0x06	Alarm History Clearing ［ALMHCLR］		Unsigned32	RW	No	0x00000000
	Clears alarm history.		Setting range	0x00000000-0x4C434841		
	To avoid clearing wrongly, it is performed just when specified sign is inputted. Sign "AHCL". Master writes "0x4C434841" (ASCII code). After writing, alarm history will be cleared. After clearing the sign, Alarm History Clearing Operation Monitor also cleared and Waiting state will be displayed.					
0x07	Alarm History Clearing Operation Monitor ［ALMHCLRMON］		Unsigned8	RO	No	-
			Display range	0x00-0x03		
	Status of Alarm History Clearing is below. 0x00: Waiting state 0x01: In operation 0x02: Normal completion 0x03: Abnormal completion					

0x20F3: Position Control Selection

Index	0x20F3	Selects control characteristic and control-use encoder for the control mode of cyclic sync position (csp), profile position (pp), interpolated position (ip).		Object Code		ARRAY
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Number of entry		Unsigned8	RO	No	0x02
0x01	Position Control Selection ［PCNTSEL］		Unsigned8	RW	No	0x00
	Selects model following control type and valid/invalid.		Setting range	0x00-0x04		
	0x00: Standard control (Model Following Position Control detached) 0x01: Model Following Control (Rigid model) 0x02: Model Following Vibration Suppression Control (Machine stand vibration model) 0x03: Model Following Control/ Standard position control switching 0x04: Model Following Vibration Suppression Control/ Standard position control switching 0x05-0xFF: Reserved ✓ Alarm DE (Parameter Change Completion) will issued if the value differ from set value is set. ✓ Set value will be switched after power cycle.					
0x02	Position Loop-controlling Encoder Selection ［PLMODE］		Unsigned8	RW	No	0x00
	Selects the encoder that the servo amplifier uses for Position Loop Control.		Setting range	0x00-0x01		
	0x00: Semi-closed Control (motor encoder used) 0x01: Full-closed Control (external encoder used) ✍ The function becomes valid after control power cycle.					

0x20F5: Torque (force) Limit Input Selection in Power Supply Shortage

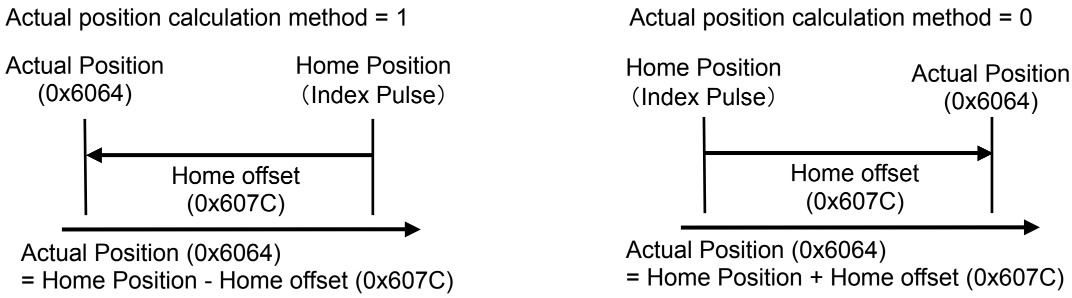
Index	0x20F5	Selects whether the normal limit value or the sequence operation torque (force) limit of the motor output current is used, in power supply shortage detection. Provided as SEMI F47 support function.	Object Code	VARIABLE

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Torque (force) Limit Input Selection in Power Supply Shortage [CPETLSEL] Selects a torque limit input at power supply shortage. 0x00: No limitation. (According to standard torque limit method) 0x01: Uses torque limit value. Positive direction limit is in 0x60E0. Negative direction limit is in 0x60E1. 0x02: Uses torque limit value. Positive/Negative direction limit is in 0x60E0. 0x03: Limits with value in 0x201E. ✓ For the operation sequence, refer the section "SEMI F47 support function".	Unsigned8	RW	No	0x00
		Setting range	0x00-0x03		

0x20F6: Manufacturer Homing Parameter

Index	0x20F6	For the homing mode (hm), sets the parameter of manufacturer specific homing method.	Object Code	Record

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Number of entry	Unsigned8	RO	No	0x04
0x01	Actual position calculation method [HMPSEL] At homing process, defines calculation of actual position (0x6064). 0x20F6-1=0 : Calculation method 1 0x20F6-1=1 : Calculation method 2	Unsigned8	RW	No	0x00
		Setting range	0x00-0x01		



Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x02	Hard Stop Torque Limit [HSTRQ] In the Hard stop homing (0x6098: from -4 to -1), this value is torque (force) limitation when reaching hard stop. Hard stop detection is judged with this value.	Unsigned16	RW	No	0x03E8 (100.0)
		Setting range	0x0000-0x1388 (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 the state of limiting by hard stop current limit value. After hard stop detection, state will transit as below. Homing method (0x6098) is -1 or -2. --> Home position detected. -3 or -4. --> Go reverse to find index position.	Unsigned16	RW	No	0x000A (10)
		Setting range	0x000A-0xFFFF (10 to 65535)		
		Unit	ms		
0x04	Position Deviation Excess Value for Hard Stop [HSOFLV] In the Hard stop homing (0x6098: from -4 to -1), sets the position deviation excess value to be used at the hard stop. When actual value exceeds a position deviation window, position deviation excess alarm occurs. |Actual position deviation| ≧ Set value Homing method (0x6098) is -1 or -2. --> Home position detected. -3 or -4. --> Go reverse to find index position.	Unsigned16	RW	No	0x4C4B40 (5000000)
		Setting range	0x00000001-0x7FFFFFFF (1 to 2147483647)		
		Unit	UP (User Position unit)		

0x20F7: Amplifier Special Setting

Index	0x20F7	Sets whether or not the special function of the servo amplifier is usable.		Object Code		VARIABLE
Sub-Idx	**Description**		**Data Type**	**Access**	**PDO**	**Initial value**
0x00	Bit0-1: Reserved		Unsigned16	RW	No	0x0000
			Setting range	0x0000-0xFFFF		
	Bit2: Modulo initializing process selection Selects a calculation method of modulo initial value at power ON. 0: Normal initialization process (Encoder coordinate (lower 32bit) is dividable by modulo coordinate.) 1: Special initialization process (Encoder coordinate (lower 32bit) is not dividable by modulo coordinate.) Bit3: Backlash command direction saving function selection Selects whether saving a command direction to internal memory, at control power shutdown. Saved command direction is used as initial value of direction for Actual Position 2 calculation. 0: Command direction is not saved to internal memory, at control power shutdown. 1: Command direction is saved to internal memory, at control power shutdown. Bit4-8: Reserved Bit9: Gain switching function selection Selects a gain switching function. 0: Sets a gain by gain switching selection (bit 4-5) in parameter selection (0x2001). 1: Sets a gain by gain switching condition (0x20B0). Bit10: Velocity loop proportional control switching function selection Selects a velocity loop proportional control switching function. 0: Sets by bit 2 in function control word (0x2000). 1: Sets a velocity loop proportional control by a velocity loop proportional control switching condition (0x20F8-8). Bit11-15: Reserved					

0x20F8: General Purpose Input Setting

Index	0x20F8	Selects the function of General Purpose Input 1 to 7 (CONT1 to 7).	Object Code	ARRAY

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Number of entry	Unsigned8	RO	No	0x06
0x01	Positive Over-Travel Function ［PLIMSW］	Unsigned8	RW	No	0x00
	Selects valid condition of Positive Over-Travel Function.	Setting range	0x00-0x29		
	Selection contents are same as 0x00 to 0x29 of function valid condition list in 0x2010. If using as over-travel, it shall be selected from general input 1 to 7 (CONT1 to CONT7).				
0x02	Negative Over-Travel Function ［NLIMSW］	Unsigned8	RW	No	0x00
	Selects valid condition of Negative Over-Travel Function.	Setting range	0x00-0x29		
	Selection contents are same as 0x00 to 0x29 of function valid condition list in 0x2010. If using as over-travel, it shall be selected from general input 1 to 7 (CONT1 to CONT7).				
0x03	External Trip Input Function ［EXT-E］	Unsigned8	RW	No	0x00
	Sets the trip valid condition for a trip input of the external regenerative resistor etc.	Setting range	0x00-0x29		
	Selection contents are same as 0x00 to 0x29 of function valid condition list in 0x2010.				
0x04	Main Circuit Power Discharge Selection ［DISCHRGE］	Unsigned8	RW	No	0x01
	Sets the valid condition of the discharge function in case of main circuit power shutdown.	Setting range	0x00-0x01		
	0x00: Not_Discharge (discharge disabled) 0x01: Discharge (discharge enabled) ✍ Function becomes valid after control power cycle.				
0x05	Emergency Sop Function ［EMR］	Unsigned8	RW	No	0x00
	Sets the valid condition of the input function in case of emergency stop.	Setting range	0x00-0x29		
	Selection contents are same as 0x00 to 0x29 of function valid condition list in 0x2010.				
0x06	Magnetic Pole Position Detection Command function ［CSET］	Unsigned8	RW	No	0x00
[Linear]	Sets valid condition for inputting fixed magnetic pole position estimation function on the linear motor without Hall effect sensor output.	Setting range	0x00-0x29		
	Selection contents are same as 0x00 to 0x29 of function valid condition list in 0x2010.				
0x07	Torque Limit Switching Condition ［TL］	Unsigned8	RW	No	0x01
	Selects a valid condition of torque limit function.	Setting range	0x00-0x29		
	Selection contents are same as 0x00 to 0x29 of function valid condition list in 0x2010. ✓ The values of 0x6072, 0x60E0 and 0x60E1 become invalid if torque limit becomes invalid due to this setting.				
0x08	Velocity Loop Proportional Control Switching Condition ［VLPCON］	Unsigned8	RW	No	0x00
	Selects a valid condition of velocity loop proportional control function.	Setting range	0x00-0x29		
	Selection contents are same as 0x00 to 0x29 of function valid condition list in 0x2010. This function becomes valid if "1" is set to bit 10 in 0x20F7.				

0x20F9: General Purpose Output Function Selection

Index	0x20F9	Selects General Output 1, 2(OUT1, OUT2) function.		Object Code		ARRAY
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Number of entry		Unsigned8	RO	No	0x02
0x01	General Purpose Output 1 [OUT1] Selects output signal for General Purpose Output 1. For a detailed list, see the General Purpose Output Parameters list.		Unsigned8	RW	No	0x84
			Setting range	0x00-0x87 (Initial value: 84: FOUT1_ON)		
0x02	General Purpose Output 2 [OUT2] Selects output signal for General Purpose Output 2. For a detailed list, see the General Purpose Output Parameters list.		Unsigned8	RW	No	0x86
			Setting range	0x00-0x87 (Initial value: 86: FOUT2_ON)		

◆To control from EtherCAT communications

Physical output 0x60FE, 0x01:bit16 setting	84：FOUT1_ON	85：FOUT1_OFF
Physical output 0x60FE, 0x01:bit17 setting	86：FOUT2_ON	87：FOUT2_OFF

◆To output a generic input status

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
General Input, CONT5 is ON	42:CONT5_ON	43:CONT5_OFF
General Input, CONT6 is ON	44:CONT6_ON	45:CONT6_OFF
General Input, CONT7 is ON	46:CONT7_ON	47:CONT7_OFF

◆To output an internal status of servo amplifier

運転準備完了中	02:S-RDY_ON	03:S-RDY_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	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 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 Torque Attainment Status	5E:TA_ON	5F:TA_OFF
While model control/model vibration suppression control	68:MODLCH_ON	69:MODLCH_OFF
While velocity with Velocity Command 0 Status	6A:VCZV_ON	6B:VCZV_OFF
While in Alarm Status	38:ALM_ON	39:ALM_OFF

◆To output a positioning signal

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	5A:INPZ_ON	5B:INPZ_OFF
While Position Command Distribution Completion	60:TRJCMP_ON	61:TRJCMP_OFF

✓ All codes not on the list are Reserved and indeterminate.

0x20FA: Extended Station Alias

Index	0x20FA	Extension parameter to set the address exceeding the value set by rotary switch (0 to 255).	Object Code	VARIABLE

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Number of entry	Unsigned8	RO	No	0x02
0x01	Extended Alias Number ［EXALIAS］ Sets bit15-8 of the Inherent Slave address (Station Alias Reg: 0x0012, 0x0013).	Unsigned8	RW	No	0x00
		Setting range	0x00-0xFF		
	Sets bit7-0 by rotary switches of amplifier front panel. If 0x20FA.02=0x00 then logical sum of rotary switch setting and this set value will be written to the station alias Reg: 0x0012, 0x0013. ✓ Alarm DE (Parameter Change Completion) will issued if the value differ from set value is set. ✍ Function becomes valid after control power cycle.				
0x02	Station Alias Selection ［ALIASEL］ Selects contents to reflect to the station alias Reg: 0x0012, 0x0013 of ESC.	Unsigned8	RW	No	0x01
		Setting range	0x00-0x01		
	0x00: Reflects value of the rotary switches (bit7-0) and the extended alias number (bit15-8). 0x01: If the rotary switches setting is 0x00, reflects the set value of non-volatile memory address 0x04. If the rotary switches setting is except of 0x00, reflects the rotary switches setting. ✓ Alarm DE (Parameter Change Completion) will issued if the value differ from set value is set. ✍ Function becomes valid after control power cycle.				

0x20FB: Torque Addition at Servo ON

Index	0x20FB	Sets the torque addition value until the command at servo ON becomes valid.	Object Code	VARIABLE

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Torque Addition at Servo ON ［SON_TCSET］ During the time to the holding brake release delay time from servo ON, the set torque command will be input. Torque command is reduced every 4 ms, and becomes to zero by the end of the holding brake release delay time.	Integer16	RW	No	0
		Setting range	0xFC18-0x03E8 (-100.0 to 100.0)		
		Unit	%		
	When servo amplifier is used with gravity axis, a self weight fall at servo ON is able to prevent. ✍ Set value is always valid. Please set 0x0000 if this function is not required.				

0x20FC: Modulo Initialization Warning Setting

Index	0x20FC	Sets threshold of Modulo initialization warning which outputs when modulo function is enabled and motor is too much rotating during control power off.	Object Code	VARIABLE

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Sets that the warning in initialization issues when how many multiple of the number of pulse (modulo range) of modulo coordinate is moved from the recorded position at previous power shut down.	Unsigned16	RW	No	0x0000
		Setting range	0x0000-0xFFFF		
	Records the actual position value at control power off. Then calculating motor rotation during power off at initial processing of next power on. Warning flag will be set when pulse number of motor rotation is over the value that multiplied [Pulse number of modulo coordinate] by the setting value that has +/-. See below calculation of [Pulse number threshold] for warning detection. [Pulse number threshold] = [Pulse number of modulo coordinate] x [Set value of 0x20FC] Pulse number threshold will be hold to 0x3FFFFFFF when the value became bigger than 0x3FFFFFFF. ✓ Detection is enabled at condition of 0x20F7 Bit2=1. ✓ Detection occur only at 0x3FFFFFFF when the setting value is zero. For example) 0x607B. 01=0, 0x607B. 02=655359, 0x20FC. 00=5 See below calculation with condition above. [Pulse number of modulo coordinate]: 655360 (= 655359- 0+ 1) [Pulse number threshold]: +/- 3276800 (= 655360 x 5) ✓ Function becomes valid after control power cycle.				

0x20FD: Servo Amplifier System Selection

Index	0x20FD Selects the system configuration of the servo amplifier.		Object Code		ARRAY
Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Number of entry	Unsigned8	RO	No	0x08
0x01	Main Circuit 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) 0x03-0xFF: Reserved ✍ Function becomes valid after control power cycle.	Unsigned8 Setting range	RW 0x00-0x02	No	0x00
0x02	Regenerative Resistor Selection [RGKIND] Selects the presence/absence of regenerative resistance and the connection forms. 0x00: Regenerative resistor disconnected 0x01: Built-in regenerative resistor used 0x02: External regenerative resistor used 0x03 - 0xFF: Reserved ✍ Function becomes valid after control power cycle.	Unsigned8 Setting range	RW 0x00-0x02	No	0x01
0x03	Motor Structure [MOTSTR] Selects the motor structure. 0x00: Rotary motor 0x01: Linear motor 0x02: Direct Drive motor ✍ Function becomes valid after control power cycle.	Unsigned8 Setting range	RW 0x00-0x02	No	0x00
0x08	Control Cycle [CNTCYC] Selects the control cycle. 0x00: Standard sampling mode 0x01: High speed sampling mode ✍ Function becomes valid after control power cycle.	Unsigned8 Setting range	RW 0x00-0x01	No	0x00

0x20FE: Motor Code

Index	0x20FE	Sets the code of motor to be driven.		Object Code		VARIABLE
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Motor Code ［MOCODE］ Sets the combination motor code.		Unsigned16	RW	No	0x8000
			Setting range	0x0000-0xFFFF		

■ Rotary motor (200V)

Series	Motor code	Servo motor model number	Input type	Amplifier capacity	Flange size	Rated output	Maximum speed
R1 Series	0x057C	R1AA04005F	AC200V	10A	40mm sq.	50W	6,000 min^{-1}
	0x0533	R1AA04010F	AC200V	10A	40mm sq.	100W	6,000 min^{-1}
	0x0579	R1AA06020F	AC200V	20A	60mm sq.	200W	6,000 min^{-1}
	0x0534	R1AA06040F	AC200V	20A	60mm sq.	400W	6,000 min^{-1}
	0x0576	R1AA08075V	AC200V	30A	80mm sq.	750W	6,000 min^{-1}
	0x0515	R1AA10100H	AC200V	30A	100mm sq.	1.0kW	3,000 min^{-1}
	0x0512	R1AA10150H	AC200V	30A	100mm sq.	1.5kW	3,000 min^{-1}
	0x0577	R1AA08075F	AC200V	50A	80mm sq.	750W	6,000 min^{-1}
	0x0516	R1AA10100F	AC200V	50A	100mm sq.	1.0kW	6,000 min^{-1}
	0x04FA	R1AA10150F	AC200V	50A	100mm sq.	1.5kW	6,000 min^{-1}
	0x0513	R1AA10200H	AC200V	50A	100mm sq.	2.0kW	3,000 min^{-1}
	0x0517	R1AA10250H	AC200V	50A	100mm sq.	2.5kW	3,000 min^{-1}
	0x050F	R1AA10200F	AC200V	75A	100mm sq.	2.0kW	6,000 min^{-1}
	0x0518	R1AA10250F	AC200V	75A	100mm sq.	2.5kW	6,000 min^{-1}
	0x0511	R1AA13300H	AC200V	75A	130mm sq.	3.0kW	3,000 min^{-1}
	0x0508	R1AA13300F	AC200V	100A	130mm sq.	3.0kW	6,000 min^{-1}
	0x0519	R1AA13400H	AC200V	100A	130mm sq.	4.0kW	3,000 min^{-1}
	0x050E	R1AA13500H	AC200V	100A	130mm sq.	5.0kW	3,000 min^{-1}
	0x051A	R1AA13400F	AC200V	150A	130mm sq.	4.0kW	6,000 min^{-1}
	0x051B	R1AA13500F	AC200V	150A	130mm sq.	5.0kW	6,000 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}

■ Rotary motor (200V)

Series	Motor code	Servo motor model number	Input type	Amplifier capacity	Flange size	Rated output	Maximum speed
R2 Series	0x0181	R2AA04003F	AC200V	10A	40mm sq.	30W	6,000 min^{-1}
	0x0182	R2AA04005F	AC200V	10A	40mm sq.	50W	6,000 min^{-1}
	0x0183	R2AA04010F	AC200V	10A	40mm sq.	100W	6,000 min^{-1}
	0x0184	R2AA06010F	AC200V	10A	60mm sq.	100W	6,000 min^{-1}
	0x0185	R2AA06020F	AC200V	20A	60mm sq.	200W	6,000 min^{-1}
	0x0186	R2AA06040F	AC200V	20A	60mm sq.	400W	6,000 min^{-1}
	0x0189	R2AA06040H	AC200V	20A	60mm sq.	400W	3,000 min^{-1}
	0x018A	R2AA08020F	AC200V	20A	80mm sq.	200W	6,000 min^{-1}
	0x0188	R2AA08040F	AC200V	20A	80mm sq.	400W	6,000 min^{-1}
	0x0187	R2AA08075F	AC200V	30A	80mm sq.	750W	6,000 min^{-1}
	0x0194	R2AAB8100H	AC200V	30A	86mm sq.	1.0kW	3,000 min^{-1}
	0x019F	R2AA10075F	AC200V	30A	100mm sq.	750W	6,000 min^{-1}
	0x018C	R2AA13050D	AC200V	30A	130mm sq.	500W	5,000 min^{-1}
	0x018F	R2AA13050H	AC200V	30A	130mm sq.	550W	3,500 min^{-1}
	0x0191	R2AA13120B	AC200V	30A	130mm sq.	1.2kW	2,000 min^{-1}
	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	5,000 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}

■ Rotary motor (200V), continued

Series	Motor code	Servo motor model number	Input type	Amplifier capacity	Flange size	Rated output	Maximum speed
R2 Series	0x04FB	R2AA13180D	AC200V	75A	130mm sq.	1.8kW	5,000 min^{-1}
	0x04FC	R2AA13200D	AC200V	75A	130mm sq.	2.0kW	5,000 min^{-1}
	0x04FD	R2AA18350V	AC200V	75A	180mm sq.	3.5kW	3,000 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}
	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}
	0x0195	R2AA22500L	AC200V	150A	220mm sq.	5.0kW	4,000 min^{-1}
	0x0484	R2AA22700S	AC200V	150A	220mm sq.	7.0kW	1,000 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}
	0x0481	R2AA2220KB	AC200V	600A	220mm sq.	20kW	2,000 min^{-1}
	0x0112	R2AA2225KB	AC200V	600A	220mm sq.	25kW	2,000 min^{-1}
	0x0499	R2AA2830KV	AC200V	600A	280mm sq.	30kW	2,000 min^{-1}

■ Rotary motor (100V)

Series	Motor code	Servo motor model number	Input type	Amplifier capacity	Flange size	Rated output	Maximum speed
R1 Series	0x0581	R1EA04005F	AC100V	20A	40mm sq.	50W	6,000 min^{-1}
	0x0582	R1EA04010F	AC100V	20A	40mm sq.	100W	6,000 min^{-1}
	0x057B	R1EA06020F	AC100V	30A	60mm sq.	200W	6,000 min^{-1}

■ Rotary motor (100V)

Series	Motor code	Servo motor model number	Input type	Amplifier capacity	Flange size	Rated output	Maximum speed
R2 Series	0x0197	R2EA04003F	AC100V	10A	40mm sq.	30W	6,000 min^{-1}
	0x0198	R2EA04005F	AC100V	20A	40mm sq.	50W	6,000 min^{-1}
	0x019D	R2EA04008F	AC100V	20A	40mm sq.	80W	6,000 min^{-1}
	0x019A	R2EA06010F	AC100V	20A	60mm sq.	100W	6,000 min^{-1}
	0x019B	R2EA06020F	AC100V	30A	60mm sq.	200W	6,000 min^{-1}

■ Rotary motor (200V)

Series	Motor code	Servo motor model number	Input type	Amplifier capacity	Flange size	Rated output	Maximum speed
R5 Series	0x049D	R5AA06020H	AC200V	10A	60mm sq.	200W	3,000 min^{-1}
	0x049E	R5AA06020F	AC200V	20A	60mm sq.	200W	6,000 min^{-1}
	0x049F	R5AA06040H	AC200V	20A	60mm sq.	400W	3,000 min^{-1}
	0x02BB	R5AA06040F	AC200V	20A	60mm sq.	400W	6,000 min^{-1}
	0x02BA	R5AA08075D	AC200V	30A	80mm sq.	750W	5,000 min^{-1}
	0x04A0	R5AA08075F	AC200V	30A	80mm sq.	750W	6,000 min^{-1}

■ Rotary motor 400V)

Series	Motor code	Servo motor model number	Input type	Amplifier capacity	Flange size	Rated 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}
	0x013C	R2CA18350D	AC400V	100A	180mm sq.	3.5kW	4,000 min^{-1}
	0x0138	R2CA18450H	AC400V	100A	180mm sq.	4.5kW	3,500 min^{-1}
	0x0522	R2CA18550R	AC400V	100A	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.	11.0kW	2,500 min^{-1}
	0x0140	R2CA2215KV	AC400V	150A	220mm sq.	15.0kW	2,000 min^{-1}
	0x056E	R2CA2220KV	AC400V	300A	220mm sq.	20.0kW	2,300 min^{-1}
	0x056A	R2CA2830KV	AC400V	300A	280mm sq.	30.0kW	2,000 min^{-1}
	0x056B	R2CA3255KB	AC400V	800A	320mm sq.	55.0kW	2,000 min^{-1}

■ Rotary motor 400V)

Series	Motor code	Servo motor model number	Input type	Amplifier capacity	Flange size	Rated 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.	11.0kW	2,500 min^{-1}
	0x0562	R1CA1815KB	AC400V	150A	180mm sq.	15.0kW	2,000 min^{-1}
	0x056D	R1CA2220KV	AC400V	300A	220mm sq.	21.0kW	2,000 min^{-1}

■ Linear motor (200V)

Series	Motor code	Servo motor model number	Input type	Amplifier capacity	Magnet width	Rated force	Maximum speed
DS Series	0x0343	DS030C1N2	AC200V	30A	30mm	160N	5.5 m/s
	0x0347	DS050C1N2	AC200V	30A	50mm	260N	3.5 m/s
	0x034C	DS075C1N2	AC200V	30A	75mm	400N	2.4 m/s
	0x03FF	DS045CC1AN	AC200V	30A	45mm	260N	3.0 m/s
	0x0344	DS030C2N2	AC200V	50A	30mm	320N	5.5 m/s
	0x0348	DS050C2N2	AC200V	50A	50mm	520N	3.5 m/s
	0x034F	DS075C2N2	AC200V	50A	75mm	800N	2.4 m/s
	0x0350	DS100C1N2	AC200V	50A	100mm	540N	4.0 m/s
	0x0353	DS150C1N2	AC200V	50A	150mm	800N	2.6 m/s
	0x04D5	DS030C3N2	AC200V	75A	30mm	480N	5.5 m/s
	0x04D6	DS050C3N2	AC200V	75A	50mm	780N	3.5 m/s
	0x04D7	DS075C3N2	AC200V	75A	75mm	1200N	2.4 m/s
	0x0346	DS030C3N2	AC200V	100A	30mm	480N	5.5 m/s
	0x034A	DS050C3N2	AC200V	100A	50mm	780N	3.5 m/s
	0x0349	DS075C3N2	AC200V	100A	75mm	1200N	2.4 m/s
	0x0351	DS100C2N2	AC200V	100A	100mm	1080N	4.0 m/s
	0x0354	DS150C2N2	AC200V	100A	150mm	1600N	2.6 m/s
	0x0352	DS100C3N2	AC200V	150A	100mm	1620N	4.0 m/s
	0x034D	DS150C3N2	AC200V	150A	150mm	2400N	2.6 m/s
DD Series	0x03D2	DD030C1Y4	AC200V	50A	30mm	430N	3.0 m/s
	0x04D8	DD030C2Y4	AC200V	75A	30mm	860N	3.0 m/s
	0x04D9	DD050C1Y2	AC200V	75A	50mm	700N	3.0 m/s
	0x04DA	DD075C1Y2	AC200V	75A	75mm	1050N	3.0 m/s
	0x04DB	DD045CB4AN	AC200V	75A	45mm	800N	3.0 m/s
	0x04D4	DD035CC2AN	AC200V	75A	35mm	610N	3.0 m/s
	0x03D3	DD030C2Y4	AC200V	100A	30mm	860N	3.0 m/s
	0x03D4	DD030C3Y4	AC200V	100A	30mm	1290N	3.0 m/s
	0x03D5	DD050C1Y2	AC200V	100A	50mm	700N	3.0 m/s
	0x03DA	DD075C1Y2	AC200V	100A	75mm	1050N	3.0 m/s
	0x03FE	DD045CB4AN	AC200V	100A	45mm	800N	3.0 m/s
	0x03D6	DD050C2Y2	AC200V	150A	50mm	1400N	3.0 m/s
	0x03DB	DD075C2Y2	AC200V	150A	75mm	2100N	3.0 m/s
	0x03D9	DD050C3Y2	AC200V	300A	50mm	2100N	3.0 m/s
	0x03DC	DD075C3Y2	AC200V	300A	75mm	3100N	3.0 m/s
	0x03DD	DD075C4Y2	AC200V	300A	75mm	4150N	3.0 m/s
DT Series	0x04D3	DT030CD1AN	AC200V	30A	30mm	350N	3.0 m/s

■ Special setting

-	Motor code	Contents
	0x8000	Auto setting of motor parameter (When connected to applicable motor)
	0xFFFF	Based on motor setting (non-volatile memory setting value) set by SANMOTION MOTOR Setup software.

✍ To be Initialized by motor code set on non-volatile memory at power-on.
If the motor code whose set parameter is differenet from non-volatile memory value, function becomes enabled when control power is re-turned on.
Re-turn on control power since alarm “DE: parameter change completed” becomes active after new value is set to EEPROM.

✍ 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: Encoder Selection

Index	0x20FF	Selects the motor encoder specifications and functions driven by combination. ✍ Function becomes valid after control power cycle.	Object Code		Record
Sub-Idx	**Description**	**Data Type**	**Access**	**PDO**	**Initial value**
0x00	Number of entry	Unsigned8	RO	No	0x08
0x01	Encoder Resolution Code ［ENCODE］	Unsigned16	RW	No	0x8000
	Sets the division number of the motor encoder.	Setting range	0x0000-0xFFFF		

■ In use of incremental encoder

Code	Resolution
0x0000	500P/R
0x0001	512P/R
0x0002	1,000P/R
0x0003	1,024P/R
0x0004	1,500P/R
0x0005	2,000P/R
0x0006	2,048P/R
0x0007	2,500P/R
0x0008	3,000P/R
0x0009	4,000P/R
0x000A	4,096P/R
0x000B	5,000P/R
0x000C	6,000P/R
0x000D	8,192P/R
0x000E	16,384P/R
0x000F	32,768P/R
0x0010	10,000P/R

■In use of absolute encoder

Code	Resolution
0x0000	2,048FMT
0x0001	4,096FMT
0x0002	8,192FMT
0x0003	16,384FMT
0x0004	32,768FMT
0x0005	65,536FMT
0x0006	131,072FMT
0x0007	262,144FMT
0x0008	524,288FMT
0x0009	1,048,576FMT
0x000A	2,097,152FMT
0x000B	4,194,304FMT
0x000C	8,388,608FMT

■ In use of linear scale encoder

Incremental encoder

Code	Resolution	
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]

Absolute encoder

Code	Resolution	
0x0080	100nm	[10,000P/mm]
0x0081	50nm	[20,000P/mm]
0x0082	10nm	[100,000P/mm]
0x0083	5nm	[200,000P/mm]
0x0084	1nm	[1,000,000P/mm]

0x8000: Auto setting of motor parameter (When connected to applicable motor.)
0xFFFF: Based on resolution setting (non-volatile memory setting value) set by SANMOTION MOTOR Setup software.

✍ Initialized by the encoder resolution number set in non-volatile memory at the turn-on state.
When the encoder resolution number set parameter is different from the non-volatile memory 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

Automatic setting of motor parameter is performed as below.

Set 0x8000 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.

In the following cases, automatic setting of motor parameter function is not available.

✓ Connected to the motor which is not supported by automatic setting.
✓ Connected to the motor which is improper combination with the amplifier.

0x02	Encoder Type Code ［ENTYPE］	Unsigned16	RW	No	0x8000
	Selects the type of motor encoder.	Setting range	0x0000-0xFFFF		
	■ Incremental encoder (Wire-saving incremental encoder: 4pairs) 0x0000: Wire-saving incremental encoder 0x0002: Incremental encoder, CS decision: Magnetic pole position estimation, CS normalization: None. ■ Incremental system (Single-turn absolute encoder) 0x0101: Single-turn absolute encoder 2.5MHz (without multi-turn output) 0x0201: Single-turn absolute encoder 4.0MHz (without multi-turn output) ✓ Uses the actual position (0x6040) at power on state as zero. ■ Absolute encoder 0x0300: Battery backup absolute encoder 2.5MHz (with multi-turn output) 0x0400: Battery backup absolute encoder 4.0MHz (with multi-turn output) 0x0500: Battery-less absolute encoder 2.5MHz (with multi-turn output) 0x0600: Battery-less absolute encoder 4.0MHz (with multi-turn output) ■ Absolute encoder / Incremental system (multi-turn backup method) 0x0301: Battery backup absolute encoder 2.5MHz (with multi-turn output) 0x0401: Battery backup absolute encoder 4.0MHz (with multi-turn output) 0x0501: Battery-less absolute encoder 2.5MHz (with multi-turn output) 0x0601: Battery-less absolute encoder 4.0MHz (with multi-turn output) ✓ When absolute encoder is used as incremental system, actual position (0x6040) becomes zero at power ON. In this setting, battery error or battery warning is not detected. ✓ To use this setting, selects incremental system at Battery backup absolute encoder function selection (0x20FF:0x05). ■ Linear encoder (Only when using linear motor) Incremental encoder 0x0800: Incremental encoder with CS, CS decision: Hall effect sensor, CS normalization: phase U 0x0810: Incremental encoder with CS, CS decision: Hall effect sensor, CS normalization: phase Z 0x0820: Incremental encoder with CS, CS decision: Hall effect sensor, CS normalization: none 0x0830: Wire-saving incremental encoder, CS decision: Hall effect sensor, CS normalization: phase Z 0x0840: Wire-saving incremental encoder, CS decision: Hall effect sensor, CS normalization: none 0x0850: Incremental encoder, CS decision: Magnetic pole position estimation, CS normalization: none 0x0860: Incremental encoder, CS decision: Forced setting, CS normalization: none Absolute encoder 0x0900: Battery-less absolute encoder (EnDat), 2Mbps, CS decision: Encoder absolute position 0x0910: Battery-less absolute encoder (EnDat), 2Mbps, CS decision: Magnetic pole position estimation 0x0920: Battery-less absolute encoder (EnDat), 4Mbps, CS decision: Encoder absolute position 0x0930: Battery-less absolute encoder (EnDat), 4Mbps, CS decision: Magnetic pole position estimation ■ Setting with the Setup software configuration 0x8000: Auto setting of motor parameter (When connected to applicable motor.) 0xFFFF: Based on encoder setting (non-volatile memory setting value) set by SANMOTION MOTOR Setup software. ✍ Initialized by the encoder type code set in non-volatile memory, at power on state. When the encoder type set parameter is different from the non-volatile memory value set, the function will be enabled by control source re-closing. After the new value is set in non-volatile memory, 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.				
0x03 [Full Close]	External Encoder Resolution Code ［EXPENRES］ Sets the external encoder resolution used for full close control.	Unsigned32	RW	No	0x000007D0 (2,000)
		Setting range	0x000001F4-0x0001869F (500 to 8,388,608)		
		Unit	Pulse		
	■ Incremental encoder Sets the (1-multiplied) pulse converted to one turn of the motor axis. The position command is the division number of the 4-multiplied one turn pulse. Setting range: 500 to 500000 (1-multiplied) ■Absolute encoder Sets the resolution of external encoder per one turn of the motor axis. Setting range: 2,048 to 8,388,608 ✍ Initialized by the encoder resolution number set in non-volatile memory, at power-on state. When the encoder resolution number set parameter is different from the non-volatile memory value set, the function will be enabled by control source re-closing. After the new value is set in non-volatile memory, alarm "DE: parameter change completed" occurs, then re-close control source.				

Sub-index	Description	Data type	Access	PDO	Default
0x04	External Encoder Type Code ［EXENTYPE］ Selects the type of external encoder. ■ Incremental encoder 0x0000: Wire-saving incremental encoder 0x0002: Incremental encoder ■Absolute encoder 0x0900: Battery-less absolute encoder (EnDat), 2Mbps 0x0920: Battery-less absolute encoder (EnDat), 4Mbps	Unsigned16 Setting range: 0x0000-0xFFFF	RW	No	0x0000
0x05	Battery Backup Absolute Encoder Function Selection [SERENSEL] ■ For battery backup absolute encoder, selects whether absolute system use including multi-turn count or incremental system use without multi-turn count. 0x0000: Absolute system 0x0001: Incremental system ✍ For use as incremental system, battery is not required. However, multi turn count does not backup. ✍ Initialized by the encoder type code set in non-volatile memory, at power on state. When the encoder type set parameter is different from the non-volatile memory value set, the function will be enabled by control source re-closing. After the new value is set in non-volatile memory, alarm "DE: parameter change completed" occurs, then re-close control source.	Unsigned8 Setting range: 0x00-0x01	RW	No	0x00
0x06	Absolute Encoder Multi Turn Count [ABSMLT] Sets the absolute encoder multi-turn count. 0x00: 1_ROT 1 turn 0x01: 2048_ROT 2048 turn 0x02: 4096_ROT 4096 turn 0x03: 8192_ROT 8192 turn 0x04: 16384_ROT 16384 turn 0x05: 32768_ROT 32768 turn 0x06: 65536_ROT 65536 turn 0x07: 131072_ROT 131072 turn 0x08: 262144_ROT 262144 turn 0x09: 524288_ROT 524288 turn 0x0A: 1048576_ROT 1048576 turn 0x0B: 2097152_ROT 2097152 turn 0x0C: 4194304_ROT 4194304 turn	Unsigned8 Setting range: 0x00-0x0C	RW	No	0x06
0x07	External Absolute Encoder Multi Turn Count [EXABSMLT] Function reserved	Unsigned8 Setting range: 0x00-0x0C	RW	No	0x00
0x08	Motor Encoder Input Selection [MOTESEL] Selects connector used for motor encoder. 0x00: EN1 is used for motor encoder input connector. 0x01: EN2 is used for motor encoder input connector. ✓ Depending on amplifier model number, connectable encoder type is specified for EN1, EN2. Please set properly depends on combination for use. ✓ Initialized by the encoder type code set in non-volatile memory, at power on state. When the encoder type set parameter is different from the non-volatile memory value set, the function will be enabled by control source re-closing. After the new value is set in non-volatile memory, alarm "DE: parameter change completed" occurs, then re-close control source.	Unsigned8 Setting range: 0x00-0x01	RW	No	0x00

Rotary motor encoder setting

The motor encoder that will be used is set. Available encoder differs by encoder type of the servo amplifier. Please set the system parameter concerned with motor encoder by following table reference below.

Target motor encoder	Applicable encoder type by servo amplifier model number			Reference
	RS3xxxx2xxx	RS3xxxxAxxx	RS3xxxxBxxx	
Absolute encoder	○	×	×	1)
Incremental encoder	○	○	○	2)

✔ ○: Combination available, ×: Combination not available

1) Absolute encoder (Applicable amplifier model number: RS3xxxx2xxx)

■ Motor encoder input selection
Select the connector for connecting motor encoder. Must set "00: EN1".

Group ID	CoE Object ID	Selection		Description
System ID 10	0x20FF, 0x08 MOTESEL	0x00	EN1	Uses EN1 for connecting motor encoder.
		0x01	EN2	Uses EN2 for connecting motor encoder.

■ Encoder type
Select the encoder type that will be connected to EN1.
Please select absolute encoder type that will be used.

Group ID	CoE Object ID	Selection		Description	
				Encoder type	Baud rate
System ID 32	0x20FF, 0x02 ENTYPE	0x0101	PA S-ABS 2.5MHz	Single-turn absolute encoder (Encoder code: H)	2.5MHz
		0x0201	PA S-ABS 4.0MHz	Single-turn absolute encoder (Encoder code: H)	4.0MHz
		0x0300	PA C-ABS 2.5MHz	Battery backup absolute encoder (Encoder code: P)	2.5MHz
		0x0400	PA C-ABS 4.0MHz	Battery backup absolute encoder (Encoder code: P)	4.0MHz
		0x0500	RA C-ABS 2.5MHz	Battery-less absolute encoder (Encoder code: R, W)	2.5MHz
		0x0600	RA C-ABS 4.0MHz	Battery-less absolute encoder (Encoder code: R, W)	4.0MHz

✔ It will be set automatically if motor automatic set function is effective.

■ Battery backup absolute encoder function selection
Select a use of battery backup absolute encoder as an absolute system with multi turn value or as an incremental system without multi turn value.

- ◆ Must connect battery if use as an absolute system.
- ◆ Battery is not necessary if use as an incremental system. As note, multi turn value does not back up.

Group ID	CoE Object ID	Selection		Description
System ID 35	14	00	Absolute_System	Use as absolute system
		01	Incremental_System	Use as incremental system

■ Absolute encoder resolution
Select the resolution of single turn of motor.

Group ID	CoE Object ID	Selection		Description	Selection		Description
System ID 31	0x20FF, 0x01 ENCODE	00	2048_FMT	2,048 division	07	262144_FMT	262,144 division
		01	4096_FMT	4,096 division	08	524288_FMT	524,288 division
		02	8192_FMT	8,192 division	09	1048576_FMT	1,048,576 division
		03	16384_FMT	16,384 division	0A	2097152_FMT	2,097,152 division
		04	32768_FMT	32,768 division	0B	4194304_FMT	4,194,304 division
		05	65536_FMT	65,536 division	0C	8388608_FMT	8,388,608 division
		06	131072_FMT	131,072 division			

✔ It will be set automatically if motor automatic set function is effective.

■ Absolute encoder multi turn value
Select the multi turn value of absolute encoder.

Group ID	CoE Object ID	Selection		Description	Selection		Description
System ID 36	0x20FF, 0x06 ABSMLT	00	1_ROT	1 turn	07	131072_ROT	131,072 turns
		01	2048_ROT	2,048 turns	08	262144_ROT	262,144 turns
		02	4096_ROT	4,096 turns	09	524288_ROT	524,288 turns
		03	8192_ROT	8,192 turns	0A	1048576_ROT	1,048,576 turns
		04	16384_ROT	16,384 turns	0B	2097152_ROT	2,097,152 turns
		05	32768_ROT	32,768 turns	0C	4194304_ROT	4,194,304 turns
		06	65536_ROT	65,536 turns			

✔ It will be set automatically if motor automatic set function is effective.

2) Incremental encoder
(Applicable amplifier model number: RS3xxxx2xxx, RS3xxxxAxxx, RS3xxxxBxxx)

■ Motor encoder input selection
Select the connector for connecting motor encoder. Must set "00: EN1".
- ◆ Select "01:EN2" if "RS3xxxx2xxx" is used.
- ◆ Select "00:EN1" if "RS3xxxxAxxx or RS3xxxxBxxx" is used.

Group ID	CoE Object ID	Selection		Description
System ID 10	0x20FF, 0x08 MOTESEL	0x00	EN1	Uses EN1 for connecting motor encoder.
		0x01	EN2	Uses EN2 for connecting motor encoder.

■ Encoder type
Select the motor encoder type.
Please select incremental encoder type that will be used.

Group ID	CoE Object ID	Selection		Description
System ID 32	0x20FF, 0x02 ENTYPE	0x0000	Pulse	Wire-saving incremental encoder

■ Incremental encoder resolution
Set the motor encoder resolution that will be used. Please set one-multiplied value.

Group ID	CoE Object ID	Selection		Description	Selection		Description
System ID 31	0x20FF, 0x01 ENCODE	00	500P/R	500 division	09	4,000P/R	4,000 division
		01	512P/R	512 division	0A	4,096P/R	4,096 division
		02	1,000P/R	1,000 division	0B	5,000P/R	5,000 division
		03	1,024P/R	1,024 division	0C	6,000P/R	6,000 division
		04	1,500P/R	1,500 division	0D	8,192P/R	8,192 division
		05	2,000P/R	2,000 division	0E	16,384P/R	16,384 division
		06	2,048P/R	2,048 division	0F	32,768P/R	32,768 division
		07	2,500P/R	2,500 division	10	10,000P/R	10,000 division
		08	3,000P/R	3,000 division			

3) System parameters setting list related to motor encoder due to encoder types each

ID	CoE Object ID	Motor model number			
		RxxxxxxxxxxHxx	RxxxxxxxxxxPxx	RxxxxxxxxxxRxx	RxxxxxxxxxxSxx
10	0x20FF, 0x08 MOTESEL Motor encoder input selection	00: EN1	00: EN1	00: EN1	00: EN1 or 01: EN2 Note 1)
32	0x20FF, 0x02 ENTYPE Encoder type code	0x0101 or 0x0201 Note 2)	0x0300 or 0x0400 Note 2)	0x0500 or 0x0600 Note 2)	0x0000
34	0x20FF, 0x04 EXENTYPE External encoder type code	Setting is just required for full-closed system use.			
35	0x20FF, 0x05 SERENSEL Battery backup absolute encoder function selection	Setting not required	00: Absolute_System or 01: Incremental_System Note 3)	Setting not required	Setting not required
31	0x20FF, 0x01 ENCODE Encoder resolution	Set according to encoder spec in use.			
36	0x20FF, 0x06 ABSMLT Absolute encoder multi turn count	Set according to encoder spec in use.		Setting not required	

Note 1) Motor encoder input connector is able to select from EN1 or EN2 when servo amplifier model number is RS3☐☐☐A2☐☐☐ (eighth digit from left is "2").
Set "00：EN1" for a use of absolute encoder, "01：EN2" for a use of incremental encoder.

Note 2) Select "0x0101, 0x0300 or 0x0500" for encoder baud rate 2.5MHz use, "0x0201, 0x0400 or 0x0600" for encoder baud rate 4.0MHz use.

Note 3) For a use of battery backup absolute encoder as incremental system without multi-turn data, select "01:Incremental_System". In this case, battery connection is not required.

Linear motor encoder setting

The linear encoder that will be used is set. Available linear encoder differs by encoder type of the servo amplifier. Please set the system parameter concerned with linear encoder by following table reference below.

Target linear encoder	Applicable encoder type by servo amplifier model number			Reference
	RS3xxxx2xxx	RS3xxxxAxxx	RS3xxxxBxxx	
Absolute encoder	○	×	×	1)
Incremental encoder	○	○	○	2)

✔ ○: Combination available, ×: Combination not available

1) Absolute encoder (Applicable amplifier model number: RS3xxxx2xxx)

■ Motor encoder input selection
Select the connector for connecting linear encoder. Must set "00: EN1".

Group ID	CoE Object ID	Selection		Description
System ID 10	0x20FF, 0x08 MOTESEL	00	EN1	Uses EN1 for connecting motor encoder.
		01	EN2	Uses EN2 for connecting motor encoder.

■ Encoder type
Selects the motor encoder type, baud rate and CS position deciding method.
Please select absolute encoder type that will be used.

Group ID	CoE Object ID	Selection	Description		
			Encoder type	Baud rate	CS decision
System	0x20FF, 0x02 ENTYPE	0x0900	Battery-less absolute encoder (EnDat)	2Mbps	Encoder absolute position
		0x0910	Battery-less absolute encoder (EnDat)	2Mbps	Magnetic pole positionestimation
		0x0920	Battery-less absolute encoder (EnDat)	4Mbps	Encoder absolute position
		0x0930	Battery-less absolute encoder (EnDat)	4Mbps	Magnetic pole positionestimation

■ Absolute encoder resolution
Select the encoder resolution.

Group ID	CoE Object ID	Selection		Description	
System ID 31	0x20FF, 0x01 ENCODE	80	10000_P/mm	10000 P/mm	(100 nm)
		81	20000_P/mm	20000 P/mm	(50 nm)
		82	100000_P/mm	100000 P/mm	(10 nm)
		83	200000_P/mm	200000 P/mm	(5 nm)
		84	1000000_P/mm	1000000 P/mm	(1 nm)

✔ It will be set automatically if motor automatic set function is effective.

■ CS offset
Sets an offset value between magnetic pole position and absolute position of absolute encoder, by electric angle conversion.

Group ID	CoE Object ID	Setting range	Unit
System ID 1A	0x20F1, 0x05 CSHIFT	0 to 359	degree

✔ Set an offset value which is estimated by the magnetic pole position estimation.
Setting is required in case below.

- At a system setup (Initial startup)
- At a servo amplifier replacement
- At a linear motor replacement
- At a linear encoder (scale or head) replacement or mounting change
- In case of occurring shift of position relation between linear motor and encoder

2) Incremental encoder
(Applicable amplifier model number: RS3xxxx2xxx, RS3xxxxAxxx, RS3xxxxBxxx)

■ Motor encoder input selection
Select the connector for connecting motor encoder.
- ◆ Select "01:EN2" if "RS3xxxx2xxx" is used.
- ◆ Select "00:EN1" if "RS3xxxxAxxx or RS3xxxxBxxx" is used.

Group ID	CoE Object ID	Selection		Description
System ID 10	0x20FF, 0x08 MOTESEL	0x00	EN1	Uses EN1 for connecting motor encoder.
		0x01	EN2	Uses EN2 for connecting motor encoder.

■ Encoder type
Selects the motor encoder type, CS position deciding method and CS position normalization method.
Please select incremental encoder type that will be used.
- ◆ For RS3xxxx2xxx, select except of "0x0800, 0x0810 or 0x0820".
- ◆ For RS3xxxxAxxx and RS3xxxxBxxx, select encoder type at this parameter.

Group ID	CoE Object ID	Selection	Description		
			Encoder type	CS decision	CS normalization
System	0x20FF, 0x02 ENTYPE	0x0800	Incremental encoder with CS	Hall effect sensor	Hall effect sensor S1-phase (U-phase)
		0x0810	Incremental encoder with CS	Hall effect sensor	Z-phase
		0x0820	Incremental encoder with CS	Hall effect sensor	None
		0x0830	Wire-saving incremental encoder	Hall effect sensor	Z-phase
		0x0840	Wire-saving incremental encoder	Hall effect sensor	None
		0x0850	Incremental encoder	Magnetic pole positionestimation	None
		0x0860	Incremental encoder	Forced setting	None

■ Incremental encoder resolution
Set the linear encoder resolution that will be used. Please set 1-multiplied value.

Group ID	CoE Object ID	Selection		Description	Selection		Description
System ID 31	0x20FF, 0x01 ENCODE	00	5 μm	200 P/mm	05	0.5 μm	2,000 P/mm
		01	2.5 μm	400 P/mm	06	0.5 μm	4,000 P/mm
		02	2 μm	500 P/mm	07	0.125 μm	8,000 P/mm
		03	1.25 μm	800 P/mm	08	0.1 μm	10,000 P/mm
		04	1 μm	1,000 P/mm	09	0.05 μm	20,000 P/mm

■ CS offset
Sets an offset value between U-phase electric angle 0 (degree) and S1-phase hall effect sensor output signal edge, by electric angle conversion.
- ◆ Just set when encoder type is "Incremental encoder with CS".
- ◆ For the CS offset value of each motors, please refer section 2.2.4 in another document M0011695.

Group ID	CoE Object ID	Setting range	Unit
System ID 1A	0x20F1, 0x05 CSHIFT	0 to 359	degree

✔ Set an U-phase electric angle at power on if "02:Type3" is set to the CS decision method selection.

■ Z-phase CS normalization offset
Sets an offset value between U-phase electric angle 0 (degree) and Z-phase signal output position, by electric angle conversion.
- ◆ Just set when CS normalization method is "Z-phase".

Group ID	CoE Object ID	Setting range	Unit
System ID 1B	0x20F1, 0x06 CSCNOF	0 to 359	degree

Full-closed system setting

Set the parameters as follows for use of full-closed control.

■ Control cycle
Select a control cycle of velocity control and torque control. "00: Standard_Sampling" shall be selected for use of full-closed control.

Group ID	CoE Object ID	Selection		Description
System ID 00	0x20FD, 0x08 CNTCYC	0x00	Standard_Sampling	Standard sampling mode

■ Operation mode selection
Selects the control mode. "02: Position" shall be selected for use of full-closed control.

Group ID	CoE Object ID	Selection		Description
Group A ID 10	0x6060, 0x00 OPMODE	0x01	PP	Profile Position mode
		0x08	CSP	Cyclic Sync Position mode

■ Motor encoder input selection
Selects the connector used as motor encoder. "00: EN1" shall be selected for use of full-closed control.

Group ID	CoE Object ID	Selection		Description
System ID 10	0x20FF, 0x08 MOTESEL	0x00	EN1	Uses EN1 as motor encoder.

■ Position loop control, position loop encoder selection
Select the encoder for use of control method of position loop and position control. "01: External_Enc" shall be selected for use of full-closed control.

Group ID	CoE Object ID	Selection		Description
System ID 20	0x20F3, 0x02 PLMODE	0x01	External_Enc	Full-closed control/ External encoder

1) Absolute encoder (Applicable amplifier model number: RS3xxxx1xxx, RS3xxxx9xxx)

■ External encoder type code
Select the external encoder type that will be connected to EN2.

Group ID	CoE Object ID	Selection		Description
System ID 34	0x20FF, 0x04 EXENTYPE	0x0900	EnDat_ABS	EnDat2.2 / 2Mbps
		0x0920	EnDat_ABS	EnDat2.2 / 4Mbps

■ External absolute encoder resolution (for absolute encoder)
Sets the external encoder resolution per equal to motor single-turn.
Be valid after control power cycle.

Group ID	CoE Object ID	Setting range	Unit
System ID 33	0x20FF, 0x03 EXPENRES	2,048 to 8,388,608	P/R

■ External Absolute Encoder Polarity Selection
Selects counting polarity of external absolute encoder.
Select polarity to get matching with increase/decrease of "Present position monitor (External encoder) [EX-APMON]" and "Present position monitor (Motor encoder) [APMON]".
Be valid after control power cycle.

Group ID	CoE Object ID	Selection		Description
Group C ID 0B	0x20F1, 0x04 EX-SENPOL	00	Standard	Inverts not an encoder operation direction.
		01	Reversed	Inverts an encoder operation direction.

✔ It may become out of control if a counting direction (increase/decrease) of motor encoder and external absolute encoder are not matched.

2) Incremental encoder (Applicable amplifier model number: RS3xxxx2xxx, RS3xxxxAxxx)

■ External encoder type code
Select the external encoder type that will be connected to EN2.

Group ID	CoE Object ID	Selection		Description
System ID 34	0x20FF, 0x04 EXENTYPE	0x0002	Pulse_without_CS	Incremental encoder

Wire-saving incremental encoder cannot use with full-closed control.

■ External encoder resolution (for incremental encoder)
Sets pulse amount (multiply 1) of external encoder per 1 turn of motor axis.
Be valid after control power cycle.

Group ID	CoE Object ID	Setting range	Unit
System ID 33	0x20FF, 0x03 EXPENRES	500 to 500,000 (1-multiplied)	P/R

■ External Encoder Digital Filter
Sets the digital filter for external encoder.
Even if noise is given to external incremental encoder, eliminate pulses below set value, as noise. Considering encoder resolution and maximum operation speed of servo motor, and set a quarter of maximum speed pulse width as a rough indication.

Group ID	CoE Object ID	Selection		Description
Group C ID 01	0x20F1, 0x03 EX-ENFIL	00	110ns	Minimum Pulse Width =110ns (Minimum pulse Phase Difference = 37.5ns)
		01	220ns	Minimum Pulse Width = 220ns
		02	440ns	Minimum Pulse Width = 440ns
		03	880ns	Minimum Pulse Width = 880ns
		04	75ns	Minimum Pulse Width = 75ns (Minimum pulse Phase Difference = 37.5ns)
		05	150ns	Minimum Pulse Width = 150ns
		06	300ns	Minimum Pulse Width = 300ns
		07	600ns	Minimum Pulse Width = 600ns

■ External Encoder Polarity Selection
Selects signal polarity of external incremental encoder.
Select polarity to get matching with increase/decrease of "Present position monitor (External encoder) [EX-APMON]" and "Present position monitor (Motor encoder) [APMON]".
Be valid after control power cycle.

Group ID	CoE Object ID	Selection		Description		
Group C ID 02	0x20F1, 0x04 EX-ENPOL	00	Type1	EX-Z /without inversion	EX-B /without inversion	EX-A /without inversion
		01	Type2	EX-Z /without inversion	EX-B /without inversion	EX-A /with inversion

✔ When count direction (increase/decrease) of external incremental encoder and motor encoder are not match, it might get runaway.

0x2100: Status Word 1

Index	0x2100	Indicates servo amplifier status.		Object Code		VARIABLE
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Status Word 1 Indicates various internal statuses of the amplifier.		Unsigned16	RO	Possible	—

MSB / LSB

Zv	sact	eact	bcnt	eclrm	ecsm	near	inps
7	6	5	4	3	2	1	0

bit0: In-Position Monitor ［INPS］ Sets to "1" when the actual position is within the position window (0x6067). (It is indefinite except for csp and ip.)
bit1: Near Range Monitor ［NEAR］ Sets to "1" when the actual position is within the near range (0x201F). (It is indefinite except for csp and ip.)
bit2: Encoder Z phase monitor ［ECSM］ Sets to “1” when the C signal (Z) of the incremental encoder is input. (It is indefinite except for INC-E.)
bit3: Encoder Clear Monitor ［ECLRM］ Sets to "1" during encoder clearance.
bit4: Brake Control ［BCNT］ This is a holding brake release timing output. Sets to "1" while the brake is released.
bit5 : Actual position effective monitor ［EACT］ Sets to "1" when encoder signal is readable.
bit6: Command reception-enable monitor ［SACT］ Sets to"1" when command reception enabled.
bit7: Speed Zero Monitor ［ZV］ Sets to "1" when the actual velocity is within zero velocity range (0x2020) for 1ms or more.

MSB / LSB

Pse	psr	Gests	Ta	vcmp	Va	ltg
15	14	13-12	11	10	9	8

bit8: Low Speed Monitor ［LTG］ Sets to "1" when the actual velocity is in the low velocity range or less (0x2021).
bit9: Speed Attainment Monitor ［VA］ Sets to "1" when the actual velocity is in the speed attainment range or greater (0x2002).
bit10: Speed Matching Monitor ［VCMP］ Sets to "1" when the actual velocity is within the range set by 0x20F0.4. (0x606D) selected: compare with the rotation number setting, min^{-1}. (0x202A) selected: compare with the proportion setting (%).
bit11: Torque (force) attainment monitor ［TA］ Sets to “1” when internal velocity command is over Torque (force) attainment (0x202E).
bit13,12: PP trajectory generation status monitor ［GESTS］ In the Profile Position mode, indicates status of trajectory generator. 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 Alarm Field

Index 0x2101	Indicates the alarm occurring in the servo amplifier. Sub-Index 0x00 indicates the number of alarms that are currently occurring, and Sub-Index 0x01-0x04 indicates up to four of the contents of alarms. Resets the alarm by setting the alarm reset in Control Word (0x6040.7).					Object Code Array
Sub-Idx	Name	Description	Data Type	Access	PDO	Initial value
0x00	Number of entry	Alarm message count in occurring	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 - 0

bit7-0: Alarm Code defined with this servo amplifier
See the Alarm Code list.

0x2102: Alarm History

Index	0x2102	Indicates the Alarm history of the servo amplifier occurring now or previously.		Object Code		Array
Sub-Idx		Description	Data Type	Access	PDO	Factory setting
0x00		Number of entry Alarm message count	Unsigned8	RO	No	0x10
0x01		Present alarm ［NOWALM］ ✓ When the Alarm doesn't occur, current alarm status is shown at bit 15 to 8.	Unsigned32	RO	Possible	0x00000000
0x02		1st past alarm ［LASTAL1］	Unsigned32	RO	No	0x00000000
0x03		2nd past alarm ［LASTAL2］	Unsigned32	RO	No	0x00000000
0x04		3rd past alarm ［LASTAL3］	Unsigned32	RO	No	0x00000000
0x05		4th past alarm ［LASTAL4］	Unsigned32	RO	No	0x00000000
0x06		5th past alarm ［LASTAL5］	Unsigned32	RO	No	0x00000000
0x07		6th past alarm ［LASTAL6］	Unsigned32	RO	No	0x00000000
0x08		7th past alarm ［LASTAL7］	Unsigned32	RO	No	0x00000000
0x09		8th past alarm ［LASTAL8］	Unsigned32	RO	No	0x00000000
0x0A		9th past alarm ［LASTAL9］	Unsigned32	RO	No	0x00000000
0x0B		10th past alarm ［LASTAL10］	Unsigned32	RO	No	0x00000000
0x0C		11th past alarm ［LASTAL11］	Unsigned32	RO	No	0x00000000
0x0D		12th past alarm ［LASTAL12］	Unsigned32	RO	No	0x00000000
0x0E		13th past alarm ［LASTAL13］	Unsigned32	RO	No	0x00000000
0x0F		14th past alarm ［LASTAL14］	Unsigned32	RO	No	0x00000000
0x10		15th past alarm ［LASTAL15］	Unsigned32	RO	No	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 (Factory setting: 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 of the 2 hour increments.

Bit15-8 Status (ALMSTS) list

Status display		ALMSTS0
Power OFF state	(P-OFF)	0x01
Power ON state	(P-ON)	0x02
Servo Ready state	(S-RDY)	0x03
Servo ON state	(S-ON)	0x04
Servo OFF Stopping	(S-OFF)	0x05
Emergency Stop state	(EMR)	0x06
Initialization state		0x0F

0x2103: Warning Status

Index	0x2103	Indicates the warnings and limitation status of the servo amplifier.	Object Code		ARRAY
Sub-Idx	**Description**		**Data Type**	**Access**	**PDO**	**Initial value**

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Number of entry	Unsigned8	RO	No	0x04
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: Overload Warning
- bit3: Regenerative Overload Warning
- bit4: While Torque Limitation
- bit5: While Velocity Command Limitation
- bit6: Axes Sync Excessive Error Warning (for compatibility)
- bit7: Position Deviation Warning

MSB … LSB

cpew	btw	maxw	minw	hlw	llw	ctw	pow
15	14	13	12	11	10	9	8

- bit8: While Main Circuit Power Charging
- bit9: Pitch Correction Table Setting Warning
- bit10: While Forward Rotation (positive direction) Overtravel
- bit11: While Reverse Rotation (negative direction) Overtravel
- bit12: While Minimum Position Limiting
- bit13: While Maximum Position Limiting
- bit14: Encoder Warning
- bit15: Control Power Voltage Reduction Warning

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x02	Warning Valid [WARENA] Sets the valid bits of warning monitor (Sub0x01). Sets the warning cause which displayed to warning monitor. (set "1") Bits other than valid bit are fixed to zero. Bit 7 of the status word (0x6041) will be set when a result of AND operation of Warning Monitor and Warning Valid is not zero.	Unsigned16	RW	No	0x4E8D

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x03	Warning Monitor 2 ［WARMON2］ 0: no warning (without limitation) 1: during warning (under limitation)	Unsigned16	RO	Possible	0x0000

MSB							LSB
—	—	—	—	—	—	—	—
7	6	5	4	3	2	1	0

- bit0: Axes Sync Excessive Error Warning
- bit1: Dual Position Error Excess Warning
- bit2: Reserved
- bit3: Adaptive Notch Filter E Frequency Warning
- bit4: Reserved
- bit5: External Encoder Warning
- bit6: Position Deviation Difference Excess Warning
- bit7: Reserved

MSB							LSB
—	—	—	—	—	—	—	—
15	14	13	12	11	10	9	8

- bit8: Reserved
- bit9: Reserved
- bit10: Reserved
- bit11: Reserved
- bit12: Reserved
- bit13: Reserved
- bit14: Reserved
- bit15: Reserved

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x04	Warning Valid 2 ［WARENA2］ Sets the valid bits of warning monitor 2 (Sub0x03). Sets the warning cause which displayed to warning monitor. (set "1") Bits other than valid bit are fixed to zero. Bit 7 of the status word (0x6041) will be set when a result of AND operation of Warning Monitor and Warning Valid is not zero.	Unsigned16	RW	No	0x0000

0x2104: Actual Gain Value Monitor

Index	0x2104	Indicates the actual setting value of the gain parameter to switch to real time various gain parameters through auto-tuning or gain switching selection.	Object Code		Array
Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Number of entry	Unsigned8	RO	No	0x08
0x01	Position Loop Proportional Gain Actual Monitor ［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)
		Display range	0x0001-0x0BB8 (1 to 3000)		
		Unit	1 /s		
0x02	Position Loop Integral Time Constant Actual Monitor ［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 (1000) Proportional control
		Display range	0x0003-0x2710 (0.3 to 1000)		
		Unit	0.1 ms		
0x03	Velocity Loop Proportional Gain Actual Monitor ［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 (50)
		Display range	0x0001-0x07D0 (1 to 2000)		
		Unit	Hz		
0x04	Velocity Loop Integral Time Constant Monitor ［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 (20)
		Display range	0x0003-0x2710 (0.3 to 1000)		
		Unit	0.1 ms		
0x05	Load Inertia Moment Ratio Actual Monitor ［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)
		Display range	0x0000-0x3A98 (0 to 15000)		
		Unit	%		
0x06	Torque (force) Command Filter Actual Monitor ［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 (600)
		Display range	0x0001～0x07D0(1 to 2000)		
		Unit	Hz		
0x07	Model Control Gain Actual Monitor［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)
		Display range	0x0001-0x0BB8 (1 to 3000)		
		Unit	1 /s		
0x08	Adaptive Notch Filter Monitor ［ADNFEMON］ Indicates the adaptive notch filter frequency. Outputs the value currently used for the servo control.	Unsigned16	RO	Possible	0x0064 (100)
		Display range	0x0064-0x03E8,0x0FA0 (100 to 1000,4000)		
		Unit	Hz		

0x2105: Zero-phase Based Actual Position

Index	0x2105	Indicates the Actual Position from Zero-phase.		Object Code		VARIABLE
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Zero-phase Based Actual Position ［CCUNIT］ ◆In the incremental encoder, indicates the position within one rotation based on Z phase. The location increases to the direction of CCW seen head-on. The unit is 1 Pulse/LSB, and four-fold value of A･B phases. ✓ It is indefinite after power ON until Z phase is detected. (Example: At the 1024P/Re encoder, 0 – 4095 pulse indicated) ◆In the Absolute Encoder, indicates the position within one rotation based on Absolute Positon.		Integer32	RO	Possible	—
			Display range	0x00000000-0xFFFFFFFF (0 to 4294967295)		
			Unit	Pulse		

0x2106: Internal Velocity Command Monitor

Index	0x2106	Has the actual velocity value calculated from the position encoder. The value is provided by the user-defined velocity unit.		Object Code		VARIABLE
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Internal Velocity Demand Value Monitor ［VCMON］ An Internal Velocity Command Value after passing the Velocity Command low-pass filter.		Integer32	RO	Possible	—
			Display range	0x80000000-0x7FFFFFFF (-2147483648 to 2147483647)		
			Unit	Pulse/s		

0x2107: Internal Torque (force) Command Monitor

Index	0x2107	Indicates the torque (force) command monitor inside the servo amplifier.		Object Code		VARIABLE
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Internal Torque (force) Demand Value 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	—
			Display range	0x8000-0x7FFF (-3276.8 to 3276.7)		
			Unit	0.1 %		

0x2108: Motor utilization monitor (Effective torque (force) estimate value)

Index	0x2108	Indicates the estimation value of the Effective Motor Torque (force).		Object Code		VARIABLE
Sub-Idx	**Description**		**Data Type**	**Access**	**PDO**	**Initial value**
0x00	Number of entry		Unsigned8	RO	No	0x02
0x01	Effective Torque (force) Estimated Value ［TRMS］ Indicates the effective torque (force) estimated value against the motor rated torque (force). ✓ The exact value is indicated, but in some operation patterns, it may take several hours to stabilize the value.		Unsigned16	RO	Possible	–
			Display range	0x0000-0xFFFF (0 to 6553.5)		
			Unit	0.1%		
0x02	Effective Torque (force) Fast Estimated 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	–
			Display range	0x0000-0xFFFF (0 to 6553.5)		
			Unit	0.1%		

0x2109: Servo Amplifier Internal Temperature

Index	0x2109	Indicates the temperature inside the servo amplifier.		Object Code		VARIABLE
Sub-Idx	**Description**		**Data Type**	**Access**	**PDO**	**Initial value**
0x00	Internal Temperature Monitor ［ATEMP］ The temperature monitor value inside the servo amplifier (near the power module). The unit is the Celsius degree and indicated by 1 °C / LSB.		Integer16	RO	Possible	–
			Display range	0x8000-0x7FFF (-32768 to 32767)		
			Unit	°C		
	Conversion to Fahrenheit (F) is calculated according to the following formula: F = 9 / 5 * C+32.					

0x210A: Regenerative Resistor Operation Percentage Monitor

Index	0x210A	An estimate monitor of the operating ratio of the servo amplifier regenerative resistor.		Object Code		VARIABLE
Sub-Idx	**Description**		**Data Type**	**Access**	**PDO**	**Initial value**
0x00	Regenerative Resistor Operation Percentage Monitor ［REGP］ Operating percentage monitor of regenerative resistor representing the regenerator-ON time ratio per 1 second.		Unsigned16	RO	Possible	0x0000 (0)
			Display range	0x0000-0xFFFF (0 to 655.35)		
			Unit	0.01 %		
	The regenerative electricity PM is calculated according to the following formula, using this monitor value. PM (W) = 400^2(V)/regenerative resistor (ohm)×Regenerative resistor operating percentage (%)/100(%)					

0x210B: Encoder Temperature Monitor

Index	0x210B	The temperature of an encoder is displayed.		Object Code		Array
Sub-Idx	**Description**		**Data Type**	**Access**	**PDO**	**Initial value**
0x00	Number of entry		Unsigned8	RO	No	0x02
0x01	Encoder Temperature Monitor ［ETEMP］ The monitor value of the temperature of the encoder control board, shown in the unit of °C Celsius/LSB.		Integer16	RO	Possible	–
			Display range	0xFF80-0x007F (-128 to 127)		
			Unit	°C		
	✓ 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.					
0x02	External Encoder Temperature Monitor ［EXETEMP］ The monitor value of the temperature of the encoder control board, shown in the unit of °C Celsius/LSB.		Integer16	RO	Possible	–
			Display range	0xFF80-0x007F (-128 to 127)		
			Unit	°C		

0x210C: Home Index Position

Index	0x210C	Home Index Positions latched by various methods of homing modes.		Object Code		VARIABLE
Sub-Idx	**Description**		**Data Type**	**Access**	**PDO**	**Initial value**
0x00	Home Index Position ［HOMEIDX］ When homing activate and lached home index then indicates Internal position. Indicates, the counter value based on control power ON with incremental system, or the absolute value of encoder data with absolute system.		Integer32	RO	Possible	–
			Display range	0x80000000-0x7FFFFFFF (-2147483648 to 2147483647)		
			Unit	Pulse		

0x210D: Position Synchronization Deviation Monitor

Index	0x210D	Position deviation between two synchronous connected amplifiers is monitored.		Object Code		VARIABLE
Sub-Idx	**Description**		**Data Type**	**Access**	**PDO**	**Initial value**
0x00	Position Synchronization Deviation Monitor ［PSYNDEV］ When position synchronization correction function is valid, the monitor indicates error pulse quantity from position deviation of amplifiers which are subject to synchronization.		Integer32	RO	Possible	–
			Display range	0x80000000-0x7FFFFFFF (-2147483648 to 2147483647)		
			Unit	Pulse		

0x2110: Control Cycle Actual Position

Index	0x2110	Returns the Actual Position value latched every control cycle (125μs). Unit of Monitor 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	Control Cycle Actual Position 1 Actual position at 125μs previous of 0x6064.	Integer32	RO	Possible	—
0x02	Control Cycle Actual Position 2 Actual position at 250μs previous of 0x6064.	Integer32	RO	Possible	—
0x03	Control Cycle Actual Position 3 Actual position at 375μs previous of 0x6064.	Integer32	RO	Possible	—
0x04	Control Cycle Actual Position 4 Actual position at 500μs previous of 0x6064.	Integer32	RO	Possible	—
0x05	Control Cycle Actual Position 5 Actual position at 625μs previous of 0x6064.	Integer32	RO	Possible	—
0x06	Control Cycle Actual Position 6 Actual position at 750μs previous of 0x6064.	Integer32	RO	Possible	—
0x07	Control Cycle Actual Position 7 Actual position at 875μs previous of 0x6064.	Integer32	RO	Possible	—

Notes		
✓ Control cycle will be 250μs when scale function is used. ✓ It cannot use when high speed sampling mode is used.	Display range	0x80000000-0x7FFFFFFF (-2147483648 to 2147483647)
	Unit	UP (User Position unit)

0x2111: Control Cycle Actual Velocity

Index	0x2111	Returns the Actual Velocity value latched every control cycle (125μs).	Object Code	Array

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Number of entry	Unsigned8	RO	No	0x07
0x01	Control Cycle Actual Velocity 1 Actual velocity at 125μs previous of 0x606C.	Integer32	RO	Possible	—
0x02	Control Cycle Actual Velocity 2 Actual velocity at 250μs previous of 0x606C.	Integer32	RO	Possible	—
0x03	Control Cycle Actual Velocity 3 Actual velocity at 375μs previous of 0x606C.	Integer32	RO	Possible	—
0x04	Control Cycle Actual Velocity 4 Actual velocity at 500μs previous of 0x606C.	Integer32	RO	Possible	—
0x05	Control Cycle Actual Velocity 5 Actual velocity at 625μs previous of 0x606C.	Integer32	RO	Possible	—
0x06	Control Cycle Actual Velocity 6 Actual velocity at 750μs previous of 0x606C.	Integer32	RO	Possible	—
0x07	Control Cycle Actual Velocity 7 Actual velocity at 875μs previous of 0x606C.	Integer32	RO	Possible	—

Notes		
✓ Data is filtered and the cutoff frequency is 250Hz. ✓ Control cycle will be 250μs when scale function is used. ✓ It cannot use when high speed sampling mode is used.	Display range	0x80000000-0x7FFFFFFF (-2147483648 to 2147483647)
	Unit	UP (User Position unit) /s

0x2112: Control Cycle Actual Torque (force)

Index	0x2112	Returns the Actual Torque (force) value latched every control cycle (125μs).	Object Code	Array

Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Number of entry	Unsigned8	RO	No	0x07
0x01	Control Cycle Actual Torque (force) 1 Actual torque (force) at 125μs previous of 0x6077.	Integer16	RO	Possible	—
0x02	Control Cycle Actual Torque (force) 2 Actual torque (force) at 250μs previous of 0x6077.	Integer16	RO	Possible	—
0x03	Control Cycle Actual Torque (force) 3 Actual torque (force) at 375μs previous of 0x6077.	Integer16	RO	Possible	—
0x04	Control Cycle Actual Torque (force) 4 Actual torque (force) at 500μs previous of 0x6077.	Integer16	RO	Possible	—
0x05	Control Cycle Actual Torque (force) 5 Actual torque (force) at 625μs previous of 0x6077.	Integer16	RO	Possible	—
0x06	Control Cycle Actual Torque (force) 6 Actual torque (force) at 750μs previous of 0x6077.	Integer16	RO	Possible	—
0x07	Control Cycle Actual Torque (force) 7 Actual torque (force) at 875μs previous of 0x6077.	Integer16	RO	Possible	—

Notes		
✓ Unit of monitor is defined by the set value of 0x2078, Torque Scale Selection. ✓ Control cycle will be 250μs when scale function is used. ✓ It cannot use when high speed sampling mode is used.	Display range	0x8000-0x7FFF (-32768 to 32767)
	Unit	UT (User Torque unit)

0x2116: Actual Velocity 2

Index	0x2116	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	Actual Velocity [ACVMON2] ✓ Data is filtered and the cutoff frequency is 20Hz.	Integer32	RO	Possible	—
		Display range	0x80000000-0x7FFFFFFF (-2147483648 to 2147483647)		
		Unit	UP (User Position unit) /s		

0x2117: Actual Position 2

Index	0x2117	Indicates the actual position without backlash correction value.	Object Code		VARIABLE
Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Actual Position 2 [APMON2] Indicates the actual position without backlash correction value.	Integer32	RO	Possible	—
		Display range	0x80000000-0x7FFFFFFF (-2147483648 to 2147483647)		
		Unit	UP (User Position unit)		
	◆With backlash correction Actual Position 2 = Actual Position (0x6064) - Backlash correction value (0x5091) ◆Without backlash correction Actual Position 2 = Actual Position				

0x2118: Encoder Monitor

Index	0x2118	Indicates the position in encoder.	Object Code		VARIABLE
Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Number of entry	Unsigned8	RO	No	0x02
0x01	Motor Encoder Monitor [EPMON] Indicates the position in motor encoder. This is the value before homing. Indication differs depending on encoder type.	Integer32	RO	Possible	—
		Display range	0x80000000-0x7FFFFFFF (-2147483648 to 2147483647)		
		Unit	Pulse		
	✓ Combination encoder: incremental encoder It becomes zero at control power on, and shows the value of 32bit-up/down free run counter that is multiplied 4 to A and B signals. ✓ Combination encoder: absolute encoder It shows the current position of encoder that includes multi turn data. For the single turn absolute encoder, it shows the current position of encoder within single turn.				
0x02	External Encoder Monitor [EX_EPMON] Indicates the position in external encoder. This is the value before homing.	Integer32	RO	Possible	—
		Display range	0x80000000-0x7FFFFFFF (-2147483648 to 2147483647)		
		Unit	Pulse		
	It becomes zero at control power on, and shows the value of 32bit-up/down free run counter that is multiplied 4 to A and B signals. ✓ This monitor is valid when 0x01 is set to 0x20F3.2 "Position Loop Control Encoder Selection". In use of Hall effect sensor with linear motor, it shows the data of Hall effect sensor.				

0x211F: Digital Input Monitor 2

Index	0x211F	Indicates lower 16bit of the Digital inputs (0x60FD).	Object Code		VARIABLE
Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Digital Input Monitor [DINPUT16] Monitors input status.	Unsigned16	RO	Possible	—
		Display range	0x0000-0xFFFF		
	Indicates the same content as lower 16bit of the Digital inputs (0x60FD). It shows state of EMR, Homem, PositiveLimit and NegativeLimit.				

0x2121: Production Number

Index	0x2121	Indicates the production number of product.		Object Code		VARIABLE
Sub-Idx	Name/Description		Data Type	Access	PDO	Value
0x00	Production Number ［Production number］ Production number of servo amplifier at factory shipment is indicated. Production number is 10 digits. 12 15 02 1234 Month Year Date Production number		Visible String （Unsigned32）	RO	No	Character strings (-)

0x2123: Cooling Fan Rotation Speed

Index	0x2123	Indicates the rotation speed of cooling fan.		Object Code		VARIABLE
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Cooling Fan Rotation Speed ［FANVEL］ Indicates the rotation speed of cooling fan.		Unsigned16	RO	Possible	0x0000 (0)
			Display range	0x0000-0xFFFF (0 to 65535)		
			Unit	min^{-1}		

0x2124: U-phase Electric Angle Monitor

Index	0x2124	Indicates the U-phase electric angle.		Object Code		VARIABLE
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	U-phase Electric Angle Monitor［CSU］ Indicates the U-phase electric angle. Always indicated except in case of encoder error.		Unsigned16	RO	Possibl e	0x0000 (0)
			Display range	0x0000-0x0167 (0 to 359)		
			Unit	degree		

0x2125: Average Power Monitor

Index	0x2125	Indicates the average power.		Object Code		VARIABLE
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Average Power Monitor ［MAVEPOW1］ For average power, it is indicated by measure result every 1 minute.		Integer32	RO	Possible	0x00000000 (0.0)
			Display range	0xFF676981-0x0098967F (-999999.9 to 999999.9)		
			Unit	0.1 W		
	✓ 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.)					

0x2126: Average Power Monitor

Index	0x2126	Indicates the average power.		Object Code		VARIABLE
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Average Power Monitor ［MAVEPOW2］ For average power, it is indicated by measure result every 1 minute.		Integer16	RO	Possible	0x0000 (0.0)
			Display range	0xD8F1-0x270F (-999.9 to 999.9)		
	✓ Not shown with the motor except R series.		Unit	0.1 kW		
	✓ 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.)					

0x2127: Each Control Status

Index	0x2127	Indicates the each control status. Dedicated for manufacturer management only.		Object Code		ARRAY
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Number of entry		Unsigned8	RO	No	0x07
0x01	Control Status	[CSTATE]	Unsigned16	RO	No	0x0000
			Display range	0x0000-0xFFFF		
0x02	Position Control Status	[PSTATE]	Unsigned16	RO	No	0x0000
			Display range	0x0000-0xFFFF		
0x03	Velocity Control Status	[VSTATE]	Unsigned16	RO	No	0x0000
			Display range	0x0000-0xFFFF		
0x04	Torque Control Status	[TSTATE]	Unsigned16	RO	No	0x0000
			Display range	0x0000-0xFFFF		
0x05	Amplifier Management Signal Status	[PCM_STA]	Unsigned8	RO	No	0x00
			Display range	0x00-0xFF		
0x06	Alarm Management Status	[PCM_ALM]	Unsigned16	RO	No	0x0000
			Display range	0x0000-0xFFFF		
0x07	Function Management Signal Status	[PCM_FUNC]	Unsigned16	RO	No	0x0000
			Display range	0x0000-0xFFFF		

0x2128: U-phase Current Readout Value

Index	0x2128	Indicates th U-phase Current Readout Value.	Object Code		VARIABLE
Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	U-phase Current Readout Value [IFEDU0] Indicates th U-phase Current Readout Value.	Integer16	RO	No	0x0000
		Display range	0x8000-0x7FFF		

0x2129: V-phase Current Readout Value

Index	0x2129	Indicates th V-phase Current Readout Value.	Object Code		VARIABLE
Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	V-phase Current Readout Value [IFEDV0] Indicates th V-phase Current Readout Value.	Integer16	RO	No	0x0000
		Display range	0x8000-0x7FFF		

0x212A: Motor Encoder Communication Error Counter

Index	0x212A	Indicates count of motor encoder communication error.	Object Code		VARIABLE
Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Motor Encoder Communication Error Counter [ERRCNTM] Indicates count of motor encoder communication error.	Unsigned32	RO	No	0x0000
		Display range	0x00000000-0xFFFFFFFF		

0x212B: External Encoder Communication Error Counter

Index	0x212B	Indicates count of external encoder communication error.	Object Code		VARIABLE
Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	External Encoder Communication Error Counter [ERRCNTE] Indicates count of external encoder communication error.	Unsigned32	RO	No	0x00000000
		Display range	0x00000000-0xFFFFFFFF		

0x212C: Motor Encoder Frequency Monitor

Index	0x212C	Indicates the encoder frequency.	Object Code		Array
Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Number of entry	Unsigned8	RO	No	0x02
0x01	Motor Encoder Frequency Monitor [MMOENCF] Indicates the motor encoder frequency in incremental encoder use.	Integer32	RO	Possible	–
		Display range	0x80000000-0x7FFFFFFF (-2147483648 to 2147483647)		
		Unit	kPulse/s		
0x02	External Encoder Frequency Monitor [MEXENCF] Indicates the external encoder frequency in incremental encoder use.	Integer32	RO	Possible	–
		Display range	0x80000000-0x7FFFFFFF (-2147483648 to 2147483647)		
		Unit	kPulse/s		

0x212D: Internal position Offset with Homing

Index	0x212D	Indicates an internal position offset with homing.		Object Code		VARIABLE
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Internal position Offset with Homing ［HOMEOFS］ Indicates an internal position offset with homing.		Integer64	RO	No	–
			Display range	0x8000000000000000 -0x7FFFFFFFFFFFFFFF		
			Unit	Pulse		

0x212E: Amplifier Operation Time

Index	0x212E	Indicates accumulate of control power ON time.		Object Code		VARIABLE
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Amplifier Operation Time ［RUNTIM］ Indicates accumulate of control power ON time.		Integer64	RO	No	–
			Display range	0x8000000000000000 -0x7FFFFFFFFFFFFFFF		
			Display format	ms		

0x212F: Overload Detection Temperature Attainment Ratio

Index	0x212F	Indicates the Overload Detection Temperature Attainment Ratio.		Object Code		VARIABLE
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Overload Detection Temperature Attainment Ratio ［OLRAT］ Indicates ratio against overload detection temperature.		Unsigned16	RO	No	–
			Display range	0x0000-0x03E8 (0.0 to 100.0%)		
			Unit	%		

0x2131: Position Deviation Difference Monitor

Index	0x2131	Indicates the Position Deviation Difference.		Object Code		VARIABLE
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Position Deviation Difference Monitor ［PDEVID］ Indicates the Position Deviation Difference. (Refer the section 5.16.1, for detail.)		Integer32	RO	Possible	–
			Display range	0x80000000 to 0x7FFFFFFF (-2147483648 to 2147483647 Pulse)		
			Unit	Pulse		

0x2134: Life-span monitor

Index	0x2134	Indicates each kind of remaining life.		Object Code		Array
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Number of entry		Unsigned8	RO	No	0x04
0x01	Remaining life of relay for an inrush current prevention ［RSRLYLF］ Accumulates ON/OFF count of a relay for an inrush current prevention, and estimates a remaining life from available switching count on specifications.		Unsigned16	RO	Possible	–
			Display range	0x0000 to 0x2710 (0.00 to 100.00)		
			Unit	0.01%		
0x02	Remaining life of relay for a dynamic brake ［DBRLYLF］ Accumulates ON/OFF count of a relay for a dynamic brake, and estimates a remaining life from available switching count on specifications.		Unsigned16	RO	Possible	–
			Display range	0x0000 to 0x2710 (0.00 to 100.00)		
			Unit	0.01%		
0x03	Remaining life of relay for a holding brake ［HBRLYLF］ Accumulates ON/OFF count of a relay for a holding brake, and estimates a remaining life from available switching count on specifications. Measures just 400V input type. For the other type amplifiers, "100.00%" is indicated.		Unsigned16	RO	Possible	–
			Display range	0x0000 to 0x2710 (0.00 to 100.00)		
			Unit	0.01%		
0x04	Remaining life of a holding brake ［HBLF］ Checks motor position change from the point of braking (holding brake signal turns OFF) to the point of slipping after brake, and estimates a remaining life of holding brake. Applies just the motor supporting remaining life of a holding brake. For the other motors, "100.00%" is indicated.		Unsigned16	RO	Possible	–
			Display range	0x0000 to 0x2710 (0.00 to 100.00)		
			Unit	0.01%		

0x2135: Electric power monitor

Index	0x2135	Indicates each kind of electric power.	Object Code		Array
Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Number of entry	Unsigned8	RO	No	0x01
0x01	Regenerative power monitor ［RegPOW］ Indicates the power consumption of regenerative resistor.	Unsigned32	RO	Possible	–
		Display range	0x00000000 to 0xFFFFFFFF (0.000 to 4294967.295)		
		Unit	0.001W		

0x2136: Communication quality monitor

Index	0x2136	Indicates each kind of communication error rate.	Object Code		Array
Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Number of entry	Unsigned8	RO	No	0x03
0x01	Error rate of motor encoder communication ［MOTE_ERRAT］ Indicates the error rate of motor encoder communication.	Unsigned32	RO	Possible	–
		Display range	0x00000000 to 0x000F4240 (0.000000 to 1.000000)		
		Unit	$\times 10^{-6}$		
0x02	Error rate of external encoder communication ［EXTE_ERRAT］ Indicates the error rate of external encoder communication.	Unsigned32	RO	Possible	–
		Display range	0x00000000 to 0x000F4240 (0.000000 to 1.000000)		
		Unit	$\times 10^{-6}$		
0x03	Error rate of EtherCAT communication ［ECAT_ERRAT］ Indicates the error rate of EtherCAT communication.	Unsigned32	RO	Possible	–
		Display range	0x00000000 to 0x000F4240 (0.000000 to 1.000000)		
		Unit	$\times 10^{-6}$		
	✓ It shows error count ratio against communication count per second.				

0x2138: Backup file information

Index	0x2138	Indicates the file information for FoE upload.	Object Code		Array
Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Number of entry	Unsigned8	RO	No	0x01
0x01	Backup file size ［FileSize］ Indicates the file size of amplifier parameter file (ap1) generated when performing parameter saving (0x1010), with byte unit. Indicates zero when file is not exist. During a file generating, stored size will be updated.	Unsigned32	RO	No	–
		Display range	0x00000000 to 0xFFFFFFFF		
		Unit	Byte		

Note) This object will be abolished due to integration to 0x2139. Backup file size will be replaced to 0x2139-1.

0x2139: Upload File Information

Index	0x2139	Upload File Information	Object Code		ARRAY
Sub-Idx	Description	Data type	Access	PDO	Initial value
0x00	Number of entry	Unsigned8	RO	No	0x03
0x01	AP1 File Size Indicates the file size of amplifier parameter file (ap1) generated when performing parameter saving (0x1010), with byte unit. Indicates zero when file is not exist. During a file generating, stored size will be updated.	Unsigned32	RO	No	0x00000000
		Display range	0 to 0xFFFFFFFF (0 to 4294967295)		
		Unit	byte		
0x02	Drive Recorder File Size Indicates the data file size if a data of drive recorder getting is exist. Indicates zero when data is not exist.	Unsigned32	RO	No	0x00000000
		Display range	0 to 0xFFFFFFFF (0 to 4294967295)		
		Unit	byte		
0x03	System Analysis File Size Indicates the data file size if a data of system analysis getting is exist. Indicates zero when data is not exist.	Unsigned32	RO	No	0x00000000
		Display range	0 to 0xFFFFFFFF (0 to 4294967295)		
		Unit	byte		

0x213A: Motor Serial Number

Index	0x213A	Indicates the serial number of connected motor.	**Object Code**		VARIABLE
Sub-Idx	**Description**	Data Type	**Access**	PDO	Initial value
0x00	Motor Serial Number Indicates the serial number of connected motor. Indicates "････････････" if the motor is not applied to motor auto setting or uses incremental encoder.	Visible String	RO	No	Character strings (-)

0x213B: Motor Information

Index	0x213B	Indicates the motor/encoder informations of connected motor.	Object Code		ARRAY
Sub-Idx	Description	Data type	Access	PDO	Initial value
0x00	Number of entry	Unsigned8	RO	No	0x02
0x01	Motor Information Indicates the connecting motor informations.	Unsigned32	RO	No	0x00000000
		Display range	0x00000000 to 0xFFFFFFFF		
		Unit	-		
	Indicates 0xFFFFFFFF for the motor unsupporting a motor auto setting.				
0x02	Encoder Information Indicates the connecting encoder informations. Indicates 0xFFFFFFFF for the motor unsupporting a motor auto setting.	Unsigned16	RO	No	0x0000
		Display range	0x0000 to 0xFFFF		
		Unit	-		

Sub-Idx 0x01:

0x 0000 0184

- 0184 → Bit15-0: Motor code
  - Identification codes for every motor model number.
  - Refer Index: 0x20FE for motor code.
- 0000 → Bit31-16: Holding brake information
  - 0x0000: Without brake
  - 0x0001: With brake (90V DC)
  - 0x0002: With brake (24V DC)
  - 0x0003 to 0xFFFF: Reserved

Sub-Idx 0x02:

0x 2 0 6 6

- 6 (last digit) → Bit3-0: Rotary encodeolution [P/R]

0: 2048	1: 4096	2: 8192
3: 16384	4: 32768	5: 65536
6: 131072	7: 262144	8: 524288
9: 1048576	A: 2097152	B: 4194304
C: 8388608	D: 16777219	E: 33554432
F: Reserved		

- 6 (third digit) → Bit7-4: Rotary encoder multi-turn data length

0: 0	1: 2048	2: 4096
3: 8192	4: 163845: 32768	5: 32768
6: 65536	7: 131072	8 to F: Reserved

- 0 (second digit) → Bit11-8: Communication baud rate

0: 2.5MHz	1: 4.0MHz	2 to F: Reserved

- 2 (first digit) → Bit15-12: Encoder function code
  - 0: Single-turn absolute encoder (PA035S)
  - 1: Battery backup absolute encoder (PA035C)
  - 2: Battery-less absolute encoder (HA035)
  - 3 to F: Reserved

Example) In case that Battery-less absolute encoder (HA035)/Communication baud rate 2.5 MHz/Multi-turn data 65536/Resolution 131072, "0x2066" is shown.

0x5080: Correction Table Control

Index	0x5080	Enables/disables the correction table function.		Object Code		VARIABLE
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Correction Table Control [COTBLEN] Enables/disables the correction table function. 0x00: Disabled 0x01: Enabled 0x02 - 0xFF: Reserved		Unsigned8	RW	No	0x00
			Setting range	0x00-0x01		

0x5081: Correction Table Interpolation Method

Index	0x5081	Sets the interpolation method of the correction table.		Object Code		VARIABLE
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Correction Table Interpolation Method [COTBLINTP] Sets the interpolation method of the correction table. 0x00: Linear 0x01-0xFF: Reserved		Unsigned8	RW	No	0x00
			Setting range	0x00		

0x5082: Correction Table Extrapolation Method

Index	0x5082	Sets the extrapolation method of the correction table.		Object Code		VARIABLE
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Correction Table Extrapolation Method [COTBLEXTP] Sets the extrapolation method of the correction table. 0x00: Linear 0x01-0xFF: Reserved		Unsigned8	RW	No	0x00
			Setting range	0x00		

0x5083: Correction Table Position

Index	0x5083 Correction Table Position		Object Code		ARRAY
Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Number of entry ✓ It becomes valid after control power cycle.	Unsigned8	RW	No	0x00
		Setting range	0x00~0x40		
0x01	Entry 1 Correction Position 1	Integer32	RW	No	0x00000000
		Setting range	0x80000000-0x7FFFFFFF		
		Unit	UP (User Position unit)		
0x02 to n	Entry 2 to Entry n Correction Position 2 to Correction Position n	Integer32	RW	No	0x00000000
		Setting range	0x80000000-0x7FFFFFFF		
		Unit	UP (User Position unit)		
	✓ "n" is up to 0x40 in maximum. ✓ Set as follows: Correction position n-1< Correction position n. (n=2 to 64) If the relation above is not given at power ON initialization, 0x2103 Warning status bit9 is changed to "1". Adjust the correction position, and then perform control power cycle. ✓ If target position overs 0x7FFFFFFF and 0x80000000, set 0x7FFFFFFF to 0x5083 correction position n and set 0 to 0x5084 offset n. Caution, if not 0, the machine may oscillate at the position of quadrant change. ✓ It becomes valid after control power cycle.				
✓ If actual position (0x6064) overs 0x7FFFFFFF and 0x80000000, set 0x80000000 to Correction Position 1 and set 0x7FFFFFFF to Correction Position n. Set same value to Offset 1 (0x5084-01) and Offset n (0x5084-n).					

0x5084: Correction Table Offset

Index	0x5084 Correction Table Offset		Object Code		ARRAY
Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Number of entry ✓ It becomes valid after control power cycle.	Unsigned8	RW	No	0x00
		Setting range	0x00~0x40		
0x01	Entry 1 Offset 1	Integer32	RW	No	0x00000000
		Setting range	0x80000000-0x7FFFFFFF		
		Unit	UP (User Position unit)		
0x02 ~ n	Entry 2 to Entry n Offset 2 to Offset n	Integer32	RW	No	0x00000000
		Setting range	0x80000000-0x7FFFFFFF		
		Unit	UP (User Position unit)		
	✓ "n" is up to 0x40 in maximum. ✓ If target position overs 0x7FFFFFFF and 0x80000000, set 0x7FFFFFFF to 0x5083 correction position n and set 0 to 0x5084 offset n. Caution, if not 0, the machine may oscillate at the position of quadrant change.				
✓ If actual position (0x6064) overs 0x7FFFFFFF and 0x80000000, set 0x80000000 to Correction Position 1 (0x5083-01)and set 0x7FFFFFFF to Correction Position n (0x5083-n). Set same value to Offset 1 and Offset n.					

0x5090: Backlash correction function selection

Index	0x5090	Sets valid/invalid of Backlash correction function.		Object Code		VARIABLE
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Backlash correction function selection [BLCEN] Sets valid/invalid of Backlash correction function. 0x00: Invalid 0x01: Valid 0x02-0xFF: Reserved		Unsigned8	RW	No	0x00
			Setting range	0x00-0x01		

0x5091: Backlash Correction Value

Index	0x5091	Sets the Backlash Correction Value.		Object Code		VARIABLE
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Backlash Correction Value [BLCVAL] Sets the Backlash Correction Value.		Unsigned32	RW	No	0x00000000
			Setting range	0x00000000-0x7FFFFFFF (0 to 2147483647)		
			Unit	UP (User Position unit)		
	◆In case that 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. ◆In case that 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: Backlash Correction Direction

Index	0x5092	Sets the correction direction of Backlash		Object Code		VARIABLE
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Backlash Correction Direction [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		

5

Operations

In this chapter, items for servo motor driving are explained.

5.1 Test operation

5.1.1 Installation and Wiring

Confirm the installation and wiring of the servo amplifier and servo motor.
Refer another document M0011696 for details of installation and wiring.

Process	Items and Contents
1	Installation ■ Install servo amplifier and servo motor according to "3. Installation". Servo motor shaft should be in disengaged state and machine should not be connected. 
2	Wiring / Connecting → Input Power ■ Wires power supply wire, servo motor and host device, following description in chapter "4. Wiring". However, do not connect CN0 (Port 0) / CN1 (Port 1) to servo amplifier after wiring. ■ Input power supply: Confirm no alarm code is displayed on the display screen on the upper front of the amplifier. When alarm code is displayed, take appropriate measures based on section 8.3. ■ When 7 segment LED does not light "≡" through main circuit power input, take appropriate measures based onsection 8.1.

5.1.2 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 (section 10.6 of M0011696) to verify normal operation.

5.1.3 Movement Confirmation

Perform JOG operations using Setup Software or Digital Operator.

Process	Items and Contents
1	Input signal check: Generic Input signals (CN2)

Select Input signals to be used from General parameter Group9 and assign in CONT1 to CONT7.

Input Signal	CN2 Pin No.	Factory Shipment Setting Value Setting Value
CONT1	3, 4	00: Always_Disable
CONT2	5, 6	00: Always_Disable
CONT3	7, 8	00: Always_Disable
CONT4	9, 10	00: Always_Disable
CONT5	11, 12	00: Always_Disable
CONT6	14, 15	00: Always_Disable
CONT7	1, 2	00: Always_Disable

✔ The factory default gives no assignment function to the general signal.

Process	Items and Contents
2	Output signal check: Generic Output signals (CN2)

■ Select Output signals to be used from General parameter Group9 and assign in OUT1 and OUT2.

Output Signal	CN2 Pin No	Factory Shipment Setting Value Setting Value	Object: Index, Sub-index
OUT1	16, 17	42: FOUT1_ON	0x20F9,0x01 (OUT1)
OUT2	18, 19	44: FOUT2_ON	0x20F9,0x01 (OUT2)

Process	Items and Contents
3	Input/Output Signal Check

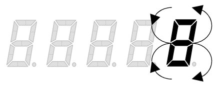
■ Check that the set Input/Output signals are functioning normally with the monitor. Refer to "Monitor Details (section 7.8.2 of M0011696)" for monitor explanation.

◆ Check using the Setup Software with monitor in menu.
Read separate manual M0010842 for the Setup Software operations.

◆ When checking with “Digital Operator”
Refer to section "7.6 Trial Run Mode (M0011696)" for digital operator operation method.

Step	JOG Operation (Input Servo ON signal)
4	■ 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 "7.6 Trial Run Mode (M0011696)" for digital operator operation method.
	■ Input Servo ON signal. Confirm that motor excitation and Digital Operator display on the front of the servo amplifier shows the “8” shape.

The following display indicates servo-on state.

	・ Servo-on state “8” is indicated continuously.

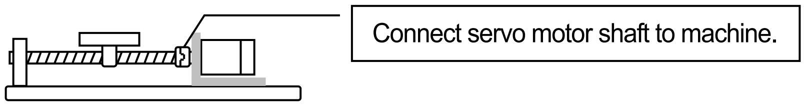
The following display indicates forward/ reverse rotation limit state.

	Forward rotation side limit state. Forward rotation side over travel state in position and velocity control form.
	Inverse rotation side limit state. Inverse rotation side overt ravel state in position and velocity control form.

■ Setting for the limit switch function can be changed in general parameter Group9 ID00, ID01.

5.1.4 Machine Movement Check

Connect servo motor shaft to machine and check movement.

Process	Items and Contents
1	Connect to machine ■ Connect motor shaft to machine.  ■ 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.
2	Operation ■ 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 chapter "6. Servo Tuning (M0011696)" for servo tuning methods.
3	Power OFF ■ Turn OFF power after turning OFF Servo ON signal.

5.2 ESC Power ON Sequence

Shows R 3E Model EtherCAT slave amplifier power ON sequence at input of control power supply.

1 Power ON : Control voltage reaches operational voltage of ESC

⇓

2 PLL Clock : Output PLL clock

⇓

3 Reset Cancel: Starts ESC operation. Prohibits memory access until SII EEPROM is loaded . Access enabled for microcontroller after reset cancellation.

⇓

4 Establish Link : Starts EtherCAT communication. Accessible to master.
(Setting data for microcontroller inside ESC also prohibits access.)
EEPROM load : Access will be enabled only when EEPROM load to ESC success.

- ESC setting register initialization completed
- Microcontroller starts operation
- Changes to 0x0110.1=1
- Process data RAM enabled
- ESM of ESC reaches "Init" state

ESC Power ON Sequence

5 Operations

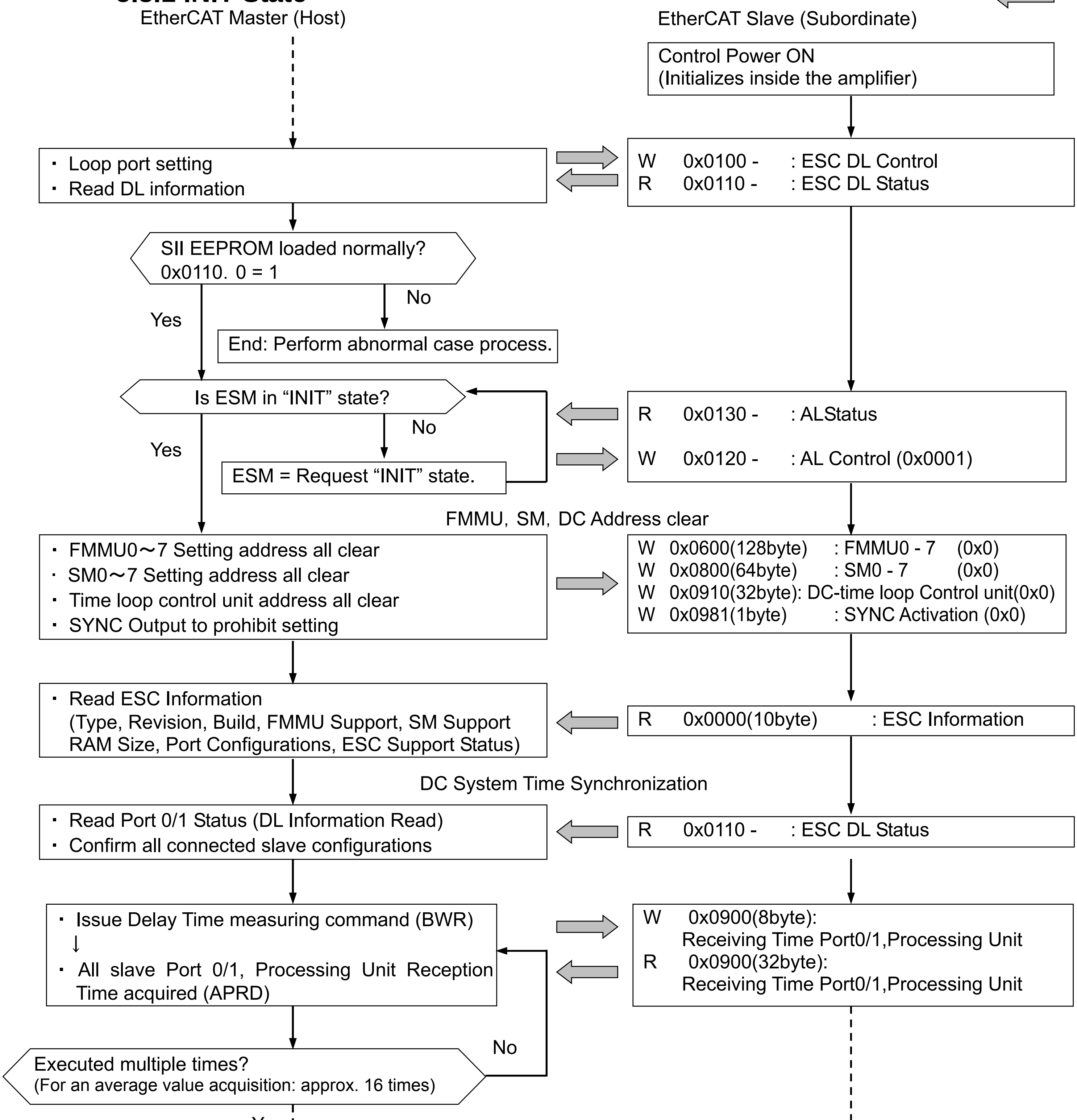
5.3 EtherCAT Communication Sequence

Various parameter settings from master to slave datalink layer and application layer are required to begin cyclic communication after control power of slave amplifier has been established.
The following procedure is an example of the initialization process:

Write ⇨

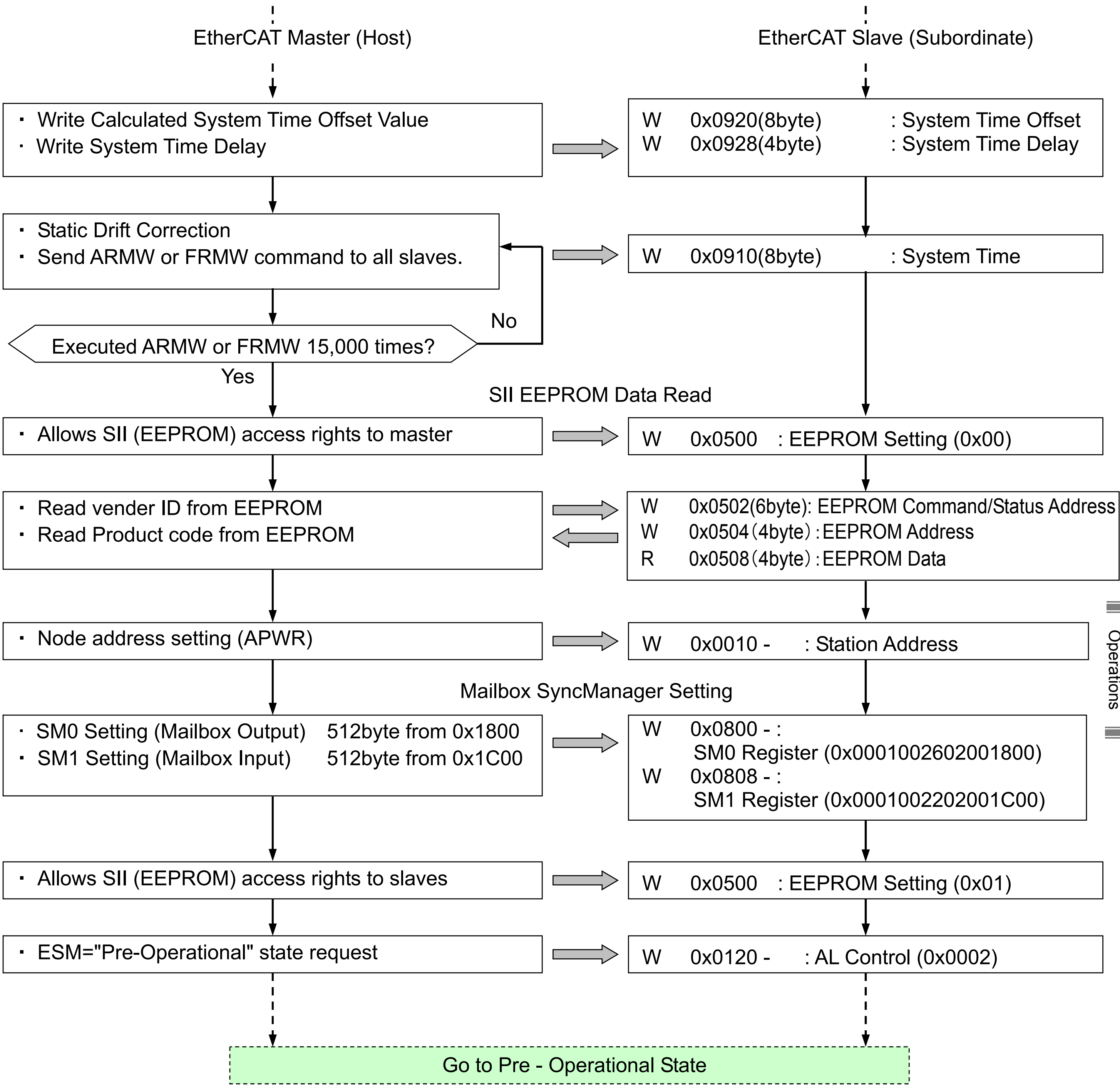
Read ⇦

5.3.1 INIT State



Initialization Procedure Example "INIT State" – 1

5.3 EtherCAT Communication Sequence



Initialization Procedure Example "INIT State" -2

5.3.2 Pre-Operational State

EtherCAT Master (Host)

EtherCAT Slave (Subordinate)

Is ESM in "Pre-Operational" state?

No

Yes

R 0x0130 - : AL Status 0x0002)

Parameter Setting in Object Dictionary Using Mailbox

- 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）
0x607A : 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

SYNC Signal Output Setting

- 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）

SYNC signals booted up?

Yes

No

R 0x0990:0x0997 : Next SYNC0 System Time
R 0x0910:0x0917 : System Time

SM and FMMU Setting for PDO

- SM2 Setting (Process Data Output) 0x1100～8byte
- SM3 Setting(Process Data Input) 0x1140～10byte

W 0x0810～ :SM2 Register（0x0001000400801100）
W 0x0818～ :SM3 Register（0x00010000000A1140）

- FMMU0 Setting (RxPDO) L:0x10000 -> P:0x1100
- FMMU1 Setting (TxPDO) L:0x10000 <- P:0x1140

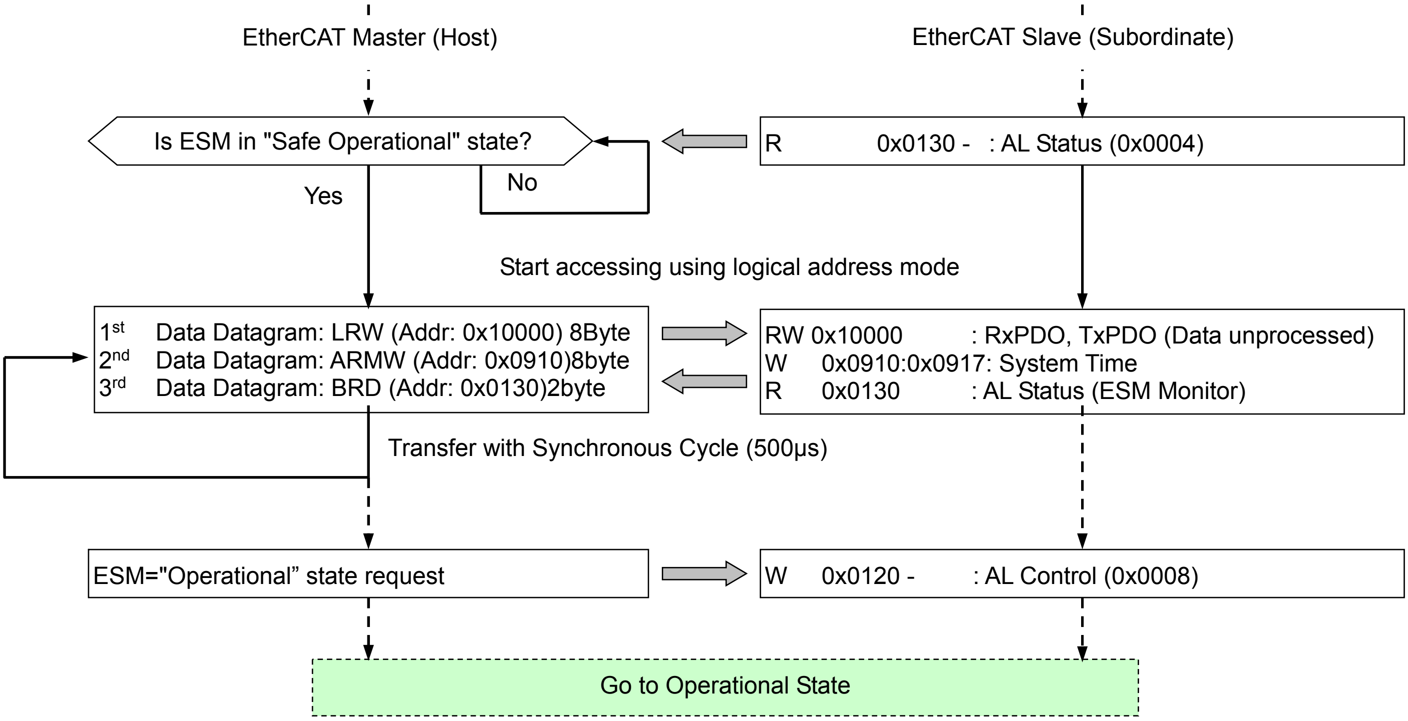
W 0x0600 - :FMMU0 Register
W 0x0610 - :FMMU1 Register

- ESM="Safe-Operational" state request

W 0x0120～ ::AL Control（0x0004）

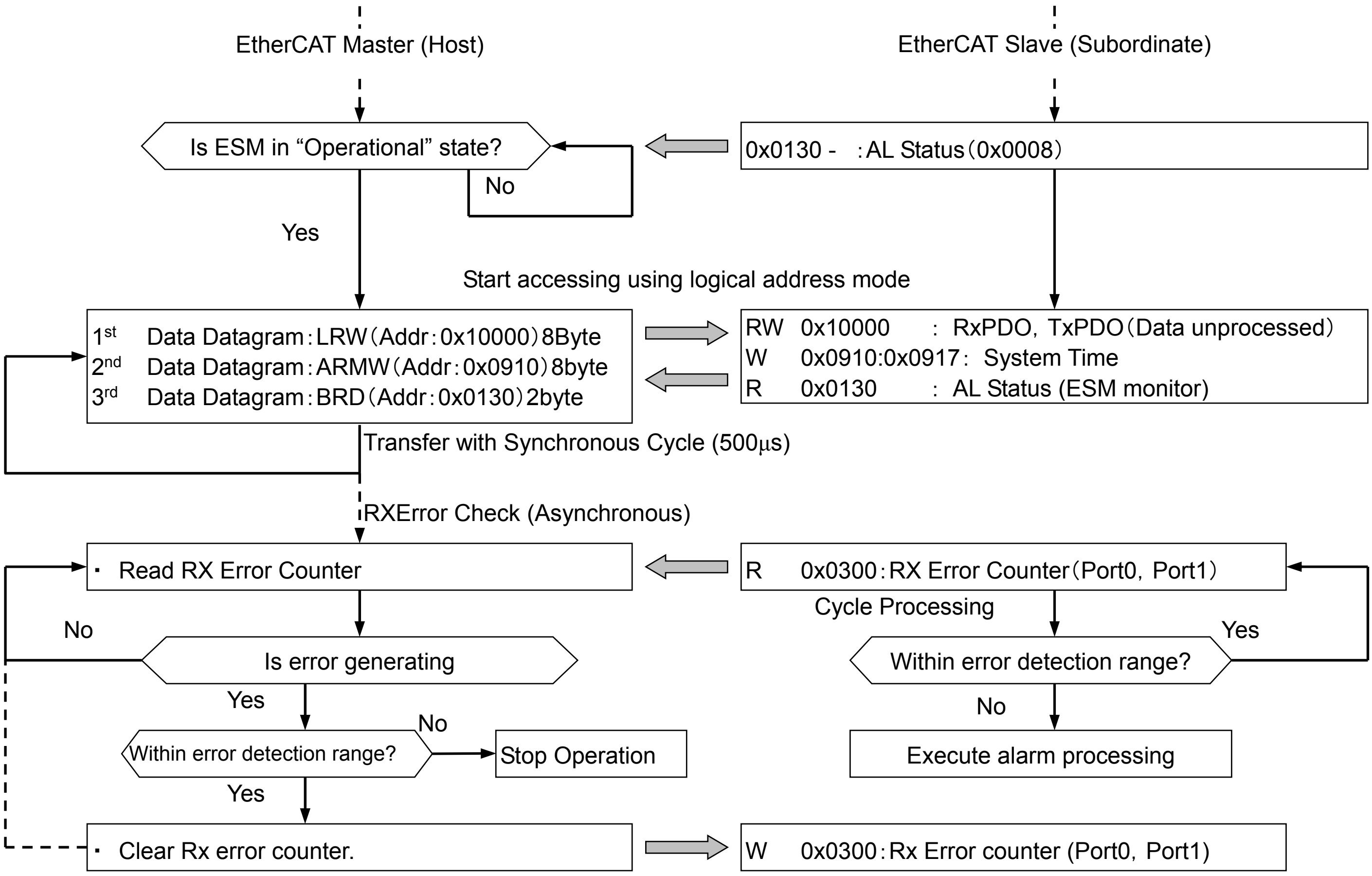
Go to Safe-Operational State

5.3.3 Safe-Operational State



Initialization Procedure Example (Safe-Operational State)

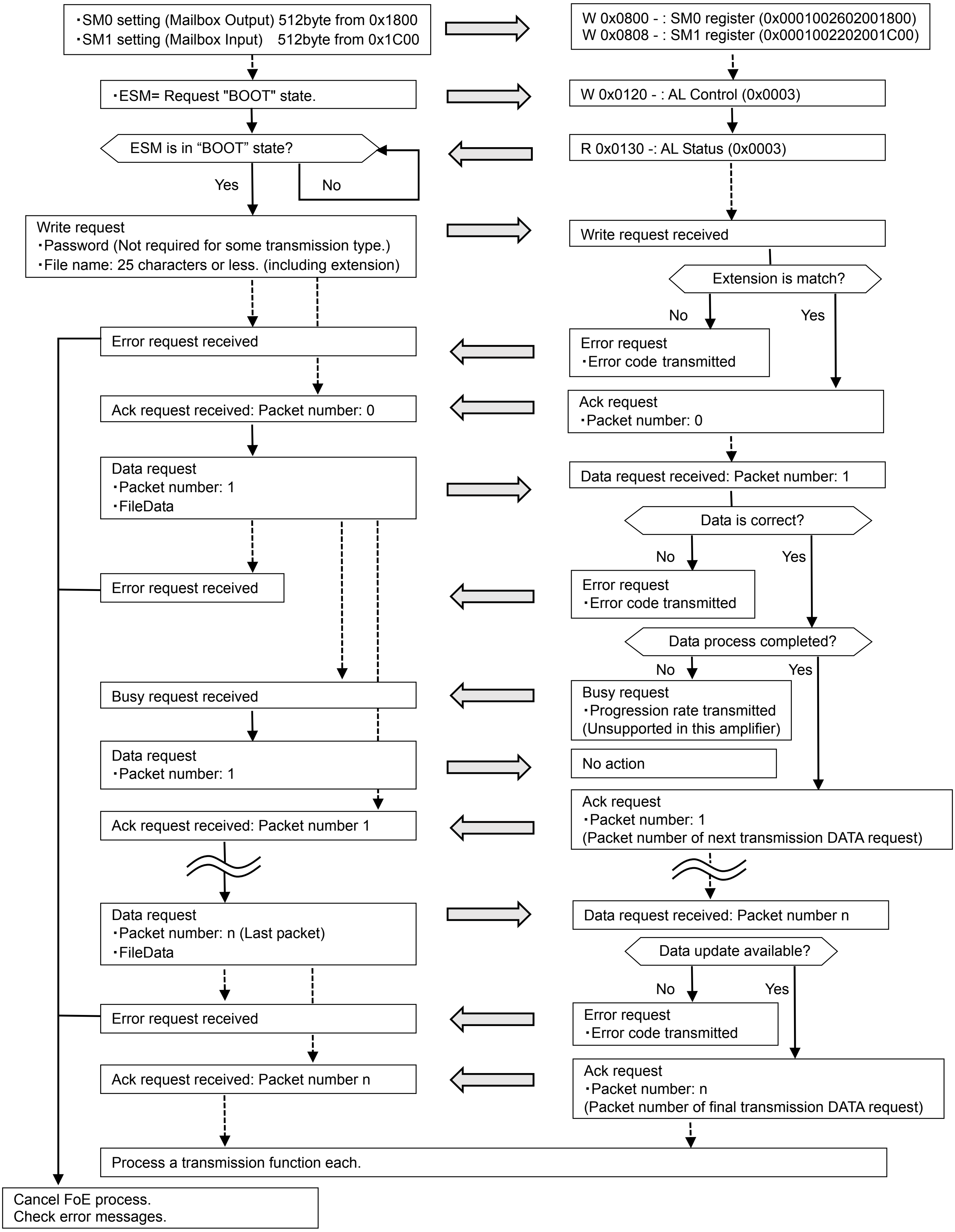
5.3.4 Operational State



5.3.5 Boot State

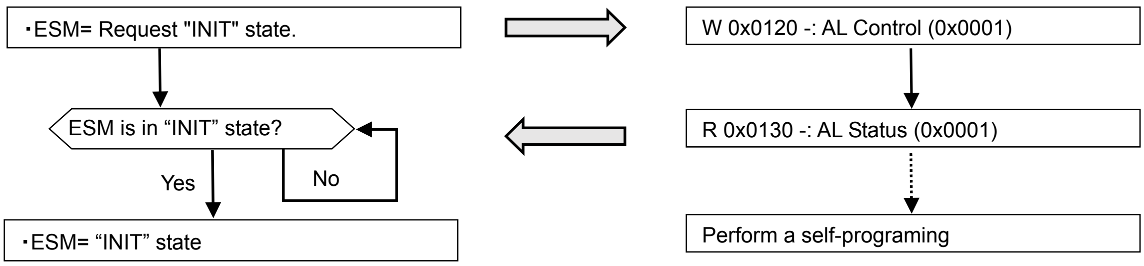
■ FoE download (Basic protocol)

BootStrap state (Common with downloads)



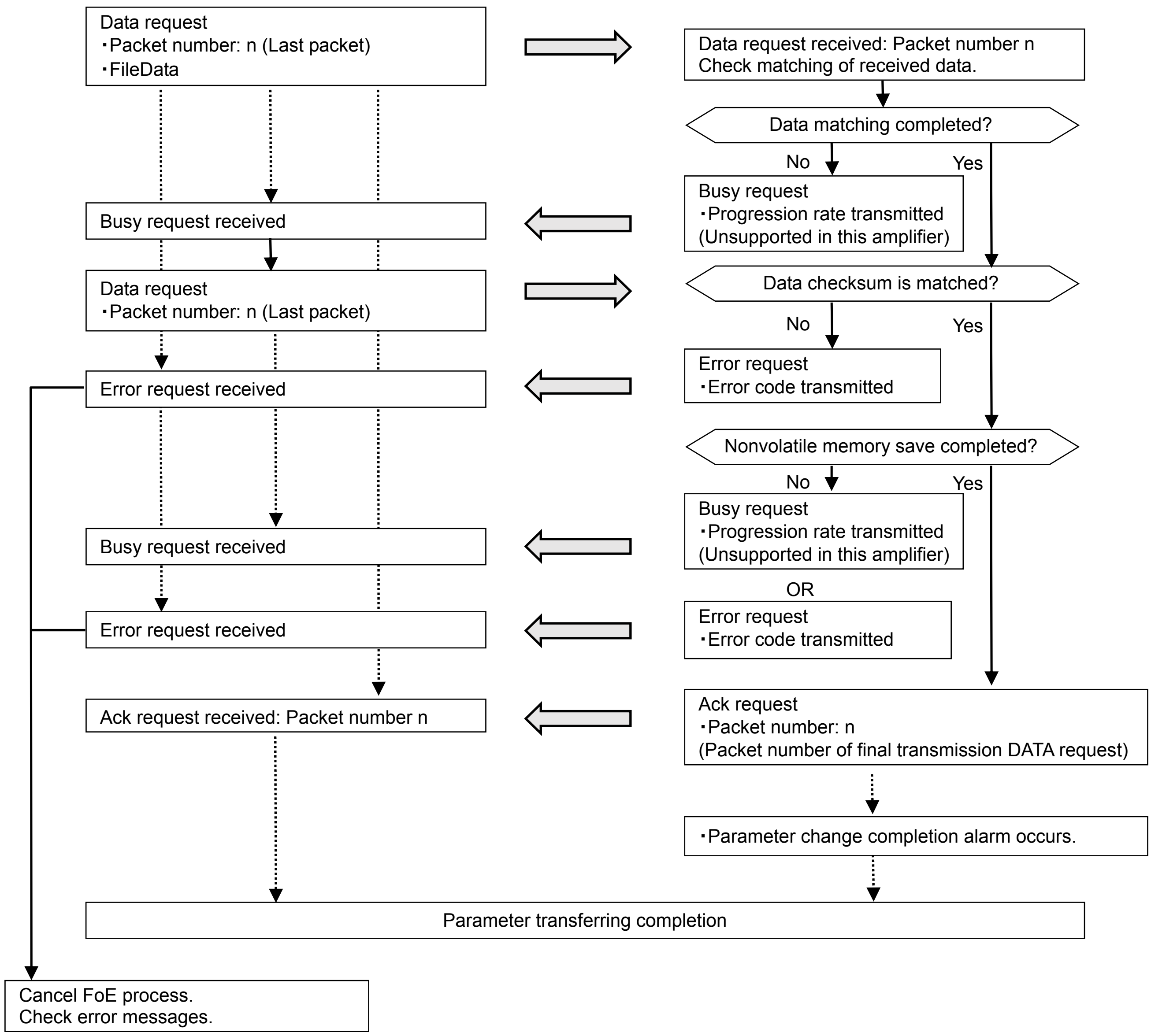
■ FoE download (Firmware update)

BootStrap state (Download firmware update)



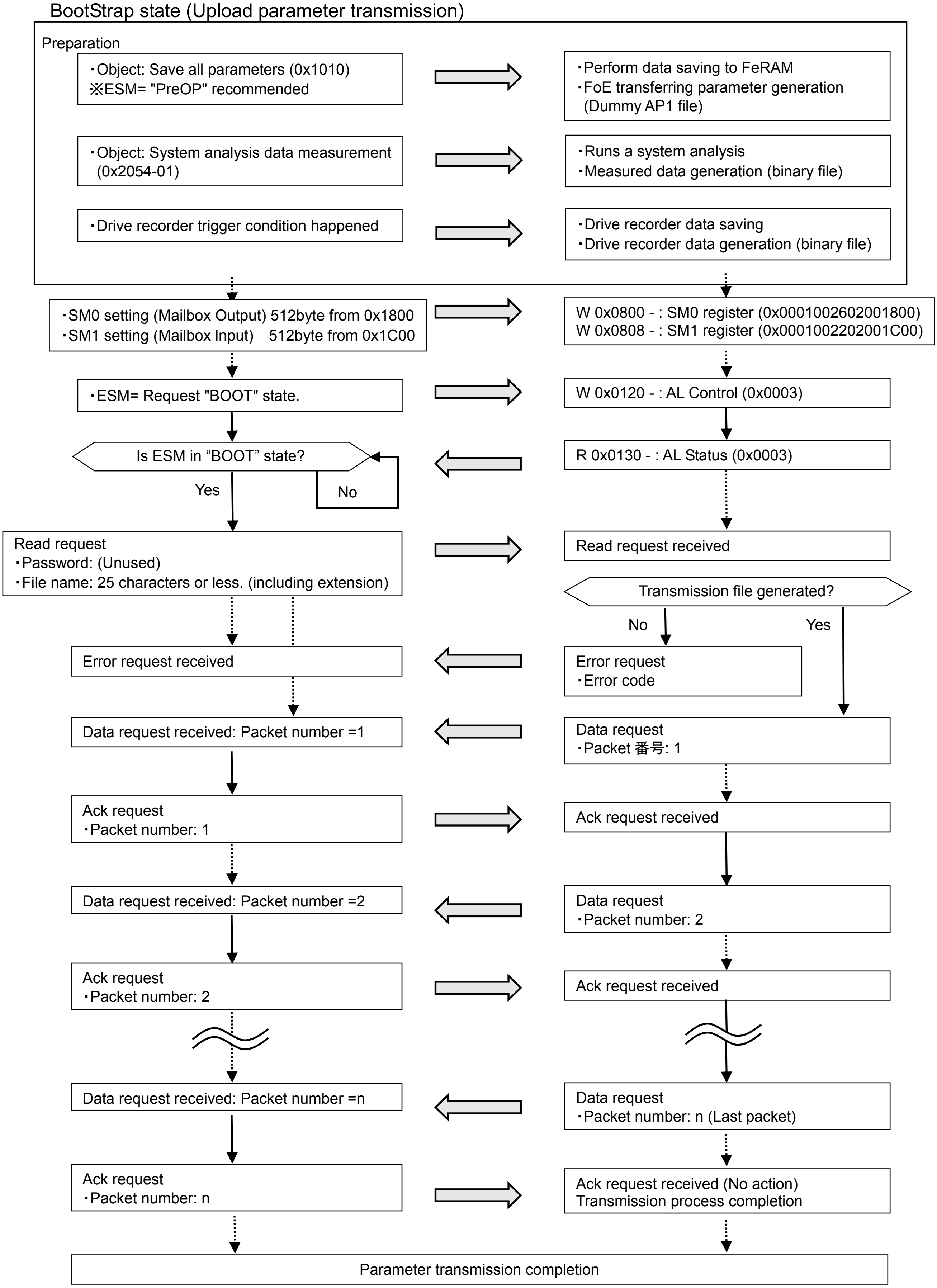
■ FoE download (Parameter download)

BootStrap state (Download parameter transmission)



■ FoE upload (Parameter upload, Drive recorder, System analysis data)

BootStrap state (Upload parameter transmission)



5.4 Servo amplifier status display

5.4.1 Normal display

Marking	Description	Status code
	Control power supply established. Control power supply (r, t) is established and amplifier (RDY) is on.	1
	Main circuit power supply established. Main power supply (R, S and T) is established, but operation preparation completion signal is off.	2
	Safe torque off working status. Main circuit power supply (R, S and T) is established and either safe torque off input 1 or 2 is "off". " --> --> " are shown sequentially.	2
	Operation setup is completed. Main power supply (R, S and T) is established and operation setup completion signal is on.	3
	Servo is on. Continue drawing of character "8", sequentially.	4

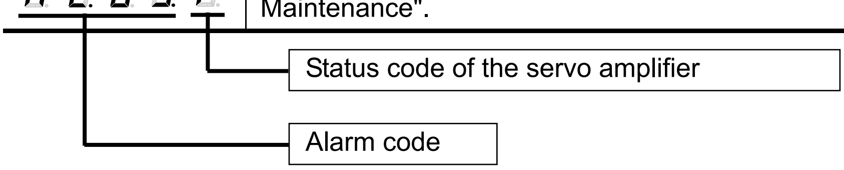
Marking	Description
	Positive direction over-travel status. Positive direction over-travel has occurred at position/velocity control.
	Negative direction over-travel status. Negative direction over-travel has occurred at position/velocity control.

✔ See "7.5.4 Warning status display" about display of warning status.

5.4.2 Alarm display

When an alarm occurs, the display shows the alarm code and the status code of the Servo amplifier.

Marking	Description
AL85F	When an alarm occurs, take corrective actions as instructed in "8. Maintenance".

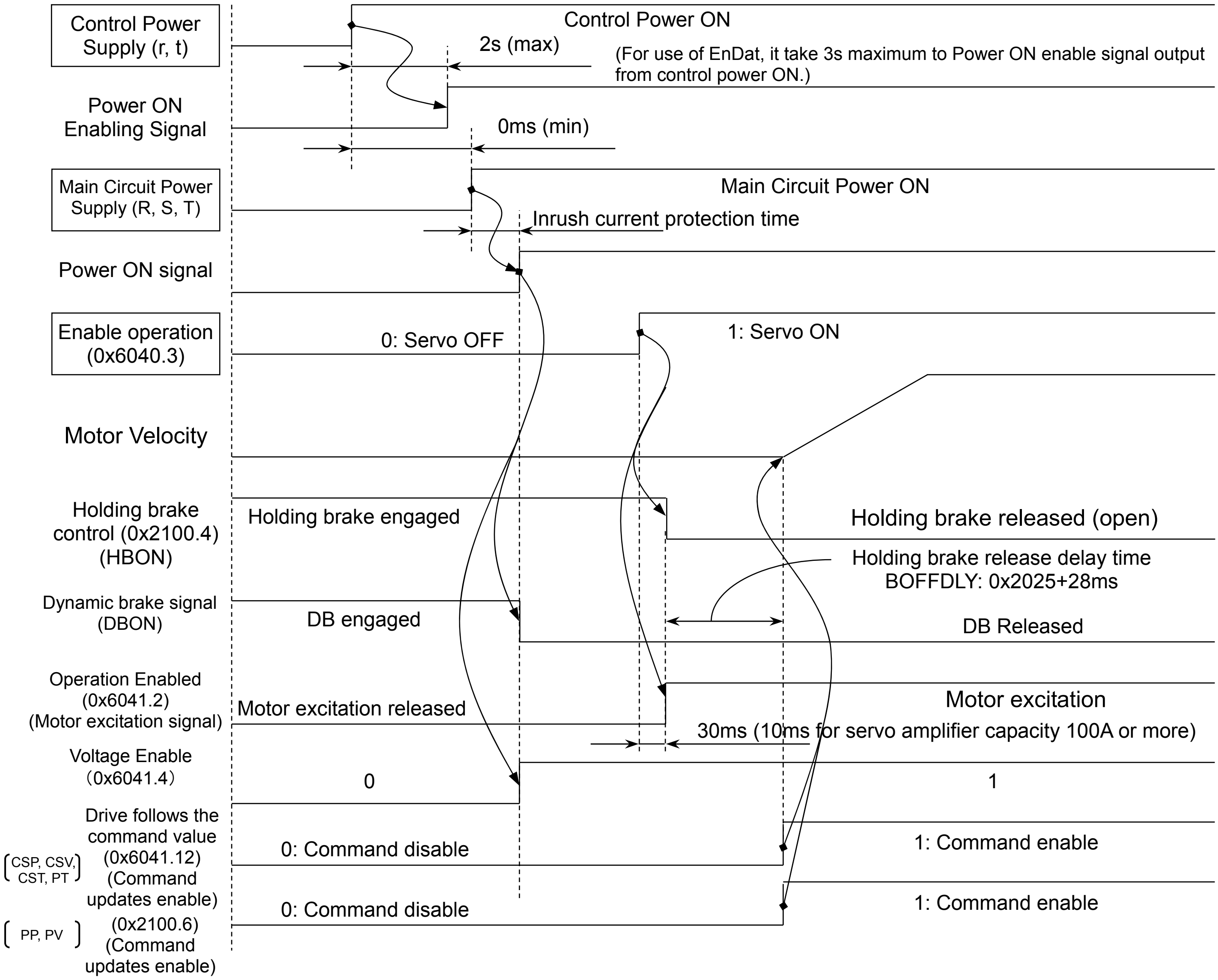


Code	Status	
1	Power OFF status	(P-OFF)
2	Power ON status	(P-ON)
3	Servo ready status	(S-RDY)
4	Servo ON status	(S-ON)
5	Servo OFF and stop status	(S-OFF)
6	Emergency stop status	(EMR)
F	Initial status	

5.5 Operation Sequence

5.5.1 Operation Sequence from Power ON to Power OFF

■ Power ON → Servo ON



- Power supply for external encoder shall be turned ON at the same timing or before of servo amplifier control power ON.
- The frequency of powering the servo amplifier ON/OFF must be less than 5 times/H and 30 times/day. In addition, the intervals between Power ON/OFF must be longer than 10 minutes.
- Inrush current suppression times of each servo amplifier size are as follows:

■ AC200V input type

Servo amplifier capacity	Inrush current suppression time	
	Three-phase	Single -phase
RS3A01#	900 [ms]	1800 [ms]
RS3A02#	900 [ms]	1800 [ms]
RS3A03#	900 [ms]	1800 [ms]
RS3A05#	900 [ms]	1800 [ms]
RS3A07#	1200 [ms]	---
RS3A10#	1200 [ms]	---
RS3A15#	1200 [ms]	---
RS3A30#	1200 [ms]	---
RS3A60#	2400 [ms]	---

■ AC100V input type

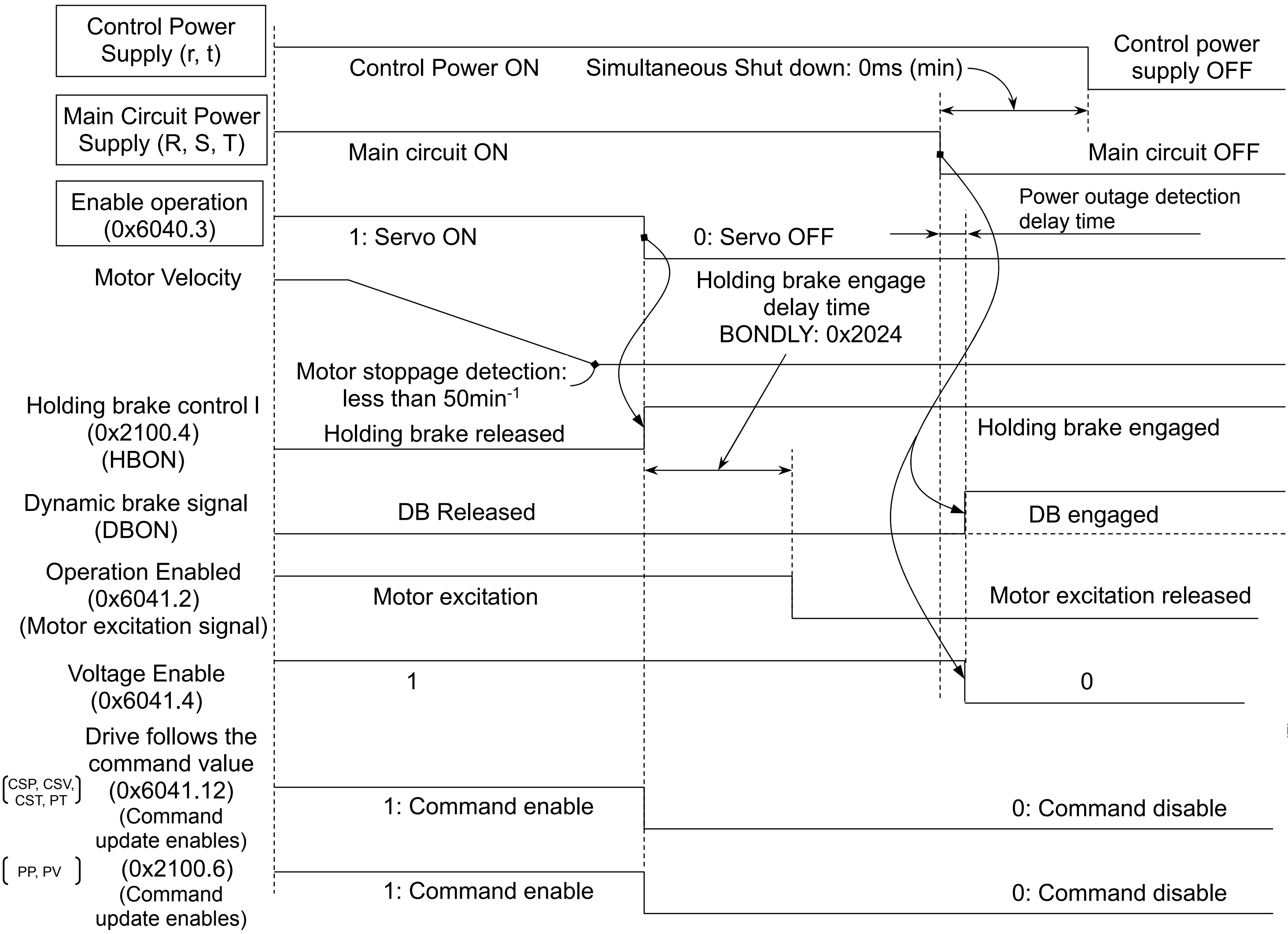
Servo amplifier capacity	Inrush current suppression time
RS3E01#	900 [ms]
RS3E02#	900 [ms]
RS3E03#	900 [ms]

■ AC400V input type

Servo amplifier capacity	Inrush current suppression time
	Three-phase
RS3C02#	1200 [ms]
RS3C05#	1200 [ms]
RS3C10#	1200 [ms]
RS3C15#	1200 [ms]
RS3C30#	1200 [ms]
RS3C80#	1200 [ms]

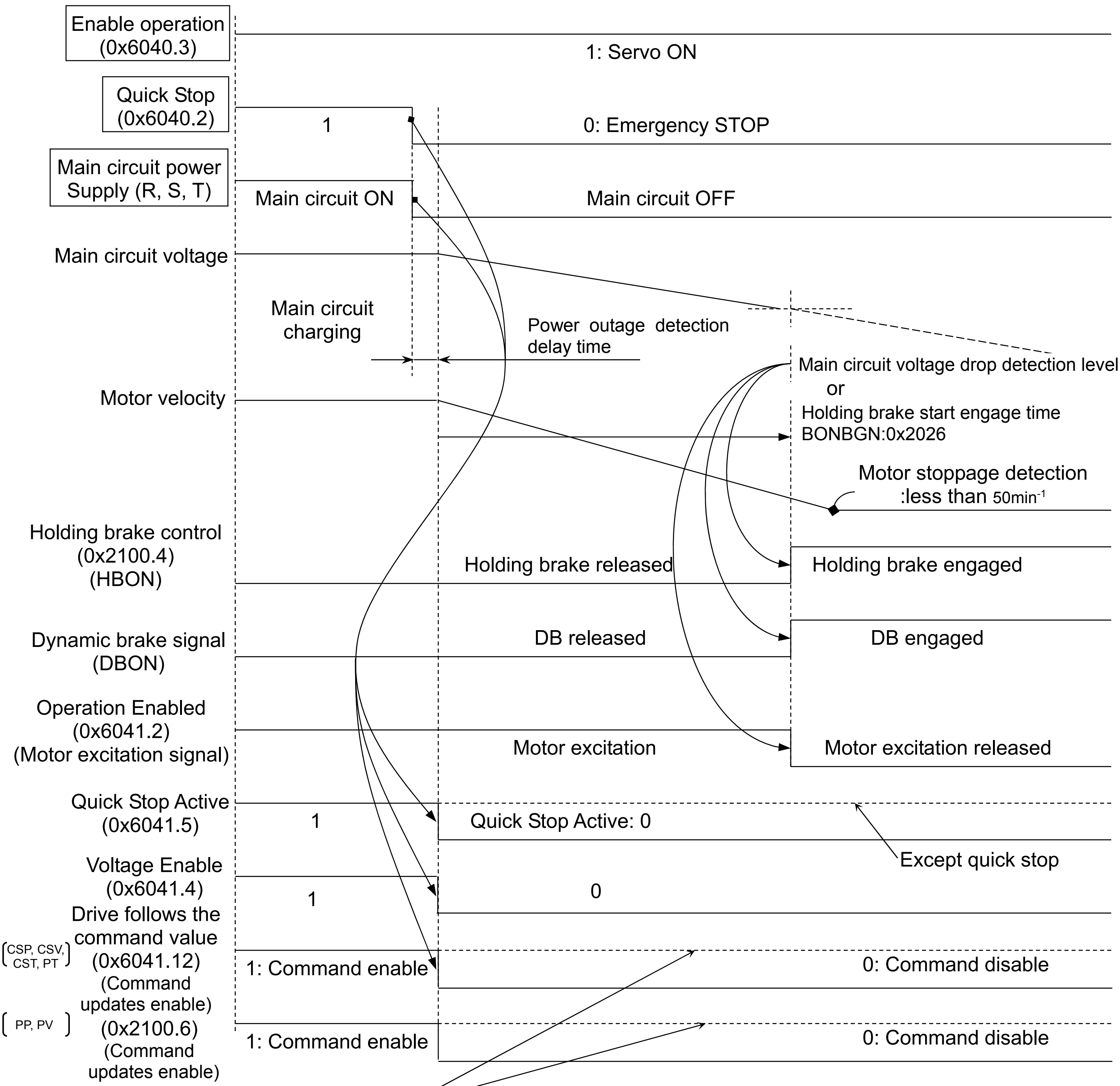
■ Servo OFF → Power OFF

Sequence in case of Servo OFF during motor rotation depends on Disable Option Code (0x605C) setting.



■ Main Circuit OFF, Quick STOP (Emergency STOP) Sequence

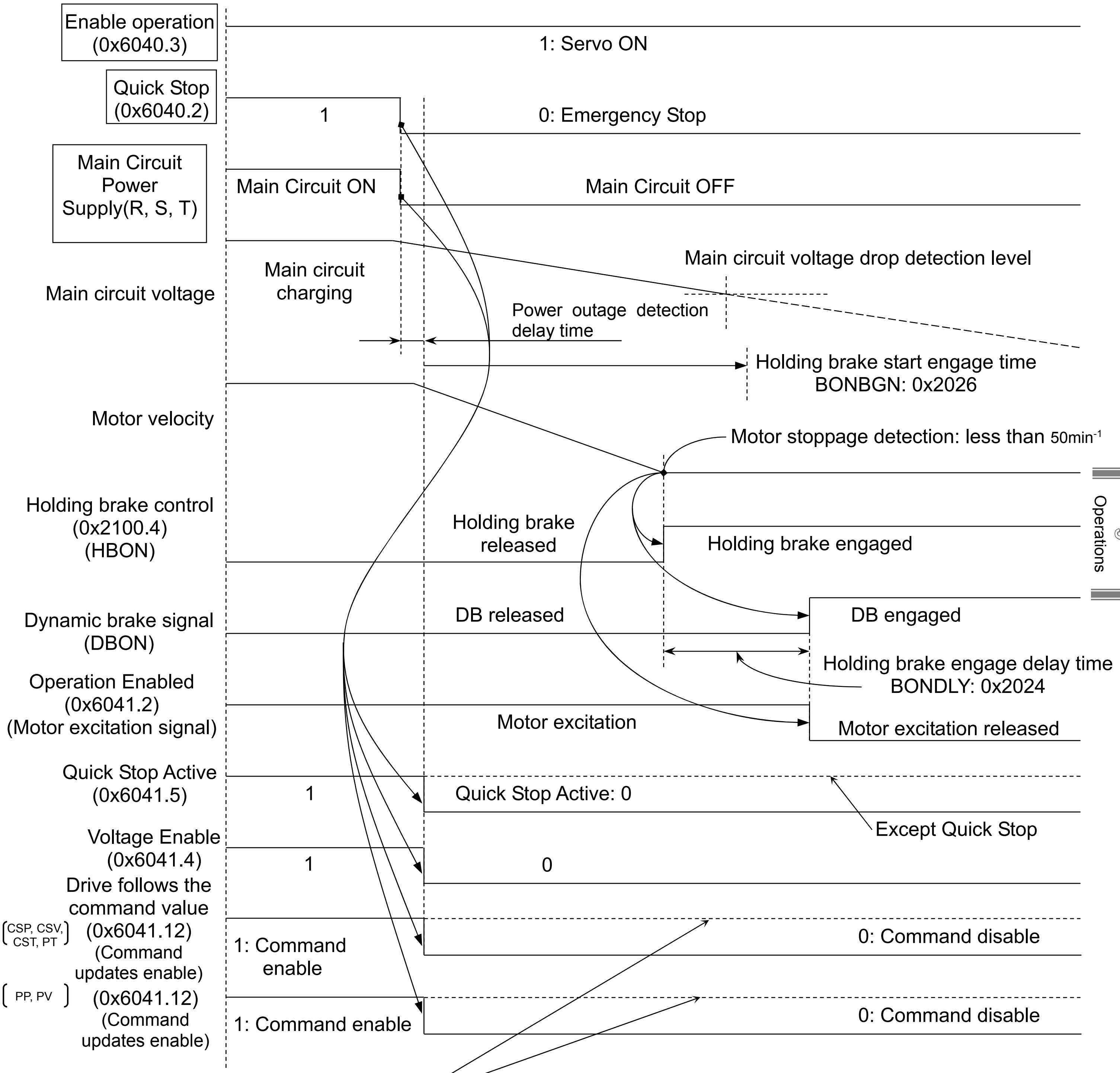
1. When motor did not stop with the setting value of the holding brake engage starting time, or main circuit voltage drop is detected



In the quick stop, "Drive follows the command value (Command updates enable)" becomes command invalid by release of the quick stop signal.

■ Main Circuit OFF, Quick STOP (Emergency STOP) Sequence

2. When motor is stopped within holding brake start engage time or before main circuit voltage drop detection

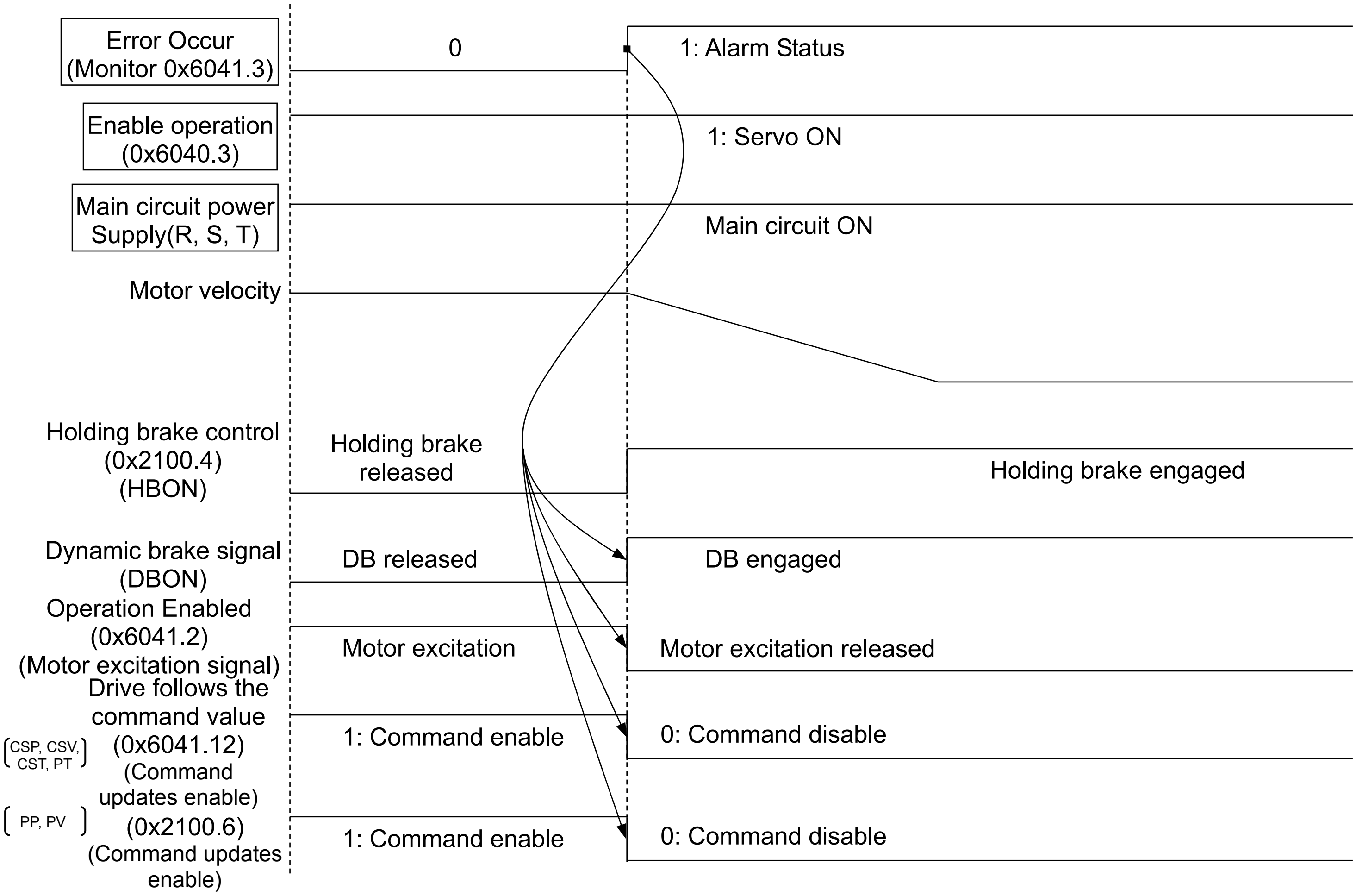


In the quick stop, "Drive follows the command value (Command updates enable)" becomes command invalid by release of the quick stop signal.

5.5.2 Alarm Occurrence Stop Sequence

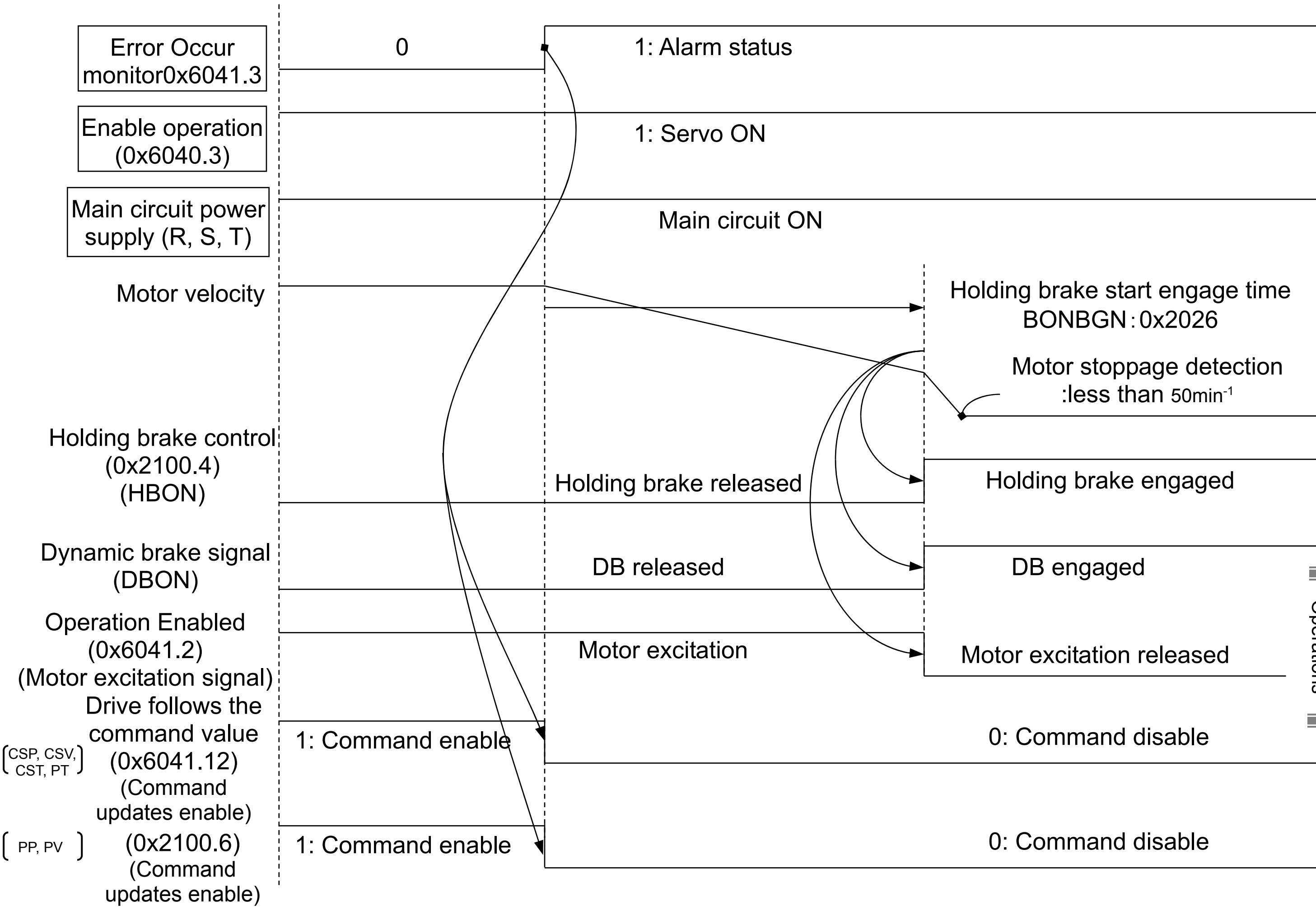
Servo motor is stopped by dynamic brake or servo brake with alarm occurrence. To stop either with dynamic brake or servo brake, please refer to “Movement of SB, DB at the time of Alarm detection” in the alarm code list. (SB: Servo brake Stop, DB: Dynamic brake Stop)
The stop method can be selected with Quick Stop option code (0x605A) for alarms that can be stopped with the servo brake. Please refer to “Alarm Display List (11-3)” for details.

■ Stop Sequence with Dynamic brake at Alarm Occurrence



■ Stop Sequence with Servo Stop (Fault Reaction code) at Alarm Occurrence

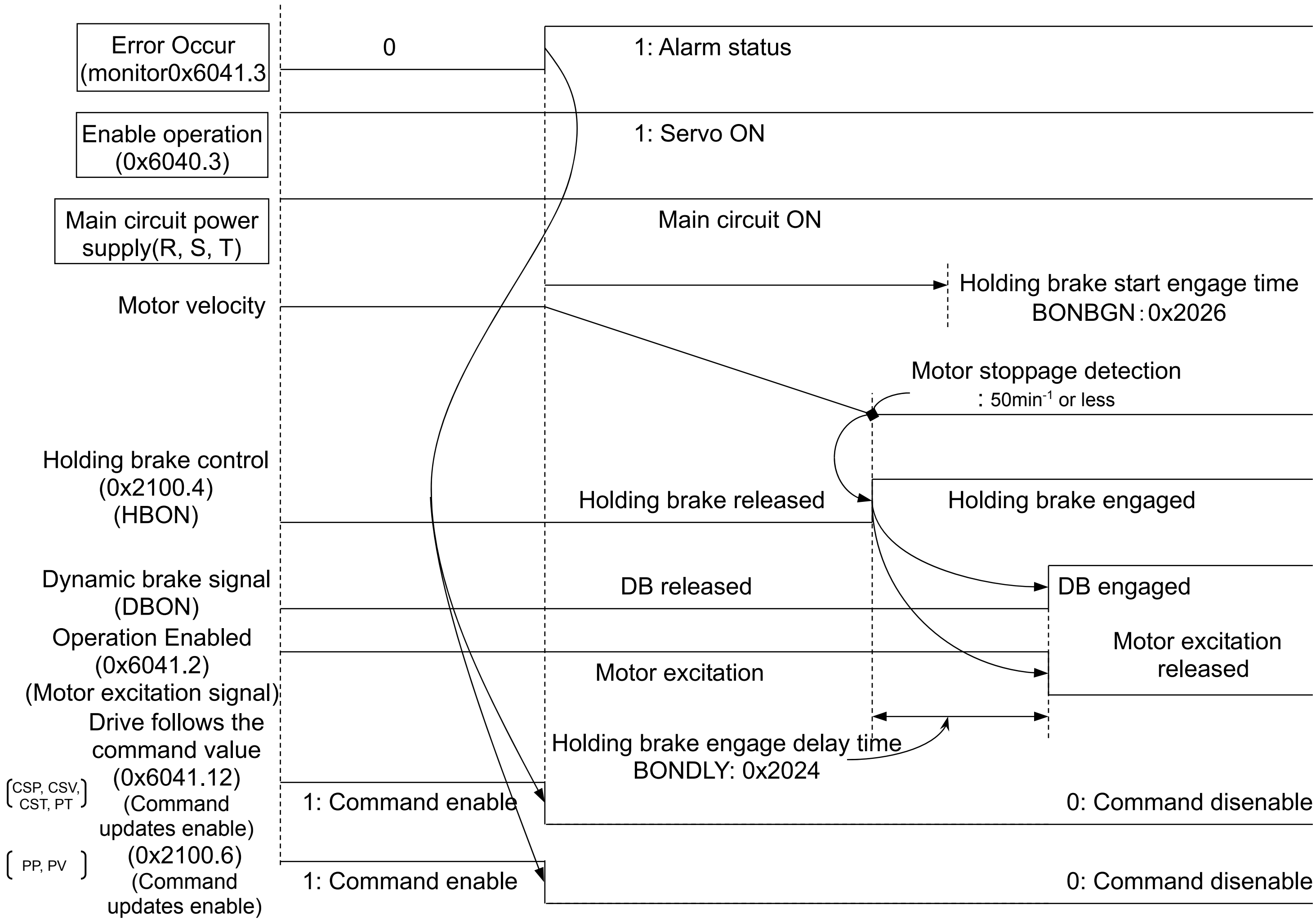
1. When a motor does not stop with the setting value of holding brake engage start time



✔ Sequence above is in case that safety circuit is prepared.
Refer the section 4.1.6 and prepare safety circuit.

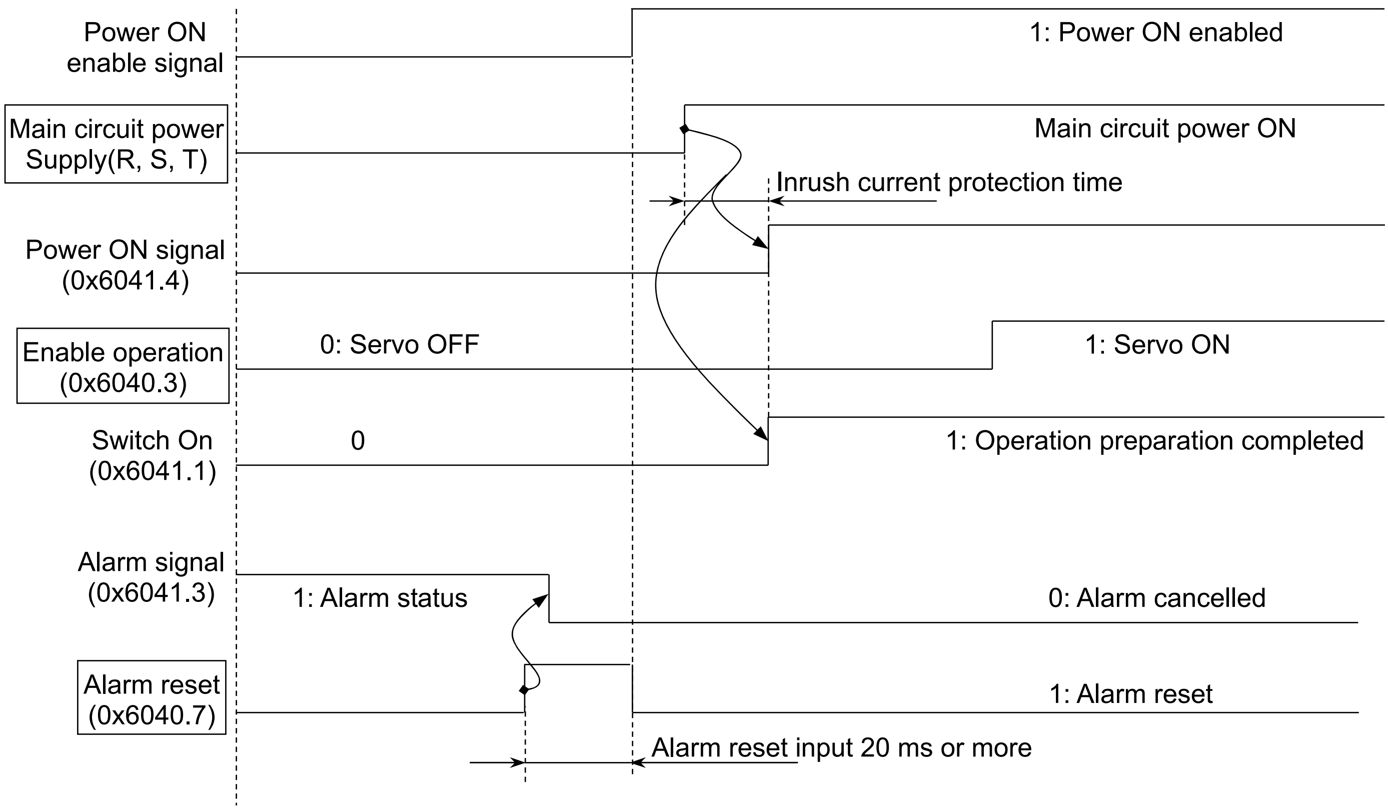
■ Stop Sequence with Servo Stop (Quick Stop option code) at Alarm Occurrence

2. When a motor has stopped with the setting value of holding brake engage start time



5.5.3 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 section “8.2 Warning and Alarm List” for details.

✔ Confirm that there is no alarm by checking alarm signal, and then cancel alarm reset signal. Alarm signal is not able to cancel if alarm state is continuing so it shall be returned to zero state after timeout 20ms or more. Moreover, alarm reset signal shall be input 20ms or more when inputting without alarm signal confirmation.

5.6 Communication timing

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

Copy and Prepare Outputs

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

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

Get and Copy Inputs

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

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

Outputs Valid

"Outputs Valid" in RS2-EtherCAT slave amplifier indicates the time, which added together the following three kinds of time.
1) Time until copies process data to local memory from SyncManager by trigger event
2) Time until servo loop operation process and the current command to ASIC for servo are written in
3) Hardware delay to current loop operation process within ASIC and IGBT gate output

Start Driving Outputs

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

Start Latch

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

Input Latch

"Input Latch" in RS2-EtherCAT slave amplifier indicates the real position acquisition timing of motor encoder.
However, when position cannot be received more correctly than encoder (serial encoder), data is not copied to SyncManager area.

User Shift Time

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

SYNC1 Cycle Time

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

Shift Time

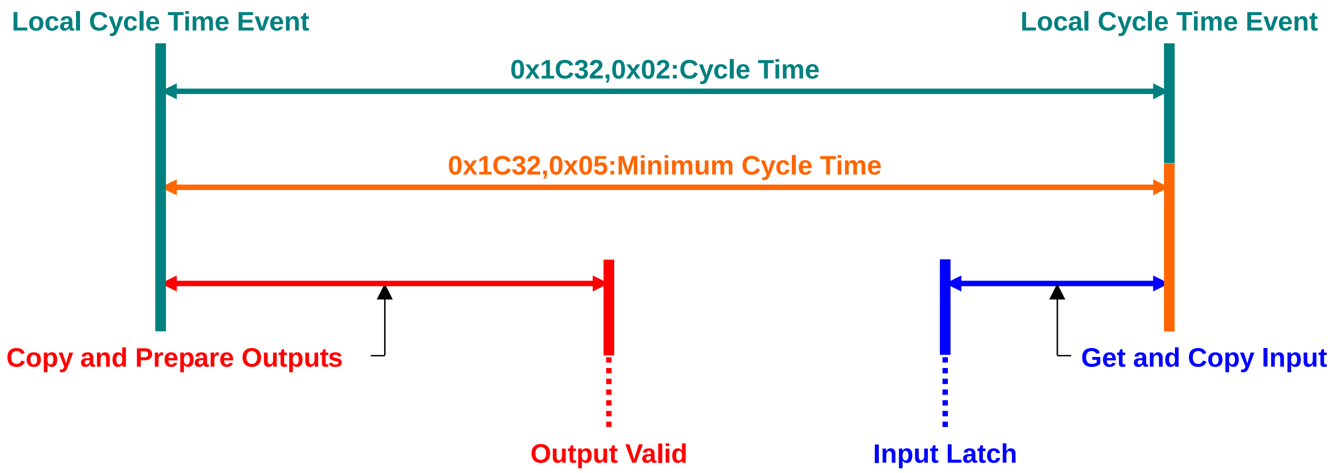
"Shift Time" defines time between the synchronous event such as SM2 event, SYNC0, and SYNC1, and also "Outputs Valid" and "Input Latch". Possible to write if its specifications can shift "Outputs Valid" or "Input Latch".

5.6.1 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	R 3E Model 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



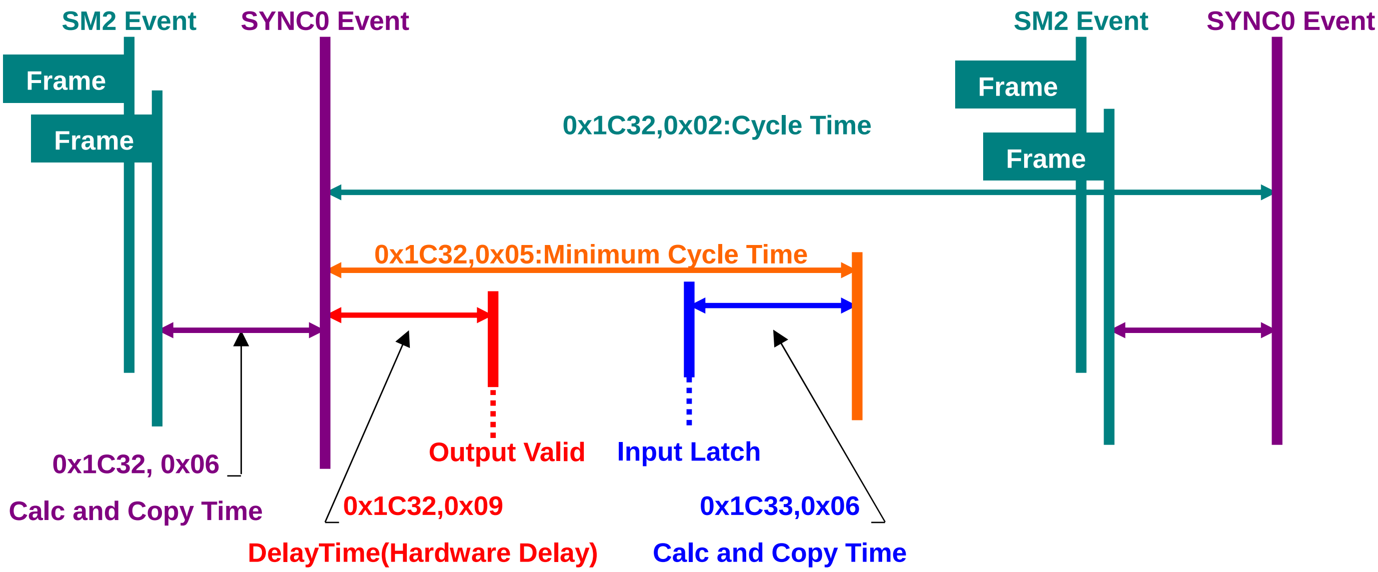
Communication Timing of Free Run Mode

5.6.2 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



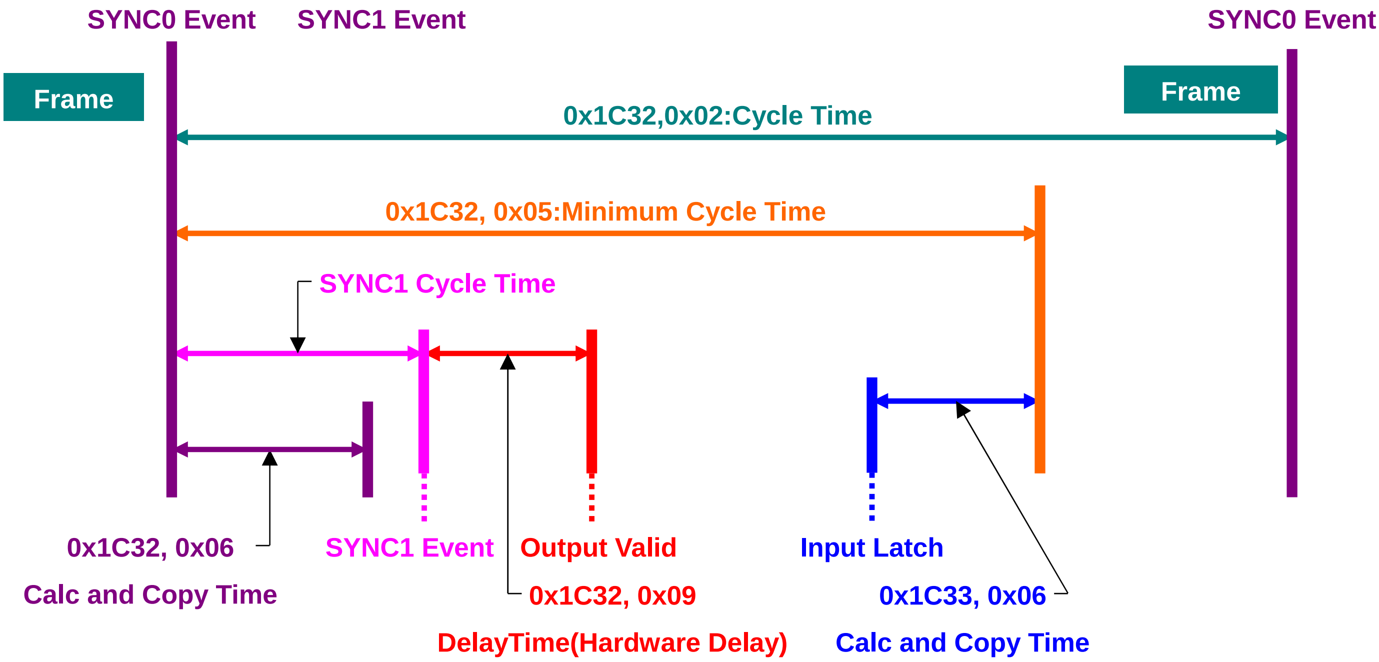
Communication Timing of DC Synchronization Mode (SYNC0)

5.6.3 DC Mode (SYNC1 Event Synchronization)

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

Parameter of DC Mode (SYNC1 Event Synchronization)

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

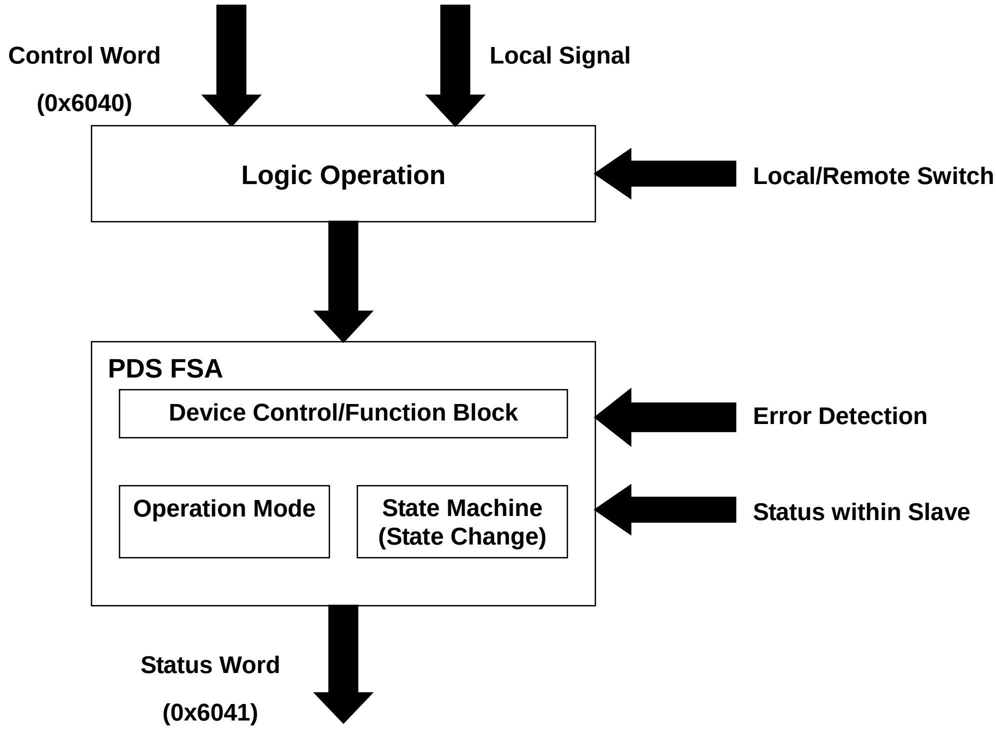


Communication Timing of DC Synchronization Mode (SYNC0)

5.7 PDS FSA

5.7.1 Abstract

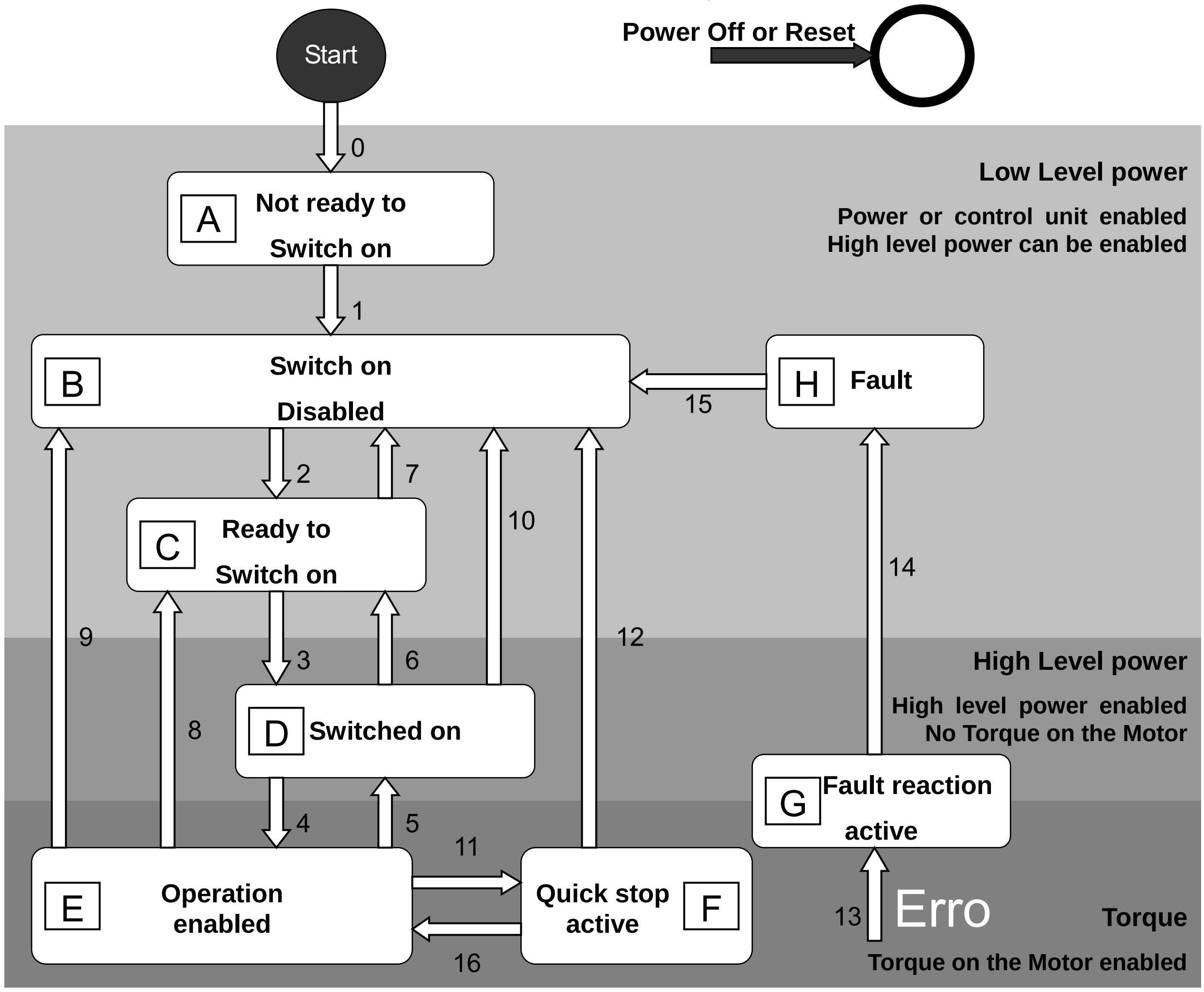
PDS (Power System Device) FSA (Finite States Automaton)of the EtherCAT slave amplifier is an abstract concept which defines the state of the control device stays or passes, operation with the Black Box. It defines the slave's application operating. Slave controls State Device, Mode, and State Change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



Control Word / Status Word Concept of Slave

5.7.2 FSA（Finite States Automaton）

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



FSA of RS2 EtherCAT Amplifier

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

FSA and FSA state describes the state transitions.

FSA State Definition

No.	State	Description
[A]	**Not Ready to Switch on**	The control source is provided to the slave and established. Slave is performing initialization or self-test.
[B]	**Switch on Disabled**	Initialization is completed, and slave is in condition to be able to set parameter. However, main circuit power supply is not in the state should be supplied.
[C]	**Ready to Switch on**	In input permission state about main circuit power supply. **Although parameter can be set, function is in invalid state.**
[D]	**Switch on**	Main circuit power supply is provided and in the completion state of 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.

5 Operations

5.8 Operation Mode

5.8.1 Kinds of operation mode

■ Operation mode list

EtherCAT-CoE specification has modes of operation shown in operation mode list.
Profiles applicable to R 3EModel 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 3EModel 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

<table>
<tr><th colspan="2">Operation Mode</th><th>bit8</th><th>bit6</th><th>bit5</th><th>bit4</th></tr>
<tr><td>pp</td><td>Profile Position Mode</td><td rowspan="8">Halt</td><td rowspan="2">Absolute / Relative Position</td><td>Change set immediately</td><td>New set point</td></tr>
<tr><td>csp</td><td>Cycle Sync. Position Mode</td><td>Reserved</td><td>Reserved</td></tr>
<tr><td>ip</td><td>Interpolated position</td><td>Reserved</td><td>Reserved</td><td>Interpolation Enable</td></tr>
<tr><td>csv</td><td>Cycle Sync. Velocity Mode</td><td>Reserved</td><td>Reserved</td><td>Reserved</td></tr>
<tr><td>pv</td><td>Profile Velocity Mode</td><td>Reserved</td><td>Reserved</td><td>Reserved</td></tr>
<tr><td>cst</td><td>Cycle Sync. Torque (force) Mode</td><td rowspan="3">Homing offset Active</td><td rowspan="3">Reserved</td><td rowspan="3">Homing Enable</td></tr>
<tr><td>tq</td><td>Torque (force) Mode</td></tr>
<tr><td>hm</td><td>Homing Mode</td></tr>
</table>

Unique Mode Bit Assigned to Status Word

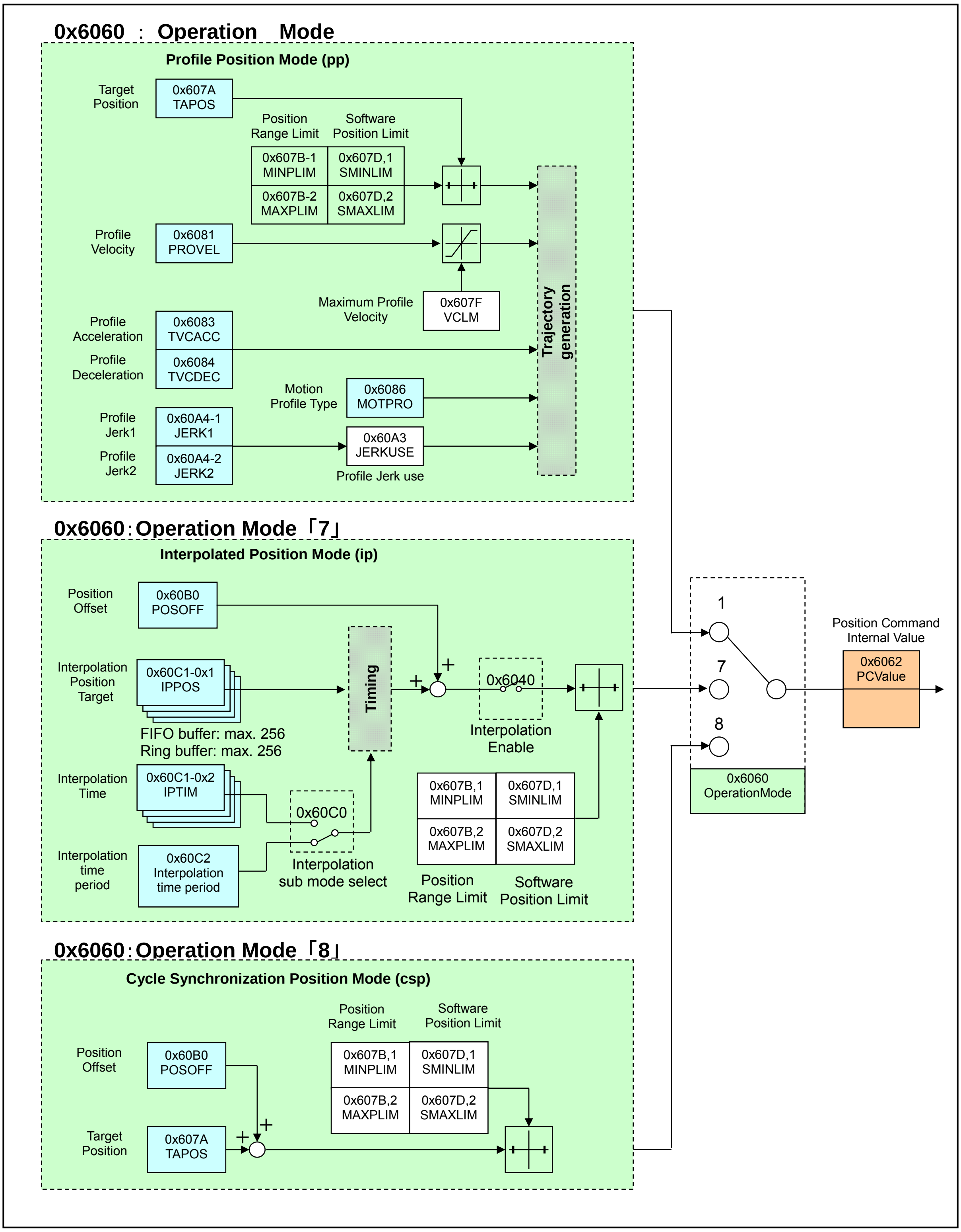
<table>
<tr><th colspan="2">Operation Mode</th><th>bit13</th><th>bit12</th><th>bit10</th></tr>
<tr><td>pp</td><td>Profile Position Mode</td><td>Following error</td><td>Set-point Acknowledge</td><td rowspan="8">Target reached
Quick Stop Finished
Operation Change Finished
Halt Active</td></tr>
<tr><td>csp</td><td>Cycle Sync. Position Mode</td><td>Following error</td><td>Target Position ignore</td></tr>
<tr><td>ip</td><td>Interpolated position</td><td>Reserved</td><td>Interpolation active</td></tr>
<tr><td>csv</td><td>Cycle Sync. Velocity Mode</td><td rowspan="2">Reserved</td><td rowspan="2">Target velocity ignore</td></tr>
<tr><td>pv</td><td>Profile Velocity Mode</td></tr>
<tr><td>cst</td><td>Cycle Sync. Torque (force) Mode</td><td rowspan="2">Reserved</td><td rowspan="2">Target torque (force) ignore</td></tr>
<tr><td>tq</td><td>Torque (force) Mode</td></tr>
<tr><td>hm</td><td>Homing Mode</td><td>Homing error</td><td>Homing attained</td></tr>
</table>

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

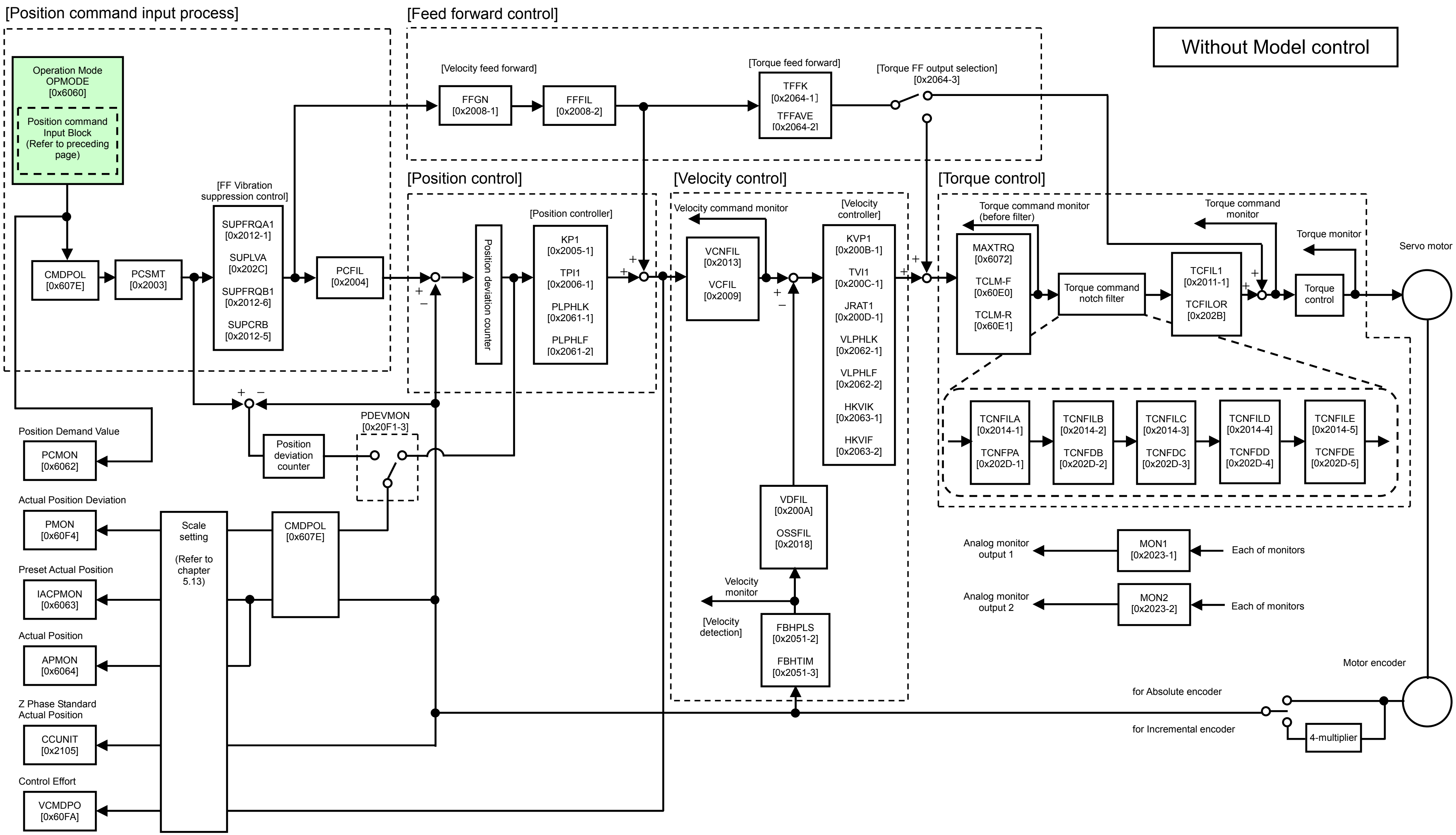
5.8.2 Function Group "Position" Mode

■ Abstract of Function Group "Position" Mode

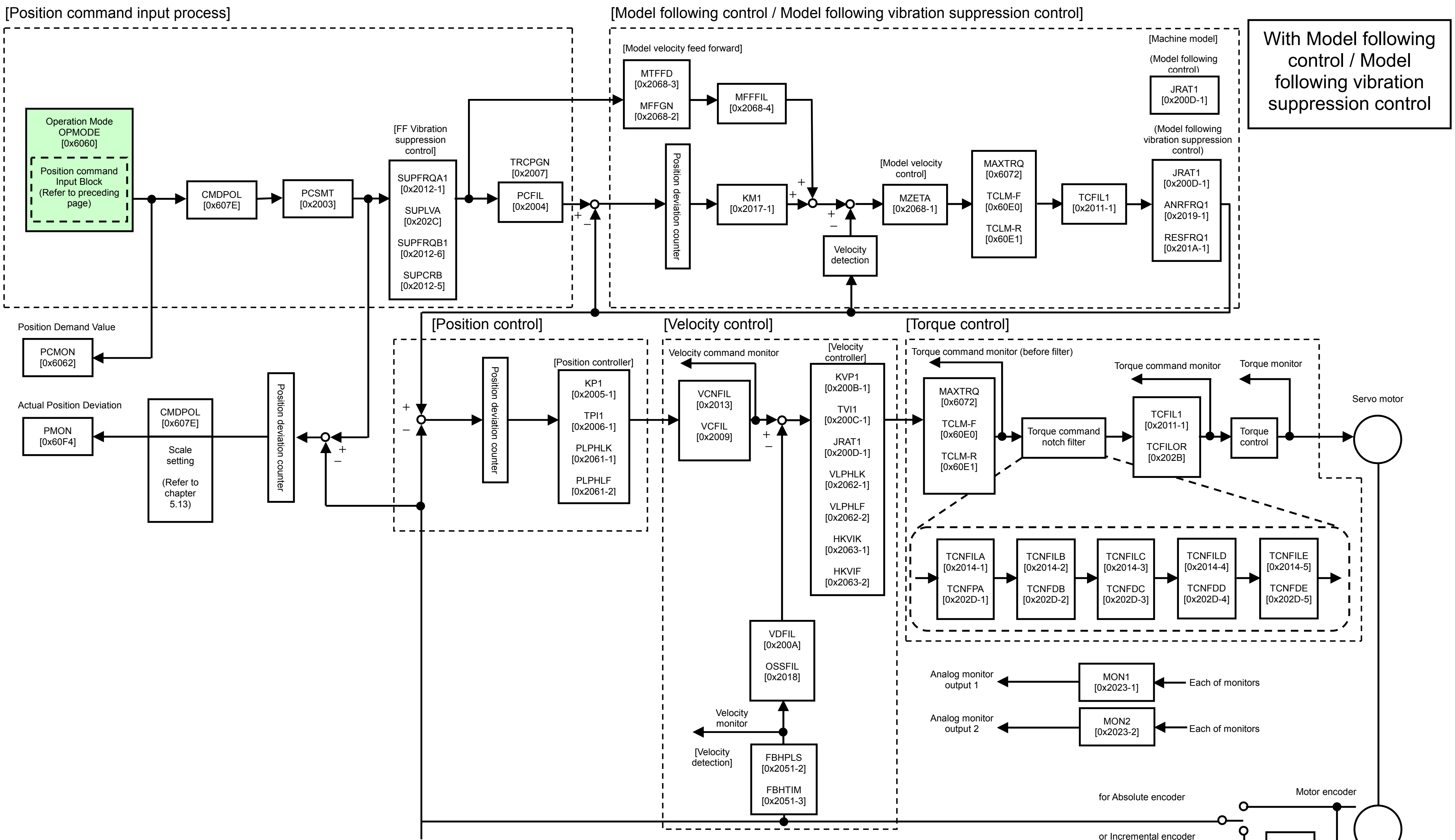
As for function group "Position" operation mode, "Profile position Mode", "Cyclic Synchronous Position Mode" and "Interpolated Position Mode"are supported. 0x6060: Operate "Profile Position Mode" by setting "1" in operation mode, "Cyclic Synchronous Position Mode" by setting "8" and "Interpolated Position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



Block diagram of function group "position" mode with Model following control / Model following vibration suppression control

■ 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.

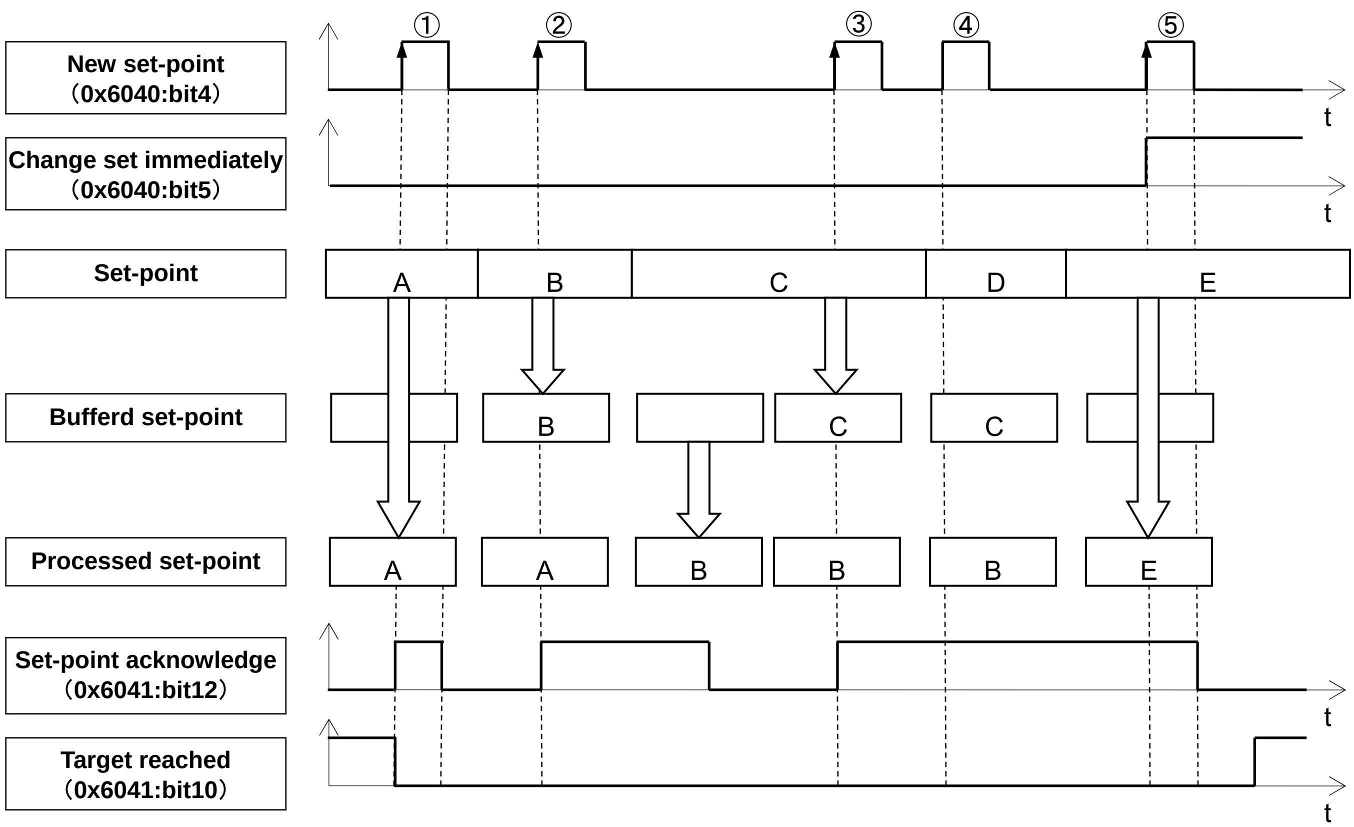
1. Single set point: [Change set immediately bit(0x6040: Control word bit5) = 1]

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.

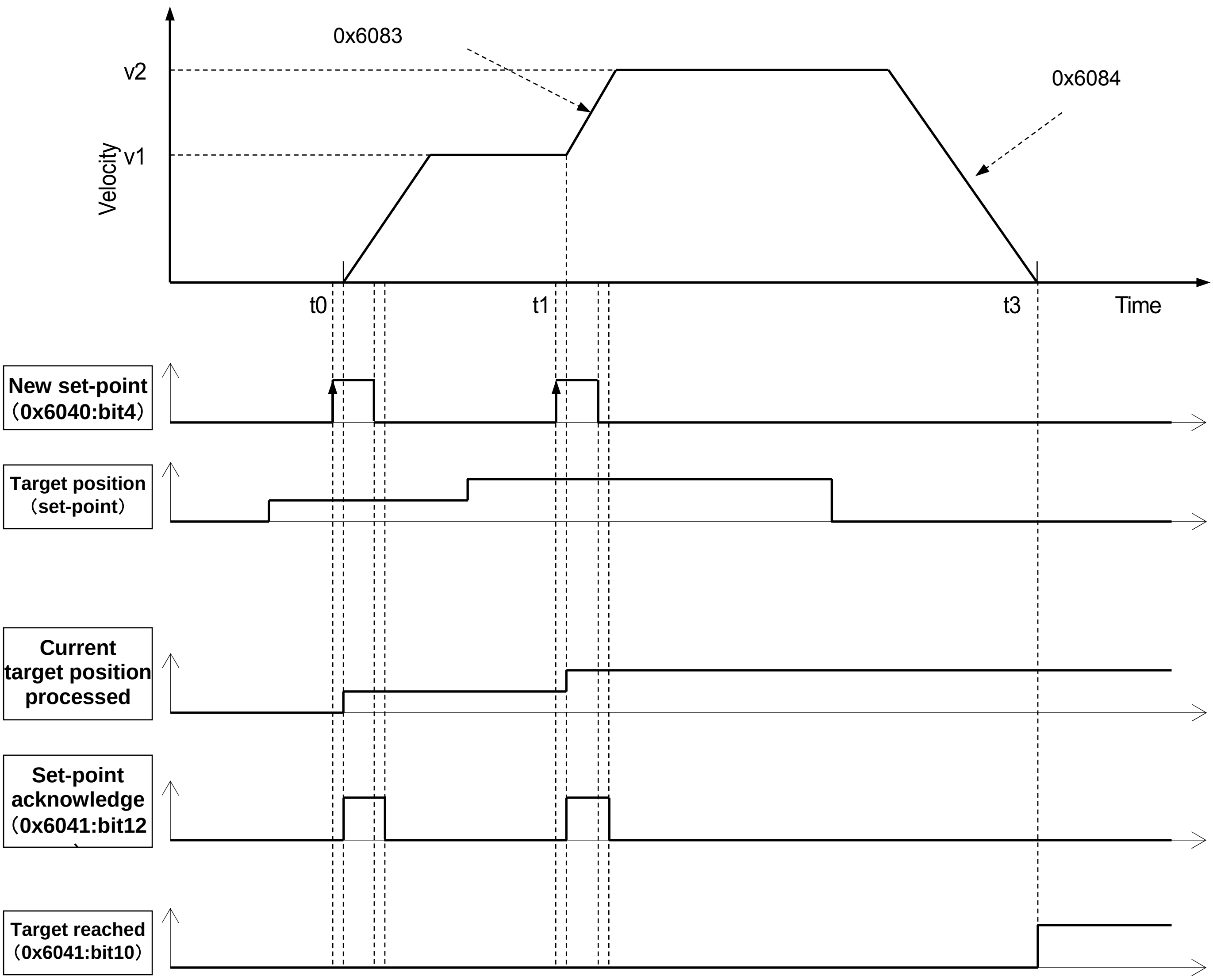
The master controller switches the two modes mentioned above by the timing of the following bits;
"New set-point(bit4)", "Change set immediately(bit5)", "Change of set-point(bit9)" in the Control Word (0x6040) and "Set-point acknowledge(bit12)" in the Status Word (0x6041).
These bits allow to set up 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.

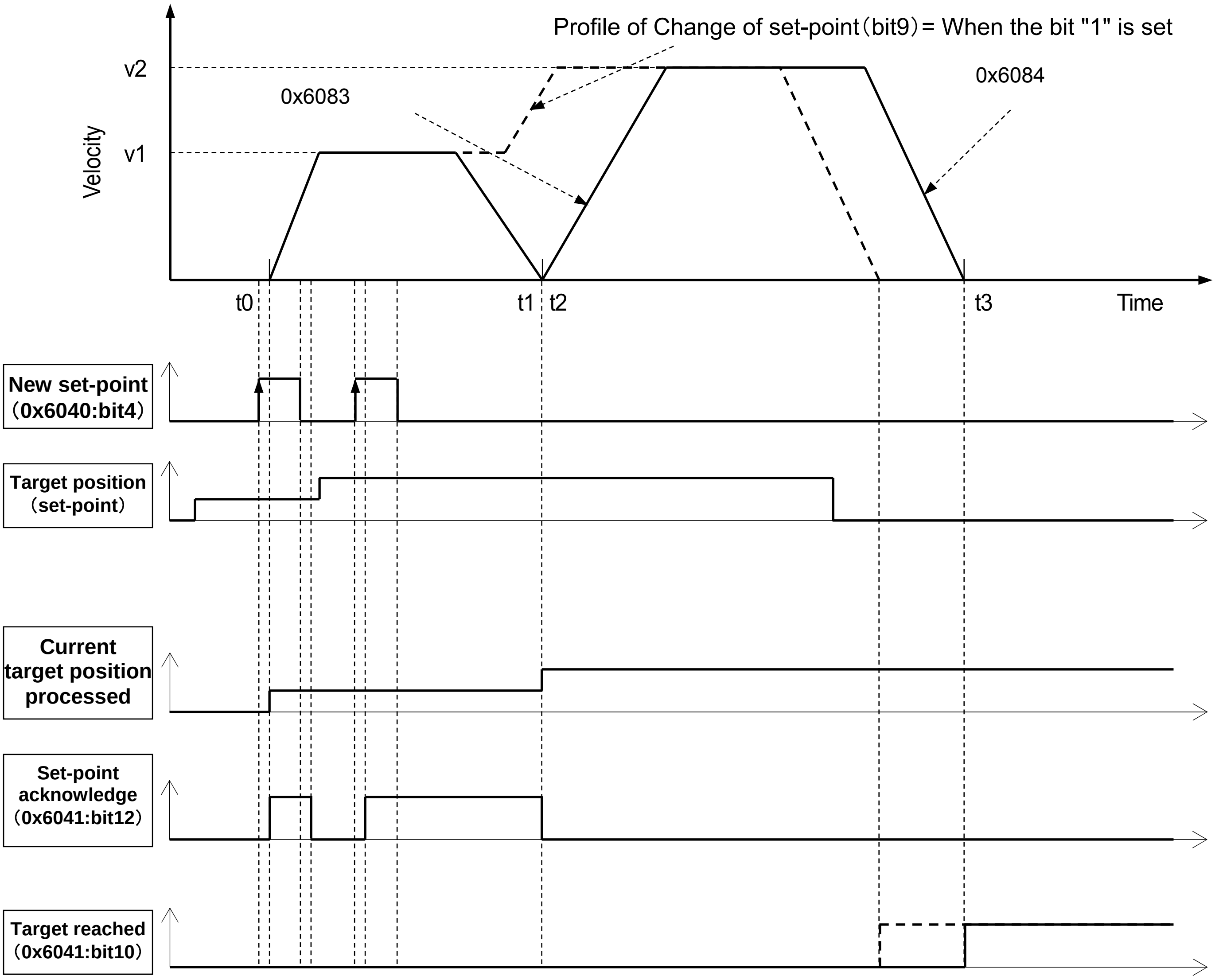


Single set-point (Update a set point immediately)

◆ Position command error 1 (AL_D2) alarm will be issued if a recalculated position by "Change set immediately (bit5)" on linear coordinate system exceeds a limit of position range.

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

MSB ... LSB

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

bit4:New set point [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	0x6041	This object indicates Operation Mode Specific bit and Manufacturer Specific bit of the Profile Position mode (pp).		Object code		Variable
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Status Word [STSWORD] * See the Pattern Status table for "Status word bit pattern (Bit 6,5, 3,2,1,0,)		Unsigned16	RO	Possible	0x0000
			Range	0x0000-0xFFFF		

MSB LSB

Csetfix	Csetpro	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.
・While software 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, jerk motion profile is able to use with acceleration/deceleration.

■ Jerk setting

For use of this function, system parameters below shall be set.

Index	Sub-index	Name	Description
0x6086	0x00	Motion profile type	Sets type of motion profile operation.
0x60A3	0x00	Profile jerk use	Sets sub index number combination of profile jerk object (0x60A4) for jerk profile operation.
0x60A4	0x01	Profile jerk 1	Sets the value of jerk 1. Variation of acceleration per second is set.
	0x02	Profile jerk 2	Sets the value of jerk 2. Variation of acceleration per second is set.

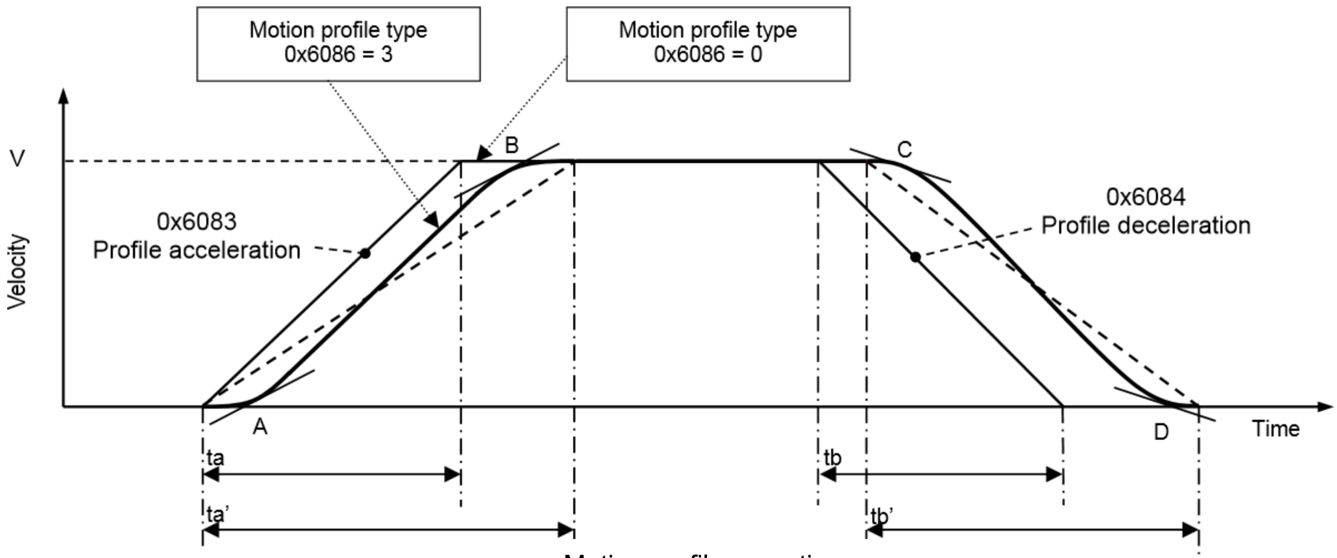
■ Jerk function abstract

(1) Motion profile type is selected at 0x6086.

Set value	Motion profile type
0x0000	Linear ramp (trapezoidal profile)
0x0003	Jerk limited ramp

(2) Applying combination of jerk (A/B/C/D) is set at 0x60A3.

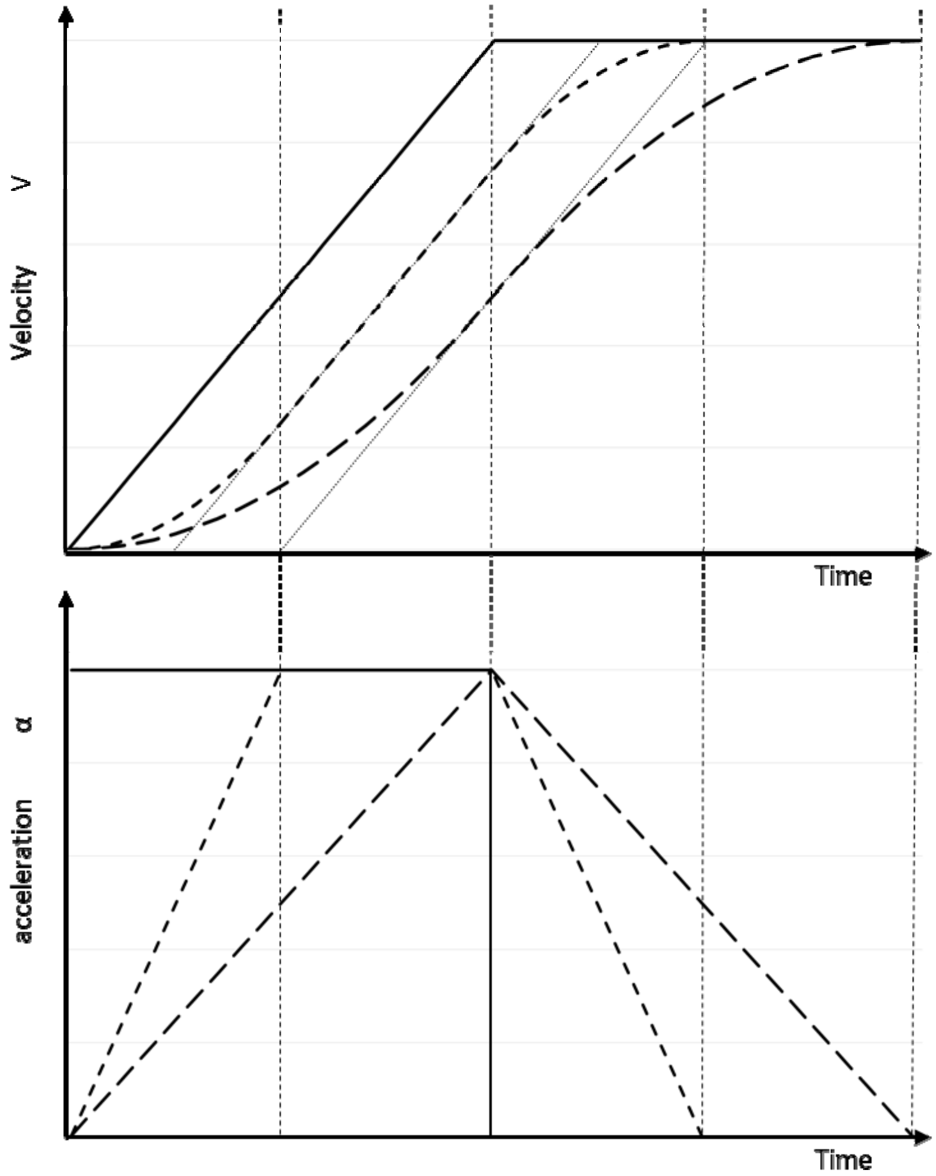
Sub-index	Jerk assign value (Sub index number in 0x60A4)			
	A	B	C	D
0x01	0x01	0x01	0x01	0x01
0x02	0x01	0x01	0x02	0x02



Motion profile operation

V = Profile velocity
A, B, C, D = Acceleration/deceleration in jerk ramp
ta = Acceleration time (Linear ramp)
tb = Deceleration time (Linear ramp)
ta' = Acceleration time (Jerk limited ramp)
tb' = Deceleration time (Jerk limited ramp)

(3) Operation and description with parameters below

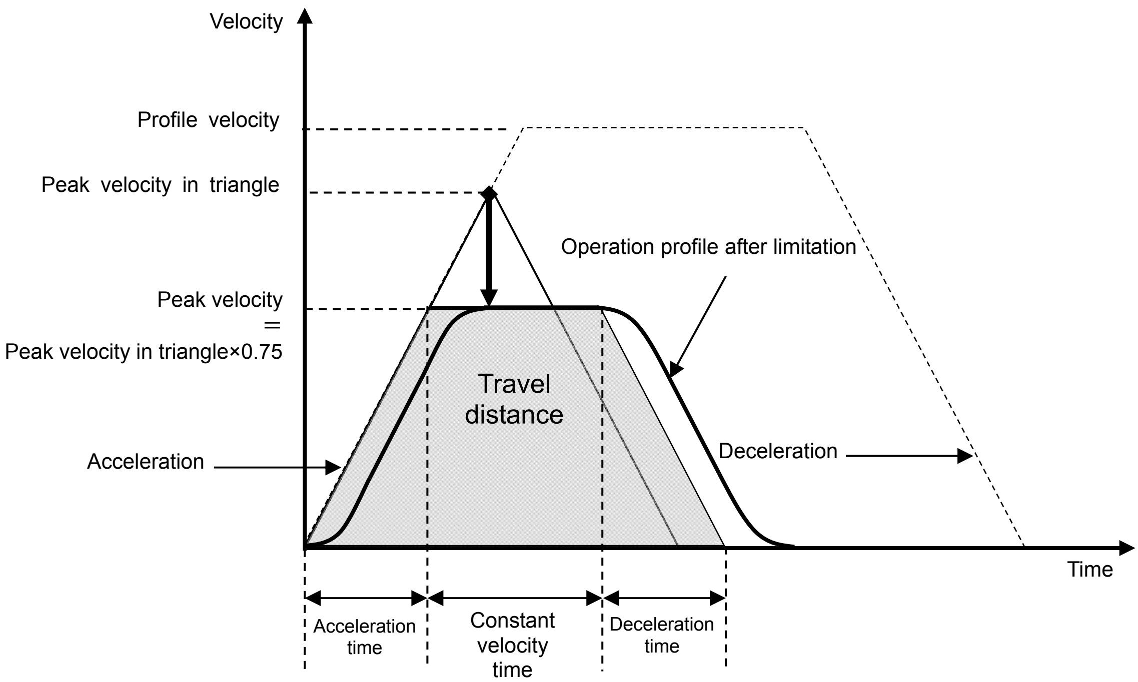


Motion profile type		Profile jerk set value	Description
———	Linear ramp	-	Trapezoidal profile operation is performed.
- - - -	Jerk limited ramp	Profile acceleration /2 < Profile jerk	Acceleration changes due to variation of acceleration per second (profile jerk).
— — —	Jerk limited ramp	Profile acceleration /2 > Profile jerk	Profile jerk is set as half of profile acceleration.

✔ When 0x02 is set to 0x60A4 profile jerk use, also deceleration reflects jerk function.

■ Profile in triangle operation

If an operation profile decided with actual position (0x6064), target position (0x607A), profile velocity (0x6081), profile acceleration (0x6083) and profile deceleration (0x6084) becomes triangle profile without reaching profile velocity, while using jerk profile operation (0x6086=0x0003), the profile with peak velocity limitation and constant velocity time is generated. If triangle operation is generated by trajectory calculation, peak velocity will be limited 75% against peak velocity in triangle calculated due to travel distance and acceleration.



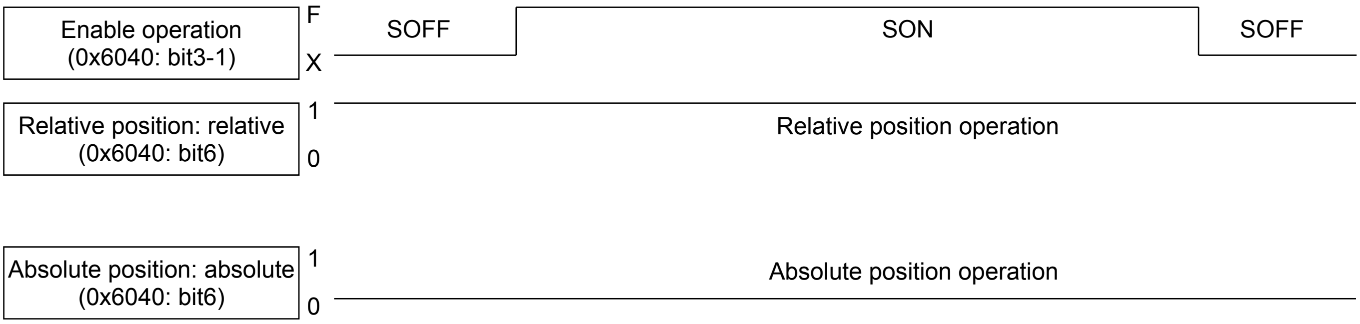
Peak limited operation profile

■ Cyclic Sync 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.

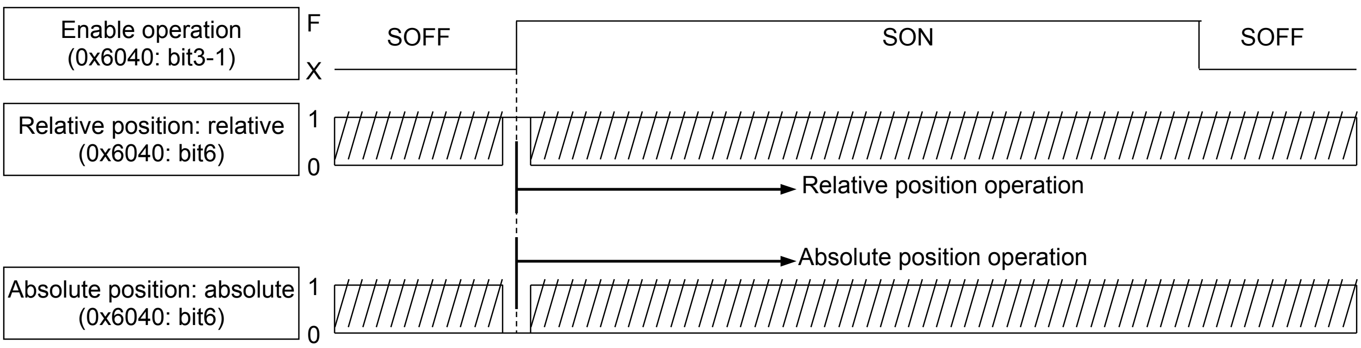
(1) Absolute/relative position selection always valid mode (0x2079-4, bit 0=0)

Absolute/relative position setting becomes always valid.
Set 1 to bit 6 of control word (0x6040) for use with relative position operation.
Set 0 to bit 6 of control word (0x6040) for use with absolute position operation.



(2) Absolute/relative position selection ratching mode (0x2079-4, bit 0=1)

Absolute/relative position decides by logic of 0x6040 bit 6 at the time of "Operation enabled (bit3-0 = 0x0F)" setting.
(bit6＝0: Absolute position command type, bit6＝1: Relative position command type)



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

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

MSB ... LSB

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

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

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

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

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

MSB LSB

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

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: While software position limit.

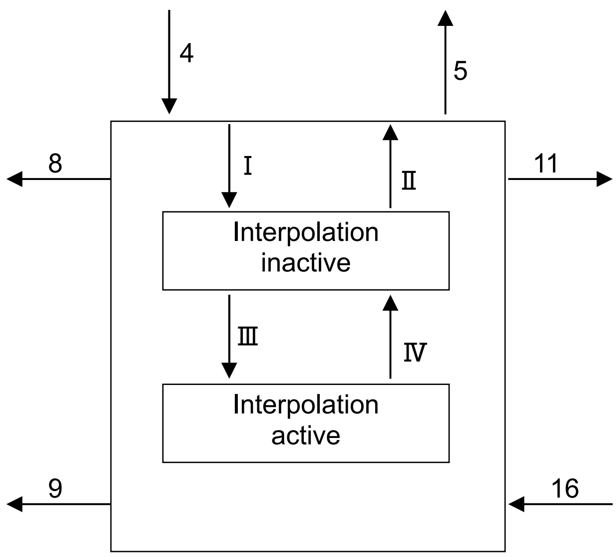
bit12: Command acceptance permitted
[Drive follows the command value]
0: Target position ignored.
1: Target position shall be used as input to position control loop.

bit13: Excessive position deviation [Following error]
0: No excessive position deviation
1: Excessive position deviation alarm

■ Interpolated Position Mode

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

State Change of Interpolated position mode



FSA status and FSA state 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)

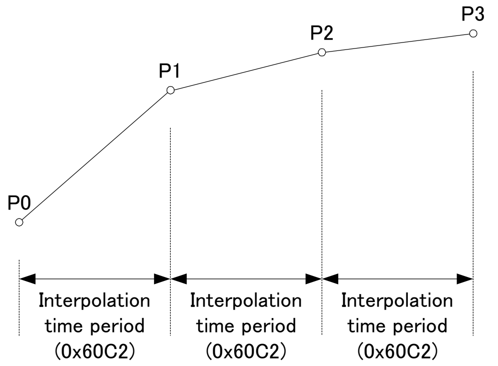
This servo amplifier corresponds to two kinds of interpolation methods. Select by using interpolation sub mode select (0x60C0).

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.

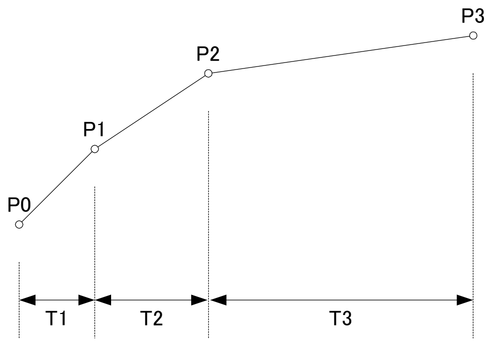


Buffer	
Interpolation Position Target 0x60C1-1	Interpolation Time 0x60C1-2
P0	−
P1	−
P2	−
P3	−

・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.

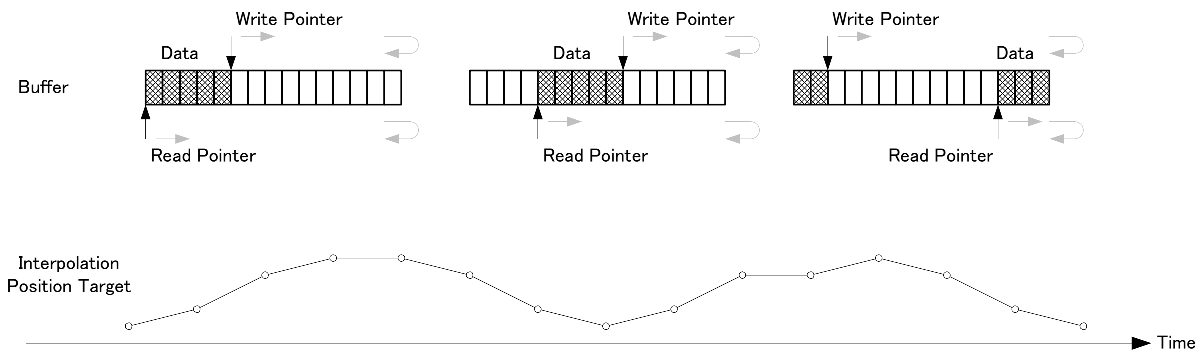
Sets interpolation position target (0x60C1-1) and interpolation time (0x60C1-2). Interpolation time period (0x60C2) is not used.



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

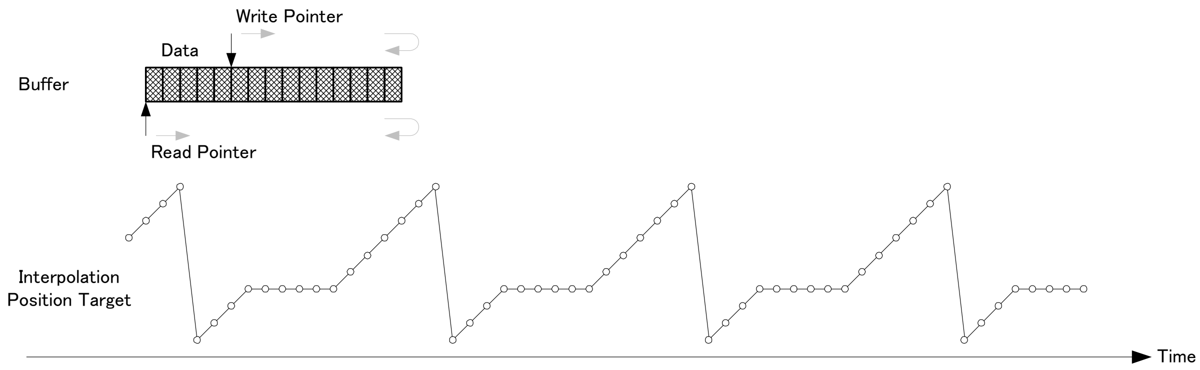
&Usage when buffer format is set to FIFO

(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.
(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	0x6040	This object indicates operation mode specific bits and manufacturer specific bits of the Interpolated Position Mode (ip)		Object code		Variable
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Control word ［CWORD］ *For details on Bit 7,3,2,1 and 0, see the table of Control Word Bit Pattern Command.		Unsigned16	RW	Possible	0x0000
			Range	0x0000 - 0xFFFF		

MSB … LSB

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

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

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

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

Index	0x6041	This object indicates operation mode specific bits and manufacturer specific bits of the Interpolated Position Mode (ip)		Object code		Variable
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Status word ［STSWORD］ *For details on Bit 6, 5, 3, 2, 1 and 0, see the Status Word List Bit Pattern. (Bit 6,5,3,2,1,0)		Unsigned16	RO	Possible	0x0000
			Range	0x0000 - 0xFFFF		

MSB … LSB

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

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

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

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

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

bit11：Internal limit active ［Internal Limit active］
0: Normal operation
1: Whilee software position limit.

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

bit13: Excessive position deviation [Following error]
0: No excessive position deviation
1: Excessive position deviation alarm

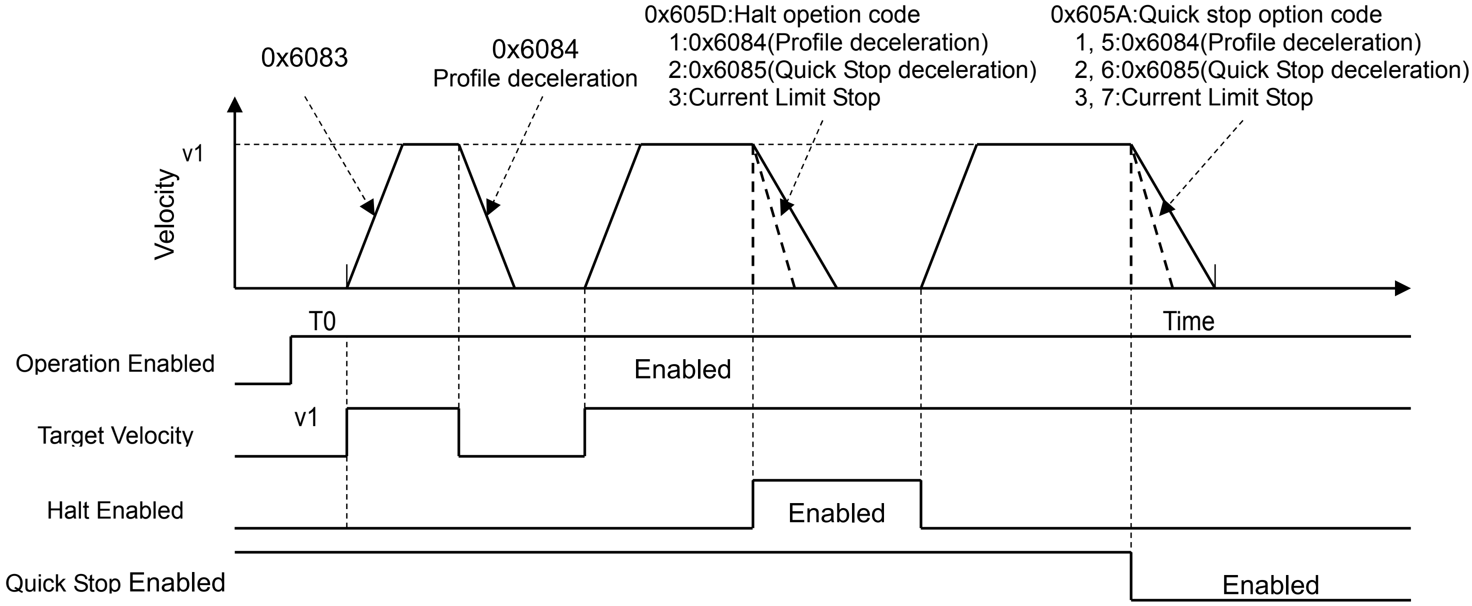
5.8.3 Function Group "Velocity"

■ Abstract of Function Group "Velocity" 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

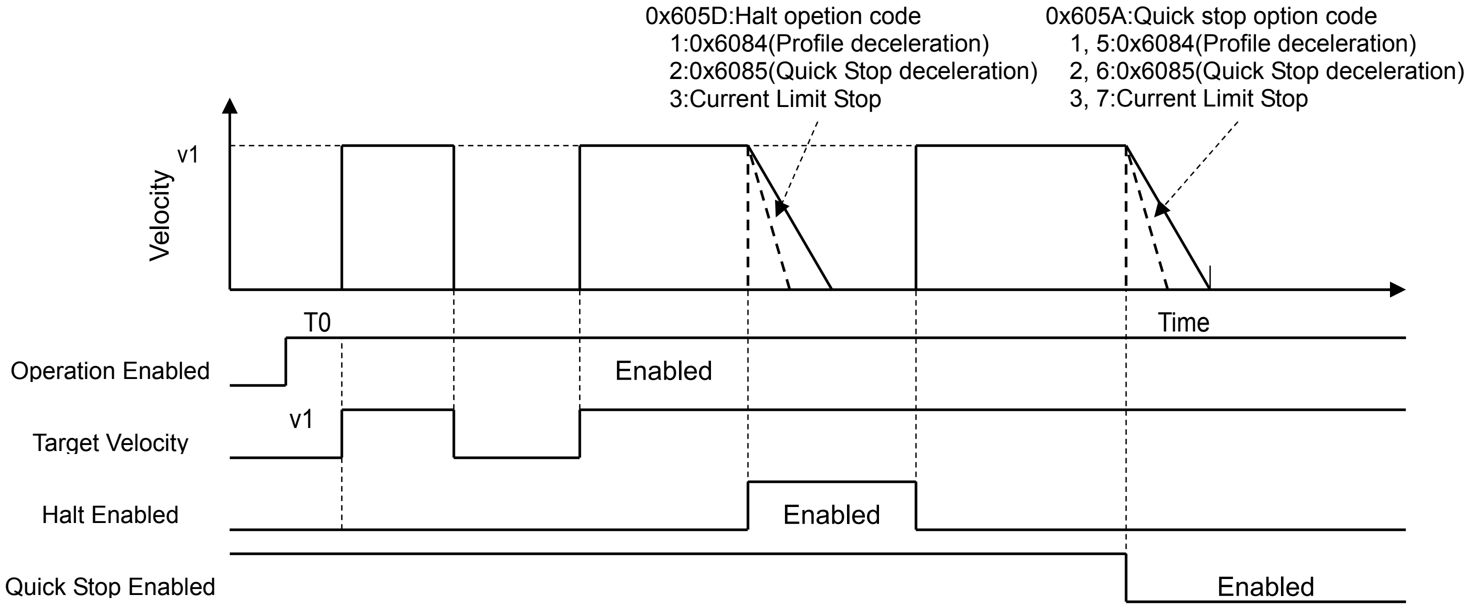
■ Profile Velocity Mode

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.



■ 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.



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

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

MSB → LSB

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

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

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

Index	0x6041	This object indicates Operation mode specific bits and Manufacturere specific bits in Cyclic Shunc. Mode (csv) and Profile velocity (pv)mode.	Object code		Variable
Sub-Idx	Description	Data Type	Access	PDO	Initial value
0x00	Status Word [STSWORD] * 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 or Drive follows the command	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

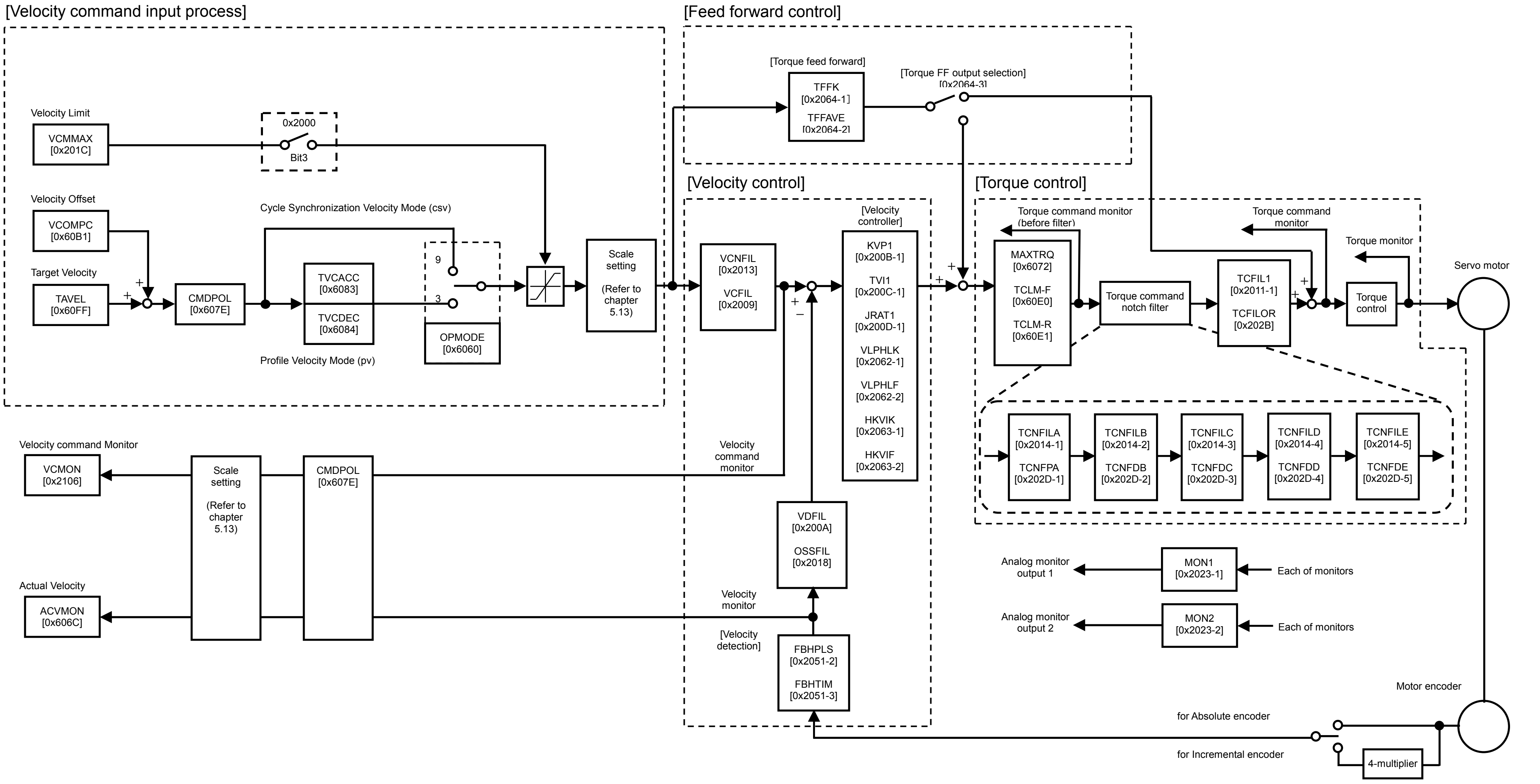
bit7:warning [warning]
0:No warning 1:warning condition

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: While velocity limit.

bit12: Command acceptance permitted [Drive follows the command value] (CSV)
0: Target velocity ignored.
1: Target velocity to be used as velocity control loop input.
bit12: Zero-speed status [Speed] (PV)
0: Not Zero-speed status
1: Zero-speed status



Block diagram of function group "velocity" mode

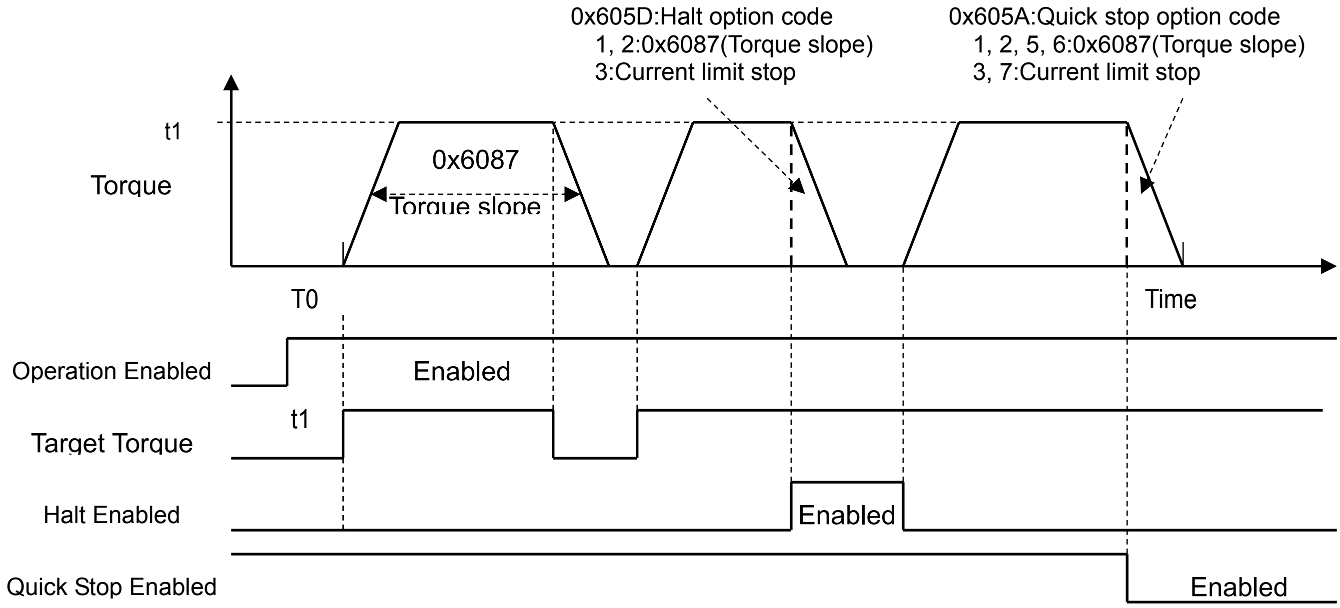
5.8.4 Function Group "Torque"

■ Abstract of Function Group "Torque" mode

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)".

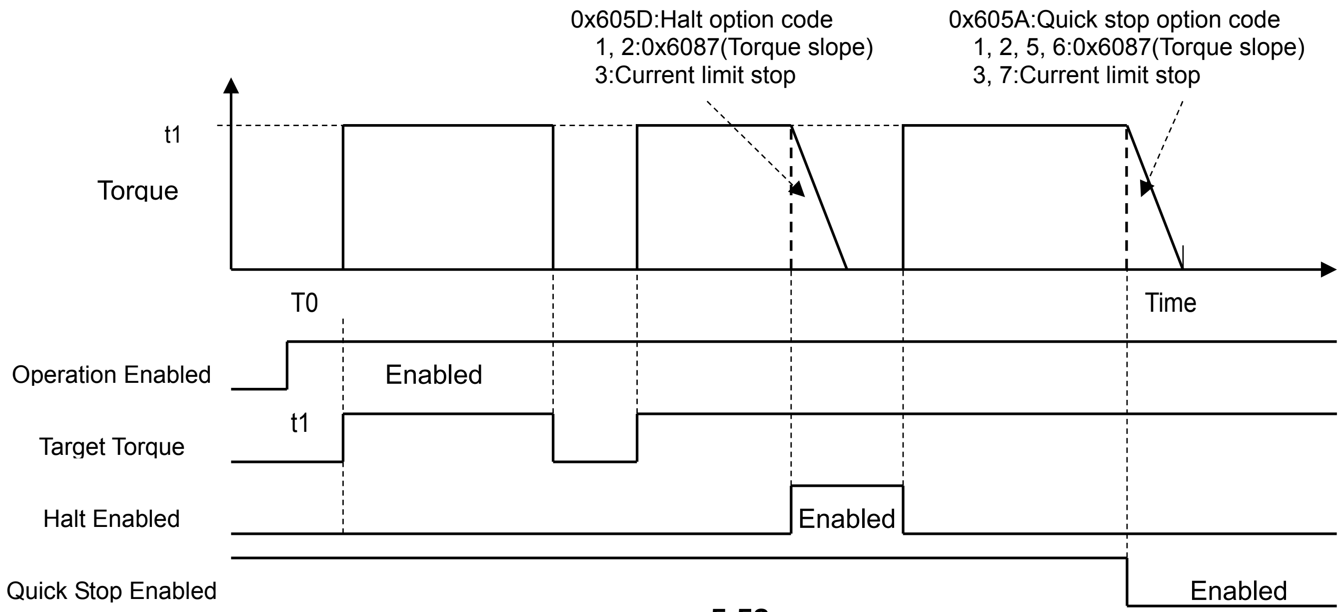
■ Profile torque (force) mode

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.



■ Cyclic Synchronous torque (force) mode

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



5
Operations

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

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

MSB LSB

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

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

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

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

MSB LSB

Csetfix	Csetpro	Res	Drive follows the command	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

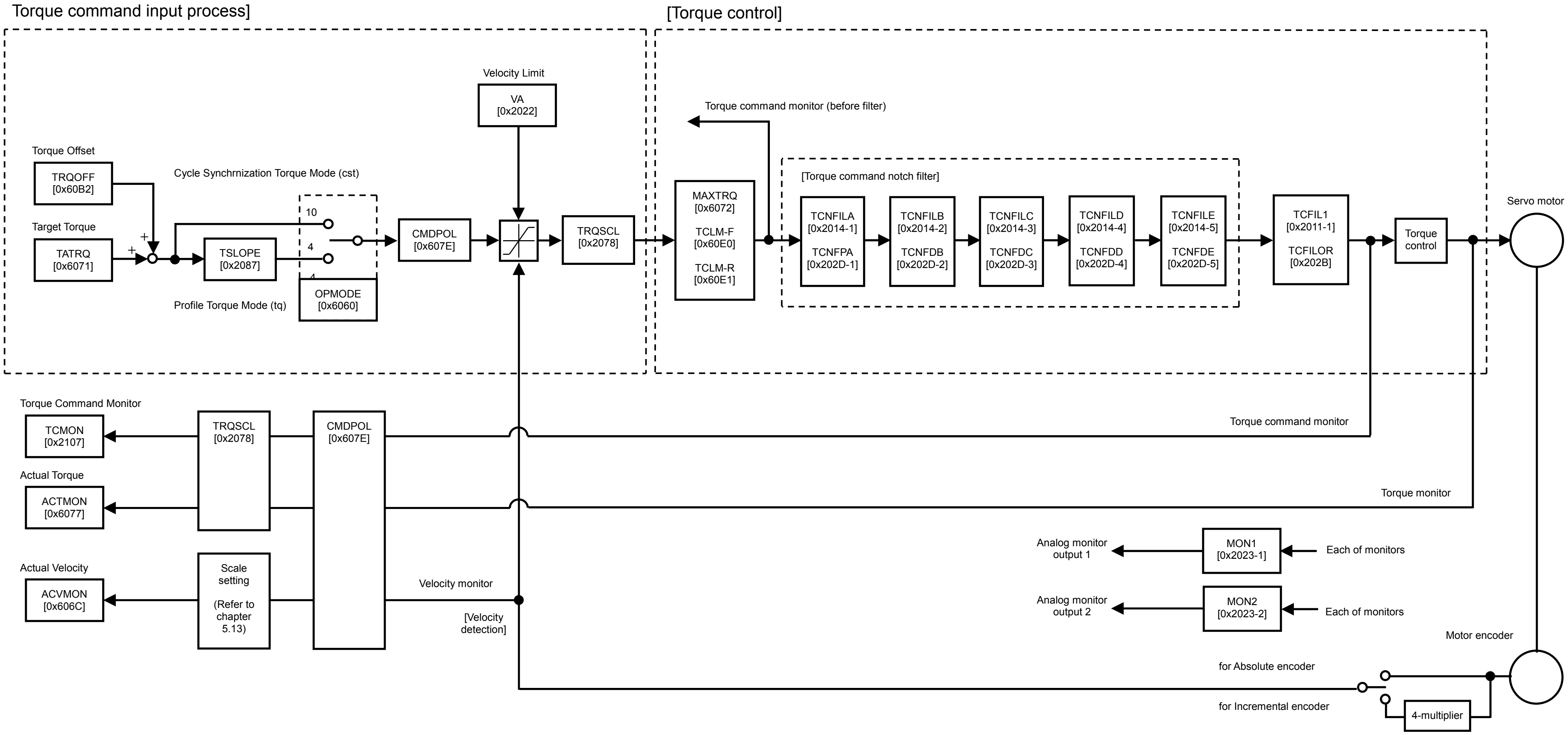
bit7:warning [warning]
0:No warning 1:warning condition

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: While torque limit.

bit12: Command acceptance permitted [Drive follows the command value]
0: Target position ignored.
1: Target torque to be used current control loop input.



Block diagram of function group "torque" mode

5.8.5 Function Group "Homing"

■ Abstract of Function Group "Homing" mode

When the bit is “6” in Homing mode, the slave performs Returning to the origin position in Position mode.

■ Homing mode

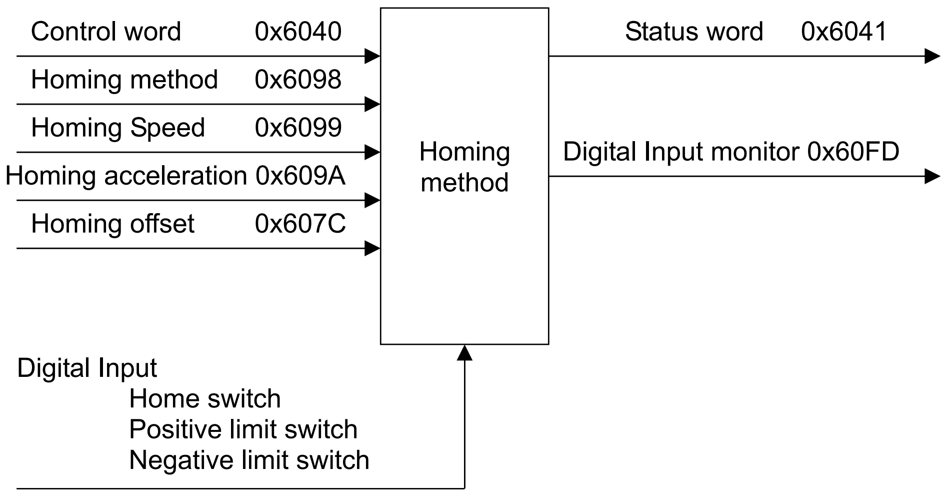
This clause describes the method by which a drive seeks the home position (also called, the datum, reference point or zero point) Input objects are defined as well as the output objects. The user may specify the speed, acceleration and the method of homing. There is a further object home offset, which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

There are two values for homing speed (0x6099): faster speed for home switch searching (Sub-Index1), and slower speed for index pulse searching (Sub-Index2). For the homing speed, set larger value than the speed zero range (0x2020). Homing might not perform correctly if smaller value than the speed zero range is set.

Here is the Objects list in the Homing mode.

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 Homing Methods list. No.-4 to -1 are manufacturer specific homing methods

Homing Method

Method	Homing Mode	Stop direction	Function
-4	Homing on hard stop (Butt) and index pulse in negative direction	positive	Supported
-3	Homing on hard stop (Butt) and index pulse in positive direction	negative	Supported
-2	Homing on hard stop (Butt) in positive direction	negative	Supported
-1	Homing on hard stop (Butt) in negative direction	positive	Supported
0	Undefined homing methods	-	-
1	Homing on negative limit switch and index pulse	positive	Supported
2	Homing on positive limit switch and index pulse	negative	Supported
3	Homing on positive home switch and index pulse	negative	Supported
4	Homing on positive home switch and index pulse	positive	Supported
5	Homing on negative home switch and index pulse	positive	Supported
6	Homing on negative home switch and index pulse	negative	Supported
7	Homing on positive limit switch, homing on positive home switch and index pulse	negative	Supported
8	Homing on positive limit switch, homing on positive home switch and index pulse	positive	Supported
9	Homing on positive limit switch, homing on negative home switch and index pulse	negative	Supported
10	Homing on positive limit switch, homing on negative home switch and index pulse	positive	Supported
11	Homing on negative limit switch, homing on positive home switch and index pulse	positive	Supported
12	Homing on negative limit switch, homing on positive home switch and index pulse	negative	Supported
13	Homing on negative limit switch, homing on negative home switch and index pulse	positive	Supported
14	Homing on negative limit switch, homing on negative home switch and index pulse	negative	Supported
17	Homing on negative limit switch	positive	Supported
18	Homing on positive limit switch	negative	Supported
19	Homing on positive home switch	positive	Supported
20	Homing on positive home switch	negative	Supported
21	Homing on negative home switch	positive	Supported
22	Homing on negative home switch	negative	Supported
23	Homing on positive limit switch and Homing on positive home switch	negative	Supported
24	Homing on positive limit switch and Homing on positive home switch	positive	Supported
25	Homing on positive limit switch and Homing on negative home switch	negative	Supported
26	Homing on positive limit switch and Homing on negative home switch	positive	Supported
27	Homing on negative limit switch and Homing on positive home switch	positive	Supported
28	Homing on negative limit switch and Homing on positive home switch	negative	Supported
29	Homing on negative limit switch and Homing on negative home switch	positive	Supported
30	Homing on negative limit switch and Homing on negative home switch	negative	Supported
33	Homing on the index pulse	negative	Supported
34	Homing on the index pulse	positive	Supported
35	Homing on the current position	-	Supported
37	Homing on the current position	-	Supported
-128 to -5, 15, 16, 31, 32, 36, 38 to 127	Reserved	-	-

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

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

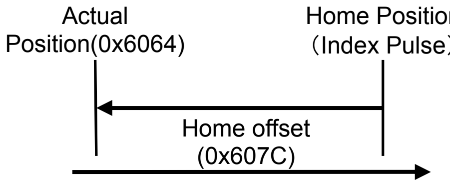
The position actual value (0x6064) is the current software position in the amplifier. It is based on the unprocessed position encoder information (single or multi turn encoder).

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

Settings of actual position calculation method".

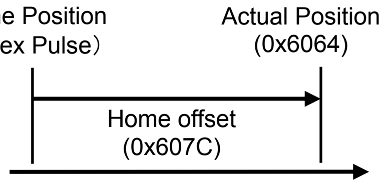
The actual position (0x6064) in home position during homing is as follows:

Actual position calculation method =1



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

Actual position calculation method =0

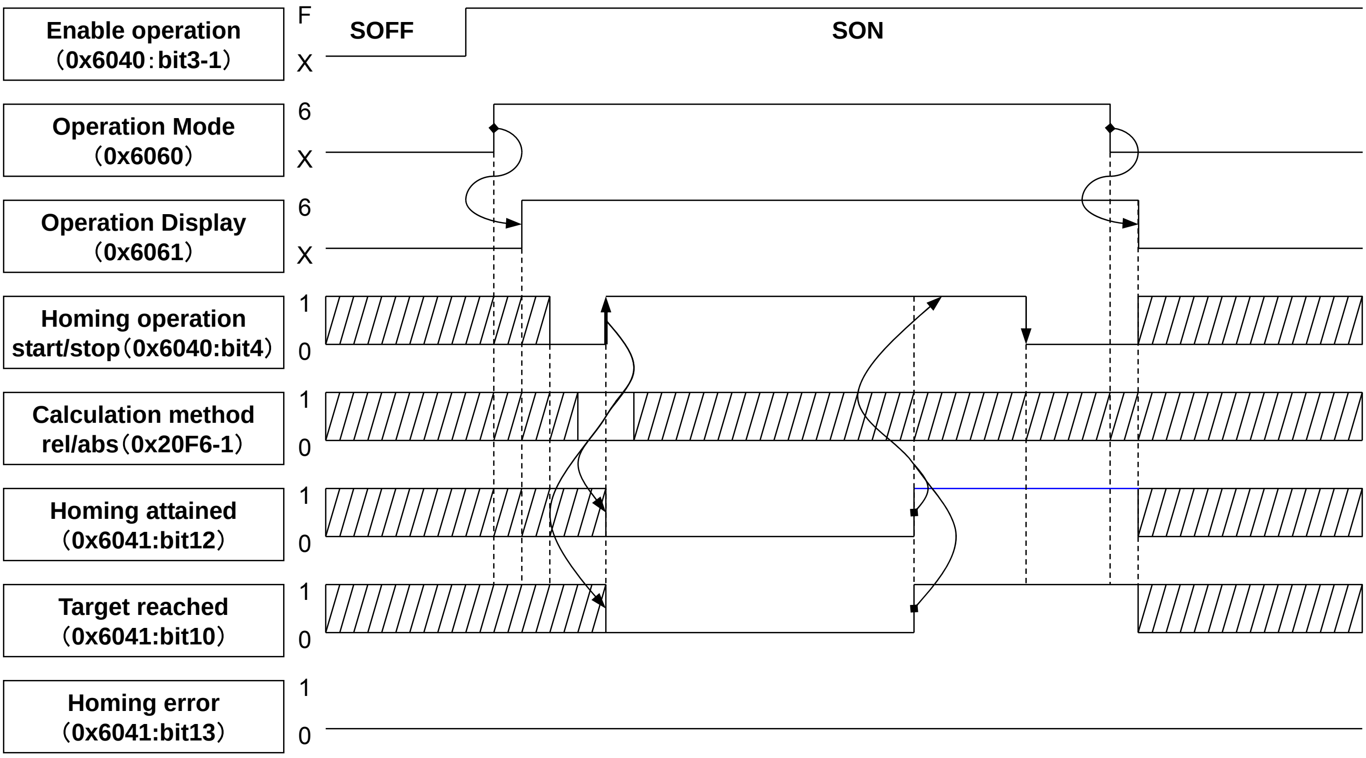


Actual Position(0x6064) = Home Position - Home offset (0x607C)

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

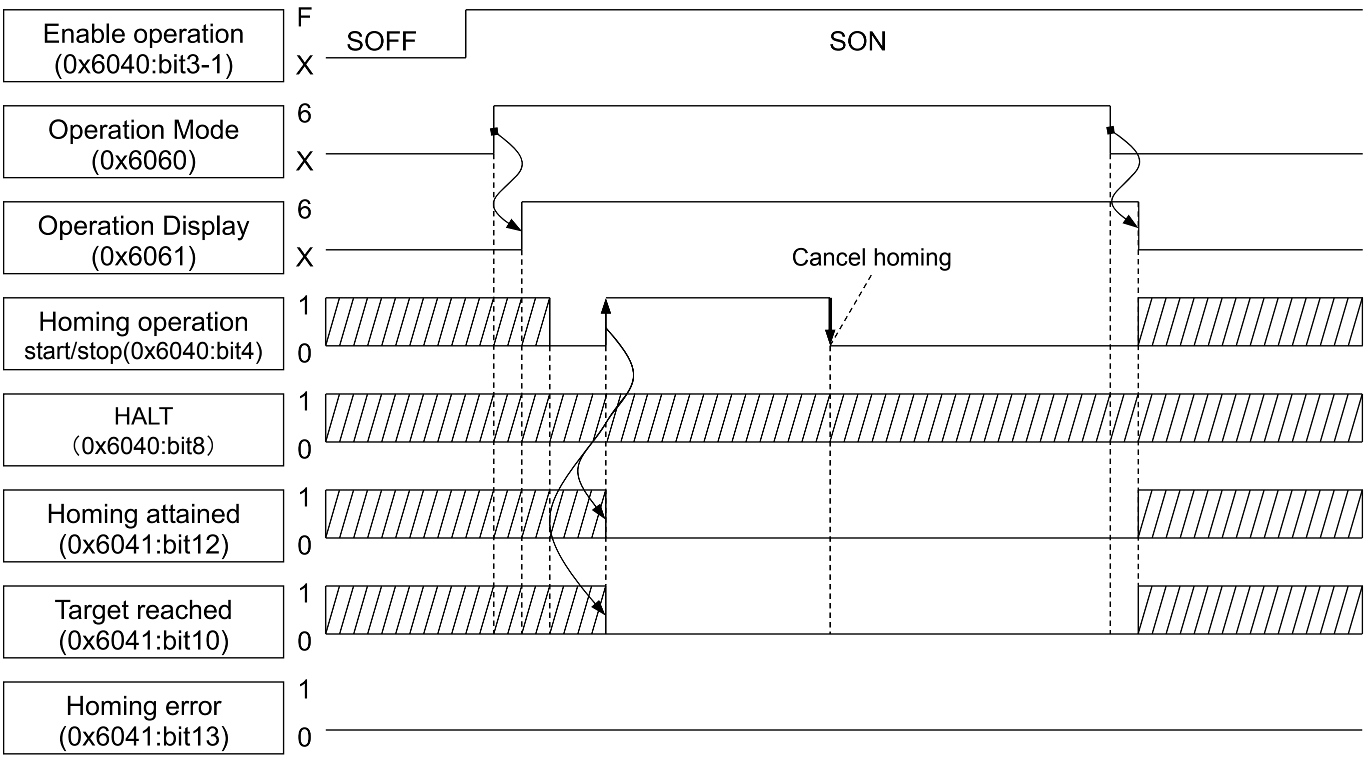
1) Start and completion sequence of homing mode



When second time homing starts while homing mode, previous time homing completion status is keeping. This homing completion status will be cleared by positive edge of second time homing start.

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 direction limit switch (positive OT) and negative direction limit switch (negative OT) are determined by setting of 0x01:Positive limit switch and 0x02:negative limit switch in 0x20F.
And also, the limit switch for the homing direction is determined by the homing method, regardless 0x01: Positive limit switch and 0x02: Negative limit switch in 0x20F8 that were previously loaded and shall be discarded.
However, the limit switch that is in the direction of no use actuates the function that is set in 0x20F8.
2) The home switch in a homing mode is allocated an exclusive use connector CONT1 (Home Switch) automatically.
This is dual input both of general-purpose input and exclusive input. Therefore, when you use Home switch input, set all selection of general-purpose input in 0x20F8 as other than "02:CONT1 ON" and "03:CONT1 OFF".
* If CONT1 is allocated to the other operation, a homing may not work normally.

The definition of home switch setting is fixed as follows:

・Home switch is on: Photocoupler of the amplifier is on, Home switch is off: Photocoupler of the amplifier is off

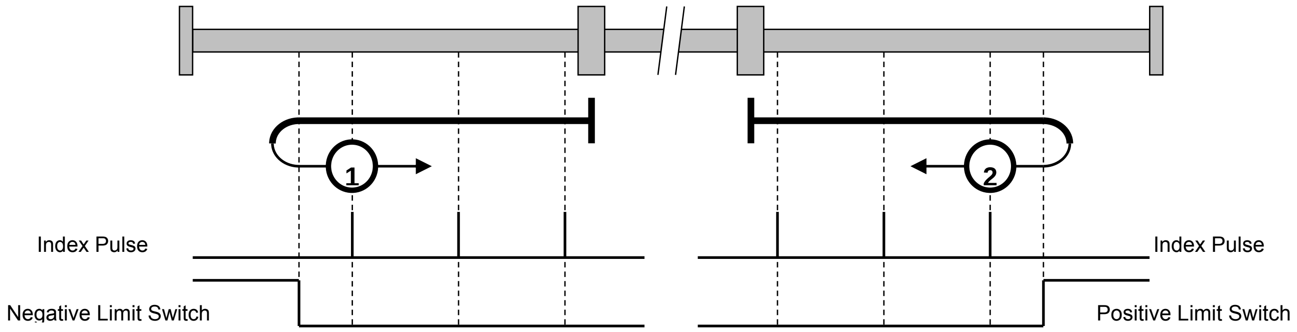
Operation direction of homing method

Move/rotation direction (see from motor shaft end) in each homing drawing depends on 0x607E: Polarity.
Move direction in drawing and motor rotation are shown below.

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

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

Using these method [1] and [2] as shown in the below figure. In the method [1], the initial direction of movement shall be leftward (Negative rotation) if the negative limit switch is inactive. The home position shall be at the first index pulse to the right of the position (Positive side) where the negative limit switch becomes active.
And using the method [2] , the initial direction of movement shall be rightward if the positive limit switch is inactive The position of home shall be at the first index pulse to the left of the position (Negative side) where the positive limit switch becomes inactive.

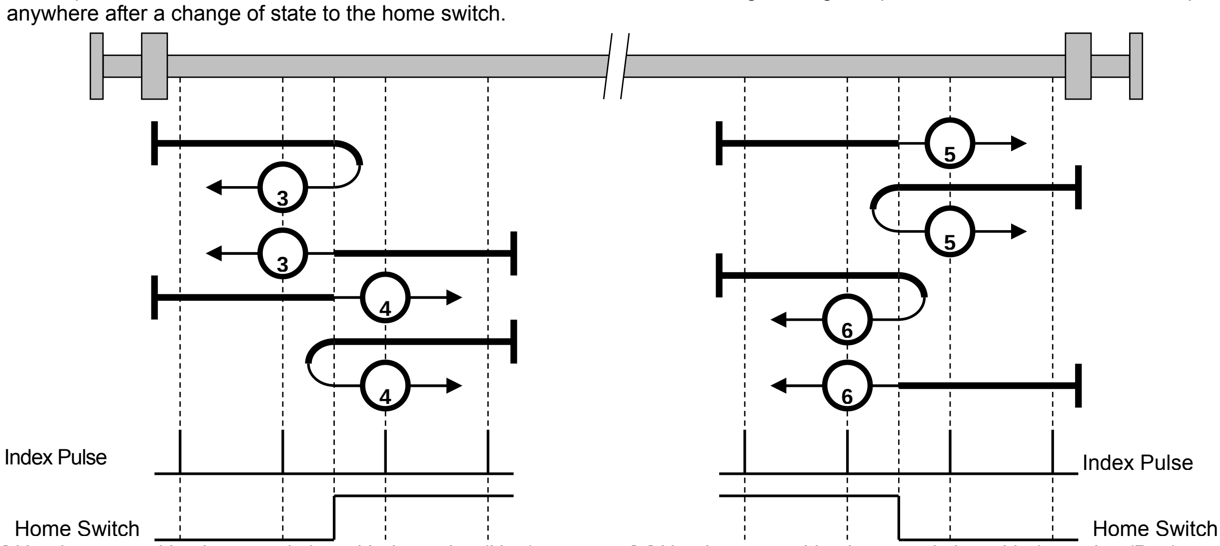


[1]Homing on negative limit switch and index pulse [2] Homing on positive limit switch and index pulse

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

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

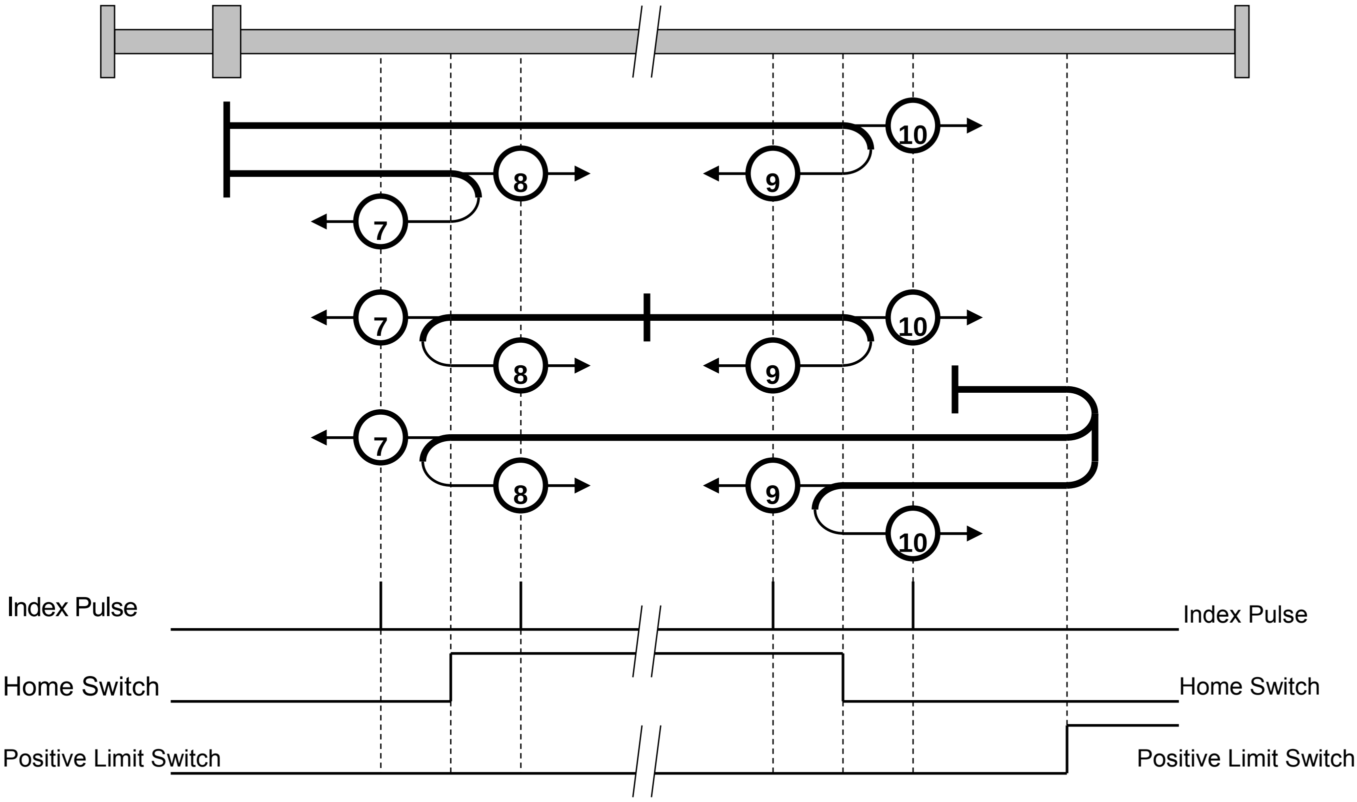
Using these methods as shown in the below figure, the initial direction of movement shall be dependent on the state of the home switch input. In the method [3] and [6], the home position shall be at the left position where the home switch changes state, and in the method [4] and [5], the home position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



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

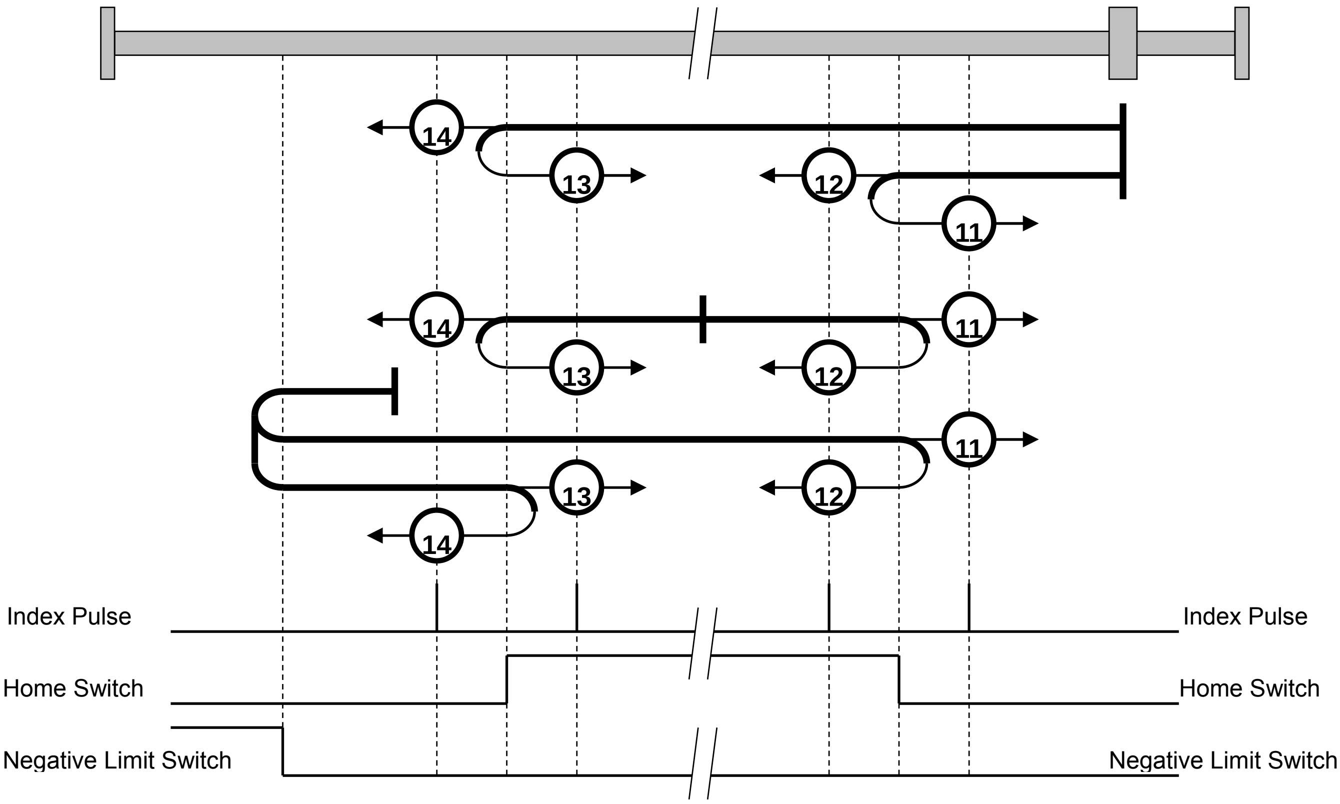
[5] Homing on positive home switch and index pulse (Pos)
[6] Homing on positive home switch and index pulse (Neg)

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



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

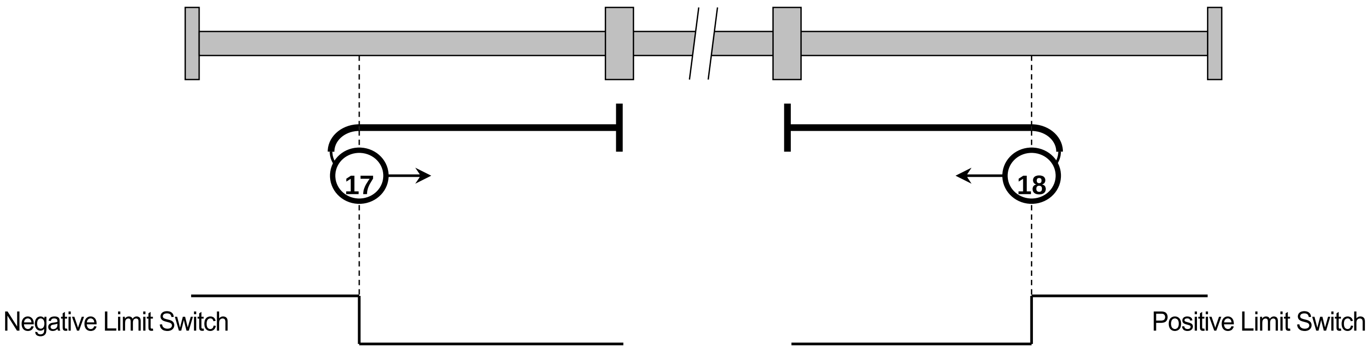
Homing Method [11][12][13][14]: Homing on negative home switch, home switch and index Pulse



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

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

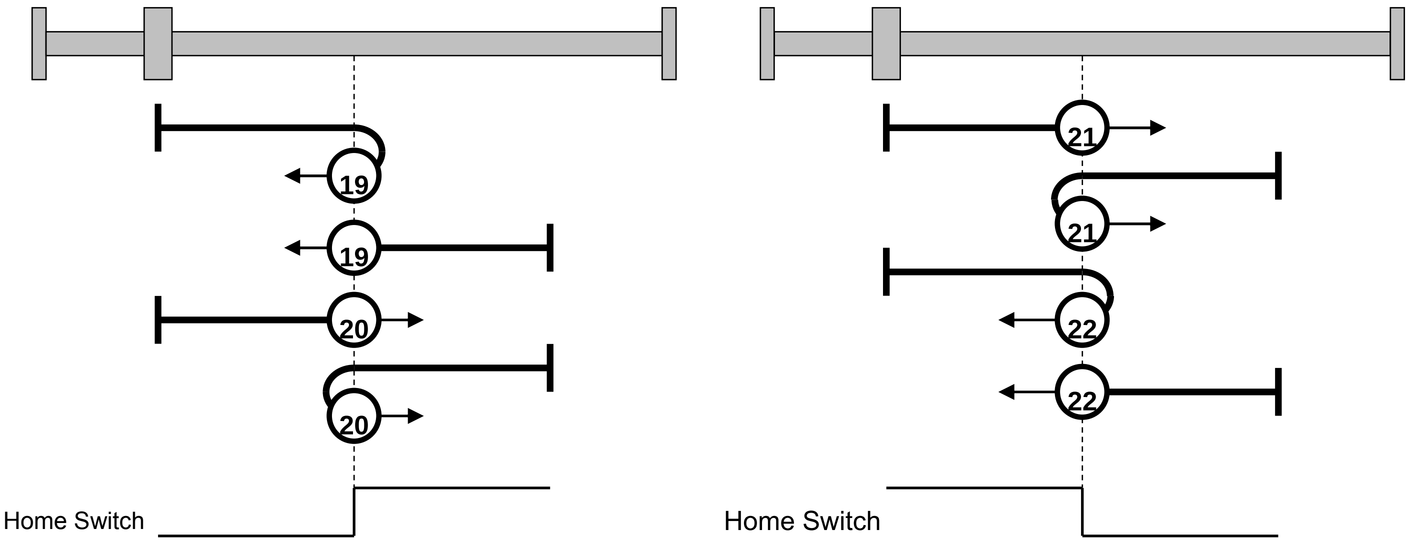
There methods are similar to methods [1] and [2]. Using these method [17] and [18] as shown in the below figure.
In the method [17], the initial direction of movement shall be leftward (Negative rotation) if the negative limit switch is inactive.
The home position shall be at the potision by the negative 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 inactive.



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

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

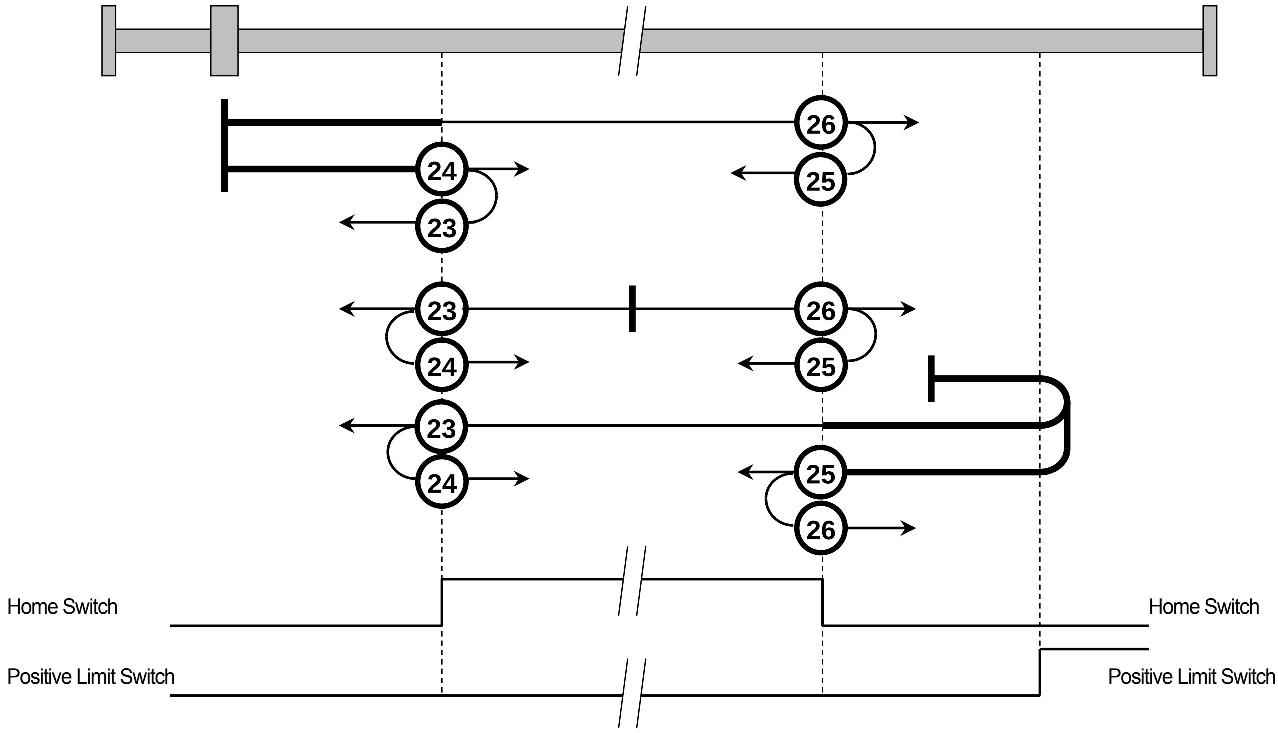
Homing without index pulse
There methods are similar to methods 3 to 6 that the home position is not dependent on the index pulse but only depend on the relevant home or limit switch transitions. The home position is found by the homing switches and Index pulses. Methods 19 to 21 stop by the homing position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



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

Homing Method [23][24][25][26]: Homing on positive home switch and home switch

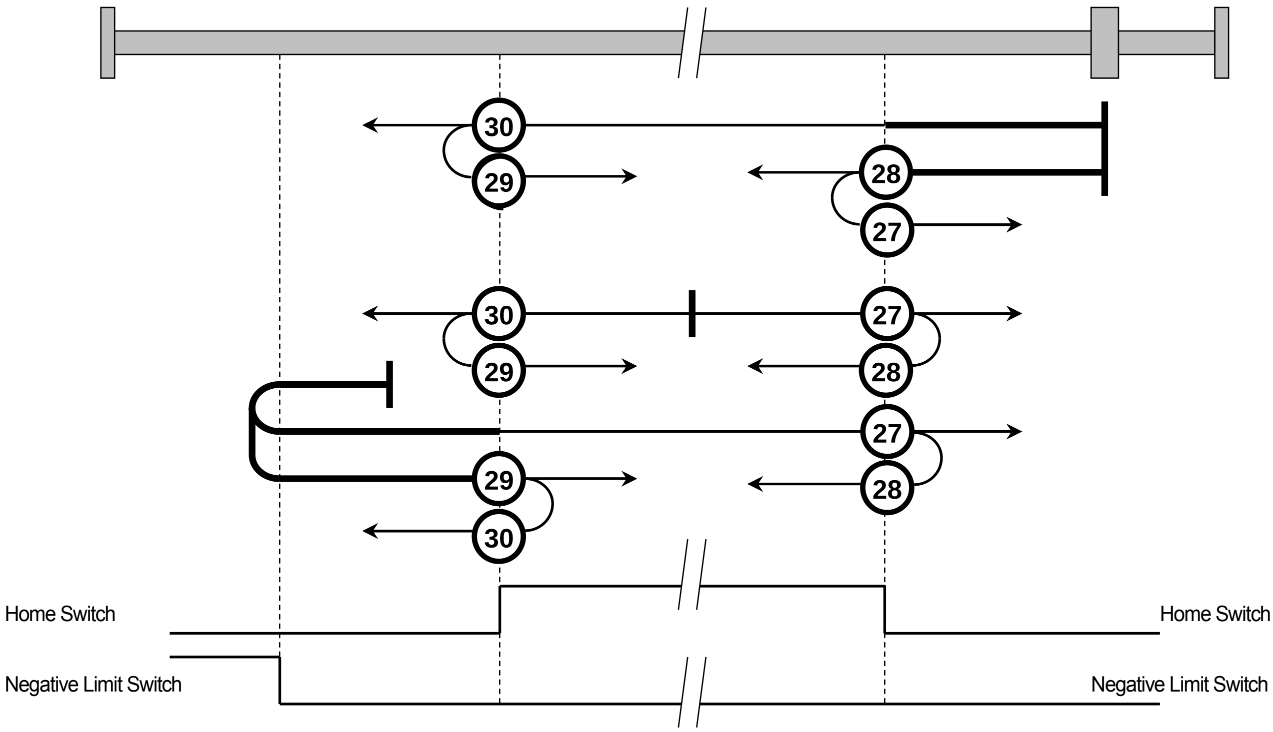
Homing without index pulse
There methods are similar to methods 7 to 10 that the home position is not dependent on the index pulse but only depend on the relevant home switch transitions.
About moving direction depending on home switch state at Homing start/Home switch change, following methods are matching: [7] =[23], [8] =[24], [9] =[25], [10] =[26].



[23] Homing on positive limit switch, homing on positive home switch
[24] Homing on positive limit switch, homing on positive home switch
[25] Homing on positive limit switch, homing on negative home switch
[26] Homing on positive limit switch, homing on negative home switch

Homing Method [27][28][29][30]: Homing on negative home switch, home switch and index Pulse

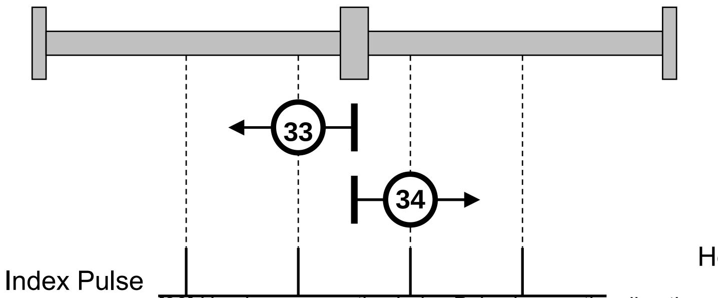
There methods are similar to methods 11 to 14 that the home position is not dependent on the index pulse but only depend on the relevant home switch transitions.
About moving direction depending on home switch state at Homing start/Home switch change, following methods are matching: [11] =[27], [12] =[28], [13] =[29], [14] =[30].



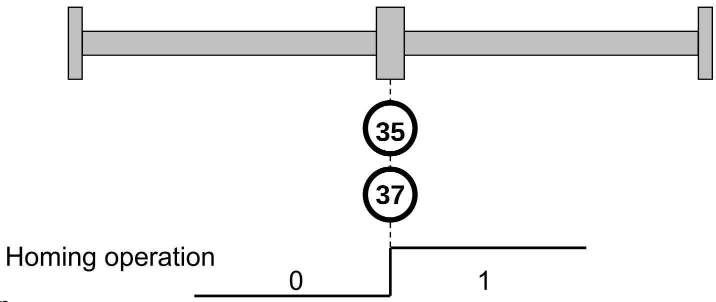
[27] Homing on negative limit switch, homing on negative home switch
[28] Homing on negative limit switch, homing on negative home switch
[29] Homing on negative limit switch, homing on positive home switch
[30] Homing on negative limit switch, homing on positive home switch

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

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



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

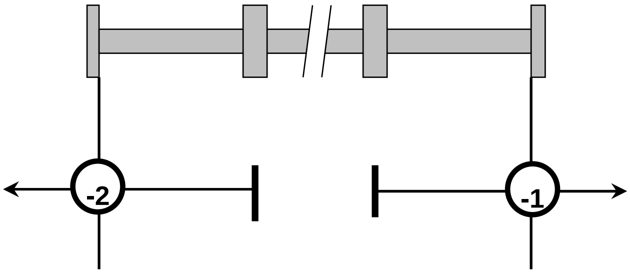


[35][37]Homing on Current position Note)

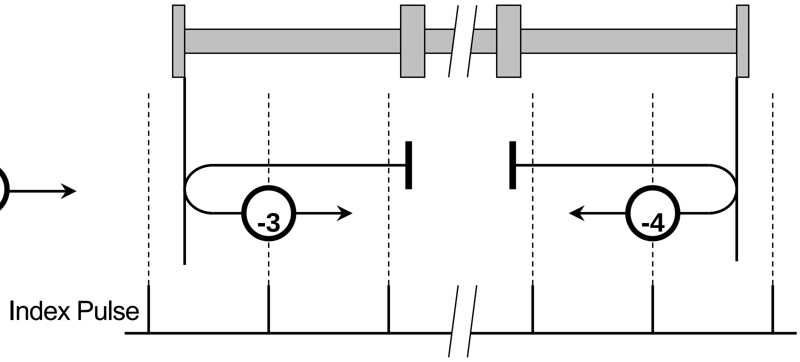
Note) Homing method [35]: Homing on current position is void at CiA402 Work Draft CANopen Drive and motion control device profile part2 Version：3.0.1.13 (26 April 2012)

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



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

Homing procedure (Ex. Homing method 7)

"Procedure for Homing method 7" is shown below:

Step 1 Preparation of homing
Set "Index 0x6098 Homing method" to "7 (0x07)".
Set "Index 0x607C Home offset".
Change "Index 0x6060 Operation mode" to "6: Homing mode".
Set "Index 0x6099-1 Home switch search speed".
Set "Index 0x6099-2 Index pulse search speed".
Set "Index 0x609A Homing acceleration".

Step 2 Homing start
Set "Index 0x6040 Control word, Bit4=1 (0x0010): Homing start".

Step 3 Motor operation
Motor operates due to home switch/limit switch as drawing of Homing method 7.
Motor stops with negative direction index pulse.

Step 4 Confirmation of base position detection
Monitor "Index 0x6041 Status word, Bit12=1: Homing completion".

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

Home position retention function when using absolute system

Execution result of homing in absolute system will be stored automatically after a homing completion.
"OD: 0x6064: Actual position" can retain the origin coordinates even when re-turning on the power next time.
In this regard, however if any encoder clear or battery errors occur, correct origin coordinate shall not be presented, so re-homing is required. Absolute system homing "origin coordinate retention procedure" is shown below:

Step 1 Preparation of homing
Set " Index 0x6098 Homing method" to be used.
Setting of "Index 0x607C Home offset"

Change " Index 0x6060 Operation mode" to "6: Homing mode".

Step 2 Homing start
Set "Index 0x6040 Control word, Bit4＝1 (0x001F): Homing start", after servo ON.

Step 3 Confirmation of reference position detection
Monitor "Index 0x6041 Status word, Bit12＝1: Homing completed".

Step 4 Setting of home offset
Calculate "OD: 0x607C Home offset" value from "OD: 0x210C Home index position", and set.
"Index 0x210C" will be update after control power cycle
Home offset (0x607C) = Origin coordinate after homing completed - Home index (0x210C)

Step 5 Storage of origin coordinate
The origin coordinates which was performed homing is stored automatically.
Do not turn off a control power
at that time.
Wait until it becomes "OD: 0x6041 Status word, Bit12＝1".

Step 6 Homing completion
Exit "Index 0x6040 Control word, Bit4 = 0 (0x0000): Homing," and then change the control mode back to the one using " Index 0x6060 Operation mode".

✔ To update the stored origin coordinate, perform a homing of absolute system again.

0x6040:Control Word (Homing Mode: hm)

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

MSB LSB

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

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

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	0x6041	This object indicates Operation Mode Specific bit and Manufacturer Specific bit in Homing Mode.		Object code		Variable
Sub-Idx	Description		Data Type	Access	PDO	Initial value
0x00	Status Word [STSWORD] *For details on Bit 6, 5, 3, 2, 1 and 0, see the Status Word List Bit Pattern (Bit 6,5,3,2,1,0)		Unsigned16	RO	Possible	0x0000
			Range	0x0000-0xFFFF		

MSB LSB

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

bit4:Voltage Enabled [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: While velocity limit.

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

5.8.6 Function Group "Touch Probe"

■ Abstract of Function Group "Touch Probe" mode

“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”.
These inputs are shared with general input so set all of selections of general input functions in 0x20F8 to except of [02: CONT1ON] [03: CONT1OFF] [04: CONT2ON] [05: CONT2OFF] for use of "Touch Probe function".
The objects used for “Touch Probe” are indicated in the following list.

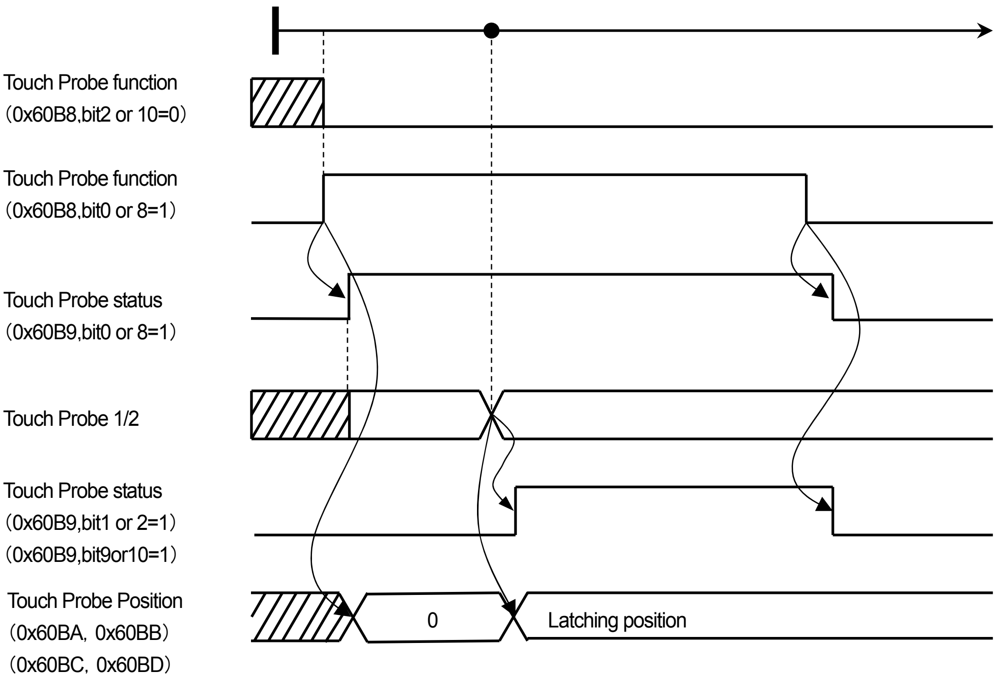
Object Lists of Touch Probe

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 value latched by Touch Probe 1/2 input

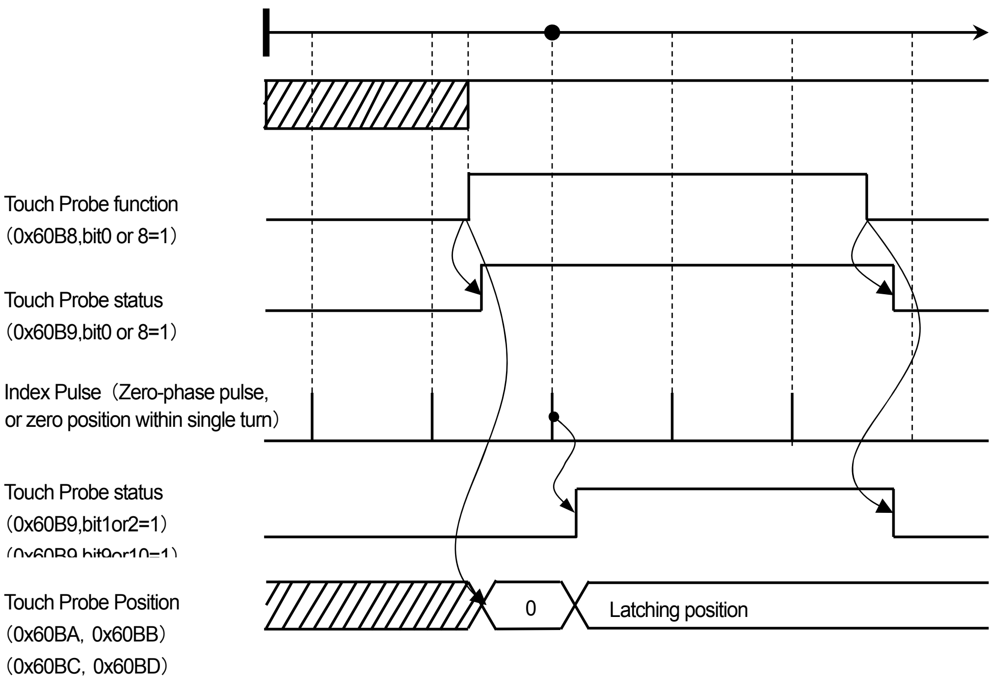


The position value of positive edge latched at Touch Probe 1 (position encoder index pulse) is stored in 0x60BA.
The position value of negative edge latched at Touch Probe 1 (position encoder index pulse) is stored in 0x60BB.
The position value of positive edge latched at Touch Probe 2 (position encoder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

5 Operations

The position value latched by index pulse of position encoder



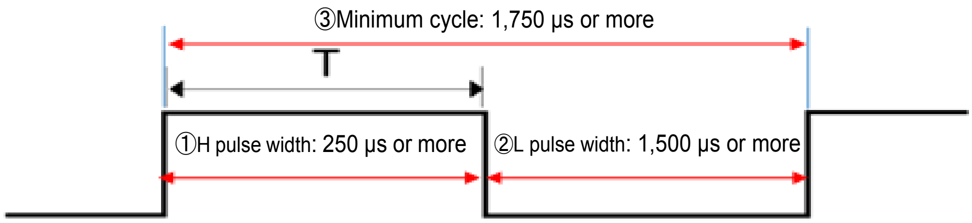
The position value by index pulse latched at Touch Probe 1 is stored in 0x60BA and 0x60BB.
The position value by index pulse latched at Touch Probe 2 is stored in 0x60BC and 0x60BD.

Position latching by touch probe function

■Specifications of touch probe input pulse

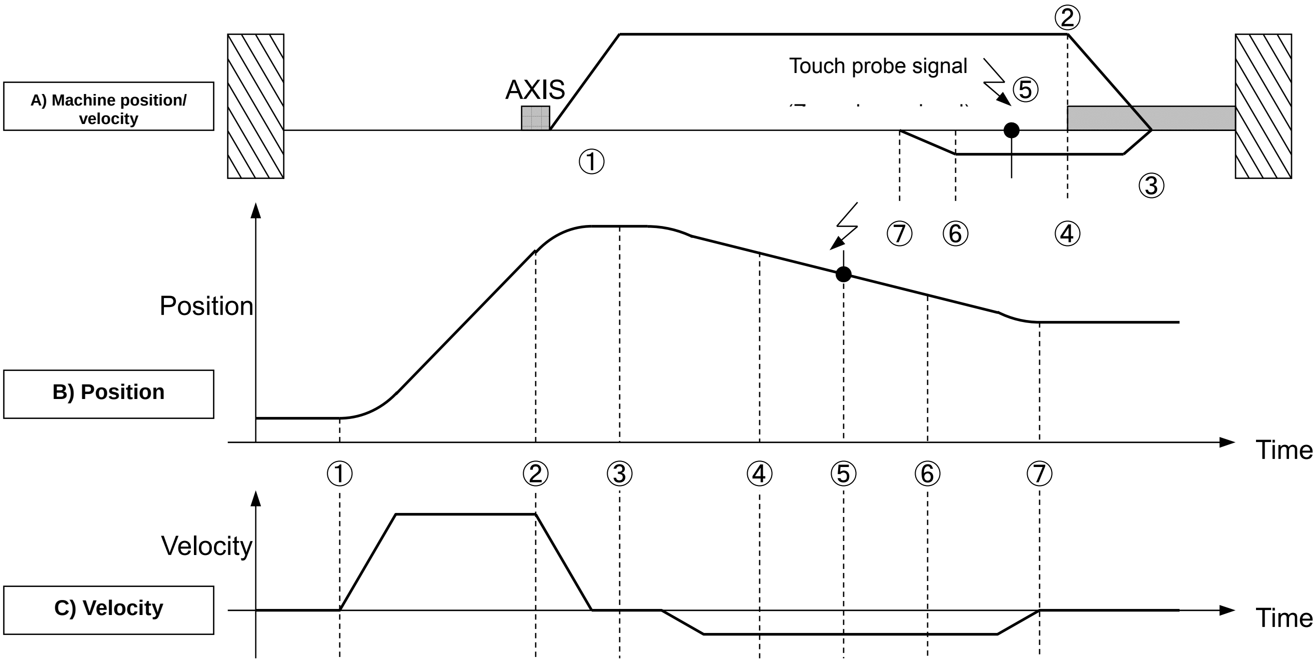
Limitation for touch probe input			Specification	Remarks
Minimum edge interval	H pulse width	①	250 μs or more	Includes turn on response.
	L pulse width	②	1500 μs or more	Includes turn on response.
Minimum cycle		③	1750 μs or more	

Input waveform

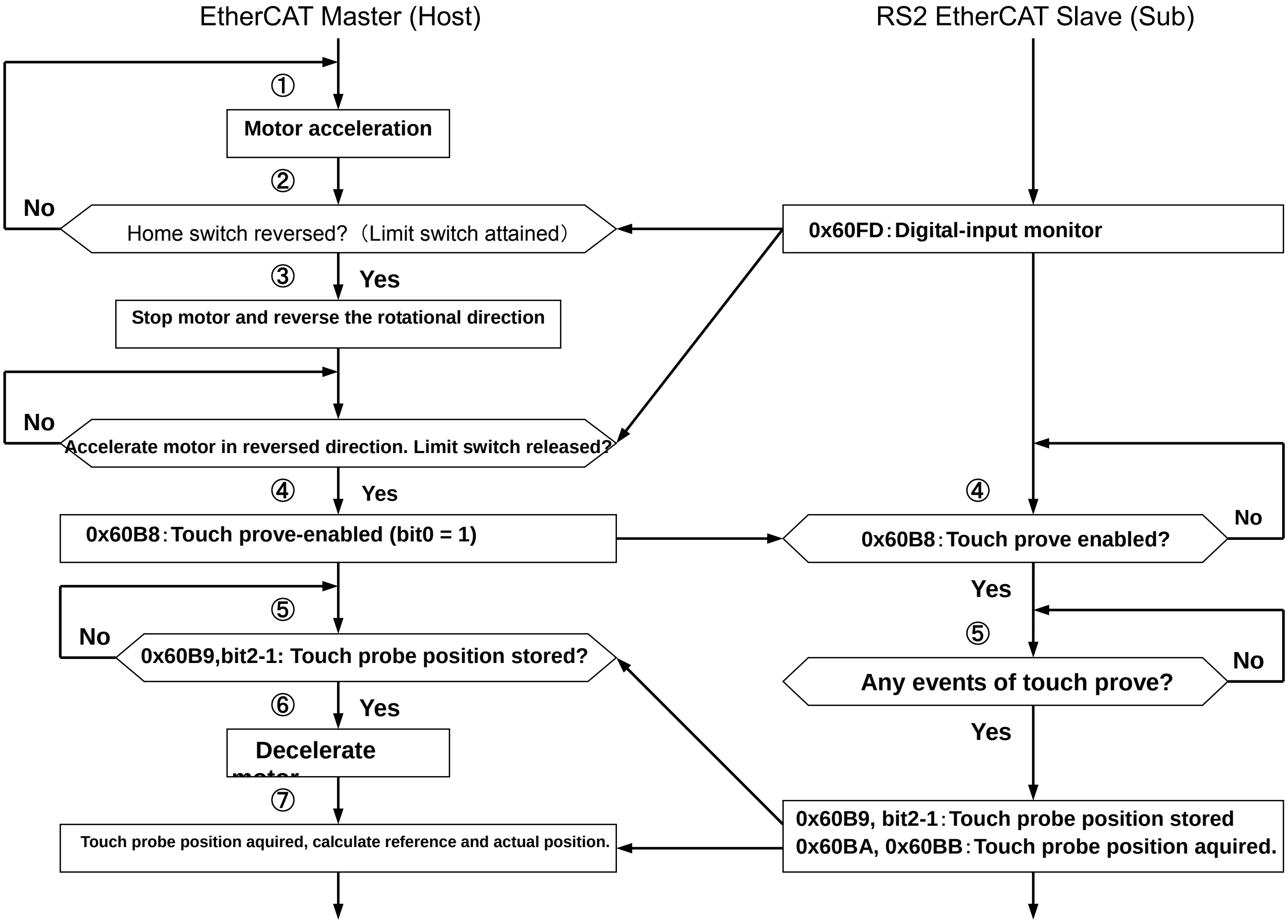


& Master-led homing (Touch probe homing method)：Homing with touch-probe (without Limit Switch)

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

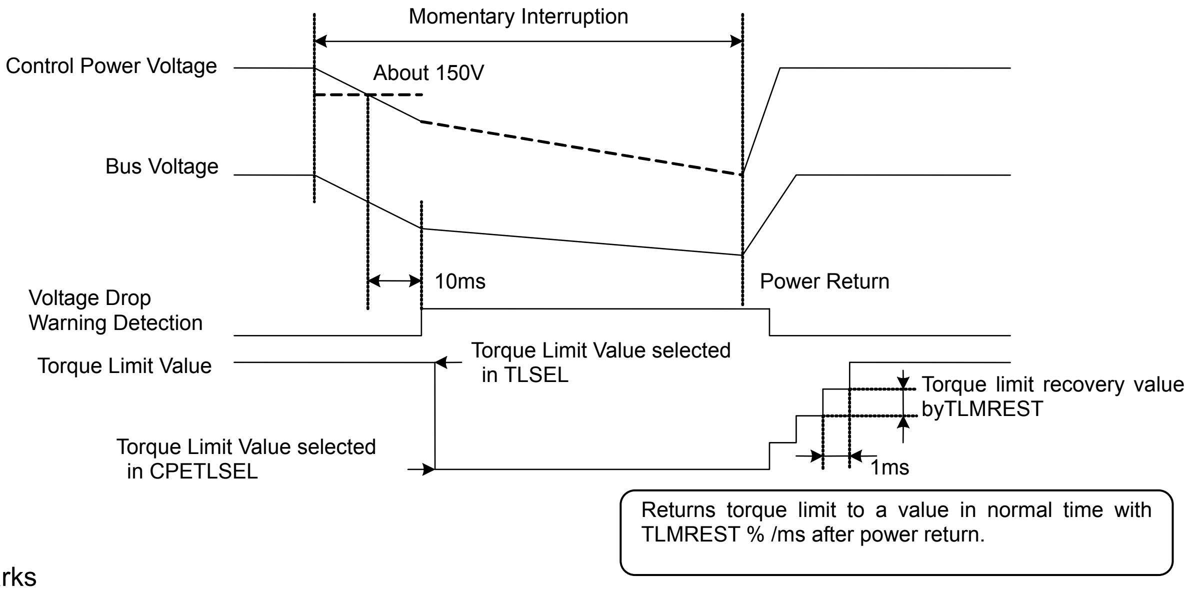
5.9 SEMI F47 Support Functions

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.

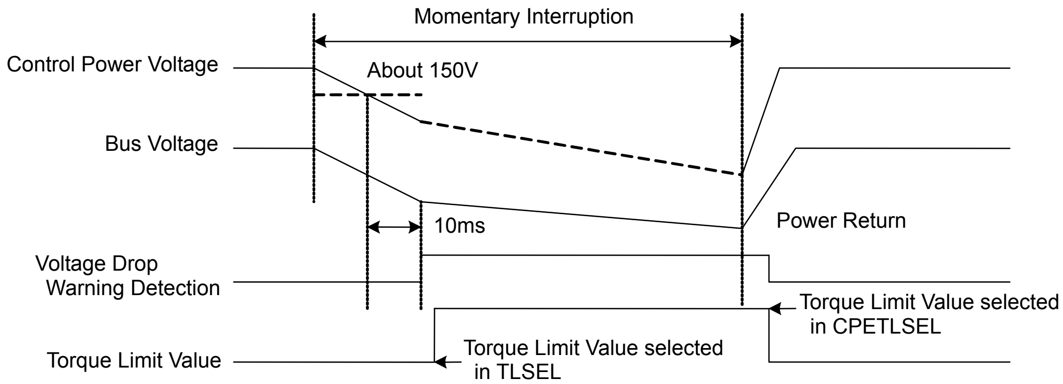
1. Parameters to be set

Index	Symbol	Name	Unit	Setting range
0x20F5	CPETLSEL	Torque limit selection at the time of power drop	-	00 - 01
0x2072	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.

5.10 Virtual motor operation function

This is the function which simulates servo motor behavior and servo amplifier status at internal of the servo amplifier. This function is able to check a sequence with output signal and check a wiring with upper controller, without actual motor operation. Thus, safer and faster start-up of a system is available by this function.
As note, servo motor and encoder connection is not necessary for this function use.

5.10.1 Setting

Sets the system parameter below for this function use.

<table>
<tr><th>ID</th><th>Contents</th></tr>
<tr><td rowspan="2">02</td><td>Operation mode selection</td></tr>
<tr><td>
■ Selects the operation mode.
<table>
<tr><th colspan="2">Selection</th><th>Contents</th></tr>
<tr><td>00</td><td>Normal</td><td>Normal operation mode</td></tr>
<tr><td>01</td><td>Virtual1</td><td>Virtual operation mode (virtual P_ON valid)</td></tr>
<tr><td>02</td><td>Virtual2</td><td>Virtual operation mode (virtual P_ON invalid)</td></tr>
</table>
✔ “Power cycle for control after setting”
■ Operation mode action
◆ 01：Virtual1 Virtual operation mode (virtual P_ON valid)
In this mode, servo motor operation can simulate by control power supply only.
Automatically change state to main power ON, after control power supplied.
◆ 02：Virtual2 Virtual operation mode (virtual P_ON invalid)
In this mode, servo motor operation can simulate after main circuit power supplied.
Main circuit power supply is necessary, after control power supplied.
</td></tr>
</table>

5.10.2 Restrictions

There are restrictions below for this function.

■ Load model for virtual motor operation is rigid body sysytem by load inertia moment.

Item	Conditions
Load torque	0 [N･m]
Load inertia moment	Load inertia moment ratio × Servo motor inertia moment
Mechanical stiffness	Rigid body

✔ Load inertia moment ratio is used from Group1 ID14.
The value set by the parameter below is used depending on gain switching condition if gain switching function is used.

Selection	Used Load inertia moment ratio		
	Group	ID	Name
1	1	14	Load inertia moment ratio 1
2	4	05	Load inertia moment ratio 2
3	4	15	Load inertia moment ratio 3
4	4	25	Load inertia moment ratio 4

■ Encoder position data does not backuped. Position data is zero when power is on.

■ Multi-turn part of encoder position data does not clear even if encoder clear function is executed.

■ Detection of alarm and warning for encoder does not work.

■ In use of pulse encoder, output pulse resolution will be 8192 [P/R] regardless of the encoder resolution setting.
Dividing is available for this resolution by the setting of GroupC ID04 Encoder Output Pulse Division.

■ U-phase electric angle monitor might show wrong value if pulse encoder is used.

■ Position, velocity and torque of servo motor is simulated to response of control system against virtual motor operation load model.

■ Action of servo motor and load model is stop at servo OFF. Free-run operation at servo OFF can not simulate.

■ When "01: Virtual" is set to Operation mode selection, main circuit power is supplied virtually, and regard as supplying rated power. As note, Alarm and regenerative operation for main power can not simulate.

■ Dynamic brake does not work. Stop operation by servo OFF or dynamic brake of emergency stop can not simulate. However, the signal of While Dynamic Braking is output from general purpose output.

■ When external encoder is serial encoder (EnDat), it works as angle encoder (resolution 28bit).

5.10.3 Digital operator display

Digital operator display will change during virtual motor operation.

Display	Description
	Alphabet "t" shows at second LED from right, during virtual motor operation. The other LEDs show same as normal status display. In case except status display mode, also the same as normal.

5.10.4 Operating precautions

- ■ Holding-brake release signal outputs same as normal operation even if virtual motor operation is executed. At vertical axis use, avoid holding-brake release as follows: Cancel the allocation of holding-brake release signal for general output. Shut off the holding-brake power. etc.

5.11 File transferring function

In EtherCAT, servo amplifier firmware/parameter update is available using FoE mailbox protocol. Also, it is able to upload a parameter backup value stored in amplifier with the parameter file format of setup software.

5.11.1 Self-programing function

The function updating servo amplifier firmware from controller. Download a program file, SANYO DENKI providing, into amplifier via controller. Amplifier updates firmware by self-programing using downloaded program.

■ Preparation

Store a firmware file for update into controller.
Set a timeout of mailbox as below. (Our ESI file setting.)
Returning Request: 2000ms
Response: 20000ms

■ Sequence

1. Download a firmware file for update into amplifier, according to communication sequence (in the section 5.3.4).
2. Firmware rewriting starts after download completion with ESM transition to INIT from BOOT.
3. "LOAD" is indicated to the digital operator display while rewriting firmware.
4. "END" is indicated after rewriting completion, then servo amplifier restarts.

■ Restrictions and precautions

- ✔ Do not shutdown a control power while rewriting firmware. It may cause of program update failure.
- ✔ EtherCAT communication is not available while rewriting firmware. (Link shutdown)
- ✔ Perform control power cycle after firmware rewriting completion. It may not be able to start operation soon due to safety module or combined encoder.
- ✔ Add extension (.hex or .efw), for acknowledge. Filename is up to 25 characters including extension.
- ✔ Contact us for password at downloading.
- ✔ Data processing time in amplifier is required, so keep communication cycle of FoE mailbox communication 15 to 20ms. (Downloading time depends on communication cycle with upper device.)
- ✔ Firmware rewriting requires 1 minute around.

5.11.2 Parameter download function

The function updating servo amplifier parameter from controller. Download a parameter file, generated by setup software (ap1) or amplifier, into amplifier via controller, and set a parameter of servo amplifier.

■ Preparation

Store a parameter file for setting into controller.

■ Sequence

1. Download a parameter file for setting into amplifier, according to communication sequence (in the section 5.3.4).
2. Performs matching check after download completion, and save a downloaded parameter if there is no problem.
3. "Parameter update completion" alarm is issued after parameter saving. Turn control power off and on again to restart a servo amplifier.

■ Restrictions and precautions

✔ Do not shutdown a control power while saving parameter. It may cause of parameter setting failure.
✔ Perform download function again when a control power was shut off while saving parameter.
✔ Mailbox size shall be set to 512byte for use.
✔ Axis name of amplifier parameter file is up to 64 characters. (1 character with 2 byte)
✔ This function updates all parameter area. (System/Motor/General parameters)
✔ Add extension (.ap1), for acknowledge. Filename is up to 25 characters including extension.
✔ Password input is not required at downloading.

5.11.3 Parameter upload function

The function reading out the parameter set value stored in amplifier, with the parameter file format of setup software. Readout parameter can check or edit by the setup software. Also, readout parameter can download to another amplifier.

■ Preparation
Generate an upload file by performing EtherCAT object, parameter save (0x1010).

■ Sequence
1. Get a stored file size, from the object: Backup file information (0x2138).
2. Set "0x00: AP1 file" to FoE Uploading File Selection (0x207B).
3. Upload a parameter file for setting into amplifier, according to communication sequence (in the section 5.3.4).
4. Confirm match with file size in the backup file information and a data size calculation of the file received via controller.

■ Restrictions and precautions

✔ Parameter file to be uploaded is the parameters when parameter save (0x1010) is performed. It is required that performing parameter save (0x1010) again if parameter is changed.
✔ Generated file size will be 220 kbytes around.
✔ Generated file is simplified format so it does not cover all functions in the setup software.

5.11.4 Drive recorder data upload function

The function reading out the drive recorder data stored in amplifier with the file format displayable in the setup software. Readout drive recorder data file can view with the setup software.

■ Preparation
Set desired monitor data/trigger to EtherCAT object, drive recorder parameter (0x2070), and get a drive recorder data by issuing trigger condition.

■ Sequence
1. Set "0x01: Drive recorder file" to FoE Uploading File Selection (0x207B).
2. Upload a parameter file for setting into amplifier, according to communication sequence (in the section 5.3.4).
3. Confirm match with file size in the drive recorder data in 0x2139-0x02 and a data size calculation of the file received via controller.

■ Restrictions and precautions

✔ Drive recorder data file to be uploaded has data due to 16 times trigger condition. To clear a drive recorder, perform the object: Drive recorder clear (0x2073).
✔ Generated file size will be 193 kbytes around.
✔ Refer separate manual M0010842 for detail of drive recorder.

5.11.5 System analysis data upload function

The function performing system analysis through communication (just performed in the setup software, in the past) and reading out the drive recorder data stored in amplifier with the file format displayable in the setup software. Readout system analysis data file can view with the setup software.

■ Preparation
Generate a system analysis file by performing EtherCAT object, System analysis data measurement (0x2054).

■ Sequence
1. Get a stored file size, from the object: System analysis file size (0x2139-0x03).
2. Set "0x02: System analysis file" to FoE Uploading File Selection (0x207B).
3. Upload a data file for setting into amplifier, according to communication sequence (in the section 5.3.4).
4. Confirm match with file size in the drive recorder data in 0x2139-0x03 and a data size calculation of the file received via controller.

■ Restrictions and precautions

✔ System analysis data file to be uploaded has parameters at the time performing a system analysis data measurement (0x2054). Data will be overwrite if drive recoder or trace function is performed so perform data upload soon after running a system analysis data measurement (0x2054).

✔ Generated file size will be 13 kbytes around.
Read separate manual M0010842 for detail of system analysis.

5.12 High speed sampling mode

It becomes that communication cycle 62.5 μs is able to use if control cycle is set as high speed sampling mode.

5.12.1 Setting

For use of this function, system parameter below shall be set.

<table>
<tr><th>ID</th><th>Description</th></tr>
<tr><td rowspan="2">00</td><td>Control cycle</td></tr>
<tr><td>■ Selects a control cycle of velocity control or torque (force) control.
<table><tr><th colspan="2">Selection</th><th>Description</th></tr><tr><td>00</td><td>Standard_Sampling</td><td>Standard sampling mode</td></tr><tr><td>01</td><td>High-freq_Sampling</td><td>High speed sampling mode</td></tr></table>
✔ Perform control power cycle after setting.</td></tr>
</table>

5.12.2 Dedicated function in high speed sampling mode

62.5 μs of communication cycle becomes available when high speed sampling mode is selected.

- ■ Applicable communication cycle is 62.5 μs only.
- ■ Object number allowing PDO mapping is 10 maximum.
- ■ Operation mode applies cyclic sync velocity mode (CSV) or cyclic sync torque (force) mode (CST) only.
- ■ The objects updating with 62.5 μs communication cycle are listed below.
  The other objects are update with 125 μs even if PDO mapping is performed.

List of objects updating with 62.5 μs communication cycle				
Index	S-Idx	Name	Data Type	Unit
0x60FF	0x00	Target velocity	Integer32	Pulse/s
0x6071	0x00	Target torque (force)	Integer16	0.1 %
0x6064	0x00	Actual position	Integer32	Pulse
0x606C	0x00	Actual velocity	Integer32	Pulse/s
0x6077	0x00	Actual torque (force) value	Integer16	0.1 %

5.12.3 Restrictions

There are restrictions for functions below, when high speed sampling mode is selected.

- This function is not able to use with servo amplifier with functional safety module.
- This function is not able to use with position control.
- Parameters of restricted functions shall be selected as below.

Parameter set values of restricted functions					
Disabled function	Index	Group	ID	Name	Set value
Model following (vibration suppression) control	0x20F3-0x01	System	07	Position control selection	0x00 : Standard
Full-closed control	0x20F3-0x02	System	20	Position loop control encoder selection	0x00 : Motor_Enc
Scale	0x6091-0x01	System	43	Motor shaft resolution	1
	0x6091-0x02	System	44	Drive shaft resolution	1
	0x6092-0x01	System	45	Feed (Travel Distance)	1

5.13 Scale function

For use of scale function, it shall be decided a scale coefficient of unit conversion.
Scale coefficient is set by a scale related parameter in system parameter.
(→ 5.13.1 Scale setting)
After scale coefficient decision, set a parameter value set by this unit.
(→ 5.13.2 Parameters affected by scale setting)

5.13.1 Scale setting

For use of this function, parameter below shall be set.

Index	Sub-index	Name	Description
0x60A8	0x00	SI unit system for position	Sets a unit of position system. In this amplifier, fixed to zero.
0x6091	0x01	Motor Shaft Resolution	Sets the rotation speed of motor axis.
0x6091	0x02	Drive Shaft Resolution	Sets the rotation speed of output axis.
0x6092	0x01	Feed (Travel Distance)	Sets the travel distance in one rotation of the motor axis.
-	-	Position loop encoder resolution	Indicates a pulse number per rotation in encoder for position loop. This is calculated by the value set at 0x20FF-0x01. In use of incremental encoder: It becomes 4-multiplied value of selected resolution. In use of absolute encoder: It becomes a value of selected FMT.

5.13.2 Parameters affected by scale setting

Index	Sub-index	Name
0x6065	0x00	Position Deviation Window (Position Deviation Counter Overflow Value)
0x6067	0x00	Position Window (Positioning completion range)
0x607A	0x00	Target Position
0x607B	0x01 0x02	Position range limit minimum value Position range limit maximum value
0x607C	0x00	Home offset
0x607D	0x01 0x02	Software position limit minimum value Software position limit maximum value
0x607F	0x00	Maximum Profile Velocity
0x6081	0x00	Profile Velocity
0x6083	0x00	Profile Acceleration
0x6084	0x00	Profile Deceleration
0x6085	0x00	Quick Stop Deceleration
0x6099	0x01	Home Switch Searching Velocity
0x6099	0x02	Zero Phase Searching Velocity
0x609A	0x00	Homing acceleration and deceleration
0x60B0	0x00	Position Offset
0x60B1	0x00	Velocity Offset (Velocity Compensation Value)
0x60C1	0x01	Interpolation position command value
0x60C5	0x00	Maximum acceleration
0x60C6	0x00	Maximum deceleration
0x60FF	0x00	Target Velocity
0x203C	0x00	Software Limit Deceleration
0x5083	0x01 to n	Correction Position 1 to Correction Position n
0x5084	0x01 to n	Offset 1 to Offset n
0x5091	0x00	Backlash Correction Value
0x20F6	0x04	Position Deviation Excess Value for Hard Stop

5.13.3 Monitors affected by scale setting

Index	Sub-index	Name
0x6062	0x00	Position Demand Value
0x6064	0x00	Actual Position
0x6069	0x00	Actual Velocity Sensor Value
0x606C	0x00	Actual Velocity Value
0x60F4	0x00	Actual Position Deviation
0x2110	0x01 to 0x07	Control Cycle Actual Position
0x2111	0x01 to 0x07	Control Cycle Actual Velocity
0x2116	0x00	Actual Velocity Value 2
0x2117	0x00	Actual Position Value 2

5.13.4 Scale conversion coefficient

Scale conversion coefficient is calculated with equation below.

(1) Scale conversion command coefficient

It is used to a command or parameter provided by upper device.

$$\text{Scale conversion command coefficient} = \frac{\text{Motor shaft resolution x Position loop encoder resolution}}{\text{Drive shaft resolution x Feed}}$$

(2) Scale conversion monitor coefficient

It is used to a monitor value responded with amplifier.

$$\text{Scale conversion monitor coefficient} = \frac{\text{Drive shaft resolution x Feed}}{\text{Motor shaft resolution x Position loop encoder resolution}}$$

5.13.5 Restrictions

There are restrictions below for scale function.

- It is not able to use with communication cycle 62.5 μs or 125 μs.
- It is not able to use with touch probe function.

5.14 Extended function selection

SANMOTION R 3E Model EtherCAT servo amplifier has Extended function selection.

5.14.1 Deceleration stop function with velocity control mode in torque control mode

Index	Sub-Index	Description
0x2079	0x01	Sets valid/invalid of deceleration stop special function in torque control mode. 0x01 (Function valid), 0x00 (Function invalid) Deceleration stop method in quick stop will be changed if function is valid.
0x2079	0x02	Selects stop condition at communication alarm when deceleration stop special function in torque control mode is valid. 0x01 (Function valid): Stops after switching in to velocity mode. 0x00 (Function invalid): Stop condition will be according to abort option code.

5.14.2 Function abstract

Functions below are worked when torque profile mode or cyclic sync torque mode is selected with operation mode (0x6060) and function valid is selected with extended function selection (0x2079-0x01).

(1) Condition performing deceleration stop after switching in to velocity mode from torque mode

Condition	Description	Remarks
Communication cause	Performs deceleration stop if quick stop is input via communication. (Quick stop is decided if bit2 of control word is zero.)	It stops with setting of profile deceleration regardless of another setting of option code for deceleration stop, when this function is selected.
	Deceleration stop is performed due to communication cause if special function selection (0x2079-0x02) is valid.	
Amplifier cause	Performs deceleration stop when servo amplifier detects cause of emergency stop (EMR). Deceleration stop method differs due to cause. Refer ① to ④ below.	
	① In case that EMR is assigned to general input and EMR request is occurred.	
	② In case that main circuit is shut down. (Power off)	This function does not work because gate will be shut down by hardware.
	③ Emergency stop (EMR) due to STO input.	
	④ Alarm cause	Depends on operation of alarm detection. In case of SB (servo brake stop): Deceleration stop is performed with this function. In case of DB (dynamic brake stop): This function does not work. It will be stop operation with dynamic brake.

(2) Operation if deceleration stop condition occurred

If deceleration stop condition occurred, actual operation motor speed will be decided to velocity command.

Based on that speed, deceleration stop is started with set profile deceleration.

5.14.3 Deceleration stop special function in position control mode

Index	Sub-Index	Description
0x2079	0x03	Selects valid/invalid of deceleration stop special function in position control mode. 0x01 (Function valid): Changes to velocity mode and performs deceleration stop. 0x00 (Function invalid): Function invalid

5.14.4 Function abstract

Functions below are worked as deceleration stop special function when cyclic sync position mode is selected with operation mode (0x6060), function valid is selected with extended function selection (0x2079-0x03), and 0x0005 or 0x0006 is selected with quick stop option code (0x605A).

(1) Condition performing deceleration stop after switching in to velocity mode from position control mode.

<table>
<tr><th>Condition</th><th>Description</th><th>Remarks</th></tr>
<tr><td>Communication cause</td><td>Performs deceleration stop if quick stop is input via communication.
(Quick stop is decided if bit2 of control word is zero.)</td><td>It stops with profile deceleration, when this function is selected and 5 is selected with quick stop option code (0x605A). It stops with quick stop deceleration when 6 is selected.
This function doesn't work with the other selections. (Normal function will be used.)</td></tr>
<tr><td colspan="3">Even if this function is selected, it performes deceleration stop due to amplifier cause when servo off (gate shut off) occurs with amplifier cause below.
Servo off (gate shut off) occurs so it cannot keep staying at quick stop active state.</td></tr>
<tr><td rowspan="5">Amplifier cause</td><td>Performs deceleration stop when servo amplifier detects cause of servo off (gate shut off).</td><td rowspan="2">Even if this function is selected, it performes deceleration stop due to amplifier cause.</td></tr>
<tr><td>① In case that EMR is assigned to general input and EMR request is occurred.</td></tr>
<tr><td>② In case that main circuit is shut down. (Power off)</td><td rowspan="2">This function does not work because gate will be shut down by hardware.</td></tr>
<tr><td>③ Emergency stop (EMR) due to STO input.</td></tr>
<tr><td>④ Alarm cause</td><td>Depends on operation of alarm detection.
In case of SB (servo brake stop):
Deceleration stop is performed with this function.
In case of DB (dynamic brake stop):
This function does not work.
It will be stop operation with dynamic brake.</td></tr>
</table>

(2) Operation if deceleration stop condition occurred

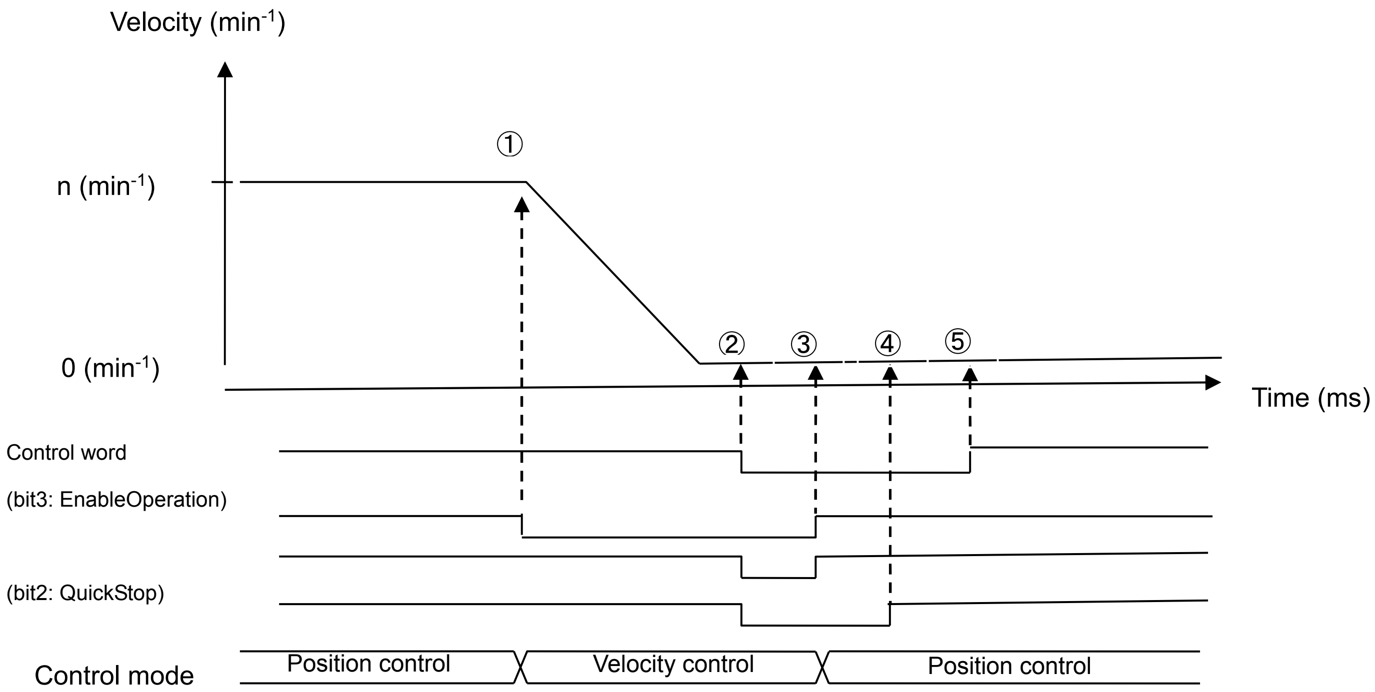
If deceleration stop condition occurred, actual operation motor speed will be decided to velocity command.

Based on that speed, deceleration stop is started with set profile deceleration.

(3) Working example

Below shows a working example: Performs quick stop by setting 0x000B to control word and performs servo off by 0x0000, then servo on.
(Control word is just shown bit 3 to bit 0.)

① Set 1011 (Quick stop) to bit 3- 0 of control word.
② Confirm completion of deceleration stop.
③ Set 0110 (Shut down) to bit 3- 0 of control word.
④ Set 0111 (Swich On) to bit 3- 0 of control word.
⑤ Set 1111 (Enable operation) to bit 3- 0 of control word.



5.14.5 Restrictions

There are restrictions below for extended function selection.

- If gate has shut down by another cause such as alarm, it is not able to stop with set deceleration speed.

- In case that deceleration stop has selected at quick stop option code, it may not perform deceleration stop correct if quick stop state cancels before starting deceleration stop. To stop motor with deceleration stop, keep a quick stop state until motor stop.

- The term of switched to velocity control mode is up to 1 second. Deceleration stop time in profile deceleration setting shall be set to 1 second or less.

- In case after deceleration stop using special function selection in position control, it has gap on a command coordinate against upper device (controller), with keeping servo on state. Do not cancel a quick stop input at this state.

5.15 Modulo function

5.15.1 Modulo setting

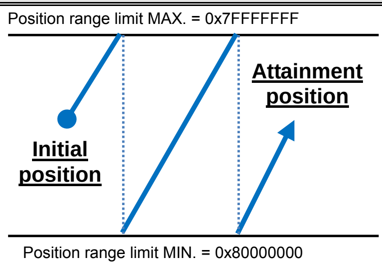
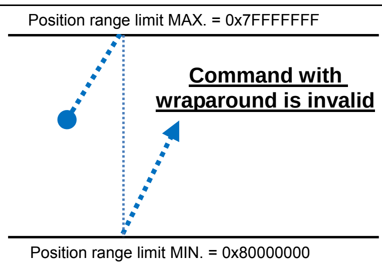
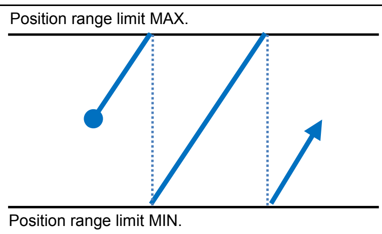
Sets the system parameter below for this function use.

Index	Sub-index	Name	Description
0x607B	0x01	Position range limit minimum value	Sets minimum value as available in position coordinate, under operation mode of position command input system.
0x607B	0x02	Position range limit maximum value	Sets maximum value as available in position coordinate, under operation mode of position command input system.
0x60F2	0x00	Positioning option code	Set a behavior of positioning operation.

5.15.2 Function abstract

(1) 0x607B: Position range limit

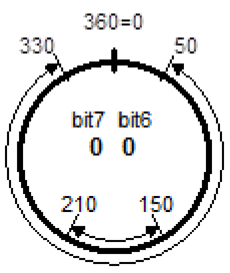
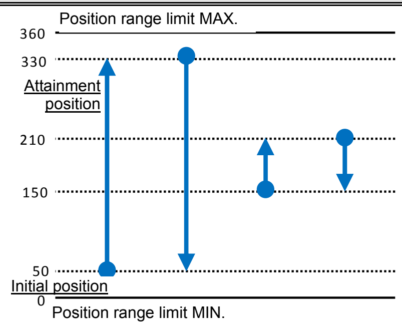
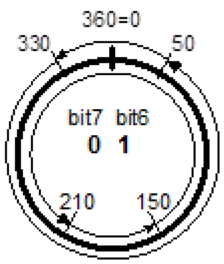
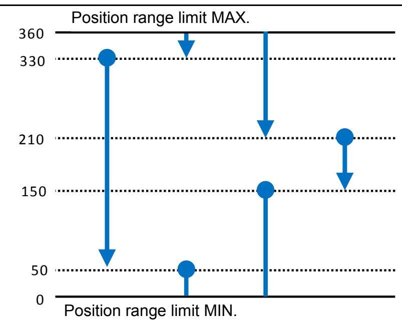
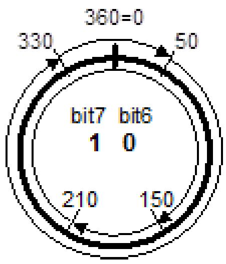
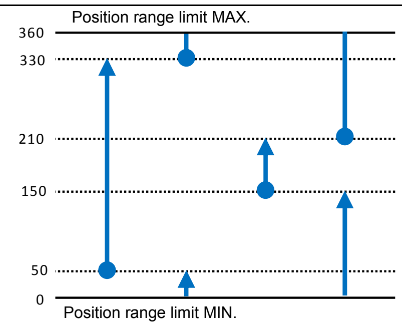
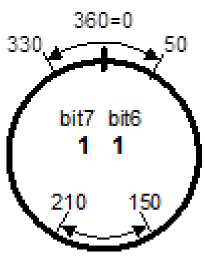
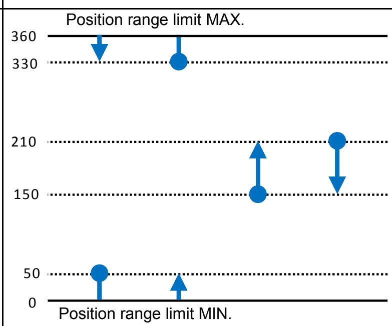
Sets range in position coordinate, under operation mode of position command input system.

0x607B Position range limit	Graphical image	Description
Min. ＝ 0x00000000 Max. ＝ 0x00000000 Linear coordinate (Linear axis)		- In case PP, wraparound is available beyond the range of position range limit when position range limits are set as below. Min. (0x607B-0x01) ＝0x00000000 Max. (0x607B-0x02) ＝0x00000000
Min. ＝ 0x80000000 Max. ＝ 0x7FFFFFFF Linear coordinate (Linear axis)		- In case PP, the command beyond the range of position range limit becomes invalid and travel disabled, when position range limits are set as below. Min. (0x607B-0x01)＝0x80000000 Max. (0x607B-0x02)＝0x7FFFFFFF - In case CSP, wraparound is available.
Except settings above Modulo coordinate (Rotary axis)		- In case coordinate increment direction, next position after reaching maximum of position range is minimum of position range. - In case coordinate decrement direction, next position after reaching minimum of position range is maximum of position range.

(2) 0x60F2: Positioning option code

In case that target position is set with absolute position command, it travels depending on positioning option code.

Below shows modulo coordinate images with conditions: minimum position range limit = 0, maximum position range limit = 359.

Positioning option code		Modulo coordinate Image with rotary axis	Modulo coordinate Graphical image	Description
Bit6	Bit7			
0	0	 Normal positioning same as linear axis		- Performs positioning of travel to the direction that modulo coordinate does not wraparound.
0	1	 Negative direction rotation only		- Performs positioning of travel to the direction of coordinate decrement. - Even if target position is larger than actual position, positioning is performed to target position go through the position set by minimum position range limit.
1	0	 Positive direction rotation only		- Performs positioning of travel to the direction of coordinate increment. - Even if target position is smaller than actual position, positioning is performed to target position go through the position set by maximum position range limit.
1	1	 Shortcut direction rotation		- Automatically decide shortcut direction, and travel. - When target position and actual position are just opposite, rotation direction is decided to positive.

■ Sequence

1. Set position range limit minimum value (0x607B-0x01) and position range limit maximum value (0x607B-0x02). To change setting, transit ESM state to Pre-Operational and change setting, then transit to Operational again.
2. Confirm with monitor value of actual position that position range limit minimum value (0x607B-0x01) and position range limit maximum value (0x607B-0x02) are reflected and actual position is not there in out of range.
3. Set a positioning operation with bit6 and bit 7 of positioning option code (0x607B-0x00). Positioning option code becomes valid soon after inputting.

■ Restrictions and precautions

✔ CSP mode is not apply to positioning option code. It travels to modulo position by position command, with shortcut direction rotation.

✔ In case that positioning option code is normal positioning same as linear axis and target position is set to out of modulo coordinate, modulo is performed to target position. For example in case position range limit minimum value is 0 and position range limit maximum value is 359, absolute position command 370 gets modulo and travel to 10, without wraparound.

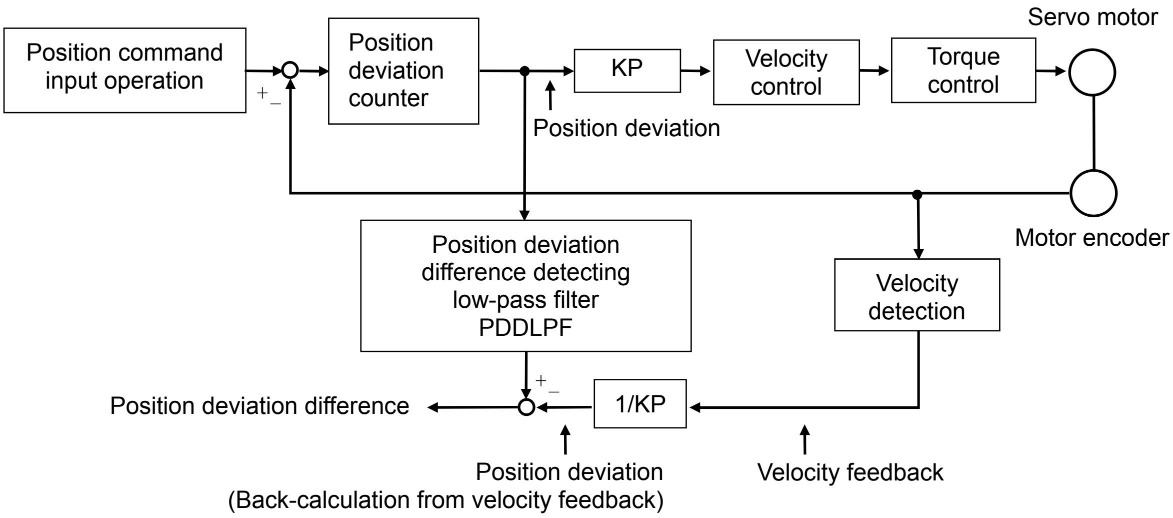
5.16 Protective function

5.16.1 Position deviation difference excess warning/alarm

■ Abstract

Position deviation difference excess warning/alarm detects position deviation error accurately in position control mode.

◆ It detects warning or alarm when absolute value of position deviation difference between counter and velocity feedback calculation becomes too large.



■ How to use

◆ To use this function, all settings below are required. If some settings are not set, position deviation difference warning level and excess value are required to set to zero. (Detection invalid)

✔ Set "01: PP" or "08: CSP" to 0x6060 Operation mode.
✔ Set "00: Standard control" to 0x20F3-0x01 Position control selection.

◆ Set servo amplifier parameters correct, and check maximum value of position deviation difference in normal operation.

✔ Position deviation difference is able to check with 0x2131 Position deviation difference monitor.
✔ In case that position deviation difference becomes too large during motor accel/decel, position deviation difference is able to suppress with adjustment of Position Deviation Difference Excess Detection LPF.

◆ In case that position deviation difference becomes large temporarily, set the time longer than it to Position Deviation Difference Detection Continuing Time.

◆ Position deviation difference warning level and excess value are required to set as larger than position deviation difference monitor value with margin.

◆ Position deviation difference excess warning/alarm occurs when position deviation difference exceeds warning level or excess value.

■ Setting parameters

To use position deviation difference excess warning/alarm, setting of parameters below are required.

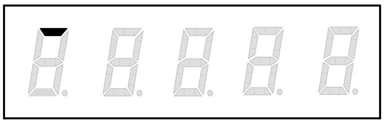
◆ Position deviation difference excess warning level

Position deviation difference excess warning occurs if position deviation difference exceeds this value and spending Position Deviation Difference Detection Continuing Time (0x2052-0x04).

Index	SubIndex	Setting range	Initial value	Unit
0x2052	0x01	0 to 2147483647	0	Pulse

✔ Position deviation difference warning is not detected when set value is 0.

✔ Warning status is able to check via monitor display and front LED.
Moreover, that is able to output via general output.



◆ Position deviation difference excess value

Position deviation difference excess alarm "AL.D8" occurs if position deviation difference exceeds this value and spending Position Deviation Difference Detection Continuing Time (0x2052-0x04).

Index	SubIndex	Setting range	Initial value	Unit
0x2052	0x02	0 to 2147483647	0	Pulse

✔ Position deviation difference warning is not detected when set value is 0.

◆ Position deviation difference excess detection low-pass filter

The set value for adjusting LPF of position deviation difference excess alarm/warning detection.

Index	SubIndex	Setting range	Initial value	Unit
0x2052	0x03	0 to 4000	0	Hz

✔ The filter is disabled by setting value 0Hz, or 2000Hz or more.

◆ Position deviation difference detection continuing time

Alarm or Warning issues when position deviation difference excess level or warning level continues with this setting time.

Index	SubIndex	Setting range	Initial value	Unit
0x2052	0x04	0 to 1000	0	ms

■ Precautions

◆ We cannot assure the perfect prevention by this function against machine break-down.

5.17 Correction table function

This is the function to correct pitch error of ball screw.

5.17.1 Related parameters

For use of this function, parameter below shall be set.

Index	Sub-index	Name	Description
0x5080	0x00	Correction Table Control	Enables/disables the correction table function.
0x5083	0x00	Correction Table Position Number of entry	Sets number of entry of correction position.
0x5083	0x01 to n	Correction Position 1 to n	Sets correction position.
0x5084	0x00	Correction Table Offset Number of entry	Sets number of entry of offset.
0x5084	0x01 to n	Offset 1 to n	Sets offset.

5.17.2 How to set a correction able

①Sets correction data number to 0x5083 sub-idx 0x00 and 0x5084 sub-idx 0x00.

Maximum correction data number is 64.

②Sets correction position to sub-idx 0x01 or later in 0x5083.

Correction position shall be set in order from small number. Set value will be stored to non-volatile memory.

③Sets offset to sub-idx 0x01 or later in 0x5084.

Set value will be stored to non-volatile memory.

④After setting correction position and offset, perform control power cycle.

■In cases below, warning for correction table setting will be set. Review set values.

◆In case that 1 is set to number of entry.

◆In case that correction position is not set with order from small number.

5.17.3 Correction table operation

Correction table function works as below.

①Refers correction table with actual position.

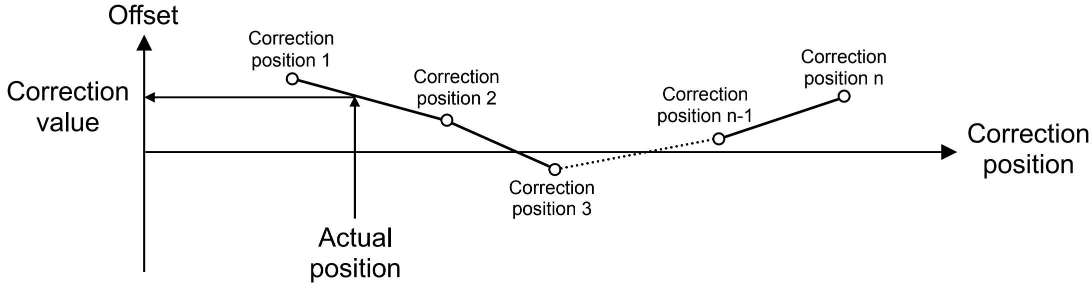
②If Actual position is inside of correction table, neighbor 2 correction positions are referenced. (See Ex. 1)

If Actual position is outside of correction table, 2 correction positions near to table reference data are referenced. (See ex. 2)

③Calculates correction value with linear interpolation of offset values due to correction positions decided above.

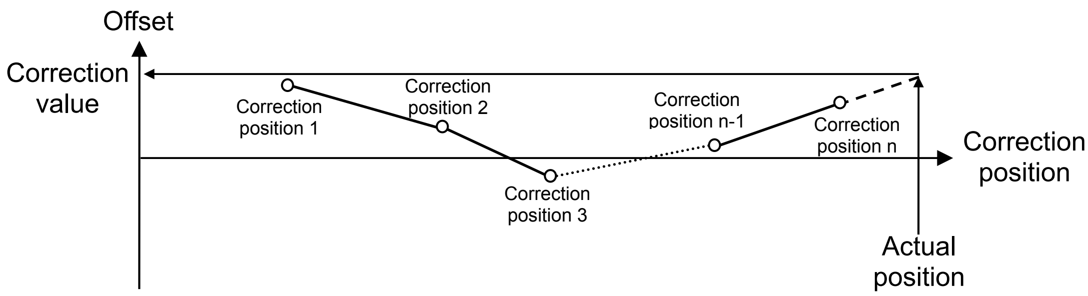
(Ex. 1) Actual position is inside of correction table

(Correction position 1 ≤ Actual position < Correction position n)



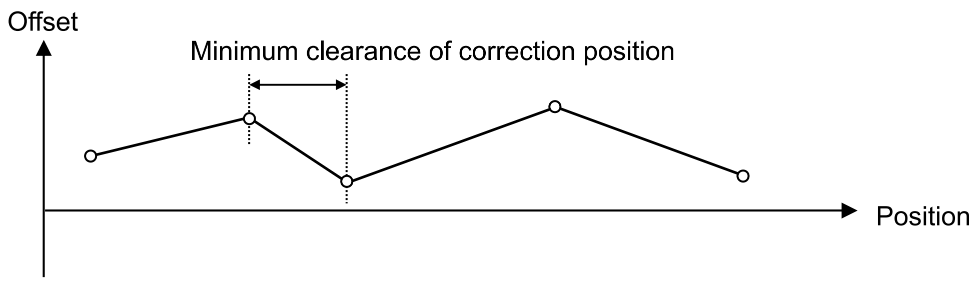
(Ex. 2) Actual position is outside of correction table

(Actual position < Correction position 1, or Correction position n ≤ Actual position)

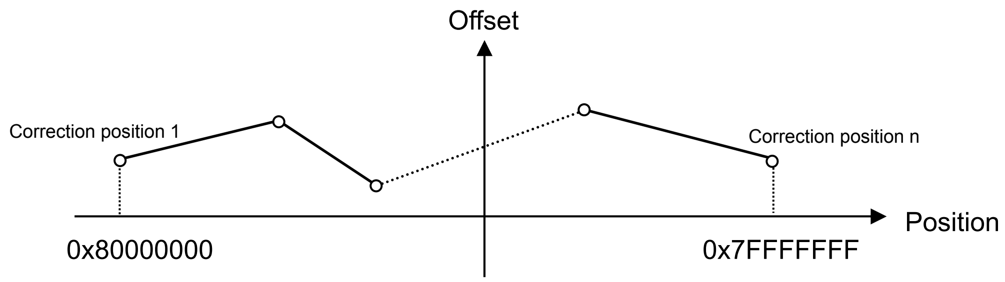


5.17.4 Precautions

①Clearance of position data, set to correction position (Index 0x5083 sub-idx 0x01-), is required to be larger than travel distance in 125μs.

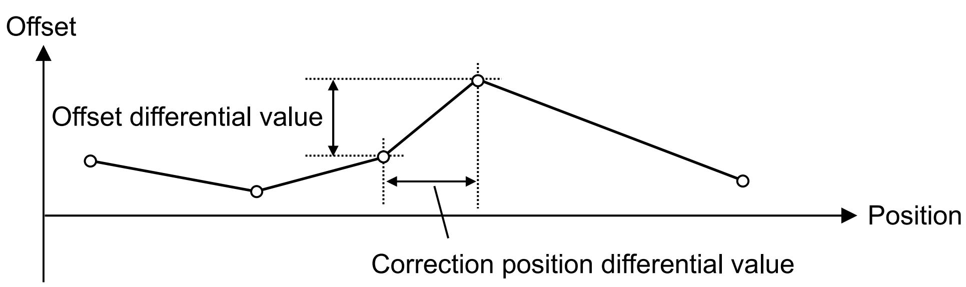


②In case that actual position steps over 0x7FFFFFFF and 0x80000000, set 0x80000000 to correction position 1 and set 0x7FFFFFFF to correction position n. Set same value to offset 1 and offset n. (n: number of entry)



③Set correction positions and offsets so as to slope of the line between 2 correction points is 0.1 or less.
Large slope may cause of vibration.

Slope = Offset differential value / Correction position differential value



5.18 Special function selection setting

Explains about functions requiring a special function selection setting.

5.18.1 How to use of gain switching function

Gain switching function setting differs due to bit 9 of special function selection setting.

Index	Set value	Description
0x20F7 Bit9	0	Sets a gain by gain switching selection (bit 4-5) of parameter selection (0x2001).
	1	Sets a gain by gain switching condition (0x20B0).

5.18.2 How to use of velocity loop proportional control switching function

Velocity loop proportional control switching function setting differs due to bit 10 of special function selection setting.

Index	Set value	Description
0x20F7 Bit10	0	Sets by bit 2 of function control word (0x2000).
	1	Sets a velocity loop proportional control by Velocity Loop Proportional Control Switching Condition (0x20F8-8).

5.19 Restrictions

SANMOTION R 3E Model EtherCAT servo amplifier has restrictions below.

5.19.1 Restriction list

Item	Restriction condition
Profile Position mode	According to communication specification, inhibit "1" set to New Setpoint when "0" is set to profile velocity/profile acceleration/profile deceleration.
Profile Position mode (Halt stop)	To restart after canceling halt stop, set profile velocity/profile acceleration/profile deceleration and set "1" to New Setpoint.
Software Position Limit	In case that software position limit valid, profile position mode works as below. If a target beyond software position limit is set, it does not move due to Internal Limit Active (bit 11 of 0x6041: Status Word).
Alarm Reset (Fault reset)	Set "1" 20ms or more to Fault Reset (bit7 of Control Word), to clear an alarm cause of amplifier internal. Alarm state will be canceled with negative edge of Fault Reset (bit7 of Control Word).
Encoder clear (Eclr)	Set "1" 200ms or more to Eclr (bit12 of Control Word), to clear battery error or multi-turn data of motor encoder internal. Actual position recalculation after multi-turn data clear will be performed with negative edge of Eclr (bit12 of Control Word).
Control cycle actual position Control cycle actual velocity Control cycle actual torque	Control cycle of monitor process will be 250μs if scale function is used. So, monitor value update of actual position/actual velocity/actual torque, outputting every control cycle, is also every 250μs.
SI unit system for position	This parameter defines scale unit, only. Decide scale unit with reference of section 5.13.4.
EtherCAT communication reception monitor	EtherCAT communication reception timing monitor becomes valid when DC sync mode is selected, only. Measure range from sync signal (negative edge of SYNC) to communication frame reception (negative edge of IRQ) is up to communication cycle. Maximum measure value is communication cycle. Measure range of communication cycle from communication frame reception (negative edge of IRQ) to communication frame reception (negative edge of IRQ) is up to twice of communication cycle. Measurement is performed under Operational status of EtherCAT State Machine (ESM). Measured value clears once if transit from Operational state.
Home Switch	CONT1 (HomeSwitch) is assigned to home switch as dedicated input automatically. This input is shared with general input so general input function selection (0x20F8) shall be set avoid "02:CONT1ON" and "03:CONT1OFF", when home switch input is used.

Release	
Revision A	Sep. 2017
Revision B	Oct. 2018
Revision C	May. 2019

■ECO PRODUCTS
Sanyo Denki's ECO PRODUCTS are designed with the concept of lessening impact on the environment in the process from product development to waste. The product units and packaging materials are designed for reduced environmental impact.
We have established our own assessment criteria on the environmental impacts applicable to all processes, ranging from design to manufacture.

■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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