RS OEMax

CSD7 Servo Drive

(EtherCAT Network type)

User Manual

Catalog Number(s) : CSD7_**BN(F)1

RS Reliable & Smart Automation

Important User Information

Solid state equipment has operational characteristics differing from those of electromechanical equipment. There are some important differences between solid state equipment and hard-wired electromechanical devices. Because of this difference, and also because of the wide variety of uses for solid state equipment, all persons responsible for applying this equipment must satisfy themselves that each intended application of this equipment is acceptable..

In no event will RS Automation Co., Ltd. be responsible or liable for indirect or consequential damages resulting from the use or application of this equipment.

The examples and diagrams in this manual are included solely for illustrative purposes. Because of the many variables and requirements associated with any particular installation, RS Automation Co., Ltd. cannot assume responsibility or liability for actual use based on the examples and diagrams.

Throughout this manual, when necessary, we use notes to make you aware of safety considerations.

WARNING	Identifies information about practices or circumstances which may lead to serious personal injury or death, property damage, or economic loss.
IMPORTANT	Identifies information that is critical for successful application and understanding of the product.
CAUTION	Identifies information about proactives or circumstances that can lead to minor personal injury, property damage, economic loss, or product malfunction. However, depending on the situation, failure to follow the directions accompanying this symbol may also lead to serious consequences.

Manual Revision History

The revision history of the manual provides the brief description of each manual revision.

CSD7-UM001A-EtherCAT-EN-Oct 2015

Revision Month, Year

Manual Version

Manual Version	Revision Information	Revision Date
A	First edition	Oct 2015
B	Updated about the STO Fuction and Medium power drive	May 2019

Table of Contents

Preface

Read this preface to familiarize you with the rest of the manual.

- Who Should Use This Manual
- About This Publication
- Additional Resources
- Conventions Used in This Manual
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Who Should Use This Manual

This manual is intended for engineers or technicians directly involved in the installation and wiring of the CSD7 servo drive, and programmers directly involved in the operation, field maintenance, and integration of the CSD7 servo drive with a Motion Card.

If you do not have a basic understanding of the CSD7 servo drive, contact your local RS Automation sales representative before using this product, for information on available training courses.

About This Publication

This manual provides detailed installation instructions for mounting, wiring, and troubleshooting your CSD7 servo drive, and system integration for your drive/motor combination with a Motion Card.

Additional Resources

The following documents contain additional information concerning related CSD7 servo drive products.You can view or download publications at www.rsautomation.biz To order paper copies of technical documentation, contact your local RS Automation Korea distributor or sales representative.

WWW.rsautomation.co.kr

For	Read This Document
Information on the installation of your CSD7 servo drive	CSD7 Servo Drive Installation Instructions
Information on the installation and operation of motors used together with CSD7 servo drive	Servo Motor User Manual

Conventions Used in This Manual

The conventions starting below are used throughout this manual.

- Bulleted lists such as this one provide information, not procedural steps.
- Numbered lists provide sequential steps or hierarchical information.

Object Description Format

The description format of objects are as follows :

Object without Sub-Index

Index	Object Name					Mode of Operation	
Setting Range	Size(Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
<Set Range>	<Size ( )>	<Unit>	<RO/RW>	<Possible/No>	<Attribute>	<Init Value>	<Parameter No.>

Object with Sub-Index

Index	Object Name					Mode of Operation	
Sub-Index 0	Number of Entries						
Setting Range	Size(Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
<Set Range>	<Size ( )>	<Unit>	<RO/RW>	<Possible/No>	<Attribute>	<Init Value>	<Parameter No.>
Sub-Index 1	<Sub-Index Name>						
Setting Range	Size(Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
<Set Range>	<Size ( )>	<Unit>	<RO/RW>	<Possible/No>	<Attribute>	<Init Value>	<Parameter No.>
			:				
Sub-Index n	<Sub-Index Name>						
Setting Range	Size(Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
<Set Range>	<Size ( )>	<Unit>	<RO/RW>	<Possible/No>	<Attribute>	<Init Value>	<Parameter No.>

Index : The indexes of objects, displayed with hexadecimal

numbers of 4 digits.
e.g.) 0x1000, 0x2004, 0x6200, etc.

Sub-Index : If there are sub-indexes, they are displayed as 2 digits in [ ] at the end of the indexes.
e.g.) 0x1600[07], 0x1A00[09], 0x2005[04], etc.

Object Name : Indicates the name of object

Mode of Operation : Displays control modes that can be used. (Supporting CSP and CST)

Setting Range : Indicates the range that can be input to the object.

Size( ) : Indicates the object size in byte.
( ) means the data type.

Unit : Indicates the unit of measure of the object

Access : Indicates whether the object is read only, or read and write
RO : Read Only
RW : Read and Write

PDO Map : Indicates the PDO mapping attribute.
Possible(RxPDO); Reception PDOs can be mapped
Possible(TxPDO); Transmission PDOs can be mapped
No ; PDs cannot be mapped

Attribute : Indicates the time during which changes are valid in the writing-enabled object.
Always : Changeable at any time
Servo off : Changes are valid when servo is OFF
Power cycling : Changes are valid after the control power is reset

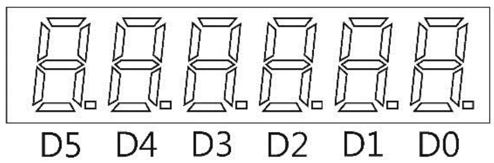
— : Writing disable

Init Value : The values of factory-setings

Ft-no : Integer numbers of manufacturer that are linked with objects in 0x2000s.

Number of Each Digit in 7-Segment for Setting Parameters

The number of each digit in the 7-segment indicator at the front of CSD7 is defined as follows: These definitions apply throughout this user manual.



Ex)

Parameter & Each digit		Definition
		[Ft-0.02][D0]
		[Ft-0.02][D1]
		[Ft-3.00][D2]

Terminology

The following describes terminologies used in this manual.

- **Servo Drive or Drive** : Refer to the CSD7 Servo Drive
- **Servo Motor or Motor** : Refer to the servo motor exclusively for the CSD7 drive.
- **Host Controller** : Refers to a controller or a device that gives command to the servo drive and controls it.
- **Initial Value** : Refer to the value set at the factory before the shipment.
- **Setting Value** : Refers to the initial value or the value changed and set by the users.
- **User's Manual** : Simply indicated as 'manual'.

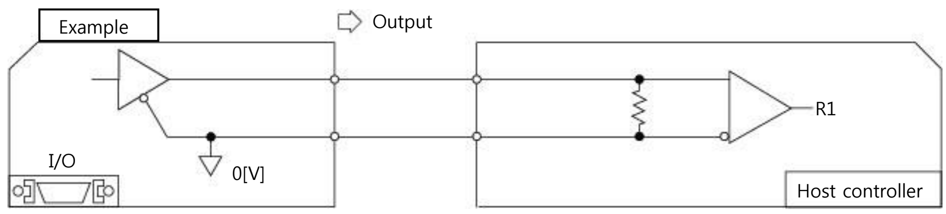
Notation Description

Within the sentences of this manual, the following is expressed as shown below. Be fully aware of them when using the servo drive.

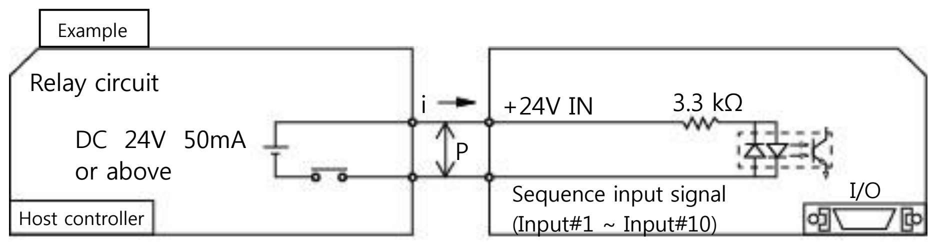
1. Use '/' in front of Active Low signal.

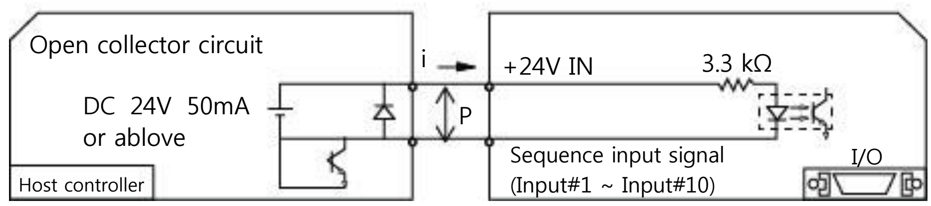
$\overline{\text{SV-ON}}$	➡	/SV-ON

2. A figure box with both the top corners cut off diagonally represents a circuit diagram. If I/O connector of the servo drive is on the left, it is the output of the servo drive.

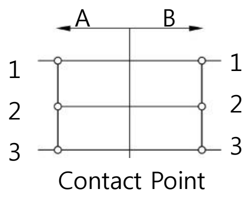


3. If I/O connector of the servo drive is on the right, it is the input of the servo drive from host controller to the servo drive.

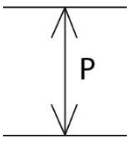
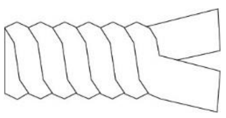




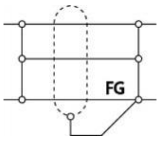
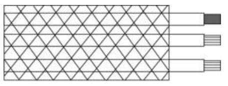
4. The following shows the symbols used on the circuit diagram.

Symbol	Description
	▶ The figure represents the pin number of the connector, which can be marked with alphabets rather than the numbers. ▶ The Contact Point is the connection between the side A and B with the connector.

5. The following figure shows a symbol used to show a twist pair wires to prevent the noise generation.

Symbol	Figure	Description
		Make a twist pair wires where this symbol is located for the noise prevention.

6. The following figure shows a symbol used to show a shield pair wire to prevent the noise generation.

Symbol	Figure	Description
		Shield the wires where this symbol is located for the noise prevention.

Manual Description Order

This manual is described in the view of users from the purchase to operation.

1. Describes things to know before using the product.
2. Describes the outline of product and marking.
3. Describes precautions upon product installation.
4. Describes wiring with the host controller and peripheral equipment.
5. Describes the operator for various settings.
6. Describes brief functions of the product.
7. Describes the basic settings that users should set.
8. Describes the function of the product for each control modes.
9. Describes the tuning to implement optimum performance of load system.
10. Describes simple supplementary functions.
11. Describes the protective function, fault diagnosis and troubleshooting.
12. Describes items corresponding to various numerical data in the Appendix.

Others

Each chapter or paragraph has a page called before you begin before description. For easier understanding of this manual, be fully aware of the contents of this page called before you begin in advance.

Safety Precautions

This is CSD7 User Manual describes safety matters using the following marks. Safety marks deals with the important matters. If the following marks and contents of each mark are indicated in the contents of this user's manual, you must be fully aware of them and follow them.

Usage

CAUTION

- Do not touch the inside of servo drive.
- Make sure that the servo drive and the motor are fully grounded.
- Completely discharged before handling after power off.
- Do not put excessive stress on the motor power and encoder cable.
- Never touch the revolving part of the motor during operation.

WARNING

- Avoid using the product near wet places or corrosive and inflammable materials.
- Operate the system with no load during pilot operation.
- Never touch the heat sink directly.

Storage

WARNING

- Do not store the product near wet places, rain, toxic gas or fluid.
- Keep the product out of the direct rays of the sun and store it within the storage temperature and humidity ranges.
- Avoid overloading when the product is stored in a warehouse.

Transportation

WARNING

- Do not carry the product by holding the cable and the motor shaft.

Installation and Wiring

WARNING

- Install a cooling fan to prevent excessive temperature increase. (Refer to the Chapter 2)
- Be careful not to wiring cables around the heat sink.

CAUTION

- Install drives with regular space (at least 10 mm, 30mm) between them.
- Pay attention to a noise protection when wiring. (Refer to Chapter 2)

Maintenance and Repair

WARNING

- Do not disassemble or remodel the product. Any damage caused after the user disassembles or remodels the product will be excluded from the company's warranty.
- The company bears no responsibility for injuries or physical damage caused by remodeling of this product.
- Life-limited Parts by mechanical friction or heat requires regular inspection. Refer to the 10-1 page "Inspection and Protection Function".
- In case of a failure that cannot be dealt with, please contact the company's technical support team or after-sales service center.

Certificate

CSD7 complies with all allicable local standards.

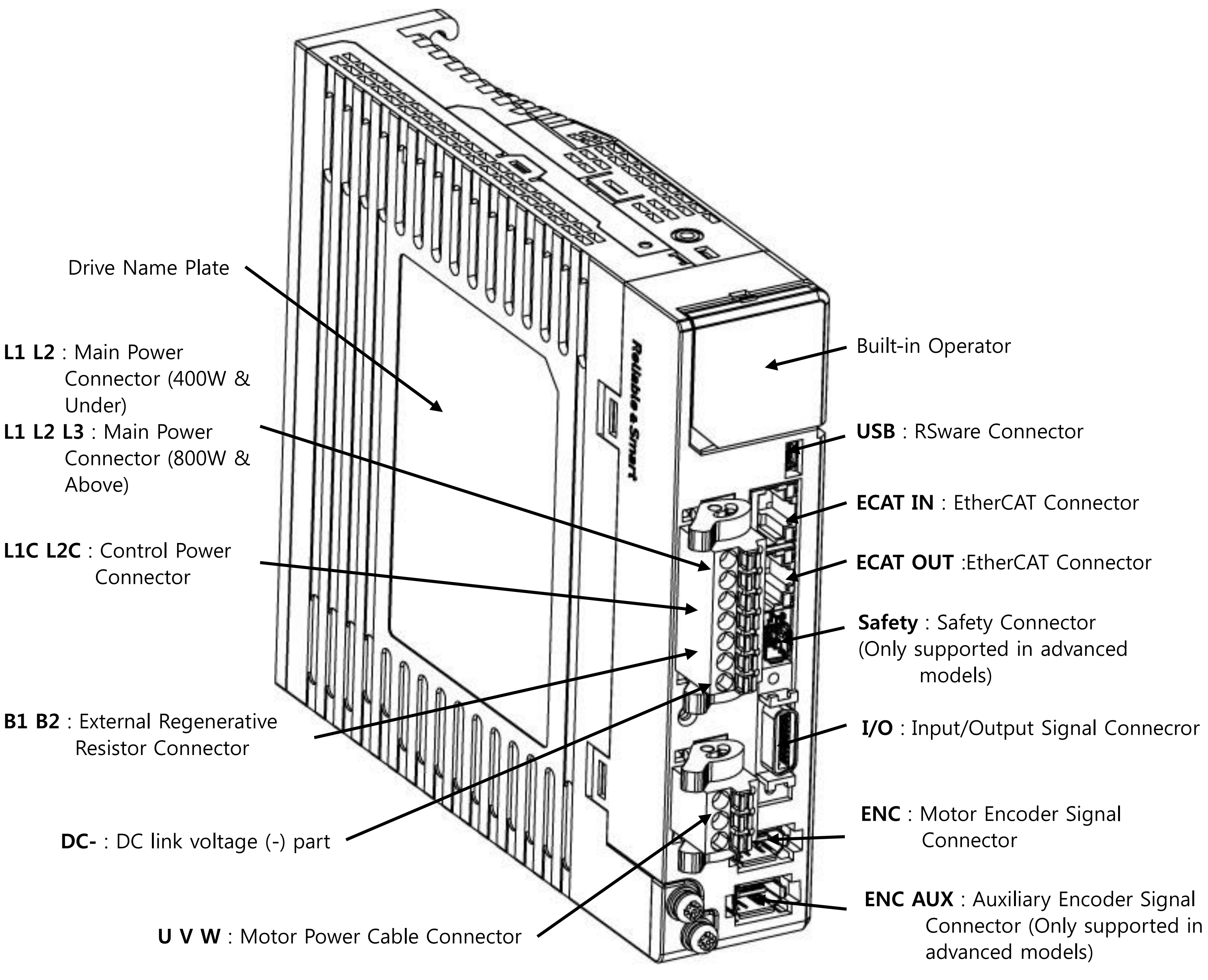
Standards		Servo Drive
EC Directive	EMC Directive	EMC Directive:201430/EU, KN IEC61326-3-1 EN61800-3, KC61800_3 IEC61000-4-2, KN61000-4-2 IEC61000-4-3, KN61000-4-3 IEC61000-4-4, KN61000-4-4 IEC61000-4-5, KN61000-4-5 IEC61000-4-6, KN61000-4-6 IEC61000-4-11, KN61000-4-11
	LVD Directive	EN61800-5-1
USA Standards	NRTL	UL508C
Canada Standards	NRTL/C	C22.2No.14_10
Functional Safety	Safe Torque Off	IEC 61508:2010 SIL2 IEC 62061:2005/A2:2015 SIL CL2 ISO 13849-1:2015 PLd, Cat3 IEC 61800-5-2:2007
	PFH (Probability of a dangerous Failure per Hour)	100W – 1.5KW : 1.3731 x 10^{-8}[1/h] 2.5KW – 5.0KW : 1.3257 x 10^{-8}[1/h]
	MTTFd (Mean Time to Dangerous Failure)	100W – 1.5KW : 3,794[Years] 2.5KW – 5.0KW : 3,830[Years]

Chapter 1. Before Using the CSD7 Servo Drive

This chapter describes the general matters and optional specifications that you should know before using the CSD7 SERVO DRIVE.

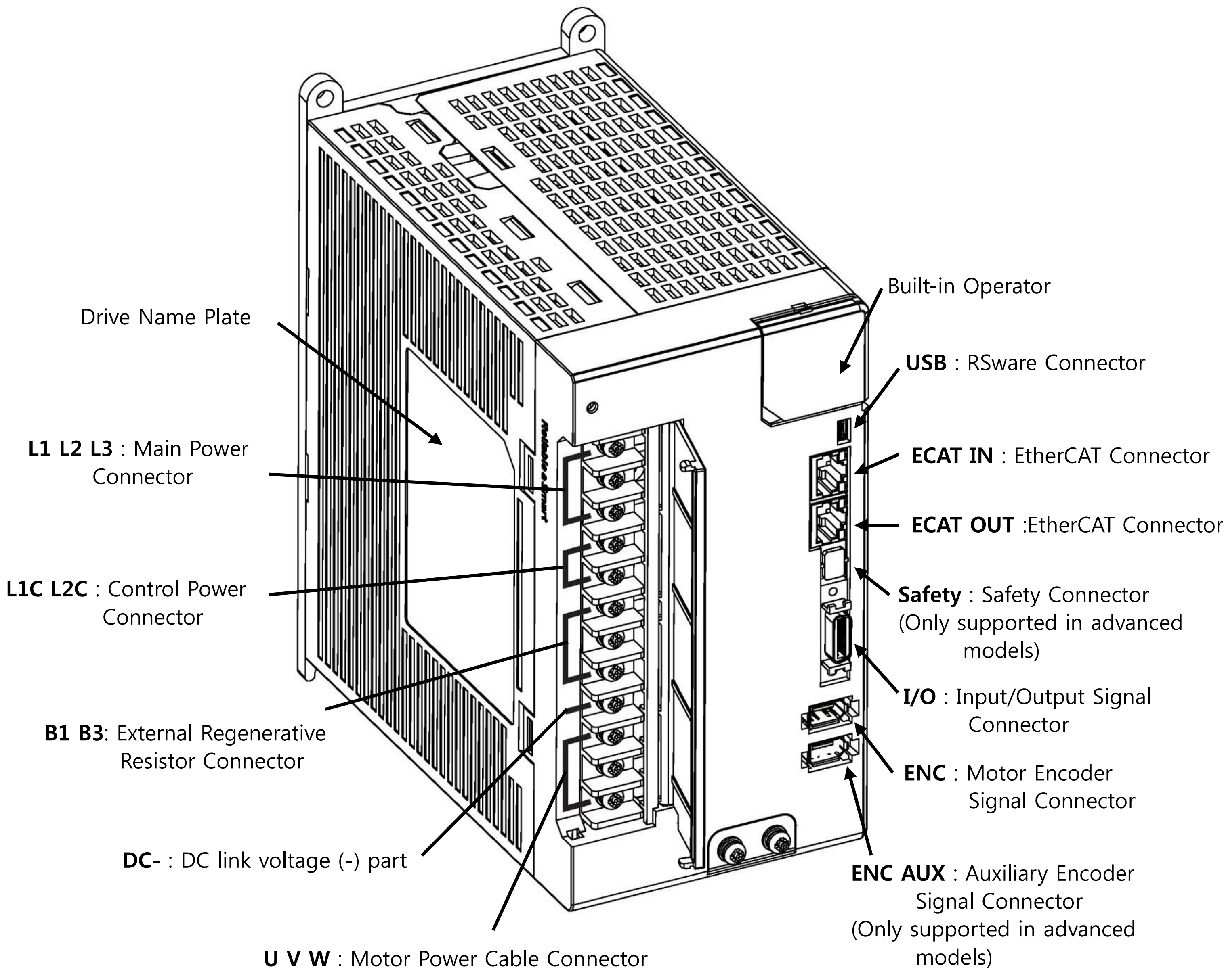
Each Part Name of Servo Drive

The following figure introduces the name of each part of the servo drive. (1.5KW or less)



Note For more detailed information about Built-in operator, please refer to “Operator” on page 4-5.

The following figure introduces the name of each part of the servo drive(2.5KW~5KW).



Model Number of the Servo Drive

The following figure describes the model name on the nameplate of the servo drive.

- The nameplate is attached on the side of the drive case. Check the model name on the nameplate, and check if it corresponds to the product ordered.
- The drive type is RS Automation Servo Drive CSD7 Series.
- The serial number is included on the nameplate. Be careful not to erase the serial number during the use.

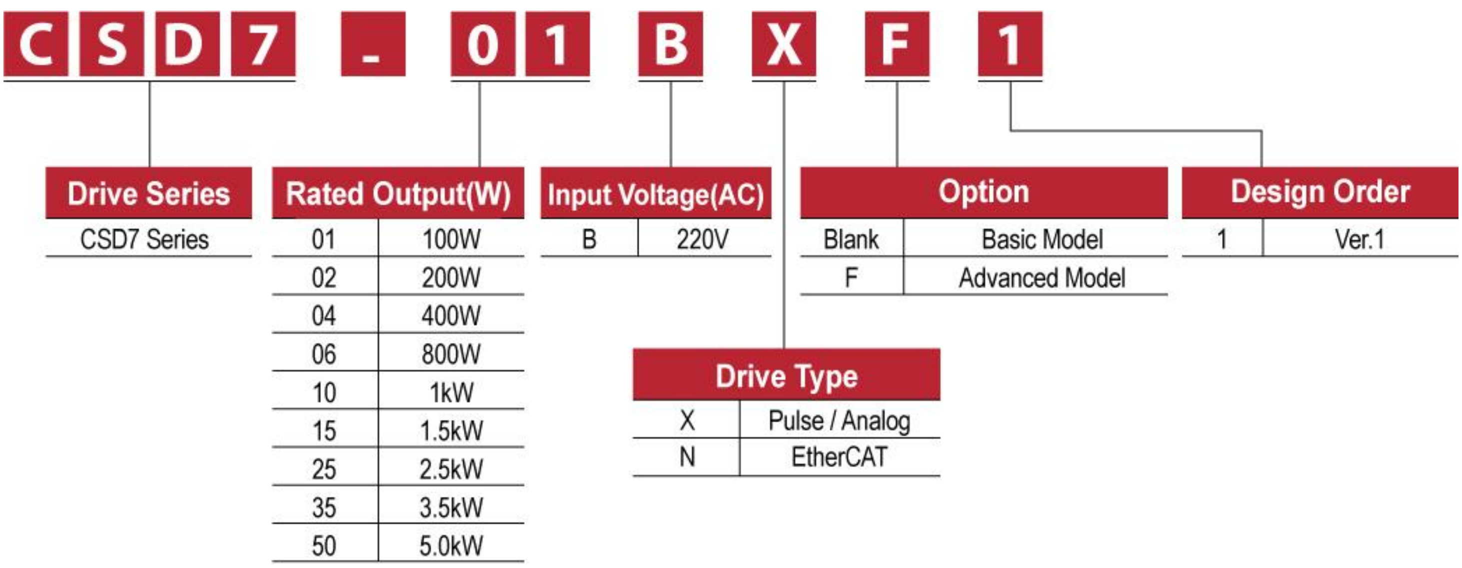


Table 1 Product Classification

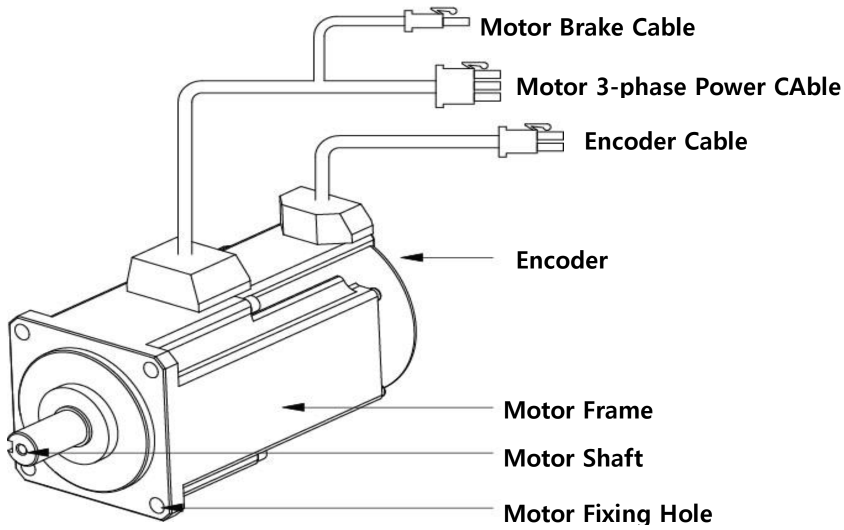
Classification	Available Operation Modes	Special Function
Basic model	• CSP (Cyclic Synchronous Position) mode • CST (Cyclic Synchronouse Torque) mode	
Advanced model	• CSP (Cyclic Synchronous Position) mode • CST (Cyclic Synchronouse Torque) mode	• STO(Safety Torque OFF) Function

Each Part Name of Servo Motor

The following figure shows the each part name of servo motor. A motor without a brake does not have a motor brake cable. The name of each part may differ from the following figure according to the motor type.

Note

For more detailed information about Servo Motor, please refer to "Servo Motor Manual (Publication SMOTOR-UM002)"



Model Number of the Servo Motor

The following figure describes the model name of the motor on the nameplate.

CSMT - 01 B R 1 A NT 3

Motor Type	
CSMT Series	50~1kW
CSMR Series	50~400W
CSMA Series	50~750W
CSMS Series	1~5kW
CSMD Series	0.75~5kW
CSMH Series	0.5~5kW

Rated Output(W)	
A5	50W
01	100W
02	200W
04	400W
06	600W
08	750W
10	1kW
15	1.5kW
20	2kW
25	2.5kW
30	3kW
40	4kW
50	5kW

Input Voltage(V)	
B	AC 220V

Encoder Form	
R	17bit Incremental
Q	17bit Absolute
T	23bit Inc/ Abs common

Encoder Type	
1	LBY Type
3	SBY Type

Option	
NT	None
BT	Brake
ST	Oil Seal
TT	Oil Seal, Brake

Motor Shaft Specification	
3	Key Type

Chapter 2. Installation

This chapter describes matters to consider when installing the servo drive and the motor.

Refer to the "Exterior Dimension and Mouning Dimension" on page A-4 for the dimension of the servo drive and the peripheral parts relevant to the installation.

Servo Drive Installation

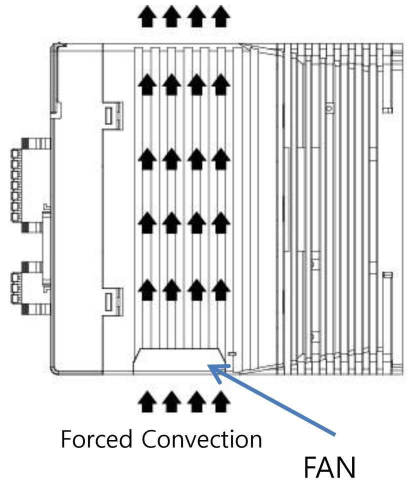
Consideration

Refer to the following figures when installing the servo drive.

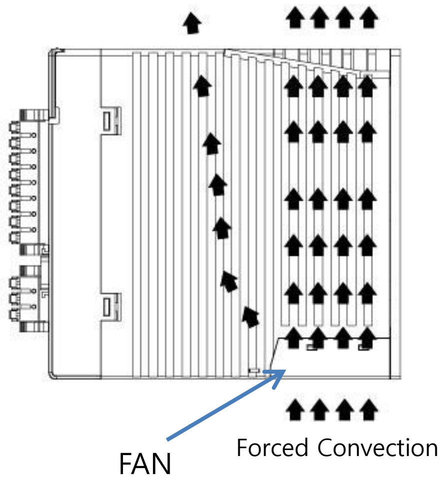
The most important thing to consider when installing the drive is the ambient temperature. Follow the operational temperature and the mounting space. Be sure to install the product vertically

Install the Servo Drive Vertically

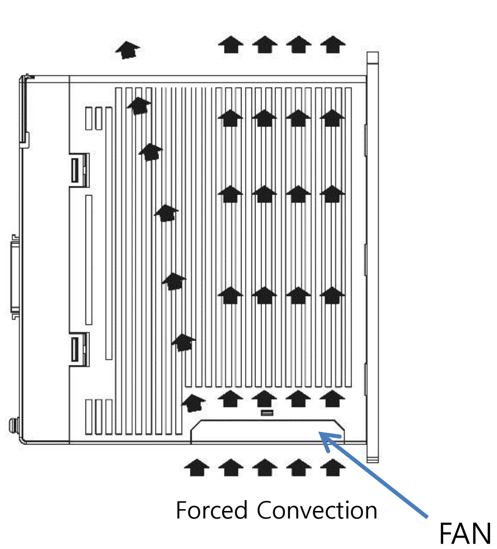
The CSD7 series servo drive adopts a forced cooling method using the fan installed inside the product. To increase cooling efficiency, be sure to install the product vertically.
As the servo drive includes electronic parts which are sensitive to static electricity, install the product in an environment in which static electricity is not generated.



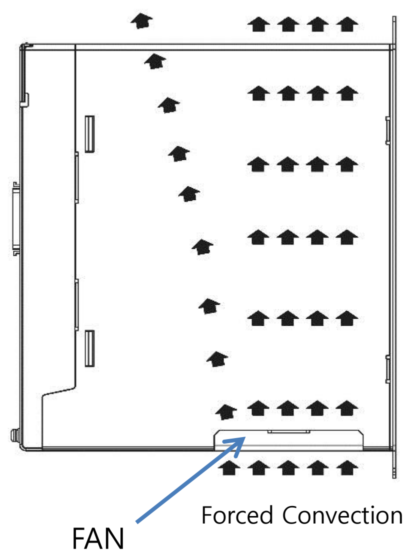
< 400W & less>



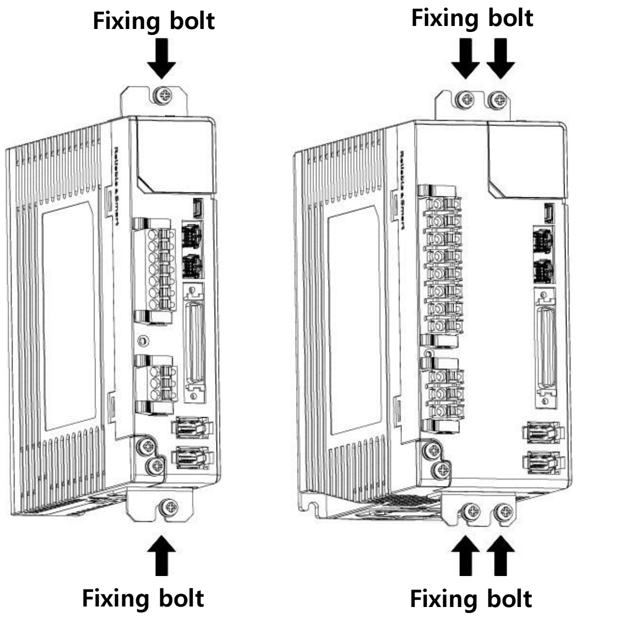
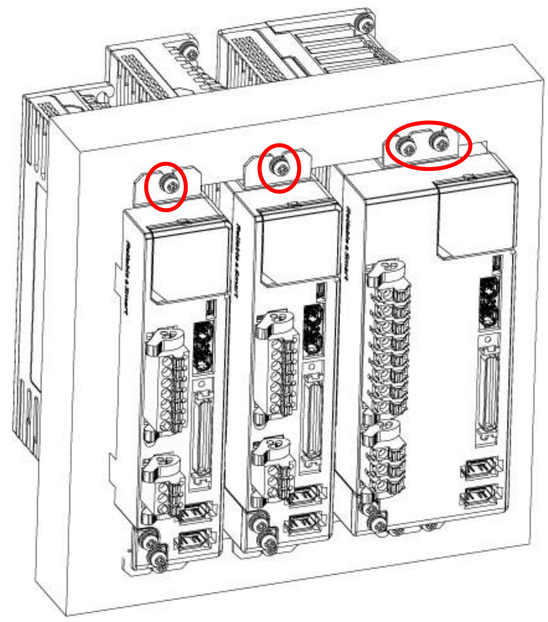
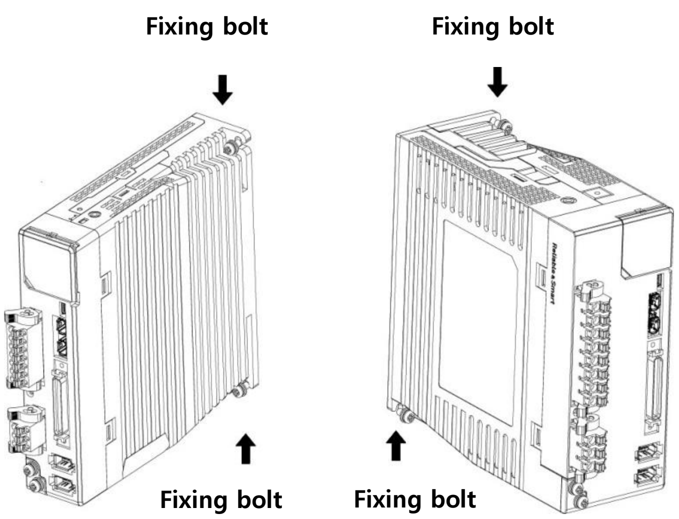
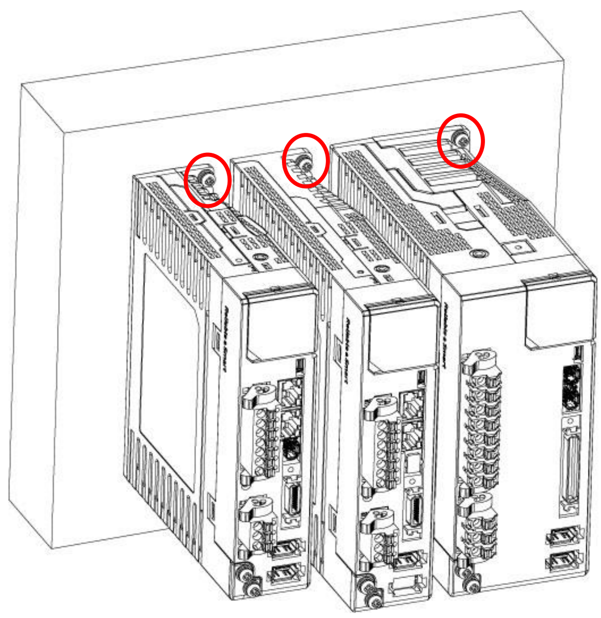
< 800W & above>

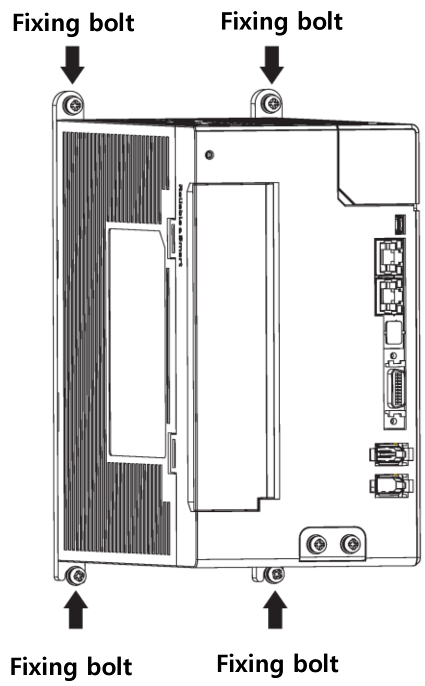
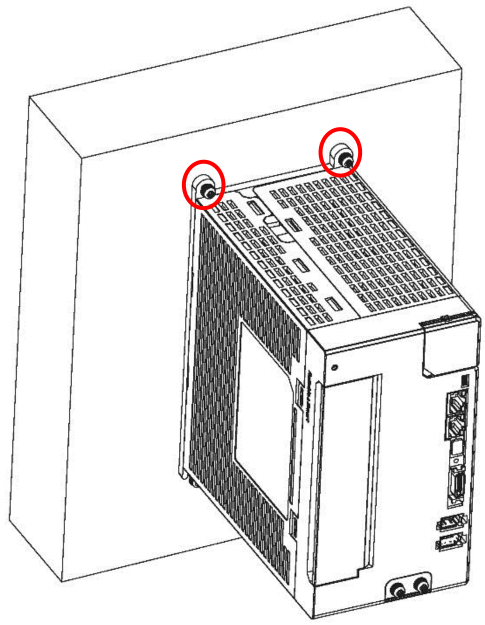
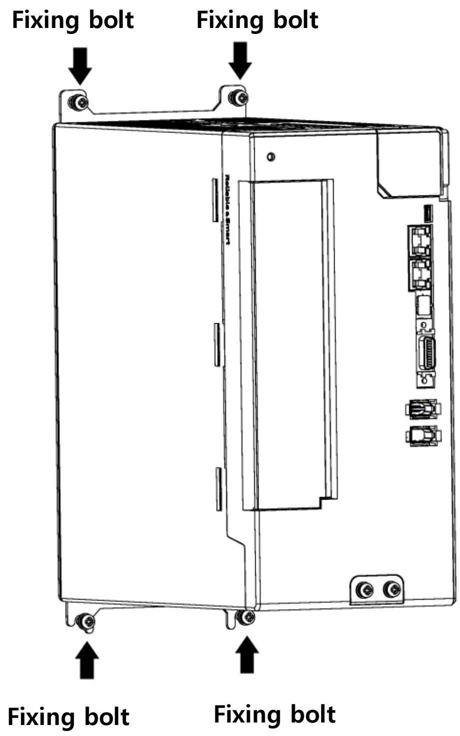
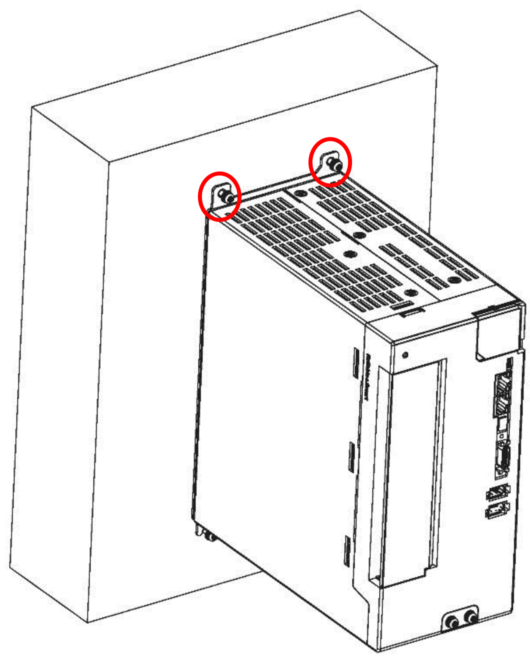


< 3.5KW >



< 5KW >

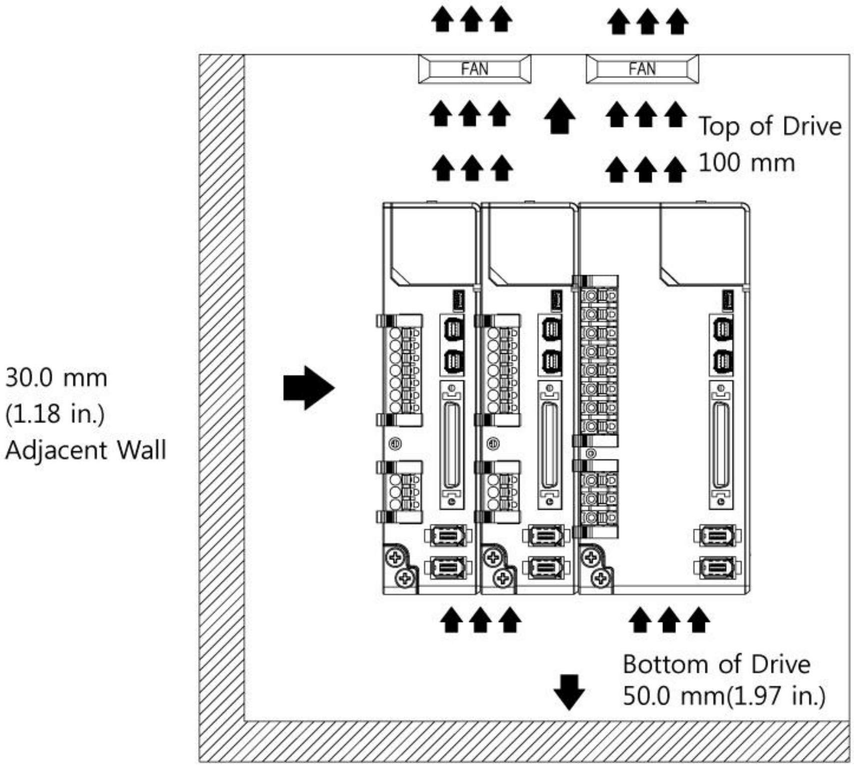
<table>
<tr><th colspan="2">< RACK MOUNT ></th></tr>
<tr><td>Fixing Bolt
• 400W & less : One M4 x L10 bolt for top and bottom
• 800W & above : Two M4 x L10 bolt for top and bottom</td><td>Apply M4 bolt to both top and bottom.
For more detailed information about the drive dimension, please refer to the page A-4 "Exterior Dimension and Mouning Dimension".</td></tr>
<tr><td>
</td><td></td></tr>
<tr><th colspan="2">< WALL MOUNT ></th></tr>
<tr><td>Fixing Bolt
• All model : One M4 x L10 bolt for top and bottom</td><td>Apply M4 bolt to both top and bottom.
For more detailed information about the drive dimension, please refer to the page A-4 "Exterior Dimension and Mouning Dimension".</td></tr>
<tr><td>
</td><td></td></tr>
</table>

< WALL MOUNT >	
Fixing Bolt All model : Two M5 x L12 bolt for top and bottom	Apply M5 bolt to both top and bottom. For more detailed information about the drive dimension, please refer to the page A-4 "Exterior Dimension and Mouning Dimension".
 < 3.5KW >	 < 3.5KW >
 < 5KW >	 < 5KW >

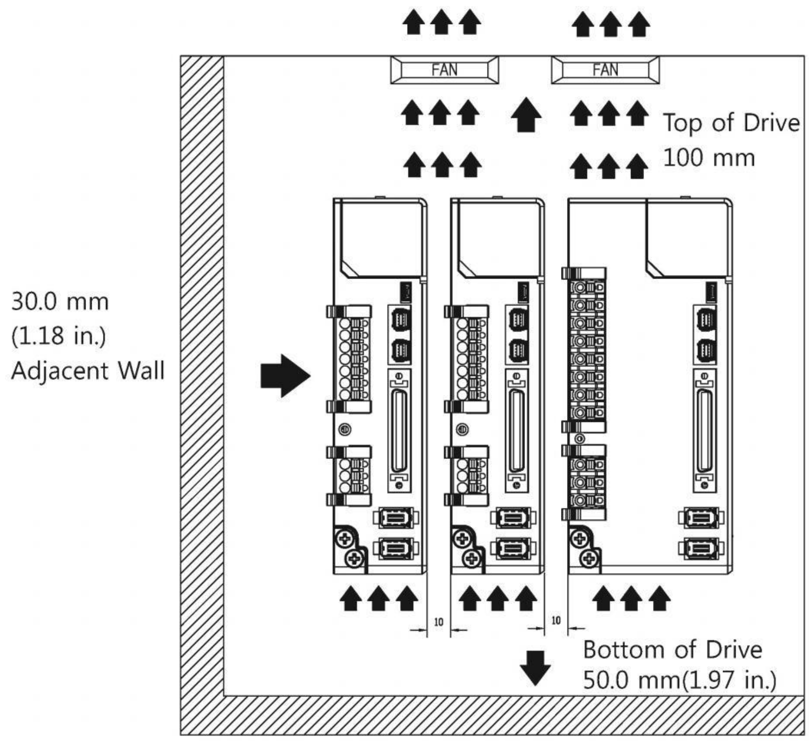
When installing several drives, you must the following criteria.

- Basically, keep distance between products: 1.5K or less: 10mm, 2.5KW or more: 30mm
- In case of zero stacking installation of the drive in 1.5KW or less, attach an external fan to keep the ambient temperature of the products below 40 degrees Celsius.

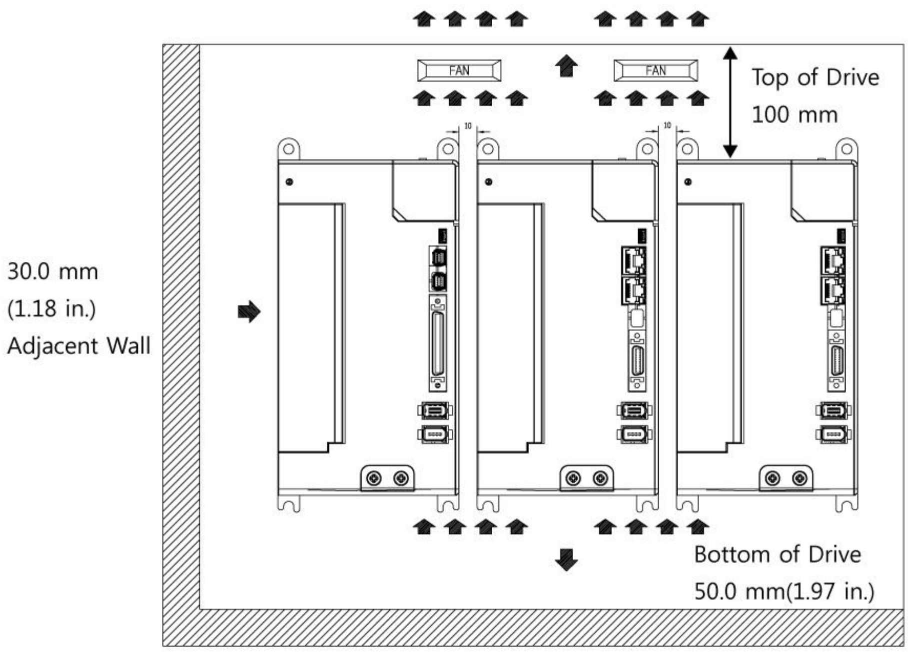
< Installation by Zero Stacking >

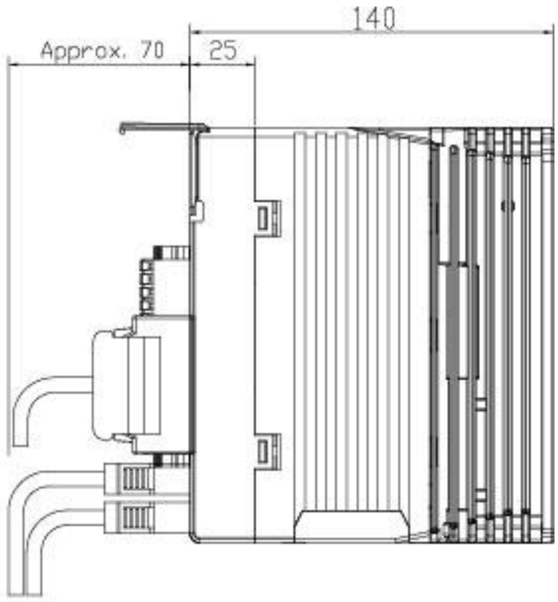


< Installation by 10mm intervals >-1.5KW or less

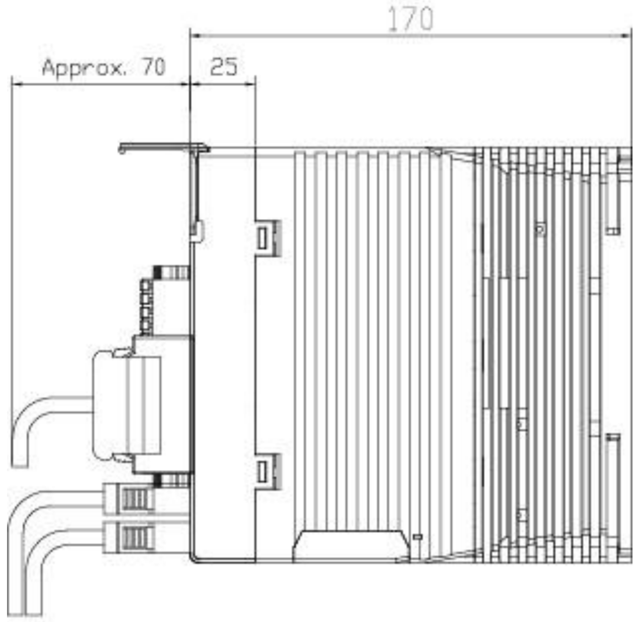


< Installation by 30mm intervals >-2.5KW or more

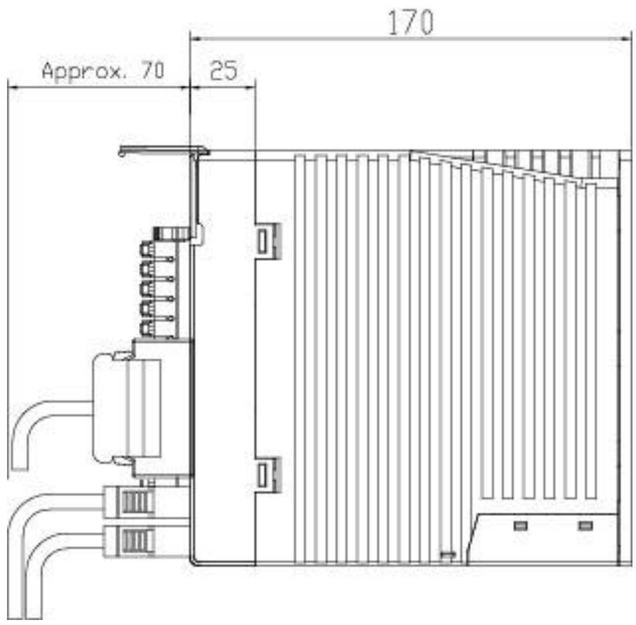




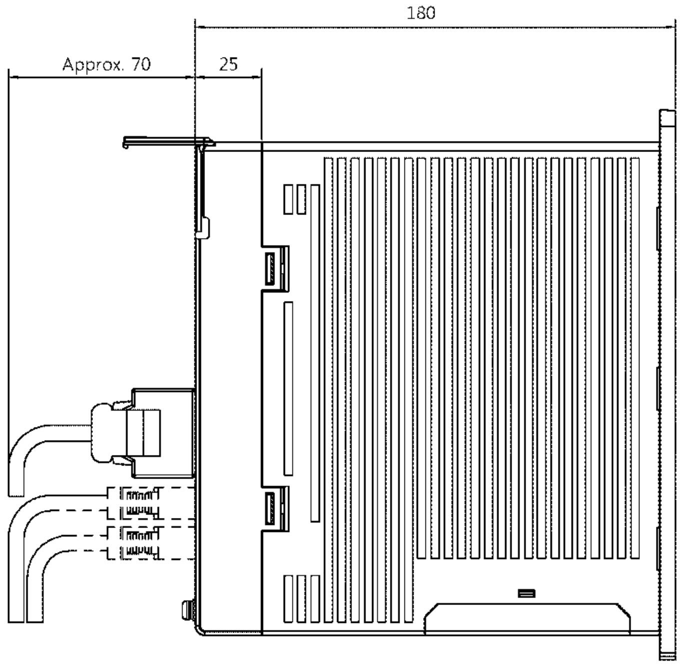
<100W, 200W>



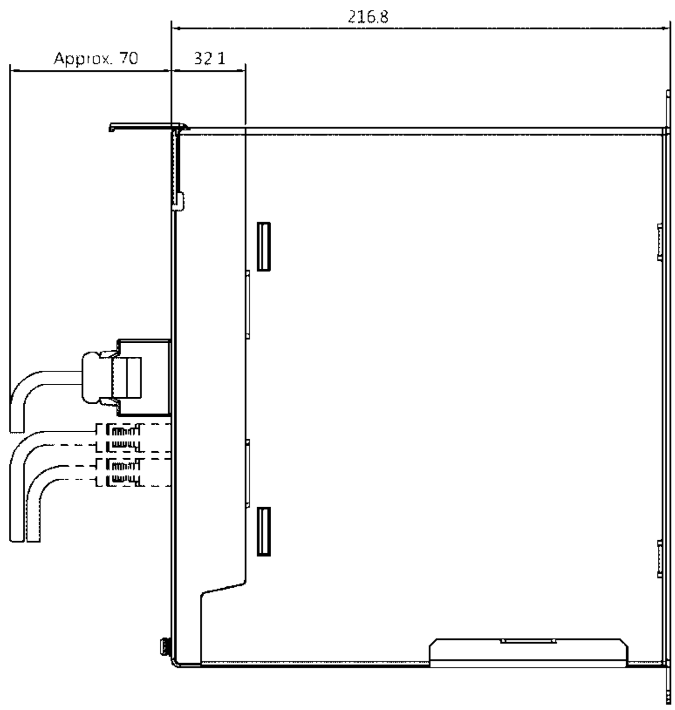
<400W>



<800W, 1KW, 1.5KW>



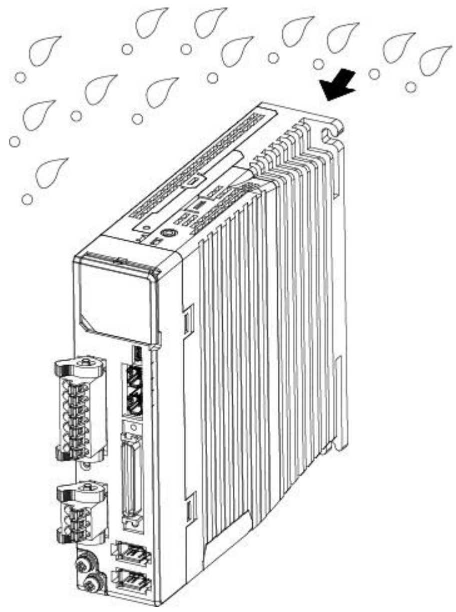
< 3.5KW >



< 5KW >

Use the drive in a clean environment

The installation environment for CSD7 Servo Drive is the pollution level 2 specified in the IEC-60664-1, and this product should be used at IP2x, so use the product in a clean environment without dust or humidity.

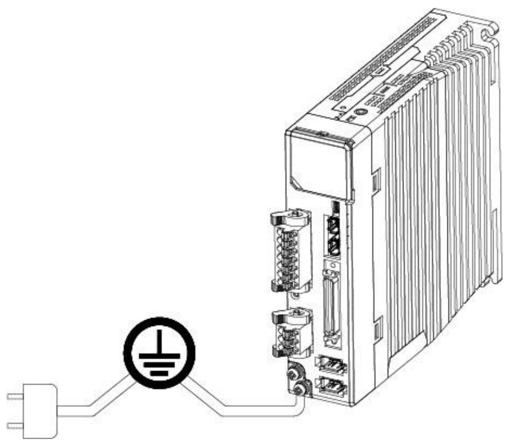


Ground Product

There is a grounding terminal at the bottom of the heat sink.

- 100W~1.5KW (All model) : Two M4 bolts
- 2.5KW~5KW (All model) : Two M5 bolts
  (for input power & motor power grounding)

If not grounded, it may reduce the performance. Be sure to connect the ground of input power and motor power to the grounding terminal of the drive.

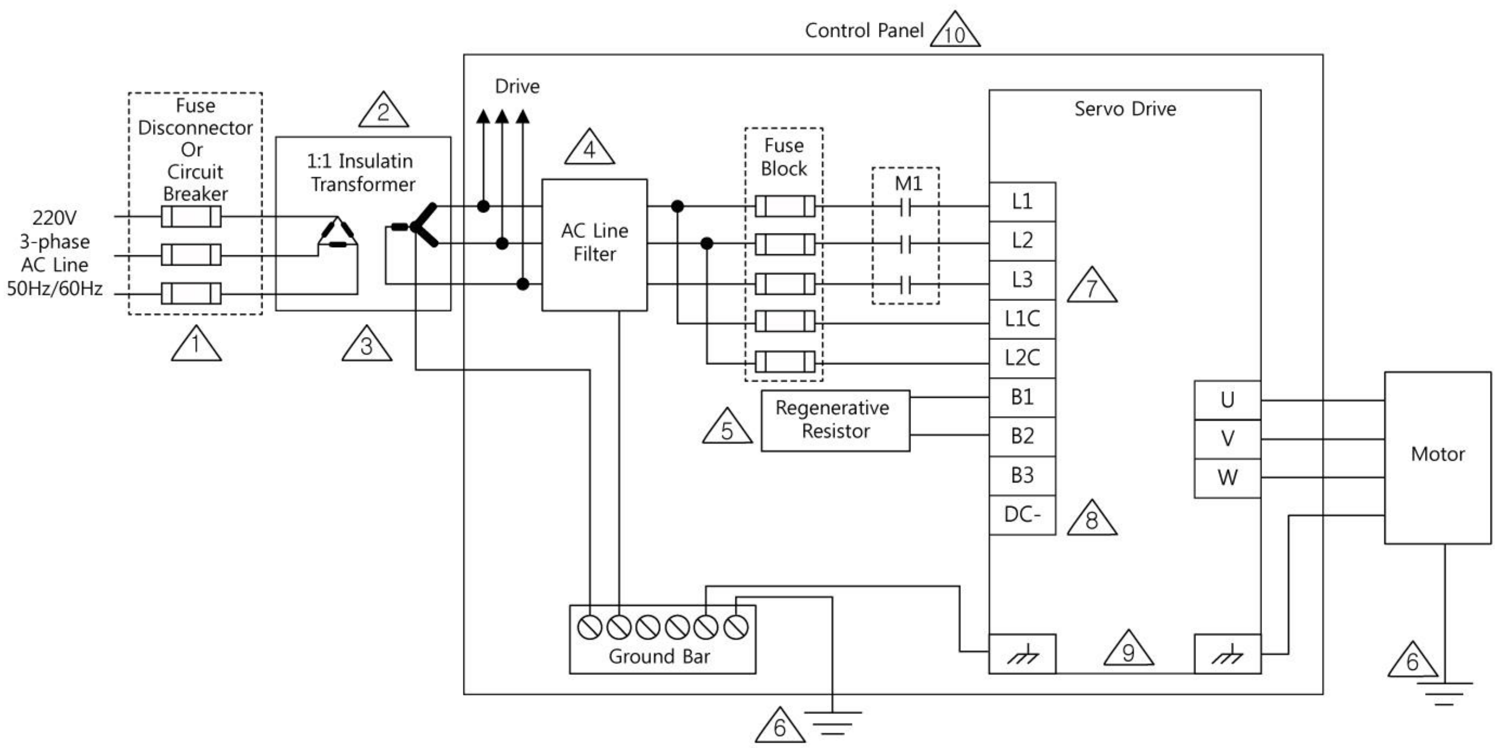


Installation Environment

The installation environment of the CSD7 servo drive is as follows.

Table 2 The installation environment of the CSD7

Item	Installation Conditions
Storage Temperature	-25 ~ 85 ℃
Operating Temperature	0 ~ 50 ℃
Operating Humidity	5 ~ 95 % RH at a place without condensations.
Vibration	5-55Hz @ 0.35mm(0.014") double amplitude, continuous displacement, 55-500Hz @ 2g peak constant acceleration.
Installation place	Installation place must meet the following conditions (IP2X, Pollution level 2) : • Indoors • Well ventilation • Easy checkup • Without explosive gas



(IP2x, Pollution level 2)

1. Power cut-off device is required for maintenance and safety purposes. Local regulations should be observed.
2. When using the transformer, the voltage between each phase and neutral point/ground should not exceed the rated input.
3. Use of insulating transformer is optional. If used, the secondary ground in a transformer should be connected to the ground plate.
4. To enhance the electromagnetic compatibility (EMC) and satisfy the European EMC directive, the AC power input filter and shielded motor cable should be used; and the ferrite core should be used in the AC power cable, motor power cable, enncoder cable, I/O cable and communication (USB & RS485) cable. As the AC power input filter has a large leakage current, discharge time is required after removing the power supply. The wiring between drive and filter should be kept as short as possible. The common ground plate should be installed close to the drive as much as possible.
5. The regenerative circuit is available only for the product of 400W and above (CSD7_04Bxx1 - CSD7_50Bxx1). For the product of 200W and below (CSD7_01Bxx1, CSD7_02Bxx1), the B1 and B2 terminal should be kept with nothing connected.
6. For the high-frequency ground, a thick braided wire is connected among the product, equipment enclosure, machine frame, motor and ground plate.
7. The product of 400W and below supports only a single-phase AC input, so there is no L3 terminal in the main power connector. Connect power cable only to L1 and L2.
8. It is a DC voltage connection terminal. Connect the DC power supply which has the circuit limiting the initial inrush current to the B1 and DC- terminal.
9. The heatsink of the CSD7 has two ground screws for motor and power ground respectively. The ground screws should be tightened with 1.25 Nm (11 lbs-in) torque.
10. As for the installation environment, the product should be installed in the environment with pollution level 1 or 2 as specified in an IEC-60664-1. Install CSD7 servo drive on the control panel which satisfies the IP54 protection.

Noise Filter and Ferrite Core

Table 3 Noise Filter and Ferrite Core

CSD7 drive	CSD7_					
	01BN1, 01BNF1	02BN1, 02BNF1	04BN1, 04BNF1	08BN1, 08BNF1	10BN1, 10BNF1	15BN1, 15BNF1
AC Power Filter	2090-XXLF-TC116(Tesch NF310/16)			2090-XXLF-TC318(Tesch NF210/16) 2090-XXLF-TC116(008xx1, if single-phase is applied)		
Ferrite Core	Wire for AC power, Motor power, Encoder signal : OP14.2x28.5-6.8H Wire for I/O, communication (USB & RS485) : OP12x20-5.6H					

CSD7 drive	CSD7_		
	25BNF1	35BNF1	50BNF1
AC Power Filter	TB3-B016AD2F (DONG IL Technology)		TB3-B050AD2F (DONG IL Technology)
Ferrite Core	Wire for AC power, Motor power, Encoder signal : ZCAT3035-1330 Wire for I/O, communication (USB & RS485) : ZCAT3035-1330		

IMPORTANT

- To maintain reliability for a long time, use it within from 0 to 35℃.
- Install a serperate cooling device at a place with high ambient temperature, and use it within the operating temperature. (0~50℃)

Servo Motor Installation

Note For the motor dimension related to the installation of the servo motor, please refer to Servo Motor Manual (Publication SMOTOR-UM002).

Chapter 3. Wiring

This chapter describes the wiring information for motor, host controller and other peripheral devices connected to the servo drive, along with the circuit diagram.

Before You Begin

Pay attention to the following precautions when wiring.

CAUTION

- Wiring should be done only by the qualified person.
- High voltage remains in the drive even through the power is off. Therefore, do not inspect components unless inside 'Charge Lamp' goes out completely.
- Pay attention to the polarity when wiring.
- The heatsink of the drive generates high temperature. Pay attention to wiring the cables not to pass by near the heatsink.

In this chapter, the circuit is divided into electric circuit and signal circuit for easier and more convenient explanation. Be fully aware of the names of each part when reading this user's manual.

<2.5Kw Under>

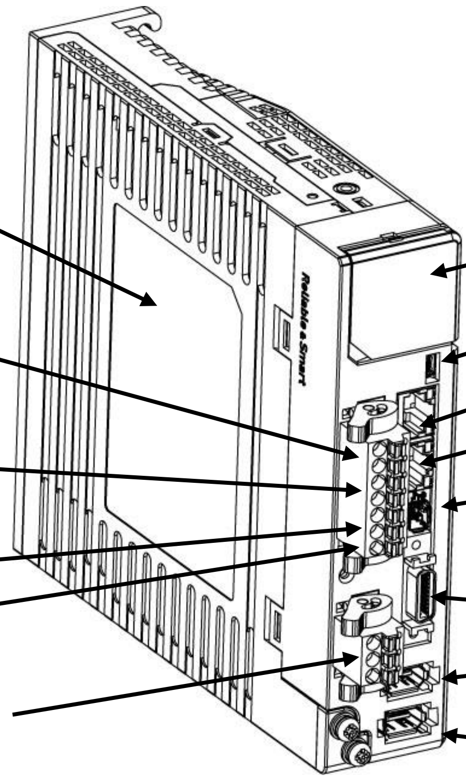
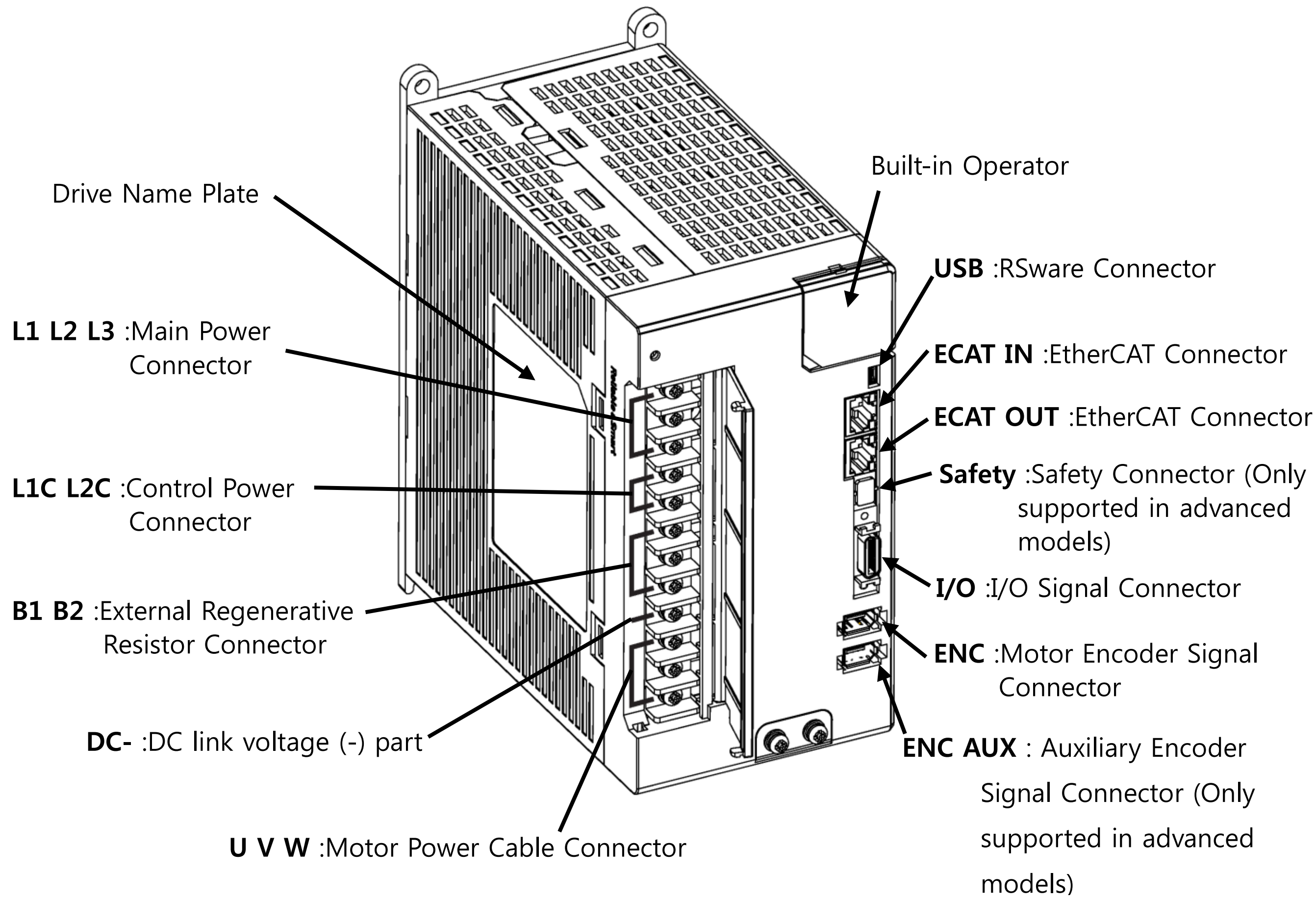


Table 4 The name of each part and function

No	Name	Function description
1	Built-in Operator	Composed of 6 7-segments and 4 buttons. Function available - Parameter Editing, Status Display, Monitoring, Run Function
2	USB	Connector for RSWare (PC Software)
3	ECAT IN, ECAT OUT	Connector for EtherCAT network
4	Safety	Provides the functional Safety function, STO (Safety Torque Off)
5	I/O	Input/Output function composed of 20 pins
6	ENC	Input the serial encoder signal of the motor used.
7	ENC^{AUX}	Connector for the external linear scale used for the full closed function.

<3.5Kw~5Kw>



The input/output signal connector (I/O) and encoder signal connector (ENC) are explained in this chapter while the USB, EtherCAT and safety connectors are explained in the Appendix B, 'Cable & Connector Specifications'.

Power Supply, Motor Power, Regenerative Resistor

Name and function of each terminal

The name of each terminal are printed on the front of the drive. Perform wiring for the drive after thoroughly reading through the table below.

Table 5 Terminal name and function

Terminal	Name	Function	
AC Main Power Input	L1, L2	400W and lower	Single-phase AC 170 ~ 253 Vrms, 50/60 Hz
	L1, L2, L3	800W and higher	3-phase AC 170 ~ 253 Vrms, 50/60 Hz (Single-phase is available at 800W)
Control Power Input	L1C, L2C	All model	Single-phase AC 170 ~ 253 Vrms, 50/60 Hz
Motor Power Cable Connector	U, V, W	Connect to the 3phase power (U,V,W) cable of motor.	
Grounding Terminal (Heat Sink)	⏚	Connect the F.G of input power and motor power to the grounding terminal of the drive.	
Regenerative Register Connector	B1, B2	200W and lower	As the function for regenerative energy consumption is not required, the regenerative resistor does not have to be mounted.
		400W and higher	If the capacity of the mounted regenerative resistor is insufficient, connect an external resistor with a larger capacity in a parallel manner to the regenerative resistor connector (B1 and B2). You should not connect the resistor with the resistor value smaller than the existing resistor value. For the value of the external regenerative resistor to be added, contact RS Automation before changing it.
	B1, B2, B3	2.5KW and higher	This connector is for the easy connection of the external shunt resistor. The external shunt resistor should be connected between B1 and B3
External Condenser Connector	B1 DC-	It is the terminal where external condenser is connected if the condenser capacity of the servo drive is insufficient. Connect the condenser (+) polarity to the B1 terminal; and (-) polarity to the DC- terminal. If it is necessary to connect an external condenser, be sure to contact RS Automation for advice.	

Main Power Connector (L1, L2, L3) and Control Power Connector (L1C, L2C)

As the main power input and control power input can be connected to the drive separately, a user can configure the peripheral circuit so that the drive itself can cut off only the main power selectively if there is an emergency.

If the drive independently checks the status and only the main power is cut off, but not the control power, the drive can display the cause of cut-off of the main power. The user can take appropriate action after identifying the cause of cut-off of the main power

Refer to the 3-7 page “Electric Circuit Diagram” for the Electric Circuit Diagram of the power separation.

Motor Power Cable Connector (U, V, W)

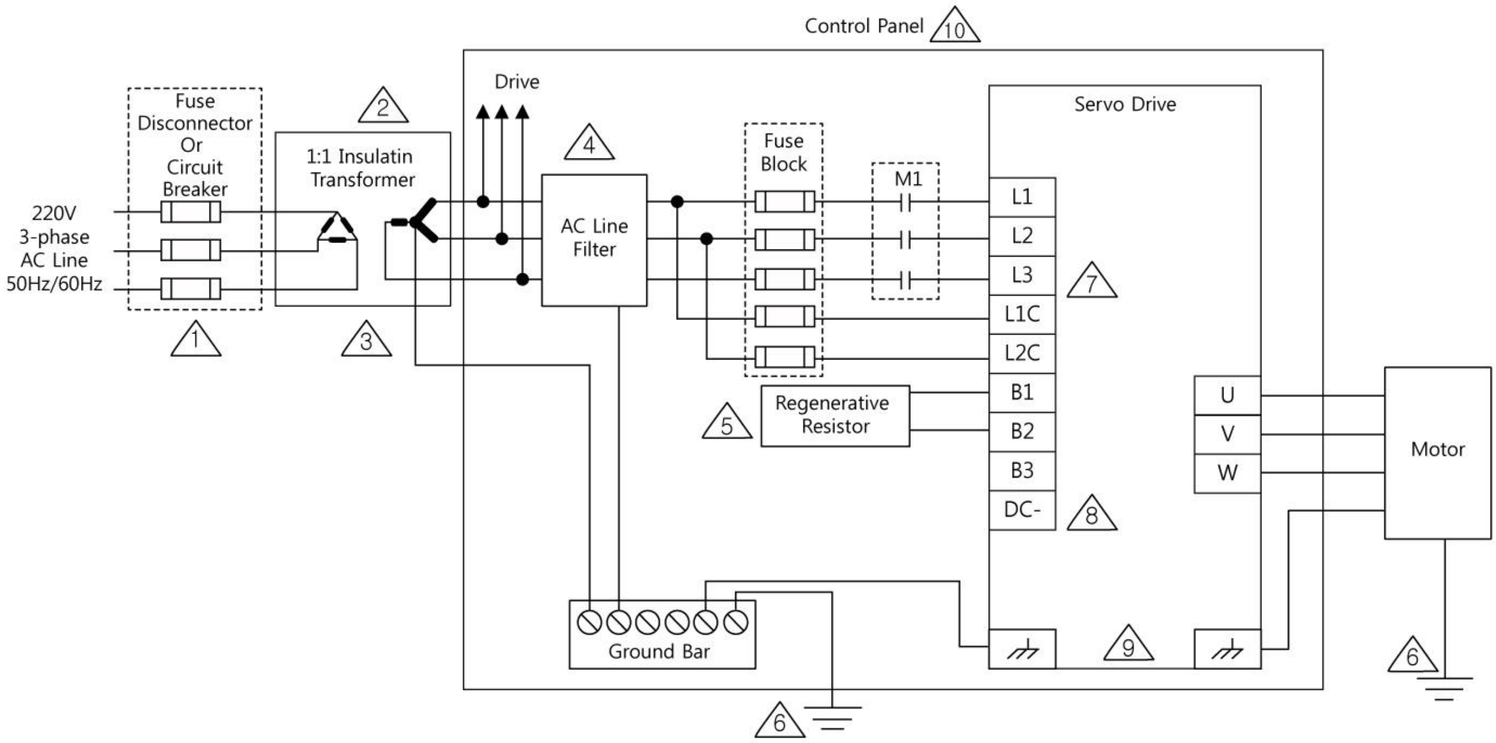
WARNING	The motor power cable connector (U, V, W) is output terminal. Do not connect the input power. It may cause the drive damage.

Regenerative Resistor Connector (B1, B2, B3)

Refer to the 9-12 page "Regenerative Braking Resistor" for details of the regenerative resistor connection.

CAUTION	• When wiring the wiring socket, be careful not to expose the core wire. It may cause an electric shock. • Completely discharged before handling after power off.

Electric Circuit Diagram



Expanation for each part

1. Power cut-off device is required for maintenance and safety purpose. The local regulations should be observed.
2. When using the insulating transformer, the voltage between each phase and neutral point/ground should not exceed the rated input voltage.
3. Use of insulating transformer is optional. If used, the secondary part in a transformer should be grounded.
4. To enhance the electromagnetic compatibility (EMC) and satisfy the European EMC directive, the AC power input filter and shielded motor power/signal cable are used; and the ferrite core should be used in the AC power line, motor power/signal line, input/output and communication (USB & RS485) cable. As the AC power input filter has a large leakage current, discharge time is required after removing the power supply. The wiring between drive and filter should be kept as short as possible. The common ground bar should be installed to the drive as close as possible.
5. The regenerative circuit is available only for the product with

400 W and above (CSD7_04Bxx1 - CSD7_50Bxx1). For the product of 200 W and below (CSD7_01Bxx1, CSD7_02Bxx1), the B1 and B2 terminal should be kept with nothing connected.

6. For the high-frequency ground, a thick braided wire is connected among the product, equipment enclosure, machine frame and motor.
7. The product of 400 W and below supports only a single-phase AC input, so there is no L3 terminal. Connect power only to L1 and L2.
8. It is a DC voltage connection terminal. Connect the DC power supply which has the circuit limiting the initial charging input current to the B1 and DC(-) terminal.
9. The heatsink on the drive has two screws for ground connection of motor and input power respectively. The ground screw should be tightened to 1.25 Nm (11 lbs-in) torque.
10. As for the installation environment, the product should be installed in the environment with pollution level 1 or 2 as specified in the IEC-60664-1. Install the drive on the control panel which satisfies the IP54 protection.

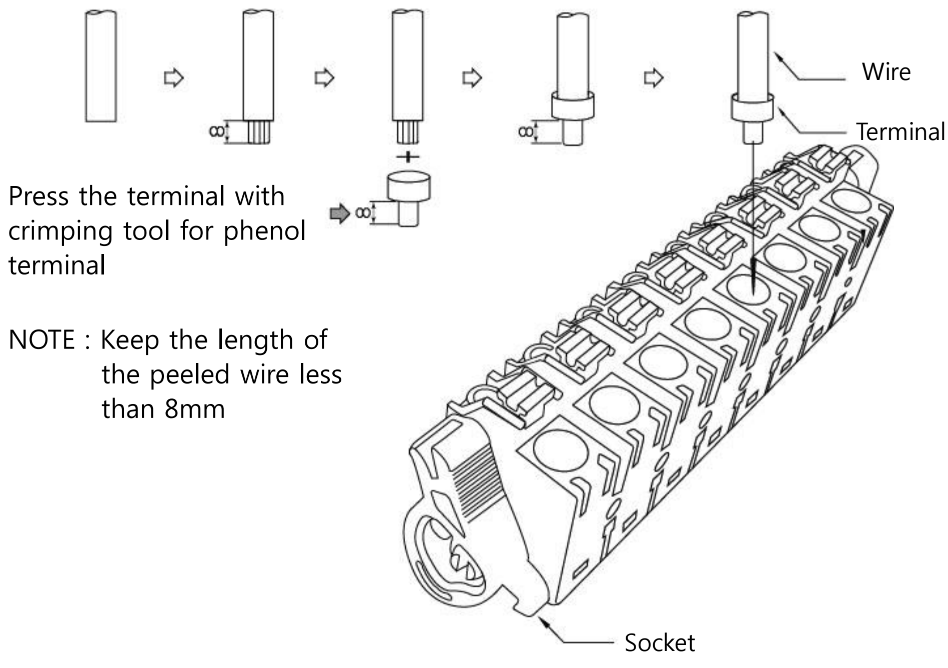
CAUTION

Use single-phase input power in servo drive whose rated output (capacity) is 400 [W] and lower.

Using Method of Socket and Lever

This section describes how to use wiring socket and lever provided with servo drive.

- Connect only one wire to the wire inlet of the socket.
- If the wire is pulled accidentally with an excessive force, reconnect the wire after trimming it properly.
- The peeled wire can be used. (Keep the length of the peeled core wire less than 8 [mm].)
- The use of phenol terminal is recommended for the reliability of wiring.
- After connecting the wire, pull it slightly to check if the connection between the socket and wire is normal.
- You can disconnect the wire by pressing the button at the top of the socket.



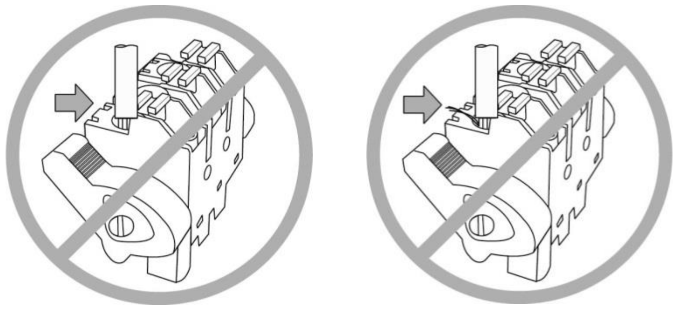
The thickness of wire allowed by the socket is shown below.

Table 6 Thickness of wire

Rated Power	Wire Thickness
400W and less	AWG26 ~ AWG14 (Stranded Wire)
800W and above	AWG20 ~ AWG14 (Stranded Wire)

CAUTION

Insert the wire completely. If peeled core wire is exposed, it may cause an electric shock.



I/O Signal (I/O)

I/O Connection Diagram

This is the circuit diagram of a connector for I/O signal. It is divided into input on the left and output on the right.

The Backup battery for absolute encoder does not have the separate terminal. It must be connected at motor encoder cable side.

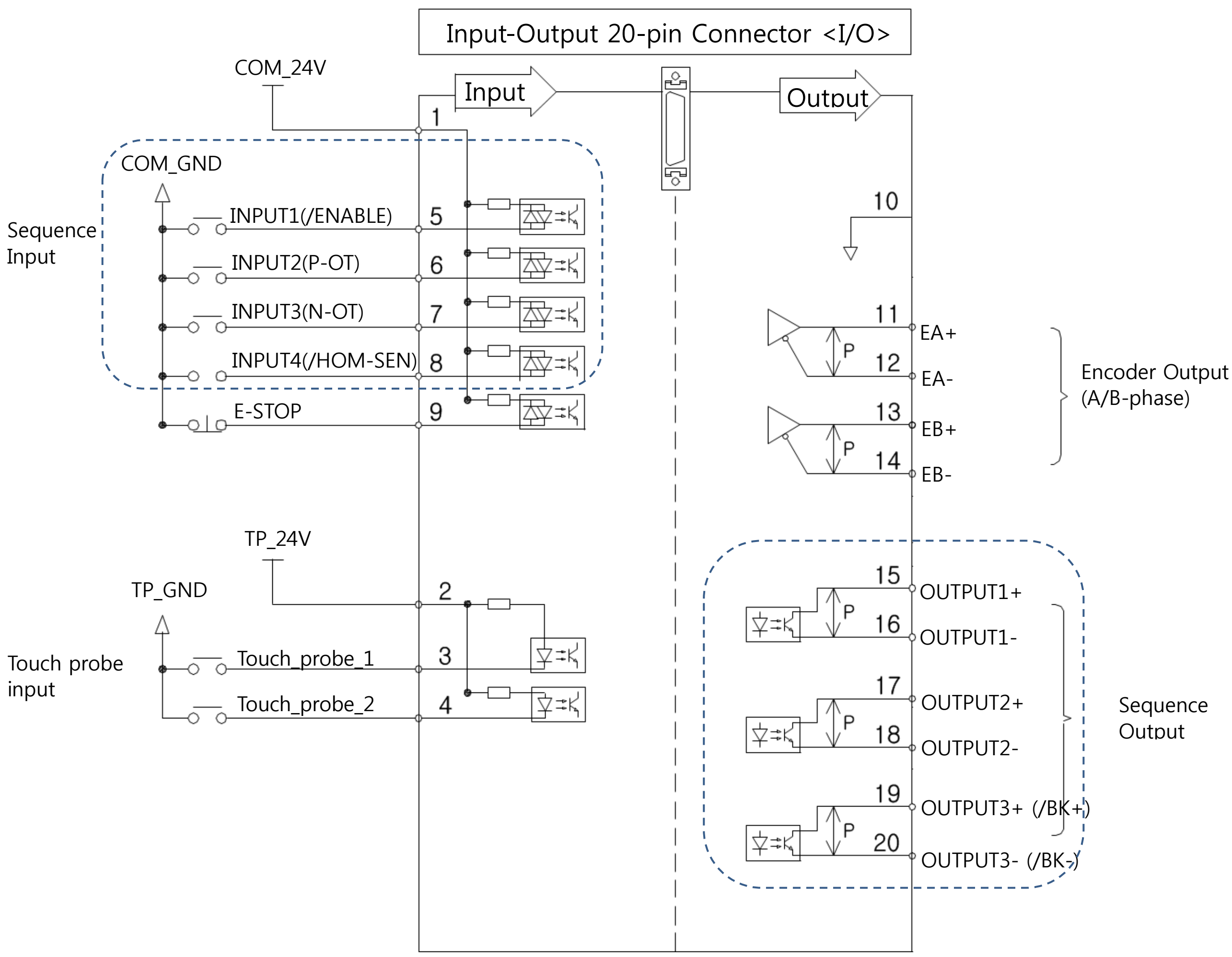


Table 7 I/O pin Specification

Pin No.	Signal Symbol	Description
1	COM_24V	Common for Digital input 1~4 (Use DC 24V normally)
2	TP_24V	Common for Touch probe input (Use DC 24V normally)
3	Touch_probe_1	Touch probe input 1
4	Touch_probe_2	Touch probe input 2
5	INPUT1	Digital input 1(/ENABLE)(1)
6	INPUT2	Digital input 2(P-OT)(1)
7	INPUT3	Digital input 3(N-OT)(1)
8	INPUT4	Digital input 4(/HOME)(1)
9	E-STOP	Emergency Stop (Initial value ; Disable)(1)
10	Signal GND	Encoder Signal Output Ground (Common GND for Pin No. 11~14)

Pin No.	Signal Symbol	Description
11	EA+	Encoder Signal Output A+
12	EA-	Encoder Signal Output A-
13	EB+	Encoder Signal Output B+
14	EB-	Encoder Signal Output B-
15	OUTPUT 1+	Digital Output 1+
16	OUTPUT 1-	Digital Output 1-
17	OUTPUT 2+	Digital Output 2+
18	OUTPUT 2-	Digital Output 2-
19	OUTPUT 3+	Digital Output 3+ (/BK+)(1)
20	OUTPUT 3-	Digital Output 3- (/BK-)(1)

(1) Factory initial values

Sequence I/O Signal

What is Sequence I/O Signal ?

To provide the optimum performance that is suitable for user's equipment, 20 pin connector of I/O is used to allow the drive can input/output signals that have various functions.

Input provides 11 functions and you can freely allocate input signal of each function with 4 pins such as pin No. 5, 6, 7 and 8 of I/O.

Output provides 12 functions and you can freely allocate output signal of each function with three pairs of pins such as pin No. (15,16), (17,18) and (19,20) of I/O.

Sequence I/O signal means the I/O signal of various functions that are required for the sequence control of the servo drive by the host controller.

Sequence I/O signal is not to process input or output signal with the fixed pin of I/O, but to select the function that the user requires in terms of circuit design of host controller and to directly allocate the selected functions to the designated pin.

Therefore, the host controller can do the sequential control that fits to the equipment to operate servo drive.

Sequence Input Signal (Allocable)

The following is the brief explanation on 11 functions of sequence input signal. You can allocate each function to seqeunce input pin of I/O. Details for each signal are explained in the reference pages listed on the right side of the table.

Table 8 I/O Sequence Input Signal

Input signal source	Description	Operation mode	Details
</ENABLE> Servo-On Available Signal	While the input is ON, the Servo-drive is changed to Servo-ON by the Servo-ON command on the host controller. (The factory-setting value of /ENABLE signal is 'b' (always ON), so the Servo-drive follows the Servo-ON command from the host controller without receiving additional /ENABLE signals.)	All	4-2 page "About Servo-ON Signal"
<A-RST>Fault Reset	It clears the fault in the drive.	All	9-41 page "Fault Reset by Sequence Input </A-RST> Signal"
</G-SEL> Gain Group Conversion	Use 2-group gain when it is set to ON and use current gain when it is set to OFF. It converts gains of 2 groups.	All	8-42 page "Gain Group Switching, </G-SEL> Function"
</P-TL> Positive Torque Limit	When it is set to ON, the forward torque is limited by the 0x2409 (Ft-4.09).	All	
</N-TL> Negative Torque Limit	When it is set to ON, the reverse torque is limited by the 0x240A (Ft-4.10).	All	
<P-OT> Positive Over-travel	It prohibits the motor from rotating forward when the motor load reaches the limit of the available section.	All	9-3 page "Overtravel Input (<P-OT>, <N-OT>)"
<N-OT> Negative Over-travel	It prohibits the motor from rotating reversely when the motor load reaches the limit of the available section.	All	9-3 page "Overtravel Input (<P-OT>, <N-OT>)"
</P-CON> P Control Conversion	It converts the Velocity Controller from P-I type controller to P type controller. It is used to suppress the undershoot in the transient response and reach the target position with a faster response.	All	8-33 page "P/PI Mode Setting Function"
</R-ABS> Absolute Encoder Multi-rotation Data Reset	Erases the multi-rotation data of the absolute encoder	All	9-34 page "Reset of Absolute Encoder (0x300A, run-10)"
</BANK-SEL> Gain Bank Select	Uses the 3rd and the 4th Gain Bank when it is set to ON. Use the 1st, 2nd Gain Bank when it is set to OFF.	All	8-44 page "</BANK-SEL> Function"
</HOM-SEN> Home Sensor	The Home sensor used for Homing.	All	

Allocation Method for Sequence Input Signal

Refer to the table below, and allocate the functions that you want to use to the 5 pin ~ 8 pin of the I/O.

As shown in the Table 10 below, the function of all sequence inputs is fixed to the each digit of the related parameter. To use a certain function, customer should set a number among ‘1’ to ‘4’ except ‘0’ to the related digit of the parameter.
For example, if you want to allocate </ENABLE> function to I/O pin No. 5, enter ‘1’ to the 0x200A[1](1st digit of 0x200A) or Ft-0.10[D0](1st digit of Ft-0.10).

Enter ‘0’ when the function of the sequence input is not used. If you want to make sequence input ‘ON’ all the time regardless of the wiring, set the related digit of the parameter to ‘b’.

Table 9 I/O Sequence Input Signal Allocation

<table>
<tr><th>Setting Value</th><th>b</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td>Input Channel No.</td><td rowspan="2">Always Valid</td><td>INPUT #4</td><td>INPUT #3</td><td>INPUT #2</td><td>INPUT #1</td><td rowspan="2">Always invalid</td></tr>
<tr><td>I/O Pin No.</td><td>8</td><td>7</td><td>6</td><td>5</td></tr>
</table>

The following table describs each digit of the parameters for sequence input signal allocation. Set the digit of the parameter to the right value customer want to use.

Table 10 Digit of Parameter for Sequence Input

Index	Parameter	Digit of Parameter / Sub-index			
		3 / Sub-index 4	2 / Sub-index 3	1 / Sub-index 2	0 / Sub-index 1
0x200A	Ft-0.10	</P-CON> Initial Value: 0	<N-OT> Initial Value: 3	<P-OT> Initial Value: 2	</ENABLE> Initial Value: b
0x200B	Ft-0.11	Reserved	</P-TL> Initial Value: 0	</N-TL> Initial Value: 0	</A-RST> Initial Value: 0
0x200C	Ft-0.12	Reserved	Reserved	Reserved	Reserved
0x200D	Ft-0.13	Reserved	</G-SEL> Initial Value: 0	Reserved	Reserved

0x200E	Ft-0.14	Reserved	Reserved	Reserved	Reserved
0x200F	Ft-0.15	Reserved	Reserved	</BANK-SEL> Initial Value: 0	</R-ABS> Initial Value: 0
0x2010	Ft-0.16	Reserved	Reserved	Reserved	</HOM-SEN> Initial Value: 4
0x2011	Ft-0.17	Reserved	Reserved	Reserved	Reserved
0x2012	Ft-0.18	Reserved	Reserved	Reserved	Reserved
0x2013	Ft-0.19	Reserved	Reserved	Reserved	Reserved

The table below is the example to allocate sequence input singal.

Table 11 Example for Sequence Input Configuration

Configuration Example			
<Index Setting> 0x200A[02] = 2 <Built-In Setting> Ft-0.10[D1] = 2		The second sub-index of 0x200A is set to 2, or the second digit of Ft-0.10 is set to 2. This value is intended to allocate the <P-OT> input function, and 2 is set here which means that "INPUT 2" (I/O connector #6 pin) will be used as a <P-OT> input.	
Applicable Modes	All	Other Details	Servo off>Configuration>Completed

Sequence Output Signal (Allocable)

The following is the brief explanation on 12 functions of sequence output signal. You can allocate each function to seqeunce output pin of I/O. Details for each signal are explained in the reference pages listed on the right side of the table.

Table 12 I/O Sequence Output Signal

Output signal source	Description	Operation mode	Details
</P-COM (+, -)> Position Completion Signal	This signal turns ON while the position error is within the value of the position completion range 0x2312 (Ft-3.18).	CSP	
</NEAR (+, -)> Position Proximity Signal	This signal turns ON while the position error is within the value of the position proximity range 0x2313 (Ft-3.19)	CSP	
</V-COM (+, -)> Speed Correspondence Signal	This signal turns ON while the velocity error is within the value of the Speed Correspondence Range 0x2212 (Ft-2.18).	All	
</TG-ON (+, -)> Rotation Detection Signal	This signal turns ON while the feedback speed of the motor is higher than the value of the Rotation Detection Level 0x2212 (Ft-2.19).	All	
</T-LMT (+, -)> Torque Limit Detection	This signal turns ON when the feedback torque of the motor reachs the value of the Torque Limit.	All	9-24page "Torque Limit and Torque Limit Detection </T-LMT> signal output"
</V-LMT (+, -)> Speed Limit Detection	This signal turns ON when the feedback speed of the motor reachs the value of the Speed Limit.	All	9-23 page "Velocity Limit and Velocity Limit Detection </V-LMT> signal output"
</BK (+, -)> Brake Control	It is the signal for the brake control of the servo motor.	All	9-6 page "Motor Brake Control"
</WARN (+, -)> Warning Detection	This signal turns ON when a servo warning is detected.	All	10-5 page "Type of Servo Warning"
</A-VLD> Absolute Position Valid	This signal turns ON when the absolute position data is valid while using absolute motor.	All	
</RDY> Drive Ready	It means servo drive is in no fault and Servo-OFF status.	All	
</RMS-CLT1> Average Torque Load Factor Trigger 1	Set 'Average Torque Load Factor Trigger 1' Signal	All	9-50 page "Detection Function of Torque Load Factor"
</RMS-CLT2> Average Torque Load Factor Trigger 2	Set 'Average Torque Load Factor Trigger 2' Signal	All	

Note In this manual, < > is applied to the name of sequence I/O signal.

ex) </ENABLE>, </P-COM>

Allocation Method for Sequence Output Signal

Refer to the table below, and allocate the functions that you want to use to the pin No. (15,16), (17,18) and (19,20) of the I/O.

As shown in the Table 14 below, the function of all sequence outputs is fixed to the each digit of the related parameter. To use a certain function, customer should set a number among '1' to '3' except '0' to the related digit of the parameter.
For example, if you want to allocate BRAKE function to I/O pin No. (19,20), enter '3' to the 0x2016[3](3rd digit of 0x2016) or Ft-0.22[D2](3rd digit of Ft-0.22).

Set the setting value as '0' when the function of the sequence output signal is not used.

Table 13 Sequence Output Signal Allocation

Setting Value	3	2	1	0
Output Chanel No.	OUTPUT #3	OUTPUT #2	OUTPUT #1	Always Invalid
I/O Pin No.	19, 20	17, 18	15, 16	

The following table describs each digit of the parameters for sequence output signal allocation. Set the digit of the parameter to the right value customer want to use.

Table 14 Digit of Parameter for Sequence Output

Index	Parameter	Digit of Parameter / Sub-index			
		3 / Sub-index 4	2 / Sub-index 3	1 / Sub-index 2	0 / Sub-index 1
0x2016	Ft-0.22	</V-COM> Initial Value: 0	</BK> Initial Value: 3	</TG-ON> Initial Value: 0	</P-COM> Initial Value: 0
0x2017	Ft-0.23	</WARN> Initial Value: 0	</NEAR> Initial Value: 0	</V-LMT> Initial Value: 0	</T-LMT> Initial Value: 0
0x2018	Ft-0.24	Reserved	Reserved	</RDY> Initial Value: 0	</A-VLD> Initial Value: 0
0x2019	Ft-0.25	Reserved	Reserved	Reserved	Reserved

0x201A	Ft-0.26	Reserved	Reserved	Reserved	Reserved
0x201B	Ft-0.27	</RMS-CLT2> Initial Value: 0	</RMS-CLT1> Initial Value: 0	Reserved	Reserved

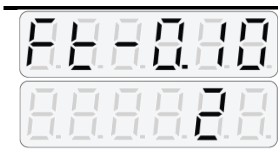
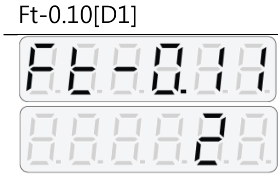
The table below is the example to allocate sequence output signal.

Table 15 Example for Sequence Output Configuration

Allocation Example			
<Object Setting> 0x2016[03] = 3 <Built-In Setting> Ft-0.22[D2] = 3		The 0x2016[03] (or Ft-0.22[D2]) is the index for allocation of </BK> function. The meaning of 3 in the 3rd digit of the index is that "OUTPUT3" (pin no. 19 and 20 of I/O connector) will be used as </BK> output function.	
Applicable Modes	All	Other Details	Servo off>Configuration>Completed

Notice for Sequence Signal Allocation

When you allocate the different functions to the same pin of I/O as shown below, the drive indicates servo warning in the 'Status Display Mode'.

 Ft-0.10[D1]	0x200A[02] or Ft-0.10[D1] was set to '2'. It means that the INPUT#2 pin of I/O is used as <P-OT> input function.
 Ft-0.11[D1]	0x200B[02] or Ft-0.11[D1] was set to '2'. It means that the INPUT#2 pin of I/O is used as </N-TL> input function.

When you allocate more than two functions to the same pin as described above, the servo warning is indicated.

Status Display Mode  (PIn)	In this case, when you reapply the power after completing the input allocation, servo warning "Pin" is indicated in the 'Status Display Mode'. Check if you allocate more than two functions to the same pin of I/O.

Note

- You can check the status of the sequence I/O signal through "Monitor mode function" on page 9-44.
- Unlike the sequence input that can be allocated, the E-STOP (Emergency Stop) signal is fixed to the pin No. 9 of I/O connector.
- Servo drive has self-diagnostic function.
- The 'servo fault' and 'servo warning' is divided according to the importance of fault diagnostic. For more information, refer to "Inspection and Protection Function" on page 10-1.

General I/O Signal

General Input Signal (Fixed)

External Power 24V

Table 16 Power Input

Signal Name	Symbol (Pin No.)	Function	Operation Mode	Details
External Power Input	COM_24V (Pin #1)	Input the external power of DC 24V as a control power input for contact signal. Power Specifications: 21.6~26.4V, 210mA	All	The common terminal for #5~#9 pin of 20-pin I/O connector
	TP_24V (Pin #2)	Input the external power of DC 24V as a common terminal for Touch Probe input signal. Power Specifications: 21.6~26.4V, 210mA	All	The common terminal for #3~#4 pin of 20-pin I/O connector

Emergency Stop

Table 17 Emergency Stop Input

Signal Name	Symbol (Pin No.)	Function	Operation Mode	Details
Emergency Stop	E-STOP (Pin #9)	Connect this signal to an extra emergency stop switch, and use it to quickly act upon emergency situation. User can select whether to use in 0x2005[04] or Ft-0.05[D3]. (0 : Disable, 1 : Enable)	All	3-23 page “Emergency Stop Input”

Touch Probe

Table 18 Touch Probe Input

Signal Name	Symbol (Pin No.)	Function	Operation Mode	Details
Touch Probe Input 1	Touch_probe_1 (Pin #3)	The exclusive terminal for the Touch Probe 1 input	All	
Touch Probe Input 2	Touch_probe_2 (Pin #4)	The exclusive terminal for the Touch Probe 2 input	All	

General Output Signal (Fixed)

Encoder Signal

Table 19 Encoder Signal

Signal Name	Symbol (Pin No.)	Function	Operation Mode	Details
Encoder Signal Output	EA+ (Pin #11)	Encoder signal A, B pulse in the form of line drive is transmitted to external device through these pins.	All	9-26 page "Position Feedback to the Host Controller"
	EA- (Pin #12)	Encoder pulse is multiplied by the value of 0x230B(Ft-3.11) and 0x230C(Ft-3.12).		
	EB+ (Pin #13)			
	EB- (Pin #14)	The direction of the encoder signal can be changed by the value of 0x2300[03] or Ft-3.00[D2].		

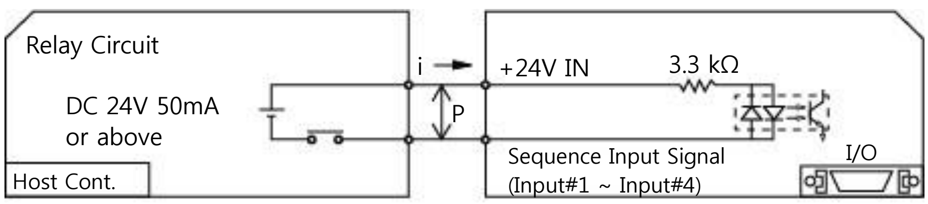
Interface with Input Circuit of I/O

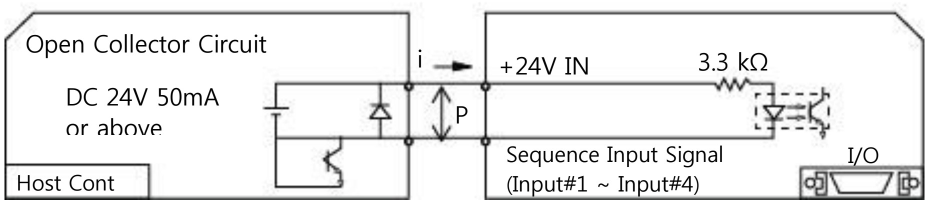
The following describes the connecontion circuit for input from the host controller to the servo drive.

Sequence Input Circuit

Relay or open collector output of the host controller is used for the sequence input circuit.

Make sure that the input current i is within 7 mA to 15 mA.





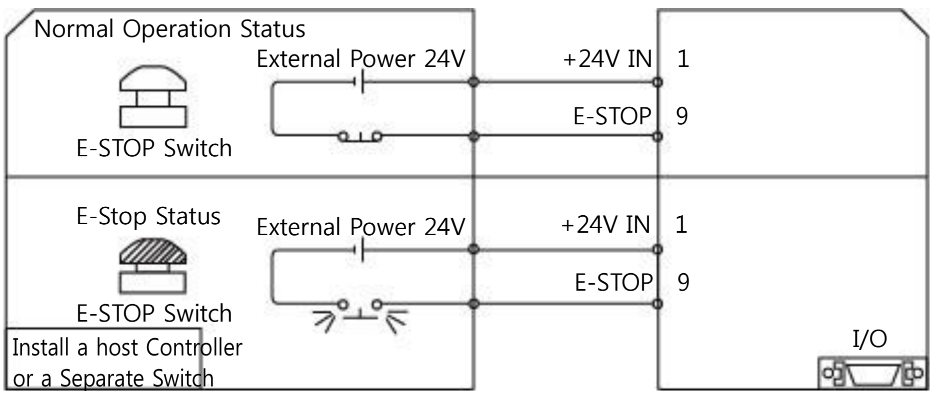
Emergency Stop Input

This drive has a built-in circuit for the emergency stop. To quickly respond to the equipment failure or dangerous situation, connect external emergency stop signal to #9 pin of I/O connector.

The I/O output of host controller or external switch for emergency stop can be used as the emergency stop signal source of the drive.

Customer can select whether to use the emergency stop input according to the value of the 0x2005[04] or Ft-0.05[D3]. The initial value is set as not to use. (Factory initial : 0x2005[04] = Ft-0.05[D3] = 0) So if you want to use this input signal, set this value to '1'.

The #9 pin of I/O is used as the input pin only for the emergency stop.



Note

- If the emergency stop signal is entered, servo fault "E.EStoP" is generated.
- For more information about the servo fault, refer to the 10-4 page "Protective Function".
- If the emergency stop is released, reset the fault by referring to the 9-40 page "Fault Reset (run-08)".
- You can check the status of emergency stop signal through the monitor mode described in the 9-44 page "Monitor mode function".

Interface with Output Circuit of I/O

There are 2 types for the servo drive output circuits. Design the input circuit at the host controller suitable for the each output circuit.

- Line Drive Output
- Photo-coupler Output

Line Drive Output

Output signal (EA+, EA-, EB+, EB-) that converted the encoder serial data into 2 phase (A phase and B phase) pulse, are transmitted through line drive circuit.
It is used to configure the position control loop in the host controller. Receive the pulse signal with the line receiver circuit in the host controller.

Set the value of R1 to 330 Ω.

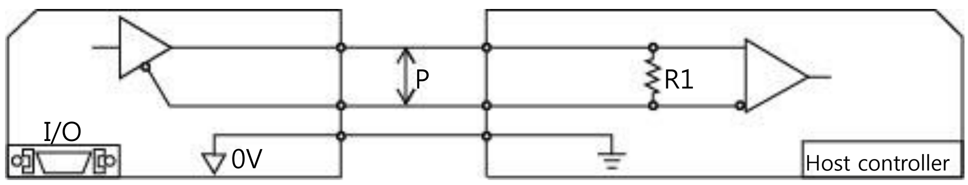
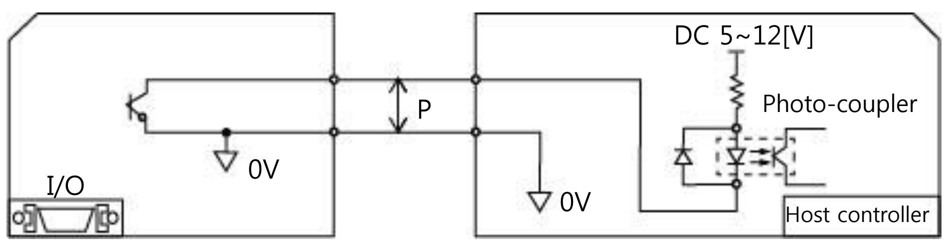


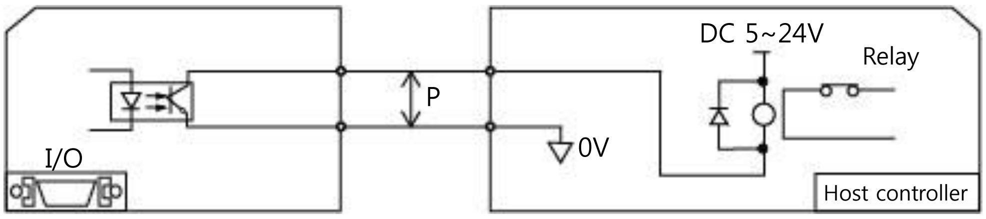
Photo-coupler Output

The sequence output signals are transmitted from photo coupler output circuits of the drive.

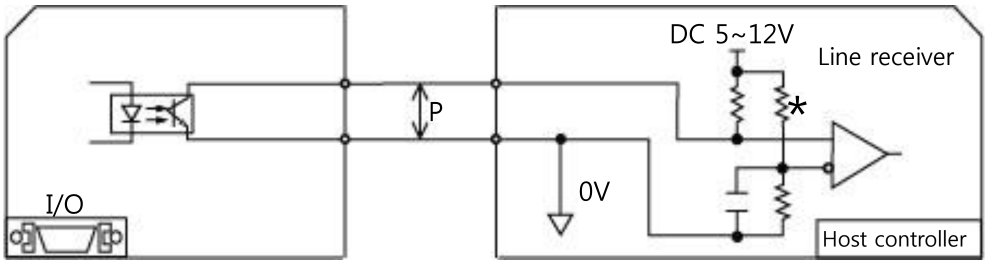
<u>In case of connection to the photo-coupler circuit of the host controller :</u>



In case of connection to the relay circuit of the host controller :



In case of connection to the line receiver circuit of the host controller :



* Terminal resistor should be connected.

Encoder Wiring

Encoder Signal Specification

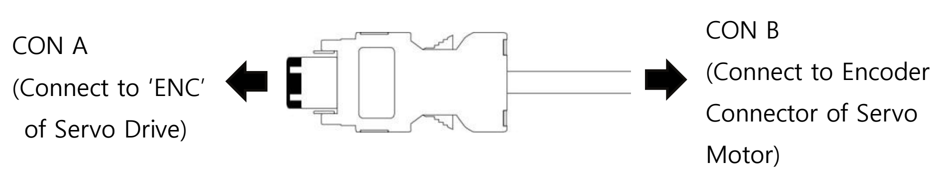
The following table describes the function for each pins of encoder connector (ENC).

Table 20 Signal Specification of Encoder Connector (ENC)

Pin No. of Servo Drive ENC Connector	Pin No. of Motor Encoder (CSMT,CSMR-17bit)	Function	Remark
1	4	SD+	Twisted pair
2	5	SD-	
3	7	VCC(5V)	
4	8	COM(0V)	
5	-	N.C	
6	-	N.C	
F.G	3	F.G	

Encoder Connector Specification

The following figure and table describe the connector specification of encoder cable.



CON A : Connector for connection to the 'ENC' of servo drive

Table 21 Encoder Connector Specification

Catalog number	Manufacturer
3E206-0100KV (Connector) 3E306-3200-008 (Assembly)	3M

The one kind of connector as listed above is used in CON A regardless of motor model and encoder.

CON B : Connector for connection to the encoder connector of servo motor

Table 22 Connector for using encoder cable of servo motor

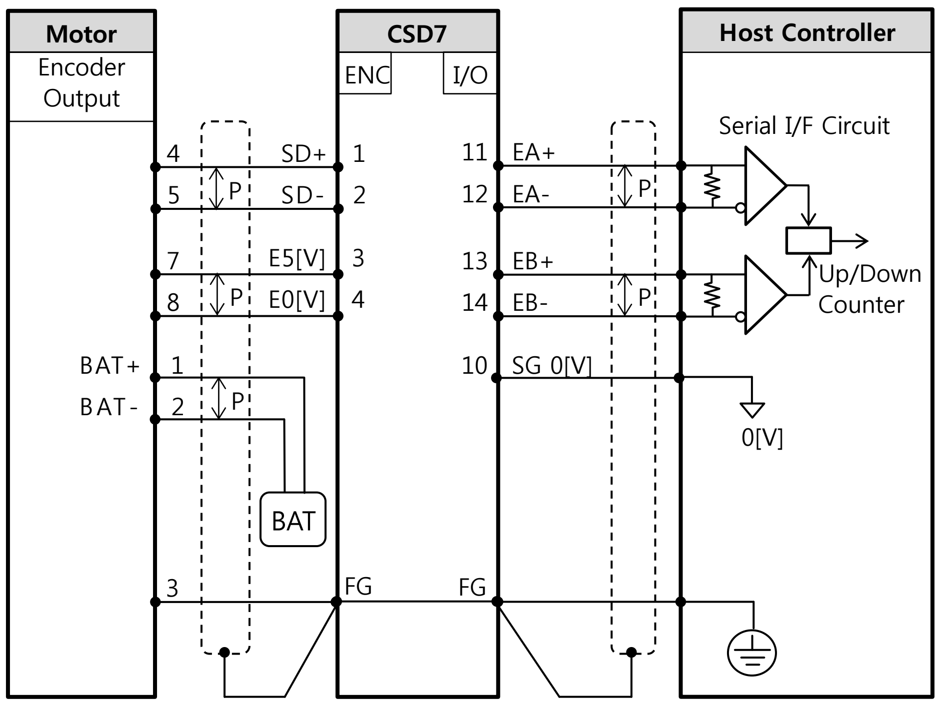
Motor	Type	Housing	Terminal	Manufacturer
CSMT, CSMR	Serial Abs., Serial Inc.	172161-1	170361-1 or 70365-1	AMP

Power cable connector for large capacity motor packed with the motor.

Note

Do not connect FG of servo drive to host controller if GND and FG are common, or if there is no separate FG.

Connection Diagram of Encoder Signal



* BAT : Connection for the Use of Absolute Encoder

General Articles Wiring

This part describes wiring to implement optimum performance of the servo drive in wiring and noise.

Precautions

Input Power Circut

- Use a thick wire as earth wire if possible.
- Class 3 grounding is recommended. (Recommendation: grounding resistance lower than 100 [Ω])
- Only 1 point must be grounded.
- Select ground phase and ground point considering the power conditions of installation region. If the power is supplied by the ground phase, wire it so that L2 of AC main power input terminal (L1, L2, and L3) becomes the ground phase.
- Use noise filter for the main power and control power.
- Electric circuit wiring and signal circuit wiring should be apart from each other as much as possible. (Min. 30 [cm] or more)
- Do not use same power with the electric ARC welding machine or electric spark machine.
- The earth wire of the servo motor must be connected to the grounding terminal of the drive. In addition, connect the grounding terminal of the drive to the building groud.
- If the wiring is inside the metal pipe, ground the pipe with class 1 grounding.
- The CSD7 cannot usable for the line-to-line input voltage in the 230/400V net. (The power network of 230/400V means that the line-to-neutral voltage is 230V and the lin-to-line voltage is 400V).

Signal Circuit

- The host controller should be installed as closely as possible to the drive, and the noise filter must be used.

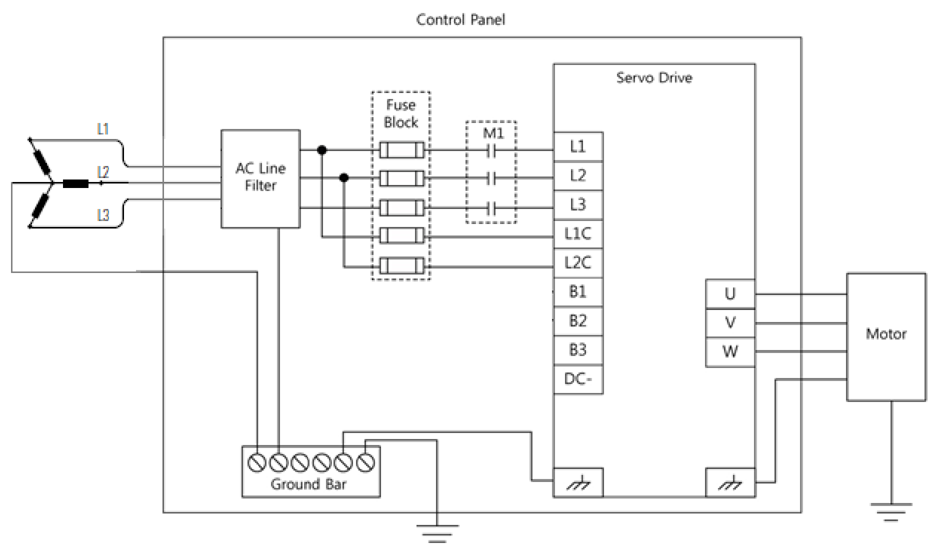
- I/O signal cable and motor encoder cable should be twist pair wire and batch shield wire.
- Note that the signal circuit wire is very thin, thus pay attention when handling it.
- If the noise is generated at command input cable, connect the cable GND to the SG(0V) befor the usage.

Others

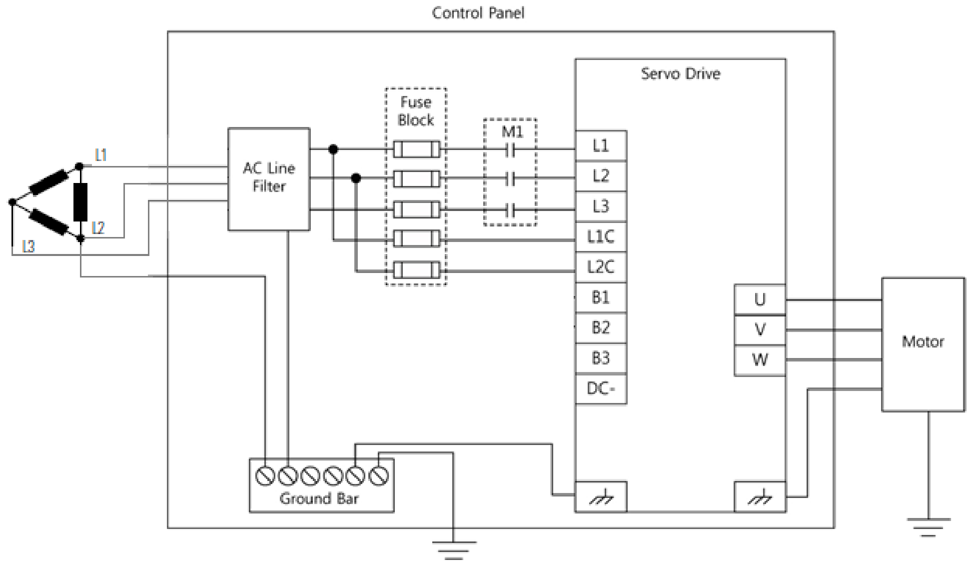
- Use the breaker or fuse for wiring to protect the servo drive.
- Make sure there is no continuous bending and stress to the wire.
- If used around residential area or the radio disturbance is concerned, use a noise filter on the input side of power line.
- As the drive is for industrial use, there are no measures for radio disturbance.
- Attach a surge absorption circuit such as surge absorber or surge suppressor to the relay, solenoid, and coil of the magnetic contactor.

Wiring examples for the Input power

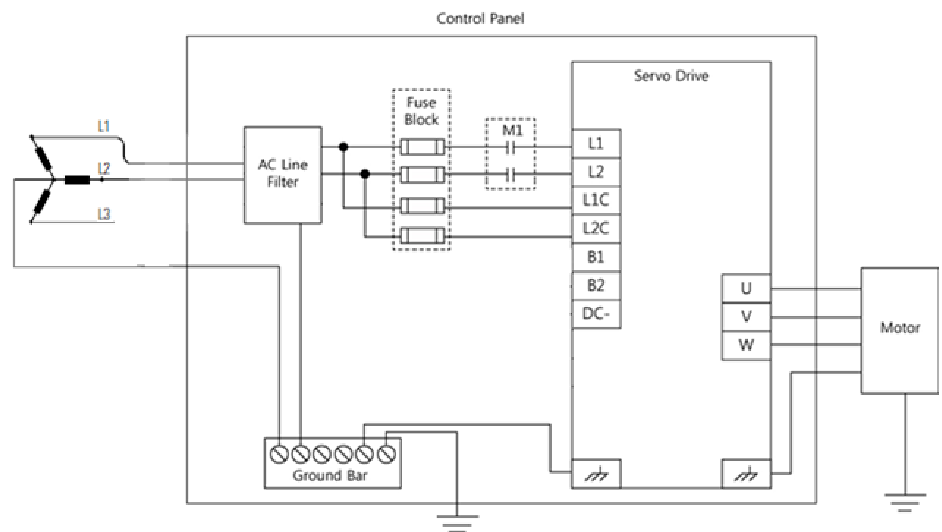
Three-phase Power Configuration (WYE secondary)



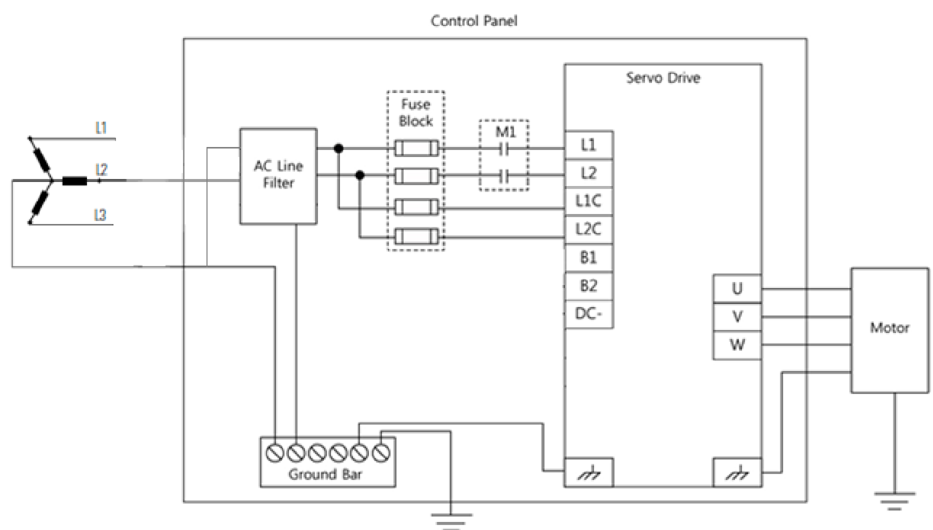
Three-phase Power Configuration (Delta secondary)



Single-phase Power Configuration (line-to-line)



Single-phase Power Configuration (line-to-neutral)



Fuse selection for the Drive

The table below shows the recommened capacity of fuse for each servo drive.

Table 23 Recommened Fuse Capacity

Drive	Powr rating	Rated Power of Drive [kVA]	MCCB or Fuse Power capacity [A]
CSD7_01BN1, CSD7_01BNF1	100 W	0.23	4
CSD7_02BN1, CSD7_02BNF1	200 W	0.45	4
CSD7_04BN1, CSD7_04BNF1	400 W	0.89	8
CSD7_08BN1, CSD7_08BNF1	800 W	1.71	10
CSD7_10BN1, CSD7_10BNF1	1 kW	2.40	10
CSD7_15BN1, CSD7_15BNF1	1.5 kW	3.46	15
CSD7_25BN1, CSD7_25BNF1	2.5 kW	4.79	45
CSD7_35BN1, CSD7_35BNF1	3.5 kW	6.44	60
CSD7_50BN1, CSD7_50BNF1	5 kW	10.53	90

The fuse capacity is the value when 100 [%] load is applied. When selecting the MCCB (Molded Case Circuit Breaker) or fuse, select the capacity considering the load ratio.

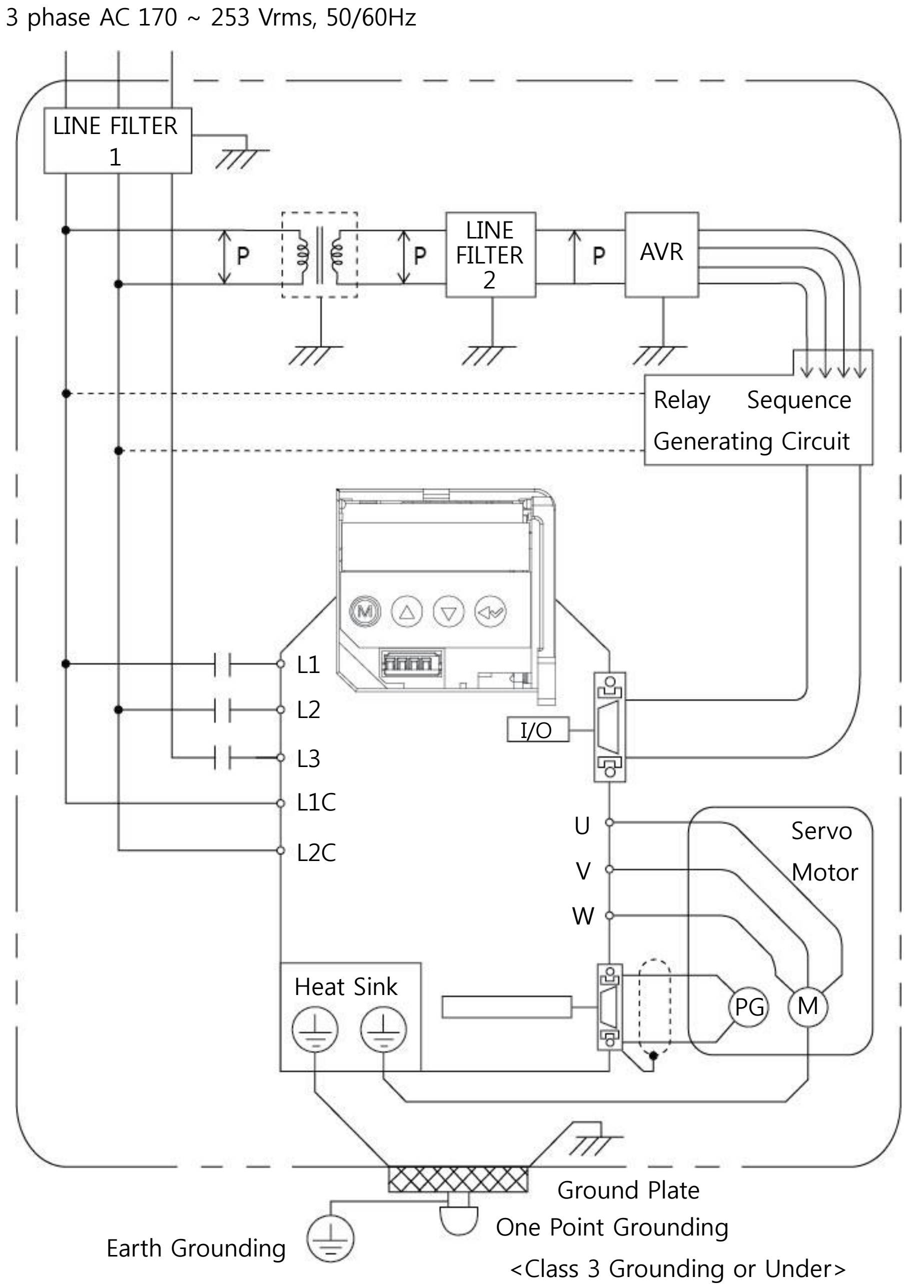
Cut-off characteristic : 200[%] - 2 seconds or more. 700[%] - 0.01 second or more

CAUTION	Using a high-speed fuse is not possible. As the power supply of the drive is condenser input type, if a high-speed fuse is used, it can blow even under normal circumstances.

Noise Protection

The high-speed switching device and microprocessor are used at the main circuit of the CSD7 servo drive. Thus, switching noise is affected by the connection and grounding methods. Use the proper wiring and grounding method to prevent any affects from the noise.

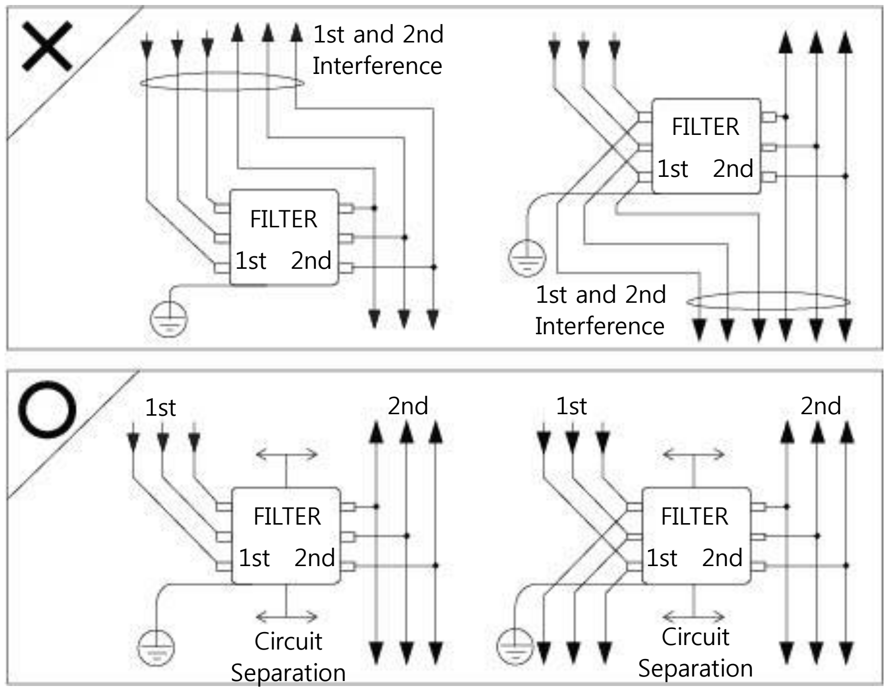
CAUTION	Use a wire of 3.5[㎟] or thicker for the earth wire. Separate the signal and power wiring.



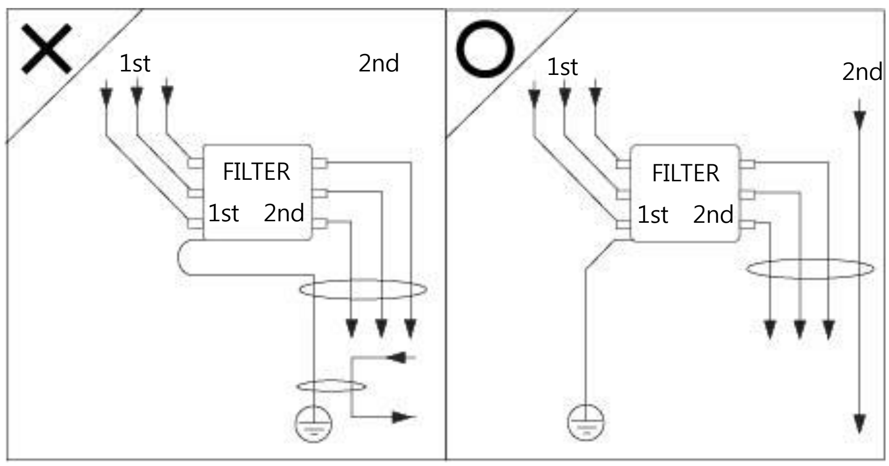
Extra caution is required when wiring the noise filter. The following figure describes precautions when wiring the noise filter. If the wiring is wrong,

the performance of the noise filter falls.

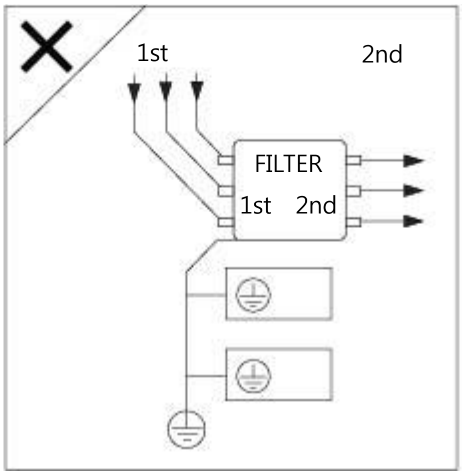
Separate the input and output wiring of the noise filter and do not tie up them together.

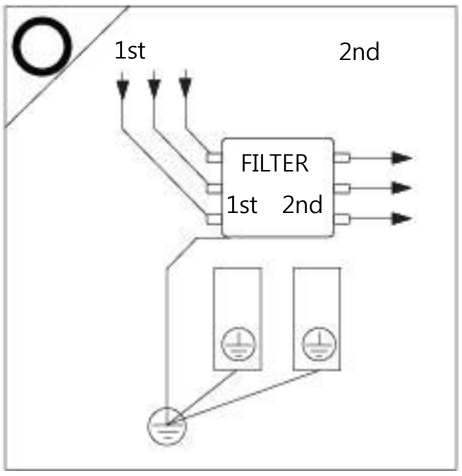


Earth wire of the noise filter should be wired in distance to the output wire and do not put other signal lines and earth wire in a same duct and tie up them together.

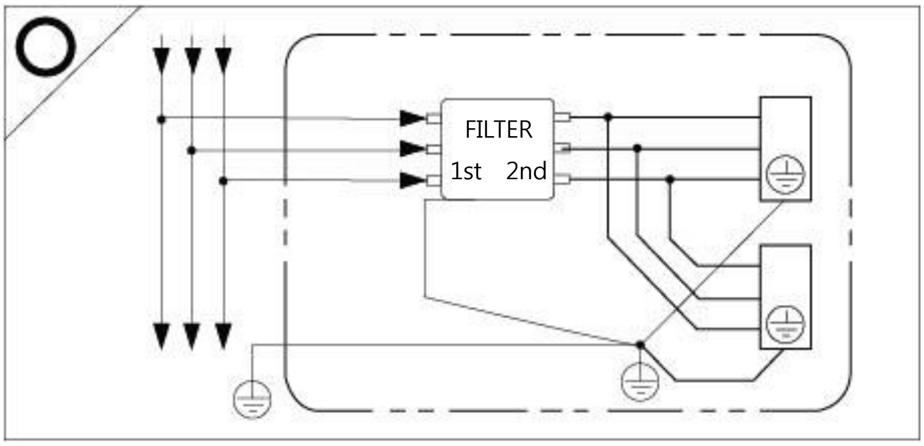


Earth wire of noise filter should be solely attached in the earth plate. Do not connect the earth wire of the noise filter to other earth wire together.





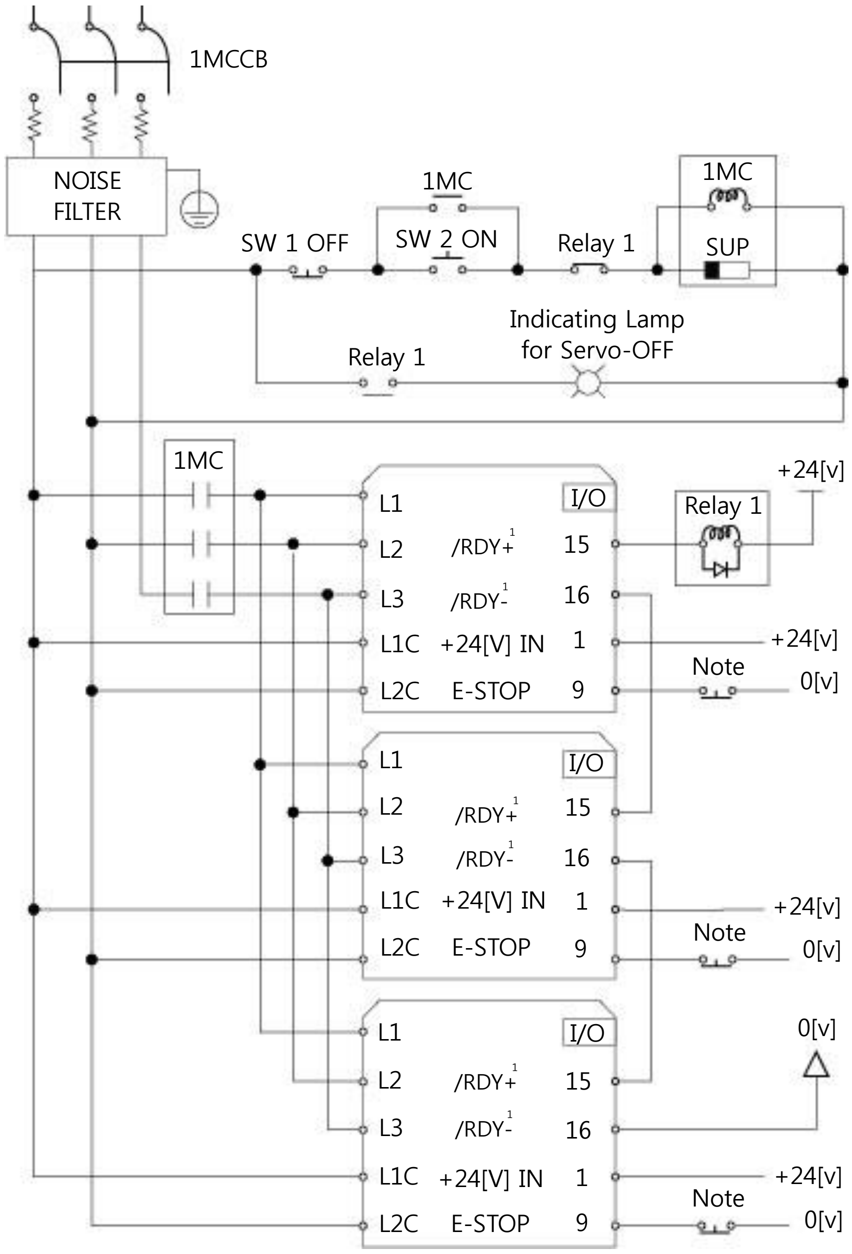
If there is noise filter inside the case (panel), connect all of the earth wires and earth wires of other equipment inside of the case to the grounding plate. And then, ground them.



Wiring When Multiple Drives Are Used

This is an example of wiring when connecting several drives.

Connect the sequence output </RDY> signal of each servo drive in a series and run Relay 1 to detect the fault. Normally, OUTPUT+ and OUTPUT- are interconnected, and with 24 [V] supplied to Relay1, the servo drive runs normally.
If the servo fault is generated, 24 [V] supplied to Relay1 is cut off.



1. Wiring diagram on the assumption that OUTPUT1 is set for the RDY signal during sequence output. In the case that OUTPUT2 is set for RDY, the pins are #17 and #18, and OUTPUT3 is set, the pins are #19 and #20.

Note Whether to use the emergency stop input can be set by the parameter. The initial value of this parameter is set as not to use (0x2005[04]=[Ft-0.05][D3]=0). Do not wiring if it does not using the emergency stop.

Chapter 4. Operator, Basic Setting and Commissioning

This chapter introduces the operator mounted on the servo drive. In addition, it describes the basic setting of servo drive, and also an example for simple startup.

Before You Begin

About Servo-ON Signal

This part describes Servo-ON signal for the control of the servo drive.

About Servo-ON Signal

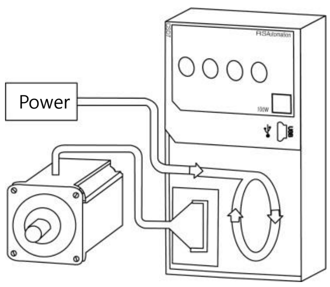
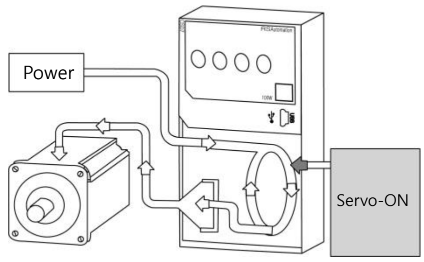
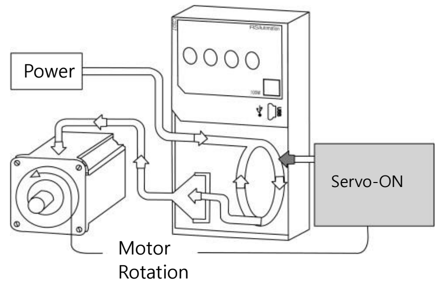
Audio or TV can select and play music and display channel that the users want from the moment the power switch is on.

However, the servo drive cannot run servo motor by simple applying the power. To complete load the system and use the servo drive, Servo-ON signal from the host controller is required.

Servo-ON signal should be applied and maintained from the host controller for the servo drive to run the motor. In servo-OFF status, it cannot run the motor.

Servo-OFF and Servo-ON

Table 24 Servo-OFF and Servo -ON

1. Servo-OFFstate	2. Servo-ON state	3. Apply the position, speed command etc. for the servo-on state and motor operation
▶ If the servo-ON signal is not applied after the power application, it is same as the servo driver and motor being separated completely. ▶ This is a ready status to run the motor.	▶ If the </ENABLE> signal is input and the servo-ON signal is applied from the host controller, the drive is ready to run the motor. At this time, if there is no command for the motor rotation, the drive maintains the motor in the stop control state	▶ If the motor run command is input from the host controller while the servo-ON signal is maintained, the drive can run the motor according to the command.
		

Servo-ON Signal and Vehicle Driving

The following describes the servo drive in relation to the transmission of the automobile.

Host Controller ⇨ Appy AC power to the drive ➡ Servo-ON signal is received while '/ENABLE' signal is input ➡ Input Position or Velocity command ➡ The motor rotates

Driver ⇨ Start the vehicle engine ➡ Place the transmission to D position ➡ Step on the accelerator ➡ The vehicle starts moving

As the transmission of the automobile should be positioned at 'D' to start the automobile, the drive can be run only when the servo-ON of the host controller is maintained.

Commands to run the motor such as the position, speed of host controller are invalid in Servo-OFF status.

Servo-ON Signal Input

Servo-On signals are entered through the network communication line from the host controller. With the ON state of the sequence input /ENABLE, the servo-ON signal should be entered through the EtherCAT network to turn Servo-ON.

In case of auto Servo-On

If the servo drive runs the motor without a command from the host controller as in the operation mode (run-00), (run-01), the drive makes itself Servo-ON for the operation.

Note

- Refer to the 9-36 page "Operation Mode Function" for the operation mode (run-00) to (run-02). In addition, the operation mode (run-00) is described in the 4-16 page "Startup".
- (run-00), (run-01), (run-08), (run-10), (run-12) are not operated in Servo-ON status.
- Servo-ON function is not operated in OP Mode of EtherCAT communication.

Servo Fault and Status

If servo fault is occurred by the self-diagnosis function of the drive while the Servo-ON signal is applied to the drive, the drive make itself Servo-OFF to stop the motor and displays the contents of servo fault. Users should inspect the contents of servo fault, take necessary action, and reset the fault (Refer to the 9-40 page "Fault Reset (run-08)". At this time, if an appropriate action against the servo fault is taken and the servo-ON signal of host controller is maintained, the drive returns to servo-ON status at the moment that fault is reset.

Refer to the 10-5 page "Type of Servo Warning" for the information of the servo fault.

Note

- All parameter setting after Chapter 4 should be done for the Servo-ON status and Servo-OFF status.
- In this manual, 'the servo drive status' means whether the servo drive is in servo-ON status or servo-OFF status.

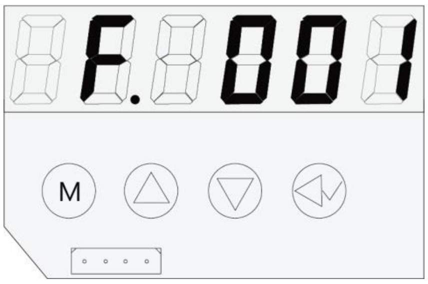
Operator

Name and Function of Each Part

The servo drive has a built-in operator for various status displays, parameter setting, operation command, and monitoring.

- Displays various contents with six 7-segment LED display. Provides all key manipulation function without a separate external operator.

The following figure shows the front side of the operator on the servo drive.



Icons for the Key Buttons

Icon is used in description throughout the manual. Thus, be fully aware of the shape, name and function of icons.

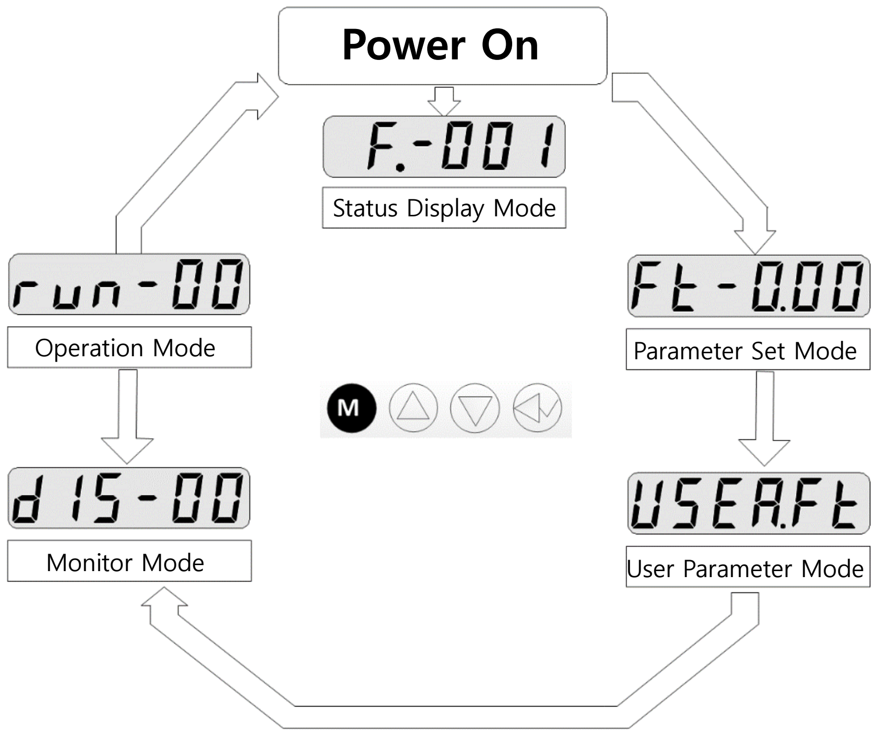
Table 25 Icon for the Key Buttons

Indicator and Key	Name	Function	Remark
	7-segment LED indicator	Displays the status with 6-digit 7-segment LED display, sets parameter, commands operation and displays monitoring.	For more information, refer to the ‘Status Display Mode’ in the page 4-8.
	Set/ Mode	Key for switching display mode, editing parameter, and running an operation mode - Initial Screen>Ft>Dis>Run switching - In a Set mode, used for applying the setting value	Same function as the Set/Mode key of existing CSD3/5
	Up	The value or parameter is increased by 1 from the cursor position; for bit field, fixed to max. value of each bit. Generally, if the Up key is pressed at 9, carry applies. Long-pressing speeds up the increase in value.	
	Down	The value or parameter is decreased by 1 from the cursor position; for bit field, fixed to min. value of each bit. Generally, if the Down key is pressed at 0, borrow applies. Long-pressing speeds up the decrease in value.	
	Enter/Shift(<)	Used to apply a parameter, enter a function or move to the left digit. 1. Moves to the left digit. 2. Enters a parameter modification mode or function (when pressed 2+ seconds). 3. As the Set mode, exits without apply the changed value.	It is the combination of the Enter and Left key of the existing CSD3/5.

Structure of the Entire Mode

As shown in the figure below, the servo drive is divided into 5 types of control modes.

The mode displayed after the power ON is the status display mode. Mode is changed whenever the MODE/SET key is pressed. Be fully aware of the following 5 types of modes and read the following.



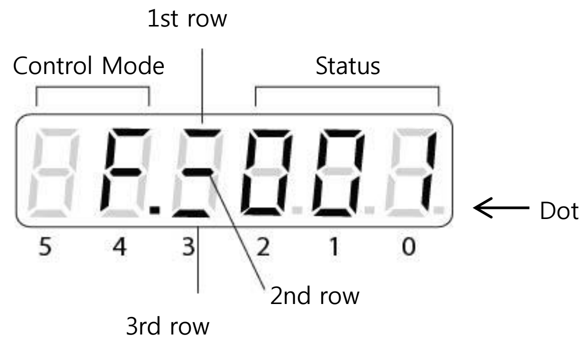
The displayed values in the above figure are the initial value of each mode.

If the value is changed in a mode and then returned, the changed value is shown instead of the initial value.

Status Display Mode

This section describes contents of the 'Status Display Mode'.

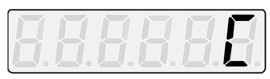
The figure below is an example of display for the description of the status mode. Refer to the table below for the meaning of each display.



Control Mode (Ft-0.00)

Displays control mode in use

Table 26 Control Mode Display

Item	Display	Description
Basic Control Mode		CSP mode * CSP : Cyclic Synchronous Position
		CST mode * CST : Cyclic Synchronous Torque

Status

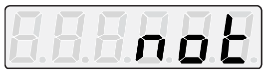
The 'Status' indicate the following states of servo drive.

1) Servo-OFF, Servo-ON status display
2) P-OT, N-OT status display
3) Warning and Fault status display

The display priority is 3) → 2) → 1).

When a servo warning or a fault goes off, a relevant alert message is displayed. For more information about servo warning and servo fault, see "Protective Function" on page 10-4.

Table 27 Status Display and Description

Displayed Message	Description
	Set value of node address that is recorded in 0x2021 (Ft-0.33). In this case, the node address is set as 001. If the value is set to 000, the node address is given a set value by the host controller.
	Displayed when forward operation prohibiting signal is input
	Displayed when reverse operation prohibiting signal is input.
Related text	Occurrence of Warning and Fault

Dot

4th Dot : The 4th dot is turned on when the main AC power is supplied and the internal DC bus is charged.

0~3rd Dot : The 0~3rd dot keeps repeating ON/OFF when the Servo is ON. These dots are turned OFF when the Servo is OFF.

1st, 2nd,3rd row

Table 28 Meaning of the each row

row	Description
1st row	It is on while </P-COM> signal is output. When using as CSP mode, if the difference between actual position and position command is smaller than the set value of 0x2312 (Ft-3.18), the servo drive output </P-COM> signal. * </P-COM> : Position completion detection signal.
2nd row	It is on while </TG-ON> signal is output. When the rotation speed of the motor is higher than the set value of rotation detection level 0x2213 (Ft-2.19), the servo drive output </TG-ON> signal. * </TG-ON> : Rotation detection signal.
3rd row	It is on while Z-pulse output of the encoder is detected. In case of linear motor, it is on while the first U-phase of hall signal is detected.

Parameter Setting Mode

This section includes brief explanation of the parameters in parameter setting mode.

The Parameter sets and saves various functions to make drive suitable for equipment.

There is a parameter that can be always set regardless of the status of the drive, and those that must be in certain status of the drive when setting them.

The contents related to parameter setting are described in details in the Chapter 7 along with the functional description of the servo drive.

The table below is to aid the understanding of parameter group.

Parameter range :

Ft-0.00 ~ Ft-5.13

Table 29 Parameter Group

Parameter Group			Description
Group 0	0x2000 ~ 0x2021	Ft-0.00~Ft-0.33	User parameter related to basic setting and I/O signal
Group 1	0x2100 ~ 0x2116	Ft-1.00~Ft-1.22	User parameter related to gain and gain tuning
Group 2	0x2200 ~ 0x2218	Ft-2.00~Ft-2.24	User parameter related to velocity control mode
Group 3	0x2300 ~ 0x2314	Ft-3.00~Ft-3.20	User parameter related to position control mode
Group 4	0x2400 ~ 0x2419	Ft-4.00~Ft-4.25	User parameter related to torque control mode
Group 5	0x2500 ~ 0x250D	Ft-5.00~Ft-5.13	User parameter related to supplementary function

User-Defined Parameter Setting Mode

The user-defined parameter setting mode is a group of parameters which a user changes frequently.

User-defined parameters are as follows. Even when the name of a parameter differs, if the number indication is the same, it is treated as the same parameter and saved as the same one.

E.g.) UF-0.03 is the same as Ft-0.03

The parameter settings will be described in detail later and in the chapter 7 along with the functions of the servo drive.

Table 30 User-defined Parameter Group

Parameter Group	Description	Same Parameter
UF-0.03	Off-line Auto Tuning Function Selection	Ft-0.03
UF-1.01	System Gain	Ft-1.01
UF-1.02	1st Proportional Gain in Speed Loop	Ft-1.02
UF-1.03	1st Integral Gain in Speed Loop	Ft-1.03
UF-1.07	1st Proportional Gain in Position Loop	Ft-1.07
UF-4.02	1st Current Command Filter Bandwidth	Ft-4.02
UF-3.02	Position Feed Forward Gain	Ft-3.02
UF-1.04	P/PI Control Switching Mode	Ft-1.04
UF-1.05	P/PI Control Switching Reference Value	Ft-1.05
UF-4.06	Current Loop Gain Setting	Ft-4.06
UF-3.04	Position Moving Average Filter	Ft-3.04

Monitor Mode

This section includes brief explanation of the parameters in monitor mode.

Displays several numerical data generated as the motor is controlled by the drive. The contents of the monitor mode can be checked regardless of the status of the drive. Be fully aware of the numbers and units displayed in monitor mode shown in the table below and refer to it when using the servo drive.

The table below shows the brief contents of each item in the monitor mode.

Monitor Mode Range:

dIS-00 ~ dIS-32

Table 31 Monitor Mode

Object monitor	Built-In monitor	Description [Unit]
0x2A00	dIS-00	Velocity feedback [rpm or mm/sec]
0x2A01	dIS-01	Velocity command [rpm or mm/sec]
0x2A02	dIS-02	Velocity error [rpm or mm/sec]
-	dIS-03	Torque command [%]
-	dIS-04	Position feedback [pulse]
-	dIS-05	Position command [pulse]
-	dIS-06	Position error [pulse]
-	dIS-07	Position command frequency [kpps]
0x2A08	dIS-08	Electrical angle [°]
0x2A09	dIS-09	Mechanical angle [°]
0x2A0A	dIS-10	Accumulated load factor of regenerative resistor [%]
-	dIS-11	DC Link voltage [V]
0x2A0C	dIS-12	The number of rotation of absolute encoder
-	dIS-15	I/O status
-	dIS-16	Fault history
-	dIS-17	Firmware version
-	dIS-18	Motor & Encoder Type
-	dIS-21	Drive rated output
-	dIS-22	Single Turn Data of Absolute Encoder
-	dIS-23	Encoder feedback counter
-	dIS-24	Maximum value of current command [%]
-	dIS-31	Load factor of average torque [%] (rated torque=100%)
-	dIS-32	Load factor of maximum torque [%] (rated toque=100%)

The items like Position feedback, Potion Command, and Encoder Feedback Counter of the monitor mode Position feedback, whose value is more than 5 digits, is not displayed at once by the 5-digit 7-segment LED display. Therefore, it is displayed separately by left and right key. Refer to the 9-44 page "Monitor mode function" for details on how to check such items.

Operation Mode

This section includes brief explanation of the parameters in operation mode.

The motor can be run in operation mode. Each item provides a special function, which can be used. Just as in the parameter setting mode, there is a status where the operation is possible/impossible according to the status of the servo drive, during the use of the operation mode. Refer to the 9-36 page "Operation Mode Function" for details of operation mode.

The table below shows the brief functions of each item in the operation mode.

Operation Mode Range :

run-01 ~ run-12

Table 32 Operation Mode

Object	Item	Operation	Reference page
-	run-00	Jog Operation	9-37
0x3001	run-01	Off-line Auto Tuning	9-38
-	run-08	Fault Reset	9-40
0x300A	run-10	Absolute Encoder Data Reset	9-41
-	run-11	Save 2-Group Gain	9-42
-	run-12	Parameter Initialization	9-43

Refer to the 9-36 page "Operation Mode Function" for details of operation mode and key button manipulation.

Basic Setting

This section includes the introduction of the control mode and the basic setting.

Overview of the Basic Setting

Basic setting must be done before using the servo drive.

- Other parameters can be set after the basic setting.
- The basic setting is possible after connecting the control power.
- Reapply the power after basic setting.
- The values of the basic setting are not changed even if the power is cut off after editing parameter or parameter is initialized by [run-12] function of the operation mode.
- To change basic setting value, change it directly from corresponding parameter and reapply the power.

Table 33 Basic Setting

No.	Basic Setting Parameter	Description
Ft-0.00	Ft-0.00 F	Control mode setting (Optional)

Control Mode Setting

Control Mode Type

As in the table below, CSD7 provide CSP mode and CST mode. Refer to the Chapter 5 for function for each control mode.
* CSP : Cyclic Synchronous Position
* CST : Cyclic Synchronous Torque

Table 34 Type of Control Mode

Item	Display	Description
Basic Control Mode	F	CSP mode
	C	CST mode

Startup

Before Startup

1. Please be aware of wiring in Chapter 3 and connect main power and control power normally. In addition, by configuring emergency stop input circuit, clear the emergency stop status.
2. Connect the motor and encoder properly.
3. Pereform basic setting in reference to the 4-14 page "Basic Setting".
4. Do not connect the load to the motor for safety purposes. If the motor is mounted on the equipment, remove coupling of the motor shaft so that load may not move.

CAUTION

Cautions when Startup

- To prevent the injury during operation, check the operation range of the motor shaft or load, and keep it away from the motor load.
- Run the drive after preparing the E-stop circuit. Then, you can cope quickly with an emergency situation.
- For more information about E-stop, refer to "Emergency Stop Input" on page 3-23.

Note

- At first, the drive is not tuned suitable for the load or motor.
- Before you start commissioning, perform the off-line auto tuning as described in the "Off-line Auto Tuning (0x3001, run-01)" on page 9-38, then you can operate the motor more smoothly and reliably.

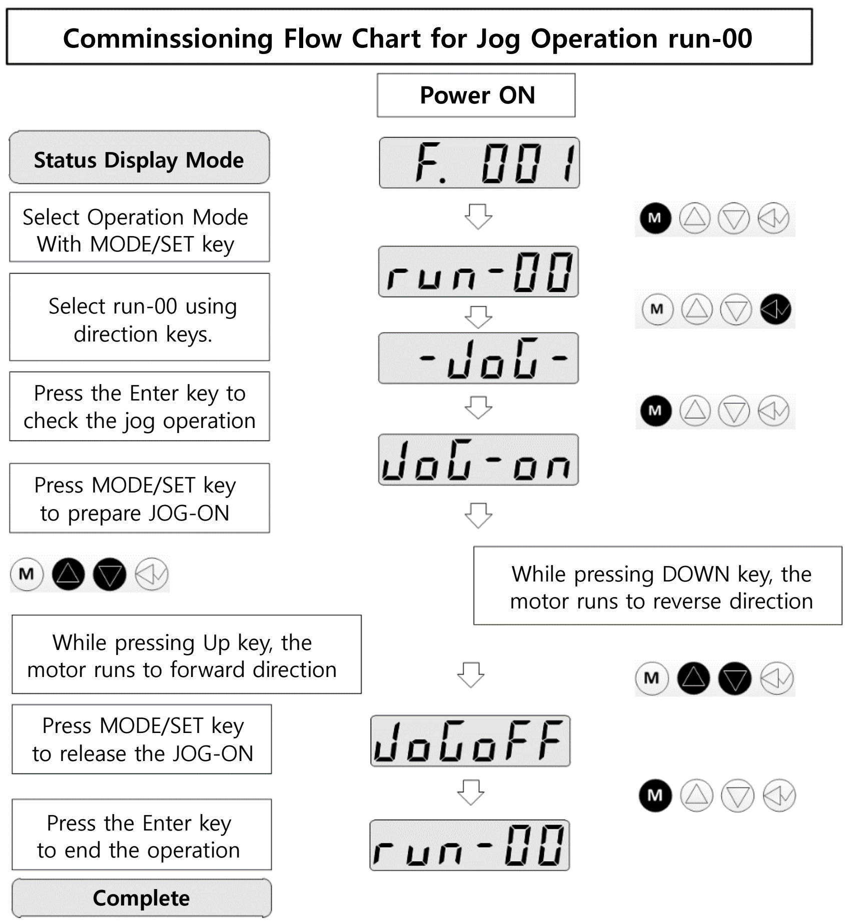
Startup

Startup 1 : Start up the Drive by Using Jog Operation

The jog operation is possible in Servo-OFF status. Remove the wiring between the drive and the host controller, or make EtherCAT communication state to 'Init'.

The speed of the motor can be set from the drive for the jog operation. The initial value of the jog operation speed is 50 [rpm]. At startup 1, runs the drive at the factory setting speed, 50 [rpm].

Start up the drive according to the following flowchart.



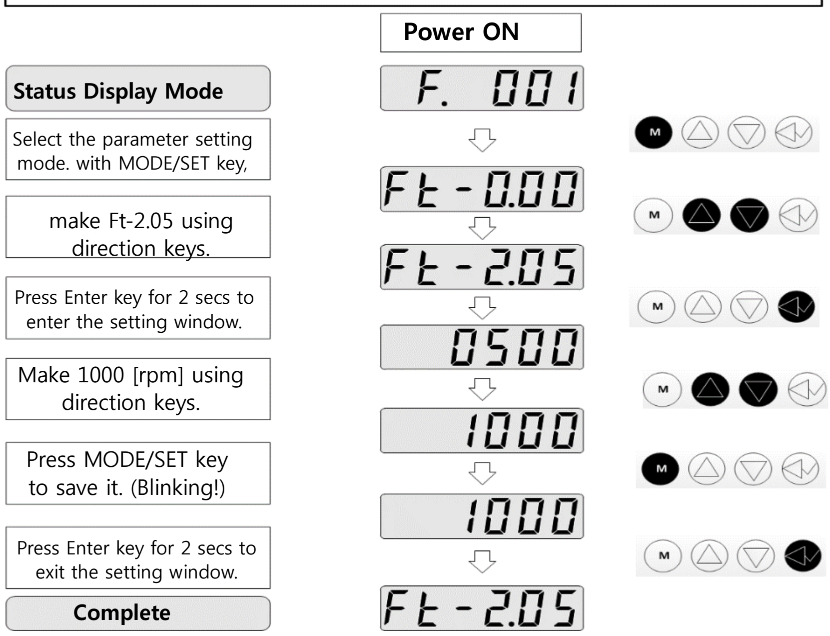
Startup 2 : Start Up the Drive by Changing the Speed

Start up the drive by changing the speed from the initial value, 50 [rpm] to 1000 [rpm].

The change of Jog operation speed should be done at 0x2205 (Ft-2.05). The speed set here is not related to other operation, and applied only upon the Jog operation. Setting range is 0 to 6000 [rpm]. Initial value is 50 [rpm].

Change the Jog operation speed by according to the following flowchart.

Flow Chart for Changing the Jog Speed



If setting is wrong, the setting window does not blink when saving it by pressing the MODE/SET key. If setting is completed normally, retry the Jog operation [run-00]. You can see that the speed is changed from 50 [rpm] to 1000 [rpm].

Chapter 5. EtherCAT Communication

This chapter describes how to use EtherCAT communication for using EtherCAT network-type CSD7.

EtherCAT Slave Information

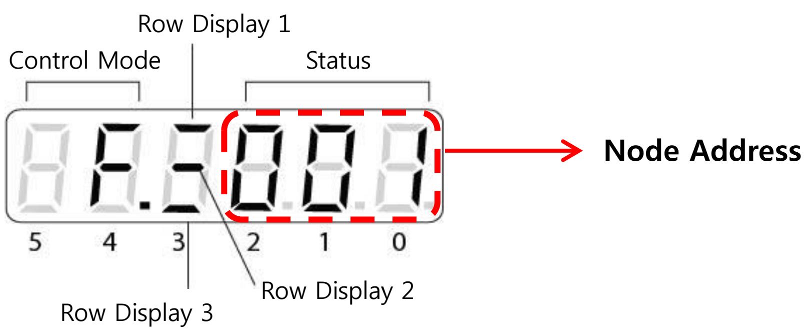
The EtherCAT slave information (ESI) of the CSD7 is provided as an XML format file.
The Master uses this information to perform network configuration, communication setting and control functions.

Set Node Address

Check and Set Node Address

You can check and set node addresses in either of the following two ways.

1. **When using Built-In Operator**
   Check and set node address in the parameter setting mode Ft-0.33. You can also directly go to Ft-0.33 for checking and setting, however, the simpler way is to check and set in the status display mode of Built-In Operator at the front when the AC power of the servo drive is turned on. In the status display mode, press and hold the SET key for about 1 second, then move to the setting mode of Ft-0.33.



2. **When using Host controller**
   Check and change node addresses in Index 0x2021. After changing node addresses in 0x2021, you must send the character string 'save' to the index 0x1010[4] to save the changed node addresses in the flash memory. (See the explanation of 0x1010 in the page 7-12)

Note After changing and saving node addresses, cycle the power so that the Master can recognize the new node addresses. The Master can configure nodes with recognized node addresses.

Definition of Node Address

Node Address	Description
0	The node address is set by the master controller.
1~255	You can configure the node address in the Master using set values.

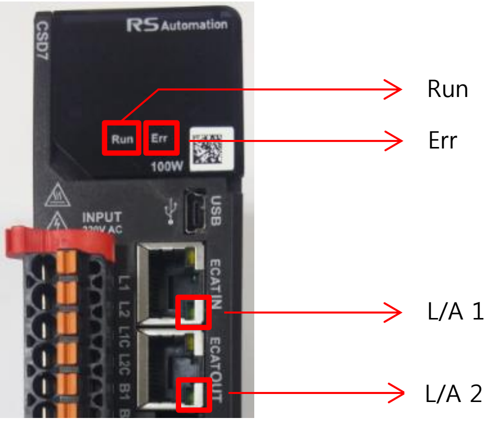
Note) Changed set values are applied after power cycling.

The factory-set value for node address is 0, in this case the node address is set by the master controller. The node address is changed according to the changing of the network wiring.

When a value from 1-255 is set, this address can be used to configure the node in the Master. If you configure the node address using this address in the Master, this address is going to be the node address of the servo drive.
You can also set it so that the node address of servo drive is not changed even when the network wiring changes, depending on the Master. (Our EtherCAT Master, MMC-EtherCAT supports this feature.)

LED state

The operator at the front of CSD7 network drive has LEDs to indicate the EtherCAT communication states, as shown in the figure below.

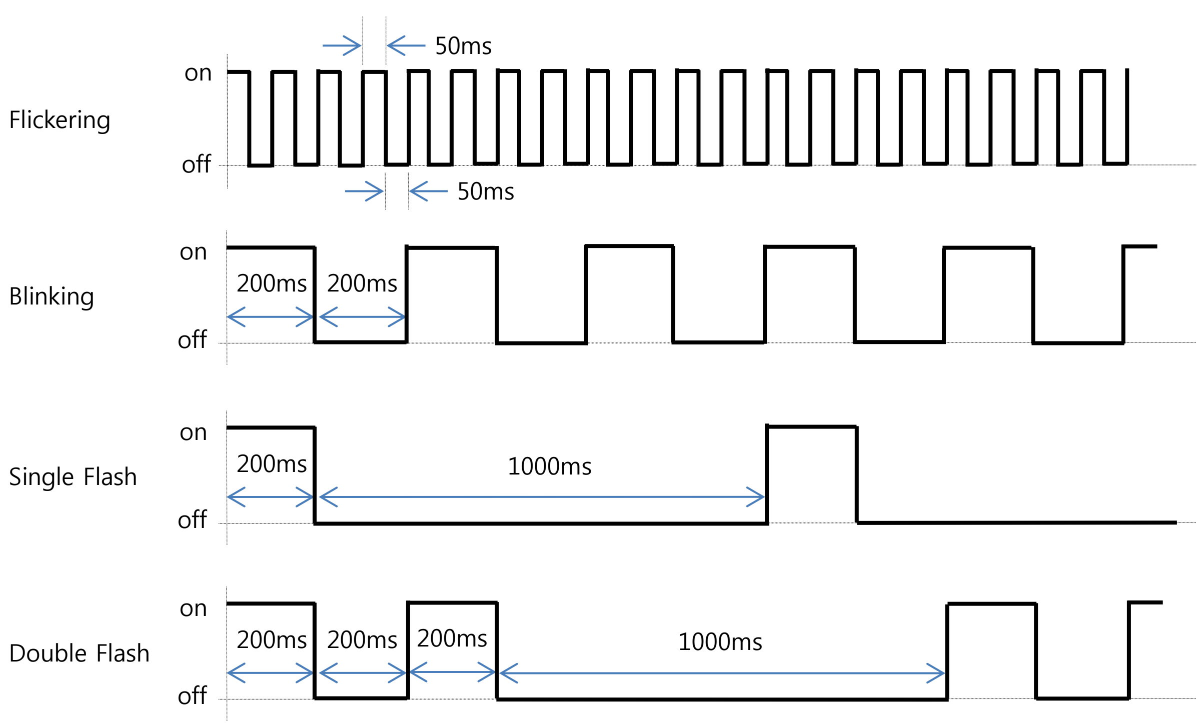


Four LEDs indicate the EtherCAT communication states as in the table below.

Table 35 LED state and EtherCAT communication state

Name	Color	LED state	EtherCAT communication state
Run	Green	Off	Initial state
		Blinking	Pre-Operational state
		Single Flash	Safe-Operational state
		On	Operational state
Error	Red	Off	No error state
		Blinking	An invalid object command in the current state is received from the EtherCAT master
		Single Flash	Synchronixation error or communication data error
		Double Flash	Watchdog timeout error on the EtherCAT communication
		Flickering	Boot error
		On	PDI watchdogn timeout error
L/A 1	Green	Off	Link is not established in physical layer
		On	Link is established in physical layer
		Flickering	In operation after establishing link
L/A 2	Green	Off	Link is not established in physical layer
		On	Link is established in physical layer
		Flickering	In operation after establishing link

Each LED state is defined as follows:



Note For more information about LED states, see "EtherCAT State Machine (ESM)".

Reference Model

The following Table 36 shows comparisons between OSI (Open Systems Interconnection) reference mode and EtherCAT communication model. When compared to the OSI reference model, the EtherCAT communication model don't have 3 - 6 layers.

Table 36 Comparisons between OSI reference model and EtherCAT 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 (Nwtwork layer)	
2	Data link (Data link layer)	SM (Sync Manager)
		FMMU[1] (Fieldbus Memory Managerment Unit)
		PDI (Process Data Interface)
		DC (Distributed Clock)
1	Physical (Physical layer)	100BASE–TX
		E-BS (LVDS for back plane)

Layer 1 (physical layer)

Encodes/decodes signals for transmission/reception in a form appropiate to the communications medium. Specifies communication media characteristics.

[1] This unit translate logical address into physical address.

Layer 2 (Data link layer)

Controls access to the communication medium. Performs error detectin, (Point-to-point transfer on a link)

Layer 3 (Network layer)

Perform message routing

Layer 4 (Transport layer)

Provides transarent reliable data transfer (end-to-end transfer across a network which may include muliple links)

Layer 5 (Session layer)

Creates and manages dialogue among lower layers.

Layer 6 (Presentation layer)

Converts data to/from standardized network formats.

Layer 7 (Application layer)

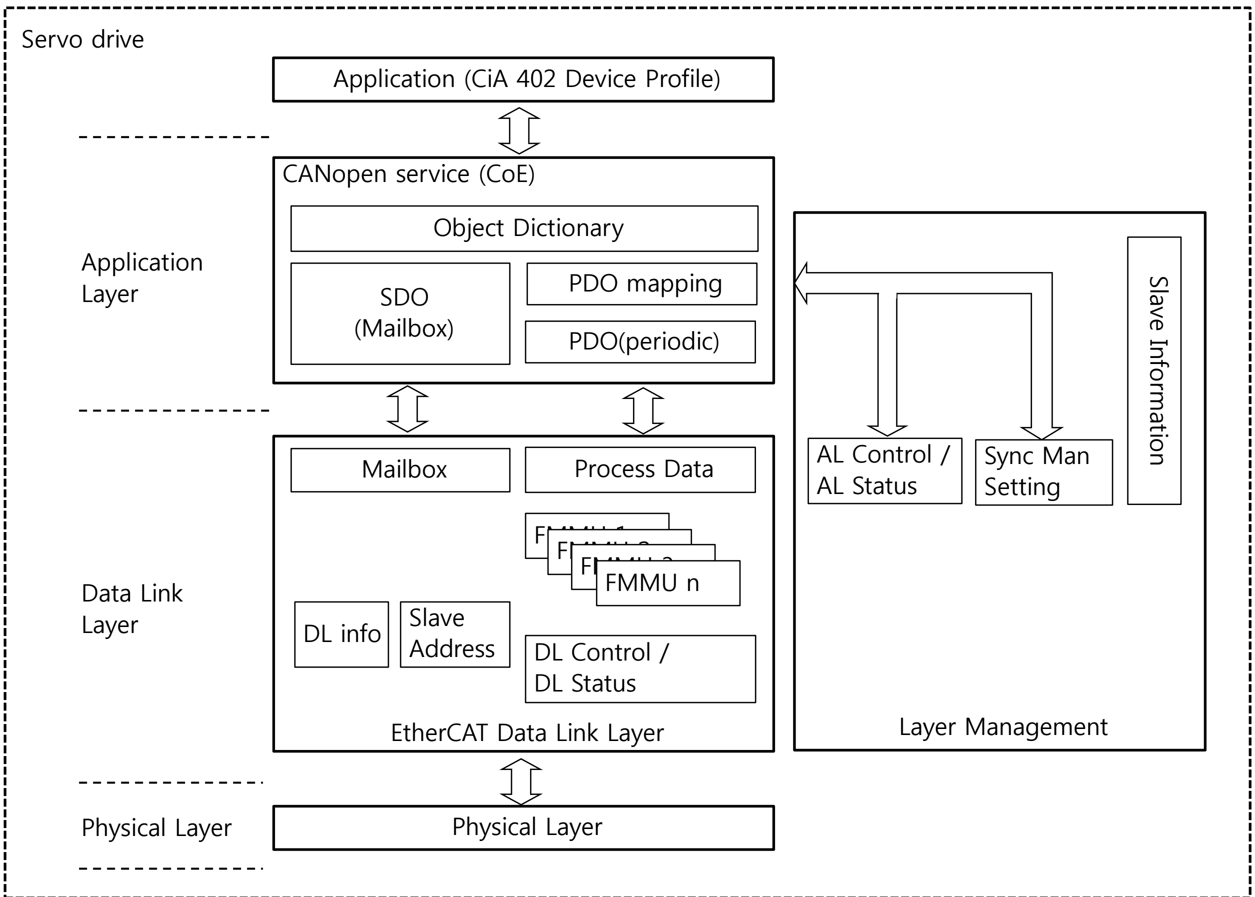
Translates demands placed on the communication stack into a form understood by the lower layers and vice versa.

Structure of CANopen over EtherCAT

CSD7 drives use the drive profile of CiA402. The object dictionary on the application layer includes parameters, application data, process data and PDO mapping information between servo interface and driver application.

PDO (Process Data Object) consists of object dictionaries that can be mapped on the PDO, while the contents of process data are defined by PDO mapping.

The process data communication reads and writes PDOs periodically, and the mailbox communication (SDO), an asynchronous message communication, can read and write all object dictionaries.



EtherCAT State Machine(ESM)

The state machine of EtherCAT Slave is controlled by the EtherCAT master.

ESM

EterCAT State Machine(ESM) includes a states defined by EtherCAT. Changes in ESM are requested by the Master. The Master can record the contents of EMS change requests to be changed in the Slave AL control register. The Slave checks the result of a state change (Succeed / Fail) and responds to the Master in the local AL state. If a request for state change fails, the Slave responds with an error flag.

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

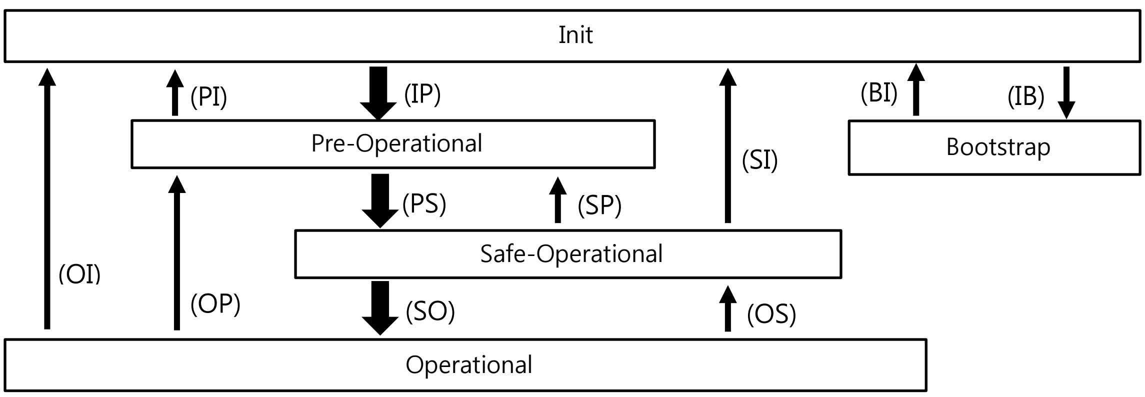


Table 37 SDO and PDO Communication in the ESM state.

Status	SDO Communication	PDO Reception	PDO Transmission	Descriptions
Init	Disabled	Disabled	Disabled	This is the initialization state of communication unit. Communication cannot be carried out.
Pre-Operational	Enabled	Disabled	Disabled	Only mailbox communication is available. After initialization, this state processes the initial settings of network.
Safe-Operational	Enabled	Disabled	Enabled	PDO transmission is available in addition to mailbox communication. In the DC mode, current states and other data can be transmitted through periodic communication.
Operational	Enabled	Enabled	Enabled	This is the operational state. Motor control is available through periodic communication in the DC mode.

Table 38 Availability of ASCII Communication in ESM State

ESM state	Jog On (JOG0)	Jog Off (SVROF)	Auto Tuning (TAT01)
EtherCAT communication cable open	ACK	ACK	ACK
Init state	ACK	ACK	ACK
Pre-Operational state	CAN	ACK	CAN
Safe-Operational state	CAN	ACK	CAN
Operational state	CAN	ACK	CAN

▶ The followings are the ASCII values and the meanings of the used control sign :

Sing	ASCII value	Meaning
ACK	0x06	Command execution
CAN	0x18	Command canceled

Table 39 Availability of Built-In Operation in ESM State

ESM state	Jog On (run-00)	Jog Off (run-00)	Auto Tuning (run-01)
EtherCAT communication cable open	Operated	Operated	Operated
Init state	Operated	Operated	Operated
Pre-Operational state	Not operated	Not operated	Not operated
Safe-Operational state	Not operated	Not operated	Not operated
Operational state	Not operated	Not operated	Not operated

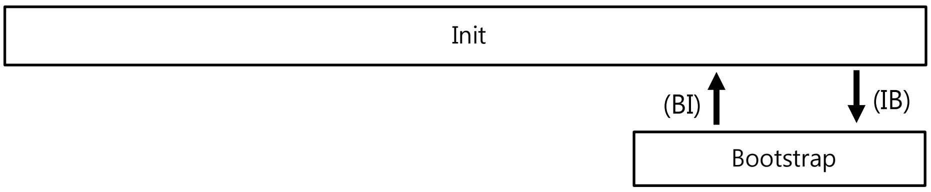
Table 40 Description of ESM State Transition

State Transition	Description
IP	Start Mailbox Communication
PI	Stop Mailbox Communication
PS	Start Input Data Update
SP	Stop Input Data Update
SO	Start Output Data Update
OS	Stop Output Data Update
OP	Stop Output Data Update, Stop Input Data Update
SI	Stop Input Data Update, Stop Mailbox Communication
OI	Stop Input Data Update, Stop Output Data Update, Stop Mailbox Communication
IB	Start Bootstrap Mode
BI	Restart Device

Bootstrap State

This mode is used for downloading firmware. In the Bootstrap state, the servo drive can download firmware to the servo drive, using the FOE (File access over EtherCAT) protocol.

When firmware downloading is completed, the Bootstrap state is shifted into the Init state in which there is no risk. Make sure that the power is not turned off during downloading. The considerations required for firmware to be used with no risk are given below.

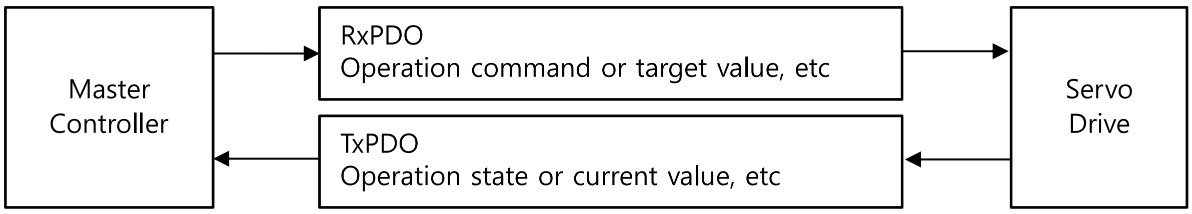


CAUTION

- Check the message of firmware download completion at the servo drive
- Check if a voltage alarm for the control power has been generated.

PDO (Process Date Object)

EtherCAT uses PDOs (Process Data Objects) to transmit data periodically. PDOs are divided into RxPDO that receives data from the master controller, and TxPDO that transmits data to the master controller.



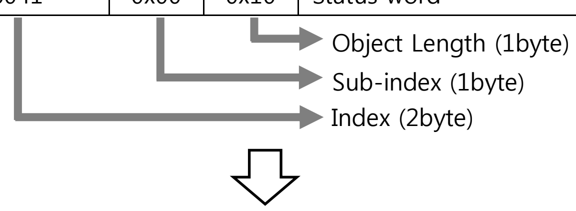
On the EtherCAT Application layer, multiple objects can be used to transmit various process data from the servo drive. The contents of process data are described in the PDO mapping object and SyncManger PDO assignment object.

Set PDO Mapping

PDO mapping indicates the mapping of application objects from the Object Dictionary to PDO. The number of mapped objects is recorded in Sub-index 0 of the mapping table.
CSD7 uses 0x1600 - 0x1604 for RxPDO mapping and 0x1A00 - 0x1A04 for TxPDO mapping. Each of them has fixed PDO mapping parameters.
The following figure provides an example of PDO mapping.

“0x1A0y” TxPDO Mapping (Example)

Sub-Index	Data (32 bit)			Name
0	5			Number of Entries
1	0x6064	0x00	0x20	Position actual value
2	0x6077	0x00	0x10	Torque actual value
3	0x6061	0x00	0x08	Modes of operation Display
4	0x0000	0x00	0x08	Reserved
5	0x6041	0x00	0x10	Status word



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

Set Sync Manager PDO Assignment

Sync Manager Channel consists of several PDO. Sync Manager PDO Assign Object (RxPDO:0x1C12, TxPDO:0x1C13) describes how PDOs are related to the Sync Manager.
The number of PDOs is written in Sub-index 0 of the Sync Manager PDO Assign table. In this table, Index 0x1C12 is for RxPDO and 0x1C13 for TxPDO.
The following figure provides an example of Sync Manager PDO mapping.

Sync Manager PDO Assign Object

Index	Sub	Object contents
0x1C1z	1	0x1B00
0x1C1z	2	0x1B01
0x1C1z	3	0x1B03
0x1C1z	4	0x1B06

Sync Manager Entity z

PDO A	PDO B	PDO D	PDO G

Mapping Object

0x1B00	PDO A
0x1B01	PDO B
0x1B02	PDO C
0x1B03	PDO D
0x1B04	PDO E
0x1B05	PDO F
0x1B06	PDO G

Default PDO Mapping

The table below shows the PDO mapping that is set by default in CSD7. The default PDO is fixed and cannot be changed. This setting is defined in the EtherCAT slave information file (XML format file).

The PDO mapping is applied differently depending on the firmware version of the CSD7 drive. Revision according to the firmware version is as follows.
Revision 1 : Firmware version 1.07.00.00 or lower
Revision 2 : Firmware version 1.20.00.00 or higher

The contents of this manual were created using the PDO mapping in Revision 2.

- PDO Mapping for Position Control

RxPDO Mapping Table(Revision 1)

Table 41 RxPDO Mapping (Revision 1)

PDO Map	PDO Map_Name	Number of sub index Entry	Size (byte)	Index	Name	Type
RxPDO	1st RxPDO Mapping (0x1600)	7	2	0x6040	Control word	UINT
			4	0x607A	Target Position	DINT
			4	0x60FF	Target Velocity	DINT
			2	0x6071	Target Torque	INT
			1	0x6060	Modes of operation	SINT
			2	0x60B8	Touch probe function	INT
			4	0x60FE	Digital Outputs	UDINT
RxPDO	2nd RxPDO Mapping (0x1601)	3	2	0x6040	Control word	UINT
			4	0x607A	Target Position	DINT
			4	0x60FE	Digital Outputs	UDINT
RxPDO	3th RxPDO Mapping (0x1602)	3	2	0x6040	Control word	UINT
			4	0x60FF	Target Velocity	DINT
			4	0x60FE	Digital Outputs	UDINT
RxPDO	4th RxPDO Mapping (0x1603)	3	2	0x6040	Control word	UINT
			2	0x6071	Target Torque	INT
			4	0x60FE	Digital Outputs	UDINT
RxPDO	5th RxPDO Mapping (0x1604)	2	2	0x6040	Control word	UINT
			4	0x60FE	Digital Outputs	UDINT

RxPDO Mapping Table(Revision 2)

Table 42 RxPDO Mapping (Revision 2)

PDO Map	PDO Map_Name	Number of sub index Entry	Size (byte)	Index	Name	Type
RxPDO	1st RxPDO Mapping (0x1600)	7	2	0x6040	Control Word	UINT
			4	0x607A	Target Position	DINT
			4	0x60FF	Target Velocity	DINT
			2	0x6071	Target Torque	INT
			1	0x6060	Modes of Operation	SINT
			1	0x0000	Padding	SINT
			2	0x60B8	Touch Probe Function	UINT
RxPDO	2nd RxPDO Mapping (0x1601)	2	2	0x6040	Control Word	UINT
			4	0x607A	Target Position	DINT
RxPDO	3th RxPDO Mapping (0x1602)	2	2	0x6040	Control Word	UINT
			4	0x60FF	Target Velocity	DINT
RxPDO	4th RxPDO Mapping (0x1603)	2	2	0x6040	Control Word	UINT
			2	0x6071	Target Torque	INT
RxPDO	5th RxPDO Mapping (0x1604)	1	2	0x6040	Control Word	UINT

TxPDO Mapping Table(Revision 1)

Table 43 TxPDO Mapping Table (Revision 1)

PDO Map	PDO Map_Name	Number of sub index Entry	Size (byte)	Index	Name	Type
TxPDO	1th txPDO Mapping (0x1A00)	9	2	0x6041	Status Word	UINT
			4	0x6064	Position Actual Value	DINT
			4	0x606C	Velocity Actual Value	DINT
			2	0x6077	Torque actual value	INT
			1	0x6061	Modes of operation Display	SINT
			4	0x60F4	Following error actual value	DINT
			2	0x60B9	Touch Probe Status	UINT
			2	0x603F	Error Code	UINT
			4	0x60FD	Digital Inputs	UDINT
TxPDO	2th txPDO Mapping (0x1A01)	8	2	0x6041	Status Word	UINT
			4	0x6064	Position Actual Value	DINT
			4	0x606C	Velocity Actual Value	DINT
			2	0x6077	Torque actual value	INT
			4	0x60F4	Following error actual value	DINT
			2	0x60B9	Touch Probe Status	UINT
			2	0x603F	Error Code	UINT
			4	0x60FD	Digital Inputs	UDINT
TxPDO	3th txPDO Mapping (0x1A02)	4	2	0x6041	Status Word	UINT
			4	0x6064	Position Actual Value	DINT

PDO Map	PDO Map_Name	Number of sub index Entry	Size (byte)	Index	Name	Type
			2	0x603F	Error Code	UINT
			4	0x60FD	Digital Inputs	UDINT
TxPDO	4th txPDO Mapping (0x1A03)	4	2	0x6041	Status Word	UINT
			2	0x6077	Torque actual value	INT
			2	0x603F	Error Code	UINT
			4	0x60FD	Digital Inputs	UDINT
TxPDO	5th txPDO Mapping (0x1A04)	4	2	0x6041	Status Word	UINT
			4	0x6064	Position Actual Value	DINT
			2	0x603F	Error Code	UINT
			4	0x60FD	Digital Inputs	UDINT

TxPDO Mapping Table(Revision 2)

Table 44 TxPDO Mapping Table (Revision 2)

PDO Map	PDO Map_Name	Number of sub index Entry	Size (byte)	Index	Name	Type
TxPDO	1th txPDO Mapping (0x1A00)	10	2	0x6041	Status Word	UINT
			4	0x6064	Position Actual Value	DINT
			4	0x606C	Velocity Actual Value	DINT
			2	0x6077	Torque Actual Value	INT
			1	0x6061	Modes of Operation Display	SINT
			1	0x1001	Error Register	USINT
			4	0x60F4	Following Error Actual Value	DINT
			2	0x60B9	Touch Probe Status	UINT
			2	0x603F	Error Code	UINT
			4	0x60FD	Digital Inputs	UDINT
TxPDO	2th txPDO Mapping (0x1A01)	8	2	0x6041	Status Word	UINT
			4	0x6064	Position Actual Value	DINT
			4	0x606C	Velocity Actual Value	DINT
			2	0x6077	Torque Actual Value	INT
			4	0x60F4	Following Error Actual Value	DINT
			2	0x60B9	Touch Probe Status	UINT
			2	0x603F	Error Code	UINT
			4	0x60FD	Digital Inputs	UDINT
TxPDO	3th txPDO Mapping (0x1A02)	4	2	0x6041	Status Word	UINT
			4	0x606C	Velocity Actual Value	DINT
			2	0x603F	Error Code	UINT
			4	0x60FD	Digital Inputs	UDINT
TxPDO	4th txPDO Mapping (0x1A03)	4	2	0x6041	Status Word	UINT
			2	0x6077	Torque Actual Value	INT
			2	0x603F	Error Code	UINT

PDO Map	PDO Map_Name	Number of sub index Entry	Size (byte)	Index	Name	Type
			4	0x60FD	Digital Inputs	UDINT
TxPDO	5th txPDO Mapping (0x1A04)	4	2	0x6041	status word	UINT
			4	0x6064	Position Actual Value	DINT
			2	0x603F	Error Code	UINT
			4	0x60FD	Digital Inputs	UDINT

User Defined PDO Mapping

CSD7 supports PDOs that can be edited or added by the user. You can use up to 10 parameters per each PDO.

RxPDO Mapping Table(Revision 1 & Revision 2)

Table 45 RxPDO Mapping Table

PDO Map	PDO Map_Name	Number of sub index Entry	Size (byte)	Index	Name	Type
RxPDO	1st RxPDO Mapping (0x1700 – 0x1704)	Max 10			1st User Definition	
					2nd User Definition	
			:	:	:	:
					10th User Definition	

TxPDO Mapping Table(Revision 1 & Revision 2)

Table 46 TxPDO Mapping Table

PDO Map	PDO Map_Name	Number of sub index Entry	Size (byte)	Index	Name	Type
TxPDO	1th txPDO Mapping (0x1B00 – 0x1B04)	Max 10			1st User Definition	
					2nd User Definition	
			:	:	:	:
					10th User Definition	

EEPROM PDO Mapping Setting

CSD7 allows you to use PDO even if you can not import and use XML.

EEPROM RxPDO Mapping Table(Revision 1)

Table 47 EEPROM RxPDO Mapping (Revision 1)

PDO Map	PDO Map_Name	Number of sub index Entry	Size (byte)	Index	Name	Type
RxPDO	1st RxPDO Mapping (0x1600)	7	2	0x6040	Control Word	UINT
			4	0x607A	Target Position	DINT
			4	0x60FF	Target Velocity	DINT
			2	0x6071	Target Torque	INT
			1	0x6060	Modes of Operation	SINT
			2	0x60B8	Touch Probe Function	UINT
			4	0x60FE	Digital Outputs	UDINT

EEPROM RxPDO Mapping Table(Revision 2)

Table 48 EEPROM RxPDO Mapping (Revision 2)

PDO Map	PDO Map_Name	Number of sub index Entry	Size (byte)	Index	Name	Type
RxPDO	1st RxPDO Mapping (0x1600)	7	2	0x6040	Control Word	UINT
			4	0x607A	Target Position	DINT
			4	0x60FF	Target Velocity	DINT
			2	0x6071	Target Torque	INT
			1	0x6060	Modes of Operation	SINT
			1	0x0000	Padding	SINT
			2	0x60B8	Touch Probe Function	UINT
RxPDO	2nd RxPDO Mapping (0x1601)	2	2	0x6040	Control Word	UINT
			4	0x607A	Target Position	DINT

EEPROM TxPDO Mapping Table(Revision 1)

Table 49 EEPROM TxPDO Mapping (Revision 1)

PDO Map	PDO Map_Name	Number of sub index Entry	Size (byte)	Index	Name	Type
TxPDO	1th txPDO Mapping (0x1A00)	9	2	0x6041	Status Word)	UINT
			4	0x6064	Position Actual Value)	DINT
			4	0x606C	Velocity Actual Value)	DINT
			2	0x6077	Torque Actual Value)	INT
			1	0x6061	Modes of Operation Display)	SINT
			4	0x60F4	Following Error Actual Value	DINT
			2	0x60B9	Touch Probe Status	UINT
			2	0x603F	Error Code	UINT
			4	0x60FD	Digital Inputs	UDINT

EEPROM TxPDO Mapping Table(Revision 2)

Table 50 EEPROM TxPDO Mapping (Revision 2)

PDO Map	PDO Map_Name	Number of sub index Entry	Size (byte)	Index	Name	Type
TxPDO	1th txPDO Mapping (0x1A00)	10	2	0x6041	Status Word	UINT
			4	0x6064	Position Actual Value	DINT
			4	0x606C	Velocity Actual Value	DINT
			2	0x6077	Torque Actual Value	INT
			1	0x6061	Modes of Operation Display	SINT
			1	0x1001	Error Register	USINT
			4	0x60F4	Following Error Actual Value	DINT
			2	0x60B9	Touch Probe Status	UINT
			2	0x603F	Error Code	UINT
			4	0x60FD	Digital Inputs	UDINT
TxPDO	2th txPDO Mapping (0x1A01)	8	2	0x6041	Status Word	UINT
			4	0x6064	Position Actual Value	DINT
			4	0x606C	Velocity Actual Value	DINT
			2	0x6077	Torque Actual Value	INT
			4	0x60F4	Following Error Actual Value	DINT
			2	0x60B9	Touch Probe Status	UINT
			2	0x603F	Error Code	UINT
			4	0x60FD	Digital Inputs	UDINT

SDO (Service Date Object)

The CSD7 servo drive supports SDO communication. SDO communication is used to set the object of CSD7 servo drive or to monitor its state. The host controller read data from related object in the object dictionary to monitor slave states, and write data to related object in the object dictionary to set the object.

Abort Code

The following table describes abort code that are sent to the master when SDO communication is abnormal.

Table 51 SDO Abort Code

Abort Code	Description
0x00000000	No SDO error
0x05030000	Toggle bit not changed
0x05040000	SDO timeout
0x05040001	Command specifier unknown
0x05040005	Out of memory
0x06010000	Unsupported Access
0x06010001	Write only entry
0x06010002	Read only entry
0x06010003	Entry can not be written because Subindex0 is not 0
0x06010004	The object can not be accessed via complete access
0x06020000	Object not existing
0x06040041	Object can not be mapped to PDO
0x06040042	Mapped Object exceeds PDO
0x06040043	Parameter is incompatible
0x06040047	Device incompatibility
0x06060000	Hardware error
0x06070010	Parameter length error
0x06070012	Parameter is too long
0x06070013	Parameter is too short
0x06090011	Subindex (Entry) not exists
0x06090030	Value exceeds
0x06090031	Value is too great
0x06090032	Value is too small
0x06090033	Detected Module Ident List (0xF030) and Configured Module Ident list (0xF050) does not match
0x06090036	Value is less than minimum value

0x08000000	General error
0x08000020	Data can not be read or written
0x08000021	Data can not be accessed because of local control
0x08000022	Data can not be read or written in the current state
0x08000023	Object is not in the object dictionary

Sync by Distributed Clock (DC)

EtherCAT communication uses distributed clock (DC) to synchronize between the Master and Slave. The Master and Slave share the reference clock (system time) for sync, and an interrupt (Sync0) that is generated by the reference clock occurs in the Slave.

CSD7 supports the DC Synchronous mode.

- DC Synchronous Mode : In the DC Synchronous mode, drives are synchronized by Sync0 signals of the EtherCAT Master.

Communication Cycle (DC Cycle)

The communication cycle is determined by setting the output cycle of Sync0 signals on the Master side.

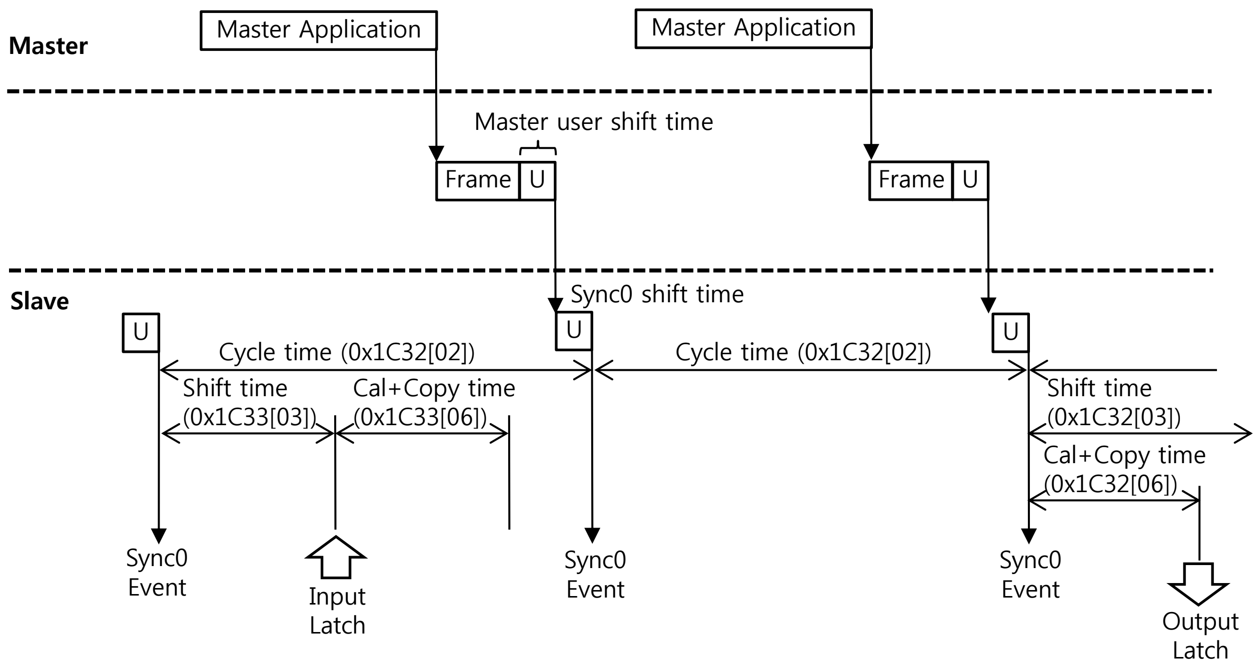
- Setting Range : 1㎳, 2㎳, 4㎳

Related Object

Index	Sub-Index	Name	Data Type	Access	PDO Map	Unit
0x1C32	32	Sync Manager output parameter	-	-	No	-
0x1C33	32	Sync Manager input parameter	-	-	No	-

Communication Timing

The EtherCAT sync processing runs separately in the Master and the Slave.



Chapter 6. CIA402 Drive Profile

CSD7 Servo Drive was designed based on the CIA402 Drive Profile of EtherCAT. This Chapter describes the CIA402 drive profile to control CSD7 Servo Drive.

State Machine

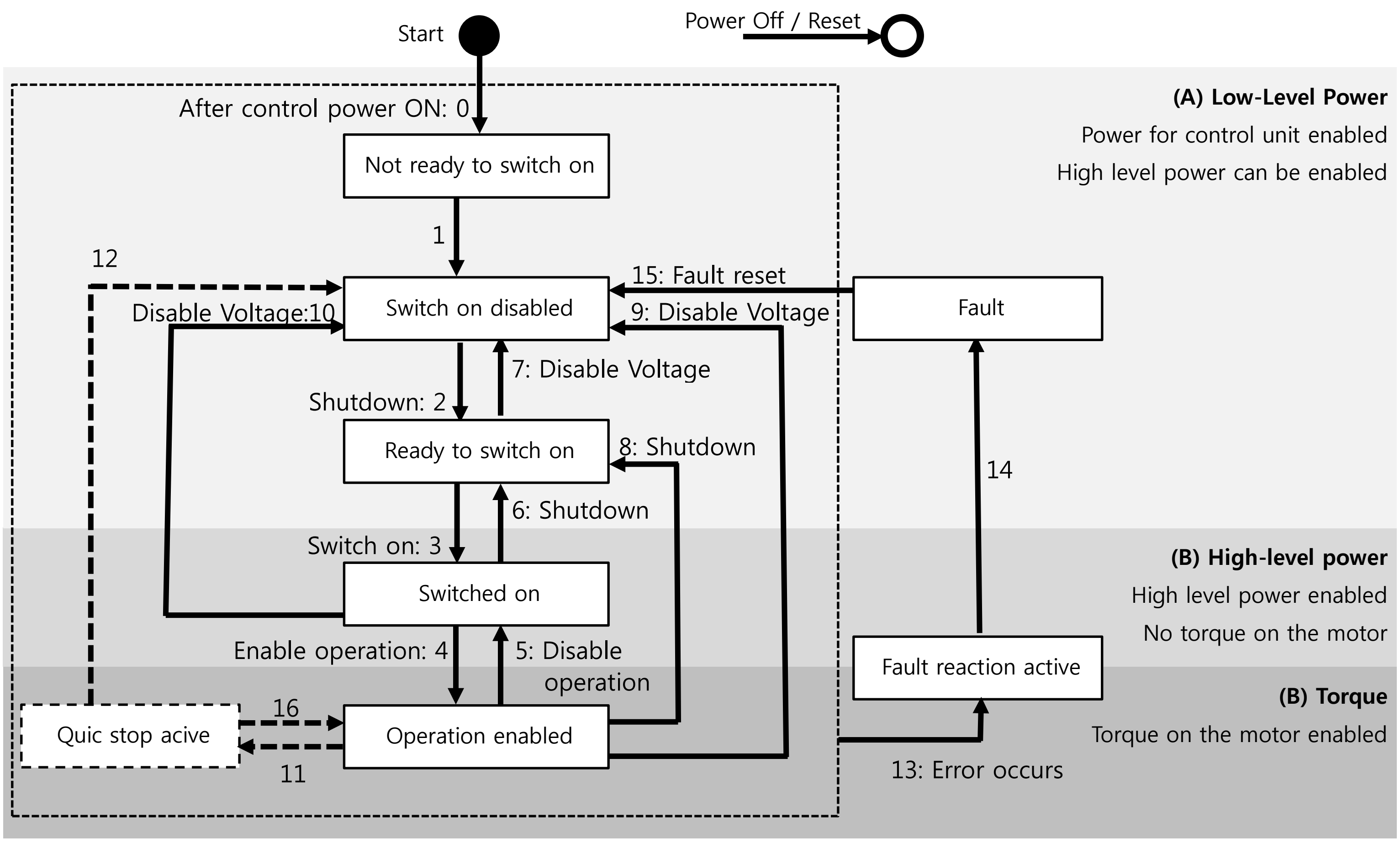
The status of CSD7 Servo Drive is controlled by Control Word (0x6040). And each status of slave is written in Status Word (0x6041).

State Machine

EtherCAT CSD7 Servo Drive has states given in the boxes in the diagram below and the movement of each state is performed by the servo drive or master.

- Transition 2 is performed by Master when needed.
- Transition 3 and 4 can be performed only by Master.
- If Control Word, Bit 0, 1 and 3 are set at the same time, the Servo Drive is run with one master command from ***Ready to switch on*** through ***Switched on*** to ***Operation enable***.

Fig 1 State machine



State Definition

Table 52 State Machine State Definition

State	Description	Remarks
Not ready to switch on	- Initialization is in progress with control power ON	Automatically run by servo drive
Switch on disabled	- Initialization is completed - The servo drive parameters are available to set	Automatically run by servo drive
Ready to switch on	- The main power is available to turn ON - The servo drive parameters are available to set - The servo drive functions are disabled	
Switched on	- The main power is turned ON - The servo drive parameters are available to set - The drive functions are disabled	
Operation enabled	- Servo-On state - The drive functions are active, and the motor is available to apply torques. - The servo drive parameters are available to set	
Fault reaction active	- A fault reaction is being processed - The servo drive parameters are available to set	Automatically run by servo drive
Fault	- A fault reaction is being generated - The servo drive functions are disabled - The servo drive parameters are available to set	

State Machine Control Command

Servo state is controlled by combining the bits of Controlword (0x6040) as shown in the table below.

Table 53 State Machine Control Command

Command	Bits of the Controlword (0x6040)					State Machine Transition
	Bit 7	Bit 3	Bit 2	Bit 1	Bit 0	
Shutdown	0	-	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
Disable voltage	0	-	-	0	-	7, 9, 10
Quick stop	0	-	0	1	-	Not supported
Disable operation	0	0	1	1	1	5
Enable operation	1	1	1	1	1	4
Fault reset	0→1	-	-	-	-	15

▶ Meaning of each bit

* Bit 7 ; Fault reset

* Bit 3 ; Enable operation

* Bit 2 ; Quick stop
* Bit 1 ; Enable voltage
* Bit 0 ; Switch on

▶ Set to '0' after Fault reset

Status Display

Each status is displayed as a combination of the following Statusword (0x6041) in the table below.

Table 54 State Machine Status Display

Status	Bits of the Statusword (0x6041)						
	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Not ready to switch on	0	X	-	0	0	0	0
Switch on disabled	1	X	-	0	0	0	0
Ready to switch on	0	1	-	0	0	0	1
Switched on	0	1	-	0	0	1	1
Operation enabled	0	1	-	0	1	1	1
Fault reaction active	0	X	-	1	1	1	1
Fault	0	X	-	1	0	0	0

▶ X : don't care

▶ Meaning of each bit

* Bit 6 ; Switch on disabled
* Bit 5 ; Quick stop
* Bit 4 ; Voltage enabled
* Bit 3 ; Fault
* Bit 2 ; Operation enabled
* Bit 1 ; Switched on
* Bit 0 ; Ready to switch on

Related Object

Table 55 State Machine Related Object

Index	Sub-Index	Name	Data Type	Access	PDO Map	Unit
0x6040	00h	Controlword	UINT	RW	RxPDO	-
0x6041	00h	Statusword	UINT	RO	TxPDO	-
0x605A	00h	Quick Stop Option Code	INT	RW	-	-
0x605B	00h	Shutdown Option Code	INT	RW	-	-
0x605C	00h	Disable Operation Option Code	INT	RW	-	-

0x605D	00h	Halt Option Code	INT	RW	-	-
0x605E	00h	Fault Reaction Option Code	INT	RW	-	-

Mode of Operation

CSD7 supports the following mode of operation (0x6060) :

- Cyclic Synchronous Position Mode
- Cyclic Synchronous Torque Mode

The operation modes of Servo Drive can be set in 0x6060 (Mode of Operation) and displayed in 0x6061 (Mode of Operation Display). you can see the operation modes that are supported in the Servo Drive in 0x6502 (Surrorted Drive Modes).

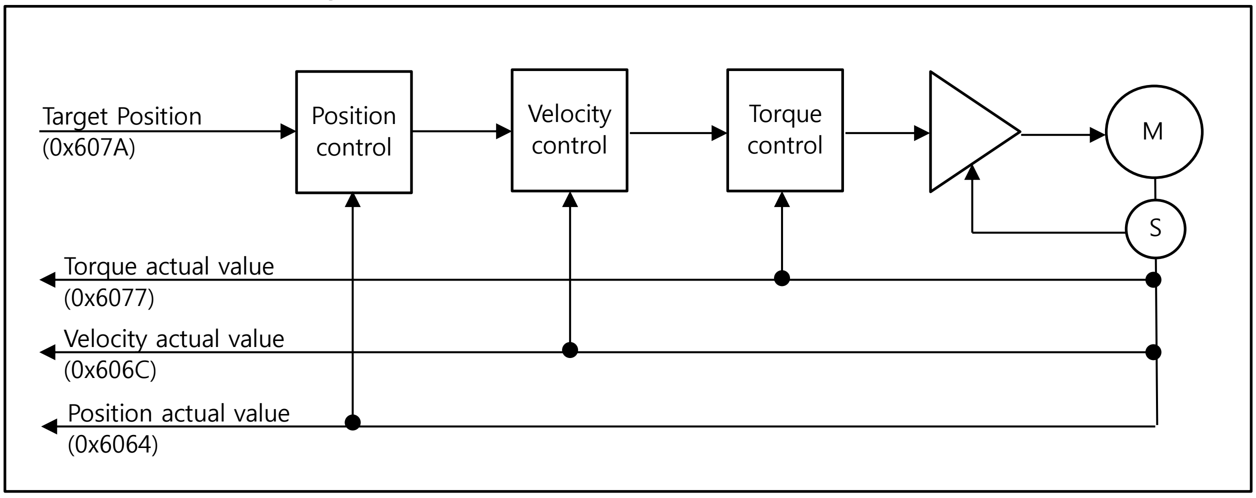
Cyclic Synchronous Position Mode (CSP mode)

In CSP mode, the master generates the position trajectories and transmits target positions (0x607A) to servo drive every PDO cycles so that the servo drives carry out Position control-Velocity control-Torque control. Position feedback (0x6064), Velocity feedback (0x606C), Torque Feedback (0x6077) are transmitted to the Master.

CSP Mode Configuration

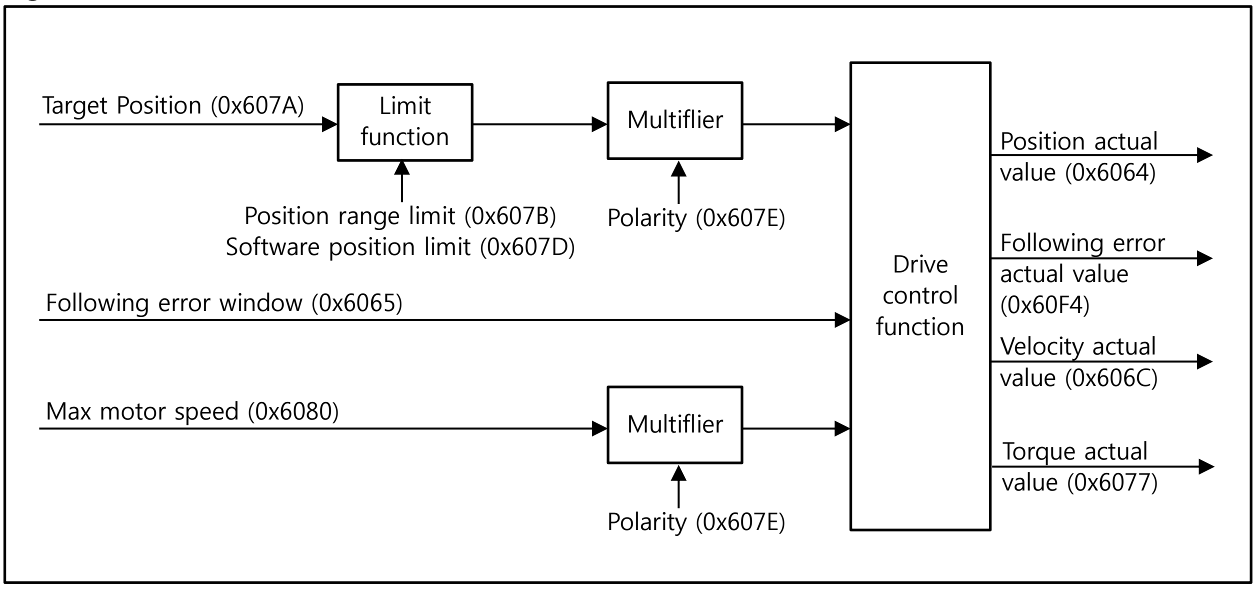
The configuration of CSP mode is as follows :

Fig 2 CSP Mode Configuration



And the control functions of CSP mode are configured as follows :

Fig 3 Control Functions of CSP Mode



Related Object

Table 56 CSP Mode Related Object

Index	Sub-Index	Name	Data Type	Access	PDO Map	Unit
0x6040	00h	Controlword	UINT	RW	RxPDO	-
0x6041	00h	Statusword	UINT	RO	TxPDO	-
0x6060	00h	Modes of Operation	SINT	RW	RxPDO	-
0x6064	00h	Position Actual Value	DINT	RO	TxPDO	pulse
0x6065	00h	Following error window	UDINT	RW	-	pulse
0x606C	00h	Velocity Actual Value	DINT	RO	TxPDO	pps
0x6077	00h	Torque actual value	INT	RW	TxPDO	0.1%
0x607A	00h	Target Position	DINT	RW	RxPDO	pulse
0x607B	00h	Position Range Limit	DINT	RO	-	-
	01h	Min Position Limit	DINT	RW	-	pulse
	02h	Max Position Limit	DINT	RW	-	pulse
0x607D	00h	Software Position Limit	DINT	RO	-	-
	01h	Min Position Limit	DINT	RW	-	pulse
	02h	Max Position Limit	DINT	RW	-	pulse
0x607E	00h	Polarity	USINT	RW	-	-
0x6080	00h	Max motor speed	UDINT	RW	-	rpm
0x60F4	00h	Following error actual value	DINT	RW	-	-

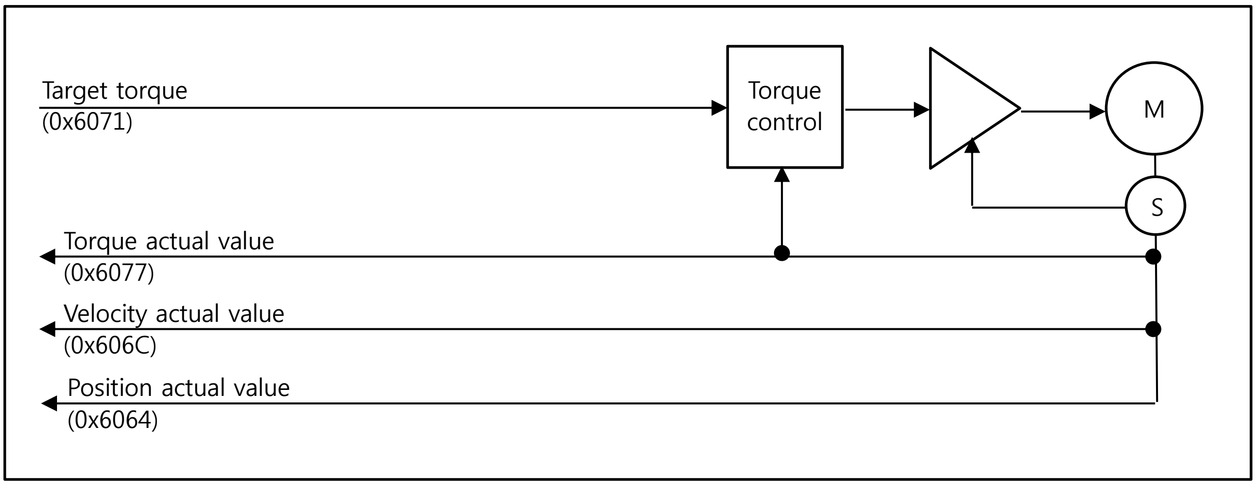
Cyclic Synchronous Torque Mode (CST mode)

In CST mode, the master transmits the target torque (0x6071) to servo drive every PDO cycles so that the servo drives carry out Torque control. In this mode, Position control and Velocity control are carried out in the master controller.

Configuration of CST Mode

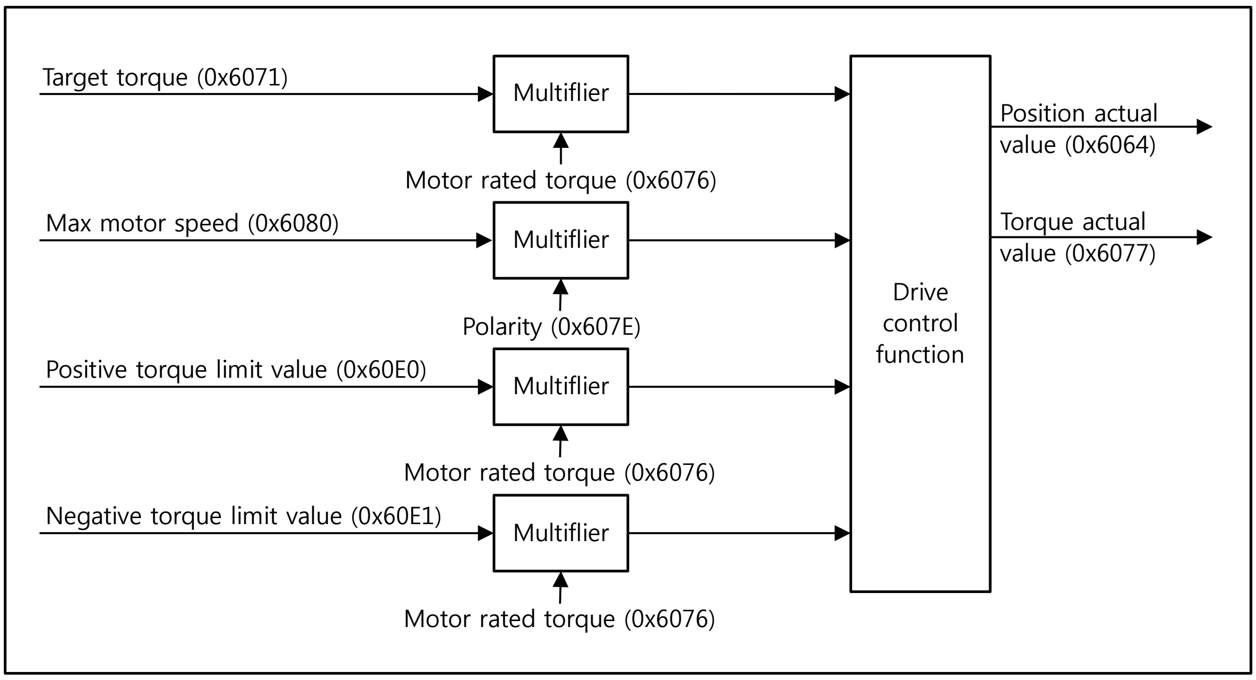
The configuration of CST mode is as follows :

Fig 4 CST Mode Configuration



And the control functions of CST mode are configured as follows:

Fig 5 Control Functions of CST Mode



Related Object

Table 57 CST Mode Related Object

Index	Sub-Index	Name	Data Type	Access	PDO Map	Unit
0x6064	-	Position Actual Value	DINT	RO	TxPDO	pulse
0x6071	-	Target Torque	INT	RW	RxPDO	0.1%
0x6076	-	Motor rated torque	UDINT	RW	-	0.1A
0x6077	-	Torque actual value	INT	RW	TxPDO	0.1%
0x607E	-	Polarity	USINT	RW	-	-
0x6080	-	Max motor speed	UDINT	RW	-	rpm
0x60E0	-	Positive Torque Limit Value	INT	RW	-	0.1%
0x60E1	-	Negative Torque Limit Value	INT	RW	-	0.1%

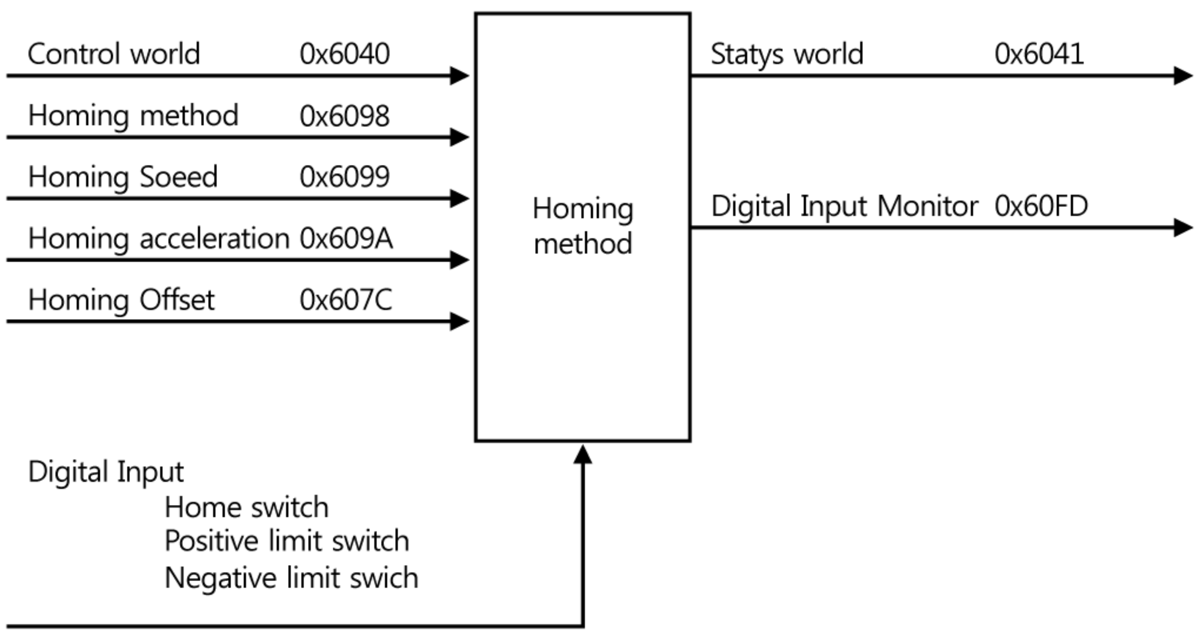
Homing Mode

Homing Mode is a mode in which homing command(0x6040) which is renewed every PDO update cycle from the controller is received and servo drive performs home return function.

Configuration of Homing Mode

The configuration of the homing mode is as follows.

Fig 6 Configuration of Homing Mode



Related Object

Table 58 Homing Mode Related Object

Index	Sub-Index	Name	Data Type	Access	PDO Map	Unit	Remark
0x6040	00h	Control Word	UINT	RW	RxPDO	-	-
0x6041	00h	Status Word	UINT	RO	TxPDO	-	-
0x607C	00h	Home Offset	DINT	RW	RxPDO	-	Ft-5.17
0x607D	00h	Software Position Limit	USINT	RO	-	0	-
	01h	Min Position Limit	DINT	RW	-	Pos units	-
	02h	Max Position Limit	DINT	RW	-	Pos units	-
0x6098	00h	Homing Method	SINT	RW	RxPDO		Ft-5.15
0x6099	00h	Homing Speeds	USINT	RO	-	-	-
	01h	Speed for Switch	UDINT	RW	RxPDO	Vel units	Ft-5.18
	02h	Speed for Zero	UDINT	RW	RxPDO	Vel units	Ft-5.19
0x609A	00h	Homing Acceleration	UDINT	RW	RxPDO	Accel units	Ft-5.20
0x60FD	00h	Digital Inputs	UDINT	RO	TxPDO	0	-
0x5030	00h	Forced Homing Flag	UINT	RW	RxPDO		-
0x5040	00h	Homing Current	UINT	RW	RxPDO	%	-
0x5041	00h	Home Current Time	UINT	RW	RxPDO	ms	-
0x2A3F	00h	ECAT Homing Status	DINT	RO	-	-	-
0x2A40	00h	ECAT Homing Error	DINT	RO	-	-	-

A list of parameters related to homing is available in Group5.

Table 59 Homing Mode Related Prameter

Para. No	Index	Name	Unit	Init Value	Min Value	Max Value
Ft-5.14	0x250E	ECAT Abs Origin Offset	pulse	0	-2147483647	2147483647
Ft-5.15	0x250F	ECAT Homing Method	-	0	-128	127
Ft-5.16	0x2510	ECAT Homing Timeout	sec	0	0	5000
Ft-5.17	0x2511	ECAT Homing Offset	pulse	0	-2147483647	2147483647
Ft-5.18	0x2512	ECAT Homing Velocity 1	pulse/sec	0	0	2147483647
Ft-5.19	0x2513	ECAT Homing Velocity 2	pulse/sec	0	0	2147483647
Ft-5.20	0x2514	ECAT Homing Acceleration	pulse/sec^2	0	0	2147483647

When the operation mode is Homing, the bit meaning of Control Word (0x6040) is as follows.

Table 60 Bit Meaning of Homing Mode Control Word

Bits of the ControlWord(0x6040)			Description
Bit 6	Bit 5	Bit 4	
-	-	0	The Homing Operation Stops
-	-	1	The Homing Operation Starts

▶ Meaning of each bit

* Bit 4 : Homing Start

When the operation mode operates in Homing mode, the Status bit of StatusWord (0x6041) indicates the Homing operation status.

Table 61 Homing Mode StatusWord Status Bit

Bits of the StatusWord(0x6041)			Description
Bit 13	Bit 12	Bit 10	
-	-	0	In Operation
-	-	1	Target Reached
-	0	-	The Homing operation is not completed
-	1	-	The Homing operation is completed
0	-	-	No Error
1	-	-	Error occurs

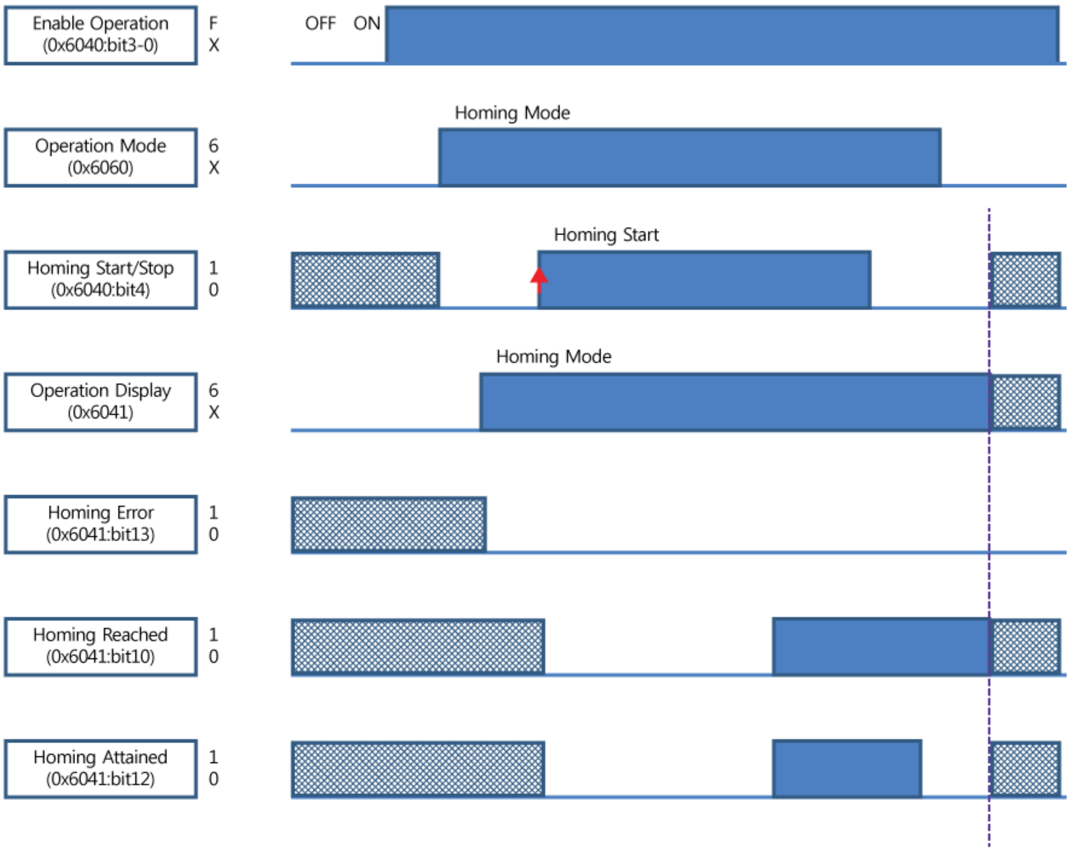
▶ Meaning of each bit

* Bit 13 : Homing Error

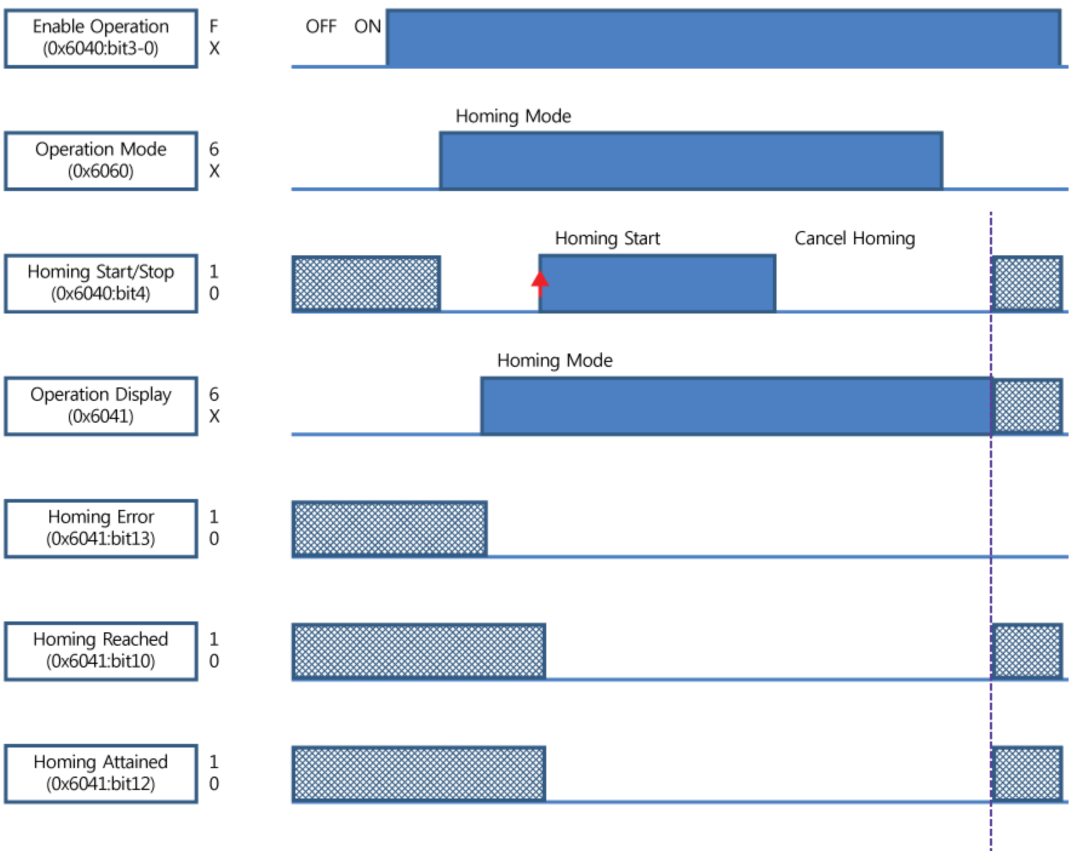
* Bit 12 : Homing Completed

* Bit 10 : Target Reached

Homing mode operation is as shown below.



Homing mode operation is as shown below.



The error conditions of the homing operation are as follows.

- In Homing mode, error status can be checked with status word (0x6041) Bit 13.
- The type of homing error can be checked at 0x2A40 (ECAT Homing Error).
- The homing error is the operation mode (0x6060) is the homing mode and the homing start bit (0x6040: bit4) is released from the rising edge.

Table 62 Homing Error Code

Error Code	Name	Description
0	HM_NO_ERROR	No errors
1	HM_SERVO_OFF	Homing starts in Servo Off state.
2	HM_POT_NOT	POT and NOT Sensor are input at the same time
3	HM_SWITCH	Unused Limit switch is operated Home sensor and POT or NOT sensor are input at the same time.
4	HM_TIME_OUT	Time Out set to 0x2510 is exceeded.
5	HM_NOT_OP	EtherCAT communication status is not Operation Mode.
6	HM_NOT_SUPPORT	Set an unsupported homing mode
7	HM_CHECK_CONDITION	Homing velocity 1, 2 is less than 1/60 rps or homing acceleration is less than 1 rps ^ 2 *Velocity is pulse / sec and acceleration is pulse / sec ^ 2 unit. However, note that rps and rps ^ 2 values change according to encoder resolution.
8	HM_SERVO_ERROR	Servo error occurred during homing operation

- The homing error is not a servo error and does not affect the operation state of the servo drive. Homing error is not cleared by servo drive Fault Clear.

The CSD7 servo drive supports the following homing methods according to the CIA402 standard, and can distinguish homing methods according to the user configuration.

- Homing Method 1 ~ 4 : Index Pulse + [POT or NOT Sensor Combination]
- Homing Method 5 ~ 6 : Index Pulse + [Home Sensor Combination]
- Homing Method 7 ~ 14 : Index Pulse + Home Sensor + [POT or NOT Sensor Combination]
- Homing Method 17 ~ 30 : [POT or NOT or Home Sensor] 혹은 [POT or NOT + Home Sensor Combination]
- Homing Method 33 ~ 34 : Only using Index Pulse
- Homing Method 40 ~ 43 : Using Stopper

Table 63 How to Homing

Number	Homing Method	Stop Direction	CSD7 Support

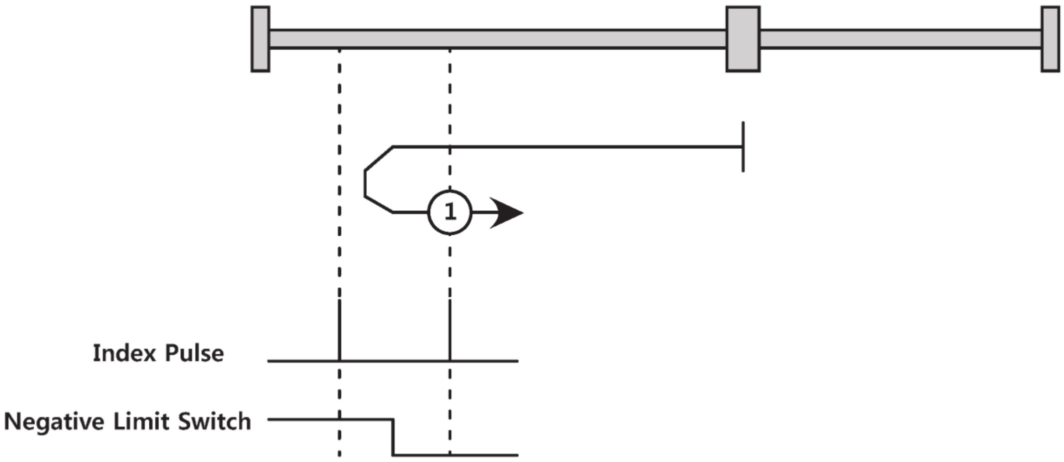
Number	Homing Method	Stop Direction	CSD7 Support
1	Homing on Negative Limit Switch and Index Pulse	Positive	O
2	Homing on Positive Limit Switch and Index Pulse	Negative	O
3	Homing on Positive Home Switch and Index Pulse	Negative	O
4	Homing on Positive Home Switch and Index Pulse	Positive	X
5	Homing on Negative Home Switch and Index Pulse	Positive	O
6	Homing on Negative Home Switch and Index Pulse	Negative	X
7	Homing on Positive Limit Switch, Homing On Positive Home Switch and Index Pulse	Negative	O
8	Homing on Positive Limit Switch, Homing On Positive Home Switch and Index Pulse	Positive	X
9	Homing on Positive Limit Switch, Homing On Negative Home Switch and Index Pulse	Negative	O
10	Homing on Positive Limit Switch, Homing On Negative Home Switch and Index Pulse	Positive	X
11	Homing on Negative Limit Switch, Homing On Positive Home Switch and Index Pulse	Positive	O
12	Homing on Negative Limit Switch, Homing On Positive Home Switch and Index Pulse	Negative	X
13	Homing on Negative Limit Switch, Homing On Negative Home Switch and Index Pulse	Positive	O
14	Homing on Negative Limit Switch, Homing On Negative Home Switch and Index Pulse	Negative	X
15	Reserved	-	X
16	Reserved	-	X
17	Homing on Negative Limit Switch	Positive	O
18	Homing on Positive Limit Switch	Negative	O
19	Homing on Positive Home Switch	Positive	O
20	Homing on Positive Home Switch	Negative	X
21	Homing on Negative Home Switch	Positive	O
22	Homing on Negative Limit Switch	Negative	X
23	Homing on Positive Limit Switch and Homing On Positive Home Switch	Negative	O
24	Homing on Positive Limit Switch and Homing On Positive Home Switch	Positive	X
25	Homing on Positive Limit Switch and Homing On Negative Home Switch	Negative	O
26	Homing on Positive Limit Switch and Homing On Negative Home Switch	Positive	X
27	Homing on Negative Limit Switch and Homing On Positive Home Switch	Positive	O
28	Homing on Negative Limit Switch and Homing On Positive Home Switch	Negative	X
29	Homing on Negative Limit Switch and Homing On Negative Home Switch	Positive	O
30	Homing on Negative Limit Switch and Homing On Negative Home Switch	Negative	X
31	Reserved	-	X
32	Reserved	-	X
33	Homing on Index Pulse	Negative	O
34	Homing on Index Pulse	Positive	O
35	Homing on the Current Position	-	O
36	Homing with Touch Probe	-	X
40	Homing on Negative stopper	Negative	O
41	Homing on Negative stopper and Positive Index Pulse	Positive	O
42	Homing on Positive stopper	Positive	O
43	Homing on Positive stopper and Negative Index Pulse	Negative	O

Number	Homing Method	Stop Direction	CSD7 Support
Else	Reserved	-	X

Homing Method 1, 2

Homing Method 1

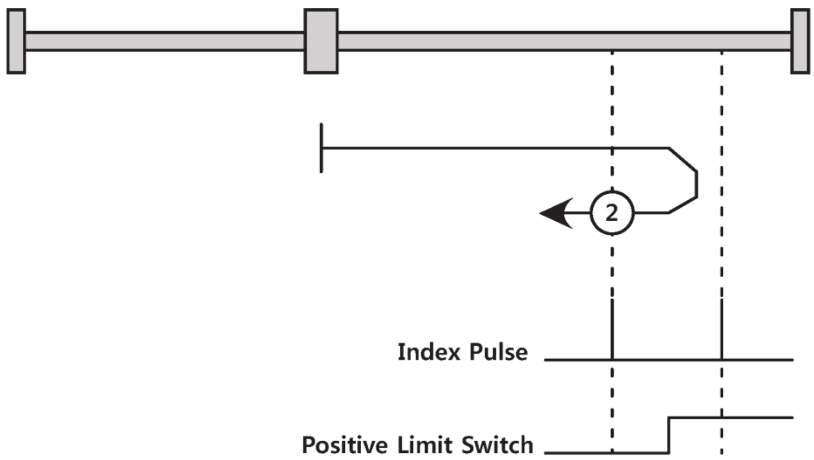
Homing on Negative Limit Switch and Index Pulse



NOT limit sensor is in the undetected position. If the NOT LIMIT sensor is detected while moving in the reverse direction, it stops after moving in the reverse direction. When the index pulse is detected, it is stopped.
In order to detect NOT Limit Sensor, it moves to the Speed for Switch (0x6099: 1). When the NOT limit sensor is detected, the stop is decelerated to stop according to the setting of Homing Acceleration (0x609A) or stops immediately.
In order to detect the index pulse, it moves to the Speed for Zero (0x6099: 2) and stops after deceleration.
If a POT is encountered during homing, a homing error occurs and homing operation stops.
When the 'NOT LIMIT sensor' is detected, it moves in the forward direction and stops when the index pulse is detected.

Homing Method 2

Homing on Positive Limit Switch and Index Pulse



If the POT limit sensor is not detected, it moves in the forward direction. If the POT limit sensor is detected, it stops and then moves in the reverse direction and stops when the index pulse is detected.
In order to detect the POT limit sensor, it moves at the speed of Speed for Switch (0x6099: 1). The stop when the POT limit sensor is detected decelerates to stop according to the setting of Homing Acceleration (0x609A) or stops immediately.
In order to detect the index pulse, it moves at the speed of Speed for Zero (0x6099: 2) and decelerates and stops. When NOT is encountered during homing, a homing error occurs and homing operation is stopped.
If a 'POT limit sensor' is detected, it moves in the reverse direction and stops when an index pulse is detected.

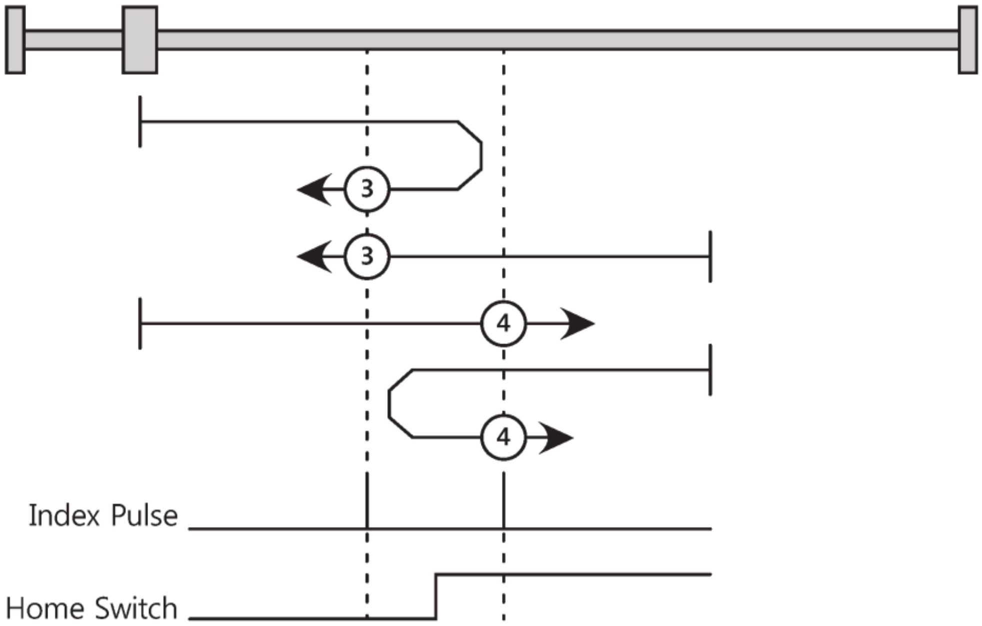
Homing Method 3,4

Homing Method 3
Homing on Positive Home Switch and Index Pulse

When the home sensor is not detected, it goes forward. When home sensor is detected, it decelerates and stops. When it moves in the reverse direction, it stops when it detects index pulse.
At the position where home sensor is detected, it moves to the reverse direction and stops when the index pulse is detected.
It moves at the speed of Speed for Switch (0x6099: 1) to detect the home sensor. When the home sensor is detected, it decelerates and stops according to the setting of Homing Acceleration (0x609A) or stops immediately.
In order to detect the index pulse in the reverse direction, it moves at the speed of Speed for Zero (0x6099: 2) and stops after deceleration. If a POT or NOT is encountered during homing, a homing error occurs and homing operation stops.

Homing Method 4

CSD7 servo drive is not supported.



Homing Method5,6

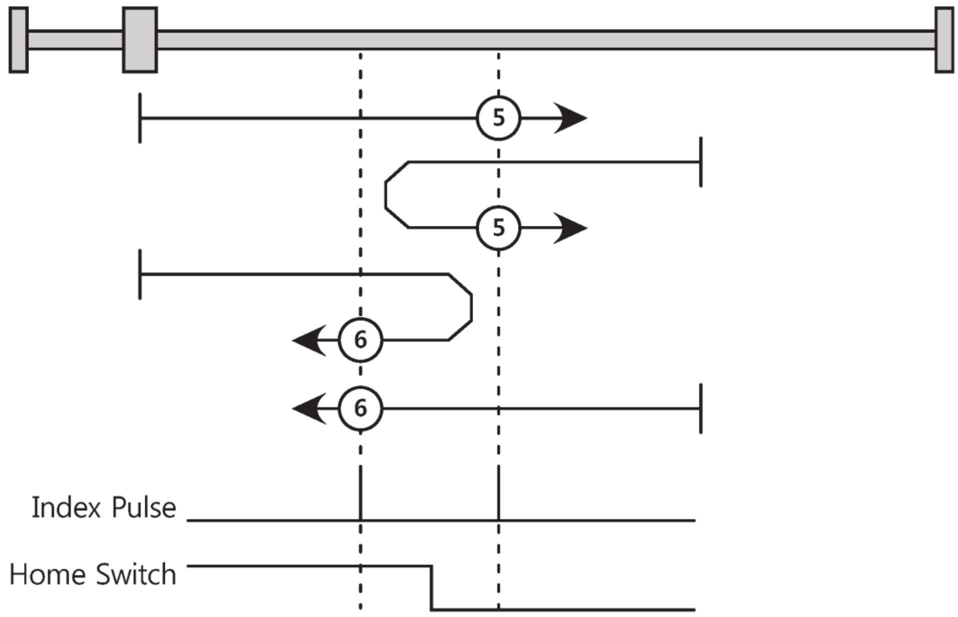
Homing Method 5

Homing on Negative Home Switch and Index Pulse

When the home sensor is not detected, it moves in the reverse direction. When the home sensor is detected, it stops after deceleration, moves in the forward direction, and stops when the index pulse is detected.
When the home sensor is detected, it moves to the positive direction and stops when the index pulse is detected.
In order to detect the home sensor, it moves at speed of Speed for Switch (0x6099: 1). When home sensor is detected, it decelerates according to the setting of Homing Acceleration (0x609A) and stops or stops immediately.
In order to detect the index pulse in the reverse direction, it moves at the speed of Speed for Zero (0x6099: 2) and stops after deceleration.
When POT or NOT is encountered during homing, homing error occurs and homing is stopped

Homing Method 6

CSD7 servo drive is not supported.



Homing Method 7, 8, 9, 10

Homing Method 7

Homing on Positive Limit Switch, Homing On Positive Home Switch and Index Pulse

When the home sensor and the POT sensor are not detected, they move in the forward direction. When home sensor is detected, it decelerates and stops, moves in the reverse direction, and stops when the index pulse is detected.
When the POT sensor is detected first, it detects the home sensor in the reverse direction and exits the home sensor, and stops when the index pulse is detected.
At the position where home sensor is detected, it moves to the reverse direction and stops when the index pulse is detected.
Moves at the speed of Speed for Switch (0x6099: 1) to detect home sensor or POT sensor.
When home sensor or POT sensor is detected, it decelerates according to the setting of Homing Acceleration (0x609A) and stops or stops immediately.
In order to detect the home sensor or index pulse in the reverse direction, it moves at the speed of Speed for Zero (0x6099: 2) and stops after decelerating.
When NOT is encountered during homing, a homing error occurs and the homing operation is stopped
Compared with Homing Method 9, the polarity to detect the sensor is different, and stopping the homing completion from the outside of the home sensor.

Homing Method 8

CSD7 servo drive is not supported.

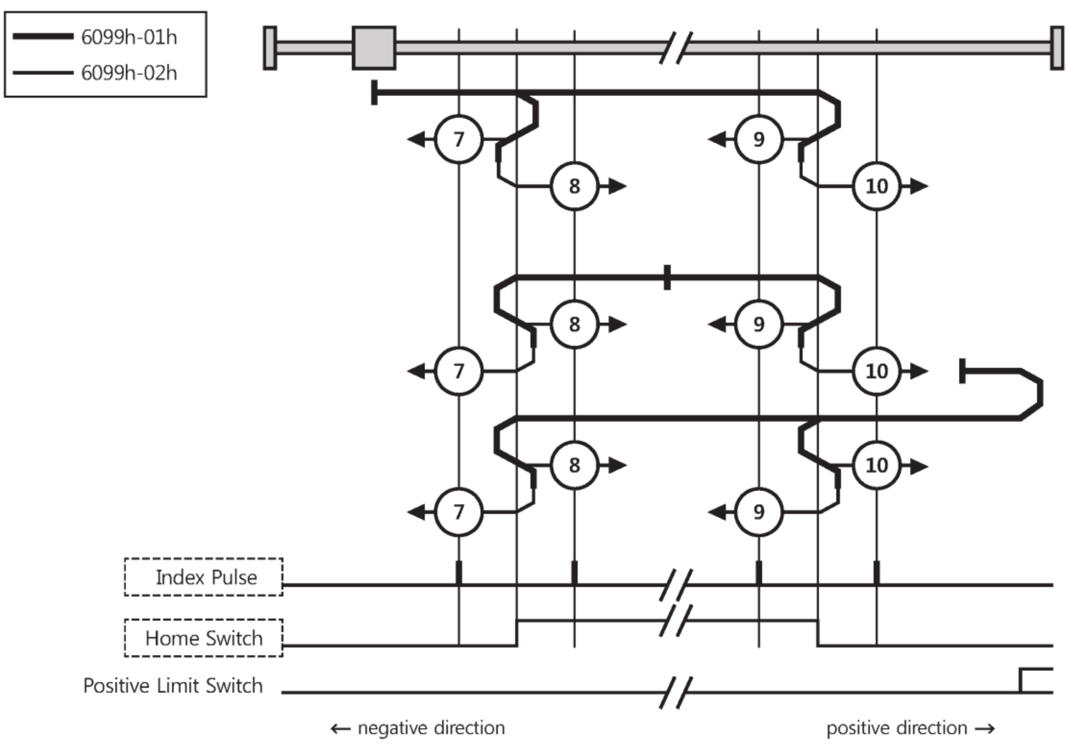
Homing Method 9

Homing on Positive Limit Switch, Homing On Negative Home Switch and Index Pulse

At the position where home sensor is not detected, it moves forward, decelerates to stop when the home sensor is detected, and stops when the index pulse is detected in the reverse direction.
If the POT sensor is detected first, it moves in the reverse direction and detects the home sensor and stops when the index pulse is detected.
When the home sensor is detected, it detects the falling edge and then stops when the index pulse is detected.
It moves at the speed of Speed for Switch (0x6099: 1) to detect home sensor or POT sensor.
When home sensor or POT sensor is detected, it decelerates according to the setting of Homing Acceleration (0x609A) and stops or stops immediately.
In order to detect the home sensor or index pulse in the reverse direction, it moves at the speed of Speed for Zero (0x6099: 2) and stops after decelerating.
When NOT is encountered during homing, a homing error occurs and the homing operation is stopped
Compared with homing method 7, the polarity to detect the sensor is different and homing is completed in the home sensor.

Homing Method 10

CSD7 servo drive is not supported.



Homing Method 11, 12, 13, 14

Homing Method 11

Homing on Negative Limit Switch, Homing On Positive Home Switch and Index Pulse

At the position that home sensor is not detected, it decelerates to stop if home sensor is detected as proceeding in the reverse direction and it stops if detected index pulse in the reverse direction. If NOT sensor is detected first, it detects the falling edge of the home sensor in the forward direction and then exits. When the index pulse is detected, it stops.
At the position that home sensor is detected, it stops if index pulse is detected after detected the falling edge in the forward direction

It moves to the switch detection speed(0x6099:1) in order to detect home sensor or NOT sensor. It decelerates to stop or stops immediately according to the setting of home return acceleration(0x609A) when home sensor or NOT sensor is detected. In order to detect home sensor or index pulse in the reverse direction, it moves to the switch zero searching speed(0x6099:2) and stops after deceleration. When POT is encountered during homing, a homing error occurs and the homing operation is stopped.

Compared with home return method 13, the polarity to detect the sensor is different, and home return completion stops from the origin sensor.

Homing Method 12

CSD7 servo drive is not supported.

Homing Method 13

Homing on Negative Limit Switch, Homing On Negative Home Switch and Index Pulse

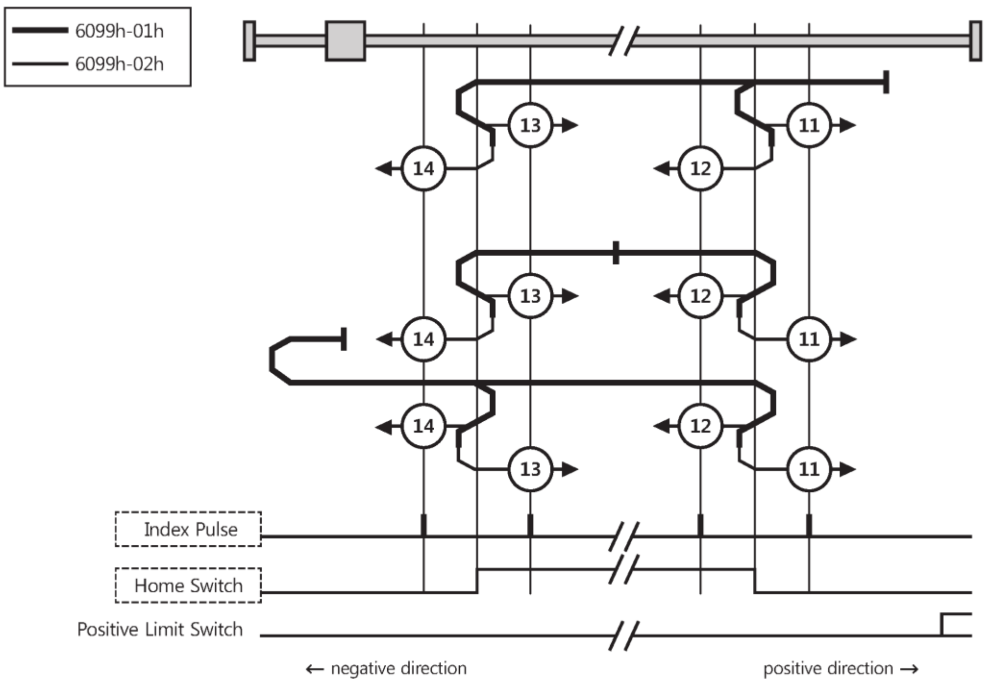
At the position that home sensor is not detected, it decelerates to stop if the falling edge of home sensor is detected and it stops if detected index pulse in the reverse direction.
If NOT sensor is detected first, it detects the falling edge of the home sensor in the forward direction and then exits in the reverse direction and stops when the index pulse is detected.
At the position that home sensor is detected, it stops if index pulse is detected in the reverse direction after detected the falling edge in the reverse direction.

It moves to the switch detection speed(0x6099:1) in order to detect home sensor or NOT sensor. It decelerates to stop or stops immediately according to the setting of home return acceleration(0x609A) when home sensor or NOT sensor is detected. In order to detect home sensor or index pulse in the reverse direction, it moves to the switch zero searching speed(0x6099:2) and stops after deceleration. When POT is encountered during homing, a homing error occurs and the homing operation is stopped.

Compared with the home return method 11, the polarity to detect the sensor is different, and home return is completed within the origin sensor.

Homing Method 14

CSD7 servo drive is not supported.



Homing Method 17, 18

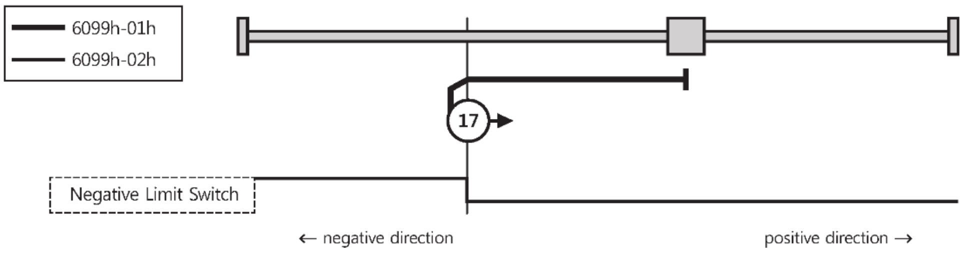
Homing Method 17

Homing on on Negative Limit Switch

At the position that NOT sensor is not detected, it decelerates to stop if NOT sensor is detected as proceding in the reverse direction and it stops if detected a falling edge in the reverse direction. At the position that NOT sensor is detected, it stops if detected a falling edge in the forward direction.

It moves to the switch detection speed(0x6099:1) in order to detect NOT sensor. It decelerates to stop or stops immediately according to the setting of home return acceleration(0x609A) when NOT sensor is detected. In order to detect the sensor in the reverse direction, it moves to the switch zero searching speed(0x6099:2) and stops after deceleration. When POT is encountered during homing, a homing error occurs and the homing operation is stopped.

Compared with home return method 1, the presence or absence of index pulse is different.



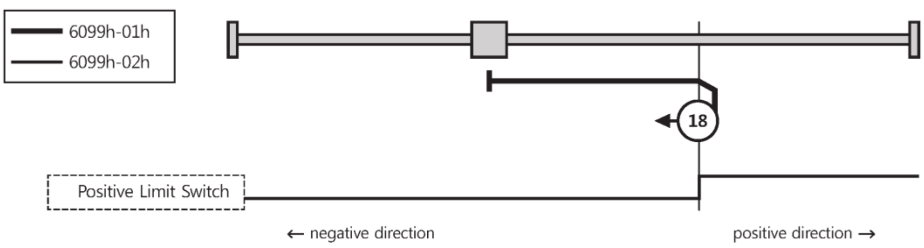
Homing Method 18

Homing on on Positive Limit Switch

At the position that POT sensor is not detected, it decelerates to stop if POT sensor is detected as proceeding in the forward direction and it stops if detected a falling edge in the reverse direction. At the position that POT sensor is detected, it stops if detected a falling edge in the reverse direction.

It moves to the switch detection speed(0x6099:1) in order to detect POT sensor. It decelerates to stop or stops immediately according to the setting of home return acceleration(0x609A) when POT sensor is detected. In order to detect the sensor in the reverse direction, it moves to the switch zero searching speed(0x6099:2) and stops after deceleration. When NOT is encountered during homing, a homing error occurs and the homing operation is stopped.

Compared with home return method 2, the presence or absence of index pulse is different.



Homing Method 19, 20

Homing Method 19

Homing on on Positive Home Switch

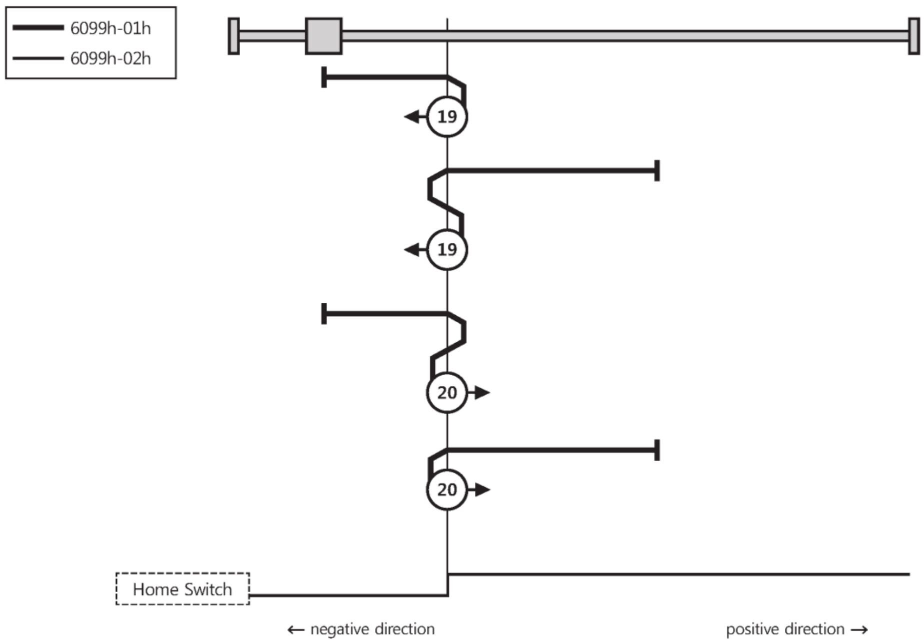
At the position that home sensor is not detected, it decelerates to stop if home sensor is detected as proceding in the forward direction and it stops if detected a falling edge in the reverse direction. At the position that home sensor is detected, it stops if detected a falling edge in the reverse direction.

It moves switch detection speed(0x6099:1) in order to detect home sensor. It decelerates to stop or stops immediately according to the setting of home return acceleration(0x609A) when POT sensor is detected. In order to detect the sensor in the reverse direction, it moves to the switch zero searching speed(0x6099:2) and stops after deceleration. If POT or NOT is encountered during home return, home return error occurs and home return operation is stopped.

Compared with home return method 3, the presence or absence of index pulse is different.

Homing Method 20

CSD7 servo drive is not supported.



Homing Method 21, 22

Homing Method 21

Homing on on Negative Home Switch

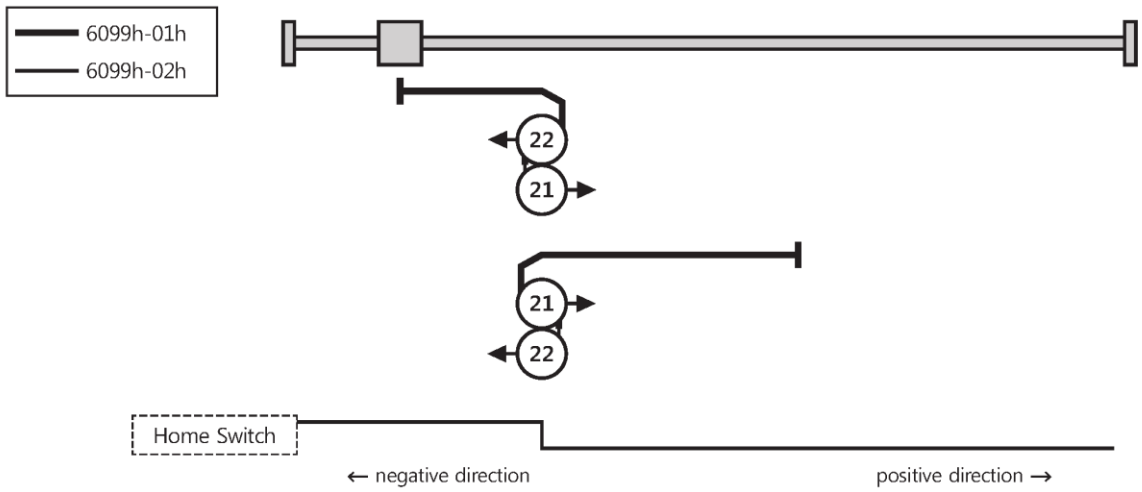
At the position that is not detected, it decelerates to stop when it detects the home sensor proceeding in ther reverse direction and stops when it detects the falling edge in the reverse direction. At the position where the home sensor is detected, it stops when the falling edge is detected in the forward direction

In order to detect home sonsor, it moves to the switch detection speed(0x6099:1) and it decelerates to stop or or stops immediately according to the setting of home return acceleration(0x609A) when it detects POT sensor. In order to detect the sensor in the reverse direction, it moves to the switch zero searching speed(0x6099:2) and stops after deceleration. If POT or NOT is encountered during home return, home return error occurs and home return operation is stopped.

Compared with home return method 5, the presence or absence of index pulse is different.

Homing Method 22

CSD7 servo drive is not supported.



Homing Method 23, 24, 25, 26

Homing Method 23

Homing on Positive Limit Switch and Homing On Positive Home Switch

When the home sensor and POT sensor are not detected, it proceeds to forward direction and decelerates to stop when the home sensor is detected, then exiting in reverse direction and stops. When the POT sensor is detected first, it detects the home sensor in the reverse direction and stops while exiting the home sensor. At the position where the home sensor is detected, it stops while exiting in the reverse direction.

In order to detect home sensor or POT sensor, it moves switch detection speed(0x6099:1). When home sensor or POT sensor is detected, it decelerates according to the setting of home return acceleration(0x609A) and stops or immediately stops operation. In order to detect home sensor or index pulse in the reverse direction, it moves to switch zero search speed (0x6099: 2) and stops after decelerating. If a NOT is encountered during home return, a home return error occurs and home return operation stops.

Compared with home return method 7, the presence or absence of index pulse is different. Compared with home return method 25, the polarity to detect the sensor is different and it stops after home return is completed outside the home sensor.

Homing Method 24
CSD7 servo drive is not supported.

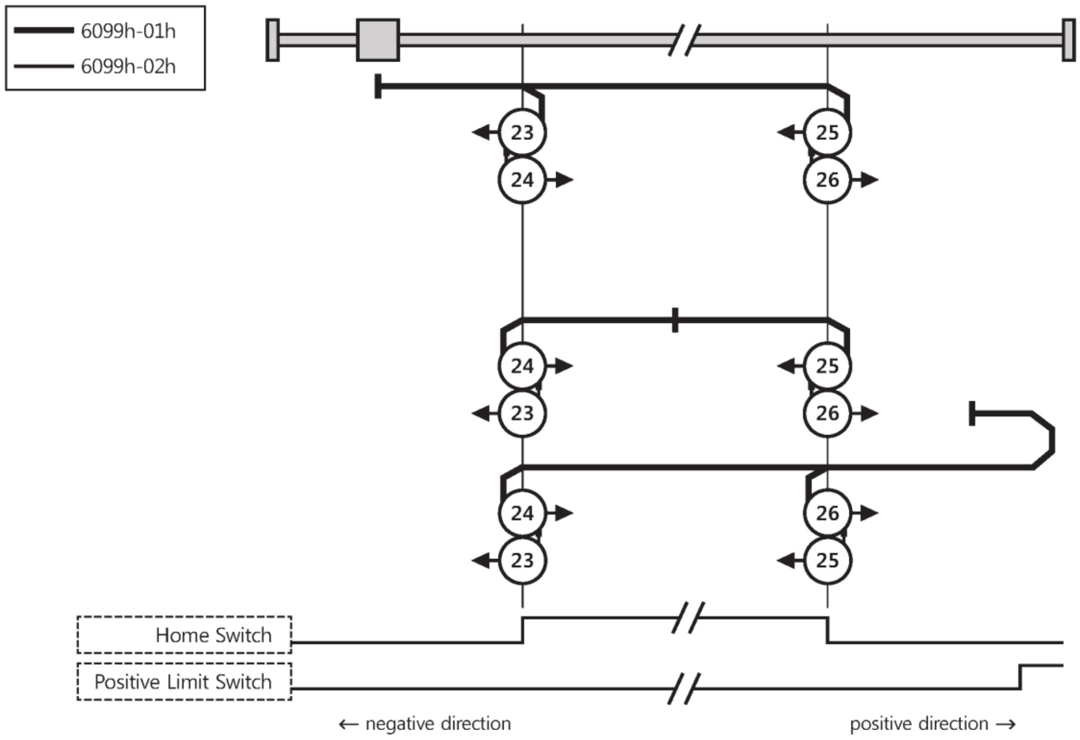
Homing Method 25
Homing on Positive Limit Switch and Homing On Negative Home Switch

When the home sensor and POT sensor are not detected, it proceeds to forward direction and decelerates to stop when the falling edge of home sensor is detected and stops in reverse direction. When the POT sensor is detected first, it detects the home sensor in the reverse direction and stops. At the position where the home sensor is detected, it proceeds to the positive direction, decelerates to stop when the falling edge is detected, and stops in the reverse direction.

In order to detect home sensor or POT sensor, it moves switch detection speed(0x6099:1). When home sensor or POT sensor is detected, it decelerates according to the setting of home return acceleration(0x609A) and stops or immediately stops operation. In order to detect home sensor or index pulse in the reverse direction, it moves to switch zero search speed (0x6099: 2) and stops after decelerating. If a NOT is encountered during home return, a home return error occurs and home return operation stops.

Compared with home return method 7, the presence or absence of index pulse is different. Compared with homing method 23, the polarity detecting sensor of home sensor is different and it stops after home return is completed within home sensor.

Homing Method 26
CSD7 servo drive is not supported.



Homing Method 27, 28, 29, 30

Homing Method 27

Homing on Negative Limit Switch, Homing On Positive Home Switch

When the home sensor and NOT sensor are not detected, it proceeds in the reverse direction and decelerates to stop when the home sensor is detected. If the NOT sensor is detected first, it senses the falling edge of the home sensor in forward direction, then exits and stops. At the position where home sensor is detected, it detects the falling edge in the forward direction and stops.

In order to detect home sensor or NOT sensor, it moves switch detection speed(0x6099:1). When home sensor or NOT sensor is detected, it decelerates according to the setting of home return acceleration(0x609A) and stops or immediately stops operation. In order to detect home sensor or index pulse in the reverse direction, it moves to switch zero search speed (0x6099: 2) and stops after decelerating. If a POT is encountered during home return, a home return error occurs and home return operation stops.

Compared with home return method 11, the presence or absence of index pulse is different. Compared with home return method 29, the polarity to detect the home sensor is different and it stops after home return completion outside the home sensor.

Homing Method 28

CSD7 servo drive is not supported.

Homing Method 29

Homing on Negative Limit Switch, Homing On Negative Home Switch

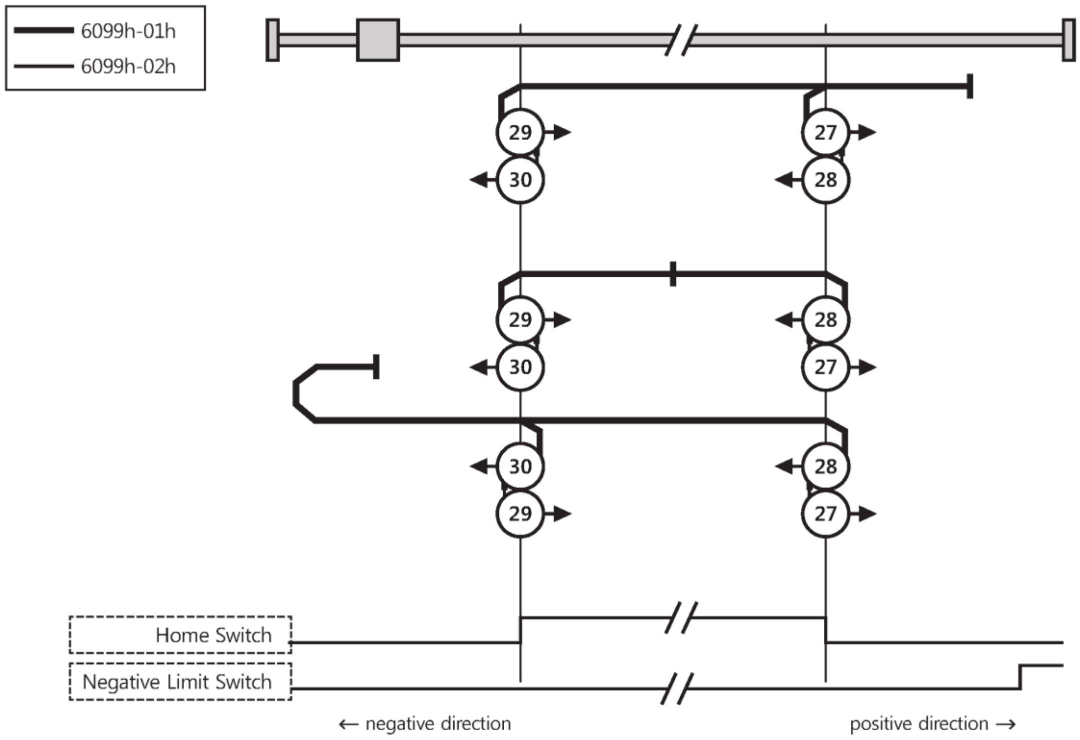
At the position where the home sensor and NOT sensor are not detected, it proceeds in the reverse direction and decelerates to stop when the falling edge of home sensor is detected and stops in the reverse direction. If the NOT sensor is detected first, it detects the rising edge of home sensor in forward direction and stops.
When the home sensor is detected, it detects the falling edge in the reverse direction and then stops in the reverse direction.

In order to detect home sensor or NOT sensor, it moves the switch detection speed (0x6099:1). When the home sensor or NOT sensor is detected, it stops after deceleration or stops immediately according to the setting of home return acceleration(0x609A). In order to detect home sensor or index pulse in reverse direction, it moves to switch zero search speed (0x6099: 2) and stops after decelerating. If a POT is encountered during home return, a home return error occurs and home return operation stops.

Compared with home return method 13, the presence or absence of index pulse is different. Compared with homing method 27, the polarity detecting sensor of home sensor is different and it stops after homing is completed in home sensor.

Homing Method 30

CSD7 servo drive is not supported.



Homing Method 33, 34

Homing Method 33

Homing on Index Pulse

When the index pulse is detected while proceeding in the reverse direction from the position where the NOT sensor and the POT sensor are not detected, it is a method of decelerating stop. In order to detect the index pulse, it moves to the switch detection speed (0x6099: 1). When the index pulse is detected, it moves to the switch zero search speed (0x6099: 2) and stops after deceleration. If a NOT or POT sensor is encountered during homing, a homing error occurs and the homing operation stops

Compared with homing method 34, the direction of travel is different.

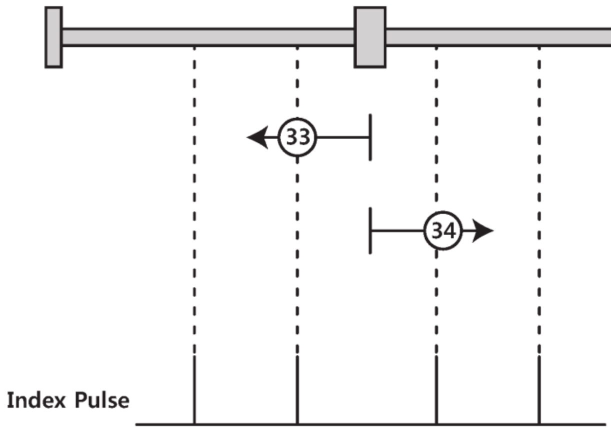
Homing Method 34

Homing on Index Pulse

It is a method to decelerate and stop when the index pulse is detected while proceeding in the forward direction at the position where the NOT sensor and the POT sensor are not detected.

In order to detect index pulse, it moves switch detection speed(0x6099:1). When the index pulse is detected, it moves to the switch zero search speed(0x6099:2) and stops after deceleration. If a NOT or POT sensor is encountered during homing, a homing error occurs and the homing operation stops.

Compared with home return method 33, the direction of travel is different.

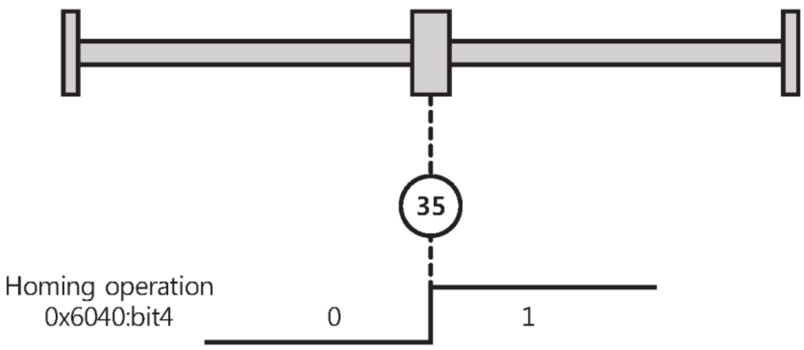


Homing Method 35

Homing Method 35

Homing on Current Position

This is how to complete homing immediately to the current location regardless of the NOT sonsor and the POT sensor.



Homing Method 40, 41, 42, 43

Homing Method 40

Homing on Negative Stopper Position On Index Pulse

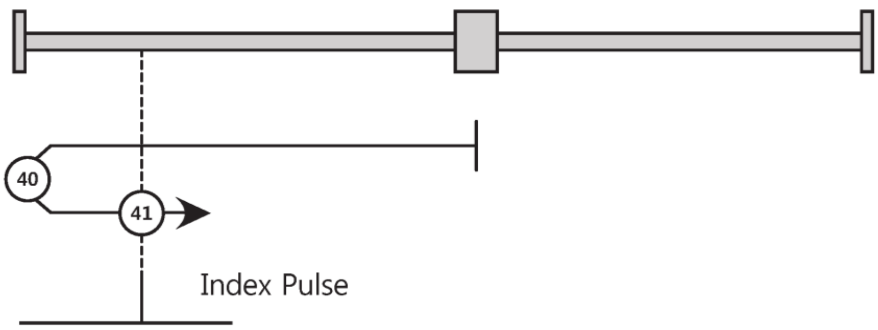
Homing uses a stopper to perform a mechanical stop. When home execution starts, the NOT sensor and the POT sensor move to the switch detection speed (0x6099: 1) in the reverse direction from the position where no sensor is detected. The home position is completed when the current value is kept higher than the home current value (Home Current: 0x5040:0).

Homing Method 41

Homing on Negative Stopper Position

Negative Stopper

Homing uses a stopper to perform a mechanical stop. When home execution starts, the NOT sensor and the POT sensor move to the switch detection speed (0x6099: 1) in the reverse direction from the position where no sensor is detected. The home position is completed when the time to stay higher than the home current value(Home Current: 0x5040:0) is larger than the home current time(Home Current Time: 0x5041:0).



Homing Method 42

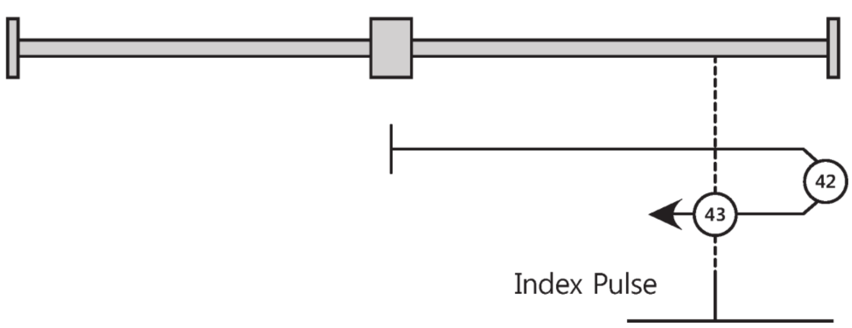
Homing on Negative Stopper Position On Index Pulse

The homing method is the same as 40 but the starting direction is different.

Homing Method 43

Homing on Negative Stopper Position

The homing method is the same as 41 but the starting direction is different.

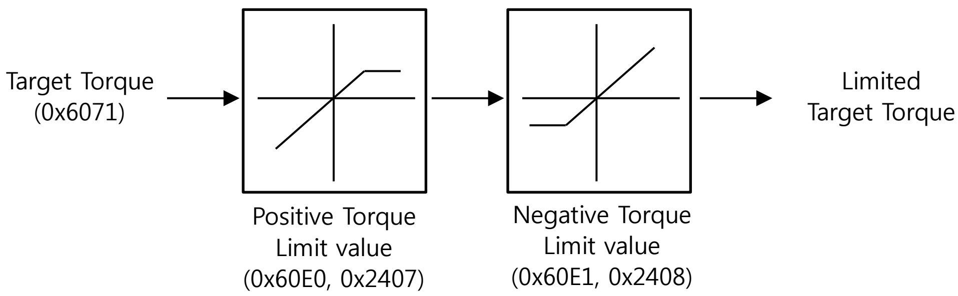


Torque Limit Function

Target torque (0x6071) are subject to torque limits.

Internal Torque Limit Value (value to be always applied)

Target torque are limited by the following two indexes.
0x60E0 and 0x2407 are the positive torque limit values and the same function.
0x60E1 and 0x2408 are the negative torque limit values and the same function.

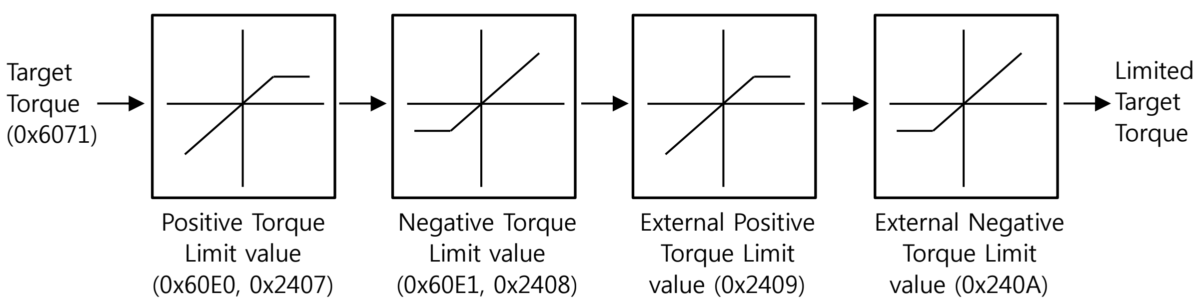


Torque Limit Value for External I/O Input (Conditional limit)

Target torque can be limited if the sequence input </P-TL>, </N-TL> signals are input.

Index 0x2409 is the External Positive Torque Limit that is applied when the sequence input </P-TL> signal is input. When the External Positive Torque Limit Signal </P-TL> is input, the smaller value between a value set by 0x2409 (Ft-4.09) and a value set by 0x60E0(or 0x2407, Ft-4.07), will be the positive torque limit value.

Index 0x240A is the External Negative Torque Limit that is applied when the sequence input </N-TL> signal is input. When the External Negative Torque Limit Signal </N-TL> is input, the smaller value between a value set by 0x240A (Ft-4.10) and a value set by 0x60E1 (or 0x2408, Ft-4.08), will be the negative torque limit value.



Note </P-TL> and </N-TL> are sequence input signals. To use these functions, see 3-15 page "Allocation Method for Sequence Input Signal" to allocate signals.

Use the </P-TL> signal for the external limit of positive torques and the </N-TL> signal for the external limit of negative torques.

Related Object

Table 64 Torque Limit Function Related Object

Index	Sub-Index	Name	Data Type	Access	PDO Map	Unit
0x60E0	-	Positive Torque Limit Value)	INT	RW	-	0.1%
0x60E1	-	Negative Torque Limit Value)	INT	RW	-	0.1%
0x2407	-	Internal Positive Torque Limit	UINT	RW	-	%
0x2408	-	Internal Negative Torque Limit	UINT	RW	-	%
0x2409	-	External Positive Torque Limit	UINT	RW	-	%
0x240A	-	External Negative Torque Limit	UINT	RW	-	%

Digital Input/Output

The following Indexes are used to display the states of digital input signals of CSD7 I/O or to control the output of digital out signals.

Related Object

Table 65 Digital Input/Output Related Object

Index	Sub-Index	Name	Data Type	Access	PDO Map	Unit
0x60FD	00h	Digital Inputs	UDINT	RO	TxPDO	-
0x60FE	Digital Outputs – Not supported					
	00h	Number of Entries	UINT	RO	-	-
	01h	Physical outputs	UDINT	-	RxPDO	-
	02h	Bit Mask	UDINT	-	-	-

Chapter 7. Object Dictionary

This Chapter describes the object dictionary for EtherCAT communication with CSD7.
The CoE (CAN application protocol over EtherCAT) protocol is based on the object dictionary.

Object Dictionary Area

The CoE (CAN application protocol over EtherCAT) protocol is based on the object dictionary. All objects uses four-digit hexadecimal number and they are assigned in each areas as shown in the table below by each function.

Table 66 Object Dictionary Area

Index	Area	Description
0x0000 ~ 0x0FFF	Data Type Area	Definition of Data Type
0x1000 ~ 0x1FFF	CoE Communication Area	Define parameters available for all servers for the purpose of dedicated communication
0x2000 ~ 0x2FFF	Manufacturer-specific Area 1	Define parameters and display functions to be used in CSD7
0x3000 ~ 0x3FFF	Manufacturer-specific Area 2	Define the functions of operation modes to be used in CSD7
0x4000 ~ 0x4FFF	Manufacturer-specific Area 3	Reserved
0x5000 ~ 0x5FFF	Manufacturer-specific Area 4	Reserved
0x6000 ~ 0x9FFF	Device Profile Area	Parameters that are defined in the CIA402 drive profile for servo drives
0xA000 ~ 0xFFFF	Reserved Area	Reserved

Data Type

This profile uses the data type as shown in the table below.

Table 67 Data Type

Data Type	Code	Size	Range
Boolean	BOOL	1 b비트	0~1
Unsigned8	USINT	1 byte	0~255
Unsigned16	UINT	2 byte	0~65535
Unsigned32	UDINT	4 byte	0~4294967295
Integer8	SINT	1 byte	-128~127
Integer16	INT	2 byte	-32768~32767
Integer32	DINT	4 byte	-2147483648~2147483647
Visible string	STRING	-	-
User data type	DT**** (**** : Index number)	Variable	Variable

Object Description Format

Object Description Format

The description format of objects are as follows :

Object without Sub-Index

Index	**Object Name**					**Mode of Operation**	
Setting Range	Size(Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
<Set Range>	<Size ( )>	<Unit>	<RO/RW>	<Possible/No>	<Attribute>	<Init Value>	<Parameter No.>

Object with Sub-Index

Index	**Object Name**					**Mode of Operation**	
Sub-Index 0	Number of Entries						
Setting Range	Size(Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
<Set Range>	<Size ( )>	<Unit>	<RO/RW>	<Possible/No>	<Attribute>	<Init Value>	<Parameter No.>
Sub-Index 1	<Sub-Index Name>						
Setting Range	Size(Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
<Set Range>	<Size ( )>	<Unit>	<RO/RW>	<Possible/No>	<Attribute>	<Init Value>	<Parameter No.>
:							
Sub-Index n	<Sub-Index Name>						
Setting Range	Size(Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
<Set Range>	<Size ( )>	<Unit>	<RO/RW>	<Possible/No>	<Attribute>	<Init Value>	<Parameter No.>

Index : The indexes of objects, displayed with hexadecimal numbers of 4 digits.
e.g.) 0x1000, 0x2004, 0x6200, etc.

Sub-Index : If there are sub-indexes, they are displayed as 2 digits in [ ] at the end of the indexes.
e.g.) 0x1600[07], 0x1A00[09], 0x2005[04], etc.

Object Name : Indicates the name of object

Mode of Operation : Displays control modes that can be used. (Supporting CSP and CST)

Setting Range : Indicates the range that can be input to the object.

Size( ) : Indicates the object size in byte. ( ) means the data type.

Unit : Indicates the unit of measure of the object

Access : Indicates whether the object is read only, or read and write
RO : Read Only
RW : Read and Write

PDO Map : Indicates the PDO mapping attribute.
Possible (RxPDO) ; Reception PDOs can be mapped

Possible (TxPDO) ; Transmission PDOs can be mapped
No ; PDs cannot be mapped

Attribute : Indicates the time during which changes are valid in the writing-enabled object.

Always	: Changeable at any time
Servo off	: Changes are valid when servo is OFF
Power cycling	: Changes are valid after the control power is reset
—	: Writing disable

Init Value : The values of factory-setings

Ft-no : Integer numbers of manufacturer that are linked with objects in 0x2000s.

Object Dictionary List

The following table is the all objects list that are used in CSD7 servo drive.

Table 68 Object Dictionary List

Object	Index	Index_Name	Sub-Index	Access	Type
Communication Profile	0x1000	Device Type	0	RO	UDINT
	0x1001	Error Register	0	RO	USINT
	0x1008	Device Name	0	RO	STRING(20)
	0x1009	Hardware Version	0	RO	STRING(20)
	0x100A	Software Version	0	RO	STRING(20)
	0x1010	Store Parameters	4	-	DT1010
	0x1011	Restore Parameters	4	-	DT1011
	0x1018	Identity	4	-	DT1018
	0x1600	1st Receive PDO Mapping	7	RO	DT1600
	0x1601	2nd Receive PDO Mapping	2(3)	RO	DT1601
	0x1602	3th Receive PDO Mapping	2(3)	RO	DT1602
	0x1603	4th Receive PDO Mapping	2(3)	RO	DT1603
	0x1604	5th Receive PDO Mapping	1(2)	RO	DT1604
	0x1A00	1st Tranmit PDO Mapping	10(9)	RO	DT1A00
	0x1A01	2nd Tranmit PDO Mapping	8	RO	DT1A01
	0x1A02	3th Tranmit PDO Mapping	4	RO	DT1A02
	0x1A03	4th Tranmit PDO Mapping	4	RO	DT1A03
	0x1A04	5th Tranmit PDO Mapping	4	RO	DT1A04
	0x1C00	Sync Manager Communication Type	4	-	DT1C00
	0x1C12	Sync Manager 2 PDO Assignment	1	RW	DT1C1X
	0x1C13	Sync Manager 3 PDO Assignment	1	RW	DT1C1X
	0x1C32	Sync Manager 2 Synchronization	32	-	DT1C32
	0x1C33	Sync Manager 3 Synchronization	32	-	DT1C32
Manufacturer-specific Object (Standard Group 0)	0x2001	Motor Model	0	RO	STRING(34)
	0x2002	Selection of 4 Basic Mode	4	-	DT2002
	0x2003	Selection of Auto Tuning Function	4	-	DT2003
	0x2004	Inertia Ratio	0	RW	UINT
	0x2005	Auxiliary Function Selection 1	4	-	DT2005
	0x2006	Auxiliary Function Selection 2	4	RO	DT2006
	0x2007	Drive Address	0	RW	USINT
	0x200A	Digital Input Assignment 1	4	RO	DT200A
	0x200B	Digital Input Assignment 2	4	RO	DT200B
	0x200C	Digital Input Assignment 3	4	-	DT200C
	0x200D	Digital Input Assignment 4	4	RO	DT200D
	0x200E	Digital Input Assignment 5	4	RO	DT200E
	0x200F	Digital Input Assignment 6	4	RO	DT200F
	0x2010	Digital Input Assignment 7	4	RO	DT2010
	0x2011	Digital Input Assignment 8	4	RO	DT2011
	0x2012	Digital Input Assignment 9	4	RO	DT2012

Object	Index	Index_Name	Sub-Index	Access	Type
	0x2013	Digital Input Assignment 10	4	RO	DT2013
	0x2014	Digital Input Assignment 11	4	RO	DT2014
	0x2015	Digital Input Assignment 12	4	RO	DT2015
	0x2016	Digital Output Assignment 1	4	RO	DT2016
	0x2017	Digital Output Assignment 2	4	RO	DT2017
	0x2018	Digital Output Assignment 3	4	RO	DT2018
	0x2019	Digital Output Assignment 4	4	RO	DT2019
	0x201A	Digital Output Assignment 5	4	RO	DT201A
	0x201B	Digital Output Assignment 6	4	RO	DT201B
	0x201C	Digital Output Assignment 7	4	RO	DT201C
	0x2021	Alias ID	0	RW	USINT
Manufacturer-specific Object (Standard Group 1)	0x2100	Velocity Regulator Response Level	0	RW	USINT
	0x2101	System Gain	0	RW	UINT
	0x2102	1st Velocity Regulator P Gain	0	RW	UINT
	0x2103	1st Velocity Regulator I Gain	0	RW	UINT
	0x2104	Velocity Regulator I Gain Mode	4	RO	DT2104
	0x2105	Velocity Regulator I Gain Disable Threshold	0	RW	UINT
	0x2106	Velocity Regulator D Gain	0	RW	UINT
	0x2107	1st Position Regulator Kp Gain	0	RW	UINT
	0x210A	Delay Time of Gain Switching	0	RW	UINT
	0x210B	Level of Gain Switching	0	RW	UINT
	0x210C	Hysterisis of Gain Switching	0	RW	UINT
	0x210D	Position Gain Switching Time	0	RW	UINT
	0x210E	2nd Velocity Regulator P Gain	0	RW	UINT
	0x210F	2nd Velocity Regulator I Gain	0	RW	UINT
	0x2110	2nd Position Regulator Kp Gain	0	RW	UINT
	0x2111	3rd Velocity Regulator P Gain	0	RW	UINT
	0x2112	3rd Velocity Regulator I Gain	0	RW	UINT
	0x2113	3rd Position Regulator Kp Gain	0	RW	UINT
	0x2114	4th Velocity Regulator P Gain	0	RW	UINT
	0x2115	4th Velocity Regulator I Gain	0	RW	UINT
	0x2116	4th Position Regulator Kp Gain	0	RW	UINT
	0x2117	Tuning Mode Setting	4	-	DT2117
	0x2118	Tuningless Gain	0	RW	UINT
	0x2119	Load Inertia Ratio Level	0	RW	UINT
	0x211A	Load Inertia Ratio Setting	0	RW	UINT
Manufacturer-specific Object (Standard Group 2)	0x2202	Velocity Command LPF Bandwidth	0	RW	UINT
	0x2203	Velocity Error Filter Bandwidth	0	RW	UINT
	0x2204	Velocity Regulator Kff Gain	0	RW	UINT
	0x2205	Jog Velocity Command	0	RW	UINT
	0x2206	Acceleration Time	0	RW	UDINT
	0x2207	Deceleration Time	0	RW	UDINT
	0x2208	S-Curve Time	0	RW	UINT
	0x2210	Manual Velocity Limit	0	RW	UINT

Object	Index	Index_Name	Sub-Index	Access	Type
	0x2211	Velocity Limit Mode	4	RO	DT2211
	0x2212	Velocity Window	0	RW	UINT
	0x2213	Up to Velocity	0	RW	UINT
	0x2215	Test Run For ANF Dwell Period	0	RW	UINT
	0x2216	Test Run For ANF Constant Velocity Period	0	RW	UINT
	0x2217	Test Run For ANF Operation Count	0	RW	UINT
	0x2218	Test Run For ANF Setting	4	RO	DT2218
Manufacturer-specific Object (Standard Group 3)	0x2300	Follower	4	RO	DT2300
	0x2301	Position Command LPF Bandwidth	0	RW	UINT
	0x2302	Position Regulator Kff Gain	0	RW	USINT
	0x2303	Position Regulator Kff LPF Bandwidth	0	RW	UINT
	0x2304	Moving Average Filter	0	RW	UINT
	0x230B	Encoder Output Ratio, Output Counts	0	RW	UDINT
	0x230C	Encoder Output Ratio, Motor Counts	0	RW	UDINT
	0x230E	1st Damping Frequency	0	RW	UINT
	0x230F	1st Damping Ratio	0	RW	UINT
	0x2310	2nd Damping Frequency	0	RW	UINT
	0x2311	2nd Damping Ratio	0	RW	UINT
	0x2312	In Position Size	0	RW	UINT
	0x2313	Near Position Size	0	RW	UINT
	0x2314	Following Error Limit	0	RW	UDINT
	0x2316	Vibration Setting	4	-	DT2316
Manufacturer-specific Object (Standard Group 4)	0x2402	1st Current Command LPF Bandwidth	0	RW	UINT
	0x2403	2nd Current Command LPF Bandwidth	0	RW	UINT
	0x2404	3rd Current Command LPF Bandwidth	0	RW	UINT
	0x2405	4th Current Command LPF Bandwidth	0	RW	UINT
	0x2406	Main Current Regulator Gain	4	-	DT2406
	0x2407	Positive Internal Current Limit	0	RW	UINT
	0x2408	Negative Internal Current Limit	0	RW	UINT
	0x2409	Positive External Current Limit	0	RW	UINT
	0x240A	Negative External Current Limit	0	RW	UINT
	0x240B	Maximum Stopping Current	0	RW	UINT
	0x240C	Initial Current Bias	0	RW	DINT
	0x240D	1st Resonant Frequency Suppression Filter	0	RW	UINT
	0x240E	1st Resonant Frequency Suppression Filter Width	0	RW	USINT
	0x240F	1st Resonant Frequency Suppression Filter Depth	0	RW	USINT
	0x2410	2nd Resonant Frequency Suppression Filter	0	RW	UINT
	0x2411	2nd Resonant Frequency Suppression Filter Width	0	RW	USINT
	0x2412	2nd Resonant Frequency Suppression Filter Depth	0	RW	USINT
	0x2413	3rd Resonant Frequency Suppression Filter	0	RW	UINT
	0x2414	3rd Resonant Frequency Suppression Filter Width	0	RW	USINT
	0x2415	3rd Resonant Frequency Suppression Filter Depth	0	RW	USINT
	0x2416	Adaptive Notch Filter (ANF) Setting	4	-	DT2416
	0x2417	RMS Current Load Factor Cumulative Time Setting	0	RW	UINT

Object	Index	Index_Name	Sub-Index	Access	Type
	0x2418	RMS Current Load Factor Threshold Setting 1	0	RW	UDINT
	0x2419	RMS Current Load Factor Threshold Setting 2	0	RW	UDINT
	0x241B	Current Command LPF Bandwidth(Tunignless)	0	RW	UINT
	0x241C	Current Command LPF Bandwidth Interlocking	4	-	DT241C
Manufacturer-specific Object (Standard Group 5)	0x2500	Brake Inactive Delay	0	RW	UINT
	0x2501	Disable Delay	0	RW	UINT
	0x2502	Brake Active Delay	0	RW	UINT
	0x2503	Braking Application Velocity	0	RW	UINT
	0x2504	AC Line Loss Fault Delay	0	RW	UINT
	0x2509	Motor Overload Method Selection	0	RW	USINT
	0x250B	Power Sag Warning Enable	0	RW	USINT
	0x250C	Power Sag Current Limit	0	RW	UINT
	0x250D	Power Sag Current Limit Release Time	0	RW	UINT
	0x250E	ECAT Abs Origin Offset	0	RW	DINT
	0x250F	ECAT Homing Method	0	RW	SINT
	0x2510	ECAT Homing Timeout	0	RW	INT
	0x2511	ECAT Homing Offset	0	RW	DINT
	0x2512	ECAT Homing Velocity 1	0	RW	DINT
	0x2513	ECAT Homing Velocity 2	0	RW	DINT
	0x2514	ECAT Homing Acceleration	0	RW	DINT
	0x2515	Linear Function	4	-	DT2515
	0x2516	Encoder Feedback Forward Direction	0	RW	UINT
	0x2517	Angle Search Current Command Ratio	0	RW	UINT
	0x2518	External Shunt Resistance	0	RW	UINT
	0x2519	External Shunt Resistor Power Rate	0	RW	UINT
	0x251A	STO Circuit Verification Mode	0	RW	USIND
	0x251E	PWM Switching Frequency	0		
Display Object	0x2A00	Velocity Feedback	0	RO	DINT
	0x2A01	Velocity Command	0	RO	DINT
	0x2A02	Velocity Error	0	RO	DINT
	0x2A08	Commutation Angle	0	RO	DINT
	0x2A09	Mechanical Angle	0	RO	DINT
	0x2A0A	Shunt Power Limit Ratio	0	RO	DINT
	0x2A0C	Absolute Rotations	0	RO	DINT
	0x2A10	U Phase Current	0	RO	DINT
	0x2A11	V Phase Current	0	RO	DINT
	0x2A12	W Phase Current	0	RO	DINT
	0x2A13	Motor Utilization	0	RO	DINT
	0x2A1B	Instantaneous Shunt Power	0	RO	DINT
	0x2A1C	Drive Utilization	0	RO	DINT
	0x2A1F	FPGA Version	0	RO	DINT
	0x2A22	Absolute Single Turn Data	0	RO	DINT
	0x2A23	Absolute Maximum Current Command	0	RO	DINT
	0x2A24	Power Time Hour	0	RO	DINT

Object	Index	Index_Name	Sub-Index	Access	Type
	0x2A25	Power Time Min Sec	0	RO	DINT
	0x2A2B	EtherCAT Version	0	RO	DINT
	0x2A2C	Current Load Factor(RMS)	0	RO	DINT
	0x2A2D	Current Peak Load Factor(RMS)	0	RO	DINT
	0x2A3B	ABSS Data	0	RO	DINT
	0x2A3C	ABSA Data	0	RO	DINT
	0x2A3D	Conv Hall Data	0	RO	DINT
	0x2A3E	Conv Alarm Data	0	RO	DINT
	0x2A3F	ECAT Homing Status	0	RO	DINT
	0x2A40	ECAT Homing Error	0	RO	DINT
Error History	0x2F00	Servo Warning	0	RO	UDINT
	0x2F01	Fault History #1	0	RO	Stirng(24)
	0x2F02	Fault History #2	0	RO	Stirng(24)
	0x2F03	Fault History #3	0	RO	Stirng(24)
	0x2F04	Fault History #4	0	RO	Stirng(24)
	0x2F05	Fault History #5	0	RO	Stirng(24)
	0x2F06	Fault History #6	0	RO	Stirng(24)
	0x2F07	Fault History #7	0	RO	Stirng(24)
	0x2F08	Fault History #8	0	RO	Stirng(24)
Operation Profile	0x3001	Auto Tuning	0	RW	USINT
	0x3009	Fault History Clear	0	RW	USINT
	0x300A	Absolute Encoder Multi Turn Clear	0	RW	USINT
	0x3010	Drive Reboot	0	RW	USINT
Homing Obejct	0x5030	Forced Homing Flag	0	RW	UINT
	0x5040	Home Current	0	RW	UINT
	0x5041	Home Current Time	0	RW	UINT
CiA402 Object	0x603F	Error Code	0	RO	UINT
	0x6040	Control Word	0	RW	UINT
	0x6041	Status Word	0	RO	UINT
	0x605A	Quick Stop Option Code	0	RW	INT
	0x605B	Shutdown Option Code	0	RW	INT
	0x605C	Disbale Operation Option Code	0	RW	INT
	0x605D	Halt Option Code	0	RW	INT
	0x605E	Fault Reaction Option Code	0	RW	INT
	0x6060	Modes of Operation	0	RW	SINT
	0x6061	Modes of Operation Display	0	RO	SINT
	0x6062	Position Demand Value	0	RO	DINT
	0x6063	Position Actual Internal Value	0	RO	DINT
	0x6064	Position Actual Value	0	RO	DINT
	0x6065	Following Error Window	0	RW	UDINT
	0x6067	Position Window	0	RW	UDINT
	0x606B	Velocity Demand Value	0	RO	DINT
	0x606C	Velocity Actual Value	0	RO	DINT
	0x606D	Velocity Window	0	RW	UINT

Object	Index	Index_Name	Sub-Index	Access	Type
	0x6071	Target Torque	0	RW	INT
	0x6072	Maximum Torque	0	RW	UINT
	0x6074	Torque Demand Value	0	RO	INT
	0x6076	Motor Rated Torque	0	RW	UDINT
	0x6077	Torque Actual Value	0	RO	INT
	0x6079	DC Link Circuit Voltage	0	RO	UDINT
	0x607A	Target Position	0	RW	DINT
	0x607B	Position Range Limit	2	-	DINT
	0x607C	Home Offset	0	RW	DINT
	0x607D	Software Position Limit	2	-	DINT
	0x607E	Polarity	0	RW	USINT
	0x6080	Max Motor Speed	0	RW	UDINT
	0x6081	Profile Velocity	0	RW	UDINT
	0x6083	Profile Acceleration	0	RW	UDINT
	0x6084	Profile Deceleration	0	RW	UDINT
	0x6085	Quick Stop Deceleration	0	RW	UDINT
	0x6098	Homing Method	0	RW	SINT
	0x6099	Homing Speeds	2	-	DINT
	0x609A	Homing Acceleration	0	RW	DINT
	0x60B0	Position Offset	0	RW	DINT
	0x60B1	Velocity Offset	0	RW	DINT
	0x60B2	Torque Offset	0	RW	INT
	0x60B8	Touch Probe Function	0	RW	INT
	0x60B9	Touch Probe Status	0	RO	UINT
	0x60BA	Touch Probe Pos1 Pos Value	0	RO	DINT
	0x60BB	Touch Probe Pos1 Neg Value	0	RO	DINT
	0x60BC	Touch Probe Pos2 Pos Value	0	RO	DINT
	0x60BD	Touch Probe Pos2 Neg Value	0	RO	DINT
	0x60E0	Positive Torque Limit Value	0	RW	INT
	0x60E1	Negative Torque Limit Value	0	RW	INT
	0x60E3	Support Homing Methods	0	RW	DINT
	0x60F2	Position Option Code	0	RW	DINT
	0x60F4	Following Error Actual Value	0	RO	DINT
	0x60FC	Position Demand Internal Value	0	RO	DINT
	0x60FD	Digital Inputs	0	RO	UDINT
	0x60FE	Digital Outputs	2	-	UINT
	0x60FF	Target Velocity	0	RW	DINT
	0x6502	Supported Drive Modes	0	RO	DINT

General Objects

0x1000	Device Type					ALL	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	4 byte(UDINT)	-	RO	No	-	0x00020192	-

- Indicate the numbers of device profiles in CoE.
- Definition of Set Value

Table 69 General Object 0x1000 Bit

Bit	Name	Description
0~15	Device Profile No.	0x0192 (402): Drive Profile(DS402)
16~23	Type	0x02: Servo Drive
24~31	Mode	0 : Manufacturer-Specific

0x1001	Error Register					ALL	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	1 byte(USINT)	-	RO	No	-	-	-

- Indicate the type of errors that occur in servo drives.
- Definition of Set Value

Table 70 General Object 0x1001 Bit

Bit	Description	Details
0	General Error	0: No Error, 1: Error
1	Current Error	Not supported
2	Voltage Error	Not supported
3	Temperature Error	Not supported
4	Communication Error	Not supported
5	Device Profile-Specific Error	Not supported
6	(Reserved)	-
7	Manufacturer-Specific Error	Not supported

0x1008	Device Name					ALL	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	20 byte(STRING)	-	RO	No	-	CSD7_**BN*1	-

- Indicates the model name of servo drives.
- The model of CSD7 EtherCAT type is as follows:
  CSD7_xxBN1, CSD7_xxBNF1
  xx : 01(100W), 02(200W), 04(400W), 08(800W), 10(1KW), 15(1.5KW)

Table 71 Servo Drive Product Description

Product Description	RSA Catalog number	Product ID
AC 170~253 Vrms 1P, 1.1Arms, 100W, Network, Standard Model	CSD7_01BN1	0x02010001
AC 170~253 Vrms 1P, 1.8Arms, 200W, Network, Standard Model	CSD7_02BN1	0x02010002
AC 170~253 Vrms 1P, 3.3Arms, 400W, Network, Standard Model	CSD7_04BN1	0x02010003
AC 170~253 Vrms 3P/1P, 6.25/10.82Arms, 800W, Network, Standard Model	CSD7_08BN1	0x02010004
AC 170~253 Vrms 3P, 8.0Arms, 1000W, Network, Standard Model	CSD7_10BN1	0x02010005
AC 170~253 Vrms 3P, 11.0Arms, 1500W, Network, Standard Model	CSD7_15BN1	0x02010006
AC 170~253 Vrms 3P, 16.0Arms, 2500W, Network, Standard Model	CSD7_25BN1	0x02010007
AC 170~253 Vrms 3P, 22.0Arms, 3500W, Network, Standard Model	CSD7_35BN1	0x02010008
AC 170~253 Vrms 3P, 32.1Arms, 5000W, Network, Standard Model	CSD7_50BN1	0x02010009
AC 170~253 Vrms 1P, 1.1Arms, 100W, Network, Advanced Model	CSD7_01BNF1	0x02010011
AC 170~253 Vrms 1P, 1.8Arms, 200W, Network, Advanced Model	CSD7_02BNF1	0x02010012
AC 170~253 Vrms 1P, 3.3Arms, 400W, Network, Advanced Model	CSD7_04BNF1	0x02010013
AC 170~253 Vrms 3P/1P, 6.25/10.82Arms, 800W, Network, Advanced Model	CSD7_08BNF1	0x02001014
AC 170~253 Vrms 3P, 8.0Arms, 1000W, Network, Advanced Model	CSD7_10BNF1	0x02010015
AC 170~253 Vrms 3P, 11.0Arms, 1500W, Network, Advanced Model	CSD7_15BNF1	0x02010016
AC 170~253 Vrms 3P, 16.0Arms, 2500W, Network, Advanced Model	CSD7_25BNF1	0x02010017
AC 170~253 Vrms 3P, 22.0Arms, 3500W, Network, Advanced Model	CSD7_35BNF1	0x02010018
AC 170~253 Vrms 3P, 32.1Arms, 5000W, Network, Advanced Model	CSD7_50BNF1	0x02010019

0x1009	Hardware Version					ALL	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	20 byte(STRING)	-	RO	No	-	-	-

▶ Indicates the version of device hardware.

▶ e.g.) 0.0.2(Rev.A), 0.0.3(Rev.B)

0x100A	Software Version					ALL	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	20 byte(STRING)	-	RO	No	-	-	-

▶ Indicates the version of device software.

▶ e.g.) 1.20.00.00, 2.01.00.00

0x1010	Store Parameters					ALL	
Sub-Index 0	Number of Entries						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no

-	2 byte(UINT)	-	RO	No	-	-	-
Sub-Index 1	Store All Parameters – Reserved						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	4 byte(UDINT)	-	RW	No	-	-	-
Sub-Index 2	Store Communication Parameters – Reserved						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	4 byte(UDINT)	-	RW	No	-	-	-
Sub-Index 3	Store CiA402 Parameters - Reserved						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	4 byte(UDINT)	-	RW	No	-	-	-
Sub-Index 4	Store CSD7 Specific Parameters						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	4 byte(UDINT)	-	RW	No	-	-	-

This object enables you to save the changed parameters to the flash memory in servo drives. To save parameters, write 'save' in each sub-index.

* ASCII code of 'save' ; 's'(0x73), 'a'(0x61), 'v'(0x76), 'e'(0x65)
Hexadecimal value ; 0x65766173

- ▶ If 'save' is written to Sub-index 1, the parameters in the whole area of Table 72 will be saved. (Reserved)
- ▶ If 'save' is written to Sub-index 2, the parameters in the CoE Communication area of Table 72 will be saved. (Reserved)
- ▶ If 'save' is written to Sub-index 3, the parameters in the Device Profile area of Table 72 will be saved. (Reserved)
- ▶ If 'save' is written to Sub-index 4, the parameters in the Manufacturer-specific area 1 - 4 of Table 72 will be saved.
- ▶ The maximum number of times that you can write to the flash memory is 100,000.

Table 72 Index Area

Index	Area	Description
0x0000 ~ 0x0FFF	Data Type Area	Definitions of date types
0x1000 ~ 0x1FFF	CoE Communication Area	Definitions of variable that can be used by all servers for dedicated communication
0x2000 ~ 0x2FFF	Manufacturer-specific Area 1	Define the parameter and display functions to be used in CSD7
0x3000 ~ 0x3FFF	Manufacturer-specific Area 2	Define the function of operation modes to be used in CSD7
0x4000 ~ 0x4FFF	Manufacturer-specific Area 3	Reserved
0x5000 ~ 0x5FFF	Manufacturer-specific Area 4	Reserved
0x6000 ~ 0x9FFF	Device Pfofile Area	Variable defined in the Servo Drive's CiA402 drive profile
0xA000 ~ 0xFFFF	Reserved Area	Reserved

0x1011	Restore Parameters					ALL	
Sub-Index 0	Number of Entries						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	2 byte(UINT)	-	RO	No	-	-	-
Sub-Index 1	Restore All Default Parameters						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	4 byte(UDINT)	-	RW	No	-	-	-
Sub-Index 2	Restore Communication Default Parameters						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	4 byte(UDINT)	-	RW	No	-	-	-
Sub-Index 3	Restore CiA402 Deafult Parameters						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	4 byte(UDINT)	-	RW	No	-	-	-
Sub-Index 4	Restore CSD7 Specific Parameters						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	4 byte(UDINT)	-	RW	No	-	-	-

The object enables you to initialize parameters that is stored in the flash memory as the factory-settings. To initialize parameters, write ‘load’ in each sub-index.

* ASCII code of ‘load’ ; ‘l’(0x6C), ‘o’(0x6F), ‘a’(0x61), ‘d’(0x64)
  Hexadecimal value ; 0x64616F6C

- ▶ If ’load’ is written to Sub-index 1, the parameters in the whole area of Table 72 will be initialized. (Reserved)
- ▶ If 'load' is written to Sub-index 2, the parameters in the CoE Communication area of Table 72 will be initialized. (Reserved)
- ▶ If 'load' is written to Sub-index 3, the parameters in the Device Profile area of Table 72 will be initialized. (Reserved)
- ▶ If 'load' is written to Sub-index 4, the parameters in the Manufacturer-specific area 1 - 4 of Table 72 will be initialized.
- ▶ The maximum number of times that you can write to the flash memory is 100,000.
- ▶ To save the initialization value to the flash memory, send 'save' to 0x1010.

0x1018	Identify Object					ALL	
Sub-Index 0	Number of Entries						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	2 byte(UINT)	-	RO	No	-	-	-
Sub-Index 1	Vendor ID						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no

-	4 byte(UDINT)	-	RO	No	-	-	-
Sub-Index 2	Product Code						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	4 byte(UDINT)	-	RO	No	-	-	-
Sub-Index 3	Revision Number						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	4 byte(UDINT)	-	RO	No	-	-	-
Sub-Index 4	Serial Number						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	4 byte(UDINT)	-	RO	No	-	-	-

- ▶ This object indicates the device information.
- ▶ Sub-index 1 indicates the vendor ID.
  0x1018[01] : Vendor ID = 0x0000033D, RSAutomation
- ▶ Sub-index 2 displays the code of product that is in use.
  0x1018[02] : Product Code

Table 73 Servo Drive Rated Output Product Code

Drive rated output (W)	Product code	
	Standard Model (CSD7_xxBN1)	Advanced Model (CSD7_xxBNF1)
100	0x02010001	0x02010011
200	0x02010002	0x02010012
400	0x02010003	0x02010013
800	0x02010004	0x02010014
1000	0x02010005	0x02010015
1500	0x02010006	0x02010016
2500	0x02010007	0x02010017
3500	0x02010008	0x02010018
5000	0x02010009	0x02010019

- ▶ Sub-index 3 indicates the revision number of device.
  0x1018[03] : Revision number example ; 0x00000001
- ▶ Sub-index 4 indicates the serial number.
  0x1018[04] : Serial number (factory-setting)

PDO Mapping Objects

Thes PDO (Process Data Objects) are used for the real-time data transmission through the CoE (CANopen over EtherCAT) protocol, in which the application objects are mapped.
Use 0x1600 ~ 0x1604 for RxPDO mapping and 0x1A00 - 0x1A04 for TxPDO mapping. Sub-indexes 1 or higher indicate the information of mapped application objects.

MSB 16	15 8	7 LSB
Index	Sub-Index	Bit Length

Bit 0~7 : The bit length of mapped objects (ex. In case of 32 bit, 0x20 is displayed)
Bit 8~15 : The sub-index of mapped objects
Bit 16~31 : The index of mapped objects

Each reception PDO and transmission PDO is mapped as follows: These mapping values are fixed.

RxPDO Assignment

0x1600	1st Receive PDO Mapping					ALL	
Sub-Index 0	Number of objects in this PDO						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	2 byte(UINT)	-	RO	-	-	7	-
Sub-Index 1	Control word : 0x6040						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	4 byte(UDINT)	-	RO	-	-	0x60400010	-
Sub-Index 2	Target Position : 0x607A						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	4 byte(UDINT)	-	RO	-	-	0x607A0020	-
Sub-Index 3	Target Velocity : 0x60FF						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	4 byte(UDINT)	-	RO	-	-	0x60FF0020	-
Sub-Index 4	Target Torque : 0x6071						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	4 byte(UDINT)	-	RO	-	-	0x60710010	-
Sub-Index 5	Modes of operation : 0x6060						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	4 byte(UDINT)	-	RO	-	-	0x60600008	-
Sub-Index 6	Padding : 0x0000						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no

-	4 byte(UDINT)	-	RO	-	-	0x00000008	-
Sub-Index 7	Touch Probe Function : 0x60B8						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	4 byte(UDINT)	-	RO	-	-	0x60B80010	-

▶ The first recieption PDO (0x1600) assignment

0x1601	**2nd Receive PDO Mapping**					**ALL**	
Sub-Index 0	Number of objects in this PDO						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	2 byte(UINT)	-	RO	-	-	2	-
Sub-Index 1	Control word : 0x6040						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	4 byte(UDINT)	-	RO	-	-	0x60400010	-
Sub-Index 2	Target Position : 0x607A						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	4 byte(UDINT)	-	RO	-	-	0x607A0020	-

▶ The second recieption PDO (0x1601) assignment

0x1602	**3th Receive PDO Mapping**					**ALL**	
Sub-Index 0	Number of objects in this PDO						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	2 byte(UINT)	-	RO	-	-	2	-
Sub-Index 1	Control word : 0x6040						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	4 byte(UDINT)	-	RO	-	-	0x60400010	-
Sub-Index 2	Target Velocity : 0x60FF						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	4 byte(UDINT)	-	RO	-	-	0x60FF0020	-

▶ The third reception PDO (0x1602) assignment

0x1603	**4th Receive PDO Mapping**					**ALL**	
Sub-Index 0	Number of objects in this PDO						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	2 byte(UINT)	-	RO	-	-	2	-
Sub-Index 1	Control word : 0x6040						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	2 byte(UINT)	-	RO	-	-	0x60400010	-
Sub-Index 2	Target Torque : 0x6071						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no

-	2 byte(INT)	-	RO	-	-	0x60710010	-

▶ The fourth reception PDO (0x1603) assignment

0x1604	5th Receive PDO Mapping					ALL	
Sub-Index 0	Number of objects in this PDO						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	2 byte(UINT)	-	RO	-	-	1	-
Sub-Index 1	Control word : 0x6040						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	4 byte(UDINT)	-	RO	-	-	0x60400010	-

▶ The fifth reception PDO (0x1604) assignment

TxPDO Assignment

0x1A00	1st Transmit PDO Mapping					ALL	
Sub-Index 0	Number of objects in this PDO						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	2 byte(UINT)	-	RO	-	-	10	-
Sub-Index 1	Status Word : 0x6041						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	4 byte(UDINT)	-	RO	-	-	0x60410010	-
Sub-Index 2	Position Actual Value : 0x6064						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	4 byte(UDINT)	-	RO	-	-	0x60640020	-
Sub-Index 3	Velocity Actual Value : 0x606C						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	4 byte(UDINT)	-	RO	-	-	0x606C0020	-
Sub-Index 4	Torque Actual Value : 0x6077						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	4 byte(UDINT)	-	RO	-	-	0x60770010	-
Sub-Index 5	Modes of operation Display : 0x6061						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	4 byte(UDINT)	-	RO	-	-	0x60610008	-
Sub-Index 6	Error Register : 0x1001						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	4 byte(UDINT)	-	RO	-	-	0x10010008	-
Sub-Index 7	Following Error Actual Value : 0x60F4						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	4 byte(UDINT)	-	RO	-	-	0x60F40020	-
Sub-Index 8	Touch Probe Status : 0x60B9						

Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	4 byte(UDINT)	-	RO	-	-	0x60B90010	-
Sub-Index 9	Error Code : 0x603F						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	4 byte(UDINT)	-	RO	-	-	0x603F0010	-
Sub-Index 10	Digital Inputs : 0x60FD						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
	4 byte(UDINT)		RO			0x60FD0020	

▶ The first transmission PDO (0x1A00) assignment

0x1A01	**2nd Transmit PDO Mapping**					**ALL**	
Sub-Index 0	Number of objects in this PDO						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	2 byte(UINT)	-	RO	-	-	8	-
Sub-Index 1	Status word : 0x6041						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	4 byte(UDINT)	-	RO	-	-	0x60410010	-
Sub-Index 2	Position actual value : 0x6064						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	4 byte(UDINT)	-	RO	-	-	0x60640020	-
Sub-Index 3	Velocity actual value : 0x606C						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	4 byte(UDINT)	-	RO	-	-	0x606C0020	-
Sub-Index 4	Torque actual value : 0x6077						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	4 byte(UDINT)	-	RO	Yes	-	0x60770010	-
Sub-Index 5	Following error actual value : 0x60F4						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	4 byte(UDINT)	-	RO	-	-	0x60F40020	-
Sub-Index 6	Touch Probe Status : 0x60B9						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	4 byte(UDINT)	-	RO	-	-	0x60B90010	-
Sub-Index 7	Error Code : 0x603F						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	4 byte(UDINT)	-	RO	-	-	0x603F0010	-
Sub-Index 8	Digital Inputs : 0x60FD						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	4 byte(UDINT)	-	RO	-	-	0x60FD0020	-

▶ The second transmission PDO (0x1A01) assignment

0x1A02	**3th Transmit PDO Mapping**	**ALL**

Sub-Index 0	Number of objects in this PDO						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	4 byte(UDINT)	-	RO	-	-	4	-
Sub-Index 1	Status word : 0x6041						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	4 byte(UDINT)	-	RO	-	-	0x60410010	-
Sub-Index 2	Velocity Actual Value : 0x606C						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	4 byte(UDINT)	-	RO	-	-	0x606C0020	-
Sub-Index 3	Error Code : 0x603F						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	4 byte(UDINT)	-	RO	-	-	0x603F0010	-
Sub-Index 4	Digital Inputs : 0x60FD						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	4 byte(UDINT)	-	RO	-	-	0x60FD0020	-

▶ The third transmission PDO (0x1A02) assignment

0x1A03	**4th Transmit PDO Mapping**					**ALL**	
Sub-Index 0	Number of objects in this PDO						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	2 byte(UINT)	-	RO	-	-	4	-
Sub-Index 1	Status word : 0x6041						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	4 byte(UDINT)	-	RO	-	-	0x60410010	-
Sub-Index 2	Torque Actual Value : 0x6077						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	4 byte(UDINT)	-	RO	-	-	0x60770010	-
Sub-Index 3	Error Code : 0x603F						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	4 byte(UDINT)	-	RO	-	-	0x603F0010	-
Sub-Index 4	Digital Inputs : 0x60FD						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	4 byte(UDINT)	-	RO	-	-	0x60FD0020	-

▶ The fourth transmission PDO (0x1A03) assignment

0x1A04	**5th Transmit PDO Mapping**					**ALL**	
Sub-Index 0	Number of objects in this PDO						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	2 byte(UINT)	-	RO	-	-	4	-
Sub-Index 1	Status word : 0x6041						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no

-	4 byte(UDINT)	-	RO	-	-	0x60410010	-
Sub-Index 2	Position Actual Value : 0x6064						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	4 byte(UDINT)	-	RO	-	-	0x60640020	-
Sub-Index 3	Error Code : 0x603F						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	4 byte(UDINT)	-	RO	-	-	0x603F0010	-
Sub-Index 4	Digital Inputs : 0x60FD						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	4 byte(UDINT)	-	RO	-	-	0x60FD0020	-

▶ The fifth transmission PDO (0x1A04) assignment

SyncManager Communication Objects

The method of the memory for EtherCAT communication set with the objects from 0x1C00 to 0x1C33.

0x1C00	Sync Manager Communication Type					ALL	
Sub-Index 0	Number of used Sync Manager channels						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	2 byte(UINT)	-	RO	-	-	4	-
Sub-Index 1	Communication Type Sync Manager0 (Mailbox receive)						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	1 byte(USINT)	-	RO	-	-	1	-
Sub-Index 2	Communication Type Sync Manager1 (Mailbox send)						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	1 byte(USINT)	-	RO	-	-	2	-
Sub-Index 3	Communication Type Sync Manager2 (Process data output)						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	1 byte(USINT)	-	RO	-	-	3	-
Sub-Index 4	Communication Type Sync Manager3 (Process data input)						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	1 byte(USINT)	-	RO	-	-	4	-

The SyncManager is set as follows :

- ▶ Sub-Index 1 : Mailbox reception (Master → Slave)
- ▶ Sub-Index 2 : Mailbox transmission (Slave → Master)
- ▶ Sub-Index 3 : Precess data output (Master → Slave)
- ▶ Sub-Index 4 : Process data input (Slave → Master)

0x1C12	Sync Manager 2 PDO Assignment					ALL	
Sub-Index 0	Number of assigned RxPDOs						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	2 byte(UINT)	-	RO	-	-	1	-
Sub-Index 1	Assigned RxPDO 1						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0x1600~0x1604	2 byte(UINT)	-	RW	-	-	0x1601	-

- ▶ Indicate the reception PDO used in this SyncManager.
- ▶ The initial value is set as 0x1601.
- ▶ This value can be changed in the EtherCAT Pre-Operational state.
- ▶ Set Sub-index 1 after Sub-index 0 is changed as 0.

0x1C13	Sync Manager 3 PDO Assignment					ALL	
Sub-Index 0	Number of assigned TxPDOs						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	2 byte(UINT)	-	RO	-	-	1	-
Sub-Index 1	Assigned TxPDO 1						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0x1A00~0x1A04	2 byte(UINT)	-	RW	-	-	0x1A01	-

- Indicate the transmission PDO used in this SyncManager.
- The initial value is set as 0x1A01.
- This value can be changed in the EtherCAT Pre-Operational state.
- Set Sub-index 1 after Sub-index 0 is changed as 0.

0x1C32	Sync Manager 2 Synchronization					ALL	
Sub-Index 0	Number of Entries						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	2 byte(UINT)	-	RO	-	-	32	-
Sub-Index 1	Synchronization Type						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	2 byte(UINT)	-	RW	-	-	2	-
Sub-Index 2	Cycle Time						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	4 byte(UDINT)	-	RO	-	-	-	-
Sub-Index 4	Synchronization Types supported						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	2 byte(UINT)	-	RO	-	-	-	-
Sub-Index 5	Minimum Cycle Time						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	4 byte(UDINT)	-	RO	-	-	-	-
Sub-Index 6	Calc and Copy Time						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	4 byte(UDINT)	-	RO	-	-	-	-
Sub-Index 8	Get Cycle Time						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	2 byte(UINT)	-	RW	-	-	-	-
Sub-Index 9	Delay Time						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	4 byte(UDINT)	-	RO	-	-	-	-
Sub-Index 10	Sync0 Cycle Time						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	4 byte(UDINT)	-	RO	-	-	-	-
Sub-Index 11	SM-Event Missed						

Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	2 byte(UINT)	-	RO	-	-	-	-
Sub-Index 12	Cycle Time Too Small						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	2 byte(UINT)	-	RO	-	-	-	-
Sub-Index 32	Sync error						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	1 byte(USINT)	-	RO	-	-	-	-

▶ Sub-index 1 (Synchronization Type) sets the sync mode of Sync Manager output parameters. CSD7 supports only 'set value = 2'.

Table 74 Sync Manager output parameter Set Value

Set value	Description
0x00h	Free Run(Not Synchronized)
0x01h	SM2 (Synchronized with SM2 Event)
0x02h	DC SYNC0 (Synchronized with Sync0 Event)
0x03h	DC SYNC1 (Synchronized with Sync1 Event), Not supported.

The following table applies according to the combination of Sync Manager 2 and ESC Register 0x981h.

Table 75 Combination of Sync Manager 2 and DC activation register ync Manager 2

Sync Manager 2	ESC Reg 0x0981h (Set in XML)	0x1C32:01 setting	PreOP~ SafeOP	Description
FreeRun	DC Disabled	00h : Free Run	00h : FreeRun	DC Deactivated
SM2	DC Disabled	01h : SM2	01h : SM2	DC Deactivated
DC SYNC0	DC Enabled	00h : Free Run	02h : DC Enabled	DC Activated
		01h : SM2	02h : DC Enabled	DC Activated
		02h : DC SYNC0	02h : DC Enabled	DC Activated

If the ESC Register is set to DC Disabled and this object is set to 02h (DC Enabled), an error (0x0030, DC Invalidated Sync Cfg) will be displayed at ESC Register 0x130.

▶ Sub-index 2 (Cycle time) sets the communication cycle time between Master and Slave. It displays the cycle time of Sync0 event cycle in nanosecond. (250us, 500us, 1㎳, 2㎳, 4㎳)

Free Run mode shows the cycle of asynchronous communication of the drive and Synchron mode shows the communication cycle set in the drive. DC mode shows DC synchronous communication cycle.

▶ Sub-index 4 (Synchronization types supported) indicates supported sync types.

▶ Sub-index 5 (Minimum Cycle Time) is supported by Slave.

▶ Sub-index 9 (Delay time) is not supported. This value is read as '00000000h'.

▶ Sub-index 10 (Sync0 Cycle Time) displays value of DC Cycle Time Resister.

▶ Sub-index 32 (Sync error) displays '1' in the case of sync errors.

0x1C33	Sync Manager 3 Synchronization					ALL	
Sub-Index 0	Number of Entries						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	2 byte(UINT)	-	RO	-	-	32	-
Sub-Index 1	Synchronization Type						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	2 byte(UINT)	-	RW	-	-	-	-
Sub-Index 2	Cycle Time						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	4 byte(UDINT)	-	RO	-	-	-	-
Sub-Index 4	Synchronization Types supported						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	2 byte(UINT)	-	RO	-	-	-	-
Sub-Index 5	Minimum Cycle Time						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	4 byte(UDINT)	-	RO	-	-	-	-
Sub-Index 6	Calc and Copy Time						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	4 byte(UDINT)	-	RO	-	-	-	-
Sub-Index 8	Get Cycle Time						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	2 byte(UINT)	-	RW	-	-	-	-
Sub-Index 9	Delay Time						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	4 byte(UDINT)	-	RO	-	-	-	-
Sub-Index 10	Sync0 Cycle Time						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	4 byte(UDINT)	-	RW	-	-	-	-
Sub-Index 11	SM-Event Missed						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	2 byte(UINT)	-	RO	-	-	-	-
Sub-Index 12	Cycle Time Too Small						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	2 byte(UINT)	-	RO	-	-	-	-
Sub-Index 32	Sync error						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	1 byte(BOOL)	-	RO	-	-	-	-

▶ Sub-index 1 (Synchronization Type) sets the sync mode of Sync Manager input(Sync Manager 3). CSD7 supports only 'set value = 0, 2, 22'.

Table 76 Sync Manager 3 Set Value

Set value	Description
0x00h	Free Run (Not Synchronized)
0x01h	Not Supported
0x22h	SM2 (Synchronized with SM2 Event)
0x02h	DC SYNC0 (Synchronized with Sync0 Event)
0x03h	DC SYNC1 (Synchronized with Sync1 Event) Not supported

The following table applies according to the combination of ESC Register 0x981h.

Table 77 Combination of Sync Manager 3 and ESC Reg 0x0981h

Sync Manager 3	ESC Reg 0x0981h (Set in XML)	0x1C33:01 setting	PreOP~ SafeOP	Description
FreeRun	DC Disabled	00h : Free Run	00h : FreeRun	DC Deactivated
SM2	DC Disabled	22h : SM2	22h : SM2	DC Deactivated
DC SYNC0	DC Enabled	00h : Free Run	02h : DC Enabled	DC Activated
		22h : SM2	02h : DC Enabled	DC Activated
		02h : DC SYNC0	02h : DC Enabled	DC Activated

If the ESC Register is set to DC Disabled and this object is set to 02h (DC Enabled), an error (0x0030, DC Invalidated Sync Cfg) will be displayed at ESC Register 0x130.

- Sub-index 2 (Cycle time) sets the communication cycle time between Master and Slave. It displays the cycle time of Sync0 event cycle in nanosecond. (250us, 500us,1㎳, 2㎳, 4㎳)

In the FreeRun Mode, it shows the asynchronous communication cycle of the Servo Drive. In the Synchronous Mode, it shows the communication cycle set internally in the drive.DC mode shows DC synchronous communication cycle.

- Sub-index 4 (Synchronization types supported) indicates supported sync types.
- Sub-index 5 (Minimum Cycle Time) is supported by Slave.
- Sub-index 8 (Get Cycle Time) can call up the control period of the applied communication type.
- Sub-index 9 (Delay time) is not supported. This value is read as '00000000h'.
- Sub-index 10 (Sync0 Cycle Time) displays the value of the DC Cycle Time Register.
- Sub-index 32 (Sync error) displays '1' in the case of sync errors.

Manufacturer Specification Objects

These objects are a manufacturer-specific area and interlocked with the parameters that are used for the CSD7 functions. You can also check and edit Ft-*.** parameters in the table below, using the built-in operator at the front of CSD7 servo drives. The Parameter Group is divided into 6 groups as follows :

Table 78 Manufacturer Specification Objects Parameter Group

Parameter Group			Description of Parameter Group
Standard Group	Manufacturer-specific Index	Built-In Mode	
Standard Group 0	0x2000 ~ 0x2021	Ft-0.00~Ft-0.33	User parameters for basic setting and input/output signals
Standard Group 1	0x2100 ~ 0x211A	Ft-1.00~Ft-1.26	User parameters for control gain and tuning
Standard Group 2	0x2200 ~ 0x2218	Ft-2.00~Ft-2.25	User parameters for velocity control
Standard Group 3	0x2300 ~ 0x2316	Ft-3.00~Ft-3.22	User parameters for position control
Standard Group 4	0x2400 ~ 0x241C	Ft-4.00~Ft-4.28	User parameters for torque control
Standard Group 5	0x2500 ~ 0x251A	Ft-5.00~Ft-5.26	User parameters for additional functions

Standard Group 0

0x2001	Motor Model Name					ALL	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
	34 byte(STRING)	-	RO	-	-	-	Ft-0.01

It indicates the motor model name connected to the servo drive.

0x2002	Selection of 4 Basic Mode					ALL	
Sub-Index 0	Number of Entries						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	2 byte(UINT)	-	RO	-	-	4	Ft-0.02
Sub-Index 1	Fault and Disable Braking						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~3	1 byte(USINT)	-	RW	-	Servo Off	0x0	Ft-0.02[D0]
Sub-Index 2	Overtravel Stop Method						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~2	1 byte(USINT)	-	RW	-	Servo Off	0x2	Ft-0.02[D1]
Sub-Index 3	Command Polarity						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~1	1 byte(USINT)	-	RW	-	Servo Off	0x0	Ft-0.02[D2]
Sub-Index 4	AC Line Loss Check						

Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~2	1 byte(USINT)	-	RW	-	Servo Off	0x0	Ft-0.02[D3]

Sub-Index 1 **Ft-0.02[D0]**	**Fault and Disable Braking** **RSWare : Drive - Stopping Functions - Fault and Disable Braking**		
Range	Value	Description	Name in RSWare
	0	Keep DB after DB stop	Brake and Hold
	1	DB is released after DB stop.	Brake and Release
	2	Stop Free run (operation) without DB stop	Free Stop
	3	Keep DB after stop Free run	Free Stop and Hold
Sub-Index 2 **Ft-0.02[D1]**	**Overtravel Stop Method** **RSWare : Drive - Stopping Functions - Over Travel Stop Method**		
Range	Value	Description	Name in RSWare
	0	Stop by normal torque contorl during overtravel. At this monent,can contorl torque by setting overtravel torque linit [Ft-4.11].	Current Control
	1	Stop by the method specified at the DB stop method selection in [Ft-0.02][D0] when overtravel occurs.	Dynamic Brake
	2	No Action	No Action
Sub-Index 3 **Ft-0.02[D2]**	**Command Polarity** **RSWare : Drive - Command Polarity**		
Range	Value	Description	Name in RSWare
	0	The command signal is not inverted so that a positive command value results in CW Rotation, (as viewed from shaft end).	Normal
	1	The command signal is inverted so that a positive command value results in CCW Rotation, (as viewed from shaft end).	Inverted
Sub-Index 4 **Ft-0.02[D3]**	**AC Line Loss Check** **RSWare : Drive - AC Line Loss Check**		
Range	Value	Description	Name in RSWare
	0	Check input power 100W~400W : Enable single-phase open check 800W~1.5kW : 3-phase open check	Enable
	1	Do not check the input power	Disable
	2	Single-phase input	Single Phase Input

0x2003	**Selection of Off-Line Auto Tuning Function**					**ALL**	
Sub-Index 0	Number of Entries						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	2 byte(UINT)	-	RO	-	-	4	Ft-0.03
Sub-Index 1	Off-Line Auto Tuning Mode						

Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~2	1 byte(USINT)	-	RW	-	Servo Off	0x1	Ft-0.03[D0]
Sub-Index 2	Reserved						
Sub-Index 3	Off-Line Auto Tuning Velocity						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
2~9	1 byte(USINT)	*100rpm	RW	-	Servo Off	0x7	Ft-0.03[D2]

Sub-Index 1 **Ft-0.03[D0]**	**Off-Line Auto Tuning Mode** **RSWare : Drive - Tuning - Autotuning - Off-Line Auto Tuning Mode**		
Range	Value	Description	Name in RSWare
	0	Inertia Moment Estimation	Inertia Moment Estimation
	1	Inertia Moment Estimation and Resonant Frequency Detection	Inertia Moment Estimation and Resonant Frequency Detection
	2	Resonance frequency Detection	Resonant Frequency Detection
Sub-Index 3 **Ft-0.03[D2]**	**Off-Line Auto Tuning Velocity** **RSWare : Drive - Tuning - Autotuning - Off-Line Auto Tuning Velocity**		
Range	Value	Description	
	2~9	The larger the setting value, the higher speed. (7*100 = 700RPM)	

0x2004	**Inertia Ratio**					**ALL**	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0.00~60.00	2 byte(UINT)	[times]	RW	-	Always	1.00	Ft-0.04

Ft-0.04	**Inertia Ratio** **RSWare : Drive - Motor - Inertia Ratio**
Description	Inertia Ratio = Load Inertia/Motor Inertia

0x2005	**Auxiliary Function Selection 1**					**ALL**	
Sub-Index 0	Number of Entries						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	2 byte(UINT)	-	RO	-	-	4	Ft-0.05
Sub-Index 1	Encoder Backup Battery						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~1	1 byte(USINT)	-	RW	-	Power cycling	0x1	Ft-0.05[D0]
Sub-Index 2	Absolute Single Turn Reset						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~1	1 byte(USINT)	-	RW	-	Power cycling	0x0	Ft-0.05[D1]
Sub-Index 3	Gain Change Enable						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no

0~1	1 byte(USINT)	-	RW	-	Power cycling	0x0	Ft-0.05[D2]
Sub-Index 4	Emergency Stop Input						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~1	1 byte(USINT)	-	RW	-	Power cycling	0x0	Ft-0.05[D3]

Sub-Index 1 Ft-0.05[D0]	**Encoder Backup Battery RSWare : Drive - Encoder - Encoder Backup Battery**		
Range	Value	Description	Name in RSWare
	0	Backup Battery Installed	Installed
	1	Backup Battery Not Installed	Not Installed
Sub-Index 2 Ft-0.05[D1]	**Absolute Single Turn Reset RSWare : Drive - Encoder - Absolute Single Turn Reset**		
Range	Value	Description	Name in RSWare
	0	Reset fuction Enable	Enable
	1	Reset fuction Disable	Disable
Sub-Index 3 Ft-0.05[D2]	**Gain Change Enable RSWare : Drive - Tuning - Gain Switching - Gain Change Enable**		
Range	Value	Description	Name in RSWare
	0	Disable	Disable
	1	Enable	Enable
Sub-Index 4 Ft-0.05[D3]	**Emergency Stop Input RSWare : Drive - Auxiliary Function Selection 1 - Emergency Stop Input**		
Range	Value	Description	Name in RSWare
	0	Disable	Disable
	1	Enable	Enable

0x2006	**Auxiliary Function Selection 2**					**ALL**	
Sub-Index 0	Number of Entries						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	2 byte(UINT)	-	RO	-	-	4	Ft-0.06
Sub-Index 1	Shunt Resistor Connection						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~2	1 byte(USINT)	-	RW	-	Always	0x0	Ft-0.06[D0]
Sub-Index 2	Auxiliary Function Selection 2						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~1	1 byte(USINT)		RO			0x0	Ft-0.06[D1]
Sub-Index 3	Mode of Gain Switching						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~9	1 byte(USINT)	-	RW	-	Always	0x0	Ft-0.06[D2]
Sub-Index 4	Absolute Feedback Transfer Type						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no

0~2	1 byte(USINT)	-	RW	-	Always	0x0	Ft-0.06[D3]

Sub-Index 1 **Ft-0.06[D0]**	**Shunt Resistor Connection** **RSWare : Drive - Shunt Resistor Connection**		
Range	Value	Description	Name in RSWare
	0	Internal Shunt Resistor	Internal
	1	Internal + External Shunt Resistor	Internal+External
	2	External Shunt Resistor	External
Sub-Index 2 **Ft-0.06[D1]**	**Auxiliary Function Selection 2** **RSWare : ECAT Homing – Absolute Homing Complete**		
Range	Value	Description	Name in RSWare
	0	Absolute Homing Incomplete	Not Completed
	1	Absolute Homing Complete	Completed
Sub-Index 3 **Ft-0.06[D2]**	**Mode of Gain Switching** **RSWare : Drive - Tuning - Gain Switching - Mode of Gain Switching**		
Range	Value	Description	Name in RSWare
	0	Fixed to the 1st gain.	1st Gain Fix
	1	Fixed to 2nd gain.	2nd Gain Fix
	2	2nd gain selection when the gain switching input is turned on.	Digital Input (G-SEL)
	3	2nd gain selection when the toque command is larger than the setups (level of gain control switching and hysteresis of control switching).	Torque Command Deviation
	4	2nd gain selection when the command speed is larger than the setups (level of gain control switching and hysteresis of control switching).	Velocity Command
	5	2nd gain selection when the positional deviation is larger than the setups (level of gain control switching and hysteresis of control switching).	Position Error
	6	2nd gain selection when more than one command pulse exists between 200usec.	Position Command
	7	2nd gain selection when the positional deviation counter value exceeds the setup of Positioning completer range.	In-Position
	8	2nd gain selection when the motor actual speed exceeds the setup.	Velocity
	9	2nd gain selection when no position commands applied and the motor actual speed falls slower than the setup.	Position command and Velocity
Sub-Index 4 **Ft-0.06[D3]**	**Absolute Feedback Transfer Type** **RSWare : Drive - Encoders - Absolute Feedback Transfer Type**		
Range	Value	Description	Name in RSWare
	0	Same as Command Polarity	Same as Command Polarity
	1	Always CCW	Always CCW
	2	Always CW	Always CW

0x2007	Servo Drive ID					ALL	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~247	1 byte(USINT)	-	RW	-	Always	1	Ft-0.07

It indicates the ID of the servo drive.

0x200A	Digital Input Assignment 1					ALL	
Sub-Index 0	Number of Entries						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	2 byte(UINT)	-	RO	-	-	4	Ft-0.10
Sub-Index 1	Drive Enable(/ENABLE)						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0x0~0xb	1 byte(USINT)	-	RW	-	Servo Off	0xb	Ft-0.10[D0]
Sub-Index 2	Overtravel - Positive (P-OT)						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0x0~0xb	1 byte(USINT)	-	RW	-	Servo Off	0x2	Ft-0.10[D1]
Sub-Index 3	Overtravel - Negative (N-OT)						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0x0~0xb	1 byte(USINT)	-	RW	-	Servo Off	0x3	Ft-0.10[D2]
Sub-Index 4	Integrator Inhibit (/P-CON)						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0x0~0xa	1 byte(USINT)	-	RW	-	Servo Off	0x0	Ft-0.10[D3]

▶ Setting Range : 0x0 ~ 0xb

0 : Always Off

B : Always On

1-A : Digital Input

Ft-0.10	Digital Input Assignment 1 RSWare : Drive - Digital Inputs		
Digit	Description	Open I/O Status	Name in RSWare
Sub-Index 1 Ft-0.10[D0]	Servo-ON Enable Signal (/ENABLE)	OFF	Drive Enable(/SV-ON)
Sub-Index 2 Ft-0.10[D1]	Positive Over-travel (P-OT)	ON	Overtravel - Positive(P-OT)
Sub-Index 3 Ft-0.10[D2]	Negative Over-travel (N-OT)	ON	Overtravel - Negative(N-OT)
Sub-Index 4 Ft-0.10[D3]	P Control (/P-CON)	OFF	Integrator Inhibit(/P-CON)

0x200B	Digital Input Assignment 2					ALL	
Sub-Index 0	Number of Entries						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	2 byte(UINT)	-	RO	-	-	4	Ft-0.11
Sub-Index 1	Fault Reset (/A-RST)						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0x0~0xa	1 byte(USINT)	-	RW	-	Servo Off	0x0	Ft-0.11[D0]
Sub-Index 2	Current Limit-Negative (/N-TL)						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0x0~0xa	1 byte(USINT)	-	RW	-	Servo Off	0x0	Ft-0.11[D1]
Sub-Index 3	Current Limit-Positive (/P-TL)						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0x0~0xa	1 byte(USINT)	-	RW	-	Servo Off	0x0	Ft-0.11[D2]

▶ Setting Range : 0x0 ~ 0xa

0 : Always Off

1-A : Digital Input

Ft-0.11	Digital Input Assignment 2 RSWare : Drive - Digital Inputs		
Digit	Description	Open I/O Status	Name in RSWare
Sub-Index 1 Ft-0.11[D0]	Fault Reset (/A-RST)	OFF	Fault Reset (/A-RST)
Sub-Index 2 Ft-0.11[D1]	Negative Current Limit (/N-TL)	OFF	Current Limit – Negative (/N-TL)
Sub-Index 3 Ft-0.11[D2]	Positive Current Limit (/P-TL)	OFF	Current Limit – Positive (/P-TL)

0x200D	Digital Input Assignment 4					CSP	
Sub-Index 0	Number of Entries						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	2 byte(UINT)	-	RO	-	-	4	Ft-0.13
Sub-Index 1	Reserved						
Sub-Index 2	Reserved						
Sub-Index 3	Alternate Gain Select (/G-SEL)						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0x0~0xa	1 byte(USINT)	-	RW	-	Servo Off	0x0	Ft-0.13[D2]

▶ Setting Range : 0x0 ~ 0xa

0 : Always Off

1-A : Digital Input

Ft-0.13	Digital Input Assignment 4

	RSWare : Drive - Digital Inputs		
Digit	Description	Open I/O Status	Name in RSWare
Sub-Index 3 Ft-0.13[D2]	Gain Group Selection (/G-SEL)	OFF	Alternate Gain Select (/G-SEL)

0x200F	Digital Input Assignment 6					ALL	
Sub-Index 0	Number of Entries						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	2 byte(UINT)	-	RO	-	-	4	Ft-0.15
Sub-Index 1	Absolute Encoder Reset (/R-ABS)						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0x0~0xa	1 byte(USINT)	-	RW	-	Servo Off	0x0	Ft-0.15[D0]
Sub-Index 2	Gain Bank Select (/BANK-SEL)						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0x0~0xa	1 byte(USINT)	-	RW	-	Servo Off	0x0	Ft-0.15[D1]

▶ Setting Range : 0x0 ~ 0xa

0 : Always Off

1-A : Digital Input

Ft-0.15	Digital Input Assignment 6 RSWare : Drive - Digital Inputs		
Digit	Description	Open I/O Status	Name in RSWare
Sub-Index 1 Ft-0.15[D0]	Reset multi-turn data of Absolute Encoder (/R-ABS)	OFF	Absolute Encoder Reset (/R-ABS)
Sub-Index 2 Ft-0.15[D1]	Gain Bank Select (/BANK-SEL)	OFF	Gain Bank Select (/BANK-SEL)

0x2010	Digital Input Assignment 7					ALL	
Sub-Index 0	Number of Entries						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	2 byte(UINT)	-	RO	-	-	4	Ft-0.16
Sub-Index 1	Home Sensor (/HOM-SEN)						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0x0~0xa	1 byte(USINT)	-	RW	-	Servo Off	0x4	Ft-0.16[D0]

▶ Setting Range : 0x0 ~ 0xa

0 : Always Off

1-A : Digital Input

Ft-0.16	Digital Input Assignment 7 RSWare : Drive - Digital Inputs		
Digit	Description	Open I/O Status	Name in RSWare
Sub-Index 1 Ft-0.16[D0]	Home Sensor (/HOM-SEN)	OFF	Home Sensor(/HOM-SEN)

0x2015	Digital Input Assignment 12					ALL	
Sub-Index 0	Number of Entries						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	2 byte(UINT)	-	RO	-	-	4	Ft-0.21
Sub-Index 1	Touch Probe 1						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0x0~0xa	1 byte(USINT)	-	RW	-	Servo Off	0x9	Ft-0.21[D0]
Sub-Index 2	Touch Probe 2						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0x0~0xa	1 byte(USINT)	-	RW	-	Servo Off	0xA	Ft-0.21[D1]

▶ Setting Range : 0x0 ~ 0xa

0 : Always Off

1-A : Digital Input

Ft-0.21	Digital Input Assignment 12 RSWare : Drive - Digital Inputs		
Digit	Description	Open I/O Status	Name in RSWare
Sub-Index 1 Ft-0.21[D0]	Touch Probe 1	OFF	Touch Probe 1
Sub-Index 2 Ft-0.21[D1]	Touch Probe 2	OFF	Touch Probe 2

0x2016	Digital Output Assignment 1					ALL	
Sub-Index 0	Number of Entries						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	2 byte(UINT)	-	RO	-	-	4	Ft-0.22
Sub-Index 1	Within In-Position Window(/P-COM)						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0x0~0x3	1 byte(USINT)	-	RW	-	Servo Off	0x0	Ft-0.22[D0]
Sub-Index 2	Up to Velocity (/TG-ON)						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0x0~0x3	1 byte(USINT)	-	RW	-	Servo Off	0x0	Ft-0.22[D1]
Sub-Index 3	Brake Control (/BK)						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no

0x0~0x3	1 byte(USINT)	-	RW	-	Servo Off	0x3	Ft-0.22[D2]
Sub-Index 4	Within Velocity Window (/V-COM)						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0x0~0x3	1 byte(USINT)	-	RW	-	Servo Off	0x0	Ft-0.22[D3]

▶ Setting Range : 0x0 ~ 0x3

0 : Always Off

1-3 : Digital Output

Ft-0.22	**Digital Output Assignment 1** **RSWare : Drive - Digital Outputs**	
Digit	Description	Name in RSWare
Sub-Index 1 Ft-0.22[D0]	Position Completion Signal (/P-COM)	Within In Position Window (/P-COM)
Sub-Index 2 Ft-0.22[D1]	Rotation Detection (/TG-ON)	Up to Velocity (/TG-ON)
Sub-Index 3 Ft-0.22[D2]	Break Control (/BK)	Brake Control (/BK)
Sub-Index 4 Ft-0.22[D3]	Speed Correspondence Signal (/V-COM)	Within Velocity Window (/V-COM)

0x2017	**Digital Output Assignment 2**					**ALL**	
Sub-Index 0	Number of Entries						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	2 byte(UINT)	-	RO	-	-	4	Ft-0.23
Sub-Index 1	Current Limited (/T-LMT)						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0x0~0x3	1 byte(USINT)	-	RW	-	Servo Off	0x0	Ft-0.23[D0]
Sub-Index 2	Velocity Limited(/V-LMT)						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0x0~0x3	1 byte(USINT)	-	RW	-	Servo Off	0x0	Ft-0.23[D1]
Sub-Index 3	Within Near-Position Window (/NEAR)						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0x0~0x3	1 byte(USINT)	-	RW	-	Servo Off	0x0	Ft-0.23[D2]
Sub-Index 4	Warning (/WARN)						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0x0~0x3	1 byte(USINT)	-	RW	-	Servo Off	0x0	Ft-0.23[D3]

▶ Setting Range : 0x0 ~ 0x3

0 : Always Off

1-3 : Digital Output

Ft-0.23	**Digital Output Assignment 2** **RSWare : Drive – Digital Outputs**

Digit	Description	Name in RSWare
Sub-Index 1 Ft-0.23[D0]	Torque Limit Detection (/T-LMT)	Current Limited (/T-LMT)
Sub-Index 2 Ft-0.23[D1]	Speed Limit Detection (/V-LMT)	Velocity Limited (/V-LMT)
Sub-Index 3 Ft-0.23[D2]	Position Proximity Signal (/NEAR)	Within Near-Position Window (/NEAR)
Sub-Index 4 Ft-0.23[D3]	Warning (/WARN)	Warning (/WARN)

0x2018	**Digital Output Assignment 3**					**ALL**	
Sub-Index 0	Number of Entries						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	2 byte(UINT)	-	RO	-	-	4	Ft-0.24
Sub-Index 1	Absolute Position Valid (/A-VLD)						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0x0~0x3	1 byte(USINT)	-	RW	-	Servo Off	0x0	Ft-0.24[D0]
Sub-Index 2	Drive Ready (/RDY)						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0x0~0x3	1 byte(USINT)	-	RW	-	Servo Off	0x0	Ft-0.24[D1]

▶ Setting Range : 0x0 ~ 0x3

0 : Always Off

1-3 : Digital Output

▶ Sub-Index 1

-The PDO communication status word (0x6041 bit8) reflects the same value

-It can not be changed using RSWare (ASCII communication) and Built-In.

-'ECAT Abs Origin Offset' (0x250E) value is saved when the servo drive homing is completed, and the Status Word (0x6041, bit8) value on the PDO is also 1. If homing is not complete, use the previous value.

-It is changed to "0" when an error related to Absolute Multi Turn 'E083, E085, E028, E084' occurs.

-It is changed to "0" when the motor rotation direction is changed.

-It is changed to “0” when Absolute Counter Reset is executed.

-It is changed to “0” when the Absolute Single Turn Counter Reset is executed.

Ft-0.24	**Digital Output Assignment 3** **RSWare : Drive - Digital Outputs**	
Digit	Description	Name in RSWare
Sub-Index 1 Ft-0.24[D0]	Absolute Position Valid (/A-VLD)	Absolute Position Valid(/A-VLD)

Sub-Index 2 Ft-0.24[D1]	Servo drive ready (/RDY)	Drive Ready(/RDY)

0x201B	**Digital Output Assignment 6**					**ALL**	
Sub-Index 0	Number of Entries						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	2 byte(UINT)	-	RO	-	-	4	Ft-0.27
Sub-Index 1	Reserved						
Sub-Index 2	Reserved						
Sub-Index 3	RMS Current Load Factor Threshold Output 1(/RMS-CLT1)						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0x0~0x3	1 byte(USINT)	-	RW	-	Servo Off	0x0	Ft-0.27[D2]
Sub-Index 4	RMS Current Load Factor Threshold Output 2(/RMS-CLT2)						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0x0~0x3	1 byte(USINT)	-	RW	-	Servo Off	0x0	Ft-0.27[D3]

▶ Setting Range : 0x0 ~ 0x3

0 : Always Off

1-3 : Digital Output

Ft-0.27	**Digital Output Assignment 6** **RSWare : Drive - Digital Outputs**	
Digit	Description	Name in RSWare
Sub-Index 3 Ft-0.24[D2]	Threshold Value 1 for Average Torque Load Factor (/RMS-CLT1)	RMS Current Load Factor Threshold Output 1 (/RMS-CLT1)
Sub-Index 4 Ft-0.24[D3]	Threshold Value 2 for Average Torque Load Factor (/RMS-CLT2)	RMS Current Load Factor Threshold Output 2 (/RMS-CLT2)

0x201C	**Digital Output Assignment 7**					**ALL**	
Sub-Index 0	Number of Entries						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	2 byte(UINT)	-	RO	-	-	4	Ft-0.28
Sub-Index 1	Commutation Angle Valid (/CAG-V)						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0x0~0x3	1 byte(USINT)	-	RW	-	Servo Off	0x0	Ft-0.28[D0]
Sub-Index 2	Reserved						
Sub-Index 3	Reserved						
Sub-Index 4	Reserved						

▶ Setting Range : 0x0 ~ 0x3

0 : Always Off

1-3 : Digital Output

Ft-0.28	**Digital Output Assignment 7** **RSWare : Drive - Digital Outputs**	
Digit	Description	Name in RSWare
Sub-Index 1 Ft-0.28[D0]	Hallless Linear Commutation Angle Valid (/CAG-V)	Commutation Angle Valid (/CAG-V)

0x2021	**Alias ID**					**ALL**	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~255	1 byte(USINT)	-	RW	-	Always	0	Ft-0.33

- ▶ It set the EtherCAT node address of the servo drive.
  0 : If the value is set to 000, the node address is decided by the host controller.
  1~255 : This value become node address.
- ▶ After changing and saving node addresses, cycle the power so that the Master can recognize the new node addresses. The Master can configure nodes with recognized node addresses.

Standard Group 1

0x2100	Velocity Regulator Response Level					CSP	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
1~100	1 byte(USINT)	%	RW	-	Always	35	Ft-1.00

- RSWare : Drive - Tuning - Velocity Regulator Response Level
- Set system gain in proportion to velocity response level automatically by referring to the estimated inertia ratio after auto tuning.

0x2101	System Gain					CSP	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
10~500	2 byte(UINT)	Hz	RW	-	Always	50	Ft-1.01

- RSWare : Drive - Tuning - System Gain
- Refers to the bandwidth of the entire velocity control loop.
- When this value is changed, basic gain values [Ft-1.02], [Ft-1.03], [Ft-1.07], [Ft-4.02] and [Ft-2.02] are set automatically according to the control mode while referring to the inertia ratio [Ft-0.04].
- The lower limit is 10 [Hz].
- A higher value results in higher basic gain values and higher responsiveness. (However, excessive values can result in noise and vibrations)
- Conversely, lower values result in smaller gain and lower responsiveness; however, the whole system's stability is increased.
- The system gain can be changed directly by a user, but it is recommended to change the value by changing the velocity response level (Ft-1.00) parameter for safety of the system.

0x2102	1st Velocity Regulator P Gain					CSP	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~10000	2 byte(UINT)	-	RW	-	Always	215	Ft-1.02

- RSWare : Drive - Tuning - Main Velocity Regulator Gains - 1st Velocity Regulator P Gain
- Parameter which determines the responsiveness of velocity control.
- Value changed simultaneously with change of inertia ratio [Ft-0.04], velocity response level [Ft-1.00] or system gain [Ft-1.01].

0x2103	1st Velocity Regulator I Gain					CSP	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no

0~60000	2 byte(UINT)	-	RW	-	Always	125	Ft-1.03

- RSWare : Drive - Tuning - Main Velocity Regulator Gains - 1st Velocity Regulator I Gain
- Removes steady state speed tolerance.
- Overshoot in velocity response can occur if set value is too large.
- Value changed by change in inertia ratio [Ft-0.04], velocity response levl [Ft-1.00] or system gain [Ft-1.01].

0x2104	**Velocity Regulator I Gain Mode**					**CSP**	
Sub-Index 0	Number of Entries						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	2 byte(UINT)	-	RO	-	-	4	Ft-1.04
Sub-Index 1	Selection of Mode						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~4	1 byte(USINT)	-	RW	-	Servo Off	0	Ft-1.04[D0]

- RSWare : Drive - Tuning - Main Velocity Regulator Gains - Velocity Regulator I Gain Mode
- Sub-Index 1

  During transient response, the Velocity Response Overshoot can be suppressed by changing the velocity controller from Proportion Integration (PI) Controller into Proportion (P)Controller. This reduces Position completion time during Position Control.

Table 79 P/PI Control Switching Mode Value

Value	Description
0	PI controller is always used.
1	When the torque command exceeds the torque value in [Ft-1.05], the velocity controller is changed from PIController to P controller.
2	When the speed command exceeds the speed value in [Ft-1.05], the Velocity controller is changed from PIController to P Controller.
3	When the position error exceeds the position error value in [Ft-1.05], the Velocity controller is changed from PIController to P Controller.
4	P and PI mode are changed automatically.

0x2105	**Velocity Regulator I Gain Disable Threshold**					**CSP**	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~3000	2 byte(UINT)	-	RW	-	Always	100	Ft-1.05

- RSWare : Drive - Tuning - Main Velocity Regulator Gains - Velocity Regulator I Gain Disable Threshold
- If the velocity/torque command or the position tolerance exceeds the value set in this parameter, the velocity controller changes from PI type to P type.

0x2106	Velocity Regulator D Gain					CSP	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~1000	2 byte(UINT)	-	RW	-	Always	0	Ft-1.06

- RSWare : Drive - Tuning - Main Velocity Regulator Gains - Velocity Regulator D Gain
- The higher the setting value, the faster the velocity response. If the setting values is too high, vibration or noise can be generated.

0x2107	1st Position Regulator Kp Gain					CSP	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~700	2 byte(UINT)	Hz	RW	-	Always	50	Ft-1.07

- RSWare : Drive - Tuning - Main Position Regulator Gains - 1st Position Regulator Kp Gain
- A parameter which determines the responsiveness of positioncontrol.
- Change the setting value according to rigidity of load.
- This value is changed simultaneously with change of inertia ratio (Ft-0.04), velocity response level (Ft-1.00) or system gain (Ft-1.01) value.

0x210A	Delay Time of Gain Switching					CSP	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~10000	2 byte(UINT)	0.125ms	RW	-	Always	0	Ft-1.10

- RSWare : Drive - Tuning - Gain Switching - Delay Time of Gain Switching
- When gain value is switched from Second gain to first gain, you can set delay time.

0x210B	Level of Gain Switching					CSP	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~10000	2 byte(UINT)	-	RW	-	Always	0	Ft-1.11

- RSWare : Drive - Tuning - Gain Switching - Level of Gain Switching
- Set the threshould for gain switching.
- The specified value is used at the gain switching mode selected from [Ft-0.06][D2].

0x210C	Hysterisis of Gain Switching					CSP	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~10000	2 byte(UINT)	-	RW	-	Always	0	Ft-1.12

- RSWare : Drive - Tuning - Gain Switching - Hysteresis of Gain Switching
- Operates Hysteresis based on operation level when gain switching.

▶ The specified value is used at the gain switching mode selected from [Ft-0.06][D2].

0x210D	Position Gain Switching Time					CSP	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~10000	2 byte(UINT)	0.125ms	RW	-	Always	0	Ft-1.13

▶ RSWare : Drive - Tuning - Gain Switching - Position Gain Switching Time

▶ Adjust as Position Gain Switching Time step by step when switching gain value from first gain to second gain.

0x210E	2nd Velocity Regulator P Gain					CSP	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~10000	2 byte(UINT)	-	RW	-	Always	60	Ft-1.14

▶ RSWare : Drive - Tuning - 2nd Regulator Gains - 2nd Velocity Regulator P Gain

▶ It determines the responsiveness of velocity control.

0x210F	2nd Velocity Regulator I Gain					CSP	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~60000	2 byte(UINT)	-	RW	-	Always	26	Ft-1.15

▶ RSWare : Drive - Tuning - 2nd Regulator Gains - 2nd Velocity Regulator I Gain

▶ Removes steady state velocity error.

▶ Overshoot in velocity response can occur if set value is too high.

0x2110	2nd Position Regulator Kp Gain					CSP	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~700	2 byte(UINT)	Hz	RW	-	Always	20	Ft-1.16

▶ RSWare : Drive - Tuning - 2nd Regulator Gains - 2nd Position Regulator Kp Gain

▶ It determines the responsiveness of position control loop.

▶ Change set value according to rigidity of load.

0x2111	3rd Velocity Regulator P Gain					CSP	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~10000	2 byte(UINT)	-	RW	-	Always	60	Ft-1.17

▶ RSWare : Drive - Tuning - 3rd Regulator Gains - 3rd Velocity Regulator P Gain

▶ It determines the responsiveness of velocity control loop.

0x2112	3rd Velocity Regulator I Gain					CSP	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~60000	2 byte(UINT)	-	RW	-	Always	26	Ft-1.18

- RSWare : Drive - Tuning - 3rd Regulator Gains - 3rd Velocity Regulator I Gain
- Removes steady state velocity error.
- Overshoot in velocity response can occur if set value is too high.

0x2113	3rd Position Regulator Kp Gain					CSP	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~700	2 byte(UINT)	Hz	RW	-	Always	20	Ft-1.19

- RSWare : Drive - Tuning - 3rd Regulator Gains - 3rd Position Regulator Kp Gain
- It determines the responsiveness of position control loop.
- Change set value according to rigidity of load.

0x2114	4th Velocity Regulator P Gain					CSP	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~10000	2 byte(UINT)	-	RW	-	Always	60	Ft-1.20

- RSWare : Drive - Tuning – 4th Regulator Gains – 4th Velocity Regulator P Gain
- It determines the responsiveness of velocity control loop.

0x2115	4th Velocity Regulator I Gain					CSP	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~60000	2 byte(UINT)	-	RW	-	Always	26	Ft-1.21

- RSWare : Drive - Tuning - 4th Regulator Gains - 4th Velocity Regulator I Gain
- Removes steady state velocity error.
- Overshoot in velocity response can occur if set value is too high.

0x2116	4th Position Regulator Kp Gain					CSP	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~700	2 byte(UINT)	Hz	RW	-	Always	20	Ft-1.22

- RSWare : Drive - Tuning - 4th Regulator Gains - 4th Position Regulator Kp Gain
- It determines the responsiveness of position control loop.
- Change set value according to rigidity of load.

0x2117	Tuning Mode Setting					ALL	
Sub-Index 0	Number of Entries						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	2 byte(UINT)	-	RO	-	-	4	Ft-1.23
Sub-Index 1	Tuning Mode						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~2	1 byte(USINT)	-	RW	-	Servo Off	1	Ft-1.23[D0]
Sub-Index 2	Load Type						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~2	1 byte(USINT)	-	RW	-	Servo Off	1	Ft-1.23[D1]
Sub-Index 3	Use Estimated Inertia						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~1	1 byte(USINT)	-	RW	-	Servo Off	1	Ft-1.23[D2]
Sub-Index 4	Reserved						

Sub-Index 1 **Ft-1.23[D0]**	**Tuning Mode** **RSWare : Drive -Tuningless – Tuning Mode**		
Range	Value	Description	Name in RSWare
	0	Using the PI controller	Gain Tuning
	1	Tuningless Mode with Inertia Ratio Estimation. By setting the 'Load Inertia Ratio Level' (Ft-1.25) and using the parameters, you can increase the response of the system.	Tuningless + Inertia Estimation
	2	This is a tuningless controller that the user sets the inertia ratio directly. When applying a system that is difficult to estimate the inertia ratio, set the inertia ratio of the system to 'Load inertia ratio setting' (Ft-1.26).	Tuningless + No Inertia Estimation
Sub-Index 2 **Ft-1.23[D1]**	**Load Type** **RSWare : Drive – Tuningless – Load Type**		
Range	Value	Description	Name in RSWare
	0	It is used for high rigidity system such as Ball Screw.	Ball Screw
	1	Used for low stiffness systems such as belts. When the parameter is set during ANF (Adaptive Notch Filter) operation, the depth of the notch filter is adjusted according to the detected resonance frequency range.	Belt
Sub-Index 3 **Ft-1.23[D2]**	**Use Estimated Inertia** **RSWare : Drive – Tuningless – Use Estimated Inertia**		
Range	Value	Description	Name in RSWare
	0	Inertia ratio estimated by Tuningless is not used in PI controller	Not Usage
	1	Using the estimated inertia ratio from Tuningless, the PI controller also changes the associated gain.	Usage

0x2118	Tuningless Gain					ALL	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~100	2 byte(UINT)	%	RW	-	Always	30	Ft-1.24

- RSWare : Drive - Tuning – Tuningless – Tuningless Gain
- This parameter controls the response of the system when tuningless mode is applied.
- When the parameter is changed, the value of the torque filter (Ft-4.27, Current Command LPF Bandwidth (Tuningless)) is also changed.

0x2119	Load Inertia Ratio Level					ALL	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~3	2 byte(UINT)	-	RW	-	Always	1	Ft-1.25

- RSWare : Drive - Tuning - Tuningless – Load Inertia Ratio Level
- This parameter sets the initial inertia ratio when using the inertia estimation mode in Tuningless Mode. By setting the inertia ratio level that matches the system inertia ratio, noise and vibration can be reduced during the tuning process.

0x211A	Load Inertia Ratio Setting					ALL	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~60.0	2 byte(UINT)	times	RW	-	Always	5.0	Ft-1.26

- RSWare : Drive - Tuning - Tuningless – Load Inertia Ratio Setting
- This parameter is for the user to set the system inertia value directly when using mode without inertia estimation function in Tuningless Mode.

Standard Group 2

0x2202	Velocity Command LPF Bandwidth					CSP	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~10000	2 byte(UINT)	Hz	RW	-	Always	1000	Ft-2.02

- RSWare : Drive – Tuning – Velocity Command LPF Bandwidth
- Enter the velocity command filter bandwidth.
- This value changed simultaneously with change of inertia ratio (Ft-0.04), velocity response level (Ft-1.00) or system gain (Ft-1.01) value.

0x2203	Velocity Error Filter Bandwidth					CSP	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~2500	2 byte(UINT)	Hz	RW	-	Always	30	Ft-2.03

- RSWare : Drive - Tuning - Velocity Error Filter Bandwidth
- Remove the high-frequency component of veloctity error.

0x2204	Velocity Regulator Kff Gain					CSP	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~6000	2 byte(UINT)	-	RW	-	Always	0	Ft-2.04

- RSWare : Drive - Tuning - Velocity Regulator Kff Gain
- The higher the setting value, the faster the response. Howerer, if f the setting values is too high, a vibration can be generated and the system can be unstable.

0x2205	Jog Velocity Command					CSP	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~6000	2 byte(UINT)	rpm (mm/s)	RW	-	Always	50	Ft-2.05

- RSWare : Drive – Velocity Control Panel – Jog Velocity Command
- Set the speed when Jog operates in run-00.

0x2206	Acceleration					CSP	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
1~ 2147483647	4 byte(UDINT)	0.01 rev /sec^2	RW	-	Always	41667	Ft-2.06

- RSWare : Drive - Acceleration Limits – Acceleration

▶ Acceleration means a slope of the velocity profile.

0x2207	Deceleration					CSP	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
1~ 2147483647	4 byte(UDINT)	0.01 rev /sec^2	RW	-	Always	41667	Ft-2.07

▶ RSWare : Drive - Acceleration Limits - Deceleration

▶ Deceleration means a slope of the velocity profile.

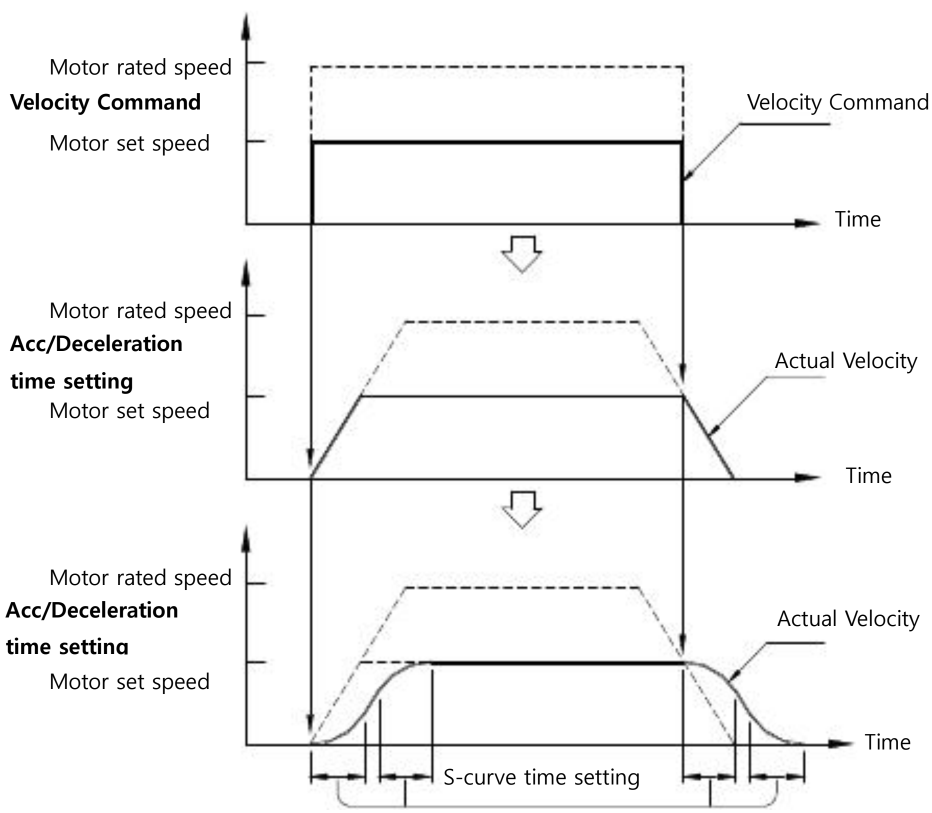
0x2208	S-Curve Time					CSP	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~5000	2 byte(UINT)	msec	RW	-	Always	0	Ft-2.08

▶ RSWare : Drive - Acceleration Limits - S-Curve Time

▶ Set the S-curve operation time for smooth operation.

▶ Applicable only when acceleration/deceleration time have been set.

▶ If the value is set to '0', S-curve operation is disabled. It the value other than '0' is set, S-curve operation is enabled upon acceleration/ deceleration.



0x2210	Set Value of Velocity Limit					ALL	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
1~6000	2 byte(UINT)	rpm (mm/s)	RW	-	Always	5000	Ft-2.16

- RSWare : Drive - Velocity Limits - Manual Velocity limit
- Limits the operation speed to below this set value in all control modes.
- In addition, in torque control mode, the mode is changed automatically to velocity control mode if motor speed exceeds this value; velocity control is performed using Speed limit command.
- If the motor speed is limited by 0x2210 (Ft-2.16), the speed limit detection signal </V-LMT> is output.

0x2211	Velocity Limit Mode					ALL	
Sub-Index 0	Number of Entries						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	2 byte(UINT)	-	RO	-	-	4	Ft-2.17
Sub-Index 1	Selection of Mode						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~3	1 byte(USINT)	rpm (mm/s)	RW	-	Always	0	Ft-2.17[D0]

- Sub-Index 1

  RSWare : Drive - Velocity Limits - Velocity Limit Mode

  Set how to limit the motor speed.

Table 80 0x2211 Velocity Limit Mode Selection Value

Value	Description	Name in RSWare
0	Not used	Disabled
1	The maximum actual speed of motor is limited by Ft-2.16.	Manual Limit
2	Reserved	
3	Reserved	

0x2212	Velocity Window					CSP	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~1000	2 byte(UINT)	rpm (mm/s)	RW	-	Always	10	Ft-2.18

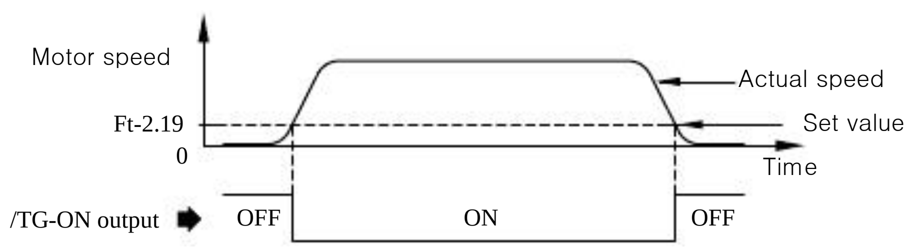
- RSWare : Drive – Speed Functions – Velocity Window
- If the velocity error is smaller than the set value and the speed correspondence signal </V-COM> is assigned, then the </V-COM> signal is turned ON.

  Velocity error < Set Value of [Ft-2.18] = /V-COM output

- The </V-COM> is sequence output signal. To use this function, assign the </V-COM> signal by referring to "Allocation Method for Sequence Output Signal" on page 3-18.
- The 1st row of the 7-segment is turned on while </V-COM> signal is output. (See "Status Display Mode" on page 4-8.)

0x2213	Up to Velocity					ALL	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
1~5000	2 byte(UINT)	rpm (mm/s)	RW	-	Always	20	Ft-2.19

- RSWare : Drive - Speed Functions - Up to Velocity
- It indicates that the motor speed is higher than defined speed. If </TG-ON> signal is assigned and the motor speed is greater than the set value, then the </TG-ON> signal is turned ON.
- The </TG-ON> is sequence output signal. To use this function, assign the </TG-ON> signal by referring to "Allocation Method for Sequence Output Signal" on page 3-18.
- The </TG-ON> signal is output as show in the figure below.



Note If you set rotation detection level [Ft-2.19] too low, </TG-ON> signal can be output even with small vibration.

0x2215	Test Run For ANF Dwell Period					ALL	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
500~5000	2 byte(UINT)	msec	RW	-	Servo off	500	Ft-2.21

- RSWare : Drive - Resonant Suppression – Test Run For ANF Settings – Test Run For ANF Dwell Period
- This parameter is used to set the dwell period required to generate the operation profile of the test operation in order to detect the resonance frequency of the system using the Adaptive Notch Filter (ANF).

0x2216	Test Run For ANF Constant Velocity Period	ALL

Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
50~10000	2 byte(UINT)	msec	RW	-	Servo off	200	Ft-2.22

- RSWare : Drive - Resonant Suppression – Test Run For ANF Settings – Test Run For ANF Constant Velocity Period
- This parameter is used to set the constant-velocity section hold time when generating the operation profile for test operation to detect the resonance frequency of the system using the Adaptive Notch Filter (ANF).

0x2217	**Test Run For ANF Operation Count**					**ALL**	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
1~10000	2 byte(UINT)	cycle	RW	-	Servo off	2	Ft-2.23

- RSWare : Drive - Resonant Suppression – Test Run For ANF Settings – Test Run For ANF Operation Count
- To detect the resonance frequency of the system using the Adaptive Notch Filter (ANF), set the number of times the test operation is repeated.

0x2218	**Test Run For ANF Setting**					**ALL**	
Sub-Index 0	Number of Entries						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	2 byte(UINT)	-	RO	-	-	4	Ft-2.24
Sub-Index 1	Test Run For ANF Enable						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~1	1 byte(USINT)	-	RW	-	Servo off	0	Ft-2.24[D0]

- Sub-Index 1
  RSWare : Drive - Resonant Suppression – Test Run For ANF Settings – Test Run For ANF Enable
- This parameter is used to set whether to use the drive's own test operation to detect the resonance frequency of the system using the ANF function.

Adaptive Notch Filter Setting

Value	**Description**	**RSWware name**
0	Not used	Disable
1	Used	Enable

0x2219	**Linear Motor Overspeed Level**					**ALL**	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0 - 5000	2 byte(UINT)	0.001m/s	RW	-	Always	0	Ft-2.25

- Vliad only for linear motor.
- Set level to detect linear motor overspeed

▶ If it is "0", Maximum Speed of motor data set in Motor Configuration is used as overspeed detection level.

0x221A	Linear Motor Velocity Error Limit					ALL	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0 - 5000	2 byte(UINT)	0.001m/s	RW	-	Always	0	Ft-2.26

▶ Vliad only for linear motor.

▶ If the linear motor data is incorrect or the encoder cable is misaligned, an fault will occur and the range will be set to reduce the probability of runaway without over-running the motor.

▶ It is detected when the speed error that occurs is above the set value.

▶ If the set value is "0", the function is not used.

Standard Group 3

0x2300	**Follower**					**CSP**	
Sub-Index 0	Number of Entries						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	2 byte(UINT)	-	RO	-	-	4	Ft-3.00
Sub-Index 1	Reserved						
Sub-Index 2	Reserved						
Sub-Index 3	Encoder Output Forward Directioin						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~1	1 byte(USINT)	-	RW	-	Servo Off	0	Ft-3.00[D2]

▶ Sub-Index 3

RSWare : Drive - Encoders - Encoder Output Forward Direction

It set the pulse direction that is output from servo drive to external device.

Value	**Description**	**RSWware name**
0	During Forward Rotation, Encoder Output Phase A have a lead of 90° over Phase B.	A Leads B
1	During Forward Rotation, Encoder Output Phase B have a lead of 90° over Phase A.	B Leads A

0x2301	**Position Command LPF Bandwidth**					**CSP**	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~1000	2 byte(UINT)	Hz	RW	-	Always	0	Ft-3.01

▶ RSWare : Drive - Tuning - Main Position Regulator Gains - Position Command LPF Bandwidth

▶ Sets low pass cutoff frequency of speed command to suppress high frequency components.

0x2302	**Position Regulator Kff Gain**					**CSP**	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~100	1 byte(USINT)	%	RW	-	Always	0	Ft-3.02

▶ RSWare : Drive - Tuning - Main Position Regulator Gains - Position Regulator Kff Gain

▶ The higher the value, the faster the position completion time and the smaller position error at transient response condition.

▶ The value can differ depending on load's type or rigidity; an excessively high value causes vibration.

0x2303	Position Regulator Kff LPF Bandwidth					CSP	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~2500	2 byte(UINT)	Hz	RW	-	Always	200	Ft-3.03

- RSWare : Drive - Tuning - Main Position Regulator Gains - Position Regulator Kff LPF Bandwidth
- Valid if position FF gain Ft-3.02 is not '0'.
- If a value other than '0' entered for Ft-3.02 results in overshoot or vibration, set this value to '0'.

0x2304	Moving Average Filter					CSP	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~1000	2 byte(UINT)	0.125ms	RW	-	Servo off	320	Ft-3.04

- RSWare : Drive - Tuning - Main Position Regulator Gains - Moving Average Filter
- Set it when smooth operation is required.
- The filter tends to reduce t he responsiveness.

0x2305	1st Gear Ratio Follower Counts					CSP	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
1~8388608	4 byte(UDINT)	-	RW	-	Servo off	1	Ft-3.05

0x2306	1st Gear Ration, Master Counts					CSP	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
1~8388608	4 byte(UDINT)	-	RW	-	Servo off	1	Ft-3.06

0x230B	Encoder Output Ratio, Output Counts					CSP	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
1~8388608	4 byte(UDINT)	pulse	RW	-	Servo off	1	Ft-3.11

- RSWare : Drive - Encoders - Output Ratio
- The numerator of position output pulse adjustment.
- Set the number of pulses to be output through the servo drive's encoder signal output (EA+, EA-, EB+, EB-) per one motor rotation.
- For [Ft-3.11], enter the numerator of the encoder's output division ratio. Generally, the number of pulses to be output per one motor rotation is entered.
- For [Ft-3.12], enter the denominator of the encoder's output division ratio. Generally, the number of pulses of the encoder connected to the motor per one rotation is entered.
- For the encoder output division ratio, the relationship [Ft-3.11] ≤ [Ft-3.12] should be satisfied.

▶ Equation for adjusting the number of pulses outputted to the higher level controller: ([Ft-3.11]/[Ft-3.12]) × No. of encoder pulses = No. of output pulses

0x230C	**Encoder Output Ratio, Motor Counts**					**CSP**	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
1~8388608	4 byte(UDINT)	pulse	RW	-	Servo off	1	Ft-3.12

▶ RSWare : Drive - Encoders – Encoder Output Ratio

▶ The numerator of position output pulse adjustment.

▶ Refer to the explanation of the Ft-3.11.

0x230E	**1st Damping Frequency**					**CSP**	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~10000	2 byte(UINT)	0.01Hz	RW	-	Servo off	0	Ft-3.14

▶ RSWare : Drive - Tuning - Vibration Suppression - 1st Damping Frequency

▶ By setting the 1st Damping Frequency, it is possible to suppress the low frequency vibration of several tens of Hz which occurs at the machine end.

▶ By using the Vibration Suppression Function provided by CSD7 (Ft-3.22 [D0] = Enable), it is possible to estimate the vibration frequency in real time or set the frequency by proceeding measurement.

0x230F	**1st Damping Ratio**					**CSP**	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~999	2 byte(UINT)	-	RW	-	Servo off	0	Ft-3.15

▶ RSWare : Drive - Tuning - Vibration Suppression - 1st Damping Ratio

0x2310	**2nd Damping Frequency**					**CSP**	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~10000	2 byte(UINT)	0.01Hz	RW	-	Servo off	0	Ft-3.16

▶ RSWare : Drive - Tuning - Vibration Suppression - 2st Damping Frequency

▶ The CSD7 drive provides two vibration filters for damping control.

0x2311	**2nd Damping Ratio**					**CSP**	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~999	2 byte(UINT)	-	RW	-	Servo off	0	Ft-3.17

▶ RSWare : Drive - Tuning - Vibration Suppression - 2st Damping Ratio

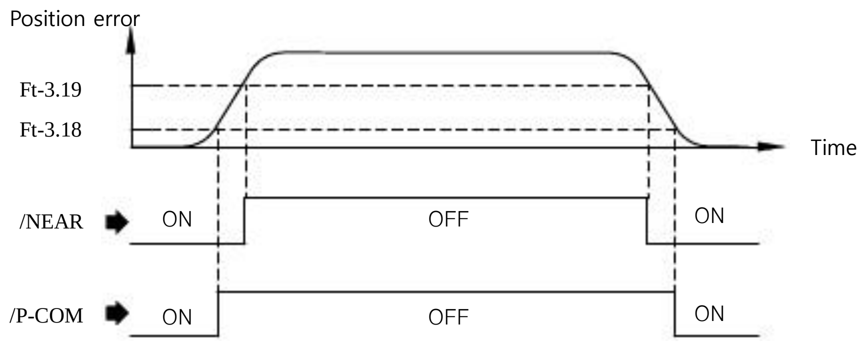
0x2312	In Position Size						CSP
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~2147483647	4 byte(UINT)	pulse	RW	-	Always	10	Ft-3.18

- RSWare : Drive - Position Functions - In Position Size
- It set the threshold to output the </P-COM> signal.
  If the position error is smaller than this set value and the </P-COM> signal is assigned, then the </P-COM> signal is turned ON.
  Position error < Set Value of [Ft-3.18] → Output </P-COM> signal
- The </P-COM> is sequence output signal. To use this function, assign the </P-COM> signal by referring to "Allocation Method for Sequence Output Signal" on page 3-18.
- The 1st row of the 7-segment is turned on while </P-COM> signal is output. (See "Status Display Mode" on page 4-8.)

0x2313	Near Position Size						CSP
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~2147483647	4 byte(UINT)	pulse	RW	-	Always	20	Ft-3.19

- RSWare : Drive - Position Functions - Near Position Size
- It set the threshold to output the </NEAR > signal.
  If the position error is smaller than this set value and the </NEAR> signal is assigned, then the </NEAR> signal is turned ON.
  Position error < Set Value of [Ft-3.19] → Output </NEAR> signal
- Position approach signal detection </NEAR> signal with position completion signal detection </P-COM> signal is useful to reduce the necessary operation at the position completion signal time. First, check the approach signal and preparing the next sequence before the host controller verifies the position completion signal detection signal. The setting of these parameters above do not influence on the accuracy of final position decision.
  Therefore, you can adjust timing to output </P-COM> signal and </ NEAR> signal by adjusting the number of position error pulse of [Ft 3.18] and [Ft-3.19].
  If the position completion signal detection, </P-COM> signal, is detected, the segment LED in line indication 1 of status indication mode is on. However, </NEAR> signal is not on.

  Sequence output </P-COM> and </NEAR> signal output as shown below.



Thus, </P-COM> and </NEAR> output are ON when satisfying the following conditions. However, the position pulse command frequency should be 100 [pps] and less.

- *Position error < Set Value of [Ft-3.18] → Output </P-COM> signal*
- *Position error < Set Value of [Ft-3.19] → Output </NEAR> signal*

CAUTION

When [Ft-3.18] is set with high value during the low-speed operation (less 100 [pps]), </P-COM> output signal remains ON.

Note

- </P-COM> and </NEAR> are sequence output signal. To use </P-COM> and </NEAR> function, allocate </P-COM> and </NEAR> signal and refer to the "Allocation Method for Sequence Output Signal" on the 3-18 page.

0x2314	Following Error Limit					CSP	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~2147483647	4 byte(UDINT)	pulse	RW	-	Always	655360	Ft-3.20

- ▶ RSWare : Drive - Faults - Following Error Limit
- ▶ It set the allowable range of position error. If the position error is bigger than this set value, the E.019 (Position Error Limit Exceeded : E.PoSEr) fault occurs.

0x2315	Touch Probe Function					CSP	
Sub-Index 0	Number of Entries						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0 - 0xF333	1 byte(USINT)	-	RO	-	Always	0	Ft-3.21
Sub-Index 1	Touch Probe Enable						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~3	1 byte(USINT)	-	RW	-	-	0	Ft-3.21[D0]

Sub-Index 2	Touch Probe Mode						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~3	1 byte(USINT)	-	RW	-	-	0	Ft-3.21[D1]
Sub-Index 3	Touch Probe Source						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~3	1 byte(USINT)	-	RW	-	-	0	Ft-3.21[D2]
Setting Range	Size (Data Type)						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~15	1 byte(USINT)	-	RW	-	-	0	Ft-3.21[D3]

Sub-Index 1 Ft-3.21[D0]	**Touch Probe Enable RSWare : Drive – Touch Probe – Enable Touch Probe**		
Range	Value	Description	Name in RSWare
	0	Touch Probe 1 and 2 do not operate	0
	1	Touch Probe 1 operates, Touch Probe 2 does not operate	1
	2	Touch Probe 1 does not operate, Touch Probe 2 operates	2
	3	Touch Probe 1 and 2 operate	3
Sub-Index2 Ft-3.21[D1]	**Touch Probe Mode RSWare : Drive – Touch Probe – Touch Probe Trigger Event Mode**		
Range	Value	Description	Name in RSWare
	0	Touch Probes 1 & 2 detect once	0
	1	Continuous detection of Touch Probe 1, detection of Touch Probe 2 once	1
	2	The Touch Probe 1 is detected once, the Touch Probe 2 is detected continuously	2
	3	Touch Probes 1 & 2 continuously detect	3
Sub-Index 3 Ft-3.21[D2]	**Touch Probe Source RSWare : Drive – Touch Probe – Touch Probe Source**		
Range	Value	Description	Name in RSWare
	0	Detected by the input of Touch Probe 1 & 2	0
	1	Touch Probe 1 is detected by index pulse, Touch Probe 2 is detected by Touch Probe 2 input	1
	2	Touch Probe 1 is detected by Touch Probe 1 input, Touch Probe 2 is detected by index pulse	2
	3	Both Touch Probes 1 & 2 are detected by index pulse	3
Sub-Index 4 Ft-3.21[D3]	**Touch Probe Edge RSWare : Drive – Touch Probe – Touch Probe Edge**		
Range	Value	Description	Name in RSWare
	0	Set for Touch Probe edge types 1,3,5,7	0
	1	Set for Touch Probe edge type 2,3,5,7	1

	2	Set for Touch Probe edge type 1,4,5,7	2
	3	Set for Touch Probe edge type 2,4,5,7	3
	4	Set for Touch Probe edge type 1,3,6,7	4
	5	Set for Touch Probe edge type 2,3,6,7	5
	6	Set for Touch Probe edge type 1,4,6,7	6
	7	Set for Touch Probe edge type 2,4,6,7	7
	8	Set for Touch Probe edge type 1,3,5,8	8
	9	Set for Touch Probe edge type 2,3,5,8	9
	A	Set for Touch Probe edge type 1,4,5,8	A
	B	Set for Touch Probe edge type 2,4,5,8	B
	C	Set for Touch Probe edge type 1,3,6,8	C
	D	Set for Touch Probe edge type 2,3,6,8	D
	E	Set for Touch Probe edge type 1,4,6,8	E
	F	Set for Touch Probe edge type 2,3,6,8	F

Touch Probe Edge Type

Case	Bit	Value	Definition
1	0	0	Disable sampling at positive edge(Rising) of Touch Probe 1
2		1	Enable sampling at positive edge(Rising) of Touch Probe 1
3	1	0	Disable sampling at negative edge(Falling) of Touch Probe 1
4		1	Enable sampling at negative edge(Falling) of Touch Probe 1
5	2	0	Disable sampling at positive edge(Rising) of Touch Probe 2
6		1	Enable sampling at positive edge(Rising) of Touch Probe 2
7	3	0	Disable sampling at negative edge(Falling) of Touch Probe 2
8		1	Enable sampling at negative edge(Falling) of Touch Probe 2

0x2316	**Vibration Setting**						**CSP**
Sub-Index 0	Number of Entries						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	2 byte(UINT)	-	RO	-	-	4	Ft-3.22
Sub-Index 1	Vibration Auto Search						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~1	1 byte(USINT)	-	RW	-	Servo Off	0	Ft-3.22[D0]
Sub-Index 2	Vibration Filter Type						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~2	1 byte(USINT)	-	RW	-	Servo Off	0	Ft-3.22[D1]
Sub-Index 3	Reserved						
Sub-Index 4	Reserved						

Sub-index 1 **Ft-3.22[D0]**	**Vibration Auto Search** **RSWare : Drive – Vibration Suppression – Vibration Auto Search**

Range	Value	Description	Name in RSWare
	0	Disable Automatic Vibration Search function	Disable
	1	Automatic detection of vibration frequency and damping ratio	Enable
Sub-index 2 **Ft-3.22[D1]**	**Vibration Filter Type** **RSWare : Drive – Vibration Suppression – Vibration Filter Type**		
Range	Value	Description	Name in RSWare
	0	No vibration suppression filter applied	Disable
	1	Apply Vibration Filter	Vibration Filter
	2	Apply Advanced Vibration Filter	Advanced Vibration Filter

Standard Group 4

0x2402	1st Current Command LPF Bandwidth					ALL	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~10000	2 byte(UINT)	Hz	RW	-	Always	500	Ft-4.02

- RSWare : Drive - Tuning - Main Current Regulator Gains - 1st Current Command LPF Bandwidth
- It is the 1st low pass filter that removes a high-frequency elements of torque command.
- The 1st low pass filter is used as a basic filter.
- This value is changed simultaneously with change of inertia ratio (Ft-0.04), velocity response level (Ft-1.00) or system gain (Ft-1.01) value.

0x2403	2nd Current Command LPF Bandwidth					ALL	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~10000	2 byte(UINT)	Hz	RW	-	Always	300	Ft-4.03

- RSWare : Drive - Tuning - 2nd Regulator Gains - 2nd Current Command LPF Bandwidth
- It is the 2nd low pass filter that removes a high-frequency elements of torque command.
- This filter can be selected by the combined signals of </G-SEL> and </BANK-SEL>. (Refer to “Gain Group Switching, </G-SEL> Function” on page 8-42.)

0x2404	3rd Current Command LPF Bandwidth					ALL	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~10000	2 byte(UINT)	Hz	RW	-	Always	300	Ft-4.04

- RSWare : Drive - Tuning – 3rd Regulator Gains – 3rd Current Command LPF Bandwidth
- It is the 3rd low pass filter that removes a high-frequency elements of torque command.
- This filter can be selected by the combined signals of </G-SEL> and </BANK-SEL>. (Refer to “Gain Group Switching, </G-SEL> Function” on page 8-42.)

0x2405	4th Current Command LPF Bandwidth					ALL	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~10000	2 byte(UINT)	Hz	RW	-	Always	300	Ft-4.05

- RSWare : Drive - Tuning – 4th Regulator Gains – 4th Current Command LPF Bandwidth
- It is the 4th low pass filter that removes a high-frequency elements of torque command.
- This filter can be selected by the combined signals of </G-SEL> and </BANK-SEL>. (Refer to “Gain Group Switching, </G-SEL> Function” on page 8-42.)

0x2406	Main Current Regulator Gain					ALL	
Sub-Index 0	Number of Entries						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	2 byte(UINT)	-	RO	-	-	4	Ft-4.06
Sub-Index 1	Selection of Gain						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~2	1 byte(USINT)	-	RW	-	Power cycling	1	Ft-4.06[D0]

▶ Sub-Index 1

RSWare : Drive - Tuning - Main Current Regulator Gains - Main Current Regulator Gain

It set the bandwidth for the current control loop.

Value	Description	Name in RSWware
0	High bandwidth (3KHz)	High
1	Medium bandwidth (2KHz)	Midium
2	Low bandwidth (1KHz)	Low

0x2407	Positive Internal Current Limit					ALL	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~500	2 byte(UINT)	%	RW	-	Always	350	Ft-4.07

▶ RSWare : Drive - Current Limits - Positive Internal Current Limit

▶ The positive torque is always limited by this value.

0x2408	Negative Internal Current Limit					ALL	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~500	2 byte(UINT)	%	RW	-	Always	350	Ft-4.08

▶ RSWare : Drive - Current Limits - Negative Internal Current Limit

▶ The negative torque is always limited by this value.

0x2409	Positive External Current Limit					ALL	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~500	2 byte(UINT)	%	RW	-	Always	100	Ft-4.09

▶ RSWare : Drive - Current Limits - Positive External Current Limit

▶ The positive torque is limited by this value while the </P-TL> signal is input.

▶ The lower value of 0x2407 (Ft-4.07) and 0x2409 (Ft-4.09) with </P-TL> signal is the positive torque limit.

0x240A	Negative External Current Limit					ALL	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~500	2 byte(UINT)	%	RW	-	Always	100	Ft-4.10

- RSWare : Drive - Current Limits - Negative External Current Limit
- The negative torque is limited by this value while the </N-TL> signal is input.
- The lower value of 0x2408 (Ft-4.08) and 0x240A (Ft-4.10) with </N-TL> signal is the negative torque limit.

0x240B	Maximum Stopping Current					ALL	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~500	2 byte(UINT)	%	RW	-	Always	350	Ft-4.11

- RSWare : Drive - Stopping Functions - Maximum Stopping Current
- Limits the torque imposed on the motor if the motor is halted by overtravel (<P-OT>,<N-OT>) input signal during rotation.
- Unlike external and internal torque limit, the torque limit value for overtravel input is same for forward and reverse direction.

0x240C	Initial Current Bias					ALL	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-100~100	4 byte(DINT)	%	RW	-	Always	0	Ft-4.12

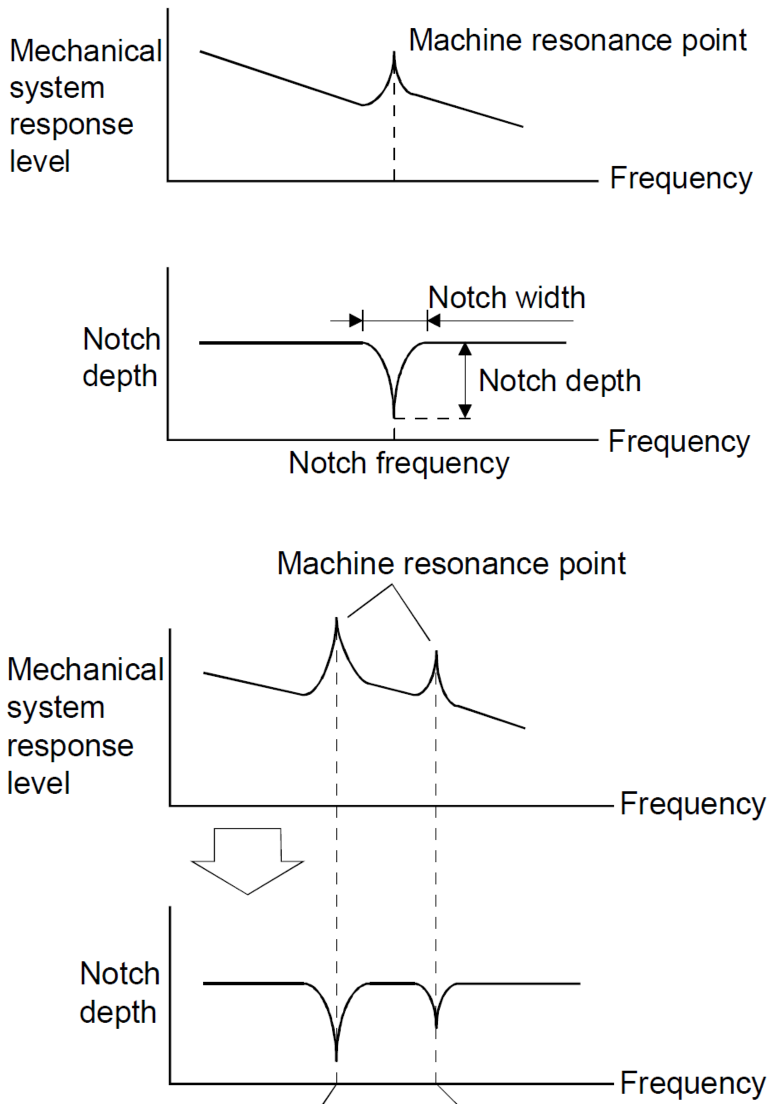
- RSWare : Drive – Initial Current Bias
- Initial torque value applied when the servo drive is activated. This is to keep the vertical axis load.

0x240D	1st Resonant Frequency Suppression Filter					ALL	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~10000	2 byte(UINT)	Hz	RW	-	Always	10000	Ft-4.13

- RSWare : Drive - Tuning - Main Current Regulator Gains - 1st Resonant Frequency Suppression Filter
- CSD7 servo drive provide three notch filters to remove resonance.
- If the notch filters are set automatically using off-line tuning function or ANF function, the 1st notch filter – the 2nd notch filter – the 3rd notch filter are set automatically in order of influential frequency of system resonance. If a frequency that has a greater influence compared to the frequency set in the existing three resonance filters is detected, the resonance filters with the lowest influence among the three filters are automatically set to the newly detected frequency.

▶ Each of the three notch filters consists of three parameters.

▶ A cut-off frequency of notch filter is set the median value of the filter frequency, a width and a depth is defined as shown in the figure below.



0x240E	1st Resonant Frequency Suppression Filter Width					ALL	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
1~20	1 byte(USINT)	-	RW	-	Always	10	Ft-4.14

▶ RSWare : Drive - Tuning - Main Current Regulator Gains - 1st Resonant Frequency Suppression Filter Width

▶ Refer to the explanation of 0x240D (Ft-4.13).

▶ This parameter sets the width of the resonance cut filter.

The width can be set in 20 steps. The higher the setting, the more resonant frequency range is applied, but the system may become unstable.

0x240F	1st Resonant Frequency Suppression Filter Depth					ALL	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~100	1 byte(USINT)	-	RW	-	Always	100	Ft-4.15

- RSWare : Drive - Tuning - Main Current Regulator Gains - 1st Resonant Frequency Suppression Filter Depth
- This parameter sets the depth of resonance cut filter. The higher the value is set, the better the resonance of the applied frequency band can be supressed, but the system may become unstable in the low frequency band below 500Hz.
- In the case of a belt load or a rigid load less than 500Hz, if the value is set to '70' or less, resonance of the corresponding band can be effectively supressed.

0x2410	2nd Resonant Frequency Suppression Filter					ALL	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~10000	2 byte(UINT)	Hz	RW	-	Always	10000	Ft-4.16

- RSWare : Drive - Tuning - Main Current Regulator Gains – 2nd Resonant Frequency Suppression Filter
- Refer to the explanation of 0x240D (Ft-4.13).
- This parameter sets the frequency of the 2nd resonance cut filter. Use offline offline tuning or real time resonance frequency detection function (ANF) to set the related frequency.

0x2411	2nd Resonant Frequency Suppression Filter Width					ALL	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
1~20	1 byte(USINT)	-	RW	-	Always	10	Ft-4.17

- RSWare : Drive - Tuning - Main Current Regulator Gains – 2nd Resonant Frequency Suppression Filter Width
- Refer to the explanation of 0x240D (Ft-4.13).
- This parameter sets the width of the 2nd resonance cutoff filter.

0x2412	2nd Resonant Frequency Suppression Filter Depth					ALL	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~100	1 byte(USINT)	-	RW	-	Always	100	Ft-4.18

- RSWare : Drive - Tuning - Main Current Regulator Gains – 2nd Resonant Frequency Suppression Filter Depth
- Refer to the explanation of 0x240D (Ft-4.13).
- This parameter sets the depth of the 2nd resonance cutoff filter.

0x2413	3rd Resonant Frequency Suppression Filter					ALL	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~10000	2 byte(UINT)	Hz	RW	-	Always	10000	Ft-4.19

- ▶ RSWare : Drive - Tuning - Main Current Regulator Gains – 3rd Resonant Frequency Suppression Filter
- ▶ Refer to the explanation of 0x240D (Ft-4.13).
- ▶ This parameter sets the frequency of the 3rd resonance cut filter. Use offline offline tuning or real time resonance frequency detection function (ANF) to set the related frequency.

0x2414	3rd Resonant Frequency Suppression Filter Width					ALL	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
1~20	1 byte(USINT)	-	RW	-	Always	10	Ft-4.20

- ▶ RSWare : Drive - Tuning - Main Current Regulator Gains – 3rd Resonant Frequency Suppression Filter Width
- ▶ Refer to the explanation of 0x240D (Ft-4.13).
- ▶ This parameter sets the width of the 3rd resonance cutoff filter.

0x2415	3rd Resonant Frequency Suppression Filter Depth					ALL	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~100	1 byte(USINT)	-	RW	-	Always	100	Ft-4.21

- ▶ RSWare : Drive - Tuning - Main Current Regulator Gains – 3rd Resonant Frequency Suppression Filter Depth
- ▶ Refer to the explanation of 0x240D (Ft-4.13).
- ▶ This parameter sets the depth of the 3rd resonance cutoff filter.

0x2416	Adaptive Notch Filter (ANF) Setting					ALL	
Sub-Index 0	Number of Entries						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	2 byte(UINT)	-	RO	-	-	4	Ft-4.22
Sub-Index 1	ANF Function						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~1	1 byte(USINT)	-	RW	-	Servo Off	0	Ft-4.22[D0]
Sub-Index 2	ANF HPF Cutoff Frequency						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~1	1 byte(USINT)	-	RW	-	Servo Off	1	Ft-4.22[D1]
Sub-Index 3	ANF Estimation Frequency Initial Value						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~1	1 byte(USINT)	-	RW	-	Servo Off	1	Ft-4.22[D2]

Sub-Index 4	ANF Detect Level						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~2	1 byte(USINT)	-	RW	-	Servo Off	1	Ft-4.22[D3]

▶ SWare : Drive - Resonant Suppression - Adaptive Notch Filter Setting

Sub-Index 1 **Ft-4.22[D0]**	**ANF Function** **RSWare : Adaptive Notch Filter(ANF) Setting - ANF Function**		
Range	Value	Description	Name in RSWare
	0	Disable ANF feature	Disable
	1	Enable ANF feature	Enable
Sub-Index 2 **Ft-4.22[D1]**	**ANF HPF Cutoff Frequency** **RSWare : Adaptive Notch Filter(ANF) Setting - ANF HPF Cutoff Frequency**		
Range	Value	Description	Name in RSWare
	0	Applied to systems with low resonance frequency such as Belt system (100Hz)	Low
	1	Applied to systems with high resonance frequency such as Ball Screw system (500Hz)	High
Sub-Index 3 **Ft-4.22[D2]**	**ANF Estimation Frequency Initial Value** **RSWare : Adaptive Notch Filter(ANF) Setting - ANF Estimation Frequency Initial Value Selection**		
Range	Value	Description	Name in RSWare
	0	Applied to systems with low resonance frequency such as Belt system (300Hz)	Low
	1	Applied to systems with high resonance frequency such as Ball Screw system (800Hz)	High
Sub-Index 4 **Ft-4.22[D3]**	**ANF Detect Level** **RSWare : Adaptive Notch Filter(ANF) Setting - ANF Detect Level**		
Range	Value	Description	Name in RSWare
	0	Reduce the level of resonant frequency detection, and use it when resonance is present but frequency is not detectable	Low
	1	Mid-level resonant frequency detection	Middle
	2	Applied when resonance is not detected well	High

0x2417	**RMS Current Load Factor Cumulative Time Setting**					**ALL**	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~60	2 byte(UINT)	sec	RW	-	Servo off	10	Ft-4.23

▶ RSWare : Drive - RMS Current Load Factor Function - RMS Current Load Factor Cumulative Time Setting

▶ It set the time window size to calculate the Average Torque Load Factor and Maximum Torque Load Factor.

0x2418	RMS Current Load Factor Threshold Setting 1					ALL	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~350.000	4 byte(UDINT)	%	RW	-	Servo off	350.000	Ft-4.24

- ▶ RSWare : Drive - RMS Current Load Factor Function - RMS Current Load Factor Threshold Setting 1
- ▶ It set the threshold value 1 of average torque load factor.

0x2419	RMS Current Load Factor Threshold Setting 2					ALL	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~350.000	4 byte(UDINT)	%	RW	-	Servo off	350.000	Ft-4.25

- ▶ RSWare : Drive - RMS Current Load Factor Function - RMS Current Load Factor Threshold Setting 2
- ▶ It set the threshold value 2 of average torque load factor.

0x241B	Current Command LPF Bandwidth (Tuningless)					ALL	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~10000	2 byte(UINT)	Hz	RW	-	Always	1146	Ft-4.27

- ▶ RSWare : Drive – Tuningless – Main Current Regulator Gains - Current Command LPF Bandwidth(Tuningless)
- ▶ Parameter for setting the Current Command filter bandwidth used only in Tuningless.

0x241C	Current Command LPF Bandwidth Interlocking					ALL	
Sub-Index 0	Number of Entries						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	2 byte(UINT)	-	RO	-	-	4	Ft-4.28
Sub-Index 1	1st Current Command LPF Bandwidth Interlocking(Gain Tuning)						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~1	1 byte(USINT)	-	RW	-	Always	0	Ft-4.28[D0]
Sub-Index 2	Current Command LPF Bandwidth Interlocking(Tuningless)						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~1	1 byte(USINT)	-	RW	-	Always	0	Ft-4.28[D1]
Sub-Index 3	Current Command Feedforward						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~1	1 byte(USINT)	-	RW	-	Always	0	Ft-4.28[D2]
Sub-Index 4	Reserved						

Sub-Index 1 **Ft-4.28[D0]**	1st Current Command LPF Bandwidth Interlocking(Gain Tuning) **RSWare : Tuning – Main Current Regulator Gains – 1st Current Command LPF Bandwidth Interlocking(Gain Tuning)**		
Range	Value	Description	Name in RSWare
	0	1st Current Command Filter Bandwidth value change interlocked	Enable
	1	1st Current Command Filter Bandwidth value change Not interlocked	Disable
Sub-Index 2 **Ft-4.28[D1]**	Current Command LPF Bandwidth Interlocking(Tuningless) **RSWare : Tuningless – Main Current Regulator Gains – Current Command LPF Bandwidth Interlocking(Tuningless)**		
Range	Value	Description	Name in RSWare
	0	Current Command Filter Bandwidth value change interlocked	Enable
	1	Current Command Filter Bandwidth value change Not interlocked	Disable
Sub-Index 3 **Ft-4.28[D2]**	Current Command Feedforward **RSWare : Tuningless – Main Current Regulator Gains – Current Command Feedforward**		
Range	Value	Description	Name in RSWare
	0	Disable Torque Command Feedforward	Disable
	1	Enable Torque Command Feedforward	Enable

0x2423	**Main Current Regulator Max Bandwidth**					**ALL**	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~100	1 byte(USINT)	%	RW	-	Always	0	Ft-4.35

▶ If the setting value is "0", it is according to the setting value of the existing Ft-4.06

▶ If the set value is not "0", the maximum current Bandwidth is set to%.

Standard Group 5

0x2500	Brake Inactive Delay					ALL	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~10000	2 byte(UINT)	msec	RW	-	Servo off	0	Ft-5.00

- ▶ RSWare : Drive - Stopping Functions - Brake Inactive Delay
- ▶ It set the delay time from servo on to brake release.

0x2501	Disable Delay					ALL	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~10000	2 byte(UINT)	msec	RW	-	Servo off	0	Ft-5.01

- ▶ RSWare : Drive - Stopping Functions - Disable Delay
- ▶ It set the delay time of actual servo-off after the motor brake is activated.

0x2502	Brake Active Delay					ALL	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~10000	2 byte(UINT)	msec	RW	-	Servo off	500	Ft-5.02

- ▶ RSWare : Drive - Stopping Functions - Brake Active Delay
- ▶ It set the delay time of brake operation after servo-off.

0x2503	Braking Application Velocity					ALL	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~1000	2 byte(UINT)	rpm	RW	-	Servo off	100	Ft-5.03

- ▶ RSWare : Drive - Stopping Functions - Braking Application Velocity
- ▶ It set the threshold motor speed to operate motor brake after servo-off.

0x2504	AC Line Loss Fault Delay					ALL	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
20~2000	2 byte(UINT)	msec	RW	-	Servo off	20	Ft-5.04

- ▶ RSWare : Drive - Faults - AC Line Loss Fault Delay
- ▶ It set the delay time prior to making an fault when momentary power failure occurs.

0x2509	Motor Overload Method Selection					ALL	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no

0~1	1 byte(USINT)	msec	RW	-	Servo off	0	Ft-5.09

- RSWare : Drive - Motor - Motor Overload Method Selection
- Motor Overload Detection Method Selection

Value	Description	Name in RSWware
0	Thermal Model Method	Thermal Model Method
1	I Square T Method	I Square T Method

0x250B	**Power Sag Warning Enable**					**ALL**	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~1	1 byte(USINT)	-	RW	-	Always	0	Ft-5.11

- RSWare : Drive - Current Limits – Power Sag Warning Enable
- To select whether to use SAG function when main power is cut off.

Value	Description	Name in RSWware
0	Not used	Disable
1	Used	Enable

0x250C	**Power Sag Current Limit**					**ALL**	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~450	2 byte(UINT)	%	RW	-	Always	50	Ft-5.12

- RSWare : Drive - Current Limits – Power Sag Current limit
- Torque limit Value while SAG function is working

0x250D	**Power Sag Current Limit Release Time**					**ALL**	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~3000	2 byte(UINT)	msec	RW	-	Always	100	Ft-5.13

- RSWare : Drive - Current Limits – Power Sag Current limit Release Time
- Duration time of torque limit while SAG function is working

0x250E	**ECAT Abs Origin Offset**					**ALL**	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-2147483647 ~ 2147483647	4 byte(DINT)	pulse	RW	-	Always	0	Ft-5.14

- RSWare : Drive – ECAT Homing – ECAT Abs Origin Offset
- After homing, set the difference value between absolute motor feedback value and home setting value (0x2511, 0x607C).

▶ To maintain the origin coordinate after power cycling using an absolute motor, save the ECAT Abs Origin Offset (0x250E).

0x250F	**ECAT Homing Method**						**ALL**
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-128~127	1 byte(SINT)	-	RW	-	Always	0	Ft-5.15

▶ RSWare : Drive – ECAT Homing – ECAT Homing Method

▶ Set the homing method in the CiA402 specification. Used with 0x6098 (Homing Method).

0x2510	**ECAT Homing Timeout**						**ALL**
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~500	2 byte(INT)	sec	RW	-	Always	0	Ft-5.16

▶ RSWare : Drive – ECAT Homing – ECAT Homing Timeout

▶ Setting homing timeout. If the set homing time is exceeded, Homing Error occurs. The type of origin error can be checked from 0x2A40 (ECAT Homing Error) and it is possible to check whether the homing error occurs in Bit 13 of the status word (0x6041).

0x2511	**ECAT Homing Offset**						**ALL**
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-2147483647 ~ 2147483647	4 byte(DINT)	pulse	RW	-	Always	0	Ft-5.17

▶ RSWare : Drive – ECAT Homing – ECAT Homing Offset

▶ Set the position value of home to be used after home return completion. Used with 0x607C (Home Offset).

0x2512	**ECAT Homing Velocity 1**						**ALL**
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~2147483647	4 byte(DINT)	pps	RW	-	Always	200000	Ft-5.18

▶ RSWare : Drive – ECAT Homing – ECAT Homing Velocity 1

▶ It is the velocity used when searching for the position such as limit switch at homing operation start. Used with Speed for Switch(0x6099: 1).

0x2513	**ECAT Homing Velocity 2**						**ALL**
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~2147483647	4 byte(DINT)	pps	RW	-	Always	200000	Ft-5.19

▶ RSWare : Drive – ECAT Homing – ECAT Homing Velocity 2

▶ This is the speed used when searching for the final position at the completion of homing. Used with Speed for Zero(0x6099: 2).

0x2514	**ECAT Homing Acceleration**					**ALL**	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~2147483647	4 byte(DINT)	pps^2	RW	-	Always	-	Ft-5.20

▶ RSWare : Drive – ECAT Homing – ECAT Homing Acceleration

▶ Acceleration / deceleration setting used when homing. Used with 0x609A (Homing Acceleration).

0x2415	**Linear Function**					**ALL**	
Sub-Index 0	Number of Entries						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	2 byte(UINT)	-	RO	-	-	4	Ft-5.21
Sub-Index 1	Converter EEPROM Write Enable						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~1	1 byte(USINT)	-	RW	-	Servo Off	0	Ft-5.21[D0]
Sub-Index 2	Angle Search Current Command Slope						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~4	1 byte(USINT)	-	RW	-	Servo Off	3	Ft-5.21[D1]
Sub-Index 3	Angle Search Moving Count						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~6	1 byte(USINT)	-	RW	-	Servo Off	2	Ft-5.21[D2]
Sub-Index 4	BiSS Commutation Angle Search Enable						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~1	1 byte(USINT)	-	RW	-	Servo Off	0	Ft-5.21[D3]

Sub-Index 1 **Ft-5.21[D0]**	**Converter EEPROM Write Enable** **RSWare : Drive -Linear Motor Setup - Converter EEPROM Write Enable**		
Range	Value	Description	Name in RSWare
	0	Serial converter EEPROM write disabled	Disable
	1	Serial converter EEPROM write enabled	Enable
Sub-Index 2 **Ft-5.21[D1]**	**Angle Search Current Command Slope** **RSWare : Drive -Linear Motor Setup –Hall Sensorless Angle Search Setting - Angle Search Current Command Slope**		
Range	Value	Description	Name in RSWare
	0	Current Command rise time, 100ms	Slope Level 4(Rapid)
	1	Current Command rise time, 200ms	Slope Level 3
	2	Current Command rise time, 300ms	Slope Level 2
	3	Current Command rise time, 440ms	Slope Level 1
	4	Current Command rise time, 580ms	Slope Level 0(Gentle)

Sub-Index 3 Ft-5.21[D2]	**Angle Search Moving Count** **RSWare : Drive -Linear Motor Setup –Hall Sensorless Angle Search Setting - Angle Search Moving Count**		
Range	Value	Description	Name in RSWare
	2	To find the electrical angle of the 'Hall sensorless linear motor', it is the number of driving times.	2
Sub-Index 4 **Ft-5.21[D3]**	**BiSS Commutation Angle Search Enable** **RSWare : Drive -Linear Motor Setup – BiSS Commutation Angle Search Enable**		
Range	Value	Description	Name in RSWare
	0	Disable BiSS electrical angle detection	Disable
	1	Enable BiSS electrical angle detection	Enable

0x2516	**Encoder Feedback Forward Direction**					**ALL**	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~1	2 byte(UINT)		RW	-	Power Cycling	0	Ft-5.22

- RSWare : Drive – Linear Motor Setup – Encoder Feedback Forward Direction
- Setting the direction of the encoder installed on the linear motor.
- If the Counter electromotive force' appears in the order of U - V - W when moving forward, A Leads B can be set and used.

Value	Description	Name in RSWare
0	The order of U - V - W when moving forward	A Leads B
1	The order of U - W - V when moving forward	B Leads A

0x2517	**Angle Search Current Command Ratio**					**ALL**	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~100	2 byte (UINT)	%	RW	-	Servo Off	70	Ft-5.23

- RSWare : Drive – Linear Motor Setup –Hall Sensorless Angle Search Setting - Angle Search Current Command Ratio
- When using 'Hall sensorless linear motor', you can set the maximum size of current command used in commutation angle detection operation.
- A value between 50% and 100% of the motor rated current is recommended.

0x2518	**External Shunt Resistance**					**ALL**	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~1000	2 byte(UINT)	Ohm	RW	-	Servo Off	0	Ft-5.24

- RSWare : Drive – Shunt Resistor – External Shunt Resistance
- When removing internal shunt resister, set the value of resistance when connecting external shunt resister

0x2519	External Shunt Resistor Power Rate					ALL	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~5000	2 byte(UINT)	W	RW	-	Servo Off	0	Ft-5.25

- RSWare : Drive – Shunt Resistor – External Shunt Resistor Power Rate
- Set the rated capacity of the external shunt resister.The rated capacity set determines the load characteristics of the regenerative circuit used.
- If it is set too small than the capacity of the actual used resistor, E.75 may occur quickly.
- If set to the 100% rated capacity of the used resistor, the temperature of the shunt resistor may rise so high that the resistor may be damaged or the risk of burning may occur. Therefore, set the 50% rating of the used resistor to the maximum value.

0x251A	STO Circuit Verification Mode					ALL	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~1	1 byte(USINT)		RW	-	Servo Off	0	Ft-5.26

- RSWare : Drive –Auxiliary Function Selection 1 – STO Circuit Verification Mode
- If set to "Enable", it is possible to verify whether the STO circuit is defective by not generating STO alarm even if STO input is on.

0x251E	PWM Switching Frequency					ALL	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~1	2 byte(UINT)			-	Always	0	Ft-5.30

- PWM switching frequency selectable at 8 kHz (initial value, 0) and 16 kHz (1)RSWare : Drive –Auxiliary Function Selection 1 – STO Circuit Verification Mode
- After changing and saving PWM Switching Frequency (Ft-5.30), Power Cycle must be executed to apply
- When the PWM frequency is changed, the related gains are applied synchronously with the drive internally.
- Applies only to motors of 800W or less. E.110 occurs when applied to motors over 800W.
- Only BS and BT Serial Encoder can operate at 10kHz.
- For 17 Bit Serial Encoder (BR, BQ), E.110 occurs when setting 10kHz.

Error Name	Error Code(Built In)	Error Code (EtherCAT)
Not Support ID	E.110(noEId)	0xFF6E

0x251F	BiSS Commutation Angle Value					ALL	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~359	4 byte(UDINT)	degree		-	Servo Off	0	Ft-5.31

0x2520	BiSS Master Clock Frequency					ALL	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~4	4 byte(UDINT)		RW	-	Servo Off	0	Ft-5.32

Value	Description	Name in RSWare
0	1.25 MHz	1.25 MHz
1	1.425871 MHz	1.425871 MHz
2	1.666667 MHz	1.666667 MHz
3	2.0 MHz	2.0 MHz
4	2.5 MHz	2.5 MHz

Monitor mode objects

The various variables that are used in servo drive can be observed through the objects as shown in table below. These variables also can be observed at built-in monitor mode in a form of 'dis-xx'. For more information about built-in monitor mode, refer to "Monitor Mode" on page 4-12.

0x2A00	Velocity feedback					ALL	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	dis-no
-	4 byte(DINT)	rpm(mm/s)	RO	-	Always	-	dis-00

▶ It indicates a velocity feedback.

▶ When using Built-in mode

Display No.	Description [Unit]
dIS-00	Actual velocity [rpm or mm/sec]

0x2A01	Velocity Command					ALL	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	dis-no
-	4 byte(DINT)	rpm(mm/s)	RO	-	Always	-	dis-01

▶ It indicates a velocity command.

▶ When using Built-in mode

Display No.	Description [Unit]
dIS-01	Velocity command [rpm or mm/sec]

0x2A02	Velocity Error					ALL	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	dis-no
-	4 byte(DINT)	rpm(mm/s)	RO	-	Always	-	dis-02

▶ It indicates a velocity error.

▶ When using Built-in mode

Display No.	Description [Unit]
dIS-02	Velocity error [rpm or mm/sec]

0x2A08	Commutation Angle					ALL	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	dis-no
-	4 byte(DINT)	°	RO	-	Always	-	dis-08

▶ It indicates a electronic angle.

▶ When using Built-in mode

Display No.	Description [Unit]
dIS-08	Electrical Angle [°]

0x2A09	Mechanical angle					ALL	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	dis-no
-	4 byte(DINT)	°	RO	-	Always	-	dis-09

▶ It indicates a mechanical angle.

▶ When using Built-in mode

Display No.	Description [Unit]
dIS-09	Mechanical angle [°]

0x2A0A	Regeneration load ratio					ALL	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	dis-no
-	4 byte(DINT)	%	RO	-	Always	-	dis-10

▶ It indicates an accumulated load rate of regenerative resistor.

▶ When using Built-in mode

Display No.	Description [Unit]
dIS-10	Accumulated load rate of regenerative resistor [%]

0x2A0C	Multi-turn data					ALL	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	dis-no
-	4 byte(DINT)	-	RO	-	Always	-	dis-12

▶ It indicates the number of rotation of absolute encoder

▶ When using Built-in mode

Display No.	Description [Unit]
dIS-12	The number of rotation of absolute encoder

0x2A10	U phase current					ALL	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	dis-no
-	4 byte(DINT)	0.001A	RO	-	Always	-	-

▶ It indicates U-phase current.

0x2A11	V phase current					ALL	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	dis-no
-	4 byte(DINT)	0.001A	RO	-	Always	-	-

▶ It indicates V-phase current.

0x2A12	**W phase current**					**ALL**	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	dis-no
-	4 byte(DINT)	0.001A	RO	-	Always	-	-

▶ It indicates W-phase current.

0x2A13	**Motor Utilization**					**ALL**	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	dis-no
-	4 byte(DINT)	%	RO	-	Always	-	-

▶ It indicates a load factor of motor.

0x2A1B	**Instantaneous Shunt Power**					**ALL**	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	dis-no
-	4 byte(DINT)	%	RO	-	Always	-	-

▶ It indicates a real-time regenerative power value.

0x2A1C	**Drive Utilization**					**ALL**	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	dis-no
-	4 byte(DINT)	%	RO	-	Always	-	-

▶ It indicates a load factor of servo drive.

0x2A1F	**FPGA version**					**ALL**	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	dis-no
-	4 byte(DINT)	-	RO	-	Always	-	-

▶ It indicates FPGA version used in servo drive.

0x2A22	**Absolute Single Turn Data**					**ALL**	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	dis-no
-	4 byte(DINT)	pulse	RO	-	Always	-	dis-22

▶ It indicates a single turn data of absolute encoder.

0x2A23	**Absolute Maximum Current Command**					**ALL**	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	dis-no
-	4 byte(DINT)	%	RO	-	Always	-	dis-24

▶ It indicates the absolute data of maximum current command.

0x2A24	Power Time Hour					ALL	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	dis-no
-	4 byte(DINT)	hour	RO	-	Always	-	-

▶ It indicates 'Hour' of the total operating time after shipment.

▶ For example, 1234 means 1234 hours.

0x2A25	Power Time Min Sec					ALL	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	dis-no
-	4 byte(DINT)	min, sec	RO	-	Always	-	-

▶ It indicates 'minute' and 'second' of the total operating time after shipment.

▶ For example, 1234 means 12 minute and 34 second.

0x2A2B	EtherCAT Version					ALL	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	dis-no
-	4 byte(DINT)	-	RO	-	Always	-	dis-30

▶ It indicates EtherCAT FPGA version used in servo drive.

0x2A2C	Current Load Factor(RMS)					ALL	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	dis-no
-	4 byte(DINT)	%	RO	-	Always	-	dis-31

▶ It indicates EtherCAT FPGA version used in servo drive.

0x2A2D	Current Peak Load Factor(RMS)					ALL	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	dis-no
-	4 byte(DINT)	%	RO	-	Always	-	dis-32

▶ It indicates EtherCAT FPGA version used in servo drive.

0x2A3B	ABSS Data					ALL	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	dis-no
-	4 byte(DINT)	-	RO	-	Always	-	-

▶ Displays the total bit value of the linear motor encoder.

0x2A3C	ABSA Data					ALL	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	dis-no
-	4 byte(DINT)	-	RO	-	Always	-	-

▶ Linear Motor Displays the distance between each revolution.

0x2A3D	Conv Hall Data					ALL	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	dis-no
-	4byts(DINT)	-	RO	-	Always	-	-

▶ Displays the Hall information coming from the serial converter.

0x2A3E	Conv Alarm Data					ALL	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	dis-no
-	4byts(DINT)	-	RO	-	Always	-	-

▶ Displays the alarm coming in from the serial converter.

0x2A3F	ECAT Homing Status					ALL	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	dis-no
-	4byts(DINT)	-	RO	-	Always	-	-

▶ Displays the homing status.

ECAT Homing Status	RSWare Name
0	IDLE
1 ~ 28	PROCESSING
30	HOMING FAIL
29, 31	HOMING SUCCESS
기타	RESERVED

0x2A40	ECAT Homing Error					ALL	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	dis-no
-	4byts(DINT)	-	RO	-	Always	-	-

▶ Displays an error that occurs when homing.

Table 81 Homing Error Code

Error Code	Name	Description
0	HM_NO_ERROR	No Error
1	HM_SERVO_OFF	Occurs at the start of homing from Servo Off state
2	HM_POT_NOT	POT and NOT Sensor occur at the same time
3	HM_SWITCH	Occurs when unused Limit switch is operated Home sensor and POT or NOT sensor occur at the same time
4	HM_TIME_OUT	Occurs when timeout time set in 0x2510
5	HM_NOT_OP	Occurs when EtherCAT communication status is not Operation Mode
6	HM_NOT_SUPPORT	Occurs when an unsupported homing mode is set.
7	HM_CHECK_CONDITION	Occurs when Origin Velocity 1 and 2 are less than 1/60 rps or the

Error Code	Name	Description
		origin acceleration is less than 1 rps ^ 2 Velocity is 'pulse / sec' and acceleration is 'pulse / sec ^ 2' unit. However, note that 'rps' and 'rps ^ 2' values change according to encoder resolution.
8	HM_SERVO_ERROR	Servo error occurred during home

0x2A49	OS Version					ALL	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	dis-no
-	String(12)	-	RO	-	Always	-	-

▶ Display OS version

0x2A4A	Product Revision					ALL	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	dis-no
-	String(12)	-	RO	-	Always	-	-

▶ Display Revision(A, B,...)

0x2A4B	Product Type					ALL	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	dis-no
-	String(12)	-	RO	-	Always	-	-

▶ Displays the product type of servo drive. (Analog or Network)

0x2F00	Servo Warning					ALL	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	dis-no
-	4byts(UDINT)	-	RO	-	Always	-	-

▶ RSWare : Drive - Faults – Status

▶ Displays the status of the warning generated by the servo drive.

0x2F01 ~ 0x2F08	Fault History #1 ~ Fault History #8					ALL	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	dis-no
-	String(24)	-	RO	-	Always	-	-

▶ Save and display 8 alarm history from servo drive.

▶ The most recent alarm is stored in # 1.

Operation mode objects

Following objects are describe operation mode function provided in servo drive. Each of operation mode functions also can be used at built-in operation mode in a form of 'run-xx'. For more information about the operation mode, refer to "Operation Mode Function" on page 9-36.

0x3001	**Off-line Auto Tuning**					**CSP**	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	run mode
-	1 byte(USINT)	-	RW	-	-	-	run-01

- ▶ It perform off-line auto tuning.
- ▶ When using Built-in mode

run-#	**Description**
run-01	Off-line auto tuning

0x3009	**Fault History Clear**					**ALL**	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	run mode
-	1 byte(USINT)	-	RW	-	-	-	-

- ▶ It removes the whole fault history that are stored in servo drive internal memory.

0x300A	**Absolute Encoder Data Reset**					**ALL**	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	run mode
-	1 byte(USINT)	-	RW	-	-	-	run-10

- ▶ It reset the data of the absolute encoder.
- ▶ When using Built-in mode

run-#	**Description**
run-10	Absolute Encoder Data Reset

0x3010	**Drive Reboot**					**ALL**	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	run mode
-	1 byte(USINT)	-	RW	-	-	-	-

- ▶ It reboots the servo drive. This function has the same effect as power cycling.

Setting Objects

The following objects describe the list of related objects due to feature changes and additions.

0x5030	Forced Homing Flag					ALL	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	run mode
-	2 byte(UINT)	-	RW	Yes	-	0	

- ▶ The controller can set whether to complete the drive homing using the corresponding object.
- ▶ The corresponding object value is not stored in Flash, and an encoder related alarm is generated or set to '0' when power cycling.
- ▶ The value of status word (0x6041) bit 14 is changed according to the value of the corresponding object (0x5030) and transmitted to the controller.
- ▶ If the value of the corresponding object is '0', the status word Bit14 is '0'. If it is not '0', the status word Bit14 is set to '1'.

0x5040	Home Current					ALL	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	run mode
1 ~ 250	2 byte(UINT)	-	RW	Yes	-	100	

- ▶ RSWare : Drive – ECAT Homing – Home Current
- ▶ This parameter is used to set home stop as stopper.
- ▶ When homing to the home position, the home position is set when the current above the value set in 0x5040 (Home Current) is kept at the specified time in 0x5041 (Home Current Time).

0x5041	Home Current Time					ALL	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	run mode
0 ~ 1000	2 byte(UINT)	msec	RW	Yes	-	0	

- ▶ RSWare : Drive – ECAT Homing – Home Current Time
- ▶ This parameter is used to set home stop as stopper.
- ▶ When homing to the home position, the home position is set when the current above the value set in 0x5040 (Home Current) is kept at the specified time in 0x5041 (Home Current Time).

CIA402 Objects

This section describes the CiA402 drive profiles that are supported by CSD7 series.

0x603F	Error Code					ALL	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	2 byte(UINT)	-	RO	TxPDO	-	-	-

- Indicate alarm/warning codes that occurred at the last in servo drives.
- The CSD7 error codes are recorded in 0xFF00 - 0xFFFF, the manufacturer-specific area.
- Each lower 16 bit in 0xFF00 - 0xFFFF indicates the main number of error indication number. For more information about the meaning of lower 16 bit, see Internal Code in the 'Table 112 Servo Fault Cause and Countermeasures' at page 10-6.

Index	Name	Data Type	Descrition of Error code
0x603F	Error Code	UINT	0x0000 : No error 0x0001 ~ 0x8FFF: CiA402 IEC61800_184 defined. 0xFF01 : Main number 1 of error indication number 0xFF02 : Main number 2 of error indication number 0xFFFF : Main number 256 of error indication number Others : Reserved

- Depending on the firmware version of the servo drive, the error number displayed on 0x603F is as follows.

Table 82 Servo drive product Fault/Error code

Servo Drive Fault code	text	Error Code	
		F/W Ver1.xx	F / W Ver2.xx or higher
E.005, IPM Fault	E.IPMFt	0x5400	0xFF05
E.006, FAN Fault	E.FAn	0x3330	0xFF06
E.009, DC Bus Low-voltage	E.UdvtG	0x3220	0xFF09
E.010, BUS Over Voltage	E.ovvtG	0x3211	0xFF0A
E.012, Failed searching for the starting point	E.HFAIL	-	0xFF0C
E.018, Motor Over-speed	E.ovSPd	0x8400	0xFF12
E.019, Position Error Limit Exceeded	E.PoSEr	0x8611	0xFF13
E.022, Continuous Current Overload of Motor	E.ConoL	0x2310	0xFF16
E.023, Drive Overload	E.drvoL	0x2220	0xFF17
E.028, Encoder multi-turn counter overflow	E.MtCoF	0x7300	0xFF1C
E.030, Encoder Cable Open	E.EnCoP	0x7306	0xFF1E
E.031, Encoder Data Parameter Error	E.EnCPE	0x5530	0xFF1F
E.036, Drive Overheat	E.drVot	0x4210	0xFF24
E.037, AC line Loss	E.ACoFF	0x3130	0xFF25
E.039, Serial converter abnormality	E.SCNEr	-	0xFF27

E.040, Polarity detection error	E.AngLE	-	0xFF28
E.041, Resolution discordance on serial converter	E.SCnrM	-	0xFF29
E.042, Abnormal single-turn data of serial converter	E.SCNSr	-	0xFF2A
E.043, Abnormal Hall signal of linear motor	E.HALEr	-	0xFF2B
E.044, Abnormal motor data	E.SAnSS	-	0xFF2C
E.053, User Parameter Initialization Error	E.PInIt	0x5520	0xFF35
E.054, Current Feedback Offset	E.oFSEt	0x7300	0xFF36
E.055, User Parameter Checksum Error	E.CHSUM	0x6310	0xFF37
E.056, Watchdog Timeout	E.CPUFt	0x6010	0xFF38
E.057, PWM Hardware Error	E.HWArE	0x5410	0xFF39
E.058, User Parameter Range Error	E.rAnGE	0x6320	0xFF3A
E.060, Drive Initialization Error	E.dInIt	0x7120	0xFF3C
E.075, Regenerative Overload Protection	E.SHtoL	0x3212	0xFF4B
E.079, Regenerative Over Current Protection	E.SHtoC	0x2211	0xFF4F
E.083, Low Battery Error of Absolute Encoder	E.rAnGE	0x6320	0xFF53
E.084, Absolute Encoder Over Speed	E.AbSoS	0x7310	0xFF54
E.085, Absolute Encoder Multi-turn Count Error	E.MtCEr	0x7300	0xFF55
E.100, Product installation error	E.SEtUP	-	0xFF64
E.101, Motor Power Cable Open	E.CAbLE	0x7122	0xFF65
E.102, Motor instantaneous current overload	E.InSoL	0x8331	0xFF66
E.103, Motor Mismatch Fault	E.MAtCH	0x6320	0xFF67
E.106, Encoder Communication Error	E.EnCCE	0x7300	0xFF6A
E.107, Serial Communication Error	E.SErCE	0x7510	0xFF6B
E.109, Abnomal setting of external regenerative resistor.	E.SHSEt	-	0xFF6D
E.110, Not supported setting	E.noEld	-	0xFF6E
E.111, Safety Torque Off Input Error	E.StoIn	0x7121	0xFF6F
E.112, Emergency Stop	E.EStoP	0x5220	0xFF70
E.114, Motor Phase Over current	E.ovCUr	0x5210	0xFF72
E.116, Load discordance	E.LdMIS	-	0xFF74
E.117, Resonance over	E.ESvrS	-	0xFF75
E.118, Velocity error of linear motor over	E.vELEr	-	0xFF76
E.200, Sync error	E.noSYn	0xFF90	0xFFC8
E.201, Sync signal error	E.SYnCH	0xFF91	0xFFC9
E.202, DC PLL sync error	E.dCPLL	0xFF92	0xFFCA
E.203, Sync watchdog error	E.SMWtd	0xFF93	0xFFCB
E.204, PDO mapping error	E.IoMAP	0xFF94	0xFFCC
E.205, Non-supported operation mode	E.oPMod	0xFF95	0xFFCD
E.206, EtherCAT CoE Error	E.EtCFG	-	0xFFCE
E.207, EtherCAT CoE error	E.EtCoE	0xFF97	0xFFCF

E.208, EtherCAT FoE error	E.EtFoE	0xFF98	0xFFD0
E.209, PDO mapping discordance	E.EtPdp	-	0xFFD1

0x6040	**Control word**					**ALL**	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	2 byte(UINT)	-	RW	RxPDO	-	-	-

- This object controls the state machine of the servo drive.
- Definition of Set Value

Table 83 Control word Set Value

Bit	Name	Description
0	Switch on	These bits control the state. Quick Stop is not supported. For more information, see "State Machine Control Command" at the page 6-3.
1	Enable voltage	
2	Quick stop	
3	Enable operation	
4~6	Operation mode specific	The bits are specific to each operation mode. They are not used in the Cyclic Synchronous Position mode
7	Fault reset	Faults/Warnings are reset when this bit is active.
8	Halt	They are not used in the Cyclic Synchronous Position mode
9	Operation mode specific	They are not used in the Cyclic Synchronous Position mode
10	Reserved	
11	Reserved	
12	Reserved	
13~15	Manufacture specific	These are manufacturer-specific bits. Always keep them as '0'.

- Commands used in control awards

Table 84 Commands used in control awards

Command	Bit 7 Fault Reset	Bit 3 Enable Operation	Bit 2 Quick Stop	Bit 1 Disable Voltage	Bit 0 Swith on	Change status
Shutdown	x	x	1	1	0	2, 6, 8
Switch on	x	x	1	1	1	3
Disable Voltage	x	x	x	0	x	7, 9, 10, 12
Quick Stop	x	x	0	1	x	7, 10, 11
Disable Operation	x	0	1	1	1	5
Enable Operation	x	1	1	1	1	4, 16
Fault Reset	1	x	x	x	x	15

Parts marked 'X' indicate no relevance.

- Operation mode specific

Table 85 Operation mode specific

Mode	Bit 9	Bit 6	Bit 5	Bit 4	Desc.
CSP	-	-	-	-	-
CSV	-	-	-	-	X
CST	-	-	-	-	-
Hm	-	-	-	Start homing	-
PP	Change on set-point	Absolute/Relative	Change set immediately	New set-point	X
PV	-	-	-	-	X
TQ	-	-	-	-	X
ETC	-	-	-	-	X

Indicates that the portion marked with an 'X' is not supported. (Set to 0)

0x6041	Status word					ALL	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	2 byte(UINT)	-	RO	TxPDO	-	-	-

▶ Definition of Set Value

Table 86 Status word Set Value

Bit	Name	Description
0	Ready to switch on	These bits indicate the states For more information, see "State Definition" at the page 6-3.
1	Switched on	
2	Operation enabled	
3	Fault	
4	Voltage enabled	
5	Quick stop	
6	Switch on disabled	
7	Warning	This bit indicates warning status. In Warning, there is not transition of states but motions keep running.
8	Manufacturer specific	Manufacturer-specific bit.
9	Remote	This bit indicates that the servo drive is being controlled by Controlword. It is set to 1 (remote) after initialization has been completed. 0(local) means that supported tools are allowed to control over servo drives.
10	Operation Mode Specific Function	
11	Internal Limit Active	
12~13	Operation Mode Specific Function	
14~15	Manufacturer specific	These are manufacturer-specific bits.

▶ States Machine of status word

Table 87 States word States Machine

State	Bit 6 Switch on disabled	Bit 5 Quick stop	Bit 3 Fault	Bit 2 Operation enabled	Bit 1 Siwthed on	Bit 0 Ready to switch on	Desc.
Not ready to switch on	0	x	0	0	0	0	
Switch on disabled	1	x	0	0	0	0	
Ready to switch on	0	1	0	0	0	1	
Switched on	0	1	0	0	1	1	
Operation enabled	0	1	0	1	1	1	
Fault	0	x	1	0	0	0	
Fault reaction active	0	x	1	1	1	1	
Quick stop active	0	0	0	1	1	1	

Parts marked 'X' indicate no relevance.

0x605A	Quick stop option code - Reserved					ALL	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~4	2 byte(INT)	-	RW	-	-	2	-

▶ This object is not supported. This command is ignored, even when it is received.

▶ Set how to stop when Quick Stop is performed.

▶ Definition of Set Value

Table 88 Quick Stop Option Code Set Value

Set Value	Description
0	Diable dirve
1	Slow down ramp
2	Quick stop ramp
3	Stop on current limit
4	Stop on voltage limit

▶ It is performed automatically from a stop as above to ‘Switch on disabled’. (See Fig 1 State machine ” in the page 6-2.)

0x605B	Shutdown option code					ALL	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	2 byte(INT)	-	RW	-	-	0	-

▶ It determines how it behaves when changing from 'Operation Enabled' to 'Ready to Switch On'.

▶ This object is applied when the control bits Bit2, 3 change from '1' to '0'.

▶ Definition of Set Value

Table 89 0x605B Shutdown option cod Set Value

Set Value	Description
0	Disable drive
1	Slow down ramp
2	Quick stop ramp
3	Stop on current limit
4	Stop on voltage limit

▶ It is performed automatically from a stop as above to 'Ready to Switch on'. (See Fig 1 State machine " in the page 6-2.)

0x605C	Disbale operation option code					ALL	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	2 byte(INT)	-	RW	-	-	1	-

▶ It determines how it behaves when changing from 'Operation Enabled' to 'Switched On'.

▶ This object is applied when the 4th lower bit in Controlword changes from 1 to 0.

▶ Definition of Set Value

Table 90 0x605C Disable Operation Option Code Set Value

Set Value	Description
0	Disable drive
1	Slow down ramp
2	Quick stop ramp
3	Stop on current limit
4	Stop on voltage limit

▶ If there is a from *Operation Enabled* state to *Ready to Switch On* state, the slow down ramp is the the deceleration value of the used mode of operation.

0x605D	Halt option code - Reserved					ALL	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	2 byte(INT)	-	RW	-	-	0	-

▶ This object is not supported. This command is ignored, even when it is received.

0x605E	Fault reaction option code	ALL

Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	2 byte(INT)	-	RW	-	-	2	-

- ▶ Determines how the alarm operates when detected by the servo drive.
- ▶ When a fault is detected in the servo drive, the slow down ramp is the deceleration value of the used mode of operation.

▶ Definition of Set Value

Table 91 Fault Reaction Option Code Set Value

Set Value	Description
0	Disable drive
1	Slow down ramp
2	Quick stop ramp
3	Stop on current limit
4	Stop on voltage limit

0x6060	Modes of Operation					ALL	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-128 ~ 127	1 byte(SINT)	-	RW	RxPDO	-	0	-

- ▶ This object set the mode of operation.
- ▶ Since the initial value is not set for the mode, it is necessary to set the operation mode after turning on the power of the drive
- ▶ E.205 (Unsupported operation mode) occurs when 'Operation enabled' state is set to '0'.

Table 92 Modes of Operation Mode

Operation Mode		Value	Support
No Operation Mode	-	0	-
Cyclic Synchronous Position	CSP	8	Supported
Cyclic Synchronous Velocity	CSV	9	Not supported
Cyclic Synchronous Torque	CST	10	Supported
Homing Mode	HM	6	Supported
Profile Position	PP	1	Not supported

0x6061	Modes of operation Display					ALL	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-128 ~ 127	1 byte(SINT)	-	RO	TxPDO	-	0	-

- ▶ This object displays the current mode of operation.
- ▶ The definition of values is the same as Mode of Operation (0x6060).

0x6062	Position Demand Value	CSP

Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	4 byte(DINT)	pulse	RO	-	-	0	-

- This object displays the internal position commands of servo drives.

0x6063	Position Actual Internal Value					CSP	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	4 byte(DINT)	pulse	RO	-	-	0	-

- This object displays the current internal position of servo drives.
- It uses the unit of encoder or external scale.

0x6064	Position Actual Value					CSP	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	4 byte(DINT)	pulse	RO	TxPDO	-	0	-

- This object indicates the current position.

0x6065	Following error window					CSP	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~ 2147483647	4 byte(UDINT)	pulse	RW	TxPDO	-	655360	Ft-3.20

- This object sets the threshold for following errors.
- If it is set to 0, the state is always a following error.

0x6067	Position Window					CSP	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0 ~ 2500	4 byte(UDINT)	pulse	RW	-	-	10	Ft-3.18

- It set the symmetrical range of accepted positions relative to the target position.
- The object is identical to the function of 0x2312 (Ft-3.18).

0x606B	Velocity Demand Value - Reserved					CSP	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	4 byte(DINT)	Rpm	RO	-	-	-	-

- This object is not supported. This value is read as 0.
- This object displays the output velocity of position controller or trajectory generator.

0x606C	Velocity Actual Value					CSP	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	4 byte(DINT)	pps	RO	TxPDO	-	-	-

- ▶ This object displays the actual velocity value derived either from the velocity sensor or the position sensor. The value is given in user-defined velocity units.
- ▶ The unit is the count numbers per second that are input from the encoder.

0x606D	Velocity Window					CSP	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0 ~ 1000	2 byte(UINT)	rpm	RW	-	-	10	Ft-2.18

- ▶ It set the symmetrical range of accepted velocity relative to the velocity command.
- ▶ The object is identical to the function of 0x2212 (Ft-2.18).

0x6071	Target Torque					ALL	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	2 byte(INT)	0.1%	RW	RxPDO	-	-	MDM-3

- ▶ This object indicate the configured input value for the torque controller in profile torque mode. (100% = Motor rated current)
- ▶ The valus is given per thousand of rated torque. (0.1% of rated torque)

0x6072	Maximum Torque					ALL	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~5000	2 byte(UINT)	0.1%	RW	-	-	3500	Ft-4.11

- ▶ This object indicate the maximum permissible torque in the motor.
- ▶ The valus is given per thousand of rated torque. (0.1% of rated torque)
- ▶ This is identical to the function of 0x240B (Ft-4.11) index. (The unit is %)

0x6074	Torque Demand Value					ALL	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	2 byte(INT)	0.1%	RO	-	-	0	-

- ▶ This object provide the output value of the trajectory generator.
- ▶ The value is given in 1/1000 of rated torque.

0x6076	Motor rated torque					ALL	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no

-	4 byte(UDINT)	0.1A	RO	-	-	0	-

▶ This object indicates the motor rated torque in the unit of 0.1[A].

0x6077	Torque actual value					ALL	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	2 byte(INT)	0.1%	RO	TxPDO	-	0	MDM-22

▶ This object provide the actual torque value given per thousand of rated torque.

▶ It correspond to the instantaneous torque in the motor.

0x6079	DC Link Circuit Voltage					ALL	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	4 byte(UDINT)	V	RO	-	-	-	-

▶ This object indicates the DC link voltage with rectified AC voltage of the main power.

▶ If AC220V is input, the DC link voltage is approximately 311Vdc.

▶ If the DC link voltage drops below 190Vdc for more than 1msec in the servo-ON state, DC bus low-voltage fault E.009 occurs.

▶ If the DC link voltage rises over 400V, Bus Over Voltage fault E.010 occurs.

▶ For more information about fault details, see "Table 112 Servo Fault Cause and Countermeasures" in the page 10-6.

0x607A	Target Position					CSP	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
–2147483648 ~ +2147483647	4 byte(DINT)	Pulse	RW	RxPDO	-	0	-

▶ This object indicate the commanded position that the drive should move to in CSP mode using the current settings of motion control parameters.

▶ A master transmit this command to the slave.

0x607B	Position range limit					-	
Sub-Index 0	Number of Entries						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	2 byte(UINT)	-	RO	-	-	2	-
Sub-Index 1	Min Position Limit						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	4 byte(DINT)	Pulse	RW	-	-	-2000000000	-
Sub-Index 2	Max Position Limit						

Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	4 byte(DINT)	pulse	RW	-	-	2000000000	-

0x607C	**Home Offset**					**HM**	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	4 byte(DINT)	Pulse	RW	RxPDO	-	-	Ft-5.17

- This object indicate the difference between the zero position for the application and the machine home position found during homing. During homing, the machine home position is found and once the homing is completed, the zero position is offset from the home position by adding the home offset to the home position.
  - Set the position value to use at the position set as origin
  - Equivalent to 0x2511 (ECAT Homing Offset).

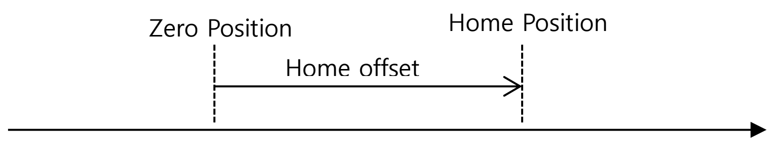


Figure 1 Home offset definition

0x607D	**Software Position Limit**					**-**	
Sub-Index 0	Number of Entries						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	2 byte(UINT)	-	RO	-	-	2	-
Sub-Index 1	Min Position Limit						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	4 byte(DINT)	Pulse	RW	-	-	-2147483647	IX_PR[0][6]
Sub-Index 2	Max Position Limit						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	4 byte(DINT)	pulse	RW	-	-	2147483647	IX_PR[0][5]

- This object sets the software limit values.
- The range of Position Demand Value (0x6062) and Position actual value (0x6064) is limited, for which a new target position is checked every time.
- A software limit value always corresponds to the machine zero point.
- Min Position Limit is the limit value for the negative rotations, while Max Position Limit is the limit value for the positive rotations.

0x607E	**Polarity**					**ALL**	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	1 byte(USINT)	-	RW	-	-	-	Ft-0.02[D2]

- ▶ Set the value for selecting the direction of motor rotation.
- ▶ When the object is changed, the value of Command Polarity (Ft-0.02 [D2], 0x2002: 3) changes together.

0x6080	**Max motor speed**					**ALL**	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	4 byte(UDINT)	Rpm	RW	-	-	5000	Ft-2.16

- ▶ This value limits the maximum speed of motor feedback. (Applies both forward and backward)
- ▶ The function of this object is the same as 0x2210(Ft-2.16)

0x6081	**Profile Velocity - Reserved**					**PV**	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	4 byte(UDINT)	-	RW	-	-	0	-

- ▶ This object sets the profile velocity in the Profile mode.

0x6083	**Profile Acceleration - Reserved**					**PV**	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	4 byte(UDINT)	-	RW	-	-	-	-

- ▶ This object sets the acceleration in the Profile mode.

0x6084	**Profile Deceleration – Reserved**					**PV**	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	4 byte(UDINT)	-	RW	-	-	-	-

- ▶ This object sets the deceleration in the Profile mode.

0x6085	**Quick Stop Deceleration**					**CSP**	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	4 byte(UDINT)	-	RW	-	-	-	-

- ▶ This object sets the deceleration used for quick stops when Quick Stop Option Code (0x605A) is set to 2.

0x6098	**Homing Method**					**HM**	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	1 byte(SINT)	-	RW	-	-	-	Ft-5.15

- ▶ This object sets the homing method.

▶ The object is identical to the function of 0x250F (Ft-5.15).

▶ Definition of Set Value

Table 93 Homing Method Set Value

Set Value	Definition	지원여부
1	Homing on Negative Limit Switch and Index Pulse	O
2	Homing on Positive Limit Switch and Index Pulse	O
3	Homing on Positive Home Switch and Index Pulse	O
4	Homing on Positive Home Switch and Index Pulse	X
5	Homing on Negative Home Switch and Index Pulse	O
6	Homing on Negative Home Switch and Index Pulse	X
7	Homing on Positive Limit Switch, Homing On Positive Home Switch and Index Pulse	O
8	Homing on Positive Limit Switch, Homing On Positive Home Switch and Index Pulse	X
9	Homing on Positive Limit Switch, Homing On Negative Home Switch and Index Pulse	O
10	Homing on Positive Limit Switch, Homing On Negative Home Switch and Index Pulse	X
11	Homing on Negative Limit Switch, Homing On Positive Home Switch and Index Pulse	O
12	Homing on Negative Limit Switch, Homing On Positive Home Switch and Index Pulse	X
13	Homing on Negative Limit Switch, Homing On Negative Home Switch and Index Pulse	O
14	Homing on Negative Limit Switch, Homing On Negative Home Switch and Index Pulse	X
15-16	Reserved	X
17	Homing on Negative Limit Switch	O
18	Homing on Positive Limit Switch	O
19	Homing on Positive Home Switch	O
20	Homing on Positive Home Switch	X
21	Homing on Negative Home Switch	O
22	Homing on Negative Limit Switch	X
23	Homing on Positive Limit Switch and Homing On Positive Home Switch	O
24	Homing on Positive Limit Switch and Homing On Positive Home Switch	X
25	Homing on Positive Limit Switch and Homing On Negative Home Switch	O
26	Homing on Positive Limit Switch and Homing On Negative Home Switch	X
27	Homing on Negative Limit Switch and Homing On Positive Home Switch	O
28	Homing on Negative Limit Switch and Homing On Positive Home Switch	X
29	Homing on Negative Limit Switch and Homing On Negative Home Switch	O
30	Homing on Negative Limit Switch and Homing On Negative Home Switch	X
31-32	Reserved	X
33	Homing on Index Pulse	O
34	Homing on Index Pulse	O
35	Homing on the Current Position	O
36	Homing with Touch Probe	X

-	-	
40	Homing on Negative stopper	O
41	Homing on Negative stopper and Positive Index Pulse	O
42	Homing on Positive stopper	O
43	Homing on Positive stopper and Negative Index Pulse	O
Others	-	X

▶ During homing, the value of the status word

Table 94 During homing, the value of the status word

Bit	Name	Value	Desc.
10	Homing Reached	0	Homing operating
		1	Homing completed and stopped state
12	Homing attained	0	In operation
		1	Homing completed
13	Homing error	0	No homing error
		1	Homing Error occurs

0x6099	Homing Speed - Reserved					HM	
Sub-Index 0	Number of Entries						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	2 byte(UINT)	-	RO	-	-	2	-
Sub-Index 1	Speed for Switch						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	4 byte(DINT)	Pulse	RW	RxPDO	-	0	Ft-5.18
Sub-Index 2	Max Position Limit						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	4 byte(DINT)	pulse	RW	RxPDO	-	0	Ft-5.19

▶ This object sets the homing speed.

▶ The object is identical to the function of 0x2512 (Ft-5.18), 0x2513 (Ft-5.19).

0x609A	Homing Acceleration					CSP	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	4 byte(DINT)	Pulse/sec^2	RW	RxPDO	-	0	Ft-5.20

▶ This object sets the homing acceleration in the user acceleration unit.

▶ The object is identical to the function of 0x2514 (Ft-5.20)

0x60B0	Position offset	CSP

Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	4 byte(DINT)	-	RW	-	-	0	-

- This object provide the offset of the target positon.
- In the CSP mode, Target Position (0x607A) added with this value is new target position.

0x60B1	**Velocity offset**					**CSP**	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	4 byte(DINT)	Rpm	RW	-	-	0	-

- This object sets the offset of velocity command in the unit of rpm.

0x60B2	**Torque offset**					**ALL**	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0 ~ 5000	2 byte (INT)	0.1%	RW	-	-	0	Ft-4.12

- This object sets the offset of torque command in the unit of 0.1% of rated torque. (100% = Motor rated current)

0x60B8	**Touch probe function - Reserved**					**CSP**	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	2 byte(INT)	-	RW	RxPDO	-	0xA000	-

0x60B9	**Touch Probe Status - Reserved**					**CSP**	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	2 byte(UINT)	-	RO	TxPDO	-	-	-

0x60BA	**Touch Probe Pos1 Pos Value - Reserved**					**CSP**	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	4 byte(DINT)	-	RO	-	-	-	-

0x60BB	**Touch Probe Pos1 Neg Value - Reserved**					**CSP**	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	4 byte(DINT)	-	RO	-	-	-	-

0x60BC	**Touch Probe Pos2 Pos Value - Reserved**	**CSP**

Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	4 byte(DINT)	-	RO	-	-	-	-

0x60BD	**Touch Probe Pos2 Neg Value - Reserved**					**CSP**	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	4 byte(DINT)	-	RO	-	-	-	-

0x60E0	**Positive Torque Limit Value**					**ALL**	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0 ~ 5000	2 byte(UINT)	0.1%	RW	-	-	3500	Ft-4.07

- ▶ The object limits the positive torque of motor.
- ▶ The input values are set in the unit of 0.1% of rated torque. (100% = Motor rated torque)
- ▶ This is identical to the function of 0x2407 (Ft-4.07) index. (The unit is 1%)

0x60E1	**Negative Torque Limit Value**					**ALL**	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0 ~ 5000	2 byte(UINT)	0.1%	RW	-	-	3500	Ft-4.08

- ▶ The object limits the negative torque of motor.
- ▶ The input values are set in the unit of 0.1% of rated torque. (100% = Motor rated torque)
- ▶ This is identical to the function of 0x2408 (Ft-4.08) index. (The unit is 1%)

0x60E3	**Support Homing Method - Reserved**					**CSP**	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	4 byte(DINT)	-	RW	-	-	-	-

0x60F2	**Position Option Code - Reserved**					**CSP**	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	4 byte(DINT)	-	RW	-	-	-	-

0x60F4	**Following Error Actual Value**					**CSP**	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	4 byte(DINT)	Pulse	RO	TxPDO	-	-	-

- ▶ This object indicates the actual value of the following error.

0x60FC	Position Demand Internal Value - Reserved					CSP	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	4 byte(DINT)	Pulse	RO	-	-	-	-

- This object is not supported. This value is read as 0.
- This is the internal position command used in servo drives.

0x60FD	Digital Inputs					ALL	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	4 byte(UDINT)	-	RO	TxPDO	-	-	-

- This object indicates the states of digital input signals that are set in the sequence input 0x200A, 0x200B, 0x200D, 0x200F, and 0x2010.
- Bit description

Table 95 Digital Inputs Bit Description

Bit	Input Signal	I/O Connector Sign	Value	Definition
0	Negative limit switch	N-OT	0	OFF
			1	ON
1	Positive limit switch	P-OT	0	OFF
			1	ON
2	Home Switch	/HOM-SEN	0	OFF
			1	ON
3~17	Reserved			
18	Motor Z-phase	-	0	Z-phase signal not detected
			1	Z-phase signal detected
19	Emergency Stop	E-STOP	0	Emergency Stop OFF
			1	Emergency Stop ON
20~21	Reserved			
22	Touch Probe Input 1 - Reserved	Touch_probe_1		
23	Touch Probe Input 2 - Reserved	Touch_probe_2		
24	Sequence Input 1	INPUT1	0	Switched OFF(open)
			1	Switched ON(close)
25	Sequence Input 2	INPUT2	0	Switched OFF(open)
			1	Switched ON(close)
26	Sequence Input 3	INPUT3	0	Switched OFF(open)
			1	Switched ON(close)
27	Sequence Input 4	INPUT4	0	Switched OFF(open)
			1	Switched ON(close)
28~31	Reserved			

0x60FE	Digital Outputs - Reserved					ALL	
Sub-Index 0	Number of Entries						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	2 byte(UINT)	-	RO	-	-	2	-
Sub-Index 1	Physical Outputs						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	4 byte(UDINT)	-	-	RxPDO	-	-	-
Sub-Index 2	Mask						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	4 byte(UDINT)	-	-	-	-	-	-

- ▶ This object sets the outputs of digital output signals that are set in the Master.
- ▶ The Bit Mask determines whether to use the Physical Outputs.

0x60FF	Target Velocity - Reserved					CSV	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	4 byte(DINT)	Pps	RW	R_PDO	-	0	MDM-1

0x6502	Supported Drive Modes					ALL	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-	4 byte(UDINT)	-	RO		-	0x02A0	-

- ▶ This object shows supported drive modes.
- ▶ Bit Description

Table 96 Supported Drive Modes Bit Description

Bit	Supported Mode	Description
0	Profile Position mode	0 (Not supported)
1	Velocity mode	0 (Not supported)
2	Profile Velocity mode	0 (Not supported)
3	Profile Torque mode	0 (Not supported)
4	Reserved	0
5	Homing mode	1 (Supported)
6	Interpolated Position mode	0 (Not supported)
7	Cyclic Synchronous Position mode	1 (Supported)
8	Cyclic Synchronous Velocity mode	0 (Not supported)
9	Cyclic Synchronous Torque mode	1 (Supported)
10 ~ 31	Reserve	0

Chapter 8. Tuning by Gain Setting

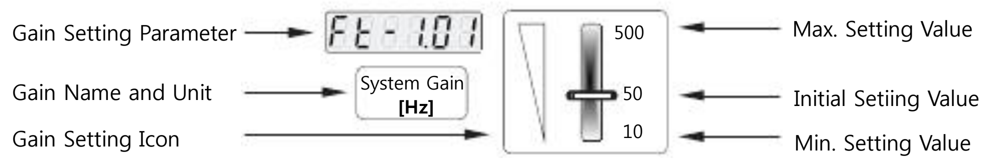
This chapter explains the servo drive setting that can achieve its optimum performance to satisfy different load system as controlling servo motor.

Before You Begin

Mark Description

The following icon is used for tuning.

< Tuning Icon >



Gain Introduction

As the audio system has equalizer to adjust the audio quality, the drive also requires adjustment to achieve the optimum performance for each load. Equalizer adjustment is not essential for the audio system, but the adjustment is important fact that is directly connected to performance for servo drive.

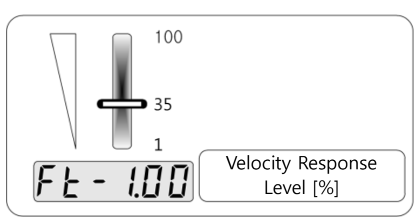
You should adjust servo drive to satisfy load condition in order to achieve optimum performance for each control.

In addition, the adjustment made to the motor that is connected to drive, to achieve the optimum performance through gain setting, is called Tuning.

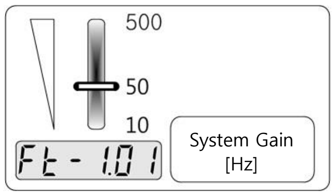
Servo Drive Gain

What kind of drive gains are there that acts like equalizers of audio system? Parameter group 1 has gain setting parameter for tuning and it is classified as follows.

Velocity Response Level



System Gain



System Gain[Hz] = Max. bandwidth[Hz] x Velocity Response Level[%]
(Maximum bandwidth is decided depend on Ft-0.04)

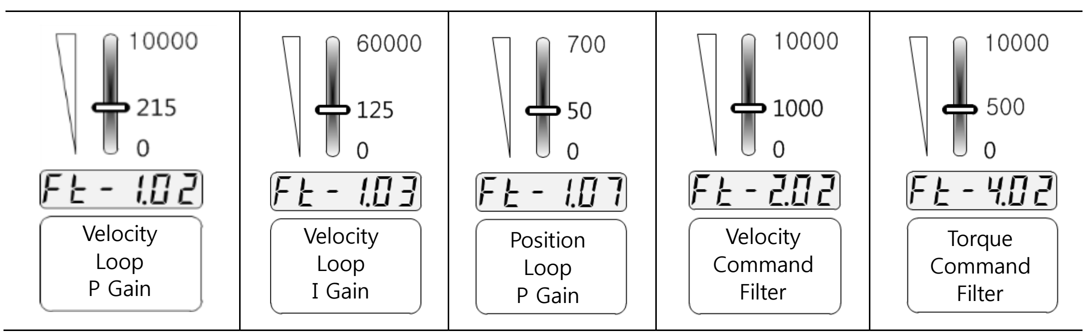
It is the same as the Bandwidth of overall velocity control loop of the servo drive.

It can adjust five basic gains at the same time.

IMPORTANT In CSD7 servo drives, if the velocity response level 0x2100 (Ft-1.00) is set to extremely low value, the system gain 0x2101 (Ft-1.01) is limited to the 10Hz as a minimum value, which can keep the proper characteristics of motions. For more information about the velocity response level, see "Velocity Response Level (0x2100, Ft-1.00)
" in the page 8-11.

Basic Gain

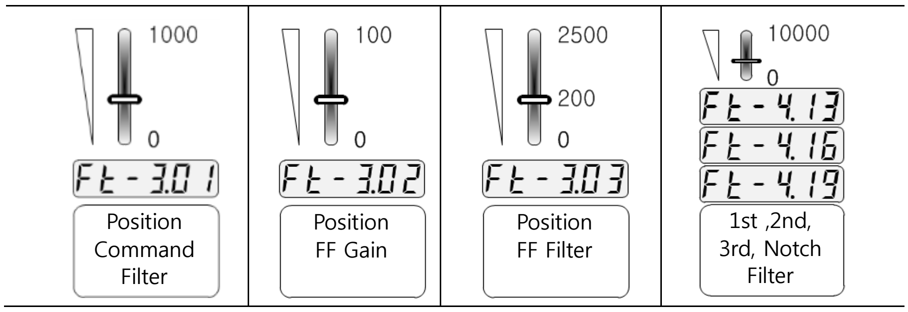
They are five fundamental gains for tuning.



0x2102 0x2103 0x2107 0x2202 0x2402

Applicatin Gain

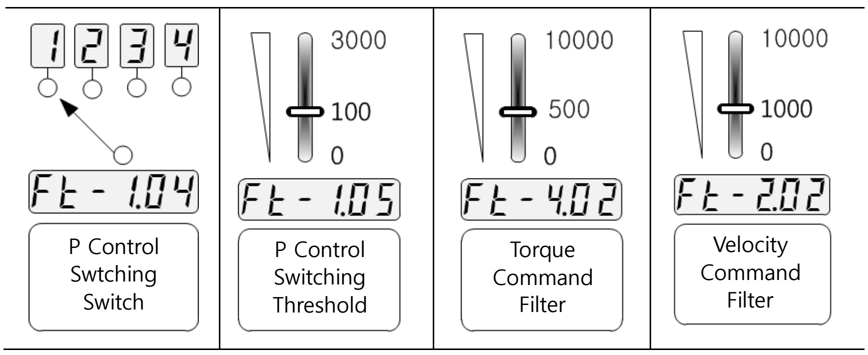
They are four gains that have separate functions.



0x2301	0x2302	0x2303	0x240D 0x2410 0x2413

Others

They are four parameters with supplementary function that is required for tuning.



0x2104	0x2105	0x2402	0x2202

As mentioned above, gains in parameter group 1 and 13 parameters related to gain are explained and the details are explained hereinafter.

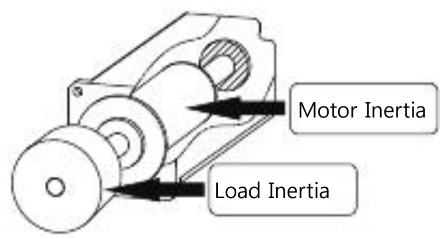
Parameter, Inertia Ratio That is Most Important for Tuning

The parameter that is considered to make motor, that is connected to servo drive achieve the optimum performance in tuning, is the inertia ratio setting parameter. First of all, you should understand that inertia ratio and gain settings are interlocked, and refer to the explanation hereinafter.

Inertia Ratio

What is Inertia Ratio ?

The following figure explains the inertia ratio.



It shows the ratio of load inertia compared to the motor (rotor) inertia.

If the motor (rotor) inertia is 3 [gf·cm·s²] and the load inertia is 30 [gf·cm·s²], the inertia ratio is 10 times. For the motor inertia table, refer to the motor specification.

Setting Unit

Setting value of Inertia Ratio uses the unit, [times]. For example, if the motor inertia is same as the load inertia, the Inertia Ratio is 1 [time] and the setting value is 1.00.

The setting value of the Inertia Ratio is determined by the following formula.

$$Inertia\ Ratio\ [times] = \frac{Load\ Inertia}{Motor\ Rotor\ Inertia}$$

Setting Parameter

Set the Inertia Ratio to the following parameter.

0x2004	Inertia Ratio					CSP	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0.00 ~60.00	2 byte(UINT)	[times]	RW	-	Always	1.00	Ft-0.04

Ft-0.04	**Inertia Ratio** **RSWare : Drive - Motor - Inertia Ratio**
Description	• Inertia Ratio = Load Inertia /Motor Rotor Inertia • If you know the inertia ratio, you can set the value directly, but usually it is measured automatically through offline auto tuning. (See "Off-line Auto Tuning (0x3001, run-01)" on page 9-38.) • If the inertia ratio is changed by auto tuning or manually, the proper system gain (Ft-1.01) is set, and the 5 basic gains 0x2102(Ft-1.02), 0x2103(Ft-1.03), 0x2107(Ft-1.07), 0x2202(Ft-2.02) and 0x2402(Ft-4.02) are also changed automatically accordingly.

Based on the motor type and the rated output, the maximum allowable inertia ratio is as below. When the allowable inertia ratio exceeds the maximum, you cannot expect a fast response.

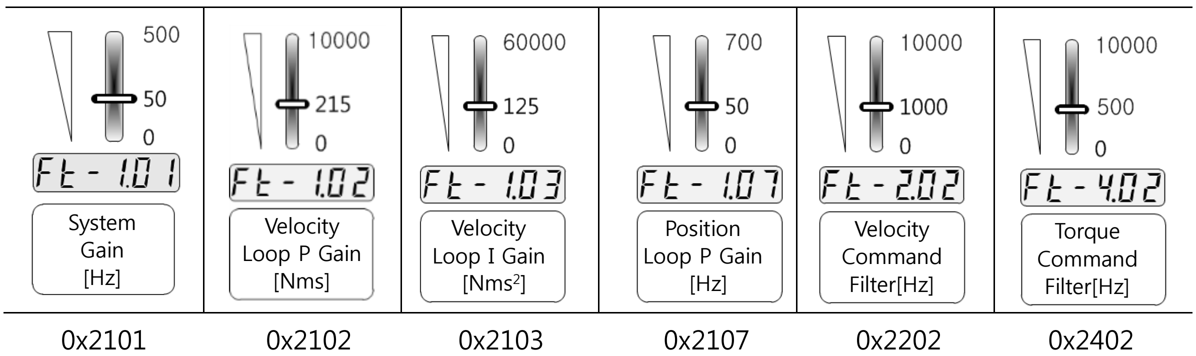
Table 97 Maximum Allowable Inertia Ratio

Motor	Capacity	Maximum Allowable Inertia Ratio
CSMT/R	100W or less	30 times
	Less than 1kW	20 times
	1kW	10 times
CSMS	ALL	10 times
CSMD	ALL	10 times
CSMH	ALL	5 times

Inertia Ratio and Gain

If the Inertia Ratio is adjusted by certain reason, it automatically changes the following system gain(0x2101, Ft-1.01) and five basic gains at the same time with the adjustment. Therefore, the Inertia Ratio setting means gain setting, so that you should be careful when adjusting or setting the Inertia Ratio.

Followings are system gain(0x2101, Ft-1.01) and five basic gains that are changed according to the adjustment of Inertia Ratio.



Gain Setting Block Diagram

This chapter explains the block diagram of the Position loop, Velocity loop, and Torque loop related to the gain setting.

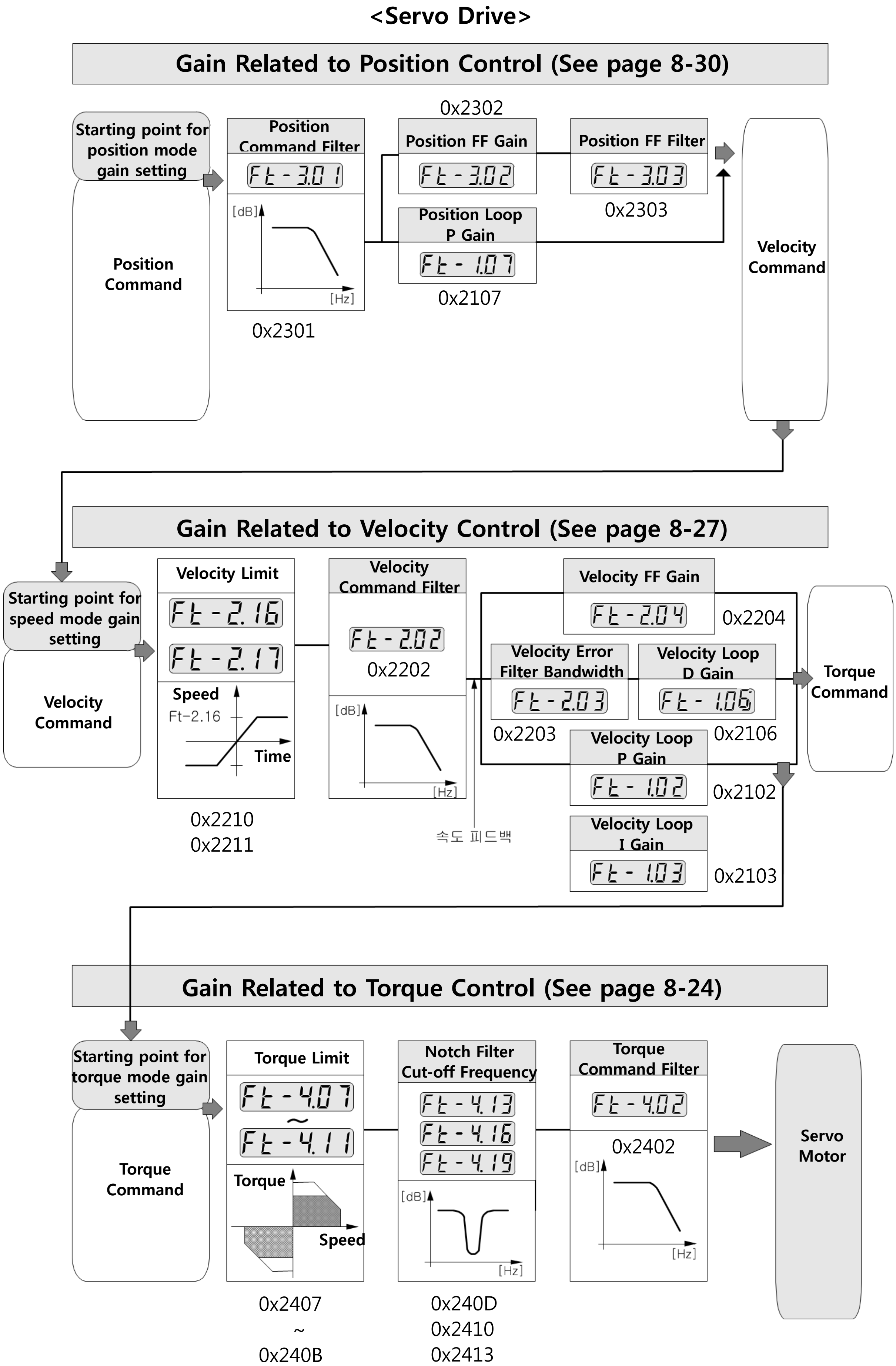
The following diagram will help you understand the gain configuration related to position, velocity and torque.

Table 98 Gain Setting Block Diagram

Starting point for position mode gain setting	Position mode (CSP) using the position command of host controller includes all gains related to velocity and torque from starting point to the servo motor as shown in the figure below. Servo drive first generates the velocity command using the position command of the host controller, velocity command generates the torque command and finally it transfers the torque command to the servo motor. Therefore, when you use the position mode, the gain can be set properly. If gain related to position control is set properly but the gain related to torque or velocity is not set properly, the optimum tuning cannot be achieved.
Starting point for speed mode gain setting	Velocity mode using velocity command of the host controller includes all gains related to torque from starting point to the servo motor as shown in the figure below. Servo drive first generates torque command using velocity command of the host controller and finally, it transfers the torque command to the servo motor. Therefore, when you use the velocity mode, the gains related to velocity and torque can be set properly. If gain related to velocity control is set properly but gain related to torque is not set properly, the optimum tuning cannot be achieved.
Starting point for torque mode gain setting	Torque mode using torque command of host controller includes all gains related to torque from starting point to servo motor as shown in the figure below. You can adjust gains related to torque in torque mode.

Note

If gains related to position are set in the condition that the velocity response is not sufficiently guaranteed through gain settings related to velocity control, system becomes unstable. Therefore, firstly you should sufficiently secure the response of velocity control loop to make the response of whole position control system good.


<Servo Drive>
Gain Related to Position Control (See page 8-30)
Starting point for position mode gain setting
Position Command
Position Command Filter
Ft-3.01
[dB]
[Hz]
0x2301
0x2302
Position FF Gain
Ft-3.02
Position FF Filter
Ft-3.03
0x2303
Position Loop P Gain
Ft-1.07
0x2107
Velocity Command
Gain Related to Velocity Control (See page 8-27)
Starting point for speed mode gain setting
Velocity Command
Velocity Limit
Ft-2.16
Ft-2.17
Speed
Ft-2.16
Time
0x2210
0x2211
Velocity Command Filter
Ft-2.02
0x2202
[dB]
[Hz]
속도 피드백
Velocity FF Gain
Ft-2.04
0x2204
Velocity Error Filter Bandwidth
Ft-2.03
0x2203
Velocity Loop D Gain
Ft-1.06
0x2106
Velocity Loop P Gain
Ft-1.02
0x2102
Velocity Loop I Gain
Ft-1.03
0x2103
Torque Command
Gain Related to Torque Control (See page 8-24)
Starting point for torque mode gain setting
Torque Command
Torque Limit
Ft-4.07
~
Ft-4.11
Torque
Speed
0x2407
~
0x240B
Notch Filter Cut-off Frequency
Ft-4.13
Ft-4.16
Ft-4.19
[dB]
[Hz]
0x240D
0x2410
0x2413
Torque Command Filter
Ft-4.02
0x2402
[dB]
[Hz]
Servo Motor

Auto Gain Setting

Auto Tuning

There are two functions that automatically detects the load status of the motor in the CSD7 servo drive.

- Off-line auto-tuning
- ANF (Adaptive Notch Filter) Function

Off-line Auto Tuning

Function

System gain(0x2101, Ft-1.01) and five basic gains are automatically set based on the calculated inetia ratio(0x2004, Ft-0.04) after off-line auto tuning.

Mode

The operation mode of 0x3001 depends on 0x2003[01] (Ft-0.03[D0] : Off-line Tuning Mode Setting). There are three kinds of operation mode for auto tuning as below.

1) 0x2003[01]=0: Inertia estimation
2) 0x2003[01]=1: Inertia and Resonance frequency estimation
3) 0x2003[01]=2: Resonance frequency estimation
   If 0x2003[01]=2, the auto tuning looks for only the resonance frequency of the system at a stationary position. This function is for the users who are interested in finding only the resonance frequency, unlike 0x2003[01]=[Ft-0.03][D0] = 1.
   However, as this function also requires the system's inertia for an accurate operation, it can be useful when the vibration suppression filter needs to be corrected once more by detecting the vibration after performing 0x2003[01]=[Ft-0.03][D0]=0 or 0x2003[01]=[Ft-0.03][D0]= 1.

Operation (Tuning) Method

For operation method of off-line auto tuning, refer to "Off-line Auto Tuning (0x3001, run-01)" on page 9-38.

Velocity Response Level (0x2100, Ft-1.00)

The available maximum bandwidth is determined based on the inertia ratio measured by auto tuning (0x3001, run-01), and the system gain 0x2101 (Ft-1.01) is set by the maximum bandwidth and the velocity response level.

System Gain (0x2101, Ft-1.01) [Hz]
*= Max. Bandwidth [Hz] * Velocity Response Level [%]*

0x2100	**Velocity Response Level**					**CSP**	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
1~100	1 byte(USINT)	%	RW	-	Always	35	Ft-1.00

Ft-1.00	**Velocity Response Level**
Description	Define the reflection ratio of the maximum bandwidth recommended by the drive on the basis of the inertia ratio measured after auto tuning.

This parameter is to define the reflection ratio of the maximum system gain recommended by the drive after performing the "inertia estimation" or "inertia and resonance frequency estimation" as defined in 0x2003[01] (Ft-0.03[D0]). For example, if the 'maximum bandwidth' of a system after auto tuning is '200Hz', the system gain 0x2101 (Ft-1.01) is defined to be 70Hz as per initial value (35%) of 0x2100 (Ft-1.00). As the "maximum bandwidth" is based on the estimated inertia ratio, it is not always the same value, but determined depending on the system features.

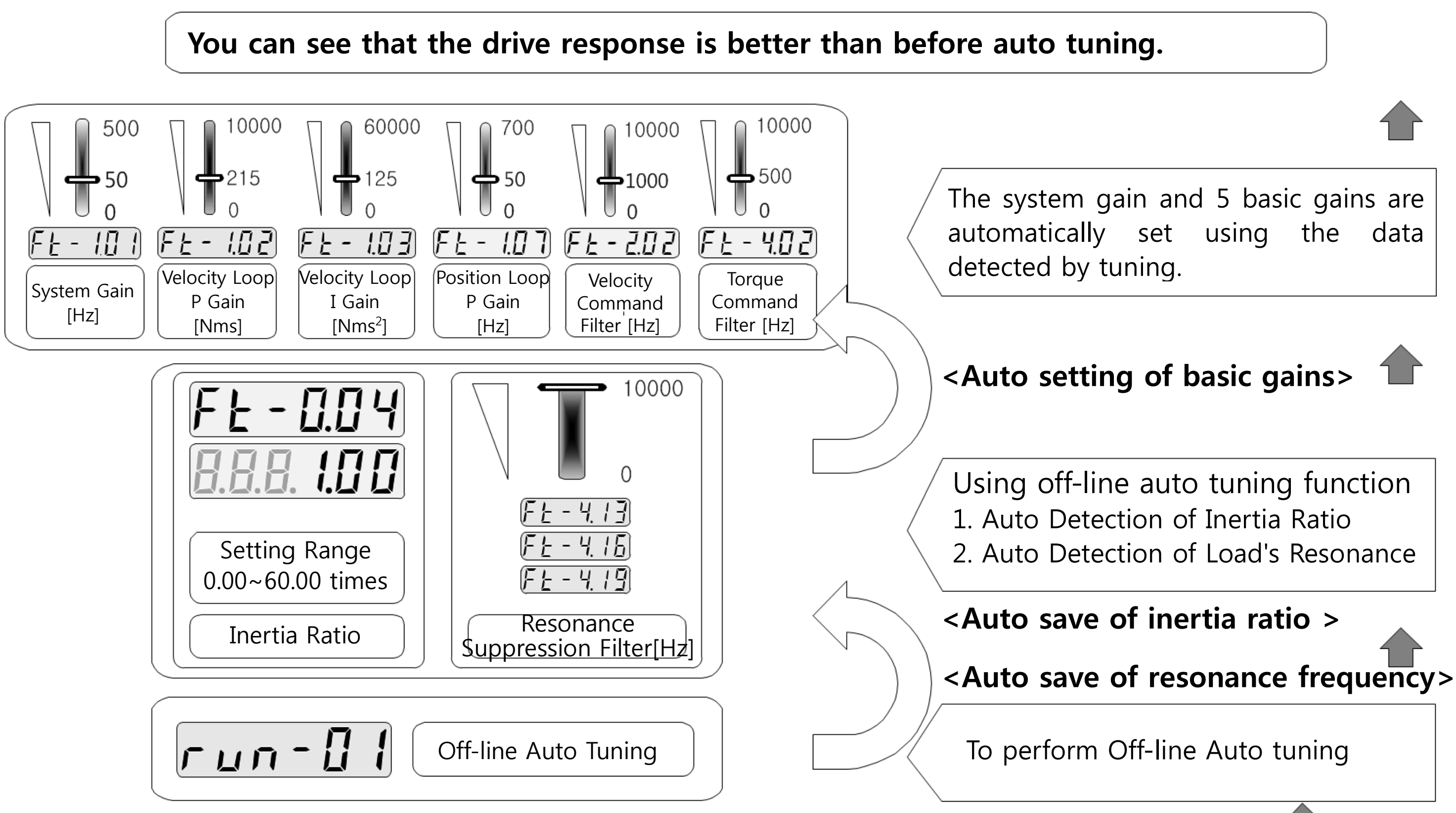
The initial value of the velocity response level is set to 35%. If this value is modified, the system gain(0x2101, Ft-1.01) and five basic gains (0x2102(Ft-1.02), 0x2103(Ft-1.03), 0x2107(Ft-1.07), 0x2202(Ft-2.02), 0x2402(Ft-4.02)) are changed to a proper values automatically.

If the velocity response level is set to extreamly low value, the system gain 0x2101 (Ft-1.01) is limited by 10 Hz that is minimum value to guarantee the motion performance.

Relationship between Off-line Auto Tuning and Gain

When you run off-line auto tuning, drive automatically Inertia Ratio 0x2004 (Ft-0.04) of load system and automatically set the system gain 0x2101 (Ft-1.01) and five basic gains as being suitable for Inertia Ratio. Therefore, it is recognized that the response quality of servomotor is improved at the same time.

In addition, a load system sometimes does resonance in the specific frequency range. For those situations, it remove the vibration of load system using resonant frequency that is automatically detected by auto tuning. Resonant frequency of load system becomes the setting value for resonance suppression filter 0x240D(Ft-4.13), 0x2410(Ft-4.16), 0x2413(Ft-4.19). If you know the exact resonant frequency of the load, you can set it directly.



Relationship between Off-line Auto Tuning and Gain

Note

Only as performing off-line auto tuning, you can prevent vibration and noise caused by resonant frequency of the system, because system gain(0x2101) and five basic gains(0x2102, 0x2103, 0x2107, 0x2202, 0x2402) and resonance suppression filters(0x240D, 0x2410, 0x2413) are automatically set by auto-tuning.

In case of 0x2003[01] (Ft-0.03[D0]) = 1, off-line auto tuning automatically sets Inertia Ratio 0x2004(Ft-0.04) and resonant suppression filter 0x240D(Ft-4.13), 0x2410(Ft-4.16) and 0x2413(Ft-4.19), but when you know exactly each value, you can directly set.
However, if the value set directly is not accurate, the system response goes down and becomes the reason of resonant noise. Therefore, be careful when setting it directly.

ANF (Adaptive Notch Filter) Function

Overview

CSD7 provides two methods of removing resonance as follows:

- RFD (Resonant Frequency Detection) :
  The resonance frequency is identified by generating excitation frequency during off-line auto tuning as described in the previous page. In this case, the setting value of 0x2003[01] (Ft-0.03[D0]) is 1 or 2.
- ANF (Adaptive Notch Filter) Function :
  This is the method to remove resonance from the equipment by the resonance frequency detected automatically in real-time.

How to Use ANF

You can use the ANF function in the steps below.

- Apply power to the servo drive, and prepare the general conditions for such operation.
- Find suitable inertia ratio for the external load connected to the servo motor by performing the offline auto tuning. (As soon as the inertia ratio is found, the system gain, velocity P-gain, velocity I-gain, position P-gain, torque command filter value, are set automatically.)
- At this time, if the off-line auto tuning mode is set to the default setting (0x2003[01] = Ft-0.03[D0] = 1), the resonance frequency is also found together with the inertia ratio automatically.

	Autotuning		
Para. No	parameter_Name	Set Value	Units
0.03 [D2]	Off-Line Auto Tuning Speed	700	RPM
0.03 [D0]	Off-Line Auto Tuning Mode	1 : Inertia Moment Estimation and Resonant Frequency Detection	

- As shown below, there may be the resonance frequency value which is found after performing offline auto tuning.

	Main Current Regulator Gains		
Para. No	parameter_Name	Set Value	Units
4.06	Main Current Regulator Gain	1: Medium	
4.02	1st Current Command LPF Bandwidth	700	
4.13	1st Resonant Frequency Suppression Filter	765	
4.14	1st Resonant Frequency Suppression Filter Width	10	
4.15	1st Resonant Frequency Suppression Filter Depth	100	
4.16	2nd Resonant Frequency Suppression Filter	10000	
4.17	2nd Resonant Frequency Suppression Filter Width	10	
4.18	2nd Resonant Frequency Suppression Filter Depth	100	
4.19	3rd Resonant Frequency Suppression Filter	10000	
4.20	3rd Resonant Frequency Suppression Filter Width	10	
4.21	3rd Resonant Frequency Suppression Filter Depth	100	

- Next, as shown below, set Adaptive Notch Filter(ANF) Enable to 'Enable'. After setting to 'Enable', if resonance occurs during motor operation, the ANF function runs to detect the resonance in real time and set the proper resonance frequency accordingly, thereby removing the resonance.

	Adaptive Notch Filter(ANF) Setting		
Para. No	parameter_Name	Set Value	Units
4.22 [D0]	ANF Function	1: Enable	
4.22 [D1]	ANF HPF Cutoff Frequency	1: High	
4.22 [D2]	ANF Estimation Frequency Initial Value	1: High	
4.22 [D3]	ANF Detect Level	1: Middle	

- If a fast enough response is not obtained by the gain value from offline auto tuning, you can speed up the response through tuning with increased system gain (One parameter tuning method). As shown below, if the system gain is 70Hz as a result of offline auto tuning, try operation at that value; if vibration or resonance does not occur, increase the system gain to 70Hz → 80Hz → 90Hz → 100Hz, etc. one by one.
- If you increase the system gain incrementally when Adaptive Notch Filter(ANF) Enable functio is set to 'Enable' (e.g., the jog mode operation of RSWare or the operation by position movement command from the host controller), sometimes the device resonance occurs; at this point, you can see that the ANF starts working to update the resonance frequency so as to

remove the resonance.

	RSWare : Drive - Tuning		
Para. No	**parameter_Name**	**Set Value**	**Units**
1.00	Velocity Regulator Response Level	35	%
1.01	Ststem Gain	70	Hz
	Main Velocity Regulator Gains		
1.02	1st Velocity Regulator P Gain	314	
1.03	1st Velocity Regulator I Gain	245	
1.04	Velocity Regulator I Gain Mode	0: Always On	
1.05	Velocity Regulator I Gain Disable Threshold	100	
1.06	Velocity Regulator D Gain	0	
2.04	Velocity Regulator Kff Gain	0	
2.03	Velocity Error Fillter Bandwidth	30	Hz
	Main Position Regulator Gains		
1.07	1st Position Regulator Kp Gain	70	Hz
3.02	Position Regulator Kff Gain	0	%
3.03	Position Regulator Kff LPF Bandwidth	200	Hz
3.01	Position Command LPF Bandwidth	0	Hz
3.04	Moving Average Filter	320	0.125ms
	Main Current Regulator Gain		
4.06	Main Current Regulator Gain	1: Medium	
4.02	1st Current Command LPF Bandwidth	700	Hz
4.13	1st Resonant Frequency Suppression Filter	765	Hz
4.14	1st Resonant Frequency Suppression Filter Width	10	
4.15	1st Resonant Frequency Suppression Filter Depth	100	
4.16	2nd Resonant Frequency Suppression Filter	10000	Hz
4.17	2nd Resonant Frequency Suppression Filter Width	10	
4.18	2nd Resonant Frequency Suppression Filter Depth	100	
4.19	3rd Resonant Frequency Suppression Filter	10000	Hz
4.20	3rd Resonant Frequency Suppression Filter Width	10	
4.21	3rd Resonant Frequency Suppression Filter Depth	100	
	Autotuning		
0.03[D2]	Off-Line Auto tuning Velocity	7: 700	RPM
0.03[D0]	Off-Line Auto Tuning Mode	1: Inertia Moment Estimation and Resonant Frequency Detection	
	RSWare : Drive - Resonant Suppression		
	Adaptive Notch Filter(ANF) Setting		
4.22 [D0]	Adaptive Notch Filter(ANF) Enable	Enable	
4.22 [D1]	ANF HPF Cutoff Frequency Selection	High	
4.22 [D2]	ANF Estimation Frequency Initial Value Selection	High	

4.22 [D3]	ANF Detct Level	Middle	

- For the load with many resonance points, everything is updated up to the 3rd resonance frequency sometimes.
- In CSD7, you can set 3 resonance frequencies (1st, 2nd and 3rd). In a rare case where a complex device has 4-5 resonance points, the resonance frequencies which, out of the 4-5 resonance points, have the great impact on the system are set automatically in the order of impact.
- There are three options used to change the conditions of ANF function: ANF HPF Cutoff Frequency Selection, ANF Estimation Frequency Initial Value Selection, and ANF Detect Level.

A. The ANF HPF Cutoff Frequency Selection is to set the HPF frequency which is used to estimate the resonance frequency; if High is selected, it is internally set to 500Hz; Low to 100Hz.
(The default setting is High. Generally, it is recommended to select High for the load (e.g., ball screw load) with high resonance point; and Low for the load (e.g., belt load) with low frequency resonance point under 500Hz.)

B. The ANF Estimation Frequency Initial Value Selection is the initial frequency value for the frequency estimation. As the actual resonance frequency is found by starting from this value, if this initial value is closer to the actual resonance frequency, the resonance frequency can be estimated in a faster way.
(The default setting is High. If High is selected, it is internally set to 800Hz; if Low, to 300Hz.) In general, it is recommended for the system with high rigidity such as ball screw has high frequency resonance point to set this value to High; the belt load to Low.)

C. Literally, the ANF Detect Level is the parameter which can be used to detect the level of resonance frequency at AFN.
(The default setting is Middle. If it is set to High, the detection level is increased; Low, decreased. Therefore, in most of the systems, the resonance point is found well with Middle setting. If, however, the ANF cannot detect the

resonance well even when there exists resonance, set this level to Low and try operation. To the contrary, if the user does not want to update the resonance frequency because resonance does not occur, set this level to High.)

	Adaptive Notch Filter(ANF) Setting		
Para. No	**parameter_Name**	**Set Value**	**Units**
4.22 [D0]	ANF Function	1: Enable	
4.22 [D1]	ANF HPF Cutoff Frequency	1: High	
4.22 [D2]	ANF Estimation Frequency Initial Value	1: High	
4.22 [D3]	ANF Detect Level	1: Middle	

- The Notch Filter Reset function shown in the figure below can be used to reset (reset the all the 1st - 3rd resonance frequencies to default value 10000) the measured resonance filter value due to any reason.

Notch Filter Reset
Start/Stop TestRun for ANF

The "Notch Filter Reset" above is useful to reset and re-find the resonance frequency found by offline auto tuning only by ANF; or to detect the 1st to 3rd resonance frequency again due to potential change in device resonance features even when the resonance frequency was found by ANF.

- If a satisfactory system gain was set by the procedure above, and the resonance frequency value was updated by the ANF under these conditions, change the Adaptive Notch Filter (ANF) Enable setting to Disable. Of course the ANF can be always on for operation, but it is recommended to set to Disable for safety purpose.

	Adaptive Notch Filter(ANF) Setting		
Para. No	**parameter_Name**	**Set Value**	**Units**
4.22 [D0]	ANF Function	0: Disable	
4.22 [D1]	ANF HPF Cutoff Frequency	1: High	
4.22 [D2]	ANF Estimation Frequency Initial Value	1: High	
4.22 [D3]	ANF Detect Level	1: Middle	

Note

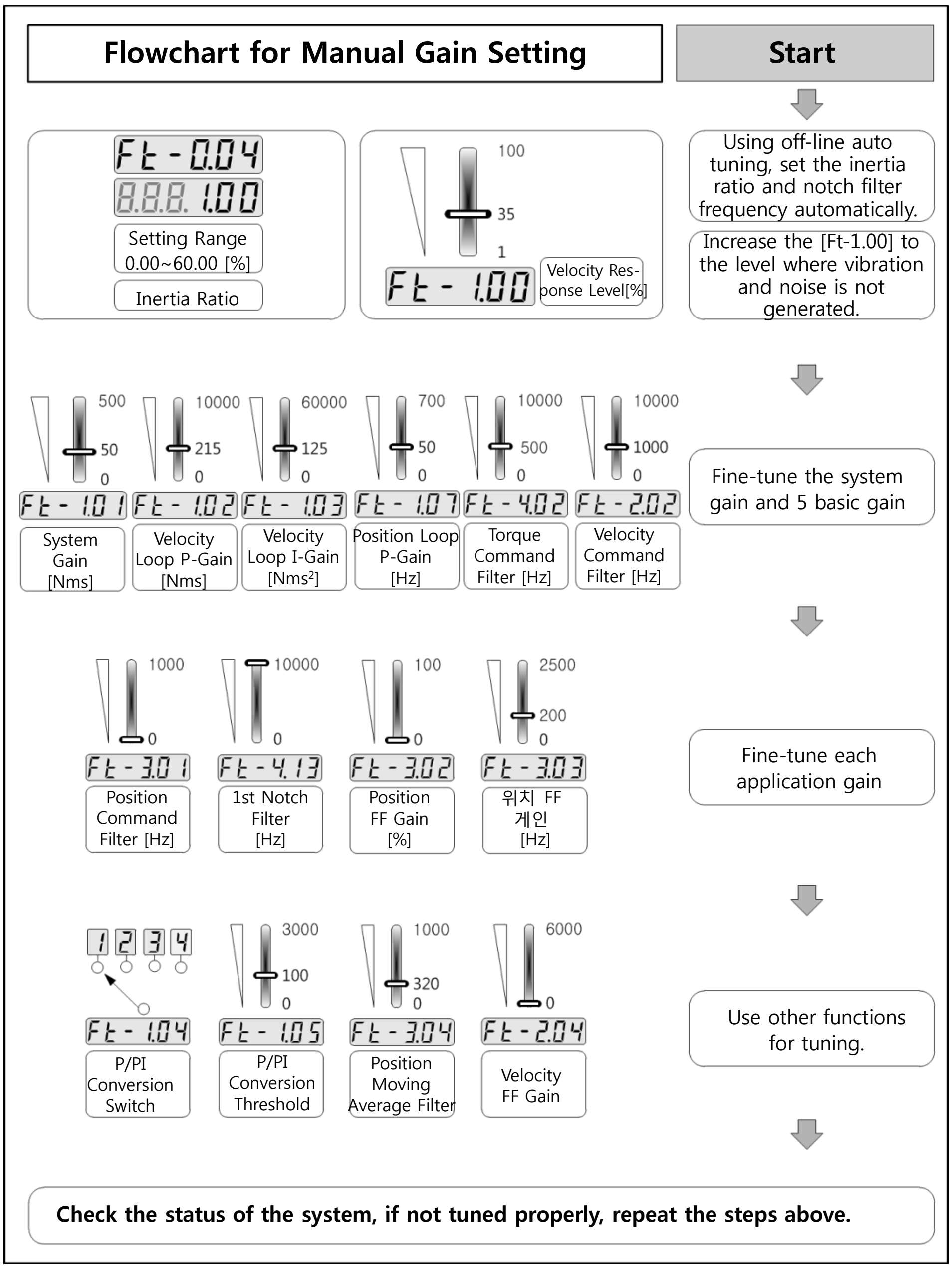
Cautions and Notes When using ANF Function

- When trying to find the resonance frequency using the ANF, do not operate it at excessively low speed with operation RPM below 50 rpm. (If rpm isxx too low, the ANF may not find the resonance point well. Excessively high rpm is not desirable, so operation at 200 - 600 rpm is recommended.)
- When finding a resonance frequency using ANF, abrupt acceleration/deceleration should be avoided.
- When, after enabling the ANF, detecting the resonance frequency by increasing the system gain, if you set the torque command filter value to 1000 Hz, you can detect the resonance point even at a lower system gain.
- When the resonance frequency is near to the operation area below 300 Hz and if it is excessively low, such resonance frequency may not be detected well.
- The resonance frequency band which can be detected by the ANF is between 100 Hz and 3 kHz.
- If multiple (3 to 4) resonance points occur simultaneously, the resonance frequency may be detected erroneously.
- If the maximum value of the resonance frequency is low, or the control gain is too low for the resonance to influence the motor speed, the resonance may not be detected well.
- If the motor speed changes due to non-linear factors such backlash including high harmonic content, the resonance may not be detected well.

Manual Gain Setting

Gain Setting Flowchart

The following figure describes whole structure and procedure of Manual Gain Setting.



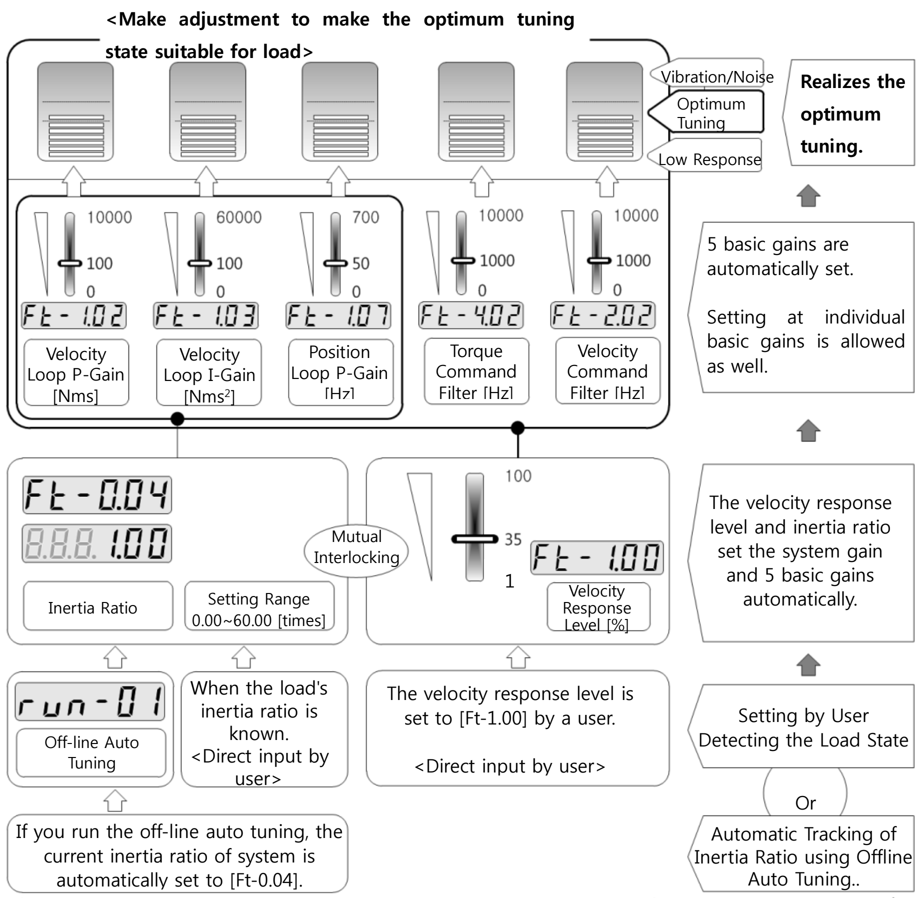
Basic Gain Setting

The following explains five Basic Gain Settings for Tuning.

Basic Gain Setting by Velocity Response Level and Inertia Ratio

- Firstly, perform the Off-line Auto Tuning for automatic setting of Inertia Ratio 0x2004(Ft-0.04).
- Set the Velocity Response Level 0x2100(Ft-1.00) to optimum tuning level. If vibration noise occurs in the system, reduce tuning level to prevent vibration noise.
- Adjust in each basic gain in detail.
- If the tuning is not sufficient, set again from the Off-line Auto Tuning.

The following figure illustrates the flowchart that inertia ratio and velocity response level set the 5 basic gains as being interlocked. The 5 basic gains are changed to be optimum tuning whenever Inertia Ratio is changed or the Velocity Response Level is adjusted.



Basic Gain Setting Flow Chart

If response performance is decreased after Off-line Auto Tuning, increase the velocity response level 0x2100(Ft-1.00), and do Off-line Auto Tuning again. We recommend securing the maximum response quality as increasing the value of velocity response level 0x2100(Ft-1.00) until noise or vibration occurs.

When maximum response quality is guaranteed in the condition that the value of Inertia Ratio 0x2004(Ft-0.04) is accurately set and there is no vibration noise in load system, (When you set the value of velocity response level 0x2100(Ft-1.00) as high as you can), it becomes bandwidth of whole velocity control loop.

As described above, as exactly set Inertia Ratio 0x2004(Ft-0.04) and set 5 basic gains using velocity response level 0x2100(Ft-1.00), you can get response quality.

The following table is for Inertia Ratio and system gain setting.

0x2004	**Inertia Ratio**					**CSP**	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0.00 ~60.00	2 byte(UINT)	[times]	RW	-	Always	1.00	Ft-0.04

Ft-0.04	**Inertia Ratio** **RSWare : Drive - Motor - Inertia Ratio**
Description	• Inertia Ratio = Load Inertia /Motor Rotor Inertia • If you know the inertia ratio, you can set the value directly, but usually it is measured automatically through offline auto tuning. (See "Off-line Auto Tuning (0x3001, run-01)" on page 9-38.) • If the inertia ratio is changed by auto tuning or manually, the proper system gain (Ft-1.01) is set, and the 5 basic gains 0x2102(Ft-1.02), 0x2103(Ft-1.03), 0x2107(Ft-1.07), 0x2202(Ft-2.02) and 0x2402(Ft-4.02) are also changed automatically accordingly.

0x2100	Velocity Response Level					CSP	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
1~100	1 byte(USINT)	%	RW	-	Always	35	Ft-1.00

Ft-1.00	Velocity Response Level
Description	• The available maximum bandwidth is determined based on the inertia ratio 0x2004 (Ft-0.04) measured by auto tuning (0x3001, run-01) • and the system gain 0x2101 (Ft-1.01) is set by the maximum bandwidth and the velocity response level. *System Gain (0x2101, Ft-1.01) [Hz]* *= Max. [Hz] * Velocity Response level (0x2100, Ft-1.00) [%]* • The system gain (0x2101, Ft-1.01) generated in this way is the bandwidth for the entire velocity control loop. If this value is changed, the 5 basic gains 0x2102(Ft-1.02), 0x2103(Ft-1.03), 0x2107(Ft-1.07), 0x2202(Ft-2.02), 0x2402(Ft-4.02) are changed automatically. If the velocity response level (0x2100, Ft-1.00) is set to high value, the values of the 5 basic gains are increased, and the responsiveness is enhanced. If, however, the value is excessively high compared to the load condition, it may cause vibration or noise. ※ You may change the 5 basic gains by directly changing the system gain. For system safety, however, it is recommended to change the system gain and basic gains by changing the velocity response level.

To improve a transient response characteristics, we will explain gain setting for torque, velocity and position control loop. Refer to the “Manual Gain Setting for Torque, Velocity, Position Control” on page 8-24.

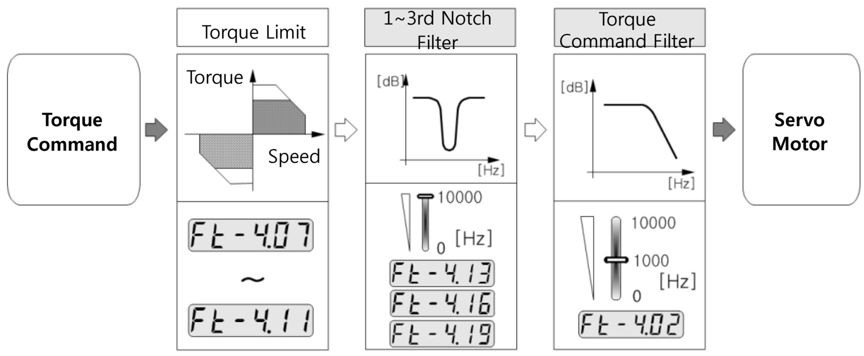
In addition, you want to get fast response in gain setting, refer to the “Tip To Get Fast Response” on page 8-32.

Manual Gain Setting for Torque, Velocity, Position Control

Gains Related to Torque Control

The following figure describes the filters related to torque control. There are torque limit, resonance suppression filter and torque command filter.

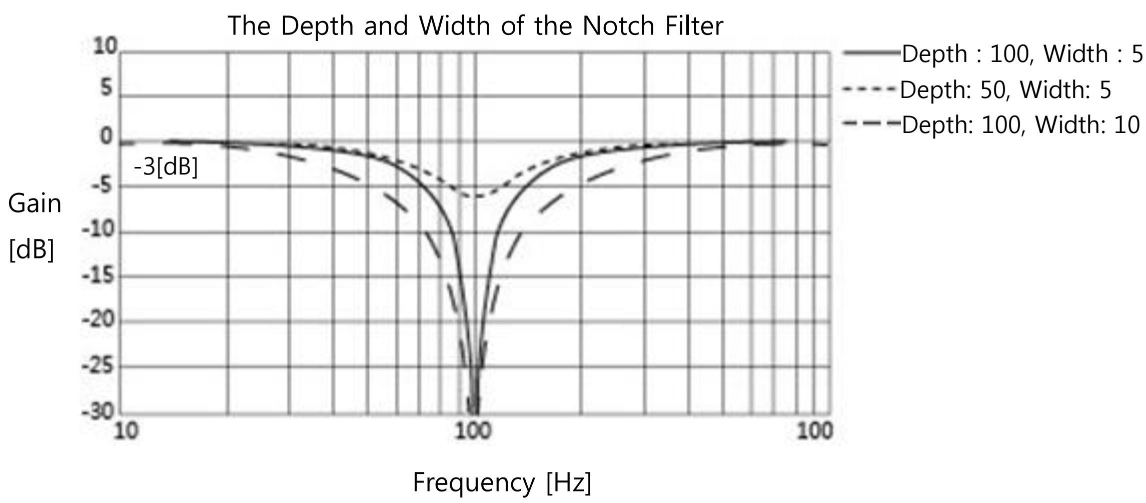
Gains Related to Torque Cotrol



1st, 2nd, 3rd Resonance Suppression Filter

The vibration suppression filter called notch filter can suppress the mechanical vibration by removing the specific frequency that generates resonance. The frequency, depth, and width of the vibration suppression filter can be adjusted.

The depth and width of the vibration suppression filter is as below



0x240D	Cut-off Frequency of 1st Notch Filter					CSP	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~10000	2 byte(UINT)	Hz	RW	-	Always	10000	Ft-4.13

0x2410	Cut-off Frequency of 2nd Notch Filter					CSP	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~10000	2 byte(UINT)	Hz	RW	-	Always	10000	Ft-4.16

0x2413	Cut-off Frequency of 3rd Notch Filter					CSP	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~10000	2 byte(UINT)	Hz	RW	-	Always	10000	Ft-4.19

Ft-4.13 Ft-4.16 Ft-4.19	Cut-off Frequency of 1st Notch Filter Cut-off Frequency of 2nd Notch Filter Cut-off Frequency of 3rd Notch Filter
Description	• The width and depth of the 1st, 2nd and 3rd Resonance Suppression Filter can be set respectively. The width range for the filter is 1 to 20, the depth is 0 to 100. • When the load system causes resonance in a specific frequency band, it suppresses the vibration caused by the resonance of the load. • If the filter was set properly, it allows other gains to be raised, so that the stability and responsiveness of the system are improved. But if it is set in a wrong way, it can cause vibration or noise.

Note

The resonance frequency of a load is the setting values of the resonance suppression filter 0x240D (Ft-4.13), 0x2410 (Ft-4.16) and 0x2313 (Ft-4.19).

The resonance frequencies are set automatically when you perform off-line auto tuning.

For more information about off-line auto tuning, refer to the “Off-line Auto Tuning” on page 8-10.

If you know exactly mechanical resonance frequency of the system, you can directly enter the value.

Torque Command Filter

The following objects are low pass filter that can remove high frequency factor that is included in torque command.

0x2402	LPF Bandwidth of 1st Current Command					CSP	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~10000	2 byte(UINT)	Hz	RW	-	Always	500	Ft-4.02

0x2403	LPF Bandwidth of 2nd Current Command					CSP	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~10000	2 byte(UINT)	Hz	RW	-	Always	300	Ft-4.03

0x2404	LPF Bandwidth of 3rd Current Command					CSP	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~10000	2 byte(UINT)	Hz	RW	-	Always	300	Ft-4.04

0x2405	LPF Bandwidth of 4th Current Command					CSP	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~10000	2 byte(UINT)	Hz	RW	-	Always	300	Ft-4.05

Ft-4.02 **Ft-4.03** **Ft-4.04** **Ft-4.05**	**LPF Bandwidth of 1st Current Command** **LPF Bandwidth of 2nd Current Command** **LPF Bandwidth of 3rd Current Command** **LPF Bandwidth of 4th Current Command**
Description	• It makes torque command smooth as suppressing higher frequency than these setting values, so it can reduce vibration or noise. • The more the value is, the faster the response is, but if you set too high, vibration can occur. If you reduce this value in the condition that the load rigidity is high, you can suppress oscillation. • Do not set too high more than necessary, the system can be unstable because these values are a delay factor.

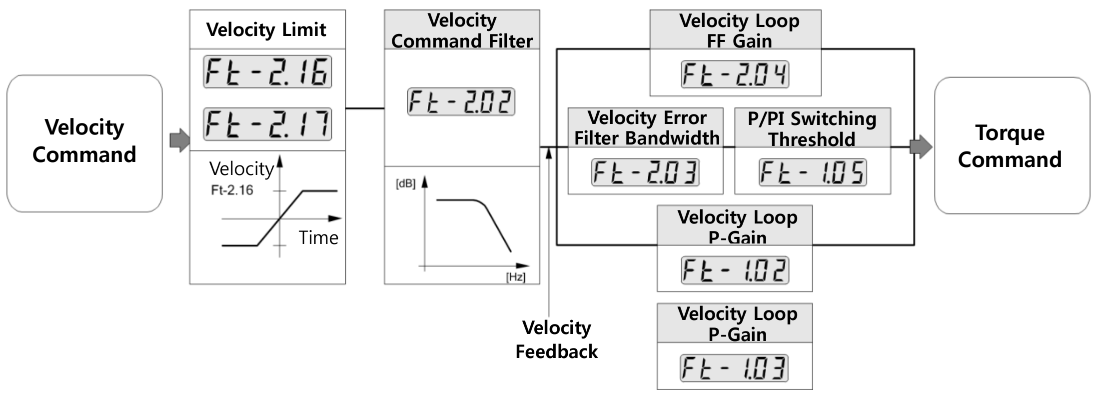
If the system uses belt or chain, rigidity is low so that you cannot expect the fast response. In addition, if you excessively increase the gains related to velocity control or position control, it can be oscillated. For those system, it is difficult to set the values of torque command filters above 100 [Hz].

Gains Related to Velocity Control

The gains related to velocity control includes velocity command filter, velocity loop P gain and velocity loop I gain.

The following figure describes the gains related to velocity control.

Gains Related to Velocity Cotrol



Velocity Loop P-Gain

0x2102	1st Velocity Loop P Gain					CSP	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~10000	2 byte(UINT)	-	RW	-	Always	215	Ft-1.02

Ft-1.02	1st Velocity Loop P Gain
Description	• The higher the value is set, the better response of velocity control loop is. • Set as high as you can within the limit that vibration does not occur.

Velocity Loop I-Gain

0x2103	1st Velocity Loop I Gain					CSP	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~60000	2 byte(UINT)	-	RW	-	Always	125	Ft-1.03

Ft-1.03	1st Velocity Loop I Gain
Description	• It is to remove velocity error in steady state as responding to very small error. • The higher the value is set, the better the velocity response and the faster the completion time. • Set this value to low level in the environment that load inertia is big or vibration can easily occur.

Velocity Command Filter

0x2202	LPF Bandwidth of Velocity Command					CSP	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~10000	2 byte(UINT)	Hz	RW	-	Always	1000	Ft-2.02

Ft-1.03	LPF Bandwidth of Velocity Command
Description	• It makes velocity command smooth as removing high frequency factor that is included in velocity command. • If this value is '0', velocity command filter is not used.

Gain Setting Procedure Related to Velocity Control

- Increase the velocity loop P-gain 0x2102 (Ft-1.02) gradually as high as possible within the range that vibration and noise does not occur.
- Set 0x2102 (Ft-1.02) as the value of 80 to 90 [%] of the maximum setting value.
- Increase the velocity loop I-gain 0x2103 (Ft-1.03) little by little as checking transient response such as overshoot, completion time, whether vibration or noise occurs. If you set it too low, the response become slow and if you set it too high, vibration or noise can occur. Maximum setting value of 0x2103 (Ft-1.03) is as the following formula.

  $$[Ft\text{-}1.03] \leq 300 \times [Ft\text{-}1.02]^2 \times \text{Inertia of applied motor}$$

- If the gain related to position control is set high more than necessary or in the environment where the noise is too big, reduce the value of the velocity command filter 0x2202 (Ft-2.02).
- It is better to set the value of torque command filter 0x2402 (Ft-4.02) as high as possible until vibration does not occur in load side.
- Adjust gains in detail as repeating transient response state.

Note

The value of 0x2102 (Ft-1.02) and 0x2103 (Ft-1.03) are calculated based on the detected inertia ratio.

Therefore, if the inertia ratio 0x2004 (Ft-0.04) for 100W motor or 1kW motor is same as 10 times, the calculated gain of 0x2102 (Ft-1.02) and 0x2103 (Ft-1.03) becomes the same.

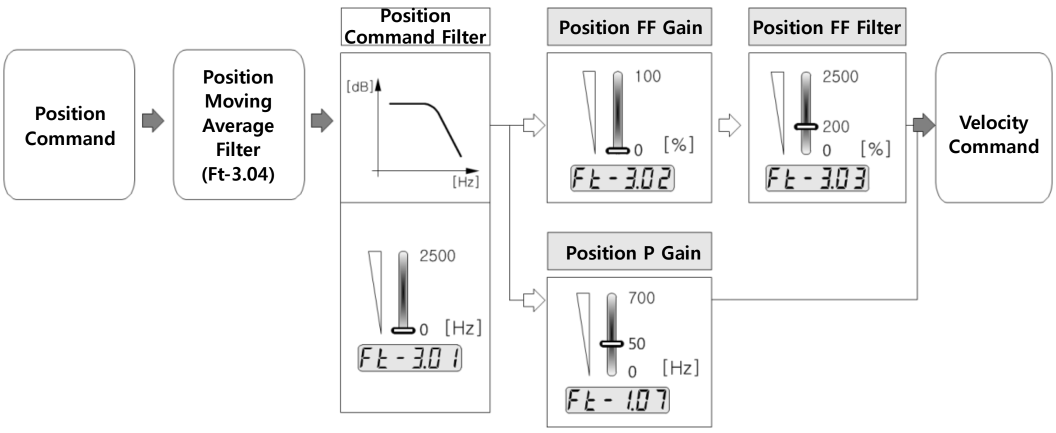
For the description of the velocity limit, see the "Velocity Limit and Velocity Limit Detection </V-LMT> signal output" on page 9-23.

Gains Related to Positon Control

The gains related to position control includes position FF gain, position FF filter and position loop P gain.

The following figure describes the gains related to position control.

Gains Related to Position Control



Position Command Filter

0x2301	LPF Bandwidth of Position Command					CSP	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~1000	2 byte(UINT)	Hz	RW	-	Always	0	Ft-3.01

Ft-3.01	LPF Bandwidth of Position Command
Description	• It makes position command smooth as removing high frequency factor that is included in position command. • If this value is '0', position command filter is not used.

Position Loop P Gain

0x2107	1st Position Loop P Gain					CSP	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~700	2 byte(UINT)	Hz	RW	-	Always	50	Ft-1.07

Ft-1.07	1st Position Loop P Gain
Description	• The higher the value is set, the better the response of the

	position control loop is. • Change the setting value in accordance with the rigidity of the load.

Gain Setting Procedure Related to Position Control

- Increase the velocity loop P gain 0x2102 (Ft-1.02) gradually in the condition while the position loop P gain 0x2107 (Ft-1.07) is set to initial value.
- If vibration or noise is generated in the load, reduce the value of 0x2102 (Ft-1.02) to 80~90% of the value in that moment.
- Increase the value of 0x2107 (Ft-1.07) up to the level that vibration and noise does not occur in transient response.
- Increase the velocity loop I gain 0x2103 (Ft-1.03) little by little as checking transient response such as overshoot, completion time, whether vibration or noise occurs. If you set too low, the response become slow and if you set it too high, vibration or noise can occur. Maximum setting value of 0x2103 (Ft-1.03) is as the following formula.

  $[Ft\text{-}1.03] \leq 300 \times [Ft\text{-}1.02]^2 \times$ *Inertia of applied motor*
- If necessary, you can suppress the excessive change of position command as reducing the value of the position command filter 0x2301 (Ft-3.01).
- It is better to set the value of torque command filter 0x2402 (Ft-4.02) as high as possible until vibration does not occur in load side.
- Adjust gains in detail as repeating transient response state.

Note For more information about position FF gain, position FF filter and initial torque bias function, see the "Tip To Get Fast Response" on page 8-32.

Tip To Get Fast Response

Position Feedforward Function

For position feed forward (FF) diagram, refer to the "Gains Related to Positon Control" on page 8-30. Position FF makes differentiation factor on position command in position control mode approved in speed command through feed forward method. Therefore, transient response characteristics is improved so that you can reduce position completion time.

The followings are the related parameters to set.

0x2302	**Position Loop FF Gain**					**CSP**	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~100	1 byte(USINT)	%	RW	-	Always	0	Ft-3.02

Ft-3.02	**Position Loop FF Gain**
Description	• The higher the value, the faster the position completion time and the smaller position error at transient response condition. • The value can differ depending on load's type or rigidity; an excessively high value causes vibration.

0x2303	**LPF Bandwidth of Position Loop FF**					**CSP**	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~2500	2 byte(UINT)	Hz	RW	-	Always	200	Ft-3.03

Ft-3.03	**LPF Bandwidth of Position Loop FF**
Description	• It makes position command smooth as removing high frequency factor that is included in position command. • If the value of 0x2302 (Ft-3.02) is not '0', it is valid. • If the value is '0', position FF filter is not used.

If you use position FF function, velocity command can increases or decreases sharply as responding to the change of position command. Therefore, if position command is entered as the type to be changed rapidly (that is to say, in case of high acceleration or high deceleration), overshoot can be caused by position FF.

At this moment, if you want to reduce position completion time, find out appropriate value as increasing the value of 0x2107 (Ft-1.07) little by little as checking transient response.

In addition, it is good method to suppress high frequency factor of position FF using velocity command filter 0x2202 (Ft-2.02) or making position command smooth using position command filter 0x2301 (Ft-3.01).

P/PI Mode Setting Function

When you control velocity or position, if you set velocity loop I gain 0x2103 (Ft-1.03), it responds to the delicate command so that you can accurately control and make the error ‘0’ in the steady state.

However, if you increase velocity loop I gain 0x2103 (Ft-1.03) to get fast response, overshoot of actual velocity occurs in transient state, as a result, position completion time can be increased.
Therefore, you can reduce position completion time as suppressing overshoot by changing I gain to ‘0’ for a little while if necessary.
In this case, velocity control loop is changed from ‘PI controller’ to ‘P controller’.

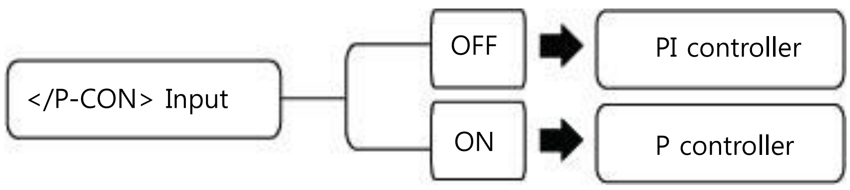
There are two methods to change velocity control loop from ‘PI controller’ to ‘P controller’.

- Manual Setting : To control by sequence input P control conversion signal </P-CON>.
- Auto Setting : To use P/PI mode switching function by parameter setting.

P/PI Control by Sequence Input </P-CON> Signal

</P-CON> is sequence input signal. To use </P-CON>, allocate </P-CON> with reference to "Allocation Method for Sequence Input Signal" on page 3-15.

</P-CON> signal is allocated, and then velocity controller is determined as following type according to allocated input channel signal.



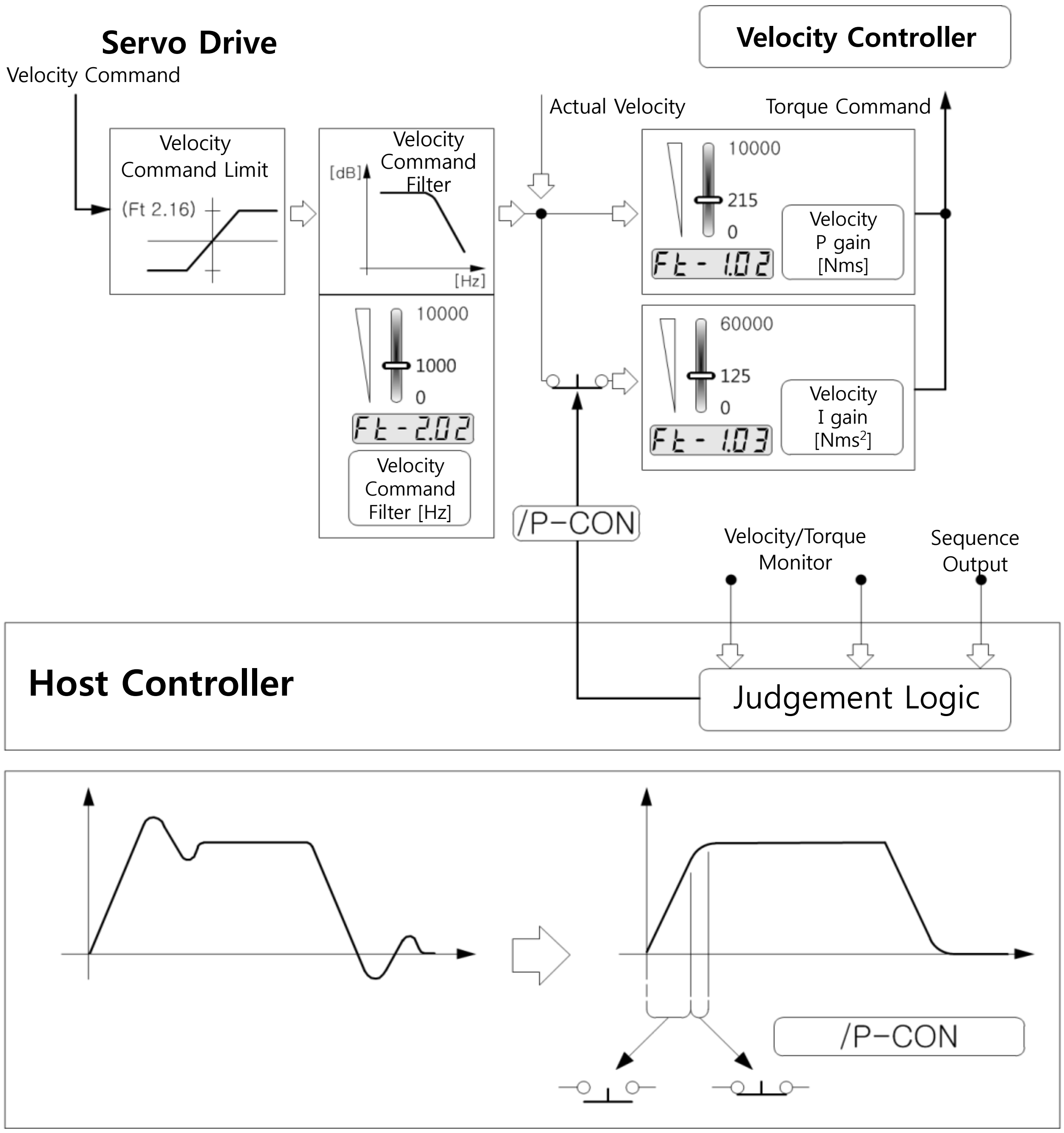
Therefore, host controller checks the monitoring output signal such as velocity or torque of servo drive and sequence output such as </P-COM>, </V-COM>, </TG-ON> and programs logics to convert controller from 'PI controller' to 'P controller'.

CAUTION

Do not use this function when overshoot occurs.

If some offset is included in velocity command when you use velocity mode, if you use 'P controller' type, motor does not respond to the offset related to '0' velocity command and remains without moving.

The following figure illustrates the conversion of 'PI controller' and 'P controller' using </P-CON> input in velocity control loop.



P/PI Control by Parameter Setting

Meanwhile, you can operate velocity controller as 'P controller' type by parameter setting without allocation external sequence input. According to parameter setting, you can change velocity controller to 'P controller' type.

- When internal torque command is bigger than setting value [%].
- When velocity command is bigger than setting value [rpm].
- When position error is bigger than setting value [pulse].

For setting related to the cases above, use the following parameters.

0x2104	**P/PI Control Switching Mode**					**CSP**	
Sub-Index 1	P/PI Control Switching Mode						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~4	1 byte(USINT)	-	RW	-	Servo Off	0	Ft-1.04[D0]

Ft-1.04[D0]	**P/PI Control Switching Mode**
Description	• 0 : P/PI conversion function is not used. • 1 : If torque command is more than setting value[%] of 0x2105 (Ft-1.05), PI control is converted into P control. • 2 : If velocity command is more than setting value[rpm] of 0x2105 (Ft-1.05), PI control is converted into P control. • 3 : If position error is more than setting value[pulse] of 0x2105 (Ft-1.05), PI control is converted into P control. • 4 : Reserved

0x2105	**Threshold for P/PI Control Switching**					**CSP**	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~3000	2 byte(UINT)	-	RW	-	Always	100	Ft-1.05

Ft-1.05	**Threshold for P/PI Control Switching**
Description	• It set the conversion threshold for P/PI control.

Note

The unit of 0x2105 (Ft-1.05) follow the value that is selected in 0x2104[01] (Ft-1.04[D0]).

- 1 (Torque Command) : [%]
- 2 (Velocity Command) : [rpm]
- 3 (Position error) : [pulse]

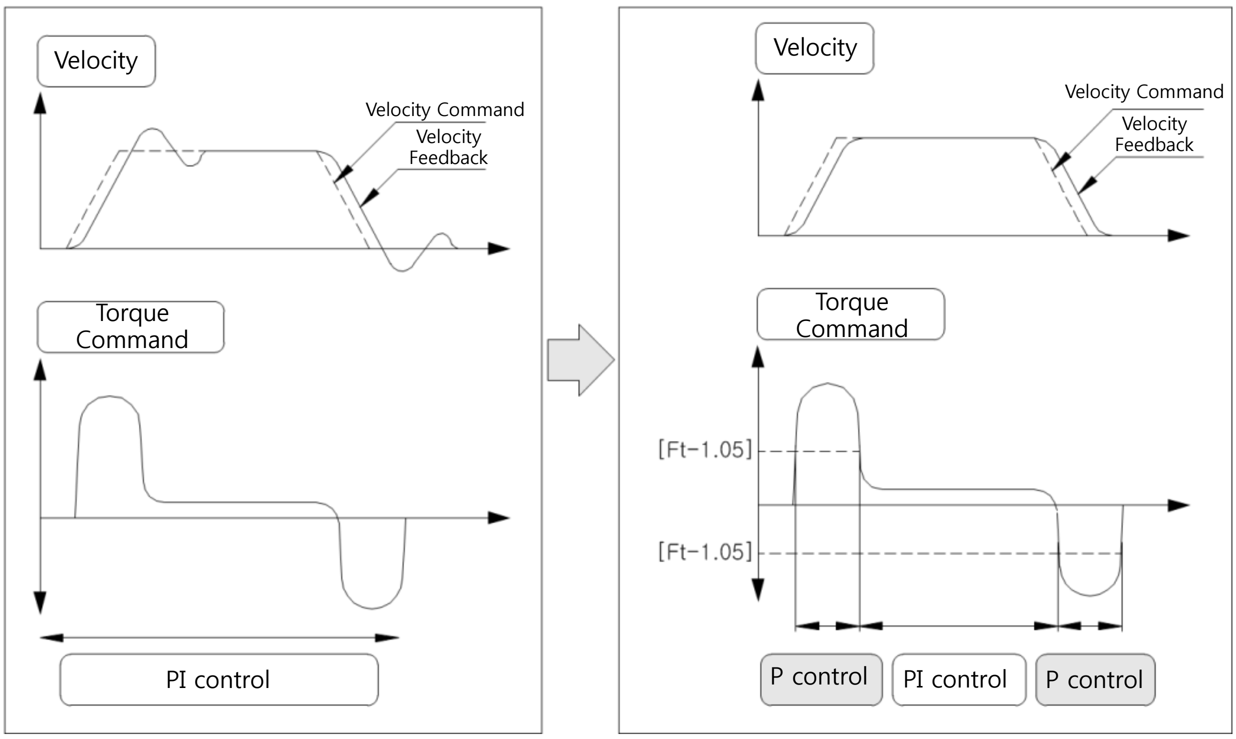
CAUTION

Sequence input </P-CON> signal is converted prior to setting of 0x2104[01] (Ft-1.04[D0]) and 0x2105 (Ft-1.05). That is to say, if </P-CON> is ON regardless of current motor condition or setting of motor value, velocity controller is converted to 'P controller'.

To reduce overshoot of velocity response or position completion time using this function, you should set appropriate value to 0x2104[01] (Ft-1.04[D0]) and 0x2105 (Ft-1.05). For optimum setting, check carefully velocity, torque, and position and be careful for setting.

The following figure is example of velocity response when velocity controller is converted from ‘PI controller’ to ‘P controller’ in the transient response state.

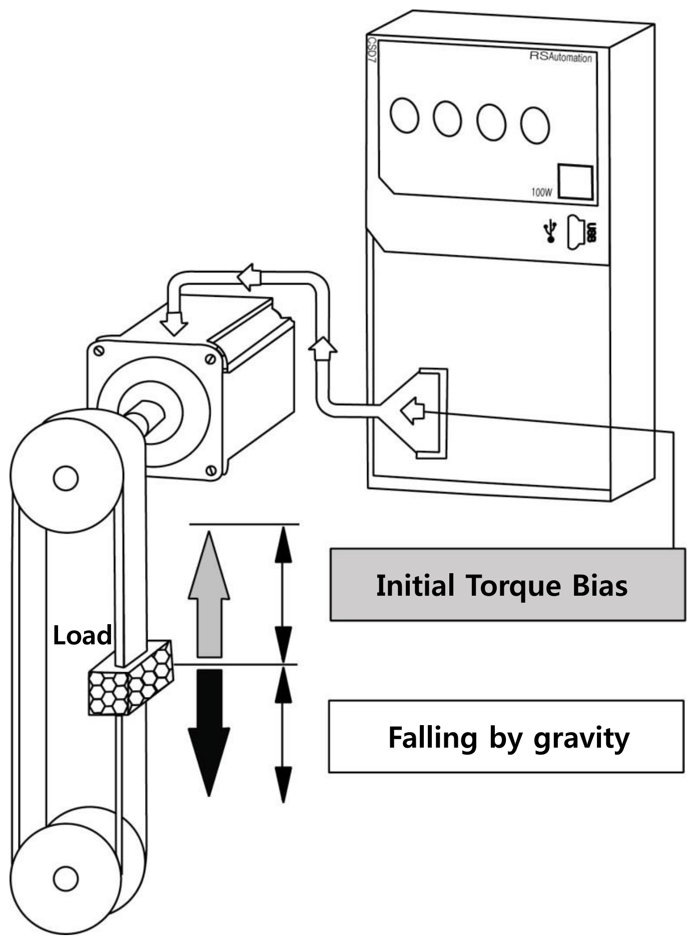
In the transient response state of the acceleration-deceleration section, if torque command is higher than setting value of 0x2105 (Ft-1.05), it becomes ‘P controller’ and the other section becomes ‘PI controller’.



Initial Torque Bias

It is the function to prevent downturn by the gravity of vertical load during initial operation.

Downturn of Load by Gravity and Initial Torque Bias



If you enter Servo-ON signal to operate motor in the condition that load is vertical as shown in the figure, downturn of load by gravity can occur.

In addition, in case of Servo-On or Servo-OFF, you need to hold or release motor brake. If you do not appropriately adjust the timing, instantly load drops occurs in the device.

As characteristics of those vertical load, velocity overshoot occurs in motor control and position completion time is delayed. In addition, if you try to operate motor under holding the brake, it can be the reason of Servo fault.

Initial torque bias is the function that generate the torque in the opposite direction of gravity to prevent falling of load when Servo-ON signal is entered in the vertical load system.

If you set initial torque bias appropriately against vertical load falling, you can prevent the downturn of vertical load during initial operation.

Setting Procedure of Initial Torque Bias

Set the appropriate value as following the procedure.

1. Check the direction of motor rotation (forward/reverse) and the motion direction of load (up/down).
2. Stop the load in the specific position using stop control.
3. Check the torque command value in 'dis-03' of the "Monitor mode function" on page 9-44 while stop control is maintained, and set this value to 0x240C (Ft-4.12) below. Set positive value if the direction that the load goes up is forward direction of motor, set negative value if the direction that the load goes up is reverse direction of motor.
   For the definition about forward and reverse rotation, refer to the "Change the Direction of Motor Rotation" on page 9-11.
4. Do detailed adjustment on the basis of current setting value as checking torque, velocity, position response of motor.

Initial Torque Bias Setting

Set the initial torque bias to the following parameter.

0x240C	**Initial Torque Bias**					**CSP**	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
-100~100	4 byte(UDINT)	%	RW	-	Always	0	Ft-4.12

Ft-4.12	**Initial Torque Bias**
Description	• The value of torque command is started from setting value of this parameter. • You can prevent falling of load, because the torque command is generated in the opposite direction of gravity when Servo-ON signal is entered.

Note

For another method of brake control, see the "Motor Brake Control" on page 9-6.

You can prevent the instantaneous drop of load just by setting the brake control timing.

CAUTION

If you set the value of initial torque bias 0x240C (Ft-4.12) too high, the load can temporarily goes up.

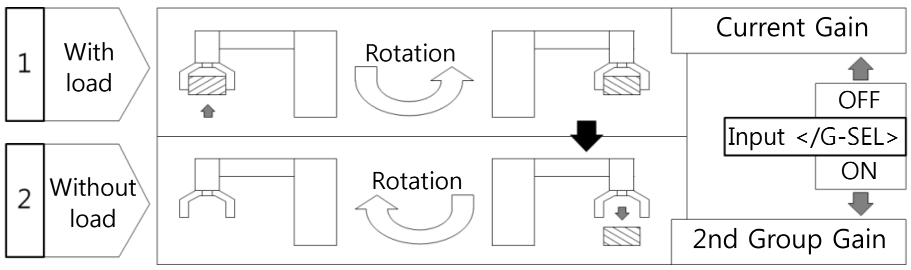
Be careful to make appropriate setting value.

Gain Group Switching, </G-SEL> Function

As shown in the figure below, two different conditions of load can be repeated. For example, robot moves a object to other position and return to the original position without any load after laying a object down.

If those movements are repeated too fast, On-line Auto Tuning is not smoothly performed. In addition, if you operate different load condition with the same gain, the response quality in one side is degraded.

In this case, you can effectively use sequence input </G-SEL> function.



The following is the procedure to use </G-SEL> function.

1. Set the optimum gain to fit for the 2nd condition in the figure above.
2. Save gains in the 2nd condition using the gain storage function (run-11). At this moment, saved gains are 2nd group gain. Corresponding gain 0x2102(Ft-1.02), 0x2103(Ft-1.03), 0x2107(Ft-1.07), 0x2402(Ft-4.02) are stored in 2nd group gain. For run-11 function, refer to the "Operation Mode Function" on page 9-36.
3. Set the optimum gain to fit for the 1st condition in the figure above. (current gain)
4. Allocate the input pin for sequence input </G-SEL> with reference to the 3-15 page "Allocation Method for Sequence Input Signal".
5. Use as matching </G-SEL> signal with the repeated movement between the 1st condition and the 2nd condition.

Therefore, if you use as dividing different loads into current gain and 2nd group gain, you can satisfy the response quality of both different load conditions.

</G-SEL> is sequence input signal. To use </G-SEL> function, allocate </G-SEL> signal with reference to the 3-15 page "Allocation Method for Sequence Input Signal".

Gain Switching Function

CSD7 Servo Drive offers the following 4 gain groups to apply various movements.

Table 99   1st Group Gain

Object	Parameter No.	Parameter Name
0x2102	Ft-1.02	1st Velocity Loop P Gain
0x2103	Ft-1.03	1st Velocity Loop I Gain
0x2107	Ft-1.07	1st Position Loop P Gain
0x2402	Ft-4.02	LPF Bandwidth of 1st Current Command

Table 100   2nd Group Gain

Object	Parameter No.	Parameter Name
0x210E	Ft-1.14	2nd Velocity Loop P Gain
0x210F	Ft-1.15	2nd Velocity Loop I Gain
0x2110	Ft-1.16	2nd Position Loop P Gain
0x2403	Ft-4.03	LPF Bandwidth of 2nd Current Command

Table 101   3rd Group Gain

Object	Parameter No.	Parameter Name
0x2111	Ft-1.17	3rd Velocity Loop P Gain
0x2112	Ft-1.18	3rd Velocity Loop I Gain
0x2113	Ft-1.19	3rd Position Loop P Gain
0x2404	Ft-4.04	LPF Bandwidth of 3rd Current Command

Table 102   4th Group Gain

Object	Parameter No.	Parameter Name
0x2114	Ft-1.20	4th Velocity Loop P Gain
0x2115	Ft-1.21	4th Velocity Loop I Gain
0x2116	Ft-1.22	4th Position Loop P Gain
0x2405	Ft-4.05	LPF Bandwidth of 4th Current Command

</BANK-SEL> Function

Four gain groups are selectable for use through </BANK-SEL>(Gain BankSelection).

</BANK-SEL> can is selected in 0x200F[02] (Ft-0.15[D1]). When the set value is ‘0’, Gain Bank 1 (1, 2 group gain), when the set value is ‘1’, Gain Bank 2 (3, 4 group gain) is selected.

0x200F	6th Assignment for Sequence Input Signal						CSP
Sub-Index 2	Gain Bank Select (/BANK-SEL)						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0x0~0xa	1 byte(USINT)	-	RW	-	Servo Off	0	Ft-0.15[D1]

[Ft-0.15][D1]	Gain Bank Select (/BANK-SEL)	
Description	0 (OFF : Open I/O state)	Gain Bank 1 (1st, 2nd gain group)
	1 (ON : Close I/O state)	Gain Bank 2 (3rd, 4th gain group)

Gain group selection between two gain groups depens on </G-SEL> signal, while gain bank selection of whether the 1st gain bank or the 2nd gain bank depends on </BANK-SEL> signal.
The 1st gain bank includes the 1st gain group and the 2nd gain group, and the 2nd gain bank includes the 3rd gain group and 4th gain group.
The following table describes gain group selection using </G-SEL> and </BANK-SEL> signal.

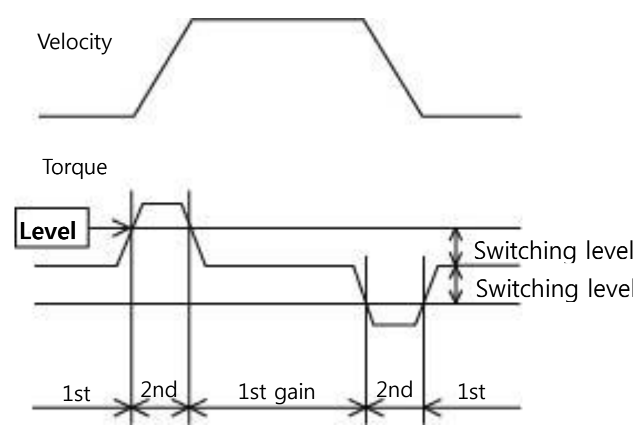
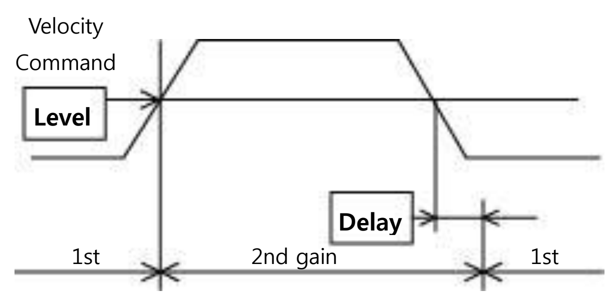
</BANK-SEL>	</G-SEL>	Gain Group Selection
0 (OFF)	0 (OFF)	1st gain group
	1 (ON)	2nd gain group
1 (ON)	0 (OFF)	3rd gain group
	ON	4th gain group

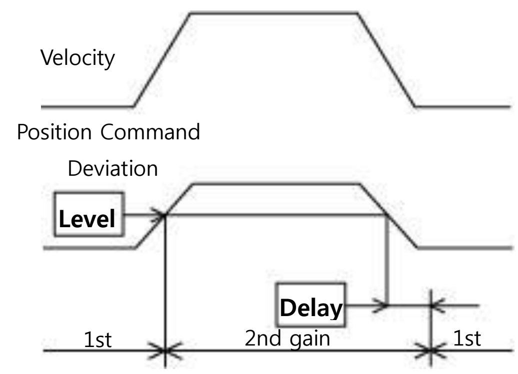
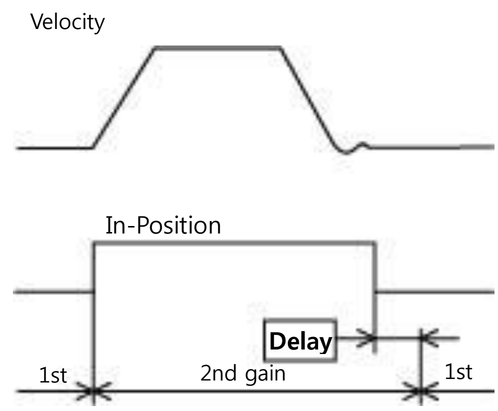
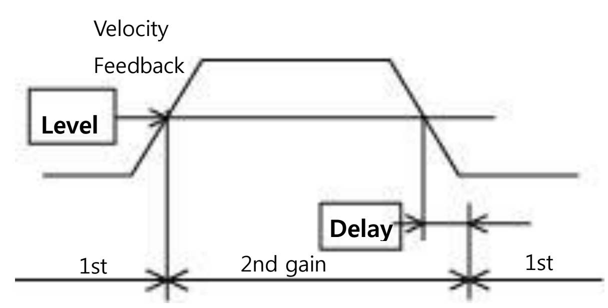
The gains after the auto tuning are saved only in the 1st gain group, and they can be manually copied to other groups and used them.

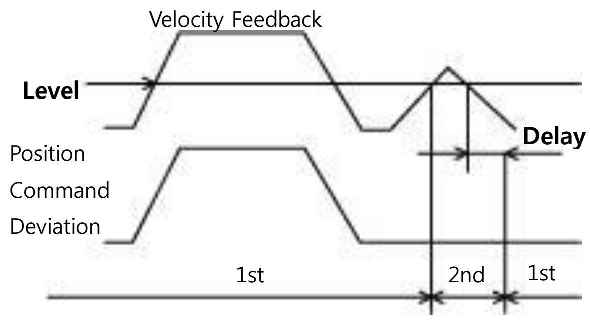
Gain Switching Mode

Gain Switching Mode can be chosen in 0x2006[03] (Ft-0.06[D2]).

0x2006	**Auxiliary Function Selection 1**						**CSP**
Sub-Index 3	Gain Switching Mode						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~9	1 byte(USINT)	-	RW	-	Always	0x0	Ft-0.06[D2]

<table>
<tr><th>Ft-0.06[D2]</th><th colspan="2">Gain Switching Mode</th></tr>
<tr><td>Range</td><td colspan="2">0~9</td></tr>
<tr><td rowspan="5">Description</td><td>0</td><td>The 1st gain is fixed (1, 3 group gain).</td></tr>
<tr><td>1</td><td>The 2nd gain is fixed (2, 4 group gain).</td></tr>
<tr><td>2</td><td>The 2nd gain is used when </G-SEL> signal is input.</td></tr>
<tr><td>3</td><td>When the torque command is higher than the set value, the 2nd gain is used.

</td></tr>
<tr><td>4</td><td>When the velocity command is higher than the set value, the 2nd gain is used.

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

	5	When the position error is higher than the set value, the 2nd gain is used. 
	6	When the velocity command is higher than the set value, the 2nd gain is used.
	7	The 2nd gain is used while the In-position signal is active. 
	8	When the motor speed is higher than the set value, the 2nd gain is used. 

	9	When the motor speed is lower than the set value without any position command, the 2nd gain is used. 

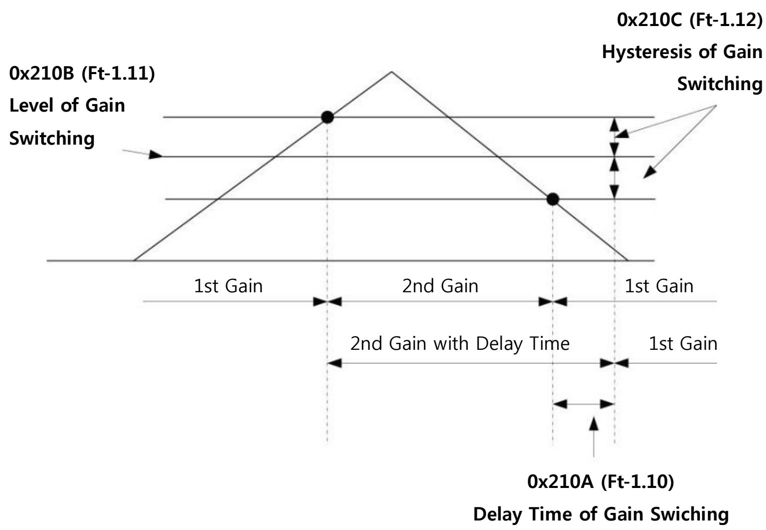
0x210A	Delay Time of Gain Switching					CSP	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~10000	2 byte(UINT)	0.125ms	RW	-	Always	0	Ft-1.10

Ft-1.10	**Delay Time of Gain Switching**
Description	When gain is switched between the first and the second gain, you can set delay time.

0x210B	Threshold for Gain Switching					CSP	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~10000	2 byte(UINT)	-	RW	-	Always	0	Ft-1.11

Ft-1.11	**Threshold for Gain Switching**
Description	It is a threshold value for gain switching. The setting value operates at the gain switching mode selected in 0x2006[03] (Ft-0.06[D2]).

0x210C	Hysterisis of Gain Switching					CSP	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~10000	2 byte(UINT)	-	RW	-	Always	0	Ft-1.12

Ft-1.12	Hysterisis of Gain Switching
Description	It is the range of Hysteresis operation when gain switching. The setting value is used in Gain Switching Mode that is selected in 0x2006[03] (Ft-0.06[D2]). 

0x210D	Position Gain Switching Time					CSP	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~10000	2 byte(UINT)	0.125ms	RW	-	Always	0	Ft-1.13

Ft-1.13	Position Gain Switching Time
Description	It set the switching delay time of position P gain when gain group is changed.

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Chapter 9. Application

This chapter describes the application function, operation mode and monitor mode when using the servo drive.

Motor Stop

Overview

The following describes the general situation when the motor can be stopped.

With the exception of motor suspended by the normal operation, the servo drive suspend its operation when the below situation occurs and result in suspension of the motor.

- Servo Fault Occurrence
- Over Travel Occurrence

The motor can be stopped by 2 above factors in normal operation of the drive, and the method of stopping the motor for each suspension factors may be set in several forms.

The method to suspend the motors by the servo drive is classified as below.

- Suspended by Using Dynamic Brake Function
- Suspended by Torque Control Consistent with Normal Operation

Servo Fault

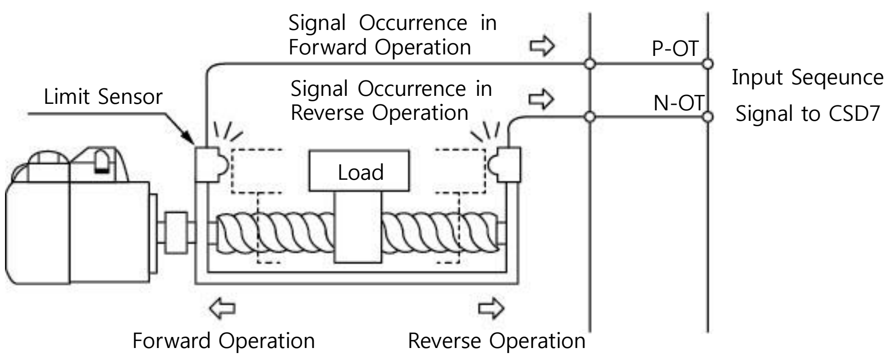
The detailed contents about servo fault are described in "Servo Fault" on page 10-6.

Overtravel Input (<P-OT>, <N-OT>)

Overtravel Signal

When the load exceeds the operation range while running, the load system may be damaged. To respond to this situation, the sensor is installed at the edge of the operation range as shown in the figure below to prevent the damages to the load system.

Allow the operation within the range so that the loading does not reach the sensor during the operation. The servo drive stops the motor to protect the load system when the signal from the sensor occurs due to the loading exceeding the operation range by a certain error. At this time, the signal occurring in forward rotation of the motor is called <P-OT> signal and the signal occurring in reverse rotation is called <N-OT> signal.



Rotation Restriction Signal In Overtravel Occurrence

The rotation restriction signals in overtravel occurrence are classified as below.

Mark	Signal Name	Description
<P-OT>	Positive Over-travel	The signal which occurs during forward rotation.
<N-OT>	Negative Over-travel	The signal which occurs during reverse rotation.

Overtravel Signal Input

<P-OT> and <N-OT> are the sequence input signals. To use these signals, refer to the "Allocation Method for Sequence Input Signal" on page 3-15 and allocate them. <P-OT> signal was allocated to #6 pin of I/O, and <N-OT> signal was allocated to #7 of I/O as a factory setting.

Note

- The overtravel signal is not the servo fault signal but it is a signal for the protection of the load system.

- When the overtravel signal is inputted, the status display mode shows the characters that the signal is inputted. For more information, see the "Status Display Mode" on page 4-8.

Stop Method in Overtravel Occurrence

Select the overtravel stop method from the below parameter.

0x2002	**Selection of Basic Mode**					**CSP**	
Sub-Index 2	Over Travel stop method						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~2	1 byte(USINT)	-	RW	-	Servo Off	2	Ft-0.02[D1]

[Ft-0.02][D1]	**Selection of Over Travel stop method**
Description	0 : The motor stops under normal control. At this time, the torque is limited by the 0x240B (Ft-4.11 : Torque Limit for Overtravel Input Signal). Refer to the "Torque Limit and Torque Limit Detection </T-LMT> signal output" on page 9-24. 1 : The motor stop depends on the setting value of 0x2002[01] (Ft-0.02[D0] : Selection of DB Stop Method). 2 : Not used. Even if <P-OT> or <N-OT> signal is detected, servo drive takes no action.

Dynamic Brake

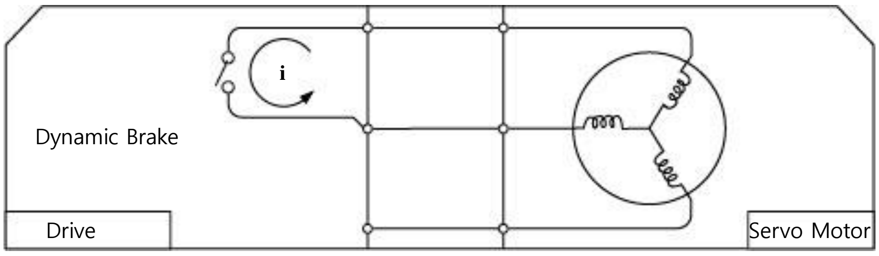
The CSD7 servo drive has a dynamic brake circuit.

Dynamic Brake

When the motor output (U, V, and W) of the servo motor is all short circuited and the motor shaft is rotated with hands, it is easy to find out that there is much more loading in the rotation than when not short circuited. The drive uses such characteristic of the motor when stopping the motor. This is referred to as a dynamic brake (DB).

The following figure shows the internal DB circuit of the servo drive.

If the motor cable is connected to the servo drive and if the power is not supplied to the servo drive, the switch in the below figure is short-circuited. This indicates that the DB is in operation. Also, the servo drive controls the DB switch according to the parameter setting for the DB operation.



CAUTION

The DB cannot be used while stopping the motor with normal torque control. The normal torque control is done in servo-ON, but the DB is only operated in servo-OFF

Dynamic Brake Stop

Dynamic brake stop means that the motor is stopped by built-in dynamic brake circuit.

Free Run Stop

Free run stop means that the motor is stopped by the mechanical friction of load only.

Dynamic Brake Stop Method

It set the DB (Dynamic Brake) stop method on the below parameter.

0x2002	**Selection of Basic Mode**					**CSP**	
Sub-Index 1	DB stop method						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~3	1 byte(USINT)	-	RW	-	Servo Off	0	Ft-0.02[D0]

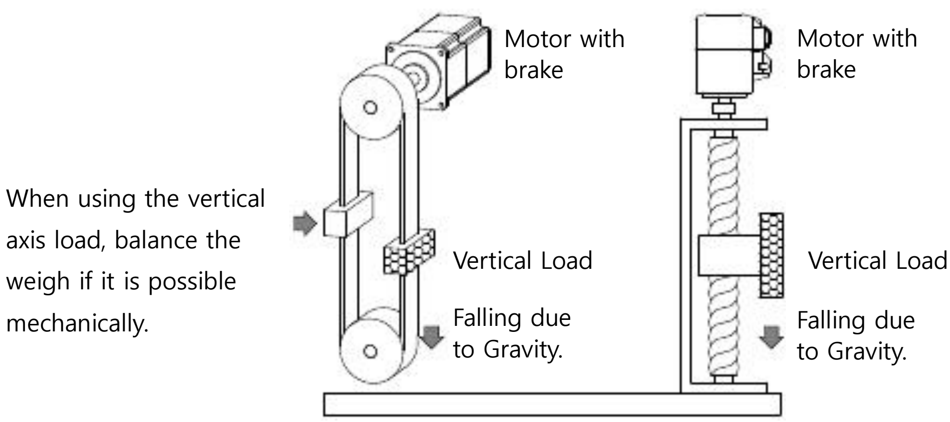
[Ft-0.02][D0]	**Selection of DB Stop Method**
Description	0: The motor is stopped by DB, and DB keep holding the motor even after the motor stop. 1: The motor is stopped by DB, and DB is released after the motor stop. 2: The DB function is not used, but the motor is stopped by free running. 3: The motor is stopped by free running, and DB keep holding the motor after the motor stop.

Motor Brake Control

Motor Brake

If you use the motor with brake, you can use the brake in the following case.

- If the load is movable by the gravity (e.g.: When applied in the vertical axis control), the falling of load can be prevented when the power is off or the drive becomes servo-off.



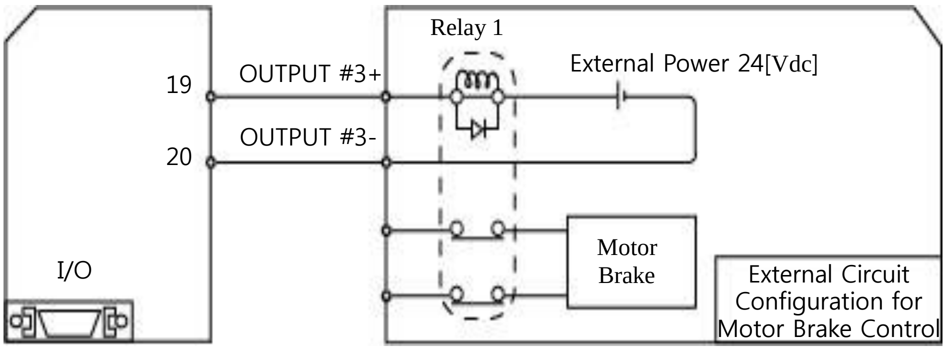
Sequence Output Signal Allocation

To use the motor brake, refer to the "Allocation Method for Sequence Output Signal" on page 3-18 first and allocate the <BK> signal. The signal for brake control is outputted with the allocatted pin. The factory setting is OUTPUT#3 (No. 19 and No. 20 pins of I/O).

Circuit Configuration

The </BK> signal is not high current that can control the motor brake directly. Therefore, the motor brake cannot be connected directly to the drive and used. So the motor brake should be controlled indirectly by configuring the external relay circuit. Refer to the indirect control circuit using a relay as shown in the figure below.

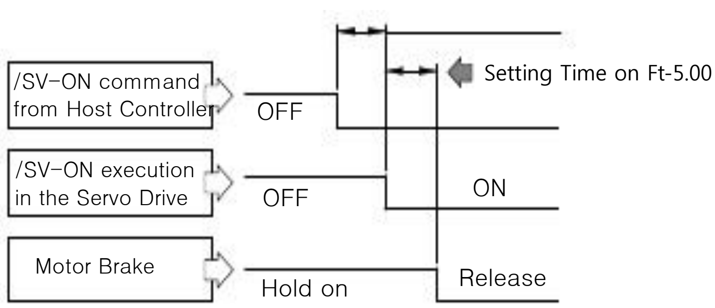
</BK> output is the sequence output signal, so the pin number of </BK> signal can be selected by the user. The </BK> pin number in the figure below is example in case of factory setting.



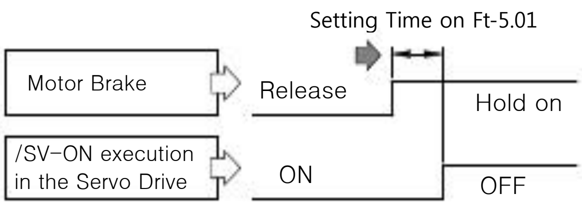
Setting for Motor Brake Control

After the allocation of the brake output signal, the detailed setting on the brake control can be made in the below parameter. Set appropriately by observing the motion of the load.

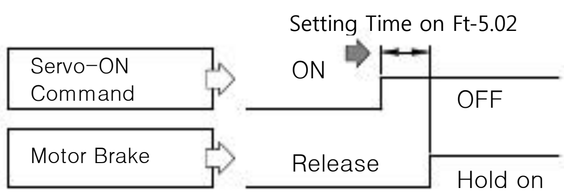
0x2500	**Delay Time of Brake Release Signal after Servo ON**					**CSP**	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~10000	2 byte(UINT)	msec	RW	-	Servo off	0	Ft-5.00

Ft-5.00	**Delay Time of Brake Release Signal after Servo ON**
Description	It set delay time of brake release signal after servo on. The motor brake has to be released first if the motor brake is in operation when the drive is about to start the motor. At this time, if the brake is released before servo-ON (or simultaneously), the vertical load will immediately fall. The drive has to be servo-on first and to prevent the fall of the vertical load, then release the brake. This setting is used to secure the time from the servo drive becomes servo-ON to the release of the motor brake. 

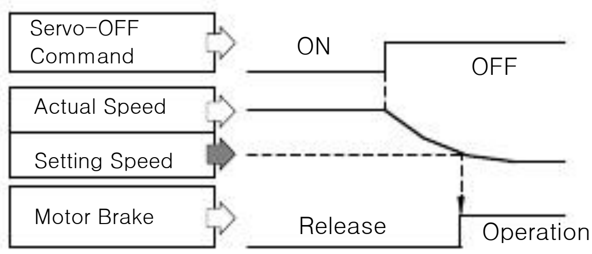
0x2501	**Servo-Off Delay Time**					**CSP**	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~10000	2 byte(UINT)	msec	RW	-	Servo off	0	Ft-5.01

Ft-5.01	**Servo-Off Delay Time**
Description	It set Servo-OFF dely time. The time between the receiving the servo-off command from the host controller to the actual servo-off by the drive can be set. This setting is used in securing the time for operating the motor brake while the host controller commanded the servo-off. 

0x2502	**Delay Time of Brake Operation**					**CSP**	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~10000	2 byte(UINT)	msec	RW	-	Servo off	500	Ft-5.02

Ft-5.02	**Delay Time of Brake Operation**
Description	It set the delay time of brake operation after servo-off. In order to stop the motor from the host controller, the servo-off command is outputted from the drive. At this time, the actual time when the motor brake is operated, can be set. 

0x2503	Threshold speed for Brake Operation					CSP	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~1000	2 byte(UINT)	rpm or mm/sec	RW	-	Servo off	100	Ft-5.03

Ft-5.03	Threshold speed for Brake Operation
Description	It set the threshold motor speed to operate motor brake after servo-off. The motor brake is activated when the motor speed go down under this set value after servo-off. 

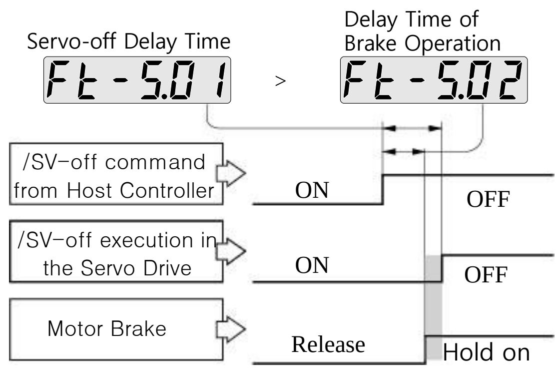
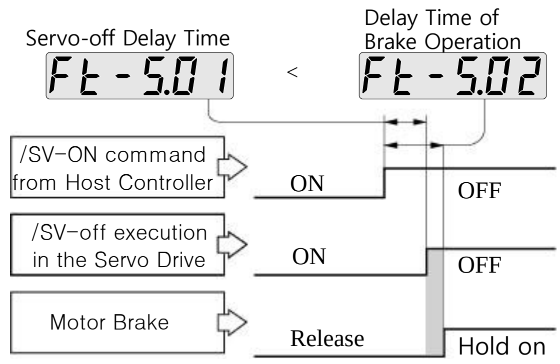
CAUTION

The brake attached to the motor should not be used to stop the running motor. Use it to maintain the stop status of the motor immediately before or after the stop.

Precautions when Setting

The below are the precautions when setting the time in Servo-ON and Servo-OFF.

As shown on the right column, if the brake operates after the actual servo-off is completed, it will temporarily be descended by the gravity in case of vertical load. As shown on the left column, lowering of the load is prevented by operating the motor brake early, before the actual Servo-OFF. In order to prevent the fall by the gravity, set the time properly.

O	X
	

The brake signal is output according to the order of priority between 0x2502 (Ft-5.02) and 0x2503 (Ft-5.03).

Others

Even when the brake attached to the motor is not used, a separate brake may be manufactured and installed by the user. When controlling the extra manufactured brake, it can be controlled by the signal from the servo drive.

Note

- Sequence output signal <BK> that is to control the motor brake is allocated at the time of the shipment.
- When not using the motor brake, allocate and use other output signal needed.
- The detailed method about the sequence output is described in the "Allocation Method for Sequence Output Signal" on page 3-18.

Change the Direction of Motor Rotation

Overview

When the rotation direction of the motor is wired differently than the intent of user by the host controller command, the rotation direction of the motor can be reversed by the below parameter setting without the separate wiring.

When the movement direction of the final mechanical part on loading side is operated to the opposite direction of the setting, the motor rotation direction can be easily converted.

Definition of Forward Rotation - CW (Clock Wise)

If the motor shaft rotates in clockwise when the motor is viewed from the load, it is rotating in forward direction.

Definition of Reverse Rotation - CCW (Counter Clock Wise)

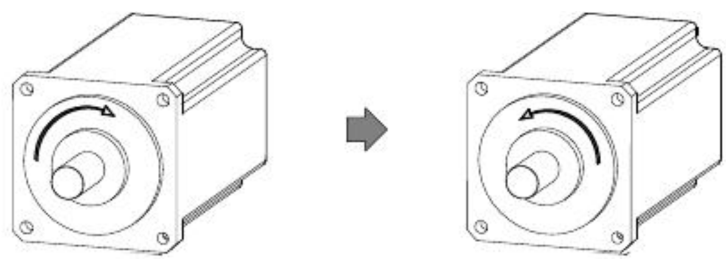
If the motor shaft rotates in counterclockwise when the motor is viewed from the load, then it is rotating in reverse direction.

Rotation Direction Setting

Set the direction of the rotation in the below parameter.

0x2002	**Selection of Basic Mode**					**CSP**	
Sub-Index 3	Rotation Direction for External Command						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~1	1 byte(USINT)	-	RW	-	Servo Off	0	Ft-0.02[D2]

Ft-0.02[D2]	**Selection of Rotation Direction for External Command**
Description	It set the rotation direction. 0 : Forward rotation is set as the CW direction. 1 : Forward rotation is set as the CCW direction.



CW direction CCW direction

Regenerative Braking Resistor

Regenerative Energy

When stopping the running motor, the motor operates like a generator and the resulting energy is called the regenerative energy.

Regenerative Braking Resistor

The regenerative energy occurring when the motor is stopped is absorbed by the servo drive in some degree, but if the energy exceeds the capacity, a separate device is needed to consume the regenerative energy. The regenerative resistor is mounted on the exterior of servo drive in order to consume the regenerative energy.

If there is excessive regenerative energy that causes the damage to the Servo Drive, but the Servo Drive is equipped with the protective circuit to shield off such phenomenon.

Generation Condition of Regenerative Energy

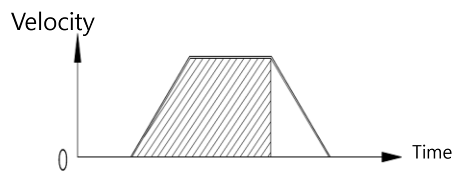
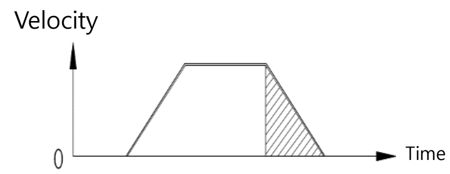
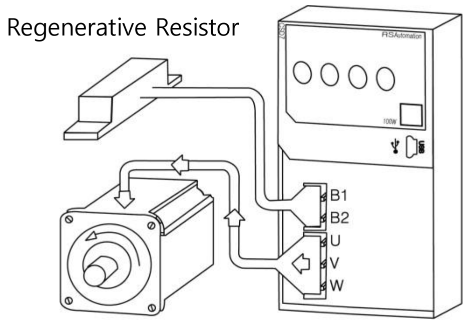
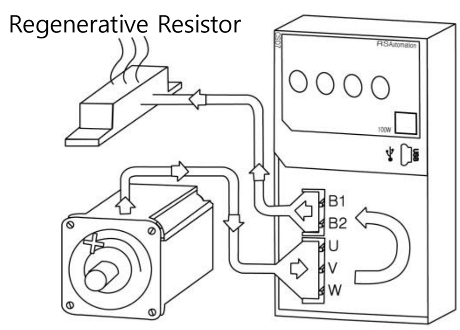
- When the speed is decelerating
- When the motor is continuously rotated by the strength of the load for example (-loading condition) or (When of operating the vertical axis loading)

Operating Condition of Regenerative Circuit

- Turn-on voltage of regenerative circuit : 385Vdc
- Turn-off voltage of regenerative circuit : 375Vdc

Precaution

Regenerative resistor equipped on the servo drive is designed to consume the regenerative energy in relatively short period of time such as in between the stops. It is not appropriate to the case when the regenerative energy is generated too much, like the cases of minus loading condition and vertical load that rotates the servo motor with the gravity. However, when the rated power of regenerative resistor that is calculated by referring to the 9-16 page "Selection Criterion of Regenerative Resistor" is smaller than the regenerative resistor attached at the time of shipment, the internal regenerative resistor can be used as is without any special actions.

Acceleration and Constant Velocity	Deceleration
	
	

Specification of Built-in Regenerative Resistor

The allowable power is 25 [%] of the rated power of the regenerative resistor mounted on the drive. But it is 50 [%] when using a cooling fan.

Table 103 Specification of Built-in Regenerative Resistor

CSD7 servo drive	Resistor (Ω)	Rated Power (W)	Allowable Power (W)	Cooling Fan
200 W or less	-	-	-	X
400 W	50	30	7.5	X
800 W	30	70	35	O
1 kW	30	70	35	O
1.5 kW	30	70	35	O
2.5 kW	12	150	75	O
3.5 kW	12	150	75	O
5.0 kW	8	250	125	O

External Regenerative Resistor

The regenerative resistor that the user connects to the outside for load is called external regenerative resistor. The following is the description when using the external regenerative resistor.

Overview

The user may consume the regenerative energy generated in the load system by increasing the rated power of regenerative resistor and installing the external regenerative resistor if the rated power of mounted regenerative resistor consumes small regenerative energy.

In order to increase the allowable power of regenerative resistor, the mounted regenerative resistor and external regenerative resistor are connected in parallel in case of 400W ~ 1.5 kW drive. Another way is to remove the internal regenerative resistor and install the separate external regenerative resistor. In case of 2.5 kW ~ 5.0 kW drive, the external resistor can be connected seperately from the mounted regenerative resistor by using the B1 and B3 terminal.

Precautions

When the rated power is increased for regenerative resistor on the above two methods, the following conditions have to be satisfied.

CAUTION

- In case of 400W ~ 1.5 kW drive, the resistor of the total regenerative resistor has to be 30 to 50 [Ω]. When used in parallel with the internal resistor, install the external regenerative resistor with resistor value 60 Ω or higher (capacity 15W or higher) for 400W drive, or the one with resistor value 180 Ω or higher (capacity 10W or higher) for 800W or higher drive
- In case of 2.5 kW ~ 5.0 kW drive, the external regenerative resistor can be connected between terminal B1 and terminal B3. The maximum resistance for the external regenerative resistor is 10 Ω for 2.5 kW ~ 3.5 kW and is 6 Ω for 5.0 kW. The external resistor power capacity should be higher than 1.0 kW.
- The regenerative resistor can be risen to 200 degree or higher of the temperature on the rated load condition. When the separate cooling

fan is not used, the temperature of the regenerative resistor may increase excessively. Therefore, user should lower it to 25 [%] of the rated power.

- The contents relating to the regenerative resistor is important. When the rated power of regenerative resistor is increased, make sure to keep the precausions above.

Selection Criterion of Regenerative Resistor

Selection Criterion Using the allowable number of repetition

The regenerative resistor has to be selected with the specification that meets the load system of the user. One of the selection standards may be the selection of optimal regenerative resistor that satisfies the load system by calculating the frequency of repeated motion of the motor.

The repeated frequency means the frequency of operation that the motor rotates and stops regardless of the rotation direction of the motor. The permitted repetition frequency means the maximum repetition frequency per minute.

The motor regenerative resistor selection by the repetitive frequency is limited to the loading operated in the horizontal direction.

Refer to the below formula to calculate the maximum allowable repetition frequency of the load system.

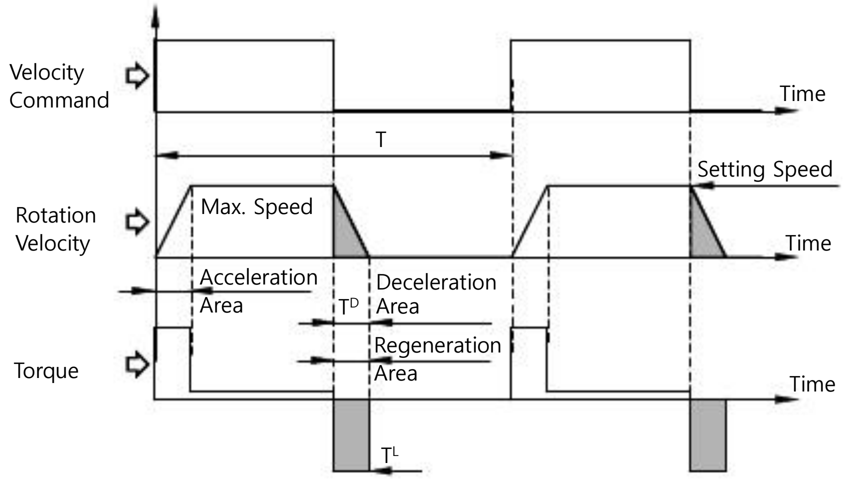
$$\text{Allowable Number of Repetition} = \frac{\text{Allowable number of repetition in without load}}{1+n} \times \left(\frac{\text{Max. Speed}}{\text{Setting Speed}}\right)^2 \ [\text{Cycles/Min}]$$

- Contents necessary in calculation shall be referred to the below.
- 'n' is the inertia ratio.
- The maximum speed of motor shall be referred to the motor specifications.

CAUTION

Make sure to use the actual repetition Frequency of the motor smaller than the permitted repetition frequency calculated on the above formula.

Tho following shows the acceleration and deceleration of the motor in certain operation cycle in horizontal axis.



$$\text{Number of repetition} = \frac{1}{T} \times 60 \text{ [Cycles/Min]}$$

It shows the allowable number of repetition per minute when operated without the load. It is left as blank if there is no applicable capacity of the motor type.

Table 104 Allowable number of repetition in Without Load [Cycles/Min]

Capacity / Motor	400W	600W	750W	950W	1.0KW	1.5KW	2.5KW	3.5KW	5.0KW
CSMR	50								
CSMR(Brake)	35								
CSMT	85	94	85	60					
CSMT(Brake)	66	75	70	56					
CSMA					50	37			
CSMA(Brake)					42	32			
CSMS									
CSMS(Brake)									
CSMD									
CSMD(Brake)									
CSMH									
CSMH(Brake)									

When the number of repetition of actual motor is larger than the allowable number of repetition that is calculated, keep the following items.

- Lower the setting velocity as far as possible.
- Set the deceleration time as long as possible after referring to the "Setting for Smooth Operation" on page 9-19.

- Limit the torque as low as possible after referring to the “Torque Limit and Torque Limit Detection </T-LMT> signal output” on page 9-24.
- Make the inertia of load small.

Setting for Smooth Operation

Overview

By setting the acceleration/deceleration time and S-curve operation time on the servo drive, the impact that may occur in acceleration or deceleration can be reduced to result in smoother operation.

Definition of Acceleration

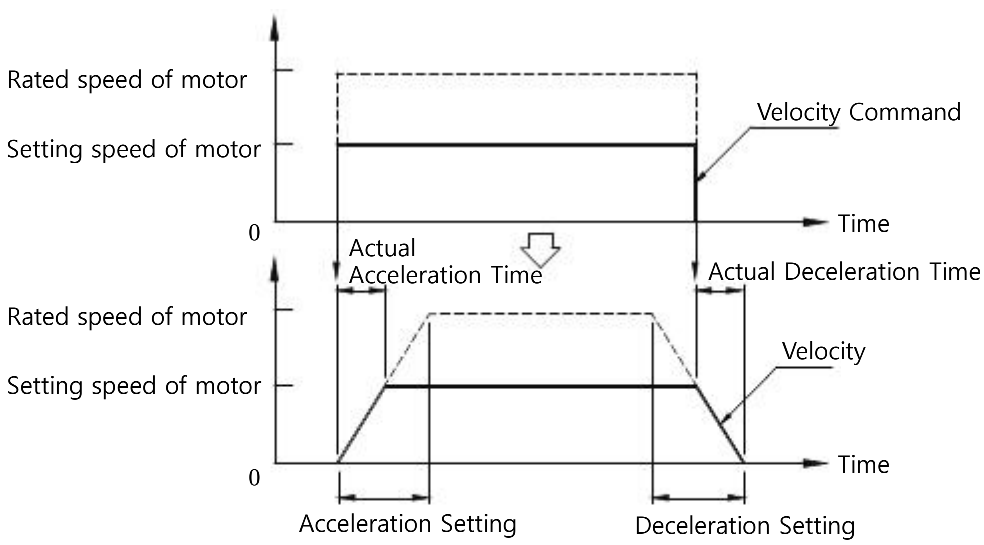
Acceleration is the rate of change in speed from stop to the motor's rated speed.

Definition of Deceleration

Deceleration is the rate of change in speed from the motor's rated speed to a stop.

Velocity Command and Acceleration/Deceleration

The figure below shows the implementation of the speed command by the Servo drive after the Acceleration/Deceleration speed is set. It shows that the longer the deceleration time is, the longer the time for the implementation of the command becomes.



Acceleration/Deceleration Setting

Set the acceleration/deceleration on the below parameters.

0x2206	Acceleration					CSP	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
1~ 2147483647	4 byte(UDINT)	10^{-2} x rev / sec^2	RW	-	Always	41667	Ft-2.06

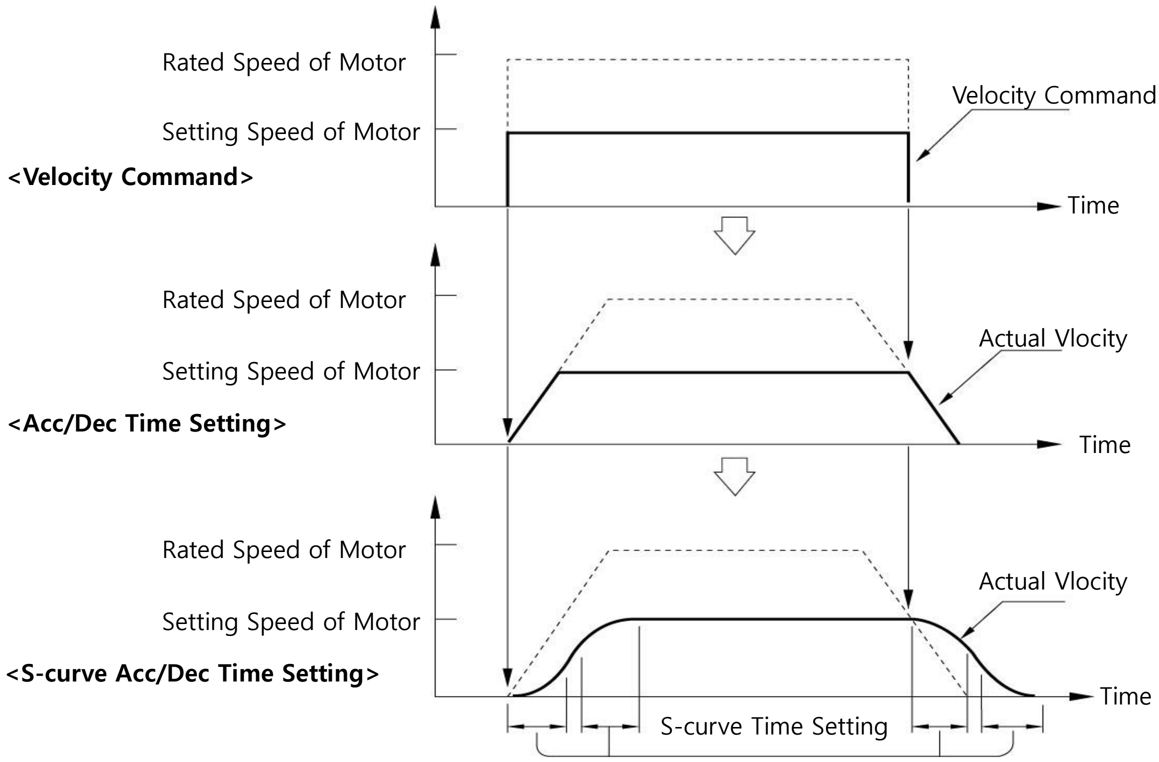
Ft-2.06	Acceleration
Description	It set the acceleration of motor.

0x2207	Deceleration					CSP	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
1~ 2147483647	4 byte(UDINT)	10^{-2} x rev / sec^2	RW	-	Always	41667	Ft-2.07

Ft-2.07	Deceleration
Description	It set the deceleration of motor.

Definition of S Curve Operation

As shown in the below figure, by performing the S-curve command at the conversion point of acceleration/deceleration, more smooth operation can be had.



S-curve Time Setting

Set the S-curve time on the below parameter.

0x2208	**S-Curve Time**					**CSP**	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~5000	2 byte(UINT)	msec	RW	-	Always	0	Ft-2.08

Ft-2.08	**S-Curve Time**
Description	It set the S-curve time in each acceleration and deceleration.

Caution

The profile time of velocity command differs according to the setting of acceleration, deceleration and S-curve time.

If the required time for initial velocity command profile is 10 seconds, its profile time after the acceleration-deceleration time setting is changed to 10 seconds + 0x2207 (Ft-2.07). Also, its time after the S-curve time setting is changed to 10 seconds + 0x2207 (Ft-2.07) + 0x2208 (Ft-2.08)

CAUTION

If the S-curve time setting is set as '0', the S-curve operation is not used. Also, without the setting of acceleration/deceleration, the S-curve operation alone can not be used. For the use of S-curve operation, first set the acceleration/deceleration that is appropriate to the user's situation.

Velocity Limit and Velocity Limit Detection </V-LMT> signal output

It describes the functions for limiting the rotation velocity of the motor.

The speed is limited by the values that are set in the following parameter by the user. Therefore, even though the host controller transmits a command with a higher speed than the set values, the servo motor nevertheless revolves at limited speed by the set values.

0x2210	**Set Value of Velocity Limit**					**CSP**	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
1~6000	2 byte(UINT)	rpm (mm/s)	RW	-	Always	5000	Ft-2.16

Ft-2.16	**Set Value of Velocity Limit**
Description	The rotation speed of motor is limited by this vales. Once the motor model is selected, the initial value of Ft-2.16 is automatically set to the maximum speed of the motor.

While the motor speed is limited by 0x2210 (Ft-2.16), the speed limit detection signal </V-LMT> is output.

Motor Rotation Speed ≥ Set Value of [Ft-2.16] → /V-LMT Signal Ouptput

The </V-LMT> is the sequence output signal. To use </V-LMT> function, see "Allocation Method for Sequence Output Signal" in the page 3-18 and assign the </V-LMT>signal.

Select Speed Limit Method

Select how to limit the speed in the following parameters.

0x2211	**Velocity Limit Mode Selection**					**CSP**	
Sub-Index 1	Selection Mode						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~1	1 byte(USINT)	rpm (mm/s)	RW	-	Always	0	Ft-2.17[D0]

Ft-2.17[D0]	**Velocity Limit Mode Selection**
Description	Set how to limit the motor speed.
설정값	0 : The speed limit function is not used 1 : The motor speed is limited by the set value of the 0x2210 (Ft-2.16).

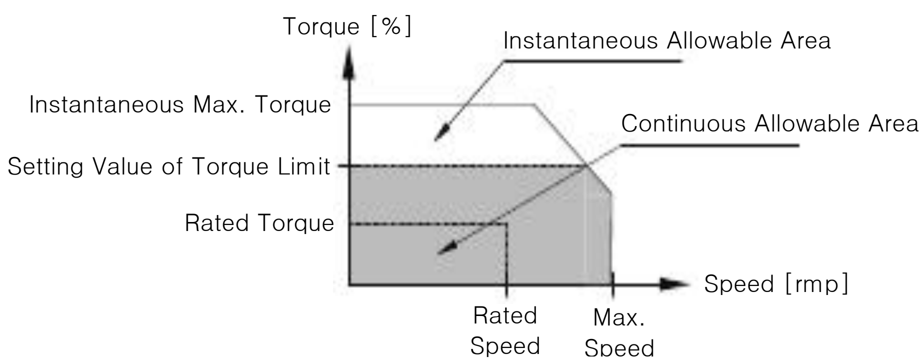
Torque Limit and Torque Limit Detection </T-LMT> signal output

In this page, additional function about torque limit is described on the basis of the “Torque Limit Function” on page 6-31. For basic function, see the “Torque Limit Function” on page 6-31

Supplementary Explanation

Internal limit is used to limit maximum value of operation torque of motor (or output torque) within set range to protect the load system or the object on work.

Generally, the allowable torque limit of motor is as shown in the figure below. Therefore, torque limit in the speed over rated speed is achieved within the momentary operation range as shown in the figure. In high speed range, torque limit according to current motor speed is automatically processed inside Servo drive. If the values of 0x60E0 (or 0x2407, Ft-4.07) and 0x60E1 (or 0x2408, Ft-4.08) are set as shown in the following figure, torque of motor is limited as the lined area in the figure.



Note Depending on the motor type, there is a maximum instantaneous torque that is less than 300 [%]. If you set 0x60E0 (or 0x2407, Ft-4.07) and 0x60E1 (or 0x2408, Ft-4.08) to the value over maximum torque that motor allows, it is limited to maximum torque value as ignoring setting value.

Torque Limit when Overtravel Occurs

When overtravel occurs except external and internal torque limits described above, you can limit torque as setting separate parameter.

For overtravel, refer to the 9-3 page “Overtravel Input (<P-OT>, <N-OT>)”.

Set torque limit value to be limited when overtravel occurs to the following parameter. The setting value is applied to both positive and negative torque as being different from the internal and external torque limits.

0x240B	**Torque Limit for Overtravel Input Signal**					**CSP**	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~500	2 byte(UINT)	%	RW	-	Always	350	Ft-4.11

- ▶ RSWare : Drive - Stopping Functions - Maximum Stopping Current
- ▶ It limits the motor torque if the motor is stopped by overtravel input signal (<P-OT>,<N-OT>) during operation.
- ▶ Unlike external and internal torque limit, both forward and reverse rotation are limited by this setting value.

Note Because internal torque limit is always valid, so if the setting values of external torque limit and overtravel torque limit are bigger than the internal torque limit, the setting value of external torque limit and overtravel torque torque limit are meaningless. So be careful of the setting.

Torque Limit Detection </T-LMT> Output

As described before, the torque applied to the motor can be limited by setting the following parameters.

- Torque Limit by Internal Value ; 0x2407 (Ft-4.07), 0x2408 (Ft-4.08)
- Torque Limit by External Input ; 0x2409 (Ft-4.09), 0x240A (Ft-4.10)
- Torque Limit by Overtravel Protection Input ; 0x240B (Ft-4.11)

While the motor torque is limited by one of the set values above, the torque limit detection signal </T-LMT> is output.

The </T-LMT> is the sequence output signal. To use the </T-LMT> function, see “Allocation Method for Sequence Output Signal” in the page 3-18 and assign the </T-LMT> signal.

Position Feedback to the Host Controller

Overview

Servo drive controls the servo motor by using several information received from the encoder. Also, the servo drive has the function to output the encoder information to host controller. In this the chapter, it describes the output function of encoder information.

Types of Output Signal Transmitted to Host Controller

The total of 2 below encoder signals is transmitted to the host controller.

Table 105 Encorder signal transmitted to the host contoller

Mark	Function	Signal Type
EA+, EA-	Output signal of encoder A+, A-	Line drive
EB+, EB-	Output signal of encoder B+, B-	Line drive

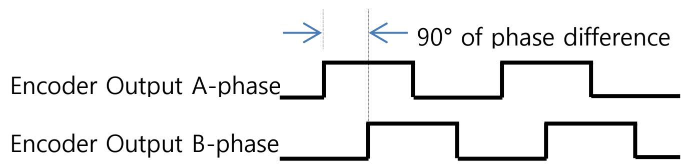
Example of Wiring with Host Controller

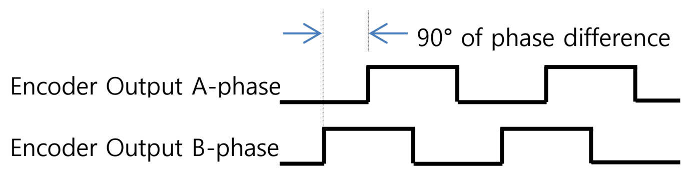
Refer to the "Encoder Wiring" on page 3-26 for the example of wiring between host controller and servo drive.

Direction Change of Encoder Pulse Output

It changes the direction of encoder pulse transmitted to the host controller.
Set the below parameter to change the direction of output pulse.

0x2300	**Encoder Pulse Setting**					**CSP**	
Sub-Index 3	Direction Change of Encoder Pulse Output						
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
0~1	1 byte(USINT)	-	RW	-	Servo Off	0	Ft-3.00[D2]

<table>
<tr><th>[Ft-3.00][D2]</th><th>Direction Change of Encoder Pulse Output</th></tr>
<tr><td>Description</td><td>It set the direction of output pulse output.</td></tr>
<tr><td>Setting Value</td><td>0 : In forward rotation, the encoder output A-phase have a lead of 90° over B-phase.


1 : In forward rotation, the encoder output B-phase have a lead of 90° over A-phase.

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

Pulse Dividing Circuit

Overview

Servo drive may adjust the number of pulse of encoder through the dividing circuit function before transmitting to the host controller through the input received from the encoder.

Calculation Formula for The Number of Pulse Output

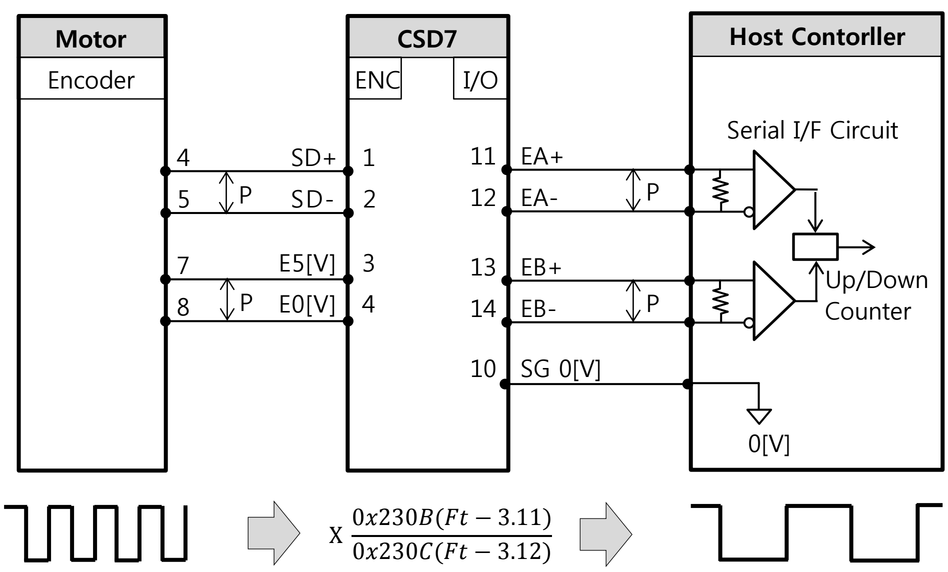
The number of output pulse is set by the formula below.

[0x230B(Ft-3.11)/0x230C(Ft-3.12)]×Number of Encoder Pulse = Output to Host Controller

If the encoder connected to the drive generates 32768 pulses per rotation, and want to transmit 1000 pulses per rotation to the host controller. Set the numerator 0x230B(Ft-3.11) to 1000 and denominator 0x230C(Ft-3.12) to 32768 as shown below.

(1000/32768) × 32768 = 1000

In the above example, the servo drive receives 32768 pulse per rotation from the encoder, but transmit 1000 pulse to the host controller.



Setting

Set the numerator and denominatior of the pulse dividing circuit to the below parameters.

0x230B	Encoder Output Ratio (Numerator)					CSP	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
1~8388808	4 byte(UDINT)	Pulse	RW	-	Servo off	1	Ft-3.11

Ft-3.11	Encoder Output Ratio (Numerator)
Description	Set the numerator of encoder output ratio. Generally, enter the the number of the pulse per rotation to be transmitted to a host controller.

0x230C	Encoder Output Ratio (Denominator)					CSP	
Setting Range	Size (Data Type)	Unit	Access	PDO Map	Attribute	Init Value	Ft-no
1~8388808	4 byte(UDINT)	pulse	RW	-	Servo off	1	Ft-3.12

Ft-3.11	Encoder Output Ratio (Denominator)
Description	Set the denominator of encoder output ratio. Generally, enter the number of the encoder pulse generated per rotaion.

If run-12 function is performed, the value of above two parameters are automatically set the number of encoder pulse being used currently.

CAUTION

CSD7 servo drive can not make the number of output pulse more than the number of receiving pulse from encoder.
Therefore, the value of numerator 0x230B (Ft-3.11) should be same or less than the value of denominator 0x230C (Ft-3.12).

Use of Absolute Encoder

The following describes on the matters related to the absolute encoder, battery, and connecting with host controller.

What is an Absolute Encoder?

Absolute encoder is an encoder that can detect the absolute position of input.

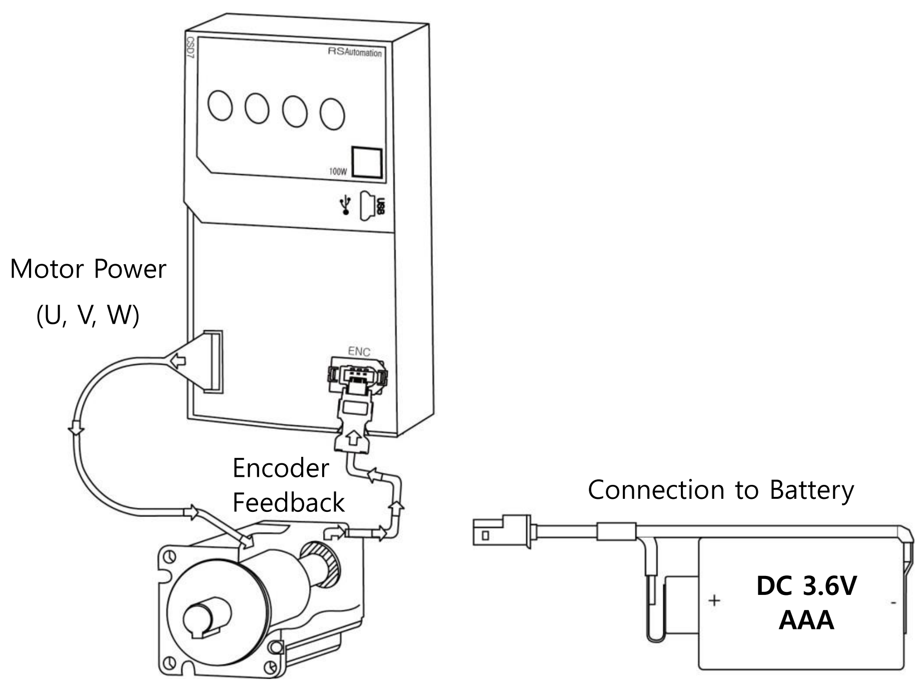
Absolute encoder can store and memorize the absolute position information of the load system by using the battery power if the power of servo drive is cut off. Absolute encoder does not accumulate the error by the noise during the signal transmission. Also, if the power is cut off as in the incremental encoder, there is no need to adjust again for initial load position, and the operation of equipment can immediately be executed by using the saved information.

When the host controller needs the absolute position of load system in the power cut off, the motor that is equipped with the absolute encoder has to be used.

Types of Absolute Encoder :

- Q type serial absolute encoder (17-bit serial·absolute encoder)

Drive Output and Encoder Feedback Flow :



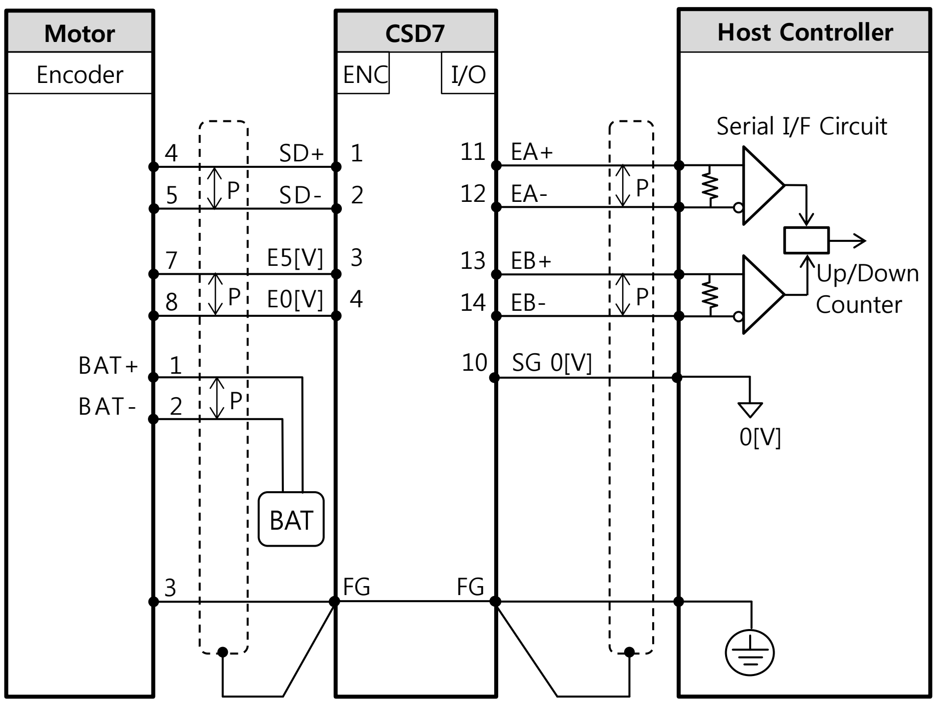
Absolute Encoder has to be connected with the Battery. The battery memorizes and maintains the absolute position of load system when the servodrive power cut off.

Connecting with Host Controller

When the motor equipped with the absolute encoder is used, the standard connection with the drive and host controller is as below figure.

For memorizing and maintaining the absolute position information, the absolute encoder shall be connected to a battery.

The battery may be connected to motor encoder cable.



* BAT : Connect when absolute encoder is used

Battery

Battery

It describes the battery for absolute encoder information preservation.

When the power of servo drive is cut off, the battery memorizes the absolute position of the load system and helps maintain it.

If the power of servo drive is cut off and discharged the battery power to lower than the standard, the saved information in absolute encoder may be damaged.

Battery specification : 3.6V

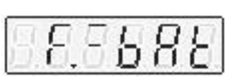
The voltage of battery is not directly monitored from the drive but the error is checked indirectly through the encoder. Prepare the low voltage detection circuit as needed basis.

Battery Voltage Diagnosis

The voltage monitored with encoder is displayed for servo warning and fault depending on the following situation.

- Servo Warning

When the voltage of battery for absolute encoder is 3.2 [V] or less, Absolute encoder battery low voltage warning occurs. At this time, the below warning characters are displayed in the status display mode.



Replace the battery before having 'Battery low voltage fault for absolute encoder' occurs with the battery low voltage in having the warning.

- Servo Fault

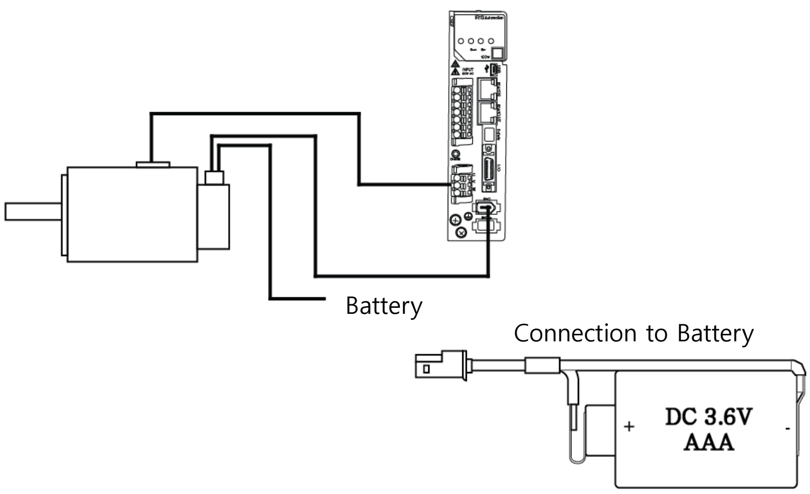
When the voltage of encoder inside is detected about 2.7 [V] or less, the battery low voltage fault for absolute encoder occurs. At this time, the servo drive stops the operation.

When 'Battery low voltage fault for absolute encoder' occurs, the saved information on encoder may be damaged.

Note In case of the Q & T type 17&23-bit absolute encoder, when an absolute encoder batter low battery warning occurs, the warning is reset only by running the fault reset (run-08). At this time, both multi-turn and single-turn data are reset.

Connecting Battery to Encoder

The below figure is how to connect the battery to encoder of servo motor.



1. Prepare the proper battery for specification.
2. Be careful of the polarity when battery is connected.

Reset of Absolute Encoder (0x300A, run-10)

Implement the absolute encoder reset (run-10) in the following cases.

- For initial trial operation
- When separate the drive and encoder cable after cutting off the power and connected again.
- When wanting to reset the number of rotation data.

Caution has to be taken on the following.

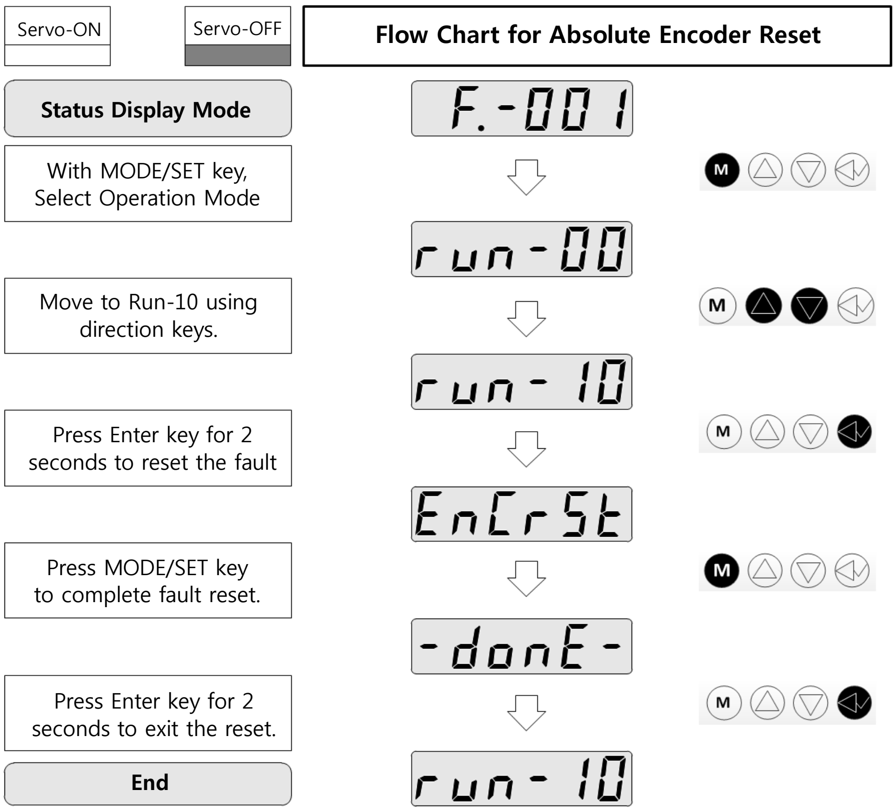
- The reset operation of absolute encoder is possible only in servo-OFF status.
- Performing the absolute encoder reset differs from performing the fault reset. Read carefully the following Table 106 prior to use.

Table 106 Comparison Table Between Absolute Encoder Reset and Fault Reset

Function	Description (Q type encoder)
Fault Reset (run-08)	• Fault clear • When the following faults occur, the multi-turn data and single-turn data are initialized. E.ABSOS(E.084) E.MTCOF(E.028) E.MTCER(E.085) E.ABSBE(E.083) • If the CNT warning is not removed automatically, the CNT warning is cleared.
Absolute Encoder Reset (0x300A, run-10)	• Multi-turn data and single-turn data are initialized. • If the CNT warning is not removed automatically, the CNT warning is cleared.

Note When using an absolute encoder, you should reset the absolute encoder (0x300A, run-10) in order to initialize the multi-turn data.

Refer to the below flow chart to make absolute encoder reset.



When Using the Absolute Encoder Without a Battery

1. When CSD7 powers up, the absolute encoder battery fault (E.AbSbE) occurs.
2. After waiting the time long enough to fully charge the internal capacitor of the encoder, run the absolute encoder reset (0x300A, run-10, multi-rotation data reset) and then run the fault reset (run-08) again.
3. After a normal reset without battery, the battery low voltage warnnig will occur continuously, however the servo drive can be operated.

Note

- While operating, if the power cut-off time is prolonged until the internal capacitor of the encoder totally discharges, 'E.AbSbE' fault will go off again. In this case, repeat the above process
- The internal multi-rotation data of the encoder may be damaged when the power is cut off while operating without a backup battery.

The serial absolute encoder (Q type) checks if the battery is connected and sends the data to the drive; 'E.AbSbE' fault will continue if there is no a battery. At this time, adjusting the parameter so the serial absolute encoder can be recognized as a serial incremental encoder will enable the operation of the motor.

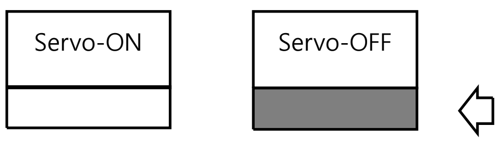
Operation Mode Function

Before You Begin

First understand the below content before reading the description of the operation mode.

- From the flow chart content, the content of display of 'Status Display Mode' may be different from the actual condition.
- The content displayed in the flow chart and the key operation sequence is the same with the actual condition.
- The black part of key button mark on the right means to press.
- The upper left side with servo-ON, servo-OFF means the status of servo drives status in setting.
- It describes to the order from (run-00) to (run-12).
- Before using the functions of operation mode, the content of each functions and flow chart shall sufficiently understand and operate it.

Adjust or operate in the black display status.



When the status of drive is not maintained, the following content is displayed during the performance or storage of each operation ode.

Jog Operation (run-00)

Function Description

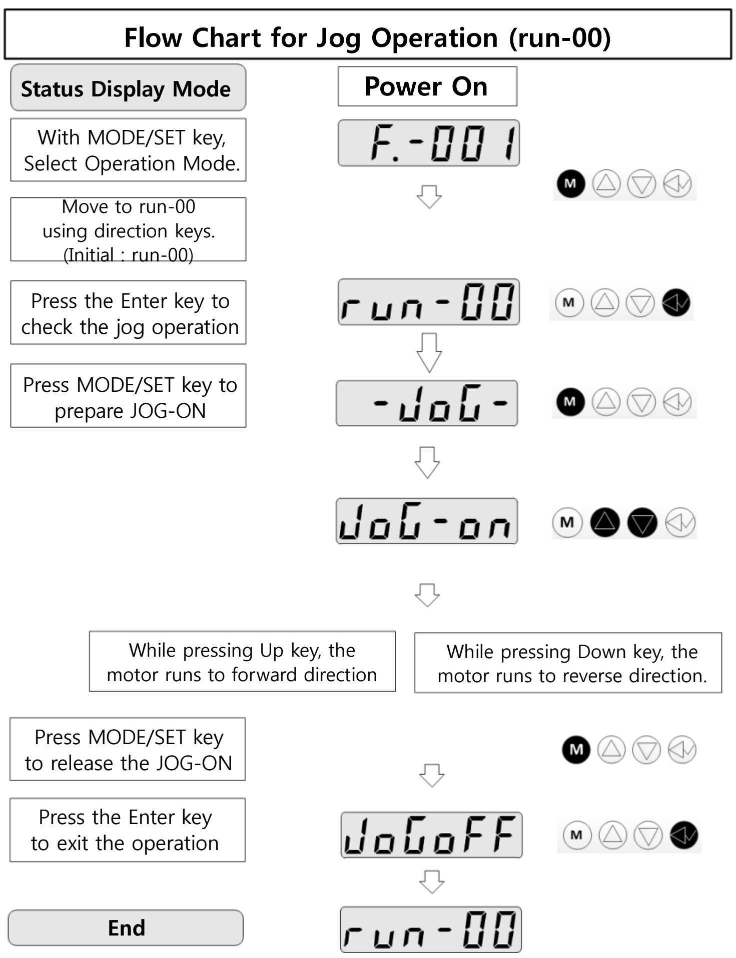
By using the direction key of the operator, the motor can be made for forward rotation or reverse rotation.

It is an appropriate function when the trial operation of equipment or simple operation is required.

The speed of the motor is determined with the setting value of 0x2205 (Ft-2.05). Confirm the setting value of 0x2205 (Ft-2.05) in advance before operation and adjust it for situation. The operation can be possible in the range of 0 to 6000 rpm and the initial setting speed is 50 rpm.

How to Operate

Refer the flow chart below and operate.



Off-line Auto Tuning (0x3001, run-01)

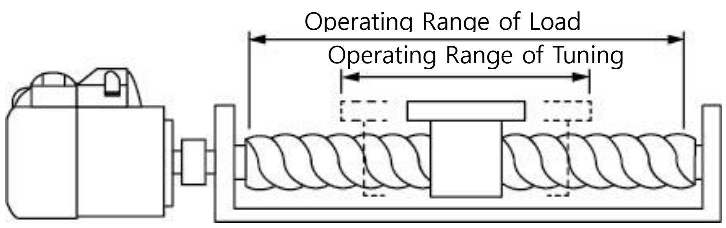
Function Description

For detailed description about off-line auto tuning, refer the "Off-line Auto Tuning" on page 8-10.

Caution

The following shall be carefully reviewed before operation.

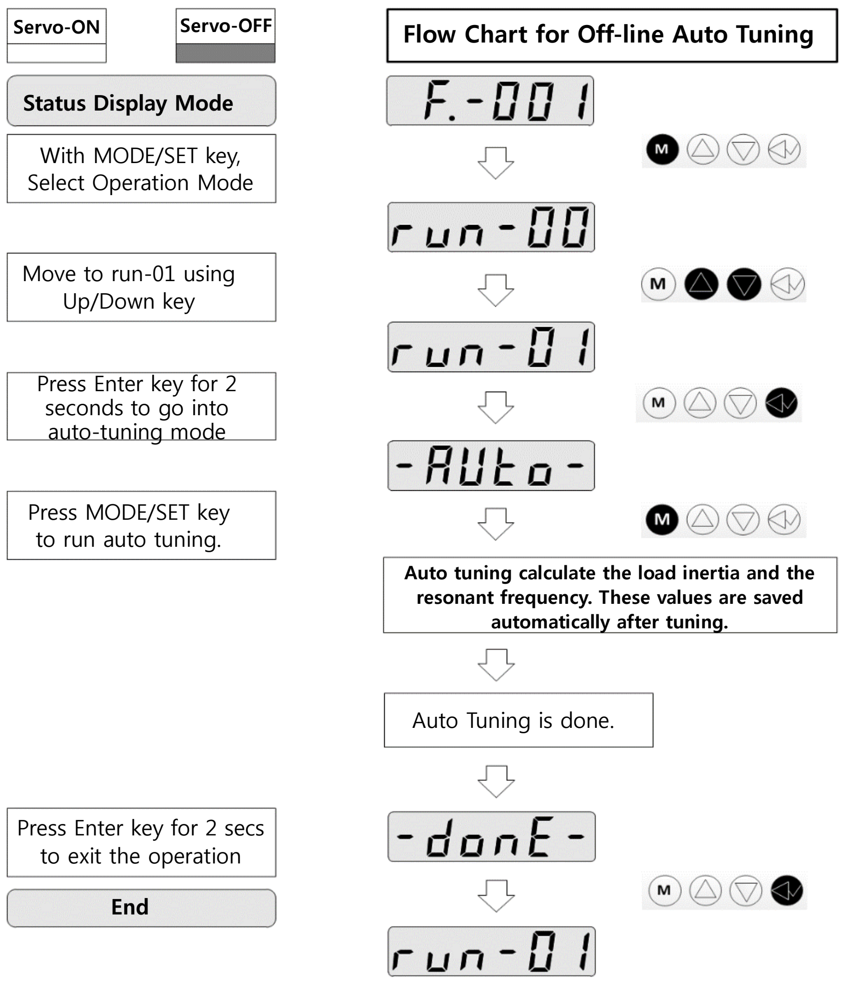
CAUTION	• Move the load to the center of operating range with the Jog operation (run-00). • The motor rotates 3 times in 360° forward and reverse direction. • Check the load not to exceed the operating range during tuning.



Operating Range of Load > Operating Range of Tuning

How to Operate

Refer to the below flow chart to operate.



Fault Reset (run-08)

Servo drive can reset the servo fault generated by the fault-diagnostic function.

Function Description

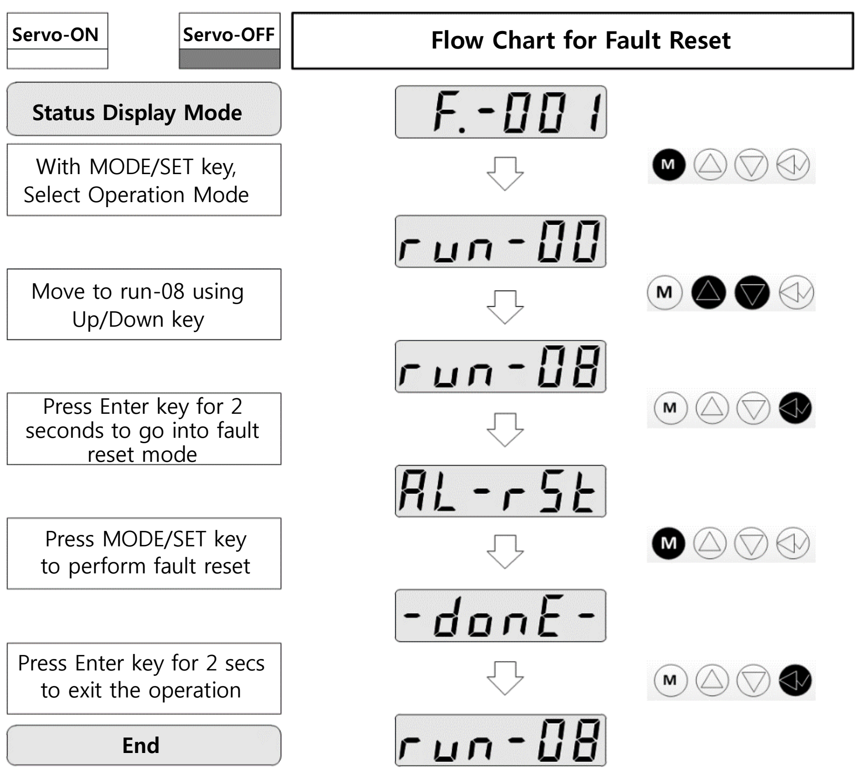
The drive monitor the system with the independent error diagnosis function from the moment the power is connected. At this time, if there is an error in the servo drive, it displays the servo fault.

User has to understand the content of fault and resolve the causes of fault for a normal use of the drive. If an fault occurs, find out the content of fault and resolve it. After that, reset it through the fault-reset operation. When the content of fault is resolved with no further problems, the occurred fault is no longer displayed.

Even if the fault reset is made, if the action taken is not sufficient or other error occurs, the drive continuously displays the fault content.

How to operate

Refer to the flow chart below and operate.



Fault Reset by Sequence Input </A-RST> Signal

There is another way to reset the fault by using the sequence input signal </A-RST>. Refer to the "Sequence Input Signal (Allocable)" on page 3-14.

Note

- Chapter 10 describes the detailed information relating to servo fault.
- Also, the fault history occurred from the beginning until now can be checked through the monitor mode. (Refer to the 9-44 page "Monitor mode function".)

Absolute Encoder Reset (0x300A, run-10)

For detailed description about the absolute encoder reset, refer to "Reset of Absolute Encoder (0x300A, run-10)" on page 9-34.

Storage of 2nd-Group Gain (run-11)

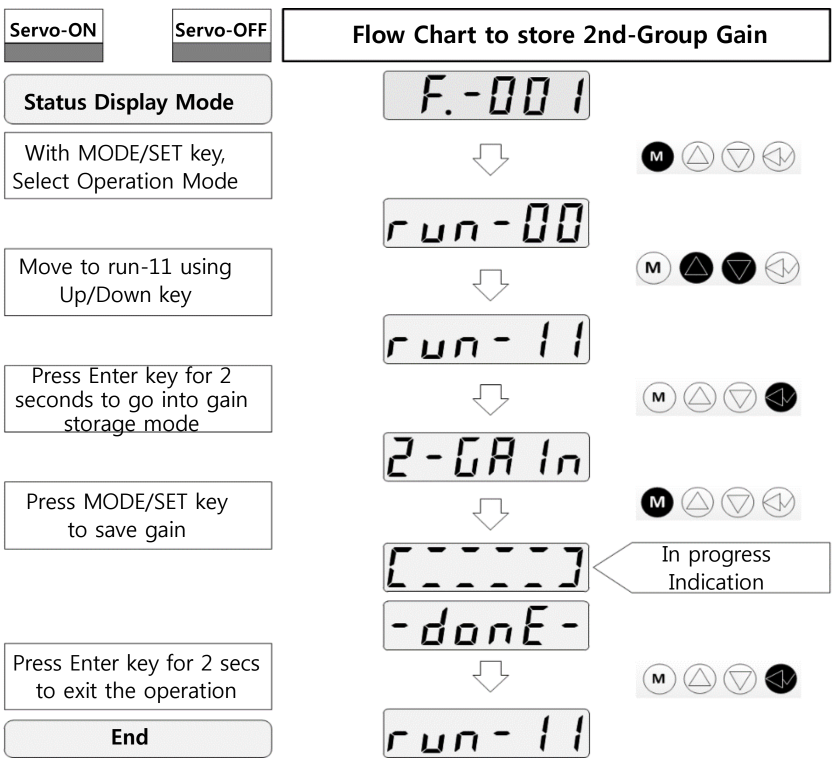
Function Description

Please read and understand the description of the page 8-42 "Gain Group Switching, </G-SEL> Function" first.

If the optimal tuning that is appropriate to the load system is done, store the 1st-group gain to the 2nd-group gain.

How to Operate

Refer to the flow chart below and operate.



Note If the </G-SEL> function described on page 8-42 is not used, this storage function is meaningless.

Parameter Initialization (run-12)

This function is to initialize the user parameter to the same status as the factory setting values.

Function Description

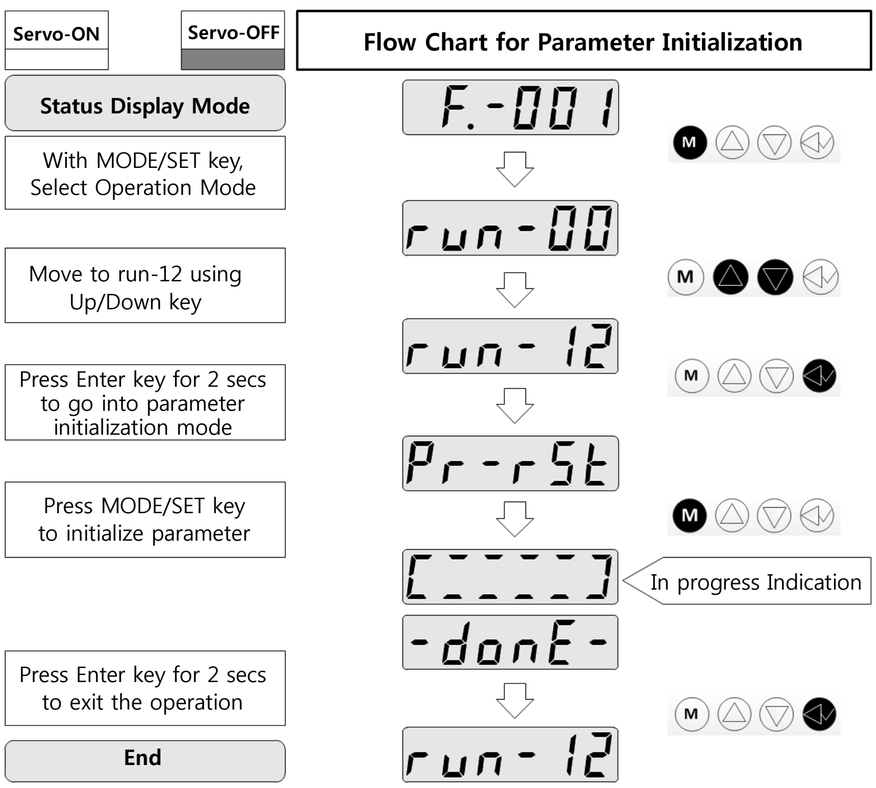
The initialization of parameter is operated carefully. After initializing parameter, the parameter has to be reset in meeting the load.

The below parameters are not changed after initializing parameter. For changing the below parameters, change them manually.

- Ft-0.00 : Control Mode Setting (Optional)
- 0x2006 (Ft-0.06) : Auxiliary Function Selection 1

How to Operate

Refer to the flow chart below and operate



Monitor mode function

Introduction to monitor mode

The below chart describes the function expressed in each monitor.

Table 107 Introduction To Monitor Mode

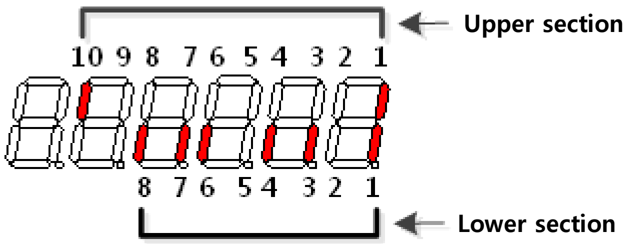
Object monitor	Built-In monitor	Description	Unit
0x2A00	dis-00	Velocity feedback	rpm
0x2A01	dis-01	Velocity command	rpm
0x2A02	dis-02	Velocity error	rpm
-	dis-03	Torque command	%
-	dis-04	Position feedback	pulse
-	dis-05	Position command	pulse

The [dis-04] and [dis-05] are displayed each upper and lower digits (5 digits each, total 10 digits) separately by left and right key in case of overflowing count data.

Object monitor	Built-In monitor	Description	Unit
-	dis-06	Position error	pulse
-	dis-07	Position command frequency	kpps
0x2A08	dis-08	Electrical angle	°
0x2A09	dis-09	Mechanical angle	°
0x2A0A	dis-10	Accumulated load factor of regenerative resistor	%
-	dis-11	DC Link voltage	V
0x2A0C	dis-12	The number of rotation of absolute encoder	-
-	dis-15	I/O status	-

<Monotor mode dis-15>

When the sequence input & output, emergency stop and servo fault signal are on, the applicable displays of each position are lit.



Upper section : The status of digital I/O input (INPUT1 ~ INPUT4)

- 1st digit : LED is turned on, while digital INPUT1 is ON.
- 2nd digit : LED is turned on, while digital INPUT2 is ON.
- 3rd digit : LED is turned on, while digital INPUT3 is ON.
- 4th digit : LED is turned on, while digital INPUT4 is ON.
- 5th ~ 8th digit : Not used
- 9th digit : Touch_probe_1 signal
- 10th digit : Touch_probe_2 signal

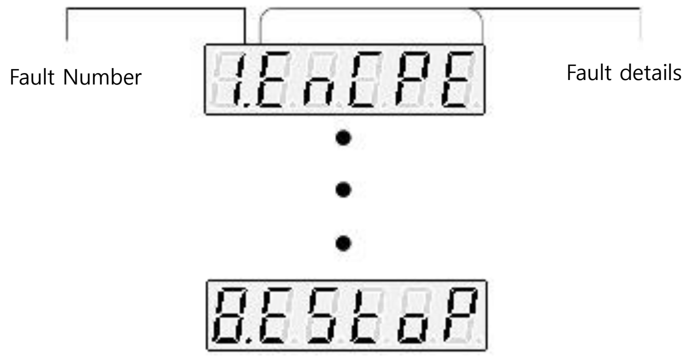
Lower section : The status of digital I/O ouput(OUTPUT1 ~ OUTPUT3), E-STOP and Fault

- 1st digit : Drive fault (LED is turned on while no fault occurs.)
- 2nd digit : Digital OUTPUT1 (LED is turned on while signal is output)
- 3rd digit : Digital OUTPUT2 (LED is turned on while signal is output)
- 4th digit : Digital OUTPUT3 (LED is turned on while signal is output)
- 5th digit : E-STOP status (LED is turned on if 0x2005[04] or Ft-0.05[D3] = 1 and E-stop signal is input)
- 6th ~8th digit : Not used

Object monitor	Built-In monitor	Description	Unit
–	dis-16	Fault history : Up to 8 Servo faults are stored.	

The fault that occurs most recently is the number 1 servo fault occurrence. If all 8 faults are stored, the fault occurring thereafter is stored as number with the earliest fault (No. 8 fault) is deleted.

Refer to “Type of Servo Warning” on page 10-5.



Object monitor	Built-In monitor	Description
–	dis-17	Firmware version : It indicates the firmware version of the servo drive. Ex) 
-	dis-18	Motor & Encoder Type

Example of CSMT_04BQ1ANT3 (CSMT motor, 400W, 17bit absolute encoder)

<u>Motor Type</u>
T : CSMT
R : CSMR
A : CSMA

<u>Motor Capacity</u>
A3 : 30W
A5 : 50W
01 : 100W
02 : 200W
04 : 400W
08 : 800W
10 : 1KW
15 : 1.5KW

<u>Encoder Type</u>
R : 17bit serial incremental
Q : 17bit serial absolute
U : 17bit serial for both Inc. and Abs.

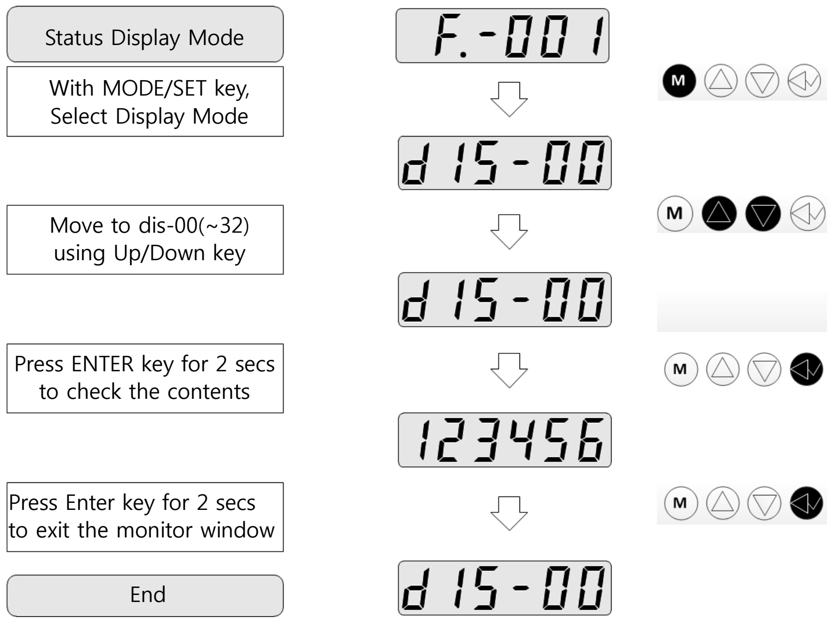
Object monitor	Built-In monitor	Description	Unit
–	dis-21	Drive rated output	-
–	dis-22	Single Turn Data of Absolute Encoder	
–	dis-23	Encoder feedback counter	pulse
–	dis-24	Maximum value of current command	%
-	dis-31	Load factor of average torque	% (rated torque=100%)
-	dis-32	Load factor of maximum torque	% (rated torque=100%)

Built-in Key Button Operation

It describes the key button operation of monitor mode.

The content of monitor mode can be observed regardless of servo drive status. Refer to the below flow chart to monitor the content of each monitor item. Use the Up/Down key to check the fault history [dis-16].

Flow Chart for Monitor Mode Key Button Operation



SAG Function

Introduction to SAG Function

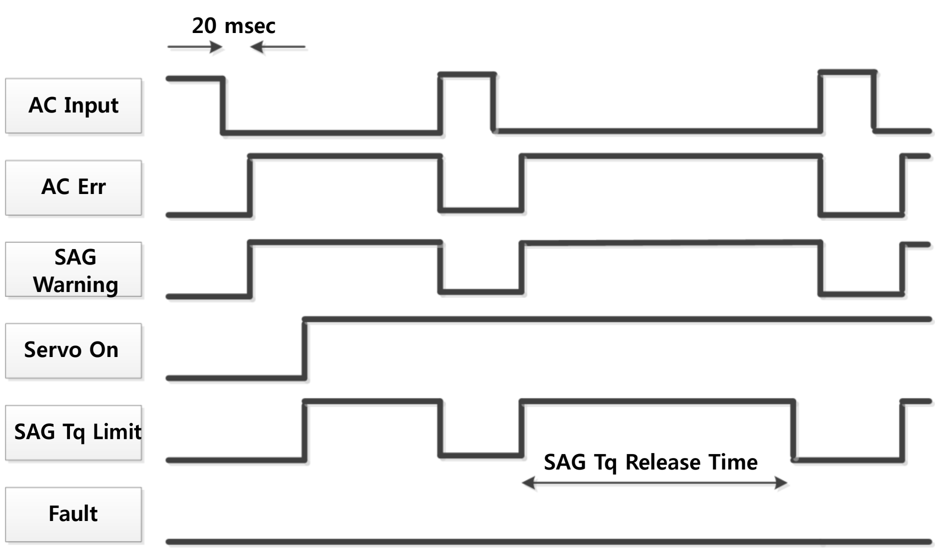
The SAG function helps maintain the control system until the restoration of power supplies by reducing the current consumption of the motor, in case of momentary power failure while the motor is driving. Follow the steps below to use this function.

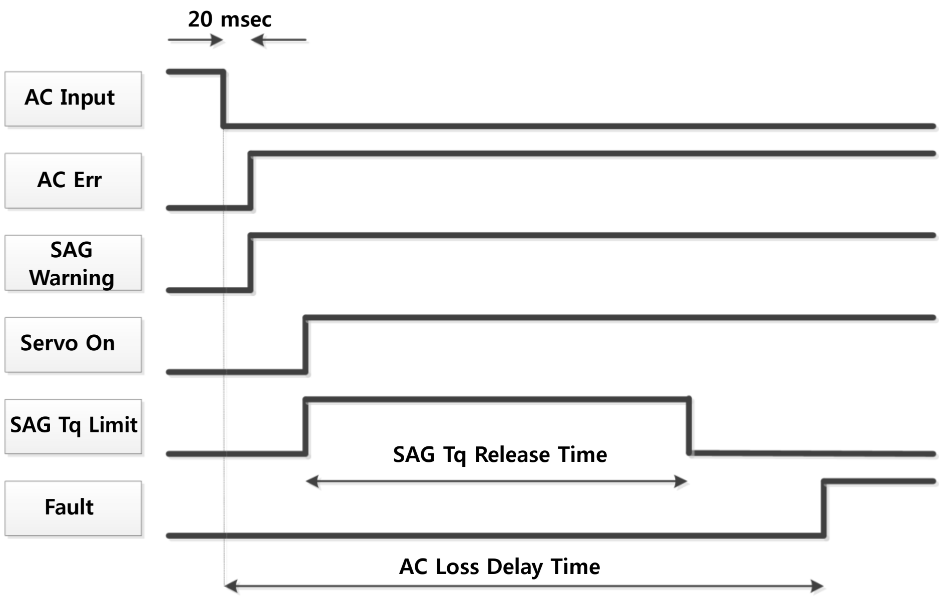
1. Set 'SAG Function' to 'Enabled' with 0x250B(Ft-5.11) = 1.

2. Input the torque value that you want to limit into 0x250C (Ft-5.12). During momentary power failure, the lower the torque limit value is, the longer the electric power charged in the capacitor of the servo drive can last. However, if the torque limit value is too low, it may not be able to properly control the motor. So, care should be used to set the value 0x250C(Ft-5.12).

3. The value of 0x250D (Ft-5.13) is the duration of torque limit value 0x250C(Ft-5.12). That is, when the SAG function is used, torque command is limited by the torque limit value of the 0x250C(Ft-5.12) for the time of 0x250D(Ft-5.13). After that, the torque limit is released and the servo drive generates the normal torque to control the motor. At this point, if the input power is yet to be restored, the servo drive is not able to control the motor properly.

4. The following figure is a timing diagram for the SAG function.





Note

If the power failure lasts for a long time, normal motor control may be not available.

Select one of the following settings so as to prevent 'AC Line Loss Alarm (E.037)' during the use of SAG function.

1. Set AC Line Open-phase Detection to 'Disable' (0x2002[04] = Ft-0.02[D3] = 1)

2. If AC Line Open-phase Detection is set to 'Enable' (0x2002[04] = Ft-0.02[D3] = 0), set 0x2504 (Ft-5.04, the delay time of momentary power failure) longer than 0x250D (Ft-5.13, the torque limit value duration of SAG function).

Detection Function of Torque Load Factor

Introduction to Function

This function provides monitoring of the load factor of the servo motor. The following values can be monitored.

- Average Torque Load Factor
- Maximum Torque Load Factor
- Average Torque Load Factor Trigger 1 Signal
- Average Torque Load Factor Trigger 2 Signal

Average Torque Load Factor & Maximum Torque Load Factor

The average torque load factor is the average value of the absolute value of real time torque loads generated in the servo motor during the time set in 0x2417 (Ft-4.23). It is expressed as a percetage(%).

The maximum torque load factor is the maximum value among the absolute values of torques within the time set in 0x2417 (Ft-4.23). It is expressed as a percetage(%).

- 0x2417 (Ft-4.23) ; Set the time range to calculate the torque load factor (0 ~ 60 sec)
- In this case, 100% means the rated torque of the servo motor.

The above two load factors can be monitored in the following two ways.

- Built-In Monitoring
- RSWare Monitoring

<u>Built-In Monitoring</u>

You can observe the load factors in digital values through 7-Segment at the front of the Servo Drive. See "Monitor mode function" in the page 9-44.

- dis-31 ; Load Factor of Average Torque

- dis-32 ; Load Factor of Maximum Torque

RSWare Monitoring

Select a channel that you want to use among four channels from RSWare: Drive - Oscilloscope, and select again the following input signal.

- Current Load Factor ; Average Torque Load Factor
- Current Peak Load Factor ; Maximum Torque Load Factor

Average Torque Load Factor Trigger 1 & 2 Signal

The Average Torque Load Factor Trigger 1 and 2 signal, which are digital, are ON when average torque load factor is more than the user's set value.

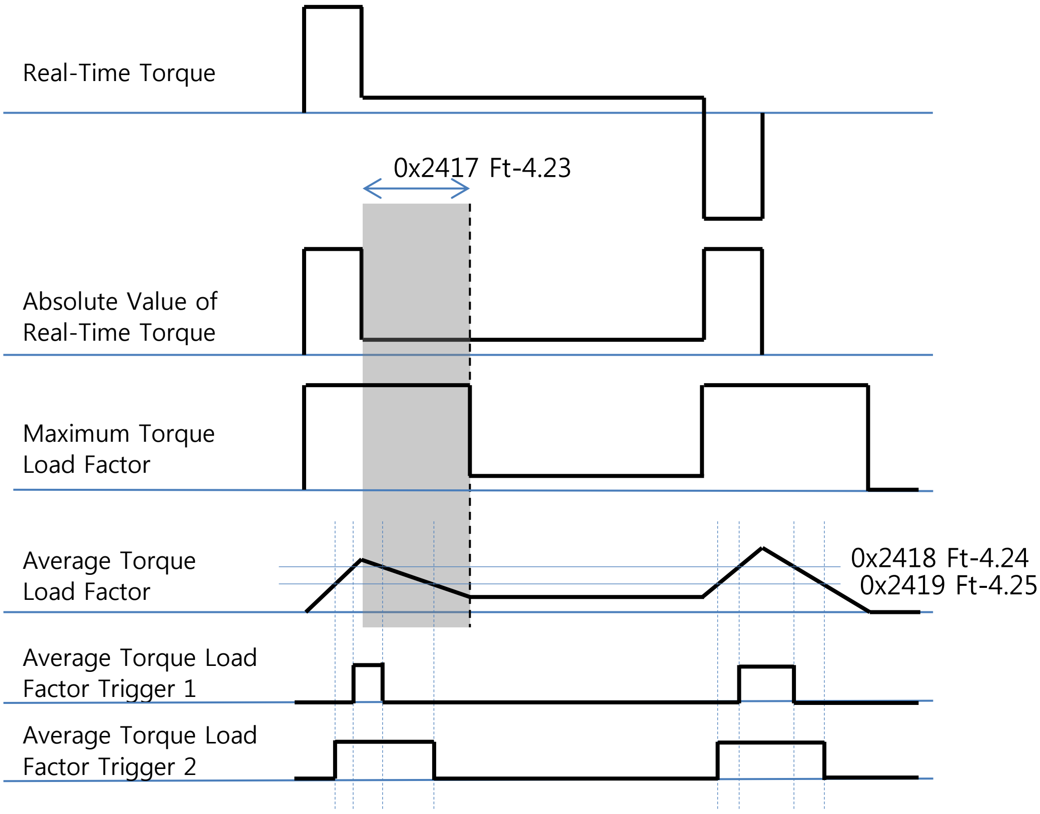
The user's set values are set in 0x2418 (Ft-4.24), 0x2419 (Ft-4.25).

- 0x2418 (Ft-4.24) ; Set value of 'Average Torque Load Factor Trigger 1' Signal
- 0x2419 (Ft-4.25) ; Set value of 'Average Torque Load Factor Trigger 2' Signal

The outputs of 'Average Torque Load Factor Trigger 1 and 2 Signals' should be assigned because of sequence output signals. See "Allocation Method for Sequence Output Signal" in the page 3-18.

- </RMS-CTL1> ; Set 'Average Torque Load Factor Trigger 1' Signal
- </RMS-CTL2> ; Set 'Average Torque Load Factor Trigger 2' Signal

The following figure is an example of timing diagram for the above 4 signals.



Functional Safety

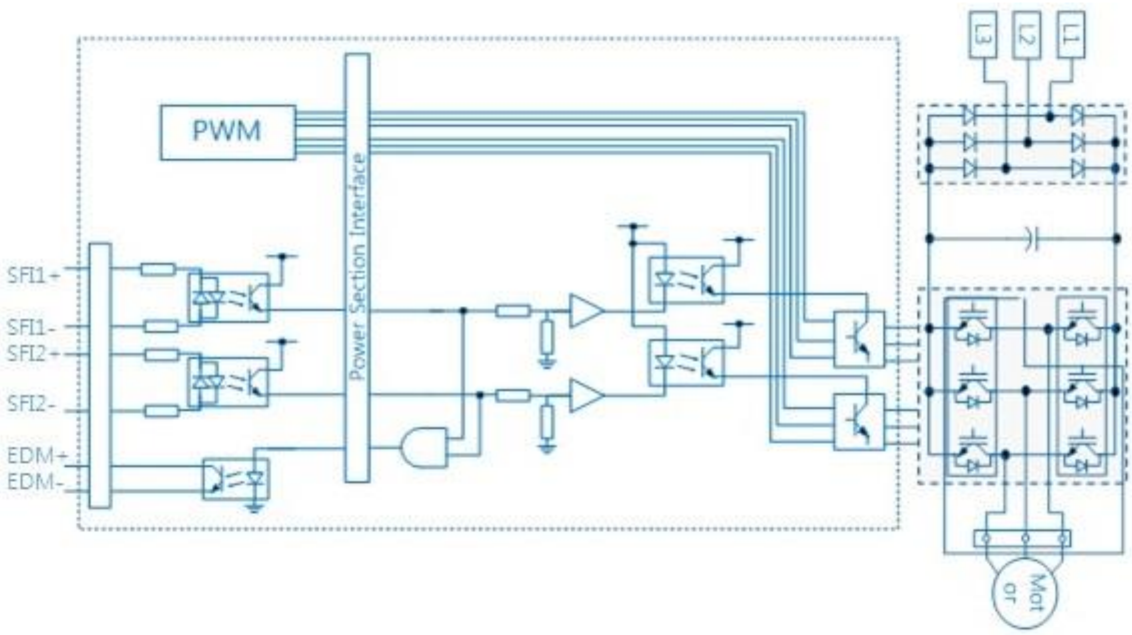
The safe torque off (STO) function is applied to this drive to prevent safety accidents in the field and to secure the safety of users, facilities and production systems.
This clause describes the STO features that can improve the value-added of the industry by increasing productivity and reducing costs by reducing maintenance time and minimizing production interruptions.

Safe Torque Off (STO) Function

The safe torque off (STO) function is a safety functions that cuts off the servo motor current and turns off the motor output torque by forcibly turning off the driving signal of the servo driver internal power module.

Function Block Diagram

The STO circuit is composed with two isolated individual channels. Therefore, one channel of two input the STO command, the motor torque is cut off.



When using the STO function, the system designer is responsible for the system's risk and potential risk assessment. The following are precautions related to the STO function. RS Automation shall not be liable for any damage or damage to such risks.

Cautions

- The STO function disables energy supply to the servo motor by electricalshut off. It does not guarantee the stop control or the deceleration control of the servo motor.
- The STO function does not guarantee that the drive part of the servo motor will not rotate due to external or other forces. Take measures to hold the motor shaft such as mechanical brake when there is an external force such as gravity.
- The energy supply to the servo motor is disabled through the STO function, but the function does not mechanically disconnect electricity from the motor. Therefore, it cannot prevent exposure to electric shock. To prevent an electric shock, install a magnetic contactor or a molded case circuit breaker to the main circuit power supply.
- For proper installation, use components that are confirmed safe or meet the required safety standards. And thoroughly read the manual of each individual safety related component.
- When the IPM, power semiconductor for driving the motor, becomes defectives, the servo motor will move to the extent equivalent of 180 electrical angle.
- Perform all risk assessments to the whole system in order to confirm that the whole system meet the safety requirement.
- The EDM output signal is not a safety signal. Do not use it for an application other than failure monitoring.
- The STO input signals (SFI1 and SFI2) must be supplied from one power source. Otherwise, the STO function may not function properly due to a sneak current, failing to bring the STO shut-off state.
- The external pins (SFI1, SFI2 and EDM) have to be connected to the devices with SELV/PELV.

Specifications of Input and Output Signals

The specification of safety input and safety output to operate STO function are shown in below table.

Table 108 STO Input/Output Specification

Signal	Description	Pin	Note

SFI1+	Safety State Input 1 (Shut-off 1) -Safety state : P/C connected to terminal is turned on. -Non Safety state : P/C connected to terminal is turned off.	4	Input
SFI1-		3	Input
SFI2+	Safety State Input 2 (Shut-off 2) -Safety state : P/C connected to terminal is turned on. -Non Safety state : P/C connected to terminal is turned off.	6	Input
SFI2-		5	Input
EDM+	Safety Circuit Status Output (Open Collector) -Safety state : It is turned on between two pins. -Non Safety state : It is turned off between two pins.	8	Output
EDM-		7	Output

* To operate STO function, connect the safety input circuit is turn-off state.

Electric Specification for STO Input/Output

Table 109 Electric Specification for STO Input/Output

Internal Impedance	Operating Voltage	Max. Delay Time
1.5KOhm	+12V ~ +24V	20usec

Max. Allowable Voltage	Max. Allowable Current	Max. Voltage Drop
26.4V	30mA	1V

Minimum Voltage for High Level	Maximum Voltage for Low Level
11.4V	Should be grounded.

Signal	Safe State	Non-safe State		
SFI1	ON	OFF	ON	OFF
SFI2	ON	ON	OFF	OFF
EDM	ON	OFF	OFF	OFF

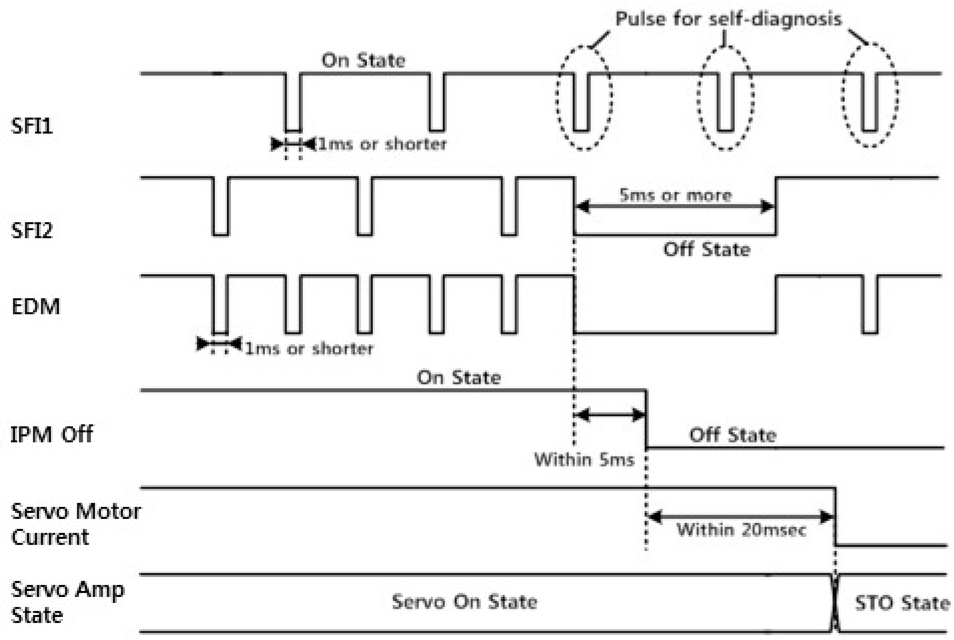
* By monitoring the logics shown in the table above, the external system can determine the status of safety input circuit and safety circuit status output circuit. That is, if the above relationships are not satisfied, the status of safety input circuit and safety circuit status output circuit shall be malfunctions.

Operating Timing for Safety Status

When you connect safety device such as a controller with a safety function, configure the safety input signal to include a diagnostic pulse for self-diagnosis of the safety circuit in the safety circuit status output signal.

The safety input circuit has built-in filter that removes the self-diagnosis pulse. Therefore, if the off period of safety input signal less than 1msec, the safety input circuit does not detect this 'Off" event. To validate this "Off" period, turn off the input signal more than 5msec.

The timing diagram and summarized table is shown in below. The maximum elapsed time to turn off the IPM after the safety signal input is 5msec. And, the maximum elapsed time to cut off the motor torque after IPM off is 20msec.



Signal Definition	
Maximum pulse width of diagnostic pulse	1msec
Minimum pulse width of SFI input signal for STO command	5msec
Maximum elapsed time until the IPM turn off after STO command is inputted	5msec
Maximum elapsed time until the motor torque cut off after IPM is off	20msec

Proof Test for the Safety Circuit

To validate the normal operation of STO function, the proof test for the safety circuit should be recommended to perform at least once per year. The proof test scenario is as follows.

1) Set the drive parameter FT-5.26 enable(1).
2) Input the normal operating signal having periodic self-diagnosis pulse to SFI1 and SFI2.
3) Confirm that the EDM signal has normal self-diagnosis pulse.
4) Confirm that the servo motor is normally rotating.
5) Input the STO command to SFI1.
6) If EDM signal is 0 and the servo motor stops, the safety circuit block 0 is normal.
7) If EDM is still 1 or the servo motor still rotates under EDM is 0, the safety circuit block 0 is faulty.
8) Remove the STO signal from SFI1 and input the normal signal.
9) Confirm that the EDM signal has normal self-diagnosis pulse.
10) Confirm that the servo motor is normally rotating.
11) Input the STO command to SFI2.
12) If EDM signal is 0 and the servo motor stops, the safety circuit block 1 is normal.
13) If EDM is still 1 or the servo motor still rotates under EDM is 0, the safety circuit block 1 is faulty
14) When the proof test is completed, set drive parameter Ft-5.26 disable(0).

- EDM signal is fixed to 1 or 0 even though the STO command is not input to SFI1 or SFI2, the safety circuit status output circuit is faulty.
- Do not disassemble the faulty drive and contact the service center.
- Life Time (Proof test interval) : 10 Years

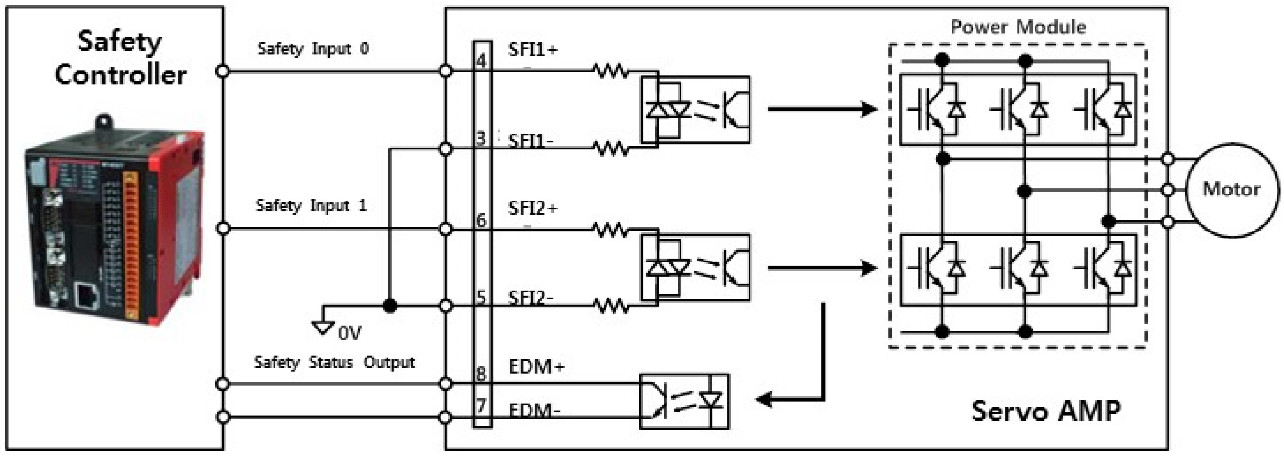
0x251A	**STO Circuit Verification Mode**					**ALL**	
Range	DataType	Unit	Access	PDO map	When enabled	Default	Ft-no
0~1	1byte(USINT)		RW	-	Servo off	0	Ft-5.26

RSWare: Drive Auxiliary Function Selection 1 - STO Circuit Verification Mode

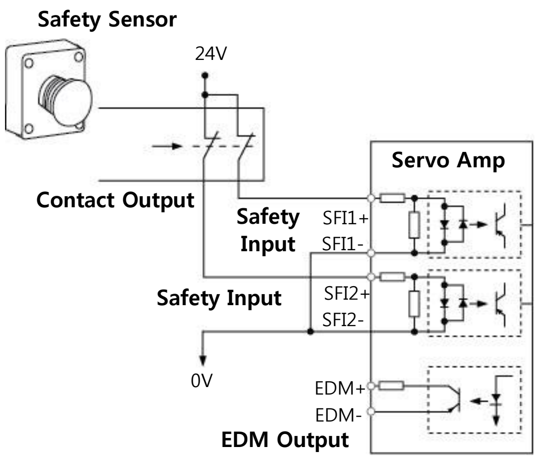
Example of Connection

Using the safety connector on the front of the drive, connect the safety controller, safety switch, safety relay, safety sensor, etc.

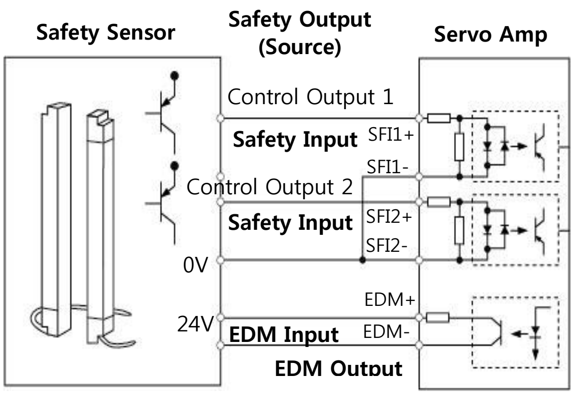
Connection to safety controller



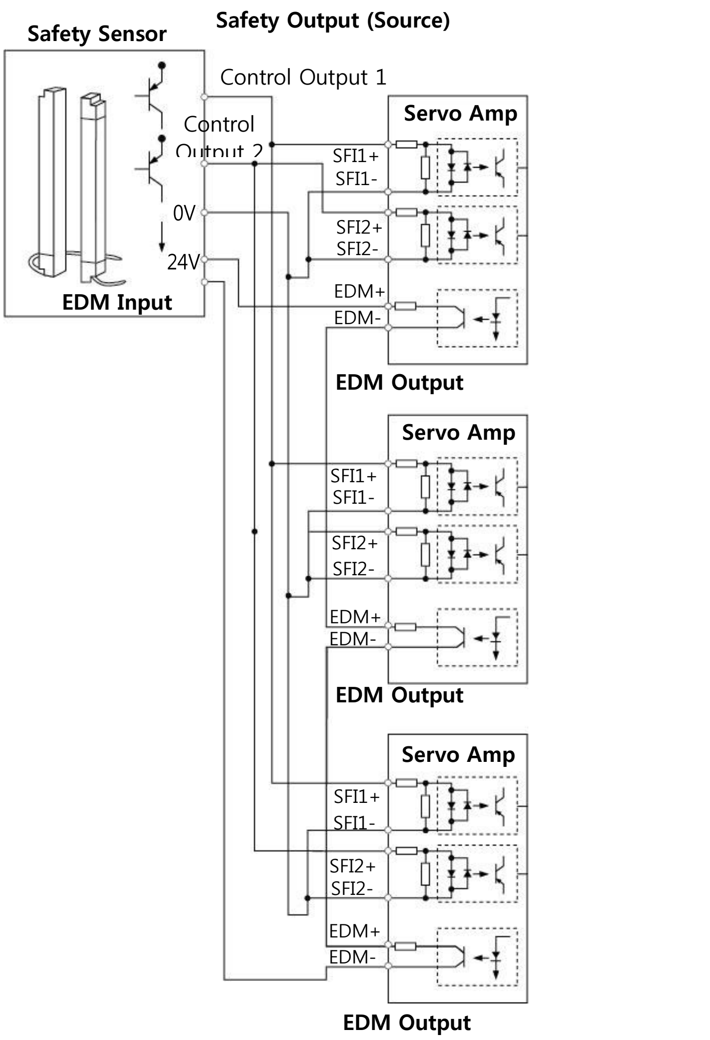
Connecting to Safety Switch



Connecting to Safety Sensor



Connecting Multiple Drives to a Single Safety Sensor



Chapter 10. Inspection and Protection Function

In this chapter, the inspection and the protective function of servo drive are described.

Inspection

It describes the basic inspection, abnormality diagnosis and how to take action of servo motor and drive. Also, it describes the protective function of drive and action to take in times of fault occurs as well as any action to take in times of breakdown following the fault code.

Inspection of Motor

Servo motor does not have a brush that causes mechanically abrasive part. A simple inspection is sufficient as follow. By considering the use environment, determine the appropriate inspection time.

Table 108 Motor Inspection

Check List	Check Period	How to check and repair	Countermeasures
Vibration and Noise	Daily Check	Determine with Sense and Hearing	It shall not be larger than usual
Foreign Substance	Immediately in Occurrence	Cleaning with Vacuum Cleaner	-
Insulation Resistor	1 year	Measure with Insulation resistor meter (500 [V] 10 [MΩ])	Inquiry to the company if the measuring value is 10 [MΩ] or less
Oil Seal	5000 hours	Oil Seal Replacement	Only for motor that has oil seal
Overall Inspection	20000 hours (5 Years)	Inquiry to the Company	Disassembly and worn-out part replacement

CAUTION

In the event of disassemble the servo motor for repair or inspection; a care shall be taken for A/S not available.

Inspection of Servo Drive

Servo drive is equipped with electronic circuit. The dust and foreign substance may cause the breakdown or malfunction that the dust shall be cleaned and tighten the nuts on a regular basis (1-year).

Table 109 Inspection of Servo Drive

Check List	Check Period	How to check and repair	Countermeasures
Cleaning of Main Body and PCB assembly	Once or more per year	Do not have dust or oil	Clean with compressed air or fabric
Socket, Connector, Nut	Once or more per year	Do not allow loosening of socket, connector, nut and others	Do not allow loosening
Abnormal Part on PCB assembly	Once or more per year	There is no discoloration by heat, damage or open circuit	Inquiry to the company

CAUTION

In the event of disassemble the servo drive for repair or inspection; a care shall be taken for A/S not available.

Part Inspection

The part below may have mechanical abrasion or material degradation. A regular inspection is needed for prevention and preservation. When the annual average ambient temperature is 30°C or less, the load rate is 80% or less, and the operation rate is 20 hours or less a day, the life of key products is as follows.

Table 110 Parts Life of Servo Drive

Parts	Parts Life
Electrolytic Capacitors	8 years
Relay	100,000 times on/off
Cooling Fan	40,000 hours
Fuse	10 years

Battery Inspection for Absolute Encoder

Refer to 9-32 page “Battery” for absolute encoder battery.

Protective Function

It describes the equipped protection function and actions taken in times of abnormal operation in order to protect the servo drive and load system. The protection function is classified into two types depending on the importance.

- **Servo Warning** : It displays a minimal abnormality that does not require the suspension of operation when occurred.
- **Servo Fault** : It displays the very serious abnormality that requires the suspension of operation when occurred.

It is classified depending on the importance, but when an abnormality occurs, remove the cause immediately and use the servo drive in normal conditio.

Servo Warning

There is a servo warning that displays a minimal abnormality as the protection function by the self-diagnosis.

Servo Warning Indication

It displays a warning through the 'Status Display Mode'.

The warning is displayed on the 3 digit of 7-segment as shown on the left. The character displayed the normal operation status does not flicker, but once the abnormality applicable for servo warning is sensed, the applicable character is displayed and flickers.

Type of Servo Warning

Servo drive displays the 10 types of warning characters as in the following.

Table 111 Cause and Countermeasures of Servo Warningk

Warning	Text Messege	Possible Cause	Countermeasures
Absolute Encoder Counter Overflow	Cnt	In the event the Q Type Absolute Encoder is rotated forward or reverses over 32768 revolutions, it is displayed.	• Reset the multi turn data of absolute encoder.
Low Voltage of Absolute Encoder Battery	bAt	It occurs when the voltage of battery or external power supply of absolute encoder is 3.2 [V] or less.	• Replace the battery or external power supply to make sure. 1)
Abnormal Initial Status of Encoder	FAS	During the drive motor for moving the control power has been applied. Abnormal initial value of incremental encoder after power on	• After making sure that the motor stops turning off the control power.
Over Current	oCC	The system does not support the motion profile.	• Check the speed loop tuning. • Check the capacity of the system.
		Current limit setting is inappropriate.	• Check if the current limit lower than the current limited capacity of the system.
Over Speed	oSC	The system does not support the motion profile.	• Check the position loop tuning. • Check the capacity of the system.
Abnormal Allocation of Sequence Input and Output	PIn	Digital input or output of the allocation is inappropriate.	• Check if it is allocated for the sequence input or output that you are going to use.
Over Motor Capacity	CAP	It occurs when motor power is set higher than the drive rated output.	• Use a motor suitable to the drive or set the torque limit below the drive capacity.
SAG Warning	SAG	This warning occurs if the input power is shut off and the torque is limited by 0x250C (Ft-5.12) after setting 0x250B (Ft-5.11) to 1(enable) to keep normal control of motor in momentary power failure.	• This function is set by user. If 0x250B (Ft-5.11) is set to zero, then this warning may not occurs.
FAN abnomality	FAn	It occurs when FAN works abnormal	• Warning will happen during 120 hours after FAN goes abnormal. Alarm will be happeded since then. FAN needs to be changed before Alarm.

1) When replacing a battery, absolute position is lost. Homing may be required..

Servo Fault

The servo fault is a serious problem. It occurs when the servo drive cannot control motor normaly. When the fault occurs, 3-digit fault code and 5-digit text message as shown in the below table are displayed by turns.

Table 112 Servo Fault Cause and Countermeasures

Fault Code	Text Message	Error Code for CiA402	Internal Code	Possible Cause	Countermeasures
E.005 IPM Fault	E.IPMFt	0xFF05	0x1	Motor cable is shorted	• Check if the motor power cable or the connector is shorted.
				It occurs when the motor coil is shorted internally.	• Disconnect the motor power cable from the motor. If the motor can not be rotated by hand, a replacement may be needed.
				It occurs when the current exceed the continuous power rating while operating.	• Check if the ambient temperature is too high. • Operate within the continuous power rating. • Decrease the acceleration and the deceleration rate.
				It occurs when an unsuitable IPM output, short circuit or over current exist in the drive.	• Check the wiring connections that go from the DC bus to U, V, and W terminal of motor after disconnecting the all power cable and the motor. • If the connections are normal, check the wires between terminals or repaire the drive.
				It occurs when the operation voltage of IPM in drive is low	• Check if the IP16V power on the power board is 15 V or above.
E.006 FAN Fault	E.FAn	0xFF06	0x4	Fan attached on servo drive work abnormally.	• Check whether there are foreign substance on the fan blade, and remove it. • Check whether the fan cable is connected to the servo drive properly. • Change the fan of the servo drive • It is possible to run 12 hours after Fan reset. FAN fault will be happened after 12 hours from the reset. • Fault reset is available by 10 times under FAN fault.
E.009 DC Bus Low-voltage	E.UdvtG	0xFF09	0x4	The AC input voltage is low. (This alarm occurs when the DC link bus voltage drops below 190V	• Check the voltage level of AC power supply. (should be more than AC 170V)

Fault Code	Text Message	Error Code for CiA402	Internal Code	Possible Cause	Countermeasures
				and lasts for over 1msec in servo-ON state.)	• Check the noise or voltage drop of AC power source. • Install a UPS (Uninterruptible Power Supply) in AC inputs.
				The AC input voltage is normal, however the DC link voltage was low due to excessive use of torque.	• Reduce the motor acceleration.
				Servo-ON signal is input while the main power turns off.	• Turn on the main power before Servo-ON signal input.
E.010 BUS Over Voltage	E.ovvtG	0xFF0A	0x4	It occurs if DC link voltage is 400V or above because the regenerative energy is excessive. That is, the drive generates an fault to protect itself from the overload when regenerative energy is excessive while the motor is rotated by the external mechanical power.	• Check the regenerative circuit. • Adjust the motion profile and keep the regenerative resistor within the range of use. • Replace the regenerative transistor. • Replace the drive.
				Excessive AC input voltage. (The range of input voltage is from AC 170 Vrms to AC 253Vrms)	• Confirm the specification of AC power input voltage.
E.012 Failed searching for the starting point	E.HFAIL	0xFF0C	0x07	Return to the starting point is not completed until the required period (IN-01.11)	• Increase the required period(IN-01.11). • Set any value except '0' on Homing velocity(IN-01.02) and Creep velocity(IN-01.03). • Make sure any obstacles on the path. • Check machine and parameter setting related with starting-point return.
E.018 Motor Over-speed	E.ovSPd	0xFF12	0x5	Motor speed exceeds the maximum speed.	• Check the wiring of the encoder. • Retune the drive system. • Check the external speed command whether it is high.
E.019 Position Error Limit Exceeded	E.PoSEr	0xFF13	0x5	It occurs when the position error exceeds the setting value of 0x2314 (Ft-3.20).	• Increase the Following Error Limit (0x2314, Ft-3.20) • Check the position loop tuning and adjust related gains.
E.022 Continuous Current Overload of Motor	E.ConoL	0xFF16	0x2	It occurs when the average current that flow through the motor coil exceed the rated current of the motor.	• Decrease the accel/decel rate. • Decrease the duty cycle of the motion profile. • Increase the allowable time for the motion • Use a motor with bigger capacity. • Check the tuning and adjust related gains. • Check the velocity for starting-

Fault Code	Text Message	Error Code for CiA402	Internal Code	Possible Cause	Countermeasures
					point return. • Make sure any mechanical hanging after servo drive is off. • Make sure whether cable of encoder and power is connected properly. • Make sure whether any collision is happened by misrecognition of limit sensor.
E.023 Drive Overload	E.drvoL	0xFF17	0x2	It occurs when the average current that flow through the drive exceed the rated current of the drive.	• Decrease the accel/decel rate. • Decrease the duty cycle of the motion profile. • Increase the allowable time for the motion. • Use a drive with bigger capacity. • Check the tuning and adjust related gains. • Check the velocity for starting-point return. • Make sure any mechanical hanging after servo drive is off. • Make sure whether cable of encoder and power is connected properly. • Make sure whether any collision is happened by misrecognition of limit sensor.
E.024 Exceed the transfer time of absolute data	E.AbSto	0xFF18	0x5	/ABS-DT output does not turn on within 5 seconds when absolute data transfer mode using photo-coupler is on. /ABS-DT output does not turn off within 5 seconds when absolute data transfer mode using photo-coupler is off. /ABS-MD input does not turn off within 5 seconds after absolute data transfer is completed.	• Check the sequence timing among absolute data transfer ready, /ABS-DT, absolute data transfer mode input. • Make sure whether I/O cable and connector are short.
E.027 Not completion of starting-point return	E.notHM	0xFF1B	0x07	Absolute coordination Index is executed under the status that the starting-point return is not completed.	• Starting-point return needs to be done before absolute coordination index function is executed
E.028 Encoder multi-	E.MtCoF	0xFF1C	0x3	Overflow of the multi-turn counter of encoder.	• Replace the motor. • Initialize absolute multi-turn data

Fault Code	Text Message	Error Code for CiA402	Internal Code	Possible Cause	Countermeasures
turn counter overflow				Damage of the encoder memory	
E.030 Encoder Cable Open	E.EnCoP	0xFF1E	0x3	It occurs when CSD7 cannot communicate with the encoder. Hall error occurred	• Check the selected motor. • Check the wiring of the encoder. • Check whether the motor is supporting automatic recognition
E.031 Encoder Data Parameter Error	E.EnCPE	0xFF1F	0x3	It occurs when the encoder is not properly programmed. It occurs when the memory of the encoder is damaged.	• Replace the motor.
E.036 Drive Overheat	E.drVot	0xFF24	0x2	It occurs when the drive overheats.	• Check if the cooling fan is working. • Check the tuning. • Decrease the accel/decel rate. • Decrease the duty cycle of the motion profile. • Increase the allowable time for the motion. • Use a drive with bigger capacity.
E.037 AC line Loss	E.ACoFF	0xFF25	0x4	It occurs when the AC input power is low.	• Check the voltage of AC input power • Increase the compensation time for instantaneous power failure.
				Servo-ON signal is input while the main power turns off.	• Turn on the main power before Servo-ON signal input.
				One or more of AC power phases is not connected.	• Disconnect the power cable and check all mechanical connections.
				The delay time parameter for fault generation is set too short.	• Increase the delay time parameter for fault generation
E.039 Serial converter abnormality	E.SCNEr	0xFF27	0x3	Serial converter supporting AqB scale goes abnormal	• Make sure the connection among serial converter, hall signal, scale signal.
E.040 Polarity detection error	E.AngLE	0xFF28	0x3	The motor is activated when polarity is not detected on the linear motor without hall detection.	• Detect the polarity on linear motor without hall detection.
E.041 Resolution discordance on serial converter	E.SCnrM	0xFF29	0x3	The esolution set on serial converter is not same as the resolution set on servo drvie.	• Set the same resolution on both serial converter and servo drive.
E.042 Abnormal single-turn data of serial converter	E.SCNSr	0xFF2A	0x3	The single-turn value corresponding hall signal position is out of range in case of using hall detection. The single-turn value is out of resolution in case of not using hall detection.	• Make sure the connection of hall signal and the phase sequence of linear motor. • Check the placement and interval of magnet. • Check the cable connection of serial converter • Check the data of serial converter.
E.043 Abnormal Hall	E.HALEr	0xFF2B	0x3	The value of hall signal is out of specified value or the change of	• Make sure the connection of hall signal and the phase sequence of

Fault Code	Text Message	Error Code for CiA402	Internal Code	Possible Cause	Countermeasures
signal of linear motor				hall signal is not conformed designated sequence in case of using hall detection.	linear motor. • Check the placement and interval of magnet. • Check the cable connection of serial converter •
E.044 Abnormal motor data	E.SAnSS	0xFF2C	0x3	Position output value is abnormal on 17bit serial incremental encoder.	• Change the motor
E.053 User Parameter Initialization Error	E.PInIt	0xFF35	0x6	An error exists on the parameter saved in the memory.	• Initialize the parameter. • Reset the values of the drive to the factory.
E.054 Current Feedback Offset	E.oFSEt	0xFF36	0x1	The compensated value of current feedback is exceed set value	• Run the compensation of current feedback(Run-07). • Replace the drive even though the error is occurred after compensation
E.055 User Parameter Checksum Error	E.CHSUM	0xFF37	0x6	Checksum of user number saved in the memory is not same. Power is off/on after F/W downgrad and save parameter are done.	• Check the parameter and reset. • Reset the values of the drive to the factory settings.
E.056 Watchdog Timeout	E.CPUFt	0xFF38	0x5	Excessive System Noise	• Check the wiring and the installation method.
				Defective Hardware	• Replace the drive.
E.057 PWM Hardware Error	E.HWArE	0xFF39	0x1	Defective Hardware of PWM signal.	• Replace the drive.
E.058 User Parameter Range Error	E.rAnGE	0xFF3A	0x6	Parameter range is invalid.	• Input the parameter within the range. • Reset the values of the drive to the factory settings.
E.060 Drive Initialization Error	E.dInIt	0xFF3C	0x7	Setting value is not same as power rating.	• Replace the drive.
E.075 Regenerative Overload Protection	E.SHtoL	0xFF4B	0x2	Exceeds the value allowed by the voltage of the regenerative resistor.	• Adjust the motion profile and keep the regenerative resistor within the limit.
				Regenerative resistor is separated or damaged.	• Check the connection of the regenerative resistor. • Check the values of the regenerative resistor.
E.079 Regenerative Over Current Protection	E.SHtoC	0xFF4F	0x1	The regenerative current exceeds the allowable instant value.	• Check if the regenerative resistor is shorted or damaged. • Check if the overload energy is excessive while decelerating.
E.083 Low Battery Error	E.AbSbE	0xFF53	0x3	The parameter of the encoder backup battery is set as 'installed,'	• Set the constant of the encoder backup battery as 'not installed.'

Fault Code	Text Message	Error Code for CiA402	Internal Code	Possible Cause	Countermeasures
of Absolute Encoder				but the battery is not installed.	
				The battery voltage is detected under 2.75 [V] DC.	• Check the battery voltage and the connections. • Replace the battery.
E.084 Absolute Encoder Over Speed	E.AbSoS	0xFF54	0x3	The encoder rotates mechanically at high speed while the drive power turns off, when it is powered by the battery.	• Remove the motor from the system. • Turn off and on the drive and reset the Warning.
E.085 Absolute Encoder Multi-turn Count Error	E.MtCEr	0xFF55	0x3	Noise from Encoder	• Turn off and on the drive and reset the Warning.
				Defective Encoder Multi rotation data is abnormal	• Replace the motor.
E.100 Product installation error	E.SEtUP	0xFF64	0x7	Linear motor not registered on 3rd party or other motor except linear motor connected with serial converter	• Register 3rd party motor before using linear motor. • Serial converter needs to be used with linear motor supporing AqB scale.
E.101 Motor Power Cable Open	E.CAbLE	0xFF65	0x2	The motor cable is not connected.	• Check the power connection between the motor and the drive.
E.102 Motor instantaneous current overload	E.InSoL	0xFF66	0x2	The motion profile requires peak current over 300% for a few second.	• Check the wiring of the motor. • Adjustthe cceleration/deceleration time. • Check if the motor selected is suitable.
				There is a defect in the current feedback detection.	• Check the phase current of motor
E.103 Motor Mismatch Fault	E.MAtCH	0xFF67	0x2	The dynamic control current of the selected motor exceeds double the value of the drive peak current rating.	• Check whether the cable is connected correctly among drive, encoder, power. • Replace the motor with appropriate power rating • Restrict max. speed under rated speed.
E.106 Encoder Communication Error	E.EnCCE	0xFF6A	0x3	The wiring between the drive and the encoder is cut off or problematic. Or encoder signals are interrupted by the EMI (noise).	• Check the wiring of the encoder. • Contact your nearest dealer.
E.107 Serial Communication Error	E.SErCE	0xFF6B	0x6	Communication error between the host and the drive (noise)	• Check the serial communication cable. • Check the noise of the serial communication interface.
E.108 Postion command frequency over	E.CdFr	0xFF6C	0x5	The frequency of position command pulse is over the setting value.	• Make sure applied position command is same as selected position circuit on the drive. • Change from open collector to line drive. • Reduce max. speed. • Revise electronic gear.

Fault Code	Text Message	Error Code for CiA402	Internal Code	Possible Cause	Countermeasures
E.109 Abnomal setting of external regenerative resistor.	E.SHSEt	0xFF6D	0x2	The value of external regenerative resistor(Ft-5.24) is set under the allowable value	• Set the value of regenerative resistor above allowable minimum value.
E.110 Not supported setting	E.noEld	0xFF6E	0x7	PWM switching frequency(Ft-5.30) is set to 16kHz when using beyond 800W motor PWM switching frequency(Ft-5.30) is set to 16kHz when the current of linear motor is above 7.1 Apeak.	• Available to set 16kHz of PWM switching frequency on below 800W motor of CSM series and RSM series.
E.111 Safety Torque Off Input Error	E.StoIn	0xFF6F	0x5	The Safety Torque Off input is open. (Normal Close input condition)	• The signal was inputted by STO input. Set the release condition. • Check the STO connection. • Check the connection of the dummy connector provided with the product.
E.112 Emergency Stop	E.EStoP	0xFF70	0x5	Emergency Stop (E-STOP) is detected.	• Remove the E-STOP condition. • If E-STOP function is not needed, erase the signal in seqeunce input.
E.113 Index position range is over	E.IrAnG	0xFF71	0x6	Index position parameter value is out of range.	• Set the value between -2,147,483,647 and +2,147,483,647
E.114 Motor Phase Over current	E.ovCUr	0xFF72	0x1	• When the error occurs when power on, there is a problem in the control/main power circuit. • When this error occurs while in operation, over current exists. (Current that is 300 [%] over the rated current is supplied to the motor for more than 250 [ms]).	• Check the motor wiring. • Check the power and set or adjust the acceleration/deceleration time.
E.115 Abnormanl Flash memory	E.FLCOV	0xFF73	0x6	• The life of flash memory is over. • Erase/program cycles of the Flash memory in the servo drive has exceeded 100,000 times.	• Change Flash memory in control board of servo drive. • Or change the control board.
E.116 Load discordance	E.LdMIS	0xFF74	0x6	• The combination of HW, FW, OS, FPGA is not right when Firmware upgrade.	• Update firmware of CSD7 on homepage.
E.117 Resonance over	E.ESvrS	0xFF75	0x2	• Current dispersion value is over some extent. • Velocity error vibrates zero-corssing with some extent of depth	• Set notch filter after enabling ANF

Fault Code	Text Message	Error Code for CiA402	Internal Code	Possible Cause	Countermeasures
E.118 Velocity error of linear motor over	E.vELEr	0xFF76	0x5	• Linear motor data is written wrongly. • Encoder cable is connected wrongly.	• Make sure linear motor data • Make sure encoder cable connection
E.200 Sync error	E.noSYn	0xFFC8	0x9	• This error occurs when sync does not work. • The network connection has been lost.	• Make sure EtherCAT cable • Make sure power status of drive.
E.201 Sync signal error	E.SYnCH	0xFFC9	0x91	• This alarm occurs when sync signals are not detected. • The network connection has been lost.	• Make sure EtherCAT cable • Make sure power status of drive
E.202 DC PLL sync error	E.dCPLL	0xFFCA	0x9	• This alarm occurs when the PLL clock sync fails. • The network connection has been lost.	• Make sure EtherCAT cable • Make sure power status of drive
E.203 Sync watchdog error	E.SMWtd	0xFFCB	0x9	• The sync watchdog detected an abnormal operation • The network connection has been lost.	• Make sure EtherCAT cable • Make sure power status of drive
E.204 PDO mapping error	E.IoMAP	0xFFCC	0x9	• The input/output PDO was not properly mapped in the section from *Pre-Operational state* to *Safe-Operational states* or from *Pre-Operational state* to *Operational states*. • A non-supported PDO is set.	•
E.205 Non-supported operation mode	E.oPMod	0xFFCD	0x9	• A non-supported operation mode is set.	•
E.206 EtherCAT CoE Error	E.EtCFG	0xFFCE	0x9	• An abnormal operation of EtherCAT CoE protocol is detected.	•
E.207 EtherCAT CoE error	E.EtCoE	0xFFCF	0x9	• An abnormal operation of EtherCAT CoE protocol is detected.	•
E.208 EtherCAT FoE error	E.EtFoE	0xFFD0	0x9	• An abnormal operation of EtherCAT FoE protocol is detected.	•
E.209 PDO mapping discordance	E.EtPdp	0xFFD1	0x9	• Failed saving or loading of mapping information	•

Confirmation before Requesting for A/S

In the event an error occurs in servo fault that is not displayed, it describes the cause and action.

If the main circuit power is allowed in a cause investigation, it is dangerous. After the power shall be disconnected to completely turn out thedischarge-confirming lamp, take action on it. In the event the error is not resolved after taking an action, promptly request for A/S to the company.

The chart below shows the diagnosis on errors when the fault does not occur.

Table 113 Diagnosis on abnormal symptom when the fault does not occur

Abnormal Symptom	Possible Cause	Countermeasures
The motor does not run.	The power does not turn on.	Check the power wiring and correct it.
	Motor and encoder wiring has a wrong connection.	Check each wiring and correct each of them.
	External command and position command is not inputted.	Confirm the wiring of input terminal and input it correctly.
	Servo-ON is not made.	Check the allocated parameter of sequence input signal 0x200A[01] (Ft-0.10[D0]).
	Over trouble input is active.	Make the <P-OT>(or <N-OT>) input signal inactive
	Drive or motor is in a state of overload.	Remove the overload cause and re-start it.
	Servo fault occurs.	Remove the fault cause and perform the fault reset then re-start it.
Motor vibrates or has large overshoot in accelerating or decelerating.	The velocity loop I gain of servo is too high.	• Lower the system gain 0x2100 (Ft-1.00) • Lower the velocity loop I gain 0x2103 (Ft-1.03)
The encoder type setting error or encoder open fault occurs.	The setting of motor and encoder is erroneous.	Check if the motor setting [Dis-18] is correct.
	Motor and encoder wiring has a wrong connection.	Check each wiring and correct each of them.
Strange noise is made.	Mechanical installation condition is bad.	Confirm the installation condition (coupling, nut tightening) and adjust.
Motor or drive is overheated.	The ambient temperature is high.	Lower the ambient temperature. (under 50 [°C])
	Drive or motor is in a state of overload.	Remove the overload cause and re-start it.

A.

Appedix A. Specification and Exterior Dimensions

Drive Specification

Table 114 Drive Specification

Item		01BN1 01BNF1	02BN1 02BNF1	04BN1 04BNF1	08BN1 08BNF1	10BN1 10BNF1	15BN1 15BNF1	25BNF1	35BNF1	50BNF1
Output	Rated Current[Arms]	1.1	1.8	3.3	6.2	8.0	11.0	16.0	22.0	32.1
	Max Current[Arms]	3.3	5.4	9.9	18.6	24.0	33.0	48.0	66.0	96.3
Main Power Supply	Voltage Range	Single-phase AC 170~253 Vrms, 50/60Hz			3-phase AC 170~353 Vrms, 50/60Hz For 800W, Single-phase can by changing parameter					
	Input Current[Arms]	1.1	2.1	4.0	5.5/7/8	7.7	11.1	15.4	20.7	33.8
Control Power Supply		Single-phase AC 170 ~ 253 vRMS AC, 50/60Hz								
Control Method		SVPWM control using IPM								
Encoder, Auxiliary Encoder		17 & 23Bit Serial Absolute/Incremental, 21Bit Biss								
Internal Regenerative Resistor		-	-	50Ω /30W	30Ω/100W			12Ω/150W		8Ω/250W
External Regenerative Resistor		-	-	Over 60Ω/15 W	Over 180Ω/10W (Parallel wiring with internal resistor)			Over 10Ω/1kW		Over 6Ω/1kW
Dynamic Brake		Provide Built-in Circuit that makes two phase (U,W) of motor short						Support built-in circuit, 3-phase(U,V,W) the short-circuited via a resistor of 0.5Ω/100W		
Communication function	USB	Connect to PC to use serial communication, RSWare should be used through this port.								
	EtherCAT	EtherCAT network lines to perform motion commands, parameter setting, status monitoring, etc. IEC 61800-7 CiA 402 Drive profile, CoE, 100BASE-TX(IEEE802.3) EtherCAT CoE, CiA402 Drive Profile, 100Mbps, Max.100m distance between nodes								
Environment	Operating Temperature/ Humidity	0°C ~ 50°C/95% RH or below (Non-condensing)								
	Storage Temperature/ Humidity	-20°C ~ 85°C/95% RH or below (Non-condensing)								
	Vibration/Shock	Vibration : 2G or below, Shock : 15G or below (1G = Gravity Acceleration 9.8m/s2)								
	IP/Pollution level	IP20 / Pollution level 2								
	Altitude	Max. 1000m above sea level								
I/O Spec.	Encoder Output	A,B Pulse Output, Line Driver Output, Division Ratio : N/M(N,M≤32768)								
	Digital Input	Function allocable 4 points, Fixed 1 point (Emergency Stop), Detection Time : 6ms ~ 8ms								
		High Speed Input 2 points, Position Registration (Touch Probe), Detection Time : 5us or under								
	Ditital Output	Function allocable 3 points								
Built-in Operator		1. Six 7-segment LED for display, 2 Four buttons for parameter setting, 3 Two LED for Indicating EtherCAT status.								
Protective Function		Over Current, Motor Overload, Drive Overload, Regenerative Resistor Overload, Over Voltage, Low Voltage, Over Heat, CPU Fault, Encoder Fault, Communication Fault, IPM Fault, Abnormal Motor								

		Speed Setting, Over Position Error, Input Phase Loss, Abbormal Motor Wiring, etc	
Safety Function	Available Function	STO(Safe Torque Off, IEC 61800-5-2:2007), Provide Additional Connector	
	Standards applied	IEC 61508:2010 SIL2, IEC 62061:2005/A2:2015 SIL Cl2, ISO 13849-1:2015 PLd, Cat3	
Certification	CE	LVD:EN61800-5-1:2007, EMC:N61800-3:2004+A1:2012	
	NRTL/C	UL508C:2013, CSA C22.2 NO.14:2013	
	KC	KN61800-3:2014	
Cooling method		Fan Cooling	
Installation	Mounting Method	Base Mounted (Standard), Rack Mounted (Need Optional Mechanical Parts)	Based Mounted
	Zero Stacking	It can be mounted without space between products.	

Fuse and Contactor Recommendations

Table 115 Fuse and Contactor Recommendations

Item \ Catalog No. CSD7_		01BN1 01BNF1	02BN1 02BNF1	04BN1 04BNF1	08BN1 10BN1 08BNF1 10BNF1	15BN1 15BNF1	25BNF1	35BNF1	50BNF1
Main Power Fuses	Recommended Fuse Group 1[2]	FNQ-R-7		FNQ-R-10	FNQ-R-20	FNQ-R-30	LPS-RK-45SP	LPS-RK-60SP	LPS-RK-90SP
	Recommended Fuse Group 2[3]	N/A		N/A	LPJ-20	LPJ-30	LPJ-45SP	LPJ-60SP	LPJ-90SP
Control Power Fuses	Recommended Fuse Group 1[4]	FRS-R-2-1/2							
	Recommended Fuse Group 2[2]	FNQ-R-7-1/2							
	Recommended Fuse Group 3[3]	LPJ-6							
Contactor		100-M05N xy	100-M09N xy	100-M12N xy	100-C16xy	100-C23xy	100-C37 xy	100-C72xy	

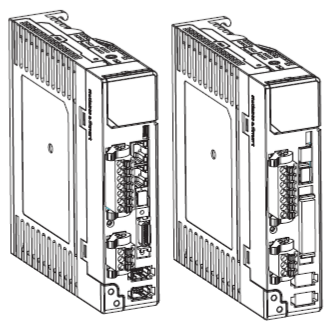
1. Fuses specified are Bussmann® fuses.
2. FNQ-R fuses are described as Time-Delay Fuses, Class CC.
3. LPJ fuses are described as Dual-Element Time-Delay Fuses, Class J.
4. FRS-R fuses are described as Dual-Element Time-Delay Fuses, Class RK5.
5. For contactors: x represents coil voltage, and y represents number of contacts.

Exterior Dimension and Mouning Dimension

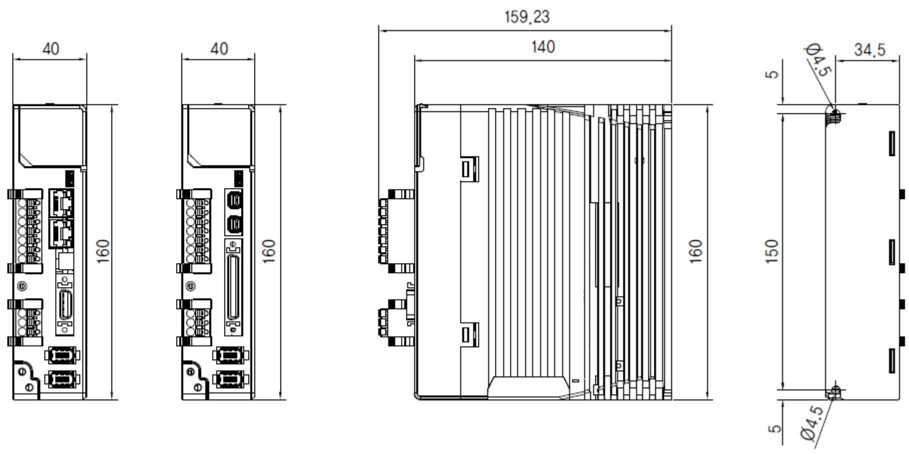
Drive dimensions are shown in the following drawing sheet.

Servo Drive Exterior Dimensions for Wall Mounting

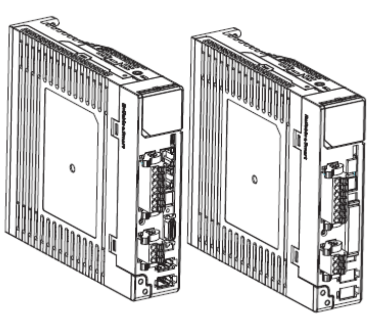
Figure A.1 CSD7_**BN(F)1 Exterior Dimensions (** : 01, 02)



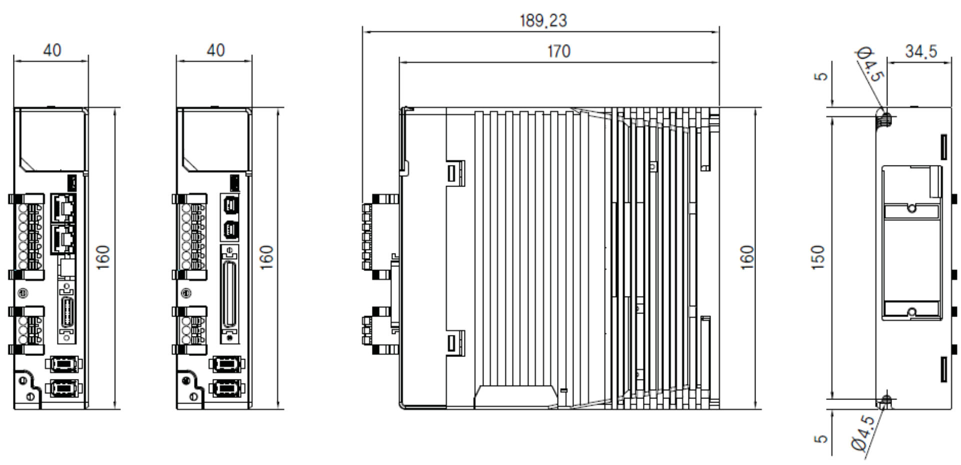
Height	Width	Depth
160 mm	40 mm	140 mm



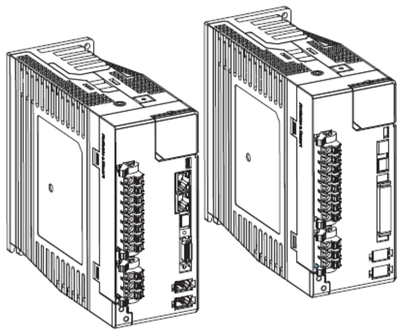
FigureA.2 CSD7_**BN(F)1 Exterior Dimensions (** : 04)



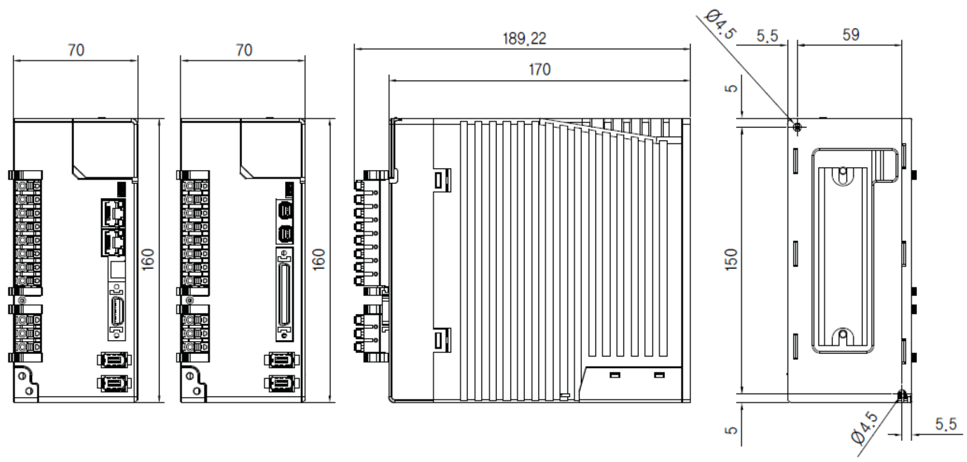
Height	Width	Depth
160 mm	40 mm	170 mm



FigureA.3 CSD7_**BN(F)1 Exterior Dimensions (** : 08, 10, 15)

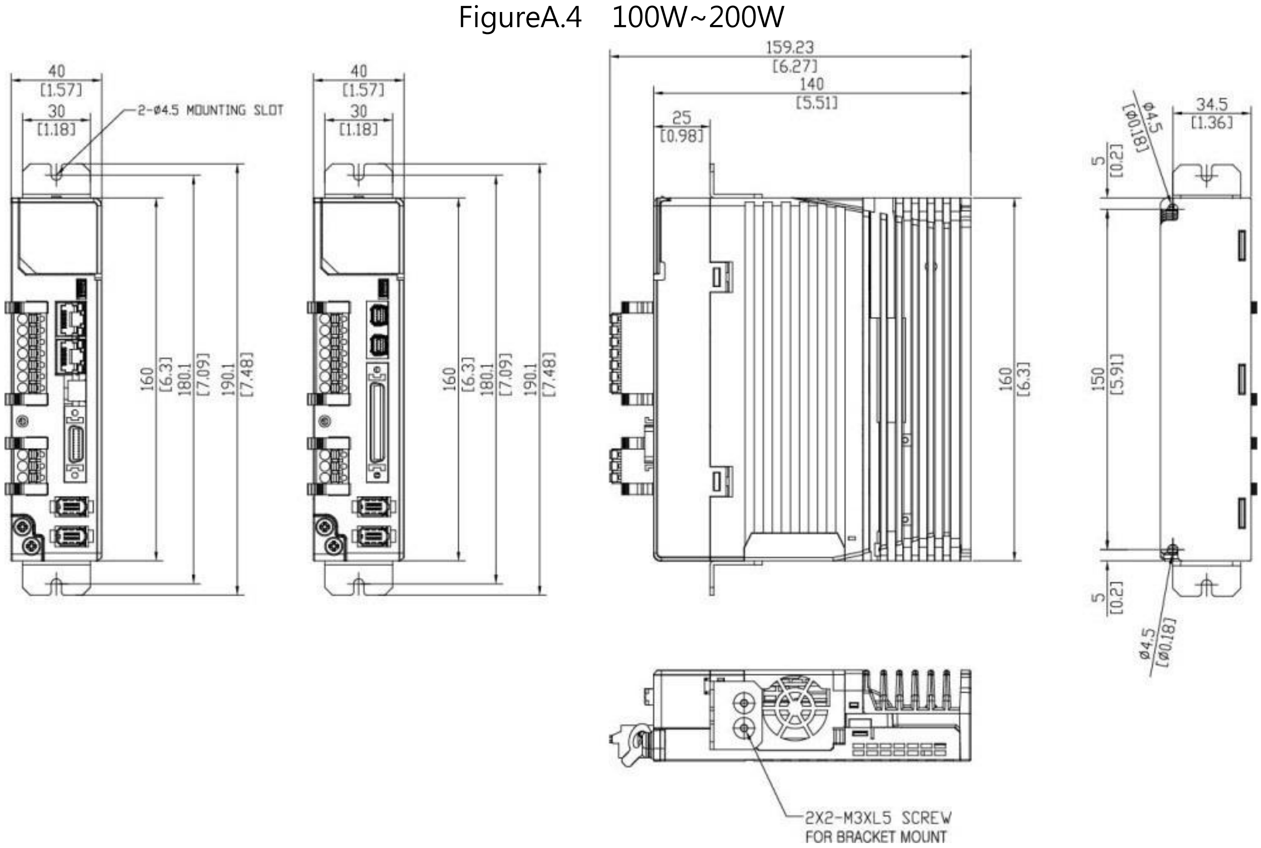


Height	Width	Depth
160 mm	70 mm	170 mm

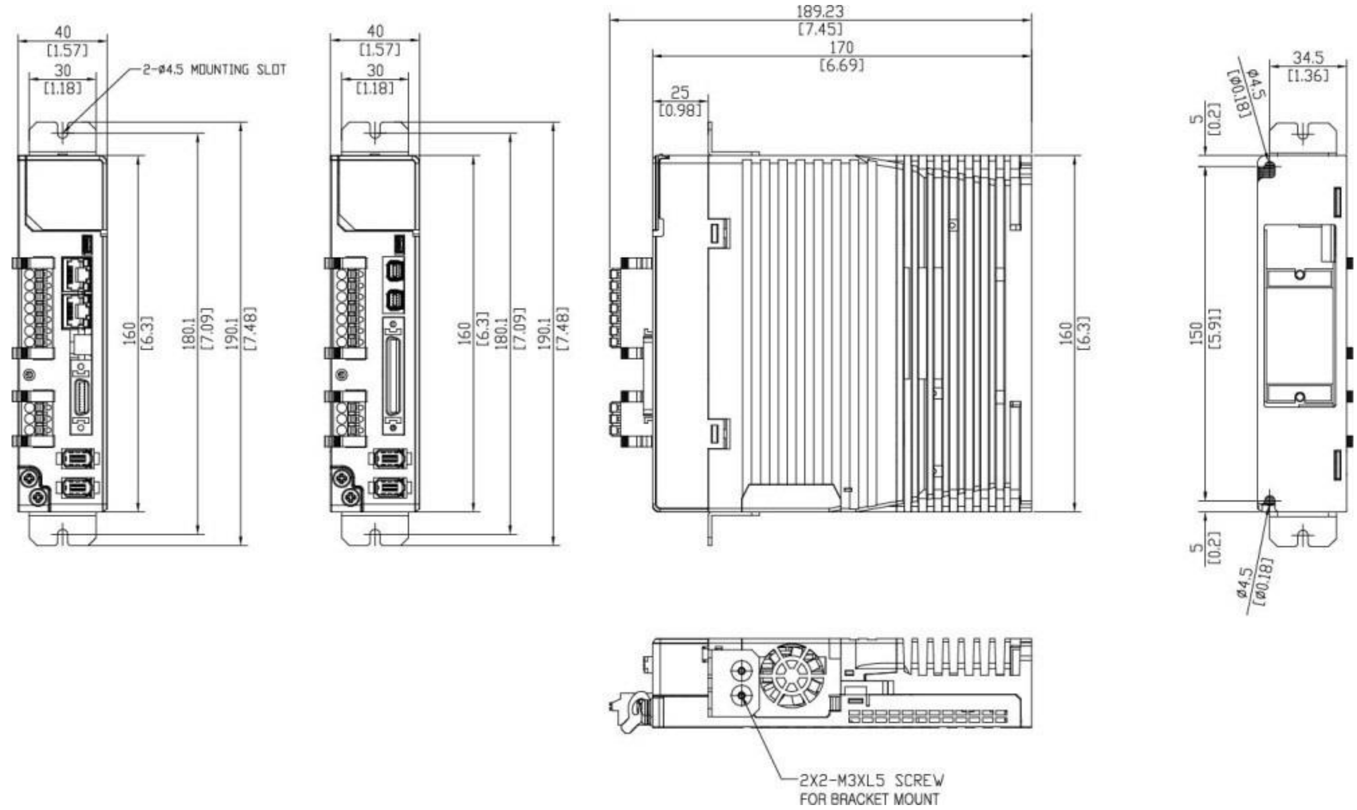


Servo Drive Exterior Dimensions for Rack Mounting

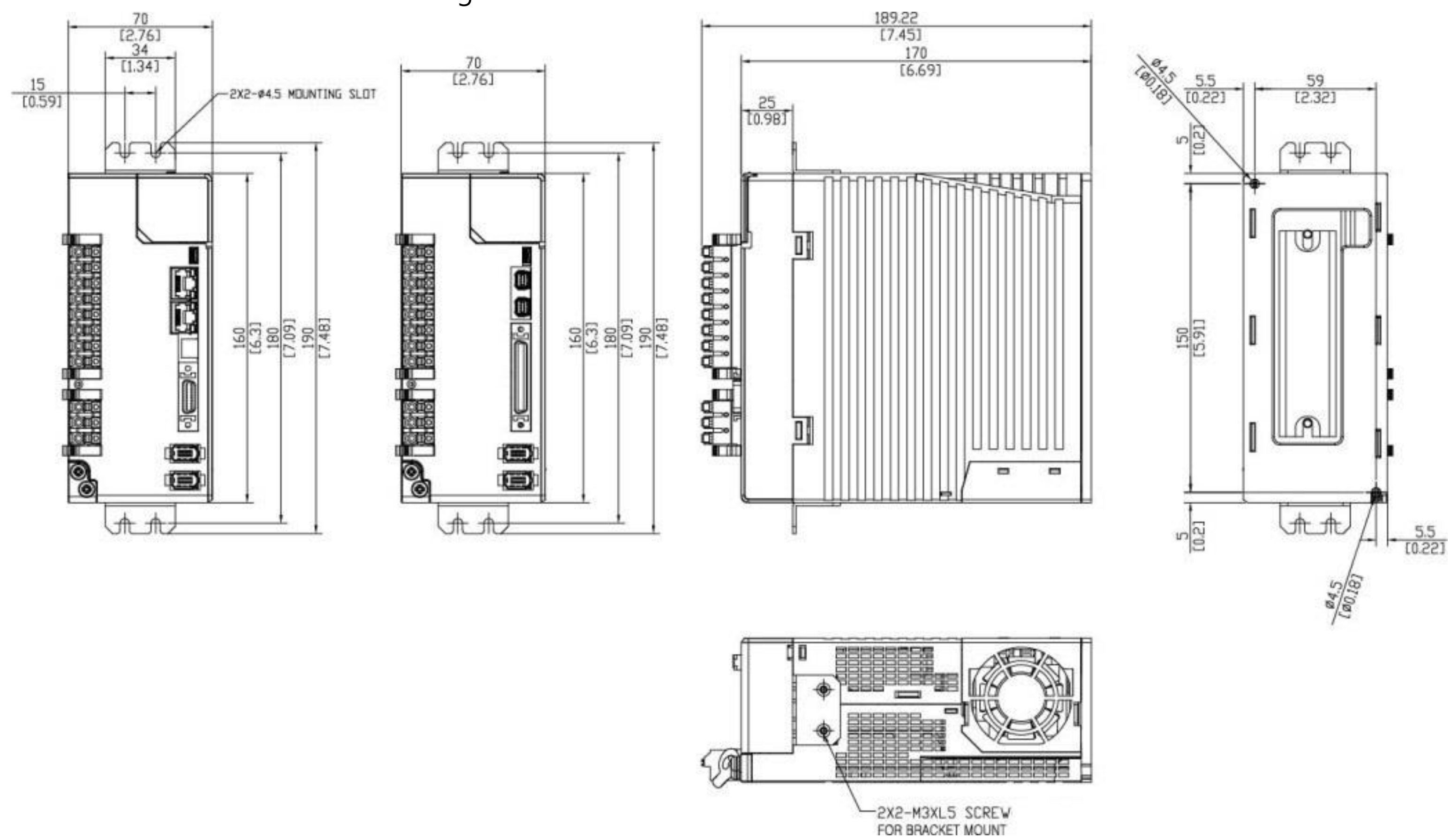
FigureA.4 100W~200W



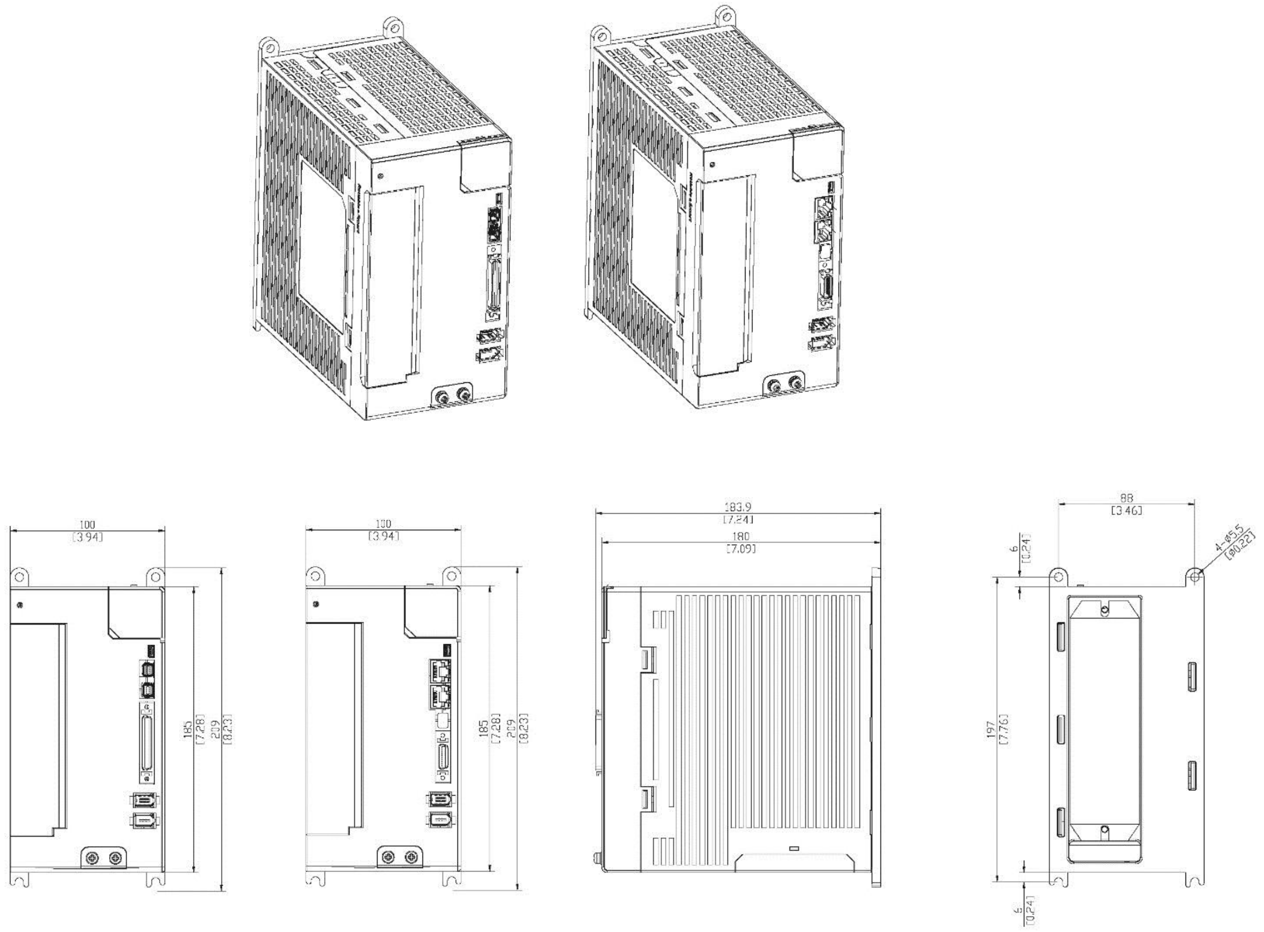
FigureA.5 400W



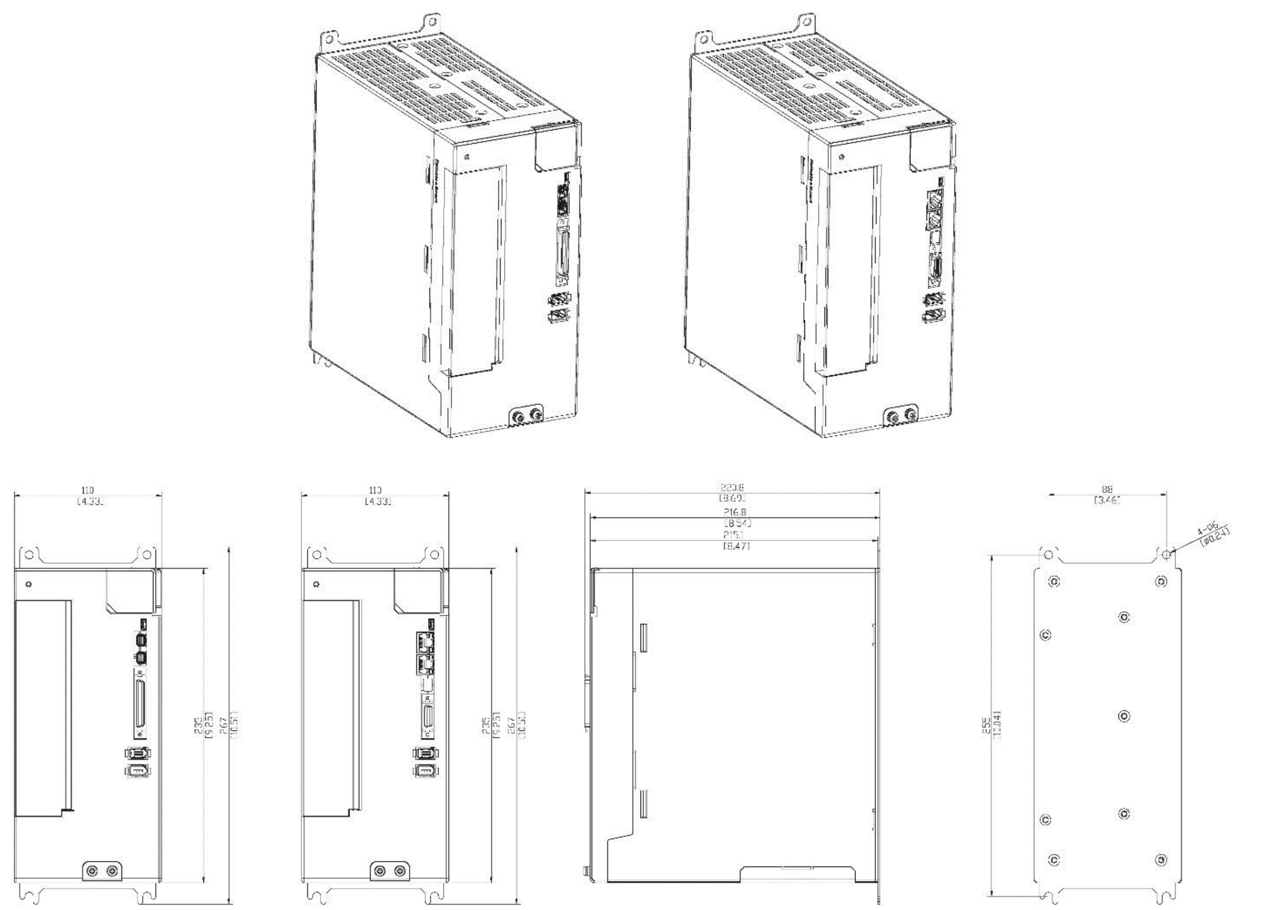
FigureA.6 800W~1.5KW



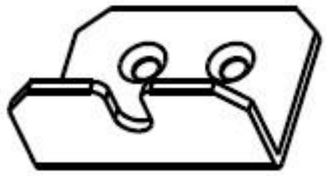
FigureA.7 3.5KW



FigureA.8 5KW



Rack mount bracket (For 100W, 200W, 400W)



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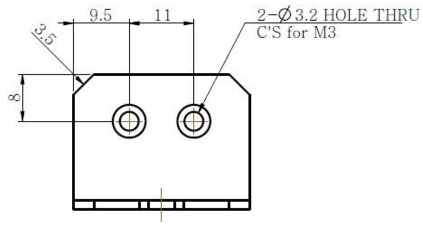

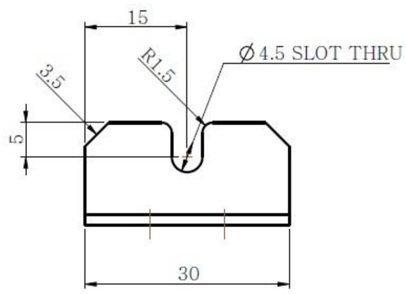

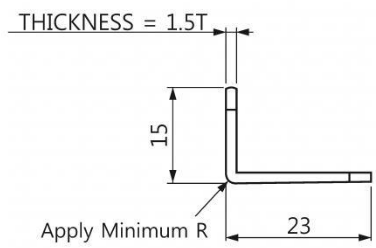

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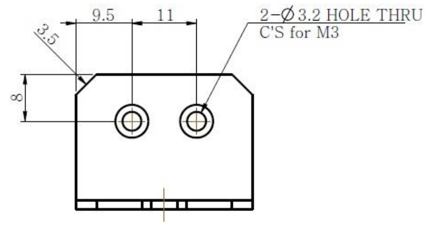

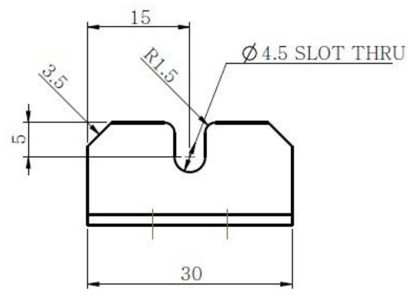

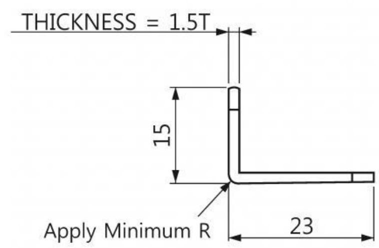

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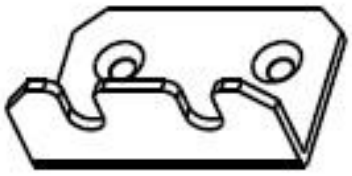
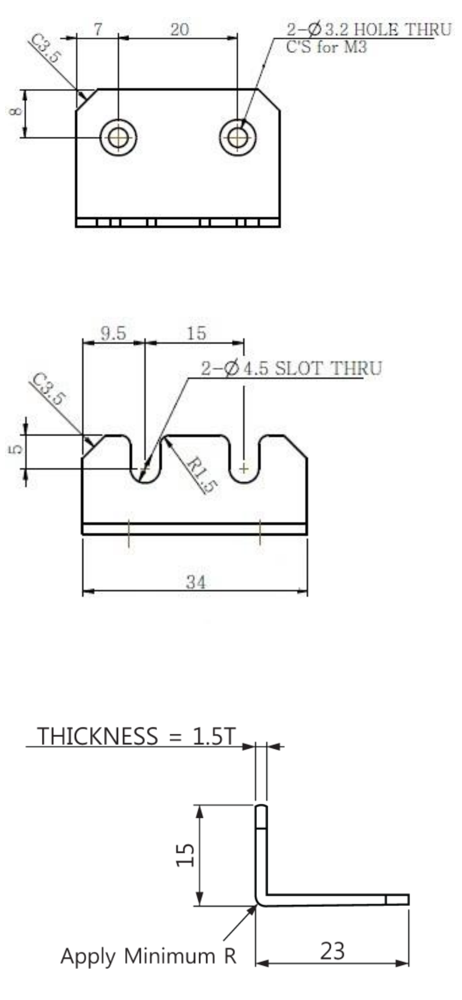
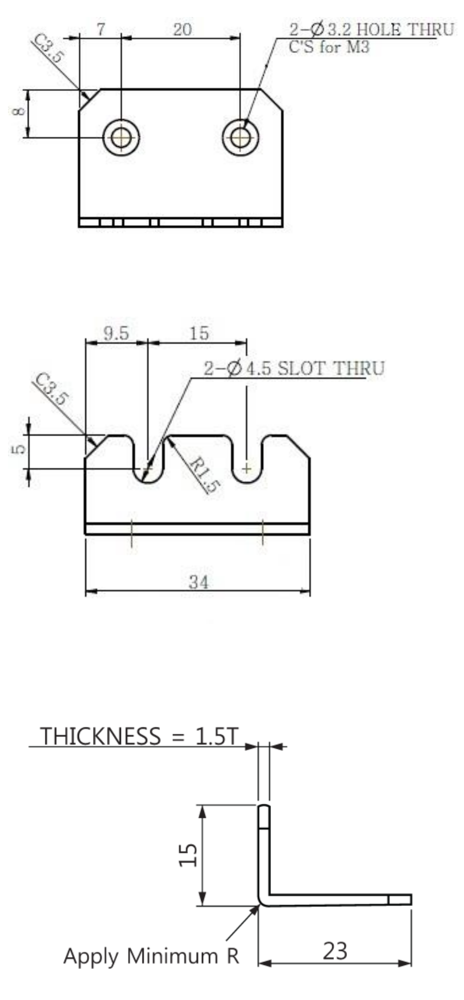
</table>

Rack mount bracket (For 800W, 1KW, 1.5KW)



Dimention	
Top	**Bottom**
	

B.

Appendix B. Cable and Connector Specification

Cable Specification for EtherCAT Communication

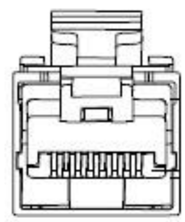
Use EtherCAT communication cables that meet the following specifications.

- Category 5 or higher cable (Among a total of four cable pairs, two cable pairs should be used for data transmission.)
- STP (Shielded Twisted Pair) cable

Recommended Specification for Connector, Cable

Table 116 Recommended Specification for Connector, Cable

Item	Manufacturer	Model	Remarks
Connector	3M	3R108-0000-000 CE	- RJ45 type - CAT 5 or higher
	TE	5-569530-5	
Cable	LS	S05E004	- CAT 5 or higher - STP cable



RJ45 connector

Note: The maximum length of EtherCAT cables between nodes is 100m. However, the length 100m may not be provided depending on the type of cables or the condition of peripheral electrical noise.

Cable Connection Diagram

The cable pins should be connected as follows :

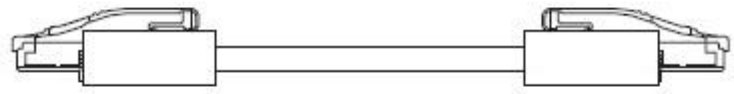


Table 117 Cable Connection Diagram

CON. A Pin No.	Signal Name	CON. B Pin No.	Wire Color	Remarks
1	TX+	1	Yellow/White	Pair
2	TX-	2	Yellow	
3	RX+	3	Green/White	Pair
6	RX-	6	Green	
5	Not used	5	Blue/White	Pair
4	Not used	4	Blue	
7	Not used	7	Brown/White	Pair
8	Not used	8	Brown	
Frame	Shield	Frame		

USB Communication Cable

The figure below is the USB wiring diagram for PC communication cable assembly required for interface between CSD7 servo drive and host computer.

Figure B.1 USB Communication Cable Spec between CSD7 and PC

- **About Connector**

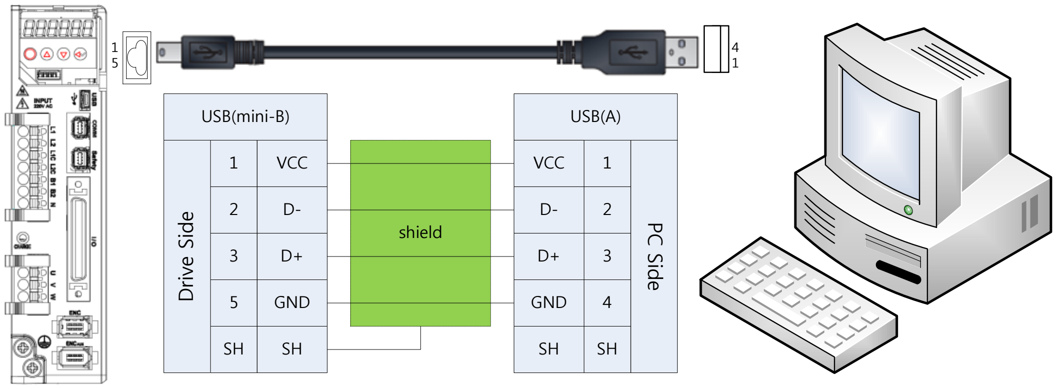
  The USB2.0 Mini 5P cable consists of USB A (Male) and USB Mini 5P (Male).

The pin map of the connector is as in the following table.

Table 118 USB Communication Cable Connector Pin Map

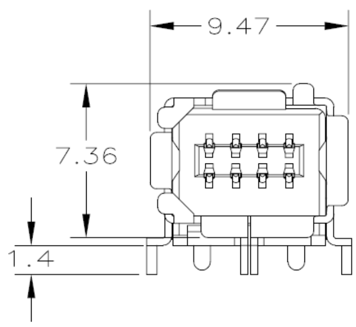
Pin No.	Signal Name	Description	Remark
1	VBUS	-	Power
2	D-	Data	Bi-Dir
3	D+	Data	Bi-Dir
4	ID	-	Input
5	GND	Ground	Power
Case	-	Shield	-

A standard USB cable can be used as the PC connection cable. If, however, the communication environment is not good due to excessive noise, it is recommended to use a cable with a ferrite core or a cable in which the shield is attached to online one side (drive side) as shown in the figure below.


USB(mini-B)
Drive Side
1 VCC
2 D-
3 D+
5 GND
SH SH
shield
USB(A)
VCC 1
D- 2
D+ 3
GND 4
SH SH
PC Side

Safety Function Connector

The industrial mini IO type connector (Tyco, 2069552-1) shown below is installed to prevent motor operation under an unsafe situation; and the dummy connector (Tyco, 1971153-1) is provided by default for the users who do not have a separate safety function. To enable the safety function, connect it to the safety sensor switch or controller using the connector shown on the right side of the figure below.

	
Drive Side (Tyco, 1981080-1)	Cable Side (Tyco, 2069577-1)

The table below shows the pin map of the safety connector. To enhance the safety standard, it consists of 2 independent input ports and 1 output port to monitor the product safety status.

Table 119 Safety Function Connector Pin Map

Pin No.	Signal Name	Description	Remark
1	NC	-	-
2	NC	-	-
3	SFI1-	Safety Input 1 -	Input
4	SFI1+	Safety Input 1 +	Input
5	SFI2-	Safety Input 2 -	Input
6	SFI2+	Safety Input 2 +	Input
7	EDM-	External Device Monitor -	Output
8	EDM+	External Device Monitor +	Output

The pin no 1 and pin no 2 in the table above is for inernal use, so user must not use it arbitrarily because this may cause failure.

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