OMRON

AC SERVOMOTORS/SERVO DRIVES

G5-series WITH BUILT-IN

EtherCAT® COMMUNICATIONS
Linear Motor Type

User's Manual

R88L-EC-□ (Linear Motors)
R88D-KN□-ECT-L (AC Servo Drives)

SYSMAC
always in control

I577-E1-04

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 in case that problems occur.

Intended Readers

This manual is intended for the following individuals.

Those who have electrical knowledge (certified electricians or individuals who have equivalent knowledge) and also are 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.

Manual Configuration

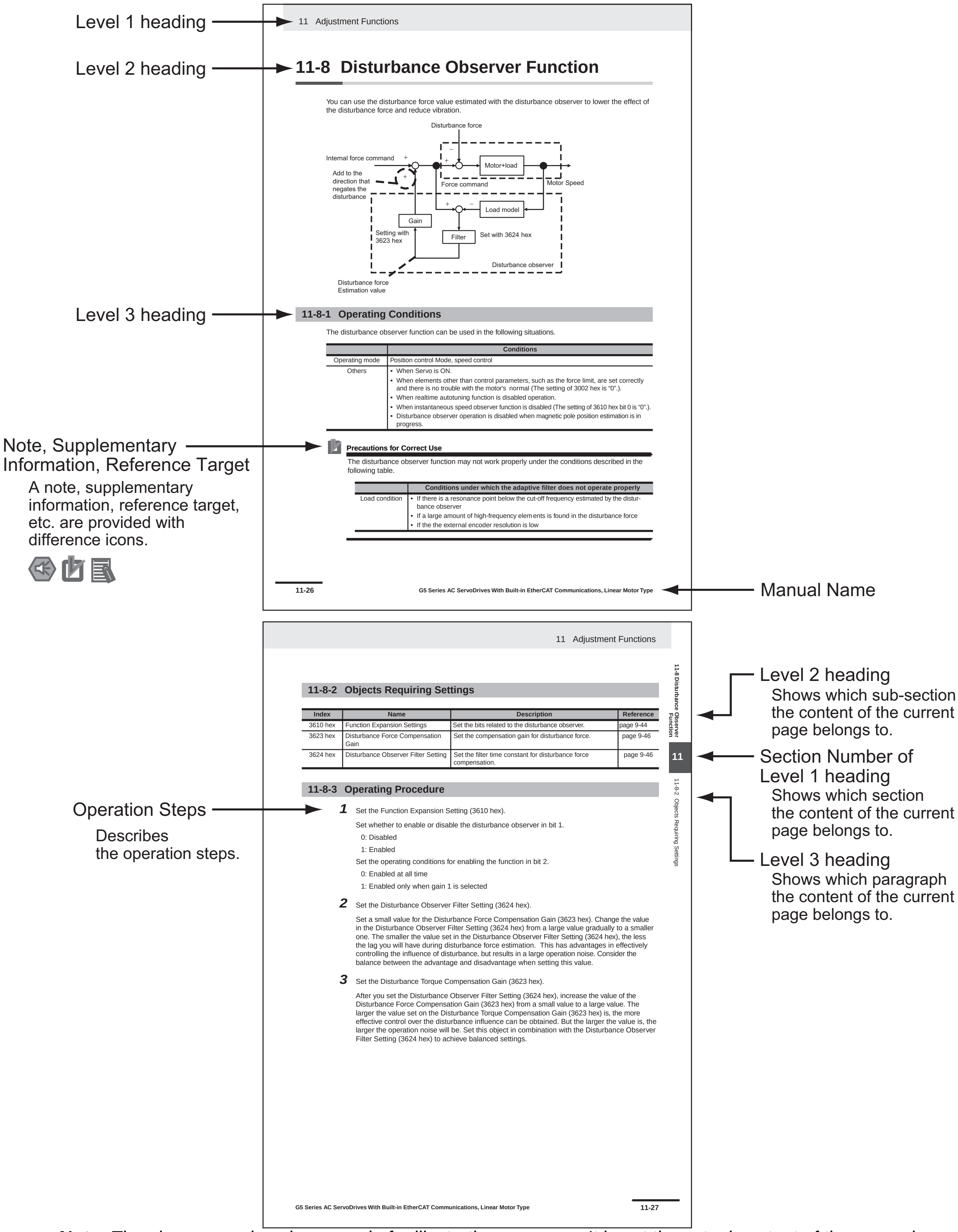
This manual consists of the following sections.

		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 Drive, Linear Motors, and peripheral devices, and provides the external dimensions and mounting dimensions.
Section 3	Specifications	This section provides the general specifications, characteristics, connector specifications, I/O circuits of the Servo Drives and Linear Motors, as well as specifications of other peripheral devices.
Section 4	System Design	This section explains the installation conditions, wiring methods which include wiring conforming to EMC directives, and regenerative energy calculation methods for the Servo Drive and Linear Motor, and also describes 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 the Machine Automation Controller NJ-series (Model: NJ301-□□□□/NJ501-□□□□) or Position Control Unit (Model: CJ1W-NC281/NC481/NC881/NCF81/NC482/NC882/NCF82).
Section 6	Basic Control Functions	This section outlines basic control functions, and explains the settings.
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 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 settings of each object.
Section 10	Operation	This section explains the operating procedures and 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 describes the items to check when problems occur, troubleshooting using the error displays, troubleshooting based on the operating conditions, and periodic maintenance.
Appendices		The appendices provide the 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.



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 Track (the magnets 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 Track (the magnets 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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Section 3 Specifications

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Section 8 Safety Function

Section 9 Servo Parameter Objects

Section 10 Operation

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Section 12 Troubleshooting and Maintenance

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Terms and Conditions Agreement

Warranty, Limitations of Liability

Warranties

- **Exclusive Warranty**

Omron's exclusive warranty is that the Products will be free from defects in materials and workmanship for a period of twelve months from the date of sale by Omron (or such other period expressed in writing by Omron). Omron disclaims all other warranties, express or implied.

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Omron Companies shall not be responsible for conformity with any standards, codes or regulations which apply to the combination of the Product in the Buyer’s application or use of the Product. At Buyer’s request, Omron will provide applicable third party certification documents identifying ratings and limitations of use which apply to the Product. This information by itself is not sufficient for a complete determination of the suitability of the Product in combination with the end product, machine, system, or other application or use. Buyer shall be solely responsible for determining appropriateness of the particular Product with respect to Buyer’s application, product or system. Buyer shall take application responsibility in all cases.

NEVER USE THE PRODUCT 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 PRODUCT(S) IS PROPERLY RATED AND INSTALLED FOR THE INTENDED USE WITHIN THE OVERALL EQUIPMENT OR SYSTEM.

Programmable Products

Omron Companies shall not be responsible for the user,Äôs programming of a programmable Product, or any consequence thereof.

Disclaimers

Performance Data

Data presented in Omron Company websites, catalogs and other materials 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 user must correlate it to actual application requirements. Actual performance is subject to the Omron’s Warranty and Limitations of Liability.

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 part numbers when published ratings or features are changed, or when significant construction changes are made. However, some specifications of the Product may be changed without any notice. When in doubt, special part numbers may be assigned to fix or establish key specifications for your application. Please consult with your Omron’s representative at any time to confirm actual specifications of purchased Product.

Errors and Omissions

Information presented by Omron Companies has been 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 and Servomotor 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

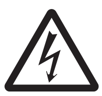
The following notation is used in this manual to provide precautions required to ensure safe usage of G5-series Servo Drives and Servomotors.

The safety precautions that are provided are extremely important to safety. Always read and heed the information provided in all safety precautions.

The display of precautions used in this manual and their meanings are explained below.

⚠ 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 and ground wires for the Servo Drive and Motor with 100 VAC or 200 VAC to 100 Ω or less, and for the Servo Drive and Motor with 400 VAC to 10 Ω or less.

Electric shock may result.

Never touch the parts inside the Servo Drive or the cable ends of the Motor Coil Unit.

Electric shock may result.

Do not remove the front cover, terminal covers, cables, or optional items while the power is being supplied.

Doing so may result in electric shock.

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.

Install the Servo Drive and Motor before wiring.

Improper grounding may result in electrical shock.

Do not damage, pull, or put excessive stress or heavy objects on the cables.

Doing so may cause electric shock, malfunction, or burning.

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.

Do not touch the Servo Drive radiator, Regeneration Resistor, or Motor while the power is supplied or for a while after the power is turned OFF becuse they get hot.
Fire or a burn injury may result.

Use the Motor and Servo Drive in a specified combination.

Fire or equipment damage may result.

Never connect a power supply directly to the Motor.

Fire or failure may result.

Do not enter the operating area during operation.

Injury may result.

Never modify the Servo Drive.

Injury or equipment damage may result.

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 is 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 Motor using an external drive source.

Fire may result.

Do not place flammable materials near the Motor, Servo Drive, or Regeneration Resistor.

Fire may result.

Install the Motor, Servo Drive, and Regeneration Resistor on non-flammable materials such as metals.

Fire may result.

When constructing a system that includes safety functions, be sure you understand the relevant safety standards and all related information in user documentation, and design the system to comply with the standards.

Not doing so may result in injury or equipment damage.

If the motor is not controlled, it may not be possible to maintain the stop.

To ensure safety, install a stop device. Risk of equipment damage and human injury.

Do not handle objects made of magnetic materials near the Linear Motor. Use nonmagnetic tools when performing installation or other work on 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.

People using a pacemaker or other electronic medical device must stay away from the linear motor.

A powerful magnetic field is generated by the stator and powered needle.

This may cause malfunctioning of electronic devices.

When shipping or transporting the Magnet Track, be sure to display that the content is a strong magnetic product.

Medical electronics such as cardiac pacemakers may malfunction or injury may result.

Do not put the product into the fire.

Burst or gas may occur and injury may result.

Caution

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 these locations may result in fire, electric shock, or equipment damage.	
The magnetic attraction force always affects between the Motor Coil Unit and Magnet Track even when the power supply is turned OFF. Design a machine which supports the magnetic attraction force and provides enough rigidity to maintain the accuracy. Malfunction or failure may result.	
Design a machine with consideration of the magnetic attraction force. Malfunction or failure may result.	
Do not hit the Motor Coil Unit against the stopper. Design the configuration so that the table mounted on the Motor Coil Unit hits against the stopper. Equipment damage may result.	
Do not apply strong impact on the product. Failure may result.	
Prevent adhesion of foreign objects to the product. Malfunction may result.	
You cannot use the Linear Motor because its magnetic pole cannot be detected in an unbalanced load such as vertical axis. If the magnetic pole cannot be detected, an error may occur and the Linear Motor may be in the free-run status. Injury or equipment damage may result.	
The protective structure of the Linear Motor is IP00. Take necessary measures to prevent dust, oil, etc. Failure may result.	
Ensure that the Linear Slider has a sufficient rigidity. Equipment damage or malfunction may result.	
Provide appropriate safety measures to prevent crashes, etc. if you design a system which cooperates multiple motor coil units such as multi-head or tandem. Equipment damage may result.	
Do not bring electronic devices, magnetic recording media, or other articles that may be affected by magnetism (clocks, computers, measuring instruments, magnetic cards, IC cards, etc.) near the linear motor. This may cause malfunctioning or equipment damage.	

Storage and Transportation

⚠ Caution

When transporting the Motor Coil Unit, do not hold the cable. Injury or equipment damage may result.	⚠
When transporting the Magnet Track, do not hold the cover to protect the magnet. Injury or equipment damage may result.	⚠
Do not overload the product. (Follow the instructions on the product label.) Injury or failure may result.	⚠
Be sure to store the product as packed in the same packing as delivered. Injury or equipment damage may result.	⚠
When transporting or storing the magnet track, pack the product in the same condition as delivered or cover the magnetic side by 30 mm or more thick material such as high density plastics. (Be sure to provide more than 60 mm of thickness.) Equipment damage may result.	⚠
The magnetic body (Motor Coil Unit, other Magnet Track or tools) generates attractive force by Magnet Track. Be careful about the ambient environment when and after disassembling the Linear Motor, and handling the Magnet Track. Injury such as getting one’s hand caught in the Linear Motor or equipment damage 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. Injury or failure may result.	⚠

Installation and Wiring

Caution

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 to wire screw type terminal blocks. Do not connect bare stranded wires directly to terminals blocks. 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.
Wire the cables correctly and securely. Runaway motor, injury, or failure may result.
Tighten the mounting screws, terminal block screws, and cable screws for the product to the specified torque. Failure may result.
Use non-magnetic mounting screws. Note also that the depth of any mounted screw is less than the effective thread depth. Equipment damage may result.
Be sure to wire the motor coil unit cable fixedly. Equipment damage may result.
For wiring between the Motor Coil Unit cable and the Servo Drive, use a robot cable. Equipment damage may result.
Be sure to securely fix the Linear Motor to the machine. The Linear Motor may come off during operation and equipment damage may result.
When installing the Linear Motor, match the center of gravity of the motor coil unit and load. Malfunction or equipment damage may result by the increase of the running load.
Install linear guides with great caution to comply with the gap specification of the motor coil unit and magnet track. (If the gap is small, the running load by the friction will increase in proportion to the magnetic attraction force.) Malfunction may result.
Do not allow foreign objects to enter between the Motor Coil Unit and Magnet Track. Equipment damage or malfunction may result.

Set a parameter to operate the Motor and external encoder in the same direction.

Malfunction or equipment damage may result.

When installing more than one Magnet Track, set the mounting screw accumulative pitch tolerance within ± 0.2 mm.

Malfunction may result.

Use the specified screws for the tap holes of Motor Coil Unit. The tap holes are used to install the Motor Coil Unit.

Equipment damage may result.

Use all tap holes of Motor Coil Unit and threaded holes of Magnet Track to install the Linear Motor.

Equipment damage may result.

Always use the power supply voltage specified in the User's Manual.

An incorrect voltage may result in malfunction or burning.

Take appropriate measures to ensure that the specified power with the rated voltage is supplied.

Be particularly careful in locations where the power supply is unstable.

An incorrect power supply may result in failure.

Connect the Servo Drive to the Motor without a contactor, etc.

Malfunction or equipment damage may result.

Take appropriate and sufficient countermeasures to provide shielding when installing systems in the following locations.

Not doing so may result in failure.

- Locations subject to static electricity or other forms of noise.
- Locations subject to strong electromagnetic fields and magnetic fields.
- Locations subject to possible exposure to radioactivity.
- Locations close to power supplies.

Do not use the Linear Motor in the location subject to magnetic powders such as iron filings.

They may adhere to the Linear Motor and failure may result.

Connect an emergency stop (immediate stop) relay in series with the brake control relay.

Injury or failure may result.

Operation and Adjustment

Caution

If the Servo Drive fails, cut off the power supply to the Servo Drive. Fire may result.	
Do not block the intake or exhaust openings. Do not allow foreign objects to enter the Servo Drive. Fire may result.	
Conduct a test operation after confirming that the equipment is not affected. Equipment damage may result.	
Check any newly set parameters and software switch settings for proper execution before actually using them. Not doing so may result in equipment damage.	
Never adjust or set parameters to extreme values, because it will make the operation unstable. Injury may result.	
Separate the Motor from the mechanical system and check its operation before installing the Motor to the machine. Injury may result.	
If the magnetic body is near the Linear Motor, the cogging will occur and affect the performance. Malfunction or equipment damage may result.	
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.	
Do not operate the Motor connected to an excessive load mass. Failure may result.	
Do not turn ON and OFF the main Servo Drive power supply frequently. Failure may result.	
Install equipment to prevent crash and reduce shock. Crash against the stroke edge may occur depending on stopping distance and equipment damage may result.	
If a problem occurs in serial communications during a test operation, you have no means to stop the Motor. Install external hardware to ensure that the Motor can be stopped at any time.	
Before transferring parameters or data from the CX-Drive and Sysmac Studio to any other node, check the safety around the target node. Injury may result.	
Check the axis (shaft) number before operating with the CX-Drive and Sysmac Studio.	

Maintenance and Inspection

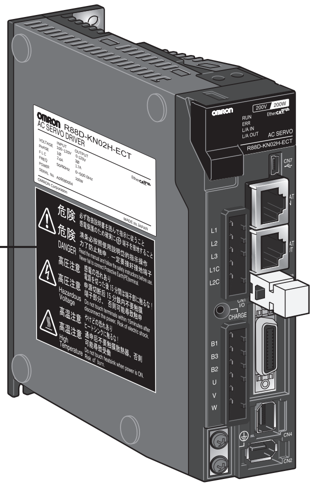
Caution

Do not attempt to disassemble, repair, or modify the Servomotor or Servo Drive. Any attempt to do so may result in electric shock or other injury.	
After replacing the Servo Drive, transfer to the new Servo Drive all data needed to resume operation, before restarting operation. Equipment damage may result.	
Turn OFF the power supply when not using the Servomotor or Servo Drive for a long period of time. Not doing so may result in injury or malfunction.	
Design the system to stop for at least ten minutes after the dynamic brake operates. If it is used under more conditions, the dynamic brake may break and the brake may not operate.	

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.



(R88D-KN02H-ECT-L)

Instructions on Warning Label

Disposal

- Dispose of the Servo Drive as industrial waste.
- When disposing of the battery, insulate it using tape and dispose of it by following the applicable ordinance of your local government.

Regulations and Standards

Overseas Use

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.

Conformance to EC Directives

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.

EC Directive	Product	Applicable standards
Low Voltage Directive	AC Servo Drives	EN61800-5-1
	Linear Motor	EN60034-1
EMC Directive	AC Servo Drives	EN55011 classA group1
		EN61000-6-2
		EN61800-3
Machinery Directives	AC Servo Drives	EN954-1 Cat.3
		EN ISO13849-1 PL c, PL d
		EN61508 (Part 1, 2, 4) SIL2
		EN62061 SIL2
		EN61800-5-2 (STO)
		IEC61326-3-1

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 4-26.

UL and cUL Standards

Standard	Product	Applicable standards	File number
UL standards	AC Servo Drives	UL 508C	E179149*1
CSA standards	AC Servo Drives	CSA C22.2 No. 14	E179149

*1 The R88D-KT20☐ and lower capacity Servo Drives are UL-listed.
The R88D-KT30☐ and higher capacity Servo Drives are UL-recognized.

This product complies with the UL 508C standard (file No. E179149) only when the following two installation conditions are met.

- Use the Servo Drive in an environment rated as Pollution Degree 2 or Pollution Degree 1 defined in IEC60664-1. For example, the product meets this requirement when installed inside an IP54 control panel.
- Be sure to connect between the power supply and the noise filter a circuit breaker or fuse that bears the UL mark (which means a UL-listed product).
  Refer to the following table for the rated current of the circuit breaker/fuse.
  For wiring, use a copper conductor wire with a temperature rating of 75 ºC or higher.

Servo Drive model	Circuit breaker rated current [A]
R88D-KN01L-ECT-L	10
R88D-KN02L-ECT-L	
R88D-KN04L-ECT-L	
R88D-KN01H-ECT-L	
R88D-KN02H-ECT-L	
R88D-KN04H-ECT-L	
R88D-KN08H-ECT-L	15
R88D-KN10H-ECT-L	
R88D-KN15H-ECT-L	20
R88D-KN06F-ECT-L	15
R88D-KN10F-ECT-L	
R88D-KN15F-ECT-L	
R88D-KN20F-ECT-L	20
R88D-KN30F-ECT-L	30

Korean Radio Regulations (KC)

- The G5-series Servo Drives comply with the Korean Radio Regulations (KC).
- The G5-series Servomotors and Linear Motors are exempt from the Korean Radio Regulations (KC).

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.

Precautions for Correct Use

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

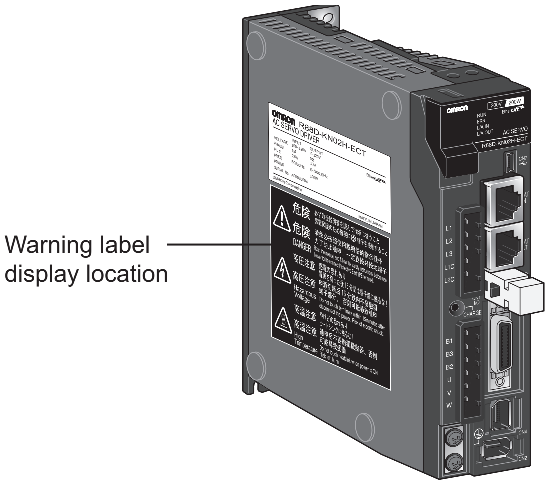
Items to Check after Unpacking

After unpacking, check the following items.

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

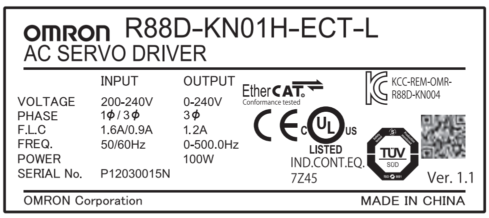
Servo Drive

Location of Servo Drive Rating Label



(R88D-KN02H-ECT-L)

Servo Drive Rating Label



Servo Drive Accessories

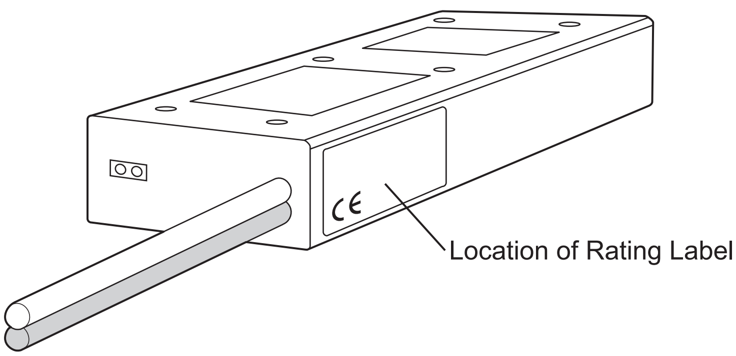
Safety Precautions document × 1 copy

- 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.
- The safety bypass connector is required if the safety function is not used. To use the safety function, provide a separate safety I/O signal connector.
- 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.

<table>
<tr><th colspan="2">Specifications</th><th>Connector for main circuit power supply terminals and control circuit power supply terminals</th><th>Connector for External Regeneration Resistor connection terminals and motor connection terminals</th><th>Safety bypass connector</th><th>Mounting brackets</th></tr>
<tr><td rowspan="3">Single-phase 100 VAC</td><td>100 W</td><td colspan="2" rowspan="11">Included</td><td rowspan="13">Included *1</td><td rowspan="11">–</td></tr>
<tr><td>200 W</td></tr>
<tr><td>400 W</td></tr>
<tr><td rowspan="5">Single-phase/ 3-phase 200 VAC</td><td>200 W</td></tr>
<tr><td>400 W</td></tr>
<tr><td>750 W</td></tr>
<tr><td>1 kW</td></tr>
<tr><td>1.5 kW</td></tr>
<tr><td rowspan="5">3-phase 400 VAC</td><td>600 W</td></tr>
<tr><td>1 kW</td></tr>
<tr><td>1.5 kW</td></tr>
<tr><td>2 kW</td><td colspan="2">Included</td><td rowspan="2">Included</td></tr>
<tr><td>3 kW</td><td colspan="2">–</td></tr>
</table>

*1 Provide a safety connector separately to use the safety function.

Location of Iron-core Linear Motor Coil Unit Rating Label



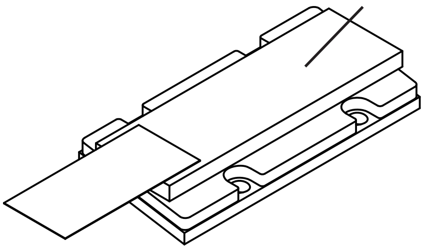
Location of Iron-core Linear Motor Magnet Track Rating Label

The iron-core Linear Motor Magnet Track bears no labels.

For the model and the production lot number, check the information provided on the product packaging box.

Iron-core Linear Motor Accessories

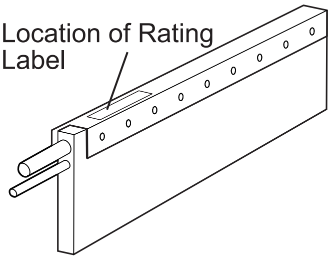
- Safety Precautions document × 1 copy
- Protective cover (for Magnet Track only) × 1

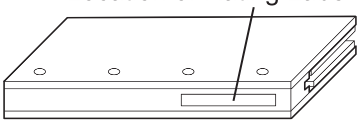


The Magnet Track has a protective cover for cushioning the impact of collision due to the magnetic attraction force until assembled. Do not remove this protective cover until you finish installing the iron-core Linear Motor.

Parts such as connectors, mounting screws, and mounting brackets are not included. Provide them separately. If any item is missing or a problem is found such as product damage, contact the OMRON dealer or sales office where you purchased your product.

Location of Coreless Linear Motor Rating Label





For the model and the production lot number, check the information provided on the rating label or the product packaging box.

Coreless Linear Motor Attachments

- Safety Precautions document × 1 copy

Parts such as connectors, mounting screws, and mounting brackets are not included. Provide them separately.

If any item is missing or a problem is found such as product damage, contact the OMRON dealer or sales office where you purchased your product.

Revision History

The manual revision code is a number appended to the end of the catalog number found in the bottom right-hand corner of the front and back covers.

Example

Cat. No.	I577-E1-04

Revision code

Revision code	Revision date	Revised content
01	October 2011	Original production
02	November 2012	Descriptions about Linear Motors were added.
03	January 2017	Added information and made corrections.
04	January 2018	Added information and made corrections.

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: NJ301-□□□□/NJ501-□□□□) 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: NJ301-□□□□/NJ501-□□□□) or EtherCAT-compatible Position Control Unit (Model: CJ1W-NC□8□) 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 encoder 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 movement direction and also via an external signal. In addition, the settings can be made easily by setting the damping frequency and filter values.

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.

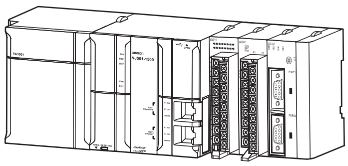
*1 G5-series Servo Drive parameters (Pn□□□) are allocated to objects 3000 to 3999 hex. Index 3□□□ hex correspond to G5-series Servo Drive parameters Pn□□□. For example, object 3504 hex is the same as parameter Pn504.
Pn□□□ uses decimal numbers but object 3□□□ is a hexadecimal number.
For details on servo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

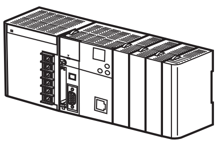
Controller (EtherCAT)

NJ-series CPU Unit with built-in EtherCAT port



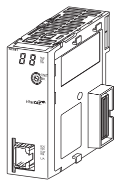
Machine Automation Controller
NJ301-□□□□/NJ501-□□□□

CJ-series CPU Unit + Position Control Unit with EtherCAT Interface



Programmable Controller
CJ□□-CPU□□

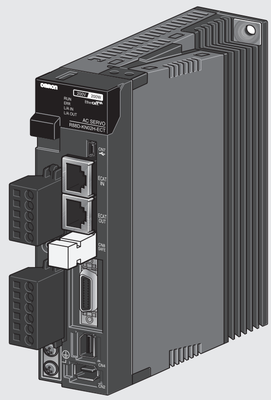
+



Position Control Unit (NC)
CJ1W-NC□8□

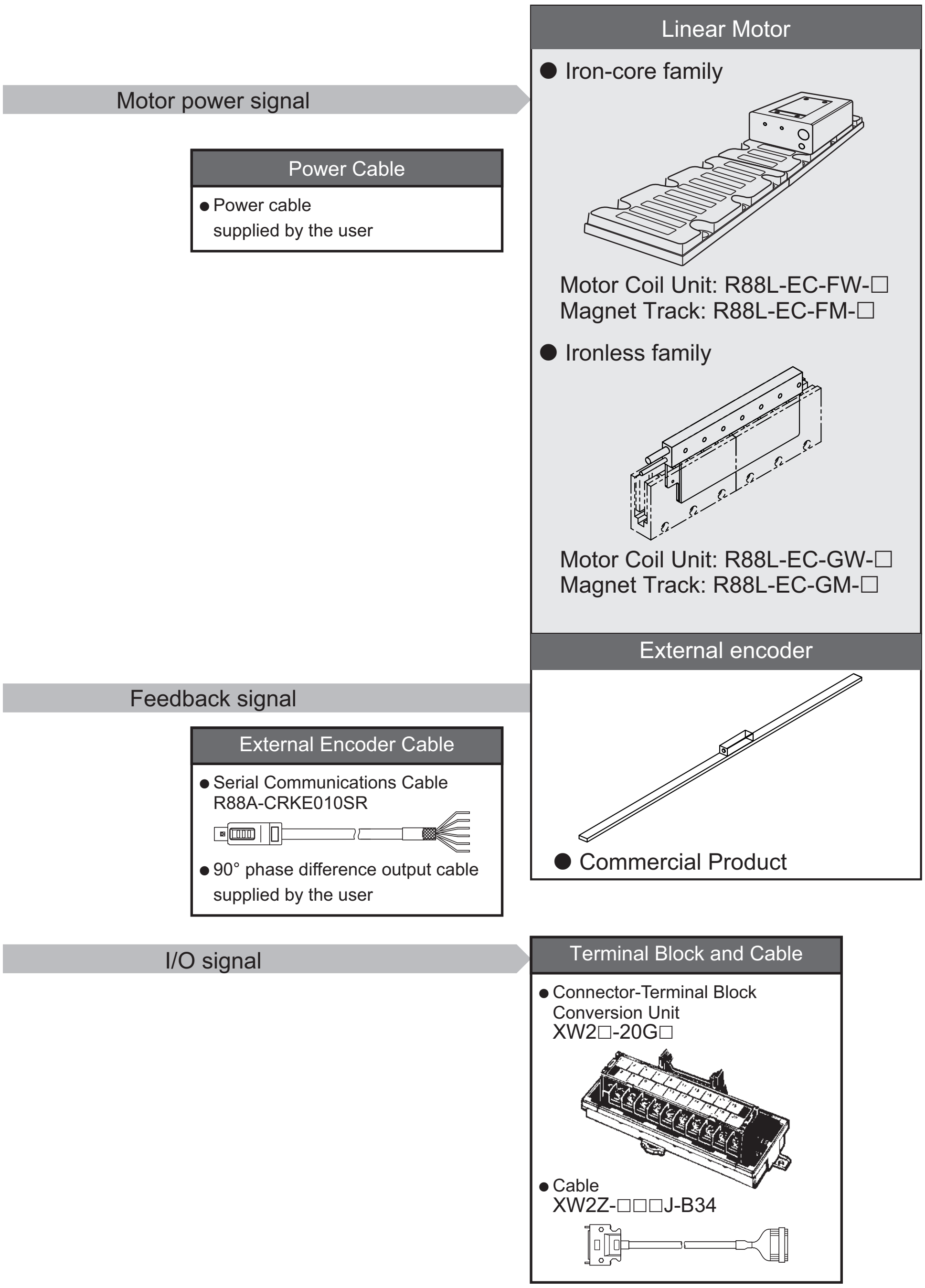
EtherCAT communications

AC Servo Drive



● G5-series Servo Drive
R88D-KN□-ECT-L

100 VAC
200 VAC
400 VAC

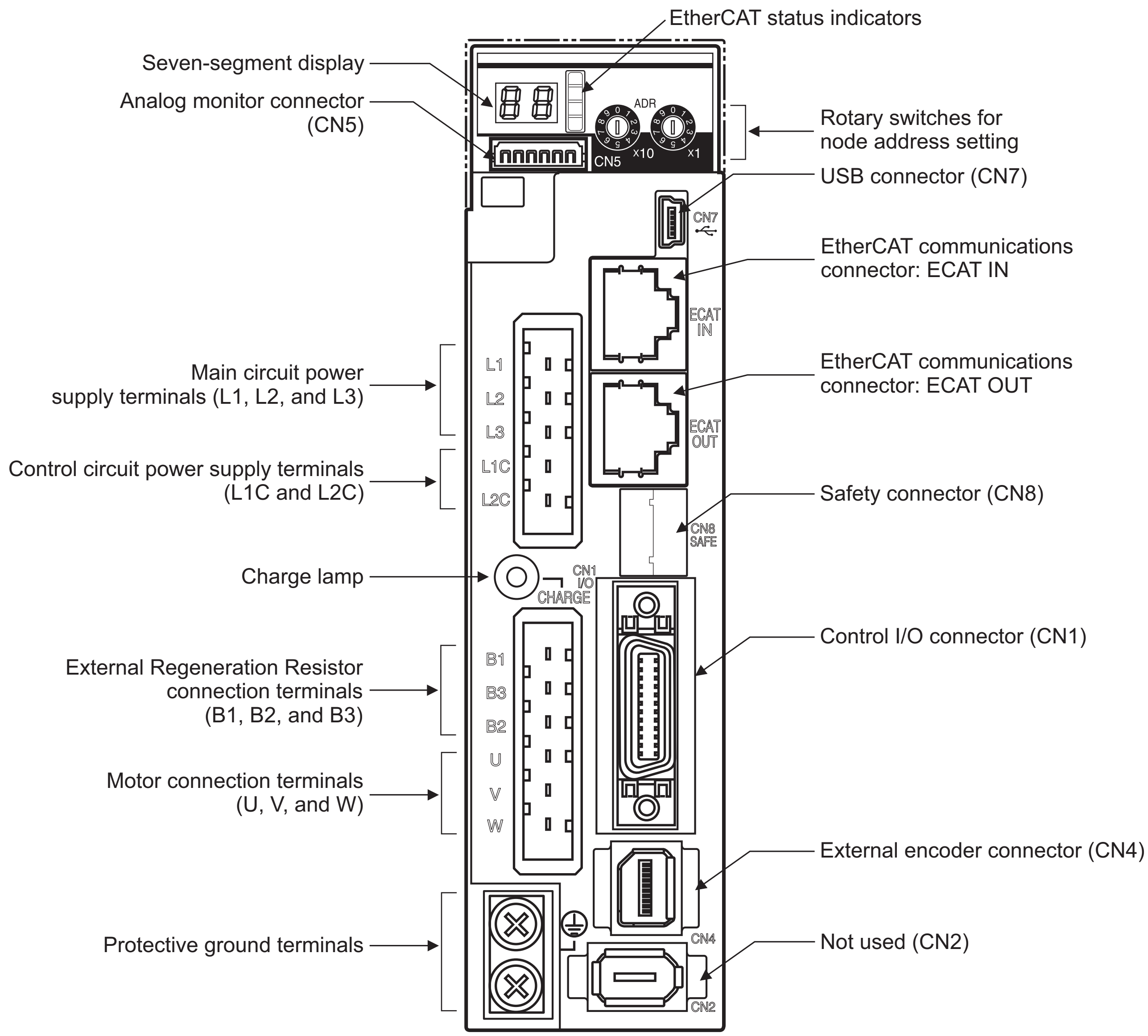

Linear Motor
● Iron-core family
Motor Coil Unit: R88L-EC-FW-☐
Magnet Track: R88L-EC-FM-☐
● Ironless family
Motor Coil Unit: R88L-EC-GW-☐
Magnet Track: R88L-EC-GM-☐
Motor power signal
Power Cable
● Power cable supplied by the user
External encoder
● Commercial Product
Feedback signal
External Encoder Cable
● Serial Communications Cable R88A-CRKE010SR
● 90° phase difference output cable supplied by the user
I/O signal
Terminal Block and Cable
● Connector-Terminal Block Conversion Unit XW2☐-20G☐
● Cable XW2Z-☐☐☐J-B34

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 *5-1-2 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)

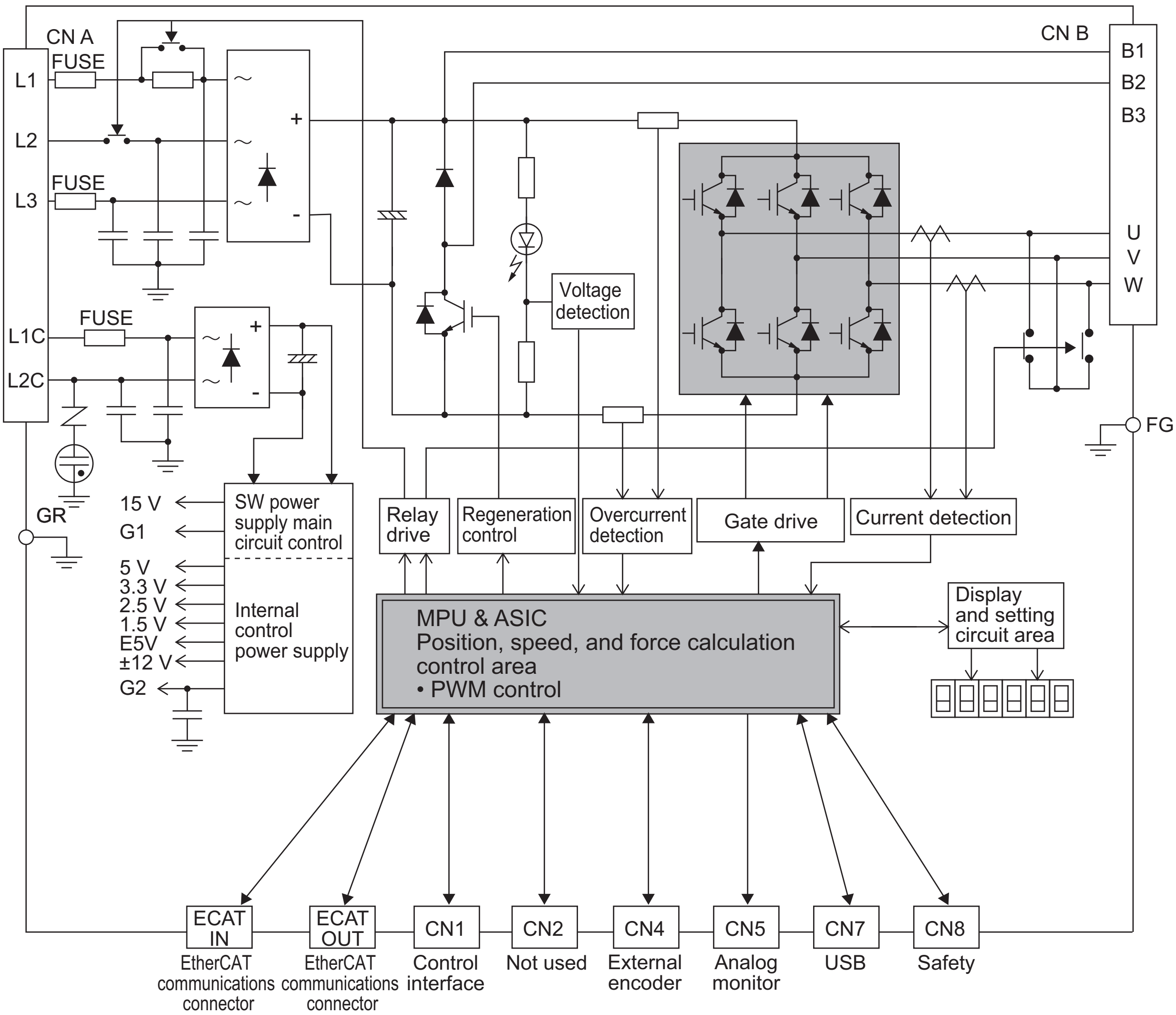
Connector for safety devices.

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

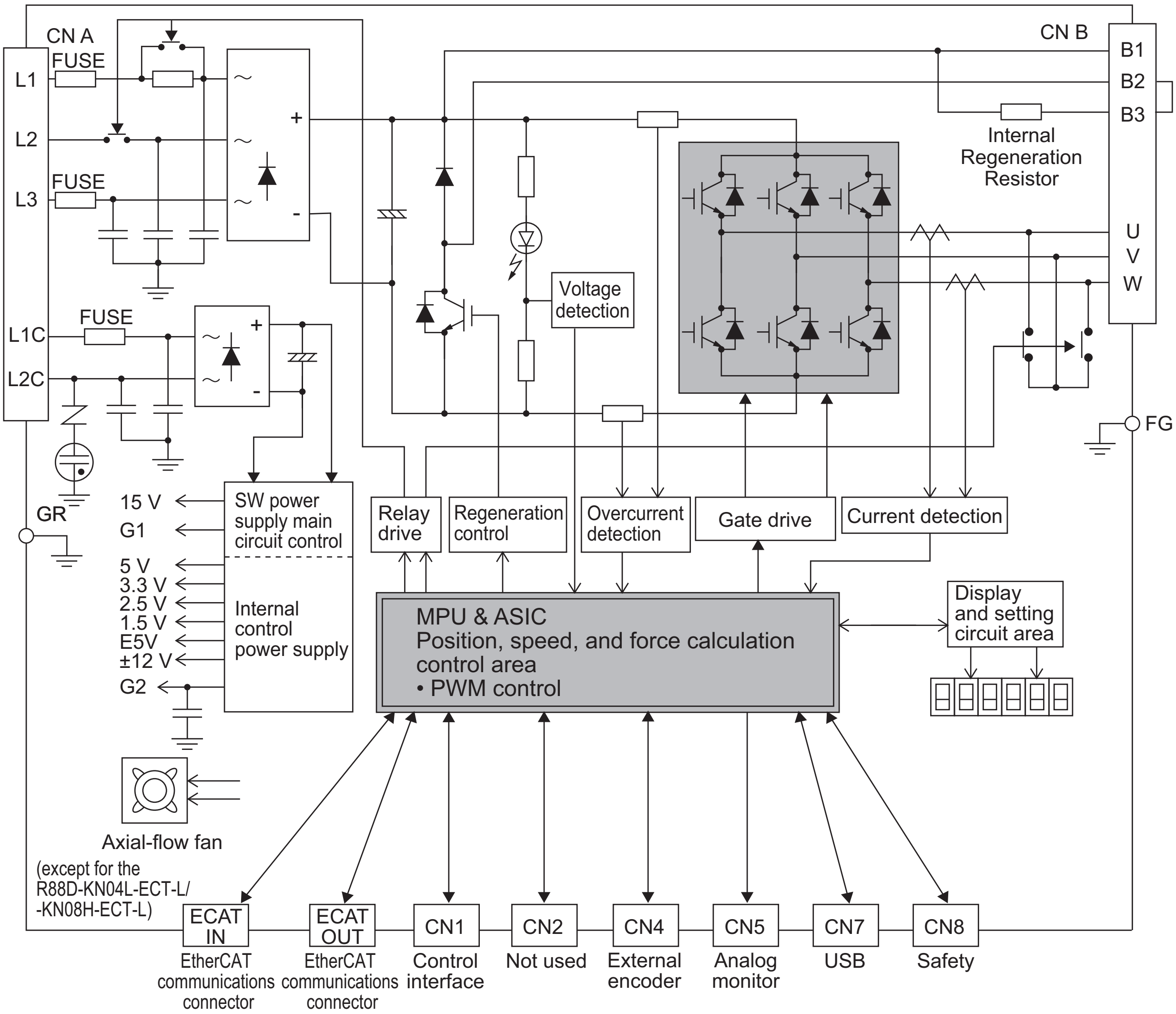
1-4 System Block Diagram

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

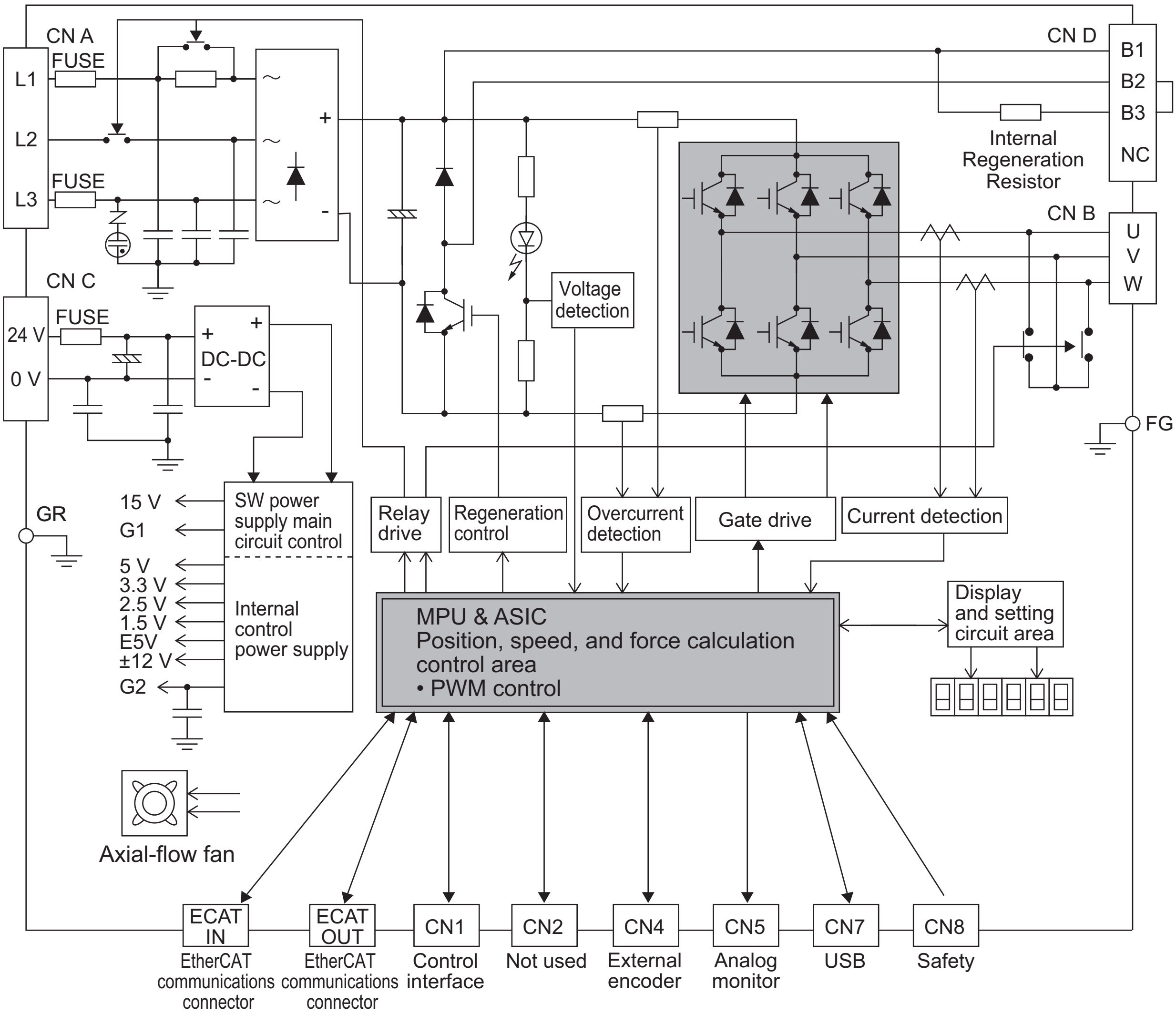
- **R88D-KN01L-ECT-L/-KN02L-ECT-L**
  R88D-KN01H-ECT-L/-KN02H-ECT-L/-KN04H-ECT-L



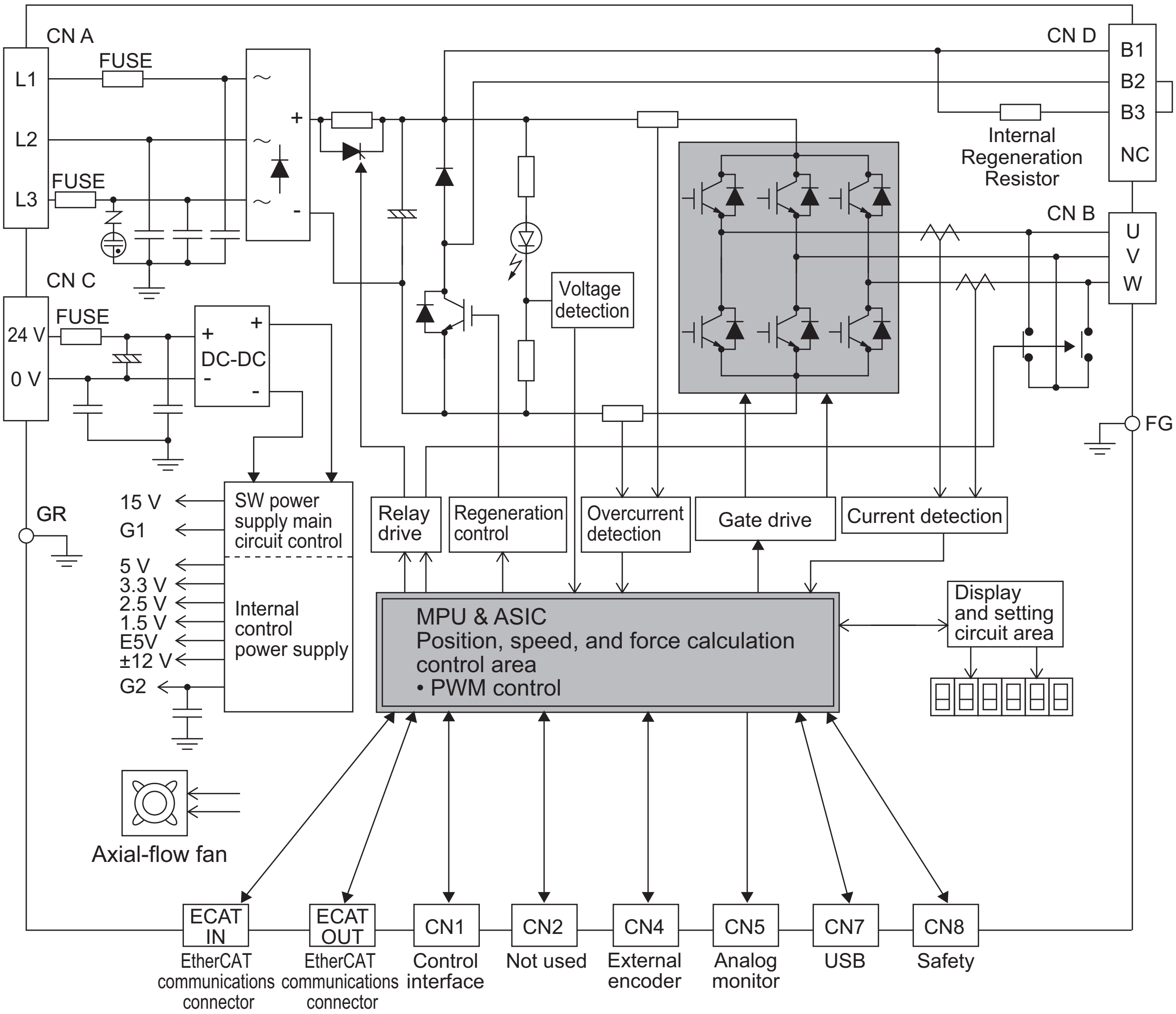
- **R88D-KN04L-ECT-L/-KN08H-ECT-L/-KN10H-ECT-L/-KN15H-ECT-L**



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



- **R88D-KN30F-ECT-L**



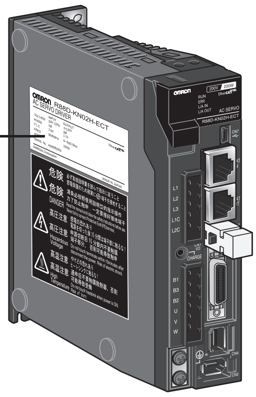
1-5 Unit Versions

The G5-series Servo Drive uses unit versions. Unit versions are used to manage differences in supported functions when product upgrades are made.

1-5-1 Confirmation Method

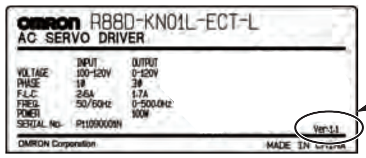
The unit version of a G5-series Servo Drive is given on the product's nameplate as shown below.

Nameplate location



(R88D-KN01L-ECT-L)

Product Nameplate



Unit Version
Here, the unit version is 1.1.

1-5-2 Unit Versions

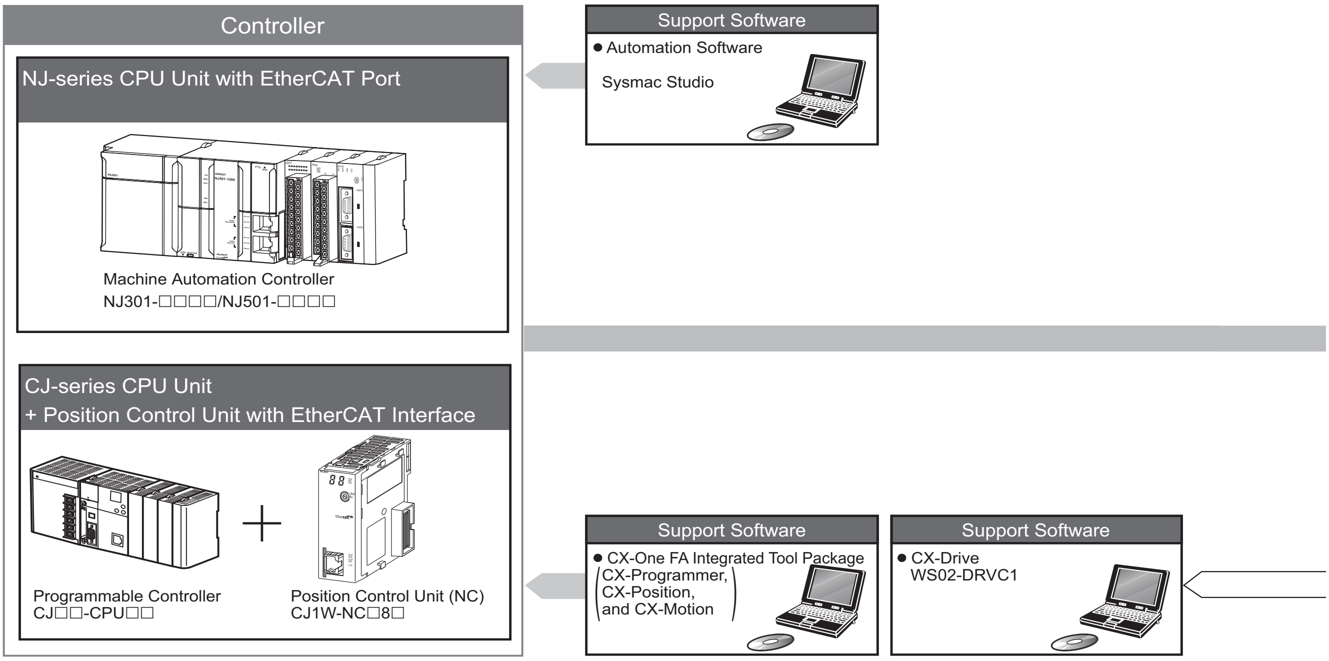
Unit version	Upgraded content	Supported CX-Drive versions
Ver. 1.0	New release	Ver. 2.70 or higher
Ver. 1.1	Added the Linear Motor Setup function.	Ver. 2.70 or higher

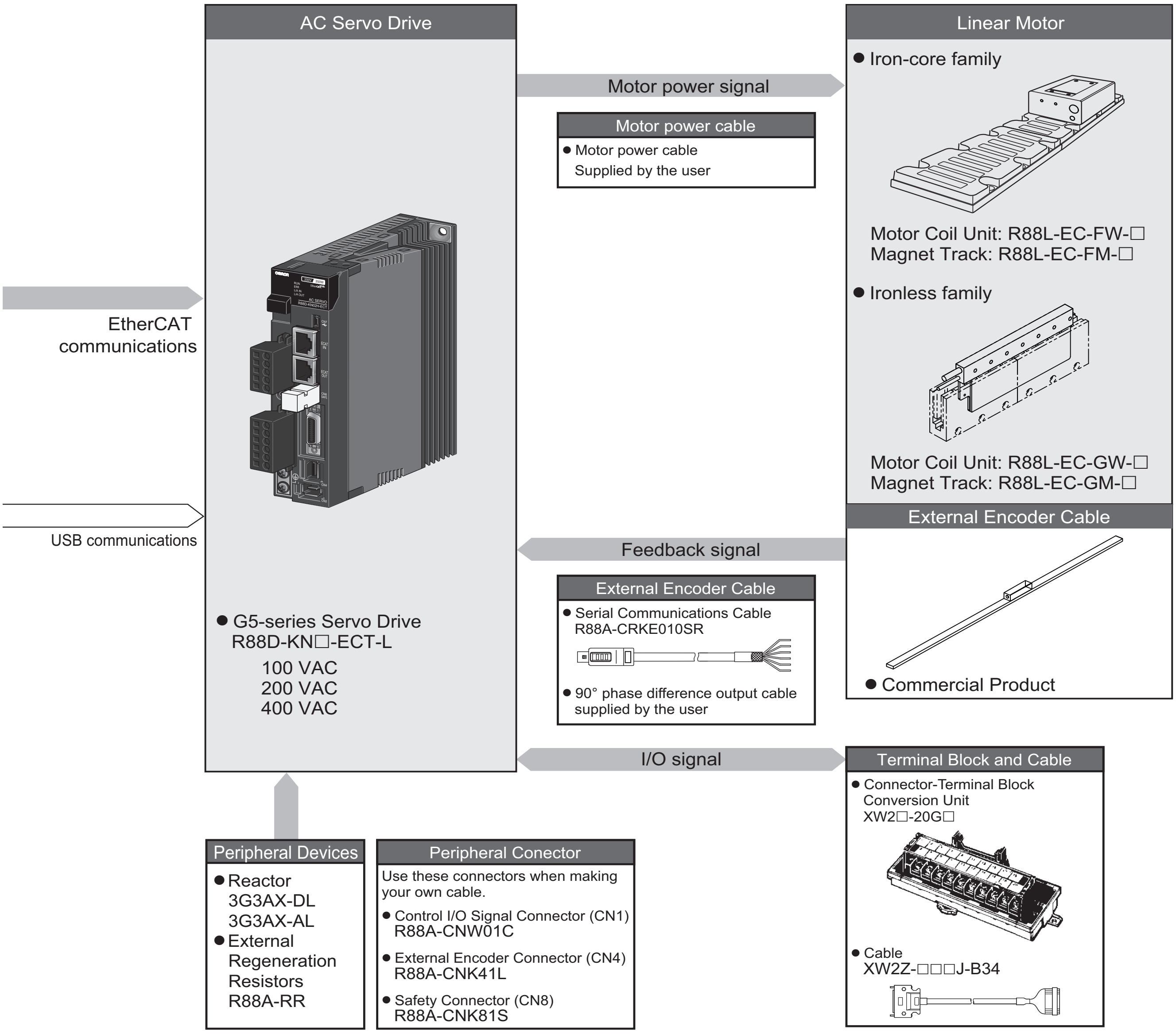
2

Models and External Dimensions

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

2-1 Servo System Configuration




AC Servo Drive
EtherCAT communications
USB communications
● G5-series Servo Drive
R88D-KN□-ECT-L
100 VAC
200 VAC
400 VAC
Motor power signal
Motor power cable
● Motor power cable
Supplied by the user
Linear Motor
● Iron-core family
Motor Coil Unit: R88L-EC-FW-□
Magnet Track: R88L-EC-FM-□
● Ironless family
Motor Coil Unit: R88L-EC-GW-□
Magnet Track: R88L-EC-GM-□
External Encoder Cable
● Commercial Product
Feedback signal
External Encoder Cable
● Serial Communications Cable
R88A-CRKE010SR
● 90° phase difference output cable
supplied by the user
I/O signal
Terminal Block and Cable
● Connector-Terminal Block
Conversion Unit
XW2□-20G□
● Cable
XW2Z-□□□J-B34
Peripheral Devices
● Reactor
3G3AX-DL
3G3AX-AL
● External
Regeneration
Resistors
R88A-RR
Peripheral Conector
Use these connectors when making your own cable.
● Control I/O Signal Connector (CN1)
R88A-CNW01C
● External Encoder Connector (CN4)
R88A-CNK41L
● Safety Connector (CN8)
R88A-CNK81S

2-2 How to Read Model Numbers

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

2-2-1 Servo Drive

The Servo Drive model number tells the Servo Drive type, 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

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

Communications Type
- ECT: EtherCAT

Motor Type
- L: Linear Motor Type

2-2-2 Linear Motor

Two models of Linear Motors are available: iron-core family and ironless family. For each of these models, the model numbers of the Motor Coil Unit and Magnet Track are defined as follows.

Iron-core family

● Motor Coil Uni

R88L-EC-FW-0303-ANPC

G5-series Linear Motor

Component Type
FW: Iron-core family Motor Coil Unit

Effective Magnet Width
03 : 30 mm
06 : 60 mm
11 : 110 mm

Coil Model
03 : 3-coil
06 : 6-coil
09 : 9-coil
12 : 12-coil
15 : 15-coil

Version
A : Ver.A

Connector
NP: Not provided

Type
C: Compact type

● Magnet Track

R88L-EC-FM-03096-A

G5-series Linear Motor

Component Type
FM: Iron-core family Magnet Track

Effective Magnet Width
03 : 30 mm
06 : 60 mm
11 : 110 mm

Magnet Track Unit Length
096 : 96 mm
144 : 144 mm
192 : 192 mm
288 : 288 mm
384 : 384 mm

Version
A : Ver.A

Ironless family

Motor Coil Unit

R88L-EC-GW-0303-ANPS

- G5-series Linear Motor: R88L-EC
- Component Type: GW
  - GW: Ironless family Motor Coil Unit
- Effective Magnet Width: 03
  - 03 : 30 mm
  - 05 : 50 mm
  - 07 : 70 mm
- Coil Model: 03
  - 03 : 3-coil
  - 06 : 6-coil
  - 09 : 9-coil
- Version: A
  - A : Ver.A
- Connector: NP
  - NP: Not provided
- Type: S
  - S: Standard type

Magnet Track

R88L-EC-GM-03090-A

- G5-series Linear Motor: R88L-EC
- Component Type: GM
  - GM: Ironless family Magnet Track
- Effective Magnet Width: 03
  - 03 : 30 mm
  - 05 : 50 mm
  - 07 : 70 mm
- Magnet Track Unit Length: 090
  - 090 : 90 mm
  - 114 : 114 mm
  - 120 : 120 mm
  - 126 : 126 mm
  - 168 : 168 mm
  - 171 : 171 mm
  - 210 : 210 mm
  - 390 : 390 mm
  - 456 : 456 mm
  - 546 : 546 mm
- Version: A
  - A : Ver.A

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 shows 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 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

2-3-2 Linear Motor Model Table

The table below shows the Linear Motor models.

Iron-core Linear Motors

Motor Coil Unit model	Continuous force*1 [N]	Momentary maximum force [N]	Magnet Track model
R88L-EC-FW-0303-ANPC	48	105	R88L-EC-FM-03096-A R88L-EC-FM-03144-A R88L-EC-FM-03384-A
R88L-EC-FW-0306-ANPC	96	210	
R88L-EC-FW-0606-ANPC	160	400	R88L-EC-FM-06192-A R88L-EC-FM-06288-A
R88L-EC-FW-0609-ANPC	240	600	
R88L-EC-FW-0612-ANPC	320	800	
R88L-EC-FW-1112-ANPC	608	1,600	R88L-EC-FM-11192-A R88L-EC-FM-11288-A
R88L-EC-FW-1115-ANPC	760	2,000	

*1 The continuous force is subject to temperature conditions. For details, refer to *3-3-2 Performance Specifications of Iron-core Linear Motors* on page 3-29.

Ironless Linear Motors

Motor Coil Unit model	Continuous force*1 [N]	Momentary maximum force [N]	Magnet Track model
R88L-EC-GW-0303-ANPS	26.5	100	R88L-EC-GM-03090-A R88L-EC-GM-03120-A R88L-EC-GM-03390-A
R88L-EC-GW-0306-ANPS	53	200	
R88L-EC-GW-0309-ANPS	80	300	
R88L-EC-GW-0503-ANPS	58	240	R88L-EC-GM-05126-A R88L-EC-GM-05168-A R88L-EC-GM-05210-A R88L-EC-GM-05546-A
R88L-EC-GW-0506-ANPS	117	480	
R88L-EC-GW-0509-ANPS	175	720	
R88L-EC-GW-0703-ANPS	117	552	R88L-EC-GM-07114-A R88L-EC-GM-07171-A R88L-EC-GM-07456-A
R88L-EC-GW-0706-ANPS	232	1,110	
R88L-EC-GW-0709-ANPS	348	1,730	

*1 The continuous force is subject to temperature conditions. For details, refer to *3-3-6 Performance Specifications of Ironless Linear Motors* on page 3-36.

2-3-3 Servo Drive and Linear Motor Combination Tables

The following table shows appropriate combinations with G5-series AC Servo Drives and Linear Motors.

Iron-core family

Motor Coil Unit model	Voltage [V]	Servo Drive model	Maximum speed [m/s]
R88L-EC-FW-0303-ANPC	100	R88D-KN01L-ECT-L	2.5
	200	R88D-KN02H-ECT-L	5
	400	R88D-KN06F-ECT-L	10
R88L-EC-FW-0306-ANPC	100	R88D-KN02L-ECT-L	2.5
	200	R88D-KN04H-ECT-L	5
	400	R88D-KN10F-ECT-L	10
R88L-EC-FW-0606-ANPC	100	R88D-KN04L-ECT-L	2
	200	R88D-KN08H-ECT-L	4
	400	R88D-KN15F-ECT-L	8
R88L-EC-FW-0609-ANPC	200	R88D-KN10H-ECT-L	4
	400	R88D-KN20F-ECT-L	8
R88L-EC-FW-0612-ANPC	200	R88D-KN15H-ECT-L	4
	400	R88D-KN30F-ECT-L	8
R88L-EC-FW-1112-ANPC	200	R88D-KN15H-ECT-L	2
	400	R88D-KN30F-ECT-L	4
R88L-EC-FW-1115-ANPC	200	R88D-KN15H-ECT-L	2
	400	R88D-KN30F-ECT-L	4

Note The maximum operation speed is restricted by the guide mechanism, encoder, and other aspects. If it is 5 m/s or higher, please consult with your OMRON representative.

Ironless family

Motor Coil Unit model	Voltage [V]	Servo Drive model	Maximum speed [m/s]
R88L-EC-GW-0303-ANPC	100	R88D-KN01L-ECT-L	8
	200	R88D-KN02H-ECT-L	16
R88L-EC-GW-0306-ANPC	100	R88D-KN04L-ECT-L	8
	200	R88D-KN08H-ECT-L	16
R88L-EC-GW-0309-ANPC	200	R88D-KN10H-ECT-L	16
R88L-EC-GW-0503-ANPC	100	R88D-KN01L-ECT-L	2.2
	200	R88D-KN01H-ECT-L	4.4
R88L-EC-GW-0506-ANPC	100	R88D-KN02L-ECT-L	2.2
	200	R88D-KN04H-ECT-L	4.4
R88L-EC-GW-0509-ANPC	100	R88D-KN04L-ECT-L	2.2
	200	R88D-KN08H-ECT-L	4.4
R88L-EC-GW-0703-ANPC	100	R88D-KN02L-ECT-L	1.2
	200	R88D-KN04H-ECT-L	2.4
R88L-EC-GW-0706-ANPC	100	R88D-KN04L-ECT-L	1.2
	200	R88D-KN08H-ECT-L	2.4
R88L-EC-GW-0709-ANPC	200	R88D-KN10H-ECT-L	2.4

Note The maximum operation speed is restricted by the guide mechanism, encoder, and other aspects. If it is 5 m/s or higher, please consult with your OMRON representative.

2-3-4 Cable and Peripheral Device Model Tables

The following tables show 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 x 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	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 Blocks	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: 180 W, 20 Ω (with 200°C thermal sensor)	R88A-RR50020S

Reactor

Applicable Servo Drives		Reactor type
Model	Number of power phases	
R88D-KN01L-ECT-L	Single-phase input	3G3AX-DL2004
R88D-KN02H-ECT-L		3G3AX-DL2007
R88D-KN04L-ECT-L		3G3AX-DL2015
R88D-KN01H-ECT-L	Single-phase input	3G3AX-DL2002
	3-phase input	3G3AX-AL2025
R88D-KN02H-ECT-L	Single-phase input	3G3AX-DL2004
	3-phase input	3G3AX-AL2025
R88D-KN04H-ECT-L	Single-phase input	3G3AX-DL2007
	3-phase input	3G3AX-AL2025
R88D-KN08H-ECT-L	Single-phase input	3G3AX-DL2015
	3-phase input	3G3AX-AL2025
R88D-KN10H-ECT-L	Single-phase input	3G3AX-DL2015
	3-phase input	3G3AX-AL2025
R88D-KN15H-ECT-L	Single-phase input	3G3AX-DL2022
	3-phase input	3G3AX-AL2025
R88D-KN06F-ECT-L	3-phase input	3G3AX-AL4025
R88D-KN10F-ECT-L		
R88D-KN15F-ECT-L		
R88D-KN20F-ECT-L		3G3AX-AL4055
R88D-KN30F-ECT-L		

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

Note Servo Drives with 2 kW or greater includes a mounting bracket. Use it when installing the Servo Drive using front mounting.

2-4 External and Mounting Dimensions

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

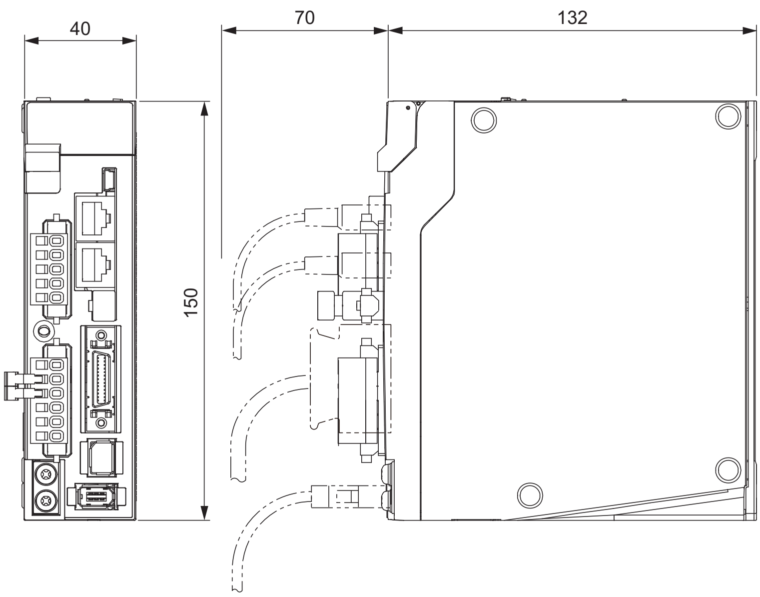
2-4-1 Servo Drive Dimensions

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

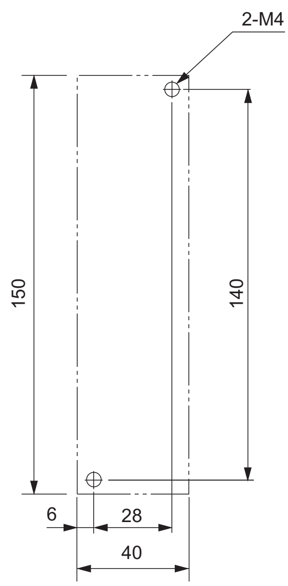
Single-phase 100 VAC: R88D-KN01L-ECT-L (100 W)
Single-phase/3-phase 100 VAC: R88D-KN01H-ECT-L/-KN02H-ECT-L (100 to 200 W)

- **Wall Mounting**

External dimensions

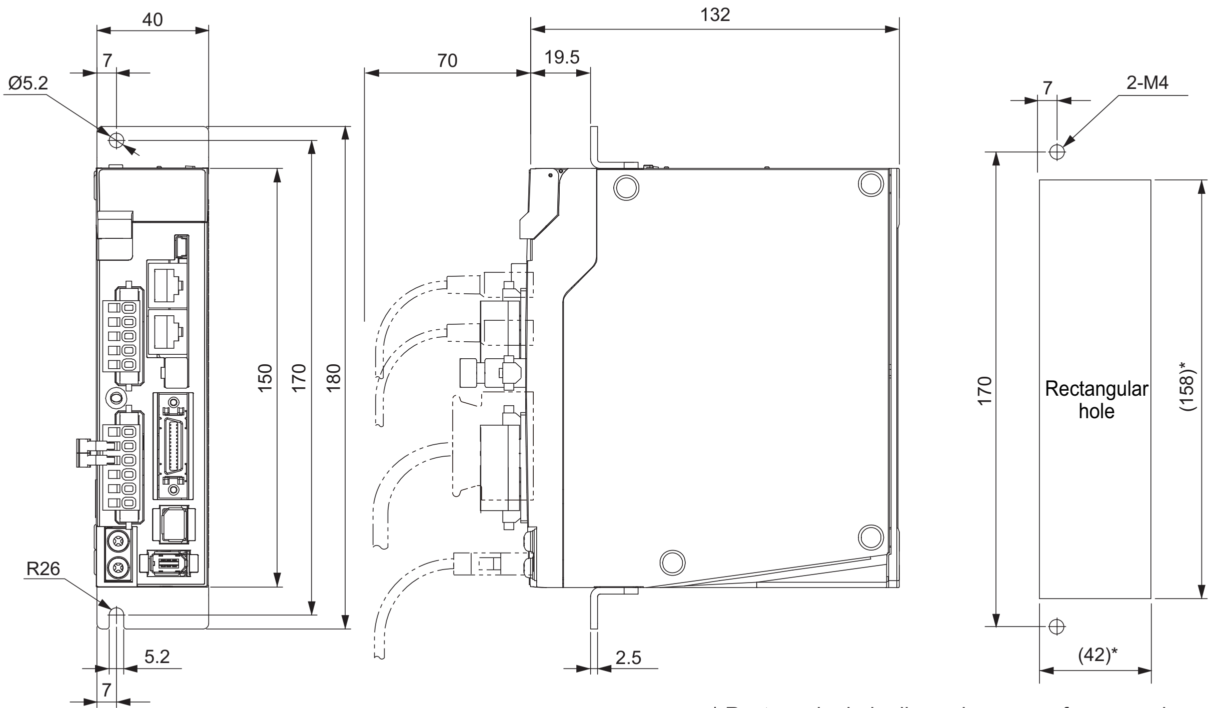


Mounting dimensions



- **Front Mounting (Using Front Mounting Brackets)**

External dimensions **Mounting dimensions**

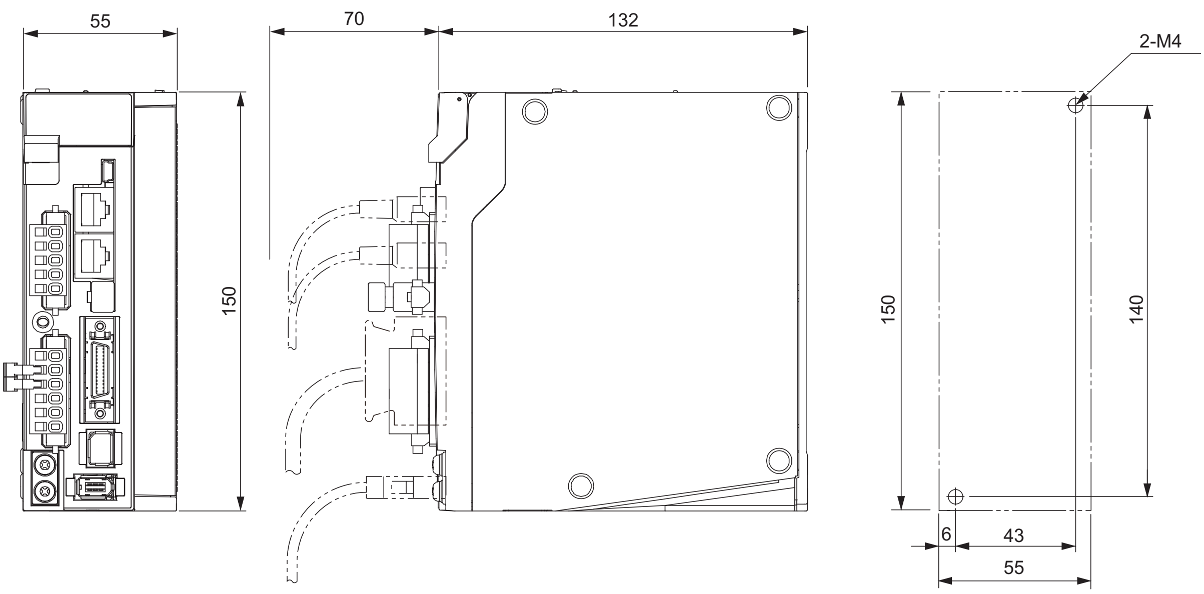


* Rectangular hole dimensions are reference values.

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

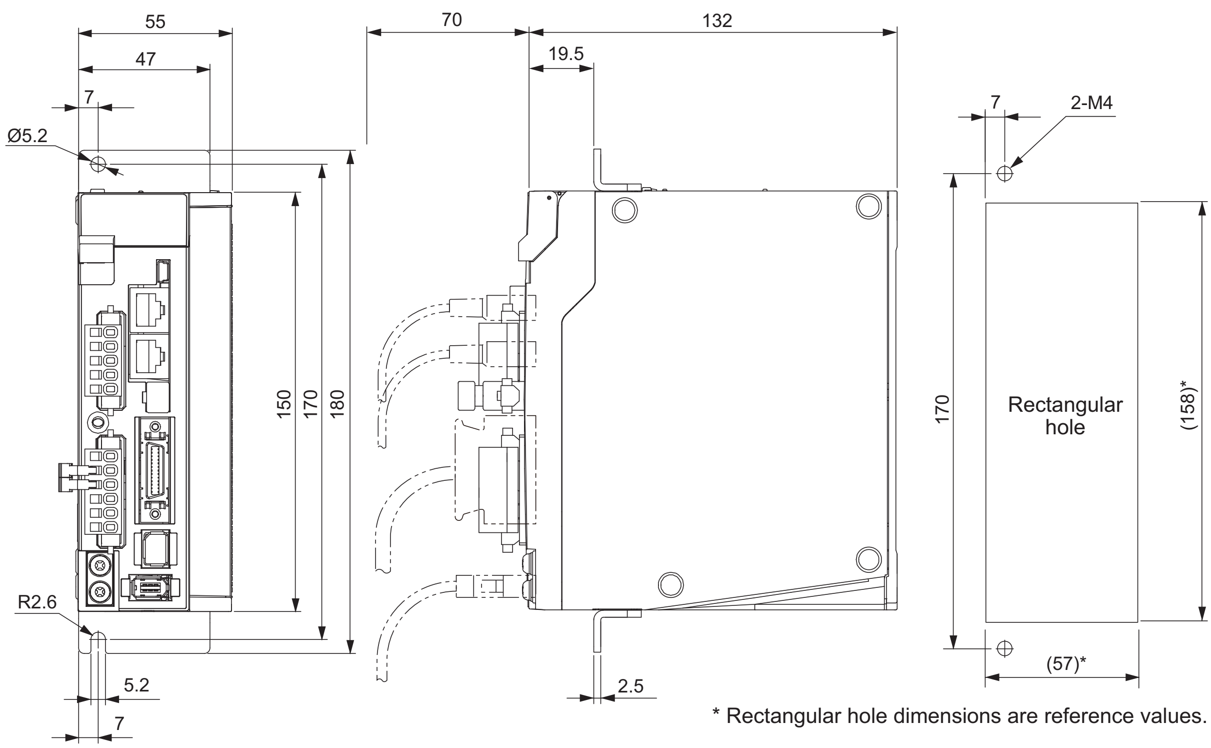
- **Wall Mounting**

External dimensions **Mounting dimensions**



- **Front Mounting (Using Front Mounting Brackets)**

External dimensions **Mounting dimensions**

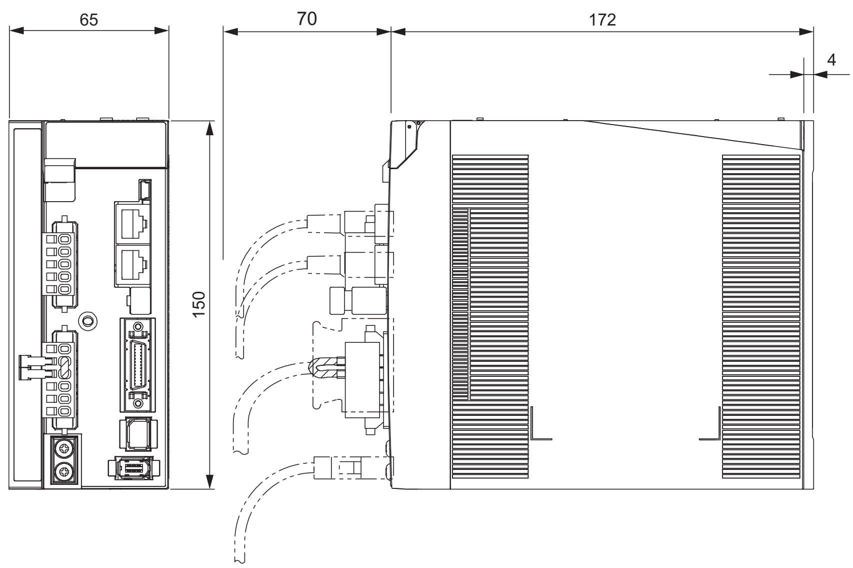


* Rectangular hole dimensions are reference values.

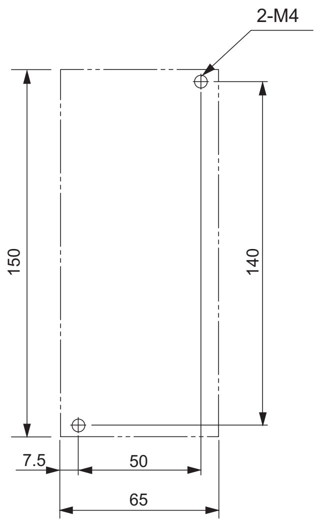
Single-phase 100 VAC: R88D-KN04L-ECT-L (400 W) Single-phase/3-phase 200 VAC: R88D-KN08H-ECT-L (750 W)

- **Wall Mounting**

External dimensions

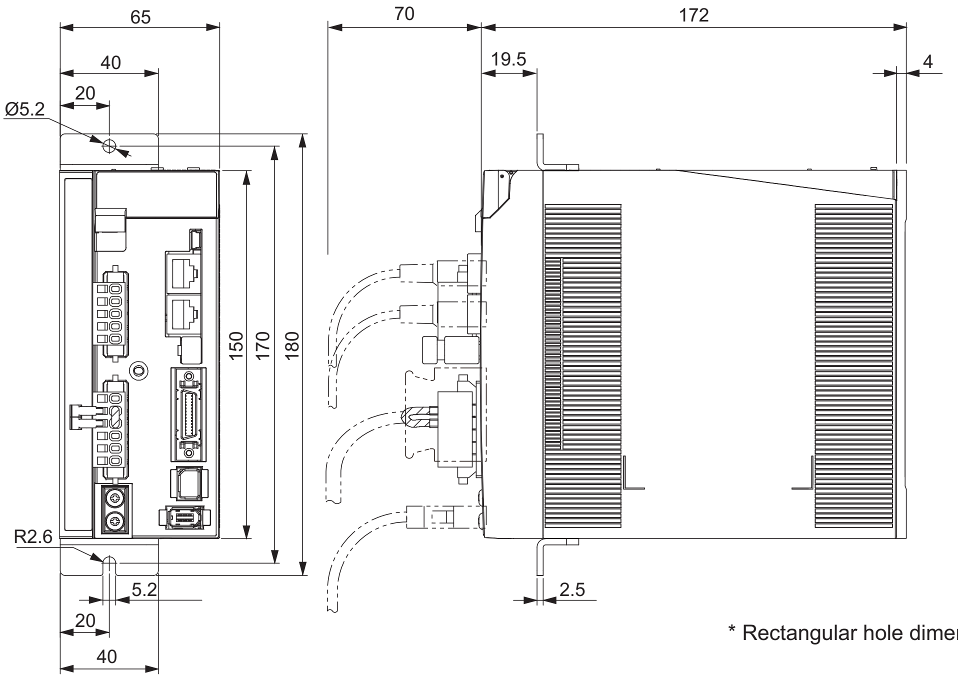


Mounting dimensions

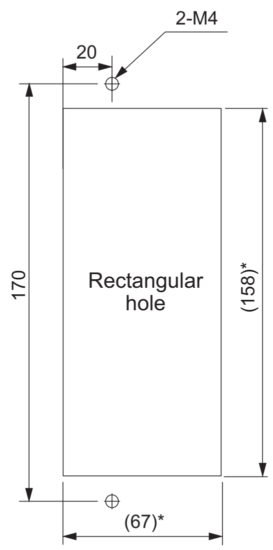


- **Front Mounting (Using Front Mounting Brackets)**

External dimensions



Mounting dimensions

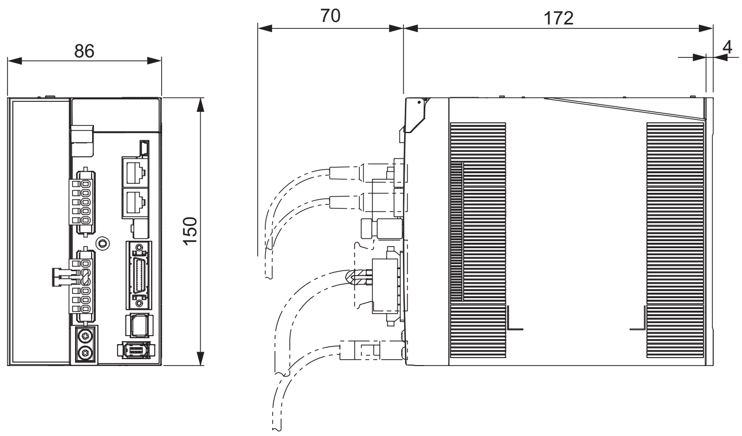


* Rectangular hole dimensions are reference values.

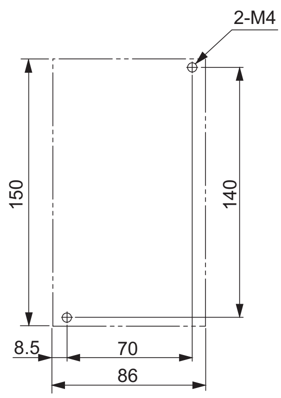
Single-phase/3-phase 200 VAC: R88D-KN10H-ECT-L/-KN15H-ECT-L (1 to 1.5 kW)

- **Wall Mounting**

External dimensions

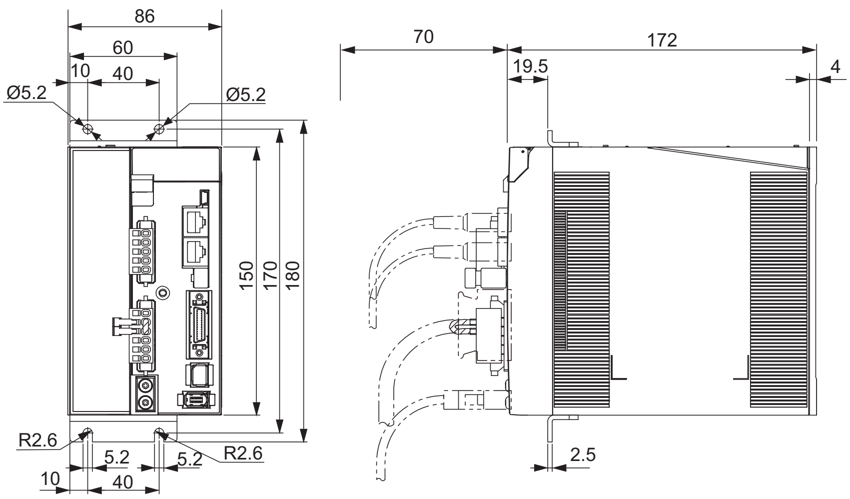


Mounting dimensions

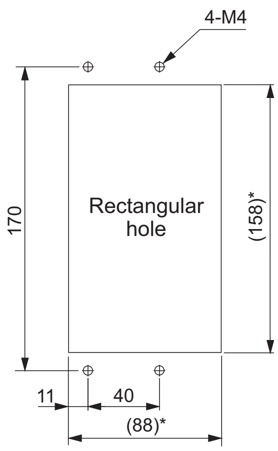


- **Front Mounting (Using Front Mounting Brackets)**

External dimensions



Mounting dimensions

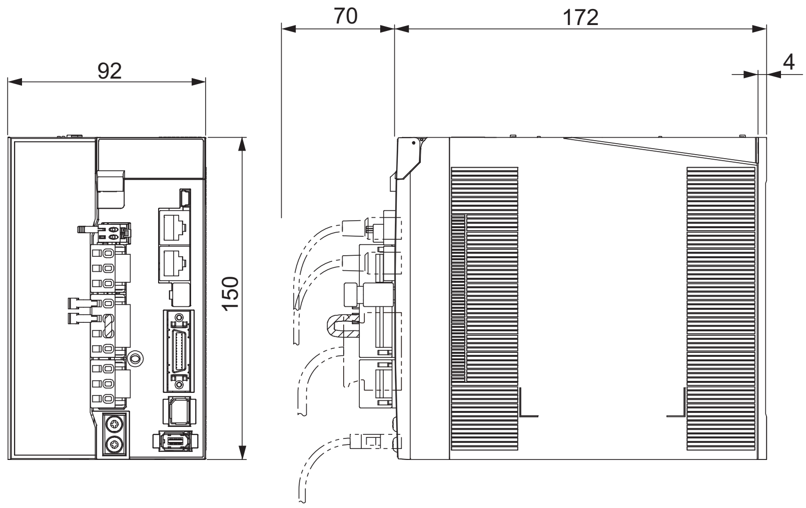


* Rectangular hole dimensions are reference values.

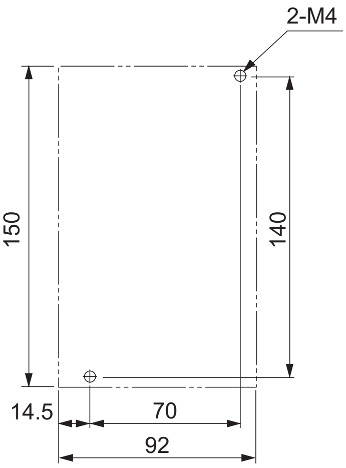
3-phase 400 VAC: R88D-KN06F-ECT-L/-KN10F-ECT-L/ -KN15F-ECT-L (600 W to 1.5 kW)

- **Wall Mounting**

External dimensions

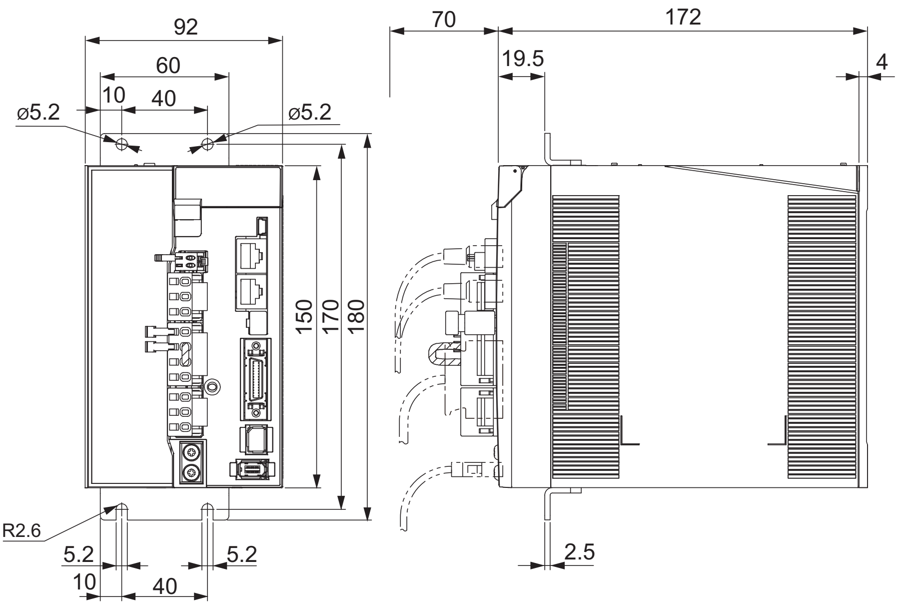


Mounting dimensions

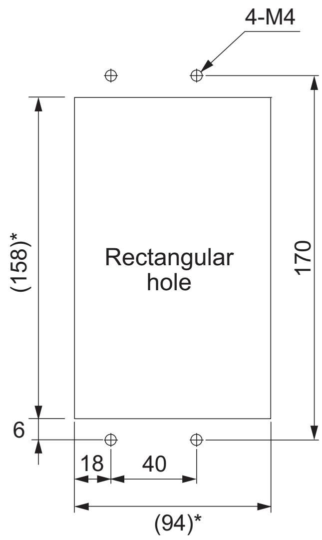


- **Front Mounting (Using Front Mounting Brackets)**

External dimensions



Mounting dimensions

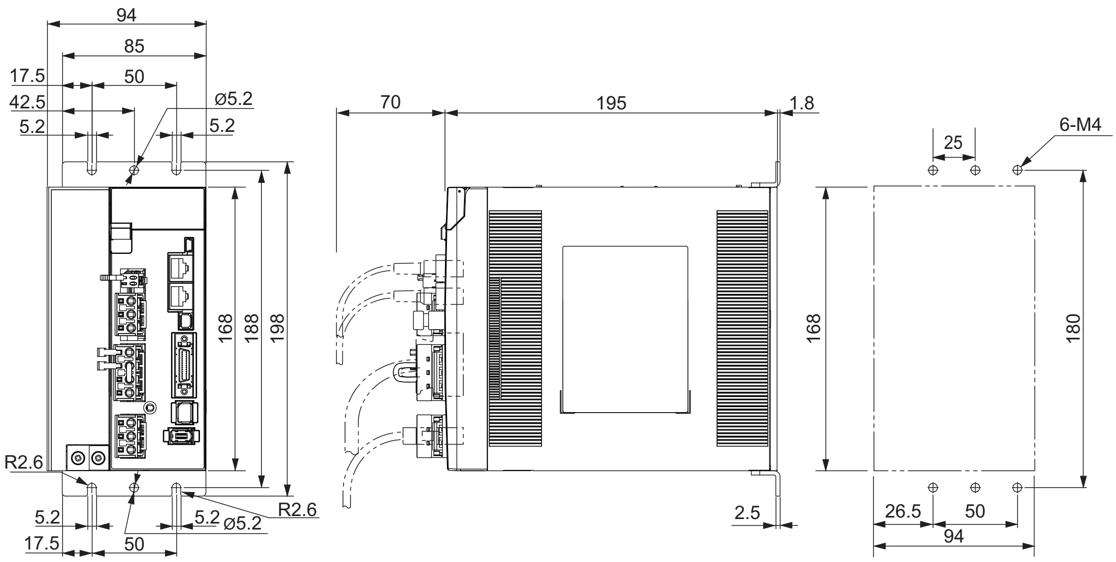


* Rectangular hole dimensions are reference values.

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

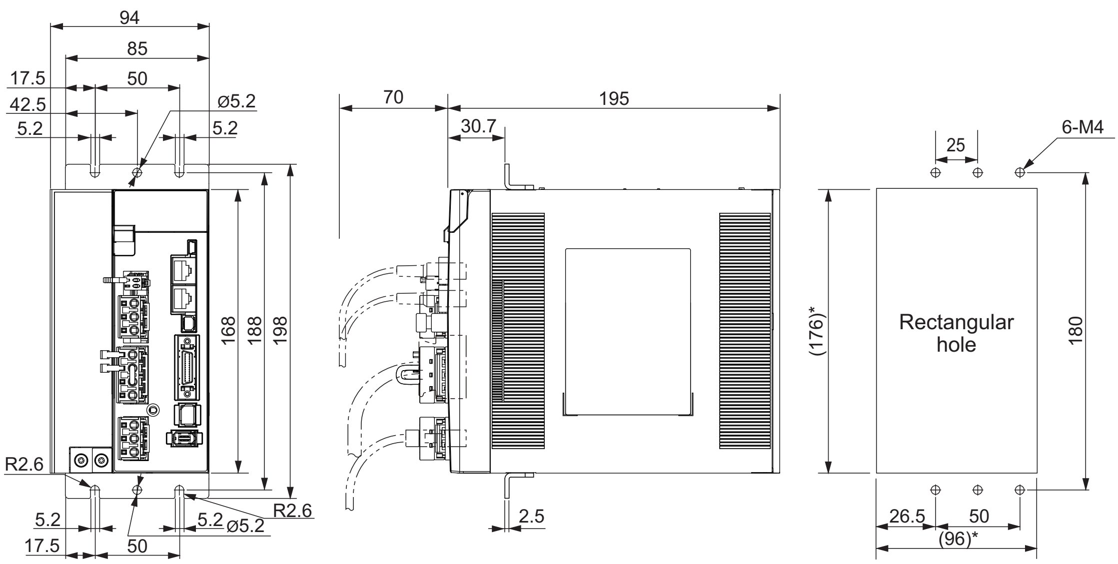
- **Wall Mounting**

External dimensions **Mounting dimensions**



- **Front Mounting (Using Front Mounting Brackets)**

External dimensions **Mounting dimensions**

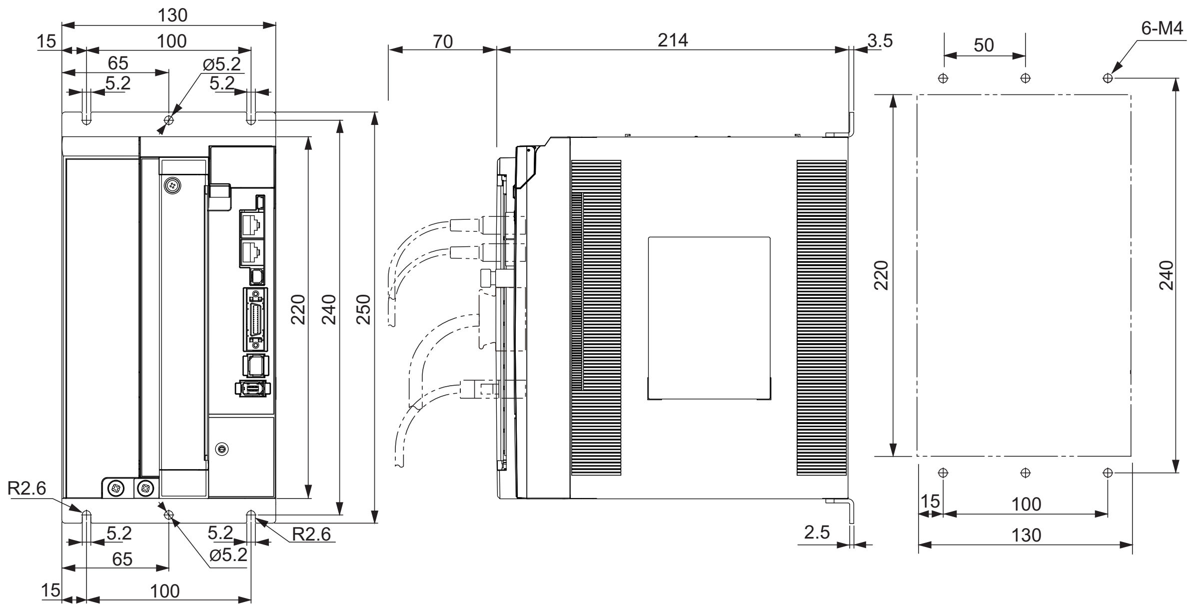


* Rectangular hole dimensions are reference values.

3-phase 400 VAC: R88D-KN30F-ECT-L (3 kW)

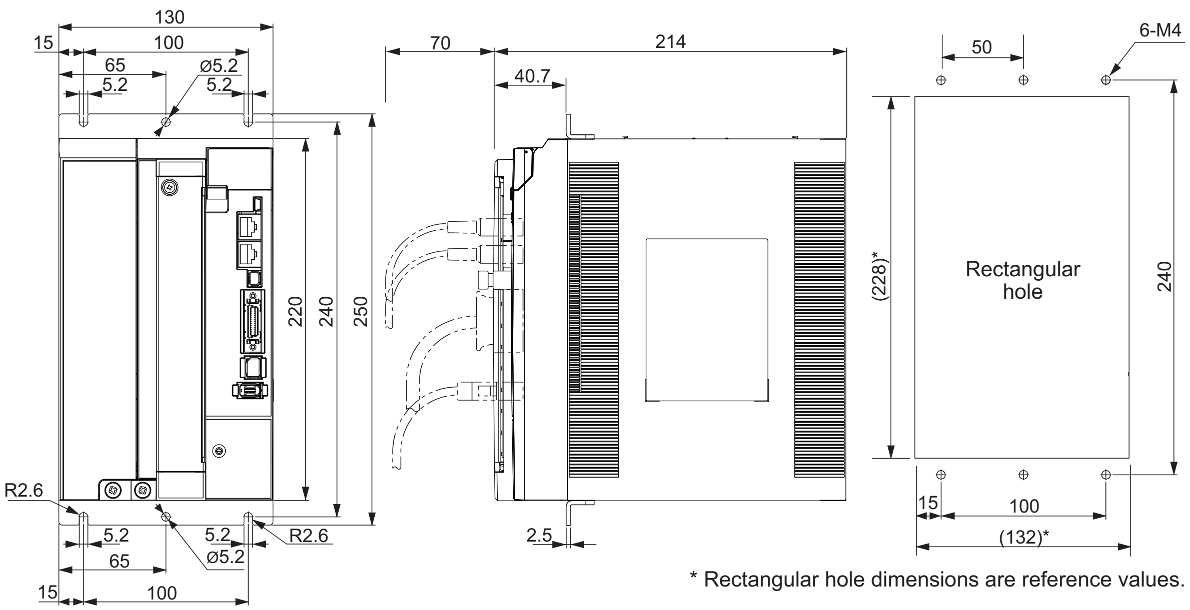
- **Wall Mounting**

External dimensions **Mounting dimensions**



- **Front Mounting (Using Front Mounting Brackets)**

External dimensions **Mounting dimensions**



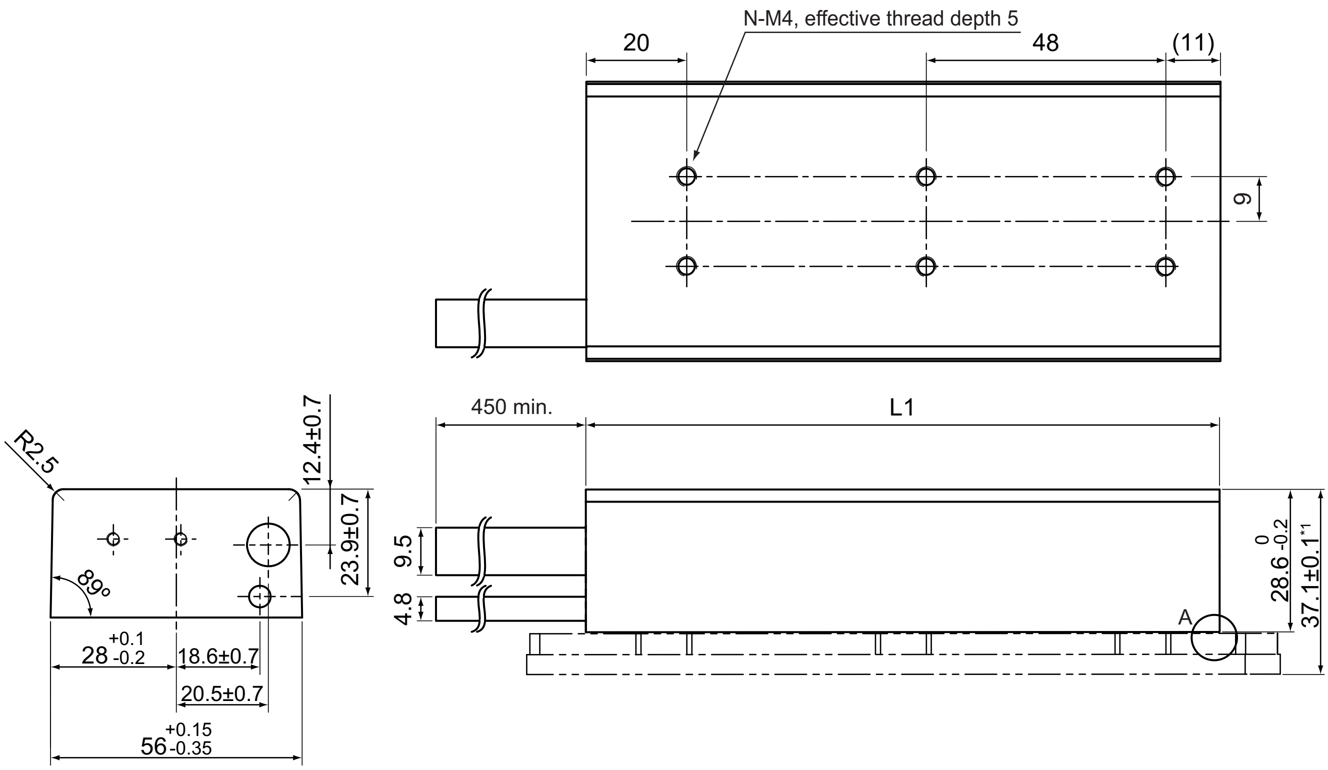
* Rectangular hole dimensions are reference values.

2-4-2 Linear Motor Dimensions

Iron-core Motors

- **R88L-EC-FW-0303/-0306**

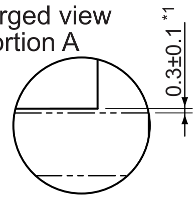
Motor Coil Unit



*1 These values indicate mounting dimensions.

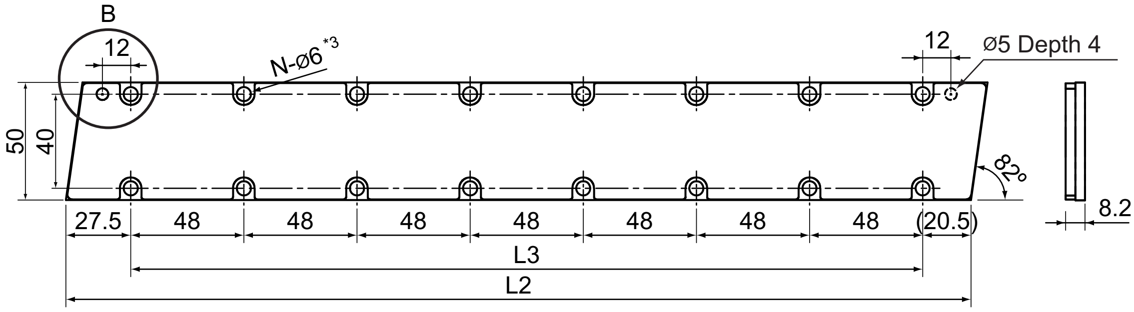
Model	L1 [mm]	Number of holes [N]	Mass*2 [kg]
R88L-EC-FW-0303	79 +0.15/–0.35	4	0.72
R88L-EC-FW-0306	127 +0.15/–0.35	6	1.03

Enlarged view of portion A



*2 The weight of a 450-mm cable is included.

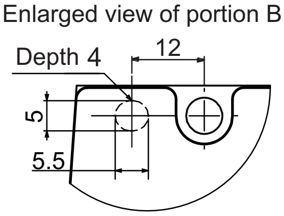
Magnet Track



*3 Use M5 low head allen head bolts.

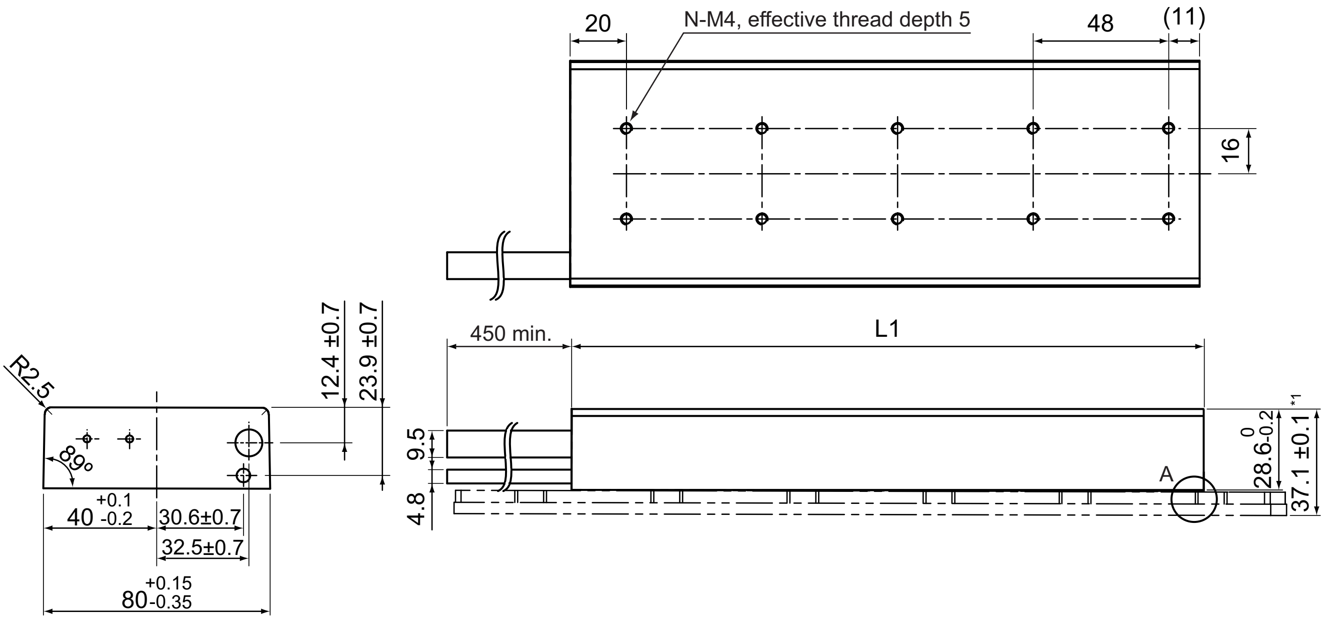
Model	L2 [mm]	L3 [mm]	Number of holes [N]	Mass [kg]
R88L-EC-FM-03096-A	96	48	4	Approx. 0.22
R88L-EC-FM-03144-A	144	96	6	Approx. 0.32
R88L-EC-FM-03384-A	384	336	16	Approx. 0.85

Enlarged view of portion B



- **R88L-EC-FW-0606/-0609/-0612**

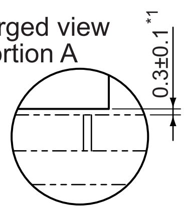
Motor Coil Unit



*1 These values indicate mounting dimensions.

Model	L1 [mm]	Number of holes [N]	Mass*2 [kg]
R88L-EC-FW-0606	127 +0.15/–0.35	6	1.59
R88L-EC-FW-0609	175 +0.15/–0.35	8	2.15
R88L-EC-FW-0612	223 +0.15/–0.35	10	2.7

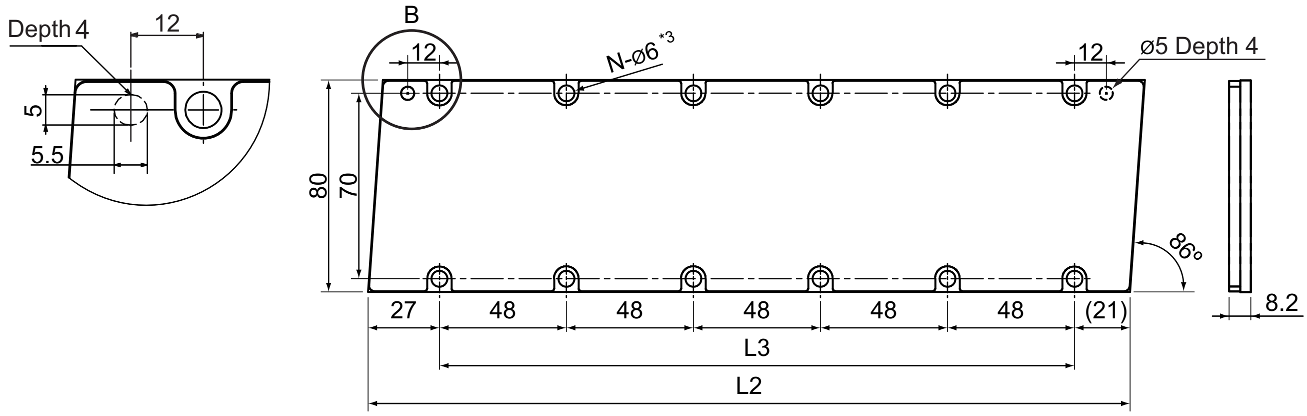
Enlarged view of portion A



*2 The weight of a 450-mm cable is included.

Magnet Track

Enlarged view of portion B

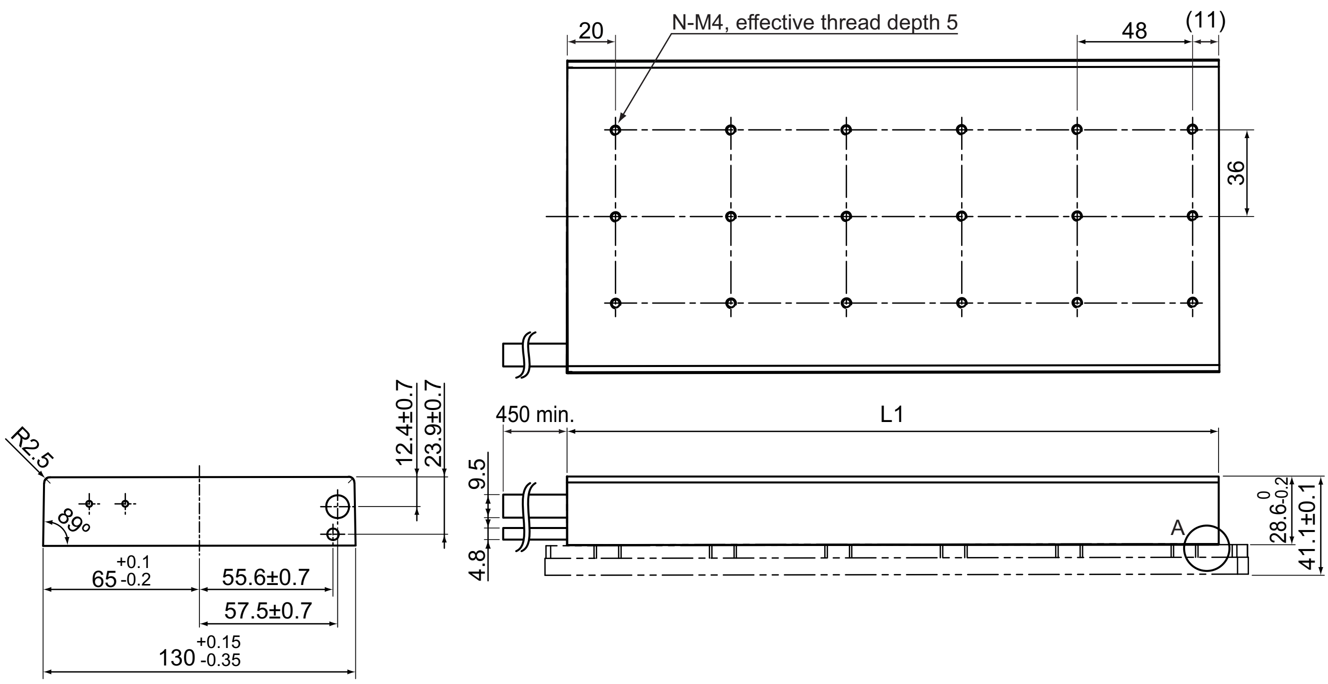


*3 Use M5 low head allen head bolts.

Model	L2 [mm]	L3 [mm]	Number of holes [N]	Mass [kg]
R88L-EC-FM-06192-A	192	144	8	Approx. 0.77
R88L-EC-FM-06288-A	288	240	12	Approx. 1.15

- **R88L-EC-FW-1112/-1115**

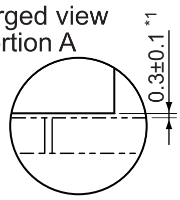
Motor Coil Unit



*1 These values indicate mounting dimensions.

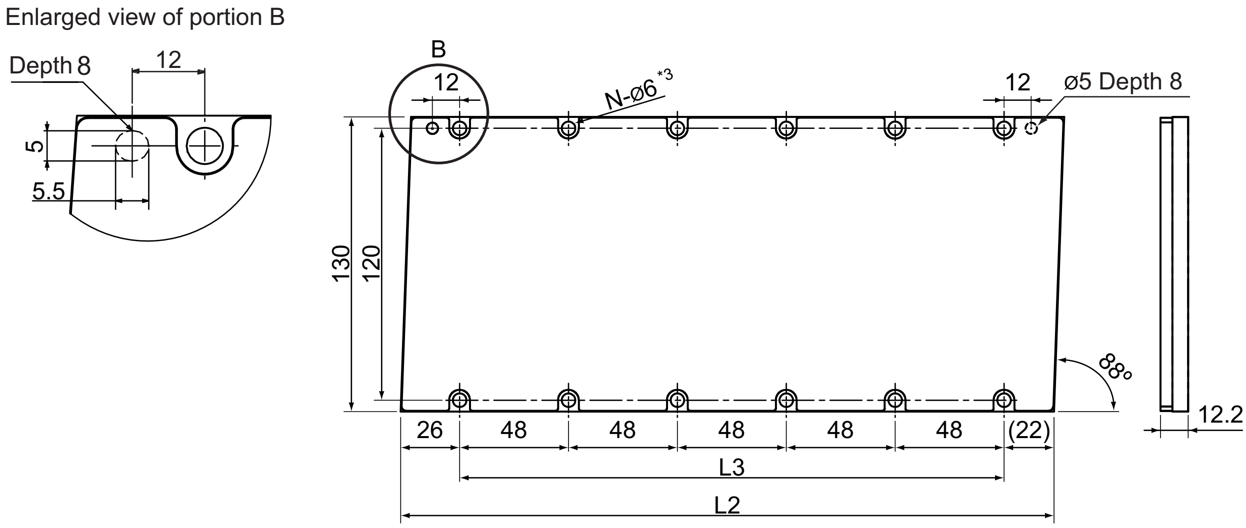
Model	L1 [mm]	Number of holes [N]	Mass*2 [kg]
R88L-EC-FW-1112	223 +0.15/–0.35	15	4.89
R88L-EC-FW-1115	271 +0.15/–0.35	18	5.94

Enlarged view of portion A



*2 The weight of a 450-mm cable is included.

Magnet Track



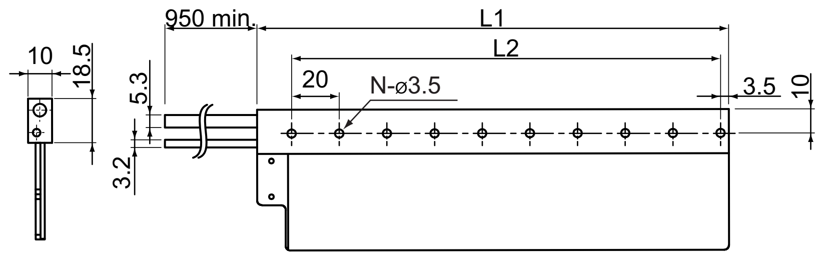
*3 Use M5 low head allen head bolts.

Model	L2 [mm]	L3 [mm]	Number of holes [N]	Mass [kg]
R88L-EC-FM-11192-A	192	144	8	Approx. 2.12
R88L-EC-FM-11288-A	288	240	12	Approx. 3.18

Ironless Motors

- **R88L-EC-GW-0303/-0306/-0309**

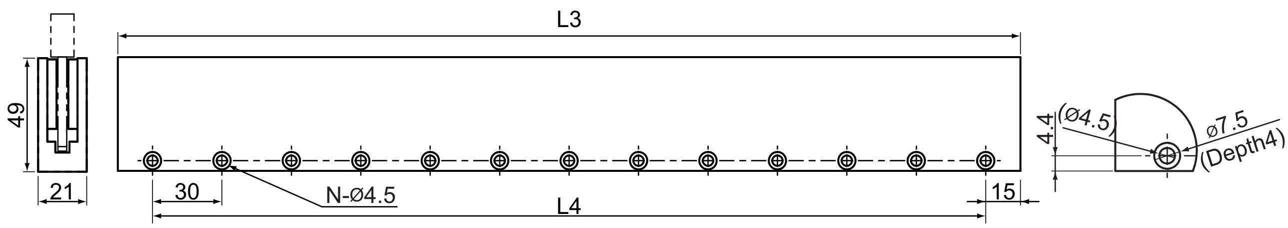
Motor Coil Unit



Model	L1 [mm]	L2 [mm]	Number of holes [N]	Mass*1 [kg]
R88L-EC-GW-0303	78	60	4	0.2
R88L-EC-GW-0306	138	120	7	0.28
R88L-EC-GW-0309	198	180	10	0.36

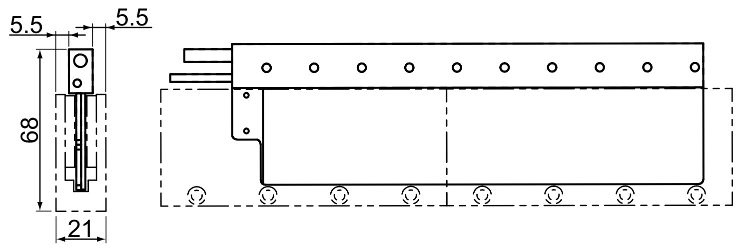
*1 The weight of a 950-mm cableis included.

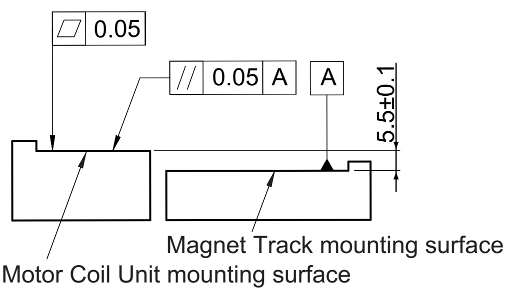
Magnet Track

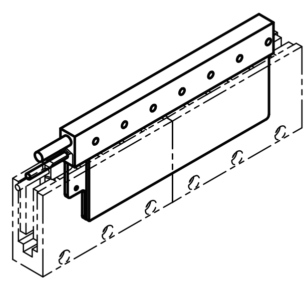


Model	L3 [mm]	L4 [mm]	Number of holes [N]	Mass [kg]
R88L-EC-GM-03090-A	90	60	3	Approx. 0.46
R88L-EC-GM-03120-A	120	90	4	Approx. 0.61
R88L-EC-GM-03390-A	390	360	13	Approx. 1.97

Combination diagram

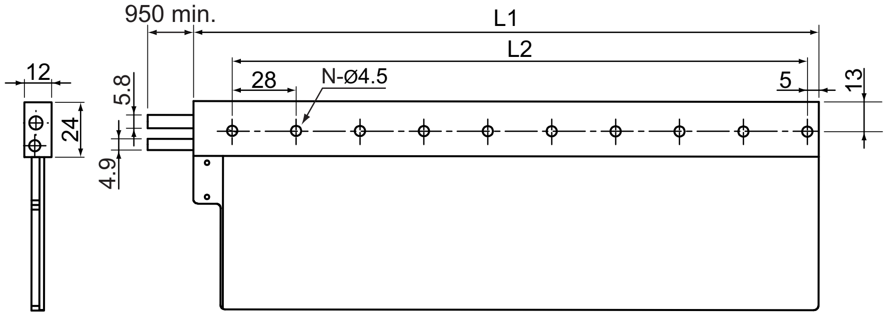






- **R88L-EC-GW-0503/-0506/-0509**

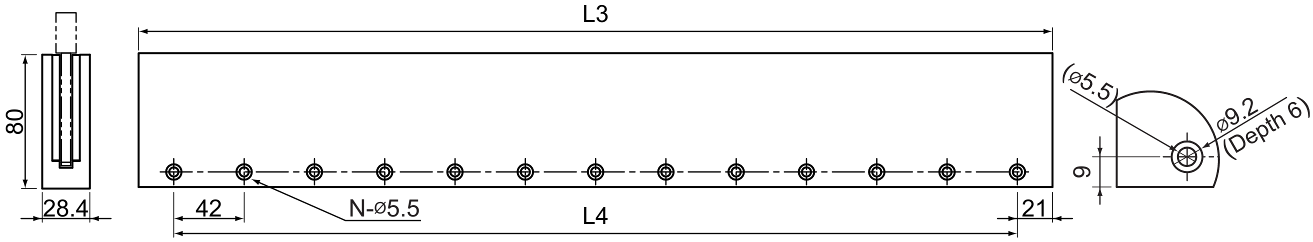
Motor Coil Unit



Model	L1 [mm]	L2 [mm]	Number of holes [N]	Mass*1 [kg]
R88L-EC-GW-0503	106	84	4	0.48
R88L-EC-GW-0506	190	168	7	0.71
R88L-EC-GW-0509	274	252	10	0.94

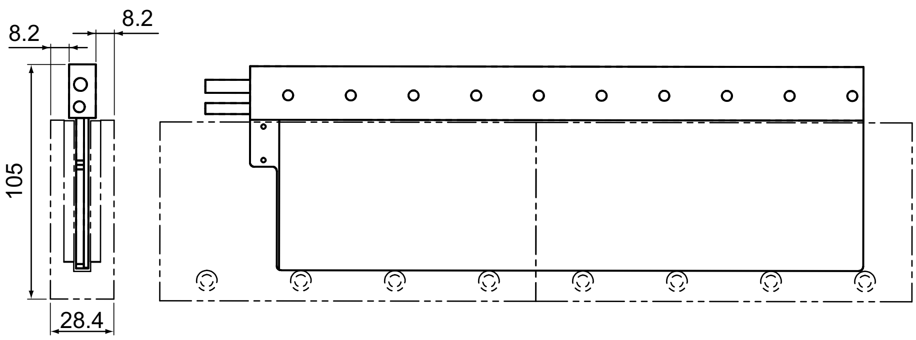
*1 The weight of a 950-mm cableis included.

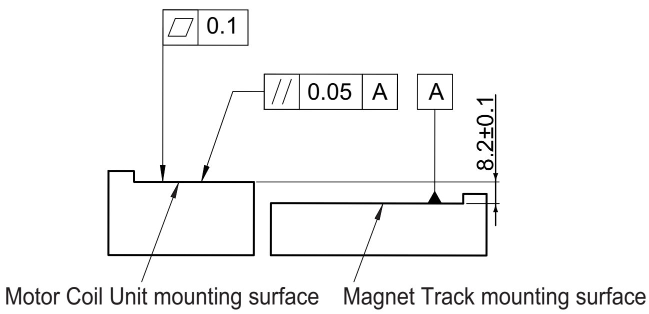
Magnet Track

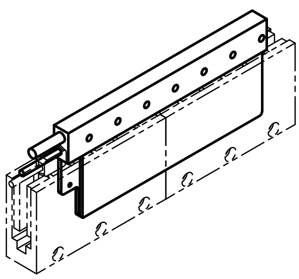


Model	L3 [mm]	L4 [mm]	Number of holes [N]	Mass [kg]
R88L-EC-GM-05126-A	126	84	3	Approx. 1.49
R88L-EC-GM-05168-A	168	126	4	Approx. 1.98
R88L-EC-GM-05210-A	210	168	5	Approx. 2.47
R88L-EC-GM-05546-A	546	504	13	Approx. 6.43

Combination diagram

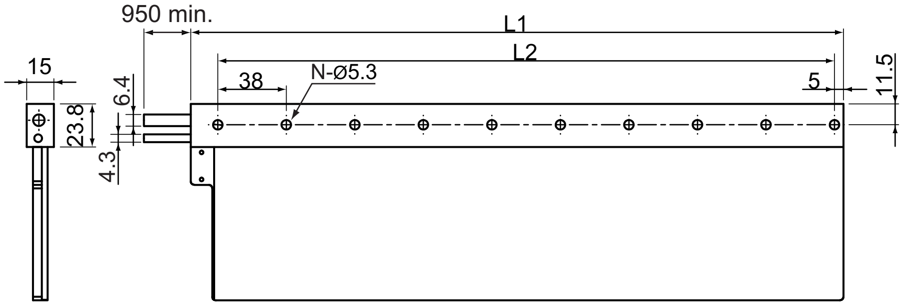






● **R88L-EC-GW-0703/-0706/-0709**

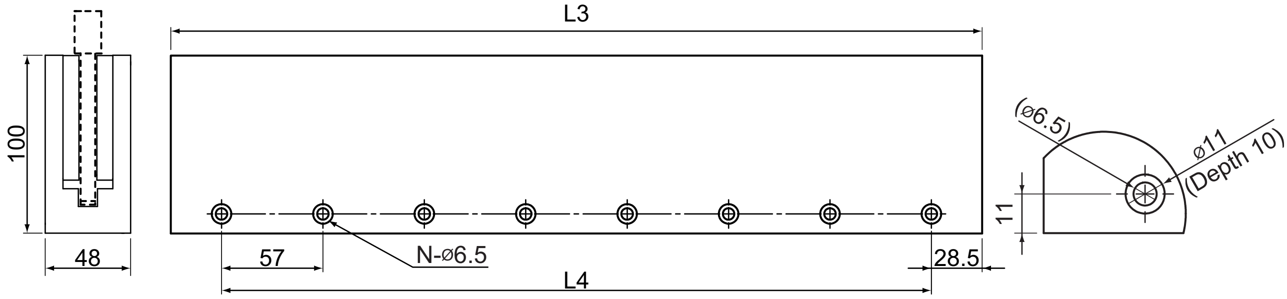
Motor Coil Unit



Model	L1 [mm]	L2 [mm]	Number of holes [N]	Mass[*1] [kg]
R88L-EC-GW-0703	134	114	4	0.9
R88L-EC-GW-0706	248	228	7	1.32
R88L-EC-GW-0709	362	342	10	1.74

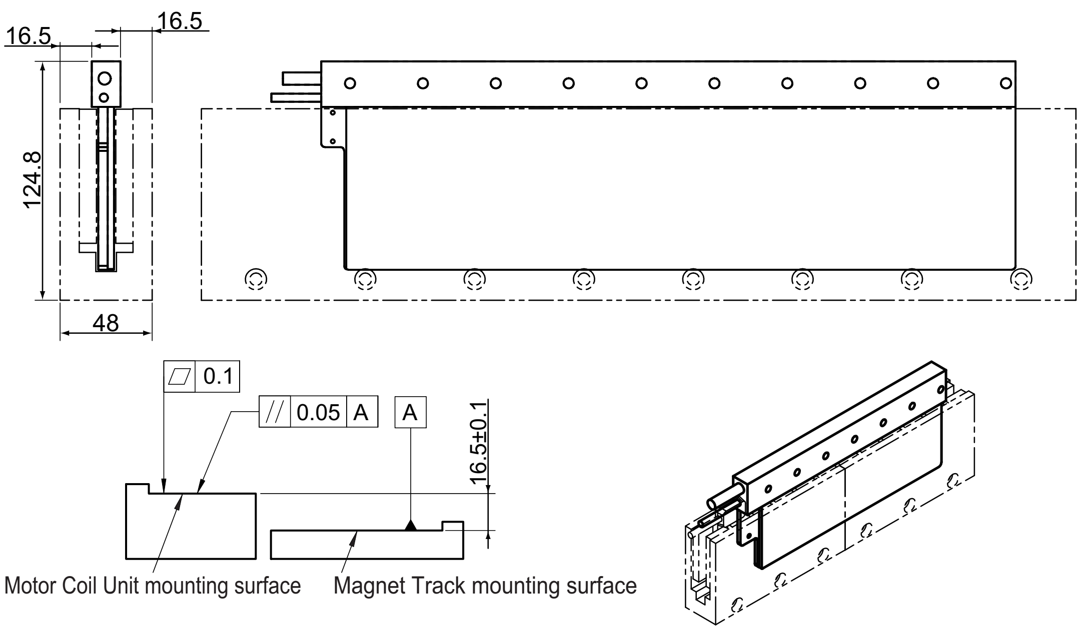
*1 The weight of a 950-mm cableis included.

Magnet Track



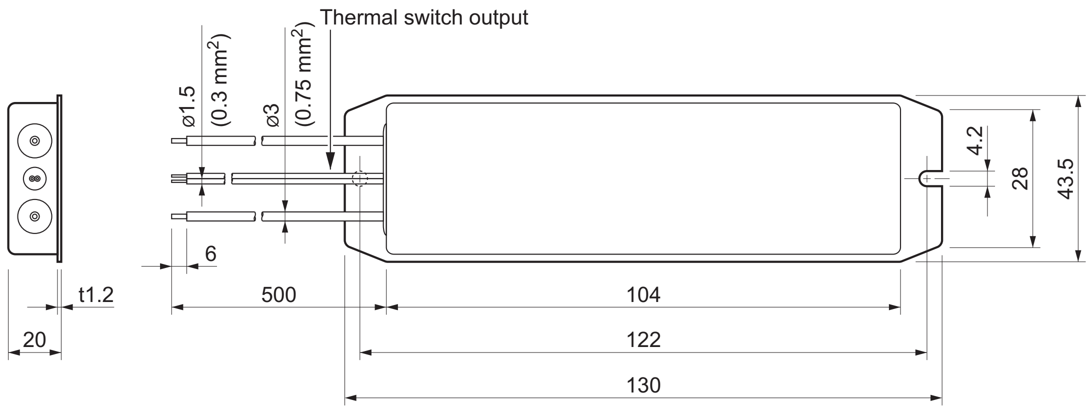
Model	L3 [mm]	L4 [mm]	Number of holes [N]	Mass [kg]
R88L-EC-GM-07114-A	114	57	2	Approx. 2.88
R88L-EC-GM-07171-A	171	114	3	Approx. 4.31
R88L-EC-GM-07456-A	456	399	8	Approx. 11.5

Combination diagram

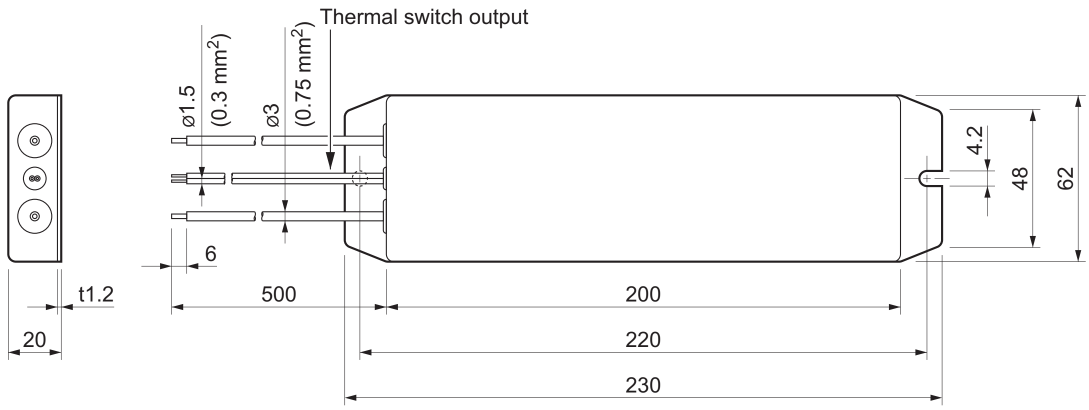


2-4-3 External Regeneration Resistor Dimensions

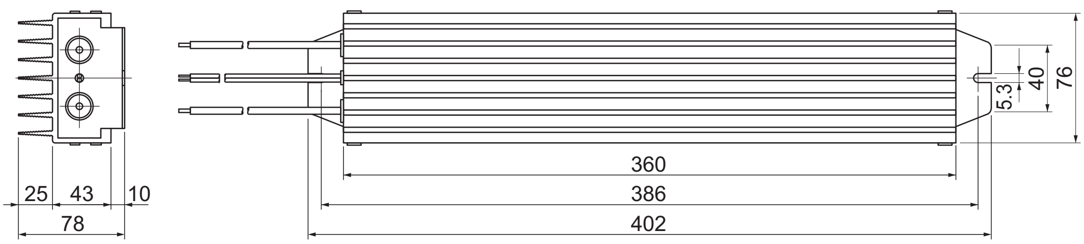
R88A-RR08050S/-RR080100S



R88A-RR22047S1

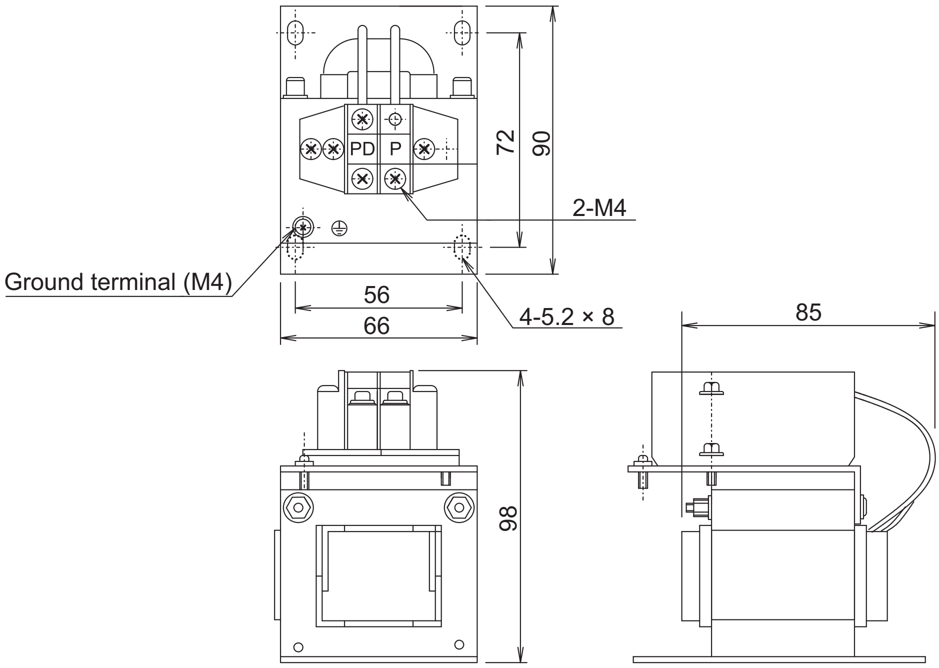


R88A-RR50020S

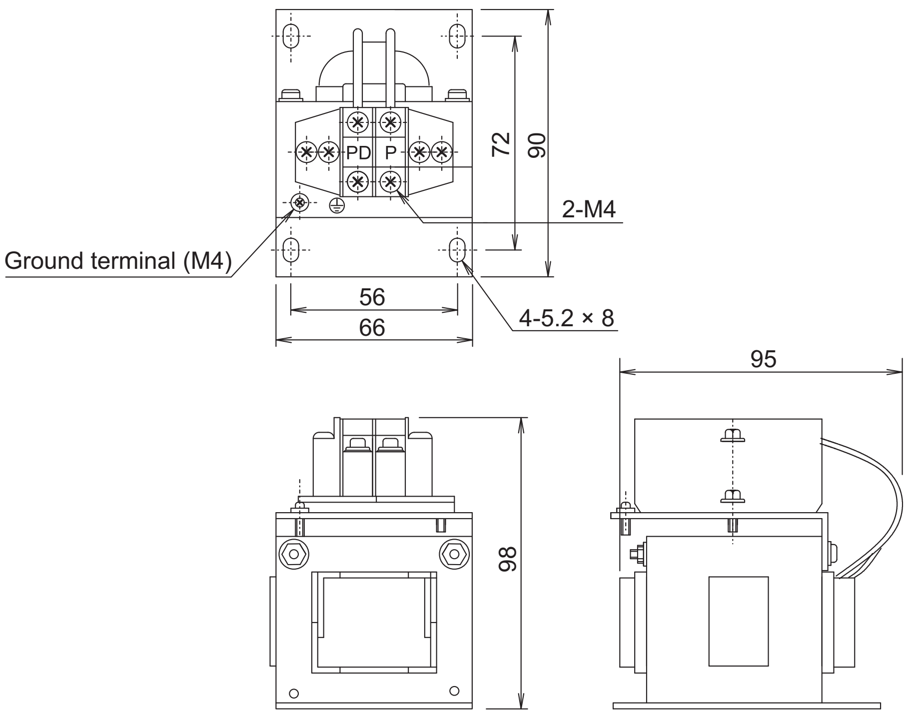


2-4-4 Reactor Dimensions

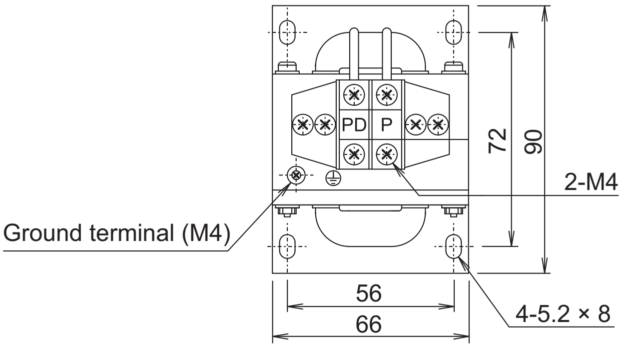
3G3AX-DL2002

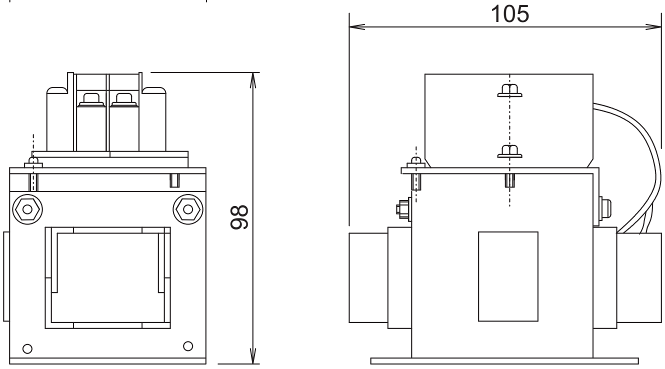


3G3AX-DL2004

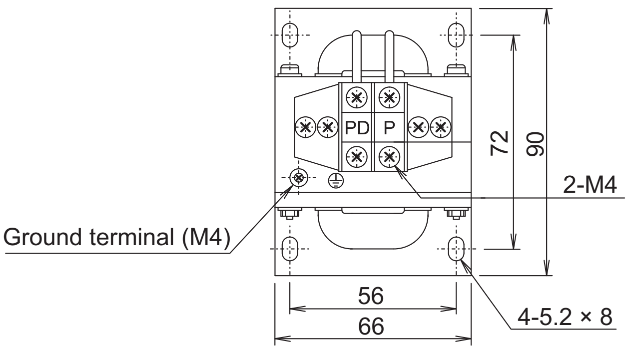


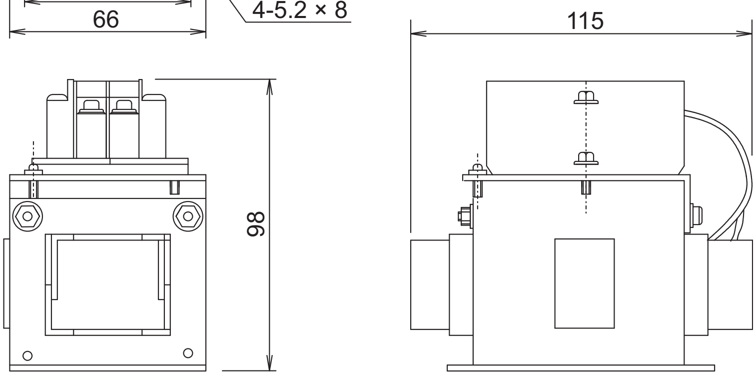
3G3AX-DL2007



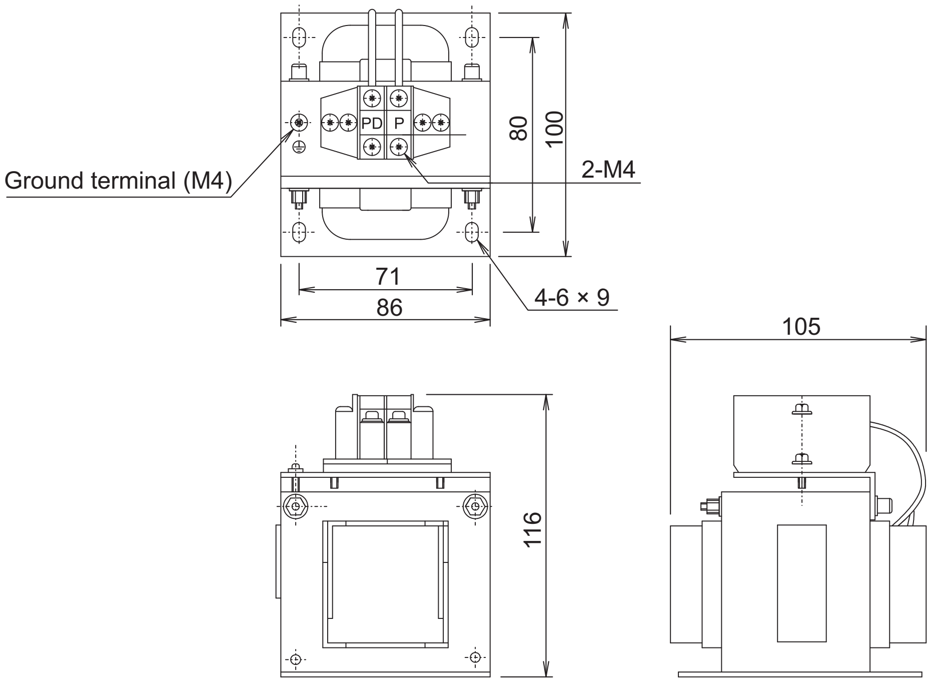


3G3AX-DL2015

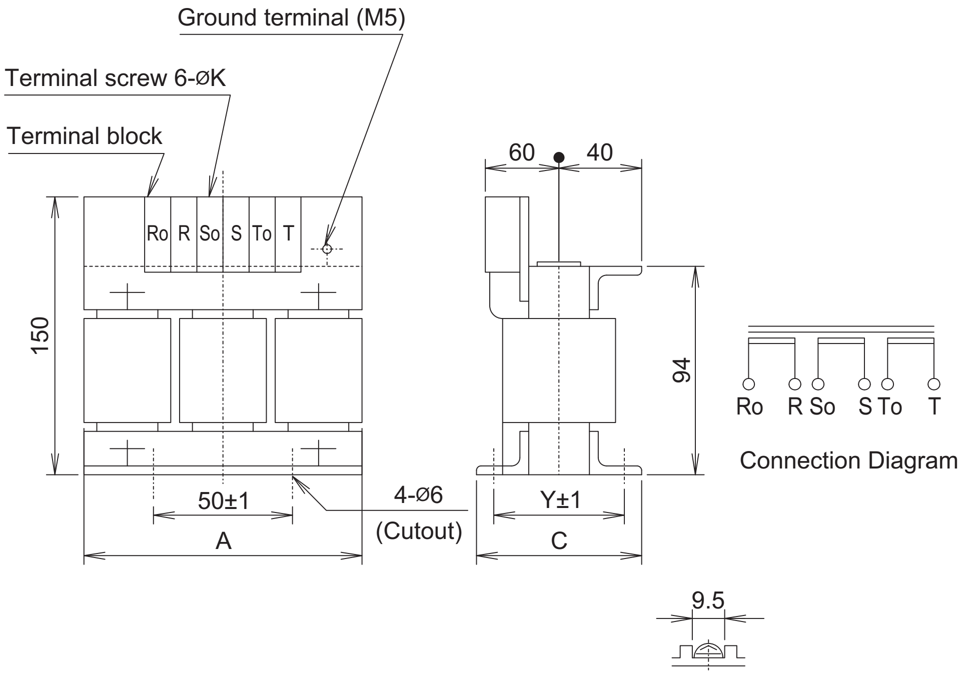




3G3AX-DL2022

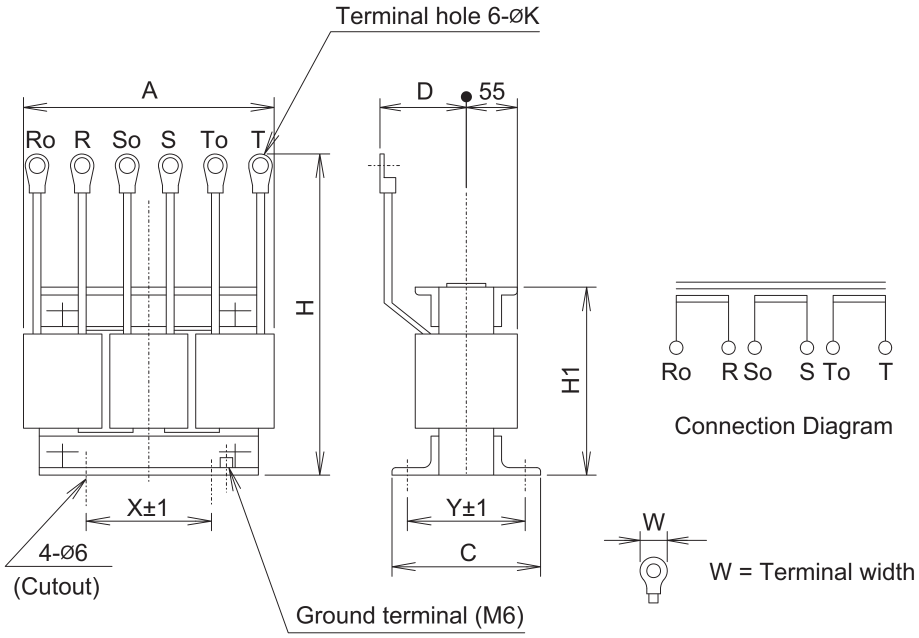


3G3AX-AL2025/-AL2055/-AL4025/-AL4055/-AL2055



Model	Dimensions [mm]			
	A	C	Y	K
3G3AX-AL2025	120	82	67	4
3G3AX-AL2055	120	98	75	4
3G3AX-AL4025	120	82	67	4
3G3AX-AL4055	120	98	75	5

3G3AX-AL2110/-AL2220/-AL4110/-AL4220



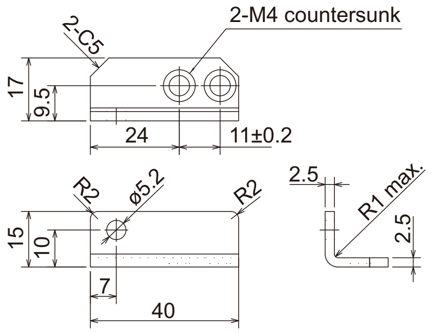
Model	Dimensions [mm]								
	A	C	D	H	H1	X	Y	K	W
3G3AX-AL2110	150	103	70	170	108	60	80	5.3	12
3G3AX-AL2220	180	113	75	190	140	90	90	8.4	16.5
3G3AX-AL4110	150	116	75	170	106	60	98	5.0	12.5
3G3AX-AL4220	180	103	75	190	140	100	80	5.3	12

2-4-5 Mounting Bracket Dimensions

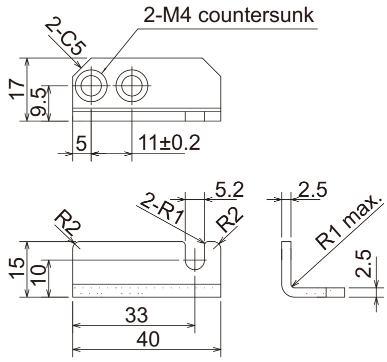
L-brackets for rack mounting are brackets attached to the top and bottom of a Servo Drive. Note that each bracket has a different shape when you attach these L-brackets.

R88A-TK01K

Mounting bracket for top side

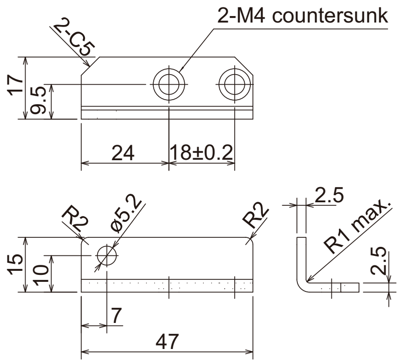


Mounting bracket for bottom side

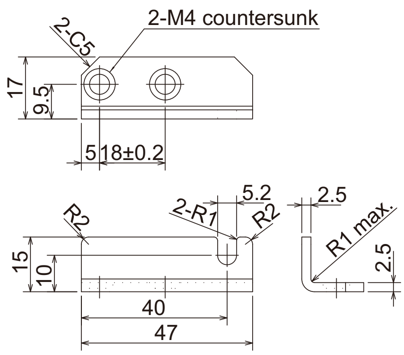


R88A-TK02K

Mounting bracket for top side

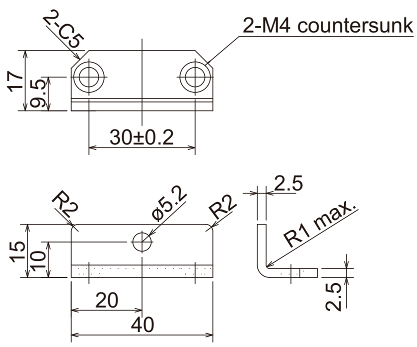


Mounting bracket for bottom side

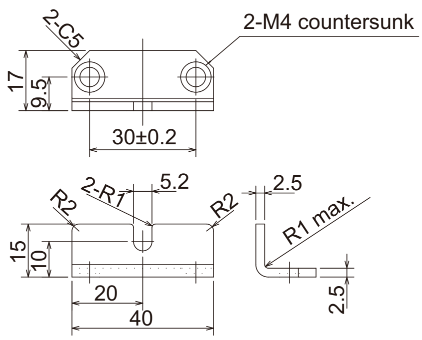


R88A-TK03K

Mounting bracket for top side

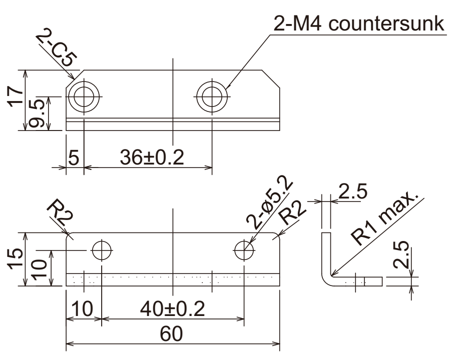


Mounting bracket for bottom side

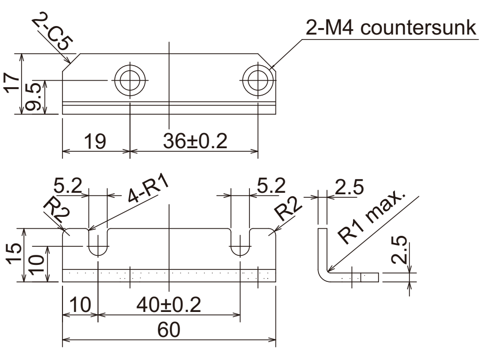


R88A-TK04K

Mounting bracket for top side



Mounting bracket for bottom side



3

Specifications

This section provides the general specifications, characteristics, connector specifications, I/O circuits of the Servo Drives and Linear Motors, as well as specifications of 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
Operating ambient temperature and 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 terminals and FG terminal: 1,500 VAC for 1 min at 50/60 Hz
Protective structure	Built into panel

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

2 Disconnect all connections to the Servo Drive before attempting a megameter test (insulation resistance measurement) on a Servo Drive. Failure to follow this guideline may result in damaging the Servo Drive.

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

4 Some Servo Drive parts will require maintenance. For details, refer to *12-5 Periodic Maintenance* on page 12-35.

5 Following may be caused by incoming electrical noise (unstable, vibration, accoustic noise, etc.). In such case, refer to *4-4 Noise Reduction* on page 4-29 for measure to reduce noise.

● International standard

EC Directives*1	EMC Directive	EN55011, EN61000-6-2, EN61800-3
	Low Voltage Directive	EN 61800-5-1
	Machinery Directives	EN954-1(Cat.3), EN ISO13849-1 (Cat.3)(PLc, d), ISO13849-1(Cat.3)(PLc, d), EN61508(SIL2), EN62061(SIL2), EN61800-5-2 (STO), IEC61326-3-1 (SIL 2)
UL standards		UL 508C
CSA standards		CSA C22.2 No.14
Korean Radio Regulations (KC)		Compliant

*1 This Servo Drive is third-party certified in combination with rotary motor models. It is the user's responsibility to perform final checks on the compliance of the entire system.

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 VAC) 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 VAC) 50/60 Hz		
		Heat value*1	4 W	4 W	4 W
Mass			Approx. 0.8 kg	Approx. 1.0 kg	Approx. 1.6 kg
Maximum motor capacity	Motor Rated Rms Current		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
Input power supply	Main circuit	Power supply capacity	0.5 kVA	0.5 kVA	0.9 kVA
		Power supply voltage	Single-phase or 3-phase 200 to 240 VAC (170 to 264 VAC) 50/60 Hz		
		Rated current	1.6/0.9 A*1	2.4/1.3 A*1	4.1/2.4 A*1
		Heat value*2	14.3/13.7 W*1	23/19 W*1	33/24 W*1
	Control circuit	Power supply voltage	Single-phase 200 to 240 VAC (170 to 264 VAC) 50/60 Hz		
		Heat value*2	4 W	4 W	4 W
Mass			Approx. 0.8 kg	Approx. 0.8 kg	Approx. 1.0 kg
Maximum motor capacity	Rated current of motor		1.2 Arms	1.6 Arms	2.6 Arms
	Maximum current of motor		3.6 Arms	4.8 Arms	7.8 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-KN08H-ECT-L	R88D-KN10H-ECT-L	R88D-KN15H-ECT-L
Input power supply	Main circuit	Power supply capacity	1.3 kVA	1.8 kVA	2.3 kVA
		Power supply voltage	Single-phase or 3-phase 200 to 240 VAC (170 to 264 VAC) 50/60 Hz		
		Rated current	6.6/3.6 A*1	9.1/5.2 A*1	14.2/8.1 A*1
		Heat value*2	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 VAC) 50/60 Hz		
		Heat value*2	4 W	7 W	7 W
Mass			Approx. 1.6 kg	Approx. 1.8 kg	Approx. 1.8 kg
Maximum motor capacity	Rated current of motor		4.1 Arms	5.9 Arms	9.4 Arms
	Maximum current of motor		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.

400-VAC Input Models

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

*1 The heat value is given for rated operation.

Item			R88D-KN20F-ECT-L	R88D-KN30F-ECT-L
Input power supply	Main circuit	Power supply capacity	3.8 kVA	4.5 kVA
		Power supply voltage	3-phase 380 to 480 VAC (323 to 528 VAC) 50/60 Hz	
		Rated current	5.9 A	7.6 A
		Heat value*1	65 W	108 W
	Control circuit	Power supply voltage	24 VDC (20.4 to 27.6 VAC)	
		Heat value*1	10 W	13 W
Mass			Approx. 2.7 kg	Approx. 4.7 kg
Maximum motor capacity	Rated current of motor		6.7 Arms	9.4 Arms
	Maximum current of motor		19.7 Arms	28.2 Arms

*1 The heat value is given for rated operation.

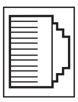
3-1-3 EtherCAT Communications Specifications

Item	Specifications
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 position 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.

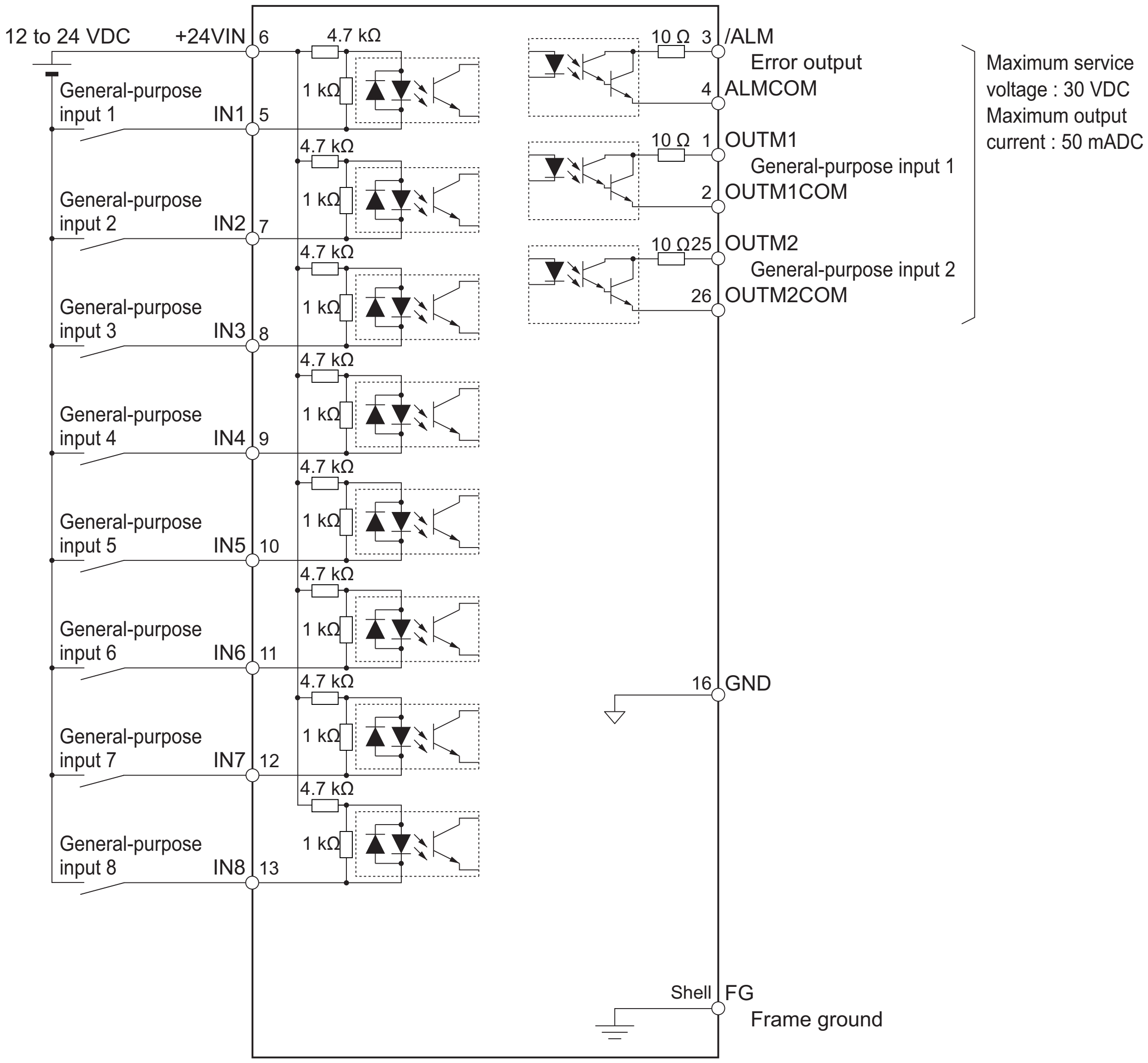
- Electrical characteristics: Conform to IEEE 802.3.
- Connector structure: RJ45 8-pin modular connector (conforms to ISO 8877)

	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 function of pins 5 and 7 to 13 are determined by the servo parameter object settings.
2 The output function 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 No.	Symbol	Signal		Function and interface
		Name	Default	
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 No.	Symbol	Signal		Function and interface
		Name	Default	
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

Pin	Signal	Function	Pin	Signal	Function	Pin	Signal	Function	Pin	Signal	Function
2	OUTM1COM	General-purpose Output 1 Common	1	OUTM1 (BKIR)	General-purpose Output 1 (Brake Interlock Output)	15		*	14		*
4	ALMCOM	Error Output Common	3	/ALM	Error Output	17		*	16	GND	Signal Ground
6	+24VIN	12 to 24 VDC Power Supply Input	5	IN1 (STOP)	General-purpose Input 1 (Immediate Stop Input)	19		*	18		*
8	IN3 (NOT)	General-purpose Input 3 (Negative Drive Prohibition Input)	7	IN2 (POT)	General-purpose Input 2 (Positive Drive Prohibition Input)	21		*	20		*
10	IN5 (EXT3)	General-purpose Input 5 (External General-purpose Latch Input 3)	9	IN4 (DEC)	General-purpose Input 4 (Origin Proximity Input)	23		*	22		*
12	IN7 (EXT1)	General-purpose Input 7 (External Latch Input 1)	11	IN6 (EXT2)	General-purpose Input 6 (External Latch Input 2)	25	OUTM2 (READY)	General-purpose Output 2 (Servo Ready Output)	24		*
			13	IN8 (MON0)	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).

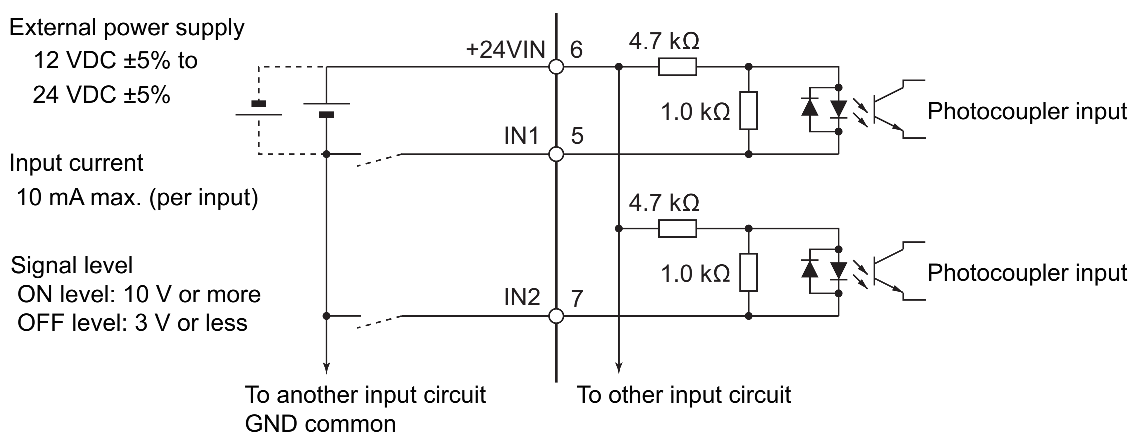
3 The output functions for general-purpose outputs (OUTM1 and OUTM2) are determined by the objects 3410 and 3411 hex (Output Signal Selection 1 and 2).

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 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 Immediate Stop Input (STOP) is turned ON while the power is supplied to the Linear Motor, the Servo Drive will stop its output, causing the Servo Motor to fall in a free state. In this case, the Linear Motor decelerates to stop according to the setting of the Fault reaction option code (605E hex). By default, the Fault reaction option code (605E hex) is set to -1 (Dynamic brake operation).
- This input is allocated to the pin 5 with the default setting.

Precautions for Safe Use

Enable 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 (default 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

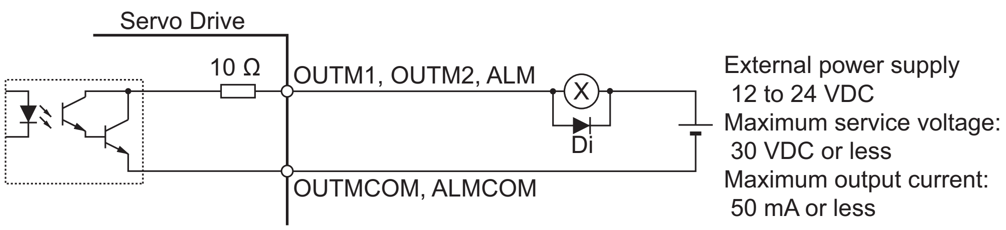
- The external latch inputs are detected by on the rising edge of the signal, but the minimal signal ON and OFF widths must be 2 ms.
- The external latch inputs can only be set to N.O. (normally open) contacts.
- The external latch inputs can be allocated to pins 10 to 12 only.

- **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

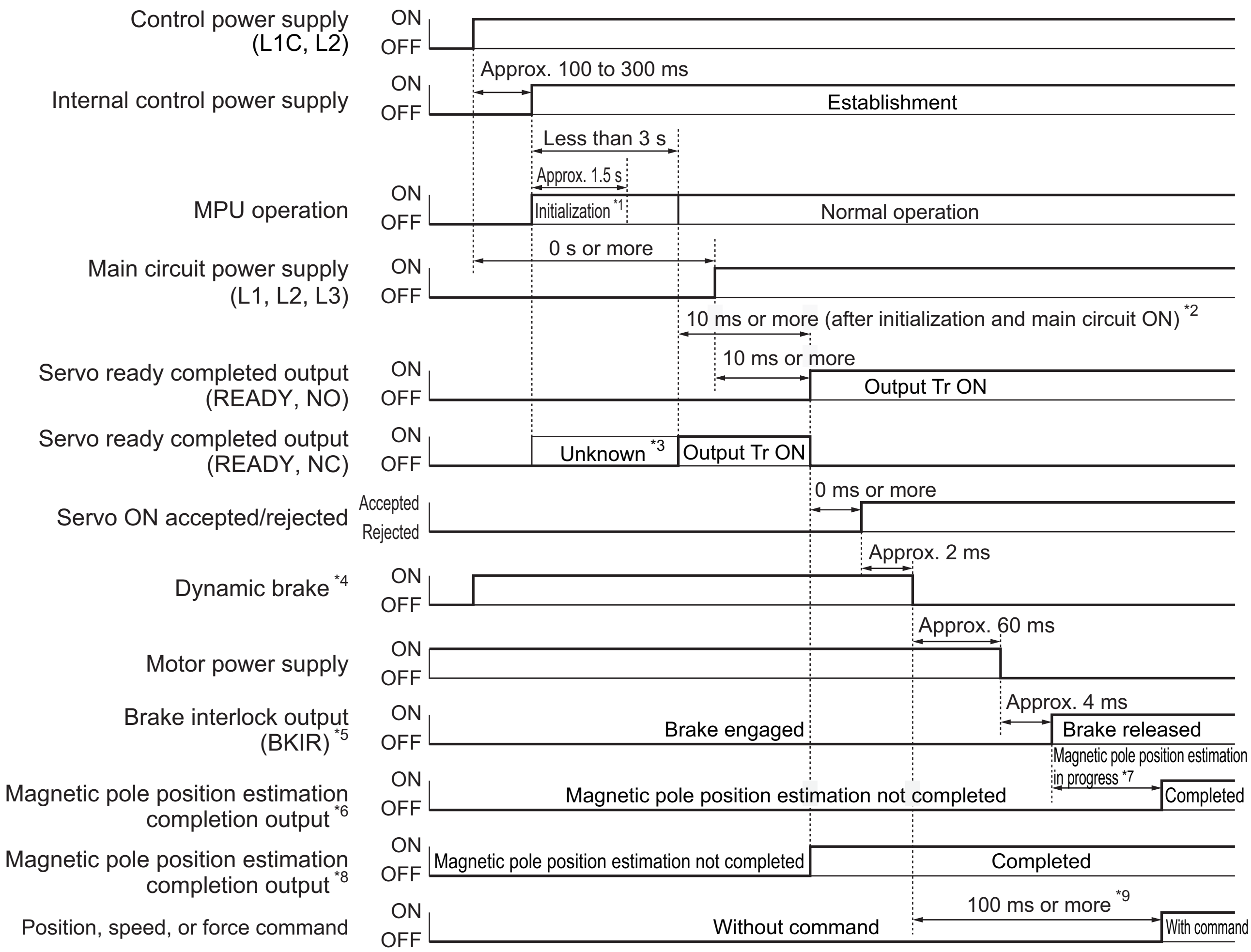
*1 When driving a relay directly with an output signal, always insert a diode as shown in the above figure. Use high-speed diodes.

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.



*1 Once the internal control power is established, the protective function starts working about 1.5 seconds 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. The period can be extended by setting the Power Supply ON Initialization Time (3618 hex).

*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 Detection Method (3920 hex) is set to 2 (Magnetic pole position estimation).

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

● Servo Ready Completed Output (READY)

- This output signal indicates the Servo Drive is ready to supply power to the Linear Motor.
- 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)

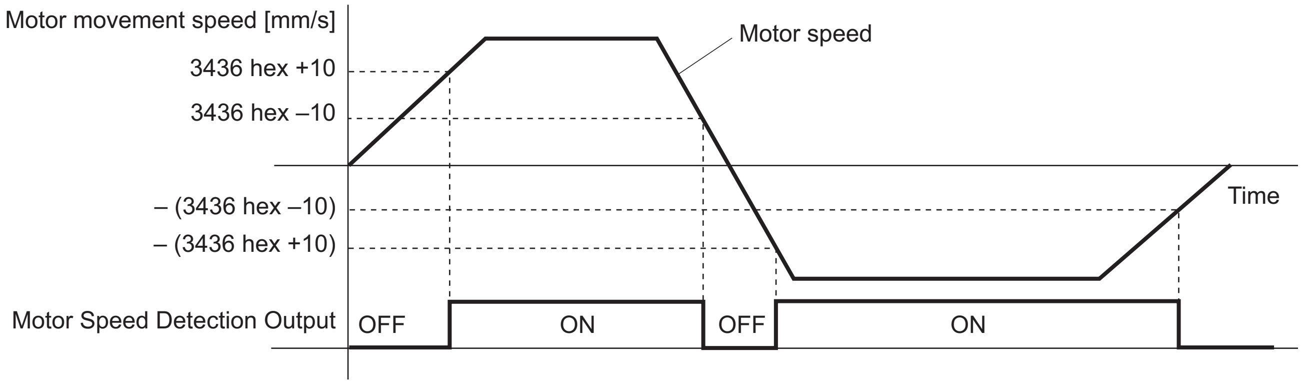
- The Brake Interlock Output outputs the external brake timing signal according to the settings of the Brake Timing When Stopped (3437 hex), the Brake Timing During Operation (3438 hex), and the Brake Threshold Speed During Operation (3439 hex).
- With the default settings, the output is allocated to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

● Positioning Completion Outputs (INP1, INP2)

- INP1 will turn ON when the position error is equal to or less than Position window (6067 hex).
- INP2 will turn 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 (3432 hex).
- The output is always OFF except in the Position Control Mode.
- With the default settings, the outputs are not allocated.

● Motor Speed Detection Output (TGON)

- This output turns ON 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 direction in which the motor moves.
- The setting has 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.

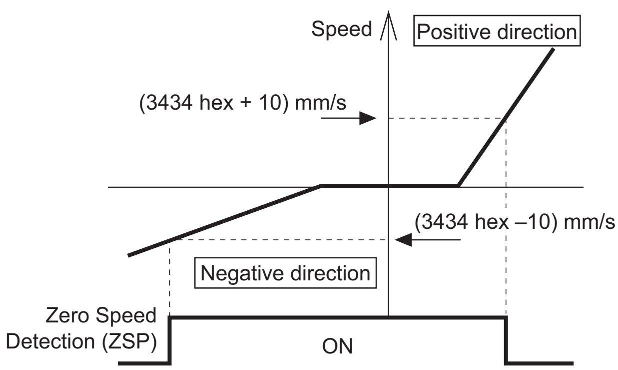


● Force Limiting Signal (TLIMT)

- 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.

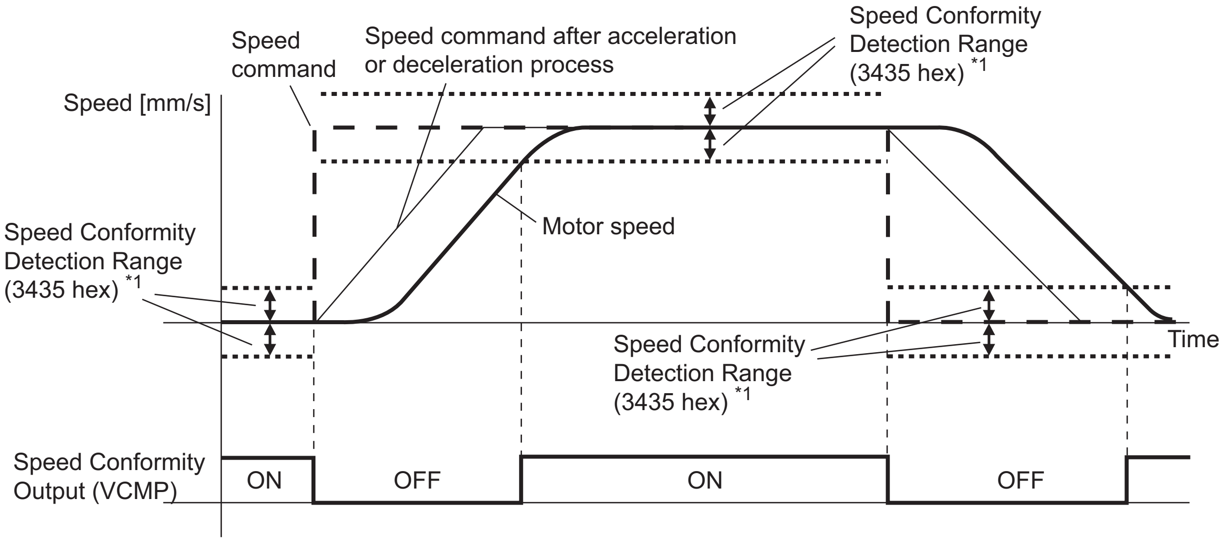
● Zero Speed Detection Output (ZSP)

- 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 the direction in which the motor moves.
- The setting has 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 setting has 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 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

● 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 output is 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 output is 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 output is 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 outputs are 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	0.001 to 10 [μm/Pulse]*1
Maximum length	Resolution x (2^{30}–1) or less
Encoder type*2	• Phase A/B, origin signal differential input • AT573A, ST778A, and ST778AL by Mitutoyo Corporation • SR75, SR77, SR85, and SR87 by Magnescale Co., Ltd
Supported encoder speed*3	• Phase A/B type (90° phase difference output) : to 4 Mpps • Serial communications type : to 400 Mpps
External encoder cable	• Cable specifications : Shielded twisted-pair cable*4 • Maximum cable length : 20 m*5

*1 Set the number of pulses per magnetic pole pitch (or one cycle of electrical angle) to at least 2,048 pulses.

*2 OMRON checked the connection of these products in serial communications by using each representative model. Although the connection is confirmed, it does not mean that the functions and performance are guaranteed in the resolution, model, and all aspects of an external encoder.

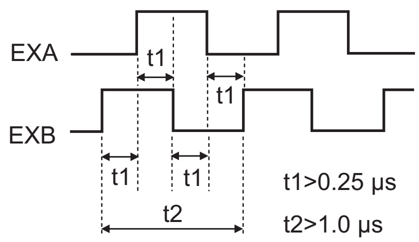
*3 This represents the encoder speed supported on the Servo Drive. Check separately the external encoder operation manual for its supported speed.

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

*5 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.

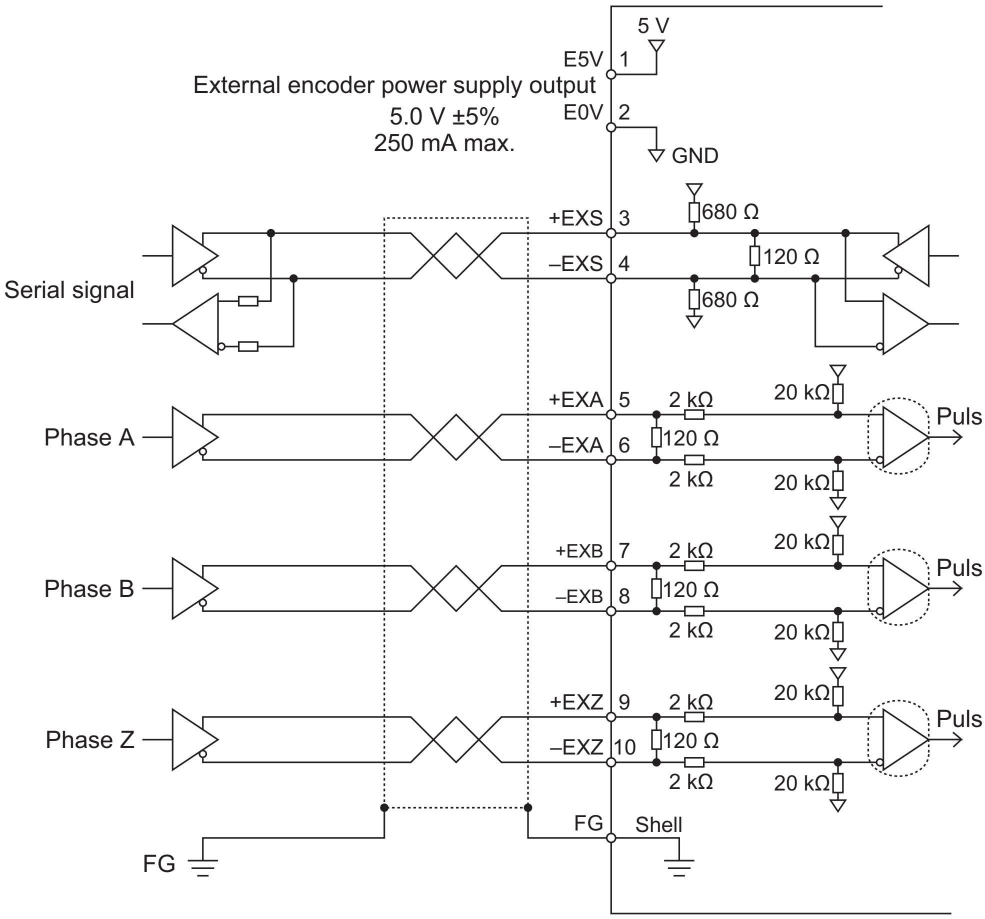
Pin No.	Symbol	Name	Function and interface
1	E5V	External encoder power supply output	External encoder power supply: 5.0 VDC ± 5%, 250 mA max. If the above capacity is exceeded, provide an appropriate power supply.
2	E0V		This is connected to the control circuit ground connected to connector CN1.
3	+EXS	External encoder signal 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

*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)

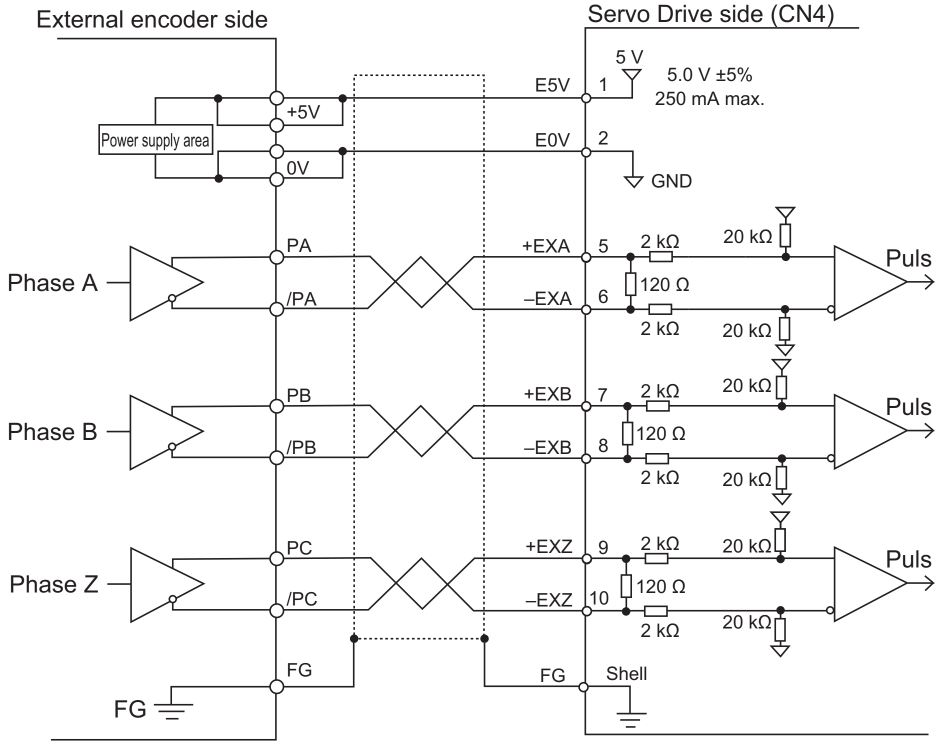
Name	Model	Manufacturer	OMRON model number
MUF Connector	MUF-PK10K-X	J.S.T. Mfg. Co., Ltd.	R88A-CNK41L

Connection of External Encoder Input Signals and Processing of External Signals

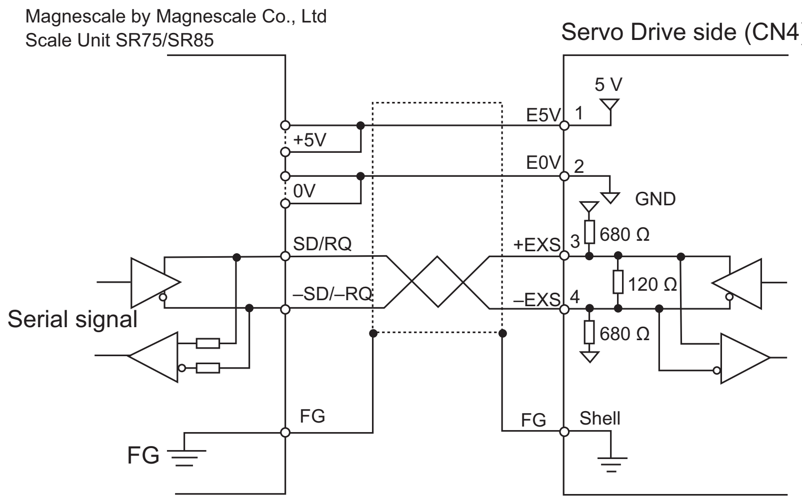


Example of Connection with External Encoder

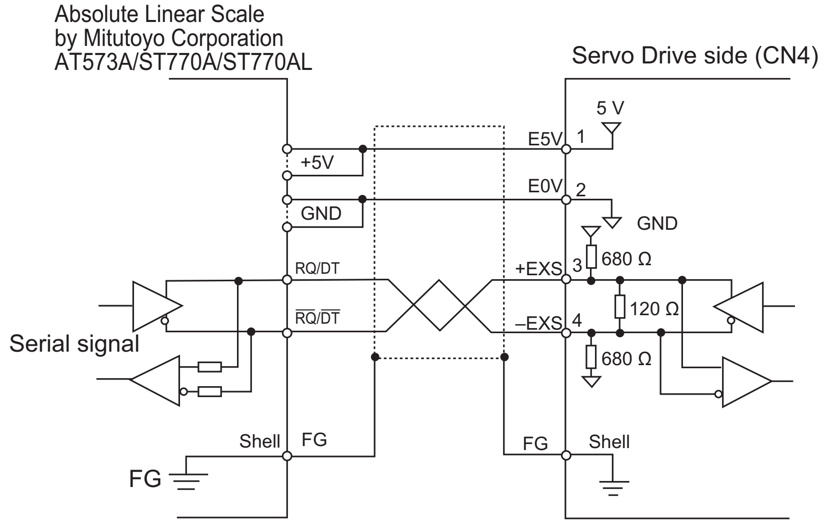
- **90° Phase Difference Output (3323 hex = 0)**

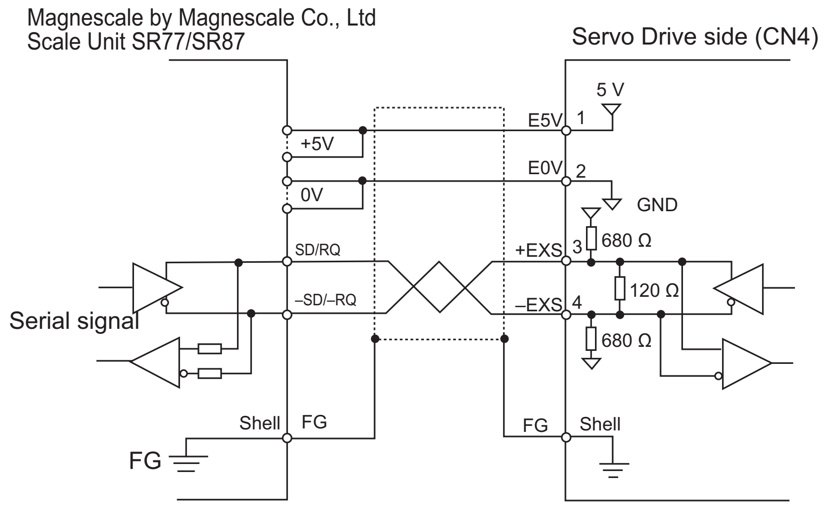


- **Serial Communications, Incremental Type External Encoder (3323 hex = 1)**



- **Serial Communications, Absolute Type External Encoder (3323 hex = 2)**





3-1-12 Analog Monitor Connector Specifications (CN5)

Monitor Output Signal Table

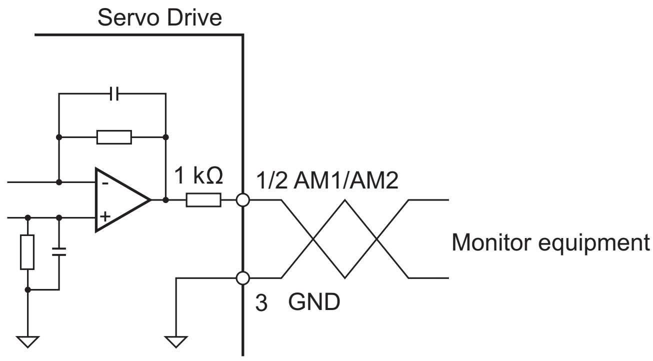
Monitor Output (CN5)

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	GND	Signal ground	Signal ground

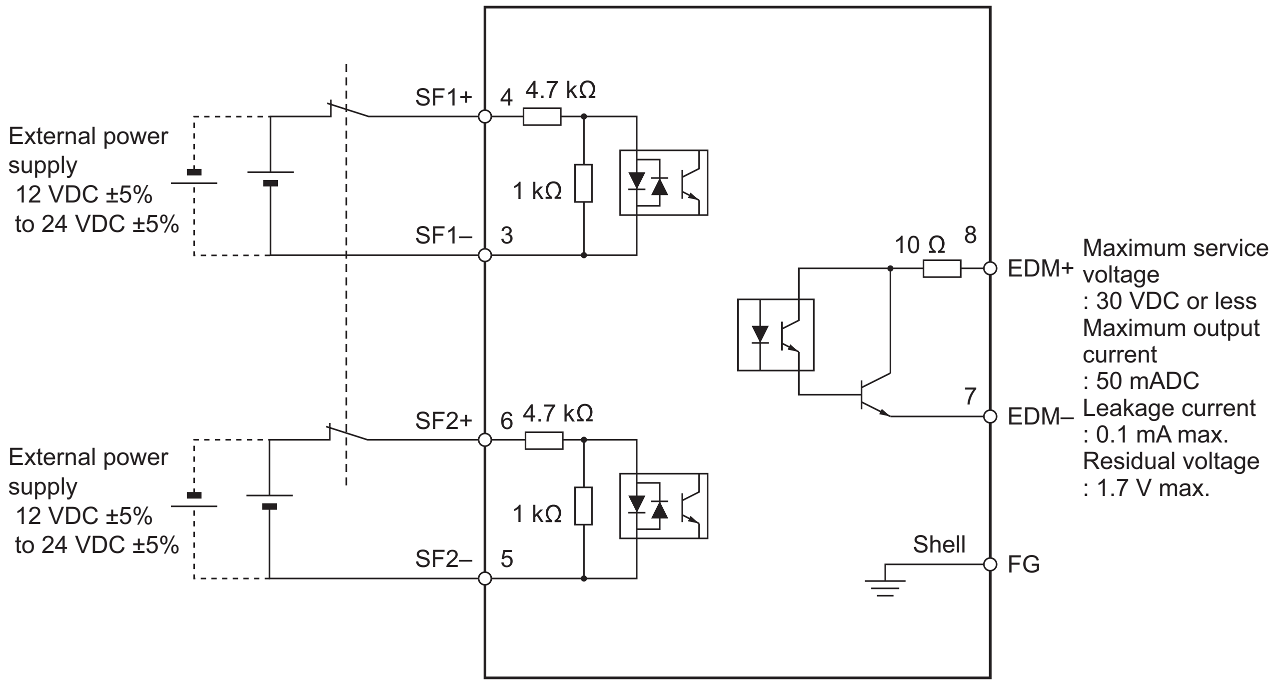
Precautions for Correct Use

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)

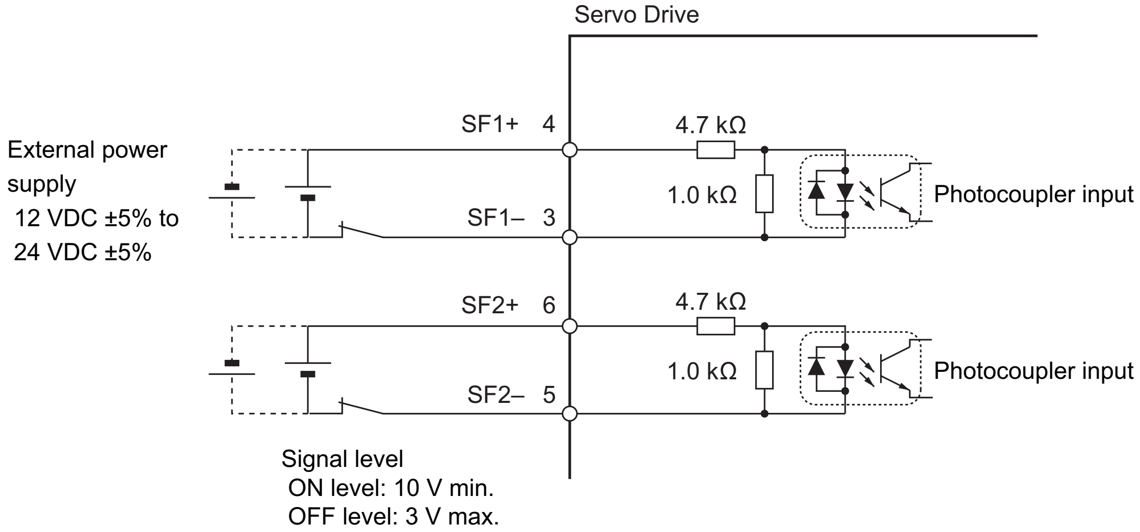
Pin No.	Symbol	Name	Function and interface
1	–	Reserved	Do not connect.
2	–		
3	SF1–	Safety input 1	Inputs 1 and 2 for operating the STO function, which are 2 independent circuits. This input turns OFF the power transistor drive signals in the Servo Drive to cut off the current output to the motor.
4	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)

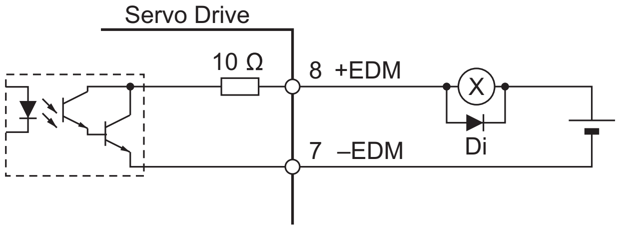
Name	Model	Manufacturer	OMRON model number
Industrial Mini I/O Connector (D-SHAPE1)	2013595-1	Tyco Electronics AMP KK	R88A-CNK81S

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



EDM Output Circuit



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

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.

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.

An overload error will occur according to the timing characteristic if the feedback value for the force command exceeds the overload level.
The overload level is dependent on the Overload Detection Level Setting (3512 hex) and the timing characteristic on the Motor Overload Curve Selection (3929 hex), respectively. Be sure to set the Overload Detection Level Setting according to the environment in which the Servo Drive is used.

Index	Name	Unit	Setting range	Description	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%.	P. 9-43
3929 hex	Motor Overload Curve Selection	–	0 to 7	This represents one of the overload detection characteristic values that correspond to eight thermal time constants. It is set automatically according to the selected motor model when the Linear Motor settings are initialized. The default setting is 0.	P. 9-70

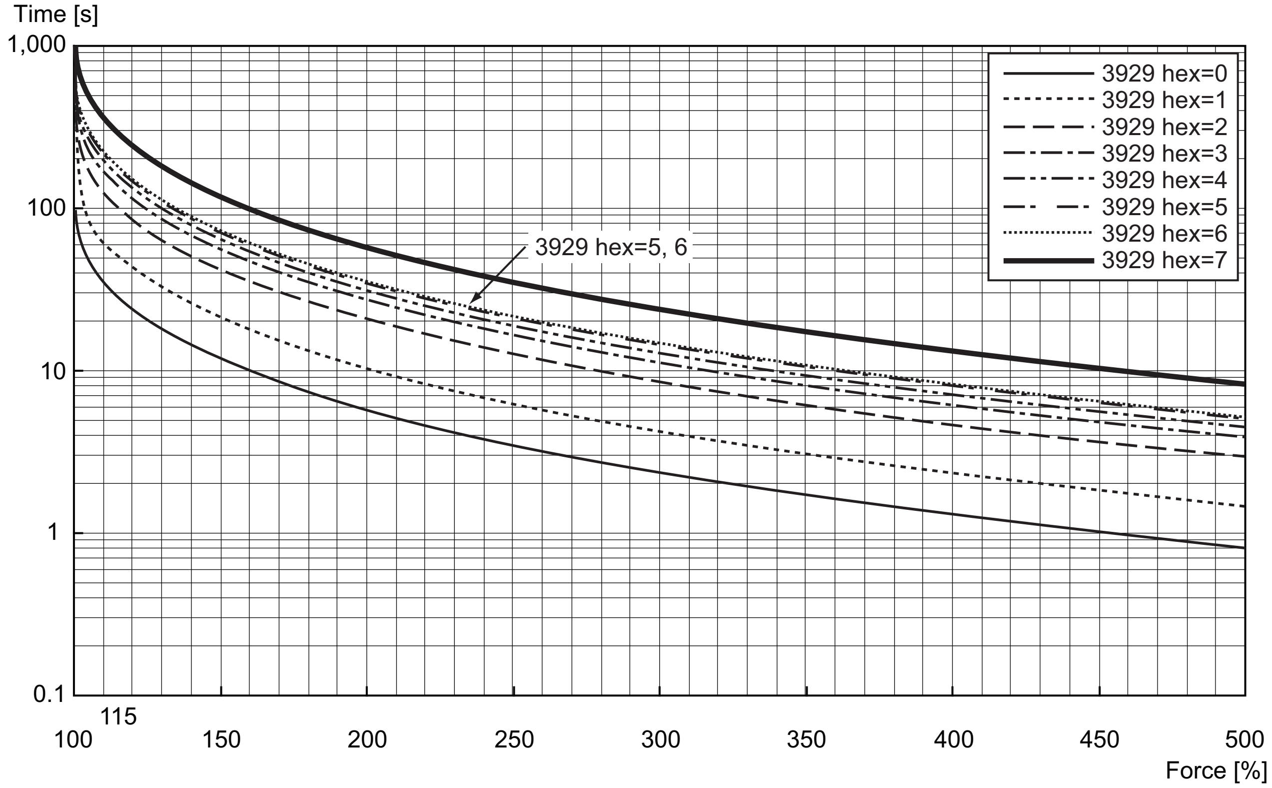
The Motor Overload Curve Selection (3929 hex) will be set automatically based on the selected Motor Coil Unit model when the Linear Motor settings are initialized.

Set value	Thermal time constant	Motor Coil Unit model
0	20	-
1	36	R88L-EC-GW-0303/-0306/-0309
2	72	R88L-EC-GW-0503/-0506/-0509
3	96	R88L-EC-GW-0703/-0706/-0709
4	110	R88L-EC-FW-0303/-0306
5	124	R88L-EC-FW-0606/-0609/-0612
6	126	R88L-EC-FW-1112/-1115
7	200	Servo Drive protection only

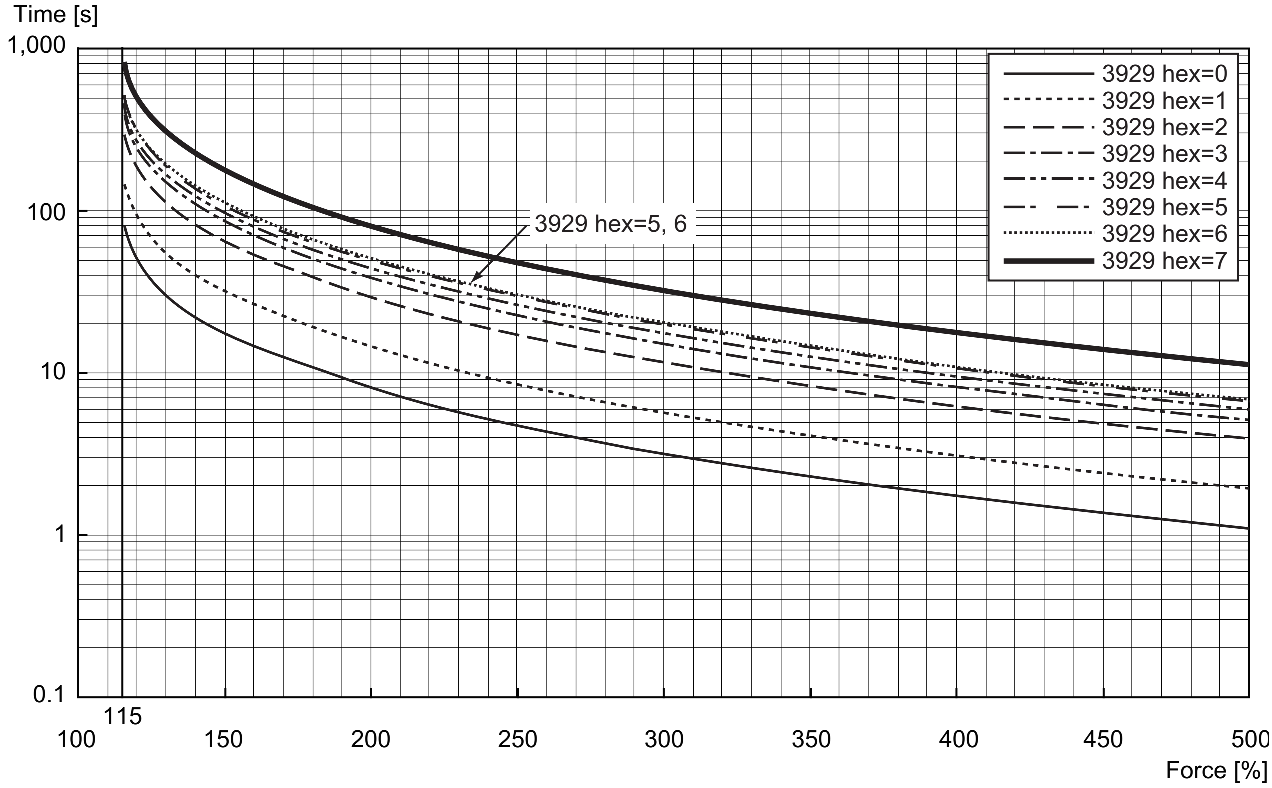
If an overload error occurs, first eliminate the cause of the error and then wait at least 1 minute for the motor temperature to drop sufficiently (for both the Motor Coil Unit and the Magnet Track) before turning ON the power again.
If the error reset is repeated at short intervals, the motor may burn 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.
- 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.

Additional Information

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

3-3 Linear Motor Specifications

Two types of Linear Motors are available: Iron-core and Ironless Linear Motors.

These Linear Motors consist of one Motor Coil Unit and two or more Magnet Track.

The Motor Coil Unit has built-in temperature sensors.

Choose an appropriate Linear Motor model based on the load and the operating characteristics.

3-3-1 General Specifications of Iron-core Linear Motors

Item	Description
Operating ambient temperature humidity	0 to 40ºC, 20% to 80% (with no condensation)
Storage ambient temperature and humidity	–20ºC to 65ºC, 85% max. (with no condensation)
Operating and storage atmosphere	No corrosive gases
Vibration resistance*1	Acceleration of 49 m/s^2 max. in X, Y, and Z directions
Impact resistance	Acceleration of 98 m/s^2 max. 3 times each in X, Y, and Z directions
Insulation resistance*2	Between power terminal and FG terminal: 10 MΩ min. (at 500 VDC)
Dielectric strength	Between power terminal and FG terminal: 2,750 VDC for 1 s Between power terminal and sensor: 2,750 VDC for 1 s
Protective structure	IP00
Maximum coil temperature (Motor Coil Unit)	130°C
Maximum magnet temperature (Magnet Track)	70°C
Insulation class	Class B
Cooling method	Self-cooling

*1 The amplitude may be increased by machine resonance. As a guideline, do not exceed 80% of the specified value.

*2 Disconnect all connections to the Linear Motor before attempting a megameter test (insulation resistance measurement) on a Linear Motor. Failure to follow this guideline may result in damaging the Linear Motor. In addition, never perform dielectric strength tests on the Linear Motor. Failure to follow this guideline may result in damaging the internal elements.

3-3-2 Performance Specifications of Iron-core Linear Motors

The following tables show the performance specifications of various iron-core Linear Motor models.

R88L-EC-FW-0303/-0306

Motor Coil Unit (R88L-EC-FW-☐-ANPC)		0303			0306		
Servo Drives (R88D-☐-ECT-L)		KN01L	KN02H	KN06F	KN02L	KN04H	KN10F
Applicable Servo Drives input voltage		100 VAC	200 VAC	400 VAC	100 VAC	200 VAC	400 VAC
Maximum speed (100 VAC)	m/s	2.5	–	–	2.5	–	–
Maximum speed (200 VAC)	m/s	–	5	–	–	5	–
Maximum speed (400 VAC)	m/s	–	–	10	–	–	10
Continuous force*1	N	48			96		
Momentary maximum force*2	N	105			210		
Continuous current*1	Arms	1.24			2.4		
Momentary maximum current*2	Arms	3.1			6.1		
Motor force constant	N/Arms	39.7			39.7		
Back electromotive force	V·s/m	13.2			13.2		
Motor constant	N/√W	9.75			13.78		
Phase resistance	Ω	5.34			2.68		
Phase inductance	mH	34.7			17.4		
Electrical time constant	ms	6.5			6.5		
Maximum continuous power consumption	W	32			63		
Thermal resistance	K/W	2.20			1.10		
Thermal time constant	s	110			110		
Magnetic attraction force	N	300			500		
Magnetic pole pitch	mm	24			24		
Mass (except cables)	kg	0.48			0.78		
Radiator plate dimensions	mm	238 x 220 x 10			238 x 220 x 10		

*1 This shows a value measured when the Motor Coil Unit is at 100ºC and the Magnet Track is at 25ºC. As a cooling condition, attach the Motor Coil Unit to the center of an aluminum radiator plate (moving table) of the specified dimensions, shown in the above table.

*2 The Motor Coil Unit is subjected to a temperature rise of 6 K/s.

R88L-EC-FW-0606/-0609/-0612

Motor Coil Unit (R88L-EC-FW-☐-ANPC)		0606			0609		0612	
Servo Drives (R88D-☐-ECT-L)		KN04L	KN08H	KN15F	KN10H	KN20F	KN15H	KN30F
Applicable Servo Drives input voltage		100 VAC	200 VAC	400 VAC	200 VAC	400 VAC	200 VAC	400 VAC
Maximum speed (100 VAC)	m/s	2	–	–	–	–	–	–
Maximum speed (200 VAC)	m/s	–	4	–	4	–	4	–
Maximum speed (400 VAC)	m/s	–	–	8	–	8	–	8
Continuous force*1	N	160			240		320	
Momentary maximum force*2	N	400			600		800	
Continuous current*1	Arms	3.4			5.2		6.9	
Momentary maximum current*2	Arms	10			15		20	
Motor force constant	N/Arms	46.5			46.5		46.5	
Back electromotive force	V·s/m	15.5			15.5		15.5	
Motor constant	N/√W	19.49			23.87		27.57	
Phase resistance	Ω	1.83			1.23		0.92	
Phase inductance	mH	13.7			9.2		6.9	
Electrical time constant	ms	7.5			7.5		7.5	
Maximum continuous power consumption	W	88			131		175	
Thermal resistance	K/W	0.78			0.52		0.39	
Thermal time constant	s	124			124		124	
Magnetic attraction force	N	1,020			1,420		1,820	
Magnetic pole pitch	mm	24			24		24	
Mass (except cables)	kg	1.31			1.84		2.37	
Radiator plate dimensions	mm	250 x 287 x 12			250 x 287 x 12		250 x 287 x 12	

*1 This shows a value measured when the Motor Coil Unit is at 100ºC and the Magnet Track is at 25ºC. As a cooling condition, attach the Motor Coil Unit to the center of an aluminum radiator plate (moving table) of the specified dimensions, shown in the above table.

*2 The Motor Coil Unit is subjected to a temperature rise of 6 K/s.

R88L-EC-FW-1112/-1115

Motor Coil Unit (R88L-EC-FW-☐-ANPC)		1112		1115	
Servo Drives (R88D-☐-ECT-L)		KN15H	KN30F	KN15H	KN30F
Applicable Servo Drives input voltage		200 VAC	400 VAC	200 VAC	400 VAC
Maximum speed (100 VAC)	m/s	–	–	–	–
Maximum speed (200 VAC)	m/s	2	–	2	–
Maximum speed (400 VAC)	m/s	–	4	–	4
Continuous force*1	N	608		760	
Momentary maximum force*2	N	1,600		2,000	
Continuous current*1	Arms	6.5		8.2	
Momentary maximum current*2	Arms	20		25	
Motor force constant	N/Arms	93.0		93.0	
Back electromotive force	V·s/m	31		31	
Motor constant	N/√W	41.47		46.37	
Phase resistance	Ω	1.6		1.29	
Phase inductance	mH	12.8		10.3	
Electrical time constant	ms	8		8	
Maximum continuous power consumption	W	279		349	
Thermal resistance	K/W	0.23		0.18	
Thermal time constant	s	126		126	
Magnetic attraction force	N	3,640		4,440	
Magnetic pole pitch	mm	24		24	
Mass (except cables)	kg	4.45		5.45	
Radiator plate dimensions	mm	371 x 330 x 14		371 x 330 x 14	

*1 This shows a value measured when the Motor Coil Unit is at 100°C and the Magnet Track is at 25°C. As a cooling condition, attach the Motor Coil Unit to the center of an aluminum radiator plate (moving table) of the specified dimensions, shown in the above table.

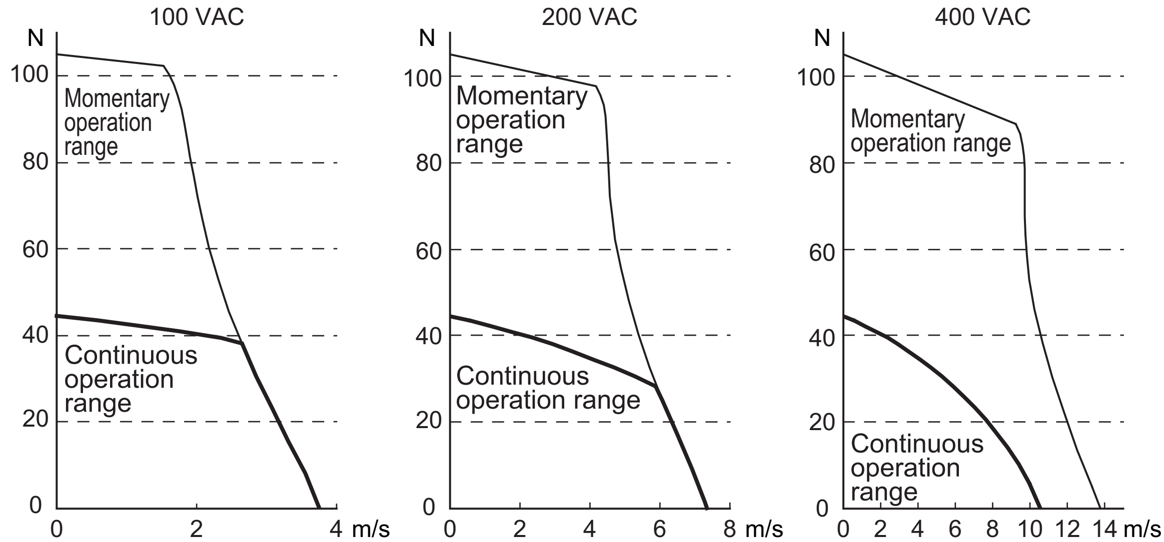
*2 The Motor Coil Unit is subjected to a temperature rise of 6 K/s.

3-3-3 Iron-core Linear Motor Speed - Force Characteristics

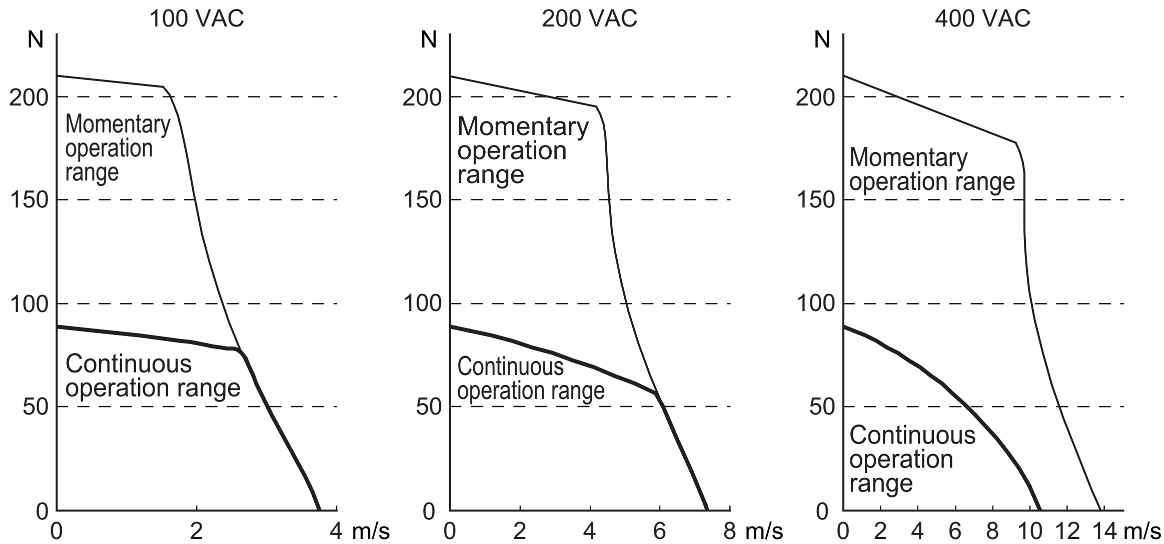
The following graphs show the characteristics when the coil temperature of the Motor Coil Unit is 100°C.

The maximum operation speed is limited by considering the guide mechanism, encoder, and other aspects. If it is 5 m/s or higher, please consult with your OMRON representative.

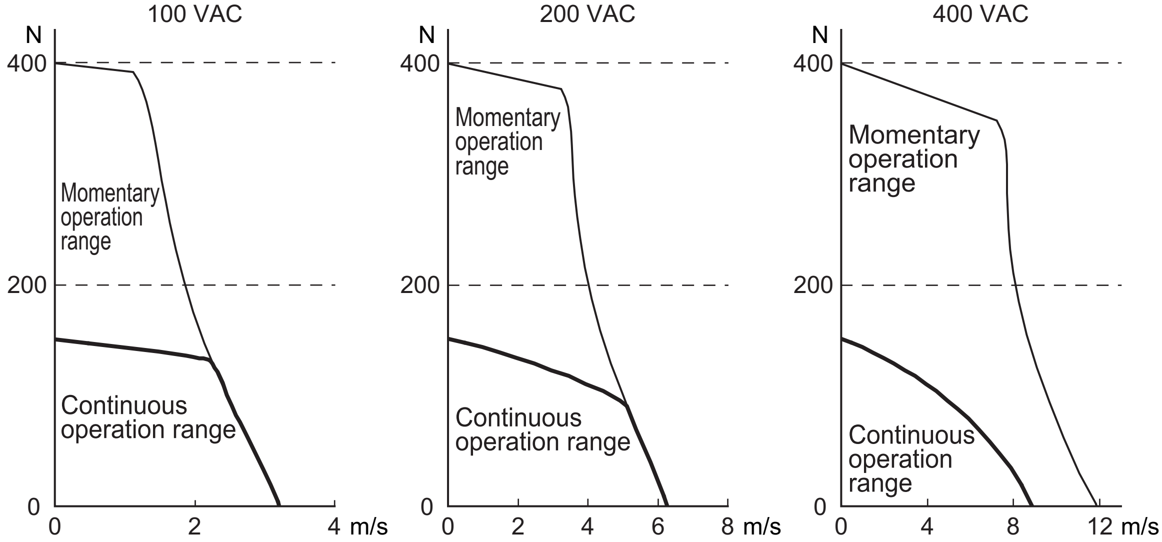
● R88L-EC-FW-0303



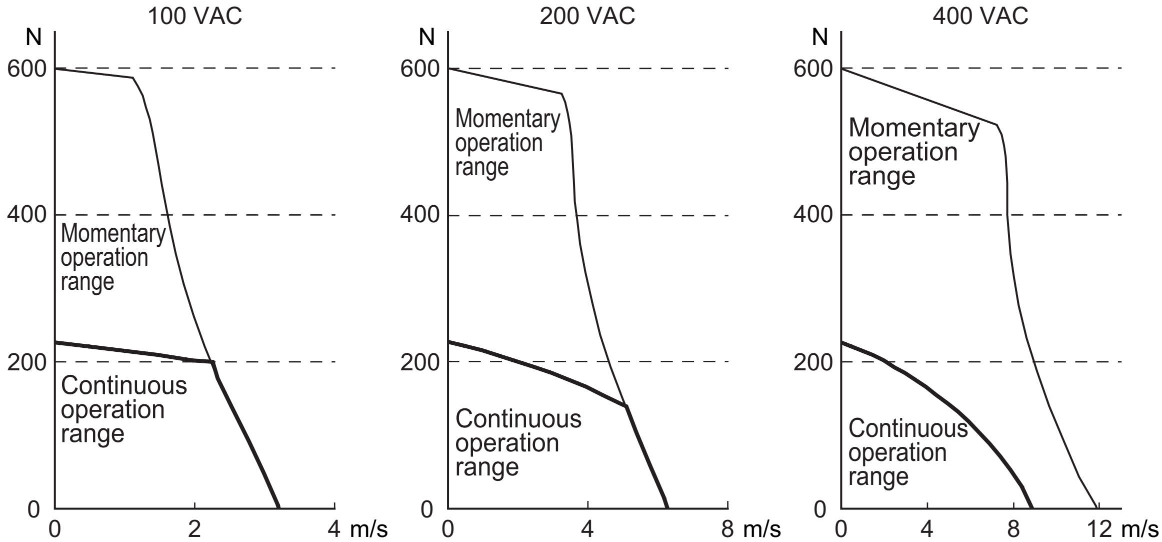
● R88L-EC-FW-0306



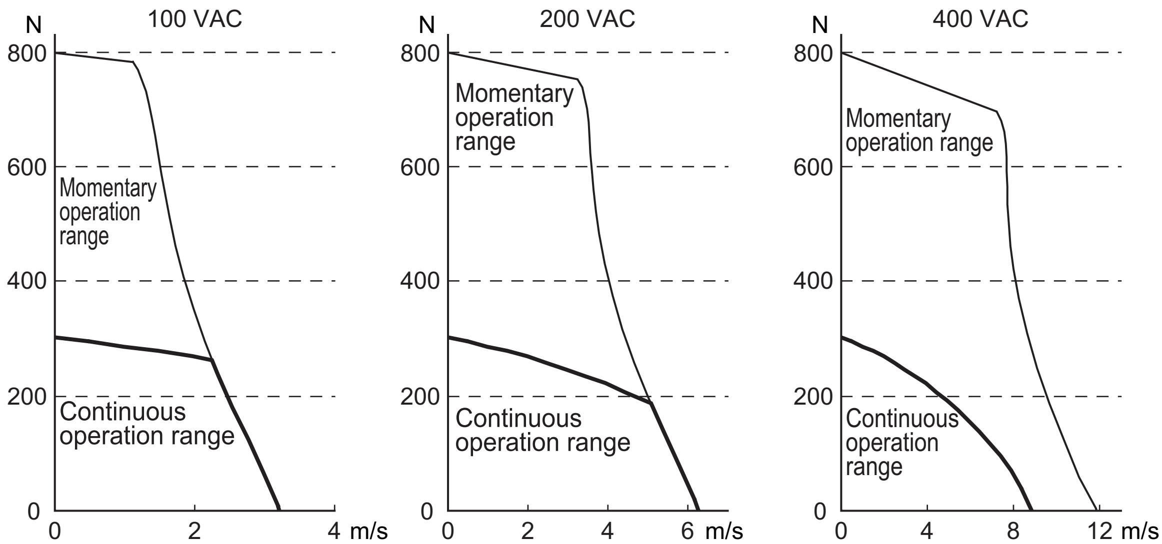
- **R88L-EC-FW-0606**



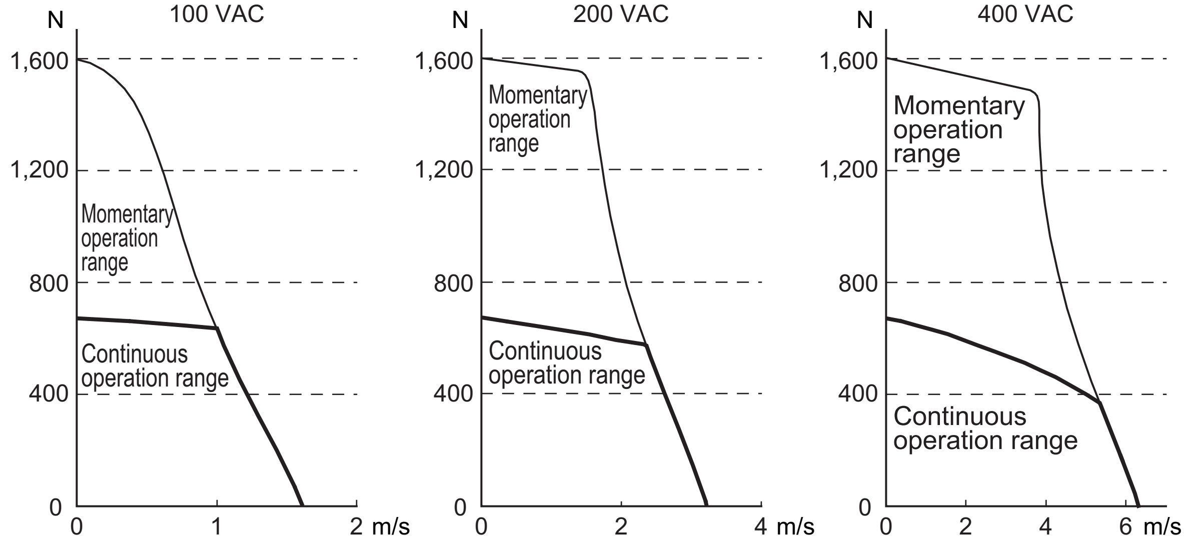
- **R88L-EC-FW-0609**



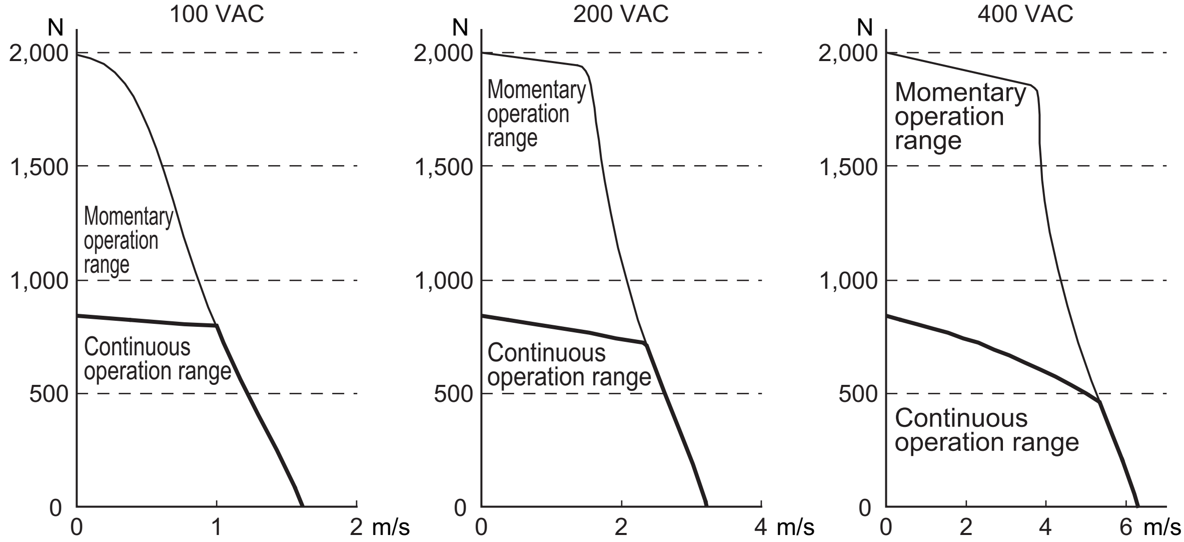
- **R88L-EC-FW-0612**



- **R88L-EC-FW-1112**



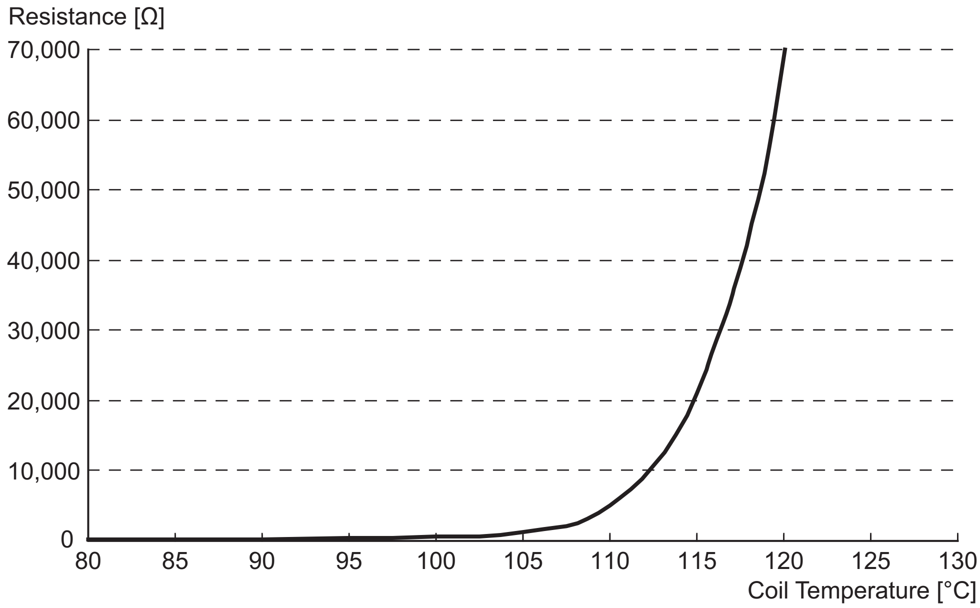
- **R88L-EC-FW-1115**



3-3-4 Temperature Sensor Specifications of Iron-core Linear Motors

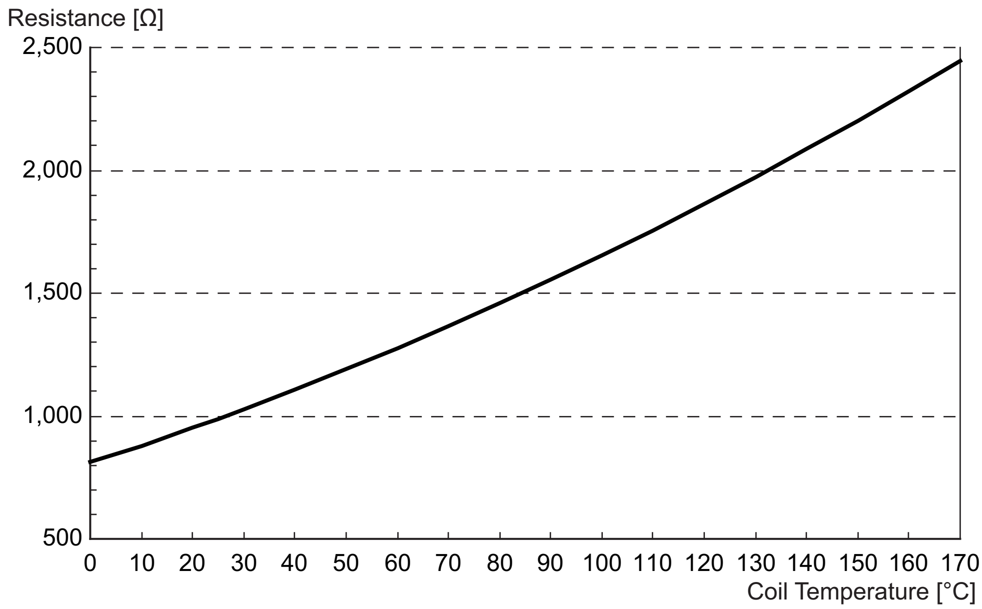
Each Iron-core Linear Motor has one series-connected PTC thermistor per phase.
The thermistor can be used as a switch to stop the motor when the Motor Coil Unit is overheated, by utilizing its characteristic that the resistance increases suddenly at around 110°C.
Iron-core motors also have KTY thermistors that enable the measurement of the average Motor Coil Unit temperature.
The following graphs show the relationship between the resistance value and the temperature.

● PTC



Note 1 The resistance value in a low temperature range is approximately 200 Ω.
2 The resistance value increases suddenly when the temperature is at over 100ºC and reaches approximately 2 kΩ or higher at 105ºC or higher.
3 The temperature detected by a PTC thermistor has an error of approximately ±10ºC. Take this error into account and use the motor within the temperature range specified in the motor specifications. The upper limit temperature is 130ºC.

● KTY



Note 1 The resistance value has an error of 3% to 5%.

3-3-5 General Specifications of Ironless Linear Motors

Item	Description
Operating ambient temperature humidity	0ºC to 40ºC, 20% to 80% (with no condensation)
Storage ambient temperature and humidity	–20ºC to 65ºC, 85% max. (with no condensation)
Operating and storage atmosphere	No corrosive gases
Vibration resistance*1	Acceleration of 49 m/s^2 max. in X, Y, and Z directions
Impact resistance	Acceleration of 98 m/s^2 max. 3 times each in X, Y, and Z directions
Insulation resistance*2	Between power terminal and FG terminal: 10 MΩ min. (at 500 VDC)
Dielectric strength	Between power terminal and FG terminal: 2,250 VDC for 1 s Between power terminal and sensor: 2,250 VDC for 1 s
Protective structure	IP00
Maximum coil temperature (Motor Coil Unit)	110°C
Maximum magnet temperature (Magnet Track)	70°C
Insulation class	Class B
Cooling method	Self-cooling

*1 The amplitude may be increased by machine resonance. As a guideline, do not exceed 80% of the specified value.

*2 Disconnect all connections to the Linear Motor before attempting a megameter test (insulation resistance measurement) on a Linear Motor. Failure to follow this guideline may result in damaging the Linear Motor. In addition, never perform dielectric strength tests on the Linear Motor. Failure to follow this guideline may result in damaging the internal elements.

3-3-6 Performance Specifications of Ironless Linear Motors

The following tables show the performance specifications of various ironless Linear Motor models.

R88L-EC-GW-0303/-0306/-0309

Motor Coil Unit (R88L-EC-GW-☐-ANPS)		0303		0306		0309
Servo Drives (R88D-☐-ECT-L)		**KN01L**	**KN02H**	**KN04L**	**KN08H**	**KN10H**
Applicable Servo Drives input voltage		**100 VAC**	**200 VAC**	**100 VAC**	**200 VAC**	**200 VAC**
Maximum speed (100 VAC)	m/s	8	–	8	–	–
Maximum speed (200 VAC)	m/s	–	16	–	16	16
Continuous force*1	N	26.5		53		80
Momentary maximum force*2	N	100	96	200		300
Continuous current*1	Arms	1.33		2.66		4.0
Momentary maximum current*2	Arms	5.0	4.8	10.0		15.0
Motor force constant	N/Arms	19.9		19.9		19.9
Back electromotive force	V·s/m	6.6		6.6		6.6
Motor constant	N/√W	4.90		6.93		8.43
Phase resistance	Ω	5.5		2.8		1.8
Phase inductance	mH	1.8		0.9		0.6
Electrical time constant	ms	0.35		0.35		0.35

Motor Coil Unit (R88L-EC-GW-☐-ANPS)		0303		0306		0309
Servo Drives (R88D-☐-ECT-L)		KN01L	KN02H	KN04L	KN08H	KN10H
Applicable Servo Drives input voltage		100 VAC	200 VAC	100 VAC	200 VAC	200 VAC
Maximum continuous power consumption	W	47		95		142
Thermal resistance	K/W	2.1		1.06		0.71
Thermal time constant	s	36		36		36
Magnetic attraction force	N	0		0		0
Magnetic pole pitch	mm	30		30		30
Mass (except cables)	kg	0.084		0.162		0.24

*1 This shows a value measured when the Motor Coil Unit is at 110°C and the Magnet Track is at 25°C.

*2 The Motor Coil Unit is subjected to a temperature rise of 40 K/s.

R88L-EC-GW-0503/-0506/-0509

Motor Coil Unit (R88L-EC-GW-☐-ANPS)		0503		0506		0509	
Servo Drives (R88D-☐-ECT-L)		KN01L	KN01H	KN02L	KN04H	KN04L	KN08H
Applicable Servo Drives input voltage		100 VAC	200 VAC	100 VAC	200 VAC	100 VAC	200 VAC
Maximum speed (100 VAC)	m/s	2.2	–	2.2	–	2.2	–
Maximum speed (200 VAC)	m/s	–	4.4	–	4.4	–	4.4
Continuous force*1	N	58		117		175	
Momentary maximum force*2	N	240		480		720	
Continuous current*1	Arms	0.87		1.76		2.60	
Momentary maximum current*2	Arms	3.50		7.1		10.6	
Motor force constant	N/Arms	68.0		68.0		68.0	
Back electromotive force	V·s/m	22.7		22.7		22.7	
Motor constant	N/√W	9.85		13.96		17.03	
Phase resistance	Ω	15.9		8.0		5.3	
Phase inductance	mH	13.0		6.5		4.2	
Electrical time constant	ms	0.8		0.8		0.8	
Maximum continuous power consumption	W	67		134		200	
Thermal resistance	K/W	1.70		0.85		0.65	
Thermal time constant	s	72		72		72	
Magnetic attraction force	N	0		0		0	
Magnetic pole pitch	mm	42		42		42	
Mass (except cables)	kg	0.25		0.47		0.69	

*1 This shows a value measured when the Motor Coil Unit is at 110°C and the Magnet Track is at 25°C.

*2 The Motor Coil Unit is subjected to a temperature rise of 20 K/s.

R88L-EC-GW-0703/-0706/-0709

Motor Coil Unit (R88L-EC-GW-☐-ANPS)		0703		0706		0709
Servo Drives (R88D-☐-ECT-L)		KN02L	KN04H	KN04L	KN08H	KN10H
Applicable Servo Drives input voltage		100 VAC	200 VAC	100 VAC	200 VAC	200 VAC
Maximum speed (100 VAC)	m/s	1.2	–	1.2	–	–
Maximum speed (200 VAC)	m/s	–	2.4	–	2.4	2.4
Continuous force*1	N	117		232		348
Momentary maximum force*2	N	552		1,110		1,730
Continuous current*1	Arms	0.94		1.87		2.81
Momentary maximum current*2	Arms	4.5		9.0		14
Motor force constant	N/Arms	124.0		124.0		124.0
Back electromotive force	V·s/m	41.3		41.3		41.3
Motor constant	N/√W	17.97		25.44		31.14
Phase resistance	Ω	15.8		7.9		5.3
Phase inductance	mH	28.0		14.0		9.0
Electrical time constant	ms	1.8		1.8		1.8
Maximum continuous power consumption	W	82		165		247
Thermal resistance	K/W	1.56		1.04		0.52
Thermal time constant	s	96		96		96
Magnetic attraction force	N	0		0		0
Magnetic pole pitch	mm	57		57		57
Mass (except cables)	kg	0.55		0.95		1.35

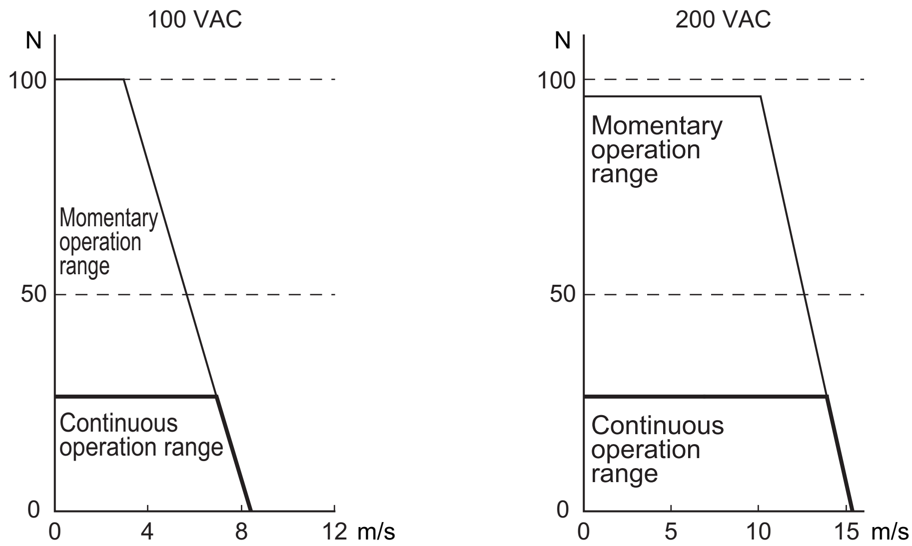
*1 This shows a value measured when the Motor Coil Unit is at 110°C and the Magnet Track is at 25°C.

*2 The Motor Coil Unit is subjected to a temperature rise of 20 K/s.

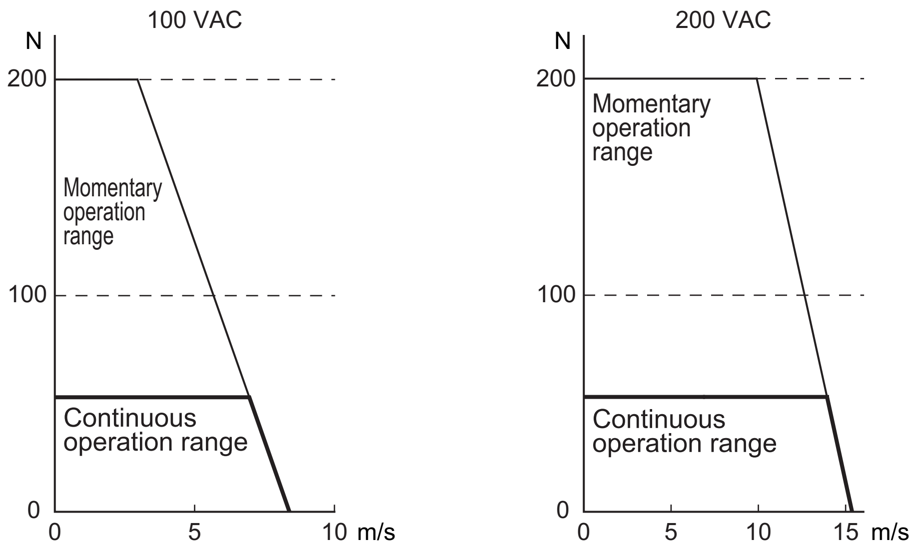
3-3-7 Ironless Linear Motor Speed - Force Characteristics

The maximum operation speed is limited by considering the guide mechanism, encoder, and other aspects. If it is 5 m/s or higher, please consult with your OMRON representative.

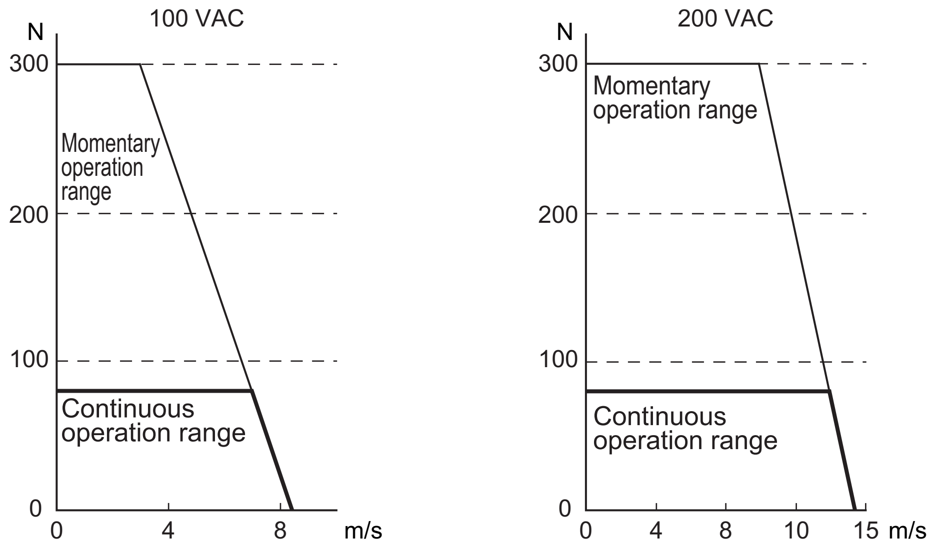
- **R88L-EC-GW-0303**



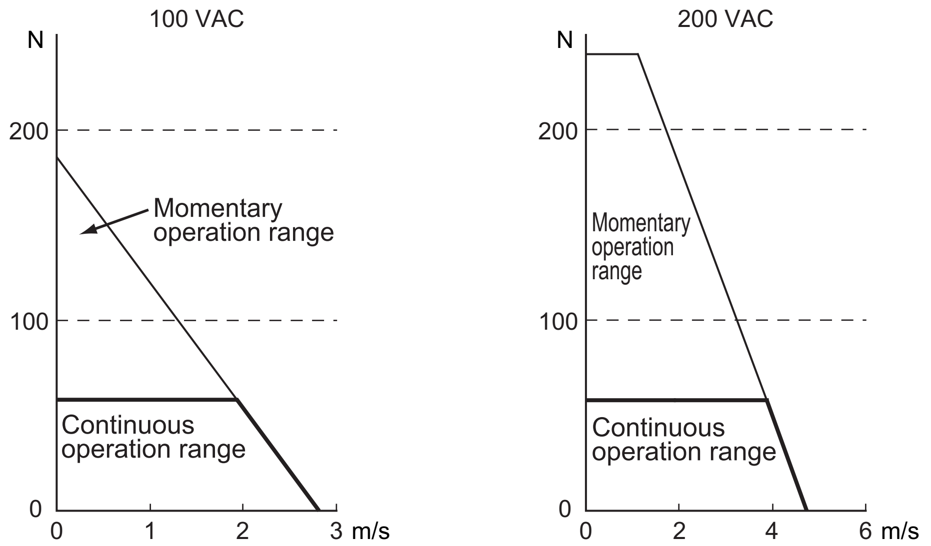
- **R88L-EC-GW-0306**



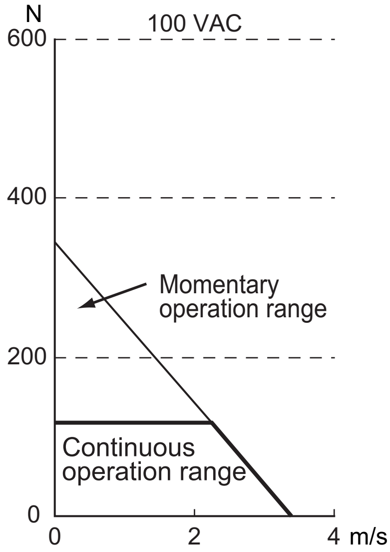
- **R88L-EC-GW-0309**

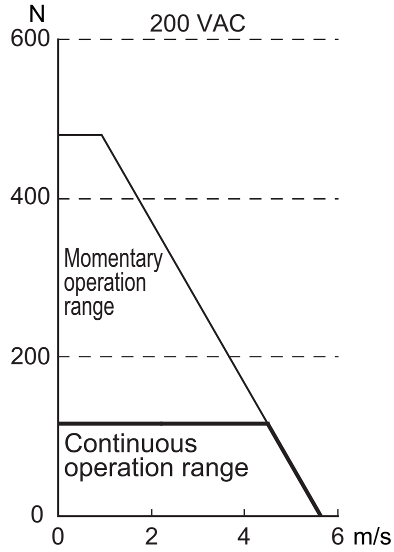


- **R88L-EC-GW-0503**

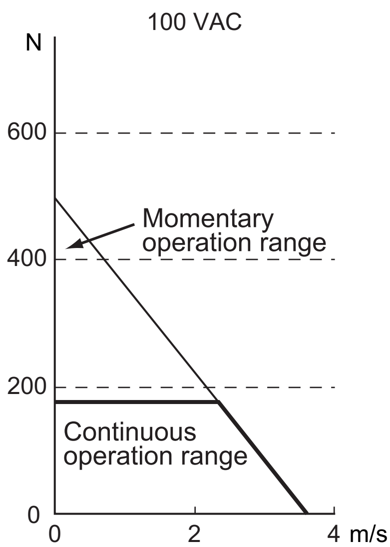


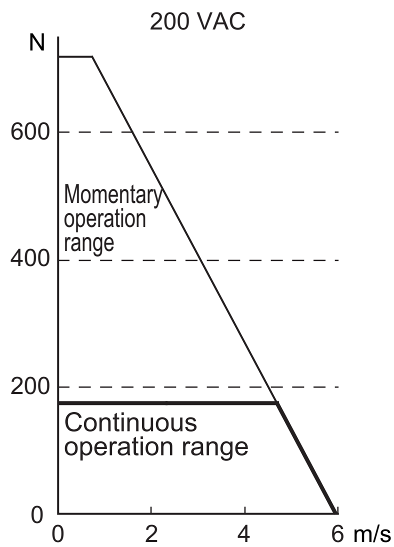
- **R88L-EC-GW-0506**



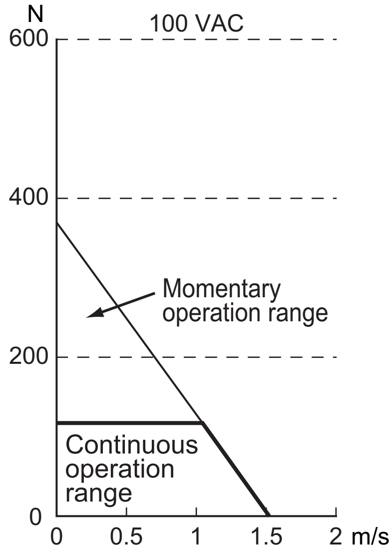


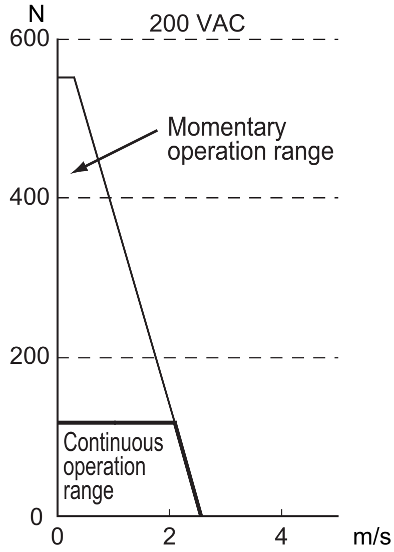
- **R88L-EC-GW-0509**



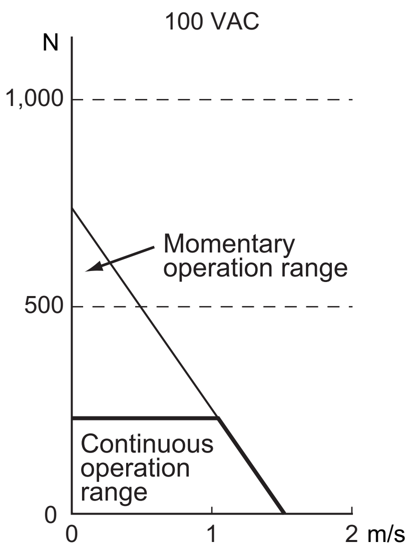


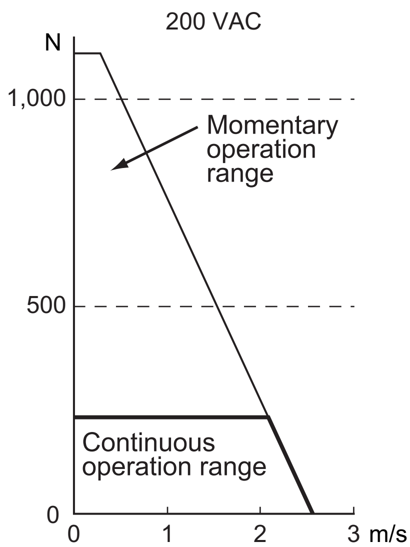
- **R88L-EC-GW-0703**



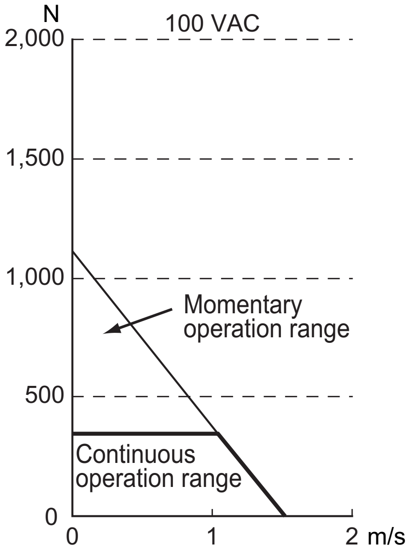


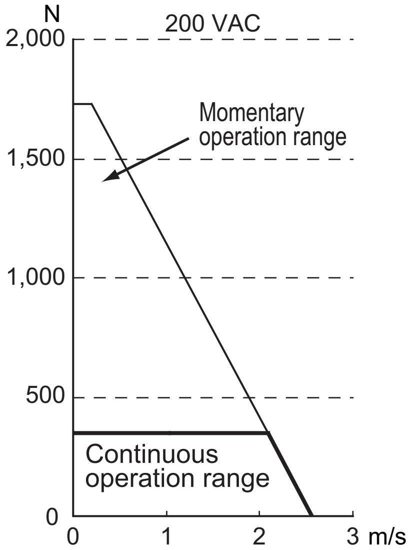
- **R88L-EC-GW-0706**





- **R88L-EC-GW-0709**

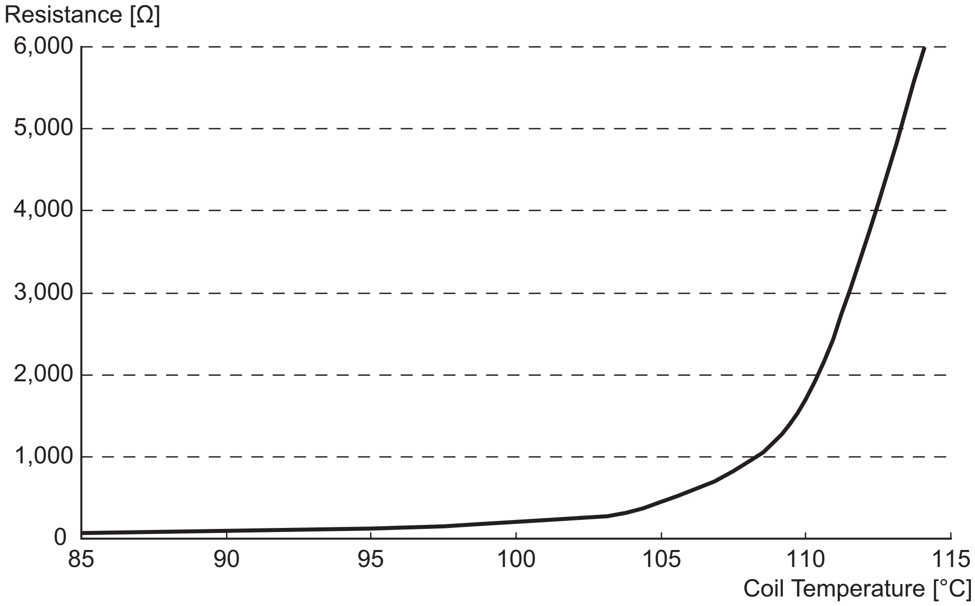




3-3-8 Temperature Sensor Specifications of Ironless Linear Motors

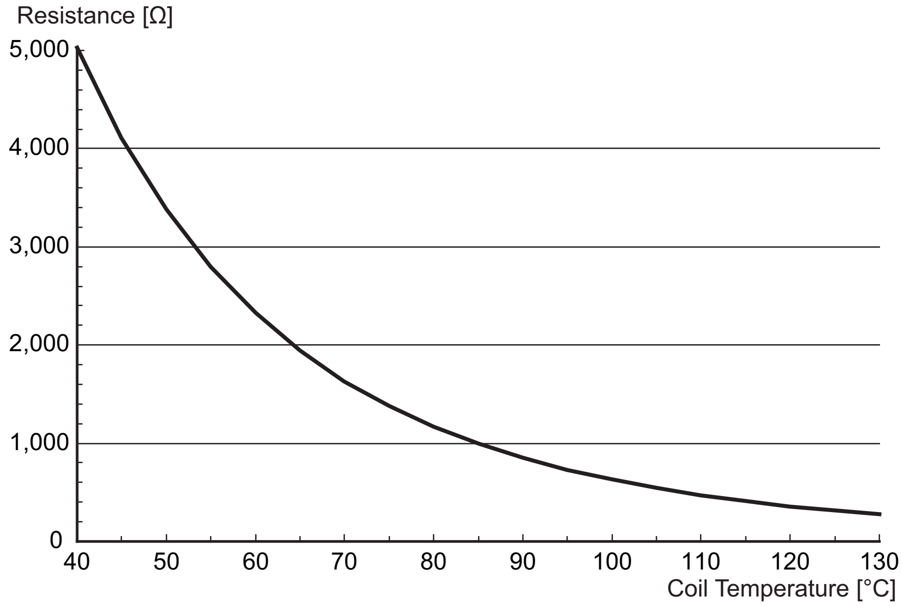
Ironless Linear Motors have one PTC thermistor in its Motor Coil Unit.
This PTC thermistor has a characteristic that the resistance increases suddenly at around 110ºC.
Utilize this characteristic to build a circuit to stop the motor in case of overheating.
Be sure to build a circuit that detects overheating at a resistance at around 90ºC to 100ºC, so that the maximum coil temperature 110ºC allowed for the Motor Coil Unit is not exceeded.
Ironless Linear Motors also have another NTC thermistor for measuring the average Motor Coil Unit temperature.

● PTC



Note 1 The resistance value in a low temperature range is approximately 50 Ω.
2 The resistance value increases gradually when the temperature is at over 90ºC.
3 The temperature detected by a PTC thermistor has an error of approximately ±10ºC. Take this error into account and use the motor at or lower than the maximum temperature allowed for the Motor Coil Unit. The upper limit temperature is 110ºC.

● NTC



Note The temperature value has an error of ±7 to ±10ºC.

3-3-9 Cable Specifications

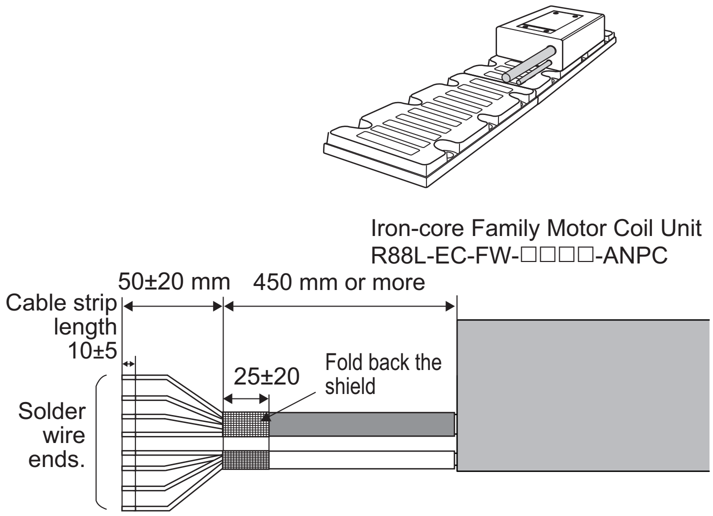
The following cables come out from iron-core/ironless family Motor Coil Units.

Iron-core Family Motor Coil Unit (R88L-EC-FW-☐-ANPC)

The cable length is 450 mm or more.

● Power Cable

Wire color	Signal name
Black (1ONE)	U
Black (2TWO)	V
Black (3THREE)	W
Green/Yellow	GND



● Temperature Sensor Cable

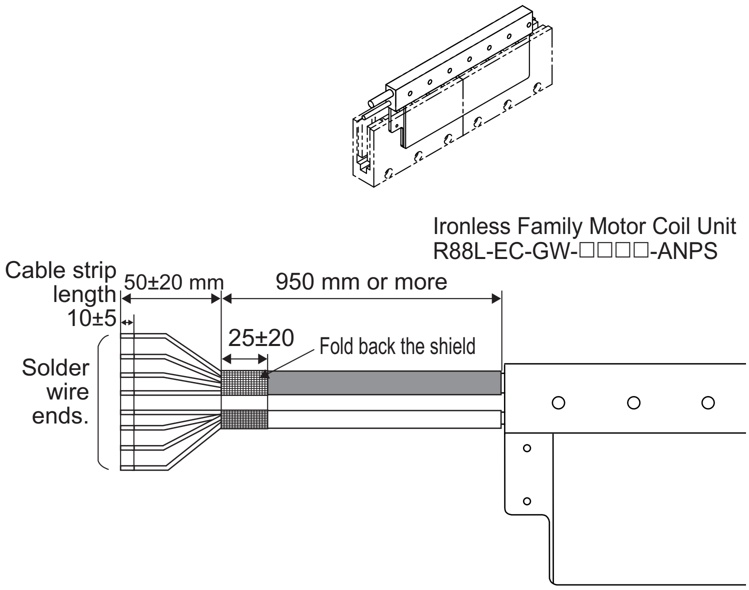
Wire color	Signal name
Green	KTY
Yellow	KTY
White	PTC
Brown	PTC

Ironless Family Motor Coil Unit (R88L-EC-GW-☐-ANPS)

The cable length is 950 mm or more.

● Power Cable

Wire color	Signal name
Black	U
Red	V
White	W
Green	GND



● Temperature Sensor Cable

Wire color	Signal name
Green	NTC
Yellow	NTC
White	PTC
Brown	PTC

3-4 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.

3-4-1 Resistance to Bending of Robot Cable

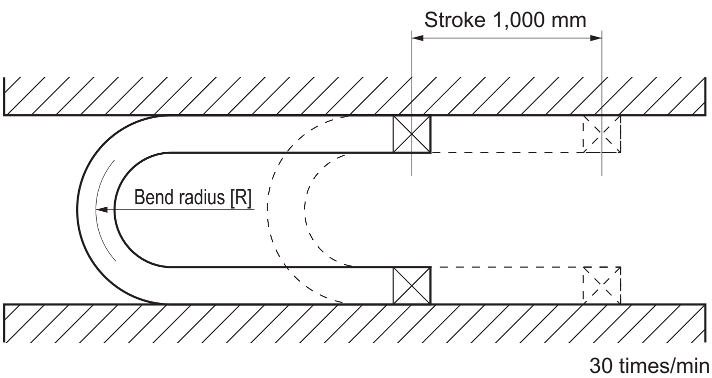
If the cable is used at a moving part, use a robot cable.

Regarding the bending life of a robot cable, a wire rod with a durability of more than 20 million times of use at or above the minimum bending radius is used under the conditions below.

Precautions for Correct Use

- Because the life expectancy data on resistance to bending is intended for reference only, use the cable with a sufficient margin.
- The durability of more than 20 million times of use refers to the number of times which the core conductor provides electrical continuity without causing cracks and scratches that can have functional impact on the sheath, which does not cover the disconnection of shielded wire.
- Malfunction or grounding fault due to dielectric breakdown may occur if cables are used at a radius smaller than the minimum bending radius.

Moving Bend Test



External Encoder Cable

Model	Minimum bend radius [R]
R88A-CRKE010SR	40 mm

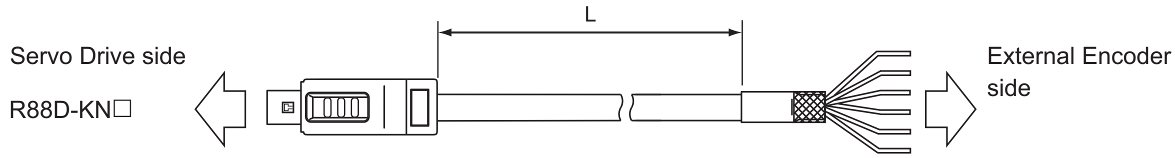
3-4-2 External Encoder Cable Specifications

These cables connect the Servo Drive and an external encoder.

● Cable Model

Model	Length [L]	Outer diameter of sheath	Mass
R88A-CRKE010SR	10 m	6.5 dia	Approx. 0.6 kg

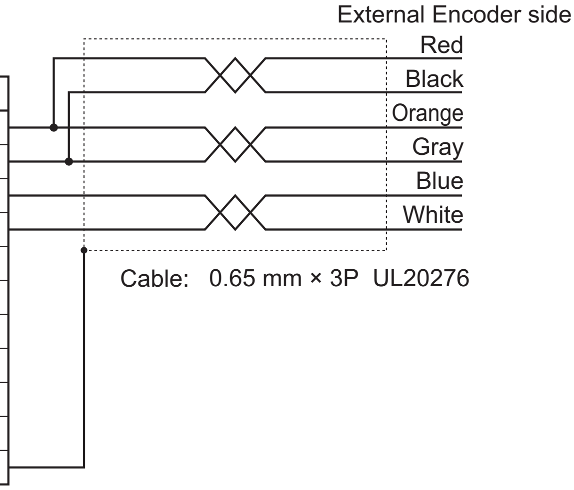
● Connection Configuration and External Dimensions



● Wiring

Servo Drive side

No.	Symbol
1	E5V
2	E0V
3	+EXS
4	-EXS
5	+EXA
6	-EXA
7	+EXB
8	-EXB
9	+EXZ
10	-EXZ
Shell	FG



[Servo Drive side connector]

Connector plug model

- MUF-PK10K-X (J.S.T. Mfg. Co., Ltd.)
- OMRON model: R88A-CNK41L

3-4-3 Connector Specifications

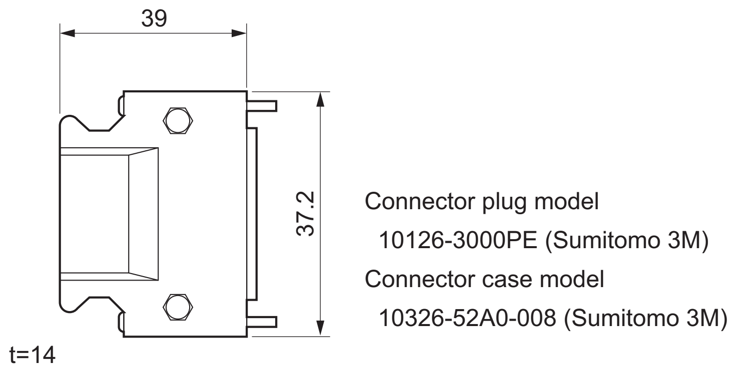
This section describes the specifications of the control I/O connector, power cable connector, external encoder connector, and safety I/O signal connector.

Control I/O Connector (R88A-CNW01C)

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

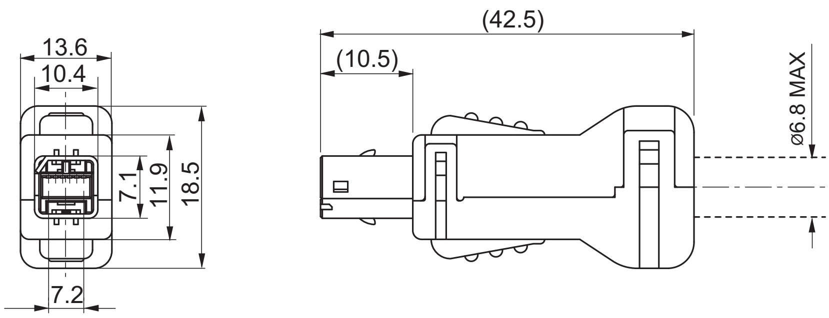
Use this connector when preparing a control cable by yourself.

- **Dimensions**



External Encoder Connector (R88A-CNK41L)

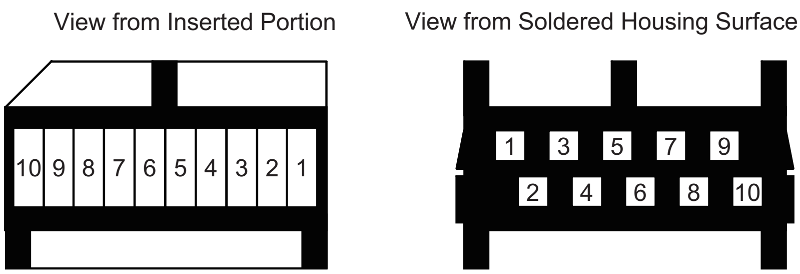
Use this connector to connect to an external encoder.



Connector plug model

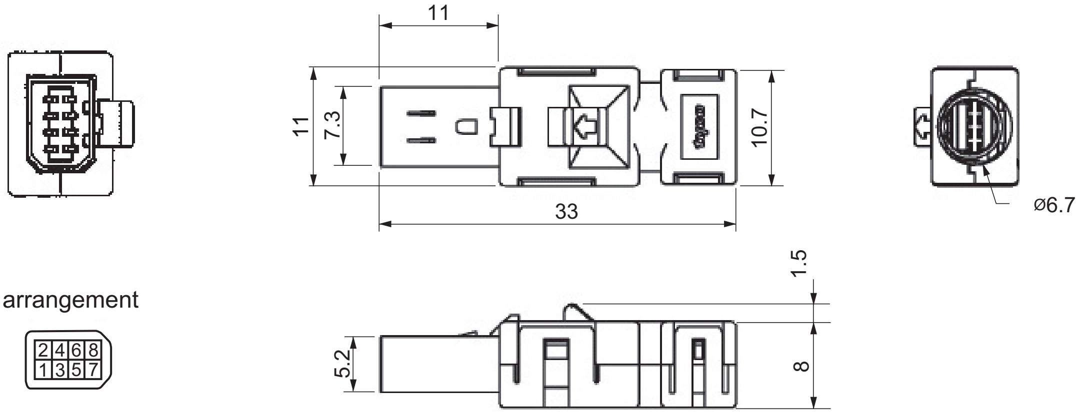
MUF-PK10K-X (J.S.T. Mfg. Co., Ltd.)

- **Pin Arrangement**



Safety I/O Signal Connector (R88A-CNK81S)

Use this connector to connect to a safety device.



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 *3-1-14 Safety Connector Specifications (CN8)* on page 3-22.

3-4-4 EtherCAT Communications Cable Specifications

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

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 x 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	Contact
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

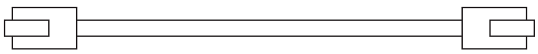
*1 It is recommended that you use this connector in combination with the Kuramo Electric Co. KETH-PSB-OMR cable.

Precautions for Correct Use

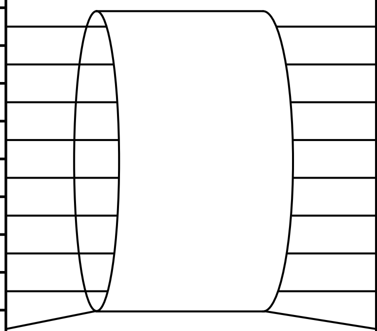
When selecting a connector, confirm that is applicable to the cable that will be used. Confirm the following items: Conductor size, conductor type (solid wire or twisted wire), number of twisted pairs (2 or 4), outer diameter, etc.

Attaching the Connectors to the Cable

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



Pin No.	Wire color
1	White-Green
2	Green
3	White-Orange
4	Blue
5	White-Blue
6	Orange
7	White-Brown
8	Brown
Connector hood	Shield



Wire color	Pin No.
White-Green	1
Green	2
White-Orange	3
Blue	4
White-Blue	5
Orange	6
White-Brown	7
Brown	8
Shield	Connector hood

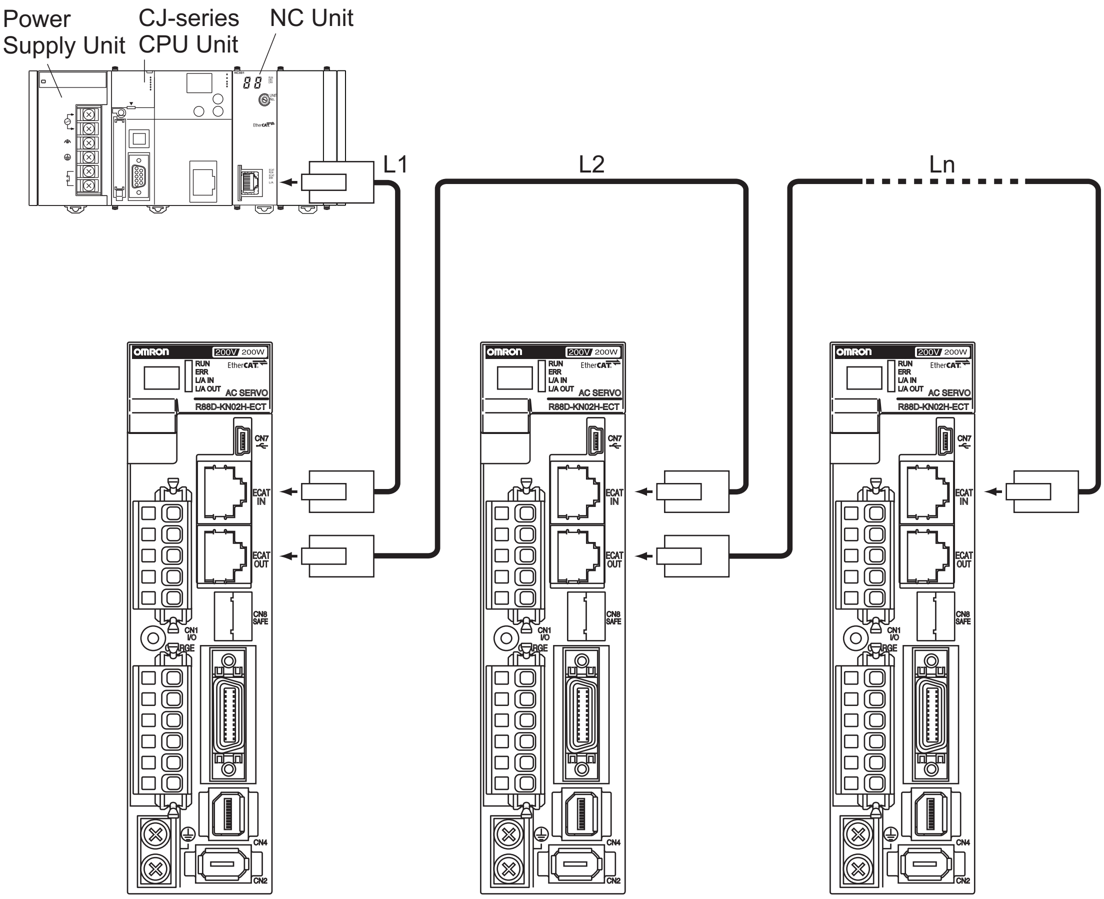
Note 1 Connect the cable shield to the connector hood at both ends of the cable.

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/NCF82 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.



Precautions for Correct Use

- 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.

3-4-5 Analog Monitor Cable Specifications

Analog Monitor Cable (R88A-CMK001S)

- **Connection Configuration and External Dimensions**

Symbol	No.
AM1	1
AM2	2
GND	3
	4
	5
	6

Red

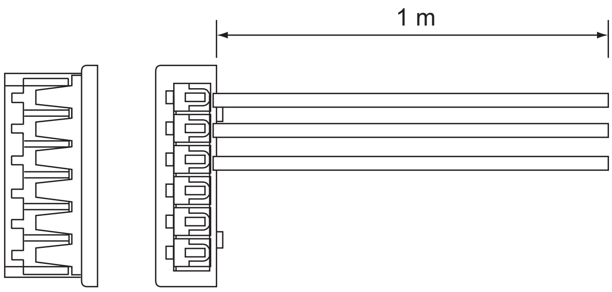
White

Black

Cable: AWG24×3C UL1007

Connector housing: 51004-0600 (Molex Japan)

Connector terminal: 50011-8000 (Molex Japan)



3-4-6 Control Cable Specifications

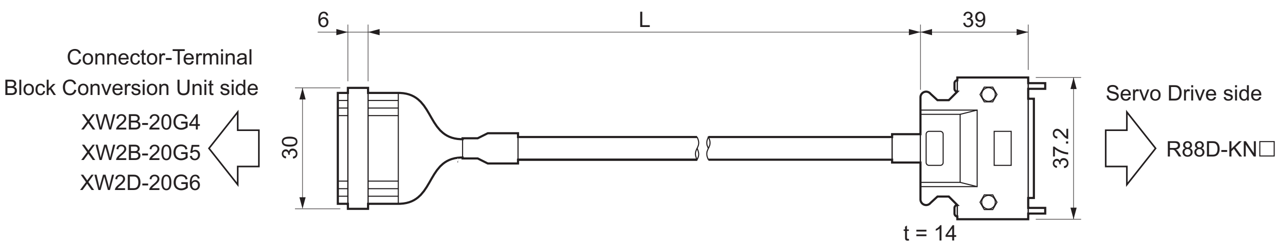
Cables for Servo Drives (XW2Z-□J-B34)

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	Mass
XW2Z-100J-B34	1 m	8.8 dia.	Approx. 0.1 kg
XW2Z-200J-B34	2 m		Approx. 0.2 kg

● Connection Configuration and External Dimensions



● Wiring

Terminal block connector / Servo Drive connector (CN1)

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

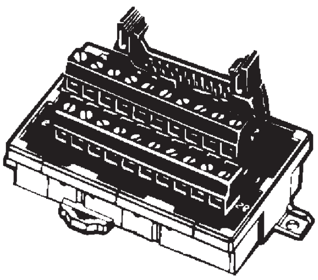
The Unit is used with a Connector Terminal Block Cable (Model: XW2Z-☐J-B34).

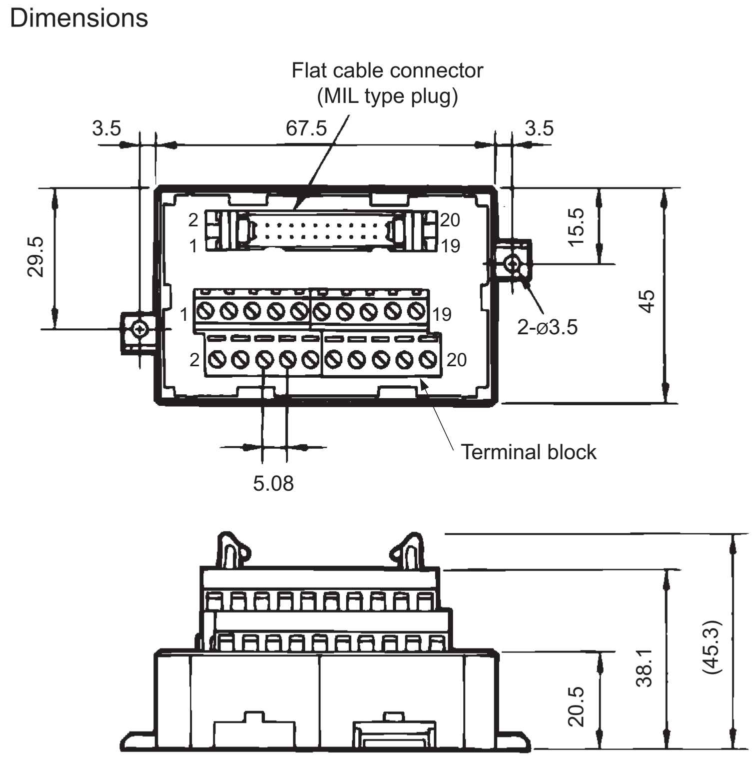
They convert the control input signal (CN1) of the G5-series Servo Drive into a terminal block.

● Terminal Block Models

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

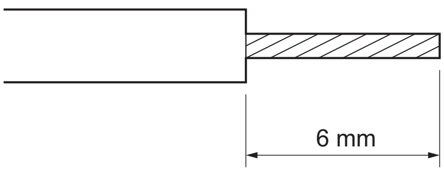
● XW2B-20G4



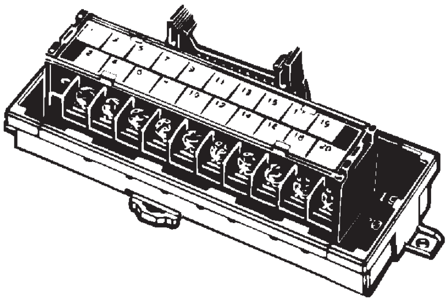


Precautions for Correct Use

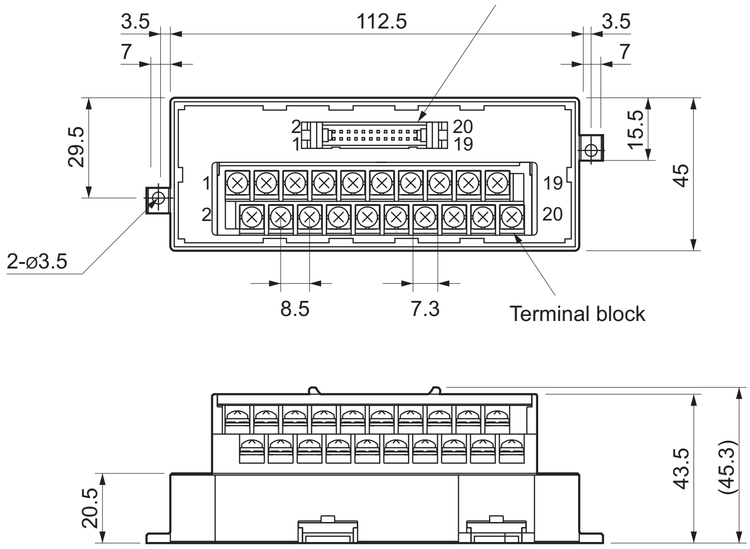
- Use 0.30 to 1.25 mm^2 wire (AWG22 to 16).
- The wire inlet of M3 screw terminal block is 1.8 mm (height) × 2.5 mm (width).
- Strip the insulation from the end of the wire for 6 mm as shown below.



- **XW2B-20G5**



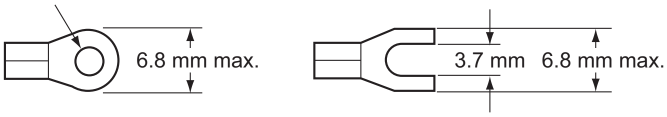
Dimensions



Note The pitch of terminals is 8.5 mm.

Precautions for Correct Use

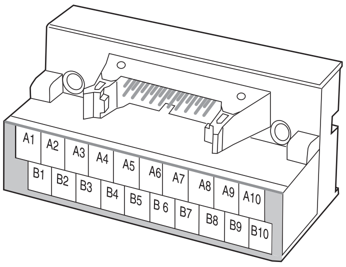
- When using crimp terminals, use crimp terminals with the following dimensions.



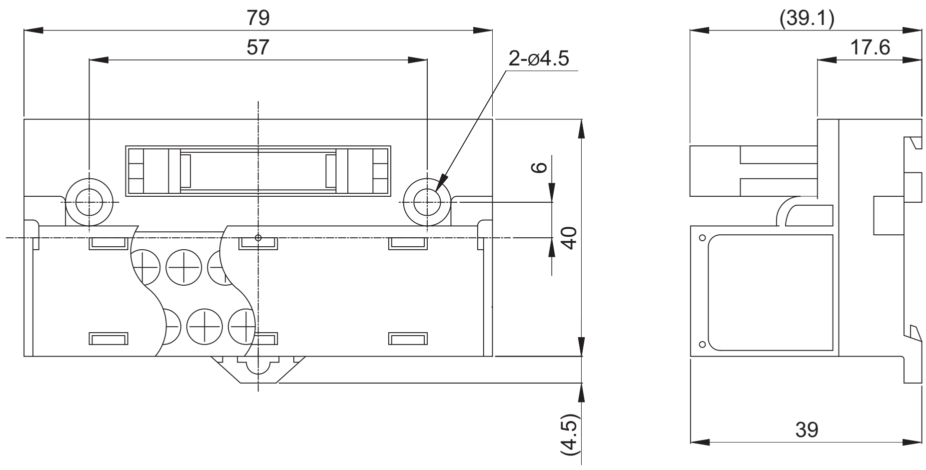
Applicable crimp terminals		Applicable wires
Round terminals	1.25 to 3	AWG22 to 16 (0.30 to 1.25 mm^2)
	2 to 3.5	AWG16 to 14 (1.25 to 2.0 mm^2)
Fork terminals	1.25Y to 3	AWG22 to 16 (0.30 to 1.25 mm^2)
	2 to 3.5	AWG16 to 14 (1.25 to 2.0 mm^2)

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

- **XW2D-20G6**

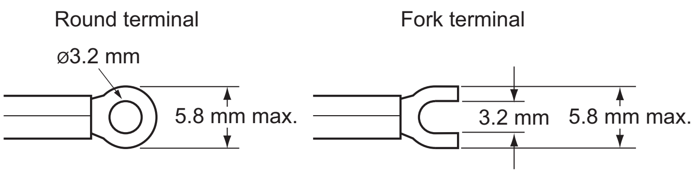


Dimensions



Precautions for Correct Use

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

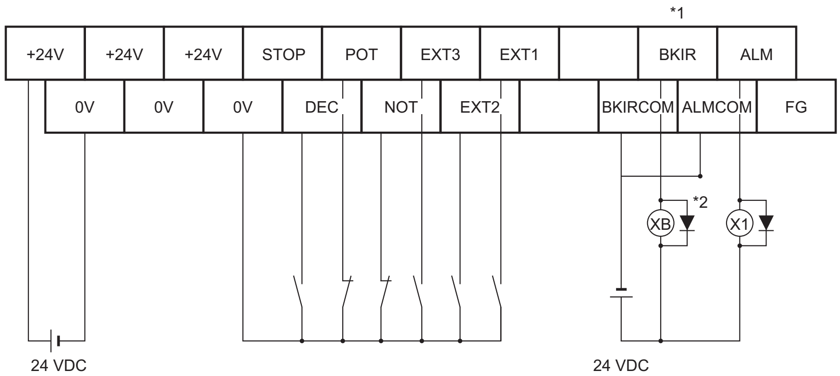


Applicable crimp terminals		Applicable wires
Round terminals	1.25 to 3	AWG22 to 16 (0.30 to 1.25 mm^2)
Fork terminals	1.25Y to 3	AWG22 to 16 (0.30 to 1.25 mm^2)

- 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.



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

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

3-5 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 *4-5 Regenerative Energy Absorption* on page 4-47.

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-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)

3-6 Reactor Specifications

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

Select an appropriate Reactor for your Servo Drive model.

Servo Drives		Reactor			
Model	Number of power phases	Model	Rated current	Inductance	Mass
R88D-KN01L-ECT-L	Single-phase input	3G3AX-DL2004	3.2A	10.7 mH	Approx. 1.0 kg
R88D-KN02L-ECT-L		3G3AX-DL2007	6.1A	6.75 mH	Approx. 1.3 kg
R88D-KN04L-ECT-L		3G3AX-DL2015	9.3A	3.51 mH	Approx. 1.6 kg
R88D-KN01H-ECT-L	Single-phase input	3G3AX-DL2002	1.6A	21.4 mH	Approx. 0.8 kg
	3-phase input	3G3AX-AL2025	10.0A	2.8 mH	Approx. 2.8 kg
R88D-KN02H-ECT-L	Single-phase input	3G3AX-DL2004	3.2A	10.7 mH	Approx. 1.0 kg
	3-phase input	3G3AX-AL2025	10.0A	2.8 mH	Approx. 2.8 kg
R88D-KN04H-ECT-L	Single-phase input	3G3AX-DL2007	6.1A	6.75 mH	Approx. 1.3 kg
	3-phase input	3G3AX-AL2025	10.0A	2.8 mH	Approx. 2.8 kg
R88D-KN08H-ECT-L	Single-phase input	3G3AX-DL2015	9.3A	3.51 mH	Approx. 1.6 kg
	3-phase input	3G3AX-AL2025	10.0A	2.8 mH	Approx. 2.8 kg
R88D-KN10H-ECT-L	Single-phase input	3G3AX-DL2015	9.3A	3.51 mH	Approx. 1.6 kg
	3-phase input	3G3AX-AL2025	10.0A	2.8 mH	Approx. 2.8 kg
R88D-KN15H-ECT-L	Single-phase input	3G3AX-DL2022	13.8A	2.51 mH	Approx. 2.1 kg
	3-phase input	3G3AX-AL2025	10.0A	2.8 mH	Approx. 2.8 kg
R88D-KN06F-ECT-L	3-phase input	3G3AX-AL4025	6.0A	7.7 mH	Approx. 2.7 kg
R88D-KN10F-ECT-L					
R88D-KN15F-ECT-L					
R88D-KN20F-ECT-L		3G3AX-AL4055	10.0A	3.5 mH	Approx. 4.0 kg
R88D-KN30F-ECT-L					

4

System Design

This section explains the installation conditions, wiring methods which include wiring conforming to EMC directives, and regenerative energy calculation methods for the Servo Drive and Linear Motor, and also describes the performance of External Regeneration Resistors.

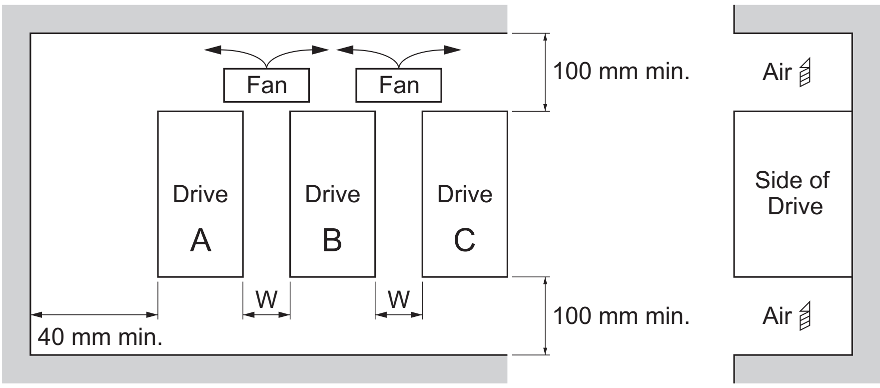
4-1 Installation Conditions

This section describes the installation conditions for the Servo Drive and Linear Motor.

4-1-1 Installation Conditions

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	10 mm min.

- 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).

To provide electrical continuity, 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.

Operating Environment Conditions

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

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

Additional Information

For Drives of 100 V or 200 V with a capacity of 750 W max., the specifications for operating ambient temperature depend on the Drive (A, B, and C) when the clearance between Drives is 1 mm.

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 a 100% output of the rated torque and rated speed, its life is expected to be approximately 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

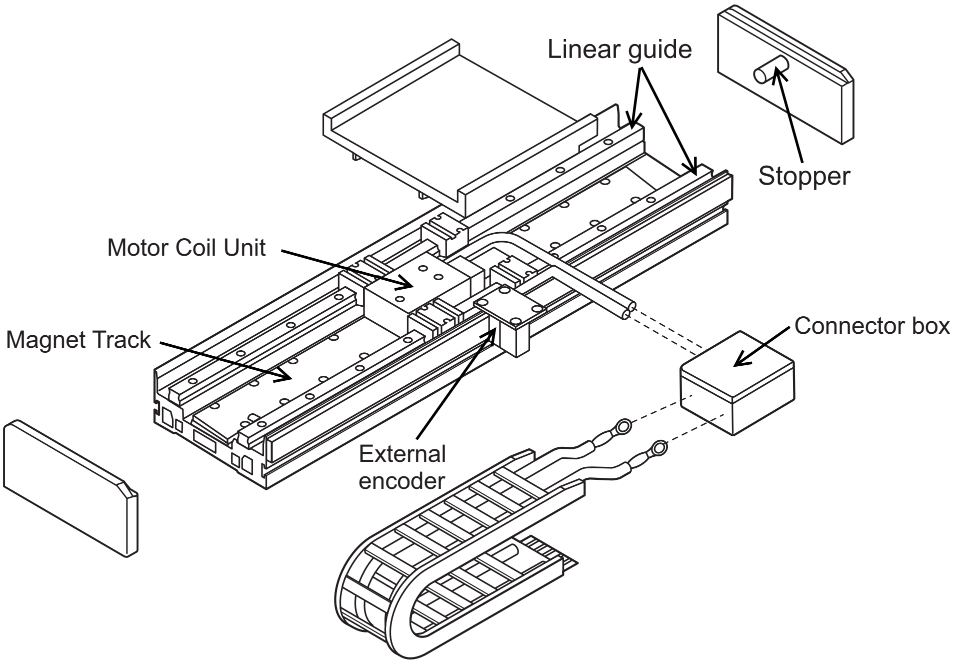
- Place a cover over the drive or take other preventative measures to prevent foreign objects, such as drill filings, from getting into the drive during installation. Be sure to remove the cover after installation is complete. If the cover is left on during operation, drive's heat dissipation is blocked,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

4-1-2 Iron-core Linear Motor Installation Conditions

Before operating the Linear Motor, it is necessary to assemble parts such as the linear guides and the external encoder into the Linear Slider, in addition to the Motor Coil Unit and the Magnet Track.

An example of the Linear Slider is shown below.

When designing a Linear Slider, prepare proper parts for the system and implement sufficient measures to ensure safety operation.

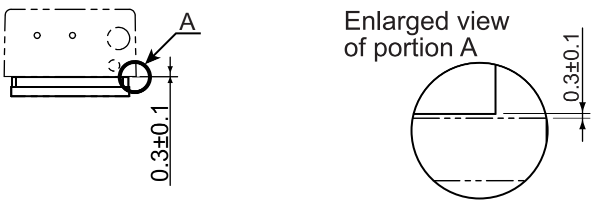


Installation and Design Conditions

● Mechanical Tolerance

Design and install a Linear Motor system that meets the following requirements.

Item	Tolerance
Flatness of Motor Coil Unit mounting surface	0.1 mm across the entire length of Motor Coil Unit
Flatness of Magnet Track mounting surface	0.1 mm/m
Accumulative pitch error of Magnet Track mounting screws	±0.2 mm
Parallelism between Motor Coil Unit and Magnet Track mounting surfaces	0.2 mm/m
Center position of Motor Coil Unit and Magnet Track	0.5 mm across the entire length of Motor Coil Unit
Distance between Motor Coil Unit and Magnet Track	0.3 mm ± 0.1 mm

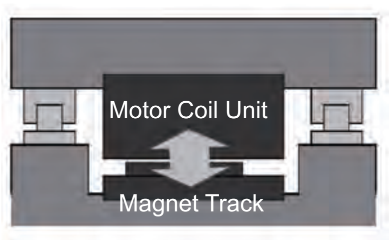


● Magnetic Attraction Force

In the Linear Motor, a magnetic attraction force is exerted between the Motor Coil Unit and the Magnet Track, which (calculated value) is shown in the table below.

Design a system with consideration of the magnetic attraction force.

Motor Coil Unit model	Magnetic attraction force [N]
R88L-EC-FW-0303-ANPC	300
R88L-EC-FW-0306-ANPC	500
R88L-EC-FW-0606-ANPC	1,020
R88L-EC-FW-0609-ANPC	1,420
R88L-EC-FW-0612-ANPC	1,820
R88L-EC-FW-1112-ANPC	3,640
R88L-EC-FW-1115-ANPC	4,440



● Thermal Conductivity of Motor Coil Unit

- The Motor Coil Unit becomes hot during operation. For the Motor Coil Unit, install a moving table (radiator plate) of the recommended dimensions or larger to provide sufficient heat dissipation into the moving table and air.

Motor Coil Unit model	Moving table dimensions
R88L-EC-FW-0303-ANPC	238 × 220 × 10
R88L-EC-FW-0306-ANPC	
R88L-EC-FW-0606-ANPC	250 × 287 × 12
R88L-EC-FW-0609-ANPC	
R88L-EC-FW-0612-ANPC	
R88L-EC-FW-1112-ANPC	371 × 330 × 14
R88L-EC-FW-1115-ANPC	

- Make sure that there is a thermal contact between the Motor Coil Unit and the moving table. To provide good heat dissipation, apply thermal conductive silicon.

- Provide appropriate ventilation as required to prevent excessive rise of the ambient temperature since the heat is dissipated into the air.
- If the rise of the ambient temperature must be suppressed for a certain application, or if the moving table dimensions are small, calibrate the cooling system separately to cool the Motor Coil Unit.

Rigidity of Linear System

The response performance of a linear system is affected by the rigidity of the Linear Slider. Ensure that the rigidity is appropriate for the required performance. If a gain is set to higher than the machine rigidity, the vibration occurs.

Take the following measures to improve rigidity.

- Use preloaded linear guides. This makes the Linear Slider highly rigid with less play in the mechanical system.
- Ensure the rigidity of the base material to which the Linear Slider is secured. The materials in descending order of rigidity: granite, steel, and aluminum.
- The moving table must have a sufficient thickness to prevent deformation and vibration.
- Install the Magnet Track and external encoder in a straight and parallel line.
- Install the external encoder as close to the Motor Coil Unit as possible.

Allen Head Bolts Used for Motor Coil Unit

For the Motor Coil Unit, use steel allen head bolts that meet the following requirements.

Bolt for Motor Coil Unit	R88L-EC-FW-03 R88L-EC-FW-0306	R88L-EC-FW-0606 R88L-EC-FW-0609 R88L-EC-FW-0612	R88L-EC-FW-1112 R88L-EC-FW-1115
Nominal diameter	M4		
Fitting length of bolt	4 mm min. 5 mm max.		
Tightening torque [N·m]	2.0 to 3.0		

Allen Head Bolts Used for Magnet Track

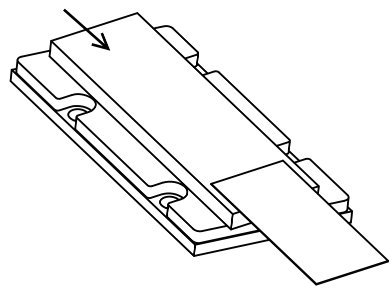
For the Magnet Track, use steel allen head bolts that meet the following requirements.

Bolt for Magnet Track	R88L-EC-FM-03□	R88L-EC-FM-06□	R88L-EC-FM-11□
Nominal diameter	M5	M5	M5
Head size	Use low head allen head bolts. Head diameter: 8.5 mm or less Head height: 3.5 mm or less		Head diameter: 8.5 mm or less Head height: 5 mm or less

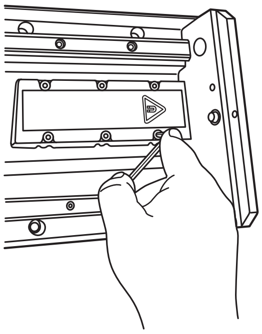
Installation Procedure

Notice

Each Magnet Track unit includes a protective cover that reduces the effect of the magnetic field. Do not remove this protective cover until the Magnet Track installation is completed.



1 **Fix the first Magnet Track unit with bolts.**



2 **Install the second Magnet Track unit.**

Place the second Magnet Track unit in a place where no magnetic attraction force is exerted with the first Magnet Track unit.

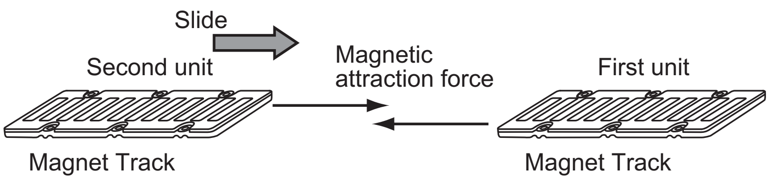
Slide the second Magnet Track unit while pushing it onto the mounting surface to prevent it from coming off the surface.

At this time, a magnetic attraction force arises between the first and second Magnet Track units. Be careful not to be injured. You may be caught between the motor parts.

Fix the second Magnet Track unit with bolts while pressing it against the first Magnet Track unit.

For third Magnet Track unit and later, follow the same procedure as for the second Magnet Track unit.

Before you finish installing all the Magnet Track units, install the moving table.



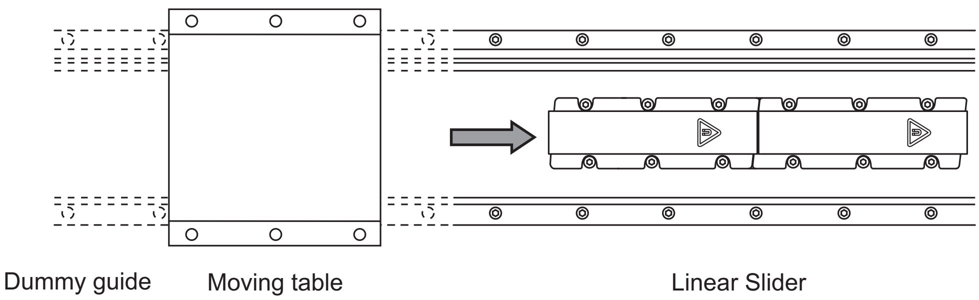
The installed Magnet Track units are attracted each other by a magnetic attraction force.

If repelling, the Magnet Track units are installed in a wrong direction.

3 **Install the Motor Coil Unit and the moving table.**

Install the Motor Coil Unit and the moving table in a place where no magnetic attraction force is exerted between the Motor Coil Unit and the Magnet Track.

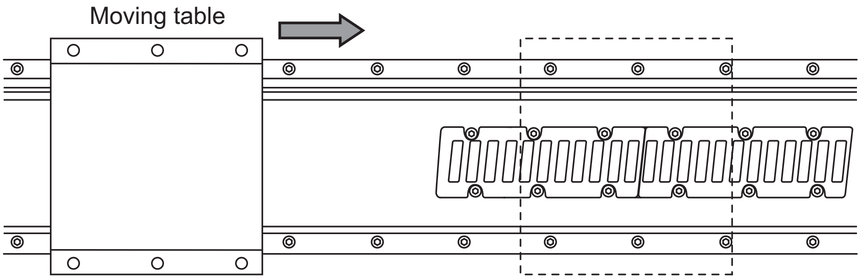
Secure a work space at the end of the Linear Slider. If not possible, install dummy guides to extend the Linear Slider.



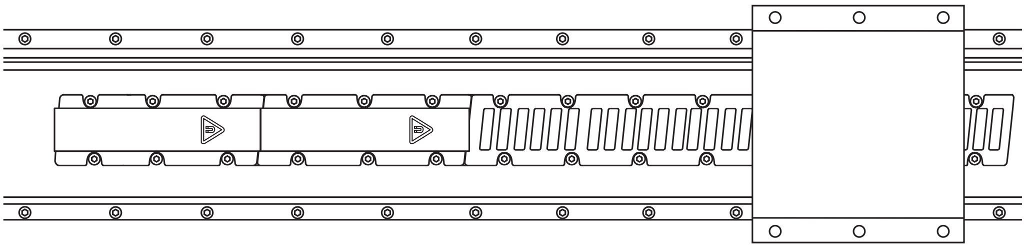
4 **Move the Motor Coil Unit and the moving table.**

Remove the protective plate from each installed Magnet Track unit and move the moving table to a position above the Magnet Track.

Be aware that, at this time, a magnetic attraction force is exerted between the Motor Coil Unit and the Magnet Track.



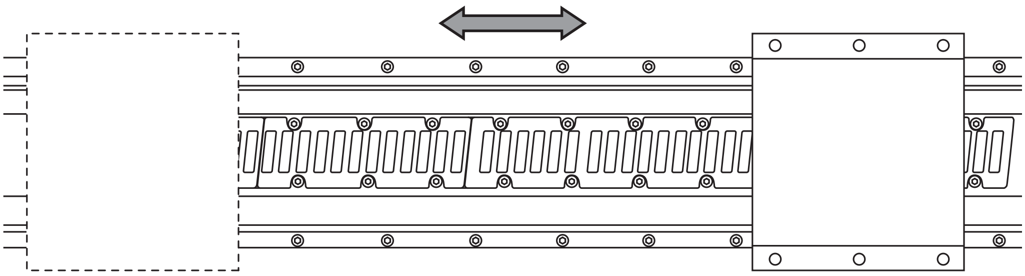
5 **Install the remaining Magnet Track units.**



6 **Check that the Motor Coil Unit and the Magnet Track are installed correctly.**

Remove all the protective covers and move the moving table slowly from end to end to be sure that the Motor Coil Unit does not make contact with the Magnet Track and that any foreign objects are not trapped.

In addition, make sure that the motor parts are installed within the specified tolerance throughout the operation range.



7 **Install the external encoder.**

8 **Wire cables to appropriate terminal blocks installed inside the connector box.**

Direction Adjustment

1 **Turn OFF the main circuit power supply and remove the motor cable from the Servo Drive.**

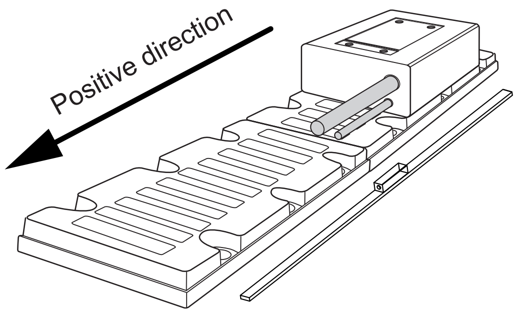
This is done easily by disconnecting the connector.

2 **Turn ON the control power supply.**

3 **Be sure to check and set the drive direction parameter on the CX-Drive’s Linear Encoder Settings screen.**

With the Sysmac Studio, this parameter can be checked using the monitor function.

4 **Adjust the parameter so that the current value of the linear encoder increases when the Motor Coil Unit moves in the direction of the cable side.**



Precautions for Correct Use

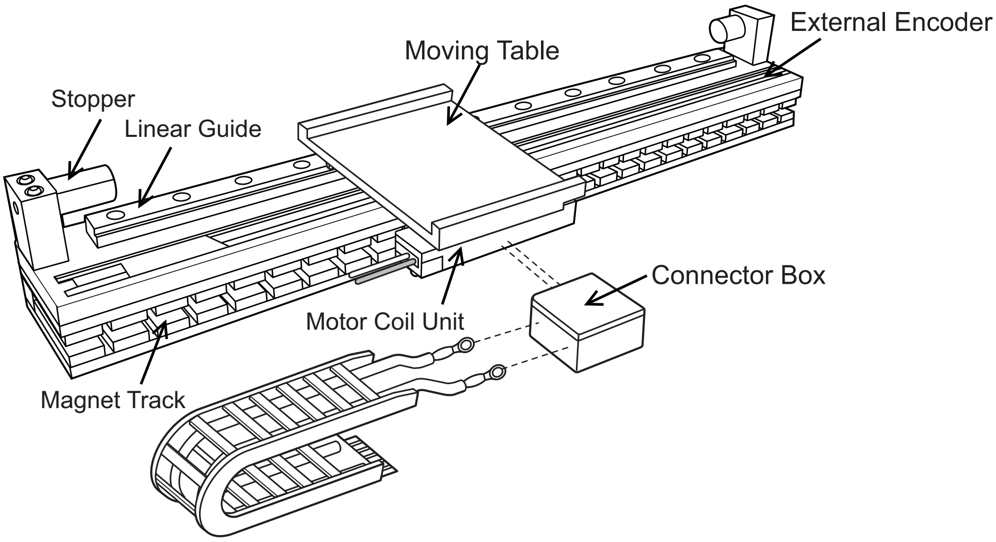
Until you complete checking on the operation direction and the motor parameter, set the maximum motor speed to low. The motor may start operating suddenly with the maximum force due to vibration or other reason.

4-1-3 Ironless Linear Motor Installation Conditions

Before operating the Linear Motor, it is necessary to assemble parts such as the linear guides and the external encoder into the Linear Slider, in addition to the Motor Coil Unit and the Magnet Track.

An example of the Linear Slider is shown below.

When designing a Linear Slider, prepare proper parts for the system and implement sufficient measures to ensure safety operation.



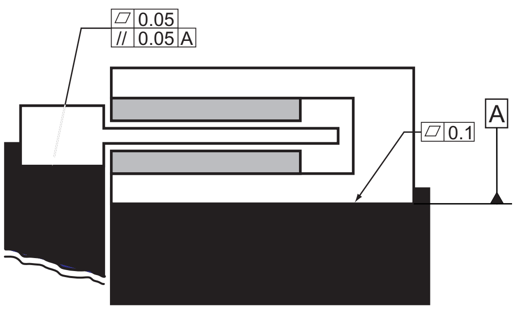
Installation Conditions

Mechanical Tolerance

Design and install a Linear Motor system that meets the requirements for each model in *2-4-2 Linear Motor Dimensions* on page 2-20.

For example, the tolerance of the R88L-EC-GW0303 is as follows:

- The flatness of the Motor Coil Unit mounting surface must be 0.1 mm.
- The flatness of the Magnet Track mounting surface must be 0.1 mm.
- The parallelism between the two mounting surfaces must be 0.05 mm.



Magnetic Attraction Force

- In an ironless Linear Motor, no magnetic attraction force is exerted when the motor is de-energized.
- In an ironless Linear Motor, a bending force is exerted if the Motor Coil Unit inclines. Therefore, it is important that the above tolerance for parallelism be strictly observed.

Cooling of Motor Coil Unit

- The Motor Coil Unit becomes hot during operation. For the Motor Coil Unit, install a moving table (radiator plate) of the recommended dimensions or larger to provide sufficient heat dissipation into the air.

Motor Coil Unit model	Moving table (radiator plate) dimensions
R88L-EC-GW-03☐	254 × 120 × 12
R88L-EC-GW-05☐	330 × 120 × 12
R88L-EC-GW-07☐	460 × 180 × 12

- To provide good heat dissipation, reduce the thermal resistance by applying thermal conductive silicon between the Motor Coil Unit and the moving table.
- Provide adequate ventilation as required to prevent an excessive rise of the ambient temperature because heat is dissipated in the air.
- If the rise of the ambient temperature must be suppressed for a certain application, or if the size of the moving table is smaller, configure a separate cooling system to cool the Motor Coil Unit.

Rigidity of Linear System

The response performance of a linear system is affected by the rigidity of the Linear Slider. Ensure that the rigidity is appropriate for the required performance. If a gain is set to higher than the machine rigidity, the vibration occurs.

Take the following measures to improve rigidity.

- Use preloaded linear guides. This makes the Linear Slider highly rigid with less play in the mechanical system.
- Ensure the rigidity of the base material to which the Linear Slider is secured.
  The materials in descending order of rigidity: granite, steel, and aluminum.
- The moving table must have a sufficient thickness to prevent deformation and vibration.
- Install the Magnet Track and external encoder in a straight and parallel line.
- Install the external encoder as close to the Motor Coil Unit as possible.

Installation Procedure

For the installation of ironless linear sliders, no particular order of assembly is specified.

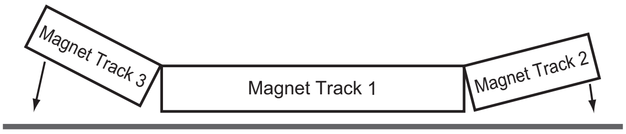
In an ironless Linear Motor, no magnetic attraction force is exerted between the Magnet Track and the Motor Coil Unit. However, a strong magnetic attraction force is present between the Magnet Track units. Be careful so that you are not caught or the magnets are damaged by shock.

As long as the Magnet Track is installed in a straight line so that it does not affect the motor functionality regardless of whether its face is front or back, the Motor Coil Unit can be installed in any direction, whether horizontal or vertical.

1 **Assemble the Linear Slider parts.**

2 **Install the Magnet Track.**

Install the Magnet Track units in a correct order. After installing the first Magnet Track unit, if you bring the second unit closer to the first unit linearly, collision may occur due to a magnetic attraction force. Approach the second unit non-linearly to fix the position as shown below.



3 **Check the linearity of the Magnet Track.**

To add Magnet Track units to the left and right of the first Magnet Track unit, bring them along the first unit as shown above. You can fix the position in a straight line.

4 **Install the Motor Coil Unit and the moving table.**

Check that the Motor Coil Unit and the Magnet Track are installed correctly.

5 **Install the external encoder.**

6 **Wire cables to appropriate terminal blocks installed inside the connector box.**

Precautions for Correct Use

There is a risk of motor runaway. Before performing trial operation, be sure to check the encoder and Motor Coil Unit directions and set the drive direction parameter. This is done easily by using the Linear Motor Parameter Setup function of the CX-Drive.

Direction Adjustment

1 **Turn OFF the main circuit power supply and remove the motor cable from the Servo Drive.**

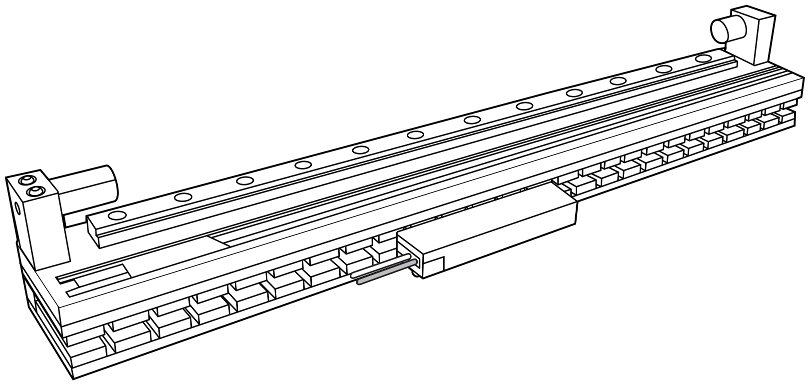
This is done easily by disconnecting the connector.

2 **Turn ON the control power supply.**

3 **Be sure to check and set the drive direction parameter on the CX-Drive's Linear Encoder Settings screen.**

With the Sysmac Studio, this parameter can be checked using the monitor function.

4 **Adjust the parameter so that the current value of the linear encoder increases when the Motor Coil Unit moves in the direction of the cable side.**



Precautions for Correct Use

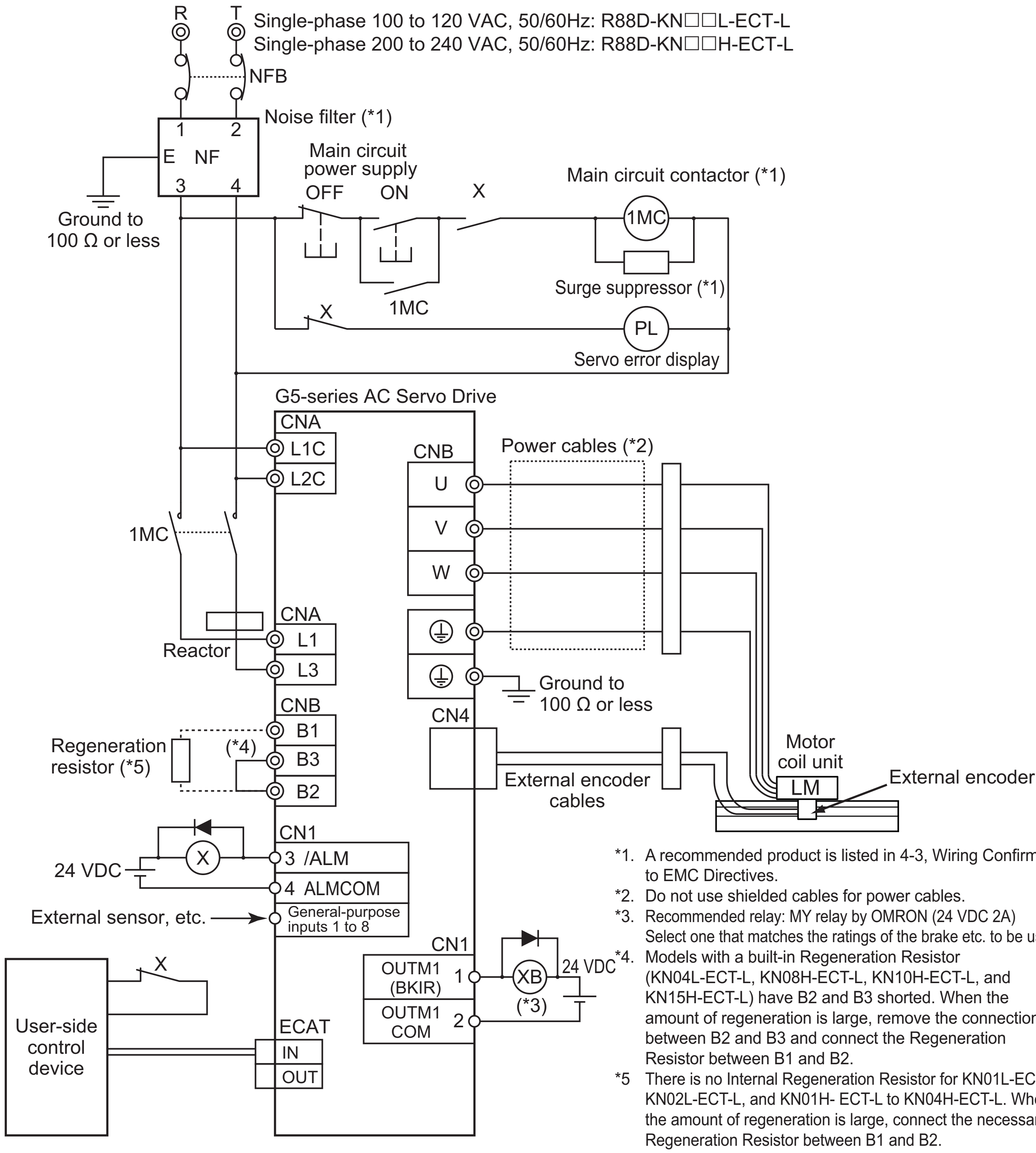
Until you complete checking on the operation direction and the motor parameter, set the maximum motor speed to low. The motor may start operating suddenly with the maximum force due to vibration or other reason.

4-2 Wiring

This section provides information on the power supply, main circuit, 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/ -KN10H-ECT-L/-KN15H-ECT-L (Single-phase Input)



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

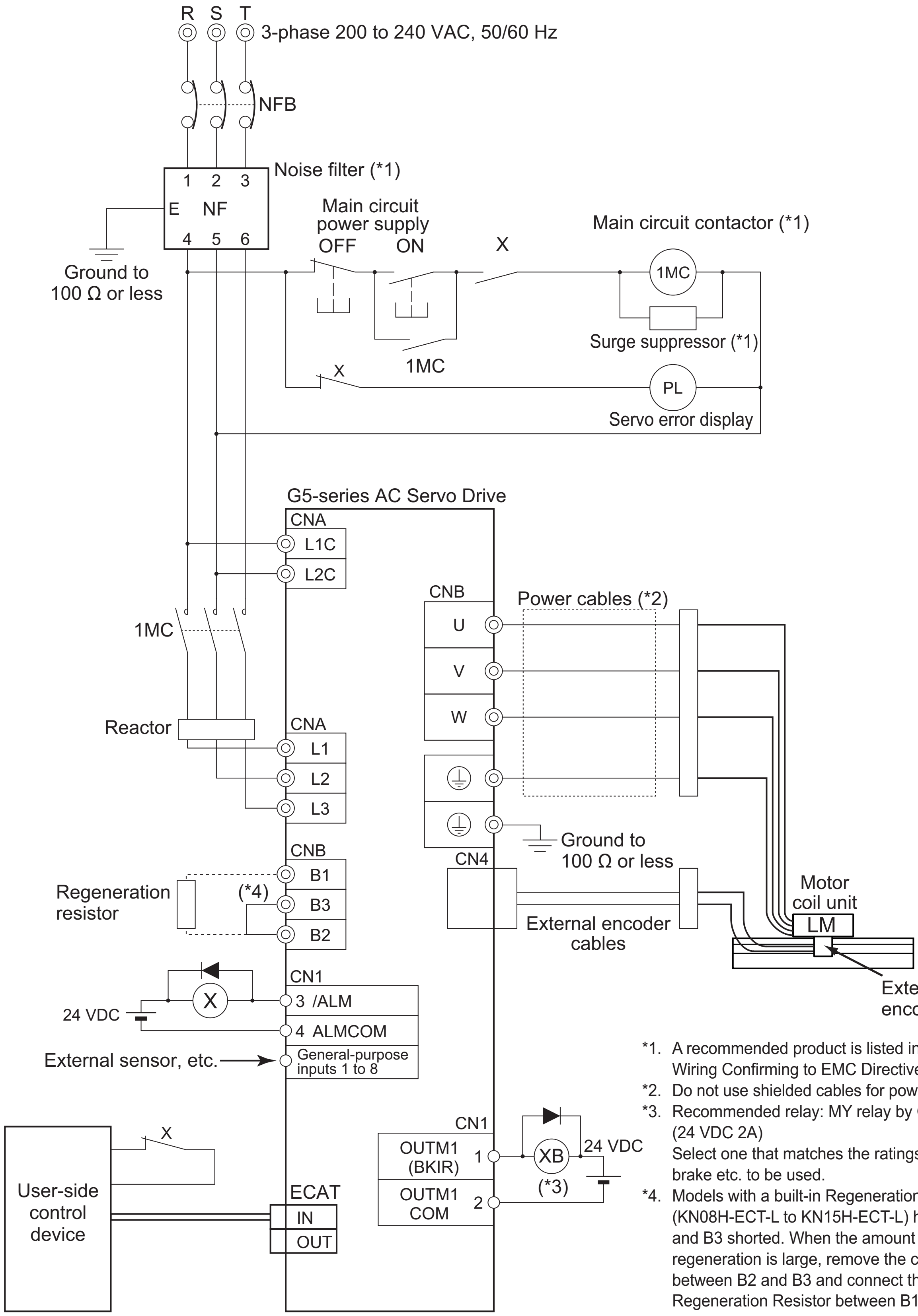
*2. Do not use shielded cables for power cables.

*3. Recommended relay: MY relay by OMRON (24 VDC 2A) Select one that matches the ratings of the brake etc. to be used.

*4. 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 the Regeneration Resistor between B1 and B2.

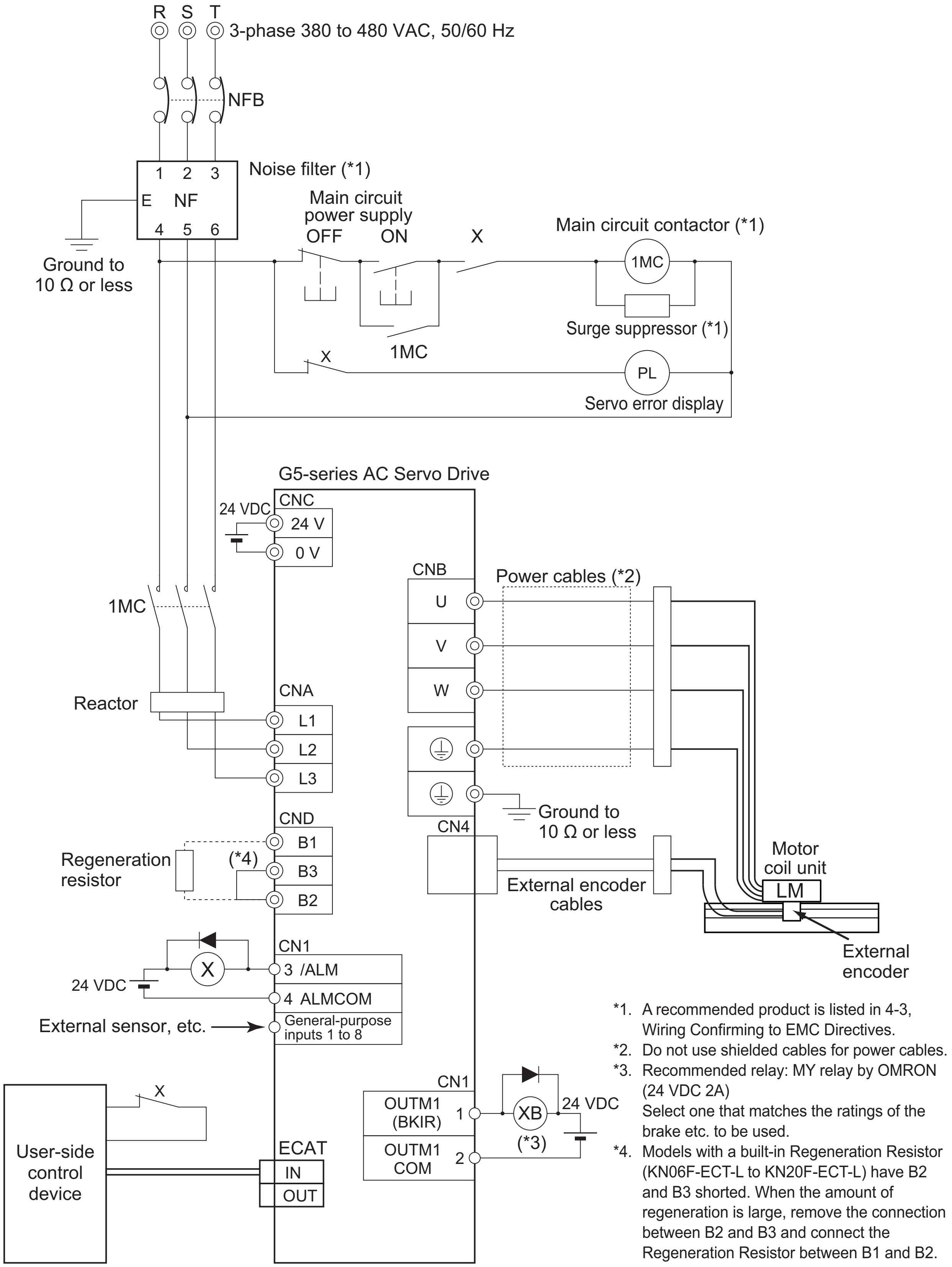
*5 There is no Internal Regeneration Resistor for KN01L-ECT-L, KN02L-ECT-L, and KN01H- ECT-L to KN04H-ECT-L. When the amount of regeneration is large, connect the necessary Regeneration Resistor between B1 and B2.

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



*1. A recommended product is listed in 4-3, Wiring Confirming to EMC Directives.
*2. Do not use shielded cables for power cables.
*3. Recommended relay: MY relay by OMRON (24 VDC 2A)
Select one that matches the ratings of the brake etc. to be used.
*4. 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 the Regeneration Resistor between B1 and B2.

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



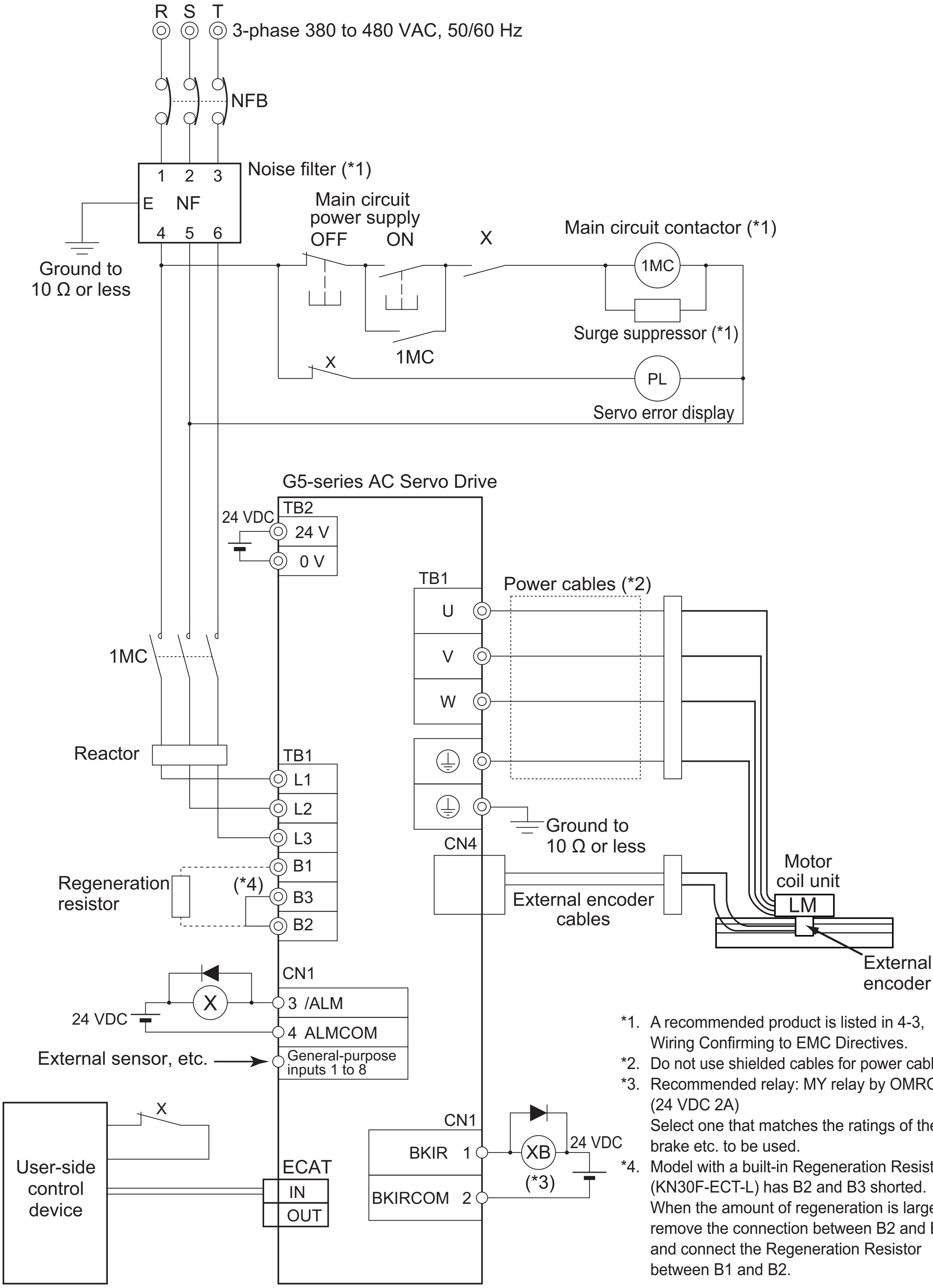
*1. A recommended product is listed in 4-3, Wiring Confirming to EMC Directives.

*2. Do not use shielded cables for power cables.

*3. Recommended relay: MY relay by OMRON (24 VDC 2A)
Select one that matches the ratings of the brake etc. to be used.

*4. 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 the Regeneration Resistor between B1 and B2.

R88D-KN30F-ECT-L



*1. A recommended product is listed in 4-3, Wiring Confirming to EMC Directives.
*2. Do not use shielded cables for power cables.
*3. Recommended relay: MY relay by OMRON (24 VDC 2A)
Select one that matches the ratings of the brake etc. to be used.
*4. Model with a built-in Regeneration Resistor (KN30F-ECT-L) has B2 and B3 shorted. When the amount of regeneration is large, remove the connection between B2 and B3 and connect the Regeneration Resistor between B1 and B2.

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 R88D-KN☐H-ECT-L (100 to 400 W): Single-phase or 3-phase 200 to 240 VAC (170 to 264 VAC) 50/60 Hz
L2		
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 R88D-KN☐H-ECT-L: Single-phase 200 to 240 VAC (170 to 264 VAC) 50/60 Hz
L2C		

*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. Be sure to wire them correctly.
V		Phase V	
W		Phase W	
⏚	Frame ground	This is the ground terminal. Ground it to 100 Ω or less.	

*1 Do not short B1 and B2. Malfunction may result.

Precautions for Correct Use

- Tighten he frame ground screw to a torque of 0.7 to 0.8 N·m (M4).
- If you connect 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 R88D-KN☐H-ECT-L (750 W to 1.5 kW): Single-phase 200 to 240 VAC (170 to 264 VAC) 50/60 Hz
L2		
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 R88D-KN☐H-ECT-L: Single-phase 200 to 240 VAC (170 to 264 VAC) 50/60 Hz
L2C		

*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 shorted. 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. Be sure to wire them correctly.
V		Phase V	
W		Phase W	
⏚	Frame ground	This is the ground terminal. Ground it to 100 Ω or less.	

*1 Do not short B1 and B2. Malfunction may result.

Precautions for Correct Use

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

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. Be sure to wire them correctly.
V		Phase V	
W		Phase W	
⏚	Frame ground	This is the ground terminal. Ground it 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 B2 and B3 are shorted. 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. Malfunction may result.

Precautions for Correct Use

- If you connect an External Regeneration Resistor, set the Regeneration Resistor Selection servo parameter object (3016 hex).
- Do not connect an external regeneration resistor between the B1 and NC terminals.

R88D-KN30F-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 B2 and B3 are shorted. 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. Be sure to wire them correctly.
V		Phase V	
W		Phase W	
⏚	Frame ground	This is the ground terminal. Ground it to 100 Ω or less.	

*1 Do not short B1 and B2. Malfunction may result.

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 bottom terminal block screws to a torque of 0.19 to 0.21 N·m (M3).
- If you connect an External Regeneration Resistor, set the Regeneration Resistor Selection servo parameter object (3016 hex).
- Do not connect an external regeneration resistor between the B1 and NC terminals.

4-2-3 Terminal Block Wire Sizes

This section shows the terminal block wire sizes used for each Servo Drive model.

100-VAC Input Drive Wire Sizes

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

Model (R88D-)			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	–	AWG 14 to 18				AWG 14	
	Screw size	–	–	–	–	–	–	–
	Tightening torque	N·m	–	–	–	–	–	–
Control circuit power supply input (L1C and L2C)	Wire size	–	AWG 18					
	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	–	AWG 14 to 18				AWG 14	
	Screw size	–	–	–	–	–	–	–
	Tightening torque	N·m	–	–	–	–	–	–
	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 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.

400-VAC Input Drive Wire Sizes

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

Model (R88D-)			KN06F-ECT-L	KN10F-ECT-L	KN15F-ECT-L	KN20F-ECT-L	KN30F-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	7.6
	Wire size	–	AWG 14				AWG12
	Screw size	–	–	–	–	–	M5
	Tightening torque	N·m	–	–	–	–	2.0
Control circuit power supply input (L1C and L2C)	Wire size	–	AWG20 to 24				AWG 18
	Screw size	–	–	–	–	–	M5
	Tightening torque	N·m	–	–	–	–	2.0
Motor connection terminals (U, V, W, and FG) *1	Rated current	A	2.9	2.9	4.7	6.7	9.4
	Wire size	–	AWG 14				AWG12
	Screw size	–	–	–	–	–	M5
	Tightening torque	N·m	–	–	–	–	2.0
	Maximum wiring length	m	20				
Frame ground (FG)	Wire size	–	AWG 14				AWG12
	Screw size	–	M4				M5
	Tightening torque	N·m	1.2				2.0
	Maximum wiring length	m	1				

*1 Use the same wire size 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.

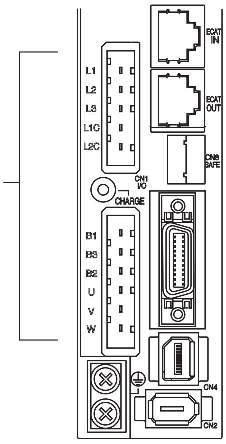
600-V Heat-resistant Vinyl Wire [HIV]

AWG size	Nominal cross-sectional area [mm^2]	Configuration [wires/mm^2]	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.

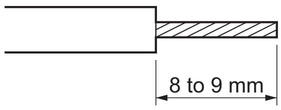


1 **Remove the terminal block from the Servo Drive before wiring.**

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 4-22 for applicable wire sizes.



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)

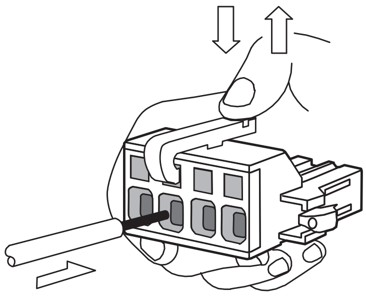


Figure A

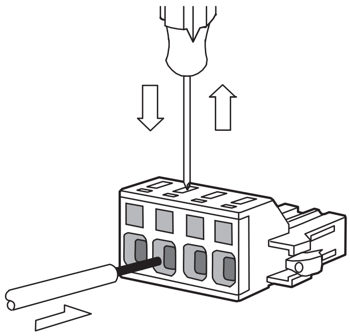


Figure B

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 wiring all of the terminals, 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 90º.
- Correct the shape of the ferrule with pliers.

4-3 Wiring Conforming to EMC Directives

G5-series Servo Drives conform to the EMC Directives (EN 55011 Class A Group 1 (EMI) and EN 61000-6-2 (EMS)).

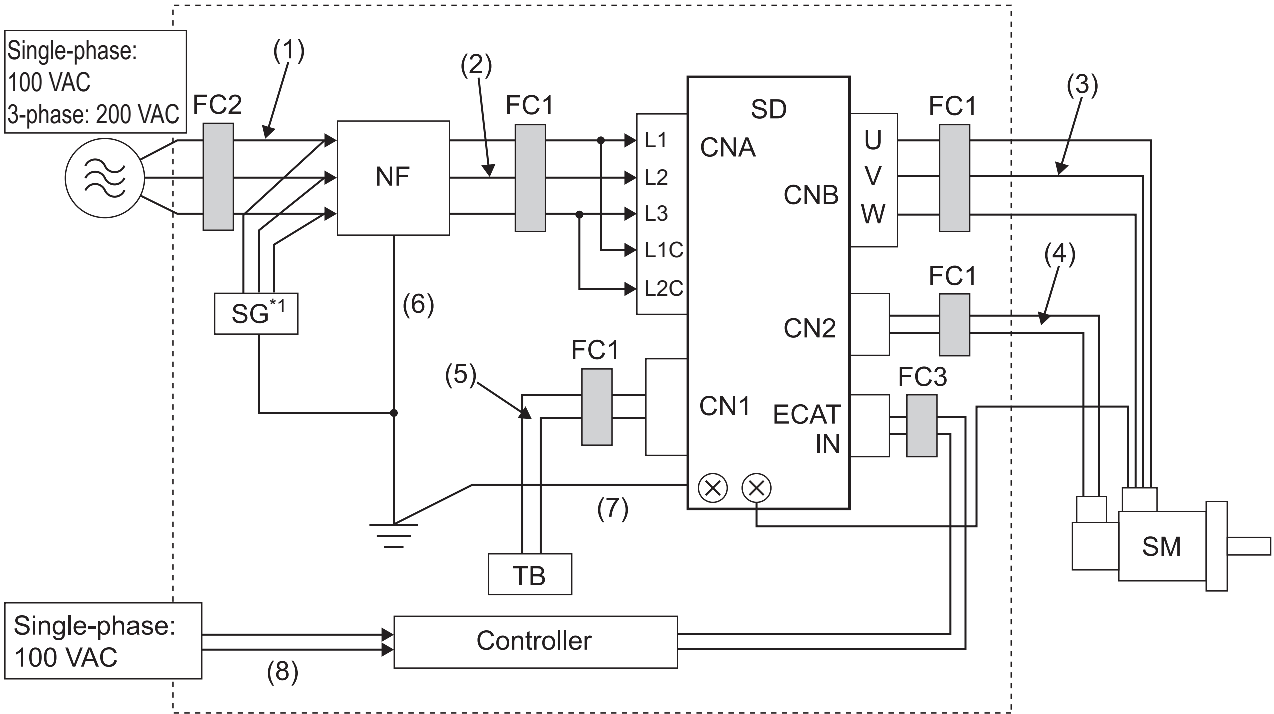
EMC-related performance of these products, however, will be influenced by the configuration, wiring, and other conditions of the equipment in which the products are installed. The EMC conformance of the system as a whole must be confirmed by the customer.

The certification of the Servo Drives is conducted with a representative rotary motor of each model by an external certification authority.

The following five conditions are for conformance of G5-series products to the EMC directives.

- The Servo Drive must be installed in a metal case (control panel).
- 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.

4-3-1 100-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.

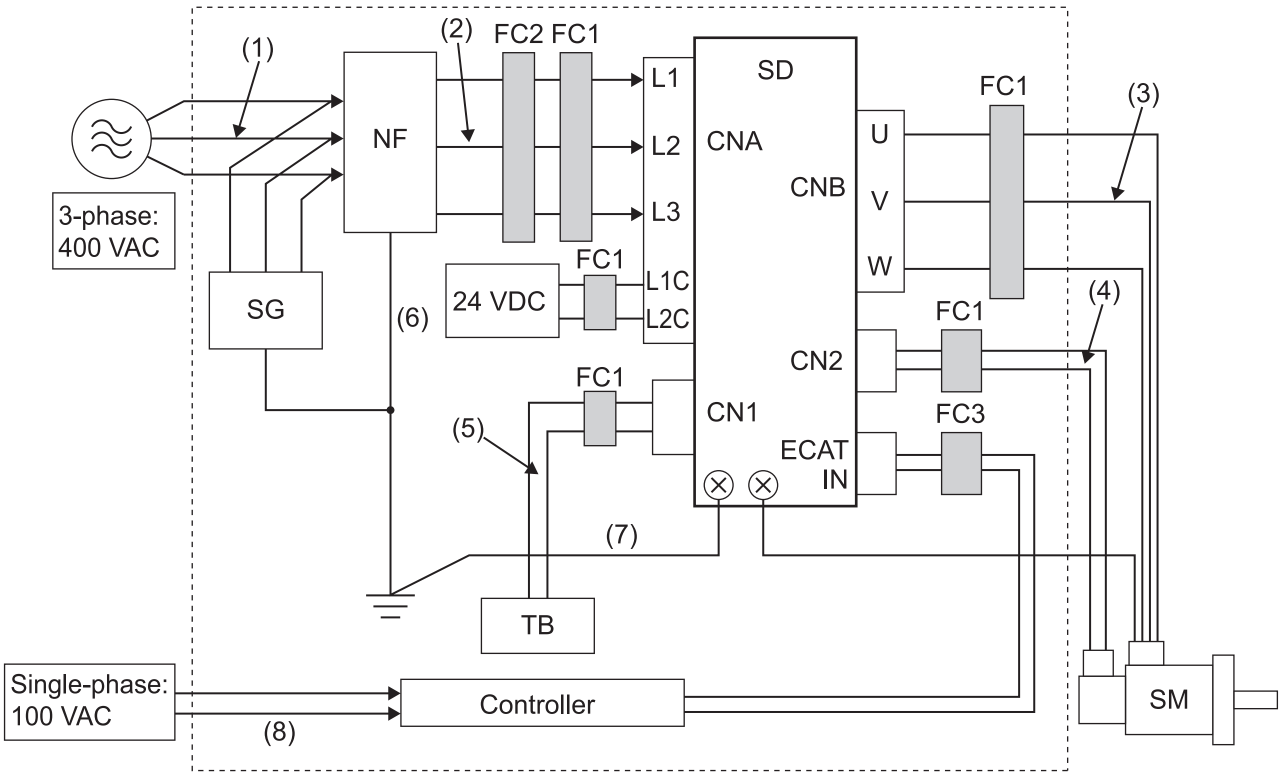
- Use ground lines with a minimum thickness of 3.5 mm^2, and arrange the wiring so that the ground lines are as short as possible.
- A no-fuse breaker, surge absorber, and noise filter should be positioned near the input terminal block (ground plate), and I/O lines should be separated and wired at the 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
SM	Servomotor	OMRON	–	*1
FC1	Clamp core	TDK	ZCAT3035-1330	–
FC2	Clamp core	Konno Industry	RJ8035	–
FC3	Clamp core	NEC TOKIN Corporation	ESD-SR-250	–
TB	Switch box	–	–	–
–	Controller	–	–	–

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

4-3-2 400-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	Schaffner EMC Inc.	FN258L-16-07	3-phase 400 VAC (16 A)
			FN258L-30-07	3-phase 400 VAC (30 A)
SD	Servo Drive	OMRON	–	*1
SM	Servomotor	OMRON	–	*1
FC1	Clamp core	TDK	ZCAT3035-1330	
FC2	Clamp core	Konno Industry	RJ8035	
FC3	Clamp core	NEC TOKIN Corporation	ESD-SR-250	
TB	Switch box	–	–	
–	Controller	–	–	–

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

● Cable Details

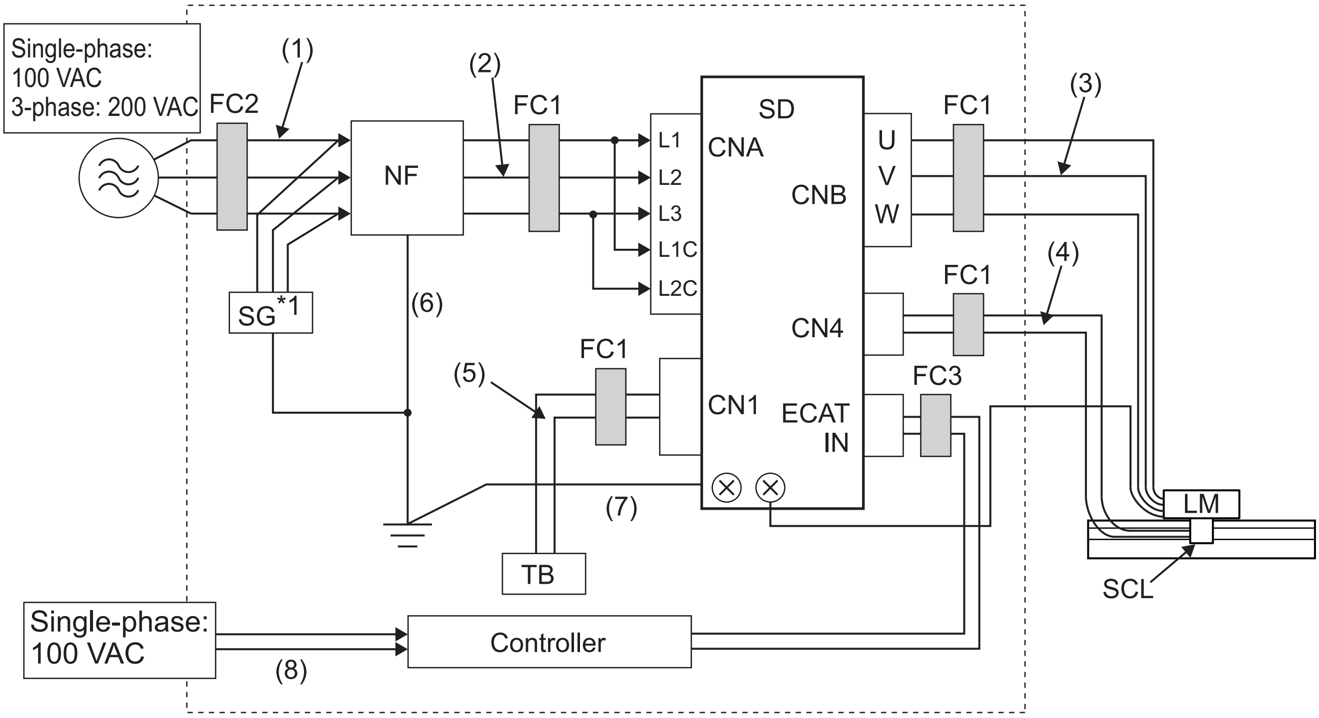
Symbol	Supplies from	Connects to	Cable name	Length	Comment	Shielded	Ferrite
(1)	AC power supply	Noise filter	Power supply line	2 m	–	No	No
(2)	Noise filter	Servo Drive	Power supply line	2 m	–	No	Yes
(3)	Servo Drive	Servomotor	Power cable	20 m	–	No	Yes
(4)	Servo Drive	Servomotor	External encoder cable	20 m	–	Yes	Yes
(5)	Switch box	Servo Drive	I/O cable	2 m	–	No	Yes
(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

4-4 Noise Reduction

This section provides a wiring example with a G5-series Linear Motor as a means to prevent anticipated noise interference with peripheral equipment when a linear system is installed.

4-4-1 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.

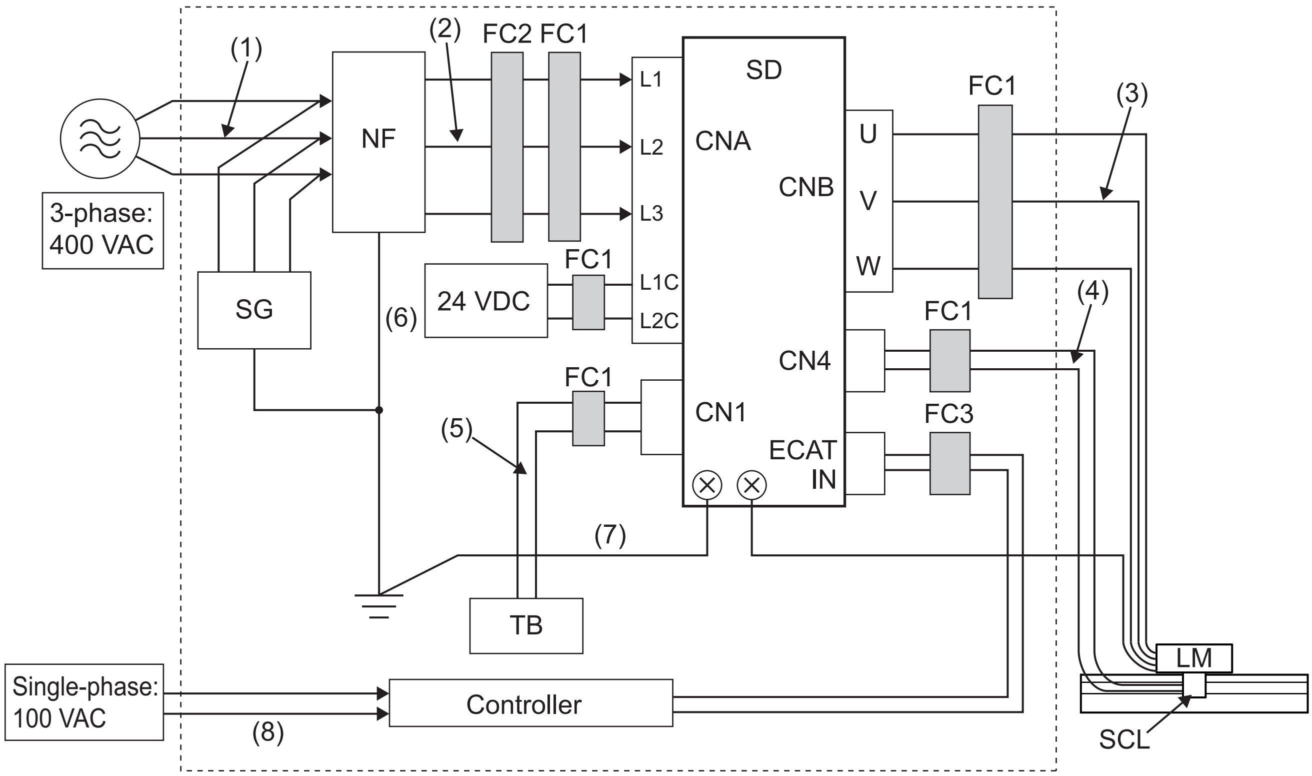
- Use a ground plate for the frame ground for each unit, as shown in the above diagrams, and ground to a single point.
- Use ground lines with a minimum thickness of 3.5 mm^2, and arrange the wiring so that the ground lines are as short as possible.
- A no-fuse breaker, surge absorber, and noise filter 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-HU50-ER-6B	13-phase 200 VAC (50 A)
SD	Servo Drive	OMRON	–	*1
LM	Linear Motor	–	–	*1
SCL	External encoder	–	–	–
FC1	Clamp core	TDK	ZCAT3035-1330	–
FC2	Clamp core	Konno Industry	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-781BWZ-4	–
NF	Noise filter	Schaffner EMC Inc.	FN258L-16-07	3-phase 400 VAC (16 A)
			FN258L-30-07	3-phase 400 VAC (30 A)
SD	Servo Drive	OMRON	–	*1
LM	Linear Motor	–	–	*1
SCL	External encoder	–	–	–
FC1	Clamp core	TDK	ZCAT3035-1330	
FC2	Clamp core	Konno Industry	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	Yes
(3)	Servo Drive	Linear Motor	Power cable	20 m	–	No	Yes
(4)	Servo Drive	External encoder	External encoder cable	20 m	–	Yes	Yes
(5)	Switch box	Servo Drive	I/O cable	2 m	–	No	Yes
(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

Control Panel Structure

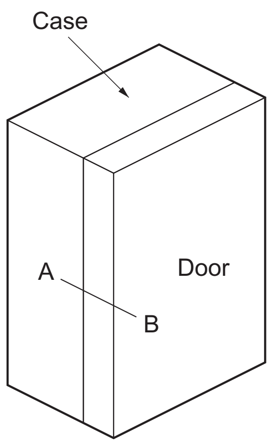
Openings in the control panel, such as holes for cables, panel mounting holes, and gaps around the door, may allow electromagnetic waves into the panel. To prevent this, observe the recommendations described below when designing or selecting a control panel.

● Case Structure

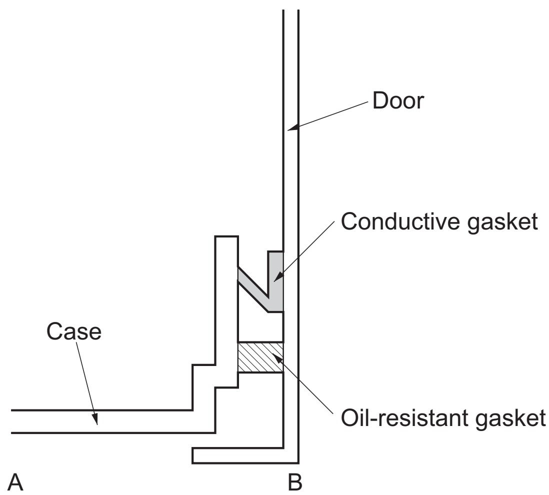
- Use a metal control panel with welded joints at the top, bottom, and sides so that the surfaces are electrically conductive.
- If assembly is required, strip the paint off the joint areas (or mask them during painting), to make them electrically conductive.
- The panel may warp and gaps may appear 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

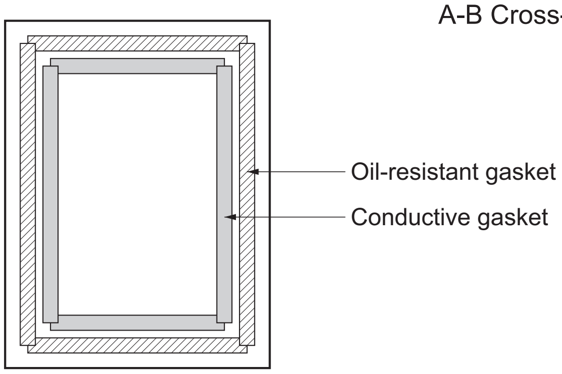
- Use a metal door.
- Use a water-draining structure where the door and case fit together, and leave no gaps. (Refer to the diagrams.)
- Use a conductive gasket between the door and the case. (Refer to the diagrams.)
- Strip the paint off the sections of the door and case that will be in contact with 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)

4-4-2 Selecting Connection Components

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 approximately 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 or low-speed no-fuse breakers are 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 Motor model is provided in *4-2-2 Main Circuit and Linear Motor Connections* on page 4-18.
- Add the current consumption of other controllers, and any other components when selecting.

● Inrush Current

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

Servo Drive model	Inrush current [A0-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-KN06F-ECT-L	28	48
R88D-KN10F-ECT-L	28	48
R88D-KN15F-ECT-L	28	48
R88D-KN20F-ECT-L	32	48
R88D-KN30F-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 leakage current values.
- The leakage breaker is activated at 50% of the rated current. Select a leakage breaker with approximately 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 (Power cable: 3 m)
R88D-KN01L-ECT-L	Single-phase 100 V	0.6 mA
R88D-KN02L-ECT-L	Single-phase 100 V	0.6 mA
R88D-KN04L-ECT-L	Single-phase 100 V	0.7 mA
R88D-KN01H-ECT-L	3-phase 200 V	1.3 mA
R88D-KN02H-ECT-L	3-phase 200 V	1.3 mA
R88D-KN04H-ECT-L	3-phase 200 V	1.4 mA
R88D-KN08H-ECT-L	3-phase 200 V	1.6 mA
R88D-KN10H-ECT-L	3-phase 200 V	1.8 mA
R88D-KN15H-ECT-L	3-phase 200 V	3.5 mA
R88D-KN06F-ECT-L	3-phase 400 V	3.0 mA
R88D-KN10F-ECT-L	3-phase 400 V	3.4 mA
R88D-KN15F-ECT-L	3-phase 400 V	4.0 mA
R88D-KN20F-ECT-L	3-phase 400 V	4.9 mA
R88D-KN30F-ECT-L	3-phase 400 V	8.6 mA

Note 1 These values vary greatly depending on the installation conditions of the motor power cable and the measurement conditions. Use them for reference only.

2 The leakage current with a power cable length of 20 m is at most approximately twice as large as that with a power cable length of 3 m.

3 The leakage current with a single-phase 200-VAC input power supply is approximately 0.8 times as large as that with a 3-phase input power supply.

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.

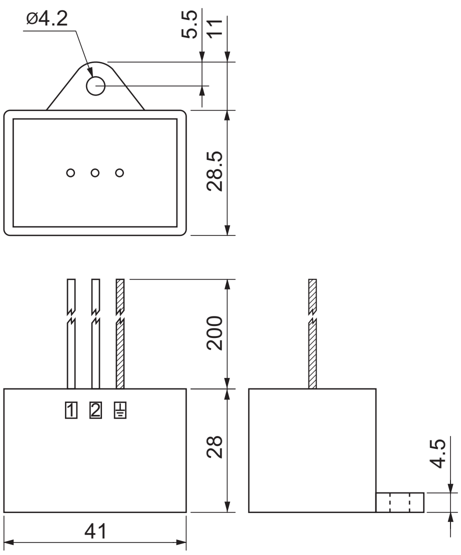
Manufacturer	Model	Surge immunity		Type	Comment
Okaya Electric Industries Co., Ltd.	R·A·V-781BWZ-4	700 V ± 20%	2,500 A	Block	Single-phase 100/200 VAC
	R·A·V-781BXZ-4	700 V ± 20%	2,500 A		3-phase 200 VAC
	R·A·V-801BXZ-4	800 V ± 20%	2,500 A		3-phase 400 VAC

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

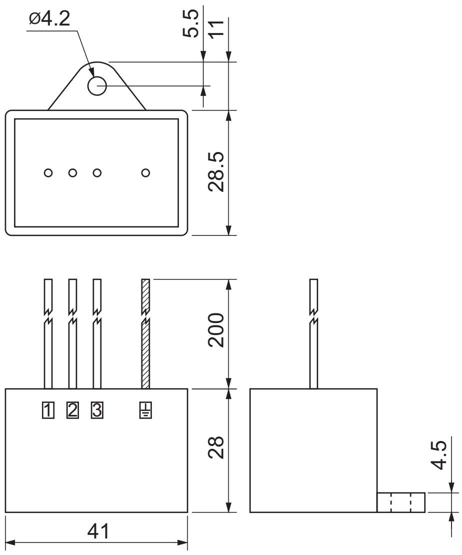
2 The surge immunity is for a standard impulse current of 8/20 μs. If pulses are wide, either decrease the current or change to a larger-capacity surge absorber.

External Dimensions

For single-phase (BWZ series)

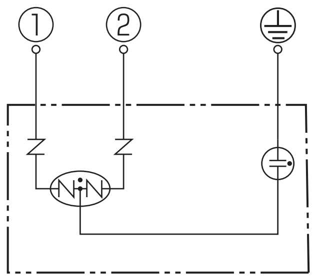


For 3-phase (BXZ series)

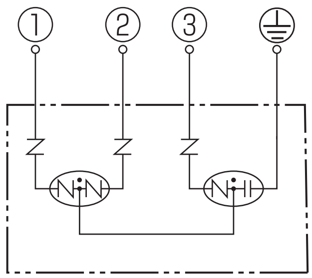


Equalizing Circuits

For single-phase (BWZ series)



For 3-phase (BXZ series)



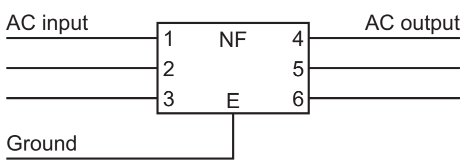
Noise Filter for Power Supply Input

We recommend using a noise filter for the Servo Drive.

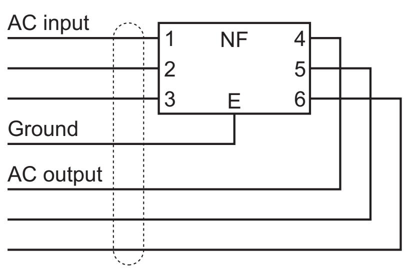
Servo Drive		Noise filter for power supply input			
Model	**Number of power phases**	**Model**	**Rated current**	**Leakage current (60 Hz) max.**	**Manufacturer**
R88D-KN01L-ECT-L	Single-phase input	SUP-EK5-ER-6	5 A	1.0 mA (at 250 VAC)	Okaya Electric Industries Co., Ltd.
R88D-KN02L-ECT-L					
R88D-KN04L-ECT-L	Single-phase input	3SUP-HU10-ER-6	10 A	3.5 mA (at 500 VAC)	
R88D-KN01H-ECT-L	Single-phase input	SUP-EK5-ER-6	5 A	1.0 mA (at 250 VAC)	
	3-phase input	3SUP-HU10-ER-6	10 A	3.5 mA (at 500 VAC)	
R88D-KN02H-ECT-L	Single-phase input	SUP-EK5-ER-6	5 A	1.0 mA (at 250 VAC)	
	3-phase input	3SUP-HU10-ER-6	10 A	3.5 mA (at 500 VAC)	
R88D-KN04H-ECT-L	Single-phase input	SUP-EK5-ER-6	5 A	1.0 mA (at 250 VAC)	
	3-phase input	3SUP-HU10-ER-6	10 A	3.5 mA (at 500 VAC)	
R88D-KN08H-ECT-L	Single-phase input·3-phase input	3SUP-HU10-ER-6	10 A	3.5 mA (at 500 VAC)	
R88D-KN10H-ECT-L		3SUP-HU30-ER-6	30 A	3.5 mA (at 500 VAC)	
R88D-KN15H-ECT-L					
R88D-KN06F-ECT-L	3-phase input	FN258L-16-07	16 A	0.8 mA (at 440 VAC/ 50 Hz)	Schaffner EMC K.K.
R88D-KN10F-ECT-L					
R88D-KN15F-ECT-L					
R88D-KN20F-ECT-L					
R88D-KN30F-ECT-L		FN258L-30-07	30 A	0.8 mA (at 440 VAC/ 50 Hz)	

- 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.



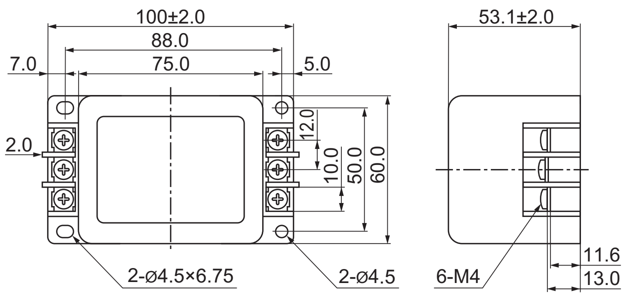
The effect of the noise filter is small.



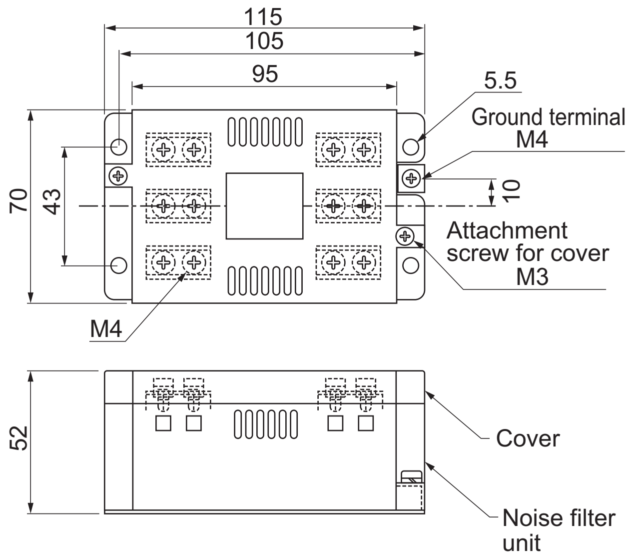
- Use twisted-pair cables for the power supply cables, or bind the cables.

● External Dimensions

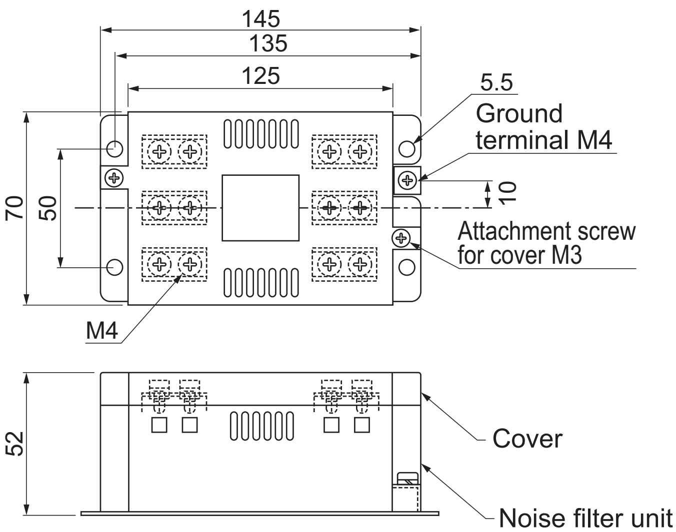
SUP-EK5-ER-6



3SUP-HU10-ER-6

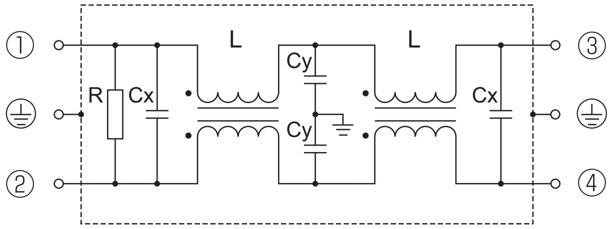


3SUP-HU30-ER-6

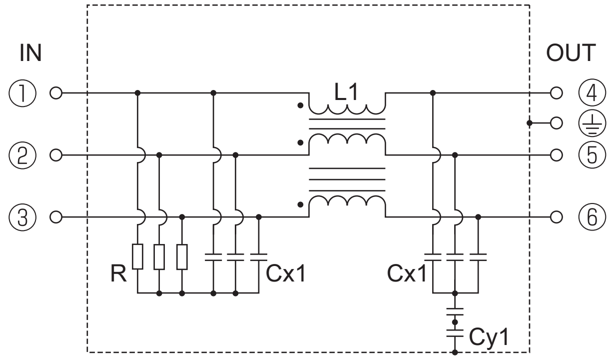


● **Circuit Diagram**

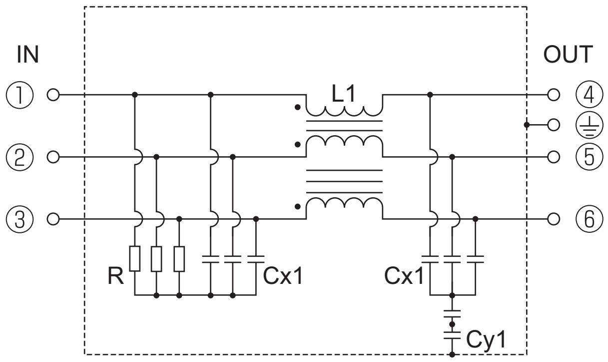
SUP-EK5-ER-6



3SUP-HU10-ER-6



3SUP-HU30-ER-6



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) Clamp Core.

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 Corporation	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.

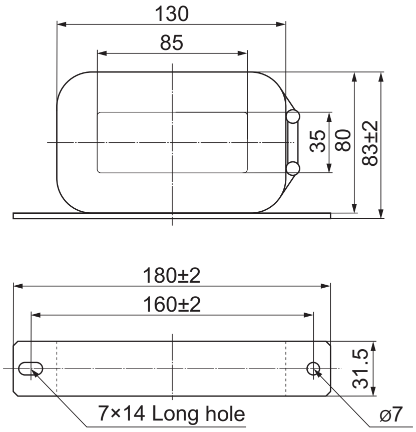
*2 Generally used for 1.5 kW or lower. The maximum number of windings is 3 turns.

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

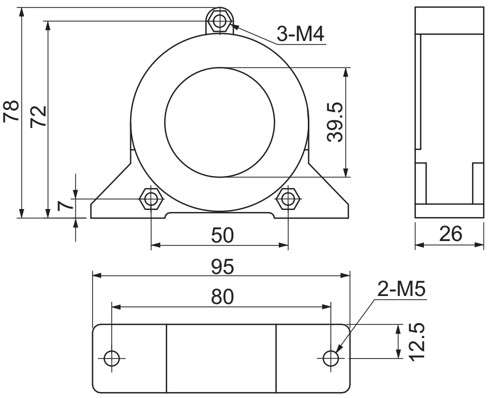
*4 Also used on the Drive output power lines to comply with the EMC Directives. Only a clamp is used. This clamp can also be used to reduce noise current on a FG line.

● External Dimensions

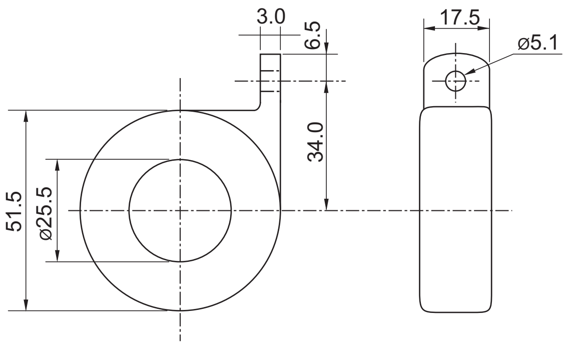
3G3AX-ZCL1



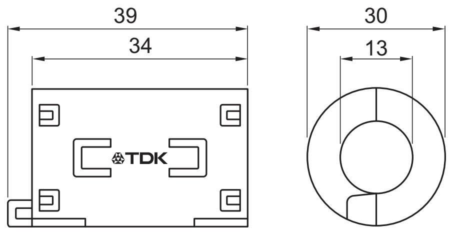
3G3AX-ZCL2



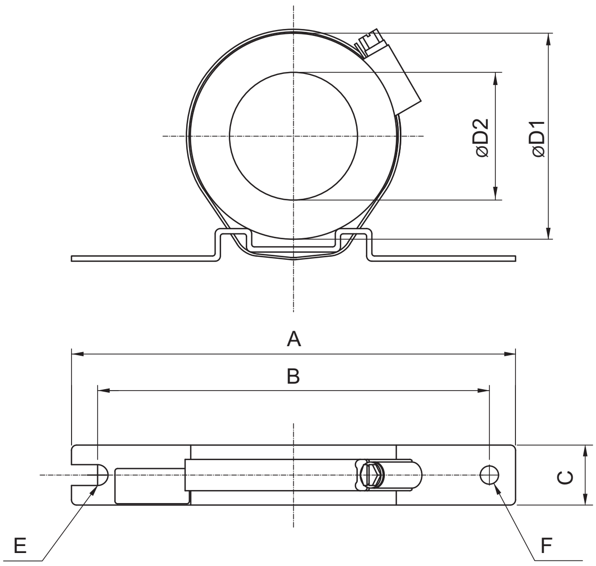
ESD-R-47B



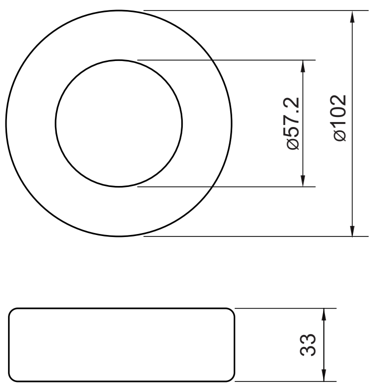
ZCAT3035-1330



RJ8035/RJ8095



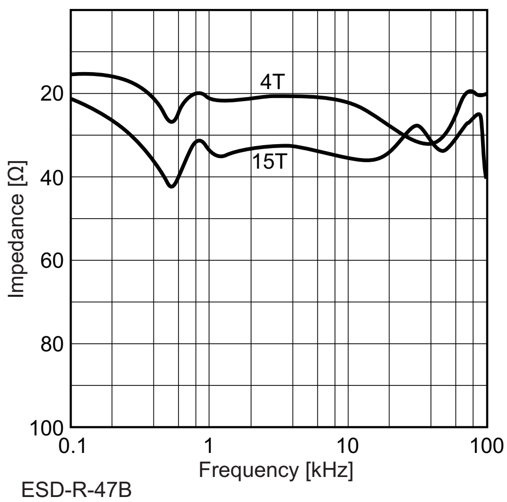
T400-61D



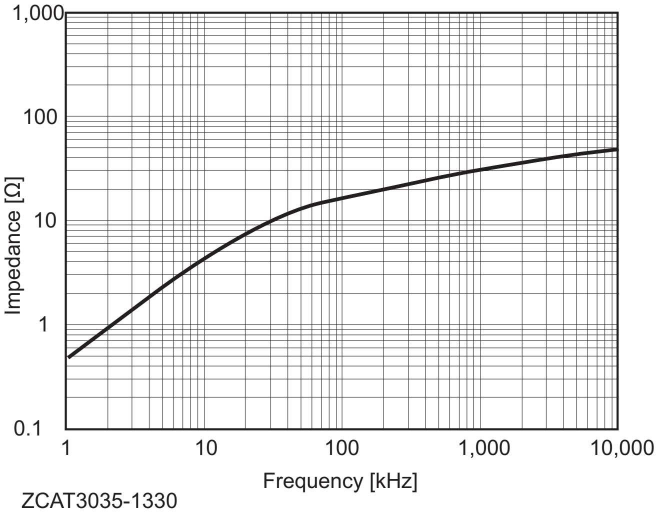
Model	Rated current	Dimensions [unit: mm]							
		A	B	C	D1	D2	Core thickness	E	F
RJ8035	35 A	170	150	23	80	53	24	R3.5	7
RJ8095	95 A	200	180	34	130	107	35	R3.5	7

● Impedance Characteristics

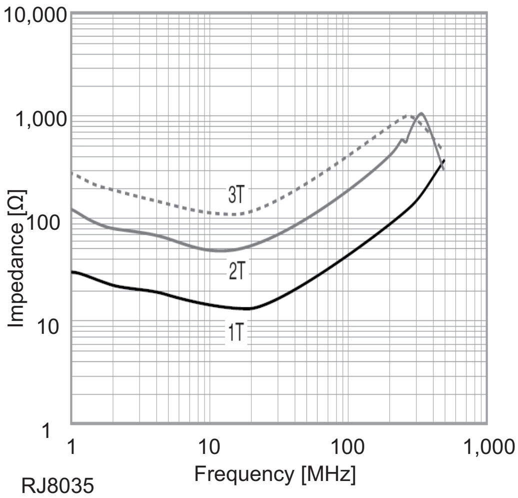
3G3AX-ZCL1



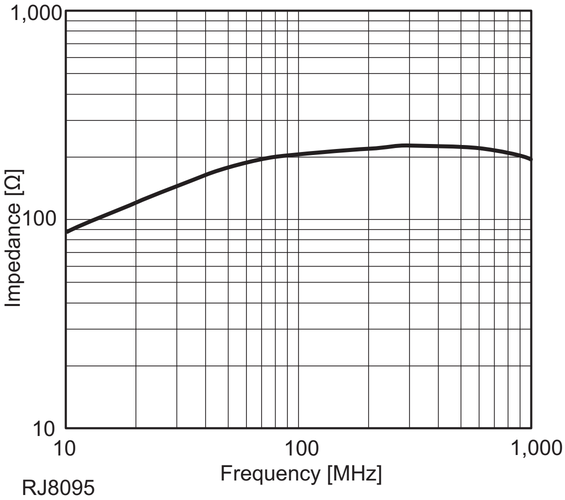
3G3AX-ZCL2



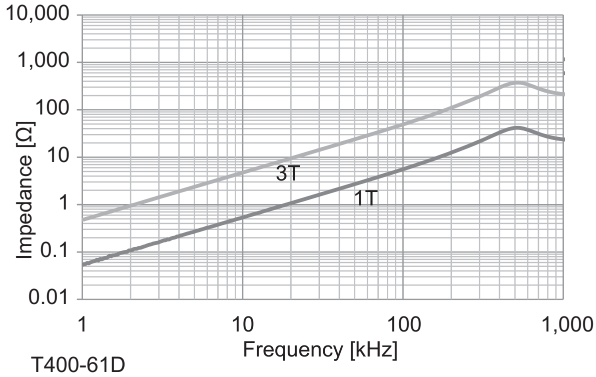
ESD-R-47B



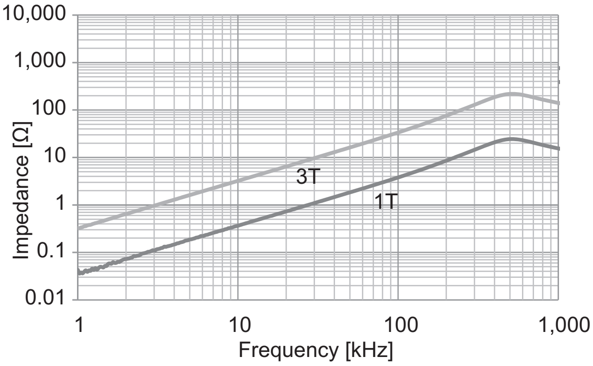
ZCAT3035-1330



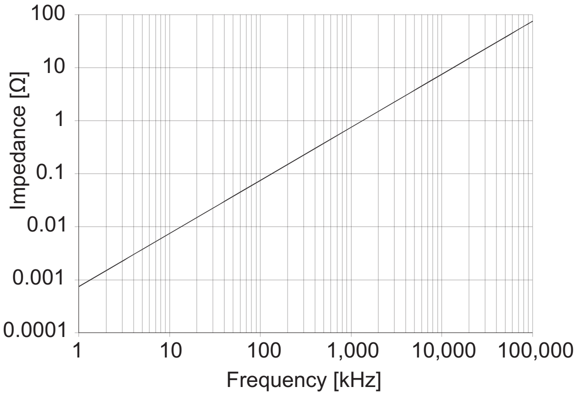
RJ8035



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 approximately 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: SEMITEC Corporation
- Varistors: SEMITEC Corporation, 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 approximately 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.
- 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 Corporation	Clamp core	ESD-SR-250	13 mm dia. max.
TDK	Clamp core	ZCAT3035-1330	13 mm dia. max.

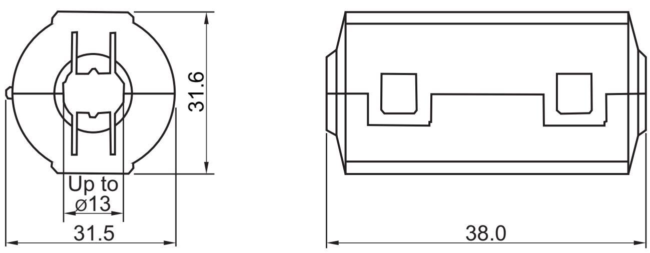
Precautions for Correct Use

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

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

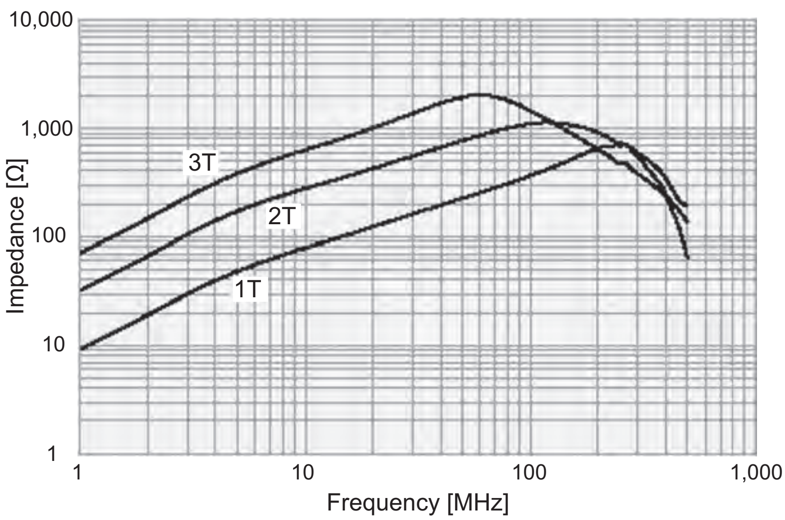
External Dimensions

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 4-40 and *Impedance Characteristics* on page 4-41.

Improving Control I/O Signal Noise Resistance

I/O signal errors can occur if control I/O is influenced by noise.

- Use completely separate power supplies for the control I/O 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 I/O power supply.
- If Brake Interlock Output (BKIR) is used, do not use the same 24-VDC power supply for both the brakes and the control I/O. Additionally, do not connect the ground wires. Connecting the ground wires may cause I/O signal errors.
- If the control I/O power supply wiring is long, add 1-µF laminated ceramic capacitors between the control I/O 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.

<table>
<tr><th colspan="2">Servo Drive</th><th colspan="3">Reactor</th></tr>
<tr><th>Number of power phases</th><th>Model</th><th>Model</th><th>Rated current</th><th>Inductance</th></tr>
<tr><td rowspan="3">Single-phase input</td><td>R88D-KN01L-ECT-L</td><td>3G3AX-DL2004</td><td>3.2 A</td><td>10.7 mH</td></tr>
<tr><td>R88D-KN02L-ECT-L</td><td>3G3AX-DL2007</td><td>6.1 A</td><td>6.75 mH</td></tr>
<tr><td>R88D-KN04L-ECT-L</td><td>3G3AX-DL2015</td><td>9.3 A</td><td>3.51 mH</td></tr>
<tr><td>Single-phase input</td><td rowspan="2">R88D-KN01H-ECT-L</td><td>3G3AX-DL2002</td><td>1.6 A</td><td>21.4 mH</td></tr>
<tr><td>3-phase input</td><td>3G3AX-AL2025</td><td>10.0 A</td><td>2.8 mH</td></tr>
<tr><td>Single-phase input</td><td rowspan="2">R88D-KN02H-ECT-L</td><td>3G3AX-DL2004</td><td>3.2 A</td><td>10.7 mH</td></tr>
<tr><td>3-phase input</td><td>3G3AX-AL2025</td><td>10.0 A</td><td>2.8 mH</td></tr>
<tr><td>Single-phase input</td><td rowspan="2">R88D-KN04H-ECT-L</td><td>3G3AX-DL2007</td><td>6.1 A</td><td>6.75 mH</td></tr>
<tr><td>3-phase input</td><td>3G3AX-AL2025</td><td>10.0 A</td><td>2.8 mH</td></tr>
<tr><td>Single-phase input</td><td rowspan="2">R88D-KN08H-ECT-L</td><td>3G3AX-DL2015</td><td>9.3 A</td><td>3.51 mH</td></tr>
<tr><td>3-phase input</td><td>3G3AX-AL2025</td><td>10.0 A</td><td>2.8 mH</td></tr>
<tr><td>Single-phase input</td><td rowspan="2">R88D-KN10H-ECT-L</td><td>3G3AX-DL2015</td><td>9.3 A</td><td>3.51 mH</td></tr>
<tr><td>3-phase input</td><td>3G3AX-AL2025</td><td>10.0 A</td><td>2.8 mH</td></tr>
<tr><td>Single-phase input</td><td rowspan="2">R88D-KN15H-ECT-L</td><td>3G3AX-DL2022</td><td>13.8 A</td><td>2.51 mH</td></tr>
<tr><td>3-phase input</td><td>3G3AX-AL2025</td><td>10.0 A</td><td>2.8 mH</td></tr>
<tr><td rowspan="5">3-phase input</td><td>R88D-KN06F-ECT-L</td><td rowspan="3">3G3AX-AL4025</td><td rowspan="3">6.0 A</td><td rowspan="3">7.7 mH</td></tr>
<tr><td>R88D-KN10F-ECT-L</td></tr>
<tr><td>R88D-KN15F-ECT-L</td></tr>
<tr><td>R88D-KN20F-ECT-L</td><td rowspan="2">3G3AX-AL4055</td><td rowspan="2">10.0 A</td><td rowspan="2">3.5 mH</td></tr>
<tr><td>R88D-KN30F-ECT-L</td></tr>
</table>

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.

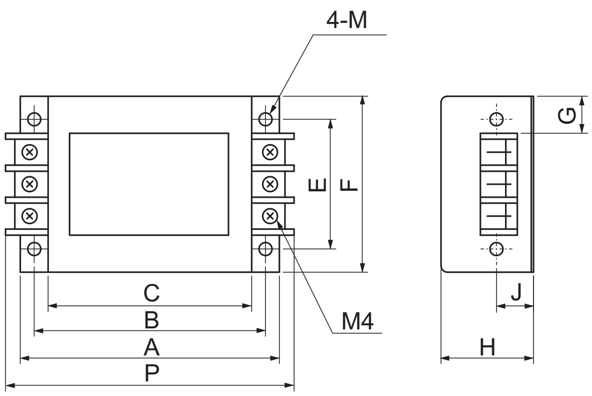
Manufacturer	Model	Rated current	Comment
OMRON	3G3AX-NFO01	6 A	For inverter output
	3G3AX-NFO02	12 A	
	3G3AX-NFO03	25 A	
	3G3AX-NFO04	50 A	
	3G3AX-NFO05	75 A	
	3G3AX-NFO06	100 A	

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.

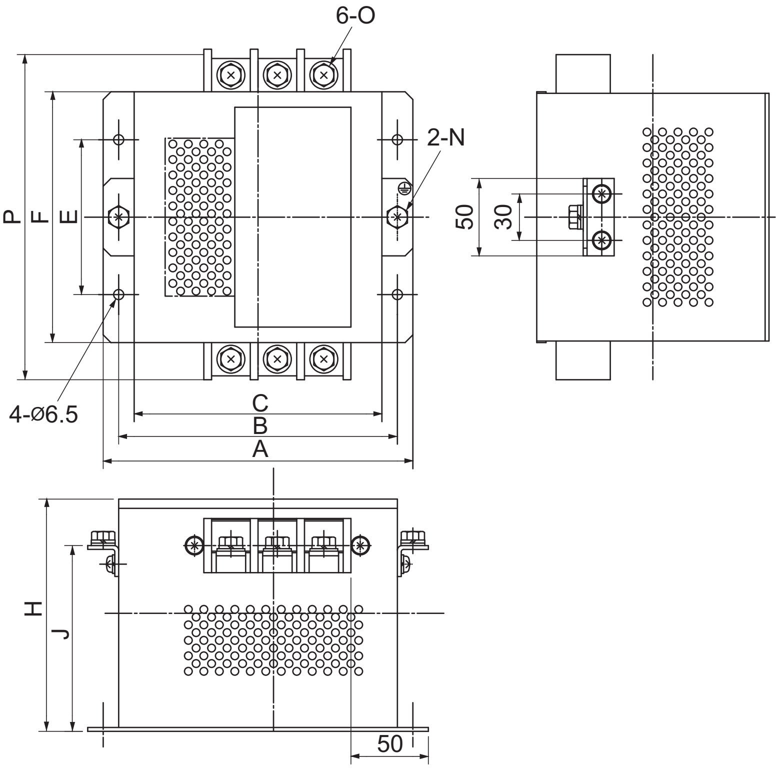
● External Dimensions

3G3AX-NFO01/-NFO02



Model	Dimensions [mm]									
	A	B	C	E	F	G	H	J	M	P
3G3AX-NFO01	140	125	110	70	95	22	50	20	4.5 dia.	156
3G3AX-NFO02	160	145	130	80	110	30	70	25	5.5 dia.	176

3G3AX-NFO03/-NFO04/-NFO05/-NFO06



Model	Dimensions [mm]									
	A	B	C	E	F	H	J	N	O	P
3G3AX-NFO03	160	145	130	80	112	120	–	–	M4	154
3G3AX-NFO04	200	180	160	100	162	150	120	M5	M5	210
3G3AX-NFO05	220	200	180	100	182	170	140	M6	M6	230
3G3AX-NFO06	220	200	180	100	182	170	140	M8	M8	237

4-5 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.

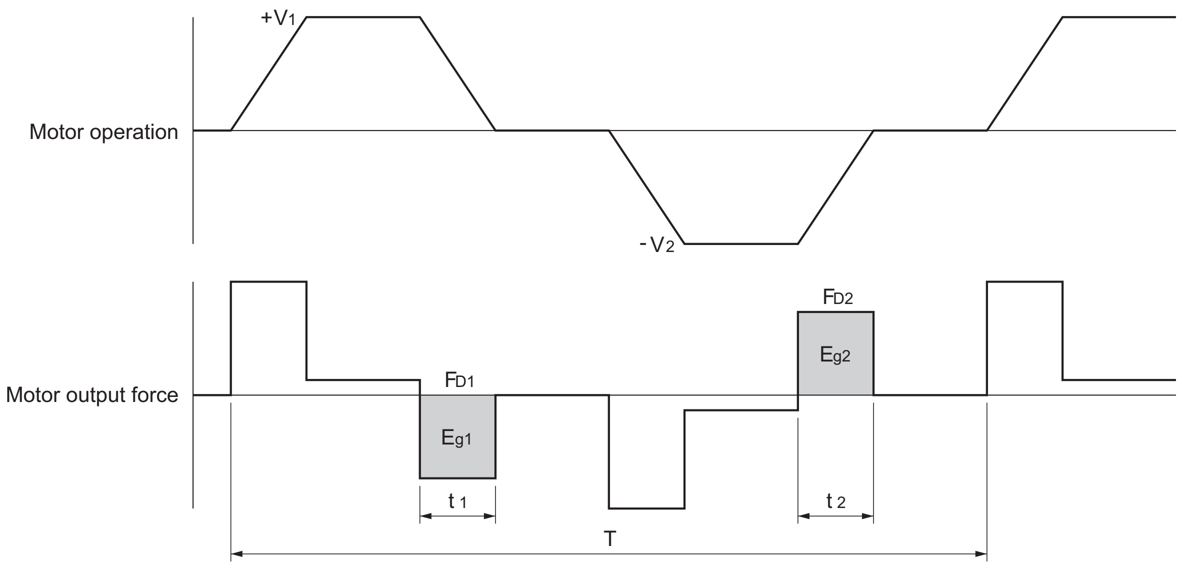
Additional Information

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

For information on whether or not your Servo Drive has an Internal Regeneration Resistor and its regeneration absorption capacity, refer to *4-5-2 Servo Drive Regeneration Absorption Capacity* on page 4-49.

4-5-1 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.

- $E_{g1} = \frac{1}{2} \cdot V_1 \cdot F_{D1} \cdot t_1$ [J]
- $E_{g2} = \frac{1}{2} \cdot V_2 \cdot F_{D1} \cdot t_2$ [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 caused by the motor winding resistance and the sliding friction, the actual regenerative energy will be approximately 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 Servo Drive's regenerative energy that can be absorbed by 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 that can be absorbed by built-in capacitors Ec [J], however, use the following equations to determine the average regeneration power Pr [W].

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

P_r : Average regeneration power that must be absorbed in 1 cycle of operation [W]
E_g : Regenerative energy that must be absorbed in 1 cycle of operation [J]
E_c : Regenerative energy that can be absorbed by built-in capacitors [J]
T : Operation cycle [s]

Note If the expression (E_{g1} - Ec) result is zero or less, regards it as 0. The expression (E_{g2} - 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 that can be absorbed 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 operation 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.)

4-5-2 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 to be absorbed by built-in capacitor Ec [J]	Internal regeneration resistor	Allowable minimum regeneration resistance [Ω]
		Average amount of regenerative energy to be absorbed [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-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

Regenerative energy to be absorbed by built-in capacitor varies depending on the input voltage to the main circuit power supply for the Servo Drive. The above value for each Servo Drive model is calculated when the input voltage is as follows.

Servo Drive model	Main circuit power supply input voltage
R88D-KN☐L-ECT-L	100 VAC
R88D-KN☐H-ECT-L	200 VAC
R88D-KN☐F-ECT-L	400 VAC

4-5-3 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 approximately 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-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)

4-5-4 Connecting an External Regeneration Resistor

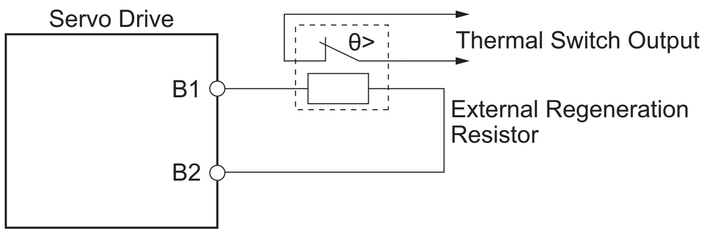
This section describes how to connect an External Regeneration Resistor.

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/ -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.

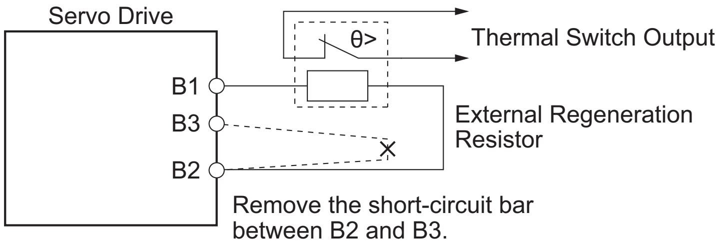
When using multiple External Regeneration Resistors, connect each thermal switch in series.

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/-KN06F-ECT-L/-KN10F-ECT-L/-KN15F-ECT-L/ -KN20F-ECT-L/-KN30F-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.



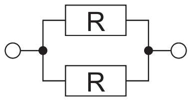
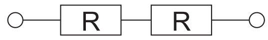
Precautions for Correct Use

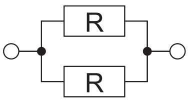
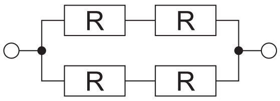
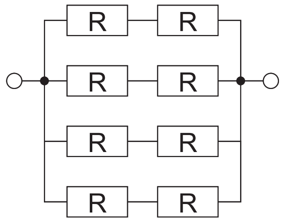
Connect the thermal switch output so that the main circuit power supply is shut OFF when the contacts open.

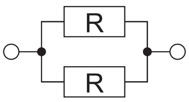
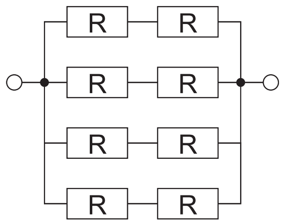
When using multiple External Regeneration Resistors, connect each thermal switch in series.

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	1,440 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 *4-5-2 Servo Drive Regeneration Absorption Capacity* on page 4-49.

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.

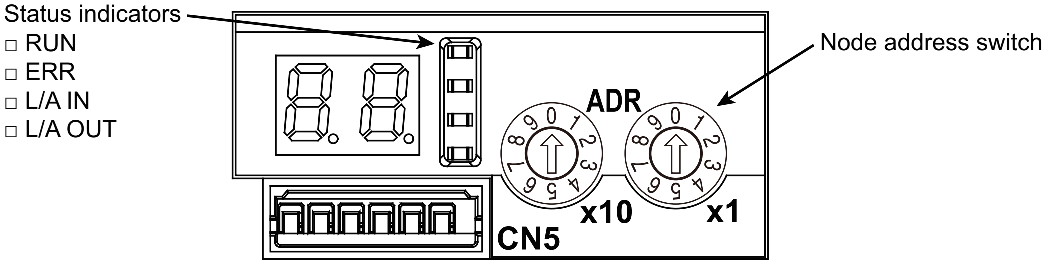
5

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: NJ301-□□□□/NJ501-□□□□) or Position Control Unit (Model: CJ1W-NC281/NC481/NC881/NCF81/NC482/NC882/NCF82).

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	Connection to NJ301-□□□□/NJ501-□□□□ series and CJ1W-NC281/NC481/NC881/NCF81/NC482/NC882/NCF82 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.

Additional Information

EtherCAT Slave Information File

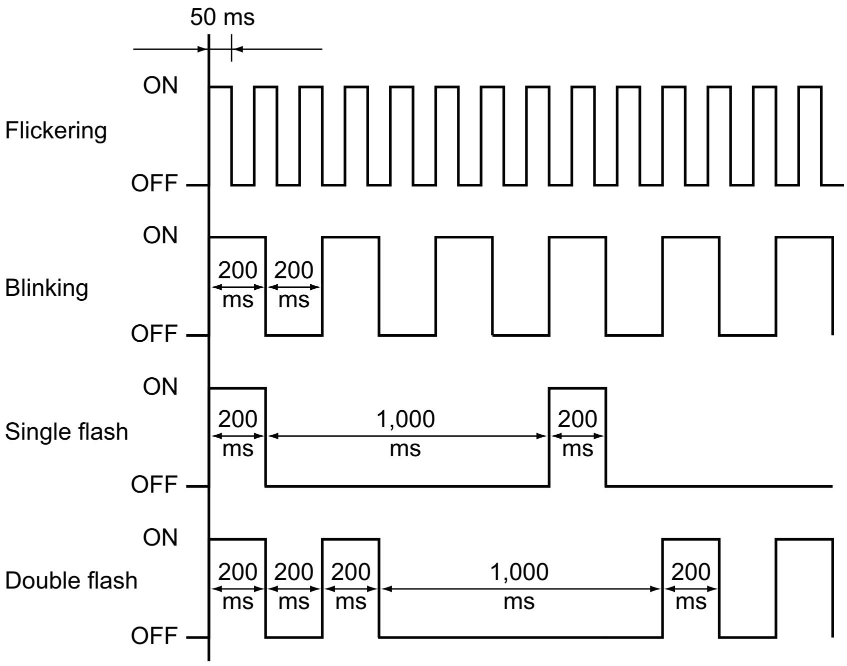
Information on EtherCAT slave settings is stored in the ESI (EtherCAT Slave Information) file. Information in this file is used by the master to configure the network and set communications parameters. This information is in an XML file.

5-1-2 Status Indicators

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

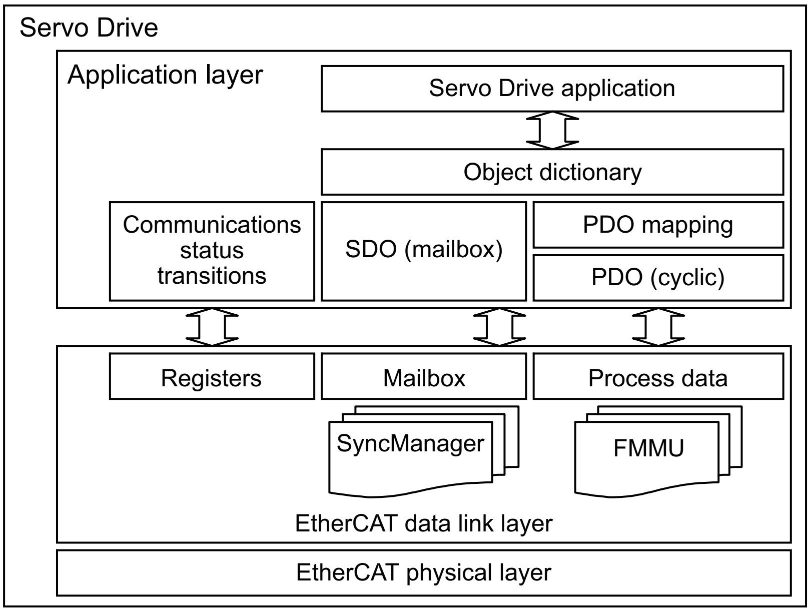
Name	Color	Status	Description
RUN	Green	OFF	Init state
		Blinking	Pre-Operational state
		Single flash	Safe-Operational state
		ON	Operational state
ERR	Red	OFF	No error
		Blinking	Communications setting error
		Single flash	Synchronization error or communications data error
		Double flash	Application 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.

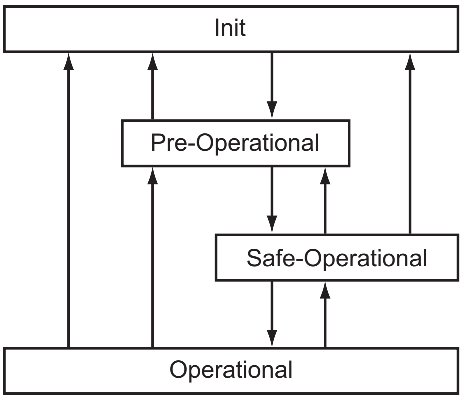
The object dictionary in the application layer contains parameters and application data as well as information on the PDO mapping between the process data servo interface and Servo Drive application.

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

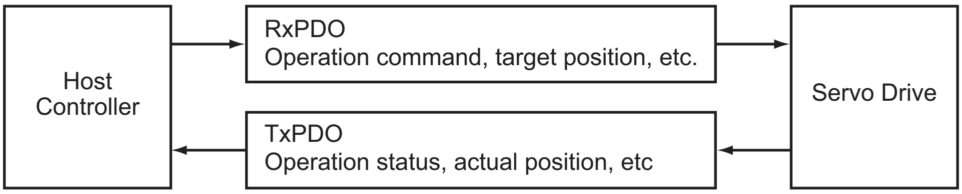
The EtherCAT State Machine (ESM) of the EtherCAT slave is controlled by the EtherCAT Master.



Status	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



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.

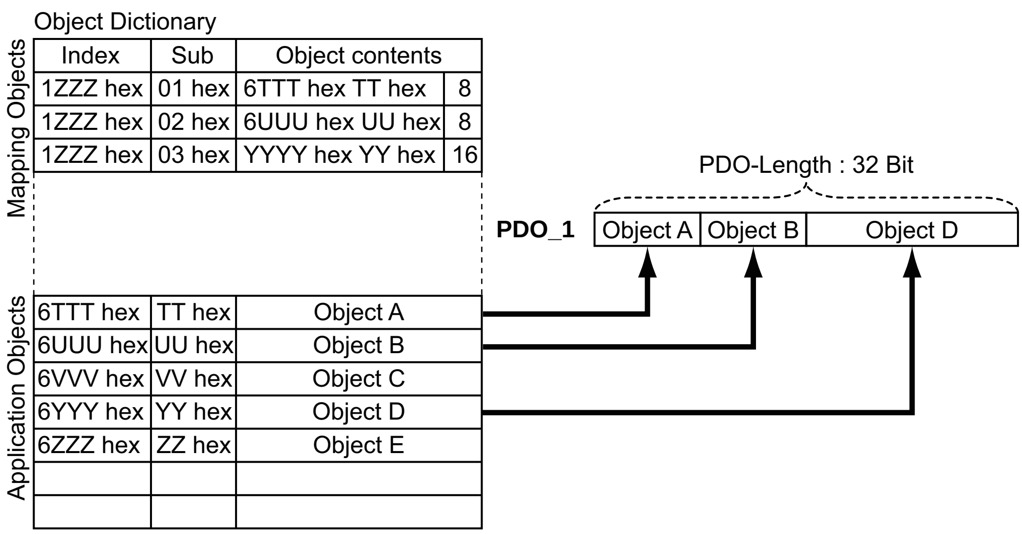
5-4-1 PDO Mapping Settings

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.

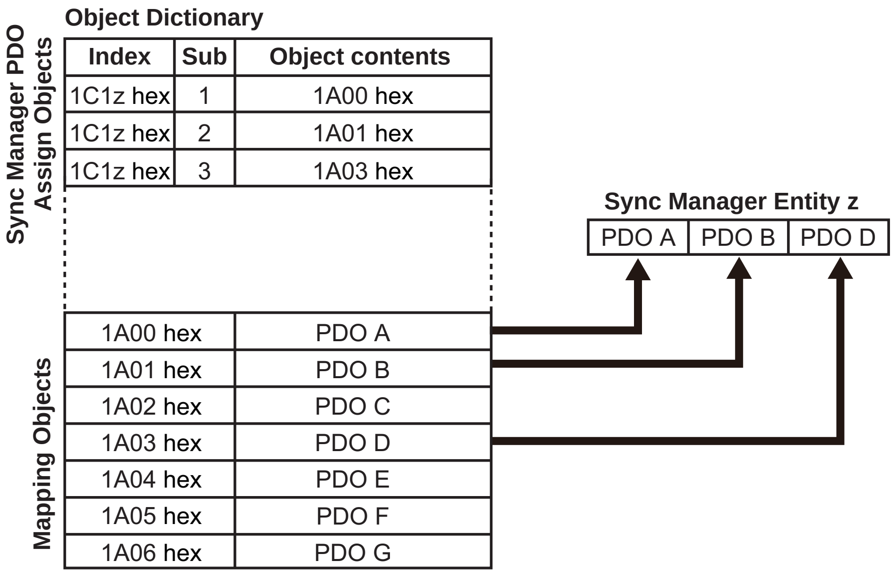


5-4-2 Sync Manager PDO Assignment Settings

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.



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 Feed-forward)

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. For details, refer to *A-1-3 Communications Cycles and Corresponding Modes of Operation* on page A-5.
- 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-31.

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. For details, refer to *A-1-3 Communications Cycles and Corresponding Modes of Operation* on page A-5.
- 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 shows 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 cannot 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: NJ301-□□□□/NJ501-□□□□) 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-95.

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-49.
- For errors displayed in Sysmac Studio, refer to *A-3 Sysmac Error Status Codes* on page A-95.

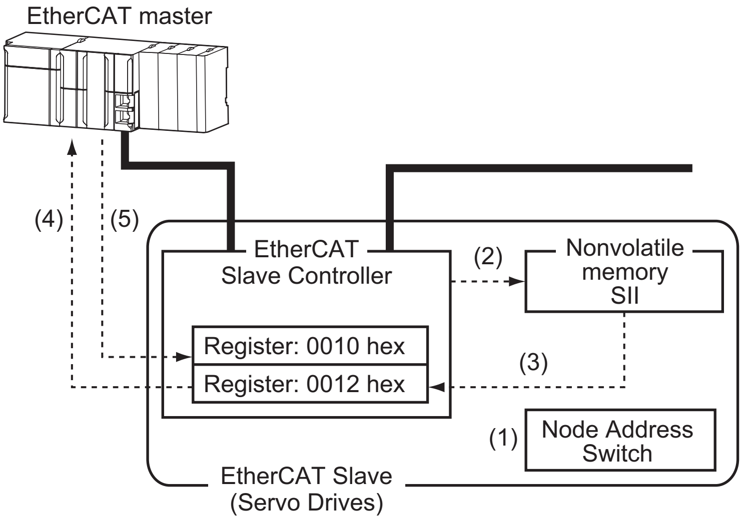
Saving the Node Address Setting

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

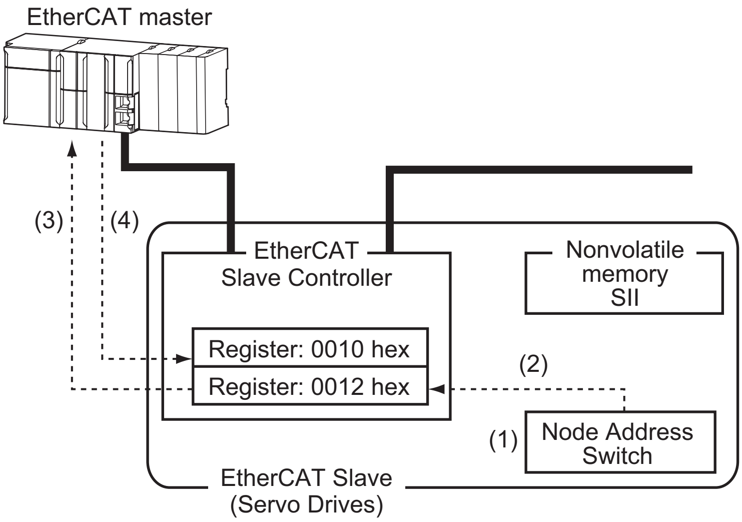
The set value saved as Slave Information Interface (SII) information in the nonvolatile memory of the slave is the node address.



(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-27.

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 outlines basic control functions, and explains the settings.

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.

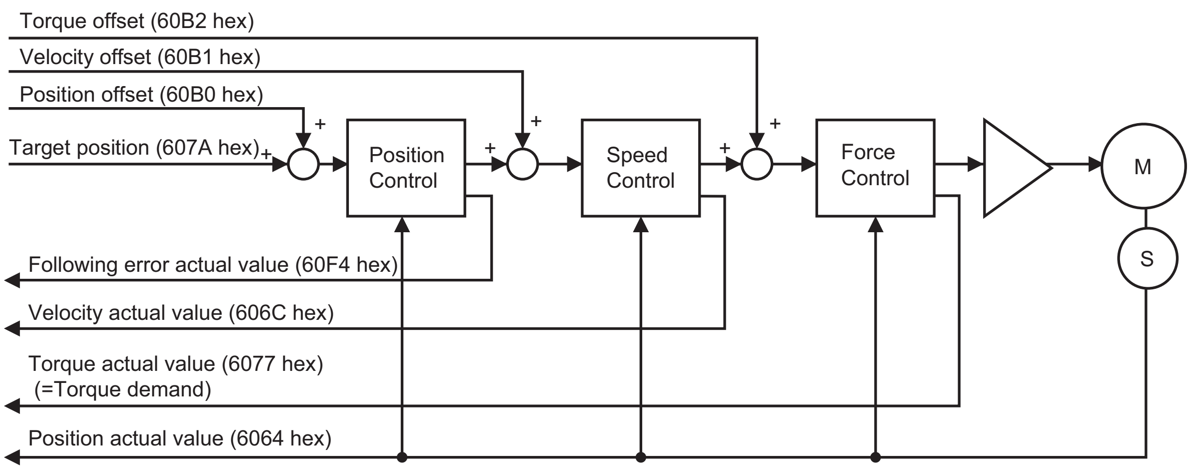
The Velocity offset (60B1 hex) and Torque offset (60B2 hex) can be used as speed feed-forward and force feed-forward amounts.

Precautions for Correct Use

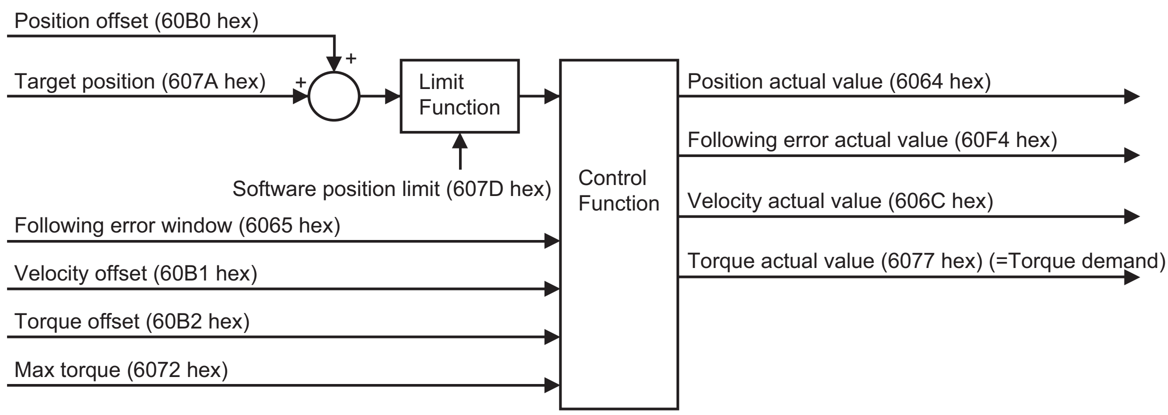
According to the CiA 402 Drive Profile, the object names between 6000 hex and 6999 hex may be represented using the word “torque,” instead of force. Read it as “force” when using this function.

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.



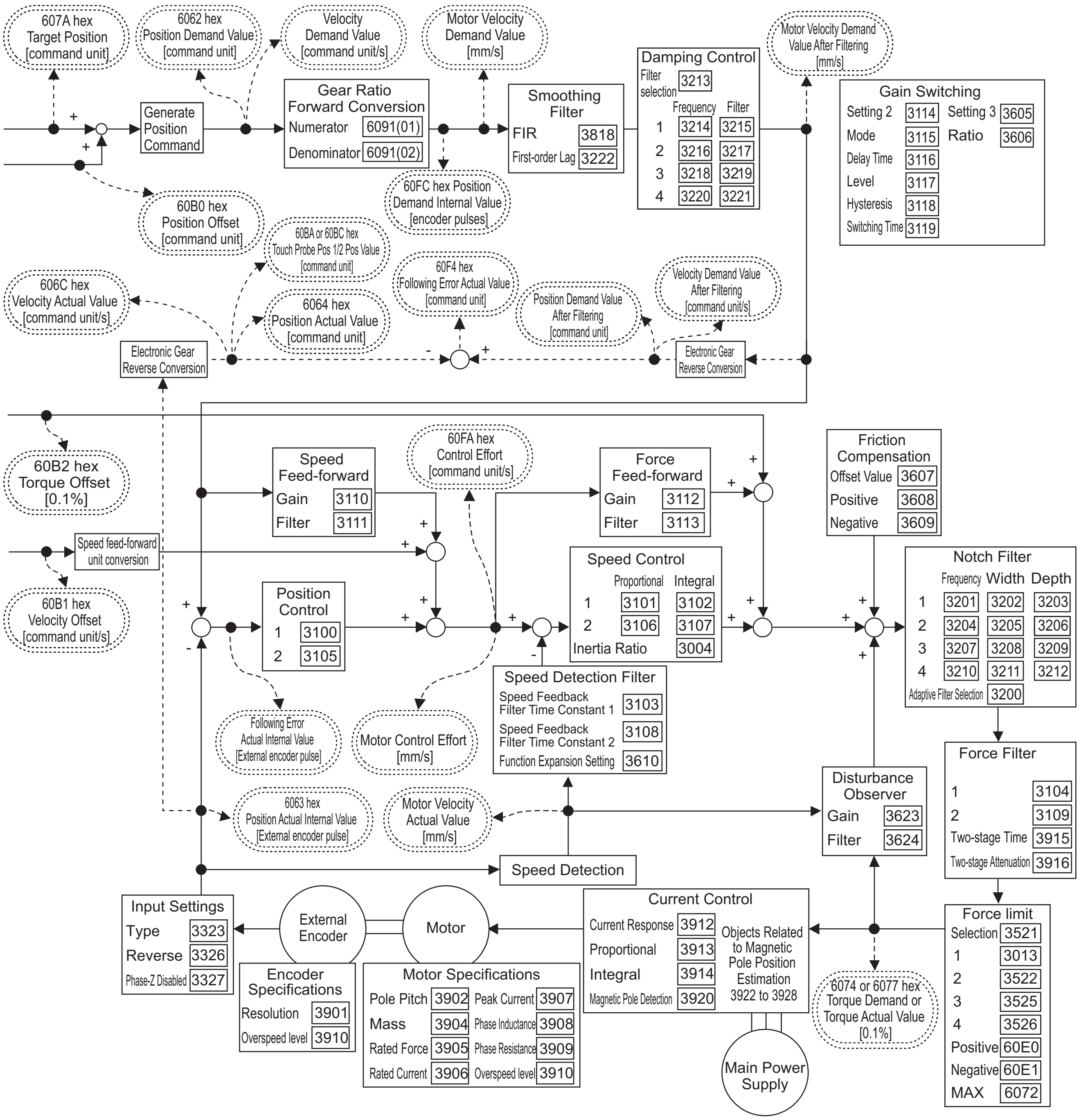
6-1-1 Related Objects

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 unit	–2,147,483,648 to 2,147,483,647	0000 hex
6065 hex*1	00 hex	Following error window	RW	U32	Command unit	0 to 134,217,728 or 4,294,967,295	100,000
6072 hex	00 hex	Max torque	RW	U16	0.1%	0 to 5,000	5,000
60B0 hex	00 hex	Position offset	RW	INT32	Command unit	–2,147,483,648 to 2,147,483,647	0000 hex
60B1 hex	00 hex	Velocity offset	RW	INT32	Command unit/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 unit	–2,147,483,648 to 2,147,483,647	0000 hex
606C hex	00 hex	Velocity actual value	RO	INT32	Command unit/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 unit	–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 set value 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.

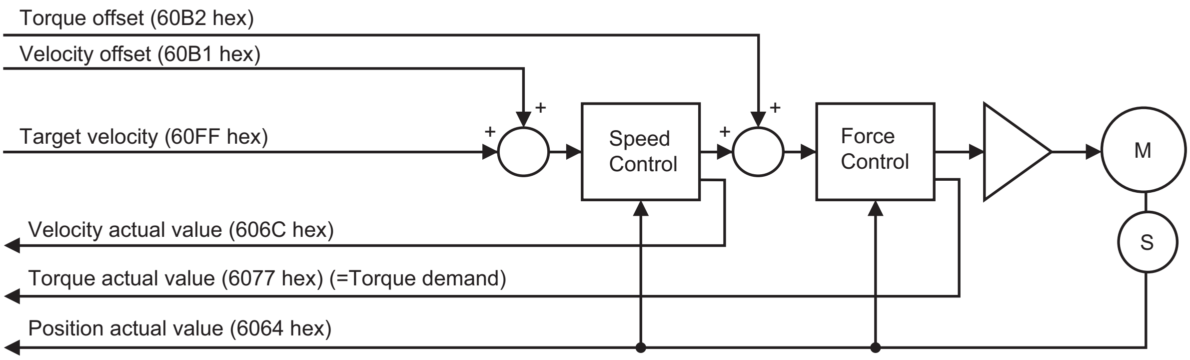
The Torque offset (60B2 hex) can be used as the force feed-forward amount.

Precautions for Correct Use

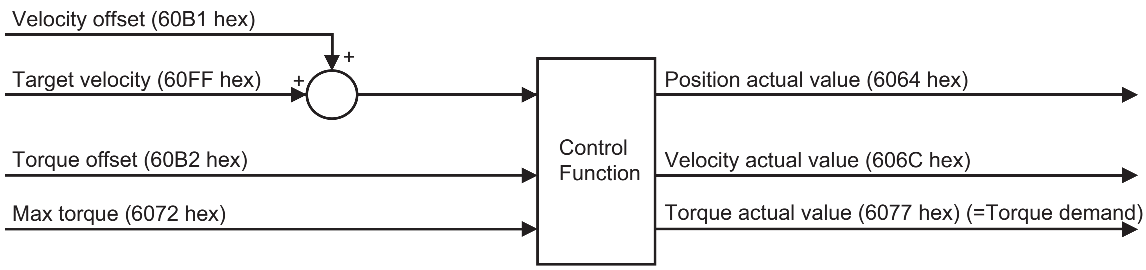
According to the CiA 402 Drive Profile, the object names between 6000 hex and 6999 hex may be represented using the word “torque,” instead of force. Read it as “force” when using this function.

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 unit/s	–2,147,483,647 to 2,147,483,647	0000 hex
6072 hex	00 hex	Max torque	RW	U16	0.1%	0 to 5,000	5,000
60B1 hex	00 hex	Velocity offset	RW	INT32	Command unit/s	–2,147,483,647 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 unit	–2,147,483,647 to 2,147,483,647	0000 hex
606C hex	00 hex	Velocity actual value	RO	INT32	Command unit/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

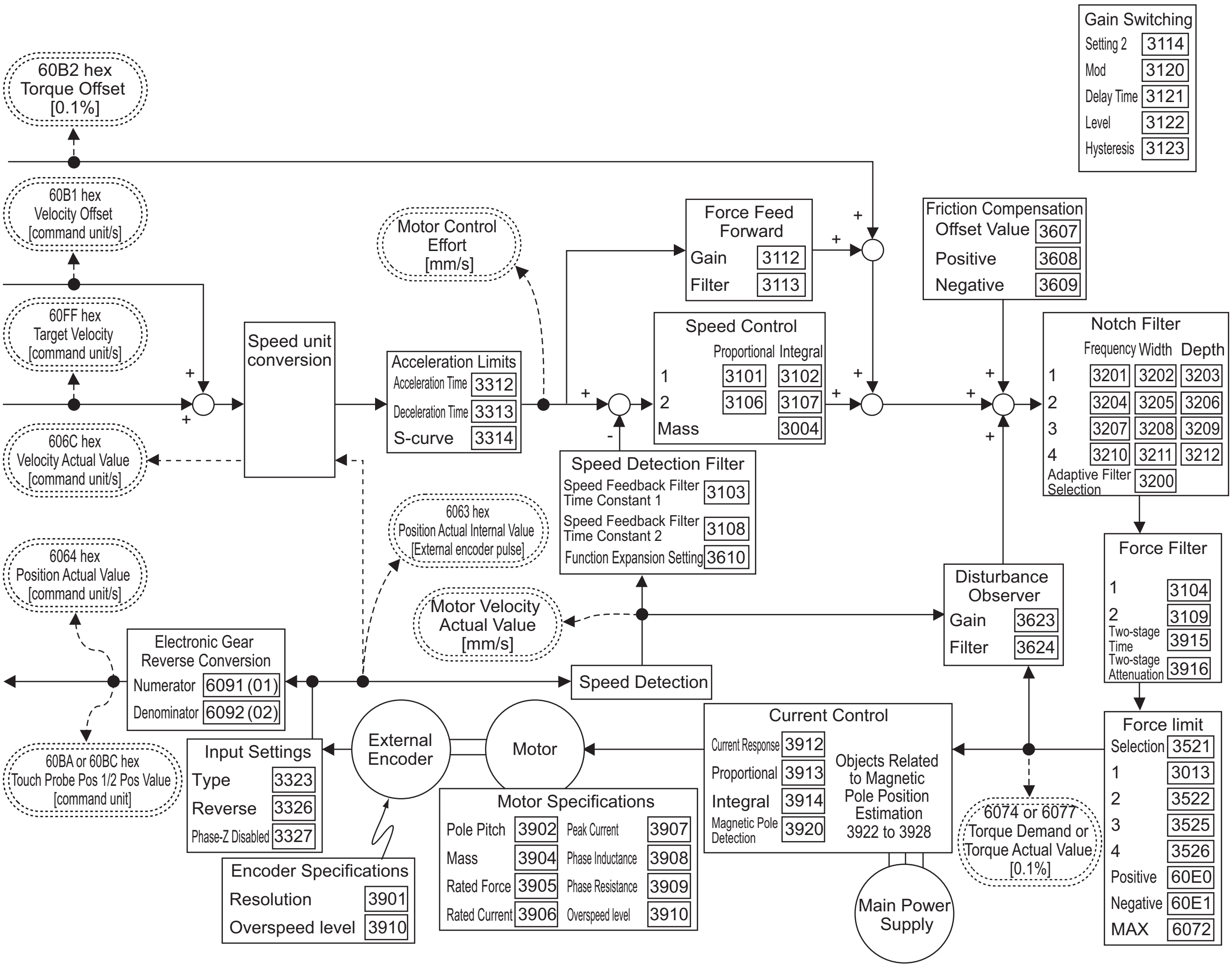
Index	Name	Description	Reference
3312 hex	Soft Start Acceleration Time	Set the acceleration time for internally set speed control. Set the time until 1,000 mm/s is reached.	P. 9-25
3313 hex	Soft Start Deceleration Time	Set the deceleration time for internally set speed control. Set the time until 1,000 mm/s is reached.	P. 9-25
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.	P. 9-26

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. The setting has a hysteresis of 10 mm/s.	P. 9-37
3436 hex	Speed for Motor Detection	Set the detection threshold for the Speed Conformity Output (TGON). A Speed Conformity Output (TGON) is output when the motor speed exceeds the set value. The setting has a hysteresis of 10 mm/s.	P. 9-38

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.



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

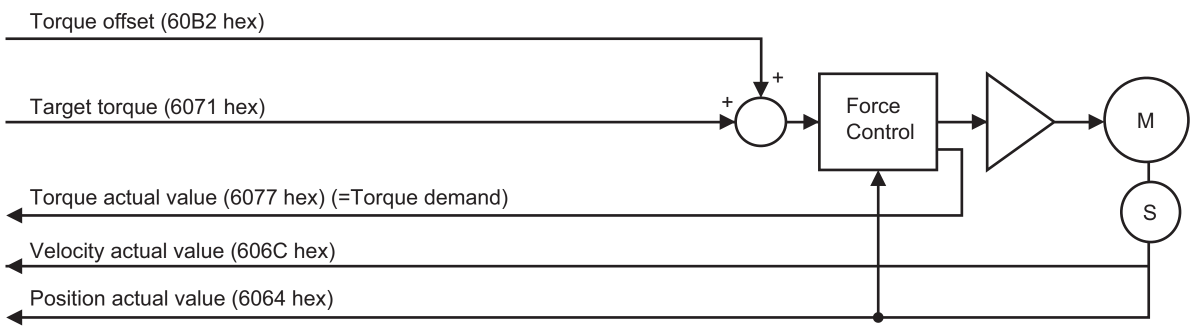
In this mode of operation, the controller has a path generation function (an operation profile calculation function) and it gives the target torque (force) to the Servo Drive using cyclic synchronization. Force control is performed by the Servo Drive.

Precautions for Correct Use

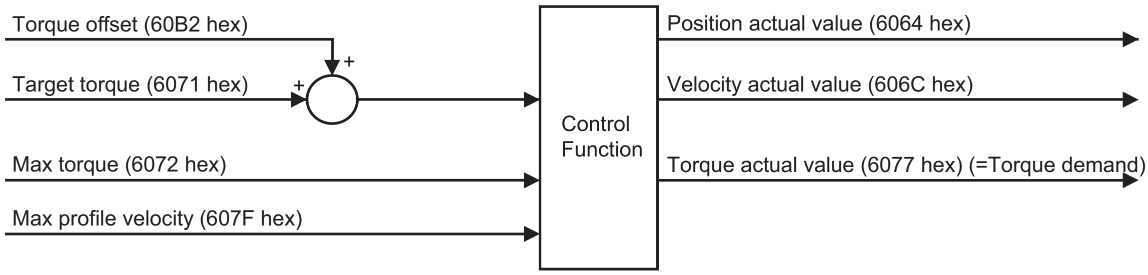
According to the CiA 402 Drive Profile, the object names between 6000 hex and 6999 hex may be represented using the word “torque,” instead of force. Read it as “force” when using this function.

Cyclic Synchronous Torque Mode Configuration

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



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



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	5,000
607F hex	00 hex	Max profile velocity	RW	U32	Command unit/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 unit	–2,147,483,648 to 2,147,483,647	0000 hex
606C hex	00 hex	Velocity actual value	RO	INT32	Command unit/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.	P. 9-26

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.

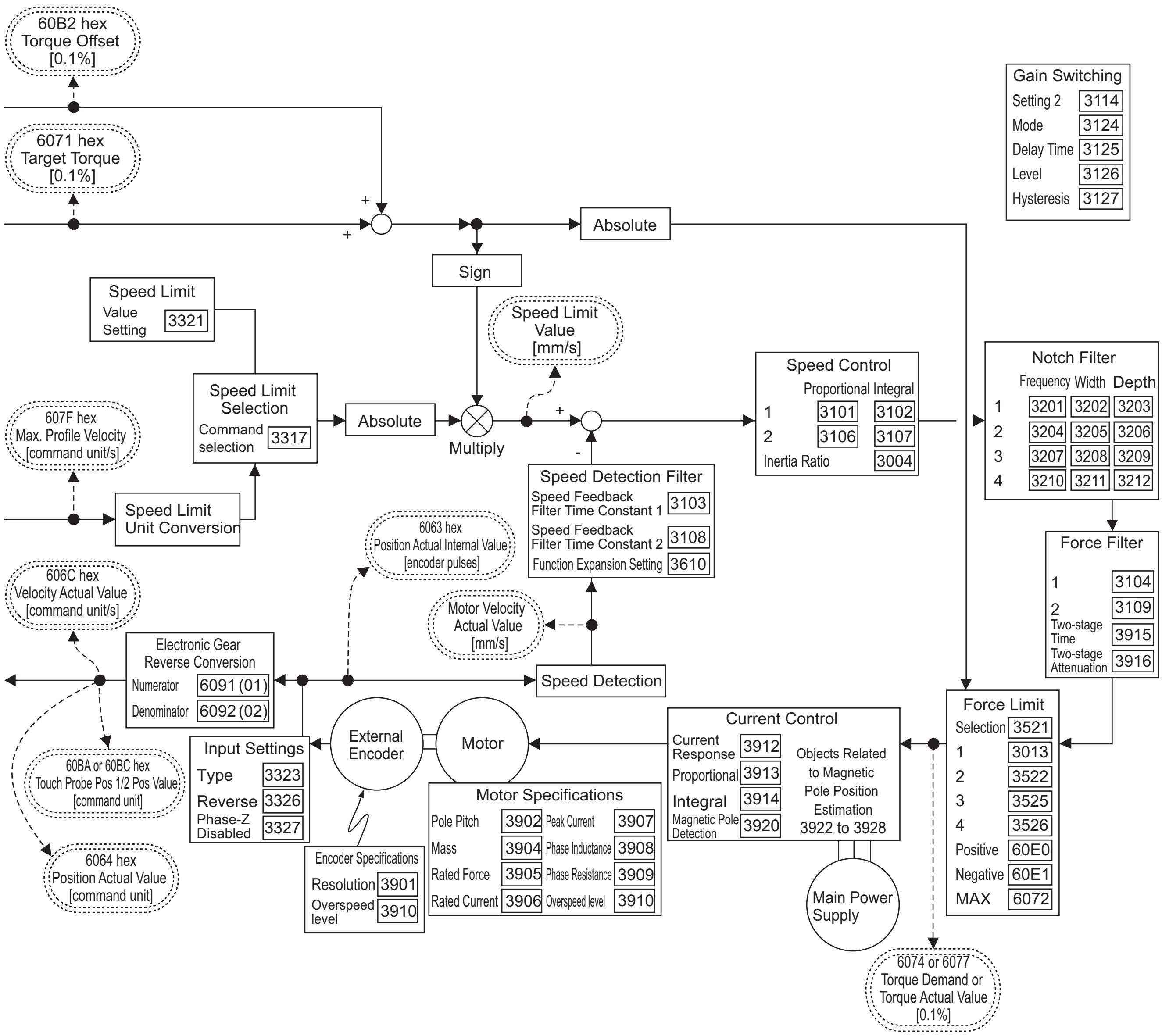
Index	Name	Description	Setting range	Unit
3317 hex	Speed Limit Selection	Selects the input type of the Speed Limit during force control. 0: Control the speed by the Speed Limit Value Setting (3321 hex). 1: Control the speed by either one of the smaller value: the Max Profile Velocity (607F hex) by EtherCAT 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 for force control. During force control, the speed is controlled so as not to exceed the level set by the speed limit value.	P. 9-26

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.



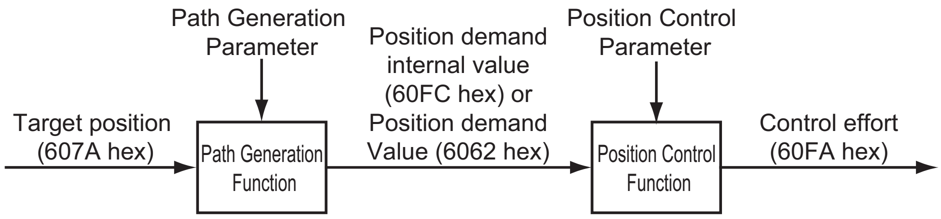
Note 1 Numbers within parentheses are sub-index numbers.

2 Numbers within boxes are hexadecimal index numbers.

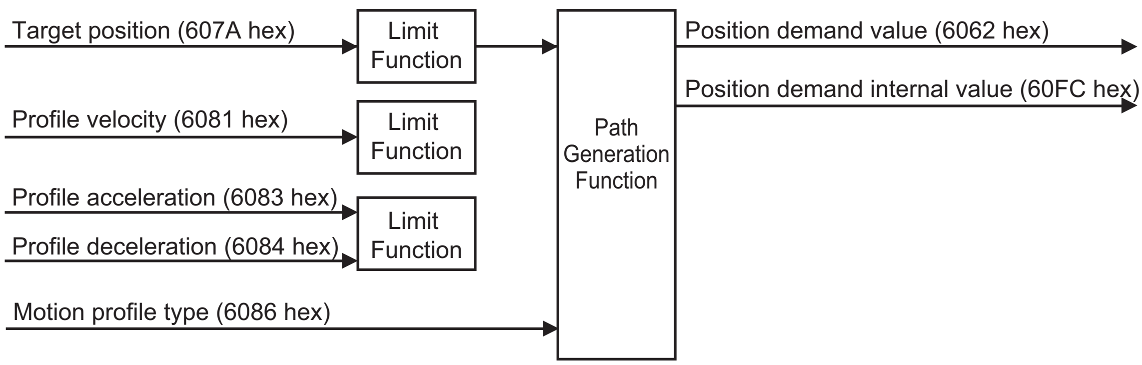
3 Read the word “torque” as “force.”

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.

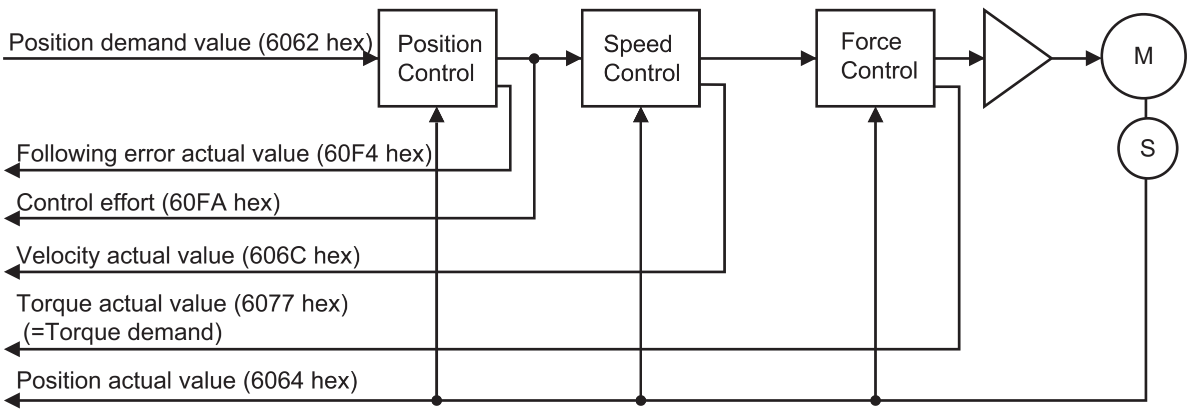


The configuration of the path generation function is as follows:

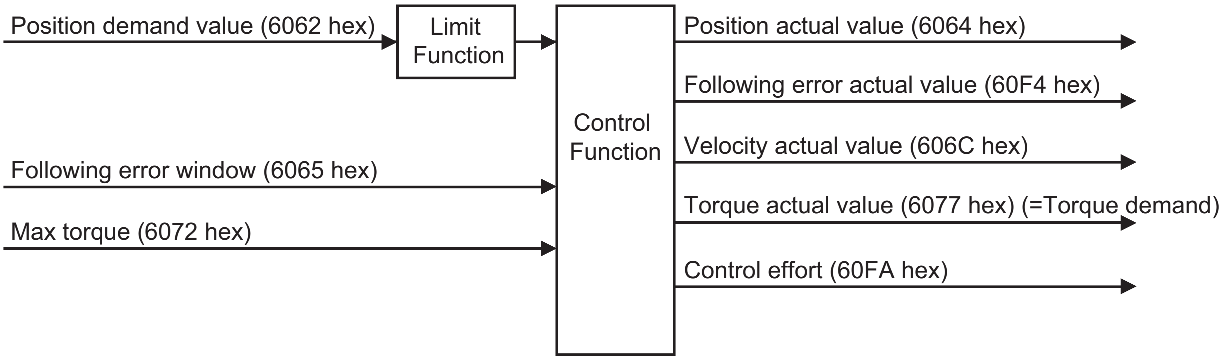


Profile Position Mode Configuration

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 unit	0 to 134,217,728, 4,294,967,295	100,000
6072 hex	00 hex	Max torque	RW	U16	0.1%	0 to 5,000	5,000
607A hex*2	00 hex	Target position	RW	INT32	Command unit	–2,147,483,648 to 2,147,483,647	0000 hex
607D hex	01 hex	Min position limit	RW	INT32	Command unit	–1,073,741,823 to 1,073,741,823	–500,000
	02 hex	Max position limit	RW	INT32	Command unit	–1,073,741,823 to 1,073,741,823	500,000
6081 hex	00 hex	Profile velocity	RW	U32	Command unit/s	0 to 2,147,483,647	0000 hex
6083 hex	00 hex	Profile acceleration	RW	U32	Command unit/s^2	1 to 655,350,000	1,000,000
6084 hex	00 hex	Profile deceleration	RW	U32	Command unit/s^2	1 to 655,350,000	1,000,000
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 unit	–2,147,483,648 to 2,147,483,647	0000 hex
6064 hex	00 hex	Position actual value	RO	INT32	Command unit	–2,147,483,648 to 2,147,483,647	0000 hex
606C hex	00 hex	Velocity actual value	RO	INT32	Command unit/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 unit	–2,147,483,648 to 2,147,483,647	0000 hex
60FA hex	00 hex	Control effort	RO	INT32	Command unit/s	–1,073,741,823 to 1,073,741,823	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 set to 134,217,728. In this case, 134,217,728 will be returned when the set value 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.

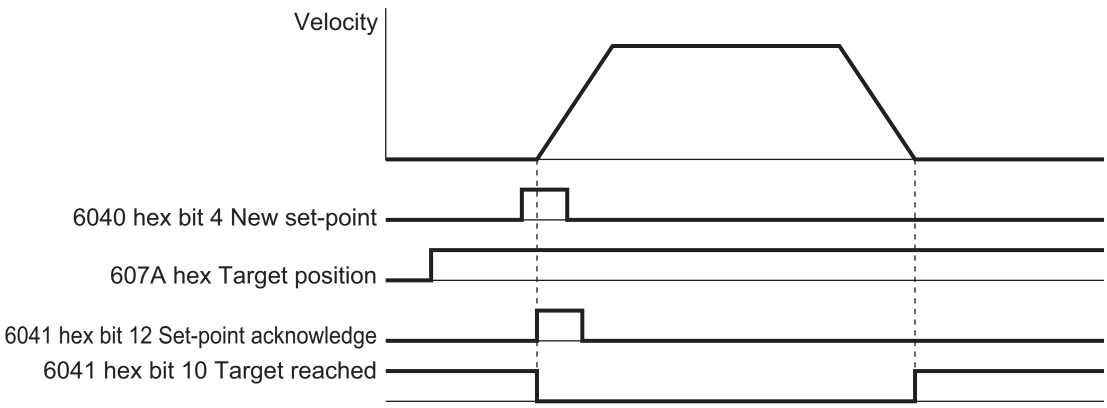
6-4-2 Description of Function

The G5-series Servo Drive can perform independent 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).

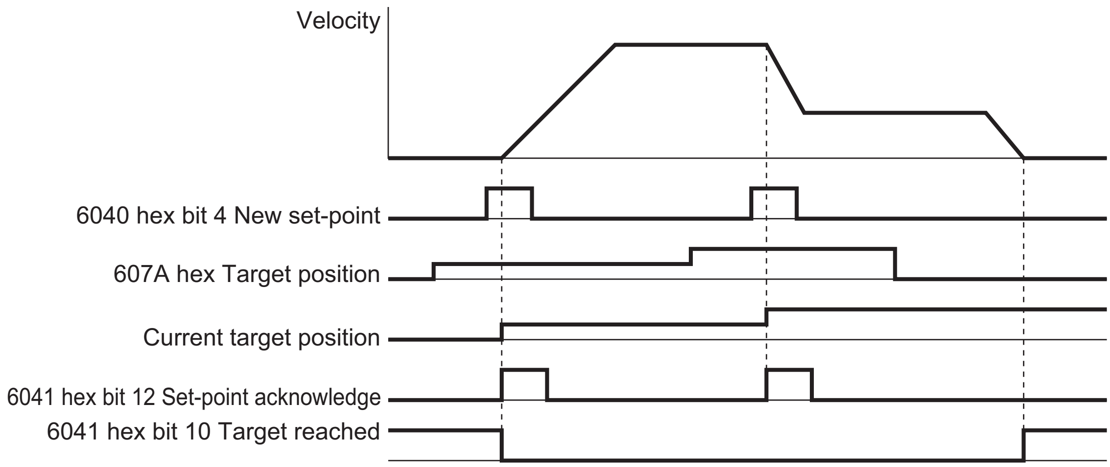
Changing the Controlword (6040 hex) bit 4 (New set-point) from 0 to 1 starts positioning to the set target position.



The Target value can be changed while PTP positioning is in progress.

During PTP positioning, change the Target position (607A hex) or 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 NJ-series Machine Automation Controllers (Model: NJ301-□□□□/NJ501-□□□□) and the Position Control Units (Model: CJ1W-NC281/NC481/NC881/NCF81/NC482/NC882/NCF82), 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 NJ-series Machine Automation Controller (Model: NJ301-□□□□/NJ501-□□□□) and an EtherCAT-compatible Position Control Unit (Model: CJ1W-NC281/NC481/NC881/NCF81/NC482/NC882/NCF82).

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 (NJ301-□□□□/NJ501-□□□□)

Index	Sub-index	Name	Default setting	Description
3013 hex	00 hex	Force Limit 1	5,000	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	0081 8181 hex	Positive Drive Prohibition Input (NC)
3402 hex	00 hex	Input Signal Selection 3	0082 8282 hex	Negative Drive Prohibition Input (NC)
3403 hex	00 hex	Input Signal Selection 4	0022 2222 hex	Origin Proximity Input (NO)
3404 hex	00 hex	Input Signal Selection 5	002B 2B2B hex	External Latch Signal 3 (NO)*1
3405 hex	00 hex	Input Signal Selection 6	0021 2121 hex	External Latch Signal 2 (NO)*1
3406 hex	00 hex	Input Signal Selection 7	0020 2020 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	5,000	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: NJ301-□□□□/NJ501-□□□□) 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

Position Control Units (CJ1W-NC281/NC481/NC881/NCF81/NC482/NC882/NCF82)

Index	Sub-index	Name	Default setting	Description
3013 hex	00 hex	Force Limit 1	5,000	Default setting is 500.0%
3401 hex	00 hex	Input Signal Selection 2	0081 8181 hex	Positive Drive Prohibition Input (NC)
3402 hex	00 hex	Input Signal Selection 3	0082 8282 hex	Negative Drive Prohibition Input (NC)
3403 hex	00 hex	Input Signal Selection 4	0022 2222 hex	Origin Proximity Input (NO)
3404 hex	00 hex	Input Signal Selection 5	002B 2B2B hex	External Latch Signal 3 (NO)*1
3405 hex	00 hex	Input Signal Selection 6	0021 2121 hex	External Latch Signal 2 (NO)*1
3406 hex	00 hex	Input Signal Selection 7	0020 2020 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	5,000	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	5,000	Default setting is 500.0%
60E1 hex	00 hex	Negative torque limit value	5,000	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: Unused

7

Applied Functions

This section outlines the applied functions such as the electronic gear and gain switching, 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	Description	Reference
3400 hex	Input Signal Selection 1	Set the IN1 input function allocation.	P. 9-30
3401 hex	Input Signal Selection 2	Set the IN2 input function allocation.	P. 9-30
3402 hex	Input Signal Selection 3	Set the IN3 input function allocation.	P. 9-30
3403 hex	Input Signal Selection 4	Set the IN4 input function allocation.	P. 9-30
3404 hex	Input Signal Selection 5	Set the IN5 input function allocation.	P. 9-30
3405 hex	Input Signal Selection 6	Set the IN6 input function allocation.	P. 9-31
3406 hex	Input Signal Selection 7	Set the IN7 input function allocation.	P. 9-31
3407 hex	Input Signal Selection 8	Set the IN8 input function allocation.	P. 9-31

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.

For the set value of each function, refer to *Function Number Table* on page 7-4.

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 (normally open) contact	NC (normally close) contact
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
Home switch (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, such as Immediate Stop Input, and Origin Proximity Input, 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 any of 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 Signals	Default setting (hex)	Default setting state					
			Position Control		Speed control		Force Control	
			Symbol	Logic *1	Symbol	Logic *1	Symbol	Logic *1
3410 hex	OUTM1	0003 0303 hex	BKIR	NO (normally open) contact	BKIR	NO (normally open) contact	BKIR	NO (normally open) contact
3411 hex	OUTM2	0002 0202 hex	READY	NO (normally open) contact	READY	NO (normally open) contact	READY	NO (normally open) contact

*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	Name	Description	Reference page
3410 hex	Output Signal Selection 1	Set the OUTM1 output function allocation. This object is set in hexadecimal.	P. 9-31
3411 hex	Output Signal Selection 2	Set the OUTM2 output function allocation.	P. 9-31

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 any of the objects from 3410 to 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	NC
Disabled	–	00 hex	00 hex
Servo Ready 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

Signal name	Symbol	Set value	
		NO	NC
Remote Output 1	R-OUT1	10 hex	Setting not available
Remote Output 2	R-OUT2	11 hex	Setting not available
Magnetic Pole Position Estimation Completion Output	CS-CMP	12 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.

7-2 Positive and Negative Drive Prohibition Functions

If the Positive Drive Prohibition Input (POT) or the Negative Drive Prohibition Input (NOT) is opened, 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	Description	Reference
3400 hex to 3407 hex	Input Signal Selection 1 to 8	Set the input signal allocations and logic.	P. 9-30
3504 hex	Drive Prohibition Input Selection	Set the operation to be performed upon positive and negative drive prohibition input.	P. 9-41
3505 hex	Stop Selection for Drive Prohibition Input	Set the deceleration and stop methods upon positive and negative drive prohibition input.	P. 9-42
3511 hex	Immediate Stop Force	Set the force limit for immediate stops.	P. 9-43

● 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 Linear 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.

Drive Prohibition Input Selection (3504 hex)	Description
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 shorted: Positive limit switch not operating and status normal. • Positive drive prohibition input open: Positive direction prohibited and negative direction permitted. • Negative drive prohibition input shorted: 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 drive prohibition input and negative drive prohibition input disabled.
2	Positive drive prohibition input 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 *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 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).

● Stop Selection for Drive Prohibition Input (3505 hex)

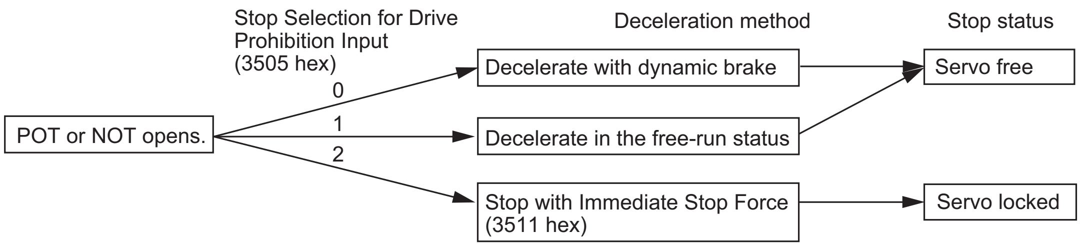
Set the deceleration and stop methods upon a positive or negative drive prohibition input.

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 Resistor control terminals	Clear	Force command is 0 for drive prohibition direction	Hold
	1	Free-run	Clear	Force command is 0 for drive prohibition direction	Hold
	2	Immediate stop *3	Clear	Force command and force limit are as specified.	Clear after deceleration completes, then hold.

*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” shows 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 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 approximately 30 mm/s or lower) and the Drive Prohibition Input is open.

Additional Information

While the Positive Drive Prohibition Input (POT) is open, the Linear 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 Linear 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 crash into the machine edge due to vibration.

7-3-1 Operating Conditions

The overrun limit works under the following conditions.

	Conditions
Operation mode	Position 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.

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 position estimation 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
3514 hex	Overrun Limit Setting	Sets the Motor's allowable operating range for the position command input range	P. 9-44

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 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
3704 hex	Backlash Compensation Selection	Select whether to enable or disable backlash compensation during position control. Set the compensation direction.	P. 9-55
3705 hex	Backlash Compensation Amount	Set the backlash compensation amount during position control.	P. 9-55
3706 hex	Backlash Compensation Time Constant	Set the backlash compensation time constant during position control.	P. 9-56

● 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 movement.	Compensate in negative direction when it is in negative movement.

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 is. Therefore, after returning to the Position Control mode again, you can restart with the backlash compensation state set in the previous Position Control Mode.
- To determine the actual position of the Linear Motor, offset the Linear 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: NJ301-□□□□/NJ501-□□□□) and Position Control Unit (Model: CJ1W-NC□8□).

7-5-1 Objects Requiring Settings

Index	Sub-index	Bit	Name	Description	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.	P. 9-38
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.	P. 9-39
3439 hex	–	–	Brake Threshold Speed During Operation	Set the speed at which to turn OFF power to the 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.	P. 9-39
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	P. A-94
	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 disabled. 1: Set Brake Bit enabled.	

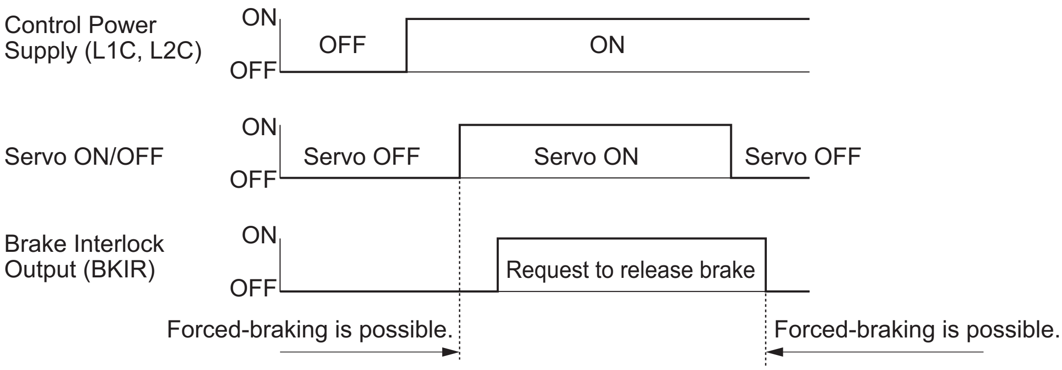
*1 The Brake Interlock Output (BKIR) is turned ON. The brake is released for a brake release command from either EtherCAT communications or the Servo Drive.

*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.

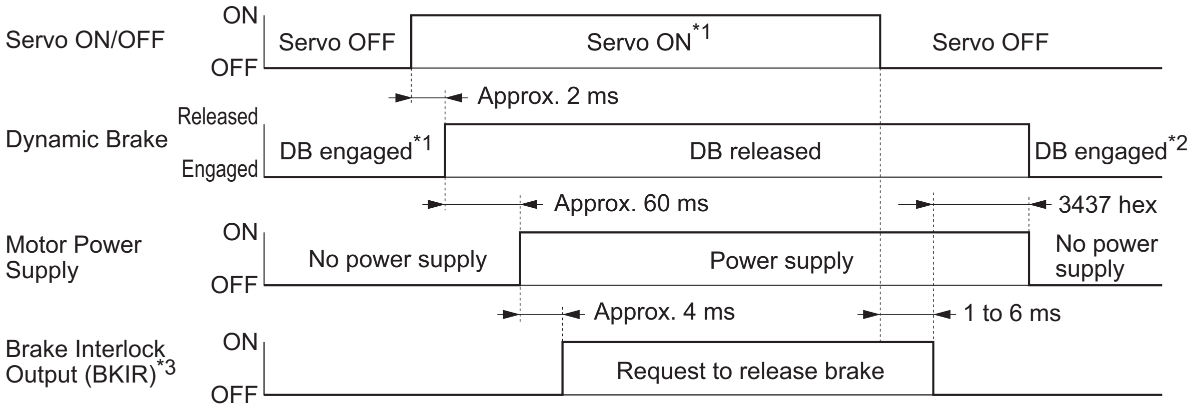
7-5-2 Operation Timing

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 approximately 30 mm/s or below.

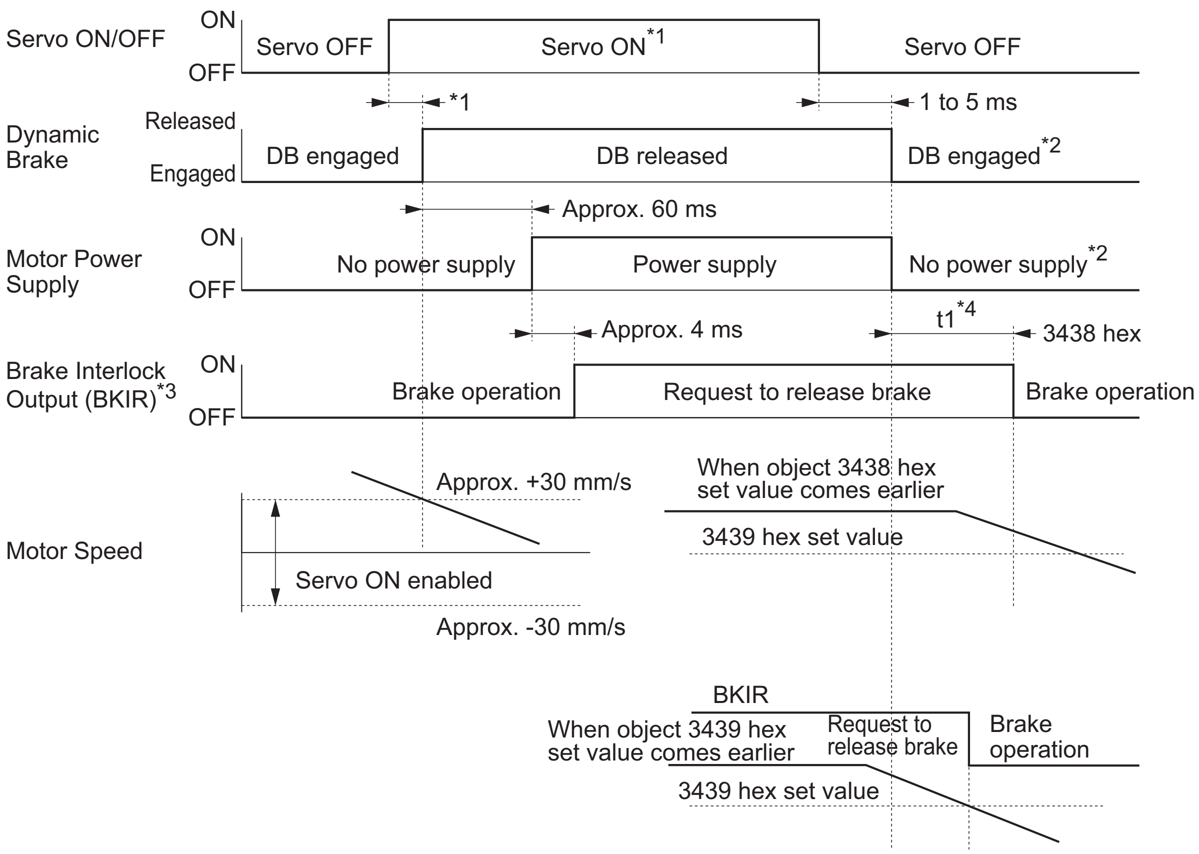
*2 The operation of the dynamic brake when the servo is OFF depends on the setting of the Disable operation option code (605C hex).

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

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 approximately 30 mm/s 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.

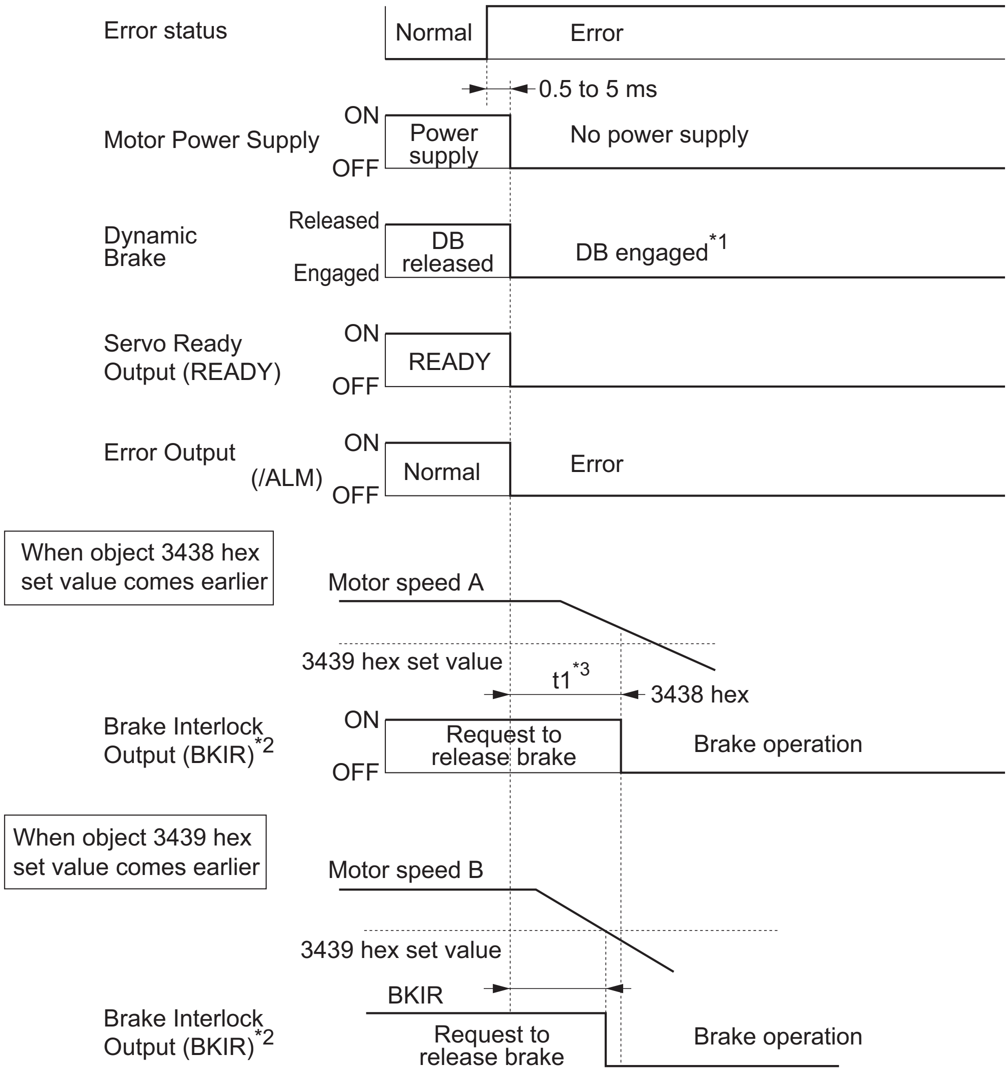
*2 The operation of the dynamic brake when the servo is OFF depends on the setting of the Disable operation option code (605C hex).

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

*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).

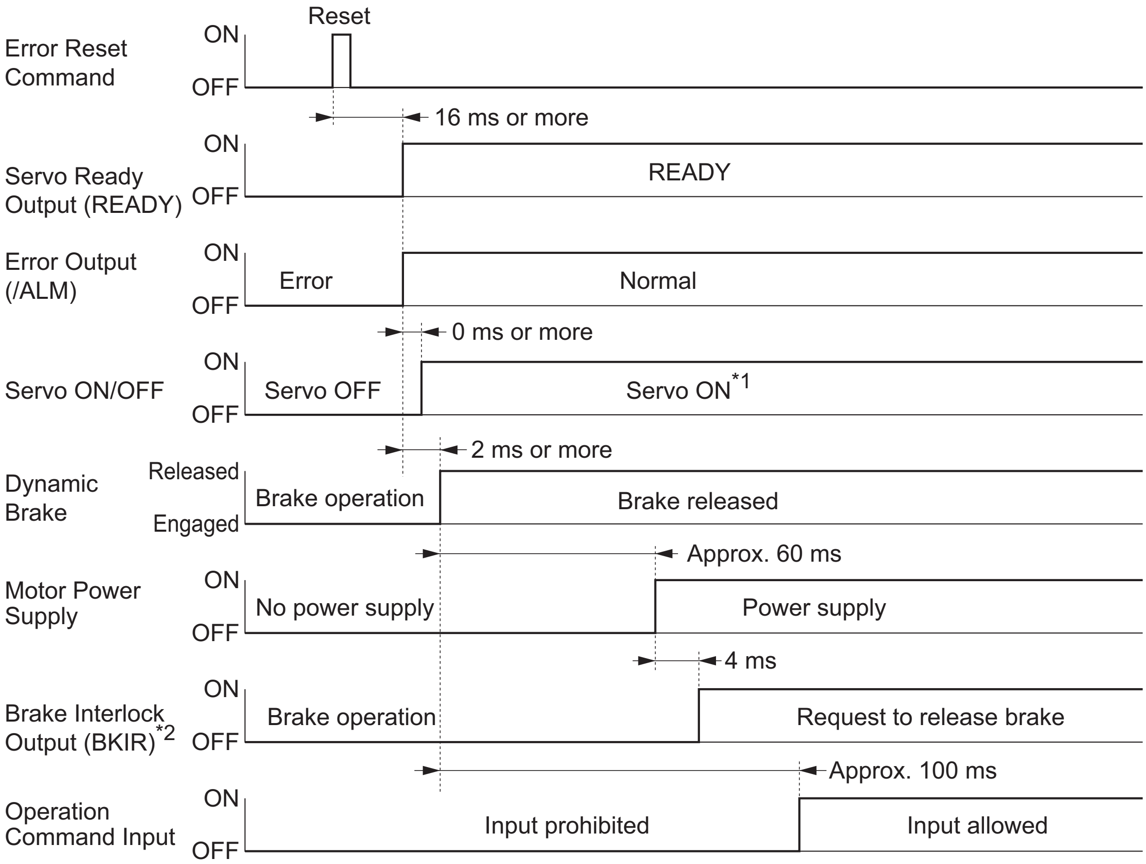
*2 The Brake Interlock Output (BKIR) turns ON either when a release request is received via servo controls or when a release request is received via EtherCAT communications. The above example shows when there is no brake release request from EtherCAT communications.
The BKIR signal is assigned to the 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 approximately 30 mm/s or below.

*2 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. 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 (Model: NJ301-□□□□/NJ501-□□□□) or Position Control Unit (Model: CJ1W-NC□81/□82), 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	Description	Reference
6091 hex	01 hex	Motor revolutions*1	Set the numerator of the electronic gear ratio.	P. A-93
	02 hex	Shaft revolutions*1	Set the denominator of the electronic gear ratio.	

*1 The electronic gear ratio must be set between 1/1,000 and 1,000. If it is set outside the range, an Object Setting Error 1 (Error No. 93.0) will occur.
Whether the electronic gear is enabled/disabled 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)

Index	Sub-index	Setting range	Description
6091 hex	01 hex	1 to 1,073,741,824	The processing changes with the set values of Motor revolutions (6091-01 hex) and Shaft revolutions (6091-02 hex). Position command → $\frac{\text{Motor revolutions (6091-01 hex)}}{\text{Shaft revolutions (6091-02 hex)}}$ → Position command Position command = Motor revolutions (6091-01 hex) / Shaft revolutions (6091-02 hex)
	02 hex		

Additional Information

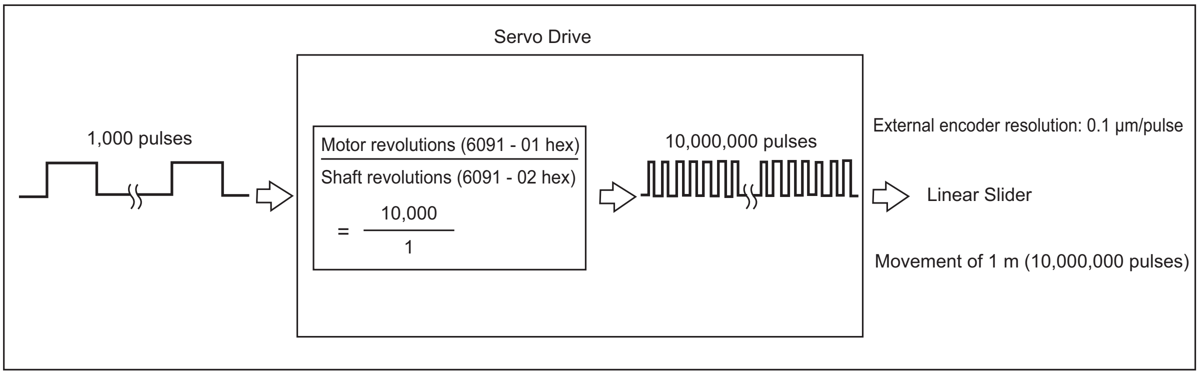
To make the position command smoother after the electronic gear setting, adjust it by using the Position Command Filter Time Constant (3222 hex) or by the Position Command FIR Filter Time Constant (3818 hex).

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:

$$\frac{\text{6091-01 hex}}{\text{6091-02 hex}} = \frac{10{,}000}{1}$$

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 (PCL), the Negative Force Limit (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	• 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.

7-7-2 Objects Requiring Settings

Index	Name	Description	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.	P. 9-5
3521 hex	Force Limit Selection	Set the force limit selection method.	P. 9-45
3522 hex	Force Limit2	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.	P. 9-46
3525 hex	Force Limit3	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.	P. 9-46
3526 hex	Force Limit4	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.	P. 9-46
60E0 hex	Positive Torque Limit Value*1	Set the Positive Force Limit value of the motor output force.	P. A-94
60E1 hex	Negative Torque Limit Value*1	Set the Negative Force Limit value of the motor output force.	P. A-94

*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	60E1or 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 input 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 or Time	Sets the acceleration time for the speed command input.	P. 9-25
3313 hex	Soft Start Deceleration Time	Sets the deceleration time for the speed command input.	P. 9-25
3314 hex	S-curve Acceleration/ Deceleration Time Setting	Sets the acceleration or deceleration processing S-curve time for the speed command input.	P. 9-26

7-8-2 Soft Start Acceleration or Deceleration Time

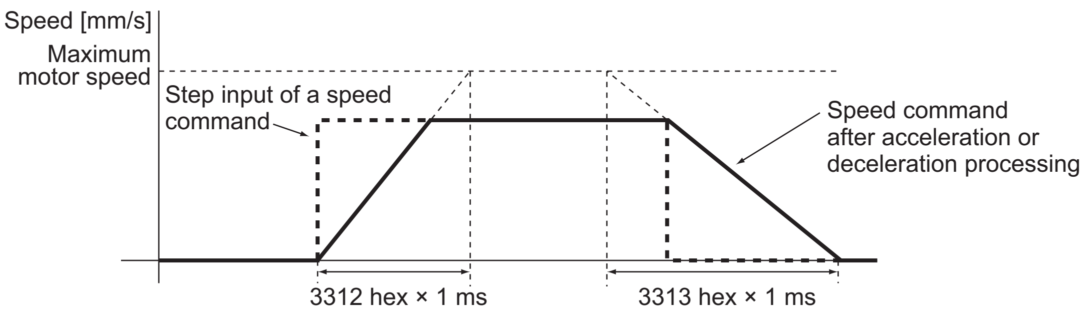
Set the time required for a step speed command to reach the maximum motor speed into the Soft Start Acceleration Time (3312 hex).

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.

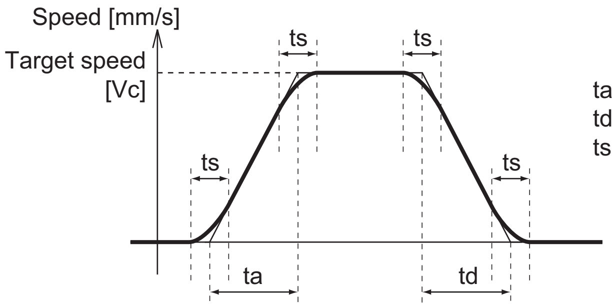
The maximum motor speed is the setting of the Overspeed Level (3910 hex).

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.



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 $\frac{ta}{2} > ts$, $\frac{td}{2} > ts$.

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:

- When decreasing the gain during servo lock stop to prevent vibration.
- When increasing the gain during stabilization stop to reduce the stabilization time.
- When increasing the gain during movement to improve the command following performance.
- When 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 operating mode for realtime autotuning. Realtime autotuning cannot be used if the gain switching function is being used.	P. 9-4
3114 hex	Gain Switching Input Operating Mode Selection	Set whether to enable or disable the gain switching function.	P. 9-11

Position Control Mode

Index	Name	Description	Reference
3115 hex	Switching Mode in Position Control	Set the condition for switching between Gain 1 and Gain 2.	P. 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)	P. 9-12
3117 hex	Gain Switching Level in Position Control *1	Set the judgement level for switching between the Gain 1 and Gain 2. The unit depends on the setting of the Switching Mode.	P. 9-12
3118 hex	Gain Switching Hysteresis in Position Control *2	Set the hysteresis width to be used for the judgement level set in Gain Switching Level (3117 hex). The unit depends on the setting of the Switching Mode.	P. 9-13
3119 hex	Position Gain Switching Time	Set the time to change from one position gain to the other one. (Unit: 0.1 ms)	P. 9-13

*1 Set the Level (3117 hex) to greater than or equal to the Hysteresis (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.	P. 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)	P. 9-15
3122 hex	Gain Switching Level in Speed Control *1	Set the judgement level for switching between the Gain 1 and Gain 2. The unit depends on the setting of the Switching Mode.	P. 9-15
3123 hex	Gain Switching Hysteresis in Speed Control *2	Set the hysteresis width to be used for the judgement level set in Gain Switching Level (3122 hex). The unit depends on the setting of the Switching Mode.	P. 9-15

*1 Set the Level (3122 hex) to greater than or equal to the Hysteresis (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.	P. 9-16
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)	P. 9-17
3126 hex	Gain Switching Level in Force Control *1	Set the judgement level for switching between the Gain 1 and Gain 2. The unit depends on the setting of the Switching Mode.	P. 9-17
3127 hex	Gain Switching Hysteresis in Force Control *2	Set the hysteresis width to be provided in the judgement level set in Gain Switching Level in Force Control (3126 hex). The unit depends on the setting of the Switching Mode.	P. 9-17

*1 Set the Level (3126 hex) to greater than or equal to the Hysteresis (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 7-31.

(✓: Enabled/–: Disabled)

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)	–	–	–
1	Always Gain 2 (3105 to 3109 hex)	–	–	–
2	Gain switching command input via EtherCAT communications	–	–	–
3	Force Command	✓	✓ [%]	✓ [%]
4	Always Gain 1 (3100 to 3104 hex)	–	–	–
5	Speed Command	✓	✓ [mm/s]	✓ [mm/s]
6	Following error actual internal value	✓	✓ [external encoder pulse]	✓ [external encoder pulse]
7	Position Command	✓	–	–

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
8	Positioning not completed	✓	–	–
9	Actual Motor Speed	✓	✓ [mm/s]	✓ [mm/s]
10	Position command + Actual motor speed	✓	✓ [mm/s]	✓ [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 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 7-31.

(✓: Enabled/–: Disabled)

3120 hex set value	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 Gain 1 (3100 to 3104 hex).	–	–	–
1	Always Gain 2 (3105 to 3109 hex).	–	–	–
2	Gain switching command input via EtherCAT communications	–	–	–
3	Force Command	✓	✓ [%]	✓ [%]
4	Speed Command Variation	✓	✓ [[10 mm/s]/s]	✓ [[10 mm/s]/s]
5	Speed Command	✓	✓ [mm/s]	✓ [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 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 7-31.

(✓: Enabled/–: Disabled)

3124 hex set value	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).	–	–	–
1	Always Gain 2 (3105 to 3109 hex).	–	–	–
2	Gain switching command input via EtherCAT communications	–	–	–
3	Force Command “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 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).

● 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.

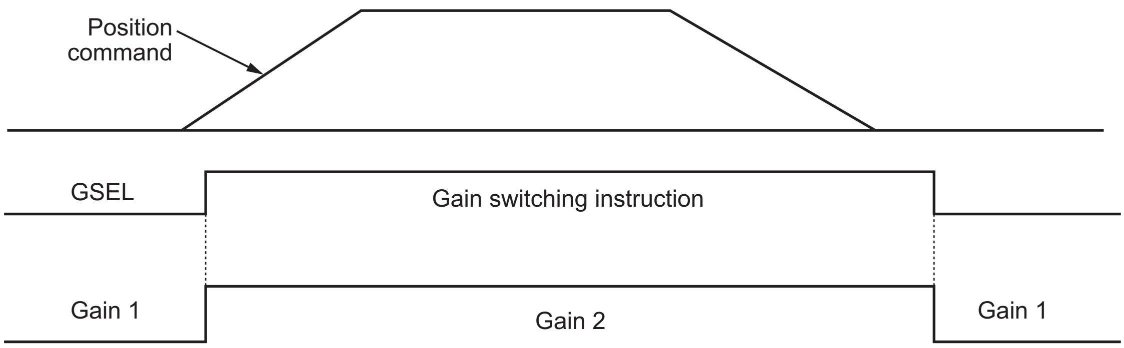
Switching between Gain 1 (3100 to 3104 hex) and Gain 2 (3105 to 3109 hex) occurs at the following timing, depending on the set value of the Switching Mode in Position Control (3115 hex), Switching Mode in Speed Control (3120 hex), or Switching Mode in Force Control (3124 hex).

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.

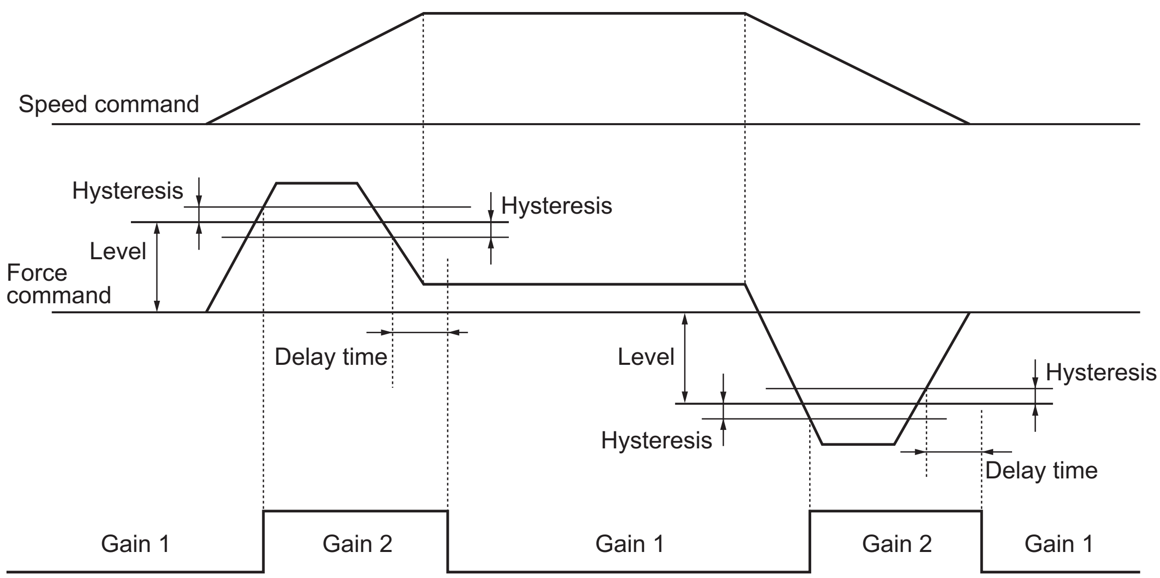
Instant switching occurs when a gain switching command is issued from the network.



3: Force Command

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.



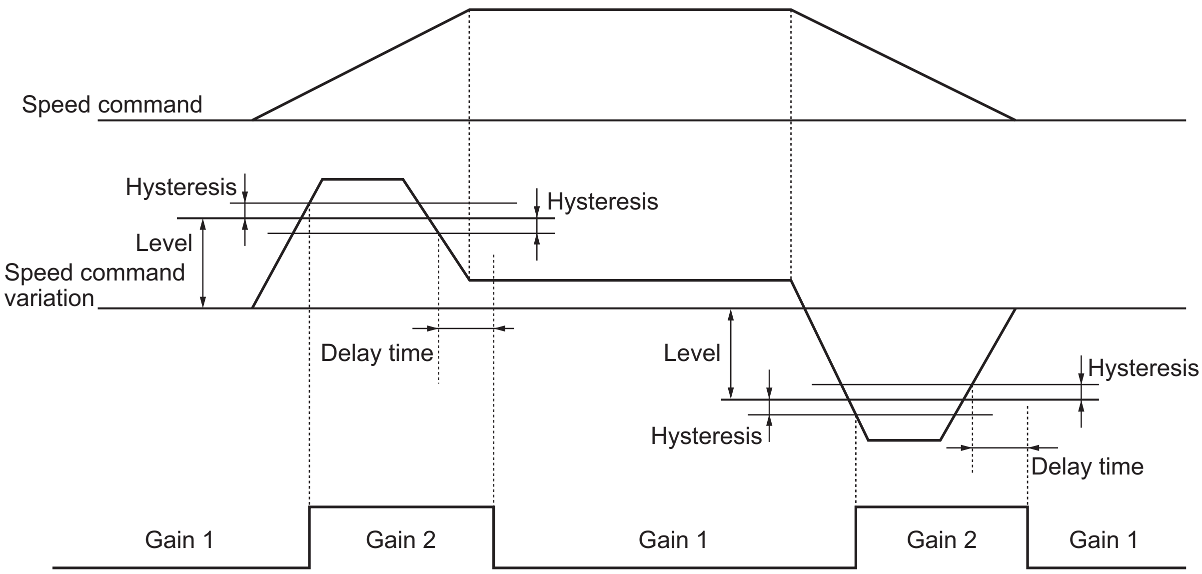
4: Speed command variation

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.

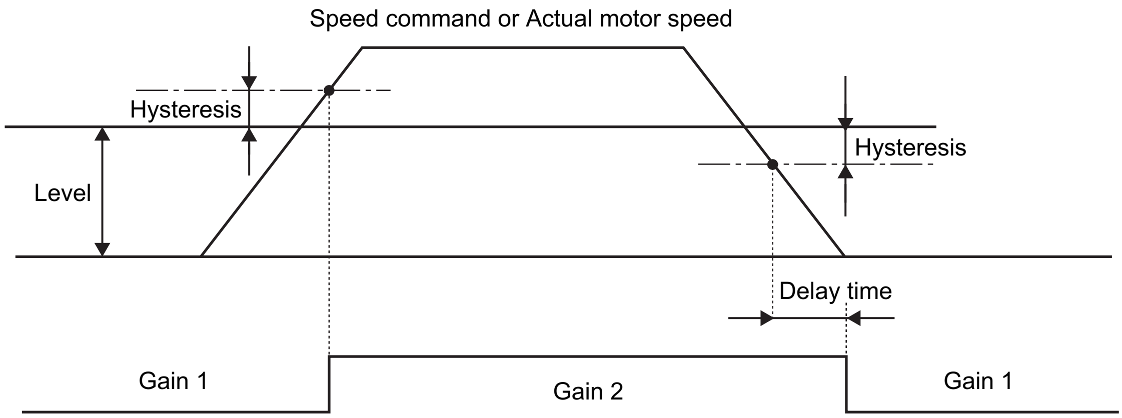
If the absolute value of the speed command variation is less than the value of the Gain Switching Level in Speed Control (3122 hex) minus the Gain Switching Hysteresis in Speed Control (3123 hex) [10 mm/s/s] and this condition lasts for the time specified in the Gain Switching Delay Time in Speed Control (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.

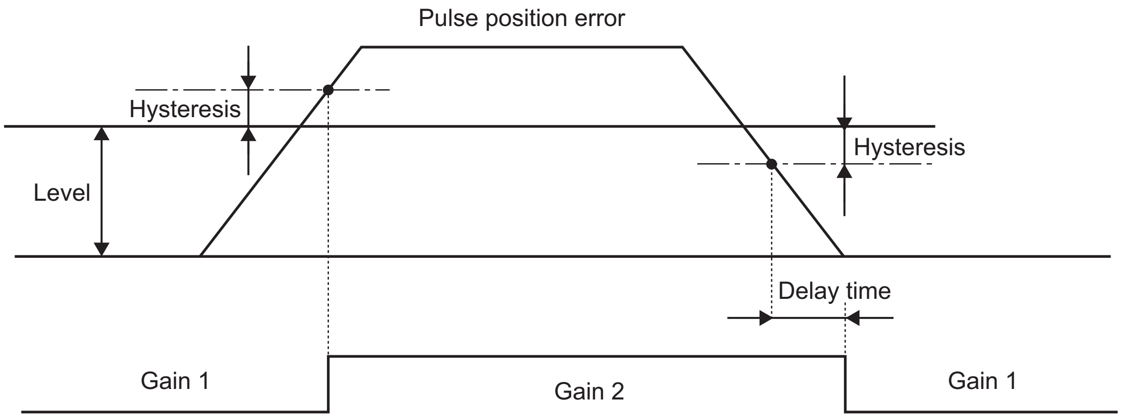


Note The “speed command” is the Motor Control Effort (401A hex) [mm/s].

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 [Pulse], 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 [Pulse] and this condition lasts for the Delay Time, the gain switches back to Gain 1.

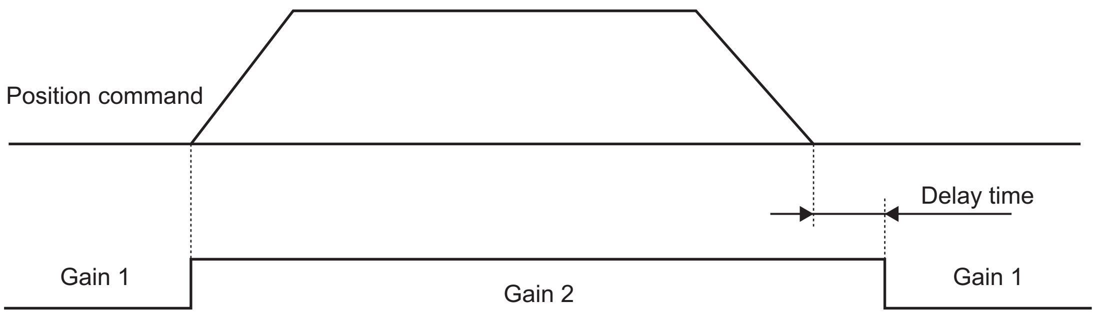


Set the Level and the Hysteresis unit [Pulse] according to the external encoder resolution.

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.

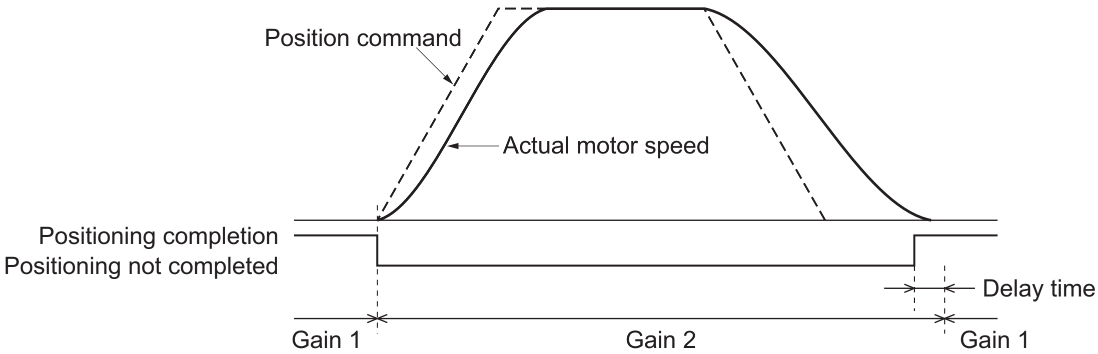


Note The “position command” is the Target Position (607A hex).

8: Positioning Not Completed

If the position command is not completed, the gain switches to Gain 2.

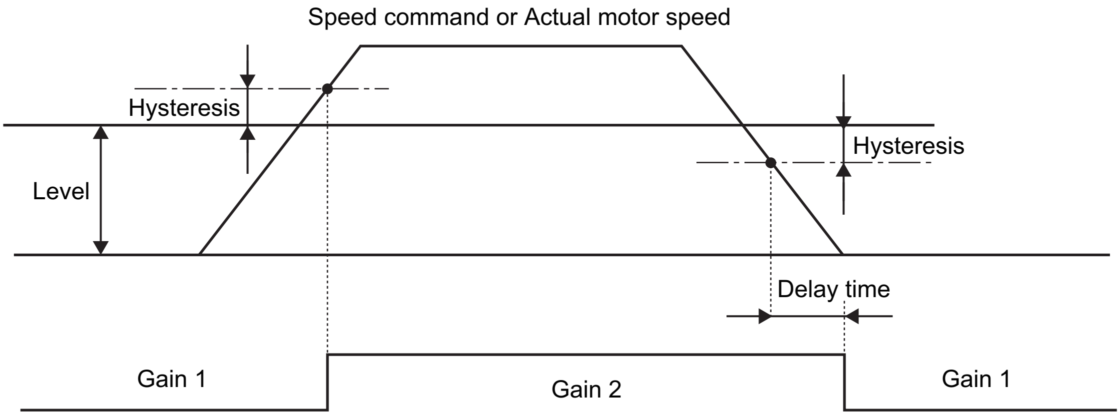
If the position command is completed and this condition lasts for the Delay Time, the gain switches back to Gain 1.



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.

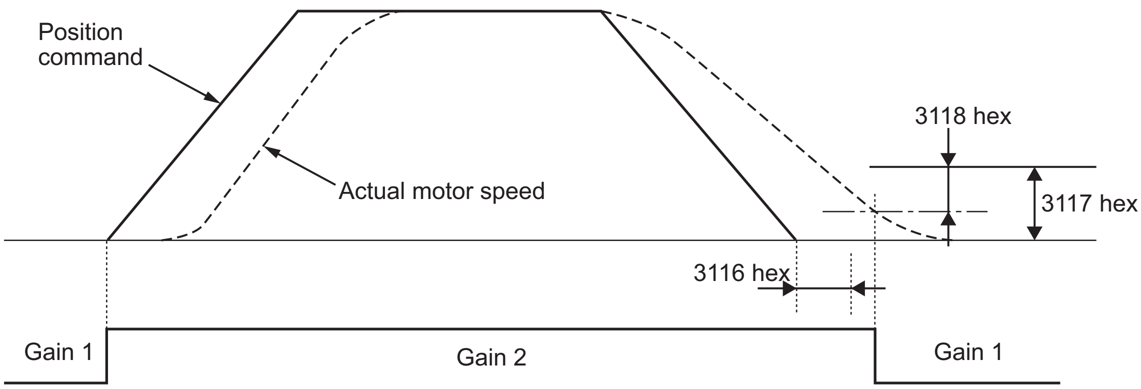


Note The “speed command” is the Motor Control Effort (401A hex) [mm/s].

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 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 or fully-closed control.

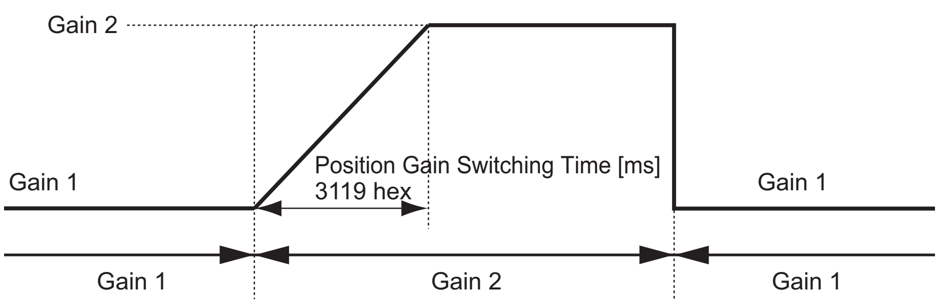
To suppress these, set a Position Gain Switching Time (3119 hex).

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.

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). It switches the gain right before a stop.

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 Switching 3 function in the following situations for position control.

	Conditions
Operation mode	Position 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.

7-10-2 Objects Requiring Settings

Index	Name	Description	Reference
3605 hex	Gain 3 Effective Time	Set effective time of Gain 3.	P. 9-47
3606 hex	Gain 3 Ratio Setting	Set Gain 3 as a multiple of Gain 1.	P. 9-47

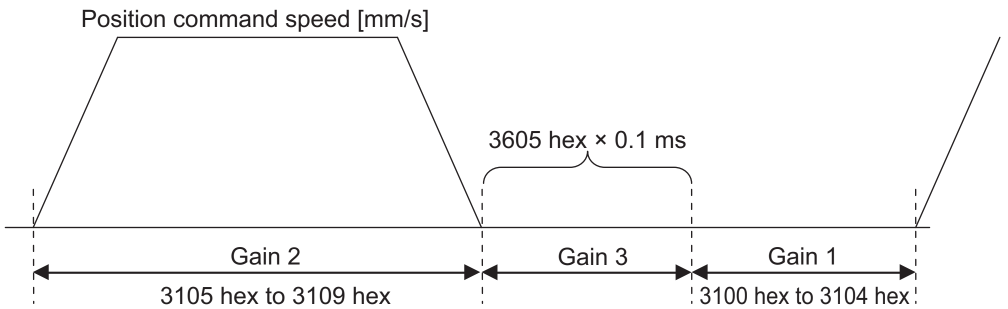
7-10-3 Operation Example

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:



[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.

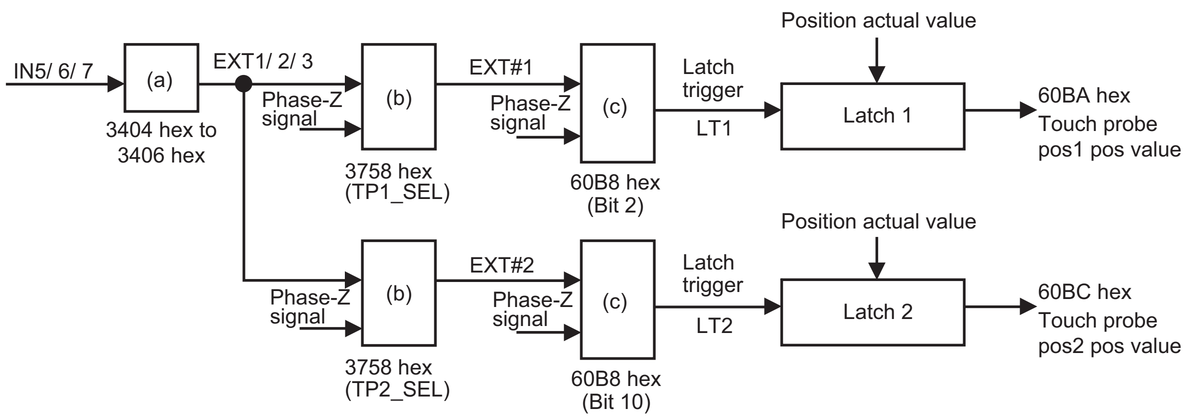
7-11-1 Objects Requiring Settings

Index	Name	Description	Reference
60B8 hex	Touch Probe Function	Controls the latch function.	P. A-94
60B9 hex	Touch Probe Status	Gives the state of latches 1 and 2.	P. A-94
60BA hex	Touch Probe Pos1 Pos Value	Latch position of latch 1.	P. A-94
60BC hex	Touch Probe Pos2 Pos Value	Latch position of latch 2.	P. A-94
3404 hex	Input Signal Selection 5	Set the function for general-purpose input 5 (IN5).	P. 9-30
3405 hex	Input Signal Selection 6	Set the function for general-purpose input 6 (IN6).	P. 9-31
3406 hex	Input Signal Selection 7	Set the function for general-purpose input 7 (IN7).	P. 9-31
3758 hex	Touch Probe Trigger Selection	Select the trigger signals for latch 1 and 2.	P. 9-56

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 whether 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)

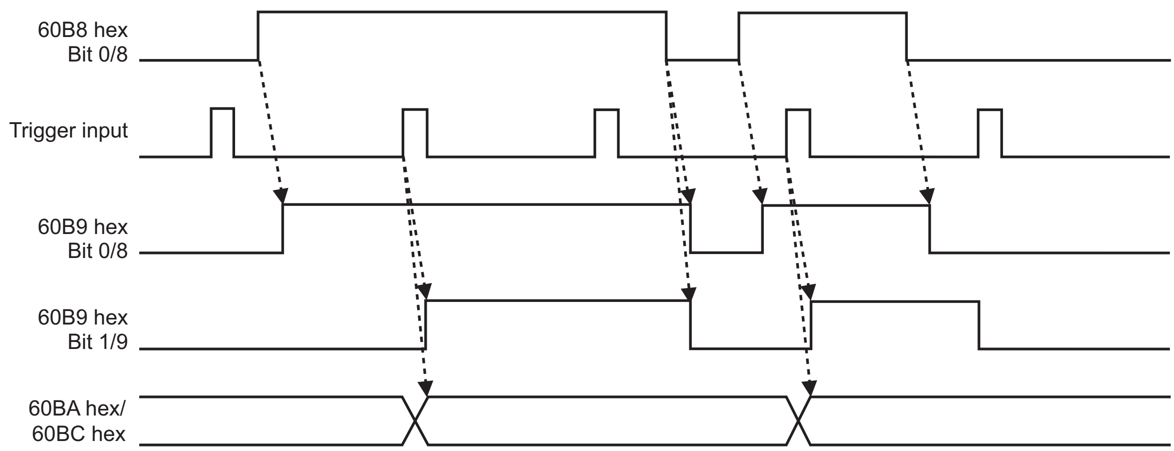
Latch 1			Latch 2		
TP1_SEL		EXT#1	TP2_SEL		EXT#2
Bit 0	Bit 1		Bit 8	Bit 9	
0	0	EXT1	0	0	EXT1
1	0	EXT2	1	0	EXT2
0	1	EXT3	0	1	EXT3
1	1	Phase Z	1	1	Phase Z

Touch probe function (60B8 hex) in (c)

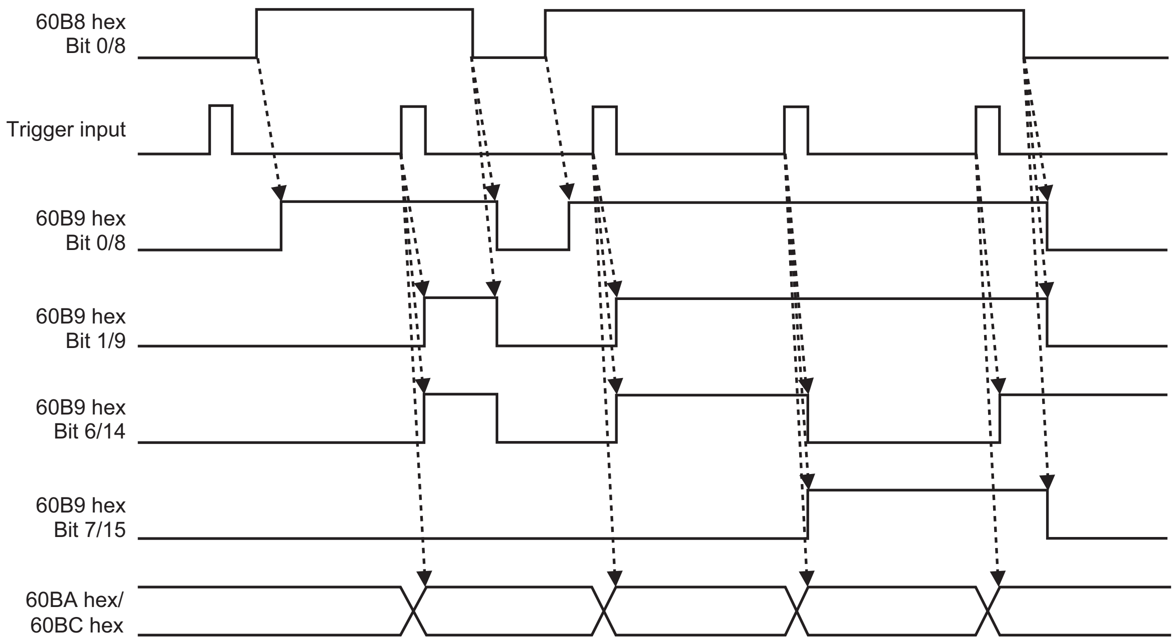
Bit 2	LT1	Bit 10	LT2
0	EXT#1	0	EXT#2
1	Phase Z	1	Phase Z

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)



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.

8-1 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 device 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.
- The EDM output signal is not a safety output. Do not use the EDM output for any purpose other than the failure monitoring function.
- Be sure to perform wiring checks during installation. In particular, check for the following points.
  - There are no shorted or disconnected wires.
  - The polarity of the EDM circuit is not reversed.
  - The SF1, SF2, and EDM signals turn ON/OFF correctly.
- The Servo Drive's safety function could be impaired if it is wired incorrectly.
- 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.

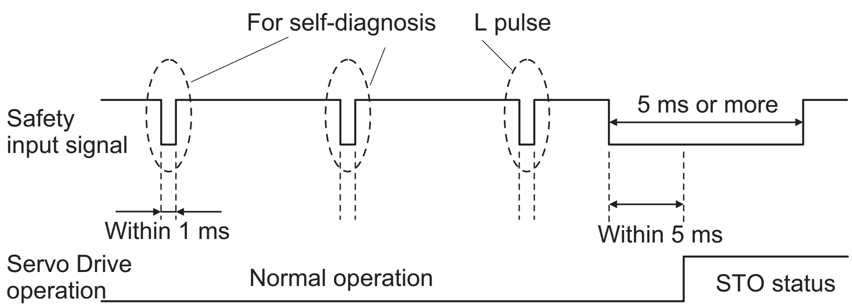
Signal name	Symbol	Pin No.	Description	Control mode		
				Position	Speed	Force
Safety input 1	SF+	CN8-4	The upper arm drive signal of the power transistor inside the Servo Drive is cut off.	✓	✓	✓
	SF–	CN8-3		✓	✓	✓
Safety input 2	SF2+	CN8-6	The lower arm drive signal of the power transistor inside the 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 force 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 device

When you connect 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 the EDM output signal to the monitoring terminal on a safety device, such as a safety controller or a safety sensor.

Signal name	Symbol	Pin No.	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.

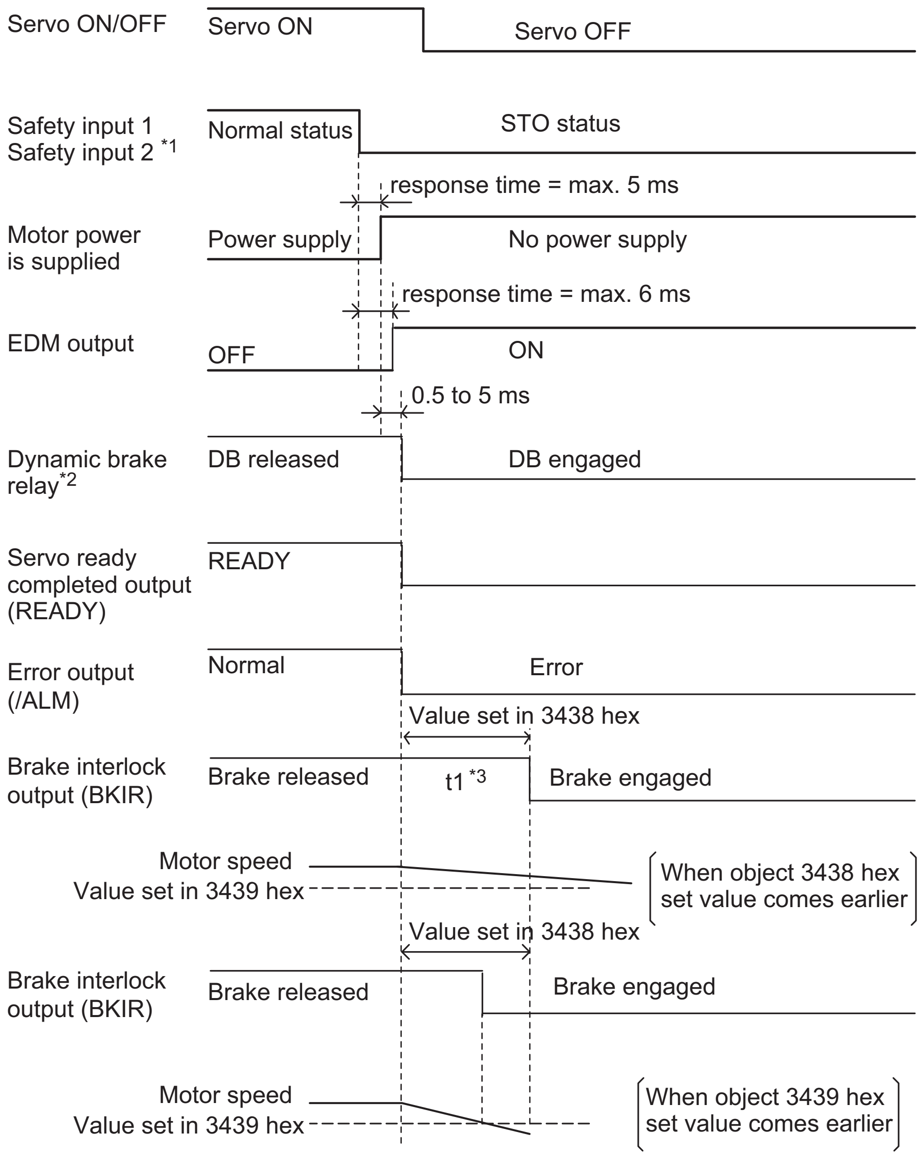
Signal name	Symbol	Signal status			
Safety input 1	SF1	ON	ON	OFF	OFF
Safety input 2	SF2	ON	OFF	ON	OFF
EDM output	EDM	OFF	OFF	OFF	ON

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 a safety status and the timing of return from a safety status.

Operation Timings to a Safety Status

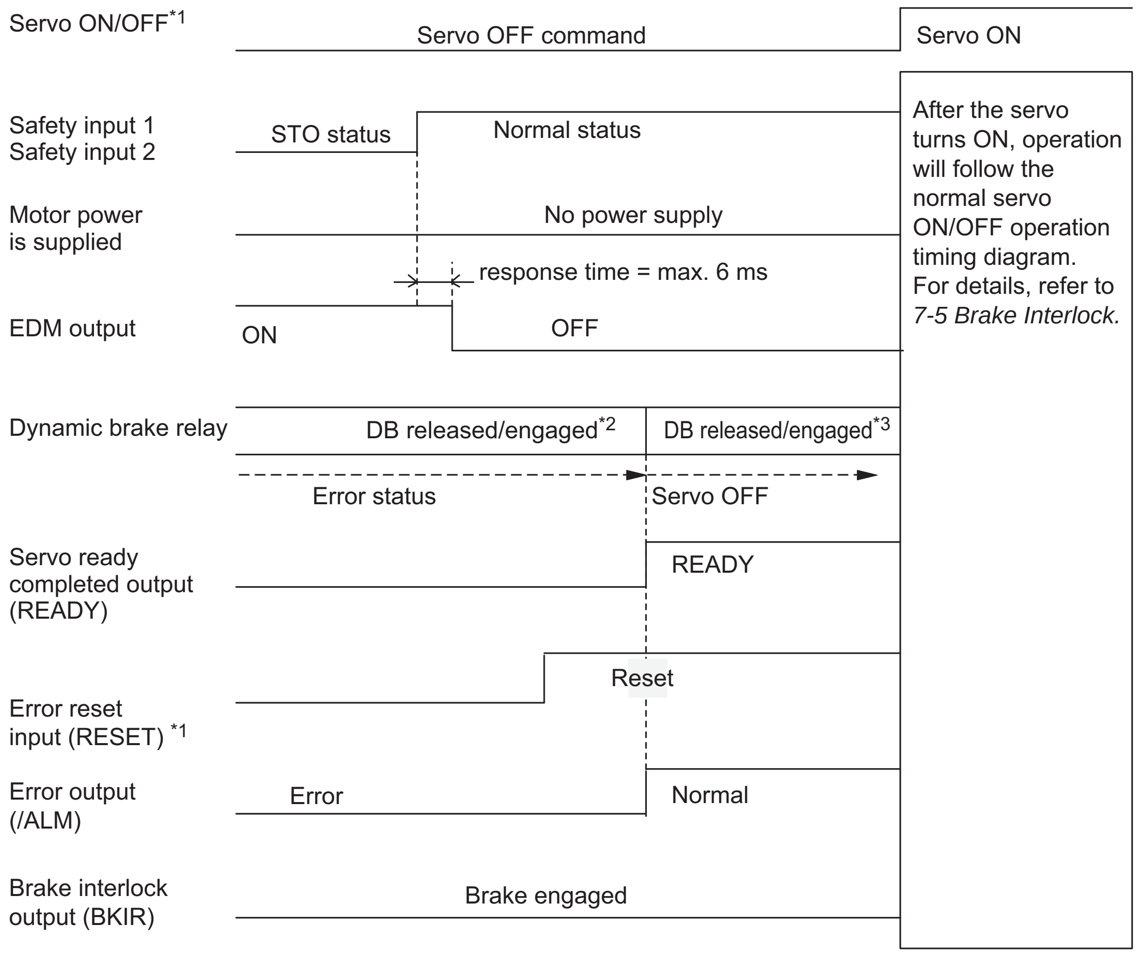


*1 STO status is entered when either safety input 1 or 2 turns “OFF.”

*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.

Timing of Return from Safety Status



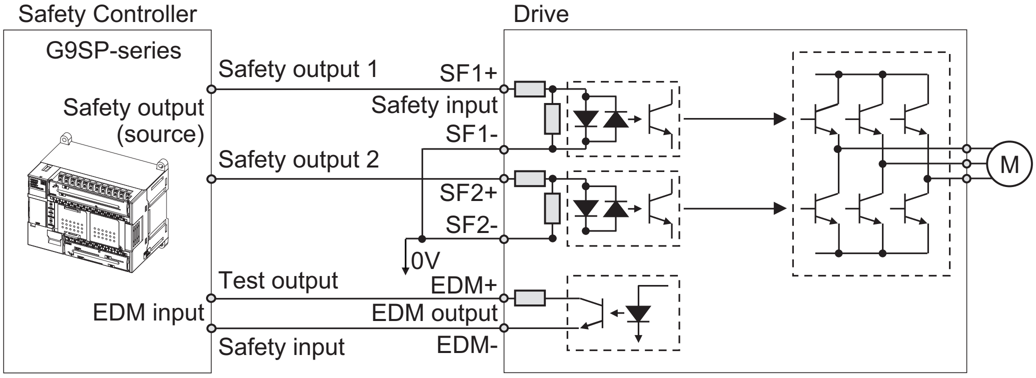
*1 Make sure that servo ON input is “OFF” when you return the input signals of safety inputs 1 and 2 to “ON.”
If an error exists in this state, be sure to clear the error when both safety inputs 1 and 2 have returned to “ON” state. If either safety input 1 or 2 is executed with “OFF,” an error occurs 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 Example

Connection with a Safety Controller



9

Servo Parameter Objects

This section explains the settings of each object.

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 □□□ hex 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 restarting the power supply to the Servo Drive. Those that require the restart of the power supply are shown in the relevant table. After changing these objects, turn OFF and then back ON the power supply again. At this time, confirm that the power supply indicator has gone OFF before turning it ON 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 after the control power is reset.
  It is not updated for a Config command via EtherCAT communications.
– : Write prohibited.

- The modes of operation are shown as follows:

All : All 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

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 Set Values

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 9-28.

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 to the Servo Drive.

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.

3000 hex set value	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 operation 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	Used when there is an unbalanced load.
4	Friction compensation and unbalanced load	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 9-51 for setting the realtime autotuning function (3632 hex).

For details on realtime autotuning, refer to *11-3 Realtime Autotuning* on page 11-7.

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.

	Low	Machine rigidity	High
	Low	Servo gain	High
3003 hex	0 1	- - - - - - - - - - - - - - -	31
	Low	Responsiveness	High

- For details on realtime autotuning, refer to *11-3 Realtime Autotuning* on page 11-7.

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.

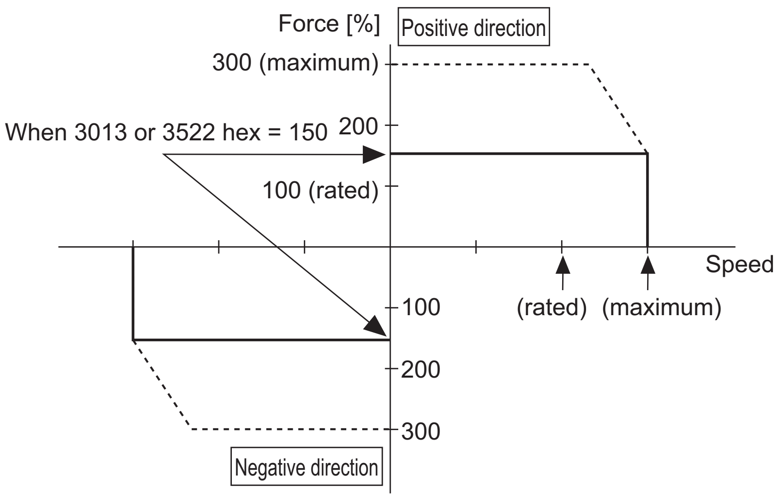
3004 hex	Mass Ratio						All
Setting range	0 to 10,000	Unit	%	Default setting	250	Data attribute	B
Size	2 bytes (INT16)		Access	RW	PDO map	Not possible	

- 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 5,000	Unit	0.1%	Default setting	5,000	Data attribute	B
Size	2 bytes (INT16)		Access	RW	PDO map	Not possible	

- Set the first force limit value of the motor output force.
- Refer to the *Force Limit Selection* on page 9-45 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 force (100%).

E.g. 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.

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) are enabled according to the Built-in Resistor. The duty ratio is approximately 1%.
1	External Resistor	The regeneration processing circuit operates, and Regeneration Overload Error (Error No. 18) 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) do not occur.
3	None	The regeneration processing circuit and Regeneration Overload Error (Error No. 18) 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 30,000	Unit	0.1/s	Default setting	480 *1	Data attribute	B
Size	2 bytes (INT16)		Access	RW	PDO map	Not possible	

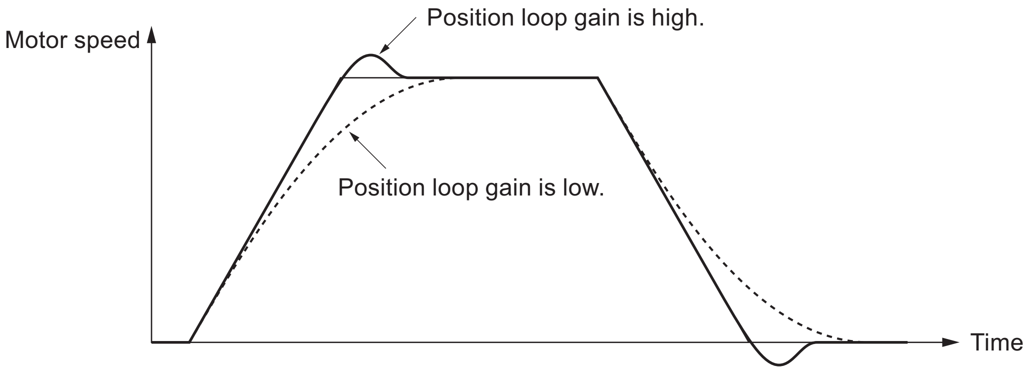
*1 The default setting is 320 for a Drive with 200 V and 1 kW or greater, or with 400 V.

- 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 function. To set it manually, set the Realtime Autotuning Mode Selection (3002 hex) to 0.

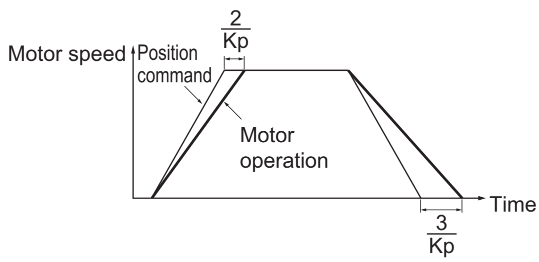
Position loop gain is generally expressed as follows:

$$\text{Position loop gain [Kp]} = \frac{\text{Command pulse frequency [Pulse/s]}}{\text{Pulse position error [Pulse]}} \text{ [0.1/s]}$$

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.

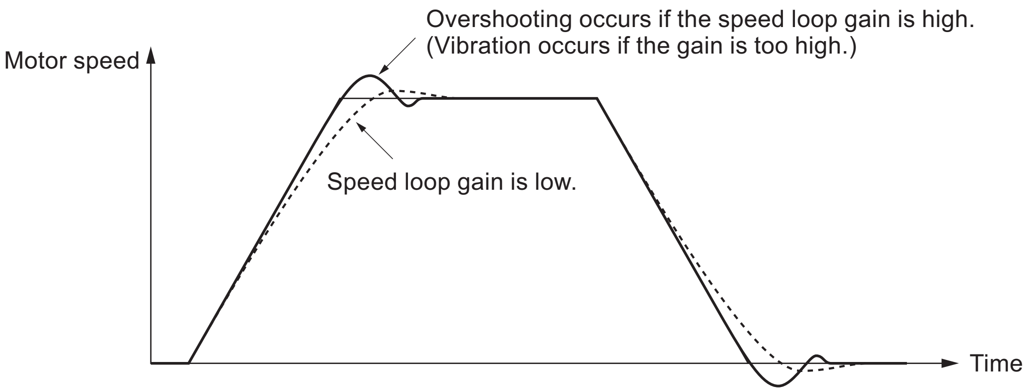


3101 hex	Speed Loop Gain 1					All	
Setting range	1 to 32,767	Unit	0.1 Hz	Default setting	270 *1	Data attribute	B
Size	2 bytes (INT16)		Access	RW	PDO map	Not possible	

*1 The default setting is 180 for a Drive with 200 V and 1 kW or greater, or for a Drive 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.

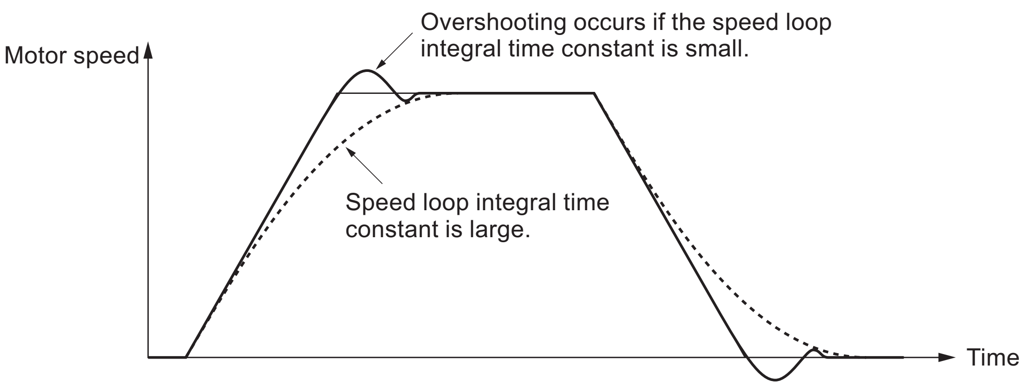


3102 hex	Speed Loop Integral Time Constant 1					All	
Setting range	1 to 10,000	Unit	0.1 ms	Default setting	210 *1	Data attribute	B
Size	2 bytes (INT16)		Access	RW	PDO map	Not possible	

*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 2,500	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 30,000	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 32,767	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 for a Drive with 400 V.

- Set the responsiveness of the second speed loop.

3107 hex	Speed Loop Integral Time Constant 2						All
Setting range	1 to 10,000	Unit	0.1 ms	Default setting	10,000	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 2,500	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 1,000	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.

For details, refer to *11-10 Feed-forward Function* on page 11-32.

3111 hex	Speed Feed-forward Command Filter					csp pp hm	
Setting range	0 to 6,400	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.

For details, refer to *11-10 Feed-forward Function* on page 11-32.

3112 hex	Force Feed-forward Gain					csp csv pp hm	
Setting range	0 to 1,000	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.

For details, refer to *11-10 Feed-forward Function* on page 11-32.

3113 hex	Force Feed-forward Command Filter					csp csv pp hm	
Setting range	0 to 6,400	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.

For details, refer to *11-10 Feed-forward Function* on page 11-32.

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 P/PI Control command in EtherCAT communications.

Refer to *7-9 Gain Switching Function* on page 7-26 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

(✓: Enabled/–: Disabled)

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).	–	–	–
1	Always Gain 2 (3105 to 3109 hex).	–	–	–
2	Gain switching command input via EtherCAT communications *4	–	–	–
3	Force command	✓	✓ [%]	✓ [%]
4	Always Gain 1 (3100 to 3104 hex).	–	–	–
5	Speed command	✓	✓ [mm/s]	✓ [mm/s]

9-2 Gain Settings

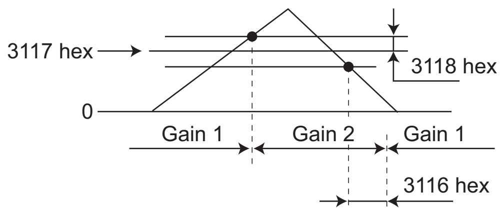
9

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
6	Pulse position error	✓	✓ [external encoder pulse]	✓ [external encoder pulse]
7	Position command	✓	–	–
8	Positioning not completed	✓	–	–
9	Actual motor speed	✓	✓ [mm/s]	✓ [mm/s]
10	Position command + Actual motor speed	✓	✓ [mm/s]	✓ [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.

For details, refer to *7-9-3 Diagrams of Gain Switching Setting* on page 7-31.

3116 hex	Gain Switching Delay Time in Position Control					csp pp hm	
Setting range	0 to 10,000	Unit	0.1 ms	Default setting	50	Data attribute	B
Size	2 bytes (INT16)		Access	RW	PDO map	Not possible	

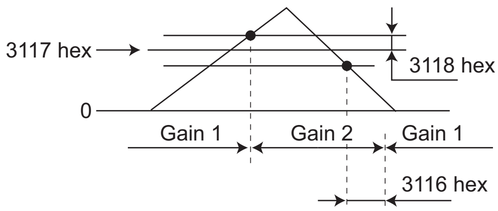
- Set the delay time when returning from Gain 2 to Gain 1 if the Switching Mode in Position Control (3115 hex) is set to 3 or 5 to 10.

3117 hex	Gain Switching Level in Position Control					csp pp hm	
Setting range	0 to 20,000	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 judgement level for switching between Gain 1 and Gain 2.
- The unit depends on the setting of the Switching Mode in Position Control (3115 hex).

3118 hex	Gain Switching Hysteresis in Position Control					csp pp hm	
Setting range	0 to 20,000	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 judgement 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.

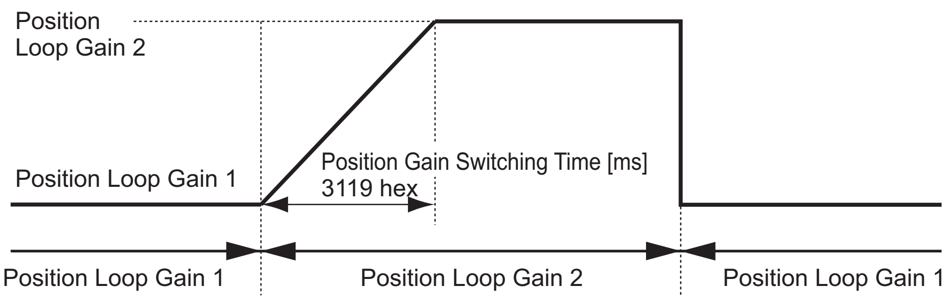


- The settings for the Gain Switching Level in Position Control (3117 hex) and the Gain Switching Hysteresis in Position Control (3118 hex) are enabled as absolute values.

3119 hex	Position Gain Switching Time					csp pp hm	
Setting range	0 to 10,000	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

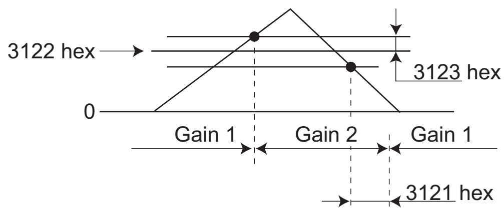
(✓: Enabled/–: Disabled)

3120 hex set value	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 Gain 1 (3100 to 3104 hex).	–	–	–
1	Always Gain 2 (3105 to 3109 hex).	–	–	–
2	Gain switching command input via EtherCAT communications *4	–	–	–
3	Force command	✓	✓ [%]	✓ [%]
4	Speed command variation	✓	✓ [[10 mm/s]/s]	✓ [[10 mm/s]/s]
5	Speed command	✓	✓ [mm/s]	✓ [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 Position 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 (G-SEL) 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 7-31 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 10,000	**Unit**	0.1 ms	**Default setting**	0	**Data attribute**	B
Size	2 bytes (INT16)		**Access**	RW	**PDO map**	Not possible	

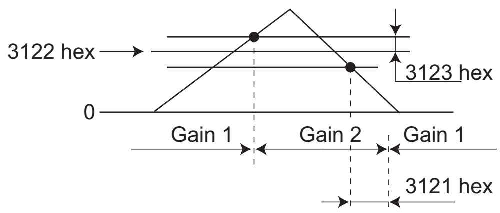
- Set the delay time when returning from Gain 2 to Gain 1 if the Switching Mode in Speed Control (3120 hex) is set to 3 to 5.

3122 hex	Gain Switching Level in Speed Control						CSV
Setting range	0 to 20,000	**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 judgement 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 20,000	**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 judgement 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 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

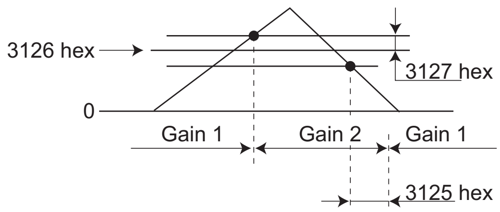
(✓: Enabled/–: Disabled)

3124 hex set value	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).	–	–	–
1	Always Gain 2 (3105 to 3109 hex).	–	–	–
2	Gain switching command input via EtherCAT communications *4	–	–	–
3	Force command	✓	✓ [%]	✓ [%]

*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 (G-SEL) is 0, the gain switches to Gain 1. When the command is 1, the gain switches to Gain 2.

For details, refer to *7-9-3 Diagrams of Gain Switching Setting* on page 7-31.

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 10,000	**Unit**	0.1 ms	**Default setting**	0	**Data attribute**	B
Size	2 bytes (INT16)		**Access**	RW	**PDO map**	Not possible	

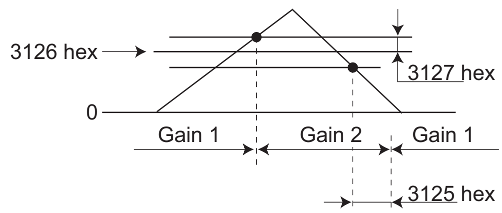
- Set the delay time when returning from Gain 2 to Gain 1 if the Switching Mode in Force Control (3124 hex) is set to 3.

3126 hex	Gain Switching Level in Force Control						cst
Setting range	0 to 20,000	**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 judgement 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 20,000	**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 judgement 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 11-17.

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.

For details, refer to *11-6 Adaptive Filter* on page 11-21.

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 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 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.

3201 hex	Notch 1 Frequency Setting					All	
Setting range	50 to 5,000	**Unit**	Hz	**Default setting**	5,000	**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.

For details, refer to *11-7 Notch Filters* on page 11-24.

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.

For details, refer to *11-7 Notch Filters* on page 11-24.

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.

For details, refer to *11-7 Notch Filters* on page 11-24.

3204 hex	Notch 2 Frequency Setting					All	
Setting range	50 to 5,000	**Unit**	Hz	**Default setting**	5,000	**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.

For details, refer to *11-7 Notch Filters* on page 11-24.

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.

For details, refer to *11-7 Notch Filters* on page 11-24.

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 notch depth of resonance suppression notch filter 2.
- Increasing the setting value shortens the notch depth and the phase lag.

For details, refer to *11-7 Notch Filters* on page 11-24.

3207 hex	Notch 3 Frequency Setting						All
Setting range	50 to 5,000	**Unit**	Hz	**Default setting**	5,000	**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 11-21 and *11-7 Notch Filters* on page 11-24.

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.
- When the adaptive filter is enabled, this object is set automatically.

Refer to *11-6 Adaptive Filter* on page 11-21 and *11-7 Notch Filters* on page 11-24.

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 notch depth of resonance suppression notch filter 3.
- Increasing the setting value shortens the notch depth and the phase lag.
- When the adaptive filter is enabled, this object is set automatically.

Refer to *11-6 Adaptive Filter* on page 11-21 and *11-7 Notch Filters* on page 11-24.

3210 hex	Notch 4 Frequency Setting						All
Setting range	50 to 5,000	**Unit**	Hz	**Default setting**	5,000	**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 11-21 and *11-7 Notch Filters* on page 11-24.

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.
- When two adaptive filters are enabled, this object is set automatically.

Refer to *11-6 Adaptive Filter* on page 11-21 and *11-7 Notch Filters* on page 11-24.

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 the adaptive filter is enabled, this object is set automatically.

Refer to *11-6 Adaptive Filter* on page 11-21 and *11-7 Notch Filters* on page 11-24.

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 Settings

Set value	Description
0	Up to two filters, Damping Filter 1 and Damping Filter 2, can be used simultaneously.
1	Reserved for manufacturer use *1
2	Reserved for manufacturer use *1
3	The damping filters are switched in the direction of the position command. *2

*1 The set value 1 and 2 are for manufacturer’s use only. 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.

(✓: Enabled/–: Disabled)

Direction of position command	Damping filter 1	Damping filter 2	Damping filter 3	Damping filter 4
Positive	✓	–	✓	–
Negative	–	✓	–	✓

3214 hex	Damping Frequency 1						csp pp hm
Setting range	0 to 2,000	**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.

For details, refer to *11-5 Damping Control* on page 11-17.

3215 hex	Damping Filter 1 Setting						csp pp hm
Setting range	0 to 1,000	**Unit**	0.1 Hz	**Default setting**	0	**Data attribute**	B
Size	2 bytes (INT16)		**Access**	RW	**PDO map**	Not possible	

- When Damping Frequency 1 (3214 hex) is set, reduce this setting if force saturation occurs or increase this 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 (2,000 - damping frequency), whichever is the smaller.

For details, refer to *11-5 Damping Control* on page 11-17.

3216 hex	Damping Frequency 2						csp pp hm
Setting range	0 to 2,000	**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.
- 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.

For details, refer to *11-5 Damping Control* on page 11-17.

3217 hex	Damping Filter 2 Setting						csp pp hm
Setting range	0 to 1,000	**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 (2,000 - damping frequency), whichever is the smaller.

For details, refer to *11-5 Damping Control* on page 11-17.

3218 hex	Damping Frequency 3					csp pp hm	
Setting range	0 to 2,000	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.
- 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.

For details, refer to *11-5 Damping Control* on page 11-17.

3219 hex	Damping Filter 3 Setting					csp pp hm	
Setting range	0 to 1,000	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 corresponding damping frequency or the value of (2,000 - damping frequency), whichever is the smaller.

For details, refer to *11-5 Damping Control* on page 11-17.

3220 hex	Damping Frequency 4					csp pp hm	
Setting range	0 to 2,000	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.
- 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.

For details, refer to *11-5 Damping Control* on page 11-17.

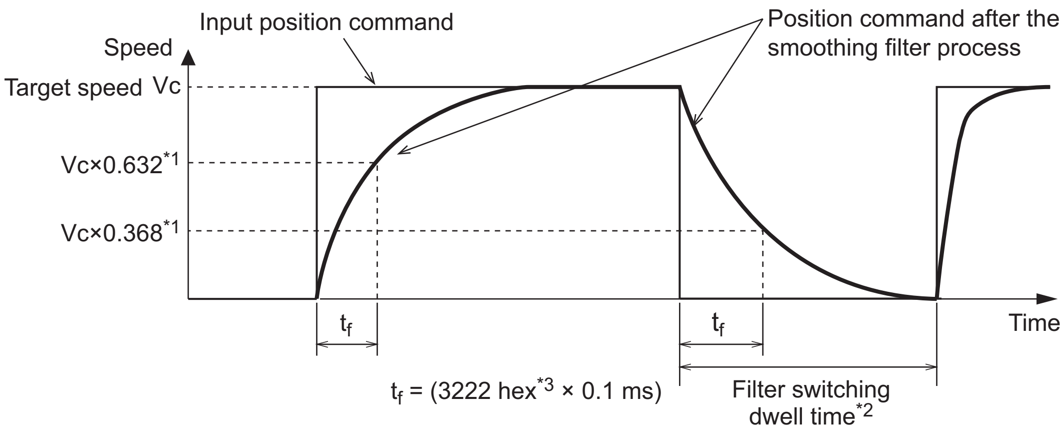
3221 hex	Damping Filter 4 Setting					csp pp hm	
Setting range	0 to 1,000	Unit	0.1 Hz	Default setting	0	Data attribute	B
Size	2 bytes (INT16)		Access	RW	PDO map	Not possible	

- First set Damping Frequency 4 (3220 hex). Then reduce the setting if 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 (2,000 - damping frequency), whichever is the smaller.

For details, refer to *11-5 Damping Control* on page 11-17.

3222 hex	Position Command Filter Time Constant					csp pp hm	
Setting range	0 to 10,000	**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 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 ms max. (absolute error) for less than 100 ms and 0.2 ms 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.

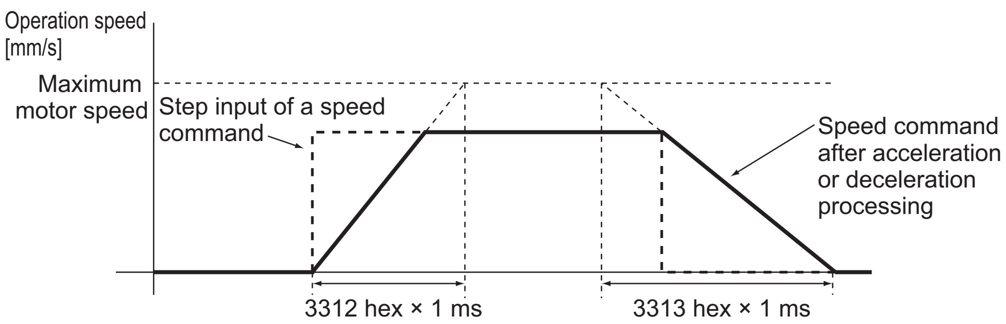
Be careful as the motor may temporarily move faster than the expected command speed.

9-4 Analog Control Objects

3312 hex	Soft Start Acceleration Time						CSV
Setting range	0 to 10,000	**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 10,000	**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.



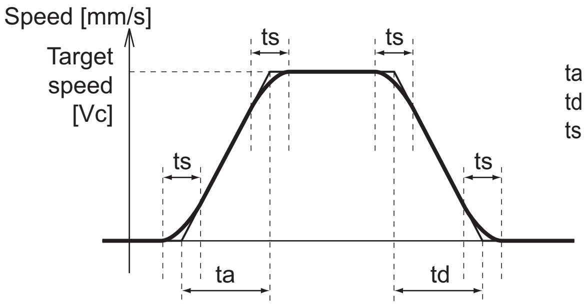
For details, refer to *7-8 Soft Start* on page 7-24.

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 1,000	**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.



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 $\frac{ta}{2}$ and $\frac{td}{2}$.

For details, refer to *7-8 Soft Start* on page 7-24.

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.
- Restricts the speed as the protection during force control.

Explanation of Settings

Set value	Description
0	Select the value set on the Speed Limit Value Setting (3321 hex).
1	Select either the speed limit value (VLIM) via EtherCAT communications or the value set by the Speed Limit Value Setting (3321 hex), whichever is smaller.

For details, refer to *6-3 Cyclic Synchronous Torque Mode* on page 6-8.

3321 hex	Speed Limit Value Setting						cst
Setting range	0 to 20,000	**Unit**	mm/s	**Default setting**	20,000	**Data attribute**	B
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.

For details, 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

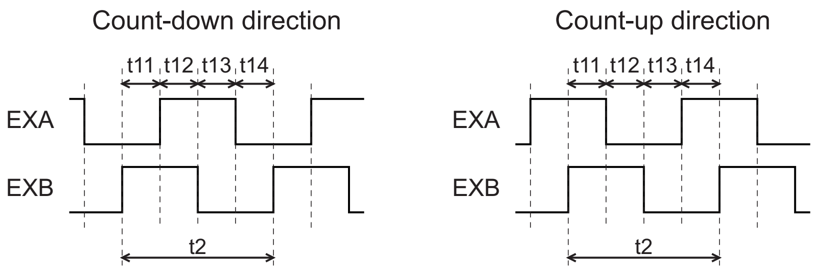
Set value	External encoder type	Supported speed *1
0	90° phase difference output type *2	0 to 4 Mpps (Multiplication × 4)
1	Serial communications type (Incremental type)	0 to 400 Mpps
2	Serial communications type (Absolute type)	0 to 400 Mpps

*1 The supported speed is the internal feedback pulse speed [external encoder pulse/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 [µm/pulse] × 400 [Mpulse/s] = 4 [m/s]

When a serial communications speed of 5 m/s is required, 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.



EXB is 90° ahead of EXA.
t11 to t14 > 0.25 µs
t2 > 1.0 µs

EXB is 90° behind EXA.
t11 to t14 > 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.

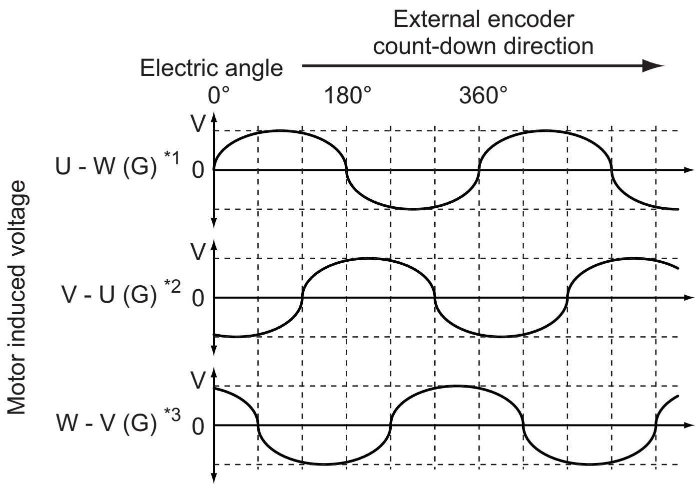
3326 hex	External Feedback Pulse Direction Switching					csp pp hm	
Setting range	0 to 1	Unit	–	Default setting	0	Data attribute	R
Size	2 bytes (INT16)		Access	RW	PDO map	Not possible	

- 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 to the Servo Drive.

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 *3-1-7 Control Input Details* on page 3-9, as well as *7-1-1 Input 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 *3-1-7 Control Input Details* on page 3-9, as well as *7-1-1 Input 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 *3-1-7 Control Input Details* on page 3-9, as well as *7-1-1 Input 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 *3-1-7 Control Input Details* on page 3-9, as well as *7-1-1 Input 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 *3-1-7 Control Input Details* on page 3-9, as well as *7-1-1 Input 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 *3-1-7 Control Input Details* on page 3-9, as well as *7-1-1 Input 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 *3-1-7 Control Input Details* on page 3-9, as well as *7-1-1 Input 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 *3-1-7 Control Input Details* on page 3-9, as well as *7-1-1 Input 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 *3-1-9 Control Output Details* on page 3-12, as well as *7-1-2 Output Signals* on page 7-5.

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 *3-1-9 Control Output Details* on page 3-12, as well as *7-1-2 Output Signals* on page 7-5.

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	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	% (Percentage of rated force)	33
5	Following error actual value	Pulse (command unit)	3000
6	Following Error Actual Internal Value	Pulse (encoder unit)	3000
7 to 8	Reserved *2	–	–
9	P-N voltage	V	80
10	Regeneration Load Ratio	%	33
11	Motor Load Ratio	%	33
12	Positive Force Limit	% (Percentage of rated force)	33
13	Negative Force Limit	% (Percentage of rated force)	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.

For details, refer to *11-1 Analog Monitor* on page 11-2.

3417 hex	Analog Monitor 1 Scale Setting						All
Setting range	0 to 214,748,364	Unit	–	Default setting	0	Data attribute	A
Size	4 byte (INT32)		Access	RW	PDO map	Not possible	

- Set the output gain for the analog monitor 1.

For details, 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	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	% (Percentage of rated force)	33
5	Following error actual value	Pulse (command unit)	3000
6	Following Error Actual Internal Value	Pulse (encoder unit)	3000
7 to 8	Reserved *2	–	–
9	P-N voltage	V	80
10	Regeneration Load Ratio	%	33
11	Motor Load Ratio	%	33
12	Positive Force Limit	% (Percentage of rated force)	33
13	Negative Force Limit	% (Percentage of rated force)	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.

For details, refer to *11-1 Analog Monitor* on page 11-2.

3419 hex	Analog Monitor 2 Scale Setting						All
Setting range	0 to 214,748,364	Unit	–	Default setting	0	Data attribute	A
Size	4 byte (INT32)		Access	RW	PDO map	Not possible	

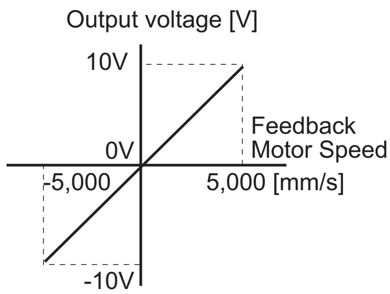
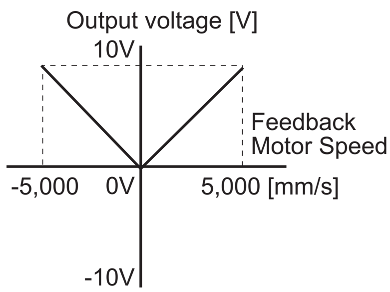
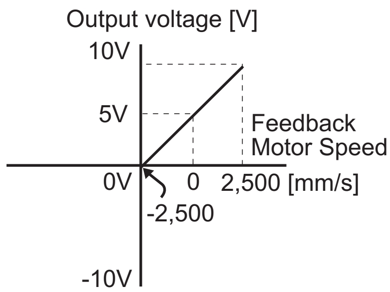
- Set the output gain for analog monitor 2.

For details, refer to *11-1 Analog Monitor* on page 11-2.

3421 hex	Analog Monitor Output Setting						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 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.

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 the center)	

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 “position command present” to “no position command” 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 30,000	Unit	ms	Default setting	0	Data attribute	A
Size	2 bytes (U16)		Access	RW	PDO map	Not possible	

- Set the hold time for when 3432 hex (Positioning Completion Condition Selection) is set to 3.

Explanation of Settings

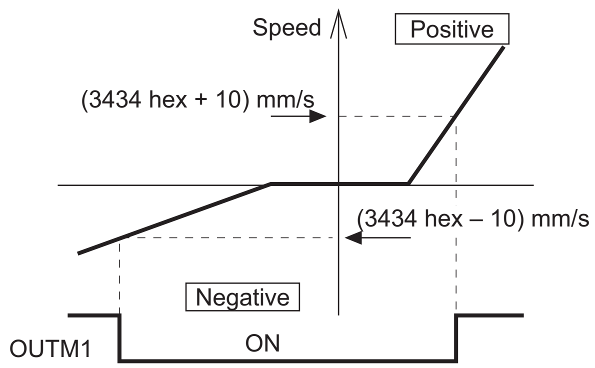
Set value	Description
0	The hold time will be an infinite time and the ON status will be held until the next position command is received.
1 to 30,000	The ON status is held for the set time [ms]. The output is turned OFF if a position command is received while the ON status is being held.

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 20,000	Unit	mm/s	Default setting	50	Data attribute	A
Size	2 bytes (INT16)		Access	RW	PDO map	Not possible	

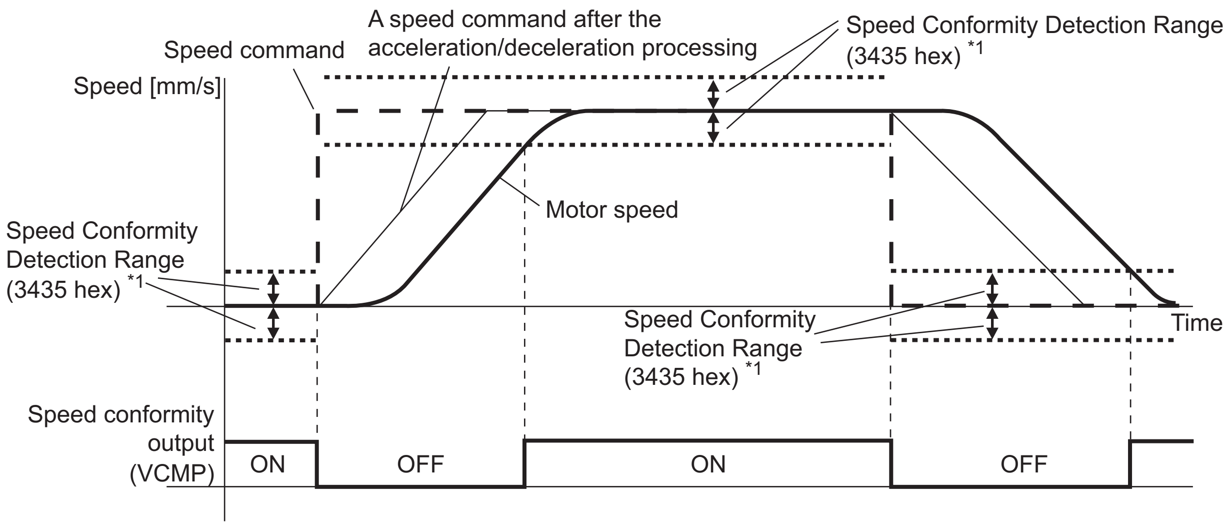
- Set the output timing of the Zero Speed Detection Output (ZSP) as motor speed [mm/s].
- The Zero Speed Detection Output (ZSP) turns ON when the motor speed is lower than the set value of this object.
- The set value of this object is valid in both positive and negative directions, regardless of the actual motor movement direction. The setting has a hysteresis of 10 mm/s.



Refer to *3-1-9 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 20,000	**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 Agreement (VCMP) flag in EtherCAT communications status.
- This setting is also used as the detection threshold for the Speed Agreement (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

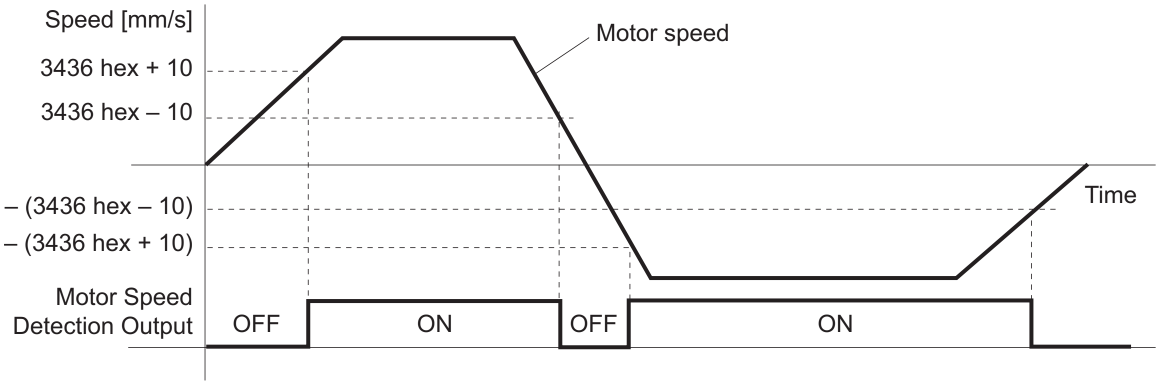
Refer to *3-1-9 Control Output Details* on page 3-12 for the Speed conformity output (VCMP).

9-5 Interface Monitor Settings

9

3436 hex	Speed for Motor Detection						csv
Setting range	10 to 20,000	Unit	mm/s	Default setting	1,000	Data attribute	A
Size	2 bytes (INT16)		Access	RW	PDO map	Not possible	

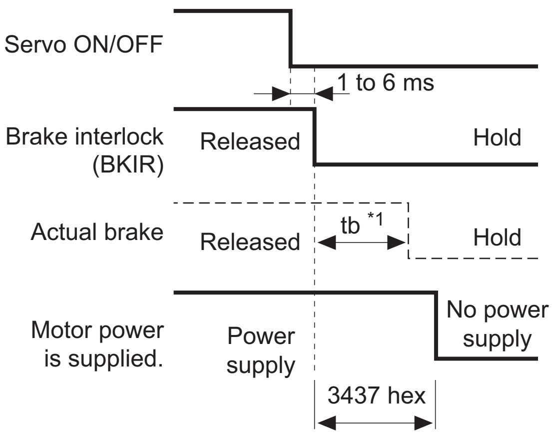
- It outputs the Motor Speed Detection Output (TGON) when the motor speed reaches the set Speed for Motor Detection (3436 hex).
- The setting has a hysteresis of 10 mm/s.



Refer to *3-1-9 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 10,000	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).

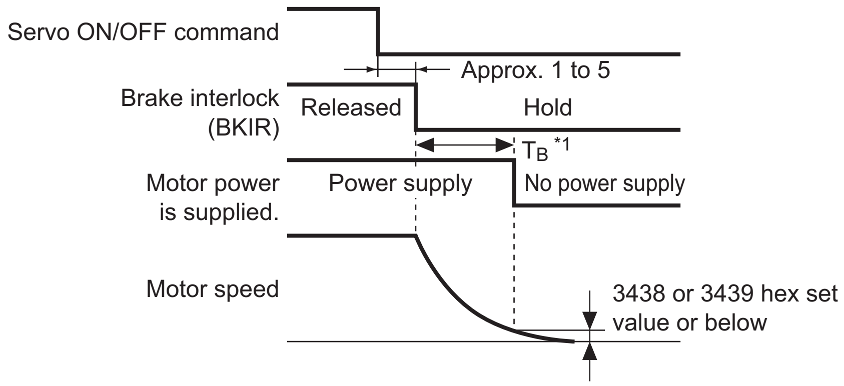


*1 Make the setting as follows to prevent the machine (workpiece) from moving or falling due to the delay time in the brake operation (tb).
Brake timing when stopped (set value × 1 ms) ≥ tb

For the operation time, refer to *7-5 Brake Interlock* on page 7-15.

3438 hex	Brake Timing During Operation					All	
Setting range	0 to 10,000	**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.

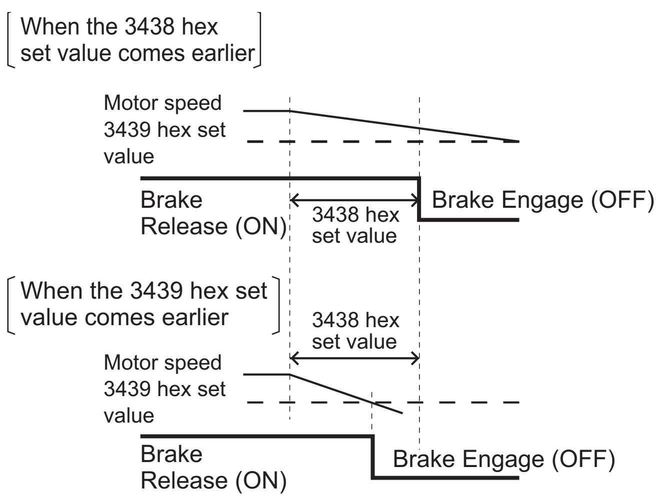


*1 The time TB in above drawing is either the brake timing during operation (i.e., the set value × 1 ms) or the time taken until it goes below the value set in the Brake Threshold Speed During Operation (3439 hex), whichever is shorter.

For the operation time, refer to *7-5 Brake Interlock* on page 7-15.

3439 hex	Brake Threshold Speed During Operation					All	
Setting range	30 to 3,000	**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.

9-5 Interface Monitor Settings

9

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 for all 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 detection warning
8	Life expectancy 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 12-5.

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 12-5.

3442 hex	Position Completion Range 2						csp pp hm
Setting range	0 to 262,144	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 default unit is command units, but Position Setting Unit Selection (3520 hex) can be used to convert to external encoder units. 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 Linear 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.
- 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 Linear 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).

Additional Information

- 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) 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) will occur when the connection between either the positive or negative prohibition input and COM is open.

For details, 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

3504 hex set value *1	3505 hex set value	Decelerating *2		After stopping (Approx. 30 mm/s or less)	
		Deceleration method	Error counter	Operation after stopping	Error counter
0	0	Dynamic brake	Clear	Force command is 0 for drive prohibition direction	Hold
	1	Free-run	Clear	Force command is 0 for drive prohibition direction	Hold
	2	Immediate stop *3	Clear	Force command and force limit are as specified.	Cleared after deceleration completes, then Hold.

*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” shows 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.

For details, 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 2,000	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 5,000	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.
- When it is set to 0, the normal force limit is used.
- 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%).

For details, 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 1,000	Unit	0.1 magnetic pole pitch	Default setting	10	Data attribute	A
Size	2 bytes (INT16)		Access	RW	PDO map	Not possible	

- Sets the Motor's 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.

For details, 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.
- The Servo Drive reads input signals 3 times in the set cycle. If the Servo Drive reads the same signal 3 times in a row, it will be accepted as the input signal.

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 selection method for the positive and negative force limits.

Explanation of Settings

3521hex 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.

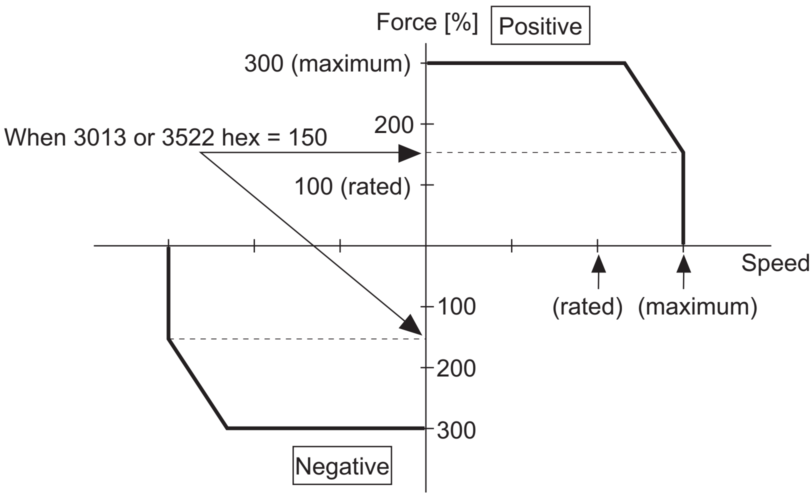
- When this object is set to 0 or 1, the Positive and Negative Force Limit Inputs are restricted by the Positive torque limit value (60E0 hex).

For details, refer to *7-7 Force Limit Switching* on page 7-22.

3522 hex	Force Limit 2					csp cst	
Setting range	0 to 5,000	Unit	0.1%	Default setting	5,000	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.
- Set the value in units of 0.1% of the rated force.

E.g. 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 5,000	Unit	0.1%	Default setting	5,000	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 9-46 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 5,000	Unit	0.1%	Default setting	5,000	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 9-46 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 Deviation Setting					csp pp hm	
Setting range	0 to 20,000	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 10,000	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.

For details, refer to *7-10 Gain Switching 3 Function* on page 7-37.

3606 hex	Gain 3 Ratio Setting					csp	
Setting range	50 to 1,000	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.

For details, 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 force (100%).

For details, refer to *11-9 Friction Force Compensation Function* on page 11-30.

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 force (100%).

For details, refer to *11-9 Friction Force Compensation Function* on page 11-30.

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 force (100%).

For details, refer to *11-9 Friction Force Compensation Function* on page 11-30.

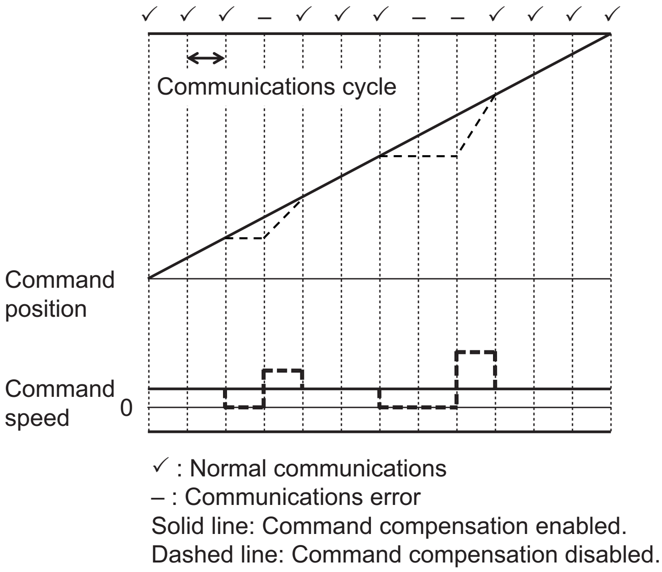
3610 hex	Function Expansion Setting					All	
Setting range	0 to 511	**Unit**	–	**Default setting**	64	**Data attribute**	B
Size	2 bytes (INT16)		**Access**	RW	**PDO map**	Not possible	

- 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 1,000,000 when represented as bits.

Explanation of Settings

Bit	Function		Set value 0	Set value 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 estimationn.	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.



Additional Information

Setting 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 11-28 and *11-11 Instantaneous Speed Observer Function* on page 11-35.

3614 hex	Error Detection Allowable Time Setting						All
Setting range	0 to 1,000	**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.

For details, refer to *12-3-2 Immediate Stop Operation at Errors* on page 12-11.

3615 hex	Overspeed Detection Level Setting at Immediate Stop						All
Setting range	0 to 20,000	**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.

For details, refer to *12-3-2 Immediate Stop Operation at Errors* on page 12-11.

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 *3-1-9 Control Output Details* on page 3-12 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 disturbance force.

For details, refer to *11-8 Disturbance Observer Function* on page 11-28.

3624 hex	Disturbance Observer Filter Setting						csp
Setting range	10 to 2,500	**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.

For details, refer to *11-8 Disturbance Observer Function* on page 11-28.

3631 hex	Realtime Autotuning Estimated Speed Selection						All
Setting range	0 to 3	Unit	–	Default setting	1	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 EEPROM.

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.

For details on realtime autotuning, refer to *11-3 Realtime Autotuning* on page 11-7.

3632 hex	Realtime Autotuning Customization Mode Setting						All
Setting range	–32,768 to 32,767	Unit	–	Default setting	0	Data attribute	B
Size	2 bytes (INT16)		Access	RW	PDO map	Not possible	

- Make detailed settings for the autotuning function, when 6: the customized mode is selected in the Realtime Autotuning Mode Selection (3002 hex).
  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: Disabled 1: Enabled
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 the Force Command Value Offset (3607 hex), Positive Direction Force Offset (3608 hex), or Negative Direction Force Offset (3609 hex) value 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.

Bit	Name	Description
7	Rigidity setting	Select to enable or disable the basic gain setting by the Realtime Autotuning Machine Rigidity Setting (3003 hex). 0: Disabled 1: Enabled
8	Fixed object settings	Select whether to allow changes to the objects that normally are fixed. 0: Use the present set value. 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 set value. 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 Inertia ratio updating, the Rigidity setting, and the Gain switch setting are enabled, the Torque compensation is set to Friction compensation (small), and the Fixed object setting is set to a Fixed value:

$$2^0 \times 1 + 2^2 \times 1 + 2^4 \times 3 + 2^7 \times 1 + 2^8 \times 1 + 2^9 \times 2 = 1461$$

For details on realtime autotuning, refer to *11-3 Realtime Autotuning* on page 11-7.

3637 hex	Vibration Detection Threshold					All	
Setting range	0 to 1,000	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 12-5.

3638 hex	Warning Mask Setting					All	
Setting range	–32,768 to 32,767	Unit	–	Default setting	4	Data attribute	C
Size	2 bytes (INT16)		Access	RW	PDO map	Not possible	

- Set a mask for warning detection.
- If you set the corresponding bit to 1, the detection of the corresponding warning is disabled.
- For details, refer to *General Warnings* on page 12-6.

Explanation of Settings

Bit	Warning number (hex)	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 32,767	**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 operations in a 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 1,000	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	Turn ON at force limits including the force command value.
1	Turn ON at force limits 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 the first positive movement after the servo turns ON.
2	Compensate for backlash at the first negative movement after the servo turns ON.

For details, refer to *7-4 Backlash Compensation* on page 7-13.

3705 hex	Backlash Compensation Amount						csp pp hm
Setting range	–32,768 to 32,767	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.

For details, refer to *7-4 Backlash Compensation* on page 7-13.

3706 hex	Backlash Compensation Time Constant					csp pp hm	
Setting range	0 to 6,400	**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.

For details, 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	–	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.
- Once you enable this setting, you will receive a Command Error if the data setting warning is detected twice in a row, which is indicated as just another warning with the default setting.

3800 hex	Communications Control						All
Setting range	–32,768 to 32,767	Unit	–	Default setting	16,384	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. Normally, use the default set value.

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 status change error
bit 2	83.2	EtherCAT illegal status change error
bit 3	83.3	Communications sync error
bit 12	83.4	Sync 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 12-26.

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 No.	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 12-7.

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.

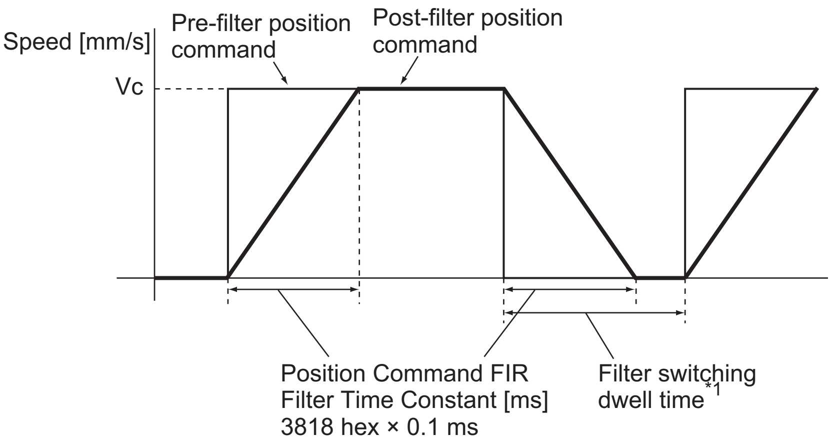
The status will also be 0 if an origin return has not been performed.

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 10,000	**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.



*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 16,777,216	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 1 and 1000000.
- For the set value, refer to the external encoder specifications.

Precautions for Correct Use

If you set this object to 0 or 1000001 or higher, a Motor Setting Error (Error No. 60.0) will occur.

3902 hex	Pole Pitch						All
Setting range	0 to 32,767	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 of the Linear Motor you connect to the Servo Drive.
  For details, refer to *3-3 Linear Motor Specifications* on page 3-28.

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 32,767	Unit	0.01 kg	Default setting	0	Data attribute	R
Size	2 bytes (INT16)		Access	RW	PDO map	Not possible	

- Set the mass (except cables) of the Linear Motor Coil Unit you connect to the Servo Drive.
  For details, refer to *3-3 Linear Motor Specifications* on page 3-28.

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 32,767	**Unit**	0.1 N	**Default setting**	0	**Data attribute**	R
Size	2 bytes (INT16)		**Access**	RW	**PDO map**	Not possible	

- Set the continuous force of the Linear Motor you connect to the Servo Drive.

  For details, refer to *3-3 Linear Motor Specifications* on page 3-28.

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 32,767	**Unit**	0.1 Arms	**Default setting**	0	**Data attribute**	R
Size	2 bytes (INT16)		**Access**	RW	**PDO map**	Not possible	

- Set the continuous current of the Linear Motor you connect to the Servo Drive.

  For details, refer to *3-3 Linear Motor Specifications* on page 3-28.

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 32,767	**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 you connect to the Servo Drive.
- Set the unit [0.1 A], instead of [0.1 Arms].

  For details, refer to *3-3 Linear Motor Specifications* on page 3-28.

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 32,767	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 you connect to the Servo Drive.

  For details, refer to *3-3 Linear Motor Specifications* on page 3-28.

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 32,767	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 you connect to the Servo Drive.

  For details, refer to *3-3 Linear Motor Specifications* on page 3-28.

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.

3910 hex	Overspeed Level						All
Setting range	0 to 20,000	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 guides, 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	Default setting
R88D-KN01L-ECT-L R88D-KN01H-ECT-L/-KN02H-ECT-L/-KN150H-ECT-L R88D-KN150F-ECT-L	60
R88D-KN02L-ECT-L/-KN04L-ECT-L 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	30

- 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, adjust the value based on the operating conditions as this may cause erroneous operation such as vibration.

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 32,767	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).

3914 hex	Current Loop Integral Gain					All	
Setting range	0 to 32,767	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 via the Current Response Auto-adjustment (3912 hex).

3915 hex	Two-stage Force Filter Time Constant						All
Setting range	0 to 2,500	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 1,000	Unit	–	Default setting	1,000	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 ζ = 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 10-9.

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 force 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 larger, 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).

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 approximately 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).

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 large command force.
- The magnetic pole position estimationn 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 force is limited with the maximum allowable force of motor.

3924 hex	Magnetic Pole Position Estimation Maximum Movement						All
Setting range	0 to 32,767	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 current 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).

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 10,000/Feedback scale resolution [0.001 µm]/(360 [degrees]/1 [degree])

3925 hex	Magnetic Pole Position Estimation Movement for Stop judgement					All	
Setting range	0 to 32,767	**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 judgement (3925 hex) or less persists for the time set in the Magnetic Pole Position Estimation Time for Stop judgement (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).

3926 hex	Magnetic Pole Position Estimation Time for Stop judgement					All	
Setting range	0 to 32,767	**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 stationary 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 judgement (3925 hex) or less persists for the time set in the Magnetic Pole Position Estimation Time for Stop judgement (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).

Precautions for Correct Use

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 Time for Stop judgement (3925 hex) and the Magnetic Pole Position Estimation Time for Stop judgement (3926 hex).

3927 hex	Magnetic Pole Position Estimation Time Limit for Stop						All
Setting range	0 to 32,767	**Unit**	ms	**Default setting**	1,000	**Data attribute**	B
Size	2 bytes (INT16)		**Access**	RW	**PDO map**	Not possible	

- Set the limit time during which the motor can be judged as stopped 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 (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).

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 2,500	**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).

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

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 application 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 properly according to the setting methods in this manual.

Item	Contents	Reference
Mounting and installation	Install the motor and drive according to the installation conditions. However, do not connect the motor to the mechanical system. First, connect the motor to a minimal structure of linear sliders for checking no-load operation.	Section 4, 4-1
Wiring and connections	Connect drive to the power supply the motor and peripheral equipment. Specified installation and wiring conditions must be satisfied, particularly for conforming the apparatus to the EC Directives.	Section 4, 4-2
Preparing and setting 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. Configure the drive for Linear Motor, external scale specification, and magnetic pole detection settings in advance. With the default settings, the Servo Drive will not operate due to an error. Turn ON the power supply again, and check to see if protective functions, such as the STOP, Drive prohibition inputs, and safety functions, respond as expected.	Section 10, 10-2
Initializing Linear Motor settings	Use the Sysmac Studio or CX-Drive to follow the steps below. 1 Set the motor constant, magnetic pole position estimation method, external encoder type, resolution, and other data according to the motor model and external encoder in use and transfer the set data to the Servo Drive. 2 The automatic setting function automatically determines the current loop gain and the encoder direction by driving the motor and stores that information in the Servo Drive. 3 On the confirmation screen, check the linear slider operation and the amount of increase/decrease of the current value and its direction.	Section 10, 10-3
Function settings	Set the objects related to the functions required for application conditions.	Section 9

Trial operation	First, check linear slider with no-load and then turn the power supply OFF and connect the linear slider to the mechanical system. Turn ON the power supply again, and check to see whether protective functions, such as the STOP and Drive prohibition inputs, work as you expected. Check operation at both low speed and high speed using the system without a workpiece, or with dummy workpieces.	Section 10, 10-4

⬇

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 operate the motor and drive after installing and wiring, and also describes 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 VAC) 50/60 Hz
Control circuit power supply	: Single-phase 100 to 120 VAC (85 to 132 VAC) 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 VAC) 50/60 Hz
Control circuit power supply	: Single-phase 200 to 240 VAC (170 to 264 VAC) 50/60 Hz

- R88D-KN06F-ECT-L/-KN10F-ECT-L/-KN15F-ECT-L/-KN20F-ECT-L/-KN30F-ECT-L (3-phase 400 VAC input)

Main circuit power supply	: 3-phase 380 to 480 VAC (323 to 528 VAC) 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), white (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

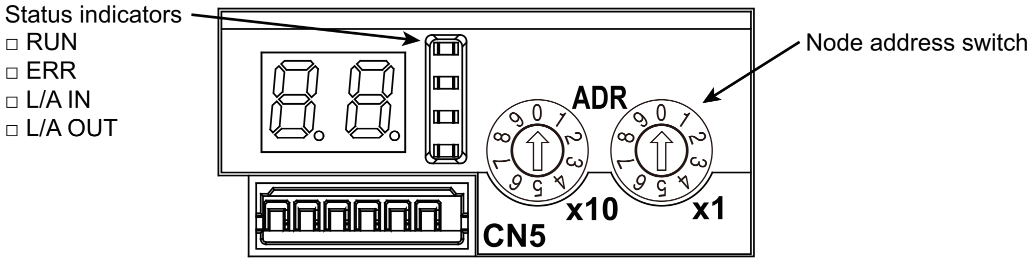
- The external encoder cable must be securely connected to the external encoder connector (CN4) at the Servo Drive.
- The cable from the Servo Drive must be securely connected to the connector at the external encoder.

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 NJ301-□□□□/NJ501-□□□□ and CJ1W-NC281/NC481/NC881/NCF81/NC482/NC882/NCF82 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 is 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.

It is indifferent whether you turn On or OFF the main circuit power.

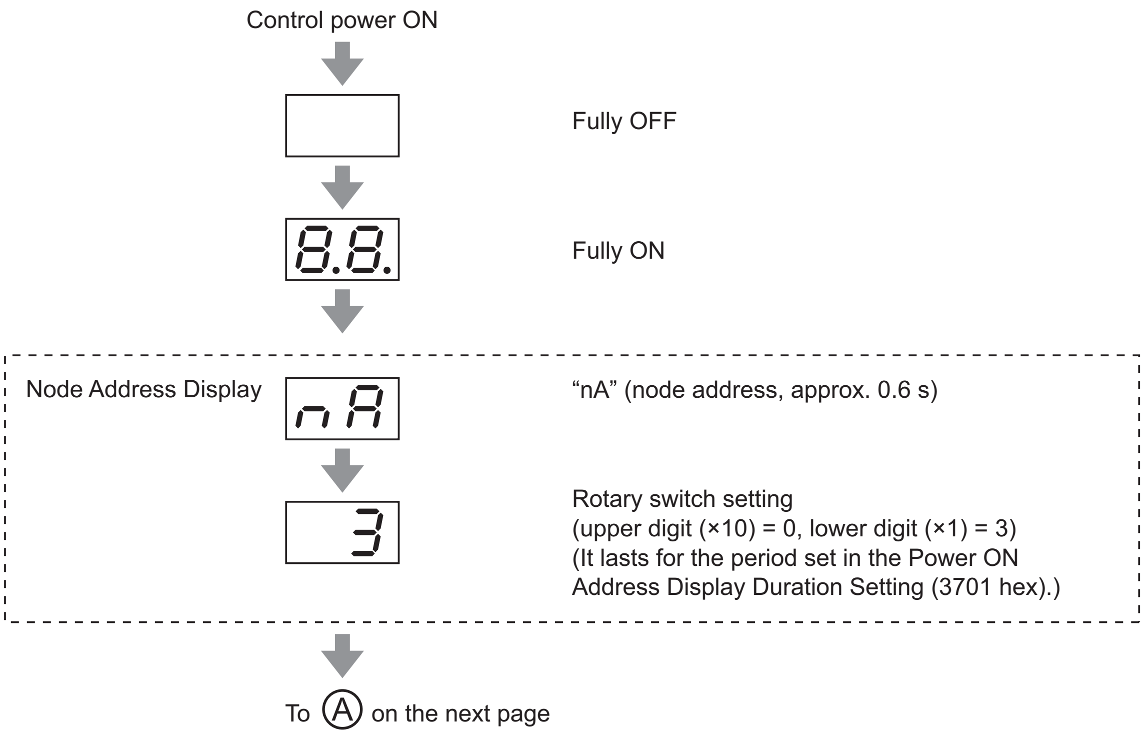
10-2-3 Checking the Displays

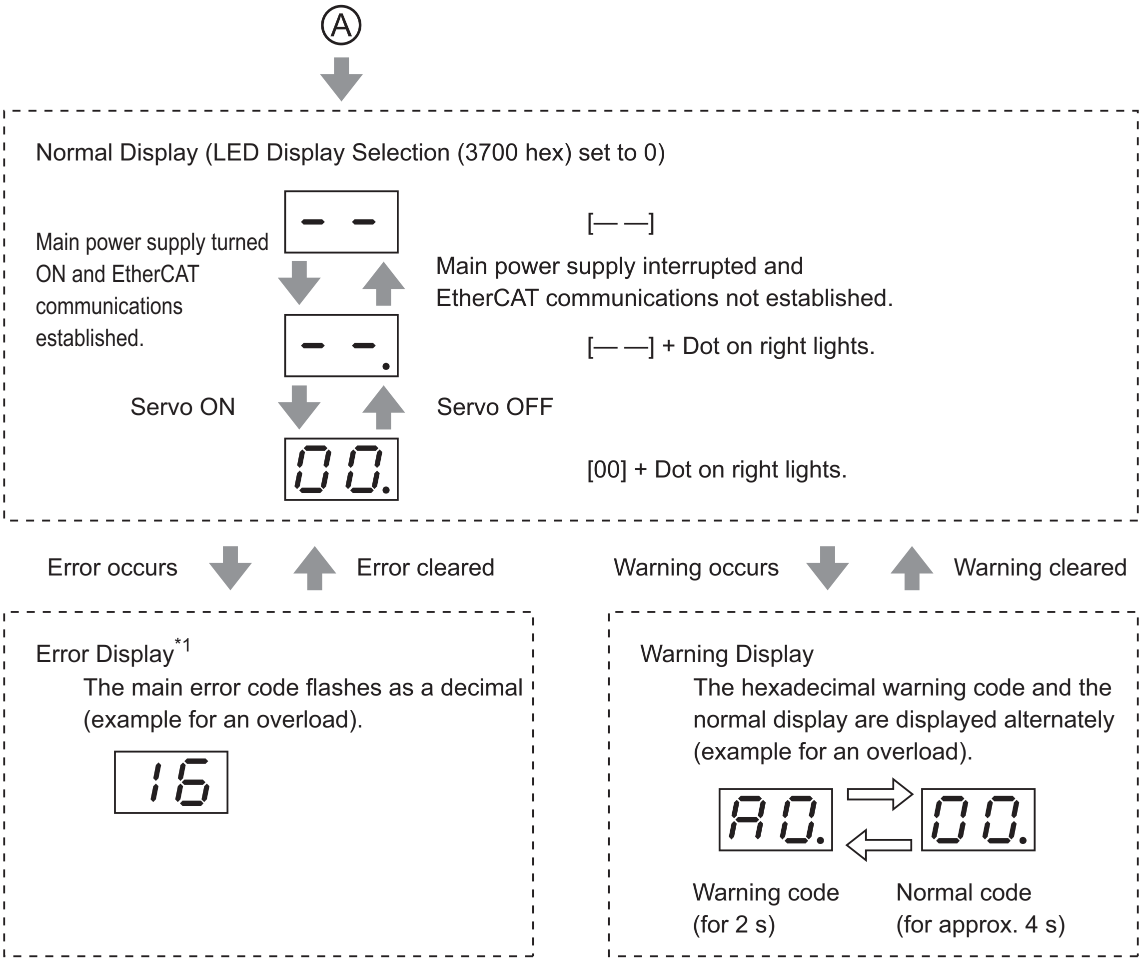
7-Segment Display

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.





*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 *5-1-2 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 appropriate to 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

To set the data obtained as above, have the Sysmac Studio or CX-Drive ready. For details on operating these tools, refer to *10-3 Linear Motor Setup* on page 10-13.

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 encoder type (90° phase difference, serial communications incremental, or serial communications absolute) of the selected external encoder. For the set value, refer to the specifications of the selected equipment.	P. 9-27
3326 hex	External Feedback Pulse Direction Switching	–	Set the count direction of the external encoder.	P. 9-28
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.	P. 9-61
3902 hex	Pole Pitch	0.01 mm	Set the magnetic pole pitch.	P. 9-61
3904 hex	Motor Coil Unit Mass	0.01 kg	Set the mass of the Linear Motor Coil Unit.	P. 9-61
3905 hex	Motor Rated Force	0.1 N	Set the rated force of the Linear Motor.	P. 9-62
3906 hex	Motor Rated Rms Current	0.1 Arms	Set the rated current of the Linear Motor.	P. 9-62
3907 hex	Motor Peak Absolute Current	0.1 A	Set the maximum momentary current of the Linear Motor. *1	P. 9-62
3910 hex	Overspeed Level	mm/s	Set the maximum speed appropriate for the specifications of the selected Linear Motor, external encoder, linear guides, or other equipment. For the set value, refer to the specifications of the selected equipment.	P. 9-63

*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) allows the Servo Drive to automatically set the calculated value based on the Motor Inductance and Motor Resistance data.

To use the Current Response Auto-adjustment (3912 hex), you must set also the Motor Inductance (3908 hex) and Motor Resistance (3909 hex).

Index	Name	Unit	Description	Reference
3908 hex	Motor Inductance	0.01 mH	Set the phase inductance of the Linear Motor.	P. 9-63
3909 hex	Motor Resistance	0.01 Ω	Set the phase resistance of the Linear Motor.	P. 9-63
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).	P. 9-64
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).	P. 9-64
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).	P. 9-64

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 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 perform magnetic pole detection again at 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.	P. 9-66
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	P. 9-66
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	P. 9-67

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	P. 9-67
3925 hex	Magnetic Pole Position Estimation Movement for Stop Judgement	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 Judgement (3926 hex) or less persists for the time set in the Magnetic Pole Position Estimation Time for Stop Judgement (3926 hex) or longer. To prevent the motor from being judged as stopped in a wrong timing, be sure to set. *3	P. 9-68
3926 hex	Magnetic Pole Position Estimation Time for Stop Judgement	ms		P. 9-68
3927 hex	Magnetic Pole Position Estimation Time Limit for Stop	ms	Set the condition for judging that the motor is 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 (Error No. 61.1) will occur. *4	P. 9-69
3328 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.	P. 9-69

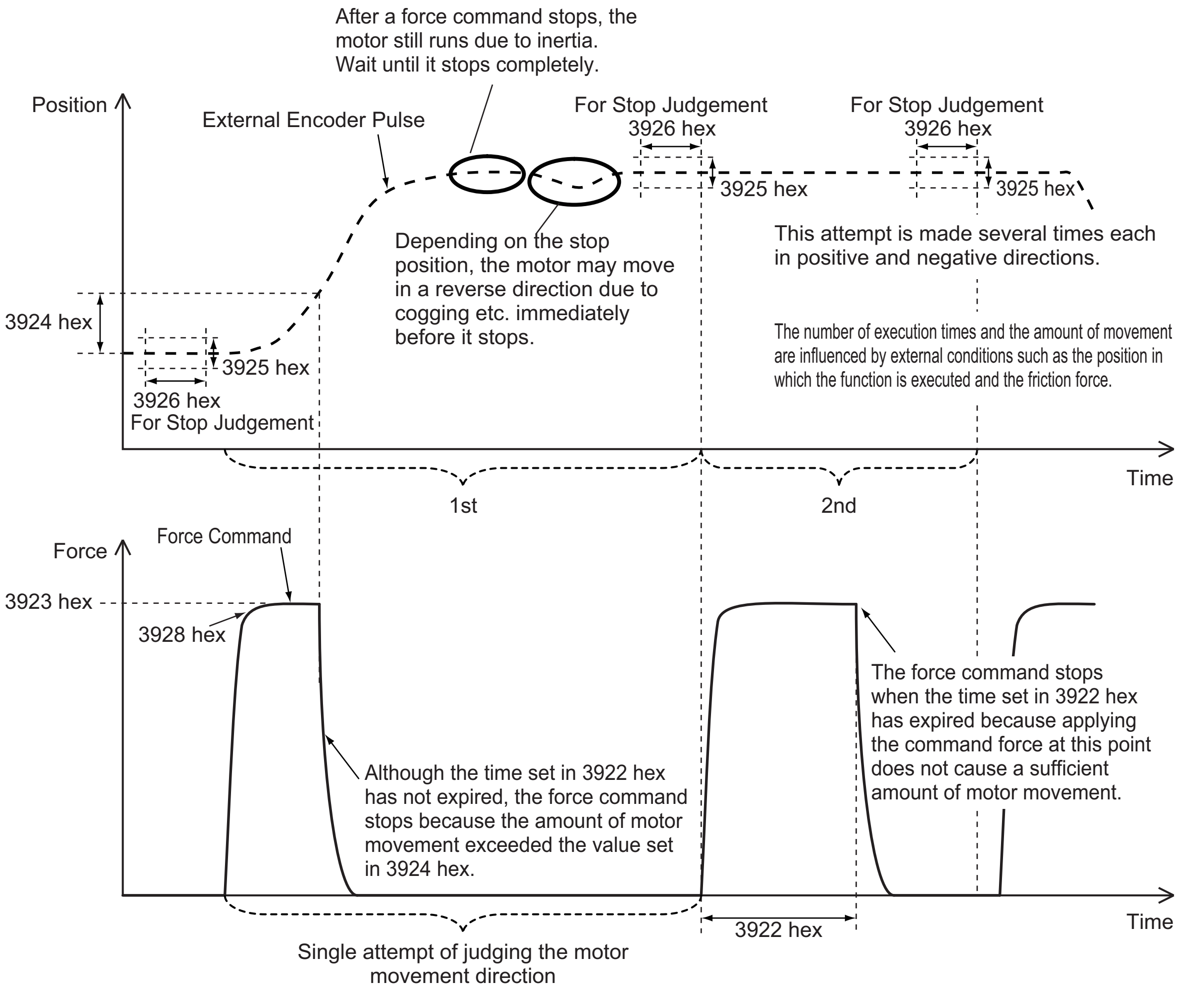
*1 The magnetic pole position estimation accuracy may be improved by increasing the set value in the Magnetic Pole Position Estimation Force Command Time (3922 hex) or Magnetic Pole Position Estimation Force Command (3923 hex). However, if you set a large value in the Magnetic Pole Position Estimation 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 10,000/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 Time for Stop Judgement (3925 hex) and the Magnetic Pole Position Estimation Time for Stop Judgement (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 position 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 restoration method is the function to restore the magnetic pole position data after the power supply is reset.

Once perform magnetic pole position estimation and change the following parameter to switch to the magnetic pole position restoration method. Then, you need not perform magnetic pole position estimation any more, regardless of whether or not the power supply is reset.

This method is available only when you connect 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.	P. 9-66

Precautions for Correct Use

- The magnetic pole position estimation method is executed at the first Servo ON after you turn ON the power supply. Because the Linear Motor operates during magnetic pole position estimation, connect a sensor to one of the general-purpose inputs and use the over-travel, external error, or other function to prevent the motor from hitting the mechanical end stop.
- The magnetic pole position estimation method may not provide correct estimation if there is a large unbalanced load or friction.
- For 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), the values set when the magnetic pole position estimation method is started will be used. Changes made during magnetic pole position estimation will not be reflected on these values.

10-3 Linear Motor Setup

Linear Motor Setup is a function included in the Sysmac Studio or CX-Drive.

Linear Motor Setup provides a wizard that helps you configure the parameters necessary to drive the Linear Motor.

Therefore, until you complete this setup, you cannot control the Motor.

Additional Information

The Linear Motor Setup function is supported in the CX-Drive Ver. 2.7 or higher.

Caution

If a problem occurs in serial communications during a test operation, you have no means to stop the Motor.

Install external hardware to ensure that the Motor can be stopped at any time.

Before transferring parameters or data from the CX-Drive and Sysmac Studio to any other node, check the safety around the target node.

Injury may result.

Check the axis (shaft) number before operating with the CX-Drive and Sysmac Studio.

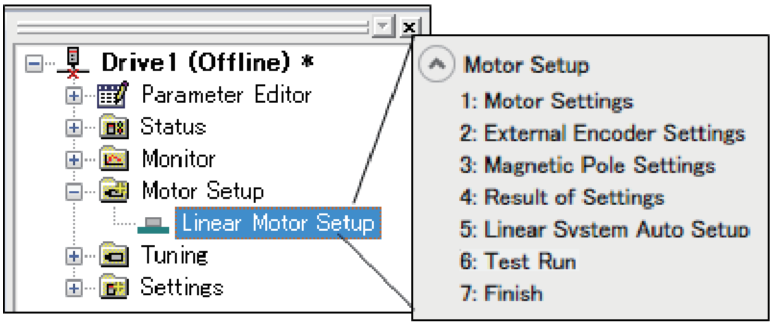
Precautions for Safe Use

Adjusting the current loop gain causes an extreme variation of the motor speed. Adjust the current loop gain under conditions where the servo OFF can be performed immediately in case of an emergency.

10-3-1 Outline of Linear Motor Setup

Linear Motor Setup requires the use of either the Sysmac Studio or the CX-Drive. Despite their difference in screen design, these software applications configure the same settings.

The following description assumes that you are using the CX-Drive to perform Linear Motor Setup.



Wizard screen	Operation
1. Motor Settings	Select the Motor model.
2. External Encoder Settings	Enter the external encoder specifications.
3. Magnetic Pole Settings	Select the magnetic pole detection method.
4. Result of Settings	Review the parameter values calculated from the specified settings and save the parameters to the EEPROM.
5. Linear System Auto Setup	Based on the above parameter values, perform the following: • Automatic current loop gain adjustment • External encoder direction parameter setting
6. Test Run	Check the external encoder for the following: • Direction in which the encoder value increases • Value that represents the mechanical movement amount
7. Finish	Check the parameter settings that have been changed and finish the wizard.

10-3-2 Operation from the CX-Drive

For USB Connection

Connect the CX-Drive with the Servo Drive via a USB cable.

1. **Connect a sensor or other device to the connector CN1.**
2. **Turn ON the power supply (12 to 24 VDC) to the CN1 control inputs (+24VIN, COM).**
3. **Turn ON the Servo Drive power.**
4. **Connect a USB cable to the USB connector (CN7).**
5. **On the computer, start the CX-Drive and go online with the Servo Drive via USB communications.**

For EtherCAT Connection

To connect the CX-Drive with the Servo Drive via EtherCAT connection, you must configure in advance the communications settings for the EtherCAT master controller.

For EtherCAT communications settings, refer to the manual for your controller.

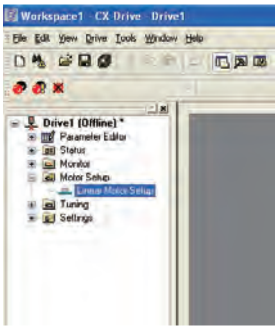
1. **Connect a sensor or other device to the connector CN1.**
2. **Connect the CX-Drive to the Servo Drive via a network cable.**
3. **Turn ON the power supply (12 to 24 VDC) to the CN1 control inputs (+24VIN, COM).**
4. **Turn ON the Servo Drive power.**

   This establishes EtherCAT communications if the required communications settings have been configured in advance.

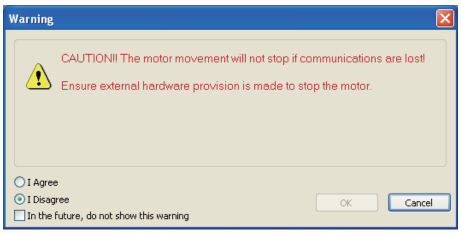
   If EtherCAT communications have not been established, configure communications settings at this point.
5. **On the computer, start the CX-Drive and go online with the Servo Drive via EtherCAT communications.**

Starting the Linear Motor Setup

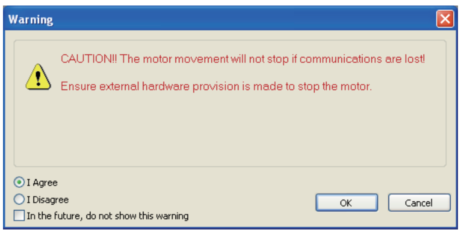
1. **To start [Linear Motor Setup], double-click [Linear Motor Setup] under [Motor Setup] in the workspace.**



The following screen appears.



2. **Select [I Agree] and click the [OK] button.**



The Linear Motor Setup wizard starts.

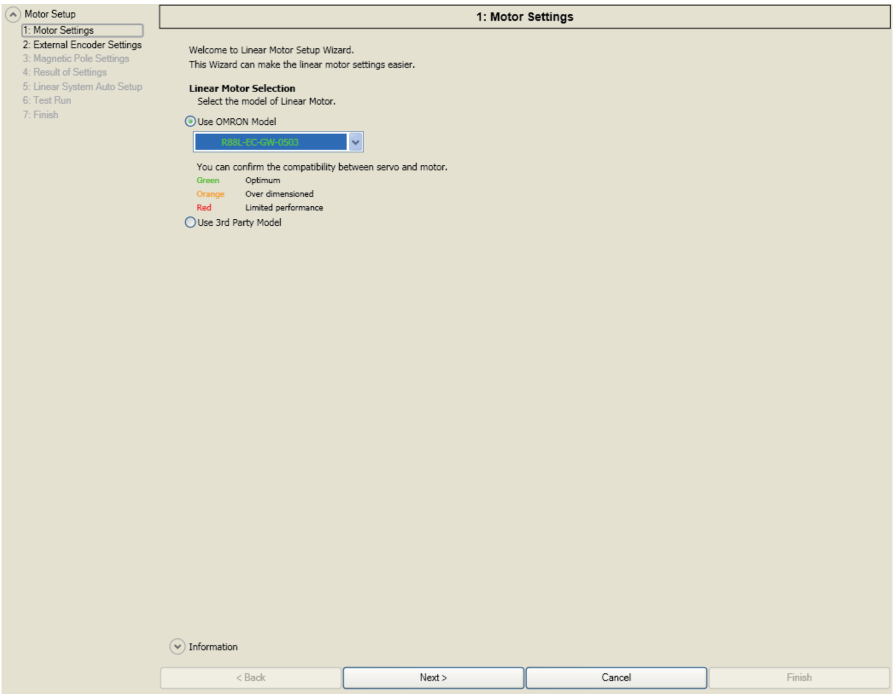
Linear Motor Setup Operation Procedure

Follow the steps below up to the end of this section to complete Linear Motor Setup.

If you are using the product in a default state, if you have interrupted the procedure before completion by clicking the [Cancel] or [Stop] button, or if you have failed to step through to the end of the procedure due to a computer failure etc., restart the following procedure from step 1.

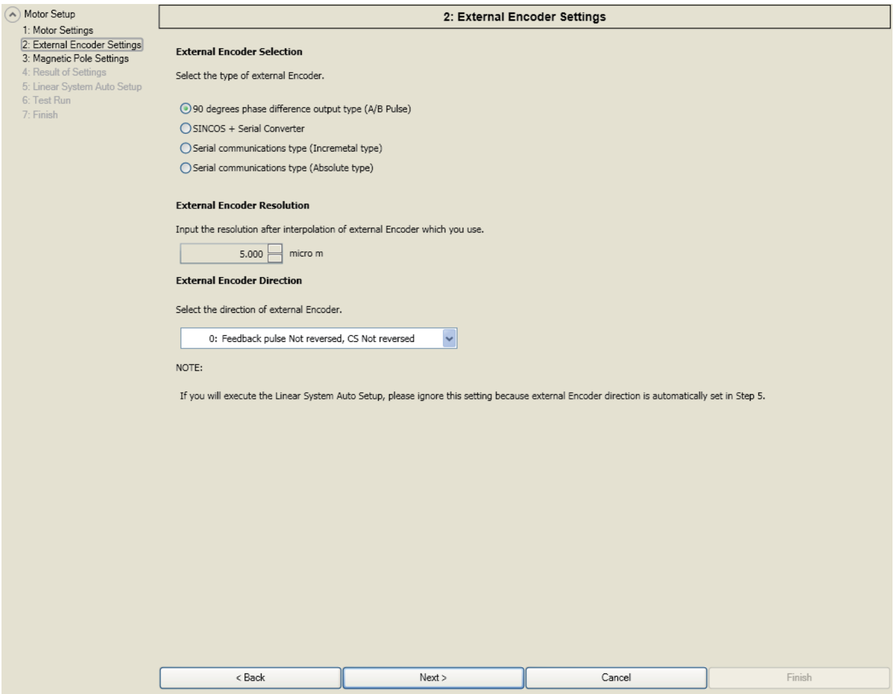
1 **Select [Use OMRON Model] in [Linear Motor Selection].**

2 **Select the model of the Linear Motor to connect.**



3 **After selecting, click [Next] button.**

The following External Encoder Settings screen appears.



4 **Select the type of external encoder.**

Select one of the following three external encoder types:

- 90º phase difference output type (Phases A, B and Z)
- Serial communications type (Incremental type)
- Serial communications type (Absolute type)

Check the instruction manual of the external encoder for the types of the external encoder.

5 **Input the resolution of the external encoder.**

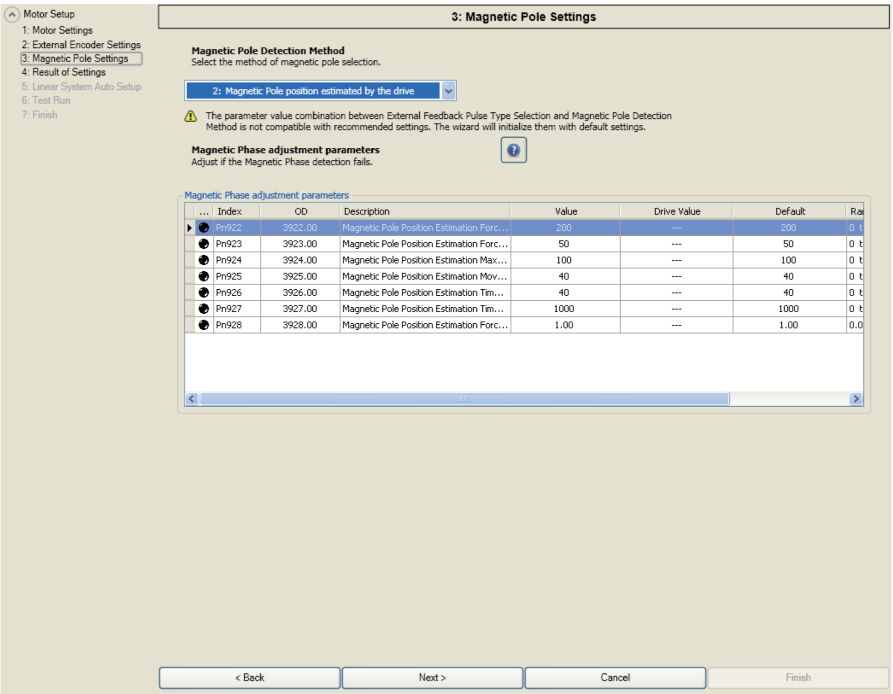
Check the instruction manual of the external encoder for the resolution of the external encoder.

After inputting, click [Next] button.

Additional Information

You do not need to set the “external encoder direction” at this step. The Linear System Auto Setup is executed later and the “external encoder direction” is automatically set.

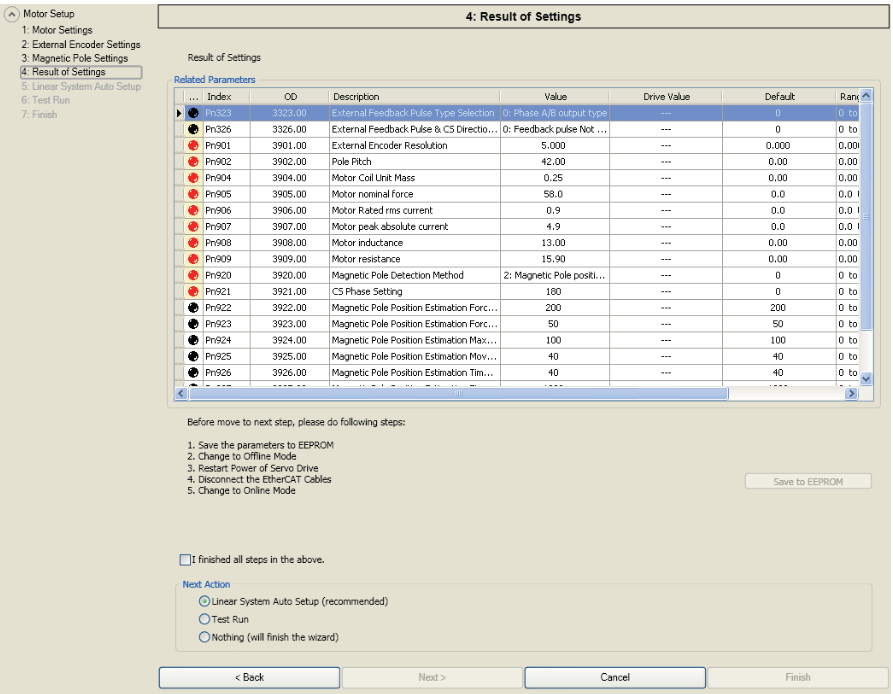
6 **Select [2: Magnetic Pole position estimated by the drive] from [Magnetic Pole Detection Method].**



For the Magnetic Pole Detection Method setting, refer to *Setting the Magnetic Pole Detection Data* on page 10-9.

After selecting, click [Next] button.

7 **The following screen appears.**



This screen shows the parameter settings that have been generated based on the settings configured in the previous steps, which cannot be changed in this step.

If they are not as you intended, restart the procedure from step 1.

8 **Follow the instructions displayed on the screen to update the parameter settings in the Servo Drive.**

(1) Click [Save to EEPROM] button.

This sends the parameter settings displayed on the screen to the Servo Drive and saves them in the EEPROM.

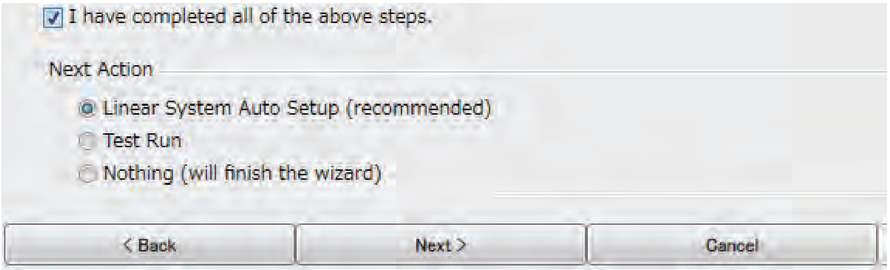
(2) Change to the offline mode.

(3) Turn OFF and then turn ON the power supply of the Servo Drive again to enable the above parameter settings.

(4) If the CX-Drive is connected via USB connection, according to the instructions displayed on the screen, disconnect the communications cable to the motion controller.
If the CX-Drive is connected via EtherCAT connection and no instructions are displayed, proceed to the next step without disconnecting the cable.

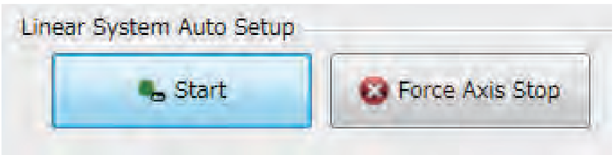
(5) Change to the online mode.

9 **Click [I finished all steps in the above] check box.**



10 **Select [Linear System Auto Setup (recommended)] from [Next Action] and click [Next] button.**

11 **Check the [Start] button displayed on the screen.**



Make sure that the [Start] button can be clicked at this point.

If the [Start] button is grayed out and cannot be clicked, this software may not be set to the commissioning mode. In this case, refer to *10-3-3 Connection from the CX-Drive via Network* on page 10-23 to switch to the commissioning mode.

Precautions for Correct Use

Note that the Linear Motor moves when the Linear System Auto Setup is executed.

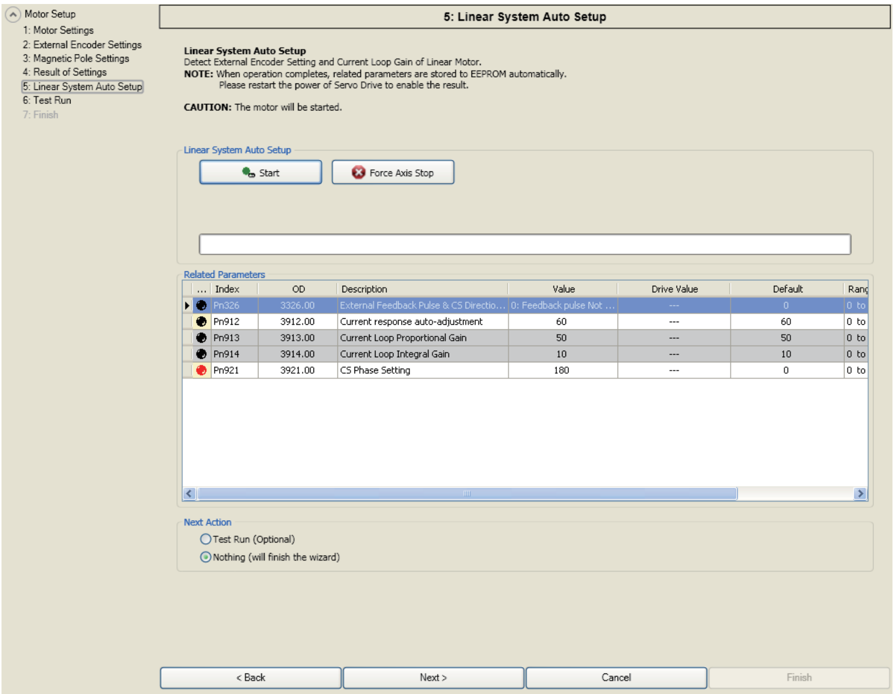
Click [Force Axis Stop] button to interrupt the Linear System Auto Setup and stop the Linear Motor forcibly.

Additional Information

If the CX-Drive is connected via USB connection and no EtherCAT cable is connected, you may click the [Start] button even when it is not set to the Test Run mode. If you can click the [Start] button, go straight forward to the next step.

12 **Click [Start] button to start.**

This automatically starts the Linear System Auto Setup.



The Servo Drive will drive the Servo Motor to determine the following settings:

- Linear Motor current loop gain
- External encoder direction setting

When the Linear System Auto Setup is completed, the established settings have been saved automatically to the EEPROM of the Servo Drive.

These parameter settings will be updated when the power supply is turned OFF and then ON again.

13 **Turn OFF and then ON the Servo Drive again to update the parameter settings.**

(1) Change to the offline mode.

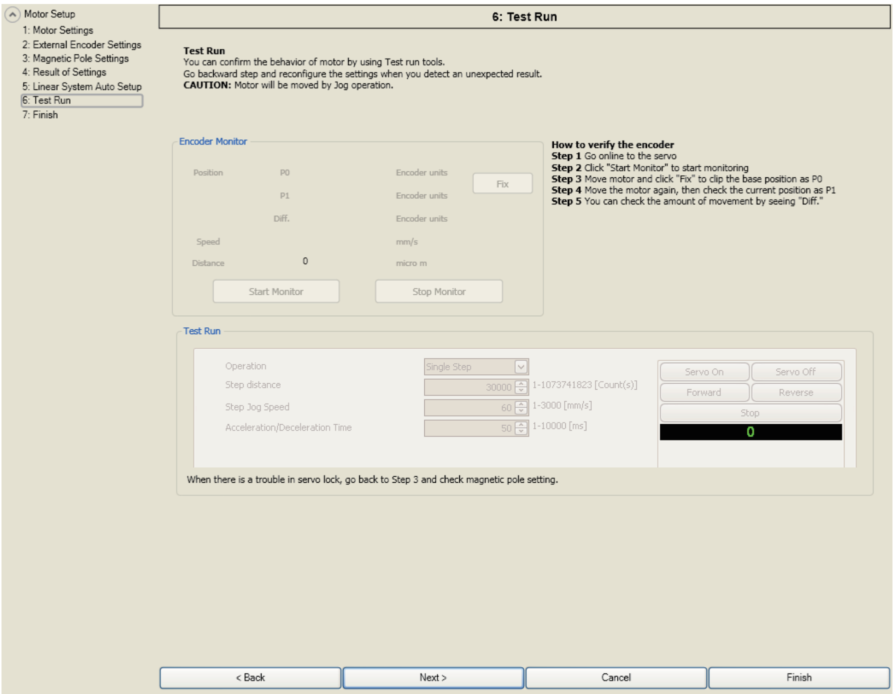
(2) Turn OFF the control power supply to the Servo Drive once.

(3) Turn ON the Servo Drive power again and check that no error has occurred.

14 **Change to the online mode.**

15 **Select [Test Run] from [Next Action] and click [Next] button.**

The following Test Run screen appears.



16 **Check how the external encoder operates via the external encoder monitor.**

Clicking [Start Monitor] enables the monitoring of the current external encoder value. Check the encoder value from the following view points:

- Move the Motor Coil Unit slightly to make sure that the direction in which the current value (or reading of the external encoder) increases/decreases matches that of the coordinate value for the system.
- After saving the current position to P0 on the screen, move the moving table slightly by hand and read the count value in P1. Doing this at a marked position on the machine enables quantitative measurement in units of pulses/mm.
- Check the relationship between the value displayed in P1 by the external encoder and the mechanical position of the Motor Coil Unit.

If the direction or pitch of the external encoder does not match the current value from the encoder monitor, check the specifications of the external encoder and initialize the Linear Motor settings from the beginning. In particular, check that the settings in steps 3 to 5 and step 8 have been completed correctly.

17 **Perform a test run.**

Perform the servo lock and jog operations to check that the Linear Motor operates as intended.

If the servo lock operation fails, check the settings again from step 1. In particular, check that, in step 5, the Magnetic Pole Detection Method has been selected correctly.

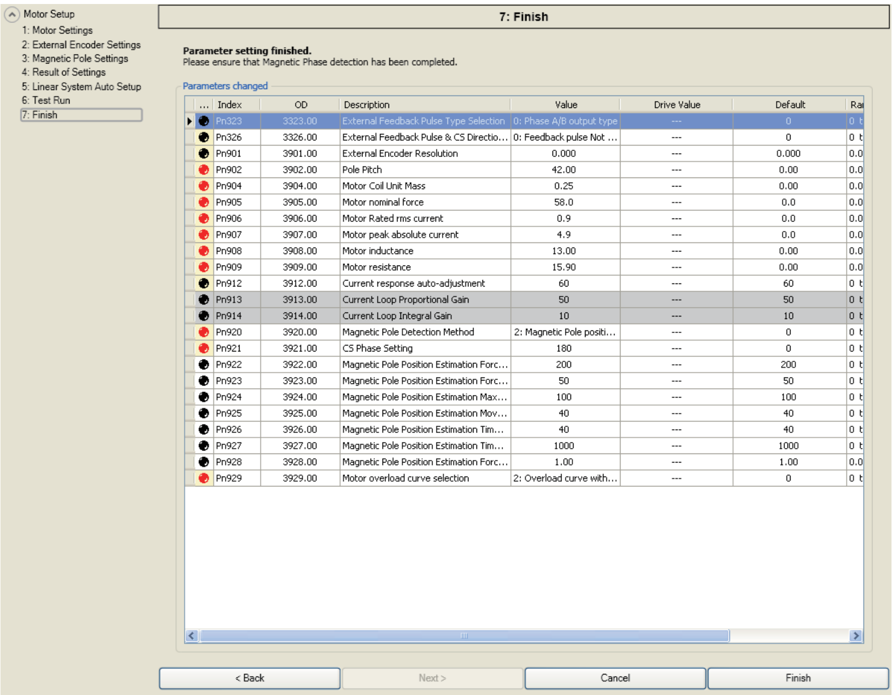
If the servo lock operation is successful but the jog operation fails, return to step 4 and check that the external encoder resolution setting matches the external encoder specifications.

Precautions for Correct Use

Note that the Linear Motor operates during the jog operation.

18 **When the test run is completed, click [Next] button.**

The following screen appears. You can check the set parameters.



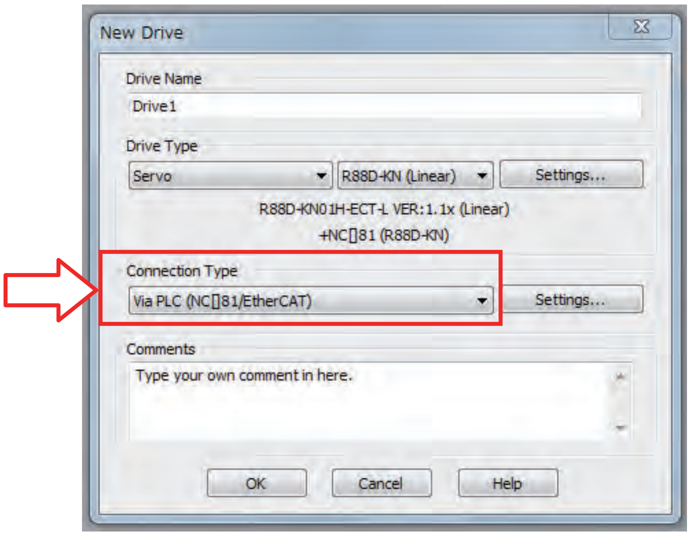
19 **Click the [Finish] button to close the wizard screen.**

Linear Motor Setup has now been completed.

10-3-3 Connection from the CX-Drive via Network

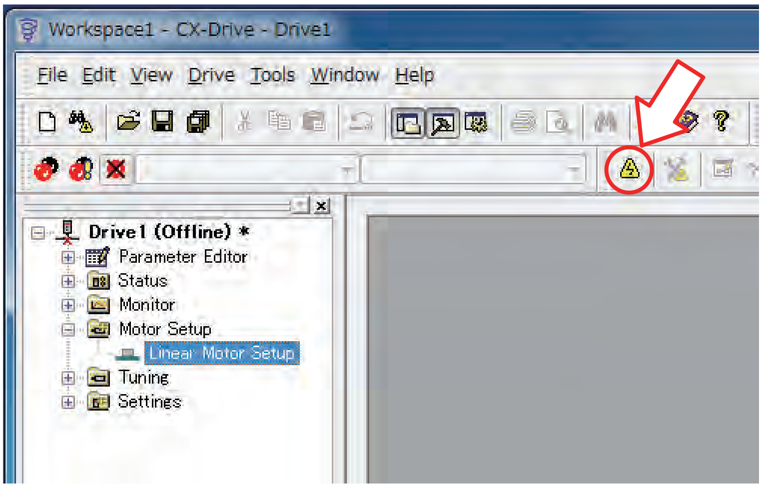
Online Operation

1 **In the CX-Drive, click [Change …] from the [Drive] menu to check that the Connection Type is selected correctly.**



2 **Click the Online icon, or click [Work Online] from the [Drive] menu.**

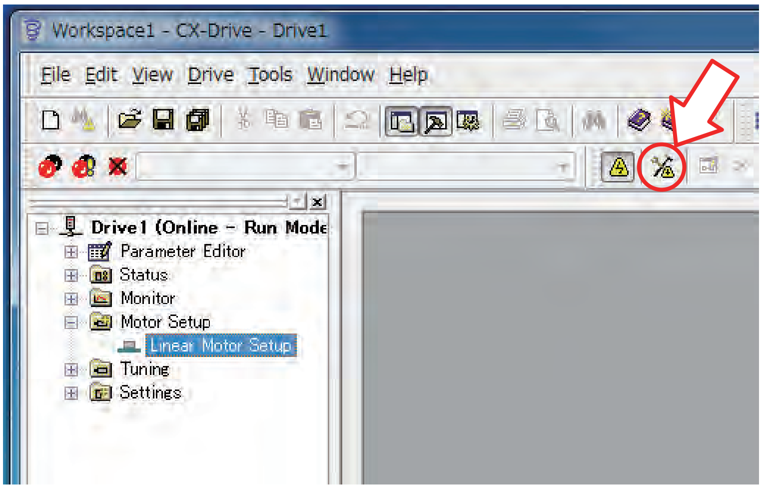
The Servo Drive is set online.



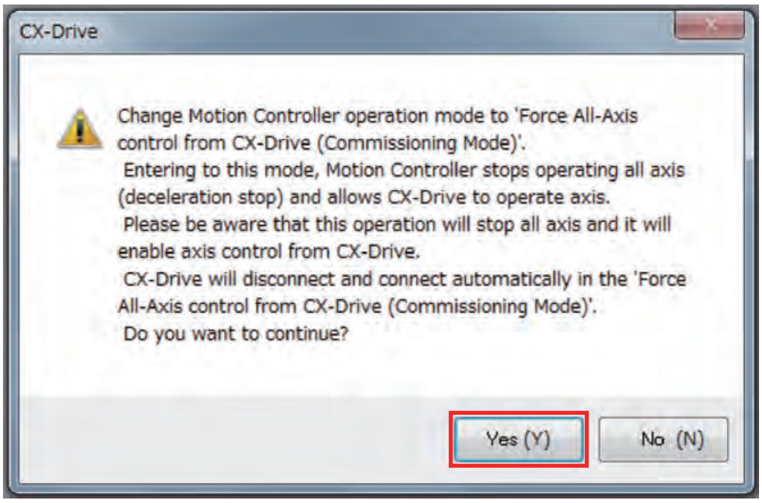
When the Servo Drive is set online, the Online icon is as shown in the diagram to the right.

Switching to the Commissioning Mode

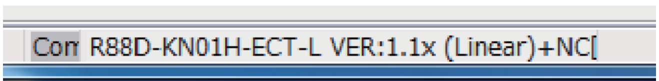
1 **When the Servo Drive is set online, click the following icon, or click [Test Run] from the [Drive] menu.**



2 **Read the precautions and click [Yes (Y)].**



Check the icon and status bar below to check that the Servo Drive is in the commissioning mode.

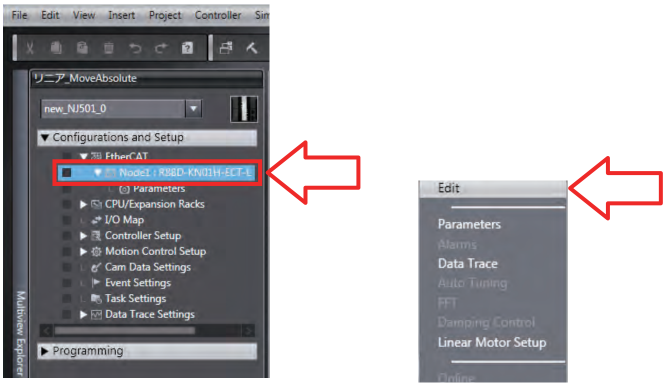


For the following steps, refer to *10-3-2 Operation from the CX-Drive* on page 10-14.

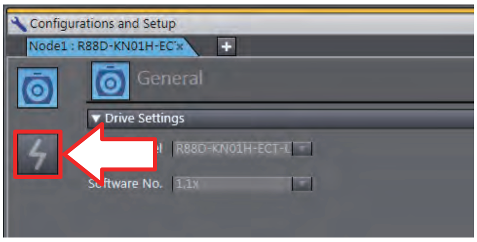
10-3-4 Connection from the Sysmac Studio via Network

Online Operation

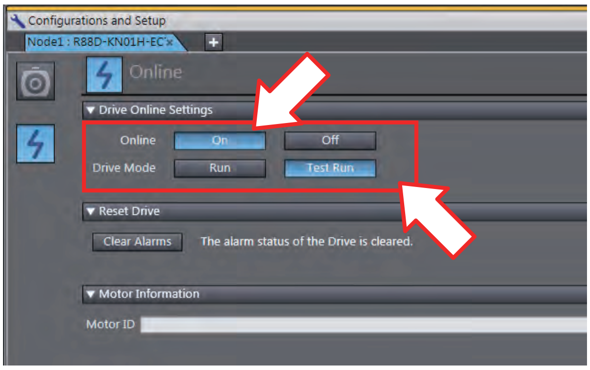
1 **In Sysmac Studio, right-click the setup target Servo Drive from the EtherCAT menu to display the [Edit] screen.**



2 **Click the following button to switch to the Online screen.**



3 **When the Online screen is open, change [Online] to On and [Drive Mode] to Test Run.**

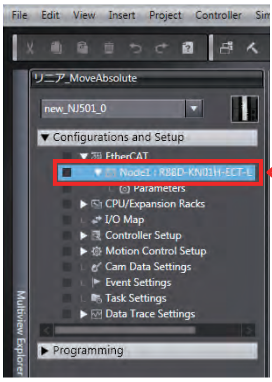


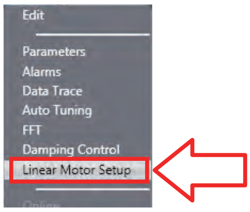
4 **Read the precautions and click [OK] button.**

The Servo Drive is changed to the test run mode.

Starting the Linear Motor Setup

1 **In Sysmac Studio, right-click the setup target Servo Drive from the EtherCAT menu and select [Linear Motor Setup].**





2 **Read the precautions and click [OK] button.**

The Linear Motor Setup screen opens.

For the following steps, you will work with screens similar to those provided in the CX-Drive. Refer to *10-3-2 Operation from the CX-Drive* on page 10-14.

10-4 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.

10-4-1 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 is disconnected from the mechanical system.

● Brake Released

- Make sure that the brake is released.

● Connections to the Mechanical System

- Is the load on the Linear Motor within specifications?

10-4-2 Trial 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. **In the CX-Drive, set various initial setting parameters using the Linear Motor Setup Wizard.**

   For details on this Setup Wizard, refer to *10-3 Linear Motor Setup* on page 10-13.
7. **Select [Test Run] from the [Tuning] Menu of the CX-Drive.**
8. **Select [Servo ON] to servo-lock the Linear Motor.**
9. **Select [Positive] or [Negative] and start the Linear Motor.**

   The Linear Motor will move until [Stop] is selected.

Precautions for Correct Use

The trial operation function via USB communications from the CX-Drive cannot be used while EtherCAT communications are established.

10-4-3 Setup via Network

The Linear Motor Setup Wizard, tuning, and trial operation require online operation from a personal computer.

For details, refer to *10-3 Linear Motor Setup* on page 10-13.

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	Description	Reference
3416 hex	Analog Monitor 1 Selection	Select the monitoring item for the analog monitor 1.	P. 9-32
3417 hex	Analog Monitor 1 Scale Setting	Set the output gain for the analog monitor 1.	P. 9-32
3418 hex	Analog Monitor 2 Selection	Select the monitoring item for the analog monitor 2.	P. 9-33
3419 hex	Analog Monitor 2 Scale Setting	Set the output gain for the analog monitor 2.	P. 9-33
3421 hex	Analog Monitor Output Setting	Select the analog monitor output method.	P. 9-34

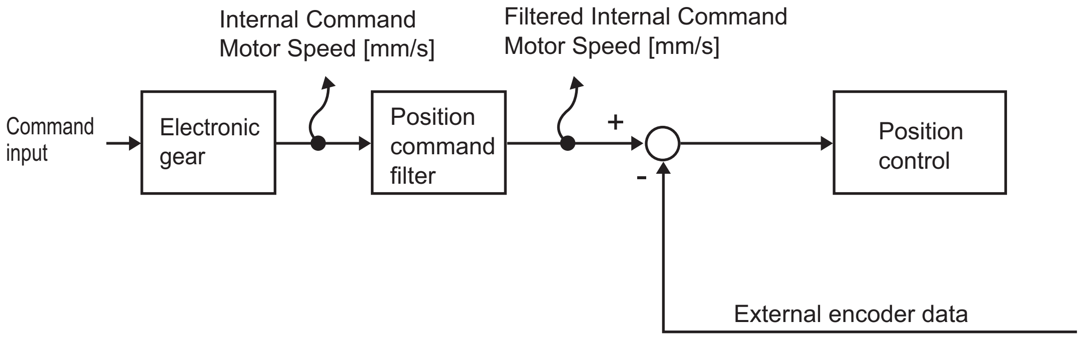
● Analog Monitor Objects (3416, 3417, 3418 and 3419 hex)

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.

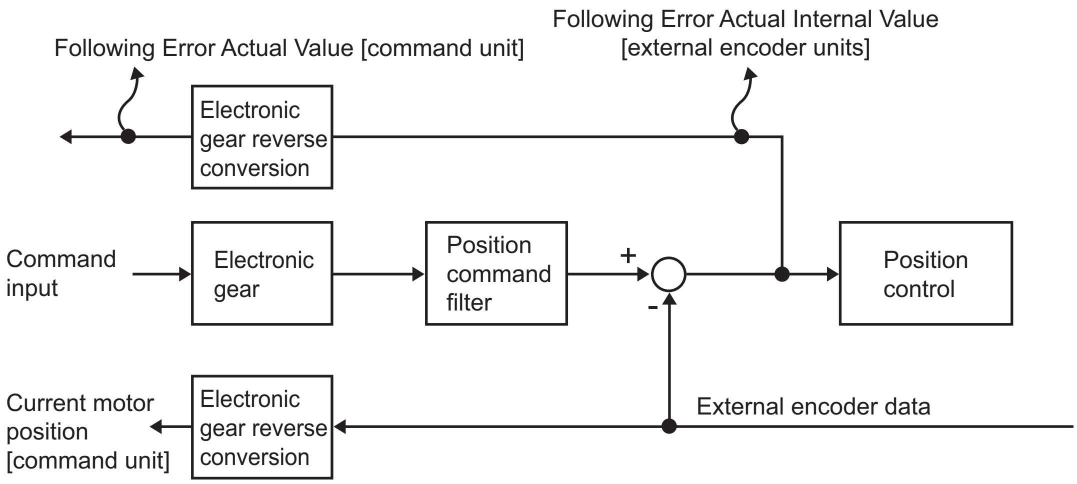
3416 hex 3418 hex set value	Monitor type	Unit	Output gain when 3417 hex and 3419 hex are set to 0
0	Motor Velocity Actual Value	mm/s	500
1	Motor Velocity Demand Value*1	mm/s	500
2	Motor Velocity Demand Value After Filtering*1	mm/s	500
3	Motor Control Effort	mm/s	500
4	Torque demand*2	% (Percentage of rated force)	33
5	Following Error Actual Value*3	Pulses (command unit)	3,000
6	Following Error Actual Internal Value*3	Pulses (encoder unit)	3,000
7 to 8	Reserved	–	–
9	P-N Voltage	V	80
10	Regeneration Load Ratio	%	33
11	Motor Load Ratio	%	33
12	Positive Force Limit	% (Percentage of rated force)	33
13	Negative Force Limit	% (Percentage of rated force)	33
14	Speed Limit Value	mm/s	500
15	Mass Ratio	%	500
16 to 19	Reserved	–	–
20	Servo Drive Temperature	°C	10
21 to 22	Reserved	–	–

*1. The Motor Velocity Demand Value is the speed before the command input passes through the command filter (smoothing filter or FIR filter). The Motor Velocity Demand Value After Filtering is the speed after the command input passes through the command filter.



*2. Read the word “torque” as “force.”

*3. The Following error actual value is calculated for the command input after processing for the position command filter. The Following Error Actual Internal Value is reversely converted to command units for application.
The Following Error Actual Internal Value is the error for the position control input.

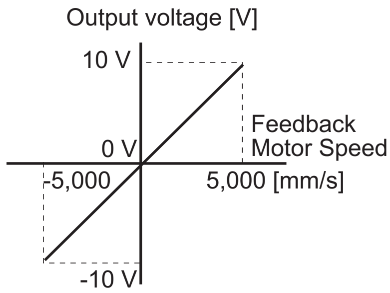
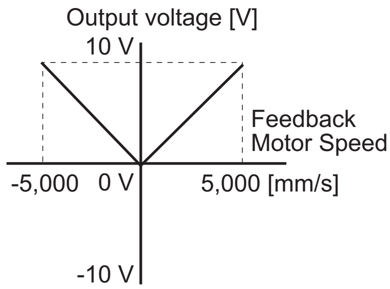
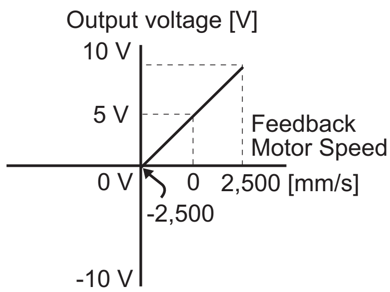


● Analog Monitor Output Setting (3421 hex)

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.

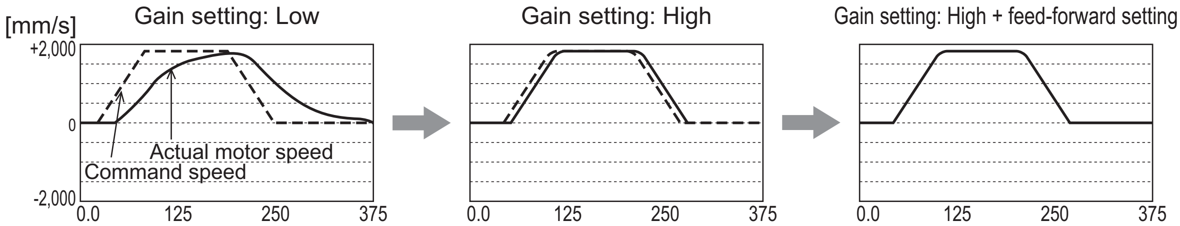
With this function, gain adjustments can be made easily even by those using a servo system for the first time.

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

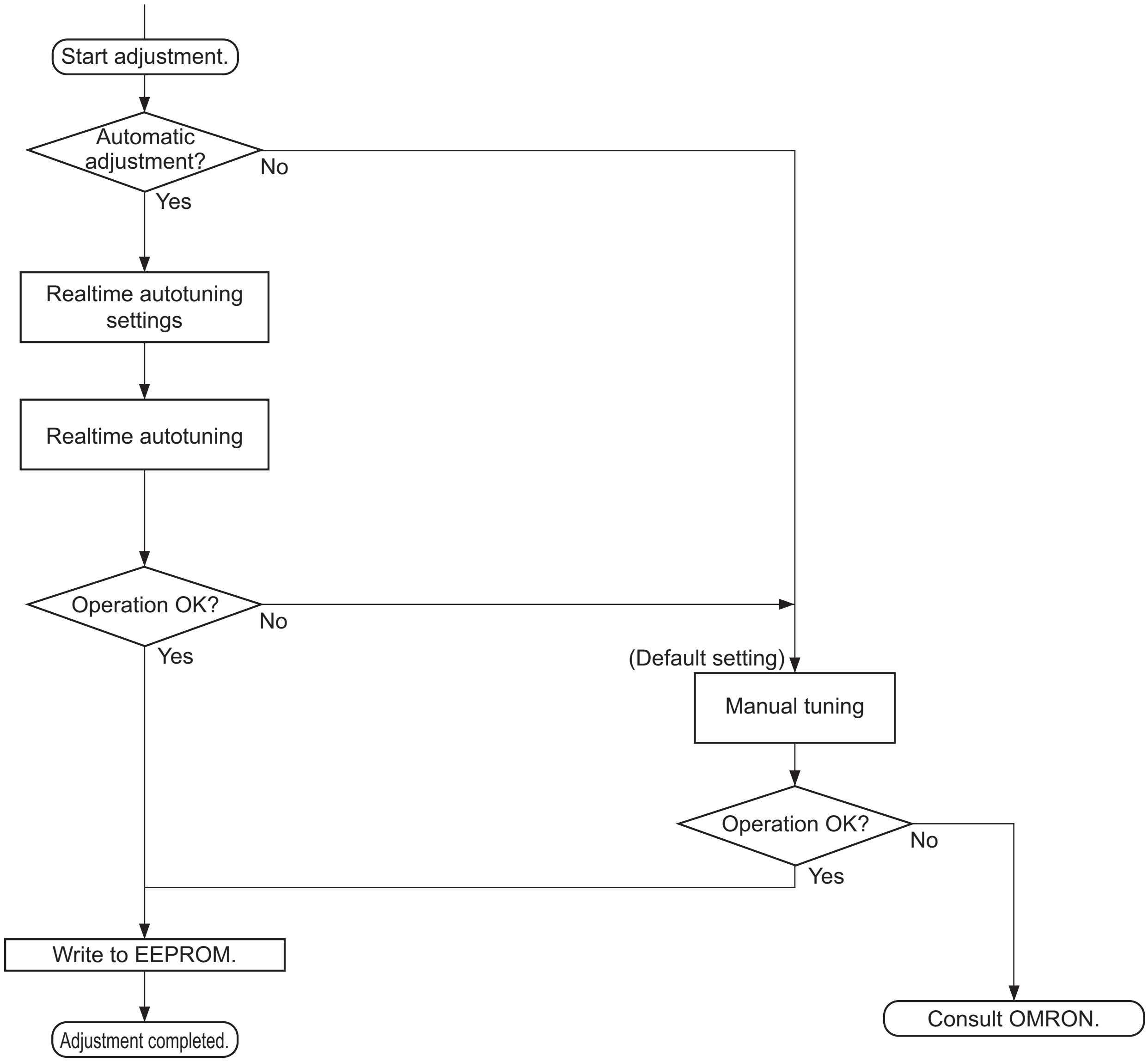
11-2-2 Gain Adjustment Methods

Function			Description	Reference
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.	P. 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.	P. 10-9
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.	P. 11-15
		Basic procedure	Position control mode adjustment	P. 11-16

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



Gain Adjustment and Machine Rigidity

To improve machine rigidity, install the machine on a secure base so that it does not have any play.

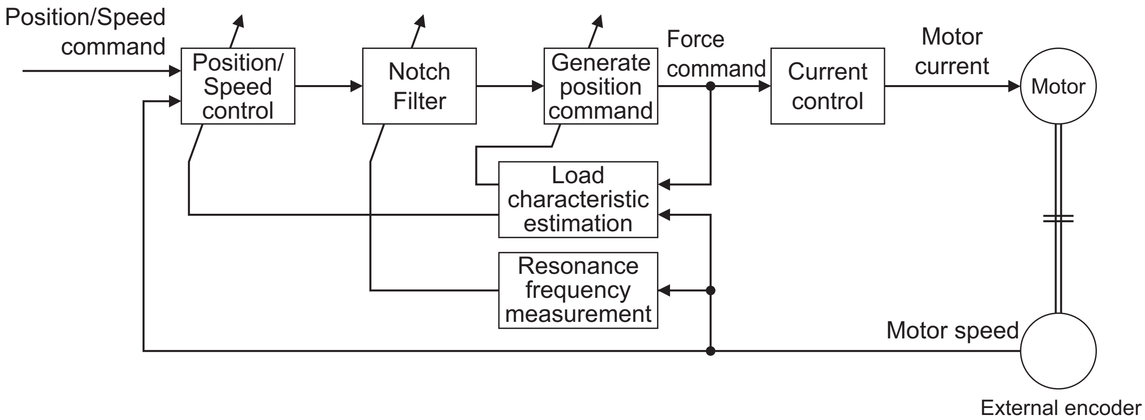
The specific vibration (resonance frequencies) of the mechanical system has a large impact on the gain adjustment of the servo. The servo system responsiveness cannot be set high for machines with a low resonance frequency (low machine rigidity).

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 11-21 for details about adaptive filters.



11-3-1 Operating Conditions

Realtime autotuning works under the following conditions.

	Operating conditions
Operation mode	The available realtime autotuning mode varies depending on the control mode.*1
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 under which realtime autotuning does not operate properly
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	Description	Reference
3002 hex	Realtime Autotuning Mode Selection	Set the operation mode for the realtime autotuning.	P. 9-4
3003 hex	Realtime Autotuning Machine Rigidity Setting	Set the responsiveness when the realtime autotuning is enabled.	P. 9-4
3631 hex	Realtime Autotuning Estimated Speed Selection	Set the speed to estimate the load characteristic while the realtime autotuning is enabled.	P. 9-51
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).	P. 9-51

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 4. Enabling the conventional gain switching function automatically sets the Switching Mode in Position Control (3115 hex) to 10 (Position command + Actual motor speed).

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.
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 Mode; 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 (3609 hex) 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.

Realtime Autotuning Object Table

Rigidity	Gain 1				Gain 2			
	3100 hex	3101 hex	3102 hex	3104 hex	3105 hex	3106 hex	3107 hex	3109 hex
	Position [0.1/s]	Speed [0.1 Hz]	Speed Integral [0.1 ms]	Force [0.01 ms]	Position [0.1/s]	Speed [0.1 Hz]	Speed*1 Integral [0.1 ms]	Force [0.01 ms]
0	20	15	3,700	1,500	25	15	10,000	1,500
1	25	20	2,800	1,100	30	20	10,000	1,100
2	30	25	2,200	900	40	25	10,000	900
3	40	30	1,900	800	45	30	10,000	800
4	45	35	1,600	600	55	35	10,000	600
5	55	45	1,200	500	70	45	10,000	500
6	75	60	900	400	95	60	10,000	400
7	95	75	700	300	120	75	10,000	300
8	115	90	600	300	140	90	10,000	300
9	140	110	500	200	175	110	10,000	200
10	175	140	400	200	220	140	10,000	200
11	320	180	310	126	380	180	10,000	126
12	390	220	250	103	460	220	10,000	103
13	480	270	210	84	570	270	10,000	84
14	630	350	160	65	730	350	10,000	65
15	720	400	140	57	840	400	10,000	57
16	900	500	120	45	1,050	500	10,000	45
17	1,080	600	110	38	1,260	600	10,000	38
18	1,350	750	90	30	1,570	750	10,000	30
19	1,620	900	80	25	1,880	900	10,000	25
20	2,060	1,150	70	20	2,410	1,150	10,000	20
21	2,510	1,400	60	16	2,930	1,400	10,000	16
22	3,050	1,700	50	13	3,560	1,700	10,000	13
23	3,770	2,100	40	11	4,400	2,100	10,000	11
24	4,490	2,500	40	9	5,240	2,500	10,000	9
25	5,000	2,800	35	8	5,900	2,800	10,000	8
26	5,600	3,100	30	7	6,500	3,100	10,000	7
27	6,100	3,400	30	7	7,100	3,400	10,000	7
28	6,600	3,700	25	6	7,700	3,700	10,000	6
29	7,200	4,000	25	6	8,400	4,000	10,000	6
30	8,100	4,500	20	5	9,400	4,500	10,000	5
31	9,000	5,000	20	5	10,500	5,000	10,000	5

*1 When the unbalanced load mode, or the friction compensation and unbalanced load mode is set for realtime autotuning, 9,999 is set before the load characteristic estimation, i.e., estimation of Mass Ratio, Force Command Value Offset, and Positive/Negative Direction Force Offset, is completed. 10.000 is set after the load characteristic estimation is completed.

11-3-5 Objects to Be Updated

This section describes the objects to be updated 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 1	Set to 0.
3108 hex	Speed Feedback Filter Time Constant 2	Set to 0.
3110 hex	Speed Feed-forward Gain	Set to 300 (30%).
3111 hex	Speed Feed-forward Command Filter	Set to 50 (0.5 ms).
3112 hex	Force Feed-forward Gain*1	Set this to 0.
3113 hex	Force Feed-forward Command Filter*1	Set this to 0.
3114 hex	Gain Switching Input Operating Mode Selection	If the current setting is “not retained,” set this to 1.
3115 hex	Switching Mode in Position Control	If gain switching is enabled, set this 10. If gain switching is disabled, set this 0.
3116 hex	Gain Switching Delay Time in Position Control	If the current setting is “not retained,” set this to 50.
3117 hex	Gain Switching Level in Position Control	If the current setting is “not retained,” set this to 50.
3118 hex	Gain Switching Hysteresis in Position Control	If the current setting is “not retained,” set this to 33.
3119 hex	Position Gain Switching Time	If the current setting is “not retained,” set this to 33.
3120 hex	Switching Mode in Speed Control	If the current setting is “not retained,” set this to 0.
3121 hex	Gain Switching Delay Time in Speed Control	If the current setting is “not retained,” set this to 0.
3122 hex	Gain Switching Level in Speed Control	If the current setting is “not retained,” set this to 0.
3123 hex	Gain Switching Hysteresis in Speed Control	If the current setting is “not retained,” set this to 0.
3124 hex	Switching Mode in Force Control	If the current setting is “not retained,” set this to 0.
3125 hex	Gain Switching Delay Time in Force Control	If the current setting is “not retained,” set this to 0.
3126 hex	Gain Switching Level in Force Control	If the current setting is “not retained,” set this to 0.
3127 hex	Gain Switching Hysteresis in Force Control	If the current setting is “not retained,” set this 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, or 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, G5-series Servo Drives 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 Motor Velocity Actual Value, Motor Velocity Demand Value, Force Command, and Following Error Actual Value can be measured as an analog voltage level using an oscilloscope or other device.

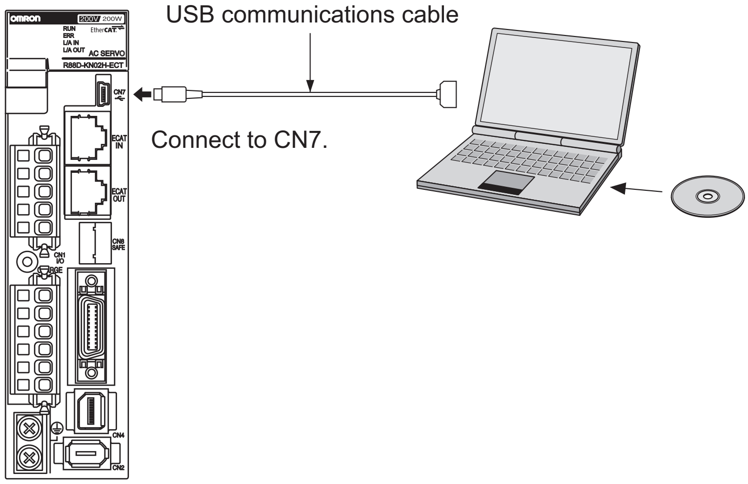
The type of signal to output and the output voltage level are set with Analog Monitor 1 Selection (3416 hex) and Analog Monitor 2 Selection (3418 hex) settings.

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, Force Command, and Following Error Actual Value) can be displayed on a computer as waveforms.

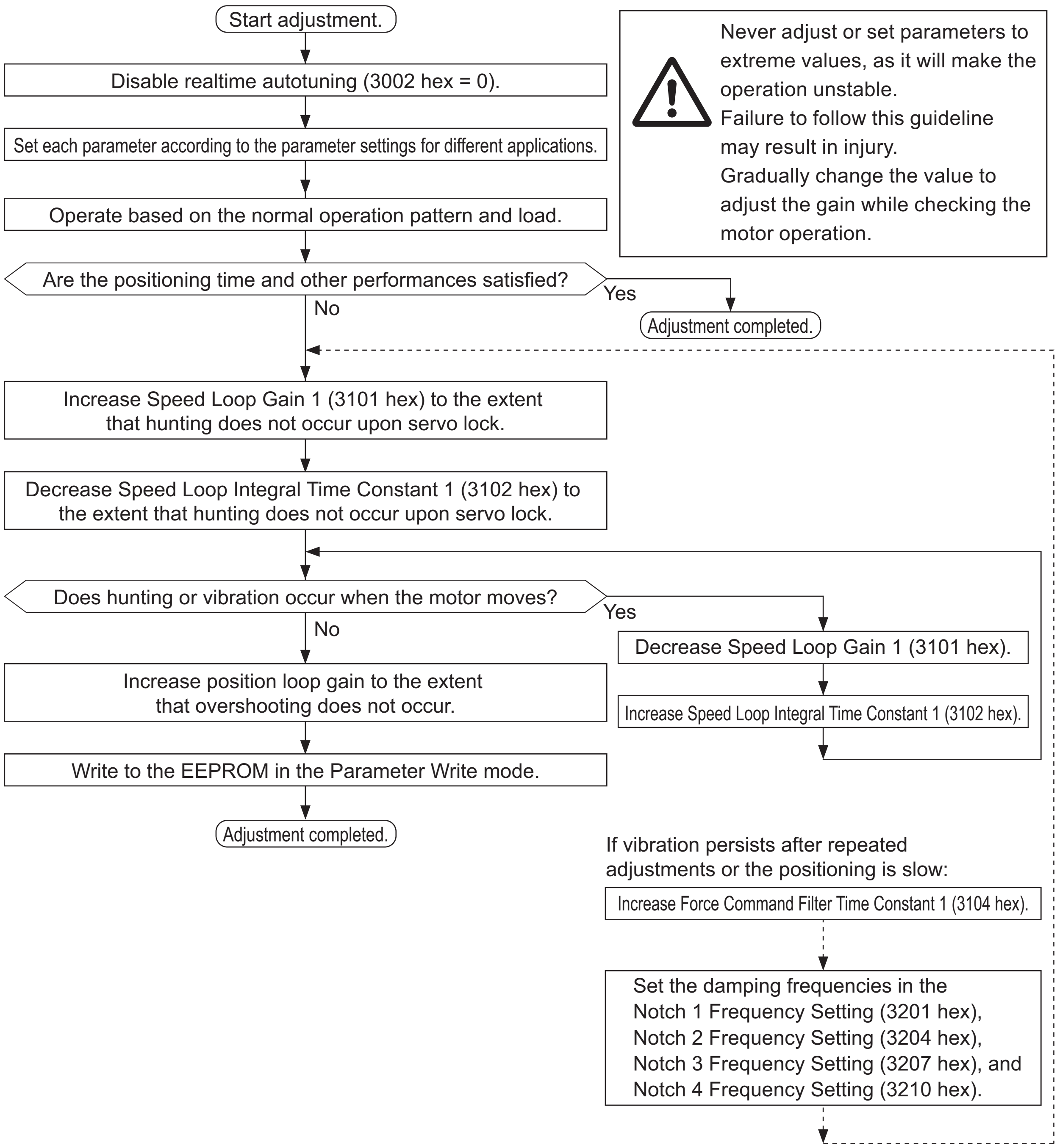
Refer to the CX-Drive Operation Manual (Cat. No. W453).



11-4-2 Position Control Mode Adjustment

Use the following procedure to perform the adjustment in position control for the Servo Drive.

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.

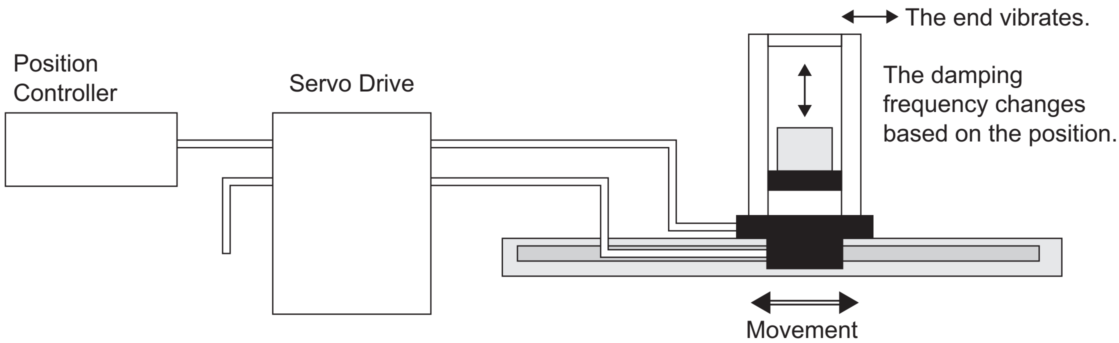


11-5 Damping Control

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 condition.

	Operating Condition
Operation mode	Position control mode

Precautions for Correct Use

- Stop operation before changing the objects or switching with DFSEL.
- The damping control function may not function properly or the effect may not be apparent under the following conditions.

	Conditions under which damping control is blocked
Load condition	• If causes 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	P. 9-21
3214 hex	Damping Frequency 1	Set damping frequency 1 to suppress vibration at the end of the load in damping control. Measure the frequency of vibration 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	P. 9-22
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. They are normally set to 0.	P. 9-22
3216 hex	Damping Frequency 2	Set damping frequency 2 to suppress vibration at the end of the load in damping control. The function the same with the Damping Frequency 1 (3214 hex).	P. 9-22
3217 hex	Damping Filter 2 Setting	The function the same with the Damping Filter 1 Setting (3215 hex).	P. 9-22
3218 hex	Damping Frequency 3	Set damping frequency 3 to suppress vibration at the end of the load in damping control. The function the same with the Damping Frequency 1 (3214 hex).	P. 9-23
3219 hex	Damping Filter 3 Setting	The function the same with the Damping Filter 1 Setting (3215 hex).	P. 9-23
3220 hex	Damping Frequency 4	Set damping frequency 4 to suppress vibration at the end of the load in damping control. The function the same with the Damping Frequency 1 (3214 hex).	P. 9-23
3221 hex	Damping Filter 4 Setting	The function the same with the Damping Filter 1 Setting (3215 hex).	P. 9-23

*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 filter switch wait time expires 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.

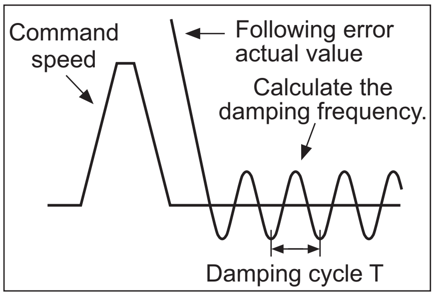
2 **Measure the damping frequency at the tip of the mechanical unit.**

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 Following Error Actual Value 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

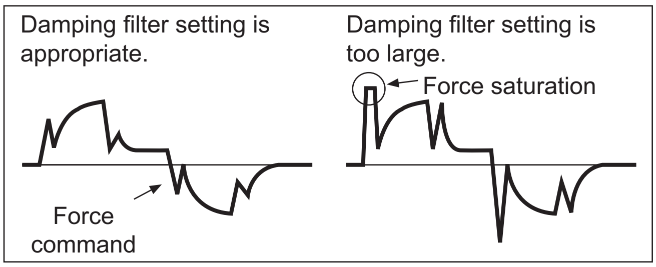
If the damping cycle is 100 ms or 20 ms, set 100 or 500 in the object so that the damping frequency becomes 10 Hz or 50 Hz.

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 a Damping Frequency is set, reduce this setting if force saturation occurs or increase this setting to increase operation speed. 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. (✓: Enabled/–: Disabled)

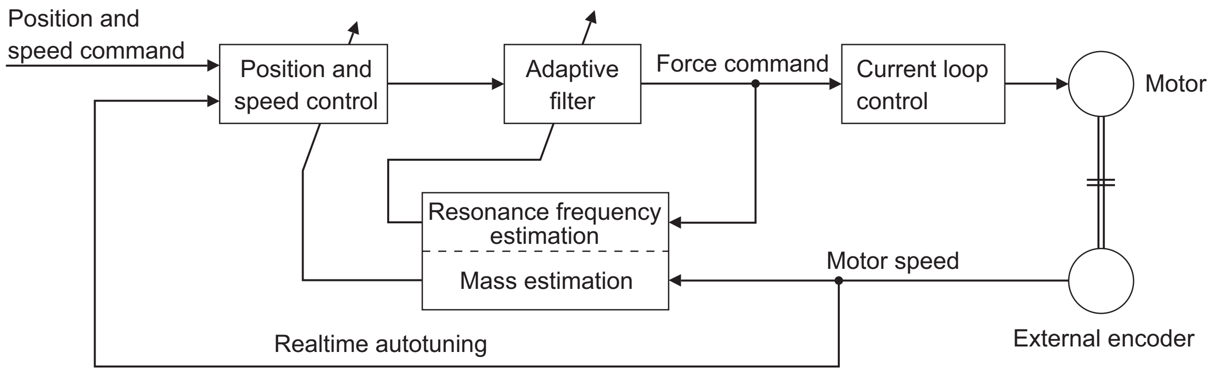
Direction of position command	Damping filter 1	Damping filter 2	Damping filter 3	Damping filter 4
Positive	✓	–	✓	–
Negative	–	✓	–	✓

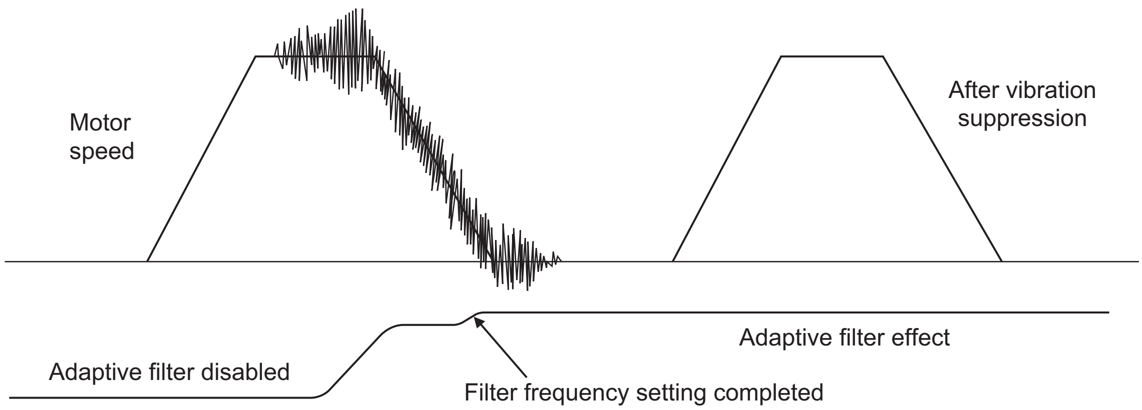
11-6 Adaptive Filter

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 11-24 for information on notch filter.





11-6-1 Operating Conditions

The adaptive filter operates under the following conditions.

	Operating conditions
Operation mode	Position Control Mode, Speed 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. • Adaptive operation is disabled when magnetic pole position estimation is in progress.

Precautions for Correct Use

- The 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 conditions	• 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 the notch 1 (3201 to 3203 hex) or notch 2 (3204 to 3206 hex) settings to reduce resonance according to the manual adjustment procedure.
  For details on the notch filter function, refer to *11-7 Notch Filters* on page 11-24.

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.	P. 9-18

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 5,000 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 5,000 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 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.
  - 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) to 5,000 (disabled). Next, enable 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.

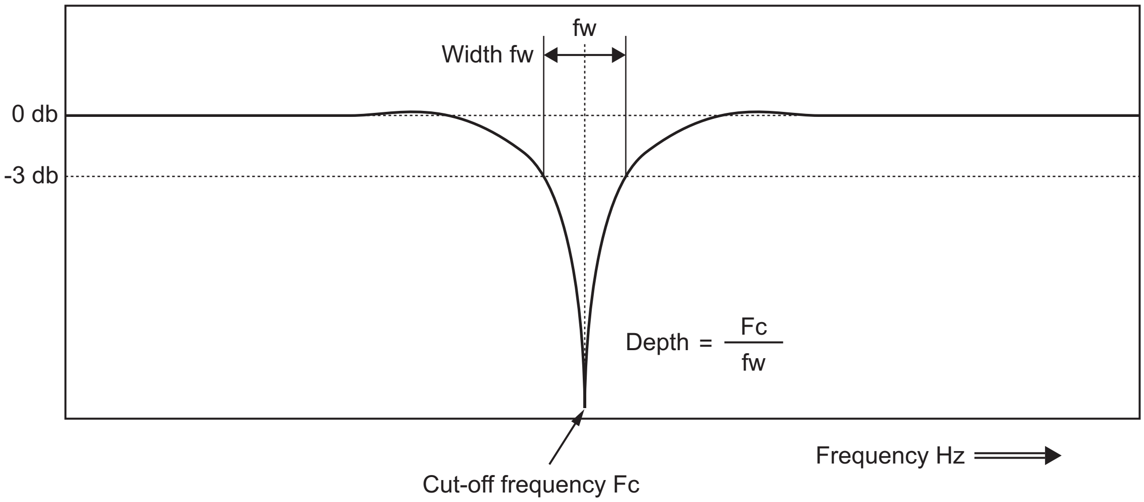
11-7 Notch Filters

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.

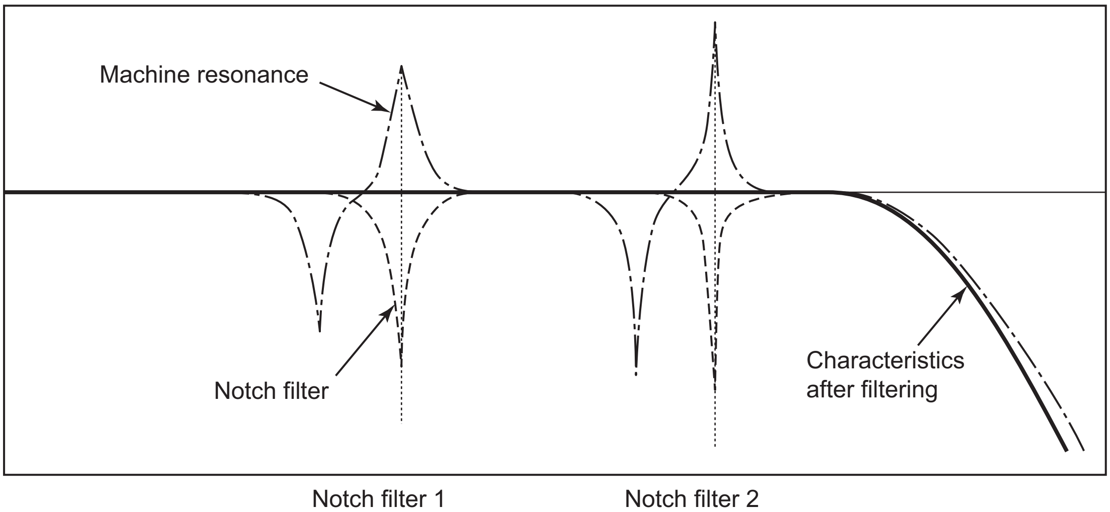
The G5-series Servo Drives provide four notch filters that can be used for adjusting frequency, width and depth.

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.	P. 9-18
3202 hex	Notch 1 Width Setting	Select the width of the notch filter 1 frequency. Increasing the set value widens the notch width. The setting range is between 0 and 20.	P. 9-18
3203 hex	Notch 1 Depth Setting	Select the depth of the notch filter 1 center frequency. Increasing the set 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.	P. 9-19
3204 hex	Notch 2 Frequency Setting	Set the center frequency of notch filter 2. The details are the same with the notch filter 1 frequency.	P. 9-19
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.	P. 9-19
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.	P. 9-19
3207 hex	Notch 3 Frequency Setting*1	Set the center frequency of notch filter 3. The details are the same with the notch filter 1 frequency.	P. 9-20
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.	P. 9-20
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.	P. 9-20
3210 hex	Notch 4 Frequency Setting*2	Set the center frequency of notch filter 4. The details are the same with the notch filter 1 frequency.	P. 9-20
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.	P. 9-21
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.	P. 9-21

*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

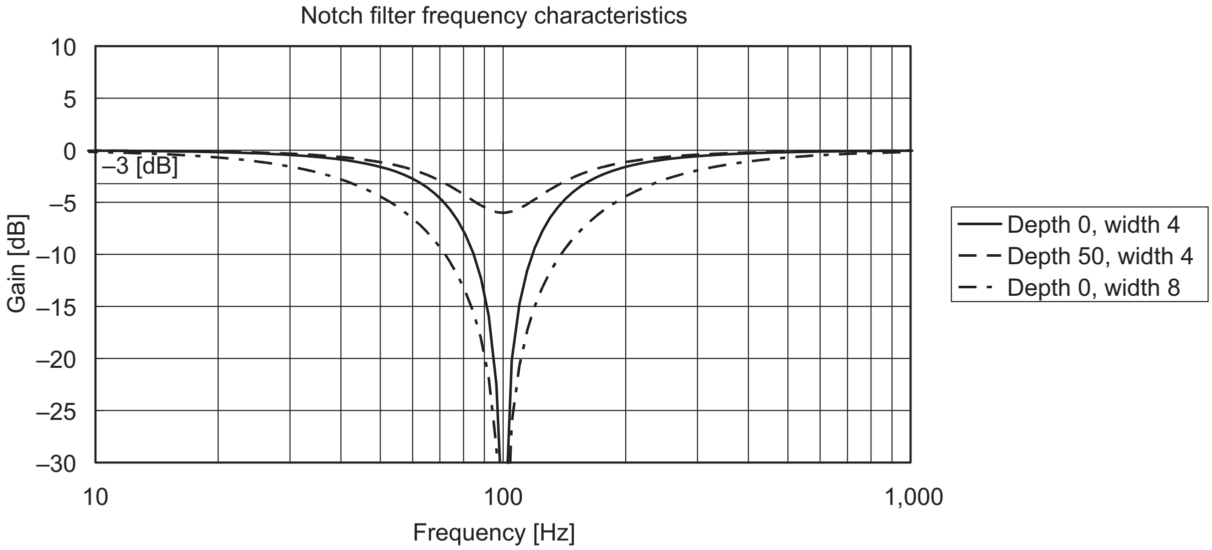
This is the ratio of the frequency bandwidth at a damping factor of -3 [dB] relative to the center frequency when the depth is “0.” This value should conform to the left column in the table below.

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.

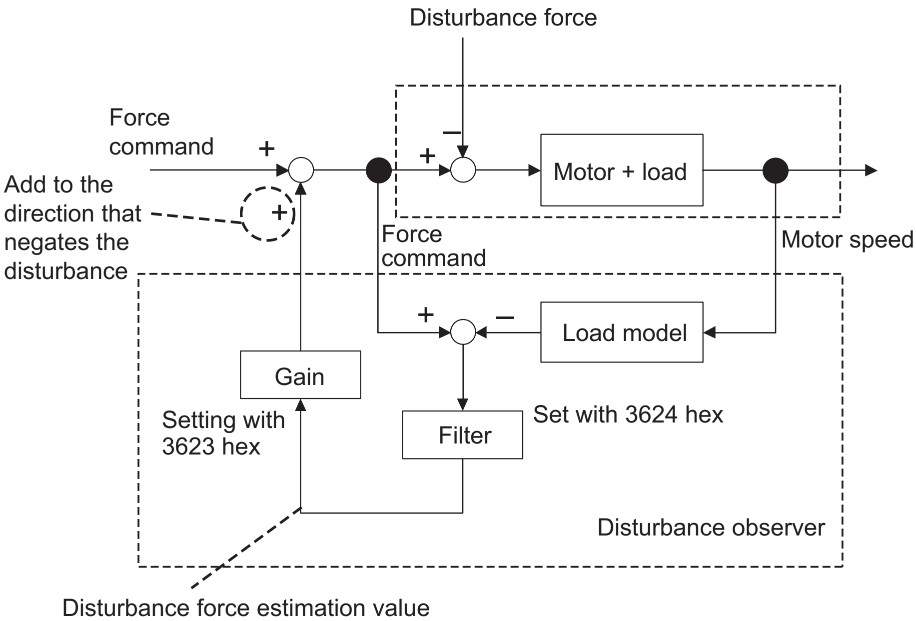
Width	
Set value	**Bandwidth/center frequency**
0	0.50
1	0.59
2	0.71
3	0.84
4	1.00
5	1.19
6	1.41
7	1.68
8	2.00
9	2.38
10	2.83
11	3.36
12	4.00
13	4.76
14	5.66
15	6.73
16	8.00
17	9.51
18	11.31
19	13.45
20	16.00

Depth		
Set value	**I/O ratio [%]**	**Damping factor [dB]**
0	0 (Cut off)	∞
1	1	-40.0
2	2	-34.0
3	3	-30.5
4	4	-28.0
5	5	-26.0
10	10	-20.0
15	15	-16.5
20	20	-14.0
25	25	-12.0
30	30	-10.5
35	35	-9.1
40	40	-8.0
45	45	-6.9
50	50	-6.0
60	60	-4.4
70	70	-3.1
80	80	-1.9
90	90	-0.9
100	100 (Passed)	0.0


Notch filter frequency characteristics
10
5
0
–3 [dB]
–5
–10
–15
–20
–25
–30
Gain [dB]
10
100
1,000
Frequency [Hz]
Depth 0, width 4
Depth 50, width 4
Depth 0, width 8

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 situations.

	Operating conditions
Operation mode	Position Control Mode, Speed 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. • 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 conditions	• 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 Setting	Set the bits related to the disturbance observer.	P. 9-48
3623 hex	Disturbance Force Compensation Gain	Set the compensation gain for disturbance force.	P. 9-50
3624 hex	Disturbance Observer Filter Setting	Set the filter time constant for disturbance force compensation.	P. 9-50

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: Always updated
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 Force 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 Torque 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
Operation mode	The operating mode depends on the control mode.*1
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.

*1 Refer to *11-9-2 Objects Requiring Settings* on page 11-30 for details.

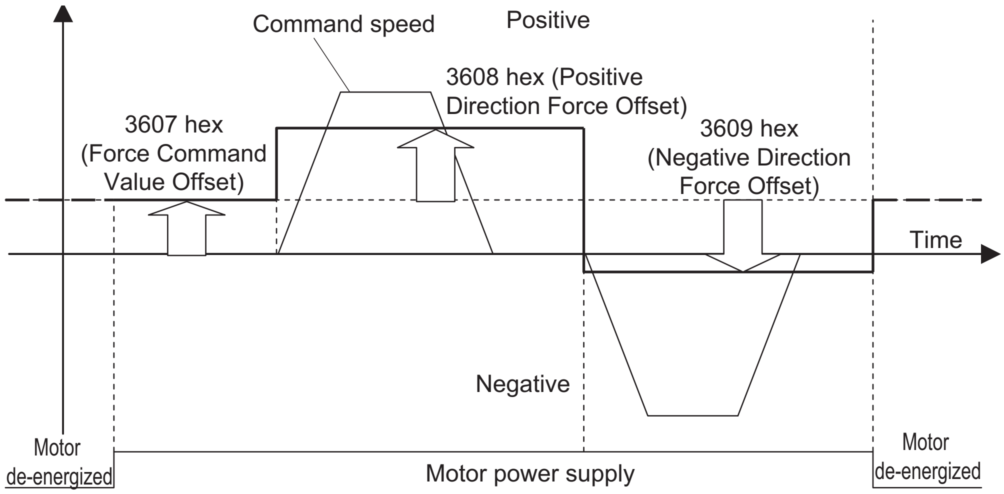
11-9-2 Objects Requiring Settings

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.	P. 9-47
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.	P. 9-47
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.	P. 9-48

11-9-3 Operating Procedure

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. Setting this object helps 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), set the friction force in each operating direction for loads that require a large amount of dynamic friction force. This helps 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).

11-10 Feed-forward Function

The feed-forward function come in 2 types: speed feed-forward and force feed-forward.

The speed feed-forward can minimize the Following Error Actual Value 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.	P. 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.	P. 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.	P. 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.	P. 9-11
60B1 hex	Velocity offset	Set the offset for the speed command. It will be added to the Control effort (60FA hex).	P. A-68
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.	P. A-69

11-10-2 Operating Procedure

Speed Feed-forward Operating Method

1 **Set the Speed Feed-forward Command Filter (3111 hex).**

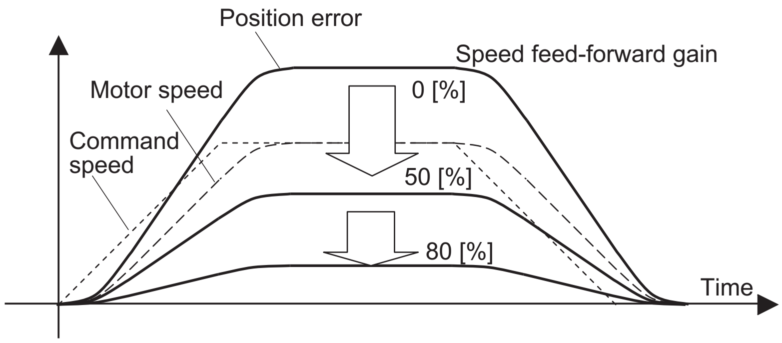
Set the Speed Feed-forward Command Filter (3111 hex) to approximately 50 (0.5 ms).

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 Following error actual value during an operation at a certain speed will decrease based on the following formula according to the speed feed-forward gain value.

$$\text{Position error [command unit]} = \frac{\text{Command speed [command unit/s]}}{\text{Position loop gain [1/s]}} \times \frac{(100 - \text{Speed feed-forward gain [\%]})}{100}$$



The Following Error Actual Value 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 Following Error Actual Value 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.

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.

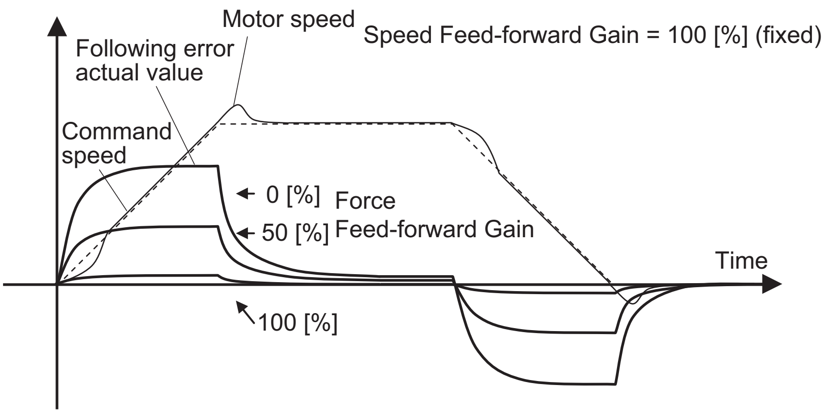
2 **Set the Force Feed-forward Command Filter (3113 hex).**

Set the Force Feed-forward Command Filter (3113 hex) to approximately 50 (0.5 ms).

3 **Gradually increase the value of 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 Following Error Actual Value during acceleration/deceleration at a constant speed to close to 0. This enables the Following Error Actual Value to be controlled to almost 0 throughout the entire operation range during a trapezoidal speed pattern under ideal conditions where no disturbance torque is working.

In reality, disturbance force is always applied and therefore the Following Error Actual Value cannot be completely “0.”



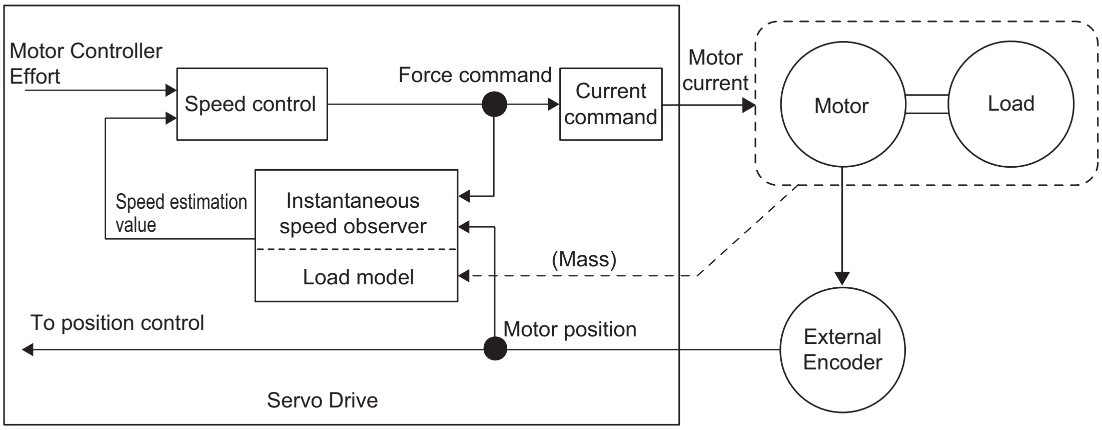
Force feed-forward can reduce the Following Error Actual Value in a range of constant acceleration/deceleration.

Precautions for Correct Use

- If you increase the Force Feed-forward Command Filter time constant, the operation noise will be reduced. However, the Following Error Actual Value 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) 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 situations.

	Operating conditions
Operation mode	Position Control Mode, Speed 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. • 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 function properly or the effect may not be apparent under the following conditions.

	Conditions that interfere with the adaptive filter
Load conditions	• 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.	P. 9-5
3100 hex	Position Loop Gain 1	Set The Position Loop Gain 1.	P. 9-7
3101 hex	Speed Loop Gain 1	Set The Speed Loop Gain 1.	P. 9-8
3610 hex	Function Expansion Setting,	Set whether to enable or disable the instantaneous observer function.	P. 9-48

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 Following Error Actual Value 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 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 to 400 W	Single-phase 100 to 120 VAC (85 to 132 VAC) 50/60 Hz
R88D-KN☐H-ECT-L	100 W to 1.5 kW	Single-phase 200 to 240 VAC (170 to 264 VAC) 50/60 Hz
	750 W to 1.5 kW	3-phase 200 to 240 VAC (170 to 264 VAC) 50/60 Hz
R88D-KN☐F-ECT-L	750 W to 3 kW	3-phase 380 to 480 VAC (323 to 528 VAC) 50/60 Hz

Control Circuit Power Supply Input Terminals (L1C, L2C)

Model	Capacity	Power supply voltage
R88D-KN☐L-ECT-L	100 to 400 W	Single-phase 100 to 120 VAC (85 to 132 VAC) 50/60 Hz
R88D-KN☐H-ECT-L	100 W to 1.5 kW	Single-phase 200 to 240 VAC (170 to 264 VAC) 50/60 Hz
R88D-KN☐F-ECT-L	750 W to 3 kW	24 VDC (21.6 to 26.4 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.

- 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 12-13 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 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 Linear Motor or Servo Drive

Use the following procedure to replace the Linear Motor or Servo Drive.

Replacing the Linear Motor

Remove the Linear Motor by reversing the Motor installation procedure.

Precautions for Correct Use

- Disconnect all the cables connected to the Linear Motor in advance.
- Be very careful of the magnetic attraction force when removing the Magnet Track units.

1. **Move the Motor Coil Unit to one side of the Liner Slider.**
2. **Remove the Magnet Track units on the side where the Motor Coil Unit is not located.**
3. **Move the Motor Coil Unit to the side of the Liner Slider, where the Magnet Track units were removed.**
4. **To avoid problems caused by the magnetic attraction force, remove the Motor Coil Unit on the side where no Magnet Track units are present.**
5. **Remove the remaining Magnet Track units in order, starting from the end of the Linear Slider.**
6. **Install a new Motor according to the Linear Motor installation procedure.**

Replacing 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

<table>
<tr><th colspan="2">Index</th><th>Name</th><th>Description</th><th>Reference</th></tr>
<tr><td colspan="2">3440 hex</td><td>Warning Output Selection 1</td><td>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 12-6.</td><td>P. 9-40</td></tr>
<tr><td colspan="2">3441 hex</td><td>Warning Output Selection 2</td><td>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 12-6.</td><td>P. 9-40</td></tr>
<tr><td colspan="2">3638 hex</td><td>Warning Mask Setting</td><td>Set a mask for warning detection. If you set the corresponding bit to “1”, the detection of the corresponding warning is disabled.
For details, refer to 12-2-2 Warning List on page 12-6.</td><td>P. 9-53</td></tr>
<tr><td rowspan="2">3759 hex</td><td>bit 0</td><td>Warning Hold Selection for Communications-related Warnings</td><td rowspan="2">Select whether to hold servo-related and communications-related warning state.
0: Do not hold
1: Hold</td><td rowspan="2">P. 9-56</td></tr>
<tr><td>bit 1</td><td>Warning Hold Selection for General Warnings</td></tr>
<tr><td colspan="2">3781 hex</td><td>Data Setting Warning Detection Setting</td><td>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.</td><td>P. 9-57</td></tr>
<tr><td colspan="2">3800 hex</td><td>Communications Control</td><td>Controls errors and warnings related to EtherCAT communications.
If you set the corresponding bit to “1”, the detection of the corresponding warning is disabled.</td><td>P. 9-57</td></tr>
</table>

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 hold 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 more communications errors in series than the specified value.	✓	10	bit 10

*1 The check mark symbol (✓) in the above table means that you can switch between the “Do not hold (for 1 s)” and “Hold” warning statuses in the Warning Hold Selection (3759 hex). Life Expectancy Warning is fixed to “Hold.”

*2 Set the Warning Output Selection 1 (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 corresponding bits are shown in the table. 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." • An Enable Operation command was sent to request turning ON the Servo when 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.	✓	12	bit 5
		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.			
B2 hex	EtherCAT Communications Warning*4	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 1 (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 corresponding bits are shown in the table. When the bit is set to "1," the warning detection is masked.

*4 This warning also occurs when the power supply for the master is turned OFF with EtherCAT communications established. Therefore, if you turn OFF a G5-series Servo Drive immediately after the power supply for the master is turned OFF, a diagnosis message may be left in the Diagnosis History.

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 12-13 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. For details, refer to *12-3-1 Error List* on page 12-9.
- An Overload Error (Error No. 16) cannot be reset for 10 seconds after it occurs.
- If “hh,” “ㅋㅋ,” 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.		Error detection function	Attribute		
Main	Sub		History	Can be reset	Deceleration method *1
11 hex	0 hex	Control Power Supply Undervoltage	–	✓	B
12 hex	0 hex	Overvoltage	✓	✓	B
13 hex	0 hex	Main Power Supply Undervoltage (insufficient voltage between P and N)	–	✓	B
	1 hex	Main Power Supply Undervoltage (AC cutoff detected)	–	✓	B
14 hex	0 hex	Overcurrent	✓	–	B
	1 hex	IPM Error	✓	–	B
15 hex	0 hex	Servo Drive Overheat	✓	–	A
16 hex	0 hex	Overload	✓	✓ *2	B
18 hex	0 hex	Regeneration Overload	✓	–	A
	1 hex	Regeneration Tr Error	✓	–	B
24 hex	0 hex	Following Error Counter Overflow	✓	✓	A
	1 hex	Excessive Speed Deviation Error	✓	✓	A
26 hex	0 hex	Overspeed	✓	✓	A
	1 hex	Overspeed 2	✓	✓	B
27 hex	4 hex	Command Error	✓	–	B
	5 hex	Command Generation Error	✓	–	B
	6 hex	Operation Command Duplicated	✓	✓	B
	7 hex	Position Data Initialized	–	✓	B
29 hex	1 hex	Following Error Counter Overflow 1	✓	–	B
	2 hex	Following Error Counter Overflow 2	✓	–	B
30 hex	0 hex	Safety Input Error	–	✓	B

Error No.		Error detection function	Attribute		
Main	Sub		History	Can be reset	Deceleration method *1
33 hex	0 hex	Interface Input Duplicate Allocation Error 1	✓	–	B
	1 hex	Interface Input Duplicate Allocation Error 2	✓	–	B
	2 hex	Interface Input Function Number Error 1	✓	–	B
	3 hex	Interface Input Function Number Error 2	✓	–	B
	4 hex	Interface Output Function Number Error 1	✓	–	B
	5 hex	Interface Output Function Number Error 2	✓	–	B
	8 hex	External Latch Input Allocation Error	✓	–	B
34 hex	0 hex	Overrun Limit Error	✓	✓	B
36 hex	0 hex to 2 hex	Object Error	–	–	B
37 hex	0 hex to 2 hex	Object Corrupted	–	–	B
38 hex	0 hex	Drive Prohibition Input Error 1	–	✓	B
	1 hex	Drive Prohibition Input Error 2	–	✓	B
50 hex	0 hex	External Encoder Connection Error	✓	–	B
	1 hex	External Encoder Communications Data Error	✓	–	B
51 hex	0 hex	External Encoder Status Error 0	✓	–	B
	1 hex	External Encoder Status Error 1	✓	–	B
	2 hex	External Encoder Status Error 2	✓	–	B
	3 hex	External Encoder Status Error 3	✓	–	B
	4 hex	External Encoder Status Error 4	✓	–	B
	5 hex	External Encoder Status Error 5	✓	–	B
55 hex	0 hex	Phase-A Connection Error	✓	–	B
	1 hex	Phase-B Connection Error	✓	–	B
	2 hex	Phase-Z Connection Error	✓	–	B
60 hex	0 hex	Motor Setting Error	–	–	B
	1 hex	Motor Combination Error 1	–	–	B
	2 hex	Motor Combination Error 2	–	–	B
61 hex	0 hex	Magnetic Pole Position Estimation Error 1	✓	✓	B
	1 hex	Magnetic Pole Position Estimation Error 2	✓	✓	B
	2 hex	Magnetic Pole Position Estimation Error 3	–	–	B
83 hex	1 hex	EtherCAT State Change Error	✓	✓ *3	B
	2 hex	EtherCAT Illegal State Change Error	✓	✓ *3	B
	3 hex	Communications Synchronization Error	✓	✓ *3	B
	4 hex	Synchronization Error	✓	✓ *3	B
	5 hex	Sync Manager WDT Error	✓	✓ *3	B
87 hex	0 hex	Immediate Stop Input Error	–	✓	B
88 hex	0 hex	Node Address Setting Error	✓	–	B
	1 hex	ESC Initialization Error	✓	–	B
	2 hex	Interruptions Error	✓	–	B
	3 hex	SII Verification Error	✓	–	B
90 hex	0 hex	External Communications Setting Error	✓	✓ *3	B
91 hex	1 hex	Command Error	✓	✓	B

Error No.		Error detection function	Attribute		
Main	Sub		History	Can be reset	Deceleration method *1
93 hex	0 hex	Object Setting Error 1	✓	–	B
	3 hex	External Encoder Connection Error	✓	–	B
	4 hex	Function Setting Error	✓	✓	B
99 hex	0 hex	Other errors	✓	–	B
Other numbers					

*1 Deceleration method: When the Fault reaction option code (605E hex) is set to -4 to -7, the stop distance differs depending on the error number. However, any error that will occur during magnetic pole position estimation causes operation B.
For details, refer to *Fault reaction option code* on page A-92.

*2 This error cannot be reset for 10 seconds after it occurs.

*3 Communications Errors (Error No. 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,” “ヨヨ,” 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

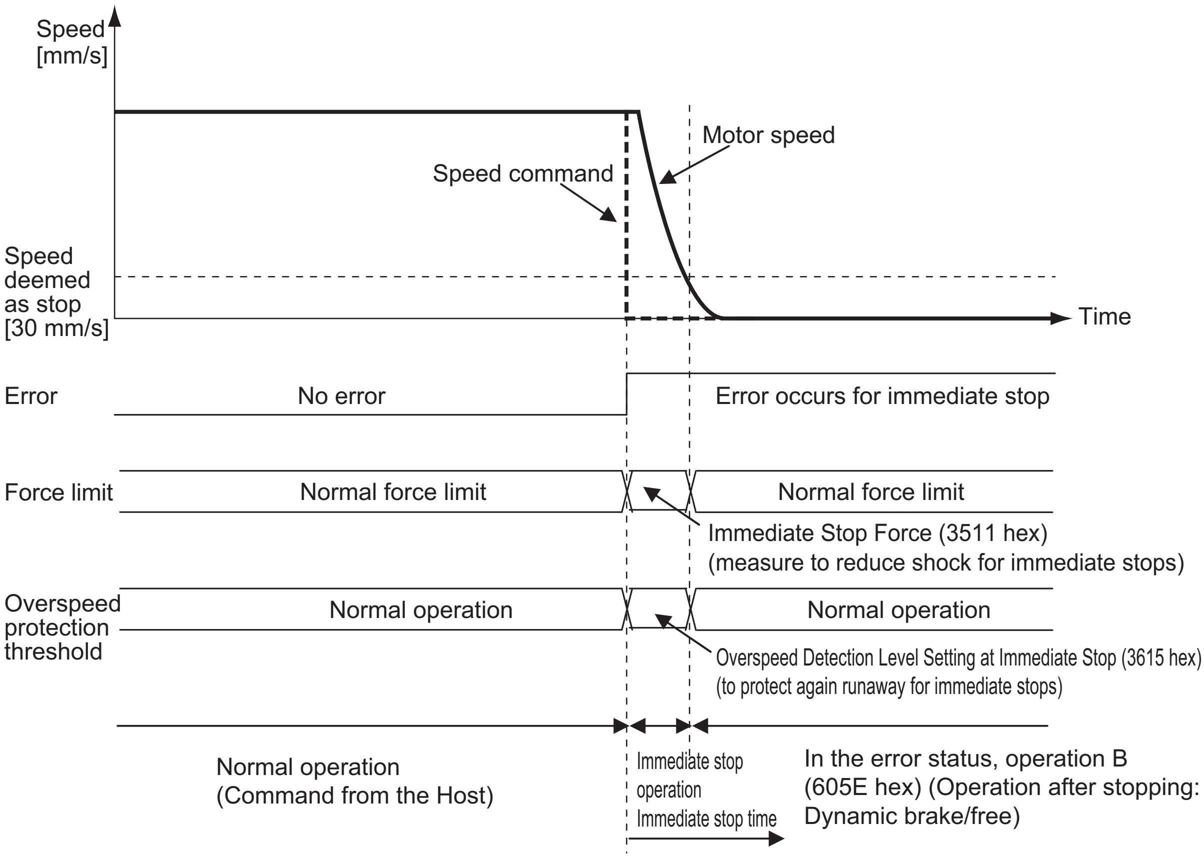
The immediate stop function controls the motor and stop it if an error that causes an immediate stop (Deceleration method: operation A) occurs.

For the applicable errors, refer to *12-3-1 Error List* on page 12-9. This function applies to those errors that are indicated as “A” in the Deceleration method column.

Related Objects

Index	Name	Description	Reference
605E hex	Fault reaction option code	Set the state during deceleration and after stopping for when an error occurs.	P. A-61
3511 hex	Immediate Stop Force	Set the force limit for immediate stops.	P. 9-43
3614 hex	Error Detection Allowable Time Setting	Set the allowable time until stopping if an immediate stop is executed when an error is detected.	P. 9-49
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.	P. 9-50

Immediate Stop Operation



Precautions for Correct Use

- To prevent operation from running out of control for an immediate stop, set an allowable overspeed value in Overspeed Detection Level Setting at Immediate Stop (3615 hex). An Overspeed 2 Error (Error No. 26.1) does not cause an immediate stop, therefore if this occurs, the motor will switch to operation B (605E hex).
- 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 speed is not lower than 30 mm/s after the time set in the Error Detection Allowable Time Setting (3614 hex) elapses from when an error that causes the operation A occurs, the deceleration method switches to the operation B.
- If an error that causes the operation B also occurs during deceleration with the operation A, the operation B has a priority as the deceleration method.

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. Main	Error No. Sub	Name	Cause	Measures
11 hex	0 hex	Control Power Supply Undervoltage	The voltage between the positive and negative terminals in the control power supply converter dropped below the specified value.	Measure the voltage between the L1C and L2C lines on the connectors and the terminal block.
			• The power supply voltage is low. A momentary power interruption occurred.	• Increase the power supply voltage. Change the power supply.
			• Insufficient power supply capacity: the power supply voltage dropped because there was inrush current when the main power supply was turned ON.	• Increase the power supply capacity.
			• The Servo Drive is faulty (circuit fault).	• Replace the Servo Drive.
12 hex	0 hex	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).	Measure the voltage between the connector (L1, L2, and L3) lines. Input the correct voltage. Remove the phase advance capacitor.
			• The Regeneration Resistor wiring is broken.	• 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.
			• The External Regeneration Resistor is inappropriate and cannot absorb all of the regenerative energy. The load mass is too large.	• 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.)
			• The Servo Drive is faulty (circuit fault).	• Replace the Servo Drive.

Error No.		Name	Cause	Measures
Main	Sub			
13 hex	0 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 (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.	Measure the voltage between the connector (L1, L2, and L3) lines.
			• The power supply voltage is low.	• 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 hex	Main Power Supply Undervoltage (AC interruption detected)	• A momentary power interruption occurred.	• Check the setting of the Momentary Hold Time (3509 hex). Set each phase of the power supply correctly.
			• Insufficient power supply capacity: the power supply voltage dropped because there was inrush current when the main power supply was turned ON.	• Increase the power supply capacity.
			• Phase-failure: a Servo Drive with 3-phase input specifications was operated with single-phase power supply.	• 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.
			• The Servo Drive is faulty (circuit fault).	• Replace the Servo Drive.

Error No.		Name	Cause	Measures
Main	Sub			
14 hex	0 hex	Overcurrent	The current flowing through the converter exceeded the specified value.	
			• The Servo Drive is faulty (faulty circuit, faulty IGBT part, etc.).	• Disconnect the motor cable, and turn ON the servo. If the problem immediately recurs, replace the Servo Drive with a new one.
			• The motor cable is short-circuited between phases U, V, and W.	• 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.
			• The motor cable is ground-faulted.	• 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.
			• Motor windings are burned out.	• Check the balance between the resistance of each wire of the motor. If resistance is unbalanced, replace the motor.
	1 hex	IPM Error	• The motor wiring contacts are faulty.	• Check for missing connector pins in motor connections U, V, and W. If any loose or missing connector pins are found, secure them firmly.
			• The relay for the dynamic brake has been welded due to frequent servo ON/OFF operations.	• Replace the Servo Drive. Do not start or stop the system by turning the servo ON or OFF.
			• The motor is not suitable for the Servo Drive.	• Check model (capacity) of the motor and the Servo Drive on the nameplates. Replace the motor with 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.
			• The resistance of the connected External Regeneration Resistor is less than the minimum allowable value.*1	• Connect an External Regeneration Resistor whose resistance is more than the minimum allowable value.*2
15 hex	0 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.	• Improve the ambient temperature and the cooling conditions of the Servo Drive.
			• Overload	• Increase the capacities of the Servo Drive and the motor. Set longer acceleration and deceleration times. Reduce the load.

Error No.		Name	Cause	Measures
Main	Sub			
16 hex	0 hex	Overload *3	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).	Check if force (current) waveforms oscillate or excessively fluctuate vertically during analog output or communications. Check the overload warning display and the load rate through communications.
			• The load was heavy, the effective force exceeded the rated force, and operation continued too long.	• Increase the capacities of the Servo Drive and the motor. Set longer acceleration and deceleration times. Reduce the load.
			• Vibration or hunting occurred due to faulty gain adjustment. The motor vibrates or makes unusual noise. The Mass Ratio (3004 hex) setting is faulty.	• Readjust the gain.
			• The motor wiring is incorrect or broken.	• Connect the motor cable as shown in the wiring diagram. Replace the cable.
			• The machine was hit by an object, or the machine load suddenly became heavy. The machine was distorted.	• Remove the distortion from the machine. Reduce the load.
			• The brake remains ON.	• Measure the voltage at the brake terminals. Turn OFF the brake.
			• When multiple machines were wired, the wiring was incorrect and the motor cable to was connected to a motor for another axis.	• Wire the motor and the external encoder correctly so that the wires match the axes.
18 hex	0 hex	Regeneration Overload *4	The regenerative energy exceeds the processing capacity of the Regeneration Resistor.	Check the load rate of the Regeneration Resistor through communications. This Regeneration Resistor cannot be used for continuous regenerative braking.
			• 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.	• 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.
			• The motor speed is too high to absorb the regenerative energy within the specified deceleration time.	• 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. Reduce the motor speed. Use an External Regeneration Resistor.
			• The operating limit of the external resistor is limited to a 10% duty.	• Set the Regeneration Resistor Selection (3016 hex) to "2."
	1 hex	Regeneration Tr Error	The Servo Drive regeneration drive Tr is faulty.	Replace the Servo Drive.

Error No. Main	Error No. Sub	Name	Cause	Measures
24 hex	0 hex	Following Error Counter Overflow	Position error pulses exceeded the setting of the Following error window (6065 hex). • Motor operation does not follow the command.	• Check to see if the 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. Lengthen the acceleration and deceleration times. Reduce the load and the speed.
			• The value of the Following error window (6065 hex) is small.	• Increase the set value of object 6065 hex.
	1 hex	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). *5	• Increase the value set in the Excessive Speed Deviation Setting (3602 hex). • 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 hex	0 hex	Overspeed	The motor speed exceeded the value set in the Overspeed Detection Level Setting (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 correctly as shown in the wiring diagram.
	1 hex	Overspeed 2	The motor speed exceeded the value set on Overspeed Detection Level Setting at Immediate Stop (3615 hex).	
27 hex	4 hex	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 hex	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 hex	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 hex	Position Data Initialized *6	A Config operation was performed during EtherCAT communications.	Check to see if Config operation was performed was cleared for the absolute encoder during EtherCAT communications.

Error No.		Name	Cause	Measures
Main	Sub			
29 hex	1 hex	Following Error Counter Overflow 1	The value that is obtained *7 by dividing the absolute encoder position (in pulses) by the electronic gear ratio exceeded $\pm 2^{31}$ (2,147,483,648) during the initialization of position data.	Review the operation range of the absolute encoder position and the electronic gear ratio.
	2 hex	Following Error Counter Overflow 2	The position error in pulses exceeded $\pm 2^{29}$ (536,870,912). Alternatively, the position error in command units exceeded $\pm 2^{30}$ (1,073,741,824).	• Check to see if the 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 hex	0 hex	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 hex	0 hex	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 hex	Interface Input Duplicate Allocation Error 2	There is a duplicate setting in the input signal (IN5, IN6, IN7, and IN8) function allocations.	
	2 hex	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 hex	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 hex	Interface Input Function Number Error 1	There is an undefined number specification in the output signal (OUTM1) function allocation.	
	5 hex	Interface Input Function Number Error 2	There is an undefined number specification in the output signal (OUTM2) function allocation.	
	8 hex	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.		Name	Cause	Measures
Main	Sub			
34 hex	0 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 is not appropriate.	• Check the gains (the balance between position loop gain and speed loop gain) and the mass ratio.
			• The set value of object 3514 hex is too small.	• Increase the set value of object 3514 hex. Alternatively,set object 3514 hex to “0” to disable the protection function.
36 hex	0 hex 1 hex 2 hex	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.
37 hex	0 hex 1 hex 2 hex	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.
38 hex	0 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. 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 hex	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.	

Error No. Main	Error No. Sub	Name	Cause	Measures
50 hex	0 hex	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 as shown in the wiring diagram. Correct the connector pin connections.
	1 hex	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.
51 hex	0 hex	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 hex	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 hex	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 hex	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 hex	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 hex	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 hex	0 hex	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 hex	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 hex	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 hex	0 hex	Motor Setting Error	Settings associated with the motor and external encoder are not initialized.	Check the specifications of the motor and external encoder and initialize their settings.

Error No. Main	Error No. Sub	Name	Cause	Measures
60 hex (Continued from previous page)	1 hex	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). If there is no problem in the set values, the Servo Drive must be replaced with one with a higher capacity.
	2 hex	Motor Combination Error 2	• The rated current of the motor is too low compared with that of the motor.	• Check the value set for the Motor Rated Rms Current (3906 hex). If there is no problem in the set value, the Servo Drive must be replaced with one with a lower capacity.
			• The percentage of the Motor Coil Unit Mass to the rated force is too high.	• Check the values set for the Motor Rated Force (3905 hex) and Motor Coil Unit Mass (3904 hex).
			• 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).
			• The percentage of the maximum current to the rated current of the motor is greater than 500%.	• Check the values set for the Motor Peak Absolute Current (3907 hex) and Motor Rated Rms Current (3906 hex).
61 hex	0 hex	Magnetic Pole Position Estimation Error 1	The magnetic pole position estimation was not completed successfully.	
			• The external encoder direction setting is wrong.	• Check the specifications of the external encoder and set correct values.
			• The force command/command time value for the magnetic pole position estimation is insufficient.	• 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).
			• 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.
	1 hex	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) elapsed.	Increase the value set for the Magnetic Pole Position Estimation Time Limit for Stop (3927 hex). • 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). 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).

Error No. Main	Error No. Sub	Name	Cause	Measures
61 hex (Continued from previous page)	2 hex	Magnetic Pole Position Estimation Error 3	• The Magnetic Pole Detection Method (3920 hex) is set to "3," although 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 magnetic pole position estimation once. Then, set "3" in object 3920 hex again. The error should not occur any more. • Make sure that you are using an absolute type external encoder.
83 hex	1 hex	EtherCAT State Change Error	For details, refer to *Troubleshooting Errors Related to EtherCAT Communications* on page 12-25.	
	2 hex	EtherCAT Illegal State Change Error		
	3 hex	Communications Synchronization Error*8		
	4 hex	Synchronization Error		
	5 hex	Sync Manager WDT Error		
87 hex	0 hex	Immediate Stop Input Error	An Immediate Stop (STOP) signal was input.	Check the Immediate Stop (STOP) signal wiring.
88 hex	0 hex	Node Address Setting Error	For details, refer to *Troubleshooting Errors Related to EtherCAT Communications* on page 12-25.	
	1 hex	ESC Initialization Error		
	2 hex	Interruptions Error		
	3 hex	SII Verification Error		
90 hex	0 hex	Communications Setting Error		
91 hex	1 hex	Command Error		
93 hex	0 hex	Object Setting Error 1	The electronic gear ratio exceeded the allowable range.	Check the object settings. The electronic gear ratio must be set between 1/1000 and 1000.
	3 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 actually connected for serial communications.	Set object 3323 hex to conform with the external encoder type that is actually connected.

Error No.		Name	Cause	Measures
Main	Sub			
93 hex (Continued from previous page)	4 hex	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. • More than 20 bytes were mapped for RxPDO when the communications period was set to 250 µs. • The number of bytes (objects) mapped to RxPDO is 0. • More than 10 objects were mapped for RxPDO. • More than 11 objects were mapped for 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 Modes 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.
99 hex	0 hex	Other Errors	• An error was reset when safety input 1 or 2 was not normal (one of the input photocouplers is not ON). *9 • 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.	• Reset the error when safety inputs 1 and 2 are normal (both input photocouplers are ON). *10 • 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 Servomotor and/or the Servo Drive. Return the Servo Drive to the dealer that it was purchased from and ask for investigation and repair.
Other numbers			• 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 Servomotor 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 minimum allowable value, refer to *4-5-2 Servo Drive Regeneration Absorption Capacity* on page 4-49.

*2 For the available combinations of External Regeneration Resistors and resistance values, refer to *4-5-4 Connecting an External Regeneration Resistor* on page 4-51.

*3 For the overload characteristics, refer to *3-2 Overload Characteristics (Electronic Thermal Function)* on page 3-25.

*4 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.

*5 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.

*6 This operation is performed for safety and is not an error.

*7 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.

*8 This warning also occurs when the power supply for the master is turned OFF with EtherCAT communications established. Therefore, if you turn OFF a G5-series Servo Drive immediately after the power supply for the master is turned OFF, a diagnosis message may be left in the Diagnosis History.

*9 This error may occur due to the timing between safety input 1/2 and error clear input. For details, refer to *Error No. 99.0* on page 12-24.

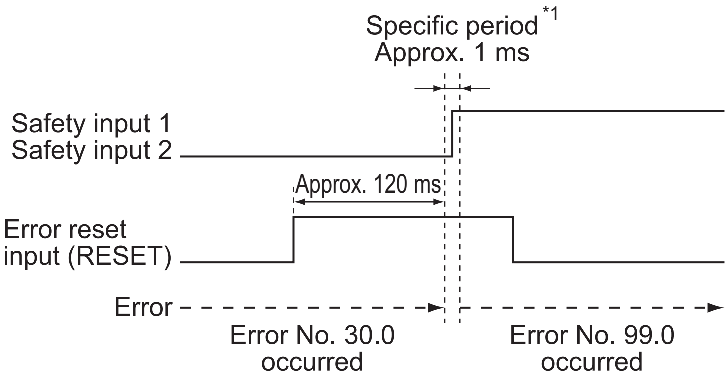
*10 For the error reset input timing, refer to *Operation Timings to a Safety Status* on page 8-5.

Error No. 99.0

Error No. 99.0 may occur due to the timing between safety input 1/2 and error clear input.

This error will occur if both of the following conditions are met:

- An error was cleared when at least one of the input photocouplers for safety inputs 1 and 2 was OFF (which means that a Safety Input Error (Error No. 30.0) had occurred).
- At least one of the input photocouplers for safety inputs 1 and 2 was turned from OFF to ON in a specific period during the error clear process (See below).



*1 Error No. 99.0 will occur if at least one of the input photocouplers for safety inputs 1 and 2 is turned from OFF to ON.

Precautions for Correct Use

Be sure to clear the error after turning ON the photocouplers for safety inputs 1 and 2 again.

Troubleshooting Errors Related to EtherCAT Communications

Error No. Main	Error No. Sub	Name	Error timing	Cause	Measures
83 hex	1 hex	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 hex	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 hex	Communications Synchronization Error	Occurs during operation.	The number of consecutive errors in receiving data during the communication sync time exceeded the value specified for the Communications Error Setting (2200 hex).	• 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 hex	Synchronization Error	Occurs during operation.	Control PCB error	Replace the Servo Drive.
	5 hex	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.
88 hex	0 hex	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 hex	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 hex	Interruptions 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.
	3 hex	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 hex	0 hex	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.

Error No.		Name	Error timing	Cause	Measures
Main	Sub				
91 hex	1 hex	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 status (Servo ON), a command that changes the communications status from Operational to another status (Init, Pre-Operational, Safe-Operational) was received. • An unsupported number was set for the Modes of operation (6060 hex). • The setting of the Modes of operation (6060 hex) was changed at an interval of less than 2 ms. • The homing operation was started when the Homing method (6098 hex) is set to other than 8, 12, 19, 20, 33, 34, and 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 with the AL Status Code

The AL status codes indicate errors related to EtherCAT communications.

The following list shows causes and measures of each AL status code of which the G5-series Servo Drive notifies the host controller.

AL Status Code List

AL status code	Name	Cause	Measures
0011 hex	Illegal State Transition Request Received	An incorrect state transition request was received.	Change the state correctly by the host controller.
0012 hex	Error State Transition Received	An unknown state transition request was received.	Change the state correctly by the host controller.
0013 hex	Bootstrap State Transition Request Received	A request of state transition to Bootstrap mode was received.	Check the host controller setting so that the host controller does not request the transition to Bootstrap mode.
0014 hex	Slave Unit Verification Error	Data written to the SII does not match data inside the Servo Drive.	• Write correct values to the SII, and cycle the power supply. • Replace the Servo Drive.
0016 hex	Mailbox Setting Error	An incorrect setting was detected in the mailbox of the Sync Manager.	Review the mailbox setting in the host controller.
001A hex	• Communications Synchronization Error • Synchronization Error	• The number of consecutive errors in receiving data during the communication sync time exceeded the value specified for the Communications Error Setting (2200 hex). • The Sync0 signal was interrupted during PDO communications.	• Take measures, which are described in Troubleshooting, for a Communications Synchronization Error (Error No. 83.3) and a Synchronization Error (Error No. 83.4). • Review the synchronization setting in the host controller.
001B hex	Process Data WDT Error	A timeout was detected for a transmission frame of process data.	• Wire the EtherCAT communications cable correctly. • Check to see if the EtherCAT communications cable is exposed to excessive noise. • Review the synchronous cycle setting in the host controller. • Review the WDT setting in the host controller.
001D hex	RxPDO Setting Error	A Sync Manager RxPDO setting is incorrect.	Review the RxPDO setting in the host controller.
001E hex	TxPDO Setting Error	A Sync Manager TxPDO setting is incorrect.	Review the TxPDO setting in the host controller.
001F hex	PDO WDT Setting Error	A PDO WDT setting is incorrect.	Review the PDO WDT setting in the host controller.
0020 hex	Slave Unit Verification Error	Data written to the SII does not match data inside the Servo Drive.	• Cycle the power supply. • If this error occurs again after you cycled the power supply, replace the Servo Drive.
0021 hex	Node Address Updated	• The set node address is different from the value that was set at the last operation. • Communications were established without cycling the power supply after you changed the node address.	Cycle the power supply.

AL status code	Name	Cause	Measures
0024 hex	TxPDO Mapping Error	A TxPDO mapping setting is incorrect.	Review the TxPDO mapping setting in the host controller.
0025 hex	RxPDO Mapping Error	An RxPDO mapping setting is incorrect.	Review the RxPDO mapping setting in the host controller.
0027 hex	Free-Run Mode Setting Error	The synchronization mode was set to Free-Run Mode.	Review the setting of the synchronization mode in the host controller.
0028 hex	SM Event Mode Setting Error	The synchronization mode was set to SM Event Mode.	Review the setting of the synchronization mode in the host controller.
002C hex	Synchronization Interruption Error	After DC Mode was confirmed, the first SYNC0 signal input was never detected.	• Wire the EtherCAT communications cable correctly. • Check to see if the EtherCAT communications cable is exposed to excessive noise. • Review the synchronous cycle setting in the host controller.
0030 hex	DC Setting Error	A mistake was made in the DC Mode operation setting.	Review the setting of DC Mode in the host controller.
0035 hex	Synchronization Cycle Setting Error	An unsupported synchronous cycle (SYNC0 cycle) was set.	Review the synchronous cycle (SYNC0 cycle) setting in the host controller.

12-4-3 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 12-25.	
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 the cause listed in *12-4-1 Troubleshooting with Error Displays* on page 12-13.	

Symptom	Probable cause	Items to check	Measures
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.
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 runs.	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.

Symptom	Probable cause	Items to check	Measures
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 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.
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.

Symptom	Probable cause	Items to check	Measures
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.
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.

Symptom	Probable cause	Items to check	Measures
The Linear Motor or the load generates abnormal noise or vibration. (Continued from previous page)	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.
	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^2.	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 external encoder cable because the 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^2.	Use a control I/O signal 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.

Symptom	Probable cause	Items to check	Measures
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.
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.

Symptom	Probable cause	Items to check	Measures
The Linear System Auto Setup by the CX-Drive or Sysmac Studio is not completed normally.	The set value of Force Limit 1 is too small. The force command value automatically generated by the computer exceeds the force limit.	• Check the set value of the Force Limit 1 (3013 hex). • Checking the force command value is not meaningful because it is automatically generated.	• Increase the set value of the Force Limit 1 (3013 hex). • Retry under conditions where the motor is allowed to be moved, by changing the start position according to the set value, etc.
	An error occurred in the Servo Drive.	Check for the cause of the error that occurred.	Check the error number in *12-4-1 Troubleshooting with Error Displays* on page 12-13.
	An excessive load or external force is applied to the Servo Drive.	• Check to be sure that the linear guides provide smooth movement. • Check to be sure that moving parts are not blocked by the brakes or a foreign object.	• Retry with the minimum load. • Retry the Linear System Auto Setup without external forces.
	Cables are not connected correctly.	• Check to see if the power cable is connected securely. • If a USB cable is connected to the servo system, check to be sure that the EtherCAT cable is disconnected from the servo system.	Check the wiring of the power cable, external encoder cable, and communications (USB or EtherCAT) cable.
	Other causes	Stored parameters are downloaded, but they are differently configured.	Retry the Linear System Auto Setup from the initial model selection.

12-5 Periodic Maintenance

Caution

After replacing the unit, transfer to the new Servo Drive all data needed to resume operation, before restarting the operation.
Equipment damage may result.

Do not attempt to disassemble, repair, or modify the Servomotor or Servo Drive.
Any attempt to do so may result in electric shock or other injury.

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.

12-5-1 Linear Slider Life Expectancy

OMRON Linear Motor (Motor Coil Unit and Magnet Track) products do not contain parts with limited life expectancy.

Additional Information

The external encoder, linear guides, and other parts that configure the Linear Slider made by the user require maintenance.

For more details, contact the manufacturers directly.

12-5-2 Servo Drive Life Expectancy

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 55ºC, 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 operating 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 operating ambient temperature. Generally, an increase of 10°C in the operating ambient temperature will reduce capacitor service life by 50%.
  For example, when the operating ambient 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.

A

Appendices

The appendices provide the 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).

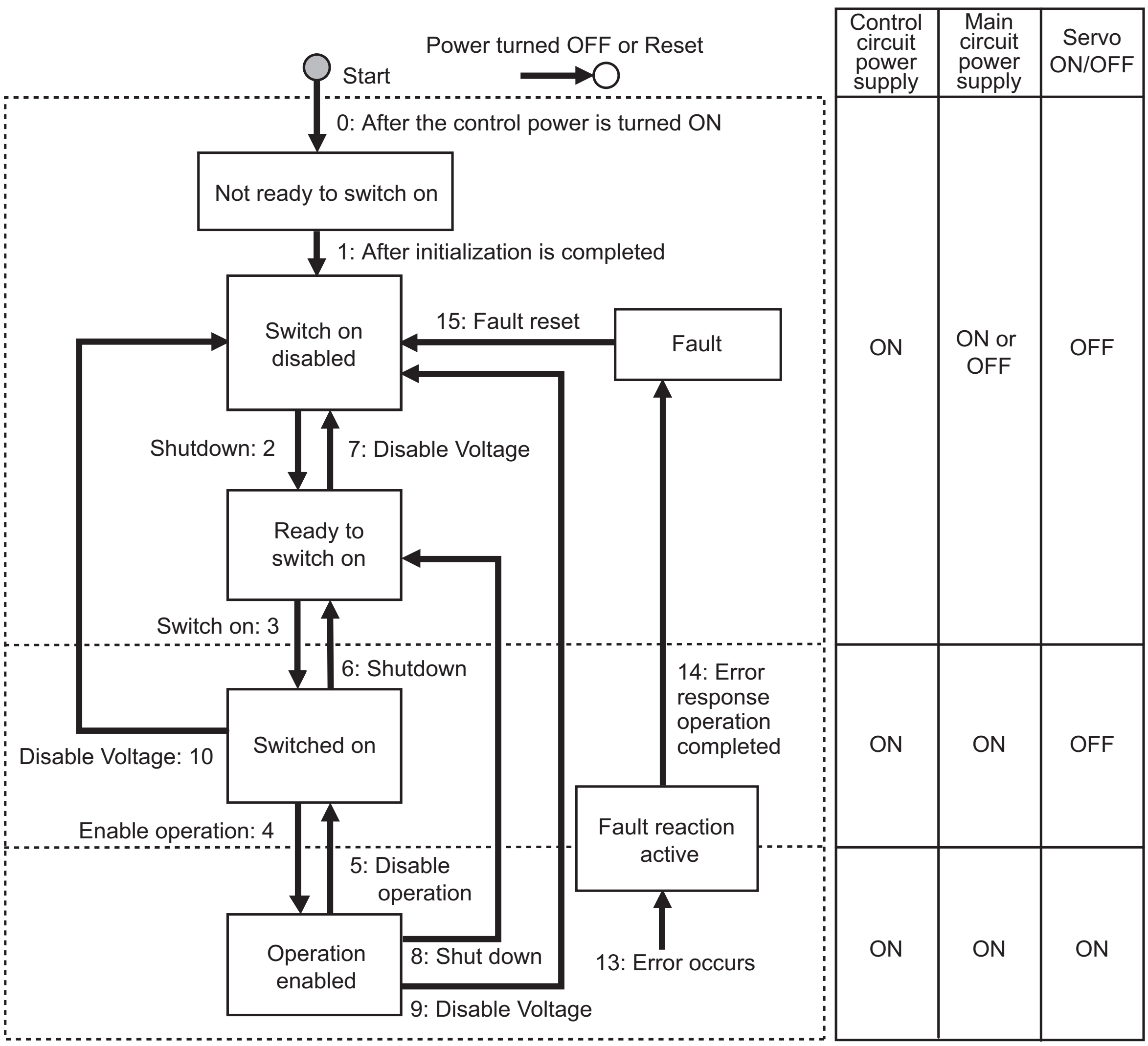
The Status word (6041 hex) is displayed in each PDS state.

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 Description* on page A-3. For details on command coding, refer to *Command Coding* on page A-3.



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 Description

Conditions	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 Ready). 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	Bit 3	Bit 2	Bit 1	Bit 0	
	Fault reset	Enable operation	Quick stop	Enable voltage	Switch on	
Shutdown	Disabled	Disabled	1	1	0	2, 6, 8
Switch on	Disabled	0	1	1	1	3
Switch on + Enable operation	Disabled	1	1	1	1	3 + 4 *1
Disable voltage	Disabled	Disabled	Disabled	0	Disabled	7, 9, 10
Quick stop	Disabled	Disabled	0	1	Disabled	Not supported *2
Disable operation	Disabled	0	1	1	1	5
Enable operation	Disabled	1	1	1	1	4
Fault reset	0→1 *3*4	Disabled	Disabled	Disabled	Disabled	15

*1 The state automatically moves to Operation enabled state after Servo Ready (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 (Switch on disabled). • 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.

Conditions	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	Disabled	0	0	0	0
Switch on disabled	1	1	Disabled	0	0	0	0
Ready to switch on	0	1	Disabled	0	0	0	1
Switched on	0	1	Disabled	0	0	1	1
Operation enabled	0	1	Disabled	0	1	1	1
Fault reaction active	0	1	Disabled	1	1	1	1
Fault	0	1	Disabled	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 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, 1705, 1600 hex*4
250	csp, csv, cst	_ *5	_ *5
500	csp, csv, cst	csp, csv, cst	_ *5
1,000	csp, csv, cst, pp, hm	csp, csv, cst, pp, hm	csp, csv, cst, pp, hm
2,000	csp, csv, cst, pp, hm	csp, csv, cst, pp, hm	csp, csv, cst, pp, hm
4,000	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	Modes 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 pp, hm, 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.

*5 Realtime autotuning must be disabled to enable the instantaneous speed observer.
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 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 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 Motor will momentarily fall in an immediate stop state. However, when the Halt bit is ON, the 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 approximately 2 ms, but the stop operation for drive prohibition will not be executed. Therefore, change the control mode with the 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 (6061 hex)
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 the Modes of operation display (6061 hex) is shown in the following table:

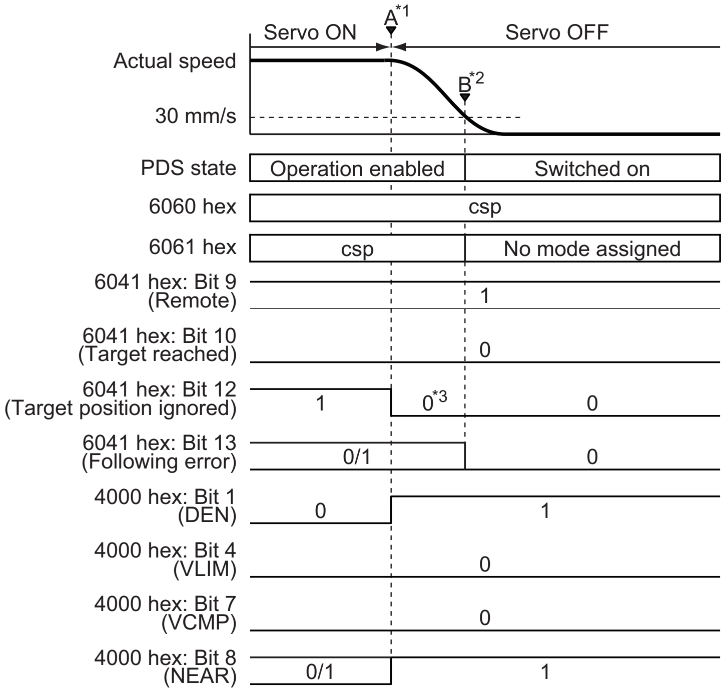
Object	Bit	Modes of Operation Display (6061 hex)					
		Position Control Mode				Speed Control Mode	Force Control Mode
		csp	pp	hm	Not specified	csv	cst
6041 hex	10	0	Target reached	Target reached	0	0	0
	12	Target position ignored *1	Acknowledge	Home attained *2	0	Target velocity ignored*1	Target torque ignored*1
	13	Following error	Following error	Homing error*3	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 (ignored). For details, see figures (b) and (c) below.

● (a) Example of Servo OFF during Operation in csp



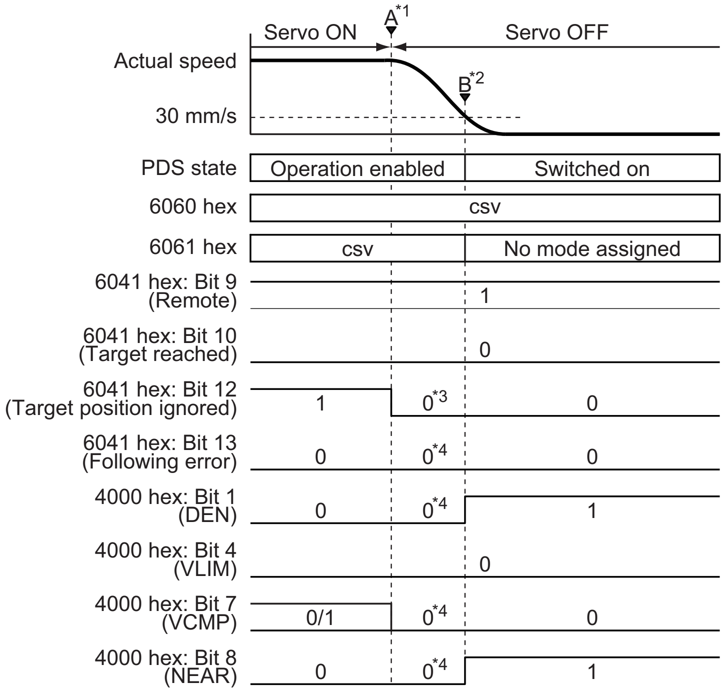
*1 When the servo is turned OFF, a deceleration stop starts and 6061 hex continues to show the same mode as the mode of operation (csp) specified in 6060 hex.

*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



*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.

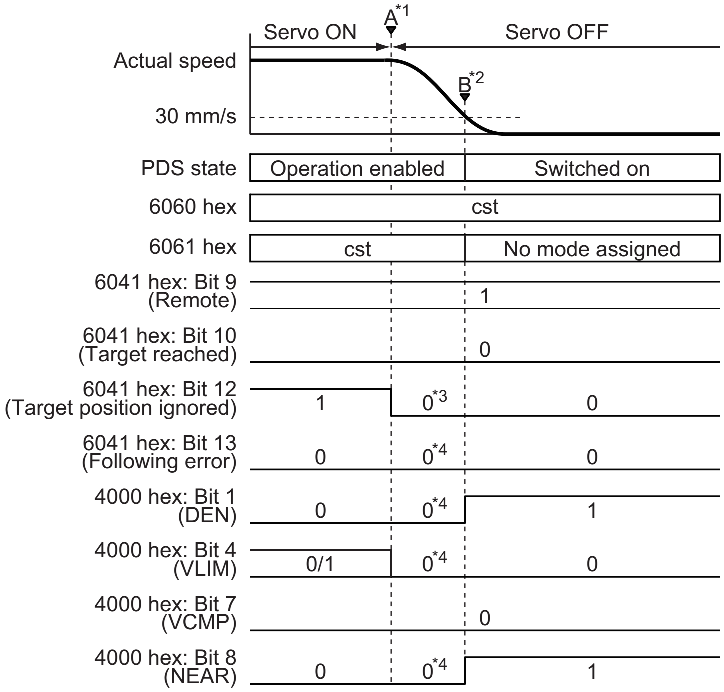
*2 After the motor stops, No mode assigned is shown by 6061 hex.

*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.

(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.

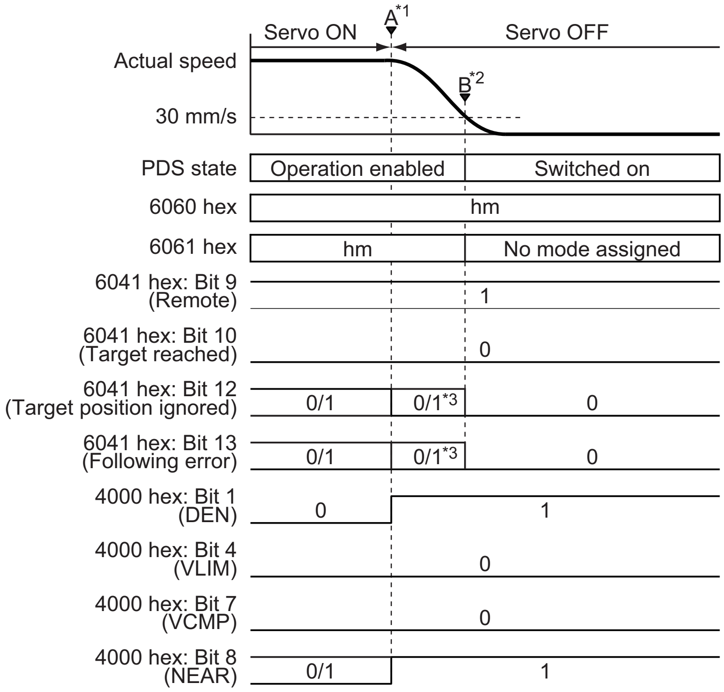
*2 After the motor stops, No mode assigned is shown by 6061 hex.

*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



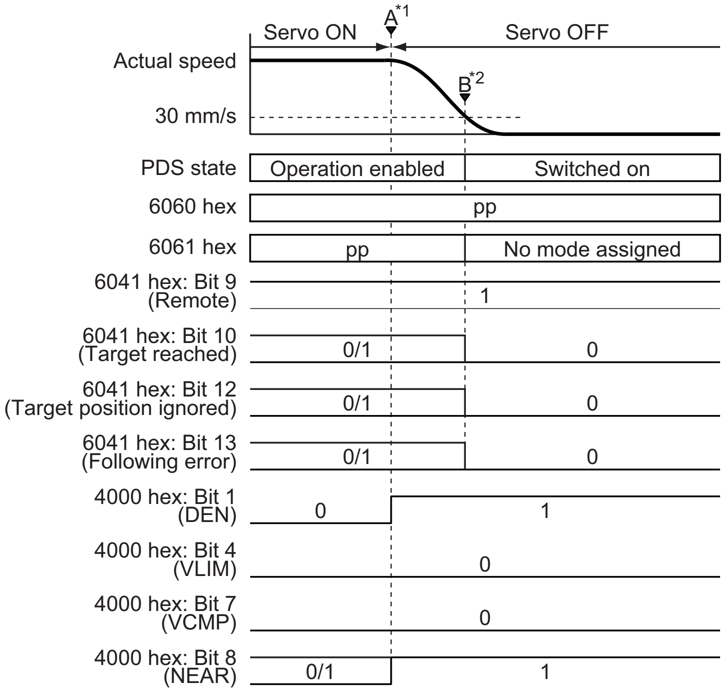
*1 When the servo is turned OFF, a deceleration stop starts and 6061 hex continues to show the same mode as the mode of operation (hm) specified in 6060 hex.

*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.

(e) Example of Servo OFF during Operation in pp



*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.

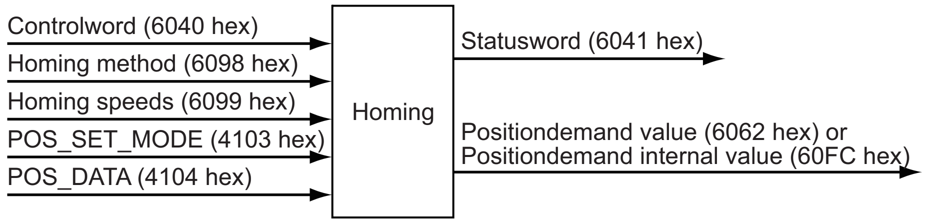
Note The operation during the interval from A to B for drive prohibition and main circuit power OFF is the same as when the servo is turned OFF.

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	Description	Reference
0	Not specified	–
8	Homing by Origin Proximity Input and origin signal (positive operation start)	P.A-18
12	Homing by Origin Proximity Input and origin signal (negative operation start)	P.A-18
19	Homing without origin signal (positive operation start)	P.A-19
20	Homing without origin signal (negative operation start)	P.A-19
33	Homing with origin signal (negative operation start)	P.A-20
34	Homing with origin signal (positive operation start)	P.A-20
35	Present home preset	P.A-21

The homing methods supported by the Servo Drive can be checked in Supported homing method (60E3 hex).

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	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 unit/s	100 to 3,276,700	5,000
6099 hex	02 hex	Speed during search for zero	RW	U32	Command unit/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 unit/s^2	1 to 655,350,000	1,000,000
6084 hex	00 hex	Profile deceleration	RW	U32	Command unit/s^2	1 to 655,350,000	1,000,000
6086 hex	00 hex	Motion profile type	RW	INT16	–	–1 to 0	0

Controlword (6040 hex) in Homing Mode

Bit	Name	Value	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. The status based on the combination of the bits are shown in the following table.
12	Homing attained	
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.

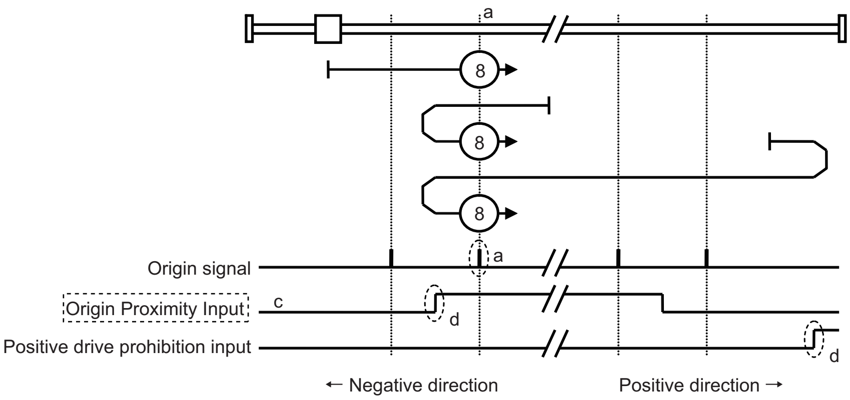
● Homing Methods 8 and 12: Homing by Origin Proximity Input and Origin Signal

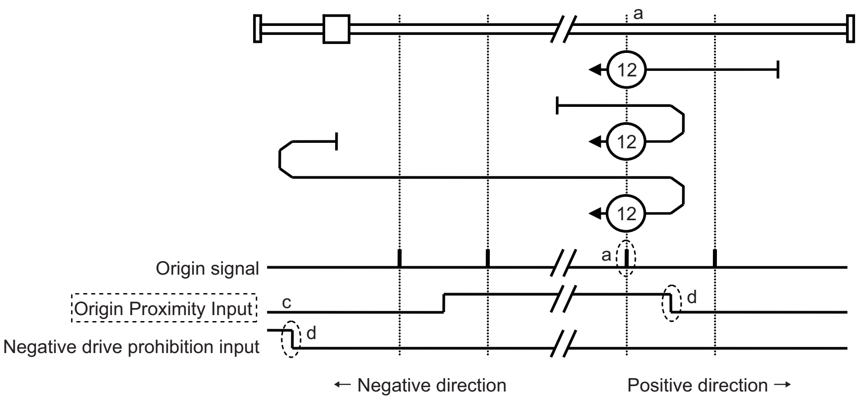
These Homing methods use the Origin Proximity Input that is enabled only in some parts of the drive range, and stops when an origin signal is detected.

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.

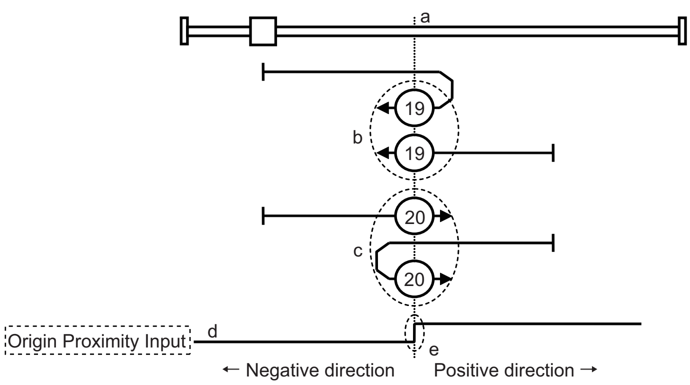
Precautions for Correct Use

- 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.

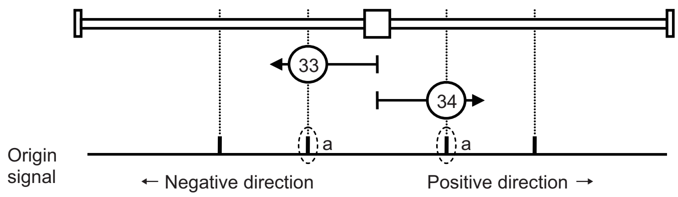
Precautions for Correct Use

- 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.



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 (Homing 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-index	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 hex

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 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).
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 type

Data types shown in the following table are used in this profile.

Data type	Code	Size	Range
Boolean	BOOL	1 bit	0 to 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.

<table>
<tr><th><Index></th><td colspan="7"><Object name> Modes of Operation</td></tr>
<tr><th>Setting range</th><td><Range></td><th>Unit</th><td><Unit></td><th>Default setting</th><td><Default></td><th>Data attribute</th><td><Attribute></td></tr>
<tr><th>Size</th><td colspan="2"><Size></td><th>Access</th><td><Access></td><th>PDO map</th><td colspan="2"><Possible/Not possible></td></tr>
</table>

Data is indicated in pointed brackets < >.

Possible data are listed below.

Name	Description
Index	Object index given by a four-digit hexadecimal number.
Name	The object name.
Modes of operation	Related operation modes. 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
Setting range	The possible range of settings.
Unit	Physical units.
Default setting	Default value set before shipment.
Data attribute	The timing when a change in the contents is updated for a writable object. A: Always updated B: Prohibited to change during motor operation or commands. If it is changed during motor operation or commands, 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 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 sub-indices is shown below.

<Index>	<Object name>						Modes of Operation
Sub-index 00 hex		Number of entries					
Setting range	<Range>	**Unit**	<Unit>	**Default setting**	<Default>	**Data attribute**	<Attribute>
Size	<Size>		**Access**	<Access>	**PDO map**	<Possible/Not possible>	
Sub-index 01 hex		<Sub-index name>					
Setting range	<Range>	**Unit**	<Unit>	**Default setting**	<Default>	**Data attribute**	<Attribute>
Size	<Size>		**Access**	<Access>	**PDO map**	<Possible/Not possible>	
Sub-index 02 hex		<Sub-index name>					
Setting range	<Range>	**Unit**	<Unit>	**Default setting**	<Default>	**Data attribute**	<Attribute>
Size	<Size>		**Access**	<Access>	**PDO map**	<Possible/Not possible>	
			:				
Sub-index NN hex		<Sub-index name>					
Setting range	<Range>	**Unit**	<Unit>	**Default setting**	<Default>	**Data 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
Setting range	–	**Unit**	–	**Default setting**	0002 0192 hex	**Data attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	

- Gives the CoE device profile number.

Explanation of Settings

Bit	Name	Description
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
Setting range	–	**Unit**	–	**Default setting**	0	**Data attribute**	–
Size	1 byte (U8)		**Access**	RO	**PDO map**	Not possible	

- Gives the error type that has occurred in the Servo Drive.

Explanation 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	
Setting range	–	**Unit**	–	**Default setting**	*1	**Data 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 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

- Gives the Servo Drive model number.

1009 hex	Manufacturer Hardware Version					All	
Setting range	–	**Unit**	–	**Default setting**	–	**Data 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	
Setting range	–	**Unit**	–	**Default setting**	*1	**Data 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					
Setting range	–	**Unit**	–	**Default setting**	01 hex	**Data attribute**	–
Size	1 byte (U8)		**Access**	RO	**PDO map**	Not possible	
Sub-index 01 hex		Store Parameters					
Setting range	–	**Unit**	–	**Default setting**	0000 0001 hex	**Data 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 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 Errors 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
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					
Setting range	–	**Unit**	–	**Default setting**	01 hex	**Data attribute**	–
Size	1 byte (U8)		**Access**	RO	**PDO map**	Not possible	
Sub-index 01 hex		Restore Default Parameters					
Setting range	–	**Unit**	–	**Default setting**	0000 0001 hex	**Data attribute**	A
Size	4 bytes (U32)		**Access**	RW	**PDO map**	Not possible	

- Parameters are returned to their default values.
- 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 “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 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.

1018 hex	Identity Object						All
Sub-index 00 hex		Number of entries					
Setting range	–	**Unit**	–	**Default setting**	04 hex	**Data attribute**	–
Size	1 byte (U8)		**Access**	RO	**PDO map**	Not possible	
Sub-index 01 hex		Vender ID					
Setting range	–	**Unit**	–	**Default setting**	0000 0083 hex	**Data attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	
Sub-index 02 hex		Product Code					
Setting range	–	**Unit**	–	**Default setting**	Refer to the table.	**Data attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	
Sub-index 03 hex		Revision Number					
Setting range	–	**Unit**	–	**Default setting**	Refer to the table.	**Data attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	
Sub-index 04 hex		Serial Number					
Setting range	–	**Unit**	–	**Default setting**	0000 0000 hex	**Data 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 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

- Sub-index 03 hex (Revision number) gives the device revision number.

Bit	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					
Setting range	–	Unit	–	Default setting	02 hex	Data attribute	–
Size	1 byte (U8)		Access	RO	PDO map	Not possible	
Sub-index 01 hex		Backup Parameter Checksum					
Setting range	–	Unit	–	Default setting	–	Data attribute	–
Size	4 bytes (U32)		Access	RO	PDO map	Not possible	
Sub-index 02 hex		Backup Parameter Changed					
Setting range	–	Unit	–	Default setting	0	Data 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					
Setting range	–	Unit	–	Default setting	13 hex	Data attribute	–
Size	1 byte (U8)		Access	RO	PDO map	Not possible	
Sub-index 01 hex		Maximum Messages					
Setting range	00 to 0E hex	Unit	–	Default setting	00 hex	Data attribute	–
Size	1 byte (U8)		Access	RO	PDO map	Not possible	
Sub-index 02 hex		Newest Message					
Setting range	06 to 13 hex	Unit	–	Default setting	06 hex	Data attribute	–
Size	1 byte (U8)		Access	RO	PDO map	Not possible	
Sub-index 05 hex		Flags					
Setting range	0000 to 0001 hex	Unit	–	Default setting	0000 hex	Data attribute	A
Size	2 bytes (U16)		Access	RW	PDO map	Not possible	
Sub-indexes 06 to 13 hex		Diagnosis Messages 1 to 14					
Setting range	–	Unit	–	Default setting	–	Data 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	**Data 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	**Data attribute**	D
Size	4 bytes (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	**Data attribute**	D
Size	4 bytes (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	**Data attribute**	D
Size	4 bytes (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	**Data attribute**	D
Size	4 bytes (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	**Data attribute**	D
Size	4 bytes (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	**Data attribute**	D
Size	4 bytes (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	**Data attribute**	D
Size	4 bytes (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	**Data attribute**	D
Size	4 bytes (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	**Data attribute**	D
Size	4 bytes (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	**Data attribute**	D
Size	4 bytes (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. For details, 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.
- In the following cases, an ABORT code is 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	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					
Setting range	–	**Unit**	–	**Default setting**	04 hex	**Data attribute**	–
Size	1 byte (U8)		**Access**	RO	**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	**Data attribute**	–
Size	4 bytes (U32)		**Access**	RO	**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	**Data attribute**	–
Size	4 bytes (U32)		**Access**	RO	**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	**Data attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	
Sub-index 04 hex		PDO entry 4 (4th Output Object to be mapped)					
Setting range	–	**Unit**	–	**Default setting**	60FE 0120 hex	**Data 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 mode (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					
Setting range	–	**Unit**	–	**Default setting**	07 hex	**Data attribute**	–
Size	1 byte (U8)		**Access**	RO	**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	**Data attribute**	–
Size	4 bytes (U32)		**Access**	RO	**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	**Data attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	
Sub-index 03 hex		PDO entry 3 (3rd Output Object to be mapped)					
Setting range	–	**Unit**	–	**Default setting**	60FF 0020 hex	**Data attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	
Sub-index 04 hex		PDO entry 4 (4th Output Object to be mapped)					
Setting range	–	**Unit**	–	**Default setting**	6071 0010 hex	**Data attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	
Sub-index 05 hex		PDO entry 5 (5th Output Object to be mapped)					
Setting range	–	**Unit**	–	**Default setting**	6060 0008 hex	**Data attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	
Sub-index 06 hex		PDO entry 6 (6th Output Object to be mapped)					
Setting range	–	**Unit**	–	**Default setting**	60B8 0010 hex	**Data attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	
Sub-index 07 hex		PDO entry 7 (7th Output Object to be mapped)					
Setting range	–	**Unit**	–	**Default setting**	607F 0020 hex	**Data 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					
Setting range	–	Unit	–	Default setting	07 hex	Data attribute	–
Size	1 byte (U8)		Access	RO	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	Data attribute	–
Size	4 bytes (U32)		Access	RO	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	Data attribute	–
Size	4 bytes (U32)		Access	RO	PDO map	Not possible	
Sub-index 03 hex		PDO entry 3 (3rd Output Object to be mapped)					
Setting range	–	Unit	–	Default setting	60FF 0020 hex	Data attribute	–
Size	4 bytes (U32)		Access	RO	PDO map	Not possible	
Sub-index 04 hex		PDO entry 4 (4th Output Object to be mapped)					
Setting range	–	Unit	–	Default setting	6060 0008 hex	Data attribute	–
Size	4 bytes (U32)		Access	RO	PDO map	Not possible	
Sub-index 05 hex		PDO entry 5 (5th Output Object to be mapped)					
Setting range	–	Unit	–	Default setting	60B8 0010 hex	Data attribute	–
Size	4 bytes (U32)		Access	RO	PDO map	Not possible	
Sub-index 06 hex		PDO entry 6 (6th Output Object to be mapped)					
Setting range	–	Unit	–	Default setting	60E0 0010 hex	Data attribute	–
Size	4 bytes (U32)		Access	RO	PDO map	Not possible	
Sub-index 07 hex		PDO entry 7 (7th Output Object to be mapped)					
Setting range	–	Unit	–	Default setting	60E1 0010 hex	Data 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					
Setting range	–	Unit	–	Default setting	09 hex	Data attribute	–
Size	1 byte (U8)		Access	RO	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	Data attribute	–
Size	4 bytes (U32)		Access	RO	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	Data attribute	–
Size	4 bytes (U32)		Access	RO	PDO map	Not possible	
Sub-index 03 hex		PDO entry 3 (3rd Output Object to be mapped)					
Setting range	–	Unit	–	Default setting	60FF 0020 hex	Data attribute	–
Size	4 bytes (U32)		Access	RO	PDO map	Not possible	
Sub-index 04 hex		PDO entry 4 (4th Output Object to be mapped)					
Setting range	–	Unit	–	Default setting	6071 0010 hex	Data attribute	–
Size	4 bytes (U32)		Access	RO	PDO map	Not possible	
Sub-index 05 hex		PDO entry 5 (5th Output Object to be mapped)					
Setting range	–	Unit	–	Default setting	6060 0008 hex	Data attribute	–
Size	4 bytes (U32)		Access	RO	PDO map	Not possible	
Sub-index 06 hex		PDO entry 6 (6th Output Object to be mapped)					
Setting range	–	Unit	–	Default setting	60B8 0010 hex	Data attribute	–
Size	4 bytes (U32)		Access	RO	PDO map	Not possible	
Sub-index 07 hex		PDO entry 7 (7th Output Object to be mapped)					
Setting range	–	Unit	–	Default setting	607F 0020 hex	Data attribute	–
Size	4 bytes (U32)		Access	RO	PDO map	Not possible	
Sub-index 08 hex		PDO entry 8 (8th Output Object to be mapped)					
Setting range	–	Unit	–	Default setting	60E0 0010 hex	Data attribute	–
Size	4 bytes (U32)		Access	RO	PDO map	Not possible	
Sub-index 09 hex		PDO entry 9 (9th Output Object to be mapped)					
Setting range	–	Unit	–	Default setting	60E1 0010 hex	Data 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						
Setting range	–	**Unit**	–	**Default setting**	08 hex	**Data attribute**	–
Size	1 byte (U8)		**Access**	RO	**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	**Data attribute**	–
Size	4 bytes (U32)		**Access**	RO	**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	**Data attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	
Sub-index 03 hex	PDO entry 3 (3rd Output Object to be mapped)						
Setting range	–	**Unit**	–	**Default setting**	60FF 0020 hex	**Data attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	
Sub-index 04 hex	PDO entry 4 (4th Output Object to be mapped)						
Setting range	–	**Unit**	–	**Default setting**	6060 0008 hex	**Data attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	
Sub-index 05 hex	PDO entry 5 (5th Output Object to be mapped)						
Setting range	–	**Unit**	–	**Default setting**	60B8 0010 hex	**Data attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	
Sub-index 06 hex	PDO entry 6 (6th Output Object to be mapped)						
Setting range	–	**Unit**	–	**Default setting**	60E0 0010 hex	**Data attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	
Sub-index 07 hex	PDO entry 7 (7th Output Object to be mapped)						
Setting range	–	**Unit**	–	**Default setting**	60E1 0010 hex	**Data attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	
Sub-index 08 hex	PDO entry 8 (8th Output Object to be mapped)						
Setting range	–	**Unit**	–	**Default setting**	60B2 0010 hex	**Data 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 setting	07 hex	Data 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	Data attribute	D
Size	4 bytes (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	Data attribute	D
Size	4 bytes (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	Data attribute	D
Size	4 bytes (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	Data attribute	D
Size	4 bytes (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	Data attribute	D
Size	4 bytes (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	Data attribute	D
Size	4 bytes (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	Data attribute	D
Size	4 bytes (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	Data attribute	D
Size	4 bytes (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	Data attribute	D
Size	4 bytes (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	Data attribute	D
Size	4 bytes (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.
For details, 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.
- In the following cases, an ABORT code is 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	Name
2002 hex	00 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	Target torque
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					
Setting range	–	Unit	–	Default setting	09 hex	Data 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 setting	603F 0010 hex	Data attribute	–
Size	4 bytes (U32)		Access	RO	PDO map	Not possible	
Sub-index 02 hex		PDO entry 2 (2nd Input Object to be mapped)					
Setting range	–	Unit	–	Default setting	6041 0010 hex	Data attribute	–
Size	4 bytes (U32)		Access	RO	PDO map	Not possible	
Sub-index 03 hex		PDO entry 3 (3rd Input Object to be mapped)					
Setting range	–	Unit	–	Default setting	6064 0020 hex	Data attribute	–
Size	4 bytes (U32)		Access	RO	PDO map	Not possible	
Sub-index 04 hex		PDO entry 4 (4th Input Object to be mapped)					
Setting range	–	Unit	–	Default setting	6077 0010 hex	Data attribute	–
Size	4 bytes (U32)		Access	RO	PDO map	Not possible	
Sub-index 05 hex		PDO entry 5 (5th Input Object to be mapped)					
Setting range	–	Unit	–	Default setting	60F4 0020 hex	Data attribute	–
Size	4 bytes (U32)		Access	RO	PDO map	Not possible	
Sub-index 06 hex		PDO entry 6 (6th Input Object to be mapped)					
Setting range	–	Unit	–	Default setting	60B9 0010 hex	Data attribute	–
Size	4 bytes (U32)		Access	RO	PDO map	Not possible	
Sub-index 07 hex		PDO entry 7 (7th Input Object to be mapped)					
Setting range	–	Unit	–	Default setting	60BA 0020 hex	Data attribute	–
Size	4 bytes (U32)		Access	RO	PDO map	Not possible	
Sub-index 08 hex		PDO entry 8 (8th Input Object to be mapped)					
Setting range	–	Unit	–	Default setting	60BC 0020 hex	Data attribute	–
Size	4 bytes (U32)		Access	RO	PDO map	Not possible	
Sub-index 09 hex		PDO entry 9 (9th Input Object to be mapped)					
Setting range	–	Unit	–	Default setting	60FD 0020 hex	Data 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 mode (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					
Setting range	–	Unit	–	Default setting	09 hex	Data 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 setting	603F 0010 hex	Data attribute	–
Size	4 bytes (U32)		Access	RO	PDO map	Not possible	
Sub-index 02 hex		PDO entry 2 (2nd Input Object to be mapped)					
Setting range	–	Unit	–	Default setting	6041 0010 hex	Data attribute	–
Size	4 bytes (U32)		Access	RO	PDO map	Not possible	
Sub-index 03 hex		PDO entry 3 (3rd Input Object to be mapped)					
Setting range	–	Unit	–	Default setting	6064 0020 hex	Data attribute	–
Size	4 bytes (U32)		Access	RO	PDO map	Not possible	
Sub-index 04 hex		PDO entry 4 (4th Input Object to be mapped)					
Setting range	–	Unit	–	Default setting	6077 0010 hex	Data attribute	–
Size	4 bytes (U32)		Access	RO	PDO map	Not possible	
Sub-index 05 hex		PDO entry 5 (5th Input Object to be mapped)					
Setting range	–	Unit	–	Default setting	6061 0008 hex	Data attribute	–
Size	4 bytes (U32)		Access	RO	PDO map	Not possible	
Sub-index 06 hex		PDO entry 6 (6th Input Object to be mapped)					
Setting range	–	Unit	–	Default setting	60B9 0010 hex	Data attribute	–
Size	4 bytes (U32)		Access	RO	PDO map	Not possible	
Sub-index 07 hex		PDO entry 7 (7th Input Object to be mapped)					
Setting range	–	Unit	–	Default setting	60BA 0020 hex	Data attribute	–
Size	4 bytes (U32)		Access	RO	PDO map	Not possible	
Sub-index 08 hex		PDO entry 8 (8th Input Object to be mapped)					
Setting range	–	Unit	–	Default setting	60BC 0020 hex	Data attribute	–
Size	4 bytes (U32)		Access	RO	PDO map	Not possible	
Sub-index 09 hex		PDO entry 9 (9th Input Object to be mapped)					
Setting range	–	Unit	–	Default setting	60FD 0020 hex	Data 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					
Setting range	–	**Unit**	–	**Default setting**	0A hex	**Data 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 setting**	603F 0010 hex	**Data attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	
Sub-index 02 hex		PDO entry 2 (2nd Input Object to be mapped)					
Setting range	–	**Unit**	–	**Default setting**	6041 0010 hex	**Data attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	
Sub-index 03 hex		PDO entry 3 (3rd Input Object to be mapped)					
Setting range	–	**Unit**	–	**Default setting**	6064 0020 hex	**Data attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	
Sub-index 04 hex		PDO entry 4 (4th Input Object to be mapped)					
Setting range	–	**Unit**	–	**Default setting**	6077 0010 hex	**Data attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	
Sub-index 05 hex		PDO entry 5 (5th Input Object to be mapped)					
Setting range	–	**Unit**	–	**Default setting**	60F4 0020 hex	**Data attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	
Sub-index 06 hex		PDO entry 6 (6th Input Object to be mapped)					
Setting range	–	**Unit**	–	**Default setting**	6061 0008 hex	**Data attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	
Sub-index 07 hex		PDO entry 7 (7th Input Object to be mapped)					
Setting range	–	**Unit**	–	**Default setting**	60B9 0010 hex	**Data attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	
Sub-index 08 hex		PDO entry 8 (8th Input Object to be mapped)					
Setting range	–	**Unit**	–	**Default setting**	60BA 0020 hex	**Data attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	
Sub-index 09 hex		PDO entry 9 (9th Input Object to be mapped)					
Setting range	–	**Unit**	–	**Default setting**	60BC 0020 hex	**Data attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	
Sub-index 10 hex		PDO entry 10 (10th Input Object to be mapped)					
Setting range	–	**Unit**	–	**Default setting**	60FD 0020 hex	**Data 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.

<table>
<tr><td>1B04 hex</td><td colspan="7">261th transmit PDO Mapping</td><td>All</td></tr>
<tr><td colspan="2">Sub-index 00 hex</td><td colspan="7">Number of objects in this PDO</td></tr>
<tr><td>Setting range</td><td colspan="2">–</td><td>Unit</td><td>–</td><td>Default setting</td><td>0A hex</td><td>Data attribute</td><td>–</td></tr>
<tr><td>Size</td><td colspan="2">1 byte (U8)</td><td colspan="2">Access</td><td>RO</td><td>PDO map</td><td colspan="2">Not possible</td></tr>
<tr><td colspan="2">Sub-index 01 hex</td><td colspan="7">PDO entry 1 (1st Input Object to be mapped)</td></tr>
<tr><td>Setting range</td><td colspan="2">–</td><td>Unit</td><td>–</td><td>Default setting</td><td>603F 0010 hex</td><td>Data attribute</td><td>–</td></tr>
<tr><td>Size</td><td colspan="2">4 bytes (U32)</td><td colspan="2">Access</td><td>RO</td><td>PDO map</td><td colspan="2">Not possible</td></tr>
<tr><td colspan="2">Sub-index 02 hex</td><td colspan="7">PDO entry 2 (2nd Input Object to be mapped)</td></tr>
<tr><td>Setting range</td><td colspan="2">–</td><td>Unit</td><td>–</td><td>Default setting</td><td>6041 0010 hex</td><td>Data attribute</td><td>–</td></tr>
<tr><td>Size</td><td colspan="2">4 bytes (U32)</td><td colspan="2">Access</td><td>RO</td><td>PDO map</td><td colspan="2">Not possible</td></tr>
<tr><td colspan="2">Sub-index 03 hex</td><td colspan="7">PDO entry 3 (3rd Input Object to be mapped)</td></tr>
<tr><td>Setting range</td><td colspan="2">–</td><td>Unit</td><td>–</td><td>Default setting</td><td>6064 0020 hex</td><td>Data attribute</td><td>–</td></tr>
<tr><td>Size</td><td colspan="2">4 bytes (U32)</td><td colspan="2">Access</td><td>RO</td><td>PDO map</td><td colspan="2">Not possible</td></tr>
<tr><td colspan="2">Sub-index 04 hex</td><td colspan="7">PDO entry 4 (4th Input Object to be mapped)</td></tr>
<tr><td>Setting range</td><td colspan="2">–</td><td>Unit</td><td>–</td><td>Default setting</td><td>6077 0010 hex</td><td>Data attribute</td><td>–</td></tr>
<tr><td>Size</td><td colspan="2">4 bytes (U32)</td><td colspan="2">Access</td><td>RO</td><td>PDO map</td><td colspan="2">Not possible</td></tr>
<tr><td colspan="2">Sub-index 05 hex</td><td colspan="7">PDO entry 5 (5th Input Object to be mapped)</td></tr>
<tr><td>Setting range</td><td colspan="2">–</td><td>Unit</td><td>–</td><td>Default setting</td><td>6061 0008 hex</td><td>Data attribute</td><td>–</td></tr>
<tr><td>Size</td><td colspan="2">4 bytes (U32)</td><td colspan="2">Access</td><td>RO</td><td>PDO map</td><td colspan="2">Not possible</td></tr>
<tr><td colspan="2">Sub-index 06 hex</td><td colspan="7">PDO entry 6 (6th Input Object to be mapped)</td></tr>
<tr><td>Setting range</td><td colspan="2">–</td><td>Unit</td><td>–</td><td>Default setting</td><td>60B9 0010 hex</td><td>Data attribute</td><td>–</td></tr>
<tr><td>Size</td><td colspan="2">4 bytes (U32)</td><td colspan="2">Access</td><td>RO</td><td>PDO map</td><td colspan="2">Not possible</td></tr>
<tr><td colspan="2">Sub-index 07 hex</td><td colspan="7">PDO entry 7 (7th Input Object to be mapped)</td></tr>
<tr><td>Setting range</td><td colspan="2">–</td><td>Unit</td><td>–</td><td>Default setting</td><td>60BA 0020 hex</td><td>Data attribute</td><td>–</td></tr>
<tr><td>Size</td><td colspan="2">4 bytes (U32)</td><td colspan="2">Access</td><td>RO</td><td>PDO map</td><td colspan="2">Not possible</td></tr>
<tr><td colspan="2">Sub-index 08 hex</td><td colspan="7">PDO entry 8 (8th Input Object to be mapped)</td></tr>
<tr><td>Setting range</td><td colspan="2">–</td><td>Unit</td><td>–</td><td>Default setting</td><td>60BC 0020 hex</td><td>Data attribute</td><td>–</td></tr>
<tr><td>Size</td><td colspan="2">4 bytes (U32)</td><td colspan="2">Access</td><td>RO</td><td>PDO map</td><td colspan="2">Not possible</td></tr>
<tr><td colspan="2">Sub-index 09 hex</td><td colspan="7">PDO entry 9 (9th Input Object to be mapped)</td></tr>
<tr><td>Setting range</td><td colspan="2">–</td><td>Unit</td><td>–</td><td>Default setting</td><td>60FD 0020 hex</td><td>Data attribute</td><td>–</td></tr>
<tr><td>Size</td><td colspan="2">4 bytes (U32)</td><td colspan="2">Access</td><td>RO</td><td>PDO map</td><td colspan="2">Not possible</td></tr>
<tr><td colspan="2">Sub-index 10 hex</td><td colspan="7">PDO entry 10 (10th Input Object to be mapped)</td></tr>
<tr><td>Setting range</td><td colspan="2">–</td><td>Unit</td><td>–</td><td>Default setting</td><td>606C 0020 hex</td><td>Data attribute</td><td>–</td></tr>
<tr><td>Size</td><td colspan="2">4 bytes (U32)</td><td colspan="2">Access</td><td>RO</td><td>PDO map</td><td colspan="2">Not possible</td></tr>
</table>

- 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 setting	01 hex	Data 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 setting	2002 0108 hex	Data attribute	–
Size	4 bytes (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 connect the G5-series Servo Drive with a Machine Automation Controller NJ-series (Model: NJ301-□□□□/NJ501-□□□□), 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					
Setting range	–	Unit	–	Default setting	04 hex	Data attribute	–
Size	1 byte (U8)		Access	RO	PDO map	Not possible	
Sub-index 01 hex		Communication type Synch Manager 0					
Setting range	–	Unit	–	Default setting	01 hex	Data attribute	–
Size	1 byte (U8)		Access	RO	PDO map	Not possible	
Sub-index 02 hex		Communication type Synch Manager 1					
Setting range	–	Unit	–	Default setting	02 hex	Data attribute	–
Size	1 byte (U8)		Access	RO	PDO map	Not possible	
Sub-index 03 hex		Communication type Synch Manager 2					
Setting range	–	Unit	–	Default setting	03 hex	Data attribute	–
Size	1 byte (U8)		Access	RO	PDO map	Not possible	
Sub-index 04 hex		Communication type Synch Manager 3					
Setting range	–	Unit	–	Default setting	04 hex	Data 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					
Setting range	–	Unit	–	Default setting	00 hex	Data 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					
Setting range	–	Unit	–	Default setting	00 hex	Data 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					
Setting range	0 to 2	Unit	–	Default setting	01 hex	Data attribute	D
Size	1 byte (U8)	Access	RW	PDO map	Not possible		
Sub-index 01 hex		1st PDO Mapping Object Index of assigned PDO					
Setting range	0000 to FFFF hex	Unit	–	Default setting	1701 hex	Data attribute	D
Size	2 bytes (U16)	Access	RW	PDO map	Not possible		
Sub-index 02 hex		2nd PDO Mapping Object Index of assigned PDO					
Setting range	0000 to FFFF hex	Unit	–	Default setting	0000 hex	Data 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					
Setting range	–	Unit	–	Default setting	01 hex	Data attribute	D
Size	1 byte (U8)		Access	RW	PDO map	Not possible	
Sub-index 01 hex		1st PDO Mapping Object Index of assigned PDO					
Setting range	0000 to FFFF hex	Unit	–	Default setting	1B01 hex	Data attribute	D
Size	2 bytes (U16)		Access	RW	PDO map	Not possible	
Sub-index 02 hex		2nd PDO Mapping Object Index of assigned PDO					
Setting range	0000 to FFFF hex	Unit	–	Default setting	0000 hex	Data 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 hex to 1B04 hex, and 1BFF hex

1C32 hex	Sync Manager 2 Synchronization						All
Sub-index 00 hex	Number of Synchronization Parameters						
Setting range	–	**Unit**	–	**Default setting**	20 hex	**Data attribute**	–
Size	1 byte (U8)		**Access**	RO	**PDO map**	Not possible	
Sub-index 01 hex	Synchronization Type						
Setting range	–	**Unit**	–	**Default setting**	0002 hex	**Data attribute**	A
Size	2 bytes (U16)		**Access**	RW	**PDO map**	Not possible	
Sub-index 02 hex	Cycle Time						
Setting range	–	**Unit**	–	**Default setting**	0000 0000 hex	**Data attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	
Sub-index 04 hex	Synchronization Types supported						
Setting range	–	**Unit**	–	**Default setting**	0004 hex	**Data attribute**	–
Size	2 bytes (U16)		**Access**	RO	**PDO map**	Not possible	
Sub-index 05 hex	Minimum Cycle Time						
Setting range	–	**Unit**	–	**Default setting**	0000 3A98 hex	**Data attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	
Sub-index 06 hex	Calc and Copy Time						
Setting range	–	**Unit**	–	**Default setting**	0007 A120 hex	**Data attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	
Sub-index 09 hex	Delay Time						
Setting range	–	**Unit**	–	**Default setting**	0000 0000 hex	**Data attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	
Sub-index 20 hex	Sync Error						
Setting range	–	**Unit**	–	**Default setting**	0	**Data 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					
Setting range	–	**Unit**	–	**Default setting**	20 hex	**Data attribute**	–
Size	1 byte (U8)		**Access**	RO	**PDO map**	Not possible	
Sub-index 01 hex		Synchronization Type					
Setting range	–	**Unit**	–	**Default setting**	0002 hex	**Data attribute**	A
Size	2 bytes (U16)		**Access**	RW	**PDO map**	Not possible	
Sub-index 02 hex		Cycle Time					
Setting range	–	**Unit**	ns	**Default setting**	0000 0000 hex	**Data attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	
Sub-index 04 hex		Synchronization Types supported					
Setting range	–	**Unit**	–	**Default setting**	0004 hex	**Data attribute**	–
Size	2 bytes (U16)		**Access**	RO	**PDO map**	Not possible	
Sub-index 05 hex		Minimum Cycle Time					
Setting range	–	**Unit**	ns	**Default setting**	0000 3A98 hex	**Data attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	
Sub-index 06 hex		Calc and Copy Time					
Setting range	–	**Unit**	ns	**Default setting**	0006 06F8 hex	**Data attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	
Sub-index 09 hex		Delay Time					
Setting range	–	**Unit**	–	**Default setting**	0000 0000 hex	**Data attribute**	–
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	
Sub-index 20 hex		Sync Error					
Setting range	–	**Unit**	–	**Default setting**	0	**Data 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 correspond to G5-series Servo Drive parameters 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	**Data 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	**Data 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	**Data attribute**	A	
Size	1 byte (U8)		**Access**	RW	**PDO map**	Not possible		

- This object notifies of and clears the contents of Sysmac Error Status.
- Sysmac Error Status (Sub-index 01 hex): This object notifies the Controller of an error on the G5-series Servo Drive.
  If you connect the G5-series Servo Drive with a Machine Automation Controller NJ-series (Model: NJ301-□□□□/NJ501-□□□□), 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	
Setting range	0000 0000 to FFFF FFFF hex	**Unit**	–	**Default setting**	0000 0000 hex	**Data 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	
Setting range	0 to 15	**Unit**	–	**Default setting**	1	**Data attribute**	C
Size	1 byte (U8)		**Access**	RW	**PDO map**	Not possible	

- This object sets the number of times which a communications error can occur consecutively before a Communications Synchronization Error (Error No. 83.3) is detected.
- 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

When the default setting is 1, a Communications Synchronization Error (Error No. 83.3) is detected if a communications error occurs 2 consecutive times.

2201 hex	Sync Not Received Timeout Setting					All	
Setting range	0 to 600	**Unit**	s	**Default setting**	0	**Data 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
Setting range	0000 to FFFF hex	**Unit**	–	**Default setting**	0000 hex	**Data attribute**	–
Size	2 bytes (U16)		**Access**	RO	**PDO map**	Possible	

- This object gives the present state of the Servo Drive.

Explanation of Settings

Bit	Name	Symbol	Value	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	Switched on	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
csp mode	When the position command distribution amount before or after position command filtering is “0” during the communications cycle.
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).

3703 hex set value	Description
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).

3317 hex set value	Description
0	The speed is limited by the Speed Limit Value Setting (3321 hex).
1	The speed is limited by the value of the Speed Limit Value Setting (3321 hex) or Max profile velocity (607F hex), whichever is the smaller.

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 judgement 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) flag is “0” during deceleration processing for the drive prohibition input.
  For details, refer to *Target value ignored or Homing attained* on page A-57.

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 Agreement (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 judgement 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
Setting range	0000 to FFFF hex	Unit	–	Default setting	0000 hex	Data 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
Setting range	0000 0000 to FFFF FFFF hex	Unit	–	Default setting	0000 0000 hex	Data attribute	B
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
Setting range	0000 to FFFF hex	Unit	–	Default setting	0083 hex	Data attribute	B
Size	2 bytes (U16)		Access	RW	PDO map	Possible	

- Set the mode during coordinate system setting.

4104 hex	Coordinate System Setting Position						All
Setting range	–2,147,483,648 to 2,147,483,647	Unit	Command unit	Default setting	0	Data attribute	B
Size	4 bytes (INT32)		Access	RW	PDO map	Possible	

- Set the position information during coordinate system setting.

4107 hex	Error Reset						All
Setting range	0000 0000 to FFFF FFFF hex	Unit	–	Default setting	0000 0000 hex	Data attribute	A
Size	4 bytes (U32)		Access	RW	PDO map	Not possible	

- Reset the trip or fault status.
- This function can be executed by writing 7473 7274 hex using SDO mailbox communications.
- When executing the Error Reset object, remove the cause of the trip or fault before writing.
- In the following two cases, an ABORT code is returned.

  Writing with CompleteAccess.

  Writing a value other than 7473 7274 hex.

A-1-12 Servo Drive Profile Objects

This section describes the CiA402 drive profile supported by G5-series Servo Drives.

603F hex	Error code					All	
Setting range	0000 to FFFF hex	Unit	–	Default setting	0000 hex	Data 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.
- 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 type	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

A-1 CiA402 Drive Profile

A

A-1-12 Servo Drive Profile Objects

6040 hex	Controlword						All
Setting range	0000 to FFFF hex	**Unit**	–	**Default setting**	0000 hex	**Data attribute**	A
Size	2 bytes (U16)		**Access**	RW	**PDO map**	Possible	

- This object controls the state machine of the Servo Drive.

Explanation of Settings

Bit	Name	Description
0	Switch on	The state is controlled by these bits. Quick stop is not supported. The Quick stop bit is ignored even if set to “0”. *1
1	Enable voltage	
2	Quick stop	
3	Enable operation	
4 to 6	Operation mode specific	This bit is specific to the operating 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
Setting range	0000 to FFFF hex	**Unit**	–	**Default setting**	0000 hex	**Data attribute**	–
Size	2 bytes (U16)		**Access**	RO	**PDO map**	Possible	

- This object gives the present state of the Servo Drive.

Explanation of Settings

Bit	Name	Description
0	Ready to switch on	These bits give the state. For details, refer to *State Coding* on page A-4.
1	Switched on	
2	Operation enabled	
3	Fault	
4	Voltage enabled *1	
5	Quick Stop *2	
6	Switch on disabled	
7	Warning	If a warning occurs, this bit indicates that warning status exists. Operation continues without changing the status.
8	Manufacturer specific	These are manufacturer specific bits. This is not used by G5-series Servo Drives.
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	This bit is specific to the operating 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 It 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).

Bit	Name	Description
13	Following error	This bit is specific to the operating 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 to 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
Setting range	–5 to 0	**Unit**	–	**Default setting**	–1	**Data 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 stopped, following the Ready to switch on (Shutdown) state.

Explanation 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” means that after the start of deceleration, the time during which the motor runs at 30 mm/s or higher.
Once the motor speed reaches 30 mm/s or lower and the status changes to “After stopping”, subsequently the operation after stopping is performed regardless of the motor speed.

*2 “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.

*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). By default, the Undervoltage Error Selection (3508 hex) is set to “1”.

605C hex	Disable operation option code						All
Setting range	–5 to 0	Unit	–	Default setting	–1	Data 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 stopped, following the Servo OFF (Disable operation) state.

Explanation 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” means that after the start of deceleration, the time during which the motor runs at 30 mm/s or higher.
Once the motor speed reaches 30 mm/s or lower and the status changes to “After stopping”, subsequently the operation after stopping is performed regardless of the motor speed.

*2 “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.

*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	
Setting range	1 to 3	Unit	–	Default setting	1	Data 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).

Explanation of Settings

Set value	Description
1	Profile deceleration (6084 hex)
2	Not supported
3	Immediate stop

605E hex	Fault reaction option code					All	
Setting range	–7 to 0	Unit	–	Default setting	–1	Data attribute	B
Size	2 bytes (INT16)		Access	RW	PDO map	Not possible	

- This object sets the behavior when an error occurs.

Explanation of Settings

Set value	Decelerating *1			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	Clear*4		
–6	Operation A*2	Immediate Stop *3 Immediate Stop Force = 3511 hex	Clear*4	Free	Clear*4
	Operation B*2	Dynamic brake operation	Clear*4		
–5	Operation A*2	Immediate Stop *3 Immediate Stop Force = 3511 hex	Clear*4	Dynamic brake operation	Clear*4
	Operation B*2	Free-run	Clear*4		
–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	Clear*4		
–3	Common	Dynamic brake operation	Clear*4	Free	Clear*4
–2	Common	Free-run	Clear*4	Dynamic brake operation	Clear*4
–1	Common	Dynamic brake operation	Clear*4	Dynamic brake operation	Clear*4
0	Common	Free-run	Clear*4	Free	Clear*4

*1 “Decelerating” means that after the start of deceleration, the time during which the motor runs at 30 mm/s or higher.
Once the motor speed reaches 30 mm/s or lower and the status changes to “After stopping”, subsequently the operation after stopping is performed regardless of the motor speed.

*2 Operation A/B is determined for each error number. For details on errors, refer to *12-3 Errors* on page 12-9. To have the Servo Drive perform the same operation independent of the error number, set this object to 0 to –3.

*3 For the immediate stop function, refer to *12-3-2 Immediate Stop Operation at Errors* on page 12-11.

*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
Setting range	0 to 10	**Unit**	–	**Default setting**	0	**Data 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.

Explanation of Settings

Set value	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
Setting range	0 to 10	**Unit**	–	**Default setting**	0	**Data 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	
Setting range	–2,147,483,648 to 2,147,483,647	**Unit**	Command unit	**Default setting**	0	**Data 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	
Setting range	–2,147,483,648 to 2,147,483,647	**Unit**	Puls	**Default setting**	0	**Data 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	
Setting range	–2,147,483,648 to 2,147,483,647	**Unit**	Command unit	**Default setting**	0	**Data attribute**	–
Size	4 bytes (INT32)		**Access**	RO	**PDO map**	Possible	

- This object gives the present position.

6065 hex	Following error window					csp pp hm	
Setting range	0 to 134,217,728, 4,294,967,295	**Unit**	Command unit	**Default setting**	100,000	**Data 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	
Setting range	0 to 262,144	**Unit**	Command unit	**Default setting**	10	**Data attribute**	A
Size	4 bytes (U32)		**Access**	RW	**PDO map**	Not possible	

- Select the position error threshold at which the positioning completion signal (INP1) is output. The default unit is command units, but Position Setting Unit Selection (3520 hex) can be used to convert to external encoder units. However, note that the unit for the Following error window (6065 hex) will change as well.
- 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	
Setting range	–2,147,483,647 to 2,147,483,647	**Unit**	Command unit/s	**Default setting**	0	**Data attribute**	–
Size	4 bytes (INT32)		**Access**	RO	**PDO map**	Possible	

- This object gives the present speed.

6071 hex	Target torque					cst	
Setting range	–5,000 to 5,000	**Unit**	0.1%	**Default setting**	0	**Data attribute**	A
Size	2 bytes (INT16)		**Access**	RW	**PDO map**	Possible	

- This object sets the force command in the Cyclic synchronous torque mode.

6072 hex	Max torque					All	
Setting range	0 to 5,000	**Unit**	0.1%	**Default setting**	5,000	**Data 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	
Setting range	–5,000 to 5,000	**Unit**	0.1%	**Default setting**	0	**Data 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
Setting range	–5,000 to 5,000	**Unit**	0.1%	**Default setting**	0	**Data 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
Setting range	–2,147,483,648 to 2,147,483,647	**Unit**	Command unit	**Default setting**	0	**Data 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
Setting range	–1,073,741,823 to 1,073,741,823	**Unit**	Command unit	**Default setting**	0	**Data 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					
Setting range	–	**Unit**	–	**Default setting**	02 hex	**Data attribute**	–
Size	1 byte (U8)		**Access**	RO	**PDO map**	Not possible	
Sub-index 01 hex		Min position limit					
Setting range	–1,073,741,823 to 1,073,741,823	**Unit**	Command unit	**Default setting**	–500,000	**Data attribute**	A
Size	4 bytes (INT32)		**Access**	RW	**PDO map**	Not possible	
Sub-index 02 hex		Max position limit					
Setting range	–1,073,741,823 to 1,073,741,823	**Unit**	Command unit	**Default setting**	500,000	**Data 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
Setting range	0 to 2,147,483,647	**Unit**	Command unit/s	**Default setting**	0	**Data 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
Setting range	0 to 2,147,483,647	**Unit**	Command unit/s	**Default setting**	0	**Data attribute**	A
Size	4 bytes (U32)		**Access**	RW	**PDO map**	Possible	

- This object sets the target velocity for Profile position mode (pp).

6083 hex	Profile acceleration						pp hm
Setting range	1 to 655,350,000	**Unit**	Command unit/s^2	**Default setting**	1,000,000	**Data 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
Setting range	1 to 655,350,000	**Unit**	Command unit/s^2	**Default setting**	1,000,000	**Data 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
Setting range	–1 to 0	**Unit**	–	**Default setting**	0	**Data 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						
Setting range	–	**Unit**	–	**Default setting**	02 hex	**Data attribute**	–	
Size	1 byte (U8)		**Access**	RO	**PDO map**	Not possible		
Sub-index 01 hex		Motor revolutions						
Setting range	1 to 1,073,741,824	**Unit**	–	**Default setting**	1	**Data attribute**	C	
Size	4 bytes (U32)		**Access**	RW	**PDO map**	Not possible		
Sub-index 02 hex		Shaft revolutions						
Setting range	1 to 1,073,741,824	**Unit**	–	**Default setting**	1	**Data 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 it is set outside the range, an Object Setting Error 1 (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
Setting range	–128 to 127	**Unit**	Command unit/s^2	**Default setting**	0	**Data attribute**	B
Size	1 byte (INT8)	**Access**	RW	**PDO map**	Not possible		

- This objects sets the Homing method in the Homing mode (hm).

Explanation of Settings

Set value	Description
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						
Setting range	–	**Unit**	–	**Default setting**	02 hex	**Data attribute**	–
Size	1 byte (U8)		**Access**	RO	**PDO map**	Not possible	
Sub-index 01 hex	Speed during search for switch						
Setting range	100 to 3,276,700	**Unit**	Command unit/s	**Default setting**	5,000	**Data attribute**	B
Size	4 bytes (U32)		**Access**	RO	**PDO map**	Not possible	
Sub-index 02 hex	Speed during search for zero						
Setting range	100 to 3,276,700	**Unit**	Command unit/s	**Default setting**	5,000	**Data 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. The maximum value is limited based on the internal processing and the maximum motor speed.
- 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. The maximum value is limited based on the internal processing and the maximum motor speed.

60B0 hex	Position offset						csp
Setting range	–2,147,483,648 to 2,147,483,647	**Unit**	Command unit	**Default setting**	0	**Data 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
Setting range	–2,147,483,648 to 2,147,483,647	**Unit**	Command unit/s	**Default setting**	0	**Data 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	
Setting range	–5,000 to 5,000	**Unit**	0.1%	**Default setting**	0	**Data 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 Torque Feed-forward Gain (3112 hex) for use as the torque 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	
Setting range	–	**Unit**	–	**Default setting**	0	**Data 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.

Explanation of Settings

Bit	Value	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
Setting range	–	**Unit**	–	**Default setting**	0	**Data attribute**	–
Size	2 bytes (U16)		**Access**	RO	**PDO map**	Possible	

- This object gives the status of the Touch probe function (Latch Function).

Explanation of Settings

Bit	Value	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 to 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
Setting range	–2,147,483,648 to 2,147,483,647	**Unit**	Command unit	**Default setting**	0	**Data attribute**	–
Size	4 bytes (INT32)		**Access**	RO	**PDO map**	Possible	

- This object gives the latch position for Latch 1.

60BC hex	Touch probe pos 2 pos value						All
Setting range	–2,147,483,648 to 2,147,483,647	**Unit**	Command unit	**Default setting**	0	**Data 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
Setting range	0 to 5,000	**Unit**	0.1%	**Default setting**	5,000	**Data attribute**	A
Size	2 bytes (U16)		**Access**	RW	**PDO map**	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 on the force limit, refer to *7-7 Force Limit Switching* on page 7-22.

60E1 hex	Negative torque limit value						All
Setting range	0 to 5,000	Unit	0.1%	Default setting	5,000	Data attribute	A
Size	2 bytes (U16)		Access	RW	PDO map	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 on the force limit, refer to *7-7 Force Limit Switching* on page 7-22.

60E3 hex	Supported homing method						hm
Sub-index 00 hex		Number of entries					
Setting range	–	Unit	–	Default setting	07 hex	Data attribute	–
Size	1 byte (U8)		Access	RO	PDO map	Not possible	
Sub-index 01 hex		1st supported homing method					
Setting range	–	Unit	–	Default setting	0008 hex	Data attribute	–
Size	2 bytes (U16)		Access	RO	PDO map	Not possible	
Sub-index 02 hex		2nd supported homing method					
Setting range	–	Unit	–	Default setting	0012 hex	Data attribute	–
Size	2 bytes (U16)		Access	RO	PDO map	Not possible	
Sub-index 03 hex		3rd supported homing method					
Setting range	–	Unit	–	Default setting	0019 hex	Data attribute	–
Size	2 bytes (U16)		Access	RO	PDO map	Not possible	
Sub-index 04 hex		4th supported homing method					
Setting range	–	Unit	–	Default setting	0020 hex	Data attribute	–
Size	2 bytes (U16)		Access	RO	PDO map	Not possible	
Sub-index 05 hex		5th supported homing method					
Setting range	–	Unit	–	Default setting	0033 hex	Data attribute	–
Size	2 bytes (U16)		Access	RO	PDO map	Not possible	
Sub-index 06 hex		6th supported homing method					
Setting range	–	Unit	–	Default setting	0034 hex	Data attribute	–
Size	2 bytes (U16)		Access	RO	PDO map	Not possible	
Sub-index 07 hex		7th supported homing method					
Setting range	–	Unit	–	Default setting	0035 hex	Data 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	
Setting range	–536,870,912 to 536,870,912	Unit	Command unit	Default setting	0	Data 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	
Setting range	–1,073,741,823 to 1,073,741,823	Unit	Command unit/s	Default setting	0	Data attribute	–
Size	4 bytes (INT32)		Access	RO	PDO map	Possible	

- This object shows the Velocity Demand Value for the G5-series Servo Drive.

60FC hex	Position demand internal value					All	
Setting range	–1,073,741,823 to 1,073,741,823	Unit	Encoder unit	Default setting	0	Data attribute	–
Size	4 bytes (INT32)		Access	RO	PDO map	Possible	

- This object shows the Position demand internal value.

60FD hex	Digital inputs					All	
Setting range	0000 0000 to FFFF FFFF hex	Unit	–	Default setting	0000 0000 hex	Data 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.

Explanation of Settings

Bit	Signal name	Symbol	Value	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
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					
Setting range	–	Unit	–	Default setting	02 hex	Data attribute	–
Size	1 byte (U8)		Access	RO	PDO map	Not possible	
Sub-index 01 hex		Physical outputs					
Setting range	0000 0000 to FFFF FFFF hex	Unit	–	Default setting	0000 0000 hex	Data attribute	A
Size	4 bytes (U32)		Access	RW	PDO map	Possible	
Sub-index 02 hex		Bit mask					
Setting range	0000 0000 to FFFF FFFF hex	Unit	–	Default setting	0000 0000 hex	Data 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	Value	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 NJ301-□□□□/NJ501-□□□□ 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	Value	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
Setting range	–2,147,483,647 to 2,147,483,647	**Unit**	Command unit/s	**Default setting**	0	**Data 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
Setting range	–	**Unit**	–	**Default setting**	3	**Data 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
Setting range	–	Unit	–	Default setting	0000 03A1 hex	Data attribute	–
Size	4 bytes (U32)		Access	RO	PDO map	Not possible	

- This object indicates the supported Modes of operation.

Explanation of Settings

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 updated

B : Prohibited to change during motor operation or commands.
If it is changed during motor operation or commands, 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 after the control power is reset.
It is not updated for a Config command via EtherCAT communications.

RO : Write prohibited.

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	Store 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 Default Parameters	0000 0001 hex	–	–	4 bytes (U32)	B	Not possible	–

Index	Sub-Index	Name	Default setting	Setting range	Unit	Size	Data attribute	PDO map	Corresponding Pn number
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 *1018 hex* on page A-29.	–	–	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	–
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	–

Index	Sub-Index	Name	Default setting	Setting range	Unit	Size	Data attribute	PDO map	Corresponding Pn number
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)	D	Not possible	–
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	–

Index	Sub-Index	Name	Default setting	Setting range	Unit	Size	Data attribute	PDO map	Corresponding Pn number
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	–
1704 hex		261th RxPDO mapping parameter	–	–	–	–	–	–	–
	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	–

Index	Sub-Index	Name	Default setting	Setting range	Unit	Size	Data attribute	PDO map	Corresponding Pn number
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	–
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	–

Index	Sub-Index	Name	Default setting	Setting range	Unit	Size	Data attribute	PDO map	Corresponding Pn number
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	–
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	60610008 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	–

Index	Sub-Index	Name	Default setting	Setting range	Unit	Size	Data attribute	PDO map	Corresponding Pn number
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	–
	10 hex	10th Input Object to be mapped	60FD 0020 hex	–	–	4 bytes (U32)	RO	Not possible	–
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	–
	10 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	–

Index	Sub-Index	Name	Default setting	Setting range	Unit	Size	Data attribute	PDO map	Corresponding Pn number
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	–
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	–

Index	Sub-Index	Name	Default setting	Setting range	Unit	Size	Data attribute	PDO map	Corresponding Pn number
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	SynchronizationTypes 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	SynchronizationTypes 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 Errors Setting	01 hex	00 to 0F hex	–	1 byte (U8)	C	Not possible	Pn776
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

Index	Sub-Index	Name	Default setting	Setting range	Unit	Size	Data attribute	PDO map	Corresponding Pn number
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 10,000	%	2 bytes (INT16)	B	Not possible	Pn004
3013 hex	00 hex	Force Limit 1	5,000	0 to 5,000	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 30,000	0.1/s	2 bytes (INT16)	B	Not possible	Pn100
3101 hex	00 hex	Speed Loop Gain 1	180/270 *4	1 to 32,767	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 10,000	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 2,500	0.01 ms	2 bytes (INT16)	B	Not possible	Pn104
3105 hex	00 hex	Position Loop Gain 2	380/570 *7	0 to 30,000	0.1 Hz	2 bytes (INT16)	B	Not possible	Pn105
3106 hex	00 hex	Speed Loop Gain 2	180/270 *8	1 to 32,767	0.1 Hz	2 bytes (INT16)	B	Not possible	Pn106
3107 hex	00 hex	Speed Loop Integral Time Constant 2	10,000	1 to 10,000	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 2,500	0.01 ms	2 bytes (INT16)	B	Not possible	Pn109
3110 hex	00 hex	Speed Feed-forward Gain	300	0 to 1,000	0.1%	2 bytes (INT16)	B	Not possible	Pn110
3111 hex	00 hex	Speed Feed-forward Command Filter	50	0 to 6,400	0.01 ms	2 bytes (INT16)	B	Not possible	Pn111
3112 hex	00 hex	Force Feed-forward Gain	0	0 to 1,000	0.1%	2 bytes (INT16)	B	Not possible	Pn112
3113 hex	00 hex	Force Feed-forward Command Filter	0	0 to 6,400	0.01 ms	2 bytes (INT16)	B	Not possible	Pn113

*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.

Index	Sub-Index	Name	Default setting	Setting range	Unit	Size	Data attribute	PDO map	Corresponding Pn number
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 10,000	0.1 ms	2 bytes (INT16)	B	Not possible	Pn116
3117 hex	00 hex	Gain Switching Level in Position Control	50	0 to 20,000	–	2 bytes (INT16)	B	Not possible	Pn117
3118 hex	00 hex	Gain Switching Hysteresis in Position Control	33	0 to 20,000	–	2 bytes (INT16)	B	Not possible	Pn118
3119 hex	00 hex	Position Gain Switching Time	33	0 to 10,000	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 10,000	0.1 ms	2 bytes (INT16)	B	Not possible	Pn121
3122 hex	00 hex	Gain Switching Level in Speed Control	0	0 to 20,000	–	2 bytes (INT16)	B	Not possible	Pn122
3123 hex	00 hex	Gain Switching Hysteresis in Speed Control	0	0 to 20,000	–	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 10,000	0.1 ms	2 bytes (INT16)	B	Not possible	Pn125
3126 hex	00 hex	Gain Switching Level in Force Control	0	0 to 20,000	–	2 bytes (INT16)	B	Not possible	Pn126
3127 hex	00 hex	Gain Switching Hysteresis in Force Control	0	0 to 20,000	–	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	5,000	50 to 5,000	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	5,000	50 to 5,000	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	5,000	50 to 5,000	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
3210 hex	00 hex	Notch 4 Frequency Setting	5,000	50 to 5,000	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

Index	Sub-Index	Name	Default setting	Setting range	Unit	Size	Data attribute	PDO map	Corresponding Pn number
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 2,000	0.1 Hz	2 bytes (INT16)	B	Not possible	Pn214
3215 hex	00 hex	Damping Filter 1 Setting	0	0 to 1,000	0.1 Hz	2 bytes (INT16)	B	Not possible	Pn215
3216 hex	00 hex	Damping Frequency 2	0	0 to 2,000	0.1 Hz	2 bytes (INT16)	B	Not possible	Pn216
3217 hex	00 hex	Damping Filter 2 Setting	0	0 to 1,000	0.1 Hz	2 bytes (INT16)	B	Not possible	Pn217
3218 hex	00 hex	Damping Frequency 3	0	0 to 2,000	0.1 Hz	2 bytes (INT16)	B	Not possible	Pn218
3219 hex	00 hex	Damping Filter 3 Setting	0	0 to 1,000	0.1 Hz	2 bytes (INT16)	B	Not possible	Pn219
3220 hex	00 hex	Damping Frequency 4	0	0 to 2,000	0.1 Hz	2 bytes (INT16)	B	Not possible	Pn220
3221 hex	00 hex	Damping Filter 4 Setting	0	0 to 1,000	0.1 Hz	2 bytes (INT16)	B	Not possible	Pn221
3222 hex	00 hex	Position Command Filter Time Constant	0	0 to 10,000	0.1 ms	2 bytes (INT16)	B	Not possible	Pn222
3312 hex	00 hex	Soft Start Acceleration Time	0	0 to 10,000	ms/max. motor speed	2 bytes (INT16)	B	Not possible	Pn312
3313 hex	00 hex	Soft Start Deceleration Time	0	0 to 10,000	ms/max. motor speed	2 bytes (INT16)	B	Not possible	Pn313
3314 hex	00 hex	S-curve Acceleration/ Deceleration Time Setting	0	0 to 1,000	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	20,000	0 to 20,000	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
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

Index	Sub-Index	Name	Default setting	Setting range	Unit	Size	Data attribute	PDO map	Corresponding Pn number
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 214,748,364	–	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 214,748,364	–	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	Pn432
3433 hex	00 hex	Positioning Completed Hold Time	0	0 to 30,000	m	2 bytes (INT16)	A	Not possible	Pn433
3434 hex	00 hex	Zero Speed Detection	50	10 to 20,000	mm/s	2 bytes (INT16)	A	Not possible	Pn434
3435 hex	00 hex	Speed Conformity Detection Range	50	10 to 20,000	mm/s	2 bytes (INT16)	A	Not possible	Pn435
3436 hex	00 hex	Speed for Motor Detection	1,000	10 to 20,000	mm/s	2 bytes (INT16)	A	Not possible	Pn436
3437 hex	00 hex	Brake Timing when Stopped	0	0 to 10,000	ms	2 bytes (INT16)	B	Not possible	Pn437
3438 hex	00 hex	Brake Timing During Operation	0	0 to 10,000	ms	2 bytes (INT16)	B	Not possible	Pn438
3439 hex	00 hex	Brake Threshold Speed During Operation	30	30 to 3,000	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 262,144	Command unit	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 2,000	ms	2 bytes (INT16)	C	Not possible	Pn509
3511 hex	00 hex	Immediate Stop Force	0	0 to 5,000	0.1%	2 bytes (INT16)	B	Not possible	Pn755
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 1,000	0.1 magnetic pole pitch	2 bytes (INT16)	A	Not possible	Pn514

*1 For units, refer to *3416 hex* on page 9-32.

Index	Sub-Index	Name	Default setting	Setting range	Unit	Size	Data attribute	PDO map	Corresponding Pn number
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	5,000	0 to 5,000	0.1%	2 bytes (INT16)	B	Not possible	Pn754
3525 hex	00 hex	Force Limit 3	5,000	0 to 5,000	0.1%	2 bytes (INT16)	B	Not possible	Pn730
3526 hex	00 hex	Force Limit 4	5,000	0 to 5,000	0.1%	2 bytes (INT16)	B	Not possible	Pn731
3602 hex	00 hex	Excessive Speed Deviation Setting	0	0 to 20,000	mm/s	2 bytes (INT16)	B	Not possible	Pn602
3605 hex	00 hex	Gain 3 Effective Time	0	0 to 10,000	0.1 ms	2 bytes (INT16)	B	Not possible	Pn605
3606 hex	00 hex	Gain 3 Ratio Setting	100	50 to 1,000	%	2 bytes (INT16)	B	Not possible	Pn606
3607 hex	00 hex	Force Command Value Offset	0	–100 to 100	%	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 1,000	ms	2 bytes (INT16)	B	Not possible	Pn614
3615 hex	00 hex	Overspeed Detection Level Setting at Immediate Stop	0	0 to 20,000	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 2,500	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	–32,768 to 32,767	–	2 bytes (INT16)	B	Not possible	Pn632
3637 hex	00 hex	Vibration Detection Threshold	0	0 to 1,000	0.1%	2 bytes (INT16)	B	Not possible	Pn637
3638 hex	00 hex	Warning Mask Setting	4	–32,768 to 32,767	–	2 bytes (INT16)	C	Not possible	Pn638
3700 hex	00 hex	LED Display Selection	0	0 to 32,767	–	2 bytes (INT16)	A	Not possible	Pn700
3701 hex	00 hex	Power ON Address Display Duration Setting	0	0 to 1,000	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

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	–32,768 to 32,767	Command unit	2 bytes (INT16)	B	Not possible	Pn705
3706 hex	00 hex	Backlash Compensation Time Constant	0	0 to 6,400	0.01 ms	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)	R	Not possible	Pn759
3781 hex	00 hex	Data Setting Warning Detection Setting	1	0 to 15	Times	2 bytes (INT16)	C	Not possible	Pn781
3800 hex	00 hex	Communications Control	16,384	–32,768 to 32,767	–	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 unit	2 bytes (INT16)	A	Not possible	Pn803
3818 hex	00 hex	Position Command FIR Filter Time Constant	0	0 to 10,000	0.1 ms	2 bytes (INT16)	B	Not possible	Pn818
3901 hex	00 hex	External Encoder Resolution	0	0 to 16,777,216	0.001 µm	4 bytes (INT32)	R	Not possible	Pn901
3902 hex	00 hex	Pole Pitch	0	0 to 32,767	0.01 mm	2 bytes (INT16)	R	Not possible	Pn902
3904 hex	00 hex	Motor Coil Unit Mass	0	0 to 32,767	0.01 kg	2 bytes (INT16)	R	Not possible	Pn904
3905 hex	00 hex	Motor Rated Force	0	0 to 32,767	0.1 N	2 bytes (INT16)	R	Not possible	Pn905
3906 hex	00 hex	Motor Rated Rms Current	0	0 to 32,767	0.1 Arms	2 bytes (INT16)	R	Not possible	Pn906
3907 hex	00 hex	Motor Peak Absolute Current	0	0 to 32,767	0.1A	2 bytes (INT16)	R	Not possible	Pn907
3908 hex	00 hex	Motor Inductance	0	0 to 32,767	0.01 mH	2 bytes (INT16)	R	Not possible	Pn908
3909 hex	00 hex	Motor Resistance	0	0 to 32,767	0.01 Ω	2 bytes (INT16)	R	Not possible	Pn909
3910 hex	00 hex	Overspeed Level	0	0 to 20,000	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 32,767	–	2 bytes (INT16)	B	Not possible	Pn913
3914 hex	00 hex	Current Loop Integral Gain	10	0 to 32,767	–	2 bytes (INT16)	B	Not possible	Pn914
3915 hex	00 hex	Two-stage Force Filter Time Constant	0	0 to 2,500	0.01 ms	2 bytes (INT16)	B	Not possible	Pn915
3916 hex	00 hex	Two-stage Force Filter Attenuation Term	1,000	0 to 1,000	–	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

*1 For details, refer to *3912 hex* on page 9-64.

Index	Sub-Index	Name	Default setting	Setting range	Unit	Size	Data attribute	PDO map	Corresponding Pn number
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 32,767	Pulse	2 bytes (INT16)	B	Not possible	Pn924
3925 hex	00 hex	Magnetic Pole Position Estimation Movement for Stop Judgement	40	0 to 32,767	Pulse	2 bytes (INT16)	B	Not possible	Pn925
3926 hex	00 hex	Magnetic Pole Position Estimation Time for Stop Judgement	40	0 to 32,767	ms	2 bytes (INT16)	B	Not possible	Pn926
3927 hex	00 hex	Magnetic Pole Position EstimationTime Limit for Stop	1,000	0 to 32,767	ms	2 bytes (INT16)	B	Not possible	Pn927
3928 hex	00 hex	Magnetic Pole Position Estimation Force Filter Time Constant	100	0 to 2,500	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	Statusword1	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	–2,147,483,648 to 2,147,483,647	Command unit	4 bytes (INT32)	B	RxPDO	–
4107 hex	00 hex	Error Reset	0000 0000 hex	0000 0000 to FFFF FFFF hex	–	4 bytes (U32)	A	Not possible	–
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	–2,147,483,648 to 2,147,483,647	Command unit	4 bytes (INT32)	RO	TxPDO	–
6063 hex	00 hex	Position actual internal value	0	–2,147,483,648 to 2,147,483,647	External encoder unit	4 bytes (INT32)	RO	TxPDO	–

Index	Sub-Index	Name	Default setting	Setting range	Unit	Size	Data attribute	PDO map	Corresponding Pn number
6064 hex	00 hex	Position actual value	0	–2,147,483,648 to 2,147,483,647	Command unit	4 bytes (INT32)	RO	TxPDO	–
6065 hex	00 hex	Following error window	10,0000	0 to 134,217,728 or 4,294,967,295	Command unit	4 bytes (U32)	A	Not possible	Pn739
6067 hex	00 hex	Position window	10	0 to 262,144	Command unit	4 bytes (U32)	A	Not possible	Pn740
606C hex	00 hex	Velocity actual value	0	–2,147,483,647 to 2,147,483,647	Command unit/s	4 bytes (INT32)	RO	TxPDO	–
6071 hex	00 hex	Target torque	0	–5,000 to 5,000	0.1%	2 bytes (INT16)	A	RxPDO	–
6072 hex	00 hex	Max torque	5,000	0 to 5,000	0.1%	2 bytes (U16)	A	RxPDO	–
6074 hex	00 hex	Torque demand	0	–5,000 to 5,000	0.1%	2 bytes (INT16)	RO	TxPDO	–
6077 hex	00 hex	Torque actual value	0	–5,000 to 5,000	0.1%	2 bytes (INT16)	RO	TxPDO	–
607A hex	00 hex	Target position	0	–2,147,483,648 to 2,147,483,647	Command unit	4 bytes (INT32)	A	RxPDO	–
607C hex	00 hex	Home offset	0	–1,073,741,823 to 1,073,741,823	Command unit	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	–500,000	–1,073,741,823 to 1,073,741,823	Command unit	4 bytes (INT32)	A	Not possible	Pn743
	02 hex	Max position limit	500,000	–1,073,741,823 to 1,073,741,823	Command unit	4 bytes (INT32)	A	Not possible	Pn744
607F hex	00 hex	Max profile velocity	0	0 to 2,147,483,647	Command unit/s	4 bytes (U32)	A	RxPDO	–
6081 hex	00 hex	Profile velocity	0	0 to 2,147,483,647	Command unit/s	4 bytes (U32)	A	RxPDO	–
6083 hex	00 hex	Profile acceleration	1,000,000	1 to 655,350,000	Command unit/s^2	4 bytes (U32)	B	Not possible	Pn745
6084 hex	00 hex	Profile deceleration	1,000,000	1 to 655,350,000	Command unit/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 1,073,741,824	–	4 bytes (U32)	C	Not possible	Pn748
	02 hex	Shaft revolutions	1	1 to 1,073,741,824	–	4 bytes (U32)	C	Not possible	Pn749
6098 hex	00 hex	Homing method	0	–128 to 127	–	1 bytes (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	5,000	100 to 3,276,700	Command unit/s	4 bytes (U32)	B	Not possible	Pn751
	02 hex	Speed during search for zero	5,000	100 to 3,276,700	Command unit/s	4 bytes (U32)	B	Not possible	Pn752
60B0 hex	00 hex	Position offset	0	–2,147,483,648 to 2,147,483,647	Command unit	4 bytes (INT32)	A	RxPDO	–

Index	Sub-Index	Name	Default setting	Setting range	Unit	Size	Data attribute	PDO map	Corresponding Pn number
60B1 hex	00 hex	Velocity offset	0	–2,147,483,648 to 2,147,483,647	Command unit/s	4 bytes (INT32)	A	RxPDO	–
60B2 hex	00 hex	Torque offset	0	–5,000 to 5,000	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	–2,147,483,648 to 2,147,483,647	Command unit	4 bytes (INT32)	RO	TxPDO	–
60BC hex	00 hex	Touch probe pos2 pos value	0	–2,147,483,648 to 2,147,483,647	Command unit	4 bytes (INT32)	RO	TxPDO	–
60E0 hex	00 hex	Positive torque limit value	5,000	0 to 5,000	0.1%	2 bytes (U16)	A	Not possible	–
60E1 hex	00 hex	Negative torque limit value	5,000	0 to 5,000	0.1%	2 bytes (U16)	A	Not possible	–
60E3 hex		Supported homing methods	–	–	–	–	–	–	–
	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	–536,870,912 to 536,870,912	Command unit	4 bytes (INT32)	RO	TxPDO	–
60FA hex	00 hex	Control effort	0	–1,073,741,823 to 1,073,741,823	Command unit	4 bytes (INT32)	RO	TxPDO	–
60FC hex	00 hex	Position demand internal value	0	–1,073,741,823 to 1,073,741,823	Encoder unit	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	–
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	–
60FF hex	00 hex	Target velocity	0	–2,147,483,647 to 2,147,483,647	Command unit/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 can 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	Description	Assumed cause	Level					Reference
				Maj	Prt	Min	Obs	Info	
04A8 0000 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.			✓			P.A-110
04A9 0000 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.			✓			P.A-111

Event code	Event name	Description	Assumed cause	Level					Reference
				Maj	Prt	Min	Obs	Info	
04AA 0000 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 single-phase power supply. • The Servo Drive failed.			✓			P.A-112
04AB 0000 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 single-phase power supply. • The Servo Drive failed.			✓			P.A-113
04AC 0000 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.			✓			P.A-114

Event code	Event name	Description	Assumed cause	Level					Reference
				Maj	Prt	Min	Obs	Info	
04AD 0000 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 command input timing is the same as or earlier than the Servo ON timing.			✓			P.A-115
04AE 0000 hex	Regeneration Tr Error	The Servo Drive regeneration drive transistor is faulty.	The Servo Drive regeneration drive Tr is faulty.			✓			P.A-116
04B1 0000 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.			✓			P.A-116
04B2 0000 hex	Other Errors	The Servo Drive malfunctioned, or an error occurred in the Servo Drive.	• The control circuit malfunctioned temporarily due to excess noise or some other problem. • The Servo Drive's self-diagnosis function detected an error in the Servo Drive.			✓			P.A-117
080B 0000 hex	Safety Input Error	One of the input photocouplers for safety inputs 1 and 2 turned OFF.	The cable is disconnected or broken.			✓			P.A-117
080C 0000 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.			✓			P.A-118
080D 0000 hex	External Encoder Communications Data Error	There was a communications error in data from external encoder.	• There is insufficient external encoder power supply voltage. • Noise			✓			P.A-118
080E 0000 hex	External Encoder Status Error 0	Bit 00 of the external encoder error code (ALMC) was set to 1.	Bit 00 of the external encoder error code (ALMC) was set to 1.			✓			P.A-119
080F 0000 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.			✓			P.A-119

Event code	Event name	Description	Assumed cause	Level					Reference
				Maj	Prt	Min	Obs	Info	
0810 0000 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.			✓			P.A-120
0811 0000 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.			✓			P.A-120
0812 0000 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.			✓			P.A-121
0813 0000 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.			✓			P.A-121
0814 0000 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.			✓			P.A-122
0815 0000 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.			✓			P.A-122
0816 0000 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.			✓			P.A-123
14A8 0000 hex	Object Error	The object area data in non-volatile memory is corrupted.	• Noise • Non-volatile memory failure			✓			P.A-123
14A9 0000 hex	Object Error	The object area data in non-volatile memory is corrupted.	• Noise • Non-volatile memory failure			✓			P.A-124
14AA 0000 hex						✓			P.A-124
14AB 0000 hex	Object Corrupted	The checksum data in non-volatile memory is corrupted.	Non-volatile memory failure			✓			P.A-125
14AC 0000 hex						✓			P.A-125
14AD 0000 hex						✓			P.A-126
2801 0000 hex	Motor Setting Error	Settings associated with the motor and external encoder are missing.	Settings associated with the motor and external encoder are missing.			✓			P.A-126
2802 0000 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.			✓			P.A-127

Event code	Event name	Description	Assumed cause	Level					Reference
				Maj	Prt	Min	Obs	Info	
2803 0000 hex	Motor Combination Error 2	The value set for the motor exceeds the drive range of the motor.	• The Motor Rated Rms Current is 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%.			✓			P.A-128
34E1 0000 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			✓			P.A-129
34E2 0000 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.			✓			P.A-130
34E3 0000 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.)			✓			P.A-131
34E4 0000 hex	Following Error Counter Overflow	Following error actual value 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.			✓			P.A-132

Event code	Event name	Description	Assumed cause	Level					Reference
				Maj	Prt	Min	Obs	Info	
34E5 0000 hex	Excessive Speed Deviation 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.			✓			P.A-133
34E6 0000 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.			✓			P.A-134
3840 0000 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.			✓			P.A-135
3841 0000 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.			✓			P.A-135
3842 0000 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 an “over the calculation range“ error occurred.			✓			P.A-136
3843 0000 hex	Following 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).			✓			P.A-136
3844 0000 hex	Following 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 ±2 2^{30} (1,073,741,824).	• There is insufficient force. • There is insufficient gain. • The external encoder wiring is incorrect.			✓			P.A-137
3845 0000 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.			✓			P.A-138
3846 0000 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.			✓			P.A-138

Event code	Event name	Description	Assumed cause	Level					Reference
				Maj	Prt	Min	Obs	Info	
3847 0000 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).			✓			P.A-139
3848 0000 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).			✓			P.A-140
3849 0000 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.			✓			P.A-141
384A 0000 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.			✓			P.A-142
384B 0000 hex	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. • A latch input is assigned to an NC signal. • The same latch input is not assigned to the same pin in all Control Modes.			✓			P.A-143
384C 0000 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.			✓			P.A-144
384F 0000 hex	Object Setting Error 1	The electronic gear ratio exceeded the allowable range.	The electronic gear ratio exceeded the allowable range.			✓			P.A-144
3850 0000 hex	Object Setting Error 2	External encoder ratio exceeded the allowable range.	External encoder ratio exceeded the allowable range.			✓			P.A-145

Event code	Event name	Description	Assumed cause	Level					Reference
				Maj	Prt	Min	Obs	Info	
3851 0000 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.			✓			P.A-145
3852 0000 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 11objects were mapped for TxPDO.			✓			P.A-146
3853 0000 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.			✓			P.A-147
3854 0000 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 Position Estimation 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.			✓			P.A-148

Event code	Event name	Description	Assumed cause	Level					Reference
				Maj	Prt	Min	Obs	Info	
3855 0000 hex	Magnetic Pole Position Estimation Error 3	Magnetic pole position restoration was not completed successfully.	• The Magnetic Pole Detection Method (3920 hex) was set to 3 (Magnetic pole position restoration method), although 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.			✓			P.A-149
3856 0000 hex	Motor Auto-setting Error	Overshooting occurred when the electric current was applied to the motor to execute the lock operation or FFT measurement preparation.	The Current Loop Proportional Gain or Current Loop Integral Gain value before automatic setting is too large.			✓			P.A-150
64E0 0000 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.			✓			P.A-150

Event code	Event name	Description	Assumed cause	Level					Reference
				Maj	Prt	Min	Obs	Info	
64E1 0000 hex	Drive Prohibition Input Error 2	When the Drive Prohibition Input Selection (3504 hex) was set to “0” and either the Positive Drive Prohibition input or the Negative Drive Prohibition input (POT/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.			✓			P.A-151
64E2 0000 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).			✓			P.A-151

Event code	Event name	Description	Assumed cause	Level					Reference
				Maj	Prt	Min	Obs	Info	
7481 0000 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 status (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 Modes of operation (6060 hex). • The setting of the Modes of operation (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).			✓			P.A-152
7801 0000 hex	Operation Command Duplicated	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 alone or a 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 alone or a trial run.			✓			P.A-153

Event code	Event name	Description	Assumed cause	Level					Reference
				Maj	Prt	Min	Obs	Info	
84B1 0000 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.			✓			P.A-153
84B2 0000 hex	EtherCAT Illegal State Change Error	An undefined communications state change command was received.	An undefined communications state change command was received.			✓			P.A-154
84B3 0000 hex	Communications Synchronization Error	The number of consecutive errors in receiving data during the communication sync time exceeded the value specified for the Communications Error Setting (2200 hex).	• The power supply for the host controller was shut off during PDO communications. • An EtherCAT communications cable is disconnected, broken, or incorrectly connected. • Noise			✓			P.A-154
84B4 0000 hex	Synchronization Error	A synchronization error occurred.	• Noise • Control PCB error.			✓			P.A-155
84B5 0000 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. • Control PCB error.			✓			P.A-155
84B6 0000 hex	ESC Initialization Error	An error occurred in ESC initialization.	Control PCB error.			✓			P.A-156
84B7 0000 hex	Slave Unit Verification Error	An error occurred in Slave Unit verification.	Control PCB error.			✓			P.A-156
84B8 0000 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.			✓			P.A-157
84B9 0000 hex	Synchronization Interruptions Error	A synchronization interruption error occurred.	Control PCB error.			✓			P.A-157
9802 0000 hex	Position Data Initialized	A Config operation was performed during EtherCAT communications.	A Config operation was performed during EtherCAT communications.			✓			P.A-158
0802 0000 hex	Fan Warning	The fan stop state continued for 1 second.	• There is foreign matter in the fan. • The Servo Drive failed.				✓		P.A-158
0804 0000 hex	External Encoder Overheating Warning	The external encoder temperature exceeded the specified value.	• The ambient temperature is too high. • Linear Motor failed.				✓		P.A-159
0805 0000 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.				✓		P.A-159

Event code	Event name	Description	Assumed cause	Level					Reference
				Maj	Prt	Min	Obs	Info	
0806 0000 hex	External Encoder Error Warning	The external encoder detected a warning.	• There is insufficient external encoder power supply voltage. • Noise is entering on the external encoder connector cable. • The external encoder failed.				✓		P.A-160
0807 0000 hex	External Encoder Communications Warning	The external encoder had more communications errors than the specified value.	• There is insufficient external encoder power supply voltage. • Noise is entering on the external encoder connector cable.				✓		P.A-161
34E0 0000 hex	Data Setting Warning	An object setting is out of range.	An object setting is out of range.				✓		P.A-161
383C 0000 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.				✓		P.A-162
383D 0000 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.				✓		P.A-163
383E 0000 hex	Vibration Detection Warning	Vibration was detected.	The gain or mass ratio setting is not suitable.				✓		P.A-164
7480 0000 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.				✓		P.A-165

Event code	Event name	Description	Assumed cause	Level					Reference
				Maj	Prt	Min	Obs	Info	
84B0 0000 hex	EtherCAT Communications Warning	EtherCAT communications errors occurred one or more times.	• The EtherCAT communications cable is disconnected or broken. • Noise				✓		P.A-166

A-3-2 Error Description

This section describes errors.

Controller Error Descriptions

<table>
<tr><td>Event name</td><td colspan="3">Gives the name of the error.</td><td>Event code</td><td colspan="2">Gives the code of the error.</td></tr>
<tr><td>Description</td><td colspan="6">Gives a short description of the error.</td></tr>
<tr><td>Source</td><td colspan="2">Gives the source of the error.</td><td>Source details</td><td>Gives details on the source of the error.</td><td>Detection timing</td><td>Tells when the error is detected.</td></tr>
<tr><td>Error attributes</td><td>Level</td><td>Tells the influence on control. *1</td><td>Recovery</td><td>Gives the recovery method. *2</td><td>Log category</td><td>Tells which log the error is saved in. *3</td></tr>
<tr><td>Effects</td><td>User program</td><td>Tells what will happen to execution of the user program. *4</td><td>Operation</td><td colspan="3">Provides special information on the operation that results from the error.</td></tr>
<tr><td>Indicators</td><td colspan="6">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.</td></tr>
<tr><td rowspan="2">System -defined variables</td><td colspan="2">Variable</td><td colspan="2">Data type</td><td colspan="2">Name</td></tr>
<tr><td colspan="6">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.</td></tr>
<tr><td rowspan="2">Cause and correction</td><td colspan="2">Assumed cause</td><td colspan="2">Correction</td><td colspan="2">Prevention</td></tr>
<tr><td colspan="6">Lists the possible causes, remedies, and preventive measures for the error.</td></tr>
<tr><td>Attached information</td><td colspan="6">Provides the additional information that is displayed by the Sysmac Studio or an NS-series PT.</td></tr>
<tr><td>Precautions/ Remarks</td><td colspan="6">Provides precautions, restrictions, and supplemental information.</td></tr>
</table>

*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

Event name	Control Power Supply Undervoltage			**Event code**	04A8 0000 hex	
Description	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**		**Correction**		**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).					

<table>
<tr><th>Event name</th><td colspan="3">Overvoltage</td><th>Event code</th><td colspan="2">04A9 0000 hex</td></tr>
<tr><th>Description</th><td colspan="6">The power supply voltage exceeded the allowable input voltage range.</td></tr>
<tr><th>Source</th><td colspan="2">EtherCAT Master Function Module</td><th>Source details</th><td>Slave</td><th>Detection timing</th><td>Continuously</td></tr>
<tr><th>Error attributes</th><th>Level</th><td>Minor fault</td><th>Recovery</th><td>Error reset
(after resetting slave errors)</td><th>Log category</th><td>System</td></tr>
<tr><th>Effects</th><th>User program</th><td>Continues.</td><th>Operation</th><td colspan="3">Power drive circuit is OFF for relevant slave.</td></tr>
<tr><th rowspan="2">Indicators</th><th colspan="2">EtherNet/IP NET RUN</th><th colspan="2">EtherNet/IP NET ERR</th><th colspan="2">EtherNet/IP LINK/ACT</th></tr>
<tr><td colspan="2">–</td><td colspan="2">–</td><td colspan="2">–</td></tr>
<tr><th rowspan="2">System -defined variables</th><th colspan="2">Variable</th><th colspan="2">Data type</th><th colspan="2">Name</th></tr>
<tr><td colspan="2">None</td><td colspan="2">–</td><td colspan="2">–</td></tr>
<tr><th rowspan="6">Cause and correction</th><th colspan="2">Assumed cause</th><th colspan="2">Correction</th><th colspan="2">Prevention</th></tr>
<tr><td colspan="2">The voltage between the positive and negative terminals in the control power supply converter exceeded the specified value.</td><td colspan="2">Input the correct voltage.</td><td colspan="2">Input the correct voltage.</td></tr>
<tr><td colspan="2">The voltage was suddenly increased by the phase advance capacitor or the uninterruptible power supply (UPS).</td><td colspan="2">Remove the phase-advancing capacitor or UPS.</td><td colspan="2">Do not use a phase-advancing capacitor or UPS.</td></tr>
<tr><td colspan="2">The Regeneration Resistor wiring is broken.</td><td colspan="2">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.</td><td colspan="2">None</td></tr>
<tr><td colspan="2">The External Regeneration Resistor is not suitable.</td><td colspan="2">Change the Regeneration Resistor based on the specified regeneration resistance and the calculated power (W).</td><td colspan="2">Determine the Regeneration Resistor based on the specified regeneration resistance and the calculated power (W).</td></tr>
<tr><td colspan="2">The Servo Drive failed.</td><td colspan="2">Replace the Servo Drive.</td><td colspan="2">None</td></tr>
<tr><th>Attached information</th><td colspan="6">None</td></tr>
<tr><th>Precautions/ Remarks</th><td colspan="6">“12” is displayed on the Servo Drive front panel and F012 is given as the AlarmCode (4001 hex).</td></tr>
</table>

Event name	Main Circuit Power Supply Undervoltage (Undervoltage between positive and negative terminals)			**Event code**	04AA 0000 hex	
Description	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**		**Correction**		**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 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**	04AB 0000 hex	
Description	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**		**Correction**		**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 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**	04AC 0000 hex	
Description	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**		**Correction**		**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).					

<table>
<tr><th>Event name</th><td colspan="3">IPM Error</td><th>Event code</th><td colspan="2">04AD 0000 hex</td></tr>
<tr><th>Description</th><td colspan="6">The current flowing through the converter exceeded the specified value.</td></tr>
<tr><th>Source</th><td colspan="2">EtherCAT Master Function Module</td><th>Source details</th><td>Slave</td><th>Detection timing</th><td>Continuously</td></tr>
<tr><th>Error attributes</th><th>Level</th><td>Minor fault</td><th>Recovery</th><td>Error reset (after cycling slave power)</td><th>Log category</th><td>System</td></tr>
<tr><th>Effects</th><th>User program</th><td>Continues.</td><th>Operation</th><td colspan="3">Power drive circuit is OFF for relevant slave.</td></tr>
<tr><th rowspan="2">Indicators</th><th colspan="2">EtherNet/IP NET RUN</th><th colspan="2">EtherNet/IP NET ERR</th><th colspan="2">EtherNet/IP LINK/ACT</th></tr>
<tr><td colspan="2">–</td><td colspan="2">–</td><td colspan="2">–</td></tr>
<tr><th rowspan="2">System -defined variables</th><th colspan="2">Variable</th><th colspan="2">Data type</th><th colspan="2">Name</th></tr>
<tr><td colspan="2">None</td><td colspan="2">–</td><td colspan="2">–</td></tr>
<tr><th rowspan="7">Cause and correction</th><th colspan="2">Assumed cause</th><th colspan="2">Correction</th><th colspan="2">Prevention</th></tr>
<tr><td colspan="2">A short-circuit, line-to-ground fault, contact failure, or insulation failure occurred on the U, V, or W motor line.</td><td colspan="2">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.</td><td colspan="2">Confirm that the U, V, and W motor lines are connected correctly.</td></tr>
<tr><td colspan="2">The Servo Drive failed.</td><td colspan="2">Disconnect the motor lines and turn ON the Servo. If this error occurs immediately, replace the Servo Drive.</td><td colspan="2">None</td></tr>
<tr><td colspan="2">The relay for the dynamic brake has been welded due to frequent servo ON/OFF operations.</td><td colspan="2">Replace the Servo Drive.</td><td colspan="2">Do not start and stop operation by frequently switching the Servo ON/OFF.</td></tr>
<tr><td colspan="2">Motor windings are burned out.</td><td colspan="2">Check the balance of the resistance between the lines of the motor. If resistance is unbalanced, replace the motor.</td><td colspan="2">Do not apply excessive load on the motor.</td></tr>
<tr><td colspan="2">The motor is not suitable for the Servo Drive.</td><td colspan="2">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.</td><td colspan="2">Use a motor that matches the Servo Drive.</td></tr>
<tr><td colspan="2">The command input timing is the same as or earlier than the servo ON timing.</td><td colspan="2">Wait at least 100 ms after the servo has been turned ON, then input commands.</td><td colspan="2">Wait at least 100 ms after the servo has been turned ON, then input commands.</td></tr>
<tr><th>Attached information</th><td colspan="6">None</td></tr>
<tr><th>Precautions/ Remarks</th><td colspan="6">“14” is displayed on the Servo Drive front panel and F114 is given as the AlarmCode (4001 hex).</td></tr>
</table>

Event name	Regeneration Tr Error			**Event code**	04AE 0000 hex	
Description	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**		**Correction**		**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**	04B1 0000 hex	
Description	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**		**Correction**		**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).					

Event name	Other Errors			**Event code**	04B2 0000 hex	
Description	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	**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**		**Correction**		**Prevention**	
	The control circuit malfunctioned temporarily due to excess noise or some other problem.		Turn OFF then ON again the power supply.		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**	080B 0000 hex	
Description	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**		**Correction**		**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**	080C 0000 hex		
Description	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**		**Correction**		**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**	080D 0000 hex		
Description	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**		**Correction**		**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	080E 0000 hex	
Description	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		Correction		Prevention	
	Bit 00 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 F051 is given as the AlarmCode (4001 hex).					

Event name	External Encoder Status Error 1			Event code	080F 0000 hex	
Description	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		Correction		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	0810 0000 hex	
Description	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		Correction		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	0811 0000 hex	
Description	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		Correction		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).					

<table>
<tr><th>Event name</th><td colspan="3">External Encoder Status Error 4</td><th>Event code</th><td colspan="2">0812 0000 hex</td></tr>
<tr><th>Description</th><td colspan="6">Bit 04 of the external encoder error code (ALMC) was set to 1.</td></tr>
<tr><th>Source</th><td colspan="2">EtherCAT Master Function Module</td><th>Source details</th><td>Slave</td><th>Detection timing</th><td>Continuously</td></tr>
<tr><th>Error attributes</th><th>Level</th><td>Minor fault</td><th>Recovery</th><td>Error reset (after cycling slave power)</td><th>Log category</th><td>System</td></tr>
<tr><th>Effects</th><th>User program</th><td>Continues.</td><th>Operation</th><td colspan="3">Power drive circuit is OFF for relevant slave.</td></tr>
<tr><th rowspan="2">Indicators</th><th colspan="2">EtherNet/IP NET RUN</th><th colspan="2">EtherNet/IP NET ERR</th><th colspan="2">EtherNet/IP LINK/ACT</th></tr>
<tr><td colspan="2">–</td><td colspan="2">–</td><td colspan="2">–</td></tr>
<tr><th rowspan="2">System -defined variables</th><th colspan="2">Variable</th><th colspan="2">Data type</th><th colspan="2">Name</th></tr>
<tr><td colspan="2">None</td><td colspan="2">–</td><td colspan="2">–</td></tr>
<tr><th rowspan="2">Cause and correction</th><th colspan="2">Assumed cause</th><th colspan="2">Correction</th><th colspan="2">Prevention</th></tr>
<tr><td colspan="2">Bit 04 of the external encoder error code (ALMC) was set to 1.</td><td colspan="2">Check the external encoder specifications and take suitable corrective actions.</td><td colspan="2">Take preventative actions according to the external encoder specifications.</td></tr>
<tr><th>Attached information</th><td colspan="6">None</td></tr>
<tr><th>Precautions/ Remarks</th><td colspan="6">“51” is displayed on the Servo Drive front panel and F451 is given as the AlarmCode (4001 hex).</td></tr>
</table>

<table>
<tr><th>Event name</th><td colspan="3">External Encoder Status Error 5</td><th>Event code</th><td colspan="2">0813 0000 hex</td></tr>
<tr><th>Description</th><td colspan="6">Bit 05 of the external encoder error code (ALMC) was set to 1.</td></tr>
<tr><th>Source</th><td colspan="2">EtherCAT Master Function Module</td><th>Source details</th><td>Slave</td><th>Detection timing</th><td>Continuously</td></tr>
<tr><th>Error attributes</th><th>Level</th><td>Minor fault</td><th>Recovery</th><td>Error reset (after cycling slave power)</td><th>Log category</th><td>System</td></tr>
<tr><th>Effects</th><th>User program</th><td>Continues.</td><th>Operation</th><td colspan="3">Power drive circuit is OFF for relevant slave.</td></tr>
<tr><th rowspan="2">Indicators</th><th colspan="2">EtherNet/IP NET RUN</th><th colspan="2">EtherNet/IP NET ERR</th><th colspan="2">EtherNet/IP LINK/ACT</th></tr>
<tr><td colspan="2">–</td><td colspan="2">–</td><td colspan="2">–</td></tr>
<tr><th rowspan="2">System -defined variables</th><th colspan="2">Variable</th><th colspan="2">Data type</th><th colspan="2">Name</th></tr>
<tr><td colspan="2">None</td><td colspan="2">–</td><td colspan="2">–</td></tr>
<tr><th rowspan="2">Cause and correction</th><th colspan="2">Assumed cause</th><th colspan="2">Correction</th><th colspan="2">Prevention</th></tr>
<tr><td colspan="2">Bit 05 of the external encoder error code (ALMC) was set to 1.</td><td colspan="2">Check the external encoder specifications and take suitable corrective actions.</td><td colspan="2">Take preventative actions according to the external encoder specifications.</td></tr>
<tr><th>Attached information</th><td colspan="6">None</td></tr>
<tr><th>Precautions/ Remarks</th><td colspan="6">“51” is displayed on the Servo Drive front panel and F551 is given as the AlarmCode (4001 hex).</td></tr>
</table>

<table>
<tr><td>Event name</td><td colspan="3">Phase-A Connection Error</td><td>Event code</td><td colspan="2">0814 0000 hex</td></tr>
<tr><td>Description</td><td colspan="6">An error such as broken wiring was detected in the external encoder phase-A connection.</td></tr>
<tr><td>Source</td><td colspan="2">EtherCAT Master Function Module</td><td>Source details</td><td>Slave</td><td>Detection timing</td><td>Continuously</td></tr>
<tr><td>Error attributes</td><td>Level</td><td>Minor fault</td><td>Recovery</td><td>Error reset
(after cycling slave power)</td><td>Log category</td><td>System</td></tr>
<tr><td>Effects</td><td>User program</td><td>Continues.</td><td>Operation</td><td colspan="3">Power drive circuit is OFF for relevant slave.</td></tr>
<tr><td rowspan="2">Indicators</td><td colspan="2">EtherNet/IP NET RUN</td><td colspan="2">EtherNet/IP NET ERR</td><td colspan="2">EtherNet/IP LINK/ACT</td></tr>
<tr><td colspan="2">–</td><td colspan="2">–</td><td colspan="2">–</td></tr>
<tr><td rowspan="2">System -defined variables</td><td colspan="2">Variable</td><td colspan="2">Data type</td><td colspan="2">Name</td></tr>
<tr><td colspan="2">None</td><td colspan="2">–</td><td colspan="2">–</td></tr>
<tr><td rowspan="2">Cause and correction</td><td colspan="2">Assumed cause</td><td colspan="2">Correction</td><td colspan="2">Prevention</td></tr>
<tr><td colspan="2">An error such as broken wiring was detected in the external encoder phase-A connection.</td><td colspan="2">Wire phase A of the external encoder correctly as shown in the wiring diagram. If the cable is broken, replace it.</td><td colspan="2">Wire phase A of the external encoder correctly as shown in the wiring diagram.</td></tr>
<tr><td>Attached information</td><td colspan="6">None</td></tr>
<tr><td>Precautions/ Remarks</td><td colspan="6">“55” is displayed on the Servo Drive front panel and F055 is given as the AlarmCode (4001 hex).</td></tr>
</table>

<table>
<tr><td>Event name</td><td colspan="3">Phase-B Connection Error</td><td>Event code</td><td colspan="2">0815 0000 hex</td></tr>
<tr><td>Description</td><td colspan="6">An error such as broken wiring was detected in the external encoder phase-B connection.</td></tr>
<tr><td>Source</td><td colspan="2">EtherCAT Master Function Module</td><td>Source details</td><td>Slave</td><td>Detection timing</td><td>Continuously</td></tr>
<tr><td>Error attributes</td><td>Level</td><td>Minor fault</td><td>Recovery</td><td>Error reset
(after cycling slave power)</td><td>Log category</td><td>System</td></tr>
<tr><td>Effects</td><td>User program</td><td>Continues.</td><td>Operation</td><td colspan="3">Power drive circuit is OFF for relevant slave.</td></tr>
<tr><td rowspan="2">Indicators</td><td colspan="2">EtherNet/IP NET RUN</td><td colspan="2">EtherNet/IP NET ERR</td><td colspan="2">EtherNet/IP LINK/ACT</td></tr>
<tr><td colspan="2">–</td><td colspan="2">–</td><td colspan="2">–</td></tr>
<tr><td rowspan="2">System -defined variables</td><td colspan="2">Variable</td><td colspan="2">Data type</td><td colspan="2">Name</td></tr>
<tr><td colspan="2">None</td><td colspan="2">–</td><td colspan="2">–</td></tr>
<tr><td rowspan="2">Cause and correction</td><td colspan="2">Assumed cause</td><td colspan="2">Correction</td><td colspan="2">Prevention</td></tr>
<tr><td colspan="2">An error such as broken wiring was detected in the external encoder phase-B connection.</td><td colspan="2">Wire phase B of the external encoder correctly as shown in the wiring diagram. If the cable is broken, replace it.</td><td colspan="2">Wire phase B of the external encoder correctly as shown in the wiring diagram.</td></tr>
<tr><td>Attached information</td><td colspan="6">None</td></tr>
<tr><td>Precautions/ Remarks</td><td colspan="6">“55” is displayed on the Servo Drive front panel and F155 is given as the AlarmCode (4001 hex).</td></tr>
</table>

<table>
<tr><td>Event name</td><td colspan="3">Phase-Z Connection Error</td><td>Event code</td><td colspan="2">0816 0000 hex</td></tr>
<tr><td>Description</td><td colspan="6">An error such as broken wiring was detected in the external encoder phase-Z connection.</td></tr>
<tr><td>Source</td><td colspan="2">EtherCAT Master Function Module</td><td>Source details</td><td>Slave</td><td>Detection timing</td><td>Continuously</td></tr>
<tr><td>Error attributes</td><td>Level</td><td>Minor fault</td><td>Recovery</td><td>Error reset (after cycling slave power)</td><td>Log category</td><td>System</td></tr>
<tr><td>Effects</td><td>User program</td><td>Continues.</td><td>Operation</td><td colspan="3">Power drive circuit is OFF for relevant slave.</td></tr>
<tr><td rowspan="2">Indicators</td><td colspan="2">EtherNet/IP NET RUN</td><td colspan="2">EtherNet/IP NET ERR</td><td colspan="2">EtherNet/IP LINK/ACT</td></tr>
<tr><td colspan="2">–</td><td colspan="2">–</td><td colspan="2">–</td></tr>
<tr><td rowspan="2">System -defined variables</td><td colspan="2">Variable</td><td colspan="2">Data type</td><td colspan="2">Name</td></tr>
<tr><td colspan="2">None</td><td colspan="2">–</td><td colspan="2">–</td></tr>
<tr><td rowspan="2">Cause and correction</td><td colspan="2">Assumed cause</td><td colspan="2">Correction</td><td colspan="2">Prevention</td></tr>
<tr><td colspan="2">An error such as broken wiring was detected in the external encoder phase-Z connection.</td><td colspan="2">Wire phase Z of the external encoder correctly as shown in the wiring diagram. If the cable is broken, replace it.</td><td colspan="2">Wire phase Z of the external encoder correctly as shown in the wiring diagram.</td></tr>
<tr><td>Attached information</td><td colspan="6">None</td></tr>
<tr><td>Precautions/ Remarks</td><td colspan="6">“55” is displayed on the Servo Drive front panel and F255 is given as the AlarmCode (4001 hex).</td></tr>
</table>

<table>
<tr><td>Event name</td><td colspan="3">Object Error</td><td>Event code</td><td colspan="2">14A8 0000 hex</td></tr>
<tr><td>Description</td><td colspan="6">The object area data in non-volatile memory is corrupted.</td></tr>
<tr><td>Source</td><td colspan="2">EtherCAT Master Function Module</td><td>Source details</td><td>Slave</td><td>Detection timing</td><td>When establishing communications after turning ON power to the slave</td></tr>
<tr><td>Error attributes</td><td>Level</td><td>Minor fault</td><td>Recovery</td><td>Error reset (after cycling slave power)</td><td>Log category</td><td>System</td></tr>
<tr><td>Effects</td><td>User program</td><td>Continues.</td><td>Operation</td><td colspan="3">Power drive circuit is OFF for relevant slave.</td></tr>
<tr><td rowspan="2">Indicators</td><td colspan="2">EtherNet/IP NET RUN</td><td colspan="2">EtherNet/IP NET ERR</td><td colspan="2">EtherNet/IP LINK/ACT</td></tr>
<tr><td colspan="2">–</td><td colspan="2">–</td><td colspan="2">–</td></tr>
<tr><td rowspan="2">System -defined variables</td><td colspan="2">Variable</td><td colspan="2">Data type</td><td colspan="2">Name</td></tr>
<tr><td colspan="2">None</td><td colspan="2">–</td><td colspan="2">–</td></tr>
<tr><td rowspan="3">Cause and correction</td><td colspan="2">Assumed cause</td><td colspan="2">Correction</td><td colspan="2">Prevention</td></tr>
<tr><td colspan="2">Noise</td><td colspan="2">Reset all of the objects. Take noise countermeasures.</td><td colspan="2">Reset all of the objects. Take noise countermeasures.</td></tr>
<tr><td colspan="2">Non-volatile memory failure</td><td colspan="2">If the error persists, replace the Servo Drive.</td><td colspan="2">None</td></tr>
<tr><td>Attached information</td><td colspan="6">None</td></tr>
<tr><td>Precautions/ Remarks</td><td colspan="6">“36” is displayed on the Servo Drive front panel and F036 is given as the AlarmCode (4001 hex).</td></tr>
</table>

Event name	Object Error			**Event code**	14A9 0000 hex	
Description	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**		**Correction**		**Prevention**	
	Noise		Reset all of the objects. Take noise countermeasures.		Reset all of the objects. Take 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**	14AA 0000 hex	
Description	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**		**Correction**		**Prevention**	
	Noise		Reset all of the objects. Take noise countermeasures.		Reset all of the objects. Take 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).					

<table>
<tr><th>Event name</th><td colspan="3">Object Corrupted</td><th>Event code</th><td colspan="2">14AB 0000 hex</td></tr>
<tr><th>Description</th><td colspan="6">The checksum data in non-volatile memory is corrupted.</td></tr>
<tr><th>Source</th><td colspan="2">EtherCAT Master Function Module</td><th>Source details</th><td>Slave</td><th>Detection timing</th><td>When establishing communications after turning ON power to the slave</td></tr>
<tr><th>Error attributes</th><th>Level</th><td>Minor fault</td><th>Recovery</th><td>Error reset (after cycling slave power)</td><th>Log category</th><td>System</td></tr>
<tr><th>Effects</th><th>User program</th><td>Continues.</td><th>Operation</th><td colspan="3">Power drive circuit is OFF for relevant slave.</td></tr>
<tr><th rowspan="2">Indicators</th><th colspan="2">EtherNet/IP NET RUN</th><th colspan="2">EtherNet/IP NET ERR</th><th colspan="2">EtherNet/IP LINK/ACT</th></tr>
<tr><td colspan="2">–</td><td colspan="2">–</td><td colspan="2">–</td></tr>
<tr><th rowspan="2">System -defined variables</th><th colspan="2">Variable</th><th colspan="2">Data type</th><th colspan="2">Name</th></tr>
<tr><td colspan="2">None</td><td colspan="2">–</td><td colspan="2">–</td></tr>
<tr><th rowspan="2">Cause and correction</th><th colspan="2">Assumed cause</th><th colspan="2">Correction</th><th colspan="2">Prevention</th></tr>
<tr><td colspan="2">Non-volatile memory failure</td><td colspan="2">Replace the Servo Drive.</td><td colspan="2">None</td></tr>
<tr><th>Attached information</th><td colspan="6">None</td></tr>
<tr><th>Precautions/ Remarks</th><td colspan="6">“37” is displayed on the Servo Drive front panel and F037 is given as the AlarmCode (4001 hex).</td></tr>
</table>

<table>
<tr><th>Event name</th><td colspan="3">Object Corrupted</td><th>Event code</th><td colspan="2">14AC 0000 hex</td></tr>
<tr><th>Description</th><td colspan="6">The checksum data in non-volatile memory is corrupted.</td></tr>
<tr><th>Source</th><td colspan="2">EtherCAT Master Function Module</td><th>Source details</th><td>Slave</td><th>Detection timing</th><td>When establishing communications after turning ON power to the slave</td></tr>
<tr><th>Error attributes</th><th>Level</th><td>Minor fault</td><th>Recovery</th><td>Error reset (after cycling slave power)</td><th>Log category</th><td>System</td></tr>
<tr><th>Effects</th><th>User program</th><td>Continues.</td><th>Operation</th><td colspan="3">Power drive circuit is OFF for relevant slave.</td></tr>
<tr><th rowspan="2">Indicators</th><th colspan="2">EtherNet/IP NET RUN</th><th colspan="2">EtherNet/IP NET ERR</th><th colspan="2">EtherNet/IP LINK/ACT</th></tr>
<tr><td colspan="2">–</td><td colspan="2">–</td><td colspan="2">–</td></tr>
<tr><th rowspan="2">System -defined variables</th><th colspan="2">Variable</th><th colspan="2">Data type</th><th colspan="2">Name</th></tr>
<tr><td colspan="2">None</td><td colspan="2">–</td><td colspan="2">–</td></tr>
<tr><th rowspan="2">Cause and correction</th><th colspan="2">Assumed cause</th><th colspan="2">Correction</th><th colspan="2">Prevention</th></tr>
<tr><td colspan="2">Non-volatile memory failure</td><td colspan="2">Replace the Servo Drive.</td><td colspan="2">None</td></tr>
<tr><th>Attached information</th><td colspan="6">None</td></tr>
<tr><th>Precautions/ Remarks</th><td colspan="6">“37” is displayed on the Servo Drive front panel and F137 is given as the AlarmCode (4001 hex).</td></tr>
</table>

Event name	Object Corrupted			Event code	14AD 0000 hex	
Description	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		Correction		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	2801 0000 hex	
Description	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		Correction		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	"60" 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**	2802 0000 hex	
Description	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**		**Correction**		**Prevention**	
	The Motor Rated Rms Current/Motor Peak Absolute Current 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	“60” is displayed on the Servo Drive front panel and F160 is given as the AlarmCode (4001 hex).					

<table>
<tr><td>Event name</td><td colspan="3">Motor Combination Error 2</td><td>Event code</td><td colspan="2">2803 0000 hex</td></tr>
<tr><td>Description</td><td colspan="6">The value set for the motor exceeds the drive range of the motor.</td></tr>
<tr><td>Source</td><td colspan="2">EtherCAT Master Function Module</td><td>Source details</td><td>Slave</td><td>Detection timing</td><td>Continuously</td></tr>
<tr><td>Error attributes</td><td>Level</td><td>Minor fault</td><td>Recovery</td><td>Error reset
(after cycling slave power)</td><td>Log category</td><td>System</td></tr>
<tr><td>Effects</td><td>User program</td><td>Continues.</td><td>Operation</td><td colspan="3">Power drive circuit is OFF for relevant slave.</td></tr>
<tr><td rowspan="2">Indicators</td><td colspan="2">EtherNet/IP NET RUN</td><td colspan="2">EtherNet/IP NET ERR</td><td colspan="2">EtherNet/IP LINK/ACT</td></tr>
<tr><td colspan="2">–</td><td colspan="2">–</td><td colspan="2">–</td></tr>
<tr><td rowspan="2">System -defined variables</td><td colspan="2">Variable</td><td colspan="2">Data type</td><td colspan="2">Name</td></tr>
<tr><td colspan="2">None</td><td colspan="2">–</td><td colspan="2">–</td></tr>
<tr><td rowspan="5">Cause and correction</td><td colspan="2">Assumed cause</td><td colspan="2">Correction</td><td colspan="2">Prevention</td></tr>
<tr><td colspan="2">The Motor Rated Rms Current is too low compared with the maximum motor capacity of the Servo Drive.</td><td colspan="2">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.</td><td colspan="2">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.</td></tr>
<tr><td colspan="2">The percentage of the Motor Coil Unit Mass to the Motor Rated Force is too high.</td><td colspan="2">Check the Motor Coil Unit Mass (3904 hex)/ Motor Rated Force (3905 hex) and correct the set value if incorrect.</td><td colspan="2">Make sure that the values set for the Motor Coil Unit Mass (3904 hex) and Motor Rated Force (3905 hex) are correct.</td></tr>
<tr><td colspan="2">The automatically adjusted Current Loop Proportional Gain/Current Loop Integral Gain is too high.</td><td colspan="2">Check the values set for the Motor Rated Rms Current (3906 hex), Motor Inductance (3908 hex), and Motor Resistance (3909 hex) and correct the set value if incorrect.</td><td colspan="2">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.</td></tr>
<tr><td colspan="2">The percentage of the Motor Rated Rms Current to the rated current of the motor is greater than 500%.</td><td colspan="2">Check the Motor Rated Rms Current (3906 hex)/Motor Peak Absolute Current (3907 hex) and correct the set value if incorrect.</td><td colspan="2">Make sure that the value set for the Motor Rated Rms Current (3906 hex)/Motor Peak Absolute Current (3907 hex) is correct.</td></tr>
<tr><td>Attached information</td><td colspan="6">None</td></tr>
<tr><td>Precautions/ Remarks</td><td colspan="6">“60” is displayed on the Servo Drive front panel and F260 is given as the Alarm Code (4001 hex).</td></tr>
</table>

<table>
<tr><th>Event name</th><td colspan="3">Servo Drive Overheat</td><th>Event code</th><td colspan="2">34E1 0000 hex</td></tr>
<tr><th>Description</th><td colspan="6">The temperature of the Servo Drive radiator or power elements exceeded the specified value.</td></tr>
<tr><th>Source</th><td colspan="2">EtherCAT Master Function Module</td><th>Source details</th><td>Slave</td><th>Detection timing</th><td>Continuously</td></tr>
<tr><th>Error attributes</th><th>Level</th><td>Minor fault</td><th>Recovery</th><td>Error reset
(after cycling slave power)</td><th>Log category</th><td>System</td></tr>
<tr><th>Effects</th><th>User program</th><td>Continues.</td><th>Operation</th><td colspan="3">Power drive circuit is OFF for relevant slave.</td></tr>
<tr><th rowspan="2">Indicators</th><th colspan="2">EtherNet/IP NET RUN</th><th colspan="2">EtherNet/IP NET ERR</th><th colspan="2">EtherNet/IP LINK/ACT</th></tr>
<tr><td colspan="2">–</td><td colspan="2">–</td><td colspan="2">–</td></tr>
<tr><th rowspan="2">System -defined variables</th><th colspan="2">Variable</th><th colspan="2">Data type</th><th colspan="2">Name</th></tr>
<tr><td colspan="2">None</td><td colspan="2">–</td><td colspan="2">–</td></tr>
<tr><th rowspan="3">Cause and correction</th><th colspan="2">Assumed cause</th><th colspan="2">Correction</th><th colspan="2">Prevention</th></tr>
<tr><td colspan="2">The ambient temperature of the Servo Drive exceeded the specified value.</td><td colspan="2">Improve the ambient temperature and the cooling conditions of the Servo Drive.</td><td colspan="2">Check the ambient temperature of the Servo Drive and set up the necessary cooling conditions.</td></tr>
<tr><td colspan="2">Overload</td><td colspan="2">Increase the capacities of the Servo Drive and the motor. Or, increase the setting of the acceleration/deceleration time and lighten the load.</td><td colspan="2">Increase the setting of the acceleration/deceleration time and lighten the load as much as possible.</td></tr>
<tr><th>Attached information</th><td colspan="6">None</td></tr>
<tr><th>Precautions/ Remarks</th><td colspan="6">“15” is displayed on the Servo Drive front panel and F015 is given as the AlarmCode (4001 hex).</td></tr>
</table>

<table>
<tr><th>Event name</th><td colspan="2">Overload</td><th colspan="2">Event code</th><td colspan="2">34E2 0000 hex</td></tr>
<tr><th>Description</th><td colspan="6">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.</td></tr>
<tr><th>Source</th><td colspan="2">EtherCAT Master Function Module</td><th>Source details</th><td>Slave</td><th>Detection timing</th><td>While power is supplied to motor</td></tr>
<tr><th>Error attributes</th><th>Level</th><td>Minor fault</td><th>Recovery</th><td>Error reset (after resetting slave errors)</td><th>Log category</th><td>System</td></tr>
<tr><th>Effects</th><th>User program</th><td>Continues.</td><th>Operation</th><td colspan="3">Power drive circuit is OFF for relevant slave.</td></tr>
<tr><th rowspan="2">Indicators</th><th colspan="2">EtherNet/IP NET RUN</th><th colspan="2">EtherNet/IP NET ERR</th><th colspan="2">EtherNet/IP LINK/ACT</th></tr>
<tr><td colspan="2">–</td><td colspan="2">–</td><td colspan="2">–</td></tr>
<tr><th rowspan="2">System -defined variables</th><th colspan="2">Variable</th><th colspan="2">Data type</th><th colspan="2">Name</th></tr>
<tr><td colspan="2">None</td><td colspan="2">–</td><td colspan="2">–</td></tr>
<tr><th rowspan="3">Cause and correction</th><th colspan="2">Assumed cause</th><th colspan="2">Correction</th><th colspan="2">Prevention</th></tr>
<tr><td colspan="2">Operation was continued for a long time while overloaded.</td><td colspan="2">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.</td><td colspan="2">Check the items given for corrections in advance and implement countermeasures as required.</td></tr>
<tr><td colspan="2">There is incorrect wiring of the motor line or a broken cable.</td><td colspan="2">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.</td><td colspan="2">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.</td></tr>
<tr><th>Attached information</th><td colspan="6">None</td></tr>
<tr><th>Precautions/ Remarks</th><td colspan="6">“16” is displayed on the Servo Drive front panel and F016 is given as the AlarmCode (4001 hex).</td></tr>
</table>

Event name	Regeneration Overload			**Event code**	34E3 0000 hex	
Description	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**		**Correction**		**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 Resistor load rate and the excessive regeneration warning, and perform the following accordingly. • Increase the capacities 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 is 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).					

<table>
<tr><td>Event name</td><td colspan="3">Following Error Counter Overflow</td><td colspan="2">Event code</td><td colspan="2">34E4 0000 hex</td></tr>
<tr><td>Description</td><td colspan="7">Position error pulses exceeded the setting of the Following error window (6065 hex).</td></tr>
<tr><td>Source</td><td colspan="2">EtherCAT Master Function Module</td><td>Source details</td><td>Slave</td><td colspan="2">Detection timing</td><td>While power is supplied to motor</td></tr>
<tr><td>Error attributes</td><td>Level</td><td>Minor fault</td><td>Recovery</td><td>Error reset
(after resetting slave errors)</td><td colspan="2">Log category</td><td>System</td></tr>
<tr><td>Effects</td><td>User program</td><td>Continues.</td><td>Operation</td><td colspan="4">Power drive circuit is OFF for relevant slave.</td></tr>
<tr><td rowspan="2">Indicators</td><td colspan="2">EtherNet/IP NET RUN</td><td colspan="2">EtherNet/IP NET ERR</td><td colspan="3">EtherNet/IP LINK/ACT</td></tr>
<tr><td colspan="2">–</td><td colspan="2">–</td><td colspan="3">–</td></tr>
<tr><td rowspan="2">System -defined variables</td><td colspan="2">Variable</td><td colspan="2">Data type</td><td colspan="3">Name</td></tr>
<tr><td colspan="2">None</td><td colspan="2">–</td><td colspan="3">–</td></tr>
<tr><td rowspan="4">Cause and correction</td><td colspan="2">Assumed cause</td><td colspan="2">Correction</td><td colspan="3">Prevention</td></tr>
<tr><td colspan="2">Motor operation does not follow the command.</td><td colspan="2">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.</td><td colspan="3">Adjust the gain and force limits. Increase the acceleration/deceleration time, lighten the load, and reduce the velocity as much as possible.</td></tr>
<tr><td colspan="2">The value of the Following error window (6065 hex) is small.</td><td colspan="2">Increase the setting of the Following error window (6065 hex) to an acceptable range.</td><td colspan="3">Increase the setting of the Following error window (6065 hex) to an acceptable range.</td></tr>
<tr><td colspan="2">The external encoder wiring is incorrect.</td><td colspan="2">Wire the external encoder correctly as shown in the wiring diagram.</td><td colspan="3">Wire the external encoder correctly as shown in the wiring diagram.</td></tr>
<tr><td>Attached information</td><td colspan="7">None</td></tr>
<tr><td>Precautions/ Remarks</td><td colspan="7">“24” is displayed on the Servo Drive front panel and F024 is given as the AlarmCode (4001 hex).</td></tr>
</table>

Event name	Excessive Velocity Error			**Event code**	34E5 0000 hex	
Description	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**		**Correction**		**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).					

<table>
<tr><td>Event name</td><td colspan="3">Overspeed</td><td>Event code</td><td colspan="2">34E6 0000 hex</td></tr>
<tr><td>Description</td><td colspan="6">The motor speed exceeded the value set on the Overspeed Detection Leve Setting (3513 hex).</td></tr>
<tr><td>Source</td><td colspan="2">EtherCAT Master Function Module</td><td>Source details</td><td>Slave</td><td>Detection timing</td><td>While power is supplied to motor</td></tr>
<tr><td>Error attributes</td><td>Level</td><td>Minor fault</td><td>Recovery</td><td>Error reset
(after resetting slave errors)</td><td>Log category</td><td>System</td></tr>
<tr><td>Effects</td><td>User program</td><td>Continues.</td><td>Operation</td><td colspan="3">Power drive circuit is OFF for relevant slave.</td></tr>
<tr><td rowspan="2">Indicators</td><td colspan="2">EtherNet/IP NET RUN</td><td colspan="2">EtherNet/IP NET ERR</td><td colspan="2">EtherNet/IP LINK/ACT</td></tr>
<tr><td colspan="2">–</td><td colspan="2">–</td><td colspan="2">–</td></tr>
<tr><td rowspan="2">System -defined variables</td><td colspan="2">Variable</td><td colspan="2">Data type</td><td colspan="2">Name</td></tr>
<tr><td colspan="2">None</td><td colspan="2">–</td><td colspan="2">–</td></tr>
<tr><td rowspan="4">Cause and correction</td><td colspan="2">Assumed cause</td><td colspan="2">Correction</td><td colspan="2">Prevention</td></tr>
<tr><td colspan="2">The velocity command value is too large.</td><td colspan="2">Reduce the velocity command value. Adjust the input frequency, dividing ratio, and multiplication ratio of the command pulse.</td><td colspan="2">Set the velocity command value so that the number of motor speed does not exceed the Overspeed Level (3910 hex). Adjust the input frequency, dividing ratio, and multiplication ratio of the command pulse.</td></tr>
<tr><td colspan="2">There is overshooting.</td><td colspan="2">Decrease the gain.</td><td colspan="2">Do not make the gain too large.</td></tr>
<tr><td colspan="2">The wiring is incorrect.</td><td colspan="2">Wire the external encoder correctly as shown in the wiring diagram.</td><td colspan="2">Wire the external encoder correctly as shown in the wiring diagram.</td></tr>
<tr><td>Attached information</td><td colspan="6">None</td></tr>
<tr><td>Precautions/ Remarks</td><td colspan="6">“26” is displayed on the Servo Drive front panel and F026 is given as the AlarmCode (4001 hex).</td></tr>
</table>

Event name	Overspeed 2			Event code	3840 0000 hex	
Description	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		Correction		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. Adjust 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 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 F126 is given as the AlarmCode (4001 hex).					

Event name	Command Error			Event code	3841 0000 hex	
Description	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		Correction		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).					

<table>
<tr><th>Event name</th><td colspan="3">Command Generation Error</td><th>Event code</th><td colspan="2">3842 0000 hex</td></tr>
<tr><th>Description</th><td colspan="6">During position command processing, an error such as a calculation range error occurred.</td></tr>
<tr><th>Source</th><td colspan="2">EtherCAT Master Function Module</td><th>Source details</th><td>Slave</td><th>Detection timing</th><td>Continuously</td></tr>
<tr><th>Error attributes</th><th>Level</th><td>Minor fault</td><th>Recovery</th><td>Error reset (after cycling slave power)</td><th>Log category</th><td>System</td></tr>
<tr><th>Effects</th><th>User program</th><td>Continues.</td><th>Operation</th><td colspan="3">Power drive circuit is OFF for relevant slave.</td></tr>
<tr><th rowspan="2">Indicators</th><th colspan="2">EtherNet/IP NET RUN</th><th colspan="2">EtherNet/IP NET ERR</th><th colspan="2">EtherNet/IP LINK/ACT</th></tr>
<tr><td colspan="2">–</td><td colspan="2">–</td><td colspan="2">–</td></tr>
<tr><th rowspan="2">System -defined variables</th><th colspan="2">Variable</th><th colspan="2">Data type</th><th colspan="2">Name</th></tr>
<tr><td colspan="2">None</td><td colspan="2">–</td><td colspan="2">–</td></tr>
<tr><th rowspan="2">Cause and correction</th><th colspan="2">Assumed cause</th><th colspan="2">Correction</th><th colspan="2">Prevention</th></tr>
<tr><td colspan="2">During position command processing, an error such as an “over the calculation range” error occurred.</td><td colspan="2">Check whether the electronic gear ratio and acceleration/deceleration rate are within the limits and make any necessary corrections.</td><td colspan="2">Set the electronic gear ratio, acceleration rate, and deceleration rate to meet the restrictions.</td></tr>
<tr><th>Attached information</th><td colspan="6">None</td></tr>
<tr><th>Precautions/ Remarks</th><td colspan="6">“27” is displayed on the Servo Drive front panel and F527 is given as the AlarmCode (4001 hex).</td></tr>
</table>

<table>
<tr><th>Event name</th><td colspan="3">Following Error Counter Overflow 1</td><th>Event code</th><td colspan="2">3843 0000 hex</td></tr>
<tr><th>Description</th><td colspan="6">When an absolute external encoder was in use, the value of Position actual internal value [external encoder pulse] divided by Gear ratio exceeded $\pm 2^{31}$ (2,147,483,648).</td></tr>
<tr><th>Source</th><td colspan="2">EtherCAT Master Function Module</td><th>Source details</th><td>Slave</td><th>Detection timing</th><td>While power is supplied to motor</td></tr>
<tr><th>Error attributes</th><th>Level</th><td>Minor fault</td><th>Recovery</th><td>Error reset (after cycling slave power)</td><th>Log category</th><td>System</td></tr>
<tr><th>Effects</th><th>User program</th><td>Continues.</td><th>Operation</th><td colspan="3">Power drive circuit is OFF for relevant slave.</td></tr>
<tr><th rowspan="2">Indicators</th><th colspan="2">EtherNet/IP NET RUN</th><th colspan="2">EtherNet/IP NET ERR</th><th colspan="2">EtherNet/IP LINK/ACT</th></tr>
<tr><td colspan="2">–</td><td colspan="2">–</td><td colspan="2">–</td></tr>
<tr><th rowspan="2">System -defined variables</th><th colspan="2">Variable</th><th colspan="2">Data type</th><th colspan="2">Name</th></tr>
<tr><td colspan="2">None</td><td colspan="2">–</td><td colspan="2">–</td></tr>
<tr><th rowspan="2">Cause and correction</th><th colspan="2">Assumed cause</th><th colspan="2">Correction</th><th colspan="2">Prevention</th></tr>
<tr><td colspan="2">When an absolute external encoder was in use, the value of Position actual internal value [external encoder pulse] divided by Gear ratio exceeded $\pm 2^{31}$ (2,147,483,648).</td><td colspan="2">When an absolute external encoder was in use, check the operation range of the Position actual internal value [external encoder pulse] and correct the electronic gear ratio.</td><td colspan="2">When an absolute external encoder was in use, check the operation range of the Position actual internal value [external encoder pulse] and correct the electronic gear ratio.</td></tr>
<tr><th>Attached information</th><td colspan="6">None</td></tr>
<tr><th>Precautions/ Remarks</th><td colspan="6">“29” is displayed on the Servo Drive front panel and F129 is given as the AlarmCode (4001 hex).</td></tr>
</table>

Event name	Following Error Counter Overflow 2		**Event code**	3844 0000 hex	
Description	The position following error in pulses exceeded ±2^{29} (536,870,912). Or, the position following error in command units exceeded ±2^{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**	**Correction**		**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).				

<table>
<tr><td>Event name</td><td colspan="3">Interface Input Duplicate Allocation Error 1</td><td>Event code</td><td colspan="2">3845 0000 hex</td></tr>
<tr><td>Description</td><td colspan="6">There is a duplicate setting in the input signal (IN1, IN2, IN3, and IN4) function allocations.</td></tr>
<tr><td>Source</td><td colspan="2">EtherCAT Master Function Module</td><td>Source details</td><td>Slave</td><td>Detection timing</td><td>When establishing communications after turning ON power to the slave or when transferring EtherCAT Configuration Setup</td></tr>
<tr><td>Error attributes</td><td>Level</td><td>Minor fault</td><td>Recovery</td><td>Error reset (after cycling slave power)</td><td>Log category</td><td>System</td></tr>
<tr><td>Effects</td><td>User program</td><td>Continues.</td><td>Operation</td><td colspan="3">Power drive circuit is OFF for relevant slave.</td></tr>
<tr><td rowspan="2">Indicators</td><td colspan="2">EtherNet/IP NET RUN</td><td colspan="2">EtherNet/IP NET ERR</td><td colspan="2">EtherNet/IP LINK/ACT</td></tr>
<tr><td colspan="2">–</td><td colspan="2">–</td><td colspan="2">–</td></tr>
<tr><td rowspan="2">System -defined variables</td><td colspan="2">Variable</td><td colspan="2">Data type</td><td colspan="2">Name</td></tr>
<tr><td colspan="2">None</td><td colspan="2">–</td><td colspan="2">–</td></tr>
<tr><td rowspan="2">Cause and correction</td><td colspan="2">Assumed cause</td><td colspan="2">Correction</td><td colspan="2">Prevention</td></tr>
<tr><td colspan="2">There is a duplicate setting in the input signal (IN1, IN2, IN3, and IN4) function allocations.</td><td colspan="2">Allocate the functions to the connector pins so that each function is allocated only once.</td><td colspan="2">Allocate the functions to the connector pins so that each function is allocated only once.</td></tr>
<tr><td>Attached information</td><td colspan="6">None</td></tr>
<tr><td>Precautions/ Remarks</td><td colspan="6">“33” is displayed on the Servo Drive front panel and F033 is given as the AlarmCode (4001 hex).</td></tr>
</table>

<table>
<tr><td>Event name</td><td colspan="3">Interface Input Duplicate Allocation Error 2</td><td>Event code</td><td colspan="2">3846 0000 hex</td></tr>
<tr><td>Description</td><td colspan="6">There is a duplicate setting in the input signal (IN5, IN6, IN7, and IN8) function allocations.</td></tr>
<tr><td>Source</td><td colspan="2">EtherCAT Master Function Module</td><td>Source details</td><td>Slave</td><td>Detection timing</td><td>When establishing communications after turning ON power to the slave or when transferring EtherCAT Configuration Setup</td></tr>
<tr><td>Error attributes</td><td>Level</td><td>Minor fault</td><td>Recovery</td><td>Error reset (after cycling slave power)</td><td>Log category</td><td>System</td></tr>
<tr><td>Effects</td><td>User program</td><td>Continues.</td><td>Operation</td><td colspan="3">Power drive circuit is OFF for relevant slave.</td></tr>
<tr><td rowspan="2">Indicators</td><td colspan="2">EtherNet/IP NET RUN</td><td colspan="2">EtherNet/IP NET ERR</td><td colspan="2">EtherNet/IP LINK/ACT</td></tr>
<tr><td colspan="2">–</td><td colspan="2">–</td><td colspan="2">–</td></tr>
<tr><td rowspan="2">System -defined variables</td><td colspan="2">Variable</td><td colspan="2">Data type</td><td colspan="2">Name</td></tr>
<tr><td colspan="2">None</td><td colspan="2">–</td><td colspan="2">–</td></tr>
<tr><td rowspan="2">Cause and correction</td><td colspan="2">Assumed cause</td><td colspan="2">Correction</td><td colspan="2">Prevention</td></tr>
<tr><td colspan="2">There is a duplicate setting in the input signal (IN5, IN6, IN7, and IN8) function allocations.</td><td colspan="2">Allocate the functions to the connector pins so that each function is allocated only once.</td><td colspan="2">Allocate the functions to the connector pins so that each function is allocated only once.</td></tr>
<tr><td>Attached information</td><td colspan="6">None</td></tr>
<tr><td>Precautions/ Remarks</td><td colspan="6">“33” is displayed on the Servo Drive front panel and F133 is given as the AlarmCode (4001 hex).</td></tr>
</table>

<table>
<tr><th>Event name</th><td colspan="3">Interface Input Function Number Error 1</td><th>Event code</th><td colspan="2">3847 0000 hex</td></tr>
<tr><th>Description</th><td colspan="6">There is an undefined number specification in the input signal (IN1, IN2, IN3, and IN4) function allocations. Or, a logic setting error was detected.</td></tr>
<tr><th>Source</th><td colspan="2">EtherCAT Master Function Module</td><th>Source details</th><td>Slave</td><th>Detection timing</th><td>When establishing communications after turning ON power to the slave or when transferring EtherCAT Configuration Setup</td></tr>
<tr><th>Error attributes</th><th>Level</th><td>Minor fault</td><th>Recovery</th><td>Error reset (after cycling slave power)</td><th>Log category</th><td>System</td></tr>
<tr><th>Effects</th><th>User program</th><td>Continues.</td><th>Operation</th><td colspan="3">Power drive circuit is OFF for relevant slave.</td></tr>
<tr><th rowspan="2">Indicators</th><th colspan="2">EtherNet/IP NET RUN</th><th colspan="2">EtherNet/IP NET ERR</th><th colspan="2">EtherNet/IP LINK/ACT</th></tr>
<tr><td colspan="2">–</td><td colspan="2">–</td><td colspan="2">–</td></tr>
<tr><th rowspan="2">System -defined variables</th><th colspan="2">Variable</th><th colspan="2">Data type</th><th colspan="2">Name</th></tr>
<tr><td colspan="2">None</td><td colspan="2">–</td><td colspan="2">–</td></tr>
<tr><th rowspan="3">Cause and correction</th><th colspan="2">Assumed cause</th><th colspan="2">Correction</th><th colspan="2">Prevention</th></tr>
<tr><td colspan="2">There is an undefined number specification in the input signal (IN1, IN2, IN3, and IN4) function allocations.</td><td colspan="2">Allocate the functions to the connector pins using only the numbers that are defined.</td><td colspan="2">Allocate the functions to the connector pins using only the numbers that are defined.</td></tr>
<tr><td colspan="2">Different logic is set for the same function in the function assignments of the input signals (IN1, IN2, IN3, and IN4).</td><td colspan="2">Correct the settings so that the same logic is used for the same function.</td><td colspan="2">Use the same logic for the same function.</td></tr>
<tr><th>Attached information</th><td colspan="6">None</td></tr>
<tr><th>Precautions/ Remarks</th><td colspan="6">“33” is displayed on the Servo Drive front panel and F233 is given as the AlarmCode (4001 hex).</td></tr>
</table>

Event name	Interface Input Function Number Error 2		**Event code**	3848 0000 hex	
Description	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**		**Correction**	**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).				

<table>
<tr><td>Event name</td><td colspan="3">Interface Output Function Number Error 1</td><td>Event code</td><td colspan="2">3849 0000 hex</td></tr>
<tr><td>Description</td><td colspan="6">There is an undefined number specification in the output signal (OUTM1) function allocation.</td></tr>
<tr><td>Source</td><td colspan="2">EtherCAT Master Function Module</td><td>Source details</td><td>Slave</td><td>Detection timing</td><td>When establishing communications after turning ON power to the slave or when transferring EtherCAT Configuration Setup</td></tr>
<tr><td>Error attributes</td><td>Level</td><td>Minor fault</td><td>Recovery</td><td>Error reset
(after cycling slave power)</td><td>Log category</td><td>System</td></tr>
<tr><td>Effects</td><td>User program</td><td>Continues.</td><td>Operation</td><td colspan="3">Power drive circuit is OFF for relevant slave.</td></tr>
<tr><td rowspan="2">Indicators</td><td colspan="2">EtherNet/IP NET RUN</td><td colspan="2">EtherNet/IP NET ERR</td><td colspan="2">EtherNet/IP LINK/ACT</td></tr>
<tr><td colspan="2">–</td><td colspan="2">–</td><td colspan="2">–</td></tr>
<tr><td rowspan="2">System -defined variables</td><td colspan="2">Variable</td><td colspan="2">Data type</td><td colspan="2">Name</td></tr>
<tr><td colspan="2">None</td><td colspan="2">–</td><td colspan="2">–</td></tr>
<tr><td rowspan="2">Cause and correction</td><td colspan="2">Assumed cause</td><td colspan="2">Correction</td><td colspan="2">Prevention</td></tr>
<tr><td colspan="2">There is an undefined number specification in the output signal (OUTM1) function allocation.</td><td colspan="2">Allocate the functions to the connector pins using only the numbers that are defined.</td><td colspan="2">Allocate the functions to the connector pins using only the numbers that are defined.</td></tr>
<tr><td>Attached information</td><td colspan="6">None</td></tr>
<tr><td>Precautions/ Remarks</td><td colspan="6">“33” is displayed on the Servo Drive front panel and F433 is given as the AlarmCode (4001 hex).</td></tr>
</table>

Event name	Interface Output Function Number Error 2			**Event code**	384A 0000 hex	
Description	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**		**Correction**		**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).					

<table>
<tr><td>Event name</td><td colspan="3">External Latch Input Allocation Error</td><td>Event code</td><td colspan="2">384B 0000 hex</td></tr>
<tr><td>Description</td><td colspan="6">There is an error in the latch input function allocation.</td></tr>
<tr><td>Source</td><td colspan="2">EtherCAT Master Function Module</td><td>Source details</td><td>Slave</td><td>Detection timing</td><td>When establishing communications after turning ON power to the slave or when transferring EtherCAT Configuration Setup</td></tr>
<tr><td>Error attributes</td><td>Level</td><td>Minor fault</td><td>Recovery</td><td>Error reset
(after cycling slave power)</td><td>Log category</td><td>System</td></tr>
<tr><td>Effects</td><td>User program</td><td>Continues.</td><td>Operation</td><td colspan="3">Power drive circuit is OFF for relevant slave.</td></tr>
<tr><td rowspan="2">Indicators</td><td colspan="2">EtherNet/IP NET RUN</td><td colspan="2">EtherNet/IP NET ERR</td><td colspan="2">EtherNet/IP LINK/ACT</td></tr>
<tr><td colspan="2">–</td><td colspan="2">–</td><td colspan="2">–</td></tr>
<tr><td rowspan="2">System -defined variables</td><td colspan="2">Variable</td><td colspan="2">Data type</td><td colspan="2">Name</td></tr>
<tr><td colspan="2">None</td><td colspan="2">–</td><td colspan="2">–</td></tr>
<tr><td rowspan="4">Cause and correction</td><td colspan="2">Assumed cause</td><td colspan="2">Correction</td><td colspan="2">Prevention</td></tr>
<tr><td colspan="2">The function was allocated to input signals other than IN5, IN6, or IN7.</td><td colspan="2">Allocate the latch input to input signals IN5, IN6, or IN7.</td><td colspan="2">Allocate the latch input to input signals IN5, IN6, or IN7.</td></tr>
<tr><td colspan="2">A latch input is assigned to an NC signal.</td><td colspan="2">Assign a latch input to an NO signal.</td><td colspan="2">Assign a latch input to an NO signal.</td></tr>
<tr><td colspan="2">The same latch input is not assigned to the same pin in all Control Modes.</td><td colspan="2">Assign the same latch input in all Control Modes.</td><td colspan="2">Assign the same latch input to the same pin in all Control Modes.</td></tr>
<tr><td>Attached information</td><td colspan="6">None</td></tr>
<tr><td>Precautions/ Remarks</td><td colspan="6">“33” is displayed on the Servo Drive front panel and F833 is given as the AlarmCode (4001 hex).</td></tr>
</table>

Event name	Overrun Limit Error			**Event code**	384C 0000 hex	
Description	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**		**Correction**		**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**	384F 0000 hex	
Description	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**		**Correction**		**Prevention**	
	The electronic gear ratio exceeded the allowable range.		Correct the electronic gear ratio to between 1/1,000 and 1,000.		Set the 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	3850 0000 hex	
Description	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		Correction		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	3851 0000 hex	
Description	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		Correction		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**	3852 0000 hex	
Description	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**		**Correction**		**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 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	
	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).					

<table>
<tr><th>Event name</th><td colspan="3">Magnetic Pole Position Estimation Error 1</td><th>Event code</th><td colspan="2">3853 0000 hex</td></tr>
<tr><th>Description</th><td colspan="6">Magnetic pole position estimation was not completed successfully.</td></tr>
<tr><th>Source</th><td colspan="2">EtherCAT Master Function Module</td><th>Source details</th><td>Slave</td><th>Detection timing</th><td>During magnetic pole position estimation</td></tr>
<tr><th>Error attributes</th><th>Level</th><td>Minor fault</td><th>Recovery</th><td>Error reset
(after resetting slave errors)</td><th>Log category</th><td>System</td></tr>
<tr><th>Effects</th><th>User program</th><td>Continues.</td><th>Operation</th><td colspan="3">Power drive circuit is OFF for relevant slave.</td></tr>
<tr><th rowspan="2">Indicators</th><th colspan="2">EtherNet/IP NET RUN</th><th colspan="2">EtherNet/IP NET ERR</th><th colspan="2">EtherNet/IP LINK/ACT</th></tr>
<tr><td colspan="2">–</td><td colspan="2">–</td><td colspan="2">–</td></tr>
<tr><th rowspan="2">System -defined variables</th><th colspan="2">Variable</th><th colspan="2">Data type</th><th colspan="2">Name</th></tr>
<tr><td colspan="2">None</td><td colspan="2">–</td><td colspan="2">–</td></tr>
<tr><th rowspan="4">Cause and correction</th><th colspan="2">Assumed cause</th><th colspan="2">Correction</th><th colspan="2">Prevention</th></tr>
<tr><td colspan="2">Settings associated with the external encoder are incorrect.</td><td colspan="2">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).</td><td colspan="2">Set the External Encoder Resolution (3901 hex)/External Feedback Pulse Direction Switching (3326 hex) values according to the specifications of the external encoder.</td></tr>
<tr><td colspan="2">The command time or force command value for magnetic pole position estimation is insufficient.</td><td colspan="2">Increase the value set for the Magnetic Pole Position Estimation Force Command Time (3922 hex) or Magnetic Pole Position Estimation Force Command (3923 hex).</td><td colspan="2">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.</td></tr>
<tr><td colspan="2">There is a large unbalanced load or friction.</td><td colspan="2">If the axis has a large unbalanced load or friction, the magnetic pole position estimation function cannot be used.</td><td colspan="2">None</td></tr>
<tr><th>Attached information</th><td colspan="6">None</td></tr>
<tr><th>Precautions/ Remarks</th><td colspan="6">“61” is displayed on the Servo Drive front panel and F061 is given as the AlarmCode (4001 hex).</td></tr>
</table>

<table>
<tr><td>Event name</td><td colspan="3">Magnetic Pole Position Estimation Error 2</td><td>Event code</td><td colspan="2">3854 0000 hex</td></tr>
<tr><td>Description</td><td colspan="6">Magnetic pole position estimation was not completed successfully because the motor did not stop within the Magnetic Pole Position Estimation Time Limit for Stop.</td></tr>
<tr><td>Source</td><td colspan="2">EtherCAT Master Function Module</td><td>Source details</td><td>Slave</td><td>Detection timing</td><td>During magnetic pole position estimation</td></tr>
<tr><td>Error attributes</td><td>Level</td><td>Minor fault</td><td>Recovery</td><td>Error reset
(after resetting slave errors)</td><td>Log category</td><td>System</td></tr>
<tr><td>Effects</td><td>User program</td><td>Continues.</td><td>Operation</td><td colspan="3">Power drive circuit is OFF for relevant slave.</td></tr>
<tr><td rowspan="2">Indicators</td><td colspan="2">EtherNet/IP NET RUN</td><td colspan="2">EtherNet/IP NET ERR</td><td colspan="2">EtherNet/IP LINK/ACT</td></tr>
<tr><td colspan="2">–</td><td colspan="2">–</td><td colspan="2">–</td></tr>
<tr><td rowspan="2">System -defined variables</td><td colspan="2">Variable</td><td colspan="2">Data type</td><td colspan="2">Name</td></tr>
<tr><td colspan="2">None</td><td colspan="2">–</td><td colspan="2">–</td></tr>
<tr><td rowspan="3">Cause and correction</td><td colspan="2">Assumed cause</td><td colspan="2">Correction</td><td colspan="2">Prevention</td></tr>
<tr><td colspan="2">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.</td><td colspan="2">Increase the value set for the Magnetic Pole Position Estimation Time Limit for Stop (3927 hex).</td><td colspan="2">Set the Magnetic Pole Position Estimation Time Limit for Stop (3927 hex) according to the actual stop time of the motor.</td></tr>
<tr><td colspan="2">The motor is moving when no force is applied.</td><td colspan="2">Remove causes that allow the motor to move without force, such as unbalanced load, from the installation environment.</td><td colspan="2">Ensure during installation that there is no unbalanced load or other causes that allow the motor to move without force.</td></tr>
<tr><td>Attached information</td><td colspan="6">None</td></tr>
<tr><td>Precautions/ Remarks</td><td colspan="6">“61” is displayed on the Servo Drive front panel and F161 is given as the AlarmCode (4001 hex).</td></tr>
</table>

<table>
<tr><td>Event name</td><td colspan="3">Magnetic Pole Position Estimation Error 3</td><td>Event code</td><td colspan="2">3855 0000 hex</td></tr>
<tr><td>Description</td><td colspan="6">Magnetic pole position restoration was not completed successfully.</td></tr>
<tr><td>Source</td><td colspan="2">EtherCAT Master Function Module</td><td>Source details</td><td>Slave</td><td>Detection timing</td><td>When the magnetic pole position restoration method is selected</td></tr>
<tr><td>Error attributes</td><td>Level</td><td>Minor fault</td><td>Recovery</td><td>Error reset
(after cycling slave power)</td><td>Log category</td><td>System</td></tr>
<tr><td>Effects</td><td>User program</td><td>Continues.</td><td>Operation</td><td colspan="3">Power drive circuit is OFF for relevant slave.</td></tr>
<tr><td rowspan="2">Indicators</td><td colspan="2">EtherNet/IP NET RUN</td><td colspan="2">EtherNet/IP NET ERR</td><td colspan="2">EtherNet/IP LINK/ACT</td></tr>
<tr><td colspan="2">–</td><td colspan="2">–</td><td colspan="2">–</td></tr>
<tr><td rowspan="2">System -defined variables</td><td colspan="2">Variable</td><td colspan="2">Data type</td><td colspan="2">Name</td></tr>
<tr><td colspan="2">None</td><td colspan="2">–</td><td colspan="2">–</td></tr>
<tr><td rowspan="3">Cause and correction</td><td colspan="2">Assumed cause</td><td colspan="2">Correction</td><td colspan="2">Prevention</td></tr>
<tr><td colspan="2">The Magnetic Pole Detection Method (3920 hex) was set to 3 (Magnetic pole position restoration method), although magnetic pole position estimation had never been executed.</td><td colspan="2">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).</td><td colspan="2">Before setting the Magnetic Pole Detection Method (3920 hex) to 3 (Magnetic pole position restoration method), once set the object to 2 (Magnetic pole position estimation method) and execute magnetic pole position estimation.</td></tr>
<tr><td colspan="2">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.</td><td colspan="2">Change the external encoder to an absolute type.</td><td colspan="2">Before setting the Magnetic Pole Detection Method (3920 hex) to 3 (Magnetic pole position restoration method), make sure that your external encoder is an absolute type.</td></tr>
<tr><td>Attached information</td><td colspan="6">None</td></tr>
<tr><td>Precautions/ Remarks</td><td colspan="6">“61” is displayed on the Servo Drive front panel and F261 is given as the AlarmCode (4001 hex).</td></tr>
</table>

Event name	Motor Auto-setting Error			**Event code**	3856 0000 hex	
Description	Overshooting occurred when the electric current is applied to the motor to execute the lock operation or FFT measurement preparation.					
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**		**Correction**		**Prevention**	
	The Current Loop Proportional Gain or Current Loop Integral Gain value before automatic setting is too large.		Reduce the set value for the Current Loop Proportional Gain or Current Loop Integral Gain.		None	
Attached information	None					
Precautions/ Remarks	"60" is displayed on the Servo Drive front panel and F360 is given as the AlarmCode (4001 hex).					

Event name	Drive Prohibition Input Error 1			**Event code**	64E0 0000 hex	
Description	• 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**		**Correction**		**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).					

<table>
<tr><td>**Event name**</td><td colspan="3">Drive Prohibition Input Error 2</td><td>**Event code**</td><td colspan="2">64E1 0000 hex</td></tr>
<tr><td>**Description**</td><td colspan="6">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.</td></tr>
<tr><td>**Source**</td><td colspan="2">EtherCAT Master Function Module</td><td>**Source details**</td><td>Slave</td><td>**Detection timing**</td><td>Continuously</td></tr>
<tr><td>**Error attributes**</td><td>**Level**</td><td>Minor fault</td><td>**Recovery**</td><td>Error reset (after resetting slave errors)</td><td>**Log category**</td><td>System</td></tr>
<tr><td>**Effects**</td><td>**User program**</td><td>Continues.</td><td>**Operation**</td><td colspan="3">Power drive circuit is OFF for relevant slave.</td></tr>
<tr><td rowspan="2">**Indicators**</td><td colspan="2">**EtherNet/IP NET RUN**</td><td colspan="2">**EtherNet/IP NET ERR**</td><td colspan="2">**EtherNet/IP LINK/ACT**</td></tr>
<tr><td colspan="2">–</td><td colspan="2">–</td><td colspan="2">–</td></tr>
<tr><td rowspan="2">**System -defined variables**</td><td colspan="2">**Variable**</td><td colspan="2">**Data type**</td><td colspan="2">**Name**</td></tr>
<tr><td colspan="2">None</td><td colspan="2">–</td><td colspan="2">–</td></tr>
<tr><td rowspan="2">**Cause and correction**</td><td colspan="2">**Assumed cause**</td><td colspan="2">**Correction**</td><td colspan="2">**Prevention**</td></tr>
<tr><td colspan="2">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.</td><td colspan="2">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.</td><td colspan="2">The goal is to detect the error. (A preventative measure is not required.)</td></tr>
<tr><td>**Attached information**</td><td colspan="6">None</td></tr>
<tr><td>**Precautions/ Remarks**</td><td colspan="6">“38” is displayed on the Servo Drive front panel and F138 is given as the AlarmCode (4001 hex).</td></tr>
</table>

<table>
<tr><td>**Event name**</td><td colspan="3">Immediate Stop Input Error</td><td>**Event code**</td><td colspan="2">64E2 0000 hex</td></tr>
<tr><td>**Description**</td><td colspan="6">An Immediate Stop (STOP) signal was input.</td></tr>
<tr><td>**Source**</td><td colspan="2">EtherCAT Master Function Module</td><td>**Source details**</td><td>Slave</td><td>**Detection timing**</td><td>Continuously</td></tr>
<tr><td>**Error attributes**</td><td>**Level**</td><td>Minor fault</td><td>**Recovery**</td><td>Error reset (after resetting slave errors)</td><td>**Log category**</td><td>System</td></tr>
<tr><td>**Effects**</td><td>**User program**</td><td>Continues.</td><td>**Operation**</td><td colspan="3">Power drive circuit is OFF for relevant slave.</td></tr>
<tr><td rowspan="2">**Indicators**</td><td colspan="2">**EtherNet/IP NET RUN**</td><td colspan="2">**EtherNet/IP NET ERR**</td><td colspan="2">**EtherNet/IP LINK/ACT**</td></tr>
<tr><td colspan="2">–</td><td colspan="2">–</td><td colspan="2">–</td></tr>
<tr><td rowspan="2">**System -defined variables**</td><td colspan="2">**Variable**</td><td colspan="2">**Data type**</td><td colspan="2">**Name**</td></tr>
<tr><td colspan="2">None</td><td colspan="2">–</td><td colspan="2">–</td></tr>
<tr><td rowspan="3">**Cause and correction**</td><td colspan="2">**Assumed cause**</td><td colspan="2">**Correction**</td><td colspan="2">**Prevention**</td></tr>
<tr><td colspan="2">An Immediate Stop (STOP) signal was entered.</td><td colspan="2">Clear the cause of the immediate stop input (STOP).</td><td colspan="2">The goal is to detect the error. (A preventative measure is not required.)</td></tr>
<tr><td colspan="2">Incorrect wiring of the immediate stop input (STOP).</td><td colspan="2">Correct the wiring of the immediate stop input (STOP) if it is incorrect.</td><td colspan="2">Make sure that the immediate stop input (STOP) wiring is incorrect.</td></tr>
<tr><td>**Attached information**</td><td colspan="6">None</td></tr>
<tr><td>**Precautions/ Remarks**</td><td colspan="6">“87” is displayed on the Servo Drive front panel and F087 is given as the AlarmCode (4001 hex).</td></tr>
</table>

<table>
<tr><td>Event name</td><td colspan="3">Command Error</td><td>Event code</td><td colspan="2">7481 0000 hex</td></tr>
<tr><td>Description</td><td colspan="6">A mistake was made in using a command.</td></tr>
<tr><td>Source</td><td colspan="2">EtherCAT Master Function Module</td><td>Source details</td><td>Slave</td><td>Detection timing</td><td>Continuously</td></tr>
<tr><td>Error attributes</td><td>Level</td><td>Minor fault</td><td>Recovery</td><td>Error reset
(after resetting slave errors)</td><td>Log category</td><td>System</td></tr>
<tr><td>Effects</td><td>User program</td><td>Continues.</td><td>Operation</td><td colspan="3">Power drive circuit is OFF for relevant slave.</td></tr>
<tr><td rowspan="2">Indicators</td><td colspan="2">EtherNet/IP NET RUN</td><td colspan="2">EtherNet/IP NET ERR</td><td colspan="2">EtherNet/IP LINK/ACT</td></tr>
<tr><td colspan="2">–</td><td colspan="2">–</td><td colspan="2">–</td></tr>
<tr><td rowspan="2">System -defined variables</td><td colspan="2">Variable</td><td colspan="2">Data type</td><td colspan="2">Name</td></tr>
<tr><td colspan="2">None</td><td colspan="2">–</td><td colspan="2">–</td></tr>
<tr><td rowspan="7">Cause and correction</td><td colspan="2">Assumed cause</td><td colspan="2">Correction</td><td colspan="2">Prevention</td></tr>
<tr><td colspan="2">When bit 9 (Remote) of the Statusword (6041 hex) was set to 1 (remote), and the Servo Drive was in operation enabled status (Servo ON), a command was received that changes the communications state from Operational to another state (Init, Pre-operational, or Safe-operational state).</td><td colspan="2" rowspan="6">Check the command specifications of the host controller and correct the command.</td><td colspan="2" rowspan="6">Check the command specifications of the host controller and correct the command.</td></tr>
<tr><td colspan="2">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.</td></tr>
<tr><td colspan="2">An unsupported number was set for the Modes of operation (6060 hex).</td></tr>
<tr><td colspan="2">The setting of the Operation Mode (6060 hex) was changed at an interval of less than 2 ms.</td></tr>
<tr><td colspan="2">Homing was started when the Homing Method (6098 hex) was set to a value other than 8, 12, 19, 20, 33, 34, or 35.</td></tr>
<tr><td colspan="2">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).</td></tr>
<tr><td>Attached information</td><td colspan="6">None</td></tr>
<tr><td>Precautions/ Remarks</td><td colspan="6">“91” is displayed on the Servo Drive front panel and F191 is given as the AlarmCode (4001 hex).</td></tr>
</table>

Event name	Operation Command Duplicated			**Event code**	7801 0000 hex	
Description	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**		**Correction**		**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**	84B1 0000 hex	
Description	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**		**Correction**		**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).					

<table>
<tr><td>Event name</td><td colspan="3">EtherCAT Illegal State Change Error</td><td>Event code</td><td colspan="2">84B2 0000 hex</td></tr>
<tr><td>Description</td><td colspan="6">An undefined communications state change command was received.</td></tr>
<tr><td>Source</td><td colspan="2">EtherCAT Master Function Module</td><td>Source details</td><td>Slave</td><td>Detection timing</td><td>Continuously</td></tr>
<tr><td>Error attributes</td><td>Level</td><td>Minor fault</td><td>Recovery</td><td>Error reset
(after resetting slave errors)</td><td>Log category</td><td>System</td></tr>
<tr><td>Effects</td><td>User program</td><td>Continues.</td><td>Operation</td><td colspan="3">Power drive circuit is OFF for relevant slave.</td></tr>
<tr><td rowspan="2">Indicators</td><td colspan="2">EtherNet/IP NET RUN</td><td colspan="2">EtherNet/IP NET ERR</td><td colspan="2">EtherNet/IP LINK/ACT</td></tr>
<tr><td colspan="2">–</td><td colspan="2">Flashes at 1-s intervals.</td><td colspan="2">–</td></tr>
<tr><td rowspan="2">System -defined variables</td><td colspan="2">Variable</td><td colspan="2">Data type</td><td colspan="2">Name</td></tr>
<tr><td colspan="2">None</td><td colspan="2">–</td><td colspan="2">–</td></tr>
<tr><td rowspan="2">Cause and correction</td><td colspan="2">Assumed cause</td><td colspan="2">Correction</td><td colspan="2">Prevention</td></tr>
<tr><td colspan="2">An undefined communications state change command was received.</td><td colspan="2">Check the command specifications for communications state transitions in the host controller and correct host controller processing.</td><td colspan="2">Check the command specifications for communications state transitions in the host controller and program host controller processing.</td></tr>
<tr><td>Attached information</td><td colspan="6">None</td></tr>
<tr><td>Precautions/ Remarks</td><td colspan="6">“83” is displayed on the Servo Drive front panel and F283 is given as the AlarmCode (4001 hex).</td></tr>
</table>

<table>
<tr><td>Event name</td><td colspan="3">Communications Synchronization Error</td><td>Event code</td><td colspan="2">84B3 0000 hex</td></tr>
<tr><td>Description</td><td colspan="6">The number of consecutive errors in receiving data during the communication sync time exceeded the value specified for the Communications Error Setting (2200 hex).</td></tr>
<tr><td>Source</td><td colspan="2">EtherCAT Master Function Module</td><td>Source details</td><td>Slave</td><td>Detection timing</td><td>Continuously</td></tr>
<tr><td>Error attributes</td><td>Level</td><td>Minor fault</td><td>Recovery</td><td>Error reset
(after resetting slave errors)</td><td>Log category</td><td>System</td></tr>
<tr><td>Effects</td><td>User program</td><td>Continues.</td><td>Operation</td><td colspan="3">Power drive circuit is OFF for relevant slave.</td></tr>
<tr><td rowspan="2">Indicators</td><td colspan="2">EtherNet/IP NET RUN</td><td colspan="2">EtherNet/IP NET ERR</td><td colspan="2">EtherNet/IP LINK/ACT</td></tr>
<tr><td colspan="2">–</td><td colspan="2">Flashes at 1-s intervals.</td><td colspan="2">–</td></tr>
<tr><td rowspan="2">System -defined variables</td><td colspan="2">Variable</td><td colspan="2">Data type</td><td colspan="2">Name</td></tr>
<tr><td colspan="2">None</td><td colspan="2">–</td><td colspan="2">–</td></tr>
<tr><td rowspan="4">Cause and correction</td><td colspan="2">Assumed cause</td><td colspan="2">Correction</td><td colspan="2">Prevention</td></tr>
<tr><td colspan="2">The power supply for the host controller was shut off during PDO communications.</td><td colspan="2">Execute an error reset on the host controller. This is only a notification of an error that was detected when the power supply for the host controller was shut off, not the error that has occurred.</td><td colspan="2">When you shut off the power supply for the host controller, also shut off the power supply for the Servo Drive.</td></tr>
<tr><td colspan="2">An EtherCAT communications cable is disconnected, broken, or incorrectly connected.</td><td colspan="2">Connect the EtherCAT communications cable securely. If the cable is broken, replace it.</td><td colspan="2">Connect the EtherCAT communications cable securely.</td></tr>
<tr><td colspan="2">Noise</td><td colspan="2">Take noise countermeasures if excessive noise is affecting the EtherCAT communications cable.</td><td colspan="2">Take noise countermeasures if excessive noise is affecting the EtherCAT communications cable.</td></tr>
<tr><td>Attached information</td><td colspan="6">None</td></tr>
<tr><td>Precautions/ Remarks</td><td colspan="6">“83” is displayed on the Servo Drive front panel and F383 is given as the AlarmCode (4001 hex).</td></tr>
</table>

Event name	Synchronization Error			Event code	84B4 0000 hex	
Description	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		Correction		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	84B5 0000 hex	
Description	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		Correction		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 is 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).					

<table>
<tr><td>Event name</td><td colspan="3">ESC Initialization Error</td><td>Event code</td><td colspan="2">84B6 0000 hex</td></tr>
<tr><td>Description</td><td colspan="6">An error occurred in ESC initialization.</td></tr>
<tr><td>Source</td><td colspan="2">EtherCAT Master Function Module</td><td>Source details</td><td>Slave</td><td>Detection timing</td><td>When establishing communications after turning ON power to the slave</td></tr>
<tr><td>Error attributes</td><td>Level</td><td>Minor fault</td><td>Recovery</td><td>Error reset (after cycling slave power)</td><td>Log category</td><td>System</td></tr>
<tr><td>Effects</td><td>User program</td><td>Continues.</td><td>Operation</td><td colspan="3">Power drive circuit is OFF for relevant slave.</td></tr>
<tr><td rowspan="2">Indicators</td><td colspan="2">EtherNet/IP NET RUN</td><td colspan="2">EtherNet/IP NET ERR</td><td colspan="2">EtherNet/IP LINK/ACT</td></tr>
<tr><td colspan="2">–</td><td colspan="2">–</td><td colspan="2">–</td></tr>
<tr><td rowspan="2">System -defined variables</td><td colspan="2">Variable</td><td colspan="2">Data type</td><td colspan="2">Name</td></tr>
<tr><td colspan="2">None</td><td colspan="2">–</td><td colspan="2">–</td></tr>
<tr><td rowspan="2">Cause and correction</td><td colspan="2">Assumed cause</td><td colspan="2">Correction</td><td colspan="2">Prevention</td></tr>
<tr><td colspan="2">Control PCB error.</td><td colspan="2">Replace the Servo Drive.</td><td colspan="2">None</td></tr>
<tr><td>Attached information</td><td colspan="6">None</td></tr>
<tr><td>Precautions/ Remarks</td><td colspan="6">“88” is displayed on the Servo Drive front panel and F188 is given as the AlarmCode (4001 hex).</td></tr>
</table>

<table>
<tr><td>Event name</td><td colspan="3">SII Verification Error</td><td>Event code</td><td colspan="2">84B7 0000 hex</td></tr>
<tr><td>Description</td><td colspan="6">An error occurred in Slave Unit verification.</td></tr>
<tr><td>Source</td><td colspan="2">EtherCAT Master Function Module</td><td>Source details</td><td>Slave</td><td>Detection timing</td><td>When establishing communications after turning ON power to the slave</td></tr>
<tr><td>Error attributes</td><td>Level</td><td>Minor fault</td><td>Recovery</td><td>Error reset (after cycling slave power)</td><td>Log category</td><td>System</td></tr>
<tr><td>Effects</td><td>User program</td><td>Continues.</td><td>Operation</td><td colspan="3">Power drive circuit is OFF for relevant slave.</td></tr>
<tr><td rowspan="2">Indicators</td><td colspan="2">EtherNet/IP NET RUN</td><td colspan="2">EtherNet/IP NET ERR</td><td colspan="2">EtherNet/IP LINK/ACT</td></tr>
<tr><td colspan="2">–</td><td colspan="2">Flashes at 1-s intervals.</td><td colspan="2">–</td></tr>
<tr><td rowspan="2">System -defined variables</td><td colspan="2">Variable</td><td colspan="2">Data type</td><td colspan="2">Name</td></tr>
<tr><td colspan="2">None</td><td colspan="2">–</td><td colspan="2">–</td></tr>
<tr><td rowspan="2">Cause and correction</td><td colspan="2">Assumed cause</td><td colspan="2">Correction</td><td colspan="2">Prevention</td></tr>
<tr><td colspan="2">Control PCB error.</td><td colspan="2">Replace the Servo Drive.</td><td colspan="2">None</td></tr>
<tr><td>Attached information</td><td colspan="6">None</td></tr>
<tr><td>Precautions/ Remarks</td><td colspan="6">“88” is displayed on the Servo Drive front panel and F388 is given as the AlarmCode (4001 hex).</td></tr>
</table>

Event name	Communications Setting Error			Event code	84B8 0000 hex	
Description	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		Correction		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	Interruptions Error			Event code	84B9 0000 hex	
Description	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		Correction		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**	9802 0000 hex	
Description	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**	**Correction**	**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**	0802 0000 hex	
Description	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**	**Correction**	**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	0804 0000 hex	
Description	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		Correction		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	0805 0000 hex	
Description	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		Correction		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.					

<table>
<tr><td>Event name</td><td colspan="3">External Encoder Error Warning</td><td>Event code</td><td colspan="2">0806 0000 hex</td></tr>
<tr><td>Description</td><td colspan="6">The external encoder detected a warning.</td></tr>
<tr><td>Source</td><td colspan="2">EtherCAT Master Function Module</td><td>Source details</td><td>Slave</td><td>Detection timing</td><td>Continuously</td></tr>
<tr><td>Error attributes</td><td>Level</td><td>Observation</td><td>Recovery</td><td>–</td><td>Log category</td><td>System</td></tr>
<tr><td>Effects</td><td>User program</td><td>Continues.</td><td>Operation</td><td colspan="3">Not affected.</td></tr>
<tr><td rowspan="2">Indicators</td><td colspan="2">EtherNet/IP NET RUN</td><td colspan="2">EtherNet/IP NET ERR</td><td colspan="2">EtherNet/IP LINK/ACT</td></tr>
<tr><td colspan="2">–</td><td colspan="2">–</td><td colspan="2">–</td></tr>
<tr><td rowspan="2">System -defined variables</td><td colspan="2">Variable</td><td colspan="2">Data type</td><td colspan="2">Name</td></tr>
<tr><td colspan="2">None</td><td colspan="2">–</td><td colspan="2">–</td></tr>
<tr><td rowspan="4">Cause and correction</td><td colspan="2">Assumed cause</td><td colspan="2">Correction</td><td colspan="2">Prevention</td></tr>
<tr><td colspan="2">There is insufficient external encoder power supply voltage.</td><td colspan="2">Provide the required external encoder power supply voltage 5 VDC ±5% (4.75 to 5.25 V).</td><td colspan="2">Provide the required external encoder power supply voltage 5 VDC ±5% (4.75 to 5.25 V).</td></tr>
<tr><td colspan="2">Noise is entering on the external encoder connector cable.</td><td colspan="2">If the motor cable and the external encoder cable are bundled together, separate them. Connect the shield to FG.</td><td colspan="2">If the motor cable and the external encoder cable are bundled together, separate them. Connect the shield to FG.</td></tr>
<tr><td colspan="2">The external encoder failed.</td><td colspan="2">If none of the above causes applies, replace the external encoder.</td><td colspan="2">None</td></tr>
<tr><td>Attached information</td><td colspan="6">None</td></tr>
<tr><td>Precautions/ Remarks</td><td colspan="6">“A8” is displayed on the front panel of the Servo Drive.</td></tr>
</table>

<table>
<tr><td>Event name</td><td colspan="3">External Encoder Communications Warning</td><td>Event code</td><td colspan="2">0807 0000 hex</td></tr>
<tr><td>Description</td><td colspan="6">The external encoder had more communications errors than the specified value.</td></tr>
<tr><td>Source</td><td colspan="2">EtherCAT Master Function Module</td><td>Source details</td><td>Slave</td><td>Detection timing</td><td>Continuously</td></tr>
<tr><td>Error attributes</td><td>Level</td><td>Observation</td><td>Recovery</td><td>–</td><td>Log category</td><td>System</td></tr>
<tr><td>Effects</td><td>User program</td><td>Continues.</td><td>Operation</td><td colspan="3">Not affected.</td></tr>
<tr><td rowspan="2">Indicators</td><td colspan="2">EtherNet/IP NET RUN</td><td colspan="2">EtherNet/IP NET ERR</td><td colspan="2">EtherNet/IP LINK/ACT</td></tr>
<tr><td colspan="2">–</td><td colspan="2">–</td><td colspan="2">–</td></tr>
<tr><td rowspan="2">System -defined variables</td><td colspan="2">Variable</td><td colspan="2">Data type</td><td colspan="2">Name</td></tr>
<tr><td colspan="2">None</td><td colspan="2">–</td><td colspan="2">–</td></tr>
<tr><td rowspan="3">Cause and correction</td><td colspan="2">Assumed cause</td><td colspan="2">Correction</td><td colspan="2">Prevention</td></tr>
<tr><td colspan="2">There is insufficient external encoder power supply voltage.</td><td colspan="2">Provide the required external encoder power supply voltage 5 VDC ±5% (4.75 to 5.25 V).</td><td colspan="2">Provide the required external encoder power supply voltage 5 VDC ±5% (4.75 to 5.25 V).</td></tr>
<tr><td colspan="2">Noise is entering on the external encoder connector cable.</td><td colspan="2">If the motor cable and the external encoder cable are bundled together, separate them. Connect the shield to FG.</td><td colspan="2">If the motor cable and the external encoder cable are bundled together, separate them. Connect the shield to FG.</td></tr>
<tr><td>Attached information</td><td colspan="6">None</td></tr>
<tr><td>Precautions/ Remarks</td><td colspan="6">“A9” is displayed on the front panel of the Servo Drive.</td></tr>
</table>

<table>
<tr><td>Event name</td><td colspan="3">Data Setting Warning</td><td>Event code</td><td colspan="2">34E0 0000 hex</td></tr>
<tr><td>Description</td><td colspan="6">An object setting is out of range.</td></tr>
<tr><td>Source</td><td colspan="2">EtherCAT Master Function Module</td><td>Source details</td><td>Slave</td><td>Detection timing</td><td>Continuously</td></tr>
<tr><td>Error attributes</td><td>Level</td><td>Observation</td><td>Recovery</td><td>–</td><td>Log category</td><td>System</td></tr>
<tr><td>Effects</td><td>User program</td><td>Continues.</td><td>Operation</td><td colspan="3">Not affected.</td></tr>
<tr><td rowspan="2">Indicators</td><td colspan="2">EtherNet/IP NET RUN</td><td colspan="2">EtherNet/IP NET ERR</td><td colspan="2">EtherNet/IP LINK/ACT</td></tr>
<tr><td colspan="2">–</td><td colspan="2">–</td><td colspan="2">–</td></tr>
<tr><td rowspan="2">System -defined variables</td><td colspan="2">Variable</td><td colspan="2">Data type</td><td colspan="2">Name</td></tr>
<tr><td colspan="2">None</td><td colspan="2">–</td><td colspan="2">–</td></tr>
<tr><td rowspan="2">Cause and correction</td><td colspan="2">Assumed cause</td><td colspan="2">Correction</td><td colspan="2">Prevention</td></tr>
<tr><td colspan="2">An object setting is out of range.</td><td colspan="2">Correct the object settings so that they are within the specified ranges.</td><td colspan="2">Correct the object settings so that they are within the specified ranges.</td></tr>
<tr><td>Attached information</td><td colspan="6">None</td></tr>
<tr><td>Precautions/ Remarks</td><td colspan="6">“B0” is displayed on the front panel of the Servo Drive.</td></tr>
</table>

<table>
<tr><td>Event name</td><td colspan="4">Overload Warning</td><td>Event code</td><td colspan="2">383C 0000 hex</td></tr>
<tr><td>Description</td><td colspan="7">The load ratio is 85% or more of the protection level.</td></tr>
<tr><td>Source</td><td colspan="2">EtherCAT Master Function Module</td><td>Source details</td><td>Slave</td><td>Detection timing</td><td colspan="2">While power is supplied to motor</td></tr>
<tr><td>Error attributes</td><td>Level</td><td>Observation</td><td>Recovery</td><td>–</td><td>Log category</td><td colspan="2">System</td></tr>
<tr><td>Effects</td><td>User program</td><td>Continues.</td><td>Operation</td><td colspan="4">Not affected.</td></tr>
<tr><td rowspan="2">Indicators</td><td colspan="2">EtherNet/IP NET RUN</td><td colspan="2">EtherNet/IP NET ERR</td><td colspan="3">EtherNet/IP LINK/ACT</td></tr>
<tr><td colspan="2">–</td><td colspan="2">–</td><td colspan="3">–</td></tr>
<tr><td rowspan="2">System -defined variables</td><td colspan="2">Variable</td><td colspan="2">Data type</td><td colspan="3">Name</td></tr>
<tr><td colspan="2">None</td><td colspan="2">–</td><td colspan="3">–</td></tr>
<tr><td rowspan="3">Cause and correction</td><td colspan="2">Assumed cause</td><td colspan="2">Correction</td><td colspan="3">Prevention</td></tr>
<tr><td colspan="2">Overload</td><td colspan="2">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.</td><td colspan="3">Check the items given for corrections in advance and implement countermeasures as required.</td></tr>
<tr><td colspan="2">There is incorrect wiring of the motor line or a broken cable.</td><td colspan="2">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.</td><td colspan="3">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.</td></tr>
<tr><td>Attached information</td><td colspan="7">None</td></tr>
<tr><td>Precautions/ Remarks</td><td colspan="7">“A0” is displayed on the front panel of the Servo Drive.</td></tr>
</table>

Event name	Excessive Regeneration Warning			**Event code**	383D 0000 hex	
Description	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**		**Correction**		**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**	383E 0000 hex	
Description	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**		**Correction**		**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.					

<table>
<tr><td>Event name</td><td colspan="3">Command Warning</td><td>Event code</td><td colspan="2">7480 0000 hex</td></tr>
<tr><td>Description</td><td colspan="6">A command could not be executed.</td></tr>
<tr><td>Source</td><td colspan="2">EtherCAT Master Function Module</td><td>Source details</td><td>Slave</td><td>Detection timing</td><td>Continuously</td></tr>
<tr><td>Error attributes</td><td>Level</td><td>Observation</td><td>Recovery</td><td>–</td><td>Log category</td><td>System</td></tr>
<tr><td>Effects</td><td>User program</td><td>Continues.</td><td>Operation</td><td colspan="3">Not affected.</td></tr>
<tr><td rowspan="2">Indicators</td><td colspan="2">EtherNet/IP NET RUN</td><td colspan="2">EtherNet/IP NET ERR</td><td colspan="2">EtherNet/IP LINK/ACT</td></tr>
<tr><td colspan="2">–</td><td colspan="2">–</td><td colspan="2">–</td></tr>
<tr><td rowspan="2">System -defined variables</td><td colspan="2">Variable</td><td colspan="2">Data type</td><td colspan="2">Name</td></tr>
<tr><td colspan="2">None</td><td colspan="2">–</td><td colspan="2">–</td></tr>
<tr><td rowspan="6">Cause and correction</td><td colspan="2">Assumed cause</td><td colspan="2">Correction</td><td colspan="2">Prevention</td></tr>
<tr><td colspan="2">A forced brake operation request was sent while the servo was ON.</td><td colspan="2" rowspan="5">Make sure that the settings meet the object’s operation conditions.
Check the drive prohibition input and operation command, and take actions accordingly.</td><td colspan="2" rowspan="5">Make sure that the settings meet the object’s operation conditions.
Check the drive prohibition input and operation command, and take actions accordingly.</td></tr>
<tr><td colspan="2">A Switch ON command was sent when the main power was OFF. (When 3508 hex = 0)</td></tr>
<tr><td colspan="2">An Enable Operation command was sent to request turning ON the Servo when the motor was operating at 30 mm/s or higher.</td></tr>
<tr><td colspan="2">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).</td></tr>
<tr><td colspan="2">An operation command is given in the prohibited direction after the motor made an immediate stop due to a drive prohibition input.</td></tr>
<tr><td>Attached information</td><td colspan="6">None</td></tr>
<tr><td>Precautions/ Remarks</td><td colspan="6">“B1” is displayed on the front panel of the Servo Drive.</td></tr>
</table>

<table>
<tr><td>Event name</td><td colspan="3">EtherCAT Communications Warning</td><td>Event code</td><td colspan="2">84B0 0000 hex</td></tr>
<tr><td>Description</td><td colspan="6">EtherCAT communications errors occurred one or more times.</td></tr>
<tr><td>Source</td><td colspan="2">EtherCAT Master Function Module</td><td>Source details</td><td>Slave</td><td>Detection timing</td><td>Continuously</td></tr>
<tr><td>Error attributes</td><td>Level</td><td>Observation</td><td>Recovery</td><td>–</td><td>Log category</td><td>System</td></tr>
<tr><td>Effects</td><td>User program</td><td>Continues.</td><td>Operation</td><td colspan="3">Not affected.</td></tr>
<tr><td rowspan="2">Indicators</td><td colspan="2">EtherNet/IP NET RUN</td><td colspan="2">EtherNet/IP NET ERR</td><td colspan="2">EtherNet/IP LINK/ACT</td></tr>
<tr><td colspan="2">–</td><td colspan="2">–</td><td colspan="2">–</td></tr>
<tr><td rowspan="2">System -defined variables</td><td colspan="2">Variable</td><td colspan="2">Data type</td><td colspan="2">Name</td></tr>
<tr><td colspan="2">None</td><td colspan="2">–</td><td colspan="2">–</td></tr>
<tr><td rowspan="3">Cause and correction</td><td colspan="2">Assumed cause</td><td colspan="2">Correction</td><td colspan="2">Prevention</td></tr>
<tr><td colspan="2">The EtherCAT communications cable is disconnected or broken.</td><td colspan="2">Connect the EtherCAT communications cable securely. If the cable is broken, replace it.</td><td colspan="2">Connect the EtherCAT communications cable securely.</td></tr>
<tr><td colspan="2">Noise</td><td colspan="2">Take noise countermeasures if excessive noise is affecting the EtherCAT communications cable.</td><td colspan="2">Take noise countermeasures if excessive noise is affecting the EtherCAT communications cable.</td></tr>
<tr><td>Attached information</td><td colspan="6">None</td></tr>
<tr><td>Precautions/ Remarks</td><td colspan="6">“B2” is displayed on the front panel of the Servo Drive.</td></tr>
</table>

A-4 Response Time in EtherCAT Process Data Communications

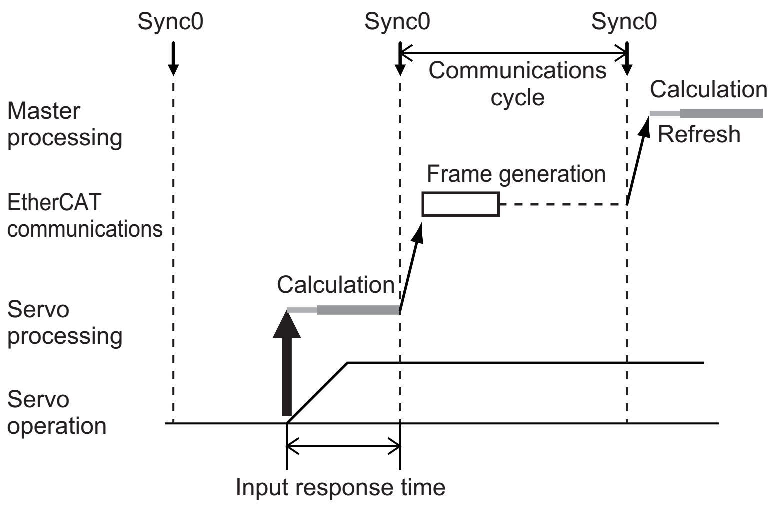
The input response time and the output response time for each slave are necessary to calculate the I/O response time of the system in EtherCAT process data communications.

This section describes the specifications of the input and output response time for this product.

For information on calculating the I/O response time of the system, refer to the manual for the EtherCAT Master.

A-4-1 Input Response Time

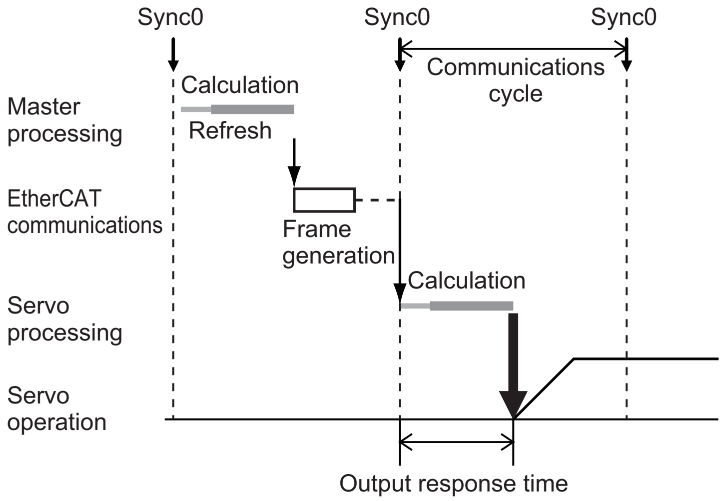
The input response time for this product is shown below.



Model	Input response time
R88D-KN01L-ECT-L	395 µs
R88D-KN02L-ECT-L	
R88D-KN04L-ECT-L	
R88D-KN01H-ECT-L	
R88D-KN02H-ECT-L	
R88D-KN04H-ECT-L	
R88D-KN08H-ECT-L	
R88D-KN10H-ECT-L	
R88D-KN15H-ECT-L	
R88D-KN06F-ECT-L	
R88D-KN10F-ECT-L	
R88D-KN15F-ECT-L	
R88D-KN20F-ECT-L	380 µs
R88D-KN30F-ECT-L	

A-4-2 Output Response Time

The output response time for this product is shown below.



Model	Output response time
R88D-KN01L-ECT-L	290 to 380 µs
R88D-KN02L-ECT-L	330 to 420 µs
R88D-KN04L-ECT-L	
R88D-KN01H-ECT-L	290 to 380 µs
R88D-KN02H-ECT-L	
R88D-KN04H-ECT-L	330 to 420 µs
R88D-KN08H-ECT-L	
R88D-KN10H-ECT-L	
R88D-KN15H-ECT-L	
R88D-KN06F-ECT-L	
R88D-KN10F-ECT-L	
R88D-KN15F-ECT-L	
R88D-KN20F-ECT-L	415 to 500 µs
R88D-KN30F-ECT-L	

Note The output response time depends on the application conditions of the product, such as filter processing.

A-5 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 Sub-index 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.
Sub-index	–	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 user's and manufacturer's 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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