OMRON

AC SERVO DRIVES

G5-series WITH BUILT-IN EtherCAT COMMUNICATIONS Linear Motor Type

User's Manual

R88D-KN□-ECT-L (AC Servo Drives)

sysmac
always in control

Introduction

Thank you for purchasing a G5-series Servo Drive. This manual explains how to install and wire the Servo Drive, set parameters needed to operate the Servo Drive, and remedies to be taken and inspection methods to be used should problems occur.

Intended Readers

This manual is intended for the following individuals.

Those having electrical knowledge (certified electricians or individuals having equivalent knowledge) and also being qualified for one of the following:

- Introducing FA equipment
- Designing FA systems
- Managing FA sites

Notice

This manual contains information you need to know to correctly use the Servo Drive and peripheral equipment. Before using the Servo Drive, read this manual and gain a full understanding of the information provided herein.

After you finished reading this manual, keep it in a convenient place so that it can be referenced at any time.

Make sure this manual is delivered to the end user.

Structure of This Document

This manual consists of the following sections.

		Outline
Section 1	Features and System Configuration	This section explains the features of the Servo Drive, and name of each part.
Section 2	Models and External Dimensions	This section explains the models of Servo Drives and peripheral equipment, and provides the external dimensions and mounting dimensions.
Section 3	Specifications	This section provides the general specifications, characteristics, connector specifications, and I/O circuits of the Servo Drives as well as the general specifications, characteristics, encoder specifications of the peripheral devices.
Section 4	System Design	This section explains the installation conditions for the Servo Drive, wiring methods including wiring conforming to EMC Directives and regenerative energy calculation methods as well as the performance of External Regeneration Resistors.
Section 5	EtherCAT Communications	This section describes EtherCAT communications under the assumption that the G5-series Servo Drive is connected to a Machine Automation Controller NJ-series (Model: NJ501-1□00) or Position Control Unit (CJ1W-NC281/NC481/NC881/NCF81/NC482/NC882/F82).
Section 6	Basic Control Functions	This section explains an outline of basic control functions and explains the contents of setting.
Section 7	Applied Functions	This section outlines the applied functions such as the electronic gear and gain switching, and explains the settings.
Section 8	Safety Function	This function stops the Linear motor based on a signal from a safety controller or safety sensor. An outline of the function is given together with operation and connection examples.
Section 9	Servo Parameter Objects	This section explains the set values and contents of each object.
Section 10	Operation	This section gives the operating procedures and explains how to operate in each mode.
Section 11	Adjustment Functions	This section explains the functions, setting methods, and items to note regarding various gain adjustments.
Section 12	Troubleshooting and Maintenance	This section explains the items to check when problems occur, error diagnosis using the error display and measures, error diagnosis based on the operating condition and measures, and periodic maintenance.
Appendicies		The appendix provides explanation for the profile that is used to control the Servo Drive, lists of objects, Sysmac Error Status codes, and other information.

Manual Structure

Page Structure and Symbol Icons

The following page structure and symbol icons are used in this manual.

Level 1 heading

Level 2 heading

Level 3 heading

Note,
Supplementary
Information,
Reference Target

A note, supplementary
information, reference
target, etc. are provided
with difference icons.

Operation Steps
Describes the
operation steps.

Level 2 heading
Shows which sub-section
the content of the current
page belongs to.

Section Number of
Level 1 heading
Shows which section the
content of the current
page belongs to.

Level 3 heading
Shows which paragraph
the content of the
current page belongs to.

Manual Name

Note The above page is only a sample for illustrative purposes. It is not the actual content of the manual.

Special Information

Special information in this manual is classified as follows:

Precautions for Safe Use

Precautions on what to do and what not to do to ensure safe usage of the product.

Precautions for Correct Use

Precautions on what to do and what not to do to ensure proper operation and performance.

Additional Information

Additional information to read as required.

This information is provided to increase understanding or make operation easier.

Terms and Expressions Used for the Linear Motor

In this manual, the term "Linear Motor" is defined as an OMRON product that consists of a Motor Coil Unit (the coil on the primary side) and a Magnet Trac (the magnet on the secondary side).

In addition to these components, constructing a Linear Motor system also requires the following parts, which are built into a component called the "Linear Slider."

- Motor Coil Unit (the coil on the primary side)
- Magnet Trac (the magnet on the secondary side)
- External encoder [1]
- Linear guide [1]
- Chassis [1]

[1] Not available from OMRON.

Because a Linear Motor provides a linear movement, terms or expressions different from rotary motors are used.

Example

Rotary	Linear
Torque [N·m]	Force [N]
Rotation speed [r/min]	Speed [mm/s]
Inertia [kg·m^2]	Mass [kg]

However, for object names with respect to the CiA 402 Drive Profile and the terms used for the Safe Torque OFF (STO) function, the manual uses the word "torque" for conformance with the relevant standards.

Read "torque" as "force" when using these object names.

Sections in this Manual

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Appendicies

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Read and Understand this Manual

Warranty and Limitations of Liability

WARRANTY
OMRON's exclusive warranty is that the products are free from defects in materials and workmanship for a period of one year (or other period if specified) from date of sale by OMRON. OMRON MAKES NO WARRANTY OR REPRESENTATION, EXPRESS OR IMPLIED, REGARDING NONINFRINGEMENT, MERCHANTABILITY, OR FITNESS FOR PARTICULAR PURPOSE OF THE PRODUCTS. ANY BUYER OR USER ACKNOWLEDGES THAT THE BUYER OR USER ALONE HAS DETERMINED THAT THE PRODUCTS WILL SUITABLY MEET THE REQUIREMENTS OF THEIR INTENDED USE. OMRON DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED.

LIMITATIONS OF LIABILITY
OMRON SHALL NOT BE RESPONSIBLE FOR SPECIAL, INDIRECT, OR CONSEQUENTIAL DAMAGES, LOSS OF PROFITS OR COMMERCIAL LOSS IN ANY WAY CONNECTED WITH THE PRODUCTS, WHETHER SUCH CLAIM IS BASED ON CONTRACT, WARRANTY, NEGLIGENCE, OR STRICT LIABILITY. In no event shall the responsibility of OMRON for any act exceed the individual price of the product on which liability is asserted. IN NO EVENT SHALL OMRON BE RESPONSIBLE FOR WARRANTY, REPAIR, OR OTHER CLAIMS REGARDING THE PRODUCTS UNLESS OMRON'S ANALYSIS CONFIRMS THAT THE PRODUCTS WERE PROPERLY HANDLED, STORED, INSTALLED, AND MAINTAINED AND NOT SUBJECT TO CONTAMINATION, ABUSE, MISUSE, OR INAPPROPRIATE MODIFICATION OR REPAIR.

Application Considerations

SUITABILITY FOR USE
OMRON shall not be responsible for conformity with any standards, codes, or regulations that apply to the combination of products in the customer's application or use of the products. At the customer's request, OMRON will provide applicable third party certification documents identifying ratings and limitations of use that apply to the products. This information by itself is not sufficient for a complete determination of the suitability of the products in combination with the end product, machine, system, or other application or use. The following are some examples of applications for which particular attention must be given. This is not intended to be an exhaustive list of all possible uses of the products, nor is it intended to imply that the uses listed may be suitable for the products: • Outdoor use, uses involving potential chemical contamination or electrical interference, or conditions or uses not described in this manual. • Nuclear energy control systems, combustion systems, railroad systems, aviation systems, medical equipment, amusement machines, vehicles, safety equipment, and installations subject to separate industry or government regulations. • Systems, machines, and equipment that could present a risk to life or property. Please know and observe all prohibitions of use applicable to the products. NEVER USE THE PRODUCTS FOR AN APPLICATION INVOLVING SERIOUS RISK TO LIFE OR PROPERTY WITHOUT ENSURING THAT THE SYSTEM AS A WHOLE HAS BEEN DESIGNED TO ADDRESS THE RISKS, AND THAT THE OMRON PRODUCTS ARE PROPERLY RATED AND INSTALLED FOR THE INTENDED USE WITHIN THE OVERALL EQUIPMENT OR SYSTEM.

PROGRAMMABLE PRODUCTS
OMRON shall not be responsible for the user's programming of a programmable product, or any consequence thereof.

Disclaimers

CHANGE IN SPECIFICATIONS

Product specifications and accessories may be changed at any time based on improvements and other reasons. It is our practice to change model numbers when published ratings or features are changed, or when significant construction changes are made. However, some specifications of the products may be changed without any notice. When in doubt, special model numbers may be assigned to fix or establish key specifications for your application on your request. Please consult with your OMRON representative at any time to confirm actual specifications of purchased products.

DIMENSIONS AND WEIGHTS

Dimensions and weights are nominal and are not to be used for manufacturing purposes, even when tolerances are shown.

PERFORMANCE DATA

Performance data given in this manual is provided as a guide for the user in determining suitability and does not constitute a warranty. It may represent the result of OMRON's test conditions, and the users must correlate it to actual application requirements. Actual performance is subject to the OMRON Warranty and Limitations of Liability.

ERRORS AND OMISSIONS

The information in this manual has been carefully checked and is believed to be accurate; however, no responsibility is assumed for clerical, typographical, or proofreading errors, or omissions.

Safety Precautions

To ensure that the G5-series Servo Drive as well as peripheral equipment are used safely and correctly, be sure to read this Safety Precautions section and the main text before using the product.
Learn all items you should know before use, regarding the equipment as well as the required safety information and precautions.
Make an arrangement so that this manual also gets to the end user of this product.
After reading this manual, keep it in a convenient place so that it can be referenced at any time.

Definition of Precautionary Information

The following notation is used in this manual to provide precautions required to ensure safe usage of a G5 series Servo Drives and Servomotors. The safety precautions that are provided are extremely important to safety. Always read and heed the information provided in all safety precautions.
The following notation is used.

⚠ **DANGER**	Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury. Additionally, there may be severe property damage.
⚠ **Caution**	Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury, or property damage.

Explanation of Symbols

🚫	⃠ This symbol indicates a prohibited item. The specific instruction is indicated using an illustration inside ⃠ and text. The symbol shown to the left indicates "disassembly prohibited."
⏚	● This symbol indicates a compulsory item. The specific instruction is indicated using an illustration inside ● and text. The symbol shown to the left indicates "grounding required."
⚡	△ This symbol indicates danger and caution. The specific instruction is indicated using an illustration inside △ and text. The symbol shown to the left indicates "beware of electric shock."
♨	△ This symbol indicates danger and caution. The specific instruction is indicated using an illustration inside △ and text. The symbol shown to the left indicates the "risk of hot surface."
🔥	△ This symbol indicates danger and caution. The specific instruction is indicated using an illustration inside △ and text. The symbol shown to the left indicates the "risk of fire."
⚠	△ This symbol indicates danger and caution. The specific instruction is indicated using an illustration inside △ and text. The symbol shown to the left indicates a "general precaution."

Precautions for Safe Use of This Product

- Illustrations contained in this manual sometimes depict conditions without covers and safety shields for the purpose of showing the details. When using this product, be sure to install the covers and shields as specified and use the product according to this manual.
- If the product has been stored for an extended period of time, contact your OMRON sales representative.

⚠ DANGER

Be sure to ground the frame ground terminals of the Servo Drive and Servomotor to 100 Ω or less for the Servo Drives with 100VAC or 200VAC. For the Servo Drive and Servomotor of 400VAC, ground the frame ground terminals to Electric shock may result.

Never touch the parts inside the Servo Drive.
Electric shock may result.

While the power is supplied, do not remove the front cover, terminal covers, cables, and options.
Electric shock may result.

Installation, operation, and maintenance or inspection by unauthorized personnel is prohibited.
Electric shock or injury may result.

Before carrying out wiring or inspection, turn OFF the main circuit power and wait for at least 15 minutes.
Electric shock may result.

Do not damage, pull, stress strongly, or pinch the cables or place heavy articles on them.
Electric shock, stopping of Servo Drive operation, or burn damage may result.

Do not use the cable when it is laying in oil or water.
Electric shock, injury, or fire may result.

Do not perform wiring or any operation with wet hands.
Electric shock, injury, or fire may result.

Never connect a commercial power supply directly to the Servomotor.
Fire or failure may result.

Never touch the Linear Motor during operation.
Injury may result.

Never modify the Servo Drive.
Injury or equipment damage may result.

⚠ DANGER

Install a stopping device on the machine to ensure safety.
* The holding brake is not a stopping device to ensure safety.
Injury may result.

Install an immediate stop device externally to the machine so that the operation can be stopped and the power supply cut off immediately.
Injury may result.

When the power is restored after a momentary power interruption, the machine may restart suddenly. Never come close to the machine when restoring power.
* Implement measures to ensure safety of people nearby even when the machine is restarted.
Injury may result.

After an earthquake, be sure to conduct safety checks.
Electric shock, injury, or fire may result.

Never drive the Servomotor using an external drive source.
Fire may result.

Do not place flammable materials near the Servomotor, Servo Drive, or Regeneration Resistor.
Fire may result.

Install the Servomotor, Servo Drive, and Regeneration Resistor on non-flammable materials such as metals.
Fire may result.

When you perform a system configuration using the safety function, be sure to fully understand the relevant safety standards and the information in the operation manual, and apply them to the system design.
Injury or damage may result.

The Linear Motor, if not controlled by some means, may not be able to keep a stopped state. Install an appropriate stopping device to ensure safety.
Injury or damage may result.

Do not allow people who wear medial electronic equipment such as a cardiac pacemaker to approach the Linear Motor.
The Magnet Trac and the energized Motor Coil Unit generate a strong magnetic field, which may cause medical electronic equipment to malfunction.

Do not handle objects made of magnetic materials near the Linear Motor. The objects may be attracted by the magnetic field of the Linear Motor and you may be caught between the motor parts, resulting in injury.
Use nonmagnetic tools when performing installation or other work on the Linear Motor.

⚠ Caution

The Servo Drive radiator, Regeneration Resistor, Servomotor, etc., may become hot while the power is supplied or remain hot for a while even after the power supply is cut off. Never touch these components.
A burn injury may result.

Use the Servomotor and Servo Drive in a specified combination.
Fire or equipment damage may result.

Do not store or install the Servo Drive in the following locations:
- Location subject to direct sunlight
- Location where the ambient temperature exceeds the specified level
- Location where the relative humidity exceeds the specified level
- Location subject to condensation due to rapid temperature changes
- Location subject to corrosive or flammable gases
- Location subject to high levels of dust, salt content, or iron dust
- Location subject to splashes of water, oil, chemicals, etc.
- Location where the Servo Drive may receive vibration or impact directly

Installing or storing the Servo Drive in any of these locations may result in fire, electric shock, or equipment damage.

Do not carry objects influenced by magnetic fields such as electronics and magnetic storage media (for example, a watch, personal computer, measuring instrument, magnetic card, or IC card) closer to the Linear Motor.
Malfunction or failure may result.

Storage and Transportation

⚠ Caution

When transporting the Servo Drive, do not hold it by the cables.
Injury or failure may result.

Do not overload the Servo Drive. (Follow the instructions on the product label.)
Injury or failure may result.

When lifting a 15 kW or higher Servo Drive during moving or installation, always have two people lift the product by grasping a metal part. Do not grasp a plastic part.
Risk of injury or product damage.

Installation and Wiring

<div align="center">

⚠ **Caution**

</div>

Do not block the intake or exhaust openings. Do not allow foreign objects to enter the Servo Drive.
Fire may result.

Provide the specified clearance between the Servo Drive and the inner surface of the control panel or other equipment.
Fire or failure may result.

Use crimp terminals for wiring.

If simple twisted wires are connected directly to a terminal block, fire may result.

Provide safety measures, such as a breaker, to protect against short circuiting of external wiring.
Fire may result.

Do not step on the Servo Drive or place heavy articles on it.
Injury may result.

Be sure to observe the mounting direction.
Failure may result.

Do not apply strong impact on the Servo Drive.
Failure may result.

Wire the cables correctly and securely.
Runaway Servomotor, injury, or failure may result.

Securely tighten the mounting screws, terminal block screws, and cable screws.
Failure may result.

Only use the power supply voltage specified in this manual.
Burn damage may result.

In locations where the power supply infrastructure is poor, make sure the rated voltage can be supplied.
Equipment damage may result.

If the Servo Drive is used in the following locations, provide sufficient shielding measures.

- Location subject to noise e.g., due to static electricity
- Location subject to a strong electric or magnetic field
- Location where exposure to radioactivity may occur
- Location near power supply lines

Using the Servo Drive in any of these locations may result in equipment damage.

Connect an immediate stop relay in series with the brake control relay.
Injury or failure may result.

Operation and Adjustment

<table>
<tr><td colspan="2" align="center">⚠ **Caution**</td></tr>
<tr><td>If the Servo Drive fails, cut off the power supply to the Servo Drive at the power supply.
Fire may result.</td><td align="center">🔥</td></tr>
<tr><td>Conduct a test operation after confirming that the equipment is not affected.
Equipment damage may result.</td><td align="center">⚠</td></tr>
<tr><td>Before operating the Servo Drive in an actual environment, check if it operates correctly based on the parameters and switches you have set.
Equipment damage may result.</td><td align="center">⚠</td></tr>
<tr><td>Never adjust or set parameters to extreme values, because it will make the operation unstable.
Injury may result.</td><td align="center">⚠</td></tr>
<tr><td>Separate the Servomotor from the mechanical system and check its operation before installing the Servomotor to the machine.
Injury may result.</td><td align="center">⚠</td></tr>
<tr><td>If an error occurs, remove the cause of the error and ensure safety, and then reset the alarm and restart the operation.
Injury may result.</td><td align="center">⚠</td></tr>
<tr><td>Do not operate the Linear Motor connected to an excessive load mass.
Failure may result.</td><td align="center">⚠</td></tr>
<tr><td>Do not turn ON and OFF the main Servo Drive power supply frequently.
Failure may result.</td><td align="center">⚠</td></tr>
</table>

Maintenance and Inspection

<table>
<tr><td colspan="2" align="center">⚠ **Caution**</td></tr>
<tr><td>Never repair the Servo Drive by disassembling it.
Electric shock or injury may result.</td><td align="center">🚫</td></tr>
<tr><td>After replacing the Servo Drive, transfer to the new Servo Drive all data needed to resume operation, before restarting operation.
Equipment damage may result.</td><td align="center">⚠</td></tr>
<tr><td>Be sure to turn OFF the power supply when the Servo Drive is not going to be used for a prolonged period of time.
Injury may result.</td><td align="center">⚠</td></tr>
</table>

Location of Warning Label

The Servo Drive bears a warning label at the following location to provide handling warnings.

When handling the Servo Drive, be sure to observe the instructions provided on this label.

Warning label display location

(R88D-KN02H-ECT-L)
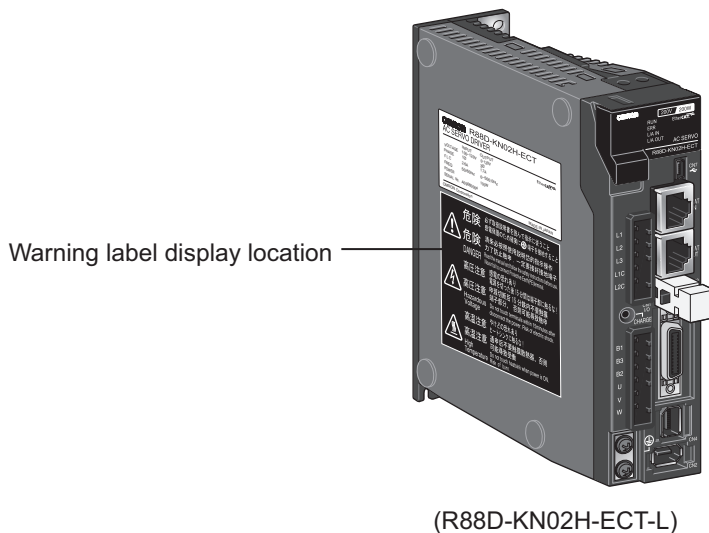
Instructions on Warning Label

Disposal

Dispose of the Servo Drive as industrial waste.

Regulations and Standards

To export (or provide to nonresident aliens) any part of this product that falls under the category of goods (or technologies) for which an export certificate or license is mandatory according to the Foreign Exchange and Foreign Trade Control Law of Japan, an export certificate or license (or service transaction approval) according to this law is required.

Therefore, for the G5-series Servo Drive which is an EC-compliant product, it is the user's responsibility to check and ensure the compliance of the equipment and the entire system with the applicable EC Directives.

Conformance to EC Directives

EC Directive	Product	Applicable standards
Low Voltage Directive	AC Servo Drives	EN 61800-5-1: 2007
EMC Directive	AC Servo Drives	EN 55011/A2: 2007 (CISPR11)
		IEC 61800-3: 2005
		EN 61000-6-2: 2004
Machinery Directive	AC Servo Drives	EN954-1: 1996 Cat.3
		EN ISO13849-1: 2008 PL c, PL d (MTTFd=85.9 years, Dcavg=87.5%)
		EN61508: 2001(Part 1, 2, 4) SIL2
		EN62061: 2005 SIL2
		EN61800-5-2: 2007(STO)
		IEC61326-3-1: 2008

Note To conform to EMC Directives, the Servo Drive must be installed under the conditions described in *4-3 Wiring Conforming to EMC Directives* on page 4-31.

UL and cUL Standards

Standard	Product	Applicable standards	File number
UL standards	AC Servo Drives	UL 508C	E164620
CSA standards	AC Servo Drives	CSA 22.2	No. 14

SEMI F47

- Servo Drives conform to the SEMI F47 standard for momentary power interruptions (voltage sag immunity) for no-load or light-load operation.
- This standard applies to semiconductor manufacturing equipment.

Note 1 It does not apply to Servo Drivers with single-phase 100-V specifications or with 24-VDC specifications for the control power input.

2 Always perform evaluation testing for SEMI F47 compliance in the actual system.

Trademarks

- Sysmac and SYSMAC are trademarks or registered trademarks of OMRON Corporation in Japan and other countries for OMRON factory automation products.

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

Other company names and product names in this document are the trademarks or registered trademarks of their respective companies.

Items to Check after Unpacking

After unpacking, check the following items.

- Is this the model you ordered?
- Was there any damage sustained during shipment?

Accessories

Safety Precautions document x 1 copy

- Connectors, mounting screws, mounting brackets, and other accessories other than those in the table below are not supplied. They must be prepared by the customer.
- If any item is missing or a problem is found such as Servo Drive damage, contact the OMRON dealer or sales office where you purchased your product.

Specifications		Connector for main circuit power supply terminals and control circuit power supply terminals	Connector for External Regeneration Resistor connection terminals and Motor connection terminals	Safety bypass connector	Mounting Brackets
Single-phase 100 VAC	100 W	Included		Included	–
	200 W				
	400 W				
Single-phase/3-phase 200 VAC	100 W				
	200 W				
	400 W				
	750 W				
	1 kW				
	1.5 kW				
3-phase 200 VAC	2 kW				Included
	3 kW	–			
	5 kW				
	7.5 kW				
	15 kW				
3-phase 400 VAC	600 W	Included			–
	1 kW				
	1.5 kW				
	2 kW				Included
	3 kW	–			
	5 kW				
	7.5 kW				
	15 kW				

Revision History

The manual revision code is a number appended to the end of the catalog number found in the bottom left-hand corner of the front or back cover.

Example

Cat. No. | I577-E1-01

Revision code

Revision code	Revision Date	Revised content
01	October 2011	Original production

1

Features and System Configuration

This section explains the features of the Servo Drive and name of each part.

1-1 Outline

The G5 Series AC Servo Drives With Built-in EtherCAT Communications, Linear Motor Type supports 100-Mbps EtherCAT.

When you use the G5-series Servo Drive with a Machine Automation Controller NJ-series (Model: NJ501-1□00) or EtherCAT-compatible Position Control Unit (Model: CJ1W-NC□8□), you can construct a sophisticated positioning control system. Also, you need only one communications cable to connect the Servo Drive and the Controller. Therefore, you can realize a position control system easily with reduced wiring effort.

With real time autotuning, adaptive filter, notch filter, and damping control, you can set up a system that provides stable operation by suppressing vibration in low-rigidity machines.

1-1-1 Features of G5-series Servo Drives

G5-series Servo Drives have the following features.

Optimal Functionality and Operability by Standardizing Specifications

As a Sysmac Device[1], the G5 Series AC Servo Drives With Built-in EtherCAT Communications, Linear Motor Type is designed to provide optimal functionality and ease of use when used in conjunction with a Machine Automation Controller such as NJ series and the automation software Sysmac Studio.

[1] Sysmac Device is a generic term for OMRON control devices such as an EtherCAT Slave, designed with unified communications specifications and user interface specifications.

Data Transmission Using EtherCAT Communications

Combining the G5-series Servo Drive with a Machine Automation Controller NJ-series (Model: NJ501-1□00) or CJ1W-NC□8□ EtherCAT-compatible Position Control Unit enables you to exchange all position information with the controller in high-speed data communications.

Since the various control commands are transmitted via data communications, Servomotor's operational performance is maximized without being limited by interface specifications such as the response frequency of the external feedback pulses.

You can use the Servo Drive's various control parameters and monitor data on a host controller, and unify the system data for management.

Safe Torque OFF (STO) Function to Ensure Safety

You can cut off the motor current to stop the motor based on a signal from an emergency stop button or other safety equipment. This can be used for an emergency stop circuit that is compliant with safety standards without using an external contactor. Even during the torque (force) OFF status, the present position of the motor is monitored by the control circuits to eliminate the need to perform an origin search when restarting.

Suppressing Vibration of Low-rigidity Mechanisms during Acceleration/Deceleration

The damping control function suppresses vibration of low-rigidity mechanisms or devices whose tips tend to vibrate.

Two damping filters are provided to enable switching the damping frequency automatically according to the operation direction and also via an external signal. In addition, the settings can be made easily by setting the damping frequency and filter values. You are assured of stable operation even if the set values are inappropriate.

1-1-2   What is EtherCAT?

EtherCAT is an open high-speed industrial network system that conforms to Ethernet (IEEE 802.3). Each node achieves a short cycle time by transmitting Ethernet frames at high speed. A mechanism that allows sharing clock information enables high-precision synchronization control with low communications jitter.

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

1-1-3   Object Dictionary

G5 Series AC Servo Drives With Built-in EtherCAT Communications, Linear Motor Type use the object dictionary for CAN application protocol over EtherCAT (CoE) as a base for communications.

An object is a special data structure inside a device that consists of data, parameters, and methods.

An object dictionary is a data structure that describes the data type objects, communications objects, and application objects.

All objects are assigned four-digit hexadecimal numbers in the areas shown in the following table.

Indexes	Area	Contents
0000 to 0FFF hex	Data Type Area	Definitions of data types.
1000 to 1FFF hex	CoE Communications Area	Definitions of variables that can be used by all servers for designated communications.
2000 to 2FFF hex	Manufacturer Specific Area 1	Variables with common definitions for all OMRON products.
3000 to 5FFF hex	Manufacturer Specific Area 2	Variables with common definitions for all G5-series Servo Drives (servo parameters).[1]
6000 to 9FFF hex	Device Profile Area	Variables defined in the Servo Drive's CiA402 drive profile.
A000 to FFFF hex	Reserved Area	Area reserved for future use.

*1   G5-series Servo Drive parameters (Pn□□□) are allocated to objects 3000 to 3999 hex. Indexes 3□□□ hex correspond to G5-series Servo Drive parameters Pn□□□. For example, object 3504 hex is the same as parameter Pn504.
Pn□□□ uses decimal numbers but object 3□□□ hex is a hexadecimal number.
For details on servo parameters, refer to *Section 9 Servo Parameter Objects*.

1-2 System Configuration

The system configuration for a G5-Series AC Servo Drive with Built-in EtherCAT Communications, Linear Motor Type is shown below.

Controller (EtherCAT)

NJ-series Machine Automation Controller

Programmable Controller SYSMAC CJ2

Position Control Unit CJ1W-NC□8□

EtherCAT

G5 Series AC Servo Drive R88D-KN□-ECT-L
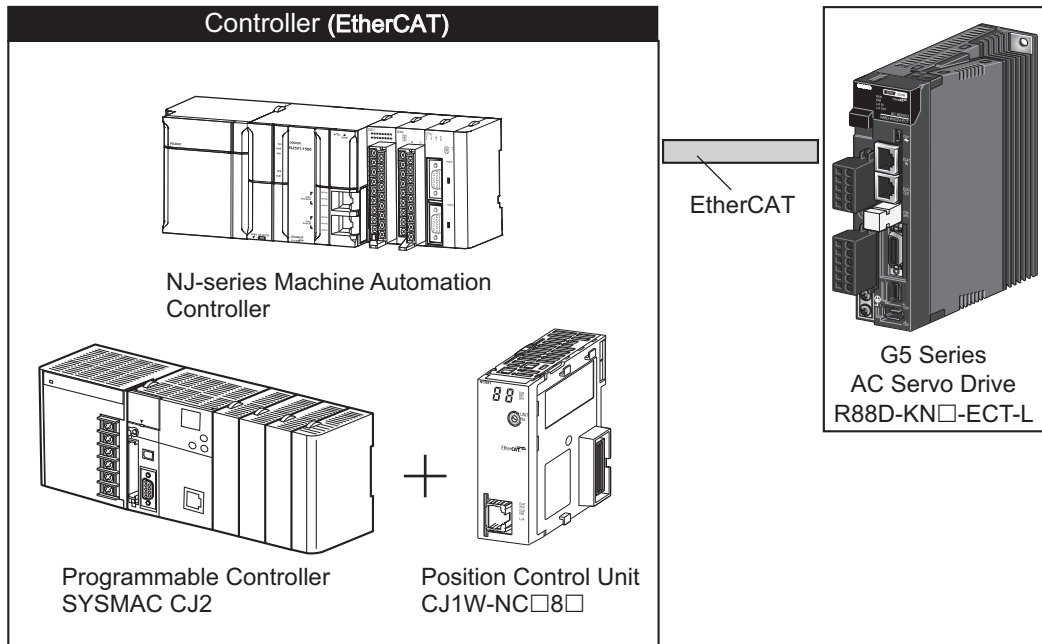
1-3 Names and Functions

This section describes the names and functions of Servo Drive parts.

1-3-1 Servo Drive Part Names

The Servo Drive part names are given below.
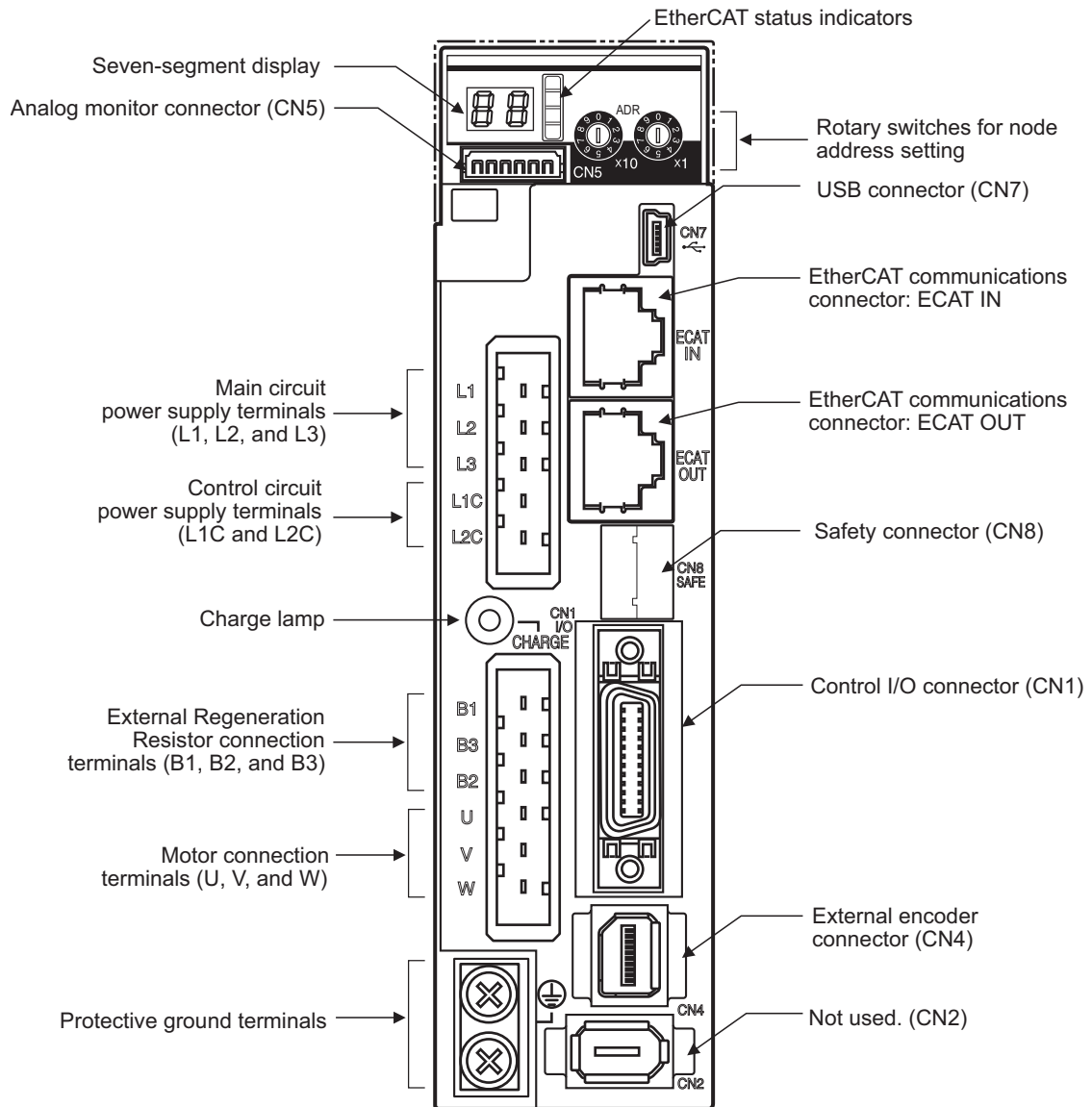
1-3-2   Servo Drive Functions

The functions of each part are described below.

Display

A 2-digit 7-segment display shows the node address, error codes, and other Servo Drive status.

Charge Lamp

Lights when the main circuit power supply is turned ON.

EtherCAT Status Indicators

These indicators show the status of EtherCAT communications.

For details, refer to *Status Indicators* on page 5-3.

Control I/O Connector (CN1)

Used for command input signals and I/O signals.

External Encoder Connector (CN4)

Connector for an external encoder signal.

EtherCAT Communications Connectors (ECAT IN and ECAT OUT)

Connectors for EtherCAT communications.

Analog Monitor Connector (CN5)

You can use a special cable to monitor values, such as the motor speed, force command value, etc.

USB Connector (CN7)

Communications connector for the computer.

Safety Connector (CN8)

Connector for safety devices.

If no safety devices are used, keep the factory-set safety bypass connector installed.

1-4   System Block Diagram

This is the block diagram of the G5-series AC Servo Drive with Built-in EtherCAT Communications, Linear Motor Type.

● **R88D-KN01L-ECT-L/-KN02L-ECT-L/-KN04L-ECT-L/
R88D-KN01H-ECT-L/-KN02H-ECT-L/-KN04H-ECT-L/-KN08H-ECT-L**
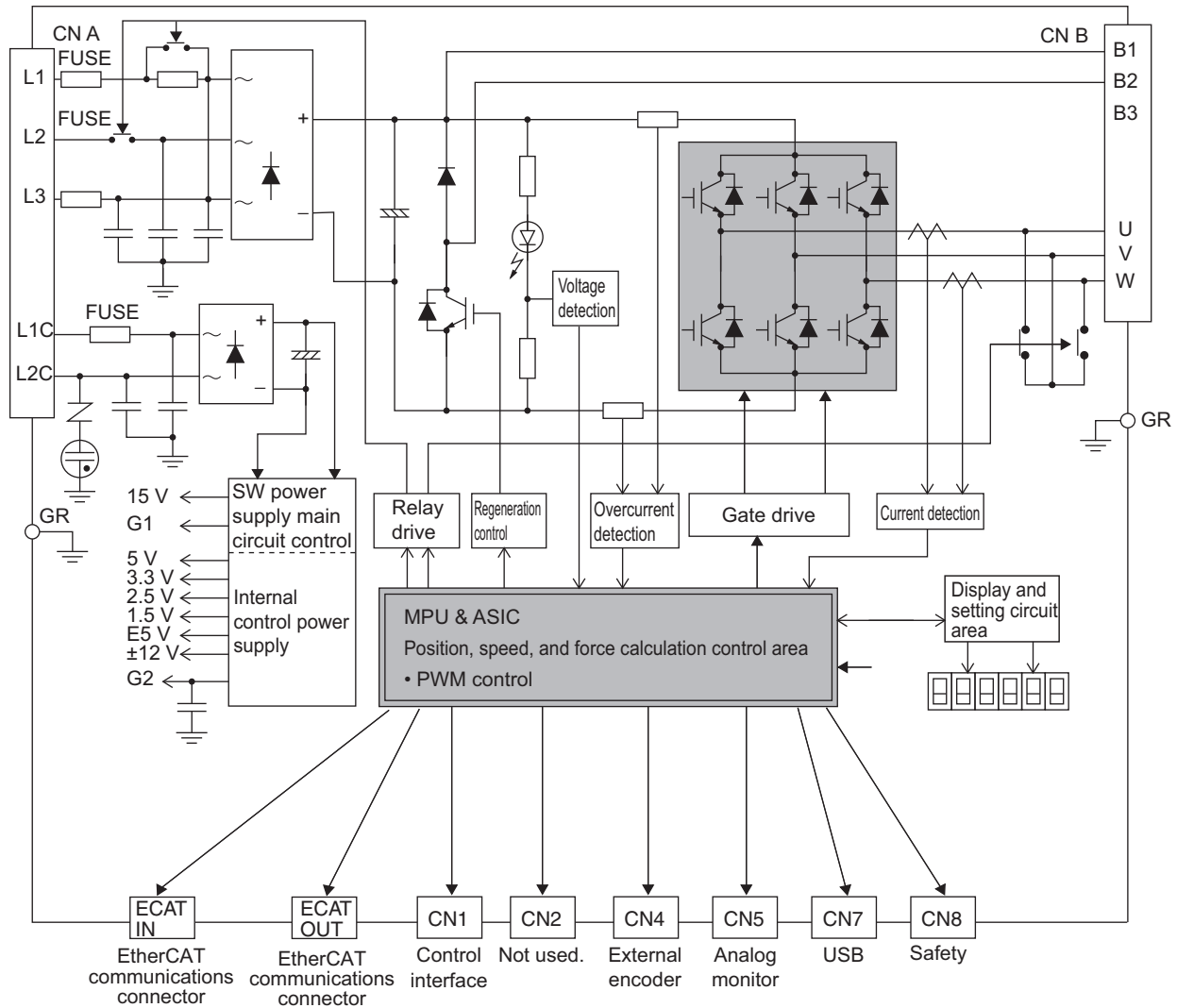
● **R88D-KN10H-ECT-L/-KN15H-ECT-L/-KN20H-ECT-L**
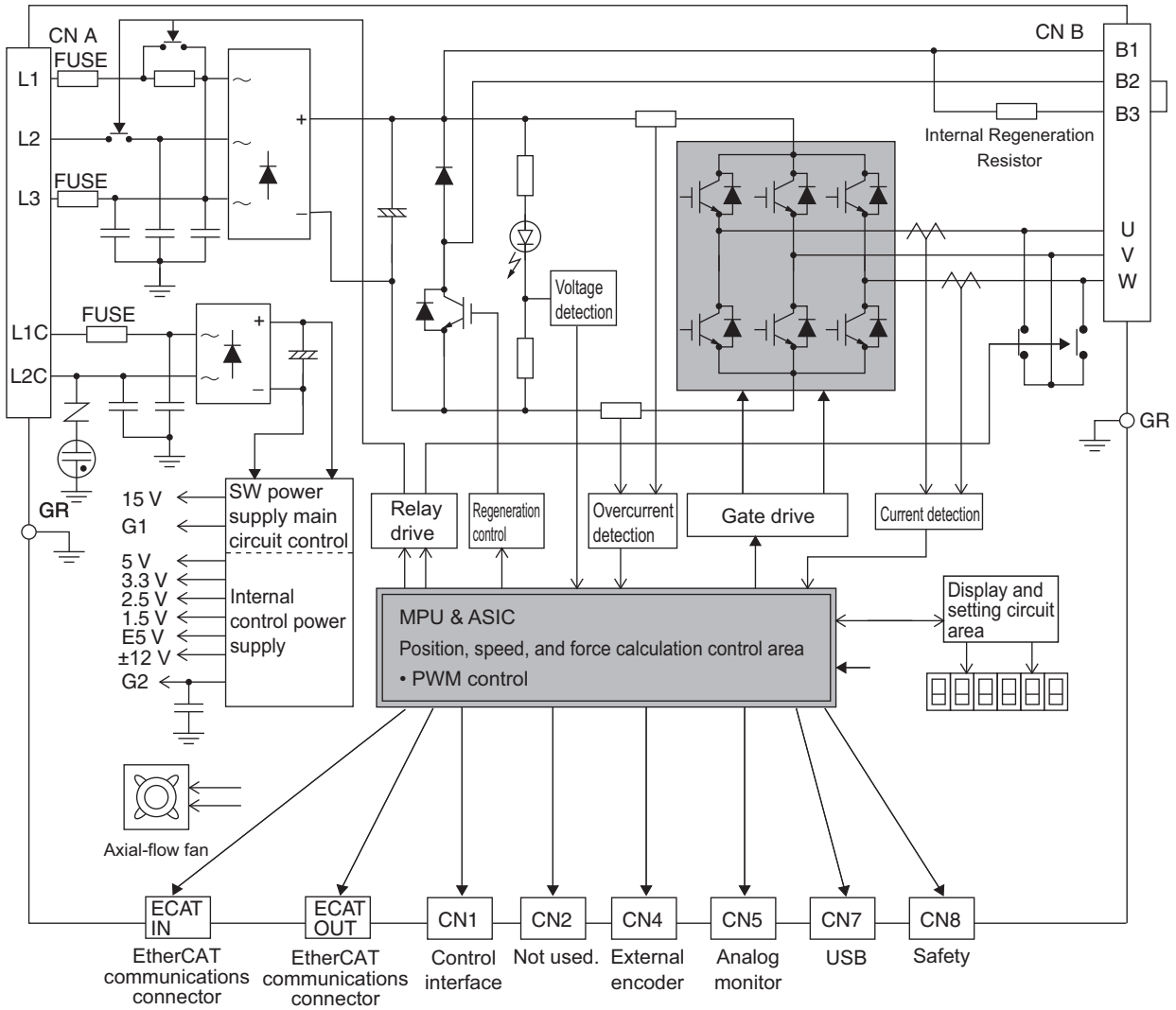
● **R88D-KN30H-ECT-L/-KN50H-ECT-L**
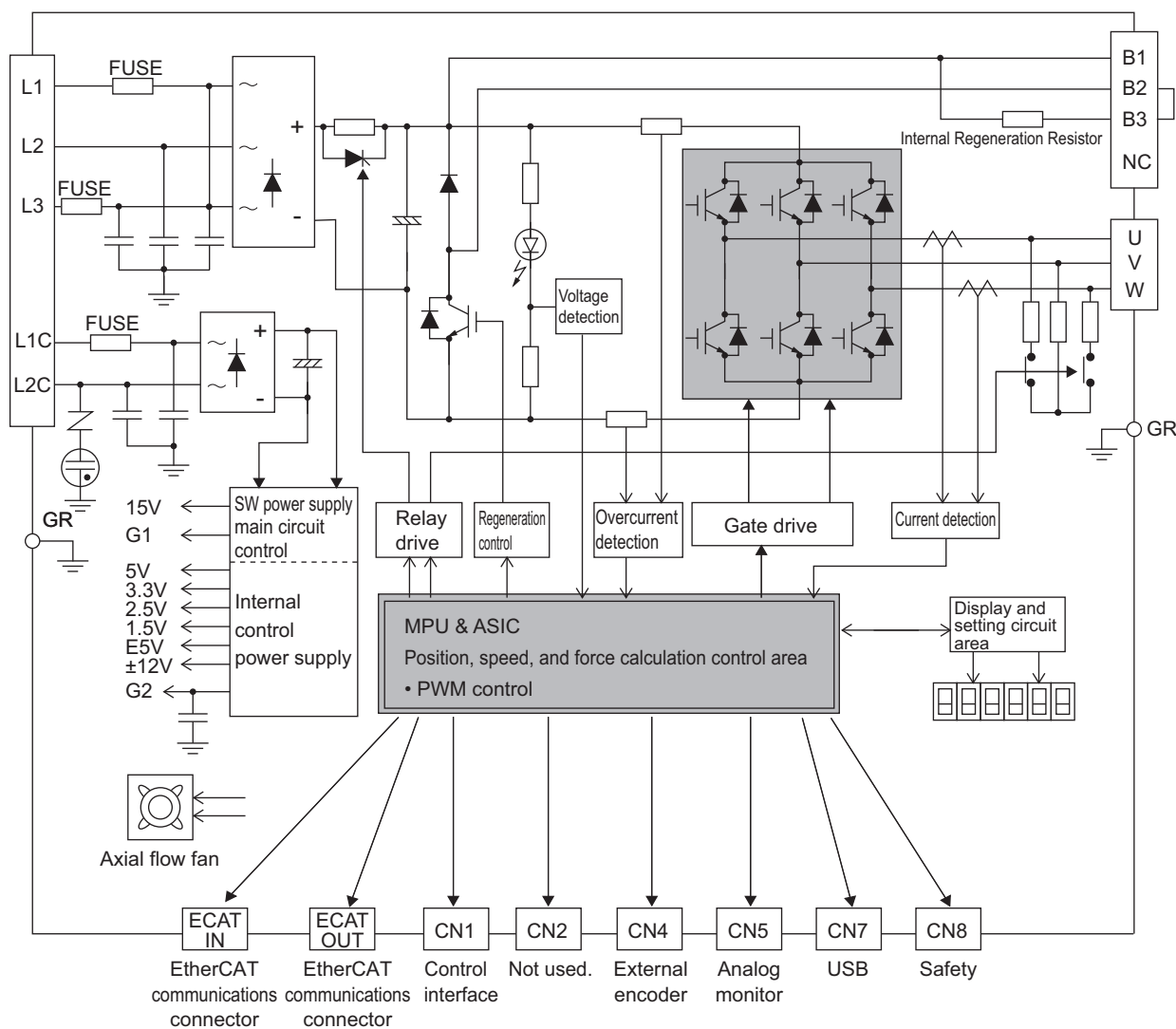
● R88D-KN75H-ECT-L
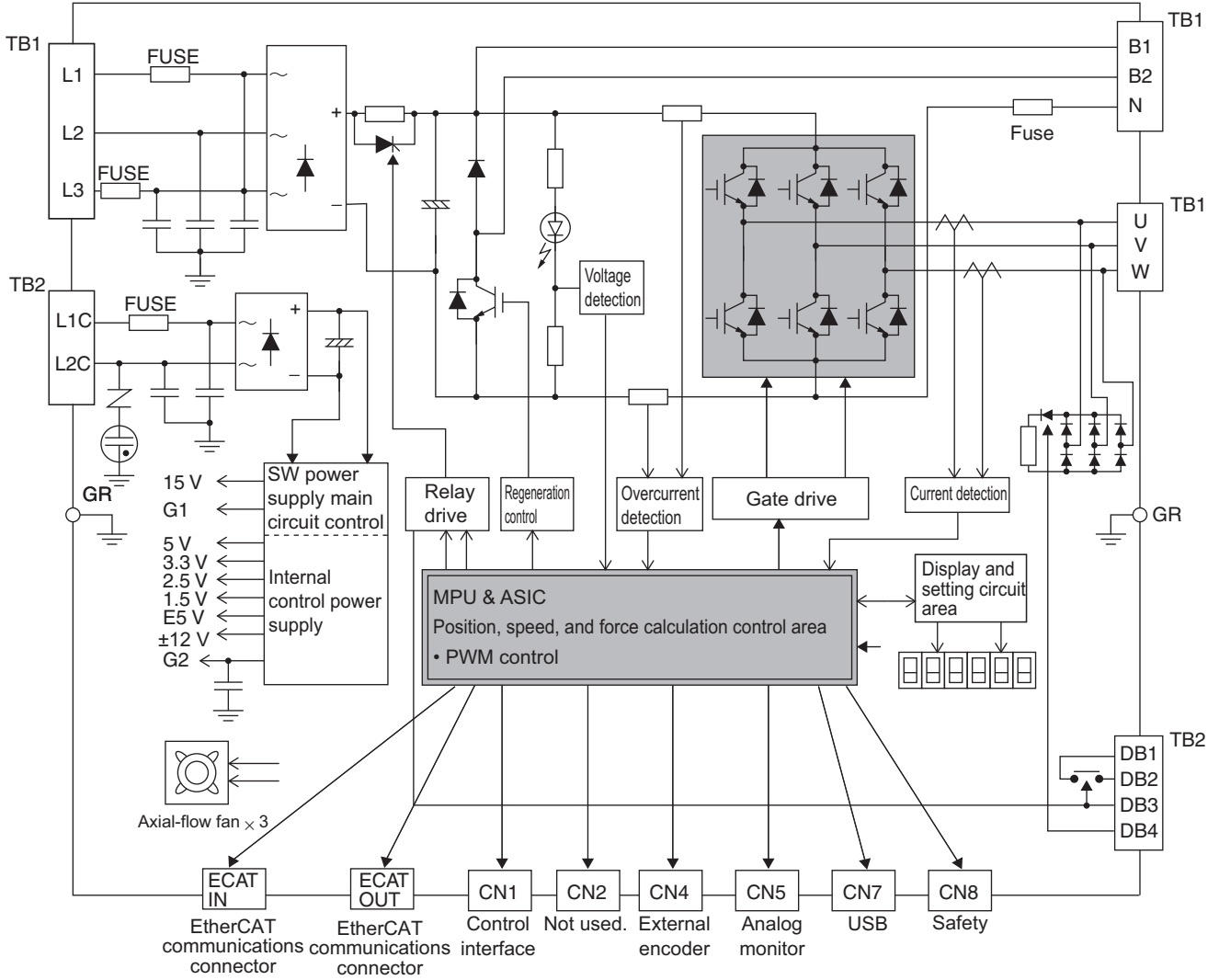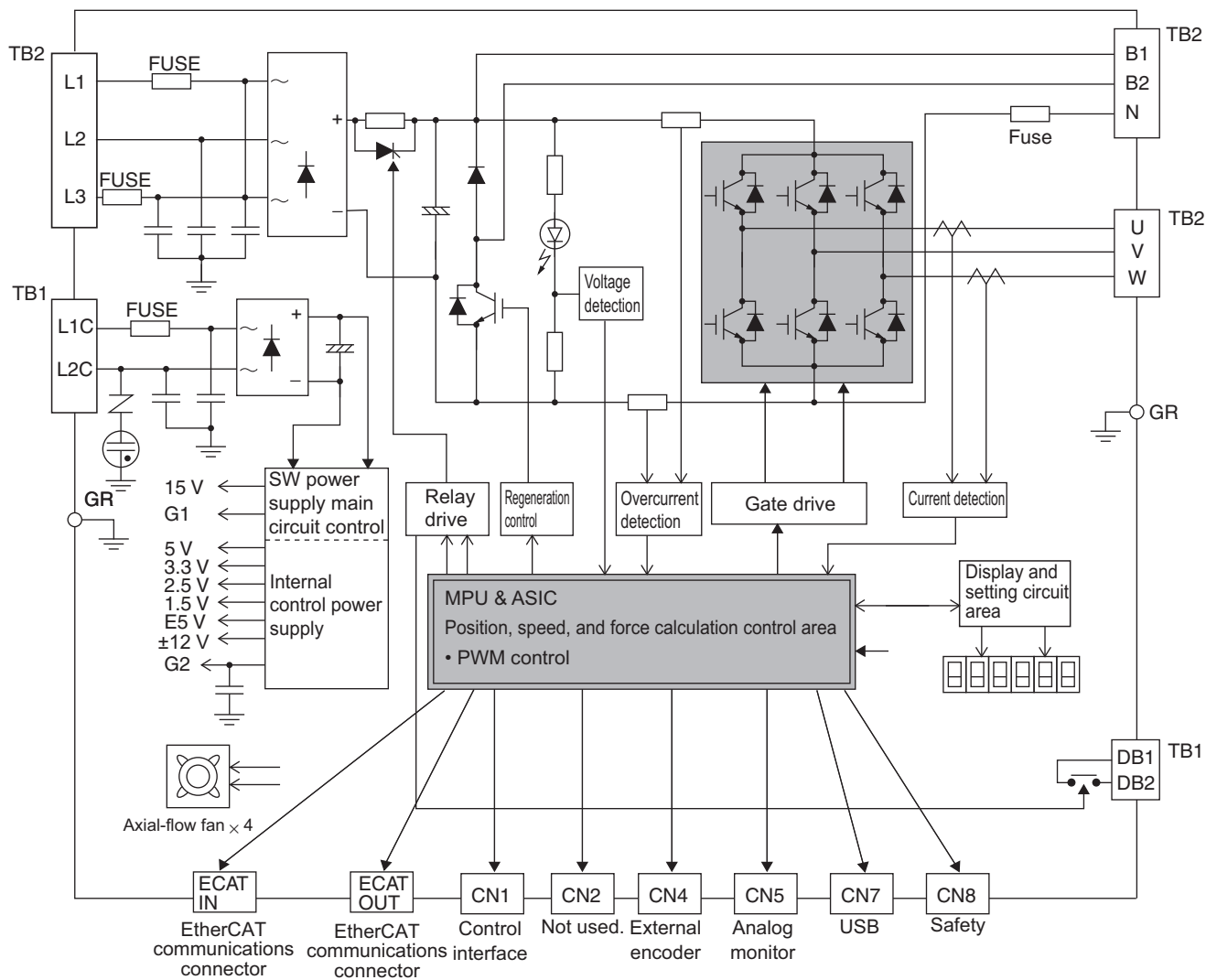
● R88D-KN150H-ECT-L

● **R88D-KN06F-ECT-L/-KN10F-ECT-L/-KN15F-ECT-L/-KN20F-ECT-L**
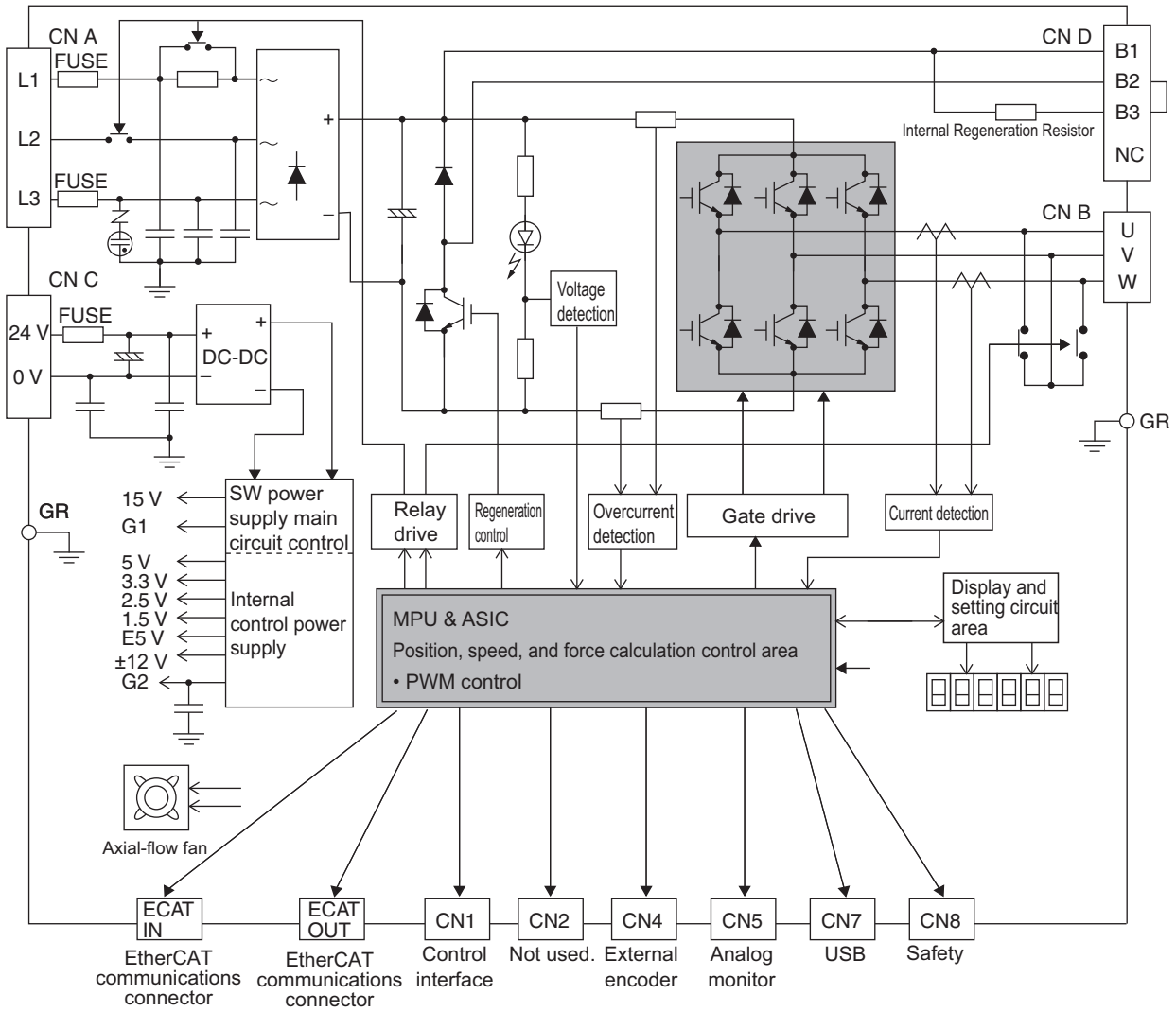
● R88D-KN30F-ECT-L/-KN50F-ECT-L
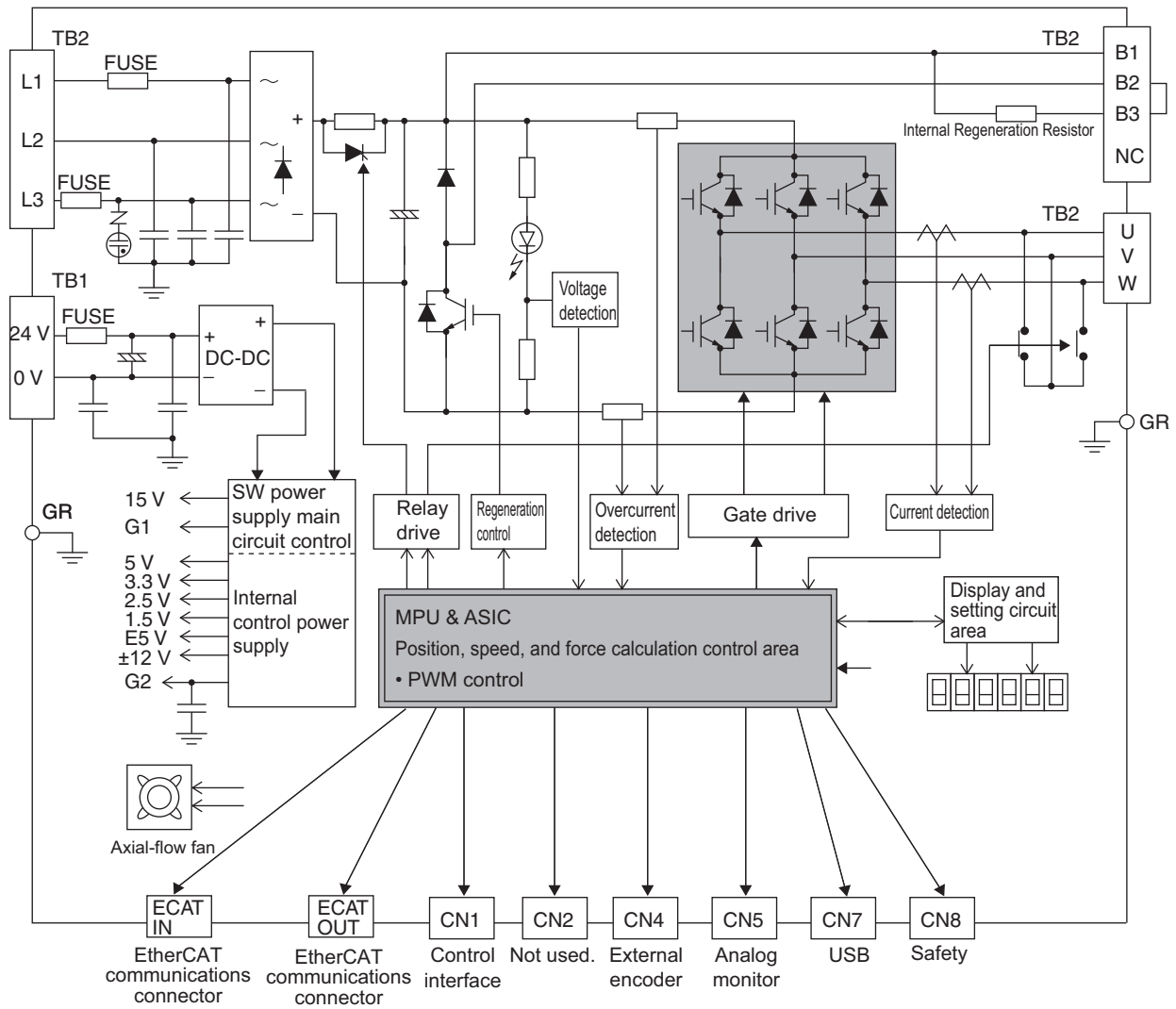
● **R88D-KN75F-ECT-L**
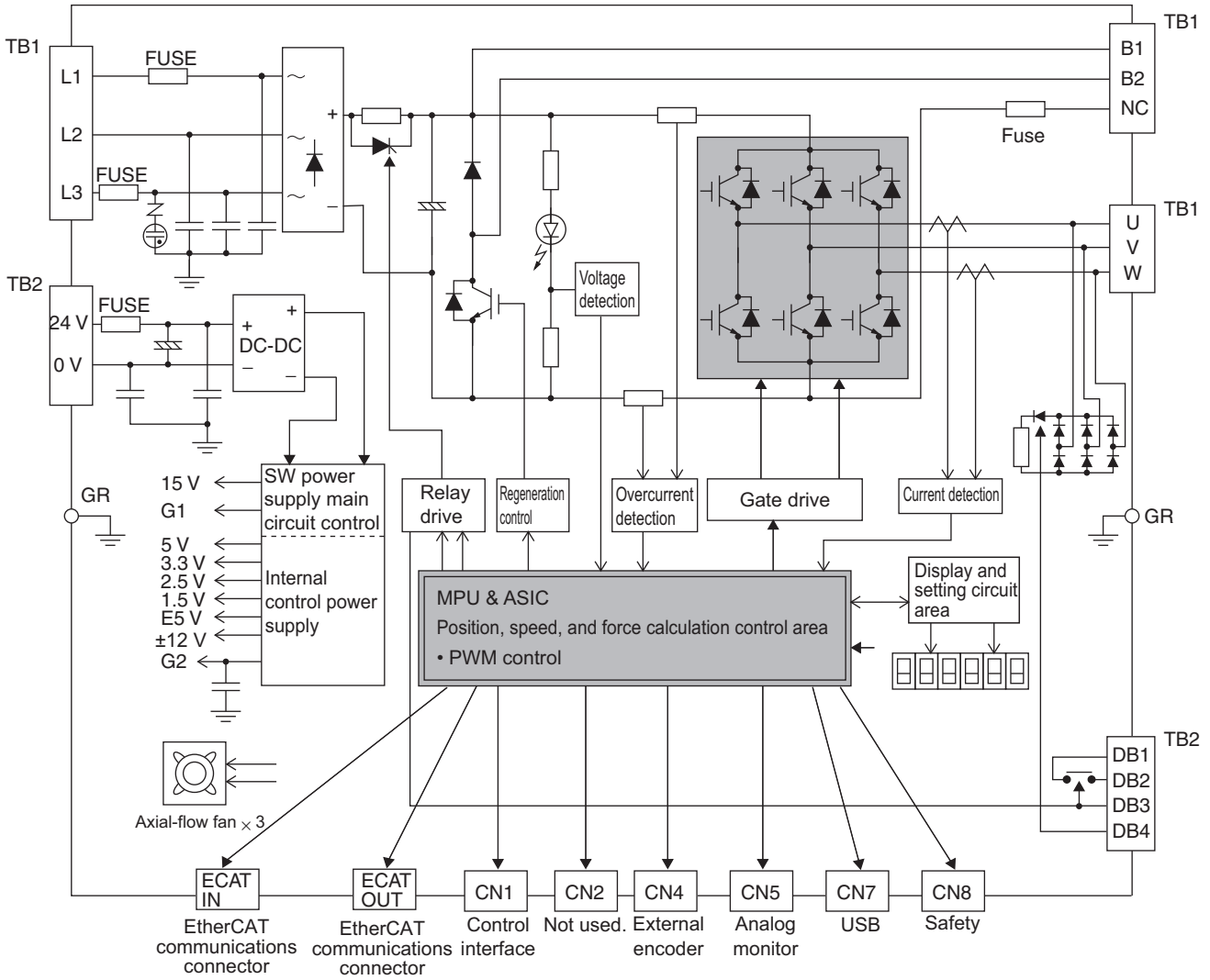
● **R88D-KN150F-ECT-L**

2
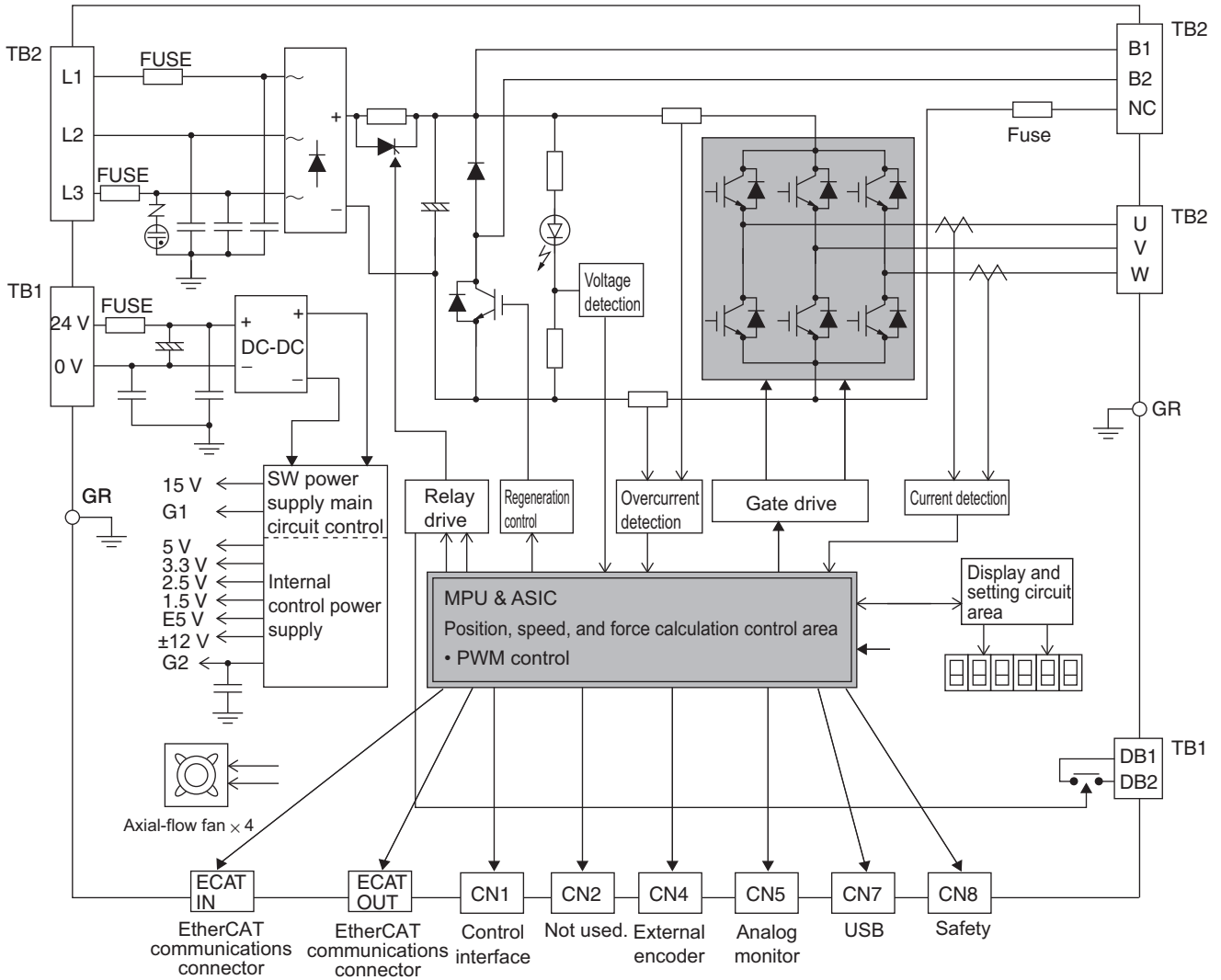
Models and External Dimensions

This section explains the models of Servo Drive and peripheral devices, and provides the external dimensions and mounting dimensions.

2-1   Servo System Configuration

Controller	Support Software
NJ-series CPU Unit with EtherCAT Port	• Automation Software Sysmac Studio
Machine Automation Controller NJ501-1□00	

	Support Software	Support Software
CJ-series CPU Unit + Position Control Unit with EtherCAT Interface	• CX-One FA Integrated Tool Package (CX-Programmer, CX-Position, and CX-Motion)	• CX-One FA Integrated Tool Package (Including CX-Drive) • CX-Drive WS02-DRVC1
Programmable Controller CJ□□-CPU□□ Position Control Unit (NC) CJ1W-NC□8□		

| AC Servo Drive | Motor power signals | Linear Motor / External Encoder |

EtherCAT
communications

USB communications

- G5-series Servo Drive
  R88D-KN□-ECT-L
      100 VAC
      200 VAC
      400 VAC

Feedback Signals

External
encoder

Peripheral Devices
- Reactor
  3G3AX-DL
  3G3AX-AL
- External Regeneration
  Resistors
  R88A-RR

2-2   How to Read Model Numbers

This section describes how to read and understand the model numbers of Servo Drives.

2-2-1   Servo Drive

The Servo Drive model number tells the Servo Drive type, applicable Linear Motor, power supply voltage, etc.

R88D-KN01H-ECT-L

G5-series Servo Drive

Drive Type
 N: Network

Maximum Applicable
Linear Motor Capacity

 01: 100 W
 02: 200 W
 04: 400 W
 06: 600 W
 08: 750 W
 10: 1 kW
 15: 1.5 kW
 20: 2 kW
 30: 3 kW
 50: 5 kW
 75: 7.5 kW
 150: 15 kW

 Power Supply Voltage
  L: 100 VAC
  H: 200 VAC
  F: 400 VAC

Communications Type
ECT: EtherCAT

Motor type
L: Linear motor type
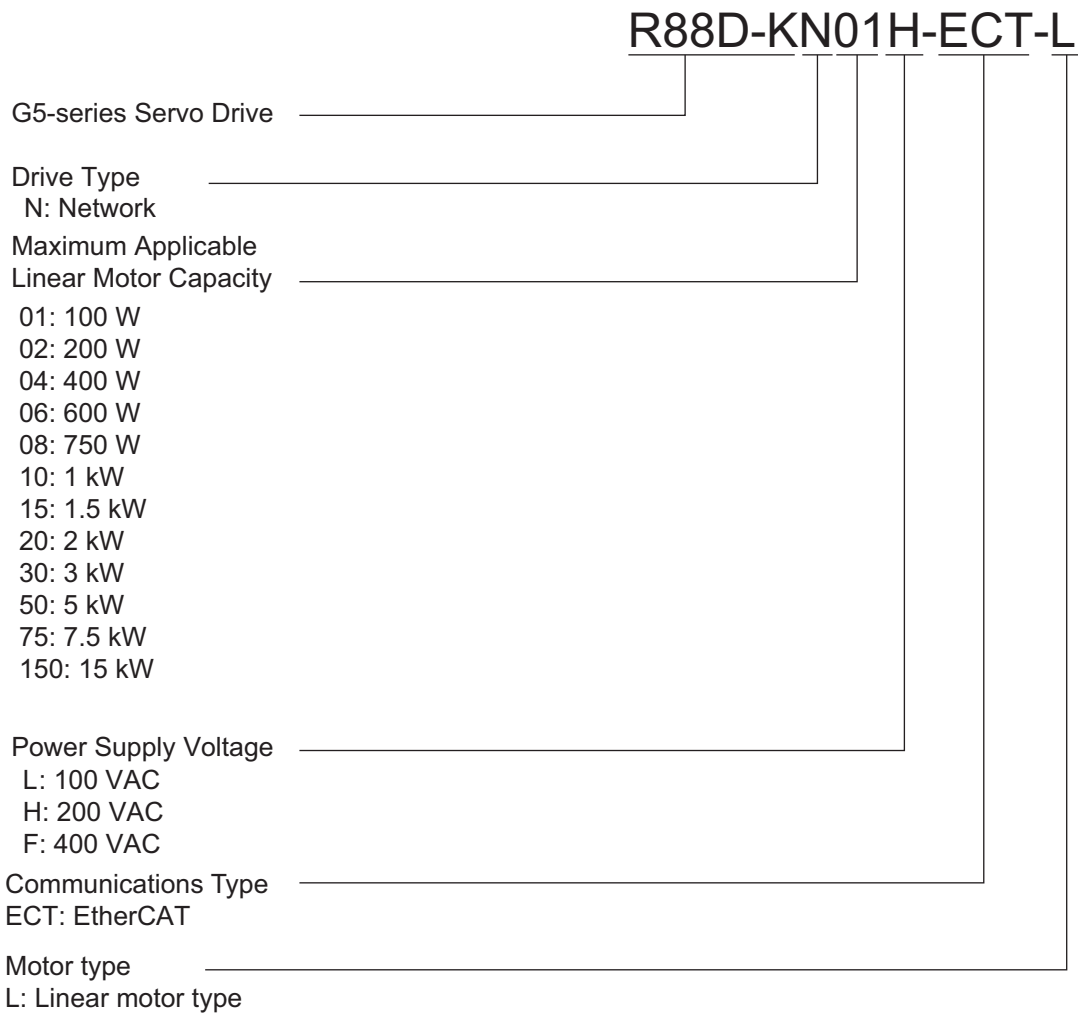
2-3   Model Tables

This section lists the standard models of Servo Drives, Connectors, and peripheral equipment.

2-3-1   Servo Drive Model Table

The table below lists the Servo Drive models.

Specifications		Model
Single-phase 100 VAC	100 W	R88D-KN01L-ECT-L
	200 W	R88D-KN02L-ECT-L
	400 W	R88D-KN04L-ECT-L
Single-phase/3-phase 200 VAC	100 W	R88D-KN01H-ECT-L
	200 W	R88D-KN02H-ECT-L
	400 W	R88D-KN04H-ECT-L
	750 W	R88D-KN08H-ECT-L
	1 kW	R88D-KN10H-ECT-L
	1.5 kW	R88D-KN15H-ECT-L
3-phase 200 VAC	2 kW	R88D-KN20H-ECT-L
	3 kW	R88D-KN30H-ECT-L
	5 kW	R88D-KN50H-ECT-L
	7.5 kW	R88D-KN75H-ECT-L
	15 kW	R88D-KN150H-ECT-L
3-phase 400 VAC	600 W	R88D-KN06F-ECT-L
	1 kW	R88D-KN10F-ECT-L
	1.5 kW	R88D-KN15F-ECT-L
	2 kW	R88D-KN20F-ECT-L
	3 kW	R88D-KN30F-ECT-L
	5 kW	R88D-KN50F-ECT-L
	7.5 kW	R88D-KN75F-ECT-L
	15 kW	R88D-KN150F-ECT-L

2-3-2   Cable and Peripheral Device Model Tables

The following tables list the models of EtherCAT communications cables (recommended) and analog monitor cables, as well as the models of peripheral devices such as External Regeneration Resistors and Reactors.

EtherCAT Communications Cable (Recommended)

Size x Number of cable cores (pairs)	Recommended manufacturer	Model
AWG24 x 4P	Tonichi kyosan Cable, Ltd.	NETSTAR-C5E SAB 0.5 × 4P
	Kuramo Electric Co.	KETH-SB
	SWCC Showa Cable Systems Co.	FAE-5004
AWG22 x 2P	Kuramo Electric Co.	KETH-PSB-OMR

Ethernet Category 5 (100BASE-TX) or higher (twisted-pair cable with double, aluminum tape and braided shielding) is recommended.

Analog Monitor Cable

Name		Model
Analog Monitor Cable	1 m	R88A-CMK001S

Connectors

Name and applications	Model
Control I/O Connector (CN1)	R88A-CNW01C
External Encoder Connector (CN4)	R88A-CNK41L
Safety Connector (CN8)	R88A-CNK81S

Control Cables

Name		Model
Connector-terminal Block Cables	1 m	XW2Z-100J-B34
	2 m	XW2Z-200J-B34
Connector-terminal Block	M3 screws	XW2B-20G4
	M3.5 screws	XW2B-20G5
	M3 screws	XW2D-20G6

External Regeneration Resistors

Specifications	Model
Regeneration process capacity: 20 W, 50 Ω (with 150°C thermal sensor)	R88A-RR08050S
Regeneration process capacity: 20 W, 100 Ω (with 150°C thermal sensor)	R88A-RR080100S
Regeneration process capacity: 70 W, 47 Ω (with 150°C thermal sensor)	R88A-RR22047S1
Regeneration process capacity: 70 W, 47 Ω (with 170°C thermal sensor)	R88A-RR22047S
Regeneration process capacity: 180 W, 20 Ω (with 200°C thermal sensor)	R88A-RR50020S

Reactor

Applicable Servo Drives	Model	Reactor type
R88D-KN01H-ECT-L (For single-phase input)	3G3AX-DL2002	DC reactor
R88D-KN01L-ECT-L/-KN02H-ECT-L (For single-phase input)	3G3AX-DL2004	
R88D-KN02L-ECT-L/-KN04H-ECT-L (For single-phase input)	3G3AX-DL2007	
R88D-KN04L-ECT-L/-KN08H-ECT-L/-KN10H-ECT-L (For single-phase input)	3G3AX-DL2015	
R88D-KN15H-ECT-L (For single-phase input)	3G3AX-DL2022	
R88D-KN01H-ECT-L/-KN02H-ECT-L/-KN04H-ECT-L/ -KN08H-ECT-L/-KN10H-ECT-L/-KN15H-ECT-L (For 3-phase input)	3G3AX-AL2025	AC reactor
R88D-KN20H-ECT-L/-KN30H-ECT-L	3G3AX-AL2055	
R88D-KN50H-ECT-L	3G3AX-AL2110	
R88D-KN75H-ECT-L/-KN150H-ECT-L	3G3AX-AL2220	
R88D-KN06F-ECT-L/-KN10F-ECT-L/-KN15F-ECT-L	3G3AX-AL4025	
R88D-KN20F-ECT-L/-KN30F-ECT-L	3G3AX-AL4055	
R88D-KN50F-ECT-L	3G3AX-AL4110	
R88D-KN75F-ECT-L/-KN150F-ECT-L	3G3AX-AL4220	

Mounting Brackets (L-brackets for Rack Mounting)

Applicable Servo Drives	Model
R88D-KN01L-ECT-L/-KN01H-ECT-L/-KN02H-ECT-L	R88A-TK01K
R88D-KN02L-ECT-L/-KN04H-ECT-L	R88A-TK02K
R88D-KN04L-ECT-L/-KN08H-ECT-L	R88A-TK03K
R88D-KN10H-ECT-L/-KN15H-ECT-L/-KN06F-ECT-L/-KN10F-ECT-L/-KN15F-ECT-L	R88A-TK04K

2-4   External and Mounting Dimensions

This section describes the external dimensions and the mounting dimensions of Servo Drives and peripheral devices.

2-4-1   Servo Drive Dimensions

The dimensional description starts with a Servo Drive of the smallest capacity, which is followed by the next smallest, and so on.

Single-phase 100 VAC: R88D-KN01L-ECT-L (50 to 100 W)
Single-phase/3-phase 100 VAC: R88D-KN01H-ECT-L/-KN02H-ECT-L (100 to 200 W)

● **Wall Mounting**
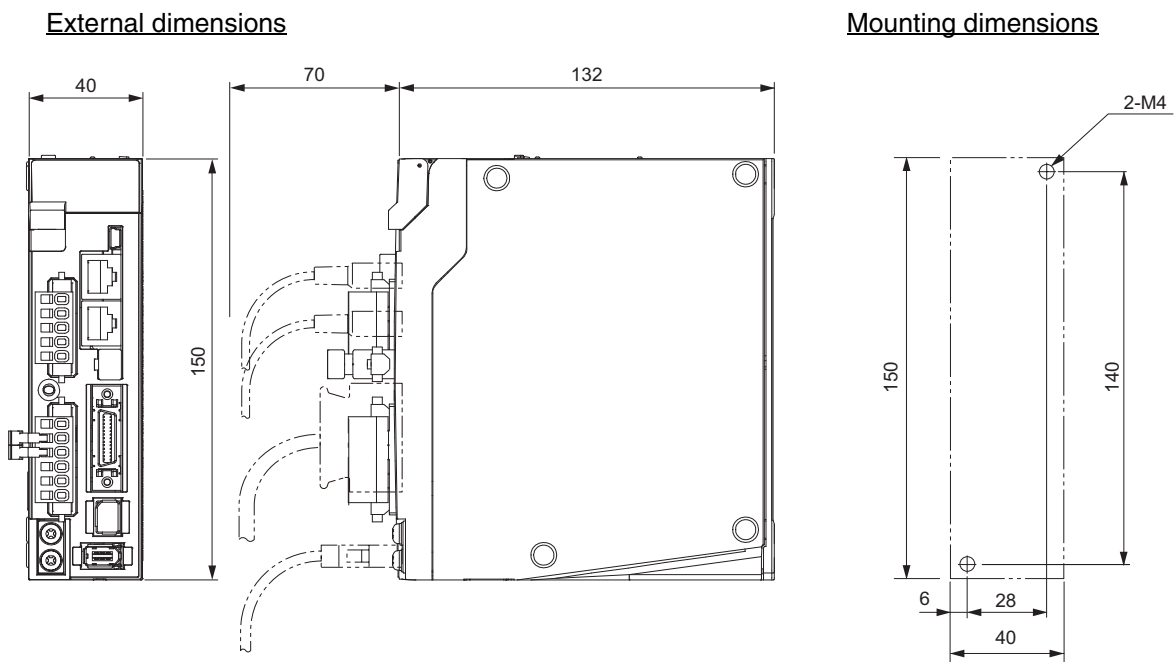
External dimensions

Mounting dimensions

● **Front Mounting (Using Front Mounting Brackets)**

External dimensions

Mounting dimensions

40

7

φ5.2

150

170

180

R26

5.2

7

132

70

19.5

2.5

7

2-M4

170

Rectangular hole

(158)*

(42)*
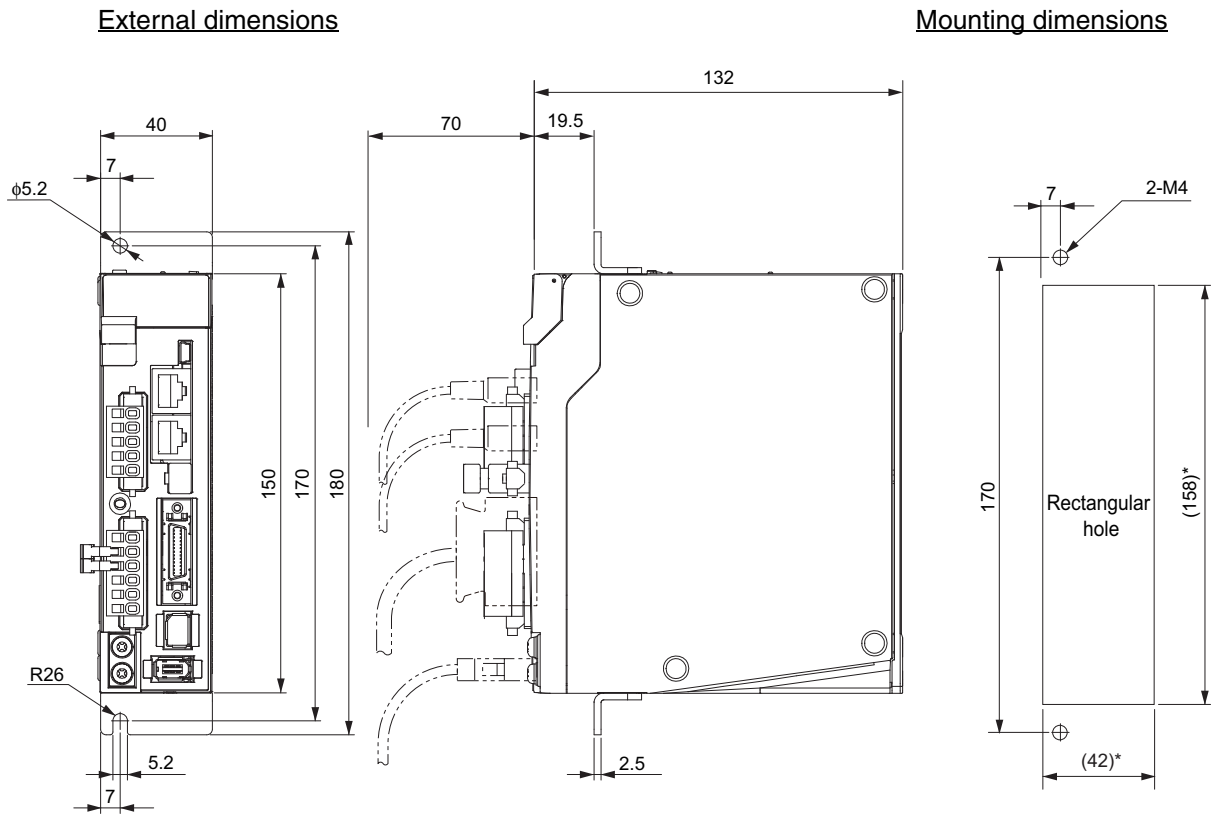
* Rectangular hole dimensions are reference values.

Single-phase 100 VAC: R88D-KN02L-ECT-L (200 W)
Single-phase/3-phase 200 VAC: R88D-KN04H-ECT-L (400 W)

● **Wall Mounting**

External dimensions   Mounting dimensions

● **Front Mounting (Using Front Mounting Brackets)**

External dimensions   Mounting dimensions

* Rectangular hole dimensions are reference values.
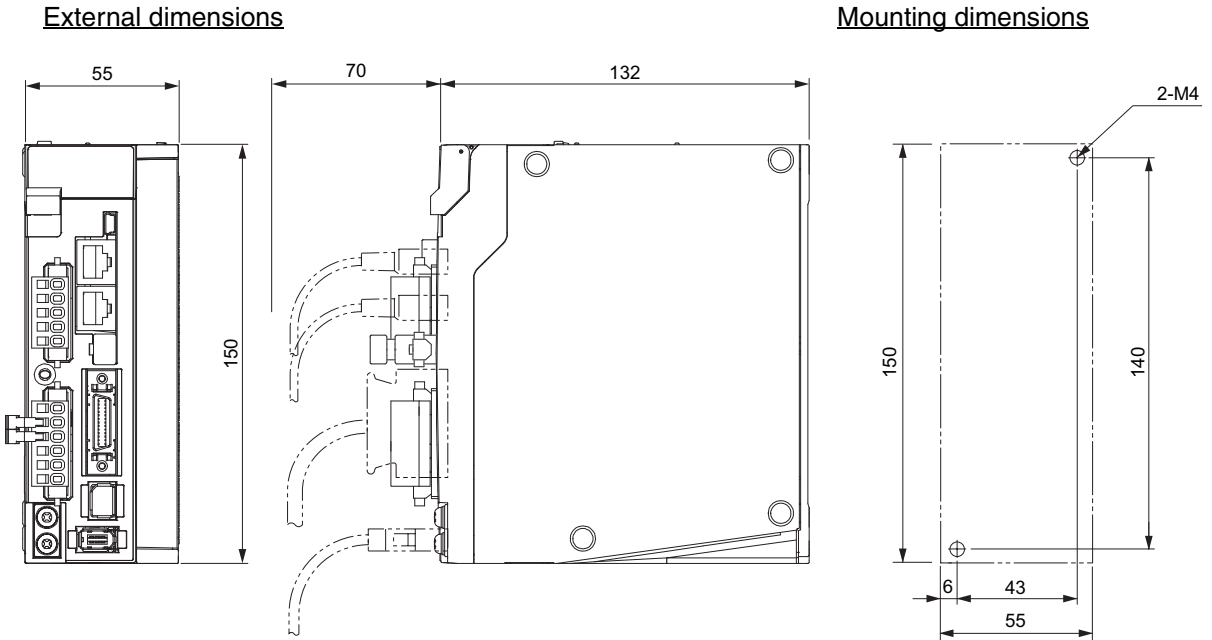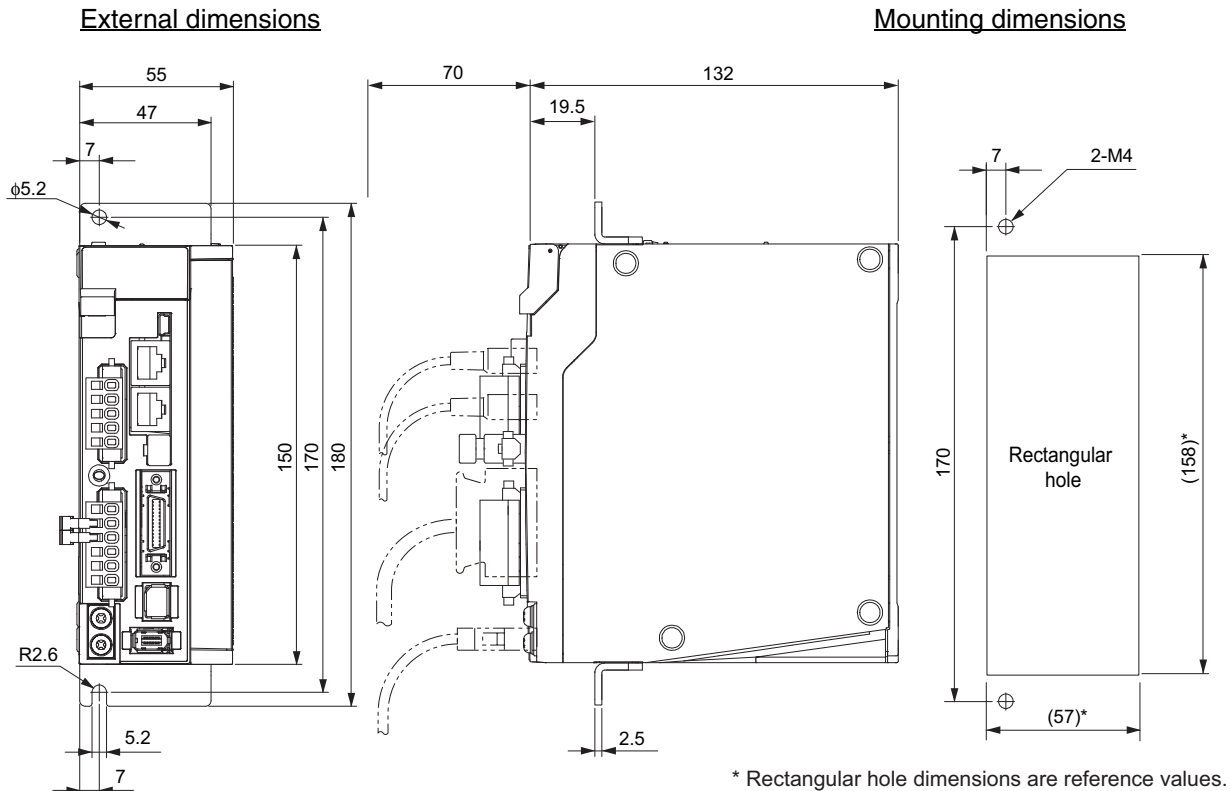
Single-phase 100 VAC: R88D-KN04L-ECT-L (400 W)
Single-phase/3-phase 200 VAC: R88D-KN08H-ECT-L (750 W)

● **Wall Mounting**

External dimensions

Mounting dimensions

● **Front Mounting (Using Front Mounting Brackets)**

External dimensions

Mounting dimensions
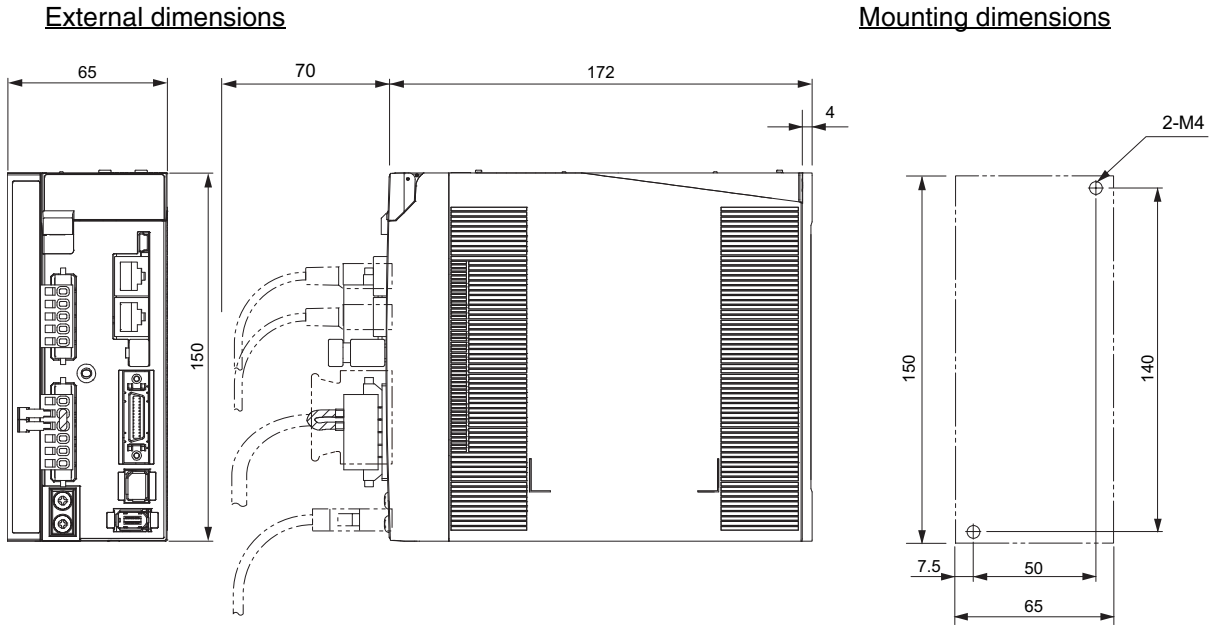
* Rectangular hole dimensions are reference values.
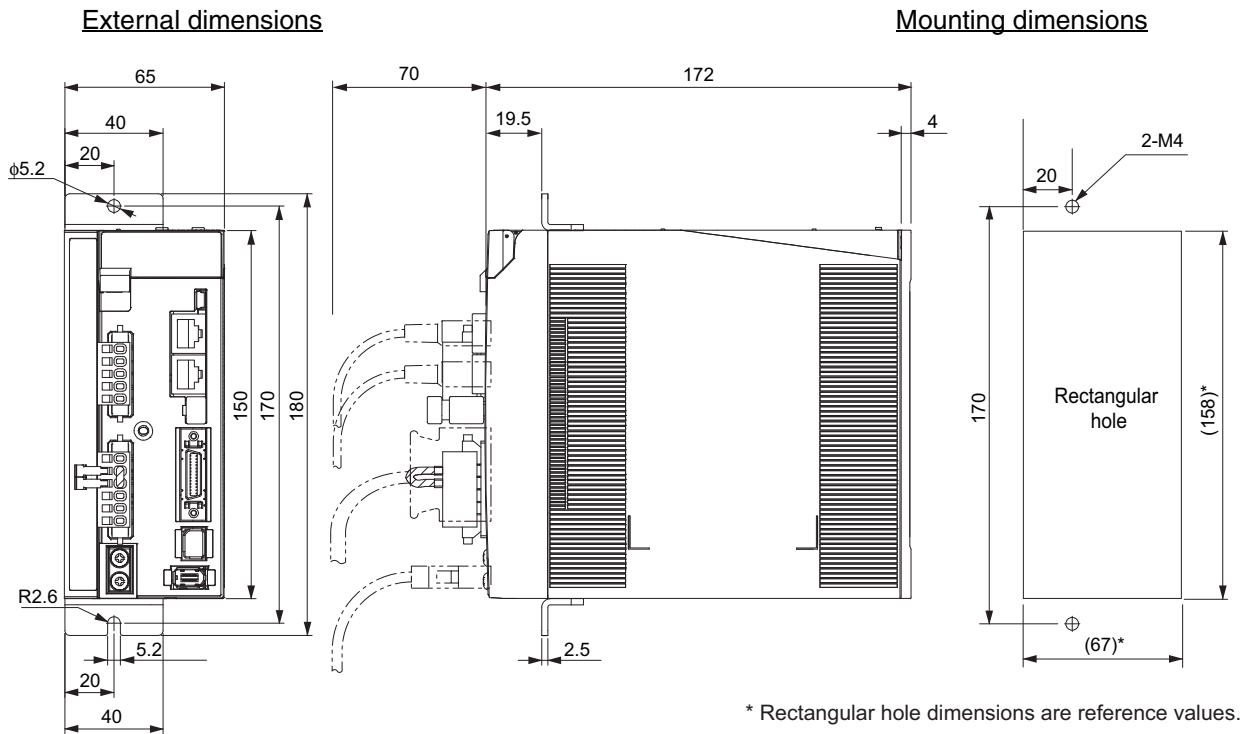
Single-phase/3-phase 200 VAC: R88D-KN10H-ECT-L/-KN15H-ECT-L (900 W to 1.5 kW)

● Wall Mounting
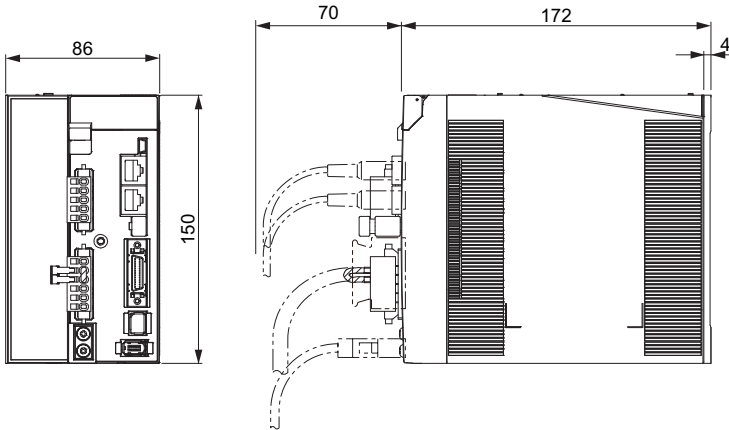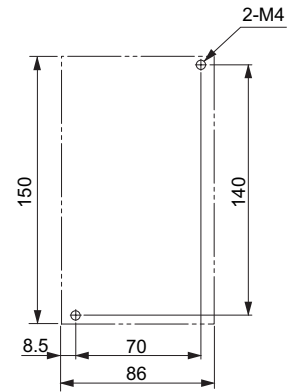
External dimensions

Mounting dimensions

● Front Mounting (Using Front Mounting Brackets)

External dimensions
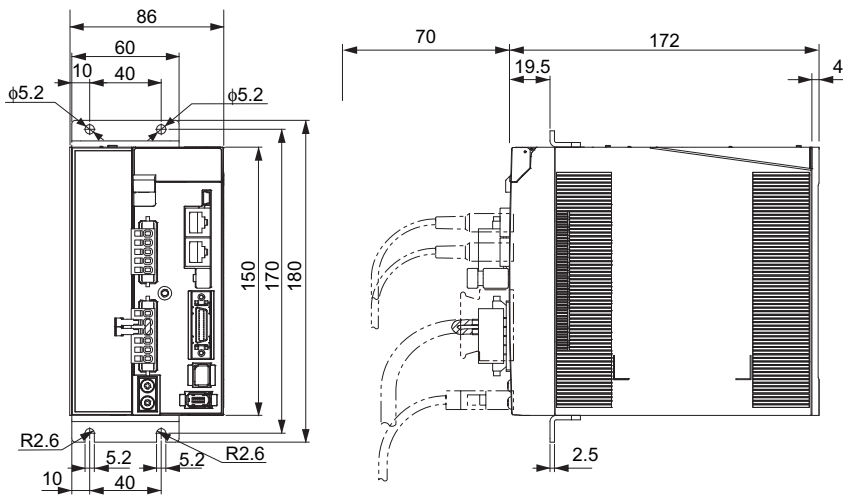
Mounting dimensions
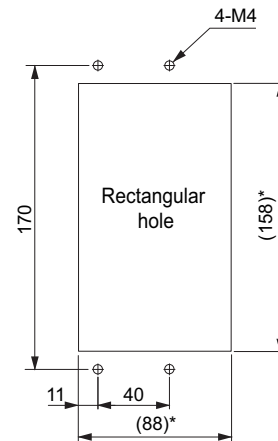
* Rectangular hole dimensions are reference values.

3-phase 200 VAC: R88D-KN20H-ECT-L (2 kW)

● Wall Mounting
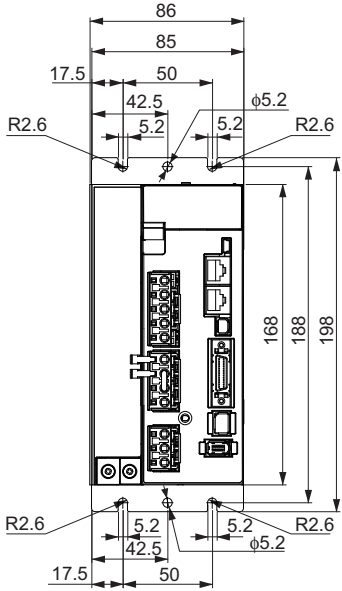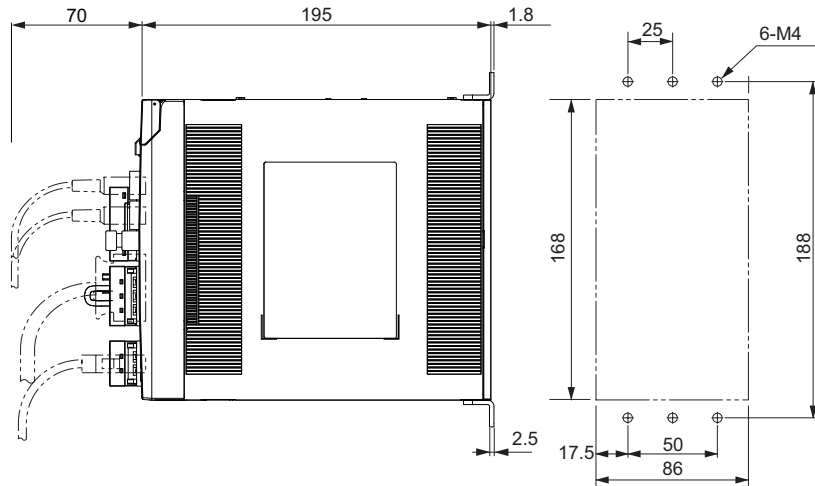
External dimensions

Mounting dimensions

● Front Mounting (Using Front Mounting Brackets)

External dimensions
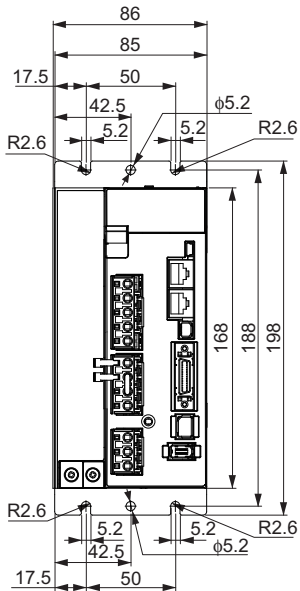
Mounting dimensions
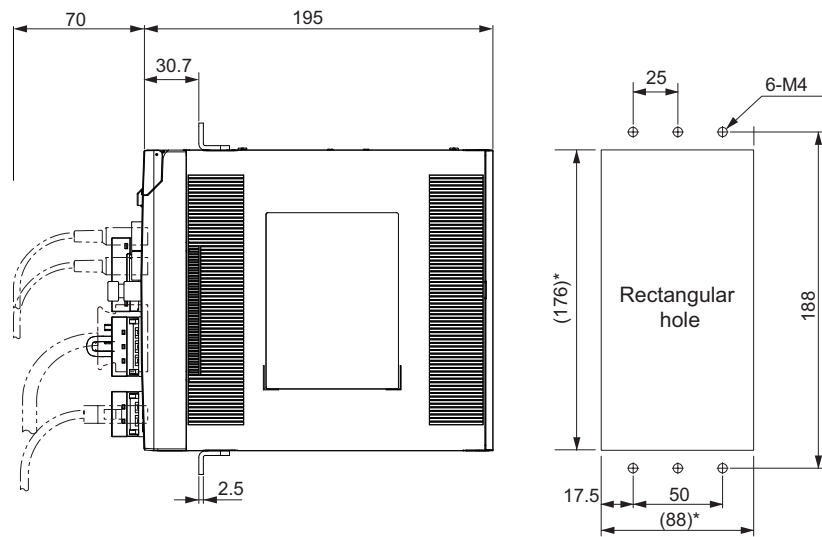
* Rectangular hole dimensions are reference values.

3-phase 200 VAC: R88D-KN30H-ECT-L/-KN50H-ECT-L (3 to 5 kW)

● **Wall Mounting**
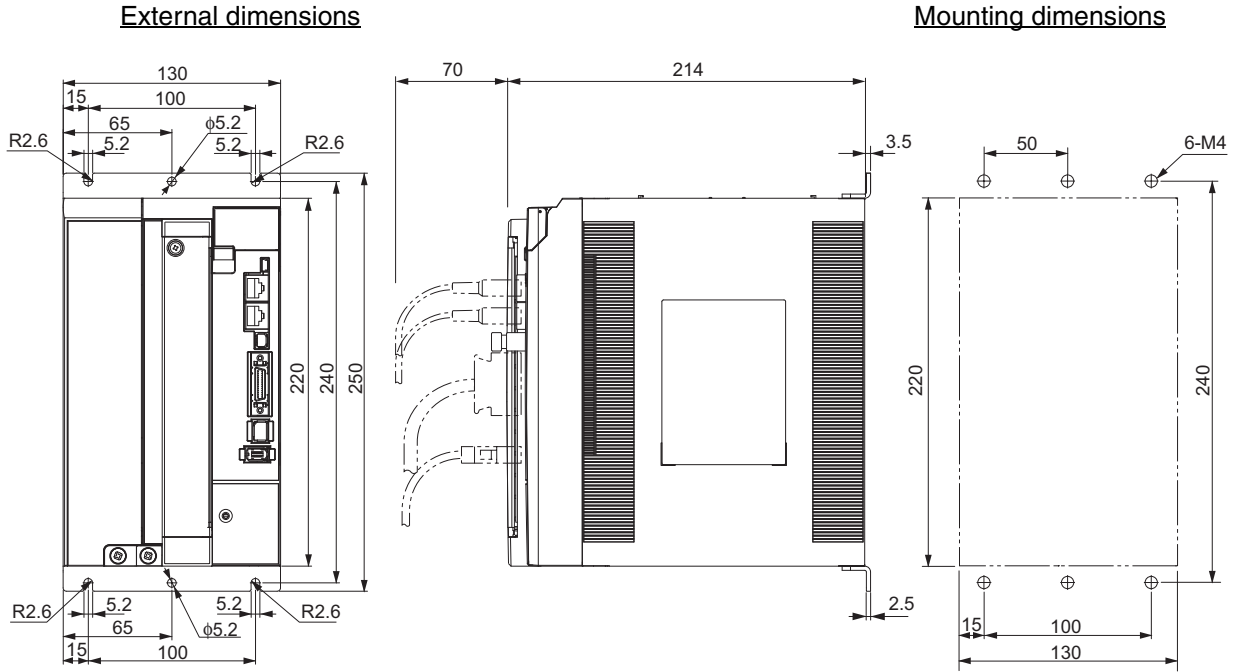
External dimensions

Mounting dimensions

● **Front Mounting (Using Front Mounting Brackets)**

External dimensions

Mounting dimensions
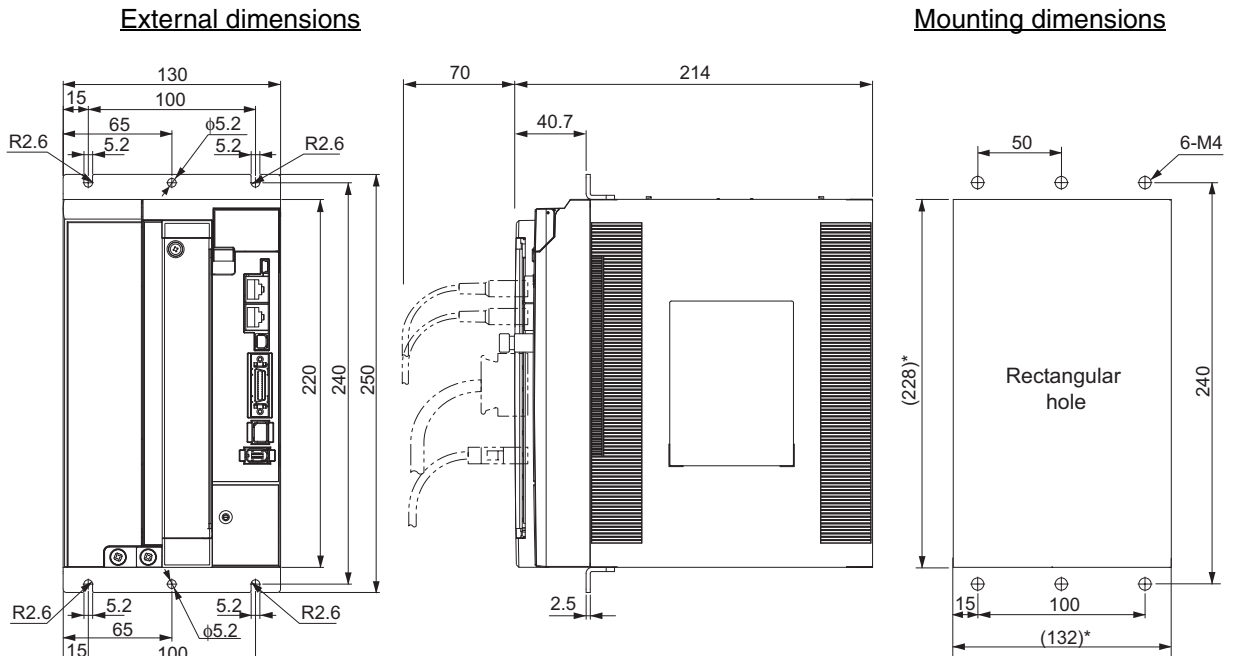
* Rectangular hole dimensions
  are reference values.

3-phase 200 VAC: R88D-KN75H-ECT-L (7.5 kW)

● Wall Mounting
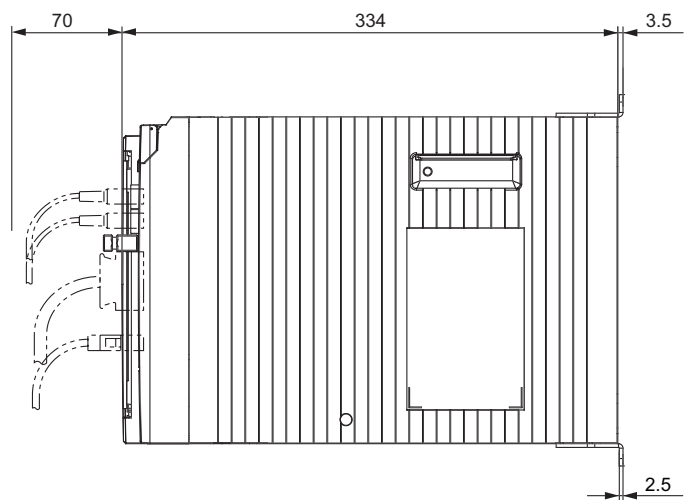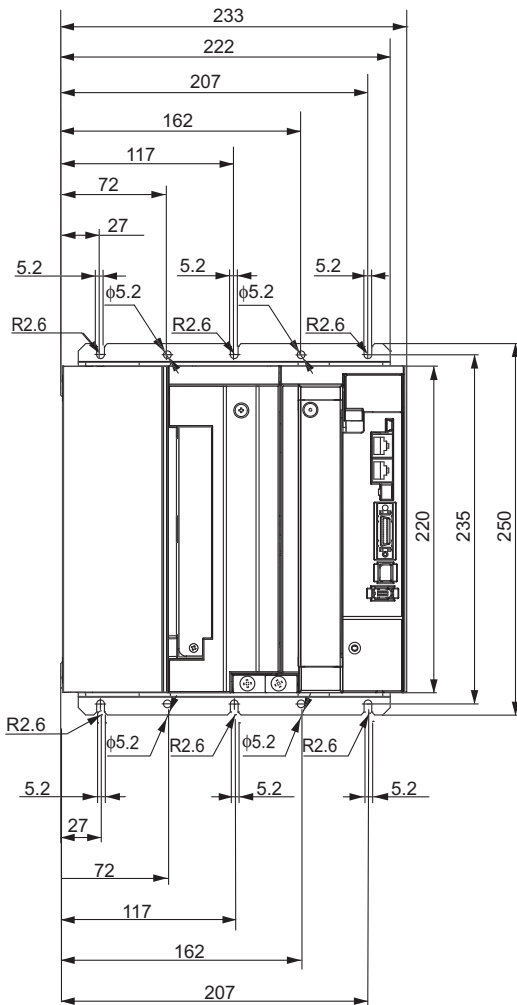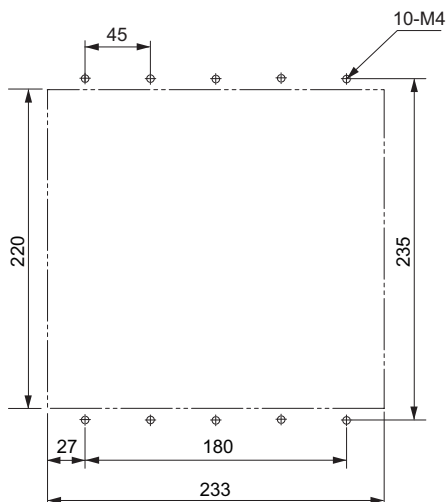
External dimensions

Mounting dimensions

● **Front Mounting (Using Front Mounting Brackets)**

External dimensions
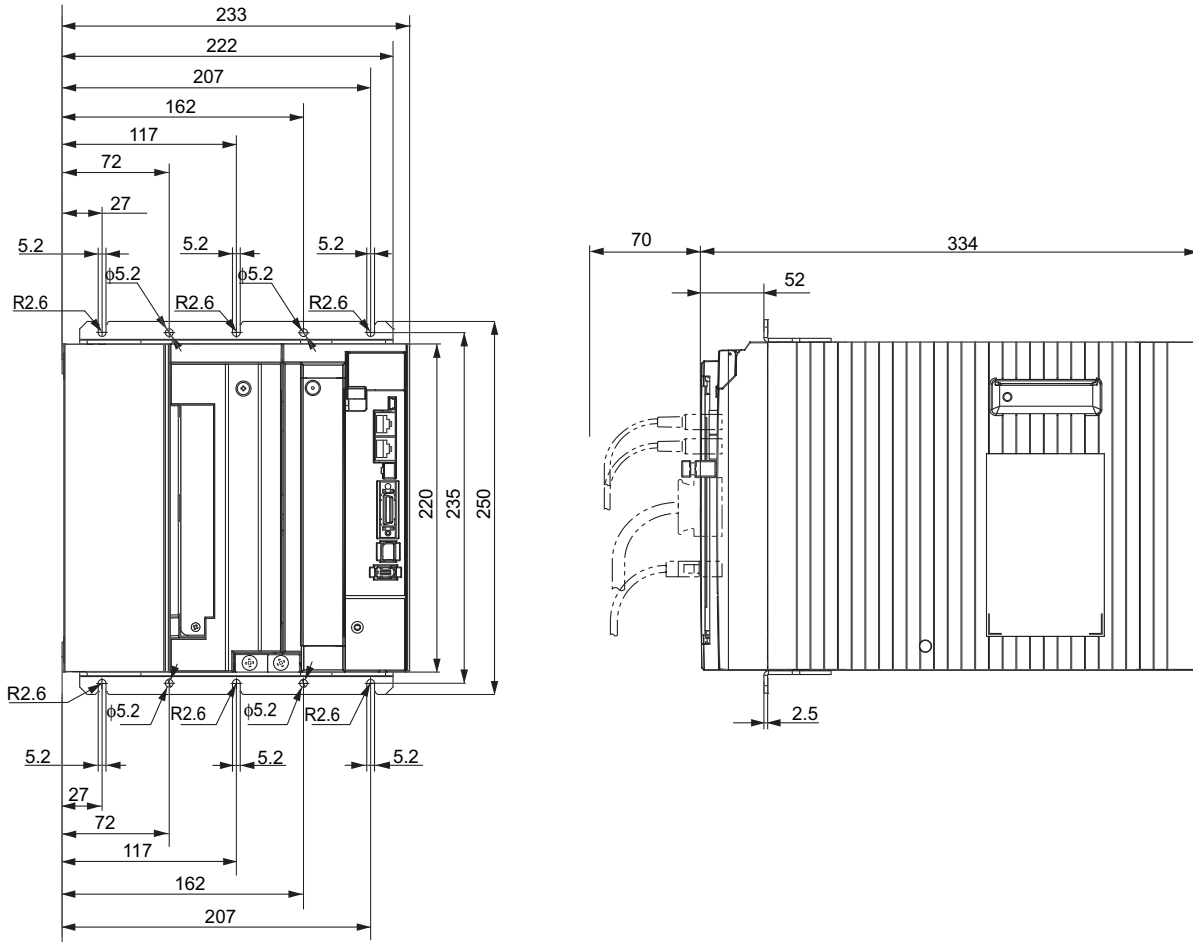
Mounting dimensions
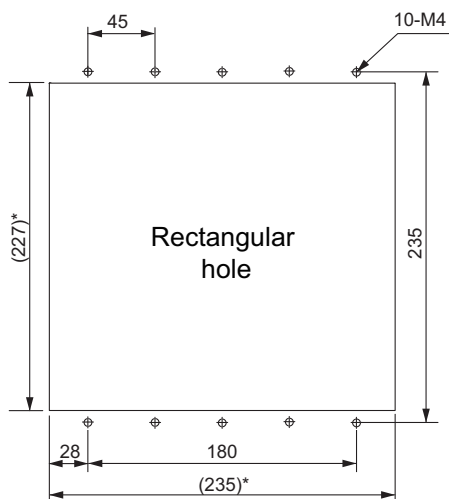
* Rectangular hole dimensions are reference values.

3-phase 200 VAC: R88D-KN150H-ECT-L (15 kW)

● Wall Mounting

External dimensions
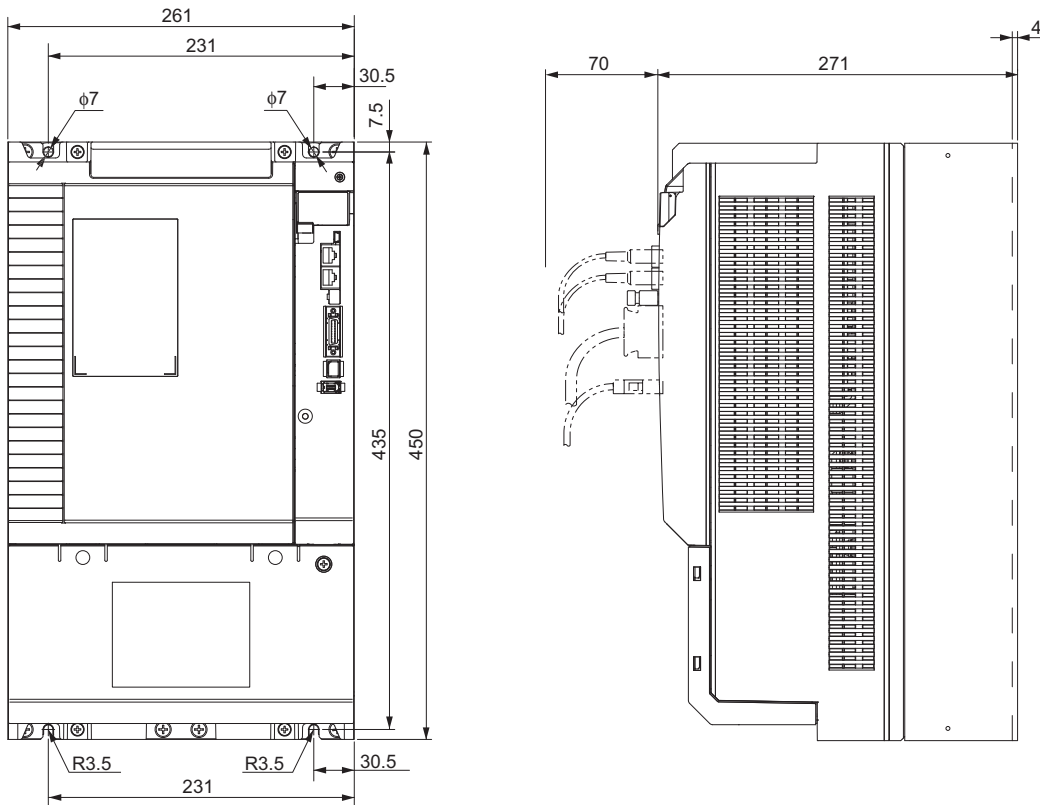
Mounting dimensions
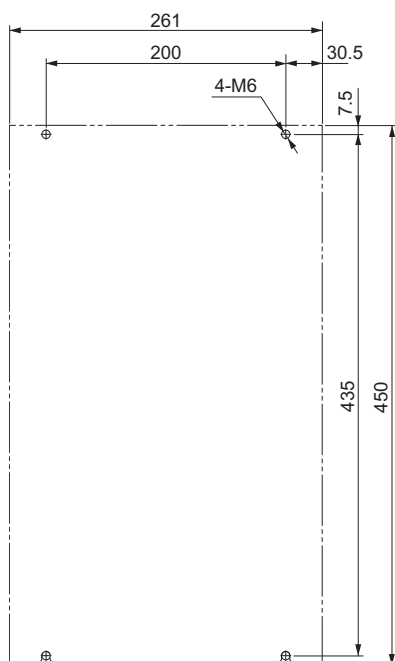
3-phase 400 VAC: R88D-KN06F-ECT-L/-KN10F-ECT-L/ -KN15F-ECT-L (600 W to 1.5 kW)

● **Wall Mounting**
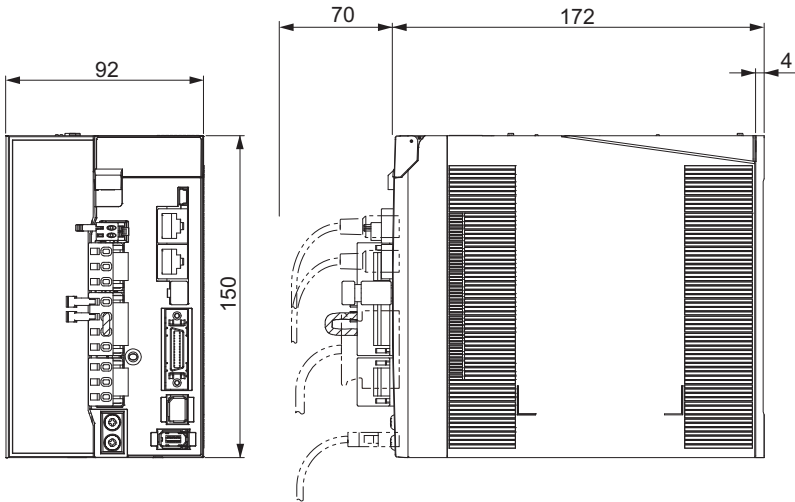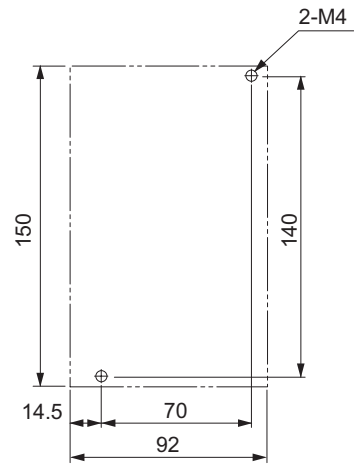
External dimensions   Mounting dimensions

● **Front Mounting (Using Front Mounting Brackets)**

External dimensions   Mounting dimensions
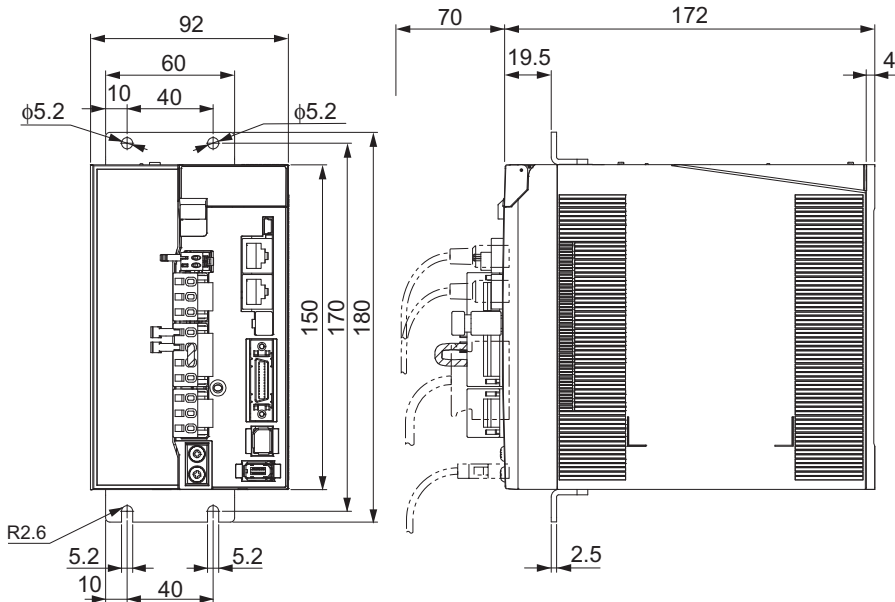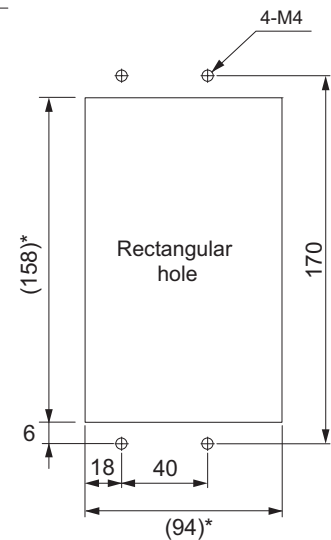
Rectangular hole

* Rectangular hole dimensions are reference values.

3-phase 400 VAC: R88D-KN20F-ECT-L (2 kW)

● Wall Mounting
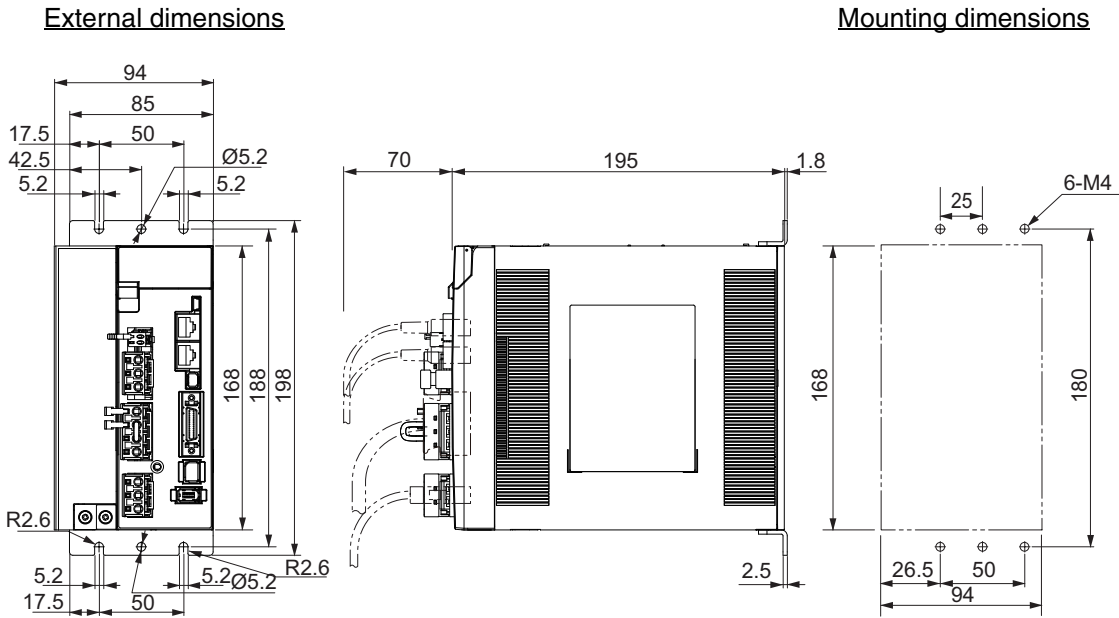
External dimensions

Mounting dimensions

● Front Mounting (Using Front Mounting Brackets)

External dimensions

Mounting dimensions
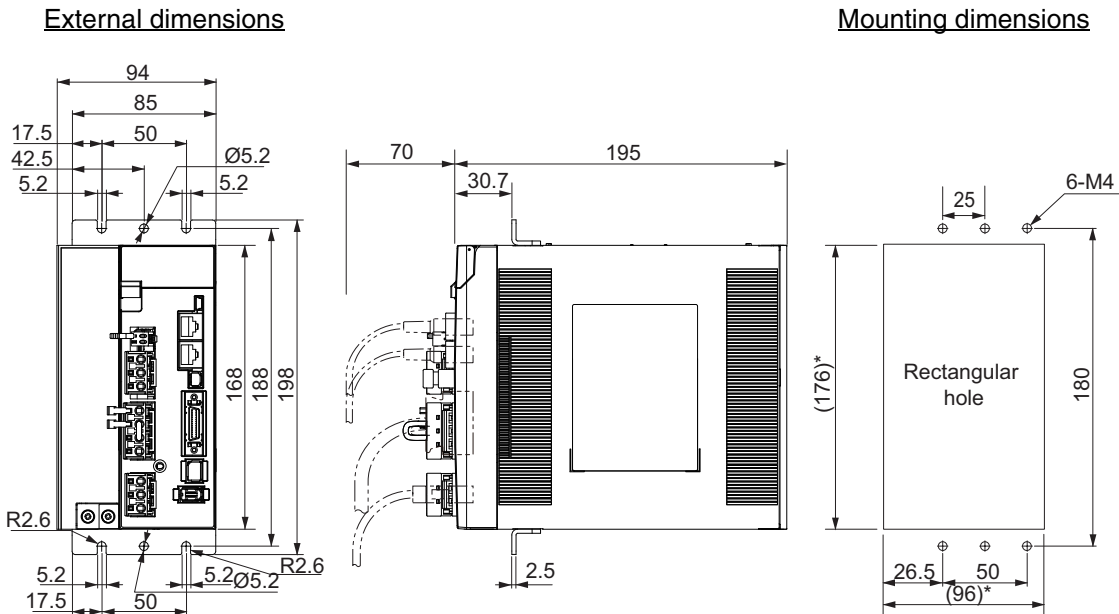
* Rectangular hole dimensions are reference values.

3-phase 400 VAC: R88D-KN30F-ECT-L/-KN50F-ECT-L (3 to 5 kW)

● **Wall Mounting**

External dimensions   Mounting dimensions

● **Front Mounting (Using Front Mounting Brackets)**

External dimensions   Mounting dimensions

* Rectangular hole dimensions are reference values.
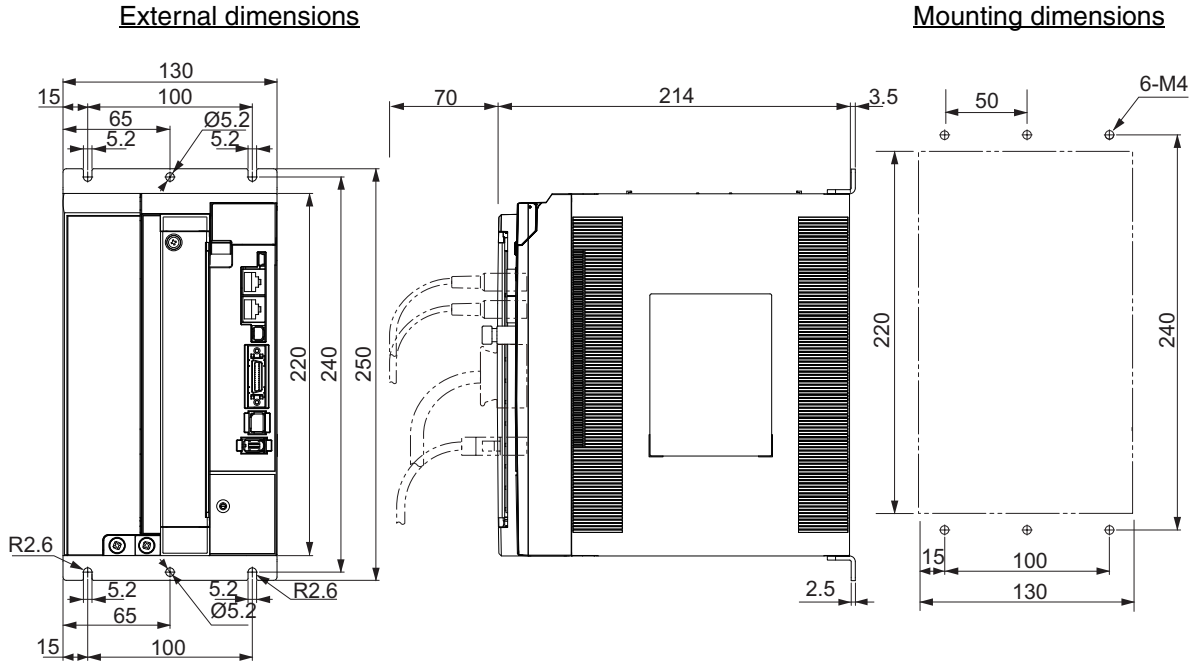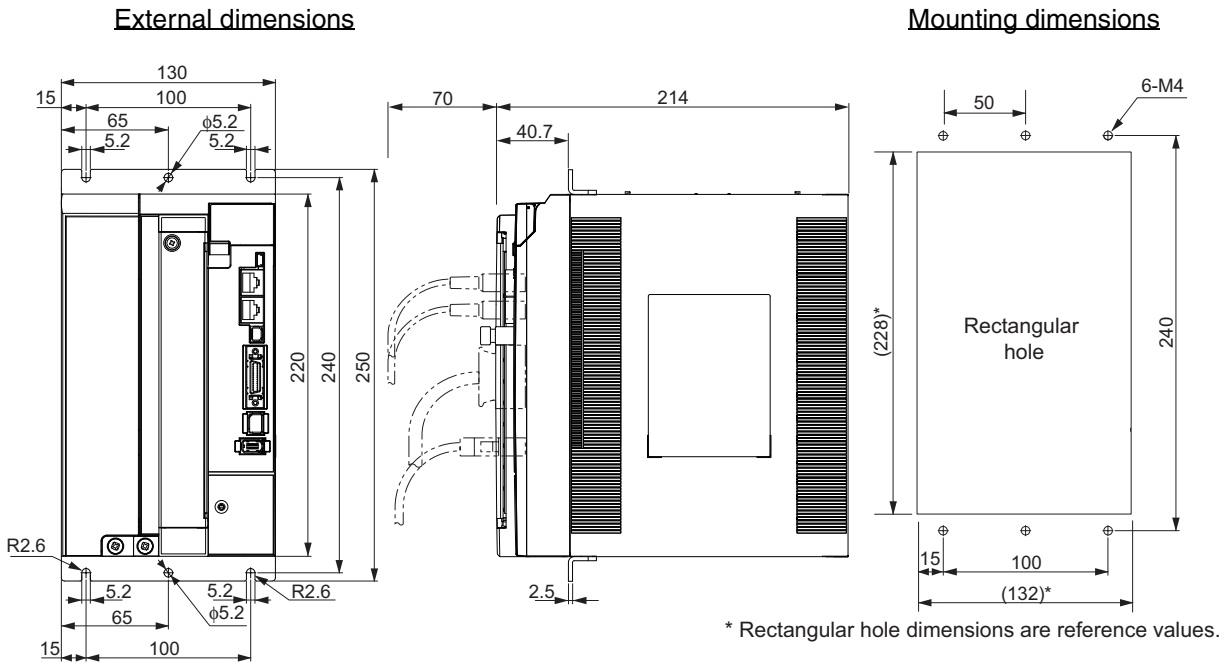
3-phase 400 VAC: R88D-KN75F-ECT-L (7.5 kW)

● Wall Mounting
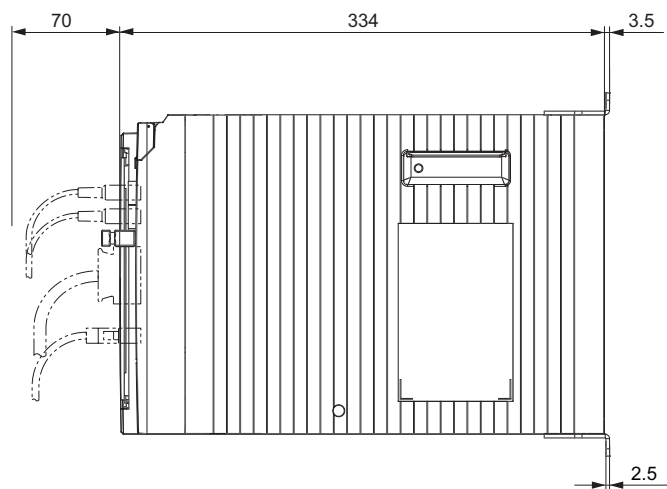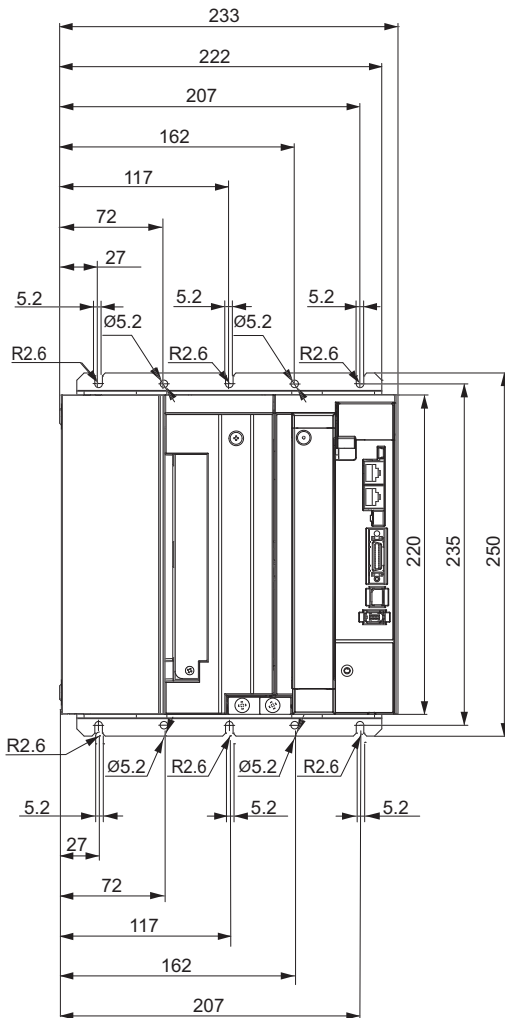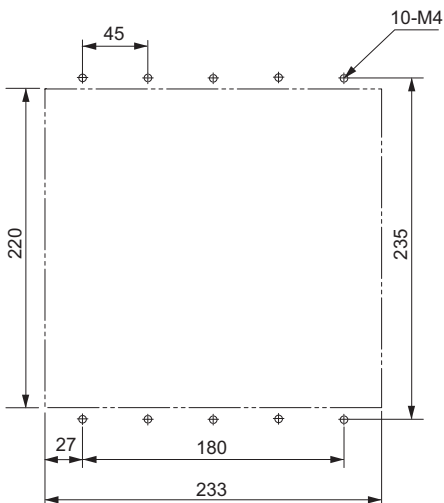
External dimensions

Mounting dimensions

● **Front Mounting (Using Front Mounting Brackets)**

External dimensions
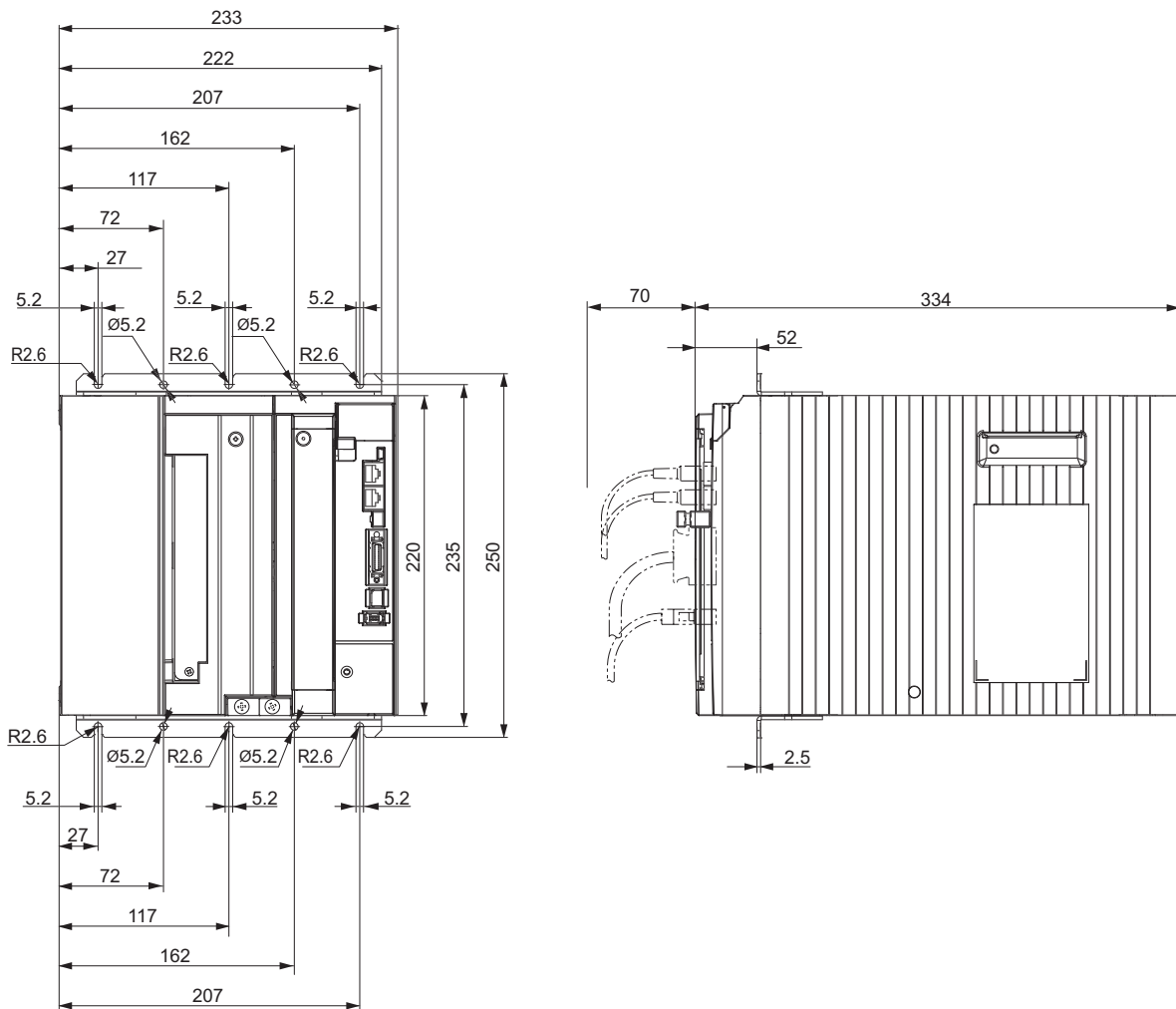
Mounting dimensions
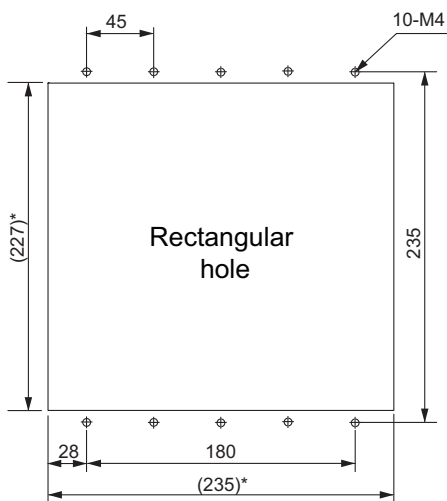
Rectangular hole

* Rectangular hole dimensions are reference values.

3-phase 400 VAC: R88D-KN150F-ECT-L (15 kW)

● **Wall Mounting**

External dimensions
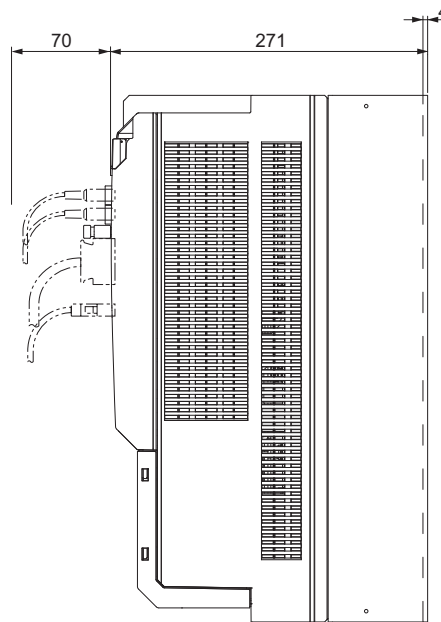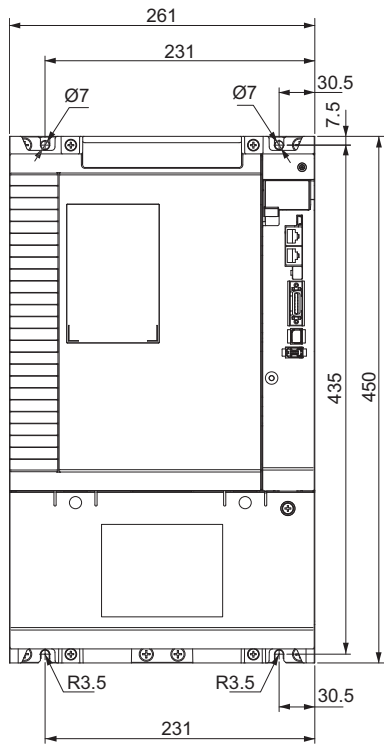
Mounting dimensions
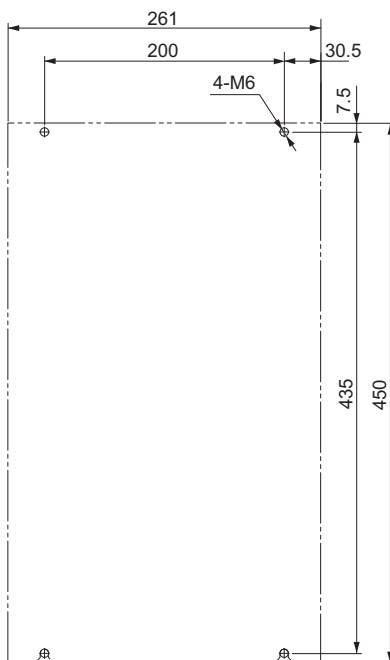
2-4-2   External Regeneration Resistor Dimensions

R88A-RR08050S/-RR080100S
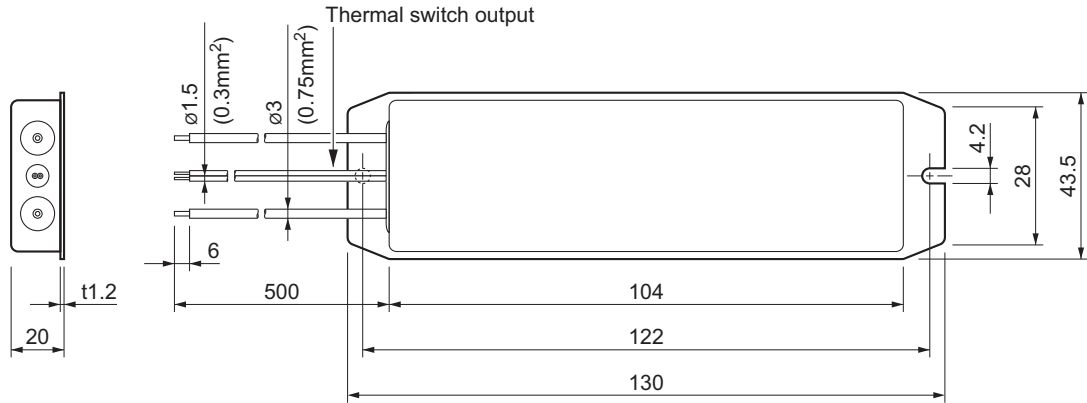
R88A-RR22047S/-RR22047S1
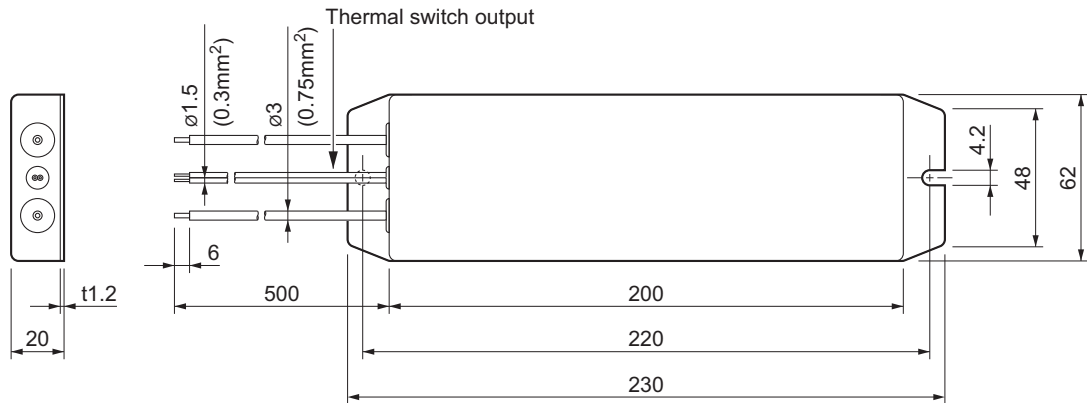
R88A-RR50020S
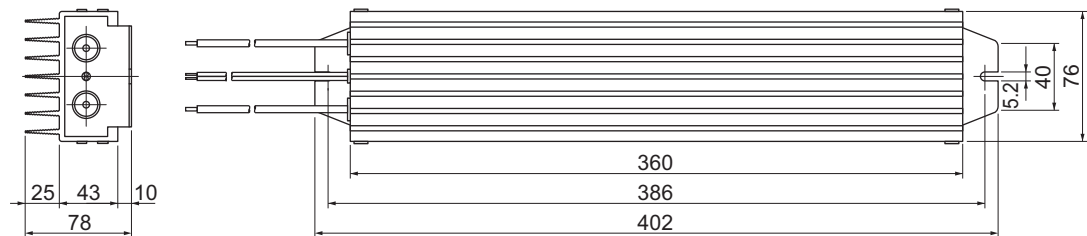
2-4-3   Reactor Dimensions

3G3AX-DL2002

Ground terminal (M4)

2-M4

72

90

56

66

4-5.2 × 8

85

98

3G3AX-DL2004

Ground terminal (M4)

2-M4

72

90

56

66

4-5.2 × 8

95

98

3G3AX-DL2007

Ground terminal (M4)

72
90
2-M4
56
66
4-5.2 × 8
105
98

3G3AX-DL2015

Ground terminal (M4)

72
90
2-M4
56
66
4-5.2 × 8
115
98

3G3AX-DL2022

Ground terminal (M4)

2-M4

4-6 × 9

71
86

80
100

105

116
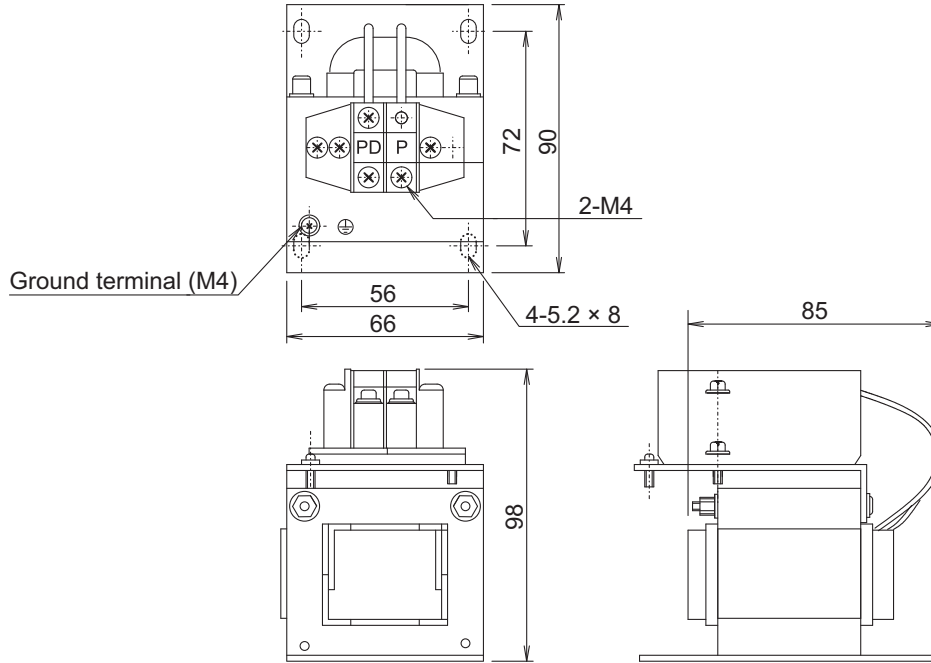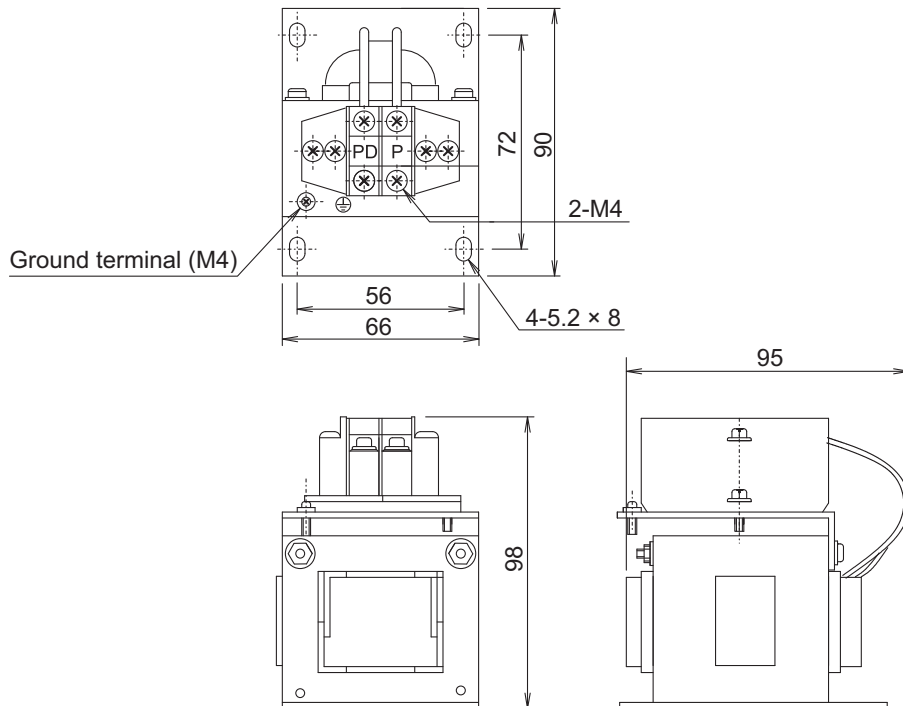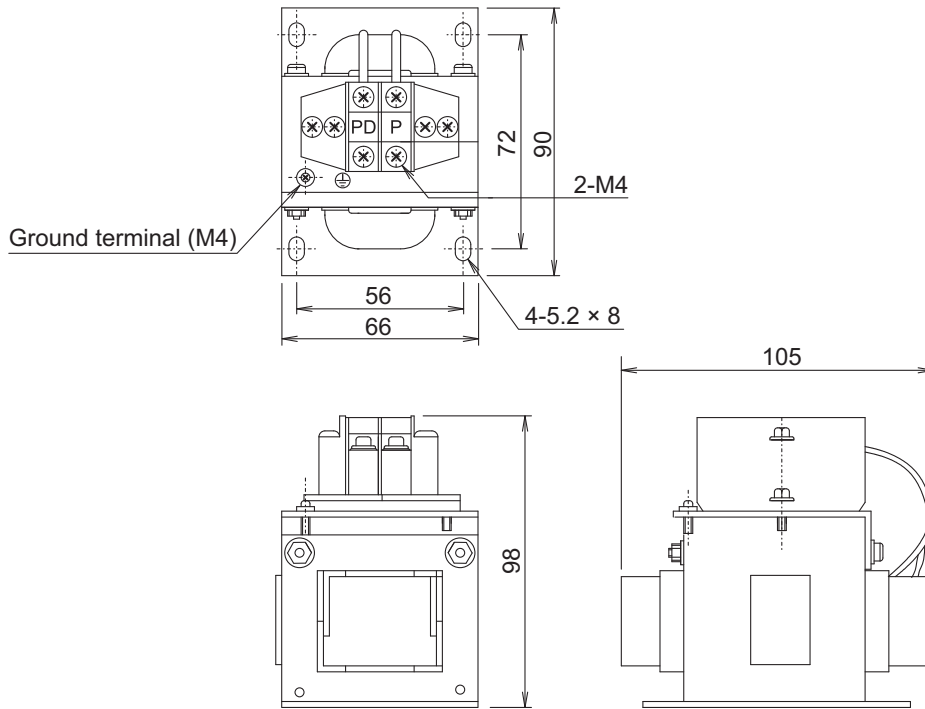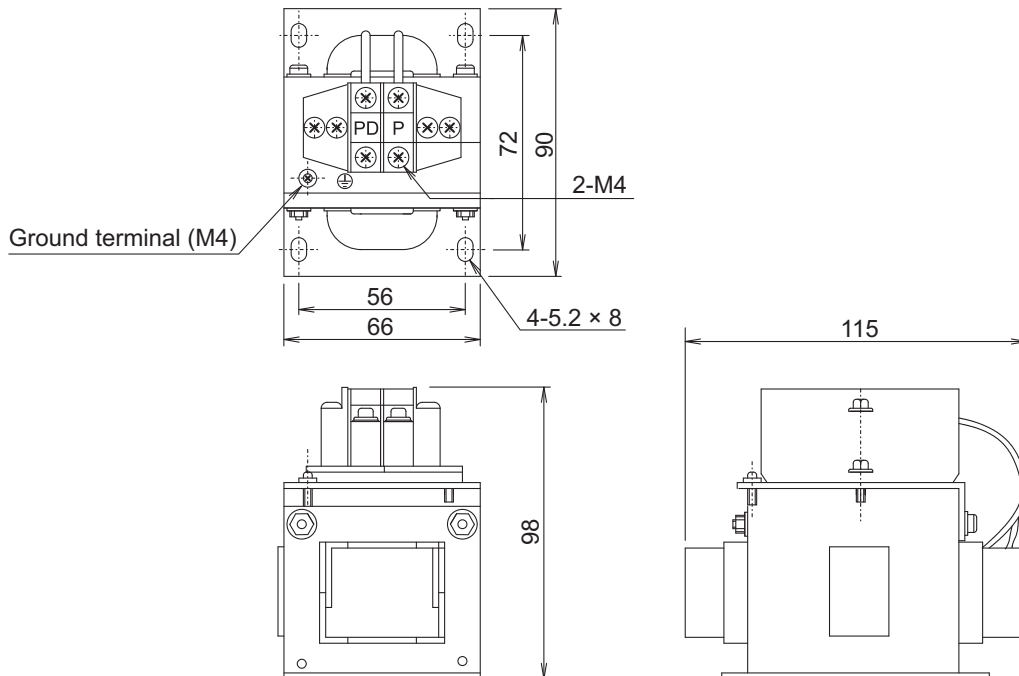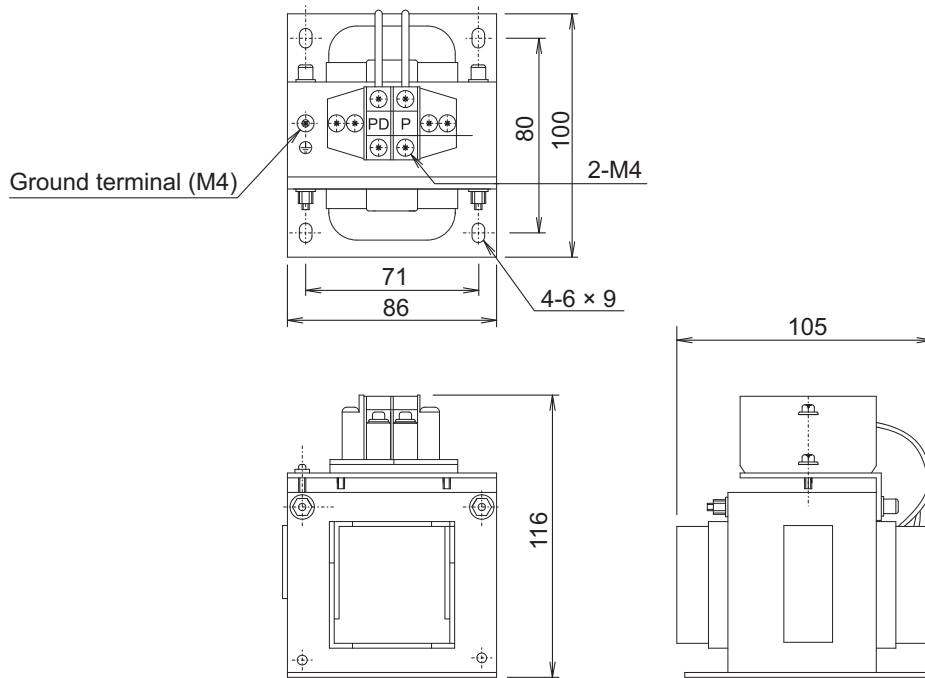
3G3AX-AL2025/-AL2055/-AL4025/-AL4055

Ground terminal (M5)

Terminal screw 6-ØK

Terminal block

Ro R So S To T

150

50±1

4-Ø6
(Cutout)

A

60   40

92

Y±1

C

9.5

Ro R So S To T

Connection Diagram
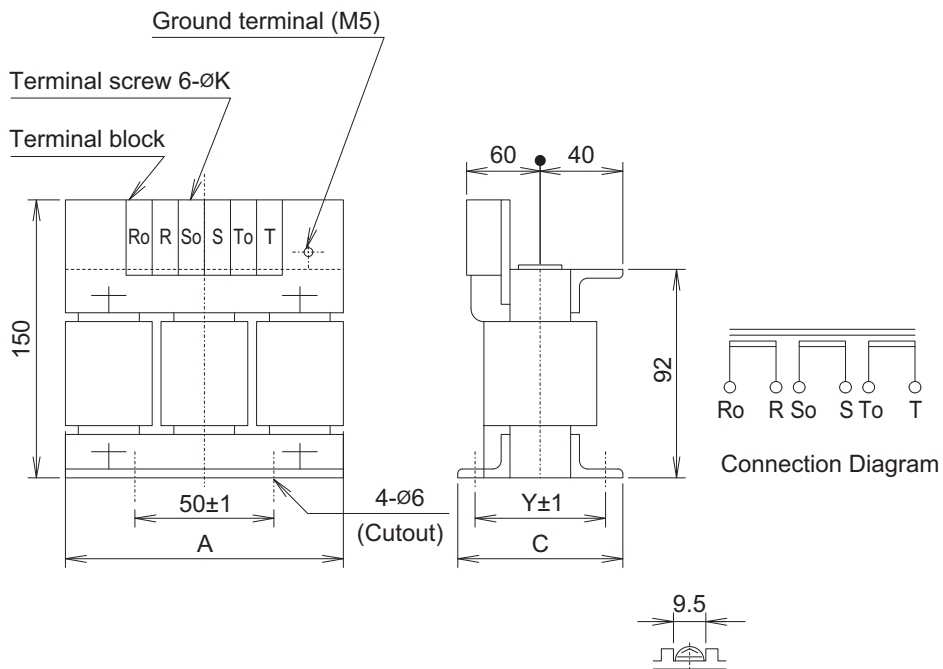
Model	Dimensions [mm]			
	A	C	Y	K
3G3AX-AL2025	130	82	67	4
3G3AX-AL2055	140	98	75	4
3G3AX-AL4025	130	82	67	4
3G3AX-AL4055	130	98	75	5

3G3AX-AL2110/-AL2220/-AL4110/-AL4220
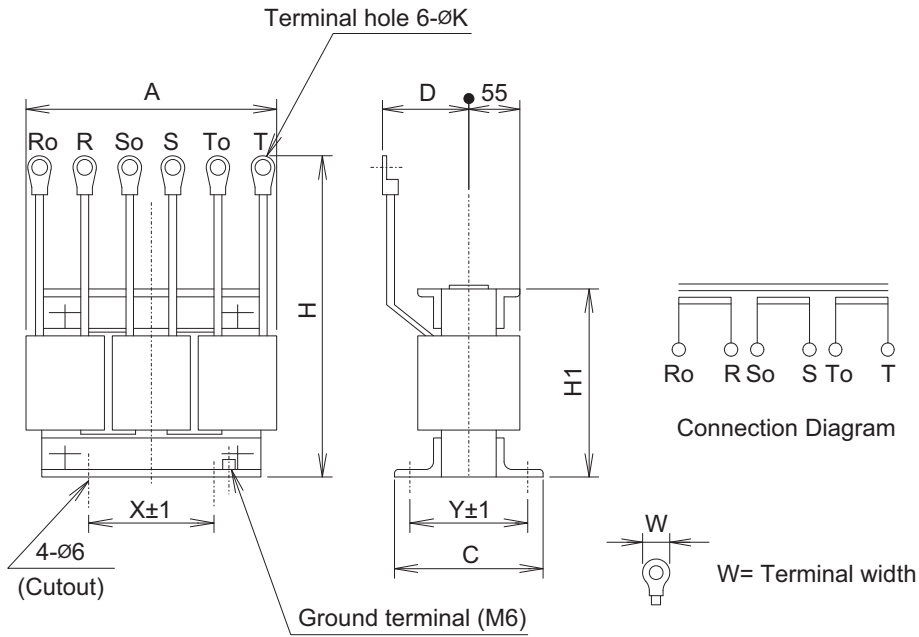
Model	Dimensions [mm]								
	A	**C**	**D**	**H**	**H1**	**X**	**Y**	**K**	**W**
3G3AX-AL2110	160	103	70	170	106	60	80	5.3	12
3G3AX-AL2220	180	113	75	190	136	90	90	8.4	16.5
3G3AX-AL4110	160	116	75	170	106	60	98	5.0	12.5
3G3AX-AL4220	180	103	75	190	138	100	80	5.3	12

2-4-4   Mounting Bracket Dimensions

L-brackets for rack mounting are brackets attached to the top and bottom of a Servo Drive. Note that each bracket has a different shape when you attach these L-brackets.

R88A-TK01K

Mounting bracket for top side
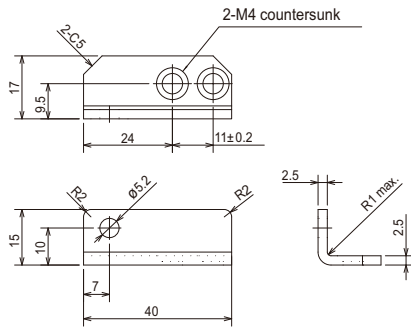
Mounting bracket for bottom side
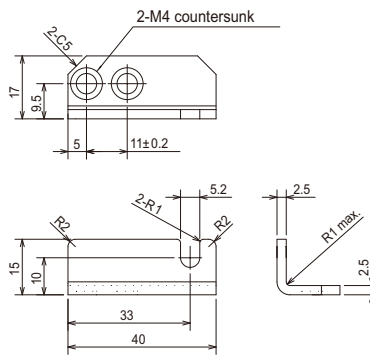
R88A-TK02K

Mounting bracket for top side
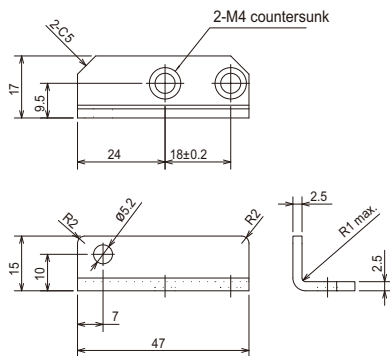
Mounting bracket for bottom side
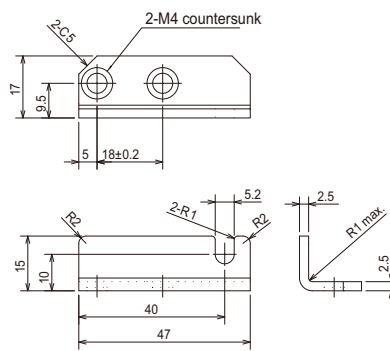
R88A-TK03K

Mounting bracket for top side
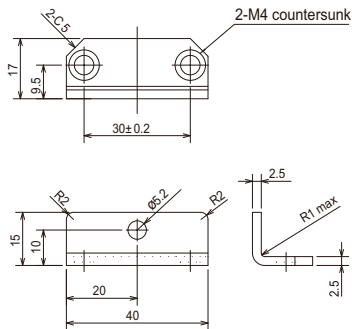
Mounting bracket for bottom side
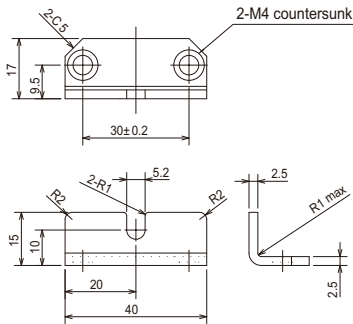
R88A-TK04K

Mounting bracket for top side
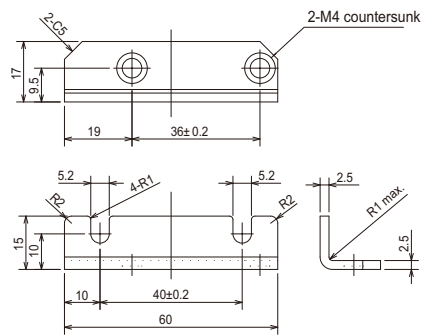
Mounting bracket for bottom side

G5 Series AC Servo Drives With Built-in EtherCAT Communications, Linear Motor Type

3

Specifications

This section provides the general specifications, characteristics, connector specifications, I/O circuits of the Servo Drives, and other peripheral devices.

3-1　Servo Drive Specifications

Select a Servo Drive that matches the Linear motor to be used.

3-1-1　General Specifications

Item	Specifications
Ambient operating temperature and operating humidity	0 to 55°C, 20 to 85% max. (with no condensation)
Storage ambient temperature and humidity	−20 to 65°C, 20 to 85% max. (with no condensation)
Operating and storage atmosphere	No corrosive gases
Vibration resistance	10 to 60 Hz and at an acceleration of 5.88 m/s^2 or less (Not to be run continuously at a resonance point)
Insulation resistance	Between power supply terminals/power terminals and FG terminal: 0.5 MΩ min. (at 500 VDC)
Dielectric strength	Between power supply/power line terminals and FG terminal: 1,500 VAC for 1 min at 50/60 Hz
Protective structure	Built into panel
International standard	EC Directives	EMC Directive	EN 55011/A2:2007(CISPR11), EN 61000-6-2:2005, EN 61800-3:2004
		Low Voltage Directive	EN 61800-5-1:2007
	UL standards		UL 508C (File No.E164620)
	CSA standards		CSA22.2 No. 14
	Functional safety		EN954-1:1996 Cat. 3, EN ISO13849-1:2008 PL c, PL d (MTTFd= 85.9 years, DCavg= 87.5 %), EN61508:2001(Part 1,2,4) SIL2, EN62061:2005 SIL2, EN61800-5-2:2007 (STO), IEC61326-3-1:2008

Note 1 The above items reflect individual evaluation testing. The results may differ under compound conditions.

　　　2 Never perform dielectric strength or other megameter tests on the Servo Drive. Failure to follow this guideline may result in damaging the internal elements.

　　　3 Depending on the operating conditions, some Servo Drive parts will require maintenance. For details, refer to *12-5 Periodic Maintenance* on page 12-28.

3-1-2　Characteristics

100-VAC Input Models

Item			R88D-KN01L-ECT-L	R88D-KN02L-ECT-L	R88D-KN04L-ECT-L
Input power supply	Main circuit	Power supply capacity	0.4 KVA	0.5 KVA	0.9 KVA
		Power supply voltage	Single-phase 100 to 120 VAC (85 to 132 V) 50/60 Hz		
		Rated current	2.6 A	4.3 A	7.6 A
		Heat value[1]	16.6 W	21 W	25 W
	Control circuit	Power supply voltage	Single-phase 100 to 120 VAC (85 to 132 V) 50/60 Hz		
		Heat value[1]	4 W	4 W	4 W
Weight			Approx. 0.8 kg	Approx. 1.0 kg	Approx. 1.6 kg
Maximum motor capacity	Rated effective current of motor		1.7 Arms	2.5 Arms	4.6 Arms
	Maximum current of motor		5.1 Arms	7.5 Arms	13.8 Arms

*1　The heat value is given for rated operation.

200-VAC Input Models

Item			R88D-KN01H-ECT-L	R88D-KN02H-ECT-L	R88D-KN04H-ECT-L	R88D-KN08H-ECT-L	R88D-KN10H-ECT-L	R88D-KN15H-ECT-L
Input power supply	Main circuit	Power supply capacity	0.5 KVA	0.5 KVA	0.9 KVA	1.3 KVA	1.8 KVA	2.3KVA
		Power supply voltage	Single-phase or 3-phase 200 to 240 VAC (170 to 264 V) 50/60 Hz					
		Rated current	1.6/0.9 A [1]	2.4/1.3 A [1]	4.1/2.4 A [1]	6.6/3.6 A [1]	9.1/5.2 A [1]	14.2/8.1 A [1]
		Heat value[2]	14.3/13.7 W [1]	23/19 W [1]	33/24 W [1]	30/35.5 W [1]	57/49 W [1]	104/93 W [1]
	Control circuit	Power supply voltage	Single-phase 200 to 240 VAC (170 to 264 V) 50/60 Hz					
		Heat value[2]	4 W	4 W	4 W	4 W	7 W	7 W
Weight			Approx. 0.8 kg	Approx. 0.8 kg	Approx. 1.0 kg	Approx. 1.6 kg	Approx. 1.8 kg	Approx. 1.8 kg
Maximum motor capacity	Rated effective current of motor		1.2 Arms	1.6 Arms	2.6 Arms	4.1 Arms	5.9 Arms	9.4 Arms
	Maximum current of motor		3.6 Arms	4.8 Arms	7.8 Arms	12.3 Arms	16.9 Arms	28.2 Arms

[1] The first value is for single-phase input power and the second value is for 3-phase input power.

[2] The heat value is given for rated operation.

| Item			R88D-KN20H-ECT-L	R88D-KN30H-ECT-L	R88D-KN50H-ECT-L	R88D-KN75H-ECT-L	R88D-KN150H-ECT-L
Input power supply	Main circuit	Power supply capacity	3.3 KVA	4.5 KVA	7.5 KVA	11.0 KVA	22.0 KVA
		Power supply voltage	3-phase 200 to 230 VAC (170 to 253 V) 50/60 Hz[2]				
		Rated current	11.8 A	15.1 A	21.6 A	32.0 A	58.0 A
		Heat value[1]	139 W	108 W	328 W	381 W	720 W
	Control circuit	Power supply voltage	Single-phase 200 to 230 VAC (170 to 253 V) 50/60 Hz[2]				
		Heat value[1]	10 W	13 W	13 W	15 W	17 W
Weight			Approx. 2.7 kg	Approx. 4.8 kg	Approx. 4.8 kg	Approx. 13.5 kg	Approx. 21.0 kg
Maximum motor capacity	Rated effective current of motor		13.4 Arms	18.7 Arms	33.0 Arms	44.0 Arms	66.1 Arms
	Maximum current of motor		40.2 Arms	56.1 Arms	84.8 Arms	116.6 Arms	167.2 Arms

[1] The heat value is given for rated operation.

400-VAC Input Models

Item			R88D-KN06F-ECT-L	R88D-KN10F-ECT-L	R88D-KN15F-ECT-L	R88D-KN20F-ECT-L
Input power supply	Main circuit	Power supply capacity	1.2 KVA	1.8 KVA	2.3 KVA	3.8 KVA
		Power supply voltage	3-phase 380 to 480 VAC (323 to 528 V) 50/60 Hz			
		Rated current	2.1 A	2.8 A	3.9 A	5.9 A
		Heat value[*1]	32.2 W	48 W	49 W	65 W
	Control circuit	Power supply voltage	24 VDC (20.4 to 27.6 V)			
		Heat value[*1]	7 W	7 W	7 W	10 W
Weight			Approx. 1.9 kg	Approx. 1.9 kg	Approx. 1.9 kg	Approx. 2.7 kg
Maximum motor capacity	Rated effective current of motor		1.5 Arms	2.9 Arms	4.7 Arms	6.7 Arms
	Maximum current of motor		4.5 Arms	8.7 Arms	14.1 Arms	19.7 Arms

*1   The heat value is given for rated operation.

Item			R88D-KN30F-ECT-L	R88D-KN50F-ECT-L	R88D-KN75F-ECT-L	R88D-KN150F-ECT-L
Input power supply	Main circuit	Power supply capacity	4.5 KVA	6.0 KVA	11.0 KVA	22.0 KVA
		Power supply voltage	3-phase 380 to 480 VAC (323 to 528 V) 50/60 Hz			
		Rated current	7.6 A	12.1 A	16.0 A	29.0 A
		Heat value[*1]	108 W	200 W	300 W	590 W
	Control circuit	Power supply voltage	24 VDC (20.4 to 27.6 V)			
		Heat value[*1]	13 W	13 W	15 W	22 W
Weight			Approx. 4.7 kg	Approx. 4.7 kg	Approx. 13.5 kg	Approx. 21.0 kg
Maximum motor capacity	Rated effective current of motor		9.4 Arms	16.5 Arms	22.0 Arms	33.1 Arms
	Maximum current of motor		28.2 Arms	42.4 Arms	58.7 Arms	83.7 Arms

*1   The heat value is given for rated operation.

3-1-3   EtherCAT Communications Specifications

Item	Specification
Communications standard	IEC 61158 Type 12, IEC 61800-7 CiA 402 Drive Profile
Physical layer	100BASE-TX (IEEE802.3)
Connectors	RJ45 × 2 (shielded) ECAT IN: EtherCAT input ECAT OUT: EtherCAT output
Communications media	Ethernet Category 5 (100BASE-TX) or higher (twisted-pair cable with double, aluminum tape and braided shielding) is recommended.
Communications distance	Distance between nodes: 100 m max.
Process data	Fixed PDO mapping
Mailbox (CoE)	Emergency messages, SDO requests, SDO responses, and SDO information
Distributed clock (DC)	Synchronization in DC mode. DC cycle: 250 μs, 500 μs, 1 ms, 2 ms, 4 ms
Indicators	L/A IN (Link/Activity IN) × 1 L/A OUT (Link/Activity OUT) × 1 RUN × 1 ERR × 1
CiA402 Drive Profile	• Cyclic synchronous position mode • Cyclic synchronous velocity mode • Cyclic synchronous torque mode • Profile potion mode • Homing mode • Touch probe function (Latch function) • Torque limit function (Force limit function)

3-1-4   EtherCAT Communications Connector Specifications (RJ45)

The EtherCAT twisted-pair cable is connected to a shielded connector.

• Electrical characteristics: Conforms to IEEE 802.3.
• Connector structure: RJ45 8-pin modular connector (conforms to ISO 8877)

	Pin No.	Signal name	Abbreviation	Direction
	1	Send data +	TD+	Output
	2	Send data −	TD−	Output
	3	Receive data +	RD+	Input
	4	Not used	–	–
	5	Not used	–	–
	6	Receive data −	RD−	Input
	7	Not used	–	–
	8	Not used	–	–
	Connector hood	Protective ground	FG	–

3-1-5   Control I/O Specifications (CN1)

For the control I/O signal cable, use a shielded twisted-pair cable with 0.18 mm^2 or thicker core wires. The cable length must be 3 m or less.

Control I/O Signal Connections and External Signal Processing
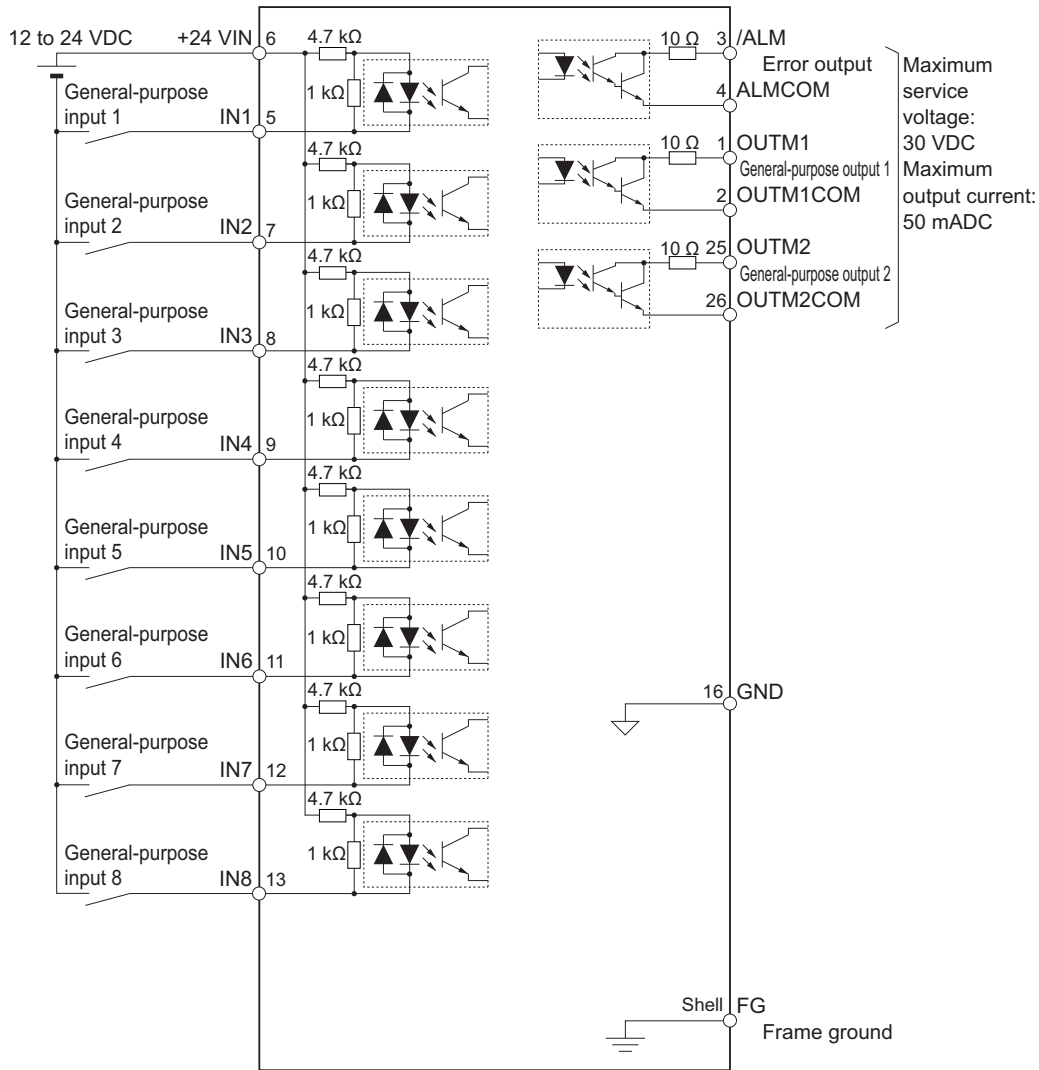
Note 1 The input functions of pins 5 and 7 to 13 are determined by the servo parameter object settings.

    2 The output functions of pins 1, 2, 25 and 26 are determined by the servo parameter object settings.

    3 It is not necessary to wire unused input pins.

Control I/O Signal Tables

● CN1 Control Inputs

Pin number	Symbol	Signal Name	Signal Default	Function and interface
6	+24 VIN	Power supply input 12 to 24 VDC.		The positive input terminal of the external power supply (12 to 24 VDC) for sequence inputs
5	IN1	General-purpose Input 1	Immediate Stop Input	These are general-purpose inputs. The input functions can be selected with servo parameter objects.[1] External Latch Signals 1 to 3 can be allocated only to IN5 to IN7 (or pins 10 to 12) respectively.
7	IN2	General-purpose Input 2	Positive Drive Prohibition Input	
8	IN3	General-purpose Input 3	Negative Drive Prohibition Input	
9	IN4	General-purpose Input 4	Origin Proximity Input	
10	IN5	General-purpose Input 5	External Latch Signal 3	
11	IN6	General-purpose Input 6	External Latch Signal 2	
12	IN7	General-purpose Input 7	External Latch Signal 1	
13	IN8	General-purpose Input 8	Monitor Input 0	

*1   Refer to *7-1 Sequence I/O Signals* on page 7-2 for the allocations.

● CN1 Control Outputs

Pin number	Symbol	Signal Name	Signal Default	Function and interface
3	/ALM	Error Output		The output turns OFF when an error occurs in the Servo Drive.
4	ALMCOM			
1	OUTM1	General-purpose Output 1	Brake Interlock Output	These are general-purpose outputs. The input functions can be selected with servo parameter objects.[1]
2	OUTM1COM			
25	OUTM2	General-purpose Output 2	Servo Ready Output	
26	OUTM2COM			
16	GND	Signal Ground		This is the signal ground.

*1   Refer to *7-1 Sequence I/O Signals* on page 7-2 for the allocations.

CN1 Pin Arrangement

1	OUTM1 (BKIR)	General-purpose Output 1 (Brake Interlock Output)				14		*			
			2	OUTM1COM	General-purpose Output 1 Common				15	BATGND	*
3	/ALM	Error Output				16	GND	Signal Ground			
			4	ALMCOM	Error Output Common				17		*
5	IN1 (STOP)	General-purpose Input 1 (Immediate Stop Input)				18		*			
			6	+24 VIN	12 to 24-VDC Power Supply Input				19		*
7	IN2 (POT)	General-purpose Input 2 (Positive Drive Prohibition Input)				20		*			
			8	IN3 (NOT)	General-purpose Input 3 (Negative Drive Prohibition Input)				21		*
9	IN4 (DEC)	General-purpose Input 4 (Origin Proximity Input)				22		*			
			10	IN5 (EXT3)	General-purpose Input 5 (External Latch Input 3)				23		*
11	IN6 (EXT2)	General-purpose Input 6 (External Latch Input 2)				24		*			
			12	IN7 (EXT1)	General-purpose Input 7 (External Latch Input 2)				25	OUTM2 (READY)	General-purpose Output 2 (Servo Ready Output)
13	IN8 (MONO)	General-purpose Input 8 (Monitor Input 0)				26	OUTM2COM	General-purpose Output 2 Common			

Note 1 Do not connect anything to unused pins (those marked with *).

   2 The input functions for general-purpose inputs 1 to 8 (or IN1 to IN8) are determined by the objects 3400 to 3407 hex (Input Signal Selection 1 to 8).

   3 The output functions for general-purpose outputs (OUTM1 and OUTM2) are determined by the objects 3410 and 3411 hex (Output Signal Selection 1 and 2).

   4 The functions that are allocated by default are given in parentheses.
Refer to *7-1 Sequence I/O Signals* on page 7-2 for details on the allocations.

Connectors for CN1 (Pin 26)

Name	Model	Manufacturer	OMRON model number
Plug	10126-3000PE	Sumitomo 3M	R88A-CNW01C
Cable Case	10326-52A0-008		

3-1-6   Control Input Circuits
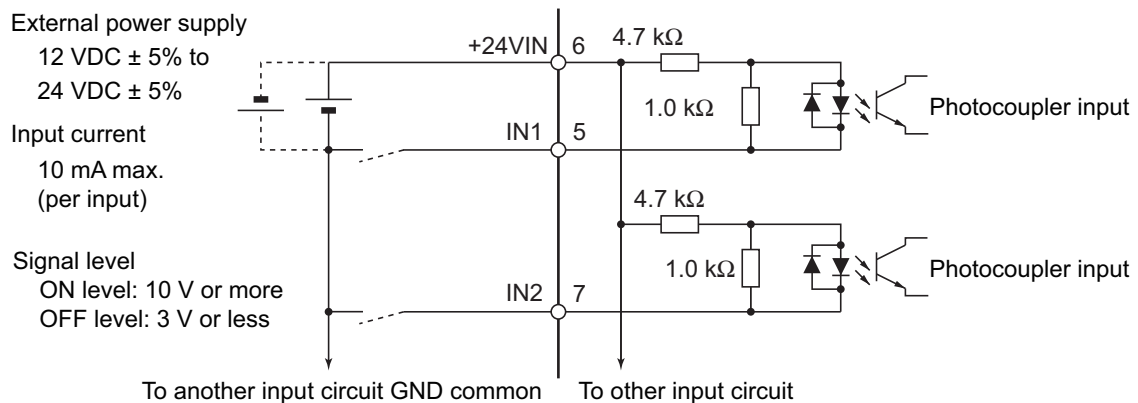
3-1-7   Control Input Details

This is the detailed information about the CN1 connector input pins.

General-purpose Inputs (IN1 to IN8)

Pin 5:	General-purpose Input 1 (IN1)	–	[Immediate Stop Input (STOP)]
Pin 7:	General-purpose Input 2 (IN2)	–	[Positive Drive Prohibition Input (POT)]
Pin 8:	General-purpose Input 3 (IN3)	–	[Negative Drive Prohibition Input (NOT)]
Pin 9:	General-purpose Input 4 (IN4)	–	[Origin Proximity Input (DEC)]
Pin 10:	General-purpose Input 5 (IN5)	–	[External Latch Input 3 (EXT3)]
Pin 11:	General-purpose Input 6 (IN6)	–	[External Latch Input 2 (EXT2)]
Pin 12:	General-purpose Input 7 (IN7)	–	[External Latch Input 1 (EXT1)]
Pin 13:	General-purpose Input 8 (IN8)	–	[Monitor Input 0 (MON0)]

Note The functions that are allocated by default are given in brackets.
Refer to *7-1 Sequence I/O Signals* on page 7-2 for the allocation procedures.

● **Immediate Stop Input (STOP)**

- STOP is used when an external sequence such as the host forcibly turns OFF the servo.
- If the input is turned OFF when the Linear Motor is moving, the dynamic brake makes a deceleration stop. After the motor stops, it remains in servo-free state.
- If the Immediate Stop Input (STOP) turns ON when the motor is energized, an Immediate Stop Input Error (Error No. 87.0) will occur.
- This input is allocated to the pin 5 with the default setting.

🔊 **Precautions for Safe Use**

Turn OFF the Immediate Stop Input (STOP) at the same time when you turn OFF the main power. When the main power turns OFF due to an external immediate stop, the motor will continues to operate due to residual voltage. This may cause human injuries or damages to the machine and devices.

● **Positive Drive Prohibition Input (POT) / Negative Drive Prohibition Input (NOT)**

   • These two signals are the inputs to prohibit positive or negative drive (over-travel inputs).
   • When these terminals are shorted (factory setting), the Servo Drive can drive in the specified movement direction.
   • In the drive prohibition state, motor switches to servo lock state after a deceleration stop.
   • The maximum force for a deceleration stop is the same as the maximum force of the Linear Motor.
   • In the drive prohibition state, the Servo Drive does not switch to an error state.
   • When the Drive Prohibition Input Selection (3504 hex) is set to 1, the operation at a drive prohibit input can be selected in the Stop Selection for Drive Prohibition Input (3505 hex).
   • If the Drive Prohibition Input Selection (3504 hex) is set to 2, a Drive Prohibition Input Error (Error No. 38.0) will occur when there is a drive prohibition input.
   • With the default settings, the Positive Drive Prohibition Input (POT) is allocated to pin 7, and the Negative Drive Prohibition Input (NOT) is allocated to pin 8.

Precautions for Correct Use

Both signals are disabled (in a state in which drive prohibition will not operation) in the default settings. If prohibiting the drive input is required, set the Drive Prohibit Input Selection (3504 hex) to either 0 or 2. The setting on the Input Signal Selection 1 to 8 (3400 to 3407 hex) can change the logic and allocation for the respective Input terminals (CN1 to 7 and 8).

● **Origin Proximity Input (DEC)**

   • This is the deceleration signal for origin returns.
   • If the Origin Proximity Input turns ON while the Linear Motor is moving at the origin proximity input search speed, it will decelerate to the Speed during search for zero (6099 hex).
   • With the default settings, the Origin Proximity Input is assigned to pin 9.

Additional Information

Although this signal input is enabled also in the Speed Control Mode and the Force Control Mode, it does not affect operation.

● **External Latch Input Signals (EXT1, EXT2, and EXT3)**

   • These are the external input signals to latch the actual value in the feedback pulse counter.
   • The encoder position data is obtained when the External Latch Input is turned ON.
   • With the default settings, External Latch Input 1 is allocated to pin 12, External Latch Input 2 to pin 11, and External Latch Input 3 to pin 10.

Precautions for Correct Use

   • The external latch inputs are detected by on the rising edge of the signal, but the minimal signal ON and OFF widths must be 2 ms.
   • The external latch inputs can only be set to NO (normally open) contacts.
   • The external latch inputs can be allocated to pins 10 to 12 only.

● **Monitor Inputs (MON0, MON1, and MON2)**

   • These are the general-purpose monitor inputs.

   • The general-purpose monitor inputs do not affect operation and can only be monitored from the host controller.

   • With the default settings, MON0 is allocated to pin 13.

● **Positive Force Limit Input (PCL)/Negative Force Limit Input (NCL)**

   • Turn ON these inputs to limit the force to the value set in the Positive Force Limit (3525 hex) or the Negative Force Limit (3526 hex).

   • While the input is ON, operation continues within the force limit.

   • With the default settings, the inputs are not allocated.

3-1-8   Control Output Circuits

▌Sequence Outputs
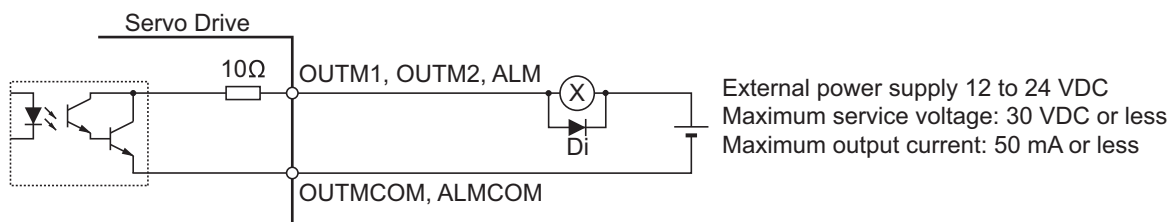
Di: Surge voltage prevention diode[1]

*1   When driving a relay directly with an output signal, always insert a diode as shown in the above figure. Use high-speed diodes.

3-1-9   Control Output Details

Control Output Sequence

The chart below illustrates the timing of the command inputs after the control power supply is turned ON. Input the Servo ON/OFF operation, position, speed, and force commands in the correct timing, as shown in the chart.

Signal	State	Timing Notes
Control power supply (L1C, L2)	ON / OFF	
Internal control power supply	ON / OFF	Approx. 100 to 300 ms — Establishment
MPU operation	ON / OFF	Less than 3 s; Approx. 1.5 s; Initialization *1 — Normal operation
Main circuit power supply (L1, L2, L3)	ON / OFF	0 s or more
Servo ready completed output (READY, NO)	ON / OFF	10 ms or more (after initialization and main circuit ON) *2; 10 ms or more — Output Tr ON
Servo ready completed output (READY, NC)	ON / OFF	Unknown *3 / Output Tr ON
Servo ON accepted/rejected	Accepted / Rejected	0 ms or more
Dynamic brake *4	ON / OFF	Approx. 2 ms
Motor power supply	ON / OFF	Approx. 60 ms
Brake interlock output (BKIR) *5	ON / OFF	Brake engaged — Approx. 4 ms — Brake released
Magnetic pole position estimation completion output *6	ON / OFF	Magnetic pole position estimation not completed — Magnetic pole position estimation in progress *7 — Completed
Magnetic pole position estimation completion output *8	ON / OFF	Magnetic pole position estimation not completed — Completed
Position, speed, or force command	ON / OFF	Without command — 100 ms or more *9 — With command

*1   Once the internal control power is established, the protective function starts working about 1.5 s after the MPU starts initializing itself. Be sure that all I/O signals that are connected to the Servo Drive are stable before the protective function starts working. This is true especially for the Positive/Negative Drive Prohibition Input (POT/NOT), the Origin Proximity Input (DEC), and the external encoder input.

*2   The Servo Ready Completed Output (READY) turns ON only when all of these conditions are met: MPU initialization is completed. The main power supply is established. No error exists. EtherCAT communications and servo are synchronized (phase alignment).

*3   If general-purpose output signals are used as NO contact, wait at least 3.3 seconds after the control power is turned ON.

*4   The above timing chart applies when the servo ON signal is accepted as soon as doing so is enabled.

*5   The Brake Interlock Output (BKIR) turns ON either when a release request is received via servo controls or when a release request is received via EtherCAT communications.

*6   The magnetic pole position estimation completion output is enabled. The Magnetic Pole Position Detection Method (3920 hex) is set to 2 (Magnetic pole position estimation method).

*7   The Magnetic Pole Position Estimation Command Time changes with the servo parameter object settings. Make sure that the magnetic pole position estimation completion output flag is turned "ON" before executing the command. If magnetic pole position estimation is not completed successfully, the magnetic pole position estimation completion flag will not turn "ON".

*8   The magnetic pole position estimation completion output is disabled. The Magnetic Pole Position Detection Method (3920 hex) is set to 0 (Not specified), 1 (Reserved), or 3 (Magnetic pole position restoration method).

*9   Although the servo ON operation is accepted in this section, it is not yet enabled.

Error Output (/ALM)

Pin 3:   Error Output (/ALM)

Pin 4:   Error Output Common (ALMCOM)

● Function

- This output is turned OFF when the drive detects an error.
- This output is OFF when the power supply is turned ON, but turns ON when the drive's initial processing has been completed.

General-purpose Outputs (OUTM1 and OUTM2)

Pin 1:   General-purpose Output 1 (OUTM1) − [Brake Interlock Output (BKIR)]

Pin 2:   General-purpose Output 1 Common (OUTM1COM)

Pin 25:   General-purpose Output 2 (OUTM2) − [Servo Ready Output (READY)]

Pin 26:   General-purpose Output 2 Common (OUTM2COM)

Note The functions that are allocated by default are given in brackets.
Refer to the description in Output Signals in *7-1 Sequence I/O Signals* on page 7-2 for the allocations.

● Servo Ready Completed Output (READY)

- This output signal indicates the Drive is ready to be energized.
- It turns ON when no error is detected after the main circuit power supply turns ON.
- With the default settings, the output is allocated to pins 25 and 26.

● Brake Interlock Output (BKIR)

- The Brake Interlock Output outputs the external brake timing signal according to the settings of the Brake Timing When Stopped (3437 hex), the Brake Timing During Operation (3438 hex), and the Brake Threshold Speed During Operation (3439 hex).
- With the default settings, the output is allocated to pins 1 and 2.

● Positioning Completion Output (INP1, INP2)

- INP1 turns ON when the position error is equal to or less than Position window (6067 hex).
- INP2 will turn 3 ON when the position error is equal to or less than Positioning Completion Range 2 (3442 hex).
- This output turns ON based on the Positioning Completion Condition Selection (3434 hex).
- The output is always OFF except in the Position Control Mode.
- With the default settings, the output is not allocated.

● Motor Speed Detection Output (TGON)

- This output turns OFF when the motor speed exceeds the value set by the Speed for Motor Detection (3436 hex).
- The output is effective both in positive and negative directions regardless the actual movement direction of the motor.
- The detection contains a hysteresis of 10 mm/s.
- The output is always OFF except in the Speed Control Mode and the Force Control Mode.
- With the default settings, the output is not allocated.
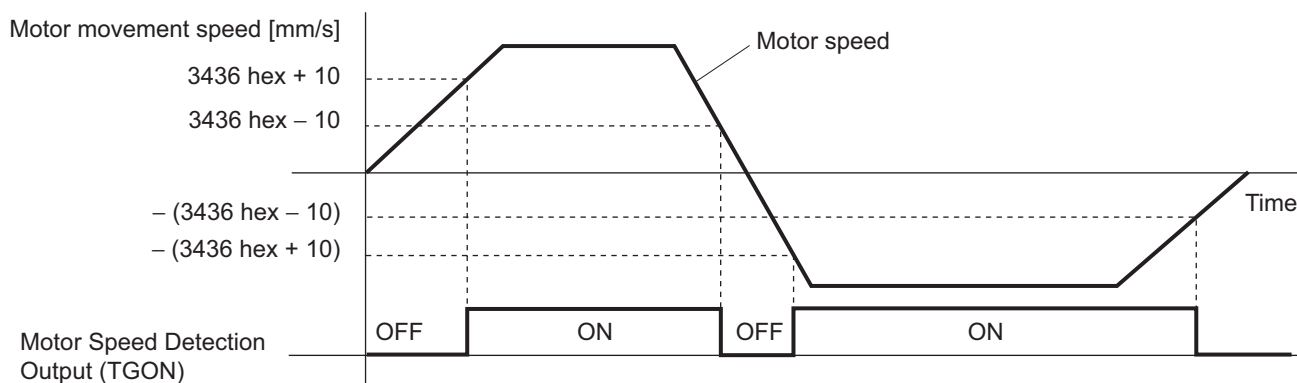
● Force Limiting Signal (TLIMT)

- The output turns ON when the output force reaches the limit set in the Positive torque limit value (60E0 hex) or the Negative torque limit value (60E1 hex).
- With the default settings, the output is not allocated.

● Zero Speed Detection Output (ZSP)

- This output turns ON when the motor speed goes below the value set in the Zero Speed Detection (3434 hex).
- The output is effective both in positive and negative directions regardless of the actual direction that the motor rotates.
- The detection contains a hysteresis of 10 mm/s.
- With the default settings, the output is not allocated.
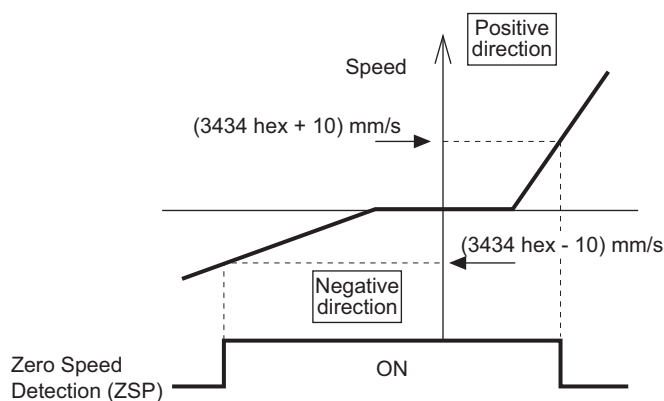
● Speed Conformity Output (VCMP)

- This output turns ON when the motor speed falls into the range set in the Speed Conformity Detection Range (3435 hex).
- It is determined to be conforming when the difference between the commanded speed before acceleration or deceleration process inside the Drive and the motor speed is within the set range of Speed Conformity Detection Range (3435 hex).
- The detection contains a hysteresis of 10 mm/s.
- The output is always OFF except in the Speed Control Mode and the Force Control Mode.
- With the default settings, the output is not allocated.
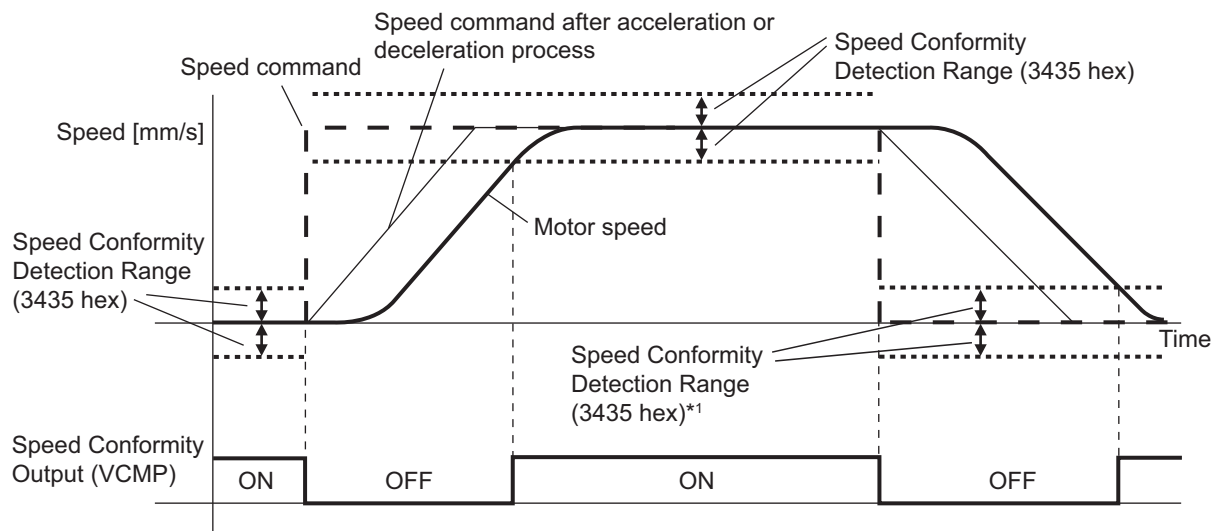
*1   Because the Speed Conformity Detection Range has a hysteresis of 10 mm/s, the actual detection range is as follows:
     Threshold for transition from OFF to ON: (3435 hex - 10) mm/s
     Threshold for transition from ON to OFF: (3435 hex + 10) mm/s

● **Warning Outputs (WARN1 and WARN2)**

- The Warning Output 1 (WARN1) turns ON when the warning set by the Warning Output Selection 1 (3440 hex) is detected.
- The Warning Output 2 (WARN2) turns ON when the warning set by the Warning Output Selection 2 (3441 hex) is detected.
- With the default settings, the outputs are not allocated.

● **Position Command Status Output (PCMD)**

- This output turns ON when the position command is in the Profile Position Mode.
- The output is always OFF except in the Profile Position Mode (pp).
- With the default settings, the outputs are not allocated.

● **Speed Limiting Output (VLIMT)**

- This output turns ON when the motor speed reaches the limit set in the Speed Limit Value Setting (3321 hex).
- The output is always OFF except in the Force Control Mode.
- With the default settings, the outputs are not allocated.

● **Error Clear Attribute Output (ALM-ATB)**

- This output turns ON when an error that can be reset occurs.
- With the default settings, the output is not allocated.

● **Speed Command Status Output (VCMD)**

- This output turns ON when the speed command is in the Speed Control Mode.
- The output is always OFF except in the Speed Control Mode.
- With the default settings, the outputs are not allocated.

- ● **Remote Outputs (R-OUT1 and R-OUT2)**
    - • Remote Output 1 (R-OUT1) turns ON and OFF according to the ON/OFF status of bit 16 in the Digital outputs (60FE hex).
    - • Remote Output 2 (R-OUT2) turns ON and OFF according to the ON/OFF status of bit 17 in the Digital outputs (60FE hex).
    - • With the default settings, the output is not allocated.

- ● **Magnetic Pole Position Estimation Completion Output (CS-CMP)**
    - • This output turns ON when the magnetic pole position estimation is completed.
    - • With the default settings, the output is not allocated.

3-1-10   External Encoder Specifications

These are the specifications of the external encoder that can be used in conjunction with the Servo Drive.

Item	Specifications
Resolution	0.01 to 10 [μm/ pulse][1]
Maximum length	Resolution x (2^{30}-1) or less
Encoder type	• Phase A/B, origin signal differential input • AT573A, ST770A, and ST770AL by Mitutoyo Corporation • SR75, SR77, SR85, and SR87 by Magnescale Co., Ltd
Supported encoder speed[2]	• Phase A/B type (90° phase difference input) : to 4 Mpps • Serial communications type : to 400 Mpps
External Encoder Cable	Cable specifications : Shielded twisted-pair cable[3] Maximum cable length : 20 m[4]

[1]   Set the number of pulses per magnetic pole pitch (or one cycle of electrical angle) to at least 2048 pulses.

[2]   This represents the encoder speed supported on the Servo Drive. Check separately the external encoder operation manual for its supported speed.

[3]   For the external encoder signal cable, use a shielded twisted-pair cable with 0.18 mm^2 or thicker core wires.

[4]   We recommend you to use a 5 V power supply with the double wiring technique to reduce the effects of a voltage drop if the wiring length is long.

3-1-11   External Encoder Connector Specifications (CN4)

These are the specifications of the connector that connect with the external encoder.

Pin No.	Symbol	Name	Function and interface
1	E5V	External encoder power supply output	External encoder power supply: 5.0 VDC $\pm$ 5%, 250 mA max. If the above capacity is exceeded, provide an appropriate power supply.
2	E0V		This is connected to the control circuit ground connected to connector CN1.
3	+EXS	External encoder signal serial interface I/O (serial signal)	This is an external encoder serial bi-directional signal. (Conforms to EIA485)[1] Maximum response frequency: 400 Mpps
4	−EXS		
5	+EXA	External encoder signal 90° phase difference input (Phases A, B and Z)	This is an external encoder 90° phase difference input signal.[1] Maximum response frequency: 4 Mpps (quadruple multiplier)
6	−EXA		
7	+EXB		
8	−EXB		
9	+EXZ		
10	−EXZ		
Shell	FG	Frame ground	Frame ground

EXA

EXB

t1 > 0.25µs

t2 > 1.0µs
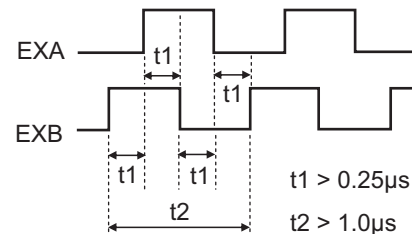
*1   Connect external encoder signals to the serial interface (+EXS/−EXS) or 90° phase difference inputs according to the encoder type.

● Connectors for CN4 (10 Pins)

Name	Model	Manufacturer	OMRON model number
MUF Connector	MUF-PK10K-X	J.S.T. Mfg. Co., Ltd.	R88A-CNK41L

Connection of External Encoder Input Signals and Processing of External Signals
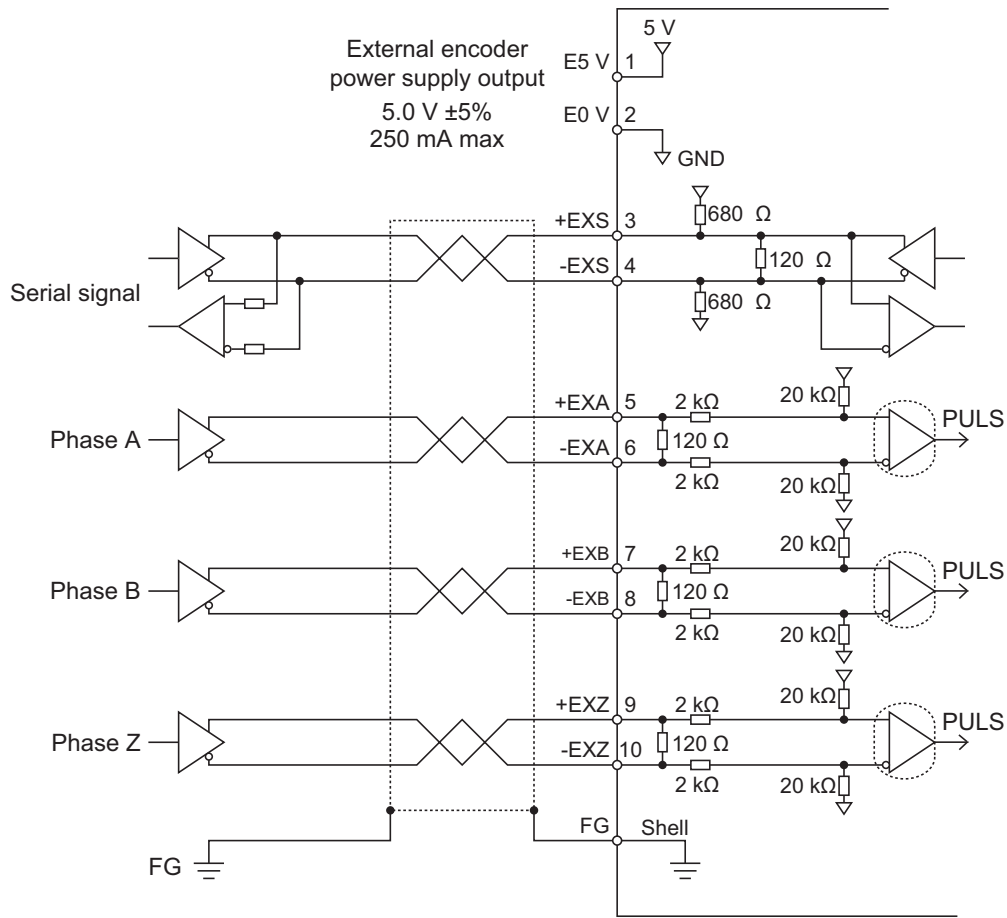
Example of Connection with External Encoder

● 90° Phase Difference Input (3323 Hex = 0)
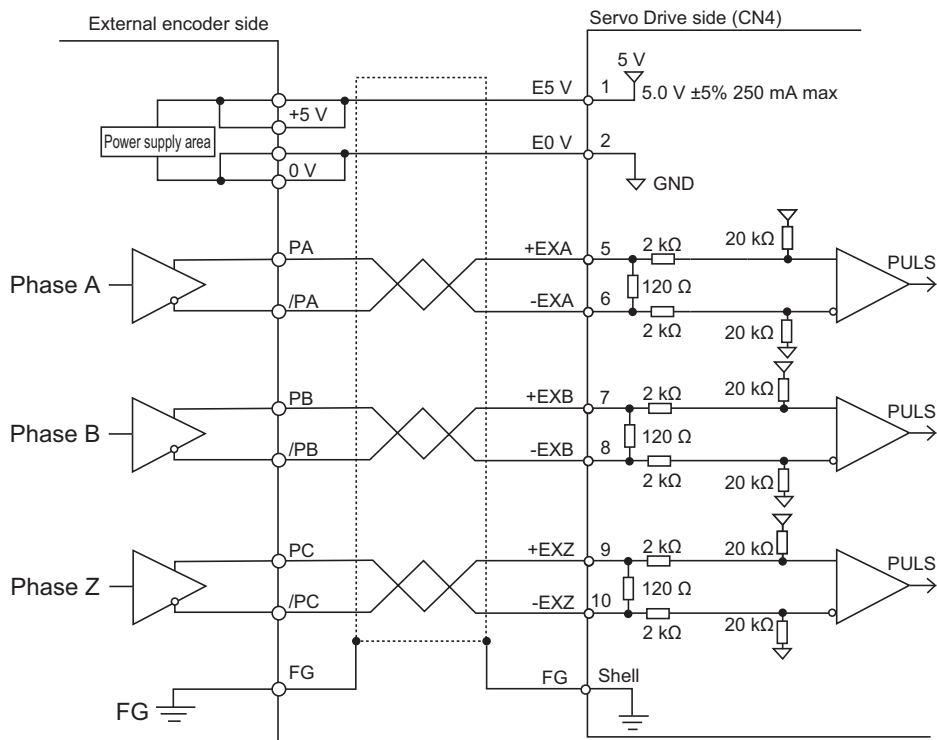
● Serial Communications, Incremental Type External Encoder (3323 Hex = 1)
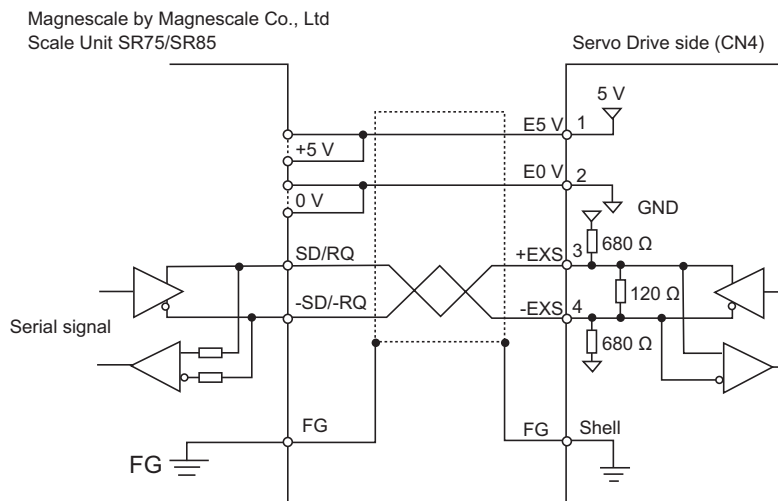
● **Serial Communications, Absolute Type External Encoder (3323 Hex = 2)**

Absolute Linear Scale
by Mitutoyo Corporation
AT573A/ST770A/ST770AL

Servo Drive side (CN4)
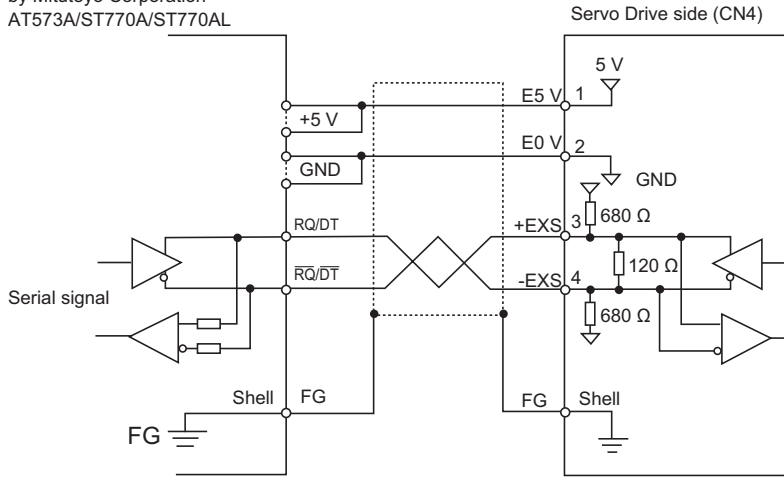
Magnescale by Magnescale Co., Ltd
Scale Unit SR77/SR87

Servo Drive side (CN4)
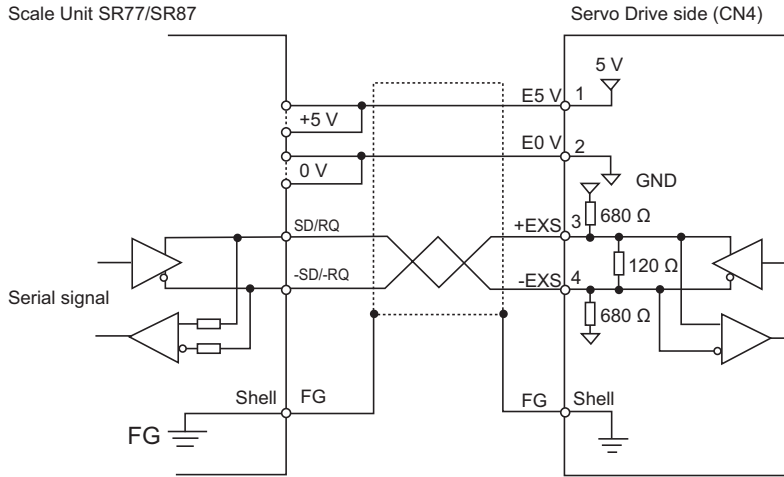
3-1-12   Analog Monitor Connector Specifications (CN5)

■ Monitor Output Signal Table

● Monitor Output (CN5)

Pin No.	Symbol	Name	Function and interface
1	AM1	Analog monitor output 1	Outputs the analog signal for the monitor.
			Default setting: Motor speed 1 V/(500 mm/s)
			You can use objects 3416 hex and 3417 hex to change the item and unit.
			You can use object 3421 hex to change the output method.
2	AM2	Analog monitor output 2	Outputs the analog signal for the monitor.
			Default setting: Force command 1 V/(33 %)
			You can use objects 3418 hex and 3419 hex to change the item and unit.
			You can use object 3421 hex to change the output method.
3	GND	Analog monitor ground	Ground for analog monitors 1, 2
4	–	Not used	Do not connect.
5	–	Not used	Do not connect.
6	–	Not used	Do not connect.

● Connectors for CN5 (6 pins)

Name	Model	Manufacturer
Connector housing	51004-0600	Molex Japan
Connector terminal	50011-8000	Molex Japan

■ Monitor Output Circuit
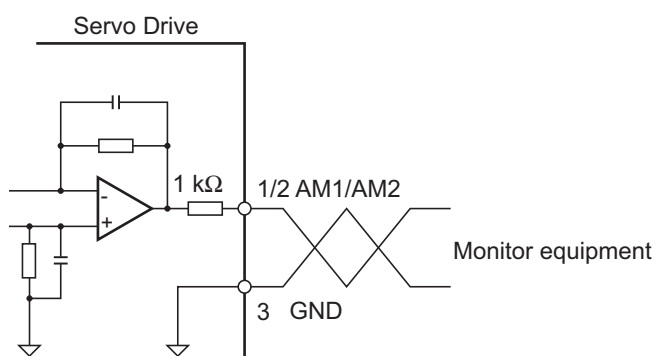
3-1-13   USB Connector Specifications (CN7)

Through the USB connection with computer, operations such as parameter setting and changing, monitoring of control status, checking error status and error history, and parameter saving and loading can be performed.

Pin No.	Symbol	Name	Function and interface
1	VBUS	USB signal terminal	Use this function for computer communication.
2	D–		
3	D+		
4	–	Reserved for manufacturer use	Do not connect.
5	SENGND	Signal ground	Signal ground

Precautions for Correct Use

- Use a commercially available USB cable that is shielded, equipped with a ferrite core for noise immunity, and supports USB2.0.
  The Mini B type USB cable can be used.

3-1-14 Safety Connector Specifications (CN8)

Connection of Safety I/O Signals and Processing of External Signals
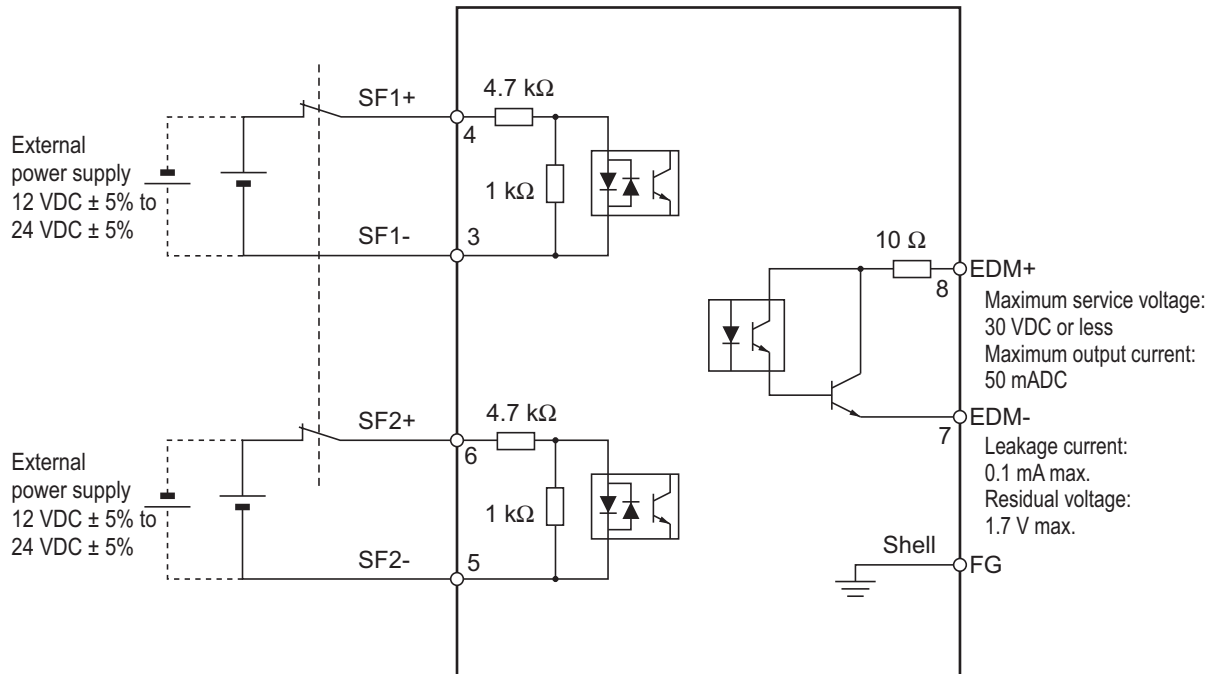
Safety I/O Signal Table

● Safety I/O (CN8)

Pin No.	Symbol	Name	Function and interface
1	–	Reserved	Do not connect.
2	–		
3	SF1–	Safety input 1	Inputs 1 and 2 for operating the STO function, which are 2 independent circuits. This input turns OFF the power transistor drive signals in the Servo Drive to cut off the current output to the motor.
4	SF1+		
5	SF2–	Safety input 2	
6	SF2+		
7	EDM–	EDM output	A monitor signal is output to detect a safety function failure.
8	EDM+		
Shell	FG	Frame ground	Connected to the ground terminal inside the Servo Drive.

● Connector for CN8 (8 pins)

Name	Model	Manufacturer	OMRON model number
Industrial Mini I/O Connector (D-SHAPE1)	2013595-1	Tyco Electronics AMP KK	R88A-CNK81S

Note The recommended cable is a 6-core shielded cable with a wire size of AWG30 to AWG26 and a finished outer diameter of 6.7 mm or less.

Safety Input Circuits

External power supply
12 VDC ± 5% to
24 VDC ± 5%

SF1+ 4   4.7 kΩ

1.0 kΩ   Photocoupler input

SF1- 3

SF2+ 6   4.7 kΩ

1.0 kΩ   Photocoupler input

SF2- 5

Servo Drive

Signal level
ON level: 10 V min.
OFF level: 3 V max.

EDM Output Circuit

Servo Drive

10 Ω   8 +EDM

7 -EDM   Di

External power supply
12 to 24 VDC
Maximum service voltage: 30 VDC or less
Maximum output current: 50 mA max.
Leakage current: 0.1 mA max.
Residual voltage: 1.7 V max.

Di: Surge voltage prevention diode
(Use a high-speed diode.)

Note When driving a relay directly with an output signal, always insert a diode as shown in the above figure.

3-2   Overload Characteristics (Electronic Thermal Function)

An overload protection function (electronic thermal) is built into the Servo Drive to protect the drive and linear motor from overloading.

Overload protection will be activated according to the timing characteristic if the feedback value for the force command exceeds the overload level.

Set the overload level in the Overload Detection Level Setting (3512 hex) and the timing characteristic in the Motor Overload Curve Selection (3929 hex), respectively. Be sure that these settings conform to the environment in which the Servo Drive is used.

Index	Name	Unit	Setting range	Explanation	Reference
3512 hex	Overload Detection Level Setting	%	0 to 500	Set the overload detection level. If set to 0, the overload level will be 115%. If set to 115 or higher, this will be restricted internally to 115%.	page 9-39
3929 hex	Motor Overload Curve Selection	–	0 to 7	Select one of the eight motor overload characteristic curves. If set to 0, the standard motor overload characteristic curve will be selected.	page 9-64

If an overload does occur, first eliminate the cause of the error and then wait at least 1 minute for the motor temperature to drop before turning ON the power again.
If the error reset is repeated at short intervals, the motor may burn out.

The following graphs show the motor overload characteristic curves that can be selected in the Motor Overload Curve Selection (3929 hex), where the horizontal axis represents the load ratio and the vertical axis represents electronic thermal operation time.

● When Overload Detection Level Setting is 100%
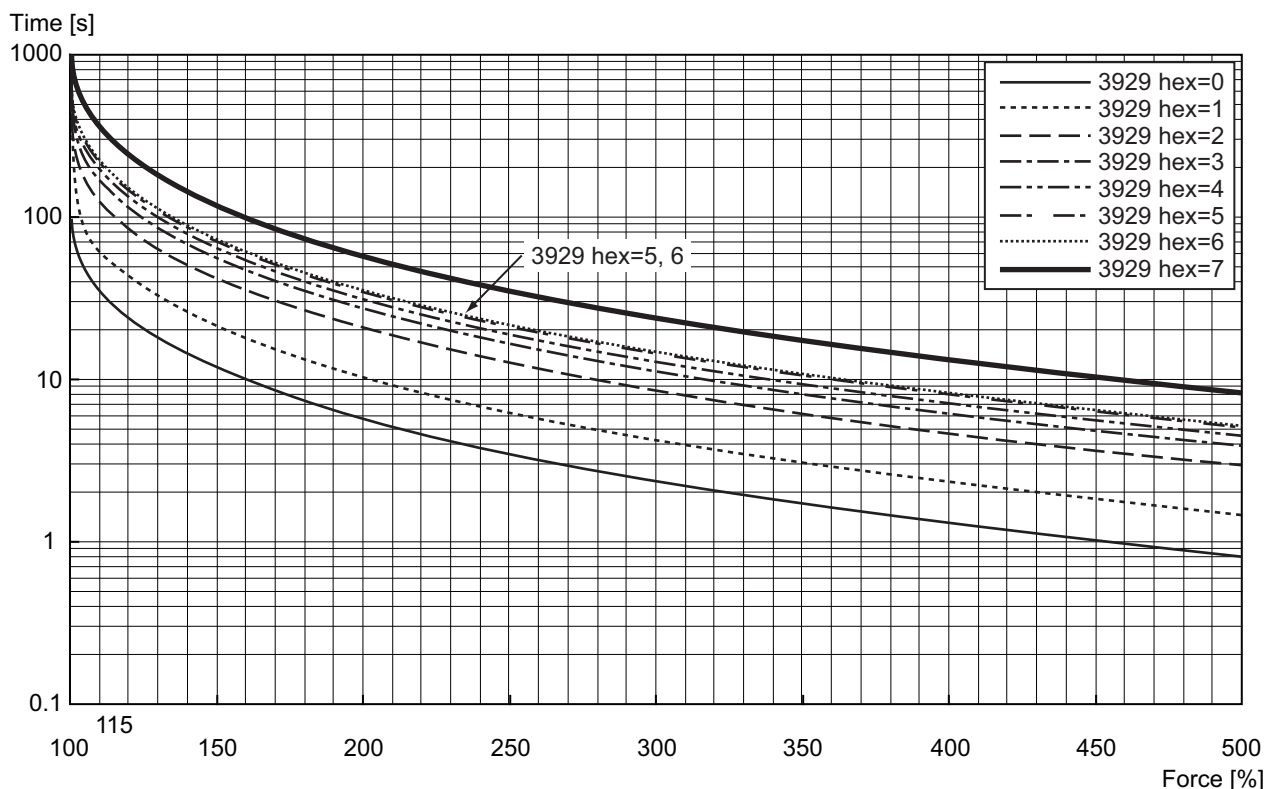
● When Overload Detection Level Setting is 115%
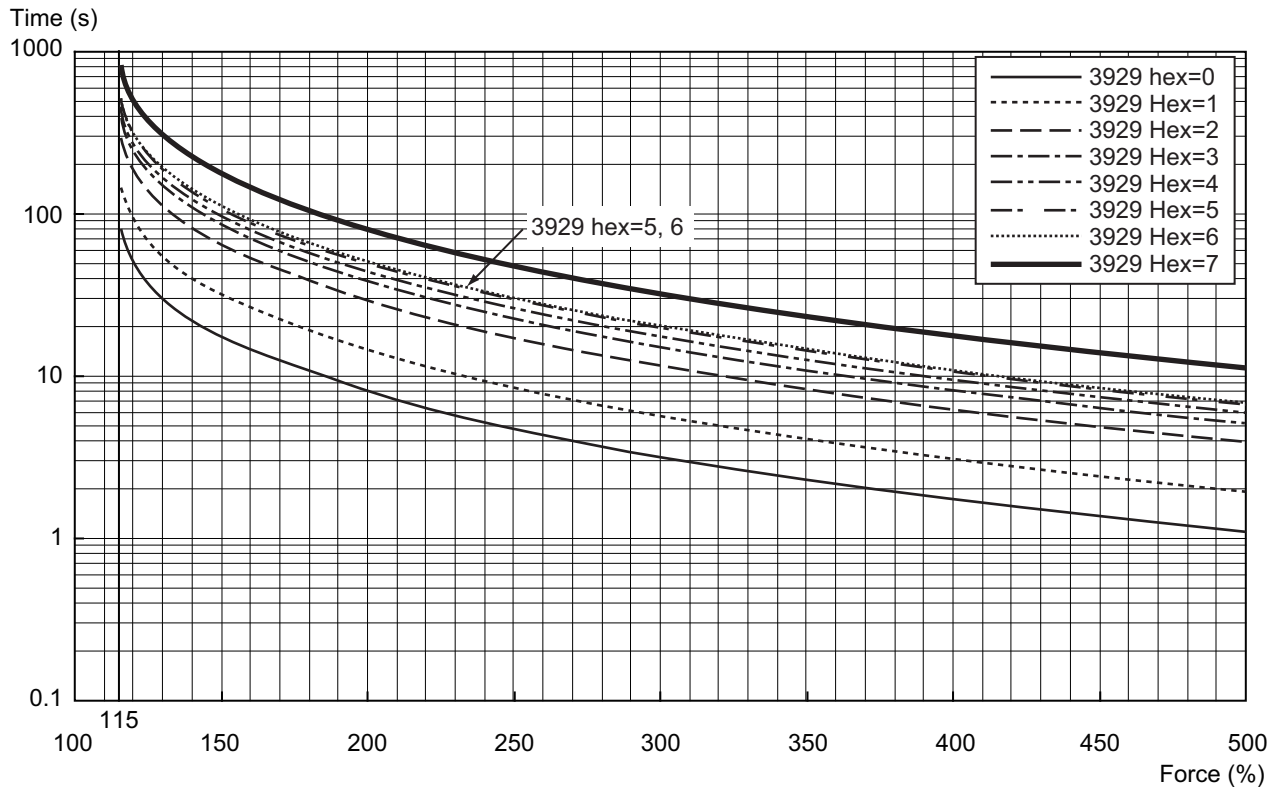
If a constant force command is continuously applied after a period of time equivalent to 3 or more times the overload time constant with the force command value set to 0, the overload time t [s] will be:

t [s] = -Overload time constant [s] x $\log_e$ (1 - Overload level [%]/Force command [%])^2

Precautions for Correct Use

- The overload protection function is not designed to provide protection against errors caused by heat generated by the motor.
- If you improperly set the Motor Overload Curve Selection (3929 hex) value too high, the Motor Coil Unit may burn. Check in the actual operating environment to be sure that no problem occurs due to heat generated by the motor or other causes before using the Servo Drive.

Additional Information

The overload time constant [s] depends on the linear motor. The standard overload level is 100%.

3-3   Cable and Connector Specifications

The specifications of the cables to connect Servo Drives are shown below. The information on the cable types are also provided.

3-3-1   Bend Radius of Robot Cable

If the cable is used at a moving part, use a robot cable.

For bend radius limit of robot cable, the wire rod with the durability of more than 20 million times of use is used.

Precautions for Correct Use

- As for the limit data of bend radius durability is reference only, use cables with margin.
- The data of the minimum bend radius indicates the number of cracks or scratches that occur on sheath through the functional flow, and does not cover the disconnection of shielded wire.
- Malfunction or grounding fault may be occurred by dielectric breakdown if cables are used with a smaller radius of the minimum bend radius.

Moving Flexural Testing

Stroke 750mm

Bend radius (R)

30 mm/s
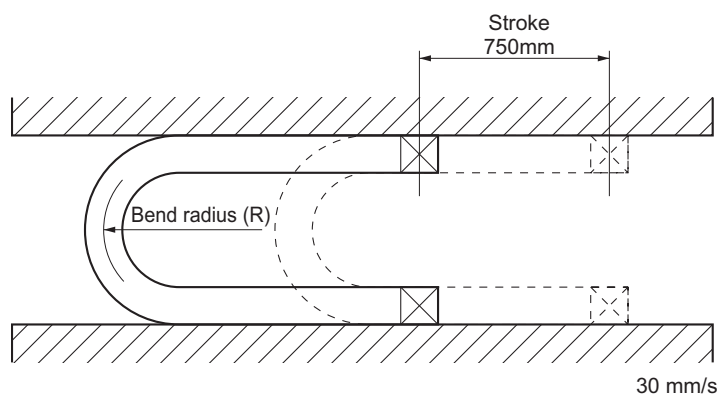
Note The following shows the stroke in some parts of the model.

R88A-CRK□	: 500mm
R88A-CAKA□SR	: 1000mm
R88A-CAKA□BR (3 to 20m)	: 1000mm

3-3-2   Connector Specifications

This section lists the specifications of the control I/O connector, power cable connector, external encoder connector, and safety I/O signal connector.

Control I/O Connector (R88A-CNW01C)

This is the connector to be connected to the drive's control I/O connector (CN1).

Use this connector when preparing a control cable by yourself.

● **Dimensions**

39

37.2

Connector plug model
10126-3000PE (Sumitomo 3M)
Connector case model
10326-52A0-008 (Sumitomo 3M)

t = 14
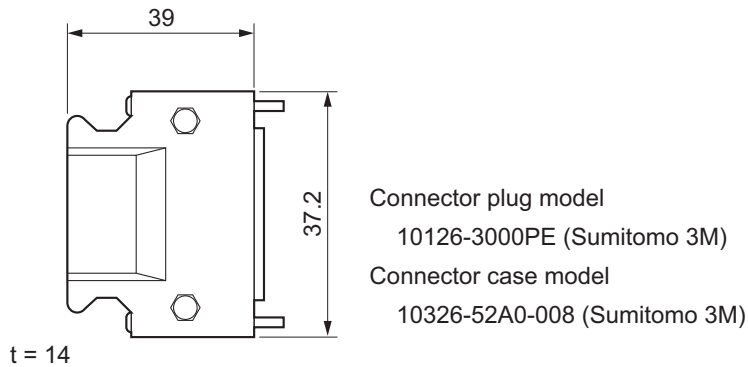
External Encoder Connector (R88A-CNK41L)

Use this connector to connect to an external encoder.

13.6
10.4
18.5
11.9
7.1
7.2

(42.5)
(10.5)
⌀6.8 MAX
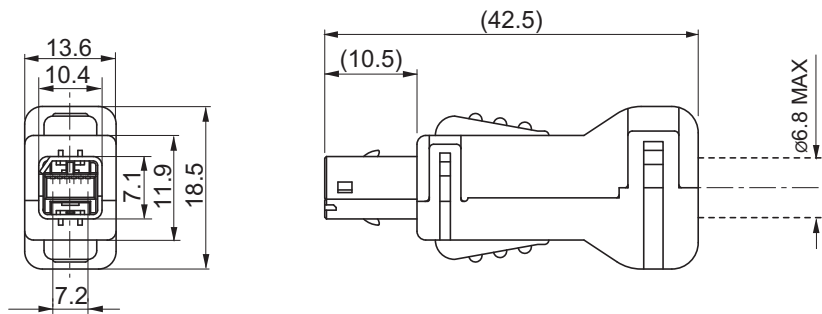
Connector plug model

MUF-PK10K-X (J.S.T. Mfg. Co., Ltd.)

● **Pin Arrangement**

View from Inserted Portion

10 9 8 7 6 5 4 3 2 1
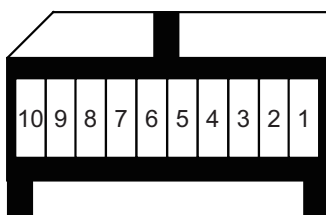
View from Soldered Housing Surface

1 3 5 7 9
2 4 6 8 10
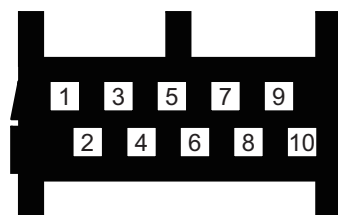
Safety I/O Signal Connector (R88A-CNK81S)

Use this connector to connect to a safety device.

Pin arrangement
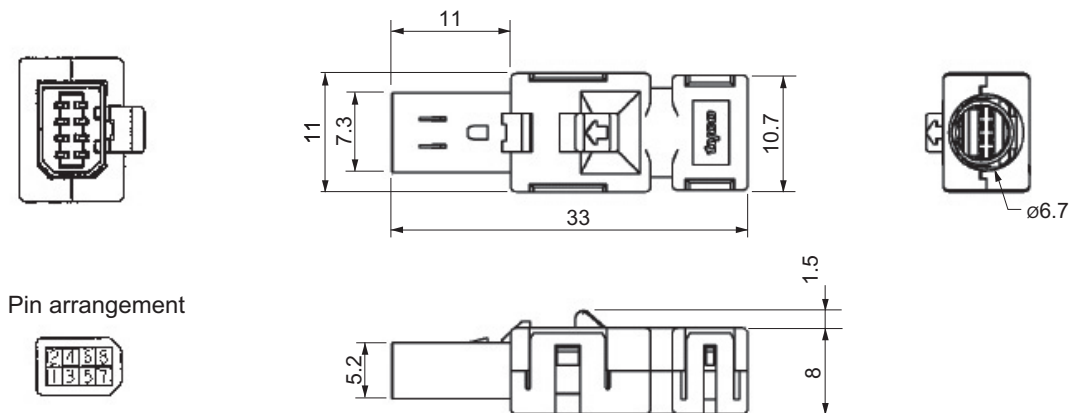
Note 1 The recommended cable is a 6-core shielded cable with a wire size of AWG30 to AWG26 and a finished outer diameter of 6.7 mm or less.

2 For information on wiring, refer to *Safety Connector Specifications (CN8)* on page 3-23.

3-3-3 EtherCAT Communications Cable Specifications

For the EtherCAT communications cable, use an Ethernet Category 5 (100BASE-TX) or higher twisted-pair cable (with double, aluminum tape and braided shielding).

Recommended cable is shown below.

Recommended Cable

Size x Number of cable cores (pairs)	Recommended manufacturer	Model
AWG24 x 4P	Tonichi kyosan Cable, Ltd.	NETSTAR-C5E SAB 0.5 × 4P
	Kuramo Electric Co.	KETH-SB
	SWCC Showa Cable Systems Co.	FAE-5004
AWG22 x 2P	Kuramo Electric Co.	KETH-PSB-OMR[1]

*1 It is recommended that you use this cable in combination with the OMRON XS6G-T421-1 connector.

Precautions for Correct Use

The maximum length between nodes is 100 m. However, some cables are specified for less than 100 m. Generally speaking, if the conductors are twisted wire rather than solid wire, transmission performance will be lower, and reliable communications may not be possible at 100 m. Confirm details with the cable manufacturer.

Additional Information

If an Ethernet cable of Ethernet Category 5 (100BASE-TX) or higher is used, communications will be possible even if the cable is not shielded. However, we recommend a cable with double, aluminum tape and braided shielding to ensure sufficient noise immunity.

Recommended Connector (Modular Plug)

Use a shielded connector of Ethernet Category 5 (100BASE-TX) or higher.

Recommended connector is shown below.

Size x Number of cable cores (pairs)	Recommended manufacturer	Model	Contacts
AWG24 x 4P	Panduit Corporation	MPS588	Panduit Corporation Japan Branch Osaka Sales Office
AWG22 x 2P	OMRON Corporation	XS6G-T421-1[*1]	OMRON Corporation Customer Support

*1   It is recommended that you use this connector in combination with the Kuramo Electric Co. KETH-PSB-OMR cable.

Precautions for Correct Use

When selecting a connector, confirm that it is applicable to the cable that will be used. Confirm the following items: Conductor size, conductor type (solid wire or twisted wire), number of twisted pairs (2 or 4), outer diameter, etc.

Attaching the Connectors to the Cable

Use straight wiring for the communications cable, as shown below.

Pin No.	Wire color		Wire color	Pin No.
1	White-Green		White-Green	1
2	Green		Green	2
3	White-Orange		White-Orange	3
4	Blue		Blue	4
5	White-Blue		White-Blue	5
6	Orange		Orange	6
7	White-Brown		White-Brown	7
8	Brown		Brown	8
Connector hood	Shield		Shield	Connector hood
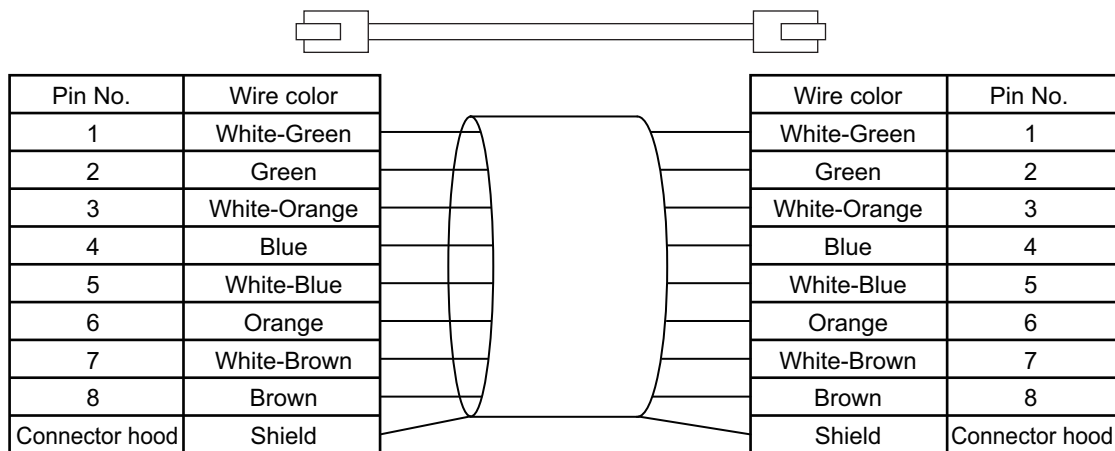
Note 1   Connect the cable shield to the connector hood at both ends of the cable.

2   There are two connection methods for Ethernet: T568A and T568B. The T568A connection method is shown above, but the T568B connection method can also be used.

Wiring

This example shows how to connect a CJ1W-NC281/NC481/NC881/NCF81/NC482/NC882/F82 Position Control Unit to Servo Drives using EtherCAT Communications Cables.

Connect the EtherCAT master to the ECAT IN connector on the first Servo Drive. Connect the ECAT OUT connector on the first Servo Drive to the ECAT IN connector on the next Servo Drive. Do not connect the ECAT OUT connector on the last Servo Drive.
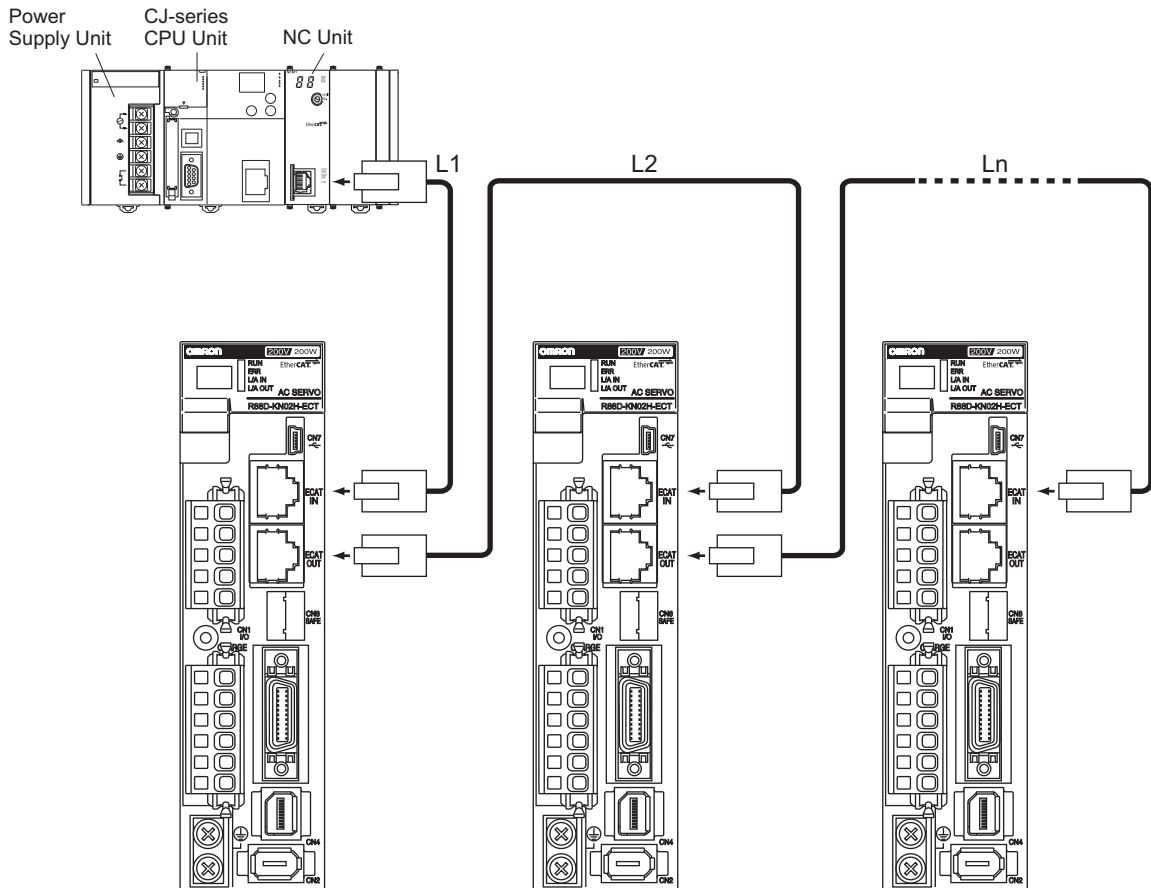
📖 Additional Information

- Always turn OFF the power supply to the Position Control Unit and Servo Drives before connecting or disconnecting the EtherCAT Communications Cables.
- The cable between the two nodes (L1, L2 ... Ln) must be 100 m or less.

3-3-4   Analog Monitor Cable Specifications

Analog Monitor Cable (R88A-CMK001S)

● **Connection Configuration and External Dimensions**

Symbol	No.	
SP	1	Red
IM	2	Black
GND	3	White
	4	
	5	
	6	Cable: AWG24×3C UL1007

Connector housing: 51004-0600 (Molex Japan)

Connector terminal: 50011-8000 (Molex Japan)

1000mm (1m)
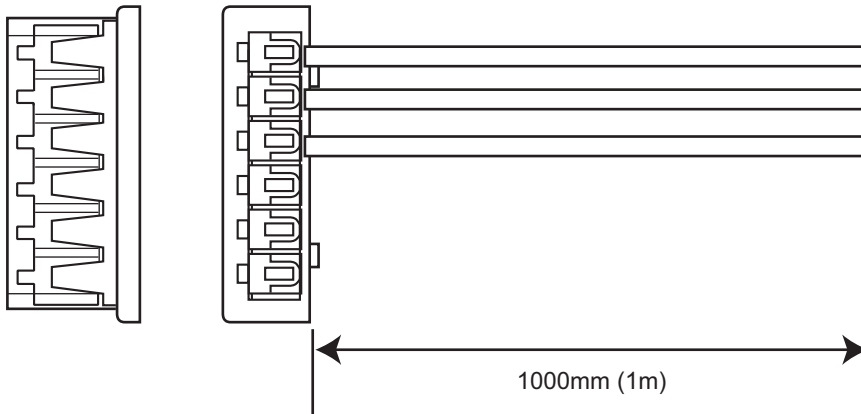
3-3-5   Control Cable Specifications

Cables for Servo Drives (XW2Z-□J-B34)

These cables connect to the connector terminal blocks on G5-series Servo Drives with Built-in EtherCAT Communications.

● **Cable Models**

Model	Length (L)	Outer diameter of sheath	Weight
XW2Z-100J-B34	1 m	8.8 dia.	Approx. 0.1 kg
XW2Z-200J-B34	2 m		Approx. 0.2 kg

● **Connection Configuration and Dimensions**

Connector-Terminal Block Conversion Unit side
XW2B-20G4
XW2B-20G5
XW2D-20G6

Servo Drive side
R88D- KN□

6   L   39   30   37.2   t = 14

● **Wiring**

Terminal block connector

Signal	No.
+24 V	1
0 V	2
+24 V	3
0 V	4
+24 V	5
0 V	6
STOP	7
DEC	8
POT	9
NOT	10
EXT1	11
EXT2	12
EXT3	13
BATGND	14
BAT	15
BKIRCOM	16
BKIR	17
ALMCOM	18
ALM	19
FG	20

Servo Drive connector (CN1)

No.	Signal
6	+24 VIN
5	STOP
9	DEC
7	POT
8	NOT
10	EXT1
11	EXT2
12	EXT3
15	BATGND
14	BAT
2	BKIRCOM
1	BKIR
4	ALMCOM
3	ALM
Shell	FG

Servo Drive Connector
  Connector plug:
    10126-3000PE (Sumitomo 3M)
  Connector case:
    10326-52A0-008 (Sumitomo 3M)

Terminal Block Connector
  Connector socket:
    XG4M-2030 (OMRON)
  Strain relief:
    XG4T-2004 (OMRON)

Cable
  AWG28 × 3P + AWG28 × 8C UL2464

* Before you use the Servo Drive, confirm that the signals of Servo Drive connector are set as shown above.

Connector-Terminal Block Conversion Unit (XW2B-20G□)

The Unit is used with a Connector Terminal Block Cable (XW2Z-□J-B34). They convert the control input signal (CN1) of the G5-series Servo Drive into a terminal block.

● **Terminal Block Models**

Model	Description
XW2B-20G4	M3 screw terminal block
XW2B-20G5	M3.5 screw terminal block
XW2D-20G6	M3 screw terminal block

● **XW2B-20G4**

Dimensions

Flat cable connector (MIL type plug)

Terminal block
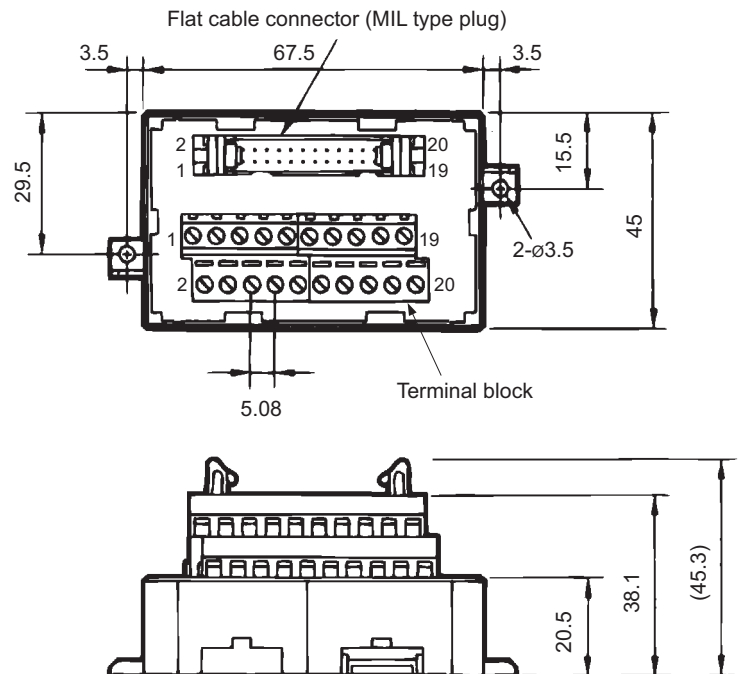
![Precautions icon]

Precautions for Correct Use

- Use 0.3 to 1.25 mm^2 wire (AWG22 to 16).
- The wire inlet of M3 screw terminal block is 1.8 mm (height) × 2.5 mm (width).
- Strip the insulation from the end of the wire for 6 mm as shown below.

6mm

● **XW2B-20G5**

Dimensions

Flat cable connector
(MIL type plug)

3.5   112.5   3.5

7   7

29.5   15.5   45

2   20
1   19

1   19
2   20

2-ø3.5

8.5   7.3   Terminal block

20.5   43.5   (45.3)
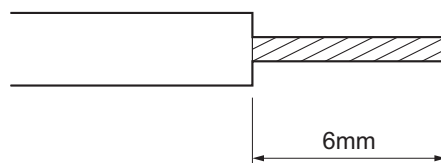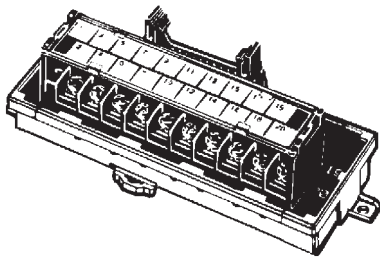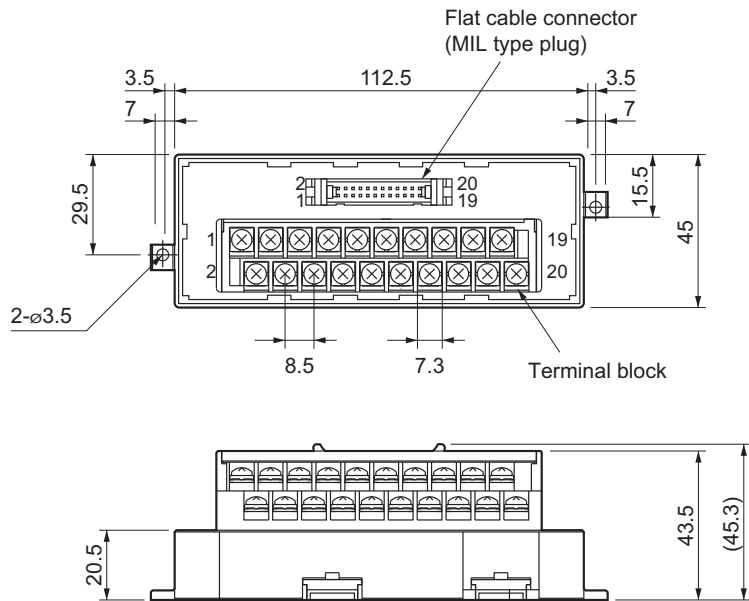
Note The pitch of terminals is 8.5 mm.

Precautions for Correct Use

• When using crimp terminals, use crimp terminals with the following dimensions.

Round terminal   Fork terminal

ø3.7mm

6.8mm max.   3.7mm   6.8mm max.
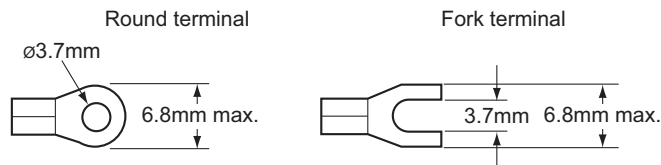
Applicable crimp terminals		Applicable wires
Round terminals	1.25 to 3	AWG22 to 16 (0.30 to 1.25 mm^2)
	2 to 3.5	AWG16 to 14 (1.25 to 2.0 mm^2)
Fork terminals	1.25Y to 3	AWG22 to 16 (0.30 to 1.25 mm^2)
	2 to 3.5	AWG16 to 14 (1.25 to 2.0 mm^2)

• When connecting wires and crimp terminals to a terminal block, tighten them to a tightening torque of 0.59 N·m.

● **XW2D-20G6**
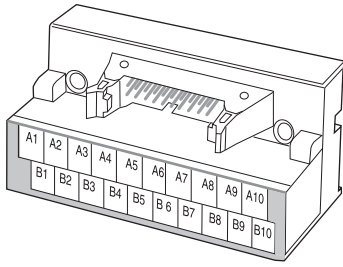
Dimensions
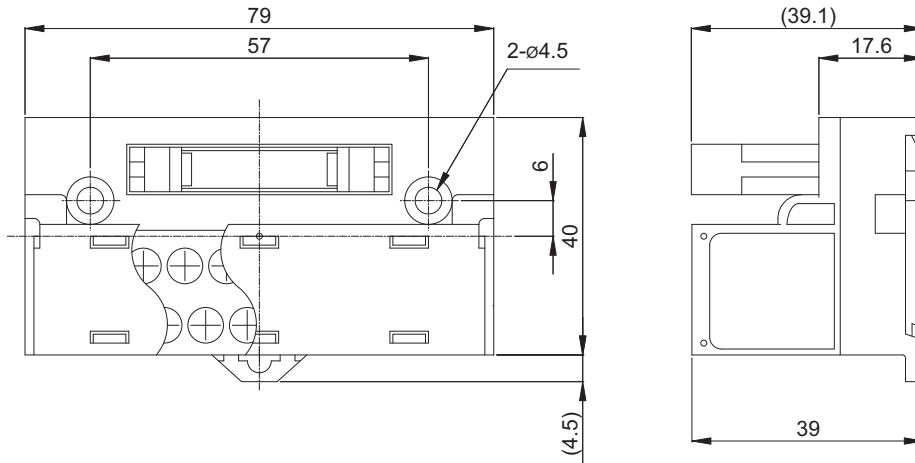
![Precautions icon] **Precautions for Correct Use**

• When using crimp terminals, use crimp terminals with the following dimensions.
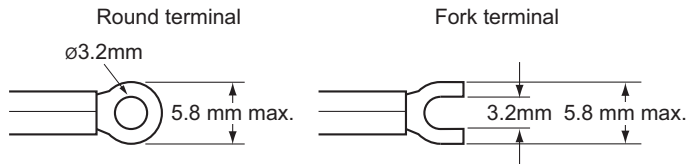
Applicable crimp terminals		Applicable wires
Round terminals	1.25 to 3	AWG22 to 16 (0.30 to 1.25 mm^2)
Fork terminals	1.25Y to 3	AWG22 to 16 (0.30 to 1.25mm^2)

• When connecting wires and crimp terminals to a terminal block, tighten them to a tightening torque of 0.7 N·m.

Terminal Block Wiring Example

The example is for the XW2B-20G4, XW2B-20G5, and XW2D-20G6.

+24V	+24V	+24V	STOP	POT	EXT1	EXT3		BKIR	ALM

*1

| | 0V | 0V | 0V | DEC | NOT | EXT2 | | BKIRCOM | ALMCOM | FG |

XB *2   X1

24 VDC   24 VDC
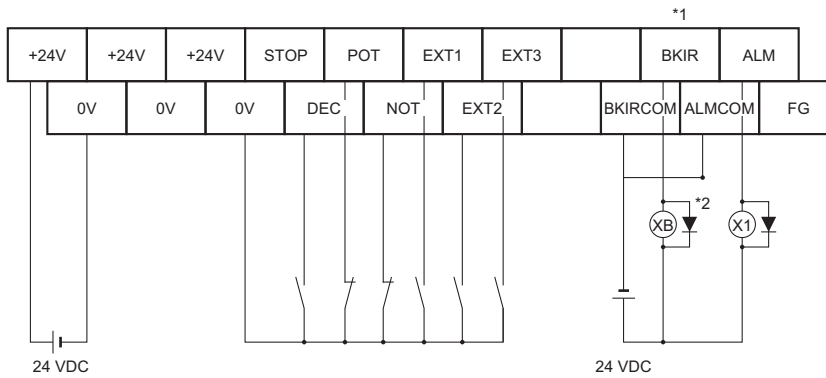
*1   Assign the brake interlock output (BKIR) to pin CN1-1.

*2   The XB contact is used to turn ON/OFF the electromagnetic brake.

3-4 External Regeneration Resistor Specifications

Five types of External Regeneration Resistors are available, as shown in the table below.

For how to calculate the amount of regeneration, refer to *4-4 Regenerative Energy Absorption* on page 4-51.

Model	Resistance value	Nominal capacity	Regeneration absorption for 120°C temperature rise	Heat radiation condition	Thermal switch output specifications
R88A-RR08050S	50 Ω	80 W	20 W	Aluminum 350 × 350, Thickness: 3.0	Operating temperature: 150°C ± 5% NC contact Rated output (resistive load) 125 VAC, 0.1 A max. 30 VDC, 0.1 A max. (minimum current: 1 mA)
R88A-RR080100S	100 Ω	80 W	20 W	Aluminum 350 × 350, Thickness: 3.0	Operating temperature: 150°C ± 5% NC contact Rated output (resistive load) 125 VAC, 0.1 A max. 30 VDC, 0.1 A max. (minimum current: 1 mA)
R88A-RR22047S	47 Ω	220 W	70 W	Aluminum 350 × 350, Thickness: 3.0	Operating temperature: 170°C ± 7°C NC contact Rated output (resistive load) 250 VAC, 3 A max.
R88A-RR22047S1	47 Ω	220 W	70 W	Aluminum 350 × 350, Thickness: 3.0	Operating temperature: 150°C ± 5% NC contact Rated output (resistive load) 250 VAC, 0.2 A max. 42 VDC, 0.2 A max. (minimum current: 1 mA)
R88A-RR50020S	20 Ω	500 W	180 W	Aluminum 600 × 600, Thickness: 3.0	Operating temperature: 200°C ± 7°C NC contact Rated output (resistive load): 250 VAC, 0.2 A max. 42 VDC, 0.2 A max. (minimum current: 1 mA)

3-5   Reactor Specifications

A Reactor is connected to the Servo Drive to suppress harmonic currents.

Select an appropriate Reactor for your Servo Drive model.

Servo Drive model	Reactor				
	Model	Rated current	Inductance	Weight	Reactor Type
R88D-KN01H-ECT-L (For single-phase input)	3G3AX-DL2002	1.6 A	21.4 mH	Approx. 0.8 kg	DC reactor
R88D-KN01L-ECT-L R88D-KN02H-ECT-L (For single-phase input)	3G3AX-DL2004	3.2 A	10.7 mH	Approx. 1.0 kg	
R88D-KN02L-ECT-L R88D-KN04H-ECT-L (For single-phase input)	3G3AX-DL2007	6.1 A	6.75 mH	Approx. 1.3 kg	
R88D-KN04L-ECT-L R88D-KN08H-ECT-L R88D-KN10H-ECT-L (For single-phase input)	3G3AX-DL2015	9.3 A	3.51 mH	Approx. 1.6 kg	
R88D-KN15H-ECT-L (For single-phase input)	3G3AX-DL2022	13.8 A	2.51 mH	Approx. 2.1 kg	
R88D-KN08H-ECT-L R88D-KN10H-ECT-L R88D-KN15H-ECT-L (For 3-phase input)	3G3AX-AL2025	10.0 A	2.8 mH	Approx. 2.8 kg	AC reactor
R88D-KN20H-ECT-L R88D-KN30H-ECT-L	3G3AX-AL2055	20.0 A	0.88 mH	Approx. 4.0 kg	
R88D-KN50H-ECT-L	3G3AX-AL2110	34.0 A	0.35 mH	Approx. 5.0 kg	
R88D-KN75H-ECT-L R88D-KN150H-ECT-L	3G3AX-AL2220	67.0 A	0.18 mH	Approx. 10.0 kg	
R88D-KN06F-ECT-L R88D-KN10F-ECT-L R88D-KN15F-ECT-L	3G3AX-AL4025	5.0 A	7.7 mH	Approx. 2.7 kg	
R88D-KN20F-ECT-L R88D-KN30F-ECT-L	3G3AX-AL4055	10.0 A	3.5 mH	Approx. 4.0 kg	
R88D-KN50F-ECT-L	3G3AX-AL4110	17.0 A	1.3 mH	Approx. 6.0 kg	
R88D-KN75F-ECT-L R88D-KN150F-ECT-L	3G3AX-AL4220	34.0 A	0.74 mH	Approx. 10.0 kg	

4

System Design

This section explains the installation conditions, wiring methods (including wiring conforming to EMC Directives), and regenerative energy calculation methods for the Servo Drive. It also explains the performance of External Regeneration Resistors.

4-1   Installation Conditions

This section describes the installation conditions for the Servo Drive.

Space Conditions around Servo Drives

Install the Servo Drives according to the dimensions shown in the following illustration to ensure proper dispersion of heat from inside the drives and convection inside the panel. If the drives are installed side by side, install a fan for air circulation to prevent uneven temperatures inside the panel.
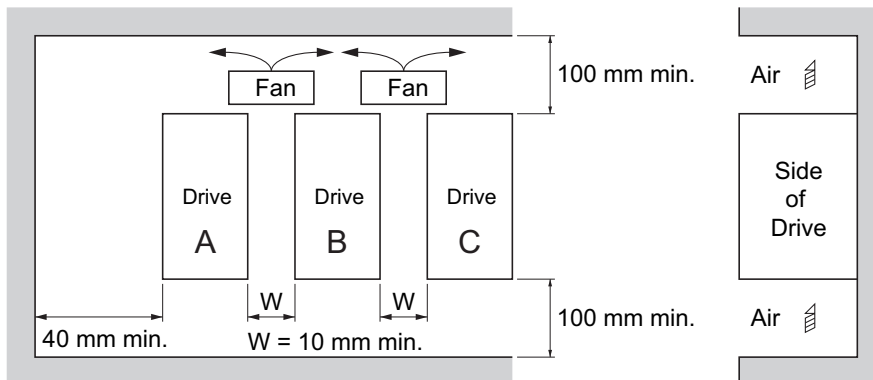
Capacity	Dimensions [mm]
100 W to 5 kW	More than 10 mm
7.5 kW / 15 kW	More than 50 mm

To provide electrical conduction, remove any paint from the surface on which you are installing G5-series Servo Drives.
Also, it is recommended that you apply conductive plating if you are making the mounting bracket yourself.

Mounting Direction

Mount the drive perpendicular on the panel so that the model number reads normally.

● Environment Operating Conditions

The environment in which drives are operated must meet the following conditions. Drives may malfunction if operated under any other conditions.

- Ambient operating temperature: 0 to 55°C (Take into account the following temperature rises in the individual drives themselves.)
- Operating humidity: 20 to 85% max. (with no condensation)
- Operating atmosphere: No corrosive gases.
- Altitude: 1,000 m max.

📝 **Additional Information**

Drives of 100 V or 200 V with a capacity of 750 W max. can be installed side by side with a 1-mm clearance (W in above illustration). However, the specifications for operating ambient temperature depends on the drive.

Drive A: 0 to 50°C

Drive B: 0 to 40°C

Drive C: 0 to 45°C

Ambient Temperature Control

- Operation in an environment in which there is minimal temperature rise is recommended to maintain a high level of reliability.

- When the drive is installed in a closed space, such as a box, the ambient temperature may rise due to temperature rise in each unit. Use a fan or air conditioner to prevent the drive's ambient temperature from exceeding 55°C.

- Drive surface temperatures may rise to as much as 30°C above the ambient temperature. Use heat-resistant materials for wiring, and provide a distance from any devices or wiring that are sensitive to heat.

- The service life of a Servo Drive is largely determined by the ambient temperature around the internal electrolytic capacitors. When an electrolytic capacitor reaches its limit, electrostatic capacity drops and internal resistance increases. This leads to overvoltage errors, malfunctioning due to noise, and damage to individual elements.

- If a drive is always operated at the ambient temperature of 55°C and with the rated force and rated speed, its life is expected to be approx. 28,000 hours (excluding the axial-flow fan). A drop of 10°C in the ambient temperature will double the expected life of the drive.

Keeping Foreign Objects Out of Units

- Place a cover over the drive or take other preventative measures to prevent foreign objects, such as drill filings, from getting into the drive during installation. Be sure to remove the cover after installation is complete. If the cover is left on during operation, drive's heat dissipation is blocked, which may result in malfunction.

- Take measures during installation and operation to prevent foreign objects such as metal particles, oil, machining oil, dust, or water from getting inside of the drives.

4-2   Wiring

This section provides information on the power supply, main circuit, and terminal blocks and other parts of the G5-series Servo Drives.

4-2-1   Peripheral Equipment Connection Examples

R88D-KN01L-ECT-L/-KN02L-ECT-L/-KN04L-ECT-L
R88D-KN01H-ECT-L/-KN02H-ECT-L/-KN04H-ECT-L/-KN08H-ECT-L/
R88D-KN10H-ECT-L/-KN15H-ECT-L (Single-phase Input)
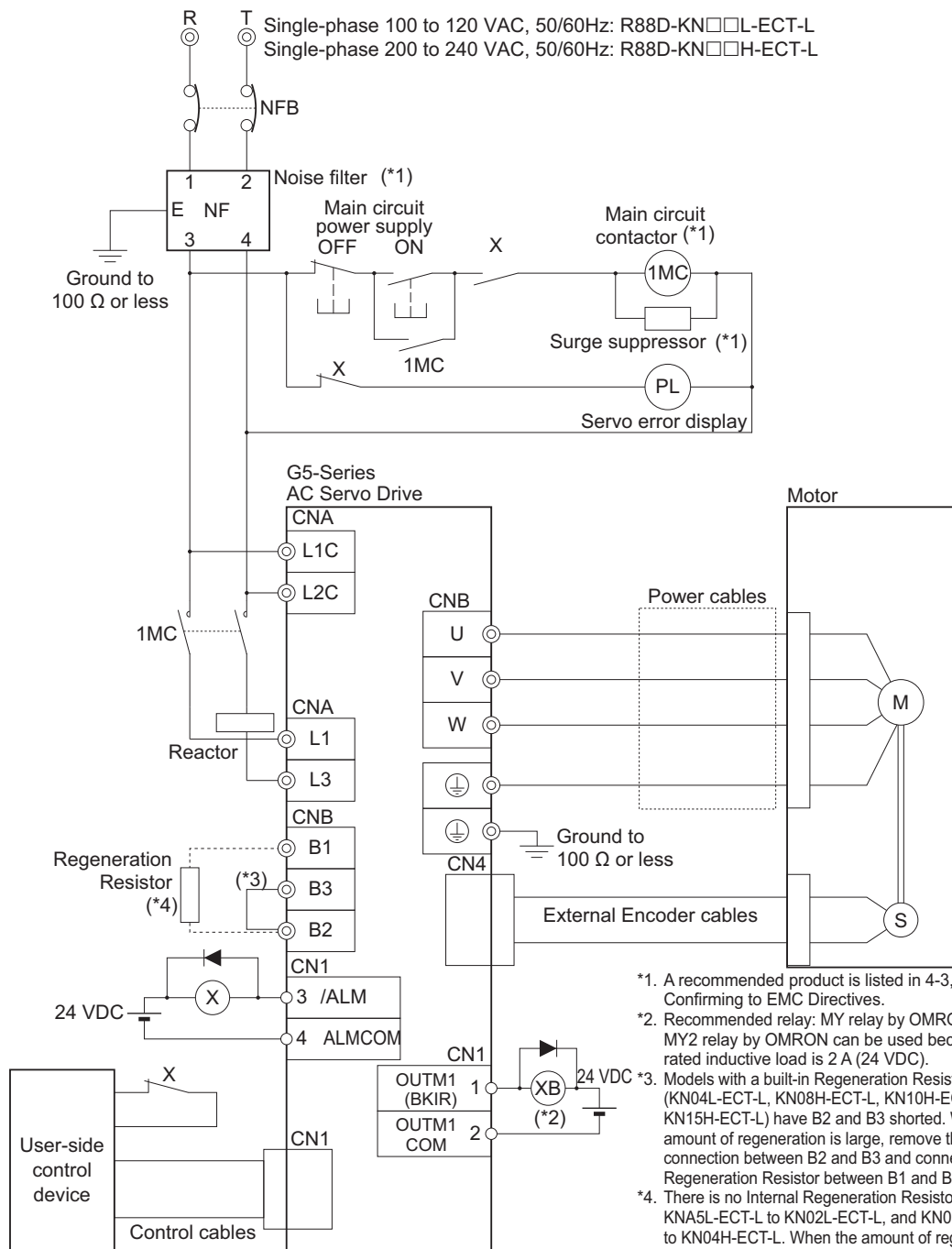
*1. A recommended product is listed in 4-3, Wiring Confirming to EMC Directives.
*2. Recommended relay: MY relay by OMRON (24-V) MY2 relay by OMRON can be used because its rated inductive load is 2 A (24 VDC).
*3. Models with a built-in Regeneration Resistor (KN04L-ECT-L, KN08H-ECT-L, KN10H-ECT-L and KN15H-ECT-L) have B2 and B3 shorted. When the amount of regeneration is large, remove the connection between B2 and B3 and connect a Regeneration Resistor between B1 and B2.
*4. There is no Internal Regeneration Resistor for KNA5L-ECT-L to KN02L-ECT-L, and KN01H-ECT-L to KN04H-ECT-L. When the amount of regeneration is large, connect the necessary Regeneration Resistor between B1 and B2.

R88D-KN01H-ECT-L/-KN02H-ECT-L/-KN04H-ECT-L/-KN08H-ECT-L/ -KN10H-ECT-L/-KN15H-ECT-L (3-phase Input)

R   S   T

3-phase 200 to 240 VAC, 50/60 Hz

NFB

Noise filter (*1)

1	2	3
E	NF	
4	5	6

Ground to 100 Ω or less

Main circuit power supply
OFF   ON   X

Main circuit contactor (*1)

1MC

Surge suppressor (*1)

1MC

X

PL

Servo error display

G5-Series AC Servo Drive

CNA

L1C

L2C

1MC

Reactor

CNA

L1

L2

L3

CNB

B1

Regeneration Resistor   (*3)   B3

B2

24 VDC   X   3   /ALM

4   ALMCOM

User-side control device

X

CN1

Control cables

CNB

U

V

W

Motor

Power cables

M

Ground to 100 Ω or less

CN4

External Encoder cables

S

CN1

OUTM1 (BKIR)   1

OUTM1 COM   2

XB   24 VDC

(*2)

*1. A recommended product is listed in 4-3, Wiring Confirming to EMC Directives.

*2. Recommended relay: MY relay by OMRON (24-V) MY2 relay by OMRON can be used for a rated inductive load of 2 A (24 VDC).

*3. Models with a built-in Regeneration Resistor (KN08H-ECT-L to KN15H-ECT-L) have B2 and B3 shorted. When the amount of regeneration is large, remove the connection between B2 and B3 and connect a Regeneration Resistor between B1 and B2.

R88D-KN20H-ECT-L

R S T

3-phase 200 to 230 VAC, 50/60 Hz

NFB

Noise filter (*1)

1 2 3
E NF
4 5 6

Ground to 100 Ω or less

Main circuit power supply OFF   ON

X

Main circuit contactor (*1)

1MC

Surge suppressor (*1)

X 1MC

PL

Servo error display

G5-Series AC Servo Drive

CNA
L1C
L2C

1MC

Reactor

CNA
L1
L2
L3

CNC
B1
Regeneration Resistor   (*3) B3
B2

CNB
U
V
W

Ground to 100 Ω or less

CN4

Power cables

Motor

M

S

External Encoder cables

CN1
X 3 /ALM
24 VDC 4 ALMCOM

User-side control device

X

CN1

CN1
BKIR 1   XB   24 VDC
BKIRCOM 2   (*2)

Control cables

*1. A recommended product is listed in 4-3, Wiring Confirming to EMC Directives.
*2. Recommended relay: MY relay by OMRON (24-V)
    MY2 relay by OMRON can be used for a rated inductive load of 2 A (24 VDC).
*3. Models with a built-in Regeneration Resistor (KN20H-ECT-L) have B2 and B3 shorted. When the amount of regeneration is large, remove the connection between B2 and B3 and connect a Regeneration Resistor between B1 and B2.

R88D-KN30H-ECT-L/-KN50H-ECT-L

R S T
3-phase 200 to 230 VAC, 50/60 Hz

NFB

Noise filter (*1)

1 2 3
E   NF
4 5 6

Ground to
100 Ω or less

Main circuit
power supply
OFF   ON   X

Main circuit
contactor (*1)

1MC

Surge suppressor (*1)

X   1MC

PL

Servo error display

G5-Series
AC Servo Drive

TB1

L1C

L2C

1MC

Reactor

TB1

L1

L2

L3

B1

Regeneration
Resistor   (*3)   B3

B2

CN1

X

24 VDC

3 /ALM

4 ALMCOM

User-side
control
device

X

CN1

Control cables

TB1

U

V

W

CN4

Motor

Power cables

M

Ground to
100 Ω or less

External Encoder cables

S

CN1

BKIR 1

BKIRCOM 2

XB
(*2)

24 VDC

*1. A recommended product is listed in 4-3,
    Wiring Confirming to EMC Directives.
*2. Recommended relay: MY relay by
    OMRON (24-V)
    MY2 relay by OMRON can be used for a
    rated inductive load of 2 A (24 VDC).
*3. Models with a built-in Regeneration
    Resistor (KN30H-ECT-L, KN50H-ECT-L)
    have B2 and B3 shorted. When the
    amount of regeneration is large, remove
    the connection between B2 and B3 and
    connect a Regeneration Resistor
    between B1 and B2.

R88D-KN75H-ECT-L

*1. A recommended product is listed in 4-3, Wiring Confirming to EMC Directives.
*2. Recommended relay: MY relay by OMRON (24-V)
MY2 relay by OMRON can be used for a rated inductive load of 2 A (24 VDC).
*3. When using an externally connected Dynamic Brake Resistor, remove the short bar from between DB3 and DB4.
*4. Provide auxiliary contacts to protect the system with an external sequence so that a Servo ON state will not occur due to deposition in the Dynamic Brake Resistor.
*5. A Dynamic Brake Resistor of 2 Ω, 180 W is built in. If the capacity is insufficient, use an external Dynamic Brake Resistor of 1.2 Ω, 400 W. Do not use the built-in resistor and an external resistor at the same time.
*6. Install an external protective device, such as a temperature fuse. Monitor the temperature of the external Dynamic Brake Resistor.

R88D-KN150H-ECT-L
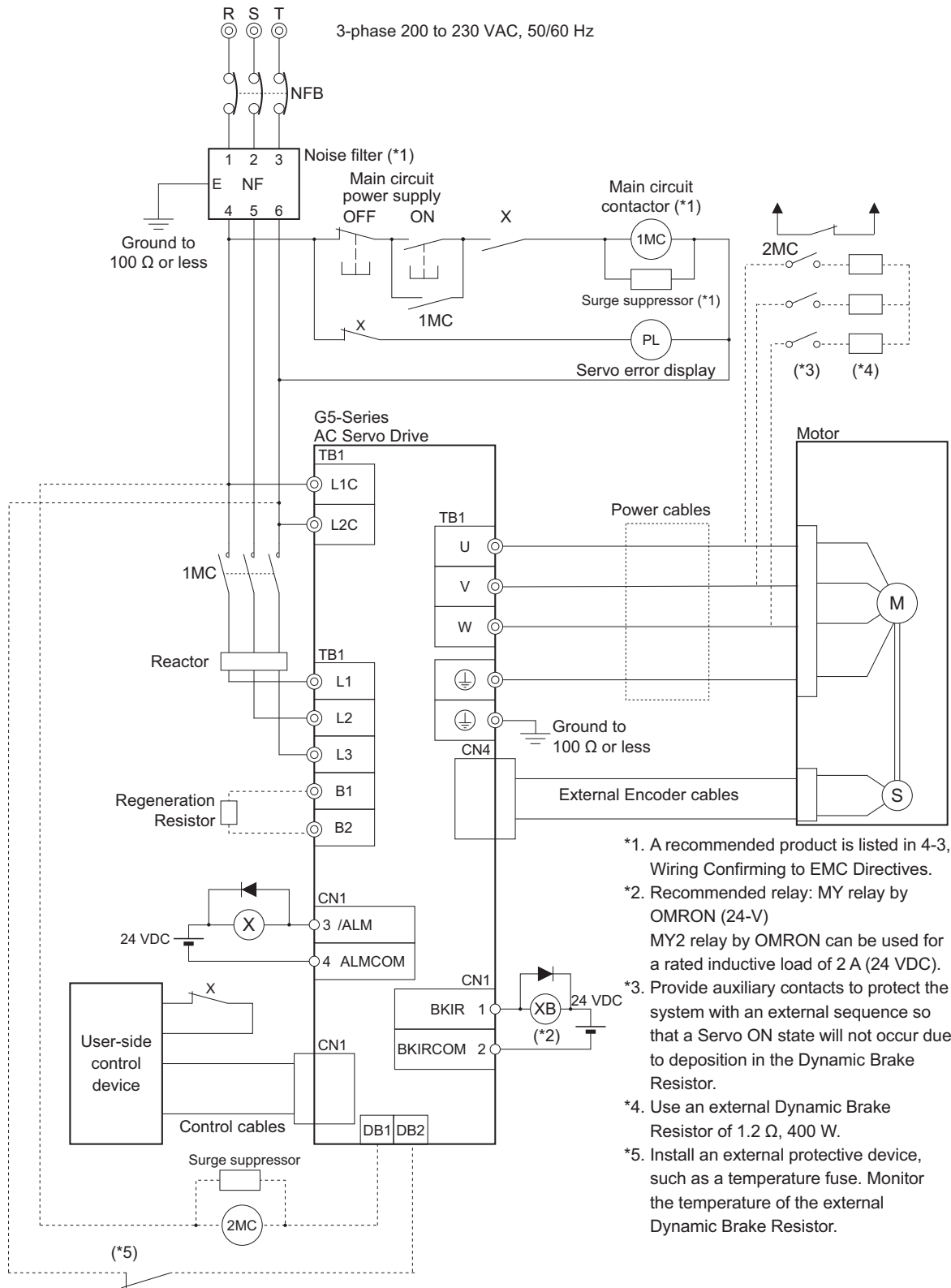
R S T

3-phase 200 to 230 VAC, 50/60 Hz

NFB

Noise filter (*1)

Main circuit power supply
OFF   ON   X

Main circuit contactor (*1)

1MC

2MC

Surge suppressor (*1)

1MC

PL

Servo error display

(*3)   (*4)

Ground to 100 Ω or less

G5-Series AC Servo Drive

Motor

TB1

L1C

L2C

TB1

Power cables

U

V

W

Ground to 100 Ω or less

1MC

Reactor

TB1

L1

L2

L3

CN4

External Encoder cables

M

S

Regeneration Resistor

B1

B2

24 VDC

X

CN1

3   /ALM

4   ALMCOM

CN1

BKIR   1

XB   24 VDC

(*2)

User-side control device

X

CN1

BKIRCOM   2

Control cables

DB1 DB2

Surge suppressor

2MC

(*5)

*1. A recommended product is listed in 4-3, Wiring Confirming to EMC Directives.

*2. Recommended relay: MY relay by OMRON (24-V)
MY2 relay by OMRON can be used for a rated inductive load of 2 A (24 VDC).

*3. Provide auxiliary contacts to protect the system with an external sequence so that a Servo ON state will not occur due to deposition in the Dynamic Brake Resistor.

*4. Use an external Dynamic Brake Resistor of 1.2 Ω, 400 W.

*5. Install an external protective device, such as a temperature fuse. Monitor the temperature of the external Dynamic Brake Resistor.

R88D-KN06F-ECT-L/-KN10F-ECT-L/-KN15F-ECT-L/-KN20F-ECT-L
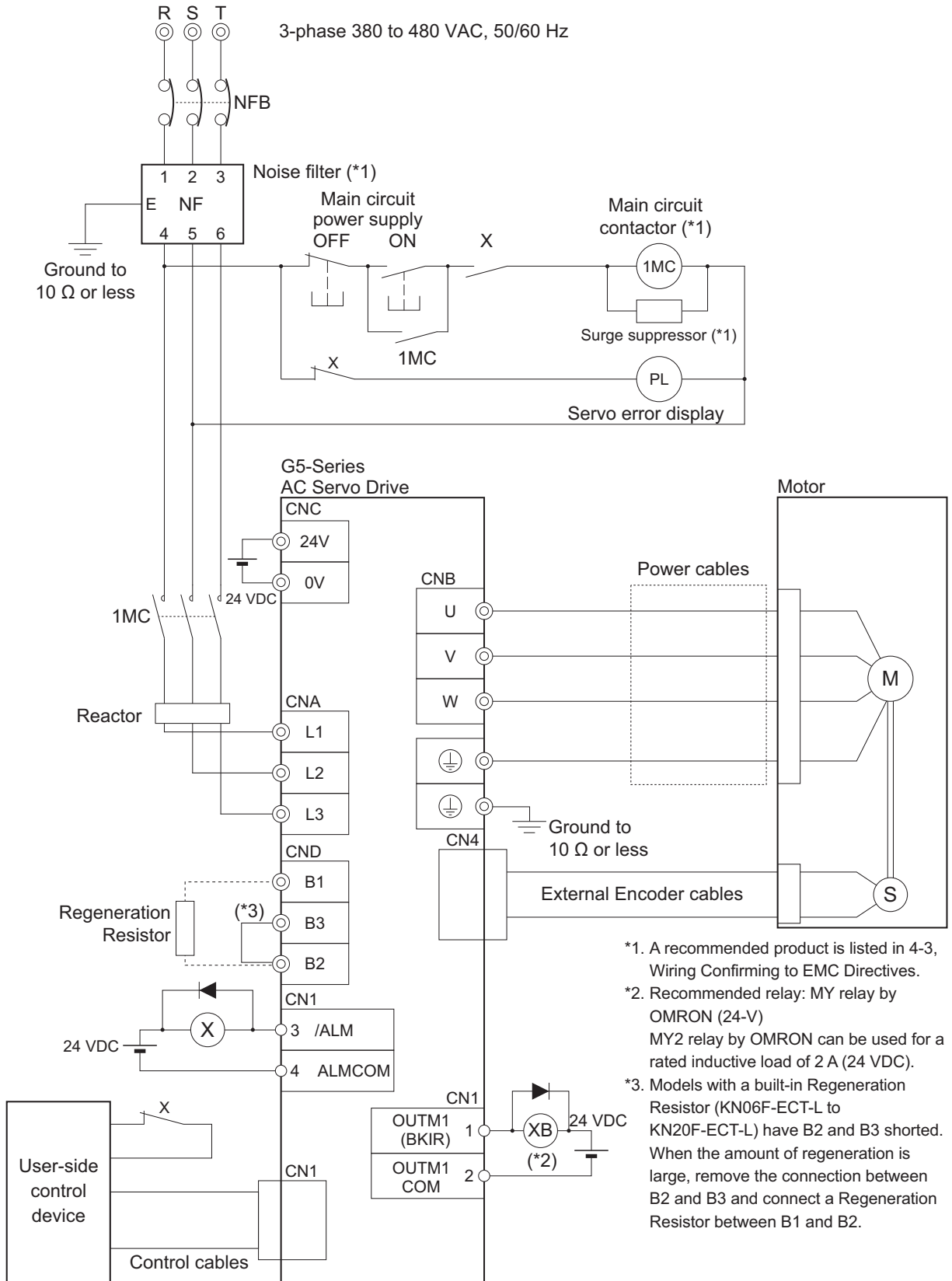
R S T
3-phase 380 to 480 VAC, 50/60 Hz

NFB

Noise filter (*1)

1 2 3
E   NF
4 5 6

Ground to
10 Ω or less

Main circuit
power supply
OFF   ON   X

Main circuit
contactor (*1)

1MC

Surge suppressor (*1)

X   1MC

PL

Servo error display

G5-Series
AC Servo Drive

CNC

24V

0V

24 VDC

1MC

Reactor

CNA

L1

L2

L3

CND

B1

Regeneration
Resistor

(*3)   B3

B2

CN1

24 VDC

X

3 /ALM

4   ALMCOM

User-side
control
device

X

CN1

Control cables

CNB

U

V

W

Power cables

Motor

M

Ground to
10 Ω or less

CN4

External Encoder cables

S

CN1

OUTM1
(BKIR)   1

XB   24 VDC

(*2)

OUTM1
COM   2

*1. A recommended product is listed in 4-3,
    Wiring Confirming to EMC Directives.
*2. Recommended relay: MY relay by
    OMRON (24-V)
    MY2 relay by OMRON can be used for a
    rated inductive load of 2 A (24 VDC).
*3. Models with a built-in Regeneration
    Resistor (KN06F-ECT-L to
    KN20F-ECT-L) have B2 and B3 shorted.
    When the amount of regeneration is
    large, remove the connection between
    B2 and B3 and connect a Regeneration
    Resistor between B1 and B2.

R88D-KN30F-ECT-L/-KN50F-ECT-L
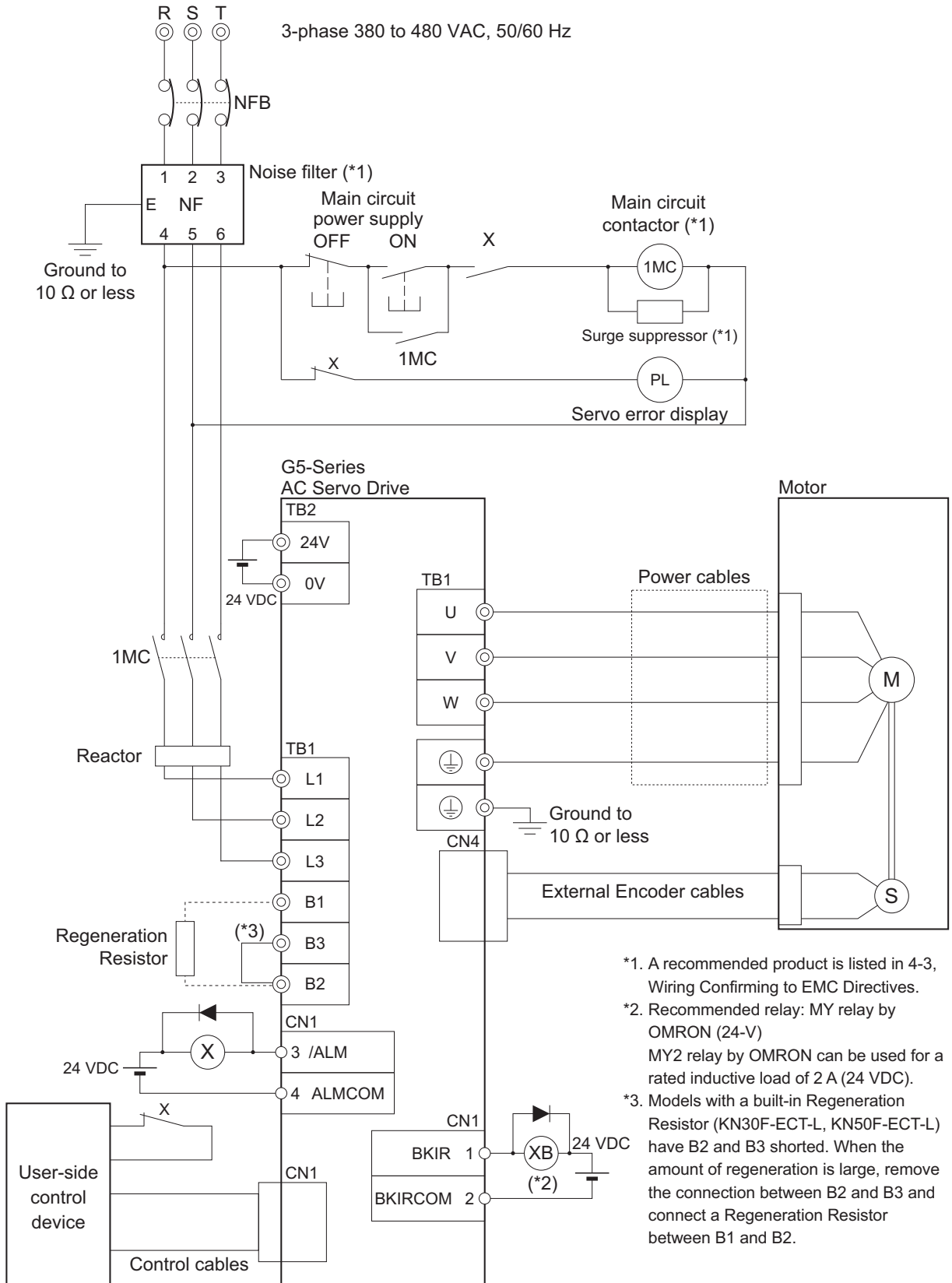
R S T

3-phase 380 to 480 VAC, 50/60 Hz

NFB

Noise filter (*1)

Main circuit
power supply
OFF ON X

Main circuit
contactor (*1)

1MC

Surge suppressor (*1)

1MC

X

PL

Servo error display

Ground to
10 Ω or less

G5-Series
AC Servo Drive

Motor

TB2

24V

0V

24 VDC

TB1

Power cables

U

V

W

Ground to
10 Ω or less

1MC

Reactor

TB1

L1

L2

L3

B1

B3

B2

CN4

External Encoder cables

M

S

Regeneration
Resistor

(*3)

CN1

3 /ALM

4 ALMCOM

24 VDC

X

X

User-side
control
device

CN1

CN1

BKIR 1

BKIRCOM 2

XB

(*2)

24 VDC

Control cables

*1. A recommended product is listed in 4-3,
    Wiring Confirming to EMC Directives.
*2. Recommended relay: MY relay by
    OMRON (24-V)
    MY2 relay by OMRON can be used for a
    rated inductive load of 2 A (24 VDC).
*3. Models with a built-in Regeneration
    Resistor (KN30F-ECT-L, KN50F-ECT-L)
    have B2 and B3 shorted. When the
    amount of regeneration is large, remove
    the connection between B2 and B3 and
    connect a Regeneration Resistor
    between B1 and B2.

R88D-KN75F-ECT-L

*1. A recommended product is listed in 4-3, Wiring Confirming to EMC Directives.
*2. Recommended relay: MY relay by OMRON (24-V)
MY2 relay by OMRON can be used for a rated inductive load of 2 A (24 VDC).
*3. When using an externally connected Dynamic Brake Resistor, remove the short bar from between DB3 and DB4.
*4. Provide auxiliary contacts to protect the system with an external sequence so that a Servo ON state will not occur due to deposition in the Dynamic Brake Resistor.
*5. A Dynamic Brake Resistor of 8 Ω, 180 W is built in. If the capacity is insufficient, use an external Dynamic Brake Resistor of 4.8 Ω, 400 W. Do not use the built-in resistor and an external resistor at the same time.
*6. Wire the circuit so that the voltage between DB1 and DB2 is 400 VAC or less. Install an external protective device, such as a temperature fuse. Monitor the temperature of the external Dynamic Brake Resistor.

R88D-KN150F-ECT-L

*1. A recommended product is listed in 4-3, Wiring Confirming to EMC Directives.

*2. Recommended relay: MY relay by OMRON (24-V)
MY2 relay by OMRON can be used for a rated inductive load of 2 A (24 VDC).

*3. Provide auxiliary contacts to protect the system with an external sequence so that a Servo ON state will not occur due to deposition in the Dynamic Brake Resistor.

*4. Use an external Dynamic Brake Resistor of 4.8 Ω, 400 W.

*5. Wire the circuit so that the voltage between DB1 and DB2 is 400 VAC or less.
Install an external protective device, such as a temperature fuse. Monitor the temperature of the external Dynamic Brake Resistor.

4-2-2   Main Circuit and Linear Motor Connections

When wiring the main circuit, use proper wire sizes, grounding systems, and noise resistance.

R88D-KN01L-ECT-L/-KN02L-ECT-L/ R88D-KN01H-ECT-L/-KN02H-ECT-L/-KN04H-ECT-L

● **Main Circuit Connector Specifications (CNA)**

Symbol	Name	Function
L1	Main circuit power supply input[1]	R88D-KN□L-ECT-L 100 to 200 W : Single-phase 100 to 120 VAC (85 to 132 VAC) 50/60 Hz
L2		R88D-KN□H-ECT-L 100 W to 400 W : Single-phase or 3-phase 200 to 240 VAC (170 to 264 VAC) 50/60 Hz
L3		
L1C	Control circuit power supply input	R88D-KN□L-ECT-L : Single-phase 100 to 120 VAC (85 to 132 VAC) 50/60Hz
L2C		R88D-KN□H-ECT-L : Single-phase 200 to 240 VAC (170 to 264 VAC) 50/60 Hz

*1   Single-phase should connect to L1 and L3.

● **Motor Connector Specifications (CNB)**

Symbol	Name	Function	
B1	External Regeneration Resistor connection terminals[1]	Normally B2 and B3 are open. If there is high regenerative energy, connect an External Regeneration Resistor between B1 and B2.	
B3			
B2			
U	Motor connection terminals	Phase U	These are the output terminals to the Linear Motor.
V		Phase V	Be sure to wire them correctly.
W		Phase W	
⏚	Frame ground	This is the ground terminal. Ground to 100 Ω or less.	

*1   Do not short B1 and B2. Doing so may result in malfunctioning.

📝 **Precautions for Correct Use**

- Tighten the frame ground screw to a torque of 0.7 to 0.8 N·m (M4).
- If you are connecting an External Regeneration Resistor, set the Regeneration Resistor Selection servo parameter object (3016 hex).

R88D-KN04L-ECT-L
R88D-KN08H-ECT-L/-KN10H-ECT-L/-KN15H-ECT-L

● Main Circuit Connector Specifications (CNA)

Symbol	Name	Function
L1	Main circuit power supply input[1]	R88D-KN□L-ECT-L (400 W) : Single-phase 100 to 120 VAC (85 to 132 VAC) 50/60 Hz
L2		R88D-KN□H-ECT-L (750 W to 1.5 kW) : Single-phase 200 to 240 VAC (170 to 264 VAC) 50/60 Hz
L3		
L1C	Control circuit power supply input	R88D-KN□L-ECT-L : Single-phase 100 to 120 VAC (85 to 132 VAC) 50/60 Hz
L2C		R88D-KN□H-ECT-L : Single-phase 200 to 240 VAC (170 to 264 VAC) 50/60 Hz

*1   Single-phase should connect to L1 and L3.

● Motor Connector Specifications (CNB)

Symbol	Name	Function	
B1	External Regeneration Resistor connection terminals[1]	Normally short B2 and B3. If there is high regenerative energy, remove the short-circuit bar between B2 and B3 and connect an External Regeneration Resistor between B1 and B2.	
B3			
B2			
U	Motor connection terminals	Phase U	These are the output terminals to the Linear Motor.
V		Phase V	Be sure to wire them correctly.
W		Phase W	
⏚	Frame ground	This is the ground terminal. Ground to 100 Ω or less.	

*1   Do not short B1 and B2. Doing so may result in malfunctioning.

Precautions for Correct Use

- Tighten the frame ground screw to a torque of 0.7 to 0.8 N·m (M4).
- If you are connecting an External Regeneration Resistor, set the Regeneration Resistor Selection servo parameter object (3016 hex).

R88D-KN20H-ECT-L

● Main Circuit Connector Specifications (CNA)

Symbol	Name	Function
L1	Main circuit power supply input	3-phase: 200 to 230 VAC (170 to 253 VAC) 50/60 Hz
L2		
L3		
L1C	Control circuit power supply input	Single-phase 200 to 230 VAC (170 to 253 VAC) 50/60 Hz
L2C		

● Motor Connector Specifications (CNB)

Symbol	Name	Function	
U	Motor connection terminals	Phase U	These are the output terminals to the Linear Motor. Be sure to wire them correctly.
V		Phase V	
W		Phase W	
⏚	Frame ground	This is the ground terminal. Ground to 100 Ω or less.	

● External Regeneration Resistor Connector Specifications (CNC)

Symbol	Name	Function
B1	External Regeneration Resistor connection terminals[*1]	Normally short B2 and B3. If there is high regenerative energy, remove the short-circuit bar between B2 and B3 and connect an External Regeneration Resistor between B1 and B2.
B3		
B2		
NC	Do not connect.	

*1   Do not short B1 and B2. Doing so may result in malfunctioning.

Precautions for Correct Use

- Tighten the frame ground screw to a torque of 0.7 to 0.8 N·m (M4).
- If you are connecting an External Regeneration Resistor, set the Regeneration Resistor Selection servo parameter object (3016 hex).
- Do not connect any External Regeneration Resistors between B1 and NC.

R88D-KN30H-ECT-L/-KN50H-ECT-L

● Terminal Block Specifications

Symbol	Name	Function		
L1	Main circuit power supply input	3-phase 200 to 230 VAC (170 to 253 VAC) 50/60 Hz		
L2				
L3				
L1C	Control circuit power supply input	Single-phase 200 to 230 VAC (170 to 253 VAC) 50/60 Hz		
L2C				
B1	External Regeneration Resistor connection terminals[*1]	Normally short B2 and B3. If there is high regenerative energy, remove the short-circuit bar between B2 and B3 and connect an External Regeneration Resistor between B1 and B2.		
B3				
B2				
NC	Do not connect.			
U	Motor connection terminals	Phase U	These are the output terminals to the Linear Motor.	
V		Phase V	Be sure to wire them correctly.	
W		Phase W		
⏚	Frame ground	This is the ground terminal. Ground to 100 Ω or less.		

*1 Do not short B1 and B2. Doing so may result in malfunctioning.

Precautions for Correct Use

- Tighten the frame ground screw to a torque of 1.4 to 1.6 N·m (M5).
- Tighten the terminal block screws to a torque of 1.0 to 1.7 N·m (M5). Exceeding the maximum allowable torque for terminal block screws may cause damage to the terminal block.
- Tighten the fixing screw of the terminal block cover to a torque of 0.19 to 0.21 N·m (M3).
- If you are connecting an External Regeneration Resistor, set the Regeneration Resistor Selection servo parameter object (3016 hex).
- Do not connect any External Regeneration Resistors between B1 and NC.

R88D-KN75H-ECT-L

● Terminal Block Specifications, Left Terminal Block (TB1)

Symbol	Name	Function		
L1	Main circuit power supply input	3-phase 200 to 230 VAC (170 to 253 VAC) 50/60 Hz		
L2				
L3				
B1	External Regeneration Resistor connection terminals	Connect an External Regeneration Resistor between B1 and B2.		
B2				
NC	Do not connect.			
U	Motor connection terminals	Phase U	These are the output terminals to the Linear Motor.	
V		Phase V	Be sure to wire them correctly.	
W		Phase W		

● Terminal Block Specifications, Right Terminal Block (TB2)

Symbol	Name	Function
L1C	Control circuit power supply input	Single-phase 200 to 230 VAC (170 to 253 VAC) 50/60 Hz
L2C		
DB1	Dynamic Brake Resistor control terminals	These terminals are used to control the MC for externally connected dynamic brake resistance. The output contact specifications are 1 A max. at 300 VAC/100 VDC max.
DB2		Connect them if required.
DB3		Normally DB3 and DB4 are shorted.
DB4		When using an externally connected Dynamic Brake Resistor, remove the short bar from between DB3 and DB4.
⏚	Frame ground	This is the ground terminal. Ground it to 100 Ω or less.
NC	Do not connect.	

🖘 Precautions for Correct Use

- Tighten the frame ground screw to a torque of 1.4 to 1.6 N·m (M5).
- Tighten the left terminal block screws to a torque of 2.0 to 2.4 N·m (M5). Exceeding the maximum allowable torque for terminal block screws may cause damage to the terminal block.
- Tighten the fixing screw of the left terminal block cover to a torque of 0.3 to 0.5 N·m (M3).
- Tighten the right terminal block screws to a torque of 1.0 to 1.7 N·m (M5). Exceeding the maximum allowable torque for terminal block screws may cause damage to the terminal block.
- Tighten the fixing screw of the right terminal block cover to a torque of 0.19 to 0.21 N·m (M3).
- If you are connecting an External Regeneration Resistor, set the Regeneration Resistor Selection servo parameter object (3016 hex).
- Do not connect any External Regeneration Resistors between B1 and NC.

R88D-KN150H-ECT-L

● Terminal Block Specifications, Top Terminal Block (TB1)

Symbol	Name	Function
L1C	Control circuit power supply input	Single-phase 200 to 230 VAC (170 to 253 VAC) 50/60 Hz
L2C		
DB1	Dynamic Brake Resistor control terminals	These terminals are used to control the MC for externally connected dynamic brake resistance. The output contact specifications are 1 A max. at 300 VAC/100 VDC max.
DB2		Connect them if required.

● Terminal Block Specifications, Bottom Terminal Block (TB2)

Symbol	Name	Function		
L1	Main circuit power supply input	3-phase 200 to 230 VAC (170 to 253 VAC) 50/60 Hz		
L2				
L3				
B1	External Regeneration Resistor connection terminals	Connect an External Regeneration Resistor between B1 and B2.		
B2				
NC	Do not connect.			
U	Motor connection terminals	Phase U	These are the output terminals to the Linear Motor.	
V		Phase V	Be sure to wire them correctly.	
W		Phase W		
⏚	Frame ground	This is the ground terminal. Ground to 100 Ω or less.		

☑ Precautions for Correct Use

- Tighten the frame ground screw to a torque of 2.4 to 2.6 N·m (M6).
- Tighten the top terminal block screws to a torque of 0.7 to 1.0 N·m (M4). Exceeding the maximum allowable torque for terminal block screws may cause damage to the terminal block.
- Tighten the bottom terminal block screws to a torque of 2.2 to 2.5 N·m (M6). Exceeding the maximum allowable torque for terminal block screws may cause damage to the terminal block.
- Tighten the fixing screw of the terminal block cover to a torque of 2.0 to 2.5 N·m (M5).
- If you are connecting an External Regeneration Resistor, set the Regeneration Resistor Selection servo parameter object (3016 hex).
- Do not connect any External Regeneration Resistors between B1 and NC.

R88D-KN06F-ECT-L/-KN10F-ECT-L/-KN15F-ECT-L/-KN20F-ECT-L

● **Main Circuit Connector Specifications (CNA)**

Symbol	Name	Function
L1	Main circuit power supply input	3-phase: 380 to 480 VAC (323 to 528 VAC) 50/60 Hz
L2		
L3		

● **Motor Connector Specifications (CNB)**

Symbol	Name	Function	
U	Motor connection terminals	Phase U	These are the output terminals to the Linear Motor.
V		Phase V	Be sure to wire them correctly.
W		Phase W	
⏚	Frame ground	This is the ground terminal. Ground to 100 Ω or less.	

> **Precautions for Correct Use**
>
> • Tighten the frame ground screw to a torque of 0.7 to 0.8 N·m (M4).

● **Control Circuit Connector Specifications (CNC)**

Symbol	Name	Function
24 V	Control circuit power supply input	24 VDC (20.4 to 27.6 VDC)
0 V		

● **External Regeneration Resistor Connector Specifications (CND)**

Symbol	Name	Function
B1	External Regeneration Resistor connection terminals[*1]	Normally short B2 and B3.
B3		If there is high regenerative energy, remove the short-circuit bar between B2 and B3 and connect an External Regeneration Resistor between B1 and B2.
B2		
NC	Do not connect.	

*1 Do not short B1 and B2. Doing so may result in malfunctioning.

> **Precautions for Correct Use**
>
> • If you are connecting an External Regeneration Resistor, set the Regeneration Resistor Selection servo parameter object (3016 hex).
> • Do not connect any External Regeneration Resistors between B1 and NC.

R88D-KN30F-ECT-L/-KN50F-ECT-L

● Control Circuit Terminal Block Specifications (TB1)

Symbol	Name	Function
24 V	Control circuit power supply input	24 VDC (20.4 to 27.6 VDC)
0 V		

● Main Circuit Terminal Block Specifications (TB2)

Symbol	Name	Function	
L1	Main circuit power supply input	3-phase 380 to 480 VAC (323 to 528 VAC) 50/60 Hz	
L2			
L3			
B1	External Regeneration Resistor connection terminals[1]	Normally short B2 and B3.	
B3		If there is high regenerative energy, remove the short-circuit bar between B2 and B3 and connect an External Regeneration Resistor between B1 and B2.	
B2			
NC	Do not connect.		
U	Motor connection terminals	Phase U	These are the output terminals to the Linear Motor.
V		Phase V	Be sure to wire them correctly.
W		Phase W	
⏚	Frame ground	This is the ground terminal. Ground to 100 Ω or less.	

*1   Do not short B1 and B2. Doing so may result in malfunctioning.

Precautions for Correct Use

- Tighten the frame ground screw to a torque of 1.4 to 1.6 N·m (M5).
- Tighten the 24 V terminal block screws to a torque of 0.4 to 0.6 N·m (M3).
- Tighten the terminal block screws to a torque of 0.7 to 1.0 N·m (M4). Exceeding the maximum allowable torque for terminal block screws may cause damage to the terminal block.
- Tighten the fixing screw of the terminal block cover to a torque of 0.19 to 0.21 N·m (M3).
- If you are connecting an External Regeneration Resistor, set the Regeneration Resistor Selection servo parameter object (3016 hex).
- Do not connect any External Regeneration Resistors between B1 and NC.

R88D-KN75F-ECT-L

● Terminal Block Specifications, Left Terminal Block (TB1)

Symbol	Name	Function	
L1	Main circuit power supply input	3-phase 380 to 480 VAC (323 to 528 VAC) 50/60 Hz	
L2			
L3			
B1	External Regeneration Resistor connection terminals	Connect an External Regeneration Resistor between B1 and B2.	
B2			
NC	Do not connect.		
U	Motor connection terminals	Phase U	These are the output terminals to the Linear Motor.
V		Phase V	Be sure to wire them correctly.
W		Phase W	
⏚	Frame ground	This is the ground terminal. Ground to 100 Ω or less.	

● Terminal Block Specifications, Right Terminal Block (TB2)

Symbol	Name	Function
24 V	Control circuit power supply input	24 VDC (20.4 to 27.6 VDC)
0 V		
DB1	Dynamic Brake Resistor control terminals	These terminals are used to control the MC for externally connected dynamic brake resistance. The output contact specifications are 1 A max. at 300 VAC/100 VDC max.
DB2		Connect them if required.
DB3		Normally DB3 and DB4 are shorted.
DB4		When using an externally connected Dynamic Brake Resistor, remove the short bar from between DB3 and DB4.
⏚	Frame ground	This is the ground terminal. Ground to 100 Ω or less.
NC	Do not connect.	

📝 **Precautions for Correct Use**

- Tighten the frame ground screw to a torque of 1.4 to 1.6 N·m (M5).
- Tighten the left terminal block screws to a torque of 2.0 to 2.4 N·m (M5). Exceeding the maximum allowable torque for terminal block screws may cause damage to the terminal block.
- Tighten the fixing screw of the left terminal block cover to a torque of 0.3 to 0.5 N·m (M3).
- Tighten the right terminal block screws to a torque of 1.0 to 1.7 N·m (M5). Exceeding the maximum allowable torque for terminal block screws may cause damage to the terminal block.
- Tighten the fixing screw of the right terminal block cover to a torque of 0.19 to 0.21 N·m (M3).
- If you are connecting an External Regeneration Resistor, set the Regeneration Resistor Selection servo parameter object (3016 hex).
- Do not connect any External Regeneration Resistors between B1 and NC.

R88D-KN150F-ECT-L

● Terminal Block Specifications, Top Terminal Block (TB1)

Symbol	Name	Function
24 V	Control circuit power supply input	24 VDC (20.4 to 27.6 VDC)
0 V		
DB1	Dynamic Brake Resistor control terminals	These terminals are used to control the MC for externally connected dynamic brake resistance. The output contact specifications are 1 A max. at 300 VAC/100 VDC max.
DB2		Connect them if required.

● Terminal Block Specifications, Bottom Terminal Block (TB2)

Symbol	Name	Function		
L1	Main circuit power supply input	3-phase 380 to 480 VAC (323 to 528 VAC) 50/60 Hz		
L2				
L3				
B1	External Regeneration Resistor connection terminals	Connect an External Regeneration Resistor between B1 and B2.		
B2				
NC	Do not connect.			
U	Motor connection terminals	Phase U	These are the output terminals to the Linear motor.	
V		Phase V	Be sure to wire them correctly.	
W		Phase W		
⏚	Frame ground	This is the ground terminal. Ground to 100 Ω or less.		

✍ Precautions for Correct Use

- Tighten the frame ground screw to a torque of 2.4 to 2.6 N·m (M6).
- Tighten the top terminal block screws to a torque of 0.7 to 1.0 N·m (M4). Exceeding the maximum allowable torque for terminal block screws may cause damage to the terminal block.
- Tighten the bottom terminal block screws to a torque of 2.2 to 2.5 N·m (M6). Exceeding the maximum allowable torque for terminal block screws may cause damage to the terminal block.
- Tighten the fixing screw of the terminal block cover to a torque of 2.0 to 2.5 N·m (M5).
- If you are connecting an External Regeneration Resistor, set the Regeneration Resistor Selection servo parameter object (3016 hex).
- Do not connect any External Regeneration Resistors between B1 and NC.

4-2-3   Terminal Block Wire Sizes

This section describes the recommended size of wire to be connected to the terminal blocks.

100-VAC Input Drive Wire Sizes

The terminal block wire sizes used for 100-VIC input Servo Drive models are as shown below.

Model (R88D-)			KN01L-ECT-L	KN02L-ECT-L	KN04L-ECT-L
Item		Unit			
Power supply capacity		kVA	0.4	0.5	0.9
Main circuit power supply input (L1 and L3, or L1, L2 and L3)	Rated current	A	2.6	4.3	7.6
	Wire size	–	AWG 14 to 18		
Control circuit power supply input (L1C and L2C)	Wire size	–	AWG 18		
Motor connection terminals (U, V, W, and FG) [*1]	Rated current	A	1.7	2.5	4.6
	Wire size	–	AWG 14 to 18		
	Maximum wiring length	m	20		
Frame ground (FG)	Wire size	–	AWG 14		
	Screw size	–	M4		
	Tightening torque	N·m	1.2		
	Maximum wiring length	m	1		

*1   Use the same wire size for B1 and B2.

200 VAC Input Drive Wire Sizes

The terminal block wire sizes used for 200-VIC input Servo Drive models are as shown below.

Model (R88D-)		Unit	KN01H-ECT-L	KN02H-ECT-L	KN04H-ECT-L	KN08H-ECT-L	KN10H-ECT-L	KN15H-ECT-L
Item		**Unit**						
Power supply capacity		kVA	0.5	0.5	0.9	1.3	1.8	2.3
Main circuit power supply input (L1 and L3, or L1, L2 and L3)	Rated current	A	1.3	2.4/1.3[*1]	4.1/2.4[*1]	6.6/3.6[*1]	9.1/5.9[*1]	14.2/8.1[*1]
	Wire size	−	AWG14 to 18				AWG14	
	Screw size	−	−	−	−	−	−	−
	Tightening torque	N·m	−	−	−	−	−	−
Control circuit power supply input (L1C and L2C)	Wire size	−	AWG18					
	Screw size	−	−	−	−	−	−	−
	Tightening torque	N·m	−	−	−	−	−	−
Motor connection terminals (U, V, W, and FG) *2	Rated current	A	1.2	1.6	2.6	4.1	5.9	9.4
	Wire size	−	AWG14 to 18				AWG14	
	Screw size	−	−	−	−	−	−	−
	Tightening torque	N·m	−	−	−	−	−	−
	Maximum wiring length	m	20					
Frame ground (FG)	Wire size	−	AWG14					
	Screw size	−	M4					
	Tightening torque	N·m	1.2					
	Maximum wiring length	m	1					

*1   The first value is for single-phase input power and the second value is for 3-phase input power.

*2   Use the same wire size for B1 and B2.

4-2 Wiring

4

4-2-3 Terminal Block Wire Sizes

Model (R88D-)		Unit	KN20H-ECT-L	KN30H-ECT-L	KN50H-ECT-L	KN75H-ECT-L	KN150H-ECT-L
Item							
Power supply capacity		kVA	3.3	4.5	7.5	11.0	22.0
Main circuit power supply input (L1 and L3, or L1, L2 and L3)	Rated current	A	11.8	15.1	21.6	32.0	58.0
	Wire size	–	AWG14	AWG12		AWG10	AWG6
	Screw size	–	–	M5			M6
	Tightening torque	N·m	–	2.0		2.0 to 2.4	2.2 to 2.5
Control circuit power supply input (L1C and L2C)	Wire size	–	AWG18				
	Screw size	–	–	M5			M4
	Tightening torque	N·m	–	2.0		1.3 to 1.5	0.7 to 0.8
Motor connection terminals (U, V, W, and FG) *2	Rated current	A	13.4	18.6	33.0	44.0	66.7
	Wire size	–	AWG12			AWG6	AWG4
	Screw size	–	–	M5			M6
	Tightening torque	N·m	–	2.0		2.0 to 2.4	2.2 to 2.5
	Maximum wiring length	m	20				
Frame ground (FG)	Wire size	–	AWG14	AWG12		AWG6	AWG4
	Screw size	–	M4	M5			M6
	Tightening torque	N·m	1.2	2.0		1.4 to 1.6	2.4 to 2.8
	Maximum wiring length	m	1				
Dynamic brake resister control terminals	Wire size	–	–			AWG18	
	Screw size	–				M5	M4
	Tightening torque	N·m				1.3 to 1.5	0.7 to 0.8

*1   Use the same wire size for B1 and B2.

400 VAC Input Drive Wire Sizes

The terminal block wire sizes used for 400-VIC input Servo Drive models are as shown below.

Model (R88D-)		Unit	KN06F-ECT-L	KN10F-ECT-L	KN15F-ECT-L	KN20F-ECT-L
Item		**Unit**				
Main circuit power supply input (L1 and L3, or L1, L2 and L3)	Rated current	A	2.8	2.8	3.9	5.9
	Wire size	–	AWG14			
	Screw size	–	–	–	–	–
	Tightening torque	N·m	–	–	–	–
Control circuit power supply input (L1C and L2C)	Wire size	–	AWG20 to 24			
	Screw size	–	–	–	–	–
	Tightening torque	N·m	–	–	–	–
Motor connection terminals (U, V, W, and FG) [*1]	Rated current	A	2.9	2.9	4.7	6.7
	Wire size	–	AWG14			
	Screw size	–	–	–	–	–
	Tightening torque	N·m	–	–	–	–
	Maximum wiring length	m	20			
Frame ground (FG)	Wire size	–	AWG14			
	Screw size	–	M4			
	Tightening torque	N·m	1.2			
	Maximum wiring length	m	1			

*1   Use the same wire sizes for B1 and B2.

Model (R88D-)			KN30F-ECT-L	KN50F-ECT-L	KN75F-ECT-L	KN150F-ECT-L
Item		Unit				
Main circuit power supply input (L1 and L3, or L1, L2 and L3)	Rated current	A	7.6	12.1	16.0	29.0
	Wire size	–	AWG12		AWG10	AWG6
	Screw size	–	M5			M6
	Tightening torque	N·m	2.0		2.0 to 2.4	2.2 to 2.5
Control circuit power supply input (L1C and L2C)	Wire size	–	AWG18			
	Screw size	–	M5			M4
	Tightening torque	N·m	2.0		1.3 to 1.5	0.7 to 0.8
Motor connection terminals (U, V, W, and FG) [*1]	Rated current	A	9.4	16.5	22.0	33.4
	Wire size	–	AWG12		AWG6	AWG4
	Screw size	–	M5			M6
	Tightening torque	N·m	2.0		2.0 to 2.4	2.2 to 2.5
	Maximum wiring length	m	20			
Frame ground (FG)	Wire size	–	AWG12		AWG6	AWG4
	Screw size	–	M5			M6
	Tightening torque	N·m	2.0		1.4 to 1.6	2.4 to 2.8
	Maximum wiring length	m	1			
Dynamic brake resister control terminals	Wire size	–	–		AWG18	
	Screw size	–			M5	M6
	Tightening torque	N·m			1.3 to 1.5	0.7 to 0.8

*1   Use the same wire sizes for B1 and B2.

📖 **Additional Information**

Wire Sizes and Allowable Current

The following table shows the allowable current when there are 3 power supply wires. Use a current below these specified values.

600-V Heat-resistant Vinyl Wire (HIV)

AWG size	Nominal cross-sectional area [mm²]	Configuration [wires/mm²]	Conductive resistance [Ω/km]	Allowable current [A] for ambient temperature		
				30°C	40°C	50°C
20	0.5	19/0.18	39.5	6.6	5.6	4.5
–	0.75	30/0.18	26.0	8.8	7.0	5.5
18	0.9	37/0.18	24.4	9.0	7.7	6.0
16	1.25	50/0.18	15.6	12.0	11.0	8.5
14	2.0	7/0.6	9.53	23	20	16
12	3.5	7/0.8	5.41	33	29	24
10	5.5	7/1.0	3.47	43	38	31
8	8.0	7/1.2	2.41	55	49	40
6	14.0	7/1.6	1.35	79	70	57
4	22.0	7/2.0	0.85	99	88	70

4-2-4   Terminal Block Wiring Procedure

On a Servo Drive with 2.0 kW or less, connector-type terminal blocks are used.

The procedure for wiring these terminal blocks is explained below.

Connector-type terminal blocks

For example, R88D-KN02H-ECT-L
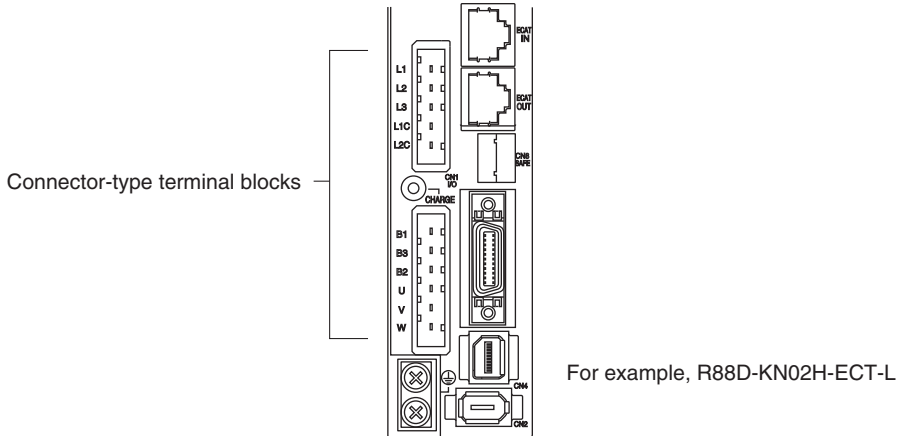
1 Remove the terminal block from the Servo Drive before wiring.

　　 The Servo Drive may be damaged if the wiring is done with the terminal block in place.

2 Strip off 8 to 9 mm of the covering from the end of each wire.

　　 Refer to *4-2-3 Terminal Block Wire Sizes* on page 4-24 for applicable wire sizes.

8 to 9 mm
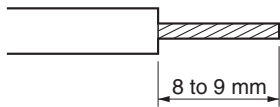
3 Open the wire insertion slots in the terminal block using a tool.

　　 There are 2 ways to open the wire insertion slots, as follows.

- Pry the slot open using the lever that comes with the Servo Drive. (Figure A)
- Insert a flat-blade screwdriver (end width: 3.0 to 3.5 mm) into the opening for the driver on the terminal block, and press down firmly to open the slot. (Figure B)
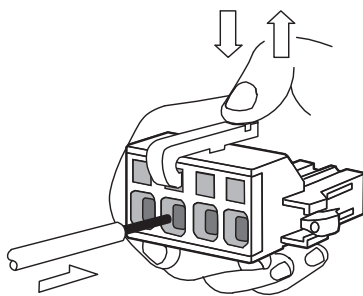
Figure A
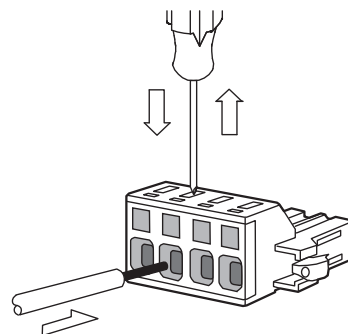
Figure B

4 With the wire insertion slot held open, insert the end of the wire.

　　 After inserting the wire, let the slot close by releasing the pressure from the lever or the screwdriver.

5 Mount the terminal block to the Servo Drive.

After all of the terminals have been wired, return the terminal block to its original position on the Servo Drive.

Additional Information

The wire may not be inserted easily depending on the shape of the ferrule connected to it.
If this occurs, perform one of the following methods before inserting the wire.

- Change the direction of inserting the connector by 90 degrees.
- Correct the shape of the ferrule with pliers.

4-3   Wiring Conforming to EMC Directives

Conformance to the EMC Directives (EN 55011 Class A Group 1 (EMI) and EN 61000-6-2 (EMS)) can be ensured by wiring under the conditions described in this section.

These conditions are for conformance of G5-series products to the EMC directives.

EMC-related performance of these products, however, may be influenced by the configuration, wiring, and other conditions of the equipment in which the products are installed. The EMC conformance of the system as a whole must be confirmed by the customer.

The following are the requirements for EMC Directive conformance.

- The Servo Drive must be installed in a metal case (control panel). (The motor does not, however, have to be covered with a metal plate.)
- Noise filters and lightening surge absorptive elements (surge absorbers) must be installed on power supply lines.
- Braided shielded cables must be used for all I/O signal cables and external encoder cables. (Use tinplated, mild steel wires for the shielding.)
- All cables, I/O wiring, and power lines connected to the Servo Drive must have clamp cores installed.
- The shields of all cables must be directly connected to a ground plate.

4-3-1   Wiring Method

100 VAC and 200 VAC Input Servo Drive Models
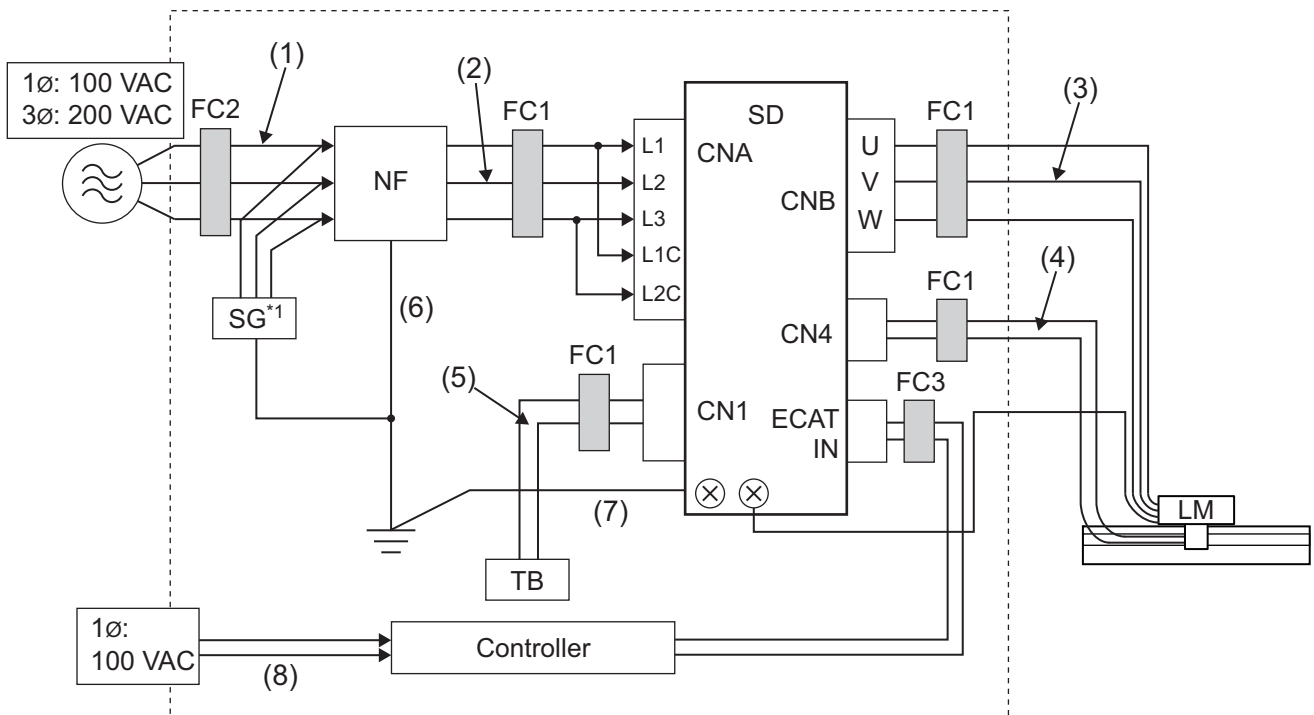
*1   Not required for single-phase models with a 100-VAC input.

Note   For models with a single-phase power supply input, the main circuit power supply input terminals are L1 and L3.

- Use a ground plate for the frame ground for each unit, as shown in the above diagrams, and ground to a single point.
- Use ground lines with a minimum thickness of 3.5 mm^2, and arrange the wiring so that the ground lines are as short as possible.
- A no-fuse breaker, surge absorber, and noise filter should be positioned near the input terminal block (ground plate), and I/O lines should be separated and wired at the shortest distance.

Unit Details

Symbol	Name	Manufacturer	Model	Comment
SG	Surge absorber	Okaya Electric Industries Co., Ltd.	R·A·V-781BWZ-4	Single-phase 100 VAC
			R·A·V-781BXZ-4	3-phase 200 VAC
NF	Noise filter	Okaya Electric Industries Co., Ltd.	SUP-EK5-ER-6	Single-phase 100/200 VAC (5 A)
			3SUP-HU10-ER-6	3-phase 200 VAC (10 A)
			3SUP-HU30-ER-6	3-phase 200 VAC (30 A)
			3SUP-HL50-ER-6B	3-phase 200 VAC (50 A)
SD	Servo Drive	OMRON	–	*1
LM	Linear Motor	–	–	*1
FC1	Clamp core	TDK	ZCAT3035-1330	–
FC2	Clamp core	Schaffner	RJ8035	–
FC3	Clamp core	NEC TOKIN Corporation	ESD-SR-250	–
TB	Switch box	–	–	–
-	Controller	–	–	–

*1   A specified combination of Servo Drive and Linear Motor must be used.

400 VAC Input Servo Drive Models
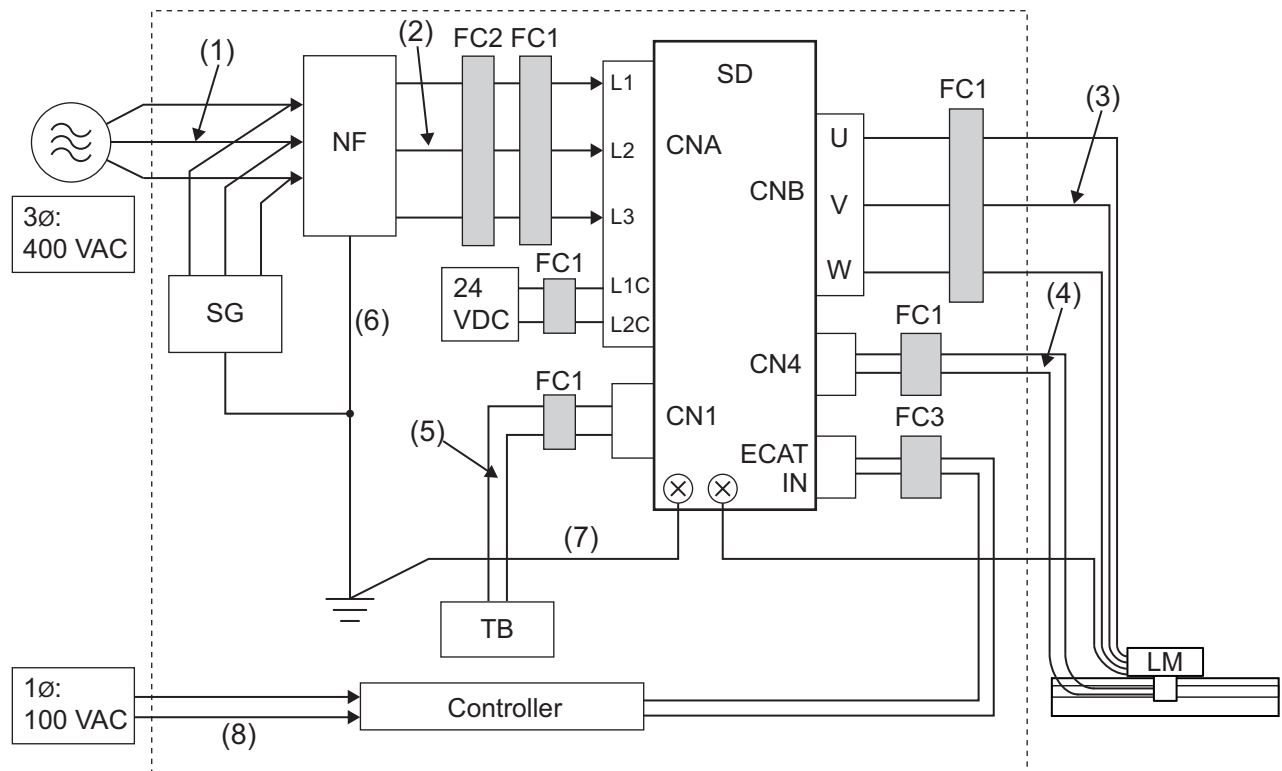
Unit Details

Symbol	Name	Manufacturer	Model	Comment
SG	Surge absorber	Okaya Electric Industries Co., Ltd.	R·A·V-801BXZ-4	–
NF	Noise filter	Okaya Electric Industries Co., Ltd.	3SUP-HQ10-ER-6	–
			3SUP-HL50-ER-6B	–
		Schaffner	FN258-42-07	–
SD	Servo Drive	OMRON	–	*1
LM	Linear Motor	–	–	*1
FC1	Clamp core	TDK	ZCAT3035-1330	
FC2	Clamp core	Schaffner	RJ8035	
FC3	Clamp core	NEC TOKIN Corporation	ESD-SR-250	
TB	Switch box	–	–	
–	Controller	–	–	–

*1   A specified combination of Servo Drive and Linear Motor must be used.

● **Cable Details**

Symbol	Supplies from	Connects to	Cable name	Length	Comment	Shielded	Ferrite
(1)	AC power supply	Noise filter	Power supply line	2 m	–	No	No
(2)	Noise filter	Servo Drive	Power supply line	2 m	–	No	Optional
(3)	Servo Drive	Linear Motor	Power cable	20 m	–	No	Optional
(4)	Servo Drive	Linear Motor	External encoder cable	20 m	–	Yes	Optional
(5)	Switch box	Servo Drive	I/O cable	2 m	–	No	Optional
(6)	Frame ground	Noise filter	FG line	1.5 m	–	No	No
(7)	Frame ground	Noise filter	FG line	1.5 m	–	No	No
(8)	AC power supply	Controller	Power supply line	1.5 m	–	No	No

Noise Filter for Power Supply Input

We recommend using a noise filter for the Servo Drive.

Servo Drive model	Noise filter for power supply input				Manufacturer
	Model	Rated current	Phase	Leakage current (60 Hz) max	
R88D-KN01L-ECT-L	SUP-EK5-ER-6	5 A	Single-phase	1.0mA (at 250VAC)	Okaya Electric Industries Co., Ltd.
R88D-KN02L-ECT-L					
R88D-KN04L-ECT-L	3SUP-HQ10-ER-6	10 A	3-phase	3.5mA (at 500VAC)	
R88D-KN01H-ECT-L	SUP-EK5-ER-6	5 A	Single-phase	1.0mA (at 250VAC)	
R88D-KN02H-ECT-L					
R88D-KN04H-ECT-L					
R88D-KN08H-ECT-L	3SUP-HQ10-ER-6	10 A	3-phase	3.5mA (at 500VAC)	
R88D-KN10H-ECT-L	3SUP-HU30-ER-6	30 A	3-phase	3.5mA (at 500VAC)	
R88D-KN15H-ECT-L					
R88D-KN20H-ECT-L					
R88D-KN30H-ECT-L	3SUP-HL50-ER-6B	50 A	3-phase	8.0mA (at 500VAC)	
R88D-KN50H-ECT-L					
R88D-KN06F-ECT-L	3SUP-HQ10-ER-6	10 A	3-phase	3.5mA (at 500VAC)	
R88D-KN10F-ECT-L					
R88D-KN15F-ECT-L					
R88D-KN20F-ECT-L	3SUP-HU30-ER-6	30 A	3-phase	3.5mA (at 500VAC)	
R88D-KN30F-ECT-L					
R88D-KN50F-ECT-L					
R88D-KN01L-ECT-L	SUP-EK5-ER-6	5 A	Single-phase	1.0mA (at 250VAC)	
R88D-KN02L-ECT-L					
R88D-KN04L-ECT-L	3SUP-HU10-ER-6	10 A	3-phase	3.5mA (at 500VAC)	
R88D-KN01H-ECT-L	SUP-EK5-ER-6	5 A	Single-phase	1.0mA (at 250VAC)	
R88D-KN02H-ECT-L					
R88D-KN04H-ECT-L					
R88D-KN08H-ECT-L	3SUP-HU10-ER-6	10 A	3-phase	3.5mA (at 500VAC)	
R88D-KN10H-ECT-L	3SUP-HU30-ER-6	30 A	3-phase	3.5mA (at 500VAC)	
R88D-KN15H-ECT-L					

Servo Drive model	Noise filter for power supply input				
	Model	Rated current	Phase	Leakage current (60 Hz) max	Manufacturer
R88D-KN20H-ECT-L	3SUP-HU50-ER-6	50 A	3-phase	3.5mA (at 500VAC)	Okaya Electric Industries Co., Ltd.
R88D-KN30H-ECT-L	3SUP-HL50-ER-6B	50 A	3-phase	8.0mA (at 500VAC)	
R88D-KN50H-ECT-L					
R88D-KN75H-ECT-L	FS5559-60-34	60 A	3-phase	1.35mA (at 480VAC/50Hz)	Schaffner
R88D-KN150H-ECT-L	FS5559-80-34	80 A			
R88D-KN06F-ECT-L	3SUP-HQ10-ER-6	10 A	3-phase	3.5mA (at 500VAC)	Okaya Electric Industries Co., Ltd.
R88D-KN10F-ECT-L					
R88D-KN15F-ECT-L					
R88D-KN20F-ECT-L	3SUP-HL50-ER-6B	50 A	3-phase	8.0mA (at 500VAC)	
R88D-KN30F-ECT-L					
R88D-KN50F-ECT-L					
R88D-KN75F-ECT-L	FN258-42-07	42 A	3-phase	25.8mA (at 440VAC/50Hz)	Schaffner
R88D-KN150F-ECT-L					

- If no-fuse breakers are installed at the top and the power supply line is wired from the lower duct, use metal tubes for wiring or make sure that there is adequate distance between the input lines and the internal wiring. If input and output lines are wired together, noise resistance will decrease.
- Separate power supply lines and signal lines when wiring.
- The noise filter must be installed as close as possible to the entrance of the control panel. Wire as shown at the left in the following illustration.

⬤ Separate the input and output.   ⊘ The effect of the noise filter is small.
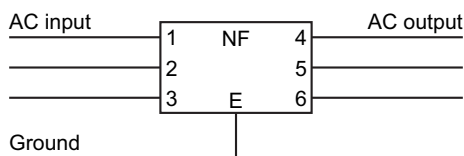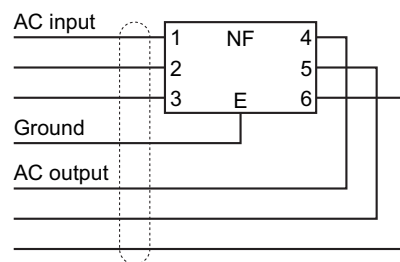
- Use twisted-pair cables for the power supply cables, or bind the cables.
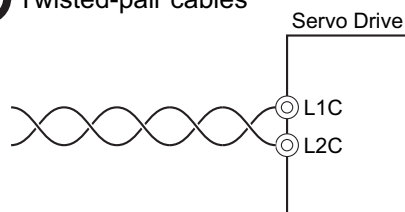
⬤ Twisted-pair cables   ⬤ Bound cables
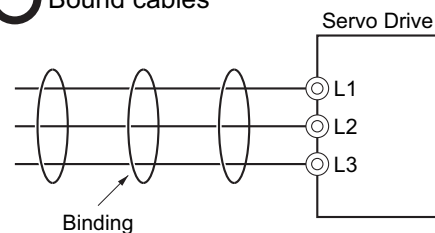
● **External Dimensions**

SUP-EK5-ER-6/3SUP-HQ10-ER-6
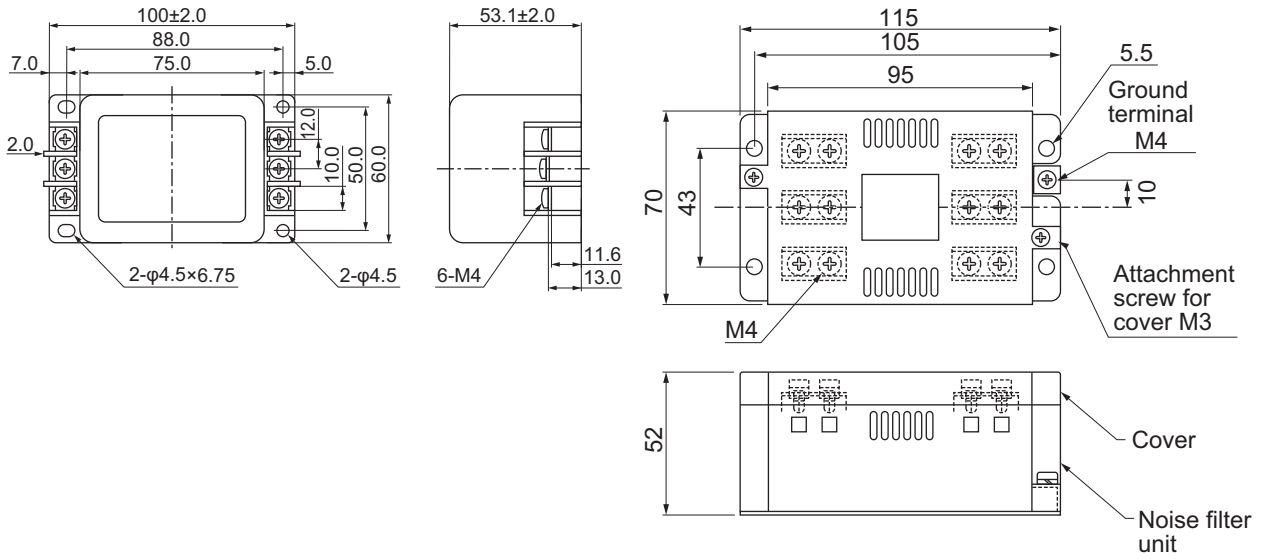
3SUP-HU30-ER-6/3SUP-HL50-ER-6B
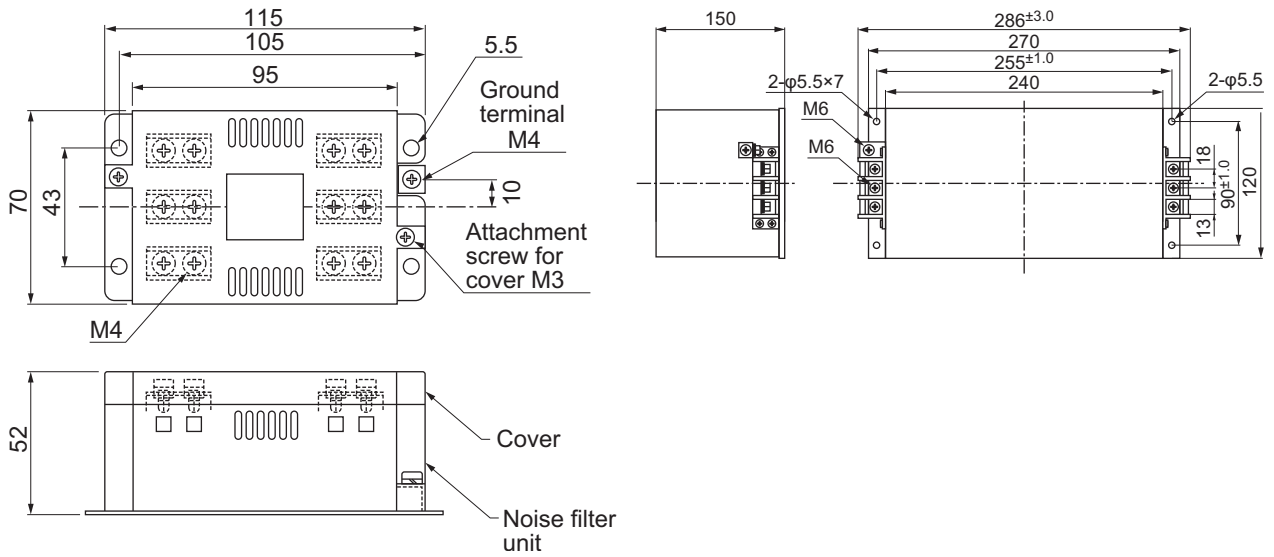
● **Circuit Diagram**

SUP-EK5-ER-6
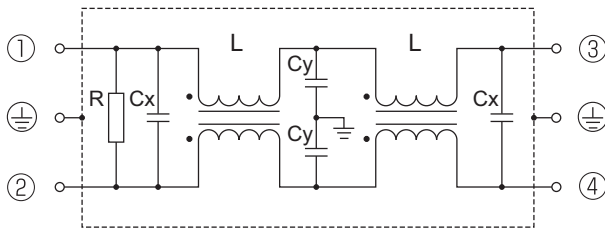
3SUP-HQ10-ER-6
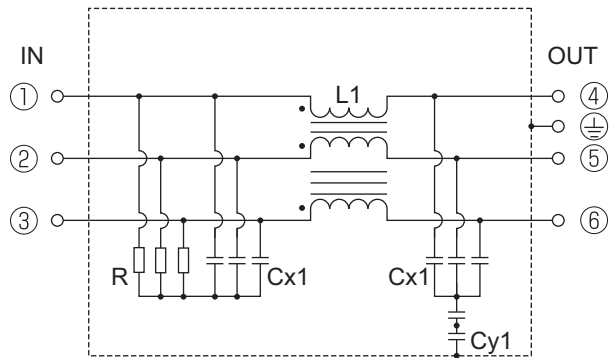
3SUP-HU30-ER-6
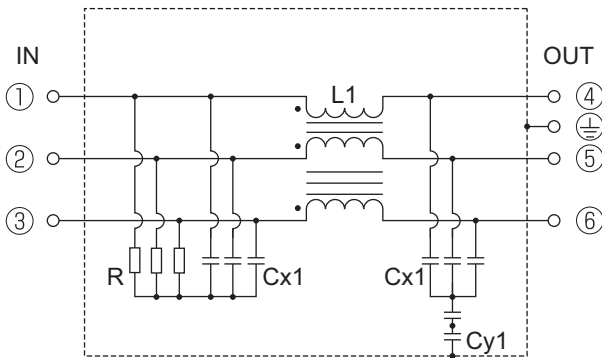
3SUP-HL50-ER-6B
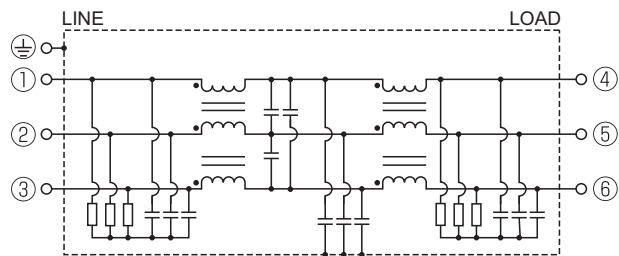
Control Panel Structure

Openings in the control panel, such as holes for cables, panel mounting holes, and gaps around the door, may allow electromagnetic waves into the panel. To prevent this, observe the recommendations described below when designing or selecting a control panel.

● **Case Structure**

- Use a metal control panel with welded joints at the top, bottom, and sides so that the surfaces are electrically conductive.
- If assembly is required, strip the paint off the joint areas (or mask them during painting), to make them electrically conductive.
- The panel may warp and gaps may appear when screws are tightened. Be sure that no gaps appear when tightening screws.
- Do not leave any conductive part unconnected.
- Ground all units within the case to the case itself.

● **Door Structure**

- Use a metal door.
- Use a water-draining structure where the door and case fit together, and leave no gaps. (Refer to the diagrams.)
- Use a conductive gasket between the door and the case. (Refer to the diagrams.)
- Strip the paint off the sections of the door and case that will be in contact with the conductive gasket (or mask them during painting), so that they are electrically conductive.
- The panel may warp and gaps may appear when screws are tightened. Be sure that no gaps appear when tightening screws.

Control Panel

A-B Cross-section Diagram

Door (Interior Side)
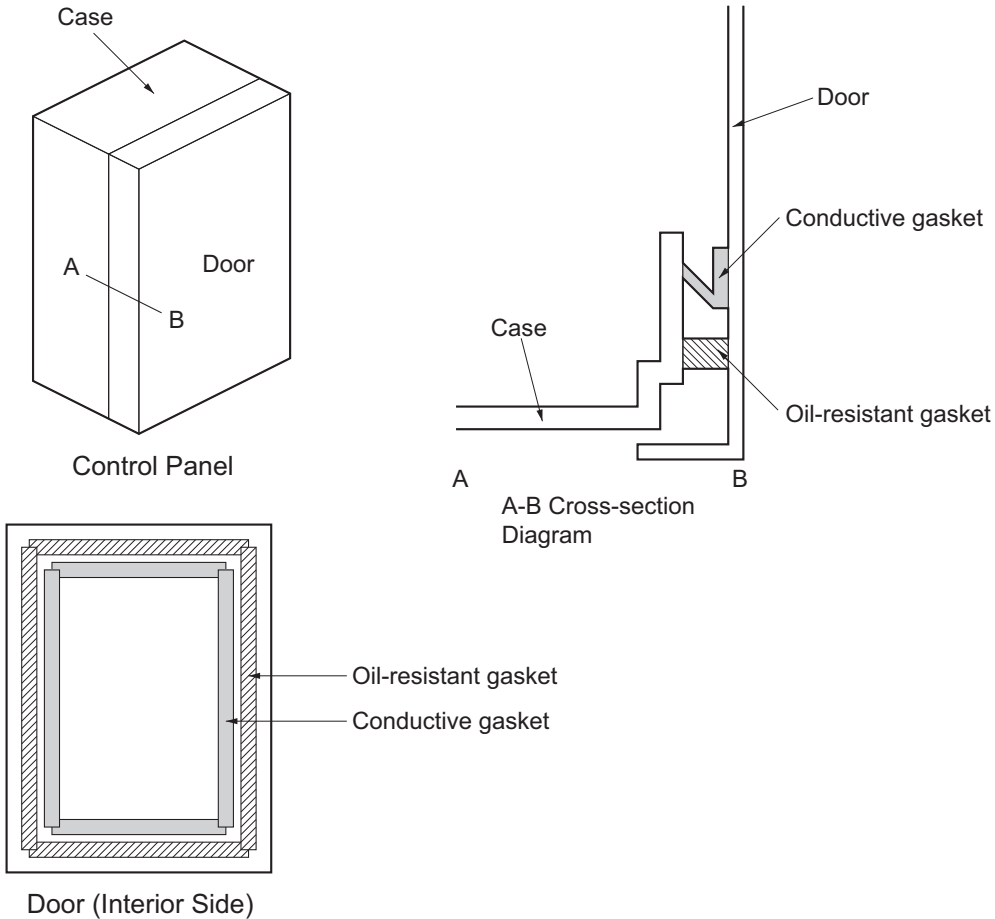
4-3-2   Selecting Connection Component

This section explains the criteria for selecting the connection components required to improve noise resistance.

Understand each component's characteristics, such as its capacity, performance, and applicable range when selecting the connection components.

For more details, contact the manufacturers directly.

No-fuse Breaker (NFB)

When selecting a no-fuse breaker, consider the maximum input current and the inrush current.

● Maximum Input Current

- The momentary maximum output of Servo Drive is approx. 3 times the rated output, and can be output for up to 3 seconds.
  Therefore, select no-fuse breakers with an operation time of at least 5 seconds at 300% of the rated current ratio. General and low-speed no-fuse breakers are generally suitable.
- Select a no-fuse breaker with a rated current greater than the total effective load current of all the motors (when multiple Servo Drives are used).
  The rated current of the power supply input for each Linear Motor model is provided in *4-2-2 Main Circuit and Linear Motor Connections* on page 4-14.
- Add the current consumption of other controllers, and any other components when selecting.

● Inrush Current

- The following table lists the Servo Drive inrush currents.
- With low-speed no-fuse breakers, an inrush current 10 times the rated current can flow for 0.02 second.
- When the power of multiple Servo Drives are turned ON simultaneously, select a no-fuse breaker with a 20-ms allowable current that is greater than the total inrush current, shown in the following table.

Servo Drive model	Inrush current [Ao-p]	
	Main circuit power supply	Control circuit power supply
R88D-KN01L-ECT-L	7	14
R88D-KN02L-ECT-L	7	14
R88D-KN04L-ECT-L	15	14
R88D-KN01H-ECT-L	14	28
R88D-KN02H-ECT-L	14	28
R88D-KN04H-ECT-L	14	28
R88D-KN08H-ECT-L	29	28
R88D-KN10H-ECT-L	29	28
R88D-KN15H-ECT-L	29	28
R88D-KN20H-ECT-L	29	14
R88D-KN30H-ECT-L	22	14
R88D-KN50H-ECT-L	22	14
R88D-KN75H-ECT-L	66	15
R88D-KN150H-ECT-L	66	15
R88D-KN06F-ECT-L	28	48
R88D-KN10F-ECT-L	28	48

Servo Drive model	Inrush current [Ao-p]	
	Main circuit power supply	Control circuit power supply
R88D-KN15F-ECT-L	28	48
R88D-KN20F-ECT-L	32	48
R88D-KN30F-ECT-L	32	48
R88D-KN50F-ECT-L	32	48
R88D-KN75F-ECT-L	32	48
R88D-KN150F-ECT-L	32	48

Leakage Breaker

- Select a leakage breaker for high frequencies and surge resistance.
- When selecting leakage breakers, remember to add the leakage current from devices other than the motor, such as devices using a switching power supply, noise filters, inverters, and so on.
  To prevent malfunction due to inrush current, we recommend using a leakage breaker of 10 times the total of all current values.
- The leakage breaker is activated at 50% of the rated current. Select a leakage breaker with approx. twice the capacity.
- For details on leakage breakers selection method, refer to the manufacturer's catalog.
- Because switching takes place inside the Servo Drives, high-frequency current leaks from the SW elements of the Servo Drive, the armature of the motor, and the cables.
  High-frequency, surge-resistant leakage breakers, because they do not detect high-frequency current, can prevent operation with high-frequency leakage current.
  When using a general leakage breaker, use 3 times the total of the leakage current given in the following table as a reference value.

The following table shows the leakage current of each Servo Drive model.

Servo Drive model	Input power supply	Leakage current (Cable: 3 m)	Increase per 10 m of cable
R88D-KN01L-ECT-L	Single-phase 100 V	0.39 mA	0.1 mA
R88D-KN02L-ECT-L	Single-phase 100 V	0.41 mA	
R88D-KN04L-ECT-L	Single-phase 100 V	0.46 mA	0.12 mA
R88D-KN01H-ECT-L	Single-phase 200 V	0.83 mA	0.23 mA
	3-phase 200 V	1.03 mA	
R88D-KN02H-ECT-L	Single-phase 200 V	0.84 mA	
	3-phase 200 V	1.02 mA	
R88D-KN04H-ECT-L	Single-phase 200 V	0.96 mA	0.3 mA
	3-phase 200 V	1.27 mA	
R88D-KN08H-ECT-L	Single-phase 200 V	1.01 mA	1.1 mA
	3-phase 200 V	1.39 mA	
R88D-KN10H-ECT-L	Single-phase 200 V	0.88 mA	0.93 mA
	3-phase 200 V	1.14 mA	
R88D-KN15H-ECT-L	Single-phase 200 V	0.96 mA	
	3-phase 200 V	1.18 mA	
R88D-KN20H-ECT-L	3-phase 200 V	1.53 mA	1.23 mA
R88D-KN30H-ECT-L	3-phase 200 V	1.52 mA	
R88D-KN50H-ECT-L	3-phase 200 V	1.39 mA	
R88D-KN75H-ECT-L	3-phase 200 V	3.50 mA	2.07 mA
R88D-KN150H-ECT-L	3-phase 200 V	5.30 mA	1.13 mA

Servo Drive model	Input power supply	Leakage current (Cable: 3 m)	Increase per 10 m of cable
R88D-KN06F-ECT-L	3-phase 400 V	2.28 mA	1.8 mA
R88D-KN10F-ECT-L	3-phase 400 V	2.20 mA	
R88D-KN15F-ECT-L	3-phase 400 V	2.55 mA	2.03 mA
R88D-KN20F-ECT-L	3-phase 400 V	2.92 mA	2.4 mA
R88D-KN30F-ECT-L	3-phase 400 V	3.92 mA	3.23 mA
R88D-KN50F-ECT-L	3-phase 400 V	3.54 mA	2.9 mA
R88D-KN75F-ECT-L	3-phase 400 V	6.70 mA	3.73 mA
R88D-KN150F-ECT-L	3-phase 400 V	10.40 mA	2.73 mA

Note   These values vary greatly depending on the installation conditions of the motor power cable and the measurement conditions. Use the values for reference only.

Surge Absorber

- Use surge absorbers to absorb lightning surge voltage and abnormal voltage from power supply input lines.
- When selecting surge absorbers, take into account the varistor voltage, the surge immunity and the energy tolerated dose.
- For 200-VAC systems, use surge absorbers with a varistor voltage of 620 V.

The surge absorbers shown in the following table are recommended.

Manufacturer	Model	Surge immunity		Type	Comment
Okaya Electric Industries Co., Ltd.	R·A·V-781BWZ-4	700 V ± 20%	2500 A	Block	Single-phase 100/200 VAC
Okaya Electric Industries Co., Ltd.	R·A·V-781BXZ-4	700 V ± 20%	2500 A		3-phase 200 VAC
Okaya Electric Industries Co., Ltd.	R·A·V-801BXZ-4	800V ± 20%	2500 A		3-phase 400 VAC

Note 1   Refer to the manufacturers' catalog for operating details.

2   The surge immunity is for a standard impulse current of 8/20 μs. If pulses are wide, either decrease the current or change to a larger-capacity surge absorber.

● **External Dimensions**

For single-phase (BWZ series)

For 3-phase (BXZ series)

● **Equalizing Circuits**

For single-phase (BWZ series)
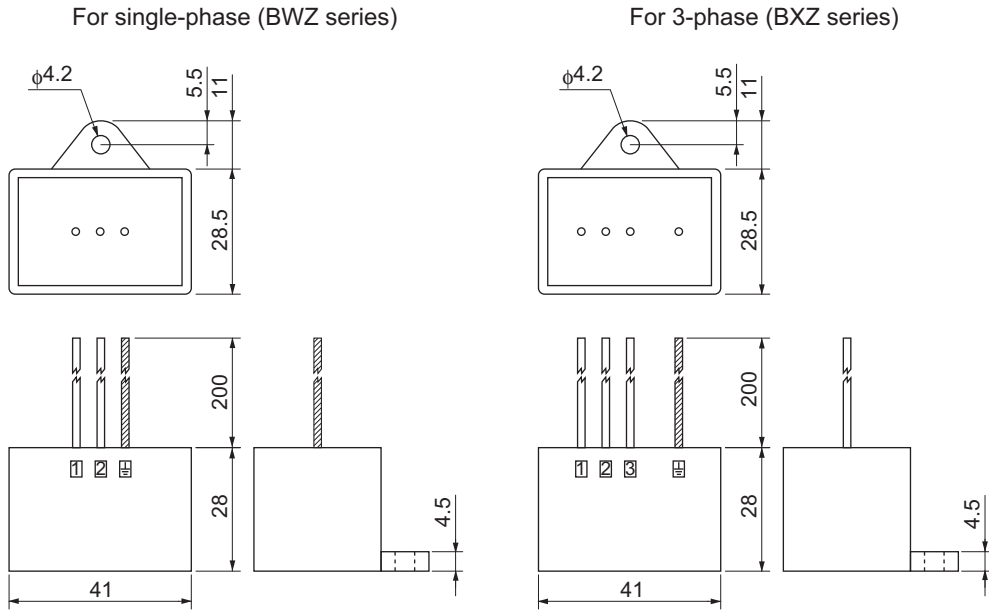
For 3-phase (BXZ series)
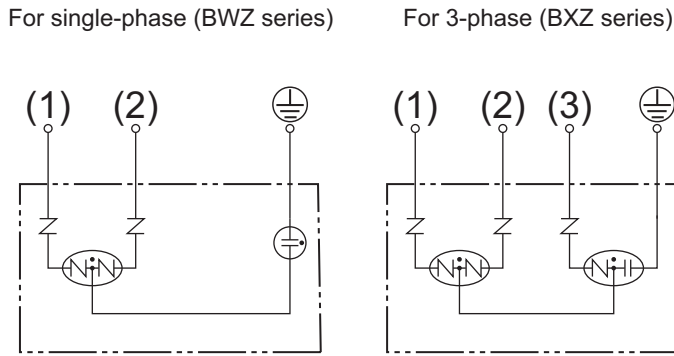
Noise Filter for the Brake Power Supply

- Use the following noise filter for the brake power supply.

Model	Rated current	Rated voltage	Leakage current	Manufacturer
SUP-EK5-ER-6	5 A	250 V	1.0 mA (at 250 Vrms, 60 Hz)	Okaya Electric Industries Co., Ltd.

Additional Information

Noise can also be reduced by 1.5 turns with the ZCAT3035-1330 (TDK) Radio Noise Filter.

Radio Noise Filter and Emission Noise Prevention Clamp Core

Use one of the following filters to prevent switching noise of PWM of the Servo Drive and to prevent noise emitted from the internal clock circuit.

Model	Manufacturer	Application
3G3AX-ZCL1 [*1]	OMRON	For Drive output and power cable
3G3AX-ZCL2 [*2]	OMRON	For Drive output and power cable
ESD-R-47B [*3]	NEC TOKIN	For Drive output and power cable
ZCAT3035-1330 [*4]	TDK	For External encoder and I/O cable

*1 Generally used for 1.5 kW or higher.

*2 Generally used for 1.5 kW or lower. The maximum number of windings is 3 turns.

*3 Generally used for 100 W. The maximum number of windings is 2 turns.

*4 Also used on the Drive output power lines to comply with the EMC Directives. Only a clamp is used. This clamp can also be used to reduce noise current on a FG line.

● External Dimensions

3G3AX-ZCL1
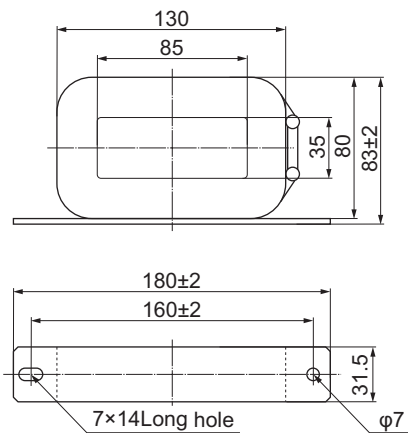
3G3AX-ZCL2
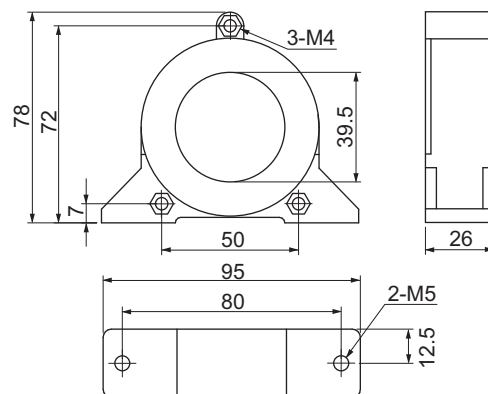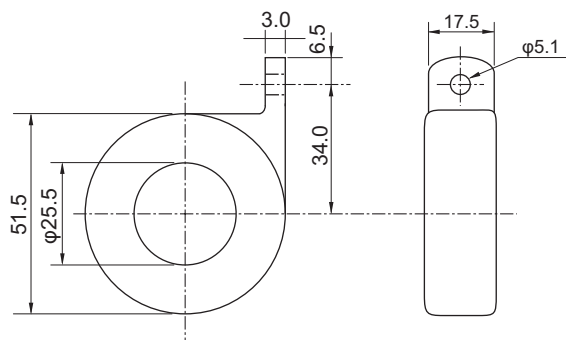
ESD-R-47B
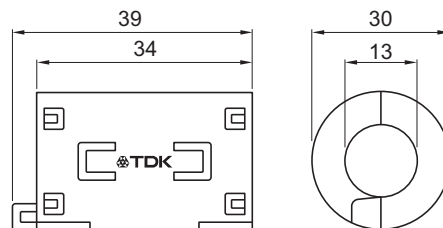
ZCAT3035-1330
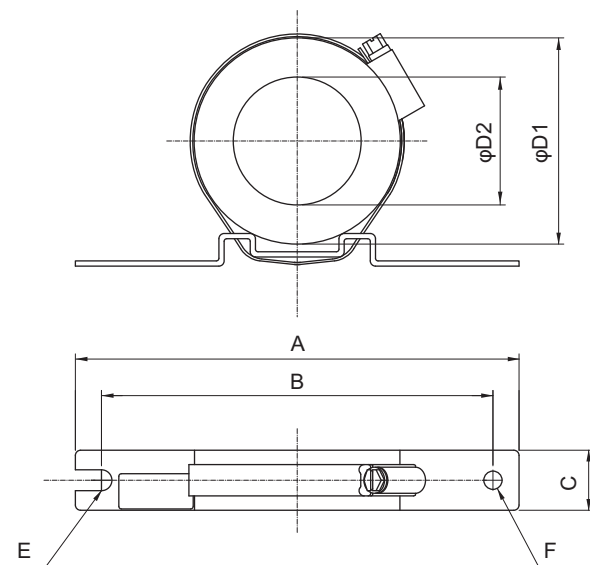
RJ8035/RJ8095

T400-61D
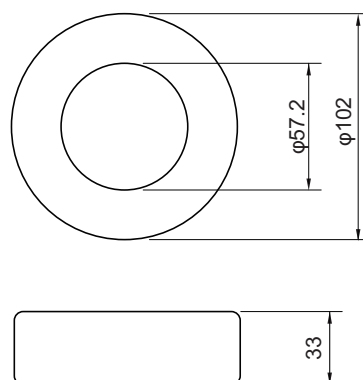
Model	Rated current	Dimensions [mm]							
		A	B	C	D1	D2	Core thickness	E	F
RJ8035	35A	170	150	23	80	53	24	R3.5	7
RJ8095	95A	200	180	34	130	107	35	R3.5	7

● **Impedance Characteristics**

3G3AX-ZCL1

3G3AX-ZCL2

ESD-R-47B

ZCAT3035-1330

RJ8035

RJ8095

T400-61D
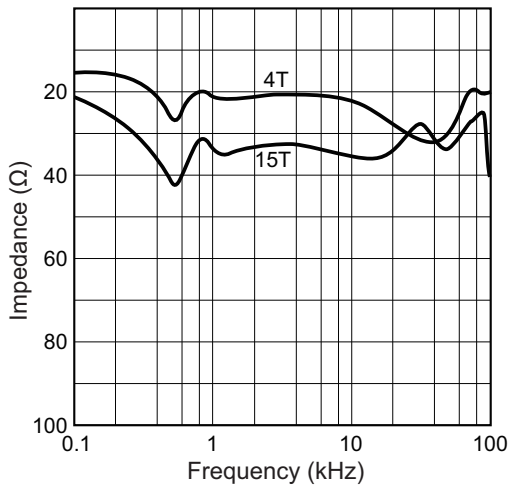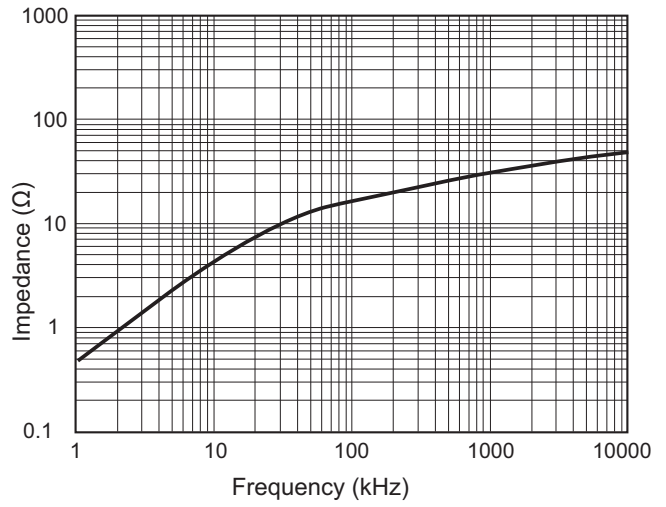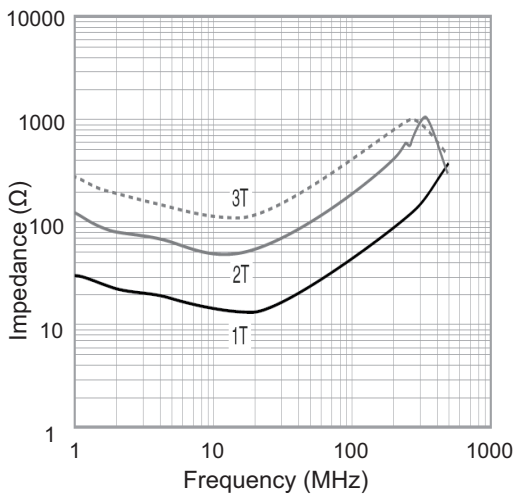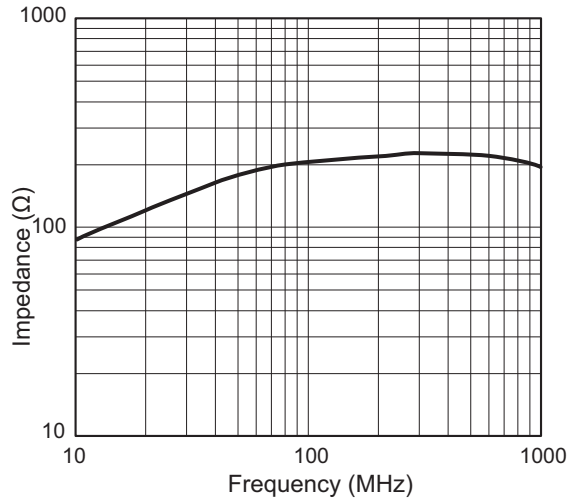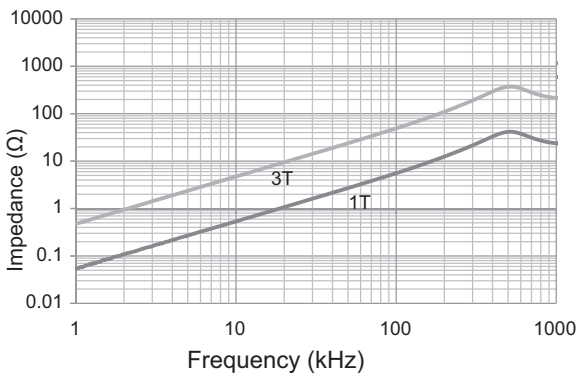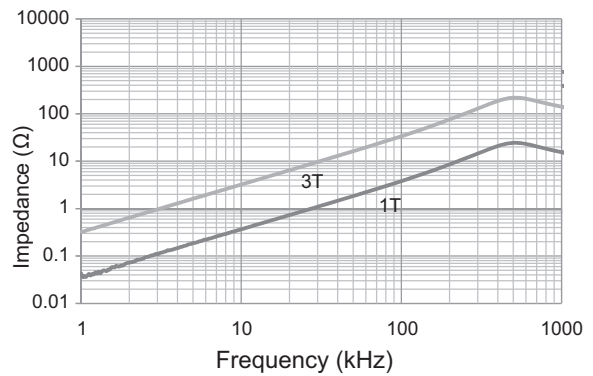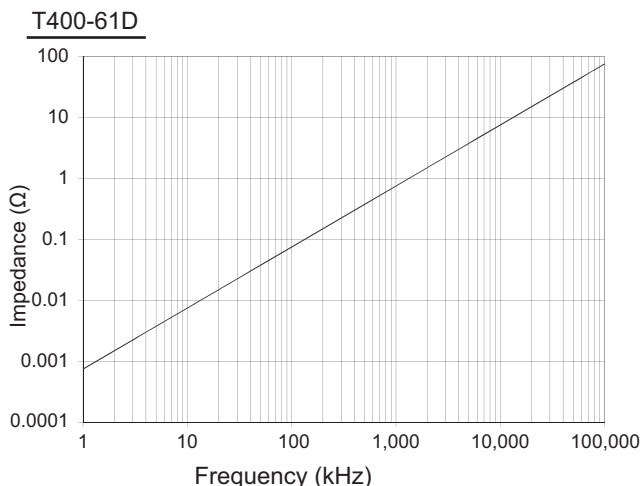
Surge Suppressors

- Install surge suppressors for loads that have induction coils, such as relays, solenoids, brakes, clutches, etc.

The following table shows the types of surge suppressors and recommended products.

Type	Feature	Recommended product
Diodes	Diodes are used for relatively small loads such as relays when the reset time is not a critical issue. At power shutoff the surge voltage is the lowest, but the reset time takes longer. Used for 24/48-VDC systems.	Use a fast-recovery diode with a short reverse recovery time. (e.g. RU2 of Sanken Electric Co., Ltd.).
Thyristors and varistors	Thyristors and varistors are used for loads when induction coils are large, as in electromagnetic brakes, solenoids, etc., and when reset time is critical. The surge voltage at power shutoff is approx. 1.5 times the varistor voltage.	Select the varistor voltage as follows. • 24-VDC systems: varistor voltage 39 V • 100-VDC systems: varistor voltage 200 V • 100-VAC systems: varistor voltage 270 V • 200-VAC systems: varistor voltage 470 V
Capacitor + resistor	The capacitor plus resistor combination is used to absorb vibration in the surge at power supply shutoff. The reset time can be shortened by selecting the appropriate capacitance and resistance.	Okaya Electric Industries Co., Ltd. • XEB12002 0.2 μF-120 Ω • XEB12003 0.3 μF-120 Ω

📝 Additional Information

Thyristors and varistors are made by the following manufacturers. Refer to manufacturer's documentation for details on these components.

- Thyristors: Ishizuka Electronics Co.
- Varistor: Ishizuka Electronics Co., Panasonic Corporation

Contactors

- Select contactors based on the circuit's inrush current and the maximum momentary phase current.
- The drive inrush current is covered in the preceding explanation of no-fuse breaker selection. And the maximum momentary phase current is approx. twice the rated current.

Improving External Encoder Cable Noise Resistance

Take the following steps during wiring and installation to improve the external encoder's noise resistance.

- Always use the specified external encoder cables.
- If cables are joined midway, be sure to use connectors. And do not remove more than 50 mm of the cable insulation. In addition, always use shielded cables.
- Do not roll cables. If cables are long and are rolled, mutual induction and inductance will increase and cause malfunctions. Always use cables fully extended.
- When installing noise filters for external encoder cables, use clamp cores.

The following table shows the recommended clamp cores.

Manufacturer	Product name	Model	Specifications
NEC TOKIN	Clamp core	ESD-SR-250	13 mm dia. max.
TDK	Clamp core	ZCAT3035-1330	13 mm dia. max.

Precautions for Correct Use

Do not place the external encoder cable with the following cables in the same duct.

- Control cables for brakes, solenoids, clutches, and valves.

● **External Dimensions**

ESD-SR-250
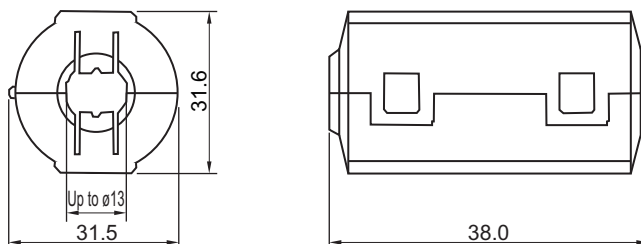
● **Impedance Characteristics**

ESD-SR-250
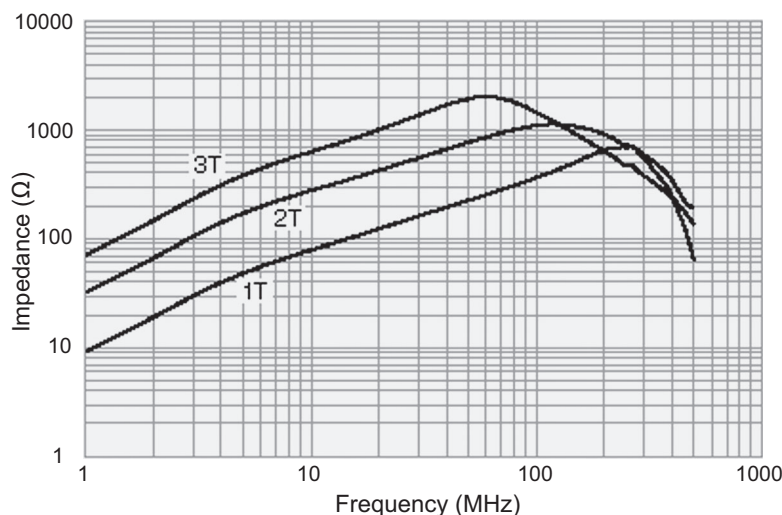
For information on an external dimensions and impedance characteristics of ZCAT3035-1330, refer to *External Dimensions* on page 4-43 and *Impedance Characteristics* on page 4-45.

Improving Control I/O Signal Noise Resistance

Positioning can be affected and I/O signal errors can occur if control I/O is influenced by noise.

- Use completely separate power supplies for the control power supply (especially 24 VDC) and the external operation power supply. In particular, do not connect the 2 power supply ground wires.
- Install a noise filter on the primary side of the control power supply.
- If Brake Interlock Output (BKIR) is being used, do not use the same 24-VDC power supply for both the brakes and the control I/O.
- If the control power supply wiring is long, add 1-μF laminated ceramic capacitors between the control power supply and ground at the drive input section or the controller output section. This will improve the noise resistance.

Reactor to Reduce Harmonic Current

● Harmonic Current Measures

- Use a Reactor to suppress harmonic currents. The Reactor functions to suppress sudden and quick changes in electric currents.

Select the proper Reactor model according to the Servo Drive to be used.

Servo Drive model	Reactor			
	Model	Rated current	Inductance	Type
R88D-KN01H-ECT-L (For single-phase input)	3G3AX-DL2002	1.6 A	21.4 mH	DC reactor
R88D-KN01L-ECT-L R88D-KN02H-ECT-L (For single-phase input)	3G3AX-DL2004	3.2 A	10.7 mH	
R88D-KN02L-ECT-L R88D-KN04H-ECT-L (For single-phase input)	3G3AX-DL2007	6.1 A	6.75 mH	
R88D-KN04L-ECT-L R88D-KN08H-ECT-L R88D-KN10H-ECT-L (For single-phase input)	3G3AX-DL2015	9.3 A	3.51 mH	
R88D-KN15H-ECT-L (For single-phase input)	3G3AX-DL2022	13.8 A	2.51 mH	
R88D-KN08H-ECT-L R88D-KN10H-ECT-L R88D-KN15H-ECT-L (For 3-phase input)	3G3AX-AL2025	10.0 A	2.8 mH	AC reactor
R88D-KN20H-ECT-L R88D-KN30H-ECT-L	3G3AX-AL2055	20.0 A	0.88 mH	
R88D-KN50H-ECT-L	3G3AX-AL2110	34.0 A	0.35 mH	
R88D-KN75H-ECT-L R88D-KN150H-ECT-L	3G3AX-AL2220	67.0 A	0.18 mH	
R88D-KN06F-ECT-L R88D-KN10F-ECT-L R88D-KN15F-ECT-L	3G3AX-AL4025	5.0 A	7.7 mH	
R88D-KN20F-ECT-L R88D-KN30F-ECT-L	3G3AX-AL4055	10.0 A	3.5 mH	
R88D-KN50F-ECT-L	3G3AX-AL4110	17.0 A	1.3 mH	
R88D-KN75F-ECT-L R88D-KN150F-ECT-L	3G3AX-AL4220	34.0 A	0.74 mH	

Selecting Other Parts for Noise Resistance

This section explains the criteria for selecting the connection components required to improve noise resistance.

Understand each component's characteristics, such as its capacity, performance, and applicable range when selecting the connection components.

For more details, contact the manufacturers directly.

● **Noise Filters for Motor Output**

- Use noise filters without built-in capacitors on the motor output lines.
- Select a noise filter with a rated current at least twice the Servo Drive's continuous output current.

The following table shows the noise filters that are recommended for motor output lines.

Manufacturer	Model	Rated current	Comment
OMRON	3G3AX-NF001	6 A	For inverter output
	3G3AX-NF002	12 A	
	3G3AX-NF003	25 A	
	3G3AX-NF004	50 A	
	3G3AX-NF005	75 A	
	3G3AX-NF006	100 A	

Note 1 Motor output lines cannot use the same noise filters for power supplies.

2 General noise filters are made for power supply frequencies of 50/60 Hz. If these noise filters are connected to output of the Servo Drive, a very large (about 100 times larger) leakage current may flow through the noise filter's capacitor. This may damage the Servo Drive.

● **External Dimensions**

3G3AX-NF001/-NF002
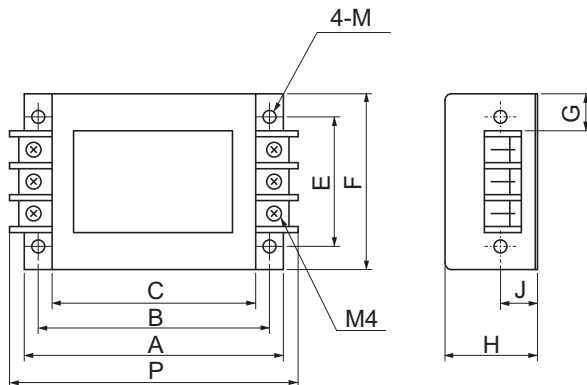
Model	Dimensions [mm]									
	A	B	C	E	F	G	H	J	M	P
3G3AX-NF001	140	125	110	70	95	22	50	20	4.5 dia.	156
3G3AX-NF002	160	145	130	80	110	30	70	25	5.5 dia.	176

3G3AX-NF003/-NF004/-NF005/-NF006
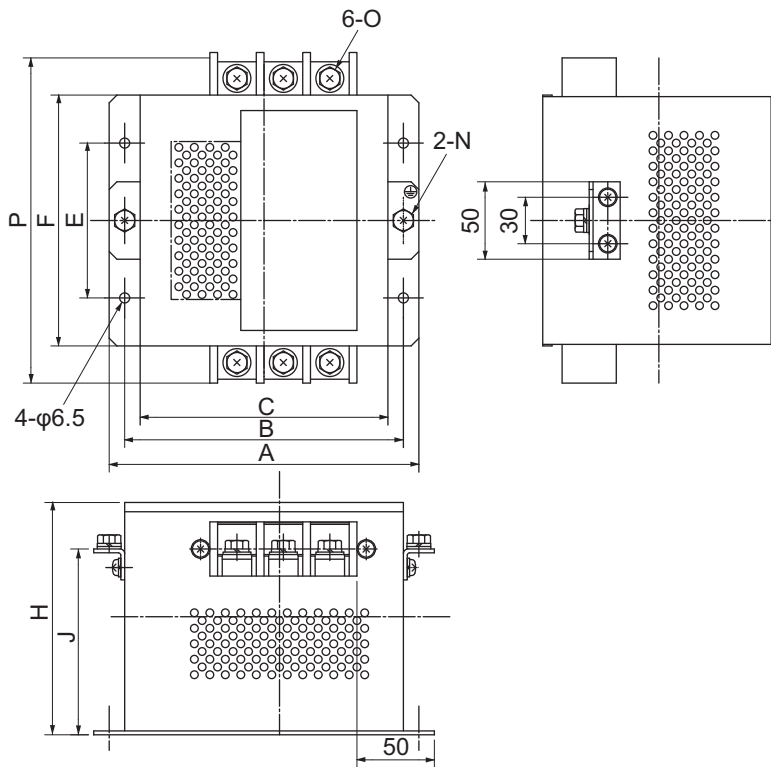
Model	Dimensions [mm]									
	A	B	C	E	F	H	J	N	O	P
3G3AX-NF003	160	145	130	80	112	120	–	–	M4	154
3G3AX-NF004	200	180	160	100	162	150	120	M5	M5	210
3G3AX-NF005	220	200	180	100	182	170	140	M6	M6	230
3G3AX-NF006	220	200	180	100	182	170	140	M8	M8	237

4-4 Regenerative Energy Absorption

A Servo Drive uses its built-in capacitors to absorb the regenerative energy produced during Linear Motor deceleration. If the amount of regenerative energy is too much for the built-in capacitors to absorb, it also uses an Internal Regeneration Resistor. An overvoltage error occurs, however, if the amount of regenerative energy from the Linear Motor is too large. If this occurs, reduce the regenerative energy by changing operating patterns or increase the regeneration process capacity by connecting External Regeneration Units.

Additional Information

- Some Servo Drive models do not have any built-in Internal Regeneration Resistor.
- The regeneration absorption capacity of a Servo Drive varies depending on the Servo Drive model.

For information on whether or not your Servo Drive has an Internal Regeneration Resistor and its regeneration absorption capacity, refer to *4-4-2 Servo Drive Regeneration Absorption Capacity* on page 4-53

4-4-1 Calculating the Regenerative Energy

This section describes how to calculate the regenerative energy for the horizontal axis.
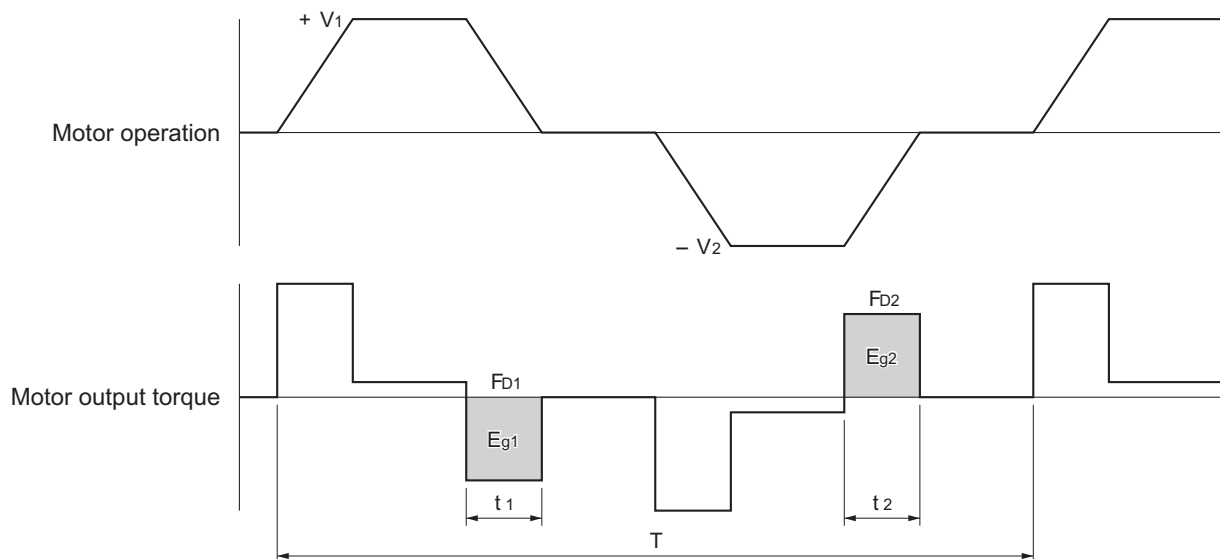
In the output force graph, acceleration in a positive direction is shown as positive, and acceleration in a negative direction is shown as negative.

The regenerative energy values in each region can be derived from the following equations.

$$\cdot\ E_{g1} = \frac{1}{2} \cdot V_1 \cdot F_{D1} \cdot t_1 \quad [\text{J}]$$

$$\cdot\ E_{g2} = \frac{1}{2} \cdot V_2 \cdot F_{D2} \cdot t_2 \quad [\text{J}]$$

V_1, V_2:   Speed of deceleration   [mm/s]

F_{D1}, F_{D2}: Deceleration force   [N]

t_1, t_2:   Deceleration time   [s]

Note Due to the loss of motor winding resistance and PWM, the actual regenerative energy will be approx. 90% of the values derived from these equations.

● **Determining the Capacity of Regenerative Energy Absorption by Built-in Capacitors**

If both the values Eg1 and Eg2 [J] mentioned above are equal to or less than the value of the regenerative energy that can be absorbed by Servo Drive's built-in capacitors Ec [J], the Servo Drive can process regenerative energy only by its built-in capacitors.

If either the value Eg1 or Eg2 [J] exceeds the value of the Servo Drive's regenerative energy absorbable by built-in capacitors Ec [J], however, use the following equations to determine the average regeneration power Pr [W].

$E_g = (E_{g1} - E_c) + (E_{g2} - E_c)$ [J]
$P_r = E_g / T$ [W]

Pr   : Average regeneration power that must be absorbed in 1 cycle of operation [W]

Eg   : Regenerative energy that must be absorbed in 1 cycle of operation [J]

Ec   : Regenerative energy absorbable by built-in capacitors [J]

T   : Operation cycle [s]

Note If the expression (Eg1 - Ec) result is zero or less, regards it as 0. The expression (Eg2 - Ec) must also be handled in the same way.

The above expressions calculate the average regeneration power Pr [W], which cannot be absorbed by the built-in capacitors. If this average regeneration power Pr [W] is equal to or less than the average amount of regeneration absorbable by the Servo Drive's Internal Regeneration Resistor, the Servo Drive can independently process the regenerative energy.

If this average regeneration power Pr [W] cannot be processed only by the Servo Drive, take the following processes.

• Connect an External Regeneration Resistor. (Regeneration process capacity improves.)
• Reduce the operating speed. (The amount of regeneration is proportional to the square of the speed.)
• Lengthen the deceleration time. (Regenerative energy per unit time decreases.)
• Lengthen the operation cycle, i.e., the cycle time. (Average regenerative power decreases.)

4-4-2   Servo Drive Regeneration Absorption Capacity

The following table shows the regenerative energy (and amount of regeneration) that each drive can absorb. If these values are exceeded, take the processes described above.

Servo Drive model	Regenerative energy absorbable by built-in capacitor [J]	Internal regeneration resistor	Allowable minimum regeneration resistance [Ω]
		Average amount of regenerative energy absorbable [W]	
R88D-KN01L-ECT-L	11	–	17
R88D-KN02L-ECT-L	15	–	17
R88D-KN04L-ECT-L	22	17	13
R88D-KN01H-ECT-L	18	–	34
R88D-KN02H-ECT-L	18	–	34
R88D-KN04H-ECT-L	26	–	34
R88D-KN08H-ECT-L	46	12	25
R88D-KN10H-ECT-L	74	18	25
R88D-KN15H-ECT-L	74	18	25
R88D-KN20H-ECT-L	74	72	10
R88D-KN30H-ECT-L	113	60	7
R88D-KN50H-ECT-L	113	60	5
R88D-KN75H-ECT-L	282	–	4
R88D-KN150H-ECT-L	254	–	4
R88D-KN06F-ECT-L	64	21	100
R88D-KN10F-ECT-L	64	21	100
R88D-KN15F-ECT-L	64	21	100
R88D-KN20F-ECT-L	64	29	40
R88D-KN30F-ECT-L	106	60	40
R88D-KN50F-ECT-L	106	60	29
R88D-KN75F-ECT-L	273	–	14
R88D-KN150F-ECT-L	492	–	14

4-4-3   Regenerative Energy Absorption with an External Regeneration Resistor

If the regenerative energy exceeds the regeneration absorption capacity of the Servo Drive, connect an External Regeneration Resistor.

Connect the External Regeneration Resistor between B1 and B2 terminals on the Servo Drive.

Double-check the terminal names when connecting the resistor because the drive may be damaged if connected to the wrong terminals.

The surface of the External Regeneration Resistor will heat up to approx. 200°C. Do not place it near equipment and wiring that is easily affected by heat. Attach radiator plates suitable for the heat radiation conditions.

Model	Resistance value	Nominal capacity	The amount of regeneration absorption for 120°C temperature rise	Heat radiation condition	Thermal switch output specifications
R88A-RR08050S	50 Ω	80 W	20 W	Aluminum 350 × 350, Thickness: 3.0	Operating temperature: 150°C ± 5% NC contact Rated output (resistive load): 125 VAC, 0.1 A max. 30 VDC, 0.1 A max. (minimum current: 1 mA)
R88A-RR080100S	100 Ω	80 W	20 W	Aluminum 350 × 350, Thickness: 3.0	Operating temperature: 150°C ± 5% NC contact Rated output (resistive load): 125 VAC, 0.1 A max. 30 VDC, 0.1 A max. (minimum current: 1 mA)
R88A-RR22047S	47 Ω	220 W	70 W	Aluminum 350 × 350, Thickness: 3.0	Operating temperature: 170°C ± 7°C NC contact Rated output: 250 VAC, 3 A max.
R88A-RR22047S1	47 Ω	220 W	70 W	Aluminum 350 × 350, Thickness: 3.0	Operating temperature: 150°C ± 5% NC contact Rated output (resistive load): 250 VAC, 0.2 A max. 42 VDC, 0.2 A max. (minimum current: 1 mA)
R88A-RR50020S	20 Ω	500 W	180 W	Aluminum 600 × 600, Thickness: 3.0	Operating temperature 200°C ± 7°C NC contact Rated output: 250 VAC, 0.2 A max. 42 VDC, 0.2 A max. (minimum current: 1 mA)

4-4-4   Connecting an External Regeneration Resistor

This section describes how to connect an External Regeneration Resistor.

Check your Servo Drive model before connecting an External Regeneration Resistor because the connection method varies depending on the Servo Drive.

R88D-KN01L-ECT-L/-KN02L-ECT-L/-KN01H-ECT-L/ R88D-KN02H-ECT-L/-KN04H-ECT-L

Normally B2 and B3 are open.

If an External Regeneration Resistor is necessary, connect the External Regeneration Resistor between B1 and B2 as shown in the diagram below.

Precautions for Correct Use

Connect the thermal switch output so that the main circuit power supply is shut OFF when the contacts open.
When using multiple External Regeneration Resistors, connect each thermal switch in series. The resistor may be damaged by burning, or cause fire if it is used without setting up a power supply shutoff sequence using the output from the thermal switch.

R88D-KN04L-ECT-L/-KN08H-ECT-L/-KN10H-ECT-L/-KN15H-ECT-L/ -KN20H-ECT-L/-KN30H-ECT-L/-KN50H-ECT-L/-KN06F-ECT-L/ -KN10F-ECT-L/-KN15F-ECT-L/-KN20F-ECT-L/-KN30F-ECT-L/-KN50F-ECT-L

Normally B2 and B3 are shorted.

If an External Regeneration Resistor is necessary, remove the short-circuit bar between B2 and B3, and then connect the External Regeneration Resistor between B1 and B2 as shown in the diagram below.

Remove the short-circuit bar between B2 and B3.

Precautions for Correct Use

Connect the thermal switch output so that the main circuit power supply is shut OFF when the contacts open.
When using multiple External Regeneration Resistors, connect each thermal switch in series.
The resistor may be damaged by burning, or cause fire if it is used without setting up a power supply shutoff sequence using the output from the thermal switch.

R88D-KN75H-ECT-L/-KN150H-ECT-L/-KN75F-ECT-L/-KN150F-ECT-L

If an External Regeneration Resistor is necessary, connect the External Regeneration Resistor between B1 and B2 as shown in the diagram below.

Precautions for Correct Use
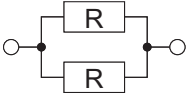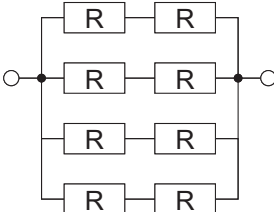
Connect the thermal switch output so that the main circuit power supply is shut OFF when the contacts open.
When using multiple External Regeneration Resistors, connect each thermal switch in series.
The resistor may be damaged by burning, or cause fire if it is used without setting up a power supply shutoff sequence using the output from the thermal switch.

Combining External Regeneration Resistors

Regeneration absorption capacity [1]	20 W	40 W	70 W	140 W
Model	R88A-RR08050S R88A-RR080100S	R88A-RR08050S R88A-RR080100S	R88A-RR22047S R88A-RR22047S1	R88A-RR22047S R88A-RR22047S1
Resistance value [2]	50 Ω/100 Ω	25 Ω/50 Ω	47 Ω	94 Ω
Connection method				

Regeneration absorption capacity [1]	140 W	280 W	560 W
Model	R88A-RR22047S R88A-RR22047S1	R88A-RR22047S R88A-RR22047S1	R88A-RR22047S R88A-RR22047S1
Resistance value [2]	23.5 Ω	47 Ω	23.5 Ω
Connection method			

Regeneration absorption capacity [1]	180 W	360 W	1440 W
Model	R88A-RR50020S	R88A-RR50020S	R88A-RR50020S
Resistance value [2]	20 Ω	10 Ω	10 Ω
Connection method			

[1]   Select a combination that has an absorption capacity greater than the average regeneration power (Pr).

[2]   Do not use a combination with resistance values lower than the allowable minimum regeneration resistance of each drive. For information on the allowable minimum regeneration resistance, refer to *4-4-2 Servo Drive Regeneration Absorption Capacity* on page 4-53.

Precautions for Safe Use

Surface temperatures on regeneration resistance can reach 200°C.
Do not place objects that tend to catch fire nearby. To prevent people from touching them, install a cover that enables heat dissipation.

G5 Series AC Servo Drives With Built-in EtherCAT Communications, Linear Motor Type

5

EtherCAT Communications

This section describes EtherCAT communications under the assumption that the G5-series Servo Drive is connected to the Machine Automation Controller NJ-series (Model: NJ501-1□00) or CJ1W-NC281/NC481/NC881/NCF81/NC482/NC882/F82 Position Control Unit.

5-1   Display Area and Settings

The display area of the G5 Series AC Servo Drives With Built-in EtherCAT Communications, Linear Motor Type is as shown below.
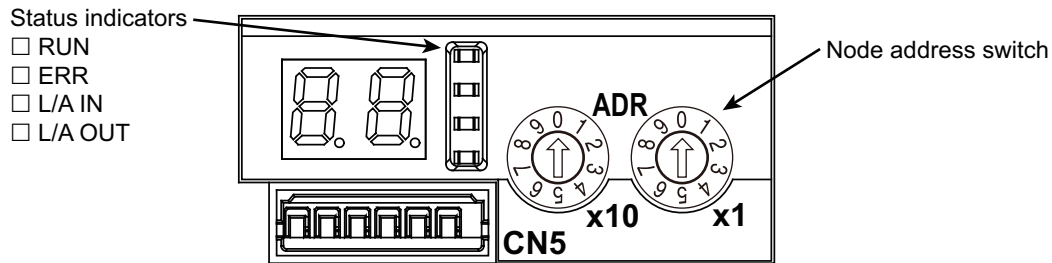
5-1-1   Node Address Setting

The node address switches located in the display area are used to set the EtherCAT node address.

Node address switch setting	Description
	Connection to NJ501-1□00 and CJ1W-NC281/NC481/NC881/NCF81/NC482/NC882/F82 Position Control Unit
00	The controller sets the node address.
01 to 99	The node address switch setting is used as the node address.

Precautions for Correct Use

- Do not change the Node address switch setting after the turning ON the power supply.
- The node address switches can be set to between 00 and 99.
  The node address used over the network is determined by the value set on the node address switches.
  If the node address is not between 00 and 99, a Node Address Setting Error (Error No. 88.0) will occur.

Additional Information

EtherCAT Slave Information File

Information on EtherCAT slave settings is stored in the ESI (EtherCAT Slave Information) file.

Information in this file is used by the master to configure the network and set communications parameters. This information is in an XML file.

5-1-2   Status Indicators

The following table shows the EtherCAT status indicators and their meaning.

Name	Color	Status	Description
RUN	Green	OFF	Init state
		Blinking	Pre-Operational state
		Single flash	Safe-Operational state
		ON	Operational state
ERR	Red	OFF	No error
		Blinking	Communications setting error
		Single flash	Synchronization error or communications data error
		Double flash	Application WDT timeout
		Flickering	Boot error
		ON	PDI WDT timeout
L/A IN	Green	OFF	Link not established in physical layer
		ON	Link established in physical layer
		Flickering	In operation after establishing link
L/A OUT	Green	OFF	Link not established in physical layer
		ON	Link established in physical layer
		Flickering	In operation after establishing link

Indicator status is described below.
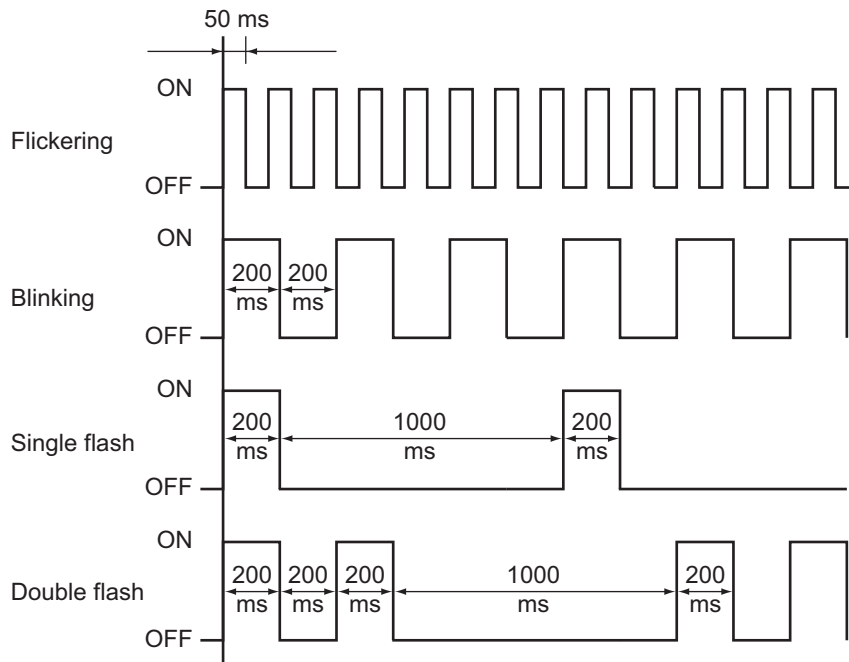
5-2   Structure of the CAN Application Protocol over EtherCAT

The structure of the CAN application protocol over EtherCAT (CoE) for the G5 Series AC Servo Drives With Built-in EtherCAT Communications, Linear Motor Type is described in this section.
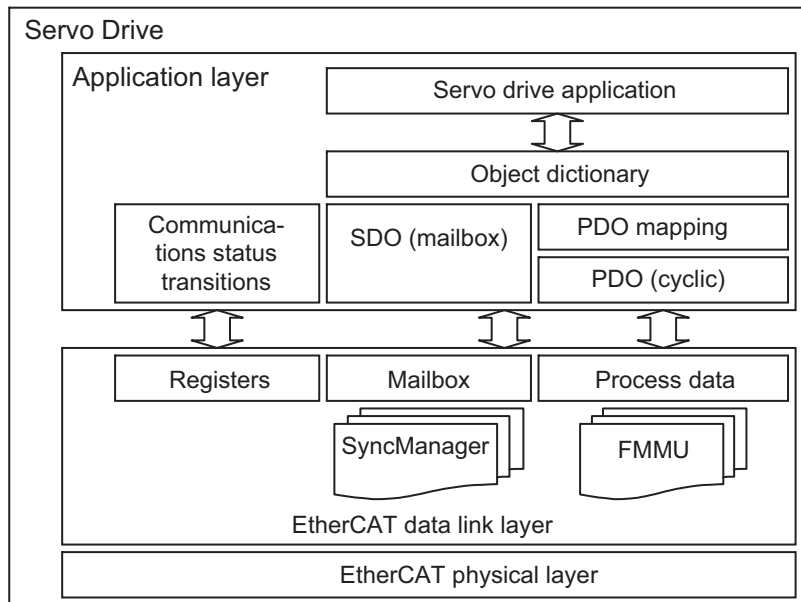
Normally, multiple protocols can be transmitted using EtherCAT. The IEC 61800-7 (CiA 402) drive profile is used for the G5 Series AC Servo Drives With Built-in EtherCAT Communications, Linear Motor Type.

The object dictionary in the application layer contains parameters and application data as well as information on the PDO mapping between the process data servo interface and Servo Drive application.

The process data object (PDO) consists of objects in the object dictionary that can be mapped to the PDO. The contents of the process data are defined by the PDO mapping.

Process data communications cyclically reads and writes the PDO. Mailbox communications (SDO) uses asynchronous message communications where all objects in the object dictionary can be read and written.

5-3   EtherCAT State Machine

The EtherCAT State Machine (ESM) of the EtherCAT slave is controlled by the EtherCAT Master.
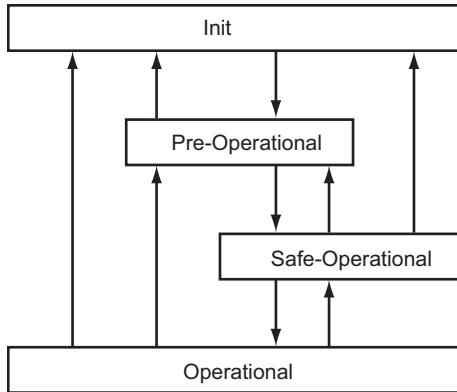
State	SDO communications	PDO reception	PDO transmission	Description
Init	Not possible.	Not possible.	Not possible.	Communications are being initialized. Communications are not possible.
Pre-Operational (Pre-Op)	Possible.	Not possible.	Not possible.	Only mailbox communications are possible in this state. This state is entered after initialization has been completed. It is used to initialize network settings.
Safe-Operational (Safe-Op)	Possible.	Not possible.	Possible.	In this state, PDO transmissions are possible in addition to mailbox communications. DC mode cyclic communications can be used to send information such as status from the Servo Drive.
Operational (Op)	Possible.	Possible.	Possible.	This is a normal operating state. DC mode cyclic communications can be used to control the motor.

5-4   Process Data Objects (PDOs)

The process data objects (PDOs) are used to transfer data during cyclic communications in realtime. PDOs can be reception PDOs (RxPDOs), which receive data from the controller, or transmission PDOs (TxPDOs), which send status from the Servo Drive to the host controller.

```
┌────────────┐      ┌──────────────────────────────────────┐      ┌────────────┐
│            │─────▶│ RxPDO                                │─────▶│            │
│   Host     │      │ Operation command, target position, etc.│      │            │
│            │      └──────────────────────────────────────┘      │ Servo Drive │
│ Controller │      ┌──────────────────────────────────────┐      │            │
│            │◀─────│ TxPDO                                │◀─────│            │
│            │      │ Operation status, actual position, etc │      │            │
└────────────┘      └──────────────────────────────────────┘      └────────────┘
```
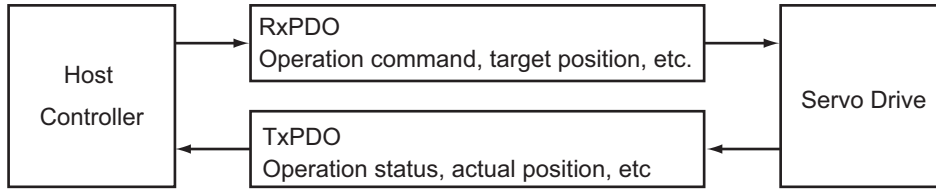
The EtherCAT application layer can hold multiple objects to enable transferring Servo Drive process data. The contents of the process data are described in the PDO Mapping object and the Sync manager PDO assignment object.

G5-series Servo Drives support PDO mapping for position control.

5-4-1   PDO Mapping Settings

The PDO mapping indicates the mapping for application objects (realtime process data) between the object dictionary and PDO.

The number of mapped objects is described in sub-index 00 hex of the mapping table. In this mapping table, 1600 hex to 17FF hex are for RxPDOs and 1A00 hex to 1BFF hex are for TxPDOs.

G5-series Servo Drives can use up to two mappings in 1600 hex and 1701 to 1705 hex for an RxPDO and in 1A00 hex, 1B01 to 1B04 hex, and 1BFF hex for a TxPDO, respectively.

The following table is an example of PDO mapping.

Object Dictionary

Mapping objects

Index	Sub	Object contents	
1ZZZ Hex	01 Hex	6TTT Hex TT Hex	8
1ZZZ Hex	02 Hex	6UUU Hex UU Hex	8
1ZZZ Hex	03 Hex	YYYY Hex YY Hex	16

PDO-Length: 32 bits

PDO_1

Object A	Object B	Object D

Application objects

6TTT Hex	TT Hex	Object A
6UUU Hex	UU Hex	Object B
6VVV Hex	VV Hex	Object C
6YYY Hex	YY Hex	Object D
6ZZZ Hex	ZZ Hex	Object E
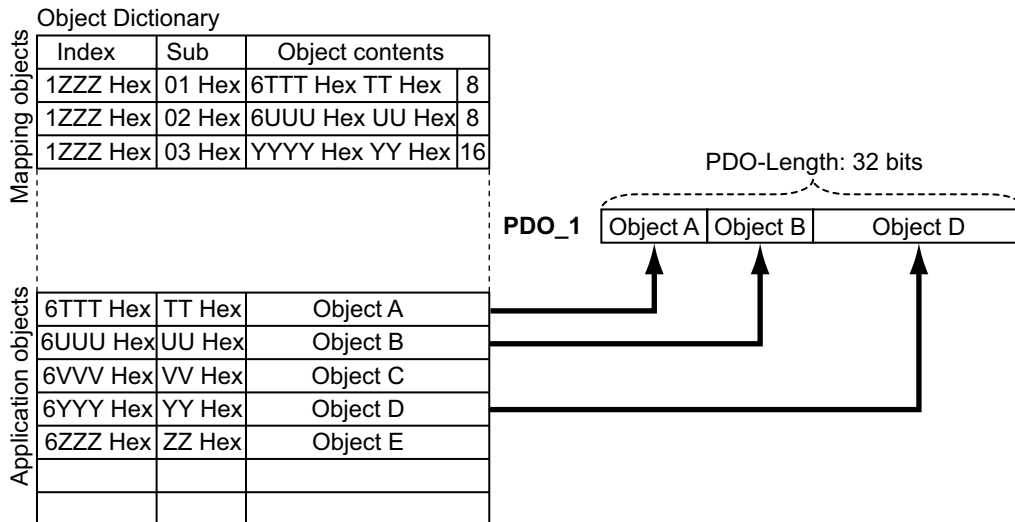
5-4-2   Sync Manager PDO Assignment Settings

A Sync manager channel consists of several PDOs. The Sync manager PDO assignment objects describe how these PDOs are related to the Sync Manager. The number of PDOs is given in sub-index 00 hex of the Sync manager PDO assignment table. In this table, index 1C12 hex is for RxPDOs and 1C13 hex is for TxPDOs.

The following table is an example of sync manager PDO mapping.

Object Dictionary

Index	Sub	Object contents
1C1z Hex	1	1A00 Hex
1C1z Hex	2	1A01 Hex
1C1z Hex	3	1A03 Hex

Sync Manager PDO Assign objects

Sync Manager Entity z

PDO A	PDO B	PDO D

Mapping objects

1A00 Hex	PDO A
1A01 Hex	PDO B
1A02 Hex	PDO C
1A03 Hex	PDO D
1A04 Hex	PDO E
1A05 Hex	PDO F
1A06 Hex	PDO G
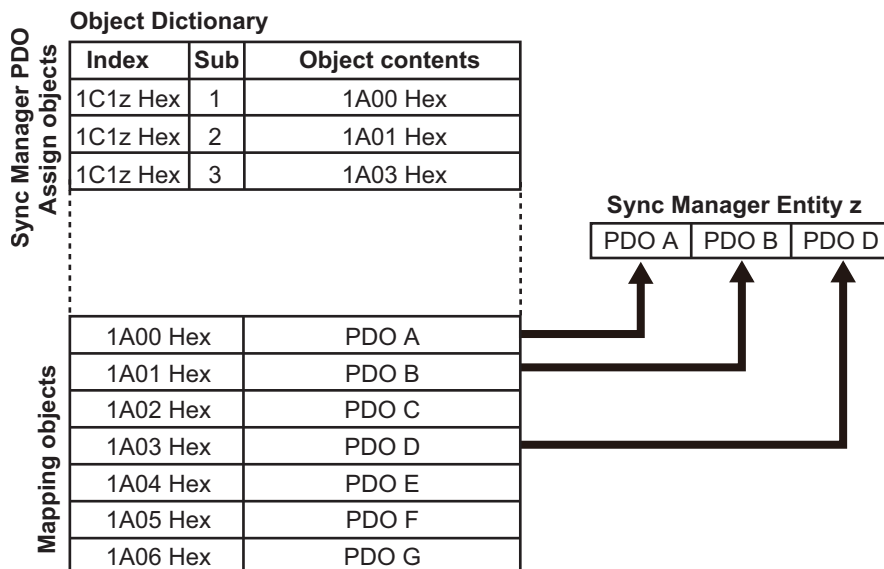
5-4-3   Fixed PDO Mapping

This section describes the contents of fixed PDO mapping for G5-series Servo Drives. This contents cannot be changed.

The PDO mapping to be used is specified in Sync Manager 2 PDO Assignment (1C12 hex) and Sync Manager 3 PDO Assignment (1C13 hex).

Some typical examples of RxPDO and TxPDO combinations are provided below.

PDO Mapping 1 (Position Control and Touch Probe Function)

This object gives the mapping for an application that uses only cyclic synchronous position mode (csp). Touch probe function is available.

RxPDO (1701 hex)	Controlword (6040 hex), Target position (607A hex), Touch probe function (60B8 hex), and Digital outputs (60FE hex)
TxPDO (1B01 hex)	Error code (603F hex), Statusword (6041 hex), Position actual value (6064 hex), Torque actual value (6077 hex), Following error actual value (60F4 hex), Touch probe status (60B9 hex), Touch probe pos1 pos value (60BA hex), Touch probe pos2 pos value (60BC hex), and Digital inputs (60FD hex)

PDO Mapping 2 (Position Control, Speed Control, Force Control, and Touch Probe Function)

This is the mapping for an application that uses one of the following modes: Cyclic synchronous position mode (csp), Cyclic synchronous velocity mode (csv), and Cyclic synchronous torque mode (cst). Touch probe function is available.

RxPDO (1702 hex)	Controlword (6040 hex), Target position (607A hex), Target velocity (60FF hex), Target torque (6071 hex), Modes of operation (6060 hex), Touch probe function (60B8 hex), and Max profile velocity (607F hex)
TxPDO (1B02 hex)	Error code (603F hex), Statusword (6041 hex), Position actual value (6064 hex), Torque actual value (6077 hex), Modes of operation display (6061 hex), Touch probe status (60B9 hex), Touch probe pos1 pos value (60BA hex), Touch probe pos2 pos value (60BC hex), and Digital inputs (60FD hex)

PDO Mapping 3 (Position Control, Speed Control, Touch Probe Function, and Force Limit)

This is the mapping for an application that switches between Cyclic synchronous position mode (csp) and Cyclic synchronous velocity mode (csv). Touch probe function and force limit can be used.

RxPDO (1703 hex)	Controlword (6040 hex), Target position (607A hex), Target velocity (60FF hex), Modes of operation (6060 hex), Touch probe function (60B8 hex), Positive torque limit value (60E0 hex), and Negative torque limit value (60E1 hex)
TxPDO (1B03 hex)	Error code (603F hex), Statusword (6041 hex), Position actual value (6064 hex), Torque actual value (6077 hex), Following error actual value (60F4 hex), Modes of operation display (6061 hex),Touch probe status (60B9 hex), Touch probe pos1 pos value (60BA hex), Touch probe pos2 pos value (60BC hex), and Digital inputs (60FD hex)

PDO Mapping 4 (Position Control, Speed Control, Force Control, Touch Probe Function, and Force Limit)

This is the mapping for an application that uses one of the following modes: Cyclic synchronous position mode (csp), Cyclic synchronous velocity mode (csv), and Cyclic synchronous torque mode (cst). Touch probe function and force limit can be used.

RxPDO (1704 hex)	Controlword (6040 hex), Target position (607A hex), Target velocity (60FF hex), Target torque (6071 hex), Modes of operation (6060 hex), Touch probe function (60B8 hex), Max profile velocity (607F hex), Positive torque limit value (60E0 hex), and Negative torque limit value (60E1 hex)
TxPDO (1B04 hex)	Error code (603F hex), Statusword (6041 hex), Position actual value (6064 hex), Torque actual value (6077 hex), Modes of operation display (6061 hex), Touch probe status (60B9 hex), Touch probe pos1 pos value (60BA hex), Touch probe pos2 pos value (60BC hex), and Digital inputs (60FD hex)

PDO Mapping 5 (Position Control, Speed Control, Touch Probe Function, Force Limit, and Force FF)

This is the mapping for an application that switches between Cyclic synchronous position mode (csp) and Cyclic synchronous velocity mode (csv). Touch probe function and force limit can be used. The force feed-forward amount can be specified by using the Torque offset (60B2 hex).

RxPDO (1705 hex)	Controlword (6040 hex), Target position (607A hex), Target velocity (60FF hex), Modes of operation (6060 hex), Touch probe function (60B8 hex), Positive torque limit value (60E0 hex), Negative torque limit value (60E1 hex), and Torque offset (60B2 hex)
TxPDO (1B05 hex)	Error code (603F hex), Statusword (6041 hex), Position actual value (6064 hex), Torque actual value (6077 hex), Modes of operation display (6061 hex), Following error actual value (60F4 hex), Touch probe status (60B9 hex), Touch probe pos1 pos value (60BA hex), Digital inputs (60FD hex), and Velocity actual value (606C hex)

5-4-4   Variable PDO Mapping

G5 Series AC Servo Drives With Built-in EtherCAT Communications, Linear Motor Type allow you to change the object mappings.

The PDO mappings for which you can change the mapped objects are the 1st receive PDO Mapping (1600 hex) and the 1st transmit PDO Mapping (1A00 hex).

To change the object mappings, set these values in Sync Manager 2 PDO Assignment (1C12 hex) and in Sync Manager 3 PDO Assignment (1C13 hex), respectively.

These object mappings can be changed only when the EtherCAT communications state is Pre-Operational (Pre-Op). Since the mappings you changed are not saved in EEPROM, you must specify objects each time you turn ON the power of the G5-series Servo Drive in order to use the mapping other than the default setting.

Default Setting

RxPDO (1600 hex)	Controlword (6040 hex), Target position (607A hex), and Touch probe function (60B8 hex)
TxPDO (1A00 hex)	Error code (603F hex), Statusword (6041 hex), Position actual value (6064 hex), Touch probe status (60B9 hex), Touch probe pos1 pos value (60BA hex), Touch probe pos2 pos value (60BC hex), and Digital inputs (60FD hex)

Maximum Number of Objects and Maximum Total Size Allowed in a PDO Mapping

PDO Mapping Object	Max. No. of Objects	Max. Total Size of Objects
RxPDO (1600 hex)	10	24 bytes
TxPDO (1A00 hex)	10	30 bytes[*1]

*1   When you assign the PDO mapping other than 1A00 hex simultaneously to TxPDO, total size must be 30 bytes or less. For example, if you assign 1BFF hex simultaneously, the total size of objects in 1A00 hex will be 29 bytes or less.

Precautions for Correct Use

- The communications cycle you can set varies depending on the total size of mapped objects. Refer to *A-1-3 Communications Cycles and Corresponding Modes of Operation* on page A-5 for details.
- If the size of the mapped objects exceeds the maximum total size, a Function Setting Error (Error No. 93.4) will occur.
- For information on the maximum number of objects allowed in a PDO Mapping, refer to *A-1-9 PDO Mapping Objects* on page A-30

5-4-5   Multiple PDO Mapping

G5 Series AC Servo Drives With Built-in EtherCAT Communications, Linear Motor Type allow you to use combinations of up to two PDO mappings.

To use multiple object mappings, select two PDO mappings in Sync manager 2 PDO assignment (1C12 hex) and Sync manager 3 PDO assignment (1C13 hex), respectively.

This maps the object you selected with sub-index 01 (hex) at first and then the object you selected with sub-index 02 (hex).

If you map the same object more than once, the value of the last object will be enabled.

These object mappings can be changed only when the EtherCAT communications state is Pre-Operational (Pre-Op). Since the mappings you changed are not saved in EEPROM, you must specify objects each time you turn ON the power of the G5-series Servo Drive in order to use the mapping other than the default setting.

Default Setting

Receive PDO mapping (RxPDO)	Transmit PDO mapping (TxPDO)
• 1701 hex	• 1B01 hex

Available PDO Mapping Combinations

Receive PDO mapping (RxPDO)[1]	Transmit PDO mapping (TxPDO) [2]
• One of the mappings in 1701 to 1705 hex and another in 1600 hex	• One of the mappings in 1B01 to 1B04 hex and another in 1A00 hex
	• One of the mappings in 1B01 to 1B04 hex and another in 1BFF hex
	• One mapping in 1A00 hex and another in 1BFF hex

[1]   A maximum of 10 objects in total can be mapped to the Receive PDO mapping.

[2]   A maximum of 11 objects in total can be mapped to the Transmit PDO mapping.

Precautions for Correct Use

- The communications cycle you can set varies depending on the total size of mapped objects. Refer to *A-1-3 Communications Cycles and Corresponding Modes of Operation* on page A-5 for details.
- If the size of the mapped objects exceeds the maximum total size, a Function Setting Error (Error No. 93.4) will occur.
- If the number of the mapped objects exceeds the maximum allowed number, a Function Setting Error (Error No. 93.4) will occur.

5-5   Service Data Objects (SDOs)

G5-series Servo Drives support SDO communications. SDO communications are used for setting objects and monitoring the status of G5-series Servo Drives. Objects can be set and the status monitored by reading and writing data to the entries in the object dictionary of the host controller.

● **Abort Codes**

The following table lists the abort codes for when an SDO communications error occurs.

Abort Codes	Meaning
0503 0000 hex	Toggle bit not changed
0504 0000 hex	SDO protocol timeout
0504 0001 hex	Client/Server command specifier not valid or unknown
0504 0005 hex	Out of memory
0601 0000 hex	Unsupported access to an object
0601 0001 hex	Attempt to read a write only object
0601 0002 hex	Attempt to write to a read only object
0602 0000 hex	The object does not exist in the object directory
0604 0041 hex	The object can not be mapped into the PDO.
0604 0042 hex	The number and length of the objects to be mapped would exceed the PDO length.
0604 0043 hex	General parameter incompatibility reason
0604 0047 hex	General internal incompatibility in the device.
0606 0000 hex	Access failed due to a hardware error.
0607 0010 hex	Data type does not match, length of service parameter does not match
0607 0012 hex	Data type does not match, length of service parameter too high
0607 0013 hex	Data type does not match, length of service parameter too low
0609 0011 hex	Subindex does not exist
0609 0030 hex	Value range of parameter exceeded (only for write access)
0609 0031 hex	Value of parameter written too high
0609 0032 hex	Value of parameter written too low
0609 0036 hex	Maximum value is less than minimum value
0800 0000 hex	General error
0800 0020 hex	Data cannot be transferred or stored to the application
0800 0021 hex	Data cannot be transferred or stored to the application because of local control
0800 0022 hex	Data cannot be transferred or stored to the application because of the present device state
0800 0023 hex	Object dictionary dynamic generation fails or no object dictionary is present

5-6   Synchronization with Distributed Clocks

A mechanism called a distributed clock (DC) is used to synchronize EtherCAT communications.

The DC mode is used for G5-series Servo Drives to perform highly accurate control in a multi-axis system.

In DC mode, the master and slaves are synchronized by sharing the same clock.

Interruptions (Sync0) are generated in the slaves at precise intervals based on this clock.

Servo Drive control is carried out at this precise timing.

● Communications Cycle (DC Cycle)

The communications cycle is determined by setting the Sync0 signal output cycle.

Setting range: 250 μs/500 μs/1 ms/2 ms/4 ms

Precautions for Correct Use

- Set 6091 hex (Gear ratio) to 1:1 for 250 μs or 500 μs.
  If it is not set to 1:1, a Function Setting Error (Error 93.4) will occur.
- The communications cycle you can set varies depending on conditions such as the Servo Drive unit version or the modes of operation in use. For details on the communications cycle you can set, refer to *A-1-3 Communications Cycles and Corresponding Modes of Operation* on page A-5
- The setting range for the communications cycle varies depending on the master. For example, Machine Automation Controllers NJ-series (Model: NJ501-1□00) do not provide the setting of 250 μs.
  In addition, Position Control Unit (Model: CJ1W-NC□8□) do not provide the setting of 4 ms.

5-7   Emergency Messages

When an error or warning occurs in a G5-series Servo Drive, an emergency message is sent to the master using mailbox communications. An emergency message is not sent for a communications error.

You can select whether to send emergency messages by setting Diagnosis History (10F3 hex).

In the default setting, the Diagnosis History object (10F3 hex, Sub: 05 hex (Flags)) is 0 and no emergency message will be sent.

To send emergency messages, set the sub-index 05 hex (Flags) in the Diagnosis History object 10F3 hex to 1 every time the power is turned ON.

Emergency messages consist of 8 bytes of data.

Byte	0	1	2	3	4	5	6	7
Contents	Emergency Error Code[1]		Error Register (1001 hex)		Manufacturer Specific Error Field (Reserved)			

*1   Error codes (FF00 hex to FFFF hex) in the manufacturer-specific area are used.

📖 **Additional Information**

- For details on errors and warnings of the Servo Drive, refer to *Section 12 Troubleshooting and Maintenance*.
- For details on error event codes, refer to *A-3 Sysmac Error Status Codes* on page A-93.

5-8   Sysmac Device Features

The control device product designed according to standardized communications and user interface specifications for OMRON control devices are called a Sysmac Device.

And the features available with such a Device is called Sysmac Device Features.
This section describes the features the G5-series Servo Drive provides when combined with a Machine Automation Controller such as NJ series and automation software.

● Sysmac Error Status

Because, in Sysmac Devices, errors that may occur in slaves are systematized, you can check the causes and remedies for errors with a common procedure.

The status of an error can be monitored in the Sysmac Error Status (2002-01 hex). To display the error status detected by the G5-series Servo Drive in Sysmac Studio, the Sysmac Error Status (2002-01 hex) must be mapped to the PDO. Sysmac Studio, by default, uses the 512th transmit PDO Mapping assignment to map the Sysmac Error Status (2002-01 hex) automatically to the PDO.

Additional Information

- For the Sysmac Error Status (2002-01 hex), refer to *A-1-11 Manufacturer Specific Objects* on page A-48.
- For errors displayed in Sysmac Studio, refer to *A-3 Sysmac Error Status Codes* on page A-93.

● Saving the Node Address Setting

When the node address switch setting is "00" (Software Setup mode), the node address value you set in Sysmac Studio is enabled.

In the Software Setup mode, in Sysmac Studio, execute [Write Slave Node Address] on the [EtherCAT Edit] screen to save the slave node address setting in the nonvolatile memory of the G5-series Servo Drive.

Software Setting

The set value saved as Slave Information Interface (SII) information in the nonvolatile memory of the slave is the node address.

EtherCAT master

(1) The Node Address Switch is set to "00" at power OFF.
(2) Write a node address set value to Slave SII from the master.
(3) The value of the node address setting is applied to Register: 0012 hex by the software, when the slave power is ON.
(4) EtherCAT master reads the set value of Register: 0012 hex.
(5) EtherCAT master writes the value of 0012 hex address to 0010 hex address as the node address value.

Node Address Switch Setting

The value set on the node address switches is the node address.

(1) The Node Address Switch is set at power OFF.
(2) The value of Node Address Switch is applied to Register: 0012 hex, when the slave power is ON.
(3) EtherCAT master reads the set value of Register: 0012 hex.
(4) EtherCAT master writes the value of 0012 hex address to 0010 hex address as the node address value.
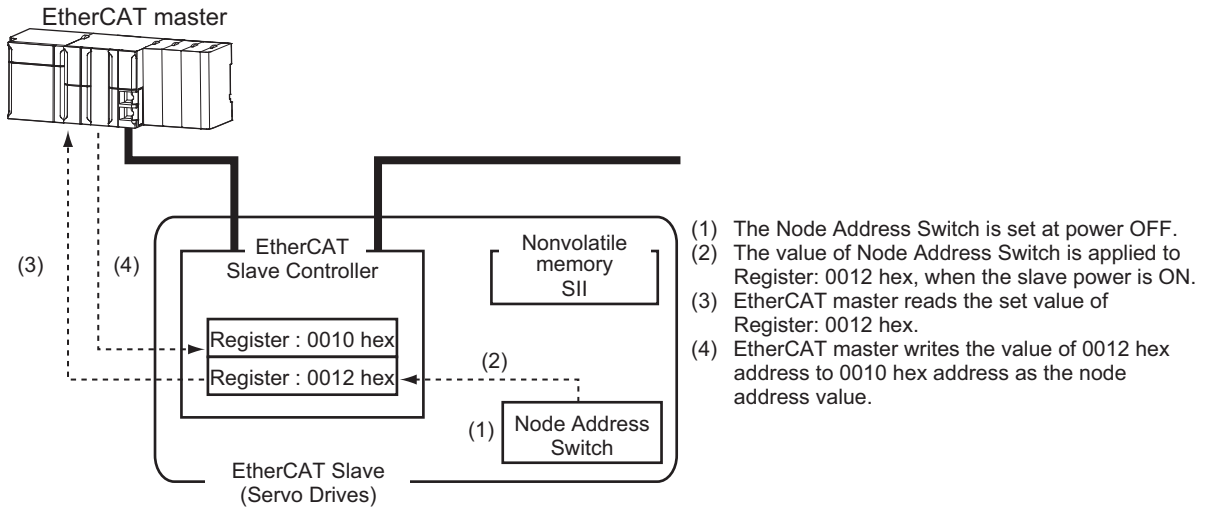
● **Serial Number Display**

The serial number saved in the nonvolatile memory of the G5-series Servo Drive is displayed in the Serial Number (1018-04 hex). Controllers that support Sysmac Device Features can use this serial number to check the network configuration.

To enable this check, in Sysmac Studio, set [Serial No. Check Condition] to [Set Value = Actual Unit] on the [EtherCAT Edit] screen.

If the set condition is not met, a Network Configuration Check Error will occur.

Additional Information

This network configuration check detects any slave devices that have been replaced, which prevents you from forgetting to set parameters on those slaves.

● **Compliance with ESI Specification (ETG.2000 S (R) V1.0.1)**

The ESI Specification is a set of specifications that define the entries required in an EtherCAT Slave Information (ESI) file.

Controllers that support Sysmac Device Features can use the Option function defined in the ESI Specification to identify the backup parameters stored on slaves.

The backup parameters on an identified slave can be backed up and restored from Sysmac Studio.

For the parameters backed up with the G5-series Servo Drive, refer to *Store Parameters* on page A-26.

● **SII Data Check**

The Slave Information Interface (SII) is an interface area in the nonvolatile memory of an EtherCAT slave that stores the configuration information specific to that EtherCAT slave.

Sysmac Device EtherCAT slaves check the SII information from the slave side.

If one of these slaves finds that SII information with which it cannot operate was written, it generates an SII Check Error (Error No. 88.3).If this error persists even after turning OFF and then ON the power again, contact your OMRON sales representative.

Precautions for Correct Use

Do not use third-party or any other configuration tools to edit the SII information.

6

Basic Control Functions

This section explains an outline of basic control functions and explains the contents of setting.

6-1   Cyclic Synchronous Position Mode

In this mode of operation, the controller has a path generation function (an operation profile calculation function) and it gives the target position to the Servo Drive using cyclic synchronization. Position control, speed control, and force control are performed by the Servo Drive.

The Velocity offset (60B1 hex) and Torque offset (60B2 hex) can be used as speed feed-forward and force feed-forward amounts.

> ✅ **Precautions for Correct Use**
>
> According to the CiA 402 Drive Profile, the object names between 6000 hex and 6999 hex may be represented using the word "torque," instead of force. Read it as "force" when using these objects.

Cyclic Synchronous Position Mode Configuration

The following diagram shows the configuration of the Cyclic synchronous position mode.
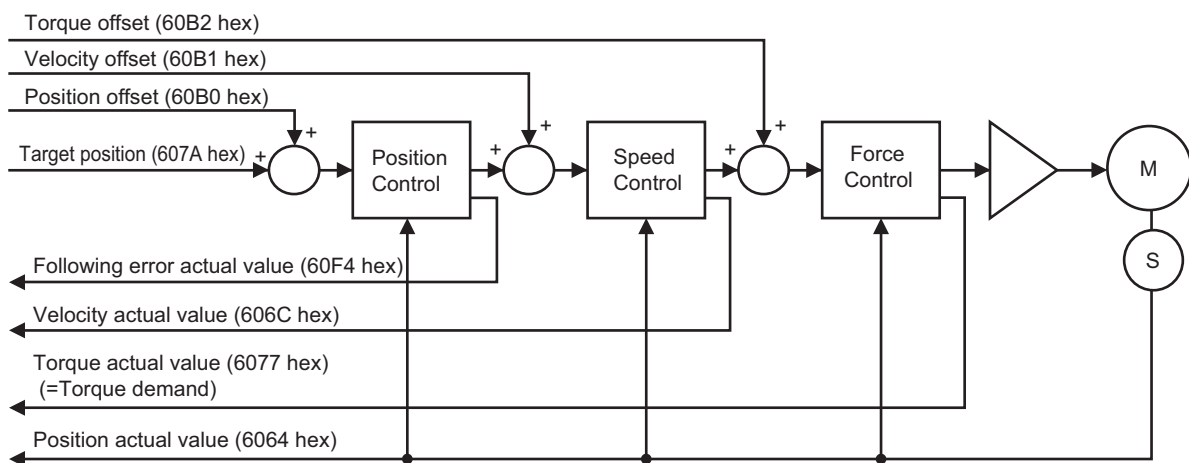
The following diagram shows the configuration of the control function of the Cyclic synchronous position mode.
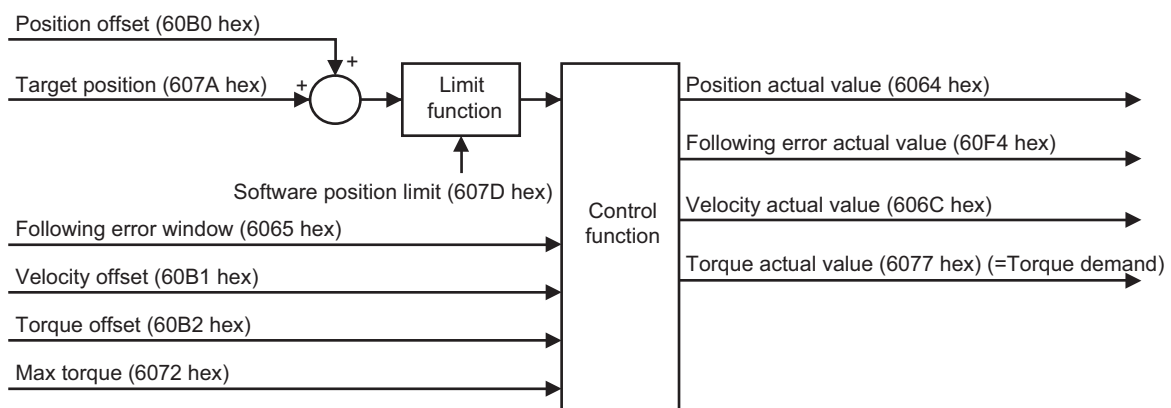
6-1-1   Related Objects

Index	Sub-index	Name	Access	Size	Unit	Setting range	Default setting
6040 hex	00 hex	Controlword	RW	U16	–	0 to FFFF hex	0000 hex
6060 hex	00 hex	Modes of operation	RW	INT8	–	0 to 10	0
607A hex	00 hex	Target position	RW	INT32	Command units	−2,147,483,648 to 2,147,483,647	0000 hex
6065 hex[1]	00 hex	Following error window	RW	U32	Command units	0 to 134,217,728, or 4,294,967,295	100000
6072 hex	00 hex	Max torque	RW	U16	0.1%	0 to 5,000	5000
60B0 hex	00 hex	Position offset	RW	INT32	Command units	−2,147,483,648 to 2,147,483,647	0000 hex
60B1 hex	00 hex	Velocity offset	RW	INT32	Command units/s	−2,147,483,648 to 2,147,483,647	0000 hex
60B2 hex	00 hex	Torque offset	RW	INT16	0.1%	−5,000 to 5,000	0
6041 hex	00 hex	Statusword	RO	U16	–	0 to FFFF hex	0000 hex
6064 hex	00 hex	Position actual value	RO	INT32	Command units	−2,147,483,648 to 2,147,483,647	0000 hex
606C hex	00 hex	Velocity actual value	RO	INT32	Command units/s	−2,147,483,648 to 2,147,483,647	0000 hex
6077 hex	00 hex	Torque actual value	RO	INT16	0.1%	−5,000 to 5,000	0000 hex
60F4 hex	00 hex	Following error actual value	RO	INT32	Command units	−2,147,483,648 to 2,147,483,647	0000 hex

*1   The Following error window object can be set to between 0 and 134,217,728, or 4,294,967,295. If the object is set to 4,294,967,295, the detection of Following error will be disabled. If it is set to 0, a Following error will always occur. If the set value is between 134,217,729 and 4,294,967,294, it is set to 134,217,728. In this case, 134,217,728 will be returned when the object is read.

6-1-2   Block Diagram for Position Control Mode

The following block diagram is for position control using an R88D-KN□□□-ECT-L-series Servo Drive.
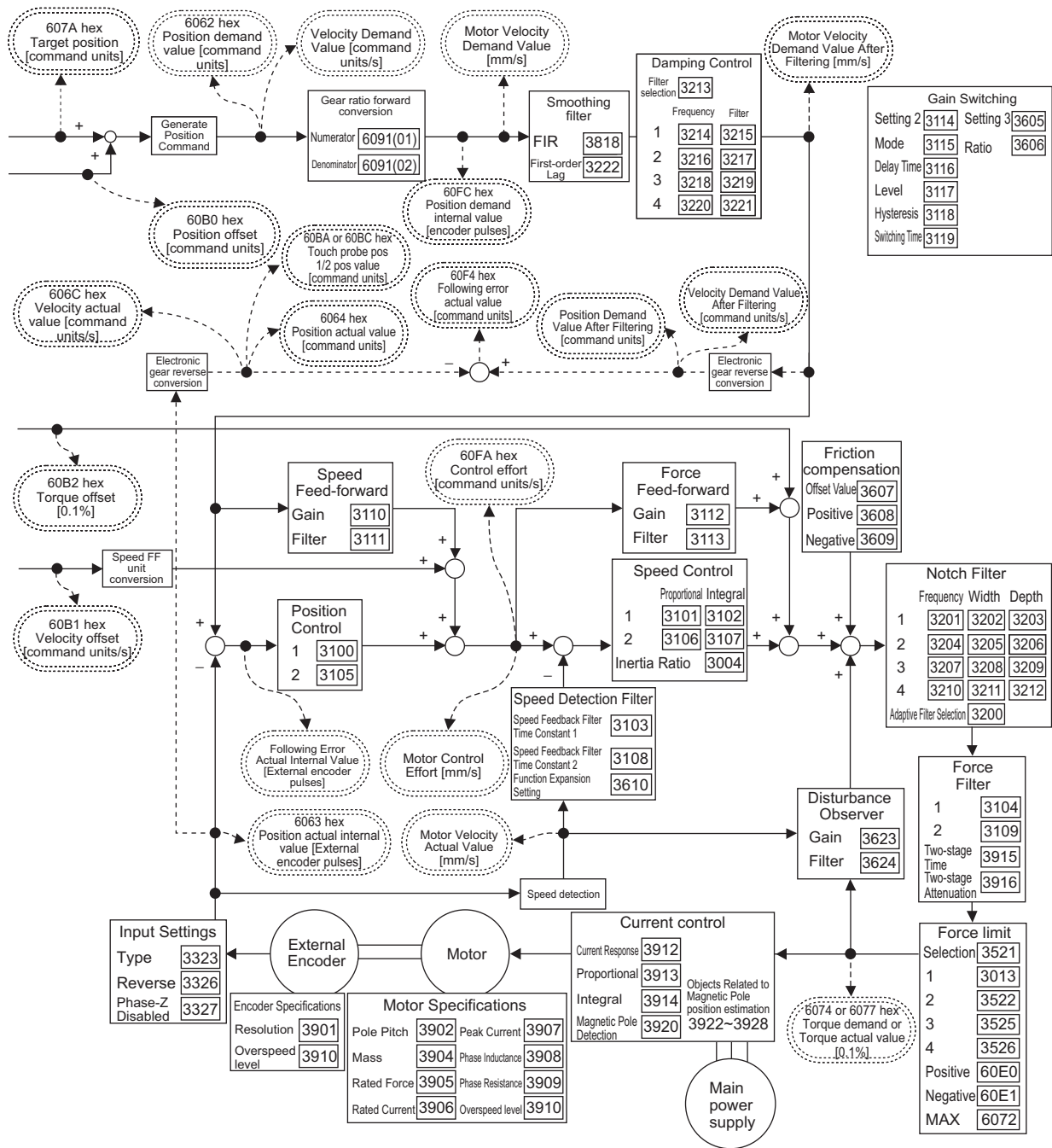
Note 1 Numbers within parentheses are sub-index numbers.

  2 Numbers within boxes are hexadecimal index numbers.

  3 Profile position mode (pp) and Homing mode (hm) are also included in this block diagram.

  4 Read the word "torque" as "force."

6-2 Cyclic Synchronous Velocity Mode

In this mode of operation, the controller has a path generation function (an operation profile calculation function) and it gives the target speed to the Servo Drive using cyclic synchronization. Speed control and force control are performed by the Servo Drive.

The Torque offset (60B2 hex) can be used as the force feed-forward amount.

✔ **Precautions for Correct Use**

According to the CiA 402 Drive Profile, the object names between 6000 hex and 6999 hex may be represented using the word "torque," instead of force. Read it as "force" when using these objects.

Cyclic Synchronous Velocity Mode Configuration

The following diagram shows the configuration of the Cyclic synchronous velocity mode.
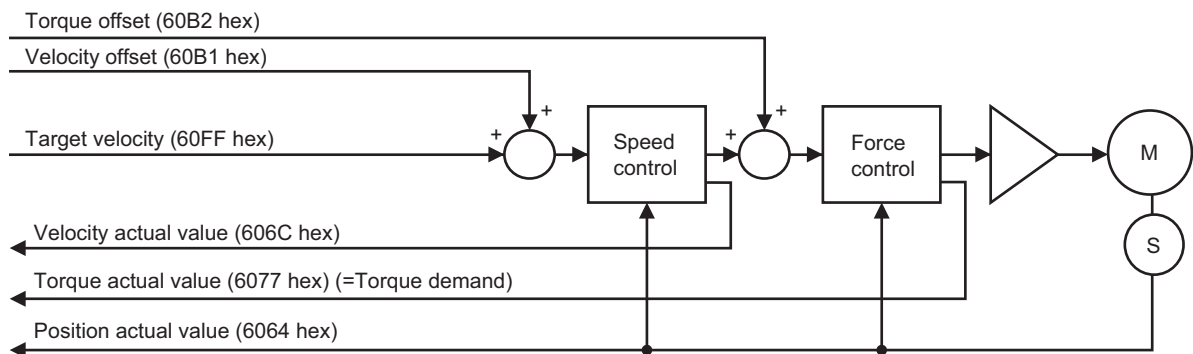
The following diagram shows the control function configuration of the Cyclic synchronous velocity mode.
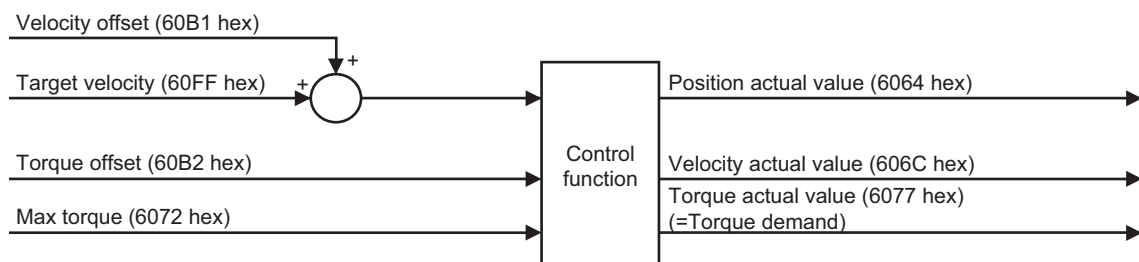
6-2-1   Related Objects

Index	Sub-index	Name	Access	Size	Unit	Setting range	Default setting
6040 hex	00 hex	Controlword	RW	U16	–	0 to FFFF hex	0000 hex
6060 hex	00 hex	Modes of operation	RW	INT8	–	0 to 10	0
60FF hex	00 hex	Target velocity	RW	INT32	Command units/s	−2,147,483,648 to 2,147,483,647	0000 hex
6072 hex	00 hex	Max torque	RW	U16	0.1%	0 to 5,000	5000
60B1 hex	00 hex	Velocity offset	RW	INT32	Command units/s	−2,147,483,648 to 2,147,483,647	0000 hex
60B2 hex	00 hex	Torque offset	RW	INT16	0.1%	−5,000 to 5,000	0
6041 hex	00 hex	Statusword	RO	U16	–	0 to FFFF hex	0000 hex
6064 hex	00 hex	Position actual value	RO	INT32	Command units	−2,147,483,648 to 2,147,483,647	0000 hex
606C hex	00 hex	Velocity actual value	RO	INT32	Command units/s	−2,147,483,647 to 2,147,483,647	0000 hex
6077 hex	00 hex	Torque actual value	RO	INT16	0.1%	−5,000 to 5,000	0000 hex

6-2-2   Objects Requiring Settings

Index	Name	Description	Reference
3312 hex	Soft Start Acceleration Time	Set the acceleration time for internally set speed control. Set the time until 1,000 mm/s is reached.	page 9-23
3313 hex	Soft Start Deceleration Time	Set the deceleration time for internally set speed control. Set the time until 1,000 mm/s is reached.	page 9-23
3314 hex	S-curve Acceleration/ Deceleration Time Setting	Set the S-curve time in the time width centered on the inflection points for acceleration and deceleration.	page 9-24

6-2-3   Related Functions

Index	Name	Description	Reference
3435 hex	Speed Conformity Detection Range	Set the detection threshold for speed conformity output. If the difference between the speed command and motor speed is within the set threshold, a speed conformity output is output. This setting has a hysteresis of 10 mm/s for detection.	page 9-33
3436 hex	Speed for Motor Detection	Set the detection threshold for the Motor Speed Detection Output (TGON). A Motor Speed Detection Output (TGON) is output when the motor speed exceeds the set value. This setting has a hysteresis of 10 mm/s for detection.	page 9-34

6-2-4   Block Diagram for Speed Control Mode

The following block diagram is for speed control using an R88D-KN□□□-ECT-L-series Servo Drive.

Gain Switching
Setting 2 | 3114
Mode | 3120
Delay Time | 3121
Level | 3122
Hysteresis | 3123

60B2 hex
Torque offset
[0.1%]

60B1 hex
Velocity offset
[command units/s]

60FF hex
Target velocity
[command units/s]

606C hex
Velocity actual value
[command units/s]

6064 hex
Position actual value
[command units/s]

6063 hex
Position actual
internal value
[External encoder pulses]

Motor Control
Effort [mm/s]

Speed unit
conversion

Acceleration Limits
Acceleration Time | 3312
Deceleration Time | 3313
S-curve | 3314

Force feed forward
Gain | 3112
Filter | 3113

Speed Control
| | Linear | Integral
1 | 3101 | 3102
2 | 3106 | 3107
Mass | | 3004

Speed Detection Filter
Speed Feedback Filter Time Constant 1 | 3103
Speed Feedback Filter Time Constant 2 | 3108
Function Expansion Setting | 3610

Motor Velocity
Actual Value

Friction compensation
Offset Value | 3607
Positive | 3608
Negative | 3609

Notch Filter
| Frequency | Width | Depth
1 | 3201 | 3202 | 3203
2 | 3204 | 3205 | 3206
3 | 3207 | 3208 | 3209
4 | 3210 | 3211 | 3212
Adaptive Filter Selection | 3200

Force Filter
1 | 3104
2 | 3109
Two-stage Time | 3915
Two-stage Attenuation | 3916

Disturbance Observer
Gain | 3623
Filter | 3624

Force limit
Selection | 3521
1 | 3013
2 | 3522
3 | 3525
4 | 3526
Positive | 60E0
Negative | 60E1
MAX | 6072

6074 or 6077 hex
Torque demand or
Torque actual value
[0.1%]

Electronic gear
reverse conversion
Numerator | 6091 (01)
Denominator | 6092 (02)

60BA or 60BC hex
Touch probe pos
1/2 pos value
[command units]

Input Settings
Type | 3323
Reverse | 3326
Phase-Z Disabled | 3327

External Encoder

Motor

Speed detection

Current control
Current Response | 3912
Proportional | 3913
Integral | 3914
Magnetic Pole Detection | 3920
Objects Related to Magnetic Pole position estimation | 3922~3928

Main power supply

Encoder Specifications
Resolution | 3901
Overspeed level | 3910

Motor Specifications
Pole Pitch | 3902 | Peak Current | 3907
Mass | 3904 | Phase Inductance | 3908
Rated Force | 3905 | Phase Resistance | 3909
Rated Current | 3906 | Overspeed level | 3910

Note 1 Numbers within parentheses are sub-index numbers.

   2 Numbers within boxes are hexadecimal index numbers.

   3 Read the word "torque" as "force."

6-3   Cyclic Synchronous Torque Mode

In this mode of operation, the controller has a path generation function (an operation profile calculation function) and it gives the target torque (force) to the Servo Drive using cyclic synchronization. Force control is performed by the Servo Drive.

Precautions for Correct Use

According to the CiA 402 Drive Profile, the object names between 6000 hex and 6999 hex may be represented using the word "torque," instead of force. Read it as "force" when using these objects.

Cyclic Synchronous Torque Mode Configuration

The following diagram shows the configuration of the Cyclic synchronous torque mode.

Torque offset (60B2 hex)

Target torque (6071 hex)

Force control

M

S

Torque actual value (6077 hex) (=Torque demand)

Velocity actual value (606C hex)

Position actual value (6064 hex)

The following diagram shows the configuration of the Cyclic synchronous torque mode.

Torque offset (60B2 hex)

Target torque (6071 hex)

Max torque (6072 hex)

Max profile velocity (607F hex)

Control function

Position actual value (6064 hex)

Velocity actual value (606C hex)

Torque actual value (6077 hex) (=Torque demand)
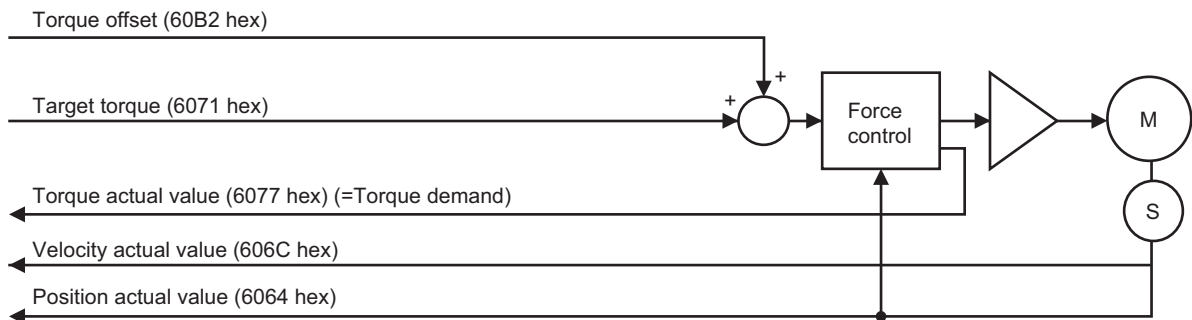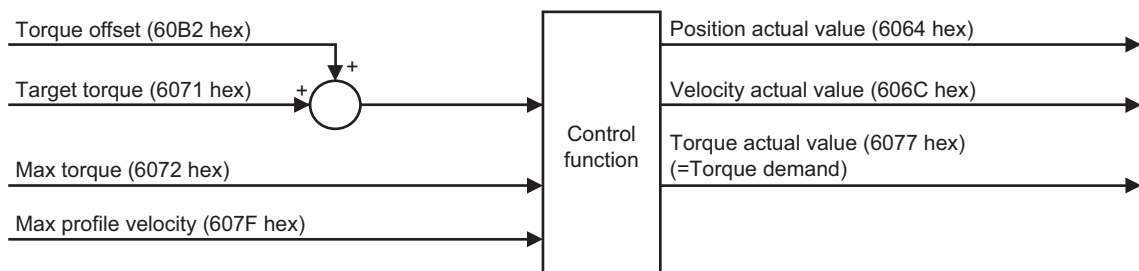
6-3-1   Related Objects

Index	Sub-index	Name	Access	Size	Unit	Setting range	Default setting
6040 hex	00 hex	Controlword	RW	U16	–	0 to FFFF hex	0000 hex
6060 hex	00 hex	Modes of operation	RW	INT8	–	0 to 10	0
6071 hex	00 hex	Target torque	RW	INT16	0.1%	−5,000 to 5,000	0000 hex
6072 hex	00 hex	Max torque	RW	U16	0.1%	0 to 5,000	5000
607F hex	00 hex	Max profile velocity	RW	U32	Command units/s	0 to 2,147,483,647	0000 hex
60B2 hex	00 hex	Torque offset	RW	INT16	0.1%	−5,000 to 5,000	0
6041 hex	00 hex	Statusword	RO	U16	–	0 to FFFF hex	0000 hex
6064 hex	00 hex	Position actual value	RO	INT32	Command units	−2,147,483,648 to 2,147,483,647	0000 hex
606C hex	00 hex	Velocity actual value	RO	INT32	Command units/s	−2,147,483,648 to 2,147,483,647	0000 hex
6077 hex	00 hex	Torque actual value	RO	INT16	0.1%	−5,000 to 5,000	0000 hex

6-3-2   Objects Requiring Settings

Index	Name	Description	Reference
3317 hex	Speed Limit Selection	Select the input location for the speed limit.	page 9-24

Speed Limit Selection (3317 hex)

Restricts the speed as the protection during force control.

Controls that the speed does not exceed the Speed Limit during force control.

Index	Name	Description	Setting range	Unit
3317 hex	Speed Limit Selection	Selects the input type of the Speed Limit during force control. 0: Control the speed by the Speed Limit Value Setting (3321 hex). 1: Control the speed by either one of the smaller value: the Max Profile Velocity (607F hex) by EtherCAT communications, or the Speed Limit Value Setting (3321 hex)	0 to 1	–

6-3-3   Related Functions

Index	Name	Description	Reference
3321 hex	Speed Limit Value Setting	Set the speed limit value applicable during force control. During force control, the speed is controlled so as not to exceed the level set by the speed limit value.	page 9-24

6-3-4   Block Diagram for Force Control Mode

The following block diagram is for force control using an R88D-KN□□□-ECT-L-series Servo Drive.
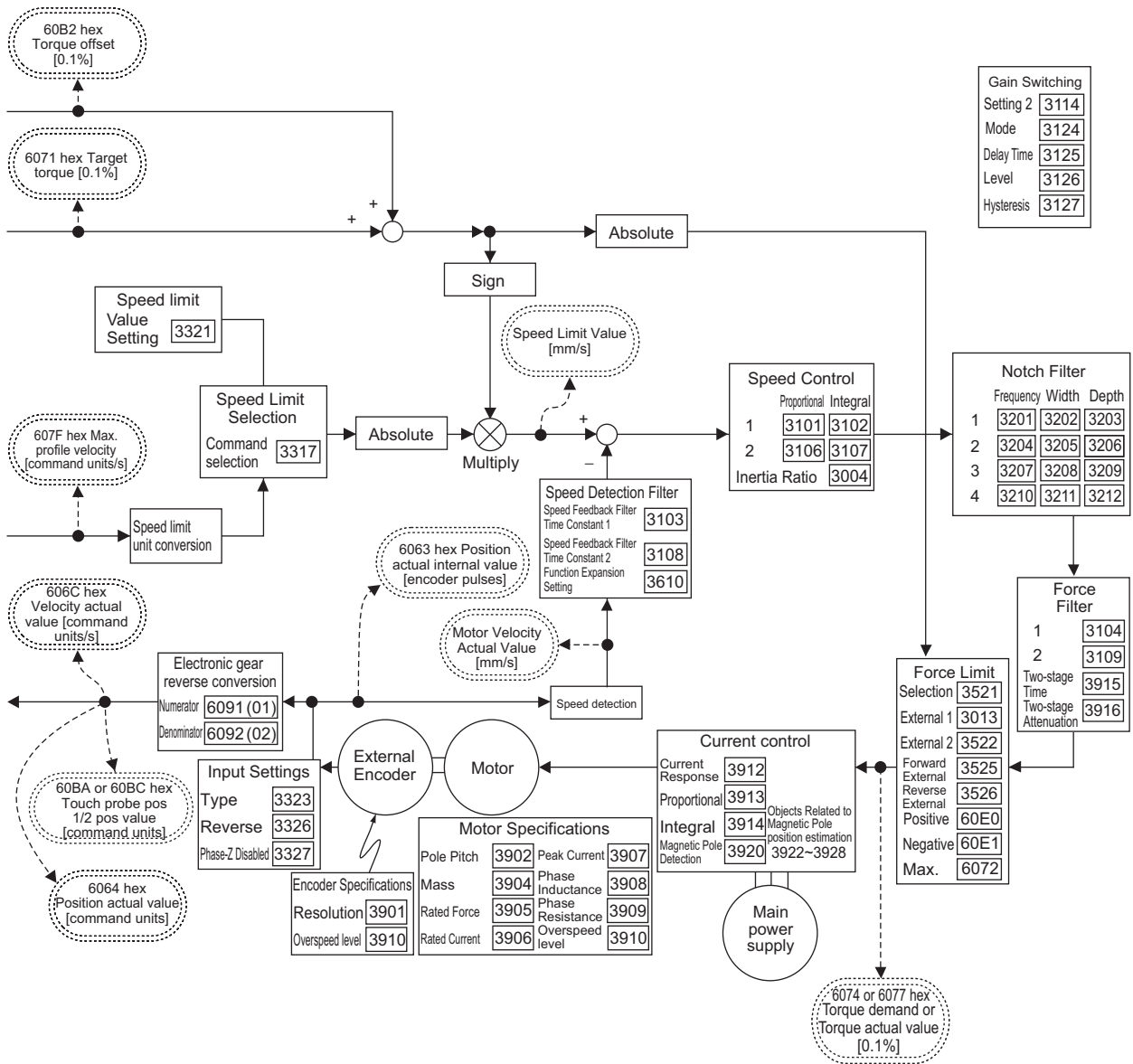
Note 1   Numbers within parentheses are sub-index numbers.

   2   Numbers within boxes are hexadecimal index numbers.

   3   Read the word "torque" as "force."

6-4 Profile Position Mode

In this mode of operation, the controller uses the path generation function (an operation profile calculation function) inside the G5-series Servo Drive to perform PTP positioning operation. It executes path generation, position control, speed control, and torque control based on the target position, profile velocity, profile acceleration, profile deceleration, and other information.
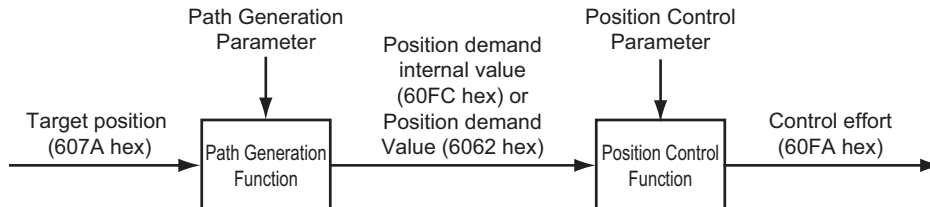
The configuration of the path generation function is as follows:
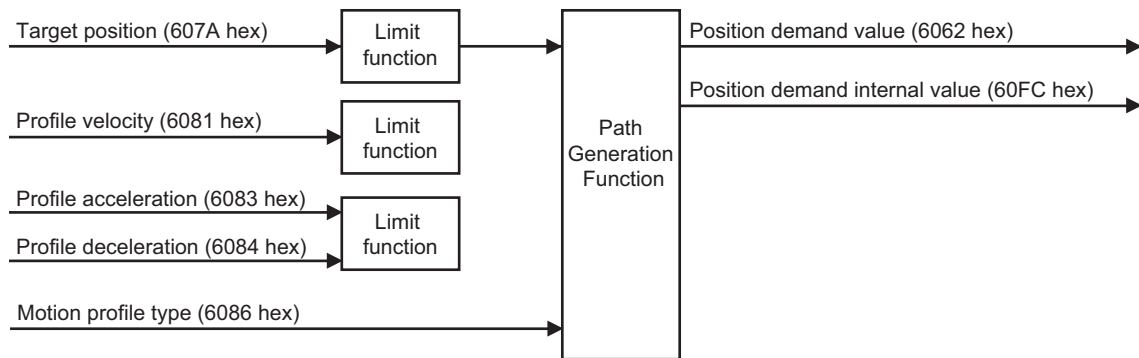
Profile Position Mode Configuration

The configuration of Profile position mode is as follows:
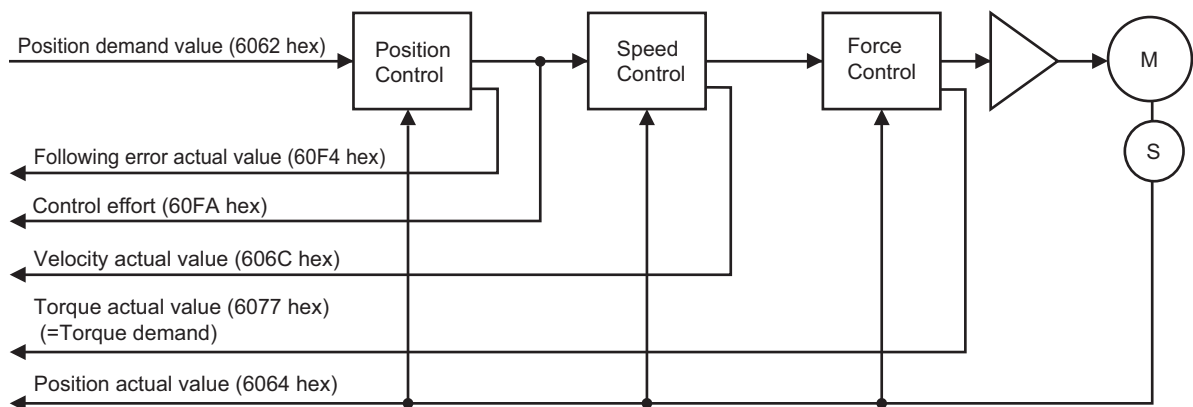
The following diagram shows the control function configuration of Profile position mode.

6-4-1   Related Objects

Index	Sub-index	Name	Access	Size	Unit	Setting range	Default setting
6040 hex	00 hex	Controlword	RW	U16	–	0 to FFFF hex	0000 hex
6060 hex	00 hex	Modes of operation	RW	INT8	–	0 to 10	0
6065 hex [*1]	00 hex	Following error window	RW	U32	Command units	0 to 134,217,728, or 4,294,967,295	100000
6072 hex	00 hex	Max torque	RW	U16	0.1%	0 to 5000	5000
607A hex [*2]	00 hex	Target position	RW	INT32	Command units	−2,147,483,648 to 2,147,483,647	0000 hex
607D hex	01 hex	Min position limit	RW	INT32	Command units	−1,073,741,823 to 1,073,741,823	-500000
	02 hex	Max position limit	RW	INT32	Command units	−1,073,741,823 to 1,073,741,823	500000
6081 hex	00 hex	Profile velocity	RW	U32	Command units/s	0 to 2,147,483,647	0000 hex
6083 hex	00 hex	Profile acceleration	RW	U32	Command units/s^2	1 to 655,350,000	1000000
6084 hex	00 hex	Profile deceleration	RW	U32	Command units/s^2	1 to 655,350,000	1000000
6086 hex	00 hex	Motion profile type	RW	INT16	–	−1 to 0	0
6041 hex	00 hex	Statusword	RO	U16	–	0 to FFFF hex	0000 hex
6062 hex	00 hex	Position demand value	RO	INT32	Command units	−2,147,483,648 to 2,147,483,647	0000 hex
6064 hex	00 hex	Position actual value	RO	INT32	Command units	−2,147,483,648 to 2,147,483,647	0000 hex
606C hex	00 hex	Velocity actual value	RO	INT32	Command units/s	−2,147,483,648 to 2,147,483,647	0000 hex
6077 hex	00 hex	Torque actual value	RO	INT16	0.1%	-5,000 to 5,000	0000 hex
60F4 hex	00 hex	Following error actual value	RO	INT32	Command units	−2,147,483,648 to 2,147,483,647	0000 hex
60FA hex	00 hex	Control effort	RO	INT32	Command units/s	−1,073,741,823 to 1073741823	0000 hex
60FC hex	00 hex	Position demand internal value	RO	INT32	External encoder units	−2,147,483,648 to 2,147,483,647	0000 hex

*1   The Following error window object can be set to between 0 and 134,217,728, or 4,294,967,295. If the object is set to 4,294,967,295, the detection of Following error will be disabled. If it is set to 0, a Following error will always occur. If the set value is between 134,217,729 and 4,294,967,294, it is assumed that 134,217,728 is set. In this case, 134,217,728 will be returned when the object is read.

*2   For the Servo Drive to accept commands without fail, the object value must always be retained for two communications cycles or more.

6-4-2   Description of Function

The G5-series Servo Drove can perform PTP positioning operation.

Set the Controlword (6040 hex) bit 5 (Change set immediately) to 1.

Set the Target position (607A hex) and the Profile velocity (6081 hex).

Changing the Controlword (6040 hex) bit 4 (New set point) from 0 to 1 starts positioning to the set target position.
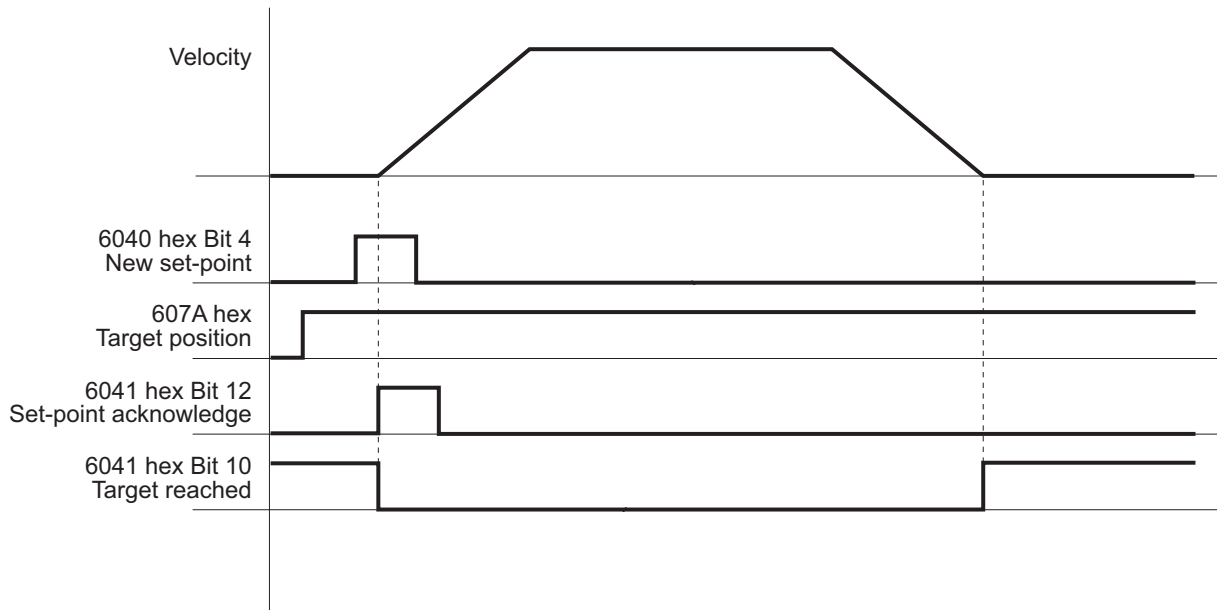
The Target value can be changed while PTP positioning is in progress.

During PTP positioning, changing the Target position (607A hex)/Profile velocity (6081 hex) value. Changing the Controlword (6040 hex) bit 4 (New set point) from 0 to 1 causes the G5-series Servo Drive to execute positioning with the changed value.
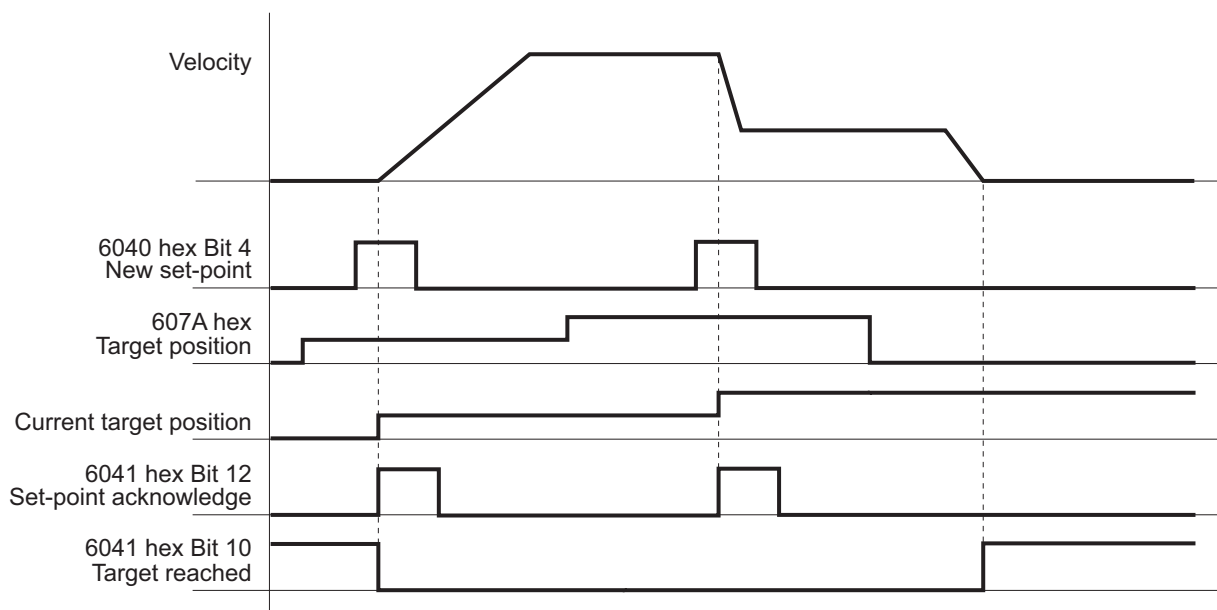
6-4-3   Controlword (6040 hex) in Profile Position Mode

Bit	Name	Description
4	New set-point	Starts positioning at the rising edge, from 0 to 1, of the signal.
		In this timing, the Target position (607A hex) and Profile velocity (6081 hex) values are obtained.
5	Change set immediately	Always set to 1 (Change set immediately).
		If set to 0, positioning does not occur due to a Command warning.
6	abs/rel	Always set to 0 (abs).
		If set to 1 (rel), positioning does not occur due to a Command warning.
8	Halt	When set to 0, positioning starts or continues.
		When set to 1, positioning stops according to the Halt option code (605D hex) setting.
9	Change on Set-point	Unused for G5-series Servo Drives.

6-4-4   Statusword (6041 hex) in Profile Position Mode

Bit	Name	Value	Description
10	Target reached	0	Halt bit is 0:Positioning is not completed.
			Halt bit is 1:The axis is decelerating.
		1	Halt bit is 0:Positioning is completed.
			Halt bit is 1:The axis speed is "0."
12	Set-point acknowledge	0	Waiting for a new Target position.
		1	Ready to accept updates (overwriting) of the Target position.
13	Following error	0	No Following error occurred.
		1	A Following error occurred.

6-5 Homing Mode

In this mode of operation, the Servo Drive has a path generation function (an operation profile calculation function) and it executes the homing operation using the Homing method specified from the controller.

When a controller is connected, the following two homing procedures are available depending on the controller specifications.

● Procedure 1

Create a homing operation pattern in the controller, and provide the command to the Servo Drive using Cyclic synchronous position mode (csp).

When performing the homing operation using this procedure, refer to the operating manual for the controller.

● Procedure 2

Use the Homing mode of the Servo Drive. The controller specifies a homing method supported by the Servo Drive and commands the start of the homing operation.

When performing the homing operation using this procedure, refer to the operating manual for the controller and *A-1-6 Homing Mode Specifications* on page A-15.

> **Additional Information**
>
> With the OMRON Machine Automation Controllers NJ-series (Model: NJ501-1□00) and the CJ1W-NC281/NC481/NC881/NCF81/NC482/NC882/NCF82 Position Control Units, use Procedure 1.
>
> Create a homing operation pattern in the controller, provide the command to the Servo Drive using the Cyclic synchronous position mode (csp), and perform the homing operation.

6-6   Connecting with OMRON Controllers

This section describes the settings required to connect the Servo Drive with an OMRON Machine Automation Controller NJ-series (Model: NJ501-1□00) and CJ1W-NC281/NC481/NC881/NCF81/NC482/NC882/NCF82 Position Control Unit with EtherCAT Interface.

Related Objects

Objects listed in the following table can be used without changing them from their default values. If you are changing these settings, read and understand the relevant specifications in advance and set values.

● **Machine Automation Controller NJ-series (NJ501-1□00)**

Index	Sub-index	Name	Default setting	Description
3013 hex	00 hex	External Force Limit 1	5000	Default setting is 500.0%
3317 hex	00 hex	Speed Limit Selection	1	Speed Limit during force control is done using Max profile velocity (607F hex) or Speed Limit Value Setting (3321 hex), whichever has the smaller value.
3401 hex	00 hex	Input Signal Selection 2	00818181 hex	Positive Drive Prohibition Input (NC)
3402 hex	00 hex	Input Signal Selection 3	00828282 hex	Negative Drive Prohibition Input (NC)
3403 hex	00 hex	Input Signal Selection 4	00222222 hex	Home Proximity Input (NO)
3404 hex	00 hex	Input Signal Selection 5	002B2B2B hex	External Latch Signal 3 (NO)[1]
3405 hex	00 hex	Input Signal Selection 6	00212121 hex	External Latch Signal 2 (NO)[1]
3406 hex	00 hex	Input Signal Selection 7	00202020 hex	External Latch Signal 1 (NO)[1]
3504 hex	00 hex	Drive Prohibition Input Selection	1	The drive prohibition input is disabled in the servo and processed in the controller.
3508 hex	00 hex	Undervoltage Error Selection	1	Stopping for undervoltage errors.
3521 hex	00 hex	Force Limit Selection	6	Use the 60E0 hex and 60E1 hex values to limit torque, with PCL and NCL OFF.
3522 hex	00 hex	Force Limit 2	5000	Default setting is 500.0%
3703 hex	00 hex	Force Limit Flag Output Setting	1	Turn ON at force limits excluding the force command value.
3801 hex	00 hex	Software Position Limit Function	3	Disable the software limits in both directions.
3758 hex	00 hex	Touch Probe Trigger Selection	0100 hex	Touch probe1 = External Latch Signal 1 Touch probe2 = External Latch Signal 2
3759 hex	00 hex	Warning Hold Selection	0000 hex	Automatically cleared when the cause is removed.
607C hex	00 hex	Home offset	0	An offset value of 0 is used by the Servo Drive.
6091 hex	01 hex	Motor revolutions	1	Gear ratio used by the Servo Drive is 1:1, and user units are handled by the controller.
	02 hex	Shaft revolutions	1	

*1   Machine Automation Controller NJ-series (Model: NJ501-1□00) uses the latch signals as follows:
External Latch Signal 1: Trigger signal from external Touch probe function (External Latch Input 1)
External Latch Signal 2: Trigger signal from external Touch probe function (External Latch Input 2)
External Latch Signal 3: Unused

● **CJ1W-NC281/NC481/NC881/NCF81/NC482/NC882/NCF82 Position Control Units**

Index	Sub-index	Name	Default setting	Description
3013 hex	00 hex	Force Limit 1	5000	Default setting is 500.0%
3401 hex	00 hex	Input Signal Selection 2	00818181 hex	Positive Drive Prohibition Input (NC)
3402 hex	00 hex	Input Signal Selection 3	00828282 hex	Negative Drive Prohibition Input (NC)
3403 hex	00 hex	Input Signal Selection 4	00222222 hex	Home Proximity Input (NO)
3404 hex	00 hex	Input Signal Selection 5	002B2B2B hex	External Latch Signal 3 (NO)[1]
3405 hex	00 hex	Input Signal Selection 6	00212121 hex	External Latch Signal 2 (NO)[1]
3406 hex	00 hex	Input Signal Selection 7	00202020 hex	External Latch Signal 1 (NO)[1]
3504 hex	00 hex	Drive Prohibition Input Selection	1	The drive prohibition input is disabled in the servo and processed in the controller.
3508 hex	00 hex	Undervoltage Error Selection	1	Stopping for undervoltage errors.
3521 hex	00 hex	Force Limit Selection	6	Both positive and negative directions have two limits which are switched using PCL and NCL.
3522 hex	00 hex	Force Limit 2	5000	Default setting is 500.0%
3801 hex	00 hex	Software Position Limit Function	3	Disable the software limits in both directions.
3758 hex	00 hex	Touch Probe Trigger Selection	0100 hex	Touch probe1 = External Latch Signal 1 Touch probe2 = External Latch Signal 2
3759 hex	00 hex	Warning Hold Selection	0000 hex	Automatically cleared when the cause is removed.
607C hex	00 hex	Home offset	0	An offset value of 0 is used by the Servo Drive.
6091 hex	01 hex	Motor revolutions	1	Gear ratio used by the Servo Drive is 1:1, and user units are handled by the controller.
	02 hex	Shaft revolutions	1	
60E0 hex	00 hex	Positive torque limit value	5000	Default setting is 500.0%
60E1 hex	00 hex	Negative torque limit value	5000	Default setting is 500.0%

*1   The CJ1W-NC□8□ uses the latch signals as follows:
   External Latch Signal 1: Origin Input
   External Latch Signal 2: Interrupt Input
   External Latch Signal 3: Not used.

6-6 Connecting with OMRON Controllers

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7

Applied Functions

This section outlines the applied functions such as the electronic gear, gain switching and soft start, and explains the settings.

7-1   Sequence I/O Signals

You can set sequences in various operating conditions.

For the connection of I/O signals and processing of external signals, refer to *3-1-5 Control I/O Specifications (CN1)* on page 3-6.

7-1-1   Input Signals

You can allocate input signal functions to the input pins of the control I/O connector (CN1). In addition, you can change logic. Refer to *Input Signal Allocation Method* on page 7-3 for more information because some signals have allocation limitations.

The allocations of the default input signals are as follows.

Refer to *Input Signal Allocation Method* on page 7-3 to change the allocations.

Index	Input signal	Default setting (hex)	Default setting state					
			Position control		Speed control		Force control	
			Signal name	Logic [1]	Signal name	Logic [1]	Signal name	Logic [1]
3400 hex	IN1	0094 9494 hex	STOP	NC	STOP	NC	STOP	NC
3401 hex	IN2	0081 8181 hex	POT	NC	POT	NC	POT	NC
3402 hex	IN3	0082 8282 hex	NOT	NC	NOT	NC	NOT	NC
3403 hex	IN4	0022 2222 hex	DEC	NO	DEC	NO	DEC	NO
3404 hex	IN5	002B 2B2B hex	EXT3	NO	EXT3	NO	EXT3	NO
3405 hex	IN6	0021 2121 hex	EXT2	NO	EXT2	NO	EXT2	NO
3406 hex	IN7	0020 2020 hex	EXT1	NO	EXT1	NO	EXT1	NO
3407 hex	IN8	002E 2E2E hex	MON0	NO	MON0	NO	MON0	NO

[1]   NO (normally open) and NC (normally close) in the table above refer to the following states.
   NO: Disabled (OFF) when signal input is open with COM−
        Enabled (ON) when signal input is shorted with COM−
   NC: Disabled (OFF) when signal input is shorted with COM−
        Enabled (ON) when signal input is open with COM−

Objects That Can Be Assigned

Use the following objects when changing the input signal allocations.

For the setting method, refer to *Input Signal Allocation Method* on page 7-3.

Index	Name	Explanation	Reference
3400 hex	Input Signal Selection 1	Set the IN1 input function allocation.	page 9-27
3401 hex	Input Signal Selection 2	Set the IN2 input function allocation.	page 9-27
3402 hex	Input Signal Selection 3	Set the IN3 input function allocation.	page 9-27
3403 hex	Input Signal Selection 4	Set the IN4 input function allocation.	page 9-27
3404 hex	Input Signal Selection 5	Set the IN5 input function allocation.	page 9-27
3405 hex	Input Signal Selection 6	Set the IN6 input function allocation.	page 9-28
3406 hex	Input Signal Selection 7	Set the IN7 input function allocation.	page 9-28
3407 hex	Input Signal Selection 8	Set the IN8 input function allocation.	page 9-28

Note This object is set in hexadecimal. (The display on the front panel shows the settings in decimal.)

Input Signal Allocation Method

Input the setting for each control mode to any of the objects from 3400 to 3407 hex to allocate the signals.

Set the objects using hexadecimal.

Set the set value of the function for each control mode in "**" below.

Refer to the function number table provided later for the set value of each function. The logic setting is included in the function numbers.

00****** hex
- Position control
- Speed control
- Force control
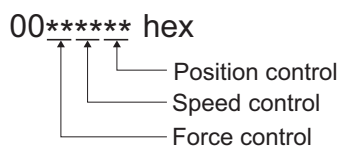
Example:

Position control: Monitor Input 0 with NO (normally open) contacts (2E hex)

Speed control: Disabled (00 hex)

Force control: Positive Force Limit Input with NO contacts (2C hex)
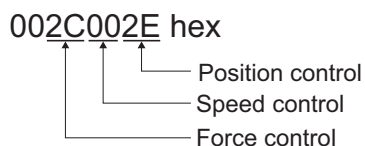
002C002E hex
- Position control
- Speed control
- Force control

● **Function Number Table**

The set values to be used for allocations are as follows:

Signal name	Symbol	Set value	
		NO	**NC**
Disabled	–	00 hex	Setting not available
Positive Drive Prohibition Input	POT	01 hex	81 hex
Negative Drive Prohibition Input	NOT	02 hex	82 hex
Immediate Stop Input	STOP	14 hex	94 hex
External Latch Input 1	EXT1	20 hex	Setting not available
External Latch Input 2	EXT2	21 hex	Setting not available
Origin Proximity Input	DEC	22 hex	A2 hex
External Latch Input 3	EXT3	2B hex	Setting not available
Positive Force Limit Input	PCL	2C hex	AC hex
Negative Force Limit Input	NCL	2D hex	AD hex
Monitor Input 0	MON0	2E hex	AE hex
Monitor Input 1	MON1	2F hex	AF hex
Monitor Input 2	MON2	30 hex	B0 hex

📝 **Precautions for Correct Use**

- Do not use any settings other than the settings listed.
- Do not allocate the same function to more than one input signal. If you allocate the same function to more than one input signal, and Interface Input Duplicate Allocation Error 1 (Error No. 33.0) or Interface Input Duplicate Allocation Error 2 (Error No. 33.1) will occur.
- The External Latch Inputs 1, 2, and 3 (EXT1, EXT2 and EXT3) can be allocated only to IN5 to IN7. If you allocate them to any other inputs, an External Latch Input Allocation Error (Error No. 33.8) will occur.
- If you use the External Latch Input 1, 2, or 3 (EXT1, EXT2 or EXT3), you must set it for all control modes. Otherwise, an External Latch Input Allocation Error (Error No. 33.8) will occur.
- The External Latch Inputs 1, 2, and 3 (EXT1, EXT2 and EXT3) can be set only to NO (normally open) contacts. If set to NC (normally close) contacts, an External Latch Input Allocation Error (Error No. 33.8) will occur.
- The control input pins that are disabled do not affect the operation. It also does not affect the response in EtherCAT Communications.
- The functions that are used by more than one control mode must be allocated to the same pin, in the same logic. If they are allocated to different pins, an Interface Input Duplicate Allocation Error 1 (Error No. 33.0) or an Interface Input Duplicate Allocation Error 2 (Error No. 33.1) will occur.
  If the logic is inconsistent, an Interface Input Function Number Error 1 (Error No. 33.2) or an Interface Input Function Number Error 2 (Error No. 33.3) will occur.

7-1-2   Output Signals

You can allocate output signal functions to the output pins for the control I/O connector (CN1).

In addition, you can change logic.

Output Signal Default Setting

The allocations of the default output signals are as follows.

Refer to *Output Signal Allocation Method* on page 7-6 to change the allocations.

Index	Output signal	Default setting (hex)	Default setting state					
			Position control		Speed control		Force control	
			Signal name	Logic[1]	Signal name	Logic[1]	Signal name	Logic[1]
3410 hex	OUTM1	0003 0303 hex	BKIR	NO	BKIR	NO	BKIR	NO
3411 hex	OUTM2	0002 0202 hex	READY	NO	READY	NO	READY	NO

[1] NO (normally open) and NC (normally close) refer to the following states.
   NO: When the function is disabled (OFF state), output transistor is OFF.
      When the function is enabled (ON state), output transistor is ON.
   NC: When the function is disabled, output transistor is ON.
      When the function is enabled, output transistor is OFF.

Objects That Can Be Assigned

Use the following objects when changing the output signal allocations.

For the setting method, refer to *Output Signal Allocation Method* on page 7-6.

Index	Object name	Explanation	Reference
3410 hex	Output Signal Selection 1	Set the OUTM1 output function allocation. This object is set in hexadecimal.	page 9-28
3411 hex	Output Signal Selection 2	Set the OUTM2 output function allocation.	page 9-28

Note   For the setting method, refer to *Function Number Table* on page 7-6.

Output Signal Allocation Method

Input the setting for each control mode to objects 3410 and 3411 hex to allocate the signals.

Set the objects based on hexadecimal in the same manner as for the input signal allocations.

Set the set value of the function for each control mode in "**" below.

For the set value of each function, refer to *Function Number Table* on page 7-6.

The logic setting is included in the function numbers.

00****** hex
- Position control
- Speed control
- Force control
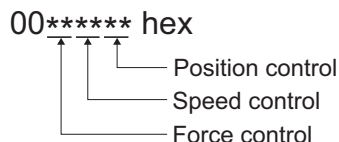
Example:

Position control: Position command output (08 hex)

Speed control: Motor speed detection output (05 hex)

Force control: Zero speed detection signal (07 hex)
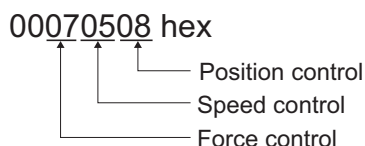
00070508 hex
- Position control
- Speed control
- Force control

● **Function Number Table**

The set values to be used for allocations are as follows:

Signal name	Symbol	Set value	
		NO (or normally open) contact	NC (or normally close) contact
Disabled	–	00 hex	00 hex
Servo Ready Completed Output	READY	02 hex	82 hex
Brake Interlock Output	BKIR	03 hex	Setting not available
Positioning Completion Output	INP1	04 hex	84 hex
Motor Speed Detection Output	TGON	05 hex	85 hex
Force Limiting Signal	TLIMT	06 hex	86 hex
Zero Speed Detection Output	ZSP	07 hex	87 hex
Speed Conformity Output	VCMP	08 hex	88 hex
Warning Output 1	WARN1	09 hex	89 hex
Warning Output 2	WARN2	0A hex	8A hex
Position Command Status Output	PCMD	0B hex	8B hex
Positioning Completion Output 2	INP2	0C hex	8C hex
Speed Limiting Output	VLIMT	0D hex	8D hex
Error Clear Attribute Output	ALM-ATB	0E hex	8E hex
Speed Command Status Output	VCMD	0F hex	8F hex
Remote Output 1	R-OUT1	10 hex	Setting not available
Remote Output 2	R-OUT2	11 hex	Setting not available

Precautions for Correct Use

- Do not use any settings other than the settings listed.
- You can allocate the same function to more than one output signal, but the set value must be in the same logic.
- When you disable the control output pin, the output transistor always stays OFF. It also does not affect the response in EtherCAT Communications.
- If you use the Brake Interlock Output (BKIR), you must set the function in all control modes. Otherwise, an Interface Output Function Number Error 1 (Error No. 33.4) or an Interface Output Function Number Error 2 (Error No. 33.5) will occur.
- The Brake Interlock Output (BKIR) can be set only to NO (normally open) contacts. If set to NC (normally close) contacts, an Interface Output Function Number Error 1 (Error No. 33.4) or an Interface Output Function Number Error 2 (Error No. 33.5) will occur.

7-1 Sequence I/O Signals

7

7-1-2 Output Signals

7-2   Positive and Negative Drive Prohibition Functions

If the Positive Drive Prohibition Input (POT) or the Negative Drive Prohibition Input (NOT) is turned OFF, the motor will stop moving.

You can thus prevent the motor from moving outside of the movement range of the device by using limit inputs from the device connected to the Servo Drive.

Objects Requiring Settings

Index	Name	Explanation	Reference
3400 hex to 3407 hex	Input Signal Selection 1 to 8	Set the input signal allocations and logic.	page 9-27
3504 hex	Drive Prohibition Input Selection	Set the operation to be performed upon positive and negative drive prohibition input.	page 9-37
3505 hex	Stop Selection for Drive Prohibition Input	Set the deceleration and stop methods upon positive and negative drive prohibition input.	page 9-38
3511 hex	Immediate Stop Force	Set the force limit for immediate stops.	page 9-39

● **Input Signal Selection Function (Default Settings: 3401 Hex, 3402 Hex)**

In the default settings, the allocations are as follows.

Index	Name	Default setting	
		Set value	Position Control
3401 hex	Input Signal Selection 2	0081 8181 hex	POT (NC)
3402 hex	Input Signal Selection 3	0082 8282 hex	NOT (NC)

Note   Refer to *7-1 Sequence I/O Signals* on page 7-2 for details on input signal selections 1 to 8.

● **Drive Prohibition Input Selection (3504 Hex)**

Set the operation of the Positive Drive Prohibition Input (POT) and the Negative Drive Prohibition Input (NOT). Install limit switches at both ends of the axis to prohibit the motor from driving in the direction specified by the switch. This can be used to prevent the workpiece from driving too far and thus prevent damage to the machine. Set the operation to be performed upon positive and negative drive prohibition input.

Drive Prohibition Input Selection (3504 hex)	Explanation
0	**Positive drive prohibition input and negative drive prohibition input enabled.** The operation when a signal is input is as follows: • Positive drive prohibition input closed: Positive limit switch not operating and status normal. • Positive drive prohibition input open: Positive direction prohibited and negative direction permitted. • Negative drive prohibition input closed: Negative limit switch not operating and status normal. • Negative drive prohibition input open: Negative direction prohibited and positive direction permitted. The motor decelerates and stops according to the sequence set in Stop Selection for Drive Prohibition Input (3505 hex).[1] If the positive and the negative prohibition inputs are both open, a Drive Prohibition Input Error 1 (Error No. 38.0) will occur because it is taken that Servo Drive is in error condition.
1	**Positive and negative drive prohibition input disabled.**
2	**Positive and negative drive prohibition input enabled.** If either the positive or the negative prohibition input is open, a Drive Prohibition Input Error 1 (Error No. 38.0) will occur.

[1]   For details, refer to explanation for *Stop Selection for Drive Prohibition Input* (3505 Hex) on page 7-9.

📝 **Precautions for Correct Use**

Both signals are disabled (in a state in which drive prohibition will not operate) in the default settings. If a drive prohibition input is required, set the Drive Prohibit Input Selection (3504 hex) to either 0 or 2. The setting on the Input Signal Selection 1 to 8 (3400 to 3407 hex) can change the logic and allocation for the respective Input terminals (CN1 to 7 and 8).

● **Stop Selection for Drive Prohibition Input (3505 Hex)**

Set the deceleration and stop methods upon a positive or negative drive prohibition input.

3504 hex set value[1]	3505 hex set value	Decelerating[2]		After stopping	
		Deceleration method	Error counter	Operation after stop	Error counter
0	0	Dynamic brake	Clear	Force command is 0 for drive prohibition direction	Held
	1	Free-run	Clear	Force command is 0 for drive prohibition direction	Held
	2	Immediate stop[3]	Clear	Force command and force limit are as specified.	Cleared after deceleration completes, then held.

[1]   If the Drive Prohibition Input Selection (3504 hex) is set to 2, a Drive Prohibition Input Error (Error No. 38.0) will occur as soon as either the Positive or Negative Drive Prohibition Input becomes open. Therefore, regardless of the set value, the subsequent operation will be performed according to the setting of the Fault reaction option code (605E hex). In the same way, the Fault reaction option code (605E hex) takes priority when any other error occurs.

*2   The term "During deceleration" means the distance until the motor decreases its speed to 30 mm/s or less from the normal operation. Once it decelerates to 30 mm/s or lower, the operation conforms to the description for "post-stopping", regardless of the actual motor speed.

*3   "Immediate Stop" means that the motor stops immediately by using controls while the servo is kept ON. The force limit at this time is controlled by the Immediate Stop Force (3511 hex) set value.
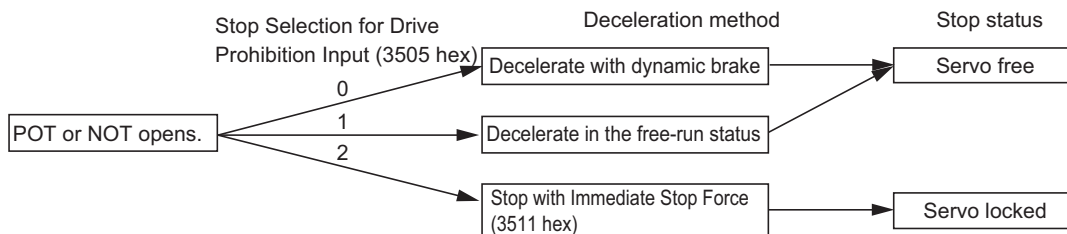
Precautions for Correct Use

- An immediate stop forces the motor to decelerate quickly, which momentarily causes a large position error in position control. This may result in an Error Counter Overflow (Error No. 24.0) or an Overrun Limit Error (Error No. 34.0). If an error occurs, set the Following error window (6065 hex) and the Overrun Limit Setting (3514 hex) to appropriate values.

- A Command Warning (Warning No. B1 hex) will occur if a command is given in the drive prohibition direction while the motor is stopped (i.e., decreases the speed to 30 mm/s or lower) and the Drive Prohibition Input is open.

Additional Information

While the Positive Drive Prohibition Input (POT) is open, the motor cannot be driven in the positive direction, but it can be driven in the negative direction. Conversely, while the Negative Drive Prohibition Input (NOT) is open, the motor cannot be driven in the negative direction, but it can be driven in the positive direction.

● Immediate Stop Force (3511 Hex)

This is the force limit when the Stop Selection for Drive Prohibition Input (3505 hex) is set to 2, and the motor decelerates due to a drive prohibition input.
The settable range is 0 to 500% in units of 0.1%. When it is set to 0%, the normal force limit is used.

7-3   Overrun Protection

This function detects an Overrun Limit Error (Error No. 34.0) and stops the Linear Motor if the motor exceeds the allowable operating range set for the Overrun Limit Setting (3514 hex) with respect to the position command input.

The function can also prevent the motor from clash into the machine edge due to vibration.

7-3-1   Operating Conditions

The overrun limit works under the following conditions.

	Conditions
Operating Mode	Position Control Mode
Others	• Servo ON state • The factors other than control parameters must be set correctly. This includes the force limit. The motor must operate normally without any failures.

Conditions for Clearing the Position Command Input Range

The position command input range will be cleared to zero under any of the following conditions.

• When the power supply is turned ON,

• While the position error is cleared. This includes when the servo is OFF and when the error counter is cleared due to a deceleration stop for the drive prohibit input.

• When a trial operation via USB communications starts and when it ends.

• When Speed Control or Force Control is enabled.

• When the position data is initialized. This includes at a component setup request, at homing, when setting the coordinate system and at an adjustment command.

• When magnetic pole detection is in progress.

Precautions for Correct Use

• This function is not intended to protect against incorrect position commands.

• When this function works, the motor decelerates and stops according to the Fault reaction option code (605E hex). However, the load may hit the machine edges during deceleration, causing damage. Take this deceleration operation into account when you set the Overrun Limit Setting (3514 hex).

• The overrun limit function is disabled for FFT analysis from the CX-Drive.

7-3-2   Objects Requiring Settings

Index	Name	Description	Reference page
3514 hex	Overrun Limit Setting	Sets the motor's allowable operating range for the position command input range.	page 9-39

7-3-3   Operation Example

No Position Command Input (Servo ON)

No position command is entered. The motor's allowable operating range is the range set in object 3514 hex on both the right and left. An overrun limit error will occur (Error No. 34.0) if the load enters the error range due to vibration.

Positive Movement (Servo ON)

When a positive position command is entered, the Linear Motor's allowable operating range increases by the commanded amount. The resulting range will be the position command input range added with the amount of movement set in 3514 hex on both sides.

Negative Movement (Servo ON)

When a negative position command is entered, the Linear Motor's allowable operating range further increases.

7-4   Backlash Compensation

The function compensates for backlash for position control.

> 📝 **Additional Information**
>
> The Servo Drive supports this function although backlash never occurs in a Linear Motor.

Objects Requiring Settings

Index	Name	Description	Reference page
3704 hex	Backlash Compensation Selection	Select whether to enable or disable backlash compensation during position control. Set the compensation direction.	page 9-51
3705 hex	Backlash Compensation Amount	Set the compensation amount during position control.	page 9-51
3706 hex	Backlash Compensation Time Constant	Set the backlash compensation time constant during position control.	page 9-51

● Backlash Compensation Selection (3704 Hex)

This object is used to select whether to enable or disable backlash compensation during position control, and to set the compensation direction.

Set value	Description
0	Disable backlash compensation.
1	Compensate for backlash at the first positive movement after the servo is turned ON.
2	Compensate for backlash at the first negative movement after the servo turns ON.

● Setting Method

The backlash compensation works in different directions depending on the setting in the Backlash Compensation Selection (3704 hex) and on whether the set value for the Backlash Compensation Amount (3705 hex) is positive or negative.

3704 hex	3705 hex contains a positive value	3705 hex contains a negative value
1	Compensate in a positive direction during positive movement.	Compensate in a negative direction during positive movement.
2	Compensate in positive direction when it is in negative operation.	Compensate in negative direction when it is in negative operation.

Precautions for Correct Use

- When the mode of operation is switched from the Position Control Mode to the Speed/Force Control Mode, the backlash compensation state is retained as it is. Therefore, after returning to the Position Control mode again, the Servo Drive will restart with the backlash compensation state set in the previous Position Control Mode.
- To determine the actual position of the motor, offset the motor position data acquired via EtherCAT communications by the backlash compensation amount.
- Backlash compensation is performed on the first position command in the set direction after the servo is turned ON. Any prior operations in the opposite direction are not compensated. But the first reverse operation after the initial backlash compensation is compensated. Backlash compensation is not performed again as long as the operation continues in the same direction.
- Until the output of backlash compensation is distributed completely, do not perform position data latching/initialization or control mode switching operation.
- When the servo is turned OFF while backlash compensation is performed, the position command data of the Servo Drive is preset with the Linear Motor position data that includes the backlash compensation amount. When the servo is turned ON again, backlash compensation is performed as described above.
- Be sure to change objects related to backlash compensation when the servo is OFF.

Additional Information

Conditions for Clearing Backlash Compensation
- When the position error is reset. This includes when the servo is turned OFF, and when the error counter is reset for the drive prohibition input.
- When the position data is initialized, except for the homing operation in Homing mode (hm). This includes Config (4100 hex).

7-5   Brake Interlock

This function lets you set the output timing for the brake interlock output (BKIR) that activates the holding brake when the servo is turned ON, an error occurs, or the servo is turned OFF.

It is also possible to use the controller's function to force the brake control via EtherCAT communications.

Additional Information

It is not supported on the OMRON Machine Automation Controller NJ-series (Model: NJ501-1□00) and CJ1W-NC□81/□82 Position Control Unit.

7-5-1   Objects Requiring Settings

Index	Sub-index	Bit	Name	Explanation	Reference
3437 hex	–	–	Brake Timing when Stopped	Set the time after a servo OFF command is issued upon servo lock stop, until the brake interlock output (BKIR) turns OFF and power supply stops.	page 9-34
3438 hex	–	–	Brake Timing During Operation	Set the time after a servo OFF command is issued while the motor is moving, until the brake interlock output (BKIR) turns OFF and power supply stops. If the speed drops to or below the value set in object 3439 hex before the time set here, BKIR will turn OFF.	page 9-35
3439 hex	–	–	Brake Threshold Speed During Operation	Set the speed at which to turn OFF power to the Linear Motor when the Brake Interlock Output (BKIR) signal turns OFF after execution of a servo OFF command while the motor is moving. If the time set in object 3438 hex elapses before the motor drops to the speed set here, BKIR will turn OFF.	page 9-35
60FE hex	01 hex	0	Physical outputs	This is the Set Brake Bit to force the brake control via EtherCAT communications. 0: Brake released[1] 1: Brake engaged[2]	page A-91
	02 hex	0	Bit mask	This is the Set Brake Mask Bit for enabling/disabling the Set Brake Bit for EtherCAT communications. 0: Set Brake Bit enabled. 1: Set Brake Bit disabled.	

[1]   The Brake Interlock Output (BKIR) is turned ON. The brake is released for a brake release command from either EtherCAT communications or the Servo Drive.

[2]   The Brake Interlock Output (BKIR) is turned OFF. The brake is engaged only when a set brake command is received from both EtherCAT communications and the Servo Drive.
Applying the brake from EtherCAT communications is enabled only while the servo is OFF. If a Set Brake command is received while the servo is ON, a Command Warning (B1 hex) will occur.

7-5-2   Operation Timing

This section shows the timing of the Brake Interlock Output (BKIR).

Basic Timing
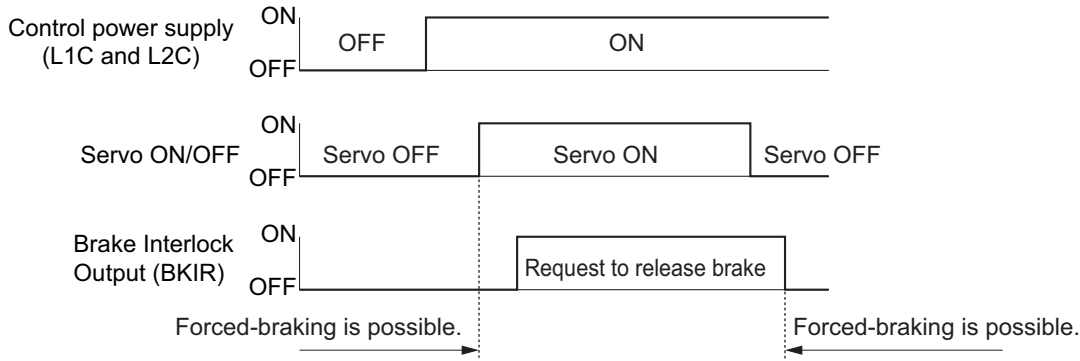
Servo ON/OFF Operation Timing When Motor is Stopped
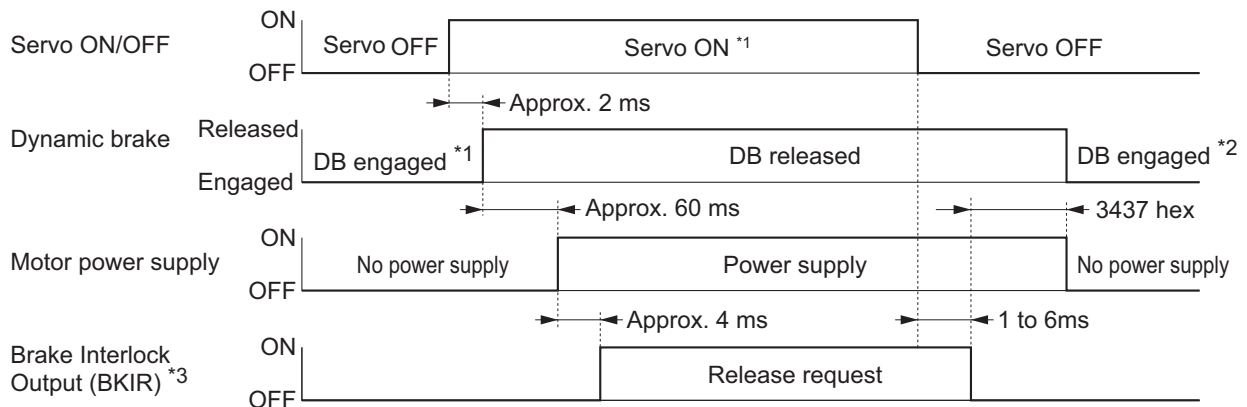
*1   The servo does not turn ON until the motor speed drops to approx. 30 mm/s or below.

*2   The operation of the dynamic brake when the servo is OFF depends on the setting of the Disable operation option code (605C hex).

*3   The Brake Interlock Output (BKIR) signal is output either when a release request command is received via Servo controls or when a release request command is received via EtherCAT communications. The above example shows when there is no brake release request from EtherCAT communications. The BKIR is assigned to the general-purpose output (CN1).

Servo ON/OFF Operation Timing When Motor Is Moving

Based on these operation timings, regenerative energy is produced if the motor movement stops abnormally. Accordingly, repeated operation cannot be performed. Provide a wait time of at least 10 minutes for the motor to cool down.
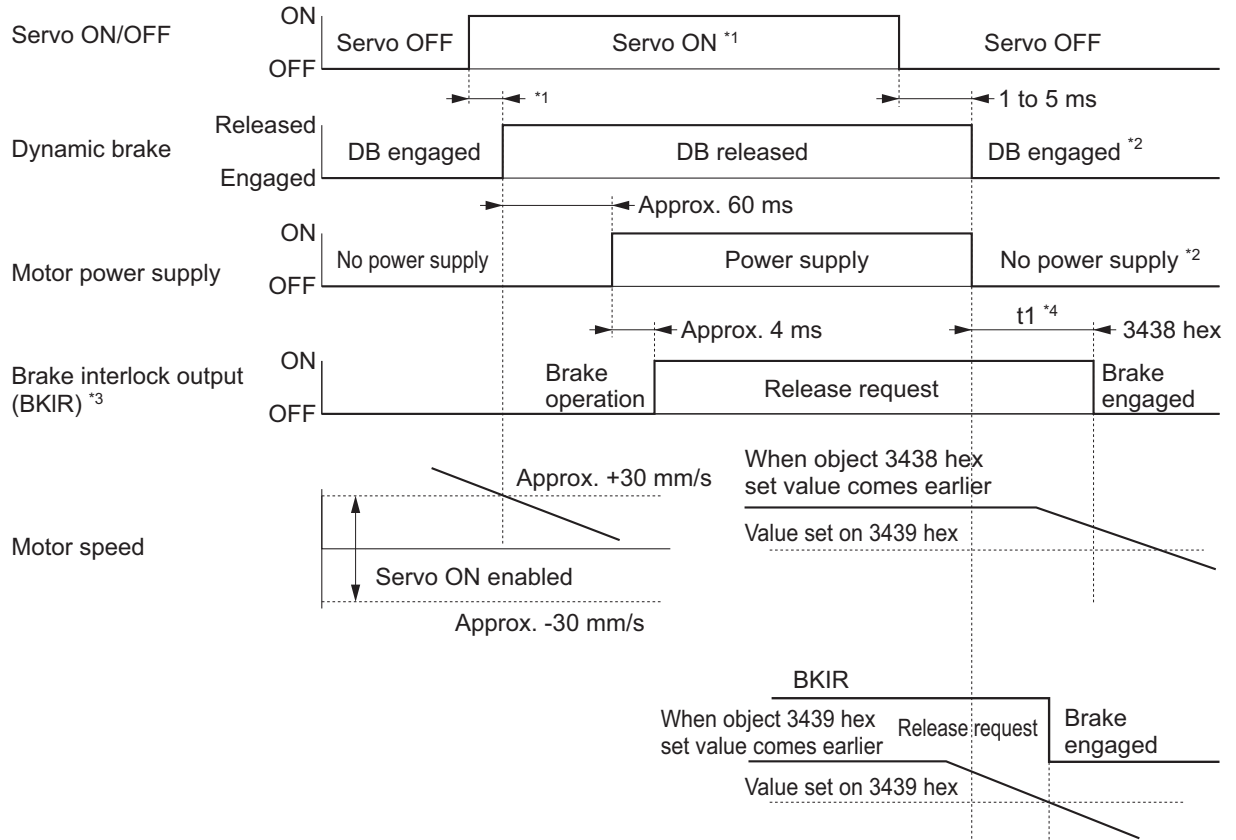
*1 The servo does not turn ON until the motor speed drops to 3439 hex set value or below. If a Servo ON is commanded during motor movement, the Command Warning (Warning No. B1 hex) will occur. The Servo ON command is ignored.

*2 The operation of the dynamic brake when the servo is OFF depends on the setting of the Disable operation option code (605C hex).

*3 The Brake Interlock output (BKIR) signal is output when a release request command is received from Servo controls or from EtherCAT communications. In the above example, there is no release request command from EtherCAT communications. The BKIR signal is assigned to the general-purpose output (CN1).

*4 "t1" is the period until the value becomes lower than the set value on the Brake Timing During Operation (3438 hex) or the Brake Threshold Speed During Operation (3439 hex), whichever is shorter.

Note Even when the Servo ON Input is turned ON again while the motor is decelerating, the system does not enter the servo ON state until the motor stops.

Operation Timing When an Error Occurs (Servo ON)
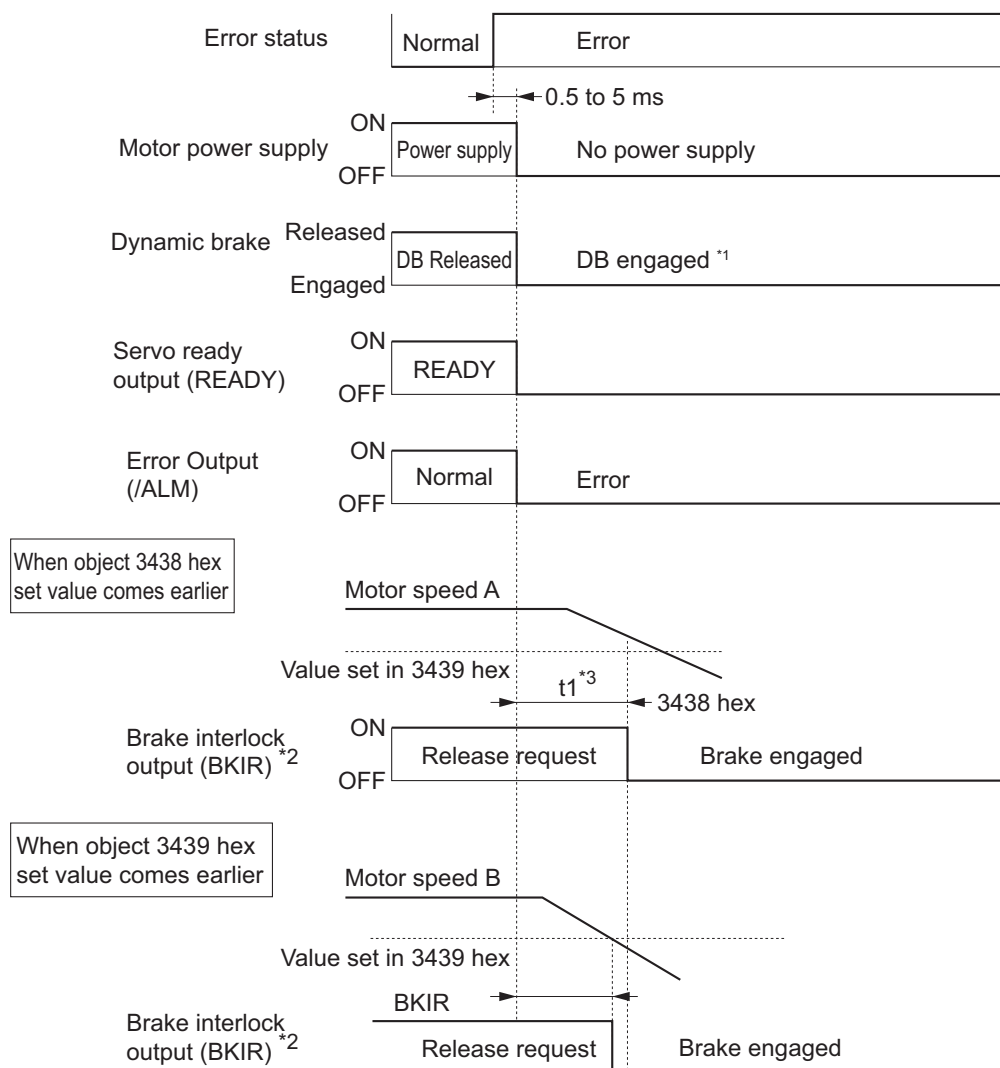
*1   The operation of the dynamic brake when there is an error depends on the setting of the Fault reaction option code (605E hex).

*2   The Brake Interlock Output (BKIR) signal is output either when a release request command is received via Servo controls or when a release request command is received via EtherCAT communications. The above example shows when there is no brake release request from EtherCAT communications. The BKIR signal is assigned to the general-purpose output (CN1).

*3   "t1" is the period until the value becomes lower than the set value on the Brake Timing During Operation (3438 hex) or the Brake Threshold Speed During Operation (3439 hex), whichever is shorter.

Note 1   Even when the servo ON input is turned ON again while the motor is decelerating, the system does not enter the servo ON state until the motor stops.

   2   If the main circuit power supply turns OFF while the motor is operating, a phase loss error or main circuit voltage low error will occur, in which case this operation timing is applied.

Operation Timing When Resetting Errors
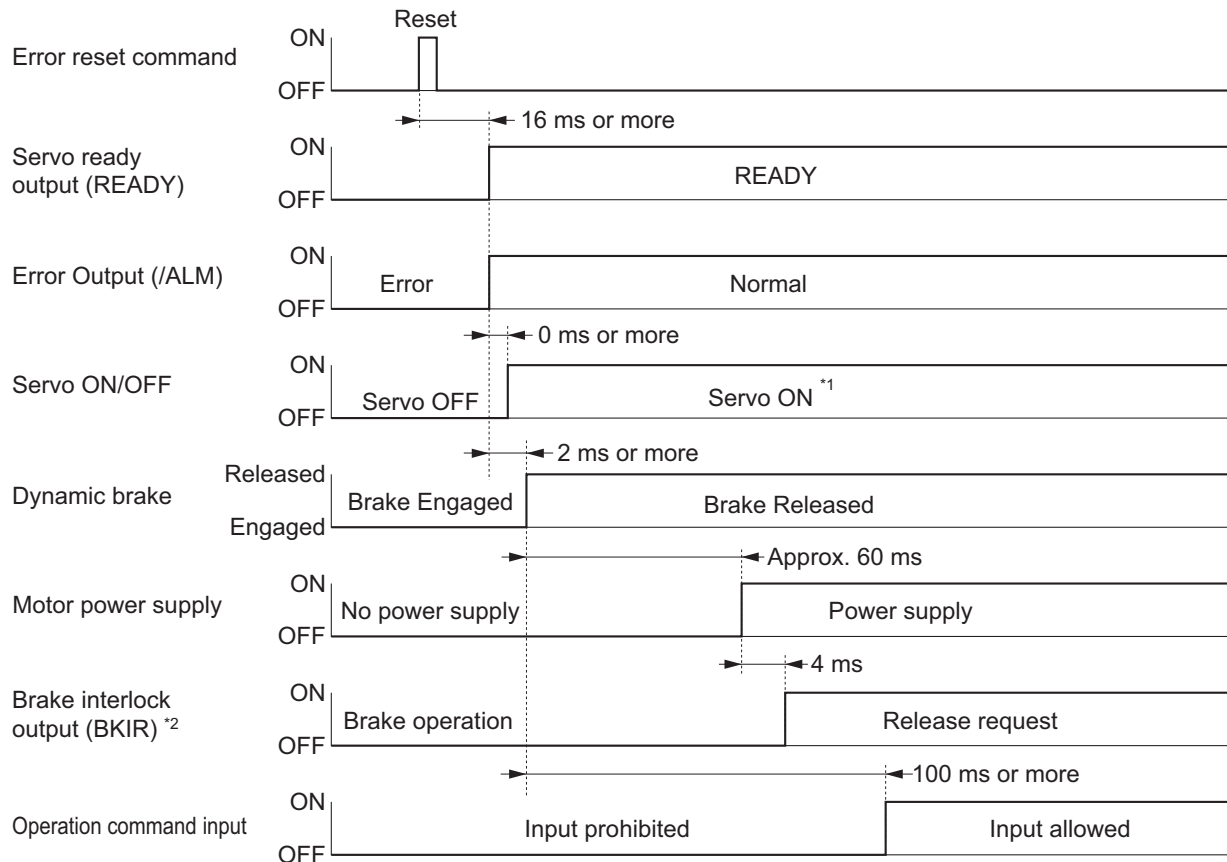
*1   The servo does not turn ON until the motor speed drops to approx. 30 mm/s or below.

*2   The Brake Interlock Output (BKIR) signal is output either when a release request command is received via Servo controls or when a release request command is received via EtherCAT communications. The above example shows when there is no brake release request from EtherCAT communications. The BKIR signal is assigned to the general-purpose output (CN1).

Note After the error has been reset, the system enters the servo OFF state (motor not energized). To turn ON the servo, send a servo ON command again after resetting the error, according to the above timing.

7-6   Electronic Gear Function

This function controls the position by using the value multiplied the position command entered on the Host Controller by the preset electronic gear ratio. The functions is supported only in the Position Control when the communications cycle is 1, 2, or 4 ms.

For communications cycles for which the electronic gear is not supported (250 or 500 μs), a Function Setting Error (Error No. 93.4) will occur if the electronic gear is enabled.

> **Additional Information**
>
> When connected to an OMRON Machine Automation Controller NJ-series (Model: NJ501-1□00) or CJ1W-NC□81/□82 Position Control Unit, the electronic gear ratio is set in the controller. Set the electronic gear ratio in the Servo Drive to 1:1.

7-6-1   Objects Requiring Settings

Index	Sub-index	Name	Explanation	Reference
6091 hex	01 hex	Motor revolutions [*1]	Set the numerator of the electronic gear ratio.	page A-90
	02 hex	Shaft revolutions [*1]	Set the denominator of the electronic gear ratio.	

*1 The electronic gear ratio must be set between 1/1000 and 1000. If it is set outside the range, an Object Setting Error 1 (Error No. 93.0) will occur.
Whether the electronic gear is enabled is determined from the setting of the objects. If the gear ratio setting is 1:1, the electronic gear is disabled.

Gear ratio Setting (6091-01 and 6091-02 Hex)

Motor revolutions (6091-01 hex)	Shaft revolutions (6091-02 hex)	Description
1 to 1073741824	1 to 1073741824	The processing changes with the set values of Motor revolutions (6091-01 hex) and Shaft revolutions (6091-02 hex). Position command → [Motor revolutions (6091-01 hex) / Shaft revolutions (6091-02 hex)] → Position command Position command = Motor revolutions (6091-01 hex) / Shaft revolutions (6091-02 hex)

> **Additional Information**
>
> To make the position command smoother after the electronic gear setting, adjust it by using the Position Command Filter Time Constant (3222 hex) or by the Position Command FIR Filter Time Constant (3818 hex).

7-6-2   Operation Example

Using a Linear Slider with an external encoder that has a resolution of 0.1 μm/pulse, set as follows:

$$\frac{6091\text{-}01 \text{ hex}}{6091\text{-}02 \text{ hex}} = \frac{10,000}{1}$$

The resulting movement is the same as that of the Linear Slider with an external encoder having a resolution of 1 mm/pulse.
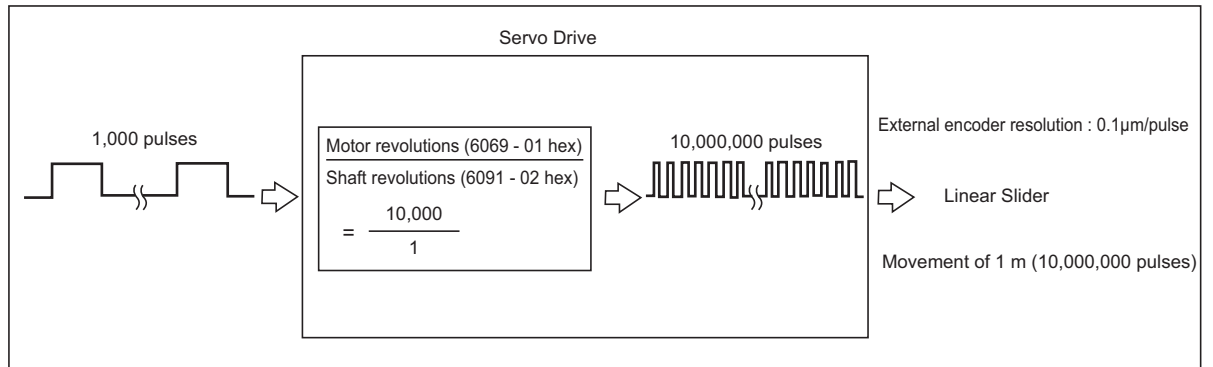
7-7   Force Limit Switching

This function switches the force limit according to the movement direction, and depending on the Positive Force Limit Input (PCL), the Negative Force Limit Input (NCL), and the Positive /Negative Force Limit Input Commands from EtherCAT communications.

This function is useful in the following conditions.

- When push-motion operation is performed.
- When the force at startup and during deceleration should be suppressed to protect the mechanical system, etc.

The Force Limit Selection (3521 hex) setting is used to select a method to switch the force limit.

7-7-1   Operating Conditions

The force limit switching function works under the following conditions.

	Conditions
Operation mode	Position Control Mode, Speed Control Mode, Force Control Mode
Others	• Servo ON state • The factors other than control parameters must be set correctly. This includes the force limit. The motor must operate normally without any failures.

7-7-2   Objects Requiring Settings

Index	Name	Explanation	Reference
3013 hex	Force Limit 1	Set the first force limit value of the motor output force. The upper limit of the set value is restricted based on the maximum force of the motor being connected.	page 9-5
3521 hex	Force Limit Selection	Set the force limit selection method.	page 9-41
3522 hex	Force Limit 2	Set the second force limit value of the motor output force. The upper limit of the set value is restricted based on the maximum force of the motor being connected.	page 9-42
3525 hex	Force Limit 3	Set the third force limit value of the motor output force. The upper limit of the set value is restricted based on the maximum force of the motor being connected.	page 9-42
3526 hex	Force Limit 4	Set the fourth force limit value of the motor output force. The upper limit of the set value is restricted based on the maximum force of the motor being connected.	page 9-42
60E0 hex	Positive torque limit value[1]	Set the Positive Force Limit value of the motor output force.	page A-68
60E1 hex	Negative torque limit value[2]	Set the Negative Force Limit value of the motor output force.	page A-69

*1   Read the word "torque" as "force" when using these objects.

Force Limit in Position, Speed, and Force Controls

3521 hex set value	Position control/speed control/force control			
	Positive Direction Force Limit[*1]		Negative Direction Force Limit[*2]	
	PCL ON	PCL OFF	NCL ON	NCL OFF
0,1	3013 hex			
2	3013 hex		3522 hex	
3	3522 hex	3013 hex	3522 hex	3013 hex
4	60E0 or 3013 hex[*3]		60E1 or 3522 hex[*4]	
5	60E0 or 3013 hex[*3]	3013 hex	60E1 or 3522 hex[*4]	3522 hex
6	3525 hex	60E0 or 3013 hex[*3]	3526 hex	60E1 or 3522 hex[*4]
7	3013 hex	3525 hex	3522 hex	3526 hex

*1   PCL ON is the state in which either the Positive Force Limit Input (PCL) or the EtherCAT communications torque control command (P-CL) is ON; PCL OFF is the state in which both of these are OFF.

*2   NCL ON is the state in which either the Negative Force Limit Input (NCL) or the EtherCAT communications torque control command (N-CL) is ON; NCL OFF is the state in which both of these are OFF.

*3   The smaller of 60E0 hex or 3013 hex is used.

*4   The smaller of 60E1 hex or 3522 hex is used.

7-8   Soft Start

This function is used to control the speed. It sets the acceleration and deceleration against the speed command in the Servo Drive.

The function can be used for step speed commands, and allows soft starts. The S-curve Acceleration and Deceleration function is used to reduce any impacts by acceleration changes.

Precautions for Correct Use

Do not set the Soft Start Acceleration Time and the Soft Start Deceleration Time when the position loop structure with a Host Controller is used.

7-8-1   Objects Requiring Settings

Index	Name	Description	Reference
3312 hex	Soft Start Acceleration Time	Sets the acceleration time for the speed command input.	page 9-23
3313 hex	Soft Start Deceleration Time	Sets the deceleration time for the speed command input.	page 9-23
3314 hex	S-curve Acceleration/Deceleration Time Setting	Sets the acceleration or deceleration processing S-curve time for the speed command input.	page 9-24

7-8-2   Soft Start Acceleration or Deceleration Time

Set the time required for a step speed command to reach the maximum motor speed into the Soft Start Acceleration Time (3312 hex). In the same manner, set the time required for the command to decrease the speed from the maximum motor speed to "0 mm/s" into the Soft Start Deceleration Time (3313 hex).

The time taken for acceleration or deceleration is calculated by the following formula, where Vc [mm/s] is the target speed of the speed command.

The maximum motor speed is the setting of the Overspeed Level (3910 hex).

Acceleration Time [ms] = Vc / Maximum motor speed × 3312 hex × 1 ms

Deceleration Time [ms] = Vc / Maximum motor speed × 3313 hex × 1 ms
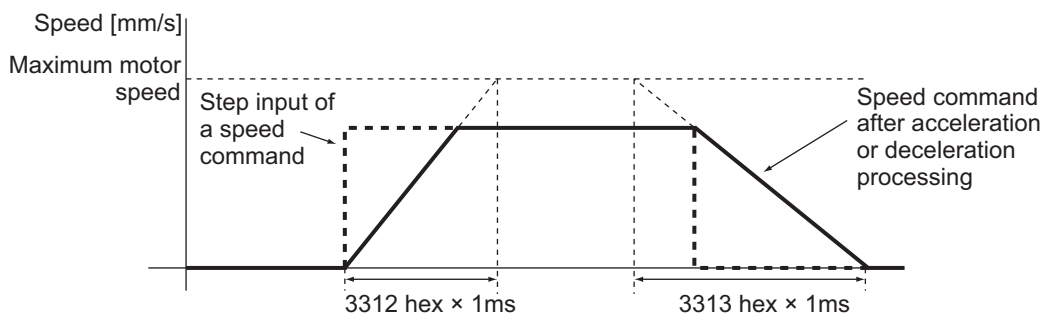
7-8-3   S-curve Acceleration or Deceleration Time

The function sets the S-curve time for the acceleration and deceleration time set by the Soft Start Acceleration Time (3312 hex) and the Soft Start Deceleration Time (3313 hex). The S-curve time is a duration around an inflection point during acceleration and deceleration.

Speed [mm/s]

Target speed (Vc)

ts   ts   ts   ts

ta   td
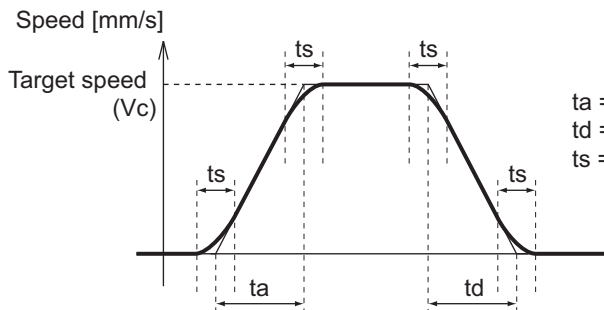
$ta = Vc$ / Maximum motor speed × 3312 hex × 1 ms
$td = Vc$ / Maximum motor speed × 3313 hex × 1 ms
$ts = 3314$ hex × 1 ms

Note   Be sure that ts is smaller than the values obtained by the divisions of

$$\frac{ta}{2} \text{ and } \frac{td}{2}.$$

7-9   Gain Switching Function

This function switches the position, speed, and force control gains.

Select enable or disable using Gain Switching Input Operating Mode Selection (3114 hex). Set the switching condition using the gain switching setting.

If the load mass changes or you want to change the responsiveness depending on whether the motor is stopping or operating, you can perform optimal control by using gain switching.

The function is used when the realtime autotuning does not work effectively, such as:

- Decreasing the gain during servo lock stop to prevent vibration.
- Increasing the gain during stabilization stop to reduce the stabilization time.
- Increasing the gain during movement to improve the command following performance.
- Switching the gain via an external signal depending on the equipment state.

Precautions for Correct Use

When Gain 2 has been selected, realtime autotuning does not operate normally. If using the gain switching, set the Realtime Autotuning to "Disabled" (3002 hex = 0).

7-9-1   Objects Requiring Settings

● Common to All Modes

Index	Name	Description	Reference
3002 hex	Realtime Autotuning Mode Selection	Set the operation mode for realtime autotuning. Realtime autotuning cannot be used if the gain switching function is being used.	page 9-4
3114 hex	Gain Switching Input Operating Mode Selection	Set whether to enable or disable the gain switching function.	page 9-11

● Position Control Mod

Index	Name	Description	Reference
3115 hex	Switching Mode in Position Control	Set the condition for switching between Gain 1 and Gain 2.	page 9-11
3116 hex	Gain Switching Delay Time in Position Control	Set the time until the gain is actually switched after switching from the Gain 2 to Gain 1. (Unit: 0.1 ms)	page 9-12
3117 hex	Gain Switching Level in Position Control[1]	Set the judgment level for switching between the Gain 1 and Gain 2. The unit depends on the setting of the Switching Mode.	page 9-12
3118 hex	Gain Switching Hysteresis in Position Control[2]	Set the hysteresis width to be used for the judgment level set in Gain Switching Level (3117 hex). The unit depends on the setting of the Switching Mode.	page 9-12
3119 hex	Position Gain Switching Time	Set the time to change from one position gain to the other one. (Unit: 0.1 ms)	page 9-13

[1]   Set the level set in Gain Switching Level in Position Control (3117 hex) to greater than or equal to the hysteresis set in Gain Switching Hysteresis in Position Control (3118 hex).

[2]   If set to greater than the level set in Gain Switching Level in Position Control (3117 hex), the hysteresis set in Gain Switching Hysteresis in Position Control (3118 hex) will be automatically adjusted to equal to the level set in Gain Switching Level in Position Control (3117 hex).

● **Speed Control Mode**

Index	Name	Description	Reference
3120 hex	Switching Mode in Speed Control	Set the condition for switching between Gain 1 and Gain 2.	page 9-14
3121 hex	Gain Switching Delay Time in Speed Control	Set the time until the gain is actually switched after switching from the Gain 2 to Gain 1. (Unit: 0.1 ms)	page 9-14
3122 hex	Gain Switching Level in Speed Control[*1]	Set the judgment level for switching between the Gain 1 and Gain 2. The unit depends on the setting of the Switching Mode.	page 9-15
3123 hex	Gain Switching Hysteresis in Speed Control[*2]	Set the hysteresis width to be provided in the judgment level set in Gain Switching Level in Speed Control (3122 hex). The unit depends on the setting of the Switching Mode.	page 9-15

*1 Set the level set in Gain Switching Level in Speed Control (3122 hex) to greater than or equal to the hysteresis set in Gain Switching Hysteresis in Speed Control (3123 hex).

*2 If set to greater than the level set in Gain Switching Level in Speed Control (3122 hex), the hysteresis set in Gain Switching Hysteresis in Speed Control (3123 hex) will be automatically adjusted to equal to the level set in Gain Switching Level in Speed Control (3122 hex).

● **Force Control Mode**

Index	Name	Description	Reference
3124 hex	Switching Mode in Force Control	Set the condition for switching between Gain 1 and Gain 2.	page 9-15
3125 hex	Gain Switching Delay Time in Force Control	Set the time until the gain is actually switched after switching from the Gain 2 to Gain 1. (Unit: 0.1 ms)	page 9-16
3126 hex	Gain Switching Level in Force Control[*1]	Set the judgment level for switching between the Gain 1 and Gain 2. The unit depends on the setting of the Switching Mode.	page 9-16
3127 hex	Gain Switching Hysteresis in Force Control[*2]	Set the hysteresis width to be provided in the judgment level set in Gain Switching Level in Force Control (3126 hex). The unit depends on the setting of the Switching Mode.	page 9-16

*1 Set the level set in Gain Switching Level in Force Control (3126 hex) to greater than or equal to the hysteresis set in Gain Switching Hysteresis in Force Control (3127 hex).

*2 If set to greater than the level set in Gain Switching Level in Force Control (3126 hex), the hysteresis set in Gain Switching Hysteresis in Force Control (3127 hex) will be automatically adjusted to equal to the level set in Gain Switching Level in Force Control (3126 hex).

7-9-2   Gain Switching Based on the Control Mode

The settable switching conditions vary depending on the control mode used. Set the objects for each control mode.

Refer to *Section 9 Servo Parameter Objects* for details on gain-related objects.

Position Control Mode

In the Position Control mode, operation varies as follows according to Switching Mode in Position Control (3115 hex).
For operation details, refer to *7-9-3 Diagrams of Gain Switching Setting* on page 7-32.

3115 hex set value	Gain switching conditions	Gain Switching Delay Time in Position Control (3116 hex)[1]	Gain Switching Level in Position Control (3117 hex)[2]	Gain Switching Hysteresis in Position Control (3118 hex) [3]
0	Always Gain 1 (3100 to 3104 hex).	Disabled	Disabled	Disabled
1	Always Gain 2 (3105 to 3109 hex).	Disabled	Disabled	Disabled
2	Gain switching command input via EtherCAT communications	Disabled	Disabled	Disabled
3	Force command	Enabled	Enabled [%]	Enabled [%]
4	Always Gain 1 (3100 to 3104 hex).	Disabled	Disabled	Disabled
5	Speed command	Enabled	Enabled [mm/s]	Enabled [mm/s]
6	Pulse position error	Enabled	Enabled [external encoder pulses]	Enabled [external encoder pulses]
7	Position command	Enabled	Disabled	Disabled
8	Positioning not completed	Enabled	Disabled	Disabled
9	Actual motor speed	Enabled	Enabled [mm/s]	Enabled [mm/s]
10	Position command + Actual motor speed	Enabled	Enabled [mm/s]	Enabled [mm/s]

*1   The Gain Switching Delay Time in Position Control (3116 hex) becomes effective when the gain is switched from 2 to 1.

*2   Set the level set in Gain Switching Level in Position Control (3117 hex) to greater than or equal to the hysteresis set in Gain Switching Hysteresis in Position Control (3118 hex).

*3   If set to greater than the level set in Gain Switching Level in Position Control (3117 hex), the hysteresis set in Gain Switching Hysteresis in Position Control (3118 hex) will be automatically adjusted to equal to the level set in Gain Switching Level in Position Control (3117 hex).

● **Gain switching command input via EtherCAT communications**

The gain is switched instantly when a gain switching command is issued via EtherCAT communications.

● **Force command**

The gain is switched via a force command.

● **Speed command**

The gain is switched via a speed command.

● **Following error actual value**

The gain is switched via the pulse position error in external encoder units.

● **Position Command**

The gain is switched according to whether there is a position command.

● **Positioning not completed**

The gain is switched according to the presence/absence of a positioning completion signal (INP1).

● **Actual motor speed**

The gain is switched via the actual motor speed.

● **Position command + Actual motor speed**

In addition to the presence or absence of a position command, the gain is switched according to the combination with the actual motor speed.

Speed Control Mode

In the Speed Control Mode, it varies as follows according to Switching Mode in Speed Control (3120 hex). For operation details, refer to *7-9-3 Diagrams of Gain Switching Setting* on page 7-32.

3120 hex set value	Description			
	Gain switching conditions	Gain Switching Delay Time in Speed Control (3121 hex) [*1]	Gain Switching Level in Speed Control (3122 hex) [*2]	Gain Switching Hysteresis in Speed Control (3123 hex) [*3]
0	Always the Gain 1 (3100 to 3104 hex).	Disabled	Disabled	Disabled
1	Always the Gain 2 (3105 to 3109 hex).	Disabled	Disabled	Disabled
2	Gain switching command input via EtherCAT communications	Disabled	Disabled	Disabled
3	Force command variation	Enabled	Enabled [%]	Enabled [%]
4	Speed command change amount	Enabled	Enabled [[10 mm/s]/s]	Enabled [[10 mm/s]/s]
5	Speed command	Enabled	Enabled [mm/s]	Enabled [mm/s]

*1   The Gain Switching Delay Time in Speed Control (3121 hex) becomes effective when the gain is switched from 2 to 1.

*2   Set the level set in Gain Switching Level in Speed Control (3122 hex) to greater than or equal to the hysteresis set in Gain Switching Hysteresis in Speed Control (3123 hex).

*3   If set to greater than the level set in Gain Switching Level in Speed Control (3122 hex), the hysteresis set in Gain Switching Hysteresis in Speed Control (3123 hex) will be automatically adjusted to equal to the level set in Gain Switching Level in Speed Control (3122 hex).

● **Gain switching command input via EtherCAT communications**

The gain is switched instantly when a gain switching command is issued via EtherCAT communications.

● **Force command**

The gain is switched via a force command.

● **Speed command variation**

The gain is switched via the speed command variation.

● **Speed command**

The gain is switched via a speed command.

Force Control Mode

In the Force Control Mode, it varies as follows according to the Switching Mode in Force Control (3124 hex).

For operation details, refer to *7-9-3 Diagrams of Gain Switching Setting* on page 7-32.

3124 hex set value	Description			
	Gain switching conditions	Gain Switching Delay Time in Force Control (3125 hex) [1]	Gain Switching Level in Force Control (3126 hex)[2]	Gain Switching Hysteresis in Force Control (3127 hex) [3]
0	Always Gain 1 (3100 to 3104 hex).	Disabled	Disabled	Disabled
1	Always Gain 2 (3105 to 3109 hex).	Disabled	Disabled	Disabled
2	Gain switching command input via EtherCAT communications	Disabled	Disabled	Disabled
3	Force command	Enabled	Enabled [%]	Enabled [%]

[1]   The Gain Switching Delay Time in Force Control (3125 hex) becomes effective when the gain is switched from 2 to 1.

[2]   Set the level set in Gain Switching Level in Force Control (3126 hex) to greater than or equal to the hysteresis set in Gain Switching Hysteresis in Force Control (3127 hex).

[3]   If set to greater than the level set in Gain Switching Level in Force Control (3126 hex), the hysteresis set in Gain Switching Hysteresis in Force Control (3127 hex) will be automatically adjusted to equal to the level set in Gain Switching Level in Force Control (3126hex).

● Gain switching command input via EtherCAT communications

The gain is switched instantly when a gain switching command is issued via EtherCAT communications.

● Force command

The gain is switched via a force command.

7-9-3   Diagrams of Gain Switching Setting

This section describes the timing in which switching between Gain 1 (3100 to 3104 hex) and Gain 2 (3105 to 3109 hex) occurs.

Switching between Gain 1 (3100 to 3104 hex) and Gain 2 (3105 to 3109 hex) occurs at the following timing, depending on the set value of the Switching Mode in Position Control (3115 hex), Switching Mode in Speed Control (3120 hex), or Switching Mode in Force Control (3124 hex).

For the position loop gain, however, switching occurs based on the Position Gain Switching Time (3119 hex) setting.

2: Gain Switching Command Input via EtherCAT Communications

When the Gain Switching command of EtherCAT communications (G-SEL) is 0, the gain switches to Gain 1. When the command is 1, the gain switches to Gain 2.

Instant switching occurs when a gain switching command is issued from the network.
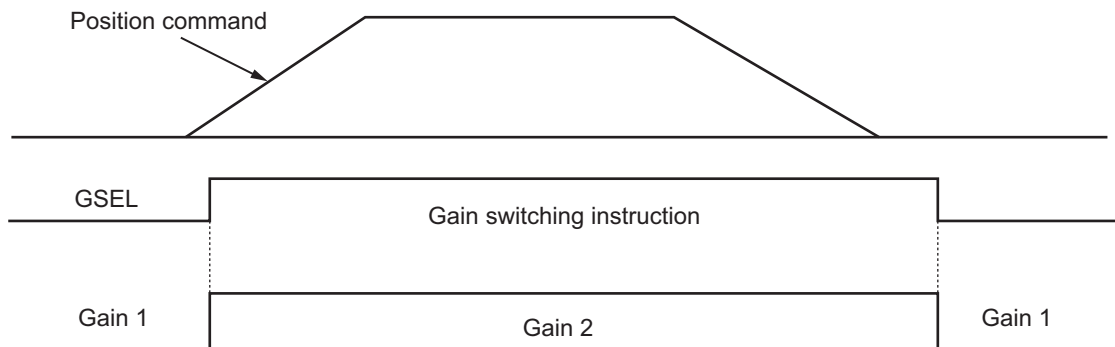
3: Command Force

If the absolute value of the force command exceeds the value of the Gain Switching Level plus the Gain Switching Hysteresis [%], the gain switches to Gain 2.

If the absolute value of the force command is less than the value of the Gain Switching Level minus the Gain Switching Hysteresis [%] and this condition lasts for the time specified in the Gain Switching Delay Time, the gain switches back to Gain 1.
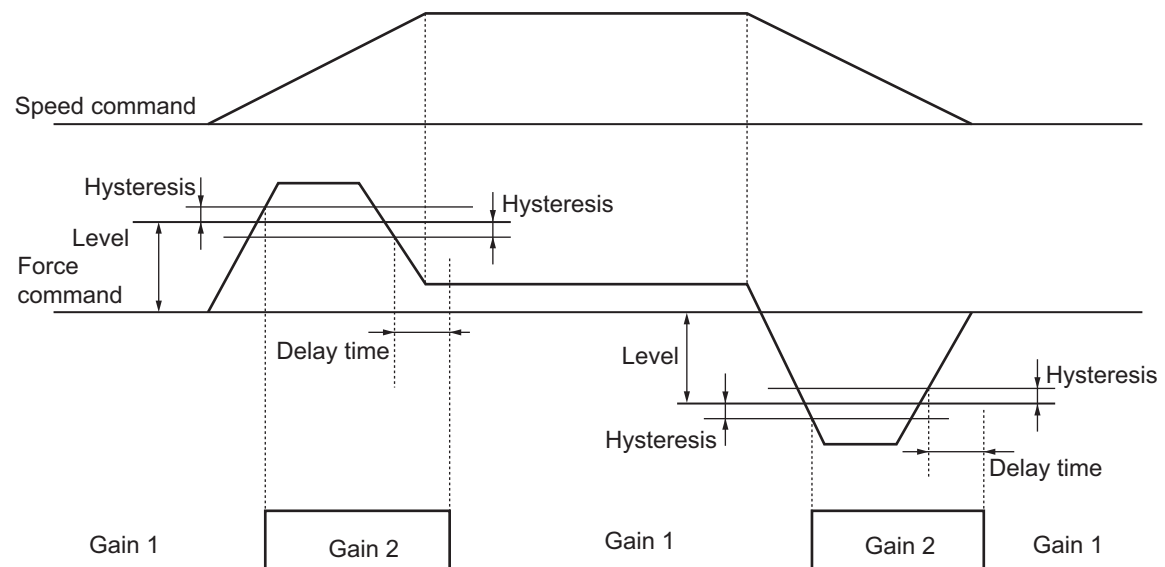
4: Speed Command Variation

The gain can be switched in the Speed Control Mode.

In the Position Control Mode, however, the gain is always Gain 1 (3100 to 3104 hex).

If the absolute value of the speed command variation exceeds the value of the Gain Switching Level in Speed Control (3122 hex) plus the Gain Switching Hysteresis in Speed Control (3123 hex) [10 mm/s/s], the gain switches to Gain 2.

If the absolute value of the speed command variation is less than the value of the Gain Switching Level in Speed Control (3122 hex) minus the Gain Switching Hysteresis in Speed Control (3123 hex) [10 mm/s/s] and this condition lasts for the time specified in the Gain Switching Delay Time in Speed Control (3121 hex), the gain switches back to Gain 1.
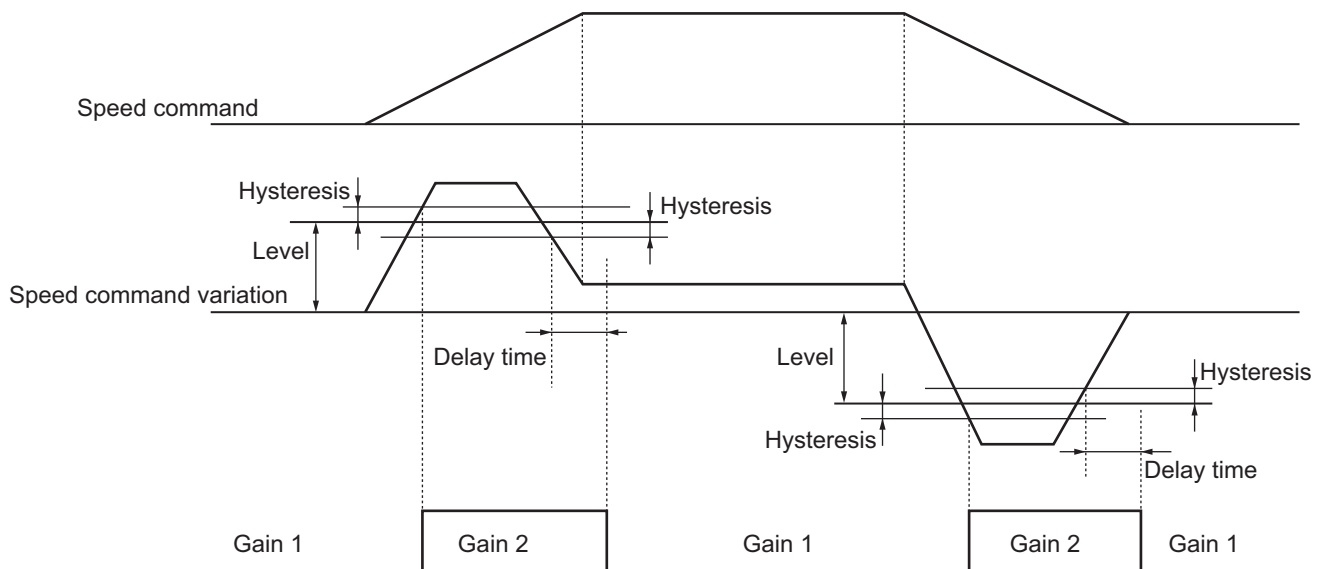
5: Speed Command

If, in Gain 1, the absolute value of the speed command exceeds the value of the Gain Switching Level plus the Gain Switching Hysteresis [mm/s], the gain switches to Gain 2.

If, in Gain 2, the absolute value of the speed command is less than the value of the Gain Switching Level minus the Gain Switching Hysteresis [mm/s] and this condition lasts for the Delay Time, the gain switches back to Gain 1.
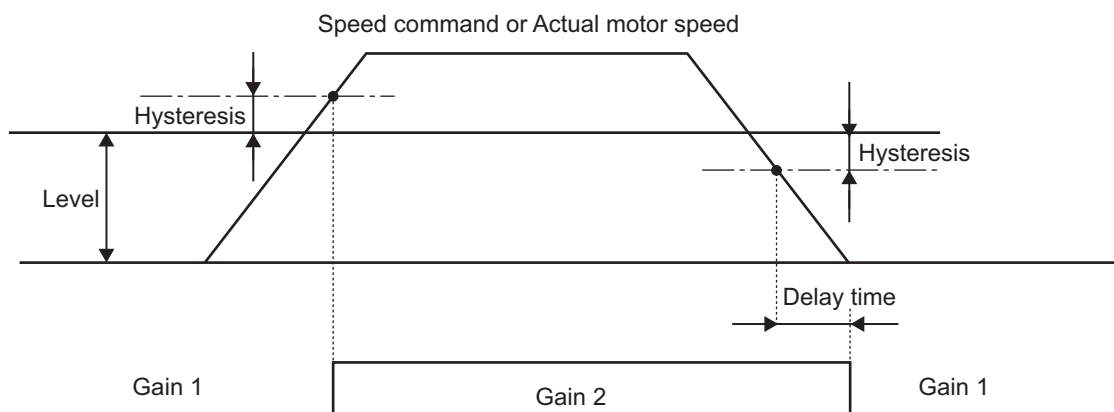
Note The "speed command" is the Motor Control Effort (401A hex) [mm/s].

6: Pulse Position Error

If the absolute value of the pulse position error exceeds the value of the Gain Switching Level plus the Gain Switching Hysteresis [pulses], the gain switches to Gain 2.

If the absolute value of the position error is less than the value of the Gain Switching Level minus the Gain Switching Hysteresis [pulses] and this condition lasts for the Delay Time, the gain switches back to Gain 1.
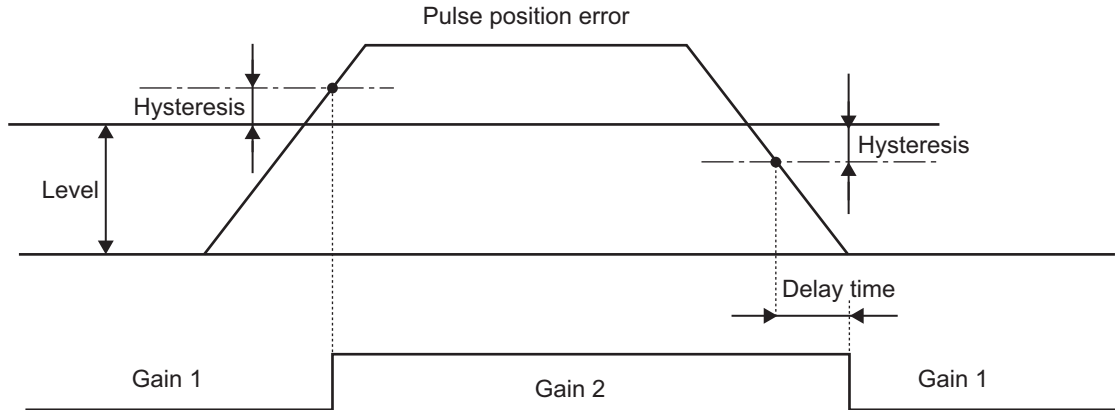
Set the Level and the Hysteresis unit [pulses] according to the external encoder resolution.

7: Position Command

If the position command value is not 0, the gain switches to Gain 2.

If the position command value is 0 and this condition lasts for the Delay Time, the gain switches back to Gain 1.

Note The "position command" is the Target Position (607A hex).

8: Positioning Not Completed

If the position command is not completed, the gain switches to Gain 2.

If the position command is completed and this condition lasts for the Delay Time, the gain switches back to Gain 1.
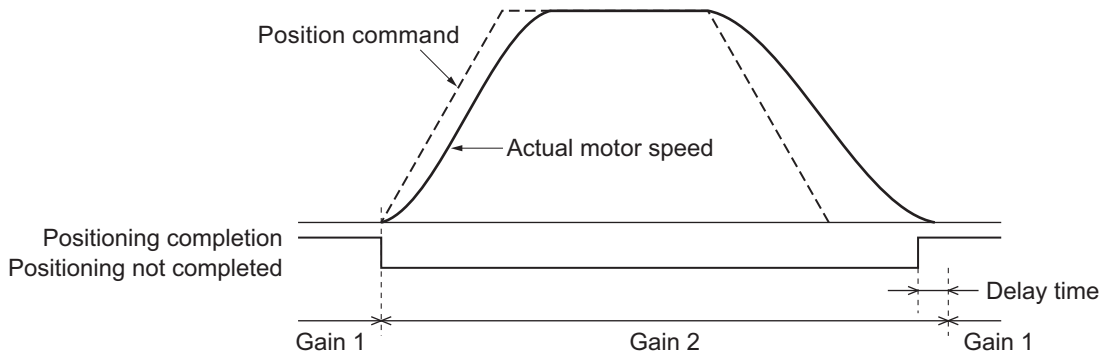
9: Actual Motor Speed

If the absolute value of the actual motor speed exceeds the value of the Gain Switching Level plus the Gain Switching Hysteresis [mm/s], the gain switches to Gain 2.

If the absolute value of the actual motor speed is less than the value of the Gain Switching Level minus the Gain Switching Hysteresis [mm/s] and this condition lasts for the Delay Time, the gain switches back to Gain 1.
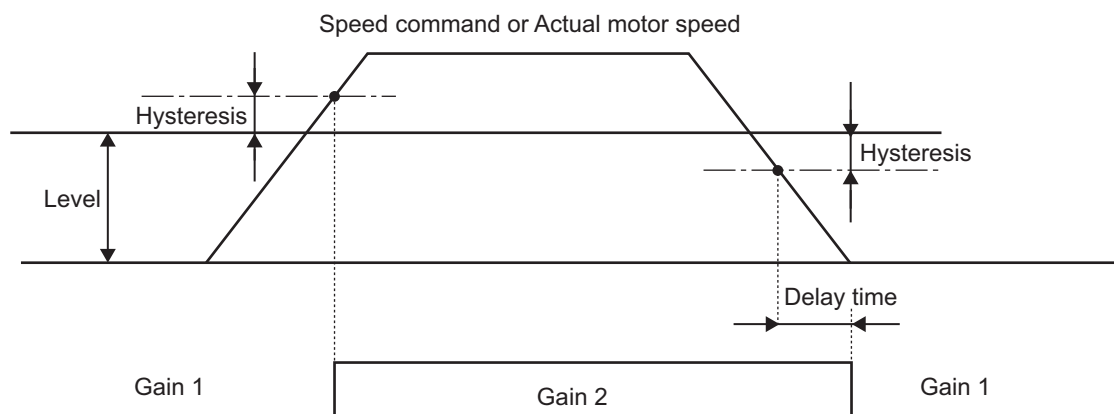
Note   The "speed command" is the Motor Control Effort (401A hex) [mm/s].

10: Position Command + Actual Motor Speed

If there is a position command in Gain 1, the gain switches to Gain 2.

If a condition where there is no position command lasts for the Gain Switching Delay Time in Position Control (3116 hex) and the absolute value of the actual motor speed is less than the value of the Gain Switching Level in Position Control (3117 hex) minus the Gain Switching Hysteresis in Position Control (3118 hex) [mm/s], the gain switches back to Gain 1.
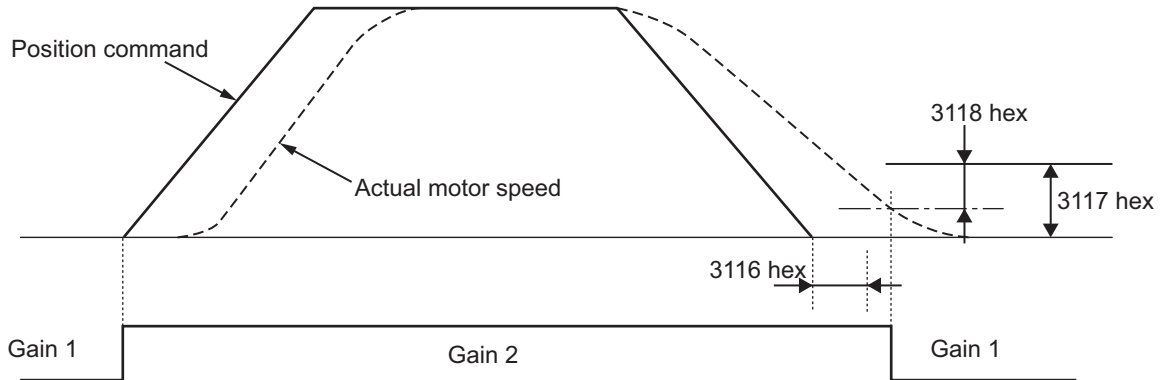
Note   The "position command" is the Target Position (607A hex).

7-9-4   Position Gain Switching Time (3119 Hex)

Torque fluctuations or vibration will occur if the position loop gain is changed too quickly during position control.

To suppress these, set a Position Gain Switching Time (3119 hex).

By setting the Position Gain Switching Time (3119 hex), the gain will be switched gradually when there is a large change in the position loop gain.

If there is a large difference between Position Loop Gain 1 (3100 hex) and Position Loop Gain 2 (3105 hex), set the Position Gain Switching Time (3119 hex).

When the position loop gain increases, the gain changes in the set time.
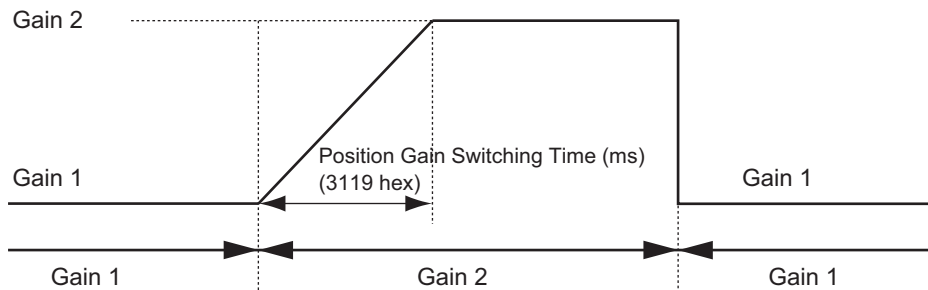
Position Loop Gain 1 < Position Loop Gain 2

Precautions for Correct Use

When the position loop gain is switched to a smaller value, Position Gain Switching Time (3119 hex) is ignored and the gain is switched immediately.

In the above figure, this operation occurs when switching from Gain 2 to Gain 1.

7-10 Gain Switching 3 Function

This function adds a new setting (gain 3) to the gain switching function of the Gain Switching Input Operating Mode Selection (3114 hex).

The positioning stabilization time can be reduced by keeping the gain immediately before the stop at a higher level for a certain period of time.

7-10-1 Operating Conditions

You can use the gain 3 switching function in the following situations for position control.

	Conditions
Operating mode	Position Control Mode
Others	• Servo ON state. • The factors other than control parameters must be set correctly. This includes the force limit. The motor must operate normally without any failures.

7-10-2 Objects Requiring Settings

Index	Name	Explanation	Reference
3605 hex	Gain 3 Effective Time	Set effective time of Gain 3.	page 9-43
3606 hex	Gain 3 Ratio Setting	Set Gain 3 as a multiple of Gain 1.	page 9-43

7-10-3 Operation Example

When the conventional gain switching function works correctly, set the time to use Gain 3 in the Gain 3 Effective Time (3605 hex).

Set the magnification ratio of Gain 3 to Gain 1 in the Gain 3 Ratio Setting (3606 hex).

Operation Timings of Gain 1, 2 and 3

When the Switching Mode in Position Control (3115 hex) is set to 7 (Position command), the operation is as shown below:

Position command speed [mm/s]

3605 hex × 0.1 ms

Gain 2
3105 to 3109 hex

Gain 3

Gain 1
3100 to 3104 hex

Gain 3 region

Position loop gain = 3100 × 3606 hex/100

Speed loop gain = 3101 × 3606 hex/100
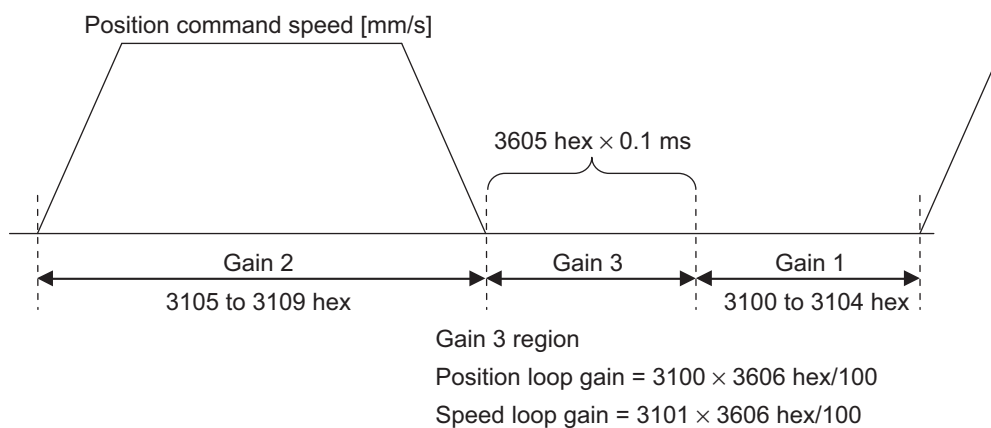
The Gain 1 values are used for the speed loop integral time constant, speed feedback filter time constant, and force command filter time constant.

Precautions for Correct Use

- If Gain 3 is not used, set the Gain 3 Effective Time (3605 hex) to 0 and the Gain 3 Ratio Setting (3606 hex) to 100.
- In the Gain 3 region, only the position loop gain and the speed loop gain are treated as Gain 3, and the Gain 1 setting is applied for all other gains.
- If the Gain 2 switching condition is established in the Gain 3 region, operation switches to Gain 2.
- If Gain 2 is switching to Gain 3, the Position Gain Switching Time (3119 hex) is applied.
- There is a Gain 3 region even when Gain 2 is switched to Gain 1 due to an object change and so forth.

7-11 Touch Probe Function (Latch Function)

The touch probe (latch) function latches the position actual value when an external latch input signal or the external encoder's phase-Z signal turns ON. G5-series Servo Drives can latch two positions.

7-11-1 Objects Requiring Settings

Index	Name	Description	Reference
60B8 hex	Touch probe function	Controls the latch function.	page A-91
60B9 hex	Touch probe status	Gives the state of latches 1 and 2.	page A-91
60BA hex	Touch probe pos1 pos value	Latch position of latch 1.	page A-91
60BC hex	Touch probe pos2 pos value	Latch position of latch 2.	page A-91
3404 hex	Input Signal Selection 5	Set the function for general-purpose input 5 (IN5).	page 9-27
3405 hex	Input Signal Selection 6	Set the function for general-purpose input 6 (IN6).	page 9-28
3406 hex	Input Signal Selection 7	Set the function for general-purpose input 7 (IN7).	page 9-28
3758 hex	Touch Probe Trigger Selection	Select the trigger signals for latch 1 and 2.	page 9-52

7-11-2 Trigger Signal Settings

The latch trigger can be selected from general-purpose inputs 5 to 7 or the external encoder's phase-Z signal. The functions of general-purpose signals 5 to 7 from the control I/O connector are set with the Input Signal Selection 5 to 7 (3404 to 3406 hex). External latch input signals used by Latches 1 and 2 are set with the Touch Probe Trigger Selection (3758 hex).

Bits 2 and 10 of the Touch probe function (60B8 hex) are used to specify weather to latch with an external signal or the phase-Z signal.
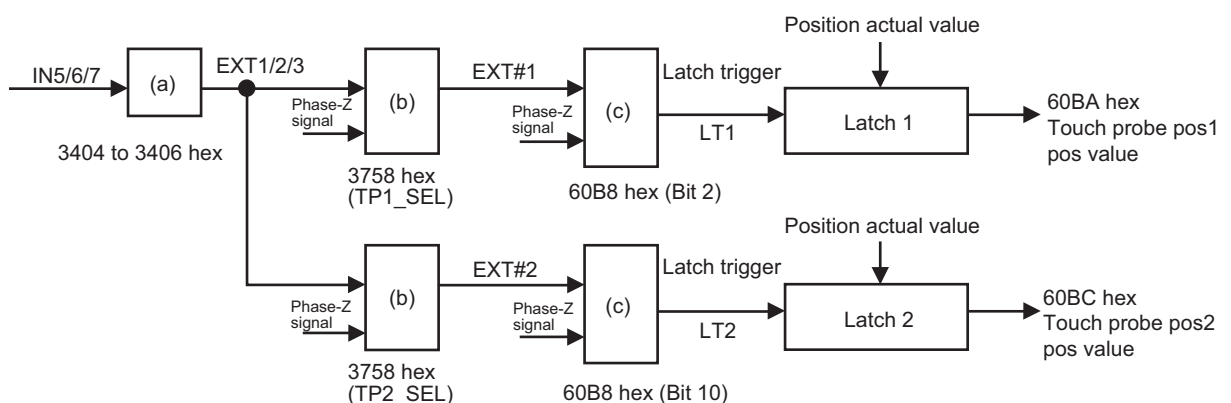
General-purpose Input Assignment in (a)

Signal	Index	Assignment[1]
IN5	3404 hex	Select either EXT1, EXT2, or EXT3.
IN6	3405 hex	Select either EXT1, EXT2, or EXT3.
IN7	3406 hex	Select either EXT1, EXT2, or EXT3.

[1]   The same function cannot be assigned more than once.

Touch Probe Trigger Selection (3758 hex) in (b)

Latch 1			Latch 2		
TP1_SEL		EXT#1	TP2_SEL		EXT#2
Bit 0	Bit 1		Bit 8	Bit 9	
0	0	EXT1	0	0	EXT1
1	0	EXT2	1	0	EXT2
0	1	EXT3	0	1	EXT3
1	1	Phase-Z signal	1	1	Phase-Z signal

Touch probe function (60B8 hex) in (c)

Bit 2	LT1	Bit 10	LT2
0	EXT#1	0	EXT#2
1	Phase-Z signal	1	Phase-Z signal

7-11-3 Operation Sequences

Trigger first event (60B8 Hex Bit 1/9 = 0: Trigger first event)
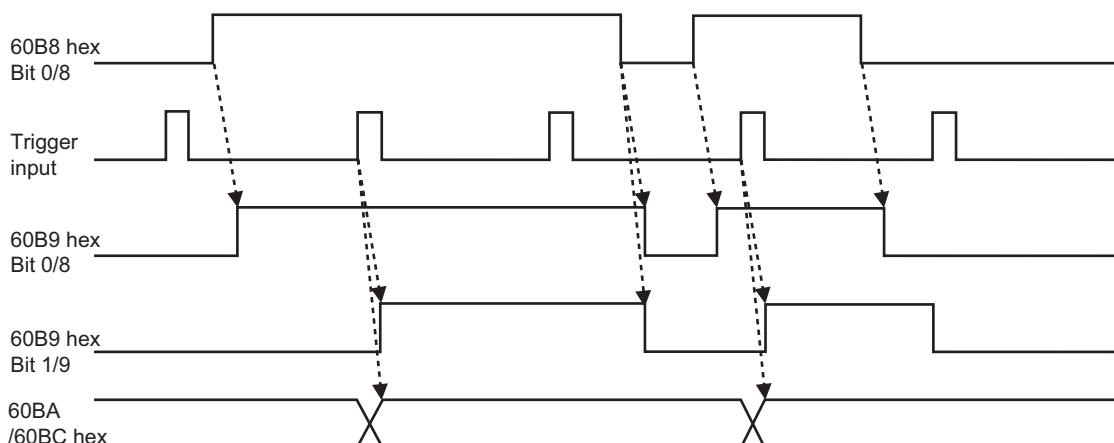
Continuous (60B8 Hex Bit 1/9 = 1: Continuous)

7-11 Touch Probe Function (Latch Function)

7

7-11-3 Operation Sequences

8

Safety Function

This function stops the motor based on a signal from a safety controller or safety sensor. An outline of the function is given together with operation and connection examples.

8

8-1   Safe Torque OFF Function

The safe torque OFF function (hereinafter referred to as STO according to IEC 61800-5-2) is used to cut off the motor current and stop the motor with the input signals from a safety device, such as a safety controller or safety sensor.

When the STO function is operating, the Servo Drive turns OFF the servo ready completed output (READY) to go into the safety status.

To connect a Servo Drive to safety devices such as a safety controller or a safety sensor, use the safety connector (CN8).

The PFH value is 2.30×10^{-8}.

Precautions for Safe Use

- When using the STO function, be sure to execute a risk assessment of the equipment to confirm that the system safety requirements are met.
- There are the following risks even when the STO function is operating. Be sure to take safety into account as part of the risk assessment.
  - The motor runs if an external force is present. If holding is required, implement appropriate measures, such as providing external brakes.
  - Even if there is no external force, when the Fault reaction option code (605E hex) is set to free-run with the dynamic brake disabled, the motor uses free-run stopping and the stop distance is long.
  - In case of internal failure of components, the motor may operate in the range of up to 180 degrees of electrical angle.
  - The power supply to the motor is cut off by the STO function, but the power supply to the Servo Drive will not be cut off nor electrically isolated. For Servo Drive maintenance, cut off the power supply to the Servo Drive through another means.
- Do not use the EDM output for any purpose other than the failure monitoring function. The EDM output signal is not a safety output.
- The dynamic brake and external brake release signal outputs are not safety-related parts. Make sure to design the equipment not to be dangerous even if the external brake release fails during the STO status.
- When using the STO function, connect equipment that meets the safety standards.

Precautions for Correct Use

According to EN61800-5-2, the safety function is referred to as the "Safe torque off" function using the word "torque" instead of force. Read it as "force" when using this function.

8-1-1   Safety Input Signals

There are 2 safety input circuits to operate the STO function.

Signal name	Symbol	Pin number	Description	Control mode		
				Position	Speed	Force
Safety input 1	SF+	CN8-4	The upper arm drive signal of the power transistor inside the Servo Drive is cut off.	√	√	√
	SF−	CN8-3		√	√	√
Safety input 2	SF2+	CN8-6	The lower arm drive signal of the power transistor inside the Servo Drive is cut off.	√	√	√
	SF2−	CN8-5		√	√	√

- When safety input 1 or 2 turns "OFF," the STO function will start operating within 5 ms of the input, and the motor output torque will be reduced to 0.
- Connect the equipment so that the safety input circuit is turned OFF to operate the STO function.
- Set the operation when the safety input turns "OFF" in the Fault reaction option code (605E hex).

Precautions for Correct Use

L pulses for self-diagnosis of safety equipment

When you are connecting a safety device, such as a safety controller or a safety sensor, the safety output signal of the device may include L pulses for self-diagnosis. To avoid malfunction due to the L pulses for self-diagnosis, a filter that removes the L pulses is built into the safety input circuit. If the OFF time of the safety input signal is 1 ms or less, the safety input circuit does not recognize it as "OFF." To make sure that "OFF" is recognized, maintain the OFF status of safety input signal for at least 5 ms.
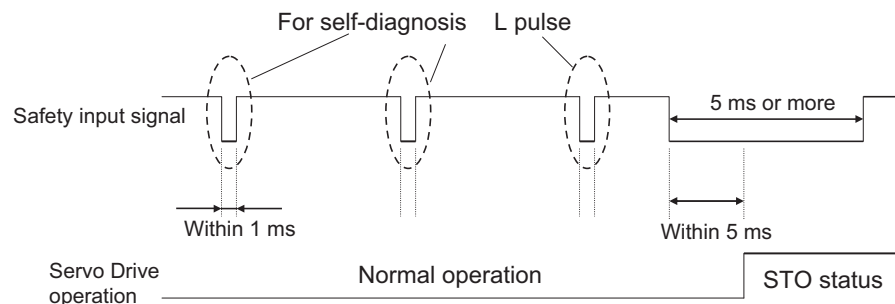
8-1-2   External Device Monitor (EDM) Output Signal

This is a monitor output signal that is used to monitor the status of safety input signals using an external device. Connect a safety device, such as a safety controller or a safety sensor. Connect the EDM output signal to the monitoring terminal on a safety device.

Signal name	Symbol	Pin number	Description	Control mode		
				Position	Speed	Force
EDM output[1]	EDM+	CN8-8	Monitor signal is output to detect malfunctioning of the safety function.	√	√	√
	EDM−	CN8-7		√	√	√

*1   This is not a safety output.

8-1-3   Relationship between Safety Input Signals and EDM Output Signal

Normally when both safety inputs 1 and 2 are OFF, i.e., when the STO function is activated for both safety input circuits, the EDM output is ON.

You can detect a failure of the safety input circuit and the EDM output circuit by monitoring all of the following 4 signal states using an external device.

These are the two cases of errors:
- Both safety inputs 1 and 2 are OFF, but the EDM output circuit signal does not turn ON.
- Either or both safety inputs 1 and 2 are ON, but the EDM output circuit signal is ON.

Signal name	Symbol	Signal status			
Safety input 1	SF1	ON	ON	OFF	OFF
Safety input 2	SF2	ON	OFF	ON	OFF
EDM output	EDM	OFF	OFF	OFF	ON

The maximum delay time is 6 ms after the safety input signal is input until the EDM output signal is output.

8-2   Operation Example

This section provides timing charts showing the operation timings to enter a safety status and the timing of return from a safety status.

Operation Timings to a Safety Status

Servo ON/OFF	Servo ON	Servo OFF
Safety input 1 Safety input 2 [*1]	Normal status	STO status
Motor power is supplied.	Power supply	No power supply — Response time = max 5ms
EDM output	OFF	ON — Response time = max 6ms
Dynamic brake relay [*2]	DB released	DB engaged — 0.5 to 5ms
Servo ready completed output (READY)	READY	
Error output (/ALM)	Normal	Error
Brake interlock output (BKIR)	Brake released	t1 [*3] Brake engaged — Value set in 3438 hex
Motor speed Value set in 3439 hex		When object 3438 hex set value comes earlier
Brake interlock output (BKIR)	Brake released	Brake engaged — Value set in 3438 hex
Motor speed Value set in 3439 hex		When object 3439 hex set value comes earlier

*1   STO status is entered when either safety input 1 or 2 turns "OFF."

*2   The dynamic brake operates according to the setting of the Fault reaction option code (605E hex).

*3   t1 is the set value of the Brake Timing During Operation (3438 hex), or the time needed for the motor speed to drop to or below the Brake Threshold Speed During Operation (3439 hex), whichever occurs first.

8-2 Operation Example

8

Timing of Return from Safety Status

Servo ON /OFF[*1]
Servo OFF command
Servo ON

Safety input 1
Safety input 2
STO status
Normal status

After the servo turns ON, operation will follow the normal servo ON/OFF operation timing diagram. For details, refer to *7-5 Brake Interlock*.

Motor power is supplied.
No power supply

Response time = 6 ms max.

EDM output
ON
OFF

Dynamic brake relay
DB released/engaged [*2]
DB released/engaged [*3]

Error
Servo OFF

Servo ready completed output (READY)
READY

Error reset input (RESET)[*1]
Reset

Error Output (/ALM)
Error
Normal

Brake interlock output (BKIR)
Brake engaged

*1   Make sure that servo ON input is "OFF" when you return the input signals of safety inputs 1 and 2 to "ON." If an error exists in this state, be sure to clear the error when both safety inputs 1 and 2 have returned to "ON" state. If either safety input 1 or 2 is executed with "OFF", an error occurs immediately. Also, depending on the execution timing, an Other Error (Error No. 99.9) may occur.
If this error (Error No. 99.9) occurs, turn OFF and then ON the power again.

*2   An error exists in this state. The dynamic brake operates according to the Fault reaction option code (605E hex).

*3   This is a nomal servo OFF state. The dynamic brake operates according to the Disable operation option code (605C hex).

8-3   Connection Examples

Connection with a Safety Controller

Safety Controller
G9SP-series
Safety output (source)

Safety output 1
Safety output 2
Test output
EDM input
Safety input

Drive
SF1+
Safety input
SF1-
SF2+
SF2-
0V
EDM+
EDM output
EDM-
M

9
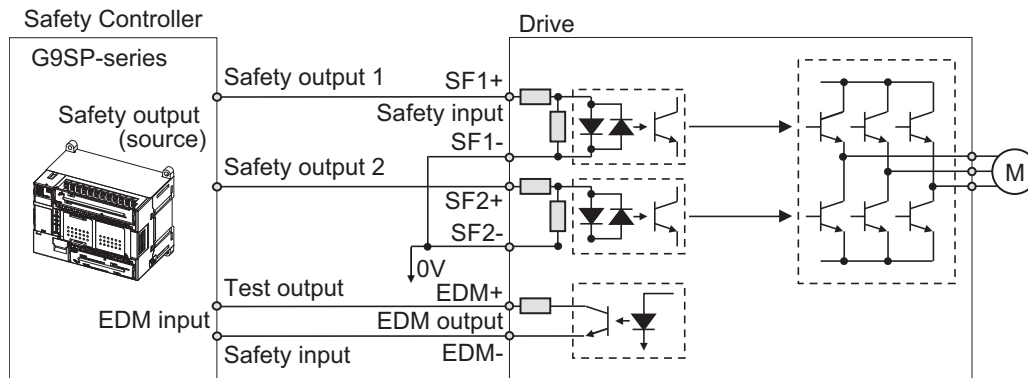
Servo Parameter Objects

This section explains the settings of each object.

9

9-1　Basic Settings

This section describes objects specific to G5-series Servo Drives with built-in EtherCAT communications. G5-series Servo Drive parameters (Pn□□□) are allocated to objects 3000 to 3999 hex. Index 3□□□ hex correspond to G5-series Servo Drive parameters Pn□□□. For example, object 3504 hex is the same as parameter Pn504.

📝 Precautions for Correct Use

- Pn□□□ uses decimal numbers but object 3□□□ is a hexadecimal number.
- According to the CiA 402 Drive Profile, the object names listed below may be represented using the word "torque," instead of force. Read it as "force" when using these objects.

- Some objects are enabled by turning the power supply OFF and then ON again. After changing these objects, turn OFF the power supply, confirm that the power supply indicator has gone OFF, and then turn ON the power supply again.
- Do not change the objects marked "reserved." Also, do not change the set values that are indicted as being unused or reserved for the system.
- See below for the data attributes.

A	:	Always enabled
B	:	Prohibited to change during motor operation or commands. If it is changed during motor operation or commands, the update timing will be unknown.
C	:	Updated after the control power is reset, or after a Config command is executed via EtherCAT communications.
D	:	Changeable only when the EtherCAT communications state is Pre-Operational (Pre-Op).
R	:	Updated when the control power supply is reset. It is not updated for a Config command via EtherCAT communications.
−	:	Write prohibited.

- The operation modes are shown as follows:

All	:	All operation modes
csp	:	Cyclic synchronous position mode
csv	:	Cyclic synchronous velocity mode
cst	:	Cyclic synchronous torque mode
pp	:	Profile position mode
hm	:	Homing mode

3000 hex	Movement Direction Setting						All
Setting range	0 to 1	Unit	–	Default setting	1	Data attribute	C
Size	2 bytes (INT16)		Access	RW	PDO map	Not possible.	

- This object switches the motor movement direction for a position, speed, or force command.

Explanation of Settings

Set value	Description
0	A positive direction command causes the external encoder to count in a negative direction.
1	A positive direction command causes the external encoder to count in a positive direction.

Changing the Movement Direction Setting

To change the Movement Direction Setting (3000 hex), follow the steps below.

1 **First of all, set the External Feedback Pulse Direction Switching (3326 hex).**

For the setting method, refer to *3326 hex* on page 9-26.

When finished, write the setting to the EEPROM and turn OFF and then ON the power supply to the Servo Drive.

2 **Set the Movement Direction Setting (3000 hex) and write the setting to the EEPROM.**

When finished, turn OFF and then ON the power supply to the Servo Drive again.

3 **With the servo OFF, move the motor in the direction that you want the system to recognize as positive.**

At this time, check the direction in which the external encoder counts, and set the Movement Direction Setting (3000 hex) to 0 if the count direction is negative or 1 if the count direction is positive.

When finished, write the setting to the EEPROM and turn OFF and then ON the power supply.

The external encoder count direction can be checked in the tool software, by monitoring the direction in which the "Position actual internal value" changes.

Additional Information

In this manual, the term "positive/negative direction" refers to the direction you set in the above procedure.

For example, the following table shows the relationship of the Movement Direction Setting with the Positive/Negative Drive Prohibition Input.

Set value 3000 hex	Command direction	Feedback pulse direction	Positive Drive Prohibition Input	Negative Drive Prohibition Input
0	Positive	Negative	Enabled	–
	Negative	Positive	–	Enabled
1	Positive	Positive	Enabled	–
	Negative	Negative	–	Enabled

3002 hex	Realtime Autotuning Mode Selection						All
Setting range	0 to 6	**Unit**	–	**Default setting**	1	**Data attribute**	B
Size	2 bytes (INT16)		**Access**	RW	**PDO map**	Not possible.	

- Set the operating mode for realtime autotuning.

Explanation of Settings

Set value	Realtime autotuning	Description
0	Disabled	Realtime autotuning is disabled.
1	Focus on stability (default setting)	No unbalanced load, friction compensation, or gain switching.
2	Focus on position control	Used when there is no unbalanced load and a little friction.
3	Unbalanced load mode	Used when an unbalanced load is present.
4	Friction compensation and unbalanced load mode	Used when there is an unbalanced load and a large friction. Variations in the positioning stabilization time are suppressed when friction is large.
5	Reserved	Do not set.
6	Customization	This mode is used for customizing the realtime autotuning function by using the Realtime Autotuning Customization Mode Setting (3632 hex).[1]

*1   Refer to *Realtime Autotuning Customization Mode Setting* on page 9-47 for setting the realtime autotuning function (3632 hex).

Refer to *11-3 Realtime Autotuning* on page 11-7 for details of realtime autotuning settings.

3003 hex	Realtime Autotuning Machine Rigidity Setting						All
Setting range	0 to 31	**Unit**	–	**Default setting**	13 [1]	**Data attribute**	B
Size	2 bytes (INT16)		**Access**	RW	**PDO map**	Not possible.	

*1   The default setting is 11 for a Drive with 200 V and 1 kW or greater, or for a Drive with 400 V.

- Set the machine rigidity to one of 32 levels when realtime autotuning is enabled.
- The higher the machine rigidity set value is, the higher the responsiveness is, however, the more vibration occurs.

<div align="center">

Low ←Machine rigidity→ High

Low   ←Servo gain→   High

3003 hex	0.1 - - - - - - - - - - - - - - - 31

Low ←Responsiveness→ High

</div>

- Refer to *11-3 Realtime Autotuning* on page 11-7 for details of realtime autotuning settings.

> **Precautions for Correct Use**
>
> If the set value is changed suddenly by a large amount, the gain may change rapidly, subjecting the machine to shock. Always start with a small setting, and gradually increase the setting while monitoring machine operation.

3004 hex	Mass Ratio						All
Setting range	0 to 10000	Unit	%	Default setting	250	Data attribute	B
Size	2 bytes (INT16)		Access	RW	PDO map	Not possible.	

- Set the load mass as a percentage of the Motor Coil Unit Mass.
- 3004 hex = (Load mass/Motor Coil Unit Mass) x 100%
- When realtime autotuning is enabled, the Mass Ratio is continuously estimated and saved to the EEPROM every 30 minutes.
- If the Mass Ratio is set correctly, the setting unit for the Speed Loop Gain 1 (3101 hex) and Speed Loop Gain 2 (3106 hex) is Hz.
- If the Mass Ratio (3004 hex) is set larger than the actual value, the setting for speed loop gain will increase. If the Mass Ratio (3004 hex) is set smaller than the actual value, the setting for speed loop gain will decrease.

3013 hex	Force Limit 1						All
Setting range	0 to 5000	Unit	0.1 %	Default setting	5000	Data attribute	B
Size	2 bytes (INT16)		Access	RW	PDO map	Not possible.	

- Set the limit value 1 for the motor output force.
- Refer to the *Force Limit Selection* on page 9-41 for details of force limit selection.
- During force control, it limits the maximum force in positive and negative directions.
- Set the value in units of 0.1% of the rated voltage (100%).

E.g. When the maximum force is limited to 150.0%.
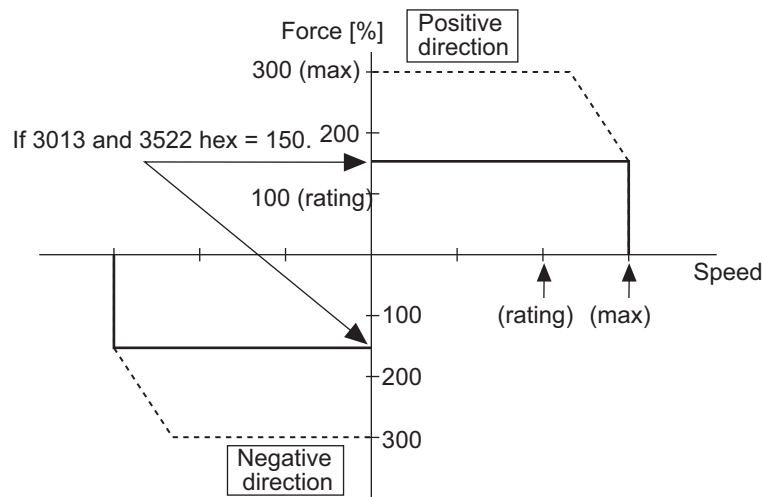
Refer to *7-7 Force Limit Switching* on page 7-22 for the force control and the force limit selection.

9-1 Basic Settings

9

3016 hex	Regeneration Resistor Selection						All
Setting range	0 to 3	Unit	–	Default setting	3[*1]	Data attribute	C
Size	2 bytes (INT16)		Access	RW	PDO map	Not possible.	

*1   The default setting is 0 for a Drive with 100 V and 400 W, with 200 V and 750 W or greater, or with 400 V.

- The setting is different whether the Regeneration Resistor built in the Drive is directly used, or it is removed and replaced by an External Regeneration Resistor.
- An external regeneration resistor can be connected as required to the external regeneration resistor connection terminal.

Explanation of Settings

Set value	Regeneration Resistor used	Description
0	Built-in Resistor	The regeneration processing circuit operates and the Regeneration Overload Error (Error No. 18.0) are enabled according to the Built-in Resistor. The duty ratio is approx. 1%.
1	External Resistor	The regeneration processing circuit operates, and Regeneration Overload Error (Error No. 18.0) cause a trip when the operating rate of the Regeneration Resistor exceeds 10%.
2	External Resistor	The regeneration processing circuit operates, but Regeneration Overload Error (Error No. 18.0) do not occur.
3	None	The regeneration processing circuit and Regeneration Overload Error (Error No. 18.0) do not operate, and all regenerative energy is processed by the built-in capacitor.

Precautions for Correct Use

- Do not touch the External Regeneration Resistor. A burn injury may result.
- Always provide a temperature fuse or other protective measure when using an External Regeneration Resistor. Regardless of whether the regeneration overload error is enabled or disabled, the Regeneration Resistor can generate heat and may cause burning.
- To use the Built-in Regeneration Resistor, always set this object to 0.

3017 hex	External Regeneration Resistor Setting						All
Setting range	0 to 4	Unit	–	Default setting	0	Data attribute	C
Size	2 bytes (INT16)		Access	RW	PDO map	Not possible.	

- Select the method to calculate the regeneration resistance load ratio, when the External Resistor is selected in the Regeneration Resistor Selection.

Explanation of Settings

Set value	Description
0	Regeneration load ratio is 100% when operating rate of the External Regeneration Resistor is 10%.
1	Reserved
2	Reserved
3	Reserved
4	Reserved

9-2   Gain Settings

Refer to *11-2 Gain Adjustment* on page 11-5 for the settings for gain adjustment.

3100 hex	Position Loop Gain 1						csp pp hm
Setting range	0 to 30000	**Unit**	0.1/s	**Default setting**	480[*1]	**Data attribute**	B
Size	2 bytes (INT16)		**Access**	RW	**PDO map**	Not possible.	

*1   The default setting is 320 for a Drive with 200 V and 1 kW or greater, or with 400 V.

- Set the position loop response in accordance with the machine rigidity.
- The responsiveness of the servo system is determined by the position loop gain.
- Servo systems with a high position loop gain have a high responsiveness and fast positioning.
- To increase the position loop gain, you must improve machine rigidity and increase the specific damping frequency. This should be 500 to 700 [0.1/s] for ordinary machine tools, 300 to 500 [0.1/s] for general-use and assembly machines, and 100 to 300 [0.1/s] for industrial robots. The default position loop gain is 480 [0.1/s], so be sure to lower the set value for machines with low machine rigidity.
- Increasing the position loop gain in systems with low machine rigidity or systems with low specific damping frequencies may cause machine resonance, resulting in an overload error.
- If the position loop gain is low, you can shorten the positioning time using feed-forward.
- This object is automatically changed by executing realtime autotuning. To set it manually, set the Realtime Autotuning Mode Selection (3002 hex) to 0.

Position loop gain is generally expressed as follows:

$$\text{Position loop gain (Kp)} = \frac{\text{Command pulse frequency (pulses/s)}}{\text{Pulse position error (pulses)}} \ (0.1/s)$$

Response for Position Loop Gain Changes
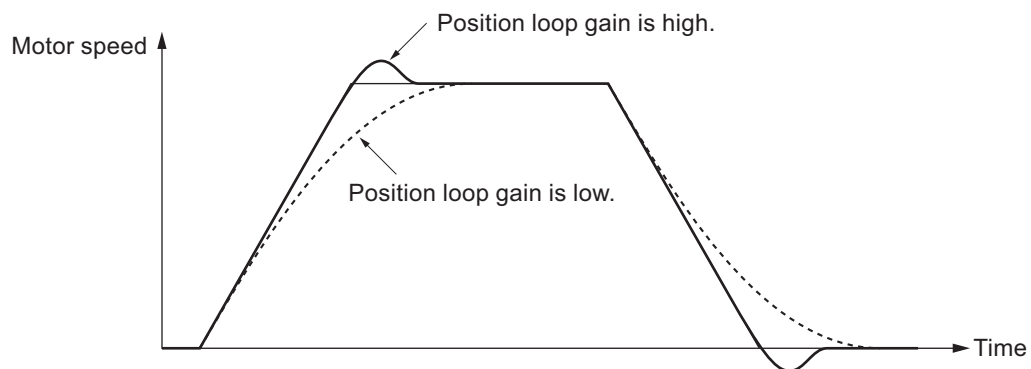
- If the speed loop gain and position loop gain are optimally set, the motor operation for the command delays 2/Kp at acceleration and delays 3/Kp at deceleration.
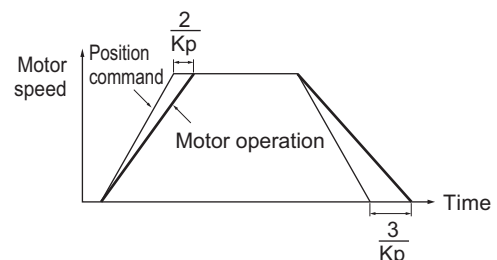
3101 hex	Speed Loop Gain 1						All
Setting range	1 to 32767	Unit	0.1 Hz	Default setting	270[*1]	Data attribute	B
Size	2 bytes (INT16)		Access	RW	PDO map	Not possible.	

*1   The default setting is 180 for a Drive with 200 V and 1 kW or greater, or with 400 V.

- This object determines speed loop responsiveness.
- The setting for the speed loop gain must be increased to increase the position loop gain and improve the responsiveness of the entire servo system. Setting too high, however, may result in vibration.
- The setting unit for the Speed Loop Gain 1 (3101 hex) is Hz if the Mass Ratio (3004 hex) is set correctly.

Response when the speed loop gain is changed.
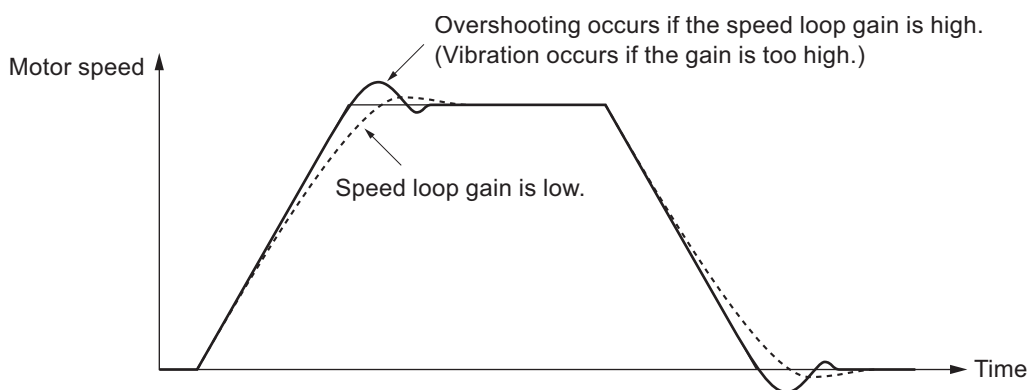
3102 hex	Speed Loop Integral Time Constant 1						All
Setting range	1 to 10000	Unit	0.1 ms	Default setting	210[*1]	Data attribute	B
Size	2 bytes (INT16)		Access	RW	PDO map	Not possible.	

*1   The default setting is 310 for a Drive with 200 V and 1 kW or greater, or with 400 V.

- Set the speed loop integral time constant.
- The smaller the set value, the faster the error approaches "0" when stopping.

Response when the speed loop integral time constant is changed.

3103 hex	Speed Feedback Filter Time Constant 1						All
Setting range	0 to 5	Unit	–	Default setting	0	Data attribute	B
Size	2 bytes (INT16)		Access	RW	PDO map	Not possible.	

- Set the time constant for the low pass filter (LPF) after speed detection to one of 6 levels (0 to 5).
- Increasing the set value increases the time constant and decreases the noise generated by the motor. Responsiveness, however, also decreases.
- Normally, use the default set value.

3104 hex	Force Command Filter Time Constant 1						All
Setting range	0 to 2500	Unit	0.01 ms	Default setting	84[*1]	Data attribute	B
Size	2 bytes (INT16)		Access	RW	PDO map	Not possible.	

*1   The default setting is 126 for a Drive with 200 V and 1 kW or greater, or with 400 V.

- Set the time constant for the first-order lag filter inserted into the force command.
- This object may be effective in suppressing vibration due to torsion resonance.

3105 hex	Position Loop Gain 2						csp pp hm
Setting range	0 to 30000	Unit	0.1/s	Default setting	570[*1]	Data attribute	B
Size	2 bytes (INT16)		Access	RW	PDO map	Not possible.	

*1   The default setting is 380 for a Drive with 200 V and 1 kW or greater, or with 400 V.

- Set the responsiveness of the position control system for the second position loop.

3106 hex	Speed Loop Gain 2						All
Setting range	1 to 32767	Unit	0.1 Hz	Default setting	270[*1]	Data attribute	B
Size	2 bytes (INT16)		Access	RW	PDO map	Not possible.	

*1   The default setting is 180 for a Drive with 200 V and 1 kW or greater, or with 400 V.

- Set the responsiveness of the second speed loop.

3107 hex	Speed Loop Integral Time Constant 2						All
Setting range	1 to 10000	Unit	0.1 ms	Default setting	10000	Data attribute	B
Size	2 bytes (INT16)		Access	RW	PDO map	Not possible.	

- Set the second speed loop integral time constant.

3108 hex	Speed Feedback Filter Time Constant 2						All
Setting range	0 to 5	Unit	–	Default setting	0	Data attribute	B
Size	2 bytes (INT16)		Access	RW	PDO map	Not possible.	

- Set the second speed feedback filter.

3109 hex	Force Command Filter Time Constant 2						All
Setting range	0 to 2500	**Unit**	0.01 ms	**Default setting**	84[*1]	**Data attribute**	B
Size	2 bytes (INT16)		**Access**	RW	**PDO map**	Not possible.	

*1   The default setting is 126 for a Drive with 200 V and 1 kW or greater, or with 400 V.

- Set the second force filter time constant.
- The objects from 3105 to 3109 hex are the gain and time constants to be selected when the Gain Switching Input Operating Mode Selection (3114 hex) is enabled.
- The gain is switched according to the condition set in the Switching Mode (3115 hex, 3120 hex, and 3124 hex).
- If the mechanical system mass changes greatly or if you want to change the responsiveness depending on whether the motor is moving or being stopped, you can achieve the appropriate control by setting the gains and time constants beforehand for each of these conditions, and switching them according to the condition.
- This object is automatically changed by executing realtime autotuning function. To set it manually, set the Realtime Autotuning Mode Selection (3002 hex) to "0."

3110 hex	Speed Feed-forward Gain					csp	pp	hm
Setting range	0 to 1000	**Unit**	0.1%	**Default setting**	300	**Data attribute**	B	
Size	2 bytes (INT16)		**Access**	RW	**PDO map**	Not possible.		

- Set the feed-forward gain.
- Increasing the set value decreases the position error and increases the responsiveness. Overshooting, however, will occur more easily.

Refer to *11-10 Feed-forward Function* on page 11-30.

3111 hex	Speed Feed-forward Command Filter					csp	pp	hm
Setting range	0 to 6400	**Unit**	0.01 ms	**Default setting**	50	**Data attribute**	B	
Size	2 bytes (INT16)		**Access**	RW	**PDO map**	Not possible.		

- Set the time constant for the first-order lag filter inserted into the feed-forward.
- Setting the filter may improve operation if speed overshooting occurs or the noise during operation is large when the feed-forward is set high.

Refer to *11-10 Feed-forward Function* on page 11-30.

3112 hex	Force Feed-forward Gain					csp	csv	pp	hm
Setting range	0 to 1000	**Unit**	0.1%	**Default setting**	0	**Data attribute**	B		
Size	2 bytes (INT16)		**Access**	RW	**PDO map**	Not possible.			

- Set the feed-forward gain in force control. Increasing the set value decreases the position error and increases the responsiveness. Overshooting, however, will occur more easily.

Refer to *11-10 Feed-forward Function* on page 11-30.

3113 hex	Force Feed-forward Command Filter					csp csv pp hm	
Setting range	0 to 6400	Unit	0.01 ms	Default setting	0	Data attribute	B
Size	2 bytes (INT16)		Access	RW	PDO map	Not possible.	

- Set the time constant for the first-order lag filter inserted into the feed-forward.
- Setting the filter may improve operation if speed overshooting occurs or the noise during operation is large when the feed-forward is set high.

  Refer to *11-10 Feed-forward Function* on page 11-30.

3114 hex	Gain Switching Input Operating Mode Selection					All	
Setting range	0 to 1	Unit	–	Default setting	1	Data attribute	B
Size	2 bytes (INT16)		Access	RW	PDO map	Not possible.	

- Select either PI/P operation switching or Gain 1/Gain 2 switching.
- The PI/P operation switching is performed with the Speed Loop PI/P Control command in EtherCAT communications.

  Refer to *7-10 Gain Switching 3 Function* on page 7-37 for the Gain 1/Gain 2 switching.

Explanation of Settings

Set value	Description
0	Gain 1 (PI/P switching enabled)
1	Gain 1/gain 2 switching available

3115 hex	Switching Mode in Position Control					csp pp	
Setting range	0 to 10	Unit	–	Default setting	0	Data attribute	B
Size	2 bytes (INT16)		Access	RW	PDO map	Not possible.	

- Select the conditions for switching between Gain 1 and Gain 2 when the Gain Switching Input Operating Mode Selection (3114 hex) is set to 1.

Explanation of Settings

3115 hex set value	Description			
	Gain switching conditions	Gain Switching Delay Time in Position Control (3116 hex) [1]	Gain Switching Level in Position Control (3117 hex) [2]	Gain Switching Hysteresis in Position Control (3118 hex) [3]
0	Always Gain 1 (3100 to 3104 hex).	Disabled	Disabled	Disabled
1	Always Gain 2 (3105 to 3109 hex).	Disabled	Disabled	Disabled
2	Gain Switching Command Input via EtherCAT Communications [4]	Disabled	Disabled	Disabled
3	Force Command	Enabled	Enabled [%]	Enabled [%]
4	Always Gain 1 (3100 to 3104 hex).	Disabled	Disabled	Disabled
5	Speed Command	Enabled	Enabled [mm/s]	Enabled [mm/s]
6	Pulse Position Error	Enabled	Enabled [external encoder pulses]	Enabled [external encoder pulses]
7	Position Command	Enabled	Disabled	Disabled

9-2 Gain Settings

9

3115 hex set value	Description			
	Gain switching conditions	Gain Switching Delay Time in Position Control (3116 hex) [*1]	Gain Switching Level in Position Control (3117 hex) [*2]	Gain Switching Hysteresis in Position Control (3118 hex) [*3]
8	Positioning Not Completed	Enabled	Disabled	Disabled
9	Actual Motor Speed	Enabled	Enabled [mm/s]	Enabled [mm/s]
10	Position Command + Actual Motor Speed	Enabled	Enabled [mm/s]	Enabled [mm/s]

*1 The Gain Switching Delay Time in Position Control (3116 hex) becomes effective when the gain is switched from 2 to 1.

*2 Set the Level (3117 hex) to greater than or equal to the Hysteresis (3118 hex).

*3 The Gain Switching Hysteresis in Position Control (3118 hex) is defined as shown in the diagram to the right. If the Hysteresis (3118 hex) is set to greater than the Level (3117 hex), the Hysteresis (3118 hex) will be automatically adjusted to equal to the Level (3117 hex).

*4 When the Gain Switching command of EtherCAT communications is 0, the gain switches to Gain 1. When the command is 1, the gain switches to Gain 2.

Refer to *7-9-3 Diagrams of Gain Switching Setting* on page 7-32 for details on setting.

3116 hex	Gain Switching Delay Time in Position Control					csp pp hm
Setting range	0 to 10000	Unit	0.1 ms	Default setting	50	Data attribute B
Size	2 bytes (INT16)	Access	RW	PDO map	Not possible.	

• Set the delay time when returning from Gain 2 to Gain 1 if the Switching Mode in Position Control (3115 hex) is set to 3 or 5 to 10.

3117 hex	Gain Switching Level in Position Control					csp pp hm
Setting range	0 to 20000	Unit	–	Default setting	50	Data attribute B
Size	2 bytes (INT16)	Access	RW	PDO map	Not possible.	

• This object is enabled when the Switching Mode in Position Control (3115 hex) is 3, 5, 6, 9 or 10. It sets the judgment level for switching between Gain 1 and Gain 2.

• The unit depends on the Switching Mode in Position Control (3115 hex).

3118 hex	Gain Switching Hysteresis in Position Control					csp pp hm
Setting range	0 to 20000	Unit	–	Default setting	33	Data attribute B
Size	2 bytes (INT16)	Access	RW	PDO map	Not possible.	

• Set the hysteresis width above and below the judgment level set in the Gain Switching Level in Position Control (3117 hex).

• The unit depends on the setting of the Switching Mode in Position Control (3115 hex).

• The Gain Switching Delay Time in Position Control (3116 hex), Gain Switching Level in Position Control (3117 hex), and Gain Switching Hysteresis in Position Control (3118 hex) are defined as shown in the diagram to the right.
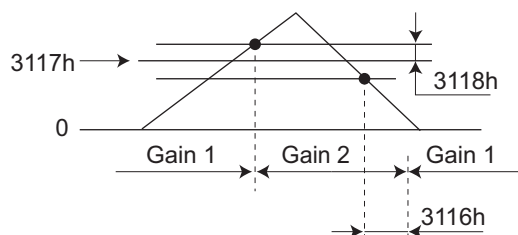
• The settings for the Gain Switching Level in Position Control (3117 hex) and the Gain Switching Hysteresis in Position Control (3118 hex) are enabled as absolute values.

3119 hex	Position Gain Switching Time					csp pp hm
Setting range	0 to 10000	**Unit**	0.1 ms	**Default setting**	33	**Data attribute**	B
Size	2 bytes (INT16)		**Access**	RW	**PDO map**	Not possible.

- Torque fluctuations or vibration will occur if the position loop gain is changed too quickly during position control or fully-closed control. To suppress these, set a Position Gain Switching Time (3119 hex).
- By setting the Position Gain Switching Time (3119 hex), the gain will be switched gradually when there is a large change in the position loop gain.
- If there is a large difference between Position Loop Gain 1 (3100 hex) and Position Loop Gain 2 (3105 hex), set the Position Gain Switching Time (3119 hex).
- When the position loop Gain 1 increases, the gain changes in the set time.

Position Loop Gain 1 < Position Loop Gain 2

Precautions for Correct Use

When the position loop gain is switched to a smaller value, Position Gain Switching Time (3119 hex) is ignored and the gain is switched immediately.

In the above figure, this operation occurs when switching from Gain 2 to Gain 1.

3120 hex	Switching Mode in Speed Control						CSV
Setting range	0 to 5	Unit	–	Default setting	0	Data attribute	B
Size	2 bytes (INT16)		Access	RW	PDO map	Not possible.	

- Select the conditions for switching between Gain 1 and Gain 2 when the Gain Switching Input Operating Mode Selection (3114 hex) is set to 1.

Explanation of Settings

3120 hex set value	Description			
	Gain switching conditions	Gain Switching Delay Time in Speed Control (3121 hex) [*1]	Gain Switching Level in Speed Control (3122 hex) [*2]	Gain Switching Hysteresis in Speed Control (3123 hex) [*3]
0	Always the Gain 1 (3100 to 3104 hex).	Disabled	Disabled	Disabled
1	Always the Gain 2 (3105 to 3109 hex).	Disabled	Disabled	Disabled
2	Gain switching command input via EtherCAT communications [*3]	Disabled	Disabled	Disabled
3	Force command	Enabled	Enabled [%]	Enabled [%]
4	Speed command variation	Enabled	Enabled [[10 mm/s]/s]	Enabled [[10 mm/s]/s]
5	Speed command	Enabled	Enabled [mm/s]	Enabled [mm/s]

*1   The Gain Switching Delay Time in Speed Control (3121 hex) becomes effective when the gain is switched from 2 to 1.

*2   Set the Level (3122 hex) to greater than or equal to the Hysteresis (3123 hex).

*3   The Gain Switching Hysteresis in Speed Control (3123 hex) is defined as shown in the diagram to the right.
If set to greater than the Level (3122 hex), the Hysteresis (3123 hex) will be automatically adjusted to equal to the Level (3122 hex).

*4   When the Gain switching command of EtherCAT communications is 0, the gain switches to Gain 1. When the command is 1, the gain switches to Gain 2.
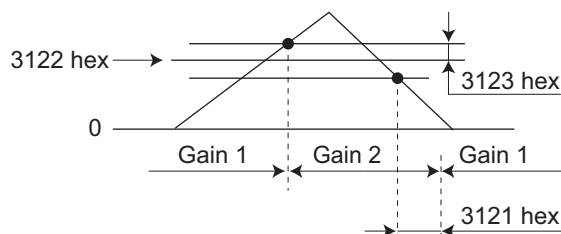
Refer to *7-9-3 Diagrams of Gain Switching Setting* on page 7-32 for details on setting.

> **Precautions for Correct Use**
>
> The gain is always Gain 1 regardless of the gain input if the Switching Mode in Speed Control (3120 hex) is 2 and the Force Limit Selection (3521 hex) is 3 or 6.

3121 hex	Gain Switching Delay Time in Speed Control						CSV
Setting range	0 to 10000	Unit	0.1 ms	Default setting	0	Data attribute	B
Size	2 bytes (INT16)		Access	RW	PDO map	Not possible.	

- Set the delay time when returning from Gain 2 to Gain 1 if the Switching Mode in Speed Control (3120 hex) is set to 3 to 5.

3122 hex	Gain Switching Level in Speed Control						CSV
Setting range	0 to 20000	Unit	–	Default setting	0	Data attribute	B
Size	2 bytes (INT16)		Access	RW	PDO map	Not possible.	

- In Speed Control Mode, this is enabled when the Switching Mode in Speed Control (3120 hex) is set to 3 to 5. Set the judgment level for switching between Gain 1 and Gain 2.
- The unit depends on the Switching Mode in Speed Control (3120 hex).

3123 hex	Gain Switching Hysteresis in Speed Control						CSV
Setting range	0 to 20000	Unit	–	Default setting	0	Data attribute	B
Size	2 bytes (INT16)		Access	RW	PDO map	Not possible.	

- Set the hysteresis width above and below the judgment level set in the Gain Switching Level in Speed Control (3122 hex).
- The unit depends on the setting of the Switching Mode in Speed Control (3120 hex).
- The Gain Switching Delay Time in Speed Control (3121 hex), Gain Switching Level in Speed Control (3122 hex), and Gain Switching Hysteresis in Speed Control (3123 hex) are defined as shown in the diagram to the right.
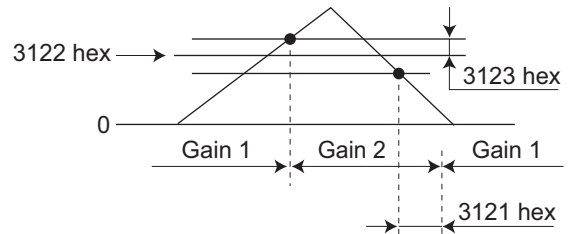
- The settings for the Gain Switching Level in Speed Control (3122 hex) and the Gain Switching Hysteresis in Speed Control (3123 hex) are enabled as absolute values.

3124 hex	Switching Mode in Force Control						cst
Setting range	0 to 3	Unit	–	Default setting	0	Data attribute	B
Size	2 bytes (INT16)		Access	RW	PDO map	Not possible.	

- Select the switching condition between Gain 1 and Gain 2 when the Gain Switching Input Operating Mode Selection (3114 hex) is set to 1.

Explanation of Settings

3124 hex set value	Description			
	Gain switching conditions	Gain Switching Delay Time in Force Control (3125 hex) [*1]	Gain Switching Level in Force Control (3126 hex) [*2]	Gain Switching Hysteresis in Force Control (3127 hex) [*3]
0	Always Gain 1 (3100 to 3104 hex).	Disabled	Disabled	Disabled
1	Always Gain 2 (3105 to 3109 hex).	Disabled	Disabled	Disabled
2	Gain switching command input via EtherCAT communications [*4]	Disabled	Disabled	Disabled
3	Force command	Enabled	Enabled [%]	Enabled [%]

*1 The Gain Switching Delay Time in Force Control (3125 hex) becomes effective when the gain is switched from 2 to 1.

*2 Set the Level (3126 hex) to greater than or equal to the Hysteresis (3127 hex).

*3   The Gain Switching Hysteresis in Force Control (3127 hex) is defined as shown in the diagram to the right.
If set to greater than the Level (3126 hex), the Hysteresis (3127 hex) will be automatically adjusted to equal to the Level (3126 hex).

*4   When the Gain switching command of EtherCAT communications is 0, the gain switches to Gain 1. When the command is 1, the gain switches to Gain 2.
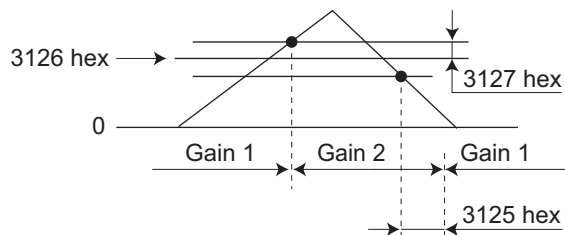
Refer to *7-9-3 Diagrams of Gain Switching Setting* on page 7-32 for details on setting.

✓ **Precautions for Correct Use**

The gain is always Gain 1 regardless of the gain input if the Switching Mode in Force Control (3124 hex) is 2 and the Force Limit Selection (3521 hex) is 3 or 6.

3125 hex	Gain Switching Delay Time in Force Control						cst
Setting range	0 to 10000	**Unit**	0.1 ms	**Default setting**	0	**Data attribute**	B
Size	2 bytes (INT16)	**Access**	RW	**PDO map**	Not possible.		

• Set the delay time when returning from Gain 2 to Gain 1 if the Switching Mode in Force Control (3124 hex) is set to 3.

3126 hex	Gain Switching Level in Force Control						cst
Setting range	0 to 20000	**Unit**	–	**Default setting**	0	**Data attribute**	B
Size	2 bytes (INT16)	**Access**	RW	**PDO map**	Not possible.		

• This is enabled when the Switching Mode in Force Control (3124 hex) is set to 3. It sets the judgment level for switching between Gain 1 and Gain 2.

• The unit depends on the setting of Switching Mode in Force Control (3124 hex).

3127 hex	Gain Switching Hysteresis in Force Control						cst
Setting range	0 to 20000	**Unit**	–	**Default setting**	0	**Data attribute**	B
Size	2 bytes (INT16)	**Access**	RW	**PDO map**	Not possible.		

• Set the hysteresis width above and below the judgment level set in the Gain Switching Level in Force Control (3126 hex).

• The unit depends on the setting of Switching Mode in Force Control (3124 hex).

• The Gain Switching Delay Time in Force Control (3125 hex), Gain Switching Level in Force Control (3126 hex), and Gain Switching Hysteresis in Force Control (3127 hex) are defined as shown in the diagram to the right.

• The settings for the Gain Switching Level in Force Control (3126 hex) and the Gain Switching Hysteresis in Force Control (3127 hex) are enabled as absolute values.
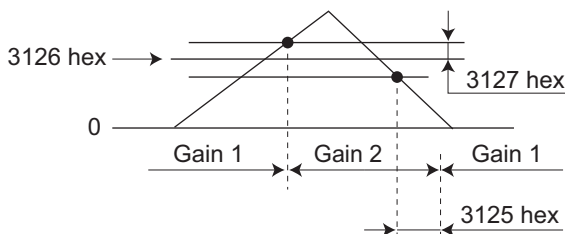
9-3   Vibration Suppression Settings

For vibration suppression, refer to *11-5 Damping Control* on page 11-16.

3200 hex	Adaptive Filter Selection					csp	csv	pp	hm
Setting range	0 to 4	**Unit**	–	**Default setting**	0	**Data attribute**			B
Size	2 bytes (INT16)	**Access**	RW	**PDO map**		Not possible.			

- Set the operation of the adaptive filter.

Refer to *11-6 Adaptive Filter* on page 11-20.

Explanation of Settings

Set value	Description
0	Adaptive filter disabled. The parameters related to notch filters 3 and 4 retain the current values.
1	One adaptive filter is enabled. The objects related to notch filter 3 are automatically updated.
2	Two adaptive filters are enabled. The objects related to notch filters 3 and 4 are updated.
3	Mode for measuring the resonance frequency. The resonance frequency is measured. The measured result can be checked using the support software. The parameters related to notch filters 3 and 4 retain the current values.
4	Adaptive result is cleared. Objects related to notch filters 3 and 4 are disabled and the adaptive result is cleared.

3201 hex	Notch 1 Frequency Setting					All			
Setting range	50 to 5000	**Unit**	Hz	**Default setting**	5000	**Data attribute**			B
Size	2 bytes (INT16)	**Access**	RW	**PDO map**		Not possible.			

- Set the frequency of resonance suppression notch filter 1.
- The notch filter function is disabled if this object is set to 5000.

Refer to *11-7 Notch Filters* on page 11-23.

3202 hex	Notch 1 Width Setting					All			
Setting range	0 to 20	**Unit**	–	**Default setting**	2	**Data attribute**			B
Size	2 bytes (INT16)	**Access**	RW	**PDO map**		Not possible.			

- Set the width of resonance suppression notch filter 1 to one of 20 levels.
- Increasing the setting value widens the notch width. Normally, use the default set value.

Refer to *11-7 Notch Filters* on page 11-23.

3203 hex	Notch 1 Depth Setting					All			
Setting range	0 to 99	**Unit**	–	**Default setting**	0	**Data attribute**			B
Size	2 bytes (INT16)	**Access**	RW	**PDO map**		Not possible.			

- Set the notch depth of resonance suppression notch filter 1.
- Increasing the setting value shortens the notch depth and the phase lag.

Refer to *11-7 Notch Filters* on page 11-23.

3204 hex	Notch 2 Frequency Setting						All
Setting range	50 to 5000	Unit	Hz	Default setting	5000	Data attribute	B
Size	2 bytes (INT16)		Access	RW	PDO map	Not possible.	

- Set the frequency of resonance suppression notch filter 2.
- The notch filter function is disabled if this object is set to 5000.

Refer to *11-7 Notch Filters* on page 11-23.

3205 hex	Notch 2 Width Setting						All
Setting range	0 to 20	Unit	–	Default setting	2	Data attribute	B
Size	2 bytes (INT16)		Access	RW	PDO map	Not possible.	

- Set the width of resonance suppression notch filter 2 to one of 20 levels.
- Increasing the setting value widens the notch width. Normally, use the default set value.

Refer to *11-7 Notch Filters* on page 11-23.

3206 hex	Notch 2 Depth Setting						All
Setting range	0 to 99	Unit	–	Default setting	0	Data attribute	B
Size	2 bytes (INT16)		Access	RW	PDO map	Not possible.	

- Set the depth of resonance suppression notch filter 2.
- Increasing the setting value shortens the notch depth and the phase lag.

Refer to *11-7 Notch Filters* on page 11-23.

3207 hex	Notch 3 Frequency Setting						All
Setting range	50 to 5000	Unit	Hz	Default setting	5000	Data attribute	B
Size	2 bytes (INT16)		Access	RW	PDO map	Not possible.	

- Set the frequency of resonance suppression notch filter 3.
- The notch filter function is disabled if this object is set to 5000.
- While the adaptive filter is enabled, the resonance frequency 1 that is assumed by the adaptive filter is automatically set. If no resonance point is found, the value 5000 is set.

Refer to *11-6 Adaptive Filter* on page 11-20 and *11-7 Notch Filters* on page 11-23.

3208 hex	Notch 3 Width Setting						All
Setting range	0 to 20	Unit	–	Default setting	2	Data attribute	B
Size	2 bytes (INT16)		Access	RW	PDO map	Not possible.	

- Set the width of resonance suppression notch filter 3 to one of 20 levels.
- Increasing the setting value widens the notch width. Normally, use the default set value.
- While the adaptive filter is enabled, this object is set automatically.

Refer to *11-6 Adaptive Filter* on page 11-20 and *11-7 Notch Filters* on page 11-23.

3209 hex	Notch 3 Depth Setting						All
Setting range	0 to 99	**Unit**	–	**Default setting**	0	**Data attribute**	B
Size	2 bytes (INT16)	**Access**	RW	**PDO map**	Not possible.		

- Set the depth of resonance suppression notch filter 3.
- Increasing the setting value shortens the notch depth and the phase lag.
- While the adaptive filter is enabled, this object is set automatically.

Refer to *11-6 Adaptive Filter* on page 11-20 and *11-7 Notch Filters* on page 11-23.

3210 hex	Notch 4 Frequency Setting						All
Setting range	50 to 5000	**Unit**	Hz	**Default setting**	5000	**Data attribute**	B
Size	2 bytes (INT16)	**Access**	RW	**PDO map**	Not possible.		

- Set the frequency of resonance suppression notch filter 4.
- The notch filter function is disabled if this object is set to 5000.
- While two adaptive filters are enabled, the resonance frequency 2 that is assumed by the adaptive filter is automatically set. If no resonance point is found, the value 5000 is set.

Refer to *11-6 Adaptive Filter* on page 11-20 and *11-7 Notch Filters* on page 11-23.

3211 hex	Notch 4 Width Setting						All
Setting range	0 to 20	**Unit**	–	**Default setting**	2	**Data attribute**	B
Size	2 bytes (INT16)	**Access**	RW	**PDO map**	Not possible.		

- Set the width of resonance suppression notch filter 4 to one of 20 levels.
- Increasing the setting value widens the notch width. Normally, use the default set value.
- This object is automatically set when two adaptive filters are enabled.

Refer to *11-6 Adaptive Filter* on page 11-20 and *11-7 Notch Filters* on page 11-23.

3212 hex	Notch 4 Depth Setting						All
Setting range	0 to 99	**Unit**	–	**Default setting**	0	**Data attribute**	B
Size	2 bytes (INT16)	**Access**	RW	**PDO map**	Not possible.		

- Set the notch depth of resonance suppression notch filter 4.
- Increasing the setting value shortens the notch depth and the phase lag.
- When two adaptive filters are enabled, this object is set automatically.

Refer to *11-6 Adaptive Filter* on page 11-20 and *11-7 Notch Filters* on page 11-23.

9-3 Vibration Suppression Settings

9

3213 hex	Damping Filter Selection					csp csv pp hm	
Setting range	0 to 3	**Unit**	–	**Default setting**	0	**Data attribute**	B
Size	2 bytes (INT16)		**Access**	RW	**PDO map**	Not possible.	

- Set the method to switch among four damping control filters.

Explanation of Set Values

Set value	Explanation
0	Up two damping filters, damping filters 1 and 2, can be used at the same time.
1	Reserved for manufacturer use [1]
2	Reserved for manufacturer use [1]
3	The damping filters are switched with position command direction. [2]

*1 Users are not allowed to set 1 and 2 for this object.

*2 The table below shows the damping filter you can switch to based on the command direction.

Position command direction	Damping filter 1	Damping filter 2	Damping filter 3	Damping filter 4
Positive	Enabled	Disabled	Enabled	Disabled
Negative	Disabled	Enabled	Disabled	Enabled

3214 hex	Damping Frequency 1					csp pp hm	
Setting range	0 to 2000	**Unit**	0.1 Hz	**Default setting**	0	**Data attribute**	B
Size	2 bytes (INT16)		**Access**	RW	**PDO map**	Not possible.	

- Set damping frequency 1 to suppress vibration at the end of the load in damping control.
- Measure the frequency of vibration at the end of the load and make the setting in units of 0.1 Hz.
- The range of setting frequency is 1.0 to 200.0 Hz. The function is disabled if the setting is 0 to 0.9 Hz.

Refer to *11-5 Damping Control* on page 11-16.

3215 hex	Damping Filter 1 Setting					csp pp hm	
Setting range	0 to 1000	**Unit**	0.1 Hz	**Default setting**	0	**Data attribute**	B
Size	2 bytes (INT16)		**Access**	RW	**PDO map**	Not possible.	

- First set Damping Frequency 1 (3214 hex). Then reduce the setting if force saturation occurs or increase the setting to increase operation speed. Normally, use a setting of "0."
- The upper limit of the set value is restricted to the corresponding damping frequency or the value of (2000 - damping frequency), whichever is the smaller.

Refer to *11-5 Damping Control* on page 11-16.

3216 hex	Damping Frequency 2					csp	pp	hm
Setting range	0 to 2000	Unit	0.1 Hz	Default setting	0	Data attribute		B
Size	2 bytes (INT16)		Access	RW	PDO map	Not possible.		

- Set damping frequency 2 to suppress vibration at the end of the load in damping control.
- Measure the frequency of vibration at the end of the load and make the setting in units of 0.1 Hz.
- Setting frequency is 1.0 to 200.0 Hz. The function is disabled if the setting is 0 to 0.9 Hz.

  Refer to *11-5 Damping Control* on page 11-16.

3217 hex	Damping Filter 2 Setting					csp	pp	hm
Setting range	0 to 1000	Unit	0.1 Hz	Default setting	0	Data attribute		B
Size	2 bytes (INT16)		Access	RW	PDO map	Not possible.		

- First set Damping Frequency 2 (3216 hex). Then reduce the setting if force saturation occurs or increase the setting to increase operation speed. Normally, use a setting of "0."
- The upper limit of the set value is restricted to the corresponding damping frequency or the value of (2000 - damping frequency), whichever is the smaller.

  Refer to *11-5 Damping Control* on page 11-16.

3218 hex	Damping Frequency 3					csp	pp	hm
Setting range	0 to 2000	Unit	0.1 Hz	Default setting	0	Data attribute		B
Size	2 bytes (INT16)		Access	RW	PDO map	Not possible.		

- Set damping frequency 3 to suppress vibration at the end of the load in damping control.
- Measure the frequency of vibration at the end of the load and make the setting in units of 0.1 Hz.
- Setting frequency is 1.0 to 200.0 Hz. The function is disabled if the setting is 0 to 0.9 Hz.

  Refer to *11-5 Damping Control* on page 11-16.

3219 hex	Damping Filter 3 Setting					csp	pp	hm
Setting range	0 to 1000	Unit	0.1 Hz	Default setting	0	Data attribute		B
Size	2 bytes (INT16)		Access	RW	PDO map	Not possible.		

- First set Damping Frequency 3 (3218 hex). Then reduce the setting if force saturation occurs or increase the setting to increase operation speed. Normally, use a setting of "0."
- The upper limit of the set value is restricted to the smaller value of the corresponding damping frequency or (2000 − damping frequency).

  Refer to *11-5 Damping Control* on page 11-16.

3220 hex	Damping Frequency 4					csp	pp	hm
Setting range	0 to 2000	Unit	0.1 Hz	Default setting	0	Data attribute		B
Size	2 bytes (INT16)		Access	RW	PDO map	Not possible.		

- Set damping frequency 4 to suppress vibration at the end of the load in damping control.
- Measure the frequency of vibration at the end of the load and make the setting in units of 0.1 Hz.
- Setting frequency is 1.0 to 200.0 Hz. The function is disabled if the setting is 0 to 0.9 Hz.

  Refer to *11-5 Damping Control* on page 11-16.

3221 hex	Damping Filter 4 Setting					csp pp hm	
Setting range	0 to 1000	**Unit**	0.1 Hz	**Default setting**	0	**Data attribute**	B
Size	2 bytes (INT16)	**Access**	RW	**PDO map**		Not possible.	

- First set Damping Frequency 4 (3220 hex). Then reduce the setting if torque saturation occurs or increase the setting to increase operation speed. Normally, use a setting of 0.
- The upper limit of the set value is restricted to the smaller value of the corresponding damping frequency or (2000 − damping frequency).

Refer to *11-5 Damping Control* on page 11-16.

3222 hex	Position Command Filter Time Constant					csp pp hm	
Setting range	0 to 10000	**Unit**	0.1 ms	**Default setting**	0	**Data attribute**	B
Size	2 bytes (INT16)	**Access**	RW	**PDO map**		Not possible.	

- The Position Command Filter Time Constant is the first-order lag filter that is inserted after the electronic gear ratio for the command input.
- This constant is used to reduce the stepping movement of the motor to achieve a smooth operation when the electronic gear ratio is set to 10 times or greater.
- It sets the first-order lag filter time constant, as shown below, for the square-wave command of target speed Vc.
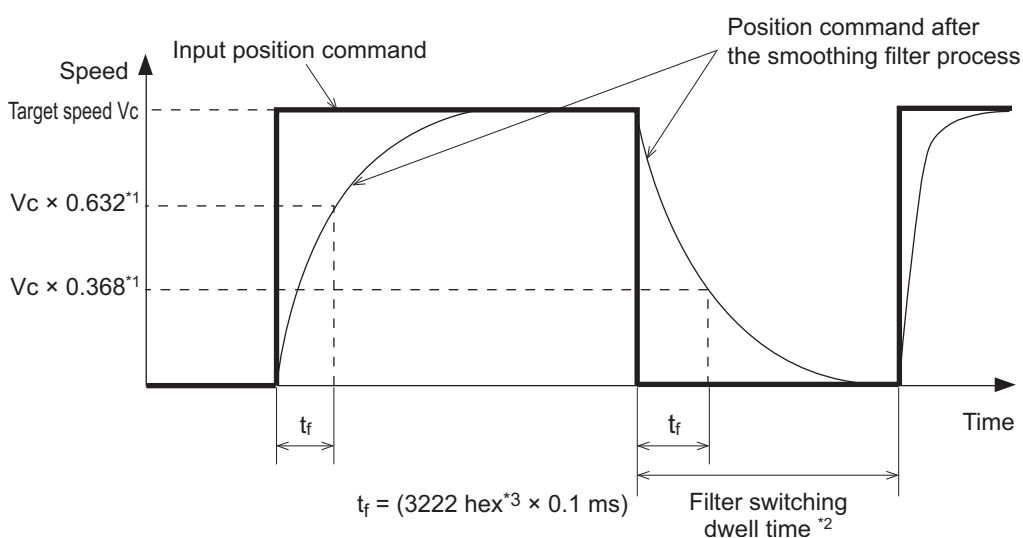
*1   The error in the position command filter time constant is 0.4 max. (absolute error) for less than 100 ms and 0.2% max. (relative error) for 20 ms or greater for the set value times 0.1 ms.

*2   The Position Command Filter Time Constant (3222 hex) is switched when the position command value per 0.250 ms changes from 0 to a value other than 0 while the positioning completed output is ON.

*3   There is a delay from when the Position Command Filter Time Constant (3222 hex) is changed until the new value is applied in internal calculations. If the filter switch wait time expires during this delay, the change may be placed on hold.

Precautions for Safe Use

If a large Position window is set, decreasing the Position Command Filter Time Constant may cause a sudden motor movement immediately after switching.

This occurs due to the pulses accumulated in the filter at the time of switching, which are distributed rapidly after switching to restore the normal position.

Be careful as the motor may temporarily move faster than the expected command speed.

9-4   Analog Control Objects

3312 hex	Soft Start Acceleration Time						CSV
Setting range	0 to 10000	**Unit**	ms/maximum motor speed	**Default setting**	0	**Data attribute**	B
Size	2 bytes (INT16)		**Access**	RW	**PDO map**	Not possible.	

3313 hex	Soft Start Deceleration Time						CSV
Setting range	0 to 10000	**Unit**	ms/maximum motor speed	**Default setting**	0	**Data attribute**	B
Size	2 bytes (INT16)		**Access**	RW	**PDO map**	Not possible.	

- Control the speed by setting acceleration/deceleration to the speed command inside the Servo Drive.
- A soft start can be set when inputting speed commands of stepping movement or when using internal speed setting.
- Do not set acceleration/deceleration time settings when using the Servo Drive in combination with an external position loop. Be sure to set both the Soft Start Acceleration Time (3312 hex) and the Soft Start Deceleration Time (3313 hex) to 0.
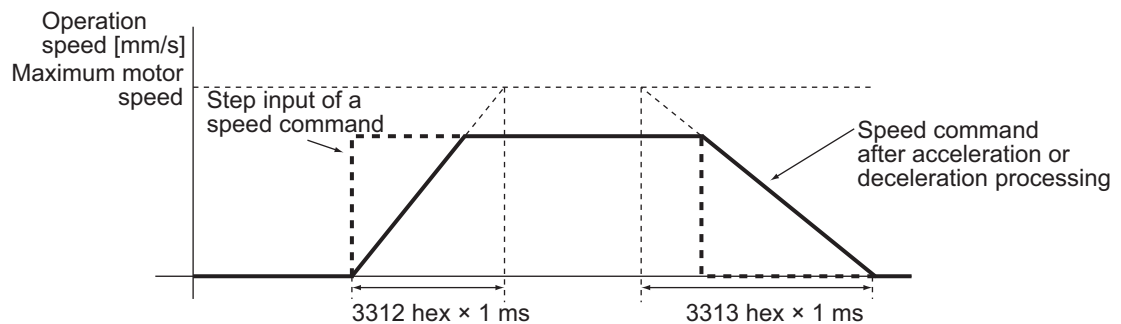
Refer to *7-8 Soft Start* on page 7-25.

Precautions for Correct Use

Do not set the Soft Start Acceleration Time and the Soft Start Deceleration Time when the position loop structure with a Host Controller is used.

3314 hex	S-curve Acceleration/Deceleration Time Setting						csv
Setting range	0 to 1000	**Unit**	ms	**Default setting**	0	**Data attribute**	B
Size	2 bytes (INT16)		**Access**	RW	**PDO map**	Not possible.	

- The S-curve acceleration/deceleration function ensures smooth operation in applications where linear acceleration or deceleration could cause impact due to a large change in the acceleration or deceleration speed during start, stop, or other operation.
- This is achieved by adding a pseudo-S-curve acceleration/deceleration value to the linear acceleration/deceleration speed command.

Speed [mm/s]

Target speed (Vc)

ta = Vc / Maximum motor speed × 3312 hex × 1 ms
td = Vc / Maximum motor speed × 3313 hex × 1 ms
ts = 3314 hex × 1 ms

Be sure that ts is smaller than the values obtained by the divisions of

$$\frac{ta}{2} \text{ and } \frac{td}{2}.$$
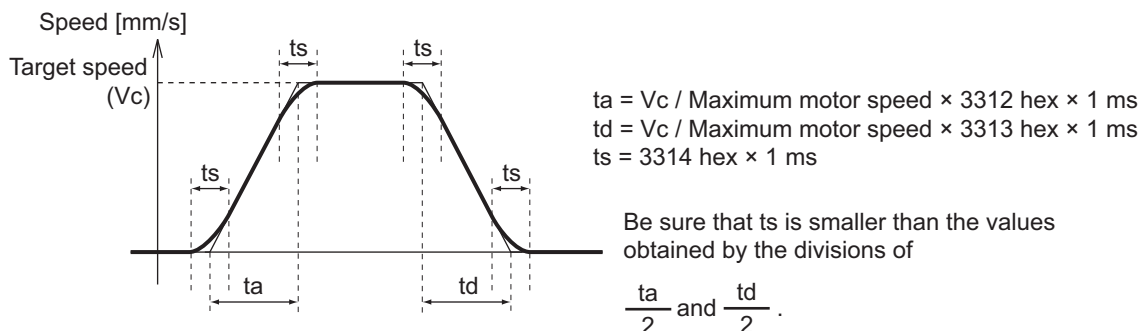
Refer to *7-8 Soft Start* on page 7-25.

3317 hex	Speed Limit Selection						cst
Setting range	0 to 1	**Unit**	–	**Default setting**	1	**Data attribute**	B
Size	2 bytes (INT16)		**Access**	RW	**PDO map**	Not possible.	

- Select the speed limit.
- The speed limit is used as a protection during force control.

Explanation of Settings

Set value	Description
0	Restrict the speed using the value set on the Speed Limit Value Setting (3321 hex).
1	Restrict the speed using either the speed limit value (VLIM) via EtherCAT communications or the value set by the Speed Limit Value Setting (3321 hex), whichever is smaller.

Refer to *6-3 Cyclic Synchronous Torque Mode* on page 6-8.

3321 hex	Speed Limit Value Setting						cst
Setting range	0 to 20000	**Unit**	mm/s	**Default setting**	20000	**Data attribute**	A
Size	2 bytes (INT16)		**Access**	RW	**PDO map**	Not possible.	

- Set the speed limit value for force control.
- It controls that the speed during force control does not exceed the set value.

Refer to *6-3 Cyclic Synchronous Torque Mode* on page 6-8.

3323 hex	External Feedback Pulse Type Selection					csp pp hm	
Setting range	0 to 2	Unit	–	Default setting	0	Data attribute	R
Size	2 bytes (INT16)	Access	RW	PDO map	Not possible.		

- Select the type of the external encoder to be used.
- For the set value, refer to the external encoder specifications.

Explanation of Settings

Set value	Description	Supported speed[1]
0	90° phase difference output type[2]	0 to 4 Mpps (Multiplication × 4)
1	Serial communications type (Incremental type)	0 to 400 Mpps
2	Serial communications type (Absolute type)	0 to 400 Mpps

[1] The supported speed is the internal feedback pulse speed [external encoder pulses/s] of the external encoder that can be processed by the Servo Drive.
Check the instruction manual of the external encoder for the speed range supported by your external encoder. For example, the maximum speed of a serial communications external encoder with a resolution of 0.01 μm is 4 m/s.

$$0.01 \text{ [μm/pulse]} \times 400 \text{ [Mpulse/s]} = 4 \text{ [m/s]}$$

When a serial communications type encoder is used for speed of 5 m/s, choose a serial external encoder with a resolution of 0.0125 μm or lower.

[2] These are the directions that the Drive counts a 90° phase difference output.

Count-down direction
EXA
EXB
t1
t2
EXB is 90° ahead of EXA.
t1 > 0.25 μs
t2 > 1.0 μs

Count-up direction
EXA
EXB
t1
t2
EXB is 90° behind EXA.
t1 > 0.25 μs
t2 > 1.0 μs
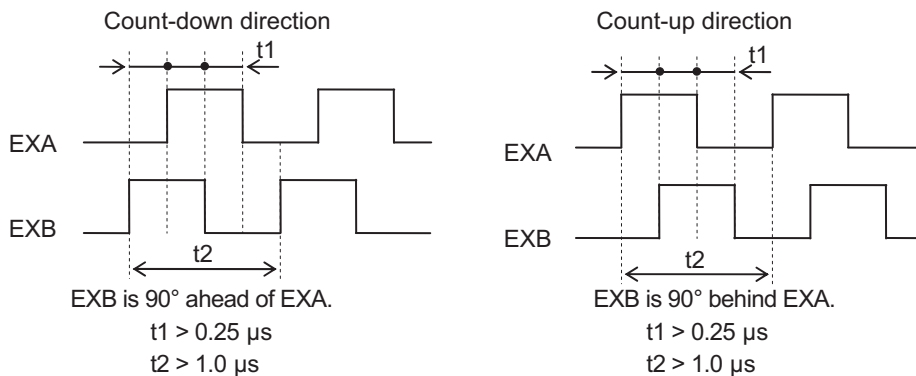
Precautions for Correct Use

- If you set this object to 1 or 2 when an external encoder with a 90° phase difference output is connected, an External Encoder Connection Error (Error No. 50.0) will occur.
- If you set this object to 0 when a serial communications external encoder is connected, a Phase-A Connection Error (Error No. 55.0), Phase-B Connection Error (Error No. 55.1), or Phase-Z Connection Error (Error No. 55.2) will occur.

3326 hex	External Feedback Pulse Direction Switching					csp pp hm	
Setting range	0 to 1	Unit	–	Default setting	0	Data attribute	R
Size	2 bytes (INT16)	Access	RW	PDO map	Not possible.		

- Use this object to change the count direction of the external encoder.

Explanation of Settings

Set value	Description
0	External feedback pulse direction not reversed
1	External feedback pulse direction reversed

- Set the pulse count direction so that relationship between the count direction of the external encoder and the induced voltage of the motor in each phase is as shown below.
- To check the external encoder count direction, disconnect the motor cable and monitor the Position actual value (6064 hex) while manually operating the Motor Coil Unit.
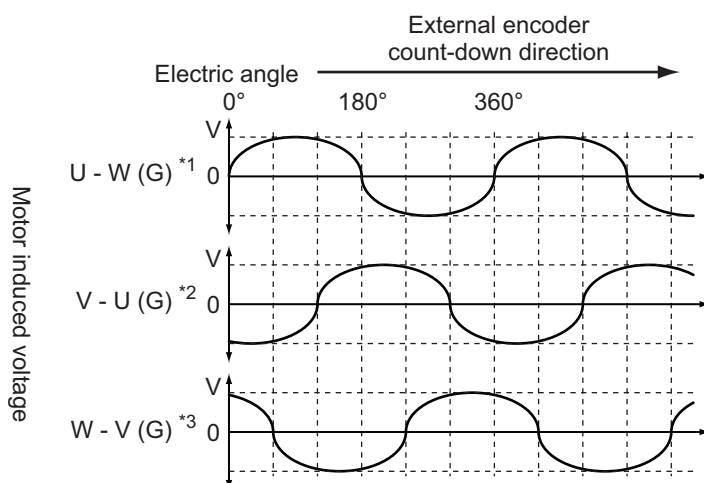
*1   The waveform of the induced voltage monitored at the U terminal, with the W terminal connected to GND.

*2   The waveform of the induced voltage monitored at the V terminal, with the U terminal connected to GND.

*3   The waveform of the induced voltage monitored at the W terminal, with the V terminal connected to GND.

Precautions for Correct Use

Before checking the count direction, be sure to set the Movement Direction Setting (3000 hex) to 1, write the setting to the EEPROM, and turn OFF and then ON the power supply.

3327 hex	External Feedback Pulse Phase-Z Setting					csp pp hm	
Setting range	0 to 1	Unit	–	Default setting	0	Data attribute	R
Size	2 bytes (INT16)	Access	RW	PDO map	Not possible.		

- Set to enable or disable phase-Z disconnection detection when an external encoder with a 90° phase difference output is used.

Explanation of Settings

Set value	Description
0	Phase-Z disconnection detection enabled
1	Phase-Z disconnection detection disabled

9-5   Interface Monitor Settings

3400 hex	Input Signal Selection 1						All
Setting range	0 to 00FF FFFF hex	Unit	–	Default setting	0094 9494 hex	Data attribute	C
Size	4 bytes (INT32)	Access	RW	PDO map	Not possible.		

- Set the function and logic for general-purpose input 1 (IN1).

Refer to the Details of Control Inputs in *Control Input Details* on page 3-9, as well as *7-1 Sequence I/O Signals* on page 7-2.

3401 hex	Input Signal Selection 2						All
Setting range	0 to 00FF FFFF hex	Unit	–	Default setting	0081 8181 hex	Data attribute	C
Size	4 bytes (INT32)	Access	RW	PDO map	Not possible.		

- Set the function and logic for general-purpose input 2 (IN2).

Refer to the Details of Control Inputs in *Control Input Details* on page 3-9, as well as *7-1 Sequence I/O Signals* on page 7-2.

3402 hex	Input Signal Selection 3						All
Setting range	0 to 00FF FFFF hex	Unit	–	Default setting	0082 8282 hex	Data attribute	C
Size	4 bytes (INT32)	Access	RW	PDO map	Not possible.		

- Set the function and logic for general-purpose input 3 (IN3).

Refer to the Details of Control Inputs in *Control Input Details* on page 3-9, as well as *7-1 Sequence I/O Signals* on page 7-2.

3403 hex	Input Signal Selection 4						All
Setting range	0 to 00FF FFFF hex	Unit	–	Default setting	0022 2222 hex	Data attribute	C
Size	4 bytes (INT32)	Access	RW	PDO map	Not possible.		

- Set the function and logic for general-purpose input 4 (IN4).

Refer to the Details of Control Inputs in *Control Input Details* on page 3-9, as well as *7-1 Sequence I/O Signals* on page 7-2.

3404 hex	Input Signal Selection 5						All
Setting range	0 to 00FF FFFF hex	Unit	–	Default setting	002B 2B2B hex	Data attribute	C
Size	4 bytes (INT32)	Access	RW	PDO map	Not possible.		

- Set the function and logic for general-purpose input 5 (IN5).

Refer to the Details of Control Inputs in *Control Input Details* on page 3-9, as well as *7-1 Sequence I/O Signals* on page 7-2.

3405 hex	Input Signal Selection 6						All
Setting range	0 to 00FF FFFF hex	Unit	–	Default setting	0021 2121 hex	Data attribute	C
Size	4 bytes (INT32)	Access	RW	PDO map	Not possible.		

- Set the function and logic for general-purpose input 6 (IN6).

Refer to the Details of Control Inputs in *Control Input Details* on page 3-9, as well as *7-1 Sequence I/O Signals* on page 7-2.

3406 hex	Input Signal Selection 7						All
Setting range	0 to 00FF FFFF hex	Unit	–	Default setting	0020 2020 hex	Data attribute	C
Size	4 bytes (INT32)	Access	RW	PDO map	Not possible.		

- Set the function and logic for general-purpose input 7 (IN7).

Refer to the Details of Control Inputs in *Control Input Details* on page 3-9, as well as *7-1 Sequence I/O Signals* on page 7-2.

3407 hex	Input Signal Selection 8						All
Setting range	0 to 00FF FFFF hex	Unit	–	Default setting	002E 2E2E hex	Data attribute	C
Size	4 bytes (INT32)	Access	RW	PDO map	Not possible.		

- Set the function and logic for general-purpose input 8 (IN8).

Refer to the Details of Control Inputs in *Control Input Details* on page 3-9, as well as *7-1 Sequence I/O Signals* on page 7-2.

3410 hex	Output Signal Selection 1						All
Setting range	0 to 00FF FFFF hex	Unit	–	Default setting	0003 0303 hex	Data attribute	C
Size	4 bytes (INT32)	Access	RW	PDO map	Not possible.		

- Set the function assignment for general-purpose output 1 (OUTM1).

Refer to the Details of Control Inputs in *Control Output Details* on page 3-12, as well as *7-1 Sequence I/O Signals* on page 7-2.

3411 hex	Output Signal Selection 2						All
Setting range	0 to 00FF FFFF hex	Unit	–	Default setting	0002 0202 hex	Data attribute	C
Size	4 bytes (INT32)	Access	RW	PDO map	Not possible.		

- Set the function assignment for general-purpose output 2 (OUTM2).

Refer to the Details of Control Inputs in *Control Output Details* on page 3-12, as well as *7-1 Sequence I/O Signals* on page 7-2.

3416 hex	Analog Monitor 1 Selection						All
Setting range	0 to 22	Unit	–	Default setting	0	Data attribute	A
Size	2 bytes (INT16)		Access	RW	PDO map	Not possible.	

- Analog signals of various monitor values can be output from the analog monitor connector on the front panel.
- Set the type of the analog monitor signal output from Analog Monitor Output 1 in the Analog Monitor 1 Selection (3416 hex).
- The scaling (or output gain) can be set as needed in the Analog Monitor 1 Scale Setting (3417 hex). Setting the Analog Monitor 1 Scale Setting (3417 hex) to 0 automatically applies the output gain as shown below.

Explanation of Settings

Set value	Explanation		
	Monitor type	Unit	Output gain when object 3417 hex = 0
0	Motor Velocity Actual Value	mm/s	500
1	Motor Velocity Demand Value	mm/s	500
2	Motor Velocity Demand Value After Filtering	mm/s	500
3	Motor Control Effort	mm/s	500
4	Torque demand [1]	% (rated force ratio)	33
5	Following error actual value	pulses (command units)	3000
6	Following Error Actual Internal Value	pulses (encoder units)	3000
7 to 8	Reserved [2]	–	–
9	P-N voltage	V	80
10	Regeneration Load Ratio	%	33
11	Motor Load Ratio	%	33
12	Positive Direction Force Limit	% (rated force ratio)	33
13	Negative Direction Force Limit	% (rated force ratio)	33
14	Speed Limit Value	mm/s	500
15	Mass Ratio	%	500
16 to 19	Reserved [2]	–	–
20	Servo Drive Temperature	°C	10
21 to 22	Reserved [2]	–	–

*1   Read the word "torque" as "force."

*2   The set values shown as "Reserved" must not be used.

Refer to *11-1 Analog Monitor* on page 11-2.

3417 hex	Analog Monitor 1 Scale Setting						All
Setting range	0 to 214748364	Unit	3416 hex monitor unit/V	Default setting	0	Data attribute	A
Size	4 bytes (INT32)		Access	RW	PDO map	Not possible.	

- Set the output gain for analog monitor 1.

Refer to *11-1 Analog Monitor* on page 11-2.

3418 hex	Analog Monitor 2 Selection						All
Setting range	0 to 22	**Unit**	–	**Default setting**	4	**Data attribute**	A
Size	2 bytes (INT16)		**Access**	RW	**PDO map**	Not possible.	

- Analog signals of various monitor values can be output from the analog monitor connector on the front panel.
- Set the type of the analog monitor signal output from Analog Monitor Output 2 in the Analog Monitor 2 Selection (3418 hex).
- The scaling (or output gain) can be set as needed in the Analog Monitor 2 Scale Setting (3419 hex). Setting the Analog Monitor 2 Scale Setting (3419 hex) to 0 automatically applies the output gain as shown below.

Explanation of Settings

Set value	Explanation		
	Monitor type	**Unit**	**Output gain when object 3419 hex = 0**
0	Motor Velocity Actual Value	mm/s	500
1	Motor Velocity Demand Value	mm/s	500
2	Motor Velocity Demand Value After Filtering	mm/s	500
3	Motor Control Effort	mm/s	500
4	Torque demand [1]	% (rated force ratio)	33
5	Following error actual value	pulses (command units)	3000
6	Following Error Actual Internal Value	pulses (encoder units)	3000
7 to 8	Reserved [2]	–	–
9	P-N voltage	V	80
10	Regeneration Load Ratio	%	33
11	Motor Load Ratio	%	33
12	Positive Direction Force Limit	% (rated force ratio)	33
13	Negative Direction Force Limit	% (rated force ratio)	33
14	Speed Limit Value	mm/s	500
15	Mass Ratio	%	500
16 to 19	Reserved [2]	–	–
20	Servo Drive Temperature	°C	10
21 to 22	Reserved [2]	–	–

*1   Read the word "torque" as "force."

*2   The set values shown as "Reserved" must not be used.

Refer to *11-1 Analog Monitor* on page 11-2.

3419 hex	Analog Monitor 2 Scale Setting						All
Setting range	0 to 214748364	**Unit**	Monitor unit of 3418 hex/V	**Default setting**	0	**Data attribute**	A
Size	4 bytes (INT32)		**Access**	RW	**PDO map**	Not possible.	

- Set the output gain for analog monitor 2.

Refer to *11-1 Analog Monitor* on page 11-2.

3421 hex	Analog Monitor Output Selection						All
Setting range	0 to 2	**Unit**	–	**Default setting**	0	**Data attribute**	A
Size	2 bytes (INT16)		**Access**	RW	**PDO map**	Not possible.	

- Select the analog monitor output voltage direction.
- The output voltage range and the data output direction when the Analog Monitor 1 Selection (3416 hex) is set to 0 (motor speed) and the Analog Monitor 1 Scale Setting (3417 hex) is set to 0 are as shown below.
  The following explanation of settings also applies when the Analog Monitor 2 Selection (3418 hex) and the Analog Monitor 2 Scale Setting (3419 hex) are set to 0.

Explanation of Settings

Set value	Output range	Data output
0	−10 to 10 V	
1	0 to 10 V	
2	0 to 10 V (5 V as a center)	

9-5 Interface Monitor Settings

9

3432 hex	Positioning Completion Condition Selection					csp pp hm	
Setting range	0 to 4	Unit	–	Default setting	0	Data attribute	A
Size	2 bytes (INT16)		Access	RW	PDO map	Not possible.	

• Select the condition under which the positioning completion signal (INP1) is output.

Explanation of Settings

Set value	Description
0	Turn ON when the position error is equal to or lower than the Position window (6067 hex).
1	Turn ON when there is no position command and the position error is equal to or lower than the Position window (6067 hex).
2	Turn ON when there is no position command, the zero speed detection signal is ON, and the position error is equal to or lower than the Position window (6067 hex).
3	Turn ON when there is no position command and the position error is equal to or lower than the Position window (6067 hex). Then, hold the ON state for the time set in the Positioning Completion Hold Time (3433 hex). After the Positioning Completion Hold Time expires, turn the INP1 output ON or OFF according to the position command and position error at that time.
4	Turn ON when there is no position command and the position error is equal to or lower than the Position window (6067 hex). Positioning starts when the time set in the Positioning Completion Hold Time (3433 hex) has expired since the transition from a "no position command" to "position command present" state.

📑 **Additional Information**

The setting of this parameter affects the detection condition for the Target reached flag in Statusword (6041 hex).

3433 hex	Positioning Completion Hold Time					csp pp hm	
Setting range	0 to 30000	Unit	ms	Default setting	0	Data attribute	A
Size	2 bytes (U16)		Access	RW	PDO map	Not possible.	

• Set the hold time for when Positioning Completion Condition Selection (3432 hex) is set to 3.

Explanation of Settings

Set value	Description
0	The hold time will be an infinite time and the ON status will be held until the next position command is received.
1 to 30000	The ON status is held for the set time [ms]. The output is turned OFF if a position command is received while the ON status is being held.

📑 **Additional Information**

The setting of this parameter does not affect the detection condition for the Target reached flag in Statusword (6041 hex).

3434 hex	Zero Speed Detection						All
Setting range	10 to 20000	Unit	mm/s	Default setting	50	Data attribute	A
Size	2 bytes (INT16)		Access	RW	PDO map	Not possible.	

- Set the output timing of the Zero Speed Detection Output (ZSP) as motor speed [mm/s].
- The Zero Speed Detection Output (ZSP) turns ON when the motor speed is lower than the set value of this object.
- The set value of this object is valid in both positive and negative directions, regardless of the actual motor movement direction. The setting has a hysteresis of 10 mm/s.
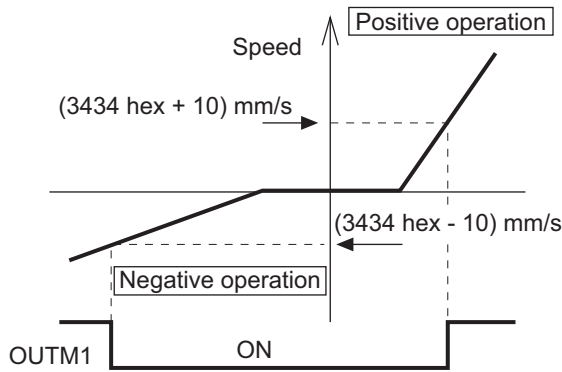
Refer to *Control Output Details* on page 3-12 for the Zero speed detection output (ZSP).

3435 hex	Speed Conformity Detection Range						CSV
Setting range	10 to 20000	Unit	mm/s	Default setting	50	Data attribute	A
Size	2 bytes (INT16)		Access	RW	PDO map	Not possible.	

- It outputs the Speed conformity output (VCMP) when the speed command conforms to the motor speed.
- It is regarded as conformed when the difference between the speed command before the acceleration or deceleration process inside the Drive and the motor speed is smaller than the set value on the Speed Conformity Detection Range (3435 hex). The setting has a hysteresis of 10 mm/s.
- The speed conformity status can also be checked with the Speed Conformity (VCMP) flag in EtherCAT communications status.
- This setting is also used as the detection threshold for the Speed Conformity (VCMP) flag in EtherCAT communications status.
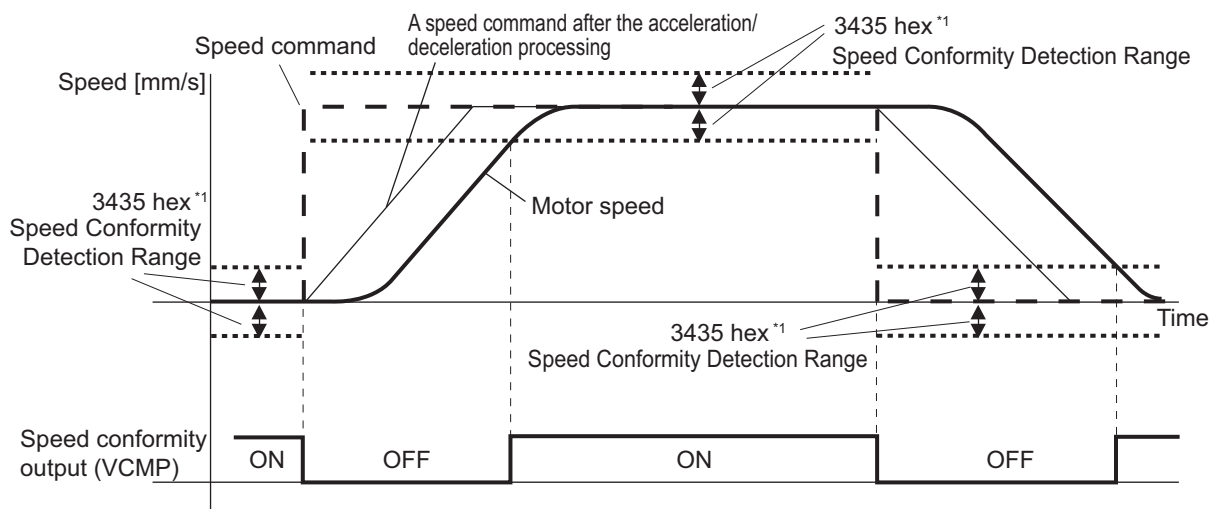
*1   Because the Speed Conformity Detection Range has a hysteresis of 10 mm/s, the actual detection range will be as follows:
Threshold for transition from OFF to ON: (3435 hex - 10) mm/s
Threshold for transition from ON to OFF: (3435 hex + 10) mm/s

Refer to the Control Output Details in *Control Output Details* on page 3-12 for the Speed conformity output (VCMP).

3436 hex	Speed for Motor Detection						CSV
Setting range	10 to 20000	**Unit**	mm/s	**Default setting**	1,000	**Data attribute**	A
Size	2 bytes (INT16)	**Access**	RW	**PDO map**	Not possible.		

- It outputs the Motor Speed Detection Output (TGON) when the motor speed reaches the set Speed for Motor Detection (3436 hex).
- The setting has a hysteresis of 10 mm/s.
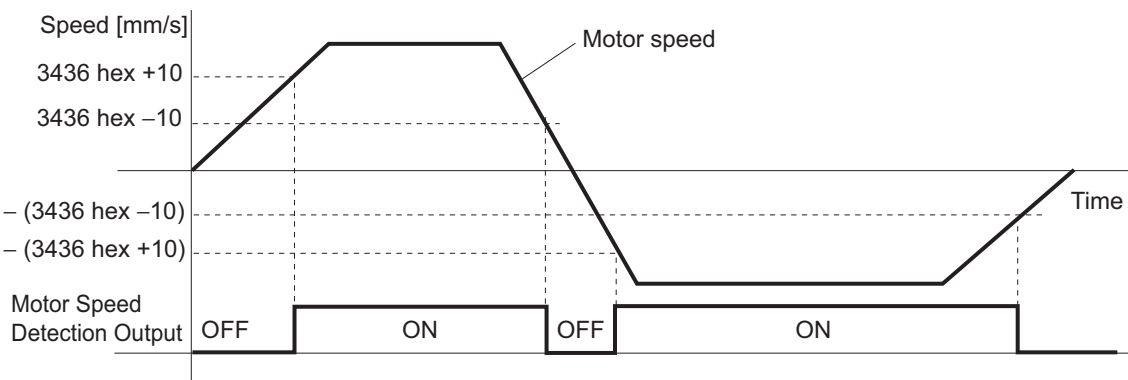
Refer to the Control Output Details in *Control Output Details* on page 3-12 for the Motor Speed Detection Output (TGON).

3437 hex	Brake Timing when Stopped						All
Setting range	0 to 10000	**Unit**	ms	**Default setting**	0	**Data attribute**	B
Size	2 bytes (INT16)	**Access**	RW	**PDO map**	Not possible.		

- Set the time required for the motor to be de-energized (servo free) after the brake interlock output (BKIR) turns OFF (i.e., brake held), when servo OFF status is entered while the motor is stopped.
- When the servo is turned OFF while the motor is stopped, the brake interlock output (BKIR) turns ON, and the servo is de-energized after waiting for the set time (set value × ms).
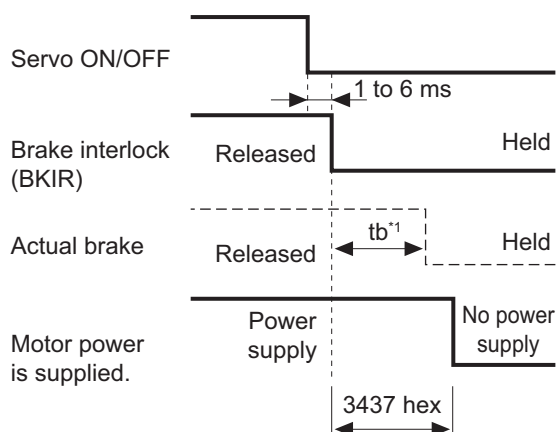
*1 Make the setting as follows to prevent the machine (workpiece) from moving or falling due to the delay time in the brake operation (tb).
Brake timing when stopped (set value × 1 ms) ≥ tb

For the operation time, refer to *7-5 Brake Interlock* on page 7-15.

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3438 hex	Brake Timing During Operation						All
Setting range	0 to 10000	Unit	ms	Default setting	0	Data attribute	B
Size	2 bytes (INT16)		Access	RW	PDO map	Not possible.	

- Set the required time for the Brake Interlock Output (BKIR) to turn OFF after the motor is de-energized, when servo OFF status is entered while the motor is operating.
- When the servo is turned OFF while the motor is operating, the motor decelerates to reduce speed, and the brake interlock output (BKIR) turns ON after the set time (set value x 1 ms) has elapsed.
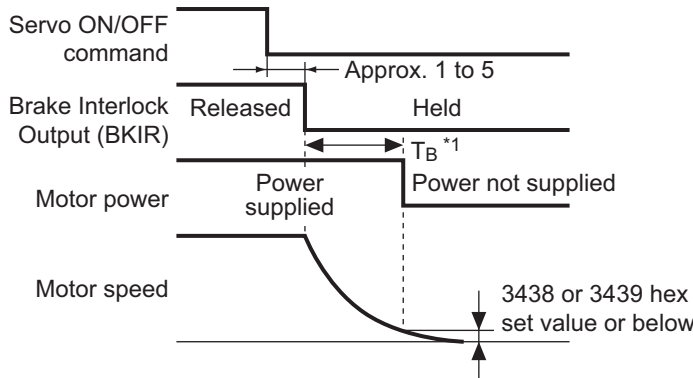
*1   The time TB in above drawing is either the brake timing during operation (i.e., the set value × 1 ms) or the time taken until it goes below the value set in the Brake Threshold Speed During Operation (3439 hex), whichever is shorter.

For the operation timing, refer to *7-5 Brake Interlock* on page 7-15.

3439 hex	Brake Threshold Speed During Operation						All
Setting range	30 to 3000	Unit	mm/s	Default setting	30	Data attribute	B
Size	2 bytes (INT16)		Access	RW	PDO map	Not possible.	

- Set the required speed for the Brake Interlock Output (BKIR) to turn OFF after the servo OFF command is detected while the motor is operating.
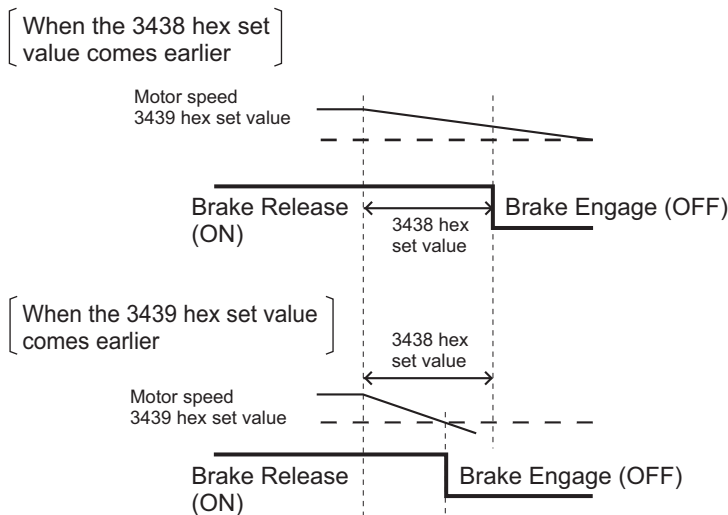
For the operation time, refer to *7-5 Brake Interlock* on page 7-15.

3440 hex	Warning Output Selection 1						All
Setting range	0 to 13	Unit	–	Default setting	0	Data attribute	A
Size	2 bytes (INT16)		Access	RW	PDO map	Not possible.	

• Select the warning type to be output by Warning Output 1.

Explanation of Settings

Set value	Description
0	Output by all types of warnings
1	Overload warning
2	Excessive regeneration warning
3	Reserved (Do not use.)
4	Fan warning
5	Reserved (Do not use.)
6	Reserved (Do not use.)
7	Vibration warning
8	Service life warning
9	External encoder error warning
10	External encoder communications error warning
11	Data setting warning
12	Command warning
13	EtherCAT communications warning

Refer to *12-2 Warnings* on page 12-4.

3441 hex	Warning Output Selection 2						All
Setting range	0 to 13	Unit	–	Default setting	0	Data attribute	A
Size	2 bytes (INT16)		Access	RW	PDO map	Not possible.	

• Select the warning type to be output by Warning Output 2.
• Refer to the Warning Output Selection 1 (3440 hex) for the object setting method.

Refer to *12-2 Warnings* on page 12-4.

3442 hex	Positioning Completion Range 2						csp pp hm
Setting range	0 to 262144	Unit	Command unit	Default setting	10	Data attribute	A
Size	4 bytes (INT32)		Access	RW	PDO map	Not possible.	

• Set the positioning completion range to output Positioning Completion Output 2 (INP2).
• The Positioning Completion Output 2 (INP2) is not affected by the position commands. It is ON as long as the position error is below the set value.
• The setting unit is command units. It can be changed to external encoder units by the Position Setting Unit Selection (3520 hex). However, note that the unit for the Following error window (6065 hex) will change as well.

9-6 Extended Objects

3504 hex	Drive Prohibition Input Selection					All
Setting range	0 to 2	**Unit**	–	**Default setting**	1	**Data attribute**	C
Size	2 bytes (INT16)	**Access**	RW	**PDO map**	Not possible.	

- Set the operation of the Positive Drive Prohibition Input (POT) and the Negative Drive Prohibition Input (NOT).

Explanation of Settings

Set value	Description
0	An error will occur if both the positive and negative drive prohibition inputs are open at the same time.
1	Positive drive prohibition input and negative drive prohibition input disabled.
2	An error will occur if either the positive or the negative drive prohibition input is open.

- Install limit switches at both ends of the axis to prohibit the motor from traveling in the direction where one of the switches operates. This can be used to prevent the workpiece from traveling too far and thus prevent damage to the machine.
- When the object is set to 0, the operation is as follows:

  Positive Drive Prohibition Input (POT) closed: Positive limit switch not operating and status normal.

  Positive Drive Prohibition Input (POT) open: Positive direction prohibited and negative direction permitted.

  Negative Drive Prohibition Input (NOT) closed: Negative limit switch not operating and status normal.

  Negative Drive Prohibition Input (NOT) open: Negative direction prohibited and positive direction permitted.
- If this object is set to 0, the motor decelerates and stops according to the sequence set in the Stop Selection for Drive Prohibition Input (3505 hex). For details, refer to explanation for Stop Selection for Drive Prohibition Input (3505 hex).

Precautions for Correct Use

- If this object is set to 0 and the positive and negative prohibition inputs are both open, a Drive Prohibition Input Error (Error No. 38.0) will occur because it is taken that Servo Drive is in error condition.
- If this object is set to 2, a Drive Prohibition Input Error (Error No. 38.0) will occur when the connection between either the positive or negative prohibition input and COM is open.

Refer to *7-2 Positive and Negative Drive Prohibition Functions* on page 7-8.

3505 hex	Stop Selection for Drive Prohibition Input						All
Setting range	0 to 2	Unit	–	Default setting	0	Data attribute	C
Size	2 bytes (INT16)	Access	RW	PDO map	Not possible.		

- Set the drive conditions during deceleration and after stopping, when the Positive or Negative Drive Prohibition Input is enabled.

Explanation of Settings

Set value of 3504 hex[1]	Set value of 3505 hex	Decelerating[2]		After stopping (Approx.30 mm/s or less)	
		Deceleration method	Error counter	Operation after stopping	Error counter
0	0	Dynamic brake	Cleared	Force command in drive-prohibited direction = 0	Held
	1	Free-run	Cleared	Force command in drive-prohibited direction = 0	Held
	2	Immediate stop[3]	Cleared	Force limits and force command are as specified.	Cleared after deceleration completes, then held.

[1]   If the Drive Prohibition Input Selection (3504 hex) is set to 2, a Drive Prohibition Input Error (Error No. 38.0) will occur as soon as either the Positive or Negative Drive Prohibition Input becomes open. Therefore, instead of the set value, the subsequent operation will be performed according to the setting of the Fault reaction option code (605E hex). In the same way, the Fault reaction option code (605E hex) takes priority when any other error occurs.

[2]   The term "During deceleration" means the distance until the motor decreases its speed to 30 mm/s or less from the normal operation. Once it decelerates to 30 mm/s or lower speed, the operation conforms to the description for "after stopping", regardless of the actual speed.

[3]   "Immediate Stop" means that the Linear Motor stops immediately by using controls while the servo is kept ON. The force command value at this time is controlled by the Immediate Stop Force (3511 hex) set value.

Precautions for Correct Use

- An immediate stop forces the motor to decelerate quickly, which momentarily causes a large position error in position control. This may result in an Error Counter Overflow (Error No. 24.0) or an Overrun Limit Error (Error No. 34.0). If an error occurs, set the Following error window (6065 hex) and the Overrun Limit Setting (3514 hex) to appropriate values.

- A Command Warning (Warning No. B1 hex) will occur if a command is given in the drive prohibition direction while the motor is stopped (or decreased the speed to 30 mm/s or lower) and the Drive Prohibition Input is ON.

Refer to *7-2 Positive and Negative Drive Prohibition Functions* on page 7-8.

3508 hex	Undervoltage Error Selection						All
Setting range	0 to 1	Unit	–	Default setting	1	Data attribute	B
Size	2 bytes (INT16)		Access	RW	PDO map	Not possible.	

- Select either to let the servo off or to stop the error when a main power error occurs.

Explanation of Settings

Set value	Description
0	The servo is turned OFF based on the setting of the Shutdown option code (605B hex). The servo is then turned back ON when the main power supply is turned ON.
1	A Main Power Supply Undervoltage Error (Error No. 13.1) occurs and operation stops.

3509 hex	Momentary Hold Time						All
Setting range	70 to 2000	Unit	ms	Default setting	70	Data attribute	C
Size	2 bytes (INT16)		Access	RW	PDO map	Not possible.	

- Set main power supply error detection time.
- The main power supply OFF detection is disabled if this object is set to 2000.

3511 hex	Immediate Stop Force						All
Setting range	0 to 5000	Unit	0.1%	Default setting	0	Data attribute	B
Size	2 bytes (INT16)		Access	RW	PDO map	Not possible.	

- Set the force limit for immediate stops.
- Set the force limit for the following cases.
  - Drive prohibition deceleration with the Stop Selection for Drive Prohibition Input (3505 hex) set to 2.
  - When decelerating and the Disable operation option code (605C hex) is 8 or 9
  - When decelerating and the Shutdown option code (605B hex) is 8 or 9
- The normal force limit is applied if this object is set to 0.
- Set the value in units of 0.1% of the rated force (100%).

3512 hex	Overload Detection Level Setting						All
Setting range	0 to 500	Unit	%	Default setting	100	Data attribute	A
Size	2 bytes (INT16)		Access	RW	PDO map	Not possible.	

- Set the overload detection level.
- When the object is set to 0, the setting is 115%.
- If 115 or higher is set, a value of 115% will be used.
- Set the value in units of 1% of the rated force (100%).

Refer to *3-2 Overload Characteristics (Electronic Thermal Function)* on page 3-25.

3514 hex	Overrun Limit Setting						csp pp hm
Setting range	0 to 1000	Unit	0.1 magnetic pole pitch	Default setting	10	Data attribute	A
Size	2 bytes (INT16)		Access	RW	PDO map	Not possible.	

- Set the allowable operating range for the position command input range.
- If the set value is exceeded, and Overrun Limit Error (Error No. 34.0) will occur.

Refer to *7-3 Overrun Protection* on page 7-11.

3515 hex	Control Input Signal Read Setting						All
Setting range	0 to 3	Unit	–	Default setting	0	Data attribute	C
Size	2 bytes (INT16)		Access	RW	PDO map	Not possible.	

- Select the signal read cycle for control input (digital input).
- The External Latch Inputs 1, 2 and 3 (EXT1, 2, and 3) are excluded.

Explanation of Settings

Set value	Description
0	0.250 ms
1	0.500 ms
2	1.5 ms
3	2.5 ms

3520 hex	Position Setting Unit Selection						csp pp hm
Setting range	0 to 1	Unit	–	Default setting	0	Data attribute	C
Size	2 bytes (INT16)		Access	RW	PDO map	Not possible.	

- Select the setting unit of Position window (6067 hex), Position Completion Range 2 (3442 hex) and Following error window (6065 hex).

Explanation of Settings

Set value	Description
0	Command units
1	External encoder units

Precautions for Correct Use

- Detection of the Positioning Completed status in EtherCAT communications is always performed using command units, regardless of the setting on this object.
- Normally, use the default setting of 0 (command units).

3521 hex	Force Limit Selection						csp
Setting range	0 to 7	**Unit**	–	**Default setting**	6	**Data attribute**	B
Size	2 bytes (INT16)		**Access**	RW	**PDO map**	Not possible.	

• Select the method to set the positive and negative force limits.

Explanation of Settings

Set value	Position control/speed control/force control			
	Positive Direction Force Limit[*1]		Negative Direction Force Limit[*2]	
	PCL ON	**PCL OFF**	**NCL ON**	**NCL OFF**
0,1	3013 hex			
2	3013 hex		3522 hex	
3	3522 hex	3013 hex	3522 hex	3013 hex
4	60E0 or 3013 hex[*3]		60E1 or 3522 hex[*4]	
5	60E0 or 3013 hex[*3]	3013 hex	60E1 or 3522 hex[*4]	3522 hex
6	3525 hex	60E0 or 3013 hex[*3]	3526 hex	60E1 or 3522 hex[*4]
7	3013 hex	3525 hex	3522 hex	3526 hex

*1   PCL ON is the state in which either the Positive Force Limit Input (PCL) or the EtherCAT communications torque control command (P-CL) is ON; PCL OFF is the state in which both of these are OFF.

*2   NCL ON is the state in which either the Negative Force Limit Input (NCL) or the EtherCAT communications torque control command (N-CL) is ON; NCL OFF is the state in which both of these are OFF.

*3   The smaller of 60E0 hex or 3013 hex is used.

*4   The smaller of 60E1 hex or 3522 hex is used.

• When this object is set to 0 or 1, the Positive and Negative Force Limit Inputs are restricted by the Positive torque limit value (60E0 hex).

3522 hex	Force Limit 2					csp	cst
Setting range	0 to 5000	**Unit**	0.1%	**Default setting**	5000	**Data attribute**	B
Size	2 bytes (INT16)		**Access**	RW	**PDO map**	Not possible.	

- Set the limit value for the output force (Force Limit 1: 3013 hex, Force Limit 2: 3522 hex) of the motor.
- Refer to information on the Force Limit Selection (3521 hex) to select the force limits.
- During force control, maximum forces for both positive and negative directions are limited. Settings in Force Limit Selection (3521 hex) and Force Limit 2 (3522 hex) is ignored.
- Make the settings as a percentage of the rated force.

When the maximum force is limited to 150%
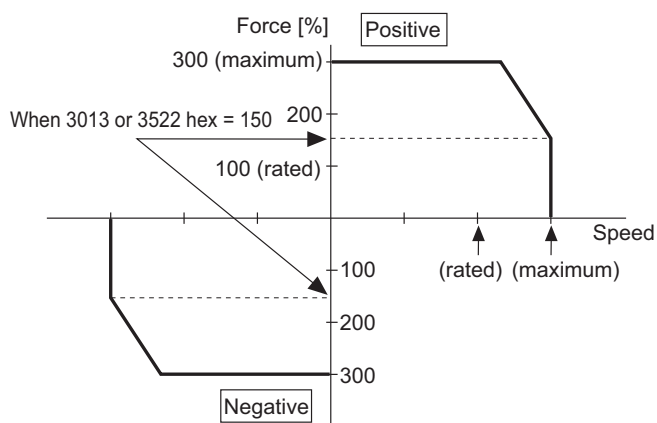
For the force limits and force limit selection, also refer to *7-7 Force Limit Switching* on page 7-22.

3525 hex	Force Limit 3					csp	cst
Setting range	0 to 5000	**Unit**	0.1%	**Default setting**	5000	**Data attribute**	B
Size	2 bytes (INT16)		**Access**	RW	**PDO map**	Not possible.	

- Set the third force limit value of the motor output force.
- Refer to *Force Limit 2* on page 9-42 for settings.

For the force limits and force limit selection, also refer to *7-7 Force Limit Switching* on page 7-22.

3526 hex	Force Limit 4					csp	cst
Setting range	0 to 5000	**Unit**	0.1%	**Default setting**	5000	**Data attribute**	B
Size	2 bytes (INT16)		**Access**	RW	**PDO map**	Not possible.	

- Set the fourth force limit value of the motor output force.
- Refer to *Force Limit 2* on page 9-42 for settings.

For the force limits and force limit selection, also refer to *7-7 Force Limit Switching* on page 7-22.

9-7　Special Objects

3602 hex	Excessive Speed Error Setting					csp pp hm	
Setting range	0 to 20000	**Unit**	mm/s	**Default setting**	0	**Data attribute**	B
Size	2 bytes (INT16)		**Access**	RW	**PDO map**	Not possible.	

• Set the value for an Excessive Speed Deviation Error (Error No. 24.1).

• If the set value is "0," excessive speed errors will not be detected.

3605 hex	Gain 3 Effective Time					csp	
Setting range	0 to 10000	**Unit**	0.1 ms	**Default setting**	0	**Data attribute**	B
Size	2 bytes (INT16)		**Access**	RW	**PDO map**	Not possible.	

• Set effective time of gain 3 of 3-step gain switching.

Refer to *7-10 Gain Switching 3 Function* on page 7-37.

3606 hex	Gain 3 Ratio Setting					csp	
Setting range	50 to 1000	**Unit**	%	**Default setting**	100	**Data attribute**	B
Size	2 bytes (INT16)		**Access**	RW	**PDO map**	Not possible.	

• Set gain 3 as a multiple of Gain 1.

Refer to *7-10 Gain Switching 3 Function* on page 7-37.

3607 hex	Force Command Value Offset					All	
Setting range	−100 to 100	**Unit**	%	**Default setting**	0	**Data attribute**	B
Size	2 bytes (INT16)		**Access**	RW	**PDO map**	Not possible.	

• Set the offset force to be added to force commands in the control mode other than the Force Control Mode.

• Set the value in units of 1% of the rated voltage (100%).

Refer to *11-9 Friction Force Compensation Function* on page 11-28.

3608 hex	Positive Direction Force Offset					All	
Setting range	−100 to 100	**Unit**	%	**Default setting**	0	**Data attribute**	B
Size	2 bytes (INT16)		**Access**	RW	**PDO map**	Not possible.	

• Set the value to be added to a force command during positive movement in the Position Control Mode.

• Set the value in units of 1% of the rated voltage (100%).

Refer to *11-9 Friction Force Compensation Function* on page 11-28.

3609 hex	Negative Direction Force Offset					All	
Setting range	−100 to 100	**Unit**	%	**Default setting**	0	**Data attribute**	B
Size	2 bytes (INT16)		**Access**	RW	**PDO map**	Not possible.	

• Set the value to be added to a force command during negative movement in the Position Control Mode.

• Set the value in units of 1% of the rated voltage (100%).

Refer to *11-9 Friction Force Compensation Function* on page 11-28.

3610 hex	Function Expansion Setting						All
Setting range	0 to 511	**Unit**	–	**Default setting**	64	**Data attribute**	B
Size	2 bytes (INT16)	**Access**	RW	**PDO map**	Not possible.		

- Set the functions by bit.
- Set the decimal value that has been converted from the bits.
- In the default settings, only the command compensation for communications errors for CSP is enabled. The number 64 (decimal) is 1000 000 when represented as bits.

Explanation of Settings

Bit	Function		Set value	
			0	1
bit 0	Instantaneous speed observer function		Disabled	Enabled
bit 1	Disturbance observer function		Disabled	Enabled
bit 2	Disturbance observer operation setting		Enabled at all time	Only when Gain 1 is selected
bit 3	Reserved		Fixed to 0.	
bit 4	Electric current response improvement function		Disabled	Enabled
bit 5	Reserved		Fixed to 0.	
bit 6	Command compensation for communications errors for CSP		Disabled	Enabled
bit 7	INP output limit	Positioning completion signal (INP1)	Output based on the presence/absence of a position error or command, regardless of the completion status of magnetic pole position estimation.	When the Magnetic Pole Detection Method (3920 hex) is set to 2, both the positioning completion signal 1 (INP1) and the positioning completion signal 2 (INP2) will be forced to OFF unless magnetic pole position estimation is completed.
		Positioning completion signal (INP2)	Output based on the position error, regardless of the completion status of magnetic pole position estimation.	
bit 8	Reserved		Fixed to 0.	

- If the command compensation for communications errors for CSP is enabled and a communications error occurs, the Servo Drive will compensate and control the internal command based on the value of the Target position (607A hex) that was most recently received normally.
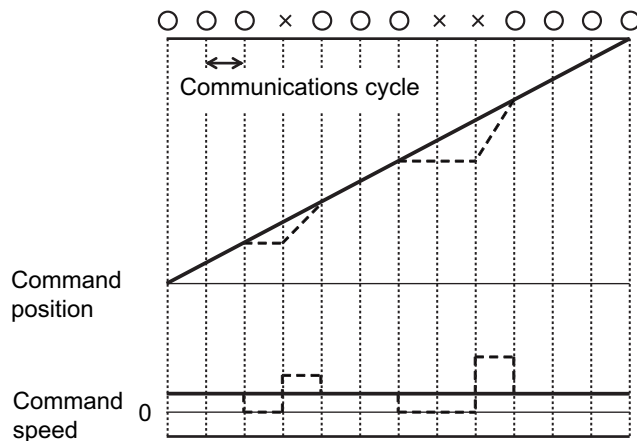
Solid line: Command compensation enabled.
Dashed line: Command compensation disabled.
○: Normal communications
×: Communications error

📝 **Additional Information**

Example

Instantaneous speed observer function: enabled
Disturbance observer function: enabled
Disturbance observer operation setting: enabled at all time
Electric current response improvement function: enabled
Command compensation for communications errors for CSP: Disabled

If the settings are as described above, the bit will be 0010011, and the decimal value 19.
Therefore, the set value will be 19.

Refer to *11-8 Disturbance Observer Function* on page 11-26 and *11-11 Instantaneous Speed Observer Function* on page 11-33.

3614 hex	Error Detection Allowable Time Setting						All
Setting range	0 to 1000	**Unit**	ms	**Default setting**	200	**Data attribute**	B
Size	2 bytes (INT16)		**Access**	RW	**PDO map**	Not possible.	

- Set the allowable time until stopping if an immediate stop is executed when an error is detected.
- When the time exceeds the set value, the operation forcibly turns to an error state.
- When the object is set to 0, the protection for the allowable time does not function.

Refer to the *Immediate Stop Operation* on page 12-10.

3615 hex	Overspeed Detection Level Setting at Immediate Stop						All
Setting range	0 to 20000	**Unit**	mm/s	**Default setting**	0	**Data attribute**	A
Size	2 bytes (INT16)		**Access**	RW	**PDO map**	Not possible.	

- If the motor speed exceeds the set value during an immediate stop resulting from an error, an Overspeed 2 Error (Error No. 26.1) will occur.
- The overspeed detection level setting is 1.2 times the maximum motor speed if this object is set to 0.
- This object should normally be set to 0. The setting should be changed only when it is necessary to lower the overspeed detection level.

Refer to *Immediate Stop Operation* on page 12-10.

3618 hex	Power Supply ON Initialization Time						All
Setting range	0 to 100	**Unit**	0.1 s	**Default setting**	0	**Data attribute**	R
Size	2 bytes (INT16)		**Access**	RW	**PDO map**	Not possible.	

- Set the initialization time after turning ON the power supply to the standard 1.5 seconds plus the specified value.

Refer to the Control Output Sequence in *3-1 Servo Drive Specifications* on page 3-2 for the details at power ON.

3623 hex	Disturbance Force Compensation Gain						csp
Setting range	−100 to 100	**Unit**	%	**Default setting**	0	**Data attribute**	B
Size	2 bytes (INT16)		**Access**	RW	**PDO map**	Not possible.	

- Set the compensation gain for the disturbance force.

Refer to *11-8 Disturbance Observer Function* on page 11-26.

3624 hex	Disturbance Observer Filter Setting						csp
Setting range	10 to 2500	**Unit**	0.01 ms	**Default setting**	53	**Data attribute**	B
Size	2 bytes (INT16)		**Access**	RW	**PDO map**	Not possible.	

- Set the filter time constant for disturbance force compensation.

Refer to *11-8 Disturbance Observer Function* on page 11-26.

3631 hex	Realtime Autotuning Estimated Speed Selection						All
Setting range	0 to 3	**Unit**	–	**Default setting**	0	**Data attribute**	B
Size	2 bytes (INT16)		**Access**	RW	**PDO map**	Not possible.	

- Set the speed to estimate the load characteristic while the realtime autotuning is enabled.
- The higher the set value is, the earlier the load characteristic change is followed, but the estimated variation against the disturbance becomes greater.
- The estimated results is updated in every 30 minutes and saved in EEPEOM.

Explanation of Settings

Set value	Mode	Description
0	No change	Stops load estimation.
1	Little change	Estimates every minute from the load characteristic changes.
2	Gradual change	Estimates every second from the load characteristic changes.
3	Sharp change	Estimates the optimum from the load characteristic changes.

Refer to *11-3 Realtime Autotuning* on page 11-7 for details of realtime autotuning settings.

3632 hex	Realtime Autotuning Customization Mode Setting					All	
Setting range	−32768 to 32767	Unit	–	Default setting	0	Data attribute	B
Size	2 bytes (INT16)		Access	RW	PDO map	Not possible.	

- Set the details of the autotuning function when the Realtime Autotuning Mode Selection (3002 hex) is set to 6.

For the Realtime Autotuning Mode Selection (3002 hex), refer to *Realtime Autotuning Mode Selection* on page 9-4.

Explanation of Settings

Bit	Name	Description
0 to 1	Load characteristic estimation [*1]	Select to enable or disable load characteristic estimation. 0: Disable 1: Enable
2 to 3	Mass ratio updating	Select whether to update the present set value of the Mass Ratio (3004 hex) with the load characteristic estimation result. 0: Use the present set value. 1: Update with the estimation result.
4 to 6	Force compensation	Select whether to update three objects, Force Command Value Offset (3607 hex), Positive Direction Force Offset (3608 hex), and Negative Direction Force Offset (3609 hex), with the load characteristic estimation result. 0: Use the present set value. 1: Disable the force compensation. Clear the above three objects to zero. 2: Unbalanced load. Update 3607 hex. Clear 3608 hex and 3609 hex to zero. 3: Friction compensation (small). Update 3607 hex. Set a small compensation to 3608 hex and 3609 hex. 4: Friction compensation (intermediate). Update 3607 hex. Set an intermediate compensation in 3608 hex and 3609 hex. 5: Friction compensation (large). Update 3607 hex. Set a large compensation in 3608 hex and 3609 hex.
7	Rigidity setting	Select to enable or disable the basic gain setting by the Realtime Autotuning Machine Rigidity Setting (3003 hex). 0: Disable 1: Enable
8	Fixed object settings	Select whether to allow changes to the objects that normally are fixed. 0: Use the present settings. 1: Set to fixed values.
9 to 10	Gain switch setting	Select the method to set the objects that relate to gain switching while the realtime autotuning is enabled. 0: Use the present settings. 1: Disable gain switching. 2: Enable gain switching.

*1   When load characteristic estimation is disabled, mass ratio updating is also disabled, even if the latter is set to be updated with the estimation result. When force compensation is updated with the estimation result, load characteristic estimation is disabled.

Precautions for Correct Use

This object must be set in units of bits. Users must be fully aware that proper operation of your system is not guaranteed, if you have incorrect object settings. Pay a particular attention when you set them.

Additional Information

Procedure to Set the Object Bit by Bit

Follow these steps and calculate the set values, when you make any setting other than 0.

(1) Confirm the least significant bit (LSB) in each set value.

E.g. LSB of force compensation function: 4

(2) Multiply the set value by 2 to the power of the bit number of the LSB.

E.g. To set the force compensation to Friction compensation (small): The set value is 3. The exponent is 4.

$$2^4 \times 3 = 48$$

(3) Repeat Step (1) and (2) for all bit settings. Add all results and set the outcome to 3632 hex.

E.g. When all of the Load characteristic estimation, the mass ratio updating, the Rigidity setting, and the Gain switch setting are enabled, the Force compensation is set to Friction compensation (small), and the Fixed object setting is set to a Fixed value:

$$2^0 \times 1 + 2^2 \times 1 + 2^4 \times 3 + 2^7 \times 1 + 2^8 \times 1 + 2^9 \times 2 = 1461$$

Refer to *11-3 Realtime Autotuning* on page 11-7 for details of realtime autotuning settings.

3637 hex	Vibration Detection Threshold						All
Setting range	0 to 1000	**Unit**	0.1%	**Default setting**	0	**Data attribute**	B
Size	2 bytes (INT16)	**Access**	RW	**PDO map**	Not possible.		

- Set the vibration detection threshold.
- If force vibration that exceeds this setting is detected, a vibration detection warning occurs.
- Set the value in units of 0.1% of the rated voltage (100%).

Refer to *12-2 Warnings* on page 12-4.

3638 hex	Warning Mask Setting						All
Setting range	−32768 to 32767	Unit	–	Default setting	4	Data attribute	C
Size	2 bytes (INT16)		Access	RW	PDO map	Not possible.	

- Set the warning detection mask setting.
- If you set the corresponding bit to 1, the corresponding warning detection is disabled.

Refer to the *General Warnings* on page 12-5.

Explanation of Settings

Bit	Warning number	Warning name	Warning condition
0 to 1	-	Reserved (Do not use.)	
2	A7	Life Expectancy Warning	The life expectancy of the capacitor or the fan is shorter than the specified value.
3	-	Reserved (Do not use.)	
4	-	Reserved (Do not use.)	
5	A1	Excessive Regeneration Warning	The regeneration load ratio is 85% or more of the level.
6	A3	Fan Warning	The fan stops for 1 second.
7	A0	Overload Warning	The load ratio is 85% or more of the protection level.
8	A8	External Encoder Error Warning	The external encoder detects a warning.
9	A6	Vibration Detection Warning	Vibration is detected.
10	A9	External Encoder Communications Warning	The external encoder has more communications errors in series than the specified value.

3700 hex	LED Display Selection						All
Setting range	0 to 32767	**Unit**	–	Default setting	0	**Data attribute**	A
Size	2 bytes (INT16)		**Access**	RW	**PDO map**	Not possible.	

- Select a data type to display on the 7-segment display on the front panel.

Explanation of Settings

Set value	Indicated item	Description
0	Normal state	Displays "– –" during Servo-OFF, and "00" during Servo ON.
1	Reserved	Do not use.
2	Electric angle	Displays a value between 0 and FF hex.
		The value 0 indicates the position when the U-phase electro-motive force shows the positive peak.
		The value increments when the motor rotates in the positive direction.
		The value returns to 0 when it exceeds FF, but the count continues.
3	Total number of EtherCAT communications errors[1]	Displays a value between 0 and FF hex.
		The cumulative count is saturated when it reaches the maximum value (FFFF hex).
		In this case, only the lowest order byte is shown.
		The value returns to 00 when it exceeds FF, but the count continues.
4	Rotary switch setting (node address)	Displays the rotary switch setting (i.e. node address) read at power-ON. The displayed value is in decimal.
		The value is not altered by any changes to the rotary switch setting after the power-ON.
5	Reserved	Do not use.
6	Total number of external encoder communications errors[1]	Displays a value between 0 and FF hex.
		The cumulative count is saturated when it reaches the maximum value (FFFF hex).
		In this case, only the lowest order byte is shown.
		The value returns to 00 when it exceeds FF, but the count continues.
7	Z-phase counter [2]	Displays the Z-phase count value read from the external encoder when an incremental external encoder is used. The value between 0 an FF hex is displayed.
8 or over	Reserved	Do not use.

*1   The cumulative count of communication errors is cleared when the control power is cut OFF.

*2   The value read from the external encoder is indicated directly, regardless of the External Feedback Pulse Direction Switching (3326 hex).

3701 hex	Power ON Address Display Duration Setting						All
Setting range	0 to 1000	**Unit**	100 ms	**Default setting**	0	**Data Attribute**	R
Size	2 bytes (INT16)		**Access**	RW	**PDO map**	Not possible.	

• Set the time to indicate the node address when the control power is turned ON.

3703 hex	Force Limit Flag Output Setting						cst
Setting range	0 to 1	**Unit**	–	**Default setting**	1	**Data Attribute**	A
Size	2 bytes (INT16)		**Access**	RW	**PDO map**	Not possible.	

• Set the condition for force limiting signal during force control.

Explanation of Settings

Set value	Description
0	On by the force limit value including the force command value.
1	On by the force limit value excluding the force command value.

3704 hex	Backlash Compensation Selection						csp pp hm
Setting range	0 to 2	**Unit**	–	**Default setting**	0	**Data Attribute**	C
Size	2 bytes (INT16)		**Access**	RW	**PDO map**	Not possible.	

• Select to enable or disable the backlash compensation during position control. Set the compensation direction when compensation is enabled.

Explanation of Settings

Set value	Description
0	Disable backlash compensation.
1	Compensate for backlash at first positive direction operation after the servo turns ON.
2	Compensate for backlash at first negative direction operation after the servo turns ON.

Refer to *7-4 Backlash Compensation* on page 7-13.

3705 hex	Backlash Compensation Amount						csp pp hm
Setting range	−32768 to 32767	**Unit**	Command unit	**Default setting**	0	**Data Attribute**	B
Size	2 bytes (INT16)		**Access**	RW	**PDO map**	Not possible.	

• Set the backlash compensation amount during position control.

Refer to *7-4 Backlash Compensation* on page 7-13.

3706 hex	Backlash Compensation Time Constant						csp pp hm
Setting range	0 to 6400	**Unit**	0.01 ms	**Default setting**	0	**Data Attribute**	B
Size	2 bytes (INT16)		**Access**	RW	**PDO map**	Not possible.	

• Set the backlash compensation time constant for position control.

Refer to *7-4 Backlash Compensation* on page 7-13.

3758 hex	Touch Probe Trigger Selection						All
Setting range	0000 to FFFF hex	Unit	–	Default setting	0100 hex	Data Attribute	B
Size	2 bytes (U16)		Access	RW	PDO map	Not possible.	

• Select EXT1, EXT2, EXT3, or phase Z at the external latch trigger for the latch function.

Explanation of Settings

Latch 1			Latch 2		
Bit 0	Bit 1	Trigger signal 1	Bit 8	Bit 9	Trigger signal 2
0	0	EXT1	0	0	EXT1
1	0	EXT2	1	0	EXT2
0	1	EXT3	0	1	EXT3
1	1	Phase-Z signal	1	1	Phase-Z signal

For details on the latch function, refer to *7-11 Touch Probe Function (Latch Function)* on page 7-39.

3759 hex	Warning Hold Selection						All
Setting range	0000 to FFFF hex	Unit	–	Default setting	0000 hex	Data Attribute	R
Size	2 bytes (U16)		Access	RW	PDO map	Not possible.	

• Select whether to hold communications-related and general warning status.

Explanation of Settings

Bit	Function	Set value	Warning status	Resetting warning status
0	Holding Communications-related Warning Status	0	Do not hold	The warnings are automatically cleared when the cause of the warning is eliminated. However, warnings are held for at least 1 s.
		1	Hold	Remove the cause of the warning and then send a warning reset command.
1	Holding General Warning Status[*1]	0	Do not hold	The warnings are automatically cleared when the cause of the warning is eliminated. However, warnings are held for at least 1 s.
		1	Hold	Remove the cause of the warning and then send a warning reset command.

*1   The warning state for the Life Expectancy Warning (A7 hex) will be held independent of this setting.

3781 hex	Data Setting Warning Detection Setting						All
Setting range	0 to 15	Unit	Times	Default setting	1	Data Attribute	C
Size	2 bytes (INT16)		Access	RW	PDO map	Not possible.	

- Set how many times the EtherCAT communications data setting warning should be detected continuously without an error.
- If a Data Setting Warning (Warning No. B0 hex) occurs more than this setting, a Command Error (Error No. 91.1) will occur.
- It can be set to between 0 and 15. The error will occur when the number of detected Data Setting Warning exceeds this set value + 1.

Additional Information

- In the default setting, the data setting warning (Warning No. B0 hex) will not occur because the Communications Control (3800 hex) bit 14 is 1, and therefore no Command Error (Error No. 91.1) will occur.
- To enable this setting, set the Communications Control (3800 hex) bit 14 to 0.
- When you enable this setting and do not change the default setting value (default: 1), a Command Error will occur if the data setting warning is detected twice in a row.

3800 hex	Communications Control						All
Setting range	−32768 to 32767	Unit	–	Default setting	16384	Data Attribute	C
Size	2 bytes (INT16)		Access	RW	PDO map	Not possible.	

- Set the error and warning masks for EtherCAT communications.

Precautions for Correct Use

This function is for debugging. For normal operation, leave this object at the default setting.

Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Function		Error masks								Warning masks			Error masks			

Error masks

The following table shows the error you can mask by setting each error mask bit of the Communications Control object (3800 hex).
To mask an error, set the corresponding error bit to 1.

Communications Control (3800 hex)	Error	
	Error No. (hex)	Error name
Bit 1	83.1	EtherCAT state change error
Bit 2	83.2	EtherCAT illegal state change error
Bit 3	83.3	Communications synchronization error
Bit 12	83.4	Synchronization error
Bit 13	83.5	Sync Manager WDT Error
Bit 14[1]	91.1	Command Error

*1. Only Command Errors (Error No. 91.1) due to the data setting warning (B0 hex) are masked. Command Errors (Error No. 91.1) due to other causes are not masked.
For details on the causes of a Command Error (Error No. 91.1), refer to *Command error* on page 12-21.

Warning masks

The following table shows the warning you can mask by setting each warning mask bit of the Communications Control object (3800 hex).
To mask a warning, set the corresponding warning bit to 1.

Communications Control (3800 hex)	Warning		
	Warning number	Warning name	Warning occurrence conditions
Bit 4	B0 hex	Data setting warning	• The set value in the command argument is out of the specified range. • Object write processing failed. • The command set value is incorrect.
Bit 5	B1 hex	Command warning	• The command transmission conditions are not met. • The sub-command transmission conditions are not met. • An operation command is given in the prohibited direction after the motor made an emergency stop due to a drive prohibition input.
Bit 6	B2 hex	EtherCAT communications warning	EtherCAT communications errors occurred one or more times.

For details on the warning detection mask setting, refer to *Warnings Related to EtherCAT Communications* on page 12-6.

3801 hex	Software Position Limit Function						All
Setting range	0 to 3	Unit	–	Default setting	3	Data Attribute	A
Size	2 bytes (INT16)		Access	RW	PDO map	Not possible.	

- Select whether to enable or disable the software position limit function.
- When this function is enabled, set the positive software limit value in the Max position limit (607D-02 hex) and the negative software limit value in the Min position limit (607D-01 hex).

Explanation of Settings

Set value	Description
0	Enable the software limits in both directions.
1	Disable the positive software limit, but enable the negative software limit.
2	Enable the positive software limit, but disable the negative software limit.
3	Disable the software limits in both directions.

Precautions for Correct Use

EtherCAT communications status will be 0 for limit signals that are disabled. The status will also be 0 if an origin return has not been performed.

3803 hex	Origin Range						All
Setting range	0 to 250	**Unit**	Command unit	**Default setting**	10	**Data Attribute**	A
Size	2 bytes (INT16)		**Access**	RW	**PDO map**	Not possible.	

• Set the threshold for detecting the origin as an absolute value.

3818 hex	Position Command FIR Filter Time Constant						csp pp hm
Setting range	0 to 10000	**Unit**	0.1 ms	**Default setting**	0	**Data attribute**	B
Size	2 bytes (INT16)		**Access**	RW	**PDO map**	Not possible.	

• Set the time constant of FIR filter for the position command.
• The Position command FIR filter can be selected to enable or disable, by the position command filer switch input via EtherCAT communications.
• Enable and disable the position command FIR filter in the Motion profile type (6086 hex).
• It can be set only when the Communications synchronization is 1 ms or more.
• It sets the time to arrive at the target speed Vc, as shown below, for the square-wave command of Vc.

Position Command FIR Filter Time Constant [ms] 3818 hex × 0.1 ms

Filter switching dwell time [1]
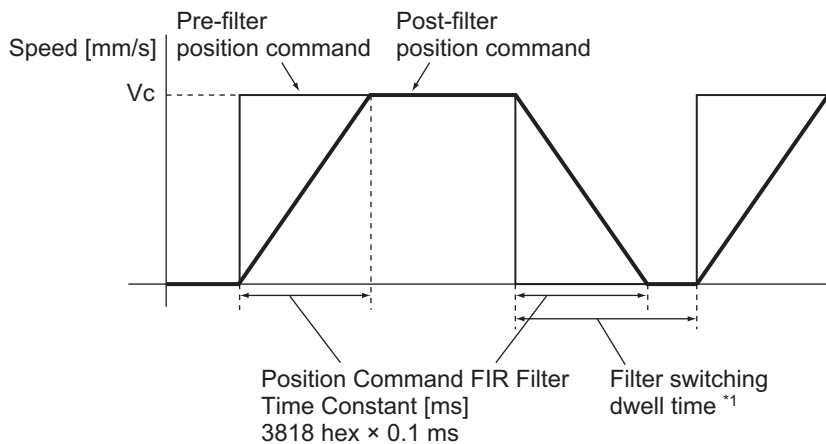
*1   Change the Position Command FIR Filter Time Constant (3818 hex) setting only after the command pulse stops and the filter switching dwell time elapses.
The dwell time is calculated by the following formulas depending on the value set on 3818 hex. If 3818 hex set value is less than 10 ms, the set value × 0.1 ms + 0.25 ms. If 3818 hex set value is more than 10 ms, the set value × 0.1 ms × 1.05.

Precautions for Correct Use

• If the Position Command FIR Filter Time Constant (3818 hex) is changed when the position command is entered, the change is not reflected immediately. It is updated only after the subsequent state of no position command persists for the filter switching dwell time.
• There is some time lag from when the Position Command FIR Filter Time Constant (3818 hex) is change and to when the change is applied. If the filter switching dwell time elapses during the lag, the change may be suspended.

9-8   Linear Motor Objects

3901 hex	External Encoder Resolution						All
Setting range	0 to 16777216	Unit	0.001 μm	Default setting	0	Data Attribute	R
Size	4 bytes (INT32)	Access	RW	PDO map	Not possible.		

- Select the resolution of the external encoder.
- The effective setting range is between 10000 and 1048576.
- For the set value, refer to the external encoder specifications.

Precautions for Correct Use

If you set this object to 0, a Motor Setting Error (Error No. 60.0) will occur.

3902 hex	Pole Pitch						All
Setting range	0 to 32767	Unit	0.01 mm	Default setting	0	Data Attribute	R
Size	2 bytes (INT16)	Access	RW	PDO map	Not possible.		

- Set the magnetic pole pitch.

Precautions for Correct Use

If you set this object to 0, a Motor Setting Error (Error No. 60.0) will occur.

3904 hex	Motor Coil Unit Mass						All
Setting range	0 to 32767	Unit	0.01 kg	Default setting	0	Data Attribute	R
Size	2 bytes (INT16)	Access	RW	PDO map	Not possible.		

- Set the coil unit mass of the Linear Motor.

Precautions for Correct Use

If you set this object to 0, a Motor Setting Error (Error No. 60.0) will occur.

3905 hex	Motor Rated Force						All
Setting range	0 to 32767	Unit	0.1 N	Default setting	0	Data Attribute	R
Size	2 bytes (INT16)	Access	RW	PDO map	Not possible.		

- Set the rated force of the Linear Motor.

Precautions for Correct Use

If you set this object to 0, a Motor Setting Error (Error No. 60.0) will occur.

3906 hex	Motor Rated Rms Current						All
Setting range	0 to 32767	Unit	0.1 Arms	Default setting	0	Data Attribute	R
Size	2 bytes (INT16)		Access	RW	PDO map	Not possible.	

- Set the rated current of the Linear Motor.

✍ **Precautions for Correct Use**

- If you set this object to 0, a Motor Setting Error (Error No. 60.0) will occur.
- If the rated current value allowable for the Servo Drive is exceeded, a Motor Combination Error 1 (Error No. 60.1) will occur.

3907 hex	Motor Peak Absolute Current						All
Setting range	0 to 32767	Unit	0.1 A	Default setting	0	Data Attribute	R
Size	2 bytes (INT16)		Access	RW	PDO map	Not possible.	

- Set the maximum momentary current of the Linear Motor.
- Set the unit [0.1 A], instead of [0.1 Arms].

✍ **Precautions for Correct Use**

- If you set this object to 0, a Motor Setting Error (Error No. 60.0) will occur.
- If the rated current value allowable for the Servo Drive is exceeded, a Motor Combination Error 1 (Error No. 60.1) will occur.
- Use the following formula for unit conversion from Arms to A.
  Motor Rated Rms Current [A] = Maximum Motor Current [Arms] x Square Root of 2

3908 hex	Motor Inductance						All
Setting range	0 to 32767	Unit	0.01 mH	Default setting	0	Data Attribute	R
Size	2 bytes (INT16)		Access	RW	PDO map	Not possible.	

- Set the phase inductance of the Linear Motor.

✍ **Precautions for Correct Use**

If you set this object to 0 when the Current Response Auto-adjustment (3912 hex) is not 0, a Motor Setting Error (Error No. 60.0) will occur.

3909 hex	Motor Resistance						All
Setting range	0 to 32767	Unit	0.01 Ω	Default setting	0	Data Attribute	R
Size	2 bytes (INT16)		Access	RW	PDO map	Not possible.	

- Set the phase resistance of the Linear Motor.

✍ **Precautions for Correct Use**

If you set this object to 0 when the Current Response Auto-adjustment (3912 hex) is not 0, a Motor Setting Error (Error No. 60.0) will occur.

9-8 Linear Motor Objects

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3910 hex	Overspeed Level						All
Setting range	0 to 20000	**Unit**	mm/s	**Default setting**	0	**Data Attribute**	R
Size	2 bytes (INT16)		**Access**	RW	**PDO map**	Not possible.	

- Set the detection level for an Overspeed Error (Error No. 26.0).
- Set the maximum speed appropriate for the specifications of the selected Linear Motor, external encoder, linear guide, or other equipment.
- For the set value, refer to the specifications of the selected equipment.

Precautions for Correct Use

If you set this object to 0, a Motor Setting Error (Error No. 60.0) will occur.

3912 hex	Current Response Auto-adjustment						All
Setting range	0 to 100	**Unit**	%	**Default setting**	*1	**Data Attribute**	R
Size	2 bytes (INT16)		**Access**	RW	**PDO map**	Not possible.	

*1   The default setting varies depending on the Servo Drive model, as shown below.

Drive model	Set value
R88D-KN01L-ECT-L	60
R88D-KN01H-ECT-L/-KN02H-ECT-L/-KN150H-ECT-L	
R88D-KN150F-ECT-L	
R88D-KN02L-ECT-L/-KN04L-ECT-L	30
R88D-KN04H-ECT-L/-KN08H-ECT-L/-KN10H-ECT-L/-KN15H-ECT-L/ -KN20H-ECT-L/-KN30H-ECT-L/-KN50H-ECT-L/-KN75H-ECT-L	
R88D-KN06F-ECT-L/-KN10F-ECT-L/-KN15F-ECT-L/-KN20F-ECT-L/ -KN30F-ECT-L/-KN50F-ECT-L/-KN75F-ECT-L	

- Set the condition for the electric current response if you perform the automatic setting of the Current Loop Proportional Gain (3913 hex) or Current Loop Integral Gain (3914 hex).
- Although setting a larger value improves the electric current response, this may cause erroneous operation such as vibration. Adjust the value based on the operating.

Precautions for Correct Use

If this object is set to 0, the Current Loop Proportional Gain (3913 hex)/Current Loop Integral Gain (3914 hex) will not be set automatically.

If you set the Current Response Auto-adjustment (3912 hex) to 0, manually set the Current Loop Proportional Gain (3913 hex) and the Current Loop Integral Gain (3914 hex).

3913 hex	Current Loop Proportional Gain						All
Setting range	0 to 32767	**Unit**	–	**Default setting**	50	**Data Attribute**	B
Size	2 bytes (INT16)	**Access**	RW	**PDO map**	Not possible.		

- Set the current loop proportional gain.
- Normally, use the value automatically set via the Current Response Auto-adjustment (3912 hex) object as is.

3914 hex	Current Loop Integral Gain						All
Setting range	0 to 32767	**Unit**	–	**Default setting**	10	**Data Attribute**	B
Size	2 bytes (INT16)	**Access**	RW	**PDO map**	Not possible.		

- Set the current loop integral gain
- Normally, use the value automatically set by the Current Response Auto-adjustment (3912 hex) object.

3915 hex	Two-stage Force Filter Time Constant						All
Setting range	0 to 2500	**Unit**	0.01 ms	**Default setting**	0	**Data Attribute**	B
Size	2 bytes (INT16)	**Access**	RW	**PDO map**	Not possible.		

- Set the two-stage force filter time constant.
- When set to 0, this object is disabled.

When used for the secondary filter with the Two-stage Force Filter Attenuation Term (3916 hex) set to greater than or equal to 50

The supported time constant is 5 to 159 (0.05 to 1.59 ms), which is equivalent to a frequency of 100 to 3,000 Hz. The set values 1 to 4 correspond to the time constant 5 (3,000 Hz); the set values 159 to 2500 correspond to the time constant 159 (100 Hz).

Precautions for Correct Use

Setting an excessively large value may cause an unstable control behavior, resulting in vibration. Adjust the value while checking the operating conditions.

3916 hex	Two-stage Force Filter Attenuation Term					All	
Setting range	0 to 1000	**Unit**	–	**Default setting**	1000	**Data Attribute**	B
Size	2 bytes (INT16)		**Access**	RW	**PDO map**	Not possible.	

- Set the two-stage force filter time attenuation term.
- This setting is used to switch the filter order (primary or secondary) of the two-stage force filter.

Explanation of Settings

Set value	Description
0 to 49	The filter behaves as the primary filter.
50 to 1000	The filter behaves as the secondary filter. 1000 indicates a secondary filter of $\zeta = 1.0$. Setting a smaller value results in larger vibration. Normally, set this object to 1000.

Precautions for Correct Use

- Setting an excessively large value may cause an unstable control behavior, resulting in vibration. Adjust the value while checking the operating conditions.
- Changing the set value during operation may result in vibration. Stop the Servo Drive before changing the set value.

3920 hex	Magnetic Pole Detection Method					All	
Setting range	0 to 3	**Unit**	–	**Default setting**	0	**Data attribute**	R
Size	2 bytes (INT16)		**Access**	RW	**PDO map**	Not possible.	

- Set the magnetic pole detection method.

Explanation of Settings

Set value	Description
0	Not specified
1	Reserved
2	Magnetic pole position estimation method
3	Magnetic pole position restoration method

For details on the Magnetic Pole Detection Method, refer to *Setting the Magnetic Pole Detection Data* on page 10-8.

Precautions for Correct Use

If you set this object to 0, a Motor Setting Error (Error No. 60.0) will occur.

3922 hex	Magnetic Pole Position Estimation Force Command Time						All
Setting range	0 to 200	**Unit**	ms	**Default setting**	200	**Data attribute**	B
Size	2 bytes (INT16)		**Access**	RW	**PDO map**	Not possible.	

- Set the command application time for a single force command during magnetic pole position estimation.
- If the number of motor movement pulses reaches the value set in the Magnetic Pole Position Estimation Maximum Movement (3924 hex) or a larger value, the force command will stop even before the force application time expires.
- This setting is enabled only when the Magnetic Pole Detection Method (3920 hex) is set to 2 (Magnetic pole position estimation method).

Precautions for Correct Use

- If this object is set to a small value, the motor may not show its full performance, resulting in a poor detection accuracy or a Magnetic Pole Position Estimation Error. If the motor is subjected to a large load or resistance, set a sufficiently long force command time.
- The magnetic pole position estimation accuracy may be improved by increasing the set value in the Magnetic Pole Position Estimation Force Command Time (3922 hex) or Magnetic Pole Position Estimation Force Command (3923 hex). However, if you set a large value in the Magnetic Pole Position Estimation Force Command Time (3922 hex), an Overload Error (Error No. 16.0) will occur depending on the Magnetic Pole Position Estimation Force Command (3923 hex) setting.
- The actual command time will be approx. the set value plus 4 ms.

3923 hex	Magnetic Pole Position Estimation Force Command						All
Setting range	0 to 300	**Unit**	%	**Default setting**	50	**Data attribute**	B
Size	2 bytes (INT16)		**Access**	RW	**PDO map.**	Not possible.	

- Set the command force for a single force command during magnetic pole position estimation.
- This setting is enabled only when the Magnetic Pole Detection Method (3920 hex) is set to 2 (Magnetic pole position estimation method).

Precautions for Correct Use

- If this object is set to a small value, the motor may not show its full performance, resulting in a poor detection accuracy or a Magnetic Pole Position Estimation Error. If the motor is subjected to a large load or resistance, set a sufficiently long force command time.
- The magnetic pole position estimation accuracy may be improved by increasing the set value in the Magnetic Pole Position Estimation Force Command Time (3922 hex) or Magnetic Pole Position Estimation Force Command (3923 hex). However, if you set a large value in the Magnetic Pole Position Estimation Force Command Time (3922 hex), an Overload Error (Error No. 16.0) will occur depending on the Magnetic Pole Position Estimation Force Command (3923 hex) setting.
- The actual command time will be approx. the set value plus 4 ms.

3924 hex	Magnetic Pole Position Estimation Maximum Movement					All	
Setting range	0 to 32767	**Unit**	pulse	**Default setting**	100	**Data attribute**	B
Size	2 bytes (INT16)		**Access**	RW	**PDO map**	Not possible.	

- Set the pulse width to be judged as zero movement during magnetic pole position estimation.
- It will be judged as zero movement if the number of motor movement pulses is less than the set value when a force is applied with the conditions set in the Magnetic Pole Position Estimation Force Command Time (3922 hex) and the Magnetic Pole Position Estimation Force Command (3923 hex).
- Although setting a smaller value contributes to the reduction in the amount of movement during magnetic pole position estimation, it may result in a poor detection accuracy. As a guide, set the number of pulses corresponding to one degree of electrical angle.
- This setting is enabled only when the Magnetic Pole Detection Method (3920 hex) is set to 2 (Magnetic pole position estimation method).

📝 **Additional Information**

Calculation formula for the number of pulses corresponding to one degree of electrical angle (for linear system)

Number of pulses corresponding to one degree of electrical angle (for linear system) = Magnetic pole pitch [0.01 mm] x 10000/Feedback scale resolution [0.001 μm]/(360 [degrees]/1 [degree])

3925 hex	Magnetic Pole Position Estimation Movement for Stop Judgment					All	
Setting range	0 to 32767	**Unit**	pulse	**Default setting**	40	**Data attribute**	B
Size	2 bytes (INT16)		**Access**	RW	**PDO map**	Not possible.	

- Set the condition for judging that the motor is stopped during magnetic pole position estimation.
- Set the number of motor movement pulses per unit time [2 ms].
- The motor will be judged as stopped if a condition where the number of motor movement pulses per unit time [2 ms] set in the Magnetic Pole Position Estimation Movement for Stop Judgment (3926 hex) or less persists for the time set in the Magnetic Pole Position Estimation Time for Stop Judgment (3926 hex) or longer.
- This setting is enabled only when the Magnetic Pole Detection Method (3920 hex) is set to 2 (Magnetic pole position estimation method).

3926 hex	Magnetic Pole Position Estimation Time for Stop Judgment					All	
Setting range	0 to 32767	**Unit**	ms	**Default setting**	40	**Data attribute**	B
Size	2 bytes (INT16)		**Access**	RW	**PDO map**	Not possible	

- Set the condition for judging that the motor is stopped during magnetic pole position estimation.
- Set the time during which the motor must be stopped in order to be judged as stopped.
- The motor will be judged as stopped if a condition where the number of motor movement pulses per unit time [2 ms] set in the Magnetic Pole Position Estimation Movement for Stop Judgment (3926 hex) or less persists for the time set in the Magnetic Pole Position Estimation Time for Stop Judgment (3926 hex) or longer.
- This setting is enabled only when the Magnetic Pole Detection Method (3920 hex) is set to 2 (Magnetic pole position estimation method).

Precautions for Correct Use

After applying a force command, the command force stops and the motor decelerates. After that, the motor comes to a stop momentarily but may move in a reverse direction due to cogging or other phenomena.

To prevent the motor from being judged as stopped in a wrong timing when it has not come to a complete stop in this way, be sure to set the Magnetic Pole Position Estimation Movement for Stop Judgment (3925 hex) and the Magnetic Pole Position Estimation Time for Stop Judgment (3926 hex).

3927 hex	Magnetic Pole Position Estimationn Time Limit for Stop						All
Setting range	0 to 32767	**Unit**	ms	**Default setting**	1000	**Data attribute**	B
Size	2 bytes (INT16)		**Access**	RW	**PDO map**	Not possible	

- Set the limit time for judging motor stop during magnetic pole position estimation.
- This time represents the time elapsed after the stoppage of a force command until the motor comes to a complete stop.
- If the motor has not been judged as stopped when the set limit time expires, a Magnetic Pole Position Estimation Error 2 (Error No. 61.1) will occur.
- This setting is enabled only when the Magnetic Pole Detection Method (3920 hex) is set to 2 (Magnetic pole position estimation method).

Precautions for Correct Use

If you set a large value in the Magnetic Pole Position Estimation Force Command (3923 hex) or Magnetic Pole Position Estimation Maximum Movement (3924 hex), it may take a long time until the motor stops because the motor speed when a force command stops will become high. The motor may take a long time to stop due to a low kinetic friction. In these cases, increase the set value.

3928 hex	Magnetic Pole Position Estimation Force Filter Time Constant						All
Setting range	0 to 2500	**Unit**	0.01 ms	**Default setting**	100	**Data attribute**	B
Size	2 bytes (INT16)		**Access**	RW	**PDO map**	Not possible.	

- Set the filter time constant for force commands during magnetic pole position estimation.
- When the set value is 0, the filter is disabled and commands will be processed as step commands.
- This setting is enabled only when the Magnetic Pole Detection Method (3920 hex) is set to 2 (Magnetic pole position estimation method).

9-8 Linear Motor Objects

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3929 hex	Motor Overload Curve Selection						All
Setting range	0 to 7	**Unit**	–	**Default setting**	0	**Data attribute**	R
Size	2 bytes (INT16)		**Access**	RW	**PDO map**	Not possible.	

• Select one of the eight motor overload characteristic curves.

For details on the motor overload curves, refer to *3-2 Overload Characteristics (Electronic Thermal Function)* on page 3-25.

> **Precautions for Correct Use**
>
> • The overload protection function is not designed to provide protection against errors caused by heat generated by the motor.
> • Therefore, if you set the Motor Overload Curve Selection (3929 hex) value too high, the Motor Coil Unit may burn. Check in the actual operating environment to be sure that no problem occurs due to heat generated by the motor or other causes before using the Servo Drive.

10

10

Operation

This section explains the operating procedures and how to operate in each mode.

10-1 Operational Procedure

Turn ON the power supply after the correct installation and wiring to check the operation of the individual motor and drive.

Then make the function settings as required according to the use of the motor and drive.

If the user objects are set incorrectly, there is a risk of unexpected motor operation, which can be dangerous. Set the objects accurately according to the setting methods in this manual.

Item	Contents	Reference
Mounting and installation	Install the motor and drive according to the installation conditions. Do not connect the motor to the mechanical system before checking no-load operation.	Section 4, 4-1
Wiring and connections	Connect the motor and drive to the power supply and peripheral equipment. Perform Linear Motor and external scale specification settings, as well as the magnetic pole detection settings in advance. With the default settings, the Servo Drive will not operate due to an error.	Section 4, 4-2
Preparing for operation	Check the necessary items and then turn ON the power supply. Check on the display to see whether there are any internal errors in the drive. Perform Linear Motor and external scale specification settings, as well as the magnetic pole detection settings in advance. With the default settings, the Servo Drive will not operate due to an error.	Section 10, 10-2
Function settings	Set the objects related to the functions required for application conditions.	Section 9
Trial operation	First, check motor operation with no-load. Then turn the power supply OFF and connect the motor to the mechanical system. Turn ON the power supply again, and check to see whether protective functions, such as the immediate stop and operational limits, are functioning properly. Check operation at both low speed and high speed using the system without a workpiece, or with dummy workpieces.	Section 10, 10-3
Adjustment	Manually adjust the gain if necessary. Further adjust the various functions to improve the control performance.	Section 11
Operation	Operation can now be started. If any problems should occur, refer to *Section 12 Troubleshooting and Maintenance*.	Section 12

10-2 Preparing for Operation

This section explains the procedure to prepare the mechanical system for operation following installation and wiring of the motor and drive. It explains items to check both before and after turning ON the power supply.

10-2-1   Items to Check Before Turning ON the Power Supply

Checking Power Supply Voltage

Check to be sure that the power supply voltage is within the ranges shown below.

- R88D-KN01L-ECT-L/-KN02L-ECT-L/-KN04L-ECT-L (Single-phase 100-VAC input)

  Main circuit power supply: Single-phase 100 to 120 VAC (85 to 132) 50/60 Hz
  Control circuit power supply: Single-phase 100 to 120 VAC (85 to 132) 50/60 Hz

- R88D-KN01H-ECT-L/-KN02H-ECT-L/-KN04H-ECT-L/-KN08H-ECT-L/-KN10H-ECT-L/-KN15H-ECT-L
  (Single-phase/3-phase 200 VAC input)

  Main circuit power supply: Single-phase/3-phase 200 to 240 VAC (170 to 264) 50/60 Hz
  Control circuit power supply: Single-phase 200 to 240 VAC (170 to 264) 50/60 Hz

- R88D-KN20H-ECT-L/-KN30H-ECT-L/-KN50H-ECT-L/-KN75H-ECT-L/-KN150H-ECT-L
  (3-phase 200 VAC input)

  Main circuit power supply: 3-phase 200 to 230 VAC (170 to 253) 50/60 Hz
  Control circuit power supply: Single-phase 200 to 230 VAC (170 to 253) 50/60 Hz

- R88D-KN06F-ECT-L/-KN10F-ECT-L/-KN15F-ECT-L/-KN20F-ECT-L/-KN30F-ECT-L/-KN50F-ECT-L/
     -KN75F-ECT-L/-KN150F-ECT-L (3-phase 400 VAC input)

  Main circuit power supply: 3-phase 380 to 480 VAC (323 to 528) 50/60 Hz
  Control circuit power supply: 24 VDC ± 15%

Checking Terminal Block Wiring

- The main circuit power supply inputs (L1/L3 or L1/L2/L3) must be properly connected to the terminal block.
- The control circuit power supply inputs (L1C/L2C) must be properly connected to the terminal block.
- The motor's red (U), write (V), and blue (W) power lines and the green/yellow (⏚) must be properly connected to the terminal block.

Checking the Motor

- There should be no load on the motor. (Do not connect the mechanical system.)
- The motor side power lines and the power cables must be securely connected.

Checking the External Encoder Wiring

- The external encoder cable must be securely connected to the external encoder connector (CN4) at the Servo Drive.
- The cable from the Servo Drive must be securely connected to the connector at the external encoder.

Checking the EtherCAT Communications Connectors

- The EtherCAT Communications Cables must be connected securely to the EtherCAT Communications Connectors (ECAT IN and ECAT OUT).

Checking the Node Address Setting

Make sure that the node address is correctly set on the node address switches.
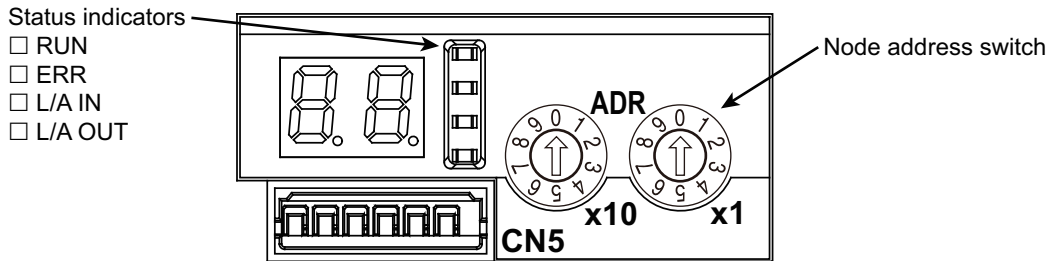
Node address switch setting	Connection to NJ501-1□00 and CJ1W-NC281/NC481/NC881/NCF81/NC482/NC882/F82 Position Control Unit
00	The controller sets the node address.
01 to 99	The Node Address switch setting is used as the node address.

Precautions for Correct Use

- Do not change the setting on the Node Address switches after the power supply has been turned ON.
- The node address switches can be set to between 00 and 99.
  The node address used over the network is determined by the value set on the Node Address switches.
  If the node address is not between 00 and 99, a Node Address Setting Error (Error No. 88.0) will occur.

10-2-2   Turning ON the Power Supply

Turn ON the control circuit power after you conduct the pre-power-ON checking.
You may turn ON the main circuit power, but it is not a required.

10-2-3 Checking the Displays

7-Segment Display

The 7-segment display is on the front panel.

When the power is turned ON, it shows the node address that is set by the rotary switches. Then the display changes according to the setting of the LED Display Selection (3700 hex).

An error code is displayed if an error occurs. A warning code is displayed if a warning occurs.

Control power ON

Fully OFF

Fully ON

Node Address Display   "nA" (node address, approx. 0.6 s)

Rotary switch setting
(upper digit (×10) = 0, lower digit (×1) = 3)
(It lasts for the period set in the Power ON Address
Display Duration Setting (3701 hex).)

To Ⓐ on the next page

Ⓐ

Normal Display (LED Display Selection (3700 hex) set to 0)

```
 ⎓ ⎓
```
[— —]

Main power supply turned ON and EtherCAT communications established.

Main power supply interrupted and EtherCAT communications not established.

```
 ⎓ ⎓.
```
[— —] + Dot on right lights.

Servo ON   Servo OFF

```
 00.
```
［00］ + Dot on right lights.

Error occurs   Error cleared   Warning occurs   Warning cleared

Error Display*1

The main error code flashes as a decimal (example for an overload).

```
 16
```

Warning Display

The hexadecimal warning code and the normal display are displayed alternately (example for an overload).

```
 A0.          00.
```

Warning code (for 2 s)   Normal code (for approx. 4 s)

*1 : "St" will flash when a Safety Input Error (Error No. 30.0) occurs.

"30" does not flash on the display.

EtherCAT Status Indicators

Check the status of the status indicators.

If the RUN indicator will not turn ON or the ERR indicator will not turn OFF, refer to *Status Indicators* on page 5-3 and check the status.

10-2-4 Preparing the Linear Motor for Operation

At the Servo Drive, you must perform the following three types of basic settings based on the Linear Motor and external encoder you connect to it.

- Setting the Linear Motor and external encoder specifications
- Adjusting the current loop gain
- Setting the magnetic pole detection data

The details of the objects that must be set for each of the above basic settings are described below.

Setting the Linear Motor and External Encoder Specifications

Check the specifications of the Linear Motor you connect to the Servo Drive and set the necessary objects according to the following table.

Index	Name	Unit	Description	Reference
3323 hex	External Feedback Pulse Type Selection	–	Set the external encoder type (90° phase difference input, serial communications incremental, or serial communications absolute) of the selected external encoder. For the set value, refer to the specifications of the selected equipment.	page 9-25
3326 hex	External Feedback Pulse Direction Switching	–	Set the count direction of the external encoder.	page 9-26
3901 hex	External Encoder Resolution	0.001 μm	Set the resolution of the selected external encoder. For the set value, refer to the specifications of the selected equipment.	page 9-56
3902 hex	Pole Pitch	0.01 mm	Set the magnetic pole pitch.	page 9-56
3904 hex	Motor Coil Unit Mass	0.01 kg	Set the mass of the Linear Motor coil unit.	page 9-56
3905 hex	Motor Rated Force	0.1 N	Set the rated force of the Linear Motor.	page 9-56
3906 hex	Motor Rated Rms Current	0.1 Arms	Set the rated current of the Linear Motor.	page 9-57
3907 hex	Motor Peak Absolute Current	0.1 A	Set the maximum momentary current of the Linear Motor. [1]	page 9-57
3910 hex	Overspeed Level	mm/s	Set the maximum speed appropriate for the specifications of the selected Linear Motor, external encoder, linear guide, or other equipment. For the set value, refer to the specifications of the selected equipment.	page 9-58

*1   Set the maximum value, instead of the effective value.

Adjusting the Current Loop Gain

At the Servo Drive, you need to adjust the current loop gain.

Using the Current Response Auto-adjustment (3912 hex) object allows the Servo Drive to automatically set the current loop gain.

To use the Current Response Auto-adjustment (3912 hex) object, you must set also the Motor Inductance (3908 hex) and Motor Resistance (3909 hex) objects.

Index	Name	Unit	Description	Reference
3908 hex	Motor Inductance	0.01 mH	Set the phase inductance of the Linear Motor.	page 9-57
3909 hex	Motor Resistance	0.01 Ω	Set the phase resistance of the Linear Motor.	page 9-57
3912 hex	Current Response Auto-adjustment	%	Set the condition for the electric current response if you perform the automatic setting of the Current Loop Proportional Gain (3913 hex) or Current Loop Integral Gain (3914 hex).	page 9-58
3913 hex	Current Loop Proportional Gain	–	Set the current loop proportional gain. Normally, use the value automatically set via the Current Response Auto-adjustment (3912 hex) object as is.	page 9-59
3914 hex	Current Loop Integral Gain	–	Set the current loop integral gain. Normally, use the value automatically set via the Current Response Auto-adjustment (3912 hex) object as is.	page 9-59

Setting the Magnetic Pole Detection Data

The magnetic pole detection function detects the positional relationship between a magnetic pole and an external encoder.

This Servo Drive offers the following two types of magnetic pole detection:
- Magnetic pole position estimation method
- Magnetic pole position restoration method

● Magnetic Pole Position Estimation Method

In the magnetic pole position estimation method, the position of each magnetic pole is estimated automatically at the first Servo ON after you turn ON the power supply.

The estimated pole position data will be effective until you reset the power supply. After resetting the power supply, the Servo Drive will estimate the magnetic pole positions again the first Servo ON.

Index	Name	Unit	Description	Reference
3920 hex	Magnetic Pole Detection Method	–	Set the magnetic pole detection method. Select 2 to set the magnetic pole position estimation method.	page 9-60
3922 hex	Magnetic Pole Position Estimation Force Command Time	ms	Set the force application time for a single force command during magnetic pole position estimation to judge the motor movement direction. If the motor is subjected to a large load or resistance, set a sufficiently long force command time. [1]	page 9-61
3923 hex	Magnetic Pole Position Estimation Force Command	%	Set the command force for a single force command during magnetic pole position estimation. If the motor is subjected to a large load or resistance, set a sufficiently large command force.[1]	page 9-61

Index	Name	Unit	Description	Reference
3924 hex	Magnetic Pole Position Estimation Maximum Movement	pulse	Set the pulse width to be judged as zero movement during magnetic pole position estimation. As a guide, set the number of pulses corresponding to one degree of electrical angle. [2]	page 9-62
3925 hex	Magnetic Pole Position Estimation Movement for Stop Judgment	pulse	Set the condition for judging that the motor is stopped during magnetic pole position estimation. The motor will be judged as stopped if a condition where the number of motor movement pulses per unit time [2 ms] set in the Magnetic Pole Position Estimation Movement for Stop Judgment (3926 hex) or less persists for the time set in the Magnetic Pole Position Estimation Time for Stop Judgment (3926 hex) or longer. To prevent the motor from being judged as stopped in a wrong timing, be sure to set. [3]	page 9-62
3926 hex	Magnetic Pole Position Estimation Time for Stop Judgment	ms		page 9-62
3927 hex	Magnetic Pole Position Estimation Time Limit for Stop	ms	Set the limit time during which the motor can be judged as stopped during magnetic pole position estimation. If the motor has not been judged as stopped when the set limit time expires after the command force stops, a Magnetic Pole Position Estimation Error 2 (Error No. 61.1) will occur. [4]	page 9-63
3928 hex	Magnetic Pole Position Estimation Force Filter Time Constant	0.01 ms	Set the filter time constant for force commands during magnetic pole position estimation. When the set value is 0, the filter is disabled and commands will be processed as step commands.	page 9-63

*1   The magnetic pole position estimation accuracy may be improved by increasing the set value in the Magnetic Pole Position Estimation Force Command Time (3922 hex) or Magnetic Pole Position Estimation Force Command (3923 hex). However, if you set a large value in the Magnetic Pole Position Estimation Force Command Time (3922 hex), an Overload Error (Error No. 16.0) will occur depending on the Magnetic Pole Position Estimation Force Command (3923 hex) setting.

*2   If the amount of motor movement is less than the pulse width set for the motor after application of the set command force for the set force command time, the Servo Drive judges that the motor has not moved (zero movement).
The calculation formula for the number of pulses corresponding to one degree of electrical angle (for linear system) is as follows:
Number of pulses corresponding to one degree of electrical angle (for linear system) = Magnetic pole pitch [0.01 mm] x 10000/Feedback scale resolution [0.001 μm]/(360 [degrees]/1 [degree])

*3   After executing a force command, the command force stops and the motor decelerates. After that, the motor comes to a stop momentarily but may move in a reverse direction due to cogging or other phenomena.
To prevent the motor from being judged as stopped in a wrong timing when it has not come to a complete stop in this way, be sure to set the Magnetic Pole Position Estimation Movement for Stop Judgment (3925 hex) and the Magnetic Pole Position Estimation Time for Stop Judgment (3926 hex).

*4   If you set a large value in the Magnetic Pole Position Estimation Force Command (3923 hex) or Magnetic Pole Position Estimation Maximum Movement (3924 hex), it may take a long time until the motor stops because the motor speed when a force command stops will become high. The motor may take a long time to stop due to a low kinetic friction. In these cases, increase the set value.
This time represents the time elapsed after the stoppage of a force command until the motor comes to a complete stop.

Conceptual Diagram of Magnetic Pole Position Estimation
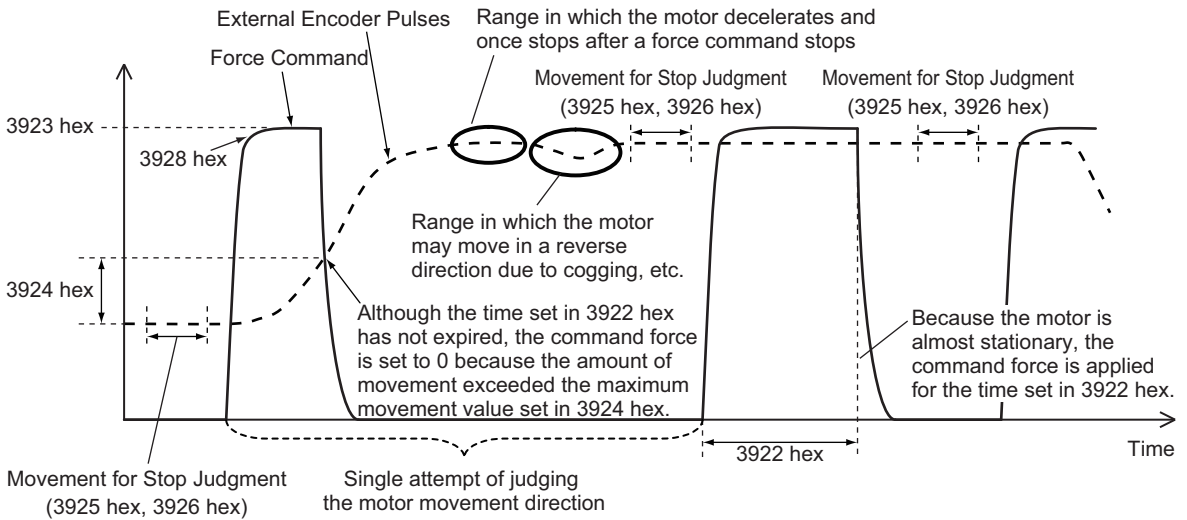
Note The magnetic pole estimation function estimates the position of each magnetic pole by judging the movement direction of the motor several times when the force command (electric current) is applied.

Precautions for Correct Use

- The magnetic pole position estimation function is executed at the first Servo ON after you turn ON the power supply. Because the Linear Motor operates during magnetic pole position estimation, take care so that the motor does not hit the mechanical end stop.
- The magnetic pole position estimation function may not operate successfully if there is a large unbalanced load or friction.
- The values in the objects starting from Magnetic Pole Position Estimation Force Command Time (3922 hex) through to Magnetic Pole Position Estimation Time Limit for Stop (3927 hex) are the values set when the magnetic pole position estimation function is started. Changes made during magnetic pole position estimation are not reflected on these values.

● Magnetic Pole Position Restoration Method

The magnetic pole position data, once estimated by the magnetic pole position estimation function, can be stored so that it can be used to control the motor after the power supply is reset.

In the magnetic pole position restoration method, you need to execute magnetic pole position estimation only once after the power supply is turned ON and, after that, you need not perform magnetic pole position estimation regardless of whether or not the power supply is reset.

This method is available only when you use an absolute type external encoder.

Index	Name	Unit	Description	Reference
3920 hex	Magnetic Pole Detection Method	–	Set the magnetic pole detection method. Select 3 to set the magnetic pole position restoration method.	page 9-60

Precautions for Correct Use

- If you have never executed magnetic pole position estimation, a Magnetic Pole Position Estimation Error 3 (Error No. 61.2) will occur when you select the magnetic pole position restoration method. This also applies if you select the magnetic pole position restoration method with the result of magnetic pole position estimation cleared. The result of magnetic pole position estimation will be cleared when the Magnetic Pole Detection Method (3920 hex) is set to 0 (Not specified). However, the result will not be cleared if an EEPROM-related Error (Error No. 36.0 to 36.2 or 37.0 to 37.2) occurs.

- If you are using a non-absolute type external encoder, a Magnetic Pole Position Estimation Error 3 (Error No. 61.2) will occur when you select the magnetic pole position restoration method.

- The result of magnetic pole position estimation will be stored in the Servo Drive. If you have changed the combination of the Servo Drive and the Linear Motor, the Servo Drive cannot control the motor successfully because their positions are misaligned.
  If you have replaced any of the Servo Drive, Linear Motor, and external encoder, execute magnetic pole position estimation once before using the magnetic pole position restoration method.

10-3 Trial Operation

When you have finished installation, wiring, and switch settings, and have confirmed that status is normal after turning ON the power supply, perform trial operation. The main purpose of trial operation is to confirm that the servo system is electrically correct.

If an error occurs during trial operation, refer to *Section 12 Troubleshooting and Maintenance* to eliminate the cause. Then check for safety, and retry trial operation.

10-3-1 Preparations for Trial Operation

Check the following items.

● **Wiring**

- Make sure that there are no wiring errors (especially for the power supply input and motor output).
- Make sure that there are no short-circuits. (Check the ground for short circuits as well.)
- Make sure that there are no loose connections.

● **Power Supply Voltage**

- Make sure that the voltage corresponds to the rated voltage.
- Is the voltage stable?

● **Linear Motor Installation**

- Make sure that the Linear Motor is securely installed.

● **Disconnection from Mechanical System**

- If necessary, make sure that the load has been disconnected from the mechanical system.

● **Brake Released**

- Make sure that the brake has been released.

● **Connections to the Mechanical System**

- Is the load on the Linear Motor within specifications?

10-3-2 Test Operation via USB Communications from the CX-Drive

1 Use the Connector CN1.

2 Supply 12 to 24 VDC to the control signal connector pins +24 VIN and COM.

3 Turn ON the Servo Drive power.

4 Connect a USB cable to the USB connector (CN7).

5 Start the CX-Drive and go online with the Servo Drive via USB communications.

6 Select *Test Run* from the *Tuning* Menu of the CX-Drive.

7 Select *Servo ON* to servo-lock the Linear Motor.

8 Select *Positive or Negative* and move the Linear Motor.

The Linear Motor will move until *Stop* is selected.

Precautions for Correct Use

The test operation function via USB communications from the CX-Drive cannot be used while EtherCAT communications are established.

11

Adjustment Functions

This section explains the functions, setting methods, and items to note regarding various gain adjustments.

11-1 Analog Monitor

Two types of analog signals can be output from the analog monitor connector on the front panel.

They are used when the monitoring is required for adjustment.

The monitor items to be output and the scaling (output gain) can be set as required for each of the objects.

The refresh period of the analog monitor is 1 ms. The analog monitor is not synchronized with another axes in the EtherCAT system.

Objects Requiring Settings

Index	Name	Explanation	Reference
3416 hex	Analog Monitor 1 Selection	Select the monitoring item for the analog monitor 1.	page 9-29
3417 hex	Analog Monitor 1 Scale Setting	Set the output gain for the analog monitor 1.	page 9-29
3418 hex	Analog Monitor 2 Selection	Select the monitoring item for the analog monitor 2.	page 9-30
3419 hex	Analog Monitor 2 Scale Setting	Set the output gain for the analog monitor 2.	page 9-30
3421 hex	Analog Monitor Output Setting	Select the analog monitor output method.	page 9-31

● **Analog Monitor Objects (3416, 3417, 3418 and 3419 Hex)**

The analog monitor scales (3417 hex and 3419 hex) are set in units for 1 V. When the objects are set to 0, the values shown in the table below are automatically set.

3416 hex and 3418 hex set value	Description		
	Monitoring item	Unit	Output gain when 3417 hex and 3419 hex are set to 0
0	Feedback Motor Speed	mm/s	500
1	Internal Command Motor Speed [1]	mm/s	500
2	Filtered Internal Command Motor Speed [1]	mm/s	500
3	Motor Control Effort	mm/s	500
4	Torque demand [2]	% (rated force ratio)	33
5	Position Error [3]	pulses (command units)	3,000
6	Pulse Position Error [3]	pulses (external encoder units)	3,000
7 to 8	Reserved	–	–
9	P-N Voltage	V	80
10	Regeneration Load Ratio	%	33
11	Motor Load Ratio	%	33
12	Positive Direction Force Limit	% (rated force ratio)	33
13	Negative Direction Force Limit	% (rated force ratio)	33
14	Speed Limit Value	mm/s	500
15	Mass Ratio	%	500

3416 hex and 3418 hex set value	Description		
	Monitoring item	Unit	Output gain when 3417 hex and 3419 hex are set to 0
16 to 19	Reserved	−	−
20	Servo Drive Temperature	°C	10
21 to 22	Reserved	−	−

*1   The Internal Command Motor Speed is the speed before the command input passes through the command filter (smoothing filter or FIR filter). The Filtered Internal Command Motor Speed is the speed after the command input passes through the command filter.
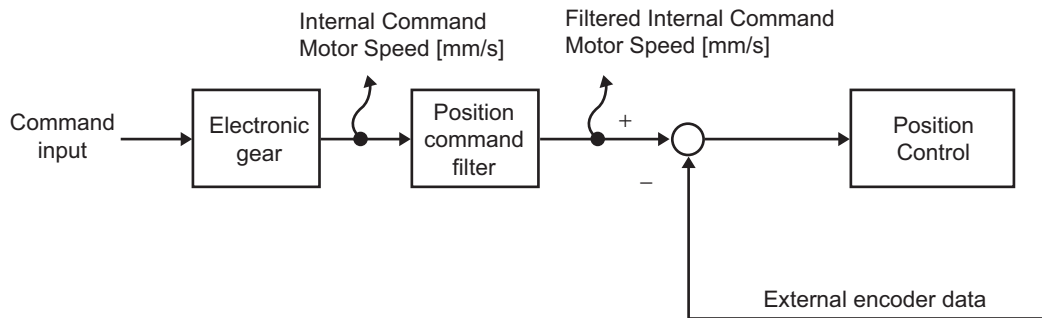
*2   Read the word "torque" as "force."

*3   The position error is calculated for the command input after processing for the position command filter. The pulse position error is reversely converted to command units for application. The pulse position error is the error for the position control input.
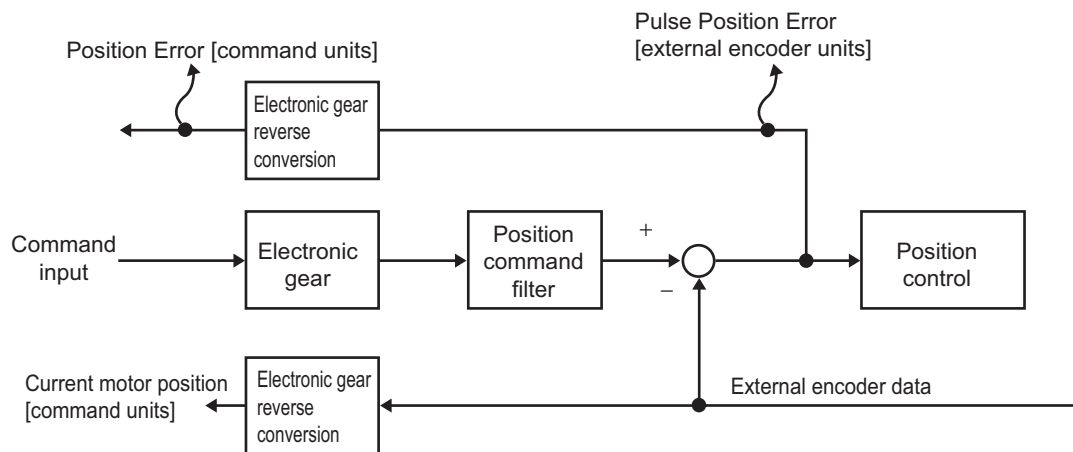
● Analog Monitor Output Setting (3421 Hex)

Select the direction for analog monitor output voltage.

The output voltage range and the data output direction when the Analog Monitor 1 Selection (3416 hex) is set to 0 (motor speed) and the Analog Monitor 1 Scale Setting (3417 hex) is set to 0 are as shown below.

The following explanation of settings also applies when the Analog Monitor 2 Selection (3418 hex) and the Analog Monitor 2 Scale Setting (3419 hex) are set to 0.

Set value	Output range	Data output
0	−10 to 10 V	
1	0 to 10 V	
2	0 to 10 V (5 V as the center)	

11-2 Gain Adjustment

G5-Series Servo Drives provide a realtime autotuning function.

With this function, gain adjustments can be made easily even by those using a servo system for the first time.

If you cannot obtain the desired responsiveness with autotuning, use manual tuning.

11-2-1 Purpose of the Gain Adjustment

The Servo Drive must operate the motor in response to commands from the host system with minimal time delay and maximum reliability. The gain is adjusted to bring the actual operation of the motor as close as possible to the operation specified by the commands, and to maximize the performance of the machine.

Example

Gain setting: Low		Gain setting: High		Gain setting: High + feed-forward setting	
Position loop gain:	3.0	Position loop gain:	251.0	Position loop gain:	251.0
Speed loop gain:	2.5	Speed loop gain:	140.0	Speed loop gain:	180.0
Speed loop integral time constant:	190.0	Speed loop integral time constant:	6.0	Speed loop integral time constant:	6.0
Speed feed-forward:	30	Speed feed-forward:	30	Speed feed-forward:	100
Mass ratio:	300	Mass ratio:	300	Mass ratio:	300

11-2-2 Gain Adjustment Methods

Function		Description	Reference page
Automatic adjustment	Realtime autotuning	Realtime autotuning estimates in realtime the load characteristic according to the motor speed and the force command and, according to the result of the estimation, automatically sets the optimal gain. It also adds simultaneously the friction force to the force command in advance to reduce the positioning stabilization time.	page 11-7
	Current loop gain	Setting the condition for the electric current response value in the Current Response Auto-adjustment (3912 hex) enables the Current Loop Proportional Gain (3913 hex) and Current Loop Integral Gain (3914 hex) values to be set automatically.	page 10-8
Manual adjustment	Manual tuning	Manual adjustment is performed if autotuning cannot be executed due to restrictions on the control mode or load conditions or if ensuring that the maximum responsiveness matches each load is required.	page 11-14
		Basic procedure	Position Control Mode adjustment	page 11-15

> ⬛ **Precautions for Safe Use**
>
> • Take sufficient measures to ensure safety.
> • If vibration occurs (unusual noise or vibration), immediately turn OFF the power supply or turn OFF the servo.

11-2-3 Gain Adjustment Procedure

```
                    Start adjustment.
                          │
                          ▼
                   ╱ Automatic ╲
                  ╱  adjustment? ╲──── No ────────────────────────┐
                   ╲            ╱                                   │
                     ╲  Yes   ╱                                     │
                          │                                         │
                          ▼                                         │
                  ┌──────────────────┐                             │
                  │    Realtime      │                             │
                  │ autotuning settings │                          │
                  └──────────────────┘                             │
                          │                                         │
                          ▼                                         │
                  ┌──────────────────┐                             │
                  │ Realtime autotuning │                          │
                  └──────────────────┘                             │
                          │                                         │
                          ▼                                         │
                   ╱          ╲                                     │
                  ╱ Operation OK? ╲──── No ──────────────────────►│
                   ╲            ╱                                   │
                     ╲  Yes   ╱              (Default setting)      │
                          │                          ▼             ▼
                          │                  ┌──────────────────┐
                          │                  │   Manual tuning  │
                          │                  └──────────────────┘
                          │                          │
                          │                          ▼
                          │                   ╱          ╲
                          │                  ╱ Operation OK? ╲── No ──┐
                          │                   ╲            ╱           │
                          │                     ╲  Yes   ╱             │
                          │◄─────────────────────────┘                │
                          ▼                                           │
                  ┌──────────────────┐                               │
                  │ Write to EEPROM. │                               ▼
                  └──────────────────┘                      Consult OMRON.
                          │
                          ▼
                  Adjustment completed.
```
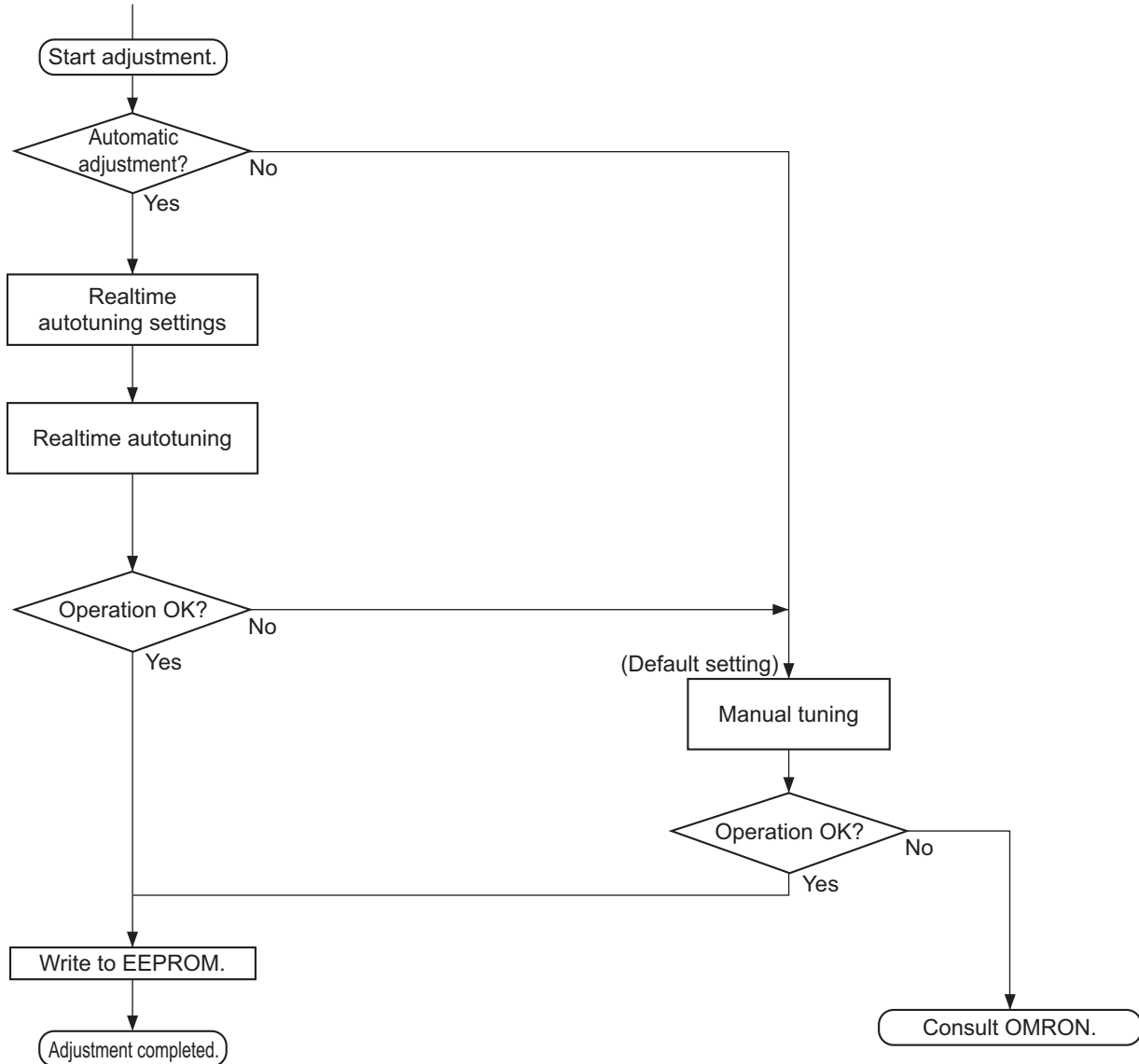
▌ Gain Adjustment and Machine Rigidity

To improve machine rigidity, install the machine on a secure base so that it does not have any play.

The specific vibration (resonance frequencies) of the mechanical system has a large impact on the gain adjustment of the servo. The servo system responsiveness cannot be set high for machines with a low resonance frequency (low machine rigidity).

11-3 Realtime Autotuning

Realtime autotuning estimates in realtime the load characteristic according to the motor speed and the force command and operates the machine by automatically setting the gain according to the result of the estimation. At the same time, it can lower the resonance and vibration if the adaptive filter is enabled.

Realtime autotuning is enabled for any control to adjust the speed loop PI control.

Refer to *11-6 Adaptive Filter* on page 11-20 for details about adaptive filters.
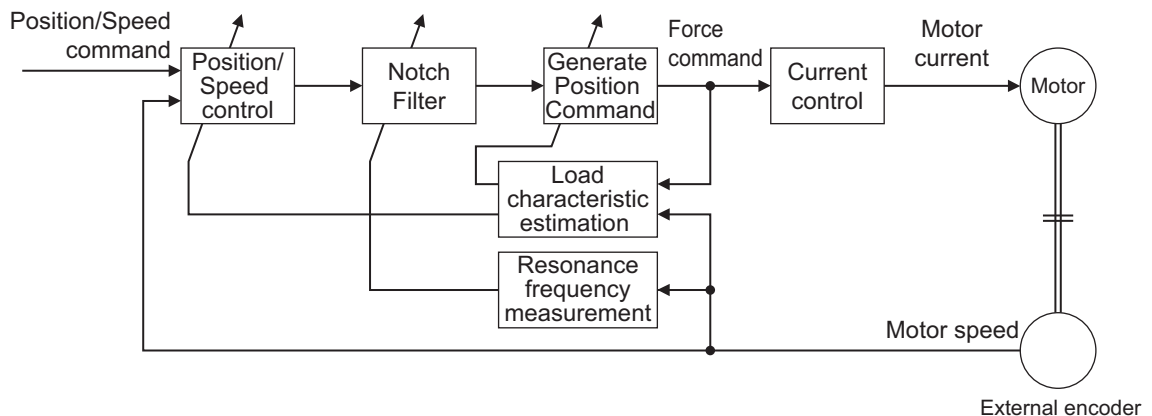
11-3-1 Operationg Conditions

Realtime autotuning works under the following conditions.

Operationg conditions	
Operating mode	The available realtime autotuning mode varies depending on the control mode.
Others	• When Servo is ON. • When elements other than control objects, such as the force limit settings, are set correctly and there is no trouble with the motor's normal operation. • Mass ratio estimation operation is disabled when magnetic pole position estimation is in progress.

*1   For details, refer to *Realtime Autotuning Mode Selection* on page 9-4.

Precautions for Correct Use

- Realtime autotuning may not function properly under the conditions described in the following table. In such cases, change the load condition or the operating pattern, or use manual tuning.

	Conditions that interfere with the realtime autotuning
Load condition	• If the load mass is too small or too large compared with the Motor Coil Unit Mass (less than 3 times, or more than 20 times or more). • If the load mass changes. • If the machine rigidity is extremely low. • If there is non-linear characteristics, such as a backlash.
Operation pattern	• If the speed continues at below 100 [mm/s]. • If the acceleration/deceleration is below 2,000 [mm/s] in 1 [s]. • If either a speed of 100 [mm/s] or higher, or an acceleration/deceleration of 2,000 [mm/s] or higher in 1 [s] does not last for at least 50 [ms]. • If the acceleration/deceleration force is too small compared with the unbalanced load and the viscous friction force.

- The force feed-forward function cannot be used when realtime autotuning is being used. Set both the Force Feed-forward Gain (3112 hex) and Force Feed-forward Command Filter (3113 hex) to 0.

11-3-2 Objects Requiring Settings

Index	Name	Explanation	Reference
3002 hex	Realtime Autotuning Mode Selection	Set the operation mode for the realtime autotuning.	page 9-4
3003 hex	Realtime Autotuning Machine Rigidity Setting	Set the responsiveness when the realtime autotuning is enabled.	page 9-4
3631 hex	Realtime Autotuning Estimated Speed Selection	Set the speed to estimate the load characteristic when the realtime autotuning is enabled.	page 9-46
3632 hex	Realtime Autotuning Customization Mode Setting	Make detailed settings for the autotuning function, when 6: the customized mode is selected in the Realtime Autotuning Mode Selection (3002 hex).	page 9-47

11-3-3 Setting Realtime Autotuning

1 When setting realtime autotuning, turn the servo OFF.

2 Set Realtime Autotuning mode Selection (3002 hex) depending on the load.

Normally, set the object to 1 or 2.

Use a setting of 3 or 4 when there is an unbalanced load.

A setting of 5 is used in combination with a software tool. Do not use it for normal operation.

Gain switching function is enabled for set values 2 to 6.

Set value	Realtime autotuning	Description
0	Disabled	Realtime autotuning is disabled.
1	Focus on stability (default setting)	No unbalanced load or friction compensation, nor gain switching.
2	Focus on positioning [*1]	Used when there is no unbalanced load and a little friction.
3	Unbalanced load [*2]	Used when there is an unbalanced load.
4	Friction compensation and unbalanced load [*3]	Used when there is an unbalanced load and a large friction. Variations in the positioning stabilization time are suppressed when friction is large.
5	Reserved	Do not set any value.
6	Customization	Customization can be set in the Realtime Autotuning Customization Mode Setting (3632 hex).

[*1] The description for the set value 1 applies to the Speed Control/Force Control Mode.

[*2] The description for the set value 1 applies to the Force Control Mode.

[*3] The description for the set value 3 applies to the Speed Control; the description for the set value 1 applies to the Force Control Mode.

11-3-4 Setting Machine Rigidity

1 Set the Realtime Autotuning Machine Rigidity Setting (3003 hex).

Start from the lower machine rigidity number and check the operation.

2 Turn the servo ON and operate the machine with a normal pattern.

To increase responsiveness, increase the machine rigidity number, and check the response. If vibration occurs, enable the adaptive filter and operate. If already enabled, lower the machine rigidity number.

3 If there are no problems with the operation, turn the servo OFF and set the Realtime Autotuning Mode Selection (3002 hex) to 0 (disabled).

The adaptive filter can be left enabled even if realtime autotuning is disabled after the completion of adjustments. Even if the adaptive filter is disabled, the settings of notch filters 3 and 4 are held.

📝 **Precautions for Correct Use**

- With realtime autotuning, each object is fixed to the value in the machine rigidity table at the time the machine rigidity is set. By estimating the mass ratio from the operation pattern, the operation coefficient for the speed loop gain and the integral time constant are altered. Doing this for each pattern can cause vibration, so the estimation value is set conservatively.

- An unusual noise or vibration may occur until load characteristic estimation is stabilized after startup, immediately after the first servo ON, or when the Realtime Autotuning Machine Rigidity Setting (3003 hex) is increased. This is not a problem if the noise or vibration disappears right away. If vibration occurs, or if an unusual noise lasts for three or more reciprocating operations, however, take the following measures.
  - Lower the Realtime Autotuning Machine Rigidity Setting (3003 hex).
  - Set the Realtime Autotuning Mode Selection (3002 hex) to 0 to disable the realtime autotuning function.
  - Set the Mass Ratio (3004 hex) to the value calculated for the equipment and the Force Command Value Offset (3607 hex), Positive Direction Force Offset (3608 hex), or Negative Direction Force Offset to 0.

- Once unusual noise or vibration occurs, the Mass Ratio (3004 hex) value and the Force Command Value Offset (3607 hex), Positive Direction Force Offset (3608 hex), or Negative Direction Force Offset (3609 hex) value may have changed to extreme values. In this case, also take the measures described above.

- Out of the results of realtime autotuning, the Mass Ratio (3004 hex), Force Command Value Offset (3607 hex), Positive Direction Force Offset (3608 hex) and Negative Direction Force Offset (3609 hex) values are automatically saved to the EEPROM every 30 minutes. Realtime autotuning uses this saved data as the default settings when the power supply is turned ON again.
  However, if the power supply is turned OFF before the 30-minute period elapses, the results of realtime autotuning are not saved. In this case, you need to manually write the object settings to the EEPROM and turn OFF the power supply.

- The object is automatically set based on the Realtime Autotuning Machine Rigidity Setting (3003 hex) if realtime autotuning is enabled.

11-3-5   Objects to be Changed

This section lists the objects to be changed by the realtime autotuning function.

Objects to be Updated

● Objects to be updated by the Realtime Autotuning Mode Selection (3002 hex) and Realtime Autotuning Customization Mode Setting (3632 hex) settings

Setting the Realtime Autotuning Mode Selection (3002 hex) and the Realtime Autotuning Customization Mode Setting (3632 hex) causes the following objects to be updated using the load characteristic estimation value.

Index	Name	Description
3004 hex	Mass Ratio	Updated when realtime autotuning is operating. However, in the customized mode, this object may not be updated depending on its settings.[1]
3607 hex	Force Command Value Offset	Updated when the unbalanced load mode for realtime autotuning is enabled.
3608 hex	Positive Direction Force Offset	Updated when the friction compensation/unbalanced load mode for realtime autotuning is enabled.
3609 hex	Negative Direction Force Offset	Updated when the friction compensation/unbalanced load mode for realtime autotuning is enabled.

[1]   The Mass Ratio will be updated if the Realtime Autotuning Customization Mode Setting (3632 hex) bits 2 to 3 are set to 1 (Update with the estimation result).

● Objects to be updated by the Realtime Autotuning Machine Rigidity Setting (3003 hex) setting

Setting the Realtime Autotuning Machine Rigidity Setting (3003 hex) causes the following objects to be updated.

For details, refer to *Realtime Autotuning Object Table* on page 11-11.

Index	Name	Description
3100 hex	Position Loop Gain	Updated according to the rigidity.
3101 hex	Speed Loop Gain 1	
3102 hex	Speed Loop Integral Time Constant 1	
3104 hex	Force Command Filter Time Constant 1	
3105 hex	Position Loop Gain 2	
3106 hex	Speed Loop Gain 2	
3107 hex	Speed Loop Integral Time Constant 2	
3109 hex	Force Command Filter Time Constant 2	

Objects to Have a Fixed Value

Index	Name	Description
3103 hex	Speed Feedback Filter Time Constant	Set this object to 0.
3108 hex	Speed Feedback Filter Time Constant 2	Set this object to 0.
3110 hex	Speed Feed-forward Gain	Set this object to 300 (30%).
3111 hex	Speed Feed-forward Command Filter	Set this object to 50 (0.5 ms).

Index	Name	Description
3112 hex	Force Feed-forward Gain [1]	Set this object to 0.
3113 hex	Force Feed-forward Command Filter [1]	Set this object to 0.
3114 hex	Gain Switching Input Operating Mode Selection	If the current setting is "not retained," set this object to 1.
3115 hex	Switching Mode in Position Control	If gain switching is enabled, set this object to 10. If gain switching is disabled, set this object to 0.
3116 hex	Gain Switching Delay Time in Position Control	If the current setting is "not retained," set this object to 50.
3117 hex	Gain Switching Level in Position Control	If the current setting is "not retained," set this object to 50.
3118 hex	Gain Switching Hysteresis in Position Control	If the current setting is "not retained," set this object to 33.
3119 hex	Position Gain Switching Time	If the current setting is "not retained," set this object to 33.
3120 hex	Switching Mode in Speed Control	If the current setting is "not retained," set this object to 0.
3121 hex	Gain Switching Delay Time in Speed Control	If the current setting is "not retained," set this object to 0.
3122 hex	Gain Switching Level in Speed Control	If the current setting is "not retained," set this object to 0.
3123 hex	Gain Switching Hysteresis in Speed Control	If the current setting is "not retained," set this object to 0.
3124 hex	Switching Mode in Force Control	If the current setting is "not retained," set this object to 0.
3215 hex	Gain Switching Delay Time in Force Control	If the current setting is "not retained," set this object to 0.
3126 hex	Gain Switching Level in Force Control	If the current setting is "not retained," set this object to 0.
3127 hex	Gain Switching Hysteresis in Force Control	If the current setting is "not retained," set this object to 0.

[1]   Set these objects to 0 during realtime autotuning because force feed-forward function cannot be used.

Objects to be Disabled

When the Realtime Autotuning Mode Selection (3002 hex) is not 0, i.e., when the autotuning function is enabled, the following objects are disabled.

Index	Name	Description
3610 hex	Function Expansion Setting	The instantaneous speed observer function (bit 0) and the disturbance observer function (bit 1) is disabled.
3623 hex	Disturbance Force Compensation Gain	This object is functionally disabled although the set value can be changed.
3624 hex	Disturbance Observer Filter Setting	This object is functionally disabled although the set value can be changed.

Precautions for Correct Use

Although, for these objects, the set value is displayed, the function itself is disabled.

In addition, these objects are functionally disabled although their set values can be changed.

11-4 Manual Tuning

As described before, the G5-series have a realtime autotuning function. However, there are cases where realtime autotuning cannot adjust the gain properly due to restrictions such as load conditions. Moreover, you may need to ensue optimum responsiveness and stability for each load. Manual tuning is required in these situations.

This section describes how to perform manual tuning for each control mode and function.

11-4-1 Preparation for Manual Tuning

More reliable adjustment can be performed quickly by using waveform monitoring with the data tracing function of the CX-Drive or by measuring the analog voltage waveform with the monitor function.

Analog Monitor Output

The feedback motor speed, internal command motor speed, command force, and position error can be measured as an analog voltage level using an oscilloscope or other device. The type of signal to output and the output voltage level are set with Analog Monitor 1 Selection (3416 hex) and Analog Monitor 2 Selection (3418 hex) settings.

For details, refer to *11-1 Analog Monitor* on page 11-2.

CX-Drive Data Tracing Function

Commands to the motor and motor operation (speed, command force, and position error) can be displayed on a computer as waveforms.

Refer to the *CX-Drive Operation Manual* (Cat. No. W453).

USB communications cable

Connect to CN7.
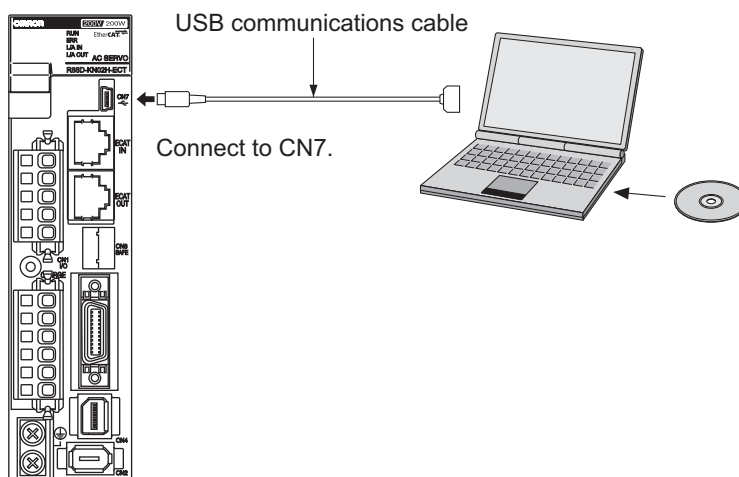
Position Control Mode Adjustment

Use the following procedure to perform the adjustment in position control for the Servo Drive.

```
                    ( Start adjustment. )
                            │
                            ▼
        ┌────────────────────────────────────────────────┐
        │ Disable realtime autotuning (3002 hex = 0).     │
        └────────────────────────────────────────────────┘
                            │
                            ▼
        ┌────────────────────────────────────────────────────────────────┐
        │ Set each parameter according to the parameter settings for      │
        │ different applications.                                          │
        └────────────────────────────────────────────────────────────────┘
                            │
                            ▼
        ┌────────────────────────────────────────────────┐
        │ Operate based on the normal operation pattern   │
        │ and load.                                        │
        └────────────────────────────────────────────────┘
                            │
                            ▼
        < Are the positioning time and other performances satisfied? >──Yes──▶ ( Adjustment completed. )
                            │ No
                            ▼
        ┌────────────────────────────────────────────────┐
        │ Increase Speed Loop Gain 1 (3101 hex) to the    │
        │ extent that hunting does not occur upon servo   │
        │ lock.                                            │
        └────────────────────────────────────────────────┘
                            │
                            ▼
        ┌────────────────────────────────────────────────┐
        │ Decrease Speed Loop Integral Time Constant 1    │
        │ (3102 hex) to the extent that hunting does not  │
        │ occur upon servo lock.                           │
        └────────────────────────────────────────────────┘
                            │
                            ▼
        < Does hunting or vibration occur when the motor moves? >──Yes──▶ ┌──────────────────────────────┐
                            │ No                                            │ Decrease Speed Loop Gain 1   │
                            ▼                                               │ (3101 hex).                  │
        ┌────────────────────────────────────────────────┐                └──────────────────────────────┘
        │ Increase position loop gain to the extent that  │                               │
        │ overshooting does not occur.                     │                               ▼
        └────────────────────────────────────────────────┘                ┌──────────────────────────────┐
                            │                                               │ Increase Speed Loop Integral │
                            ▼                                               │ Time Constant 1 (3102 hex).  │
        ┌────────────────────────────────────────────────┐                └──────────────────────────────┘
        │ Write to the EEPROM in the Parameter Write mode.│
        └────────────────────────────────────────────────┘
                            │
                            ▼
                    ( Adjustment completed. )
```

> ⚠ Never adjust or set parameters to extreme values, as it will make the operation unstable.
> Failure to follow this guideline may result in injury. Gradually change the value to adjust the gain while checking the motor operation.

If vibration persists after repeated adjustments or the positioning is slow:

```
┌────────────────────────────────────────────────┐
│ Increase Force Command Filter Time Constant 1   │
│ (3104 hex).                                      │
└────────────────────────────────────────────────┘
                    │
                    ▼
┌────────────────────────────────────────────────┐
│ Set the damping frequencies in the              │
│ Notch 1 Frequency Setting (3201 hex),           │
│ Notch 2 Frequency Setting (3204 hex),           │
│ Notch 3 Frequency Setting (3207 hex), and       │
│ Notch 4 Frequency Setting (3210 hex).           │
└────────────────────────────────────────────────┘
```

11-5 Damping Control

If the tip of the mechanical unit vibrates or the whole system sways, you can use the damping control function to reduce vibration. This is effective on vibration generated by a machine of low rigidity. The applicable frequencies are from 1 to 200 Hz.

You can set four frequencies, and use two of them at the same time.
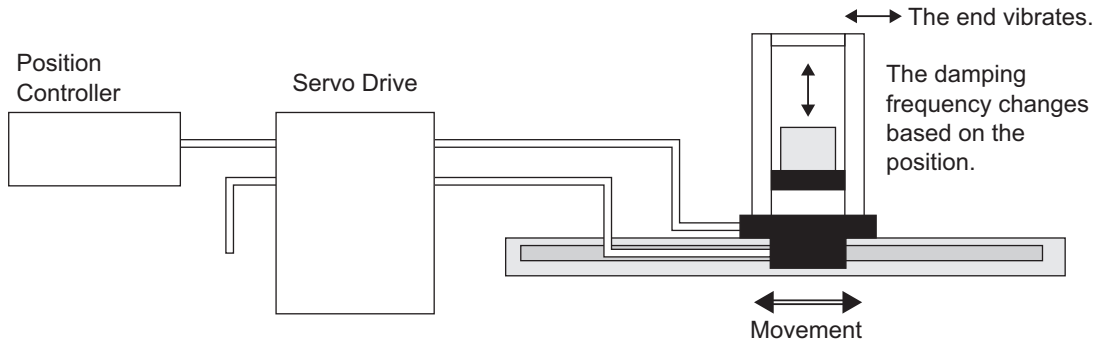
11-5-1 Operating Conditions

The damping control function works under the following conditions.

	Operating conditions
Operating mode	Position control mode

Precautions for Correct Use

- Stop operation before changing the objects or switching with DFSEL.
- The damping control may not function properly or the effect may not be apparent under the following conditions.

	Conditions that interfere with the damping control
Load condition	• If forces other than commands, such as external forces, cause vibration. • If the ratio of the resonance frequency to anti-resonance frequency is large. • If the damping frequency is outside the range of 1.0 to 200.0 Hz.

11-5-2 Objects Requiring Settings

Index	Name	Description	Reference
3213 hex	Damping Filter Selection	Select the Damping Filter Switching Mode according to the condition of the unit. 0: Up to two filters can be used simultaneously. 3: Switching with command direction.	page 9-20
3214 hex	Damping Frequency 1	Set damping frequency 1 to suppress vibration at the end of the load in damping control. Measure the vibration frequency at the tip of the load and make the setting in units of 0.1 Hz. The effective frequency setting range is 1.0 to 200.0 Hz. [1]	page 9-20
3215 hex	Damping Filter 1 Setting	When Damping Frequency 1 (3214 hex) is set[2], reduce this setting if force saturation occurs or increase this setting to increase operation speed. Normally "0" is set.	page 9-20
3216 hex	Damping Frequency 2	Set damping frequency 2 to suppress vibration at the end of the load in damping control. The function is the same with the Damping Frequency 1 (3214 hex).	page 9-21
3217 hex	Damping Filter 2 Setting	The function is the same with the Damping Filter 1 Setting (3215 hex).	page 9-21
3218 hex	Damping Frequency 3	Set damping frequency 3 to suppress vibration at the end of the load in damping control. The function is the same with the Damping Frequency 1 (3214 hex).	page 9-21
3219 hex	Damping Filter 3 Setting	The function is the same with the Damping Filter 1 Setting (3215 hex).	page 9-21
3220 hex	Damping Frequency 4	Set damping frequency 4 to suppress vibration at the end of the load in damping control. The function is the same with the Damping Frequency 1 (3214 hex).	page 9-21
3221 hex	Damping Filter 4 Setting	The function is the same with the Damping Filter 1 Setting (3215 hex).	page 9-22

*1   If the damping control function is not used, set the damping frequency to a value between 0 and 0.9 Hz.

*2   This object is also disabled when the damping frequency is disabled. In addition, the upper limit of the set value is restricted to the corresponding damping frequency or the value of (2000 minus damping frequency), whichever is the smaller.

Precautions for Correct Use

- The damping frequency and damping filter settings are switched when the position command value per 0.250 ms changes from 0 to a value other than 0 while the positioning completed output is ON.
  In particular, if the damping frequency is changed to a larger value or disabled and a large Position window is set, the motor may move suddenly immediately after switching.
  This occurs due to the pulses accumulated in the filter at the time of switching, which are distributed rapidly after switching to restore the normal position.
  Be careful as the motor may temporarily operate faster than the expected command speed.

- There is a delay from the time when the damping frequency and damping filter settings are changed until the new values are applied in internal calculations. If the switch timing arrives during this delay, the change may be placed on hold.

11-5-3 Operating Procedure

1 Adjust the Position Loop Gain 1 (3100 hex), Speed Loop Gain 1 (3101 hex), Speed Loop Integral Time Constant 1 (3102 hex), and Force Command Filter Time Constant 1 (3104 hex) settings.

If no problem occurs in realtime autotuning, you can continue to use the settings.

2 Measure the damping frequency at the tip of the mechanical unit.

Measure the damping frequency by using a measurement device such as a laser displacement sensor, servo acceleration meter, or acceleration pick-up.

Set the measured damping frequency in one of Damping Frequency 1 to Damping Frequency 4 according to the operation.

Also set the Switching Mode using Damping Filter Selection (3213 hex).

If the measurement device cannot be used, use CX-Drive tracing function, and read the residual damping frequency [Hz] from the position error waveform as shown in the following figure.
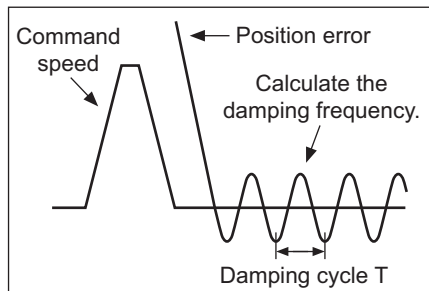
- The damping frequency in the figure is calculated with the following formula:

$$f\,[\mathrm{Hz}] \; = \; \frac{1}{T\,[\mathrm{s}]}$$

Since the object unit is 0.1 Hz:
(3214 hex, 3216 hex, 3218 hex, 3220 hex) = 10 × f

- Application example
  If the damping cycle is 100 ms or 20 ms, set 100 or 500 in the object so that the damping frequency becomes 10 Hz or 50 Hz.

If vibration persists after setting the frequency, increase or decrease the resonance frequency to find a proper one with minimum vibration.

3 Make the damping filter 1 to 4 settings.

First, set the filter to 0 and check the force waveform during operation.

The stabilization time can be reduced by setting a large value; however, force ripple will increase at the command change point as shown in the following figure. Set a range that will not cause force saturation under actual operation conditions. The effects of vibration suppression will be lost if force saturation occurs.
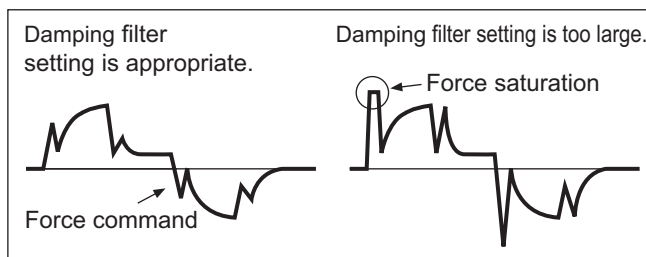
When setting the damping frequencies, reduce the setting if the force become saturated and increase the setting to make operation faster. Normally 0 is set.

The setting range is as follows:

Damping filter setting range: Damping filter setting ≤ Damping frequency
100 ≤ (Damping frequency + Damping filter setting)

4 Set the Damping Filter Selection (3213 hex).

Damping filters 1 to 4 can be switched according to the conditions of the machine vibration.

Set value	Description
0	Up to two filters, Damping Filter 1 and Damping Filter 2, can be used simultaneously.
1	Reserved [1]
2	Reserved [1]
3	The damping filters are switched in the direction of the position command. [2]

*1   The set value 1 and 2 are reserved for system use. Users are not allowed to set 1 and 2 for this object.

*2   The table below shows the damping filter you can switch to based on the command direction.

Direction of position command	Damping filter 1	Damping filter 2	Damping filter 3	Damping filter 4
Positive	Enabled	Disabled	Enabled	Disabled
Negative	Disabled	Enabled	Disabled	Enabled

11-6 Adaptive Filter

The adaptive filter reduces resonance point vibration by estimating the resonance frequency from the vibration component that appears in the motor speed during actual operation and automatically sets the frequency of the notch filter, which removes the resonance component from the force command.

The automatically set notch filter frequency is set in Notch 3 (3207 to 3209 hex) or Notch 4 (3210 to 3212 hex).

Refer to *11-7 Notch Filters* on page 11-23 for information on notch filter.
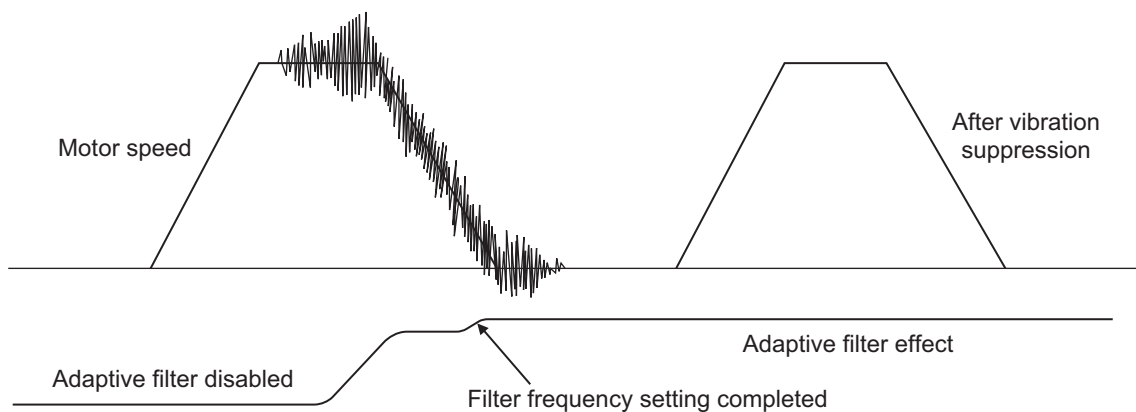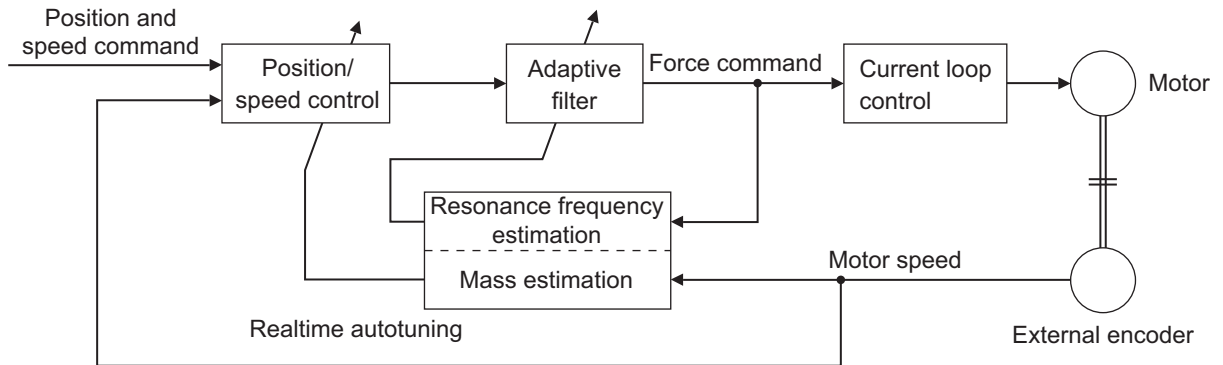
11-6-1 Operating Conditions

The adaptive filter operates under the following conditions.

	Operating conditions
Operating mode	Position Control Mode, Speed Control Mode
Others	• When Servo is ON. • When elements other than control objects, such as the force limits, are set correctly and there is no trouble with the motor's normal operation. • Adaptive operation is disabled when magnetic pole position estimation is in progress.

Precautions for Correct Use

• Adaptive filter may not operate correctly under the following conditions.

	Conditions that interfere with the adaptive filter
Resonance points	• If the resonance frequency is less than 3 times the response time frequency [Hz]. • If the resonance peak or control gain is too low to affect the motor speed. • If there are three or more resonance points.
Load	• If the motor speed with high-frequency components changes due to backlash or other non-linear elements.
Operation pattern	• If the acceleration/deceleration is 3,000 [mm/s] or higher.

• If the adaptive filter does not operate properly, use Notch 1 (3201 to 3203 hex) or Notch 2 (3204 to 3206 hex) to reduce resonance according to the manual adjustment procedure. Refer to *11-7 Notch Filters* on page 11-23 for information on notch filter.

11-6-2 Objects Requiring Settings

Index	Name	Description	Reference
3200 hex	Adaptive Filter Selection	Set the number of resonance frequencies to be estimated by the adaptive filter and the operation to be performed after estimation. 0: Adaptive filter disabled. 1: One adaptive filter enabled. The objects related to notch filter 3 are automatically updated. 2: Two adaptive filters enabled. The objects related to notch filters 3 and 4 are automatically updated. 3: Mode for measuring the resonance frequency. The resonance frequency is measured. The measured result can be checked using the support software. The parameters related to notch filters 3 and 4 retain the current values. 4: Adaptive result is cleared. Objects related to notch filters 3 and 4 are disabled and the adaptive result is cleared.	page 9-17

11-6-3 Objects to be Set Automatically

The adaptive filter function sets the following objects automatically.

Index	Name	Description
3207 hex	Notch 3 Frequency Setting	The resonance frequency 1 that is assumed by the adaptive filter is automatically set. If no resonance point is found, the value 5000 is set.
3208 hex	Notch 3 Width Setting	When the adaptive filter is enabled, this object is set automatically.
3209 hex	Notch 3 Depth Setting	When the adaptive filter is enabled, this object is set automatically.
3210 hex	Notch 4 Frequency Setting	The resonance frequency 2 that is assumed by the adaptive filter is automatically set. If no resonance point is found, the value 5000 is set.
3211 hex	Notch 4 Width Setting	When two adaptive filters are enabled, this object is set automatically.
3212 hex	Notch 4 Depth Setting	When two adaptive filters are enabled, this object is set automatically.

11-6-4 Operating Procedure

1 Select adaptive filter 1 or 2 in the Adaptive Filter Selection (3200 hex).

2 Enter an operation command and start the actual operation.

3 When the influence of a resonance point appears in the motor speed, the notch filters 3 and 4 objects are set automatically according to the number of adaptive filters.

Precautions for Correct Use

- An unusual noise or vibration may occur until load characteristic estimation is stabilized after startup, immediately after the first servo ON, or when the Realtime Autotuning Machine Rigidity Setting (3003 hex) is increased.
  This is not a problem if it falls in a stable state right away. If vibration occurs, or if an unusual noise lasts for three or more reciprocating operations, however, take the following measures.
  - Write the objects used during normal operation to the EEPROM.
  - Lower the Realtime Autotuning Machine Rigidity Setting (3003 hex).
  - Disable the adaptive filter by setting the Adaptive Filter Selection (3200 hex) to 0.
  - Manually set the notch filter.
- If unusual noise or vibration occurs, the setting of Notch 3 (3207 to 3209 hex) or Notch 4 (3210 to 3212 hex) may have changed to an extreme value. In this case, first of all, set the Adaptive Filter Selection (3200 hex) to 0 to disable the object. Then, set the Notch 3 Frequency Setting (3207 hex) and Notch 4 Frequency Setting (3210 hex) objects to 5000 (disabled). After that, enable the Adaptive Filter Selection again.
- The Notch 3 Frequency Setting (3207 hex) and Notch 4 Frequency Setting (3210 hex) are written to the EEPROM every 30 minutes. When the power supply is turned OFF and then turned ON again, this data is used as the default settings to perform adaptive operation.

11-7 Notch Filters

When the machine rigidity is low, machine resonance may produce vibration and noise. Thus you may not be able to set a high gain. The notch filter can restrict the resonance peak, and allows a high gain setting and vibration reduction.

The G5-series Servo Drives provide four notch filters that can be used for adjusting frequency, width and depth. If controlled device causes resonance at a specific location, you can set the resonance frequency using a notch filter to eliminate resonance.

A notch filter is used to eliminate a specified frequency component.
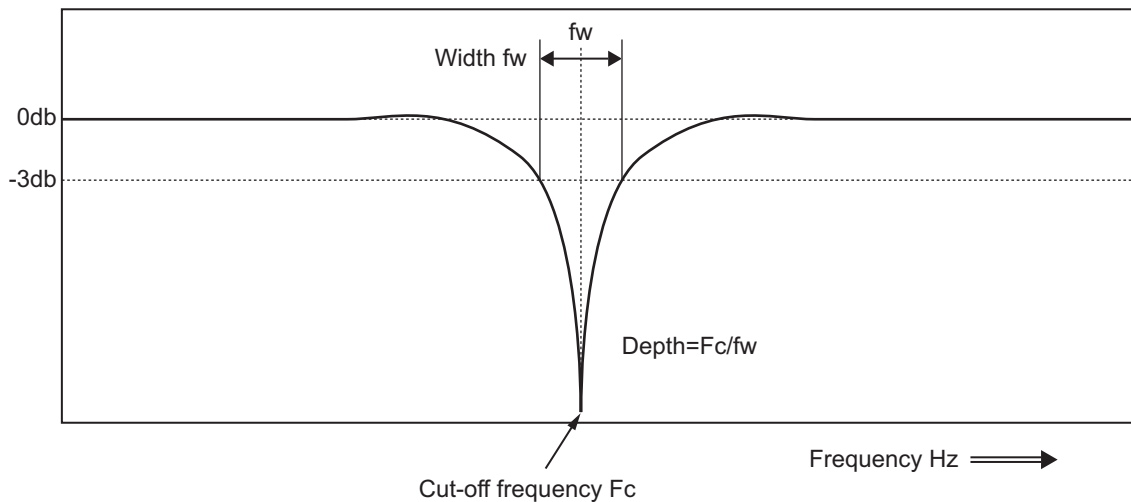
If machine resonance occurs, use this notch filter to eliminate resonance.
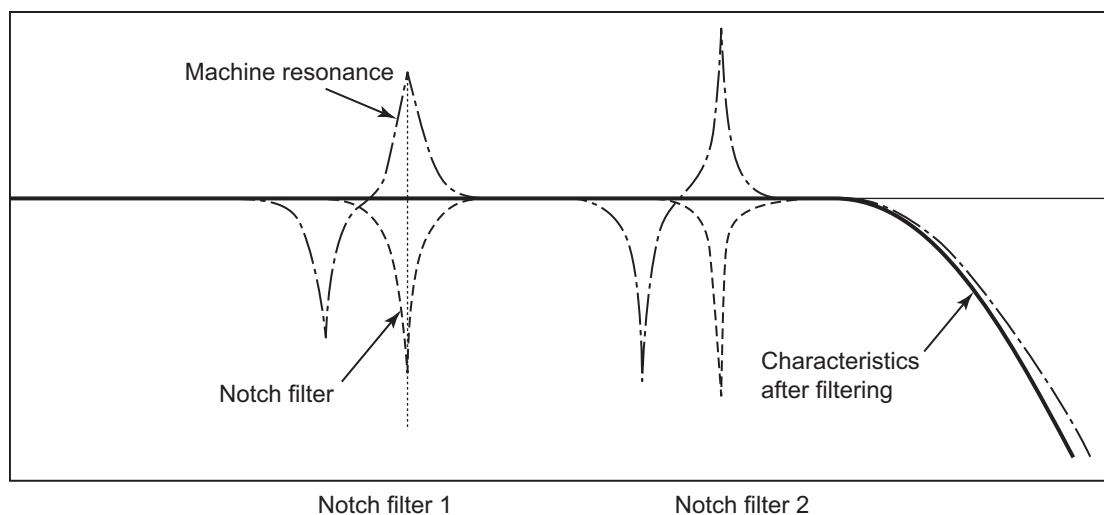
11-7-1 Objects Requiring Settings

Index	Name	Description	Reference
3201 hex	Notch 1 Frequency Setting	Set the center frequency of notch filter 1. The notch filter is enabled at 50 to 4,999 [Hz], and disabled if 5,000 [Hz] is set.	page 9-17
3202 hex	Notch 1 Width Setting	Select the width of the notch filter 1 frequency. Increasing the value widens the notch width. The setting range is 0 to 20.	page 9-17
3203 hex	Notch 1 Depth Setting	Select the depth of the notch filter 1 center frequency. Increasing the value decreases the notch depth and thereby reduces the phase delay. The setting range 0 to 99 is enable. The notch filter is disabled if 100 is set.	page 9-17
3204 hex	Notch 2 Frequency Setting	Set the center frequency of the notch filter 2. The details are the same with the notch filter 1 frequency.	page 9-18
3205 hex	Notch 2 Width Setting	Select the width of the notch filter 2 frequency. The details are the same with the notch filter 1 width.	page 9-18
3206 hex	Notch 2 Depth Setting	Select the depth of the notch filter 2 center frequency. The details are the same with the notch filter 1 depth.	page 9-18
3207 hex	Notch 3 Frequency Setting [1]	Set the center frequency of the notch filter 3. The details are the same with the notch filter 1 frequency.	page 9-18
3208 hex	Notch 3 Width Setting [1]	Select the width of the notch filter 3 frequency. The details are the same with the notch filter 1 width.	page 9-18
3209 hex	Notch 3 Depth Setting [1]	Select the depth of the notch filter 3 center frequency. The details are the same with the notch filter 1 depth.	page 9-19
3210 hex	Notch 4 Frequency Setting [2]	Set the center frequency of the notch filter 4. The details are the same with the notch filter 1 frequency.	page 9-19
3211 hex	Notch 4 Width Setting [2]	Select the width of the notch filter 4 frequency. The details are the same with the notch filter 1 width.	page 9-19
3212 hex	Notch 4 Depth Setting [2]	Select the depth of the notch filter 4 center frequency. The details are the same with the notch filter 1 depth.	page 9-19

[1]   If an adaptive filter is used, these objects are set automatically.

[2]   These objects are set automatically when two adaptive filters are enabled.

Additional Information

- Identify the resonance frequency using the FFT analysis function or operation waveform of the waveform graphics function of CX-Drive and set the identified frequency as the notch filter frequency.

11-7-2 Notch Filter Width and Depth

Width Setting

This is the ratio of the frequency bandwidth at a damping factor of -3 [dB] relative to the center frequency when the depth is "0". This value should conform to the left column in the table below.

Depth Setting

This is the I/O ratio at which the center frequency input is completely cut off at a set value of "0" and completely passed at a set value of "100". If the indication unit is [dB], this value should conform to the right column in the table below.

Width			Depth		
Set value	Bandwidth/center frequency		Set value	I/O ratio [%]	Damping factor [dB]
0	0.50		0	0 (Cut off)	−∞
1	0.59		1	1	−40.0
2	0.71		2	2	−34.0
3	0.84		3	3	−30.5
4	1.00		4	4	−28.0
5	1.19		5	5	−26.0
6	1.41		10	10	−20.0
7	1.68		15	15	−16.5
8	2.00		20	20	−14.0
9	2.38		25	25	−12.0
10	2.83		30	30	−10.5
11	3.36		35	35	−9.1
12	4.00		40	40	−8.0
13	4.76		45	45	−6.9
14	5.66		50	50	−6.0
15	6.73		60	60	−4.4
16	8.00		70	70	−3.1
17	9.51		80	80	−1.9
18	11.31		90	90	−0.9
19	13.45		100	100 (Passed)	0.0
20	16.00				

Notch filter frequency characteristics

11-8 Disturbance Observer Function

You can use the disturbance force value estimated with the disturbance observer to lower the effect of the disturbance force and reduce vibration.
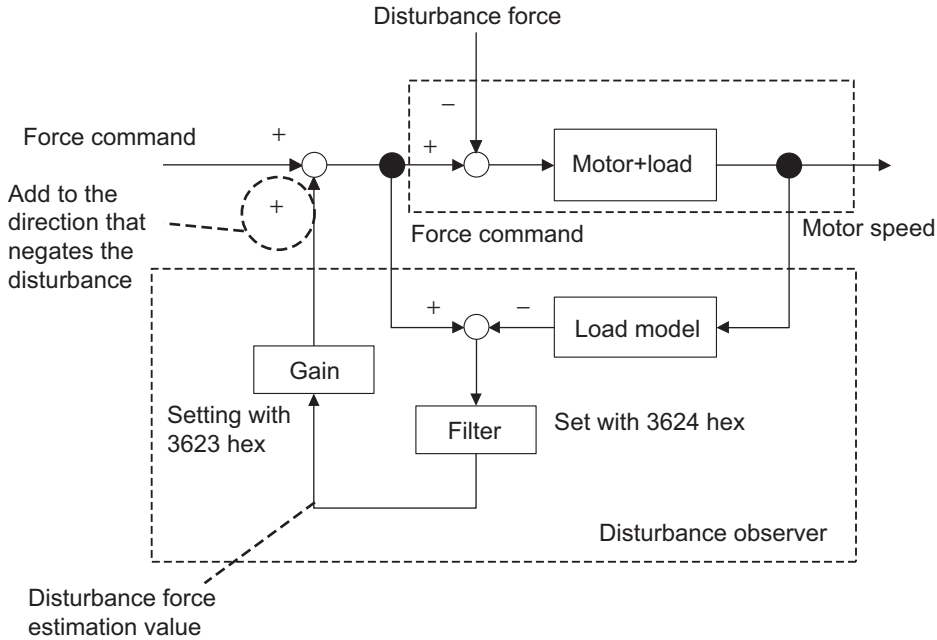
11-8-1 Operating Conditions

The disturbance observer function can be used in the following conditions.

	Operating conditions
Operating mode	Position control mode, Speed control mode
Others	• When Servo is ON. • When elements other than control parameters, such as the force limit, are set correctly and there is no trouble with the motor's normal operation. • When realtime autotuning function is disabled (The setting of 3002 hex is "0."). • When instantaneous speed observer function is disabled (The setting of 3610 hex bit 0 is "0."). • Disturbance observer operation is disabled when magnetic pole position estimation is in progress.

📝 **Precautions for Correct Use**

The disturbance observer function may not work properly under the conditions described in the following table.

	Conditions that interfere with the adaptive filter
Load condition	• If there is a resonance point below the cut-off frequency estimated by the disturbance observer. • If a large amount of high-frequency elements is found in the disturbance force. • If the the external encoder resolution is low.

11-8-2 Objects Requiring Settings

Index	Name	Description	Reference
3610 hex	Function Expansion Settings	Set the bits related to the disturbance observer.	page 9-44
3623 hex	Disturbance Force Compensation Gain	Set the compensation gain for disturbance force.	page 9-46
3624 hex	Disturbance Observer Filter Setting	Set the filter time constant for disturbance force compensation.	page 9-46

11-8-3 Operating Procedure

1 Set the Function Expansion Setting (3610 hex).

Set whether to enable or disable the disturbance observer in bit 1.

   0: Disabled

   1: Enabled

Set the operating conditions for enabling the function in bit 2.

   0: Enabled at all time

   1: Enabled only when Gain 1 is selected

2 Set the Disturbance Observer Filter Setting (3624 hex).

Set a small value for the Disturbance Force Compensation Gain (3623 hex). Change the value in the Disturbance Observer Filter Setting (3624 hex) from a large value gradually to a smaller one. The smaller the value set in the Disturbance Observer Filter Setting (3624 hex), the less the lag you will have during disturbance force estimation. This has advantages in effectively controlling the influence of disturbance, but results in a large operation noise. Consider the balance between the advantage and disadvantage when setting this value.

3 Set the Disturbance Torque Compensation Gain (3623 hex).

After you set the Disturbance Observer Filter Setting (3624 hex), increase the value of the Disturbance Force Compensation Gain (3623 hex) from a small value to a large value. The larger the value set on the Disturbance Force Compensation Gain (3623 hex) is, the more effective control over the disturbance influence can be obtained. But the larger the value is, the larger the operation noise will be. Set this object in combination with the Disturbance Observer Filter Setting (3624 hex) to achieve balanced settings.

11-9 Friction Force Compensation Function

Two types of friction force compensations can be set to reduce the influence of mechanical frictions.

- Unbalanced load compensation that offsets the constantly applied unbalance force
- Dynamic friction compensation that changes the offset direction in accordance with the operating direction

11-9-1 Operating Conditions

You can use the function under the following conditions:

	Operating conditions
Operating mode	The operating mode depends on the control mode.[1]
Others	• When Servo is ON. • When elements other than control parameters, such as the force limit, are set correctly and there is no trouble with the motor's normal operation.

[1] Refer to *11-9-2 Objects Requiring Settings* on page 11-28 for details.

11-9-2 Objects Requiring Settings

The friction force compensation function needs the combined settings of following three objects.

Index	Name	Description	Reference
3607 hex	Force Command Value Offset	Set the unbalanced load compensation value that is always added to the force command in the control mode other than force control.	page 9-43
3608 hex	Positive Direction Force Offset	Set the dynamic friction compensation value that is added to the force command when a positive position command is input for position control.	page 9-43
3609 hex	Negative Direction Force Offset	Set the dynamic friction compensation value that is added to the force command when a negative position command is input for position control.	page 9-43

11-9-3 Operation Example

The friction force compensation is applied in the input direction of the position command as shown in the drawing below.
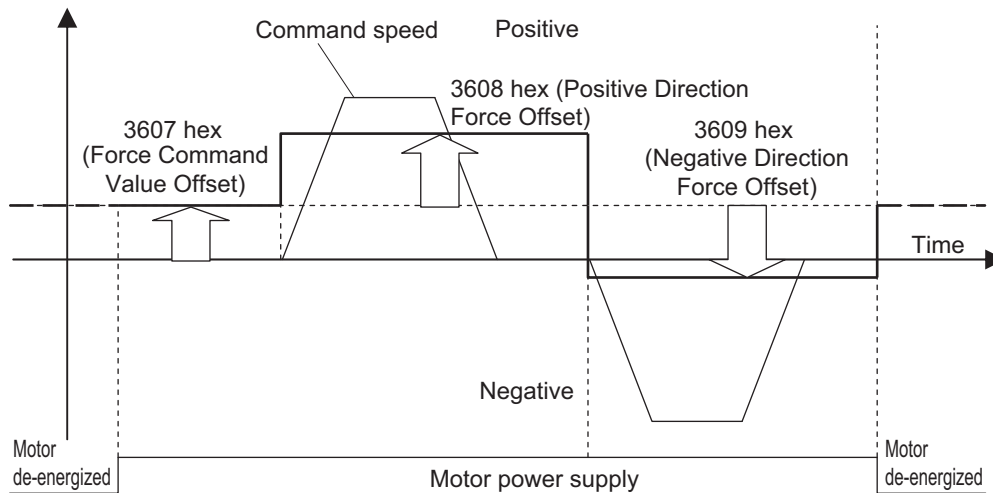
In the Force Command Value Offset (3607 hex), set the force command value if a certain amount of unbalanced load force is always applied to the motor. This object setting can reduce the variations of positioning operation due to the movement directions.

In the Positive Direction Force Offset (3608 hex) and Negative Direction Force Offset (3609 hex) objects, set the friction force in each operating direction for loads that require a large amount of dynamic friction force. These objects settings can reduce the deterioration and inconsistencies in the positioning stabilization time due to dynamic friction.

Precautions for Correct Use

You can use the unbalanced load compensation and the dynamic friction compensation together or separately. Take note that the following use limit is applied upon control mode switching or servo ON.

During Force Control

- The unbalanced load compensation and the dynamic friction compensation are 0 regardless of the object setting.

When the Servo is OFF during Speed Control

- The unbalanced load compensation is enabled based on the Force Command Value Offset (3607 hex). The dynamic friction compensation will be 0 regardless of the object setting.

When the Servo is Turned ON during Position Control

- The unbalanced load compensation and the dynamic friction compensation values are held until the first position command is input. When the position command is input, the unbalanced load compensation is updated based on the Force Command Value Offset (3607 hex). Also, based on the command direction, the dynamic friction compensation value is updated according to the Positive Direction Force Offset (3608 hex) and Negative Direction Force Offset (3609 hex) objects.

11-10 Feed-forward Function

The feed-forward function comes in 2 types: speed feed-forward and force feed-forward.

The speed feed-forward can minimize the position error and increase the responsiveness during the position control.

Responsiveness is improved by adding the speed feed-forward value calculated from the internal position command and related objects (3110 hex and 3111 hex) to the speed command calculated by comparing the internal position command and the position feedback.

If the Velocity offset (60B1 hex) is set, both the set value and the speed feed-forward valued are added to the Control effort (60FA hex).

The force feed-forward can increase the responsiveness of the speed control system.

Responsiveness is improved by adding the force feed-forward value calculated from the Control effort (60FA hex) and related objects (3112 hex and 3113 hex) to the force command calculated by comparing the Control effort (60FA hex) and the speed feedback.

If the Torque offset (60B2 hex) is set, both the set value and the force feed-forward valued are added to the force command.

11-10-1 Objects Requiring Settings

Index	Name	Description	Reference
3110 hex	Speed Feed-forward Gain	The speed command from position control processing is added to the product of the Control effort (60FA hex) that is calculated from the internal position command times the ratio in this object.	page 9-10
3111 hex	Speed Feed-forward Command Filter	Set the time constant for the first-order lag filter that is applied to speed feed-forward input.	page 9-10
3112 hex	Force Feed-forward Gain	The force command from speed control processing is added to the product of the Control effort (60FA hex) times the ratio in this object.	page 9-10
3113 hex	Force Feed-forward Command Filter	Set the time constant for the first-order lag filter that is applied to force feed-forward input.	page 9-11
60B1 hex	Velocity offset	Set the offset for the speed command. It will be added to the Control effort (60FA hex).	page A-66
60B2 hex	Torque offset	Set the offset for the force command. This object corresponds to the Force Feed-forward object in Cyclic synchronous position mode (csp) or Cyclic synchronous velocity mode (csv). It will be added to the force command value.	page A-66

11-10-2 Operating Procedure

▌Speed Feed-forward Operating Method

1 Set the Speed Feed-forward Command Filter (3111 hex).

Set the Speed Feed-forward Command Filter (3111 hex) to approx. 50 (0.5 ms).

2 Adjust the Speed Feed-forward Gain (3110 hex).

Gradually increase the value of the Speed Feed-forward Gain (3110 hex) and finely adjust it to avoid overshooting during acceleration/deceleration.

The position error during an operation at a certain speed will decrease based on the following formula according to the speed feed-forward gain value.

$$\text{Position error [command units]} = \frac{\text{Command speed [command units/s]}}{\text{Position loop gain [1/s]}} \times \frac{(100 - \text{Speed feed-forward gain [\%]})}{100}$$
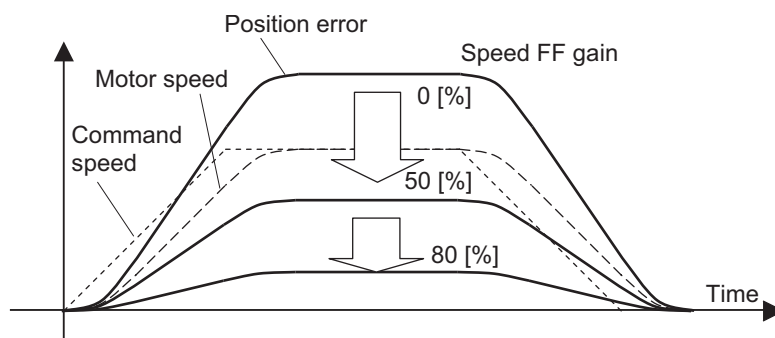
The position error in the range of constant speed becomes smaller as the speed feed-forward gain increases.

✍ Precautions for Correct Use

- If the speed feed-forward gain is set to 100%, the position error is calculated to 0. However, large overshooting will occur during acceleration/deceleration.
- If the updating cycle of the position command input is longer than the Servo Drive control cycle, or if the input command frequency is not uniform, the operating noise may increase while the speed feed-forward is enabled. Apply the position command filter (first-order lag or FIR smoothing) or increase the speed feed-forward filter setting.
- The force feed-forward function cannot be used when realtime autotuning is being used. Set both the Force Feed-forward Gain (3112 hex) and Force Feed-forward Command Filter (3113 hex) objects to 0.

Force Feed-forward Operating Method

1 Set the Mass Ratio (3004 hex).

Set the Mass ratio as correctly as possible.

In the Mass Ratio (3004 hex), use the estimated value obtained during realtime autotuning or set the mass ratio calculated from the machine specifications.

2 Set the Force Feed-forward Command Filter (3113 hex).

Set the Force Feed-forward Command Filter (3113 hex) to approx. 50 (0.5 ms).

3 Adjust the Force Feed-forward Gain (3112 hex).

By increasing the Force Feed-forward Gain (3112 hex) value little by little, it is possible to reduce the position error during acceleration/deceleration at a constant speed to close to 0. This enables the position error to be controlled to almost 0 throughout the entire operation range during a trapezoidal speed pattern under ideal conditions where no disturbance force is working.
In reality, disturbance force is always applied and therefore the position error cannot be completely "0."
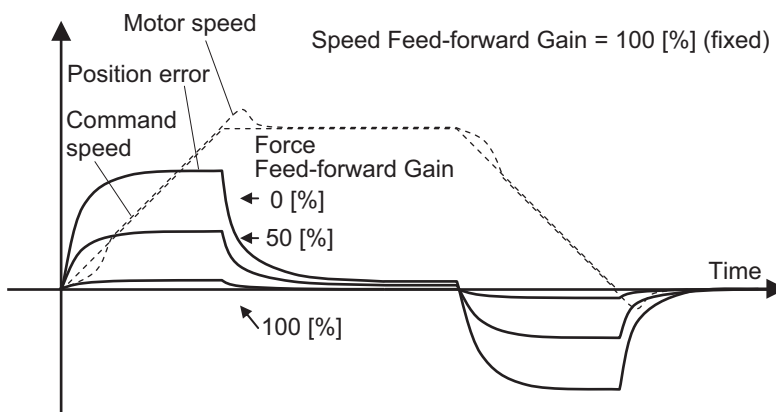
Force feed-forward can reduce the position error in a range of constant acceleration/ deceleration.

Precautions for Correct Use

• If you increase the Force Feed-forward Command Filter time constant, the operation noise will be reduced. However, the position error where the acceleration changes will become larger.

• If the the external encoder resolution is low, or if the command refresh period of host controller is long, the Force Feed-forward output will contain a large amount of noise. In this case, increase the value set for the Force Feed-forward Command Filter (3113 hex).

• The force feed-forward function cannot be used when realtime autotuning is being used. Set both the Force Feed-forward Gain (3112 hex) and Force Feed-forward Command Filter (3113 hex) objects to 0.

11-11 Instantaneous Speed Observer Function

This function uses a load model to estimate the motor speed. It improves the speed detection accuracy and can provide both high responsiveness and minimum vibration when stopping.
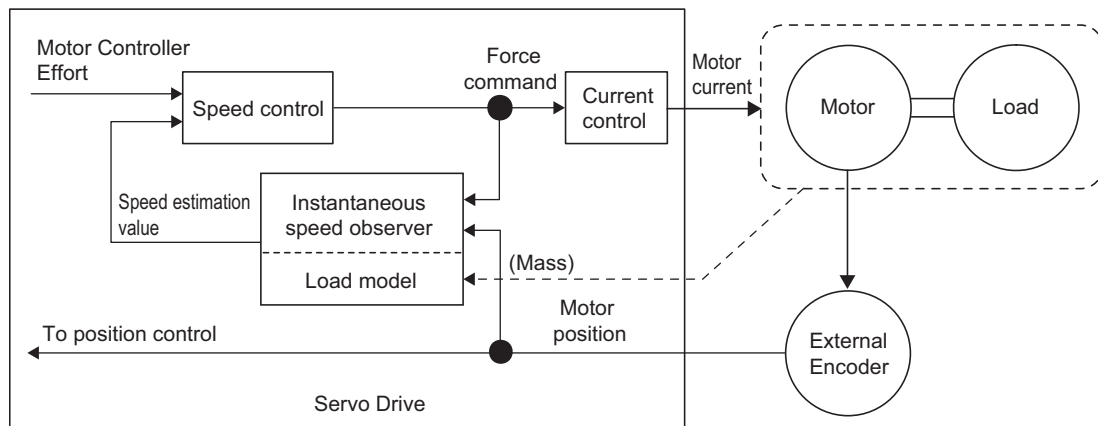
11-11-1 Operating Conditions

The instantaneous speed observer function can be used in the following conditions.

	Operating conditions
Operating mode	Position control mode, Speed control mode
Others	• When Servo is ON. • When elements other than control parameters, such as the force limit, are set correctly and there is no trouble with the motor's normal operation. • When realtime autotuning function is disabled (The setting of 3002 hex is "0."). • Speed estimation operation is disabled when magnetic pole position estimation is in progress.

☑ Precautions for Correct Use

The instantaneous speed observer function may not operate properly or the effect may not be apparent under the following conditions.

	Conditions that interfere with the adaptive filter
Load condition	• If there is a substantial difference between the mass load when considering the motor and mass as a whole and that of the actual equipment. For example, if there is a large resonance point at a frequency of 300 Hz or lower or if there is a non-linear element such as a large backlash. • If the load mass changes. • If there is a large disturbance force with high-frequency elements applied.
Others	• If the stabilization range for positioning is small.

11-11-2 Objects Requiring Settings

Index	Name	Description	Reference
3004 hex	Mass Ratio	Set the Mass ratio.	page 9-5
3100 hex	Position Loop Gain 1	Set the position loop gain.	page 9-7
3101 hex	Speed Loop Gain 1	Set the speed loop gain.	page 9-8
3610 hex	Function Expansion Settings	Set whether to enable or disable the instantaneous observer function.	page 9-44

11-11-3 Operating Procedure

1 Set the Mass Ratio (3004 hex).

Set the Mass ratio as correctly as possible.
- If the Mass Ratio (3004 hex) is obtained in realtime autotuning, use the set value.
- If the mass ratio is calculated in load calculation, etc., input the calculated value.
- If the mass ratio is not known, perform autotuning and set the result in the Mass Ratio (3004 hex).

2 Adjust the Position Loop Gain 1 (3100 hex), Speed Loop Gain 1 (3101 hex), Speed Loop Integral Time Constant 1 (3102 hex), and Force Command Filter Time Constant 1 (3104 hex) settings.

If no problem occurs in realtime autotuning, you can continue to use the settings.

3 Set the Function Expansion Setting (3610 hex).
- Set whether to enable or disable the instantaneous speed observer function in bit 0.
  If you set this to 1 (enabled), the speed detection method switches to instantaneous speed observer.
- If fluctuations in the force waveform or the operation noise increase significant enough to cause a problem, return the setting to 0 and make sure that the mass ratio or the adjustment objects are correct.
- If fluctuations in the force waveform or the operation noise decrease, make small adjustments to the Mass Ratio (3004 hex) to find the setting that makes the smallest fluctuations while monitoring the position error waveform and the actual speed waveform.
- If Position Loop Gain 1 (3100 hex), Speed Loop Gain 1 (3101 hex), or Speed Loop Integral Time Constant 1 (3102 hex) is changed, the optimal value for the Mass Ratio (3004 hex) may change, so make small adjustments to the value of the Mass Ratio (3004 hex) again to set a value that makes the smallest fluctuations.

12

Troubleshooting and Maintenance

This section describes the items to check when problems occur, troubleshooting using the error displays, troubleshooting based on the operating conditions, and periodic maintenance.

12-1 Actions for Problems

The following sections describe the preliminary checks and precautions that will be required if a problem occurs.

12-1-1 Preliminary Checks When a Problem Occurs

This section explains the preliminary checks and analytical software required to determine the cause of a problem if one occurs.

Checking the Power Supply Voltage

• Check the voltage at the power supply input terminals.

Main Circuit Power Supply Input Terminals (L1, L2, L3)

Model	Capacity	Power supply voltage
R88D-KN□L-ECT-L	100 W to 400 W	Single-phase 100 to 120 VAC (85 to 132 V) 50/60 Hz
R88D-KN□H-ECT-L	100 W to 1.5 kW	Single-phase 200 to 240 VAC (170 to 264 V) 50/60 Hz
	750 W to 1.5 kW	3-phase 200 to 240 VAC (170 to 264 V) 50/60 Hz
	2 kW to 15 kW	3-phase 200 to 230 VAC (170 to 253 V) 50/60 Hz
R88D-KN□F-ECT-L	750 W to 15 kW	3-phase 380 to 480 VAC (323 to 528 V) 50/60 Hz

Control Circuit Power Supply Input Terminals (L1C, L2C)

Model	Capacity	Power supply voltage
R88D-KN□L-ECT-L	100 W to 400 W	Single-phase 100 to 120 VAC (85 to 132 V) 50/60 Hz
R88D-KN□H-ECT-L	100 W to 1.5 kW	Single-phase 200 to 240 VAC (170 to 264 V) 50/60 Hz
	2 kW to 15 kW	3-phase 200 to 230 VAC (170 to 253 V) 50/60 Hz
R88D-KN□F-ECT-L	750 W to 15 kW	24 VDC (21.6 to 26.4 V)

   If the voltage is out of range, there is a risk of operation failure. Be sure that the power supply is within the specified range.

• Check the voltage of the sequence input power supply (+24 VIN terminal (CN1 pin 7)).

   It must be between 11 and 25 VDC.

   If the voltage is out of range, there is a risk of operation failure. Be sure that the power supply is within the specified range.

Checking Whether an Error Has Occurred

Make an analysis using the 7-segment display on the front of the Servo Drive or using CX-Drive tools.

● **When an Error Has Occurred**

   Check the error display (□□) and make an analysis based on the error that is indicated.

● **When an Error Has Not Occurred**

   Make an analysis according to the error conditions.

In either case, refer to *12-4 Troubleshooting* on page 12-11 for details.

12-1-2   Precautions When a Problem Occurs

When checking and verifying I/O after a problem has occurred, the Servo Drive may suddenly start to operate or suddenly stop. Always take the following precautions.

You should assume that anything not described in this manual is not possible with this product.

Precautions

- Disconnect the wiring before checking for cable breakage. If you test conduction with the cable connected, test results may not be accurate due to conduction via bypassing circuit.
- If the encoder signal is lost, the motor may run away, or an error may occur. Be sure to disconnect the loading equipment before checking the encoder signal.
- When measuring the encoder output, perform the measurement based on the GND (CN1 pin 16).
- When performing tests, first check that there are no persons in the vicinity of the equipment, and that the equipment will not be damaged even if the motor runs away. Before performing the tests, verify that you can immediately stop the machine using an immediate stop in case the machine runs out of control.

12-1-3   Replacing the Servo Drive

Use the following procedure to replace the Servo Drive.

1 Take a record of all object settings.

Use the CX-Drive or other software and take a record of the settings of all objects.

2 Replace the Servo Drive.

3 Set the objects.

Use the CX-Drive or other software and set all of the objects.

12-2   Warnings

This function outputs a warning signal and notifies state such as an overload before an error occurs. Set whether to hold warning state by setting the Warning Hold Selection (3759 hex).

If not holding warnings is selected, a warning will be cleared automatically when the cause of the warning has been eliminated. If holding warnings is selected, the normal procedure to clear errors must be performed after removing the cause of the error.

12-2-1   Related Objects

Index		Name	Description	Reference
3440 hex		Warning Output Selection 1	Select the warning for Warning Output 1 (WARN1). 0: Output for all warnings. 1 or higher: Refer to *12-2-2 Warning List* on page 12-5.	page 9-36
3441 hex		Warning Output Selection 2	Select the warning for Warning Output 2 (WARN2). 0: Output for all warnings. 1 or higher: Refer to *12-2-2 Warning List* on page 12-5.	page 9-36
3638 hex		Warning Mask Setting	Set a mask for warning detection. If you set the corresponding bit to 1, the detection of the corresponding warning is disabled. Refer to *12-2-2 Warning List* on page 12-5.	page 9-49
3759 hex	Bit 0	Warning Hold Selection for Communications-related Warnings	Select whether to hold servo-related and communications-related warning state. 0: Do not hold 1: Hold	page 9-52
	Bit 1	Warning Hold Selection for General Warnings		
3781 hex		Data Setting Warning Detection Setting	Set how many times the EtherCAT communications data setting warning should be detected continuously without an error. If a Data Setting Warning (Warning No. B0 hex) occurs more than this setting, a Command Error (Error No. 91.1) will occur.	page 9-53
3800 hex		Communications Control	Controls errors and warnings related to EtherCAT communications. If you set the corresponding bit to 1, the detection of the corresponding warning is disabled.	page 9-53

12-2-2   Warning List

There are two types of warnings: general warnings and warnings related to EtherCAT communications.

General Warnings

Warning number	Warning name	Warning condition	Warning Hold Selection (3759 hex) [1]	Warning Output Selection (3440 hex, 3441 hex) [2]	Warning Mask Setting (3638 hex) [3]
A0 hex	Overload Warning	The load ratio is 85% or more of the protection level.	√	1	Bit 7
A1 hex	Excessive Regeneration Warning	The regeneration load ratio is 85% or more of the level.	√	2	Bit 5
A2 hex	–	Not used (Do not use.)			
A3 hex	Fan Warning	The fan stop state continues for 1 second.	√	4	Bit 6
A4 hex	–	Not used (Do not use.)			
A5 hex	–	Not used (Do not use.)			
A6 hex	Vibration Detection Warning	Vibrating is detected.	√	7	Bit 9
A7 hex	Life Expectancy Warning	Life Expectancy Warning	Fixed to latch mode	8	Bit 2
A8 hex	External Encoder Error Warning	The external encoder detects a warning.	√	9	Bit 8
A9 hex	External Encoder Communications Warning	The external encoder has communications errors in series more than the specified value.	√	10	Bit 10

*1   The check mark symbol (√) in the above table means that you can switch between Latch and Non-latch modes in the Warning Hold Selection (3759 hex). Life Expectancy Warning is fixed to Latch mode only.

*2   Set the Warning Output Selection 1 (3440 hex) to the warning type to output to Warning Output 1 (WARN1), and set the Warning Output Selection 2 (3441 hex) to the warning type to output to the Warning Output 2 (WARN2). If you set these objects to 0, all warning types are output.

*3   Detection of general warnings can be masked with the Warning Mask Setting (3638 hex) and detection of EtherCAT communications-related warnings can be masked with the Communications Control (3800 hex). When the bit is set to 1, the warning detection is masked.

Precautions for Correct Use

- Do not use any settings for Error Output Selection 1 (3440 hex) and Error Output Selection 2 (3441 hex) other than those given in the above table.
- You can clear these warnings by executing the error rest command. The command does clear the warning even if the cause of the warning is not removed, but the same warning will occur again.

Warnings Related to EtherCAT Communications

Warning number	Warning name	Warning condition	Warning Hold Selection (3759 hex) [1]	Warning Output Selection (3440 hex, 3441 hex) [2]	Warning Mask Setting (3800 hex)[3]
B0 hex	Data Setting Warning	An object setting is out of range.	√	11	Bit 4
B1 hex	Command Warning	Object operating conditions are not satisfied. • A forced brake operation request was sent while the servo was ON. • A Switch ON command was sent when the main circuit power supply was OFF and object 3508 hex = 0. • The motor was operating at 30 mm/s or higher. • An Enable Operation command was sent to request turning ON the servo when Modes of operation (6060 hex) was not set. A latch operation was started under the following conditions. • During Homing mode • The data is being cleared or the Config operation is being performed. • The Statusword (6041 hex) bit 9 (remote) is 0 (local). An operation command was applied in the drive-prohibited direction after an immediate stop for a drive prohibition input.	√	12	Bit 5
B2 hex	EtherCAT Communications Warning	EtherCAT communications errors occurred one or more times.	√	13	Bit 6

*1   The check mark symbol (√) in the above table means that you can switch between Latch and Non-latch modes in the Warning Hold Selection (3759 hex).

*2   Set the Warning Output Selection (3440 hex) to the warning type to output to Warning Output 1 (WARN1), and set Warning Output Selection 2 (3441 hex) to the warning type to output to Warning Output 2 (WARN2). If you set these objects to 0, all warning types are output.

*3   Detection of general warnings can be masked with the Warning Mask Setting (3638 hex) and detection of EtherCAT communications-related warnings can be masked with the Communications Control (3800 hex). The warning detection is masked when you set the corresponding bit to 1.

Precautions for Correct Use

Do not use any settings for Error Output Selection 1 (3440 hex) and Error Output Selection 2 (3441 hex) other than those given in the above table.

12-3 Errors

If the Servo Drive detects an abnormality, it outputs an error (ALM), turns OFF the power drive circuit, and displays the main error number on the front panel.

Precautions for Correct Use

- Refer to *12-4-1 Troubleshooting with Error Displays* on page 12-11 for troubleshooting errors.
- Reset the error using one of the following methods. Remove the cause of the error first.

    Turn OFF the power supply, then turn it ON again.

    Reset the error via EtherCAT communications or from the CX-Drive via USB communications.

    However, some errors can only be reset by turning the power supply OFF then ON again. Refer to the *12-3-1 Error List* on page 12-7.

- An Overload Error (Error No. 16.0) cannot be reset for 10 seconds after it occurs.
- If "hh," "FF," or "HH" is displayed as the error number, the internal MPU has malfunctioned. Turn OFF the power immediately if one of these error numbers is displayed.

12-3-1 Error List

| Error No. (hex) | | Error detection function | Attribute | | |
Main	Sub		History	Can be reset	Immediate stop[*1]
11	0	Control Power Supply Undervoltage	–	√	–
12	0	Overvoltage	√	√	–
13	0	Main Power Supply Undervoltage (insufficient voltage between P and N)	–	√	–
	1	Main Power Supply Undervoltage (AC cutoff detected)	–	√	–
14	0	Overcurrent	√	–	–
	1	IPM Error	√	–	–
15	0	Servo Drive Overheat	√	–	√
16	0	Overload	√	√[*2]	–
18	0	Regeneration Overload	√	–	√
	1	Regeneration Tr Error	√	–	–
24	0	Error Counter Overflow	√	√	√
	1	Excessive Speed Deviation Error	√	√	√
26	0	Overspeed	√	√	√
	1	Overspeed 2	√	√	–
27	4	Command Error	√	–	–
	5	Command Generation Error	√	–	–
	6	Operation Command Duplicated	√	√	–
	7	Position Data Initialized	–	√	–
29	1	Error Counter Overflow 1	√	–	–
	2	Error Counter Overflow 2	√	–	–
30	0	Safety Input Error	–	√	–

Error No. (hex)		Error detection function	Attribute		
Main	Sub		History	Can be reset	Immediate stop[*1]
33	0	Interface Input Duplicate Allocation Error 1	√	–	–
	1	Interface Input Duplicate Allocation Error 2	√	–	–
	2	Interface Input Function Number Error 1	√	–	–
	3	Interface Input Function Number Error 2	√	–	–
	4	Interface Output Function Number Error 1	√	–	–
	5	Interface Output Function Number Error 2	√	–	–
	8	External Latch Input Allocation Error	√	–	–
34	0	Overrun Limit Error	√	√	–
36	0 to 2	Object Error	–	–	–
37	0 to 2	Object Corrupted	–	–	–
38	0	Drive Prohibition Input Error 1	–	√	–
	1	Drive Prohibition Input Error 2	–	√	–
50	0	External Encoder Connection Error	√	–	–
	1	External Encoder Communications Data Error	√	–	–
51	0	External Encoder Status Error 0	√	–	–
	1	External Encoder Status Error 1	√	–	–
	2	External Encoder Status Error 2	√	–	–
	3	External Encoder Status Error 3	√	–	–
	4	External Encoder Status Error 4	√	–	–
	5	External Encoder Status Error 5	√	–	–
55	0	Phase-A Connection Error	√	–	–
	1	Phase-B Connection Error	√	–	–
	2	Phase-Z Connection Error	√	–	–
60	0	Motor Setting Error	–	–	–
	1	Motor Combination Error 1	–	–	–
	2	Motor Combination Error 2	–	–	–
61	0	Magnetic Pole Position Estimation Error 1	√	√	–
	1	Magnetic Pole Position Estimation Error 2	√	√	–
	2	Magnetic Pole Position Estimation Error 3	–	–	–
83	1	EtherCAT State Change Error	√	√[*3]	–
	2	EtherCAT Illegal State Change Error	√	√[*3]	–
	3	Communications Synchronization Error	√	√[*3]	–
	4	Synchronization Error	√	√[*3]	–
	5	Sync Manager WDT Error	√	√[*3]	–
87	0	Immediate Stop Input Error	–	√	–
88	0	Node Address Setting Error	√	–	–
	1	ESC Initialization Error	√	–	–
	2	The SYNC0 interruption is abnormal	√	–	–
	3	SII Verification Error	√	–	–
90	0	Communications Setting Error	√	√[*3]	–
91	0	Command Error	√	√	–

| Error No. (hex) | | Error detection function | Attribute | | |
Main	Sub		History	Can be reset	Immediate stop[*1]
93	0	Object Setting Error 1	√	–	–
	3	External Encoder Connection Error	√	–	–
	4	Function Setting Error	√	√	–

*1   An immediate stop error is displayed if an immediate stop is performed when −4 to −7 is set for the Fault reaction option code (605E hex). During the Magnetic Pole Position Estimation, however, an error trip, instead of an immediate stop, will occur immediately.
For details, refer to *Fault reaction option code* on page A-89.

*2   This error cannot be reset for 10 seconds after it occurs.

*3   Communications Errors (Error Nos. 83.1 to 83.5) and the Communications Setting Error (Error No. 90.0) cannot be reset until the cause of the error is removed by performing an operation from the master.
When resetting an error via a USB connection, remove the cause of the error beforehand.

Note 1   If an error that cannot be reset occurs, remove the error factor and turn OFF the control power to reset the error.

2   If a resettable error occurs, reset the error via EtherCAT communications or on the CX-Drive.

3   If "hh," "FF," or "HH" is displayed as the error number, the internal MPU has malfunctioned. Turn OFF the power immediately if one of these error numbers is displayed.

12-3-2   Immediate Stop Operation at Errors

The immediate stop function controls the motor and stops it immediately if an error that supports for immediate stopping occurs.

Related Objects

Index	Name	Explanation	Reference
605E hex	Fault reaction option code	Set the state during deceleration and after stopping for when an error occurs.	page A-59
3511 hex	Immediate Stop Force	Set the force limit for immediate stops.	page 9-39
3614 hex	Error Detection Allowable Time Setting	Set the allowable time until stopping if an immediate stop is executed when an error is detected.	page 9-45
3615 hex	Overspeed Detection Level Setting at Immediate Stop	If the motor speed exceeds the set value during an immediate stop resulting from an error, an Overspeed 2 Error (Error No. 26.1) will occur.	page 9-45

Immediate Stop Operation
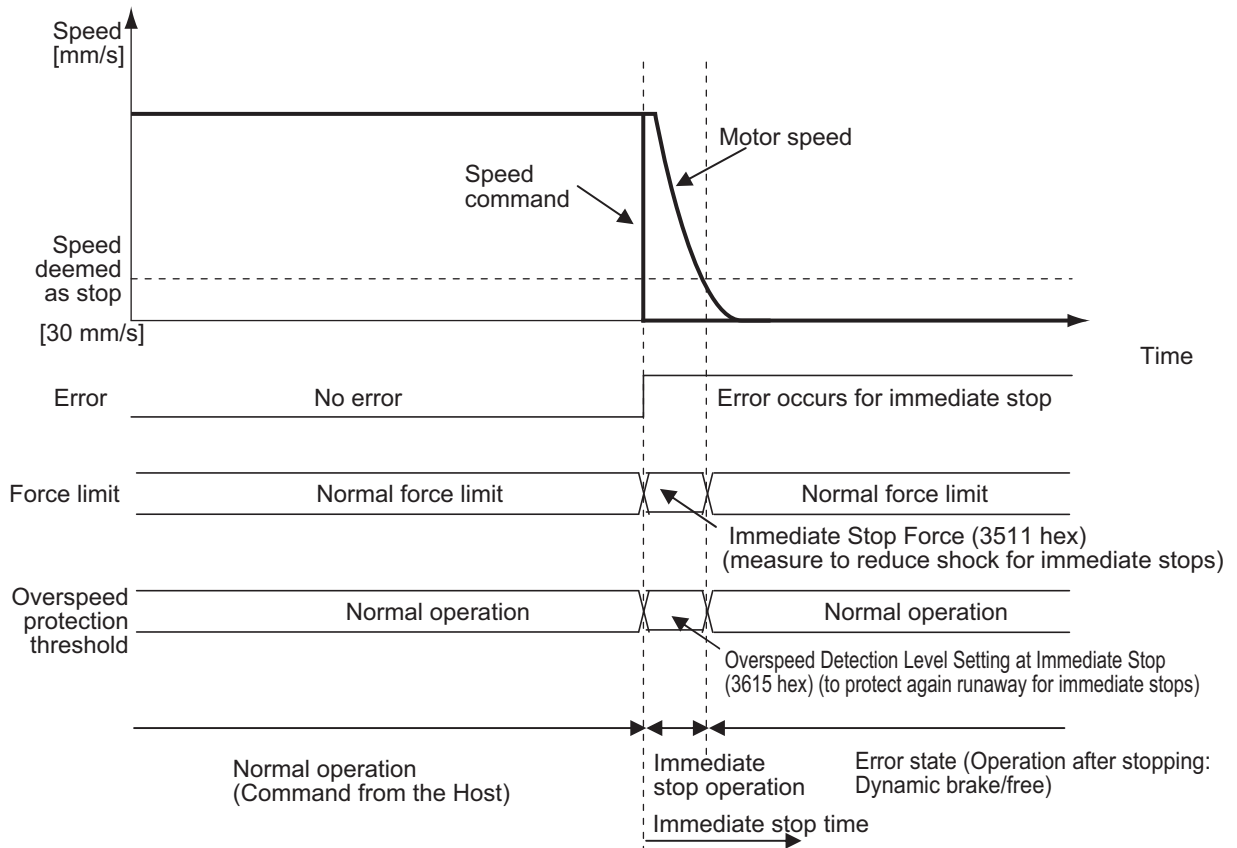
Precautions for Correct Use

- To prevent operation from running out of control for an immediate stop, set the allowable Overspeed Detection Level Setting at Immediate Stop (3615 hex). An Overspeed 2 Error (Error No. 26.1) does not support immediate stopping. If it occurs, an error trip will occur immediately.

- Set a higher value for the Overspeed Detection Level Setting at Immediate Stop (3615 hex) than for the Overspeed Detection Level Setting (3513 hex). If a value lower than the Overspeed Detection Level Setting (3513 hex) is set, an Overspeed 2 Error (Error No. 26.1) will occur before an Overspeed Error (Error No. 26.0). Thus an immediate stop will not occur. If an Overspeed Error (Error No. 26.0) and an Overspeed 2 error (Error No. 26.1) occur at the same time, the immediate stop will not occur, either.

- If the actual operation speed is not lower than 30 mm/s after the time set on the Error Detection Allowable Time Setting (3614 hex) elapses from when an error that supports immediate stopping occurs, an error state will occur immediately.

- If an error that does not support immediate stopping occurs during an immediate stop, an error state will occur immediately.

12-4 Troubleshooting

If an error occurs in the machine, determine the error conditions from the error displays and operation state, identify the cause of the error, and take appropriate measures.

12-4-1 Troubleshooting with Error Displays

Error List

Error No. (hex)		Name	Cause	Measures
Main	Sub			
11	0	Control Power Supply Undervoltage	The voltage between the positive and negative terminals in the control power supply converter dropped below the specified value. • The power supply voltage is low. A momentary power interruption occurred. • Insufficient power supply capacity: the power supply voltage dropped because there was inrush current when the main power supply was turned ON. • The Servo Drive is faulty (circuit fault).	Measure the voltage between the L1C and L2C lines on the connectors and the terminal block. • Increase the power supply voltage. Change the power supply. • Increase the power supply capacity. • Replace the Servo Drive.
12	0	Overvoltage	The power supply voltage exceeded the allowable input voltage range, causing the voltage between the positive and negative terminals in the converter to exceed the specified value. The power supply voltage is high. The voltage was suddenly increased by the phase advance capacitor or the uninterruptible power supply (UPS). • The Regeneration Resistor wiring is broken. • The External Regeneration Resistor is inappropriate and cannot absorb all of the regenerative energy. The load mass is too large. • The Servo Drive is faulty (circuit fault).	Measure the voltage between the connector (L1, L2, and L3) lines. Input the correct voltage. Remove the phase advance capacitor. • Use a tester to measure the resistance of the external resistor between the B1 and B2 terminals on the Servo Drive. If the resistance is infinite, the wiring is broken. Replace the external resistor. • Change the regeneration resistance and wattage to the specified values. (Calculate the regenerative energy and connect an External Regeneration Resistor with the required regeneration absorption capacity.) • Replace the Servo Drive.

Error No. (hex)		Name	Cause	Measures
Main	Sub			
13	0	Main Circuit Power Supply Undervoltage (Undervoltage between positive and negative terminals)	If the Undervoltage Error Selection (3508 hex) is set to 1, a momentary power interruption occurred between L1 and L3 for longer than the value specified for the Momentary Hold Time (3509 hex). Alternatively, the voltage between the positive and negative terminals in the main power supply converter dropped below the specified value while the servo was ON. • The power supply voltage is low.	Measure the voltage between the connector (L1, L2, and L3) lines. • Increase the power supply voltage. Change the power supply. Eliminate the cause of the failure of the electromagnetic contactor on the main circuit power supply, and then turn ON the power again.
	1	Main Power Supply Undervoltage (AC interruption detected)	• A momentary power interruption occurred. • Insufficient power supply capacity: the power supply voltage dropped because there was inrush current when the main power supply was turned ON. • Phase-failure: a Servo Drive with 3-phase input specifications was operated with single-phase power supply. • The Servo Drive is faulty (circuit fault).	• Check the setting of the Momentary Hold Time (3509 hex). Set each phase of the power supply correctly. • Increase the power supply capacity. Refer to *2-3-1 Servo Drive Model Table* on page 2-5 for information on the power supply capacity. • Connect each phase (L1, L2, and L3) of the power supply correctly. Use L1 and L3 for single-phase 100 V and single-phase 200 V. • Replace the Servo Drive.
14	0	Overcurrent	The current flowing through the converter exceeded the specified value. • The Servo Drive is faulty (faulty circuit, faulty IGBT part, etc.). • The motor cable is short-circuited between phases U, V, and W. • The motor cable is ground-faulted. • Motor windings are burned out.	• Disconnect the motor cable, and turn ON the servo. If the problem immediately recurs, replace the Servo Drive with a new one. • Check to see if the motor cable is short-circuited between phases U, V and W by checking for loose wire strands on the connector lead. Connect the motor cable correctly. • Check the insulation resistance between phases U, V, and W of the motor cable and the grounding wire of the motor. If the insulation is faulty, replace the motor. • Check the balance between the resistance of each wire of the motor. If resistance is unbalanced, replace the motor.
	1	IPM Error	• The motor wiring contacts are faulty. • The relay for the dynamic brake has been welded due to frequent servo ON/OFF operations. • The motor is not suitable for the Servo Drive. • The command input timing is the same as or earlier than the Servo ON timing. • The resistance of the connected External Regeneration Resistor is less than the minimum allowable value.	• Check for missing connector pins in motor connections U, V, and W. If any loose or missing connector pins are found, secure them firmly. • Replace the Servo Drive. Do not start or stop the system by turning the servo ON or OFF. • Check model (capacity) of the motor and the Servo Drive on the nameplates. Replace the motor with a motor that matches the Servo Drive. • Wait at least 100 ms after the servo has been turned ON, then input commands. • Connect an External Regeneration Resistor whose resistance is more than the minimum allowable value.

Error No. (hex)		Name	Cause	Measures
Main	Sub			
15	0	Servo Drive Overheat	The temperature of the Servo Drive radiator or power elements exceeded the specified value. • The ambient temperature of the Servo Drive exceeded the specified value. • Overload	• Improve the ambient temperature and the cooling conditions of the Servo Drive. • Increase the capacities of the Servo Drive and the motor. Set longer acceleration and deceleration times. Reduce the load.
16	0	Overload[*1]	When the feedback value for force command exceeds the overload level specified in the Overload Detection Level Setting (3512 hex), overload protection is performed according to the overload characteristic curve set in the Motor Overload Curve Selection (3929 hex). • The load was heavy, the effective force exceeded the rated force, and operation continued too long. • Vibration or hunting occurred due to faulty gain adjustment. The motor vibrates or makes unusual noise. The Mass Ratio (3004 hex) setting is faulty. • The motor wiring is incorrect or broken. • The machine was hit by an object, or the machine load suddenly became heavy. The machine was distorted. • The brake remains ON. • When multiple machines were wired, the wiring was incorrect and the motor cable to was connected to a motor for another axis.	Check if force (current) waveforms oscillate or excessively oscillates vertically during analog output or communications. Check the overload warning display and the load rate through communications. • Increase the capacities of the Servo Drive and the motor. Set longer acceleration and deceleration times. Reduce the load. • Readjust the gain. • Connect the motor cable as shown in the wiring diagram. Replace the cable. • Remove the distortion from the machine. Reduce the load. • Measure the voltage at the brake terminals. Turn OFF the brake. • Wire the motor and the external encoder correctly so that the wiring matches the axes.
18	0	Regeneration Overload[*2]	The regenerative energy exceeds the processing capacity of the Regeneration Resistor. • The regenerative energy during deceleration caused by a large load mass increased the converter voltage, and then insufficient energy absorption by the Regeneration Resistor further increased the voltage. • The motor speed is too high to absorb the regenerative energy within the specified deceleration time. • The operating limit of the external resistor is limited to a 10% duty.	Check the load rate of the Regeneration Resistor through communications. This Regeneration Resistor cannot be used for continuous regenerative braking. • Check the operation pattern (speed monitor). Check the load rate of the Regeneration Resistor and check for the excessive regeneration warning display. Increase the capacities of the Servo Drive and the motor, and length the deceleration time. Use an External Regeneration Resistor. • Check the operation pattern (speed monitor). Check the load rate of the Regeneration Resistor and the excessive regeneration warning display. Increase the capacities of the Servo Drive and the motor, and lengthen the deceleration time. Reduce the motor speed. Use an External Regeneration Resistor. • Set the Regeneration Resistor Selection (3016 hex) to 2.
	1	Regeneration Tr Error	The Servo Drive regeneration drive Tr is faulty.	Replace the Servo Drive.

Error No. (hex)		Name	Cause	Measures
Main	Sub			
24	0	Error Counter Overflow	Position error pulses exceeded the setting of the Following error window (6065 hex). • Motor operation does not follow the command. • The value of the Following error window (6065 hex) is small.	• Check to see if the motor operates according to the position command pulse. Check on the force monitor to see if the output force is saturated. Adjust the gain. Maximize the Force Limit setting being used. Wire the external encoder as shown in the wiring diagram. Lengthen the acceleration and deceleration times. Reduce the load and the speed. • Increase the set value of object 6065 hex.
	1	Excessive Speed Deviation Error	The difference (speed deviation) between Motor Velocity Demand Value After Filtering and actual speed has exceeded the set value of the Excessive Speed Deviation Setting (3602 hex).[3]	• Increase the set value of the Excessive Speed Deviation Setting (3602 hex) object. • Lengthen the acceleration time of the Motor Velocity Demand Value After Filtering. Alternatively, improve the tracking (following) performance by adjusting the gain. • Disable the Excessive Speed Deviation Setting (3602 hex).
26	0	Overspeed	The motor speed exceeded the value set in Overspeed Level (3910 hex).	• Do not give excessive speed commands. • Check the input frequency, dividing ratio, and multiplication ratio of the position command. • If overshooting occurred due to faulty gain adjustment, adjust the gain. • Wire the external encoder as shown in the wiring diagram.
	1	Overspeed 2	The motor speed exceeded the value set for the Overspeed Detection Level Setting at Immediate Stop (3615 hex).	
27	4	Command Error	The position command variation after the electronic gear is higher than the specified value.	• Check to see if the position command variation is large. • Check the electronic gear ratio. • Check to see if the backlash compensation amount is too large.
	5	Command Generation Error	During position command processing, an error such as an "over the calculation range" error occurred.	Check to see if the electronic gear ratio, and the acceleration and deceleration rates meet the restrictions.
	6	Operation Command Duplicated	An attempt was made to establish EtherCAT communications (change from Init to Pre-Operational state) or to turn ON the servo from the controller (enable operation) while executing an FFT that operates with the Servo Drive alone or a trial run.	Check to see if EtherCAT communications is established or the servo is turned ON (enable operation) while an FFT or a trial run was being conducted.
	7	Position Data Initialized[4]	A Config operation was performed was cleared for the absolute encoder during EtherCAT communications.	Check to see if Config operation was performed was cleared for the absolute encoder during EtherCAT communications.

Error No. (hex)		Name	Cause	Measures
Main	Sub			
29	1	Error Counter Overflow 1	The value that is obtained by dividing the absolute encoder position (in pulses) by the electronic gear ratio exceeded $\pm2^{31}$ (2,147,483,648) during the initialization of position data.[5]	Review the operation range of the absolute encoder position and the electronic gear ratio.
	2	Error Counter Overflow 2	The position error in pulses exceeded $\pm2^{29}$ (536,870,912). Alternatively, the position error in command units exceeded $\pm2^{30}$ (1,073,741,824).	• Check to see if the Linear Motor operates according to the position command. • Check on the force monitor to see if the output force is not saturated. • Adjust the gain. • Maximize the Force Limit setting being used. • Wire the external encoder as shown in the wiring diagram.
30	0	Safety Input Error	At least one of the input photocouplers for safety inputs 1 and 2 turned OFF.	Check the input wiring of safety inputs 1 and 2.
33	0	Interface Input Duplicate Allocation Error 1	There is a duplicate setting in the input signal (IN1, IN2, IN3, and IN4) function allocations.	Allocate the functions to the connector pins correctly.
	1	Interface Input Duplicate Allocation Error 2	There is a duplicate setting in the input signal (IN5, IN6, IN7, and IN8) function allocations.	
	2	Interface Input Function Number Error 1	There is an undefined number specification in the input signal (IN1, IN2, IN3, and IN4) function allocations. Alternatively, a logic setting error was detected.	
	3	Interface Input Function Number Error 2	There is an undefined number specification in the input signal (IN5, IN6, IN7, and IN8) function allocations. Alternatively, a logic setting error was detected.	
	4	Interface Output Function Number Error 1	There is an undefined number specification in the output signal (OUTM1) function allocation.	
	5	Interface Output Function Number Error 2	There is an undefined number specification in the output signal (OUTM2) function allocation.	
	8	External Latch Input Allocation Error	There is an error in the latch input function allocation. • The function was allocated to input signals other than IN5, IN6, or IN7. • The function was allocated to NC. • The function was not allocated for all control modes.	

Error No. (hex)		Name	Cause	Measures
Main	Sub			
34	0	Overrun Limit Error	The motor exceeded the allowable operating range set in the Overrun Limit Setting (3514 hex) with respect to the position command input range. • The gain is not appropriate. • The set value of object 3514 hex is too small.	• Check the gains (the balance between position loop gain and speed loop gain) and the mass ratio. • Increase the set value of object 3514 hex. Alternatively, set object 3514 hex to 0 to disable the protection function.
36	0	Object Error	Data in the Object Save Area was corrupted when the power supply was turned ON and data was read from the EEPROM.	• Reset all of the objects. • If this error occurs repeatedly, the Servo Drive may be faulty. In this case, replace the Servo Drive. Return the Servo Drive to the dealer that it was purchased from and ask for investigation and repair.
	1			
	2			
37	0	Object Corrupted	EEPROM write verification data was corrupted when the power supply was turned ON and data was read from the EEPROM.	The Servo Drive is faulty. Replace the Servo Drive. Return the Servo Drive to the dealer that it was purchased from and ask for investigation and repair.
	1			
	2			
38	0	Drive Prohibition Input Error 1	When the Drive Prohibition Input Selection (3504 hex) was set to 0, both the Positive Drive Prohibition Input (POT) and the Negative Drive Prohibition Input (NOT) turned ON. When object 3504 hex was set to 2, either the Positive Drive Prohibition Input or the Negative Drive Prohibition Input turned ON. When object 3504 hex was set to 0 and Magnetic Pole Position Estimation was in progress, either the Positive Drive Prohibition Input or the Negative Drive Prohibition Input turned ON.	Check for any problems with the switches, wires, and power supplies that are connected to the Positive Drive Prohibition Input or the Negative Drive Prohibition Input. In particular, check to see if the control signal power supply (12 to 24 VDC) turned ON too slowly.
	1	Drive Prohibition Input Error 2	POT or NOT turned ON while operation was being performed for a CX-Drive operation command. Or an operation command (such as a trial run or FFT) was received from the CX-Drive when: • Object 3504 hex was set to 0, EtherCAT communications were interrupted, and either POT or NOT was ON.	
50	0	External Encoder Connection Error	A disconnection was detected because communications between the external encoder and the Servo Drive were interrupted more than the specified number of times.	Wire the external encoder correctly as shown in the connection diagram. Correct the connector pin connections.
	1	External Encoder Communications Data Error	There was a communications error in data from external encoder. There was a data error mainly due to noise. The external encoder connection cable is connected, but a communications data error occurred.	• Provide the required external encoder power supply voltage 5 VDC ±5% (4.75 to 5.25 V). Be careful especially when the external encoder connection cable is long. • If the motor cable and the external encoder connection cable are bundled together, separate them. • Connect the shield to FG. Refer to the external encoder connection diagram.

Error No. (hex)		Name	Cause	Measures
Main	Sub			
51	0	External Encoder Status Error 0	Bit 0 of the external encoder error code (ALMC) was set to 1. Refer to the external encoder specifications.	Eliminate the cause of the error and then clear the external encoder error. Then, temporarily turn OFF the control power supply to reset.
	1	External Encoder Status Error 1	Bit 1 of the external encoder error code (ALMC) was set to 1. Refer to the external encoder specifications.	
	2	External Encoder Status Error 2	Bit 2 of the external encoder error code (ALMC) was set to 1. Refer to the external encoder specifications.	
	3	External Encoder Status Error 3	Bit 3 of the external encoder error code (ALMC) was set to 1. Refer to the external encoder specifications.	
	4	External Encoder Status Error 4	Bit 4 of the external encoder error code (ALMC) was set to 1. Refer to the external encoder specifications.	
	5	External Encoder Status Error 5	Bit 5 of the external encoder error code (ALMC) was set to 1. Refer to the external encoder specifications.	
55	0	Phase-A Connection Error	An error such as broken wiring was detected in the external encoder phase-A connection.	Check the external encoder phase A connection.
	1	Phase-B Connection Error	An error such as broken wiring was detected in the external encoder phase-B connection.	Check the external encoder phase-B connection.
	2	Phase-Z Connection Error	An error such as broken wiring was detected in the external encoder phase-Z connection.	Check the external encoder phase-Z connection.
60	0	Motor Setting Error Protection	Settings associated with the motor and external encoder are not initialized.	Check the specifications of the motor and external encoder and initialize their settings.
	1	Motor Combination Error 1	The rated/maximum current of the motor exceeds the rated/maximum current allowed for the Servo Drive.	Check the values set for the Motor Rated Rms Current (3906 hex) and Motor Peak Absolute Current (3907 hex) objects. If there is no problem in the set values, the Servo Drive must be replaced with a higher capacity Servo Drive.
	2	Motor Combination Error 2	• The rated current of the motor is too low compared with the rated current of the Servo Drive. • The percentage of the Motor Coil Unit Mass to the rated force is too high. • The automatically adjusted Current Loop Proportional Gain/Current Loop Integral Gain is too high. • The percentage of the maximum current to the rated current of the motor is greater than 500%.	• Check the value set for the Motor Rated Rms Current (3906 hex) object. If there is no problem in the set value, the Servo Drive must be replaced with a lower capacity Servo Drive. • Check the values set for the Motor Rated Force (3905 hex) and Motor Coil Unit Mass (3904 hex) objects. • Check the values set for the Motor Rated Rms Current (3906 hex), Motor Inductance (3908 hex), and Motor Resistance (3909 hex) objects. • Check the values set for the Motor Peak Absolute Current (3907 hex) and Motor Rated Rms Current (3906 hex) objects.

Error No. (hex)		Name	Cause	Measures
Main	**Sub**			
61	0	Magnetic Pole Position Estimation Error 1	The Magnetic Pole Position Estimation was not completed successfully. • The external encoder direction setting is wrong. • The force command/command time value for the Magnetic Pole Position Estimation is insufficient. • There is a large unbalanced load or friction.	• Check the specifications of the external encoder and set correct values. • If the motor is subjected to a large load or resistance, increase the set value in the Magnetic Pole Position Estimation Force Command Time (3922 hex) or Magnetic Pole Position Estimation Force Command (3923 hex). • If the axis has a large unbalanced load or friction, the Magnetic Pole Position Estimation function cannot be used.
	1	Magnetic Pole Position Estimation Error 2	The motor did not stop although the time set in the Magnetic Pole Position Estimation Time Limit for Stop (3927 hex) object elapsed.	Increase the value set for the Magnetic Pole Position Estimation Time Limit for Stop (3927 hex) object. • Check the installation environment to be sure there is no unbalanced load, etc. • Check the motor to be sure that it does not operate with the force command set to 0. • If it takes a long time until the motor stops because the value set in the Magnetic Pole Position Estimation Force Command (3923 hex) or Magnetic Pole Position Estimation Maximum Movement (3924 hex) is large, increase the value set for the Magnetic Pole Position Estimation Time Limit for Stop (3927 hex) object. Similarly, if the motor takes a long time to stop due to a low kinetic friction, increase the value set for the Magnetic Pole Position Estimation Time Limit for Stop (3927 hex) object.
	2	Magnetic Pole Position Estimation Error 3	• The Magnetic Pole Position Estimation Method (3920 hex) object is set to 3, although the Magnetic Pole Position Estimation has never been executed. • Object 3920 hex was set to 3 when a non-absolute type external encoder was used.	• Set object 3920 hex to 2 and execute the Magnetic Pole Position Estimation once. Then, set 3 in object 3920 hex again. The error should not occur any more. • Make sure that you use an absolute type external encoder.
83	1	EtherCAT State Change Error	For details, refer to *Troubleshooting Errors Related to EtherCAT Communications* on page 12-20	
	2	EtherCAT Illegal State Change Error		
	3	Communications Synchronization Error		
	4	Synchronization Error		
	5	Sync Manager WDT Error		
87	0	Immediate Stop Input Error	An Immediate Stop (STOP) signal was entered.	Check the Immediate Stop (STOP) signal wiring.

Error No. (hex)		Name	Cause	Measures
Main	Sub			
88	0	Node Address Setting Error	For details, refer to *Troubleshooting Errors Related to EtherCAT Communications* on page 12-20.	
	1	ESC Initialization Error		
	2	The SYNC0 interruption is abnormal		
	3	SII Verification Error		
90	0	Communications Setting Error		
91	1	Command Error		
93	0	Object Setting Error 1	Electronic gear ratio exceeded the allowable range.	Check the object settings. The electronic gear ratio must be set between 1/1000 and 1000.
	3	External Encoder Connection Error	The set value of the External Feedback Pulse Type Selection (3323 hex) differs from the external encoder type that is actually connected for serial communications.	Set object 3323 hex to conform with the external encoder type that is actually connected.
	4	Function Setting Error	The function that was set does not support the communications cycle. • The electronic gear object ratio was not 1:1 when the communications cycle was set to 250/500 μs. • Homing mode (hm) was set in Modes of operation (6060 hex) when the communications cycle was set to 250 or 500 μs. • A mapping exceeding 20 bytes was set in an RxPDO when the communications cycle was set to 250 μs. • The number of bytes (objects) mapped to RxPDO is 0. • 11 or more objects were mapped to RxPDO. • 12 or more objects were mapped to TxPDO.	• Check the communications cycle settings or the electronic gear object. • Check the communications cycle settings or control mode settings. • Check the communications cycle settings or the mode of operation. • Check the communications cycle settings or the number of bytes of mapping. • Check the number of bytes of mapping or the parameters for the control mode settings. • Check the number of mapped objects. • Check the mapped objects.
Other numbers		Other errors	The control circuit malfunctioned due to excess noise or some other problem. The self-diagnosis function of the Servo Drive was activated, and an error occurred in the Servo Drive.	• Turn OFF the power once, and turn it ON again. • If the error is displayed even after the power is turned ON again, the system may be faulty. Stop using the system, and replace the motor and/or the Servo Drive. Return the Servo Drive to the dealer that it was purchased from and ask for investigation and repair.

*1   For the overload characteristics, refer to *3-2 Overload Characteristics (Electronic Thermal Function)* on page 3-25.

*2   Always provide a temperature fuse or other protective measure when setting the External Regeneration Resistor Setting (3017 hex) to 2. Otherwise, the Regeneration Resistor will not be protected, generate excessive heat, and be burned out.

*3   When Motor Velocity Demand Value After Filtering is forced to 0 during an immediate stop due to a halt or Positive/ Negative Drive Prohibition Input, the speed deviation immediately increases. The speed deviation also increases when the Motor Velocity Demand Value After Filtering starts. Therefore, provide enough margin when making the settings.

*4   This operation is performed for safety and is not an error.

*5   The initialization of position data occurs at any of the following four timings.
     After the control power was turned ON, after a Config operation, after FFT was executed, and after a trial run was executed

Troubleshooting Errors Related to EtherCAT Communications

Error No. (hex)		Name	Error timing	Cause	Measures
Main	Sub				
83	1	EtherCAT state change error	Occurs during operation.	A communications state change command was received for which the current communications state could not be changed.	Check the specifications of the communications state change command for the host controller.
	2	EtherCAT illegal state change error	Occurs during operation.	An undefined communications state change command was received.	Check the specifications of the communications state change command for the host controller.
	3	Communications sync error	Occurs during operation.	The number of consecutive errors in receiving data during the communication sync time exceeded the value specified for the Communications Control Setting.	• Connect the EtherCAT communications cable correctly. • Check to see if the EtherCAT communications cable is exposed to excessive noise. • Check that the host controller completed communications before a interruption is generated in the synchronous cycle (SYNC0 cycle).
	4	Sync Error	Occurs during operation.	Control PCB error	Replace the Servo Drive.
	5	Sync Manager WDT Error	Occurs during operation.	PDO communications were stopped for more than the specified period of time.	• Check the operation of the host controller. • Connect the EtherCAT communications cable correctly.

Error No. (hex)		Name	Error timing	Cause	Measures
Main	**Sub**				
88	0	Node address setting error	Occurs when the power supply is turned ON.	The node address that was read from the rotary switches was not between 00 and 99.	• Turn OFF the power supply, then turn it ON again. • Replace the Servo Drive.
	1	ESC initialization error	Occurs when the power supply is turned ON.	Control PCB error	• Turn OFF the power supply, then turn it ON again. • Replace the Servo Drive.
	2	The SYNC0 interruption is abnormal	Occurs when the power supply is turned ON.	Control PCB error	• Turn OFF the power supply, then turn it ON again. • Replace the Servo Drive.
	3	SII Verification Error	Occurs when the power supply is turned ON.	Control PCB error	• Turn OFF the power supply, then turn it ON again. • Replace the Servo Drive.
90	0	Communications setting error	Occurs when the power supply is turned ON.	• An out-of-range value was set from the host controller. • A command that changes the communications state to an unsupported state was received.	• Make EtherCAT communications settings such as the synchronous cycle (SYNC0 cycle) correctly. • Check the specifications of the communications state change command for the host controller.
91	1	Command error	Occurs during operation.	• When bit 9 (Remote) of the Statusword (6041 hex) was set to 1 (remote), and the Servo Drive was in operation enabled state (Servo ON), a command that changes the communications state from Operational to another state (Init, Pre-Operational, Safe-Operational) was received. • An unsupported number was set in Modes of operation (6060 hex). • The Modes of operation (6060 hex) was switched in less than 2 ms. • The homing operation was started when the Homing method (6098 hex) was set to a value other than 8, 12, 19, 20, 33, 34, or 35. • The Data Setting Warning (Warning No. B0 hex) occurred in a row, exceeding the Data Setting Warning Detection Setting (3781 hex) value.	Check the command specifications of the host controller.

12-4-2 Troubleshooting Using the Operation State

Symptom	Probable cause	Items to check	Measures
The 7-segment display does not light.	The control power is not supplied.	Check to see if the power supply input is within the allowed power supply voltage range.	Supply the correct power supply voltage.
		Check to see if the power supply input is wired correctly.	Wire correctly.
The ERR indicator flashes or lights.	A communications-related error occurred.	For details, refer to *Troubleshooting Errors Related to EtherCAT Communications* on page 12-20.	
The L/A IN and the L/A OUT indicators are OFF.	A link in the EtherCAT physical communications layer has not been established yet.	Check to see if the communications cable is connected correctly.	Connect the communications cable correctly.
		Check to see if the host controller has started.	Start the host controller.
An error occurred.	Read the error number and the error log.	Check and take appropriate measures against the cause listed in *12-4-1 Troubleshooting with Error Displays* on page 12-11.	
The servo does not lock.	The power cable is not connected correctly.	Check to see if the motor power cable is connected properly.	Wire the motor power cable correctly.
	The motor power supply is not ON.	Check the main circuit wiring and power voltage.	Input the correct power and voltage for the main circuit.
	The Positive or Negative Drive Prohibition Input (POT or NOT) is OFF.	• Check to see if the input for Positive or Negative Drive Prohibition Input (POT or NOT) is OFF. • Check the input of +24 VIN to CN1.	• Turn ON POT and NOT. Input +24 VIN to CN1.
	The force limit is set to 0.	Check to see if the force limits in the Positive torque limit value (60E0 hex) and the Negative torque limit value (60E1 hex) are set to 0.	Set the maximum force to be used for each of these objects.
	The Servo Drive has broken down.	–	Replace the Servo Drive.

Symptom	Probable cause	Items to check	Measures
The servo locks but the motor does not operate.	The host controller does not give a command.	For a position command, check to see if the speed and position are set to 0.	Enter position and speed data. Start the motor.
	The Servo Drive received a command but it is not accepted.	Check to see if the Servo Drive retains the object value for two communications cycles or more in Profile position mode (pp).	Set the Servo Drive so that it retains the object value for two communications cycles or more.
	It is hard to determine if the motor is rotating	Check to see it the speed command given by the host controller is too small.	Check the speed command from the host controller.
	The brake is operating.	Check the brake interlock output (BKIR) signal and the +24 VDC power supply.	Check to see if the brake is released.
	The force limits set in the Positive torque limit value (60E0 hex) and the Negative torque limit value (60E1 hex) are too small.	Check to see if the force limits in objects 60E0 hex and 60E1 hex are set to a value close to 0.	Set the maximum force to be used for each of these objects.
	The Positive or Negative Drive Prohibition Input (POT or NOT) is OFF.	Check the ON/OFF state of the POT and NOT signals from the CX-Drive.	• Turn ON the POT and NOT signals. • Disable them in the settings when the POT and NOT signals are not used.
	The control mode does not conform to the command.	Check the set value of the Control Mode Selection (3001 hex).	Set the control mode according to the command.
	The motor power cable is wired incorrectly.	Check the wiring.	Wire correctly.
	The external encoder cable is wired incorrectly.		
	Power is not supplied.	Check the power supply and the 7-segment display.	Turn ON the power.
		Check the voltage between the power terminals.	Wire the power-ON circuit correctly.
	The Servo Drive has broken down.	–	Replace the Servo Drive.
The motor operates momentarily, but then it does not operate after that.	The position commands given are too little.	Check the position data and the electronic gear ratio at the host controller.	Set the correct data.
	The motor power cable is wired incorrectly.	Check the wiring of the motor power cable's phases U, V, and W.	Wire correctly.
	The external encoder cable is wired incorrectly.	Check the external encoder cable's wiring.	Wire correctly.
The motor operates without a command.	There are inputs of small values in speed control mode.	Check if there is an input in speed control mode.	Set the speed command to "0." Alternatively, change the mode to position control mode.
	The Servo Drive has broken down.	–	Replace the Servo Drive.

Symptom	Probable cause	Items to check	Measures
The motor operates in the reverse direction from the command.	The value set in the Movement Direction Setting (3000 hex) is incorrect.	Check the set value of object 3000 hex.	Change the set value of object 3000 hex.
	The command given by the host controller is incorrect.	• The size of the absolute command is set incorrect. • The polarity of an incremental command is set incorrect.	• Check the actual and target values. • Check the operation direction.
The holding brake does not work.	Power is supplied to the holding brake.	Check to see if power is supplied to the holding brake.	• Check the brake interlock output (BKIR) signal and the relay circuit. • Check to see if the holding brake is worn down.
Motor operation is unstable.	The motor power cable or external encoder cable is wired incorrectly.	Check the wiring of the motor power cable's phases U, V, and W and check the external encoder cable's wiring.	Wire correctly.
	Low rigidity is causing vibration.	Measure the vibration frequency of the load.	Enable the damping control. Set the damping filter frequency.
	The load mass exceeds the Servo Drive's allowable value.	Calculate the load mass.	• Check if manual tuning can achieve proper adjustment. • Increase the motor capacity.
	Loose joint and/or large clearance with the machine	Check the joint with the machine.	Remove the joint looseness with the machine.
	The load and gain do not match.	Check the response waveforms for speed and force.	Adjust the speed loop gain to stabilize the operation.
The motor is overheating.	The ambient temperature is too high.	Check to see if the ambient temperature around the motor is over 40°C.	• Lower the ambient temperature around the motor to 40°C or less. (Use a fan or air conditioner.) • Lower the load ratio.
	The heat radiation condition for the motor is inappropriate.	• Check to see if the specified radiation conditions are observed. • For a motor with a brake, check the load ratio.	• Improve the radiation conditions. • Reduce the load. • Improve ventilation.
	The motor is overloaded.	Measure the force on the analog monitor on the front panel or from the CX-Drive.	• Decrease the acceleration and deceleration rates. • Lower the speed and check the load.
	The motor vibrates during operation.		
The machine position is misaligned.	There is an error in the coupling of the Liner Motor and the mechanical system.	Check to see if the coupling of the Linear Motor and the machine is misaligned.	• Tighten the coupling again.
	The host controller gave a deceleration stop command.	Check the control ladder program in the host controller.	Review the control in the host controller.
The motor does not stop or is hard to stop even if the servo is turned OFF while the motor is operating.	The load mass is too large.	• Check the load mass. • Check the motor speed. • The dynamic brake resistance is disconnected.	• Review the load mass. • Replace the motor and Servo Drive with proper ones.
	The dynamic brake is disabled.	Check if the dynamic brake is disabled or broken.	• Enable the dynamic brake, if it is disabled. • Replace the brake if it is broken or if the resistor is disconnected.

Symptom	Probable cause	Items to check	Measures
The Linear Motor or the load generates abnormal noise or vibration.	Vibration occurs due to improper mechanical installation.	Check to see if the Linear Motor's mounting screws are loose.	Retighten the mounting screws.
		Check the load for eccentricity.	Eliminate the eccentricity.
		Check to see if the coupling with the load is unbalanced.	Balance the operation.
	Vibration occurs due to low mechanical rigidity.	Check to see if the vibration frequency is 100 Hz or lower.	If the frequency is 100 Hz or lower, set the correct damping frequency for the damping filter to eliminate the vibration.
	Vibration occurs due to machine resonance.	Check to see if the resonance frequency is high or low.	If the resonance frequency is high, set the adaptive filter to eliminate the resonance. Alternatively, measure the resonance frequency and set Notch Filter 1 and 2.
	There is a problem with the linear guides.	Check for noise or vibration around the linear guides.	Check to see if the linear guides are mounted properly, and adjust them if necessary.
	The gain is wrong.	–	Check if manual tuning can achieve proper adjustment.
	The Speed Feedback Filter Time Constant 1 (3103 hex) is wrong.	Check the set value of object 3103 hex. Normally set 0.	Return the setting to the default value of 0. Alternatively, set a large value and operate the motor.
	The Force Command Filter Time Constant 1 (3104 hex) does not match the load.	Review the set value of object 3104 hex.	Set a larger value for object 3104 hex to eliminate the vibration.

Symptom	Probable cause	Items to check	Measures
The Linear Motor or the load generates abnormal noise or vibration.	The Position Loop Gain 1 (3100 hex) is too large.	Review the setting of object 3100 hex.	Use the CX-Drive or the analog monitor to measure the response and adjust the gain.
	The Speed Loop Gain 1 (3101 hex) and the Speed Loop Integral Time Constant 1 (3102 hex) are balanced incorrectly.	Review the set values of objects 3101 hex and 3102 hex.	
	Noise is entering into the control I/O signal cable because the cable does not meet specifications.	Check to see if the cable is a twisted-pair cable or shielded twisted-pair cable with core wires that are at least 0.08 mm dia.	Use a control I/O signal cable that meets specifications.
	Noise is entering into the control I/O signal cable because the cable is longer than the specified length.	Check the length of the control I/O signal cable.	Shorten the control I/O signal cable to 3 m or less.
	Noise is entering into the cable because the external encoder cable does not meet specifications.	Check to see if it is a shielded twisted-pair cable with core wires that are at least 0.12 mm dia.	Use an external encoder cable that meets specifications.
	Noise is entering into the external encoder cable because the cable is longer than the specified length.	Check the length of the external encoder cable.	Shorten the external encoder cable to less than 50 m.
	Noise is entering into the signal lines because the external encoder cable is stuck or the sheath is damaged.	Check the external encoder cable for damage.	Correct the external encoder cable's pathway.
	Excessive noise on external encoder cable.	Check to see if the external encoder cable is bound together with or too close to high-current lines.	Install the external encoder cable where it won't be subjected to surges.
	The FG's potential is fluctuating due to devices near the Linear Motor, such as welding machines.	Check for ground problems (loss of ground or incomplete ground) at equipment such as welding machines near the Linear Motor.	Ground the equipment properly and prevent current from flowing to the external encoder FG.
	Errors are being caused by excessive vibration or shock on the external encoder.	There are problems with mechanical vibration or motor installation (such as the precision of the mounting surface or attachment).	Reduce the mechanical vibration or correct the Linear Motor's installation.
Overshooting at startup or when stopping	The Position Loop Gain 1 (3100 hex) is too large.	Review the setting of object 3100 hex.	Adjust the gain to prevent overshooting.
	The Speed Loop Gain 1 (3101 hex) and the Speed Loop Integral Time Constant 1 (3102 hex) are balanced incorrectly.	Review the set values of objects 3101 hex and 3102 hex.	Use the CX-Drive or the analog monitor to measure the response and adjust the gain.
	The machine rigidity set by realtime autotuning is incorrect.	Review the setting of the machine rigidity.	Match the machine rigidity setting to the load rigidity.
	The set mass ratio differs from the load.	Review the set value of the Mass Ratio (3004 hex).	Adjust the set value of object 3004 hex with the load.

Symptom	Probable cause	Items to check	Measures
Vibration is occurring at the same frequency as the power supply.	Inductive noise is occurring.	Check to see if the drive control signal lines are too long.	Shorten the control signal lines.
		Check to see if the control signal lines and power supply lines are bound together.	• Separate control signal lines from power supply lines. • Use a low-impedance power supply for control signals.
The position is misaligned. (Position misalignment occurs without an error being output.)	The coupling of the mechanical system is insufficient.	Check to see if the mechanical system is misaligned.	Correct the coupling of the mechanical system.
	The gain is wrong.	–	Check if manual tuning can achieve proper adjustment.
	The load mass is too large.	• Check the load mass. • Check the motor speed. • The dynamic brake resistance is disconnected.	• Review the load mass. • Replace the motor and Servo Drive with proper ones.

12-5 Periodic Maintenance

> ## ⚠ Caution
>
> After replacing the unit, transfer to the new unit all data needed to resume operation, before restarting the operation. Equipment damage may result.
>
> Never repair the product by disassembling it. Electric shock or injury may result.

Linear Sliders and Servo Drives contain many components and will operate properly only when each of the individual components is operating properly. Some of the electrical and mechanical components require maintenance depending on application conditions. Periodic inspection and replacement are necessary to ensure proper long-term operation of Linear Sliders and Servo Drives. (Quoted from *The Recommendation for Periodic Maintenance of a General-purpose Inverter* published by JEMA.)

The periodic maintenance cycle depends on the installation environment and application conditions of the Linear Sliders and Servo Drives. Recommended maintenance times are given below for Linear Sliders and Servo Drives. Use these for reference in periodic maintenance.

Servo Drive Life Expectancy

- The lifetimes for the different drive parts are given below.
  Aluminum electrolytic capacitors: 28,000 hours
  (at an ambient drive operating temperature of 55°C, constant output at rated force, constant output at rated speed, and installation as described in this manual)
  Axial-flow fan: 10,000 to 30,000 hours (The limit depends on the operating conditions.)
  Inrush current prevention relay: Approx. 20,000 operations (The limit depends on the operation conditions.)

- When using the Servo Drive in continuous operation, use fans or air conditioners to maintain the ambient temperature below 40°C.

- We recommend that the ambient temperature and the power supply ON time be reduced as much as possible to lengthen the service life of the Servo Drive.

- The limit of aluminum electrolytic capacitors is greatly affected by the ambient operating temperature. Generally, an increase of 10°C in the operating ambient temperature will reduce capacitor service life by 50%.
  For example, when the ambient operating temperature is 25°C, the life expectancy will be as follows:

$$\text{Life expectancy at 25°C} = \text{Life expectancy at 55°C} \times 2^{\frac{55 - 25}{10}}$$
$$= 224{,}000 \text{ hours}$$

- The aluminum electrolytic capacitors deteriorate even when the Servo Drive is stored with no power supplied. If the Servo Drive is not used for a long time, we recommend periodic inspection and a part replacement period of 5 years.

- If the motor or Servo Drive is not to be used for a long time, or if they are to be used under conditions worse than those described above, a periodic inspection period of 5 years is recommended.

- Upon request, OMRON will inspect the Servo Drive and motor and determine if part replacement is required.

App

Appendicies

The appendix provides explanation for the profile that is used to control the Servo Drive, lists of objects, Sysmac Error Status codes, and other information.

A-1　CiA402 Drive Profile

This section describes the profile that is used to control the Servo Drive.

A-1-1　Controlling the State Machine of the Servo Drive

The state of G5-series Servo Drives with built-in EtherCAT communications is called "PDS state." The PDS state is controlled by the Controlword (6040 hex).

The Status word (6041 hex) is displayed in each PDS state.

State Machine

The state of an G5-series Servo Drive changes as shown below.

Each box indicates a state, while numbers 2 to 10 and 15 indicate the state control commands.

For details on the states, refer to *State Descriptions* on page A-3 and *Command Coding* on page A-3.

			Control circuit power supply	Main circuit power supply	Servo ON/OFF
Power turned OFF or Reset					
Start					
0: After the control power is turned ON					
Not ready to switch on			ON	ON or OFF	OFF
1: After initialization is completed					
Switch on disabled　15: Fault reset　Fault					
Shutdown: 2　7: Disable Voltage					
Ready to switch on					
Switch on: 3					
6: Shutdown　14: Error response operation completed			ON	ON	OFF
Disable Voltage: 10　Switched on					
Enable operation: 4					
5: Disable operation					
Fault reaction active					
Operation enabled　8: Shut down　13: Error occurs			ON	ON	ON
9: Disable Voltage					

Note 1　Quick stop active state is not supported. Even if a Quick stop command is received, it will be ignored.

> **2** The operation to perform when the main circuit power is turned OFF while the Servo is ON can be set using the Undervoltage Error Selection (3508 hex).
> 3508 hex=0: Moves to a state where the main circuit power supply is turned OFF and stops according to the setting of the Shutdown option code (605B hex).
> 3508 hex=1: Moves to an error processing state and stops according to the setting of the Fault reaction option code (605E hex).

State Descriptions

States	Description
Not ready to switch on	The control circuit power supply is turned ON and initialization is being executed.
Switch on disabled	Initialization has been completed.
	Servo Drive parameters can be set.
Ready to switch on	The main circuit power supply can be turned ON.
	Servo Drive parameters can be set.
Switched on	The main circuit power supply is ON.
	Servo Drive parameters can be set.
Operation enabled	The Servo is ON.
	Servo Drive parameters can be set.
Fault reaction active	There was an error in the Servo Drive and the cause is being determined.
	Servo Drive parameters can be set.
Fault	There is an error in the Servo Drive.
	Servo Drive parameters can be set.

Command Coding

State is controlled by combining the bits in the Controlword (6040 hex) as shown in the following table.

Command	Controlword Bit					Move to
	Bit 7 Fault reset	Bit 3 Enable operation	Bit 2 Quick stop	Bit 1 Enable voltage	Bit 0 Switch on	
Shutdown	×	×	1	1	0	2, 6, 8
Switch on	×	0	1	1	1	3
Switch on + Enable operation	×	1	1	1	1	3 + 4[*1]
Disable voltage	×	×	×	0	×	7, 9, 10
Quick stop	×	×	0	1	×	Not supported[*2]
Disable operation	×	0	1	1	1	5
Enable operation	×	1	1	1	1	4
Fault reset	0 → 1[*3*4]	×	×	×	×	15

*1   The state automatically moves to Operation enabled state after Switched on state.

*2   Quick stop commands are not supported. Even if a quick stop command is received, it will be ignored.

*3   Bit 7: Operation when Fault reset bit turns ON.

Fault state	• Errors are reset and the Servo Drive returns to its initialized state. • Check the Statusword (6041 hex) bit 7 (Warning) and reset it if an error has occurred.
State other than Fault state	• Check the Statusword (6041 hex) bit 7 (Warning) and reset it if an error has occurred. • The state will change according to command bits 0 to 3.

*4   When an error reset is executed with bit 7, set the bit back to 0 before giving the next command.

State Coding

State is indicated by the combination of bits in Statusword (6041 hex), as shown in the following table.

State	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
Not ready to switch on	0	0	×	0	0	0	0
Switch on disabled	1	1	×	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	1	×	1	1	1	1
Fault	0	1	×	1	0	0	0

A-1-2   Modes of Operation

G5-series Servo Drives with built-in EtherCAT communications support the following Modes of operation.

csp: Cyclic synchronous position mode

csv: Cyclic synchronous velocity mode

cst: Cyclic synchronous torque mode

pp: Profile position mode

hm: Homing mode

The operation mode is set in Modes of operation (6060 hex). It is also given in Modes of operation display (6061 hex).

The operation modes supported by the Servo Drive can be checked in Supported drive modes (6502 hex).

If an unsupported operation mode is specified, a Function Setting Error (Error No. 93.4) will occur.

A-1-3 Communications Cycles and Corresponding Modes of Operation

This section describes the Modes of operation that can be used for each combination of communications cycle and PDO mapping set in the RxPDO.

● Position Control

Any of 1701 to 1705 hex or 1600 hex can be set in the RxPDO when 0 to 5 (position control) is set for the Control Mode Selection (3001 hex). The following table shows the Modes of operation that can be used for each combination of communications cycle and RxPDO.

When the RxPDO is set to the 1st receive PDO Mapping (1600 hex), the combination of the communications cycle and the available Modes of operation varies depending on the total size of mapped objects.

For details on the 1st receive PDO Mapping (1600 hex), refer to *5-4-4 Variable PDO Mapping* on page 5-9.

Communications cycle (μs)[*1]	RxPDO		
	When electronic gear ratio is 1:1		When electronic gear ratio is not 1:1
	1701, 1702, 1703, 1705, 1600 hex [*2]	1704, 1600 hex[*3]	1701, 1702, 1703, 1704, 1705, 1600 hex[*4]
250	csp, csv, cst	_[*5]	_[*5]
500	csp, csv, cst	csp, csv, cst	_[*5]
1000	csp, csv, cst, pp, hm	csp, csv, cst, pp, hm	csp, csv, cst, pp, hm
2000	csp, csv, cst, pp, hm	csp, csv, cst, pp, hm	csp, csv, cst, pp, hm
4000	csp, csv, cst, pp, hm	csp, csv, cst, pp, hm	csp, csv, cst, pp, hm

*1 The communications cycle is set in the controller. Refer to the manual of the controller that is connected for the setting procedure.

*2 Applicable when the total size of objects mapped to RxPDO is 20 bytes or less.

*3 Applicable when the total size of objects mapped to RxPDO is 21 to 24 bytes.

*4 Applicable when the total size of objects mapped to RxPDO is 24 bytes or less.

*5 The Function Setting Error (Error No. 93.4) will occur if a setting labeled "− (Not supported)" is set.

A-1-4   Modes of Operation and Applied Functions

The relationships between the modes of operation of G5-series Servo Drives with built-in EtherCAT communications and the application functions are shown below.

❍: Supported, −: Not supported

Function	Mode of operation		
	csp pp hm	csv	cst
Notch filter (notch 1 to notch 4)[*1]	❍	❍	❍
Damping filter	❍	−	−
Speed feed-forward	❍	−	−
Force feed-forward function[*2]	❍	❍	−
Position command FIR filter[*3]	❍	−	−
Position command smoothing filter	❍	−	−
Realtime Autotuning[*4]	❍	❍	❍
Instantaneous speed observer[*5]	❍	❍	−
Disturbance Observer[*6]	❍	❍	−

*1   When one adaptive filter is enabled, notch 3 is set automatically. When two adaptive filters are enabled, notch 3 and notch 4 are set automatically.

*2   When Realtime Autotuning is enabled, you cannot use the force feed-forward function. (They are in an exclusive relationship.)

*3   The FIR filter is enabled only in hm, pp and csp mode when the communications cycle is set to 1 ms or above.

*4   When Realtime Autotuning is enabled, the instantaneous speed observer and disturbance observer are automatically disabled. Realtime Autotuning must be disabled to enable the instantaneous speed observer.

*5   When the instantaneous speed observer is enabled, the disturbance observer is automatically disabled.

*6   Realtime Autotuning and the instantaneous speed observer must be disabled to enable the disturbance observer.

A-1-5   Changing the Mode of Operation

The operation mode of the G5-series Servo Drives with built-in EtherCAT communications is changed as described below.

Changing the Mode of Operation

By setting a mode of operation from the controller, the motor can be operated while switching the control mode of the Servo Drive.

The mode of operation is changed by changing the set value of Modes of operation (6060 hex).

When changing the mode of operation, also change the command value of the object mapped to the RxPDO.

For example, in the Cyclic synchronous position mode (csp), which is a position control mode, the Target position (607A hex) is enabled as the command value. However, in the Cyclic synchronous velocity mode (csv), which is a speed control mode, the Target velocity (60FF hex) is enabled as the command value.

Therefore, when the Mode of operation is changed from the position control mode to the speed control mode, the enabled command value must be set to the Target velocity (60FF hex) at the same time.

The actual mode of operation of the Servo Drive can be checked from the Modes of operation display (6061 hex).

Precautions for Correct Use

- Change the operation mode while the motor is stopped.
  If you change the operation mode while the motor is running, shock may occur in the operation of the motor.
- Wait at least 2 ms before changing the mode of operation again. If you change the mode of operation again within 2 ms, a Command Error (Error No. 91.1) will occur.

Changing to an Unsupported Control Mode

- If Modes of operation (6060 hex) is set to a value other than 0 (nma), 1 (pp), 6 (hm), 8 (csp), 9 (csv), or 10 (cst), a Command Error (Error No. 91.1) will occur.
- If 6060 hex is set to 6 (hm) when the communications cycle is set to 250 or 500 μs, a Function Setting Error (Error No. 93.4) will occur.

Changing the Control Mode under Warning Conditions

The operation when there is a Data setting warning or Command warning is different depending on the control mode as follows.

● Changing to csp, csv, or cst

If there is a warning for the related data, you cannot change to csp, csv, or cst. The current operation mode is maintained.

● Changing to hm and pp

The operation mode changes even when there is a warning for the related data.
For the hm mode, a homing error occurs instead of a warning.

Changing the Control Mode to pp or hm Mode When the Motor Is Running

If the rising edge of the Controlword (6040 hex) bit 4 (start bit) is not detected when the control mode is changed to pp or hm mode while the Linear Motor is running, the motor will stop differently depending on whether the Halt bit is ON or OFF.

- When the Halt bit is OFF, the motor comes to an immediate stop.
- When the Halt bit is ON, the motor performs the stop operation according to the setting of the Halt option code (605D hex).

Precautions for Correct Use

Precautions in hm Mode

- If you change the control mode to hm mode during motor operation, the Linear Motor will disable the stop process using drive prohibition. Therefore, regardless of the detection of the rising edge of the Controlword (6040 hex) bit 4 (start bit), the Linear Motor will momentarily fall in an immediate stop state. However, when the Halt bit is ON, the Linear Motor stops according to the setting of the Halt option code (605D hex).
- If you change to another operation mode during homing operation in hm mode, the operation will continue for approx. 2 ms, but the stop operation for drive prohibition will not be executed. Therefore, change the control mode with the Linear Motor stopped after homing is attained.

Modes of Operation Display

The actual mode of operation can be checked from the Modes of operation display (6061 hex). The display is as follows depending on the state of the Servo Drive:

Servo Drive status		Modes of Operation Display
Servo OFF (not operation enabled state)		0: Not specified
Servo ON (operation enabled state)		The value that is shown depends on the setting of Modes of operation (6060 hex).
Not following commands in the Controlword (6040 hex) when the servo is ON	Drive prohibition[1]	The value that is shown depends on the setting of Modes of operation (6060 hex). [2]
	Deceleration stop in progress due to main circuit power OFF[3]	
	Deceleration stop in progress due to Servo OFF	
Deceleration stop in progress due to an error		0: Not specified[4]

[1] When Drive Prohibition Input Selection (3504 hex) = 0.

[2] The stop process is executed using a deceleration stop command generated independently inside the Servo Drive.

[3] Applicable when the Undervoltage Error Selection (3508 hex) is set to 0.

[4] The Servo Drive is in a Fault reaction active or Fault state during an error.

Bit Displays According to Modes of Operation Display (6061 Hex)

Some of the bits in the Statusword (6041 hex) and Statusword 1 (4000 hex) are dependent on the control mode. Their relationship with Modes of operation display is shown in the following table:

| Object | Bit | Modes of Operation Display (6061 hex) | | | | Speed Control Mode | Force Control Mode |
| | | Position control mode | | | | | |
		csp	pp	hm	Not specified	csv	cst
6041 hex	10	0	Target reached	Target reached	0	0	0
	12	Target position ignored[*1]	Acknowledge	Home attained[*2]	0	Target velocity ignored[*1]	Target torque ignored[*1]
	13	Following error	Following error	Homing error	0	0	0
4000 hex	1	DEN	DEN	DEN	1	0	0
	4	0	0	0	0	0	VLIM[*3]
	7	0	0	0	0	VCMP[*3]	0
	8	NEAR	NEAR	NEAR	1	0	0

*1 When commands in the Controlword (6040 hex) are not followed when the servo is ON, this bit will be 0 (ignored). For details, see figures (a) to (c) below.

*2 When commands in the Controlword (6040 hex) are not followed when the servo is ON, the preceding value is retained. For details, see figure (d) below.

*3 When commands in the Controlword (6040 hex) are not followed when the servo is ON, this bit will be 0. For details, see figures (b) and (c) below.

● **(a) Example of Servo OFF during Operation in csp**
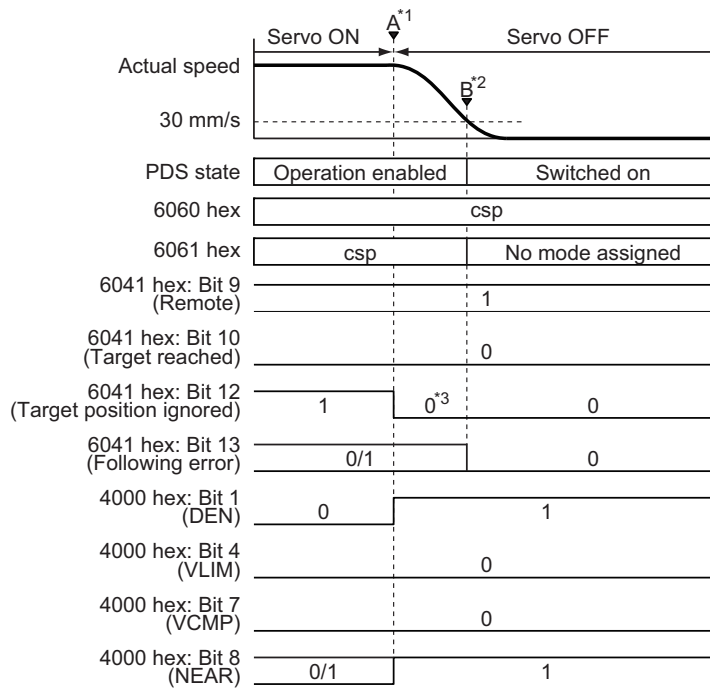
	Servo ON		Servo OFF
Actual speed		A*1	
30 mm/s			B*2
PDS state	Operation enabled		Switched on
6060 hex		csp	
6061 hex	csp		No mode assigned
6041 hex: Bit 9 (Remote)			1
6041 hex: Bit 10 (Target reached)			0
6041 hex: Bit 12 (Target position ignored)	1	0*3	0
6041 hex: Bit 13 (Following error)	0/1		0
4000 hex: Bit 1 (DEN)	0		1
4000 hex: Bit 4 (VLIM)			0
4000 hex: Bit 7 (VCMP)			0
4000 hex: Bit 8 (NEAR)	0/1		1

*1 When the servo is turned OFF, a deceleration stop starts and 6061 hex continues to show the same mode as the mode of operation (csp) specified in 6060 hex.

*2 After the motor stops, No mode assigned is shown by 6061 hex.

*3 Bit 12 will be "0" during a deceleration due to servo OFF.

Note The operation during the interval from A to B for drive prohibition and main circuit power OFF is the same as when the servo is turned OFF.

● (b) Example of Servo OFF during Operation in csv
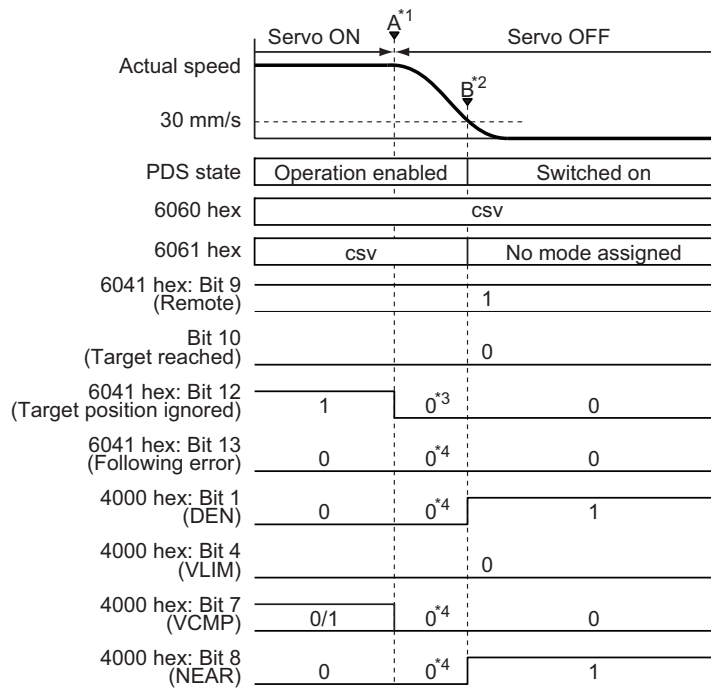
	Servo ON		Servo OFF
Actual speed		A*1	
30 mm/s		B*2	
PDS state	Operation enabled		Switched on
6060 hex	csv		
6061 hex	csv		No mode assigned
6041 hex: Bit 9 (Remote)			1
Bit 10 (Target reached)			0
6041 hex: Bit 12 (Target position ignored)	1	0*3	0
6041 hex: Bit 13 (Following error)	0	0*4	0
4000 hex: Bit 1 (DEN)	0	0*4	1
4000 hex: Bit 4 (VLIM)			0
4000 hex: Bit 7 (VCMP)	0/1	0*4	0
4000 hex: Bit 8 (NEAR)	0	0*4	1

*1　When the servo is turned OFF, a deceleration stop starts and 6061 hex continues to show the same mode as the mode of operation (csv) specified in 6060 hex.

*2　After the motor stops, No mode assigned is shown by 6061 hex.

*3　Bit 12 will be "0" during a deceleration due to servo OFF.

*4　The mode shown in 6061 hex is forced to "0" because the mode shown in 6061 hex is different from the mode of operation.

Note　The operation during the interval from A to B for drive prohibition and main circuit power OFF is the same as when the servo is turned OFF.

App

A-1 CiA402 Drive Profile

A-1-5 Changing the Mode of Operation

● **(c) Example of Servo OFF during Operation in cst**

*1 When the servo is turned OFF, a deceleration stop starts and 6061 hex continues to show the same mode as the mode of operation (cst) specified in 6060 hex.

*2 After the motor stops, No mode assigned is shown by 6061 hex.

*3 Bit 12 will be "0" during a deceleration due to servo OFF.

*4 The mode shown in 6061 hex is forced to "0" because the mode shown in 6061 hex is different from the mode of operation.

Note The operation during the interval from A to B for drive prohibition and main circuit power OFF is the same as when the servo is turned OFF.

● (d) Example of Servo OFF during Operation in hm
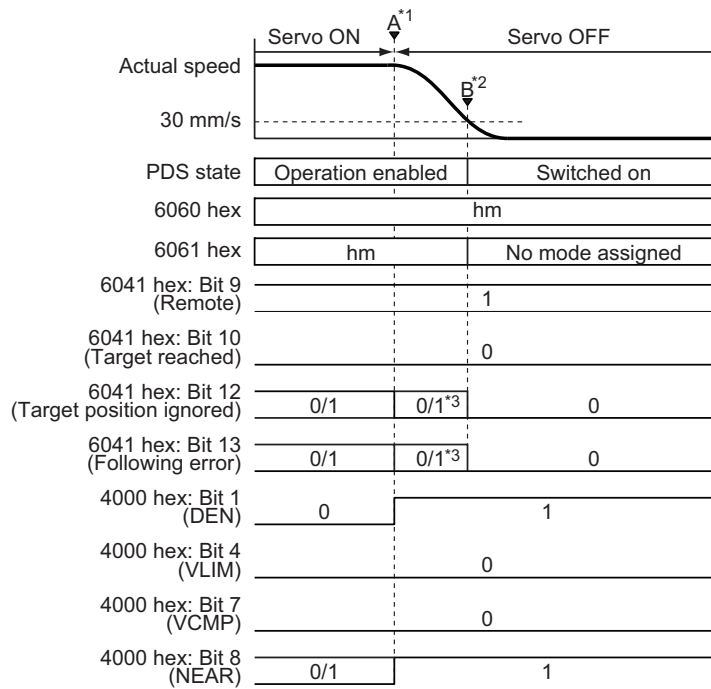
*1 When the servo is turned OFF, a deceleration stop starts and 6061 hex continues to show the same mode as the mode of operation (hm) specified in 6060 hex.

*2 After the motor stops, No mode assigned is shown by 6061 hex.

*3 Bits 12 and 13 will retain the preceding values during deceleration when the servo is turned OFF.

Note The operation during the interval from A to B for main circuit power OFF is the same as when the servo is turned OFF. The stop function due to drive prohibition is disabled during the homing operation in hm mode.
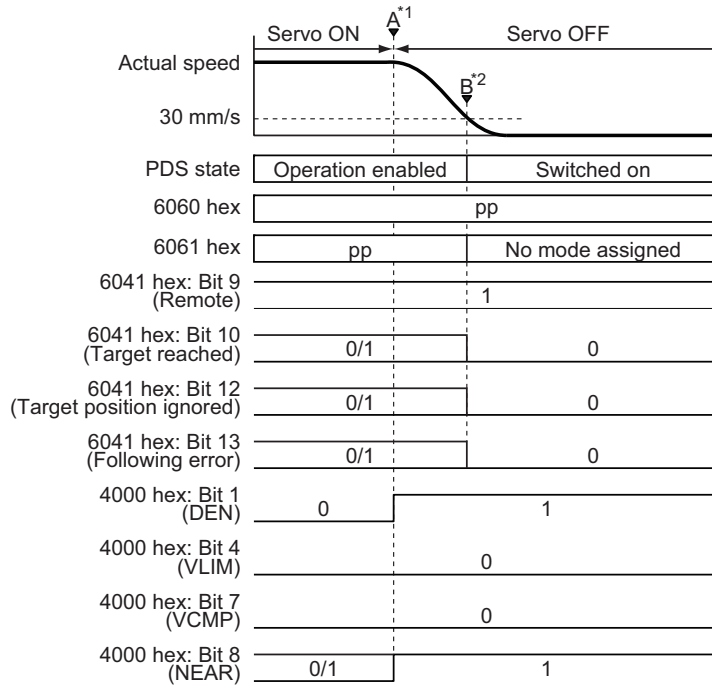
A-1 CiA402 Drive Profile

App

A-1-5 Changing the Mode of Operation

● **(e) Example of Servo OFF during Operation in pp**

	Servo ON	A*1	Servo OFF
Actual speed			
30 mm/s		B*2	
PDS state	Operation enabled		Switched on
6060 hex		pp	
6061 hex	pp		No mode assigned
6041 hex: Bit 9 (Remote)		1	
6041 hex: Bit 10 (Target reached)	0/1		0
6041 hex: Bit 12 (Target position ignored)	0/1		0
6041 hex: Bit 13 (Following error)	0/1		0
4000 hex: Bit 1 (DEN)	0		1
4000 hex: Bit 4 (VLIM)		0	
4000 hex: Bit 7 (VCMP)		0	
4000 hex: Bit 8 (NEAR)	0/1		1

*1 When the servo is turned OFF, a deceleration stop starts and 6061 hex continues to show the same mode as the mode of operation (pp) specified in 6060 hex.

*2 After the motor stops, No mode assigned is shown by 6061 hex.

Note The operation during the interval from A to B for drive prohibition and main circuit power OFF is the same as when the servo is turned OFF.

A-1-6   Homing Mode Specifications

This section describes the Homing mode of the G5 Series AC Servo Drives With Built-in EtherCAT Communications, Linear Motor Type.

Homing Mode Configuration

The configuration of the Homing mode is as follows:
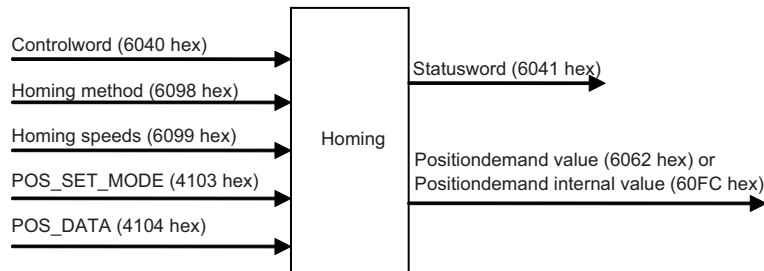
Supported Homing Methods

The following homing methods are supported by G5 Series AC Servo Drives With Built-in EtherCAT Communications, Linear Motor Type:

Homing method	Explanation	Reference page
0	Not specified	–
8	Homing by Origin Proximity Input and origin signal (positive operation start)	page A-18
12	Homing by Origin Proximity Input and origin signal (negative operation start)	page A-18
19	Homing without origin signal (positive operation start)	page A-19
20	Homing without origin signal (negativee operation start)	page A-19
33	Homing with origin signal (negative operation start)	page A-20
34	Homing with origin signal (positive operation start)	page A-20
35	Present home preset	page A-21

The homing methods supported by the Servo Drive can be checked in Supported homing method (60E3 hex).

Related Objects

Index	Sub-index	Object name	Access	Size	Unit	Setting range	Default setting
6040 hex	00 hex	Controlword	RW	U16	–	0 to FFFF hex	0000 hex
6060 hex	00 hex	Modes of operation	RW	INT8	–	0 to 10	0000 hex
6098 hex	00 hex	Homing method	RW	INT8	–	−128 to 127	0
6099 hex	01 hex	Speed during search for switch	RW	U32	Command units/s	100 to 3,276,700	5,000
6099 hex	02 hex	Speed during search for zero	RW	U32	Command units/s	100 to 3,276,700	5,000
4103 hex	00 hex	Coordinate System Setting Mode	RW	U16	–	0000 to FFFF hex	0000 hex
4104 hex	00 hex	Coordinate System Setting Position	RW	INT32	Command units	−2,147,483,648 to 2,147,483,647	0
6041 hex	00 hex	Statusword	RO	U16	–	0 to FFFF hex	0000 hex
6083 hex	00 hex	Profile acceleration	RW	U32	Command units/s^2	1 to 655,350,000	1,000,000
6084 hex	00 hex	Profile deceleration	RW	U32	Command units/s^2	1 to 655,350,000	1,000,000
6086 hex	00 hex	Motion profile type	RW	INT16	–	−1 to 0	0

G5 Series AC Servo Drives With Built-in EtherCAT Communications, Linear Motor Type

Controlword (6040 hex) in Homing Mode

Bit	Name	Code	Description
4	Homing operation start	0	Do not start homing procedure.
		1	Start or continue homing procedure.
8	Halt	0	Enable bit 4
		1	Stop axis according to halt option code (605D hex)

Bit 6 is not used.

For details on other bits, refer to *Controlword* (6040 hex).

Statusword (6041 hex) in Homing Mode

Bit	Name	Description
10	Target reached	The status of the homing operation is indicated by the combination of these bits.
12	Homing attained	The status based on the combination of the bits are shown in the following table.
13	Homing error	

Bit 13	Bit 12	Bit 10	Description
0	0	0	Homing procedure is in progress.
0	0	1	Homing procedure is interrupted or not started.
0	1	0	Homing is attained, but target is not reached.
0	1	1	Homing procedure is completed successfully.
1	0	0	Homing error occurred, velocity is not "0."
1	0	1	Homing error occurred, velocity is "0."
1	1	0	Reserved
1	1	1	Reserved

Homing Operation

This section describes the operation of the supported homing methods.

● **Homing Methods 8 and 12: Homing by Origin Proximity Input and Origin Signal**

These Homing methods use the Origin Proximity Input that is enabled only in some parts of the drive range, and stops when an origin signal is detected.

An origin signal is detected in the positive direction for Homing method 8 and in the negative direction for Homing method 12.

The operation start direction of the homing operation is the same as the direction of detection of the origin signal when the Origin Proximity Input is OFF, and the reverse direction when the Origin Proximity Input is ON.

The operation direction reverses for the positive drive prohibition input.
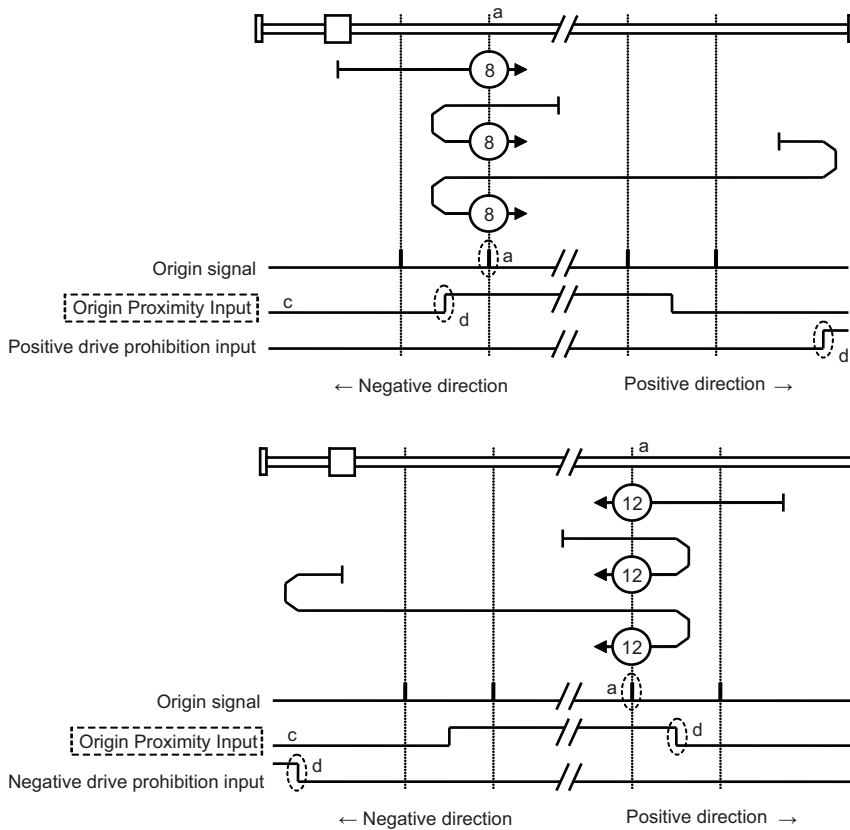
A homing error (Home error) 1 will occur in the following cases.

• When the drive prohibition inputs on both sides are ON at the same time.

• When the drive prohibition input of one side is ON, and the drive prohibition input of the other side is turned ON without detecting the rising edge of the Origin Proximity Input.

> **Precautions for Correct Use**
>
> - If an origin signal exists near the point where the Origin Proximity Input turns ON or OFF, the first origin signal after the Origin Proximity Input is turned ON or OFF may not be detected. Set the Origin Proximity Input so that the origin signal occurs away from the point where the Origin Proximity Input turns ON or OFF.
> - During the homing operation, the stop function for the Stop Selection for Drive Prohibition Input is disabled.
> - When the Drive Prohibition Input Selection (3504 hex) is set to 0, a Drive Prohibition Input Error 1 (Error No. 38.0) will occur if the drive prohibition input is detected on both sides.
> - When the Drive Prohibition Input Selection (3504 hex) is set to 1, a homing error (Home error) 1 will occur when the drive prohibition input is detected on both sides. If this Homing method is used without using the drive prohibition input, do not assign the drive prohibition input to a general-purpose input.
>   For details on assigning the general-purpose input signals, refer to *7-1 Sequence I/O Signals* on page 7-2.
> - When the Drive Prohibition Input Selection (3504 hex) is set to 2, a Drive Prohibition Input Error 1 (Error No. 38.0) will occur if the drive prohibition input is detected on one side. When using this Homing method, set the Drive Prohibition Input Selection (3504 hex) to a value other than 2.

● Homing Methods 19 and 20: Homing without an Origin Signal

In these homing methods, only the Origin Proximity Input is used. Homing method 19 stops when the Origin Proximity Input turns OFF, and Homing method 20 stops when the Origin Proximity Input turns ON. The operation start direction of the homing operation is the positive direction for an OFF Origin Proximity Input, and the negative direction for an ON Origin Proximity Input.
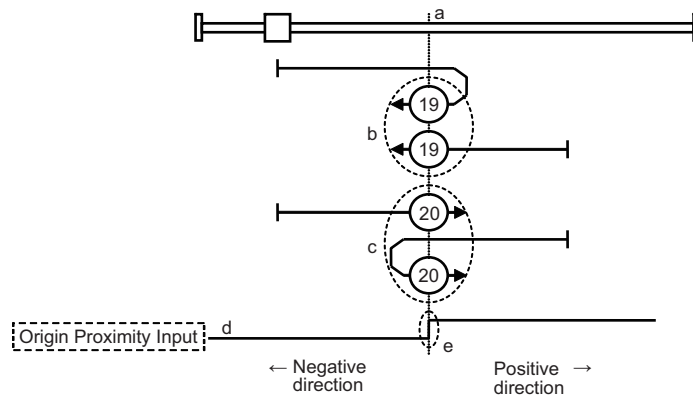
A homing error (Home error) 1 will occur in the following cases.

- When the drive prohibition inputs on both sides are ON at the same time.
- When an ON or OFF Origin Proximity Input is not detected before the drive prohibition input in the drive direction turns ON.

Precautions for Correct Use

- During the homing operation, the stop function for the Stop Selection for Drive Prohibition Input is disabled.
- When the Drive Prohibition Input Selection (3504 hex) is set to 0, a Drive Prohibition Input Error 1 (Error No. 38.0) will occur if the drive prohibition input is detected on both sides.
- When the Drive Prohibition Input Selection (3504 hex) is set to 1, a homing error (Home error) 1 will occur when the drive prohibition input is detected on both sides.
  If this Homing method is used without using the drive prohibition input, do not assign the drive prohibition input to a general-purpose input.
  For details on assigning the general-purpose input signals, refer to *7-1 Sequence I/O Signals* on page 7-2.
- When the Drive Prohibition Input Selection (3504 hex) is set to 2, a Drive Prohibition Input Error 1 (Error No. 38.0) will occur if the drive prohibition input is detected on one side.
  When using this Homing method, set the Drive Prohibition Input Selection (3504 hex) to a value other than 2.

● **Homing Methods 33 and 34: Homing with an Origin Signal**

In these Homing methods, only the origin signal is used.

The operation start direction of the homing operation is the negative direction in Homing method 33 and the positive direction in Homing method 34.
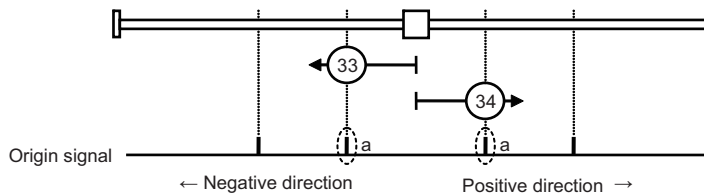
Origin signal

← Negative direction   Positive direction →

A homing error (Home error) 1 will occur in the following cases.
- When the drive prohibition inputs on both sides are ON at the same time.
- If no origin signal is detected before the drive prohibition input of the drive direction turns ON.

Precautions for Correct Use

- During the homing operation, the stop function for the Stop Selection for Drive Prohibition Input is disabled.
- When the Drive Prohibition Input Selection (3504 hex) is set to 0, a Drive Prohibition Input Error 1 (Error No. 38.0) will occur if the drive prohibition input is detected on both sides.
- When the Drive Prohibition Input Selection (3504 hex) is set to 1, a homing error (Home error) 1 will occur when the drive prohibition input is detected on both sides.
  If this Homing method is used without using the drive prohibition input, do not assign the drive prohibition input to a general-purpose input.
  For details on assigning the general-purpose input signals, refer to *7-1 Sequence I/O Signals* on page 7-2.
- When the Drive Prohibition Input Selection (3504 hex) is set to 2, a Drive Prohibition Input Error 1 (Error No. 38.0) will occur if the drive prohibition input is detected on one side.
  When using this Homing method, set the Drive Prohibition Input Selection (3504 hex) to a value other than 2.

● **Homing Method 35: Present Home Presetting**

In this Homing method, the present position is considered as the origin.

Set the mode in Coordinate System Setting Mode (4103 hex). By using the Coordinate System Setting Position (4104 hex), you can specify the value of the present position.

You can use this method even when you are using an absolute encoder, but the position is not saved in the Home offset (607C hex). When the control power is turned OFF or when Config (4100 hex) is executed, the origin set by this Homing method is disabled.

This Homing method can be executed only when the mode of operation is set to Homing mode (hm) and the servo is ON. If this Homing method is executed during the latch operation, the latch operation is disabled.

A homing error (Home error) 1 will occur in the following cases.

• During the Cyclic synchronous velocity mode (csv) or Cyclic synchronous torque mode (cst)

• When backlash compensation is not completed.

Coordinate System Setting Mode (4103 hex)

Index	Sub Index	Name	R/W	Data type	Unit	min	max	default
4103 hex	00 hex	POS_SET_MODE (Coordinate System Setting Mode)	rw	U16	-	*1	*1	83 hex

*1 For the set value, refer to the table below.

Bit	15 to 8	7	6	5	4	3 to 0
	Reserved ("0")	REFE	0	0	0	POS_SEL

The operation vary depending on whether [POS_SEL] is in bit 3 or not.

When [POS_SEL] is in bit 3

Set the value of the Coordinate System Setting Position (4104 hex) to the Position Demand Value (6062 hex) and Position Demand Value After Filtering (4018 hex).

For the Position actual value (6064 hex), set the value obtained by subtracting the Following error actual value (60F4 hex) from the Position Demand Value After Filtering (4018 hex).

When [POS_SEL] is not in bit 3

A homing error (Home error) 1 will occur.

For the [REFE], refer to the table below.

Set value	Conditions
0	The Homing not attained state is reached when this Homing method ends normally.
1	The Homing attained state is reached when this Homing method ends normally.

📝 **Precautions for Correct Use**

The REFE bits are enabled only when an incremental encoder is used. An absolute encoder is always in a Homing attained state.

Set Value of the Coordinate System Setting Position (4104 hex) and Position Actual Value (6064 hex)

Index	Sub	Name	R/W	Data type	Unit	Min	Max	Default
4104 hex	00 hex	POS_DATA (Coordinate System Setting Position)	rw	INT32	Command units	-2^{31} (8000 0000 hex)	$2^{31}-1$ (7FFF FFFF hex)	0

A-1-7　Object Dictionary

Object Dictionary Area

CAN application protocol over EtherCAT (CoE) uses the object dictionary as its base. All objects are assigned four-digit hexadecimal numbers in the areas shown in the following table.

Index	Area	Description
0000 to 0FFF hex	Data Type Area	Definitions of data types.
1000 to 1FFF hex	CoE Communication Area	Definitions of variables that can be used by all servers for designated communications.
2000 to 2FFF hex	Manufacturer Specific Area 1	Variables with common definitions for all OMRON products.
3000 to 5FFF hex	Manufacturer Specific Area 2	Variables with common definitions for all G5-series Servo Drives (servo parameters).
6000 to 9FFF hex	Device Profile Area	Variables defined in the Servo Drive's CiA402 drive profile.
A000 to FFFF hex	Reserved Area	Area reserved for future use.

Data Types

Data types shown in the following table are used in this profile.

Data Types	Code	Size	Range
Boolean	BOOL	1 bit	0 or 1
Unsigned 8	U8	1 byte	0 to 255
Unsigned 16	U16	2 bytes	0 to 65,535
Unsigned 32	U32	4 bytes	0 to 4,294,967,295
Integer 8	INT8	1 byte	−128 to 127
Integer 16	INT16	2 bytes	−32,768 to 32,767
Integer 32	INT32	4 bytes	−2,147,483,648 to 2,147,483,647
Visible string	VS	–	–
Octet string	OS	–	–

Object Description Format

In this manual, objects are described in the following format.

● Object Description Format

The object format is shown below.

\<Index\>	*\<Object name\>*					Modes of Operation	
Range	*\<Range\>*	**Unit**	*\<Unit\>*	**Default**	*\<Default\>*	**Attribute**	*\<Attribute\>*
Size	*\<Size\>*		**Access**	*\<Access\>*	**PDO map**	*\<Possible/Not possible\>*	

Data is indicated in pointed brackets <>.

Possible data are listed below.

Name	Contents
Index	Object index given by a four-digit hexadecimal number.
Object name	The object name.
Modes of Operation	Related operation modes. Common : All operation modes csp : Cyclic synchronous position mode csv : Cyclic synchronous velocity mode cst : Cyclic synchronous torque mode pp : Profile position mode hm : Homing mode
Range	The possible range of settings.
Uniit	Physical units
Default	Default value set before shipment.
Attribute	The timing when a change in the contents is updated for a writable object. A : Always updated B : Changing prohibited during motor movement or commands. If a change is made during motor movement or commands, the update timing is unknown. C : Updated after the control power is reset, or after a Config command is executed via EtherCAT communications. D : Changeable only when the EtherCAT communications state is Pre-Operational (Pre-Op). R : Updated after the control power is reset. It is not updated for a Config command via EtherCAT communications. - : Write prohibited.
Size	The object size is given in bytes.
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. Not possible : PDOs cannot be mapped.

● Format When There Is Sub-indexing

The object description format with subindices is shown below.

<Index>	<Object name>					Modes of Operation	
Sub-index 00 hex	Number of entries						
Range	*<Range>*	**Unit**	*<Unit>*	**Default**	*<Default>*	**Attribute**	*<Attribute>*
Size	*<Size>*		**Access**	*<Access>*	**PDO map**	*<Possible/Not possible>*	
Sub-index 01 hex	*<Sub-index name>*						
Range	*<Range>*	**Unit**	*<Unit>*	**Default**	*<Default>*	**Attribute**	*<Attribute>*
Size	*<Size>*		**Access**	*<Access>*	**PDO map**	*<Possible/Not possible>*	
Sub-index 02 hex	*<Sub-index name>*						
Range	*<Range>*	**Unit**	*<Unit>*	**Default**	*<Default>*	**Attribute**	*<Attribute>*
Size	*<Size>*		**Access**	*<Access>*	**PDO map**	*<Possible/Not possible>*	

:

Sub-index NN hex	*<Sub-index name>*						
Range	*<Range>*	**Unit**	*<Unit>*	**Default**	*<Default>*	**Attribute**	*<Attribute>*
Size	*<Size>*		**Access**	*<Access>*	**PDO map**	*<Possible/Not possible>*	

The data remains the same even with sub-indexing.

A-1-8   Communication Objects

1000 hex	Device Type					All	
Range	–	**Unit**	–	**Default**	0002 0192 hex	**Attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	

• Gives the CoE device profile number.

Description of Settings

Bit	Name	Contents
0 to 15	Device profile number	402 (192 hex): Drive Profile
16 to 23	Type	02: Servo Drive
25 to 31	Mode	0: Manufacturer specific

1001 hex	Error Register						All
Range	–	**Unit**	–	**Default**	0	**Attribute**	–
Size	1 byte (U8)		**Access**	RO	**PDO map**	Not possible	

- Gives the error type that has occurred in the Servo Drive.

Description of Settings

Bit	Description	Bit	Description
0	Generic error	4	Communication error
1	Current error	5	Device profile specific error
2	Voltage error	6	(Reserved)
3	Temperature error	7	Manufacturer specific error

1008 hex	Manufacturer Device Name						All
Range	–	**Unit**	–	**Default**	*1	**Attribute**	–
Size	20 bytes (VS)		**Access**	RO	**PDO map**	Not possible	

*1   The following table shows the default settings.

Specifications		Model
Single-phase 100 VAC	100 W	R88D-KN01L-ECT-L
	200 W	R88D-KN02L-ECT-L
	400 W	R88D-KN04L-ECT-L
Single-phase/3-phase 200 VAC	100 W	R88D-KN01H-ECT-L
	200 W	R88D-KN02H-ECT-L
	400 W	R88D-KN04H-ECT-L
	750 W	R88D-KN08H-ECT-L
	1 kW	R88D-KN10H-ECT-L
	1.5 kW	R88D-KN15H-ECT-L
3-phase 200 VAC	2 kW	R88D-KN20H-ECT-L
	3 kW	R88D-KN30H-ECT-L
	5 kW	R88D-KN50H-ECT-L
	7.5 kW	R88D-KN75H-ECT-L
	15 kW	R88D-KN150H-ECT-L
3-phase 400 VAC	600 W	R88D-KN06F-ECT-L
	1 kW	R88D-KN10F-ECT-L
	1.5 kW	R88D-KN15F-ECT-L
	2 kW	R88D-KN20F-ECT-L
	3 kW	R88D-KN30F-ECT-L
	5 kW	R88D-KN50F-ECT-L
	7.5 kW	R88D-KN75F-ECT-L
	15 kW	R88D-KN150F-ECT-L

- Gives the Servo Drive model number.

1009 hex	Manufacturer Hardware Version						All
Range	–	**Unit**	–	**Default**	–	**Attribute**	–
Size	20 bytes (VS)	**Access**	RO	**PDO map**	Not possible		

- Gives the version of the Servo Drive hardware.
- This is not used by G5-series Servo Drives.

100A hex	Manufacturer Software Version						All
Range	–	**Unit**	–	**Default**	*1	**Attribute**	–
Size	20 bytes (VS)	**Access**	RO	**PDO map**	Not possible		

1 The version number is saved in "V.**".

- Gives the version of the Servo Drive software.

1010 hex	Store Parameters						All
Sub-index 00 hex	Number of entries						
Range	–	**Unit**	–	**Default**	01 hex	**Attribute**	–
Size	1 byte (U8)	**Access**	RO	**PDO map**	Not possible		
Sub-index 01 hex	Store Parameters						
Range	–	**Unit**	–	**Default**	0000 0001 hex	**Attribute**	A
Size	4 bytes (U32)	**Access**	RW	**PDO map**	Not possible		

- All savable parameters are saved in the Servo Drive EEPROM.
- Saving is executed only when a specific value is written to sub-index 01 hex. This prevents parameter values from being accidentally overwritten.
- The specific value means "save".

MSB			LSB
e	v	a	s
65 hex	76 hex	61 hex	73 hex

- A value of 0000 0001 hex (command valid) is given when reading.
- Nothing can be saved to the EEPROM while there is a Control Power Supply Undervoltage Error (Error No. 11.0).
- Objects with attribute C are enabled for Config (4100 hex) or when the control power supply is reset.
- Objects with attribute R are enabled when the control power supply is reset.
- In the following cases, an ABORT code is returned.
  Writing with CompleteAccess.
  Writing a value other than 6576 6173 hex.
  Writing when there is a Control Power Supply Undervoltage Error (Error No. 11.0).
- Writing to the EEPROM may take up to 10 seconds. (This is when all objects are changed.)
- There is a limit to the number of times you can write to the EEPROM.
- The following objects are saved.

Index	Sub-index	Description
2200 hex	00 hex	Communications Error Setting
3000 to 3999 hex	00 hex	All G5-series Servo Drive parameters
605B hex	00 hex	Shutdown option code
605C hex	00 hex	Disable operation option code
605E hex	00 hex	Fault reaction option code

Index	Sub-index	Description
6065 hex	00 hex	Following error window
607C hex	00 hex	Home offset
607D hex	01 hex	Min position limit
607D hex	02 hex	Max position limit
6091 hex	01 hex	Motor revolutions
6091 hex	02 hex	Shaft revolutions
60E0 hex	00 hex	Positive torque limit value
60E1 hex	00 hex	Negative torque limit value

1011 hex	Restore Default Parameters						All
Sub-index 00 hex	Number of entries						
Range	–	**Unit**	–	**Default**	01 hex	**Attribute**	–
Size	1 byte (U8)		**Access**	RO	**PDO map**	Not possible	
Sub-index 01 hex	Restore all default parameters						
Range	–	**Unit**	–	**Default**	000 0001 hex	**Attribute**	A
Size	4 bytes (U32)		**Access**	RW	**PDO map**	Not possible	

- Parameters are returned to their default values.
- A restoration operation is executed only when a specific value is written to sub-index 01 hex. This prevents parameter values from being accidentally overwritten.
- The specific value means "load."

MSB			LSB
d	a	o	l
64 hex	61 hex	6F hex	6C hex

- A value of 0000 0001 hex (command valid) is given when reading.
- EEPROM contents cannot be reset to default values if there is a Control Power Supply Undervoltage Error (Error No. 11.0).
- Reset the control power supply to enable the objects.
- In the following cases, an ABORT code is returned.
  Writing with CompleteAccess.
  Writing a value other than 6461 6F6C hex.
  Writing when there is a Control Power Supply Undervoltage Error (Error No. 11.0).
  Writing in operation enabled state.
- Writing to the EEPROM may take up to 10 seconds. (This is when all objects are changed.)
- There is a limit to the number of times you can write to the EEPROM.

A-1 CiA402 Drive Profile

App

A-1-8 Communication Objects

1018 hex	Identity Object						All
Sub-index 00 hex	Number of entries						
Range	–	**Unit**	–	**Default**	04 hex	**Attribute**	–
Size	1 byte (U8)		**Access**	RO	**PDO map**	Not possible	
Sub-index 01 hex	Vender ID						
Range	–	**Unit**	–	**Default**	0000 0083 hex	**Attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	
Sub-index 02 hex	Product Code						
Range	–	**Unit**	–	**Default**	Refer to the table.	**Attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	
Sub-index 03 hex	Revision Number						
Range	–	**Unit**	–	**Default**	Refer to the table.	**Attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	
Sub-index 04 hex	Serial Number						
Range	–	**Unit**	–	**Default**	0000 0000 hex	**Attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	

- This object contains device information.
- Sub-index 01 hex (Vendor ID) gives the manufacturer identifier.
- Sub-index 02 hex (Product Code) gives the value assigned to each device.

Specifications		Model	Product Code
Single-phase 100 VAC	100 W	R88D-KN01L-ECT-L	0000 0066 hex
	200 W	R88D-KN02L-ECT-L	0000 0067 hex
	400 W	R88D-KN04L-ECT-L	0000 0068 hex
Single-phase/3-phase 200 VAC	100 W	R88D-KN01H-ECT-L	0000 0069 hex
	200 W	R88D-KN02H-ECT-L	0000 006A hex
	400 W	R88D-KN04H-ECT-L	0000 006B hex
	750 W	R88D-KN08H-ECT-L	0000 006C hex
	1 kW	R88D-KN10H-ECT-L	0000 006D6 hex
	1.5 kW	R88D-KN15H-ECT-L	0000 006E hex
3-phase 200 VAC	2 kW	R88D-KN20H-ECT-L	0000 006F hex
	3 kW	R88D-KN30H-ECT-L	0000 0070 hex
	5 kW	R88D-KN50H-ECT-L	0000 0071 hex
	7.5 kW	R88D-KN75H-ECT-L	0000 0072 hex
	15 kW	R88D-KN150H-ECT-L	0000 0073 hex
3-phase 400 VAC	600 W	R88D-KN06F-ECT-L	0000 0074 hex
	1 kW	R88D-KN10F-ECT-L	0000 0075 hex
	1.5 kW	R88D-KN15F-ECT-L	0000 0076 hex
	2 kW	R88D-KN20F-ECT-L	0000 0077 hex
	3 kW	R88D-KN30F-ECT-L	0000 0078 hex
	5 kW	R88D-KN50F-ECT-L	0000 0079 hex
	7.5 kW	R88D-KN75F-ECT-L	0000 007A hex
	15 kW	R88D-KN150F-ECT-L	0000 007B hex

- Sub-index 03 hex (Revision Number) gives the device revision number.

Bits	Description
0 to 15	Device's minor revision number
16 to 31	Device's major revision number

- Sub-index 04 hex (Serial number) is not used. A value of 0000 0000 hex is always given.

10F0 hex	Backup Parameters Mode						All
Sub-index 00 hex	Number of entries						
Range	–	**Unit**	–	**Default**	02 hex	**Attribute**	–
Size	1 byte (U8)		**Access**	RO	**PDO map**	Not possible	
Sub-index 01 hex	Backup Parameter Checksum						
Range	–	**Unit**	–	**Default**	–	**Attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	
Sub-index 02 hex	Backup Parameter Changed						
Range	–	**Unit**	–	**Default**	0	**Attribute**	A
Size	1 bit (BOOL)		**Access**	RW	**PDO map**	Not possible	

- This object gives the state of EEPROM changes.
- Sub-index 01 hex (Backup Parameter Checksum) gives the EEPROM's checksum value. The checksum value is calculated based on objects saved for Store parameters (1010 hex).
- Sub-index 02 hex (Backup Parameter Changed) gives "1" when the EEPROM is changed. After you have checked that it is "1", write "0" to it from the Master.

10F3 hex	Diagnosis History						All
Sub-index 00 hex	Number of entries						
Range	–	**Unit**	–	**Default**	13 hex	**Attribute**	–
Size	1 byte (U8)		**Access**	RO	**PDO map**	Not possible	
Sub-index 01 hex	Maximum Messages						
Range	00 to 0E hex	**Unit**	–	**Default**	00 hex	**Attribute**	–
Size	1 byte (U8)		**Access**	RO	**PDO map**	Not possible	
Sub-index 02 hex	Newest Message						
Range	06 to 13 hex	**Unit**	–	**Default**	06 hex	**Attribute**	–
Size	1 byte (U8)		**Access**	RO	**PDO map**	Not possible	
Sub-index 05 hex	Flags						
Range	0000 to 0001 hex	**Unit**	–	**Default**	0000 hex	**Attribute**	A
Size	2 bytes (U16)		**Access**	RW	**PDO map**	Not possible	
Sub-indexes 06 to 13 hex	Diagnosis Messages 1 to 14						
Range	–	**Unit**	–	**Default**	–	**Attribute**	–
Size	16 bytes (VS)		**Access**	RO	**PDO map**	Not possible	

- This object gives up to 14 error history items. It also enables/disables emergency messages.
- Sub-index 01 hex (Maximum Messages) gives the number of error messages.
- Sub-index 02 hex (Newest Message) gives the sub index where the latest error history is saved.
- Sub-index 05 hex (Flags) sets whether or not to notify the error history as an emergency message. It is set to Emergency Message Disabled (0000 hex) when power is turned ON. Write 0001 hex from the master to enable this function.
- Sub-indexes 06 to 13 hex (Diagnosis Messages 1 to 14) give the error history. The error history is saved in Diagnosis Messages 1 to 14 in ascending order. When the 15th error is reached, it is saved as Diagnosis Message 1 and the sequence starts again.

A-1-9   PDO Mapping Objects

Indexes 1600 to 17FF hex are used for Receive PDO mapping and indexes 1A00 to 1BFF hex are used for Transmit PDO mapping. Sub-indexes after sub-index 01 hex provide information about the application object being mapped.

31	16	15	8	7	0
	Index		Sub-index		Bit length

MSB   LSB
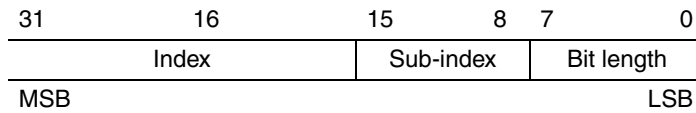
Bits 0 to 7:   Bit length of the mapped object. (For example, for 32 bits, 20 hex is given.)

Bits 8 to 15:   Sub-index of the mapped object.

Bits 16 to 31:   Index of the mapped object.

1600 hex	1st receive PDO Mapping						All
Sub-index 00 hex	Number of objects in this PDO						
Setting range	00 to 0A hex	**Unit**	–	**Default setting**	03 hex	**Attribute**	D
Size	1 byte (U8)	**Access**	RW	**PDO map**	Not possible.		
Sub-index 01 hex	PDO entry 1 (1st Output Object to be mapped)						
Setting range	–	**Unit**	–	**Default setting**	6040 0010 hex	**Attribute**	D
Size	4 byte (U32)	**Access**	RW	**PDO map**	Not possible.		
Sub-index 02 hex	PDO entry 2 (2nd Output Object to be mapped)						
Setting range	–	**Unit**	–	**Default setting**	607A 0020 hex	**Attribute**	D
Size	4 byte (U32)	**Access**	RW	**PDO map**	Not possible.		
Sub-index 03 hex	PDO entry 3 (3rd Output Object to be mapped)						
Setting range	–	**Unit**	–	**Default setting**	60B8 0010 hex	**Attribute**	D
Size	4 byte (U32)	**Access**	RW	**PDO map**	Not possible.		
Sub-index 04 hex	PDO entry 4 (4th Output Object to be mapped)						
Setting range	–	**Unit**	–	**Default setting**	0000 0000 hex	**Attribute**	D
Size	4 byte (U32)	**Access**	RW	**PDO map**	Not possible.		
Sub-index 05 hex	PDO entry 5 (5th Output Object to be mapped)						
Setting range	–	**Unit**	–	**Default setting**	0000 0000 hex	**Attribute**	D
Size	4 byte (U32)	**Access**	RW	**PDO map**	Not possible.		
Sub-index 06 hex	PDO entry 6 (6th Output Object to be mapped)						
Setting range	–	**Unit**	–	**Default setting**	0000 0000 hex	**Attribute**	D
Size	4 byte (U32)	**Access**	RW	**PDO map**	Not possible.		
Sub-index 07 hex	PDO entry 7 (7th Output Object to be mapped)						
Setting range	–	**Unit**	–	**Default setting**	0000 0000 hex	**Attribute**	D
Size	4 byte (U32)	**Access**	RW	**PDO map**	Not possible.		
Sub-index 08 hex	PDO entry 8 (8th Output Object to be mapped)						
Setting range	–	**Unit**	–	**Default setting**	0000 0000 hex	**Attribute**	D
Size	4 byte (U32)	**Access**	RW	**PDO map**	Not possible.		
Sub-index 09 hex	PDO entry 9 (9th Output Object to be mapped)						
Setting range	–	**Unit**	–	**Default setting**	0000 0000 hex	**Attribute**	D
Size	4 byte (U32)	**Access**	RW	**PDO map**	Not possible.		
Sub-index 0A hex	PDO entry 10 (10th Output Object to be mapped)						
Setting range	–	**Unit**	–	**Default setting**	0000 0000 hex	**Attribute**	D
Size	4 byte (U32)	**Access**	RW	**PDO map**	Not possible.		

• These object mappings can be changed only when the EtherCAT communications state is Pre-Operational (Pre-Op).

- Since the mappings you changed are not saved in EEPROM, you must specify objects each time you turn ON the power of the G5-series Servo Drive in order to use the mapping other than the default setting.
- You can map up to 10 objects in a PDO mapping. If you attempt to map 11 or more objects, a Function Setting Error (Error No. 93.4) will occur.
- The communications cycle you can set varies depending on the total size of mapped objects. Refer to *A-1-3 Communications Cycles and Corresponding Modes of Operation* on page A-5. If the number of the mapped objects is 0, a Function Setting Error (Error No. 93.4) will occur.
- If you map the same object more than once, the value of the last object will be enabled.
- If any of the following operations is attempted, an ABORT code will be returned.

    Writing when the EtherCAT communications state is Safe-Operational (Safe-Op) or Operational (Op)

    Writing with non-existent objects specified

    Writing with incorrect object size specified

    Writing with objects that cannot be mapped in the PDO mapping specified
- The following objects can be mapped to the Receive PDO mapping.

Index	Sub-Index	Bit length	Object name
4103 hex	00 hex	10 hex	Coordinate System Setting Mode
4104 hex	00 hex	20 hex	Coordinate System Setting Position
6040 hex	00 hex	10 hex	Controlword
6060 hex	00 hex	08 hex	Modes of operation
6071 hex	00 hex	10 hex	Target torque
6072 hex	00 hex	10 hex	Max torque
607A hex	00 hex	20 hex	Target position
607F hex	00 hex	20 hex	Max profile velocity
6081 hex	00 hex	20 hex	Profile velocity
6086 hex	00 hex	10 hex	Motion profile type
60B0 hex	00 hex	20 hex	Position offset
60B1 hex	00 hex	20 hex	Velocity offset
60B2 hex	00 hex	10 hex	Torque offset
60B8 hex	00 hex	10 hex	Touch probe function
60E0 hex	00 hex	10 hex	Positive torque limit value
60E1 hex	00 hex	10 hex	Negative torque limit value
60FE hex	01 hex	20 hex	Physical outputs
60FF hex	00 hex	20 hex	Target velocity

1701 hex	258th receive PDO Mapping						All
Sub-index 00 hex	Number of objects in this PDO						
Range	–	**Unit**	–	**Default**	04 hex	**Attribute**	–
Size	1 byte (U8)	**Access**	RO	**PDO map**	Not possible		
Sub-index 01 hex	PDO entry 1 (1st Output Object to be mapped)						
Range	–	**Unit**	–	**Default**	6040 0010 hex	**Attribute**	–
Size	4 bytes (U32)	**Access**	RO	**PDO map**	Not possible		
Sub-index 02 hex	PDO entry 2 (2nd Output Object to be mapped)						
Range	–	**Unit**	–	**Default**	607A 0020 hex	**Attribute**	–
Size	4 bytes (U32)	**Access**	RO	**PDO map**	Not possible		
Sub-index 03 hex	PDO entry 3 (3rd Output Object to be mapped)						
Range	–	**Unit**	–	**Default**	60B8 0010 hex	**Attribute**	–
Size	4 bytes (U32)	**Access**	RO	**PDO map**	Not possible		
Sub-index 04 hex	PDO entry 4 (4th Output Object to be mapped)						
Range	–	**Unit**	–	**Default**	60FE 0120 hex	**Attribute**	–
Size	4 bytes (U32)	**Access**	RO	**PDO map**	Not possible		

- This object gives the mapping for an application that uses only cyclic synchronous position control (csp).
- Touch probe function is available.
- The following objects are mapped.

  Controlword (6040 hex), Target position (607A hex), Touch probe function (60B8 hex), and Digital outputs (60FE hex)

1702 hex	259th receive PDO Mapping						All
Sub-index 00 hex	Number of objects in this PDO						
Range	–	**Unit**	–	**Default**	07 hex	**Attribute**	–
Size	1 byte (U8)		**Access**	RO	**PDO map**	Not possible	
Sub-index 01 hex	PDO entry 1 (1st Output Object to be mapped)						
Range	–	**Unit**	–	**Default**	6040 0010 hex	**Attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	
Sub-index 02 hex	PDO entry 2 (2nd Output Object to be mapped)						
Range	–	**Unit**	–	**Default**	607A 0020 hex	**Attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	
Sub-index 03 hex	PDO entry 3 (3rd Output Object to be mapped)						
Range	–	**Unit**	–	**Default**	60FF 0020 hex	**Attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	
Sub-index 04 hex	PDO entry 4 (4th Output Object to be mapped)						
Range	–	**Unit**	–	**Default**	6071 0010 hex	**Attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	
Sub-index 05 hex	PDO entry 5 (5th Output Object to be mapped)						
Range	–	**Unit**	–	**Default**	6060 0008 hex	**Attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	
Sub-index 06 hex	PDO entry 6 (6th Output Object to be mapped)						
Range	–	**Unit**	–	**Default**	60B8 0010 hex	**Attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	
Sub-index 07 hex	PDO entry 7 (7th Output Object to be mapped)						
Range	–	**Unit**	–	**Default**	607F 0020 hex	**Attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	

- This is the mapping for an application that uses one of the following modes: Cyclic synchronous position mode (csp), Cyclic synchronous velocity mode (csv), and Cyclic synchronous torque mode (cst).
- Touch probe function is available.

1703 hex	260th receive PDO Mapping						All
Sub-index 00 hex	Number of objects in this PDO						
Range	–	**Unit**	–	**Default**	07 hex	**Attribute**	–
Size	1 byte (U8)	**Access**	RO	**PDO map**	Not possible		
Sub-index 01 hex	PDO entry 1 (1st Output Object to be mapped)						
Range	–	**Unit**	–	**Default**	6040 0010 hex	**Attribute**	–
Size	4 bytes (U32)	**Access**	RO	**PDO map**	Not possible		
Sub-index 02 hex	PDO entry 2 (2nd Output Object to be mapped)						
Range	–	**Unit**	–	**Default**	607A 0020 hex	**Attribute**	–
Size	4 bytes (U32)	**Access**	RO	**PDO map**	Not possible		
Sub-index 03 hex	PDO entry 3 (3rd Output Object to be mapped)						
Range	–	**Unit**	–	**Default**	60FF 0020 hex	**Attribute**	–
Size	4 bytes (U32)	**Access**	RO	**PDO map**	Not possible		
Sub-index 04 hex	PDO entry 4 (4th Output Object to be mapped)						
Range	–	**Unit**	–	**Default**	6060 0008 hex	**Attribute**	–
Size	4 bytes (U32)	**Access**	RO	**PDO map**	Not possible		
Sub-index 05 hex	PDO entry 5 (5th Output Object to be mapped)						
Range	–	**Unit**	–	**Default**	60B8 0010 hex	**Attribute**	–
Size	4 bytes (U32)	**Access**	RO	**PDO map**	Not possible		
Sub-index 06 hex	PDO entry 6 (6th Output Object to be mapped)						
Range	–	**Unit**	–	**Default**	60E0 0010 hex	**Attribute**	–
Size	4 bytes (U32)	**Access**	RO	**PDO map**	Not possible		
Sub-index 07 hex	PDO entry 7 (7th Output Object to be mapped)						
Range	–	**Unit**	–	**Default**	60E1 0010 hex	**Attribute**	–
Size	4 bytes (U32)	**Access**	RO	**PDO map**	Not possible		

- This is the mapping for an application that switches between Cyclic synchronous position mode (csp) and Cyclic synchronous velocity mode (csv).
- Touch probe and force limit are available.

1704 hex	261th receive PDO Mapping						All
Sub-index 00 hex	Number of objects in this PDO						
Range	–	**Unit**	–	**Default**	09 hex	**Attribute**	–
Size	1 byte (U8)		**Access**	RO	**PDO map**	Not possible	
Sub-index 01 hex	PDO entry 1 (1st Output Object to be mapped)						
Range	–	**Unit**	–	**Default**	6040 0010 hex	**Attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	
Sub-index 02 hex	PDO entry 2 (2nd Output Object to be mapped)						
Range	–	**Unit**	–	**Default**	607A 0020 hex	**Attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	
Sub-index 03 hex	PDO entry 3 (3rd Output Object to be mapped)						
Range	–	**Unit**	–	**Default**	60FF 0020 hex	**Attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	
Sub-index 04 hex	PDO entry 4 (4th Output Object to be mapped)						
Range	–	**Unit**	–	**Default**	6071 0010 hex	**Attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	
Sub-index 05 hex	PDO entry 5 (5th Output Object to be mapped)						
Range	–	**Unit**	–	**Default**	6060 0008 hex	**Attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	
Sub-index 06 hex	PDO entry 6 (6th Output Object to be mapped)						
Range	–	**Unit**	–	**Default**	60B8 0010 hex	**Attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	
Sub-index 07 hex	PDO entry 7 (7th Output Object to be mapped)						
Range	–	**Unit**	–	**Default**	607F 0020 hex	**Attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	
Sub-index 08 hex	PDO entry 8 (8th Output Object to be mapped)						
Range	–	**Unit**	–	**Default**	60E0 0010 hex	**Attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	
Sub-index 09 hex	PDO entry 9 (9th Output Object to be mapped)						
Range	–	**Unit**	–	**Default**	60E1 0010 hex	**Attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	

- This is the mapping for an application that uses one of the following modes: Cyclic synchronous position mode (csp), Cyclic synchronous velocity mode (csv), and Cyclic synchronous torque mode (cst).
- Touch probe and force limit are available.

1705 hex	262th receive PDO Mapping						All
Sub-index 00 hex	Number of objects in this PDO						
Range	–	**Unit**	–	**Default**	08 hex	**Attribute**	–
Size	1 byte (U8)		**Access**	RO	**PDO map**	Not possible	
Sub-index 01 hex	PDO entry 1 (1st Output Object to be mapped)						
Range	–	**Unit**	–	**Default**	6040 0010 hex	**Attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	
Sub-index 02 hex	PDO entry 2 (2nd Output Object to be mapped)						
Range	–	**Unit**	–	**Default**	607A 0020 hex	**Attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	
Sub-index 03 hex	PDO entry 3 (3rd Output Object to be mapped)						
Range	–	**Unit**	–	**Default**	60FF 0020 hex	**Attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	
Sub-index 04 hex	PDO entry 4 (4th Output Object to be mapped)						
Range	–	**Unit**	–	**Default**	6060 0008 hex	**Attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	
Sub-index 05 hex	PDO entry 5 (5th Output Object to be mapped)						
Range	–	**Unit**	–	**Default**	60B8 0010 hex	**Attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	
Sub-index 06 hex	PDO entry 6 (6th Output Object to be mapped)						
Range	–	**Unit**	–	**Default**	60E0 0010 hex	**Attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	
Sub-index 07 hex	PDO entry 7 (7th Output Object to be mapped)						
Range	–	**Unit**	–	**Default**	60E1 0010 hex	**Attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	
Sub-index 08 hex	PDO entry 8 (8th Output Object to be mapped)						
Range	–	**Unit**	–	**Default**	60B2 0010 hex	**Attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	

- This is the mapping for an application that switches between Cyclic synchronous position mode (csp) and Cyclic synchronous velocity mode (csv).
- Touch probe and force limit are available.
- The force feed-forward amount can be specified using the Torque offset (60B2 hex).

1A00 hex	1st transmit PDO Mapping						All
Sub-index 00 hex	Number of objects in this PDO						
Setting range	00 to 0A hex	**Unit**	–	**Default**	07 hex	**Attribute**	D
Size	1 byte (U8)		**Access**	RW	**PDO map**	Not possible	
Sub-index 01 hex	PDO entry 1 (1st Input Object to be mapped)						
Setting range	–	**Unit**	–	**Default setting**	6041 0010 hex	**Attribute**	D
Size	4 byte (U32)		**Access**	RW	**PDO map**	Not possible.	
Sub-index 02 hex	PDO entry 2 (2nd Input Object to be mapped)						
Setting range	–	**Unit**	–	**Default setting**	6064 0020 hex	**Attribute**	D
Size	4 byte (U32)		**Access**	RW	**PDO map**	Not possible.	
Sub-index 03 hex	PDO entry 3 (3rd Input Object to be mapped)						
Setting range	–	**Unit**	–	**Default setting**	60B9 0010 hex	**Attribute**	D
Size	4 byte (U32)		**Access**	RW	**PDO map**	Not possible.	
Sub-index 04 hex	PDO entry 4 (4th Input Object to be mapped)						
Setting range	–	**Unit**	–	**Default setting**	60BA 0020 hex	**Attribute**	D
Size	4 byte (U32)		**Access**	RW	**PDO map**	Not possible.	
Sub-index 05 hex	PDO entry 5 (5th Input Object to be mapped)						
Setting range	–	**Unit**	–	**Default setting**	60BC 0020 hex	**Attribute**	D
Size	4 byte (U32)		**Access**	RW	**PDO map**	Not possible.	
Sub-index 06 hex	PDO entry 6 (6th Input Object to be mapped)						
Setting range	–	**Unit**	–	**Default setting**	603F 0010 hex	**Attribute**	D
Size	4 byte (U32)		**Access**	RW	**PDO map**	Not possible.	
Sub-index 07 hex	PDO entry 7 (7th Input Object to be mapped)						
Setting range	–	**Unit**	–	**Default setting**	60FD 0020 hex	**Attribute**	D
Size	4 byte (U32)		**Access**	RW	**PDO map**	Not possible.	
Sub-index 08 hex	PDO entry 8 (8th Input Object to be mapped)						
Setting range	–	**Unit**	–	**Default setting**	0000 0000 hex	**Attribute**	D
Size	4 byte (U32)		**Access**	RW	**PDO map**	Not possible.	
Sub-index 09 hex	PDO entry 9 (9th Input Object to be mapped)						
Setting range	–	**Unit**	–	**Default setting**	0000 0000 hex	**Attribute**	D
Size	4 byte (U32)		**Access**	RW	**PDO map**	Not possible.	
Sub-index 0A hex	PDO entry 10 (10th Input Object to be mapped)						
Setting range	–	**Unit**	–	**Default setting**	0000 0000 hex	**Attribute**	D
Size	4 byte (U32)		**Access**	RW	**PDO map**	Not possible.	

- These object mappings can be changed only when the EtherCAT communications state is Pre-Operational (Pre-Op).
- Since the mappings you changed are not saved in EEPROM, you must specify objects each time you turn ON the power of the G5-series Servo Drive in order to use the mapping other than the default setting.
- You can map up to 10 objects in a PDO mapping. If you attempt to map 11 or more objects, a Function Setting Error (Error No. 93.4) will occur.
- The communications cycle you can set varies depending on the total size of mapped objects. Refer to *A-1-3 Communications Cycles and Corresponding Modes of Operation* on page A-5.
- If the number of the mapped objects is 0, a Function Setting Error (Error No. 93.4) will occur.
- If you map the same object more than once, the value of the last object will be enabled.
- If any of the following operations is attempted, an ABORT code will be returned.

  Writing when the EtherCAT communications state is Safe-Operational (Safe-Op) or Operational (Op)

  Writing with non-existent objects specified

  Writing with incorrect object size specified

  Writing with objects that cannot be mapped in the PDO mapping specified

• The following objects can be mapped to the Receive PDO mapping.

Index	Sub-Index	Bit length	Object name
2002 hex	01 hex	08 hex	Sysmac Error Status
4000 hex	00 hex	10 hex	Statusword1
4001 hex	00 hex	10 hex	Sub Error Code
603F hex	00 hex	10 hex	Error code
6041 hex	00 hex	10 hex	Statusword
6061 hex	00 hex	08 hex	Modes of operation display
6062 hex	00 hex	20 hex	Position demand value
6063 hex	00 hex	20 hex	Position actual internal value
6064 hex	00 hex	20 hex	Position actual value
606C hex	00 hex	20 hex	Velocity actual value
6074 hex	00 hex	10 hex	Torque demand
6077 hex	00 hex	10 hex	Torque actual value
60B9 hex	00 hex	10 hex	Touch probe status
60BA hex	00 hex	20 hex	Touch probe pos1 pos value
60BC hex	00 hex	20 hex	Touch probe pos2 pos value
60F4 hex	00 hex	20 hex	Following error actual value
60FA hex	00 hex	20 hex	Control effort
60FC hex	00 hex	20 hex	Position demand internal value
60FD hex	00 hex	20 hex	Digital inputs

1B01 hex	258th transmit PDO Mapping						All
Sub-index 00 hex	Number of objects in this PDO						
Range	–	**Unit**	–	**Default**	09 hex	**Attribute**	–
Size	1 byte (U8)		**Access**	RO	**PDO map**	Not possible	
Sub-index 01 hex	PDO entry 1 (1st Input Object to be mapped)						
Range	–	**Unit**	–	**Default**	603F 0010 hex	**Attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	
Sub-index 02 hex	PDO entry 2 (2nd Input Object to be mapped)						
Range	–	**Unit**	–	**Default**	6041 0010 hex	**Attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	
Sub-index 03 hex	PDO entry 3 (3rd Input Object to be mapped)						
Range	–	**Unit**	–	**Default**	6064 0020 hex	**Attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	
Sub-index 04 hex	PDO entry 4 (4th Input Object to be mapped)						
Range	–	**Unit**	–	**Default**	6077 0010 hex	**Attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	
Sub-index 05 hex	PDO entry 5 (5th Input Object to be mapped)						
Range	–	**Unit**	–	**Default**	60F4 0020 hex	**Attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	
Sub-index 06 hex	PDO entry 6 (6th Input Object to be mapped)						
Range	–	**Unit**	–	**Default**	60B9 0010 hex	**Attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	
Sub-index 07 hex	PDO entry 7 (7th Input Object to be mapped)						
Range	–	**Unit**	–	**Default**	60BA 0020 hex	**Attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	
Sub-index 08 hex	PDO entry 8 (8th Input Object to be mapped)						
Range	–	**Unit**	–	**Default**	60BC 0020 hex	**Attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	
Sub-index 09 hex	PDO entry 9 (9th Input Object to be mapped)						
Range	–	**Unit**	–	**Default**	60FD 0020 hex	**Attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	

- This object gives the mapping for an application that uses only cyclic synchronous position control (csp).
- Touch probe status is available.
- The following objects are mapped.

Error code (603F hex)	Torque actual value (6077 hex)	Touch probe pos1 pos value (60BA hex)
Statusword (6041 hex)	Following error actual value (60F4 hex)	Touch probe pos2 pos value (60BC hex)
Position actual value (6064 hex)	Touch probe status (60B9 hex)	Digital inputs (60FD hex)

1B02 hex	259th transmit PDO Mapping						All
Sub-index 00 hex	Number of objects in this PDO						
Range	–	**Unit**	–	**Default**	09 hex	**Attribute**	–
Size	1 byte (U8)		**Access**	RO	**PDO map**	Not possible	
Sub-index 01 hex	PDO entry 1 (1st Input Object to be mapped)						
Range	–	**Unit**	–	**Default**	603F 0010 hex	**Attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	
Sub-index 02 hex	PDO entry 2 (2nd Input Object to be mapped)						
Range	–	**Unit**	–	**Default**	6041 0010 hex	**Attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	
Sub-index 03 hex	PDO entry 3 (3rd Input Object to be mapped)						
Range	–	**Unit**	–	**Default**	6064 0020 hex	**Attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	
Sub-index 04 hex	PDO entry 4 (4th Input Object to be mapped)						
Range	–	**Unit**	–	**Default**	6077 0010 hex	**Attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	
Sub-index 05 hex	PDO entry 5 (5th Input Object to be mapped)						
Range	–	**Unit**	–	**Default**	6061 0008 hex	**Attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	
Sub-index 06 hex	PDO entry 6 (6th Input Object to be mapped)						
Range	–	**Unit**	–	**Default**	60B9 0010 hex	**Attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	
Sub-index 07 hex	PDO entry 7 (7th Input Object to be mapped)						
Range	–	**Unit**	–	**Default**	60BA 0020 hex	**Attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	
Sub-index 08 hex	PDO entry 8 (8th Input Object to be mapped)						
Range	–	**Unit**	–	**Default**	60BC 0020 hex	**Attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	
Sub-index 09 hex	PDO entry 9 (9th Input Object to be mapped)						
Range	–	**Unit**	–	**Default**	60FD 0020 hex	**Attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	

- This is the mapping for an application that uses different modes of operation.
- Touch probe status is available.

1B03 hex	260th transmit PDO Mapping						All
Sub-index 00 hex	Number of objects in this PDO						
Range	–	**Unit**	–	**Default**	0A hex	**Attribute**	–
Size	1 byte (U8)		**Access**	RO	**PDO map**	Not possible	
Sub-index 01 hex	PDO entry 1 (1st Input Object to be mapped)						
Range	–	**Unit**	–	**Default**	603F 0010 hex	**Attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	
Sub-index 02 hex	PDO entry 2 (2nd Input Object to be mapped)						
Range	–	**Unit**	–	**Default**	6041 0010 hex	**Attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	
Sub-index 03 hex	PDO entry 3 (3rd Input Object to be mapped)						
Range	–	**Unit**	–	**Default**	6064 0020 hex	**Attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	
Sub-index 04 hex	PDO entry 4 (4th Input Object to be mapped)						
Range	–	**Unit**	–	**Default**	6077 0010 hex	**Attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	
Sub-index 05 hex	PDO entry 5 (5th Input Object to be mapped)						
Range	–	**Unit**	–	**Default**	60F4 0020 hex	**Attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	
Sub-index 06 hex	PDO entry 6 (6th Input Object to be mapped)						
Range	–	**Unit**	–	**Default**	6061 0008 hex	**Attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	
Sub-index 07 hex	PDO entry 7 (7th Input Object to be mapped)						
Range	–	**Unit**	–	**Default**	60B9 0010 hex	**Attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	
Sub-index 08 hex	PDO entry 8 (8th Input Object to be mapped)						
Range	–	**Unit**	–	**Default**	60BA 0020 hex	**Attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	
Sub-index 09 hex	PDO entry 9 (9th Input Object to be mapped)						
Range	–	**Unit**	–	**Default**	60BC 0020 hex	**Attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	
Sub-index 0A hex	PDO entry 10 (10th Input Object to be mapped)						
Range	–	**Unit**	–	**Default**	60FD 0020 hex	**Attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	

- This is the mapping for an application that uses different modes of operation.
- Touch probe status is available.
- Following error actual value (60F4 hex) is provided.

1B04 hex	261th transmit PDO Mapping						All
Sub-index 00 hex	Number of objects in this PDO						
Range	–	**Unit**	–	**Default**	0A hex	**Attribute**	–
Size	1 byte (U8)		**Access**	RO	**PDO map**	Not possible	
Sub-index 01 hex	PDO entry 1 (1st Input Object to be mapped)						
Range	–	**Unit**	–	**Default**	603F 0010 hex	**Attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	
Sub-index 02 hex	PDO entry 2 (2nd Input Object to be mapped)						
Range	–	**Unit**	–	**Default**	6041 0010 hex	**Attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	
Sub-index 03 hex	PDO entry 3 (3rd Input Object to be mapped)						
Range	–	**Unit**	–	**Default**	6064 0020 hex	**Attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	
Sub-index 04 hex	PDO entry 4 (4th Input Object to be mapped)						
Range	–	**Unit**	–	**Default**	6077 0010 hex	**Attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	
Sub-index 05 hex	PDO entry 5 (5th Input Object to be mapped)						
Range	–	**Unit**	–	**Default**	6061 0008 hex	**Attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	
Sub-index 06 hex	PDO entry 6 (6th Input Object to be mapped)						
Range	–	**Unit**	–	**Default**	60B9 0010 hex	**Attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	
Sub-index 07 hex	PDO entry 7 (7th Input Object to be mapped)						
Range	–	**Unit**	–	**Default**	60BA 0020 hex	**Attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	
Sub-index 08 hex	PDO entry 8 (8th Input Object to be mapped)						
Range	–	**Unit**	–	**Default**	60BC 0020 hex	**Attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	
Sub-index 09 hex	PDO entry 9 (9th Input Object to be mapped)						
Range	–	**Unit**	–	**Default**	60FD 0020 hex	**Attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	
Sub-index 0A hex	PDO entry 10 (10th Input Object to be mapped)						
Range	–	**Unit**	–	**Default**	606C 0020 hex	**Attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	

- This is the mapping for an application that uses different modes of operation.
- Touch probe status is available. Only one latch position is supported.
- The Following error actual value (60F4 hex) and Velocity actual value (606C hex) are provided.

1BFF hex	512th transmit PDO Mapping					All	
Sub-index 00 hex	Number of objects in this PDO						
Setting range	–	**Unit**	–	**Default**	01 hex	**Attribute**	–
Size	1 byte (U8)		**Access**	RO	**PDO map**	Not possible	
Sub-index 01 hex	PDO entry 1 (1st Input Object to be mapped)						
Setting range	–	**Unit**	–	**Default**	20020108 hex	**Attribute**	–
Size	4 byte (U32)		**Access**	RO	**PDO map**	Not possible	

- This object mapping is for notifying that the G5-series Servo Drive has detected an error.
- Sysmac Error Status (2002-01 hex) is mapped.
- If you are connecting the G5-series Servo Drive with a Machine Automation Controller NJ-series (Model: NJ501-1□00), map this object to Sync Manager 3 PDO Assignment (1C13 hex).
- Sysmac Studio, by default, automatically maps this object to Sync Manager 3 PDO Assignment (1C13 hex).

A-1-10   Sync Manager Communication Objects

Objects 1C00 to 1C33 hex set how to use the EtherCAT communications memory.

1C00 hex	Sync Manager Communication Type					All	
Sub-index 00 hex	Number of used Sync Manager channels						
Range	–	**Unit**	–	**Default**	04 hex	**Attribute**	–
Size	1 byte (U8)		**Access**	RO	**PDO map**	Not possible	
Sub-index 01 hex	Communication type Synch Manager 0						
Range	–	**Unit**	–	**Default**	01 hex	**Attribute**	–
Size	1 byte (U8)		**Access**	RO	**PDO map**	Not possible	
Sub-index 02 hex	Communication type Synch Manager 1						
Range	–	**Unit**	–	**Default**	02 hex	**Attribute**	–
Size	1 byte (U8)		**Access**	RO	**PDO map**	Not possible	
Sub-index 03 hex	Communication type Synch Manager 2						
Range	–	**Unit**	–	**Default**	03 hex	**Attribute**	–
Size	1 byte (U8)		**Access**	RO	**PDO map**	Not possible	
Sub-index 04 hex	Communication type Synch Manager 3						
Range	–	**Unit**	–	**Default**	04 hex	**Attribute**	–
Size	1 byte (U8)		**Access**	RO	**PDO map**	Not possible	

- The sync manager has the following settings.

SM0:   Mailbox receive (Master to Slave)

SM1:   Mailbox send (Slave to Master)

SM2:   Process data output (Master to Slave)

SM3:   Process data input (Slave to Master)

1C10 hex	Sync Manager 0 PDO Assignment						All
Sub-index 00 hex		Number of assigned PDOs					
Range	–	**Unit**	–	**Default**	00 hex	**Attribute**	–
Size	1 byte (U8)		**Access**	RO	**PDO map**	Not possible	

- The PDO mapping used by this sync manager is given. Mailbox reception sync manager does not have PDOs.

1C11 hex	Sync Manager 1 PDO Assignment						All
Sub-index 00 hex		Number of assigned PDOs					
Range	–	**Unit**	–	**Default**	00 hex	**Attribute**	–
Size	1 byte (U8)		**Access**	RO	**PDO map**	Not possible	

- The PDO mapping used by this sync manager is given. Mailbox reception sync manager does not have PDOs.

1C12 hex	Sync Manager 2 PDO Assignment						All
Sub-index 00 hex		Number of assigned PDOs					
Range	–	**Unit**	–	**Default**	01 hex	**Attribute**	D
Size	1 byte (U8)		**Access**	RW	**PDO map**	Not possible	
Sub-index 01 hex		1st PDO Mapping Object Index of assigned PDO					
Range	0000 to FFFF hex	**Unit**	–	**Default**	1701 hex	**Attribute**	D
Size	2 bytes (U16)		**Access**	RW	**PDO map**	Not possible	
Sub-index 02 hex		2nd PDO Mapping Object Index of assigned PDO					
Range	0000 to FFFF hex	**Unit**	–	**Default**	0000 hex	**Attribute**	D
Size	2 bytes (U16)		**Access**	RW	**PDO map**	Not possible	

- The reception PDOs used by this sync manager are given.
- These object mappings can be changed only when the EtherCAT communications state is Pre-Operational (Pre-Op).
- Since the mappings you changed are not saved in EEPROM, you must specify objects each time you turn ON the power of the G5-series Servo Drive in order to use the mapping other than the default setting.
- If any of the following operations is attempted, an ABORT code for SDO mailbox communications will be returned.
  Writing when the EtherCAT communications state is other than Pre-Operational (Pre-Op)
  Writing to other than 1600 hex and 1701 to 1705 hex
  Data written to 1C13 hex is other than 1A00 hex, 1B01 to 1B04 hex, and 1BFF hex.

1C13 hex	Sync Manager 3 PDO Assignment						All
Sub-index 00 hex	Number of assigned PDOs						
Range	–	**Unit**	–	**Default**	01 hex	**Attribute**	D
Size	1 byte (U8)	**Access**	RO	**PDO map**	Not possible		
Sub-index 01 hex	1st PDO Mapping Object Index of assigned PDO						
Range	0000 to FFFF hex	**Unit**	–	**Default**	1B01 hex	**Attribute**	D
Size	2 bytes (U16)	**Access**	RW	**PDO map**	Not possible		
Sub-index 02 hex	2nd PDO Mapping Object Index of assigned PDO						
Range	0000 to FFFF hex	**Unit**	–	**Default**	0000 hex	**Attribute**	D
Size	2 bytes (U16)	**Access**	RW	**PDO map**	Not possible		

- The transmission PDOs used by this sync manager are given.
- These object mappings can be changed only when the EtherCAT communications state is Pre-Operational (Pre-Op).
- Since the mappings you changed are not saved in EEPROM, you must specify objects each time you turn ON the power of the G5-series Servo Drive in order to use the mapping other than the default setting.
- If any of the following operations is attempted, an ABORT code for SDO mailbox communications will be returned.
  Writing when the EtherCAT communications state is other than Pre-Operational (Pre-Op)
  Writing to other than 1A00 hex, 1B01 to 1B04 hex, and 1BFF hex

1C32 hex	Sync Manager 2 Synchronization						All
Sub-index 00 hex	Number of Synchronization Parameters						
Range	–	**Unit**	–	**Default**	20 hex	**Attribute**	–
Size	1 byte (U8)		**Access**	RO	**PDO map**	Not possible	
Sub-index 01 hex	Synchronization Type						
Range	–	**Unit**	–	**Default**	0002 hex	**Attribute**	A
Size	2 bytes (U16)		**Access**	RO	**PDO map**	Not possible	
Sub-index 02 hex	Cycle Time						
Range	–	**Unit**	–	**Default**	0000 0000 hex	**Attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	
Sub-index 04 hex	Synchronization Types supported						
Range	–	**Unit**	–	**Default**	0004 hex	**Attribute**	–
Size	2 bytes (U16)		**Access**	RO	**PDO map**	Not possible	
Sub-index 05 hex	Minimum Cycle Time						
Range	–	**Unit**	–	**Default**	0000 3A98 hex	**Attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	
Sub-index 06 hex	Calc and Copy Time						
Range	–	**Unit**	–	**Default**	0007 A120 hex	**Attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	
Sub-index 09 hex	Delay Time						
Range	–	**Unit**	–	**Default**	0000 0000 hex	**Attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	
Sub-index 20 hex	Sync Error						
Range	–	**Unit**	–	**Default**	0	**Attribute**	–
Size	1 bit (BOOL)		**Access**	RO	**PDO map**	Not possible	

- The Synchronization Type indicates the synchronization mode of Sync Manager 2.

  0002 hex: DC mode 0
- The Cycle Time indicates the sync 0 event cycle in nanoseconds.
- The Synchronization Types supported indicates the types of synchronization supported.

  0004 hex: DC mode 0
- The Sync Error is 1 when there is a synchronization error.

1C33 hex	Sync Manager 3 Synchronization						All
Sub-index 00 hex	Number of Synchronization Parameters						
Range	–	**Unit**	–	**Default**	20 hex	**Attribute**	–
Size	1 byte (U8)		**Access**	RO	**PDO map**	Not possible	
Sub-index 01 hex	Synchronization Type						
Range	–	**Unit**	–	**Default**	0002 hex	**Attribute**	A
Size	2 bytes (U16)		**Access**	RO	**PDO map**	Not possible	
Sub-index 02 hex	Cycle Time						
Range	–	**Unit**	ns	**Default**	0000 0000 hex	**Attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	
Sub-index 04 hex	Synchronization Types supported						
Range	–	**Unit**	–	**Default**	0004 hex	**Attribute**	–
Size	2 bytes (U16)		**Access**	RO	**PDO map**	Not possible	
Sub-index 05 hex	Minimum Cycle Time						
Range	–	**Unit**	ns	**Default**	0000 3A98 hex	**Attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	
Sub-index 06 hex	Calc and Copy Time						
Range	–	**Unit**	ns	**Default**	0006 06F8 hex	**Attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	
Sub-index 09 hex	Delay Time						
Range	–	**Unit**	–	**Default**	0000 0000 hex	**Attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	
Sub-index 20 hex	Sync Error						
Range	–	**Unit**	–	**Default**	0	**Attribute**	–
Size	1 bit (BOOL)		**Access**	RO	**PDO map**	Not possible	

- The Synchronization Type indicates the synchronization mode of Sync Manager 3.

  0002 hex: DC mode 0
- The Cycle time indicates the sync 0 event cycle in nanoseconds.
- The Synchronization Types supported indicates the types of synchronization supported.

  0004 hex: DC mode 0
- The Delay Time is not supported. It reads as 0000 0000 hex.
- The Sync Error is 1 when there is a synchronization error.

A-1-11   Manufacturer Specific Objects

This section describes objects specific to G5-series Servo Drives with built-in EtherCAT communications. G5-series Servo Drive parameters (Pn□□□) are allocated to objects 3000 to 3999 hex. Index 3□□□ hex corresponds to G5-series Servo Drive parameter Pn□□□. For example, object 3504 hex is the same as parameter Pn504.

For details on servo parameters, refer to *Section 9 Servo Parameter Objects*.

Precautions for Correct Use

Pn□□□ uses decimal numbers but object 3 □□□ hex is a hexadecimal number.

2002 hex	Sysmac Error						All
Sub-index 00 hex	Number of entries						
Setting range	–	**Unit**	–	**Default setting**	02 hex	**Attribute**	–
Size	1 byte (U8)		**Access**	RO	**PDO map**	Not possible	
Sub-index 01 hex	Sysmac Error Status						
Setting range	–	**Unit**	–	**Default setting**	00 hex	**Attribute**	–
Size	1 byte (U8)		**Access**	RO	**PDO map**	Possible	
Sub-index 02 hex	Sysmac Error Status Clear						
Setting range	–	**Unit**	–	**Default setting**	00 hex	**Attribute**	A
Size	1 byte (U8)		**Access**	RW	**PDO map**	Not possible	

- This object is used to monitor Sysmac error status and clear the errors.
- Sysmac Error Status (Sub-index 01 hex):
  This object notifies the Controller of an error on the G5 Servo Drive.
  If you are connecting the G5-series Servo Drive with a Machine Automation Controller NJ-series (Model: NJ501-1□00), map this object to the PDO.
- Sysmac Error Status Clear (Sub-index 02 hex):
  This object enables a Sysmac Product controller to reset the error that has occurred in the G5-series Servo Drive.

Additional Information

Sysmac Studio, by default assign the Sysmac Error Status (sub-index 01 hex) automatically, because it is mapped in the 512th transmit PDO Mapping (1BFF hex).

2100 hex	Error History Clear						All
Range	0000 0000 to FFFF FFFF hex	Unit	–	Default	0000 0000 hex	Attribute	A
Size	4 bytes (U32)		Access	RW	PDO map	Not possible	

- This object clears the contents of Diagnosis history (10F3 hex).
- This function can be executed by writing 6c63 6861 hex using SDO mailbox communications.
- The error history is saved in the EEPROM. If there is a Control Power Supply Undervoltage Error (Error No. 11.0), you cannot make write access to the EEPROM. This means that the diagnosis history cannot be cleared.
- In the following cases, an ABORT code is returned.

  Writing with CompleteAccess.

  Writing a value other than 6c63 6861 hex.

  Writing when there is a Control Power Supply Undervoltage Error (Error No. 11.0).

2200 hex	Communications Error Setting						All
Range	0 to 15	Unit	Times	Default	1	Attribute	C
Size	1 byte (U8)		Access	RW	PDO map	Not possible	

- This object sets the number of times communications errors can occur consecutively before being detected as an error.
- It can be set to between 0 and 15. The detection value will be set to one value higher than the set value.

> **Additional Information**
>
> The default setting is 1, i.e., an error is detected when two communications errors occur consecutively.

2201 hex	Sync Not Received Timeout Setting						All
Range	0 to 600	Unit	s	Default	0	Attribute	C
Size	2 bytes (U16)		Access	RO	PDO map	Not possible	

- Set a value for which Interruptions Error (Error No. 88.2) are detected.
  If the set value is 0, the detection time will be 120 seconds.

4000 hex	Statusword 1						All
Range	0000 to FFFF hex	**Unit**	–	**Default**	0000 hex	**Attribute**	–
Size	2 bytes (U16)	**Access**	RO	**PDO map**	Possible		

• This object gives the present state of the Servo Drive.

Description of Settings

Bit	Name	Symbol	Code	Description	Support in each mode		
					Position	Speed	Force
0	Origin Position	ZPOINT	0	Outside origin range	◯	◯	◯
			1	Within origin range			
1	Distribution Completed	DEN	0	Distributing	◯	×	×
			1	Distribution completed			
2	Zero Speed Detected	ZSP	0	Zero speed not detected	◯	◯	◯
			1	Zero speed detected			
3	Force Limit Applied	TLIMT	0	Force limit not applied	◯	◯	◯
			1	Force limit applied			
4	Speed Limit	VLIMT	0	Speed limit not detected during force control	×	×	◯
			1	Speed limit detected during force control			
5	Positive Software Limit	PSOT	0	Outside limit range	◯	◯	◯
			1	Within limit range			
6	Negative Software Limit	NSOT	0	Outside limit range	◯	◯	◯
			1	Within limit range			
7	Speed Conformity	VCMP	0	No speed conformity during speed control	×	◯	×
			1	Speed conformity during speed control			
8	Positioning Completed 2	INP2	0	Outside positioning proximity range during positioning control	◯	×	×
			1	Within positioning proximity range during positioning control			
9	Servo Ready	CMDRDY	0	Commands cannot be accepted during processing	◯	◯	◯
			1	Commands can be accepted			
10 to 15	Reserved	–	–	–	–	–	–

• If an unsupported bit is read, the value will be undefined.

Bit 0: Origin Position (ZPOINT)

This bit is 1 when Position actual value (6064 hex) is within the Origin Range (3803 hex) after homing is completed. In the absolute mode, homing is completed when the control power is turned ON or when the Config operation is completed.

Bit 1: Distribution Completed (DEN)

This bit shows Distribution Completed (DEN) for the position command. DEN is 1 under the following conditions:

Mode	Conditions
In csp mode	When the position command distribution amount before or after position command filtering is "0" during the communications cycle.
In hm mode	When the position command distribution amount before or after position command filtering is "0" during the communications cycle when the NC built into the servo amplifier has completed command distribution up to the target position.

Bit 2: Zero Speed Detected (ZSP)

This bit shows Zero Speed (ZSPD).
ZSPD is 1 when the absolute velocity actual value is less than Zero Speed Detection (3434 hex).

Bit 3: Force Limit (TLIM)

T_LIM is 1 during force limit. T_LIM is 0 when the servo is OFF. The judgment conditions during force limit can be changed in the Force Limit Flag Output Setting (3703 hex).

Value set in 3703 hex	Contents
0	1 at force limit, including force command value
1	1 at force limit, excluding force command value

Bit 4: Speed Limit (VLIMT)

This bit shows Speed Limiting (VLIMT). VLIMT is 1 when the speed is being limited.
The speed limiting operation varies according to the value set in the Speed Limit Selection (3317 hex).

Value set in 3317 hex	Contents
0	The speed is limited by the Speed Limit Value Setting (3321 hex).
1	The speed is limited by the smaller of the Speed Limit Value Setting (3321 hex) and Max profile velocity (607F hex).

Precautions for Correct Use

- The position error in external encoder pulses can be set as the threshold value for the external output signal INP2 output from the Position Setting Unit Selection (3520 hex). However, this signal is always in command units.
  Therefore, there may be differences in the judgment conditions for INP2 and NEAR, i.e., when an electronic gear is set.

- This bit is forced to 0 when the Target velocity ignored (6041 hex, bit 12) is 0 during deceleration processing for the drive prohibition input.
  For details, refer to *Target value ignored* on page A-56.

Bit 5: Positive Software Limit (PSOT) and Bit 6: Negative Software Limit (NSOT)

PSOT is 1 when the Position actual value is greater than the set value of the Max position limit (607D hex, Sub-index: 02 hex).
NSOT is 1 when the Position actual value is less than the set value of the Min position limit (607D hex, Sub-index: 01 hex).
The value is 0 when the Software Position Limit Function (3801 hex) is disabled and when homing is not attained.

Bit 7: Speed Conformity (VCMP)

This bit operates as the Speed Conformity (VCMP). VCMP is 1 when the absolute value of the difference between the command speed before acceleration limit and the Velocity actual value is less than the Speed Conformity Detection Range (3435 hex).

Precautions for Correct Use

- The position error in external encoder pulses can be set as the threshold value for the external output signal INP1 output from the Position Setting Unit Selection (3520 hex). However, this signal is always in command units.
  The set values of Positioning Completion Condition Selection (3432 hex) and Positioning Completed Hold Time (3433 hex) do not affect this signal.
  Therefore, there may be differences in the judgment conditions for INP1 and Target reached (6041 hex bit 10), i.e., when an electronic gear is set.
- This bit is forced to 0 when the Target velocity ignored (6041 hex, bit 12) flag is 0 during deceleration processing for the drive prohibition input.

Bit 8: Positioning Proximity (NEAR)

Only during position control, this bit operates as the Positioning Proximity (NEAR). NEAR will be "1" when the absolute value of the position error converted to command units is less than the Position Completion Range 2 (3442 hex) regardless of whether position command distribution is completed.

Bit 9: Servo Ready (CMDRDY)

This bit indicates if command reception is possible or not possible. When Servo Ready is 0, one of the following operations is being processed. It changes to 1 when all processing has been completed.

- Writing to object using SDO mailbox communications.
- Executing Config (4100 hex).
- Resetting Warning/Error.
- Executing Error History Clear (2100 hex).
- Executing Backup parameter changed (10F0 hex, 02 hex).
- Executing Save all parameters (1010 hex, 01 hex).
- Executing Restore all default parameters (1011 hex, 01 hex).
- From when a Servo ON command (Enable operation) is accepted until the Servo ON state is reached.
- From when a Servo OFF command (Disable operation, Shutdown, or Disable Voltage) is accepted until the Servo OFF state is reached.

4001 hex	Sub Error Code						All
Range	0000 to FFFF hex	Unit	–	Default	0000 hex	Attribute	–
Size	2 bytes (U16)		Access	RO	PDO map	Possible	

- This object shows errors that have occurred in the Servo Drive.

4100 hex	Config						All
Range	0000 0000 to FFFF FFFF hex	Unit	–	Default	0000 0000 hex	Attribute	A
Size	4 bytes (U32)		Access	RW	PDO map	Not possible	

- This object enables changing objects with data attribute C.
- This function can be executed by writing 666e 6f63 hex using SDO mailbox communications.
- The Servo will be forced OFF if Configuration is executed in the Servo ON state.
- The Servo Drive moves to a Fault state (Error No. 27.7) after this process is completed.
- In the following cases, an ABORT code is returned.

  Writing with CompleteAccess.

  Writing a value other than 666e 6f63 hex.

  Writing when there is a Control Power Supply Undervoltage Error (Error No. 11.0).

4103 hex	Coordinate System Setting Mode						All
Range	0000 to FFFF hex	Unit	–	Default	0083 hex	Attribute	B
Size	2 bytes (U16)		Access	RO	PDO map	Possible	

- Set the mode during coordinate system setting.

4104 hex	Coordinate System Setting Position						All
Range	−2,147,483,648 to 2,147,483,647 hex	Unit	Command units	Default	0	Attribute	B
Size	4 bytes (INT32)		Access	RO	PDO map	Possible	

- Set the position information during coordinate system setting.

A-1-12   Servo Drive Profile Object

This section describes the CiA402 drive profile supported by G5-series Servo Drives.

603F hex	Error code						All
Range	0000 to FFFF hex	**Unit**	–	**Default**	0000 hex	**Attribute**	–
Size	2 bytes (U16)		**Access**	RO	**PDO map**	Possible	

- This object gives the latest error code or warning code in the Servo Drive.
- The given error is from the manufacturer specific area FF00 to FFFF hex.
- The lower word of FF00 to FFFF hex gives the main number of the error.
- 4001 hex: Sub Error Code (4001 hex) gives the main number and sub number of the error.
- The main number and sub number are hexadecimal numbers but are combinations of 0 to 9.

Index	Name	Data types	Specifications	
603F hex	Error code	U16	0000 hex:	No error
			FF01 hex:	Error main number 1
			FF02 hex:	Error main number 2
			:	:
			FF99 hex:	Error main number 99
			FFA0 hex:	Warning A0 hex
			:	:
			FFA9 hex:	Warning A9 hex
			FFB0 hex:	Warning B0 hex
			FFB1 hex:	Warning B1 hex
			FFB2 hex:	Warning B2 hex
			Others	Reserved
4001 hex	Sub Error Code	U16	Upper 8 bits F0 to F9 hex:	Sub numbers 0 to 9
			Lower 8 bits 00 to 99 hex:	Main numbers 0 to 99

6040 hex	Controlword							All
Range	0000 to FFFF hex	**Unit**	–	**Default**	0000 hex	**Attribute**	A	
Size	2 bytes (U16)		**Access**	RW	**PDO map**	Possible		

- This object controls the state machine of the Servo Drive.

Description of Set Values

Bit	Name	Description
0	Switch on	The state is controlled by these bits.
1	Enable voltage	Quick stop is not supported. The Quick stop bit is ignored even if set to 0. [1]
2	Quick stop	
3	Enable operation	
4 to 6	Operation mode specific	These bits are specific to the operation mode. They are not used in Cyclic synchronous position mode.
7	Fault reset	Errors and warnings are reset when this bit turns ON.
8	Halt	This bit is specific to the operating mode. [2]
9	Operation mode specific	They are not used in Cyclic synchronous position mode.
10	Reserved	
11	P_CL	These bits switch the force limit function. They are normally set to 0. [3]
12	N_CL	
13 to 15	Manufacturer specific	These are manufacturer specific bits. Always keep them at 0.

[1] For details, refer to *Command Coding* on page A-3.

[2] If this bit is set to 1 during the Homing mode (hm), the motor stops according to the settings of the Halt option code (605D hex). This bit is ignored in other modes of operation.

[3] For details, refer to *7-7 Force Limit Switching* on page 7-22.

6041 hex	Statusword							All
Range	0000 to FFFF hex	**Unit**	–	**Default**	0000 hex	**Attribute**	–	
Size	2 bytes (U16)		**Access**	RO	**PDO map**	Possible		

- This object gives the present state of the Servo Drive.

Description of Settings

Bit	Name	Description
0	Ready to switch on	These bits give the state.
1	Switched on	For details, refer to *State Coding* on page A-4.
2	Operation enabled	
3	Fault	
4	Voltage enabled [1]	
5	Quick Stop [2]	
6	Switch on disabled	
7	Warning	This bit indicates that warning status exists. Operation continues without changing the status.
8	Manufacturer specific	These are manufacturer specific bits. This bit is not used by G5-series Servo Drives.

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A-1-12 Servo Drive Profile Object

Bit	Name	Description
9	Remote	This bit indicates that the Servo Drive is being controlled by the Controlword. Changes to 1 (remote) after initialization has been completed. When 0 (local) is given, it indicates that the support software has the control right to the Servo Drive.
10	Target reached	This bit is 1 when homing is completed during the Homing mode. [*3] This bit is not used in other modes of operation.
11	Internal limit active	This bit indicates that the limit function is in effect. This bit becomes 1 when the limit function in the Servo Drive is activated. The limit function has four limits, the torque limit, speed limit, drive prohibition input, and software limit.
12	Target value ignored or Homing attained	These bits are specific to the operation mode. This bit is 0 when the Servo Drive could not move according to the host command while the Servo is ON or in csp mode, csv mode, or cst mode. This bit will not become 0 if there is an error. [*4] This bit becomes 0 in the following cases. • Between when the drive prohibition input (PLS/NLS) is input until when the motor decelerates and stops when the Drive Prohibition Input Selection (3504 hex) is set to 0. • When a warning occurs for a mode of operation. • When a data setting warning (B0 hex) occurs while the mode of operation is being changed and instead of changing the mode of operation, the current mode of operation is retained. • When a drive prohibition direction command is received while in a drive prohibition state. • When there is a change in position command that exceeds the motor's maximum speed. This bit changes to 1 when the homing operation reaches its target while in the Homing mode (hm).
13	Following error	These bits are specific to the operation mode. The Following error (Error counter overflow) is indicated in Cyclic synchronous position mode. Position Error Counter Overflow is set to 1 when the Position actual value (6064 hex) exceeds the Following error window (6065 hex) that is set based on Position demand value (6062 hex). This bit changes to 1 when the homing operation is not completed successfully while in the Homing mode (hm).
14 and 15	Manufacturer specific	These are manufacturer specific bits. This bit is not used by G5-series Servo Drives.

*1 The Voltage enabled bit indicates that the main circuit power supply is ON when it is 1.

*2 Not applicable in Quick stop active state. This bit is 0 in a "Not ready to switch ON" state only. It is always 1 in all other cases.

*3 This bit will also change to 1 when the actual speed becomes less than 30 mm/s after bit 8 (Halt) in Controlword (6040 hex) is set to 1 during operation in the Homing mode.
For details, refer to *6-5 Homing Mode* on page 6-15.

*4 Although the Servo Drive need not be updated when combined with an OMRON Controller, when using a third-party controller, update the target value taking the following points into consideration.
When the Target value ignored bit is 0, the target value is ignored and operation will follow the Servo Drive's internal command. However, when the Target Value Ignored bit later changes to 1 and the target value is enabled, the target position of the controller and that of the Servo Drive will vary. Therefore, it is necessary to update the Target position or other target values in the controller while monitoring items such as the Position actual value.

605B hex	Shutdown option code						All
Range	−5 to 0	**Unit**	–	**Default**	−1	**Attribute**	B
Size	2 bytes (INT16)		**Access**	RW	**PDO map**	Not possible	

- This object sets the operation of the G5-series Servo Drive during deceleration and after stop, following the main circuit power OFF (Shutdown) state.

Description of Settings

Set value	Decelerating[*1]		After stopping	
	Deceleration method	**Error**	**Operation after stopping**	**Error**
-5	Immediate Stop[*2] Immediate Stop Force = 3511 hex	Clear[*3]	Free	Clear[*3]
-4	Immediate Stop[*2] Immediate Stop Force = 3511 hex	Clear[*3]	Dynamic brake operation	Clear[*3]
-3	Dynamic brake operation	Clear[*3]	Free	Clear[*3]
-2	Free-run	Clear[*3]	Dynamic brake operation	Clear[*3]
-1	Dynamic brake operation	Clear[*3]	Dynamic brake operation	Clear[*3]
0	Free-run	Clear[*3]	Free	Clear[*3]

*1 Decelerating is the time between when the motor is running and when the motor speed reaches 30 mm/s or less. Once the motor reaches 30 mm/s or less and moves to the after-stop status, subsequent operation is based on the after-stop status regardless of the motor speed.

*2 "Immediate Stop" means that the motor stops immediately by using controls while the servo is kept ON. The force command value at this time is restricted by the Immediate Stop Force (3511 hex).

*3 When the error is cleared, a process which makes the Position demand value follow the Position actual value comes into effect. To operate in cyclic sync mode (csp) after the servo turns ON, reset the command coordinates in the host controller and then execute the operation. The motor may move suddenly.

Precautions for Correct Use

- Position control is forced into operation during deceleration and after the motor has stopped (main power supply OFF). The internal position command generation process is also forced to stop.

- If an error occurs while the main power supply is OFF, operation will follow the Fault reaction option code (605E hex).

- If the main power supply turns OFF while the Servo is ON and the Undervoltage Error Selection (3508 hex) is set to 1, a Main Power Supply Undervoltage (Error No. 13.1) will occur. Operation will then follow the Fault reaction option code (605E hex). The default value of the Undervoltage Error Selection (3508 hex) is 1.

605C hex	Disable operation option code					All
Range	−5 to 0	**Unit**	–	**Default**	−1	**Attribute**	B
Size	2 bytes (INT16)	**Access**	RW	**PDO map**	Not possible	

- This object sets the operation of the G5-series Servo Drive during deceleration and after stop, following the Servo OFF (Disable operation) state.

Description of Settings

Set value	Decelerating[*1]		After stopping	
	Deceleration method	**Error**	**Operation after stopping**	**Error**
-5	Immediate Stop[*2] Immediate Stop Force = 3511 hex	Clear[*3]	Free	Clear[*3]
-4	Immediate Stop[*2] Immediate Stop Force = 3511 hex	Clear[*3]	Dynamic brake operation	Clear[*3]
-3	Dynamic brake operation	Clear[*3]	Free	Clear[*3]
-2	Free-run	Clear[*3]	Dynamic brake operation	Clear[*3]
-1	Dynamic brake operation	Clear[*3]	Dynamic brake operation	Clear[*3]
0	Free-run	Clear[*3]	Free	Clear[*3]

*1 Decelerating is the time between when the motor is running and when the motor speed reaches 30 mm/s or less. Once the motor reaches 30 mm/s or less and moves to the after-stop status, subsequent operation is based on the after-stop status regardless of the motor speed.

*2 "Immediate Stop" means that the motor stops immediately by using controls while the servo is kept ON. The force command value at this time is restricted by the Immediate Stop Force (3511 hex).

*3 When the error is cleared, a process which makes the Position demand value follow the Position actual value comes into effect. To operate in cyclic sync mode (csp) after the servo turns ON, reset the command coordinates in the host controller and then execute the operation. The motor may move suddenly.

Precautions for Correct Use

- Position control is forced into operation during deceleration and after the motor has stopped (during servo OFF). The internal position command generation process is also forced to stop.
- If an error occurs while the servo is OFF, operation will follow the Fault reaction option code (605E hex).
- If the main power supply turns OFF while the servo is OFF, the Shutdown option code (605B hex) will be followed.

605D hex	Halt option code					pp hm
Range	1 to 3	**Unit**	–	**Default**	1	**Attribute**	B
Size	2 bytes (INT16)	**Access**	RW	**PDO map**	Not possible	

- This object sets the stop method when bit 8 (Halt) in Controlword (6040 hex) is set to 1 during the Homing mode (hm).

Description of Settings

Set value	Description
1	Profile deceleration (6084 hex)
2	Not supported
3	Immediate stop

605E hex	Fault reaction option code					All
Range	−7 to 0	**Unit**	–	**Default**	−1	**Attribute**	B
Size	2 bytes (INT16)	**Access**	RW	**PDO map**	Not possible	

- This object sets the behavior when an error occurs.

Description of Settings

Set value	Decelerating[1]		Error	After stopping	
	Deceleration method		Error	Operation after stopping	Error
−7	Operation A[2]	Immediate Stop[3] Immediate Stop Force = 3511 hex	Clear[4]	Free	Clear[4]
	Operation B[2]	Free-run			
−6	Operation A[2]	Immediate Stop[3] Immediate Stop Force = 3511 hex	Clear[4]	Free	Clear[4]
	Operation B[2]	Dynamic brake operation			
−5	Operation A[2]	Immediate Stop[3] Immediate Stop Force = 3511 hex	Clear[4]	Dynamic brake operation	Clear[4]
	Operation B[2]	Free-run			
−4	Operation A[2]	Immediate Stop[3] Immediate Stop Force = 3511 hex	Clear[4]	Dynamic brake operation	Clear[4]
	Operation B[2]	Dynamic brake operation			
−3	Dynamic brake operation		Clear[4]	Free	Clear[4]
−2	Free-run		Clear[4]	Dynamic brake operation	Clear[4]
−1	Dynamic brake operation		Clear[4]	Dynamic brake operation	Clear[4]
0	Free-run		Clear[4]	Free	Clear[4]

*1 Decelerating is the time between when the motor is running and when the motor speed reaches 30 mm/s or less. Once the motor reaches 30 mm/s or less and moves to the after-stop status, subsequent operation is based on the after-stop status regardless of the motor speed.

*2   Operation A and B indicate whether or not to stop immediately when an error occurs. If this value is set to between 4 and 7, the motor is stopped immediately when a specified error occurs as indicated by operation A. If an error occurs that is not subject to this function, an immediate stop is not applied and dynamic braking is applied or the motor is left to run free as indicated by operation B.
For details on errors, refer to *Errors* on page 12-7.

*3   "Immediate Stop" means that the motor stops immediately by using controls while the servo is kept ON. The force command value at this time is restricted by the Immediate Stop Force (3511 hex).

*4   When the error is cleared, a process which makes the Position demand value follow the Position actual value comes into effect. To operate in cyclic sync mode (csp) after the servo turns ON, reset the command coordinates in the host controller and then execute the operation. The motor may move suddenly.

> **Precautions for Correct Use**
>
> Position control is forced into operation during deceleration and after the motor has stopped (during an error or when the servo is OFF). The internal position command generation process is also forced to stop.

6060 hex	Modes of operation						All
Range	0 to 10	**Unit**	–	**Default**	0	**Attribute**	A
Size	1 byte (INT8)		**Access**	RW	**PDO map**	Possible	

- This object sets the operation mode.
- The default value is 0 (Not specified). Set the operation mode from the master after the power supply is turned ON.
- A Command Warning (Error No. B1 hex) occurs if the servo is turned ON (Operation enabled = 1) with the default setting of 0 (Not specified).
- Even when the default value (0: Not specified) is set again after changing the mode of operation, the mode of operation does not return to "Not specified." The previous mode of operation is retained.
- Similarly, when an unsupported mode of operation is set, the previous mode is retained.
- When an unsupported mode of operation is set using SDO mailbox communications, an ABORT code is returned.

Description of Settings

Code	Description
0	Not specified
1	Profile position mode (pp)
6	Homing mode (hm)
8	Cyclic synchronous position mode (csp)
9	Cyclic synchronous velocity mode (csv)
10	Cyclic synchronous torque mode (cst)

For details about changing the modes of operation, refer to *A-1-5 Changing the Mode of Operation* on page A-7.

6061 hex	Modes of operation display						All
Range	0 to 10	**Unit**	–	**Default**	0	**Attribute**	–
Size	1 byte (INT8)		**Access**	RO	**PDO map**	Possible	

- This object gives the present operation mode.
- The value definitions are the same as for the Modes of operation (6060 hex).

6062 hex	Position demand value						csp pp hm
Range	−2,147,483,648 to 2,147,483,647	**Unit**	Command units	**Default**	0	**Attribute**	−
Size	4 bytes (INT32)		**Access**	RO	**PDO map**	Possible	

- This object gives the Servo Drive's internal command position.

6063 hex	Position actual internal value						All
Range	−2,147,483,648 to 2,147,483,647	**Unit**	Pulses	**Default**	0	**Attribute**	−
Size	4 bytes (INT32)		**Access**	RO	**PDO map**	Possible	

- This object gives the Servo Drive's present internal position.
- The value is in external encoder units.

6064 hex	Position actual value						All
Range	−2,147,483,648 to 2,147,483,647	**Unit**	Command units	**Default**	0	**Attribute**	−
Size	4 bytes (INT32)		**Access**	RO	**PDO map**	Possible	

- This object gives the present position.

6065 hex	Following error window						csp pp hm
Range	0 to 134,217,728, 4,294,967,295	**Unit**	Command units	**Default**	100,000	**Attribute**	A
Size	4 bytes (U32)		**Access**	RW	**PDO map**	Not possible	

- This object sets the threshold for following errors.
- If it is set to 4,294,967,295 (FFFF FFFF hex), detection of following errors is disabled.
- If it is set to 0, there will always be a following error.
- When it is set to between 134,217,729 and 4,294,967,294, the set value becomes 134,217,728.

6067 hex	Position window						csp pp hm
Range	0 to 262,144	**Unit**	Command units	**Default**	10	**Attribute**	A
Size	4 bytes (U32)		**Access**	RW	**PDO map**	Not possible	

- Select the position error threshold at which the positioning completion signal (INP 1) is output. The default unit is command units, but Position Setting Unit Selection (3520 hex) can be used to convert to external encoder units. If the unit is converted, the unit of Following error window (6065 hex) will also be converted.
- This setting is also used for the Target reached flag in the EtherCAT communications status. The unit, however, is always command units regardless of the setting of Position Setting Unit Selection (3520 hex).

606C hex	Velocity actual value						All
Range	−2,147,483,647 to 2,147,483,647	**Unit**	Command units/s	**Default**	0	**Attribute**	−
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Possible	

- This object gives the present speed.

6071 hex	Target torque						cst
Range	−5,000 to 5,000	**Unit**	0.1%	**Default**	0	**Attribute**	A
Size	2 bytes (U16)	**Access**	RW	**PDO map**		Possible	

- This object sets the force command in the Cyclic synchronous torque mode.

6072 hex	Max torque						All
Range	0 to 5,000	**Unit**	0.1%	**Default**	5,000	**Attribute**	A
Size	2 bytes (U16)	**Access**	RW	**PDO map**		Possible	

- This object sets the maximum force.
- Set the value in units of 0.1% of the rated force (100%).

6074 hex	Torque demand						All
Range	−5,000 to 5,000	**Unit**	0.1%	**Default**	0	**Attribute**	−
Size	2 bytes (INT16)	**Access**	RO	**PDO map**		Possible	

- This object gives the Servo Drive's internal force command value.
- Set the value in units of 0.1% of the rated force (100%).

6077 hex	Torque actual value						All
Range	−5,000 to 5,000	**Unit**	0.1%	**Default**	0	**Attribute**	−
Size	2 bytes (INT16)	**Access**	RO	**PDO map**		Possible	

- This object gives the feedback force value. The values are the same as for the internal force command value.
- Set the value in units of 0.1% of the rated force (100%).

607A hex	Target position						csp pp
Range	−2,147,483,648 to 2,147,483,647	**Unit**	Command units	**Default**	0	**Attribute**	A
Size	4 bytes (INT32)	**Access**	RW	**PDO map**		Possible	

- This object sets the target position in the Cyclic synchronous position mode.

607C hex	Home offset						All
Range	−1,073,741,823 to 1,073,741,823	**Unit**	Command units	**Default**	0	**Attribute**	C
Size	4 bytes (INT32)	**Access**	RW	**PDO map**		Not possible	

- This object sets the position of the external encoder when an absolute external encoder is in use and the amount of offset for the machine coordinate position.

607D hex	Software position limit						All
Sub-index 00 hex		Number of entries					
Range	–	**Unit**	–	**Default**	02 hex	**Attribute**	–
Size	1 byte (U8)	**Access**	RO	**PDO map**	Not possible		
Sub-index 01 hex		Min position limit					
Range	−1,073,741,823 to 1,073,741,823	**Unit**	Command units	**Default**	−500,000	**Attribute**	A
Size	4 bytes (INT32)	**Access**	RW	**PDO map**	Not possible		
Sub-index 02 hex		Max position limit					
Range	−1,073,741,823 to 1,073,741,823	**Unit**	Command units	**Default**	500,000	**Attribute**	A
Size	4 bytes (INT32)	**Access**	RW	**PDO map**	Not possible		

- This object sets the software limit.
- Ranges for the Position demand value and Position actual value are restricted. Whenever a new target position is set, it is checked against these ranges.
- The software limit is always a relative value to the mechanical origin.
- The Min position limit is the limiting value for negative direction and the Max position limit is the limiting value for positive direction.

Precautions for Correct Use

- Make sure that the Positive position limit is larger than the Negative position limit.
- The software position limit is disabled when an origin return has not been completed.

607F hex	Max profile velocity						cst
Range	0 to 2,147,483,647	**Unit**	Command units/s	**Default**	0	**Attribute**	A
Size	4 bytes (U32)	**Access**	RW	**PDO map**	Possible		

- This object sets the maximum velocity in the Cyclic synchronous torque mode.

6081 hex	Profile Velocity						pp
Range	0 to 2,147,483,647	**Unit**	Command units/s	**Default setting**	0	**Attribute**	A
Size	4 bytes (U32)	**Access**	RW	**PDO map**	Possible		

- This object sets the target velocity for Profile position mode (pp).

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6083 hex	Profile acceleration						pp hm
Range	1 to 655,350,000	**Unit**	Command units/s^2	**Default**	1,000,000	**Attribute**	B
Size	4 bytes (U32)		**Access**	RW	**PDO map**	Not possible	

- This object sets the acceleration rate in the Cyclic synchronous torque mode (cst).
- The setting resolution is 4,000. For example, if you set 5,000, the resolution will be 4,000.

6084 hex	Profile deceleration						pp hm
Range	1 to 655,350,000	**Unit**	Command units/s^2	**Default**	1,000,000	**Attribute**	B
Size	4 bytes (U32)		**Access**	RW	**PDO map**	Not possible	

- This object sets the deceleration rate in the Cyclic synchronous torque mode (cst).
- The setting resolution is 4,000. For example, if you set 5,000, the resolution will be 4,000.

6086 hex	Motion profile type						csp pp hm
Range	−1 to 0	**Unit**	–	**Default**	0	**Attribute**	B
Size	2 bytes (INT16)		**Access**	RW	**PDO map**	Possible	

- This object enables and disables the position command FIR filter.
- When this object is set to −1, the value of Position Command FIR Filter Time Constant (3818 hex) is enabled.
- When this object is set to 0, the position command FIR filter is disabled.
- The position command FIR filter can be used in Cyclic synchronous position mode (csp), Profile position mode (pp), and Homing mode (hm).
- When the communications cycle is set to 250 μs or 500 μs, the position command FIR filter is disabled regardless of this setting.

6091 hex	Gear ratio						All
Sub-index 00 hex		Number of entries					
Range	–	**Unit**	–	**Default**	02 hex	**Attribute**	–
Size	1 byte (U8)	**Access**	RO	**PDO map**	Not possible		
Sub-index 01 hex		Motor revolutions					
Range	0 to 1,073,741,824	**Unit**	–	**Default**	1	**Attribute**	C
Size	4 bytes (U32)	**Access**	RW	**PDO map**	Not possible		
Sub-index 02 hex		Shaft revolutions					
Range	1 to 1,073,741,824	**Unit**	–	**Default**	1	**Attribute**	C
Size	4 bytes (U32)	**Access**	RW	**PDO map**	Not possible		

- These objects set the gear ratio.
- Set the numerator of the electronic gear in the object for Motor revolutions (Sub-index 01 hex).
- Set the denominator of the electronic gear in the object for Shaft revolutions (Sub-index 02 hex).
- Set the gear ratio to between 1/1,000 and 1,000. If the gear ratio is out of range, an Object Setting Error (Error No. 93.0) will occur.

For details on the electronic gear settings, refer to *7-6 Electronic Gear Function* on page 7-20.

6098 hex	Homing method						hm
Range	−128 to 127	**Unit**	Command units/s^2	**Default**	0	**Attribute**	B
Size	1 byte (INT8)	**Access**	RW	**PDO map**	Not possible		

- This objects sets the Homing method in the Homing mode (hm).

Description of Settings

Set value	Explanation
0	Not specified
8	Homing by Origin Proximity Input and origin signal (positive operation start)
12	Homing by Origin Proximity Input and origin signal (negative operation start)
19	Homing without origin signal (positive operation start)
20	Homing without origin signal (negative operation start)
33	Homing with origin signal (negative operation start)
34	Homing with origin signal (positive operation start)
35	Present home preset

- If the homing operation is started by setting a value other than 8, 12, 19, 20, 33, 34, or 35, a Command Error (Error No. 91.1) will occur.

For details on homing, refer to *A-1-6 Homing Mode Specifications* on page A-15.

6099 hex	Homing speeds						hm
Sub-index 00 hex	Number of entries						
Range	–	**Unit**	–	**Default**	02 hex	**Attribute**	–
Size	1 byte (U8)		**Access**	RO	**PDO map**	Not possible	
Sub-index 01 hex	Speed during search for switch						
Range	100 to 3,276,700	**Unit**	Command units/s	**Default**	5,000	**Attribute**	B
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	
Sub-index 02 hex	Speed during search for zero						
Range	100 to 3,276,700	**Unit**	Command units/s	**Default**	5,000	**Attribute**	B
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	

- This object sets the homing speed.
- For Speed during search for switch (Sub-index 01 hex), set the operation speed during the homing operation from the start of the homing operation until the Origin Proximity Input turns ON.
- For Speed during search for zero (Sub-index 02 hex), set the operation speed during the homing operation from when the Origin Proximity Input turns ON until the latch signal is detected after the Origin Proximity Input again turns OFF.

60B0 hex	Position offset						csp
Range	−2,147,483,648 to 2,147,483,647	**Unit**	Command units	**Default**	0	**Attribute**	A
Size	4 bytes (INT32)		**Access**	RW	**PDO map**	Possible	

- This object sets the position command offset.
- In Cyclic synchronous position mode (csp), the offset value is added to the Target position (607A hex) for use as the target position in controlling the position.
- Set the relationship between the Target position (607A hex) and Position offset (60B0 hex) so that the following expression is fulfilled. If the relational expression is not met, the operation may be performed in the direction opposite to the command increment direction.
Absolute value of (Current position command additional value − Previous position command additional value) ≤ Maximum motor speed ≤ 2,147,483,647

60B1 hex	Velocity offset						csp csv
Range	−2,147,483,648 to 2,147,483,647	**Unit**	Command units/s	**Default**	0	**Attribute**	A
Size	4 bytes (INT32)		**Access**	RW	**PDO map**	Possible	

- In Cyclic synchronous position mode (csp), the value of this object is added to the Speed Feed-forward Gain (3110 hex) for use as the speed feed-forward input value in controlling the speed.

60B2 hex	Torque offset						csp csv cst
Range	−5,000 to 5,000	**Unit**	0.1%	**Default**	0	**Attribute**	A
Size	2 bytes (INT16)		**Access**	RW	**PDO map**	Possible	

- In Cyclic synchronous position mode (csp) or Cyclic synchronous velocity mode (csv), the value of this object is added to the Force Feed-forward Gain (3112 hex) for use as the force feed-forward input value in controlling the torque.
- In Cyclic synchronous torque mode (cst), the value of this object is used as the offset value of the Target torque (6071 hex) to control the torque.

60B8 hex	Touch probe function (Latch function)						All
Range	–	**Unit**	–	**Default**	0	**Attribute**	A
Size	2 bytes (U16)		**Access**	RW	**PDO map**	Possible	

- This object sets and controls the latch function.
- There are two channels, Latch 1 (bits 1 to 7) and Latch 2 (bits 8 to 15).
- Bits 0 and 8 execute latching when changed from 0 to 1.
- To change the settings, set bit 0 or 8 to 0 and then to 1 again.
- Latching is disabled in the following cases.

  When communications is in the Init state.

  When the Statusword (6041 hex) bit 9 (remote) is 0 (local).

For details on the latch function, refer to *7-11 Touch Probe Function (Latch Function)* on page 7-39.

Description of Settings

Bit	Code	Description
0	0	Latch 1 is disabled.
	1	Latch 1 is enabled.
1	0	Trigger first event (Latch on the first trigger).
	1	Continuous (Latch continuously on trigger input).
2	0	Latch on the signal selected in the Touch Probe Trigger Selection (3758 hex).
	1	Latch on the encoder's phase-Z signal.
3 to 7	0	Reserved (always set to 0).
8	0	Latch 2 is disabled.
	1	Latch 2 is enabled.
9	0	Trigger first event (Latch on the first trigger).
	1	Continuous (Latch continuously on trigger input).
10	0	Latch on the signal selected in the Touch Probe Trigger Selection (3758 hex).
	1	Latch on the encoder's phase-Z signal.
11 to 15	0	Reserved (always set to 0).

60B9 hex	Touch probe status (Latch status)						All
Range	–	Unit	–	Default	0	Attribute	–
Size	2 bytes (U16)		Access	RO	PDO map	Possible	

• This object gives the status of the Touch probe function (Latch Function).

Description of Settings

Bit	Code	Description
0	0	Latch 1 is disabled.
	1	Latch 1 is enabled.
1	0	No value latched with Latch 1.
	1	There is a value latched with Latch 1.
2 to 5	0	Reserved (always set to 0).
6 and 7	0 to 3	The number of times latching is performed by Latch 1 in continuous latching.[1]
8	0	Latch 2 is disabled.
	1	Latch 2 is enabled.
9	0	No value latched with Latch 2.
	1	There is a value latched with Latch 2.
10 to 13	0	Reserved (always set to 0).
14 to 15	0 to 3	The number of times latching is performed by Latch 2 in continuous latching.[1]

[1] These bits cyclically indicate the number of times latching is performed between 0 and 3 when continuous latching is set (bits 1 or 9 of 60B8 hex is set to 1). They are cleared when bit 0 or 8 becomes 0.

60BA hex	Touch probe pos1 pos value						All
Range	−2,147,483,648 to 2,147,483,647	Unit	Command units	Default	0	Attribute	–
Size	4 bytes (INT32)		Access	RO	PDO map	Possible	

• This object gives the latch position for Latch 1.

60BC hex	Touch probe pos2 pos value						All
Range	−2,147,483,648 to 2,147,483,647	Unit	Command units	Default	0	Attribute	–
Size	4 bytes (INT32)		Access	RO	PDO map	Possible	

• This object gives the latch position for Latch 2.

60E0 hex	Positive torque limit value						All
Range	0 to 5,000	Unit	0.1%	Default	5,000	Attribute	B
Size	2 bytes (U16)		Access	RW	PDO map	Not possible	

• This object sets the positive force limit.
• It is limited by the maximum force of the connected motor.
• Set the value in units of 0.1% of the rated force (100%).

For details refer to *7-7 Force Limit Switching* on page 7-22.

60E1 hex	Negative torque limit value						All
Range	0 to 5000	**Unit**	0.1%	**Default**	5000	**Attribute**	B
Size	2 bytes (U16)	**Access**	RW	**PDO map**	Not possible		

- This object sets the negative force limit.
- It is limited by the maximum force of the connected motor.
- Set the value in units of 0.1% of the rated force (100%).

For details refer to *Force Limit Switching* on page 7-22.

60E3 hex	Supported homing method						hm
Sub-index 00 hex	Number of entries						
Range	–	**Unit**	–	**Default**	07 hex	**Attribute**	–
Size	1 byte (U8)	**Access**	RO	**PDO map**	Not possible		
Sub-index 01 hex	1st supported homing method						
Range	–	**Unit**	–	**Default**	0008 hex	**Attribute**	–
Size	2 bytes (U16)	**Access**	RO	**PDO map**	Not possible		
Sub-index 02 hex	2nd supported homing method						
Range	–	**Unit**	–	**Default**	0012 hex	**Attribute**	–
Size	2 bytes (U16)	**Access**	RO	**PDO map**	Not possible		
Sub-index 03 hex	3rd supported homing method						
Range	–	**Unit**	–	**Default**	0019 hex	**Attribute**	–
Size	2 bytes (U16)	**Access**	RO	**PDO map**	Not possible		
Sub-index 04 hex	4th supported homing method						
Range	–	**Unit**	–	**Default**	0020 hex	**Attribute**	–
Size	2 bytes (U16)	**Access**	RO	**PDO map**	Not possible		
Sub-index 05 hex	5th supported homing method						
Range	–	**Unit**	–	**Default**	0033 hex	**Attribute**	–
Size	2 bytes (U16)	**Access**	RO	**PDO map**	Not possible		
Sub-index 06 hex	6th supported homing method						
Range	–	**Unit**	–	**Default**	0034 hex	**Attribute**	–
Size	2 bytes (U16)	**Access**	RO	**PDO map**	Not possible		
Sub-index 07 hex	7th supported homing method						
Range	–	**Unit**	–	**Default**	0035 hex	**Attribute**	–
Size	2 bytes (U16)	**Access**	RO	**PDO map**	Not possible		

- This object shows the supported Homing methods.

60F4 hex	Following error actual value					csp pp hm	
Range	−536,870,912 to 536,870,912	**Unit**	Command units	**Default**	0	**Attribute**	–
Size	4 bytes (INT32)	**Access**	RO	**PDO map**	Possible		

- This object gives the amount of position error.

60FA hex	Control effort					pp hm csp csv	
Range	-1,073,741,823 to 1,073,741,823	**Unit**	Command units/s	**Default**	0	**Attribute**	–
Size	4 bytes (INT32)	**Access**	RO	**PDO map**	Possible		

- This object shows the Velocity Demand Value for the Servo Drive.

60FC hex	Position demand internal value					All	
Range	−1,073,741,823 to 1,073,741,823	**Unit**	Encoder units	**Default**	0	**Attribute**	–
Size	4 bytes (INT32)	**Access**	RO	**PDO map**	Possible		

- This object shows the Position demand internal value.

60FD hex	Digital inputs					All	
Range	0000 0000h to FFFF FFFF hex	**Unit**	–	**Default**	0000 0000 hex	**Attribute**	–
Size	4 bytes (U32)	**Access**	RO	**PDO map**	Possible		

- The bits in this object give the signal status of functions allocated by servo parameters 3400 to 3407, 3410, and 3411 hex.
- The brake interlock output gives the output status when brake interlock is selected as the general-purpose output.
- EDM output status gives the status of the EDM output.

Description of Settings

Bit	Signal name	Symbol	Code	Description
0	Negative Drive Prohibition Input (Negative limit switch)	NOT	0	OFF
			1	ON
1	Positive Drive Prohibition Input (Positive limit switch)	POT	0	OFF
			1	ON
2	Home switch (Origin Proximity Input)	DEC	0	OFF
			1	ON
3 to 15	Reserved	–	–	–
16	Encoder Phase Z Detection	PC	0	Phase-Z signal not detected during communication cycle
			1	Phase-Z signal detected during communication cycle
17	External Latch Input 1	EXT1	0	OFF
			1	ON
18	External Latch Input 2	EXT2	0	OFF
			1	ON

Bit	Signal name	Symbol	Code	Description
19	External Latch Input 3	EXT3	0	OFF
			1	ON
20	Monitor Input 0	MON0	0	OFF
			1	ON
21	Monitor Input 1	MON1	0	OFF
			1	ON
22	Monitor Input 2	MON2	0	OFF
			1	ON
23	Positive Force Limit Input	PCL	0	OFF
			1	ON
24	Negative Force Limit Input	NCL	0	OFF
			1	ON
25	Immediate Stop Input	STOP	0	OFF
			1	ON
26	Brake Interlock Output	BKIR	0	Brake released
			1	Brake locked
27	Safety Input 1	SF1	0	OFF
			1	ON
28	Safety Input 2	SF2	0	OFF
			1	ON
29	EDM Output	EDM	0	OFF
			1	ON

• This object will be 0 if the brake interlock output (BKIR) is not assigned to a general-purpose output.

60FE hex	Digital outputs						All
Sub-index 00 hex		Number of entries					
Range	–	**Unit**	–	**Default**	02 hex	**Attribute**	–
Size	1 byte (U8)	**Access**	RO	**PDO map**	Not possible		
Sub-index 01 hex		Physical outputs					
Range	0000 0000 to FFFF FFFF hex	**Unit**	–	**Default**	0000 0000 hex	**Attribute**	A
Size	4 bytes (U32)	**Access**	RW	**PDO map**	Possible		
Sub-index 02 hex		Bit mask					
Range	0000 0000 to FFFF FFFF hex	**Unit**	–	**Default**	0000 0000 hex	**Attribute**	B
Size	4 bytes (U32)	**Access**	RW	**PDO map**	Not possible		

- The bits in the physical outputs of this object set the outputs of function signals allocated by servo parameters 3400 to 3407, 3410, and 3411 hex.
- The bit mask sets masks for the physical outputs.

Settings for Sub-index 01 hex

Bit	Signal name	Symbol	Code	Description
0	Set brake (Brake Interlock Output)[1]	BKIR	0	don't set brake
			1	set brake
1 to 15	Reserved[2]	–	0	–
16	Remote Output 1	R-OUT1	0	OFF
			1	ON
17	Remote Output 2	R-OUT2	0	OFF
			1	ON
24	Gain Switching	G-SEL	0	Gain 1
			1	Gain 2
25	Reserved[2]	–	0	–
26	Speed Loop P/PI Control	P/PI	0	PI control
			1	P control

[1] This bit cannot be used for NJ501-1☐00 and CJ1W-NC☐8☐.

[2] Set all Reserved bits to 0.

- The gain can be switched when realtime autotuning is disabled and gain 2 is enabled.
- Speed loop P/PI control can be switched when realtime autotuning and gain 2 are disabled.

Settings for Sub-index 02 hex

Bit	Signal name	Symbol	Code	Description
0	Set brake Mask (Brake Interlock Output Mask)	BKIR	0	Set brake disable output
			1	Set brake enable output
1 to 15	Reserved[1]	–	0	–
16	Remote Output 1 Mask	R-OUT1	0	R-OUT1 disable output
			1	R-OUT1 enable output
17	Remote Output 2 Mask	R-OUT2	0	R-OUT2 disable output
			1	R-OUT2 enable output
24	Gain Switching Mask	G-SEL	0	Switch setting disable
			1	Switch setting enable
25	Reserved[1]	–	0	–
26	Speed Loop P/PI Control Mask	P/PI	0	Switch setting disable
			1	Switch setting enable

*1   Set all Reserved bits to 0.

60FF hex	Target velocity						All
Range	−2,147,483,647 to 2,147,483,647	Unit	Command units/s	Default	0	Attribute	A
Size	4 bytes (INT32)		Access	RO	PDO map	Possible	

- Set the command speed for the Cyclic synchronous velocity.

6402 hex	Motor type						All
Range	–	Unit	–	Default	3	Attribute	–
Size	2 bytes (U16)		Access	RO	PDO map	Not possible	

- This object indicates the type of motor that is connected.
- It is always 3 (PM synchronous motor) for G5-series Servo Drives.

6502 hex	Supported drive modes						All
Range	–	**Unit**	–	**Default**	0000 03A1 hex	**Attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	

- This object indicates the supported operation modes.

Bit Descriptions

Bit	Supported mode	Definition
0	pp (Profile position mode)	1: Supported
1	vl (Velocity mode)	0: Not supported
2	pv (Profile velocity mode)	0: Not supported
3	tq (Profile torque mode)	0: Not supported
4	Reserved	0
5	hm (Homing mode)	1: Supported
6	ip (Interpolated position mode)	0: Not supported
7	csp (Cyclic synchronous position mode)	1: Supported
8	csv (Cyclic synchronous velocity mode)	1: Supported
9	cst (Cyclic synchronous torque mode)	1: Supported
10 to 31	Reserved	0

A-2   Object List

This section describes the profile that is used to control the Servo Drive.

- Some objects are enabled by turning the power supply OFF and then ON again. After changing these objects, turn OFF the power supply, confirm that the power supply indicator has gone OFF, and then turn ON the power supply again.
- See below for the data attributes.

A: Always enabled

B: Prohibited to change during motor operation or commanding.
If it is changed during motor operation or commanding, the reflection timing is unknown.

C: Updated after the control power is reset, or after a Config command is executed via EtherCAT communications.

D: Changeable only when the EtherCAT communications state is Pre-Operational (Pre-Op).

R: Updated when the control power supply is reset.
It is not updated for a Config command via EtherCAT communications.

RO: Read only

Index	Sub-Index	Name	Default setting	Setting range	Unit	Size	Data attribute	PDO map	Corresponding Pn number
1000 hex	00 hex	Device Type	0002 0192 hex	–	–	4 bytes (U32)	RO	Not possible.	–
1001 hex	00 hex	Error Register	0	–	–	1 byte (U8)	RO	Not possible.	–
1008 hex	00 hex	Manufacturer Device Name	R88D-KN□□□-ECT-L	–	–	20 bytes (VS)	RO	Not possible.	–
1009 hex	00 hex	Manufacturer Hardware Version	–	–	–	20 bytes (VS)	RO	Not possible.	–
100A hex	00 hex	Manufacturer Software Version	Contains a number indicating the Servo Drive software version.	–	–	20 bytes (VS)	RO	Not possible.	–
1010 hex		Store Parameters	–	–	–	–	–	–	–
	00 hex	Number of entries	01 hex	–	–	1 byte (U8)	RO	Not possible.	–
	01 hex	Save all parameters	0000 0001 hex	–	–	4 bytes (U32)	A	Not possible.	–
1011 hex		Restore Default Parameters	–	–	–	–	–	–	–
	00 hex	Number of entries	01 hex	–	–	1 byte (U8)	RO	Not possible.	–
	01 hex	Restore all default parameters	0000 0001 hex	–	–	4 bytes (U32)	B	Not possible.	–
1018 hex		Identity Object	–	–	–	–	–	–	–
	00 hex	Number of entries	04 hex	–	–	1 byte (U8)	RO	Not possible.	–
	01 hex	Vender ID	0000 0083 hex	–	–	4 bytes (U32)	RO	Not possible.	–
	02 hex	Product Code	Refer to the table for object 1018 hex on page A-28.	–	–	4 bytes (U32)	RO	Not possible.	–
	03 hex	Revision Number		–	–	4 bytes (U32)	RO	Not possible.	–
	04 hex	Serial Number		–	–	4 bytes (U32)	RO	Not possible.	–

Index	Sub-Index	Name	Default setting	Setting range	Unit	Size	Data attribute	PDO map	Corresponding Pn number
10F0 hex		Backup Parameters Mode	–	–	–	–	–	–	–
	00 hex	Number of entries	02 hex	–	–	1 byte (U8)	RO	Not possible.	–
	01 hex	Backup Parameter Checksum	–	–	–	4 bytes (U32)	RO	Not possible.	–
	02 hex	Backup Parameter Changed	0	–	–	1 bit (BOOL)	A	Not possible.	–
10F3 hex		Diagnosis History	–	–	–	–	–	–	–
	00 hex	Number of entries	13 hex	–	–	1 byte (U8)	RO	Not possible.	–
	01 hex	Maximum Messages	00 hex	–	00 to 0E hex	1 byte (U8)	RO	Not possible.	–
	02 hex	Newest Message	06 hex	–	06 to 13 hex	1 byte (U8)	RO	Not possible.	–
	05 hex	Flags	0000 hex	–	0000 to 0001 hex	2 bytes (U16)	A	Not possible.	–
	06 hex	Diagnosis Message 1	–	–	–	16 bytes (VS)	RO	Not possible.	–
	07 hex	Diagnosis Message 2	–	–	–	16 bytes (VS)	RO	Not possible.	–
	:	:	:	:	:	:	:	:	:
	13 hex	Diagnosis Message 14	–	–	–	16 bytes (VS)	RO	Not possible.	–
1600 hex		1st receive PDO Mapping	–	–	–	–	–	–	–
	00 hex	Number of objects in this PDO	03 hex	–	–	1 byte (U8)	D	Not possible.	–
	01 hex	1st Output Object to be mapped	6040 0010 hex	–	–	4 bytes (U32)	D	Not possible.	–
	02 hex	2nd Output Object to be mapped	607A 0020 hex	–	–	4 bytes (U32)	D	Not possible.	–
	03 hex	3rd Output Object to be mapped	60B8 0010 hex	–	–	4 bytes (U32)	D	Not possible.	–
	04 hex	4th Output Object to be mapped	0000 0000 hex	–	–	4 bytes (U32)	D	Not possible.	–
	05 hex	5th Output Object to be mapped	0000 0000 hex	–	–	4 bytes (U32)	D	Not possible.	–
	06 hex	6th Output Object to be mapped	0000 0000 hex	–	–	4 bytes (U32)	D	Not possible.	–
	07 hex	7th Output Object to be mapped	0000 0000 hex	–	–	4 bytes (U32)	D	Not possible.	–
	08 hex	8th Output Object to be mapped	0000 0000 hex	–	–	4 bytes (U32)	D	Not possible.	–
	09 hex	9th Output Object to be mapped	0000 0000 hex	–	–	4 bytes (U32)	D	Not possible.	–
	0A hex	10th Output Object to be mapped	0000 0000 hex	–	–	4 bytes (U32)		Not possible.	–

Index	Sub-Index	Name	Default setting	Setting range	Unit	Size	Data attribute	PDO map	Corresponding Pn number
1701 hex		258th receive PDO Mapping	–	–	–	–	–	–	–
	00 hex	Number of objects in this PDO	04 hex	–	–	1 byte (U8)	RO	Not possible.	–
	01 hex	1st Output Object to be mapped	6040 0010 hex	–	–	4 bytes (U32)	RO	Not possible.	–
	02 hex	2nd Output Object to be mapped	607A 0020 hex	–	–	4 bytes (U32)	RO	Not possible.	–
	03 hex	3rd Output Object to be mapped	60B8 0010 hex	–	–	4 bytes (U32)	RO	Not possible.	–
	04 hex	4th Output Object to be mapped	60FE 0120 hex	–	–	4 bytes (U32)	RO	Not possible.	–
1702 hex		259th receive PDO Mapping	–	–	–	–	–	–	–
	00 hex	Number of objects in this PDO	07 hex	–	–	1 byte (U8)	RO	Not possible.	–
	01 hex	1st Output Object to be mapped	6040 0010 hex	–	–	4 bytes (U32)	RO	Not possible.	–
	02 hex	2nd Output Object to be mapped	607A 0020 hex	–	–	4 bytes (U32)	RO	Not possible.	–
	03 hex	3rd Output Object to be mapped	60FF 0020 hex	–	–	4 bytes (U32)	RO	Not possible.	–
	04 hex	4th Output Object to be mapped	6071 0010 hex	–	–	4 bytes (U32)	RO	Not possible.	–
	05 hex	5th Output Object to be mapped	6060 0008 hex	–	–	4 bytes (U32)	RO	Not possible.	–
	06 hex	6th Output Object to be mapped	60B8 0010 hex	–	–	4 bytes (U32)	RO	Not possible.	–
	07 hex	7th Output Object to be mapped	607F 0020 hex	–	–	4 bytes (U32)	RO	Not possible.	–
1703 hex		260th receive PDO Mapping	–	–	–	–	–	–	–
	00 hex	Number of objects in this PDO	07 hex	–	–	1 byte (U8)	RO	Not possible.	–
	01 hex	1st Output Object to be mapped	6040 0010 hex	–	–	4 bytes (U32)	RO	Not possible.	–
	02 hex	2nd Output Object to be mapped	607A 0020 hex	–	–	4 bytes (U32)	RO	Not possible.	–
	03 hex	3rd Output Object to be mapped	60FF 0020 hex	–	–	4 bytes (U32)	RO	Not possible.	–
	04 hex	4th Output Object to be mapped	6060 0008 hex	–	–	4 bytes (U32)	RO	Not possible.	–
	05 hex	5th Output Object to be mapped	60B8 0010 hex	–	–	4 bytes (U32)	RO	Not possible.	–
	06 hex	6th Output Object to be mapped	60E0 0010 hex	–	–	4 bytes (U32)	RO	Not possible.	–
	07 hex	7th Output Object to be mapped	60E1 0010 hex	–	–	4 bytes (U32)	RO	Not possible.	–

A-2 Object List

App

Index	Sub-Index	Name	Default setting	Setting range	Unit	Size	Data attribute	PDO map	Corresponding Pn number
1704 hex		261th receive PDO Mapping	–	–	–	–	–	–	–
	00 hex	Number of objects in this PDO	09 hex	–	–	1 byte (U8)	RO	Not possible.	–
	01 hex	1st Output Object to be mapped	6040 0010 hex	–	–	4 bytes (U32)	RO	Not possible.	–
	02 hex	2nd Output Object to be mapped	607A 0020 hex	–	–	4 bytes (U32)	RO	Not possible.	–
	03 hex	3rd Output Object to be mapped	60FF 0020 hex	–	–	4 bytes (U32)	RO	Not possible.	–
	04 hex	4th Output Object to be mapped	6071 0010 hex	–	–	4 bytes (U32)	RO	Not possible.	–
	05 hex	5th Output Object to be mapped	6060 0008 hex	–	–	4 bytes (U32)	RO	Not possible.	–
	06 hex	6th Output Object to be mapped	60B8 0010 hex	–	–	4 bytes (U32)	RO	Not possible.	–
	07 hex	7th Output Object to be mapped	607F 0020 hex	–	–	4 bytes (U32)	RO	Not possible.	–
	08 hex	8th Output Object to be mapped	60E0 0010 hex	–	–	4 bytes (U32)	RO	Not possible.	–
	09 hex	9th Output Object to be mapped	60E1 0010 hex	–	–	4 bytes (U32)	RO	Not possible.	–
1705 hex		262th receive PDO Mapping	–	–	–	–	–	–	–
	00 hex	Number of objects in this PDO	08 hex	–	–	1 byte (U8)	RO	Not possible.	–
	01 hex	1st Output Object to be mapped	6040 0010 hex	–	–	4 bytes (U32)	RO	Not possible.	–
	02 hex	2nd Output Object to be mapped	607A 0020 hex	–	–	4 bytes (U32)	RO	Not possible.	–
	03 hex	3rd Output Object to be mapped	60FF 0020 hex	–	–	4 bytes (U32)	RO	Not possible.	–
	04 hex	4th Output Object to be mapped	6060 0008 hex	–	–	4 bytes (U32)	RO	Not possible.	–
	05 hex	5th Output Object to be mapped	60B8 0010 hex	–	–	4 bytes (U32)	RO	Not possible.	–
	06 hex	6th Output Object to be mapped	60E0 0010 hex	–	–	4 bytes (U32)	RO	Not possible.	–
	07 hex	7th Output Object to be mapped	60E1 0010 hex	–	–	4 bytes (U32)	RO	Not possible.	–
	08 hex	8th Output Object to be mapped	60B2 0010 hex	–	–	4 bytes (U32)	RO	Not possible.	–

Index	Sub-Index	Name	Default setting	Setting range	Unit	Size	Data attribute	PDO map	Corresponding Pn number
1A00 hex		1st transmit PDO Mapping	–	–	–	–	–	–	–
	00 hex	Number of objects in this PDO	07 hex	–	–	1 byte (U8)	RW	Not possible.	–
	01 hex	1st Input Object to be mapped	6041 0010 hex	–	–	4 bytes (U32)	RW	Not possible.	–
	02 hex	2nd Input Object to be mapped	6064 0020 hex	–	–	4 bytes (U32)	RW	Not possible.	–
	03 hex	3rd Input Object to be mapped	60B9 0010 hex	–	–	4 bytes (U32)	RW	Not possible.	–
	04 hex	4th Input Object to be mapped	60BA 0020 hex	–	–	4 bytes (U32)	RW	Not possible.	–
	05 hex	5th Input Object to be mapped	60BC 0020 hex	–	–	4 bytes (U32)	RW	Not possible.	–
	06 hex	6th Input Object to be mapped	603F 0010 hex	–	–	4 bytes (U32)	RW	Not possible.	–
	07 hex	7th Input Object to be mapped	60FD 0020 hex	–	–	4 bytes (U32)	RW	Not possible.	–
	08 hex	8th Input Object to be mapped	0000 0000 hex	–	–	4 bytes (U32)	RW	Not possible.	–
	09 hex	9th Input Object to be mapped	0000 0000 hex	–	–	4 bytes (U32)	RW	Not possible.	–
	0A hex	10th Input Object to be mapped	0000 0000 hex	–	–	4 bytes (U32)	RW	Not possible.	–
1B01 hex		258th transmit PDO Mapping	–	–	–	–	–	–	–
	00 hex	Number of objects in this PDO	09 hex	–	–	1 byte (U8)	RO	Not possible.	–
	01 hex	1st Input Object to be mapped	603F 0010 hex	–	–	4 bytes (U32)	RO	Not possible.	–
	02 hex	2nd Input Object to be mapped	6041 0010 hex	–	–	4 bytes (U32)	RO	Not possible.	–
	03 hex	3rd Input Object to be mapped	6064 0020 hex	–	–	4 bytes (U32)	RO	Not possible.	–
	04 hex	4th Input Object to be mapped	6077 0010 hex	–	–	4 bytes (U32)	RO	Not possible.	–
	05 hex	5th Input Object to be mapped	60F4 0020 hex	–	–	4 bytes (U32)	RO	Not possible.	–
	06 hex	6th Input Object to be mapped	60B9 0010 hex	–	–	4 bytes (U32)	RO	Not possible.	–
	07 hex	7th Input Object to be mapped	60BA 0020 hex	–	–	4 bytes (U32)	RO	Not possible.	–
	08 hex	8th Input Object to be mapped	60BC 0020 hex	–	–	4 bytes (U32)	RO	Not possible.	–
	09 hex	9th Input Object to be mapped	60FD 0020 hex	–	–	4 bytes (U32)	RO	Not possible.	–

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Index	Sub-Index	Name	Default setting	Setting range	Unit	Size	Data attribute	PDO map	Corresponding Pn number
1B02 hex		259th transmit PDO Mapping	–	–	–	–	–	–	–
	00 hex	Number of objects in this PDO	09 hex	–	–	1 byte (U8)	RO	Not possible.	–
	01 hex	1st Input Object to be mapped	603F 0010 hex	–	–	4 bytes (U32)	RO	Not possible.	–
	02 hex	2nd Input Object to be mapped	6041 0010 hex	–	–	4 bytes (U32)	RO	Not possible.	–
	03 hex	3rd Input Object to be mapped	6064 0020 hex	–	–	4 bytes (U32)	RO	Not possible.	–
	04 hex	4th Input Object to be mapped	6077 0010 hex	–	–	4 bytes (U32)	RO	Not possible.	–
	05 hex	5th Input Object to be mapped	6061 0008 hex	–	–	4 bytes (U32)	RO	Not possible.	–
	06 hex	6th Input Object to be mapped	60B9 0010 hex	–	–	4 bytes (U32)	RO	Not possible.	–
	07 hex	7th Input Object to be mapped	60BA 0020 hex	–	–	4 bytes (U32)	RO	Not possible.	–
	08 hex	8th Input Object to be mapped	60BC 0020 hex	–	–	4 bytes (U32)	RO	Not possible.	–
	09 hex	9th Input Object to be mapped	60FD 0020 hex	–	–	4 bytes (U32)	RO	Not possible.	–
1B03 hex		260th transmit PDO Mapping	–	–	–	–	–	–	–
	00 hex	Number of objects in this PDO	0A hex	–	–	1 byte (U8)	RO	Not possible.	–
	01 hex	1st Input Object to be mapped	603F 0010 hex	–	–	4 bytes (U32)	RO	Not possible.	–
	02 hex	2nd Input Object to be mapped	6041 0010 hex	–	–	4 bytes (U32)	RO	Not possible.	–
	03 hex	3rd Input Object to be mapped	6064 0020 hex	–	–	4 bytes (U32)	RO	Not possible.	–
	04 hex	4th Input Object to be mapped	6077 0010 hex	–	–	4 bytes (U32)	RO	Not possible.	–
	05 hex	5th Input Object to be mapped	60F4 0020 hex	–	–	4 bytes (U32)	RO	Not possible.	–
	06 hex	6th Input Object to be mapped	6061 0008 hex	–	–	4 bytes (U32)	RO	Not possible.	–
	07 hex	7th Input Object to be mapped	60B9 0010 hex	–	–	4 bytes (U32)	RO	Not possible.	–
	08 hex	8th Input Object to be mapped	60BA 0020 hex	–	–	4 bytes (U32)	RO	Not possible.	–
	09 hex	9th Input Object to be mapped	60BC 0020 hex	–	–	4 bytes (U32)	RO	Not possible.	–
	0A hex	10th Input Object to be mapped	60FD 0020 hex	–	–	4 bytes (U32)	RO	Not possible.	–

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Index	Sub-Index	Name	Default setting	Setting range	Unit	Size	Data attribute	PDO map	Corresponding Pn number
1B04 hex		261th transmit PDO Mapping	–	–	–	–	–	–	–
	00 hex	Number of objects in this PDO	0A hex	–	–	1 byte (U8)	RO	Not possible.	–
	01 hex	1st Input Object to be mapped	603F 0010 hex	–	–	4 bytes (U32)	RO	Not possible.	–
	02 hex	2nd Input Object to be mapped	6041 0010 hex	–	–	4 bytes (U32)	RO	Not possible.	–
	03 hex	3rd Input Object to be mapped	6064 0020 hex	–	–	4 bytes (U32)	RO	Not possible.	–
	04 hex	4th Input Object to be mapped	6077 0010 hex	–	–	4 bytes (U32)	RO	Not possible.	–
	05 hex	5th Input Object to be mapped	6061 0008 hex	–	–	4 bytes (U32)	RO	Not possible.	–
	06 hex	6th Input Object to be mapped	60B9 0010 hex	–	–	4 bytes (U32)	RO	Not possible.	–
	07 hex	7th Input Object to be mapped	60BA 0020 hex	–	–	4 bytes (U32)	RO	Not possible.	–
	08 hex	8th Input Object to be mapped	60BC 0020 hex	–	–	4 bytes (U32)	RO	Not possible.	–
	09 hex	9th Input Object to be mapped	60FD 0020 hex	–	–	4 bytes (U32)	RO	Not possible.	–
	0A hex	10th Input Object to be mapped	606C 0020 hex	–	–	4 bytes (U32)	RO	Not possible.	–
1BFF hex		512th transmit PDO Mapping	–	–	–	–	–	–	–
	00 hex	Number of objects in this PDO	01 hex	–	–	1 byte (U8)	RO	Not possible.	–
	01 hex	1st Input Object to be mapped	2002 0108 hex	–	–	4 bytes (U32)	RO	Not possible.	–
1C00 hex		Sync Manager Communication Type	–	–	–	–	–	–	–
	00 hex	Number of used sync manager channels	04 hex	–	–	1 byte (U8)	RO	Not possible.	–
	01 hex	Communication type Synch Manager 0	01 hex	–	–	1 byte (U8)	RO	Not possible.	–
	02 hex	Communication type Synch Manager 1	02 hex	–	–	1 byte (U8)	RO	Not possible.	–
	03 hex	Communication type Synch Manager 2	03 hex	–	–	1 byte (U8)	RO	Not possible.	–
	04 hex	Communication type Synch Manager 3	04 hex	–	–	1 byte (U8)	RO	Not possible.	–
1C10 hex		Sync Manager 0 PDO Assignment	–	–	–	–	–	–	–
	00 hex	Number of assigned PDOs	00 hex	–	–	1 byte (U8)	RO	Not possible.	–
1C11 hex		Sync Manager 1 PDO Assignment	–	–	–	–	–	–	–
	00 hex	Number of Assigned PDOs	00 hex	–	–	1 byte (U8)	RO	Not possible.	–
1C12 hex		Sync Manager 2 PDO Assignment	–	–	–	–	–	–	–
	00 hex	Number of Assigned PDOs	01 hex	–	–	1 byte (U8)	D	Not possible.	–
	01 hex	1st PDO Mapping Object Index of assigned PDO	1701 hex	0000 to FFFF hex	–	2 bytes (U16)	D	Not possible.	–
	02 hex	2nd PDO Mapping Object Index of assigned PDO	0000 hex	0000 to FFFF hex	–	2 bytes (U16)	D	Not possible.	–

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Index	Sub-Index	Name	Default setting	Setting range	Unit	Size	Data attribute	PDO map	Corresponding Pn number
1C13 hex		Sync Manager 3 PDO Assignment	–	–	–	–	–	–	–
	00 hex	Number of assigned PDOs	01 hex	–	–	1 byte (U8)	D	Not possible.	–
	01 hex	1st PDO Mapping Object Index of assigned PDO	1B01 hex	0000 to FFFF hex	–	2 bytes (U16)	D	Not possible.	–
	02 hex	2nd PDO Mapping Object Index of assigned PDO	0000 hex	0000 to FFFF hex	–	2 bytes (U16)	D	Not possible.	–
1C32 hex		Sync Manager 2 synchronization	–	–	–	–	–	–	–
	00 hex	Number of Synchronization Parameters	20 hex	–	–	1 byte (U8)	RO	Not possible.	–
	01 hex	Synchronization Type	0002 hex	–	–	2 bytes (U16)	RO	Not possible.	–
	02 hex	Cycle Time	0000 0000 hex	–	ns	4 bytes (U32)	RO	Not possible.	–
	04 hex	Synchronization Types supported	0004 hex	–	–	2 bytes (U16)	RO	Not possible.	–
	05 hex	Minimum Cycle Time	0000 3A98 hex	–	ns	4 bytes (U32)	RO	Not possible.	–
	06 hex	Calc and Copy Time	0007 A120 hex	–	ns	4 bytes (U32)	RO	Not possible.	–
	09 hex	Delay Time	0000 0000 hex	–	ns	4 bytes (U32)	RO	Not possible.	–
	20 hex	Sync Error	0	–	–	1 bit (BOOL)	RO	TxPDO	–
1C33 hex		Sync Manager 3 synchronization	–	–	–	–	–	–	–
	00 hex	Number of Synchronization Parameters	20 hex	–	–	1 byte (U8)	RO	Not possible.	–
	01 hex	Synchronization Type	0002 hex	–	–	2 bytes (U16)	–	Not possible.	–
	02 hex	Cycle Time	0000 0000 hex	–	ns	4 bytes (U32)	RO	Not possible.	–
	04 hex	Synchronization Types supported	0004 hex	–	–	2 bytes (U16)	RO	Not possible.	–
	05 hex	Minimum Cycle Time	0000 3A98 hex	–	ns	4 bytes (U32)	RO	Not possible.	–
	06 hex	Calc and Copy Time	0006 06F8 hex	–	ns	4 bytes (U32)	RO	Not possible.	–
	09 hex	Delay Time	0000 0000 hex	–	ns	4 bytes (U32)	RO	Not possible.	–
	20 hex	Sync Error	0	–	–	1 bit (BOOL)	RO	TxPDO	–
2002 hex		Sysmac Error	–	–	–	–	–	–	–
	00 hex	Number of entries	02 hex	–	–	1 byte (U8)	RO	Not possible.	–
	01 hex	Sysmac Error Status	00 hex	–	–	1 byte (U8)	RO	TxPDO	–
	02 hex	Sysmac Error Status Clear	00 hex	–	–	1 byte (U8)	A	Not possible.	–
2100 hex	00 hex	Error History Clear	0000 0000 hex	0 to 15	–	4 bytes (U32)	A	Not possible.	–
2200 hex	00 hex	Communications Error Setting	1	00 to 0F hex	Times	1 byte (U8)	C	Not possible.	Pn776

Index	Sub-Index	Name	Default setting	Setting range	Unit	Size	Data attribute	PDO map	Corresponding Pn number
2201 hex	00 hex	Sync Not Received Timeout Setting	0	0 to 600	s	2 bytes (U16)	C	Not possible.	Pn777
3000 hex	00 hex	Movement Direction Setting	1	0 to 1	–	2 bytes (INT16)	C	Not possible.	Pn000
3002 hex	00 hex	Realtime Autotuning Mode Selection	1	0 to 6	–	2 bytes (INT16)	B	Not possible.	Pn002
3003 hex	00 hex	Realtime Autotuning Machine Rigidity Setting	11/13[*1]	0 to 31	–	2 bytes (INT16)	B	Not possible.	Pn003
3004 hex	00 hex	Mass Ratio	250	0 to 10000	%	2 bytes (INT16)	B	Not possible.	Pn004
3013 hex	00 hex	Force Limit 1	5000	0 to 5000	0.1%	2 bytes (INT16)	B	Not possible.	Pn753
3016 hex	00 hex	Regeneration Resistor Selection	0/3[*2]	0 to 3	–	2 bytes (INT16)	C	Not possible.	Pn016
3017 hex	00 hex	External Regeneration Resistor Setting	0	0 to 4	–	2 bytes (INT16)	C	Not possible.	Pn017
3100 hex	00 hex	Position Loop Gain 1	320/480[*3]	0 to 30000	0.1/s	2 bytes (INT16)	B	Not possible.	Pn100
3101 hex	00 hex	Speed Loop Gain 1	180/270[*4]	1 to 32767	0.1 Hz	2 bytes (INT16)	B	Not possible.	Pn101
3102 hex	00 hex	Speed Loop Integral Time Constant 1	210/310[*5]	1 to 10000	0.1 ms	2 bytes (INT16)	B	Not possible.	Pn102
3103 hex	00 hex	Speed Feedback Filter Time Constant 1	0	0 to 5	–	2 bytes (INT16)	B	Not possible.	Pn103
3104 hex	00 hex	Force Command Filter Time Constant 1	84/126[*6]	0 to 2500	0.01 ms	2 bytes (INT16)	B	Not possible.	Pn104
3105 hex	00 hex	Position Loop Gain 2	380/570[*7]	0 to 30000	0.1 Hz	2 bytes (INT16)	B	Not possible.	Pn105
3106 hex	00 hex	Speed Loop Gain 2	180/270[*8]	1 to 32767	0.1 Hz	2 bytes (INT16)	B	Not possible.	Pn106
3107 hex	00 hex	Speed Loop Integral Time Constant 2	10000	1 to 10000	0.1 ms	2 bytes (INT16)	B	Not possible.	Pn107
3108 hex	00 hex	Speed Feedback Filter Time Constant 2	0	0 to 5	–	2 bytes (INT16)	B	Not possible.	Pn108
3109 hex	00 hex	Force Command Filter Time Constant 2	84/126[*9]	0 to 2500	0.01 ms	2 bytes (INT16)	B	Not possible.	Pn109

*1 The default setting is 11 for a Drive for 200 V and 1 kW or greater, or for a Drive for 400 V. It is set to 13 for other Drives.

*2 The default setting is 0 for a Drive for 100 V and 400 W, for 200 V and 750 W or greater, or for a Drive for 400 V. It is set to 3 for other Drives.

*3 The default setting is 320 for a Drive for 200 V and 1 kW or greater, or for a Drive for 400 V. It is set to 480 for other Drives.

*4 The default setting is 180 for a Drive for 200 V and 1 kW or greater, or for a Drive for 400 V. It is set to 270 for other Drives.

*5 The default setting is 310 for a Drive for 200 V and 1 kW or greater, or for a Drive for 400 V. It is set to 210 for other Drives.

*6 The default setting is 126 for a Drive for 200 V and 1 kW or greater, or for a Drive for 400 V. It is set to 84 for other Drives.

*7 The default setting is 380 for a Drive for 200 V and 1 kW or greater, or for a Drive for 400 V. It is set to 570 for other Drives.

*8 The default setting is 180 for a Drive for 200 V and 1 kW or greater, or for a Drive for 400 V. It is set to 270 for other Drives.

*9 The default setting is 126 for a Drive for 200 V and 1 kW or greater, or for a Drive for 400 V. It is set to 84 for other Drives.

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Index	Sub-Index	Name	Default setting	Setting range	Unit	Size	Data attribute	PDO map	Corresponding Pn number
3110 hex	00 hex	Speed Feed-forward Gain	300	0 to 1000	0.1%	2 bytes (INT16)	B	Not possible.	Pn110
3111 hex	00 hex	Speed Feed-forward Command Filter	50	0 to 6400	0.01 ms	2 bytes (INT16)	B	Not possible.	Pn111
3112 hex	00 hex	Force Feed-forward Gain	0	0 to 1000	0.1%	2 bytes (INT16)	B	Not possible.	Pn112
3113 hex	00 hex	Force Feed-forward Command Filter	0	0 to 6400	0.01 ms	2 bytes (INT16)	B	Not possible.	Pn113
3114 hex	00 hex	Gain Switching Input Operating Mode Selection	1	0 to 1	–	2 bytes (INT16)	B	Not possible.	Pn114
3115 hex	00 hex	Switching Mode in Position Control	0	0 to 10	–	2 bytes (INT16)	B	Not possible.	Pn115
3116 hex	00 hex	Gain Switching Delay Time in Position Control	50	0 to 10000	0.1 ms	2 bytes (INT16)	B	Not possible.	Pn116
3117 hex	00 hex	Gain Switching Level in Position Control	50	0 to 20000	–	2 bytes (INT16)	B	Not possible.	Pn117
3118 hex	00 hex	Gain Switching Hysteresis in Position Control	33	0 to 20000	–	2 bytes (INT16)	B	Not possible.	Pn118
3119 hex	00 hex	Position Gain Switching Time	33	0 to 10000	0.1 ms	2 bytes (INT16)	B	Not possible.	Pn119
3120 hex	00 hex	Switching Mode in Speed Control	0	0 to 5	–	2 bytes (INT16)	B	Not possible.	Pn120
3121 hex	00 hex	Gain Switching Delay Time in Speed Control	0	0 to 10000	0.1 ms	2 bytes (INT16)	B	Not possible.	Pn121
3122 hex	00 hex	Gain Switching Level in Speed Control	0	0 to 20000	–	2 bytes (INT16)	B	Not possible.	Pn122
3123 hex	00 hex	Gain Switching Hysteresis in Speed Control	0	0 to 20000	–	2 bytes (INT16)	B	Not possible.	Pn123
3124 hex	00 hex	Switching Mode in Force Control	0	0 to 3	–	2 bytes (INT16)	B	Not possible.	Pn124
3125 hex	00 hex	Gain Switching Delay Time in Force Control	0	0 to 10000	0.1 ms	2 bytes (INT16)	B	Not possible.	Pn125
3126 hex	00 hex	Gain Switching Level in Force Control	0	0 to 20000	–	2 bytes (INT16)	B	Not possible.	Pn126
3127 hex	00 hex	Gain Switching Hysteresis in Force Control	0	0 to 20000	–	2 bytes (INT16)	B	Not possible.	Pn127
3200 hex	00 hex	Adaptive Filter Selection	0	0 to 4	–	2 bytes (INT16)	B	Not possible.	Pn200
3201 hex	00 hex	Notch 1 Frequency Setting	5000	50 to 5000	Hz	2 bytes (INT16)	B	Not possible.	Pn201
3202 hex	00 hex	Notch 1 Width Setting	2	0 to 20	–	2 bytes (INT16)	B	Not possible.	Pn202
3203 hex	00 hex	Notch 1 Depth Setting	0	0 to 99	–	2 bytes (INT16)	B	Not possible.	Pn203
3204 hex	00 hex	Notch 2 Frequency Setting	5000	50 to 5000	Hz	2 bytes (INT16)	B	Not possible.	Pn204
3205 hex	00 hex	Notch 2 Width Setting	2	0 to 20	–	2 bytes (INT16)	B	Not possible.	Pn205
3206 hex	00 hex	Notch 2 Depth Setting	0	0 to 99	–	2 bytes (INT16)	B	Not possible.	Pn206
3207 hex	00 hex	Notch 3 Frequency Setting	5000	50 to 5000	Hz	2 bytes (INT16)	B	Not possible.	Pn207
3208 hex	00 hex	Notch 3 Width Setting	2	0 to 20	–	2 bytes (INT16)	B	Not possible.	Pn208
3209 hex	00 hex	Notch 3 Depth Setting	0	0 to 99	–	2 bytes (INT16)	B	Not possible.	Pn209

Index	Sub-Index	Name	Default setting	Setting range	Unit	Size	Data attribute	PDO map	Corresponding Pn number
3210 hex	00 hex	Notch 4 Frequency Setting	5000	50 to 5000	Hz	2 bytes (INT16)	B	Not possible.	Pn210
3211 hex	00 hex	Notch 4 Width Setting	2	0 to 20	–	2 bytes (INT16)	B	Not possible.	Pn211
3212 hex	00 hex	Notch 4 Depth Setting	0	0 to 99	–	2 bytes (INT16)	B	Not possible.	Pn212
3213 hex	00 hex	Damping Filter Selection	0	0 to 3	–	2 bytes (INT16)	B	Not possible.	Pn213
3214 hex	00 hex	Damping Frequency 1	0	0 to 2000	0.1 Hz	2 bytes (INT16)	B	Not possible.	Pn214
3215 hex	00 hex	Damping Filter 1 Setting	0	0 to 1000	0.1 Hz	2 bytes (INT16)	B	Not possible.	Pn215
3216 hex	00 hex	Damping Frequency 2	0	0 to 2000	0.1 Hz	2 bytes (INT16)	B	Not possible.	Pn216
3217 hex	00 hex	Damping Filter 2 Setting	0	0 to 1000	0.1 Hz	2 bytes (INT16)	B	Not possible.	Pn217
3218 hex	00 hex	Damping Frequency 3	0	0 to 2000	0.1 Hz	2 bytes (INT16)	B	Not possible.	Pn218
3219 hex	00 hex	Damping Filter 3 Setting	0	0 to 1000	0.1 Hz	2 bytes (INT16)	B	Not possible.	Pn219
3220 hex	00 hex	Damping Frequency 4	0	0 to 2000	0.1 Hz	2 bytes (INT16)	B	Not possible.	Pn220
3221 hex	00 hex	Damping Filter 4 Setting	0	0 to 1000	0.1 Hz	2 bytes (INT16)	B	Not possible.	Pn221
3222 hex	00 hex	Position Command Filter Time Constant	0	0 to 10000	0.1 ms	2 bytes (INT16)	B	Not possible.	Pn222
3312 hex	00 hex	Soft Start Acceleration Time	0	0 to 10000	ms/max. motor speed	2 bytes (INT16)	B	Not possible.	Pn312
3313 hex	00 hex	Soft Start Deceleration Time	0	0 to 10000	ms/max. motor speed	2 bytes (INT16)	B	Not possible.	Pn313
3314 hex	00 hex	S-curve Acceleration/Deceleration Time Setting	0	0 to 1000	ms	2 bytes (INT16)	B	Not possible.	Pn314
3317 hex	00 hex	Speed Limit Selection	1	0 to 1	–	2 bytes (INT16)	B	Not possible.	Pn317
3321 hex	00 hex	Speed Limit Value Setting	20000	0 to 20000	mm/s	2 bytes (INT16)	B	Not possible.	Pn321
3323 hex	00 hex	External Feedback Pulse Type Selection	0	0 to 2	–	2 bytes (INT16)	R	Not possible.	Pn323
3326 hex	00 hex	External Feedback Pulse Direction Switching	0	0 to 1	–	2 bytes (INT16)	R	Not possible.	Pn326
3327 hex	00 hex	External Feedback Pulse Phase-Z Setting	0	0 to 1	–	2 bytes (INT16)	R	Not possible.	Pn327
3400 hex	00 hex	Input Signal Selection 1	0094 9494 hex	0 to 00FF FFFF hex	–	4 bytes (INT32)	C	Not possible.	Pn400
3401 hex	00 hex	Input Signal Selection 2	0081 8181 hex	0 to 00FF FFFF hex	–	4 bytes (INT32)	C	Not possible.	Pn401
3402 hex	00 hex	Input Signal Selection 3	0082 8282 hex	0 to 00FF FFFF hex	–	4 bytes (INT32)	C	Not possible.	Pn402
3403 hex	00 hex	Input Signal Selection 4	0022 2222 hex	0 to 00FF FFFF hex	–	4 bytes (INT32)	C	Not possible.	Pn403
3404 hex	00 hex	Input Signal Selection 5	002B 2B2B hex	0 to 00FF FFFF hex	–	4 bytes (INT32)	C	Not possible.	Pn404
3405 hex	00 hex	Input Signal Selection 6	0021 2121 hex	0 to 00FF FFFF hex	–	4 bytes (INT32)	C	Not possible.	Pn405

Index	Sub-Index	Name	Default setting	Setting range	Unit	Size	Data attribute	PDO map	Corresponding Pn number
3406 hex	00 hex	Input Signal Selection 7	0020 2020 hex	0 to 00FF FFFF hex	–	4 bytes (INT32)	C	Not possible.	Pn406
3407 hex	00 hex	Input Signal Selection 8	002E 2E2E hex	0 to 00FF FFFF hex	–	4 bytes (INT32)	C	Not possible.	Pn407
3410 hex	00 hex	Output Signal Selection 1	0003 0303 hex	0 to 00FF FFFF hex	–	4 bytes (INT32)	C	Not possible.	Pn410
3411 hex	00 hex	Output Signal Selection 2	0002 0202 hex	0 to 00FF FFFF hex	–	4 bytes (INT32)	C	Not possible.	Pn411
3416 hex	00 hex	Analog Monitor 1 Selection	0	0 to 22	*1	2 bytes (INT16)	A	Not possible.	Pn416
3417 hex	00 hex	Analog Monitor 1 Scale Setting	0	0 to 214748364	*2	4 bytes (INT32)	A	Not possible.	Pn417
3418 hex	00 hex	Analog Monitor 2 Selection	4	0 to 22	–	2 bytes (INT16)	A	Not possible.	Pn418
3419 hex	00 hex	Analog Monitor 2 Scale Setting	0	0 to 214748364	*3	4 bytes (INT32)	A	Not possible.	Pn419
3421 hex	00 hex	Analog Monitor Output Setting	0	0 to 2	–	2 bytes (INT16)	A	Not possible.	Pn421
3432 hex	00 hex	Positioning Completion Condition Selection	0	0 to 4	–	2 bytes (INT16)	A	Not possible.	–
3433 hex	00 hex	Positioning Completion Hold Time	0	0 to 30000	ms	2 bytes (INT16)	A	Not possible.	–
3434 hex	00 hex	Zero Speed Detection	50	10 to 20000	mm/s	2 bytes (INT16)	A	Not possible.	Pn434
3435 hex	00 hex	Speed Conformity Detection Range	50	10 to 20000	mm/s	2 bytes (INT16)	A	Not possible.	Pn435
3436 hex	00 hex	Speed for Motor Detection	1000	10 to 20000	mm/s	2 bytes (INT16)	A	Not possible.	Pn436
3437 hex	00 hex	Brake Timing when Stopped	0	0 to 10000	ms	2 bytes (INT16)	B	Not possible.	Pn437
3438 hex	00 hex	Brake Timing During Operation	0	0 to 10000	ms	2 bytes (INT16)	B	Not possible.	Pn438
3439 hex	00 hex	Brake Threshold Speed During Operation	30	30 to 3000	mm/s	2 bytes (INT16)	B	Not possible.	Pn439
3440 hex	00 hex	Warning Output Selection 1	0	0 to 13	–	2 bytes (INT16)	A	Not possible.	Pn440
3441 hex	00 hex	Warning Output Selection 2	0	0 to 13	–	2 bytes (INT16)	A	Not possible.	Pn441
3442 hex	00 hex	Position Completion Range 2	10	0 to 262144	Command units	4 bytes (INT32)	A	Not possible.	Pn442
3504 hex	00 hex	Drive Prohibition Input Selection	1	0 to 2	–	2 bytes (INT16)	C	Not possible.	Pn504
3505 hex	00 hex	Stop Selection for Drive Prohibition Input	0	0 to 2	–	2 bytes (INT16)	C	Not possible.	Pn505
3508 hex	00 hex	Undervoltage Error Selection	1	0 to 1	–	2 bytes (INT16)	B	Not possible.	Pn508
3509 hex	00 hex	Momentary Hold Time	70	70 to 2000	ms	2 bytes (INT16)	C	Not possible.	Pn509
3511 hex	00 hex	Immediate Stop Force	0	0 to 5000	0.1%	2 bytes (INT16)	B	Not possible.	Pn755

*1 For units, refer to information on object 3416 hex on page 9-29.

*2 Monitor unit in object 3416 hex/V

*3 Monitor unit in object 3418 hex/V

Index	Sub-Index	Name	Default setting	Setting range	Unit	Size	Data attribute	PDO map	Corresponding Pn number
3512 hex	00 hex	Overload Detection Level Setting	100	0 to 500	%	2 bytes (INT16)	A	Not possible.	Pn512
3514 hex	00 hex	Overrun Limit Setting	10	0 to 1000	0.1 magnetic pole pitch	2 bytes (INT16)	A	Not possible.	Pn514
3515 hex	00 hex	Control Input Signal Read Setting	0	0 to 3	–	2 bytes (INT16)	C	Not possible.	Pn515
3520 hex	00 hex	Position Setting Unit Selection	0	0 to 1	–	2 bytes (INT16)	C	Not possible.	Pn520
3521 hex	00 hex	Force Limit Selection	6	0 to 7	–	2 bytes (INT16)	B	Not possible.	Pn521
3522 hex	00 hex	Force Limit 2	5000	0 to 5000	0.1%	2 bytes (INT16)	B	Not possible.	Pn754
3525 hex	00 hex	Force Limit 3	5000	0 to 5000	0.1%	2 bytes (INT16)	B	Not possible.	Pn730
3526 hex	00 hex	Force Limit 4	5000	0 to 5000	0.1%	2 bytes (INT16)	B	Not possible.	Pn731
3602 hex	00 hex	Excessive Speed Deviation Setting	0	0 to 20000	mm/s	2 bytes (INT16)	B	Not possible.	–
3605 hex	00 hex	Gain 3 Effective Time	0	0 to 10000	0.1 ms	2 bytes (INT16)	B	Not possible.	Pn605
3606 hex	00 hex	Gain 3 Ratio Setting	100	0 to 10000	%	2 bytes (INT16)	B	Not possible.	Pn606
3607 hex	00 hex	Force Command Value Offset	0	50 to 1000	%	2 bytes (INT16)	B	Not possible.	Pn607
3608 hex	00 hex	Positive Direction Force Offset	0	-100 to 100	%	2 bytes (INT16)	B	Not possible.	Pn608
3609 hex	00 hex	Negative Direction Force Offset	0	-100 to 100	%	2 bytes (INT16)	B	Not possible.	Pn609
3610 hex	00 hex	Function Expansion Setting	64	0 to 511	–	2 bytes (INT16)	B	Not possible.	Pn610
3614 hex	00 hex	Error Detection Allowable Time Setting	200	0 to 1000	ms	2 bytes (INT16)	B	Not possible.	Pn614
3615 hex	00 hex	Overspeed Detection Level Setting at Immediate Stop	0	0 to 20000	mm/s	2 bytes (INT16)	A	Not possible.	Pn615
3618 hex	00 hex	Power Supply ON Initialization Time	0	0 to 100	0.1 s	2 bytes (INT16)	R	Not possible.	Pn618
3623 hex	00 hex	Disturbance Force Compensation Gain	0	−100 to 100	%	2 bytes (INT16)	B	Not possible.	Pn623
3624 hex	00 hex	Disturbance Observer Filter Setting	53	10 to 2500	0.01 ms	2 bytes (INT16)	B	Not possible.	Pn624
3631 hex	00 hex	Realtime Autotuning Estimated Speed Selection	1	0 to 3	–	2 bytes (INT16)	B	Not possible.	Pn631
3632 hex	00 hex	Realtime Autotuning Customization Mode Setting	0	−32768 to 32767	–	2 bytes (INT16)	B	Not possible.	Pn632
3637 hex	00 hex	Vibration Detection Threshold	0	0 to 1000	0.1%	2 bytes (INT16)	B	Not possible.	Pn637
3638 hex	00 hex	Warning Mask Setting	4	−32768 to 32767	–	2 bytes (INT16)	C	Not possible.	Pn638
3700 hex	00 hex	LED Display Selection	0	0 to 32767	–	2 bytes (INT16)	A	Not possible.	Pn700
3701 hex	00 hex	Power ON Address Display Duration Setting	0	0 to 1000	100 ms	2 bytes (INT16)	R	Not possible.	Pn701
3703 hex	00 hex	Force Limit Flag Output Setting	1	0 to 1	–	2 bytes (INT16)	A	Not possible.	Pn703
3704 hex	00 hex	Backlash Compensation Selection	0	0 to 2	–	2 bytes (INT16)	C	Not possible.	Pn704

A-2 Object List

App

Index	Sub-Index	Name	Default setting	Setting range	Unit	Size	Data attribute	PDO map	Corresponding Pn number
3705 hex	00 hex	Backlash Compensation Amount	0	−32768 to 32767	Command units	2 bytes (INT16)	B	Not possible.	Pn705
3706 hex	00 hex	Backlash Compensation Time Constant	0	0 to 6400	0.01ms	2 bytes (INT16)	B	Not possible.	Pn706
3758 hex	00 hex	Touch Probe Trigger Selection	0100 hex	0000 to FFFF hex	–	2 bytes (U16)	B	Not possible.	Pn758
3759 hex	00 hex	Warning Hold Selection	0000 hex	0000 to FFFF hex	–	2 bytes (U16)	B	Not possible.	Pn759
3781 hex	00 hex	Data Setting Warning Detection Setting	1	0 to 15	–	2 bytes (INT16)	C	Not possible.	Pn781
3800 hex	00 hex	Communications Control	16384	−32768 to 32767	–	2 bytes (INT16)	C	Not possible.	Pn800
3801 hex	00 hex	Software Position Limit Function	3	0 to 3	–	2 bytes (INT16)	A	Not possible.	Pn801
3803 hex	00 hex	Origin Range	10	0 to 250	Command units	2 bytes (INT16)	A	Not possible.	Pn803
3818 hex	00 hex	Position Command FIR Filter Time Constant	0	0 to 10000	0.1 ms	2 bytes (INT16)	B	Not possible.	Pn818
3901 hex	00 hex	External Encoder Resolution	0	0 to 16777216	0.00 μm	4 bytes (INT32)	R	Not possible.	Pn901
3902 hex	00 hex	Pole Pitch	0	0 to 32767	0.01 mm	2 bytes (INT16)	R	Not possible.	Pn902
3904 hex	00 hex	Motor Coil Unit Mass	0	0 to 32767	0.01 kg	2 bytes (INT16)	R	Not possible.	Pn904
3905 hex	00 hex	Motor Rated Force	0	0 to 32767	0.1 N	2 bytes (INT16)	R	Not possible.	Pn905
3906 hex	00 hex	Motor Rated Rms Current	0	0 to 32767	0.1 Arms	2 bytes (INT16)	R	Not possible.	Pn906
3907 hex	00 hex	Motor Peak Absolute Current	0	0 to 32767	0.1 A	2 bytes (INT16)	R	Not possible.	Pn907
3908 hex	00 hex	Motor Inductance	0	0 to 32767	0.01 mH	2 bytes (INT16)	R	Not possible.	Pn908
3909 hex	00 hex	Motor Resistance	0	0 to 32767	0.01 Ω	2 bytes (INT16)	R	Not possible.	Pn909
3910 hex	00 hex	Overspeed Level	0	0 to 20000	mm/s	2 bytes (INT16)	R	Not possible.	Pn910
3912 hex	00 hex	Current Response Auto-adjustment	*1	0 to 100	%	2 bytes (INT16)	R	Not possible.	Pn912
3913 hex	00 hex	Current Loop Proportional Gain	50	0 to 32767	–	2 bytes (INT16)	B	Not possible.	Pn913
3914 hex	00 hex	Current Loop Integral Gain	10	0 to 32767	–	2 bytes (INT16)	B	Not possible.	Pn914
3915 Hex	00 hex	Two-stage Force Filter Time Constant	0	0 to 2500	0.01 ms	2 bytes (INT16)	B	Not possible.	Pn915
3916 hex	00 hex	Two-stage Force Filter Attenuation Term	1000	0 to 1000	–	2 bytes (INT16)	B	Not possible.	Pn916
3920 hex	00 hex	Magnetic Pole Detection Method	0	0 to 3	–	2 bytes (INT16)	R	Not possible.	Pn920
3922 hex	00 hex	Magnetic Pole Position Estimation Force Command Time	200	0 to 200	ms	2 bytes (INT16)	B	Not possible.	Pn922
3923 hex	00 hex	Magnetic Pole Position Estimation Force Command	50	0 to 300	%	2 bytes (INT16)	B	Not possible.	Pn923
3924 hex	00 hex	Magnetic Pole Position Estimation Maximum Movement	100	0 to 32767	pulse	2 bytes (INT16)	B	Not possible.	Pn924

*1   For details, refer to 3912 hex on page 9-58.

Index	Sub-Index	Name	Default setting	Setting range	Unit	Size	Data attribute	PDO map	Corresponding Pn number
3925 hex	00 hex	Magnetic Pole Position Estimation Movement for Stop Judgement	40	0 to 32767	pulse	2 bytes (INT16)	B	Not possible.	Pn925
3926 hex	00 hex	Magnetic Pole Position Estimation Time for Stop Judgement	40	0 to 32767	ms	2 bytes (INT16)	B	Not possible.	Pn926
3927 hex	00 hex	Magnetic Pole Position Estimation Time Limit for Stop	1000	0 to 32767	ms	2 bytes (INT16)	B	Not possible.	Pn927
3928 hex	00 hex	Magnetic Pole Position Estimation Force Filter Time Constant	100	0 to 2500	0.01 ms	2 bytes (INT16)	B	Not possible.	Pn928
3929 hex	00 hex	Motor Overload Curve Selection	0	0 to 7	–	2 bytes (INT16)	R	Not possible.	Pn929
4000 hex	00 hex	Statusword 1	0000 hex	0000 to FFFF hex	–	2 bytes (U16)	RO	TxPDO	–
4001 hex	00 hex	Sub Error Code	0000 hex	0000 to FFFF hex	–	2 bytes (U16)	RO	TxPDO	–
4100 hex	00 hex	Config	0000 0000 hex	0000 0000 to FFFF FFFF hex	–	4 bytes (U32)	B	Not possible.	–
4103 hex	00 hex	Coordinate System Setting Mode	0083 hex	0000 to FFFF hex	–	2 bytes (U16)	B	RxPDO	–
4104 hex	00 hex	Coordinate System Setting Position	0	-2147483648 to 2147483647	Command units	4 bytes (INT32)	B	RxPDO	–
603F hex	00 hex	Error code	0000 hex	0000 to FFFF hex	–	2 bytes (U16)	RO	TxPDO	–
6040 hex	00 hex	Controlword	0000 hex	0000 to FFFF hex	–	2 bytes (U16)	A	RxPDO	–
6041 hex	00 hex	Statusword	0000 hex	0000 to FFFF hex	–	2 bytes (U16)	RO	TxPDO	–
605B hex	00 hex	Shutdown option code	−1	−5 to 0	–	2 bytes (INT16)	B	Not possible.	Pn735
605C hex	00 hex	Disable operation option code	−1	−5 to 0	–	2 bytes (INT16)	B	Not possible.	Pn736
605D hex	00 hex	Halt option code	1	1 to 3	–	2 bytes (INT16)	B	Not possible.	Pn737
605E hex	00 hex	Fault reaction option code	−1	−7 to 0	–	2 bytes (INT16)	B	Not possible.	Pn738
6060 hex	00 hex	Modes of operation	0	0 to 10	–	1 byte (INT8)	A	RxPDO	–
6061 hex	00 hex	Modes of operation display	0	0 to 10	–	1 byte (INT8)	RO	TxPDO	–
6062 hex	00 hex	Position demand value	0	−2147483648 to 2147483647	Command units	4 bytes (INT32)	RO	TxPDO	–
6063 hex	00 hex	Position actual internal value	0	−2147483648 to 2147483647	External encoder units	4 bytes (INT32)	RO	TxPDO	–
6064 hex	00 hex	Position actual value	0	−2147483648 to 2147483647	Command units	4 bytes (INT32)	RO	TxPDO	–
6065 hex	00 hex	Following error window	100000	0 to 134217728 or 4294967295	Command units	4 bytes (U32)	A	Not possible.	Pn739
6067 hex	00 hex	Position window	10	0 to 262144	Command units	4 bytes (U32)	A	Not possible.	Pn740

Index	Sub-Index	Name	Default setting	Setting range	Unit	Size	Data attribute	PDO map	Corresponding Pn number
606C hex	00 hex	Velocity actual value	0	−2147483647 to 2147483647	Command units/s	4 bytes (INT32)	RO	TxPDO	−
6071 hex	00 hex	Target torque	0	−5000 to 5000	0.1%	2 bytes (INT16)	A	RxPDO	−
6072 hex	00 hex	Max torque	5000	0 to 5000	0.1%	2 bytes (U16)	A	RxPDO	−
6074 hex	00 hex	Torque demand	0	−5000 to 5000	0.1%	2 bytes (INT16)	RO	TxPDO	−
6077 hex	00 hex	Torque actual value	0	−5000 to 5000	0.1%	2 bytes (INT16)	RO	TxPDO	−
607A hex	00 hex	Target position	0	−2147483648 to 2147483647	Command units	4 bytes (INT32)	A	RxPDO	−
607C hex	00 hex	Home offset	0	−1073741823 to 1073741823	Command units	4 bytes (INT32)	C	Not possible.	Pn742
607D hex		Software position limit	−	−	−	−	−	−	−
	00 hex	Number of entries	02 hex	−	−	1 byte (U8)	RO	Not possible.	−
	01 hex	Min position limit	−500000	−1073741823 to 1073741823	Command units	4 bytes (INT32)	A	Not possible.	Pn743
	02 hex	Max position limit	500000	−1073741823 to 1073741823	Command units	4 bytes (INT32)	A	Not possible.	Pn744
607F hex	00 hex	Max profile velocity	0	0 to 2147483647	Command units/s	4 bytes (U32)	A	RxPDO	−
6081 hex	00 hex	Profile velocity	0	0 to 2147483647	Command units/s	4 bytes (U32)	A	RxPDO	−
6083 hex	00 hex	Profile acceleration	1000000	1 to 655350000	Command units/s^2	4 bytes (U32)	B	Not possible.	Pn745
6084 hex	00 hex	Profile deceleration	1000000	1 to 655350000	Command units/s^2	4 bytes (U32)	B	Not possible.	Pn746
6086 hex	00 hex	Motion profile type	0	−1 to 0	−	2 bytes (INT16)	B	RxPDO	−
6091 hex		Gear ratio	−	−	−	−	−	−	−
	00 hex	Number of entries	02 hex	−	−	1 byte (U8)	RO	Not possible.	−
	01 hex	Motor revolutions	1	1 to 1073741824	−	4 bytes (U32)	C	Not possible.	Pn748
	02 hex	Shaft revolutions	1	1 to 1073741824	−	4 bytes (U32)	C	Not possible.	Pn749
6098 hex	00 hex	Homing method	0	−128 to 127	−	1 byte (INT8)	B	Not possible.	Pn750
6099 hex		Homing speeds	−	−	−	−	−	−	−
	00 hex	Number of entries	02 hex	−	−	1 byte (U8)	RO	Not possible.	−
	01 hex	Speed during search for switch	5000	100 to 3276700	Command units/s	4 bytes (U32)	B	Not possible.	Pn751
	02 hex	Speed during search for zero	5000	100 to 3276700	Command units/s	4 bytes (U32)	B	Not possible.	Pn752

Index	Sub-Index	Name	Default setting	Setting range	Unit	Size	Data attribute	PDO map	Corresponding Pn number
60B0 hex	00 hex	Position offset	0	−2147483648 to 2147483647	Command units	4 bytes (INT32)	A	RxPDO	–
60B1 hex	00 hex	Velocity offset	0	−2147483648 to 2147483647	Command units/s	4 bytes (INT32)	A	RxPDO	–
60B2 hex	00 hex	Torque offset	0	−5000 to 5000	0.1%	2 bytes (INT16)	A	RxPDO	–
60B8 hex	00 hex	Touch probe function	0	–	–	2 bytes (U16)	A	RxPDO	–
60B9 hex	00 hex	Touch probe status	0	–	–	2 bytes (U16)	RO	TxPDO	–
60BA hex	00 hex	Touch probe pos1 pos value	0	−2147483648 to 2147483647	Command units	4 bytes (INT32)	RO	TxPDO	–
60BC hex	00 hex	Touch probe pos2 pos value	0	−2147483648 to 2147483647	Command units	4 bytes (INT32)	RO	TxPDO	–
60E0 hex	00 hex	Positive torque limit value	5000	0 to 5000	0.1%	2 bytes (U16)	B	Not possible.	–
60E1 hex	00 hex	Negative torque limit value	5000	0 to 5000	0.1%	2 bytes (U16)	B	Not possible.	–
60E3 hex		Supported homing method	–	–	–	–	–	–	–
	00 hex	Number of entries	07 hex	–	–	1 byte (U8)	RO	Not possible.	–
	01 hex	1st supported homing method	8	–	–	2 bytes (U16)	RO	Not possible.	–
	02 hex	2nd supported homing method	12	–	–	2 bytes (U16)	RO	Not possible.	–
	03 hex	3rd supported homing method	19	–	–	2 bytes (U16)	RO	Not possible.	–
	04 hex	4th supported homing method	20	–	–	2 bytes (U16)	RO	Not possible.	–
	05 hex	5th supported homing method	33	–	–	2 bytes (U16)	RO	Not possible.	–
	06 hex	6th supported homing method	34	–	–	2 bytes (U16)	RO	Not possible.	–
	07 hex	7th supported homing method	35	–	–	2 bytes (U16)	RO	Not possible.	–
60F4 hex	00 hex	Following error actual value	0	−536870912 to 536870912	Command units	4 bytes (INT32)	RO	TxPDO	–
60FA hex	00 hex	Control effort	0	-1073741823 to 1073741823	Command units/s	4 bytes (INT32)	RO	TxPDO	–
60FE hex		Digital outputs	–	–	–	–	–	–	–
	00 hex	Number of entries	02 hex	–	–	1 byte (U8)	RO	Not possible.	–
	01 hex	Physical outputs	0000 0000 hex	0000 0000 to FFFF FFFF hex	–	4 bytes (U32)	A	RxPDO	–
	02 hex	Bit mask	0000 0000 hex	0000 0000 to FFFF FFFF hex	–	4 bytes (U32)	B	Not possible.	–

Index	Sub-Index	Name	Default setting	Setting range	Unit	Size	Data attribute	PDO map	Corresponding Pn number
60FC hex	00 hex	Position demand internal value	0	−1073741823 to 1073741823	Encoder units	4 bytes (INT32)	RO	TxPDO	−
60FD hex	00 hex	Digital inputs	0000 0000 hex	0000 0000 to FFFF FFFF hex	−	4 bytes (U32)	RO	TxPDO	−
60FF hex	00 hex	Target velocity	0	-2147483647 to 2147483647	Command units/s	4 bytes (INT32)	A	RxPDO	−
6402 hex	00 hex	Motor type	3	−	−	2 bytes (U16)	RO	Not possible.	−
6502 hex	00 hex	Supported drive modes	0000 03A0 hex	−	−	4 bytes (U32)	RO	Not possible.	−

A-3   Sysmac Error Status Codes

This section lists and describes the error event codes that you may see in Sysmac Studio.

A-3-1   Error Table

The errors that may occur for this Unit are listed below.

The Level column of the table uses the following abbreviations:

Abbreviations	Name
Maj	Major fault level
Prt	Partial fault level
Min	Minor fault level
Obs	Observation
Info	Information

Refer to the *NJ-series Troubleshooting Manual* (Cat. No. W503) for all of the event codes that may occur in an NJ-series Controller.

Event code	Event name	Meaning	Assumed cause	Level					Reference
				Maj	Prt	Min	Obs	Info	
04A80000 hex	Control Power Supply Undervoltage	The voltage between the positive and negative terminals in the control power supply converter dropped below the specified value.	• Power supply undervoltage. • The power supply voltage dropped because there was inrush current when the main power supply was turned ON. • A momentary power interruption occurred. • The Servo Drive failed.			√			page A-106
04A90000 hex	Overvoltage	The power supply voltage exceeded the allowable input voltage range.	• The voltage between the positive and negative terminals in the control power supply converter exceeded the specified value. • The voltage was suddenly increased by the phase advance capacitor or the uninterruptible power supply (UPS). • The Regeneration Resistor wiring is broken. • The External Regeneration Resistor is not suitable. • The Servo Drive failed.			√			page A-107

Event code	Event name	Meaning	Assumed cause	Level					Reference
				Maj	Prt	Min	Obs	Info	
04AA0000 hex	Main Circuit Power Supply Undervoltage (Undervoltage between positive and negative terminals)	If the Undervoltage Error Selection (3508 hex) is set to 1, a momentary power interruption occurred between L1 and L3 for longer than the value specified for the Momentary Hold Time. The voltage between the positive and negative terminals in the main power supply converter dropped below the specified value while the Servo was ON.	• Insufficient power supply capacity • The electromagnetic contactor in the main circuit power supply was tripped. • A momentary power interruption occurred. • A Servo Drive with 3-phase input specifications was operated with a single-phase power supply. • The Servo Drive failed.			√			page A-108
04AB0000 hex	Main Circuit Power Supply Undervoltage (AC Cutoff Detected)	If the Undervoltage Error Selection (3508 hex) is set to 1, a momentary power interruption occurred between L1 and L3 for longer than the value specified for the Momentary Hold Time. The voltage between the positive and negative terminals in the main power supply converter dropped below the specified value while the Servo was ON.	• Insufficient power supply capacity • The electromagnetic contactor in the main circuit power supply was tripped. • A momentary power interruption occurred. • A Servo Drive with 3-phase input specifications was operated with a single-phase power supply. • The Servo Drive failed.			√			page A-109
04AC0000 hex	Overcurrent	The current flowing through the converter exceeded the specified value.	• A short-circuit, line-to-ground fault, contact failure, or insulation failure occurred on the U, V, or W motor line. • The Servo Drive failed. • The relay for the dynamic brake has been welded due to frequent Servo ON/OFF operations. • Motor windings are burned out. • The motor is not suitable for the Servo Drive. • The command input timing is the same as or earlier than the Servo ON timing.			√			page A-110

Event code	Event name	Meaning	Assumed cause	Level					Reference
				Maj	Prt	Min	Obs	Info	
04AD0000 hex	IPM Error	The current flowing through the converter exceeded the specified value.	• A short-circuit, line-to-ground fault, contact failure, or insulation failure occurred on the U, V, or W motor line. • The Servo Drive failed. • The relay for the dynamic brake has been welded due to frequent Servo ON/OFF operations. • Motor windings are burned out. • The motor is not suitable for the Servo Drive. • The pulse input timing is the same as or earlier than the Servo ON timing.			√			page A-111
04AE0000 hex	Regeneration transistor Error	The Servo Drive regeneration drive transistor is faulty.	• The Servo Drive regeneration drive transistor is faulty.			√			page A-112
04B10000 hex	Node Address Setting Error	The node address that was read from the rotary switches was not between 00 and 99.	• The Servo Drive failed.			√			page A-112
04B20000 hex	Other Errors	The Servo Drive malfunctioned, or an error occurred in the Servo Drive.	• The control circuit malfunctioned temporarily due to excess noise. • The self-diagnosis function of the Servo Drive detected an error in the Servo Drive.			√			page A-113
080B0000 hex	Safety Input Error	One of the input photocouplers for safety inputs 1 and 2 turned OFF.	• The cable is disconnected or broken.			√			page A-113
080C0000 hex	External Encoder Connection Error	A disconnection was detected because communications between the external encoder and the Servo Drive were stopped more frequently than the specified value.	• The wiring is incorrect.			√			page A-114
080D0000 hex	External Encoder Communications Data Error	There was a communications error in data from the external encoder.	• There is insufficient external encoder power supply voltage. • Noise			√			page A-114
080E0000 hex	External Encoder Status Error 0	Bit 00 of the external encoder error code (ALMC) was set to 1.	• Bit 00 of the external scale error code (ALMC) was set to 1.			√			page A-115
080F0000 hex	External Encoder Status Error 1	Bit 01 of the external encoder error code (ALMC) was set to 1.	• Bit 01 of the external encoder error code (ALMC) was set to 1.			√			page A-115
08100000 hex	External Encoder Status Error 2	Bit 02 of the external encoder error code (ALMC) was set to 1.	• Bit 02 of the external encoder error code (ALMC) was set to 1.			√			page A-116

Event code	Event name	Meaning	Assumed cause	Level					Reference
				Maj	Prt	Min	Obs	Info	
08110000 hex	External Encoder Status Error 3	Bit 03 of the external encoder error code (ALMC) was set to 1.	• Bit 03 of the external encoder error code (ALMC) was set to 1.			√			page A-116
08120000 hex	External Encoder Status Error 4	Bit 04 of the external encoder error code (ALMC) was set to 1.	• Bit 04 of the external encoder error code (ALMC) was set to 1.			√			page A-117
08130000 hex	External Encoder Status Error 5	Bit 05 of the external encoder error code (ALMC) was set to 1.	• Bit 05 of the external encoder error code (ALMC) was set to 1.			√			page A-117
08140000 hex	Phase-A Connection Error	An error such as broken wiring was detected in the external encoder phase-A connection.	• An error such as broken wiring was detected in the external encoder phase-A connection.			√			page A-118
08150000 hex	Phase-B Connection Error	An error such as broken wiring was detected in the external encoder phase-B connection.	• An error such as broken wiring was detected in the external encoder phase-B connection.			√			page A-118
08160000 hex	Phase-Z Connection Error	An error such as broken wiring was detected in the external encoder phase-Z connection.	• An error such as broken wiring was detected in the external encoder phase-Z connection.			√			page A-119
14A80000 hex	Object Error	The object area data in non-volatile memory is corrupted.	• Noise • Non-volatile memory failure			√			page A-119
14A90000 hex	Object Error	The object area data in non-volatile memory is corrupted.	• Noise • Non-volatile memory failure			√			page A-120
14AA0000 hex						√			page A-120
14AB0000 hex	Object Corrupted	The checksum data in non-volatile memory is corrupted.	• Non-volatile memory failure			√			page A-121
14AC0000 hex						√			page A-121
14AD0000 hex						√			page A-122
28010000 hex	Motor Setting Error	Settings associated with the motor and external encoder are missing.	Settings associated with the motor and external encoder are missing.			√			page A-122
28020000 hex	Motor Combination Error 1	The value set for the motor current exceeds the maximum motor capacity allowed for the Servo Drive.	The Motor Rated Rms Current/ Motor Peak Absolute Current exceeds the maximum motor capacity allowed for the Servo Drive.			√			page A-123

Event code	Event name	Meaning	Assumed cause	Level					Reference
				Maj	Prt	Min	Obs	Info	
28030000 hex	Motor Combination Error 2	The value set for the motor exceeds the drive range of the motor.	• The Motor Rated Rms Current is too low compared with the maximum motor capacity of the Servo Drive. • The percentage of the Motor Coil Unit Mass to the Motor Rated Force is too high. • The automatically adjusted Current Loop Proportional Gain/Current Loop Integral Gain is too high. • The percentage of the Motor Peak Absolute Current to the rated current of the motor is greater than 500%.			√			page A-124
34E10000 hex	Servo Drive Overheat	The temperature of the Servo Drive radiator or power elements exceeded the specified value.	• The ambient temperature of the Servo Drive exceeded the specified value. • Overload			√			page A-125
34E20000 hex	Overload	When the feedback value for force command exceeds the overload level specified in the Overload Detection Level Setting (3512 hex), overload protection is performed according to the overload characteristics.	• Operation was continued for a long time while overloaded. • There is incorrect wiring of the motor line or a broken cable.			√			page A-126
34E30000 hex	Regeneration Overload	The regenerative energy exceeds the processing capacity of the Regeneration Resistor.	• The load mass is too large. • The motor speed is too high. • This Regeneration Resistor cannot be used for continuous regenerative braking. (The operating limit of the external resistor is limited to a 10% duty.)			√			page A-127
34E40000 hex	Error Counter Overflow	Position error pulses exceeded the setting of the Following error window (6065 hex).	• Motor operation does not follow the command. • The value of the Following error window (6065 hex) is small. • The external encoder wiring is incorrect.			√			page A-128
34E50000 hex	Excessive Velocity Error	The difference between the internal position command velocity and the actual velocity (i.e., the velocity error) exceeded the Excessive Velocity Error Setting (3602 hex).	• Motor operation does not follow the command. • The setting of the Excessive Velocity Error Setting (3602 hex) is too small.			√			page A-129
34E60000 hex	Overspeed	The motor speed exceeded the value set on the Overspeed Detection Level Setting (3513 hex).	• The velocity command value is too large. • There is overshooting. • The wiring is incorrect.			√			page A-129

A-3 Sysmac Error Status Codes

App

A-3-1 Error Table

Event code	Event name	Meaning	Assumed cause	Level					Reference
				Maj	Prt	Min	Obs	Info	
38400000 hex	Overspeed 2	The motor speed exceeded the value set on Overspeed Detection Level Setting at Immediate Stop (3615 hex).	• The velocity command value is too large. • There is overshooting. • The wiring is incorrect.			√			page A-130
38410000 hex	Command Error	The position command variation after the electronic gear exceeded the specified value.	• The change in position command is too large. • The backlash compensation amount is too large.			√			page A-130
38420000 hex	Command Generation Error	During position command processing, an error such as a calculation range error occurred.	• During position command processing, an error such as a calculation range error occurred.			√			page A-131
38430000 hex	Error Counter Overflow 1	The absolute encoder position in pulses divided by the electronic gear ratio exceeded $\pm 2^{31}$ (2,147,483,648).	• The absolute encoder position in pulses divided by the electronic gear ratio exceeded $\pm 2^{31}$ (2,147,483,648).			√			page A-131
38440000 hex	Error Counter Overflow 2	The position following error in pulses exceeded $\pm 2^{29}$ (536,870,912). Or, the position following error in command units exceeded $\pm 2^{30}$ (1,073,741,824).	• There is insufficient force. • There is insufficient gain. • The external encoder wiring is incorrect.			√			page A-132
38450000 hex	Interface Input Duplicate Allocation Error 1	There is a duplicate setting in the input signal (IN1, IN2, IN3, and IN4) function allocations.	• There is a duplicate setting in the input signal (IN1, IN2, IN3, and IN4) function allocations.			√			page A-132
38460000 hex	Interface Input Duplicate Allocation Error 2	There is a duplicate setting in the input signal (IN5, IN6, IN7, and IN8) function allocations.	• There is a duplicate setting in the input signal (IN5, IN6, IN7, and IN8) function allocations.			√			page A-133
38470000 hex	Interface Input Function Number Error 1	There is an undefined number specification in the input signal (IN1, IN2, IN3, and IN4) function allocations. Or, a logic setting error was detected.	• There is an undefined number specification in the input signal (IN1, IN2, IN3, and IN4) function allocations. • Different logic is set for the same function in the function assignments of the input signals (IN1, IN2, IN3, and IN4).			√			page A-134
38480000 hex	Interface Input Function Number Error 2	There is an undefined number specification in the input signal (IN5, IN6, IN7, and IN8) function allocations. Or, a logic setting error was detected.	• There is an undefined number specification in the input signal (IN5, IN6, IN7, and IN8) function allocations. • Different logic is set for the same function in the function assignments of the input signals (IN5, IN6, IN7, and IN8).			√			page A-135

G5 Series AC Servo Drives With Built-in EtherCAT Communications, Linear Motor Type

Event code	Event name	Meaning	Assumed cause	Level					Reference
				Maj	Prt	Min	Obs	Info	
38490000 hex	Interface Output Function Number Error 1	There is an undefined number specification in the output signal (OUTM1) function allocation.	• There is an undefined number specification in the output signal (OUTM1) function allocation.			√			page A-136
384A0000 hex	Interface Output Function Number Error 2	There is an undefined number specification in the output signal (OUTM2) function allocation.	• There is an undefined number specification in the output signal (OUTM2) function allocation.			√			page A-136
384B0000 hex	External Latch Input Allocation Error	There is an error in the latch input function allocation.	• The latch input was allocated to an input signal other than IN5, IN6, or IN7. • A latch input is assigned to an NC signal. • The same latch input is not assigned to the same pin in all Control Modes.			√			page A-137
384C0000 hex	Overrun Limit Error	The motor exceeded the allowable operating range set in the Overrun Limit Setting (3514 hex) with respect to the position command input range.	• The gain or mass ratio is not suitable. • The set value of the Overrun Limit Setting (3514 hex) is too small.			√			page A-137
384F0000 hex	Object Setting Error 1	The electronic gear ratio exceeded the allowable range.	• The electronic gear ratio exceeded the allowable range.			√			page A-138
38500000 hex	Object Setting Error 2	External encoder ratio exceeded the allowable range.	• External encoder ratio exceeded the allowable range.			√			page A-138
38510000 hex	External Encoder Connection Error	The set value of the External Feedback Pulse Type Selection (3323 hex) differs from the external encoder type that is connected for serial communications.	• The set value of the External Feedback Pulse Type Selection (3323 hex) differs from the external encoder type that is connected for serial communications.			√			page A-139
38520000 hex	Function Setting Error	The function that was set does not support the communications period.	• The electronic gear object ratio was not 1:1 when the communications period was set to 250 or 500 µs. • Modes of operation (6060 hex) was set to pp or hm when the communications period was set to 250 or 500 µs. • More than 20 bytes were mapped for RxPDO when the communications period was set to 250 µs. • No bytes (i.e., no objects) were mapped for RxPDO. • More than 10 objects were mapped for RxPDO. • More than 11 objects were mapped for TxPDO.			√			page A-140

Event code	Event name	Meaning	Assumed cause	Level					Reference
				Maj	Prt	Min	Obs	Info	
38530000 hex	Magnetic Pole Position Estimation Error 1	Magnetic pole position estimation was not completed successfully.	• Settings associated with the external encoder are incorrect. • The command time or force command value for magnetic pole position estimation is insufficient. • There is a large unbalanced load or friction.			√			page A-141
38540000 hex	Magnetic Pole Position Estimation Error 2	Magnetic pole position estimation was not completed successfully because the motor did not stop within the Magnetic Pole Position Estimation Time Limit for Stop.	• The value set for the Magnetic Pole Detection Time Limit for Stop (3927 Hex) is small compared with the actual stop time of the motor. • The motor is moving when no force is applied.			√			page A-142
38550000 hex	Magnetic Pole Position Estimation Error 3	Magnetic pole position restoration was not completed successfully.	• The Magnetic Pole Detection Method (3920 hex) object was set to 3 (Magnetic pole position restoration method), although the Magnetic Pole Position Estimation had never been executed. • The Magnetic Pole Detection Method (3920 hex) was set to 3 (Magnetic pole position restoration method) when a non-absolute type external encoder was used.			√			page A-143
64E00000 hex	Drive Prohibition Input Error 1	When the Drive Prohibition Input Selection (3504 hex) was set to "0," both the Positive Drive Prohibition Input (POT) and the Negative Drive Prohibition Input (NOT) turned ON. Or, when the Drive Prohibition Input Selection (3504 hex) was set to "2," either the Positive Drive Prohibition Input (POT) or the Negative Drive Prohibition Input (NOT) turned ON.	• A problem occurred with the switches, wires, and power supplies that are connected to the Positive Drive Prohibition input or the Negative Drive Prohibition input.			√			page A-144

Event code	Event name	Meaning	Assumed cause	Level					Reference
				Maj	Prt	Min	Obs	Info	
64E10000 hex	Drive Prohibition Input Error 2	When the Drive Prohibition Input Selection (3504 hex) was set to 0 and either POT or NOT was ON, an operation command was received from the CX-Drive while EtherCAT communications were interrupted. Or POT or NOT turned ON while operation was being performed for a CX-Drive operation command.	• A problem occurred with the switches, wires, and power supplies that are connected to the Positive Drive Prohibition input or the Negative Drive Prohibition input.			√			page A-144
64E20000 hex	Immediate Stop Input Error	An Immediate Stop (STOP) signal was input.	• An Immediate Stop (STOP) signal was input. • Incorrect wiring of the immediate stop input (STOP).			√			page A-145
74810000 hex	Command Error	A mistake was made in using a command.	• When bit 09 (Remote) of the Statusword (6041 hex) was set to 1 (remote), and the Servo Drive was in operation enabled state (Servo ON), a command was received that changes the communications state from Operational to another state. • When bit 09 (Remote) of the Statusword (6041 hex) was set to 0 (local), a command was received during FFT or test run status that changes the ESM state from Operational, Safe-operational, or Pre-operational state to Init state. • An unsupported number was set for the Operation Mode (6060 hex). • During Fully-closed Control Mode, csv or cst was set for the Operation Mode (6060 hex). • The setting of the Operation Mode (6060 hex) was changed at an interval of less than 2 ms. • Homing was started when the Homing Method (6098 hex) was set to a value other than 8, 12, 19, 20, 33, 34,or 35. • Data setting warnings (B0 hex) occurred continuously for the number of data setting warnings that is set in the Data Setting Warning Detection Count (3781 hex).			√			page A-146

Event code	Event name	Meaning	Assumed cause	Level					Reference
				Maj	Prt	Min	Obs	Info	
78010000 hex	Operation Command Competition	An attempt was made to establish EtherCAT communications or to turn ON the Servo from the Controller (enable operation) while executing an FFT that operates with the Servo Drive alone or a trial run.	• EtherCAT communications (change from Init to Pre-operational state) was established while executing an FFT that operates with the Servo Drive trial run. • An attempt to turn ON the Servo from the Controller (enable operation) was made while executing an FFT that operates with the Servo Drive trial run.			√			page A-147
84B10000 hex	EtherCAT State Change Error	A communications state change command was received for which the current communications state could not be changed.	• A communications state change command was received for which the current communications state could not be changed.			√			page A-147
84B20000 hex	EtherCAT Illegal State Change Error	An undefined communications state change command was received.	• An undefined communications state change command was received.			√			page A-148
84B30000 hex	Communications Synchronization Error	The number of consecutive errors in receiving data during the communication sync time exceeded the value specified for the Communications Control Setting.	• Power to the host controller was interrupted during PDO communications. • An EtherCAT communications cable is disconnected, broken, or incorrectly connected. • Noise			√			page A-148
84B40000 hex	Synchronization Error	A synchronization error occurred.	• Noise • Control PCB error			√			page A-149
84B50000 hex	Sync Manager WDT Error	PDO communications were stopped for more than the specified period of time.	• The EtherCAT communications cable is disconnected or broken. • There is an error in the host controller.			√			page A-149
84B60000 hex	ESC Initialization Error	An error occurred in ESC initialization.	• Control PCB error			√			page A-150
84B70000 hex	Slave Unit Verification Error	An error occurred in Slave Unit verification.	• Control PCB error			√			page A-150
84B80000 hex	Communications Setting Error	There is an error in the communications settings.	• An out-of-range value was set from the host controller. • A command that changes the communications state to an unsupported state was received.			√			page A-151
84B90000 hex	Synchronization Interruption Error	A synchronization interruption error occurred.	• Control PCB error			√			page A-151
98020000 hex	Position Data Initialized	A Config operation was performed during EtherCAT communications.	• A Config operation was performed during EtherCAT communications.			√			page A-152

Event code	Event name	Meaning	Assumed cause	Level					Reference
				Maj	Prt	Min	Obs	Info	
08020000 hex	Fan Warning	The fan stop state continued for 1 second.	• There is foreign matter in the fan. • The Servo Drive failed.				√		page A-152
08040000 hex	External Encoder Overheating Warning	The external encoder temperature exceeded the specified value.	• The ambient temperature is too high. • Linear Motor failed.				√		page A-153
08050000 hex	Life Expectancy Warning	The remaining life of the capacitor or the fan is shorter than the specified value.	• The life expectancy of the capacitor or the fan is shorter than the specified value.				√		page A-153
08060000 hex	External Encoder Error Warning	The external encoder detected a warning.	• There is insufficient power supply voltage for the external encoder. • Noise is entering on the external encoder connector cable. • The external encoder failed.				√		page A-154
08070000 hex	External Encoder Communications Warning	The external encoder had more communications errors than the specified value.	• There is insufficient power supply voltage for the external encoder. • Noise is entering on the external encoder connector cable.				√		page A-154
34E00000 hex	Data Setting Warning	An object setting is out of range.	• An object setting is out of range.				√		page A-155
383C0000 hex	Overload Warning	The load ratio is 85% or more of the protection level.	• Overload • There is incorrect wiring of the motor line or a broken cable.				√		page A-155
383D0000 hex	Excessive Regeneration Warning	The regeneration load ratio is 85% or more of the level.	• There is excessive regeneration. • This Regeneration Resistor cannot be used for continuous regenerative braking.				√		page A-156

Event code	Event name	Meaning	Assumed cause	Level					Reference
				Maj	Prt	Min	Obs	Info	
383E0000 hex	Vibration Detection Warning	Vibration was detected.	• The gain or mass ratio setting is not suitable.				√		page A-156
74800000 hex	Command Warning	A command could not be executed.	• A forced brake operation request was sent while the Servo was ON. • When 3508 hex is "0," Switch ON command was sent when the main power was OFF. • An Enable Operation command was sent to request turning ON the Servo when the motor was operating at 30 mm/s or higher. • A latch operation was started when the Config operation was being performed. • A latch operation was started when the Statusword (6041 hex) bit 9 (Remote) was 0 (local). • An operation command is given in the prohibited direction after the motor made an immediate stop due to a drive prohibition input.				√		page A-157
84B00000 hex	EtherCAT Communications Warning	An EtherCAT communications error occurred one or more times.	• The EtherCAT communications cable is disconnected or broken. • Noise				√		page A-158

A-3-2   Error Description

This section describes errors.

Controller Error Descriptions

The items that are used to describe individual errors are described in the following copy of an error table.

Event name	Gives the name of the error.		Event code	Gives the code of the error.	
Meaning	Gives a short description of the error.				
Source	Gives the source of the error.		Source details	Gives details on the source of the error.	Detection timing	Tells when the error is detected.
Error attributes	Level	Tells the influence on control.*1	Recovery	Gives the recovery method.*2	Log category	Tells which log the error is saved in.*3
Effects	User program	Tells what will happen to execution of the user program.*4	Operation	Provides special information on the operation that results from the error.		
Indicators	Gives the status of the built-in EtherNet/IP port and built-in EtherCAT port indicators. Indicator status is given only for errors in the EtherCAT Master Function Module and the EtherNet/IP Function Module.				
System-defined variables	Variable		Data type		Name
	Lists the variable names, data types, and meanings for system-defined variables that provide direct error notification, that are directly affected by the error, or that contain settings that cause the error.				
Cause and correction	Assumed cause		Remedy		Prevention
	Lists the possible causes, remedies, and preventive measures for the error.				
Attached information	Provides the additional information that is displayed by the Sysmac Studio or an NS-series PT.				
Precautions/ Remarks	Provides precautions, restrictions, and supplemental information.				

*1 One of the following:
  Major fault: Major fault level
  Partial fault: Partial fault level
  Minor fault: Minor fault level
  Observation
  Information

*2 One of the following:
  Automatic recovery: Normal status is restored automatically when the cause of the error is removed.
  Error reset: Normal status is restored when the error is reset after the cause of the error is removed.
  Cycle the power supply: Normal status is restored when the power supply to the Controller is turned OFF and then back ON after the cause of the error is removed.
  Controller reset: Normal status is restored when the Controller is reset after the cause of the error is removed.
  Depends on cause: The recovery method depends on the cause of the error.

*3 One of the following:
  System: System event log
  Access: Access event log

*4 One of the following:
  Continues: Execution of the user program will continue.
  Stops: Execution of the user program stops.
  Starts: Execution of the user program starts.

Error Descriptions

The following table describes the error codes that are output to *ErrorID* when errors occur in execution of the instructions. The upper four digits of the event codes that are given in the following table are output as the error code to *ErrorID*.

Event name	Control Power Supply Undervoltage		Event code	04A80000 hex	
Meaning	The voltage between the positive and negative terminals in the control power supply converter dropped below the specified value.				
Source	EtherCAT Master Function Module		Source details	Slave	Detection timing	Continuously
Error attributes	Level	Minor fault	Recovery	Error reset (after resetting slave errors)	Log category	System
Effects	User program	Continues.	Operation	Power drive circuit is OFF for relevant slave.		
Indicators	EtherNet/IP NET RUN		EtherNet/IP NET ERR		EtherNet/IP LINK/ACT	
	---		---		---	
System-defined variables	Variable		Data type		Name	
	None		---		---	
Cause and correction	Assumed cause		Remedy		Prevention	
	Power supply undervoltage. Or, the power supply voltage dropped because there was inrush current when the main power supply was turned ON.		Increase the power supply capacity.		None	
	A momentary power interruption occurred.		Review the power supply conditions and prevent momentary power interruption.		Make sure that the power supply conditions prevent momentary power interruption.	
	The Servo Drive failed.		Replace the Servo Drive.		None	
Attached information	None					
Precautions/ Remarks	"11" is displayed on the Servo Drive front panel and F011 is given as the AlarmCode (4001 hex)					

Event name	Overvoltage			Event code	04A90000 hex
Meaning	The power supply voltage exceeded the allowable input voltage range.				
Source	EtherCAT Master Function Module		Source details	Slave	Detection timing	Continuously
Error attributes	Level	Minor fault	Recovery	Error reset (after resetting slave errors)	Log category	System
Effects	User program	Continues.	Operation	Power drive circuit is OFF for relevant slave.		
Indicators	EtherNet/IP NET RUN		EtherNet/IP NET ERR		EtherNet/IP LINK/ACT	
	---		---		---	
System-defined variables	Variable		Data type		Name	
	None		---		---	
Cause and correction	Assumed cause		Remedy		Prevention	
	The voltage between the positive and negative terminals in the control power supply converter exceeded the specified value.		Input the correct voltage.		Input the correct voltage.	
	The voltage was suddenly increased by the phase advance capacitor or the uninterruptible power supply (UPS).		Remove the phase-advancing capacitor or UPS.		Do not use a phase-advancing capacitor or UPS.	
	The Regeneration Resistor wiring is broken.		Measure the resistance of the external resistor between the B1 and B2 terminals on the Servo Drive. If the resistance is infinite, the wiring is broken. Replace the external resistor.		None	
	The External Regeneration Resistor is not suitable.		Change the Regeneration Resistor based on the specified regeneration resistance and the calculated power (W).		Determine the Regeneration Resistor based on the specified regeneration resistance and the calculated power (W).	
	The Servo Drive failed.		Replace the Servo Drive.		None	
Attached information	None					
Precautions/ Remarks	"12" is displayed on the Servo Drive front panel and F012 is given as the AlarmCode (4001 hex)					

Event name	Main Circuit Power Supply Undervoltage (Undervoltage between positive and negative terminals)		Event code	04AA0000 hex		
Meaning	If the Undervoltage Error Selection (3508 hex) is set to 1, a momentary power interruption occurred between L1 and L3 for longer than the value specified for the Momentary Hold Time. The voltage between the positive and negative terminals in the main power supply converter dropped below the specified value while the Servo was ON.					
Source	EtherCAT Master Function Module		Source details	Slave	Detection timing	While power is supplied to motor
Error attributes	Level	Minor fault	Recovery	Error reset (after resetting slave errors)	Log category	System
Effects	User program	Continues.	Operation	Power drive circuit is OFF for relevant slave.		
Indicators	EtherNet/IP NET RUN		EtherNet/IP NET ERR		EtherNet/IP LINK/ACT	
	---		---		---	
System-defined variables	Variable		Data type		Name	
	None		---		---	
Cause and correction	Assumed cause		Remedy		Prevention	
	Insufficient power supply capacity		Increase the power supply capacity.		None	
	The electromagnetic contactor in the main circuit power supply was tripped.		Eliminate the cause of the failure of the electromagnetic contactor on the main circuit power supply, and then turn ON the power again.		Check the wiring of the main circuit power supply.	
	A momentary power interruption occurred.		Review the power supply conditions and prevent momentary power interruption. Alternatively, increase the Momentary Hold Time (3509 hex) setting.		Make sure that the power supply conditions prevent momentary power interruption.	
	A Servo Drive with 3-phase input specifications was operated with a single-phase power supply.		Make sure that the phases of the power supply are set correctly before you connect them.		Make sure that the phases of the power supply are set correctly before you connect them.	
	The Servo Drive failed.		Replace the Servo Drive.		None	
Attached information	None					
Precautions/ Remarks	"13" is displayed on the Servo Drive front panel and F013 is given as the AlarmCode (4001 hex)					

Event name	Main Circuit Power Supply Undervoltage (AC Cutoff Detected)		Event code	04AB0000 hex	
Meaning	If the Undervoltage Error Selection (3508 hex) is set to 1, a momentary power interruption occurred between L1 and L3 for longer than the value specified for the Momentary Hold Time. The voltage between the positive and negative terminals in the main power supply converter dropped below the specified value while the Servo was ON.				
Source	EtherCAT Master Function Module		Source details	Slave	Detection timing	While power is supplied to motor
Error attributes	Level	Minor fault	Recovery	Error reset (after resetting slave errors)	Log category	System
Effects	User program	Continues.	Operation	Power drive circuit is OFF for relevant slave.		
Indicators	EtherNet/IP NET RUN		EtherNet/IP NET ERR		EtherNet/IP LINK/ACT	
	---		---		---	
System-defined variables	Variable		Data type		Name	
	None		---		---	
Cause and correction	Assumed cause		Remedy		Prevention	
	Insufficient power supply capacity		Increase the power supply capacity.		None	
	The electromagnetic contactor in the main circuit power supply was tripped.		Eliminate the cause of the failure of the electromagnetic contactor on the main circuit power supply, and then turn ON the power again.		Check the wiring of the main circuit power supply.	
	A momentary power interruption occurred.		Review the power supply conditions and prevent momentary power interruption. Alternatively, increase the Momentary Hold Time (3509 hex) setting.		Make sure that the power supply conditions prevent momentary power interruption.	
	A Servo Drive with 3-phase input specifications was operated with a single-phase power supply.		Make sure that the phases of the power supply are set correctly before you connect them.		Make sure that the phases of the power supply are set correctly before you connect them.	
	The Servo Drive failed.		Replace the Servo Drive.		None	
Attached information	None					
Precautions/ Remarks	"13" is displayed on the Servo Drive front panel and F113 is given as the AlarmCode (4001 hex)					

Event name	Overcurrent			Event code	04AC0000 hex
Meaning	The current flowing through the converter exceeded the specified value.				
Source	EtherCAT Master Function Module		Source details	Slave	Detection timing	Continuously
Error attributes	Level	Minor fault	Recovery	Error reset (after cycling slave power)	Log category	System
Effects	User program	Continues.	Operation	Power drive circuit is OFF for relevant slave.		
Indicators	EtherNet/IP NET RUN		EtherNet/IP NET ERR		EtherNet/IP LINK/ACT	
	---		---		---	
System-defined variables	Variable		Data type		Name	
	None		---		---	
Cause and correction	Assumed cause		Remedy		Prevention	
	A short-circuit, line-to-ground fault, contact failure, or insulation failure occurred on the U, V, or W motor line.		If there is a short-circuit, line-to-ground fault, or contact failure on the U, V, or W motor line, correct the connections. If the insulation resistance between the U, V, or W motor line and the ground line has failed, replace the motor.		Confirm that the U, V, and W motor lines are connected correctly.	
	The Servo Drive failed.		Disconnect the motor lines and turn ON the Servo. If this error occurs immediately, replace the Servo Drive.		None	
	The relay for the dynamic brake has been welded due to frequent Servo ON/OFF operations.		Replace the Servo Drive.		Do not start and stop operation by frequently switching the Servo ON/OFF.	
	Motor windings are burned out.		Check the balance of the resistance between the lines of the motor. If resistance is unbalanced, replace the motor.		Do not apply excessive load on the motor.	
	The motor is not suitable for the Servo Drive.		Check the model (capacity) of the motor and the Servo Drive on the nameplates. Replace the motor with a motor that matches the Servo Drive.		Use a motor that matches the Servo Drive.	
	The command input timing is the same as or earlier than the Servo ON timing.		Wait at least 100 ms after the Servo has been turned ON, then input commands.		Wait at least 100 ms after the Servo has been turned ON, then input commands.	
Attached information	None					
Precautions/ Remarks	"14" is displayed on the Servo Drive front panel and F014 is given as the AlarmCode (4001 hex)					

Event name	IPM Error			Event code	04AD0000 hex
Meaning	The current flowing through the converter exceeded the specified value.				
Source	EtherCAT Master Function Module		Source details	Slave	Detection timing	Continuously
Error attributes	Level	Minor fault	Recovery	Error reset (after cycling slave power)	Log category	System
Effects	User program	Continues.	Operation	Power drive circuit is OFF for relevant slave.		
Indicators	EtherNet/IP NET RUN		EtherNet/IP NET ERR		EtherNet/IP LINK/ACT	
	---		---		---	
System-defined variables	Variable		Data type		Name	
	None		---		---	
Cause and correction	Assumed cause		Remedy		Prevention	
	A short-circuit, line-to-ground fault, contact failure, or insulation failure occurred on the U, V, or W motor line.		If there is a short-circuit, line-to-ground fault, or contact failure on the U, V, or W motor line, correct the connections. If the insulation resistance between the U, V, or W motor line and the ground line has failed, replace the motor.		Confirm that the U, V, and W motor lines are connected correctly.	
	The Servo Drive failed.		Disconnect the motor lines and turn ON the Servo. If this error occurs immediately, replace the Servo Drive.		None	
	The relay for the dynamic brake has been welded due to frequent Servo ON/OFF operations.		Replace the Servo Drive.		Do not start and stop operation by frequently switching the Servo ON/OFF.	
	Motor windings are burned out.		Check the balance of the resistance between the lines of the motor. If resistance is unbalanced, replace the motor.		Do not apply excessive load on the motor.	
	The motor is not suitable for the Servo Drive.		Check the model (capacity) of the motor and the Servo Drive on the nameplates. Replace the motor with a motor that matches the Servo Drive.		Use a motor that matches the Servo Drive.	
	The command input timing is the same as or earlier than the Servo ON timing.		Wait at least 100 ms after the Servo has been turned ON, then input commands.		Wait at least 100 ms after the Servo has been turned ON, then input commands.	
Attached information	None					
Precautions/ Remarks	"14" is displayed on the Servo Drive front panel and F114 is given as the AlarmCode (4001 hex)					

Event name	Regeneration Tr Error			Event code	04AE0000 hex
Meaning	The Servo Drive regeneration drive Tr is faulty.				
Source	EtherCAT Master Function Module		Source details	Slave	Detection timing	While power is supplied to motor
Error attributes	Level	Minor fault	Recovery	Error reset (after cycling slave power)	Log category	System
Effects	User program	Continues.	Operation	Power drive circuit is OFF for relevant slave.		
Indicators	EtherNet/IP NET RUN		EtherNet/IP NET ERR		EtherNet/IP LINK/ACT	
	---		---		---	
System-defined variables	Variable		Data type		Name	
	None		---		---	
Cause and correction	Assumed cause		Remedy		Prevention	
	The Servo Drive regeneration drive Tr is faulty.		Replace the Servo Drive.		None	
Attached information	None					
Precautions/ Remarks	"18" is displayed on the Servo Drive front panel and F118 is given as the AlarmCode (4001 hex)					

Event name	Node Address Setting Error			Event code	04B10000 hex
Meaning	The node address that was read from the rotary switches was not between 00 and 99.				
Source	EtherCAT Master Function Module		Source details	Slave	Detection timing	When establishing communications after turning ON power to the slave
Error attributes	Level	Minor fault	Recovery	Error reset (after cycling slave power)	Log category	System
Effects	User program	Continues.	Operation	Power drive circuit is OFF for relevant slave.		
Indicators	EtherNet/IP NET RUN		EtherNet/IP NET ERR		EtherNet/IP LINK/ACT	
	---		---		---	
System-defined variables	Variable		Data type		Name	
	None		---		---	
Cause and correction	Assumed cause		Remedy		Prevention	
	The Servo Drive failed.		Replace the Servo Drive.		None	
Attached information	None					
Precautions/ Remarks	"88" is displayed on the Servo Drive front panel and F088 is given as the AlarmCode (4001 hex).					

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Event name	Other Errors			Event code	04B20000 hex
Meaning	The Servo Drive malfunctioned, or an error occurred in the Servo Drive.				
Source	EtherCAT Master Function Module		Source details	Slave	Detection timing	Continuously
Error attributes	Level	Minor fault	Recovery	Error reset (after cycling slave power)	Log category	System
Effects	User program	Continues.	Operation	Power drive circuit is OFF for relevant slave.		
Indicators	EtherCAT NET RUN		EtherCAT NET ERR		EtherCAT LINK/ACT	
	---		---		---	
System-defined variables	Variable		Data type		Name	
	None		---		---	
Cause and correction	Assumed cause		Remedy		Prevention	
	The control circuit malfunctioned temporarily due to excess noise.		Cycle the power supply of the Servo Drive.		Take noise countermeasures.	
	The self-diagnosis function of the Servo Drive detected an error in the Servo Drive.		If the error persists even after taking the countermeasures above, replace the Servo Drive.		None	
Attached information	None					
Precautions/ Remarks	"99" is displayed on the Servo Drive front panel and F*99 is given as the AlarmCode (4001 hex)					

Event name	Safety Input Error			Event code	080B0000 hex
Meaning	At least one of the input photocouplers for safety inputs 1 and 2 turned OFF.				
Source	EtherCAT Master Function Module		Source details	Slave	Detection timing	Continuously
Error attributes	Level	Minor fault	Recovery	Error reset (after resetting slave errors)	Log category	System
Effects	User program	Continues.	Operation	Power drive circuit is OFF for relevant slave.		
Indicators	EtherNet/IP NET RUN		EtherNet/IP NET ERR		EtherNet/IP LINK/ACT	
	---		---		---	
System-defined variables	Variable		Data type		Name	
	None		---		---	
Cause and correction	Assumed cause		Remedy		Prevention	
	The cable is disconnected or broken.		Reconnect the input wiring for safety inputs 1 and 2. If the cable is broken, replace it.		Reconnect the input wiring for safety inputs 1 and 2.	
Attached information	None					
Precautions/ Remarks	"30" is displayed on the Servo Drive front panel and F030 is given as the AlarmCode (4001 hex).					

Event name	External Encoder Connection Error			Event code	080C0000 hex
Meaning	A disconnection was detected because communications between the external encoder and the Servo Drive were stopped more frequently than the specified value.				
Source	EtherCAT Master Function Module		Source details	Slave	Detection timing	Continuously
Error attributes	Level	Minor fault	Recovery	Error reset (after cycling slave power)	Log category	System
Effects	User program	Continues.	Operation	Power drive circuit is OFF for relevant slave.		
Indicators	EtherNet/IP NET RUN		EtherNet/IP NET ERR		EtherNet/IP LINK/ACT	
	---		---		---	
System-defined variables	Variable		Data type		Name	
	None		---		---	
Cause and correction	Assumed cause		Remedy		Prevention	
	The wiring is incorrect.		Wire the external encoder correctly as shown in the wiring diagram. Correct the connector pin connections.		Wire the external encoder correctly as shown in the wiring diagram. Connect the connector pins correctly.	
Attached information	None					
Precautions/ Remarks	"50" is displayed on the Servo Drive front panel and F050 is given as the AlarmCode (4001 hex).					

Event name	External Encoder Communications Data Error			Event code	080D0000 hex
Meaning	There was a communications error in data from the external encoder.				
Source	EtherCAT Master Function Module		Source details	Slave	Detection timing	Continuously
Error attributes	Level	Minor fault	Recovery	Error reset (after cycling slave power)	Log category	System
Effects	User program	Continues.	Operation	Power drive circuit is OFF for relevant slave.		
Indicators	EtherNet/IP NET RUN		EtherNet/IP NET ERR		EtherNet/IP LINK/ACT	
	---		---		---	
System-defined variables	Variable		Data type		Name	
	None		---		---	
Cause and correction	Assumed cause		Remedy		Prevention	
	There is insufficient external encoder power supply voltage.		Provide the required external encoder power supply voltage 5 VDC ±5% (4.75 to 5.25 V).		Provide the required external encoder power supply voltage 5 VDC ±5% (4.75 to 5.25 V).	
	Noise		If the motor cable and the external encoder cable are bundled together, separate them. Connect the shield to FG.		If the motor cable and the external encoder cable are bundled together, separate them. Connect the shield to FG.	
Attached information	None					
Precautions/ Remarks	"50" is displayed on the Servo Drive front panel and F150 is given as the AlarmCode (4001 hex).					

Event name	External Encoder Status Error 0		Event code	080E0000 hex	
Meaning	Bit 00 of the external encoder error code (ALMC) was set to 1.				
Source	EtherCAT Master Function Module	Source details	Slave	Detection timing	Continuously
Error attributes	Level	Minor fault	Recovery	Error reset (after cycling slave power)	Log category	System
Effects	User program	Continues.	Operation	Power drive circuit is OFF for relevant slave.		
Indicators	EtherNet/IP NET RUN		EtherNet/IP NET ERR		EtherNet/IP LINK/ACT	
	---		---		---	
System-defined variables	Variable		Data type		Name	
	None		---		---	
Cause and correction	Assumed cause		Remedy		Prevention	
	Bit 00 of the external scale error code (ALMC) was set to 1.		Check the external encoder specifications and take suitable corrective actions.		Take preventative actions according to the external encoder specifications.	
Attached information	None					
Precautions/ Remarks	"51" is displayed on the Servo Drive front panel and F051 is given as the AlarmCode (4001 hex).					

Event name	External Encoder Status Error 1		Event code	080F0000 hex	
Meaning	Bit 01 of the external encoder error code (ALMC) was set to 1.				
Source	EtherCAT Master Function Module	Source details	Slave	Detection timing	Continuously
Error attributes	Level	Minor fault	Recovery	Error reset (after cycling slave power)	Log category	System
Effects	User program	Continues.	Operation	Power drive circuit is OFF for relevant slave.		
Indicators	EtherNet/IP NET RUN		EtherNet/IP NET ERR		EtherNet/IP LINK/ACT	
	---		---		---	
System-defined variables	Variable		Data type		Name	
	None		---		---	
Cause and correction	Assumed cause		Remedy		Prevention	
	Bit 01 of the external encoder error code (ALMC) was set to 1.		Check the external encoder specifications and take suitable corrective actions.		Take preventative actions according to the external encoder specifications.	
Attached information	None					
Precautions/ Remarks	"51" is displayed on the Servo Drive front panel and F151 is given as the AlarmCode (4001 hex).					

Event name	External Encoder Status Error 2			Event code		08100000 hex
Meaning	Bit 02 of the external encoder error code (ALMC) was set to 1.					
Source	EtherCAT Master Function Module		Source details	Slave	Detection timing	Continuously
Error attributes	Level	Minor fault	Recovery	Error reset (after cycling slave power)	Log category	System
Effects	User program	Continues.	Operation	Power drive circuit is OFF for relevant slave.		
Indicators	EtherNet/IP NET RUN		EtherNet/IP NET ERR		EtherNet/IP LINK/ACT	
	---		---		---	
System-defined variables	Variable		Data type		Name	
	None		---		---	
Cause and correction	Assumed cause		Remedy		Prevention	
	Bit 02 of the external encoder error code (ALMC) was set to 1.		Check the external encoder specifications and take suitable corrective actions.		Take preventative actions according to the external encoder specifications.	
Attached information	None					
Precautions/ Remarks	"51" is displayed on the Servo Drive front panel and F251 is given as the AlarmCode (4001 hex).					

Event name	External Encoder Status Error 3			Event code		08110000 hex
Meaning	Bit 03 of the external encoder error code (ALMC) was set to 1.					
Source	EtherCAT Master Function Module		Source details	Slave	Detection timing	Continuously
Error attributes	Level	Minor fault	Recovery	Error reset (after cycling slave power)	Log category	System
Effects	User program	Continues.	Operation	Power drive circuit is OFF for relevant slave.		
Indicators	EtherNet/IP NET RUN		EtherNet/IP NET ERR		EtherNet/IP LINK/ACT	
	---		---		---	
System-defined variables	Variable		Data type		Name	
	None		---		---	
Cause and correction	Assumed cause		Remedy		Prevention	
	Bit 03 of the external encoder error code (ALMC) was set to 1.		Check the external encoder specifications and take suitable corrective actions.		Take preventative actions according to the external encoder specifications.	
Attached information	None					
Precautions/ Remarks	"51" is displayed on the Servo Drive front panel and F351 is given as the AlarmCode (4001 hex).					

Event name	External Encoder Status Error 4			Event code	08120000 hex	
Meaning	Bit 04 of the external encoder error code (ALMC) was set to 1.					
Source	EtherCAT Master Function Module		Source details	Slave	Detection timing	Continuously
Error attributes	Level	Minor fault	Recovery	Error reset (after cycling slave power)	Log category	System
Effects	User program	Continues.	Operation	Power drive circuit is OFF for relevant slave.		
Indicators	EtherNet/IP NET RUN		EtherNet/IP NET ERR		EtherNet/IP LINK/ACT	
	---		---		---	
System-defined variables	Variable		Data type		Name	
	None		---		---	
Cause and correction	Assumed cause		Remedy		Prevention	
	Bit 04 of the external encoder error code (ALMC) was set to 1.		Check the external encoder specifications and take suitable corrective actions.		Take preventative actions according to the external encoder specifications.	
Attached information	None					
Precautions/ Remarks	"51" is displayed on the Servo Drive front panel and F451 is given as the AlarmCode (4001 hex).					

Event name	External Encoder Status Error 5			Event code	08130000 hex	
Meaning	Bit 05 of the external encoder error code (ALMC) was set to 1.					
Source	EtherCAT Master Function Module		Source details	Slave	Detection timing	Continuously
Error attributes	Level	Minor fault	Recovery	Error reset (after cycling slave power)	Log category	System
Effects	User program	Continues.	Operation	Power drive circuit is OFF for relevant slave.		
Indicators	EtherNet/IP NET RUN		EtherNet/IP NET ERR		EtherNet/IP LINK/ACT	
	---		---		---	
System-defined variables	Variable		Data type		Name	
	None		---		---	
Cause and correction	Assumed cause		Remedy		Prevention	
	Bit 05 of the external encoder error code (ALMC) was set to 1.		Check the external encoder specifications and take suitable corrective actions.		Take preventative actions according to the external encoder specifications.	
Attached information	None					
Precautions/ Remarks	"51" is displayed on the Servo Drive front panel and F551 is given as the AlarmCode (4001 hex).					

Event name	Phase-A Connection Error			Event code		08140000 hex
Meaning	An error such as broken wiring was detected in the external encoder phase-A connection.					
Source	EtherCAT Master Function Module		Source details	Slave	Detection timing	Continuously
Error attributes	Level	Minor fault	Recovery	Error reset (after cycling slave power)	Log category	System
Effects	User program	Continues.	Operation	Power drive circuit is OFF for relevant slave.		
Indicators	EtherNet/IP NET RUN		EtherNet/IP NET ERR		EtherNet/IP LINK/ACT	
	---		---		---	
System-defined variables	Variable		Data type		Name	
	None		---		---	
Cause and correction	Assumed cause		Remedy		Prevention	
	An error such as broken wiring was detected in the external encoder phase-A connection.		Wire phase A of the external encoder correctly as shown in the wiring diagram. If the cable is broken, replace it.		Wire phase A of the external encoder correctly as shown in the wiring diagram.	
Attached information	None					
Precautions/ Remarks	"55" is displayed on the Servo Drive front panel and F055 is given as the AlarmCode (4001 hex).					

Event name	Phase-B Connection Error			Event code		08150000 hex
Meaning	An error such as broken wiring was detected in the external encoder phase-B connection.					
Source	EtherCAT Master Function Module		Source details	Slave	Detection timing	Continuously
Error attributes	Level	Minor fault	Recovery	Error reset (after cycling slave power)	Log category	System
Effects	User program	Continues.	Operation	Power drive circuit is OFF for relevant slave.		
Indicators	EtherNet/IP NET RUN		EtherNet/IP NET ERR		EtherNet/IP LINK/ACT	
	---		---		---	
System-defined variables	Variable		Data type		Name	
	None		---		---	
Cause and correction	Assumed cause		Remedy		Prevention	
	An error such as broken wiring was detected in the external encoder phase-B connection.		Wire phase B of the external encoder correctly as shown in the wiring diagram. If the cable is broken, replace it.		Wire phase B of the external encoder correctly as shown in the wiring diagram.	
Attached information	None					
Precautions/ Remarks	"55" is displayed on the Servo Drive front panel and F155 is given as the AlarmCode (4001 hex).					

Event name	Phase-Z Connection Error			Event code	08160000 hex
Meaning	An error such as broken wiring was detected in the external encoder phase-Z connection.				
Source	EtherCAT Master Function Module		Source details	Slave	Detection timing	Continuously
Error attributes	Level	Minor fault	Recovery	Error reset (after cycling slave power)	Log category	System
Effects	User program	Continues.	Operation	Power drive circuit is OFF for relevant slave.		
Indicators	EtherNet/IP NET RUN		EtherNet/IP NET ERR		EtherNet/IP LINK/ACT	
	---		---		---	
System-defined variables	Variable		Data type		Name	
	None		---		---	
Cause and correction	Assumed cause		Remedy		Prevention	
	An error such as broken wiring was detected in the external encoder phase-Z connection.		Wire phase Z of the external encoder correctly as shown in the wiring diagram. If the cable is broken, replace it.		Wire phase Z of the external encoder correctly as shown in the wiring diagram.	
Attached information	None					
Precautions/ Remarks	"55" is displayed on the Servo Drive front panel and F255 is given as the AlarmCode (4001 hex).					

Event name	Object Error			Event code	14A80000 hex
Meaning	The object area data in non-volatile memory is corrupted.				
Source	EtherCAT Master Function Module		Source details	Slave	Detection timing	When establishing communications after turning ON power to the slave
Error attributes	Level	Minor fault	Recovery	Error reset (after cycling slave power)	Log category	System
Effects	User program	Continues.	Operation	Power drive circuit is OFF for relevant slave.		
Indicators	EtherNet/IP NET RUN		EtherNet/IP NET ERR		EtherNet/IP LINK/ACT	
	---		---		---	
System-defined variables	Variable		Data type		Name	
	None		---		---	
Cause and correction	Assumed cause		Remedy		Prevention	
	Noise		Reset all of the objects. Implement noise countermeasures.		Reset all of the objects. Implement noise countermeasures.	
	Non-volatile memory failure		If the error persists, replace the Servo Drive.		None	
Attached information	None					
Precautions/ Remarks	"36" is displayed on the Servo Drive front panel and F036 is given as the AlarmCode (4001 hex).					

Event name	Object Error			Event code	14A90000 hex
Meaning	The object area data in non-volatile memory is corrupted.				
Source	EtherCAT Master Function Module		Source details	Slave	Detection timing	When establishing communications after turning ON power to the slave
Error attributes	Level	Minor fault	Recovery	Error reset (after cycling slave power)	Log category	System
Effects	User program	Continues.	Operation	Power drive circuit is OFF for relevant slave.		
Indicators	EtherNet/IP NET RUN		EtherNet/IP NET ERR		EtherNet/IP LINK/ACT	
	---		---		---	
System-defined variables	Variable		Data type		Name	
	None		---		---	
Cause and correction	Assumed cause		Remedy		Prevention	
	Noise		Reset all of the objects. Implement noise countermeasures.		Reset all of the objects. Implement noise countermeasures.	
	Non-volatile memory failure		If the error persists, replace the Servo Drive.		None	
Attached information	None					
Precautions/ Remarks	"36" is displayed on the Servo Drive front panel and F136 is given as the AlarmCode (4001 hex).					

Event name	Object Error			Event code	14AA0000 hex
Meaning	The object area data in non-volatile memory is corrupted.				
Source	EtherCAT Master Function Module		Source details	Slave	Detection timing	When establishing communications after turning ON power to the slave
Error attributes	Level	Minor fault	Recovery	Error reset (after cycling slave power)	Log category	System
Effects	User program	Continues.	Operation	Power drive circuit is OFF for relevant slave.		
Indicators	EtherNet/IP NET RUN		EtherNet/IP NET ERR		EtherNet/IP LINK/ACT	
	---		---		---	
System-defined variables	Variable		Data type		Name	
	None		---		---	
Cause and correction	Assumed cause		Remedy		Prevention	
	Noise		Reset all of the objects. Implement noise countermeasures.		Reset all of the objects. Implement noise countermeasures.	
	Non-volatile memory failure		If the error persists, replace the Servo Drive.		None	
Attached information	None					
Precautions/ Remarks	"36" is displayed on the Servo Drive front panel and F236 is given as the AlarmCode (4001 hex).					

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Event name	Object Corrupted			Event code	14AB0000 hex	
Meaning	The checksum data in non-volatile memory is corrupted.					
Source	EtherCAT Master Function Module		Source details	Slave	Detection timing	When establishing communications after turning ON power to the slave
Error attributes	Level	Minor fault	Recovery	Error reset (after cycling slave power)	Log category	System
Effects	User program	Continues.	Operation	Power drive circuit is OFF for relevant slave.		
Indicators	EtherNet/IP NET RUN		EtherNet/IP NET ERR		EtherNet/IP LINK/ACT	
	---		---		---	
System-defined variables	Variable		Data type		Name	
	None		---		---	
Cause and correction	Assumed cause		Remedy		Prevention	
	Non-volatile memory failure		Replace the Servo Drive.		None	
Attached information	None					
Precautions/ Remarks	"37" is displayed on the Servo Drive front panel and F037 is given as the AlarmCode (4001 hex).					

Event name	Object Corrupted			Event code	14AC0000 hex	
Meaning	The checksum data in non-volatile memory is corrupted.					
Source	EtherCAT Master Function Module		Source details	Slave	Detection timing	When establishing communications after turning ON power to the slave
Error attributes	Level	Minor fault	Recovery	Error reset (after cycling slave power)	Log category	System
Effects	User program	Continues.	Operation	Power drive circuit is OFF for relevant slave.		
Indicators	EtherNet/IP NET RUN		EtherNet/IP NET ERR		EtherNet/IP LINK/ACT	
	---		---		---	
System-defined variables	Variable		Data type		Name	
	None		---		---	
Cause and correction	Assumed cause		Remedy		Prevention	
	Non-volatile memory failure		Replace the Servo Drive.		None	
Attached information	None					
Precautions/ Remarks	"37" is displayed on the Servo Drive front panel and F137 is given as the AlarmCode (4001 hex).					

Event name	Object Corrupted			Event code	14AD0000 hex
Meaning	The checksum data in non-volatile memory is corrupted.				
Source	EtherCAT Master Function Module		Source details	Slave	Detection timing	When establishing communications after turning ON power to the slave
Error attributes	Level	Minor fault	Recovery	Error reset (after cycling slave power)	Log category	System
Effects	User program	Continues.	Operation	Power drive circuit is OFF for relevant slave.		
Indicators	EtherNet/IP NET RUN		EtherNet/IP NET ERR		EtherNet/IP LINK/ACT	
	---		---		---	
System-defined variables	Variable		Data type		Name	
	None		---		---	
Cause and correction	Assumed cause		Remedy		Prevention	
	Non-volatile memory failure		Replace the Servo Drive.		None	
Attached information	None					
Precautions/ Remarks	"37" is displayed on the Servo Drive front panel and F237 is given as the AlarmCode (4001 hex).					

Event name	Motor Setting Error			Event code	28010000 hex
Meaning	Settings associated with the motor and external encoder are missing.				
Source	EtherCAT Master Function Module		Source details	Slave	Detection timing	Continuously
Error attributes	Level	Minor fault	Recovery	Error reset (after cycling slave power)	Log category	System
Effects	User program	Continues.	Operation	Power drive circuit is OFF for relevant slave.		
Indicators	EtherNet/IP NET RUN		EtherNet/IP NET ERR		EtherNet/IP LINK/ACT	
	---		---		---	
System-defined variables	Variable		Data type		Name	
	None		---		---	
Cause and correction	Assumed cause		Remedy		Prevention	
	Settings associated with the motor and external encoder are missing.		Check the specifications of the motor and external encoder and provide the required settings.		Check the specifications of the motor and external encoder and provide the required settings.	
Attached information	None					
Precautions/ Remarks	"50" is displayed on the Servo Drive front panel and F060 is given as the AlarmCode (4001 hex).					

Event name	Motor Combination Error 1			Event code	28020000 hex
Meaning	The value set for the motor current exceeds the maximum motor capacity allowed for the Servo Drive.				
Source	EtherCAT Master Function Module		Source details	Slave	Detection timing	Continuously
Error attributes	Level	Minor fault	Recovery	Error reset (after cycling slave power)	Log category	System
Effects	User program	Continues.	Operation	Power drive circuit is OFF for relevant slave.		
Indicators	EtherNet/IP NET RUN		EtherNet/IP NET ERR		EtherNet/IP LINK/ACT	
	---		---		---	
System-defined variables	Variable		Data type		Name	
	None		---		---	
Cause and correction	Assumed cause		Remedy		Prevention	
	The rated/maximum current of the motor exceeds the maximum motor capacity allowed for the Servo Drive.		Check the Motor Rated Rms Current (3906 hex)/Motor Peak Absolute Current (3907 hex) and correct the set value if incorrect. If the set value is correct, replace the Servo Drive with one whose maximum motor capacity is the Motor Rated Rms Current/Motor Peak Absolute Current or higher.		Make sure that the value set for the Motor Rated Rms Current (3906 hex)/ Motor Peak Absolute Current (3907 hex) is correct. Use a Servo Drive whose maximum motor capacity is the Motor Rated Rms Current/Motor Peak Absolute Current or higher.	
Attached information	None					
Precautions/ Remarks	"50" is displayed on the Servo Drive front panel and F160 is given as the AlarmCode (4001 hex).					

Event name	Motor Combination Error 2		Event code		28030000 hex	
Meaning	The value set for the motor exceeds the drive range of the motor.					
Source	EtherCAT Master Function Module		Source details	Slave	Detection timing	Continuously
Error attributes	Level	Minor fault	Recovery	Error reset (after cycling slave power)	Log category	System
Effects	User program	Continues.	Operation	Power drive circuit is OFF for relevant slave.		
Indicators	EtherNet/IP NET RUN		EtherNet/IP NET ERR		EtherNet/IP LINK/ACT	
	---		---		---	
System-defined variables	Variable		Data type		Name	
	None		---		---	
Cause and correction	Assumed cause		Remedy		Prevention	
	The Motor Rated Rms Current is too low compared with the maximum motor capacity of the Servo Drive.		Check the Motor Rated Rms Current (3906 hex) and correct the set value if incorrect. If the set value is correct, replace the Servo Drive with one whose maximum motor capacity is lower.		Make sure that the value set for the Motor Rated Rms Current (3906 hex) is correct. Use a Servo Drive that matches the Motor Rated Rms Current.	
	The percentage of the Motor Coil Unit Mass to the Motor Rated Force is too high.		Check the Motor Coil Unit Mass (3904 hex)/ Motor Rated Force (3905 hex) and correct the set value if incorrect.		Make sure that the values set for the Motor Coil Unit Mass (3904 hex) and Motor Rated Force (3905 hex) are correct.	
	The automatically adjusted Current Loop Proportional Gain/Current Loop Integral Gain is too high.		Check the values set for the Motor Rated Rms Current (3906 hex), Motor Inductance (3908 hex), and Motor Resistance (3909 hex) objects and correct the set value if incorrect.		Make sure that the values set for the Motor Rated Rms Current (3906 hex), Motor Inductance (3908 hex), and Motor Resistance (3909 hex) are correct.	
	The percentage of the Motor Rated Rms Current to the rated current of the motor is greater than 500%.		Check the Motor Rated Rms Current (3906 hex)/Motor Peak Absolute Current (3907 hex) and correct the set value if incorrect.		Make sure that the values set for the Motor Rated Rms Current (3906 hex) and Motor Peak Absolute Current (3907 hex) are correct.	
Attached information	None					
Precautions/ Remarks	"60" is displayed on the Servo Drive front panel and F260 is given as the AlarmCode (4001 hex).					

Event name	Servo Drive Overheat			Event code	34E10000 hex
Meaning	The temperature of the Servo Drive radiator or power elements exceeded the specified value.				
Source	EtherCAT Master Function Module		Source details	Slave	Detection timing	Continuously
Error attributes	Level	Minor fault	Recovery	Error reset (after cycling slave power)	Log category	System
Effects	User program	Continues.	Operation	Power drive circuit is OFF for relevant slave.		
Indicators	EtherNet/IP NET RUN		EtherNet/IP NET ERR		EtherNet/IP LINK/ACT	
	---		---		---	
System-defined variables	Variable		Data type		Name	
	None		---		---	
Cause and correction	Assumed cause		Remedy		Prevention	
	The ambient temperature of the Servo Drive exceeded the specified value.		Improve the ambient temperature and the cooling conditions of the Servo Drive.		Check the ambient temperature of the Servo Drive and set up the necessary cooling conditions.	
	Overload		Increase the capacities of the Servo Drive and the motor. Or, increase the setting of the acceleration/ deceleration time and lighten the load.		Increase the setting of the acceleration/deceleration time and lighten the load as much as possible.	
Attached information	None					
Precautions/ Remarks	"15" is displayed on the Servo Drive front panel and F015 is given as the AlarmCode (4001 hex)					

Event name	Overload			Event code	34E20000 hex
Meaning	When the feedback value for force command exceeds the overload level specified in the Overload Detection Level Setting (3512 hex), overload protection is performed according to the overload characteristics.				
Source	EtherCAT Master Function Module		Source details	Slave	Detection timing	While power is supplied to motor
Error attributes	Level	Minor fault	Recovery	Error reset (after resetting slave errors)	Log category	System
Effects	User program	Continues.	Operation	Power drive circuit is OFF for relevant slave.		
Indicators	EtherNet/IP NET RUN		EtherNet/IP NET ERR		EtherNet/IP LINK/ACT	
	---		---		---	
System-defined variables	Variable		Data type		Name	
	None		---		---	
Cause and correction	Assumed cause		Remedy		Prevention	
	Operation was continued for a long time while overloaded.		Take the following actions according to the situation. • Increase the capacities of the Servo Drive and the motor. • Increase the setting of the acceleration/deceleration time and lighten the load. • Adjust the gain or mass ratio and remove machine distortion. • Measure the voltage at the brake terminal. If the brake is ON, release it. • Correct the system if force (current) waveforms oscillate or excessively oscillate vertically during analog output or communications.		Check the items given for corrections in advance and implement countermeasures as required.	
	There is incorrect wiring of the motor line or a broken cable.		Connect the motor cable as shown in the wiring diagram. If the cable is broken, replace it. Connect the motor line and external encoder line that are used together to the same motor.		Connect the motor cable as shown in the wiring diagram. Connect the motor line and external encoder line that are used together to the same motor.	
Attached information	None					
Precautions/ Remarks	"16" is displayed on the Servo Drive front panel and F016 is given as the AlarmCode (4001 hex)					

Event name	Regeneration Overload			Event code	34E30000 hex
Meaning	The regenerative energy exceeds the processing capacity of the Regeneration Resistor.				
Source	EtherCAT Master Function Module		Source details	Slave	Detection timing	While power is supplied to motor
Error attributes	Level	Minor fault	Recovery	Error reset (after cycling slave power)	Log category	System
Effects	User program	Continues.	Operation	Power drive circuit is OFF for relevant slave.		
Indicators	EtherNet/IP NET RUN		EtherNet/IP NET ERR		EtherNet/IP LINK/ACT	
	---		---		---	
System-defined variables	Variable		Data type		Name	
	None		---		---	
Cause and correction	Assumed cause		Remedy		Prevention	
	The load mass is too large. Or, the motor speed is too high to absorb the regenerative energy within the specified deceleration time.		Check the operation pattern (velocity monitor). Check the Regeneration Register load rate and the excessive regeneration warning, and perform the following accordingly. • Increase the capacity of the motor and Servo Drive. • Increase the deceleration time. • Reduce the motor speed. • Use an External Regeneration Resistor. • Set the Regeneration Resistor Selection (3016 hex) to 2.		Check the items given for corrections in advance and implement countermeasures as required.	
	This Regeneration Resistor cannot be used for continuous regenerative braking. (The operating limit of the external resistor is limited to a 10% duty.)		Set the Regeneration Resistor Selection (3016 hex) to 2.		Set the Regeneration Resistor Selection (3016 hex) to 2.	
Attached information	None					
Precautions/ Remarks	"18" is displayed on the Servo Drive front panel and F018 is given as the AlarmCode (4001 hex)					

Event name	Error Counter Overflow			Event code	34E40000 hex
Meaning	Position error pulses exceeded the setting of the Following error window (6065 hex).				
Source	EtherCAT Master Function Module		Source details	Slave	Detection timing	While power is supplied to motor
Error attributes	Level	Minor fault	Recovery	Error reset (after resetting slave errors)	Log category	System
Effects	User program	Continues.	Operation	Power drive circuit is OFF for relevant slave.		
Indicators	EtherNet/IP NET RUN		EtherNet/IP NET ERR		EtherNet/IP LINK/ACT	
	---		---		---	
System-defined variables	Variable		Data type		Name	
	None		---		---	
Cause and correction	Assumed cause		Remedy		Prevention	
	Motor operation does not follow the command.		Make sure that the motor operates according to the position command input, and that the output force is not saturated on the force monitor. If there is a problem, perform the following. • Adjust the gain. • Maximize the force limit object settings being used (60E0 hex, 60E1 hex, 3013 hex, 3522 hex, 3525 hex, and/or 3526 hex). • Increase the acceleration/ deceleration time, lighten the load, and reduce the velocity.		Adjust the gain and force limits. Increase the acceleration/ deceleration time, lighten the load, and reduce the velocity as much as possible.	
	The value of the Following error window (6065 hex) is small.		Increase the setting of the Following error window (6065 hex) to an acceptable range.		Increase the setting of the Following error window (6065 hex) to an acceptable range.	
	The external encoder wiring is incorrect.		Wire the external encoder correctly as shown in the wiring diagram.		Wire the external encoder correctly as shown in the wiring diagram.	
Attached information	None					
Precautions/ Remarks	"24" is displayed on the Servo Drive front panel and F024 is given as the AlarmCode (4001 hex)					

Event name	Excessive Velocity Error			Event code	34E50000 hex
Meaning	The difference between the internal position command velocity and the actual velocity (i.e., the velocity error) exceeded the Excessive Velocity Error Setting (3602 hex).				
Source	EtherCAT Master Function Module		Source details	Slave	Detection timing	While power is supplied to motor
Error attributes	Level	Minor fault	Recovery	Error reset (after resetting slave errors)	Log category	System
Effects	User program	Continues.	Operation	Power drive circuit is OFF for relevant slave.		
Indicators	EtherNet/IP NET RUN		EtherNet/IP NET ERR		EtherNet/IP LINK/ACT	
	---		---		---	
System-defined variables	Variable		Data type		Name	
	None		---		---	
Cause and correction	Assumed cause		Remedy		Prevention	
	Motor operation does not follow the command.		Adjust the gain to improve the following ability. Increase the acceleration/deceleration time for the internal position command velocity.		Adjust the gain to improve the following ability. Increase the acceleration/deceleration time for the internal position command velocity as much as possible.	
	The setting of the Excessive Velocity Error Setting (3602 hex) is too small.		Increase the setting of the Excessive Velocity Error Setting (3602 hex) to an acceptable range. If there is no need to monitor the velocity error, disable detection of Excessive Velocity Error. (3602 hex = 0)		Increase the setting of the Excessive Velocity Error Setting (3602 hex) to an acceptable range. If there is no need to monitor the velocity error, disable detection of Excessive Velocity Error. (3602 hex = 0)	
Attached information	None					
Precautions/ Remarks	"24" is displayed on the Servo Drive front panel and F124 is given as the AlarmCode (4001 hex)					

Event name	Overspeed			Event code	34E60000 hex
Meaning	The motor speed exceeded the value set on the Overspeed Detection Level Setting (3513 hex).				
Source	EtherCAT Master Function Module		Source details	Slave	Detection timing	While power is supplied to motor
Error attributes	Level	Minor fault	Recovery	Error reset (after removing slave error)	Log category	System
Effects	User program	Continues.	Operation	Power drive circuit is OFF for relevant slave.		
Indicators	EtherNet/IP NET RUN		EtherNet/IP NET ERR		EtherNet/IP LINK/ACT	
	---		---		---	
System-defined variables	Variable		Data type		Name	
	None		---		---	
Cause and correction	Assumed cause		Remedy		Prevention	
	The velocity command value is too large.		Reduce the velocity command value. Adjust the input frequency, dividing ratio, and multiplication ratio of the command pulse.		Set the velocity command value so that the number of motor speed does not exceed the Overspeed Level (3910 hex). Check the input frequency, dividing ratio, and multiplication ratio of the command pulse.	
	There is overshooting.		Decrease the gain.		Do not make the gain too large.	
	The wiring is incorrect.		Wire the external encoder correctly as shown in the wiring diagram.		Wire the external encoder correctly as shown in the wiring diagram.	
Attached information	None					
Precautions/ Remarks	"26" is displayed on the Servo Drive front panel and F026 is given as the AlarmCode (4001 hex)					

Event name	Overspeed 2			Event code	38400000 hex
Meaning	The motor speed exceeded the value set on Overspeed Detection Level Setting at Immediate Stop (3615 hex).				
Source	EtherCAT Master Function Module		Source details	Slave	Detection timing	While power is supplied to motor
Error attributes	Level	Minor fault	Recovery	Error reset (after resetting slave errors)	Log category	System
Effects	User program	Continues.	Operation	Power drive circuit is OFF for relevant slave.		
Indicators	EtherNet/IP NET RUN		EtherNet/IP NET ERR		EtherNet/IP LINK/ACT	
	---		---		---	
System-defined variables	Variable		Data type		Name	
	None		---		---	
Cause and correction	Assumed cause		Remedy		Prevention	
	The velocity command value is too large.		Reduce the velocity. Adjust the input frequency, dividing ratio, and multiplication ratio of the command pulse.		Set the velocity command value in a range that does not exceed the overspeed detection level at immediate stop. Check the input frequency, dividing ratio, and multiplication ratio of the command pulse.	
	There is overshooting.		Adjust the gain.		Do not make the gain too large.	
	The wiring is incorrect.		Wire the encoder correctly as shown in the wiring diagram.		Wire the encoder correctly as shown in the wiring diagram.	
Attached information	None					
Precautions/ Remarks	"26" is displayed on the Servo Drive front panel and F126 is given as the AlarmCode (4001 hex)					

Event name	Command Error			Event code	38410000 hex
Meaning	The position command variation after the electronic gear exceeded the specified value.				
Source	EtherCAT Master Function Module		Source details	Slave	Detection timing	Continuously
Error attributes	Level	Minor fault	Recovery	Error reset (after cycling slave power)	Log category	System
Effects	User program	Continues.	Operation	Power drive circuit is OFF for relevant slave.		
Indicators	EtherNet/IP NET RUN		EtherNet/IP NET ERR		EtherNet/IP LINK/ACT	
	---		---		---	
System-defined variables	Variable		Data type		Name	
	None		---		---	
Cause and correction	Assumed cause		Remedy		Prevention	
	The change in position command is too large.		Reduce the electronic gear ratio.		Adjust the electronic gear ratio so that the changes in the position command are not too large.	
	The backlash compensation amount is too large.		Reduce the backlash compensation amount.		Adjust the backlash compensation amount so that the changes in the position command are not too large.	
Attached information	None					
Precautions/ Remarks	"27" is displayed on the Servo Drive front panel and F427 is given as the AlarmCode (4001 hex)					

Event name	Command Generation Error			Event code	38420000 hex
Meaning	During position command processing, an error such as a calculation range error occurred.				
Source	EtherCAT Master Function Module		Source details	Slave	Detection timing	Continuously
Error attributes	Level	Minor fault	Recovery	Error reset (after cycling slave power)	Log category	System
Effects	User program	Continues.	Operation	Power drive circuit is OFF for relevant slave.		
Indicators	EtherNet/IP NET RUN		EtherNet/IP NET ERR		EtherNet/IP LINK/ACT	
	---		---		---	
System-defined variables	Variable		Data type		Name	
	None		---		---	
Cause and correction	Assumed cause		Remedy		Prevention	
	During position command processing, an error such as a calculation range error occurred.		Check whether the electronic gear ratio and acceleration/deceleration rate are within the limits and make any necessary corrections.		Set the electronic gear ratio, acceleration rate, and deceleration rate to meet the restrictions.	
Attached information	None					
Precautions/ Remarks	"27" is displayed on the Servo Drive front panel and F527 is given as the AlarmCode (4001 hex)					

Event name	Error Counter Overflow 1			Event code	38430000 hex
Meaning	When an absolute external encoder was in use, the value of Position actual internal value [external encoder pulses] divided by Gear ratio exceeded $\pm 2^{31}$ (2,147,483,648).				
Source	EtherCAT Master Function Module		Source details	Slave	Detection timing	While power is supplied to motor
Error attributes	Level	Minor fault	Recovery	Error reset (after cycling slave power)	Log category	System
Effects	User program	Continues.	Operation	Power drive circuit is OFF for relevant slave.		
Indicators	EtherNet/IP NET RUN		EtherNet/IP NET ERR		EtherNet/IP LINK/ACT	
	---		---		---	
System-defined variables	Variable		Data type		Name	
	None		---		---	
Cause and correction	Assumed cause		Remedy		Prevention	
	When an absolute external encoder was in use, the value of Position actual internal value [external encoder pulses] divided by Gear ratio exceeded $\pm 2^{31}$ (2,147,483,648).		When an absolute external encoder was in use, check the operation range of the Position actual internal value [external encoder pulses] and correct the electronic gear ratio.		When an absolute external encoder was in use, check the operation range of the Position actual internal value [external encoder pulses] and correct the electronic gear ratio.	
Attached information	None					
Precautions/ Remarks	"29" is displayed on the Servo Drive front panel and F129 is given as the AlarmCode (4001 hex)					

Event name	Error Counter Overflow 2			Event code	38440000 hex
Meaning	The position following error in pulses exceeded $\pm2^{29}$ (536,870,912). Or, the position following error in command units exceeded $\pm2^{30}$ (1,073,741,824).				
Source	EtherCAT Master Function Module		Source details	Slave	Detection timing	While power is supplied to motor
Error attributes	Level	Minor fault	Recovery	Error reset (after cycling slave power)	Log category	System
Effects	User program	Continues.	Operation	Power drive circuit is OFF for relevant slave.		
Indicators	EtherNet/IP NET RUN		EtherNet/IP NET ERR		EtherNet/IP LINK/ACT	
	---		---		---	
System-defined variables	Variable		Data type		Name	
	None		---		---	
Cause and correction	Assumed cause		Remedy		Prevention	
	There is insufficient force.		Lighten the load if the output force is saturated on the force monitor. Maximize the force limit object settings being used (60E0 hex, 60E1 hex, 3013 hex, 3522 hex, 3525 hex, and/or 3526 hex).		Adjust the gain and force limits.	
	There is insufficient gain.		Increase the gain.			
	The external encoder wiring is incorrect.		Wire the external encoder correctly as shown in the wiring diagram.		Wire the external encoder correctly as shown in the wiring diagram.	
Attached information	None					
Precautions/ Remarks	"29" is displayed on the Servo Drive front panel and F229 is given as the AlarmCode (4001 hex).					

Event name	Interface Input Duplicate Allocation Error 1			Event code	38450000 hex
Meaning	There is a duplicate setting in the input signal (IN1, IN2, IN3, and IN4) function allocations.				
Source	EtherCAT Master Function Module		Source details	Slave	Detection timing	When establishing communications after turning ON power to the slave or when transferring EtherCAT Configuration Setup
Error attributes	Level	Minor fault	Recovery	Error reset (after cycling slave power)	Log category	System
Effects	User program	Continues.	Operation	Power drive circuit is OFF for relevant slave.		
Indicators	EtherNet/IP NET RUN		EtherNet/IP NET ERR		EtherNet/IP LINK/ACT	
	---		---		---	
System-defined variables	Variable		Data type		Name	
	None		---		---	
Cause and correction	Assumed cause		Remedy		Prevention	
	There is a duplicate setting in the input signal (IN1, IN2, IN3, and IN4) function allocations.		Allocate the functions to the connector pins so that each function is allocated only once.		Allocate the functions to the connector pins so that each function is allocated only once.	
Attached information	None					
Precautions/ Remarks	"33" is displayed on the Servo Drive front panel and F033 is given as the AlarmCode (4001 hex).					

Event name	Interface Input Duplicate Allocation Error 2		Event code	38460000 hex	
Meaning	There is a duplicate setting in the input signal (IN5, IN6, IN7, and IN8) function allocations.				
Source	EtherCAT Master Function Module	Source details	Slave	Detection timing	When establishing communications after turning ON power to the slave or when transferring EtherCAT Configuration Setup
Error attributes	Level	Minor fault	Recovery	Error reset (after cycling slave power)	Log category	System
Effects	User program	Continues.	Operation	Power drive circuit is OFF for relevant slave.		
Indicators	EtherNet/IP NET RUN		EtherNet/IP NET ERR		EtherNet/IP LINK/ACT	
	---		---		---	
System-defined variables	Variable		Data type		Name	
	None		---		---	
Cause and correction	Assumed cause		Remedy		Prevention	
	There is a duplicate setting in the input signal (IN5, IN6, IN7, and IN8) function allocations.		Allocate the functions to the connector pins so that each function is allocated only once.		Allocate the functions to the connector pins so that each function is allocated only once.	
Attached information	None					
Precautions/ Remarks	"33" is displayed on the Servo Drive front panel and F133 is given as the AlarmCode (4001 hex).					

Event name	Interface Input Function Number Error 1		Event code		38470000 hex	
Meaning	There is an undefined number specification in the input signal (IN1, IN2, IN3, and IN4) function allocations. Or, a logic setting error was detected.					
Source	EtherCAT Master Function Module		Source details	Slave	Detection timing	When establishing communications after turning ON power to the slave or when transferring EtherCAT Configuration Setup
Error attributes	Level	Minor fault	Recovery	Error reset (after cycling slave power)	Log category	System
Effects	User program	Continues.	Operation	Power drive circuit is OFF for relevant slave.		
Indicators	EtherNet/IP NET RUN		EtherNet/IP NET ERR		EtherNet/IP LINK/ACT	
	---		---		---	
System-defined variables	Variable		Data type		Name	
	None		---		---	
Cause and correction	Assumed cause		Remedy		Prevention	
	There is an undefined number specification in the input signal (IN1, IN2, IN3, and IN4) function allocations.		Allocate the functions to the connector pins using only the numbers that are defined.		Allocate the functions to the connector pins using only the numbers that are defined.	
	Different logic is set for the same function in the function assignments of the input signals (IN1, IN2, IN3, and IN4).		Correct the settings so that the same logic is used for the same function.		Use the same logic for the same function.	
Attached information	None					
Precautions/ Remarks	"33" is displayed on the Servo Drive front panel and F233 is given as the AlarmCode (4001 hex).					

Event name	Interface Input Function Number Error 2		Event code		38480000 hex
Meaning	There is an undefined number specification in the input signal (IN5, IN6, IN7, and IN8) function allocations. Or, a logic setting error was detected.				
Source	EtherCAT Master Function Module	Source details	Slave	Detection timing	When establishing communications after turning ON power to the slave or when transferring EtherCAT Configuration Setup
Error attributes	Level	Minor fault	Recovery	Error reset (after cycling slave power)	Log category	System
Effects	User program	Continues.	Operation	Power drive circuit is OFF for relevant slave.		
Indicators	EtherNet/IP NET RUN		EtherNet/IP NET ERR		EtherNet/IP LINK/ACT	
	---		---		---	
System-defined variables	Variable		Data type		Name	
	None		---		---	
Cause and correction	Assumed cause		Remedy		Prevention	
	There is an undefined number specification in the input signal (IN5, IN6, IN7, and IN8) function allocations.		Allocate the functions to the connector pins using only the numbers that are defined.		Allocate the functions to the connector pins using only the numbers that are defined.	
	Different logic is set for the same function in the function assignments of the input signals (IN5, IN6, IN7, and IN8).		Correct the settings so that the same logic is used for the same function.		Use the same logic for the same function.	
Attached information	None					
Precautions/ Remarks	"33" is displayed on the Servo Drive front panel and F333 is given as the AlarmCode (4001 hex).					

Event name	Interface Output Function Number Error 1			Event code	38490000 hex	
Meaning	There is an undefined number specification in the output signal (OUTM1) function allocation.					
Source	EtherCAT Master Function Module		Source details	Slave	Detection timing	When establishing communications after turning ON power to the slave or when transferring EtherCAT Configuration Setup
Error attributes	Level	Minor fault	Recovery	Error reset (after cycling slave power)	Log category	System
Effects	User program	Continues.	Operation	Power drive circuit is OFF for relevant slave.		
Indicators	EtherNet/IP NET RUN		EtherNet/IP NET ERR		EtherNet/IP LINK/ACT	
	---		---		---	
System-defined variables	Variable		Data type		Name	
	None		---		---	
Cause and correction	Assumed cause		Remedy		Prevention	
	There is an undefined number specification in the output signal (OUTM1) function allocation.		Allocate the functions to the connector pins using only the numbers that are defined.		Allocate the functions to the connector pins using only the numbers that are defined.	
Attached information	None					
Precautions/ Remarks	"33" is displayed on the Servo Drive front panel and F433 is given as the AlarmCode (4001 hex).					

Event name	Interface Output Function Number Error 2			Event code	384A0000 hex	
Meaning	There is an undefined number specification in the output signal (OUTM2) function allocation.					
Source	EtherCAT Master Function Module		Source details	Slave	Detection timing	When establishing communications after turning ON power to the slave or when transferring EtherCAT Configuration Setup
Error attributes	Level	Minor fault	Recovery	Error reset (after cycling slave power)	Log category	System
Effects	User program	Continues.	Operation	Power drive circuit is OFF for relevant slave.		
Indicators	EtherNet/IP NET RUN		EtherNet/IP NET ERR		EtherNet/IP LINK/ACT	
	---		---		---	
System-defined variables	Variable		Data type		Name	
	None		---		---	
Cause and correction	Assumed cause		Remedy		Prevention	
	There is an undefined number specification in the output signal (OUTM2) function allocation.		Allocate the functions to the connector pins using only the numbers that are defined.		Allocate the functions to the connector pins using only the numbers that are defined.	
Attached information	None					
Precautions/ Remarks	"33" is displayed on the Servo Drive front panel and F533 is given as the AlarmCode (4001 hex).					

Event name	External Latch Input Allocation Error		Event code		384B0000 hex
Meaning	There is an error in the latch input function allocation.				
Source	EtherCAT Master Function Module	Source details	Slave	Detection timing	When establishing communications after turning ON power to the slave or when transferring EtherCAT Configuration Setup
Error attributes	Level	Minor fault	Recovery	Error reset (after cycling slave power)	Log category	System
Effects	User program	Continues.	Operation	Power drive circuit is OFF for relevant slave.		
Indicators	EtherNet/IP NET RUN		EtherNet/IP NET ERR		EtherNet/IP LINK/ACT	
	---		---		---	
System-defined variables	Variable		Data type		Name	
	None		---		---	
Cause and correction	Assumed cause		Remedy		Prevention	
	The latch input was allocated to an input signal other than IN5, IN6, or IN7.		Allocate the latch input to input signals IN5, IN6, or IN7.		Allocate the latch input to input signals IN5, IN6, or IN7.	
	A latch input is assigned to an NC signal.		Assign a latch input to an NO signal.		Assign a latch input to an NO signal.	
	The same latch input is not assigned to the same pin in all Control Modes.		Assign the same latch input in all Control Modes.		Assign the same latch input to the same pin in all Control Modes.	
Attached information	None					
Precautions/ Remarks	"33" is displayed on the Servo Drive front panel and F833 is given as the AlarmCode (4001 hex).					

Event name	Overrun Limit Error		Event code		384C0000 hex
Meaning	The motor exceeded the allowable operating range set in the Overrun Limit Setting (3514 hex) with respect to the position command input range.				
Source	EtherCAT Master Function Module	Source details	Slave	Detection timing	While power is supplied to motor
Error attributes	Level	Minor fault	Recovery	Error reset (after resetting slave errors)	Log category	System
Effects	User program	Continues.	Operation	Power drive circuit is OFF for relevant slave.		
Indicators	EtherNet/IP NET RUN		EtherNet/IP NET ERR		EtherNet/IP LINK/ACT	
	---		---		---	
System-defined variables	Variable		Data type		Name	
	None		---		---	
Cause and correction	Assumed cause		Remedy		Prevention	
	The gain or mass ratio is not suitable.		Adjust the gain (the balance between position loop gain and velocity loop gain) and the mass ratio.		Adjust the gain or mass ratio.	
	The set value of the Overrun Limit Setting (3514 hex) is too small.		Increase the set value of the Overrun Limit Setting (3514 hex). Disable the protective function if it is unnecessary.		Increase the set value of the Overrun Limit Setting (3514 hex). Disable the protective function if it is unnecessary.	
Attached information	None					
Precautions/ Remarks	"34" is displayed on the Servo Drive front panel and F034 is given as the AlarmCode (4001 hex).					

Event name	Object Setting Error 1			Event code	384F0000 hex
Meaning	The electronic gear ratio exceeded the allowable range.				
Source	EtherCAT Master Function Module		Source details	Slave	Detection timing	Continuously
Error attributes	Level	Minor fault	Recovery	Error reset (after cycling slave power)	Log category	System
Effects	User program	Continues.	Operation	Power drive circuit is OFF for relevant slave.		
Indicators	EtherNet/IP NET RUN		EtherNet/IP NET ERR		EtherNet/IP LINK/ACT	
	---		---		---	
System-defined variables	Variable		Data type		Name	
	None		---		---	
Cause and correction	Assumed cause		Remedy		Prevention	
	The electronic gear ratio exceeded the allowable range.		Correct the electronic gear ratio to between 1/1,000 and 1,000.		Set the electronic gear ratio to between 1/1,000 and 1,000.	
Attached information	None					
Precautions/ Remarks	"93" is displayed on the Servo Drive front panel and F093 is given as the AlarmCode (4001 hex).					

Event name	Object Setting Error 2			Event code	38500000 hex
Meaning	External encoder ratio exceeded the allowable range.				
Source	EtherCAT Master Function Module		Source details	Slave	Detection timing	Continuously
Error attributes	Level	Minor fault	Recovery	Error reset (after cycling slave power)	Log category	System
Effects	User program	Continues.	Operation	Power drive circuit is OFF for relevant slave.		
Indicators	EtherNet/IP NET RUN		EtherNet/IP NET ERR		EtherNet/IP LINK/ACT	
	---		---		---	
System-defined variables	Variable		Data type		Name	
	None		---		---	
Cause and correction	Assumed cause		Remedy		Prevention	
	External encoder ratio exceeded the allowable range.		Correct the external encoder ratio to between 1/40 and 160.		Set the external encoder ratio to between 1/40 and 160.	
Attached information	None					
Precautions/ Remarks	"93" is displayed on the Servo Drive front panel and F293 is given as the AlarmCode (4001 hex).					

Event name	External Encoder Connection Error		Event code	38510000 hex	
Meaning	The set value of the External Feedback Pulse Type Selection (3323 hex) differs from the external encoder type that is connected for serial communications.				
Source	EtherCAT Master Function Module		Source details	Slave	Detection timing	Continuously
Error attributes	Level	Minor fault	Recovery	Error reset (after cycling slave power)	Log category	System
Effects	User program	Continues.	Operation	Power drive circuit is OFF for relevant slave.		
Indicators	EtherNet/IP NET RUN		EtherNet/IP NET ERR		EtherNet/IP LINK/ACT	
	---		---		---	
System-defined variables	Variable		Data type		Name	
	None		---		---	
Cause and correction	Assumed cause		Remedy		Prevention	
	The set value of the External Feedback Pulse Type Selection (3323 hex) differs from the external encoder type that is connected for serial communications.		Set the External Feedback Pulse Type Selection (3323 hex) according to the connected external encoder type.		Set the External Feedback Pulse Type Selection (3323 hex) according to the connected external encoder type.	
Attached information	None					
Precautions/ Remarks	"93" is displayed on the Servo Drive front panel and F393 is given as the AlarmCode (4001 hex).					

Event name	Function Setting Error			Event code	38520000 hex
Meaning	The function that was set does not support the communications period.				
Source	EtherCAT Master Function Module		Source details	Slave	Detection timing	Continuously
Error attributes	Level	Minor fault	Recovery	Error reset (after resetting slave errors)	Log category	System
Effects	User program	Continues.	Operation	Power drive circuit is OFF for relevant slave.		
Indicators	EtherNet/IP NET RUN		EtherNet/IP NET ERR		EtherNet/IP LINK/ACT	
	---		---		---	
System-defined variables	Variable		Data type		Name	
	None		---		---	
Cause and correction	Assumed cause		Remedy		Prevention	
	The electronic gear object ratio was not 1:1 when the communications period was set to 250 or 500 μs.		Check the following settings for any of the causes and correct any problems. • Communications period setting • Electronic gear object • Objects that set the Control Mode • Control Mode • Number of mapped bytes • Number of mapped objects • Mapped objects		Check the following settings for any of the causes to make sure that problems do not occur. • Communications period setting • Electronic gear object • Objects that set the Control Mode • Control Mode • Number of mapped bytes • Number of mapped objects • Mapped objects	
	Modes of operation (6060 hex) was set to pp or hm when the communications period was set to 250 or 500 μs.					
	More than 20 bytes were mapped for RxPDO when the communications period was set to 250 μs.					
	No bytes (i.e., no objects) were mapped for RxPDO.					
	More than 10 objects were mapped for RxPDO.					
	More than 11 objects were mapped for TxPDO.					
Attached information	None					
Precautions/ Remarks	"93" is displayed on the Servo Drive front panel and F493 is given as the AlarmCode (4001 hex).					

Event name	Magnetic Pole Position Estimation Error 1		Event code	38530000 hex	
Meaning	Magnetic pole position estimation was not completed successfully.				
Source	EtherCAT Master Function Module	Source details	Slave	Detection timing	During magnetic pole position estimation
Error attributes	Level	Minor fault	Recovery	Error reset (after resetting slave errors)	Log category	System
Effects	User program	Continues.	Operation	Power drive circuit is OFF for relevant slave.	
Indicators	EtherNet/IP NET RUN		EtherNet/IP NET ERR		EtherNet/IP LINK/ACT
	---		---		---
System-defined variables	Variable		Data type		Name
	None		---		---
Cause and correction	Assumed cause		Remedy		Prevention
	Settings associated with the external encoder are incorrect.		Check the specifications of the external encoder and correct the values set for the External Encoder Resolution (3901 hex) and External Feedback Pulse Direction Switching (3326 hex).		Set the External Encoder Resolution (3901 hex)/External Feedback Pulse Direction Switching (3326 hex) values according to the specifications of the external encoder.
	The command time or force command value for magnetic pole position estimation is insufficient.		Increase the value set for the Magnetic Pole Position Estimation Force Command Time (3922 hex) or Magnetic Pole Position Estimation Force Command (3923 Hex) object.		If the motor is subjected to a large load or resistance, increase the Magnetic Pole Position Estimation Force Command Time (3922 hex) or Magnetic Pole Position Estimation Force Command (3923 hex) value.
	There is a large unbalanced load or friction.		If the axis has a large unbalanced load or friction, the magnetic pole position estimation function cannot be used.		None
Attached information	None				
Precautions/ Remarks	"61" is displayed on the Servo Drive front panel and F061 is given as the AlarmCode (4001 hex).				

A-3 Sysmac Error Status Codes

App

A-3-2 Error Description

Event name	Magnetic Pole Position Estimation Error 2		Event code	38540000 hex	
Meaning	Magnetic pole position estimation was not completed successfully because the motor did not stop within the Magnetic Pole Position Estimation Time Limit for Stop.				
Source	EtherCAT Master Function Module	Source details	Slave	Detection timing	During magnetic pole position estimation
Error attributes	Level	Minor fault	Recovery	Error reset (after resetting slave errors)	Log category	System
Effects	User program	Continues.	Operation	Power drive circuit is OFF for relevant slave.		
Indicators	EtherNet/IP NET RUN		EtherNet/IP NET ERR		EtherNet/IP LINK/ACT	
	---		---		---	
System-defined variables	Variable		Data type		Name	
	None		---		---	
Cause and correction	Assumed cause		Remedy		Prevention	
	The value set for the Magnetic Pole Position Estimation Time Limit for Stop (3927 hex) is small compared with the actual stop time of the motor.		Increase the value set for the Magnetic Pole Position Estimation Time Limit for Stop (3927 hex) object.		Set the Magnetic Pole Position Estimation Time Limit for Stop (3927 hex) according to the actual stop time of the motor.	
	The motor is moving when no force is applied.		Remove causes that allow the motor to move without force, such as unbalanced load, from the installation environment.		Ensure during installation that there is no unbalanced load or other causes that allow the motor to move without force.	
Attached information	None					
Precautions/ Remarks	"61" is displayed on the Servo Drive front panel and F161 is given as the AlarmCode (4001 hex).					

Event name	Magnetic Pole Position Estimation Error 3		Event code	38550000 hex	
Meaning	Magnetic pole position restoration was not completed successfully.				
Source	EtherCAT Master Function Module	Source details	Slave	Detection timing	When the magnetic pole position restoration method is selected.
Error attributes	Level	Minor fault	Recovery	Error reset (after cycling slave power)	Log category	System
Effects	User program	Continues.	Operation	Power drive circuit is OFF for relevant slave.	
Indicators	EtherNet/IP NET RUN		EtherNet/IP NET ERR		EtherNet/IP LINK/ACT
	---		---		---
System-defined variables	Variable		Data type		Name
	None		---		---
Cause and correction	Assumed cause		Remedy		Prevention
	The Magnetic Pole Detection Method (3920 hex) object was set to 3 (Magnetic pole position restoration method), although the Magnetic Pole Position Estimation had never been executed.		Set the Magnetic Pole Detection Method (3920 hex) to 2 (Magnetic pole position estimation method) and execute the Magnetic Pole Position Estimation once. Then, set the Magnetic Pole Detection Method (3920 hex) to 3 (Magnetic pole position restoration method).		Before setting the Magnetic Pole Detection Method (3920 hex) object to 3 (Magnetic pole position restoration method), once set the object to 2 (Magnetic pole position estimation method) and execute the Magnetic Pole Position Estimation.
	The Magnetic Pole Detection Method (3920 hex) was set to 3 (Magnetic pole position restoration method) when a non-absolute type external encoder was used.		Change the external encoder to an absolute type.		Before setting the Magnetic Pole Detection Method (3920 hex) object to 3 (Magnetic pole position restoration method), make sure that your external encoder is an absolute type.
Attached information	None				
Precautions/ Remarks	"61" is displayed on the Servo Drive front panel and F261 is given as the AlarmCode (4001 hex).				

A-3 Sysmac Error Status Codes

App

A-3-2 Error Description

Event name	Drive Prohibition Input Error 1			Event code	64E00000 hex
Meaning	• When the Drive Prohibition Input Selection (3504 hex) was set to 0, both the Positive Drive Prohibition Input (POT) and the Negative Drive Prohibition Input (NOT) turned ON. • When the Drive Prohibition Input Selection (3504 hex) was set to 2, either the Positive Drive Prohibition Input (POT) or the Negative Drive Prohibition Input (NOT) turned ON. • When the Drive Prohibition Input Selection (3504 hex) was set to 0 and Magnetic Pole Position Estimation was in progress, either the Positive Drive Prohibition Input or the Negative Drive Prohibition Input turned ON.				
Source	EtherCAT Master Function Module		Source details	Slave	Detection timing	Continuously
Error attributes	Level	Minor fault	Recovery	Error reset (after resetting slave errors)	Log category	System
Effects	User program	Continues.	Operation	Power drive circuit is OFF for relevant slave.		
Indicators	EtherNet/IP NET RUN		EtherNet/IP NET ERR		EtherNet/IP LINK/ACT	
	---		---		---	
System-defined variables	Variable		Data type		Name	
	None		---		---	
Cause and correction	Assumed cause		Remedy		Prevention	
	A problem occurred with the switches, wires, and power supplies that are connected to the Positive Drive Prohibition input or the Negative Drive Prohibition input.		Remove the problem with the switches, wires, and power supplies that are connected to the Positive Drive Prohibition input or the Negative Drive Prohibition input. In particular, check to see if the control signal power supply (12 to 24 VDC) turned ON too slowly.		The goal is to detect the error. (A preventative measure is not required.)	
Attached information	None					
Precautions/ Remarks	"38" is displayed on the Servo Drive front panel and F038 is given as the AlarmCode (4001 hex).					

Event name	Drive Prohibition Input Error 2			Event code	64E10000 hex
Meaning	An operation command (such as a trial run of FFT) was received from the CX-Drive when the Drive Prohibition Input Selection (3504 hex) was set to 0, EtherCAT communications was interrupted, and either POT or NOT was ON. Or, POT or NOT turned ON while operation was being performed for a CX-Drive operation command.				
Source	EtherCAT Master Function Module		Source details	Slave	Detection timing	Continuously
Error attributes	Level	Minor fault	Recovery	Error reset (after resetting slave errors)	Log category	System
Effects	User program	Continues.	Operation	Power drive circuit is OFF for relevant slave.		
Indicators	EtherNet/IP NET RUN		EtherNet/IP NET ERR		EtherNet/IP LINK/ACT	
	---		---		---	
System-defined variables	Variable		Data type		Name	
	None		---		---	
Cause and correction	Assumed cause		Remedy		Prevention	
	A problem occurred with the switches, wires, and power supplies that are connected to the Positive Drive Prohibition input or the Negative Drive Prohibition input.		Remove the problem with the switches, wires, and power supplies that are connected to the Positive Drive Prohibition input or the Negative Drive Prohibition input. In particular, check to see if the control signal power supply (12 to 24 VDC) turned ON too slowly.		The goal is to detect the error. (A preventative measure is not required.)	
Attached information	None					
Precautions/ Remarks	"38" is displayed on the Servo Drive front panel and F138 is given as the AlarmCode (4001 hex).					

G5 Series AC Servo Drives With Built-in EtherCAT Communications, Linear Motor Type

Event name	Immediate Stop Input Error		Event code	64E20000 hex	
Meaning	An Immediate Stop (STOP) signal was input.				
Source	EtherCAT Master Function Module	Source details	Slave	Detection timing	Continuously
Error attributes	Level	Minor fault	Recovery	Error reset (after resetting slave errors)	Log category	System
Effects	User program	Continues.	Operation	Power drive circuit is OFF for relevant slave.		
Indicators	EtherNet/IP NET RUN		EtherNet/IP NET ERR		EtherNet/IP LINK/ACT	
	---		---		---	
System-defined variables	Variable		Data type		Name	
	None		---		---	
Cause and correction	Assumed cause		Remedy		Prevention	
	An Immediate Stop (STOP) signal was input.		Clear the cause of the immediate stop input (STOP).		The goal is to detect the error. (A preventative measure is not required.)	
	Incorrect wiring of the immediate stop input (STOP).		Correct the wiring of the immediate stop input (STOP) if it is incorrect.		Make sure that the immediate stop input (STOP) wiring is incorrect.	
Attached information	None					
Precautions/ Remarks	"87" is displayed on the Servo Drive front panel and F087 is given as the AlarmCode (4001 hex).					

Event name	Command Error		Event code	74810000 hex	
Meaning	A mistake was made in using a command.				
Source	EtherCAT Master Function Module	Source details	Slave	Detection timing	Continuously
Error attributes	Level	Minor fault	Recovery	Error reset (after resetting slave errors)	Log category	System
Effects	User program	Continues.	Operation	Power drive circuit is OFF for relevant slave.		
Indicators	EtherNet/IP NET RUN		EtherNet/IP NET ERR		EtherNet/IP LINK/ACT	
	---		---		---	
System-defined variables	Variable		Data type		Name	
	None		---		---	
Cause and correction	Assumed cause		Remedy		Prevention	
	When bit 09 (Remote) of the Statusword (6041 hex) was set to 1 (remote), and the Servo Drive was in operation enabled state (Servo ON), a command was received that changes the communications state from Operational to another state (Init, Pre-operational, or Safe-operational state).		Check the command specifications of the host controller and correct the command.		Check the command specifications of the host controller to use correct command.	
	When bit 09 (Remote) of the Statusword (6041 hex) was set to 0 (local), a command was received during FFT or test run status that changes the ESM state from Operational, Safe-operational, or Pre-operational state to Init state.					
	An unsupported number was set for the Operation Mode (6060 hex).					
	The setting of the Operation Mode (6060 hex) was changed at an interval of less than 2 ms.					
	Homing was started when the Homing Method (6098 hex) was set to a value other than 8, 12, 19, 20, 33, 34,or 35.					
	Data setting warnings (B0 hex) occurred continuously for the number of data setting warnings that is set in the Data Setting Warning Detection Count (3781 hex).					
Attached information	None					
Precautions/ Remarks	"91" is displayed on the Servo Drive front panel and F191 is given as the AlarmCode (4001 hex).					

Event name	Operation Command Competition			Event code	78010000 hex
Meaning	An attempt was made to establish EtherCAT communications or to turn ON the Servo from the Controller (enable operation) while executing an FFT that operates with the Servo Drive alone or a trial run.				
Source	EtherCAT Master Function Module		Source details	Slave	Detection timing	During independent slave operation
Error attributes	Level	Minor fault	Recovery	Error reset (after resetting slave errors)	Log category	System
Effects	User program	Continues.	Operation	Power drive circuit is OFF for relevant slave.		
Indicators	EtherNet/IP NET RUN		EtherNet/IP NET ERR		EtherNet/IP LINK/ACT	
	---		---		---	
System-defined variables	Variable		Data type		Name	
	None		---		---	
Cause and correction	Assumed cause		Remedy		Prevention	
	EtherCAT communications (change from Init to Pre-operational state) was established or an attempt to turn ON the Servo from the Controller (enable operation) was made while executing an FFT that operates with the Servo Drive trial run.		Do not establish EtherCAT communications while an FFT or a trial run is being performed. Do not turn ON the Servo (enable operation) while an FFT or a trial run is being performed.		Do not establish EtherCAT communications while an FFT or a trial run is being performed. Do not turn ON the Servo (enable operation) while an FFT or a trial run is being performed.	
Attached information	None					
Precautions/ Remarks	"27" is displayed on the Servo Drive front panel and F627 is given as the AlarmCode (4001 hex)					

Event name	EtherCAT State Change Error			Event code	84B10000 hex
Meaning	A communications state change command was received for which the current communications state could not be changed.				
Source	EtherCAT Master Function Module		Source details	Slave	Detection timing	Continuously
Error attributes	Level	Minor fault	Recovery	Error reset (after resetting slave errors)	Log category	System
Effects	User program	Continues.	Operation	Power drive circuit is OFF for relevant slave.		
Indicators	EtherNet/IP NET RUN		EtherNet/IP NET ERR		EtherNet/IP LINK/ACT	
	---		Flashes at 1-s intervals.		---	
System-defined variables	Variable		Data type		Name	
	None		---		---	
Cause and correction	Assumed cause		Remedy		Prevention	
	A communications state change command was received for which the current communications state could not be changed.		Check the command specifications for communications state transitions in the host controller and correct host controller processing.		Check the command specifications for communications state transitions in the host controller and program host controller processing.	
Attached information	None					
Precautions/ Remarks	"83" is displayed on the Servo Drive front panel and F183 is given as the AlarmCode (4001 hex).					

Event name	EtherCAT Illegal State Change Error			Event code	84B20000 hex
Meaning	An undefined communications state change command was received.				
Source	EtherCAT Master Function Module		Source details	Slave	Detection timing	Continuously
Error attributes	Level	Minor fault	Recovery	Error reset (after resetting slave errors)	Log category	System
Effects	User program	Continues.	Operation	Power drive circuit is OFF for relevant slave.		
Indicators	EtherNet/IP NET RUN		EtherNet/IP NET ERR		EtherNet/IP LINK/ACT	
	---		Flashes at 1-s intervals.		---	
System-defined variables	Variable		Data type		Name	
	None		---		---	
Cause and correction	Assumed cause		Remedy		Prevention	
	An undefined communications state change command was received.		Check the command specifications for communications state transitions in the host controller and correct host controller processing.		Check the command specifications for communications state transitions in the host controller and program host controller processing.	
Attached information	None					
Precautions/ Remarks	"83" is displayed on the Servo Drive front panel and F283 is given as the AlarmCode (4001 hex).					

Event name	Communications Synchronization Error			Event code	84B30000 hex
Meaning	The number of consecutive errors in receiving data during the communication sync time exceeded the value specified for the Communications Control Setting.				
Source	EtherCAT Master Function Module		Source details	Slave	Detection timing	Continuously
Error attributes	Level	Minor fault	Recovery	Error reset (after resetting slave errors)	Log category	System
Effects	User program	Continues.	Operation	Power drive circuit is OFF for relevant slave.		
Indicators	EtherNet/IP NET RUN		EtherNet/IP NET ERR		EtherNet/IP LINK/ACT	
	---		Flashes at 1-s intervals.		---	
System-defined variables	Variable		Data type		Name	
	None		---		---	
Cause and correction	Assumed cause		Remedy		Prevention	
	Power to the host controller was interrupted during PDO communications.		Reset the error in the host controller. This event reports an error that was detected when power to the host controller was interrupted. It does not indicate that an error currently exists.		If you turn OFF the power supply to the host controller, also turn OFF the power supply to the Servo Drive.	
	An EtherCAT communications cable is disconnected, broken, or incorrectly connected.		Connect the EtherCAT communications cable securely. If the cable is broken, replace it.		Connect the EtherCAT communications cable securely.	
	Noise		Take noise countermeasures if excessive noise is affecting the EtherCAT communications cable.		Take noise countermeasures if excessive noise is affecting the EtherCAT communications cable.	
Attached information	None					
Precautions/ Remarks	"83" is displayed on the Servo Drive front panel and F383 is given as the AlarmCode (4001 hex).					

Event name	Synchronization Error			Event code	84B40000 hex
Meaning	A synchronization error occurred.				
Source	EtherCAT Master Function Module		Source details	Slave	Detection timing	Continuously
Error attributes	Level	Minor fault	Recovery	Error reset (after resetting slave errors)	Log category	System
Effects	User program	Continues.	Operation	Power drive circuit is OFF for relevant slave.		
Indicators	EtherNet/IP NET RUN		EtherNet/IP NET ERR		EtherNet/IP LINK/ACT	
	---		Flashes at 1-s intervals.		---	
System-defined variables	Variable		Data type		Name	
	None		---		---	
Cause and correction	Assumed cause		Remedy		Prevention	
	Noise		Take noise countermeasures if excessive noise is affecting the EtherCAT communications cable.		Take noise countermeasures if excessive noise is affecting the EtherCAT communications cable.	
	Control PCB error		Replace the Servo Drive.		None	
Attached information	None					
Precautions/ Remarks	"83" is displayed on the Servo Drive front panel and F483 is given as the AlarmCode (4001 hex).					

Event name	Sync Manager WDT Error			Event code	84B50000 hex
Meaning	PDO communications were stopped for more than the specified period of time.				
Source	EtherCAT Master Function Module		Source details	Slave	Detection timing	Continuously
Error attributes	Level	Minor fault	Recovery	Error reset (after resetting slave errors)	Log category	System
Effects	User program	Continues.	Operation	Power drive circuit is OFF for relevant slave.		
Indicators	EtherNet/IP NET RUN		EtherNet/IP NET ERR		EtherNet/IP LINK/ACT	
	---		Flashes at 1-s intervals.		---	
System-defined variables	Variable		Data type		Name	
	None		---		---	
Cause and correction	Assumed cause		Remedy		Prevention	
	The EtherCAT communications cable is disconnected or broken.		Connect the EtherCAT communications cable securely.		Connect the EtherCAT communications cable securely.	
	There is an error in the host controller.		Check the operation of the host controller and take appropriate measures if there a problem.		None	
Attached information	None					
Precautions/ Remarks	"83" is displayed on the Servo Drive front panel and F583 is given as the AlarmCode (4001 hex).					

Event name	ESC Initialization Error			Event code	84B60000 hex
Meaning	An error occurred in ESC initialization.				
Source	EtherCAT Master Function Module		Source details	Slave	Detection timing	When establishing communications after turning ON power to the slave
Error attributes	Level	Minor fault	Recovery	Error reset (after cycling slave power)	Log category	System
Effects	User program	Continues.	Operation	Power drive circuit is OFF for relevant slave.		
Indicators	EtherNet/IP NET RUN		EtherNet/IP NET ERR		EtherNet/IP LINK/ACT	
	---		---		---	
System-defined variables	Variable		Data type		Name	
	None		---		---	
Cause and correction	Assumed cause		Remedy		Prevention	
	Control PCB error		Replace the Servo Drive.		None	
Attached information	None					
Precautions/ Remarks	"88" is displayed on the Servo Drive front panel and F188 is given as the AlarmCode (4001 hex).					

Event name	Slave Unit Verification Error			Event code	84B70000 hex
Meaning	An error occurred in Slave Unit verification.				
Source	EtherCAT Master Function Module		Source details	Slave	Detection timing	When establishing communications after turning ON power to the slave
Error attributes	Level	Minor fault	Recovery	Error reset (after cycling slave power)	Log category	System
Effects	User program	Continues.	Operation	Power drive circuit is OFF for relevant slave.		
Indicators	EtherNet/IP NET RUN		EtherNet/IP NET ERR		EtherNet/IP LINK/ACT	
	---		Flashes at 1-s intervals.		---	
System-defined variables	Variable		Data type		Name	
	None		---		---	
Cause and correction	Assumed cause		Remedy		Prevention	
	Control PCB error		Replace the Servo Drive.		None	
Attached information	None					
Precautions/ Remarks	"88" is displayed on the Servo Drive front panel and F388 is given as the AlarmCode (4001 hex).					

Event name	Communications Setting Error			Event code	84B80000 hex
Meaning	There is an error in the communications settings.				
Source	EtherCAT Master Function Module		Source details	Slave	Detection timing	Continuously
Error attributes	Level	Minor fault	Recovery	Error reset (after resetting slave errors)	Log category	System
Effects	User program	Continues.	Operation	Power drive circuit is OFF for relevant slave.		
Indicators	EtherNet/IP NET RUN		EtherNet/IP NET ERR		EtherNet/IP LINK/ACT	
	---		Flashes at 1-s intervals.		---	
System-defined variables	Variable		Data type		Name	
	None		---		---	
Cause and correction	Assumed cause		Remedy		Prevention	
	An out-of-range value was set from the host controller.		Set EtherCAT communications parameters so that the synchronous cycle (SYNC0 cycle) and other setting are within the specified ranges.		Set EtherCAT communications parameters so that the synchronous cycle (SYNC0 cycle) and other setting are within the specified ranges.	
	A command that changes the communications state to an unsupported state was received.		Check the command specifications for communications state transitions in the host controller and correct host controller processing.		Check the command specifications for communications state transitions in the host controller and program host controller processing.	
Attached information	None					
Precautions/ Remarks	"90" is displayed on the Servo Drive front panel and F090 is given as the AlarmCode (4001 hex).					

Event name	Synchronization Interruption Error			Event code	84B90000 hex
Meaning	A synchronization interruption error occurred.				
Source	EtherCAT Master Function Module		Source details	Slave	Detection timing	Continuously
Error attributes	Level	Minor fault	Recovery	Error reset (after cycling slave power)	Log category	System
Effects	User program	Continues.	Operation	Power drive circuit is OFF for relevant slave.		
Indicators	EtherNet/IP NET RUN		EtherNet/IP NET ERR		EtherNet/IP LINK/ACT	
	---		Flashes at 1-s intervals.		---	
System-defined variables	Variable		Data type		Name	
	None		---		---	
Cause and correction	Assumed cause		Remedy		Prevention	
	Control PCB error		Replace the Servo Drive.		None	
Attached information	None					
Precautions/ Remarks	"88" is displayed on the Servo Drive front panel and F288 is given as the AlarmCode (4001 hex)					

Event name	Position Data Initialized			Event code	98020000 hex
Meaning	A Config operation was performed during EtherCAT communications.				
Source	EtherCAT Master Function Module		Source details	Slave	Detection timing	Continuously
Error attributes	Level	Minor fault	Recovery	Error reset (after resetting slave errors)	Log category	System
Effects	User program	Continues.	Operation	Power drive circuit is OFF for relevant slave.		
Indicators	EtherNet/IP NET RUN		EtherNet/IP NET ERR		EtherNet/IP LINK/ACT	
	---		---		---	
System-defined variables	Variable		Data type		Name	
	None		---		---	
Cause and correction	Assumed cause		Remedy		Prevention	
	A Config operation was performed during EtherCAT communications.		This operation is performed for safety and is not an error.		(A preventative measure is not required because this is a safety measure.)	
Attached information	None					
Precautions/ Remarks	"27" is displayed on the Servo Drive front panel and F727 is given as the AlarmCode (4001 hex)					

Event name	Fan Warning			Event code	08020000 hex
Meaning	The fan stop state continued for 1 second.				
Source	EtherCAT Master Function Module		Source details	Slave	Detection timing	Continuously
Error attributes	Level	Observation	Recovery	---	Log category	System
Effects	User program	Continues.	Operation	Not affected.		
Indicators	EtherNet/IP NET RUN		EtherNet/IP NET ERR		EtherNet/IP LINK/ACT	
	---		---		---	
System-defined variables	Variable		Data type		Name	
	None		---		---	
Cause and correction	Assumed cause		Remedy		Prevention	
	There is foreign matter in the fan.		If there is foreign matter in the fan, remove it.		Do not use the fan in an area surrounded by excessive foreign matter. Also, do not allow foreign objects to enter.	
	The Servo Drive failed.		If the above cause is not the cause of the problem, replace the Servo Drive.		None	
Attached information	None					
Precautions/ Remarks	"A3" is displayed on the front panel of the Servo Drive.					

Event name	External Encoder Overheating Warning			Event code		08040000 hex	
Meaning	The external encoder temperature exceeded the specified value.						
Source	EtherCAT Master Function Module		Source details	Slave	Detection timing		Continuously
Error attributes	Level	Observation	Recovery	---	Log category		System
Effects	User program	Continues.	Operation	Not affected.			
Indicators	EtherNet/IP NET RUN		EtherNet/IP NET ERR		EtherNet/IP LINK/ACT		
	---		---		---		
System-defined variables	Variable		Data type		Name		
	None		---		---		
Cause and correction	Assumed cause		Remedy		Prevention		
	The ambient temperature is too high.		Remove the cause of external encoder overheating.		Adjust the surrounding environment so that the external encoder does not overheat.		
	Linear Motor failed.		Replace the Linear Motor.		None		
Attached information	None						
Precautions/ Remarks	"A5" is displayed on the front panel of the Servo Drive.						

Event name	Life Expectancy Warning			Event code		08050000 hex	
Meaning	The remaining life of the capacitor or the fan is shorter than the specified value.						
Source	EtherCAT Master Function Module		Source details	Slave	Detection timing		Continuously
Error attributes	Level	Observation	Recovery	---	Log category		System
Effects	User program	Continues.	Operation	Not affected.			
Indicators	EtherNet/IP NET RUN		EtherNet/IP NET ERR		EtherNet/IP LINK/ACT		
	---		---		---		
System-defined variables	Variable		Data type		Name		
	None		---		---		
Cause and correction	Assumed cause		Remedy		Prevention		
	The life expectancy of the capacitor or the fan is shorter than the specified value.		Replace the Servo Drive.		None		
Attached information	None						
Precautions/ Remarks	"A7" is displayed on the front panel of the Servo Drive.						

Event name	External Encoder Error Warning		Event code		08060000 hex	
Meaning	The external encoder detected a warning.					
Source	EtherCAT Master Function Module	Source details	Slave	Detection timing	Continuously	
Error attributes	Level	Observation	Recovery	---	Log category	System
Effects	User program	Continues.	Operation	Not affected.		
Indicators	EtherNet/IP NET RUN		EtherNet/IP NET ERR		EtherNet/IP LINK/ACT	
	---		---		---	
System-defined variables	Variable		Data type		Name	
	None		---		---	
Cause and correction	Assumed cause		Remedy		Prevention	
	There is insufficient power supply voltage for the external encoder.		Provide the required external encoder power supply voltage of 5 VDC ±5% (4.75 to 5.25 V).		Provide the required external encoder power supply voltage of 5 VDC ±5% (4.75 to 5.25 V).	
	Noise is entering on the external encoder connector cable.		If the motor cable and the external encoder cable are bundled together, separate them. Connect the shield to FG.		If the motor cable and the external encoder cable are bundled together, separate them. Connect the shield to FG.	
	The external encoder failed.		If none of the above causes applies, replace the external encoder.		None	
Attached information	None					
Precautions/ Remarks	"A8" is displayed on the front panel of the Servo Drive.					

Event name	External Encoder Communications Warning		Event code		08070000 hex	
Meaning	The external encoder had more communications errors than the specified value.					
Source	EtherCAT Master Function Module	Source details	Slave	Detection timing	Continuously	
Error attributes	Level	Observation	Recovery	---	Log category	System
Effects	User program	Continues.	Operation	Not affected.		
Indicators	EtherNet/IP NET RUN		EtherNet/IP NET ERR		EtherNet/IP LINK/ACT	
	---		---		---	
System-defined variables	Variable		Data type		Name	
	None		---		---	
Cause and correction	Assumed cause		Remedy		Prevention	
	There is insufficient power supply voltage for the external encoder.		Provide the required external encoder power supply voltage of 5 VDC ±5% (4.75 to 5.25 V).		Provide the required external encoder power supply voltage of 5 VDC ±5% (4.75 to 5.25 V).	
	Noise is entering on the external encoder connector cable.		If the motor cable and the external encoder cable are bundled together, separate them. Connect the shield to FG.		If the motor cable and the external encoder cable are bundled together, separate them. Connect the shield to FG.	
Attached information	None					
Precautions/ Remarks	"A9" is displayed on the front panel of the Servo Drive.					

Event name	Data Setting Warning		Event code	34E00000 hex	
Meaning	An object setting is out of range.				
Source	EtherCAT Master Function Module	Source details	Slave	Detection timing	Continuously
Error attributes	Level	Observation	Recovery	---	Log category	System
Effects	User program	Continues.	Operation	Not affected.		
Indicators	EtherNet/IP NET RUN		EtherNet/IP NET ERR		EtherNet/IP LINK/ACT	
	---		---		---	
System-defined variables	Variable		Data type		Name	
	None		---		---	
Cause and correction	Assumed cause		Remedy		Prevention	
	An object setting is out of range.		Correct the object settings so that they are within the specified ranges.		Set the object settings so that they are within the specified ranges.	
Attached information	None					
Precautions/ Remarks	"B0" is displayed on the front panel of the Servo Drive.					

Event name	Overload Warning		Event code	383C0000 hex	
Meaning	The load ratio is 85% or more of the protection level.				
Source	EtherCAT Master Function Module	Source details	Slave	Detection timing	While power is supplied to motor
Error attributes	Level	Observation	Recovery	---	Log category	System
Effects	User program	Continues.	Operation	Not affected.		
Indicators	EtherNet/IP NET RUN		EtherNet/IP NET ERR		EtherNet/IP LINK/ACT	
	---		---		---	
System-defined variables	Variable		Data type		Name	
	None		---		---	
Cause and correction	Assumed cause		Remedy		Prevention	
	Overload		Take the following actions according to the situation. • Increase the capacities of the Servo Drive and the motor. • Increase the setting of the acceleration/deceleration time and lighten the load. • Adjust the gain or mass ratio. • Remove machine distortion. • Measure the voltage at the brake terminal. If the brake is ON, release it. • Correct the system if force (current) waveforms oscillate or excessively oscillate vertically during analog output or communications.		Check the items given for corrections in advance and implement countermeasures as required.	
	There is incorrect wiring of the motor line or a broken cable.		Connect the motor cable as shown in the wiring diagram. If the cable is broken, replace it. Connect the motor line and external encoder line that are used together to the same motor.		Connect the motor cable as shown in the wiring diagram. Connect the motor line and external encoder line that are used together to the same motor.	
Attached information	None					
Precautions/ Remarks	"A0" is displayed on the front panel of the Servo Drive.					

Event name	Excessive Regeneration Warning			Event code		383D0000 hex
Meaning	The regeneration load ratio is 85% or more of the level.					
Source	EtherCAT Master Function Module		Source details	Slave	Detection timing	While power is supplied to motor
Error attributes	Level	Observation	Recovery	---	Log category	System
Effects	User program	Continues.	Operation	Not affected.		
Indicators	EtherNet/IP NET RUN		EtherNet/IP NET ERR		EtherNet/IP LINK/ACT	
	---		---		---	
System-defined variables	Variable		Data type		Name	
	None		---		---	
Cause and correction	Assumed cause		Remedy		Prevention	
	There is excessive regeneration.		Check the operation pattern (velocity monitor). Check the Regeneration Resistor load rate and the excessive regeneration warning, and perform the following accordingly. • Increase the capacities of the motor and the Servo Drive. • Increase the deceleration time. • Reduce the motor operation speed. • Use an External Regeneration Resistor. • Set the Regeneration Resistor Selection (3016 hex) to 2.		Check the items given for corrections in advance and implement countermeasures as required. Or, set the Regeneration Resistor Selection (3016 hex) to 2.	
	This Regeneration Resistor cannot be used for continuous regenerative braking.		This Regeneration Resistor cannot be used for continuous regenerative braking.		Do not use the Regeneration Resistor for continuous regenerative braking.	
Attached information	None					
Precautions/ Remarks	"A1" is displayed on the front panel of the Servo Drive.					

Event name	Vibration Detection Warning			Event code		383E0000 hex
Meaning	Vibration was detected.					
Source	EtherCAT Master Function Module		Source details	Slave	Detection timing	While power is supplied to motor
Error attributes	Level	Observation	Recovery	---	Log category	System
Effects	User program	Continues.	Operation	Not affected.		
Indicators	EtherNet/IP NET RUN		EtherNet/IP NET ERR		EtherNet/IP LINK/ACT	
	---		---		---	
System-defined variables	Variable		Data type		Name	
	None		---		---	
Cause and correction	Assumed cause		Remedy		Prevention	
	The gain or mass ratio setting is not suitable.		Correct the gain (the balance between position loop gain and velocity loop gain) and the mass ratio.		Adjust the gain (the balance between position loop gain and velocity loop gain) and the mass ratio.	
Attached information	None					
Precautions/ Remarks	"A6" is displayed on the front panel of the Servo Drive.					

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Event name	Command Warning			Event code	74800000 hex	
Meaning	A command could not be executed.					
Source	EtherCAT Master Function Module		Source details	Slave	Detection timing	Continuously
Error attributes	Level	Observation	Recovery	---	Log category	System
Effects	User program	Continues.	Operation	Not affected.		
Indicators	EtherNet/IP NET RUN		EtherNet/IP NET ERR		EtherNet/IP LINK/ACT	
	---		---		---	
System-defined variables	Variable		Data type		Name	
	None		---		---	
Cause and correction	Assumed cause		Remedy		Prevention	
	A forced brake operation request was sent while the Servo was ON.		Make sure that the settings meet the object's operation conditions. Check the drive prohibition input and operation command, and take actions accordingly.		Make sure that the settings meet the object's operation conditions. Check the drive prohibition input and operation command, and take actions accordingly.	
	A Switch ON command was sent when the main power was OFF. (When 3508 hex = 0)					
	An Enable Operation command was sent to request turning ON the Servo when the motor was operating at 30 mm/s or higher.					
	A latch operation was started under the following conditions. • The Config operation was being performed. • The Statusword (6041 hex) bit 09 (remote) was 0 (local).					
	An operation command is given in the prohibited direction after the motor made an immediate stop due to a drive prohibition input.					
Attached information	None					
Precautions/ Remarks	"B1" is displayed on the front panel of the Servo Drive.					

Event name	EtherCAT Communications Warning			Event code	84B00000 hex
Meaning	An EtherCAT communications error occurred one or more times.				
Source	EtherCAT Master Function Module		Source details	Slave	Detection timing	Continuously
Error attributes	Level	Observation	Recovery	---	Log category	System
Effects	User program	Continues.	Operation	Not affected.		
Indicators	EtherNet/IP NET RUN		EtherNet/IP NET ERR		EtherNet/IP LINK/ACT	
	---		---		---	
System-defined variables	Variable		Data type		Name	
	None		---		---	
Cause and correction	Assumed cause		Remedy		Prevention	
	The EtherCAT communications cable is disconnected or broken.		Connect the EtherCAT communications cable securely. If the cable is broken, replace it.		Connect the EtherCAT communications cable securely.	
	Noise		Take noise countermeasures if excessive noise is affecting the EtherCAT communications cable.		Take noise countermeasures if excessive noise is affecting the EtherCAT communications cable.	
Attached information	None					
Precautions/ Remarks	"B2" is displayed on the front panel of the Servo Drive.					

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A-4 EtherCAT Terminology

Use the following list of EtherCAT terms for reference.

Term	Abbreviation	Description
Object	–	Abstract representation of a component within a device, which consists of data, parameters, and methods.
Object Dictionary	OD	Data structure addressed by Index and Subindex that contains description of data type objects, communication objects and application objects.
Service Data Object	SDO	CoE asynchronous mailbox communications where all objects in the object dictionary can be read and written.
Index	–	Address of an object within an application process.
Subindex	–	Sub-address of an object within the object dictionary.
Process Data	–	Collection of application objects designated to be transferred cyclically or acyclically for the purpose of measurement and control.
Process Data Object	PDO	Structure described by mapping parameters containing one or several process data entities.
Receive PDO	RxPDO	A process data object received by an EtherCAT slave.
Transmit PDO	TxPDO	A process data object sent from an EtherCAT slave.
Sync Manager	SM	Collection of control elements to coordinate access to concurrently used objects.
Distributed Clock	DC	Method to synchronize slaves and maintain a global time base.
Device Profile	–	Collection of device dependent information and functionality providing consistency between similar devices of the same device type.
Fieldbus Memory Management Unit	FMMU	Single element of the fieldbus memory management unit: one correspondence between a coherent logical address space and a coherent physical memory location.
Physical Device Internal Interface	PDI	A series of elements to access data link services from the application layer.
CAN in Automation	CiA	CiA is the international users' and manufacturers' group that develops and supports higher-layer protocols.
CAN application protocol over EtherCAT	CoE	A CAN application protocol service implemented on EtherCAT.
EEPROM	EEPROM	Electrically erasable PROM.
EtherCAT Technology Group	ETG	The ETG is a global organization in which OEM, End Users and Technology Providers join forces to support and promote the further technology development.
EtherCAT Slave Controller	ESC	A controller for EtherCAT slave communication.
EtherCAT State Machine	ESM	An EtherCAT communication state machine.
EtherCAT Slave Information	ESI	An XML file that contains setting information for an EtherCAT slave.
Slave Information Interface	SII	Slave information stored in the nonvolatile memory of each slave.
Power Drive System	PDS	A power drive system consisting of a Servo Drive, an inverter, and other components.

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